GNSS storm nowcasting demonstrator for Bulgaria

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Motivation: Storm nowcasting

- WMO nowcasting ”detailed description of current weather and forecasts 0 to +6 h”
- phenomena: 1) convective storms 2) mesoscale events associated with extra-tropical & tropical storms 3) fog & low clouds 4) locally forced precipitation events 5) sand & dust storms 6) snow, ice, glazed frost, blizzards, avalanches 7) wildfires 8) air pollution
- benefits: 1) fatalities & injuries reduction 2) private, public, industrial property damage reduction 3) savings for industry, transportation, agriculture

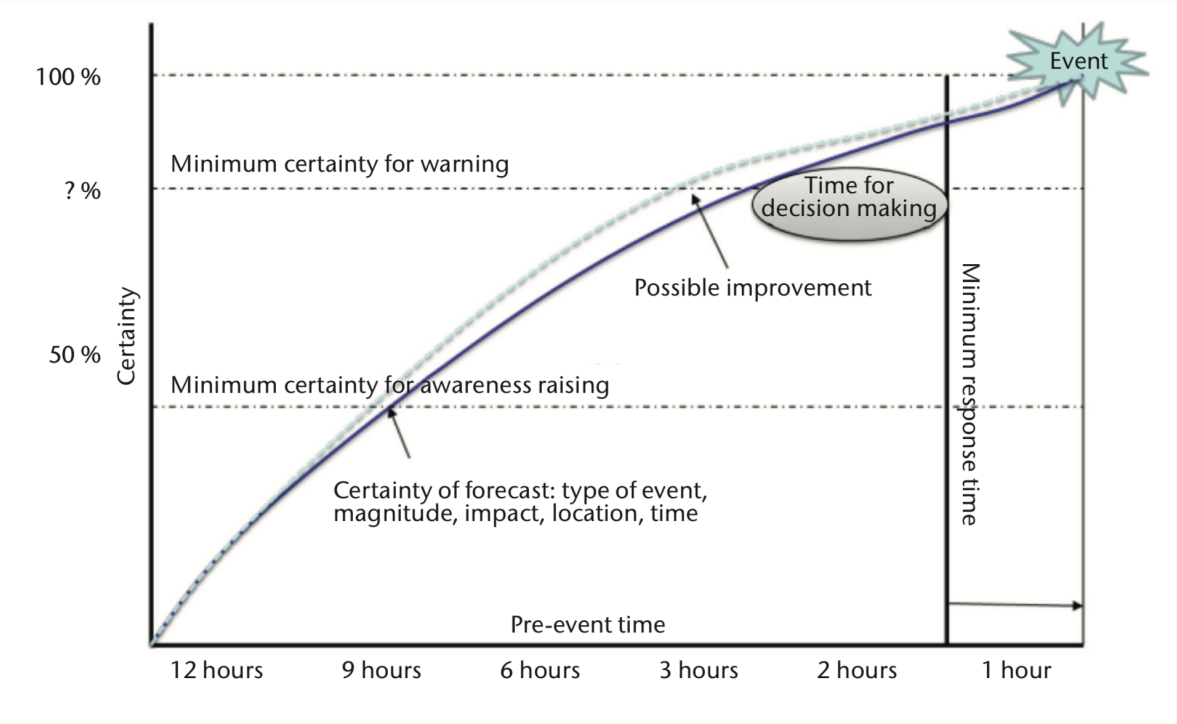


*Figure from: Mileti and Sorensen (1990)

Storm nowcasting state-of-the-art:

- weather radar data extrapolation
- ”blending” 1) in-situ and remote sensing observation, 2) Numerical Weather Prediction (NWP), 3) model output statistic data, 4) high resolution topography, 5) heuristic rules

