

UNIVERSITY OF PATRAS

SCHOOL OF SCIENCE

DEPARTMENT OF PHYSICS

LABORATORY OF ATMOSPHERIC PHYSICS

Activity Report 2019

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Ioannis Kioutsioukis

September 2020

Patras, Greece



Laboratory of Atmospheric Physics of the University of Patras¹

Activity Report 2019

Note of the Head of the LAPUP

Dear friends and colleagues,

This report provides an overview of our activities for the year 2019. You will be informed for new EU and national projects and publications. Moreover, our activities in air quality and climate change give us the opportunity to communicate the state of the art and our research outcomes to a wider audience including stakeholders, the general public etc.

However, this report provides just some general information about all these activities. For more details, I invite you to join our dissemination channels or contact us directly. LAPUP strongly believes that atmospheric sciences are a crucial part of a variety of intra-scientific fields (e.g. renewables, health), so, we are trying to build collaborations in a variety of atmosphere-related research fields.

Overall, LAPUP tried in 2019 to upgrade its instrumentation and research facilities, improve the quality of products and services and stay committed to our mission of science.

Patras, August 31, 2020

Professor Andreas Kazantzidis

¹ Your comments are more than welcome and can be addressed to akaza@upatras.gr

You can follow our activities via the following links:

- LAPUP's Web Page: www.atmosphere-upatras.gr
- The LAPUP on Facebook: <https://www.facebook.com/455557894536561>
- The LAPUP on YouTube: <https://www.youtube.com/channel/UCqMUy30C-U8IEPEebxkzJHQ>

Staff

Faculty Members

- Athanassios A. Argiriou, Physicist (University of Patras), D.E.A. (I.N.P. Grenoble) - Ph.D. (Univ. Aix-Marseille 1), Professor (2006 -).
- Andreas Kazantzidis, Physicist, M.Sc., Ph.D. (Aristotle University of Thessaloniki), Professor (2015 -).
- Ioannis Kioutsoukis, Physicist, M.Sc. (Aristotle University of Thessaloniki), Ph.D. (Aristotle University of Thessaloniki, Joint Research Centre Ispra), Assistant Professor (2016 -).

Postgraduate Researchers

- Vasileios Salamalikis, Physicist, M.Sc., Ph.D University of Patras (Stable isotopes in atmospheric processes).

Graduate Students

Ph.D. Candidates

- Vasileios Armaos, Physicist, University of Patras, M.Sc. Applied Mathematics & Theoretical Physics, University of Cambridge. Topic: Quantum computing applications in atmospheric sciences.
- Kalliopi Droutsas, Physicist, National & Kapodistrian University of Athens, M.Sc. in Environmental Physics, National & Kapodistrian University of Athens. Topic: Energy and environmental imprint of the Hellenic tertiary sector buildings and study of their energy retrofit taking into account the implications of climate change.
- Constantinos Kolokythas, Hellenic Air Force - Meteorologist, M.Sc. in Environmental Sciences, University of Patras. Topic: Wind energy forecast – Topography and extreme weather events impact.
- George Kosmopoulos, Physicist, M.Sc. Energy & Environment, University of Patras. Topic: Effect of atmospheric constituents on solar irradiance.
- Stavros – Andreas Logothetis, Physicist, M.Sc. Applied Meteorology & Environmental Physics, University of Patras. Topic: The effect of the aerosols and clouds on the energy budget of the Earth-Atmosphere system.
- Iasonas Markantonis, M.Sc. Applied Meteorology & Environmental Physics, University of Patras. Topic: Extreme and Compound Events in EMED.
- Dimitrios Michos, Mathematician, M.Sc. Applied Meteorology & Environmental Physics, University of Patras. Topic: Energy Meteorology.
- Orestis Panagopoulos – Kontostavakis, Physicist, M.Sc. in Green Energy, University of Patras. Topic: Experimental study and modelling of the Urban Heat Island in Patras.
- Areti Pappa, M.Sc. Applied Meteorology & Environmental Physics, University of Patras. Topic: Applications of complex networks in atmospheric sciences.



- Nikolaos Roukounakis, MEng Chemical Engineering, University of Birmingham, MSc Environmental Technology, Imperial College London. Thesis topic: The application of a high-resolution weather forecasting model for estimating GPS tropospheric delay over complex terrain.
- Ioannis Vamvakas, Physicist, M.Sc. Energy & Environment, M.Sc. Applied Meteorology & Environmental Physics, University of Patras. Thesis topic: Cloud and aerosol effects on solar irradiance.

Research Associates

- Ioannis Kanakaris, Informatics for Business Planning Engineer (Technical Educational Institute of Patras), M.Sc. in Accounting (Price Waterhouse Coopers S.A.)

