Department of the Atmospheric Physics

About

The Department activities focus on the long-term monitoring of various atmospheric parameters in the atmosphere (including surface layer, the troposphere, and the stratosphere), short-term campaigns within national and international grants, and modelling changes in geophysical fields and dynamical/chemical processes in different time scales from hours up to decades. The observations are routinely carried out at IGF PAS observatories in Poland (Belsk, Racibórz, and Świder) and in Svalbard (Polish Polar Station, Hornsund). The field experiments in 2018 include observations in the Beskid mountains (with the use of the Szyndzielnia Mountain cable car) and Ny-Alesund (Svalbard). Modeling using both statistical and dynamical (solving time dependent equations in 3-D spatial configuration) approach is developed to find sources of the atmosphere variability and directions of changes of environmental variables affecting human life (e.g. surface and column amount of ozone, intensity of UV radiation at the ground level, electrical field, aerosols concentrations, surface trace gases concentration). Atmospheric processes in various spatial scales are examined in 2018 including: the local scale (contamination of the atmosphere in vicinity of the shale gas wells in Wysin and valleys in the Beskid range near the Szyndzielnia Montain, thunderstorms in Warsaw and its suburban areas, UV intensity over Warsaw and Lodz), regional scale (UV index forecast over the territory of Poland, surface warm layers in the Bay of Bengal during Indian monsoon, trans-boundary aerosol transport between Poland and neighboring countries), and global scale (global electrical circuit, impact of aviation emissions on chemical composition of the atmosphere and global circulation, health exposure optimal index to control safe sunbathing over any place).

Personel

Head of the Department
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Anna Głowacka
Observer

Dorota Sawicka
Observer

Wiesława Zawisza
Observer

Research Project

- Aerosols, Clouds, and Trace gases Research Infra Structure.
  A. Pietruczuk | H2020 | 2015 -2019
- Global Coordination of Atmospheric Electricity Measurements (GloCAEM).
  M. Kubicki | NERC | 2016 -2018
- Atmospheric Electricity Network: coupling with the Earth System, climate and biological systems.
  A. Odzimek | COST | 2016 -2020
- Shale gas exploration and exploration induced Risk.
  J. Jarosławski | H2020 | 2015 -2018
- Monitoring of Total Ozone Amount in the Atmosphere and UV-B Radiation at Belsk Observatory in 2017-2020.
  J. Jarosławski | Chief Inspectorate Of Environmental Protection | 2017 -2020
- Impact of absorbing aerosols on the planetary boundary layer height.
  M. Posyniak | NCN | 2017 -2020
- UV Intercomparison and Integration in a High Arctic Environment (UV-ICARE).
  P. Sobolewski | NILU | 2017 -2018
- Multi-scale interactions over the Maritime Continent and their role in weather extremes over Central and Eastern Europe.
  D. Baranowski | FNP | 2018 -2020
- Parameterization of solar radiation attenuation by clouds in UV index forecast for Poland.
  J. Guzikowski | NCN | 2016 -2018
- Genetic and environmental factors affecting the therapy outcome of psoriasis in the Polish population.
  D. Baranowski | NCN | 2015 -2018

PhD Students

Beata Latos | Poland
supervisor: Aleksander Pietruczuk

Alnilam Fernandez | India
supervisor: Aleksander Pietruczuk

Maria Kłeczek | Poland
supervisor: Jacek Kamiński

Anahita Sattari | Iran
supervisor: Jacek Kamiński

Instruments and facilities

Equipment

LLDN - Local Lightning Detection Network consisting of four lighting detection stations (2 in Warsaw, 1 in Świder and 1 in Milanówek - the Warsaw suburban zone) to monitor vertical structure of the lightning in the vicinity of Warsaw.

System for monitoring aerosol properties in experiments with use cable car on the Szyndzielnia Mountain. It includes:

- particle counters OPC-N2 (6 psc.), PMS 7003 (6 psc.),
- sun photometer CIMEL, CE-318-1 Standard Model with1020-870-675-440-936-500-340-380 nm filters (routinely operated at the Raciborz station)
- Black carbon monitor AE51
- Meteo station Gill Met Pac (2 psc.)

Standard automatic system for monitoring air-quality at Belsk and Świder (measurements of the surface concertation of the following trace gases: ozone, NO, NO2,NOx, SO2, CO, PM10) plus monitoring of important green-house gases including CO2 and methane (only at Belsk).

Laboratory

Equipment at Świder:

- Electric field (potential gradient) by radioactive collector
- Electric field (potential gradient) by rotating-dipole field mill
- Air-Earth current density by Wilson antenna
- Air conductivity (positive and negative) – Gerdien counter
- Aerosol measurements - Condensation counter: model TSI 3025, 3 nm - 3 μm, portable counter: model TSI 8525, 20 nm - 1 μm and model TSI 3007, 10 nm - 1 μm
- Air radioactivity - Concentration of radionuclides at ASS-500 station: ^{7}Be, ^{137}Cs, ^{210}Pb, ^{40}K

Equipment in Hornsund:

- Sunshine Duration Sensor CSD3
- CMP21 Pyranometer
- CNR4 Net Radiometer
- UVS-E-T UV Radiometer
- TSI 3330 Optical Particle Sizer
- TSI 3910 Particle Size Spectrometers
- CHM 15k ceilometer

Equipment at Belsk:

- Dobson Spectrophotometer no 084 (total ozone and vertical ozone profile measurements)
- Brewer Spectrophotometer Mark II no 064 (total ozone, vertical ozone profile measurements, UV spectra 290-325 nm)
- Sun Photometer CIMEL, CE-318-1 Standard Model with 1020-870-675-440-936--500-340-380 nm filters
- Gaseous pollutants analyzers (CO, NO, NO2, NOx, O3, SO2, PM10, CO2, CH4)
- CM21 Pyranometer (Total Solar Radiation, Spectral range:280-3000 nm)

UVS-AE-T UV Radiometer Kipp&Zonen (Biological Active Solar Radiation, Spectral range:280-400 nm)

- Sunshine Duration Sensor CSD3 (3 photo-diodes with specially designed diffusers to make an analogue calculation of when it is sunny).
- Campbell-Stokes Heliograph (The glass sphere –4 inches in diameter to focus the rays from the sun onto a card mounted at the back)
- Zonntag Actinometer (direct Sun Radiation measurements)
- Weather station Vaisala -MILOS 520 (temperature, humidity, wind speed and direction, pressure)
- Lidar (constructed at Belsk) to monitor tropospheric and stratospheric aerosols characteristics

Equipment in Warsaw (roof of the IGF PAS main building in Warsaw):

- Brewer Spectrophotometer Mark III no 207 – double monochromator (total ozone, vertical ozone profile measurements, UV spectra 290-363 nm)
- Davis meteo-station (temperature, humidity, wind speed and direction, pressure, rainfall, solar total irradiation, UV index)

Hand-held UV biometers (UV index, vitamin D3 production in IU/per - minute)

Equipment in Racibórz:

- Ceilometer CHM-15K Nimbus LUFT
- Broad band biometer (Kipp&Zonen UVS-E-T)
- Cimel sunphhotometer CE-318-1 Standard Model with 1020-870-675-440-936--500-340-380 nm filters used to monitor the vertical structure of aerosols in the atmospheric boundary layer (part of global aerosols network – AERONET)

Research activity and results

Modelling and observations of solar radiation for purpose of public health | J. Krzyścin, J. Guzikowski

The beneficial (e.g. vitamin D3 synthesis) and harmful (e.g. skin cancers) effects of solar radiation are well recognized. Recently, many efforts have been made in the Department of the Physics of the Atmosphere to provide out-door activity scenarios allowing people to balance between these effects. To inform people about actual ultra violet index (UVI) distribution over the territory of Poland we provide 24-hour UVI forecast for every hour between 8 am and 5 pm. It was available (April-October 2018) on the Institute web page for cloudless and for all-sky conditions based on forecasted total ozone and cloudiness level.