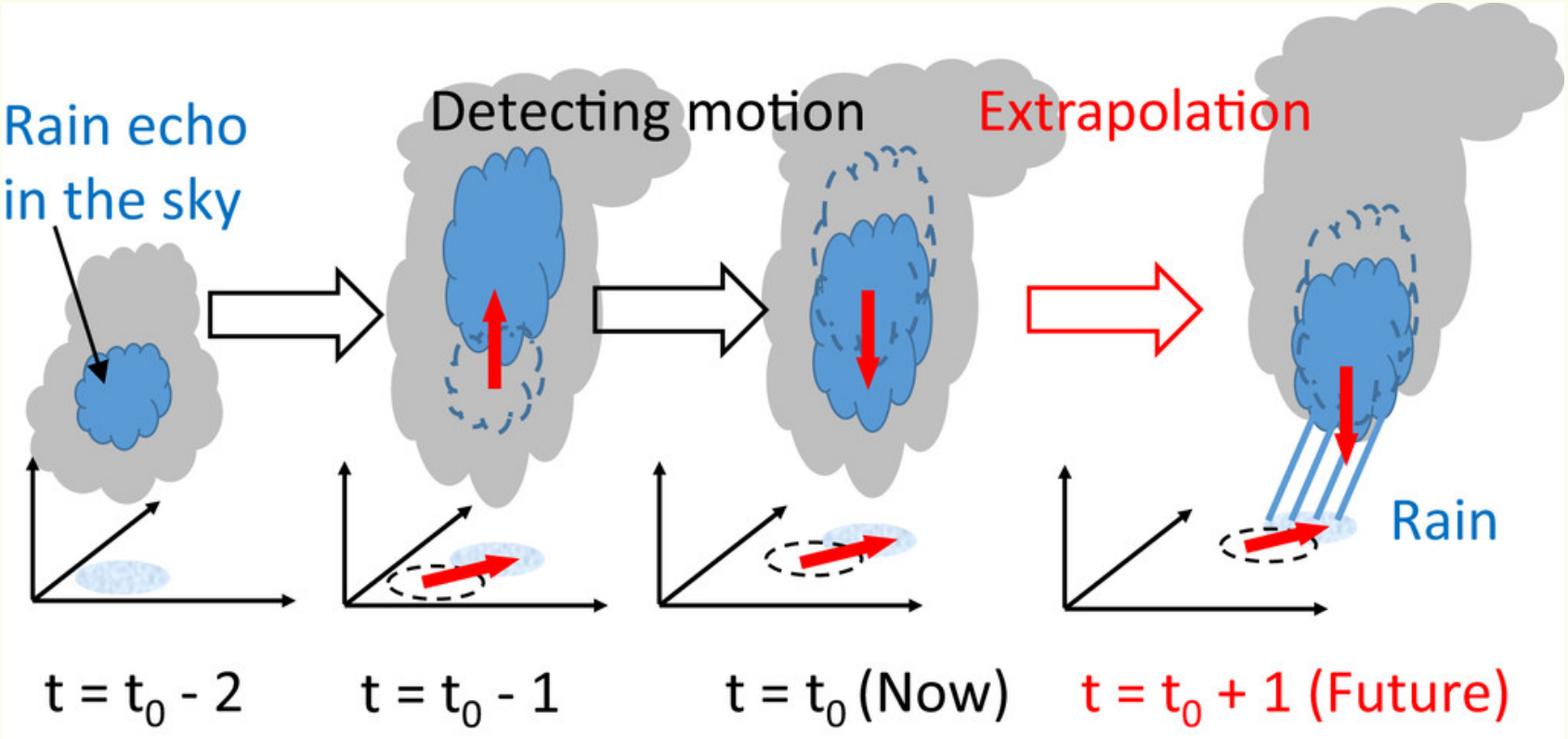
