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The effects of atmospheric pressure loading and 7-parameter transformations on estimates of geocenter motion and station heights

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Variations in fluid loads such as the oceans and the atmosphere deform the surface of the Earth. The accuracy of station coordinates - in particular heights - that can be estimated depends on how well one can separate these surface deformations from the associated translational motion between the centre of mass of the solid Earth and the total Earth (CM). We applied simulated atmospheric pressure loading effects to the coordinates of sites in the CM frame to explore to what level of accuracy both geocenter motion and accurate station coordinates can actually be recovered from geodetic analyses. We found that standard 7-parameter transformations (3 rotations, 3 translations, scale) generally recover about 80% of the geocenter motion; however, the inclusion of a scale factor permits the aliasing of surface loading deformation, introducing scale errors of up to 0.3 parts-per-billion and daily height errors as large as 4 mm. The quality of the geodetic results is extremely sensitive to the number and distribution of sites used to estimate the transformations and becomes worse when regional (rather than global) sets of sites are used. If the scale factor parameter is omitted then the amount of aliasing of surface loading effects is reduced considerably and more accurate site velocities and geocenter motion estimates are achieved.