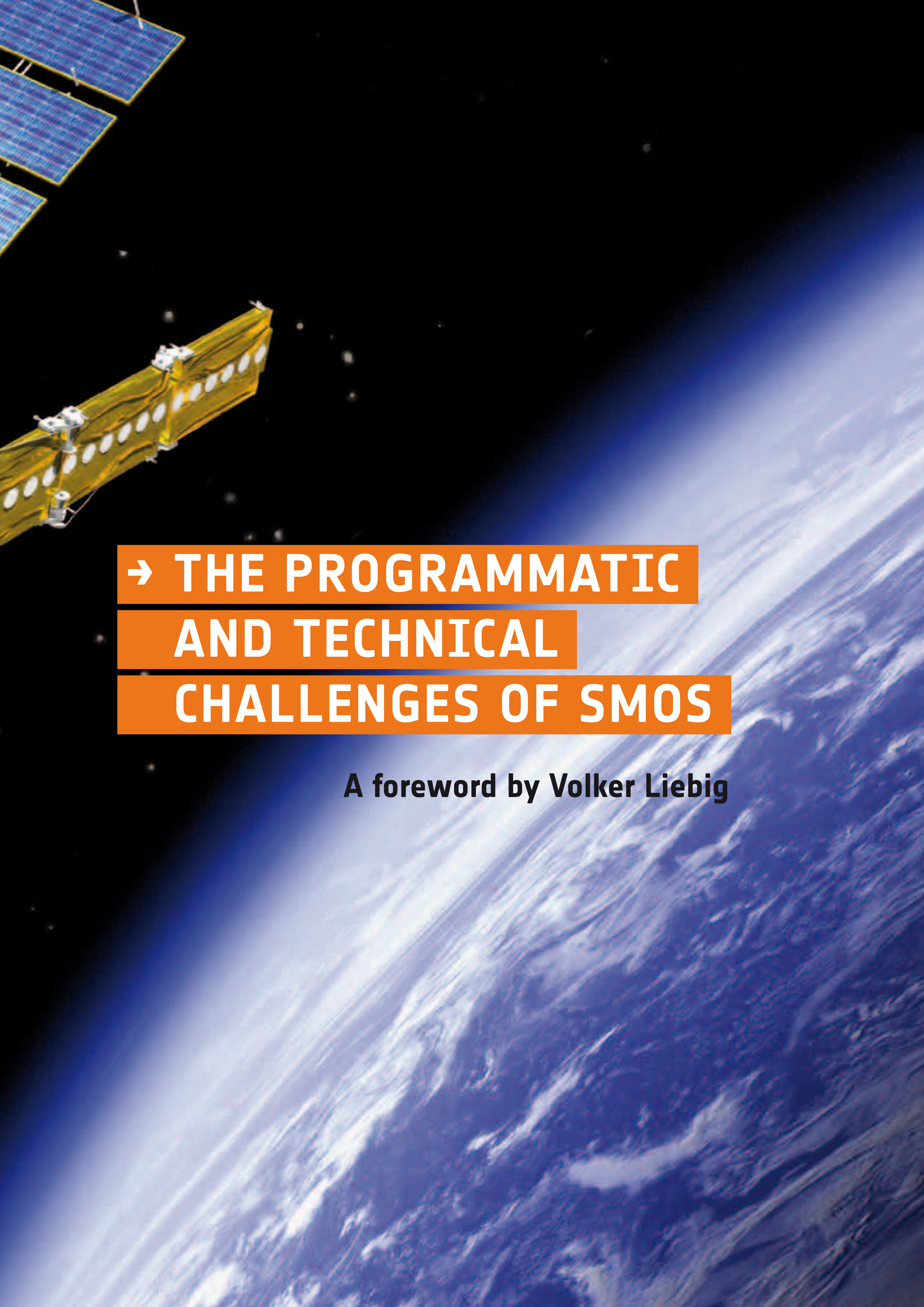

→ THE PROGRAMMATIC AND TECHNICAL CHALLENGES OF SMOS

A foreword by Volker Liebig

With the imminent launch of the Soil Moisture and Ocean Salinity (SMOS) mission, ESA continues its line of Earth Explorers in its Earth Observation Envelope Programme. For the first time we will receive global information from space about soil moisture over land and sea-surface salinity over the oceans.