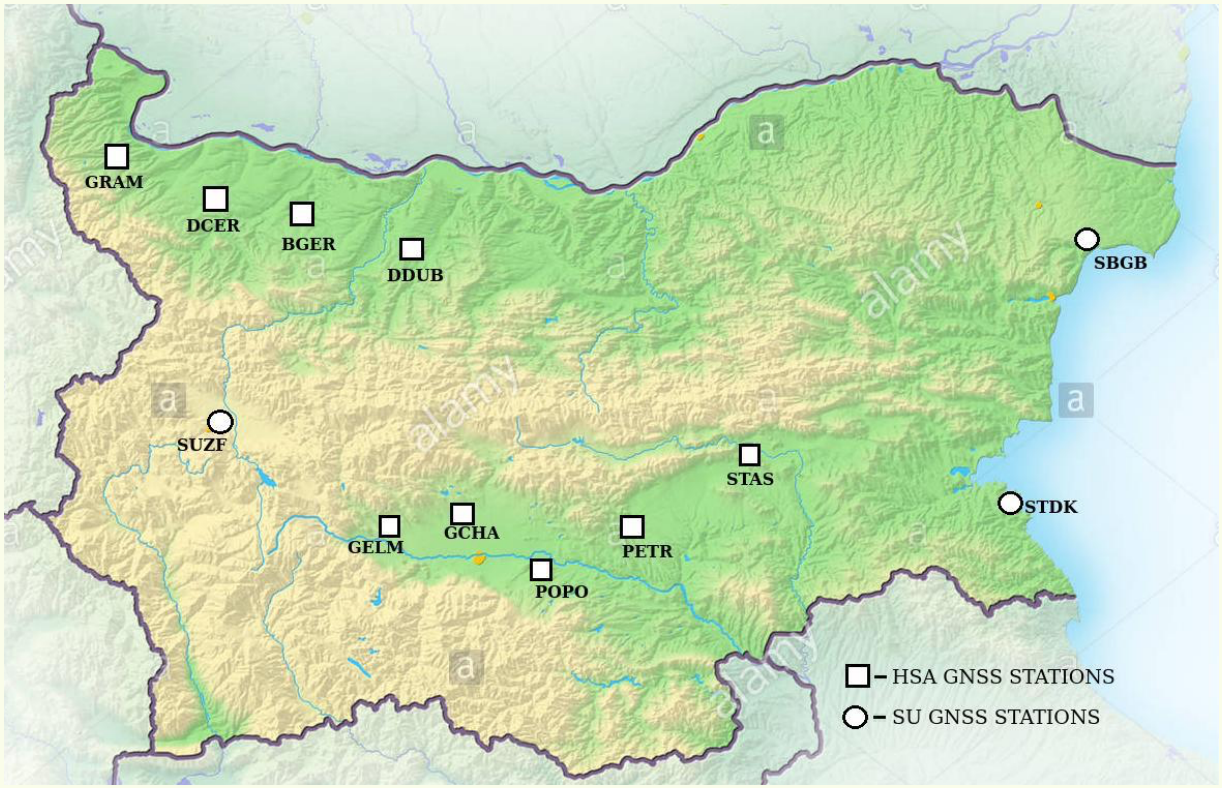


