October 2, 2024 Space Weather

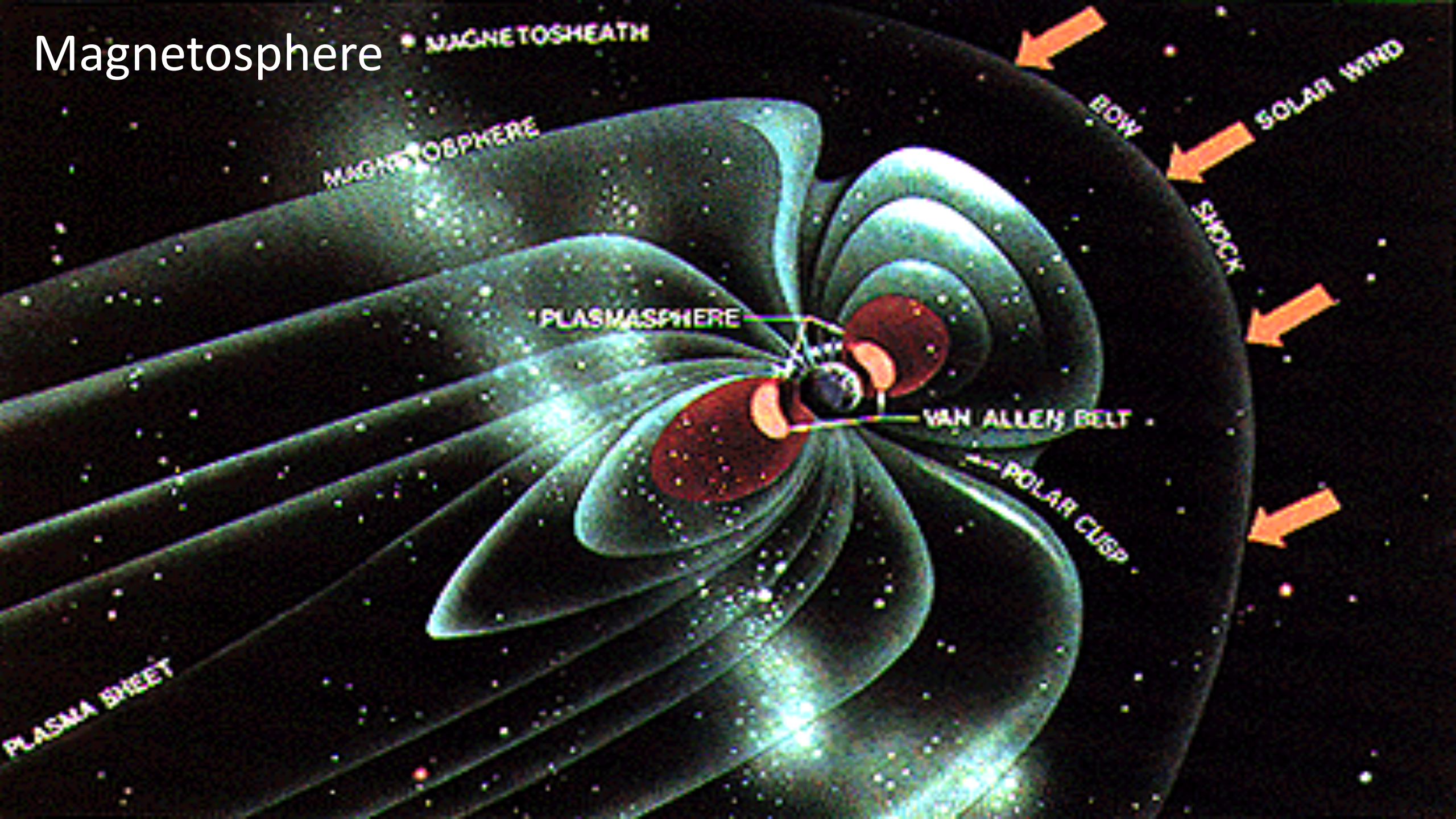
Interactions between space particles and the terrestrial upper atmosphere

Viviane Pierrard

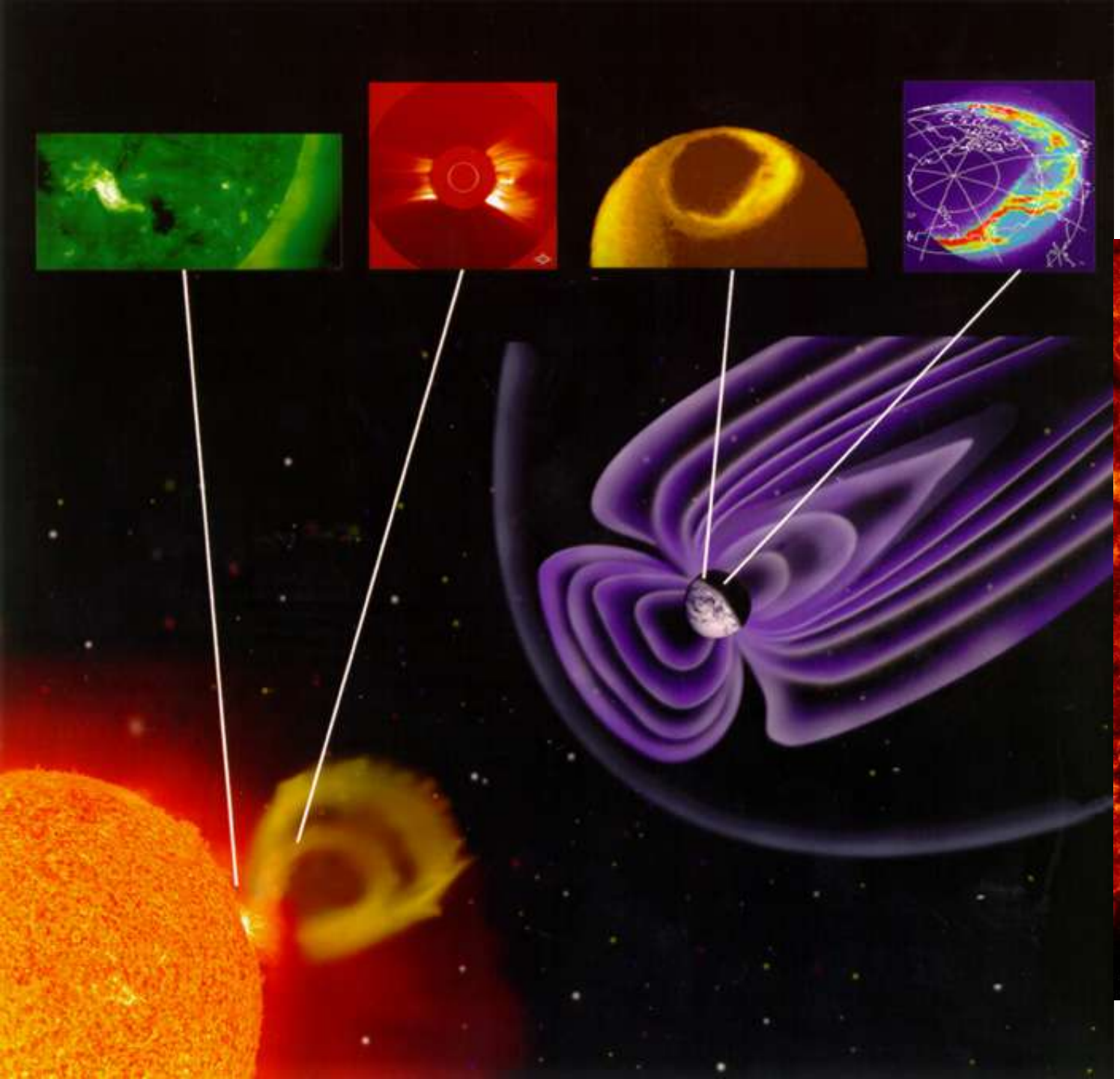
Royal Belgian Institute for Space Aeronomy
Université catholique de Louvain

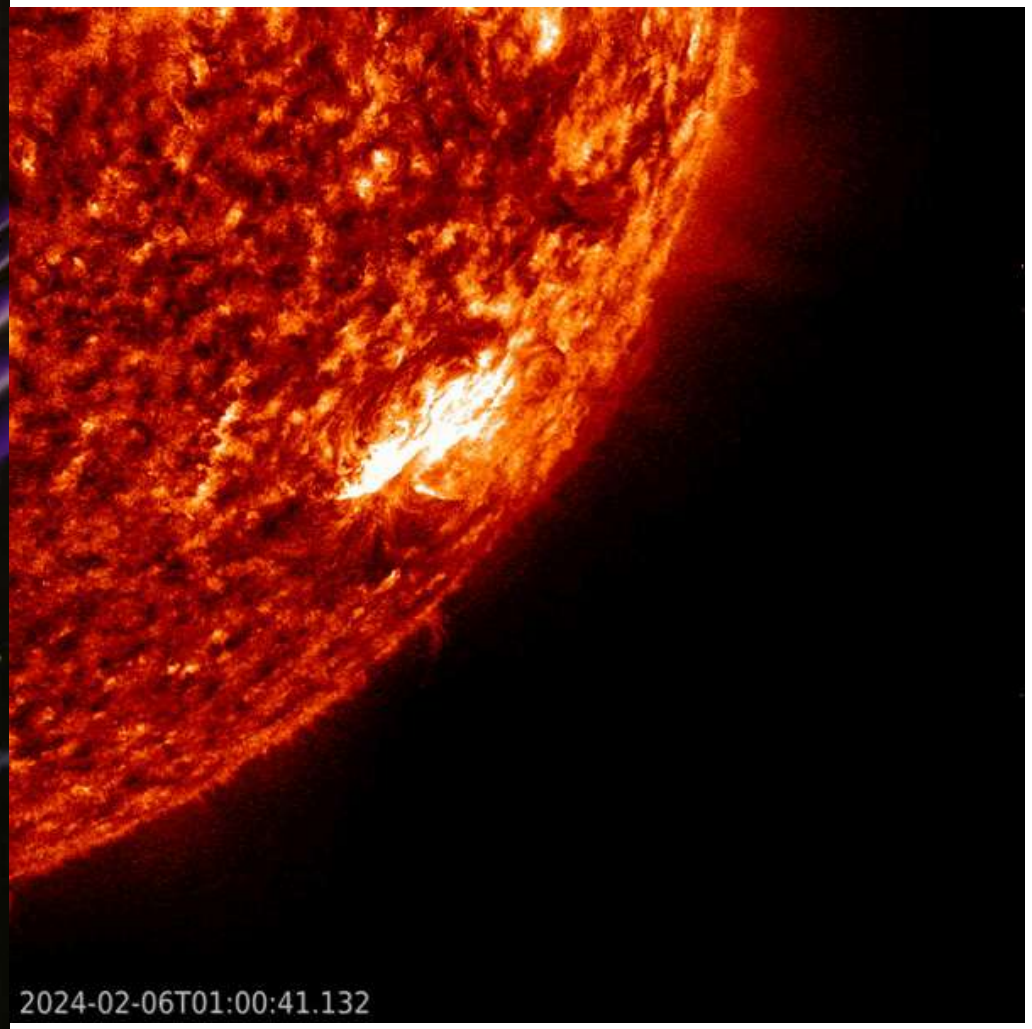
METROLOGY PARTNERSHIP | EURAMET | BIOSPHERE

