Vertical positioning errors caused by water vapor variation in the Japanese Islands

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The relationship between vertical component of the site coordinates and zenith tropospheric delay is studied by using the principal component analysis method for the purpose of developing techniques to separate vertical coordinates and zenith tropospheric delay more strictly in GPS analysis. Iwabuchi et al. [2002] showed that some correlations between site coordinates and zenith tropospheric delay estimated in the routine analysis of GSI (Geographical Survey Institute) for GOENET (GPS Earth Observation NETwork) in their preliminary study. They show the necessary to re-analyze GEONET data with precise point positioning that can avoid the clustering effects.

The data set used in the study is GOENET data in GSI. We analyze the data set from January to December, 1999 with the precise point positioning strategy in GIPSY-OASIS II software. The daily anomalies in vertical coordinate and ZTD from their averaged values are used in the analyses. The first mode of empirical orthogonal functions (EOF) in vertical coordinate anomalies and ZTD anomalies correspond to the temporal change of the averaged values for all the sites in their anomalies. The EOFs for the second and third PC show common north-south or east-west oscillation- patterns over the Japanese Islands, which may correspond to weather variations over the Japanese Islands.

The results suggest that changes in vertical component of the site coordinate are affected by water vapor variations in time-scale of several days. We will also show the relationship between site coordinate and water vapor variations within one day by using post-fit phase residuals that provide us information on real water vapor variations.

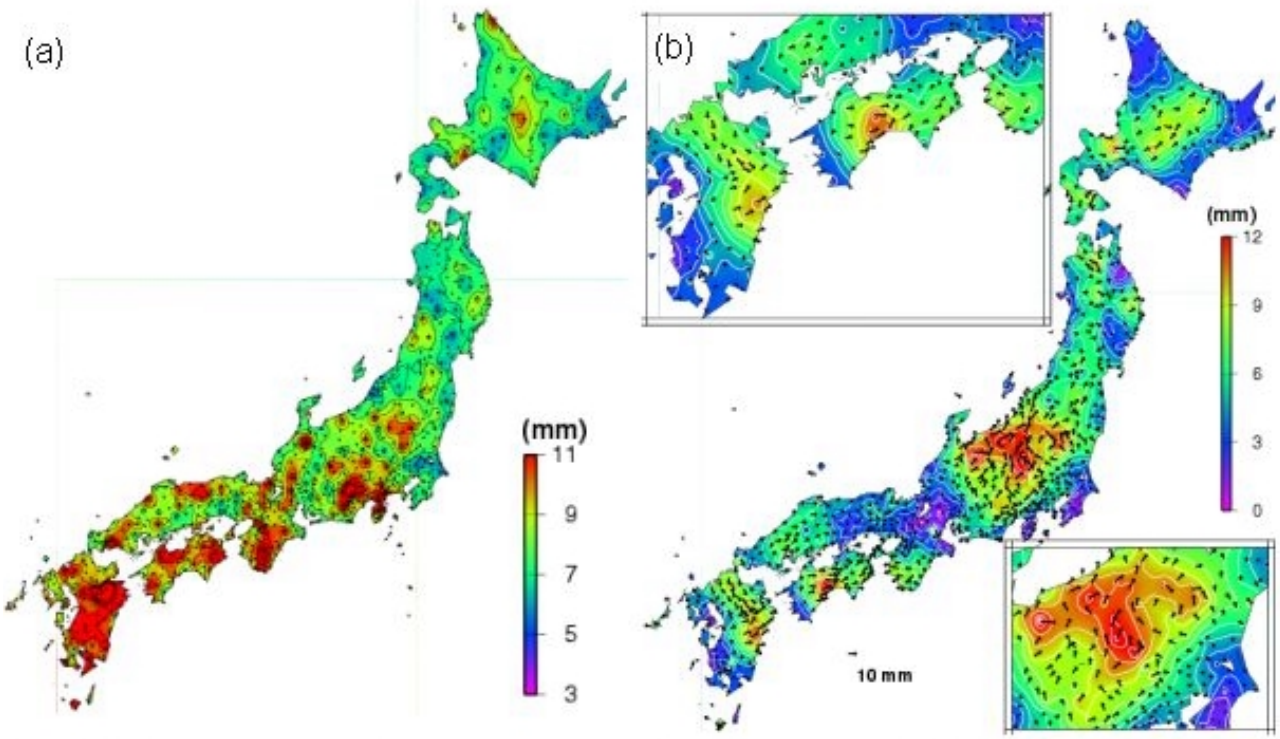

Fig.1 (a) Standard deviation in vertical coordinate variations for 31 days in August, 1999, where high pass filter (15 days) is applied in the original time series. (b) Diurnal variation in zenith tropospheric delay (ZTD) with least-square fitting for composite ZTD for 31 days in August, 1999. The vectors show magnitude and phase (the maxima correspond to north direction) of diurnal variation in composite ZTD. The magnitude is also shown with color image.

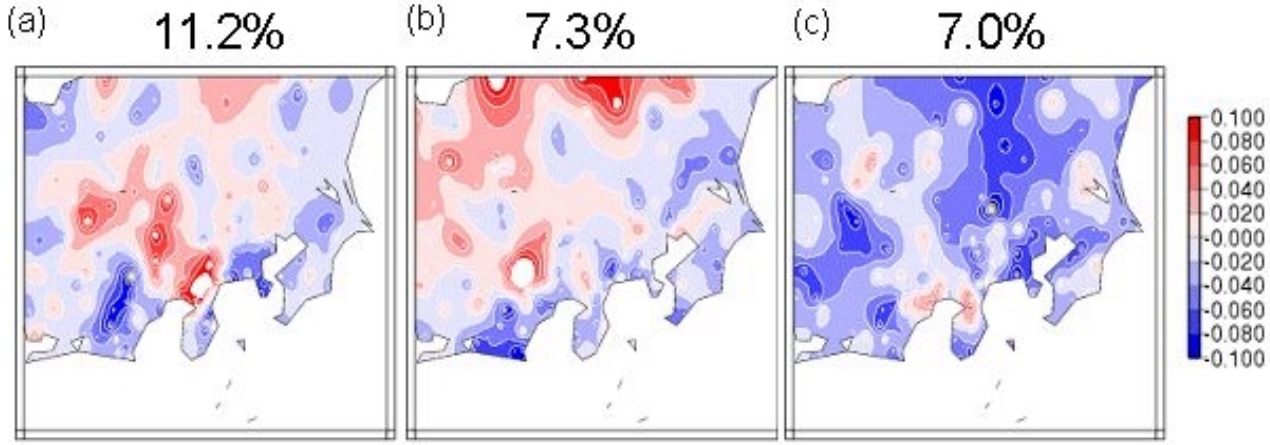

Fig.2 Empirical orthogonal functions (EOF)s for (a) first, (b) second, and (c) third mode in vertical coordinate variations for 31 days in August, 1999. Only the region depicted in the map is used for the analysis. The contribution rate for each mode are shown in the upper part of the maps.