Thunderstorm Classification Functions Based on Instability Indices and GNSS IWV for the Sofia Plain

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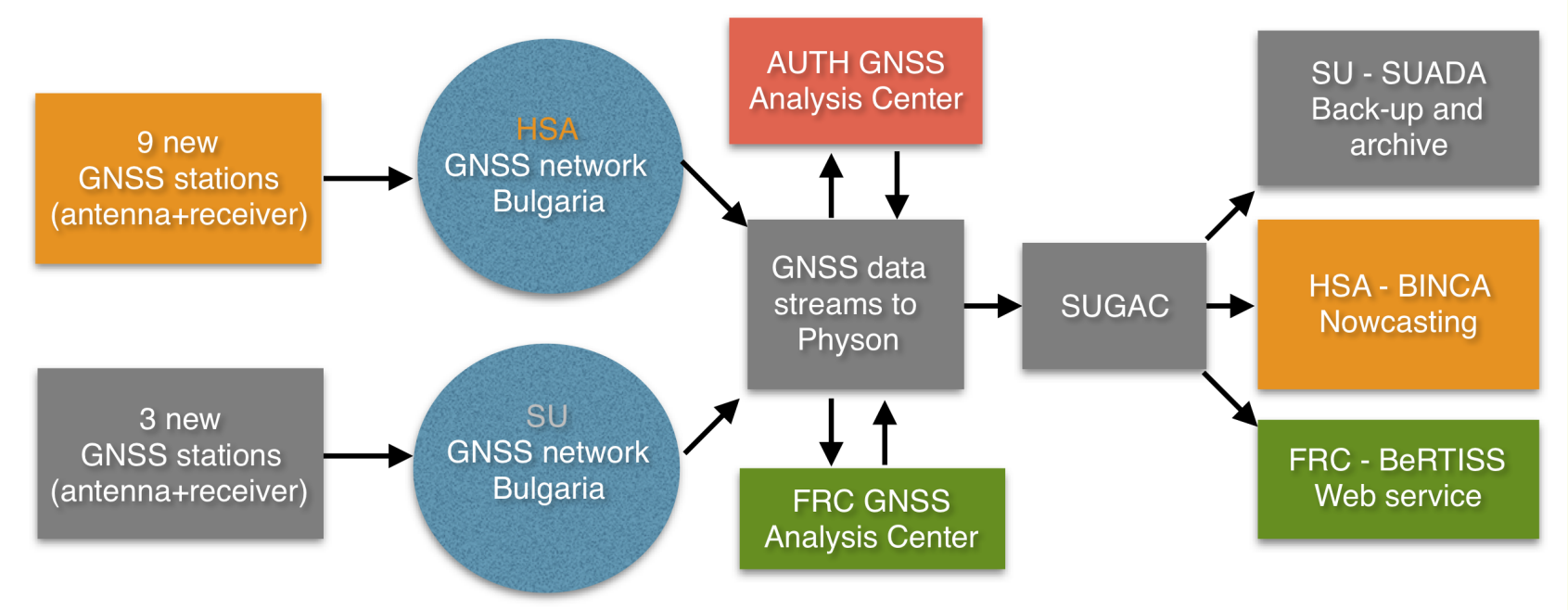
2nd Seminar ”Physics and chemistry of the Earth System”
13 November 2020, Pchelin, Bulgaria

