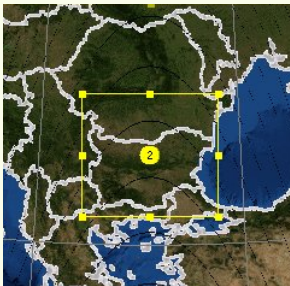


First Results of IWV comparison from GNSS and WRF model for Bulgaria in 2013

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Weather Research and Forecasting (WRF) Model



- Nonhydrostatic NWP model
- Spatial resolution- 9km
- Vertical resolution- 44 levels
- Temporal resolution- 30 min
- Initial and boundary condition from GFS Model for 6 hours
- No data assimilation

SUGAC- Ground-based GNSS network



- GNSS tropospheric products in Bulgaria/Southeast Europe- 8 stations from the Bulipos network at different altitudes
- GNSS data processed during the STSM, Tzvetan Simeonov at University of Luxembourg (host Prof. Norman Tefferle)
- NAPEOS software ZTD solution, temporal resolution- 5 min for 2013

Station altitudes in meters

Station Name	WRF	GNSS	WRF-GNSS
Montana	224.7	167.3	57.4
Lovech	350.1	191.5	158.6
Sofia (Plana)	898.8	1119.5	-220.7
Varna ●	96.0	61.7	34.3
Burgas	34	71.1	-37.1
Rozhen ●	1430.8	1778.9	-348.1
Shumen	243.1	268.0	-24.9
Stara Zagora	254.2	227.1	27.1

- 2 stations under 100 m, 4 stations under 500 m, 1 stations under 1000 m, 1 stations over 1000 m
- 5 stations with under 100 m differences and 3 station over 100 m

- IWV- GNSS- for the conversion are used surface temperature and pressure from WRF model

$$ZHD = (2.2768 \pm 0,0024) \frac{p_s}{f(\theta, h)} \quad (1)$$

$$IWV = K(ZTD - ZHD) \quad (2)$$

- IWV- WRF- using water vapor mixing ratio

$$IWV = \int_z^{z_n} \frac{\frac{p \times q}{0.622 + 0.378 \times q}}{R_v \times t} (z) dz \quad (3)$$

Yearly comparison of IWV: station Varna

GNSS4SWECC
WG2

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WRF

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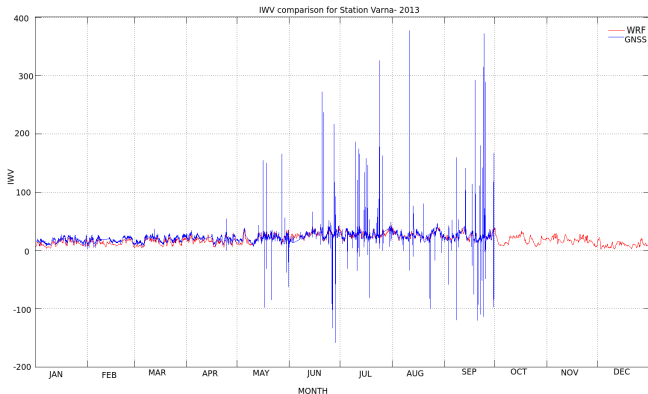
GNSS - WRF Altitude

Results- 2013

IWV

Comparison- Station
Varna

Comparison- Station
Rozhen



Yearly differences of IWV: station Varna

GNSS4SWEC
WG2

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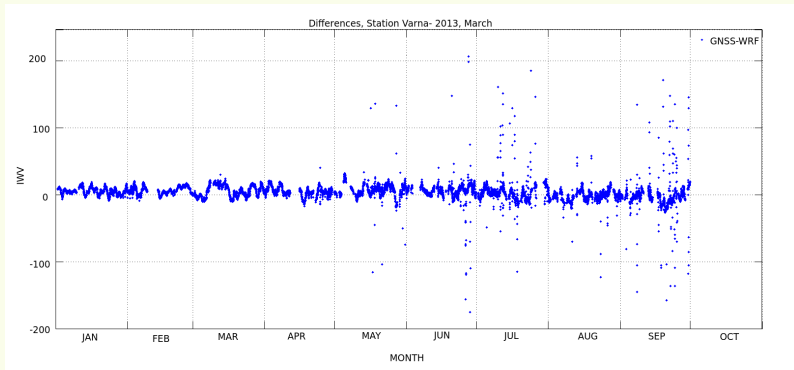
GNSS - WRF Altitude

