



WROCŁAW UNIVERSITY  
OF ENVIRONMENTAL  
AND LIFE SCIENCES

## NRT GNSS services for monitoring severe weather

Estera Trzcina, Piotr Toma, Natalia Dymarska, **Witold Rohm**, Jan Kaplon, Jan Sierny  
GNSS&Meteo Working Group, Institute of Geodesy and Geoinformatics,  
Marek Błaś, Maciej Kryza  
University of Wroclaw

# Motivation

Atmosphere pressure at the mean sea level



Geopotential height of 850hPa isobar and temperature



Convective Available Potential Energy (CAPE) and wind field

Geostacionary image

Aerological profiles

Ground based observations

750

800

850

900

950

1000

1050

12Z 03

-2

850 hPa

Sonntag

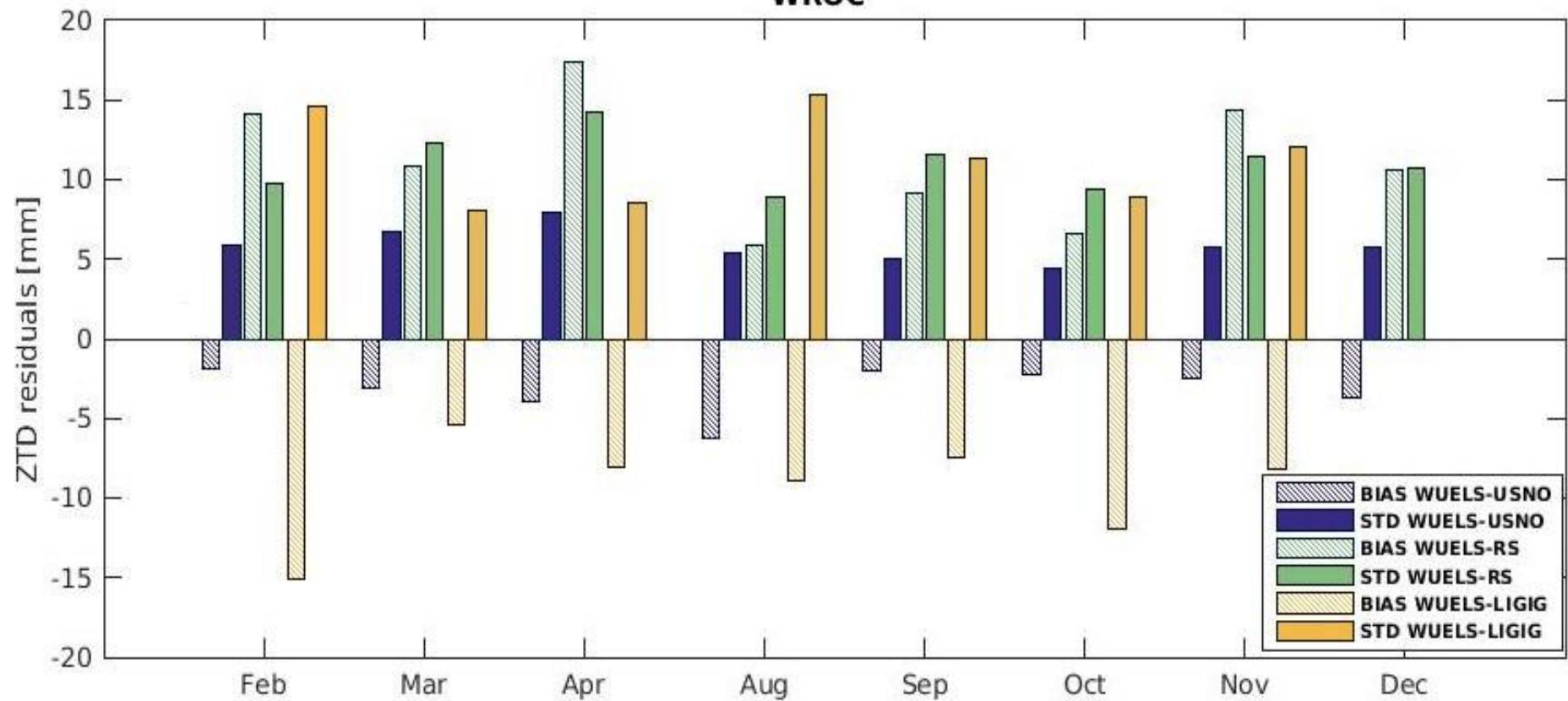
	Max	Min	Med	(C) (m/s)	(m/s)	Dir.	Int.	Gust (m/s)	(mm)	Oct	Oct	(m)	Km	weather summary
Kelblegg	34.1	16.4	24.2	15.0	75.9	555	7.2	46.6	1010.4	8.3	4.3	4.2	38.8	Cloudy
Korsør	34.3	16.7	25.4	13.8	54.8	555	11.4	50.4	1010.6	Tir	4.5	4.2	33.4	Cloudy
Læsø	35.4	17.9	25.7	13.2	52.5	555	16.1	52.4	1010.9	Tir	3.7	3.0	23.2	Cloudy
Leba	34.2	17.7	25.7	12.4	48.1	555	17.6	50.4	1011.5	Tir	3.2	2.4	22.5	Cloudy
Berlevåk	34.6	17.8	25.7	15.2	50.7	555	13.9	51.2	1010.8	---	3.0	3.5	30.0	Cloudy
Upernivik	34.0	16.2	27.0	11.9	45.1	555	12.5	---	1011.7	0.0	---	---	30.0	Cloudy
Hell	31.1	19.4	25.1	15.0	59.2	555	10.2	22.4	1012.4	Tir	3.5	3.0	22.7	Cloudy
Military Airfield	34.4	17.4	25.3	12.9	50.5	555	14.9	---	1011.8	---	3.8	3.7	42.2	Cloudy
Oksøyvika	30.2	19.5	25.5	15.9	57.4	555	13.2	---	1012.2	---	3.8	3.5	17.0	Cloudy
Gidenski	34.0	17.5	25.3	12.0	51.1	555	6.6	50.0	1012.0	---	3.2	2.4	30.0	Cloudy
Erlieg	33.2	19.5	25.9	10.9	32.6	555	12.6	50.4	1012.9	Tir	3.3	3.2	25.9	Cloudy
Kostreyn	33.8	20.2	27.1	12.3	42.3	555	19.0	46.2	1014.1	0.0	0.5	0.4	24.0	Cloudy
Bunnevik	33.7	17.5	25.3	12.4	49.2	555	9.7	50.0	1015.5	0.0	1.5	2.4	23.1	Cloudy
Svinhusejde	32.1	19.2	22.2	18.7	60.1	555	6.6	52.6	1010.1	---	5.2	6.0	25.8	Cloudy
Sæssøen	31.9	15.5	18.4	77.5	555	14.4	44.8	1010.0	50.7	5.4	6.0	10.5	Cloudy	
