Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

SGD001-P04 Room: Convention Hall Time: May 27 17:15-18:45

Reduction of positioning error by using the Quasi zenith satellite and the numerical weather model outputs

Hiromu Seko[1*], Satoshi Kogure[2], Seiichi Shimada[3]

[1]Meteorological Research Institute, [2]Japan Aerospace Exploration Agency, [3]NIED

Signals from GPS satellites are delayed by atmosphere between the GPS satellites and GPS receivers, and then cause the positioning error. Then, the delays are estimated by assuming the linear distribution of the atmospheric delays over the GPS receivers, and removed from the signals, to reduce the positioning error due to the atmosphere (PEA). However, the GPS satellites do not stay over the receivers and the paths are shifted in the nonuniform atmosphere. Thus, there is the limit of the reduction of PEA. On the other hand, Quasi-zenith satellite (QZS) stays over the receivers, with providing the continuous data over the GPS receiver, and then has the potential of the reduction of PEA.

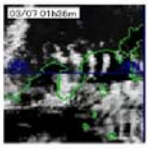

Fig. 1. Cloud image on 7 March 1997.

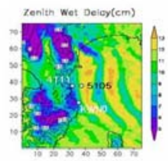

Fig. 2. Zenith wet delay distribution reproduced by NHM.

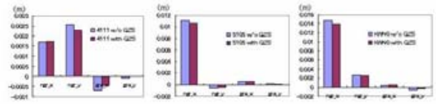
Fig. 3. Positioning error due to the atmosphere estimated from the azimuth and elevation angles and the outputs of numerical weather model. Right bars in each panel are the errors estimated from only GPS data, left are those from GPS and QZS data. 'ngr' and 'gra' indicate the results when a linear gradient model was not used, and used, respectively.

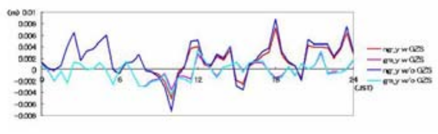
Fig. 4. Time variation of positioning error at GPS site 4111. Before 7 JST, the elevation angle of QZS was too low so that GPS receivers could not get the signal.

In the actual estimation of positioning error, the discussion on the influence of the atmosphere is difficult because other factors also cause the error. Thus, the delays produced from the outputs of the numerical models were used in estimation of PEA because the positioning error only due to the atmosphere can be discussed. In this presentation, the complicated distribution of atmosphere in the mountain lee wave case event was reproduced by Non hydro-static model (NHM) of Japan Meteorological Agency with the horizontal grid interval of 250 m, and the PEA was estimated from the delays produced from outputs of NHM.

Figure 1 shows the cloud distribution on 7th March 1997. A few cloud bands parallel to Izu Peninsula were generated. This atmospheric condition produced by NHM shows the similar pattern in the wet zenith delay distribution. These patterns indicate the complicated atmospheric distribution was reproduced by the NHM (Fig. 2).

Figure 3 is the PEA at GPS sites of 4111, 5105 and KWN. The paths from the GPS receivers were determined by a ray-tracing method, and the delays were obtained from the water vapor, temperature etc of NHM outputs. PEA was estimated by switching the linear gradient model, in the case of GPS data and that of GPS and QZS. When the linear gradient model was not used, PEA was large. However, PEA was largely reduced when QZS data was used. When linear gradient mode was used, the PEA is much smaller, and PEA was further reduced by the data of QZS. Figure 4 shows time variation of PEA at the GPS site of 4111. Before 7 JST, a signal from QZS was not received by GPS receiver because of its low elevation angle. After the signal from QZS was detected, PEA was reduced especially when PEA was large. These figures show that the delay provided from QZS have the potential to reduce PEA.

Keywords: Quasi-zenith satellite, Positioning error, Numerical weather model, GPS Meteorology