

Recent GNSS meteorology activities at Germany: Selected examples

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Operational ZTD/IWV Monitoring



Li et al., GRL, 2014





Multi-GNSS Activities

GFZ Multi-GNSS ground network (GPS,GLO,GAL,BDS)





MGEX campaign of IGS initiated routinely processing of BeiDou with EPOS Software

Initial Multi-GNSS ZTD results available

GPS+GLO: ~ 15 satellites All: ~20 satellites for each station available

ZTD RMS ~ 1mm

GMSD? Processing issue





Troposphere Product (ZTD) of TIGA Reprocessing



- ZTD with 1 hour resolution
- Pressure and temperature from GPT2
- Vienna Mapping Function
- 7 degree cut off angle
- Quality currently evaluated







German Weather Service DWD





Operational numerical weather models running at DWD

Global Model: GME, ICON Resolution 20 km, 3D-Var data assimilation

European Model: COSMO-EU

Resolution 7 km, assimilation: nudging will be replaced by ICON with a local grid refinement over EUROPE



German Local Model: COSMO-DE

Resolution 2.8 km, assimilation: nudging, will soon be replaced by a local transform ensemble Kalman Filter (LETKF)





Development GNSS observation operator

Status: GPS radio occultation data are assimilated into GME, but ground-based GNSS data are not operationally used

Current focus: Development of a STD forward operator for improving humidity information of the models

Strategy: Assimilation of STD

Operator has interfaces to all DWD models (GME/ICON, COSMO-DE) and works with the corresponding assimilation systems (LETKF and 3d-Var)

Status: Operator developed, Investigation of observationminus-background statistics

Goal: Operational STD and ZTD assimilation





University Cologne & Max-Planck-Institute for Meteorology





Use of GPS derived IWV

for assessing small scale water vapour variability

multi-instrument effort at Jülich ObservatorY for Cloud Evolution (JOYCE)
 High Definition Clouds and Precipitation for Climate Prediction (HD(CP)²)
 HD(CP)² Observation Period Experiment (HOPE) April and Mai 2013



Steinke et al., Atmospheric Physics and Chemistry, in discussion





Research project BMBF



High Definition Clouds and Precipitation: results from a unified framework to advance Climate Prediction

Florian Rauser + many others Max Planck Institute for Meteorology + 18 other institutions across Germany Project funded by the German ministry for research and education (BMBF)







Research project BMBF

GPS data (around 15 stations) used as reference for all other observation systems



S. Steinke, S. Crewell, S. Seikenberg, P.D. Girolamo, G. Dick





Hans Ertel Center for Weather Research

Use of GPS IWV data to evaluate of high resolution ($\Delta x=6$ km) reanalysis

based on COSMO model of Deutscher Wetterdienst (DWD)
produced within the Hans Ertel Centre for Weather Research (HErZ) for the period 2007 - 2013



Figure 16. Bias of the integrated water vapour (IWV) between COSMO-REA6, COSMO-DS, and ERA-Interim and observations at 157 GPS station.

RMS(mm): REA6 2; DS 4; ERA 2,8

Bollmeyer, C. et al., QJRMS, in revision