Cloud forecast is still serious problem in the weather prediction because the micro-physical processes governing the cloud cover and their transparency require high resolution calculation grid impossible to be implemented in routine weather forecasts. Sometimes the prediction is no-clouds but heavy cloud appears and vice-versa. Thus, we propose a new methodology that is able to resolve cloud attenuation of solar radiation. It is based on UV nowcasting (near-real time measurements of UV radiation) and short term UVI prediction (next 15 minute). The new model and its validation using UVI observations in Warsaw and Lodz are shown in our recent paper by Krzyścin et al. 2018 (Perspectives of UV nowcasting to monitor personal pro-health outdoor activities, J. Phot. Photoch. Photobio B, 184, 27-33). Reliable forecast of duration of safe sunbathing (without erythema risk) could be provided by a smartphone application for sites located in the distance less than 10 km from the UVI observing stations. The station in Warsaw is located on the roof of IGF PAS building. It serves as the UV source for the short-term forecasts that are valid for sand beaches located on the right bank of the Vistula river. Famous beach – Poniatówka (Fig.1- left), one of the most popular among the Warsaw's residents, is near the Prince Poniatowski Bridge. An example of the UVI measurements (white circles), hypothetical clear-sky representatives (blue circles), and UVI forecast since 11.15 pm (white curve) for 19th May are shown in Fig.1 (right).

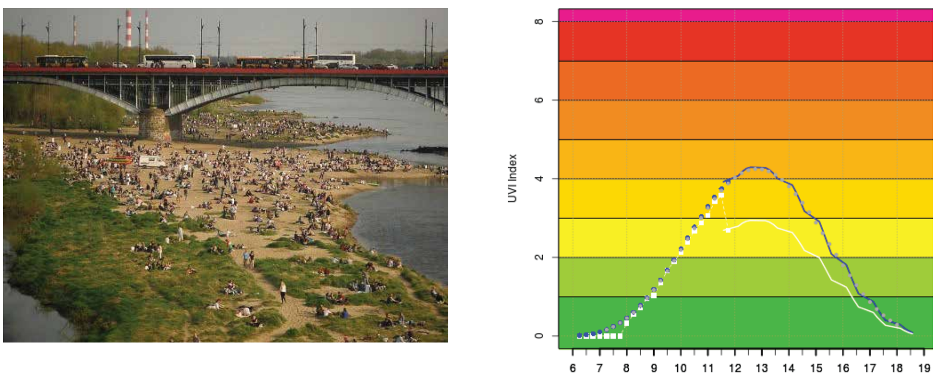

Figure 1: Poniatówka Beach (left) and UVI forecast for Warsaw on 19th May 2018 (right). |
(photo: T.Rudzki, Poniatówka Beach https://commons.wikimedia.org/wiki/File:POL_Warszawa_plaza_18.JPG)

Skin synthesis of vitamin D3 is basic source of vitamin D in the European population. However, in periods when the UV intensity is high (UVI>2) and thus proper for vitamin D

production, people should limit outdoor activities and/or apply several steps to reduce solar exposure. Typical diet could provide less than 10% of the required daily production of vitamin D. Thus, a question appears how to make a balance between beneficial (vit. D3 skin synthesis) and harmful (erythema, skin cancer, skin aging) UV effects. To solve this problem, we introduce a dimensionless index, i.e. health-optimum exposure index to get target amount of vitamin D3 dose (HOEI, Guzikowski et al. 2018, Adequate vitamin D3 skin synthesis versus erythema risk in the Northern Hemisphere midlatitudes, J. Photoch. Photobio B 179, 54-65). It gives number of daily target vitamin D3 doses (e.g. recently recommended 2000 IU per day) produced during maximum possible duration of safe (without skin erythema) exposure. HOEI larger than 1 means proper conditions for healthy sunbathing. We find an approximate formula, which is valid in midlatitudes sites in spring and summer during near noon hours regardless of human skin color. It gives that a young person (age~20 yr.) should expose at least 20% of his/her body to get 2000 IU of vitamin D without the erythema risk. Older people (age over 60 yr.), need to expose more than 40% of the whole body that is only possible during warm days. Optimal sunbathing near local noon to get 2000 IU vitamin D3 at central Poland in summer lasts between ~15-20 minute (for cloudless days) up to 1-1.5 hrs. (for heavy cloudiness) for a young person exposing 25% of the whole skin.

A new subject of the research in 2018 is modelling of melatonin reduction in humans due to natural (solar) light. Melatonin is a hormone that plays a role in sleep. It is also powerful antioxidant slowing down harmful chemical reactions damaging cells thus helps to protect nerve and brain cells from damage. The production and release of melatonin in the brain increase in darkness, usually during sleep hours, and decrease when it's light. A number of studies have reported benefits of supplemental melatonin. There are also suggestions that melatonin helps with multiple sclerosis (MS) symptoms. Various factors might contribute to the MS risks including genetics and geographical factors. A risk for MS increases with a distance from the equator. It leads us to calculation geographical (latitudinal) distribution of the radiation effective for melatonin suppression. Radiation in the UV and in the visible blue range are essential for the melatonin suppression. Figure 2 shows the daily course of radiation dose effective for melatonin suppression for three regions: the equator (200E), the mid-latitudes (Belsk), and the Arctic (Hornsund) on 21.6.2018 derived from the radiative model simulations. The model takes into account field of view of typical eye of a standing person. Two cases are considered: face towards or opposite to the direction of Sun. It means that radiation is due to superposed direct Sun and sky radiation or only due to sky radiation, respectively. A working hypothesis to lower MS risks is reducing solar exposure since 3-4 pm GMT (e.g. by wearing glasses with blue/UV cut off filter) and stop using blue light at home during night.

