NEWSLETTER

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Content

Measurement campaigns to identify and quantify the relationship between cosmic rays, solar UV radiation, and anthropogenic emission.

To study the effects of cosmic rays on the ozone shield, the correlation between extraterrestrial radiation (primary cosmic rays and solar UV radiation) in space and secondary cosmic radiation (SCR) on the ground needs to be determined and quantified. This requires simultaneous modeling and traceable measurements of (i) ground-level muon and neutron fluxes, (ii) terrestrial solar UV radiation, and (iii) the total ozone column.

Simultaneous measurements of SCR (muons and neutrons), the UV radiation spectrum, and the ozone column will be performed at four European sites that provide the necessary infrastructure for accurate measurement of atmospheric profile parameters and have different anthropogenic emission inventories to account for the influence of anthropogenic emissions on ozone dynamics.

The first measurement campaign was carried out from June 1, 2023 to August 31, 2023 at the National Centre of Scientific Research "Demokritos" (NCSR-DEM) station in Athens and included the simultaneous use of 10 instruments: UVB pyranometer and GUV-511 multichannel filters radiometer (Institut royal d'Aéronomie Spatiale de Belgique, BIRA-IASB), UV spectroradiometer BTS-Solar (Gigahertz Optik GmbH, GGO), ^{3}He neutron detector (Budapest Főváros Kormányhivatala, BFKH), portable neutron detector system based on liquid scintillator (Ústav jaderné fyziky AV ČR, v.v.i, UJF CAS), mobile muon detector based on plastic scintillator and portable gas-based muon detector (Physikalisch-Technische Bundesanstalt, PTB), and CIMEL Sun photometer, EOLE Multiwavelength Raman LIDAR, DEPOLE Depolarization LIDAR (National Technical University of Athens, NTUA) and temperature/aerosol LIDAR (Raymetrics). The campaign data budget was further complemented by input from the collaborating institution Biomedical Research Foundation of the Academy of Athens (BRFAA), which provided data from the Brewer spectrophotometer operated in Athens measuring columnar amounts of O_3 and SO_2, and irradiances in the UVB part of the spectrum at 0.5 nm intervals.

Figures 1-3 show some excerpts from the data collected during the Athens campaign, which highlight the correlation of secondary cosmic rays with various environmental

parameters such as air pressure, temperature, and total ozone column.

Figure 1 shows anticorrelation of pressure with vertical flux of muons. Air pressure is a measure of the mass of air in a column above the ground and, thus, it is a direct measure of the thickness of the matter through which the particles of SCR must pass on their way through the atmosphere. This thickness of the air directly affects the absorption of secondary cosmic radiation created in the lower stratosphere. While the dependence of muons on pressure is considerable, the dependence of neutrons is very low if it exists at all.

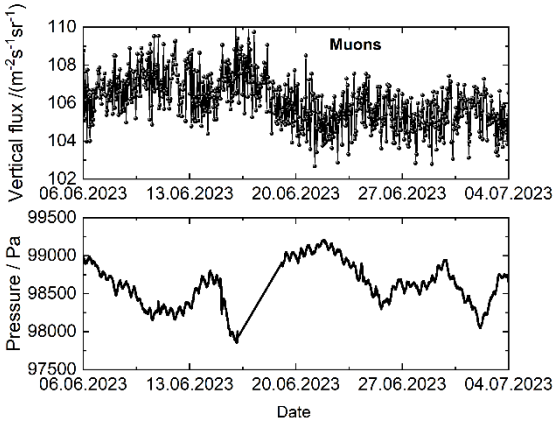

Fig. 1 Dependence of vertical muon flux rate (upper panel) on the atmospheric pressure (lower panel). The muon flux was measured with the PTB's muon detector DECOS2.

Cosmic neutrons are dependent on the water content of the atmosphere, see Figs. 2 and 3. In contrast to muons, which follow slower pressure changes, neutrons (both thermal and epithermal) are anti-correlated with the much faster temperature changes (with a period of about 12 hours) and follow the humidity dependence.

Although the relationship of secondary cosmic rays with atmospheric parameters are obvious, especially the anticorrelation of neutron count rate with the total ozone column, it is not yet possible to deduce a relationship between ozone depletion and secondary cosmic rays - more data, and in particular a large solar particle event, are needed to identify a measurable relationship which is more conclusive in this context.

