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APPLICABILITY OF GLOBAL PRESSURE AND TEMPERATURE MODEL (GPT2w) FOR GPS METEOROLOGY IN PENINSULAR MALAYSIA

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ABSTRACT

Global Positioning System (GPS) meteorology requires that, surface meteorological data (temperature and pressure) should be preferably obtained from in-situ measurements co-locating with or close to the GPS antenna, this is not always available because most GPS network is for positioning and navigation. This paper presents an assessment of GPT2w model for GPS meteorology in the equatorial region; therefore, a study over Malaysian Peninsula was conducted. The accuracy of the model interpolated temperature and pressure was first evaluated based on meteorological data interpolated from AWS observations. Using the AWS-based IWV as reference, the GPS-derived IWV from GPT2w model was assessed. From the results, relative accuracy of 1.61%, 0.67% and 1.27% were obtained for the GPT2w model-based IWV at BANT, GETI and PEKN respectively with a correlation coefficient of over 0.9 at all the GPS stations. Therefore, applicability of the GPT2w model for GPS meteorology would be beneficial for GPS atmospheric remote sensing in Malaysia.

Key words: GPS Meteorology, GPT2w model, ZHD, ZWD, interpolated surface meteorological data, GPS-IWV.

INTRODUCTION

High amount of atmospheric water vapour in the equatorial region due mainly to high evaporation rates and the prolonged seasonal monsoons has made it difficult to effectively monitor the equatorial troposphere. Thus, GPS meteorology has been recently used to support classical meteorology but requires that surface meteorological data (temperature and pressure) should be preferably obtained from in-situ measurements co-locating with or close to the GPS antenna. This is seldom available as most GPS networks are for positioning and navigation. The use of approximate pressure and temperature information obtained from empirical models such as global pressure and temperature (GPT, Böhm et al., 2007) may be remarkable for GPS meteorology projects. Recently, there has been increased awareness on the need for GPS meteorology in Malaysia, but only four of the Malaysian Real Time Kinematic GPS network (MyRTKnet) have the Automatic Weather Stations (AWS) and their collocating radiosonde launch sites located relatively at close range (Musa et al., 2011). Therefore, this paper investigates the applicability of GPT2w model for GPS meteorology in Peninsular Malaysian.

MATERIALS AND METHODS

The hourly sampled surface temperature and pressure from the AWS covering day of year 001 to 366 (one year) in 2008 as well as from GPT2w model available at http://ggosatm.hg.tuwien.ac.at/delay.html, was collected. In addition, GPS data from the three MyRTKnet stations over the same period of 2008 was accessed and used in this study, the GPS data were acquired at 15 seconds sampling rate.

Since AWS are not collocated exactly with the GPS stations, the observed data from the AWS were interpolated to the closest GPS stations. The GPS Data was processed using Bernese software version 5.0 (Dach et al., 2007) to estimate hourly zenith path delay (ZPD) based on data double-differencing technique. Also, hourly surface temperature and pressure from the 1˚ x 1˚ background grid of the GPT2w (i.e GPT2_1w) model were interpolated to the GPS sites using the station coordinate and ellipsoidal height as input. The ZPD consists of the zenith hydrostatic delay (ZHD) and the zenith wet DELAY (ZWD), the ZHD at all the GPS sites were estimated based on Saastamoinen model then, ZWD was obtained as a difference between ZPD and ZHD (Musa et al., 2011). Integrated Water Vapour (IWV) depends on ZWD and their relationship has been given by Bevis et al. (1992).

Data from the three AWS (Sepang (KLIA), Kota Bharu (KTBR) and Kuantan (KUAN)) was used to assess the surface meteorological data obtained from GPT2w model, while IWV assessment was performed relying on the GPS data from the corresponding MyRTKnet stations (BANT, GETI and PEKN). the spatial relationship between the meteorological stations and the corresponding GPS stations has been given by Musa et al. (2011).

RESULTS

The assessment was performed in two-folds; analysis of the interpolated meteorological parameters (Figure 1) and the estimated IWV (Figure 2 and Table 2) form GPT2w model and AWS data.

