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Potential of numerical model of Meteorological Agency for improving the precision of GPS coordinates

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Introduction The effect of atmosphere on GPS is the most important among many factors which bring errors to GPS analytical results. It is very important how to estimate tropospheric delay accurately to realize precise GPS positioning, while it is difficult to trace variable tropospheric parameters in response to actual atmospheric condition. In this research, we carried out test analyses using GPS data from GPS-based control station and tropospheric parameters calculated by numerical model of Meteorological Agency which reflect actual atmospheric condition.

Evaluation of correlation between the difference in tropospheric delays and the height If tropospheric delay calculated by numerical model becomes some help to improve GPS positioning precision, the difference in tropospheric delays from numerical model and GPS analysis may have some correlation with the height obtained from GPS analysis. Hence, we evaluated the above-mentioned correlation. First, we divided Japan into 9 blocks, and selected one GPS-based control station from each block on condition that the station should be near to the lattice of numerical model, and calculated its position with tropospheric zenith delay estimation from DOY 103, 2000 to DOY 50, 2001 using GIPSY-OASIS II. Next, correlation between the difference in tropospheric zenith delays, which were estimated by GPS and numerical model of the lattice nearest to selected GPS station, and the height was plotted on a graph together with correlation coefficient for objective evaluation. As a result, differences in wet delay have a trend to fluctuate more than total delay. On the other hand, differences in hydrostatic delay show minus correlation with height and similarity to each other. Their correlation coefficients indicate -0.2 ~ -0.5 except for that in Ogasawara area. It is hard to think that there was a common annual variation in both hydrostatic delay and height, because the time series of them have just little similarity. Therefore, it is expected that difference in the estimation of hydrostatic delay affect precision in height.

Analytical results by correction for zenith hydrostatic delay As a next step, we calculated the position again with substitution of hydrostatic delay from numerical model for default value in GIPSY-OASIS II analysis, and compared the results with old ones. Comparison was made for 2 cases; one that every 12-hour delay derived from actual meteorological measurement was introduced and the other that every 3-hour predicted value was added. The new results show several-mm sifts in the vertical component from the old results in both cases, but it couldn't dissolve dispersions or annual variations of several cm level.

Simulation for variation in analytical results using correction of mapping function From the above results, it was proved that correction of zenith hydrostatic delay itself can't effectively improve GPS precision. This fact suggests that correction of mapping function is also necessary for this improvement, because actual signal paths are almost always slant paths. Mr. Hatanaka (2001, Japan Earth and Planetary Science Joint Meeting) already reported the time variation of mapping function from slant delays calculated from numerical model by ray-tracing method. According to him, there were annual variation in mapping function which couldn't be eliminated by normalization by Niell's Mapping Function, and this variation can bring biases of several cm to calculated vertical positions. Therefore, it is expected that corrected mapping function might be able to improve GPS positioning precision. In the latter part of this presentation, we report simulated results when hydrostatic delay dependent on elevation angles is introduced to the analysis, together with time variations of height when this correlation is applied for the former analysis.