BalkanMed real time severe weather service BeRTISS: Bulgaria*

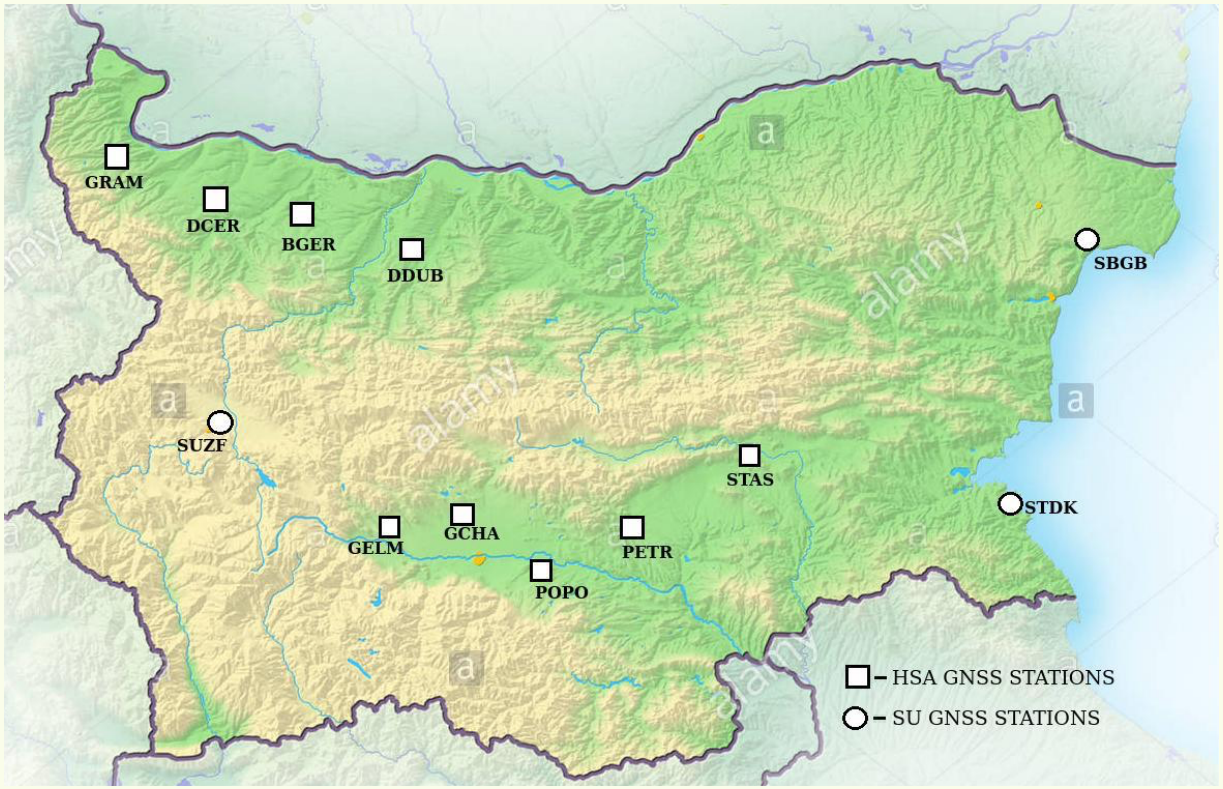
- September 2017 - March 2020 (30 months)
- Sofia University ”St Kliment Ohridski” (SU) - GNSS tropospheric products
- Hail Suppression Agency (HSA) - product user

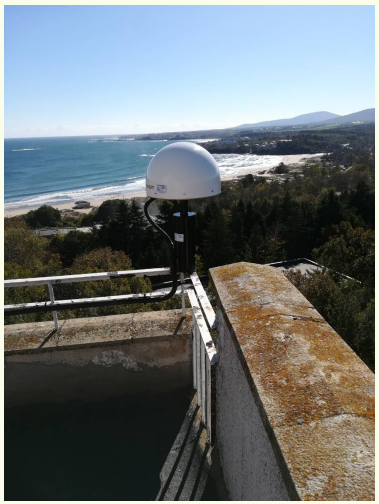


* Guerova et al. 2020. BalkanMed real time severe weather service: progress and prospects in Bulgaria, Advances Space Research, https://doi.org/10.1016/j.asr.2020.07.005.