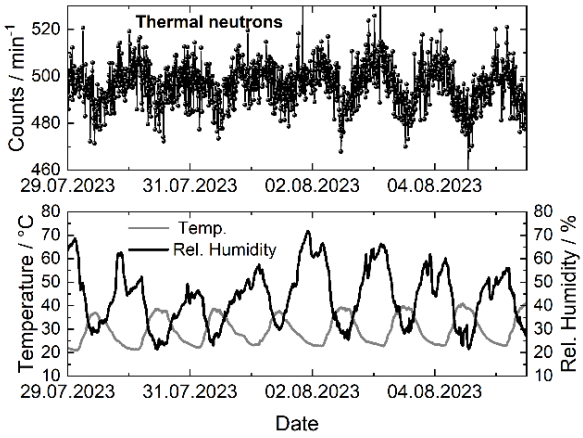

Fig. 2 Dependence of neutron count rate (upper panel) on the temperature (lower panel). The neutron rate was measured with the UJF CAS portable neutron detector based on liquid scintillators.

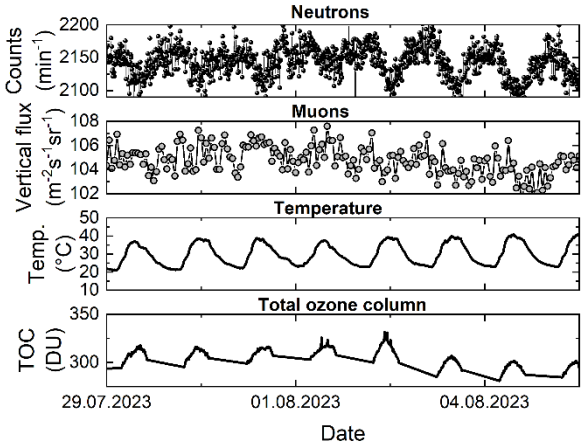

Fig. 3 Comparison of neutron count rate, muon vertical flux, temperature and total ozone column.

The data measured during the Athens campaign need to be further complemented with the Monte Carlo simulations which propagates space radiation down to the Earth's surface considering interaction with atmospheric components.

The atmosphere profiling parameters have been measured with the NTUA elastic-Raman EOLE Raman lidar and DEPOLE depolarization lidar systems, see Figs. 4 and

5.

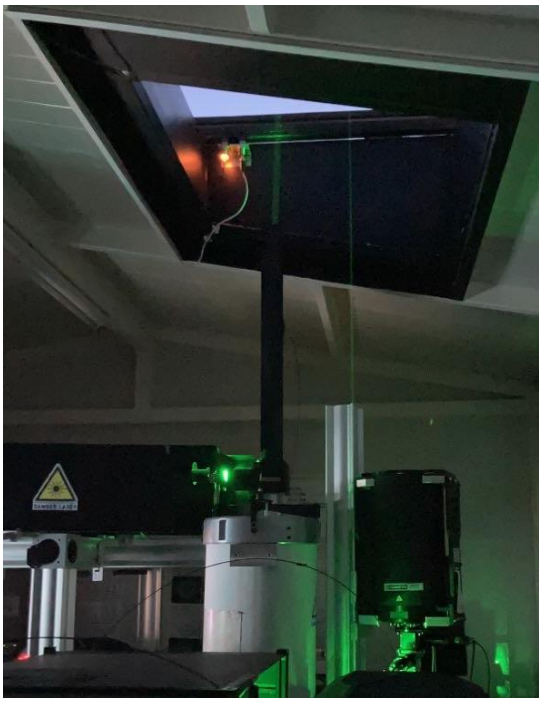

Fig. 4 The NTUA elastic-Raman EOLE Raman lidar and DEPOLE depolarization lidar systems on nighttime operation during the BIOSPHERE Athens Campaign (© Photo: Eleni Kralli, NTUA). The NTUA elastic-Raman EOLE Raman lidar and DEPOLE depolarization lidar systems belong to the European Lidar Network (EARLINET, https://www.earlinet.org).

