A new method for correcting antenna patterns in SMOS

Although SMOS was launched in November 2009, the sea surface salinity maps retrieved from SMOS brightness temperature images have not yet achieved the mission requirements. Strong spatio-temporal biases prevent consistent analysis of global datasets acquired at several week intervals. Characterization and mitigation of instrumental and model biases are of primary importance.

The systematic error correction strategy implemented in the SMOS operational processing chain mixes all kind of biases, namely related to the antenna patterns, the antenna losses, the foreign source imperfect corrections, or the errors in the forward model used for geophysical parameter inversion.

This practical strategy prevents consistent calibration error diagnostic or forward model improvement tasks. An alternative strategy which separates the different systematic error contributions and provides higher stability of the estimates is required and has recently been proposed. It allows diagnosis of the systematic (constant with time) TB errors in the antenna frame, with no impact of forward model errors.

A specific data selection strategy and the use of an empirically fitted, one-parameter (incidence angle) TB model allows to split the average brightness temperature image in two different components: the average geophysical pattern and the antenna pattern. The geophysical variability induces changes on the dielectric constant, and leads to an essentially azimuth-independent average image. The difference between the average image and the average geophysical pattern is likely associated to the azimuthal TB anomalies induced by the antenna pattern errors through the reconstruction process.

Hovmuller diagram of the modelled half 1st Stokes celestial signal as reflected by a smooth sea surface. The results correspond to the geometry of the SMOS platform during ascending passes and are averaged over the entire alias-free field of view.

Contour plot of the probability density function of auxiliary SST/SSS values corresponding to the TB observations made at 45 degree incidence angle and 8 m/s wind speed. The contour value represents one one-hundredth of the pdf maximum. The thick (thin) line corresponds to the June (December) 2011 dataset. The thin dashed lines correspond to the 93 to 96 K isolines of half of the first Stokes brightness temperature from a smooth sea surface as expected from Klein and Swift (1977). The thin square line indicates the selection domain corresponding to a selection procedure based on SSS and SST thresholds rather than a “flat sea” TB.

Top left: average SMOS reconstructed image for half of the first Stokes parameter. Isolines of incidence angle at the Earth surface are superposed. Top right: same data as left plot but represented in a one-dimensional space along incidence angle. An example of empirical polynomial regression as performed in section III is also shown. Bottom: azimuthal anomaly pattern obtained as the difference between the mean image from the left panel and the one-parameter model from the right panel.

Furthermore, the robustness of the methodology has been proved by the stability of the estimated anomaly patterns when estimated from several datasets corresponding to different range of geophysical conditions. The residual variability within the different test dataesets ranges from 0.03 to 0.14 K rms, hence providing enough control on the environmental conditions – essentially celestial contamination.

Therefore, the stable patterns obtained in the present work may be applied to the SMOS TB (half of the first Stokes parameter) images to reduce the current azimuthal inconsistency found at different locations in the image or field of view (FOV), without modifying the data average absolute level and incidence angle dependence.

This method has thus a crucial capability, both for future error characterization and forward model improvement tasks.

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