Teaching Activities

During the reporting period, the LAPUP faculty taught the following undergraduate and graduate courses:

Undergraduate Programs

- Atmospheric Physics I - Meteorology (7th semester, Dept. of Physics, University of Patras)
- Atmospheric Physics II (8th semester, Dept. of Physics, University of Patras)
- Atmospheric Pollution (7th semester, Dept. of Physics, University of Patras)
- Calculus (1st semester, Dept. of Physics, University of Patras)
- Differential Equations (2nd semester, Dept. of Physics, University of Patras)
- Introduction to Environmental Physics (5th semester, Dept. of Physics, University of Patras)
- Dynamical Systems and Complexity (7th semester, Dept. of Physics, University of Patras)
- Meteorology – Climatology (7th semester, Dept. of Geology, University of Patras)
- Atmospheric Physics I-Meteorology I (7th semester, Dept. of Mathematics, University of Patras)
- Atmospheric Physics II-Meteorology II (8th semester, Dept. of Mathematics, University of Patras)
- Physics Laboratory II (Mechanics – Fluid Mechanics) (2nd semester, Dept. of Physics, University of Patras)
- Physics Laboratory III (Thermodynamics – Waves - Optics) (3rd semester, Dept. of Physics, University of Patras)
- Physics Laboratory IV (Electromagnetism) (4th semester, Dept. of Physics, University of Patras)
- Renewable Energies Laboratory (8th semester, Dept. of Physics, University of Patras)

Graduate Programs

Graduate Program on Applied Meteorology and Environmental Physics

- Dynamic and Synoptic Meteorology (1st semester)
- Radiation and Atmosphere (1st semester)
- Measurements and Data Processing in Atmospheric Sciences (1st semester)
- Energy Meteorology (2nd semester)
- Statistical Methods in Atmospheric Sciences (2nd semester)
- Atmospheric Modelling (2nd semester)

Interdisciplinary Graduate Program on Environmental Sciences, University of Patras

- Environmental Physics (1st Semester)

Interdisciplinary Graduate Program on Distributed green electricity and advanced network infrastructure management and economy, University of Patras

- Integrated Modelling (1st semester)
- Energy Meteorology (2nd semester)

Theses

Ph.D. Theses

- Roukounakis Nikolaos, Application d'un modèle météorologique à haute résolution à la correction troposphérique d'observations interférométriques de radar à synthèse d'ouverture (InSAR) dans la région de l'ouest du golfe de Corinthe, Grèce, October 2019, Supervisors (Co-tutelle thesis with the Ecole Normale Supérieure de Paris): A. Argiriou (UP) & P. Briole (ENS) (<http://www.theses.fr/s175852>)

M.Sc. Theses

- Michos Dimitrios, Homogenization of Hellenic cloudiness time series, August 2019. Supervisor: A. Argiriou. (<http://hdl.handle.net/10889/12501>)

- Pappa Areti, Study of the impact of meteorological parameters on the abdominal aortic aneurism rupture, April 2019. Supervisor: A. Argiriou. (<http://hdl.handle.net/10889/12542>)

- Tzavella Asimina, Variation of the isotopic signature in atmospheric precipitation: interpretation based on the residence time of water vapor in the atmosphere, October 2019. Supervisor: A. Argiriou. (<http://hdl.handle.net/10889/13012>)

- Logothetis Stavros Andreas, Estimation of aerosol effect on the energy balance of the earth-atmosphere system, January 2019. Supervisor: A. Kazantzidis. (<https://nemertes.lis.upatras.gr/jspui/handle/10889/12235>)



-Kampouris Manolis, Assessment of water vapor effect on direct normal irradiance at global scale, February 2019. Supervisor: A. Kazantzidis.
(<https://nemertes.lis.upatras.gr/jspui/handle/10889/11939>)

Theodoropoulos Ioannis, Short-term prediction of the wind potential using the Analog Ensemble method, June 2019, Supervisor: I. Kioutsioukis
(<http://hdl.handle.net/10889/12841>)

Chronopoulos Andreas, Short-term prediction of the solar potential using the Analog Ensemble method, October 2019, Supervisor: I. Kioutsioukis
(<http://hdl.handle.net/10889/12746>)

Research Activities

The main research axes of the LAPUP include:

- Measurements, quality control, processing and homogenization of meteorological and environmental time series.
- Stable isotopes ($\delta^{18}\text{O}$ & $\delta^2\text{H}$, nitrogen isotopes) in rain and in atmospheric water vapor.
- Ultraviolet radiation: Measurements, modeling and biological dose rates.
- Solar Radiation: Measurements, modeling and solar energy.
- Energy meteorology.
- Artificial intelligence methods applied to atmospheric and environmental physics problems.
- Atmospheric Modeling, Ensemble Forecasting, and Predictability.
- Uncertainty propagation and Sensitivity analysis of model output.
- Chemical Weather forecasting.
- Modeling Environment and Vector-borne Disease Interaction.

In the frame of the above research axes, the LAPUP carried out a number of research projects that led to a series of publications in international scientific journals and conferences.

On-going research projects

- Aerosol and cloud effects on solar irradiance, Hellenic Foundation for Research & Innovation, 11/2017-7/2019.
- Solar Resource for High Penetration and Large Scale Applications, International Energy Agency - Photovoltaic Power Systems Program Task 16, 7/2017 – 6/2020.
- Solar Collectors with Static Concentrators, for solar thermal applications at intermediate to medium temperatures - SCoSCo (Bilateral cooperation between Greece and Germany), 5/2018 – 4/2020.