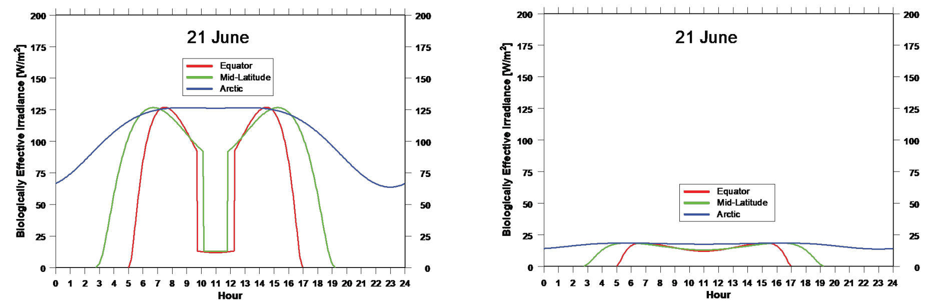

Figure 2: The daily course (21 June 2018) radiation effective for melatonin suppression received by a standing person: face towards the Sun (left), face opposite to the Sun (right)

Statistical Trajectory Technique for Determining Air-Pollution Source Regions in Poland | A. Pietruczuk, A. Szkop

Atmospheric aerosols are one of the least recognized climate-shaping factors. They influence climate both directly, by interacting with solar radiation passing through the atmosphere, and indirectly by modifying cloud evolution. Moreover, aerosols influence health and wellbeing of the human population by causing illnesses and premature deaths, as well as by modifying the amount of UV radiation reaching the Earth's surface they change the probability of skin carcinogenesis and modify the rate of D3 vitamin synthesis. This makes improving the aerosol pollution forecasts a very important issue. This requires the detailed knowledge of statistics of aerosol types over a given territory, recognition of trends in their changes and identification of regions from which the aerosols were emitted.

The main scientific goal of research is to develop an analytic scheme that allows for the determination of aerosol source regions and identification of aerosol types based on remote sensing techniques and data from atmospheric models. We investigated the multi-year trends in aerosol pollution over Poland. We show that, while the local sources might have dominated in the past decades, there are no statistically important trends observed in the last twenty years which it difficult to unambiguously determine the types and sources of the currently observed aerosols. We proposed an innovative method for determination of dominant source regions from which the identified aerosol types originated based on statistical analysis of air-mass backward trajectories. The method was then expanded with an additional analysis focused on the study of changes in the aerosol optical parameters observed during transport that allows for the determination of additional source regions.

Aerosol classification based on two chosen optical parameters is usually found in the literature. The introduction of a third, absorption based, parameter into the analysis makes a differentiation between industrial, biomass-burning and desert type aerosols possible. The proposed method for backward trajectory analysis allows for associating an air-mass source with an aerosol source. Moreover, the utilization of the novel normalization scheme for trajectory densities inhibits the main problems in the usually used methods, namely the anomalously high densities in the vicinity of the receptor and the overrepresentation of regions associated with extreme concentrations of aerosols.

The developed novel method of data analysis allows for obtaining a significant amount of information on atmospheric aerosols and their sources based on a limited number of measurements performed by a sparsely distributed network of remote optical sensors in Poland. This should result in the better verifiability of atmospheric pollution forecasts and consequently mitigate the adverse influence of aerosols on the human population. Moreover, the research may prove useful for national policymakers as well as local authorities. The identification of source regions of individual aerosol types makes it easier to intensify the efforts on emissions reduction in regions where it stands to provide a maximal advantage.

Electrical signatures of Nimbostratus and Stratus clouds in ground-level vertical atmospheric electric field and current density at mid-latitude station Swider, Poland | A. Odzimek, P. Baranski, M. Kubicki, D. Jasinkiewicz

We analyze the occurrences of low-level stratiform clouds such as Nimbostratus and Stratus, in Świder, Poland (51.15 N, 21.23 E) in the years 2005–2015. There have been on average 44 days with Nimbostratus a year between 2005 and 2015 at Świder and 51 days with Stratus over this period. Atmospheric electric field, current density and air conductivity available for the recorded cloud cases from years 2012–2015 have been analyzed and their average values obtained for all cases and separately for the cloud cases with their main types of precipitation: rain and snow for Nimbostratus, drizzle and granular snow for Stratus. The analysis of atmospheric electricity parameters confirms previous results indicating differences in the electrical behavior of raining and snowing clouds. The atmospheric electric field and conduction current are more likely downward under Stratus cloud as is its precipitation-convection current. This type of cloud mostly behaves like a passive element of the global circuit. The electric field under Nimbostratus during rain at the ground is upward and upward precipitation current occurs during heavier rain. Such raining mid-latitude Nimbostratus can potentially be an electric cloud generator which charges the Earth's global atmospheric circuit, the contribution of which needs to be investigated in more detail.

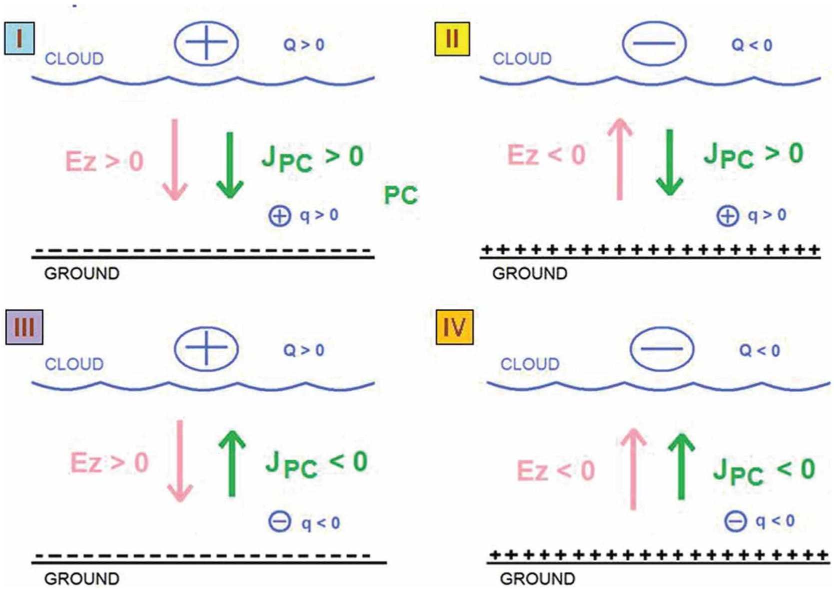

Figure 1: Four possible different scenarios illustrating directions of the electric field and precipitation-convection (JPC) current. Atmospheric ions or precipitation particles of charge q flow between the ground and the cloud layer of dominant charge Q, in relation to different directions of the vertical electric field (Ez) at ground level. The effect of the cloud precipitation (and/or convection) current may be the charging process of the ground electrode (overall globally negative), or conditions similar to "fair-weather" – discharging process of the ground electrode. Small blue circle with "+" or "–" near the ground denotes a precipitation particle and its resultant electric charge acquired after leaving the cloud base. The sign of Ez and JPC is taken as positive when positive charge flows to the ground, according to the atmospheric electricity sign convention

Potential Impact of Aviation Emissions on the Atmosphere in the Arctic |

J. W. Kamiński, M. Kossakowska

The following summary pertains to a multi-year and multi-agency research project that was finalized in December 2018. The project was carried out at York University, WxPrime Corporation, Warsaw University of Technology and Institute of Geophysics. The project was funded by Transport Canada, Federal Aviation Administration of the US Department of Transportation. While a PhD student Dr Magdalena Kossakowska received a grant (Preludium) from the Polish National Science Centre to participate in the project. The overall objectives were to assist Transport Canada and FAA in the assessment of aviation emission impact on the Arctic environment.