Magnetosphere



Auroral oval





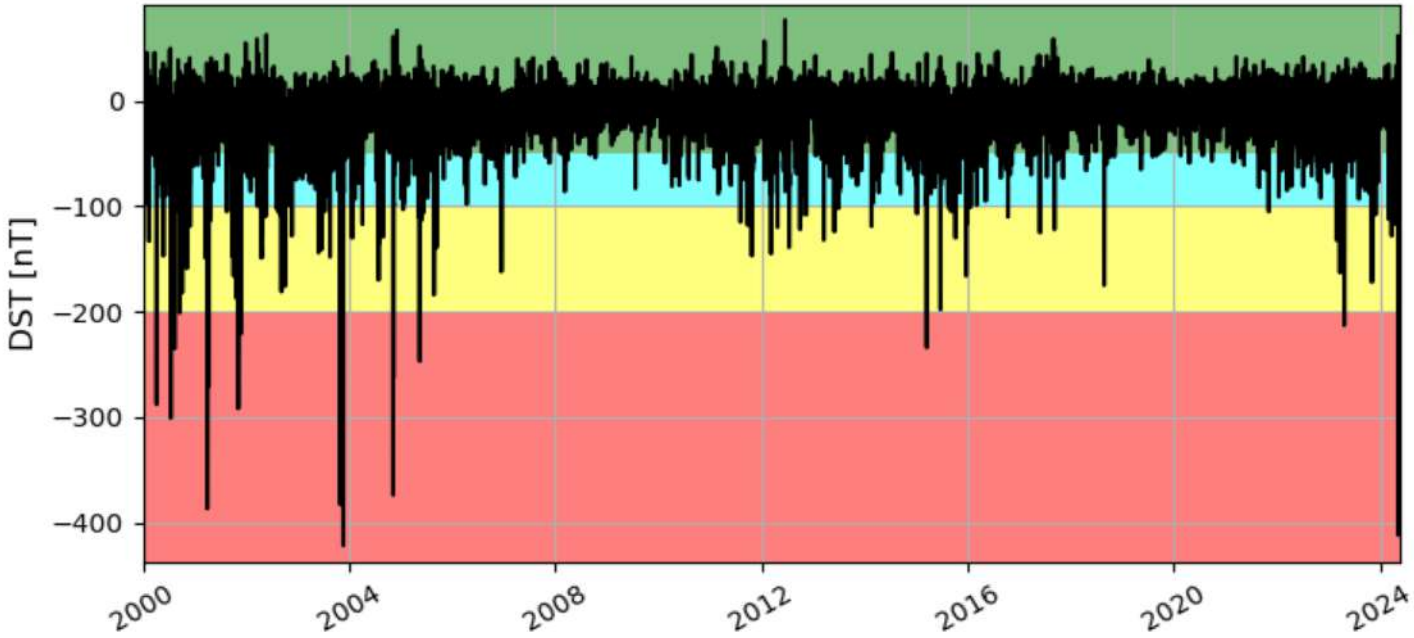
Auroras 11 May 2024

Belgium

Scotland

Spain

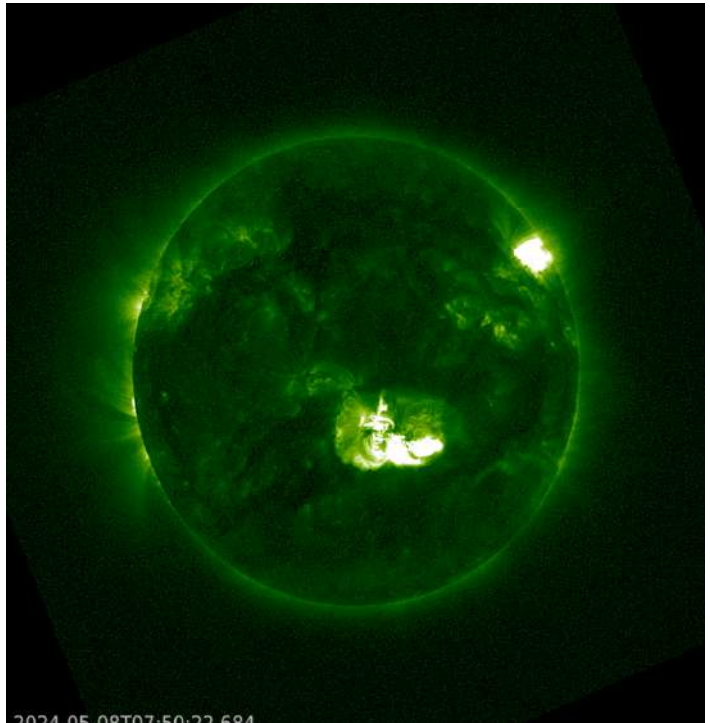
Pierrard, Science Connection, Sept 2024

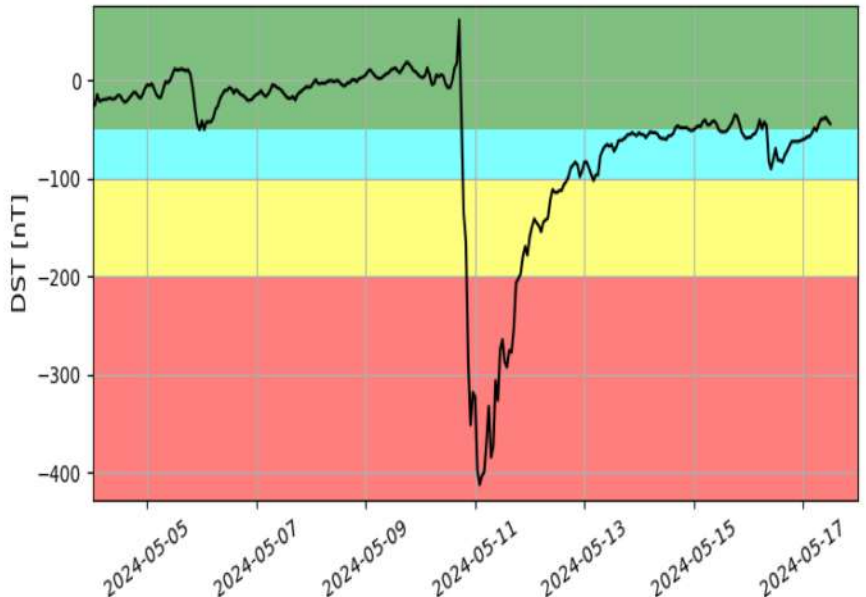


Dst Disturbed Storm Time

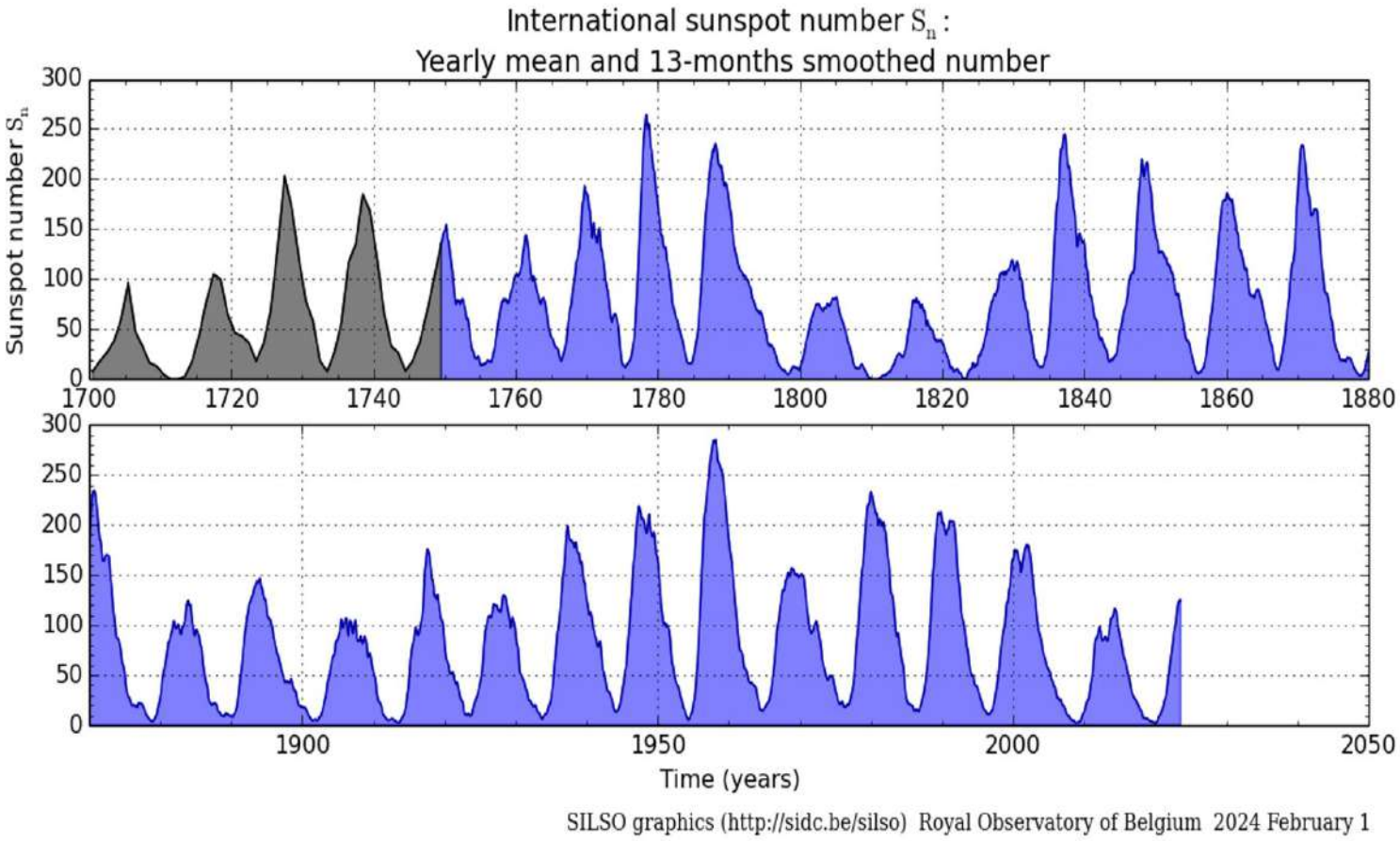
Geomagetic activity

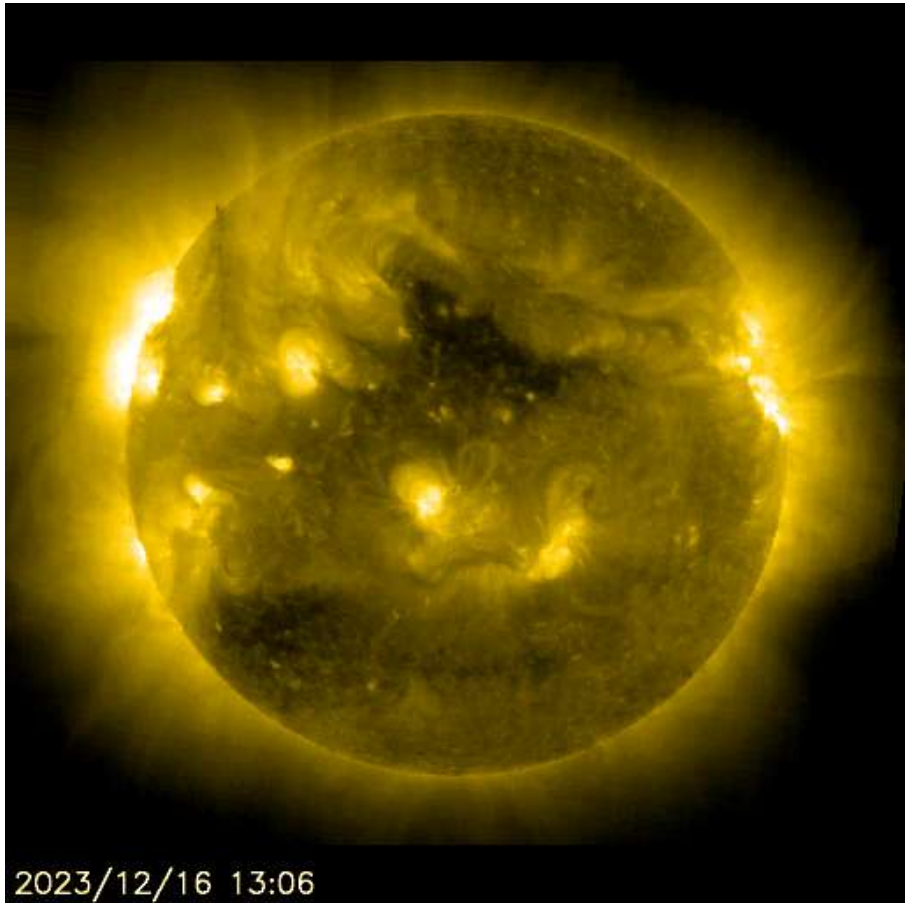
