InSAR water vapour correction models: GPS, MODIS, MERIS and InSAR integration

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Abstract

A major source of error for repeat-pass InSAR is the phase delay in radio signal propagation through the atmosphere (especially the part due to tropospheric water vapour). To date, we have developed three water vapour correction models to reduce water vapour effects on InSAR measurements using GPS, MODIS and/or MERIS data:

(1) GPS Topography-dependent Turbulence Model (GTTM) (Li et al., 2005a): Taking into account the power-law relation of water vapour variation as well as topographic effects on water vapour, the GTTM model uses only data from a dense GPS network with a DEM to reduce water vapour effects on InSAR measurements;

(2) GPS/MODIS integrated water vapour correction model (Li, 2004; Li et al., 2005c): In this model, GPS data from one or more stations is used to calibrate the scale uncertainty of MODIS near IR water vapour products, and then to produce regional 1 km × 1 km water vapour fields for InSAR atmospheric correction;

(3) MERIS water vapour correction model (Li, 2005, Li et al., 2005b; Li et al., manuscript in preparation, 2005). MERIS and the Advanced Synthetic Aperture Radar (ASAR) are on board the same platform (ENVISAT), and they can collect observations simultaneously, while there are usually time intervals of up to 60 minutes between MODIS and ASAR (or ERS-2) data. Moreover, MERIS has finer spatial resolution, up to 300 m against 1 km for MODIS. Therefore, the MERIS correction model is more advantageous to ASAR than the GPS/MODIS integrated model is to ASAR (or ERS-2).

Application of all the three correction models to ASAR data over the Los Angeles region shows that the order of water vapour effects on interferograms can be reduced from ~10 mm to ~5 mm using the GTTM, the GPS/MODIS integrated, or the MERIS models. It is also clearly shown that these three water vapour correction models are complementary. On the one hand, GPS can collect high temporal resolution (e.g. 30 seconds) observations day and night, and GPS water vapour product is insensitive to the presence of clouds. However, only a few dense continuous GPS networks such as the Southern California Integrated GPS Network (SCIGN) operate across the globe, and its spatial resolution is also limited from a few kilometres to a few hundred kilometres. On the other hand, MODIS and MERIS have a global coverage with a finer spatial resolution as compared with current Continuous GPS (CGPS) networks. But MODIS and MERIS near IR water vapour products are only available for the daytime, and are sensitive to the presence of clouds.

We also investigate the impacts of time difference between water vapour products and SAR data on the reduction of water vapour effects on InSAR measurements, as well as the influence of the spatial resolution of water vapour products.

References: (1) Li, Z., Production of regional 1 km × 1 km Water vapor fields through the integration of GPS and MODIS data (Winner of Student Paper Prize & Best Paper Presentation), in ION GNSS 2004, Long