Hellenic
Meteorological
Society

Laboratory of Meteorology
Department of Physics
University of Ioannina, Greece

MARIOLOPOULOS - KANAGINIS
FOUNDATION
FOR THE ENVIRONMENTAL SCIENCES

15th
INTERNATIONAL CONFERENCE
on Meteorology, Climatology and Atmospheric Physics

COMECAP 2021

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Hybrid Congress

SEPTEMBER **26 - 29**, 2021
Hotel Du Lac, **Ioannina, Greece**

SCIENTIFIC PROGRAM

ΜΕΣΟΓΕΙΟΣ Α.Ε.
Resource Recovery

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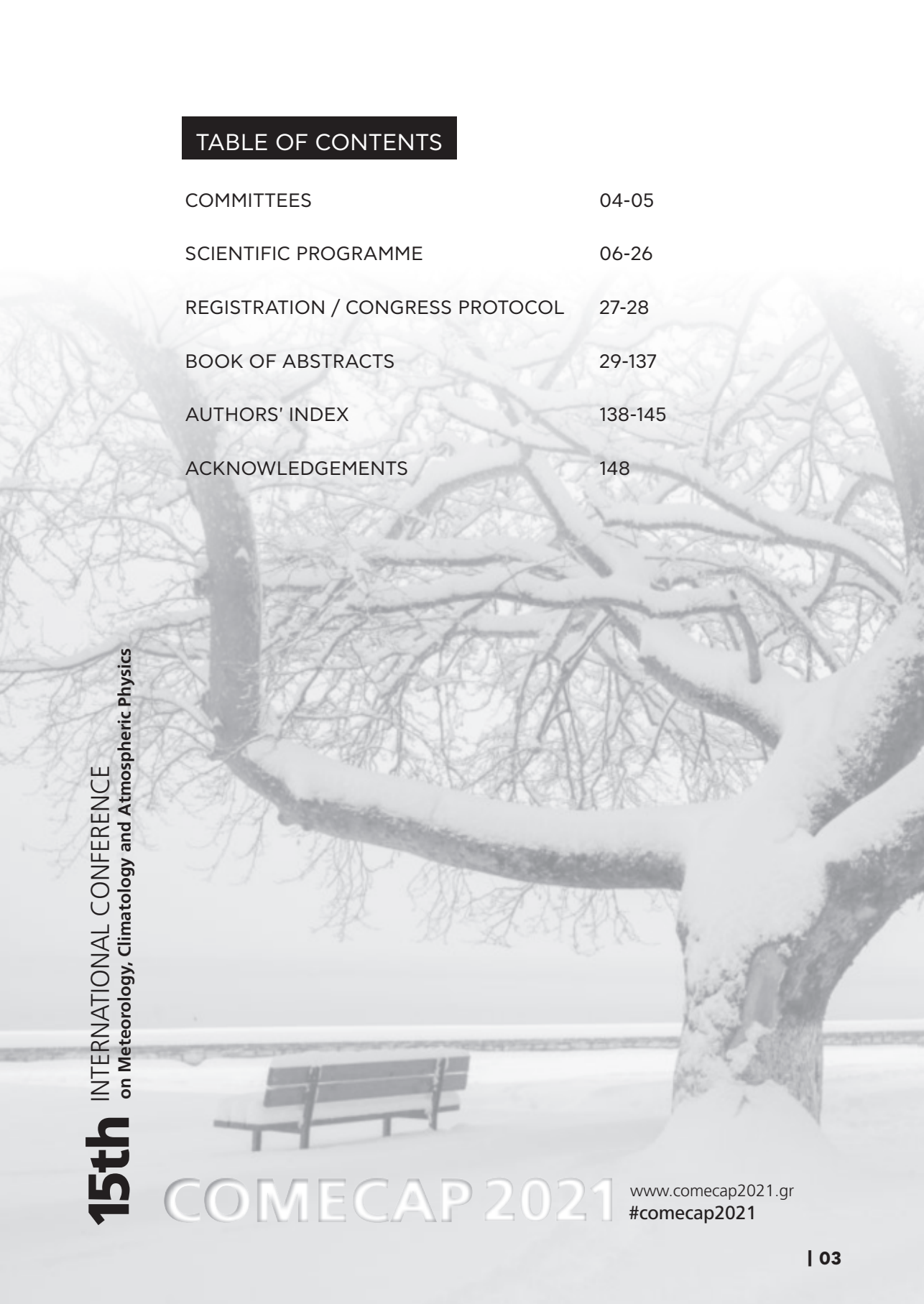

15th INTERNATIONAL CONFERENCE **on Meteorology, Climatology and Atmospheric Physics**

COMECAP 2021

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15th INTERNATIONAL CONFERENCE
on Meteorology, Climatology and Atmospheric Physics

Sunday, September 26th 2021

20.30	Welcome Reception

Monday, September 27th 2021

09.00-10.30	**ORAL SESSION Atmospheric Physics** Chairpersons: **Bais A., Balis D.**
09.00-09.15	Aerosol optical depth retrieval from ground-based surface solar radiation measurements using machine learning techniques **Logothetis S.A., Salamalikis V., Kazantzidis A.**
09.15-09.30	Validation of TROPOMI/S5P total ozone using ground based DOAS measurements in Thessaloniki, Greece **Gkertsi F., Bais A. F., Koukouli M., Garane K., Balis D., Roozendael M.V., Lerot C.**
09.30-09.45	Spatial and temporal relationships between total flash rates and radar reflectivity volumes under convection **Roupa P., Avgoustoglou E., Karacostas T.**
09.45-10.00	On the impact of sound on atmospheric particulates **Kourtidis K., Andrikopoulou A.**
10.00-10.15	The nextSENSE system: Short-term forecasting of solar energy in Europe and North Africa **Kosmopoulos P.G., Kazadzis S., Kouroutsidis D., Papachristopoulou K., Saint-Drenan Y.M., Kontoes C., Blanc P.**
10.15-10.30	Climatology and trends of aerosol optical properties and direct radiative effect of main aerosol types based on MERRA-2 reanalysis data **Korras-Carraca M.B., Gkikas A., Matsoukas C., Hatzianastassiou N.**
10.30-11.00	Coffee break
11.00-12.00	OPENING CEREMONY

12.00-13.00	**Invited Lecture** Chairpersons: **Bartzokas A.** Satellite precipitation measurement for meteorology and climate **Vincenzo Levizzani**
13.00-14.30	Lunch break
14.30-16.30	**ORAL SESSION PANACEA** Chairpersons: **Kanakidou M., Pandis S.**
14.30-14.45	Variation of CCN and potential CDNC in the Eastern Mediterranean **Neroladaki A., Stavroulas I., Tsiodra I., Kalivitis N., Myriokefalitakis S., Bougiatioti A., Mihalopoulos N., Nenes A., Kanakidou M.**
14.45-15.00	Vertical profiling of the electrical properties of charged desert dust during the pre-ASKOS campaign **Daskalopoulou V., Hloupis G., Mallios S. A., Makrakis I., Skoubris E., Kezoudi M., Ulanowskiand Z., Amiridis V.**
15.00-15.15	Case study analysis of aerosol shortwave radiative effect over Athens, using the FORTH radiative transfer model, multi-wavelength Raman-lidar measurements and satellite observations **Stathopoulos V.K., Soupiona O., Korras-Carraca M.B., Samaras S., Papayannis A., Mylonaki M., Papanikolaou C.A., Foskinis R., Hatzianastassiou N., Vardavas I., Matsoukas C.**
15.15-15.30	Optical and microphysical properties of stratospheric smoke aerosols: on the possibility to enhance AERONET retrievals of UTLS smoke **Gialitaki A., Tsekeri A., Amiridis V., Marinou E., Kampouri A., Tsichla M., Tsikoudi I., Balis D.**
15.30-15.45	Assessment of PANDORA total O_3 and total NO_2 retrievals in Athens, Greece **Raptis I.-P., Eleftheratos K., Kopania T., Kouklaki D., Kazadzis S.**
15.45-16.00	Vertical profiling of aerosol particles over the city of Ioannina (Greece) during the winter period 2020 **Papayannis A., Papanikolaou C.A., Foskinis R., Mylonaki M., Soupiona O.**
16.00-16.15	First validation of AEOLUS L2A products over PANACEA sites **Gkikas A., Gialitaki A., Binietoglou i., Proestakis E., Paschou P., Siomos N., Kampouri A., Solomos S., Kosmopoulos P., Marinou E., Voudouri K.A., Papanikolaou C., Mylonaki M., Balis D., Papayannis A., Amiridis V.**
16.15-16.30	Updated power plant NOx emissions in Greece from LOTOS-EUROS model simulations and Sentinel-5P/TROPOMI observations **Skoulidou I., Koukouli M.E., Segers A., Manders A., Stavrakou T., Balis D., Jos van Geffen, Eskes H.**

16.30-18.00	Coffee Break
	Poster Session
16.50 - 17.10	Atmospheric Physics ***ePP01 – ePP14***
17.10 - 17.25	PANACEA part 1 ***ePP15 – ePP25***
17.25 - 17.40	PANACEA part 2 ***ePP26 – ePP33***
17.40 - 18.00	Numerical Modeling and Forecasting ***ePP34 – ePP44***
	(see details below)

18.00-19.30	**ORAL SESSION Numerical Modeling and Forecasting** Chairpersons: **Katsafados P., Pytharoulis I.**
18.00-18.15	Evaluating high resolution numerical weather predictions using spatial verification methods **Tegoulias I., Pytharoulis I., Zanis P., Karacostas T.**
18.15-18.30	Optimization technique on an NWP high resolution model **Voudouri A., Carmona I., Avgoustoglou E., Levi Y.**
18.30-18.45	Early warning of epidemic spread: lessons learned from an unprecedented effort **Angelou A., Kioutsioukis I., Stilianakis N.I.**
18.45-19.00	An advanced scheme for nowcasting precipitation and its sensitivity to the assimilated remote sensing estimations **Pappa A., Spyrou C., Anagnostou M., Varlas G., Papadopoulos A., Katsafados P.**
19.00-19.15	Forecast icing potential during a low-pressure system passage over Greece **Louka P., Samos I., Gofa F.**
19.15-19.30	IRIS: Rapid response fire spread forecasting system – Operational implementation and evaluation during the 2019 fire season **Giannaros T.M., Kotroni V., Lagouvardos K.**

21.00	Dinner for all registered participants *Main Restaurant Hotel Dulac*

Atmospheric Physics

ePP01 ERATOSTHENES Centre of Excellence: The importance of atmospheric remote sensing in the EMMENA region
Mamouri R.E., Nisantzi A., Ansmann A., Bühl J., Seifert P., Engelman R., Baars H., Michaelides S., Hadjimitsis D.G.

ePP02 Air quality and cloud effects on surface solar radiation over urban and rural areas in Greece
Alexandri G., Georgoulias A.K., Balis D.

ePP03 Validation and bias-adjustment of CAMS surface solar irradiance against ground-based measurements
Salamalikis V., Tzoumanikas P., Argiriou A.A., Kazantzidis A.

ePP04 Wind and planetary boundary layer observations during the Pre-TECT campaign
Tsikoudi I., Marinou E., Gialitaki A., Tsichla M., Amiridis V., Tombrou M., Giannakaki E., Komppula M., Vakkari V., Flocas H.

ePP05 Detecting causality between aerosols, water vapor and clouds
Stathopoulos S., Tsonis A.A., Kourtidis K.

ePP06 Aerosol typing and characterization during Pre-Tect campaign over Finokalia, Crete
Voudouri K.A., Marinou E., Gialitaki A., Tsichla M., Kampouri A., Amiridis V., Baars H., Yin Z., Meleti C.

ePP07 Dust aerosols in the Greek area and their effect on surface solar irradiance
Papachristopoulou K., Kosmopoulos P. , Gkikas A., Amiridis V., Hatzaki M., Kazadzis S.

ePP08 Meteorological dynamics associated with emission and transport of dust from the Thar desert
Dumka U.C., Kaskaoutis D.G., Francis D., Chaboureau J.-P., Rashki A., Liakakou E.

ePP09 Global trends of Dust Optical Depth, over the period 2003-2017, based on the MIDAS fine resolution dataset
Logothetis S.A., Salamalikis V., Gkikas A., Kazadzis S., Amiridis V., Kazantzidis A.

ePP10 Analysis of the stable isotopes ($d^{18}O$ and $d^{2}H$) in the precipitation (rain, hail, snow) of Patras from 2000 to 2016
Argiriou A.A., Avgerinos E., Geraga M.

ePP11 Analysis of the seasonal air mass transport pathways and potential source regions of PM_{10} at a coastal site in the Eastern Mediterranean
Rizos K., Meleti C., Kouvarakis G., Mihalopoulos N., Kanakidou M., Melas D.

ePP12 Long-term MAX-DOAS NO_2 measurements over Athens and association with urban sources
Gratsea M., Athanasopoulou E., Kakouri A., Richter A., Seyler A., Gerasopoulos E.

ePP13 The evaluation of the atmospheric refraction index using COSMO Model and its comparison with radio-soundings over Greece
Zlatkos A., Avgoustoglou E.

ePP14 The convective day category index and related synoptic, radar and hail parameters
Vlachou M., Stolaki S., Sioutas M.

ePP15 **Personal dose and health risk indexes of particulate matter (PM_{10}) in several Greek cities**
Chalvatzaki E., Chatoutsidou S.E., Kopanakis I., Melas D., Parliari D., Mihalopoulos N., Lazaridis M.

ePP16 **Pollutants dispersion from domestic wood burning for heating at Ioannina**
Solomos S., Kampouri A., Amiridis V., Balis D., Bais A., Karagkiozidis D., Papayannis A., Mihalopoulos N., Bougiatioti A., Stavroulas I., Liakakou E., Gerasopoulos E., Athanasopoulou E., Poupkou A., Zerefos C., Mylonaki M., Soupiona O., Papanikolaou C., Foskinis R., Kakouri A., Karagiannis D.

ePP17 **Observations of alkylamines in the East Mediterranean atmosphere**
Tzitzikalaki E., Kalivitis N., Panagiotopoulou G., Kanakidou M.

ePP18 **Global simulations of ice nuclei and cloud condensation nuclei particles derived from insoluble mineral dust**
Chatziparaschos M., Daskalakis N., Myriokefalitakis S., Kanakidou M.

ePP19 **Interannual and seasonal variability of greenhouse gases at Finokalia station in the East Mediterranean**
Gialesakis N., Kouvarakis G., Kalivitis N., Ramonet M., Mihalopoulos N., Delmotte M., Lett C., Legendre V., Kanakidou M.

ePP20 **C10 – C16 Volatile Organic Compounds in Athens (Greece)**
Panopoulou A., Liakakou E., Sauvage S., Gros V., Locoge N., Bonsang B., Gerasopoulos E., Mihalopoulos N.

ePP21 **Aerodynamic effects on dust transport processes**
Drakaki E., Amiridis V., Mallios S., Solomos S., Spyrou C., Tsekeri A., Gkikas A., Bouris D., Katsafados P.

ePP22 **Measurements of the atmospheric electric field, $PM_{2.5}$ and meteorological parameters in Xanthi**
Kourtidis K., Karagioras A., Stavroulas I.

ePP23 **Retrieval of vertically - resolved aerosol optical and microphysical properties using Thessaloniki lidar measurements during 2019 summer PANACEA campaign**
Michailidis K., Siomos N., Voudouri K.A., Ansmann A., Chaikovsky A., Balis D.

ePP24 **Overview of the 2019-2020 winter PANACEA campaign at Ioannina, Greece**
Gavrouzou M., Korras-Carraca M.B., Liakakou E., Grivas G., Bougiatioti A., Stavroulas I., Michailidis K., Karagkiozidis D., Papanikolaou C.-A., Foskinis R., Mylonaki M., Soupiona O., Koukouli M., Hatzianastasiou N., Balis D., Bais A.F., Papayannis A., Gerasopoulos E., Mihalopoulos N.

ePP25 **Monitoring of tropospheric NO_2, HCHO and aerosols using MAX-DOAS observations for the first time in Ioannina Greece during the PANACEA winter campaign 2020**
Karagkiozidis D., Bais A.F., Hatzianastassiou N., Gavrouzou M., Koukouli M.E., Papanikolaou C., Kontos S., Balis D., Papayannis A.

ePP26 **The potential of a synergestic lidar and sunphotometer retrieval for the characterization of dust events during PRE-TECT campaign over Finokalia, Greece**
Konsta D., Tsekeri A., Lopatin A., Goloub P., Dubovil O., Amiridis V., Nastos P.

ePP27 **Air quality over Thessaloniki Greece revealed by a PANACEA summer and winter observational campaign; an overview**
Koukouli M.E., Karagkiozidis D., Michailidis K., Siomos N., Voudouri K. A., Mermigkas M., Topaloglou C., Skoulidou I., Chatzopoulou A., Symeonidis P., Christelis E., Balis D.S., Bais A.

ePP28 **Long term variability of the aerosol intensive properties over Thessaloniki**
Fountoukidis P., Biskas C., Voudouri K.A, Siomos N., Balis D.

ePP29 **Synergy of remote sensing techniques for aerosol typing over Thessaloniki**
Voudouri K.A., Siomos N., Michailidis K., Fountoulakis I., Natsis A., Karanikolas A., Garane K., Bais A., Balis D.

ePP30 **Evaluation of the LOTOS-EUROS NO_2 simulations using ground-based measurements and S5P/TROPOMI observations over Greece**
Skoulidou I., Koukouli M.E., Manders A., Segers A., Karagkiozidis D., Gratsea M., Balis D., Bais A., Gerasopoulos E., Richter A., Stavrakou T., van Geffen J., Eskes H.

ePP31 **Monitoring dust particle orientation with measurements of sunlight dichroic extinction**
Daskalopoulou V., Raptis I.P., Tsekeri A., Amiridis V., Kazadzis S., Ulanowski Z., Metallinos S., Tassis K., Martin W.

ePP32 **First demonstration of a CALIPSO-based fine-mode and coarse-mode pure-dust product**
Proestakis E., Gkikas A., Alexiou A., Marinou E., Georgiou A., Amiridis V.

ePP33 **Satellite EO of Saharan dust mass transport towards the estimation of dust deposition fluxes along the open Atlantic Ocean**
Proestakis E., Gkikas A., Benedetti A., Alexiou A., Georgiou A., Marinou E., Amiridis V.

Numerical Modeling and Forecasting

ePP34 **Validation of aeronautical weather forecasts of wind, direction and speed issued by the Regional Meteorological Centre «Macedonia»**
Stogioudis S., Balis D., Sarras C., Brikas D.

ePP35 **A 4D-Var radar data assimilation scheme for nowcasting of local extreme weather**
Papangelis G., Kalogiros J., Katsanos D., Retalis A.

ePP36 **Physical and dynamical considerations of three-way atmosphere-wave-ocean coupling**
Varlas G., Vervatis V., Spyrou C., Papadopoulou E., Papadopoulos A., Katsafados P.

ePP37 **Assessment of continental weather forecasts in the framework of AfriCulturES project**
Kartsios S., Pytharoulis I., Karacostas T., Katragkou E.

ePP38 **Improving dust forecasts through assimilation of ESA-Aeolus wind profiles**
Gkikas A. , Papangelis G., Drakaki E., Proestakis E., Spyrou C., Gialitaki A., Marinou E., Benedetti A., Rennie M., Straume A.G., Christoudias T., Kushta J., Sciare J., Amiridis V.

ePP39 **Subseasonal prediction assessment of an abnormal warm period in Greece**
Mitropoulos D., Pytharoulis I. , Zanis P., Anagnostopoulou C.

ePP40 **Validation of WRF high resolution climatic simulation of temperatures over Greece**
Politi N., Markantonis I., Karozis S., Sfetsos A., Nastos P., Vlachogiannis D.

ePP41 **Assessing two-way air-sea coupling in a deep Mediterranean cyclone**
Papadopoulou E., Spyrou C., Varlas G., Vervatis V., Papadopoulos A., Katsafados P.

ePP42 **Data assimilation of surface and satellite observations into the numerical weather prediction model WRF: an intense precipitation case study in Greece**
Vourlioti P., Kotsopoulos S., Mamouka T., Agraphiotis A.

ePP43 **Turbulence self-organization in a simplified model of a stratified atmosphere and the accurate representation of its dynamics by a generalized quasi-linear model**
Bakas N.

ePP44 **Three-dimensional Holmboe instability**
Stougiannos A., Bakas N.

NOTES

POSTER SESSION

15th INTERNATIONAL CONFERENCE
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Tuesday, September 28th 2021

09.00-10.30	**ORAL SESSION Climatology** Chairpersons: **Flocas H., Lolis C.**
09.00-09.15	Seasonal variability of heavy-severe aircraft turbulence over Europe for the period 2008-2018 **Gerogiannis V.T., Feidas H**.
09.15-09.30	Climatology and trends of global single scattering albedo based on Ozone Monitor System (OMI) ultraviolet retrievals **Drakousis P., Korras-Carraca M.B., Jethva H., Torres O., Hatzianastassiou N.**
09.30-09.45	TIN-Copula bias correction of climate modeled daily maximum temperature in the MENA region **Lazoglou G., Zittis G., Hadjinicolaou P., Lelieveld J.**
09.45-10.00	An objective definition of seasons for the Mediterranean region based on the long term mean intra-annual variations of meteorological parameters **Kotsias G., Lolis C.J., Hatzianastassiou N., Lionello P., Bartzokas A.**
10.00-10.15	Reconstructed climate variability over the Late Glacial and Holocene in a Southern Greece environment from a high-temporal resolution pollen record **Hatzaki M., Kouli K., Triantaphyllou M., Dimiza M., Gogou A., Panagiotopoulos I.P., Karagerogis A.P.**
10.15-10.30	A climatological assessment of desert dust aerosols using MODIS C6.1 and OMI-OMAERUV satellite data **Gavrouzou M., Hatzianastassiou N., Gkikas A., Mihalopoulos N.**

10.30-11.30	Coffee Break **Poster Session**
10.45 - 11.00	Climatology ***ePP45 – ePP57***
11.00 - 11.15	Applied Meteorology part 1 ***ePP58 – ePP68***
11.15 - 11.30	Applied Meteorology part 2 ***ePP69 – ePP78***
	(see details below)

11.30-13.30	**ORAL SESSION Weather Analysis and Extremes** Chairpersons: **Karacostas T., Nastos P.**
11.30-11.45	The deep depression that caused severe weather events in Greece at the end of September 2018 **Lamaris C., Papakrivou A., Gerogiannis V.T., Skrimizeas P.**
11.45-12.00	Study of cloud convection during the Mediterranean tropical-like cyclone case of September 2018 **Kolios S., Kalimeris A.**
12.00-12.15	The July 10, 2019 catastrophic supercell over Northern Greece. Part I: observational analyses **Christodoulou M., Pytharoulis I., Karacostas T.**
12.15-12.30	The severe weather outbreak in northern Greece on 10 July 2019: Atmospheric environment and storm characteristics **Sioutas M., Chatzi H., Tegoulias I.**
12.30-12.45	Impact of different heat waves definitions on their long-term statistics **Founda D., Katavoutas G., Pierros F.**
12.45-13.00	A study on the sea breeze characteristics at the coasts of Epirus, NW Greece **Doule G.T., Fotiadi A.K., Chaskos D.C., Sindosi O.A., Bartzokas A.**
13.00-13.15	An investigation of the different scale atmospheric circulation features contribution upon the 2019 warm dry October – wet November in South Europe and mainly in Greece **Prezerakos N.G., Dafis S.**
13.15-13.30	Cloud detection methodology based on RGB images captured by a low-cost ground based all-sky camera **Karagkiozidis D., Natsis A., Bais A.**

13.30-15.00 | Lunch break

15.00-17.00	**ORAL SESSION Applied Meteorology** Chairpersons: **Kioutsioukis I., Hatzaki M.**
15.00-15.15	A new method for the recognition and study of tropical-like cyclones over Mediterranean **Douvis K., Polychroni I., Nastos P.**
15.15-15.30	The role of thermal criteria on the performance of the Mediterranean Frontal Tracking Scheme **Bitsa E., Flocas H., Kouroutzoglou J., Galanis G., Hatzaki M., Rudeva I., Simmonds I.**
15.30-15.45	Freshwater wetting/drying shifts driven by warming and human water use for food and energy supply **Destouni G.**
15.45-16.00	Urban green against built environment in terms of human thermal sensation in Athens, Greece **Nastos P.T., Polychroni I.D., Charalampopoulos I., Varvaringou A., Tsiros I.**
16.00-16.15	Investigating the relationship between wind gusts and lightning activity at a wind energy power plant in a hilly region of Western Greece **Kolokythas K.V., Argiriou A.A., Kotroni V.**
16.15-16.30	Measuring and predicting heat stress conditions with the WBGT index **Gofa F., Nikas D., Skrimizeas P., Gourzoulidis G., Flouris A.**
16.30-16.45	A system for the assessment and mapping of vulnerability and risk related to high impact weather events in Greece: Yantas project **Kotroni V., Papagiannaki K., Totos K., Symeonidis P., Bezes A., Dinopoulou A., Karagiannidis A., Kroustallis E., Lagouvardos K., Messini I., Pahoula M., Vafeiadis V., Vakkas T.**
16.45-17.00	Atmospheric temperature anomalies as manifestation of the dark Universe **Zioutas K., Anastassopoulos V., Argiriou A., Cantatore G., Cetin S., Fischer H., Gardikiotis A., Haralambous H., Hoffmann D.H.H., Hofmann S., Karuza M., Kryemadhi A., Maroudas M., Mastronikolis A., Oikonomou C., Ozbozduman K., Semertzidis Y.K.**

17.00-18.00	Coffee Break
	Poster Session
17.20 - 17.40	Weather Analysis and Extremes ***ePP79 – ePP91***
17.40 - 18.00	Remote Sensing ***ePP92 – ePP108***
	(see details below)

18.00-19.30	**ORAL SESSION Remote Sensing** Chairpersons: **Kourtidis K., Giannakaki E.**
18.00-18.15	Contrail detection on SEVIRI images and one-year study of the physical properties of contrails and the atmospheric conditions favoring their formation over Europe **Dekoutsidis G., Feidas H.**
18.15-18.30	Geometrical and microphysical properties of clouds above Eastern Mediterranean during Pre-TECT **Marinou E., Voudouri K.A., Tsikoudi I., Rosoldi, M., Ene D., Meleti C.**
18.30-18.45	Study of aerosol layer height product by synergistic use of passive satellite instruments with EARLINET lidar data: Cases studies in the Mediterranean basin **Michailidis K., Siomos N., Koukouli M.E., Voudouri K.A, Veefkind J.P., de Graaf M., Tuinder O., Tilstra L.G., Wang P., Balis D.**
18.45-19.00	Rainfall estimation using microwave links from cellular communication networks in Lebanon **Daher A., Al Sakka H.**
19.00-19.15	Sentinel-5P/TROPOMI views abrupt changes in nitrogen dioxide levels over Greece after the outbreak of COVID-19 **Koukouli M.E., Skoulidou I., Karavias A., Parcharidis I., Balis D., Manders A., Segers A., Van Geffen J., Eskes H.**
19.15-19.30	Detection of NO_2 plumes from individual ships over the Mediterranean Sea with the TROPOMI/S5P **Georgoulias A.K., Folkert Boersma K., van Vliet J., Zhang X., Ronald van der A., Zanis P., de Laat J.**

19.30	**HNMS MEETING**

Climatology

ePP45 On the atmospheric circulation characteristics associated with extreme precipitation in the Iberian Peninsula
Lolis C.J., Kotsias G., Ramos A.M., Trigo R.M.

ePP46 TIN-Copula method: A new statistical method for the bias correction of extreme climate events
Lazoglou G., Anagnostopoulou C., Gräler B., Tolika K., Kolyva-Machera F.

ePP47 A weather type classification for northwestern Greece
Chaskos D.C., Lolis C.J., Kotroni V., Bartzokas A.

ePP48 Analysis of parallel measurements of daily maximum and minimum temperatures in Greece
Argiriou A., Ioannidis P., Mamara A.

ePP49 Investigation and validation of climate data timeseries as derived by ERA5 and ERA20c models and local observations for Kotili, Kastoria, Greece
Natsis A., Bais A.

ePP50 Study of trends and fluctuations of mean air temperature at the surface and in the lower troposphere in the wider region of Greece for the period 1965-2020
Philandra S.C., Ntagkounakis G.E., Kalabokas P., Philandras C.M., Zerefos C.

ePP51 A spatio-temporal study on hail in Central Macedonia, Greece
Dinopoulou E.V., Bartzokas A., Sioutas M.

ePP52 Observed and projected changes in energy demands at Mediterranean cities
Kaza I., Founda D., Giannakopoulos C., Kolokotsa D.

ePP53 On dew point climatology over Greece
Kalamaras N., Tzanis C.G., Philippopoulos K., Koutsogiannis G., Alimissis A.

ePP54 Impact of effective radii communication between microphysics and radiation schemes
Pavlidis V., Katragkou E., Zanis P., Karacostas T.

ePP55 Heating degree-days climatology over Greece at the service of government granting heating subsidy and energetic optimization of building insulation
Mamara A., Anadranistakis M., Charalambopoulos C., Samos J.

ePP56 Evaluation of incoming solar radiation at tilted surfaces at various European cities
Moustaka A., Raptis I.P., Giannakaki E., Kazadzis S.

ePP57 A global climatology of tropopause folds in CAMS Reanalysis
Akritidis D., Pozzer A., Flemming J., Inness A., Zanis P.

Applied Meteorology

ePP58 Winds, waves and sea surface chlorophyll concentrations
Kotta D., Kitsiou D., Kassomenos P.

ePP59 In-flight rerouting in adverse convective weather conditions
Lekas T., Louka P., Pytharoulis I., Kallos G.

ePP60 F - Index, a new fire weather index, well promising for Greece
Daniilidis A., Gouvas M., Papadopoulos A.

ePP61 Meteorological parameters that influence the environmental risk of a marine accident with oil pollutants in the Aegean
Giannousopoulou M., Konstandinidou M.

ePP62 Electrical properties of transported dust layers due to atmospheric ion attachment to dust particles
Mallios S.A., Papangelis G., Hloupis G., Papaioannou A., Daskalopoulou V., Amiridis V.

ePP63 An assessment of microclimatic conditions inside vegetated and non-vegetated small-scale open spaces in the Athens urban environment
Melas E., Tsiros I., Thoma E., Proutsos N., Pantavou K., Papadopoulos G.

ePP64 Exposure of Athens population to environmental stress
Katavoutas G., Founda D.

ePP65 Artificial neural networks applied on field monitoring data for the estimation of thermal sensation
Pantavou K., Delibasis K.K.

ePP66 Exposure to hot thermal conditions and heat-related symptoms in Cyprus: a field survey study among pedestrians
Pantavou K., Giallouros G., Lykoudis S., Markozannes G., Constantinou E., Panagi A., Economou M., Georgiou A., Pilavas A., Theodoridou M., Kinni P., Bonovas S., Cartalis C., Nikolopoulos G.K.

ePP67 Field surveys on the subjective assessment of sound level in urban settings
Melas E., Pantavou K., Asimakopoulos V., Kotronarou A., Lykoudis S., Tsiros I.X.

ePP68 Identifying patterns of airborne pollen distribution using a synoptic climatology approach
Paschalidou A.K., Psistaki K., Charalampopoulos A., Vokou D., Kassomenos P., Damialis A.

ePP69 The impact of the number of scale categories used in field questionnaire surveys to assess thermal sensation
Pantavou K., Melas E., Koletsis I., Lykoudis S., Tsiros X.I.

ePP70 The use of the RD-69 (Joss-type) disdrometer towards the estimation of the ZR relations for stratiform and convective rainfall events
Feloni E., Bournas A., Baltas E., Nastos P.T.

ePP71 Investigating the snow water equivalent in Greece
Voudouri K.A., Ntona M.M., Kazakis N.

ePP72 Addressing flood risk in the Rafina stream basin (Attica, Greece) in the framework of the CyFFORS project
Giannaros C., Kotroni V., Lagouvardos K., Oikonomou C., Haralambous H., Papagiannaki K.

ePP73 Evaluating the effects of urban design elements on human thermal sensation in summer
Tseliou A., Koletsis I., Tsiros I.X., Lykoudis S., Pantavou K.

ePP74 The influence of air temperature on the propagation of road traffic noise
Begou P., Kassomenos P.

ePP75 Mapping local climate zones by implementing the WUDAPT method: A case study for Thessaloniki, Greece
Adamopoulou L., Karatzas K.

ePP76 Cooling effect and thermal comfort patterns of a courtyard and its adjacent semi-open spaces under Mediterranean climate summer conditions
Thoma E., Melas E., Tsiros I.

ePP77 **Investigation of heat transfer in soil through a spatio-temporal analysis of soil temperature in Ioannina, Greece**
Ioannidis T., Bakas N.A.

ePP78 **An integrated hydrometeorological-hydraulic modelling system for investigating flooding**
Papadopoulos A., Varlas G., Papaioannou G., Mentzafou A., Terti G., Markogianni V., Panagopoulos Y., Spyrou C., Katsafados P., Loukas A., Dimitriou E.

Weather Analysis and Extremes

ePP79 **Extreme weather events and tree cover in Greece**
Mourmouri E., Radoglou K., Milios E., Kitikidou K.

ePP80 **Determination of the theoretical distribution functions of the extreme air temperature values in Thessaloniki, Greece**
Topouzi M., Farmakis N., Karacostas T., Antoniou I., Douka M.

ePP81 **The July 10, 2019 catastrophic supercell over Northern Greece. Part II: Numerical modelling**
Pytharoulis I., Karacostas T., Christodoulou M., Matsangouras I.

ePP82 **Verification of intense precipitation over diverse climatological areas**
Boucouvala D., Gofa F., Kolyvas C.

ePP83 **A new high-resolution precipitation database over Greece**
Ntagkounakis G.E., Nastos P.T., Kapsomenakis J.

ePP84 **Analysis and verification of marine warnings issued by HNMS**
Foukis I., Petropoulos G., Kotta D., Kouroutzoglou I., Myrsilidis M., Flocas H.

ePP85 **Synchronization phenomena of extreme weather events in Greece**
Vylliotis K., Kioutsioukis I.

ePP86 **Weather radar-based supercell tracking: The case of 10 July 2019, Macedonia, Greece**
Karoutsos G., Dalezios N.R., Spiliotopoulos M., Faraslis I.N.

ePP87 **Studying the effects of dust particles on cloud microphysical processes**
Chaniotis I., Platlakas P., Kallos G.

ePP88 **An extraordinary shelf cloud over Thessaloniki, Greece, on 8 June 2014: Formation conditions and associated severe weather**
Sioutas M., Traianou E.

ePP89 **Associating short-duration precipitation extreme events with land surface temperature in Thessaloniki**
Pakalidou N., Karacosta P., Douka M.

ePP90 **Evaluation of five reanalysis products in reproducing the spatio-temporal characteristics of air temperature over Greece**
Voulanas D., Mavromatis T.

ePP91 **Correlation between the extreme 24-hour rainfall events and altitude in North Greece (Chalkidiki region)**
Kastridis A.