Summary

In the course of the project, a research methodology was developed, and an integrated modelling framework was applied to study the potential effect of aviation emissions on atmospheric chemistry and dynamics in the upper troposphere and lower stratosphere (UTLS) in the current (2000-2010) and future (2045-2055) climates.

Introduction of pollutants from aviation emissions results in changes in the chemical composition of the atmosphere triggering highly non-linear chemical processes that lead to perturbation in atmospheric heating rates and consequently changes in large scale transport processes.

In order to carry out the research objectives, a number of model scenario simulations were done using the Global Environmental Multiscale Atmospheric Chemistry model (GEM–AC). GEM-AC is an on-line interactive tropospheric and stratospheric chemistry model that provides a consistent framework between the meteorological and chemistry aspects of the atmospheric system.

For evaluation purposes, the GEM-AC model was run for 10 years in current climate conditions. Model results were compared with long term satellite observations. It was determined that the model could accurately simulate atmospheric dynamical and physical processes in the current climate. The distribution of the temperature and zonal wind fields were consistent with observed climatology. The maximum zonal average mixing ratio of ozone had a value of ~10 ppm at the altitude of ~30 km for October, as calculated from a long term average. The predicted ozone mixing ratio field was consistent with satellite and ozonesonde observations. Also, the distribution of other minor species compared quite well with satellite observations.

In order to assess the impact of aviation emissions on the atmosphere, GEM-AC was run for 10 years for scenarios without and with aviation emissions that were prepared using the Aviation Environment Design Tool (AEDT 2006). Atmospheric response to aviation emissions was assessed using model results from these scenarios. Specifically, changes in the distribution of water vapour, temperature, ozone, halogens, reactive nitrogen species, and aerosols were evaluated from differences between model simulations for scenarios with and without aviation emissions.

The largest differences in water mixing ratio between emission scenarios were in the spring for the current climate and the fall for future climate. The GEM-AC model simulations indicate an increase of temperatures in the UTLS in high latitudes in the regions of high aviation emissions for current and future climate model simulations. The biggest changes in the temperature in the Arctic UTLS region were predicted during the spring. The GEM-AC model simulation showed a large increase of ozone mixing ratios in the winter for the current climate and in the spring in future climate. Similar pattern was present in the distribution of BrOx family mixing ratio in the Arctic UTLS region. An increase of ClOx mixing ratio was predicted in the summer for the current climate and in the spring in the future climate.

The GEM-AC model simulation showed that aviation emissions do impact the composition, radiative properties and dynamics of the Arctic atmosphere. Since the atmospheric response to the chemical perturbation is highly non-linear additional research and aviation emissions scenario runs are needed.

Challenges

There are on-going research and development activities in the fields of climate modelling and atmospheric chemistry, mainly in the EU and USA. The major challenge is to keep the GEM-AC model current. This would involve porting the chemical and aerosol modules to the latest version of the host meteorological model. Also, the chemical and aerosol modules would have to be updated and the model lid raised to 85 km or higher. Raising the model lid is a major challenge, as additional physical and radiative transfer processes would have to be introduced in the host GEM model. However, this would put GEM-AC on par with American (NCAR, Stanford) and European (ECMWF, UK Met Office) models. Should there be any plans and commercial viability of supersonic transport at altitudes of 65,000 ft. (20 km), only models with high lids could be used for modelling and environmental impact assessments.

The way forward

The developed modelling framework could be used for environmental impact assessment of proposed new technologies such as propulsion and alternative fuels, where the impact of higher cruising altitudes and chemistry associated with nitrate aerosols would have to be carefully evaluated. Also, emissions from rockets that deliver satellites to Earth's orbit should be taken into account in any new scenario runs. Model evaluation should be a routine and continuous activity using all available satellite and in situ observations.

Electric structure of multiple CG flashes obtained from the LLDN recordings during thunderstorms in the Warsaw region in May-September 2018 period

| P. Barański, M. Kubicki

In the present work we analyze the E-field signatures of multiple flashes obtained from the LLDN network (Local Lightning Detection Network).

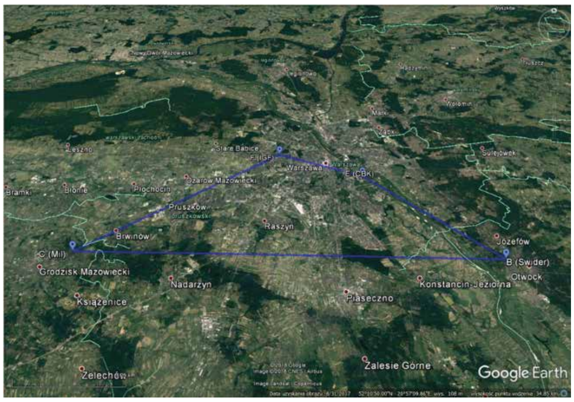

Figure 1: The LLDN configuration during field measurement campaign in 2018. The distances between particular LLDN stations are: LLDN-C(Milanówek)-LLDN-F(IGF) 23 km, LLDN-F(IGF)- LLDN-E(CBK) 9.4 km, LLDN-E(CBK)- LLDN-B(Świder) 16 km, LLDN-C(Milanówek)- LLDN-B(Świder) 39.1 km.

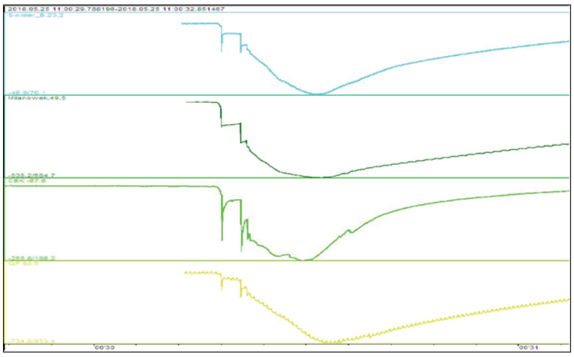

Figure 2: E-field signatures of multiple negative CG (cloud-ground) flash simultaneously recorded by four LLDN stations. The multiple CG flash recorded at 11:00:30 UT and consisted with three return strokes, and ended with continuing current stage; this flash lasted 0.21 s.

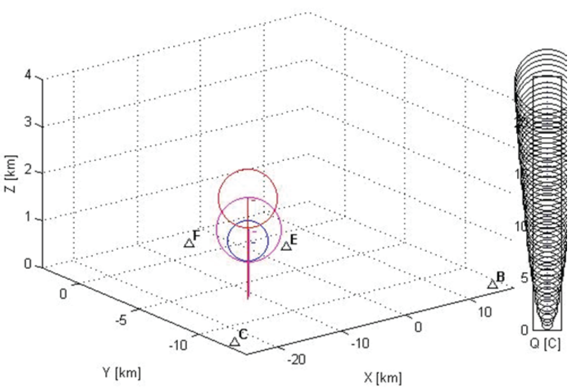

Figure 3: The (x, y, z, Q) parameters for 3 return strokes involved in multiple CG (cloud-ground) flash recorded at 11:00:30 UT; the first stroke indicated by red color, the second by magenta color and the third one by blue color. These strokes discharged total electric charge equal -51.5 C in thundercloud.