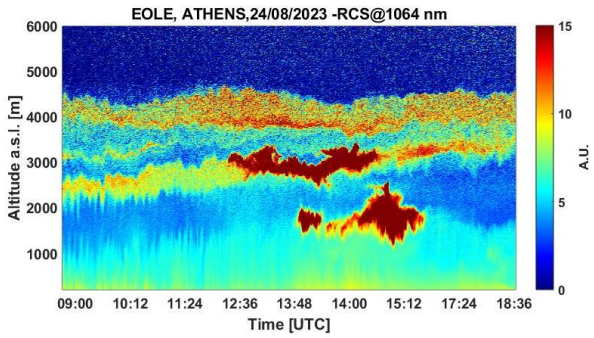

Fig. 5 Spatio-temporal evolution of the range-corrected lidar signal obtained by the NTUA elastic-Raman EOLE lidar system at 1064 nm (in arbitrary units-AU) over Athens, Greece (24 August 2023, 09:00-19:00 UTC). The aerosol layers at around 3 and 4 km height indicate the presence of mixed wildfire smoke and Saharan dust layers (© Photo: NTUA).

Brussels Campaign

The second campaign is taking place until spring 2024 in Brussels (Belgium), at one urban site where two institutes (BIRA-IASB, IRM-KMI) involved in the project are located. The site will offer numerous optical instrumentations (radiometers, spectrometers, pyranometers), amongst others from GGO for accurate spectral and wavelength-integrated measurements of solar UV irradiance, giving access to biologically effective dose rate (UV index) and atmospheric parameters (ozone abundance and aerosol optical depth).

The Royal Meteorological Institute (IRM-KMI), will actively contribute with balloon soundings for vertical profiles of atmospheric parameters and ozone concentration, and will provide total ozone column, aerosol characteristics and solar UV monitoring using ceilometer, aethalometer, nephelometer and a Brewer spectrophotometer.

The simultaneous measurement of muon and neutron flux rates using transportable detector systems from PTB, BFKH and UJF CAS will be supplemented by data from the IRM-KMI, which will also provide neutron and muon monitoring.

The monitoring of aerosols and various molecules (traces species including anthropogenic contributions) will be available from satellites and in situ measurements using BIRA-IASB instruments.

BIRA-IASB will manage the campaign.

Ozone depletion and atmospheric dynamics due to cosmic ray-induced electrons

The time course of the atmospheric ozone column shows clear correlations with the 11-year cycle of the cosmic ray flux and atmospheric ozone depletion. The details

of the underlying atmospheric processes are not understood and are under debate. Within the present project fundamental data on the interaction of low-energy cosmic ray-induced electrons with relevant atmospheric gases of both natural and anthropogenic origin are collected. In this respect, trace gases which are involved in catalytic ozone loss cycles like the nitrogen oxides or the chlorofluorocarbons (CFCs) are of particular interest. For N_2O and NO, measurements were done recently by G. Garcia (Agencia Estatal Consejo Superior de Investigaciones Cientificas, CSIC) determining the total electron scattering cross sections. Respective measurements for NO_2 will be completed in the near future.

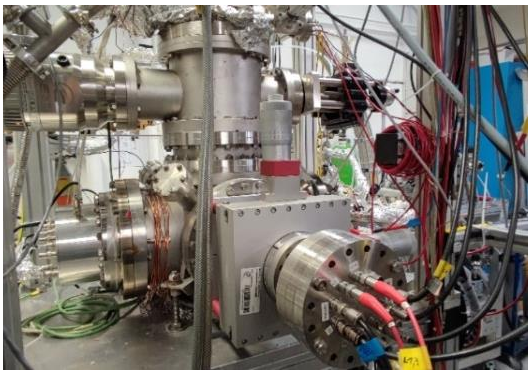

Fig. 6 The apparatus at MPG used to measure ionization cross sections for gases of atmospheric relevance.

At Max-Planck-Gesellschaft (MPG) Heidelberg an apparatus was commissioned which can obtain absolute ionization cross sections for gases (Figure 6). Measurements were done for several chlorofluorocarbons (CFCs) like CF_4, CCl_2F_2, $CClF_3$ and $CHClF_2$. If ionized, these produce Cl and F radicals which efficiently deplete ozone in the stratosphere. Exemplary, Fig. 7 shows the production of the various ionic fragments from $CHClF_2$ as a function of the electron impact energy.

Clearly the yield of the molecular fragments including the ozone active fragments Cl and F is highest at low impact energies below 100 electron volts (eV). This coincides with the most likely energies of secondary electrons from cosmic rays. The strongest fragmentation channel is $CHClF_2 \rightarrow CHF_2^+ + Cl$ from which only the residual ion is detected.