ESA's fleet of Earth Explorers are research missions focusing on the different characteristics of our planet. They will make global observations from space to advance our understanding of the interactions within the Earth system and investigate the impact of human activities on our environment.

The SMOS mission will provide data on two key variables in the hydrological (water) cycle: soil moisture and ocean salinity. Both are important in climate research to improve climate change predictions.

SMOS observations of soil moisture will further our knowledge about processes in the water and energy fluxes at the land surface/atmosphere interface and will provide information on storage of water, water uptake by vegetation, fluxes at the interface and the effect of these on water run-off.

This knowledge is important to improve meteorological and hydrological modelling and forecasting, water resource management and monitoring of plant growth, and contributes to the forecasting of hazardous events such as floods.

Ocean salinity is a key variable in characterising global ocean circulation and its seasonal and interannual variability, and thus is an important constraint in ocean-atmosphere models. SMOS observations will therefore improve seasonal-to-interannual climate predictions (e.g. for the El Niño Southern Oscillation), and the estimates of ocean rainfall and thus the global hydrologic budgets.

They will also aid the monitoring of large-scale salinity events and improve monitoring of sea-surface salinity variability. The latter is needed to better understand and characterise the distribution of bio-geochemical parameters in the ocean's surface and upper layers.

Providing such data from space represents a real technical feat. The instrument on SMOS, the Microwave Imaging Radiometer using Aperture Synthesis (MIRAS), operates in the microwave 'L band' frequency range at 1.4 GHz, and measures brightness temperatures as a function of polarisation and angle. It applies the technique of interferometry to provide a spatial resolution suitable for the

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The technology 'pathfinder': the Very Large Array in New Mexico as used by radio astronomers for . This telescope array consists of 27 25-metre diameter dish antennas that together comprise a single radio telescope system (NRAO)

global measurements we want to make. SMOS is the first mission to apply such a technique in space.

To make this concept work, the MIRAS instrument has to overcome a number of technical challenges: in particular, the 69 individual receivers that form the elements of the interferometric array have to be as 'identical' as possible in their amplitude over frequency response. For all receivers, the sampling time has to be the same within 0.5 ns, which implies the first-ever use in space of a distributed fibre optical harness. Not only that, but the three arms that accommodate the rows of receivers each span more than 4 metres. They can only be carried on the satellite if folded during launch and deployed once arriving in orbit.

Just as challenging as the technology has been the programmatic setup of SMOS. With the Envelope Programme allowing explicit interagency cooperation, SMOS has been conceived from the outset as a cooperation between ESA, the French space agency CNES and the Spanish space agency CDTI. The contribution of CDTI included funding for the payload ground segment, and also for the space segment through ESA's General Support Technology Programme. The CNES cooperation comprised the provision of a suitably adapted recurrent PROTEUS platform and its generic flight operations ground segment.

Furthermore, ESA and CNES shared equally and managed the tasks of system engineering and satellite assembly, integration and testing, up to and including the launch campaign. Finally, CNES will operate the satellite and supporting ground segment throughout its mission lifetime, while ESA will maintain the overall management responsibility for the mission and its operations.

While SMOS is readied for launch on a Rockot launcher from the Plesetsk cosmodrome in Russia, the 'finishing touches' are being made to the data-processing ground segment at ESAC, Spain. Tuning of the processors at level 1 (brightness temperature) and level 2 (soil moisture and ocean salinity, respectively) will continue, in order to have the best possible versions of the processors installed for the commissioning phase.

Also, a large number of scientific groups are preparing for the calibration and validation of the eagerly awaited data from SMOS. This comprises a variety of measurement efforts over land and sea, such as field campaigns to deploy soil moisture probes and radiometers such as ELBARA, buoys with salinity sensors, or airborne campaigns carrying instruments such as EMIRAD, which will provide measurements similar to the ones expected from MIRAS. ■

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A view of Earth, the ‘Blue Planet’, taken from Apollo 17 in 1972 (NASA)