Pierrard et al., Universe, 2024





Solar cycle of 11 years

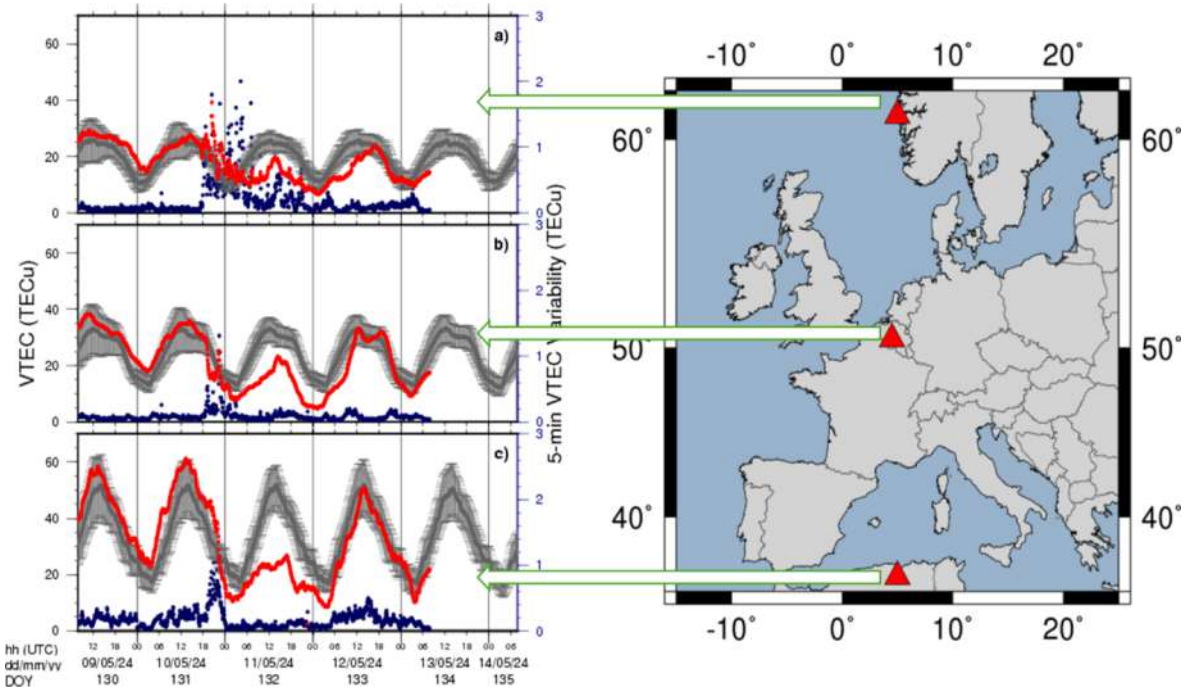




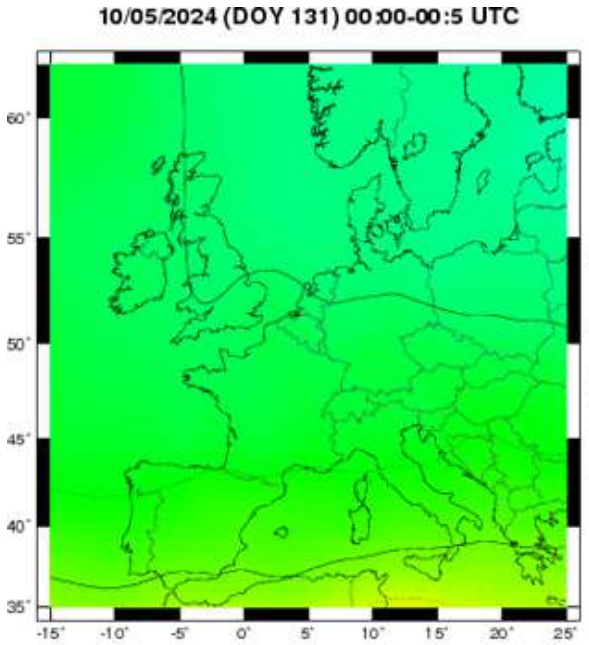
SOHO

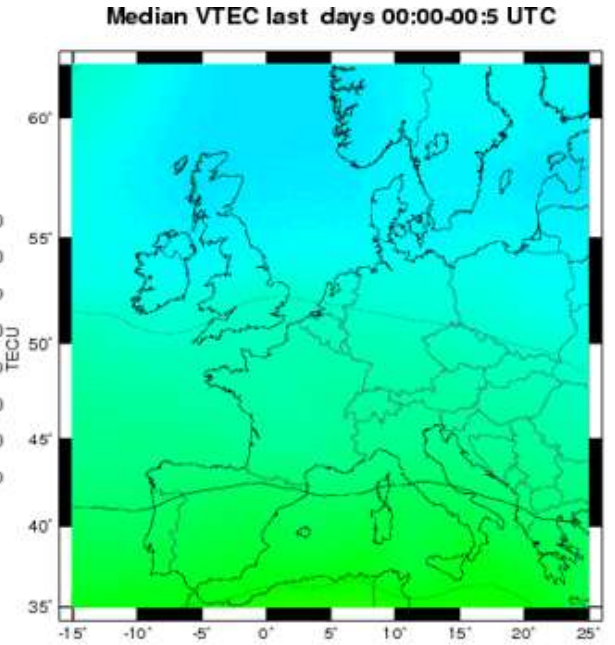
Ionization of the atmosphere
(radio wave propagation)

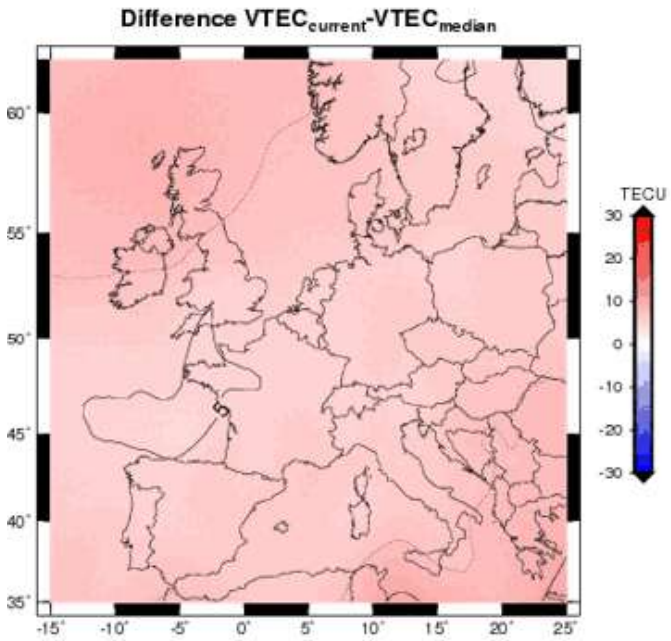
Vertical total electron content
(20,200 km GPS) during the storm