- Global Monitoring of Nitrogen Isotopes in Atmospheric Waters (International Atomic Energy Agency Coordinated Research Project F32008 – Contract #22879/R0), 6/2018 – 5/2021.
- Comparative study of changing climate extremes between China and Europe / Greece, based on homogenized daily observations -CLIMEX (Bilateral cooperation between Greece and China), 11/2019 – 11/2021.
- PatrasAir: Set-up and monitoring of the air quality in the metropolitan area of Patras (patrasair.gr). Self-funded project.
- UHI: Set-up and monitoring of the urban heat island effect in the metropolitan area of Patras (patrasair.gr). Self-funded project.
- AQMEII (phase IV): Air Quality Model Evaluation International Initiative
- Modeling Environment and Vector-borne Disease Interaction. Self-funded project.
- Early Warning for Disease epidemics. Self-funded project, 10/2019-10/2023.
- Middle East – North Africa Hybrid Solar System (HYMENSO), ERANETMED Renewable Energies, 1/11/2016 – 30/4/2019 (www.hymenso.eu).
- Towards an innovative strategy for skills development and capacity building in the space geo-information sector supporting Copernicus user uptake, H2020 Erasmus+, 1/1/2018 – 31/12/2021 (www.eo4geo.eu)
- Panhellenic infrastructure for atmospheric composition and climate change, GSRT 1/9/2018 – 31/8/2021.
- Spatiotemporal variability of air particulate matter in the city of Thessaloniki and investigation of possible effects on human health, 10/10/2018 – 9/10/2020.
- Introducing Recent Electrical Engineering Developments into undergraduate Curriculum (IREEDER), Erasmus+, 15/11/2019-14/11/2022.
- Smart Air Quality Monitoring, 1/1/2019-31/12/2020.

Publications in peer-reviewed journals

- Gaglia, A.G., Dialynas, E.N., Argiriou, A.A., Kostopoulou, E., Tsiamitros, D., Stimoniaris, D., Laskos, K.M. (2019) Energy performance of European residential buildings: Energy use, technical and environmental characteristics of the Greek residential sector – energy conservation and CO₂ reduction. *Energy and Buildings* 183:86-104 (doi: 10.1016/j.enbuild.2018.10.042).
- X. Qiu, M. Zhang, S. Wang, J. Evaristo, A. A. Argiriou, R. Guo, R. Chen, H. Meng, C. Che, D. Qu (2019) The test of the ecohydrological separation hypothesis in a dry zone of the northeastern Tibetan Plateau. *Ecohydrology*, 2019, 12(3): e2077. (<https://doi.org/10.1002/eco.2077>)

- X. Qiu, M. Zhang, S. Wang, A. A. Argiriou, R. Chen, H. Meng and R. Guo (2019) Water Stable Isotopes in an Alpine Setting of the Northeastern Tibetan Plateau. *Water*, 11(4), 770 (doi:10.3390/w11040770)
- Mengyu Shi, Shengjie Wang, Athanassios A. Argiriou, Mingjun Zhang, Rong Guo, Rong Jiao, Jingjing Kong, Yanning Zhang, Xue Qiu and Su'e Zhou (2019) Stable Isotope Composition in Surface Water in the Upper Yellow River in Northwest China. *Water*, 11, 967 (doi:10.3390/w11050967)
- Rong Guo, Shengjie Wang, Mingjun Zhang, Athanassios A. Argiriou, Xuemei Liu, Bo Su, Xue Qiu, Rong Jiao, Mengyu Shi, Su'e Zhou and Yanning Zhang (2019) Stable Hydrogen and Oxygen Isotope Characteristics of Bottled Water in China: A Consideration of Water Source. *Water*, 11, 1065 (doi: 10.3390/w11051065)
- Cunwei Che, Mingjun Zhang, Athanassios A. Argiriou, Shengjie Wang, Qinqin Du, Peipei Zhao and Zhuanzhuan Ma (2019) The Stable Isotopic Composition of Different Water Bodies at the Soil–Plant–Atmosphere Continuum (SPAC) of the Western Loess Plateau, China. *Water*, 11, 1742 (doi:10.3390/w11091742)
- A. A. Argiriou, A. Mamara, E. Dimadis (2019) Homogenization of the Hellenic cloud cover time series - Preliminary results, *Croatian Meteorological Journal*, 53, 43-54.
- Shadow-camera based solar nowcasting system for shortest-term forecasts, P. Kuhn, D. Garsche, S. Wilbert, B. Nouri, N. Hanrieder, C. Prah, L. Zarzarlejo, J. Fernandez, A. Kazantzidis, T. Schmidt, D. Heinemann, P. Blanc, R. Pitz-Paal, *Meteorologische Zeitschrift*, 10.1127/metz/2019/0954, 2019.
- Cloud height and tracking accuracy of three all sky imager systems for individual clouds, B. Nouri, P. Kuhn, S. Wilbert, N. Hanrieder, C. Prah, L. Zarzalejo, A. Kazantzidis, P. Blanc, R. Pitz-Paal, *Solar Energy*, 177, 213-228, 2019.
- Determination of the optimal camera distance for cloud height measurements with two all-sky imagers, P.Kuhn, B.Nouri, S.Wilbert, N.Hanrieder, C.Prah, L.Ramirez, L.Zarzalejo, T.Schmidt, T.Schmidt, Z.Yasser, D.Heinemann, P.Tzoumanikas, A.Kazantzidis, J.Kleissl, P.Blanc, R.Pitz-Paal, *Solar Energy*, 179, pp. 74-88, 2019
- Short-term cloudiness forecasting for solar energy purposes in Greece, based on satellite-derived information, E. Nikitidou, E. Zagouras, V. Salamalikis, A. Kazantzidis, *Meteorology and Atmospheric Physics*, 131(2), pp. 175-182, 2019
- Determination of cloud transmittance for all sky imager based solar nowcasting, B.Nouri, S.Wilbert, L.Segura, P.Kuhn, N.Hanrieder, A. Kazantzidis, T.Schmidt, L.Zarzalejo, P.Blanc, R.Pitz-Paal, *Solar Energy*, 181, 251-263, 2019.
- Real-Time Uncertainty Specification of All Sky Imager Derived Irradiance Nowcasts,, B. Nouri, S. Wilbert, P. Kuhn, N. Hanrieder, M. Schroedter-Homscheidt, A. Kazantzidis, L. Zarzalejo, P. Blanc, S. Kumar, N. Goswami, R. Shankar, R. Affolter and R. Pitz-Paal, *Remote Sensing*, 11(9), 1059, 2019.
- Kioutsioukis I, Stilianakis N, Assessment of West Nile virus transmission risk from a weather-dependent epidemiological model and a global sensitivity analysis framework, *Acta Tropica*, 193: 129-141, 2019.