Also other possible processes are presently under debate. It is suggested that electrons can be highly efficient in producing chlorine radicals if they are trapped in surface states of small water ice crystals in polar stratospheric clouds and interact with CFCs or other chlorine reservoir molecules. For studying these processes experimentally, a gas jet containing small water aggregates (water clusters) was successfully tested and measurements will start 2024.

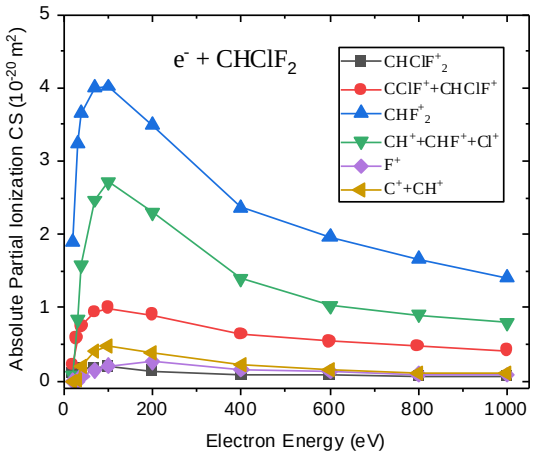

Fig. 7 Cross sections for production of various ions from $CHClF_2$. The production of CHF_2^+ together with a neutral Cl radical is the strongest channel.

In summary, these results will give insight in molecular processes affecting ozone depletion and atmospheric dynamics and provide a database of collision cross-

sections for natural atmospheric and anthropogenic gases.

Biological investigations on cells exposed to single and combined irradiation fields of SCR and UV radiation

In the frame of WP4 “Effects of combined SCR and UV radiation fields on biological systems”, the first joint biology experiments were held at PTB on July 17-21, 2023, involving PTB (Germany), Bundeswehr Institute of Radiobiology (Germany), NTUA (Greece) and National Institute of Pathology Victor Babeş – Bucharest (Romania). The experiments addressed the response of human blood cells, i.e. proliferating CRL 9855 monocytes and primary human lymphocytes, to single or combined exposure to protons and UVB, in terms of cellular viability and proliferation, DNA damage and expression changes of 84 stress genes. These original experiments conducted not only in Germany but also in Greece and Romania have shown so far a unique phenomenon when these radiation fields are combined. More specifically, we have detected that low to medium fluences of UVB in conjunction with proton irradiation drastically affected the viability and proliferation of monocytes. Moreover, distinct stress gene expression patterns at 24 h after the exposure of monocytes to protons and UVB were detected, with some overlapping genes related to autophagy and unfolded protein response (Figure 8). Most interesting, co-exposure of cells to protons and UVB has shown increased biological damage and unique signature of biological responses.

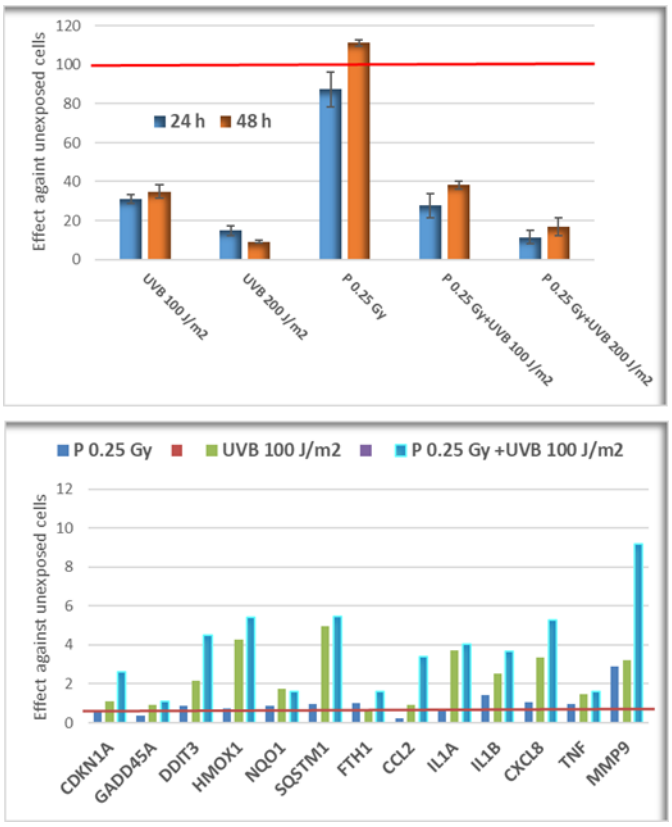

Fig. 8 The effect of single or combined exposure to protons (P) and UVB on normal proliferating CRL 9855 monocytes. Upper panel shows the effect on the number of metabolically active cells while the lower panel on the expression of stress genes. The straight lines reveal control levels.