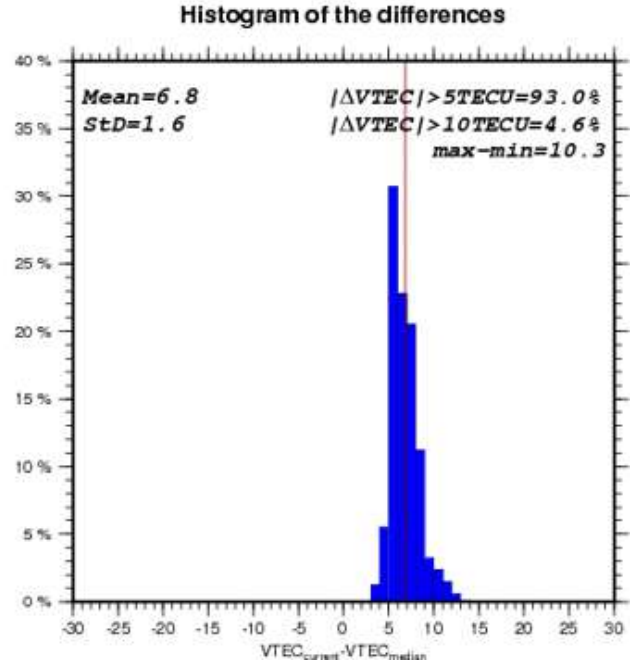


www.stce.be





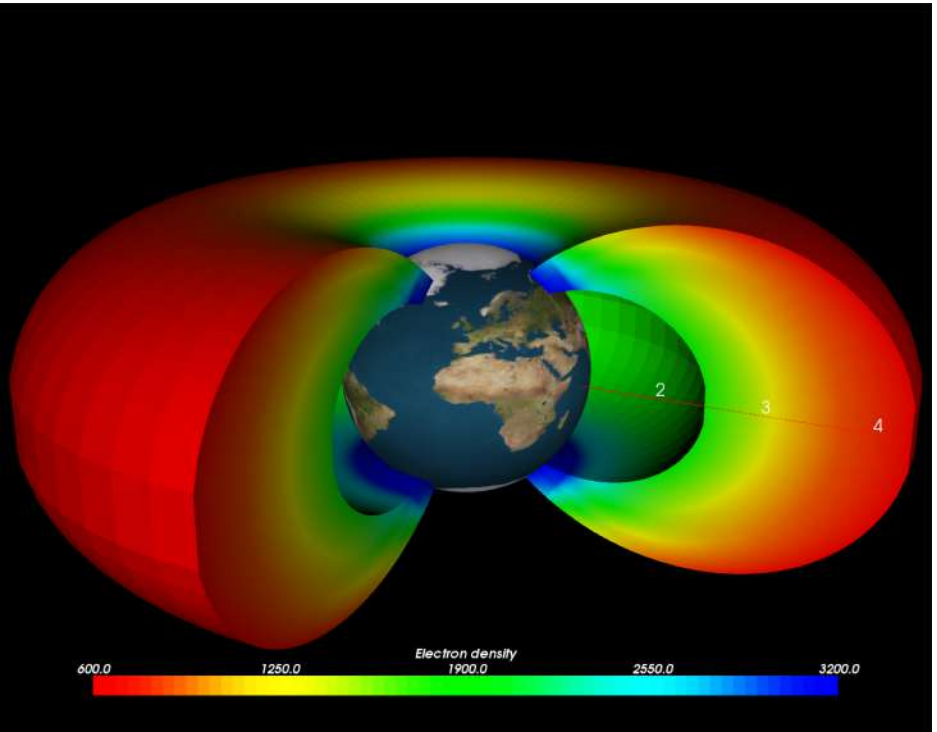


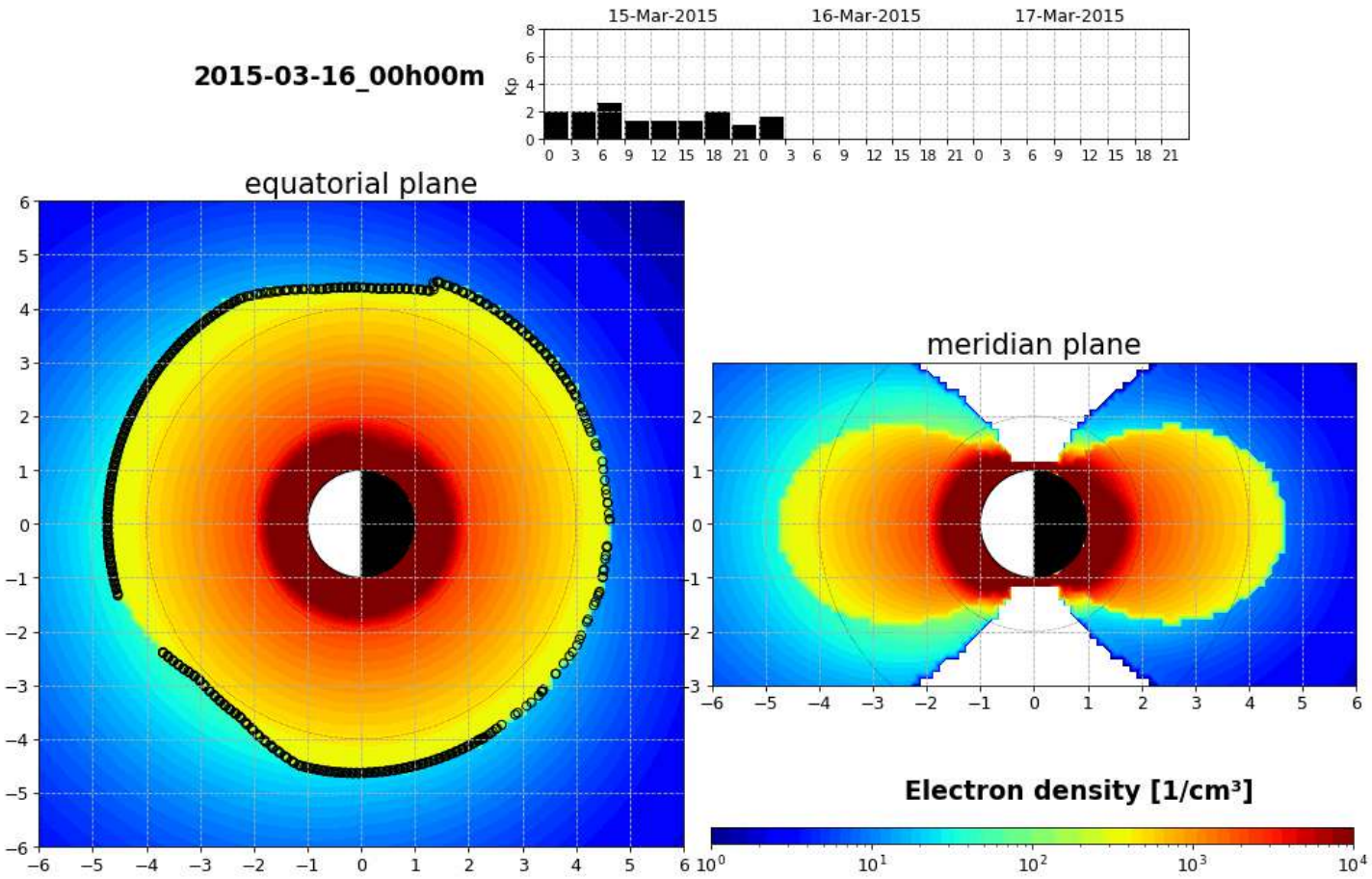


Dynamic model of the plasmasphere

- Plasmapause location
- Dynamic
- Density
- Composition
- Temperature

https://pithia-nrf.eu in real time or at a given date





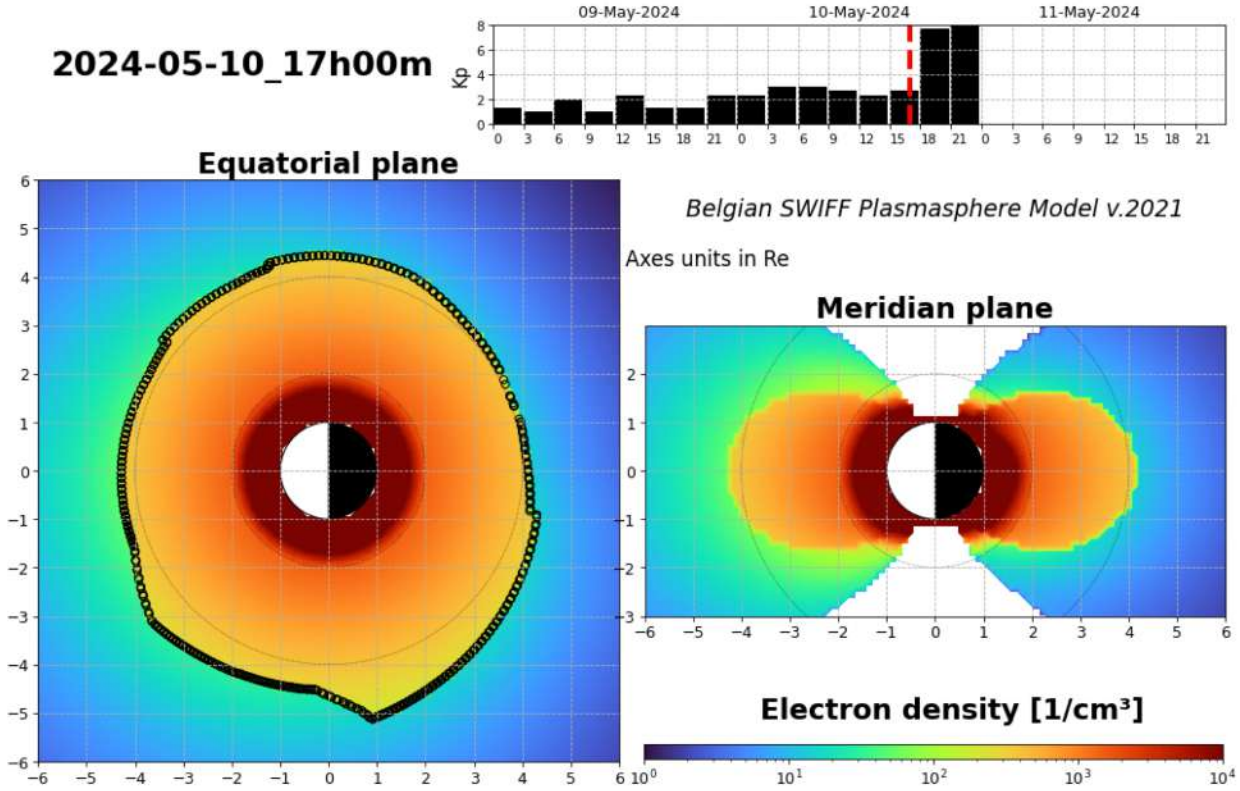
Pierrard and Stegen, JGR, 113, A10209, 2008.
Pierrard and Voiculescu, GRL, 38, L12104, 2011
Pierrard et al., Frontiers. doi:10.3389/fspas.2021.681401, 2021

