Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2018-263-RC1, 2018

Atmospheric Measurement Techniques Discussions

Interactive comment on "4DVAR assimilation of GNSS zenith path delays and precipitable water into a numerical weather prediction model WRF" *by* Witold Rohm et al.

Anonymous Referee #1

Received and published: 27 August 2018

Reviewers comments

on

4DVAR assimilation of GNSS zenith path delays and precipitable water into a numerical weather prediction model WRF

by

Witold Rohm, Jakub Guzikowski, Karina Wilgan and Maciej Kryza

Journal Atmos. Meas. Tech., https://doi.org/10.5194/amt-2018-263

General comments ————————

This Paper is concerned with evaluating the impact of GNSS observations within the WRF limited area data assimilation and modelling system over an area covering Poland. Previous work in the field of research is throughly reviewed. However, ufortunately, misinterpetations were found.

The Paper has a sound scientific basis in the sense the effect of utilizing GNSS-based observations on the quality of numerical weather prediction is investigated. The experiments carried out are quite clearly described, although some improvements can be made. Unfortunately, in my opinion, the results of the experiments is not well enough evaluated and presented. Over such a small area and for a humidity related observations it is not advisable to evaluate the impact including forecasts up to 48 h and focus on surface observations and precipitation. In my opinion one should focus on forecasts up to roughly +12h and on verification also on upper air fields. In addition the statistical significance of the results should be presented.

Major Revisions of the Paper are needed, in particular regarding the evaluation of the parallel experiment. After these have bee carried out the Paper can be considered for scientific publication in Journal Atmos. Meas. Tech..

Please find below more detailed comments and suggestions are listed.

More Specific Comments ————————-

Page 1. line 11: I suggest change 'codified' to 'represented'

Abstract.lines 15-30: Too much details in Abstract. Remove that WRF can be applief for both 3DVAR and 4DVAR and tell only what you used. Also, you do not need to tell all dates of experiments in Abstract.

Page 2. lines 23-24. Here I am confident that you have misinterpreted the findings of Lindskog et al. when it comes to benefit of 4DVAR aganst 3DVAR. As far as I can read, Lindskog et al. did not apply 4DVAR, only 3DVAR. They did an experiment with

modified background error statistics in 3DVAR and from the results they concluded that 'The assimilation of GNSS ZTD in NWP can benefit from more general data assimilation improvements, such as enhanced description of statistical information or improved data assimilation algorithms.'.

Page 2, line 19. ZTD stands for 'Zenith Total Delay' not 'Zenith Tropospheric Delay'?

Section 2.1, pages 4-6. Here you need to describe more details regarding the data assimilation setup. For example, is data assimilation only carried out in the inner domain or in both. How often are model runs started (once a day?) and when (00 UTC?). Is surface data assimilation applied and what kinds of background error representation and quality control is applied. In addition please justify the model set-up choices presented in Table 1, for example why you did not use cloud microphysics in Domain 2. Also refer to Papers presenting the details of the various schemes applied.

Section 3, methodology: The cost function can be derived from Bayesian probability theory as is done in: Lorenc, A., 1986, Analysis methods for numerical weather prediction. Q. J. R. Meteor. Soc., 112, 1177-1194. then you will see that a factor 1/2 is missing in equation 1 page 29.

In addition a reckomend to use standard notations defined in

Ide K, Courtier P, Ghil M, Lorenc A. 1997. Unified notation for data assimilation: Operational, sequen- tial and variational.J. Met. Soc. of Japan 75 : 181–189.

throughout the Paper. For example R instead of O.

page 8, line 23 Please do not use long subroutine names from model code, not so clear.

Section 2.3, Model evaluation: Here I see the main weakness of this Paper. The GNSS ZTD and PW in the first place mainly affect the 3-D distribution of humidity. That will affect rain later on. Modifying the initial humidity state will mainly influence short range forecasts due short predictability time scales and small model domain. In

addition statistical significance of results needs to be addresses.In fact already from Figures 4 in the Paper one can get a hint that one should not look for impact at ranges beyond 12-24 h. In my opinion verification scores should be re-derived using shorter forecast ranges and looking and the dependence on forecast range. In addition please look at what the data assimilation is doing at range 0 to start with and also look at forecast fields. For statistical verification do not look only at the surface but use the radiosondes you show you have in the domain for verification for different altitudes in the atmosphere. Please also prove confidence intervals to your results together with an explanation how these were derived.

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2018-263, 2018.