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Geophysical Research Abstracts
Vol. 12, EGU2010-9507-1, 2010
EGU General Assembly 2010

Water Vapour GNSS Based Tomography For Wet Delay Compensation In In-SAR Applications

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One of the most challenging exploitation of GNSS signals for meteorological applications is the retrieval of Water Vapor tridimensional distribution. The real-time (or quasi real-time) knowledge of such distributions could be very useful for several applications: from operative meteorology to atmospheric modeling, or for atmospheric compensation purposes applied for example to SAR or In-SAR observations, in order to improve land remote sensing.
In the framework of the European Space Agency project METAWAVE (Mitigation of Electromagnetic Transmission errors induced by Atmospheric Water Vapor Effects), several techniques were investigated in order to find out an In-SAR data compensation strategy for the propagation delay effects due to Water Vapour. Thanks to METAWAVE, a quite dense GPS network (7 dual frequency GPS receivers) was deployed over COMO area and was used for an extensive measurement campaign. The acquired L1 and L2 carrier phase observations were processed in terms of hourly averaged Zenith Wet Delays. These vertical information were mapped along the correspondent line of sights (by up-sampling at 30 second sample times the 15 minutes GPS satellites positions obtained from IGS files) and inverted using a tomographic procedure. The used algorithm performs a first reconstruction (namely, the tomographic pre-processing) based on generalized inversion mechanisms, in order to define a low resolution first guess for the next step. This second step inverts GPS observables using a more refined algebraic tomographic reconstruction algorithm, to improve both vertical and horizontal resolution. Results of this inversion are Wet Refractivity maps distributed over an area of 16 km x 20 km (x 10 km height) around the COMO city, characterized by horizontal resolutions varying from 2 km to 4 km and vertical resolution of 500m.
This contribution deals with the description of the results obtained evaluating Water Vapour path delays from such Wet Refractivity maps. Integrals of Wet Refractivity along given line-of-sights were validated considering a self-consistency approach. Sensitivity of final results to the observation geometry will be discussed and improvements related to the ingestion of low elevation observations will be analyzed. In addition remarks about the reconstruction error in function of distance from a certain reference station and of station height will be highlighted. Finally, interesting results related to the use of high-rate real slant Delays as input to the tomography will be shown.
The authors are grateful to ESA for supporting this work in the framework of the project METAWAVE, to the project PIs Prof. N. Pierdicca and Prof. F. Rocca and to G. Venuti and Prof. F. Sansò (Politecnico di Milano) for the COMO GPS network data acquisition and data processing.