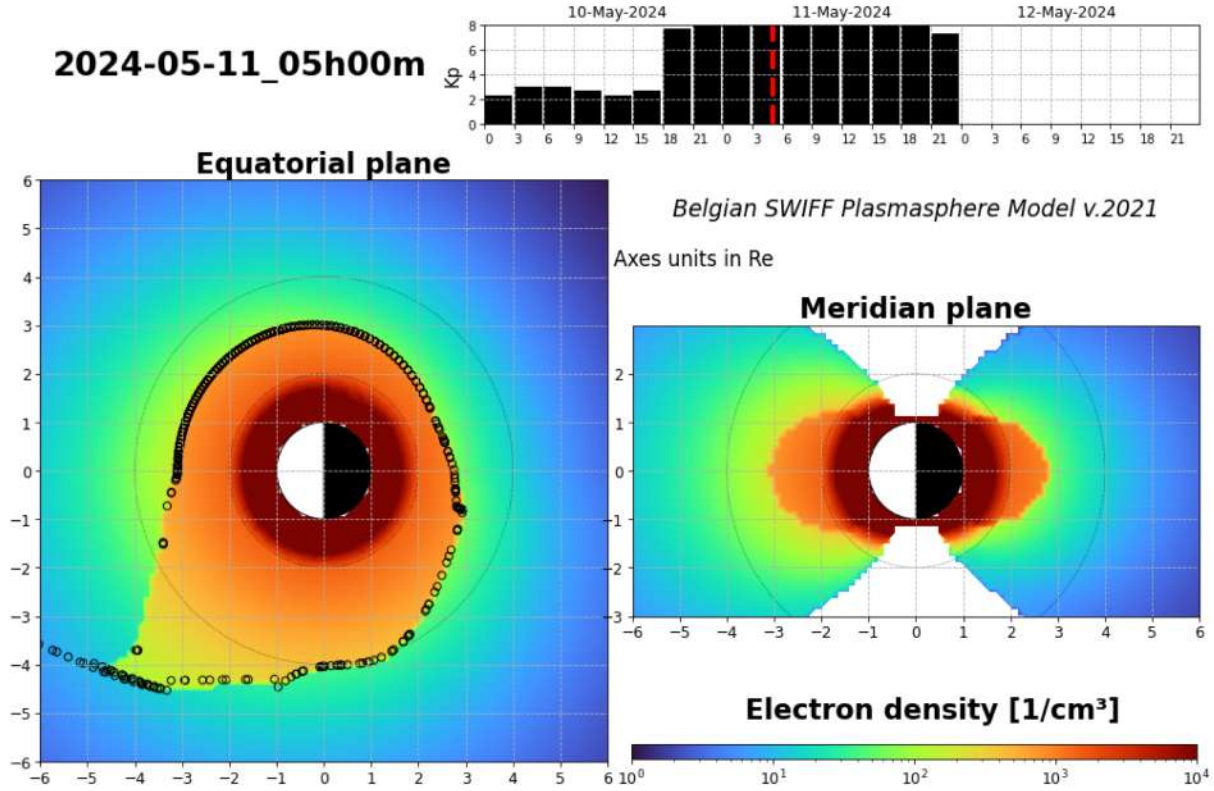
BSPM model of plasmasphere

Pierrard et al., *Front. Astron. Space Sci.*, 8:681401, 2021

on NASA https://ccmc.gsfc.nasa.gov

ESA http://swe.ssa.esa.int space radiation

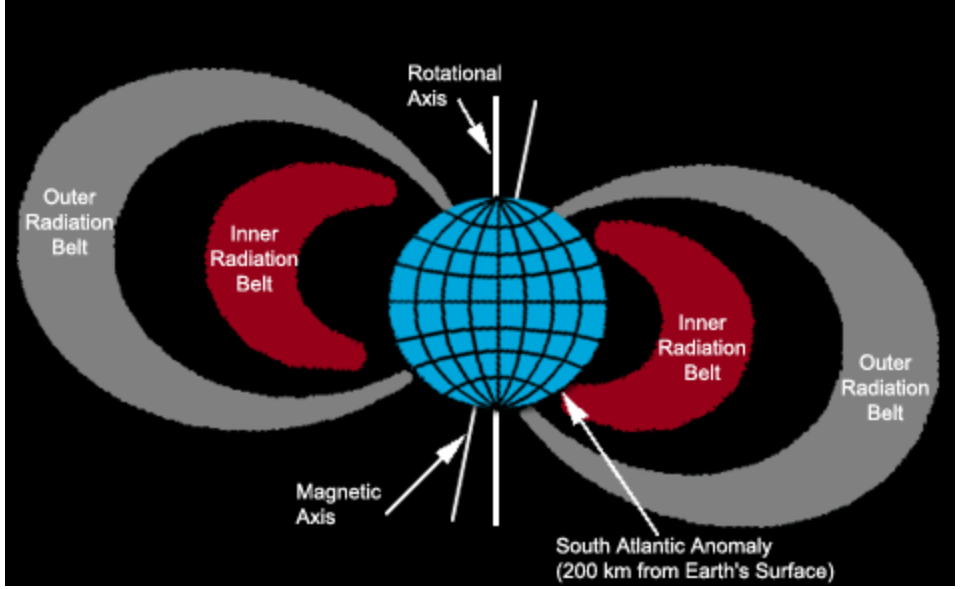




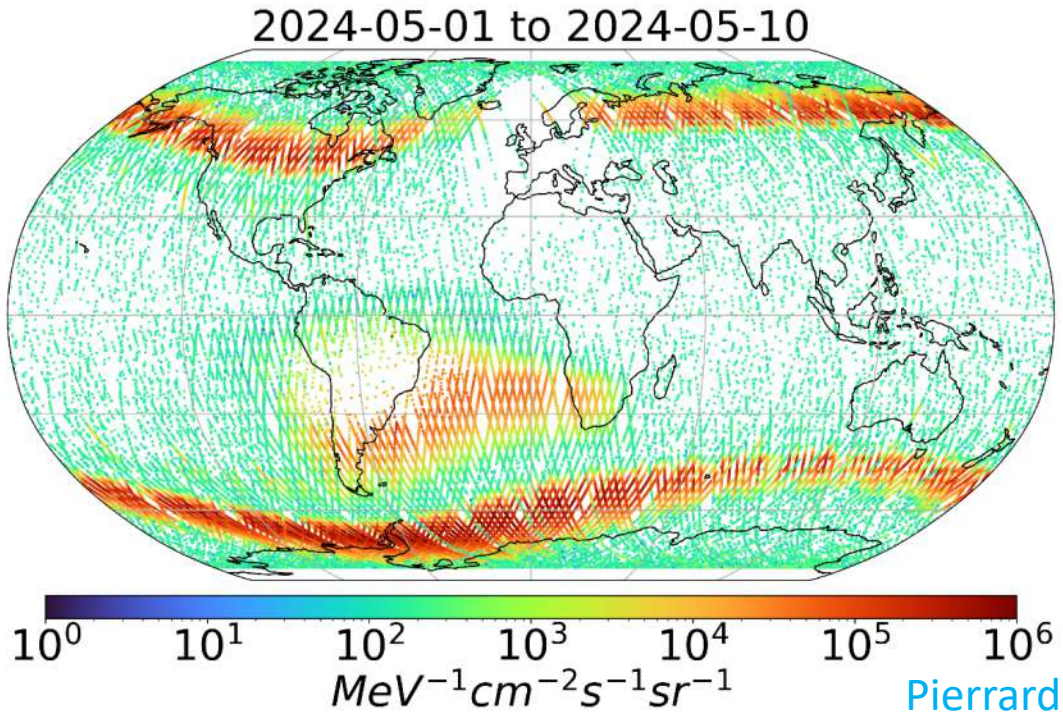
Radiation belts

South Atlantic Anomaly

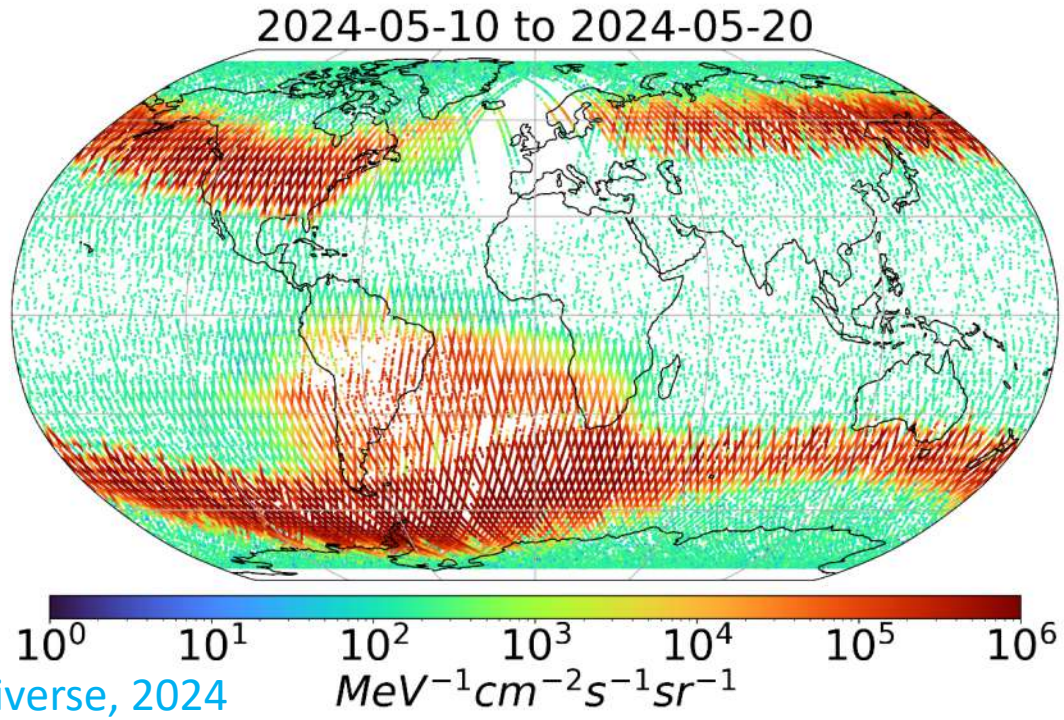
Electrons at 820 km (PROBA-V/EPT)
500-600 keV



