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Multi-geodetic characterization of the seasonal signal at the CERGA geodetic reference station, France

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Crustal deformations due to surface-mass loading account for a significant part of the variability in geodetic time series. A perfect understanding of the loading signal observed by geodetic techniques should help in improving terrestrial reference frame (TRF) realizations. Yet, discrepancies between crustal motion estimates from models of surface-mass loading and observations are still too large so that no model is currently recommended by the IERS for reducing the observations. We investigate the discrepancy observed in the seasonal variations of the position at the CERGA station, South of France.

We characterize the seasonal motions of the reference geodetic station CERGA from GNSS, SLR, LLR and InSAR. We investigate the consistency between the station motions deduced from these geodetic techniques and compare the observed station motion with that estimated using models of surface-mass change. In that regard, we compute atmospheric loading effects using surface pressure fields from ECMWF, assuming an ocean response according to the classical inverted barometer (IB) assumption, considered to be valid for periods typically exceeding a week. We also used general circulation ocean models (ECCO and GLORYS) forced by wind, heat and fresh water fluxes. The continental water storage is described using GLDAS/Noah and MERRA-land models.

Using the surface-mass models, we estimate that the seasonal signal due to loading deformation at the CERGA station is about 8-9, 1-2 and 1-2 mm peak-to-peak in Up, North and East component, respectively. There is a very good correlation between GPS observations and non-tidal loading predicted deformation due to atmosphere, ocean and hydrology which is the main driver of seasonal signal at CERGA. Despite large error bars, LLR observations agree reasonably well with GPS and non-tidal loading predictions in Up component. Local deformation as observed by InSAR is very well correlated with GPS observations corrected for non-tidal loading. Finally, we estimate local mass changes using the absolute gravity measurement campaigns available at the station and the global models of surface-mass change. We compute the induced station motion that we compare with the local deformation observed by InSAR and GPS.