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Evaluation of Seasonal Signals in the Site Coordinate of the New GEONET Solutions

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The seasonal signals are seen in the time series of site coordinates of the GEONET routine solutions. Several hypotheses are suggested for the cause of them based on the old solution of GEONET routine analysis. For example, Murakami and Miyazaki(2001) suggested Plate motion as an origin but without mentioning the mechanism. Heki(2001) attribute the cause to the snow loading effect by the comparison between the simple model calculation and the observation. Since the amplitude of the seasonal signals is comparable to the noise level of GPS baseline solutions, elimination of error factors in GPS analysis are essential for the discussion of the seasonal signals based on observation. In this paper, seasonal signals are examined based on the time series of site coordinates that are reanalyzed based on the new analysis strategy (Hatanaka, et al., 2001).

The coordinate time series of each site are modeled with constant, linear trend and seasonal terms. The seasonal terms are modeled with annual and semiannual terms each of which is composed with the sine and cosine terms. These terms are estimated from the observed time series of site coordinates during the relatively quiet period (from March, 1996 to December, 1999). Coseismic- or other offsets are also estimated when they are visible on the time series.

The seasonal components extracted from the new analysis results are slightly different from those from the old solutions in the southwest Japan area. Seasonal variation of network scale (extension in summer and shortening in winter) is more evident in the new solutions. The cause of the scale change is not identified but there are many possible error factors such as troposphere, satellite orbit, etc. that may cause scale error.

The seasonal variation of scale, rotation and transformation of the whole network is analyzed by modeling the 7 parameters of Helmert transform with seasonal terms. The scale change of the full amplitude of 6.5 ppb for annual term and 0.9 ppb for semi-annual term are obtained. The direction of the annual motion of the sites changes depending on the case whether the scale variation is eliminated or not. Therefore the correlation between the direction of seasonal signals and that of plate motion observed by Murakami & Miyazaki (2001) is questionable unless the scale variation represents true ground motion.

The average annual motion of the whole network obtained in the above is subtracted from the observed seasonal signals. The residual seasonal signals are noisy but still shows coherent motion around the main islands of Japan. They tend to point seaward in summer and landward in winter. This may suggest that the geography is likely to relate with the spatial variation of the direction of seasonal motion. The snow loading (Heki, 2001) or influence of sea level change does not contradict with this observation. Further investigation, with independent analysis or observation, is needed to check other possibilities such as effect of troposphere delay gradient or unknown effect of the geometry of the GPS network on the solutions.