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Topic: Critical drivers for ocean salinity science and applications and the future need for high-resolution technologies

Title: The Fine Resolution Explorer for Salinity, Carbon and Hydrology (FRESCH) L-band mission

Abstract: Monitoring the dynamic evolution of the coastal ocean at the interfaces with the land, the atmosphere and the cryosphere, is key to understanding the present and future climate of the Earth, the impact of human-induced environmental perturbations and their effect on the marine ecosystems and the society. Understanding the energy and biogeochemical cycles at the interfaces requires a proper representation of (sub)mesoscale processes that are ubiquitous in the entire ocean and occur at spatial scales of 1 to 100 km and temporal scales of days to months. The sea surface salinity (SSS) can be used to trace transport phenomena associated with (sub)mesoscale dynamics. In combination with other, SSS enables the identification of water masses that carry various carbon contents or other compounds in the ocean and across interfaces, via e.g. river outflows, and influence the air-sea gas exchange. and can be used to estimate the sea surface partial pressure of CO2 (pCO2), which drives air-sea CO2 flux.
The lack of sensors to observe SSS at the spatial resolution required to study interface regions (1-10 km) has not yet allowed these comprehensive studies except in the regions of the world's largest rivers plumes. Therefore, the primary goal of the Fine Resolution Explorer for Salinity, Carbon and Hydrology (FRESCH) mission is to produce SSS and pCO2 maps with a spatial resolution of ~10 km at temporal scales of 1-3 days and with an accuracy of 0.4 pss and <12 microatm, respectively. The objectives are: (i) Understanding the spatial and temporal variability of the processes taking place at the ocean's interface with land, ice and the atmosphere in coastal regions, (ii) Resolving (sub)mesoscale circulation patterns in the ocean, and (iii) Estimating pCO2 in the surface ocean.

In addition to SSS and pCO2, FRESCH will also provide estimates of soil moisture, vegetation water content and soil freeze-thaw state over land, sea ice thickness, stability and melting of ice sheets in polar regions. FRESCH will deliver data on four Essential Climate Variables (ECVs: SSS, sea ice, soil moisture and biomass) and data related to another four ECVs (dissolved inorganic carbon, evaporation from land, fires and permafrost surface temperature). Thanks to these variables, FRESCH will address a number of secondary mission objectives such as: (i) Reducing uncertainties in the terrestrial carbon and water cycle to better understand fluxes in the land-ocean interface regions, (ii) Improving estimates of the shrinking cryosphere in support of better understanding of the ice-ocean interfaces, (iii) Monitoring of extreme events, hazards and operational applications.

FRESCH is a multi-polarization, multi-incidence angle, L-band imaging radiometer composed of an array of 172 antennas distributed along a cross with four ~8.5 m orthogonal arms. An innovative beamforming approach will be used to provide a native resolution of 11-14 km. The radiometric sensitivity over the ocean will be ~0.2 K. FRESCH will be equipped of sophisticated filtering techniques to mitigate the effect of radio frequency interference from artificial sources at L-band. FRESCH was submitted to the ESA Earth Explorer 12 program. It was evaluated as "commended mission" and it is currently the subject of an ESA pre-phase 0 study to consolidate the science requirements.

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