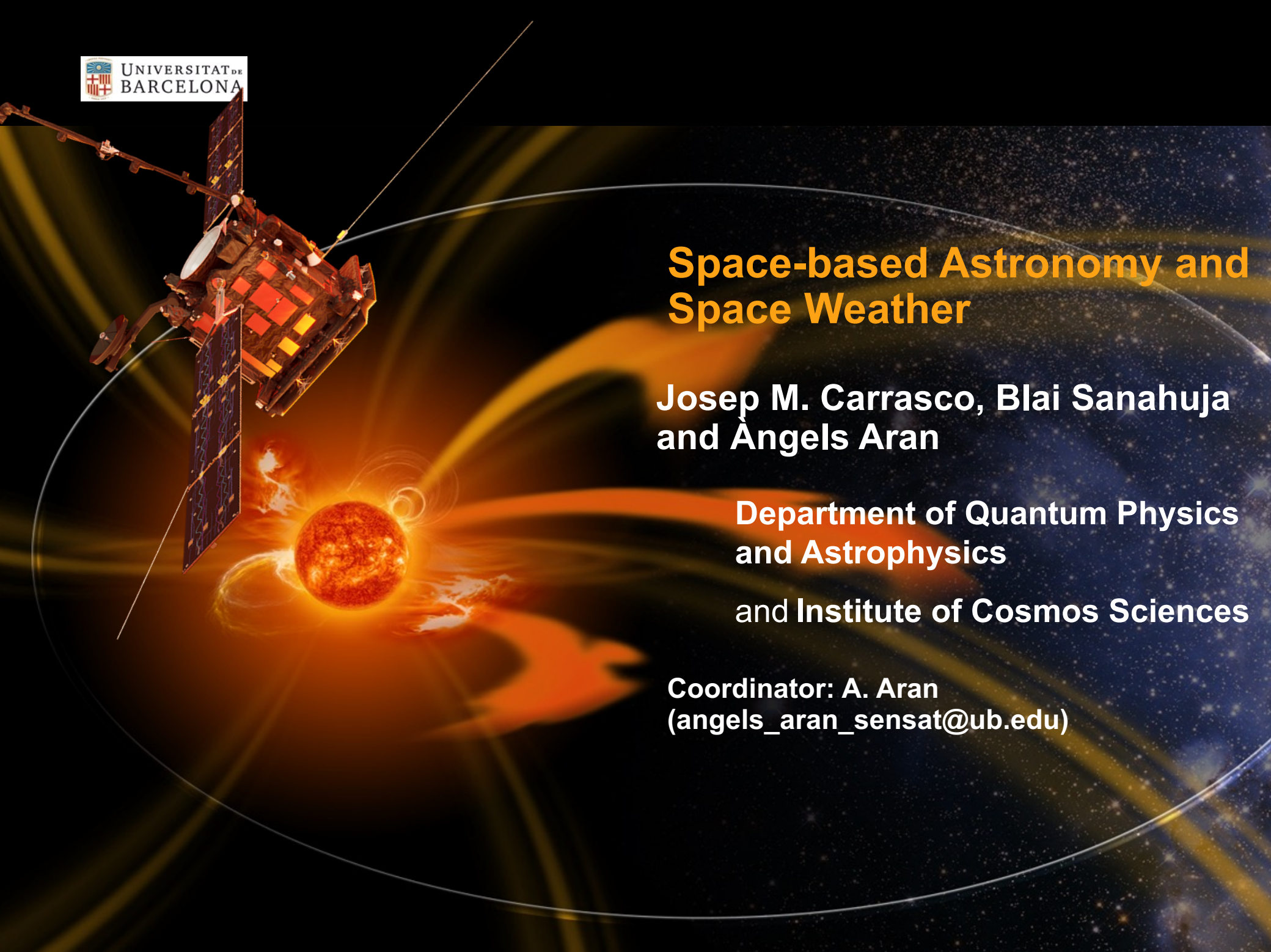

Space-based Astronomy and Space Weather

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and **Institute of Cosmos Sciences**

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Space-based Astronomy and Space Weather

Objectives:

I. To acquire the basic concepts of scientific space missions.

- Technological aspects, scientific drivers, management, requirements and limitations that play a role in the design of a scientific mission.
- Astronomical observations: review of the results of various recent Missions of ESA and NASA, at different wavelengths (and of future missions scheduled).

