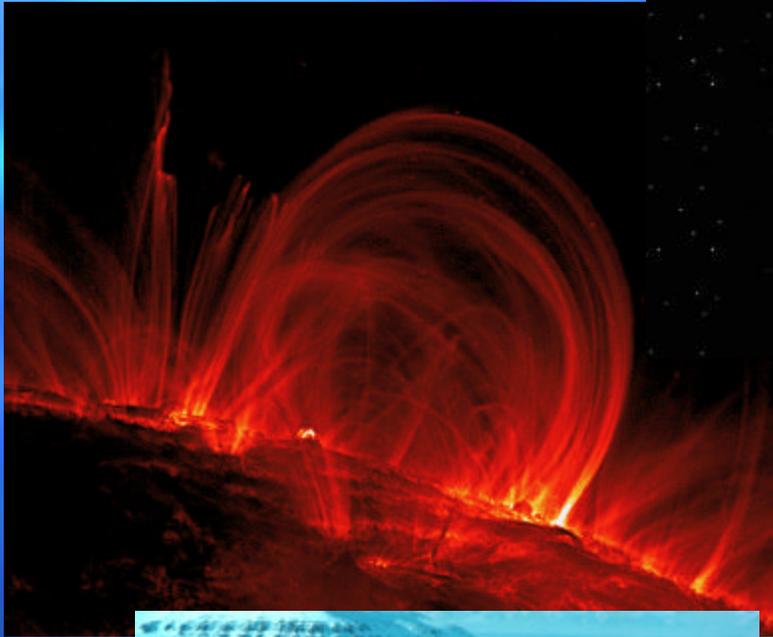


Potential ESA Contributions to **International** Living With a Star (ILWS)





LIVING WITH A STAR



**ILWS should contain more than the NASA LWS Line and international add-ons...
... rather like a global and more quantifying ISTP**

Many STP missions in the US, Europe and elsewhere fulfill the requirement of increasing our understanding and capability to predict the planetary terrestrial response to Solar drivers.