- Parselia E, Kontoes C, Tsouni A, Hadjichristodoulou C, Kioutsioukis I, Magiorkinis G, Stilianakis N, Satellite Earth Observation data in epidemiological modeling of malaria, dengue and West Nile Virus: A scoping review, *Remote Sensing*, 11, 1862, 2019.

Presentations in peer-reviewed international conferences

- K.D. Droutsas, C.A. Balaras, S. Kontogiannidis, E.D. Dascalaki, A.A. Argiriou (2019) Energy Benchmarking of Hellenic Non-Residential Buildings. EinB2019 – 8th International Conference “ENERGY in BUILDINGS 2019”, Athens, Greece, September 28, 2019.
- Study about Hybrid CSP – PV plants for the MENA Region, D. Benitez, A. Kazantzidis, A. Al-Salaymeh, S. Bouaichaoui, Abdessalem Ben Haj Ali, Moncef Balghouthi, AmenAllah Guizani, 978-1-7281-0140-8/19, The 10th International Renewable Energy Congress (IREC 2019), March 26-28, Sousse, Tunisia.
- Aerosol Optical Properties and Direct Radiative Forcing Based on Measurements From the Aerosol Robotic Network (AERONET) in Europe and Mediterranean Area, Kazantzidis A., Logothetis S., Salamalikis V., ESA Living Planet Symposium, 13-17 May 2019, Milan, Italy
- Evaluation of site adaptation techniques on satellite-derived solar surface irradiance (SSI) in Middle East – North Africa (MENA) region, Kazantzidis A., Vamvakas I., Salamalikis V., ESA Living Planet Symposium, 13-17 May 2019, Milan, Italy
- Towards an innovative strategy for skills development in the Earth Observation/Geoinformation sector, Stelmaszczuk-Górska M. , Vlad Sandru M. I., Nedelcu I. N. , Iasillo D., Kazantzidis A. , d’Auria I., Lang S., Miguel-Lago M. , Carbonaro M., Vandenbroucke D., ESA Living Planet Symposium, 13-17 May 2019, Milan, Italy
- Aerosol classification and bias adjustment of global horizontal irradiance for Middle East – North Africa region, A. Kazantzidis, V. Salamalikis , S. Logothetis , I. Vamvakas, 25th SolarPACES Conference, 1-4 October 2019, Daegu, South Korea.
- A Way to Increase Parabolic Trough Plant Yield by Roughly 2% Using All Sky Imager Derived DNI Maps, B. Nouri , K. Noureldin , T. Schlichting , S. Wilbert , T.s Hirsch , M. Schroedter-Homscheidt, P. Kuhn, A. Kazantzidis , L. Zarzalejo, P. Blanc, J. Fernández, R. Pitz-Paal, 25th SolarPACES Conference, 1-4 October 2019, Daegu, South Korea.
- Evaluation of an All Sky Imager Based Nowcasting System for Distinct Conditions and Five Sites, B. Nouri, S. Wilbert, N. Blum, P. Kuhn , T. Schmidt , Z. Yasser , T. Schmidt , L. F. Zarzalejo , F. M. Lopes , H. Silva , M. Schroedter-Homscheidt , A. Kazantzidis, C. Raeder , P. Blanc, R. Pitz-Paal, 25th SolarPACES Conference, 1-4 October 2019, Daegu, South Korea.

Organization of Conferences and Workshops

- World Meteorology Day event, March 23rd, 2019, University of Patras Conference Center.
- Varlas George December 4th, 2019, Seminar in the frame of the Graduate Program “Applied Meteorology and Environmental Physics” of the LAPUP.

Dissemination activities

- Sailing Meteorology – A free course offered for the students of the sailing schools of the Sailing Club of Patras (IOP).
- Guided visits in the Lab for high school students.
- Weather forecasts and extreme weather event analyses for the local and national news media (e.g. https://www.kathimerini.gr/1016987/article/epikairothta/ellada/oi-prwtes-provleyeis-gia-ton-kairo-toy-kalokairioy?fbclid=IwAR39Z9Gni_NGHuNEGgu0LSnTrf5WkRrL9wgtUlrHd0-SsGg9R02pHa9EaeM).
- Navarino Environmental Observatory Science – Café: Lay lectures on meteorology and environmental issues; joint venture of the Navarino Environmental Observatory and the LAPUP in collaboration with the Society for Mental Health of Patras.
 - Kioutsioukis I, Assistant Professor, LAPUP, “The science of forecasting: From the weather to the epidemics”.
 - Papatheodorou G., Professor, Department of Geology, University of Patras, “Excavating underwater antiquities with sounds”.
- Weather forecast support to the II Mediterranean Beach Games – Patras 2019 (https://www.mbgpatras2019.gr/?section=637&language=en_US&itemid1541=4355&detail1541=1)

Photos from Selected activities



Figure 1: 18-21/4/2019: Visit of the graduate students and faculty members of the LAPUP to the Environmental Station of the Navarino Environmental Observatory, Methoni, Greece.