These preliminary experiments on monocytes also revealed an increased level of DNA damages as foci (red color dots) even after 24 hr for co-exposed samples to 100 J/m^2 and 0.25 Gy of protons (Figure 9) compared to the samples exposed only with protons.

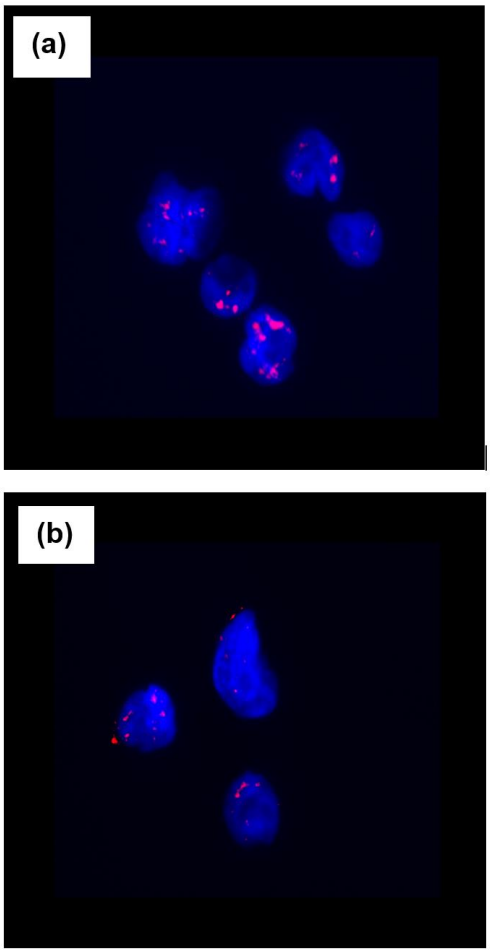

Fig. 9: Cells co-exposed to 100 J/m^2 and 0.25 Gy of protons after 3 h (a) and cells co-exposed to 100 J/m^2 and 0.25 Gy of protons after 24 h post-irradiation (b). Nucleus: blue color; DNA Damages: red color.

This outcome might be understood as a delay in the repair processes after combined exposure to ionizing and non-ionizing simulated cosmic radiations. The hypothesis of delayed repair due to synergistic exposure (0.5 Gy gamma irradiation and 100 J/m^2 UVB) is also confirmed by the experiments performed on human lymphocytes.

Past events

Metrology for Climate Action 2022

The Metrology for Climate Action 2022 was organized by BIPM, WMO, and EURAMET and was held as an online workshop on 26-30 September 2022 (https://www.bipmwmo22.org/). The aims of the workshop were: (a) To present progress and identify requirements for further development of advanced measurements, standards, reference data, comparisons, calibration supporting the physical science basis for and adaptation to climate change, and (b) To identify stakeholders' metrology needs, assess current metrological techniques, analyses, and modeling capabilities, and identify gaps in quantifying greenhouse gas emissions and uptake for effective actions on mitigating climate change and its impacts.

During this workshop, the coordinator (Faton Krasniqi, PTB) presented the objectives of the BIOSPHERE, including the operational capacity, needs and the impact, in a poster presentation and participated actively in the online meetings for Topic Specific Recommendation Development Sessions. The topics covered within the workshop included (1) Atmospheric chemistry and physics, (2) Oceans and hydrology, (3) Earth Energy Balance, (4) Biosphere monitoring, and (5) Cryosphere Monitoring. During online sessions for recommendations on key technical challenge areas for metrology over the next decade, the coordinator, on behalf of BIOSPHERE consortium, recommended WMO and BIPM to investigate the need for research into identifying and quantifying the relationship between cosmic radiation and ozone depletion and the impact this has on health and ecosystems. These recommendations were included in the workshop report that has been published on June 20, 2023 and is available on the BIPM website (https://www.bipm.org/documents/20126/27085544/RapportBIPM-2023-03.pdf/57b00234-2bd0-09e1-8d4f-4aaed2ae45fd?version=2.4&t=1687244959519&download=true).