Røsø	33.9	17.5	23.5	15.7	72.5	555	5.4	---	1009.9	1.0	---	---	---	Cloudy
Sævildum	33.5	17.5	23.5	17.1	72.1	555	14.1	---	1010.7	---	4.7	3.9	9.9	Cloudy
Sæssøndøk	34.5	16.7	24.6	13.0	55.6	555	13.3	---	1011.2	0.0	---	---	---	Cloudy
Mindesøvær	33.9	17.3	23.0	15.7	69.9	555	11.6	---	1011.3	---	4.3	2.9	10.0	Cloudy
Pule	33.7	17.4	23.5	15.2	69.7	555	5.2	57.6	1011.1	1.9	5.2	4.3	9.0	Cloudy
Ørholm	33.6	17.9	24.8	13.6	57.9	555	14.0	50.4	1011.7	1.9	3.7	3.6	22.2	Cloudy
Torøn	33.3	16.8	23.3	14.4	55.4	555	8.7	46.8	1012.2	0.0	3.9	2.6	21.2	Cloudy
Millevik	33.3	16.5	23.3	12.3	45.5	555	12.0	50.4	1012.5	0.0	2.8	0.5	23.2	Cloudy
Gjæsbyn	34.0	16.5	26.2	11.9	43.5	555	12.1	50.4	1012.4	0.0	0.8	0.7	33.0	Cloudy
Mikkelø	32.9	19.4	25.9	15.1	53.1	555	12.5	59.6	1014.4	0.0	0.8	0.5	28.8	Cloudy
Østebø	34.2	17.0	27.0	12.3	44.6	555	8.6	---	1012.9	0.0	---	0.0	---	Cloudy
Ballytak	32.9	15.2	23.7	15.5	59.1	555	6.9	---	1015.5	0.0	1.1	0.2	25.4	Cloudy
Gennøe Wilke	31.6	17.3	22.2	17.5	79.5	5	5.1	46.8	1010.6	25.7	4.9	4.0	61.1	Cloudy
Sælvæs	30.5	17.3	22.3	17.5	77.6	5	9.5	46.8	1010.6	9.0	4.4	4.2	16.8	Cloudy
Krassan	---	---	---	---	---	---	---	---	---	---	---	---	0.0	Cloudy
Reeman	32.5	16.1	23.0	16.6	72.1	555	10.7	61.2	1011.3	12.9	5.3	4.0	9.8	Cloudy
Powdrie	34.2	16.1	23.7	15.6	64.2	555	12.9	---	1011.8	---	5.1	3.9	9.8	Cloudy
Innareddø	33.3	16.5	25.3	14.2	55.3	555	17.2	---	1011.8	---	4.3	3.6	9.8	Cloudy
Køle	32.5	17.5	23.2	15.9	59.2	555	10.8	57.6	1012.2	1.8	5.4	5.4	8.3	Cloudy
Flock	31.0	15.0	25.0	14.6	57.2	555	11.5	46.8	1012.6	0.0	3.8	3.6	15.7	Cloudy
Wierøya-Øksøy	31.0	19.9	25.3	14.6	53.2	555	11.3	---	1013.3	0.0	3.5	3.2	13.4	Cloudy
Mosziewicki	34.4	17.5	25.5	15.1	43.5	555	10.6	---	1013.5	---	3.1	3.5	13.0	Cloudy
Sælles	32.6	16.9	23.5	12.9	50.3	555	9.4	56.0	1014.0	0.0	2.9	0.7	24.5	Cloudy
Torsøpol	32.6	16.4	26.2	13.6	48.3	555	7.9	1013.0	0.0	0.8	0.6	13.9	Cloudy	
Zielona Góra	29.1	16.5	20.7	17.6	55.0	5	7.2	56.0	1011.2	11.9	5.5	7.2	14.2	Cloudy

