Science Ground Segment for ESA Solar System missions: Mars Express and Venus Express

Alejandro Cardesín Moinelo

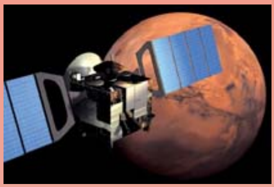
ESAC, Solar System Science Operations Division, European Space Agency

Mars Express

The Mission

The Mars Express spacecraft was launched on the 2nd June 2003 and arrived to Mars after a 400 million km journey in December 2003. The scientific objectives of the mission are mainly high-resolution imaging and mineralogical mapping of the surface, radar sounding of the subsurface structure, precise determination of the atmospheric circulation and composition, and study of the interaction of the atmosphere with the interplanetary medium. The scientific data obtained are crucial for a better understanding of the Earth from the perspective of comparative planetology.

The spacecraft carries seven scientific instruments and a Visual Monitoring Camera, all designed to contribute to solving the mystery of Mars' missing water. All of the instruments take measurements of the surface, atmosphere and interplanetary environment, from the main spacecraft in polar orbit, which allows it to gradually cover the whole planet.

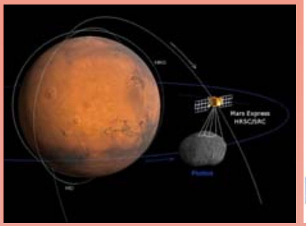


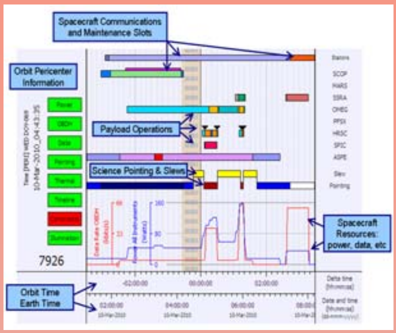
The Science Operations

The main objective of the Science Operations Center (SOC) in ESAC-Madrid is to co-ordinate the scientific observation requests from the Mars Express instrument teams and to build the final observation plan that fits in terms of available spacecraft resources (mainly battery power, data rate and downlink capacity). Among other tasks, the SOC is responsible for defining the final pointing of the spacecraft and planning the operation of the payloads.

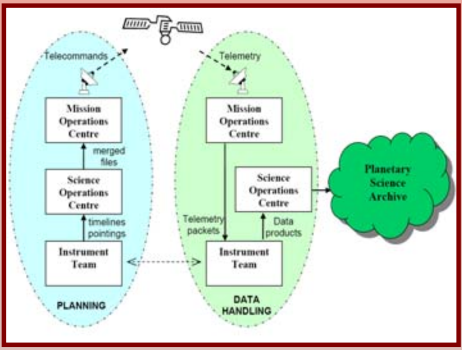
The SOC also helps teams convert their high-level scientific requirements into geometrical constraints and compute the required spacecraft attitude and associated timings. This activity is called Opportunity Analysis and answers the question:

When is What feasible and How?

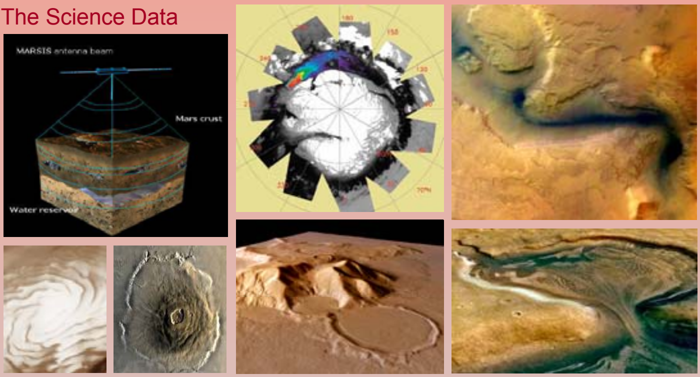




The Science Ground Segment



The Science Data



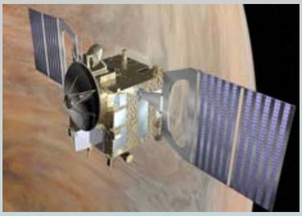
Venus Express

The Mission

Venus Express is ESA's first mission to Venus, Earth's nearest planetary neighbor. Launched on 9 November 2005 from Baikonur, the spacecraft arrived at its destination on 11 April 2006.