EURAMET TC-IR 2023

The Technical Committee for Ionising Radiation (TC-IR) is concerned with the metrology of ionising radiation related to medical, industrial, environmental, scientific and radiation protection applications. During the TC-IR meeting, the advances of BIOSPHERE were presented in an invited talk by Faton Krasniqi (PTB) in February 2023.

48th Annual Meeting on Radiation Protection

BFKH had an oral presentation at the 48th Annual Meeting on Radiation Protection about Metrology for Earth Biosphere: Cosmic rays, ultraviolet radiation and fragility of ozone shield, in Gyula, Hungary, 18-20 April 2023 for an audience of about 100 scientists.

ConRad 2023

The 25th Nuclear Medical Defense Conference, ConRad 2023-Global Conference on Radiation Topics-Preparedness, Response, Protection and Research-was held in Munich from May 8th to 11th 2023. This unique conference is hosted in Munich by the Bundeswehr Institute of Radiobiology, which is affiliated to the University of Ulm. ConRad 2023 places special emphasis on two topics highlighted in separate key sessions next to in-depth views into several fields portrayed in key lectures. The first key session “Medical impacts of the use of nuclear weapons and countermeasures” discussed the impacts after the explosion of nuclear weapons as well as the possibilities of suitable countermeasures. In the second key session “Internal radiation by radionuclides of emergencies and therapies”, a platform for mutual exchange on previous scenarios was provided. In the proven concept of this conference, further subjects comprised the presentation of new insights in radiation epidemiology, medicine, biology, physics and radiation protection, including effects of electromagnetic fields and non-ionizing radiation in biological systems, radiation biology: diagnosis related studies and radiosensitivity studies. A contribution by Faton Krasniqi (PTB) on BIOSPHERE goals was presented.

EURADOS Annual Meeting 2023

The European Radiation Dosimetry Group (EURADOS) is a network of 81 European institutions (Voting Members) and more than 600 scientists (Associate Members). A presentation introducing the BIOSPHERE project and showing some preliminary results was given by Faton Krasniqi (PTB) in the WG3 (Environmental dosimetry) of EURADOS Annual Meeting in June 2023. Iva Ambrozova participated in Working Group 11 on High energy radiation fields, every year and especially on January 26-27, 2023, in Seibersdorf, Austria. Marek Sommer also gave a presentation about the characterisation of a novel neutron detector for measurements of secondary cosmic radiation in June 12-14, 2023, Porto, Portugal.

SOLAR WIND 16

The 16th International Solar Wind Conference was held in Pacific Grove, California, June 12-16, 2023. Organized by the Space Sciences Laboratory – University of California Berkeley, the three-annual Solar Wind Conference covered all aspects of solar wind physics for around 200 specialists of the field. Viviane Pierrard, head of the WP5 of Biosphere communication, was solicited to give an **invited** talk as scene-setter about the acceleration of solar particles.

11th RAD 2023

The 11th International Conference on Radiation, Natural Sciences, Medicine, Engineering, Technology and Ecology washeld at Herceg Novi, Montenegro, from June 19 to June 23, 2023 with around 300 participants. An oral presentation about the progress made in the project BIOSPHERE about space radiation variations during Solar Energetic Particle events and geomagnetic storms was given by Viviane Pierrard from BIRA-IASB.

IWORID 2023

The International Workshops on Radiation Imaging Detectors are held yearly and provide an international forum for discussing current research and developments in the area of position sensitive detectors for radiation imaging, including semiconductor detectors, gas and scintillator-based detectors. Carlos Granja from ADVACAM gave a talk about selective detection, spectrometry and particle tracking of protons, electrons, and muons with their MiniPIX telescope in Oslo (Norway), 25-29 June 2023.

SIGMAPHI 2023

The International Conference on Statistical Physics 2023 was held in Chania, Greece, from 10 to 14 July 2023 with around 300 participants. Viviane Pierrard gave an invited talk about the velocity distribution of solar particles.

ELC 2023

M. Gidarakou gave a poster presentation at the 4th European Lidar Conference (ELC 2023), held on 13-15 September 2023 in Cluj-Napoca, Romania about Aerosol, Temperature and Water Vapor profiling during the BIOSPHERE Athens Campaign (June-August 2023).