*Figure from: Otsuka et al. 2016. Precipitation Nowcasting with Three-Dimensional Space-Time Extrapolation of Dense and Frequent Phased-Array Weather Radar Observations, Weather and Forecasting, 31(1), 329-340.

GNSS storm nowcasting demonstrator (Storm Demo)

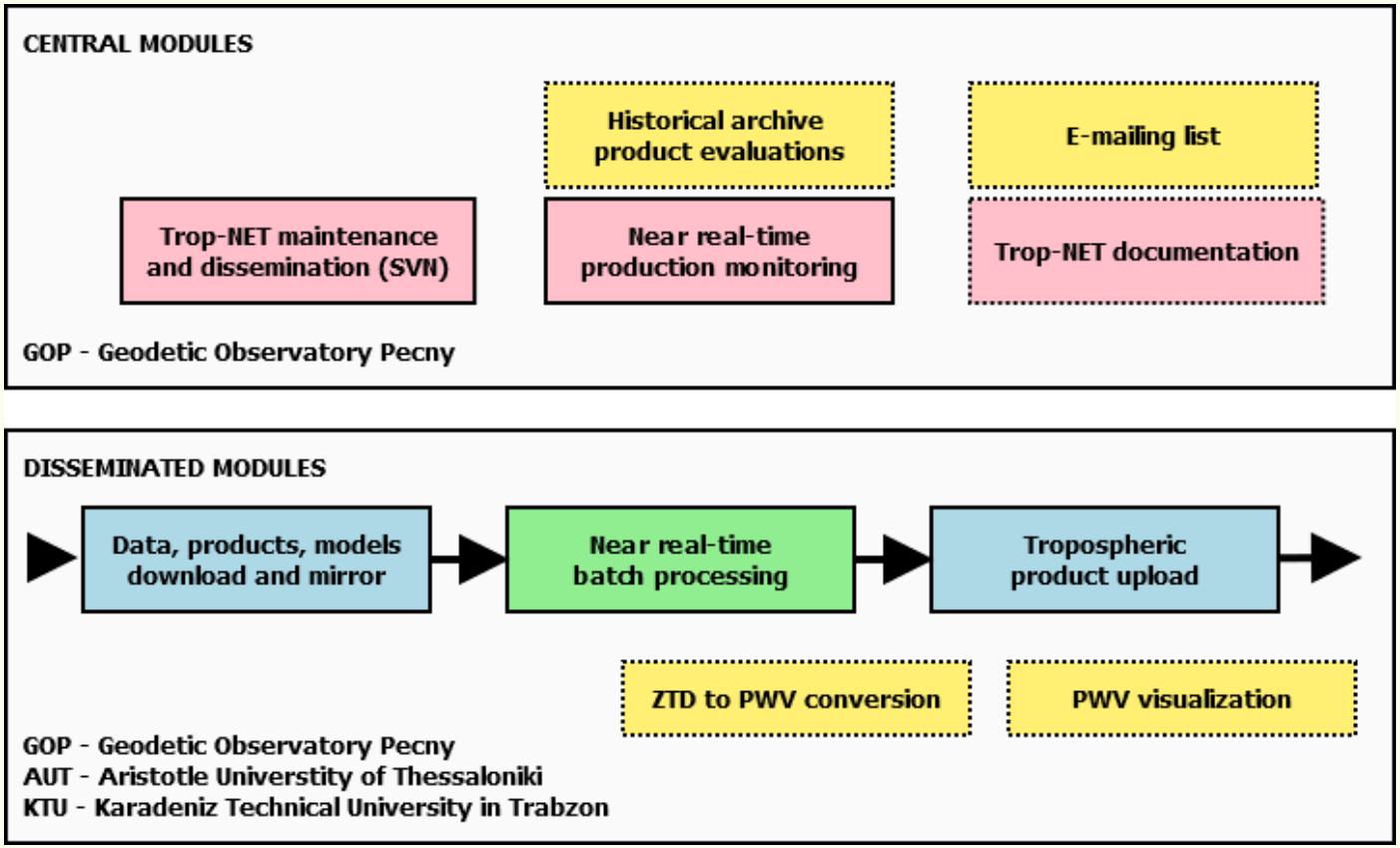
Storm Demo GNSS network

- operated by Hail Suppression Agency (HSA) since 2018
- collocated with weather radar observations
- hail suppression for agriculture protection
- hail storm season May-September