# Near real-time GNSS processing (WUEL)

Parameters

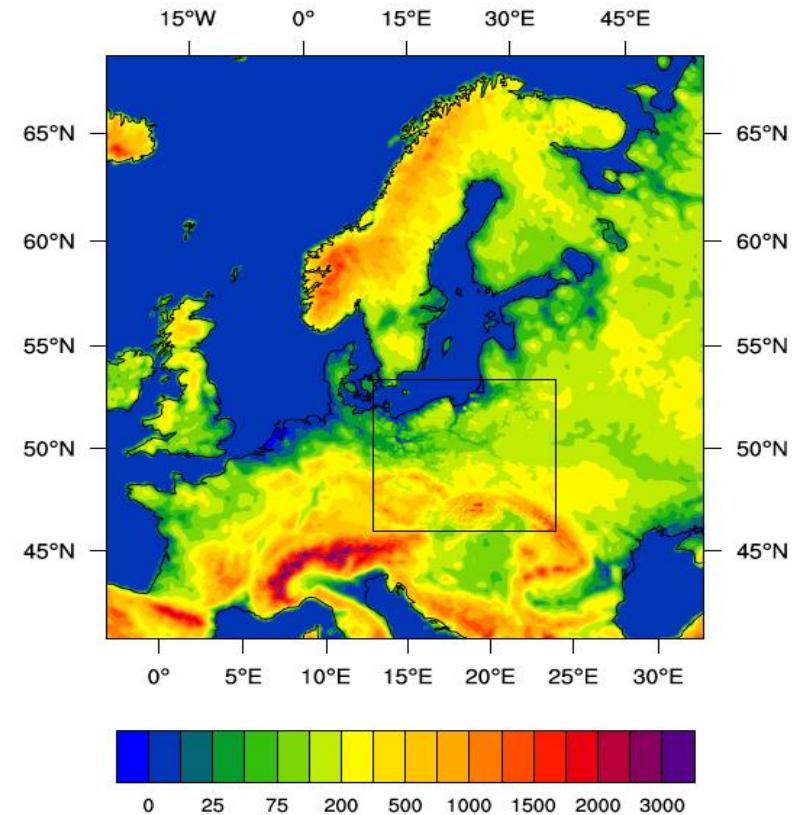
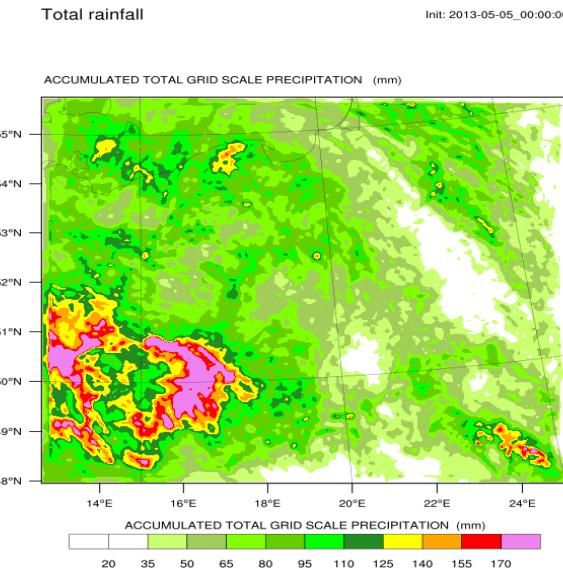
Bernese GNSS Software v. 5.2

WROC

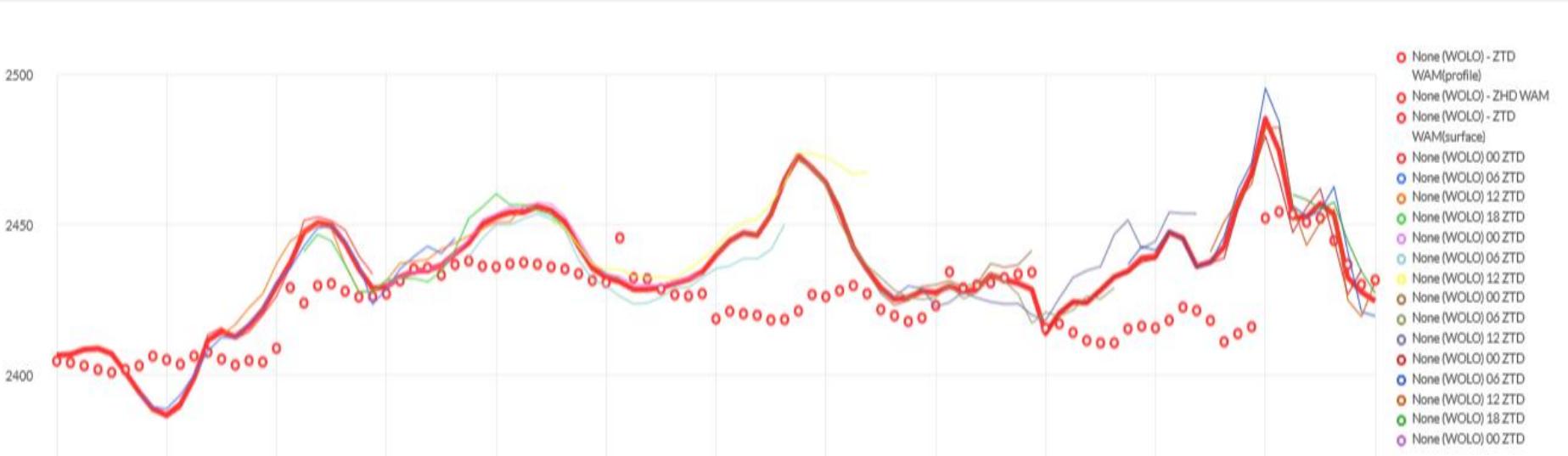


# WRF forecasts

- Model: Weather Research and Forecasting
- Assimilation: WRFDA
- Two nested domains, 12km x 12km for Europe and 4km x 4km for Poland
- 48 vertical levels
- Initial and boundary conditions: GFS  
0.5 deg x 0.5 deg



# MaGDA, C-Magda and Ligig



## IGG GNSS & METEO WORKING GROUP

» [Start](#)

### VISUALIZATION

- » [Static IWV map](#)
- » [Animated IWV map](#)
- » [IWV plots](#)
- » [Tropospheric gradient map](#)
- » [Lightning map](#)

### FURTHER INFO

- » [Visualized parameters](#)
- » [GMT](#)
- » [Blitzortung.org](#)

### ABOUT

- » [Description](#)
- » [Contact](#)



## GNSS&METEO Parameters Visualization Service

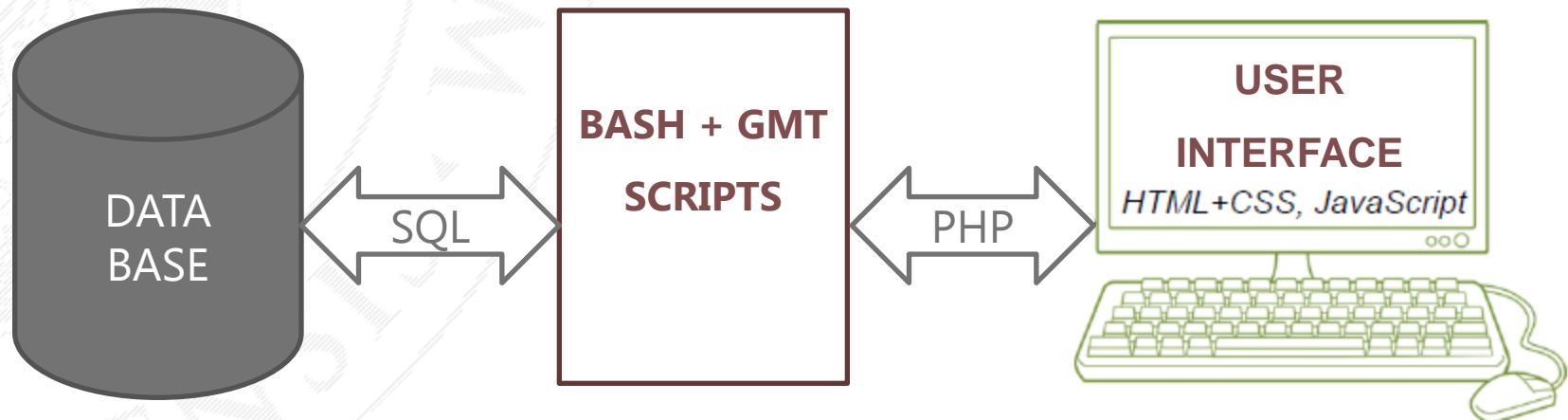
This work has been done by Piotr Toma as a part of Master Degree Thesis.