Remote Sensing

ePP92 **S5P/TROPOMI atmospheric products over Thessaloniki, Greece; validation activities of the Laboratory of Atmospheric Physics, AUTH**
Koukouli M.E., Garane K., Karagkiozidis D., Gkertsi F., Michailidis K., Siomos N., Voudouri K.A., Mermigkas M., Topaloglou C., Sarakis C., Balis D.S., Bais A.

ePP93 The LAP/AUTH quality assessment and validation chain applied to multiple satellite sensors' total ozone columns
Garane K., Koukouli M., Lerot C., Heue K.P., Valks P., Vlietinck J., Verhoelst T., Romahn F., Redondas A., Zimmer W., Xu J., Balis D., Lambert J.-C., van Roozendael M., Loyola D., Eleftheratos K., Zerefos C.

ePP94 A case study of a supercell on the 10th July, 2019 based on satellite data
Angelidou E., Feidas H.

ePP95 Volcanic SO_2 layer height by S5P/TROPOMI; the case of the Raikoke 2019
Koukouli M.E., Hedelt P., Michailidis K., Taylor I.A., Balis D.S., Grainger R.G., Efremenko D., Loyola D., Retscher C.

ePP96 A technique to retrieve vertical concentration profiles of individual aerosol species based on the synergy of lidar and spectrophotometer measurements
Siomos N., Fountoulakis I., Gkertsi F., Voudouri K.A., Michailidis K., Garane K., Karagkiozidis D., Karanikolas A., Natsis A., Koukouli M.E., Bais A.F., Balis D.

ePP97 Early detection of the cloud convection in Meteosat imagery using lightning activity
Papadopoulou E., Kolios S., Hatzianastasiou N.

ePP98 Can we decompose a complex aerosol profile to its components?
Giannakaki E., Shang X., Filioglou M., Komppula M.

ePP99 Desert dust episodes in the Mediterranean Basin during the period 2005-2018
Gavrouzou M., Hatzianastassiou N., Gkikas A., Mihalopoulos N.

ePP100 Validation of the NWC SAF CRR and CRR-Ph products over the Greek area using rain gauge data as ground truth
Karagiannidis A., Lagouvardos K., Kotroni V., Giannaros T.M.

ePP101 Estimation of the spatio–temporal distribution of wildfires in the Mediterranean basin with the use of remote sensing data and correlation with biomass burning aerosol load
Kakouri A., Korras-Carraca M.B., Hatzianastassiou N., Matsoukas C., Gkikas A., Kontos T.

ePP102 EVE: A reference lidar system for Cal/Val studies of space-borne missions
Paschou P., Siomos N. , Amiridis V., Freudenthaler V., Tsekeri A., Binietoglou I., Meleti C., Georgoussis G., Von Bismarck J.

ePP103 Vector velocity estimation of single Doppler radar–convective thunderstorm analysis
Samos I., Flocas H.A., Emmanouil A., Louka P.

ePP104 Comparison of inferred S5P/TROPOMI NO_2 surface concentrations with in-situ measurements over Central Europe
Pseftogkas A., Koukouli M.E., Skoulidou I., Balis D., Meleti C., Geffen J.V., Astrid Manders H.E., Segers A.

ePP105 Megacities around the globe: AOD spatial distribution and trends over the last two decades using spaceborne data
Papachristopoulou K., Raptis P.I. , Gkikas A., Amiridis V., Kazadzis S.

ePP106 Remote sensing and numerical modeling contributions to the investigation of the June 16 – 17, 2020 severe hailstorm event over Drama, Greece
Matsangouras I., Avgoustoglou E., Anthis A., Nastos P.T., Pytharoulis I.

ePP107 Monitoring dust particle orientation with a novel polarization lidar at Athens
Tsekeri A., Amiridis V., Louridas A., Georgoussis G., Freudenthaler V., Metallinos S., Doxastakis G., Gasteiger J., Siomos N., Paschou P., Georgiou T., Tsaknakis G., Evangelatos C., Binietoglou I.

ePP108 Remote sensing analysis of the severe storm on August 8-9, 2020 over Evia, Greece
Matsangouras I., Anthis A., Nastos P.T., Pytharoulis I.

Wednesday, September 29th 2021

09.00-10.30	**ORAL SESSION Climate Dynamics** Chairpersons: **Bartzokas A., Anagnostopoulou C.**
09.00-09.15	Fast responses on pre-industrial climate due to present-day aerosols based on three Earth System Models **Zanis P., Akritidis D., Georgoulias A.K., Kalisoras A., Deushi M., Nabat P., Olivie D., Oshima N., Schulz M., Allen R.J.**
09.15-09.30	Evaluation of seasonal forecasting over Europe **Manios E., Anagnostopoulou C., Tolika K.**
09.30-09.45	Can we predict global patterns of long-term climate change from short-term simulations? **Mansfield L. A., Nowack P. J., Kasoar M., Everitt R.G., Collins W. J., Voulgarakis A.**
09.45-10.00	Impacts of changing North Atlantic atmospheric circulation on European climate under CO_2 doubling **Rousi E., Manola I., Rahmstorf S., Coumou D.**
10.00-10.15	Future extreme heatwaves in the Middle East and North Africa region: a MENA-CORDEX perspective **Zittis G., Hadjinicolaou P., Almazroui M., Bucchignani E., Driouech F., Rhaz K.E., Kurnaz L., Nikulin G., Ntoumos A., Ozturk T., Proestos Y., Stenchikov G., Zaaboul R., Lelieveld J.**
10.15-10.30	Atmospheric energetics under different future climate change scenarios **Michaelides S.**

10.30-11.30	Coffee Break **Poster Session**
10.45 - 11.00	Climate Dynamics ***ePP109 – ePP117***
11.00 - 11.15	Climate Change ***ePP118 - ePP125***
11.15 - 11.30	Air Quality ***ePP126 – ePP142***
	(see details below)

11.30-13.30	**ORAL SESSION Climate Change** Chairpersons: **Bakas N., Kazantzidis A.**
11.30-11.45	Evaluation of CMIP5 models climatology and trends for the recent past over the MENA region with emphasis on temperature extremes **Ntoumos A., Hadjinicolaou P., Zittis G., Lelieveld J.**
11.45-12.00	Future climate change impact on wildfire danger over the Mediterranean: the case of Greece **Rovithakis A., Voulgarakis A., Grillakis M., Giannakopoulos C., Karali A.**
12.00-12.15	On the assessment of RCMs in simulating deep cyclones over the Mediterranean region: Impacts on the storm surges of coastal areas **Tolika K., Makris C., Baltikas V., Velikou K., Krestenitis Y.**
12.15-12.30	Testing of the Regional Climatic Model COSMO-CLM (CCLM) driven by ERA-Interim at the Hellenic National Meteorological Service **Avgoustoglou E., Bucchignani E., Voudouri A., Mercogliano P., Skrimizeas P.**
12.30-12.45	Spatial and temporal evolution of drought conditions in the Eastern Mediterranean **Kostopoulou E., Giannakopoulos C., Varotsos K.V.**
12.45-13.00	The impact of climate change on the tomato growing season in Greece **Anagnostopoulou C., Kalfas I., Dourvanaki K.**
13.00-13.15	Heat-related mortality under climate change and the impact of adaptation through air conditioning: A case study from Thessaloniki, Greece **Kouis P., Psistaki K., Yiallouros G., Kakkoura M., Stylianou K., Papatheodorou S.I., Paschalidou A.K.**
13.15-13.30	The impact of climate change on a data-scarce watershed hydrology using bias corrected RCMs **Venetsanou P., Lazoglou G., Anagnostopoulou C., Voudouris K.**
13.30-15.00	Lunch break

15.00-16.30	**ORAL SESSION Air Quality I** Chairpersons: **Paschalidou A., Fotiadi A.**
15.00-15.15	Air quality monitoring in the urban area of Ioannina, Greece **Begou P., Petrou I., Ladia E., Kassomenos P.**
15.15-15.30	Prediction of ozone concentration using artificial intelligence and machine learning techniques **Moustris K.P., Nastos P.T.**
15.30-15.45	Sources of atmospheric organic particulate matter in Patras, Greece **Vasilakopoulou C., Florou K., Jorga S., Pandis S.N.**
15.45-16.00	Biomass burning aerosol optical properties associated with wildfires over the Mediterranean basin based on satellite data **Manthos I., Houssos E.E., Papadimas C.D., Hatzianastassiou N., Koutsias N., Fotiadi A.**
16.00-16.15	An innovative method to arrive at high resolution emissions for city scale air quality modeling **Kakouri A., Ramacher M., Athanasopoulou E., Grivas G., Speyer O., Karl M., Kontos T., Gerasopoulos E.**
16.15-16.30	The regime of particulate matter PM_1, $PM_{2.5}$ and PM_{10} in the city center of Ioannina **Michailidis I., Gavrouzou M., Hatzianastassiou N.**
16.30-17.00	Coffee break
17.00-18.00	**ORAL SESSION Air Quality II** Chairpersons: **Kassomenos P., Founda D.**
17.00-17.15	Investigation of the mineral dust concentration and light absorption in central Los Angeles employing a novel technique **Farahani V. J., Pirhadi M., Soleimanian E., Altuwayjiri A., Sioutas C.**
17.15-17.30	The effect of regional sources on cloud properties during an extreme warm-air advection in the Arctic **Bossioli E., Sotiropoulou G., Methymaki G., Tombrou M.**
17.30-17.45	Investigation of volcanic emissions at Antikythera PANGEA station **Kampouri A., Amiridis V., Solomos S., Gialitaki A., Spyrou C., Marinou E., Papagiannopoulos N., Mona L., Georgoulias A.K., Akritidis D., Pytharoulis I., Karacostas T., Zanis P.**
17.45-18.00	Year-long greenhouse gases measurements at the urban environment of Athens, Greece **Bougiatioti A., Pierros F., Dimitriou K., Quehe P.-Y., Delmotte P., Ramonet M., Mihalopoulos N.**
18.00	**Adjourn**

Climate Dynamics

ePP109 On the study of the heat wave of 2019 in European capital cities: Application of the updated heat wave index EHF (Excess Heat Factor)
Voudouri M., Tolika K., Anagnostopoulou C., Lagouvardos K.

ePP110 Comparison of two different setups of RegCM4 model over the Mediterranean: Present time simulations
Velikou K., Tolika K.

ePP111 The impact of Madden-Julian Oscillation on the European climate
Kerasilidou M., Anagnostopoulou C., Tolika K.

ePP112 The cold winter spells over the Balkan Peninsula: A climatological and dynamic analysis
Tringa E., Tolika K., Kostopoulou E., Anagnostopoulou C.

ePP113 A contribution to the study of the Vardaris wind regime of the last 60 years
Dagkli V., Parasakis I., Brikas D. Sarras C.

ePP114 How different land surface schemes and model resolution affect simulated soil moisture-temperature coupling over the MENA region
Constantinidou K., Hadjinicolaou P., Zittis G., Lelieveld J.

ePP115 Future changes of East Mediterranean summer atmospheric circulation under high emission scenarios of CMIP5 and CMIP6 project
Logothetis I., Tourpali K., Misios S., Zanis P.

ePP116 Trends in weather type frequencies across Europe
Petrou I., Kassomenos P., Ladia E., Begou P.

ePP117 Spatial interpolation methods for distribution of Regional Climate Models' daily precipitation at basin scale
Venetsanou P., Skoulikaris C., Voudouris K.

Climate Change

ePP118 Evaluation and mapping of heating degree days in Greece
Spyropoulou E., Kostopoulou E.

ePP119 Trend analysis of snow height time series in the University Forest of Pertouli, Central Greece
Stefanidis S., Stathis D., Dafis S.

ePP120 Estimation of the carbon and energy fluxes of a forest plantation in a lignite mine restoration
Markos N., Radoglou K.

ePP121 Evaluating potential fire behaviour for the Mediterranean islands under climate change
Bacciu V., Hatzaki M., Del Giudice L., Karali A., Papachristopoulou K., Giannakopoulos C.

ePP122 Water availability changes for natural vegetation development in the mountainous area of Metsovo (N. Greece) for the period 1960-2000
Proutsos N., Tsagari C., Tsaousidis A., Tsiros I.X.

ePP123 Climatic change at Macedonia Greece, using climatic parameters
Grimpylakos G.

ePP124 Greenhouses and radiative forcing: is our increased need for food the new unknown for future climate scenarios?
Meleti C., Garane K., Koukouli M.E., Balis D.

ePP125 Impact of climate change on energy performance of Hellenic non-residential buildings
Droutsa K.G., Kontoyiannidis S., Balaras C.A., Argiriou A.A., Dascalaki E.G., Varotsos K.V., Giannakopoulos C.

Air Quality

ePP126 Estimation of chronic bronchitis incidence in adults due to PM_{10} exposure in Athens, Greece
Ntourou K.S., Manousakis N.M, Moustris K.P.

ePP127 Low-cost portable air quality sensing device quantify human exposure in city environment
Spyropoulos G., Nastos P.T., Moustris K.P.

ePP128 PM_{10} concentrations at Ioannina and relationship with meteorological conditions
Sindosi O. A., Hatzianastassiou N., Bartzokas A., Markozannes G., Rizos E., Ntzani E.

ePP129 Eastern Mediterranean high summer ozone levels and the associated synoptic meteorological conditions
Kalabokas P., Kapsomenakis J., Mihalopoulos N., Zerefos C.

ePP130 Airborne dust chemistry and health risk assessment in the Sistan Basin, southeast Iran
Kaskaoutis D.G., Dahmardeh Behrooz R., Grivas G., Esmaili-Sari A., Bahramifar N., Mihalopoulos N.

ePP131 Synergy between different earth observation platforms towards the estimation of the intra-urban population exposure to wintertime air pollution of Athens
Athanasopoulou E., Grivas G., Kakouri A., Ramacher M., Speyer O., Karl M., Gerasopoulos E.

ePP132 Studying the dispersion of a chemical agent in an indoor environment
Ladia E., Petrou I., Begou P., Kassomenos P.

ePP133 Simultaneous assessment of indoor and outdoor PM concentration relationship in a typical rural residence in Greece
Kosmopoulos G., Salamalikis V., Tzoumanikas P., Kazantzidis A.

ePP134 Air quality impacts on human health. The case of Athens, Greece
Dimitriadou L., Nastos P., Gerasopoulos E., Kapsomenakis J., Zerefos C.

ePP135 Atmospheric lapse rates and humidity profiles during dust storm events in the central-eastern Mediterranean basin
Zaverdinou M., Kolios S., Hatzianastasiou N.

ePP136 A composite air quality-climate quantification approach
Alimissis A., Tzanis C.G., Koutsogiannis I.

ePP137 Mass concentration of airborne particles and their characteristics at Akrotiri station (Chania) during a summer campaign
Chatoutsidou S.E, Lazaridis M.

ePP138 Temporal variation of particulate matter and adverse health effects in the greater Volos area, Greece
Proias G.T., Moustris K.P., Nastos P.T.

ePP139 Health impacts from exposure to $PM_{2.5}$, black and organic carbon in Europe
Paisi N., Chowdhury S., Kushta J., Georgiou G., Lelieveld J.

ePP140 Variability of CO_2, CH_4 and CO column averaged mixing ratios from two years of measurements in Thessaloniki, Greece, using a portable EM27/SUN FTIR spectrometer
Mermigkas M., Topaloglou C., Balis D., Hase F.

ePP141 Levels and sources of polycyclic aromatic hydrocarbons at the port of Piraeus
Tavernaraki K., Tsiodra I., Papoutsidaki K., Tsagaraki M., Zarmpas P., Kouvarakis G., Grivas G., Liakakou E., Stavroulas I., Gerasopoulos E., Mihalopoulos N.

ePP142 Levels and variability of gaseous acidic compounds in the atmosphere of Athens
Liakakou E., Paraskevopoulou D., Speyer O., Myriokefalitakis S.

NOTES

Registration Fees (In-Person participation) (euro / include VAT 24%)

Registration Category	Early Registration until September 4th, 2021	Late Registration from September 5th, 2021 to September 20th, 2021*
Regular	160,00€	200,00€
Students	60,00€	80,00€

**Due to the congress protocol (see below) pre-registration for in-person participation is mandatory.*

Registration Fees include:

- Admission to the main Scientific Sessions
- Admission to the exhibition
- Conference Material
- Certificate of Attendance
- Coffee Breaks & Light Lunches (lunch boxes)
- Dinner (Monday, September 27th 2021)
- Opening Ceremony and Welcome Reception

Registration Fees (On LINE ACCESS) (euro / include VAT 24%)

On LINE ACCESS will give access only to the on line transmission of the congress

Registration Category	On line Access
Regular	130,00€
Students	50,00€

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- Access to the on-line transmission of the congress
- Access to all e-posters: on-line
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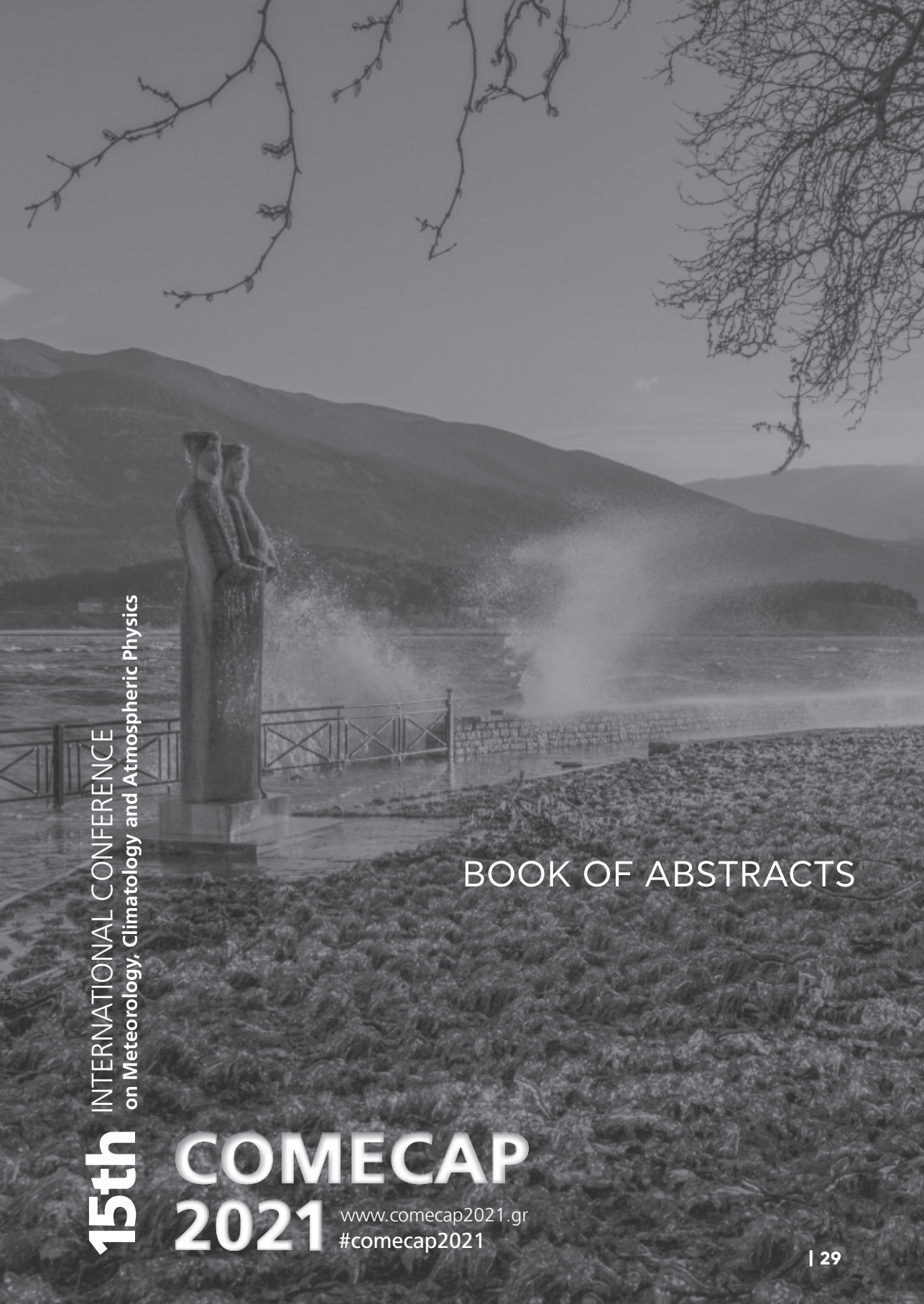

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BOOK OF ABSTRACTS

Atmospheric Physics (Oral session)

Aerosol optical depth retrieval from ground-based surface solar radiation measurements using machine learning techniques

Logothetis S. A., Salamalikis V. and Kazantzidis A.

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Aerosols have a pivotal role on the configuration of the energy budget of the Earth- Atmosphere system. Thus, the detailed knowledge of the aerosol optical properties is required at high spatio-temporal resolution. In this study, several machine learning algorithms are applied for estimating the Aerosol Optical Depth (AOD) in more than 20 stations of the Baseline Surface Radiation Network (BSRN) using ground-based measurements in conjunction with auxiliary data (e.g. reanalysis) under cloud-free conditions. Hourly data of water vapor from NASA's Modern-Era Retrospective Analysis for Research and Applications-2 (MERRA-2) reanalysis product are used. The estimated AOD is validated against Level 2.0 Version 3 (L2V3, cloud-screened and quality assured) AOD observations from AErosol RObotic NETwork (AERONET). The advances and drawbacks of the proposed methods are compared in terms of the aerosol climatic characteristics at each station considering also the presence of fine/coarse aerosols as well as their scattering/absorbing properties.

Validation of TROPOMI/S5P total ozone using ground-based DOAS measurements in Thessaloniki, Greece

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Total Ozone Column (TOC) measurements are performed routinely in the Laboratory of Atmospheric Physics in Thessaloniki, Greece, using the Phaethon DOAS/MAX-DOAS system. More than two years of ground-based data are used to validate the TOC over Thessaloniki, monitored by the Tropospheric Monitoring Instrument (TROPOMI) operating on board the Copernicus Sentinel-5 Precursor (S5P) satellite, which was launched in October 2017. S5P TROPOMI total ozone column data derived with the GODFIT_v4 CCI algorithm developed within ESA's Climate Change Initiative (CCI). The high spatial resolution of TROPOMI/S5P allows the investigation on the effect of temporal differences between the measurements, as well as other contributing factors, as, for example, the atmospheric temperature profile on ozone absorption cross sections.

Spatial and temporal relationships between total flash rates and radar reflectivity volumes under convection

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The objective of this study is to examine the total flash rates evolution and relate those spatially and temporarily with the radar reflectivity volumes under convection conditions. To meet these objectives, two case studies are examined. The first thunderstorm occurred on 5th September 2017 (Closed Long Wave Trough) during 18:00-19:00 UTC in Nea Anchialos and the second on 29th August 2017 (Open Long Wave Trough) during 17:00-18:00 UTC in Larisa airports in Thessaly, respectively. The lightning data were recorded by the Hellenic National Meteorological Service Network. Additionally, radar data from the S-band radar in Larisa are used to: a) infer the reflectivity structure in an attempt to scale the total flash rates in relation to radar echo volumes and b) investigate the existed correlation between the flash cells and the radar cells. Moreover, high resolution simulations performed through the use of the model COSMO-GR, in order to test if the maximum reflectivity agrees with the highest ice concentration and the highest convective updraft. The adopted COSMO products are vertical profiles of cloud ice content and vertical velocity, as well as convective available potential energy, which are compared with the total flash rate and the reflectivity structure.

On the impact of sound on atmospheric particulates

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We review existing literature on the impact of sound levels and frequencies on coagulation processes of atmospheric aerosols. While the literature is extensive regarding the use of sound on pollution control engineering, there is hardly any literature regarding the impact of sound on ambient levels of particulates. The main factors determining the impact of sound on particles are the sound frequency and pressure level and the particle size and concentration. We present calculation results for acoustic coagulation by bell sounds for a range of particle densities and diameters. Our results show that while the frequency spectra of bells are ideal for causing acoustic coagulation of ambient aerosols, the sound level pressure (SLP) is low and hence inhibitive. However, we cannot exclude that higher SLPs might have an impact under ambient conditions. We cannot also exclude that processes other than coagulation might also have considerable impact, through e.g. vibrational breakup of particles.

The nextSENSE system: Short-term forecasting of solar energy in Europe and North Africa

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In the framework of the EuroGEO e-shape project (http://www.e-shape.eu/) we introduce the pilot system nextSENSE, which is capable of short-term forecasting the surface solar radiation (SSR) and the subsequent energy production by the photovoltaic solar power plants in Europe and North Africa. This system was developed by the National Observatory of Athens in Greece in collaboration with the World Radiation Center of Davos in Switzerland and uses Earth observations from the satellite application facilities to support nowcasting and very short range forecasting (SAFNWC) of the European organization for the exploitation of meteorological satellites (EUMETSAT) and the Copernicus Atmosphere Monitoring Service (CAMS). The algorithmic part of the nextSENSE system consists of state-of-the-art fast radiative transfer models (FRTM) powered by high performance computing (HPC) architectures and computer vision aspects in order to short-term forecast the clouds motion and the impact on solar energy. The outcome is a massive provision (i.e. 20 million simulations per minute for Europe and North Africa) of operationally produced solar energy simulations in 5 km spatial resolution for a forecast horizon of 3 hours ahead in 15-minute time intervals in real-time. NextSENSE is going to support the solar energy producers and the local and regional electricity handling entities.

Climatology and trends of aerosol optical properties and direct radiative effect of main aerosol types based on MERRA-2 reanalysis data

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Monitoring aerosol optical properties and their long-term fluctuations can improve the assessment of the induced Direct Radiative Effects (DREs) and the subsequent climatic impacts. A suitable database for such an investigation has been made available by the Modern–Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2). In the present study, we investigate the spatio-temporal variation of the aerosol optical properties and clear-sky DREs of the main aerosol species (desert dust, sea salt, sulfate, organic and black carbon), and the total aerosol. To realize, MERRA-2 reanalysis products, at 0.5° × 0.625° resolution, are used as inputs to the FORTH deterministic spectral radiation transfer model (RTM). Clear-sky shortwave (SW) DREs have been calculated at global scale and on a monthly basis, over the period 1980–2019 (40 years), at the surface, within the atmosphere and at the top-of-the-atmosphere. According to our results, during the study period, the DREs exhibited changes in magnitude. More specifically, a strong increase of aerosol-induced atmospheric warming was observed which, in combination with an increase of surface cooling effect resulted in a slight decrease of the clear-sky TOA cooling from -5.48 Wm^{-2} during the 1980s to -5.23 Wm^{-2} during the 2010s.

PANACEA (Oral session)

Variation of CCN and potential CDNC in the Eastern Mediterranean

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The probability of an atmospheric particle to act as cloud condensation nuclei (CCN) and form cloud droplets depends on its size, chemical composition (hygroscopicity) and the levels of supersaturation that develops in ambient clouds. Here we study the aerosol-CCN-cloud droplet link at the Finokalia atmospheric observatory from February to December 2014. A comprehensive dataset of the observed submicron aerosol size distribution, chemical composition and derived CCN concentrations is being processed with a state-of-the-art droplet parameterization to calculate the potential cloud droplet number concentration (CDNC) and maximum cloud supersaturation. Bulk hygroscopicity is calculated from the mixture of salts predicted by ISORROPIA-II thermodynamic model using the observed particle composition. The calculated CCN overestimate the available observations by 5-20% for most supersaturations between 0.2 and 1.0%. This error propagates to CDNC predictions. Both calculated CCN and CDNC maximize in summer, when the maximum supersaturation needed for cloud droplet to form is minimum.

Vertical profiling of the electrical properties of charged desert dust during the pre-ASKOS campaign

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Numerous studies of the electrical properties in dusty environments, related to lofted particle charging, indicate that it is a rather complex mechanism which greatly affects the particle dynamics. The electrification of desert dust particles can differentiate their settling velocities and, therefore, can affect the removal of large particles from the atmospheric circulation. A systematic effort to orderly measure the electrical properties of elevated dust layers, with the subsequent monitoring of the respective parameters on a ground reference level, will be made in the major AEOLUS Cal/Val campaign of ASKOS in Cape Verde, in June/July 2021. The preparatory phase of the campaign was carried out in Cyprus, in November 2019, where the initial prototypes of disposable atmospheric electricity sensors were tested on-field. We report here, measurements of the vertical atmospheric electric field and atmospheric ion density through the launches of balloon-borne instrumentation under dust event conditions. We observed perturbations of the E-field within the dust layers which could be attributed to the stratification of charges within the layer, regardless of the layer structure, due to either gravitational settling or possible updraft mechanisms. To verify our findings, we plan to launch the complete instrumental suite in Cape Verde over Saharan dust elevated layers.

Case study analysis of aerosol shortwave radiative effect over Athens, using the FORTH radiative transfer model, multi-wavelength Raman-lidar measurements and satellite observations

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We calculate the shortwave aerosol radiative effect for specific pollution events over Athens. The aerosol optical depth is derived from the nighttime extinction coefficient profiles measured by the multi-wavelength depolarization Raman lidar system operated at the National Technical University of Athens (NTUA, Athens, Greece). The source areas are identified with backward trajectory analyses and information from satellite observations. The SphInX inversion algorithm is used to retrieve the shape-size distributions and single scattering albedo. SphInX approximates the particle distributions with a spheroid model assuming wavelength-independent refractive index values. The shape-size distributions are modeled as aerosol particle ensembles with the MOPSMAP software to derive the spectrally resolved single scattering albedo and the asymmetry parameter. These two quantities along with the optical depth constitute the necessary input data to the FORTH radiative transfer model, used for the calculation of the radiative effect. The column-integrated aerosol optical properties are validated with the collocated AERONET station, as well as with satellite data. The vertically resolved aerosol radiative effect is presented for selected cases, depending on data availability and overlap among the data sources.

Optical and microphysical properties of stratospheric smoke aerosols: on the possibility to enhance AERONET retrievals of UTLS smoke

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Large scale forest fires can eject biomass burning aerosols in the upper troposphere/lower stratosphere (UTLS) affecting radiation and climate for extended periods after their emission and in great distances. In this study we use lidar observations from the PANhellenic GEophysical observatory of Antikythera (PANGEA) of the National Observatory of Athens (NOA) to study the optical and microphysical properties of biomass burning particles transported in the UTLS from devastating wildfires raging North America in 2019 and 2020. Focus is given in the microphysical properties of the particles, since it has been recently noticed that they present an enhanced depolarization capability in comparison to advected forest fire plumes in the lower troposphere, with Particle Linear Depolarization Ratio () values reaching up to 20% for stratospheric smoke measured at 532 nm. Using numerical simulations, we show that a simple model of compact near-spherical particles is capable to reproduce their measured optical properties and characteristics. We further examine whether an extension of the current Aerosol Robotic Network (AERONET) scattering model to include the near-spherical shapes could be of benefit to the AERONET retrieval for UTLS smoke cases associated with enhanced .

Assessment of PANDORA total O_3 and total NO_2 retrievals in Athens, Greece

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PANDORA is a new spectrometer that measures solar and sky irradiance at spectral range 280-525 nm with 0.6nm resolution and is used for retrieving total NO_2 and total O_3. **Total** NO_2 is retrieved by calculating relative slant columns and using the direct sun air mass factor and a reference solar spectrum. Accuracy of this retrieval has been estimated at $2.7*10^{14}$ molecules cm^{-2}. Total O_3 is retrieved using a spectral fitting algorithm with an estimated uncertainty of ±2 DU. PANDORA 119, as part of PANDONIA network has been operating in Athens since 2018 and data are freely available (https://www.pandonia-global-network.org/). In this study we have used total O_3 retrieved from the Brewer monochromator, using a differential absorption method, which is operating at the Biomedical Research Foundation, Academy of Athens, 5km away from the PANDORA site. Comparison of the retrievals has been performed for measurements at solar zenith angle less than 65º. A total of 2 years of synchronous data are available and used to assess the quality of the retrievals. Total NO_2 has been compared with 16 months of satellite based (TROPOMI) retrievals for overpasses above Athens. TROPOMI is an instrument onboard Sentinel-5P, providing data at spatial resolution of 7 km x 3 km.

Vertical profiling of aerosol particles over the city of Ioannina (Greece) during the winter period 2020

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Vertical profiling of aerosol particles has been performed over the city of Ioannina (NW. Greece) during the winter period 10 January 2020 – 07 February 2020, in the frame of the PANhellenic infrastructure for Atmospheric Composition and climatE change, based on a mobile single-wavelength depolarization lidar system, AIAS. This mobile lidar system was running, mostly, under cloud-free conditions to provide the vertical profiles of the aerosol backscatter coefficient (b_{aer}) and the particle linear depolarization ratio (δ_{pldr}) both at 532 nm. In this work we demonstrate the spatio-temporal evolution of the vertical profiles of b_{aer} and δ_{pldr}, while our study emphasizes on the biomass burning particles originating, mostly, from heating activities over the city of Ioannina. The variability of the b_{aer} and δ_{pldr} values within the winter Planetary Boundary Layer leading to adverse air pollution effects over the city is also discussed.

First validation of AEOLUS L2A products over PANACEA sites

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AEOLUS satellite, developed by the European Space Agency (ESA), provides vertical wind profiles, since August 2018, acquired by the UV Doppler wind lidar ALADIN. The particle (aerosol or cloud) backscatter and extinction coefficients retrieved separately at 355 nm, relying on the high spectral resolution lidar technique, are spin-off products. The current study constitutes the first attempt to evaluate the performance of the Aeolus L2A aerosol retrievals versus ground-based measurements performed at three Greek sites (Athens, Thessaloniki, Antikythera) of the PANhellenic infrastructure for Atmospheric Composition and climatE chAnge (PANACEA) Research Infrastructure (RI). Overall, 32 cases of collocated satellite and ground-based vertically resolved backscatter coefficient retrievals have been identified. According to our preliminary results, large positive biases and root-mean-square-error (RMSE) levels reveal a poor performance when the raw Aeolus profiles are considered. Nevertheless, the agreement between space-borne and ground-based profiles improves substantially when ancillary data are jointly processed in order to remove cloud contaminated satellite retrievals. Finally, focus is given on specific cases in which different aerosol conditions prevail, aiming to highlight the capabilities and the drawbacks of Aeolus L2A observations as well as considerations which should be taken into account in relevant Cal/Val studies.