GNSS Near-real time (NRT) processing: Trop-NET

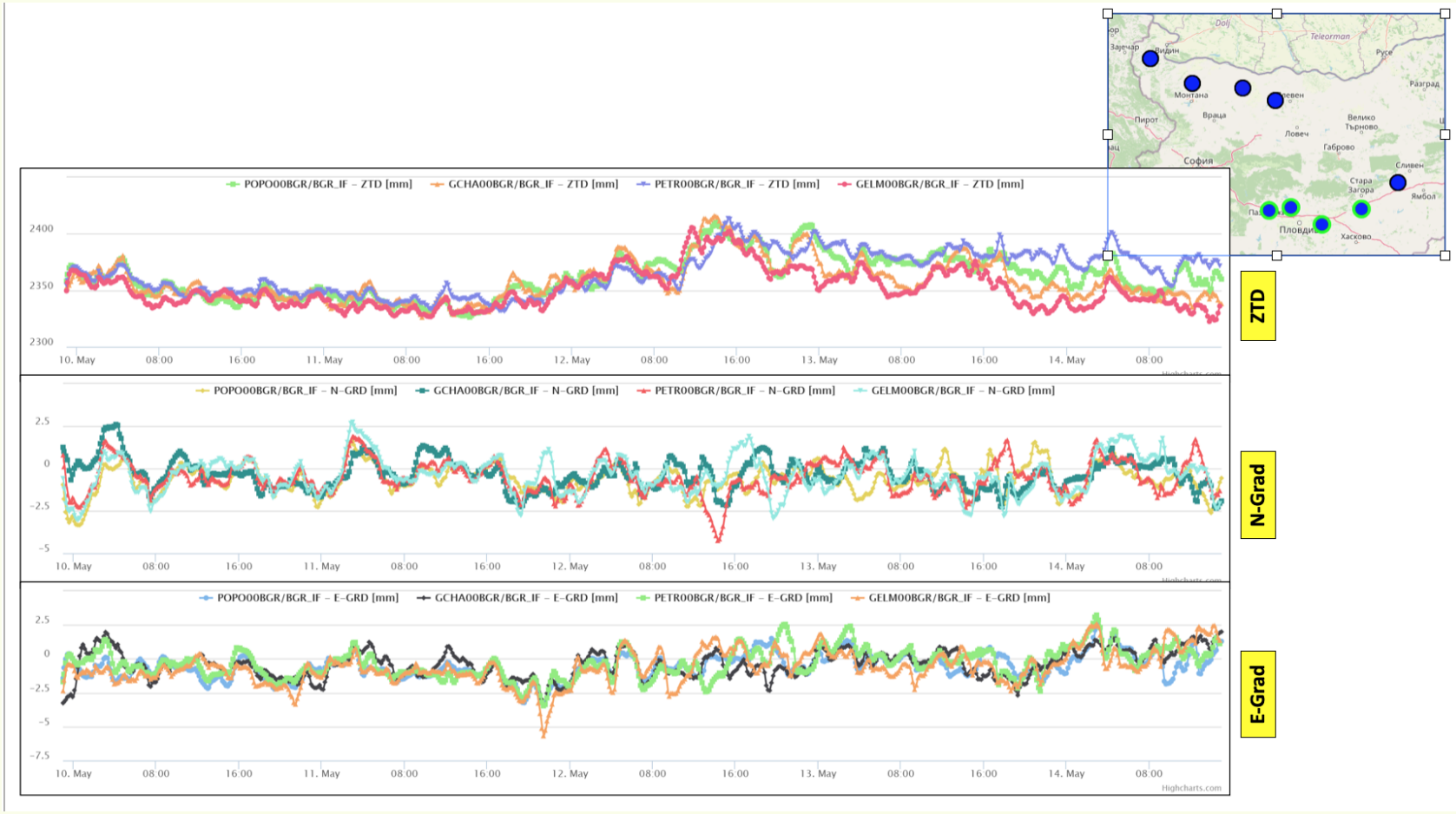
- Sofia University GNSS Analysis Center (SUGAC)
- Trop-NET software*
- Bernese 5.2 GNSS engine
- Zenith Total Delay every 60 minutes with latency 30 minutes



*developer Jan Dousa, GOP, Czech Republic

GNSS Real time (RT) processing: G-NUT*

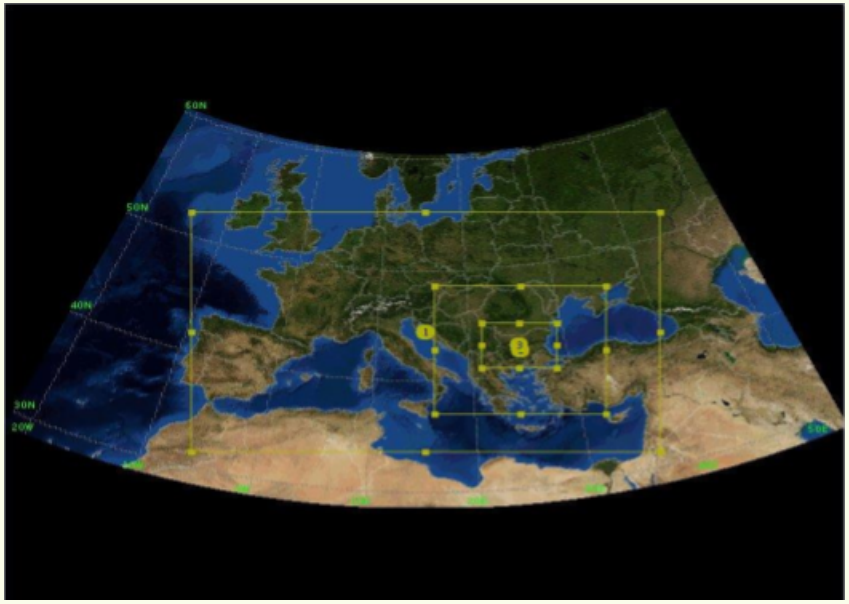
- G-Nut/Tefnut Pro
- Precise Point Positioning (PPP)
- troposphere parameters: ZTD & horizontal gradients every 5 minutes