The Plasma Universe



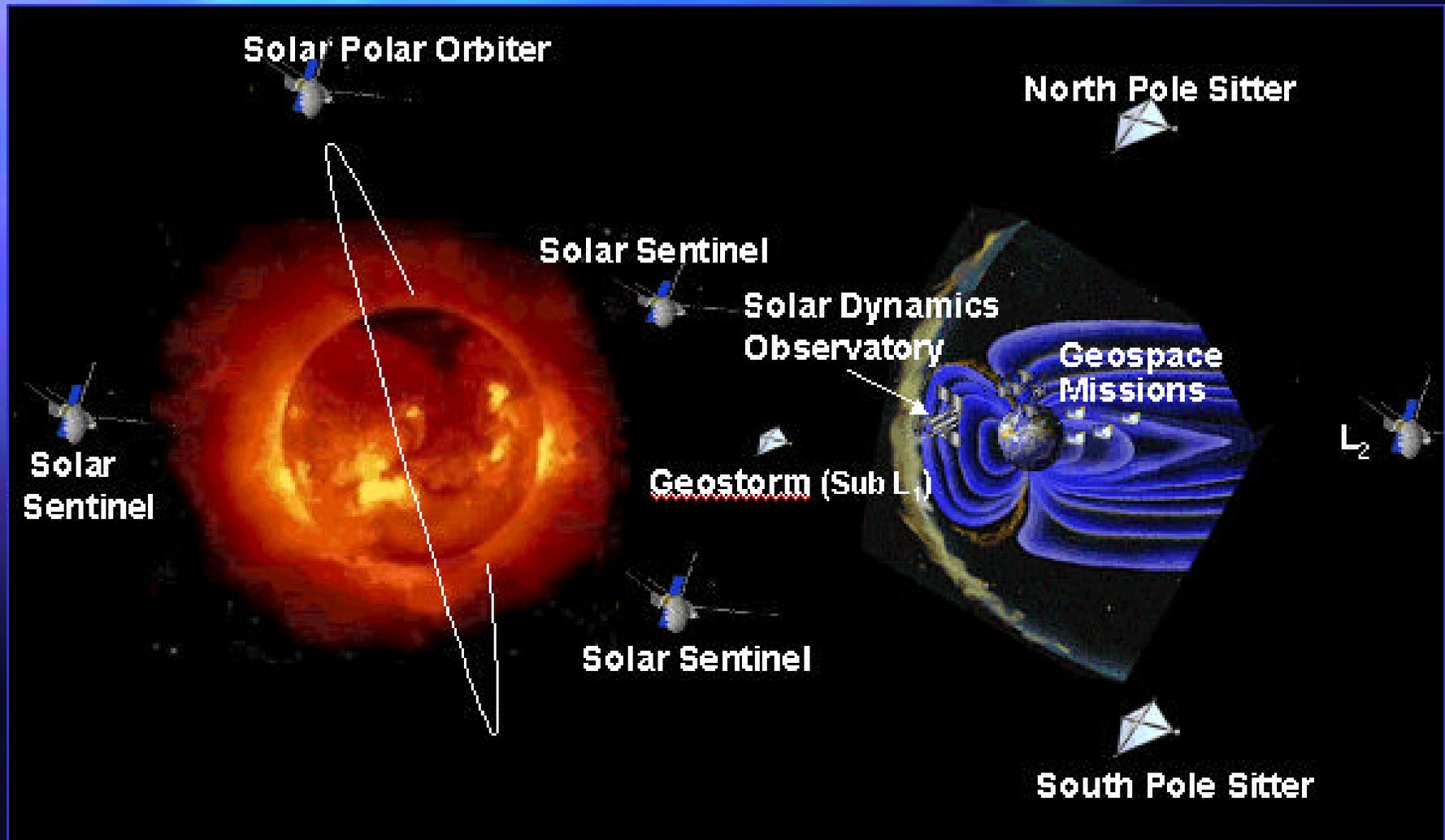
Operations

Power and Communications

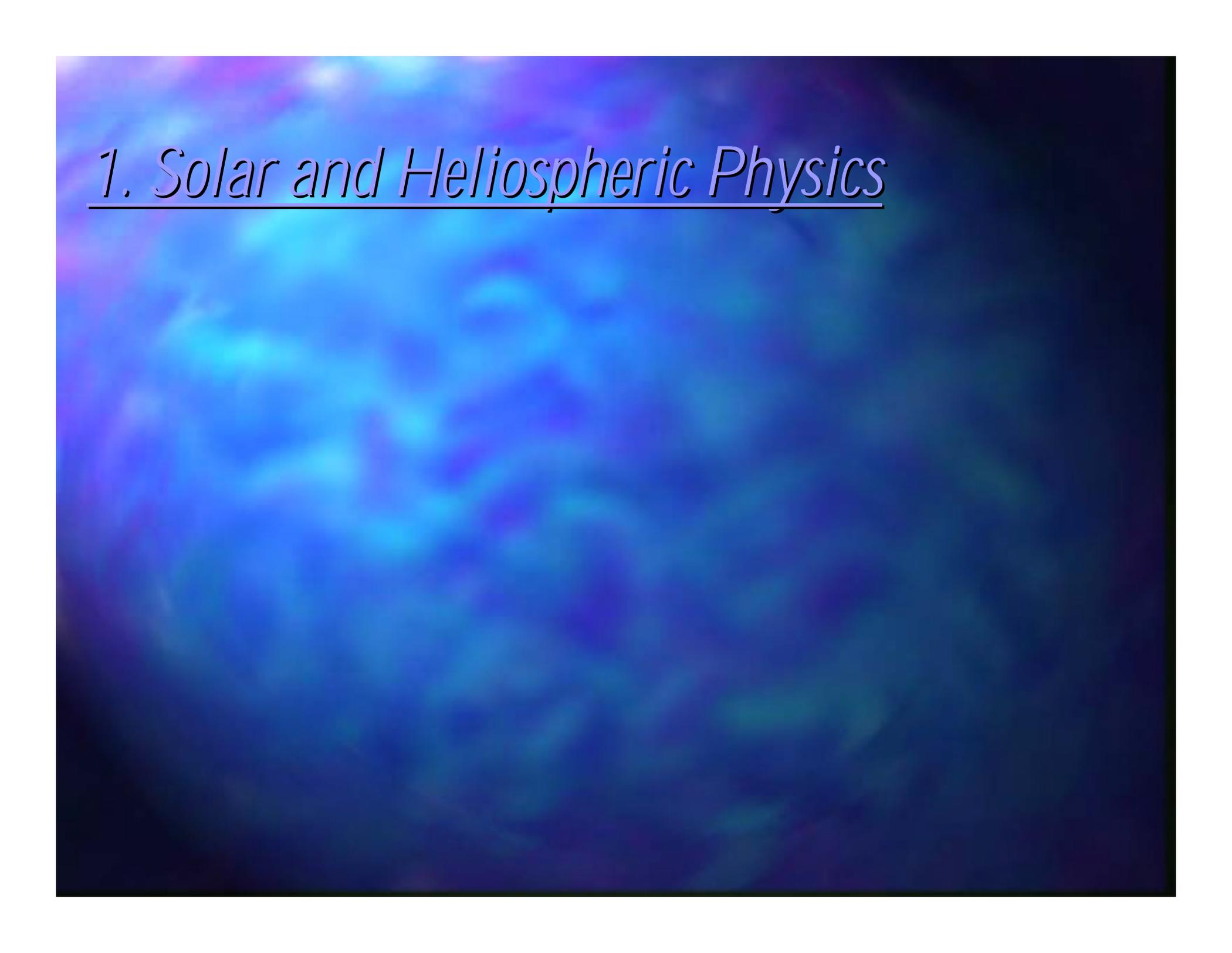


Climate Change

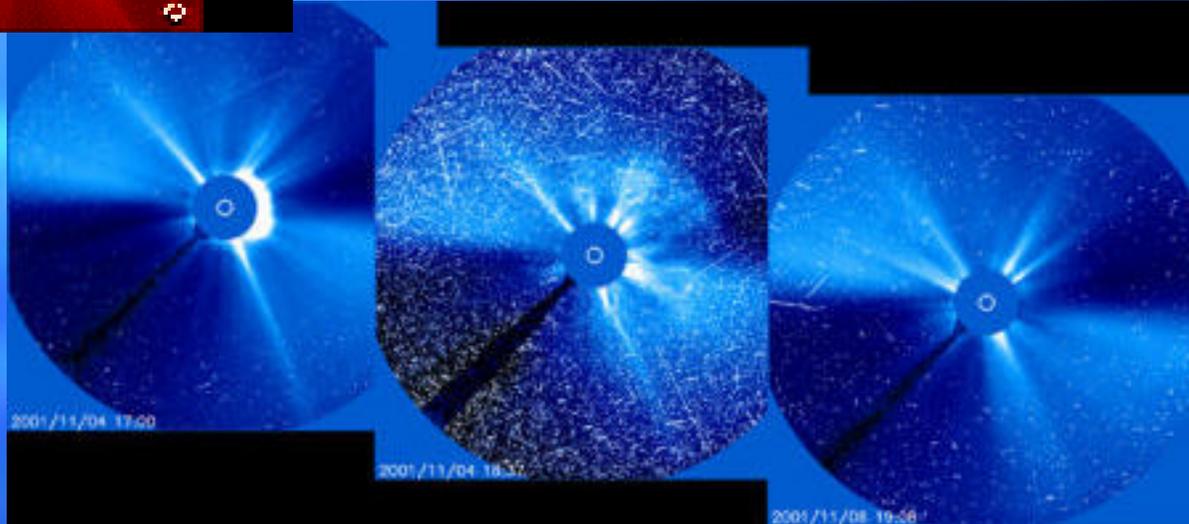
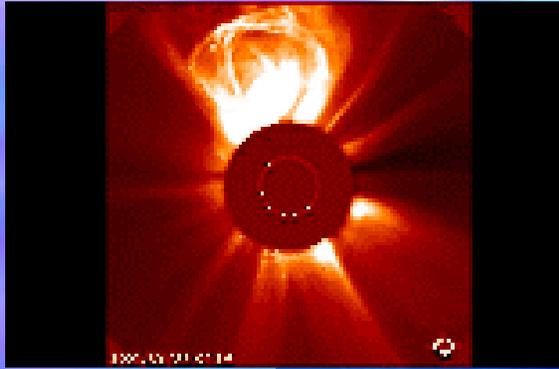
NASA's **Original** Living With a Star (LWS) Missions



1. Solar and Heliospheric Physics



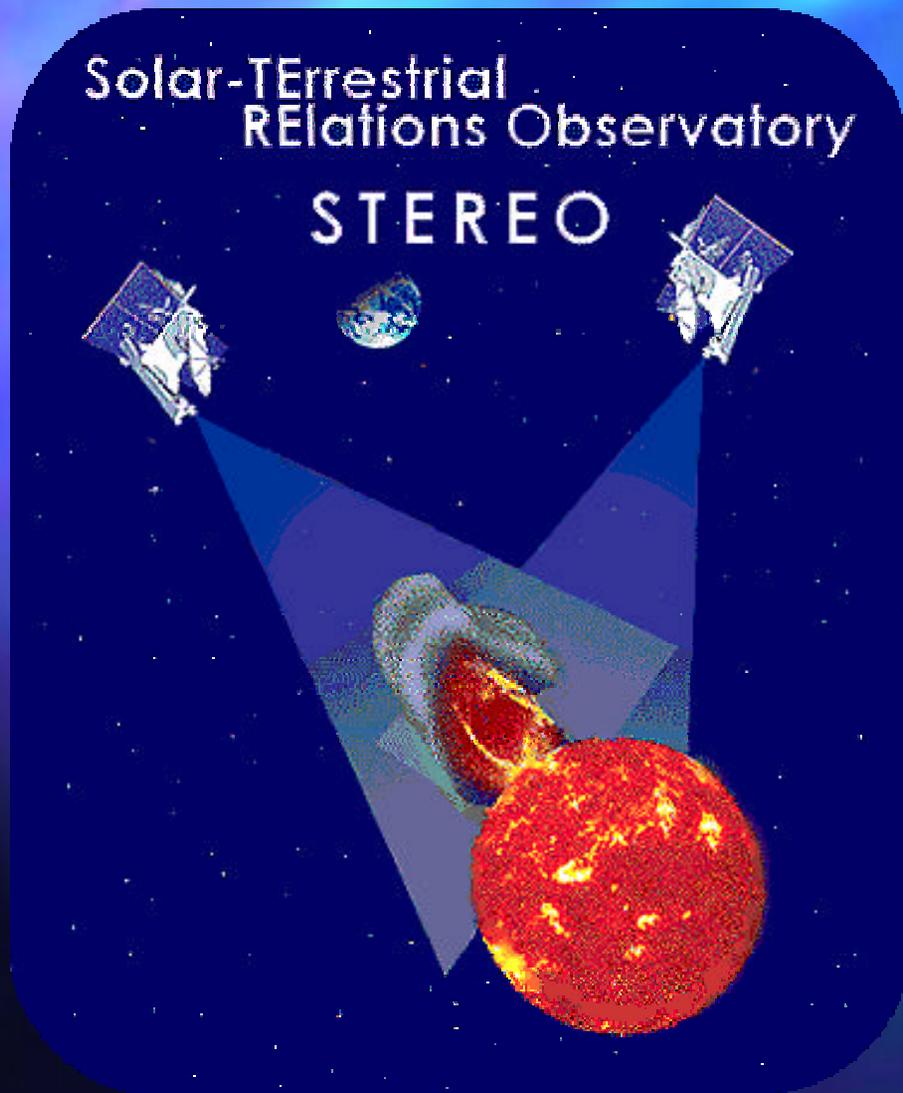
SOHO: ESA's Solar Cornerstone Mission



Solar Observation Satellite:
ESA / NASA Collaboration
4 year mission extension granted
2003-2007



