

On the possibility of correcting seasonal displacements in GPS with a-priori information

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Understanding seasonal movements of the GPS station positions is important to monitor temporal evolution of moment release of a silent earthquake and to isolate subtle coseismic crustal deformation signals. For example, it is important to discriminate slip rate changes of the 2000- Tokai silent event from apparent changes due to inappropriate removal of seasonal components. The importance of seasonal crustal deformation studies is also recognized as an independent mean to observe seasonal movements of surface loads from satellite gravity measurements. Heki [in press] tried to model the load changes caused by snow, atmospheric pressure, water impoundment in reservoirs, soil moisture and non-tidal ocean loading, and calculated bimonthly displacements of every GEONET point. He also empirically modeled seasonal (possibly apparent) scale change of unknown origin. Sums of the real crustal movements due to load changes and the apparent movements due to the scale change are compared with real GPS observations. Apart from that, it has been commonly done to estimate seasonal (i.e. annual plus semiannual) components by applying the least-squares method to real time series. Here I compared the root-mean-squares of the residuals between the former (a-priori correction) and the latter (best-fit seasonal correction) cases, and found that the residual of the former is almost as small as the latter. From such comparison studies, several new problems emerged, i.e. (1) unexplained large vertical movements in summer, (2) abnormally large horizontal seasonal movements in some areas, and (3) interannual variation of seasonal change amplitudes in the north-south component (gradual increase after 2000). As the cause of (3), I evaluated the second order ionospheric delays and their increase toward the recent sunspot maximum. It is consistent with the GPS observations that the ionospheric effect mainly causes north-south apparent displacements, but it disagrees with the observations that total electron content of the ionosphere at the Japanese magnetic latitude changes semiannually rather than annually. I hypothesized that (2) is due to seasonal changes of atmospheric delay gradient, and investigated monthly average atmospheric delay gradient fields using past meteorological data. As for the hydrostatic delay, a large WSW gradient in the Tohoku District and a large WNW gradient in the Chubu District were found. This is qualitatively consistent with abnormally large EW seasonal changes of Tokai GPS stations (westward displacement in winter) that diminishes considerably by estimating atmospheric gradients.