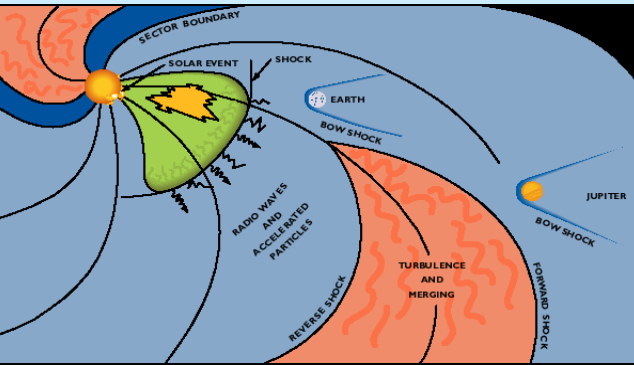


Toward a Virtual Observatory for Solar System Plasmas : an exceptional scientific opportunity.

Jacquey, C. (1), K. Bocchialini (2), J. Abouadarham (3), N. Meunier (4), N. André (5), V. Génot (1), C. Harvey (1), E. Budnik (1), R. Hitier (1), M. Gangloff (1), M. Bouchemit (1)

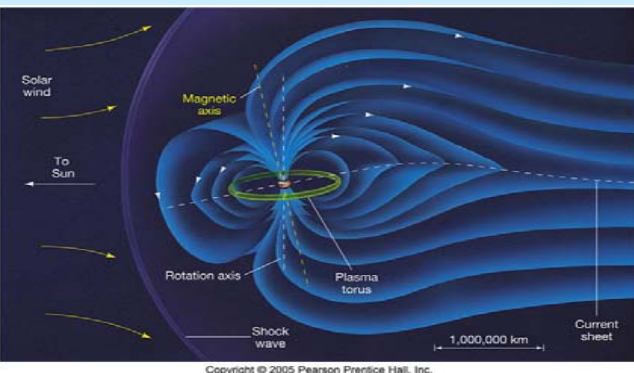
(1) CDPP/CESR, Toulouse, France, (2) MEDOC/IAS, Orsay, France ESTEC, (3) BASS2000, LESIA, Meudon, France, (4) BASS2000, OMP, Tarbes (5) Noordwijk, The Netherlands

The plasma solar system



Corona, Solar Wind, Heliosphere:

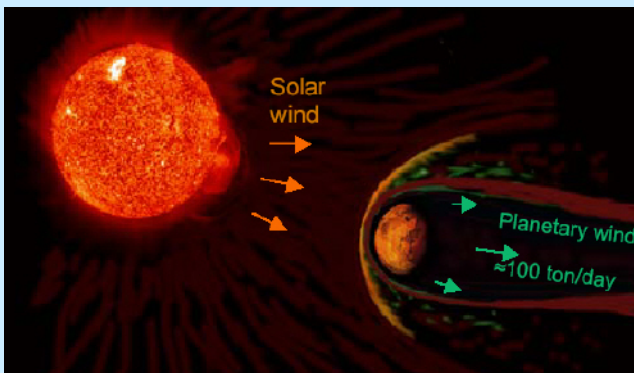
Expansion of the solar corona, generation of the solar wind, propagation of solar perturbations and interplanetary shocks, solar filaments, interplanetary clouds, ...



Planetary magnetospheres:

Interaction of the solar wind and the solar perturbations with magnetised bodies.

⇒ knowledge of local interplanetary conditions?



Comet/Mars type interaction:

Interaction of the solar wind and the solar perturbations with unmagnetised bodies.

⇒ knowledge of local interplanetary conditions?

What we ideally need for studying a plasma object

⇒ continuous observations (Dynamical processes)

⇒ global observations (imaging)

