Exploitation of ground-based GNSS for Meteorology and Climate studies in Bulgaria/South-Eastern Europe

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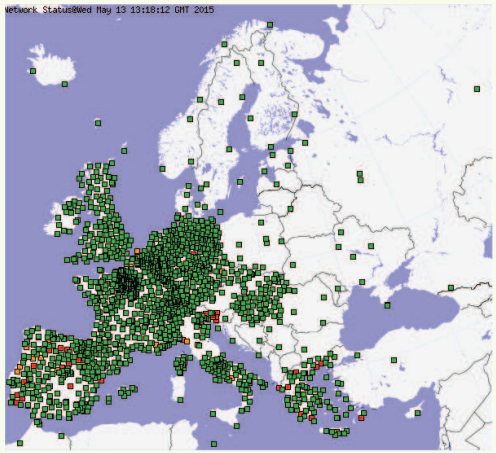
State-of-the-art of GNSS Meteorology in Europe

- over 1800 GNSS stations available in real time for EUMETNET EIG GNSS water vapour programme (E-GVAP) service
- Zenith Total Delay (ZTD) delivered within 90 minutes after observation to the UK Metoffice data server
- used by National Meteorologic Services for weather forecast model validation and improvement



Source: E-GVAP real time processing network (http://egvap.dmi.dk).

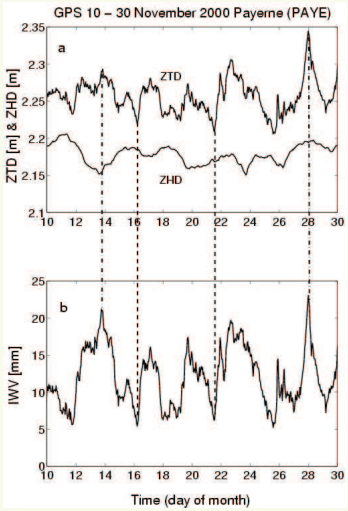
Sofia University Atmospheric Data Archive (SUADA)

- 2011-2012: SUADA development, publication of the data in May 2012
- 2012-2014: SUADA data population
- SUADA data-set: (1) GNSS networks in South-Eastern Europe, (2) regional weather and climate models and (3) other ground-based instrument
- 5 different GNSS processing for 107 GNSS station in Europe focus in South-Eastern Europe with temporal resolution 5 to 60 min

Source: Map of the GNSS stations in SUADA (http://http://suada.phys.uni-sofia.bg/).

GNSS tropospheric products: ZTD, ZHD, IWV

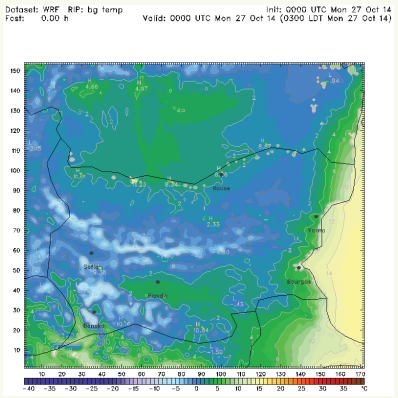
- ZHD and IWV computed from ZTD with surface pressure and temperature from the WRF model
- Youtube GNSS Meteorology explained

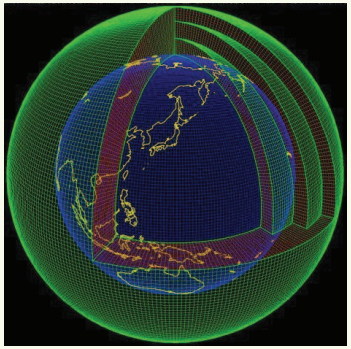


Source: Guerova et al., 2003. Validation of NWP mesoscale models with Swiss GPS Network AGNES. Journal Applied Meteorology, 42, 1, 141-150 .