II. To understand what Space weather and the heliosphere are.

- Relevant solar and heliospheric physics phenomena.
- Effects of solar storms in spacecraft and at Earth. Prediction and forecasting.
- Review of the results of recent solar and heliospheric missions of ESA and NASA.

Program. Part I

Space-based Astronomy

1. Elements of a mission

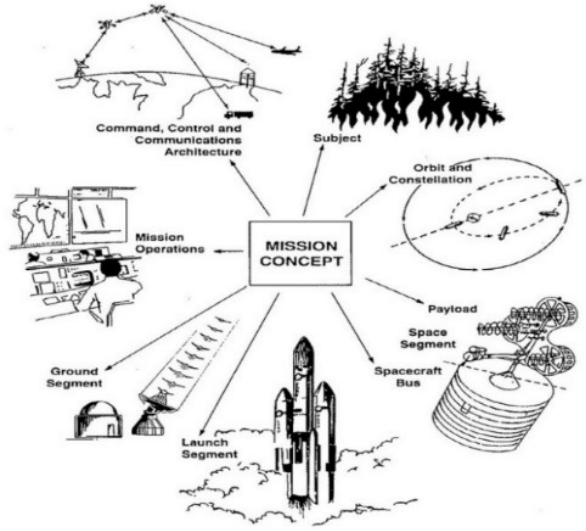
Orbits. Launch windows. Payloads
Subsystems. Launchers

2. Space mission analysis and design

Development phases
Analysis.
Selection and implementation
The main agencies: ESA and NASA
ESA's Cosmic Vision 2015−2025

3. Astronomy from the space

Scientific goals.
Missions: Types and Payloads
Data bases and exploitation
Future missions (JUICE,
Euclid, PLATO, etc.)



Program. Part II

Space Weather

1. Space Weather

Effects of solar storms in spacecraft and Earth. Extreme stormy events

Prediction. Radiation risks

ESA/EU and US programmes

2. Heliospheric physics

Solar wind plasma and interplanetary magnetic field. Earth magnetosphere

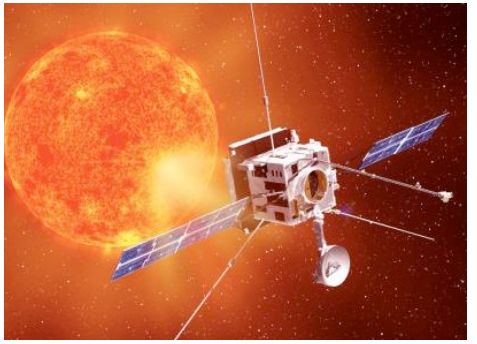
Solar activity: Flares, Coronal mass ejections and CIRs. Solar activity cycle

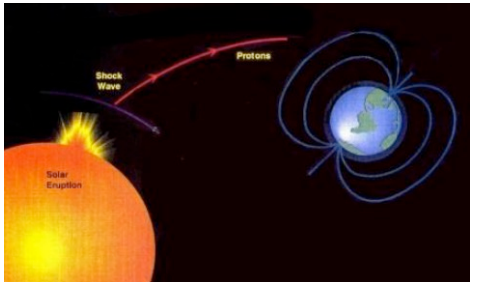
Solar energetic particles.

