Preliminary validation of SMOS products (Levels 3 and 4).

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The Soil Moisture and Ocean Salinity mission (SMOS) from the European Space Agency, launched in November 2009, has initiated the era of satellite-based salinity observations. However, because of the numerous geophysical contamination sources and the retrieval complexity, salinity products will have a low signal-to-noise ratio at Level 2. Averaging data in space and time is expected to allow a reduction of the observational error down to mission requirements (0.1 psu) at Level 3 (global maps with regular distribution). Robust, geophysical consistency is expected to be reached at Level 4, when the SMOS salinity data is combined with data from other sources as, for example, satellite sea surface temperature, surface winds, estimates of evaporation and precipitation, and even remotely-sensed ocean color.

At Level 3, salinity outputs are scrutinized on the basis of their temporal and spatial variability. The first objective is the detection of residual potential error patterns not detected at lower data processing levels (they can be attributed to residual instrument calibration, external contributions from sun or galactic glint, and land contamination). Spectific selection of environmental conditions is used to help distinguish the role of each factor. The second objective concerns the validation against average meridional distribution and global distribution maps. The results will help discerning other potential sources of bias coming from the salinity inversion algorithm and the imperfect forward empirical models and auxiliary information. The spatial patterns of departure from climatology are compared to spatial patterns of other geophysical parameters and anomalies. Other planned tasks include checking the consistency between the along-track salinities at level 2 and the spatio-temporal averages at level 3 provided by the CP34, and evaluating the expected variance reduction with increasing averaging windows.

On the other hand, two strategies are being explored at the SMOS-Barcelona Expert Centre (SMOS-BEC) to provide Level 4 salinity products: Data Fusion (combination of data from different sources to improve inferences for each product) and Data Assimilation (combination of data from different sources with a numerical model representing the dynamical evolution of the system).

The methods to be used for data fusion will be: i) the multivariate empirical orthogonal functions, and ii) multifractal inference. Both analyses will be applied at global scales. In the first case, the covariance of the level 3 salinity maps is compared against historical and model-derived covariance of salinity. The covariance of salinity is being examined individually and together with the variance of sea surface temperature to identify regions at which the level 3 salinity products are not consistent with the historical combined temperature/salinity covariance. The total fields, as well as their seasonal and interannual components, are being analyzed. In the second case, the existing cascade structure of sea surface temperature and ocean colour maps are used to improve the structure of the same cascade on sea surface salinity maps. Any scalar being advected by the flow (salinity, temperature, or chlorophyll) possesses a multifractal structure (determined by the cascade) which is independent of that scalar and only depends on the characteristics of the underlying flow. Our cascade-based data fusion technique combines this common part of the information conveyed by any scalar. Taking advantage of the ability of these methods to merge information from different sources, the best approach for merging data from SMOS and the future Aquarius mission is being investigated.

Due to the complexity of maintaining an operational ocean model (beyond the scope of the activities of the SMOS-BEC), our data assimilation efforts for assimilating sea surface salinity into an ocean model are geographically restricted to the eastern North Atlantic Ocean (a region used for the calibration of the satellite). As a first step, we have investigated the origins and structure of model-salinity errors. Three main sources of error have been identified: external forcing errors (mainly wind stress errors), initial conditions (mainly salinity and velocity fields), and uncertainties associated with various model parameters (we focused on vertical mixing parameterization and air-sea fluxes computation). The next step is the use of an Ensemble Kalman filter to simultaneously assimilate available in-situ and satellite observations to investigate the contribution of SMOS remotely sensed salinity in our region of interest.