The spacecraft stays in a stable elliptical orbit of 24 hour. Pericenter is at 250 km altitude on the north pole, with apocenter at 66000 km altitude over the south pole.

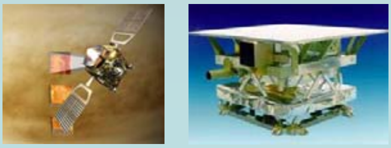
The main objective of the mission is to study the complex dynamics and chemistry of the atmosphere, as well as its interactions with the surface, which will give clues about surface's characteristics. It will also study the interplanetary environment (solar wind, plasma and magnetic field) to better understand the evolution of the planet.



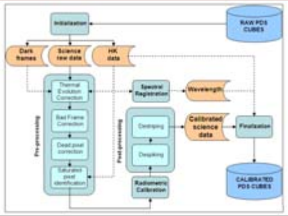
The VIRTIS Imaging Spectrometer

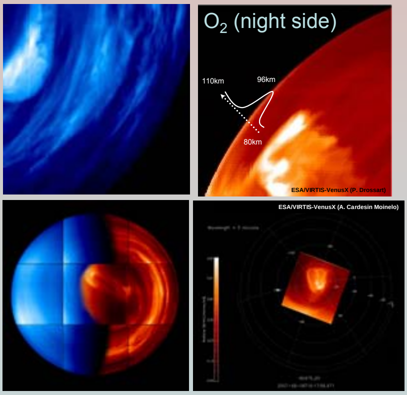
VIRTIS (Visible Infra-Red Thermal Imaging Spectrometer) is an imaging spectrometer which allows Venus Express to map details of Venus from the surface to the upper atmosphere.

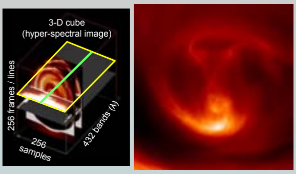
The instrument has two channels: M (mapping) devoted to hyper-spectral imaging and H for high-resolution spectral measurements. The observations obtained in the M-Infrared channel cover a wide spectral range (1µm-5µm) with very good sampling capabilities (~10nm), which are highly valuable for studies of morphology, dynamics and composition of the atmosphere and to infer the surface properties.



Data Generation and Calibration





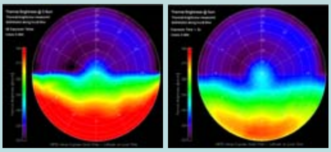


High Level Data Processing

Thermal Brightness

The following global maps show accumulated projections of more than 2000 images in the southern hemisphere of the planet, represented here with respect to Latitude and Local Time (night side up).

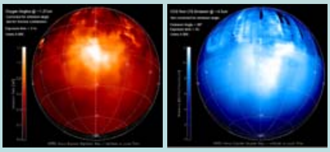
Both figures show average values of Thermal Brightness at two different wavelengths of the thermic region of the infrared spectrum: 3.8 µm and 5 µm respectively. It is noticeable the morning/evening difference, due to the atmospheric super-rotation and the relaxation of the atmosphere by radiative cooling during rotation.



Dayside and Nightside Airglows

These global maps show accumulated projections on the day and night side of the planet at two different wavelengths, represented again with respect to Latitude and Local Time (south pole down, north pole up).

The left figure shows the emission rate of Oxygen Airglow at 1.27µm, caused by the recombination of oxygen atoms in the night side of the planet, centered at the anti-solar point (midnight). The right image shows the non-LTE emission of CO_2 molecules at 4.3µm, centered around the sub-solar point (noon).



CISAS · esa · INSA INGENIERÍA Y SERVICIOS AEROESPACIALES, S.A. · INAF