BeRTISS GNSS network in Bulgaria

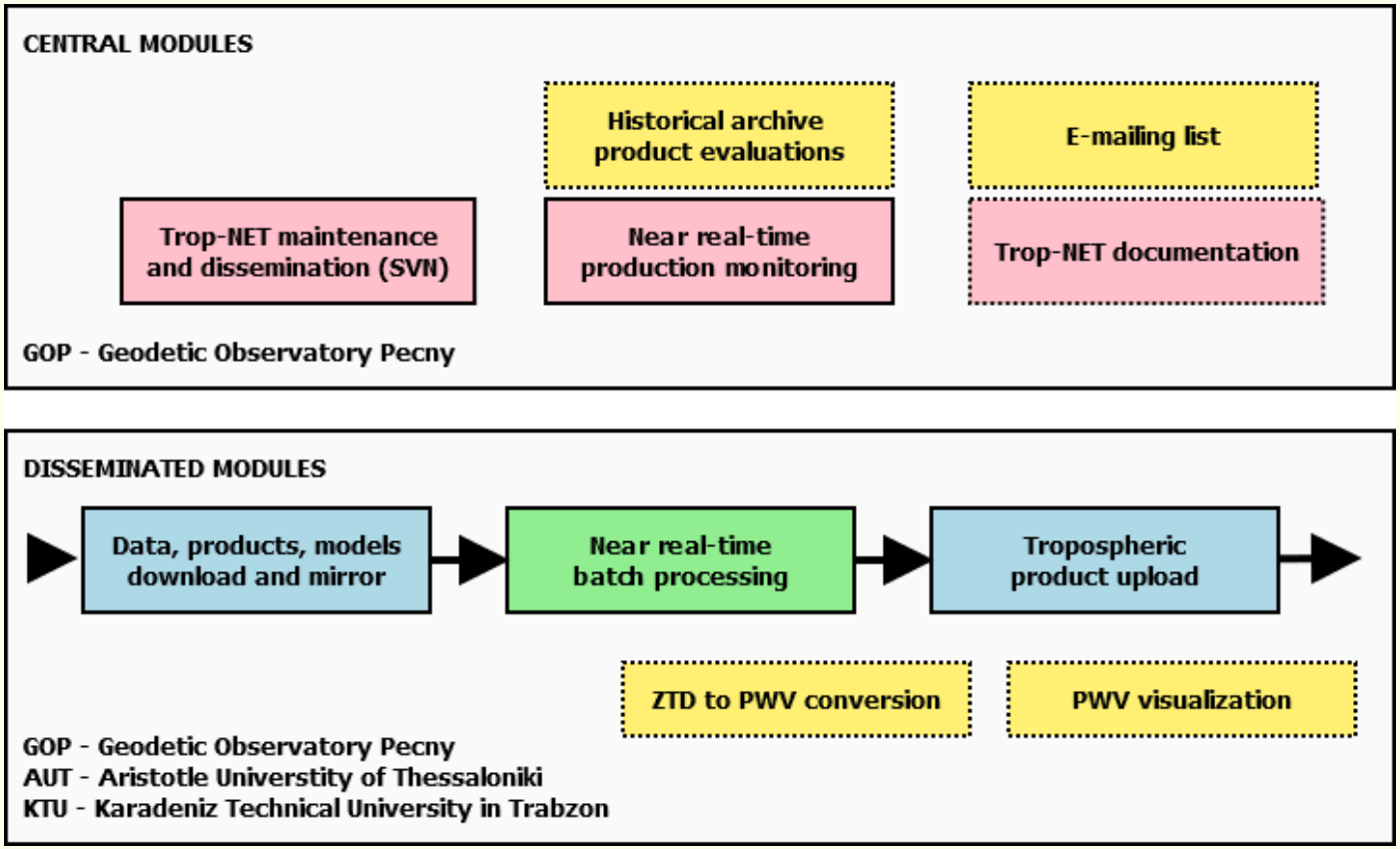
- SU GNSS stations - 3 Hitarget
- HSA GNSS stations - 9 Trimble





Sofia University GNSS Analysis Center (SUGAC)

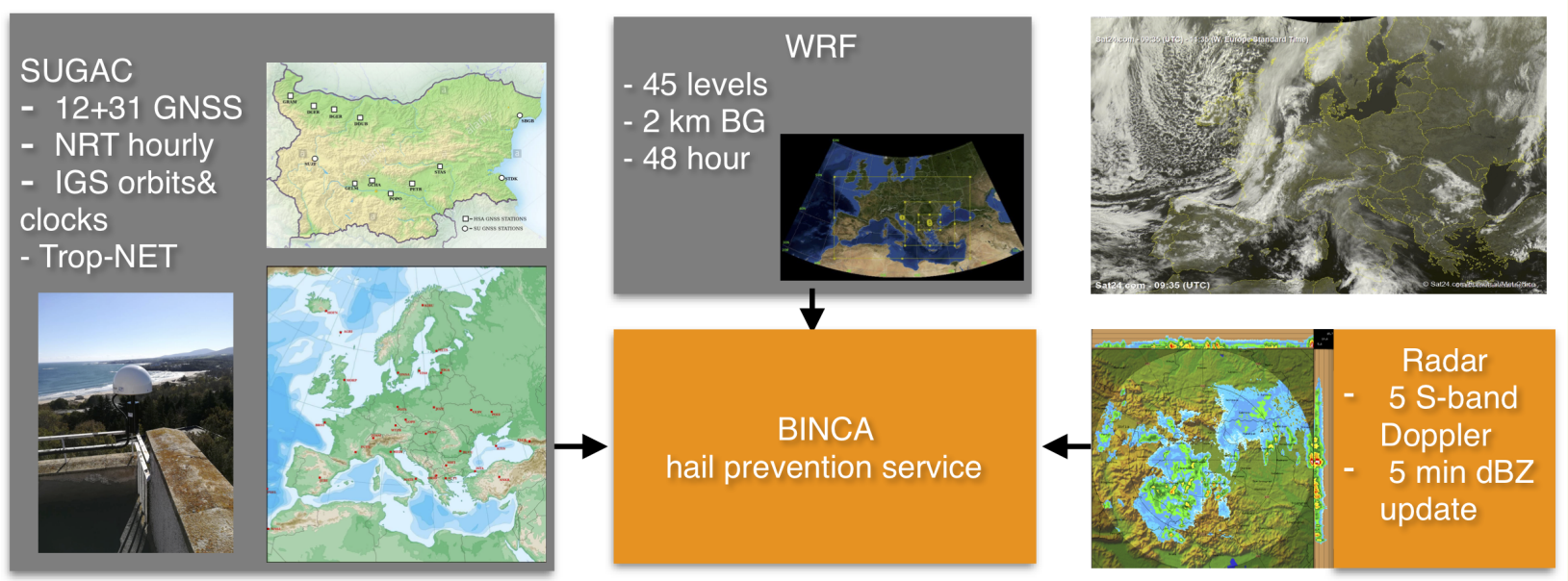
- SUGAC NRT processing - Trop-NET software*
- SUGAC post processing - Bernese 5.2