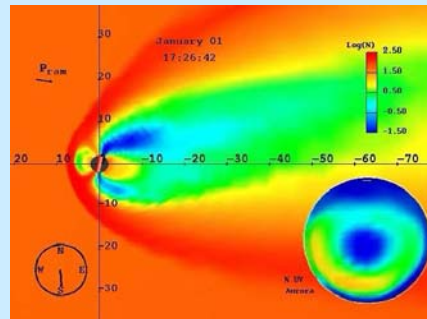


⇒ simultaneous in situ multi-point observations

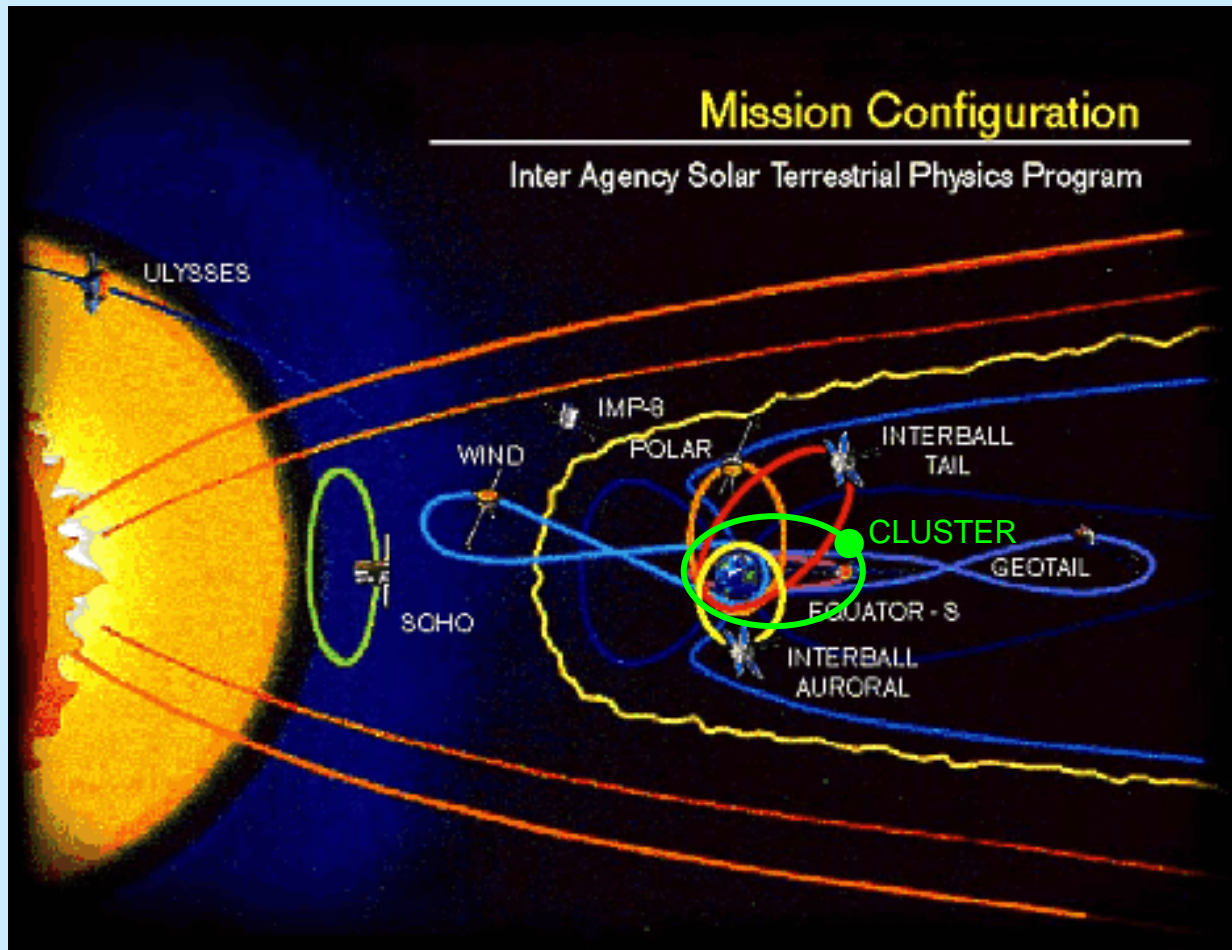
-distributed inside the key regions (Propagating processes, large distance couplings)

-at various scales (Multi-scale processes)

⇒ models and tools



Study of the Earth-magnetosphere (1992 – Now)



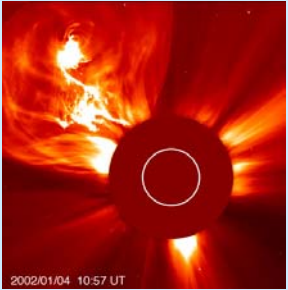
ISTP program
(~20 probes)

+

CLUSTER
(4 probes close
to each other)

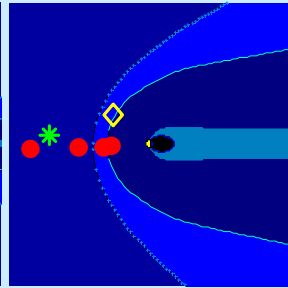
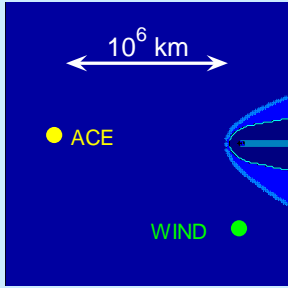
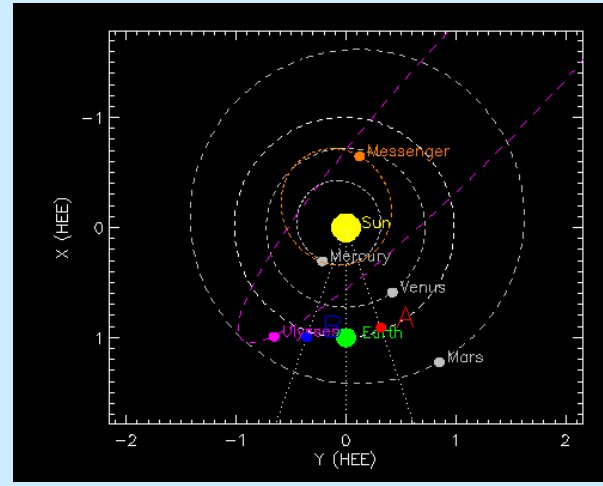
In the very next future, a comparable constellation of probes will be available at the scale of the inner heliosphere

