

Observed inhomogeneity of water vapor and systematic errors of estimated site position at a cold front passing by GPS meteorology

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Observed GPS data in and around Izu Peninsula are analyzed during a cold front passing on March 7 in 1997. In the analysis, only zenith delays at each site are estimated. Using the postfit residuals of phase data, spatial distribution of the precipitable water vapor (PWV) is estimated. Just before the front passed, detected the N-S oriented band of less, dense, and less PWV respectively from along-east-coast area to east of the Peninsula. On the other hand, every two-hour horizontal gradient of each site is also estimated, and the gradient vectors are consistent with the PWV distribution. We also present the way to reduce the systematic errors of the site coordinates that appear in the routine analysis.

Applying GPS meteorology in Japan, one of the most important issues to improve the accuracy of the estimated site coordinates is to implement the local meteorological phenomena caused by the short-band topography to the model of the GPS analyzing program. As an example, observed GPS data in and around the Izu Peninsula are analyzed during a cold front passing on March 7 in 1997, to reveal the inhomogeneity of the precipitable water vapor (PWV) and its effect on the systematic errors of site coordinates estimation.

We used GAMIT software, and analyzed 7 IGS global network sites and 18 local permanents network sites in and around the Izu Peninsula. IGS final orbit and IGS site coordinates given by ITRF97 and local site coordinates obtained from the analysis of the more than 2.5 years continuous observation are fixed, and only every 30-minutes zenith delays at each site are estimated. After the estimation of parameters, using the postfit residuals of phase data, spatial distribution of PWV is estimated, by adding the estimated zenith delays and deducing dry tropospheric delay calculated from the barometric measurement at a local network site. Just before the front passed, detected the N-S oriented band of less, dense, and less PWV respectively from along-east-coast area to east of the peninsula. The peak to peak difference is more than 4 mm. Because of the strong western wind, the cool dry air associated with the cold front climbed the N-S oriented mountain just west of the east coast of the peninsula, and moved down 5-10km off the coastline, thus relatively humid air remained at the sea area near the coastline.

Applying the same software and the same conditions but estimating the tight constrained IGS final orbit and IGS site coordinates, loose-constrained local site coordinates, and every 2-hour horizontal gradient per site, as well as zenith delay, local horizontal gradients are obtained. The distribution of the gradient vectors at the same period of the above-mentioned analysis indicates the westward dry air in the east coast of the peninsula, and the eastward dry air at a small island 7 km off the east coast, consistent with the distribution of PWV. The gradient vectors amount more than 10 cm tropospheric delay at 10 degree elevation angle at the largest sites. After passing the front, the direction of the gradient vectors are almost same, although the amplitudes become smaller as western wind ceases.

Geographical Survey Institute (1997) calculated daily displacements of the sites analyzed in this study. The displacement vectors of (the day before) - (the day of analysis), and (the day of analysis) - (the day after) are almost opposite direction with almost same amplitude, indicating the systematic errors at the day of this study caused by the tropospheric conditions. The approach to reduce such systematic error is also presented applying some options of the GPS analyzing program.

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