3. Heliophysics and space weather missions

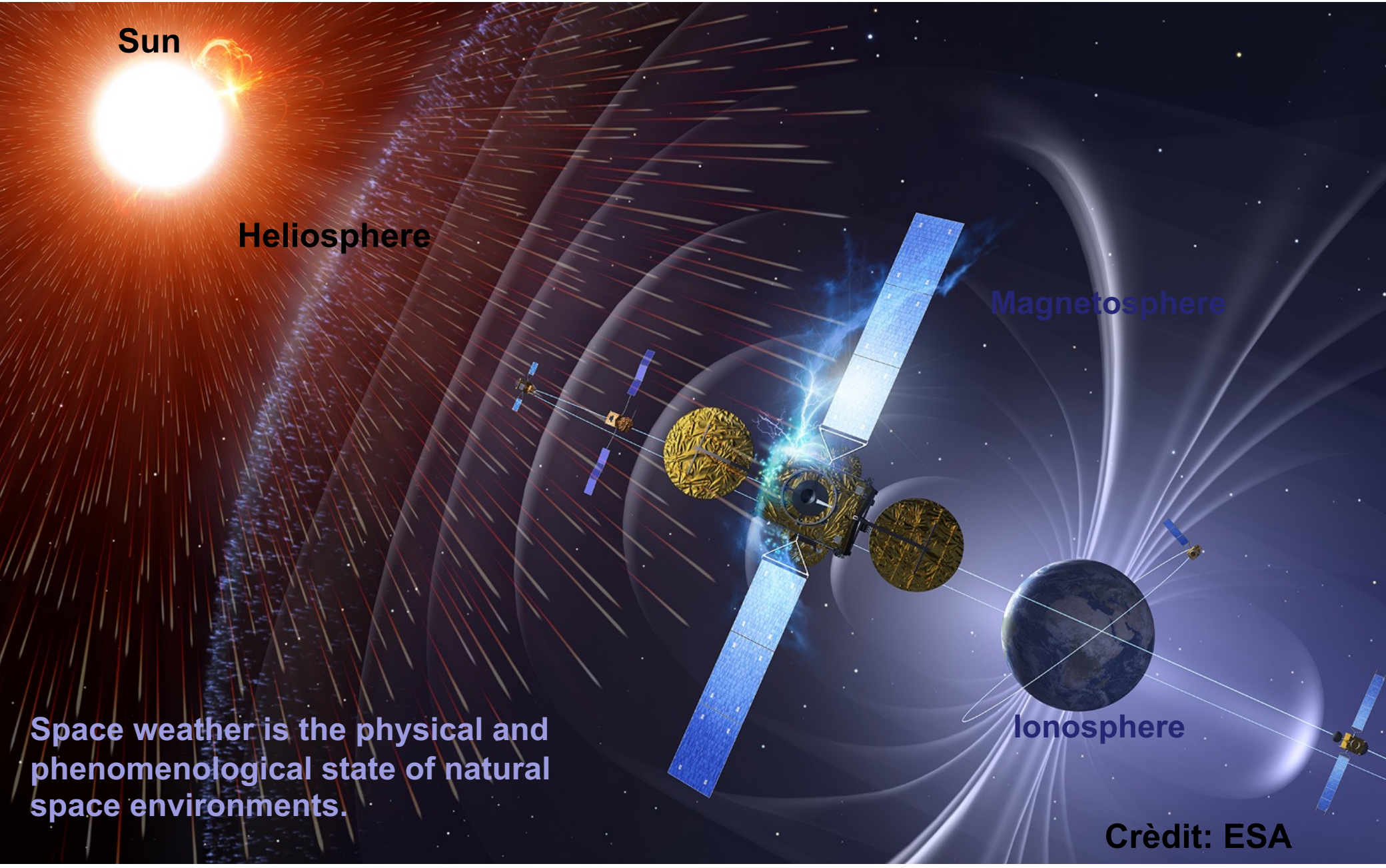
STEREO, ACE, SDO, PSP , Ulysses, SOHO. Solar Orbiter.

