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Atmospheric Measurement Techniques Discussions

Interactive comment on "The Sofia University Atmospheric Data Archive (SUADA)" *by* G. Guerova et al.

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Dear anonymous referee #1,

Thank you for recommending our paper for publication and for suggesting improvements in the presentation. Below we have addressed the proposed specific and technical corrections.

Reply to the Specific comments of Ref#1

"Page 4: L23: Please check the number of stations. I think the number is about 1500."

Actually, the number of E-GVAP stations is growing and currently in Europe they are over 1800. Recently were also added 200 stations in North America.

"Page 9: L21: Please remove statements which are not relevant for SUADA. E.g. The relative humidity sensor is a thin-film capacitor . . . Is this important for SUADA? However, you are right, it is worth to include the estimated accuracy. By the way, provide somewhere in the manuscript the estimated accuracy for the GPS ZTD (and IWV). This is relevant information for SUADA."

The revised sentence is as follow: *The relative humidity sensor has measurement range between 0 and 100 %, resolution 1 % and total uncertainty in sounding 5 %.* The following sentences are added to Page 13 line 2: *Uncertainties in the IWV derived from ground based GNSS are caused by errors in: 1) surface pressure (1 hPa corresponds to 0.33-0.37 mm in IWV) and 2) ZTD (1 mm corresponds to 0.15-0.16 mm in IWV). The accuracy of IWV is estimated to be in the range* ± 1 *mm.*

"Page 10: L9: ...but requires careful quantification of possible systematic biases. What do you mean? The quantification of possible systematic biases is not a specific problem of radiosondes. It is a problem of any observing system including the GPS ZTDs. Just to give you an example, switching from relative to absolute PCVs in 2006 introduced a systematic difference of âĹij 8 mm in GPS estimated ZTD."

The radiosonde is an established observing system and using the water vapour observations from the GNSS method was successfully applied to quantify some of the biases. Currently, within the GRUAN project a development a new "reference type

radiosonde" is targeted and complementary use of the techniques, including GNSS method, is considered.

"Page 10: L19: may be the listing of the hours with minutes is not necessary here, e.g., manually collected seven times daily every 3 hours beginning at 00:00 or similar."

Thank you for this suggestion! The revised sentence is: *The surface data is collected manually every 3 hour starting at 00:00 UTC.*

"Page 11: L11: The details about WRF can be softly removed (you use 5 lines here for this information, is not balanced). These details are not relevant for SUADA, are they? It is sufficient to provide a single reference."

Thank you for this suggestion! The revised sentences are: *WRF model description can be found in Skamarock et al. (2008).* The following reference is included: *Skamarock, W. C., J. B. Klemp, J. Dudhia, D. O. Gill, D. M.Barker, M. G. Duda, X-Y. Huang, W. Wang, and J. G. Powers, 2008, A description of the Advanced Research WRF version 3. NCAR Tech.Note, NCAR/TN-475STR, 113 pp.*

"Page 11: L22: This sounds strange. At first, you use WRF data to derive GPS IWV, and in the next step you 'verify' the WRF water vapour field with the GPS IWV. Instead of 'verify' please write 'compare'."

The model surface pressure and temperature will be considered for derivation of the GNSS-IWV. It has been shown that the models provide quality controlled surface parameters. In particular, models with high spatial resolution do better job in height

interpolation of the surface parameters, which is often required as the synop networks are rarely co-located with the GNSS receivers. The WRF-IWV will be computed by using formula 1 thus independent model fields will be used. However, the observation only GNSS-IWV is already available and will be included in the model comparison. The suggested replacement is accepted and the revised sentence is: *The near future use of WRF model will be to: (1) replace the synop observations for derivation of GNSS-IWV, (2) compare the model water vapour field with GNSS products and (3) assimilate the GNSS-IWV.*

"Page 14: You use the GFS to explain the meterological conditions (Fig. 4). This must be mentioned somewhere in the first paragraph. Next, you discuss the GPS IWV. What i do not understand is, why do you not simply provide a map of the GFS IWV? GFS data are freely available (with 1âŮę or 0.5âŮę resolution) and contain Relative Humidity, Temperature and Pressure. (http://www.nco.ncep.noaa.gov/ pmb/products/gfs/)."

