論　説

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火山周辺での GPS 観測における数値気象モデルを用いた対流圏補正

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GPS Baseline Solutions with Tropospheric Correction by Using the JMA Numerical Weather Model for Monitoring Volcanoes

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Japan Meteorological Agency (JMA) has installed and is operating GPS networks around major active volcanoes since 2000 in order to monitor volcanic ground deformation. At present, 22 volcanoes are under continuous observation using about 100 GPS stations. At most observation points single-frequency receivers are adopted in consideration of power saving and mobility in rugged environments.

GPS baseline solutions include errors due to tropospheric delays which are inhomogeneous in the actual atmosphere. Generally, computation of baseline solutions is done by using a simple atmospheric model assuming horizontal homogeneity. But if the adopted model is not consistent with the actual atmosphere, tropospheric delays cannot be accurately estimated, resulting in poor position estimates. Especially with regard to the volcano observation, the errors in the vertical component of baselines become large according to the large troposphere errors. In the case of baseline solutions between receivers with large vertical difference, the time variation of the vertical length is superposed by seasonal noise caused by spatial and temporal variations of refractive index of the atmosphere. For accurate monitoring of volcanic activities, more precise positioning in the vertical component is desirable, which should be realized by incorporating more accurate atmospheric model into the analysis procedure.

For this purpose, an improved analysis process was developed, based on the JMA's operational meso-scale numerical weather analysis (MANAL). The MANAL is applied to daily meso-scale numerical weather prediction as initial field. Generally in the differential analysis process of positioning, zenith tropospheric delay (ZTD) is estimated by least-squares method together with the positioning. In this case, initial value of ZTD is given from a simple atmosphere model. In our approach, ZTD between both receiver sites is calculated from MANAL, and then the conventional analysis process is done fixing ZTD between sites. In calculation, analysis software package Bernese Ver. 5.0 was used, while a part of the program was personally modified.

This correction strategy using MANAL was applied to the baseline solutions at Asamayama volcano, where ground deformation has been observed associated with the eruption activity from 2008 to 2009. Consequently we could approximately eliminate the vertical seasonal noise at a baseline whose vertical difference reaches to 1.5 km. This approach is quite convenient and effective for GPS observation at local and steep areas such as volcanoes.

Key words: GPS baseline solution, tropospheric correction, JMA numerical weather model, Asamayama volcano

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