GNSS Climatology : Regionality of Atmospheric Delay Gradient

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It is important in meteorology field to understand relationship between atmospheric water vapor fluctuation and climate change. Knowing the distribution and fluctuation of PWV(Precipitable Water Vapor) with high spatiotemporal resolution contributes to improvement of the accuracy of rainfall prediction. Observation of PWV using meteorological observation equipment has been carried out by various methods such as radiosonde and radiometer. However, radiosonde has low spatiotemporal resolution and radiometer is inadequate to observe PWV at continuous time in a wide range. Therefore, in recent years PWV has been estimated by space geodetic technology. Microwave from GNSS satellite delays when passing through the atmosphere. ZTD(Zenith Wet Delay) is obtained by subtracting ZHD(Zenith Hydrostatic Delay) from ZTD(Zenith Total Delay). The PWV can be calculated by multiplying ZWD by a certain coefficient. The PWV estimation by GNSS has superior spatial and temporal resolution and its accuracy is comparable to the estimation result of radiosonde.

Since the atmospheric spatial structure is not uniform, the atmospheric delay estimated by GNSS differs depending on observation points even at the same time. The nonuniformity of the delay amount due to the difference in azimuth angle of the GNSS satellite is quantified as atmospheric delay gradient. By estimating the atmospheric delay gradient, we can grasp more detailed atmospheric structure and water vapor distribution compared with the case of estimating only the ZTD. The purpose of this research is to compare the atmospheric delay gradient with various elements (e.g. meteorological phenomena, topography) and to find out how these correlations are appeared.

We used atmospheric delay gradient data of F3 solution from GEONET. Estimation of atmospheric delay gradient by GEONET is estimated as a linear function once a day. We regarded it as a gradient vector, averaged over time and plotted on the map. Atmospheric delay gradient vector has two main components southward and landward throughout the year. It can be said that the southward component reflects the north-south gradient of the atmospheric delay amount due to the latitude dependence of the temperature. In general, as the latitude decreases, the temperature rises and the amount of water vapor in the atmosphere increases, so the delay increases and a southward gradient appears. On the other hand, the landward component is considered to be the influence of convection by sea breeze. Water vapor on the sea converges inland by sea breeze and it generates convection. As a result, the upper end of the troposphere rises, which is reflected in the atmospheric delay gradient.

Since the sea breeze reaches only about 50 km from the coast, the atmospheric delay gradient is not affected by sea breeze on the inland side rather than it. We divided the atmospheric delay gradient into the coastal area and the inland area. In the inland area, although there is a difference in direction depending on observation points, the atmospheric delay gradient is constantly oriented in the same direction. We investigated the existence of correlation between this and topography and weather elements.
Thus, atmospheric delay gradient changes complicatedly in a short time scale, there is a possibility that can be explained by a combination of simple elements by looking at the average long term. By quantitatively understanding these, it becomes possible to grasp the general dynamics of the spatial distribution of water vapor, and it is expected that it will also lead to the evaluation of the positioning

error due to the non-uniformity of the atmosphere.

Keywords: GNSS, Precipitable water vapor, Atmospheric delay gradient