Thank you for pointing to the GFS data archive! With this subsection we are aiming at adding complementary information to the one already available to the operational forecasters. The GFS model predictions are available together with other models on daily bases to the forecasters. That is why no additional model fields are included. It is subject of further work to compare the 2D maps produced by GNSS-IWV with WRF-IWV and GFS-IWV. Presented here are only 2 events from a set of 22 intense precipitation events in 2012 selected in collaboration with the operational forecasters from Bulgarian National Institute of Meteorology and Hydrology. Ongoing work is use of the 2D maps to analyse those events and provide guidance to possible application in operational forecast.

"Page 27: Is it possible to replace the cyrilly letters?"

New figure without cyrillic letters is included in the revised manuscript.

“Page31 Maps quite (too) small! Why are the colormaps of the Meteosat and GNSS IWV (Fig.6) reversed? Is it possible to provide the same colormap? Otherwise, it is not obvious how well the GPS IWV fills the gap. And again, it would be usefull to see the GFS IWV map as well.”

New figures with same color for the 2D GNSS-IWV and Meteosat maps are included in the revised manuscript.

“Reference list: Please check again carefully (only some examples) ? what mean these numbers after the reference 5, 12, 8 . . .? Line 27: Mätzler or Matzler Line 32: Geophys”

The references 5, 12 and 8 are checked. The numbers refer to the page on which the reference is cited. On line 27 and line 1 (next page) Matzler is changed to *Mätzler* and on line 2 Geophzs is changed to *Geophys*.

Reply to the Technical corrections of Ref#1

"page 2: L5: Advances in GNSS data processing makes it possible to use the data for ... L10: SUADA is a user friendly . . ..

page 3: L5: ...and finds it to be . . . L14: Recent... L16: ...in the Black Forest region . . . L28: . . .by examing two case studies. L29: . . . and the second case are ...

page 4: L2: For the analysis of the case studies several methods are used . . . L15: ...was the focus of the EU projects . . .

page 7: L16: ...elevation cut-off angle.. L17: provide a reference for Global Mapping Function (GMF). L26: GLONASS and not Glonass. L28: provide a reference for the Vienna Mapping Function 1 (VMF1). L28: in addition to the SOFI station six IGS stations are archived.

Page 8: L11: ..., in total 15 stations. L18: provide a reference for the dry Niell Mapping Function (NMF).

Page9: L8: provide a reference for Saastamoinen. ... with dry NMF and a tilting gradient model. provide a reference for the gradient model. L16: Radiosondes are widely . . . L18: At the station Sofia . . . routine daily soundings are performed. L20: Since 2005 the VAISALA . . .

Page10: L5: . . . are archived in SUADA.

Page12: L6: what is ’the elevation angle of the satellite’? Better write ’the elevation angle of the station-satellite link’. L17: θ is the latitude and not the gravitational acceleration. But you are right, it appears in the equation because the gravitational acceleration depends on the latitude. L23: ZTD was already appreviated somewhere in the beginning of the long manuscript. Page 13: L6: ...are ’co-located’ instead of ’allocated’.

Page 15: L6: ...the case study presented in this paper demonstrate the synergy between.. L8: .. will be the detailed analysis of . . .

Page 16: L3: . . . Fig. 7 shows the the GNSS IWV and RS-IWV anomalies.

Page 17: Last sentence: This is already mentioned on page 15 line 8. I propose to remove it there."

All of the suggested technical comments are included in the revised manuscript. The following references for GMF, VMF1, NMF and Saastamoinen are added:

Boehm J., A. Niell, P. Tregoning, H. Schuh, 2006, The Global Mapping Function (GMF): A new empirical mapping function based on data from numerical weather model data. Geophysical Research Letters 33 L07304 DOI:10.129/2005GL025546.

Boehm J., B. Werl, H. Schuh, 2006, Troposphere mapping functions for GPS and very long baseline interferometry from European Centre for Medium-Range Weather Forecasts operational analysis data. Journal of Geophysical Research 111 B02406 DOI: 10.1029/2005JB003629.

Niell A., 1996, Global Mapping Functions for the Atmosphere Delay at Radio Wavelength. Journal of Geoph. Research 101(B2), pp 3227-3246.

Saastamoinen, J. 1972, Atmospheric correction for the troposphere and stratosphere in radio ranging of satellites, in The Use of Artificial Satellites for Geodesy, Geophys. Monogr. Ser., vol. 15, edited by S. W. Henriksen, A. Mancini, and B.H. Chovitz, pp. 247-251, AGU, Washington, D.C.