Geophysical Research Abstracts,
Vol. 10, EGU2008-A-01709, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-01709
EGU General Assembly 2008

From GPS to tomography for SAR imagine correction

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Water vapor is one fundamental component in the atmosphere and it is the main driver of meteorological processes. Both GPS and SAR signals are delayed by the presence of water vapor in the lowest atmospheric layer, the troposphere.

However using the GPS technique is possible to identify its presence: in fact the GPS network adjustment provides not only the stations coordinates but also the Zenith Tropospheric Delays that are functions of water vapor content.

The GPS system can provide tropospheric "products" at two different levels: ZTD hourly estimates for each station involved in the process and tropospheric tomography that allows the determination of the refractivity index for a 3D grid: cells size is function of GPS stations density. Both the types of products can be used to correct the atmospheric effects present in SAR interferograms.

The first aim of this work is the evaluation of GPS potential in water vapor estimation by analyzing the external consistency with other meteorological data, similarly to what are find in literature. Particularly, we have analyzed ZTD's produced from daily adjustment of GPS Lombardia permanent network. Using meteorological data (pressure, temperature and humidity) observed from meteorological stations, ZTD's have been inferred for the same sites: differences between the two estimates are of the order of some centimeters. Moreover a ZTD's spatial interpolation (using the inverse of distance method) has been tested by using as check data the same observed values. Also in this case the results shown have a consistency of a few centimeters. The experiment confirms the possibility to use GPS permanent networks for water vapor estimate: procedures and results are discussed in the paper.

Moreover a project, called MIST, to produce tropospheric tomography at a local level to correct SAR interferograms, is under development. Regional GPS networks don't allow to perform tropospheric tomography because of too large distance between stations. For this reason we are envisaging a specific test to cover very locally different scales in order to derive data suitable to correct SAR measurements.

The MIST project goal is to do tropospheric tomography in Como: the plan foresees the use of Lombardia permanent network and the installation of a six GPS receivers local network: three receivers at 100-300 meters and three 1-2 kilometer far. The idea is to compare the estimated water vapor density at different resolution with that produced the permanent scatterers analysis in the area. The receivers will acquire data for at least forty-five days in order to cover two passages of a SAR satellite. The measurement campaign is scheduled in spring 2008. The data will be analyzed with SOfTT software: the software performs tropospheric tomography by estimating refractivity index in 3D voxels centers. Tomography results will be validated by trying to apply them to SAR interferograms. Moreover a new tropospheric tomography method based on 3D kriging will be studied, implemented and tested. MIST project and first results are discussed in the paper.