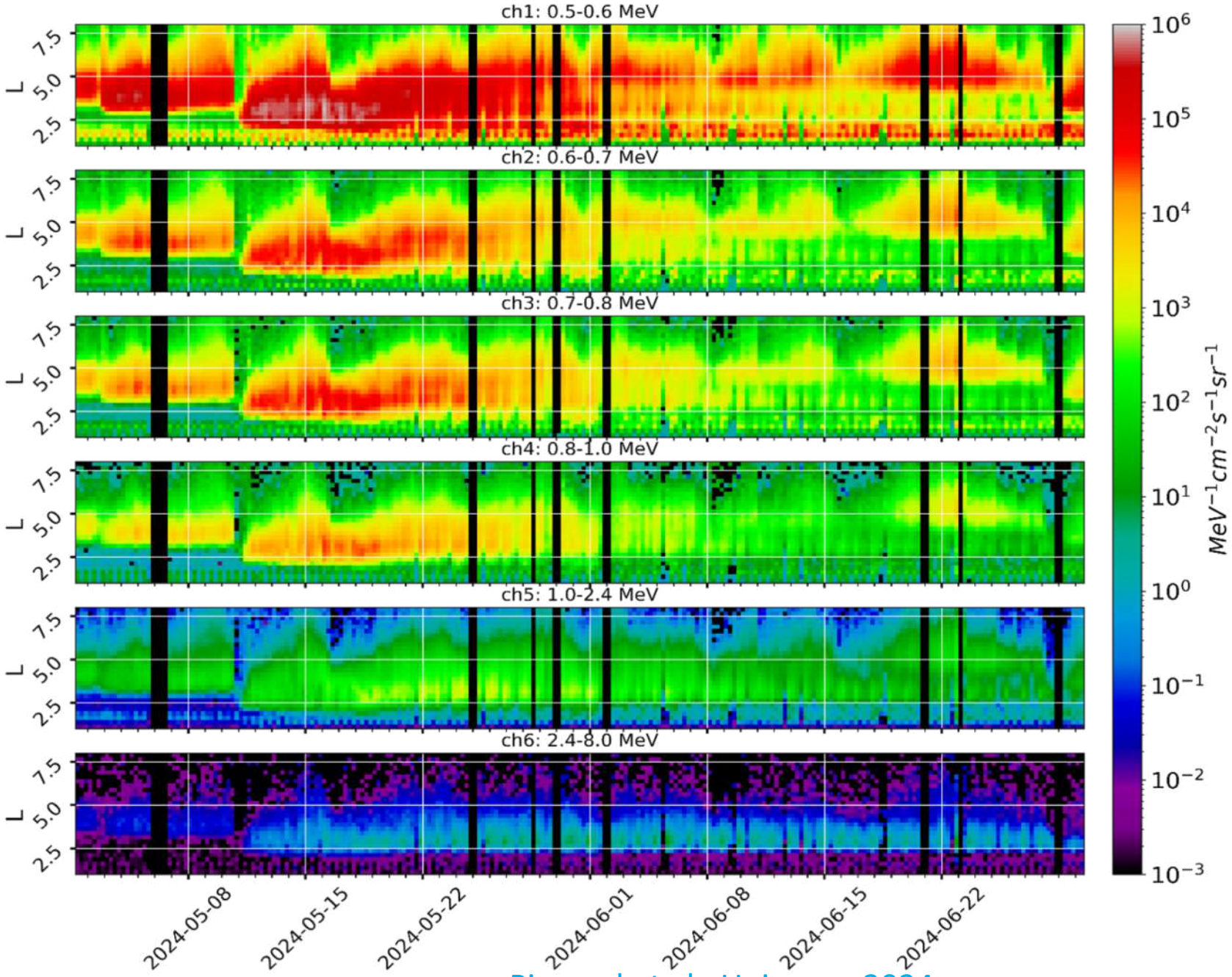
Before the storm



After the storm



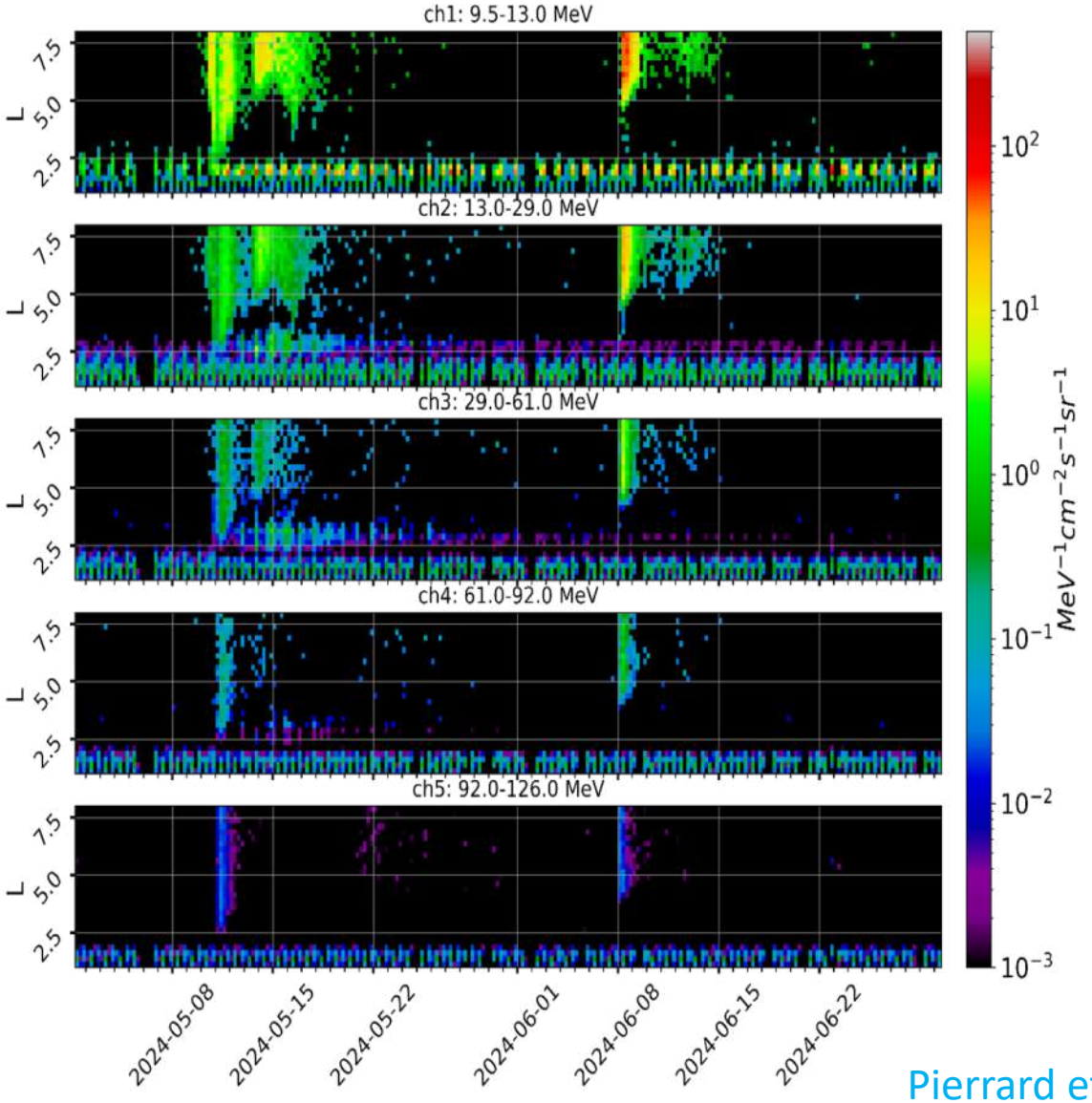
Pierrard et al, Universe, 2024

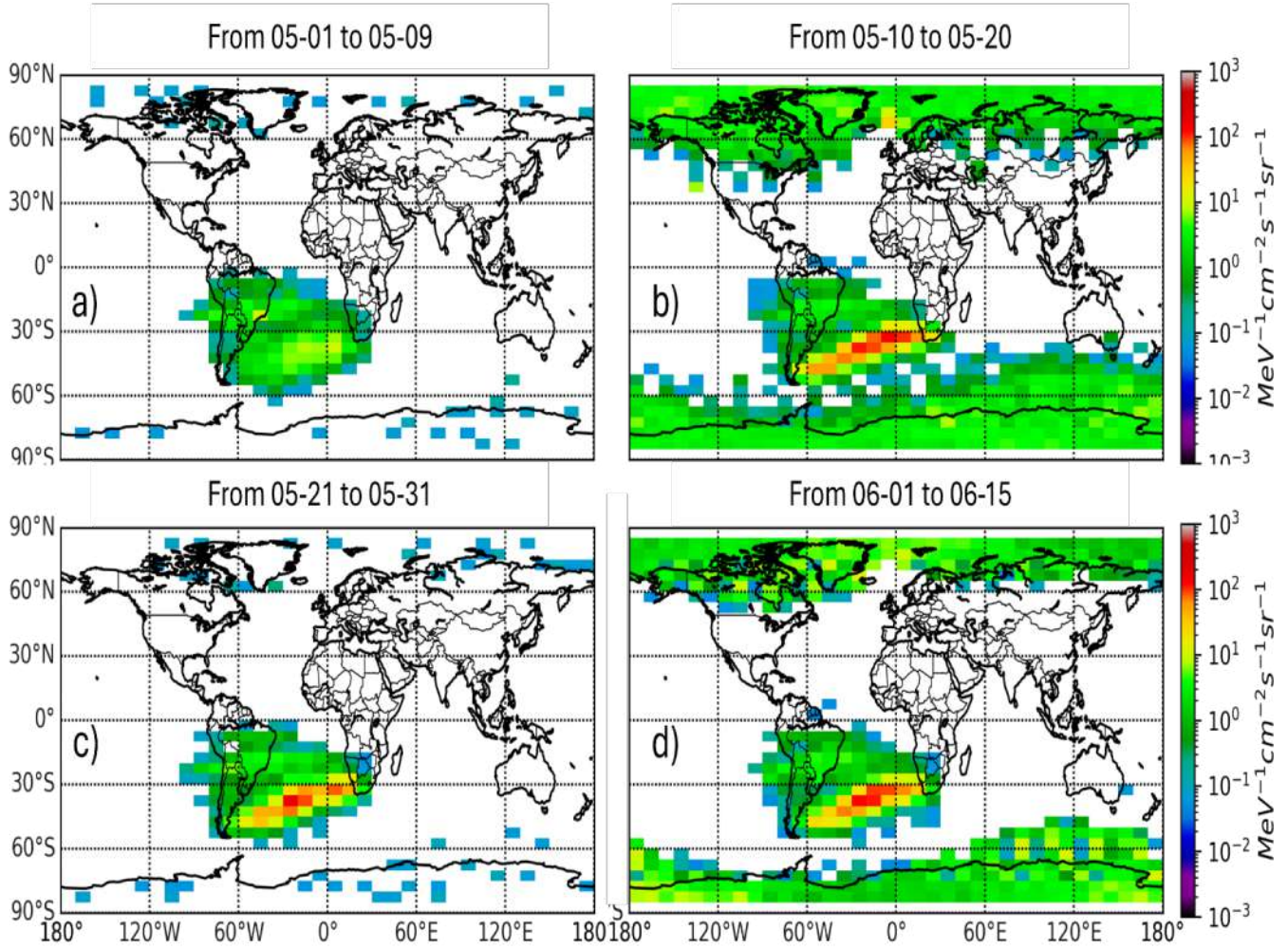


Electron fluxes observed by EPT during the 11 May 2024 storm

Pierrard et al., Universe, 2024

Protons (Belgian PROBA-V/EPT)



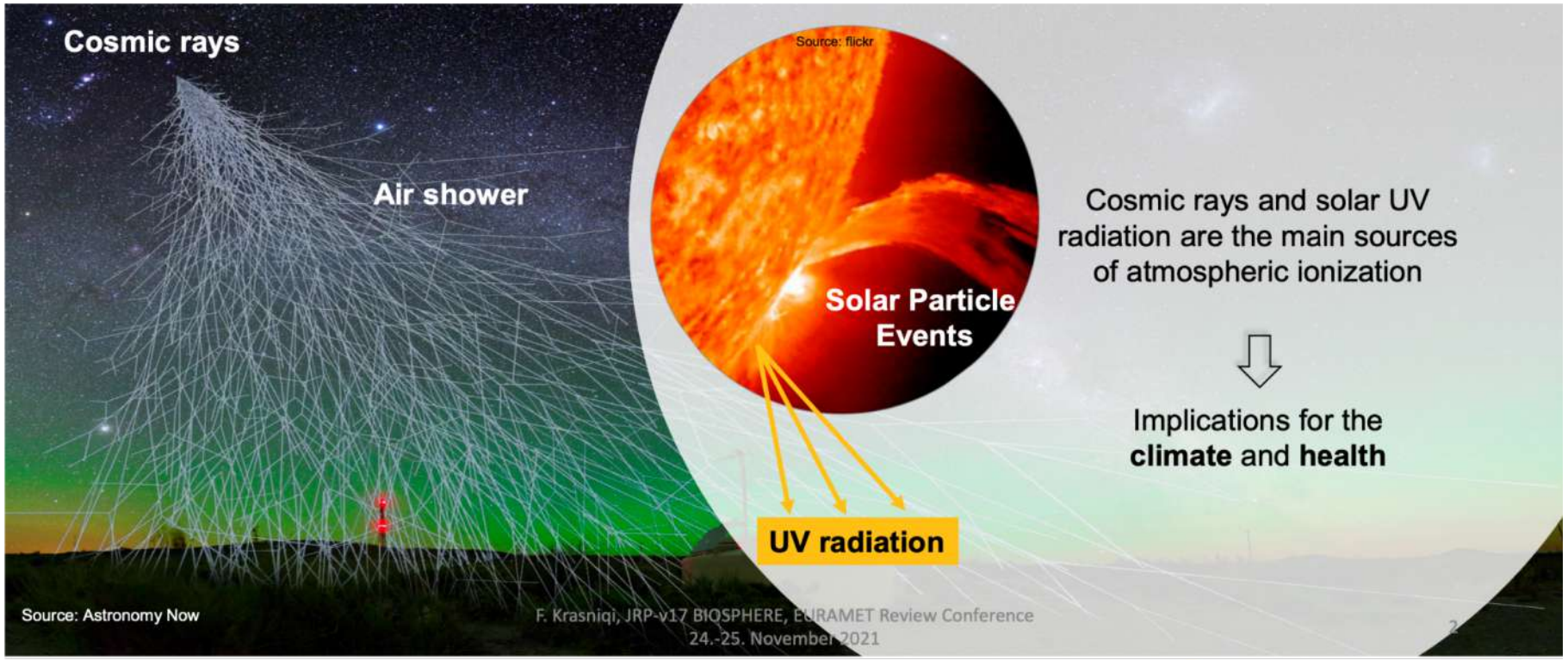


