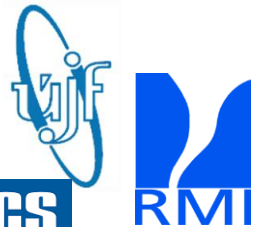


JRP-v17

Metrology for Earth Biosphere: Cosmic Rays, Ultraviolet Radiation and Fragility of Ozone Shield

Selected coordinator: F. Krasniqi (PTB)



Need: Disturbance of natural equilibrium

Cosmic rays

Air shower

Source: flickr

Solar Particle Events

Cosmic rays and solar UV radiation are the main sources of atmospheric ionization

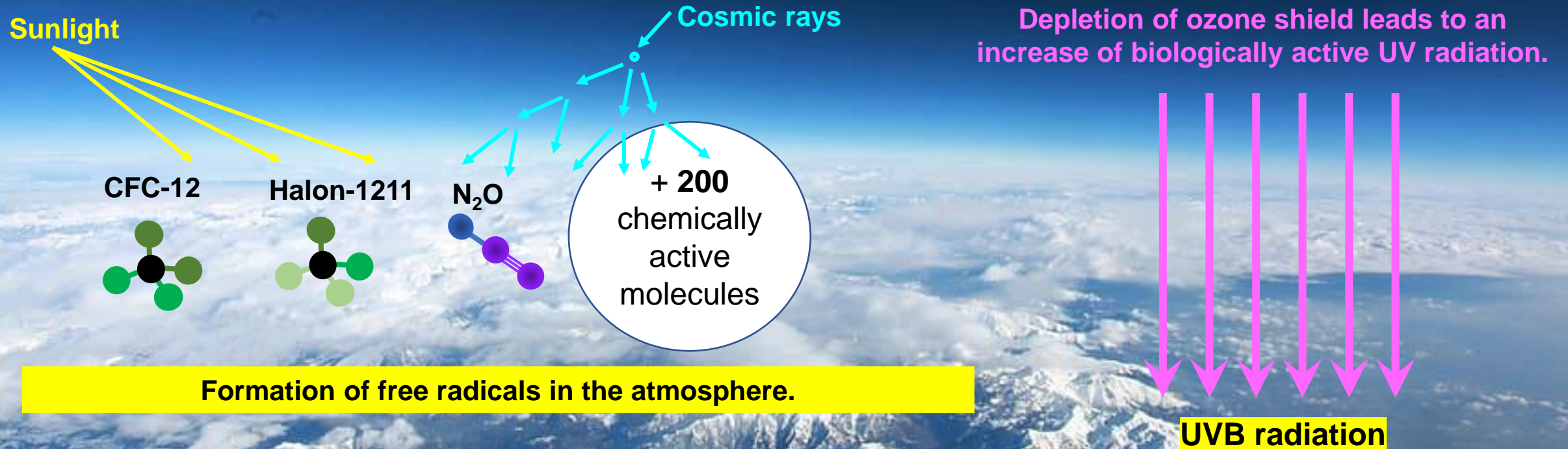


Implications for the **climate** and **health**

UV radiation

BIOSPHERE

Need: Ozone chemistry



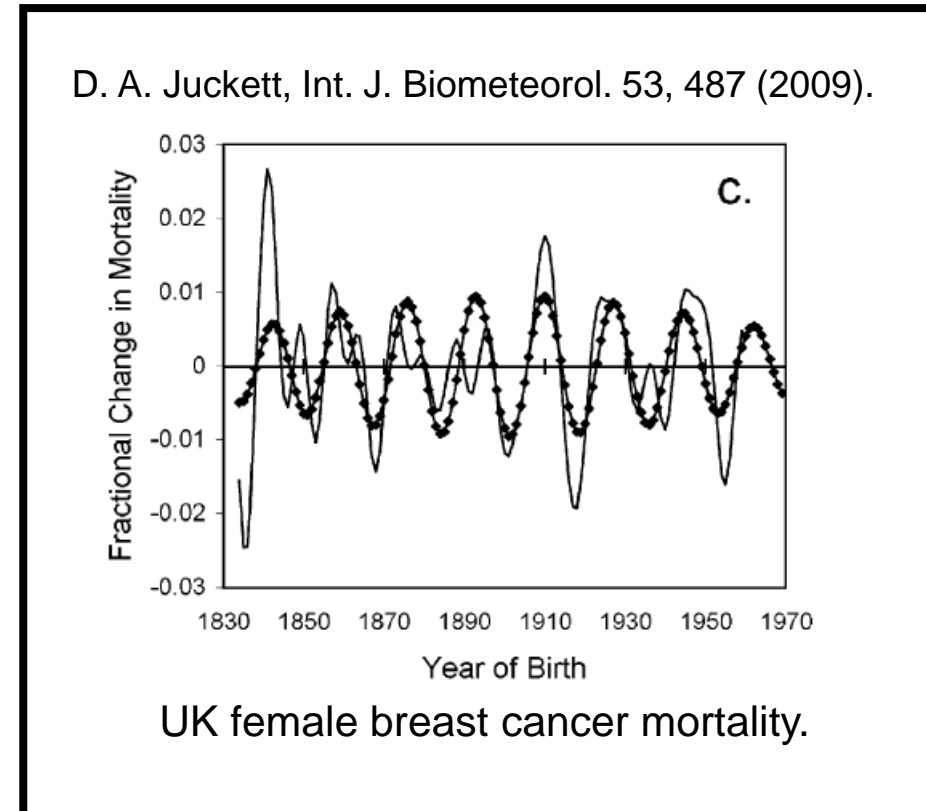
Formation of free radicals in the atmosphere.

Cl-, Br-, NO- radicals can destroy up to 100 000 ozone molecules!

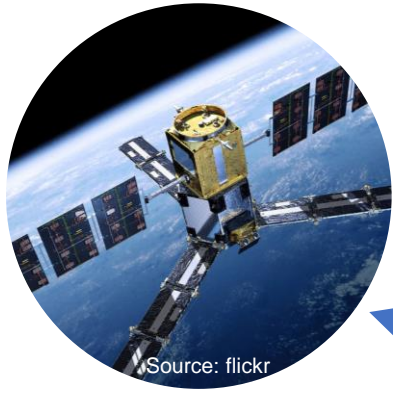
Lifetime of ODS(s): up to 4 000 years! E.g., CFC-12: 102 years.

Need: Biological implications