The up-coming “heliospheric” constellation

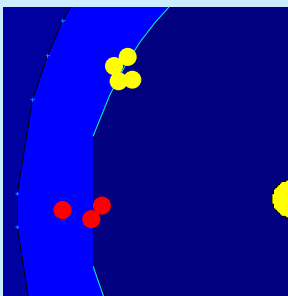


Continuous solar observations:
SOHO, STEREO, SOLAR-B, RHESSI,
Ground observatories

Constellation of probes distributed at **large scale** :
Heliospheric probes: STEREO-A/B, ULYSSES, VOYAGER
Planetary probes: MESSENGER, VEX, MEX, MGS, CASSINI



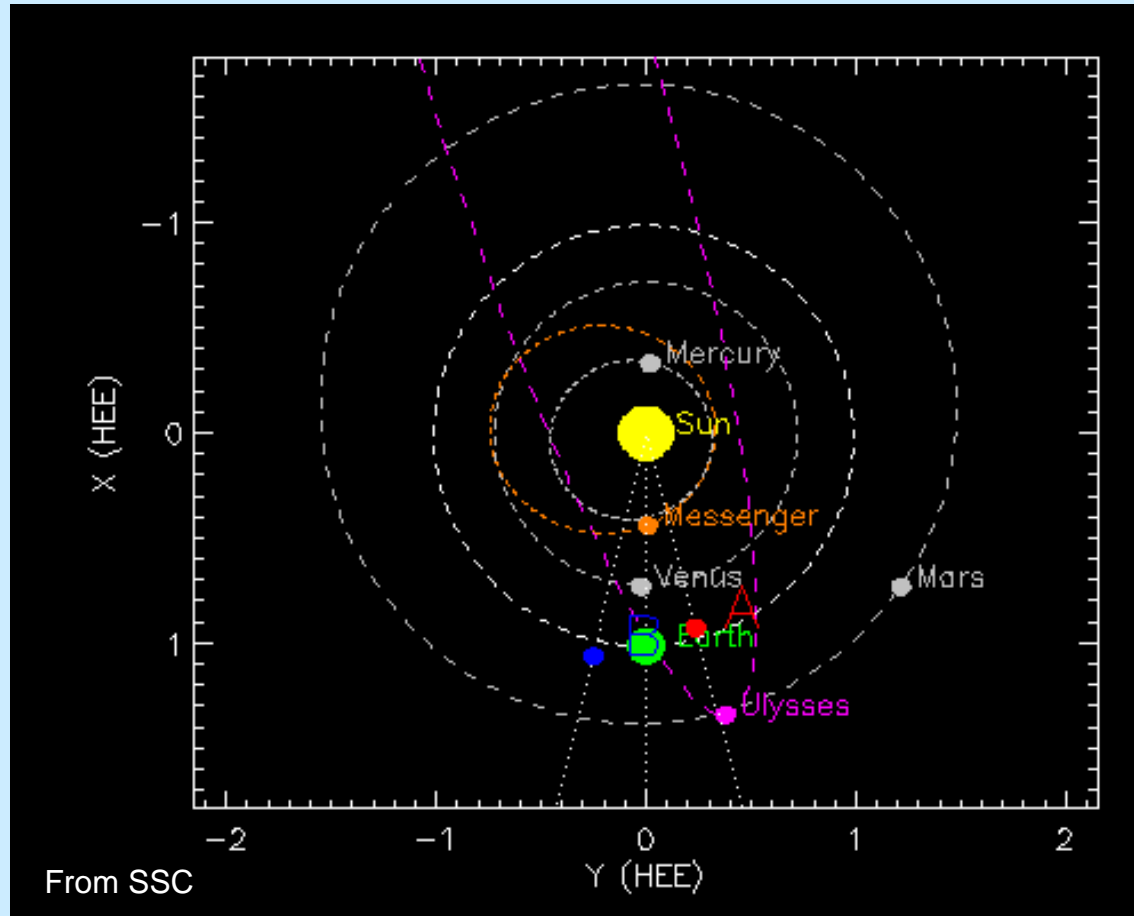
Constellation of probes distributed at **medium scale**
around the Earth orbit:
ACE, WIND, THEMIS, GOES,
GEOTAIL, CLUSTER, LANL



