SMOS – ESA's Water Mission

Mapping **S**oil **M**oisture and **O**cean **S**alinity

The Earth Explorer series continues

SMOS is next in the series of ESA's Earth Explorer missions, which are designed to observe critical Earth system variables. SMOS is the first satellite dedicated to providing global measurements of soil moisture and ocean salinity. This will further Europe's role as a key player in Earth Observation and help advance environmental research, addressing the challenges of understanding how the Earth system works and how human activity is impacting natural Earth processes.

Improving our understanding of the global water cycle

The amount of water in the soil and the salinity of the oceans may not seem connected, but, in fact, they are both key variables linked to the global water cycle. Variations in soil moisture and ocean salinity are a consequence of the continuous exchange of water between the oceans, the atmosphere and the land – Earth's water cycle, which not only sustains life on Earth but also plays an important role in weather and climate. Data from SMOS will:

- Fill the current lack of global and continuous observations of soil moisture and ocean salinity needed to improve our understanding of Earth's water cycle. This will help understand more about how a changing climate may be affecting patterns of evaporation over the land and oceans. Data from SMOS could improve weather and climate models, and have practical applications in areas such as agriculture and water resource management.

- Provide, for the first time, regularly-updated ocean salinity mapping from space, furthering our knowledge of ocean circulation patterns and their role in the climate system.

SMOS will provide global information on surface soil moisture every three days within an accuracy of 4% at a spatial resolution of 50 km. This is comparable to being able to detect one teaspoonful of water mixed into a handful of soil. SMOS will observe ocean salinity down to 0.1 psu (practical salinity unit) for a 30-day average over an area of 200x200 km, which is comparable to detecting 0.1 g of salt in a litre of water.

A completely new type of spaceborne instrument

Designed and built by a European consortium of industry and science, SMOS shows what European cooperation can achieve. SMOS demonstrates Europe's excellence in engineering and science by adopting a completely novel approach for observing Earth from space. The ability to measure soil moisture and ocean salinity is based on the fact that both parameters affect the electrical properties of land and ocean surfaces.

SMOS will carry an instrument called the Microwave Imaging Radiometer using Aperture Synthesis (MIRAS) – the first spaceborne, 2D interferometric radiometer operating at a frequency of 1.4 GHz (L-band,

wavelength ~21 cm). MIRAS will make global observations of emitted microwave radiation through almost all atmospheric conditions, at least once every three days.

To achieve the spatial resolution required for observing soil moisture and ocean salinity, a huge rotating antenna would have been necessary for a conventional radiometer. An elegant solution has been found to avoid such a costly and heavy system that would be difficult to employ in space. The required antenna aperture is synthesised from 69 separate antenna elements, which are equally distributed over three deployable arms (which form a Y-shape) and the central structure.

Facts and figures

- **Launch:** 2 November 2009
- **Orbit:** Mean altitude of 758 km and inclination of 98.44°; low-Earth, polar, Sun-synchronous, quasi-circular, dusk-dawn, 23-day repeat cycle, 3-day sub-cycle
- **Lifetime:** Three years (including a six-month commissioning phase) with a possible two-year extension
- **Instrument:** Microwave Imaging Radiometer using Aperture Synthesis – MIRAS, 2D interferometric L-band radiometer operating at 1.4 GHz (21 cm wavelength), with 69 antenna receivers distributed on a Y-shaped deployable antenna array and central hub.
  H and V polarisations measured sequentially
- **Satellite:** Proteus platform adapted to the needs of the SMOS mission
- **Satellite mass:** 658 kg (platform: 275 kg, payload: 355 kg, fuel: 28 kg)
- **Dimensions at launch:** Cylinder 2.4 m high and 2.3 m in diameter
- **Power:** Deployable solar panels with Si-cells, Li-Ion battery. Maximum power available for satellite: 1065 W, maximum consumption for MIRAS payload: 511 W
- **Communication links:** X-band downlink for science data to ESA's European Space Astronomy Centre (ESAC) in Villafranca, Spain, complemented by an X-band station in Svalbard, Norway, for acquisition of near-realtime data products; S-band uplink (4 kbps) and downlink (722 kbps) to Kiruna, Sweden, for satellite telemetry and telecommand (generic Proteus ground station)
- **Launcher:** Rockot (with Breeze-KM upper stage) by Eurockot Launch Services GmbH
- **Launch site:** Plesetsk Cosmodrome, Russia
- **Mission control:** CNES Proteus Control and Command Centre in Toulouse, France, via CNES S-band ground station network – Kiruna in Sweden, Aussaguel in France and Kourou in French Guiana
- **Data processing:** Data Processing Centre at ESAC, long-term archive at Kiruna, and User Services via ESA's Centre for Earth Observation ESRIN in Frascati, Italy

SMOS is an ESA Earth Explorer mission with national contributions provided by the French and Spanish space agencies, CNES and CDTI. For the operations phase, ESA will be responsible for the overall coordination of the mission and the ground segment operations, whereas CNES will operate the spacecraft. The design and construction of SMOS involved more than 20 European companies and was led by EADS CASA Espacio (Spain) for the payload and Thales Alenia Space Industries (France) for the satellite.

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