- The incidence rate of skin cancer increases by about 2 % for each percent of ozone layer-thickness reduction.
- Human immune-system suppression.
- Reduction of the size, productivity, and quality of crop plants.
- Impairment of the productivity of phytoplankton in aquatic ecosystems.



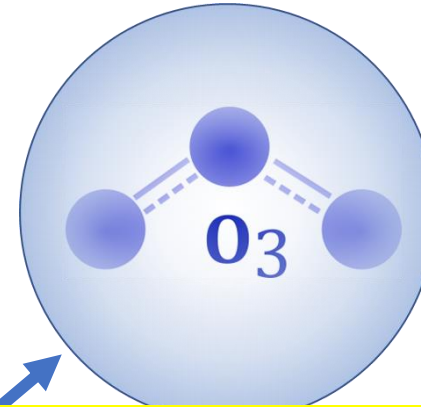
Need: Metrology for the Earth biosphere



Extraterrestrial radiation in space

- Solar particle events
- Galactic cosmic rays
- Solar radiation

Source: flickr

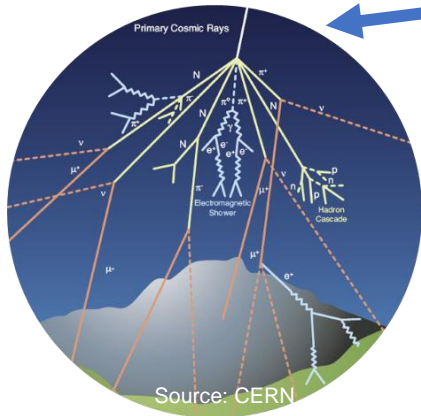


Atmospheric chemistry

- Anthropogenic activities
- Ionization
- Molecular dissociation
- Ozone depletion

Novel metrological methodologies are needed to establish **correlations** between them

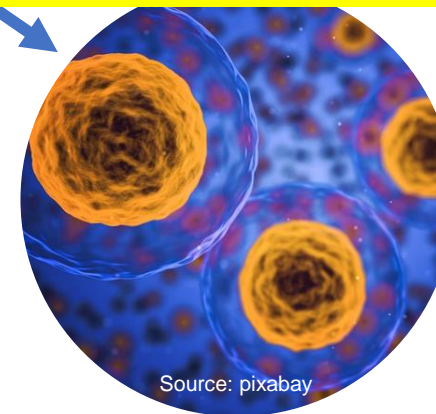
Traceability: credibility, transparency, confidence and acceptance by the public and stakeholders.