All maps and plots available on this page were made using GMT language. Presented data are derived from the Institute of Geodesy and Geoinformatics WUELS databases and are generated based on the observations from ASG-EUPOS system, Leica SmartNet with the participation of Weather Research and Forecasting (WRF) model operated by Department of Climatology and Atmosphere Protection, Wroclaw University, Blitzortung.org lightning location service. All the maps cover the area of Poland. The visualized parameters come from many sources, which may cause a gaps in the data series (it doesn't depend on the service). Some functions of the website are still in the testing stage. Institute of Geodesy and Geoinformatics takes no responsibility for the quality of the data and presentation.

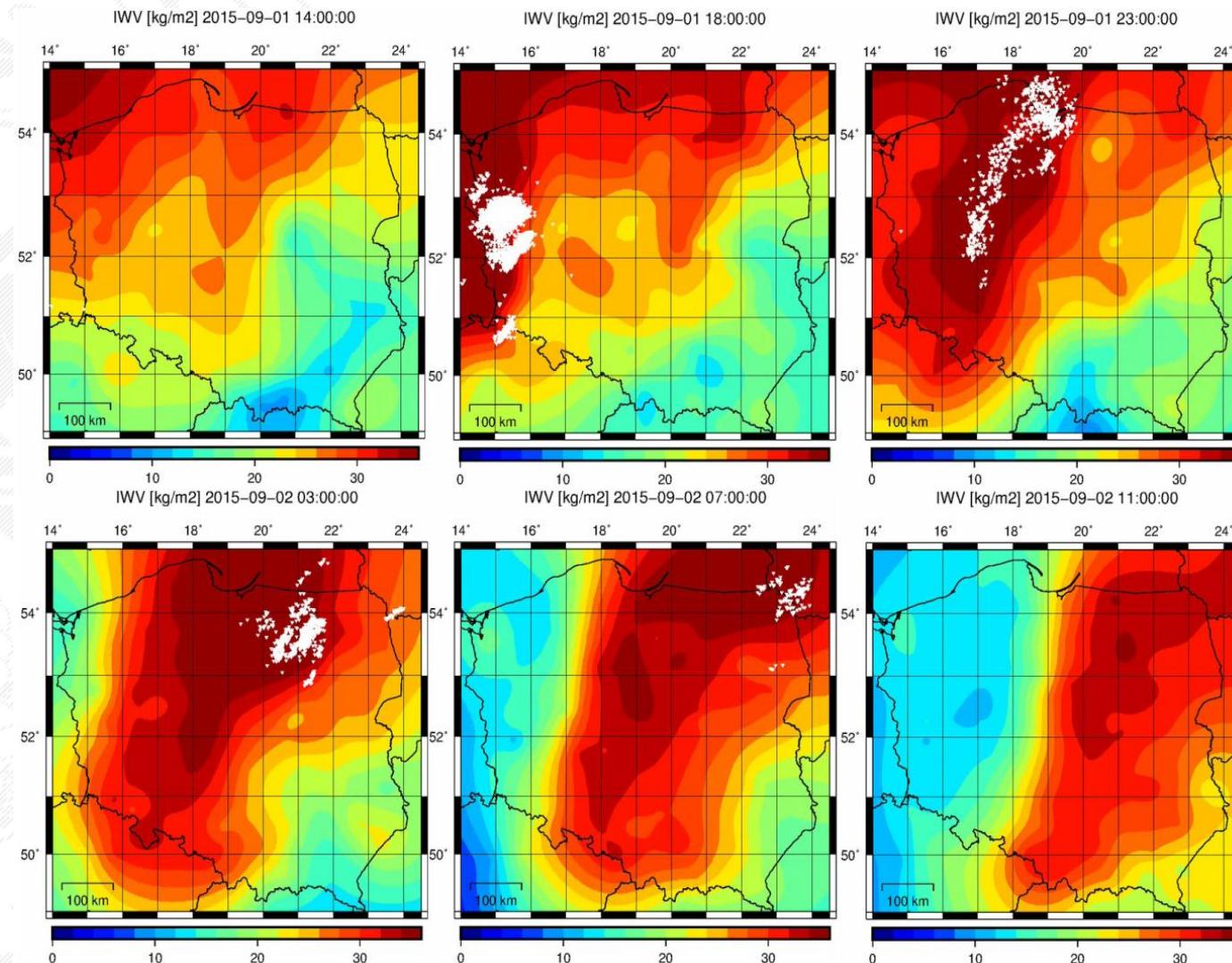
# GEO2.IGIG.UP.WROC.PL

## Implementation at GEO2 server

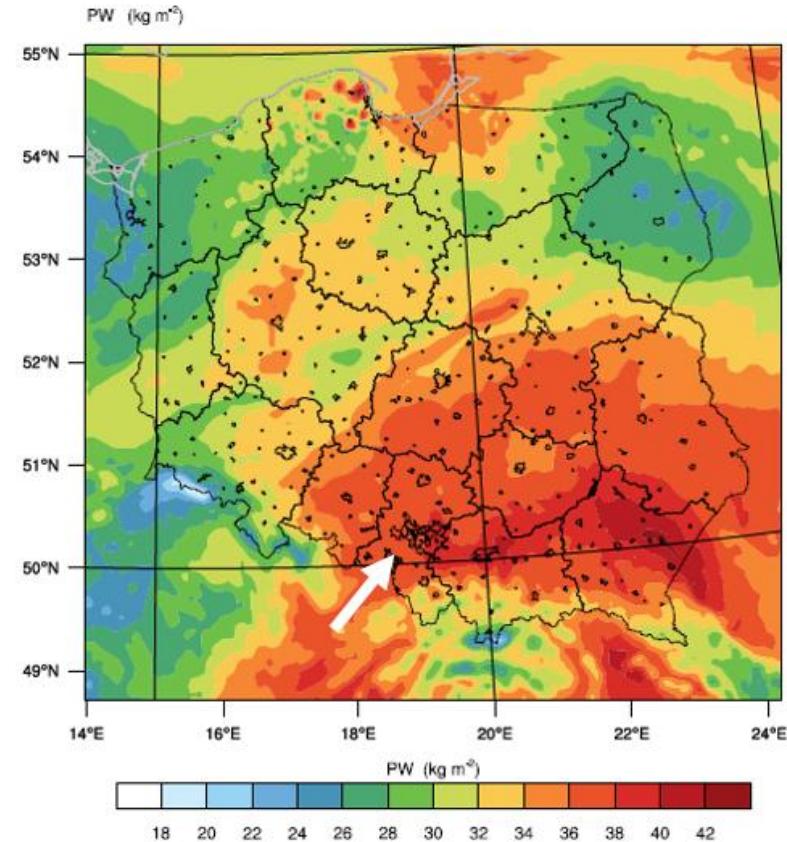
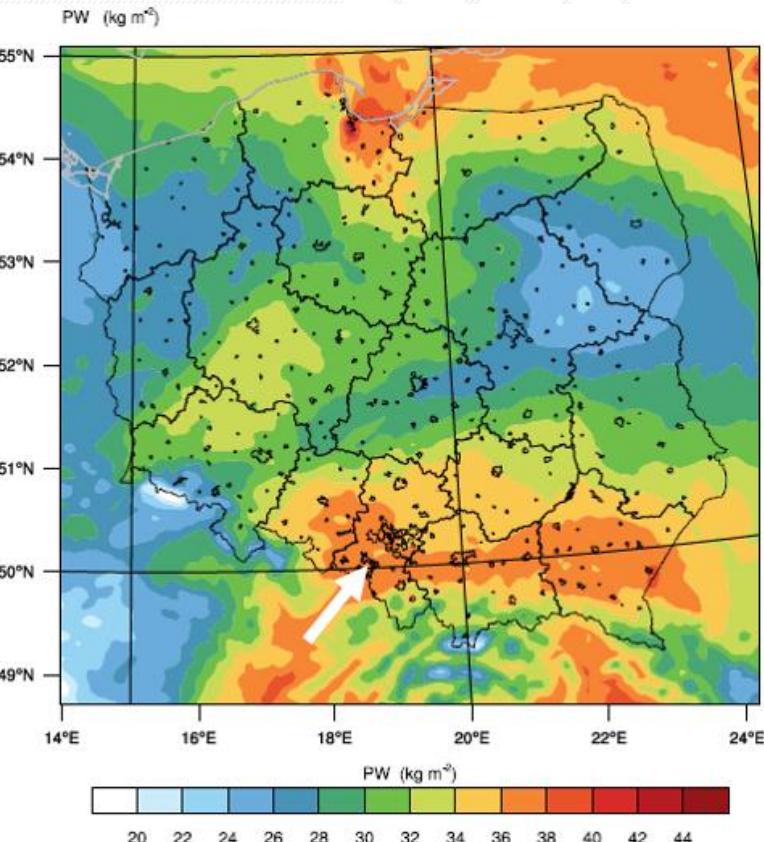
- **SQL** – downloading data from databases
- **GMT+bash** – creating maps
- **PHP** – transferring parameters from user to scripts
- **HTML + CSS** – design and buttons
- **JavaScript + jQuery** – web interface