STEREO and SDO - Solar Dynamics Observatory

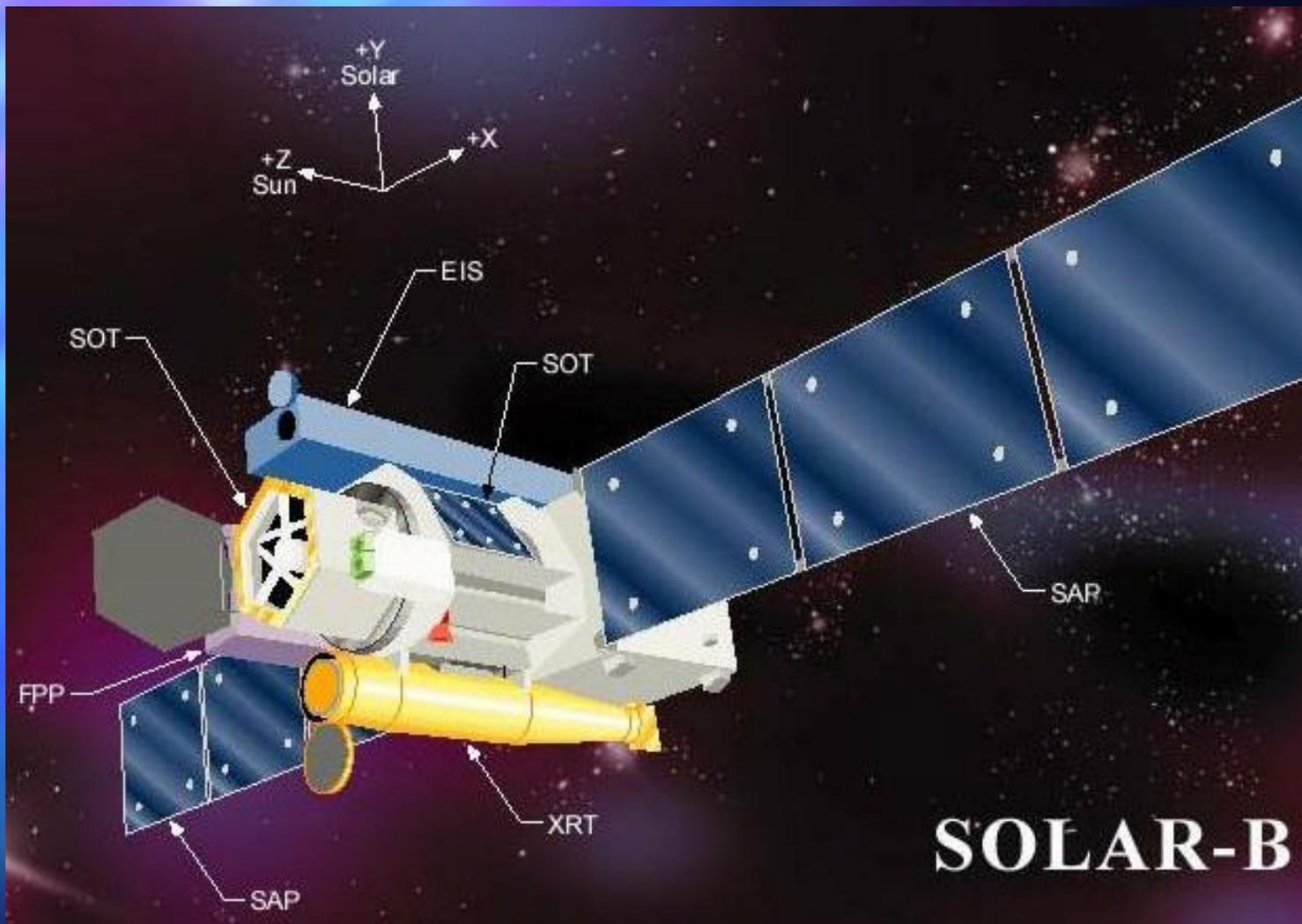


"Targets of Opportunity"

The NASA missions Stereo and SDO will contain a considerable European payload participation

ESA could still contribute to SDO and play a coordinating role in payload provision from Europe

Launches: 2005 and as of 07

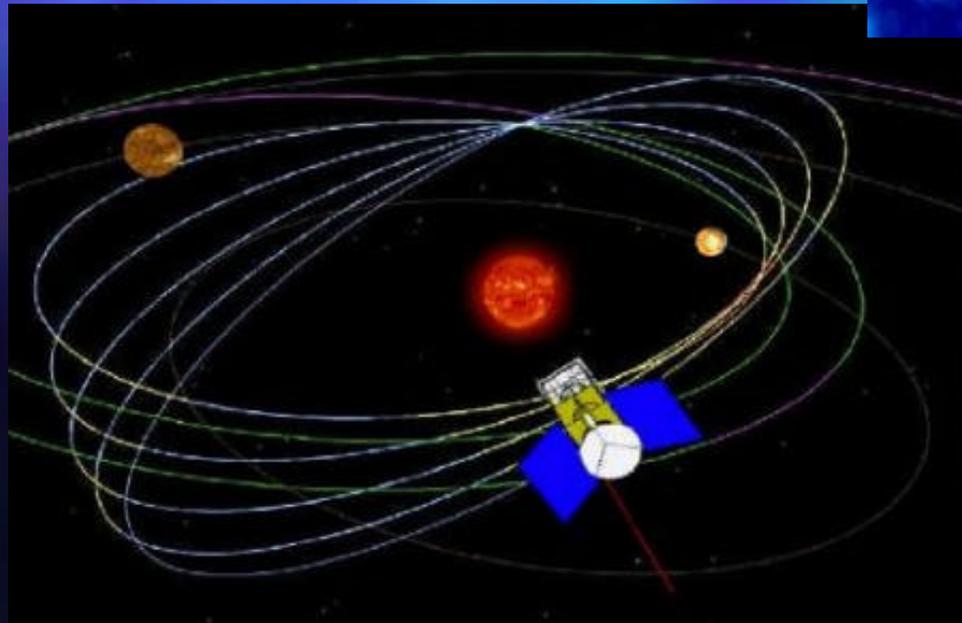
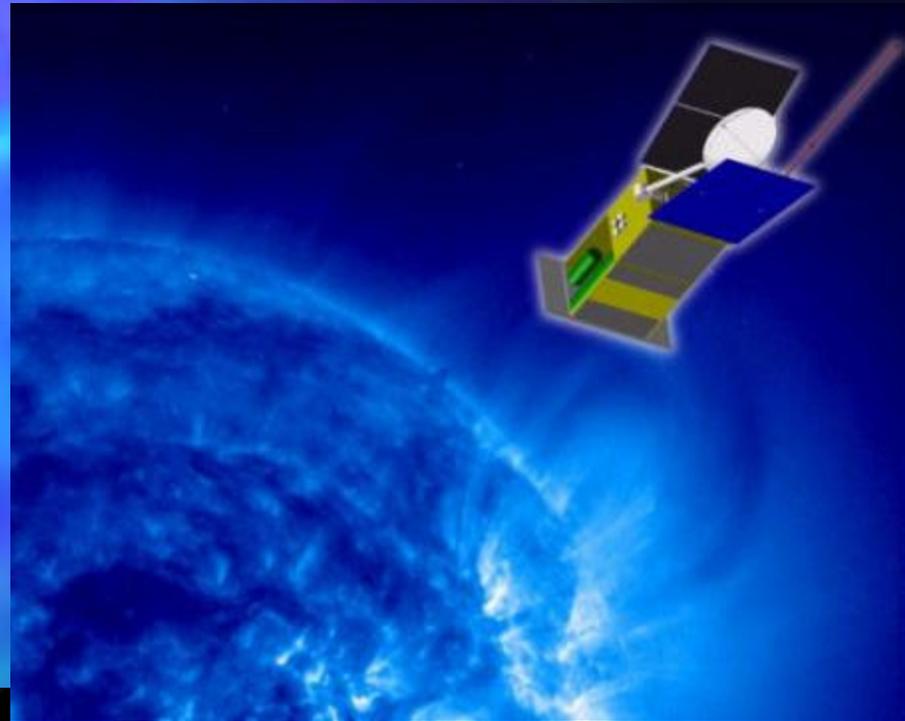


**Next Japanese Solar Mission with NASA Participation
(Ground Station Support from ESA close to agreement)
Launch late 2005**

Solar Orbiter

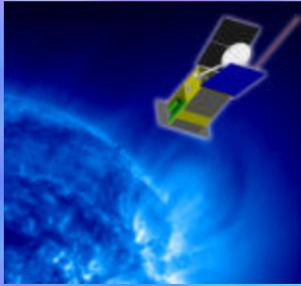
(Inner Heliosphere in-situ
and Solar Remote Sensing)

- Selected as ESA F-mission
- to be launched within the next 10 years
- lifetime 5 + 2 years
- **NASA participation under establishment**



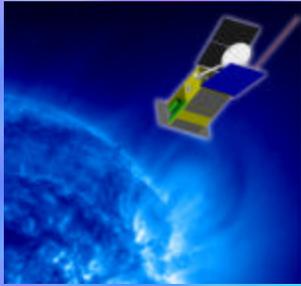
Orbit up to 38 deg
out of the ecliptic

i.e. topside view of polar
regions, CME's and the
backside of the sun



Solar Orbiter: **Mission Firsts**

- explore the uncharted innermost regions of our solar system
- study the Sun from close-up (45 solar radii or 0.21 AU)
- fly by the Sun tuned to its rotation and examine the solar surface and the space above from a co-rotating vantage point
- provide images of the Sun's polar regions from heliographic latitudes as high as 38°
 - Co-rotation remote-sensing observations
 - *In-situ* diagnostics of the innermost heliosphere
 - Close-up high-resolution imaging and spectroscopy
 - Observations from out of the ecliptic plane



Solar Orbiter: Payload

Instrument	Mass kg	Power W	kb/s
Solar Wind Plasma Analyser (SWA)	6	5	5
Radio & Plasma Waves Analyser (RPW)	10	7.5	5
Coronal Radio Sounding (CRS)	0.2	3	0
Magnetometer (MAG)	1	1	0.2
Energetic Particle Detector (EPD)	4	3	1.8
Dust Detector (DUD)	1	1	0.05
Neutral Particle Detector (NPD)	1	2	0.3
Neutron Detector (NED)	2	1	0.15

