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Secular increase of wet delays due to global warming: GPS climatology

Kiyoto Yoshida[1]; Kosuke Heki[2]

[1] Natural History Sciences, Hokkaido Univ.; [2] Dept. Natural History Sci., Hokkaido Univ.

http://www.ep.sci.hokudai.ac.jp/~heki

Space geodetic observations e.g. Very Long Baseline Interferometry (VLBI) and Global Positioning System (GPS) started in 1980s. They used microwave, and a major source of positioning error was delays by neutral atmosphere (water vapor and dry air) in troposphere and stratosphere. Water vapor has complicated spatial and temporal distribution and it was difficult to infer wet delays only with ground based meteorological measurements. However, measurements of atmospheric delays in various elevation angles make it possible to estimate zenith atmospheric delays as an independent parameter together with station coordinates using least-squares method. Thus, space geodesy can measure the atmospheric delay. The atmospheric delays consist of hydrostatic and wet delays. Because the former can be calculated from surface pressure, we can isolate the wet delay. Wet delays are proportional to precipitable water vapor, and provide useful information for meteorology. In 1990s, people who became aware of the importance of such information for weather forecast, started GPS meteorology.

The original aim of GPS meteorology was the improvement of forecast of mesoscale meteorological phenomena such as heavy precipitation. This has been fulfilled last year, when Japan Meteorological Institute started to incorporate water vapor information from GEONET, the Japanese dense continuous GPS array, into their routine weather forecast program. The present study aims at GPS climatology, i.e. we focus on the long-term trend of wet delay. Global warming enhances saturated water vapor pressure, and will increase atmospheric water vapor (Trenberth et al., 2007). Water vapor itself has a stronger greenhouse effect than carbon dioxide, and it is important to understand its dynamics. It is also important in studying the seasonal and inter-annual water budget in atmosphere, ocean and on land.

VLBI has a relatively long observation history and is suitable for studying long-term behavior of atmospheric water vapor. GPS has observation data for only 10-15 years, but we can take advantage of its higher density to clarify spatial characteristics of increasing atmospheric water vapor. Here we downloaded VLBI data analysis results from data analysis centers of International VLBI service (IVS). We fit seasonal changes and linear trend for the time series of wet delay. Wettzell (Germany) is one of the stations with the longest observation history, but water vapor there showed only insignificant long-term trend. On the other hand, a station in Arctic, Ny Alesund (Svalbard), showed increase of wet delay as rapid as 0.28 mm/year. In the northern Europe, Gradinarsky et al. (2002) reported secular increase 0.1-0.2 mm/year of precipitable water vapor in the Scandinavian Peninsula.

We also analyzed time series of total delay (wet + hydrostatic) obtained in GEONET. Surface pressure data at individual points were not available, so it was impossible to isolate wet delay trend. However, by assuming that surface pressure does not have a long-term trend, we can consider the observed secular trends to change in water vapor. Many GPS points showed increasing atmospheric water vapor, and the trends tend to be high in urbanized area possibly reflecting severer warming in these areas.

References

Gradinarsky, L.P., J.M. Johansson, H.R. Bouma, H.-G. Scherneck, and G. Elgered, Climate monitoring using GPS, Phys. Chem. Earth, 27, 335-340, 2002.

Schuh, H., J. Boehm, V. Tesmer, and H. Schmitz-Huebsch, Determination of tropospheric parameters by VLBI as a contribution to climatological studies, in Proceedings of the Weikko A. Heiskanen Symposium in Geodesy, edited by C. Jekeli, Ohio State University, 2003.

Trenberth, K.E. et al., Observations: Surface and Atmospheric Climate Change. in Climate Change 2007: The Physical Science Basis, Contribution of WG 1 to the Fourth Assessment Report of IPCC (edited by Solomon, S. et al.) Cambridge Univ. Press, Cambridge, UK, 2007.