Data bases and exploitation. In-situ instrumentation



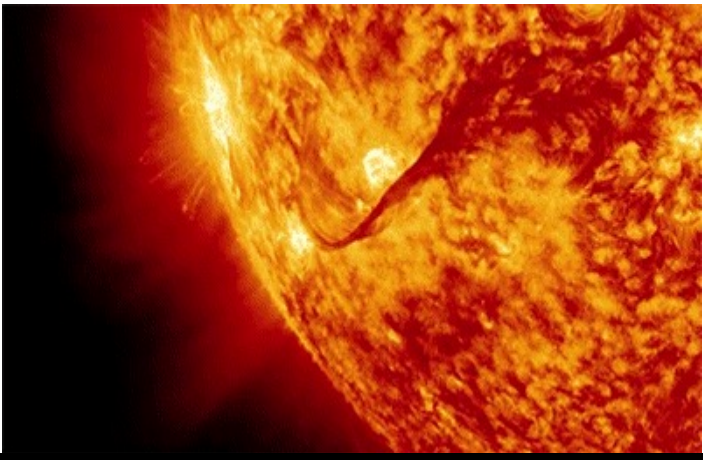


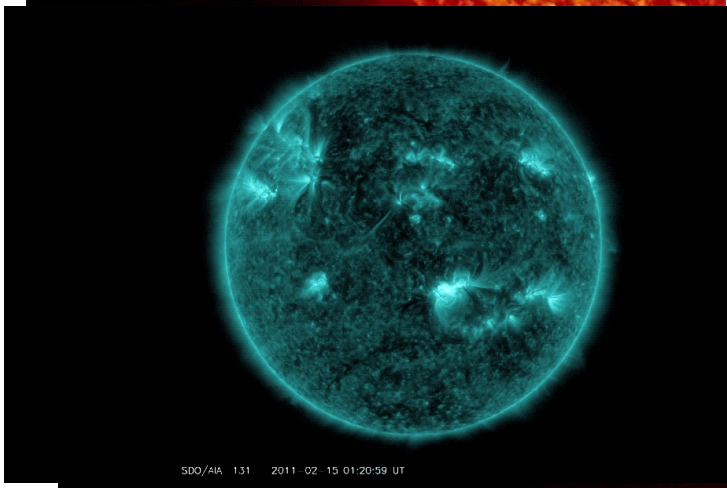
Space Weather: Definition and Domains

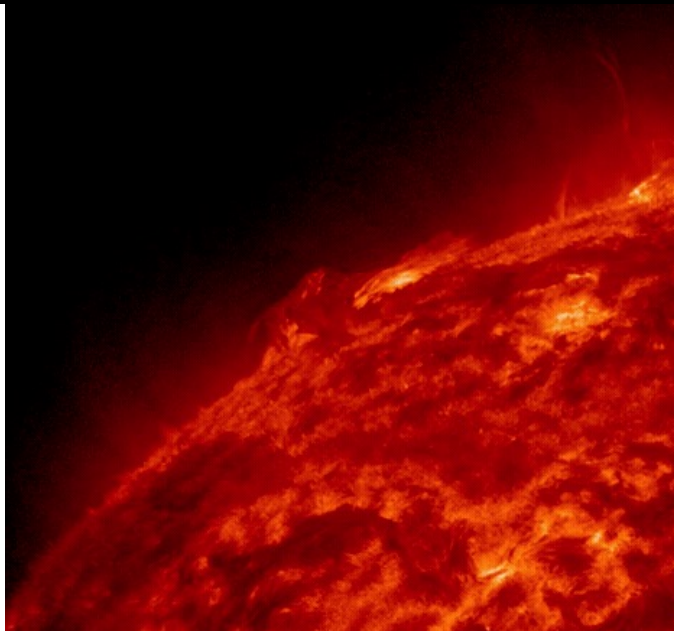


Text-Book Space Weather Storm

- Solar eruptive event:
  - Solar Flares
  - Coronal Mass Ejections (CME)
- Timeline at Earth:
  - **8 minutes:** EUV and X-ray emission reach earth:
    - Radio frequency (HF)losses, GPS signal disturbed, , astronauts endangered
  - **1 hour**: energetic particle onset
    - HF loss, GPS signal disturbed, satellites damaged, astronauts endangered
  - **1- 4 days:** CME arrives at earth
    - Disturbed GPS signal, Radio communication affected, Polar lights