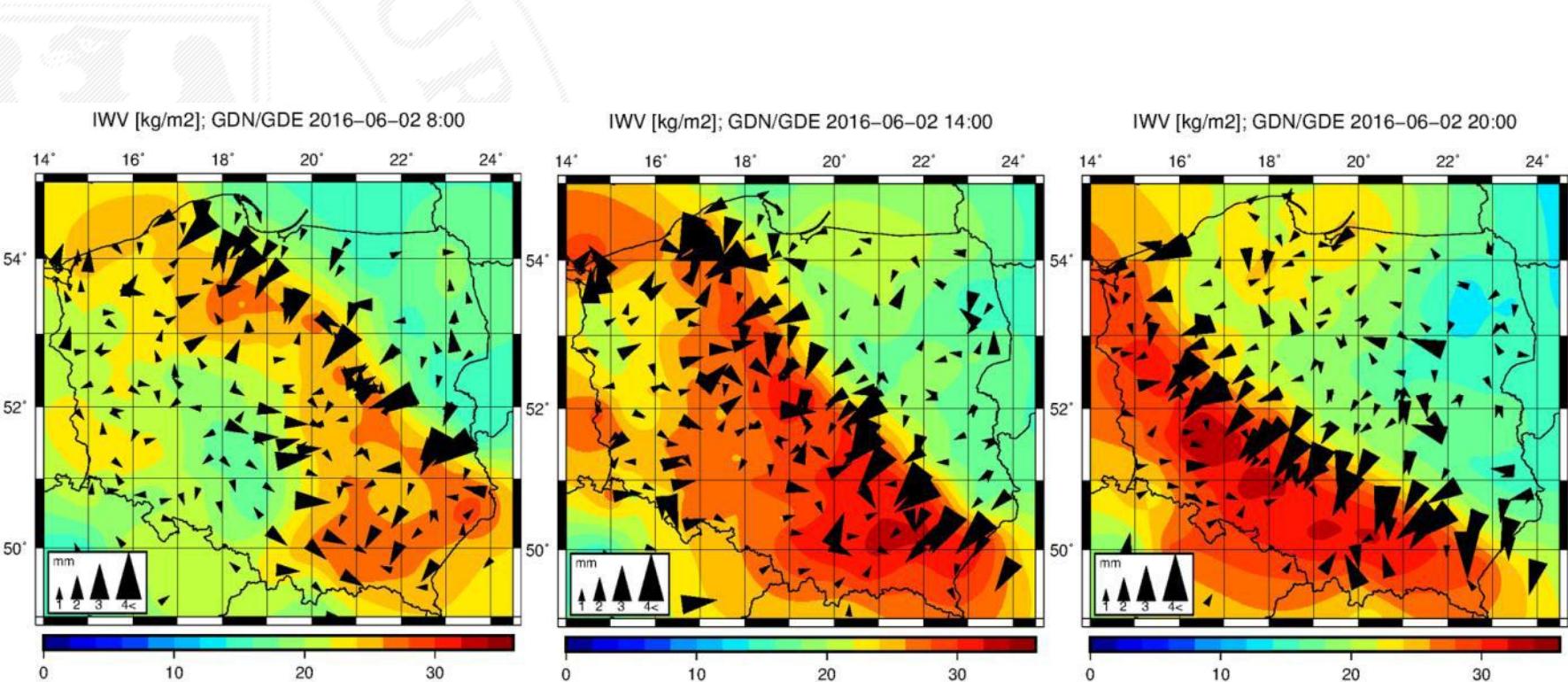
# Latent heat and IWV



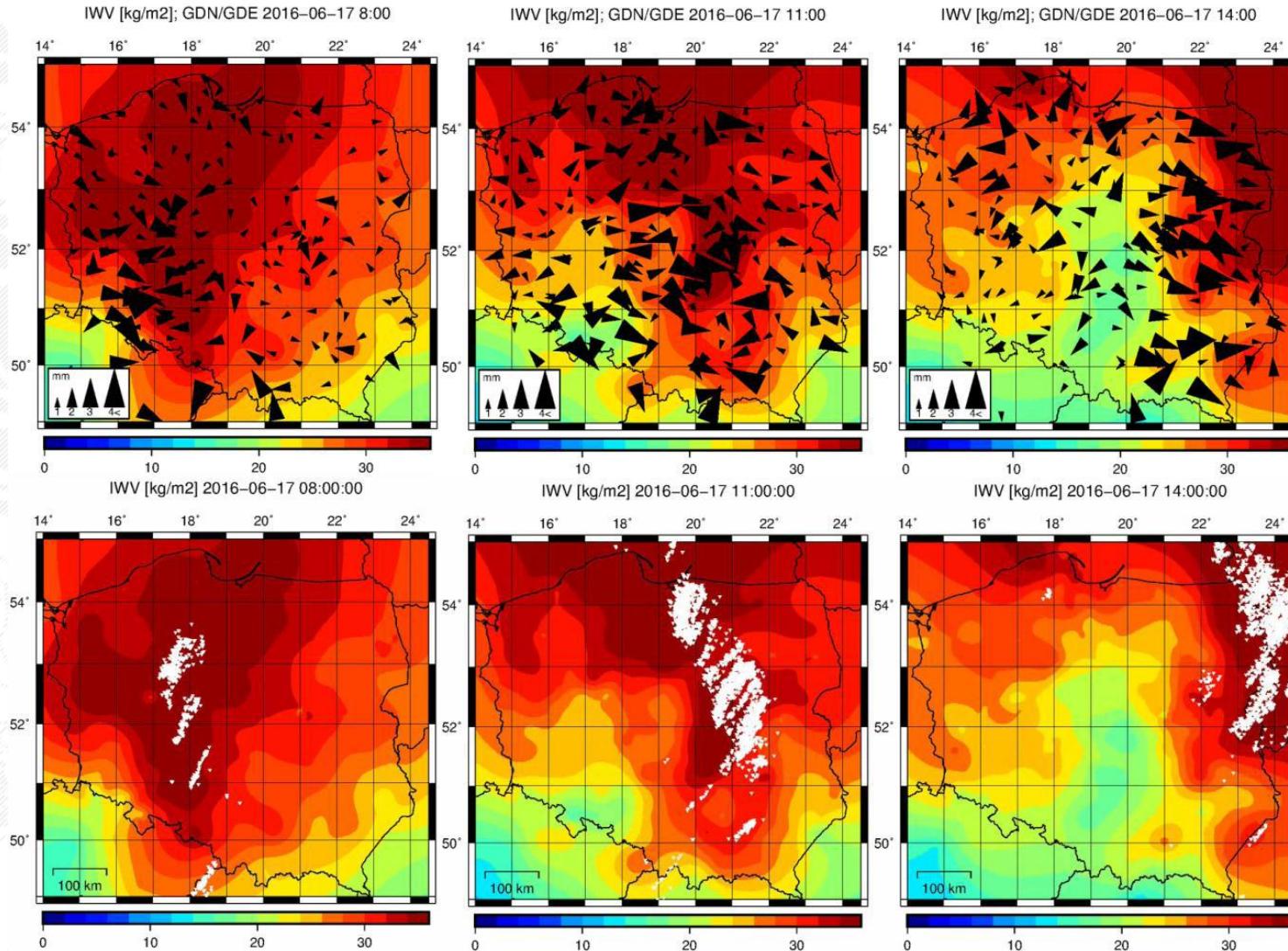
# Blocking by orography



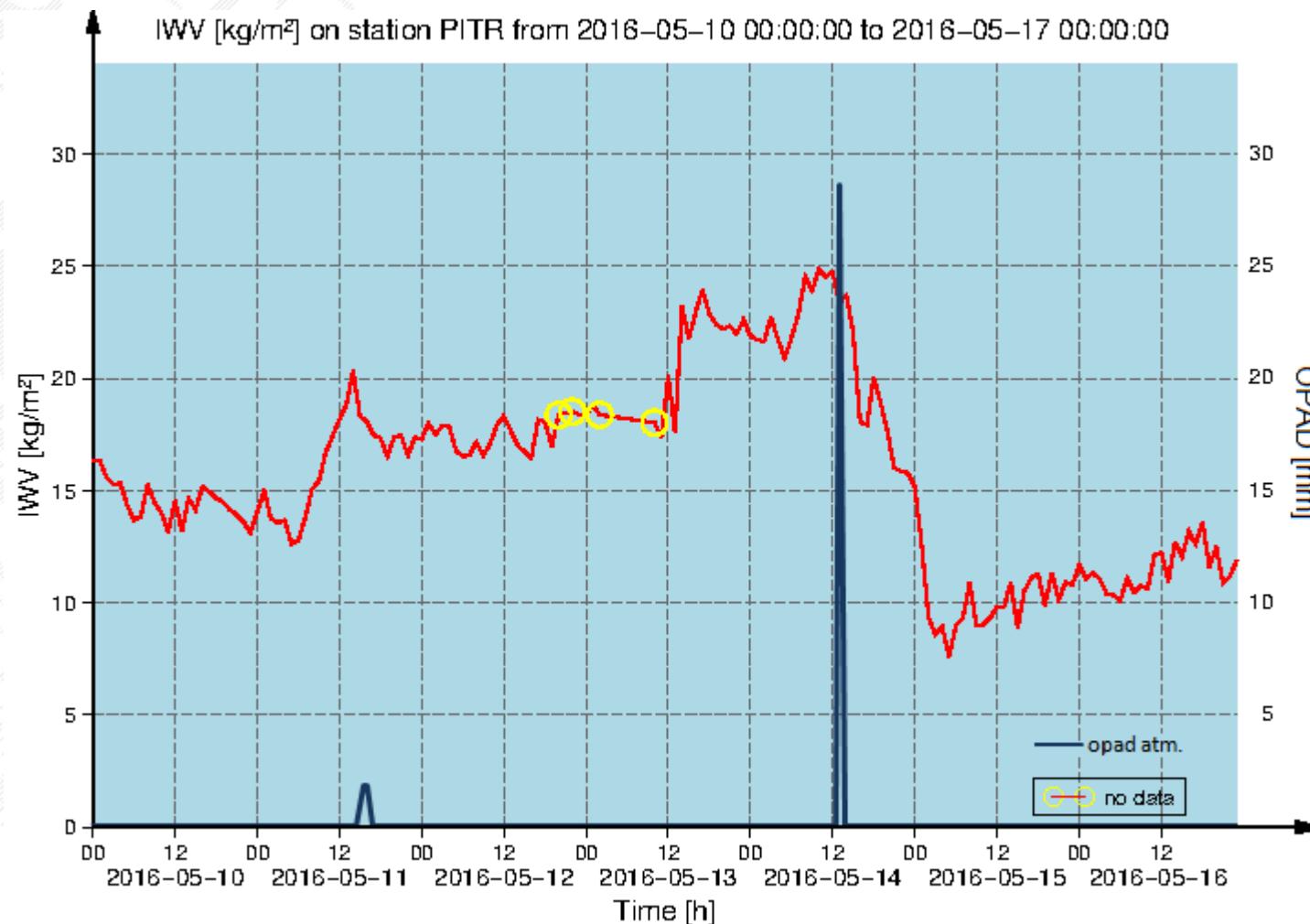
# Separation between two air masses



# Convection/Rain?



# GNSS IWV time series with rain intensity



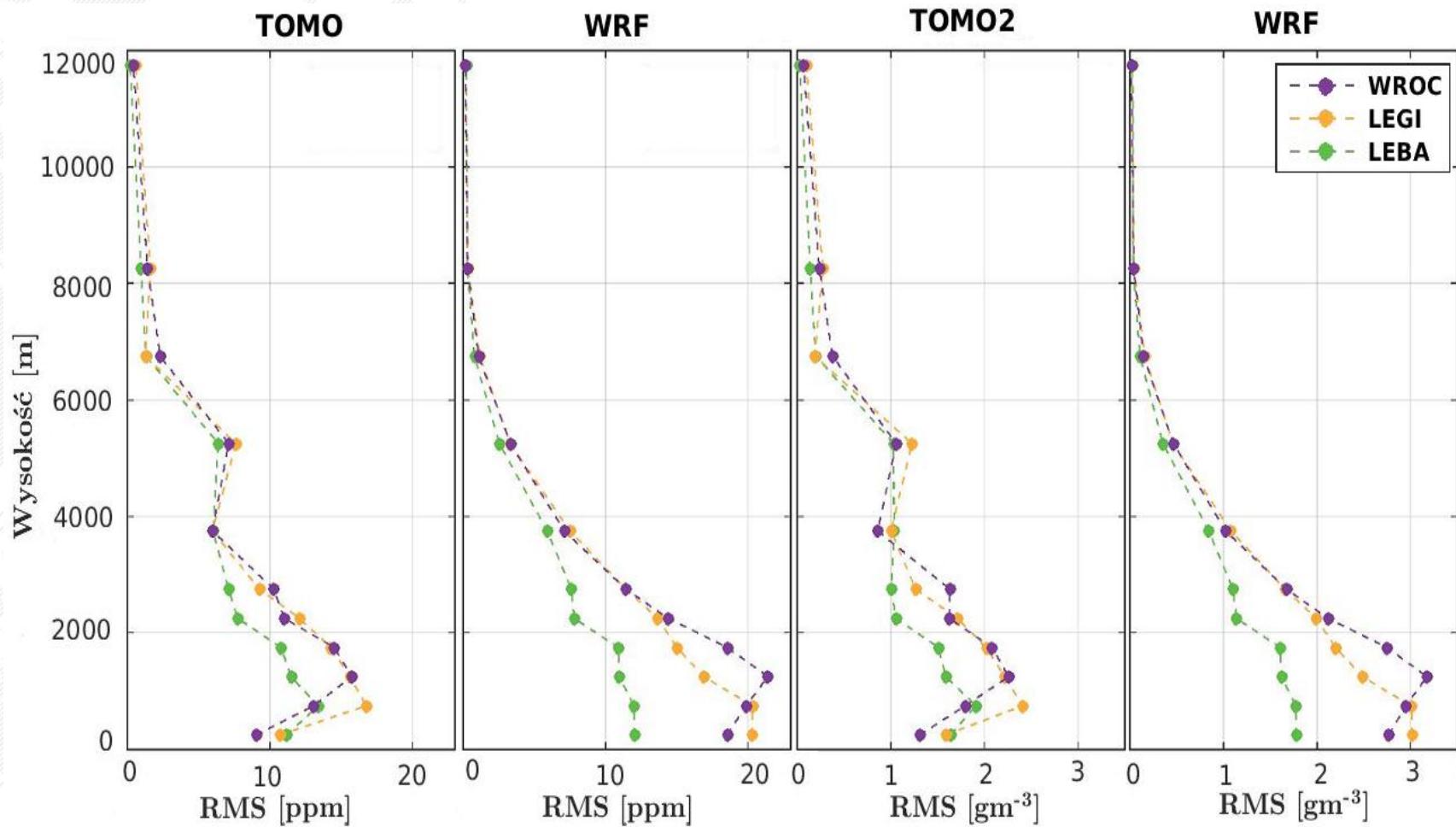
# NRT GNSS Tomography



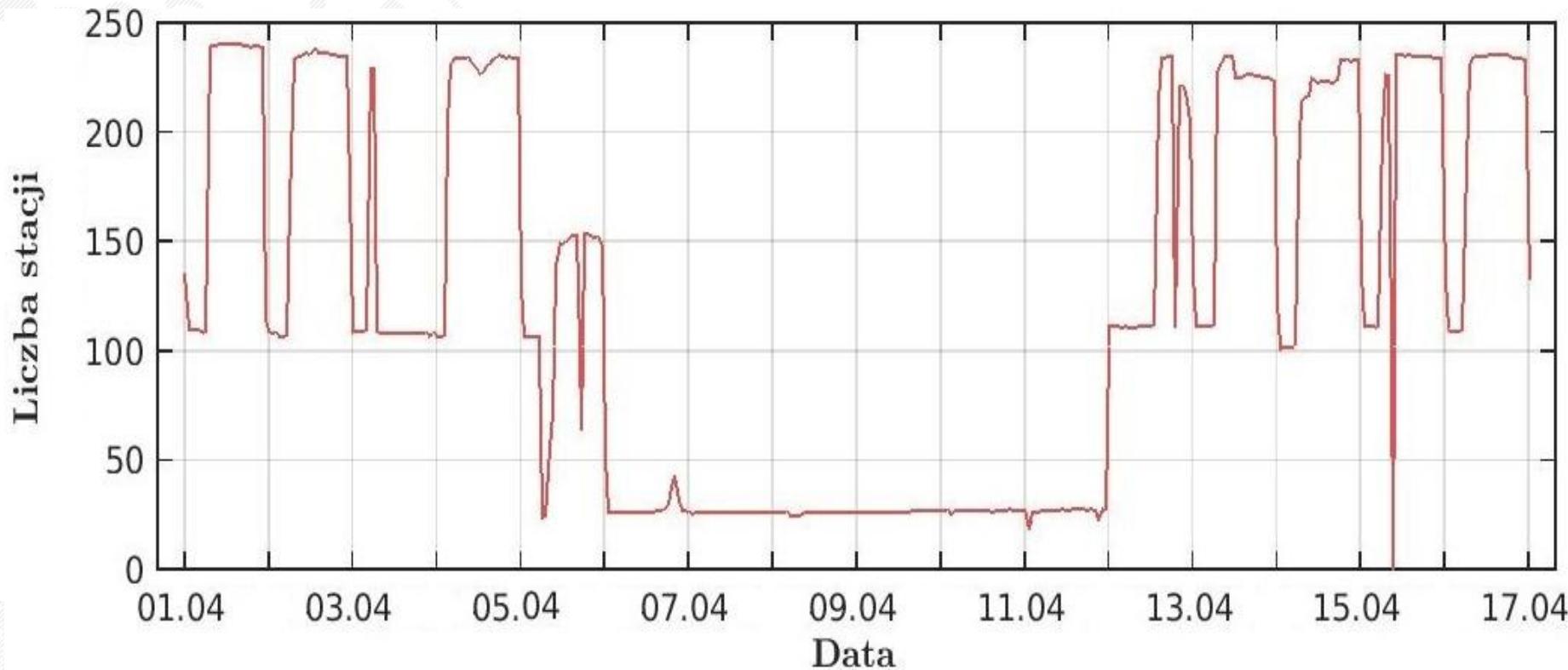
Data type	Source
coordinates	MaGDA
orbits	<a href="ftp://igs.bkg.bund.de">ftp://igs.bkg.bund.de</a>
delay	MaGDA
meteorology	WRF
a priori	UNB3m, WRF
test period	01.04.2016 – 17.04.2016
validation	Radiosondes
retrieved parameter	Wet refractivity Water vapour

# Tomography retrieval quality

Wet Refractivity