Two sub-constellations in **small scale** cluster configuration
THEMIS, CLUSTER,

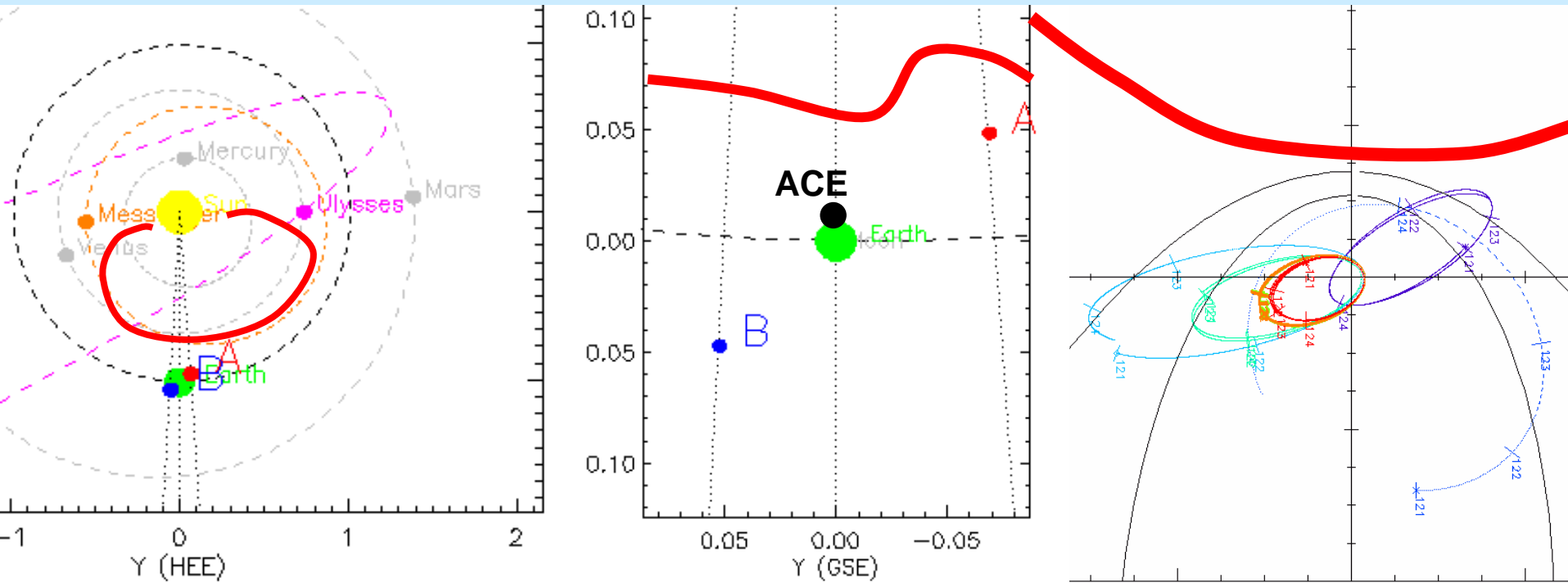
- + detailed earth-ionosphere data
- + astronomical observations (aurora)

Potential Science Cases: solar perturbation propagation



Necessity to perform **integrated analysis** of data coming from various origins

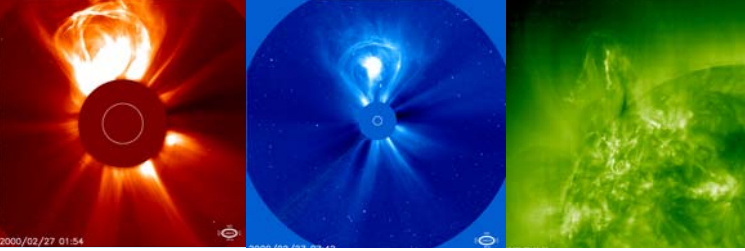
Plasma physics application



Multi-scale characterisation of:

- Heliospheric dynamics, interplanetary shocks, CME, ...
- Response of the magnetosphere to interplanetary shocks, CME
- Particle acceleration, turbulence