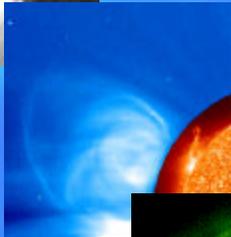
Instrument	Mass kg	Power W	kb/s
Visible Light Imager & Magnetograph (VIM)	26	25	20
Extreme UV Spectrometer (EUS)	22	25	17
Extreme UV Imager (EUI)	36	20	20
UV & Visible Light Coronagraph (UVC)	17	25	5
Radiometer (RAD)	4	6.5	0.5

Planned Future International Solar Missions



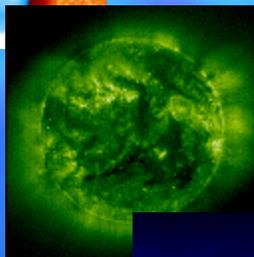
Solar-B [2005] – ISAS (+ NASA & ESA)

More Detail, Magnetic Field



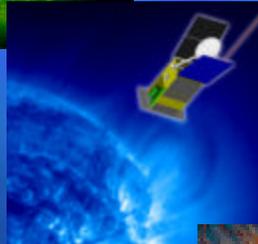
STEREO [2005] – NASA (+ European groups)

Out of Sun-Earth Line, 3-D, CMEs



Solar Dynamics Obs. [2007] – NASA (+ESA)

More Details, Helioseismology, CMEs



Solar Orbiter [2011+] – ESA (+NASA)

Out of Eccliptic, Far-Side, Co-Rotation,
Inner Heliosphere/Corona



Solar Probe - NASA

A Closer look

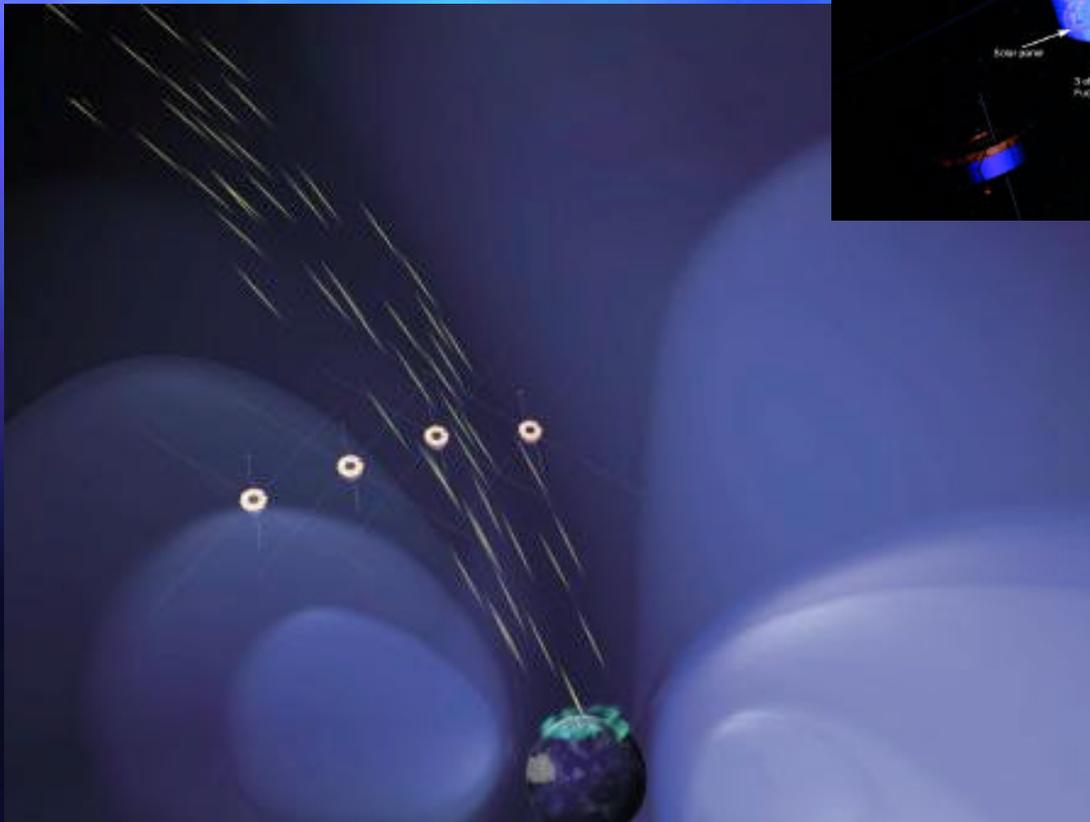
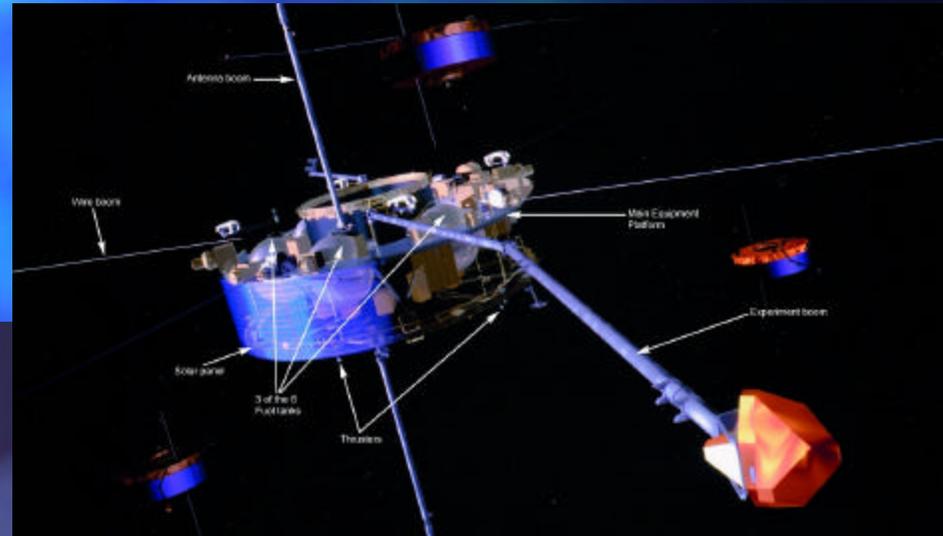
Solar Sentinels – NASA

Multipoint Inner Heliosphere

2. Magnetospheric / Ionospheric
Physics - STP or SPP

Cluster

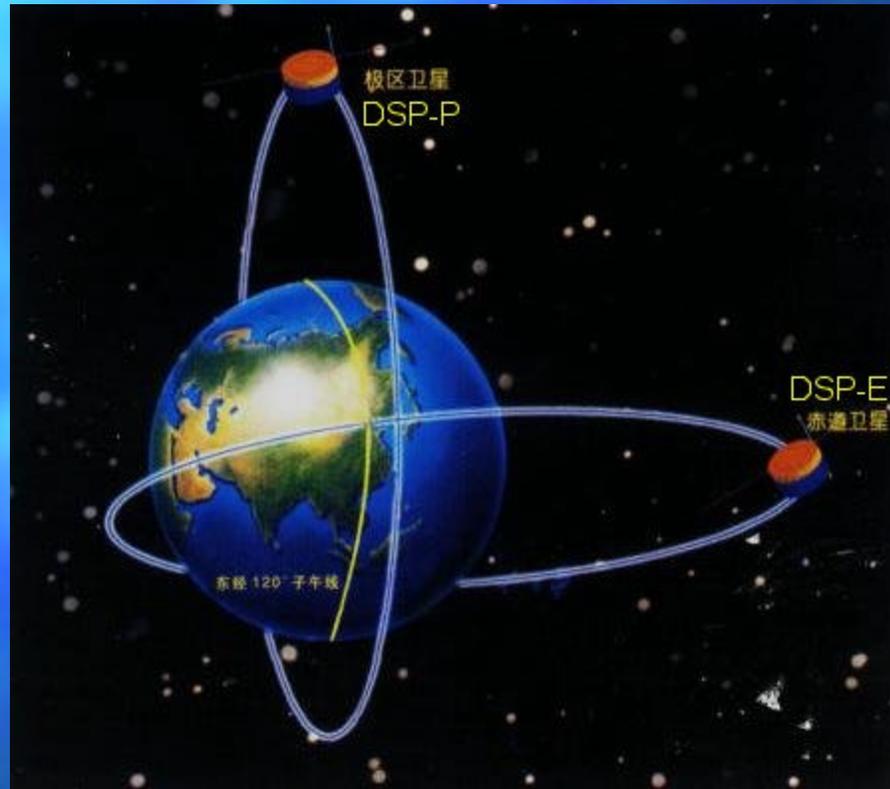
ESA's Magnetospheric Cornerstone Mission



