

## ***Interactive comment on “A new voxel-based model for the determination of atmospheric-weighted-mean temperature in GPS atmospheric sounding” by C. He et al.***

**Anonymous Referee #1**

Received and published: 29 December 2016

The manuscript describes a new empirical model (called GWMT-D) for the determination of weighted-mean temperature ( $T_m$ ). The main focus laid on the modelling of daily variations, the finding of the optimal period for the determination of semi-annual and annual variations from numerical weather model (NWM) data and the reduction of global bias and RMS with respect to radiosonde and NWM data, especially at higher atmospheric levels.

GWMT-D provides mean values, annual, semi-annual and daily variations on a  $5^\circ \times 5^\circ$  global grid and four distinct height levels at 0, 2, 5 and 9 km. These parameters were derived from four years of NCEP2 data. Unfortunately it remains unanswered why exactly these height layers were chosen.

C1

Nevertheless, in contrast to other state-of-the-art empirical models based on spherical harmonics (GTm-III, GWMT-IV and GTm\_N), the gridded GWMT-D model has a smaller global mean RMS on surface level and on distinct height levels up to 9 km above surface.

From Figure 2 only small  $T_m$  variations are visible during daytime. A comparison of daily mean values with daily variations is missing. Thus it is not entirely clear how the modelling of daily variations improves the performance of the model.

In consequence major potential for improvements is seen in the analysis of daily variations and the description of its impact on the model performance. Further the authors should make transparent their decision making process for the selection of the four height levels at 0, 2, 5 and 9 km. In the following I provide some further recommendations and corrections, separately for content and language.

Content:

- Page 2, Line 13 “ $R_v$  is the specific gas constant for the air; [ . . . ]”  $R_v$  is the specific gas constant for water vapour
- Page 2, Line 14: “ $e$  is the WV pressure (in hPa); [ . . . ]” Water vapour pressure  $e$  does not appear in Eq. 3 but rather density  $v$  of liquid water. In order to be consistent with Eq. A1 the ideal gas equation  $v = e/R \cdot T$  should be added or at least the relation between  $e$  and  $v$  should be explained here.
- Page 4, Line 26: Why is the minimum number of valid levels set to 20? The values seems to be too large. In the text above only 17 standard pressure levels are defined.
- Page 5, Line 18: Why did you select exactly these four heights layer for modeling of vertical  $T_m$  lapse rate? Please give an inside into the decision making process.
- Page 8, Line 8: “Section 3.1.2 shows that the piecewise linear algorithm [ . . . ] is better than the direct modeling of  $T_m$  [ . . . ]” In section 3.1.2 the piecewise linear algorithm is mentioned as new model feature. Up to now no results are shown that the piecewise

C2

linear algorithm is better suited than any other approach.

- Page 18, Figure2: The daily variations seem to be rather small, how large is the improvement when 6 hour values are used and interpolated by splines in comparison to daily mean values? Is it worth to add daily variations to the model? Please provide some numbers.

- Page 8, Line 19: Table 2 shows the results only for pressure levels from 1000 hPa to 600 hPa and not below as mentioned in the text.

- Page 12, Eq. A2-A4: Equations not found in given reference Aparicio et al., 2009.

- Page 12, Eq. A3: For the determination of gravity usually a height dependent term like  $(1+(h/RE))^2$  is added. Please explain why this was not used here.

- Page 12 Eq. A5: relative humidity is abbreviated with 'f' but in the text 'RH' is used, please be consistent.

- Page 23, Figure 12: Is the RMS of PWV given in (K) or rather in (mm)?

Understanding and language:

Please review language and writing. A selection of not meaningful or incorrect phrases is given in the following:

- Page 1, Line 8: "One of the most critical variables in PWV remote sensing using GPS technique is the zenith tropospheric delay (ZTD)." Not a good introduction for a paper about mean temperature.

- Page 1, Line 12: "using global reanalysis data from 2010 to 2014 provided by NCEP-DOE Reanalysis 2 data (NCEP2)." Please correct, e.g. in the following way "using global reanalysis data 2 provided by the National Centers for Environmental Prediction (NCEP2)."

- Page 2, Line 1: "using GPS-PWV" can be eliminated

C3

- Page 2, Line 3: "over the site of the station (...)." Please clarify

- Page 2, Line 4: "over the region covered by the stations (...)." Try to be more precise.

- Page 4, Line 2: The first sentence of Section 2.1 is not meaningful, reanalysis data cannot have a main aim, please correct.

- Page 4, Line 13 "Radiosonde profile data from [...] stations over the globe in 2014 (...)." ... "

- Page 5, Line 5: "Due to the fact that ... the surface Tm from GGOS data is also used ... ." clarify

- Page 7, Line 4: Assuming Tm at the target location [...] is Tm [...]" clarify

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C4