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Analysis of Scale Variations in Regional and Global GPS Networks

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A common procedure used in the realization of global and regional reference frames is to perform a seven-parameter Helmert transformation where translation, rotation, and scale are estimated to align the network to the reference frame. We investigate the impact of including scale in the transformation and the implications of such inclusion on the seasonal height variations seen in regional networks. In current analyses of GPS data, the phase center models for the ground and space segments are held fixed and thus there is no intrinsic scale uncertainty in GPS position estimates. It is not clear whether scale should be estimated or not. Incorporation of scale estimates has the potential to absorb height variations that are correlated over large areas, which is the expectation of the characteristics of large scale loading phenomena. Annual variations in global scale are clearly seen in GPS analyses and have an amplitude of $\sim$2 mm in height equivalent to 0.3 ppb scale changes. This amplitude is controlled by northern hemisphere sites despite the reference frame realization having equal numbers of northern and southern hemisphere sites. The southern hemisphere has smaller land mass and many GPS sites are on islands. The height variations in the southern hemisphere are not as spatially correlated as they are in the northern hemisphere. When scale is estimated, there is a strong potential for regional height variations to be absorbed into the scale estimates resulting in lower amplitude estimates. We will discuss the effects of different treatments of scale variations on both global GPS results, based on the recent MIT/ANU GPS reprocessing campaign, and on regional networks such as the Plate Boundary Observatory (PBO) in the United States. Amplitudes of annual signals are strongly affected by the methods used to incorporate scale into the reference frame realization with amplitudes potentially changing by factors of two depending on the approaches used.