ESA’s water mission

Science: Variability of the moisture in soil and salinity in the oceans is a consequence of the continuous exchange of water between the oceans, the atmosphere and the land - the Earth’s water cycle. However, despite the water cycle being one of the most important processes operating on the planet - sustaining life and controlling our climate - this fundamental system is still relatively poorly understood.

Mission: SMOS (Soil Moisture and Ocean Salinity) mission will carry a sophisticated interferometric radiometer capable of observing both soil moisture and ocean salinity by capturing images of emitted microwave radiation at 1.4 GHz (L-band). These data are urgently needed to understand more about the Earth’s finite water resources, as well as advance weather and climate prediction. In particular, soil moisture data will be important for extreme-event forecasting. The objective is to acquire data to produce weekly global soil moisture maps to an accuracy of 4% volumetric soil moisture with a spatial resolution of approximately 25-50 km. Over the open ocean, the goal is to observe salinity down to 0.1 practical salinity units averaged over 10-30 days and an area of 200 x 200 km.

ESA’s ice mission

Science: Almost 80% of the Earth’s fresh water is locked up in ice and snow. As land and sea ice play a major role in moderating the global climate, the consequences of receding ice cover due to global warming are far reaching and complex. It is important to determine rates of change in the thickness of marine and continental ice cover for predicting future climate and sea level.

Mission: CryoSat-2 will acquire accurate measurements of the thickness of floating sea-ice so that seasonal to inter-annual variations can be detected, and will also survey the surface of continental ice sheets to detect small elevation changes. CryoSat-2’s high spatial resolution radar altimeter is capable of operating in a number of modes, optimised for measurement over different surfaces. The mission will determine regional trends in Arctic perennial sea-ice thickness and mass, and determine the contribution that the Antarctic and Greenland sea-ice sheets are making to mean global rise in sea level. CryoSat-2 will also observe the seasonal cycle and inter-annual variability of Arctic and Antarctic sea-ice mass and variation in the thickness of the Earth’s ice caps and glaciers.

ESA’s magnetic field mission

Science: The Earth’s magnetic field is complicated. Largely, it is produced by electric currents in the outer-core, but measurements taken at or near the surface also include the superposition of fields from magnetised rocks in the crust, electric currents flowing in the ionosphere, magnetosphere and oceans, and currents induced in the Earth by time-varying external fields. There is a need to understand how the different components of the Earth’s magnetic field vary in time and space.

Mission: Swarm is a constellation of three satellites that will provide high-precision and high-resolution measurements of the strength and direction of the magnetic field. GPS receivers, an accelerometer and an electric-field instrument will provide supplementary information for studying the interaction of the magnetic field with other physical quantities describing the Earth system. The geomagnetic field models resulting from the Swarm mission will provide new insights into the Earth’s interior, further our understanding of atmospheric processes related to climate and weather, and will also have practical applications in many different areas such as space weather and radiation hazards.
Although invisible, gravity is a fundamental and complex force of nature which, due to a number of factors, varies significantly from place to place on the surface of the planet. A better knowledge of the gravity field is needed to provide more insight into the Earth’s interior whilst a precise model of the geoid (a surface of equal gravitational potential defined by the gravity field) is crucial to understanding more about ocean circulation.

**Mission:** The GOCE (Gravity Field and Steady-State Ocean Circulation Explorer) mission is dedicated to measuring the Earth’s gravity field and modelling the geoid with unprecedented accuracy and spatial resolution. By employing a three-axis electronic gravity gradiometer that measures gravity gradients in all spatial directions, GOCE will determine gravity field anomalies with an accuracy of 1 mGal (where 1 mGal = 10^-5 m/s²), and the geoid with an accuracy of 1 cm – both with a spatial resolution of better than 100 km. This mission will advance our knowledge of ocean circulation, which plays a crucial role in energy exchanges around the globe, sea-level change and Earth interior processes. GOCE will also make significant advances in the field of geodesy and surveying.

**Science:** The wind is one of the most important variables that describe the state of the atmosphere. Accurate global observations on wind speed and direction are urgently needed to enhance atmospheric modelling so that operational weather forecasting, as well as the prediction of long-term climate change, can be improved. Observations have to be performed in space if global, independent and direct measurements are to be achieved.

**Mission:** The Earth Explorer Core Mission ADM-Aeolus (Atmospheric Dynamics Mission) will be the first space mission to measure wind profiles on a global scale. Expected to result in a breakthrough in weather prediction, Aeolus will probe the atmosphere with a highly sophisticated instrument called a ‘Doppler wind lidar’ with the objective of measuring global wind profiles up to an altitude of 30 km. Wind will be measured to an accuracy of 1 m/s in the planetary boundary layer (up an altitude of 2 km), and 2 m/s in the free troposphere (up to an altitude of 16 km). This mission will improve the accuracy of numerical weather forecasting and advance our understanding of atmospheric dynamics and processes relevant to climate variability and climate modelling.

**Science:** The Earth’s radiation budget is primarily governed by the atmosphere, biosphere, hydrosphere, cryosphere and the Earth’s interior, with the overall emphasis on providing data to advance our understanding of the interactions between these components and the impact that human activity is having on natural Earth processes.

**Mission:** The ESM (Soil Moisture and Ocean Salinity) mission is dedicated to determining the state of the Earth’s surface, subsurface and ocean, with a focus on the Earth’s water cycle and the effects of climate change. SMOS will measure ocean salinity with an accuracy of 0.1% (where 1% = 10^4 m) and sea-ice concentration with a spatial resolution of 50 km. This mission will advance our knowledge of ocean circulation, which plays a crucial role in energy exchanges around the globe, sea-level change and Earth interior processes. SMOS will also make significant advances in the field of geodesy and surveying.