Extraterrestrial radiation on the ground

- Muons
- Neutrons
- UVB radiation

Source: CERN



Biology

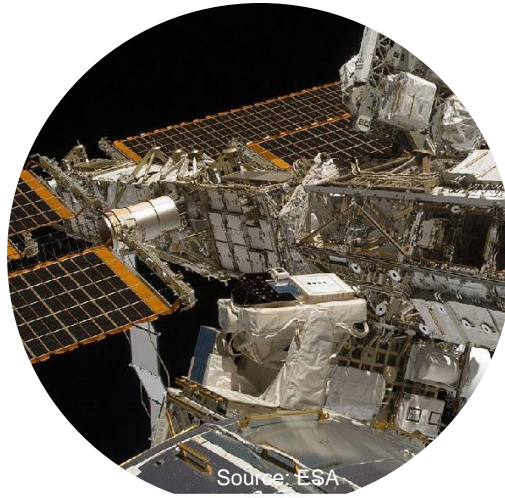
- DNA damage
- Genomic instability
- Cell death

Source: pixabay

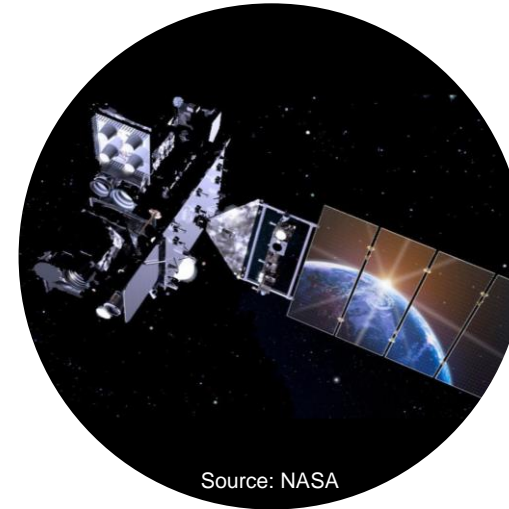
Operational capacity



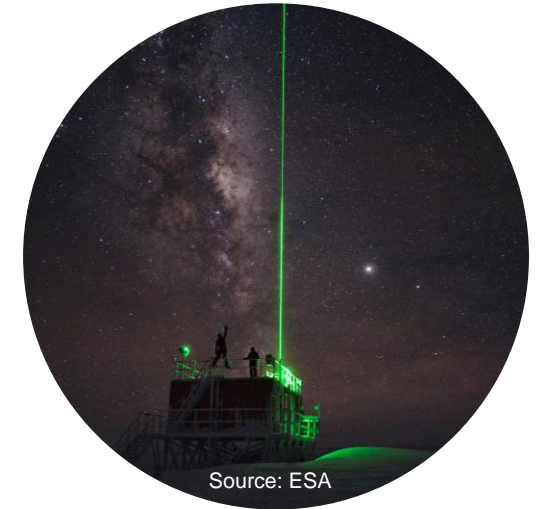
PROBA-V Satellite
Data on electron, proton and helium ion fluxes to investigate flux increases during SEP (Solar Energetic Particles) events and geomagnetic storms



SOLAR/SOLSPEC Spectrometer onboard of the ISS
Traceable absolute solar UV irradiance data