The lightning data delivered by the LLDN can be used in the post-time processing to reliable evaluation of the electric structure of multiple CG flashes by giving their important stroke parameters, i. e., the exact time occurrence up to 1 μs, 3D location and the amount of electric charge discharged by the particular stroke. On the other hand, the E-field signatures of such flashes that are recorded in the radio VLF range and are archived in the recorder memory buffer and are covering all time development of the considered cloud-ground (CG) lightning discharges, i. e., from the early preliminary breakdown, the stepped leader stage and the return stroke sequence with ending continuing current phase. Such comprehensive presentation and documentation of these CG lightning events cannot be obtained from any lightning location systems routinely operated in large scale in Poland, e. g., Polish PERUN or German LINET. It is worth noting that the LLDN lightning data superimposed in the same time on the PCAPPI and VCUT radar maps can indicate these thundercloud regions that are favorable for initiation of multiple CG flashes. Any kind of supplementary lightning data connected with initiation of multiple CG flashes are very desired to ensure relevant lightning protection of the urban high-rise buildings, especially in the Warsaw region.

Shale gas Exploration and Exploitation induced risks | **J. Jarosławski, I. Pawlak, J. Guzikowski**

Measurements results of the concentration of selected air pollutants in the vicinity of the shale gas wells area near Wysin site, Pomerania (Fig. 1) collected during the realization of the SHEER project were analyzed in order to detect and estimate the impact of processes related to the exploration and exploitation of shale gas deposits on ambient air quality. The measurements were carried out before, during and after the key stages of exploration: preparation for hydro-fracturing, hydro-fracturing and final works related to closing the wells and cleaning up the area. Continuous monitoring of the concentration of a number of pollutants important from the point of view of various aspects of the potential impact of exploration/exploitation activities related to shale gas: primary and secondary communication pollutants (nitrogen oxides, carbon monoxide, carbon dioxide, particulate matter PM10, ozone) and pollutants that could be directly emitted from the wells (methane, non-methane hydrocarbons, radon). The measurements were carried out using a mobile air pollution monitoring station with the standard equipment used in air pollution monitoring networks. The station was placed approximately 1000 m from the boreholes, taking into account the prevailing wind direction, in the nearest village.

Analysis of the obtained measurement results leads to the conclusion, that the presence of individual shale gas wells does not have a significant impact on the ambient air quality in close proximity (at distances of the order of 1000 m). Concentrations of all types of pollutants measured during the experiment remained at background levels for a significant majority of measurement time. Air quality criteria has been met for all investigated pollutants, except particulate matter and surface ozone. The few episodes when limit values have been exceeded (in the case of particulate matter and ozone) were associated with larger-scale air pollution events. Slight increases in concentration of the communication type of pollutants were observed during periods of increased activity on the well, especially during hydro-fracturing. No elevated methane concentrations were observed except for several short-term episodes of methane and non-methane hydrocarbons concentrations associated with the outflow of methane from wells during the performance of operating procedures just after the hydrofracturing phase.

Figure 1: Shale gas exploration site in Wysin, Poland with a visible gas flare. Photo by J. Jarosławski.

Measurements of aerosol properties duping campaigns in Poland and Svalbard | M. Posyniak

The planetary boundary layer is the lowest part of the atmosphere that is directly influenced by its contact with the Earth's surface. Atmospheric aerosols are minute particles suspended in the atmosphere, which are created both naturally and are result of human activity.

In the beginning of 2018 we made a field experiment on the Szyndzielnia Mountain in Bielsko-Biała (Fig.1). The aim of field measurements was the examination of the development of the planetary boundary layer and absorbing aerosols optical and microphysical properties. We are using devices collecting samples of the air and instruments performing remote measurements (using scattered laser light). Within the framework of this project it is proposed to develop vertical profiling of atmospheric aerosols properties by placing measuring set on a cable car. Fig.2 shows an example of collected data. Higher concentrations of PM10 and BC are observed below 700 m a.s.l on 2nd March 2018. This is related to temperature inversion. Numerical models, used for carrying out computer simulations of physical processes in the atmosphere, will also were applied.

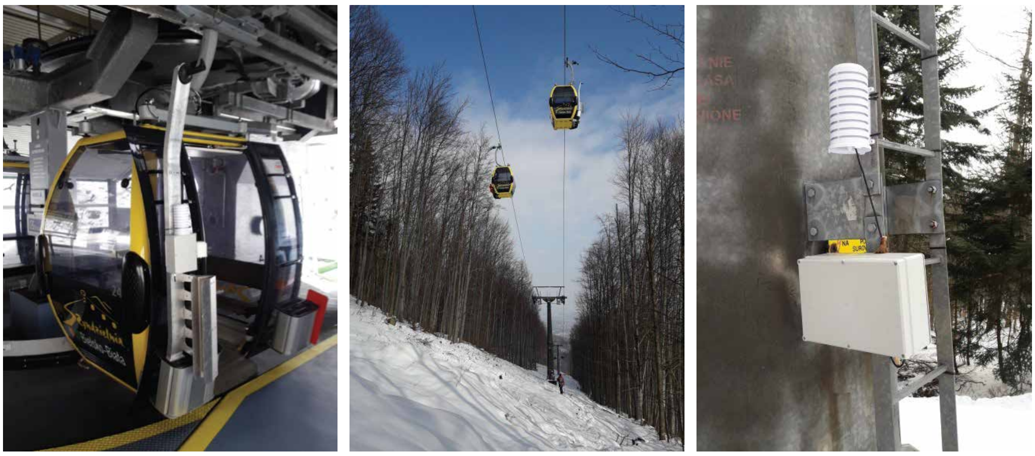

Figure 1: Equipment on the Szyndzielnia cable car (left, center) and pillars (right).

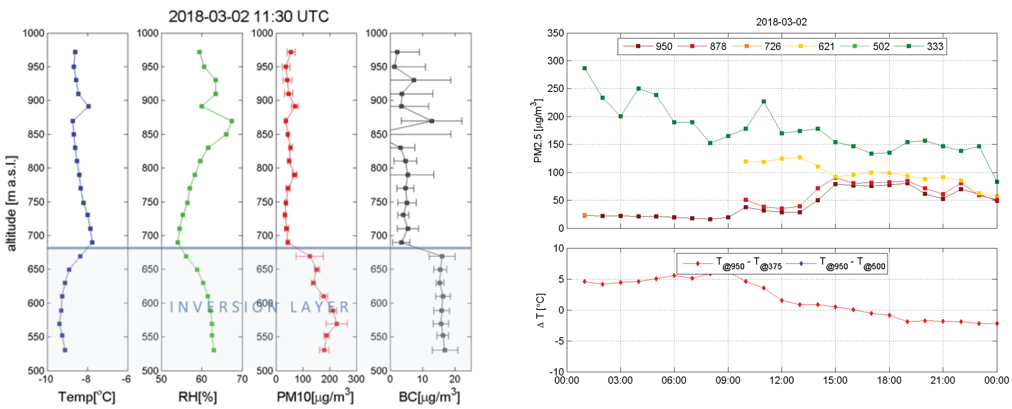

Figure 2: Results from cable car measurements on 2nd March 2018.

