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Temporal variations in ITRF station displacements analyzed with vector spherical harmonics

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The ITRF2014 candidate solutions DTRF2014 and JTRF2014 provide time-dependent station coordinates accounting for irregular station motions. DTRF2014 by DGFI-TUM expands the secular coordinate model via non-tidal loading corrections caused by changes in the atmosphere and continental water storage. JTRF2014 by JPL follows a time series approach to TRF determination based on Kalman filtering, providing weekly updates to station coordinates. The process noise model of the Kalman filter is derived from non-tidal loading deformations.

Global features in station displacements have been studied in the past by determining coefficients of spherical harmonics. So far, studies have mostly focused on individual coordinate components at a time. Typically, the vertical coordinate component is of most interest, since it most often contains the largest signals.

In this work, we apply the concept of vector spherical harmonics (VSH) to study temporal variations in station displacements of DTRF2014 and JTRF2014. The advantage of VSH compared to scalar spherical harmonics is that all three coordinate components can be considered at the same time. We estimate VSH coefficients up to degree-2, which includes dipole and quadrupole deformations. Degree-1 deformations represent translations and rotations of the frame, while degree-2 terms contain, inter alia, information on the oblateness of the Earth. We use VSH to analyze station displacements of DTRF2014 and JTRF2014 individually and to conduct comparisons between the two frames. Furthermore, since the temporal variations in both DTRF2014 and JTRF2014 are linked to non-tidal loading deformations, our analysis of temporal variations in VSH coefficients allows for geophysical interpretation.