Geophysical Research Abstracts
Vol. 18, EGU2016-15855, 2016
EGU General Assembly 2016
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The wet refractivity tomography for improving the InSAR deformation measurements on Mt. Etna

Claudia Spinetti (1), Massimo Aranzulla (2), Francesco Guglielmino (2), Flavio Cannavo' (2), Vito Romaniello (1), Pierre Briole (3), and Giuseppe Puglisi (2)

(1) Istituto Nazionale di Geofisica e Vulcanologia, Centro Nazionale Terremoti, Roma, Italy, (2) Istituto Nazionale di Geofisica e Vulcanologia - Sezione di Catania "Osservatorio Etneo", Catania, Italy, (3) Ecole Normale Supérieure – PSL Research University – UMR CNRS 8538, Paris, France

In the frame of the EC FP7 MED-SUV project, we carried out a study to improve the accuracy of the ground deformation monitoring at Mt. Etna volcano (Italy) by modelling of the tropospheric delays. We use GPS and multispectral satellite data to reduce the atmospheric artefacts in the SAR interferometry. Among various effects affecting interferograms, atmospheric artefacts are among the most significant and the most difficult to model. Due to the orography of Mt. Etna and the space-time variability weather conditions, it has been shown that the atmospheric heterogeneities can affect GPS and InSAR measurements at a vey high level, with extreme values of anomalies with respect to a standard model that can reach 100 mm (or 4 C-band fringes) in some cases. For these reasons the estimation of Mt. Etna atmospheric anomalies is crucial to calibrate the InSAR measurements.
Nowadays the Istituto Nazionale di Geofisica Vulcanologia, Osservatorio Etneo (INGV-OE) monitors the ground deformations at Mt. Etna with a network of 42 GPS permanent stations spread over and around the entire volcano edifice. Data collected by the GPS monitoring network have been processed by the GAMIT software, by adopting the Vienna Mapping Functions (VMF1) to improve the modelling of the tropospheric delays. A specific software has been developed in order to derive the tomographic imagery of the troposphere over Etna volcano starting from the tropospheric delays calculated by GPS in all the stations of the network. The algorithm developed has been validated by using synthetic tests. They consist in assuming different structures of atmospheric anomalies in the input data and verifying that the algorithm is able to reproduce them. The test results confirmed the capability of the software to return the simulated anomalies faithfully. With the aim of applying the tomography algorithm to a real case, we introduce the water vapour content estimated by the MODIS instrument on board of the satellites Terra and Aqua. When the cloud covers permits the use of this data, its addition provides a double benefit: it improves the tomographic resolution and it adds a feedback for the GPS wet delay measurements.
Finally, the tomography algorithm was applied on InSAR Sentinel-1 IW data on Mt. Etna during the 2015 year. In order to reduce the known problem of the correction for the antenna pattern, the interferometric process was performed only on one burst of one subset of Sentinel-1 IW data. We present the results of this analysis of some 2015 test cases.