The fieldwork was done in Hornsund from 2018-08-30 to 2018-09-16 to enrich the ongoing monitoring of aerosol properties. The set of aerosol particle counters (TSI 3330 and 3910) was installed in "Environmental laboratory" in the vicinity of the Polish Polar Station Hornsund. Additional service works among currently operating equipment were also made.

Figure 3: Environmental laboratory in Hornsund. Visible air inlet on the roof (left) and equipment inside (right).

Intercomprison of UV meters in Ny-Alesund in April 2018 | P. Sobolewski

There are a few sites in Svalbard where surface UV radiation has been regularly observed. The length of the UV data sets taken at Ny-Ålesund and Hornsund exceeds 20 years. This led to the idea of uniting the efforts of different research teams in the UV irradiance studies and integration of the existing Svalbard stations in a network that would be able to provide more comprehensive information for scientists working on climatic and biological issues in the Arctic and for validation of satellite data.

The UV Intercomparison and Integration in a High Arctic Environment (UV-ICARE) project (RIS 10871, https://www.researchinsvalbard.no/project/8626) was aimed to make the first step toward the creation of such a network starting with an intercomparison of the instruments carried out from 17 to 23 April (Fig.1). Considering the Brewer spectrophotometer as a reference instrument it was found that the values of erythemaly weighted solar UV irradiances provided by different devices agree with each other within 3% for solar zenith angles (SZA) less than 75°, 5% for 75° < SZA < 80° and 7 – 10% for SZA > 80°. As regard the ozone column measurements the GUV, UV-RAD and Brewer radiometers showed less than 3% differences to each other.

Such results were considered to demonstrate a good consent among the different devices bearing in mind that they are characterised with quite different spectral selection technique and electronic equipment.

Figure 1: UV meters participating in the UV-ICARE inter-comparison campaign. Instruments, from left to right: UV-RAD, GUV, UVS-E-T of IGF-PAS, UVS-E-T of USB (left). Comparison of the dark current effect by covering the meters with hats (right).

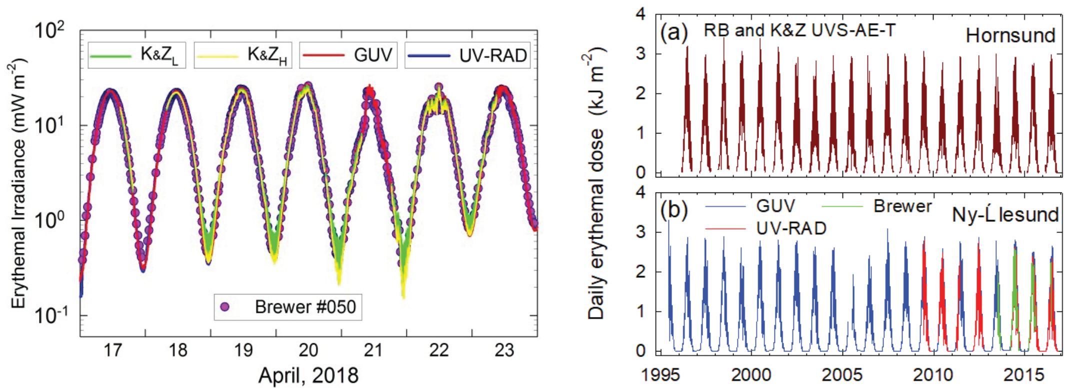

Figure 2: Results of the comparison of all four instruments (left), and long period UV data sets (1996-2018) for the Polish polar station Hornsund and Ny-Alesund (right).

Intercomparison started on 17 April, at 14:58 UT. The UVS-E-T instruments were stored in the same data logger and had to be read out regularly to be stored on a PC. The correction factor for the instrument of IGF PAS has been calculated, and after applying it, we achieved very god agreement between all the UV meters (Fig.2).

Monitoring of Total Ozone Amount in the Atmosphere and UV-B Radiation at Central Geophysical Laboratory IGF PAS in 2018 | I. Pawlak, P. Sobolewski, J. Wink, J. Borkowski, J. Krzyścin, J. Jarosławski, A. Pietruczuk

Monitoring of total ozone content and its vertical profile in the atmosphere (by the Dobson and the Brewer spectrophotometers), and UV-B Radiation (UV spectra by the Brewer spectrophotometer, erythemally weighted irradiance by the various broad-band biometers) at the Belsk Observatory have been carried for many years: ozone since March 1963, UV since May 1975. The staff of the observatory put many efforts to have the data calibrated and homogenized, thus proper for the long-term analyses. The same is also applied to the data collected in 2018.

Figure 1: Measuring equipment at the Belsk Observatory. From the left: Dobson spectrophotometer, Brewer spectrophotometer, UV-S-AE-T, Kipp& Zonen meter.

The monthly mean values of total ozone in 2018 were slightly lower than the long-term average (1963-2017) for several months April-September with maximum decline of 7% in April. The values above the norm were found in winter and autumn. Sunny conditions appeared frequently in spring and summer in 2018 moving the monthly mean erythemal doses high above the norm for that period. The highest increase of about 30% was found in April and about 10-20% in August and September. The yearly dose was also ~4% above the 2000-2017 norm. For 28 days in 2018 the maximum daily intensity of UV radiation could be classified as very high according World Health Organization (WHO) classification. For such days, people should follow special scenarios of outdoor activities to limit UV overexposure. In 2018, IGF PAS released forecast of daily course of UV index (between April and October) to inform public of excessive UV radiation.

Time series of UV and ozone measurements at Belsk are among the longest series of the world thus appropriate for analyses of the long-term trends somewhat related to climate changes. Figure 2 illustrate the yearly pattern of the total ozone and erythemal dose. The declining tendency in total ozone for the period 1980-1996 and corresponding increase in the UV radiation are apparent. Slight increase of total ozone is seen in XXI century. This is called the ozone recovery due to less contamination of the stratosphere by ozone destructive chemicals that was forced by an international agreement - the Montreal Protocol signed by UN countries in 1987. UV level seems to be stabilized in XXI century as a superposition of the cloud/aerosols/ozone effects.

More detailed analyses of the stratospheric ozone and the surface UV variability at Belsk in global perspective are subject of other activities of the Department of the Atmosphere Physics.