Figure 2: 28-29/8/2019: visit to the LAPUP of a delegation of students and faculty members of the Department of Geography, Giessen University, Germany. We discussed about Earth observation and climate.



Figure 3 December 2019: Visit to the Austrian Institute of Technology – Workshop on solar radiation spectral measurements and simulations for the needs of the photovoltaics industry.



Figure 4 December 2019: Visit to our partners of the DLR at Plataforma Solar de Almería – Working meeting on solar energy and atmospheric pollution topics.



Other Activities

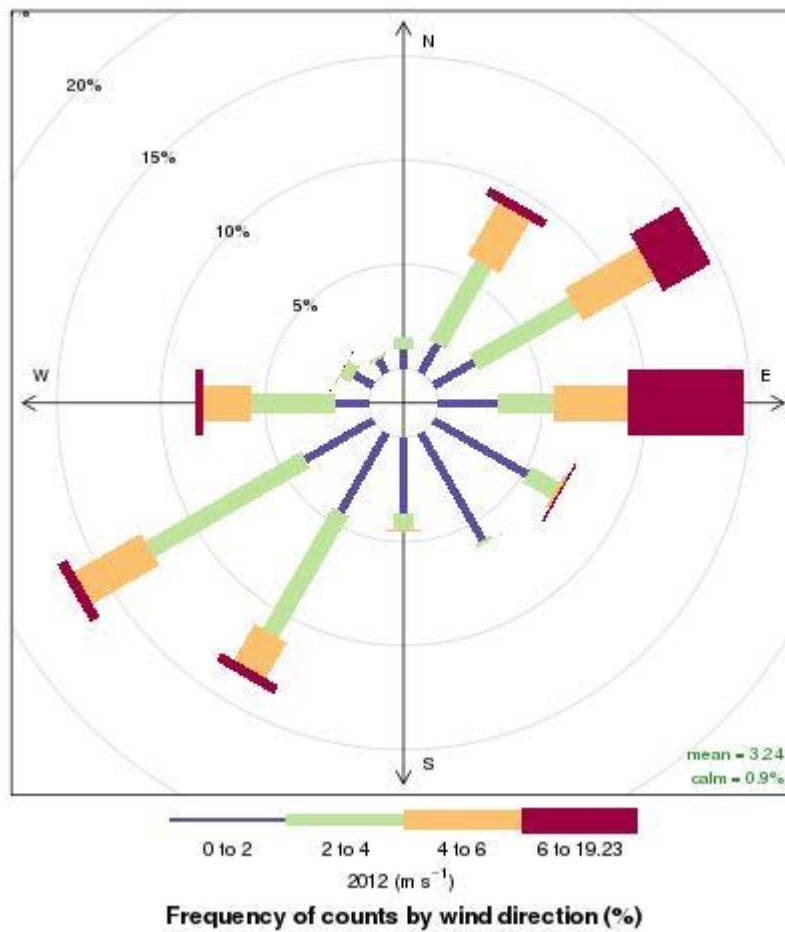
Athanassios Argiriou visited the Climate Change Center, Department Geography, Universitat Rovira I Virgili, Tarragona, Spain, from 27/01/2019 till 30/01/2019, in the frame of the Erasmus + Staff Mobility for Teaching Program agreement, where he gave the following undergraduate lectures: Physics of Climate change and Mitigation of and Adaptation to Climate Change.

Weather Bulletin

Summary

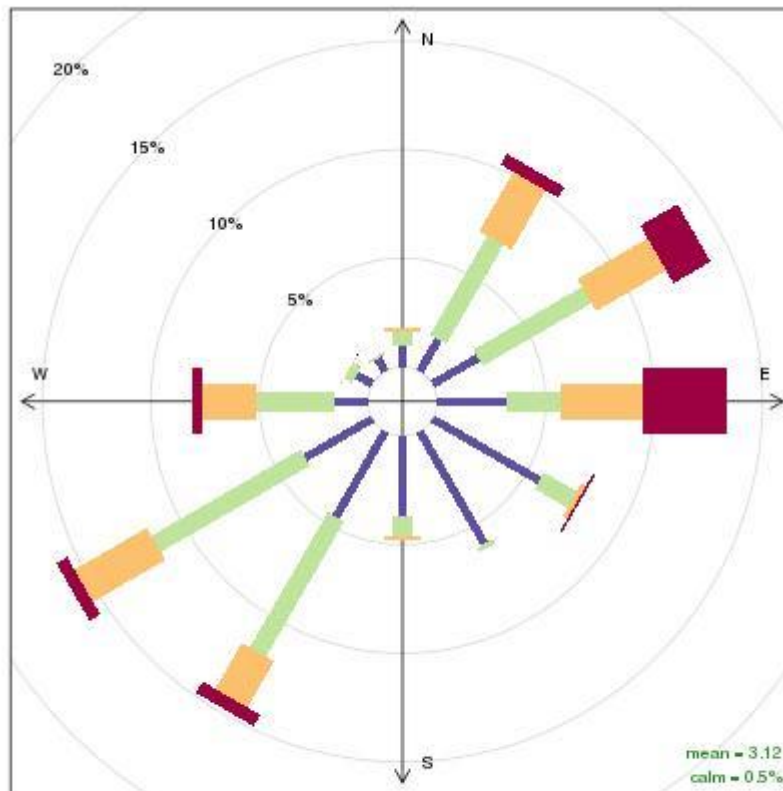
2012	Min	Max	Annual Average (Total for precipitation)
T (°C)	-0.1	38.4	17.9
RH (%)	8.5	91.3	61.5
WV [gust] (m.s ⁻¹)		19.2 [30]	
RF (mm)			1 182.8
p (hPa)	978	1027	1009