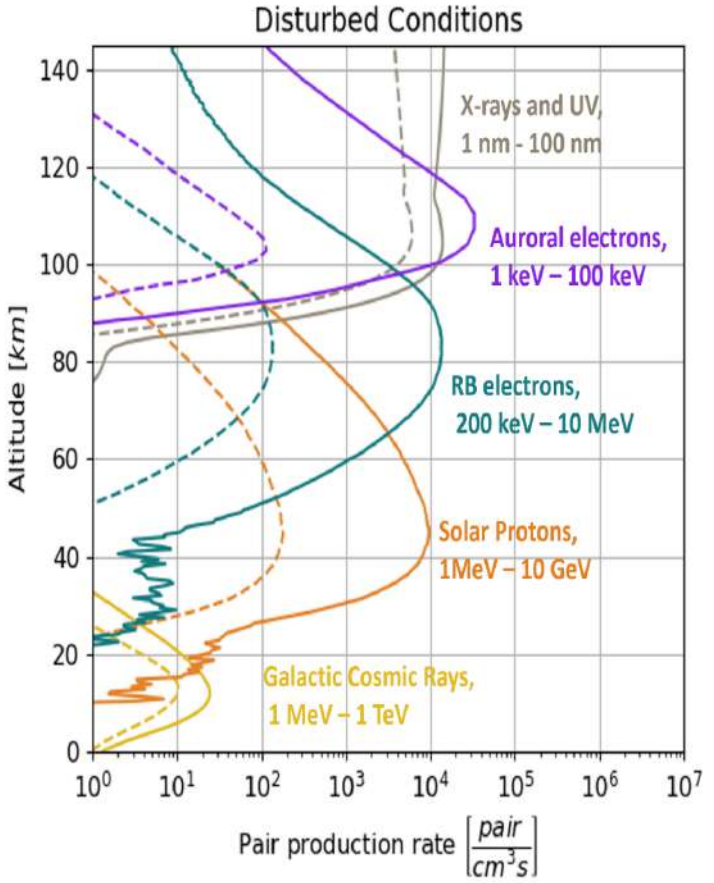
Pierrard et al., Universe, 2024

BIOSPHERE

METROLOGY PARTNERSHIP | EURAMET

- 21GRD02 BIOSPHERE www.euramet-biosphere.eu





Pierrard book, 2024

PTB · Laboratoire National Henri Becquerel LNE-LNHB · TÜBİTAK UME · IFIN-HH · Budapest Főváros Kormányhivatala · CMI Czech Metrology Institute · Central Office of Measures · IMBIH