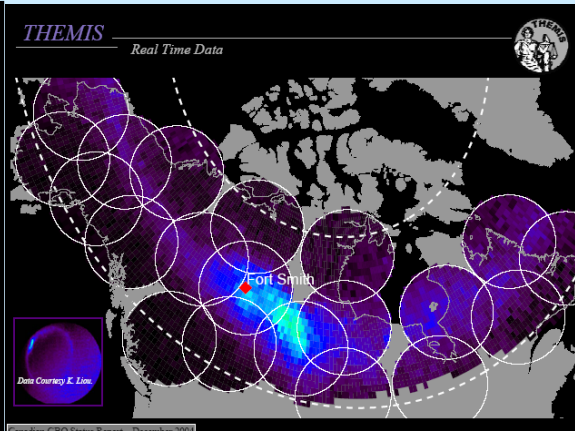
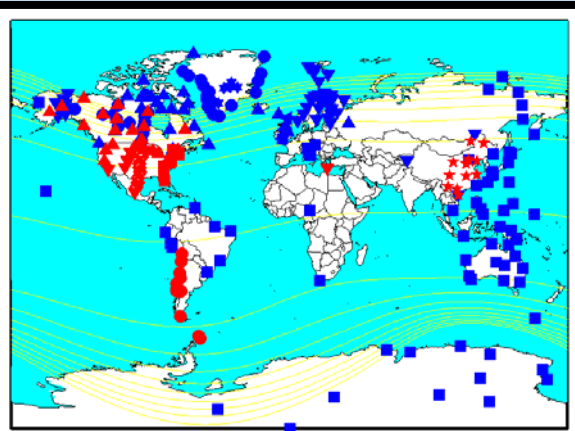
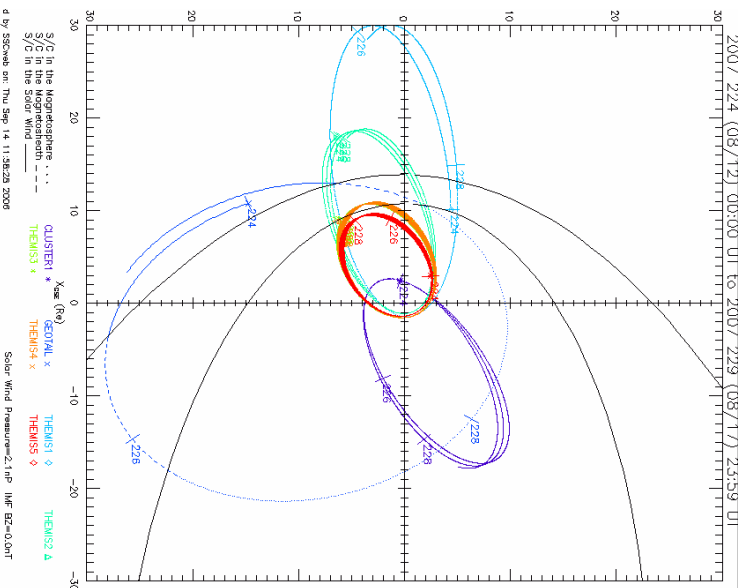
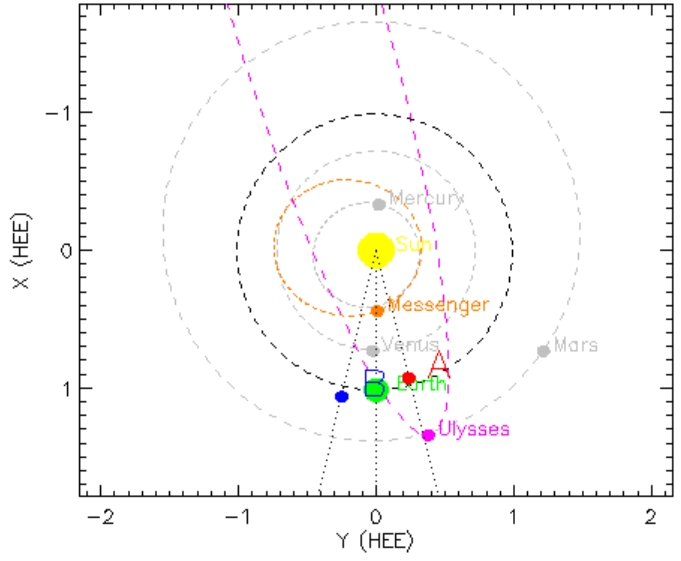
Sun-Earth Application: Space weather



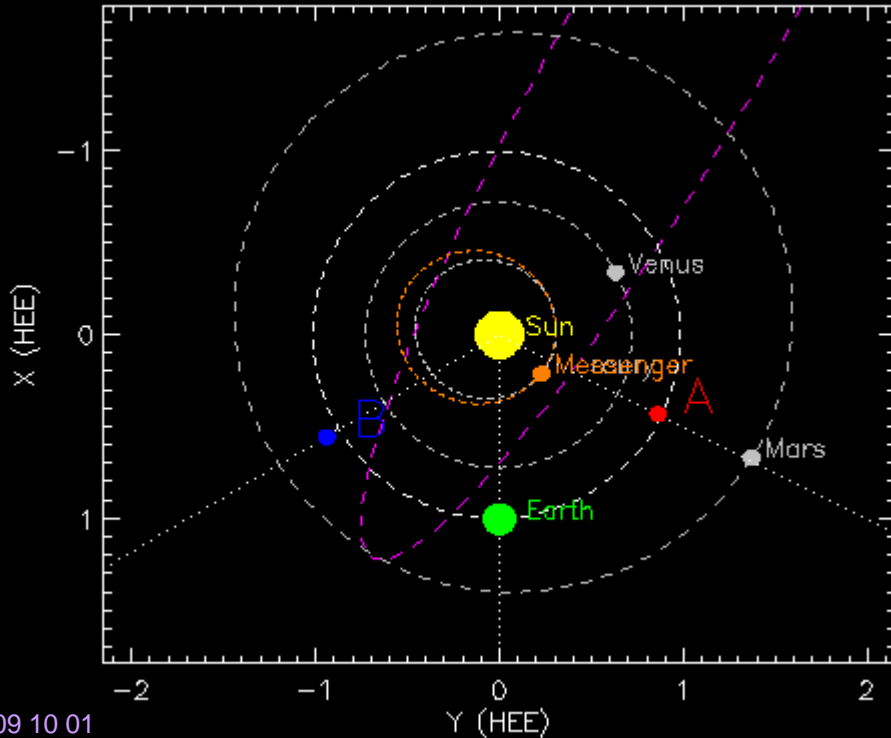
- August 2007: Radial probe distribution
- Precise evaluation of the propagation
 - Evolution of the perturbation during expansion
 - **One-to-one solar/in situ observation association**

