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Wet Tropospheric Zenith Delay and Precipitable Water Vapor Estimated From Radiosonde Data

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Continuously Operating GPS Networks are being used for meteorological and climate research. The wet tropospheric zenith delays derived from these networks are converted to the precipitable water vapour. Thus, an important data is produced for the development of numerical models of the tropospheric zenith delay and the precipitable water vapor for local, regional and global areas and for the meteorology and climate research.

The radiosonde observation data and the results derived from them are taken as references for the determination of accurate and reliable transformation parameters between the wet tropospheric zenith delay and the precipitable water vapor.

In this study, an algorithm is developed using Matlab to calculate the values of the weighted mean temperature (T_m), the wet tropospheric zenith delay, and the precipitable water vapor from the parameters of radiosonde profile data such as height (h), temperature (T), dew point temperature (T_d), pressure (p) and humidity (H). The results of the algorithm using the parameters from Istanbul, Ankara, Diyarbakir and Samsun radiosonde stations are also given.

The radiosonde temperature profile values are modelled using polynomial by the least squares method, because it is easy to integrate the polynomial as a function of height. The degree of the polynomial is taken as 5-8 and the precision of modelling depending on the amount of water vapor is found $\pm$0.1-2.0 K. In addition, the surface temperature (T_s) is obtained by using estimated temperature values. The values of water vapor pressure (e), one of the most important parameter in the meteorological research, are calculated by Tetens equations for water and ice separately. In this calculation, the values of wet bulb temperature (T_w) are found by using iteration from the model given by Danish Meteorological Institute. Henceforth, the values of (e/T) and (e/T^2) are modelled as a function of height using the polynomial again. Definite integrals are calculated from the models. In these evaluations, the estimated temperatures are used. The weighted mean temperature, the wet tropospheric zenith delay, and the precipitable water vapor are calculated by using definite integral. For the purpose of testing the algorithm, $IPWV_r$ obtained from the radiosonde station and $IPWV_a$ calculated from the developed algorithm are compared. Thus, the average, maximum and minimum of the differences between $IPWV_r$ and $IPWV_a$ for all of the stations are obtained as -0.59 mm, 2.55 mm, -4.44 mm, respectively. Comparing the accuracies obtained from the algorithm to the ones from the radiosondes indicates that this algorithm yields results with adequate accuracy.

T_s and T_m values of all of the stations were calculated for 2011. The linear correlation between T_s and T_m, has been found as T_m=57.4+0.77T_s by using linear regression. Moreover, the root mean square error of the weighted mean temperature is found as $\pm$2.57 K.

The future goals of this study are to determine the conversion parameter of different radiosonde stations in Turkey by comparing with GPS using the algorithm and to use these parameters for the meteorological and climate research in CORS-TR (the Turkish Network-RTK).