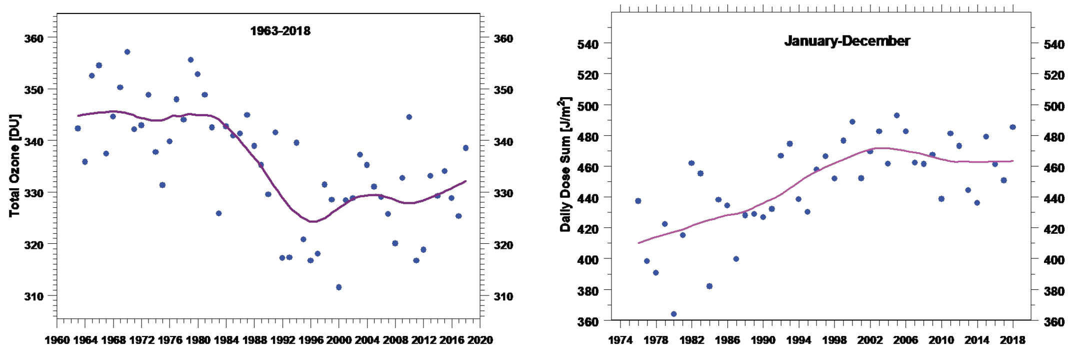

Figure 2: Yearly means (in Dobson units) of total ozone at Belsk for the period 1963-2018 (left) and yearly dose of erythemal irradiance (in kJ/m2) for the period 1976-2018 (right). Continuous curve shows the smoothed pattern.

Oceanic warm layer variability in the Bay of Bengal during Indian Monsoon
| **D. Baranowski**

Interactions between the atmosphere and the ocean play an important role in the development and evolution of the summer monsoon in the Bay of Bengal (BoB). Convective cloud systems that form over the BoB's warm waters bring rainfall to the Indian subcontinent during the summer monsoon season. The amount of energy available for development of the convective systems is highly dependent on the sea surface temperature (SST).

Surface warm layers in the ocean are relatively thin (~5m) and short-lived (~8h), and often develop at the ocean surface during the daytime through solar heating and increased SST. Persistent neglect of this layer in weather forecast models results in underestimation of the net energy flux from the ocean to the atmosphere, which may lead to biases in monsoon precipitation patterns. Although it plays an important role throughout many stages of convective development, diurnal warm layers are rarely directly measured and their spatial and temporal variability and dependence on the environmental conditions is poorly understood. Existence of warm layers is challenging for numerical weather and climate predictions, especially on subseasonal to seasonal time scales. The numerical framework not only must consist of coupled atmosphere – ocean models, the oceanic component needs sufficient vertical resolution in the upper ocean (~1m) and coupling needs to be performed frequently (timescale of less than 1h). All those requirements tremendously increase costs of simulations.

Figure 1: Kongsberg seaglider onboard R/V Sindhu Sathana BoBBLE cruise (2016) during self-tests prior to launch.

During the Bay of Bengal Boundary Layer Experiment (BoBBLE) 5 gliders (Figure 1) were deployed to measure upper ocean properties at high resolution across the BoB in July 2016. This dataset provides a unique insight into warm layer development, evolution and decay as well as its spatial and temporal variability and dependence on varying environmental conditions. Time series from the 5 individual platforms show clear variability of warm layer characteristics. In this presentation, dependence on atmospheric (surface wind speed, solar insolation and precipitation) and oceanic (stratification and currents) conditions on warm layer evolution will be addressed based on observations from those platforms. Further insight into warm layer occurrence and its spatial and temporal variability has been gained by high resolution simulations with KPP ocean model set up to represent conditions during BoBBLE experiment. Our results indicate that although warm layer formation is primarily forced by atmospheric conditions, its characteristics (e.g. amplitude of SST anomaly) depends on states of both atmosphere (wind speed and insolation) and ocean (stratification and currents).

Dynamical precursors of floods in Sumatra – meteorology and social media

| D. Baranowski, B. Latos

The Maritime Continent is an archipelago within Indo-Pacific warm pool characterized by the largest precipitation amount, globally. Such environmental conditions combined with complex topography make it favorable for extreme precipitation events and its adverse effects such as floods and mudslides.

Extreme precipitation events not only disrupt affected communities but also enhance communications related to those events. These communications include television coverage and journal articles but also social media. Given popularity of Twitter in Indonesia, extreme weather events cause spikes in communication done using this platform as well. Such spices in number of Twitter posts related to flooding are analyzed and attributed to individual events over Sumatra, an equatorial island in the western part of the archipelago. These data are combined with satellite remote sensing data about precipitation (GPM satellite) and outgoing longwave radiation, which is a measure of the strength of atmospheric convection (Meteosat 7 and Himawari 8 geostationary satellites). Therefore, crowd sourced, local measures of how an event was disruptive for a local community can be analyzed in context of local atmospheric forcing – precipitation over an effected region, as well as larger scale atmospheric circulation.

We present an analysis of Twitter-based flooding events in relation to seasonal, intra-seasonal and synoptic scale variability in the atmospheric circulation. Seasonal circulation is due to monsoon, intraseasonal (30-90 days periodicity) is related to the Madden-Julian Oscillations (MJO) and synoptic scale variability is represented by activity of equatorial waves, primarily convectively coupled Kelvin waves (CCKW). Because both MJO and CCKWs propagate eastward from Indian Ocean towards Indonesia it makes Sumatra an ideal candidate for such study.

The results show that all major flooding events are preceded by extreme 5-day precipitation accumulation. Such accumulation often occurs during prolonged periods of above normal precipitation over the island, typical for active monsoon or MJO conditions. However, many of flooding events are actually triggered by synoptic scale CCWs embedded in those large scale circulations. In some cases even CCKW events can trigger flooding by themselves. Since CCKWs affecting Sumatra are often initiated over central Indian Ocean, there is potential extended range predictability of such events, which may enable early warning for to-be-affected communities by various channels, including social media.

Further investigation will be conducted during ELO field campaign in 2019. Two Seagliders will be deployed in the ocean to measure diurnal variation in temperature and salinity during 4-months long deployment. Atmospheric measurements near Padang (western Sumatra) will be conducted using enhanced upper soundings, and surface radars.

Seminars and teaching

Seminars and lecture outside of the IG PAS

- D.Baranowski | *Atmospheric convectively coupled Kelvin waves over Indian Ocean and Maritime Continent Past, Present and Future* | Seminar
  University of East Anglia | Norwich, UK

Completed PhD thesis defense

- J. Guzikowski | *Modelling solar UV exposure for purpose of of public health* | Supervisor: J. Krzyścin
- A. Szkop | *Identification of aerosols source regions based on measured aerosols physical characteristics and backward air mass trajectories* | Supervisor: A. Pietruczuk
- M. Kossakowska | Modelling the impact of the aircraft on dynamic processes in the upper troposphere and the lower stratosphere | Supervisor: J. Kamiński

Visiting scientists

- Prof. Earle R. Williams | Massachusetts Institute of Technology Cambridge | Cambridge, USA
- Prof. Richard Menard | Environment and Climate Change | Montreal, Canada

Meeting, workshop conferences and symposia

ICAE 2018 | Nara city, Nara, Japan
Baranski, Guzikowski, Kubicki, Morawski, Skrzynski | *Dynamic and electric charge structure of thunderclouds obtained from the WRF_ELEC model and related to electric field signatures of lightning strokes recorded by the Local Lightning Detection Network in the Warsaw region during thunderstorm season in 2017* | poster