# Tomography retrieval quality



# Conclusions

Meteorologists are keen to use IWV, however in a map „format”  
IWVs, Gradients are reflecting atmosphere conditions and coincide well  
with lightnings

**geo2.igig.up.wroc.pl** is a testing platform for new GNSS products for  
meteorologists

Quality of NRT TOMO2 retrieval is similar to postprocessed values  
Next step is adding to C-MaGDA and geo2.igig.up.wroc.pl a NRT TOMO2  
outputs

„This work was done in the frame of the research project number UMO-  
2013/11/D/ST10/03473 and supported by National Science Centre”

THANK YOU!

witold.rohm@igig.up.wroc.pl

Topic	NRT GNSS services for monitoring severe weather
Presenter	Witold Rohm
Purpose	<ul style="list-style-type: none"> <li>Convince geodetic community that NRT tomography is achievable and could be one of deliverable for meteorological community</li> <li>Attract young researchers to work on tomography</li> </ul>
Key message	<ul style="list-style-type: none"> <li>GEO2.IGIG.UP.WROC.PL is a website for experimental use of GNSS with collaboration of meteorology community</li> <li>1D, 2D products are available</li> <li>Additional data like lightning discharges and GPM rainfall enrich and validate the GNSS content</li> <li>3D products should be available soon</li> </ul>
Take-out	GNSS and meteorology collaboration should extend to new data types and new ways of presentation and should be based on the discussion with meteorological community