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Improvement of the Positioning Accuracy of Space Geodetic Techniques by the GPS Meteorology

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The improvement of the estimated positioning accuracy of space geodetic techniques is one of the major subject in the 'GPS/MET Japan' project, and because of the research methodology in that the research to improve the positioning accuracy is applied using the GPS meteorological products and the delay of the introduction of the numerical meteorological model in the project, the research has some delay in the project. However, we have proved that the introduction of the atmospheric gradient improves the accuracy of the estimated positioning (especially horizontal positioning), and we have evaluated the validity and the limitation of the mapping function generated by the numerical weather models.

At first, it is known that the GPS time series are often scattered in the summer in Japan. This suggests that the atmospheric correction with an isotropic mapping function is not enough. In this paper, we retrieved the spatial distribution of position error (position anomaly) due to the anisotropy of water vapor from GSI's routine solution. The large anomaly well corresponds to the area where the spatial gradient of water vapor is expected to be high.

Then we reanalyzed two sets of GEONET data in the 1996 summer, when a tropical typhoon or weather front was passing over the Japanese Islands, having the tropospheric delay gradients estimated. The obtained gradient field shows a strong negative correlation with the position anomaly field. In addition, the position anomalies disappeared by modeling the tropospheric gradients.

Atmospheric gradients are assumed to have a simple linear form in the anisotropic mapping function. However, it suggested that this assumption is not always appropriate in the context of intense mesoscale phenomena such as the passing of cold front, heavy rainfall events, and severe storms. We assess the anisotropic mapping function using the 10-km spectral model of the Japan Meteorological Agency (JMA) to reveal the limitation of the anisotropic model. In order to quantify the improvement of the anisotropic model over the isotropic model we define the 'efficacy' of adopting the anisotropic model, for a given station-epoch, as the associated percentage reduction in the misfit of pointed delay. We are now evaluating the anisotropic model by comparing with the ray-traced slant path delay through the data sets of the non-hydrostatic numerical weather prediction model with 1.5 km or 5 km horizontal resolution in order to investigate the local scale variability of water vapor.

At last, we will present two future subjects for the improvement of the positioning estimation. One is the limitation of the simple atmospheric gradient model. It is very difficult to approximate the atmospheric horizontal waves like mountain lee wave as simple atmospheric gradient model. Especially in Japan where short-wave-length steep and complex topography is superior, atmospheric lee wave forms complex waves. It is one of the future subjects to implement the phenomena in the model of the GPS analyzing software.

Another subject is the improvement of the vertical component estimations. The scatter of the estimated vertical component is significant even without major water vapor disturbance in the plane area. The problem is more complex in complex topography area like mountain area . To improve the vertical component estimation, it is necessary to develop the analysis of the Tsukuba 2000 and 2001 campaign data and the comparison of the simulation solutions by the numerical weather data and the real data analysis.