Updated power plant NO_x emissions in Greece from LOTOS-EUROS model simulations and Sentinel-5P/TROPOMI observations

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Chemical Transport Models (CTM) and satellite observations can be essential tools for studying NO_2 emissions, concentrations and dynamics in high spatial and temporal resolution with a global coverage. The combination of space-born atmospheric observations with model simulations in order to monitor and quantify the emissions is already studied in many regions, using different satellite products and models. In this study we take advantage of the high spatial resolution that S5P/TROPOMI product, the LOTOS-EUROS data assimilation system based on the Ensemble Kalman Filter and the CAMS-TNO emission inventory for 2015 to estimate updated NO_x emissions in Northwestern Greece. In particular, updated estimated emissions (*a posteriori*) of four lignite-burning power plants located in Northwestern Greece are investigated using observations for winter and summer 2019 and the emissions from the CAMS-TNO emission inventory (*a priori*) based on year 2015 and are validated against in-situ measurements. Decreases in NO_x emissions that range between -29% and -63% are found over the two larger power plants. The estimated emission changes are compared with changes in the energy from the production units of the power plants for the same time period showing an agreement for the 2 larger power plants.

Numerical modeling (Oral session)

Evaluating high resolution numerical weather predictions using spatial verification methods

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High resolution simulations performed using Numerical Weather Prediction (NWP) models are able to provide detailed prediction for cases with intense convective activity. Despite the increased amount of information provided by the simulations, their verification becomes difficult due to the lack of available observations. Even more, traditional methods using single point observations may, in some cases, come up with misleading results about the evaluation of the predictions. Spatial verification methods, focusing on general characteristics of the predicted and observed fields can be used as an alternative. For selected cases of high convective activity in the region of Central Greece – Thessaly those methods are used in an attempt to evaluate the WRF model (WRF-ARW ver3.5.1). Three model domains, covering Europe to northern Africa (d01), Greece (d02) and central Greece - Thessaly region (d03) are used at horizontal grid-spacings of 15km, 5km and 1km respectively. An ensemble of runs is created by alternating boundary layer, microphysics and cumulus convection schemes. A C-band radar located at the center of the examined area is the source of the observed data used in the evaluation. Spatial and intensity characteristics of the forecast and observation fields are compared providing encouraging results.

Optimization technique on an NWP high resolution model

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Numerical weather prediction (NWP) and climate models (RCM) consist of many parameterization schemes to describe various physical processes, which often include free or poorly confined parameters that constitute a major source of uncertainties in both RCM and NWP models. To deal with these uncertainties model developers calibrate models manually through a procedure known as 'expert tuning'. Expert tuning, however, lacks objectivity and requires a large number of model simulations which is not achievable directly due to high computational demands. Over the last years several studies have been conducted towards substituting expert tuning by objective and automatic methodologies to calibrate unconfined model parameters existing in both NWP and RCM model. At the framework of COSMO priority projects CALMO and CALMO-MAX, a statistical surrogate of the model originally build for a regional climate model has been tested. The steps followed to implement the methodology from RCM to NWP, as well as benefits and deficits of the proposed approach are discussed in the present work.

Early warning of epidemic spread: lessons learned from an unprecedented effort

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A scalable and sustainable Early Warning System for Mosquito Borne Diseases (EYWA) has been developed to monitor and forecast the outbreak of the climate-sensitive West Nile Virus (WNV). EYWA is making use of heterogeneous data (big EO satellite data, reanalysis, epidemiological, entomological, etc) and an ensemble of models (deterministic, statistical and AI). Besides the scientific importance, this innovative approach of EYWA serves as a tool for helping regional decision-makers to improve health system responses, take preventive measures to curtail the spread of WNV and provide support to existing elimination efforts. In this study we present the dynamic core of EYWA, which is a spatial forecasting model. We assess its hindcast skill at the municipality scale for the period 2010-2019 and present its forecast skill in operational mode during 2020. Associations between emergence of human case and climatic conditions that underline the role of seasonality in WNV transmission are discussed.

An advanced scheme for nowcasting precipitation and its sensitivity to the assimilated remote sensing estimations

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NOAA's Local Analysis and Prediction System (LAPS) is a mesoscale assimilation system that combines diverse observations (surface in-situ and upper-air measurements, remote sensing data and others) with background model-based fields to generate a spatially distributed, three-dimensional representation of atmospheric conditions. A recently developed forward-advection nowcasting scheme in LAPS allows it to provide very short-term prediction (nowcasting) facilitating research efforts towards the implementation of a "state-of-the-art" early warning modeling system. In this context, the main aim of this study is to assess the sensitivity of LAPS nowcasts to the different observation types assimilated for the description of a high-impact Mediterranean storm. LAPS is applied in nowcasting mode for this case study, assimilating a wide range of meteorological data such as records from conventional surface meteorological stations, remote sensing data (satellite radiance, weather radar reflectivity etc) as well as measurements from radiosondes and aircrafts to produce objective analyses alongside with their nowcasts in a forecast window up to 3 hours. The assimilation of remote sensing data in LAPS improves its short-term predictability of precipitation, with varying performance depending on the type of satellite retrievals assimilated.

Forecast icing potential during a low-pressure system passage over Greece

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An algorithm has been developed that calculates the Forecast Icing Potential (FIP) as a percentage of in-flight icing formation. The algorithm uses the prognostic fields of air temperature and relative humidity at different flight levels, the 2m temperature, the total precipitation, including snowfall and the freezing level. These data are analyzed and the presence of a single or multiple clouds is identified, while the areas of rain, freezing rain, snow and ice pellets are determined. FIP is then calculated based on a fuzzy logic method. This prognostic module was applied offline to the output of the COSMO-GR Numerical Weather Prediction model for a selected case characterized by the passage of an intense low-pressure synoptic system over Greece. The results indicated that FIP coverage is at least 70% below 15,000ft where the depression and the associated frontal zones are located. The horizontal extent and intensity of FIP decreases above 25,000ft, while at heights of 30,000ft and more FIP is negligible. Radar data were used to evaluate the validity of the applied methodology.

IRIS: Rapid response fire spread forecasting system – Operational implementation and evaluation during the 2019 fire season

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Named under a messenger Goddess of Greek mythology, IRIS is a rapid-response fire spread forecasting system that was primarily designed and developed for supporting the operational fire suppression activities of the Hellenic Fire Corps. It employs a coupled atmosphere-fire modelling system for considering the two-way interactions between fire and weather, and a prototype ultra-high-resolution fuel models' geospatial dataset, specifically compiled for Greece. The implementation of IRIS has been carried out for the first time operationally in Greece during the 2019 fire season, in close collaboration with the Hellenic Fire Corps, providing specialized ultra-high-resolution fire spread forecasts for 17, in total, wildfire events. This study presents the overall architecture and procedures of IRIS, with emphasis given on the system's evaluation during the 2019 fire season. The latter was conducted for 8 of the 17 wildfires for which IRIS was activated, based on the availability of satellite remote sensing data. Results are quite promising, indicating a satisfactory agreement between the observed and predicted fire spread.

Atmospheric Physics (Poster session)

ERATOSTHENES centre of excellence: The importance of atmospheric remote sensing in the EMMENA region

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A modern observational remote sensing super-site is of fundamental importance to understand the atmospheric system and to effectively monitor atmospheric conditions providing relevant data for prediction modeling. This contribution reports on the recent progress regarding the buildup of a permanent, atmospheric remote sensing station in Limassol, Cyprus. Through the EU H2020 Teaming project EXCELSIOR, the ERATOSTHENES Centre of Excellence (ECoE) will be established as a Centre of Excellence for Earth Surveillance and Space-Based Monitoring of the Environment. The ECoE will utilize state-of-the-art infrastructure to provide cutting-edge data regarding atmospheric processes. A modern super site will be established in Limassol, Cyprus for long-term profiling of the atmosphere, including wind, humidity, aerosol and cloud properties and precipitation fields. Case studies of the18-month field campaign (CyCARE) will be presented to demonstrate the importance of the ground based atmospheric remote sensing observations in the region, with the main focus on lidar/radar-based studies of aerosol-cloud-precipitation relationships.

Air quality and cloud effects on surface solar radiation over urban and rural areas in Greece

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In this work, the effects of aerosols, clouds and tropospheric NO_2 on surface solar radiation (SSR) are studied over urban and rural areas in Greece by performing simulations with the Santa Barbara DISORT Atmospheric Radiative Transfer (SBDART) model for the period 2005-2019. Ground-based and satellite observations are used as input. More specifically, aerosol optical properties are taken from Moderate Resolution Imaging Spectroradiometer (MODIS) aboard the EOS Aqua satellite, the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) sensor aboard the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) satellite and the MACv2 climatology, cloud optical properties are taken from MODIS/Aqua, O_3 and NO_2 vertical column data from the Ozone Monitoring Instrument (OMI) aboard the EOS Aura satellite and surface albedo data from the CLARA-A2 satellite product. The calculated SSR values are compared against satellite-based observations from the Satellite Application Facility on Climate Monitoring (CM SAF) and measurements from ground stations. In order to assess the radiative effect of each parameter on SSR, simulations with and without the presence of aerosols, clouds and tropospheric NO_2 are performed discussing the observed differences between rural and urban areas.

Validation and bias-adjustment of CAMS surface solar irradiance against ground-based measurements

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The accurate description of surface solar irradiance (SSI) is of crucial concern for assessing the efficiency of alternative energy sources. Satellite-derived information provides the main resource for deriving historical data and short-term solar radiation forecasts with coarse spatial and temporal resolution. The uncertainties of atmospheric quantities (clouds, aerosols, water vapor, etc.) can be translated to SSI uncertainties reaching 5%-10% for a wide spatial grid and temporal interval. Those induced errors increase for finer temporal and spatial resolutions. In this study, the global component of SSI retrieved by the Copernicus Atmospheric Service (CAMS) reanalysis project is compared against ground-based data at various cloudy conditions. Furthermore, site adaptation methods are applied to adjust the biases of the model-derived global horizontal irradiance using as skill-reference the ground-based observations.

Wind and planetary boundary layer observations during the Pre-TECT campaign

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In this study, we utilize lidar measurements acquired during the large scale experimental Pre-TECT campaign (1 - 30 April 2017) that took place at the Finokalia station (35.34°N, 25.67°E, 250 m a.s.l.), in Greece. Wind lidar and Raman lidar profiles are used to study the vertical evolution of the PBL, as well as the aerosol mixing layer height. In the case studies analyzed, radiosonde measurements launched in close proximity to the lidar site are additionally used. Our results indicate that a backscatter Raman lidar is capable of capturing the residual layer top while, additional information on the water vapor mixing ratio is indicative of either a residual or a stable layer. Comparison with the Halo Doppler Wind Lidar measurements revealed lower values that were attributed to the well mixed layer.

Detecting causality between aerosols, water vapor and clouds

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Atmosphere is a complex dynamical system. Here, we investigated the causality between aerosols, water vapor, and clouds, using the Convergent Cross Mapping (CCM) method, which is based on nonlinear state space reconstruction. We utilized remote sensing data of Aerosol Optical Depth at 550 nm (AOD), Water Vapor (WV), Cloud Cover (CC), Cloud Optical Depth (COD), Cloud Effective Radius-Ice (CERI), and Cloud Effective Radius-Liquid (CERL) from Moderate Resolution Imaging Spectro-radiometer (MODIS) sensor over East Asia, for the period 2003-2018. Our analysis shows that there is a bidirectional forcing between AOD and CC, WV, COD, and CERL, while there is no causality among AOD and CERI. We conclude that CCM method can be used effectively in all aerosol – cloud interactions' studies.

Aerosol typing and characterization during pre-tect campaign over Finokalia, Crete

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Aerosol typing schemes based on the intensive properties derived from a multiwavelength Raman lidar are used for the characterization of the aerosol load over Crete. The dataset used was acquired during the Pre-TECT campaign, which was organized by the National Observatory of Athens (NOA) in the framework of the ACTRIS (Aerosol, Clouds and Trace Gases Research Infrastructure). Pre-TECT experiment took place from 1st to 30th of April 2017 at the Greek atmospheric observatory of Finokalia of the University of Crete and acquired multispectral observations of the aerosol properties above the area in high temporal and vertical resolution. The typing results are evaluated against detailed layer-characterization using auxiliary available measurements (from lidar, photometer, in-situ and satellite data) and model simulations (from backward trajectories and models specialized in dust, smoke and sea-salt transport). Aim of this work is to evaluate the performance of the new typing scheme and to provide a detailed aerosol characterization over Crete during the campaign, and the results of this work will be used in future studies of aerosol-cloud interactions in the eastern Mediterranean.

Dust aerosols in the Greek area and their effect on surface solar irradiance

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Dust aerosols through their interaction with solar radiation perturb the radiation budget of the Earth–atmosphere system. The broader Greek area is frequently affected by dust outbreaks originating across North Africa where the largest desert area (Sahara) of the planet is located. Under favorable meteorological conditions, dust loads are transported over Greece with decreasing intensities northwards. This latitudinal gradient has been revealed from several studies relying on aerosol optical depth (AOD) observations, since pure dust optical depth (DOD) databases are rare. In the current study, we are using: (i) the Copernicus Atmospheric Monitoring Service modeling and reanalysis providing total and per aerosol types AODs, including dust (2003-2017, 0.4º x 0.4º) and (ii) a recently developed MODIS DOD dataset (2003-2017, 0.1º x 0.1º, DUST-GLASS project), in which space-borne AODs and reanalysis DOD-to-AOD ratios from MODIS-Aqua and MERRA-2, respectively, are jointly processed. The key objectives of this work are: (i) the comparison of the DOD at 550nm data, derived from the two databases, (ii) the comparison of the DOD trends over the broader Greek area since 2004 and (iii) the calculation of the dust direct radiative effects (DREs) on the shortwave radiation based on simulations of the libRadtran Radiative Transfer Model.

Meteorological dynamics associated with emission and transport of dust from the Thar desert

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This study examines the atmospheric/meteorological dynamics associated with dust outbreaks from Thar Desert, northwest India and transport along the Indus and Ganges valleys. The dust storms over the region, along with anthropogenic emissions, contribute to deterioration of air quality, leading to PM_{10} concentrations above 1000 μg m^{-3}, and may alter the atmospheric stability and heating rates, thus modulating the Indian summer monsoon rainfall. Furthermore, the deposition of the South-Asian dust over the Himalayan glaciers leads to acceleration of their melting due to decrease in albedo caused by darkening of the snow surface. In June 2018, an intense dust storm facilitated by thermal low and strong density currents associated with the southwest monsoon flow originated from Thar Desert. The dust plume was initially transported to the north and accumulated in the Himalayan foothills at altitudes below 3000 m due to blocking effect and then shifted to the east along the Ganges basin by the dominant north westerlies. The study uses the synergy of satellite sensors (MODIS), along with meteorological and aerosol products from re-analysis (ERA-5) and model (Meso-NH) simulations for studying the atmospheric dynamic processes associated with the emissions, uplift, vertical profiles, long-range transport and accumulation of dust.

Global trends of dust optical depth, over the period 2003-2017, based on the MIDAS fine resolution dataset

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Dust aerosols play a key role in several aspects of the Earth-Atmosphere system thus highlighting the growing scientific concern of investigating the temporal variations of their loads, from global to regional level. This study deals with the trend analysis of the Dust Optical Depth (DOD), derived by the MIDAS (ModIs Dust AeroSol) dataset at global scale and fine spatial resolution (0.1° x 0.1°), over the period 2003-2017. The statistical significant trends at 95% confidence level are calculated, based on a linear regression model applied to the deseasonalized monthly DOD time series and considering the serial correlation between consecutive temporal steps. According to our findings, strong positive tendencies are observed in the Central Sahara (up to +0.023 yr^{-1}) and the Arabian Peninsula (up +0.024 yr^{-1}) whereas declining trends are recorded in the Bodélé Depression (down to −0.021 yr^{-1}), the Asian deserts Thar (down to −0.017 yr^{-1}), Gobi (down to −0.007 yr^{-1}) and Europe (down to −0.009 yr^{-1}). For the interpretation of the estimated DOD trends, the impact of driving forces (i.e. wind) on dust emission and transport as well as the role of meteorological variables (i.e. precipitation), regulating the amounts of mineral particles, are under investigation.

Analysis of the stable isotopes ($d^{18}O$ and $d^{2}H$) in the precipitation (rain, hail, snow) of Patras from 2000 to 2016

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This study investigates the stable isotopes ($d^{18}O$ and $d^{2}H$) in the precipitation (rain, hail, snow) of Patras which is located in western Greece. The choice of this city was based on previous similar research in various areas of Greece, including Patras. The stable isotopes of Oxygen and Hydrogen are one of the cornerstone of meteorological, climatic and hydrological research during recent years. However, despite the significant hydrological studies in our country, there are only a few surveys on isotopes in rainfall. All existing data ($d^{18}O$, $d^{2}H$, precipitation, air temperature and vapor pressure of water, per month) recorded at the Patras weather station from October 15, 2000 to December 15, 2016 are presented in this study. Through their editing, the effect of the various parameters are investigated, such as the temperature, the height and the speed of the precipitation, the seasonality and the combination of continentality and topography. Results showed that the lower the air temperature, the more the precipitation decreases, while the higher the air temperature, the higher it occurs, as well as the values of δ18O and δ2H that are directly affected by these factors.

Analysis of the seasonal air mass transport pathways and Potential Source regions of PM10 at a coastal site in the Eastern Mediterranean

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Finokalia station is a coastal background station located on the north coast of Crete in the Eastern Mediterranean. Due to its geographical location Finokalia constitutes the receptor site of air pollutants originating from various sources around it. Additionally, depending on the season the air mass pathways as well as the air pollution source regions affecting Finokalia vary. In this work, by applying cluster analysis of 72-h backward trajectory arriving over the site at an altitude of 1500 m for the time period 2011–2018 and concentration weighted trajectory (CWT) approach, we tried to determine the air mass transport pathways dominating each season over the Eastern Mediterranean and investigate the potential source regions and their contributions to PM10 concentration levels recorded at the station. The results showed that the levels of PM10 present significant seasonal variability with maximum values during spring (27.7 μg/m^3) due to the high intensity of dust events coming from North Africa and minimum during winter (17.1 μg/m^3). Additionally, the domination of northeasterly flows during summer months results in the transportation of anthropogenic PM10 from eastern Europe, Balkans and Black Sea areas over Finokalia station.

Long-term MAX-DOAS NO_2 measurements over Athens and association with urban sources

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Long-term nitrogen dioxide (NO_2) slant column density measurements, using the MAX-DOAS (Multi Axis Differential Optical Absorption Spectroscopy) technique, are used in order to demonstrate the temporal and horizontal variability of the trace gas in Athens for the period October 2012-September 2017. Measurements at different elevation angles are also shown as a primary indicator of the vertical distribution of NO_2 at the urban environment. The results are compared with in-situ chemiluminescence measurements from the National Network for Atmospheric Pollution for urban, urban background and suburban conditions, towards evaluating the trends and the spatial representativeness of the MAX-DOAS fields. NO_2 predictions from a high resolution air quality model are utilized to infer on the role of vehicle emissions on the urban NO_2 levels.

The evaluation of the atmospheric refraction index using COSMO model and its comparison with radio-soundings over Greece

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The work under consideration deals with the investigation of the atmospheric refractive index as an important factor for operational applications that involve the atmosphere as a field of interest and consequently dependent on the corresponding meteorological conditions. The estimation of the atmospheric refractive index is based on the formalism used in radio meteorology, while its evaluation is made with respect to the meteorological observations provided by the daily radio-soundings for a particular case of interest. Using these data, the notion of refractive index is evaluated on multiple atmospheric levels giving to it an integrated representation. The resulting values of reflectivity are directly compared with those of the COSMO numerical weather prediction model that is used operationally at the Hellenic National Meteorological Service over a horizontal grid resolution of 0.02^{o} (~2 km) and 60 vertical levels. In addition to the indicative model comparisons of the refractivity with the corresponding values calculated from the radio-soundings performed at the meteorological stations of Thessaloniki, Hellinikon and Heraklion, selected vertical cross sections are presented, in order to highlight the sensitivity of the refractivity especially close to mountainous areas.

The Convective Day Category index and related synoptic, radar and hail parameters

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The Convective Day Category (CDC) index represents a forecasting technique of the maximum level of convective intensity expected for a meteorological day (24-hour UTC) and has been applied for specific regions of northern and central Greece. In the context of the operational forecasting of the Greek National Hail Suppression Program (GNHSP) forecast CDC is expressed with a single number between -3 and +5 that corresponds to specific classes of weather activity (convection, thundershowers, showers) and maximum hail sizes. The observed CDC is extracted by a variety of available data, including synoptic, radiosonde, satellite and radar imagery, hailpad, lightning and surface observations. Evaluation of the forecast accuracy is presented based on forecast and observed CDC. The 20-year (1999-2019) CDC climatology shows that both the frequency of convective and fair-weather related CDC values exhibit a small increasing trend. Analysis of observed CDC and corresponding synoptic circulation types indicated short wave trough (SWT) and southwest flow (SW) as the most dominant ones on positive CDC values, while ridge (R) and northwest flow (NW) types favor negative values. Relationships between CDC and radar parameters including maximum daily values of reflectivity, cloud top and vertically integrated liquid water (VIL) are also investigated.

PANACEA (Poster session)

Personal dose and health risk indexes of particulate matter (PM_{10}) in several Greek cities

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The aim of this study was to estimate the personal dose of particulate matter (PM_{10}) for residents in several Greek cities using a dosimetry model (ExDoM2). Human health risk indexes such as the Relative Risk and the Attributable Fraction were also estimated. A 24-h outdoor exposure scenario (under light exercise activity) was implemented for a resident (adult male) in the following cities: Athens, Chania, Heraklion, Patra, Thessaloniki and Volos. Two different size distribution data (Athens and Chania) were used in the simulations. Model results showed that the daily deposited dose ranged from 295 μg (Athens-Ag.Paraskevi) to 652 μg (Thessaloniki) using the size distribution of Athens. In addition, the daily deposited dose ranged from 388 μg (Chania-Akrotiri) to 848 μg (Thessaloniki) using the size distribution data of Chania. Therefore, higher deposited dose in the human respiratory tract was found for a resident in Thessaloniki due to higher hourly median PM_{10} concentrations (28-46 $\mu g/m^3$) compared to with the other cities. Regarding health risk indexes higher values were obtained for Thessaloniki followed by Athens-Aristotelous and Heraklion. Specifically, 2.1 % of all-cause mortality in Thessaloniki could be avoided if PM_{10} concentration was reduced at the level of 10 $\mu g/m^3$. Likewise, 1.7 % of all cause-mortality in Athens-Aristotelous and Heraklion could be avoided.

Pollutants dispersion from domestic wood burning for heating at Ioannina

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Air pollution levels in Ioannina are monitored in the frame of the PANhellenic infrastructure for Atmospheric Composition and climatE change (PANACEA) with a combination of remote sensing (lidar, MAX-DOAS) and in situ techniques (NOA and NTUA air quality station). In this work we examine the spatio-temporal distribution of pollutants from domestic wood burning activities, that remains an issue in many Greek cities after the economic crisis. The analysis is based on FLEXPART- WRF simulations assuming daily emissions representative of wood burning (i.e. fireplaces, woodstoves). The simulated PM2.5 concentrations and elevated aerosol layers are discussed in accordance with the local atmospheric boundary layer properties and PANACEA observations in order to determine the possible conditions that lead to adverse air quality at Ioannina.

Observations of alkylamines in the East Mediterranean atmosphere

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Atmospheric amines have a variety of natural and anthropogenic sources. They are stronger bases than ammonia and have been shown as an important contributor to new particle formation in the atmosphere. Amines measurements are scarce and mostly covering short time-periods because they are highly reactive and therefore present in low concentrations. In order to determine the atmospheric levels of gaseous amines in the East Mediterranean, a methodology developed to sample and analyze alkylamines has been optimized, standardized and used. Samples were collected at the Finokalia monitoring station of the University of Crete on the north east coast of Crete, using glass fiber filters impregnated with phosphoric acid in order to trap gas-phase amines in the form of salts. The filters were stored in refrigeration until analysis by a Liquid Chromatography Triple Quadrupole Mass Spectrometer. Ethylamine, dimethylamine, trimethylamine, propylamine, diethylamine and triethylamine are the here studied amines.

Global simulations of ice nuclei and cloud condensation nuclei particles derived from insoluble mineral dust

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Aerosol particles serve as Cloud Condensation Nuclei (CCN) to form liquid cloud droplets or as Ice Nuclei Particles (INP) to form ice at much higher temperatures than homogeneous freezing. Mineral dust containing K-Feldspar is considered as the most important INP, while measurements of its hygroscopic growth indicate very low solubility. Most chemistry-climate models assume that CCN activation depends solely on the soluble material in the particle. However mineral dust can be wettable, adsorbing water at its surface, contributing to CCN and promoting growth of particles to CCN and formation of cloud droplets at cloud relevant supersaturation. In the present study, we use the well documented global 3-dimensional chemistry - transport model TM4-ECPL to derive dust distributions for the year 2010 and then apply experimentally derived parameterizations of INP and CCN. The atmospheric INP concentrations at ambient temperature are found to be 3 to 4 orders of magnitude (0.001-0.1 cm^{-3}) lower than the calculated CCN concentrations (100-1000 cm^{-3}) close to their emission sources. CCN from insoluble mineral dust could affect cloud droplets formation at middle and low altitudes, while INP is important only at high altitudes.

Interannual and seasonal variability of greenhouse gases at Finokalia station in the East Mediterranean

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The annual and diurnal variability of carbon dioxide (CO_2), methane (CH_4), carbon monoxide (CO), and ozone (O_3) greenhouse gases mixing ratios measured at Finokalia station on Crete in the Mediterranean region are here presented and discussed based on continuous observations from June 2014 to December 2018. Interannual variabilities have been calculated for the period 2015-2018. The CO_2 mixing ratios showed an increase of 2.6 ppm/yr with maxima during winter and minima during summer. CH_4 mixing ratios maximized in winter and minimized in summer, overall showing an increase of 7.1 ppb/yr. CH_4 diurnal variation was very small and not considered significant. CO showed a decreasing trend of 5 ppb/yr and a clear seasonality with the highest values in winter and the lowest values in summer. Finally, O_3 mixing ratios showed a clear seasonal cycle with high values in summer and low in winter and a very small interannual trend of 1.2 ppb/yr. The observations have been compared with observations from the NOAA and EBAS databases in the northern hemisphere.

C10 – C16 Volatile organic compounds in Athens (Greece)

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Volatile Organic Compounds (VOC) with 10-16 carbon atoms are important constituents of the atmosphere contributing to the formation Secondary Organic Aerosols (SOA), which in turn affect climate and human health. However, there is a lack of information on the concentrations of these VOCs in urban areas and even more for Mediterranean cities. In this context, VOC measurements took place at the Thissio Monitoring Station of the National Observatory of Athens (NOA) from January 2016 to February 2017 with continuous online monitoring of α-pinene and limonene along with other C2–C12 NMHCs (Non-Methane Hydrocarbons). Additionally, two Intensive Observation Campaigns (IOPs) were conducted on February and September 2016 by means of off-line sampling and posteriori analysis for the determination of additional C10–C16 VOC. Significant variability was observed for the measured compounds depicting the strength of the emission sources. Specifically, decane and limonene were enhanced in winter relative to summer, presenting diurnal cycles with maxima mainly during nighttime. A similar diurnal trend was observed for α-pinene and C11-C13 alkanes. On the other hand, C14-C16 alkanes exhibited similar mean levels, with their diurnal variability being dependent also on meteorological parameters. Furthermore, the SOA formation potential of α-pinene, limonene and C10–C15 alkanes was calculated.

Aerodynamic effects on dust transport processes

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Dust particles can cause fluctuations in Earth's energy budget, modify in-cloud processes, ocean and land fertilization, impacting on climate evolution. The result of those processes can be altered due to different dust particle size distribution (PSD) in the atmosphere. From recent observational and modeling studies, it seems that dust models are struggling to accurate represent dust PSD, especially the presence of large dust particles. In this work we investigate the aerodynamics that impact on particles during their vertical motion in the atmosphere testing a drag coefficient, valid in the higher Reynolds numbers. We demonstrate its performance in a Meso-β dust simulations and we compare the results with those obtained using the default code which is based on the Stoke' s drag coefficient. We limit our study in the particle sizes that already have been simulated by the model (particle effective radius up to 10 μm). The results indicate that adopting the new methodology the total simulated dust load is slightly increased, in agreement with corresponding theory. The methodology is also applicable for dust particles with sizes in the full range of the observed dust PSD.

Measurements of the atmospheric electric field, $PM_{2.5}$ and meteorological parameters in Xanthi

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In this study we present measurements of the atmospheric electric field (Potential Gradient, PG) together with meteorological parameters 2011-2019 in Xanthi, Greece. During the second half of 2019, collocated measurements of $PM_{2.5}$ have also been made in the framework of a PANACEA campaign. We present an analysis of the annual variation of the electric field as well as the hourly variations and the impact of meteorology on the latter variations. We also analyze the influence PM has on PG. We find that an increase of $PM_{2.5}$ by 10 $\mu g/m^3$ decreases PG by around 37 V/m.

Retrieval of vertically-resolved aerosol optical and microphysical properties using Thessaloniki lidar measurements during 2019 summer PANACEA campaign

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There are different inversion methods to retrieve the vertical profile of the aerosol concentration from remote sensing lidar measurements. The Lidar - Radiometer Inversion Code (LIRIC) algorithm, will be used for the estimation of the fine and coarse mode aerosol volume concentration profiles, and will be applied to the lidar measurements performed during PANACEA summer campaign 2019 (July - August), in Thessaloniki. The LIRIC algorithm requires both the raw backscattering elastic lidar signal at 355 nm, 532 nm and 1064 nm and the inversions data from a collocated CIMEL sunphotometer. The THELISYS lidar system includes two Raman channels at 355 nm and 532 nm, three elastic channels at 355, 532 and 1064 nm and two depolarization channels at 532 nm. The analysis of the air mass backward trajectories was also used to determine a possible aerosol type and its source region. On the basis of the backward HYSPLIT trajectory analysis we presume that it is the absorbing aerosol originating from the regions of seasonal biomass burning in eastern Europe. Furthermore, the polarization lidar–photometer networking (POLIPHON) technique will be applied in future work stages for the Thessaloniki lidar measurements.

Overview of the 2019-2020 winter PANACEA campaign at Ioannina, Greece

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Although Ioannina is a medium size provincial Greek city, since the onset of the recession it faces frequent occurrences of smog in winter, with high PM concentrations, due to the shift of fuel use towards biomass burning for domestic heating. The problem is exacerbated by the prevailing winter low temperature and calm conditions in the lake basin surrounded by quite high mountains. The existing instrumentation located at a downtown station, namely a reference-grade Optical Particle Counter, is insufficient for monitoring and characterizing the fine biomass burning aerosols in the city. In order to gain a better knowledge of the $PM_{2.5}$ regime and its spatiotemporal characteristics, also providing an insight into the particle chemical composition, a synergy of instrumentation (reference and low-cost PM monitors, high volume sampling on quartz filters, aethalometer), in the frame of the PANACEA project, was deployed in the city and operated for a two-month period, from 10/12/2019 to 07/02/2020. In addition, for the first time, information about the vertical profiles of particulate matter and tropospheric NO_2 and HCHO vertical column densities over the basin was obtained by the AUTH MAX-DOAS and NTUA aerosol depolarization lidar systems operating from 12/01/2020 to 07/02/2020. An overview of the winter campaign measurements is provided in this study.

Monitoring of tropospheric NO_2, HCHO and aerosols using MAX-DOAS observations for the first time in Ioannina Greece during the PANACEA winter campaign 2020

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The Multi Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) technique has been used over the past years to simultaneously retrieve atmospheric columns of trace-gas species and their vertical distribution in the lowermost troposphere. In the frame of the winter 2020 campaign of the PANACEA project, a MAX-DOAS system was installed in January 2020 on the rooftop of the Physics Department, University of Ioannina, in order to monitor, for the first time in Ioannina, tropospheric aerosols and trace-gases. The azimuth and elevation viewing directions, as well as the integration times, were selected in a way that urban and suburban levels of trace-gas concentrations can be distinguished, providing high spatial and temporal resolution. Diurnal cycles of NO_2 and HCHO are examined and differences in trace-gas amounts between weekdays and weekends are investigated. The aerosol vertical profiles retrieved by the MAX-DOAS instrument are compared with vertical profiles of the aerosol extinction measured by a quasi-co-located LiDAR depolarization system. A similar MAX-DOAS system was also operating at the Laboratory of Atmospheric Physics (LAP) in Thessaloniki, Greece during the same winter campaign and a comparison of columnar trace-gas concentrations retrieved at the two measurement sites is presented.

The potential of a synergistic lidar and sunphotometer retrieval for the characterization of dust events during PRE-TECT campaign over Finokalia, Greece

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Mineral dust is an important aerosol type of the atmosphere and it is crucial to be able to precisely study its characteristics. Toward this end, powerful ground-based observations acquired from passive and active remote sensing instruments (i.e. multi-wavelength lidars and sunphotometers) have been used. In this study, we applied the Generalized Retrieval of Atmospheric and Surface Properties (GRASP) algorithm to joint lidar and sunphotometer data to retrieve dust properties of aerosols from Saharan dust episodes that took place during the 'PREparatory: does dust TriboElectrification affect our ClimaTe' experimental campaign (PreTECT), over Finokalia, Crete in Greece, on April 2017. The measurements from the PollyXT lidar participating in the European Aerosol Research Network (EARLINET) and the CIMEL sunphotometer participating in Aerosol Robotic Network (AERONET) are synergistically combined using the GRASP algorithm. The dust episodes under study were in most cases detected at low atmospheric layers (<2 km) with high AOD values (up to 0.6). GRASP provided the vertically resolved aerosol optical properties (backscatter and extinction coefficient profiles) and vertically averaged microphysical properties (volume size distribution, complex refractive index, single scattering albedo). The retrieved properties were found in generally good agreement with the initial observations from the AERONET sunphotometer and the lidar.

Air quality over Thessaloniki Greece revealed by a PANACEA summer and winter observational campaign; an overview

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During the summer of 2019 and the winter of 2019-2020, in the frame of the PANhellenic infrastructure for Atmospheric Composition and climatE chAnge (PANACEA) project, coordinated measurements of aerosol and gaseous air quality species were performed by the Laboratory of Atmospheric Physics, AUTH, at Thessaloniki, the second largest city in Greece. The main aim of the campaign, which took place in all major Greek cities, is to chart particulate and gaseous air pollution and the resulting human exposure to atmospheric pollution. Spatiotemporal mapping of tropospheric NO_2, CO, CH_4 as well as particulate matter was performed through remote sensing and in-situ measurements and using reference and mobile atmospheric monitoring instrumentation. In the following, the air quality during summer and winter over Thessaloniki is characterized by measurements from multiple MAX-DOAS instruments, a Raman aerosol Lidar as well as an FTIR spectrometer, a CIMEL photometer and a GRIMM spectrometer. Complimentarily, space-born observations by the high spatial resolution S5P/TROPOMI instrument, as well as chemical transport modelling simulations by the LOTOS-EUROS model, aid in understanding regional pollutant levels and their seasonal signatures.