Karnas, Maslowski, Baranski | *Designation of the M-component Characteristics in Time and Time-Frequency Domain on the Basis of Cloud-to-Ground Flash Electric Field Signatures Recorded by the New Autonomous Detection Station in Rzeszow* | poster

Kubicki, Gołkowski | *On the number of lightning discharges from the GLD 360 network and the atmospheric electric field Ez in polar and middle latitude regions* | poster

34th International Conference on Lightning Protection (ICLP) | Rzeszow, Poland
Karnas, Maslowski, Baranski | *Automated Discrimination of Lightning Stepped Leader Stage from the Power Spectrum Density of the Related Electric Field Recordings* | poster

Polar Symposium | Poznań, Poland
Kubicki, Odzimek | *Preliminary analysis of measurements taken in Polish Polar Statin in Hornsund (Spitsbergen)* | poster

Seminar on Polar Climatology and Meteorology | Sosnowiec, Poland
Odzimek | *Polar Regions in the Earth's Global Atmospheric Electric Circuit* | oral

EGU General Assembly | Vienna, Austria
Baranowski | *Equatorial Line Observations (ELO): a comprehensive study of coupled atmospheric and oceanic processes within the Maritime Continent* | oral

Lopez et al including Jarosławski | *Induced seismicity response of hydraulic fracturing: results of a multidisciplinary monitoring at the Wysin site, Poland* | oral

Jarosławski, Pawlak | *Analysis of impact of the shale gas exploration and exploitation activities on the quality of ambient air – case study of Wysin, Poland* | poster

Kamiński, Kossakowska | *Potential impact of aviation emissions on chemical composition of the UTLS and global circulation – GEM-AC model simulations* | poster

Kamiński | *Impact of electromobility development on air quality in Poland* | poster

1st International Conference on Tropical Meteorology and Atmospheric Sciences | Bandung, Indonesia
Latos, Baranowski | *Equatorial Line Observations: predicting floods in Sumatra using crowdsourcing, tweeter, newspapers and meteorology* | oral

Ny-Ålesund Atmosphere Flagship open workshop | Potsdam, Germany
Sobolewski, Krzyścin, Posyniak | *UV Observations at the Polish Polar Station Hornsund in 2018* | oral

Workshop on Changes of the Polar Ecosystem 19. výroční zasedání Polární sekce České geografické společnosti | Malá Skála, Czech Republic
Sobolewski, Krzyścin, Posyniak | *Comparison of UV meters in Ny-Alesund and Observations at Hornsund in 2018* | oral

Krzyścin | *Recovery of column amount of ozone based on multi-sensor reanalysis data for the period 1979-2017* | oral

Jubileusz 65-lecia Instytutu Geofizyki PAN | Warsaw, Poland
Krzyścin | *Foto-Dermatologia-ostatnie osiągnięcia ZFA* | oral

Complex Atmospheric Monitoring and Research | Tatranska Lomnica, Slovakia
Krzyścin | *Total ozone trends from 1979to 2017 over Central Europe derived from satellite data* | oral

II Conference „Hot" Topics Dermatology | Toruń, Poland
Sobolewski | *Physics in Dermatology* | oral

Krzyścin | *The „morning after pill" in dermatology* | oral

78th Annual DGG meeting | Leoben, Austria
Cesca et al including Jarosławski | *Analysis of impact of the shale gas exploration and exploitation activities on the quality of ambient air – case study of Wysin, Poland* | oral

European Conference on Solar UV Measurements | Vienna, Austria
Krzyścin | *Modelling and measurements of ground-based UV radiation at the Institute Geophysics PAS* | oral

4th ACTRIS-2 General Meeting 2018 | Nafplio, Greece
Pietruczuk, Szkop | *Synergy of ceilometer and photometer, GRASP retrievals at Racibórz, Poland* | poster

Publications

Agnieszka Ewa Czerwińska, Jakub Guzikowski, Janusz Krzyścin, 2018, Adequate vitamin D3 skin synthesis versus erythema risk in the Northern Hemisphere midlatitudes; JOURNAL OF PHOTOCHEMISTRY AND PHOTOBIOLOGY B-BIOLOGY

Piotr Sobolewski, 2018, Altitude-temporal behaviour of atmospheric ozone, temperature and wind velocity observed at Svalbard; ATMOSPHERIC RESEARCH

Anna Odzimek, Piotr Barański, Danuta Jasinkiewicz, Marek Kubicki, 2018, Electrical signatures of Nimbostratus and Stratus clouds in ground-level vertical atmospheric electric field and current density at mid-latitude station Swider, Poland; ATMOSPHERIC RESEARCH

Marek Kubicki, Anna Odzimek, 2018, Geomagnetic Storms and Substorms as Space Weather Influence on Atmospheric Electric Field Variations; Sun and Geosphere

Stanisław Lasocki, Janusz Jarosławski, 2018, Induced seismicity response of hydraulic fracturing: results of a multidisciplinary monitoring at the Wysin site, Poland; SCIENTIFIC REPORTS OF THE NATURE PUBLISHING GROUP

Artur Szkop, Aleksander Pietruczuk, 2018, Modification of Local Urban Aerosol Properties by Long-Range Transport of Biomass Burning Aerosol; Remote Sensing

Jacek Kamiński, 2018, NOMAD, an Integrated Suite of Three Spectrometers for the ExoMars Trace Gas Mission: Technical Description, Science Objectives and Expected Performance; Space Science Reviews

Piotr Sobolewski, Jakub Guzikowski, Janusz Krzyścin, 2018, Perspectives of UV nowcasting to monitor personal pro-health outdoor activities; JOURNAL OF PHOTOCHEMISTRY AND PHOTOBIOLOGY B-BIOLOGY

Jacek Kamiński, 2018, Radiative impact of an extreme Arctic biomass-burning event; Atmospheric Chemistry and Physics

Piotr Sobolewski, Janusz Krzyścin, 2018, Trends in erythemal doses at the Polish Polar Station, Hornsund, Svalbard based on the homogenized measurements (1996-2016) and reconstructed data (1983-1995); Atmospheric Chemistry and Physics

Marek Kubicki, 2018, UAS as a Support for Atmospheric Aerosols Research: Case Study; PURE AND APPLIED GEOPHYSICS

Anna Odzimek, Piotr Barański, Eds., 2018, Atmospheric electricity: Commemorative Publication in Honor of Stanisław Michnowski on His 100-th Birthday; Publications IGF PAN

Chapters

Piotr Baranski, Jakub Guzikowski, Marek Kubicki, Marek Morawski, Andrzej Skrzynski, 2018, Dynamic and electric charge structure of thunderclouds obtained from the WRF_ELEC model and related to electric field signatures of lightning strokes recorded by the Local Lightning Detection Network in Warsaw region during thunderstorm season in 2017; Proceedings of the 16th International Conference on Atmospheric Electricity