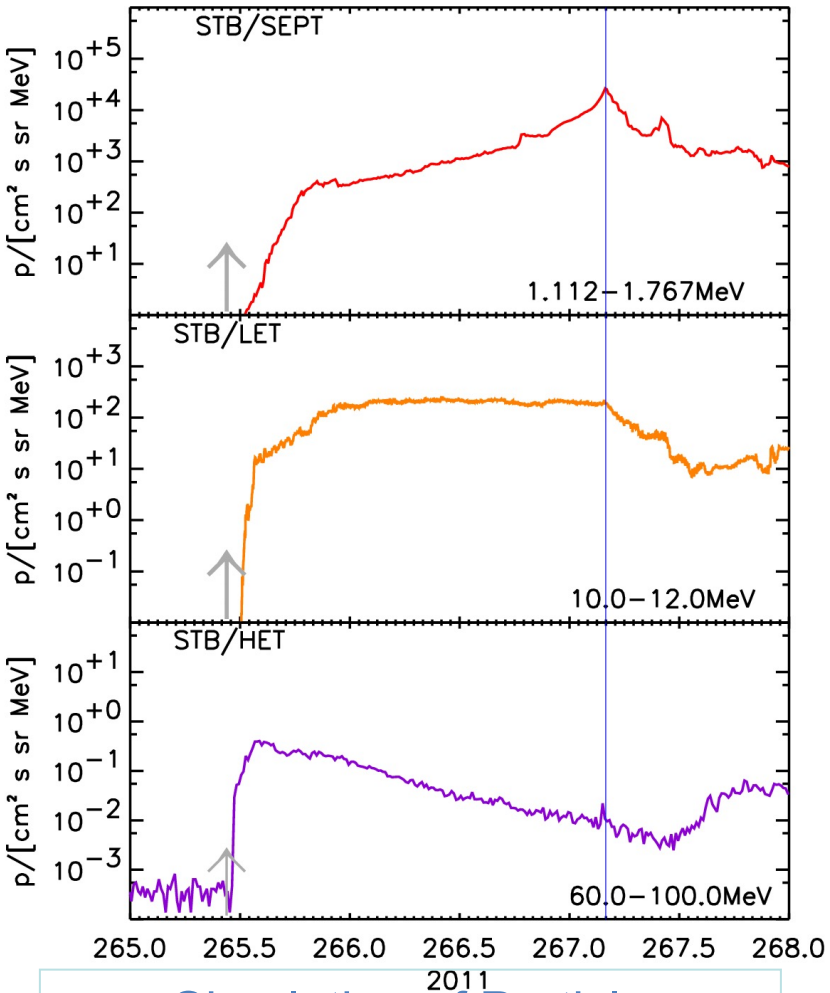




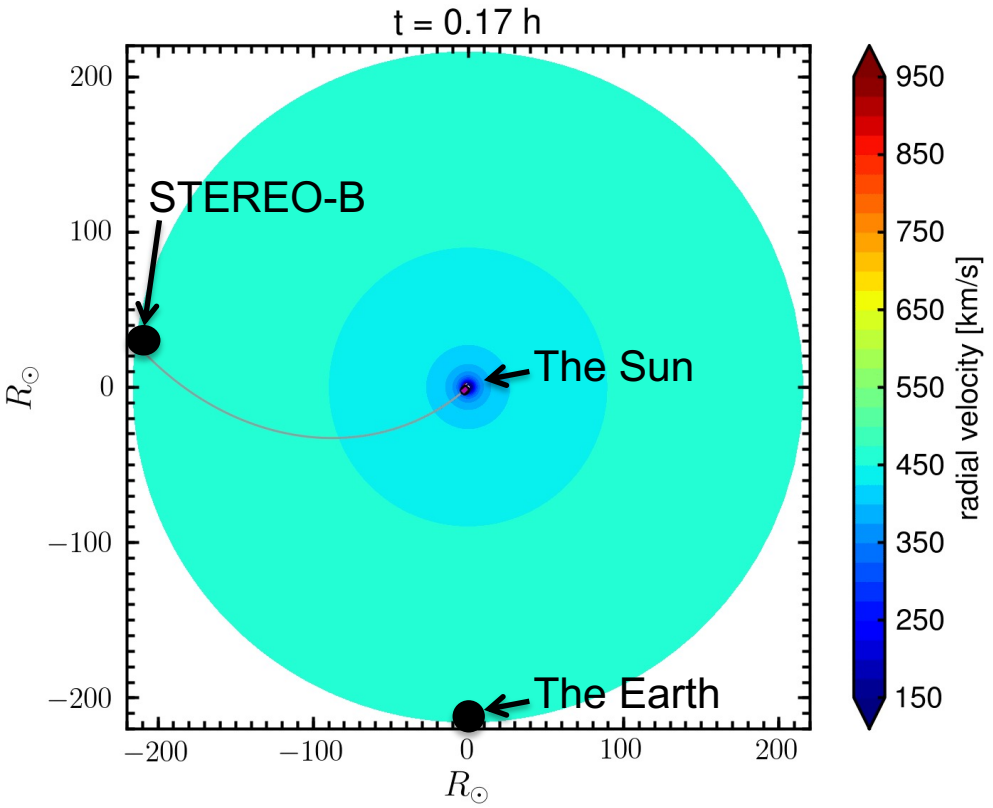


Shock-and-particle model (SaP)

Proton Intensities at STEREO-B



SaP Model was developed by KU Leuven and UB in the EU's FP-7 SPACECAST Project.