Long term variability of the aerosol intensive properties over Thessaloniki

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The particle linear depolarization ratio and the lidar ratio are intensive aerosol parameters suitable for aerosol classification and aerosol-type separation. In this study their long term variability obtained from the inversion products of the AErosol RObotic NETwork (AERONET) sun/sky radiometer measurements, is discussed in terms of monthly, yearly and seasonal base, for the urban environment of Thessaloniki, Greece (40.63°N, 22.96°E). Time series of the aforementioned parameters provide information useful for the estimation of the predominant aerosol type and their climatological behavior and variability over the years. Moreover, a point by point comparison with the products derived by the European Aerosol Research Lidar Network (EARLINET) for the time period between 2004 and 2018 is presented. Cases of discrepancy are furtherly analyzed and discussed in terms of daily variability of the aerosols, taking into account the different measurement techniques and the non-simultaneous acquisition of the measurements.

Synergy of remote sensing techniques for aerosol typing over Thessaloniki

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Operational monitoring of aerosol properties are performed routinely at the Laboratory of Atmospheric Physics, Thessaloniki (40.63°, 22.95°, 60m asl), Greece, using a combination of different ground-based instruments. These include both a single and double Brewer spectrophotometer, a multi wavelength Depolarization Raman Lidar, and a CIMEL photometer, among others. Taking advantage of the multispectral information and the high temporal and vertical resolution acquired with all the instrumentation, synergetic techniques that deploy spectrophotometer data, lidar data and sunphotometer data are applied, in order to provide a full characterization of the aerosol load over Thessaloniki, including aerosol type. The results are compared and discussed against the in-situ observations for certain case studies.

Evaluation of the LOTOS-EUROS NO_2 simulations using ground-based measurements and S5P/TROPOMI observations over Greece

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In this study we investigate the performance of LOTOS-EUROS v2.2.001 regional chemical transport model simulations of nitrogen dioxide over Greece from June to December 2018. In-situ NO_2 measurements obtained from the National Air Pollution Monitoring Network are compared with surface simulations over the two major cities of Greece, Athens and Thessaloniki. Overall, the model underestimates the NO_2 surface concentrations mostly during daytime (12 to 15 pm local time) and overestimates the low concentrations during night-time (0 to 3 am local time). Space-borne Sentinel 5-Precursor TROPOMI tropospheric NO_2 observations are compared with LOTOS-EUROS NO_2 columns in July and December 2018. The simulations over Athens agree well with the TROPOMI observations both in July and December ($r=0.95$ and $r=0.82$ respectively). Overall, the comparison of the simulations with the TROPOMI observations shows a model underestimation during summertime and an overestimation in wintertime. Lastly, the simulated tropospheric NO_2 columns are evaluated against ground-based MAX-DOAS NO_2 measurements in both cities of Athens and Thessaloniki for July and December 2018. The model underestimates the MAX-DOAS measurements both in July and December in Thessaloniki and Athens.

Monitoring dust particle orientation with measurements of sunlight dichroic extinction

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Alignment of irregularly shaped dust aerosols leading to linear dichroism has been reported in atmospheric layers. The present study intents to quantify the excess linear polarization of direct solar radiation propagating through atmospheric layers, when these contain oriented dust particles. In order to record the linear polarization, we have used the Solar Polarimeter (SolPol). SolPol is an instrument that measures the polarization of direct solar irradiance at 550nm. It is installed on an astronomical tracker in order target the solar disk. Using the measurements, the Stokes parameters are retrieved (I, Q/I, U/I and V/I) with an accuracy of ~1% and precision of 1 ppm. Collocated measurements of a sun-photometer (Aerosol Robotic Network; AERONET) and lidar are used to quantify the Aerosol Optical Depth (AOD) and identify the vertical distribution of dust layers, respectively. We will present indications of dust particle orientation recorded at the PANGEA station in the island of Antikythera, Greece, and at Nicosia, Cyprus during the preparatory phase for the ASKOS campaign in July 2021. The relation of the linear polarization of the solar irradiance to other optical properties of the dust layer is investigated.

First demonstration of a CALIPSO-based fine-mode and coarse-mode pure-dust product

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New products of fine and coarse mode dust extinction coefficient and concentrations are produced using the CALIPSO space-borne lidar observations, for the first time. The new products derived are based on the CALIOP aerosol backscatter coefficient observations and provide height-resolved separation of the fine-mode and coarse-mode portions of the pure-dust atmospheric aerosol component. The methodology follows the two-step POLIPHON ground-based lidar technique and is optimized for the different deserts globally, taking into consideration regional dust lidar-ratio (LR) values. A demonstration of the methodology is presented herein, along with first results of the CALIPSO fine-mode and coarse mode pure-dust products. Profiles of pure-dust fine-mode and coarse-mode extinction coefficient at 532 nm are calculated, for a severe pollution event over the broader Hebei province - China. Additionally, estimation of CALIPSO-based fine-mode and coarse-mode dust mass concentrations is performed. The results indicate pure-dust, coarse-dust and fine-dust mass concentrations close to the surface, as high as 905 μg/m^3, 325 μg/m^3, and 519 μg/m^3, respectively.

Satellite EO of Saharan dust mass transport towards the estimation of dust deposition fluxes along the open Atlantic Ocean

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Desert dust, produced in arid and semi-arid regions, is a key source of nitrogen (N), phosphorus (P), and iron (Fe) for marine ecosystems. In this article, we use a well-established pure-dust product to estimate the Saharan-dust mass deposition fluxes along the Atlantic Ocean. The study uses a pure-dust product, developed through applying the one-step POLIPHON technique to fourteen-years of CALIPSO CALIOP observations. Furthermore, we implement corrected lidar-ratio (LR) values, suitable for mineral dust particles with Saharan Desert origin, and AERONET depended conversion factors, to calculate the three-dimensional (3-D) mass transport of pure-dust along the Atlantic Ocean, starting from CALIOP L2 aerosol backscatter coefficient profiles at 532 nm. The article consists a conceptual demonstration of the applied methodology over the ASKOS (Support to the Aeolus Validation and Calibration Through Ground Based Observations in the Tropics) experimental campaign domain (Cape- Verde; June-July-August 2021), estimating the pure-dust mass deposited in the region approximately equal to 50.89 Tg per JJA season.

Numerical modeling (Poster session)

Validation of aeronautical weather forecasts of wind, direction and speed issued by the Regional Meteorological Centre «Macedonia»

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Wind direction and speed are the most significant weather parameters that affect the functionality of an airport. The subject of this paper is the wind speed behavior/characteristics in the area of the International Airport of Thessaloniki, Greece «Macedonia», and more specifically the deviation that the wind forecast might undergo, as far as the direction, as well as the speed, is concerned. The data of the study is the METARs and the TAFs from the Regional Meteorological Centre «Macedonia», which is located in the same airport. The task in this study is to compare TAF and METAR and quantify the accuracy of the TAF, as a wind forecast. The period of the study is December 2018 - February 2019. The results of the study show, in general, that a reliable forecast of the wind is given by the weather forecasters of Regional Meteorological Centre «Macedonia». As expected, the slight deviation tends to increase as the range of the forecast increases. Synoptic scale weather systems are almost always well forecasted, whereas the wind behavior of small scale phenomena may be subject to deviation.

A 4D-Var radar data assimilation scheme for nowcasting of local extreme weather

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Radar reflectivity data is used to improve short-term weather prediction using the WRF forecasting system. A flash flood event in the area of Mandra, Attika (15th of November 2017) is chosen to evaluate the effect of the 4D-Var data assimilation technique. The WRFDA assimilation model is used, while radar reflectivity data is provided by NOA's XPOL mobile radar. A 2-way WRF nested grid is applied over the area of interest to achieve a 1km high-resolution forecast for efficient use of the high-resolution radar observations and improvement of precipitation forecast. The radar data is assimilated as water mixing ratio. A short-term forecast (6hr) with and without DA, which covers the duration of the flood event, is performed. The simulations without DA show almost no rain in the area of Mandra, while with radar data assimilation the model is triggered to produce significant rain improving both the time, location and total precipitation forecast. Duration and timing of the assimilation window, as well as the microphysics schemes used by the WRF/WRFDA system, have a significant impact on the forecasted precipitation. The radar-DA methodology is used in an operational nowcasting web-based system for the area of Athens.

Physical and dynamical considerations of three-way atmosphere-wave-ocean coupling

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Recently, the Chemical Hydrological Atmospheric Ocean wave System (CHAOS) was fully coupled with the Nucleus for European Modeling of the Ocean (NEMO) ocean circulation model. This upgrade enables CHAOS to represent atmosphere-wave-ocean interactions explicitly. CHAOS uses sea surface temperature (SST) and ocean currents resolved by the ocean model as dynamical lower boundary conditions in the atmospheric component while exploits the current information in wave refraction modelling. The system was assessed simulating a tropical-like Mediterranean cyclone ("Medicane", 27-30 September 2018). The combination of air-sea heat transfer and Ekman transport pattern bringing sub-surface cold waters in upper-ocean layers (upwelling), resulted to SST cooling (~2-3 ^{o}C). The SST cooling initiated a negative feedback loop mechanism tending to equilibrium between atmospheric and ocean processes. SST cooling weakened the cyclone and, subsequently, attenuated the atmospheric energy embedded in the ocean, reducing upper-ocean vertical mixing, upwelling and SST cooling. In three-way coupling, the role of waves on this feedback loop was to make the system more resilient in air-sea flux variabilities. Waves additionally weakened the cyclone due to momentum flux, but enhanced upper-ocean vertical mixing and SST cooling, balancing the air-wave-sea exchanges more realistically.

Assessment of continental weather forecasts in the framework of AfriCultuReS project

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In recent years, advances in computational resources and numerical techniques paved the way for higher resolution weather forecasts by General Circulation Models (GCMs). However, their forecast skill can be limited in specific regions of the world by inadequate depiction of physical properties such as the equatorial convection. In the framework of AfriCultuReS project, the meteorological forecast and the Weather Extremes Early Warning services provide operationally deterministic and probabilistic weather forecasts from NCEP Global Forecast System (GFS) and NCEP Global Ensemble Forecast System (GEFS, 21 members), respectively, up to 180th forecast hour, over the African continent. In this study, the forecast skill of the GFS system (forecast cycle 12Z) is investigated, in terms of 2 m air temperature, 2 m relative humidity and precipitation. The verification is performed by utilizing available surface (METARs, SYNOPS) and satellite products (e.g. GPM products), by calculating several statistical scores. This work was supported by the European Union's Horizon2020 research and innovation programme "AfriCultuReS -Enhancing Food Security in African Agricultural Systems with the Support of Remote Sensing" under grant agreement No 774652.

Improving dust forecasts through assimilation of ESA-Aeolus wind profiles

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The European Space Agency, launched on 22nd August 2018 the Aeolus satellite carrying ALADIN, the first-ever Doppler Wind Lidar placed in space. ALADIN, via the HSRL technique, acquires wind profiles up to 30 km all over the globe thus advancing the current poor observational capabilities. The main goal of our work is to assess the potential improvements in dust forecasts performed with the WRF-Chem regional model, which is initialized with two sets of IFS outputs differing only in the consideration of Aeolus wind profiles in the respective assimilation scheme. Our experiments have been conducted for May 2020, when several dust outbreaks occurred in the boarder Mediterranean basin and they have been recorded by active and passive remote sensing ground-based instrumentations, operated during the EARLINET Covid-19 campaign. According to our preliminary results, there are modification signals on dust fields and wind patterns, indicating that the assimilation of Aeolus wind profiles has impact on the performance of the regional model. Nevertheless, in order to justify that this impact leads to better predictive skills, several adjustments are needed before investigating the underlying mechanisms regulating dust emission and transport processes.

Subseasonal prediction assessment of an abnormal warm period in Greece

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Heat waves pose a large threat in Europe causing numerous fatalities in western Europe and Russia over the last decades. Successful Subseasonal-to-Seasonal (S2S) predictions of intense and/or high-impact weather events have the potential to allow mitigation and prevention of human and economic losses. An abnormally warm period occurred in Greece in mid-May 2020. At 850 hPa over Greece the temperatures were 2 to 3.5 standard deviations warmer than the 1979-2008 climatology from 11 to 20 May characterizing this warming as an intense event. The shelter maximum air temperature reached 39.4^{o}C at Larissa (central Greece) on May 15. The objective of this study is to assess the S2S predictability of this event. The motivation is provided by the fact that it took place much earlier than the usual summer heat wave period and the lack of a rigorous assessment of S2S weather forecasts in Eastern Mediterranean. This research investigates the S2S ensemble predictions of ECMWF, including 1.5^{o}x1.5^{o} grid spacing forecasts and a leading time of 2 to 7 weeks. Forecasts with satisfactory skill are initialized 2.5 weeks before the event. However, a few ensemble members predicted this warming at 850 hPa 6 weeks in advance.

Validation of WRF high resolution climatic simulation of temperatures over Greece

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The study presents an initial assessment of the capacity of the WRF model to simulate temperature climatology and extremes during a historical simulation in order to strengthen our confidence for climate future studies. A dynamically downscaled climatology for Greece was produced with high resolution Weather Research and Forecasting (WRF) model simulations of 30 years of recent historical period, forced by ERA-Interim reanalysis. Two nested domains were used covering Europe and the Mediterranean region with a resolution of 20 km, reaching by downscaling 5 km in the innermost domain of the study area of Greece. This work presents the validation of the WRF configuration which is based on historical simulations from 1980 to 2010 against available observational datasets of near surface temperature and its extremes for the same period. Model results and observed data are compared in terms of standard statistical errors, and probability distributions on daily to seasonal timescales.

Assessing two-way air-sea coupling in a deep Mediterranean cyclone

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High-resolution numerical simulations using the Chemical Hydrological Atmospheric Ocean wave System (CHAOS) were conducted to investigate the impact of the coupling strategy (one versus two way) on the ocean and atmosphere interactions, and to elucidate dynamical aspects of the coupled response. CHAOS is implemented in a case study of a deep cyclone (namely Numa) formed on 15 November 2017 over central Mediterranean Sea. This case study has been simulated in offline and in two-way coupled modes. In offline mode, the atmospheric component sends the atmospheric forcing to the ocean component of CHAOS while in the two-way coupled mode both components run in parallel exchanging appropriate information at every timestep. Preliminary results indicate that two-way coupling is able to resolve the upper-ocean cooling across the track of the cyclone, which in turn reduces the air-sea heat fluxes leading to a negative feedback on cyclone intensity.

Data assimilation of surface and satellite observations into the numerical weather prediction model WRF: an intense precipitation case study in Greece

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Agriculture is perhaps the most dependent sector of the economy from the weather. From planting to harvesting, all the farming decisions are influenced by weather conditions, and weather intelligence plays a key-role in the farm decision-making process. Numerical weather prediction models, such as the Weather and Research Forecasting model (WRF) can provide weather information in a high spatial and temporal resolution. The accuracy of this information is determined not only by the spatial resolution and the physics representation but also from the initial state of the model. This study focuses on combining the forecast model with satellite (Global Precipitation Measurement (GPM)) and weather stations observations (Meteorological Assimilation Data Ingest System (MADIS)), through a 4D-var data assimilation scheme with the goal of improving the initial state of the model and the subsequent model's forecasts. An ingest scheme of GPM data into the assimilation scheme is implemented and both the value of MADIS and GPM data on weather forecasts are examined. A case study of intense precipitation event in Greece is selected and the related weather forecasts are studied. Verification techniques based on the Model Evaluation Tools (MET) are applied and the improvements of the forecasts are quantified. The evaluation showed that the precipitation forecasts are boosted, especially for the initialization on 12 UTC and for the finer resolution domain. Two-meter temperature, ten-meter wind speed and two-meter relative humidity benefit from the assimilation of surface observations and seem to improve their forecast when IMERG is included for the finer resolution domain. A degradation of the forecast skill of the variables is observed, especially for the coarser domain resolution, when both IMERG and surface data set are included in the assimilation.

Turbulence self-organization in a simplified model of a stratified atmosphere and the accurate representation of its dynamics by a generalized quasi-linear model

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Atmospheric macro-turbulence is observed to be self-organized into large-scale coherent structures such as robust vortices and zonal jets. Previous studies have addressed the self-organization dynamics using a simplified model of a barotropic atmosphere. In this study, we extend these results to a stratified atmosphere by considering a single-layer shallow water flow on a beta-plane forced at small scales by random stirring and dissipated by linear drag of potential vorticity. Numerical simulations of this model reveal four regimes depending on the energy input rate of the excitation. A homogeneous regime in which the incoherent eddies directly forced dominate the flow, a regime with coherent large-scale Rossby waves, a regime in which robust zonal jets coexist with weaker Rossby waves and a regime of strong isotropic vortices. The transitions between these four regimes occur abruptly when the energy input rate passes specific thresholds. We show that a generalized quasi-linear model retaining only the direct interactions between the large-scale structures and the small-scale eddies is able to capture both the characteristics of the dominant structures and the critical values for the regime transitions. As a result, the statistical state dynamics of turbulence self-organization can be captured by a second-order closure.

Three-dimensional Holmboe instability

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Stably stratified atmospheric shear flows are commonly observed to be unstable resulting in a turbulent collapse of the flows and producing significant mixing in the atmosphere. While for low Richardson numbers, shear flows are rendered unstable by Kelvin-Helmholtz instabilities, these flows can be rendered unstable even at high stratification by Holmboe instabilities when the density variations are concentrated in a small region of the shear flow. As a result, mixing may occur even for flows with large bulk Richardson numbers. Holmboe instability has been extensively studied in the literature focusing on the evolution of planar perturbations. In this work we extend these results and study the stability of the stratified shear layer with respect to three-dimensional perturbations under the Boussinesq approximation. We calculate the growth rate of the perturbations as well as the scales and characteristics of the emergent structures. We find that in certain regions in parameter space, the flow is stable with respect to planar perturbations but unstable to three-dimensional perturbations. We also find other regions in parameter space in which the most unstable perturbations are three dimensional. These results are interpreted using Yih's theorem.

Climatology (Oral session)

Seasonal variability of heavy-severe aircraft turbulence over Europe for the period 2008-2018

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Turbulence is a major factor affecting flight safety and its study is of great importance in order to improve air transports quality. In the atmosphere, turbulence is characterized by its highly transient and spatial variability, which introduces difficulties in its systematic measurement. Atmospheric turbulence is recorded in situ by commercial aircrafts over Europe through the Aircraft Meteorological Data Relay (AMDAR) programme. In this study we analyze a large amount of AMDAR data for the period 2008-2018 over Europe. The available indicator of turbulence is the Derived Equivalent Vertical Dust Velocity (DEVG), which is an aircraft independent metric. We study the vertical distribution and the seasonal variability of heavy-severe turbulence. The results of the statistical analyses are presented. We found an increasing number of turbulence events in the upper atmosphere (over 20.000ft MSL) during winter and spring and a minimum during summer, while below 5.000ft MSL an increasing number of turbulence events is recorded during summer.

Climatology and trends of global single scattering albedo based on Ozone Monitor System (OMI) ultraviolet retrievals

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In this study, a global climatology of aerosol SSA for a 15-year period (2005-2019) is presented. The climatology is based on OMAERUVd (PGE Version V1.8.9.1) daily L3 (1° x 1° latitude-longitude) aerosol SSA data, which are obtained from the enhanced two-channel OMAERUV algorithm that essentially uses the ultraviolet radiance data from Aura/Ozone Monitoring Instrument (OMI). Severe criteria of enough data availability are applied to ensure representative information about the geographical and seasonal variability of SSA. The OMI SSA climatological values range from about 0.8 to 0.94, with lower values over desert and biomass burning areas of the globe and higher values over urban and industrial regions. Low SSA values are also observed over oceanic areas undergoing export of dust or biomass burning aerosols, such as the tropical or southern Atlantic Ocean. An overall decrease of SSA is observed, which is stronger over the northern parts of the Saharan and Saudi Arabian deserts, as well over most of the Taklamakan and Gobi Asian deserts. Distinct seasonality of SSA is found, with larger SSA values in boreal summer over areas dominated by dust and urban/industrial aerosols.

TIN-Copula bias correction of climate modeled daily maximum temperature in the MENA region

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During the last years, climate models are considered as the fundamental practice for the projection and the assessment of the future climate conditions, both globally and regionally. However, systematic biases between the simulated model output and observed conditions are observed, mainly due to the chaotic nature of the atmospheric system, and the limitations in the representations of the sub-grid-scale processes that need to be parameterized. The objective of the present research is to test a new technique for minimizing the uncertainty of daily climate model output. We use a new bias correction method the TIN-Copula, for increasing the accuracy of the simulations, produced by the state-of-the-art global Earth System Model (Hadley Centre Global Environmental Model version 3). The recently introduced TIN-Copula approach is a combination of Triangular Irregular Networks and Copulas and achieves to model the whole dependence structure of the selected studied variables. The region of study for the present research is the Middle East and North Africa (MENA) region which is considered a global climate change hot-spot. The ERA5 reanalysis data set is used as the reference one, due to the lack of accurate and consistent observational data in the MENA region. The results of the study proved that the TIN-Copula method is able to improve significantly the simulation of maximum temperature, both annually and seasonally.

An objective definition of seasons for the Mediterranean region based on the long term mean intra-annual variations of meteorological parameters

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An objective definition of seasons for the Mediterranean region based on the mean intra-annual variations of numerous meteorological parameters is performed. The data consists of daily NCEP/NCAR Reanalysis grid point values of various meteorological parameters (air temperature, specific humidity, cloudiness, precipitation, wind, geopotential heights and precipitable water) over the Mediterranean region and refers to the period 1949-2018. Principal Component Analysis and Cluster Analysis are applied and result to 4 climatologically homogenous periods of the year (seasons). These seasons generally correspond to the conventional ones, but there are remarkable differences in some of their characteristics. The above methodology is applied also for the five overlapping 30-year subperiods 1949-1978, 1959-1988, 1969-1998, 1979-2008, 1989-2018 and results in 4 seasons too. Regarding the duration of the objectively defined seasons, it is found that winter lasts about 4 months, spring and summer are a little shorter than 3 months and autumn lasts about 2.5 months. The most remarkable long-term changes of the seasons characteristics are: i) the recent warming which is in agreement with the ongoing climate change, ii) the shortening of winter and spring due to later onset dates and iii) the extension of autumn due to a later cessation date.

Reconstructed climate variability over the Late Glacial and Holocene in a southern Greece environment from a high-temporal resolution pollen record

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In this study, we attempt to reconstruct climate variability over the Late Glacial and Holocene as deduced from the centennial resolution pollen record of a shallow marine sediment core (S2P), recovered from Elefsis Bay in the western Attica Peninsula (southern Greece). The pollen record highlighted that the temperate deciduous, open oak woodlands of Late Glacial were fully expanded before the onset of the Holocene, without any pronounced setback, in contrast to pollen archives from northern Greece. Herein, we perform a quantitative pollen-based climate reconstruction using the Modern Analogue Technique (MAT). The annual and seasonal precipitation and temperature over the last 13.500 years are reconstructed on the basis of the closest modern pollen analogues to the fossil pollen assemblages. It is found that the observed changes in both seasonality and variability of the examined climatic variables probably drove the pronounced vegetation changes that are reflected in the Elefsis pollen archive, correlating well with the vegetation changes in the borderlands of Elefsis Bay and the marine paleoenvironmental record from the Aegean Sea.

A climatological assessment of desert dust aerosols using MODIS C6.1 and OMI-OMAERUV satellite data

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In the present study, a satellite algorithm that identifies dust aerosols (DA) aerosols all over the globe is developed and applied. The algorithm determines the presence of DA by applying specific threshold values on globally distributed Aerosol Optical Depth (AOD), Aerosol Index (AI) and aerosol Angstrom Exponent (AE) products. The AOD and AI data are retrievals taken from the MODIS-Aqua Collection-6.1 Level-3 and OMI-Aura (Ozone Monitoring Instrument) datasets, respectively, while AE is calculated using MODIS spectral AOD information. The algorithm operates on a daily 1°x1° latitude-longitude pixel level basis, and estimates the frequency of occurrence and the loadings (dust AODs, i.e. DODs) of DA on a monthly and annual basis, whereas corresponding climatological quantities are also computed for the period 2005-2018. According to the algorithm results, on an annual mean basis and averaged for the 14-year study period, the highest frequency (up to 170 days/year) and load (DOD up to 1.2) of DA are observed over the western part of N. Africa (Sahara), and the Bodélé area, and secondarily over the Asian Taklamakan desert (frequencies up to 140 days/year and DODs up to 0.5). On a mean global scale, dust exhibits a clear seasonality, with highest frequencies and loadings (DOD=0.021) in June and lowest ones in the period November-December (DOD=0.002).

Weather analysis and extremes (Oral session)

The deep depression that caused severe weather events in Greece at the end of September 2018

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At the end of September 2018, a deep depression that developed in the Gulf of Sidra, moved north-northeast and caused severe weather events in Greece. The depression exhibited some special features at the mature stage, such as spiral bands of deep clouds around the "eye", very strong cyclonic winds and thunderstorms, which are typically in the case of Mediterranean tropical-like cyclones or as simple they are called Medicanes (Mediterranean Hurricanes). Medicanes are warm-core cyclones that derive their energy mainly from the warm sea of Mediterranean and the release of latent heat in cumulus convection. In operational forecasting, the weather-forecast offices are called upon to identify in time the diagnostic features of a weather system and to select appropriate numerical weather prognostic products in order to issue early warnings. This work studies the capability to early diagnose and forecast the track and weather phenomena of the depression from the operational forecaster' point of view by using satellite products provided by EUMETSAT (MSG images, H-SAF precipitation, ASCAT wind), numerical weather forecast products provided by ECMWF (HRES, EPS) and METAR/SYNOP data, from 27-9-2018, which is the day the depression developed, until 1-10-2018/00UTC, when the most intense phenomena have occurred.

Study of cloud convection during the Mediterranean tropical-like cyclone case of September 2018

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The Mediterranean tropical-like cyclones (Medicanes) are exceptional meteorological phenomena observed over the Mediterranean Sea. The occurrence of Medicanes is rather rare but during their development phase, storms are being observed reaching the strength of a hurricane (Category 1) while main societal hazards include destructive winds, heavy precipitation, and flash floods. In late September 2018, one characteristic case of Medicane appeared over the southern Ionian Sea and gradually extended mainly over the Greek peninsula, causing extreme weather conditions and damages in the sea transportation sector as well as in inland infrastructures, especially in the coastal regions. In this study, multispectral Meteosat imagery was used to detect and monitor the evolution of the convective cloud characteristics (e.g. lifecycle duration, cloud top temperatures, areal extent). The first results of our analysis regarding the main characteristics of these cloud patterns reveal - among others - that during such events many well-organized mesoscale convective systems are developing reaching the tropopause, are long-lived (lifecycles larger than 4 hours) and are moving with relatively high speed (mean speed larger than 40 km/h).

The July 10, 2019 catastrophic supercell over Northern Greece. Part I: observational analyses

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Supercell thunderstorms represent the most organized, severe and longest-lived form of isolated convective storms with a persistent mesocyclone. On the evening of 10 July 2019, an extremely violent supercell storm hit central Macedonia and particularly the coasts of Chalkidiki. At least seven people were killed, more than hundred others injured and significant damages to agriculture and properties were reported. The storm had a 6-hour lifetime, moved rapidly towards east-south-east and covered a distance of more than 500 km. It presented a maximum reflectivity of 71 dBZ and cloud tops of 17 km. Damaging winds of over 100 km/h were recorded and a hail swath was observed along supercell track. The objective of this study is to investigate the environmental conditions which affected the occurrence and severity of the storm and mainly to provide a radar documentation of this extreme event. By using the Filyro C-band radar data, the generation, evolution and structure characteristics of this severe supercell are analyzed, studied and presented. Furthermore, the variation with time of several radar parameters computed by TITAN-software, are presented and the reflectivity images are analyzed in order to identify the morphology of radar echoes during the lifecycle of the supercell storm.

The severe weather outbreak in northern Greece on 10 July 2019: Atmospheric environment and storm characteristics

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On 10 July 2019, a killer mesoscale convective system (MCS) swept northern Greece with heavy rainfall, large hail, intense lightning and high gusty winds resulting to widespread damage in houses, infrastructure and cultivations, including 7 fatalities and 150 injuries in Chalkidiki. The MCS originated in the south Adriatic Sea, moved southeastwards through Albania and then swept northern Greece until dissipated in the northeastern Aegean Sea. Traveling for more than 5 hours in about 500 km it exhibited severe characteristics, especially in its nocturnal phase, with severe downbursts and gusts measured at 132 $km.h^{-1}$ within the mesocyclone where became a killer MCS in the area of Chalkidiki. Radar data revealed bow reflectivity patterns of the squall line and several well-organized thunderstorms, some exhibiting supercellular characteristics. Hailfall recorded in the hailpad network operated by the Greek National Agricultural Insurance Organization, within the context of the Greek National Hail Suppression Program indicated maximum hail sizes of 2-3.2 cm with 30 hailpads recorded hail. The synoptic and mesoscale environment is examined using surface, upper air charts and sounding data. Wind and thermodynamic parameters indicated high wind shear, strong storm relative helicity, moderate to large convective available potential energy and high precipitable water.

Impact of different heat waves definitions on their long-term statistics

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During the past two decades, heat waves (HWs) have been recognized as one of the most disastrous natural phenomena, with profound devastating impacts on the environment and humans. Many parts across the globe are witnessing for the first time prolonged periods of unusually hot weather, facing unprecedented health and environmental risks. Yet, climate change is expected to boost the probability of occurrence of such extreme events in the future. As a result, scientific community has a keen interest in studying long-term trends and statistics of HWs characteristics. Despite the strong interest in the topic, literature is still lacking a universal metric for HWs. A plethora of HWs definition has been adopted by researchers so far, based on varying temperature or duration thresholds even at local level. Population acclimatization and reference to health impacts have also been used in the assessment and evaluation of HWs. The study attempts to summarize a number of HWs definitions broadly used in the literature and explore the impact of the adoption of different metrics on the long-term statistics of HWs properties, such as their frequency, duration or timing. The analysis revealed distinct differences in the seasonal occurrence of HWs from the adoption of different definitions.

A study on the sea breeze characteristics at the coasts of Epirus, NW Greece

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The aim of this study is to explore the characteristics of sea breeze over the coasts of Epirus, NW Greece, which is a region with high meteorological interest due to its complex topography. For this purpose, the mesoscale weather model MM5 is used to simulate the atmospheric field at a high horizontal resolution (2 km), over the study region for selected typical summer days, viz. for days without synoptic scale phenomena. The study of various meteorological parameters, including eastward and northward wind components, humidity and temperature is carried out on horizontal surfaces at various pressure levels as well as on vertical surfaces, perpendicular to the more or less straight Ionian Sea coastline. The vertical extension of the sea breeze, the inland penetration of sea breeze front, its onset and cessation time and its association with other meteorological parameters such as temperature, humidity etc. are clearly revealed.

An investigation of the different scale atmospheric circulation features contribution upon the 2019 warm dry October – wet November in South Europe and mainly in Greece

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October 2019 was anomalously warm and extremely dry, while November 2019 was anomalously warm and wet. During both months, the Azores Anticyclone was well established over the North-eastern Atlantic with a rather positive phase of the North Atlantic Oscillation (NAO). During the entire October, the geopotentials over Europe at 500 hPa were extremely high, witnessing a lack of synoptic-scale waves (Rossby waves). Studying the air mass characteristics north and south of the wide straight belt of westerlies, we identify tropical air masses, which are usually found south of the Subtropical Jet Stream (SJS) this time of the year. The unavoidable interaction between the Polar Jet Stream (PJS) and SJS increased the hydrodynamic instability and led to a change of the atmospheric circulation with a great-amplitude Rossby wave train in November. The main purpose of this paper is to study the physical processes, mainly in a seasonal-scale period, responsible for the north extension of the tropical air masses, reaching directly the polar air masses. The northern-most limit of the Hadley Cell and the convective activity in the Intertropical Convergence Zone (ITCZ), the SST anomalies and the Madden Julian Oscillation (MJO) are studied in depth. Finally, the Eulerian streamlines and the Lagrangian air particles trajectories with starting points at the ITCZ, and not only, are also calculated.

Cloud detection methodology based on RGB images captured by a low-cost ground based all-sky camera

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Clouds play an essential role in the energy balance of the atmosphere. The estimation of the cloud coverage is crucial for meteorology, Radiative Transfer Model (RTM) simulations and can be used as ancillary data for instruments performing direct-sun observations, as well as sky-radiance measurements. In this study we present an automated algorithm, based on images captured by an all-sky camera operating at the Laboratory of Atmospheric Physics, AUTH, estimating the total cloud coverage and distribution around the site. This allows the examination of the temporal and spatial distribution of clouds and their presence in front of the sun. A geometrical calibration of the camera optics is performed with a checkerboard procedure, allowing us to know the sun's position on the image relative to the sky, even during cloudy days. The skydome cloud detection algorithm is based on the comparison of the Red/Blue Ratio of each camera pixel between a cloudy image and a cloud-free reference image captured quasi-simultaneously within ± 15 days. The circular Hough transform is used for the detection of clouds obscuring the sun by checking the existence of temporarily saturated pixels.

Applied Meteorology (Oral session)

A new method for the recognition and study of tropical-like cyclones over Mediterranean

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A number of tropical-like cyclones (TLCs), also referred to as "medicanes" have been identified in recent years over the Mediterranean and nearby sea basins. These storms share some characteristics with the tropical storms that develop over tropical oceans (eg. hurricanes). However, the task of distinguishing TLCs from extra-tropical storms, the dominant low-pressure system of the region, has been proven to be challenging, given that the method routinely used to distinguish tropical from extra-tropical storms performs poorly in this case. An original method for the objective recognition and study of TLCS is proposed. Taking advantage of the axial symmetry of TLCs, a local fit of an inverted cone on the geopotential height fields is performed. Apart from the identification of TLCs, an array of data is provided including the exact position of the center, the horizontal gradient of geopotential height outwards from the center and the radius of the symmetric area. The method requires gridded data, such as analysis or model results, and provides the aforementioned parameters for all available pressure levels. Further improvement of the method may allow its application on all available historical data in order to provide a full climatology of past medicane events.

