

## Review Summary for amt-2015-395

Benchmark campaign and case study episode in Central Europe for development and assessment of advanced GNSS tropospheric models and products

By

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### Recommendation:

I would like to recommend this article to be published after its minor revision.

As authors describe, the purpose of this paper is to introduce the GNSS4SWEC Benchmark campaign.

Specifications and characteristics of the Benchmark campaign data set are described in detail. I believe the data set will contribute for both geodesy and meteorology in not only Europe but other countries and regions.

However, there are not a few typos, insufficient explanations in body, tables, and figures.

I would like authors to carefully polish the article. Followings are for reference.

### About the chapter arrangement:

(1). It would be nice to move “3 Case study episode in 2013” to after “4. Benchmark data set” and before “5. Initial analysis and reference products”

(2) Effects of hydrometeor described in the latter half of the “6. Conclusion” and latter half of the “Appendix B” should be moved to “5 Initial analysis and reference products”.

### Abstract.

#### 1 Introduction

#### 2 GNSS4SWEC Benchmark campaign

##### 2.1 Description of WG1 objectives

##### 2.2 Data inventory and requirements for the Benchmark design

##### 2.3 Selected spatial and temporal domain

P6L3: “in Sect. 0” might be “in Sect. 3.2”

P6L4: “Additionally, seven clusters were set for an effective GNSS processing.”

It is unclear which areas in figure 1 are the “seven clusters”, and what does “effective processing” mean. Please describe clearly.

P6L6: “covered areas hit by” -> “covered areas were hit by”

##### 2.4 Envisioned studies and activities

P6L13: “real-time (RT)” -> “RT”. Firstly appeared in P3L3.

P6L14: "evaluating new analytical centres" -> Please explain what the "new analytical centres" are.

P6L17: "real-time" -> "RT"

P6L24: "IWV" -> "Integrated water vapor (IWV)"

### **3 Case study episodes in 2013**

#### **3.1 Weather analysis, May 2013**

P7L7: "daily accumulated precipitation (24-hour) from" -> "daily accumulated precipitation (24-hour) at Prague-Ruzyne (11518) synoptic station from"

P7L11: "weak gradient at 500hPa" -> Of what "gradient"?

P7L11-L24: Overall synoptic characteristics in May are described but no such description is seen for June.

P7L21: "On May 31-31," -> Please check the exact date.

P7L25: Figure 4 -> It would be nice if the area of the figure is more focusing on the area of the Benchmark campaign.

#### **3.2 Extreme precipitation events in the Czech Republic, June 2013**

P8L7: Figure 5 -> It would be nice if the distance scale and topography of the area are shown. Also, locations of "Šumava mountains", "Bohemia", "Plague", "Vltava", "Elbe" should be pointed in the figure.

### **4 Benchmark data set**

#### **4.1 GNSS data**

P8L27: Figure 6. -> Mark for WVR station is hard to distinguish from that of radiosonde station.

P9L3: "processing double-difference" -> It would be nice to add a reference on "double-difference", for example "Hoffmann-Wellenhof, et al, 2000: GPS theory and practice, 5th rev. ed., Springer-Verlag Wien New York."

P9L5: Table 1 -> Does "Height" mean "Ellipsoidal height" or "Height above sea level (i.e. altitude)"?

P9L6: "All GNSS" -> It would be nice to add brief summary regarding antenna type (Choke ring, ground plane, etc.), and elevation cut off angle.

#### **4.2 E-GVAP operational GNSS products**

P9L21: "14 analysis centres (and 29 solutions)" -> It would be nice to show the names of 14 centres and 29 solutions in a table.

P9L23: "TOUGH (2004)" -> Is it appropriate to use a project name rather than specific author(s) name?

#### 4.3 Synoptic data

#### 4.4 NWM data and products

P10L10: "Table 3" -> There is no information about geopotential height at each vertical layer. How users get geopotential height at each 3D grid point?

P10L13: "Vertical resolution" -> "Vertical layers"

#### 4.5 Radiosonde data

#### 4.6 Water Vapour Radiometer data

P10L28: "Water Vapor Radiometer (WVR)" -> WVR

P11L4: "Integrated water vapor (IWV)" -> IWV

P11L9: "GOPE and WTZR" -> Please describe the detail information about these two station.

#### 4.7 Meteorological Radar images

### **5 Initial analysis and reference products**

#### 5.1 Reference tropospheric products

#### 5.2 NWM-derived tropospheric parameters

P13L11: "German Research Centre for Geosciences (GFZ)" -> "GFZ"

P13L26: "compared in the GOP-tropDB" -> It would be nice to explain how to correct height differences between NWM surface and GNSS antenna. PWV and ZTD are highly depend on height of antenna. It brings significant effect for the comparison.

P14L2: "a negative mean bias of about 5mm" -> It is important to describe possible reasons for the large negative biases.

P14L4: Figure 8 -> Color scale should be identical for both GNSS and NWM.

P14L6: "As already seen in k in the local area model" -> What is "k"?

P14L8: "good homogeneity" -> The expression is ambiguous. Please describe what it means by "homogeneity."

P14L12: "23 times better horizontal resolution" -> Please explain of which horizontal resolution is "23 times better" than of which resolution.

P14L15: "it has not been explained yet." -> At least, I would like authors to compare reproduced atmospheric fields among GFS, ERA-interim, and ALADIN. Which element field (surface pressure, water vapor, or temperature) is different in GFS from other two models?

### 5.3 GNSS and NWM tropospheric wet delay maps

P14L22: "in Section 0" -> There is no "section 0" in this article.

### 5.4 Comparison of horizontal gradients from GNSS and NWM

P14L29: "zero a priori gradients" -> Please briefly explain this. I can't understand why "zero a priori gradients" leads "all solutions are considered as independent"?

P15L9: "Figure 10" -> The amount of estimated gradients in GNSS analysis seems larger than those in NWM. Is this happened by chance? Did authors statistically compare gradients between GNSS and NWMs?

## **6 Conclusion**

P16L23-P17L2: "An initial study – GNSS4SWEC project." -> This paragraph seems to be a sudden. If authors want to discuss about the effects of hydrometeors, I want authors to discuss it in section 5 in association with difference in IWV (or ZWD) between GNSS analyses and NWMs.

### **Appendix A: GNSS tropospheric model**

A. 1 Mapping function coefficients – a, b, c

A. 2 Horizontal tropospheric gradients

### **Appendix B: Functional relation between NWM meteorological parameters and GNSS tropospheric model**

P20L1-P20L16: "For the Benchmark campaign – (%0.4)." -> This paragraph seems to be better discussing in section 5.

P22L13: "TOUGH" -> Is it appropriate to use a project name rather than specific author(s) name?

P24: Table 2. -> Available parameters of German stations are listed as "P, T, Td, RH". However, "Td" can be calculate using "P, T, and RH". Is there any reason why "Td" is listed only for Germany sites?

P30: Figure 2. "June 4, 2013" -> "June 30, 2013"

P32: Figure 4 -> It should be nice if the area of the figure is more focusing on the area of the Benchmark campaign.

P33: Figure 5 -> It should be nice if the distance scale and topography of the area are shown.

P34: Figure 6. -> Mark for WVR station is hard to distinguish from that of radiosonde station.

P36: Figure 8 -> Color scale should be identical for both GNSS and NWM.

Figure caption: "two numerical weather models" -> "three numerical weather models"