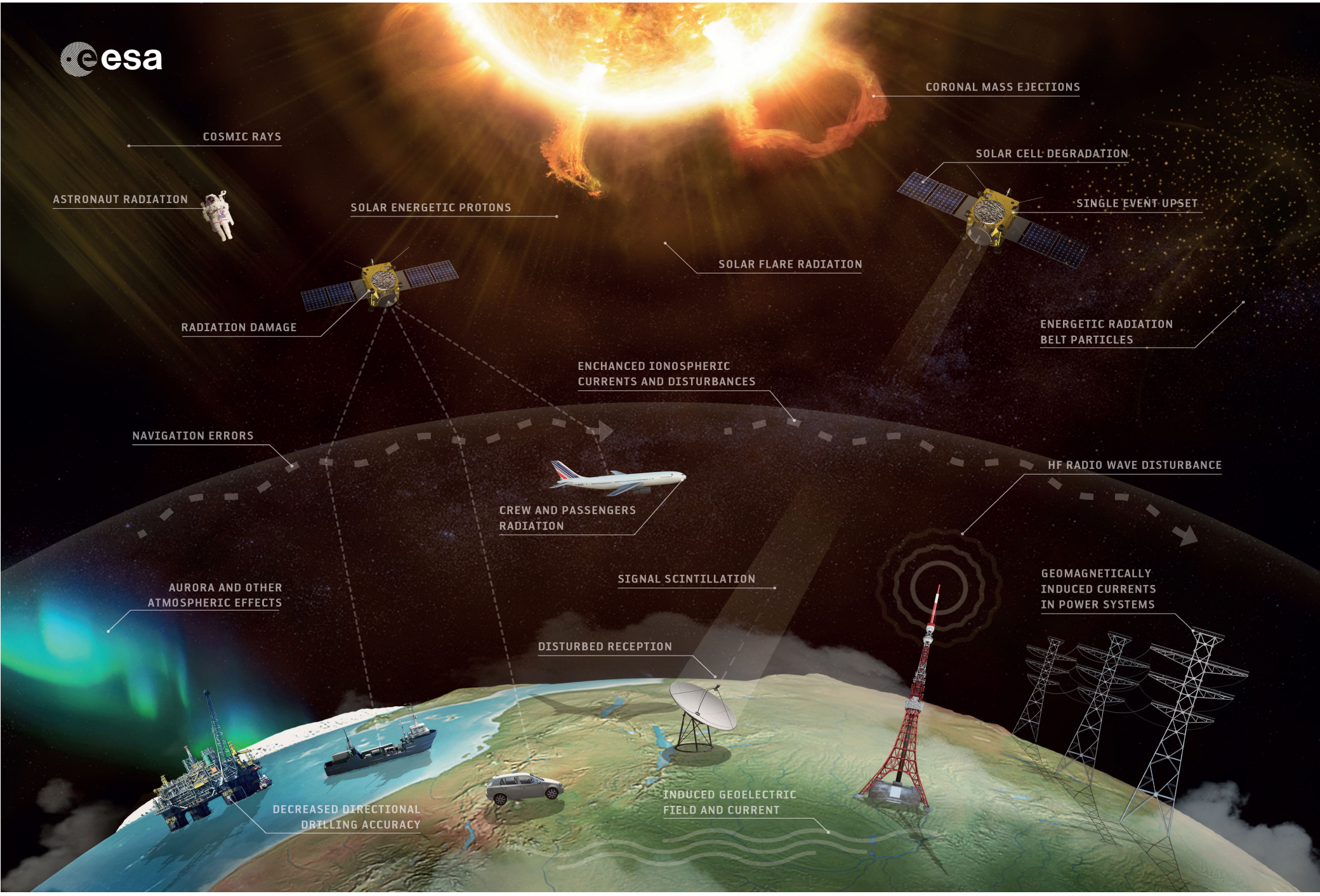


Simulation of Particle transport. Mobile source

⇐ COBPOINT ⇐

MHD Simulation of the Interplanetary shock propagation

- The model seeks to reproduce particle intensities and plasma jumps at the observer, to produce predictions of SEP intensities at other locations (e.g., SEPEM).


esa
CORONAL MASS EJECTIONS
COSMIC RAYS
SOLAR CELL DEGRADATION
ASTRONAUT RADIATION
SOLAR ENERGETIC PROTONS
SINGLE EVENT UPSET
SOLAR FLARE RADIATION
RADIATION DAMAGE
ENERGETIC RADIATION
BELT PARTICLES
ENCHANCED IONOSPHERIC
CURRENTS AND DISTURBANCES
NAVIGATION ERRORS
HF RADIO WAVE DISTURBANCE
CREW AND PASSENGERS
RADIATION
SIGNAL SCINTILLATION
GEOMAGNETICALLY
INDUCED CURRENTS
IN POWER SYSTEMS
AURORA AND OTHER
ATMOSPHERIC EFFECTS
DISTURBED RECEPTION
DECREASED DIRECTIONAL
DRILLING ACCURACY
INDUCED GEOELECTRIC
FIELD AND CURRENT

Evaluation

3 ECTS
From 17th November to 14 January
Compulsory attendance

1st Part:
Design an astronomical satellite, simulate a cubesat proposal for a Space Agency
- Oral presentation

2nd Part:
a) Oral Presentation on a selected topic
b) Daily questions
c) Hands-on study on a real Solar Energetic Particle event
-Paper Presentation (~5 pages)

Bibliography

1st Part:

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- "Spacecraft systems engineering", Peter Fortescue & John Stark, Ed. Wiley, 1991
- "Orbital motion", A.E. Roy, Ed. Hilger, 1978

2nd Part:

- Introduction to Space Physics. M.G. Kivelson and C.T. Russell (Cambridge University Press, 1995)
- Heliophysics. Space Storms and radiation: causes and Effects. C.J Schrijver and G.L. Siscoe (Cambridge University Press 2010; wwww.cambridge.org/9780521760515)
- Kallenrode, May-Britt. *Space physics : an introduction to plasmas and particles in the heliosphere and magnetospheres*. 3rd ed. Berlin : Springer, 2004
- Physics of Space Storms. From the Solar Surface to the Earth. H. E. J. Koskinen (Springer Praxis, 2011). ISBN 978-3-6-00310-3