REGULARIZED INVERSION OF FULL-POLARIMETRIC DATA FOR THE SMOS SPACE MISSION

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ABSTRACT

It is well established that Synthetic Aperture Imaging Radiometers (SAIR) promise to be powerful sensors for high-resolution observations of the earth at low microwave frequencies. Within this context, the European Space Agency (ESA) has developed the SMOS mission. The launch is scheduled for next Q3. This explorer mission is devoted to the monitoring of Soil Moisture and Ocean Salinity at global scale from L-band space borne radiometric observations obtained with the two-dimensional L-band interferometer MIRAS [1][2]. MIRAS consists of a Y-shaped interferometric array fitted with 69 equally spaced antennas operating at 1.415 GHz.

This contribution is concerned with the reconstruction of radiometric brightness temperature maps from interferometric measurements also called complex visibilities. The problem of retrieving this radiometric temperature distribution of a scene under observation from these visibilities has been widely addressed. It has been demonstrated that this problem is ill-posed and has to be regularized in order to provide a unique and stable solution [3]. This contribution extends the band-limited approach [4], selected by the ESA for the SMOS mission, to the case of the processing of full-polarimetric data.

MIRAS has two operational modes: the *dual-pol* and the *full-pol* modes. In dual-pol mode, only the two first Stokes parameters are attainable [5], whereas in full-pol mode measurements of the four stokes parameters are available. We describe here the retrieval of the corresponding four brightness temperature maps T_1, T_2, T_3 and T_4 from the four sets of complex visibilities V_1, V_2, V_3 and V_4 measured in full-pol mode. Owing to the number of Stokes parameters in full-pol mode, the modeling equations are more complex than in the dual-pol. The dimension of the problem is sixteen times larger than the simple polarization case while it was only four times larger in the dual mode. Moreover, the visibilities thus obtained are coupled, meaning that each set of visibilities depends simultaneously on the four brightness temperature distributions.

It is first shown that the band-limited approach could be extended thoroughly to the processing of full-polarimetric data. Depending on the level of coupling between the visibilities, the retrieved maps are obtained either at the cost of the resolution of a large coupled system (complete solution), or with the resolution of three independent problems of smaller size (approximate solution) if the coupling cold be neglected. It is shown that the complete solution is stable in any case. The quality of the reconstructed maps is therefore not affected by any size effects. However, contrary to the dual case, it turns out that the approximate solution may lose its stability. As a consequence, this solution can no longer be recommended for operational inversion in full-pol mode. A third intermediate solution has been

proposed for reducing the computational time [6]. It turns out that this solution is more accurate than the approximate one.

The stability of these three solutions with the level of coupling is finally studied. It is here illustrated by the plots shown in Fig. 1. With regard to the voltage patterns of MIRAS already measured (average coupling is -22 dB), it turns out that the coupling could not be neglected in the reconstruction process for the approximate solution since it is above a limit which has been found to be -40 dB . However, it could be neglected in the bias reduction technique for the intermediate solution since it is below a limit which has been found here to be -20 dB. In any case, the full maps retrieved with the complete approach are not affected by the coupling, provided that this coupling is properly taken into account.

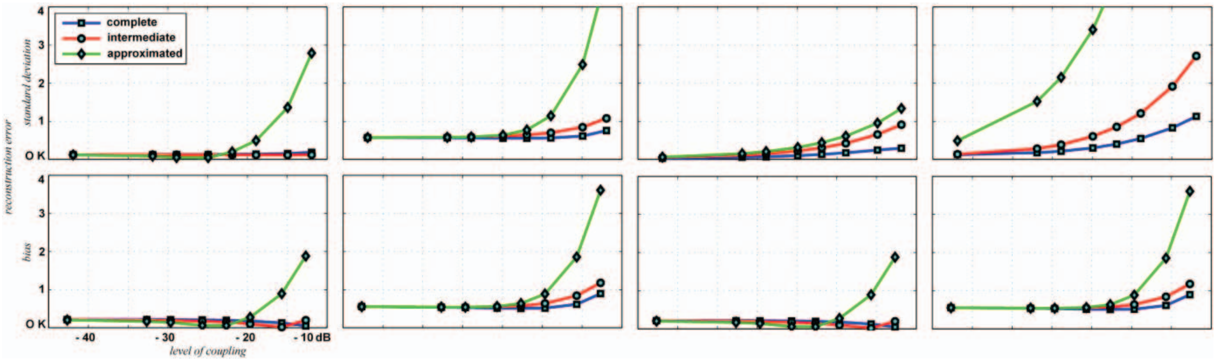

Fig. 1.- Variations of the reconstruction error (bias & standard deviation) in full-pol mode with the coupling level for the four Stokes parameters (from left to right: T_1, T_2, T_3 and T_4).

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