T: air temperature, RH: relative humidity, RF: precipitation, p (pressure at 24.78 m)



2013	Min	Max	Annual Average (Total for precipitation)
T (°C)	0.4	35.7	17.7
RH (%)	5	91.3	62.4
WV [gust] (m.s ⁻¹)		19.2 [30]	
RF (mm)			958.6
p (hPa)	985	1029	1008

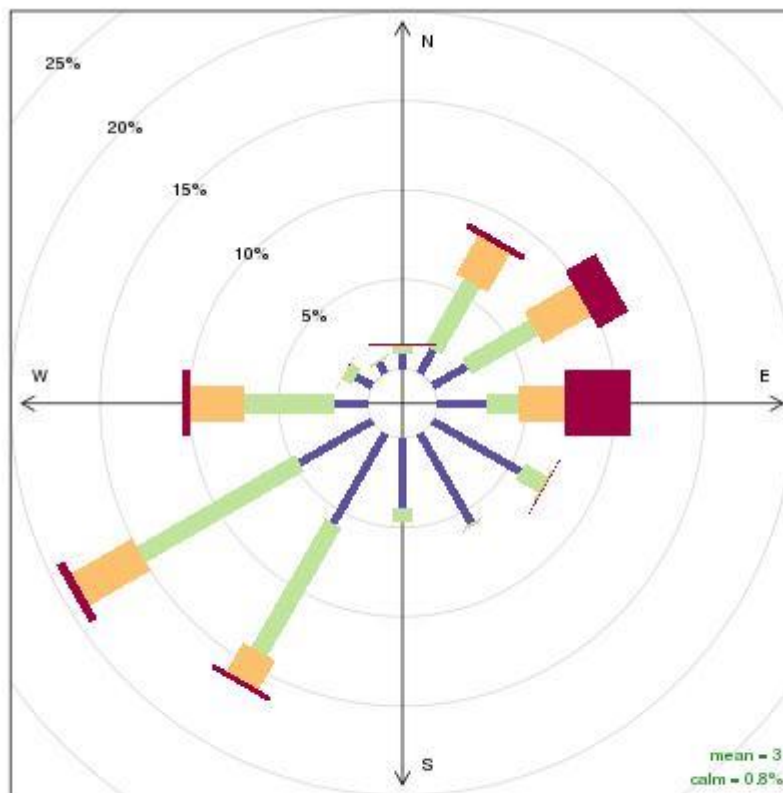
T: air temperature, RH: relative humidity, RF: precipitation, p (pressure at 24.78 m)



0 to 2 2 to 4 4 to 6 6 to 19.21
2013 (m s⁻¹)
Frequency of counts by wind direction (%)

2014	Min	Max	Annual Average (Total for precipitation)
T (°C)	3.2	35.8	17.3
RH (%)	9.4	91.2	68.1
WV [gust] (m.s ⁻¹)		19.2 [30]	
RF (mm)			976.6
p (hPa)	989	1023	1009

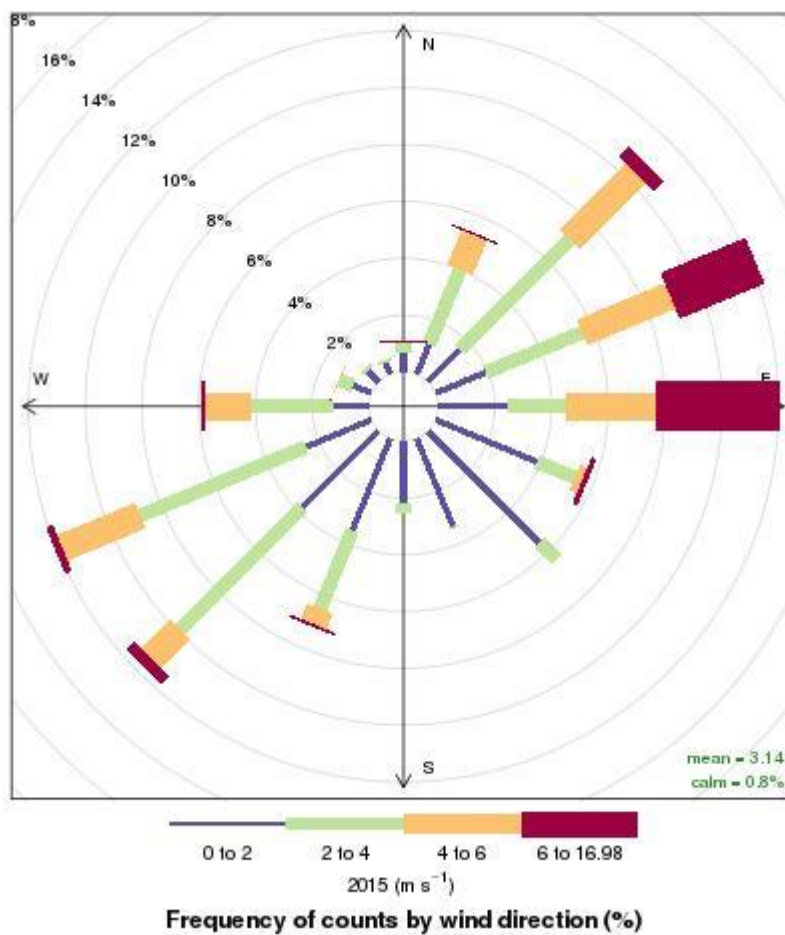
T: air temperature, RH: relative humidity, RF: precipitation, p (pressure at m.s.l.h.)



