An Experimental Campaign for Evaluation of Wet Delay Variations using Water Vapor Radiometers

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http://www.crl.go.jp/ka/radioastro/index-J.html

Anisotropic mapping functions have been developed for the purpose of better modelling propagation delays of radio signals. These mapping functions are considered a powerful tool for removing the effects of atmospheric variability from GPS and VLBI analyses. However, the assumption of simple linear form of atmosphere is not always appropriate in the context of intense mesoscale phenomena. Thus, in June 1998 we initiated a field experiment for characterizing water vapor variations using water vapor radiometers(WVRs) in the Kanto district of central Japan. In spite of relatively short distance between Tsukuba and Kashima (about 54km) the atmospheric gradients solutions from WVR are significantly different. This result suggests that the mesoscale weather pattern caused these large differences.

Radio signal delay associated with the neutral atmosphere is one of the major error sources for space-based geodetic techniques such as the Global Positioning System (GPS) and Very Long Baseline Interferometry (VLBI). Recently, several anisotropic mapping functions have been developed for the purpose of better modelling these propagation delays, thereby improving the repeatability of horizontal site coordinates(MacMillan, 1995; Chen and Herring, 1997). The anisotropic mapping function is considered a powerful tool for removing or calibrating the effects of horizontal variability of atmosphere from GPS and VLBI analyses.

Atmospheric gradients are assumed to have a simple linear form in the anisotropic mapping function. However, it suggested that this assumption is not always appropriate in the context of intense mesoscale phenomena such as the passing of cold front, heavy rainfall events, and severe storms. Thus, in June 1998 we initiated a field experiment for detecting and characterizing water vapor variations using water vapor radiometers(WVRs) in the Kanto district of central Japan. We estimate atmospheric gradients using WVR slant delays at Tsukuba and Kashima.

In spite of relatively short distance between Tsukuba and Kashima (about 54 km) the atmospheric gradients solutions are significantly different. The magnitude of the NS gradient component at Kashima is approximately several times larger than that at Tsukuba during 3-4, 9-10, and 30-31 July 1998. We investigated the zenith wet delay (ZWD) field retrieved by the permanent GPS array of the Geographical Survey Institute (GSI), by constructing maps in which ZWD is represented as a continuous spatial function (by interpolating between the GPS stations). In the vicinity of Kashima, for the period 3-4 July 1998, the ZWD field had a strong NS gradient of up to 1cm/10km. However, the gradient in Tsukuba during this time period was very much smaller. This result suggests that the mesoscale weather pattern caused large differences to develop in the NS gradient (between Kashima and Tsukuba).