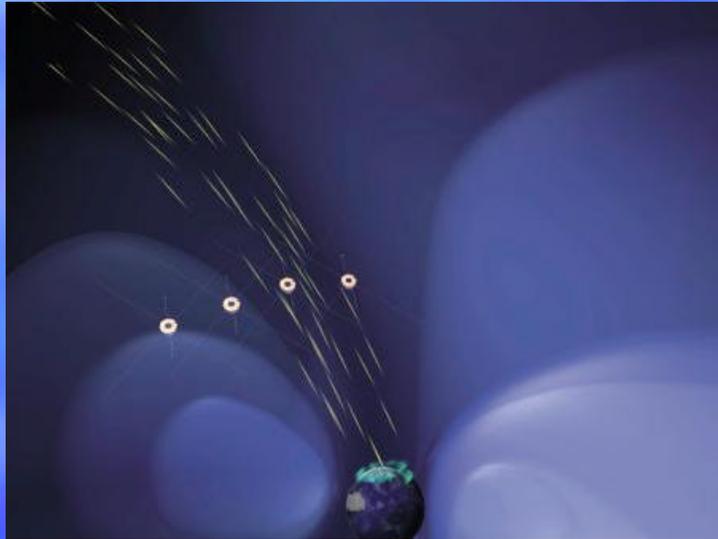
**ESA-SPC decision made
on 100 % orbital data
coverage and 3 year
mission extension
For 2003-2005**

DOUBLE STAR

Chinese / ESA / European Collaboration



**Two satellites equipped mainly with Cluster Spare Instruments
in Magnetospheric Polar and Equatorial orbits
DSP-P: 350 km x 25000 km and DSP -E: 550 km x 60000 km
Launches in December and June of 2003, resp.**



CLUSTER Active Archive Phase

New plan to establish a public - domain high -resolution data archive for the CLUSTER mission
- including multi-instrument value-added satellite and G-B data.

Proposal to be taken to ESA SPC in 2003
Presently discussed within the Cluster SWT

”Bepi Colombo”

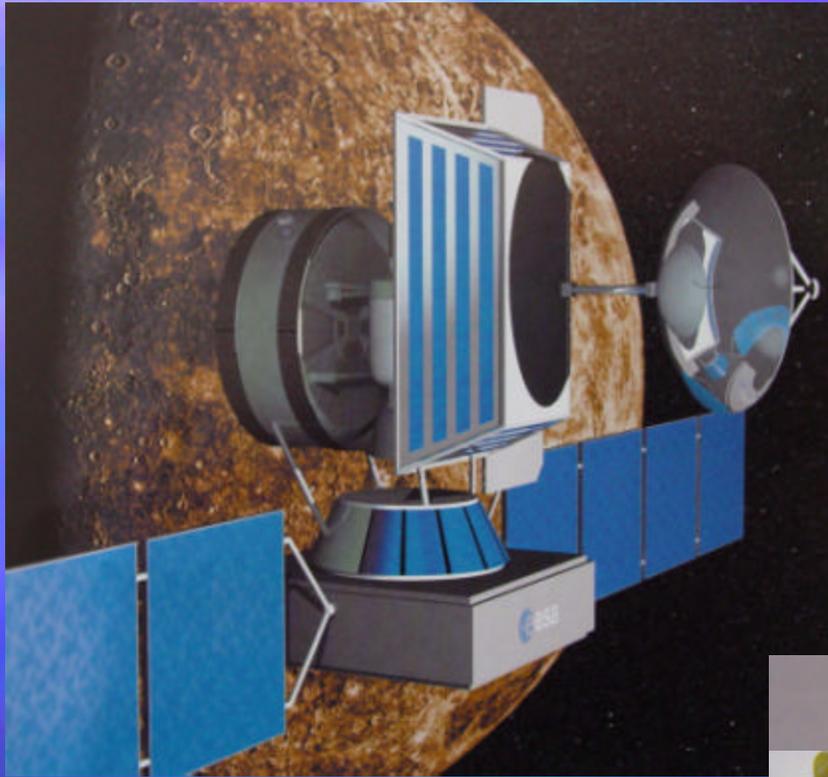
ESA’s Cornerstone Mission to Mercury



Mercury Magnetospheric Orbiter, MMO
(in close collaboration with Japan)

**A Magnetospheric Mission to investigate
Solar Wind / Magnetosphere Interaction
without a Planetary Ionosphere**

(also an ”Inner Heliospheric Sentinel” mission)



”Bepi Colombo”

consists of :

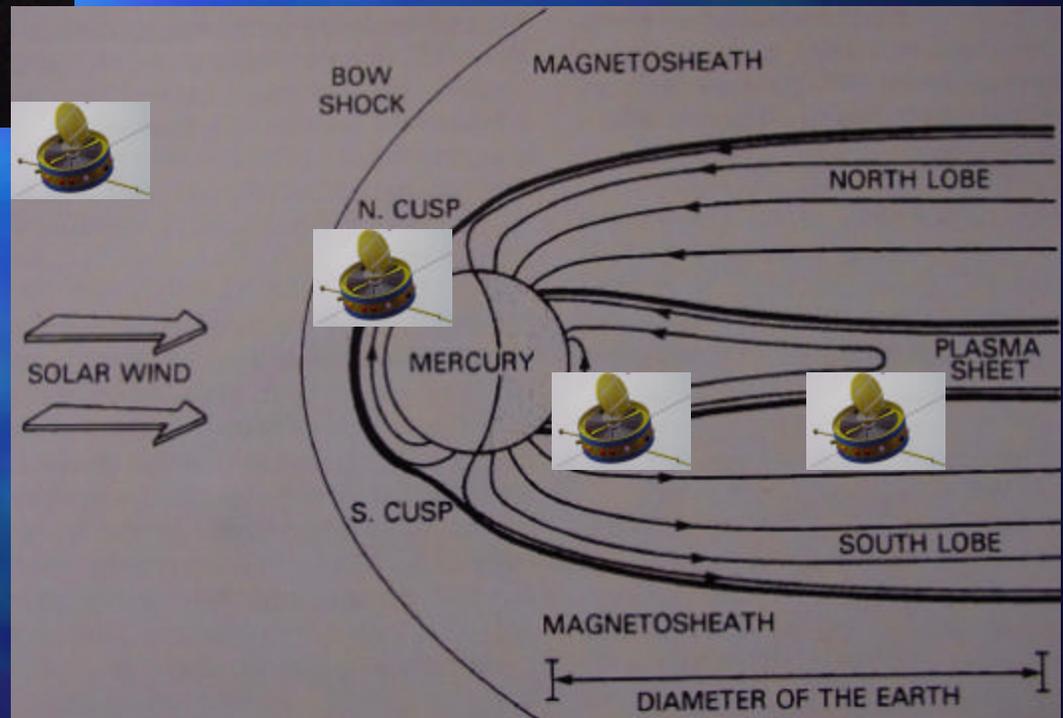
MPO, MSE, and MMO

Launches 2010/2011

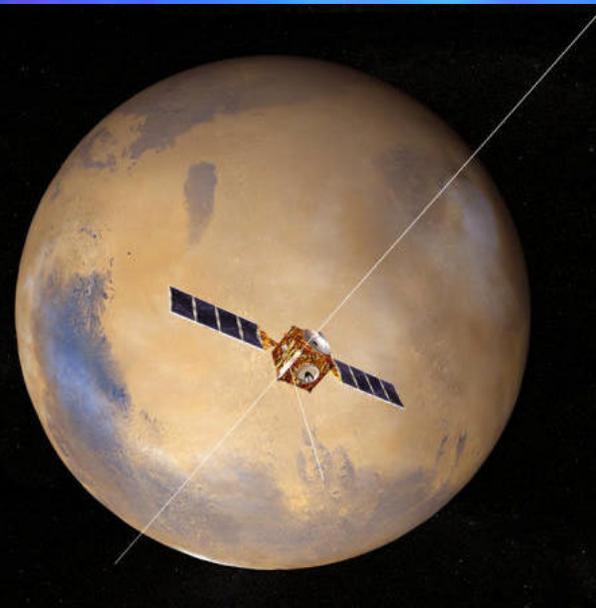
MMO →

in two orbit
locations:

at 400 km and
at 12000 km

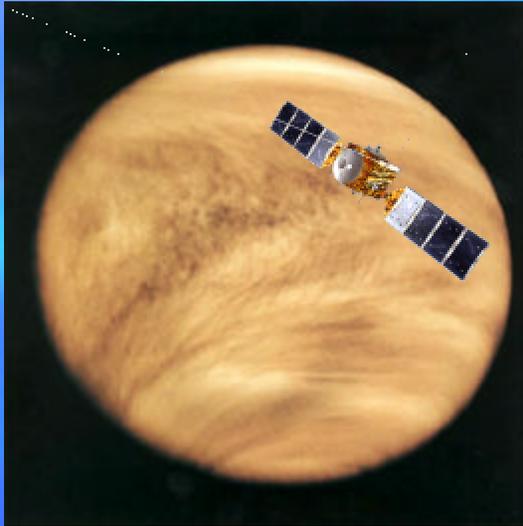


Mars Express



- ASPERA: Energetic Neutral Atoms Analyser
- HRSC: High/Super Resolution Stereo Colour Imager
- MaRS: Radio Science Experiment
- MARSIS: Subsurface Sounding Radar/Altimeter
- OMEGA: IR Mineralogical Mapping Spectrometer
- PFS: Planetary Fourier Spectrometer
- SPICAM: UV and IR Atmospheric Spectrometer
- The BEAGLE-2 lander (Search for evidence of life)