Solar perturbation/Magnetosphere-ionosphere interaction

Impact on Earth environment and human activities



Planetary application: space weather at Mars



➤ Both radial and longitudinal propagations can be measured

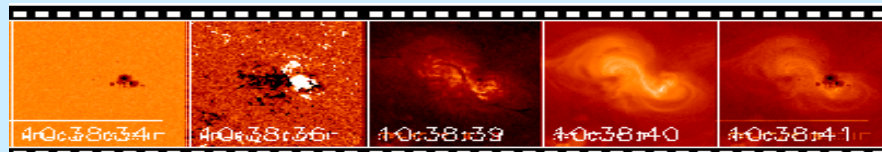
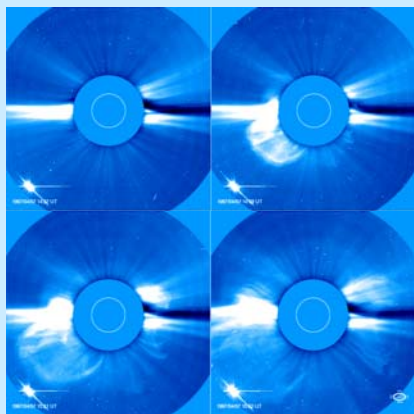
➤ Models



Predictions, forecast of the interplanetary conditions at Mars

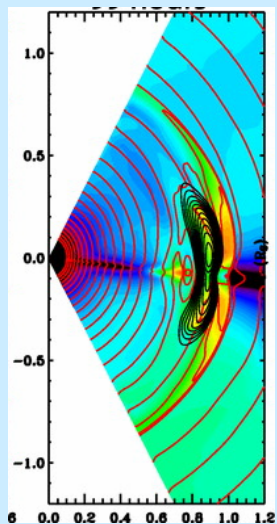
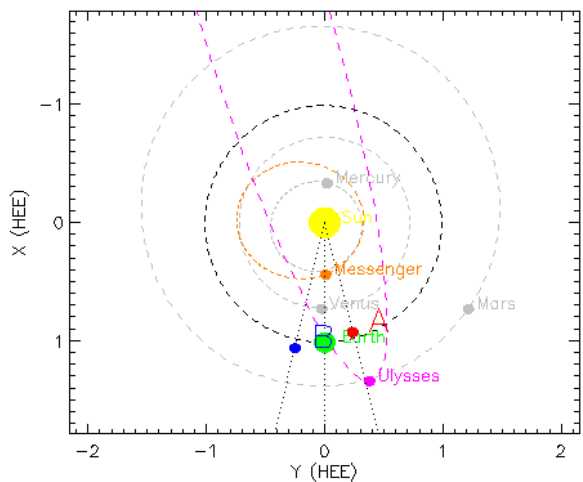
Integrated analysis