0 to 2 2 to 4 4 to 6 6 to 19.21
2014 (m s⁻¹)
Frequency of counts by wind direction (%)

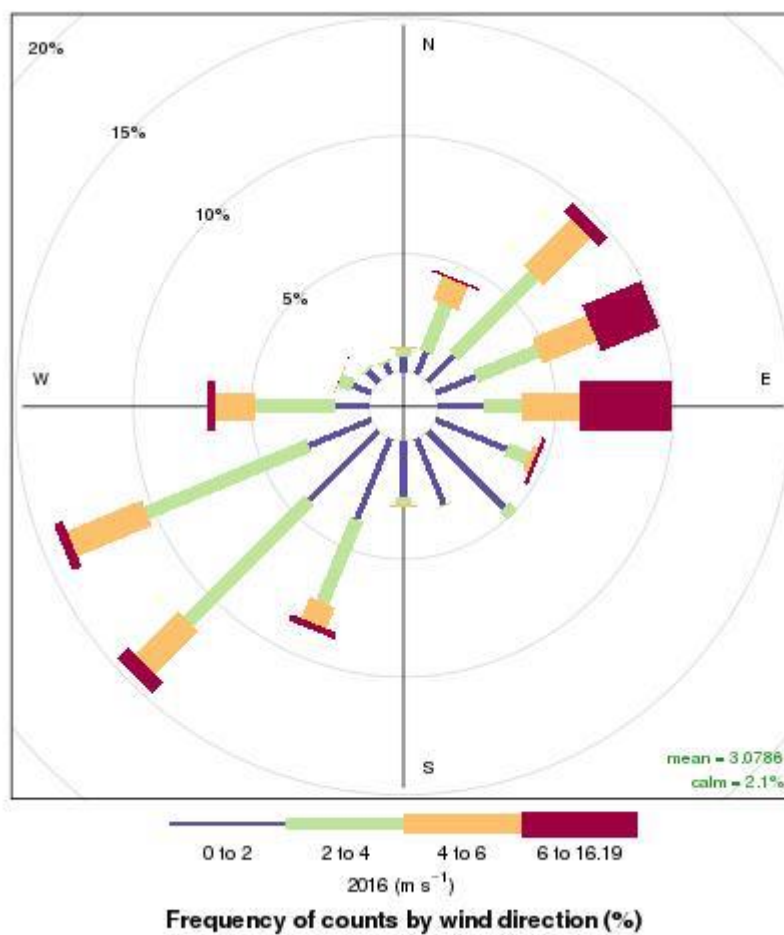
2015	Min	Max	Annual Average (Total for precipitation)
T (°C)	-0.5	37.9	18.2
RH (%)	5.8	97.7	63
WV [gust] (m.s ⁻¹)		17 [53]	
RF (mm)			803.6
p (hPa)	987	1030	1010

T: air temperature, RH: relative humidity, RF: precipitation, p (pressure at 24.78 m)



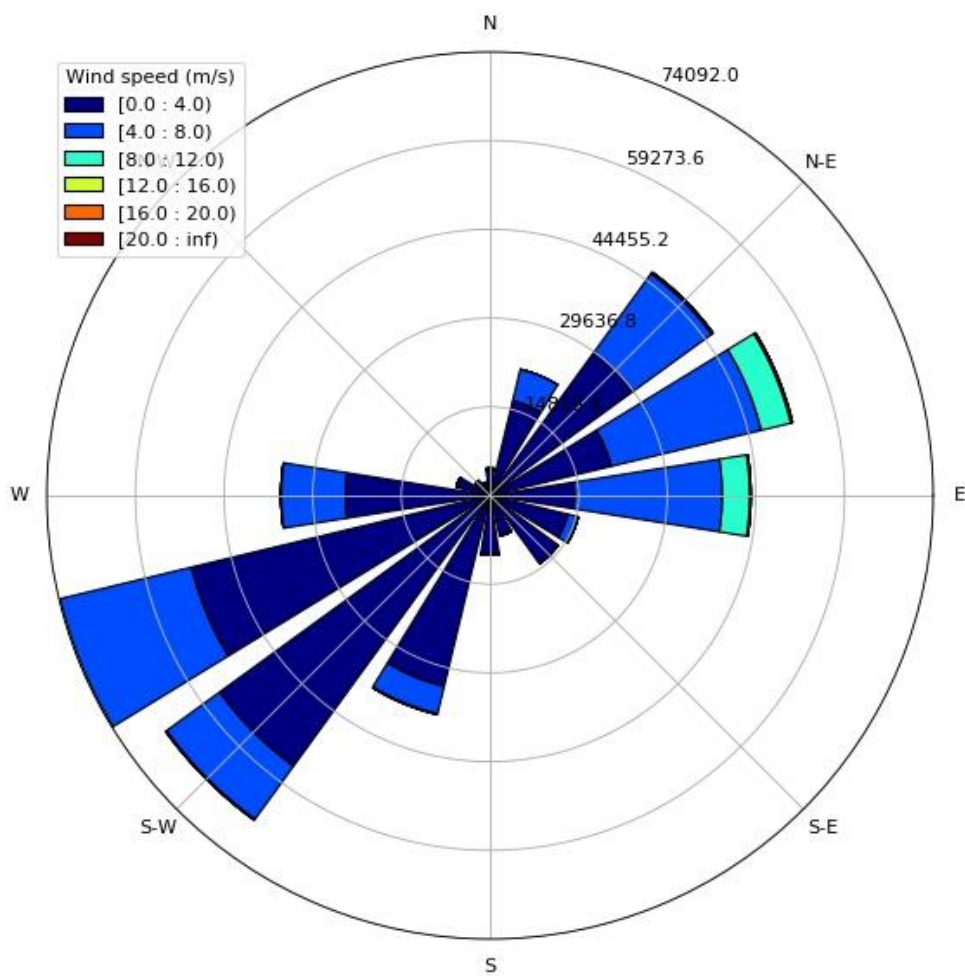
2016	Min	Max	Annual Average (Total for precipitation)
T (°C)	1.0(4)	38.8	19.2
RH (%)	11.73	97.7	64
WV [gust] (m.s ⁻¹)		17 [53]	
RF (mm)			772.4
p (hPa)	990	1029	1010

