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A Tropospheric correction method for short and long-swath InSAR processing

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Interferometric Synthetic Aperture Radar (InSAR) techniques have been used successfully in the past 20 years to study crustal deformation processes. Recently, considerable effort has been put into long-swath processing and the extraction of long-wavelength, small magnitude deformation signals. At the same time, time-series InSAR techniques have been developed, which can partly solve for the issues of temporal decorrelation and atmospheric noise. While future SAR missions will decrease the decorrelation noise by reducing the repeat time, the residual atmospheric signal can still reach dynamic signal ranges of up to 15 cm from one acquisition to another, swamping the much smaller long-wavelength tectonic signals. It is mainly the variation in water vapour in the lower parts of the troposphere that causes these signals to persist.

In the past, tropospheric signals have been corrected using external data from weather models, GPS and spectrometer data, often limited by the lower spatial resolution of the auxiliary data. In addition, the tropospheric signal has been reduced by filtering the InSAR data in space and time, which can be challenging when separating it from non-steady deformation, or by estimating it from the correlation between the interferometric phase and the topography. The latter has been achieved using data from a non-deforming area or by estimating this relationship in a frequency band insensitive to deformation. This approach does not however account for spatial variation of the atmospheric properties, which can be significant in regions larger than 100 km. In such cases, estimating the linear relationship between phase and topography in sub regions fails, as a common reference also needs to be estimated.

We have recently developed a new power law representation of the topographically-correlated phase delay that allows for spatial variations in atmospheric properties [1][2]. To account for deformation, we solve for this relation in a frequency band insensitive to tectonic deformation. We test our algorithm using Envisat and ALOS data over the Apennines (Italy) and Guerrero (Southern Mexico), where we evaluate its success by comparing the estimated atmospheric delays with radiometer data from MERIS, and by analysing the power spectra before and after correction. After correction we find a better fit between the deformation maps as derived from InSAR and GPS relative to before correction.

[1] D. Bekaert and A. Hooper (2011), A new algorithm for reduction of the tropospheric signal in InSAR data, applied to the 2006 slow slip event in Guerrero, Mexico, American Geophysical Union, Fall Meeting 2011, G22A-02.

[2] A. Hooper, D. Bekaert, K. Spaans and M. Arıkan (2012), Recent advances in SAR interferometry time series analysis for measuring crustal deformation,*Tectonophysics*, 514-517, 1-13, doi:10.1016/j.tecto.2011.10.013.