Solar data:
STEREO,
RHESSI
SOLAR-B
Ground observatories

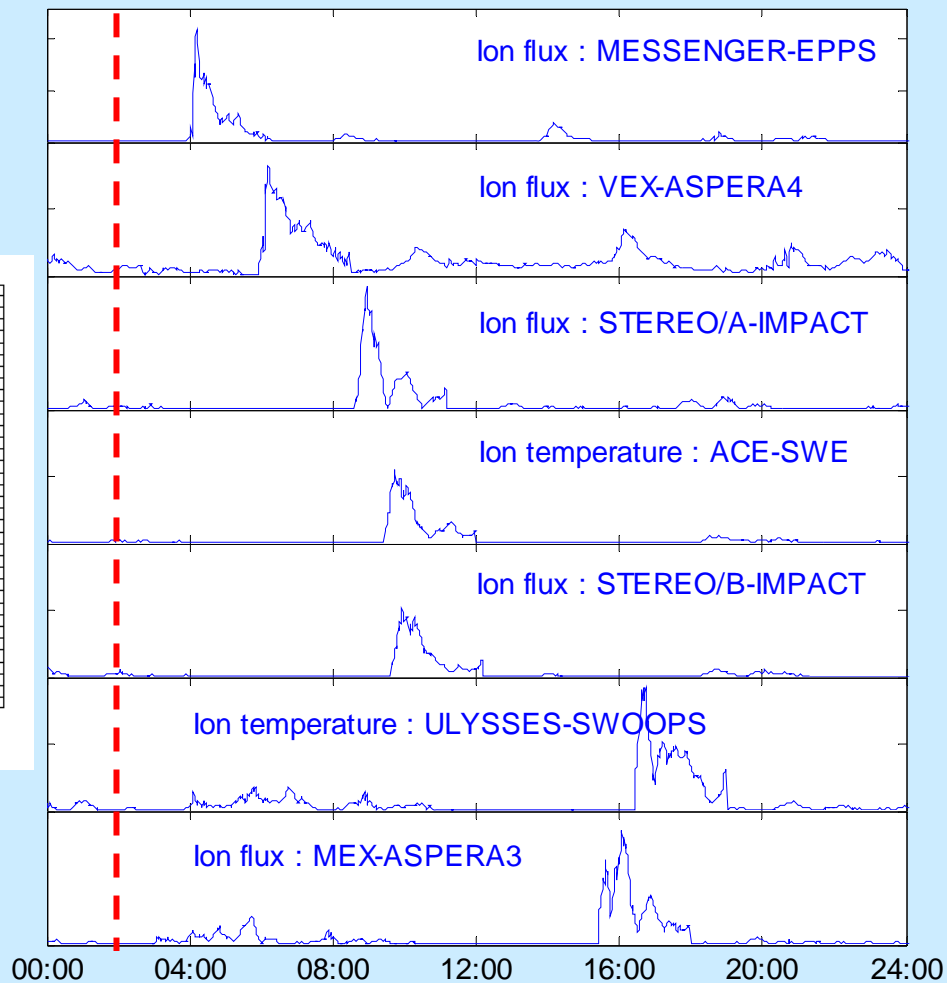


Continuum Magnetogram H alpha Soft X-ray Composite

FLARE ONSET



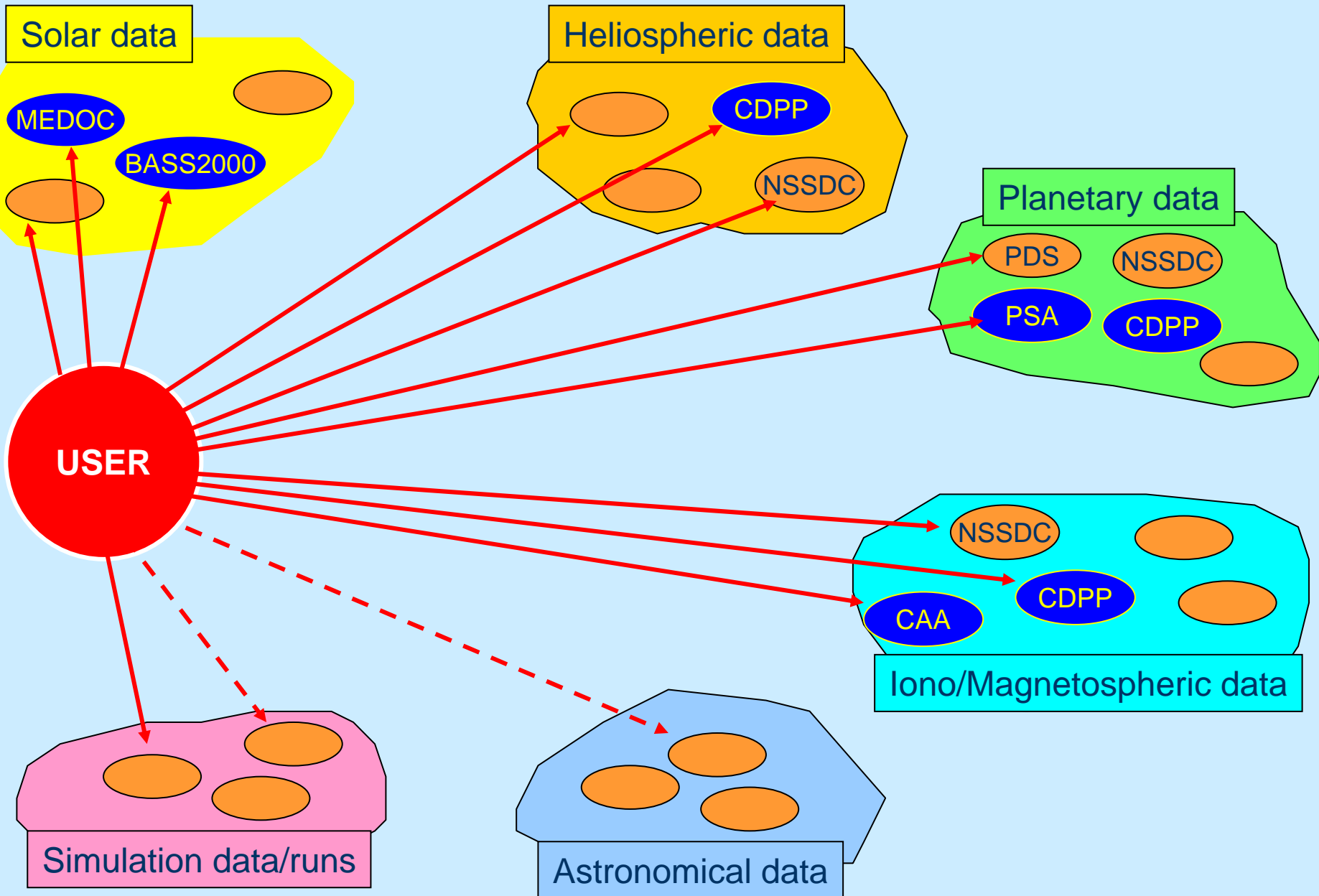
Comparison with
propagation models



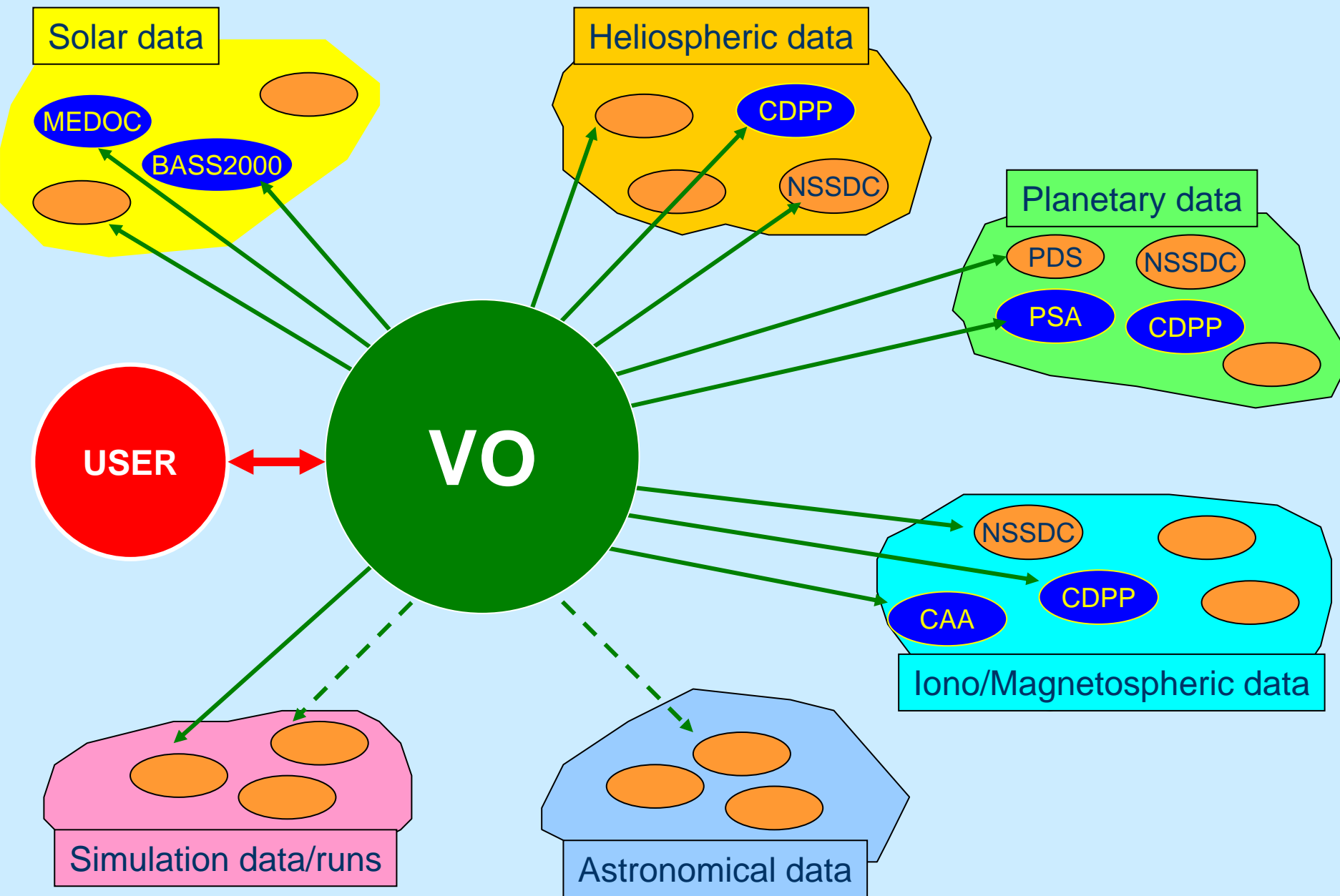
Main steps for performing an integrated analysis

- Search (and find) the data
- Access to the data and extract them
- Access to sufficient description of the data
- Format the data
- Search (and find) or develop the tools for data analysis
- Search simulation results or run models for interpreting the observations

Necessity to access to many data and tools



A virtuel observatory



Present development of VO's in Space Physics

SPASE (Space Physic Archive Search and Extract) provides a stabilised data model

Virtual observatories for Space and Solar Physics are under construction:

In US: VSO: Virtual Solar Observatory

VHO: Virtual Heliospheric Observatory

VSPO: Virtual Space Physic Observatory

VMO: Virtual Magnetospheric Observatory

In EU: EGSO: European Grid Solar Observation

⇒ Need of a VO for planeto-plasma data:
IDIS/EUROPLANET?

Conclusion: an exciting perspective for IDIS/EUROPLANET

- In the very next future, the combination of solar, heliospheric, planetary and magnetospheric mission offers a unique opportunity to study the plasma solar system
- The SPASE consortium has defined a data model which can serve as an exchange reference for solar and plasma data
- VO's are under construction in space physics and solar physics
⇒ will be operational soon
- The European missions VEX, MEX and CLUSTER are key missions

IDIS/EUROPLANET can play an important role in participating to this upcoming plasma solar system observatory
⇒ the plasma thematic could be used for prototyping IDIS

We can expect an important scientific return of this project