The role of thermal criteria on the performance of the Mediterranean Frontal Tracking Scheme

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As atmospheric fronts constitute a significant weather component, extensive research has been conducted and several identification schemes have been created for their automated identification, using either kinematic or thermal criteria. Even though their performance is competent over oceanic regions, they do not perform well in the Mediterranean region, since Mediterranean fronts exhibit smaller spatial and temporal scales, and a complicated evolution regarding their kinematic and thermodynamic characteristics, especially for specific synoptic categories. The objective of this study is to present the structure of a cold front identification scheme that was developed for the Mediterranean, named MedFTS_DT and to validate its performance. The scheme was initially based on wind criteria and then additional thermal criteria were included to improve its performance. The obtained results are validated with the aid of synoptic charts. It was found that in the MedFTS_DT, the wind criteria are prerequisites for the identification of Mediterranean cold fronts, while the thermal criteria provide a stricter filter that serves to limit the initial number of identified fronts.

Freshwater wetting/drying shifts driven by warming and human water use for food and energy supply

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Data and climate model results for covariation of temperature and precipitation (P) over land have indicated predominantly positive association (warming accompanied by wetting) in Northern Europe, mostly negative (warming-drying) in Southern Europe, and mixed in central Europe. This paper investigates more comprehensively what temperature-hydrology covariations look like, and how they have been shifting towards wetting or drying of various land areas, in terms of all main terrestrial water fluxes: P as the atmospheric water input, as well as evapotranspiration (ET, green water flux) and runoff (R, blue water flux). This is done based on measured data over (parts of) the last century, when land areas experienced both global warming and major human-driven local expansions of engineered flow regulation (dams, reservoirs) and both rain-fed and irrigated agriculture. For 13 studied hydrological basins with identified major human flow regulation and agricultural expansions in the Northern Hemisphere, results show more multifaceted and complex temperature-hydrology covariation patterns than just simple binary wetting or drying of land under warming. All study basins exhibit largely human-driven green-water wetting (ET increase), while blue-water drying (R decrease) emerges in most basins with either decreased or increased P water input (atmospheric drying or wetting).

Urban green against built environment in terms of human thermal sensation in Athens, Greece

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Green spaces within urban built environments could be beneficial for human thermal comfort at the micro-scale, especially during summer period at moderate climates, by effectively reducing heat stress. The objective of this study is to evaluate the human thermal sensation in a green-urban area of Athens during a summer day by using a three-dimensional, prognostic, microscale climate model (ENVI-met V3.1) and utilizing mobile meteorological measurements. The experimental micro-measurements of air temperature, humidity, wind speed, globe temperature and global solar radiation were conducted in two routes on July 12, 2017, from 15:00 to 17:00 and from 21:00 to 23:00 Athens local time (UTC+3:00). The meteorological parameters were recorded every 5s, using the appropriate sensors mounted on a cargo bicycle at 1.5m height. To gain insight of the human thermal sensation, the human thermal index Physiologically Equivalent Temperature (PET) was estimated with respect to both model's simulations and experimental micro-measurements. The in-situ measurements along with the model's output results reveal the thermal comfort regime of the selected area and the ability of the model to illustrate the micrometeorological conditions, under different mitigation scenarios.

Investigating the relationship between wind gusts and lightning activity at a wind energy power plant in a hilly region of Western Greece

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Wind energy power plants increase significantly nowadays in Greece, producing an important part of the increasing electricity demands. Nevertheless, wind power plants are vulnerable, among others, to abrupt weather changes caused especially by thunderstorms followed by lightning activity and the accompanying severe wind gusts and rapid wind direction changes. Power outages, problems in the utility's distribution system and extensive damage to wind turbines are some of the results that such phenomena may cause. Therefore, the knowledge of the relationship between the storm systems and the produced wind field is essential in order to establish a wind power plant during the construction and operation phase as well. In this study, the relationship of severe wind gusts in regard to lightning activity in the vicinity of a wind farm, in a hilly region of western Greece is examined. Wind speed and direction data come from wind turbines and cover the period 1-1-2012 until 31-12-2014, while the corresponding lightning data from the ZEUS European network. Results show that wind gusts are well correlated to lightning flashes. Furthermore, correlation maximizes during winter when well organized weather systems affect the area and minimum in summer as a result of local storms due to thermal instability.

Measuring and predicting heat stress conditions with the WBGT index

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Heat stress refers to a range of conditions where the body is under stress from overheating. Exposure to extreme heat combined with other meteorological conditions can result in occupational illnesses and injuries, thus its prevention is of high importance. As early as the 1950s, an index was used to control serious outbreaks of heat illness in training camps of the United States Army and Marine Corps. This index is the Wet Bulb Globe Temperature (WBGT), that has been the most popular indicator used to reflect the environmental conditions that can be potentially threaten the safety of workers. Through a collaboration with the Ministry of Labor, the Hellenic National Meteorological Service (HNMS) installed equipment provided by University of Thessaly, with the aim of monitoring WBGT fluctuations during the warm period of the year at four military airports. These measurements were analyzed and correlated with typical meteorological parameters. As with all indices that integrate elements of the thermal environment, interpretation of the observed levels of WBGT requires careful evaluation of the activity to be undertaken and other factors before linking them with adverse effects, in the context of a competent risk assessment. At the same time, high resolution temperature, wind and solar radiation forecasts from the COSMO-GR1 NWP model were used as input to a software package that was adapted to provide WBGT prognostic fields using the Liljgren methodology. Observations from the test period were used to evaluate the accuracy of the WBGT forecasts as well as to assess whether WBGT sensors should be included as part of the basic equipment of meteorological stations in order to better ensure safe working environments during the summer.

A system for the assessment and mapping of vulnerability and risk related to high impact weather events in Greece: Yantas project

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Weather-related phenomena such as floods, mass movement, windstorms, and hailstorms, cause extensive damages in Greece, while their frequency and intensity are expected to increase given the adverse climate change projections for the area. At the local scale, the interaction between meteorological conditions, geophysical and demographic features can affect the magnitude of damage and the consequent insured financial losses. Although the impact of weather-related events on insurance companies is significant, insurance practices have not yet been adjusted to account for and effectively address local weather-related risks. Towards this direction, the YANTAS project aims to meet a significant need of the Greek insurance market, specifically the part covered by the INTERAMERICAN insurance company, which is related to the assessment of weather-related risks and vulnerability at the local level. For this purpose, a science-based interactive tool is being developed and tailored to the requirements of INTERAMERICAN for mapping and analyzing insured losses in relation to weather hazards, as well as to vulnerabilities associated with geophysical and demographic conditions and human activities, at Postal Code level. This work is devoted to the presentation of the methodology applied for the development of indices of weather hazard, vulnerability, and risk of losses, followed by preliminary results. YANTAS is co-financed by the EU and national funds.

Atmospheric temperature anomalies as manifestation of the dark universe

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The manifestation of the dark Universe begun with unexpected large-scale astronomical observations. We are investigating the possible origin of small-scale anomalies, like the annual stratospheric temperature anomalies. Unexpectedly within known physics, their observed planetary relationship, does not match concurrent solar activity (F10.7 and EUV emission), whose impact on the atmosphere is unequivocal; this different behavior points at an additional energy source of exo-solar origin. A viable concept behind such observations is based on possible gravitational focusing by the Sun and its planets towards the Earth of low-speed invisible (streaming) matter; its influx towards the Earth gets temporally enhanced. Only a somehow "strongly" interacting invisible streaming matter with the little screened upper atmosphere can be behind the temperature excursions. Ordinary dark matter (DM) candidates like axions or WIMPs, cannot have any noticeable impact. The associated energy deposition O(~W/m^2) varies over the 11-years solar cycle. For the widely assumed picture of a quasi not-interacting DM, the exo-solar energy is enormous. The atmosphere is uninterruptedly monitored since decades. Therefore, it can serve as a novel (low threshold) detector for the dark Universe, with built-in spatiotemporal resolution while Sun's gravity acts temporally as signal amplifier. Analyzing observations from the anomalous ionosphere we arrived in this work to surprising relationship with inner earth activity like earthquakes. Similarly investigating the transient sudden stratospheric warmings within the same reasoning, the nature of the assumed "invisible streams" could be deciphered.

Remote Sensing (Oral session)

Contrail detection on SEVIRI images and one-year study of the physical properties of contrails and the atmospheric conditions favoring their formation over Europe

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Contrails and contrail–cirrus clouds have a great effect on the atmosphere's radiation balance and the climate. The aim of this study is to analyse the physical properties of contrails and determine the atmospheric conditions favoring their formation, with the use of satellite data. The contrails are detected on satellite images obtained by the SEVIRI radiometer, using a modified version of the Contrail Detection Algorithm. The area of interest includes central and western Europe and the time period is the year 2016.
Five contrail detection hotspots are located. The length of the detected contrails lies between 225 and 292,5km and the mean width between 5,1 and 8,1km. Results of the comparison with the ERA-5 reanalysis database show that contrail formation and persistence is favored in ice saturated areas (RHI≈100%), when the temperature is between 204 and 232K (-69 ^{o}C to -41 ^{o}C) and the specific humidity between 0,025 and 0,05gr/kg. The favorable wind direction is W-SW(240^{o}-260^{o}) and wind speed between 10 and 30m/s.

Geometrical and microphysical properties of clouds above Eastern Mediterranean during Pre-TECT

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Clouds play an important role in the Earth's climate, by modulating the radiation budget and the water cycle. The observation of clouds is crucial to study their formation, evolution, properties, radiative effect, as well as to evaluate and improve their representation in climate and weather forecast models. Nevertheless, high-quality vertically-resolved cloud observations above the Eastern Mediterranean are sparse. In this work, collocated lidar/radar observations are used to retrieve the vertical profiles of cloud properties above the Eastern Mediterranean. The study utilizes the measurements collected during the Pre-TECT experiment, between 1st and 30th April 2017, at the Greek atmospheric observatory of Finokalia, Crete (University of Crete). We investigate three cases with clouds formed in (i) a cyclone, (ii) the area between two air masses with different thermodynamic characteristics, and (iii) the presence of an intense dust event. The cloud geometrical and microphysical properties are derived using the Cloudnet target classification algorithm over Finokalia, and using the MSG-Seviri cloud top temperature product over the Mediterranean. Statistics on the clouds thermodynamic phase (ice, water, mixed-phase) at different temperatures during the Pre-TECT campaign are provided. The study demonstrates the advantages of the synergistic use of lidar and radar observations to derive the vertically resolved cloud properties with high spatio-temporal resolution. The high-resolution vertical distributions of clouds and their thermodynamic phase derived in this study can be used, in combination with further Cloudnet cloud products and lidar-retrieved aerosols properties, for studying aerosol-cloud interactions and evaluating their parameterizations in models.

Study of aerosol layer height product by synergistic use of passive satellite instruments with EARLINET lidar data: Case studies in Mediterranean Basin

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Knowledge of the aerosol layer height is essential for understanding the impact of aerosols on the climate system and also can be useful for aviation and air quality alerts. In this study we compare Aerosol Layer Height product retrieved from TROPOMI and GOME-2 satellite instruments on-board Sentinel 5-P and MetOp platforms respectively, using coincident observations from EARLINET ground-based lidar, for selected dust events, over Mediterranean Basin. The satellite ALH product, focuses on retrieval of vertically localized aerosol layers in the free troposphere, such as desert dust, biomass burning or volcanic ash plumes. The European Aerosol Research Lidar Network (EARLINET), is a lidar network for aerosol study on continental scale and is a suitable source for the long-term validation for the satellite products. We select two days with strong presence of desert dust for the comparison between satellite product and lidar backscatter profiles at a selected wavelength channel. The ultraviolet aerosol index is a method of detecting absorbing aerosols from satellite measurements in the near-UV region. Spatio-temporal collocation criteria used by EARLINET stations for correlative study measurements with satellite instruments are on the order of 150 km and 5h. Additional, HYSPLIT back trajectories are taken in order to determine the aerosol load origin.

Rainfall estimation using microwave links from cellular communication networks in Lebanon

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Rainfall measurement is very crucial for water management, weather prediction, flood warnings, agriculture and many other applications. This paper describes and analyzes a promising method for rainfall measurement in Lebanon based on commercial microwave radio links of cellular communication networks. This technique is based on the attenuation of signals transmitted between microwave links. It benefits from a low cost and high resolution. Calibration of some parameters is performed in order to enhance the accuracy of this method. Comparison between our results and classical rain gauge measurements proves the high accuracy and precision of this method. Also, this method can be combined with other rainfall measurement techniques to produce more consistent and accurate information for rainfall measurement in Lebanon.

Sentinel-5P/TROPOMI views abrupt changes in nitrogen dioxide levels over Greece after the outbreak of COVID-19

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The strict enforcement for near total lockdown of the Greek population due to the Severe Acute Respiratory Syndrome CoronaVirus-2 (COVID-19) pandemic in March 2020 has offered a unique opportunity to study the contribution of vehicular nitrogen dioxide (NO_2) emissions to the country's air quality. S5P/TROPOMI monthly mean NO_2 observations show an average decrease of -3% to -26% [-1% to -27%] with an average of -22% [-11%] for March and April 2020 respectively, compared to the previous year, over the six larger Greek metropolitan areas, attributable mostly to vehicular emission reductions. Furthermore, significant effects for shipping emissions over the Aegean Sea as well as surrounding major Greek ports were observed, of approximately -12% [-5%]. For the capital city of Athens, weekly analysis was possible which revealed a marked decline in NO_2 load between -8% and -43% for seven of the eight weeks studied. Chemical transport modelling, provided by the LOTOS-EUROS CTM, shows that the magnitude of these reductions cannot solely be attributed to the difference in meteorological factors affecting NO_2 levels. Taking this factor into account, the resulting decline was estimated to range between 0% and -37% for the largest Greek cities, with an average of ~ -10%.

Detection of NO_2 plumes from individual ships over the Mediterranean Sea with the TROPOMI/S5P

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Until now, the spatial resolution and data quality of satellite sensors allowed for monitoring tropospheric NO_2 enhancements only over the busiest shipping routes after averaging at least several months of data. Here, we observe for the first time the NO_2 pollution plumes of individual ships with the TROPOspheric Monitoring Instrument (TROPOMI) onboard the Copernicus Sentinel 5 Precursor (S5P) satellite (central Mediterranean; on 2 July 2018). The synergistic use of TROPOMI/S5P tropospheric NO_2 column measurements, Automated Identification Signal (AIS) ship data and near surface wind field data from the European Center for Medium range Weather Forecasts (ECMWF), and the application of a simple "morphing" technique showed that the vast majority of the NO_2 plume-like structures seen in the TROPOMI/S5P data can be attributed to the plumes of the largest ships or groups of ships that were sailing in the area the last three hours prior to the TROPOMI/S5P overpass. The low winds and the fact that the TROPOMI/5P measurements were taken under sunlit conditions (higher signal to noise ratio) favor the detection of such structures. Finally, the use of an emission proxy (Es) based on ship length and speed shows that the projected plumes of the largest and fastest ships, which are expected to emit more, indeed coincide with higher tropospheric NO_2 levels.

Climatology (Poster session)

On the atmospheric circulation characteristics associated with extreme precipitation in the Iberian Peninsula

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The atmospheric circulation characteristics favoring extreme precipitation in the Iberian Peninsula are examined with the application of a multivariate statistical methodology including Principal Component Analysis (PCA) and Cluster Analysis (CA) on the circulation parameters before, during and after the end of extreme precipitation events. The data used are: i) daily 0.2°×0.2° grid point values of precipitation over the Iberian Peninsula and the corresponding ranking of extreme precipitation dates obtained from IB02 data set and ii) daily NCEP/NCAR Reanalysis 2.5°×2.5° grid point values of 500 hPa and 1000 hPa geopotential height, 500 hPa and 850 hPa air temperature and 850 hPa specific humidity over the North Atlantic and western Europe, from October to March and for the period 1950-2007. The extreme precipitation events are defined as the sequences of consecutive extreme precipitation days. PCA and CA are applied on the above data for D-1, D and END days of the extreme precipitation events (D day is defined as the first day of the event, D-1 day is defined as the day before D day and END day is defined as the day after the last day of the event) and result into 6 clusters. Each cluster corresponds to a specific precipitation pattern and a specific evolution type of atmospheric circulation. Most events occur during December and January and take place in the western part (Portugal), while a low-pressure system west of Britain appears in the majority of the events.

TIN-Copula method: A new statistical method for the bias correction of extreme climate events

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Global and Regional Climate Models are two widely used tools for projecting the future climate situations globally or in smaller areas. However, it is accepted that, their ability to estimate the future climate – and specifically the future extreme events- is limited, due to several reasons. Consequently, different statistical methods are used in order to correct their results. The aim of the present study is to present and to evaluate a newly introduced statistical method which is named "TIN-Copula". The TIN-Copula method is a method combining two mathematical theories, Copulas and Triangular Irregular Networks (TIN). The TIN-Copula method is used for bias correction of extreme high and low temperatures in five stations, located in the Mediterranean area. Additionally, there are three other widely used methods, which are the Delta, Scaling and Empirical Quantile Mapping, and used for bias correction of the same parameters in the same five stations, in order to compare their results with the TIN-Copula's values. The results show that the new proposed method has important advantages and can approach extreme temperature events in the Mediterranean area with high accuracy.

A weather type classification for northwestern Greece

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A weather type classification for northwestern Greece is performed with the use of the ERA5 high resolution meteorological database. The ERA5 data used are: i) 6-hourly (00, 06, 12 and 18 UTC) values of 2 meter air temperature and dew point, 10 meter zonal and meridional wind components, cloud cover (low, medium, high and total) and convective available potential energy at 0.25ºx0.25º resolution over NW Greece and ii) 12-hourly (00 and 12 UTC) values of 850hPa air temperature and 500hPa and 1000hPa geopotential heights at 1ºx1º resolution over the Mediterranean region, for the 10-year period 1/1/2009-31/12/2018. A multivariate statistical methodology including Principal Component Analysis and K-means Cluster Analysis is applied on the above data set leading to 10 clusters (weather types) for NW Greece. The intra-annual variations of the 10 clusters' frequency show the seasonality of the corresponding weather types, while the mean patterns of the meteorological parameters for the days classified into each cluster reveal their main meteorological characteristics connected mainly to dynamic, orographic and radiation factors.

Analysis of parallel measurements of daily maximum and minimum temperatures in Greece

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Long climate records include also non climatic variations due to e.g. station relocations (from urban centres to airports), changes and calibrations of instruments, changes in the procedures of data collection and handling. These non-climatic variations (inhomogeneities), impede the use of climate records for climate change studies, especially for changes in extremes and weather variability using daily data. One important cause of inhomogeneities is the introduction of automatic weather stations (AWS) that replaced the conventional meteorological stations and methods of observation. This introduction is often accompanied by station relocation. To cope with the problem, WMO recommends a period of parallel observations, the duration of which depends on the observed parameter. The WMO guidance is 12 months for wind speed and direction, 24 months for temperature, humidity, sunshine and evaporation, and 60 months for precipitation. In literature, several studies analysing parallel measurements can be found. Also, the International Surface Temperature Initiative has set up the Parallel Observations Science Team (POST) aiming at compiling a database with parallel measurements. In this work we present the preliminary results of analysing parallel measurements of daily maximum and daily minimum temperature, coming from the weather station network of the Hellenic National Meteorological Service (HNMS).

Investigation and validation of climate data time series as derived by ERA5 and ERA20c models and local observations for Kotili, Kastoria, Greece

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We used modeled data from ERA5 and ERA20c models to reconstruct the climate conditions, of the now abandoned village of Kotili, in relation with new on-site observational data. In order, to describe the climate conditions of the last 120 years, that are needed, in further ecological and historical studies. Due to the lack of previous observations, we installed a small weather station and an array of temperature and humidity sensors in the region. By comparing the measured data, from our sensors in the area, we concluded that the modeled data are in good agreement with the observations. These results, indicate a good correlation of the measured parameters with the models, without the need of further adjustments. This approach, establish that the modeled data used, is a viable method for creating a 'best approximation' time-series describing the climatic conditions of this remote location.

Study of trends and fluctuations of mean air temperature at the surface and in the lower troposphere in the wider region of Greece for the period 1965-2020

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The present study examines the mean, mean maximum and mean minimum annual, winter and summer temperature recorded by various stations and at various levels in the wider Greek region. Our aim is the investigation of trends and correlations between the temperature at surface stations and the temperature recorded in the lower troposphere as well as the general circulation indices that affect the region. The results show that temperature increases in the surface stations are mirrored in the upper air data, which agrees with the view that climate change is reverberated in the upper atmosphere. In addition, statistically significant correlations exist between NAOI and NCPI indices, while there is no statistical correlation between SOI and the stations

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A spatio-temporal study on hail in Central Macedonia, Greece

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This study deals with hail across Central Macedonia, Greece, for a 10-year period (2008-2017), during summer (16 May – 15 September). The hail data are collected from the 153 hail recording stations (hailpads) of the Hellenic Agricultural Insurance Organization (ELGA). A detailed spatio-temporal analysis using the multivariable statistical method Factor Analysis is performed. The analysis focuses on the spatial distribution of hail in order to define sub-periods of summer with characteristic distributions of hail in the study area (T-mode analysis). The analysis has been conducted for three hail parameters: frequency, density and size. The results show that summer can be divided into 4 sub-periods, common for all parameters. The path of hail occurrence during summer is revealed and is characterized by the movement of the atmospheric systems, the storms movement and by the orography of the area. In addition, it is observed that the three hail parameters examined appear their maximum and minimum values almost at the same or nearby hailpads.

Observed and projected changes in energy demands at Mediterranean cities

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Global climate change is one of the most crucial issues of contemporary life as it has important impacts on many aspects of human life, one of which is the energy sector. This research focuses on a very responsive to climate change area, the Mediterranean, and attempts to analyze the energy demand trends from 1970 through 2100, processing not only historical temperature records but future simulations from Regional Climate Models concerning seven Mediterranean cities of different sizes and geographical characteristics. Cooling degree days (CDD) and heating degree days (HDD) have been estimated in order to point out the trends in the amount of energy demands. The research has shown a statistically significant decrease in heating demands at all cities, while cooling demands are increasing at rates reaching up to 64 degrees per decade. On the other hand, there is a remarkable expansion of the duration of the cooling demands period, at rates of 5 to 6 days per decade till the end of the century. At the same time, the duration of heating demands period presents a negative trend, at rates between -4 to -7 days per decade.

On dew point climatology over Greece

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Dew point reflects the amount of moisture content in the air and it is widely used in meteorology and climate research. The aim of this work is to perform a spatial and temporal analysis of dew point over Greece and an inter-comparison between dew point values from different datasets. For this reason, data from reanalysis products and weather stations are used. The spatial patterns of yearly, seasonal and monthly dew point from reanalysis datasets are compared with observational records to evaluate the corresponding differences and biases. Additionally, their patterns are examined and discussed in terms of the synoptic, mesoscale and local influences. Moreover, some interesting statistical aspects are examined from the dew point frequency distributions, giving emphasis to the spatiotemporal mapping of extreme values, using the upper percentiles. The results are expected to contribute to the study of climate over Greece.

Impact of effective radii communication between microphysics and radiation schemes

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In this work, we assess the impact of the communication between the microphysics and radiation schemes regarding the effective radii of cloud particles. We use the WRF 3.8.1 regional climate model forced by ERA interim reanalysis to conduct simulations over Europe with a spatial resolution of 0.44^{o} for the 2004-2008 period. Impact assessment is done by comparing two simulations: one with enabled communication between the microphysics and radiation schemes and one simulation that has it disabled and thus, relies on the assumptions of the radiation scheme to parameterize radii of cloud particles. Results indicate a strong impact on shortwave radiation at the surface. The simulation with the disabled communication presents consistently larger shortwave radiation amounts for all seasons, with the average increase ranging from +1% in autumn to +7% in winter. The radiation increase is larger above the sea, and ranges between +7 to +10%. A particularly large and statistically significant radiation increase is seen over the Atlantic Ocean in spring and especially summer, surpassing +15% over extensive areas. The impact on shortwave radiation also affects temperature, mainly over land. An extensive area of significant temperature decrease, exceeding -0.5^{o}C, is seen over central Europe in autumn.

Heating degree-days climatology over Greece at the service of government granting heating subsidy and energetic optimization of building insulation

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Heating Degree Days (HDDs) is a climate index designed to reflect the energy demand needed to heat a home or a business. HDDs index derives from measurements of outside air temperature. The objective of this study is to assist government intentions to revise the criteria for granting the heating subsidy to households. HDDs were calculated by using daily maximum and minimum temperatures of 59 meteorological stations of the Hellenic National Meteorological Service, covering 45 years (1960-2004). Daily temperature compared with a base temperature of 15.5 ^{o}C to measure how much the outside air temperature was lower than the base temperature. Then HDDs were calculated for each location on an annual basis. Afterward, a mathematical model was applied to estimate HDDs at a spatial resolution of 0.0083° (730m 38°N) by using twenty geographical and topographical variables as independent variables. Some of the predictors used are elevation, latitude, incoming solar irradiance, Euclidean distance from coastline, land to sea percentage of area coverage, peaks and valleys, east/west and north/south slopes and saddles. The geographical distribution of HDDs revealed five climate zones. The outcome of this study is the determination of coefficients for the heating subsidy at 13,548 Greek cities, towns and villages.

Evaluation of incoming solar radiation at titled surfaces at various European cities

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Solar energy is one of the most sustainable, safe and abundant renewable energy sources. Inclined Photovoltaic panels are used aiming to maximize received energy. Inclination of installation most popular choice is a tilt angle equal to location latitude, which under clear sky conditions is the most effective. Cloud coverage changes the solar radiation field by limiting the direct and enhancing the diffuse radiation and affects the optimum tilt angle. In order to study this impact, hourly data extracted from Copernicus Atmosphere Monitoring Service for 21 European cities, (2005-2019) were used. Hay model for diffuse irradiance and Isotropic constant albedo model for reflected irradiance were used to simulate the incoming radiation on surfaces with various inclination angles and constant azimuth angle (southwise). Finally, regression equations are proposed for the simple and practical estimation of the optimum angle as a function of latitude and CMF in annual and seasonal basis. Also, in order to evaluate different suggestions of changing tilt angle, three scenarios are investigated and the energy potential of annual results is compared. Results showed that with increasing cloudiness the difference of the optimum to the theoretical (equal with the location latitude) angle is increasing.

A global climatology of tropopause folds in CAMS reanalysis

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Tropopause folds are considered as the main mechanism for Stratosphere-to-Troposphere Transport (STT) affecting the composition of the troposphere and the lower stratosphere, while in terms of dynamics they may be involved in the triggering and development of surface weather systems. This study explores the global climatology of tropopause folds during the period 2003-2018 using the Copernicus Atmosphere Monitoring Service (CAMS) Reanalysis (CAMSRA) data product. A 3-D labeling algorithm is applied in CAMSRA meteorological fields to classify the air-masses, and subsequently detects the folding events. Following their detection, folds are distinguished in shallow, medium and deep, according to their vertical extent into the troposphere. On a seasonal basis, the spatial distribution of tropopause folds frequency around the globe is mainly governed by the location and intensity of the jet streams, thus exhibiting more folds at the Northern Hemisphere during winter and spring, and vice versa during summer and autumn. The spatiotemporal characteristics of shallow, medium and deep fold occurrence are consistent with recent ERA-Interim based climatological studies.

Applied Meteorology (Poster session)

Winds, waves and sea surface chlorophyll concentrations

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Sea surface chlorophyll, a proxy of phytoplankton abundance, can be impacted by meteorological factors and extreme weather events. Meteorological events that induced strong winds and high waves over a wide part of the Eastern Mediterranean Sea are examined here regarding their influence on sea surface chlorophyll concentrations. The study areas are delineated by the higher values of the ECMWF - Extreme Forecast Index. Using satellite derived data, the differences in chlorophyll between the values after the events and the ones before, as well as in respect to the monthly climatology, are calculated. The results show that enhanced wind and wave conditions are related to chlorophyll increases over a large part of the affected areas. It is noted that the relation between extreme weather events and chlorophyll concentrations over the open sea have been scarcely examined for the Eastern Mediterranean.

In-flight rerouting in adverse convective weather conditions

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Weather imposes important safety and financial issues on aviation. Adverse weather, such as convective conditions, leads to cancellations or delays of scheduled flights, or even fatal accidents. Convective conditions are usually associated with the development of TCU clouds and thunderstorms. Due to the updraft or downdraft occurring in such cases the lift, the total drag and the aerodynamic moments about all axes of the aircraft will be affected making the aerodynamic efficiency of the aircraft to decrease. It is therefore evident that convective conditions should be avoided during flight. For this purpose, a rerouting path expert system has been developed. This system firstly identifies the presence of convective areas based on predicted composite reflectivity greater than 35dBz resulted from WRF-ARW model. Then knowing the initial flight path described by way points, it is checked whether hazardous convective areas are to be traversed. Rerouting consists of determining new way points performing at the same time an estimation of the fuel quantity required for the proposed rerouting depending on the type of the aircraft. The system is initially implemented in a case of strong synoptic forcing associated with intense convective activity over Greece for various flight tracks of a specific aircraft.

F - Index, a new fire weather index, well promising for Greece

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The necessity for our country to adopt a National Fire Danger Rating System that combines convenience and objectivity was the reason to document the suitability of the F - INDEX for the Greek physical conditions. F - INDEX is related to rate of spread of the Greek forest fires. The maximum daily values serve as a measure of the maximum possible burned area, while the 5 risk classes serve as a measure of the average burned area per fire. Due to its mathematical structure, modifications of the F - INDEX are possible for an even better adaptation to Greek physical conditions, although with the available data the index responds very well.

Meteorological parameters that influence the environmental risk of a marine accident with oil pollutants in the Aegean

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Several areas of Greek territorial waters, although environmentally sensitive, have already been heavily burdened by oil pollutants caused by marine accidents. The morphology of the sea area (narrow waters, shallow waters near bays and ports), specific weather phenomena and increased traffic in certain marine routes, make the risk of an accident with environmental effects of this nature even greater. Data so far has indicated that maritime accidents and especially in the unique Greek maritime area will occur. In this particular paper, we attempted to identify all the possible weather phenomena occurring to Greek seawaters and how they could possibly influence the impact of a marine accident that causes oil pollutants. In the context of this effort, we focused on studying weather conditions that occur on certain time periods and areas of Greek seas that could possibly affect the risk of an accident to occur and how these conditions will affect the restoration of possible environmental damage. In order to fulfill the above project an effort to study and understand previous maritime accidents and their current weather conditions at Greek level was made.

Electrical properties of transported dust layers due to atmospheric ion attachment to dust particles

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Electrical processes can have a potential key role in the life-cycle of desert dust. The dust particles can be charged during their long range transport, either by the attachment of atmospheric ions or by particle-to-particle collisions (triboelectric effect). These processes, along with the gravitational sedimentation that sorts dust particles by size, can develop vertical electric fields within the dust layer, enhancing the preexisting field attributed to the depletion of atmospheric conductivity by the dust layer presence. In the present work, we have developed a novel 3D Cartesian time-dependent model that takes into account several atmospheric processes, such as: (i) the ionization due to the galactic cosmic rays radiation, (ii) the ion-ion recombination, and (iii) the ion attachment to dust particles. The model is able to self-consistently calculate the time-dynamic evolution of the atmospheric conductivity, and atmospheric electric field, under the presence of a distribution of stationary dust particles. The results, in the steady state limit, are compared with recent and unique electric field measurements within lofted dust plumes, as obtained from novel miniature low cost field mill sensors, coupled to atmospheric radiosonde launches during planned experiments of the "D-TECT" ERC project.

An assessment of microclimatic conditions inside vegetated and non-vegetated small-scale open spaces in the Athens urban environment

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A vast amount of studies on typical urban green and open spaces such as parks and urban squares does exist. Studies on small-scale clusters such as open spaces between buildings and similar design features that may provide passive cooling potential are, however, in general, limited. This study examines the microclimatic conditions of small-scale open spaces such as courtyards and small backyards in Athens. Courtyards are common architectural solutions that can be positive or negative urban climatic elements. Backyards, the result of regulations due to the high building density, are irregularly shaped space, usually without plants and trees. A vegetated courtyard and two different backyards were appropriately monitored along with two reference sites during the summer of 2019. A detailed statistical analysis was performed. The maximum values of the cool island effect were found to be on the order of 8 K inside the more vegetated locations (i.e. Vegetated Backyard, Garden Sunlit and Garden Shade). The maximum values of the heat island effect were found to be on the order of 6K (Garden Sunlit, 5.9 K; Backyard, 5.7 K).

Exposure of Athens population to environmental stress

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A crucial and open issue is the exposure of urban population to the combined impact of heat stress and air pollution. The environmental pressures due to the global and regional warming alongside with the rapid urban growth negatively affect the thermal environment, altering the thermal budget in cities which in turn affects the outdoor thermal comfort conditions. At the same time, poor air quality in urban areas constitutes an additional aggravating factor for the citizens' health. The majority of health impact studies conducted in Europe conclude that particulate matter (PM) and ground-level ozone (O_3) have the most harmful effects on human health. The present study attempts to make an overall assessment of the environmental stress due to heat stress and air pollution at the city of Athens, analyzing meteorological and air quality data for the period 1987–2017. The impact of thermal environment on humans was assessed employing the advanced Universal Thermal Climate Index (UTCI). The harmful levels of the studied pollutants (O_3, PM_{10}) were based on the latest air quality standards. The analysis reveals that the health-related threshold of O_3 and the lower heat stress level of UTCI index were simultaneously exceeded during 942 days (8.32%) of the study period.

Artificial neural networks applied on field monitoring data for the estimation of thermal sensation

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Thermal sensation is used to estimate thermal environment, although its assessment is a research issue. This study aims to develop a method based on an Artificial Neural Network (ANN) to predict actual thermal sensation (ATS), as reported by pedestrians in field-questionnaire surveys. Meteorological variables were monitored in outdoor public places, at the height of 1.1 m and questionnaire-based interviews were conducted in pedestrians at the monitoring sites. Participants reported their thermal sensation on a predetermined seven-point bipolar scale from cold (-3) to hot (+3), namely ATS. A total of 1706 questionnaires were collected spanning three seasons of the year (summer, winter and a transitional season). Multilayer perceptron (MLP) based ANN models were developed and trained to predict ATS. Several combinations of field-measured meteorological variables were tested as inputs to the ANNs. The traditional feed-forward neural architecture was utilized with different number of hidden layers and neurons per layer. Results showed that a simple two-layered ANN is able to predict ATS with an average error of 0.7 of the seven-point thermal sensation scale. The achieved error compared favorably to the corresponding error of the thermal indices Physiologically Equivalent Temperature and Universal Thermal Climate Index.