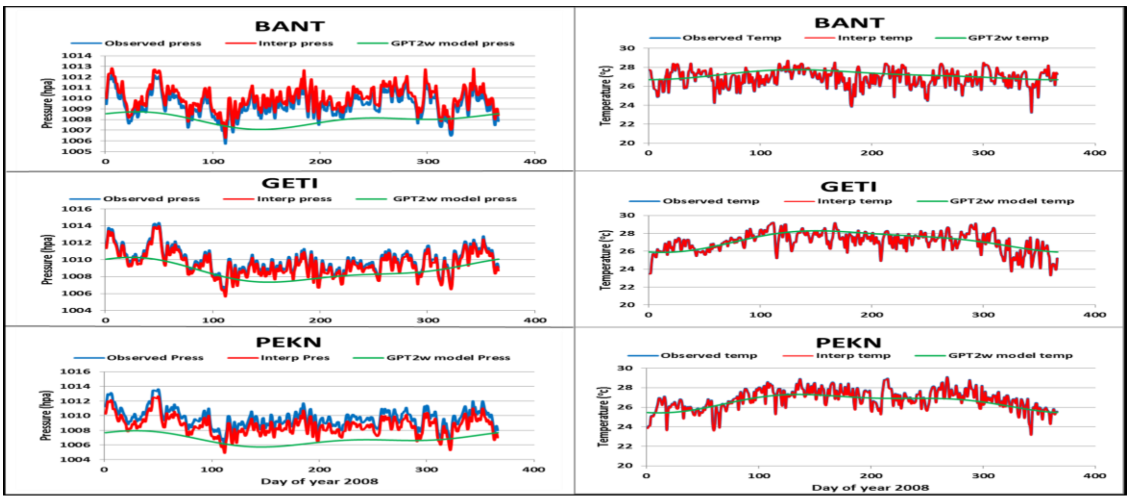

Fig. 1 Time series of the observed (blue), interpolated (red) and the GPT2w model (green) pressure (left panel) and temperature (right panel) at the three AWS and the corresponding GPS stations (BANT, GETI and PEKN) respectively.

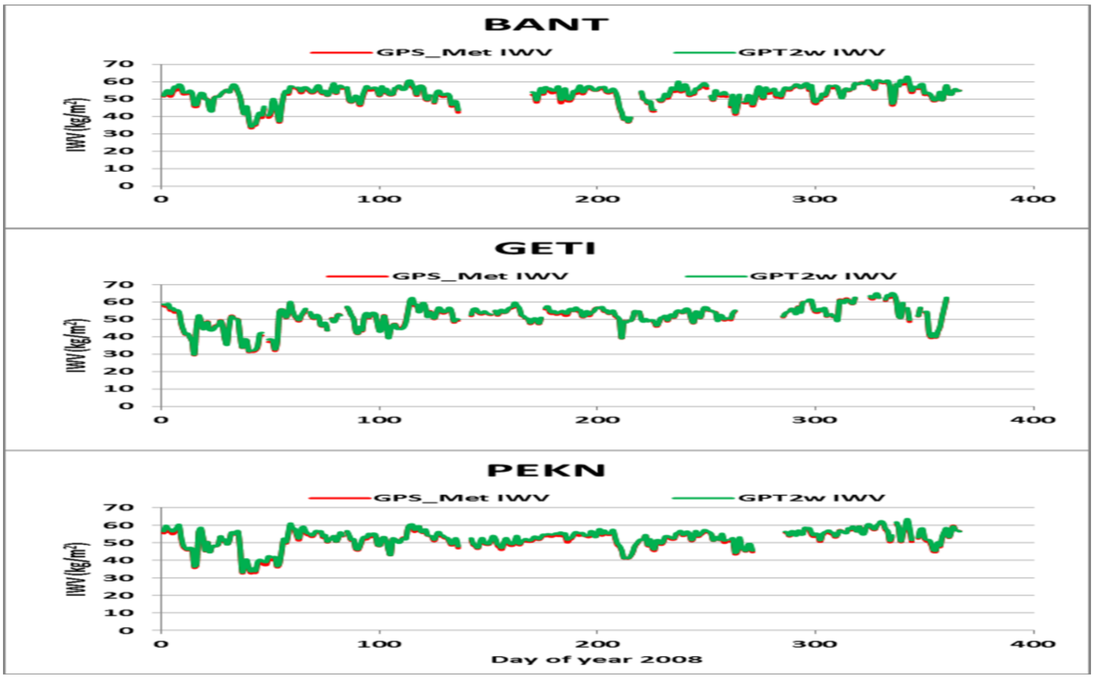

Fig. 2 Time series analysis comparing the daily trend of IWV from interpolated AWS meteorological data (green) and the GPT2w model meteorological data (red) at the three GPS stations (BANT, GETI and PEKN) respectively.

Table1 Summary of statistics of the GPT2w IWV

Station	Relative Acc.	Root Mean sq.	Correl. Coeff.
BANT	0.0161	0.9187	0.9907
GETI	0.0067	0.5871	0.9945
PEKN	0.0127	0.8129	0.9924

CONCLUSION

The applicability of GPT2w model for GPS meteorology has been investigated in this paper. It was found that GPT2w model-based GPS IWV possessed almost equivalent accuracy as GPS-derived IWV based on interpolated surface meteorological data.

REFERENCES

Bevis, M., S. Businger, T.A. Herring, C. Rocken, R.A. Anthes and R.H. Ware (1992). GPS Meteorology: Sensing Of Atmospheric Water Vapour Using the Global Positioning System. J. Geophys. Res. 97(D14), 15787-15801, October 20, Pii: 0148-0227/92JD-01517$05.00.

Böhm J, R. Heinkelmann and H. Schuh (2007). Short Note: A Global Model of Pressure and Temperature for Geodetic Applications. J. Geod 81(10):679–683. doi:10.1007/s00190-007-0135-3.

Dach R., U. Hugentobler, P. Fridez, and M. Meindl (2007). Bernese GPS Software Version 5.0. Astronomical Institute, University of Bern, Bern, Switzerland.

Musa, T.A, S. Amir, R. Othman, S. Ses, K. Omar, K. Abdullah, S. Lim and C. Rizos (2011). GPS Meteorology in a Low-Latitude Region: Remote Sensing of Atmospheric Water Vapour over the Malaysian Peninsular. J. Atmos & Solar Terr. Phys., 73 (16), 2410-2422. Doi: 10.1016/j.jast.2011.08.014.