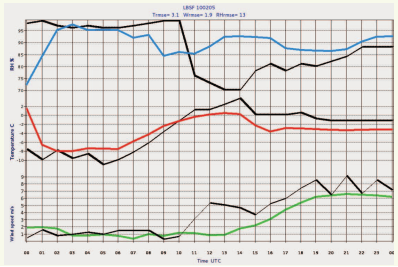
Numerical Weather Prediction (NWP) model: WRF

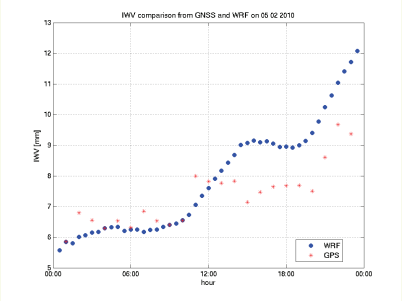
- Weather Research and Forecasting (WRF) model simulations for Bulgaria
- horizontal resolution 9 km, 44 vertical levels
- temporal resolution 30 min





Case study: fog on 5 February 2010 Sofia, Bulgaria

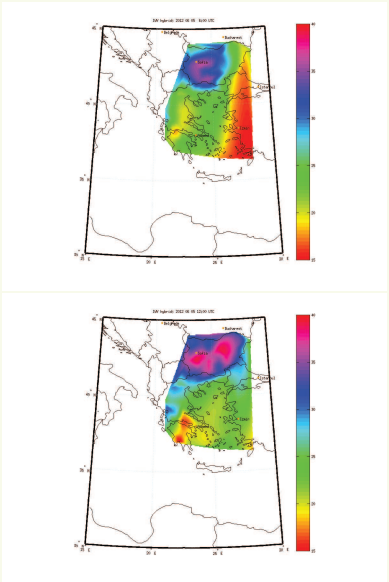




Collaboration with Prof. Keranka Vassileva, NIGGG-BAS

- from 00 to 10 UTC - relative humidity (RH) above 95 % - fog
- 11 UTC - RH drop to 75 %
- from 00 to 10 UTC - Integrated Water Vapour (IWV) 6 to 7 mm
- 11 UTC - increase of IWV to 8 mm
- IWV increase is due to transition from liquid water to water vapour and this is clear indication that the fog is dispersing
- very good timing between RH and IWV

Case study: 5 June 2012 hail storm, Bulgaria

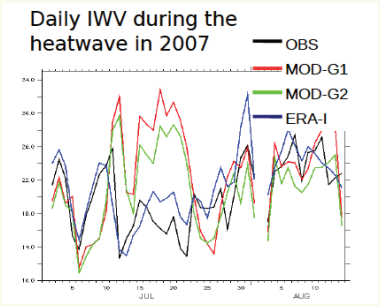


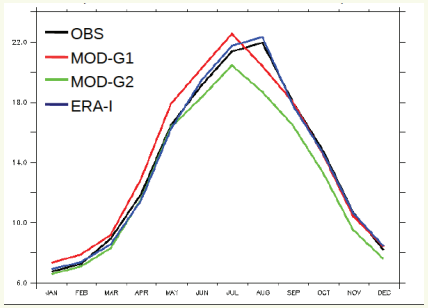
Collaboration with Prof. Chris Pikridas, Aristotle University of Thessaloniki

- 2D IWV maps for Bulgaria and Greece
- intense precipitation studies for 2012
- hail storm in Plovdiv - Pazardjik region on June 5 2012
- large increase of IWV from 06 to 12 UTC on June 5
- dry-wet gradient across South-Eastern Europe

Case study: 2007 Heatwave in South-Eastern Europe

- GNSS IWV from IGS repro 1 for station SOFI for 2000-2007
- regional ALADIN-Climate model simulations
- global atmospheric reanalysis data - ERA Interim
- GNSS IWV good agreement with ERA Interim
- evaluation for regional climate models with GNSS IWV





Collaboration with Peter Szabo, Hungarian Meteorologic Service

Conclusion

- developed at Sofia University regional Atmospheric data archive (SUADA)
- archived in SUADA: (1) ground based GNSS ZTD and IWV observations, (2) regional weather and climate model IWV and (3) observations from other ground-based instrument
- 5 different GNSS processing (PPP & DD): 107 GNSS station in Europe focus on South-Eastern Europe with temporal resolution 5 to 60 min
- application of GNSS IWV for monitoring the fog dynamics
- application of GNSS IWV for monitoring intense precipitation and hail storms
- application of GNSS IWV for climate model evaluation

GNSS4SWEC

- COST Action "Advanced Global Navigation Satellite Systems tropospheric products for monitoring severe weather events and climate (GNSS4SWEC)" 2013-2017
- 29 countries in Europe and 9 international partners

THANK YOU!