Evaluation of GPS Analyzing Software Applying the Numerical Weather Model; In the Case of the Mountain Lee Waves Observed

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The Global Positioning System (GPS) meteorological analysis detected atmospheric mountain lee waves excited by a strong westerly wind ahead of an approaching cold front. On the east coast of the Izu Peninsula, Central Japan, a dense permanent GPS network has been installed with sites separated by three to ten km. Before the approach of the cold front on 7th March 1997, significant atmospheric gradients caused by the inhomogeneous water vapor are detected at the sites along the east coast of the Izu Peninsula because of a wet and cold atmosphere to the west of these sites. In contrast, the island site 6 km east of the east coast detects a strong gradient with the opposite sense. The Geostationary Meteorological Satellite (GMS) cloud images of the region show rows of the clouds due to mountain lee waves consistent with the GPS measurements. A numerical simulation explains the wavelength and amplitude of the mountain lee waves generally, using the temperature vertical profile observed at Hamamatsu and wind vertical profile observed at Tateno by radio sonde respectively. The atmospheric gradients induce large systematic errors in the site horizontal estimates from the routine processing. This study demonstrates that large errors in position estimates can result from atmospheric phenomena like mountain waves in regions with mountainous topography like the Japanese Islands.

Using the JMA/MRI (Meteorological Research Institute) non-hydrostatic model (NHM) with the horizontal grid interval of 250 m, we simulated the mountain lee waves and tried to interpret their role in the atmospheric delay. Number of grids is 300 x 300 for horizontal and 38 for vertical component. We can reproduce the mountain lee waves consisted with the observation, although the wave length is a little shorter than observation in the midst and eastern part of the Sagami Bay. Since there are no upper air observation in the model area, we give the vertical profile of temperature observed by Hamamatsu, about 130 km WSW from the field, and wind observed by Tateno, about 200 km NE from the field, for the initial western boundary condition of the model uniformly, to fit the GMS cloud images using the trial and error for the data of the nearby three radiosonde sites concerning on the vertical profile of temperature and wind. We use the numerical weather model and estimate the site positions without estimate the simple atmospheric gradient, obtaining systematic errors of the site positions up to 2 cm, consistent with the real data analysis. Applying the simple atmospheric gradient in the estimation of the site positions, the systematic errors decrease up to 3mm in the sites on the Izu Peninsula, indicating the simple atmospheric gradient does not model the non-linear atmospheric lee waves. Considering the mountain waves observed in a GPS receiver is equal or less than half wave length, we extent the simple gradient model to a quadratic curve. Then the systematic errors reduce to the level less than the analyzing resolution.

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