Exposure to hot thermal conditions and heat-related symptoms in Cyprus: a field survey study among pedestrians

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Climate change is linked to many environmental impacts including rise in ambient temperature and more intense and frequent heat waves. Extreme thermal conditions constitute a significant public health problem increasing morbidity and mortality around the world. Exposure to heat causes heat-related illness, affects people with cardiovascular and respiratory disorders, and increases death rates. This study aims to examine the association between outdoor thermal conditions and heat-related symptoms experienced by pedestrians. We conducted field questionnaire-based surveys in outdoor public spaces in Cyprus monitoring meteorological variables and ozone and particulate matter (less than 2.5 μm in diameter) concentrations, while asking participants to self-report whether they were experiencing heat-related symptoms (i.e., headache, nausea, dizziness, weakness, exhaustion, cramps, rash and breathing difficulties). The questionnaire included items on demographics and participants' characteristics (i.e., exposure history and duration, recent thermal experience, visit purpose, medical history, thermal sensation). Physiologically Equivalent Temperature (PET) was used to estimate the integrated effect of thermal environment. Logistic regression analyses showed that one degree increase in PET was associated with increased likelihood of reporting heat-related symptoms (Odds Ratio: 1.03; 95% Confidence Interval: 1.02-1.05). Given the continuously rising temperatures from climate change, the results of this study can be used to improve mitigation measures, health care and public health services.

Field surveys on the subjective assessment of sound level in urban settings

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Noise in urban settings is an environmental source of nuisance, which together with air pollutants and adverse thermal conditions, has a strong impact on human health and well-being. This study aims to examine sound level perception due to individuals' exposure to urban acoustic conditions. Sound levels and micrometeorological conditions were monitored in five urban squares in Athens, Greece, using a mobile station installed temporarily at the monitoring sites. Pedestrians' personal sound level evaluation (SLE) was reported on a five-point symmetric scale from very low (-2) to very high (+2) during questionnaire-based interviews. Statistical analyses included chi-square, analysis of variance and ordinal logistic regression models. Results from 1762 participants showed that higher sound pressure levels and air temperature values were associated with higher ratings of SLE. One unit increase in sound pressure level resulted in 1.13 ($p<0.001$) increase in the odds for reporting a higher SLE rating. Females ($p=0.035$) and individuals visiting the site for work purposes ($p<0.001$) were more likely to report higher SLE than males or individuals visiting the site for entertainment. Age, thermal sensation and comfort, health symptoms, and preference for urban design improvements also affected SLE. These results could be applied in urban design and mitigation measures.

Identifying patterns of airborne pollen distribution using a synoptic climatology approach

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Pollen grains are well-known for their effect on public health, in the form of allergy-related diseases, including asthma, atopic eczema and rhinitis. In the present work a synoptic circulation-to-environment classification approach is used to shed light in the relationship between synoptic climatology and pollen concentrations for 11 taxa in Thessaloniki, Greece, for the 15-year period 1987-2001. It is concluded that the NW1 cyclonic weather type is linked to high Carpinus *spp.*, Corylus *spp.*, Cupressaceae, Platanus *spp.*, Pinaceae, Quercus *spp.* and Urticaceae pollen levels, forming the so-called "low winter pollen season", as opposed to the "high spring-summer season", characterized by high Oleaceae and Urticaceae pollen levels formed during the SW1 depressional weather type. Anticyclonic weather is linked to the so-called "summer-autumn pollen season" giving high levels of Poaceae and Chenopodiaceae pollen, while a strong anticyclonic system centered over Italy and resulting in light NE winds over northern Greece is associated with regional transport of Alnus pollen. These findings underline the importance of synoptic climatology in understanding the mechanisms of pollen release and accumulation and could be used to feed early-warning systems for protecting known asthmatics from exposure to elevated pollen levels.

The impact of the number of scale categories used in field questionnaire surveys to assess thermal sensation

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Five, seven and nine-point scales have been used to report thermal sensation with the last two being more prominent in the literature. This study is aimed at examining the effect of the number of scale categories on the reported thermal sensation. Field surveys were conducted in the metropolitan area of Athens, Greece (2019-2020) monitoring weather conditions and interviewing pedestrians based on a questionnaire. The participants were asked to report their thermal sensation in predetermined categories of a five, seven and nine-point thermal sensation scale. The scales included one indifference category and two opposite branches (cool and warm) with categories of increasing intensity. Cross-tabulation showed that the indifference category in the five-point scale corresponded, by a higher rate, to the cool than the warm subscale of the seven (n=375, 44.2% versus n=168, 19.8%) or nine-point scale (n=364, 42.9% versus n=163, 19.2%; $p<0.001$). The transition from the seven to the nine-point scale followed the verbal expression of the scales for over 53.7% of the responses. The rescaled numerical five-point scale produced a higher mean score than the seven and nine-point scales. Standard deviation was found to be maximized in the seven point-scale.

The use of the RD-69 (Joss-type) disdrometer towards the estimation of the ZR relations for stratiform and convective rainfall events

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This research presents the analysis of a number of rainfall events that occurred in the Greater Athens area for a ten-year period (2006 to 2016) and have been recorded and analyzed by the RD-69 (Joss-type) disdrometer. This instrument measures the raindrop size distributions continuously and automatically, having the ability to transform the vertical momentum of an impacting raindrop into an electric pulse, whose amplitude is a function of the drop diameter. The range of drop diameters that can be measured through this instrument is between 0.3 and 5.0 mm. After analyzing the disdrometer data, different ZR relations were derived for each specific event, as well as, for two groups of rainfall events regarding the prevailing regime of precipitation (convective or stratiform).

Investigating the snow water equivalent in Greece

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Snow parameters of snow coverage, snow depth and snow water equivalent constitute essential variables for hydrological models and the study of climate variability, groundwater recharge and preservation of basic flow of rivers. However, few studies have analyzed both the spatial and temporal trends in snow-covered areas of Greece using ground-based or satellite observations. The aim of this work is to analyze time series of the snow parameters focusing over representative geographical areas of Greece and to examine their seasonal variability, in terms of region and geography. This will provide a unique opportunity to better understand the spatial snow distribution and the seasonality of snow coverage which could be crucial for long term groundwater management, by combining snow data trends from in situ data and satellite statistics. The information is crucial to represent distributions of the snow water equivalent and their seasonal patterns to further improve the water resource management.

Addressing flood risk in the Rafina stream basin (Attica, Greece) in the framework of the CyFFORS project

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Extreme rainfall events associated with floods are among the most frequent weather-related disasters resulting to severe impacts. Flooding effects become even more important given that the frequency of heavy precipitation is projected to increase in the future, due to climate change, contributing to the occurrence of more flood events, especially over the Mediterranean countries. Thus, the increase of flood risk awareness and the promotion of preparedness against flooding is an imperative need. The CyFFORS (Cyprus Flood Forecasting System) project aims at contributing to this direction by developing and validating a pilot flood forecasting system targeted over three river/stream basins in Cyprus and Attica, Greece. The current paper demonstrates the analysis of flood-associated information, which is a necessary procedure prior to the development of the hydrometeorological modeling tool, in one of the study areas, namely in the Rafina catchment. The analysis focuses on 12 stream floods, occurred between 2008 and 2014, including: (a) the examination of the synoptic atmospheric conditions during the episodes, (b) the classification of the events based on their intensity in terms of hydrometeorological conditions and socio-economic impacts, and (c) the investigation of the relationships between the precipitation characteristics, the peak stream discharge and the resulting impact.

Evaluating the effects of urban design elements on human thermal sensation in summer

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In view of the global warming, there is a growing awareness that both adaptation and mitigation measures should be used to eliminate the impacts of climate change in cities by improving thermal conditions in open urban areas. This paper presents a preliminary study of the effects of various design elements of urban areas on thermal sensation. The aim of this study is to identify patterns of micrometeorological characteristics which are caused due to area's layout and lead to unfavorable human thermal conditions. The spatial and temporal distribution of micrometeorological characteristics are examined in a warm summer day in Syntagma square, the central square of Athens, Greece, and thermal conditions are assessed using the Physiologically Equivalent Temperature index (PET). The latest version of the three-dimensional model ENVI-met (ENVI-met 4.4.4) was applied to simulate the daily micrometeorological variation across the examined area. Results showed that among the examined design elements (i.e., tree, grass, fountain and pavement), areas affected by fountain and trees produce lower PET values throughout the day, yet above the comfortable levels for the most of the hours. The maximum PET value, 57.4°C (15:00LST), was found at the areas affected by pavement, whereas the minimum PET value 17.8°C (06:00LST) was found at the areas affected by fountain. These findings imply the potential of spatial planning to enhance favorable thermal conditions during the day and should be considered when designing urban outdoor areas in cities with Mediterranean climate.

The influence of air temperature on the propagation of road traffic noise

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The transportation noise is one of the major environmental issues in the urban areas and the road traffic noise is the main noise contributor to the overall urban noise. The road surface characteristics have a significant influence on the propagation of the sound generated from the passage of the vehicles. However, the noise emission is influenced by environmental factors. Especially the influence of the air temperature is substantial. In general, an increase in pavement temperature can lead to a reduction of the sound levels emitted by the tire-pavement interaction. The aim of this study is to analyze the influence of the air temperature on the tire-road interaction noise. For this purpose, we apply a well-established relationship between the air temperature and the A-weighed maximum sound pressure level (L_{Amax}) generated by the passage of the vehicles. Moreover, we present the road traffic noise levels measured by a fixed noise monitoring station in Thessaloniki, Greece.

Mapping local climate zones by implementing the WUDAPT method: A case study for Thessaloniki, Greece

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Amid rapid urbanization and with knowledge lacking about the form and functions of current cities, the need for quick and precise tools and methods to acquire such information is crucial. Through this necessity the WUDAPT (World Urban Database Portal Tools) initiative was born, implementing the already existing Local Climate Zones (LCZ) classification system for describing the urban environment and land use in combination with remote sensing tools and methods. In this paper a WUDAPT modification is applied in Thessaloniki, Greece and is compared with two other coastal Mediterranean cities, namely Lisbon, Portugal and Barcelona, Spain. Results indicate similarities and differences in terms of LCZ-related urban characteristics, demonstrate methodological limitations, and reveal dependencies between urban form and urban climate.

Cooling effect and thermal comfort patterns of a courtyard and its adjacent semi-open spaces under Mediterranean climate summer conditions

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It is well documented that the Urban Heat Island (UHI) phenomenon has important implications in terms of summertime building energy consumption and thermal comfort of occupants. In this context, passively designed urban forms need to be considered along with their main design concepts of shading, thermal mass and orientation. In the present study, the microclimatic and thermal sensation conditions of a vegetated courtyard in the city of Athens along with its adjoining semi-open spaces are estimated and evaluated. Three locations inside the courtyard and two verandas (small galleries) along courtyard's northern and southern sides, respectively, were monitored. Thermal sensation and comfort levels are evaluated by the use of the PET index appropriately adapted for the Mediterranean climate conditions. Results showed that, under typical Mediterranean summer conditions, urban design elements such as courtyards with dense vegetation and appropriately oriented semi-open spaces, despite the existence of the heat island effect during night, are associated with significant daytime cooling patterns. In addition, the bioclimatic analysis showed that such patterns may be able to effectively mitigate high human thermal stress levels and to also extend the duration of less strong thermal stress conditions under Mediterranean typical summer conditions.

Investigation of heat transfer in soil through a spatio-temporal analysis of soil temperature in Ioannina, Greece

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Heat transfer through the soil is important in shallow geothermal applications, in plant growth through the control of the relevant physiochemical and biological processes by soil temperatures and in the exchange of heat and gas between the atmosphere and the soil. In this work, heat transmission is investigated through a spatio-temporal analysis of a multiyear time series of soil temperature at Ioannina, Greece. The time series of temperature at four depths (at the ground, at 10 cm, at 30 cm and at 60 cm depths) that is available every half an hour is analyzed and the damping of the amplitude of temperature variation that occurs with depth for the annual frequency dominating the temperature temporal variability is calculated. It is shown that the observed decay indicated a depth dependent thermal diffusivity. To obtain the depth dependence of diffusivity, a novel analytical solution for the diffusion equation with piecewise constant diffusivity is presented along with a novel algorithm. Utilizing this algorithm and the temperature data, a significant change of thermal diffusivity with depth is found with the near surface layer having the smallest value.

An integrated hydrometeorological-hydraulic modelling system for investigating flooding

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An integrated hydrometeorological-hydraulic modelling system has been developed to study flood hazards. The system comprises three models: the WRF-ARW atmospheric model, the WRF-Hydro hydrological model, and the HEC-RAS 2D hydraulic-hydrodynamic model. WRF-ARW is configured to produce high-resolution meteorological forcing fields for the WRF-Hydro model, while discharge time series derived from WRF-Hydro are used as input hydrographs in the HEC-RAS model for flood inundation modelling and mapping. This study presents the application of the integrated modelling system in two urban flash flood cases occurred in Greece: 1) on 9 October 2006 in Volos city, and 2) on 15 November 2017 in the sub-urban area of Mandra, western Attica. Specifically, both examined flash floods resulted in severe economic losses and extended damages (transportation networks, buildings, and agricultural areas) while Mandra's flood caused 24 fatalities. As demonstrated, the integrated modelling system has good potential to be used in interdisciplinary flood simulation studies. Furthermore, the generated inundation maps realistically capture the extent and the high-water marks of the main affected areas. Results reveal that the newly developed physically-based modelling approach can increase the forecast lead time of weather-driven floods, therefore it can be exploited as a forecasting guidance for floodplain management and mitigation strategies.

Extreme weather events and tree cover in Greece

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According to recent findings, extreme weather events are linked to long-term effects on forests. In this work, weather data and land cover data are the input to a spatial data analysis, in order to reveal any spatial correlation between extreme weather occurrence and tree cover gain, or loss, in Greece. Extreme weather events were extracted from the European Severe Weather Database (ESWD), selecting all repots for extreme weather events occurring in Greece, over land, between a) 2001 and 2012, b) 2001-2019. Tree cover data were extracted from the Global Forest Watch (GFW) database, for tree cover loss in Greece, between 2012 and 2019. Map overlapping with layers loading in GIS mapping software, showed that changes in extreme weather events occurrence are significantly correlated to changes in tree land cover, indicating that the risk of damage due to extreme weather events, is statistically significantly related to forests land cover (gain or loss of tree land cover).

Determination of the theoretical distribution functions of the extreme air temperature values in Thessaloniki, Greece

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The objective of this study is the determination of the theoretical distributions of the extreme air temperature values in the city of Thessaloniki for the period 1955-2003. The data, used consist of daily maximum and minimum air temperature values, being retrieved from the E-OBS (Ensembles OBServational gridded dataset). The extreme daily maximum and minimum air temperature values are defined through the Peak over Threshold method, and the optimal probability distributions of the extreme temperatures were selected, through a total of sixty-one (61) examined theoretical distributions, for annual and seasonal basis. In order to come up with the best fitted probability distributions, three statistical goodness-of-fit tests were carried out; the Kolmogorov-Smirnov test, the Anderson-Darling test and the Chi-Squared test. Each one of them ranked the theoretical distributions that best describe the extremes and the most suitable one was chosen by the minimum absolute deviation value. Based upon the determined distributions, return periods for some of the most extreme air temperature values were calculated. The probability distribution functions of, Gen. Pareto, Gen. Gamma (4p), G.E.V. and Log-Logistic, are some of the best fitted theoretical models for the annual and seasonal extreme air temperature values.

The July 10, 2019 Catastrophic Supercell over Northern Greece. Part II: Numerical modelling

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A severe supercell affected northern Greece on 10 July 2019 causing 7 casualties, at least 120 reported injuries and significant damages in Chalkidiki. The regions of western and central Macedonia, along the track of the storm, were also strongly affected by hail, gale force winds (up to about 31 m/s) and lightning activity. Such severe and high impact weather phenomena provide the testbed for the evaluation of modern numerical weather prediction (NWP) systems in adverse weather conditions. This study investigates whether the operational NWP forecasts of the Laboratory of Meteorology and Climatology in the Aristotle University of Thessaloniki (based on the Weather Research and Forecasting numerical model) and the widely used ones of the European Centre for Medium-range Weather Forecasts provided an early warning of the upcoming threat. Both NWP systems provided an indication of the intense convective activity during the second half of 10 July 2019, in short to medium forecast ranges, but there was no consistency about its exact time. Life threatening mesoscale phenomena (e.g. tornadoes, downbursts) could not be predicted with high fidelity because of the available horizontal resolution and their probabilistic nature.

Verification of intense precipitation over diverse climatological areas

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Precipitation is a challenging weather forecast parameter to verify against observations as it is highly variable in space and time exhibiting sharp gradients in its value range. Many different score types and methodologies are used for precipitation verification. The ECMWF developed and applies SEEPS (Stable Equitable Error in Probability Space) as a headline verification score to monitor the accuracy of its operational forecasts. SEEPS differentiates the precipitation forecast performance into precipitation intensity categories (dry, light, heavy) based on the climatological cumulative distribution and in this way it takes into account the local characteristics of weather regimes in the areas that is applied. Similarly, the Symmetric Extremal Dependence Index (SEDI) is based on contingency tables and can be adjusted to the climatological distribution of precipitation at each location using geographically variable thresholds focused on extreme events, thus enabling the assessment of locally important aspects of the forecast while providing a reliable performance metric. In this study, the combination of these scores is suggested as a measure of the performance of a forecast system and its ability to predict relatively extreme rainfall events. SEDI and SEEPS indices are applied to a year-long dataset of 6-hour accumulated precipitation forecasts derived from high resolution NWP systems (COSMO 4km-1km) over Greece. Both scores are aggregated over climatologically diverse regions and area means are obtained.

A new high-resolution precipitation database over Greece

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In this paper we present the preliminary results of our research, aiming to construct a new high-resolution precipitation database (1 km x 1 km) on annual and monthly basis, over Greece, using the statistical approach of Regression Kriging with a Histogram-Based Gradient Boosting Regression Tree. In the process, we perform a comparison between the modelled high-resolution datasets against ERA5 datasets (nearest to the gauge cell) over the gauge precipitation totals. We achieved an average improvement of R^2 (31.7%) and of RMSE (-16.6%), while R^2 was improved more than twice on an annual basis.

Analysis and verification of marine warnings issued by HNMS

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The Hellenic National Meteorological Service issues weather and sea bulletins, for the Eastern Mediterranean and the Black Sea, that form part of the Global Maritime Distress and Safety System. The marine forecasters have the challenging task of issuing warnings when winds reach or exceed gale force. These forecasts are of great responsibility mainly for safety reasons. In this study, the marine warnings are analyzed and a validation against scatterometer measurements is presented. The period from September 2018 to March 2019 was employed because it was widely characterized by gale, strong gale and storm winds. During this period, when the forecasted winds exceeded 8 Beaufort in any of the 36 forecasting sub-regions, the forecast was validated. Considering the availability of satellite data, 500 forecast cases were finally analyzed. The results showed a considerably low percentage of incorrect warnings, while no significant difference in the forecast efficiency was observed between the Hellenic and the foreign seas. Furthermore, a demanding meteorological event, which was characterized by better performance of the forecasters' warnings as compared to the operational numerical weather wind products, is presented. It gives evidence that the human factor can give added value to the products of numerical forecasting.

Synchronization phenomena of extreme weather events in Greece

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In this study we construct regional climate networks for Greece (1979-2018) and we investigate the spatial synchronization of extreme rainfall. We identify the similarity between the rainfall time series through the count of synchronized occurrences. Seeking causality in the results, we examine whether the identified rainfall patterns agree with a climatic classification, derived from geopotential height data (850hpa). We conclude with the explainability and complementarity of the two approaches.

Weather radar-based supercell tracking: The case of 10 July 2019, Macedonia, Greece

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Supercell thunderstorms are among the most destructive weather phenomena worldwide, which, under certain conditions, can be deadly. A supercell can be defined as a thunderstorm characterized by the presence of a mesocyclone. Supercells are usually found isolated from other thunderstorms or embedded in a squall line. Typically, supercells are found in the warm sector of a low-pressure system. A single supercell storm can cause a very serious economic destruction from flooding to severe property damage, or loss of lives. At this study, the case of a supercell is examined, which entered Greece from the north west part of Florina, went through west and central Macedonia and ended in South Halkidiki and the peninsula of Kassandra lasting more than three hours. Specifically, during the last evening hours of Wednesday, July 10, 2019, storms of specific severity, accompanied by fierce winds and in some cases by hail of large dimensions, hit the study area. The most severe phenomena were recorded in the prefecture of Halkidiki, where seven people were killed, 120 people were injured and large devastation occurred. This supercell was tracked and monitored by the weather radar of 3D S.A., Greece. Indicatively, the maximum recorded radar reflectivity was 71 dbz and the maximum storm height was 16.6 km.

Studying the effects of dust particles on cloud microphysical processes

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There is a great interest regarding the effects of natural aerosols on microphysical processes in clouds due to their importance in their development and evolution. The quantification of their impact in the atmospheric processes is a key factor to better understand the climate and their feedbacks on climate change. The induced uncertainty affects the storm impact in a variety of ways like the hydrometeor species, the storm intensity or the temporal and spatial extent of the affected areas. Despite the scientific interest, the better understanding of these processes highly affects applications in early warning systems, water management, food security and agriculture. For the needs of the study, the state of the art atmospheric modeling system RAMS-ICLAMS was used to investigate the effects of desert dust concentrations on microphysical processes in clouds. The model is used to simulate storm events in very high resolutions in order to resolve cloud processes explicitly. The model performance was evaluated showing satisfactory results. Additionally, sensitivity tests were carried out in order to quantify the direct, indirect and semi-direct impact of CCN and IN concentrations showing interesting effects on the cloud microphysical processes, as well as on hydrometeors.

An extraordinary shelf cloud over Thessaloniki, Greece, on 8 June 2014: Formation conditions and associated severe weather

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A spectacular, large shelf cloud embedded in the severe thunderstorm activity swept Thessaloniki, northern Greece, occurred in the late afternoon of June 8, 2014. The extraordinary shelf cloud was observed and photographed at about 20:00 local summertime time (17:00 UTC) over the eastern Thessaloniki area, as a low, horizontal, wedge-shaped arcus type cloud, attached to the base of an approaching from the east large cumulonimbus cloud. On this date thunderstorm complexes had an unusual movement direction that was westwards as recorded by the Filiro C-band weather radar. Severe local weather conditions included heavy rainfall and temporary flash flooding in Thessaloniki downtown, gusty winds and dispersed hailfalls in central Macedonia. The meteorological conditions favored the formation and development of the remarkable shelf cloud and the associated severe thunderstorm activity are studied by examining the synoptic and mesoscale environment. Weather radar data to identify thunderstorm cell features and severity potential are studied and the local terrain features were also considered. Considerable photographic material offering to a detailed description of the extraordinary and spectacular shelf cloud is also presented.

Associating short-duration precipitation extreme events with land surface temperature in Thessaloniki

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Urban flooding is cited as one of the principal hazards in big cities in Greece. Since it is related to deaths and economic losses, as well social and environmental impacts, it is crucial to understand the behaviour of short-duration precipitation extreme events lead to these disasters. Changes in short-duration precipitation extreme records caused of changes in land surface temperature expected to be observed in the future; Clausius-Clapeyron (C-C) equation derives an increase in the capacity of precipitable water in the atmosphere scaling the warming of atmosphere at around ~6.8% per degree. In this study, the changes in precipitation extreme events constrained by C-C equation in Thessaloniki, Greece, are examined, by using a 67-yr timeseries (1953-2019) of hourly precipitation and surface air temperature records. The 1-h precipitation intensity, the daily max of the 1-h precipitation intensity and the total annual precipitation intensity are calculated, and any scaling influenced by temperature dependency of the precipitation extreme events is investigated, identified and defined. The 90th, 95th, 99th and 99.9th extreme percentiles of the distributions of the observed extreme events in the study area used, to determine the dependency of the short-duration precipitation extreme observations on air temperature.

Evaluation of five reanalysis products in reproducing the spatio-temporal characteristics of air temperature over Greece

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The availability of ground-based observations continues to be a serious constraint. Although reanalysis datasets constitute an alternative source, its evaluation is crucial, especially in regions with complex topography, before the gridded data are applied in climate research. The appropriateness of such products is assessed in this study by exploring the performance of five datasets: ERA-Interim, Agri4Cast, UERRA MESCAN-SURFEX, ERA5-Land and E-OBS, in reproducing the spatio-temporal characteristics of air temperature measured at 19 wine production regions in Greece during 1981-2012. The results highlighted the abilities of E-OBS and Agri4Cast, whose performance varied with the specific task in question. On one hand, the former product reproduced best the spatial patterns of observed Tmax and Tmin exhibiting the lower discrepancies. On the other hand, the latter product is the best alternative if temporal analysis is required.

Correlation between the extreme 24-hour rainfall events and altitude in north Greece (Chalkidiki region)

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Rainfall intensity is one of the most significant factors that contribute to flood generation. In the present research, long-term precipitation time series recorded by rain gauges located at Taxiarchis, Arnaia and Agios Prodromos regions in Chalkidiki (North Greece), were analyzed, in order to examine the correlation potential between the factors of rainfall intensity and altitude. Generally, Chalkidiki region suffers from very frequent and intense flood phenomena, causing 54 serious flood events from 1966 to 2019, while it is characterized by abrupt changes of altitude within small distances, forming a morphology of steep slopes and intense relief. The orography influences the annual precipitation of the study area, with the highest percentage of the precipitation amount to concentrate in Cholomontas mountain range. Statistical analysis of the 24h max rainfalls was implemented using data from four rain gauges, to determine the correlation degree between extreme rainfalls and altitude. The results showed that 24h max rainfalls are significantly correlated with the altitude, especially when the compared rain gauges are installed having high altitude difference. The results could be utilized by policy makers and hydrologists in the implementation of the IDF curves and the construction of flood hydrographs, in order to plan and design more accurately the flood prevent works in catchments and streams within the specific as well as similar study areas.

Remote sensing (Poster session)

S5P/TROPOMI atmospheric products over Thessaloniki, Greece; validation activities of the Laboratory of Atmospheric Physics, AUTH

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Operational monitoring of atmospheric gaseous and particular species of both tropospheric as well as stratospheric provenance are performed routinely by the Laboratory of Atmospheric Physics, Thessaloniki, Greece, using a suite of different ground based instruments including two Brewer spectrophotometers, multiple MAX-DOAS instruments, a multi-wavelength Depolarization Raman lidar as well as a NILU-UV sun photometer, an FTIR spectrometer, a CIMEL photometer, etc. All instruments operate on the rooftop of the Physics Department in the Aristotle University of Thessaloniki, located in the city center of Thessaloniki. Most of the data records provided by these instruments span the better part of two decades. In the following we present the validation efforts of nearly three years of TROPOMI/S5P total ozone columns, total and tropospheric NO2, total HCHO, CO and CH4 columns as well as the cloud fraction. The high spatial resolution of the TROPOMI/S5P measurements permit the investigation on the effect of the spatiotemporal difference between the measurements, as well as other contributing factors. Overall, all operational TROPOMI/S5P products are covered by spatiotemporally collocated observations performed, or ingested, by the Laboratory of Atmospheric Physics providing a comprehensive Synergistic Data Center for dedicated validation purposes.

The LAP/AUTH quality assessment and validation chain applied to multiple satellite sensors' total ozone columns

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The Laboratory of Atmospheric Physics, Aristotle University of Thessaloniki (LAP/AUTH), has 30 years of experience in the field of remote sensing validation. During this time, a Quality Assessment and Validation Chain has been developed and applied within numerous ESA and EUMETSAT projects to most European, as well as American, satellite Ozone monitoring sensors. The Total Ozone Column (TOC) products of multiple satellite sensors, such as TROPOMI/Sentinel-5P, GOME2/Metop-A, -B and -C, OMI/Aura and OMPS/Suomi-NPP, are validated against daily mean and individual, globally distributed ground-based (GB) Brewer and Dobson TOC measurements. The GB measurements used for the validation are retrieved from the World Ozone and Ultraviolet Radiation Data Centre (WOUDC), the European Brewer Network (Eubrewnet) and the WMO Ozone Mapping Centre operated by LAP/AUTH. The satellite TOC data quality and stability are evaluated by the statistical analysis of their comparisons to GB measurements, in terms of bias and drift. The dependence of the differences on many influence quantities, such as solar zenith angle, clouds, surface albedo, etc. is also investigated. Additionally, an inter-sensor comparison is applied to sensors that use the same or similar retrieval algorithms for TOC, to further study the consistency of their measurements, as well as their suitability for long-term trend studies.

A case study of a supercell on the 10th July, 2019 based on satellite data

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The aim of this study is to identify and examine the spectral and physical characteristics of the storm that hit Chalkidiki, Greece, on July 10, 2019, using remote sensing data. Geostationary and Polar Orbiting Satellite Data (MSG-SEVIRI, GPM) were used in conjunction with ground radar recordings to study and determine the spectral characteristics of the thunderstorm cloud system and extract information on its physical characteristics (height, shape, topography of the cloud top, rainfall distribution, etc.) and temporal evolution. The satellite analysis is applied on the channels or channel differences of visible, infrared and water vapor. The type of the storm (MCS, multicell or supercell) is determined based on the storm's physical characteristics. These findings are assessed in relation to the synoptic atmospheric conditions.

Volcanic SO2 layer height by S5P/TROPOMI; the case of the Raikoke 2019

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Volcanic eruptions eject large amounts of ash and trace gases such as sulphur dioxide (SO2) into the atmosphere. The ability to quantify the spatial extent and magnitude of these ejecta has a considerable impact on air traffic safety. A significant difficulty in mitigating the impact of volcanic SO2 clouds on aviation is that these gas emissions can be rapidly transported over long distances. The use of space-based instruments enables the global monitoring of volcanic SO2 emissions in an economical and risk-free manner. The European Space Agency Sentinel-5p+ Innovation project (S5P+I) aims to develop novel scientific products to exploit the potential of the S5P/TROPOMI capabilities. We will present the SO2 Layer Height (S5P+I: SO2 LH) project activities which are dedicated to the generation of an SO2 LH product and its extensive verification with collocated ground- and space-born measurements. On June 22nd, 2019, a vast plume of ash and volcanic gases with more than 1300 DU of SO2 was emitted during the eruption of the Raikoke volcano, Kuril Islands. This eruption could be detected even two months after the end of eruptive event, highlighting the importance of knowing the concentrations of airborne hazard at flight levels.

A technique to retrieve vertical concentration profiles of individual aerosol species based on the synergy of lidar and spectrophotometer measurements

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In this study, we present the concept of a synergistic algorithm to retrieve the vertical concentration profiles of individual aerosol species using lidar and spectrophotometer measurements. Synergies among the following instruments will be deployed: a depolarization Raman lidar, a double monochromator Brewer and a DOAS/MAX-DOAS spectrophotometer installed at the Laboratory of Atmospheric Physics in Thessaloniki, Greece. The aerosol species are modeled with the Optical Properties of Aerosols and Clouds (OPAC) database which provides the optical properties per aerosol mode. They are calculated from Mie theory assuming spherical particles with the exception of mineral dust species for which spheroid particles are assumed. Hygroscopic growth calculations are included and the corresponding optical properties are selected using relative humidity profiles currently from radiosondes and in the future from models as well. The algorithm currently compiles a lookup table of mixtures that constitute of up to four aerosol modes and identifies the mixture/mass concentration combinations that best describe the lidar attenuated backscatter profiles. In the next phase, these profiles will be imported to a radiative transfer model and the combination that best reproduces ratios between the direct solar radiance, sky radiance, and irradiance spectra measured from the spectrophotometers will be isolated.

Early detection of the cloud convection in Meteosat imagery using lightning activity

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It is well known that during the development of the rapid cloud convection, the lightning activity is a usual phenomenon. The scope of the study is to detect suitable combinations of threshold values of the Brightness Temperatures (BT) of five infrared SEVIRI channels (6.2μm, 7.3μm, 8.7μm, 10.8μm and 12.0μm) where the lightning events present the highest frequency of occurrence. A large number of different combinations of threshold values were examined and many evaluation statistics were computed in order to select the most appropriate combinations. The analyses of over than 300.000 lightning events and their corresponding BT pixel values of the Meteosat imagery, show that although the lightning activity is observed over a wide range of BTs, the most preferred threshold values for the detection of lightning events is the combination of $BT_{10.8\mu m}$ below 235 K and the difference of BT channels 10.8 μm and 12.0 μm ($BTD_{6.2\mu m\text{-}7.3\mu m}$) larger than -10 K. The results can be useful for nowcasting purposes in terms of estimating the lightning activity using multispectral satellite imagery.

Can we decompose a complex aerosol profile to its components?

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An advanced lidar method to decompose an aerosol profile into three aerosol components as a function of height is presented. The method is applied to synthetic lidar data to discuss the potential of the technique. For the decomposition we use vertically resolved particle backscatter and extinction coefficient as well as the linear particle depolarization ratio at the same wavelength. The method requires assumption of the depolarization ratio of pure dust and non-dust components as well as the lidar ratio of pure marine and dust aerosols. The lidar ratio of pure biomass burning aerosols is not assumed but it is a product of the retrieval method.

Desert dust episodes in the Mediterranean basin during the period 2005-2018

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In the present study a satellite algorithm is used to examine the spatiotemporal patterns of intense dust episodes taking place over the Mediterranean Basin (MB) during the period 2005-2018. In a first step, the algorithm identifies the presence of dust based on spectral 1°x1° gridded daily Aerosol Optical Depth (AOD) and Aerosol Index (AI) data taken from the MODIS-Aqua Collection-6.1 and OMI-Aura (Ozone Monitoring Instrument) datasets, respectively. Subsequently, it determines the occurrence of strong and extreme dust episodes on a daily and pixel level basis, considering that they occur whenever AOD values exceed the corresponding 14-year mean AOD values plus the associated two (for strong episodes) and four standard deviations (for extreme episodes). Finally, a day is named "dust aerosol episode day" (DAED) whenever dust episodes occur over at least 30 pixels. According to the algorithm results, 162 DAEDs, 113 strong and 49 extreme ones, took place in the Mediterranean Basin (MB) during the period 2005-2018. According to the algorithm results, the maximum frequencies of both strong and extreme DAEDs are found in spring (46 and 51% of total number of episodes, respectively) as well as in summer for strong DAEDs (46%). The strong Mediterranean DAEDs are mainly observed over the south-western part of the MB, while the extreme ones over its central part.