TEPA2023

Thunderstorms and Elementary Particle Acceleration is a conference organized by the Cosmic Ray Division of Yerevan Physics Institute, Armenia and Nuclear Physics Institute, Czech Republic in Prague from October 2-5, 2023. Iva Ambrožová gave a talk about Metrology for Earth Biosphere: Cosmic Rays, Ultraviolet Radiation and Fragility of Ozone Shield.

ASTROMEET2023

The 2nd International meeting on Astronomy and Astrophysics was held on Dubai (UAE) from 16 to 18 October 2023. The ASTROMEET is an event which gathers together a huge variety specialists, experts, scientists, students, even ordinary people who like to know more about the future development of astronomy and astrophysics. An invited oral presentation about the Space radiation variations during Solar Energetic Particle events in the framework of the BIOSPHERE project was given by Viviane Pierrard from BIRA-IASB.

Days of Radiation Protection 2023

Days of Radiation Protection were organized in Tábor, Czech Republic, November 6-10, 2023. Iva Ambrožová gave an invited presentation about Consequences of cosmic rays and solar UV radiation for the Earth's biosphere and Marek Sommer presented a talk about Neutron detector for measuring cosmic rays and radiation phenomena during thunderstorms.

European Space Weather Week 2023 (ESWW23)

The ESWW is the main annual event in the European Space Weather and Space Climate calendar. It is an international meeting organised annually within the European Region in collaboration with prominent members of the European space weather and Space Climate community. It began as a forum for the European Space Weather community and has since grown into an international event with global attendance. This year, ESWW was held on 20-24 November 2023 in Toulouse (France). An oral presentation dealing with forecast of radiation belt electron fluxes was given by Edith Botek from BIRA-IASB.

Note: an invited seminar about AtRIS simulations of the effects of Galactic cosmic rays on the terrestrial atmosphere was given by Alexandre Winant, PhD student at BIRA-IASB, to University of Kiel (Germany) on 25 April 2023.

An invited seminar was also given by Viviane Pierrard from BIRA-IASB at Mullard Space Science Laboratory, England, on 20 September 2023 about the acceleration of solar particles.

1st Stakeholder Committee Meeting, was virtually hosted by the Physikalisch-Technische Bundesanstalt Braunschweig, on October 4-5 2023. Each work package leader presented their results and feed-back from stakeholders was very useful to identify the needs and additional possibilities.

Upcoming events

The next Biosphere progress meeting will be held in Brussels (Belgium) on Monday and Tuesday 11-12 March 2024.

In 2024, several presentations at different conferences are already planned. For instance:

AIAC: 21st Annual International Astrophysics Conference, Turino, Italy, from March 25th to March 29th where V. Pierrard is invited to give a 25 minute-talk about bracketing solar wind.

URSI 2024: The triennial URSI Atlantic Radio Science Conference (URSI AT-RASC) is one of the URSI flagship conferences besides the URSI General Assembly and Scientific Symposium and the AP-RASC (Asia-Pacific Radio Science Conference). In 2024, the 4th URSI AT-RASC will be held in Spain from 19 to 24 May.

ILRC 2024: the 31st International Laser Radar Conference (ILRC) will be held in Landshut, Bavaria (23-29 June 2024) hosted by the German Aerospace Center (DLR).

Our publications

1) The atmospheric influence on cosmic ray induced ionization and absorbed dose rates, Alexandre Winant, Viviane Pierrard, Edith Botek, Konstantin Herbst, Universe, 9, 502, 1-17, 2023. https://doi.org/10.3390/universe912050

2) The Role of Plasmasphere in the Formation of Electron Heat Fluxes, Khazanov G. V., Pierrard V., Ma Q., Botek E., Journal of

Geophys. Res.: Space Physics, Vol. 128, Issue 11, November 2023, e2023JA032013 https://doi.org/10.1029/2023JA032013

3) Geomagnetic storm effects on the LEO proton flux during solar energetic particle events, Girgis K. M., Hada T., Yoshikawa A.,Matsukiyo S., Pierrard V., & Samwel S. W., Space Weather, 21, November 2023, e2023SW003664. https://doi.org/10.1029/2023SW003664

4) Exospheric Solar Wind Model Based on Regularized Kappa Distributions for the Electrons Constrained by Parker Solar Probe Observations, Pierrard V., Halekas J., Audoor C., and M. Péters de Bonhome, P. Whittlesey and R. Livi, Plasma, 6, 518-540, 2023. https://doi.org/10.3390/plasma6030036