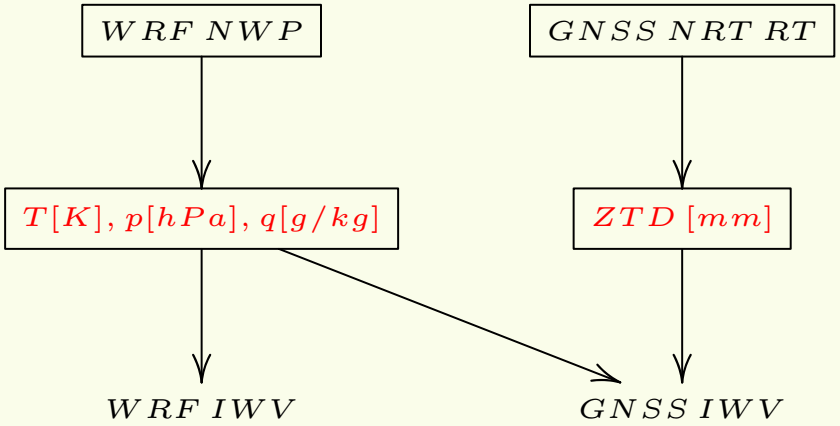


*more details in presentation by J. Dousa and P. Vaclovovic, Session 3, 27 May 2021

Weather Research and Forecasting (WRF) model: set-up

- 2 daily forecasts for 48 hours
- horizontal resolution 2 km over Bulgaria
- vertical levels 45
- surface pressure and temperature $->$ GNSS IWV
- profiles temperature and humidity $->$ WRF IWV