Validation of the NWC SAF CRR and CRR-Ph products over the Greek area using rain gauge data as ground truth

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The METEO unit at the National Observatory of Athens operates the NWC SAF (Support to Nowcasting and Very Short Range Forecasting Satellite Application Facility) system since 2016. NWC SAF combines satellite and numerical weather prediction (NWP) data along with certain auxiliary datasets to generate meteorological products that can be used for the support of nowcasting and very short-range forecasting. In the present work, the 2016 version of the NWC SAF software, driven by the HERMES (based on the WRF model) operational forecasts, is utilized. We employ the daytime algorithm of the Convective Rainfall Rate (CRR) and Convective Rainfall Rate based on Cloud Physical Properties (CRR-Ph) products with Meteosat Second Generation Spinning Enhanced Visible and InfraRed Imager (MSG SEVIRI) imagery, to estimate instantaneous convective rainfall rates every 15 minutes over the Greek territory for 2018. These estimations are compared against rainfall measurements provided by the dense network of surface automated weather stations operated by the National Observatory of Athens. Both products tend to overestimate the precipitation areas and present deviations from the recorded precipitation totals, but in general CRR-Ph outperforms CRR, especially under good illumination conditions. Some seasonal variations were identified with the most prominent being the worst performance during spring.

Estimation of the spatio–temporal distribution of wildfires in the Mediterranean basin with the use of remote sensing data and correlation with biomass burning aerosol load

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This study examines the spatio–temporal distribution of wildfire occurrence and characteristics in the Mediterranean Basin, relying on remote sensing data, as well as their correlation with fluctuations of the biomass burning aerosol load, during the last 19 years (from 2001 to 2019). For this purpose, a fully automated process for the calculation of the Normalized Burn Ratio (NBR) Index, based on Moderate Resolution Imaging Spectroradiometer (MODIS) Surface Reflectance, has been developed. We examine the relation between carbonaceous (organic and black carbon) aerosol optical depth, obtained from MERRA-2 (Modern-Era Retrospective analysis for Research and Applications, Version 2), and the difference between pre- and post-fire NBR.

EVE: A reference lidar system for Cal/Val studies of space-borne missions

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The EVE (Enhancement and Validation of ESA products) lidar is a combined linear/circular ground-based polarization system. EVE will provide the missions of the European Space Agency (ESA) with reference measurements of the particle optical properties. Its design utilizes a dual-telescope/dual-laser configuration emitting, interleaved, linearly and circularly polarized light at 355 nm, and detecting, in parallel, the linear and circular depolarization on the backscattered signals and the Raman backscattering at 387 nm. Moreover, the system allows the adjustment of the measurement zenith angle from 0 to 90°, as well as full adjustment of the measurement azimuth angle in order to fulfill the Cal/Val requirements of Aeolus mission. The Atmospheric Laser Doppler Instrument (ALADIN) onboard Aeolus, provides aerosol optical properties such as particle backscatter and extinction coefficient profiles by detecting only the co-polar component of the backscattered circularly polarized light. In strongly depolarizing scenes with non-spherical particles like desert dust, volcanic ash, and ice crystals, the undetected cross-polar component of the received radiation renders the retrieved co-polar backscatter component inadequate to represent the total aerosol backscatter coefficient. The EVE lidar aims to evaluate the aerosol retrievals for Aeolus and quantify their uncertainties during the ASKOS campaign in Cape Verde, in July 2021.

Vector velocity estimation of single Doppler radar – convective thunderstorm analysis

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The use of meteorological radars in monitoring present weather conditions is crucial regarding the evolution and dissipation of thunderstorms. Thus, Doppler velocities that are measured in each radar scan and velocity vectors derived from Numerical models- that are usually not dense in comparison to radar scans due to computational cost -are combined visually, as a monitoring utility. The objective of this study is to develop a new method that allows the implementation of a vector velocity estimation technique combining block matching and optical flow techniques. This new method could constitute a now-casting application that enables the use of a single Doppler radar. The vector velocities are estimated in each CAPPI (constant altitude plan position indicator). Then, the measured Doppler velocity, is employed after a simple correction for aliasing errors, to correct the magnitude of the extracted vectors. Consequently, a 3D vector field of velocities is calculated. Convergence of velocity vectors over orography could indicate an initial stage of a thunderstorm and further now-casting applications could make use of this technique. The performance of the method proposed is evaluated for a selected case study characterized by convective thunderstorms over Thessaloniki, Greece, making use of HNMS Radar network data.

Comparison of inferred S5P/TROPOMI NO_2 surface concentrations with in-situ measurements over Central Europe

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The present study evaluates the surface concentration of nitrogen dioxide (NO_2) inferred from S5P/TROPOMI NO_2 tropospheric column densities over central Europe, for the summer of 2018 and the winter of 2018-2019. The methodology requires as input tropospheric NO_2 column densities, surface concentrations simulations from the LOTOS-EUROS CTM as well as the CAMS 2015 emission inventory over Europe. More than two hundred in-situ stations, reporting to the European Environmental Agency air quality database, are used to carry out the comparisons. Seven station types (traffic urban, traffic suburban, background urban, background suburban, background rural, industrial suburban and industrial rural) are treated separately. TROPOMI derived NO_2 surface concentrations show improved correlations with in-situ stations NO_2 surface concentrations compared to LOTOS-EUROS simulations. Specifically, during the summertime period, TROPOMI derived NO_2 surface concentrations show better agreement with the in-situ measurements for all station types with the highest correlation for the background suburban stations (r=0.6). During the wintertime period, TROPOMI derived NO_2 surface concentrations correlate better with the in-situ measurements for all the station types except for the traffic suburban, the background suburban, and the industrial rural stations. Background rural stations show significant correlations for both datasets in the wintertime period (r=0.64 and r=0.54 respectively).

Megacities around the globe: AOD spatial distribution and trends over the last two decades using space-borne data

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In an urbanizing world, the population growth of megacities is a huge environmental issue. Space-borne aerosol retrievals and their decadal trends over these ever-growing areas are essential for anthropogenic air pollution monitoring at global level. In the current study, we focus at 56 cities with population over 5 million. We use daily satellite Aerosol Optical Depth (AOD) data from the MODerate resolution Imaging Spectroradiometer on board Aqua satellite (MODIS-Aqua), over the period 2003-2017, available at an equal lat-lon grid (0.1º x 0.1º). Taking advantage of the high sampling frequency and the fine spatial resolution of MODIS-Aqua AODs, we investigate the temporal changes of aerosol loads inside and around of fast growing Metropolitan areas. Mean and standard deviation values for all the above-mentioned areas are calculated alongside with deseasonalized trends. In addition, the spatial AOD distribution in the vicinity of the cities is investigated assessing the spatial gradients and representativeness of the satellite retrievals. Previous studies have shown a global decrease of AOD, which is opposite to the increasing trend of growing cities, especially in Asian and African megacities.

Remote sensing and numerical modeling contributions to the investigation of the June 16 – 17, 2020 severe hailstorm event over Drama, Greece

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A severe storm developed over the northern parts of Greece during the evening on June 16, 2020 and lasted until the first hours on June 17, 2020. The storm burst out with significant hail fall and caused damages in Drama city. A remote sensing analysis using the closest radar (Thessaloniki Radar Station) and satellite products is presented illustrating the evolution and severity of the hailstorm. A numerical modeling simulation of the local environment using the COnsortium for Small-scale Modeling (COSMO) model over Greece is also presented in terms of spatial and temporal resolution of the precipitation totals.

Monitoring dust particle orientation with measurements of sunlight dichroic extinction

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Alignment of irregularly shaped dust aerosols leading to linear dichroism has been reported in atmospheric layers. The present study intents to quantify the excess linear polarization of direct solar radiation propagating through atmospheric layers, when these contain oriented dust particles. In order to record the linear polarization, we have used the Solar Polarimeter (SolPol). SolPol is an instrument that measures the polarization of direct solar irradiance at 550nm. It is installed on an astronomical tracker in order target the solar disk. Using the measurements, the Stokes parameters are retrieved (I, Q/I, U/I and V/I) with an accuracy of ~1% and precision of 1 ppm. Collocated measurements of a sun-photometer (Aerosol Robotic Network; AERONET) and lidar are used to quantify the Aerosol Optical Depth (AOD) and identify the vertical distribution of dust layers, respectively. We will present indications of dust particle orientation recorded at the PANGEA station in the island of Antikythera, Greece, and at Nicosia, Cyprus during the preparatory phase for the ASKOS campaign in July 2021. The relation of the linear polarization of the solar irradiance to other optical properties of the dust layer is investigated.

Remote sensing analysis of the severe storm on August 8 -9, 2020 over Evia, Greece

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A severe storm developed over the central east mainland parts of Greece during the evening of August 8 and lasted until the early morning of August 9, 2020. The storm caused fatalities, injuries, and significant damages to the local society due to severe flash floods over several parts of the central Evia. A remote sensing analysis is presented using radar products from Hellenic National Meteorological Service Radar Network database. Although that, only data from Larisa radar station (160 km from the area of interest) were available during the storm lifetime, Constant Altitude Plan Position Indicator and Height of Maximum Vertical Reflectivity products depicted very well the severity of the storm. Remote sensing analysis based on geostationary and polar orbit satellite products are also included in the analysis, illustrating the severity and the evolution of the storm, along with nowcasting and hydrology satellite application facilities products from the European Organization for the Exploitation of Meteorological Satellites.

Climate dynamics (Oral session)

Fast responses on pre-industrial climate due to present-day aerosols based on three Earth System Models

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Coupled Model Intercomparison Project Phase 6 (CMIP6) simulations from three Earth System Models (ESMs) (CNRM-ESM2-1, MRI-ESM2-0 and NorESM2-LM) are used to study the fast climate responses on pre-industrial climate, due to present-day aerosols. All models carried out two sets of simulations including a control experiment with all forcings set to the year 1850 and a perturbation experiment with all forcings identical to the control, except for aerosols precursor emissions (SO_2, BC and OC) set to the year 2014. To decompose the effect of different present-day aerosol types additional perturbation experiments were used with applying separately present-day SO_2, Black Carbon (BC) and Organic Carbon (OC) emissions. The perturbation by the present-day aerosols indicates negative top of the atmosphere (TOA) effective radiative forcing (ERF) values around the globe, especially over continental regions of the Northern Hemisphere in summer with sulfates dominating in all-aerosols ERF. In response to the pattern of all aerosols ERF, the fast temperature responses are characterized by cooling over the continental areas, especially in the Northern Hemisphere, with sulfate being the dominant aerosol surface temperature driver for present-day emissions. Sulfate aerosols play also the main role for the precipitation decrease over East Asia.

Evaluation of seasonal forecasting over Europe

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Seasonal forecasting occurs between short-term weather forecast and long-term climate projection. Seasonal forecasting is carried out for a time period of one to six months from the initial condition. It differs from weather forecast, as the last one gives much more spatial and temporal detail, but for a short period in the future. Beyond a few days, the atmosphere's chaotic nature limits the ability to predict precise changes at local scales. This is one of the reasons that meso-scale forecasts of atmospheric conditions present some uncertainty. Early forecasting of potential climate anomalies contributes significantly to sectors related to the production process and the environment, such as agriculture and the management of water resources and water supplies, but also various sectors of the economy, such as tourism. The present study addresses the evaluation of different seasonal climate models based on the accuracy of their temperature projection in Europe. Climate models were evaluated by comparing projections with the most recent reanalysis database, ERA5. Results show that the studied climate models present a pattern, an underestimation for the warm period and an overestimation for the cold period. The intensity of this pattern differs spatially.

Can we predict global patterns of long-term climate change from short-term simulations?

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Furthering our understanding of regional climate change responses to greenhouse gas and aerosol emissions is pivotal to inform societal adaptation and mitigation. However, complex General Circulation Models (GCMs) used for climate projections are computationally expensive. Here, we utilise a unique dataset of existing climate model simulations to show that novel machine learning approaches can learn relationships between short-term and long-term temperature responses to different climate forcings, which in turn can accelerate climate change projections. This approach could reduce costs of additional scenario computations and uncover consistent early indicators of long-term climate responses. We explored several statistical techniques for supervised learning and present predictions using Ridge and Gaussian process regression. We compare the results to pattern scaling, a standard simple approach for estimating regional temperature responses under varying climate forcing scenarios. We highlight challenges and opportunities for data-driven climate model emulation, especially with regards to the use of even larger model datasets and different climate variables. We demonstrate the potential of our method for gaining new insights into how ongoing climate change can be best detected and extrapolated; proposing a blueprint for future studies and encouraging data collaborations among research institutes in order to build ever more accurate climate emulators.

Impacts of changing North Atlantic atmospheric circulation on European climate under CO_2 doubling

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Here, we examine the impacts of significant atmospheric circulation changes at seasonal scales on European temperature and precipitation and attempt to disentangle the thermodynamical from the dynamical contributions, under increasing CO_2 concentrations. We use a very high resolution fully-coupled global climate model (CM2.6 GFDL) to document significant changes in the frequency of certain atmospheric circulation patterns over North Atlantic. These changes exceed natural variability and are likely to have important repercussions on European weather and climate. In winter, we find an increase of zonal regimes, in the form of different flavors of the positive NAO phase, which could bring warmer and wetter conditions over western Europe. This may lead to enhanced flooding risk, by increasing the frequency of occurrence of events such as the prolonged floods of the 2013-14 winter in the UK. In summer, we document a significant increase in the occurrence of high-pressure systems off the UK coast, which is linked to hot and dry summer weather over western and central Europe.

Future extreme heatwaves in the Middle East and North Africa region: a MENA-CORDEX perspective

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The majority of global climate projections suggests a future intensification of summer heat extremes in the Middle East and North Africa (MENA) region. To better assess the anticipated regional impacts, information of high resolution and quality is required. So far, there is a lack of such MENA-focused robust regional climate information. In this context, we assess future heatwave events by using the recently-introduced Heat Wave Magnitude Index and a "first-of-its-kind" multi-model ensemble of regional climate projections for the region. Our results, based on a "business-as-usual" pathway, indicate a future transition to "super" and "ultra" extreme heatwave events by the end of the current century. Such events are expected to be characterized by unprecedented amplitudes (up to 56 °C) and duration (several weeks long). By 2100, about half of the region's population (approximately 600 million inhabitants) will likely be annually exposed to "super" and "ultra" extreme heatwaves. The vast majority of this population (more than 90%) is projected to be settled in urban centers.

Atmospheric energetics under different future climate change scenarios

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The aim of this study is to investigate whether different Representative Concentration Pathways (RCPs), as they are determined in the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), lead to different regimes in the energetics components of the Lorenz's energy cycle. The four energy forms on which this investigation is based on are the zonal and eddy components of the available potential and kinetic energies. The correspondingly considered transformations between these forms of energy are also studied. RCPs are time-dependent, consistent projections of emissions and concentrations of radiatively active gases and particles. In the present study, four RCPs are explored, namely, rcp26, rcp45, rcp60, rcp85; these represent projections (for the future period 2006-2100) based on scenarios that result approximately in radiative forcing of 2.6, 4.5, 6.0 and 8.5 Wm^{-2} at year 2100, respectively, relative to pre-industrial conditions. The results are presented in terms of time projections of the energetics components from 2020 to 2100 under different RCPs. The results have shown that the different RCPs yield diverse energetics regimes, consequently impacting on Lorenz's energy cycle. In this respect, Lorenz's energy cycle projections are presented, under different RCPs.

Climate change (Oral session)

Evaluation of CMIP5 models climatology and trends for the recent past over the MENA region with emphasis on temperature extremes

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We assess observed and modeled temperature extremes over the MENA region during the last four decades in order to evaluate the performance of global climate model simulations individually. For this purpose, a list of indices of temperature extremes, based on threshold, percentile, heatwave and coldwave characteristics is used, as defined by the Expert Team on Climate Change Detection and Indices (ETCCDI). We use daily near-surface air (2-metre) temperature (Tmax and Tmin) to derive the extremes indices for the period 1980-2018 from: i) re-analyses (ERA-Interim, MERRA2) and gridded observational data (Berkeley) and ii) 18 CMIP5 model runs combining historical (1950-2005) and scenario runs (2006-2018 under RCP 2.6, RCP4.5 and RCP8.5). Using these datasets, the indices of temperature extremes were derived and their differences were calculated with regard to their statistics (climatological average, trends). The obtained biases allowed the evaluation of the performance of different model realizations in space and time. Finally, a model performance ranking was performed based on their individual biases from the re-analyses and observational data. Thus, an identification of the best performing realizations was achieved, useful for selecting global model fields required for further downscaling and/or impact studies related to temperature extremes.

Future climate change impact on wildfire danger over the Mediterranean: the case of Greece

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The Canadian Fire Weather Index (FWI) is a meteorologically based index designed initially to be used in Canada but it can also be used worldwide, including the Mediterranean, to estimate fire danger in a generalized fuel type based solely on weather observations. The four weather variables are measured and used as inputs to the FWI (rain accumulated over 24 h, temperature, relative humidity, and wind speed) are usually taken daily at noon local standard time. Recent studies have shown that temperature and precipitation in the Mediterranean, and more specifically in Greece are expected to change, indicating longer and more intense summer droughts that even extend out of season. In connection to this, the frequency of forest fire occurrence and intensity is on the rise. In the present study, the FWI index is used in order to assess changes in future fire danger conditions. To represent meteorological conditions, regional EURO-CORDEX climate model simulations over the Mediterranean and mainly Greece at a spatial resolution of 11 km, were utilized. In order to assess the impact of future climate change, we used two Representative Concentration Pathway (RCP) scenarios consisting of an optimistic emission scenario where emissions peak and decline beyond 2020 (RCP2.6) and a pessimistic scenario where emissions continue to rise throughout the century (RCP8.5). We compared the FWI projections for two future time periods, 2021-2050 and 2071-2100, with a reference time period in the recent past 1971-2000. Based on the critical fire risk threshold values that have been established in previous studies for the area of Greece, the days with critical fire risk were calculated for different Greek domains.

On the assessment of RCMs in simulating deep cyclones over the Mediterranean region: Impacts on the storm surges of coastal areas

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The Mediterranean region, especially its coastal sites, has been proven in the past to be highly sensitive to Climate Change impacts, experiencing water management problems due to coastal hazards such as inundation by storm surges and sea level rise, land loss, etc. The overarching goal of the present study, being a part of the MEDAQCLIM project, is to assess the ability of updated RCMs in simulating the main meteorological parameters, leading to storm surge-induced sea level variations over the domain of interest. Three climate models were selected and compared with the CERA reanalysis database focusing on the simulation of the mean SLP level, the mean wind fields and the reproduction of the extreme barometric systems (Deep Depressions) over the Mediterranean region. Through thorough validation of the RCM outputs it is concluded that, in general, all models present a relatively high simulation skill in representing the main characteristics and spatial distribution of the examined parameters, with some differences depending on the time scale the examination takes place. Indicative evaluation of maritime hydrodynamic model hindcasts is also provided based on comparisons of storm surge simulation outputs against field observations of coastal hydrographic features.

Testing of the Regional Climatic Model COSMO-CLM (CCLM) driven by ERA-Interim at the Hellenic National Meteorological Service

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The Hellenic National Meteorological Service favors the implementation of the climatic version (CCLM) of COSMO Model as a proper choice towards the climate investigation of the wider area of Greece as well as a potential tool for seasonal forecasting. Of special value is the non-hydrostatic formulation of the Model that makes it suitable for downscaling at a horizontal spatial resolution between 1 and 20 km. The model performance is examined over a 0.0625^0 (~6.5 km) horizontal grid mesh for the wider area of Greece by placing emphasis over the Central and Eastern Mediterranean area. The forcing was applied by employing dynamical downscaling on the existing results of CCLM over the MENA-CORDEX domain at 0.22^0. These data were provided by CMCC Foundation, where CCLM was forced by the global atmospheric reanalysis of ERA-INTERIM of ECMWF. Results related to 2-meter Temperature for 10 representative Greek meteorological stations are presented. At a later stage, the goal is to go beyond this period by using the results from Global Climate models for simulations over the 21st century according to the IPCC RCP4.5 scenario.

Spatial and temporal evolution of drought conditions in the Eastern Mediterranean

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Climate change affects the hydrological equilibrium with severe consequences in socio-economic sectors, the environment and living beings. The southern parts of Europe are projected to become drier in future, while in some cases heavy precipitation events are likely to become more frequent, even in areas where total precipitation is projected to decrease. The Eastern Mediterranean region is particularly sensitive to drought and rising temperatures. A decrease in precipitation together with high temperatures lead in increased evapotranspiration and pose a severe threat for water shortages in the adjacent countries. This study analyses the spatiotemporal characteristics of drought events in the Eastern Mediterranean using the Standardized Precipitation Index (SPI). The drought index is used to describe and compare present and future long-term projections of droughts under different climatic conditions. The investigation is performed for a reference and a future period under RCP 4.5 and RCP 8.5 using a sub-set of high resolution simulations from EURO-CORDEX. Spatial distributions of the drought severity according to the indices are plotted and discussed. The assessment of drought patterns under climate change provides crucial information for decision-making on future management actions within the Eastern Mediterranean region.

The impact of climate change on the tomato growing season in Greece

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Greece has a unique Mediterranean climate, well suited for irrigated agriculture. Climate is an important factor in the production of many high-value crops, including tomatoes. However, climate change has many immediate and long-term challenges for the agricultural industry. To help farmers, growers manage risks; it is crucial to study locally relevant agronomic indicators. This study aimed to analyze the growing season trend in the top two tomato-producing regions in Greece. More specific the aim was to investigate the projected change in the amount of time required for processing tomatoes in Greece to achieve physiological maturity using accumulated growing degree days (AGDDs) into the twenty-first century. Based on the findings, the climate model indicated a significant decrease in the number of days between transplanting and maturity, with an expected harvest 10-15 days earlier than normal under current conditions. This study indicates that farmers should redesign their crop management protocols to succeed in sustainable tomato production. They should make strategic decisions such as variety selection, planting and harvest dates, agricultural water management, and studying trends in pests and diseases due to shifts and lengthening of tomato growing season in Greece's tomato production areas.

Heat-related mortality under climate change and the impact of adaptation through air conditioning: A case study from Thessaloniki, Greece

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As heat-related mortality is expected to increase due to climate change, Health Impact Assessment studies quantify the effect of heat on public health, accounting for the adaptation of population to warmer climates. Adaptation can take place through different mechanisms, with air-conditioning (AC) being one of the main technological adaptation drivers. However, the health effects associated with AC-induced air pollutants have not been examined in detail. In the present work, a HIA is performed for the population of Thessaloniki, Greece, based on temperature and population projections, under different Representative Concentration and Shared Socioeconomic Pathways, in order to study future heat-related mortality, taking into account the technological adaptation of the population through AC, as well as the adaptation trade-off between averted heat-related and increased air pollution-related mortality. It is found that heat-related mortality in Thessaloniki is expected to increase, under all scenarios studied, although adaptation is expected to take place and attenuate the number of deaths. Nevertheless, air pollution-related mortality (due to increased AC) is expected to counterbalance the averted heat-related mortality, especially under the moderate scenarios and particularly when black carbon is considered as the fuel used for power generation.

The impact of climate change on a data-scarce watershed hydrology using bias corrected RCMs

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During the last decades, climate change impacts on hydrology have been assessed by coupling the Regional Climate Models (RCMs) and the hydrological models. However, this process underlies uncertainties, which might be attributed to the biases of the RCMs. These biases are nested to the hydrological models, reducing their reliability. Bias correction methods were developed to overcome this issue. In this paper, the delta change, the linear scaling, and the empirical quantile mapping were applied to climate input data to a semi distributed hydrological model. The Regional Climate Model Version 4 (RegCM4) forcing by the HadGEM2 General Circulation Models under the extreme RCP 8.5 scenario, regarding the period from 1981 to 2000, and the ArcSWAT interface were used for a data-scarce Greek watershed simulation. The bias corrected hydrological results were evaluated against the SWAT application using as input data, the daily ERA-Interim reanalysis climate data. The results indicated that the reliability in hydrological watershed simulation was enhanced after the bias correction methods application. The discrepancies in simulated and observed discharge were significantly reduced. The accuracy of the bias correction results depends on the studied parameter (e.g., precipitation, temperature).

Air quality I (Oral session)

Air quality monitoring in the urban area of Ioannina, Greece

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The air quality monitoring has become routine in the EU member states, in response to the 2008 air quality directive (2008/50/EC). In accordance with the European directive, in the January of 2019, an additional air quality monitoring station was placed in the urban area of Ioannina, Greece. The aim of this study is to investigate the seasonal variations of the gaseous pollutants (SO_2,NO_2,NO,CO, O_3) and particulate matter (PM_1,$PM_{2.5}$,PM_4,PM_{10}) in the city centre of Ioannina. For this purpose, we analysed the concentrations of the pollutants from one year measurements (1 February 2019 to 31 January 2020). Also, we investigated their relationship with the meteorological factors such as wind speed and direction, air temperature and relative humidity. The meteorological conditions are critical in determining the pollution levels in the urban areas. The daily PM concentration levels are high and greatly exceed the standards recommended by the EU Directive and the WHO. The annual $PM_{2.5}$ and PM_{10} concentration levels were almost 20 **μg**/m^3 and 30 **μg**/m^3, respectively. The threshold values of gaseous pollutants were below the air quality standards.

Prediction of ozone concentration using artificial intelligence and machine learning techniques

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The aim of this paper is the development and comparison of different prognostic models using artificial neural networks and machine learning techniques in order to predict ground level ozone concentration. More specifically, Multilayer Perceptron (MLP), Generalized Feed Forward (GFF) and Time-Lag Recurrent Network (TLRN) artificial neural networks were trained with the same ozone concentration data at the same time using machine learning models, such as Support Vector Machine (SVM), Regression Random Forests (RRF) and Boosted Regression Tree (BRT). After the training phase, the aforementioned models were compared and combined thereafter in order to develop a hybrid forecasting model to predict the maximum hourly ozone concentration 24 hours ahead. The data used in the analysis concern hourly ozone concentration, air temperature and total daily rainfall from Agia Paraskevi, Elefsina, Maroussi and Nea Smyrni, within the greater Athens area. The ozone concentrations data have been recorded by the air pollution monitoring network which is under the auspices of the Hellenic Ministry of Environment and Energy (HMEE), while the meteorological data have been acquired from the National Observatory of Athens (NOA) meteorological stations network.

Sources of atmospheric organic particulate matter in Patras, Greece

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Organics are a significant fraction of the sub-micrometer particulate matter (PM), although only a small fraction of them has been identified so far. Field measurements using High-Resolution Time of Flight Aerosol Mass Spectrometers (HR-ToF-AMS) have advanced our knowledge of organic fine PM. However, the high cost of the AMS and its transport difficulties make its use impractical in many cases. In this study, the HR-ToF-AMS was utilized to characterize off-line organic ambient particulate matter which was collected on quartz filters. The method was applied to 17 filter samples collected at the Institute of Chemical Engineering Sciences (ICE-HT) in Patras. The sampling was conducted during autumn (16 filters collected), and winter (1 filter). The winter filter sample was collected during fat Thursday to test the method in periods with high concentration of cooking aerosol.

Biomass burning aerosol optical properties associated with wildfires over the Mediterranean basin based on satellite data

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In this work an assessment of biomass burning (BB) aerosol optical properties over the broader Mediterranean basin for the period 2002-2016 was carried out. Wildfire events (WFE), i.e. ignition date and geographical location, were identified based on MODIS (MODerate resolution Imaging Spectroradiometer) data. From the statistical analysis of the identified WFE 58 extreme wildfire events (EWFE) emerged with burned areas of thousands hectares. For these EWFEs, aerosol optical properties were investigated, namely spectral Aerosol Optical Depth (AOD), Ångström Exponent (AE), Fine Fraction (FF) and Aerosol Index (AI), describing the atmospheric load and size of BB aerosols and their change due to the occurrence of wildfires. The analyzed data were derived from Collection 006 MODIS-Terra database, except for AI, which was taken from TOMS (Total Ozone Mapping Spectrometer) and OMI-Aura (Ozone Monitoring Instrument) databases. The AI values were greater than 2.50 with maxima attaining 5.90. Ångström Exponent had a mean value around 1.80 with maxima exceeding 3.10, whereas the mean value of FF was 0.89. AOD (at 550nm) can reach values up to 2.70. For these EWFEs the spread of smoke plume was estimated through forward-trajectories computed via the HYSPLIT model.

An innovative method to arrive at high resolution emissions for city scale air quality modeling

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As cities are growing in size and complexity, the estimation of air pollution exposure requires detailed spatial representation of air pollution levels, rather than homogeneous fields, provided by global- or meso-scale models. A critical input for city-scale modeling is a temporally and spatially resolved emission inventory. Bottom-up approaches to create urban-scale emission inventories require numerous, available city-specific input data and are rather stand-alone projects than just a means to serve AQ modeling needs. This study presents a prompt and effective method to arrive at high resolution emission information, based on the spatial disaggregation of the regional, open access emission inventories, provided by the Copernicus Atmospheric Monitoring Service. In particular, a top-down approach is built upon the CAMS-REG gridded (ca. 7x7 km^2) database of anthropogenic air pollution emissions, creating added-value products of road transport emissions (line sources), mass emitted from industrial units (point sources) and of surface emissions attributed at a grid of 1 km resolution. The disaggregation is based on contemporary proxies from the Copernicus Land Monitoring Service (CLC 2018), the European Pollutant Release and Transfer Register (E-PRTR 2019) and on the Global Human Settlement (GHS) population data (2015). The downscaling of coarse emission rates for the area of Athens not only optimizes source allocation, but –once combined with contemporary land use data- it may result in the elimination of local inconsistencies.

The regime of particulate matter PM_1, $PM_{2.5}$ and PM_{10} in the city center of Ioannina

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The purpose of this study is to investigate the regime of particulate matter (PM) in the city center of Ioannina, NW Greece. The new environmental monitoring station of the Region of Epirus and University of Ioannina started its operation in February 2019. Being located downtown in the city, it provides additional and complementary information to that from the suburban Kiafa station. Here, the one-year (1 February 2019 through 31 January 2020) aerosol measurements of PM_{10} (coarse), $PM_{2.5}$ and PM_1 (fine, PM_1 measured for the first time in the city) are analyzed. The annual, monthly and daily patterns of PM were determined in order to reveal the sources of particulate matter and the local exceedances of PM concentrations. Most of the exceedances of the EU daily mean PM_{10} limit are noticed during autumn and especially in winter months, reaching highest levels usually around 10 p.m. The $PM_{2.5}/PM_{10}$ ratio values exceed 90% in the cold months of the year and range from about 40% to 70% in the warm months. The $PM_1/PM_{2.5}$ ratio fluctuates between 85% and 100% during winter and between 50% and 90% in summer, indicating a strong presence of ultrafine aerosols. Residential heating (during winter) and traffic (throughout the year) are the main contributors for PM in the region.

Air quality II (Oral session)

Investigation of the mineral dust concentration and light absorption in central Los Angeles employing a novel technique

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Ambient mineral dust particles have extensively been associated with increased morbidity and adverse health effects in urban environments. As a major component of PM_{10}, dust particles affect the Earth's radiation balance due to their absorbance and scattering properties. In this study, we investigate the real-time concentration and light absorption of dust particles in central Los Angeles using absorption photometers. As dust particles are typically mixed with black carbon which has significantly higher light absorption cross-section, we follow a novel technique by employing a coarse particle virtual impactor (with a cut-point of 2.5 μm) that concentrates coarse particles by 20-fold. Absorption of the concentrated dust particles was calculated by subtracting the absorption of $PM_{2.5}$ samples collected in parallel from light absorption of the aerosol in the virtual impactor line. The light absorption coefficient of the dust particles in central Los Angeles was calculated to be, on average, 2.62 1/Mm at 370 nm, while the corresponding value at 880 nm was 0.43 1/Mm. Lastly, we determine the absorption Angstrom exponent (AAE) of dust particles in the area to be around 2.0. Our findings confirm that this method can be efficiently used to investigate the dust properties in different urban environments.

The effect of regional sources on cloud properties during an extreme warm-air advection in the Arctic

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Anomalously large heat and moisture transport in the Arctic can result in enhanced surface warming and sea-ice melting. An extremely anomalous warm-air episode was observed during the Arctic Clouds in Summer Experiment (ACSE) in 2014, resulting in a rapid decrease in sea-ice concentrations from 90% to 50-60% (Tjernström et al. 2015). During that period varying cloud characteristics were observed (elevated clouds, optically-thick and optically-thin fog). This episode was mainly driven by changes in the large-scale circulation however the properties of the transported aerosols can also affect cloud properties and their radiative impact on the Arctic surface. In this study we investigate the impact of regional sources on CCN-activation and cloud droplet formation during this extreme episode. Numerical simulations are performed with the WRF model, fully coupled with chemistry (WRF-Chem), which explicitly solves cloud-aerosol interactions. Through a number of sensitivity simulations we investigate the role of regional emission sources (anthropogenic, biomass burning and their synergy) on the aerosols' vertical distribution and cloud droplet formation.

Investigation of volcanic emissions at Antikythera PANGEA station

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The Mt Etna eruption on 30 May 2019 was followed by a north-eastward transport of the volcanic plume towards Greece. FLEXPART dispersion model simulations confirm the volcanic plume transport from Etna towards the Antikythera Island, in Greece, mixing also with co-existing desert dust particles. Model simulations are evaluated with lidar measurements conducted at the PANhellenic GEophysical observatory of Antikythera (PANGEA) of the National Observatory of Athens (NOA), revealing the presence of the volcanic particles above the area the days following the eruption and with satellite-based SO2 observations from the TROPOspheric Monitoring Instrument onboard the Sentinel- 5 Precursor (TROPOMI/S5P). This is the first time that Etna volcanic elements are monitored at the Antikythera station with implications for the investigation of their role in the Mediterranean weather and climate.

Year-long greenhouse gases measurements at the urban environment of Athens, Greece

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The atmosphere is the layer of gases, particles and clouds surrounding our globe, receiving each year billion of tons of pollutants. Major sources of this pollution include fossil fuel combustion, cooking with solid fuels and wildfires. The ultimate by-product of all forms of burning is the emission of carbon dioxide (CO_2), which, along with carbon monoxide (CO), methane (CH_4) and water vapor (H_2O), constitute the primary greenhouse gases (GHGs). GHGs trap the long wave radiation given off by the planet, causing thus a raise in ambient temperature. First CO_2 measurements back in 1958 were merely 316 ppb, while nowadays we are well past 400 ppb. This study presents the first long-term GHGs observations in the urban environment of Athens. CO_2 and CH_4 present a clear annual cycle with maximum values during winter and minimum during summer. Maximum values for CO_2 during winter sometime exceed 600 ppm, with an annual average of 425±28 while CH_4 has an annual average of 2020±121 ppb. Levels of other major cities such as Paris and Mexico City are compared, as also background values at Finokalia, Crete. The ratio of CO/CO_2 is derived and finally, bivariate (wind speed-direction) polar plots are used to decipher point sources.