Results- 2013

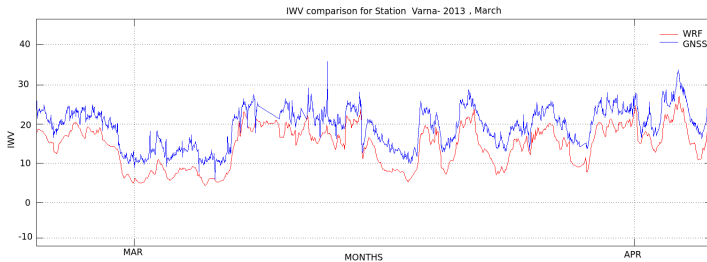
IWV

Comparison- Station
Varna

Comparison- Station
Rozhen



IWV for Station Varna in March 2013



IWV differences for Station Varna in March 2013

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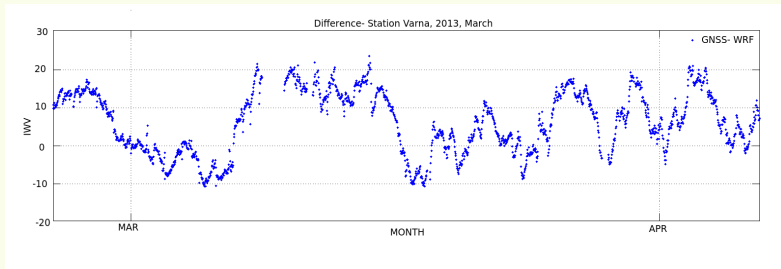
Ground-based
GNSS network
GNSS- WRF Altitude

Results- 2013

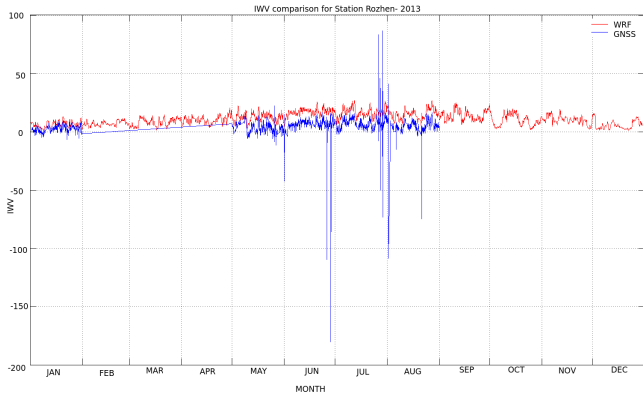
IWV

Comparison- Station
Varna

Comparison- Station
Rozhen



Yearly comparison of IWV: station Rozhen



Yearly differences of IWV: station Rozhen

WRF

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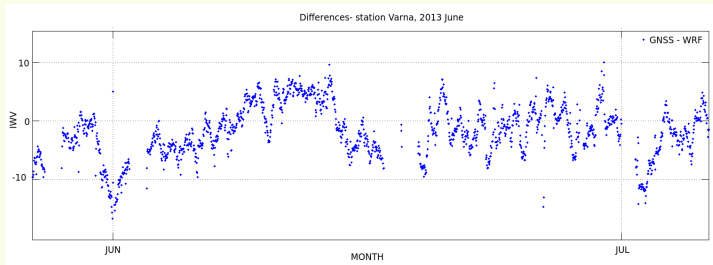
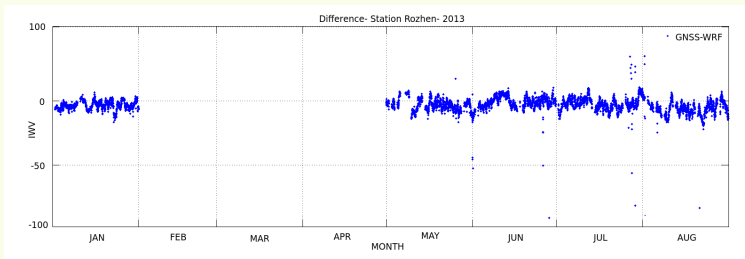
Ground-based
GNSS network
GNSS - WRF Altitude

Results- 2013

IWV

Comparison- Station
Varna

Comparison- Station
Rozhen



- For the first time the WRF model is computed and the IWV field is compared with GNSS (for 2 stations)
- IWV derived from WRF model for 8 GNSS stations, with 30 min resolution for 2013
- For station Varna both the WRF and the GNSS data have good agreement until the end of April. From May until September large deviations occur in the GNSS-WRF IWV comparison
- For the GNSS station Rozhen no such offsets are seen in the GNSS data but there are individual outliers.

WRF

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IWV

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- Compare the IWV field for all stations
- Filter the GNSS data
- Compute gradients for the 8 stations with WRF
- Data assimilation

- Prof. N. Tefferle, Tz. Simeonov, D. Sidorov for the processed data at University of Luxembourg
- Bulipos team for providing GNSS rinex data
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Thank you for the attention!