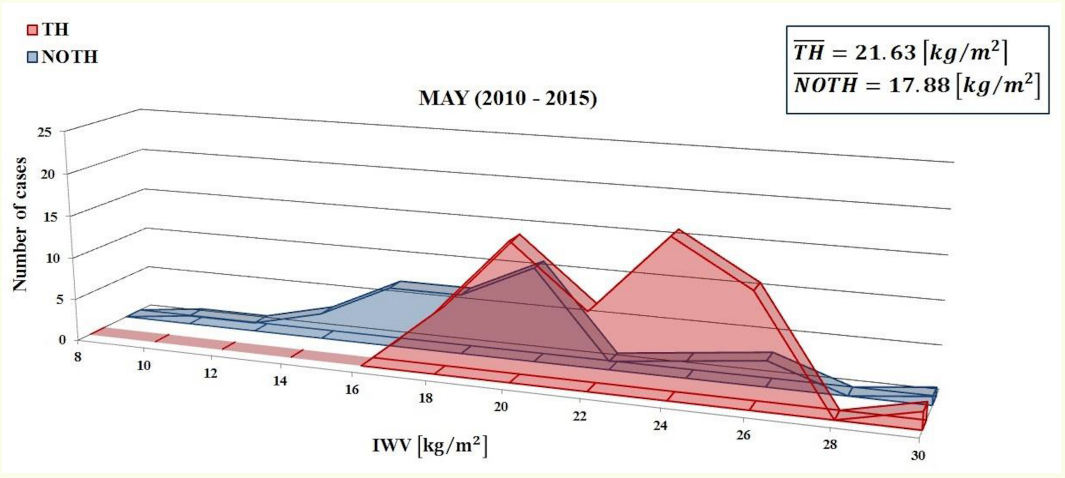


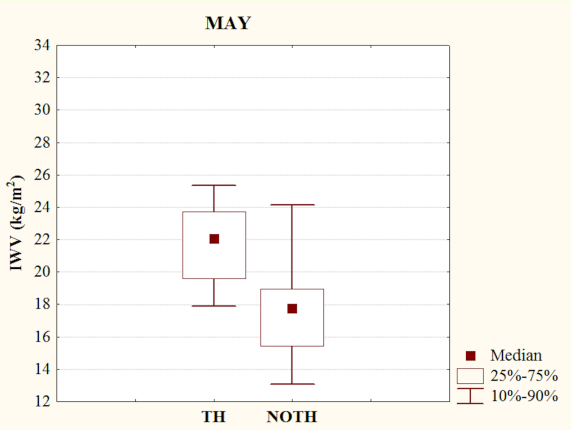
Storm Demo Geoportal

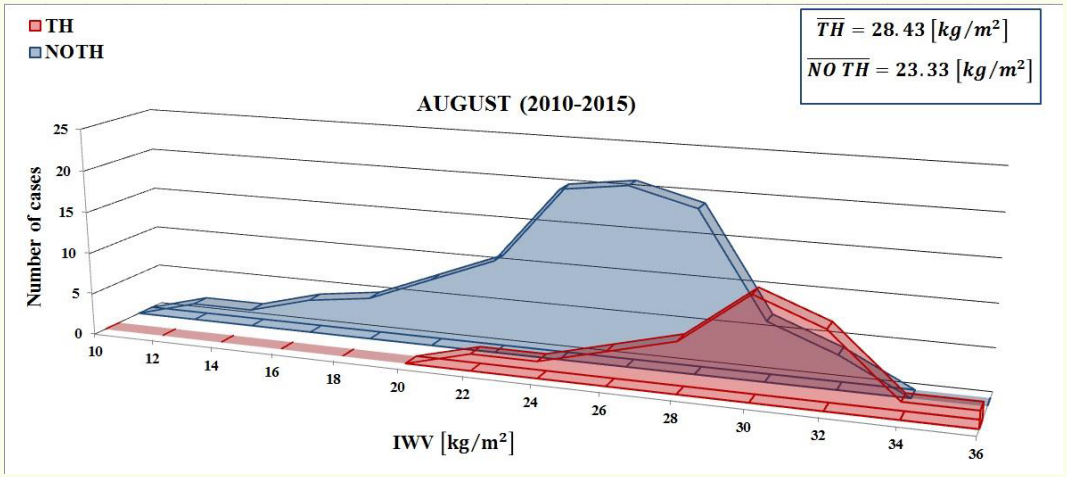
- hosted by Sofia University Atmospheric Data Archive suada.phys.uni-sofia.bg
- public access with real-time and near-real time IWV update for operational use

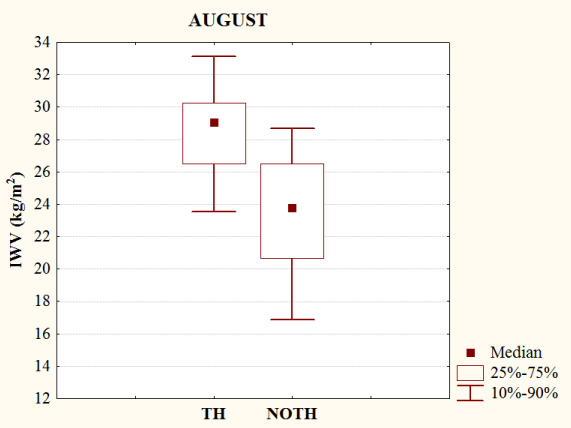
GNSS IWV Storm threshold: May & August 2010-2015*