5) Comparison of radiation belts electron fluxes simultaneously measured with PROBA-V/EPT and RBSP/MagEIS instruments. Winant, A., Pierrard, V. & Botek, E., Ann. Geophysicae, 41, 313–325, 2023. https://doi.org/10.5194/angeo-41-313-2023

6) Prediction of radiation belts electron fluxes at a Low Earth Orbit using neural networks with PROBA-V/EPT data. Botek, E., Pierrard, V., & Winant, A., Space Weather, 21, e2023SW003466, 2023. https://doi.org/10.1029/2023SW003466

7) Combined experimental and theoretical study on the elastic electron scattering cross sections of ethanol. Dinger, M., Park, Y., Hepperle, P. and Baek W.-Y., Eur. Phys. J. D 77, 52, 2023. https://doi.org/10.1140/epjd/s10053-023-00632-6

8) More than Meets the Eye: Integration of Radiomics with Transcriptomics for Reconstructing the Tumor Microenvironment and Predicting Response to Therapy. Logotheti, S., Georgakilas, A.G., Cancers, 15, 1634, 2023. https://doi.org/10.3390/cancers15061634

9) Proton flux variations during Solar Energetic Particle Events, minimum and maximum solar activity and splitting of the proton belt in the South Atlantic Anomaly, Pierrard V., S. Benck, E. Botek, S. Borisov, A. Winant, Journal of Geophysical Research: Space Physics, 128, e2022JA031202, 2023.

https://doi.org/10.1029/2022JA031202

10) Intense Storm at Low Earth Orbit and Geostationary Transfer Orbit. Viviane Pierrard, Alexandre Winant, Edith Botek, Jean-François Ripoll, Mélanie Cosmides, David M. Malaspina, Geoffrey D. Reeves and Scott A. Thaller, Simultaneous Observations of the 23 June 2015 Intense Storm at Low Earth Orbit and Geostationary Transfer Orbit, URSI Radio Science Letters, Vol. 4, 2022. doi: 10.46620/22-0016

11) Modeling of the cold electron plasma density for radiation belt physics. Ripoll J-F, Pierrard V., Cunningham G.S., Chu X., Sorathia K.A., Hartley D.P., Thaller S.A., Merkin V.G., Delzanno G.L., De Pascuale S. and Ukhorskiy A.Y., Front. Astron. Space Sci. 10:1096595, 2023. doi: 10.3389/fspas.2023.1096595

12) Radiation Type- and Dose-Specific Transcriptional Responses across Healthy and Diseased Mammalian Tissues. Sagkrioti, E.; Biz, G.M.; Takan, I.; Asfa, S.; Nikitaki, Z.; Zanni, V.; Kars, R.H.; Hellweg, C.E.; Azzam, E.I.; Logotheti, S.; Pavlopoulou, A.; Georgakilas, A.G., Antioxidants, 11, 2286, 2022. https://doi.org/10.3390/antiox11112286

13) Clustered DNA Damage Patterns after Proton Therapy Beam Irradiation Using Plasmid DNA. Souli, M.P.; Nikitaki, Z.; Puchalska, M.; Brabcová, K.P.; Spyratou, E.; Kote, P.; Efstathopoulos, E.P.; Hada, M.; Georgakilas, A.G.; Sihver, L. Int. J. Mol. Sci., 23, 15606, 2022. https://doi.org/10.3390/ijms232415606

14) Vasilopoulos, S.N.; Güner, H.; Uça Apaydın, M.; Pavlopoulou, A.; Georgakilas, A.G. Dual Targeting of DNA Damage Response Proteins Implicated in Cancer Radioresistance. Genes 2023, 14, 2227. https://doi.org/10.3390/genes14122227

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EPM 21GRD02 BIOSPHERE was launched in October 2022. It is supported by a broad global scientific community within climate research, space research, biology and medicine, atmospheric chemistry, radiation protection and metrology.

For the time being, the project BIOSPHERE has established the following collaborations by a Letter of Agreement (in the order of signature date): Collaborators by signed letters of agreement:

1. Bundeswehr Institute of Radiobiology, Germany,
2. UK Health Security Agency (Radiation Effects Department), United Kingdom,
3. University of Naples Federico II (Radiation Biophysics Laboratory), Italy,
4. Biomedical Research Foundation of the Academy of Athens, Greece.