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Study on the properties of the Integrated Precipitable Water (IPW) maps derived by GPS, SAR interferometry and numerical forecasting models

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The knowledge of spatial distribution of relative changes in atmospheric Integrated Precipitable Water (IPW) density is important for climate studies and numerical weather forecasting. An increase (or decrease) of the IPW density affects the phase of electromagnetic waves. For this reason, this quantity can be measured by techniques such as GPS and space-borne SAR interferometry (InSAR).
The aim of this work is to study the isotropic properties of the IPW maps obtained by GPS and SAR InSAR measurements and derived by a Numerical Weather Forecasting Model. The existence of a power law in their phase spectrum is verified. The relationship between the interferometric phase delay and the topographic height of the observed area is also investigated. The Lisbon region, Portugal, was chosen as a study area. This region is monitored by a network of GPS permanent stations covering an area of about squared kilometers. The network consists of 12 GPS stations of which 4 belonging to the Instituto Geográfico Português (IGP) and 8 to Instituto Geográfico do Exercito (IGEOE). All stations were installed between 1997 and the beginning of 2009. The GAMIT package was used to process GPS data and to estimate the total zenith delay with a temporal sampling of 15 minutes. A set of 25 SAR interferograms with a 35-day temporal baseline were processed using ASAR-ENVISAT data acquired over the Lisbon region during the period from 2003 to 2005 and from 2008 to 2009. These interferograms give an estimate of the variation of the global atmospheric delay. Terrain deformations related to known geological phenomena in the Lisbon area are negligible at this time scale of 35 days. Furthermore, two interferometric SAR images acquired by ERS-1/2 over the Lisbon region on 20/07/1995 and 21/07/1995, respectively, and so with a temporal baseline of just 1 day, were also processed.
The Weather Research & Forecasting Model (WRF) was used to generate the three-dimensional fields of temperature, atmospheric pressure, water vapour fraction, geopotential and precipitable liquid water at a given time. The model uses 50 vertical layers and four spatial grids with a spacing ranging from 27 to 1 km to solve diffusion equations with the final estimates given on 1 km spatial grid. The aforementioned atmospheric parameters were used to compute the hydrostatic and wet components of the tropospheric delay. Finally, both components of this simulated tropospheric delay were compared to GPS time series and SAR interferograms.
The hydrostatic and wet components of the tropospheric phase delay within the tropospheric layer are modeled using WRF forecastas of metereological parameters. The hydrostatic component has the larger in magnitude and is less spatially variable than the wet one. Modeled tropospheric delays are compared to the corresponding real GPS profiles and SAR interferograms.Temporal change in phase delay measured at GPS statons is also directly compared to the corresponding InSAR interferograms.