Assimilation of GNSS single-frequency derived ZTDs into WRF model

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INTRODUCTION

Most GNSS receivers, in particular mass-market receivers, provide only single-frequency data with limited quality. In consequence, depending on the GNSS sensor, time series of tropospheric zenith total delay (ZTD) are obtained with different accuracy. Within this study, it is analysed if the accuracy of those data is adequate for assimilation into numerical weather prediction (NWP) models.

ZTD ESTIMATION

Single-frequency code + phase data
- RTKLIB package
- Precise IGS final orbits and clocks (SP3)
- Regional Ionospheric model
- Assumed accuracy: 20 mm

Single-frequency code data
- Rokubun processing core
- Precise IGS final orbits and clocks (SP3)
- Regional Ionospheric model
- Assumed accuracy: 100 mm

Dual-frequency data (reference)
- RTKLIB package
- Precise IGS final orbits and clocks (SP3)
- Assumed accurcy: 5 mm

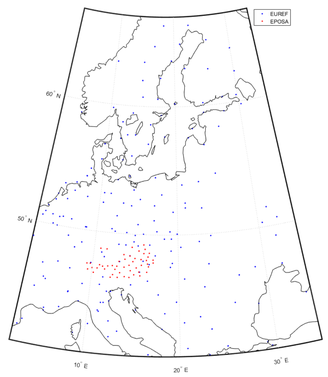

Fig. 1 Location of GNSS stations in the domain area.

In the following, results of a 3DVar **ZTD assimilation for 241 GNSS (EPOSA and EUREF) stations** (Fig. 1) for inital epoch (2016-08-02 06 AM) based on the assumed accuracy will be shown.

The weather forecast has been run for four cases, i.e. [1] base (without assimilation), [2] reference (with dual-frequency ZTD assimilation), [3] with single-frequency code + phase data assimilation, and [4] with single-frequency code ZTD assimilation. In order to assess the quality of the forecast after ZTD assimilation, we compared the results with radiosonde data (http://ruc.noaa.gov/raobs/; Fig. 3).

WRF ASSIMILATION

Forecast	
Forecast length	24 hours
Grid size in x/y axis	70/80
Grid resolution	36 km
Vertical dimension	35 levels (up to 5000 Pa)
Background data	NCEP FNL (Final)

Assimilation	
System	WRFDA 3DVar
Window	1 hour
Time	2016-08-02, 06 UTC

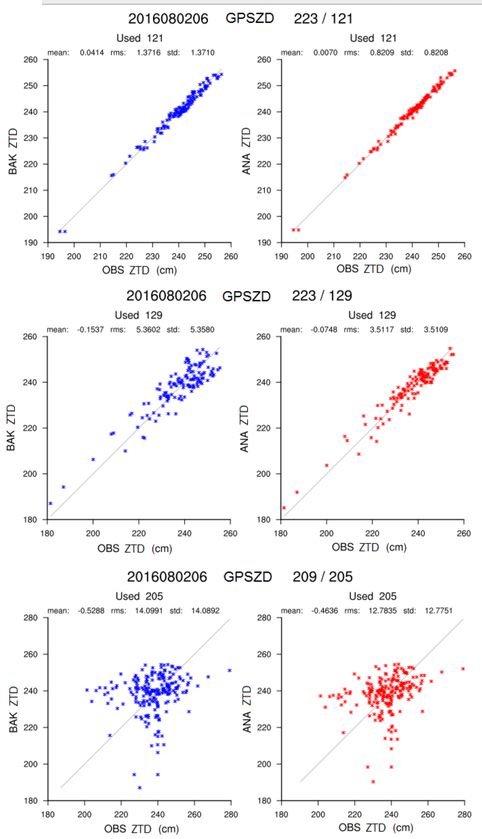

Fig. 2 Assimilation results (top – dual-frequency ZTD, middle – single-frequency code + phase ZTD, bottom – single frequency code ZTD). Left column shows the correlation between background ZTD and observed ZTD, right – the correlation between analyzed initial field (i.e. after ZTD assimilation) and observed ZTD.

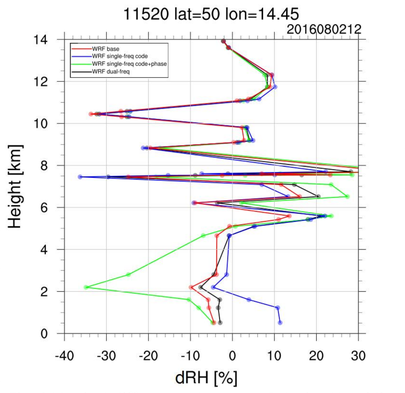

Fig. 3 Vertical differences between Relative Humidity (RH) calculated from forecast 6 hours after ZTD assimilation against radiosonde (11520) observations.

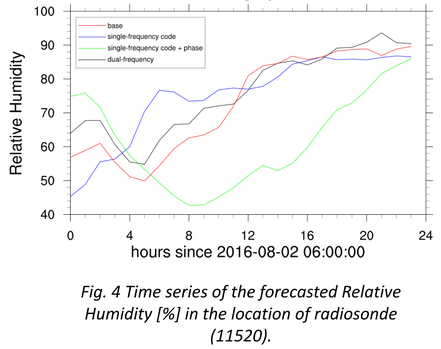

Fig. 4 Time series of the forecasted Relative Humidity [%] in the location of radiosonde (11520).

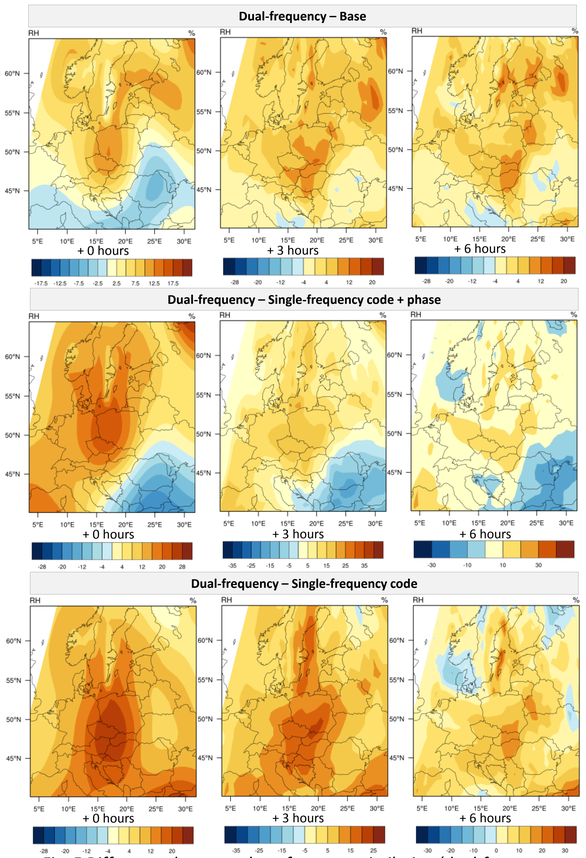

Fig. 5 Differences between the reference assimilation (dual-frequency observations) and the assimilation of single-frequency observations.

SUMMARY

In the comparison between radiosonde observations and assimilation results, **the largest discrepancies are visible in relative humidity for the single-frequency + phase observations**. Based on the received results we conclude that the weight of ZTD in case of single-frequency code + phase data is overestimated (the observations have too great impact on the state of the model). This effect might also be caused by an improper ionospheric correction of the GNSS observations. Further assimilation tests, with a larger observation error for this data set and improved ionospheric modelling shall be performed.