- clear difference between IWV for thunder (TH)/no-thunder (NOTH) storms in May





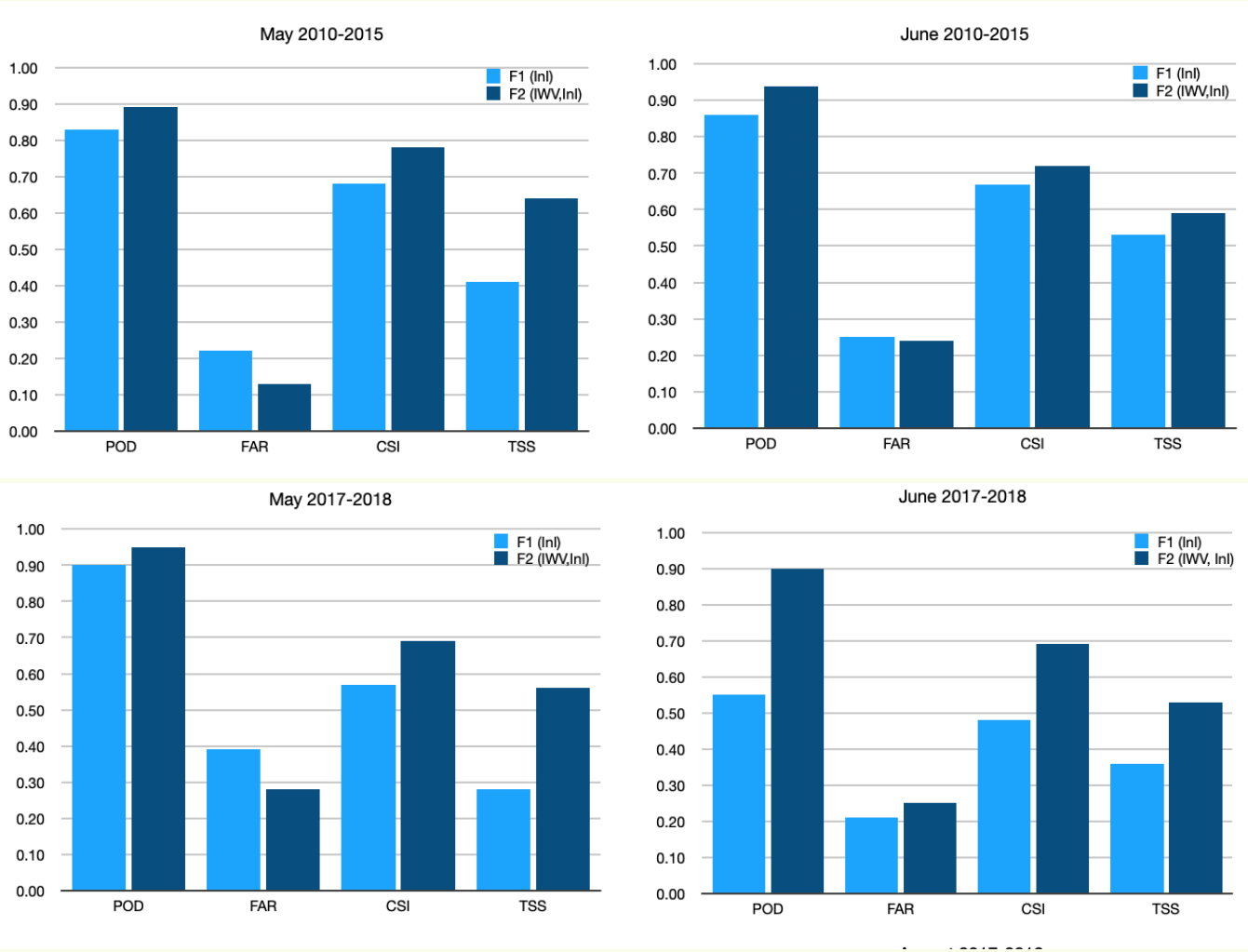




* Guerova et al. 2019. Thunderstorm Classification Functions Based on Instability Indices and GNSS IWV for the Sofia Plain, Remote sens., 11(24).

IWV and Instability Indices: May-June 2010-2015 vs 2017-2018 *

- IWV in combination with Instability Indices improves Probability of Detection (POD) and False Alarm Radio (FAR)



* Guerova et al. 2019. Thunderstorm Classification Functions Based on Instability Indices and GNSS IWV for the Sofia Plain, Remote sens., 11(24).

Conclusions

- GNSS based Storm nowcasting Demonstrator under development
- Temporal resolution of real time IWV (5 min) comparable with weather radar data
- GNSS synergy with weather prediction model and radiosonde
- Monthly threshold criteria based on IWV and Instability Indices
- Geoportal with public access and timely IWV update
- First GNSS Storm Demonstrator targeting operational hail suppression


THANK YOU!