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Improvement of the vertical component of GPS and INSAR measurements in the western Corinth Gulf (Greece), by the use of high-resolution meteorological modeling of the lower troposphere: The PaTrop Experiment

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Space geodesy techniques (SAR interferometry and GPS) have recently emerged as an important tool for mapping regional surface deformations due to tectonic movements. A limiting factor to this technique is the effect of the troposphere, as horizontal and vertical surface velocities are of the order of a few mm/yr, and high accuracy (to mm level) is essential. The troposphere introduces a path delay in the radio signal, which, in the case of GPS, can be partially removed with the use of specialized mapping functions. The primary objective of the PaTrop experiment is to further correct the vertical component in GPS measurements with the use of a high-resolution meteorological model (WRF), producing a 3D tomography of the troposphere. High resolution re-analysis enables a more precise description of regional topographic forcings due to orography or land-sea contrasts, and therefore processes strongly forced by topography, such as orographic precipitation and relative humidity, can be represented much more accurately. As such, the wet component (zenith wet delay or ZWD) of the tropospheric effect, which is much more difficult to model due to spatial and temporal variations in the distribution of atmospheric water vapour can be modeled with greater precision. Moreover, tropospheric stratification and short wavelength spatial turbulences produce an additive noise to the ground deformation calculated by the (multitemporal) INSAR methodology. Thus, the knowledge of the tropospheric parameters along the propagation medium can be used to estimate and minimize the effect of this noise, so that the remaining signal represents the deformation mostly due to tectonic or other geophysical processes. The interseismic deformation of a tectonic process could last many years and is very small; for this reason and in order to detect and measure it, there is a need of high sensitivity and measuring accuracy (of the order of 1 mm/yr), something that can be achieved by minimizing the tropospheric noise.

A network of twenty permanent and temporary GNSS receivers (Topcon GB1000 fitted with Topcon PG-A1 antennas, at 30s acquisition) provides the data for the PaTrop experiment, covering an area of approximately 100x80 km in the region of the western Corinth Gulf, Greece. The stations belong to the Corinth Rift Laboratory and NOANET networks, which monitor the seismicity of the region. The experiment runs for 12 months, in order to study seasonal effects, and receivers are distributed in both flat and mountainous areas (elevation range 0-1500m), so that different topographical and meteorological conditions are examined. Processing of the data involves the calculation of detailed tropospheric delays every 5 min, with the GIPSY-OASIS 6.12 software. Results are compared with tropospheric delays derived from weather re-analysis performed with the WRF high-resolution regional forecasting model. Values of air temperature, air pressure and relative humidity (T, P, RH) in the vertical tropospheric column are calculated every 30 min, with downscaling of the model at 5km and 1km spatial resolution. Initial results show a high degree of correlation between GPS processed tropospheric delays and results from weather re-analysis, and a significant correction with regards to the wet component.