Climate dynamics (Poster session)

On the study of the heat wave of 2019 in European capital cities: Application of the updated heat wave index EHF (Excess Heat Factor)

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In this study, the summer heatwave of 2019 is detected and analyzed in 20 European capital cities using the up –to -date heatwave index Excess Heat Factor (EHF). For this purpose, daily mean temperature data (derived from the average of the equivalent daily maximum and minimum temperatures) is utilized for the summer months of 2019 for 20 European capital cities. This data was taken from the European Climate Assessment & Dataset (ECA&D) database. For each summer month, the most intense and lasting heatwaves are presented and discussed. Furthermore, it is investigated in which European centers the EHF index did not detect the heatwave. Using the EHI acclimatization index, the 2019 heatwave is investigated and analyzed not only from a statistical point of view, but also its possible adverse effects on people and their health.

Comparison of two different setups of RegCM4 model over the Mediterranean: Present time simulations

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Global, regional and local climate system is significantly affected by the interactions between planetary and large-to-local scale processes. These processes include change in boundary layer, changes in convection processes, the interaction between the ocean and the atmosphere etc. These factors are represented by numerous physics parameterization schemes in regional climate models (RCMs). According to previous research for the sensitivity of RegCM4 to different physics parameterizations, changes in the model's cumulus convection scheme and its closure assumptions, as well as planetary boundary layer scheme parameterizations, lead to improved results in the area of study. The objective of this study is to compare two different simulations of RegCM4.4.5.1 model with different setups in the model's configurations. The spatial resolution of the model is 25x25 km and HadGEM2 was utilized as a driving GCM. The main differences between the two simulations is the use of a combination of alterations in the model's configurations that was found to be the most optimal for the domain of study, in one simulation.

The impact of Madden-Julian Oscillation on the European climate

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Teleconnection patterns (TP) describe recurring and persistent atmospheric patterns that span over various geographical regions. TP reflect changes in the large-scale atmospheric circulation and influence temperature, rainfall, storm tracks, and jet stream location or intensity over vast areas. TPs are frequently associated with the Madden–Julian oscillation (MJO), affect weather and climate phenomena. The MJO is a large scale eastward circulation anomaly, with a strong influence on the Northern Hemisphere's climate conditions. The present research aims to study the influence of the MJO pattern over the European area and, more specifically, to investigate how the MJO phases are related to two climate parameters, temperature and precipitation. For this purpose, a database of NCEP/NCAR reanalysis data covering the period from 1976 to 2015 was used. Extreme values of the RMM index (>90%) were used to study the relation between MJO and the European Climate. The results showed that a statistically significant decrease in precipitation occurs in most MJO phases. In contrast, a statistically significant increase in winter temperature is observed in eastern Europe during the 1st and 2nd phases. On the other hand, the 3rd and 4th phases of MJO are related to the decrease of winter temperatures over Scandinavia.

The cold winter spells over the Balkan Peninsula: A climatological and dynamic analysis

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The appearance of long periods with extreme low temperatures during the winter can have serious effects with a high impact on both society and the natural environment. This study presents an extensive climatic analysis of the Cold Winter Spells that occurred in the Balkan Peninsula over a 59-year study period (1961-2019). Cold Winter Spells (WCSPs hereafter) are defined as periods of at least three consecutive days where the daily minimum temperature is below 5% of the empirical winter distributions. Based on this diagnostic index the occurrence of cold events during the study period is detected and the duration, frequency, and intensity of these extreme climatic events are further analyzed. Moreover, in order to investigate the relation of the WCSPs with the atmospheric circulation, two daily circulation type calendars, derived from an advanced automatic flexible classification, were utilized. This aims on identifying the prevailing atmospheric conditions that lead to extreme cold conditions over the Balkan Peninsula.

A contribution to the study of the Vardaris wind regime of the last 60 years

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Episodes of NNW-erly windstorms, known in the area of Balkan Peninsula, as Vardaris, are identified, with the aid of wind archive data from Regional Meteorological Centre of Macedonia of the Hellenic National Meteorological Service of Greece. The study of the seasonal, interannual and diurnal variations of the occurrence of Vardaris windstorms, as well as their intensity, shows that it is a severe and long-lasting, mainly winter-time, feature, usually commencing in the morning hours. Preliminary results of the study of dynamic features accompanying Vardaris, show that these windstorms are almost totally associated with cold fronts coming from northern sectors. The presence of a northerly jet or a tropopause fold aloft, contributes to an increase of intensity or duration of the windstorms. The connection of Vardaris with these dynamical features implies, that the observed negative (positive) trends of the occurrence frequency/duration (intensity) of Vardaris windstorms, is in accord with the scenario of climate change.

How different land surface schemes and model resolution affect simulated soil moisture-temperature coupling over the MENA region

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The climate over the Middle East and North Africa (MENA) region is simulated using the Weather Research and Forecasting (WRF) model driven by the ERA- Interim reanalyses. WRF is coupled with two different land surface schemes (LSS), Noah and NoahMP, at 50 km and 16 km horizontal resolution simulations for the period 2000- 2004. We calculate coupling metrics related to the soil moisture - air temperature feedback. The effect of the different LSS and model resolution on the derived metrics is quantified and the role of the associated soil-moisture temperature feedback is discussed.

Future changes of East Mediterranean summer atmospheric circulation under high emission scenarios of CMIP5 and CMIP6 project

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The Mediterranean region is considered as a vulnerable region to the impacts of climate change. Global warming triggers warmer and drier conditions affecting the climate over the Mediterranean basin. This study investigates the possible future changes of fundamental components of eastern Mediterranean (EMed) summer tropospheric circulation during 21st century. For the analysis eleven Global Climate Models available from 5th (CMIP5) and three from 6th (CMIP6) phase of Coupled Model Intercomparison Project are used. The analysis is focused on July-August (JA) period from 1980 to 2005 according to historical scenario and on the last period of 21st century (2075- 2100) under the high emission scenarios (rcp8.5 for CMIP5 and ssp5-8.5 for CMIP6 simulations). The findings for CMIP5 simulations suggest that during future six out of eleven model simulations show a strengthening of northerly wind component. Moreover, the majority of simulations show a significant decrease of JA subsidence over EMed possibly due to the weakening of Indian Monsoon activity. Models show that the JA 250 hPa zonal wind speed increases southward of about 45°N indicating the strengthening of STJ. Finally, future changes of the dominant features of EMed tropospheric circulation in CMIP6 are in line with the results of CMIP5 simulations.

Trends in weather type frequencies across Europe

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Climate change is one of the greatest challenges facing humanity today. Its' effects are already being felt and urgent action is needed to mitigate and adapt to these changes. Most climate change research is focused on the trends in individual meteorological variables. Hence, the study of synoptic air masses, or weather types remain unexplored. The aim of this research is to examine the changes in the frequency of weather types (WTs) over Europe since 1979, utilizing a recently developed gridded weather typing classification (GWTC) system. On average, across the study domain, Warm WTs have increased by 27 days/year over the 41-year period of study, Humid Warm WTs by 18 days/year and Dry Warm WTs by an additional 14 days per year. In contrast to these increases, decreases in frequency are occurring in Cool WTs (-33 days/year) and Dry Cool WTs (-14 days/year). The most notable changes are in the polar regions. Also, significant changes in the frequency of Warm and Cool WTs are occurring in central and northern Europe. The trends in WT frequencies above, combined with climatic region characteristics may be an effective tool of communication for policy makers as well as the general public.

Spatial interpolation methods for distribution of Regional Climate Models' daily precipitation at basin scale

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The object of this research is to evaluate well-known spatial interpolation methods on hindcast precipitation data derived from up-to-date Regional Climate Models. The proposed climate models are the CMCC-CCLM4-8-19 v.1, CNRM-ALADIN52 v.1 and GUF-CCLM-NEMO4-8-18 v.1 with a spatial resolution of 0.44°. The Inverse Distance Weighting, Spline, Ordinary Kriging attributed by the Spherical, Exponential, Gaussian and Linear models, as well as Thiessen polygons spatial distribution methods are implemented into the climate model derivatives. The methodology is applied in a watershed in Northern Greece, with the outputs of the interpolation techniques to be compared against gauged precipitation records. The reliability of the spatial interpolation results is estimated by using statistic metrics and the results indicate that Ordinary Kriging is slightly superior to the other methods. By applying the latter interpolation method, future precipitation could be properly distributed at basin scales and hydrological modelling grids. Hence, the coupling of climate with rainfall-runoff models could improve the accuracy of the simulation of river discharges under climate change, especially when large scale development projects are envisioned within the watershed.

Climate change (Poster session)

Evaluation and mapping of heating degree days in Greece

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Heating degree days (HDDs) is a useful index of the energy demand needed to heat a building. This index is derived from outside temperature measurements and relative to a temperature threshold, above which a building needs no heating. The present study investigated and mapped the heating degree days in Greece for every month over the time period 1960-2015. The evolution of this indicator over time provides significant information regarding energy demands and fuel consumption in the study region. Mean daily and monthly air temperature data were obtained from thirteen meteorological stations at various geographical sites across Greece. Several maps were produced to present the spatial distribution of the HDDs in Greece. In this study it was found that the energy needs for heating in Greece vary with latitude. Heating requirements is higher in northern and northwestern continental Greece compared to southern and eastern parts of the country. The heating days for January are comparatively higher than the other two winter months at all stations in the study area. Examining the temporal variation of HDDs over the period 1960-2015 we found a decreasing trend regarding stations in Greek islands.

Trend analysis of snow height time series in the University forest of Pertouli, central Greece

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In this study, the temporal variability of snow height in the University Forest of Pertouli (Central Pindus, Greece) was evaluated. To this end, long-term (1961-2016) time series for snow height from a mountainous meteorological station were collected and analyzed. Seasonal and annual data were subjected to the Mann-Kendall test to assess the possible statistically significant trends and in case of a significant trend to detect approximately its time of occurrence. Additionally, Sen's slope method was used to estimate the trend magnitude. The results showed decreasing trends in annual and seasonal accumulation of snow, statistically significant only in autumn. Snow height non-stationarity starts to occur in the early 1980s in the autumn. Also, the average magnitude trend per decade is approximately -6,3%, -5,6%, -11,3% and -5,7% for the annual, winter, autumn and spring snow heights respectively. In addition, the National Ice Center's Interactive Multisensor Snow and Ice Mapping System (IMS) high-resolution snow cover data were used for the period 2004-2016 in order to analyze any correlated trends between the number of days with snow cover and the accumulated snow from the surface station. Comparisons between the datasets show that the decreasing accumulations of snow at the surface are negatively correlated with the number of days with snow cover mostly due to an increasing number of snow-cover days in high elevation.

Estimation of the carbon and energy fluxes of a forest plantation in a lignite mine restoration

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The estimation of carbon and energy fluxes between the ecosystems and the atmosphere is critical for the assessment of their overall performance and their contribution to the global carbon cycle and climate change mitigation. In this study we present one-year measurements of the carbon assimilation and energy fluxes of a forest plantation in the restored fields of the Western Macedonia Lignite Center, Greece, with the use of the eddy covariance technique. The dominant species of the plantation is *Robinia pseudoacacia* L. The results of this study can contribute to the better understanding of the species ecophysiology under harsh conditions. The energy closure for the site can be considered very adequate, as the sum of latent and sensible heat flux was equal to 88% of net radiation minus soil heat flux. According to our measurements, the ecosystem acts as a carbon sink for about half of the year, and as a carbon source for the rest of it. The ecosystem acts marginally as a carbon sink, with a total gain of about 15 g C m^{-2}.

Evaluating potential fire behaviour for the Mediterranean islands under climate change

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It is widely recognized that wildfire risk is likely to be exacerbated by climate change. Vulnerability and risk assessments encompass several elements to express the complex interaction of the different factors that determine the system proneness to fire. In this study, we evaluate the potential fire behaviour and exposure at the regional level under climate change for three representative vulnerable areas of the Mediterranean (Sardinia, Corsica, and Crete islands). Towards this aim, we first map the spatial and temporal distribution of fire danger and then apply the high-resolution fire spread and behaviour model (FlamMap), which requires several topographic, fuel type and meteorological parameters. Wind speed and fuel moisture content data necessary for fire simulation are derived from the 3-hourly climatic output of EURO-CORDEX RCM/GCM pairs. We find that under the RCP2.6 scenario, the conditions towards the end of the century are returning closer to the present, though, under the RCP8.5 a prominent increase of potential fire behaviour and exposure is evident, especially for Crete. The obtained information concerning burn probability and intensity can contribute to mapping fire behaviour changes due to climate change, and supporting fire managers, decisions, and policy makers to respond to the potential increase in fire vulnerability and risk.

Water availability changes for natural vegetation development in the mountainous area of Metsovo (N. Greece) for the period 1960-2000

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Precipitation and evapotranspiration are driving parameters for the development of natural rain-fed vegetation. Purpose of this study is to investigate the annual, seasonal and monthly trends of reference evapotranspiration in conjunction with the effective rainfall in NW Greece and specifically in Metsovo, a mountainous area (alt. 1160m) located in Epirus. A time-series analysis of 40 years of monthly meteorological data from 1960 to 2000 was performed. Trends were identified under different confidence levels (a=0.05 and 0.1) by employing the Mann-Kendall test. The trends' magnitudes were estimated by the Sen's method. Results showed a significant increase of evapotranspiration in summer since 1960. The other seasons were almost unchanged or with slightly increasing trends, indicating thus more severe water stress conditions for the forest ecosystems in recent summers compared to the past. Further, the effective rainfall trends were positive on an annual basis. On a seasonal basis, however, results showed that the available water through precipitation has significantly increased only in winter and not significantly changed in summer, the season with maximum water requirements. Such changes indicate that Metsovo's local mountainous forest ecosystems will have to cope with and adjust to the climate changing conditions in the future.

Climatic change at Macedonia Greece, using climatic parameters

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This paper examines the climate change at Macedonia, Greece using the climatic parameters of Annual temperature range (Supan 1880) and thermal Continentality Index (Gorczynski 1918). Specifically, it examines the alteration of climate type by using a dense network of meteorological stations. There are 85 meteorological stations, belonging to the Ministry of Rural Development and Food and Hellas Gold, positioned at the Macedonia district with data during period 1950-2010. However, only the data from 43 meteorological stations, of the studying area, had available data for temperature, to be used in order to calculate the mean monthly and annual temperature and only 19 had continuous data for the aforementioned period. The three periods that were examined are 1954-1984, 1964-1994 and 1974-2004.The climate type of Macedonia has changed from mixed, Continental and Transitional maritime climatic type to only Continental climate type from first to third examined period. This clear change in the climate type is visible at almost half meteorological stations of Macedonia.

Greenhouses and radiative forcing: is our increased need for food the new unknown for future climate scenarios?

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The rapid increase in global population during the past century has led the agricultural sector to rely heavily on greenhouse-based agriculture activities (e.g. Nikiel and Elthahir, 2019). Future projections include the installation of massive greenhouse establishments in Africa, which will alter irreversibly the Earth-Atmosphere balance in the tropical belt with unknown consequences (e.g. Dommain et al, 2018). Regional cooling and surface shortwave radiative forcing (SWRF) effects for greenhouse areas has already been reported (e.g. Campra et al., 2008) in direct contrast to continuously increasing surface temperatures in the surrounding areas. The current work is focused on assessing satellite observations of land surface temperature, the visible and infrared albedo, solar irradiance and other relevant climatic quantities over areas with known strong greenhouse growing activities, such as Almeria, Spain, The Netherlands and Crete, Greece. More than thirty years' worth of space-based observations are statistically analyzed in order to evaluate and quantify the effect that the land use change has inflicted on the local planetary balance by decreasing the near-surface temperature and inducing a negative radiative forcing. The quantification of the possible masking effect of local climate change warming effects will furthermore be discussed.

Impact of climate change on energy performance of Hellenic non-residential buildings

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Climate change is expected, among various other severe consequences, to impact the energy performance of buildings. The work focuses on non-residential (NR) buildings and exploits available data from energy audits of about 2,400 Hellenic NR buildings from the national electronic repository that have been performed for issuing energy performance certificates (EPC). The available information includes general architectural features, construction details and mechanical systems characteristics. The data are analyzed for different NR building uses and main services and screened in order to increase confidence on the results. The quality checked data are used as examples of real NR buildings to estimate the buildings' energy performance in their existing condition using typical weather data. The work then investigates the impact of climate change, by generating future weather data and estimating the anticipated energy performance of these NR buildings in their existing condition and under a retrofit scenario. The assessment considers average climatic projections following two representative concentration pathways scenarios. The first is a baseline scenario continuing business as usual, representing the highest greenhouse gas emissions. The second is an intermediate stabilization scenario, assuming the imposition of conservative emissions mitigation policies.

Air quality (Poster session)

Estimation of chronic bronchitis incidence in adults due to PM_{10} exposure in Athens, Greece

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The aim of this paper is to provide quantitative data on the long-term impact of air pollution on the health of people living in the Greater Athens Area (GAA). More specifically, the incidence of chronic bronchitis in adults due to particulate matter known as PM_{10}, is estimated by applying the AirQ+ model, a program developed by the World Health Organization (WHO). In order to process the results, daily average concentrations of PM_{10} from five different locations within the GAA, covering the period 2001-2018, are used. The aforementioned data have been recorded by the air pollution monitoring network, which is under the auspices of the Hellenic Ministry of Environment and Energy (HMEE). The results are remarkable, indicating a direct correlation between high concentrations of PM_{10} and the effects of chronic bronchitis in adults, according to the AirQ+ model. Moreover, there is a decrease in both PM_{10} concentrations and the effects of chronic bronchitis across the GAA through the examined 19 years, which is significantly higher over the 2010-2018 period.

Low-cost portable air quality sensing device quantify human exposure in city environment

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In every city, air pollution is the foremost concern because of its impact in human health and economy. This strong connection appears gaining a lot of concern, driven by new installed air quality monitoring systems. Environmental and air quality data, highly accuracy, real-time monitoring, daily and yearly statistics, data access from experts or simple users, low-cost equipment and forecasting needs, enforce the market to develop new air quality monitoring systems using advanced technologies and protocols: internet of things (IoT) and wireless sensor networks (WSN). This work examines in a specific area (historical center of Athens city) the data quality of a portable low-cost sensor device, proper interpretation of the data measurements and the spatiotemporal mapping of air pollution. Therefore, the real mobile measurements are being examined and discussed in detail. A new web application for retrieving the data, combined with a data measurement processing software, both developed by the authors, are describing in the methodology. Finally, the outcomes show the limits of such equipment and summaries the steps for the proper development of a monitoring network consists of low-cost electrochemical sensors along with the necessary precision and accuracy.

PM_{10} concentrations at Ioannina and relationship with meteorological conditions

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The present study investigates the regime of particulate air pollution (PM_{10}) at Ioannina, NW Greece, with emphasis on their relationship with prevailing meteorological conditions. The study period covers the years 2010-2012 and 2014-2017, which coincides with a deep financial crisis that, among others, caused a shift of the types of fuel used for residential heating. The annual and daily patterns of PM_{10} reveal that residential heating (during winter) and traffic are the main contributors for PM_{10} in Ioannina, leading to extremely high levels, usually at 10 p.m., during winter. The meteorological conditions play an important role, affecting both the emissions and deposition/dispersion of PM_{10}. The financial crisis led to a shift from heating oil, which was routinely used for residential heating, to alternative cheaper solutions, such as biomass burning (wood/pellets). As a result, PM_{10} levels significantly increased, and in many cases surpassed the limit (mean daily PM_{10} concentration > 50 $\mu g/m^3$) set by the European Union. It is evident that the air quality in Ioannina, especially during the cold period, significantly depends on both the type of fuels used for residential heating and the prevailing meteorological conditions.

Eastern Mediterranean high summer ozone levels and the associated synoptic meteorological conditions

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For the better understanding of the atmospheric processes leading to ozone episodes over the Eastern Mediterranean, which is one of the major global tropospheric ozone hotspots, 4-year daily rural afternoon ozone measurements from the station of Finokalia in Crete have been analyzed. For the 7% highest ozone episodes during summer the composite NOAA/ESRL reanalysis maps of some meteorological variables have been plotted and compared with the climatic seasonal averages and the corresponding HYSPLIT back trajectories. The results show that during the highest ozone episodes, the transport of tropospheric ozone-rich air masses through atmospheric subsidence significantly influences the boundary layer and surface ozone concentrations. In particular, the geographic areas with observed tropospheric subsidence seem to be the transition regions between high and low pressure synoptic meteorological systems. During the highest ozone episodes, the air masses originate almost always from northern directions. The results also show that the strongest tropospheric subsidence conditions observed at the station during the highest ozone days are linked with air masses originating from the lower troposphere of the north-western sector. Strong atmospheric subsidence is also observed under the north-eastern circulation, linked to the characteristic "etesian" winds, which prevail over the Aegean Sea and the Eastern Mediterranean during summer.

Airborne dust chemistry and health risk assessment in the Sistan Basin, southeast Iran

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This study analyses the chemical composition (water-soluble ions and heavy metals) of the total suspended particles (TSP) and PM2.5 samples collected in Sistan, southeast Iran during the dusty period June – September 2014. Intense winds cause soil weathering and deflation of evaporate minerals from the dried Hamoun lakes just north of the sampling site, resulting in intense dust storms, extremely high TSP and PM2.5 concentrations and hazardous conditions for human health. Parts of the Teflon filters from the collected air samples were analysed for water-soluble ions via Ion Chromatography, for 17 metal elements and for assessing the bio-accessibility of toxic elements by means of acid digestion and Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES). The carcinogenic and non-carcinogenic health risks of eight heavy metals and Arsenic were also assessed for three exposure pathways (dermal contact, inhalation and ingestion), separately for children and adults. The non-carcinogenic risk for inhalation is very high (Hazard Index >1) both for children and adults, while the carcinogenic risk for specific elements exceeds the safe limit of 10-4 for inhalation and partly for dermal contact. The results provide essential knowledge in atmospheric chemistry over Sistan and in establishing mitigation strategies for air pollution control.

Synergy between different earth observation platforms towards the estimation of the intra-urban population exposure to wintertime air pollution of Athens

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An ever increasing number of people lives in cities. The urban population is often exposed to harmful levels of air pollution, at times driven by a complex urban morphology. In this study, a chemistry transport model is applied over Athens during December 2018, when a novel experimental mobile campaign for black carbon (BC) mapping was realized. The EPISODE-CityChem –used in this study- is a state-of-the-art photochemical, dispersion model, providing air quality outputs in high spatiotemporal analysis (1 hour, 100m). It simulates atmospheric chemistry, street canyon, sub-grid and point source dispersion and local photochemistry in each receptor point of the gridded domain. Satellite- based products are exploited for downscaling regional emissions, and regulatory in situ air monitoring stations provide data for statistical evaluation of the model outputs. The model simulations capture well the daily variation of NO_2 and overall show a good correlation with the measurements. The mapping of BC concentrations over the entire urban center is accomplished through an evaluated data fusion (regulatory network, NOA supersite, model) against BC values from the portable sensors. The estimated population exposure to air pollution levels in a detailed spatial representation can benefit mitigation interventions, thus achieving a direct impact on reducing air pollution inequalities.

Studying the dispersion of a chemical agent in an indoor environment

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Chemical events have significant public health and emergency preparedness consequences, therefore, crisis response planning is of outmost importance. The dispersion of a chemical agent in an indoor environment, near the so-called Human breathing zone" can cause harmful effects to the occupants of the room. The present study examines the dispersion of NH_3, i.e. a colorless, highly irritating gas with a suffocating odor in an office. Specifically, the turbulent flow of NH_3, under the influence of the indoor air's circulation, has been simulated using a Computational Fluid Dynamics model, i.e. the Realizable k-e model. For the simulations the structure and the constructive components, as well as the layout of objects in the room, the position of doors and windows, the exhaust ventilation and any other object that could act as an obstacle to the flow of gas have been taken under consideration. On the whole, the study provides estimation and quantification of the NH_3 levels, mainly up to the breathing zone, as well as evaluation of the natural ventilation's contribution in the decongestion and decontamination of indoor air.

Simultaneous assessment of indoor and outdoor PM concentration relationship in a typical rural residence in Greece

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Exposure to air pollution is one of the most significant environmental factors affecting human health. Even ambient particulate matter (PM) concentrations have been widely investigated, the characterization of indoor microenvironments air quality, where people spend most of their time, is limited. In this study, simultaneous 24 h indoor and outdoor PM2.5 concentration measurements were conducted, using PMS 5003 low cost optical particle counters. The measurement campaign took place in a 2-floor residence of a suburban location in the greater area of Patras, Greece. The relationship between indoor and outdoor PM2.5 was investigated as well as the main activities and potential particle sources. Elevated indoor PM concentrations were reported. Moreover, the significant higher indoor values during winter identify the fireplace wood burning as the main origin for PM.

Air quality impacts on human health. The case of Athens, Greece

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A bulk of literature concentrates on the nexus between air quality and human health. The objective of this study is to warily examine the effects of Particulate Matter (2.5 μm or less and 10 μm or less in diameter, hereafter $PM_{2,5}$ and PM_{10}, respectively) on cardiorespiratory mortality for Athens, within the framework of the AirQ+ model developed by the World Health Organization. We calculate the Relative Risk (RR) of mortality attributed to the cardiovascular and respiratory diseases for $PM_{2,5}$, and PM_{10}, using the Generalized Linear Model (GLM) as it provides a more flexible modelling procedure and departs from the restrictive assumption of normality. Three different age groups are used for comparison purposes: people aged 20-49, 50-79 and 80+. Daily means of $PM_{2,5}$ (2007-2016) and PM_{10} (2001-2016) are acquired by the National Observatory of Athens. The findings of the performed analysis illustrate that there is an increasing effect of the pollutants to human health. More specifically, $PM_{2,5}$ has the highest effect on respiratory diseases as it is shown by its high Relative Risk.

Atmospheric lapse rates and humidity profiles during dust storm events in the central-eastern Mediterranean basin

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Dust transportation originating from Northern Africa takes place quite frequently over the central and eastern Mediterranean. The presence of huge amounts of dust in the atmosphere has negative impacts on air quality, airport traffic, renewable energy sources and seriously affect people daily life. The present study examines the prevailing atmospheric conditions during Mediterranean dust storms in the central-eastern Mediterranean, with emphasis to the vertical profiles of temperature and humidity. For the needs of the study, measurements from AERONET (AErosol RObotic NETwork) ground-based stations and nearby radiosonde stations were used. The obtained results show that extreme dust events (with AOD_{550nm} values larger than 0.4) are associated with stable atmospheric conditions between 250 and 750 m above the Earth' surface, suppressing convection and contributing significantly to the confinement of polluted air masses in the lower and middle boundary layer.

A composite air quality-climate quantification approach

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Urban planning and all related processes (design of land use, transportations, communications, power distribution networks etc.) rely on several critical elements of urban life that need to be evaluated in order to alter the physical layout of cities accordingly, while public welfare remains in the center of interest. In this context, air quality and climatic conditions, which vastly affect urban metabolism, should be studied thoroughly and in conjunction, to have a better understanding of the nature of urban climate and subsequently help policy makers to introduce more effective frameworks. Both pollutants and meteorological parameters can be evaluated, regarding their impact, by using indices. The most common categories of indices that have been developed for similar purposes, are addressing the levels of air quality and the human thermal comfort separately. However, there are known instances in which cities experience the urban heat island effect and the hot summer days coincide with poor air quality conditions. This study provides a straightforward quantification approach, by introducing the development of a metric that incorporates the effects of meteorological and air quality parameters. This approach can be utilized to alert the general public and efficiently implement urban planning interventions.

Mass concentration of airborne particles and their characteristics at Akrotiri station (Chania) during a summer campaign

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PM_{10} and $PM_{2.5}$ concentrations were measured at Akrotiri station (Chania) during a 3-months campaign (May to July 2020). PM_{10} was measured online whereas $PM_{2.5}$ was obtained by gravimetric sampling. Increased PM_{10} concentrations were measured during Sahara dust events that took place at the under study site with higher daily maximum concentration at 38.2 μg/m^3. Nevertheless, intensive fluctuations caused by the dust events were responsible only for temporal increase of ambient levels. Overall, higher ambient levels were obtained on July (monthly average 20.3 μg/m^3) which were associated with local anthropogenic sources. Analysis with wind direction has shown no link between wind direction/frequency and PM_{10} besides the south direction during dust events. On the other hand, PM_{10} was negatively correlated with wind speed (-0.61 Spearman r). $PM_{2.5}$ varied between 6.1 to 16.9 μg/m^3 with higher concentrations measured on July verifying the increased emissions of fine particles during this period. The contribution of $PM_{2.5}$ to PM_{10} was 54 % on June samples and 63 % on July samples.

Temporal variation of particulate matter and adverse health effects in the greater Volos area, Greece

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The increased industrialization coupled with population growth of metropolitan areas is strongly related to environmental problems. There is great consensus among the scientific community that suspended particulate matter is considered as one of the most harmful pollutants, particularly the inhalable particulate matter with aerodynamic diameter less than 10 mm (PM_{10}) causing respiratory health problems and heart disorders. Average daily concentrations exceeding established standard values appear, among other cases, to be the main cause of such episodes, especially during Saharan dust episodes, a natural phenomenon that degrades air quality in the urban area of Volos. In this study the AirQ+ model developed by the World Health Organization (WHO) was used to evaluate adverse health effects by PM_{10} pollution in the city of Volos during an 18-year period (2001-2018). Volos is a coastal medium size city in the Thessaly region, Central Greece. Air pollution data were obtained by a fully automated monitoring station, which was established by the Hellenic Ministry of Environment and Energy, in the Greater Area of Volos, located in the center of the city. The results have shown that there is a strong correlation between high concentrations of PM_{10} and the effects of chronic bronchitis in adults.

Health impacts from exposure to $PM_{2.5}$, black and organic carbon in Europe

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Exposure to particulate matter less than 2.5μm in diameter ($PM_{2.5}$) can result in multiple health end-points among humans, including excess mortality from lung cancer, cardiovascular, respiratory and other non-communicable diseases. About 8.9 million excess deaths may be attributed to exposure to ambient $PM_{2.5}$ globally. This estimate does not account for the potential differential toxicity of $PM_{2.5}$ components (like black and organic carbon). Here, we use the numerical Weather Research and Forecasting with Chemistry (WRF-Chem) system and a recently developed exposure response function (Global Exposure Mortality Model – GEMM) to estimate excess mortality associated with long-term exposure to ambient $PM_{2.5}$ for the year 2015 in European countries. We further attribute the estimated excess mortality to the fractions of black and organic carbon (BC+OC) in $PM_{2.5}$, based on the assumption that BC+OC are twice more toxic than other $PM_{2.5}$ components, being supported by toxicological and epidemiological studies. We estimate that an annual total of 392,000 (Uncertainty Interval: 353,000-431,000) excess deaths were associated with exposure to ambient $PM_{2.5}$, of which 65,000 (58,700-71,200) deaths (~17%) were associated with BC+OC exposure (with BC+OC being twice more toxic than other PM components). This fraction corresponds to 564 deaths/year per 100,000 population. Under the equal toxicity assumption, the BC+OC attributable mortality is reduced to 31,000 deaths (28,000-34,000) per year (~8%), which corresponds to 267 deaths/year per 100,000 population. Overall, the results differ between countries due to factors such as, the emission sources, the baseline mortality rates, populations aging, populations distribution and socioeconomic factors. The higher toxicity of BC+OC compared to other inorganic PM components gives more weight to sources such as road transport and residential combustion, which is important for air pollution mitigation strategies.

Variability of CO_2, CH_4 and CO column averaged mixing ratios from two years of measurements in Thessaloniki, Greece, using a portable EM27/SUN FTIR spectrometer

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The column-averaged dry-air mole fractions of carbon dioxide (XCO_2), methane (XCH_4) and carbon monoxide (XCO) were measured for the first time in Thessaloniki, Greece, using the Bruker EM27/SUN ground-based low-resolution Fourier Transform spectrometer, a reliable, mobile supplement to high-resolution Bruker IFS125 spectrometer used in Total Carbon Column Observing Network (TCCON). The EM27/SUN instruments constitute the Collaborative Carbon Column Observing Network (COCCON), with stations worldwide for the quantification of local sinks and sources, working as an important supplement of TCCON to increase the density of column-averaged greenhouse gas observations. Two years of XCO_2, XCH_4 and XCO measurements are presented and analyzed for diurnal and seasonal cycles. The observed XCO_2 shows expected seasonal cycle (spring maximum, late summer minimum). XCH_4 values increase in the second half of the year. XCO, following anthropogenic sources, shows high winter and low summer values, exhibiting a rise again in August and September. Diurnal cycles do not show a distinct pattern, except for XCO which decreases in the course of the day.

Levels and sources of polycyclic aromatic hydrocarbons at the port of Piraeus

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Polycyclic Aromatic Hydrocarbons (PAHs) are organic molecules with two to seven fused benzene rings characterized by well-recognized toxic and carcinogenic effects. These compounds originate mainly from incomplete combustion processes and despite their impact on human health, extensive measurements of PAHs are clearly missing in Greek urban areas. In this study, PAHs levels were measured in sixty eight (68) $PM_{2.5}$ samples collected during an one-year period (December 2018 – December 2019) in Piraeus, the largest port in Greece and one of the largest ports in the Mediterranean. Thirty three PAH members were identified and their levels and seasonal variability were investigated. The concentration levels of PAHs were significantly higher in winter, especially during intense atmospheric pollution events. Specifically, the total concentration of PAHs (Σ_{33} PAHs) was found to be up to ten-fold higher in winter compared to summer. Furthermore, an identification of the emission sources of PAHs was performed using the multivariate statistical method of Principal Component Analysis. Finally, the toxic equivalent factor approach based on Benzo(a)Pyrene (B[a]P) was used to describe the toxicity of the collected samples and the associated lifetime excess cancer risk.

Levels and variability of gaseous acidic compounds in the atmosphere of Athens

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Acidic gaseous compounds such as nitric acid, hydrochloric acid and sulfur dioxide (HNO_3, HCl and SO_2 respectively) comprise important atmospheric constituents, with impacts on air quality, human health and acidity of the atmosphere. Despite these effects and with the exception of SO_2, the rest, namely HNO_3 and HCl, are not considered as national priority pollutants and published works in the past concern short term low resolution measurements. This work concerns the levels and the variability of these three acidic compounds at the urban background atmospheric monitoring station of the National Observatory of Athens at Thissio. A high resolution automatic Wet Annular Denuder Ion Chromatography technique is operated providing time resolved hourly averaged data for the period of December 2014 to February 2015, June to October 2015 and February to March 2016. Their diurnal and seasonal variability is investigated and compared to the past works. The role of winter time biomass burning, been reflected on the night-time levels, is also assessed. Emphasis is given on SO_2 since its levels have greatly been limited over the last two decades in Athens, Greece, as a consequence of the de-industrialization of the area, the implementation of antipollution measures and the reduction of emissions due to the financial recession period arising at 2008.

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