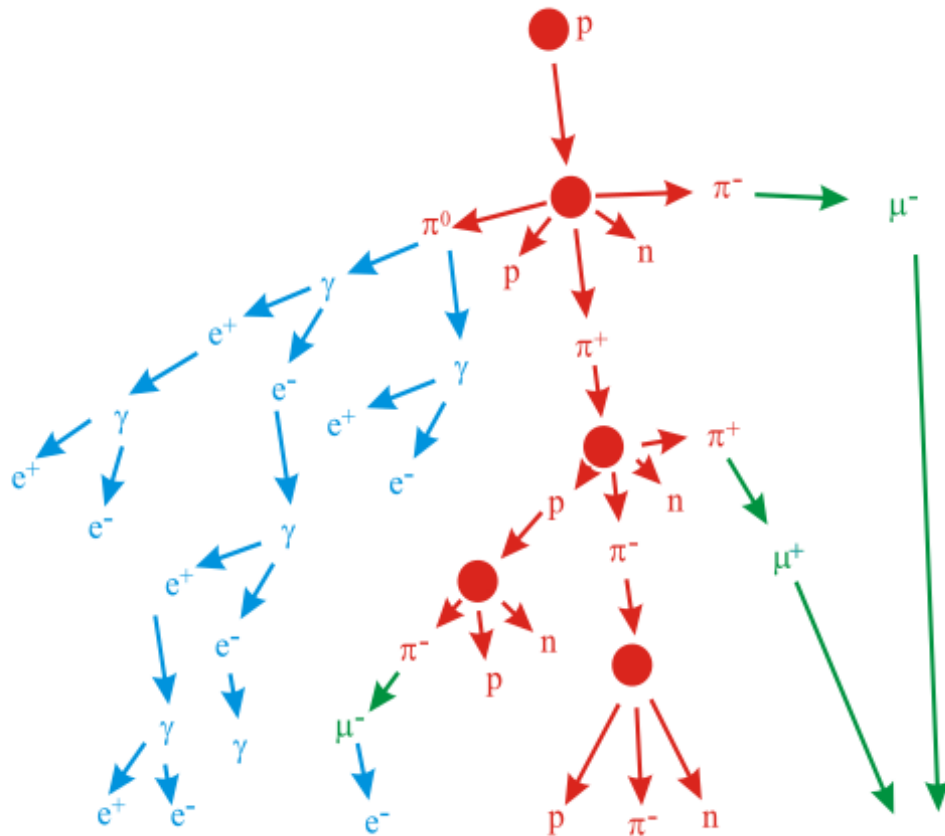


GOES Satellite
Satellite observations of energetic electron and proton fluxes



On-ground LIDAR(s), UV spectrometers and cosmic ray detectors
Data on atmospheric profiling parameters (temperature, air density), solar UV spectrum and ozone column measurements, and SCR radiation (muons and neutrons)

WP 1 The dependence of secondary cosmic ray flux on atmospheric parameters

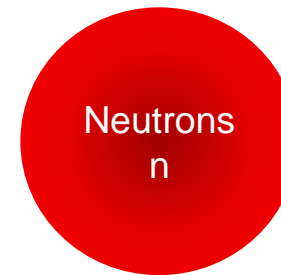


Cosmic air shower
(Source: Wikimedia Commons)

New metrological method to determine the relationship between:

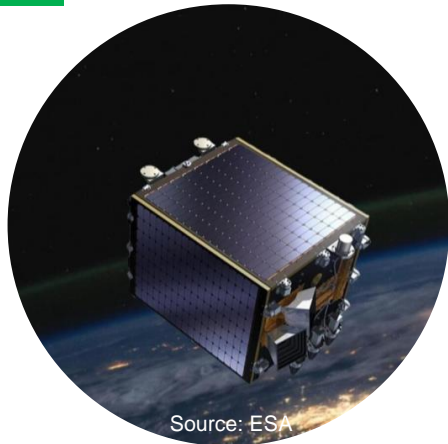
Cosmic radiation

Atmospheric profiling parameters



Raymetrics LIDAR

WP 2 Relationship between cosmic radiation, solar UV radiation and anthropogenic emission



Source: ESA

Proba-V satellite



Source: Gigahertz-Optik GmbH

UV Spectroradiometer
BTS-Solar

New metrological method to quantify correlations between



Cosmic rays

Solar UV radiation

Anthropogenic emission

Measurement campaigns

(cosmic ray detectors, LIDARS, UV Spectroradiometers)



