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## Measuring local tilts of Geoid with a GPS meteorological approach

Kiyoto Yoshida<sup>1\*</sup>, Kosuke Heki<sup>1</sup>

<sup>1</sup>Dpt. Natural History Sci. Hokkaido Univ.

Atmospheric delays estimated by GPS together with station coordinates are known to provide valuable information for meteorological studies. We report climatological behaviors of the atmospheric water vapor over the last 12 years using zenith wet delays (ZWD) at ~1000 receivers of GEONET GPS stations in Japan (the F3 solution). ZWD can be converted to precipitable water vapor (PWV), and long-term changes of PWV presented climatological signals including interannual changes due to El Nino/Southern Oscillation (ENSO), longer-term changes such as Pacific Decadal Oscillation (PDO). We also studied time series of the tropospheric delay gradients (azimuthal dependence of atmospheric delays) 2004-2010, and found that (1) almost all stations had time-averaged gradient of ~1 mm toward south, and (2) southward gradients are stronger in winter. The point (1) simply indicates higher temperature (i.e. more water vapor) in the south, and the point (2) would reflect stronger north-south temperature gradient in Japan in winter. On the other hand, the gradient vectors showed significant time-averaged east-west components in some regions. GPS data analysis software packages calculate satellite elevation angles relative to the reference ellipsoid. On the other hand, atmosphere stratifies in parallel with the local geoid. Therefore local tilt of geoid relative to the reference ellipsoid may give rise to permanent components in atmospheric delay gradients. Such gradients may amount up to a few times of 0.3 mm in the Japanese Islands.

Keywords: geoid, GPS meteorology, atmospheric delay gradient