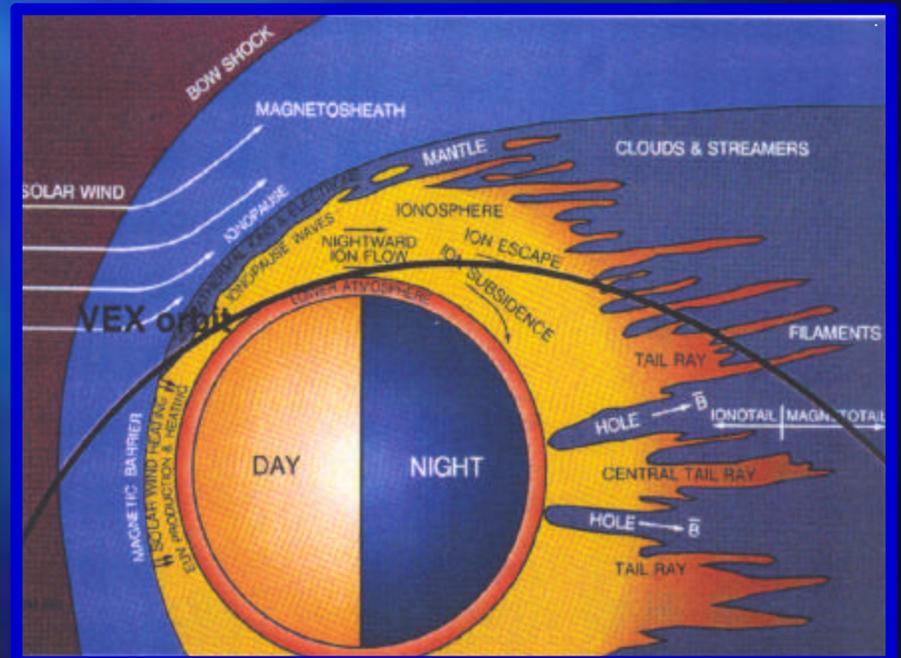
Venus Express



- *ASPERA: Analyser of Space Plasmas and Energetic Atoms*
- *PFS: High-resolution IR Fourier spectrometer*
- *SPICAM: UV and IR spectrometer*
- *VeRa: Venus Radio science instrument*
- *VIRTIS: UV-visible-IR Imaging Spectrometer*
- *VENSIS: low frequency radar sounder*
- *VMC: Venus Monitoring Camera*
- + *a Magnetometer*

will address the problems of atmospheric escape and plasma environment by

- in situ measurements of ENA, ions, electrons, and magnetic fields
- active radar sounding of the vertical structure of the topside ionosphere;
- high-resolution spectroscopic observations of CO₂ and H₂O
- remote sounding of the solar wind turbulence.



**In addition ESA will consider support of other
European missions within the ILWS realm**

**(national, as well as bi- and multi-lateral projects
can come into consideration)**

A new procedure for ESA support of "nationally-led missions" has recently been introduced, which may enhance the capabilities of individual memberstates or consortia to contribute missions to the ILWS programme.

A First Call was presented to ESA delegates in early July (closing date September 15, 2002).

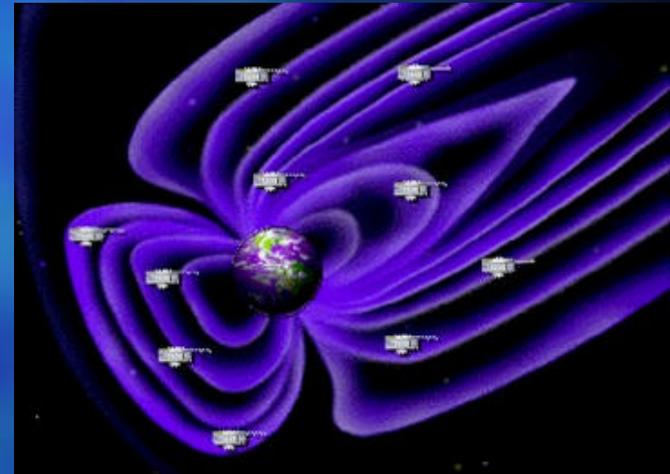
The same procedure will be repeated every year in the future.

A total support volume is yet undetermined, but

ESA's contribution will be up to 15 % of the mission cost

A number of magnetospheric missions or mission concepts have been proposed and will be (re-)considered in the near future. Many if not all of them are multi-satellite missions, e.g.

- S(ch)warm (Germany, UK, Danmark ++)
- Storms (Finland ++)
- Heracles (France ++)
- Maxwell, Apex, (UK ++)
- Auroral Quartett (Sweden ++)
- MMM or short M³ (Solar System Working Group)

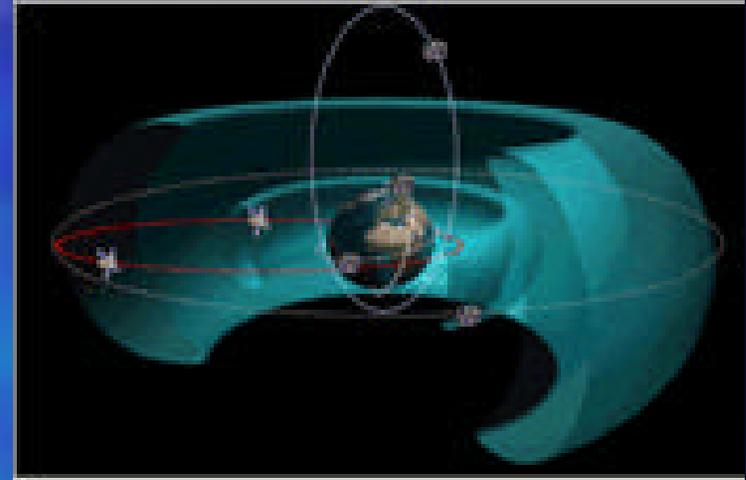
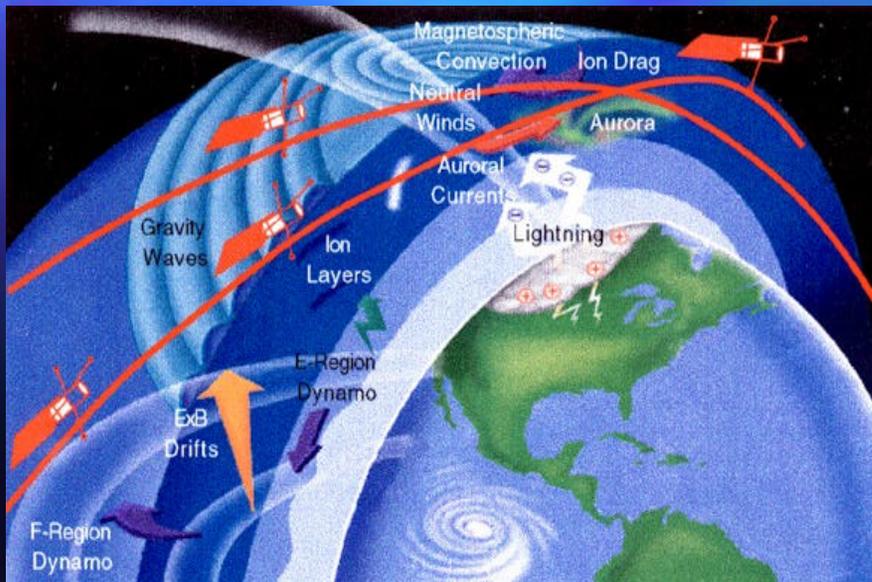


Solar and Magnetospheric Science Community Meetings in spring of 2002 discussed strategies (& reassessment) for the "After- SOHO / CLUSTER Era", including ILWS

A long term future ESA Strategy - Vision 2020 will be discussed and formulated in 2003