T: air temperature, RH: relative humidity, RF: precipitation, p (pressure at 24.78 m)



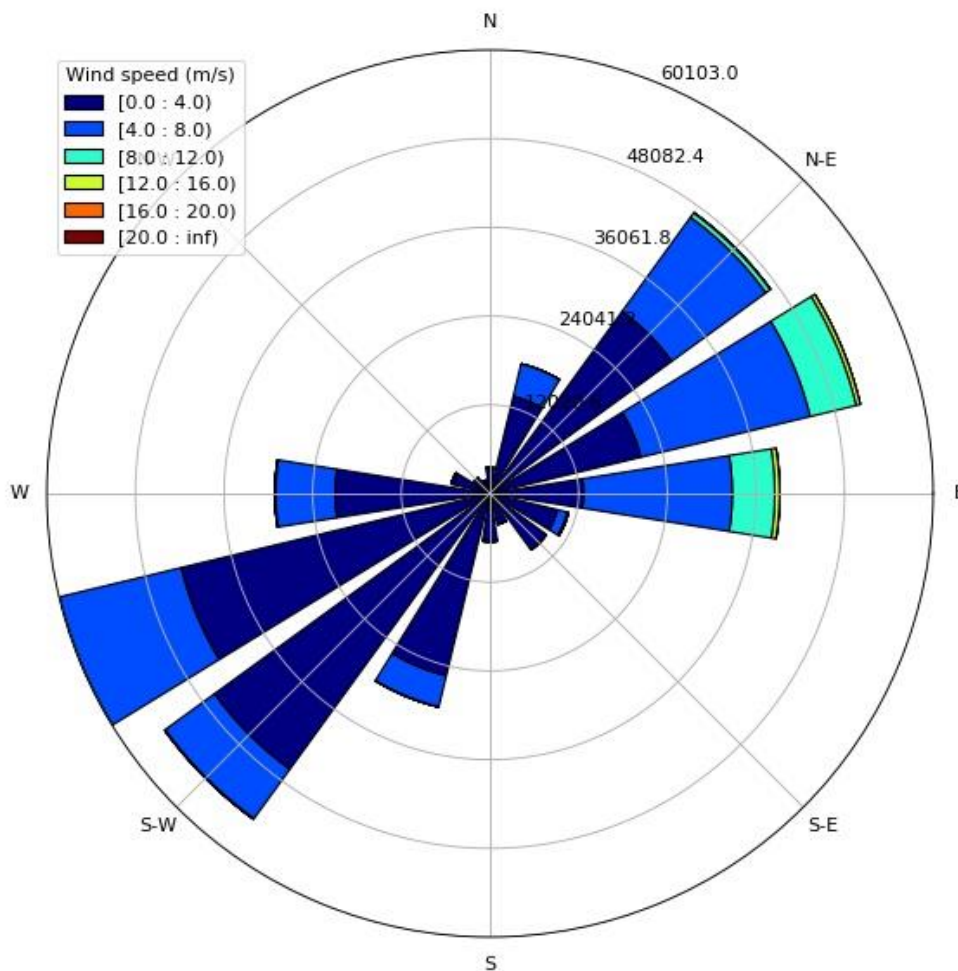
2017	Min	Max	Annual Average (Total for precipitation)
T (°C)	-1.2	40.4	18.1
RH (%)	9.15	97.7	62.7
RF (mm)			813.0
p (hPa)	978	1026	1010.3

T: air temperature, RH: relative humidity, RF: precipitation, p (pressure at 24.78 m)



2018	Min	Max	Annual Average (Total for precipitation)
T (°C)	2.5	35.4	18.7
RH (%)	7.5	97.7	64.9
RF (mm)			809.8
p (hPa)	987	1026	1008.6

T: air temperature, RH: relative humidity, RF: precipitation, p (pressure at 24.78 m)



2019	Min	Max	Annual Average (Total for precipitation)
T (°C)	-0.8	37.4	18.6
RH (%)	8.8	97.7	64.0
RF (mm)			1033.6
p (hPa)	972.2	1023.8	1008.6

T: air temperature, RH: relative humidity, RF: precipitation, p (pressure at mean sea level)