Germany



Belgium



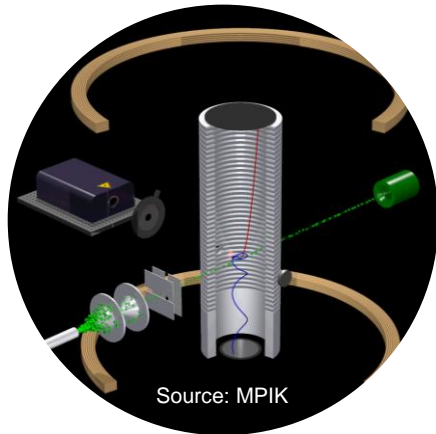
National Technical
University of Athens

Greece

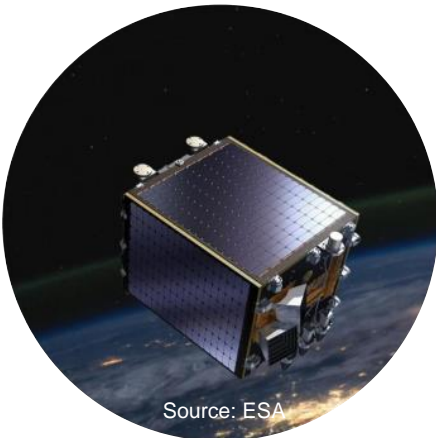


Czech Republic

WP 3 Molecular processes affecting ozone depletion and atmospheric dynamics



Reaction microscope



Proba-V satellite

For the first time, **fundamental data** on the interaction of low-energy electrons with atmospheric gases of both natural and anthropogenic origin



Molecular ionization



Molecular fragmentation

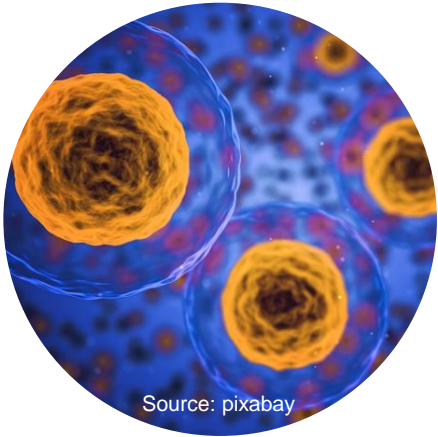


Dissociative electron attachment

Development of a **complete data base of collision cross sections** for natural atmospheric and anthropogenic gases

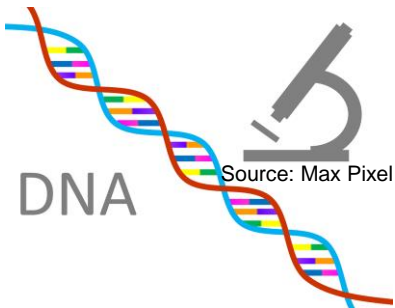
CFCs, CFC/CH₂Cl₂, N₂, O₂, NO, NO₂, CFC/CH₂Cl₂, HCl, HF, HBr, SF₆

WP 4 Effects of combined SCR and UV radiation fields on biological systems



Source: pixabay

*Human primary cell
(artistic view)*



Source: Max Pixel

Investigation of **structural** and **functional damages** inflicted by combined cosmic and UV exposure in human primary cells



Primary skin fibroblasts

Blood monocytes

Brain endothelial cell

Correlation between irradiation parameters and changes of cellular parameters using **system biology** approaches.

Current state of the art

Lack of research on the effects of combined secondary cosmic and UV radiation in humans.



E. g. cell death, chromosomal instability, damage-associated molecular patterns

No reliable data on the interaction of **low energy electrons** with anthropogenic gases.



E. g., collision cross section, absolute cross section for dissociative electron attachment

Side-by-side measurement of cosmic and solar UV radiation have never been done so far due to the lack of the proper measurement infrastructure.



E. g., correlation of secondary cosmic radiation flux rate with the solar UV spectrum

Impact

Traceable data to assess the **contribution of cosmic rays and UV radiation** exposure in the risk for developing **chronic diseases and cancer**.

ECCO (European Cancer Organisation), **EORTC** (European Organisation for Research and Treatment of Cancer), **ESMO** (European Society for Medical Oncology), and more globally World Health Organization (WHO).

A comprehensive **database of interaction cross sections** for natural atmospheric and **anthropogenic gases**.

(**GAW**) Global Atmosphere Watch, (**IAMAS**) International Association of Meteorology and Atmospheric Sciences + input to chemistry-climate models (**CCM**) such as **SOCOL** (Solar Climate Ozone Links) etc.

Identification of biomarkers of radiation exposure.

General population.

Provide **EU policymakers** with scientific assessments that improve decision-making on EU climate and environmental policies.

EU Commission, Parliament and Council, European Citizens' Initiatives.

Set the stage for establishing a **cosmic ray network** that can be **coupled** with the already **well-established networks for the solar UV radiation** and the total ozone column.

Thank you!

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