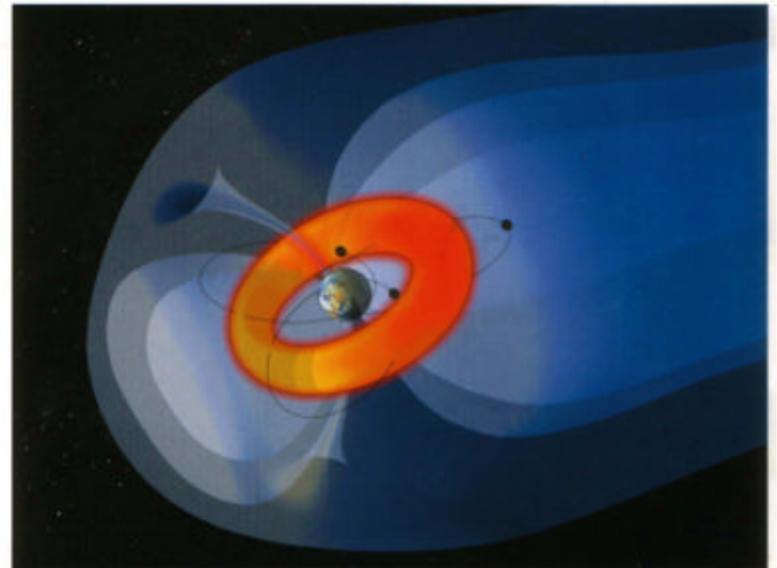
Other "targets of opportunity" :

Mission scenarios for the detailed study of ionospheric and inner magnetospheric responses (**Geospace-Regions**)



Compare **STORMS**

A Three-Spacecraft Constellation for Earth Magnetic Storms and Inner Magnetospheric Studies

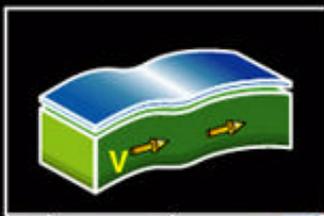


Dayside Magnetopause



Reconnection
Acceleration
Turbulence
Solar wind entry

Post-Cusp Magnetopause



Northward reconnection
Reverse convection
Pointing flux entry

MMS

"TARGET OF OPPORTUNITY"

- European participation in US-Consortia anticipated
- Dedicated ESA contribution and ESA co-ordination of the European payload provision to be discussed with NASA

Phase 1

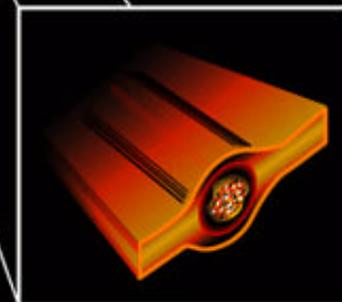
Phase 2

Reconnection
Plasma sheet boundary
Acceleration
Current disruption



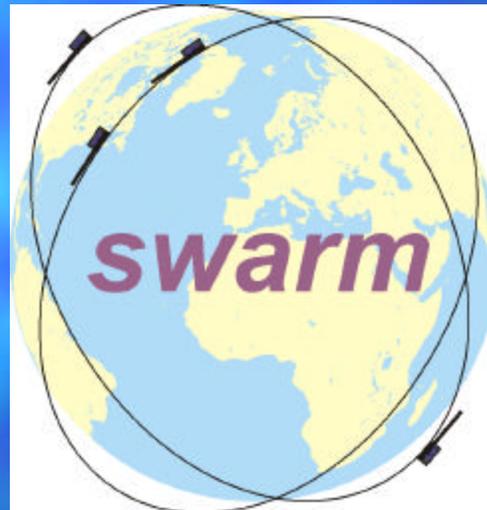
Nightside Substorm Region

structures and dynamics
Plasma escape and motion across boundaries



Magnetotail

The Danish Multi-Satellite Mission **SWARM** was recently selected within **ESA's Earth Observation Programme**



Primary aim of SWARM: Internal magnetic field dynamics

Secondary aim of SWARM: Ionospheric / atmospheric coupling via magnetically controlled processes

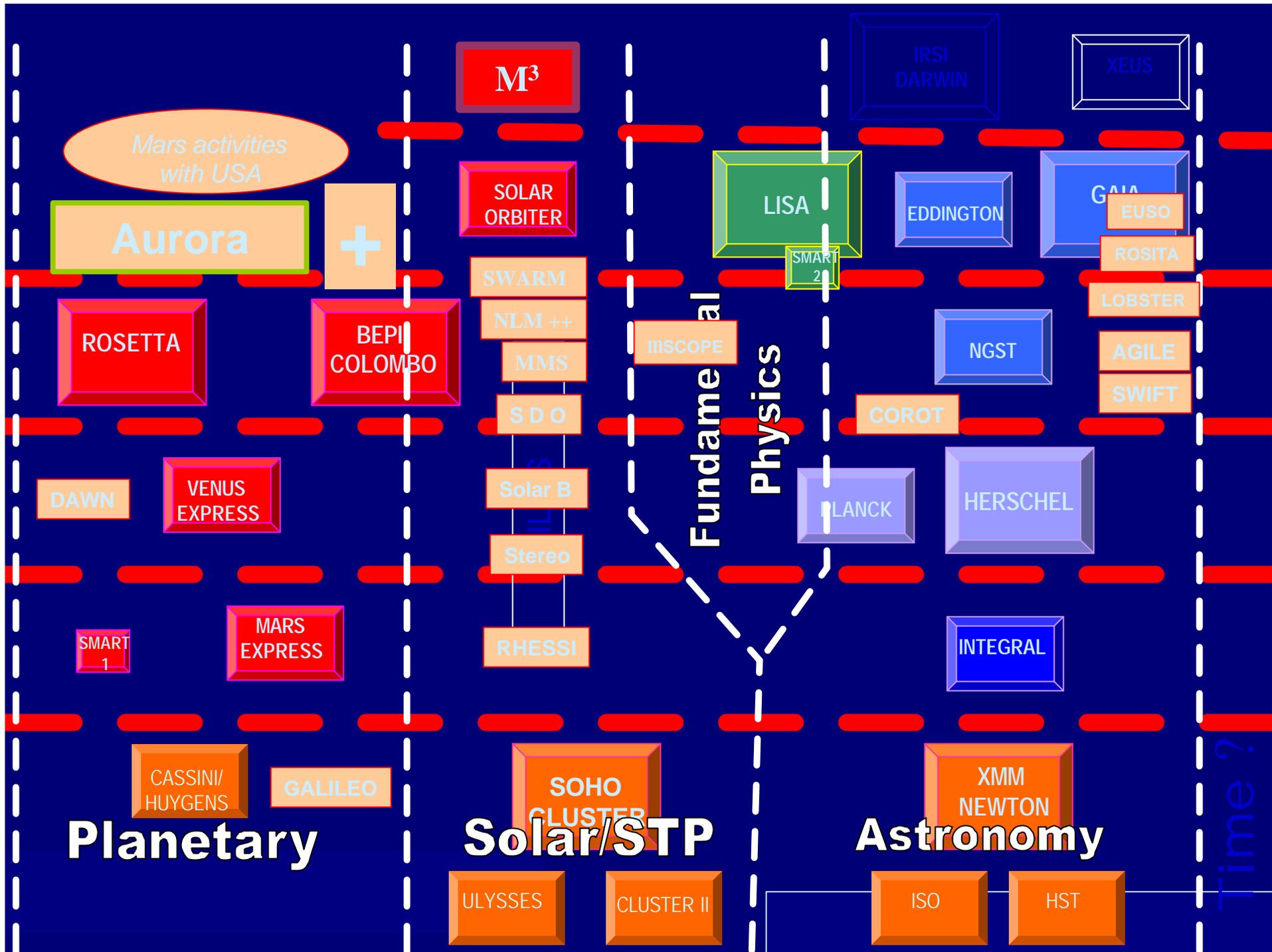
Current ESA Status: Phase A study within D/EOP with D/SCI involvement

ESA's D/TOS Space Weather Initiative:

A 2-year Space Weather pilot study has recently been approved within the ESA GS-Program

Expected outcome of this pilot study:

- European Customer identification
- Product definition and data prototype presentation
- Network establishment with US, Japan and Russia
- Plus quite logically a proposal for a first
ESA Space Weather Demonstration-Mission
(which consequently could be coordinated with
and / or implemented into the ILWS fleet)



In addition: A New Element of Enhanced Collaboration
with Ground-Based Networks to Study **Global Responses**
to Solar Wind / Magnetosphere Interaction Drivers

