A global, 2-hourly atmospheric precipitable water dataset from IGS ground-based GPS measurements: Scientific applications and Future needs

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A 2-hourly data set of atmospheric precipitable water (PW) has been produced from ground-based Global Positioning System (GPS) measurements of zenith tropospheric delay (ZTD) by using the 2-hourly IGS tropospheric product. The PW data are available every two hours at about 80-268 International GNSS Service (IGS) ground stations from 1997 to 2004. An analysis technique is developed to convert ZTD to PW on a global scale. Special efforts are made on deriving surface pressure (Ps) and water-vapour-weighted atmospheric mean temperature (Tm). Ps is derived from global, 3-hourly surface synoptic observations with temporal and vertical adjustments. Tm is calculated from NCEP/NCAR reanalysis with temporal, vertical and horizontal interpolations. The PW dataset is validated by comparing with radiosonde, microwave radiometer (MWR) and satellite data. The comparisons show no significant and systematic bias in the GPS-derived PW data. The scientific applications of the PW dataset include studying the diurnal variations in PW over the globe, quantifying spatial and temporal inhomogeneity and biases in global radiosonde PW data and estimating the diurnal sampling errors in twice-daily radiosonde humidity. The new 5-minute IGS ZTD product available at all IGS stations will be explored in the future work.

Based on our experience with the IGS tropospheric product, we would like to make the following recommendations on improving future IGS products. (1) The long-term stability (consistency in time) is crucial for the application of IGS PW data in climate monitoring studies. Every effort should be made to maintain the consistency of ZTD data in time, including minimizing changes in both instruments and analysis methods. (2) It is very important to investigate various biases in the ZTD product with special emphasis on diurnal biases, such as diurnal mapping function errors. Among the existing water vapour datasets on a global scale, only GPS-estimated PW dataset can provide sufficient temporal resolution to resolve the diurnal cycle of the atmosphere. Diurnal biases in ZTD would result in spurious PW diurnal variations. (3) The surface meteorology sensors with at minimum accurate pressure measurements at all IGS stations would be very useful for calculating the dry delay and removing atmospheric pressure loading of the earth surface. Especially as the 5-min ZTD data become available, the high resolution surface pressure data are required to derive the 5-min PW data. In addition, the IGS surface met sensors need to be regularly maintained and calibrated; the data need to be carefully quality controlled. Current limited IGS surface met data bear various problems. (4) We recommend that some future IGS stations be co-located with the future reference radiosonde network for cross-validation and improving mapping function models. (5) We suggest that in the future the IGS products can be better documented by incorporating details on data characteristics, how they were derived and user-friendly metadata.