REGULARIZED IMAGE RECONSTRUCTION FOR GEOSTATIONARY ATMOSPHERIC SOUNDERS

Eric Anterrieu(1), Andreas Colliander(2), Tapani Narhi(3), Jacob Christensen(4) and Peter de Maagt(3)

(1)Laboratoire d'Astrophysique de Toulouse-Tarbes, Université de Toulouse & CNRS,
14 avenue Edouard Belin - 31400 Toulouse, France
Email: Eric.Anterrieu@ast.obs-mip.fr

(2)Jet Propulsion Laboratory
4800 Oak Grove Drive, M/S 300-323, Pasadena, CA 91109, USA
Email : Andreas.Colliander@jpl.nasa.gov

(3)ESA-ESTEC,
Keplerlaan 1, 2200 AG Noordwijk, The Netherlands
Email: Tapani.Narhi@esa.int, Peter.de.Maagt@esa.int

(4)RUAG Aerospace AB,
Gothenburg, Sweden
Email: Jacob.Christensen@ruag.com

ABSTRACT

The concept of microwave sounding from geostationary orbit is now over three decades old and many projects are currently under studies at frequency bands of oxygen (54, 118 and 425 GHz) and water vapor (183 and 380 GHz). The primary advantage of a Geostationary Earth Orbit (GEO) for remote sensing, compared with a Low-Earth Orbit (LEO), is that continuous monitoring is possible over a large area of the Earth's surface and atmosphere. However, one technical challenge is the large antenna aperture needed to achieve the required spatial resolution, which corresponds to a 40 fold increase in the distance to Earth as compared to LEO. One solution is to utilize synthetic aperture radiometry to obtain the desired spatial and temporal resolution for atmospheric temperature and humidity profiles from interferometric measurements under all weather conditions.

Aperture synthesis technique is well established within radio astronomy for many years and has been chosen by the European Space Agency (ESA) for the SMOS mission which is just being prepared for launch 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. The signals collected by each antenna are pair wise cross-correlated to sample the so-called visibility function, i.e. the coherence function of the brightness temperature distribution of the scene under observation. The retrieved image is then obtained through post-processing of the complex visibility samples.

This contribution is concerned with the regularized inversion of interferometric measurements provided by a synthetic aperture geostationary atmosphere sounder. The problem of retrieving the radiometric temperature distribution of a scene under observation from complex 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 [5] to the case of the processing of interferometric data obtained with variable integration time.

Indeed, in order to reduce the number of antenna elements required for the desired spatial resolution from GEO, it has been suggested to use a rotating Y-shape interferometric array [6,7] and to overcome the drawback of the gridding due to the rotation by measuring the different visibility samples with different integrations times so that they all belong to a predesigned cell of a regular grid [8]. It is first shown that the band-limited approach selected for the SMOS mission could be extended thoroughly to the processing of such data without any significant additional cost despite the significant changes concerning the altitude of the platform (from LEO to GEO) and the central frequencies of observation (from 1.415 GHz to 54, 118, 183, 380 and 425 GHz). Numerical simulations are carried out in order to illustrate the impact of the variability of the integration time on the quality of the reconstructed images. It is first concluded that this variability should be taken into account. Provided that it is properly taken into account it is shown that it has a very small impact on the quality of the reconstructed images.

BIBLIOGRAPHY

[1] M. Martin-Neira *et al.*, "*Miras, a two dimensional aperture synthesis radiometer*", *proc. IGARSS'94 (Pasadena, CA, USA)* vol. **3**, pp. 1323–1325, 1994.
[2] Y.H. Kerr *et al.*, "*Soil moisture retrieval from space: the Soil Moisture and Ocean Salinity (SMOS) mission*", *IEEE TGARS* 43(**2**), pp. 1729–1735, 2005.
[3] B. Picard and E. Anterrieu. "*Comparison of regularized inversion methods in Synthetic Aperture Imaging Radiometers*", *IEEE TGARS* 43(**2**), pp. 218–224, 2005.
[4] E. Anterrieu. "*A resolving matrix approach for synthetic aperture imaging radiometers*", *IEEE TGARS* 42(8), pp. 1649–1656, 2004.
[5] E. Anterrieu and A. Khazaal, "*Brightness temperature map reconstruction from dual-polarimetric visibilities in synthetic aperture imaging radiometry*", *IEEE TGARS* 46(**3**), pp. 606–612, 2008.
[6] J. Christensen *et al.*, "*GAS: the Geostationary Atmospheric Sounder*", *proc. IGARSS'07 (Barcelona, Spain)*, 2007
[7] A. Carlstrom *et al.*, "I*mage retrieval simulations for the geo atmospheric sounder (GAS)*", *proc. IGARSS'08 (Boston, Massachusetts, U.S.A.)*, 2008
[8] H. Liu *et al.*, "*Radiometric Analysis of the Rotating Synthetic Aperture Radiometers utilizing Grid-based Measurement Approach*", *proc. IGARSS'07 (Barcelona, Spain)*, pp. 235–238, 2007.