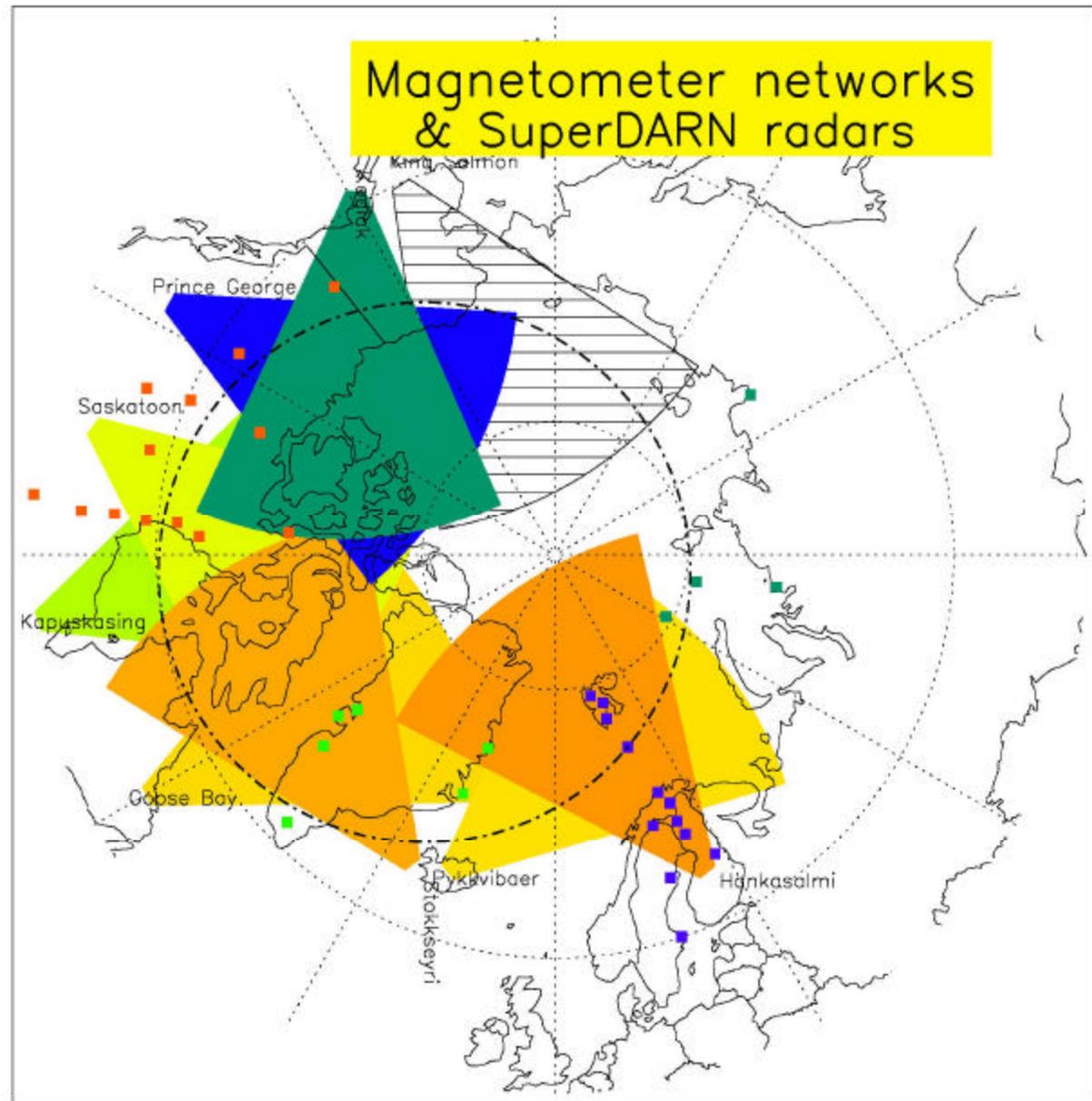


Global
Ground-
Based
Networks

In Northern
(and Southern)
Hemisphere

Value-added
Data Products
(MIRACLE,
SuperDARN)

(Canadian
Part funded by
CSA)



++ Southern Hemisphere : Halley, SANA, Syowa South, Syowa East, TIGER, Kerguelen

European Incoherent Scatter Facility - EISCAT



Three Incoherent Scatter Radars
New Widened Association 2006



EISCAT

- Three co-operating installations forming an array of radars
- The world's only multi-static Incoherent Scatter radar (KST)
- Complementary to the US radars in Millstone Hill and Søndre Strømfjord
- From 2006 new and widened organisation

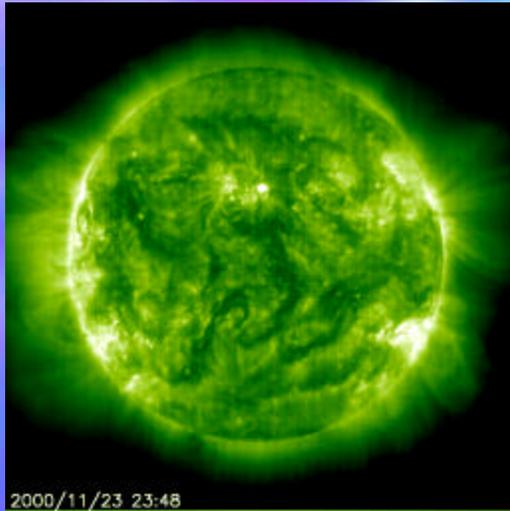


The e' Proposal: Role and Products

- PRIME (*Principal Resource for the Ionospheric and Magnetospheric Environment*)
 - Ionospheric data, on time, all the time
 - Value added data services and organization to attract other instruments and data providers.
 - Data synthesis products, including:
 - Incoherent and Coherent Scatter Radar data
 - Optical and Magnetometer data, Models
 - Dependable, reliable, quality assured data for both routine, event driven, and statistical use.
 - Scalable, responsive data products tailored to the needs of non-specialist and specialist users alike.

Financing e' : Prospective Partners

- Core Associates
- Formal agreement with USA on high-latitude co-ordination and support
- China, Russia...
- Pay-per-view partners

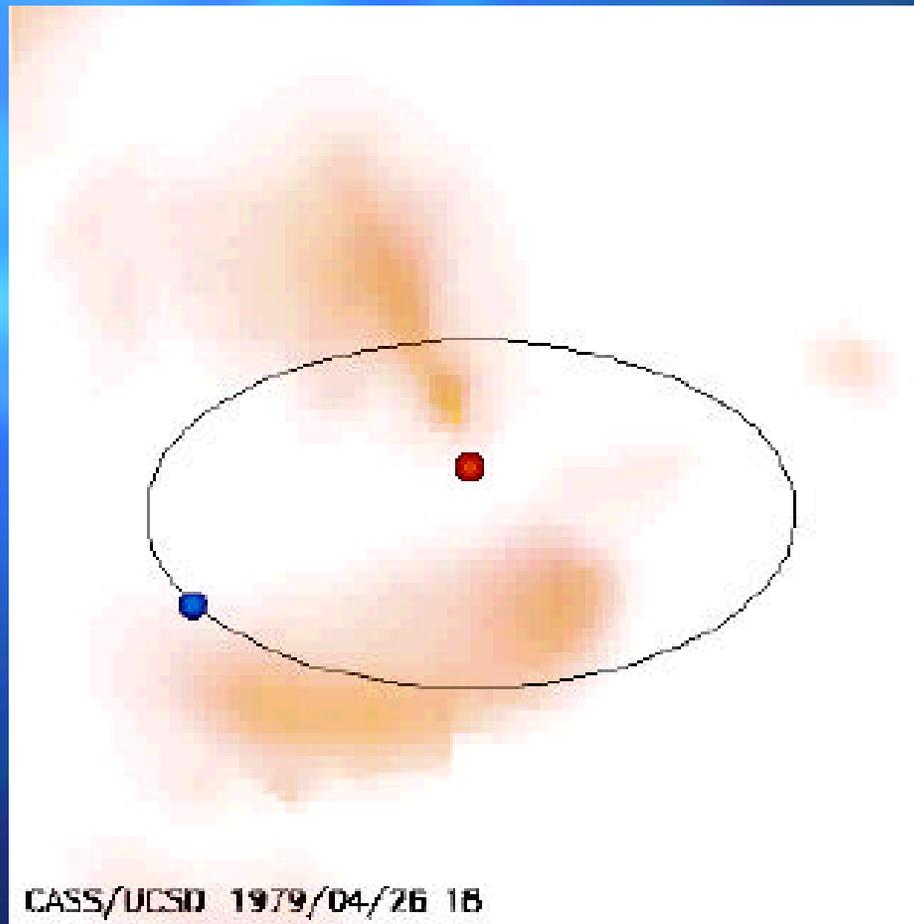


Conclusions

ESA and the ILWS

- Two ESA Cornerstone Mission extensions - CLUSTER and SOHO
- The Cluster Active Archive Phase
- "Targets of opportunity" for European payload and/or ESA contributions:
Stereo, SDO, MMS, + other ILWS missions (TBD)
- Ground Station Support for the Japanese SOLAR-B Mission
- Participation in the Chinese DOUBLE STAR Mission
- Collaboration with Japan in a Magnetospheric Mission to Mercury
– BEPI-COLOMBO / Mercury Magnetospheric Orbiter
- Space Plasma Instruments on MARS-EXPRESS, and VENUS-EXPRESS
- The ESA F-Mission SOLAR ORBITER (collaboration with NASA TBD)
- A new support program within ESA D/Sci for "Nationally Led Missions"
- Collaboration across different ESA directorates (Swarm & Space Weather)
- A new approach to large scale ground-based instrument networks

CME Movie Based on Interplanetary Scintillation data



Earth →

← Sun