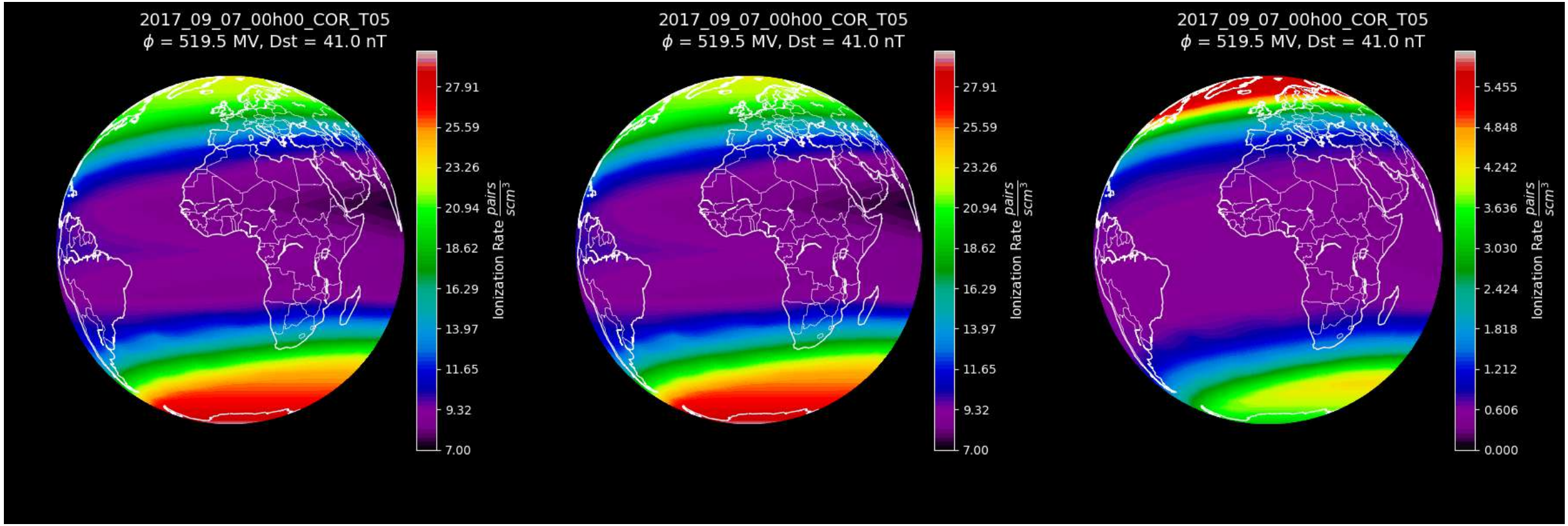
BIRA-IASB · CSIC · National Technical University of Athens · Max-Planck-Institut für Kernphysik Heidelberg · NOVA School of Science & Technology · ADVACAM Imaging the Unseen · Gigahertz-Optik Member of the BERGHOF GROUP · DWD · LZH Laser Zentrum Hannover e.V. · DTU Danmarks Tekniske Universitet · Institutul National Victor Babeș · raymetrics lidar systems · IFJ · RMI

Galactic cosmic rays ionization rate

(AtRIS) Winant et al., Universe, 2023

(also modulated by the solar cycle and geomagnetic storms)

9 km 12 km 30 km



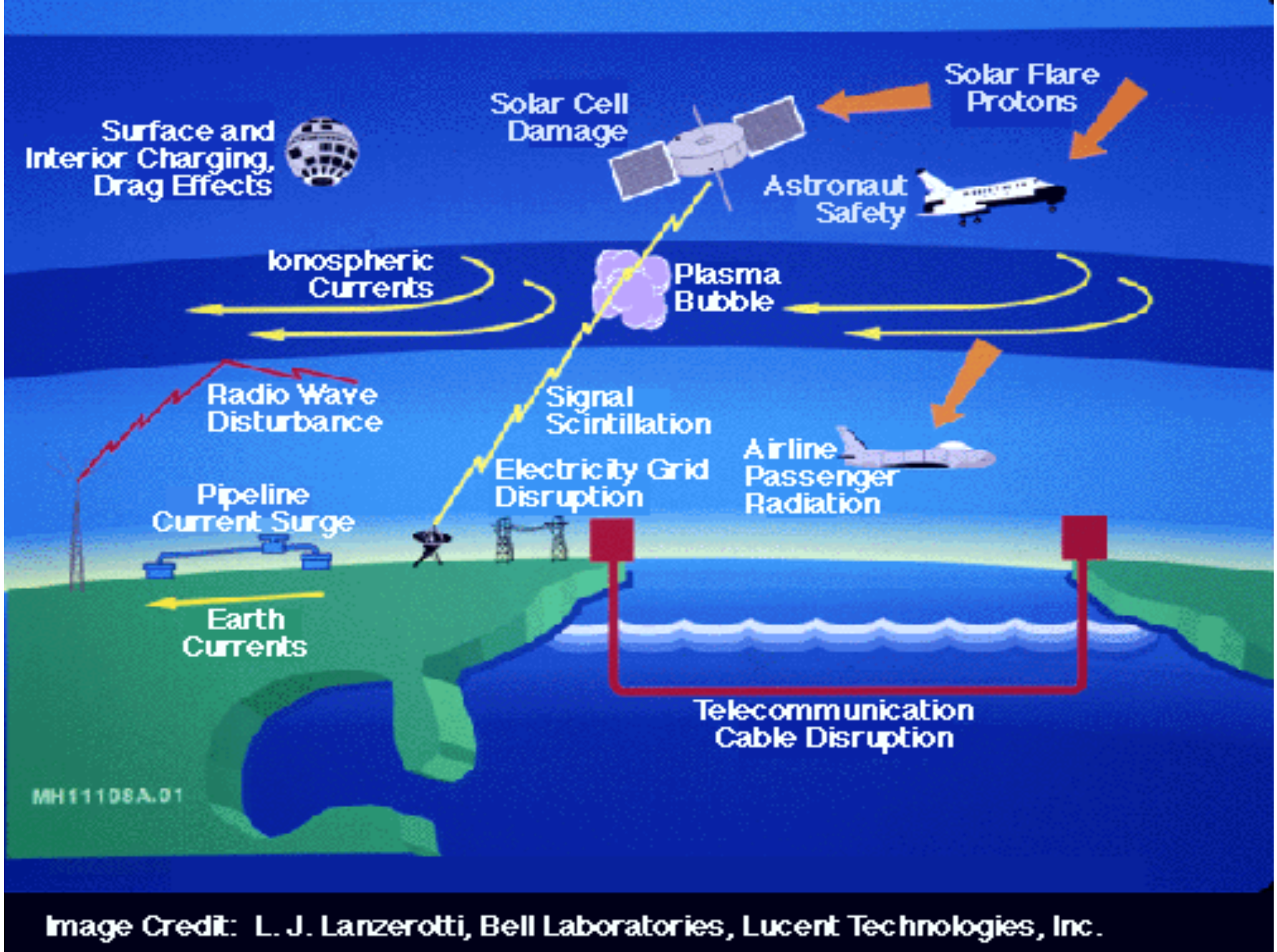


Image Credit: L. J. Lanzerotti, Bell Laboratories, Lucent Technologies, Inc.

Conclusions

Switch to Space 4

- Space particles have direct impact on our every day life (mainly due to satellite technologies, GPS, radio communication)
- Big event on 11 May 2024 (solar max)
- Ionization due to UV, solar events, cosmic rays, auroral particles, Van Allen belts

The project 21GRD02 BIOSPHERE has received funding from the European Partnership on Metrology, co-financed by the European Union's Horizon Europe Research and Innovation Programme and by the Participating States.

COURS UNIVERSITAIRES

The COURS UNIVERSITAIRES series offers university students throughout the world quality content, served by an exemplary pedagogical approach, at an affordable price.

THE BOOK

The Sun provides light and heat, making life on Earth possible. The Sun also determines the spatial environment of the planets, comets and other bodies of the solar system. Many phenomena continuously modify our environment and create visible effects like aurora, shooting stars or sunspots. Other events are less visible, but determining for space missions, our atmosphere and climate. All the interactions between the Sun and the Earth are crucial for our life and the biosphere. This university course aims to summarize the main physical mechanisms active in the space environment of the Earth. It has been written for the master students in physics or in climatology at UCLouvain for the course Physics of upper atmosphere and space, and may also interests the wide public. That is why some parts are more descriptive, to be accessible to any reader who would like to know more about space physics, stars, solar wind, comets, cosmic rays, polar aurora, climate changes, space weather, atmospheric chemistry, etc. Some parts are more specialized and provide the physics equations allowing us to better understand the observations.

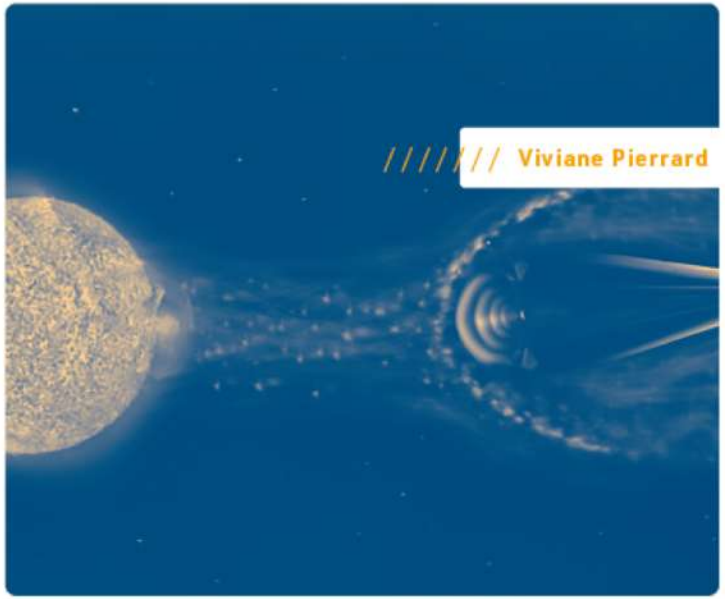
THE AUTHOR

Viviane Pierrard is doctor in physics and invited Professor of Physics at the Université catholique de Louvain since 2004. She leads the solar wind division as head Senior Scientist at the Royal Belgian Institute for Space Aeronomy. She is a space plasma physicist specializing in the solar wind and its interactions with the Earth's magnetosphere, especially the radiation belts, the population of suprathermal particles, the plasmasphere, the ionosphere and more generally space weather. She also leads the team "Fundamental Science" of the Solar-Terrestrial Center of Excellence (STCE). She obtained several prizes for her works, including the Zeldovich Medal (COSPAR 2006), Baron Nicolet award and Charles Lagrange prize from the Belgian Academy of Science.

106685 XXXX €
7 823906 144257

VIVIANE PIERRARD

EFFECTS OF THE SUN ON THE SPACE ENVIRONMENT OF THE EARTH



Viviane Pierrard

EFFECTS OF THE SUN ON THE SPACE ENVIRONMENT OF THE EARTH

LPHYS2266

PUL PRESSES UNIVERSITAIRES DE LOUVAIN

DUC livres · copies · cours

COURS UNIVERSITAIRES