* collaboration with dr. Jan Dousa, GOP, Czech Republic

Bulgarian Integrated NowCAsting tool (BINCA)

- GNSS tropospheric product (IWV and gradients) time series and maps integration with radar refractivity
- Requested 5 minute product up-date rate
- Weather Research and Forecasting (WRF) model 48 hour forecast
- Other products: e.g. cloud images MSG satellite



BINCA web portal

Български интегриран продукт за свръхкраткосрочна прогноза – БИНКА

Начало | За проекта | ГНСС мрежа | Контакти

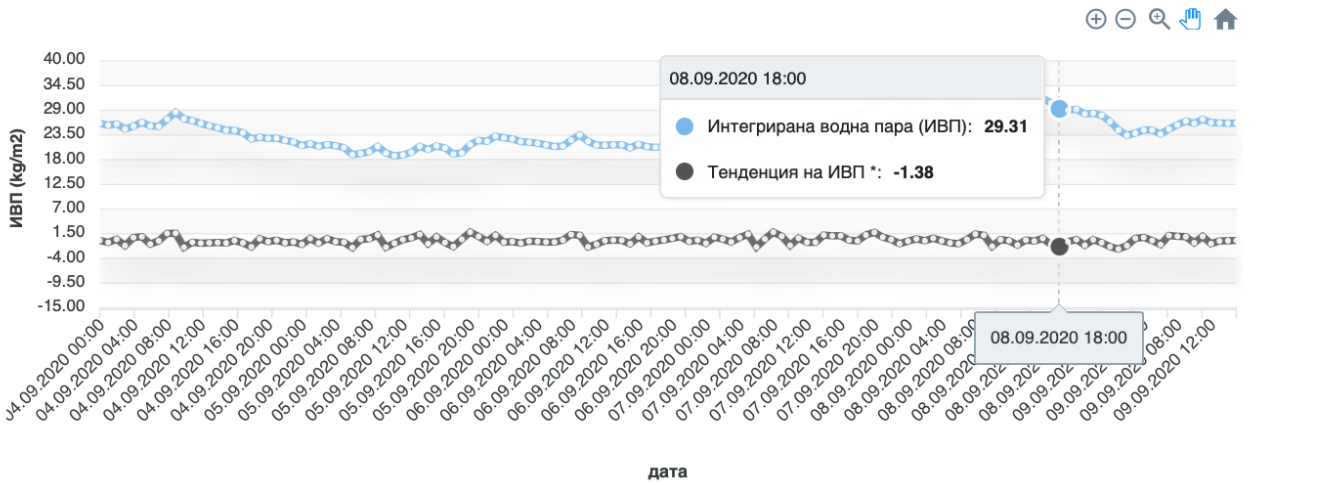
Интегрирана водна пара
IWV поле
Налягане
Специфична влажност
Температура
Пълно зенитно закъснение

Радарна информация
Радарна отражаемост
Количество валеж от дъжд за 1 ч.

Прогноза
Температура
Валежи
Снеговалеж
Облачност

Интегрирана водна пара

Станция: Бардарски геран (Враца)
От дата: 04.09.2020
До дата: 09.09.2020
Покажи



** изменение на ИВП в сравнение с предишно измерване*

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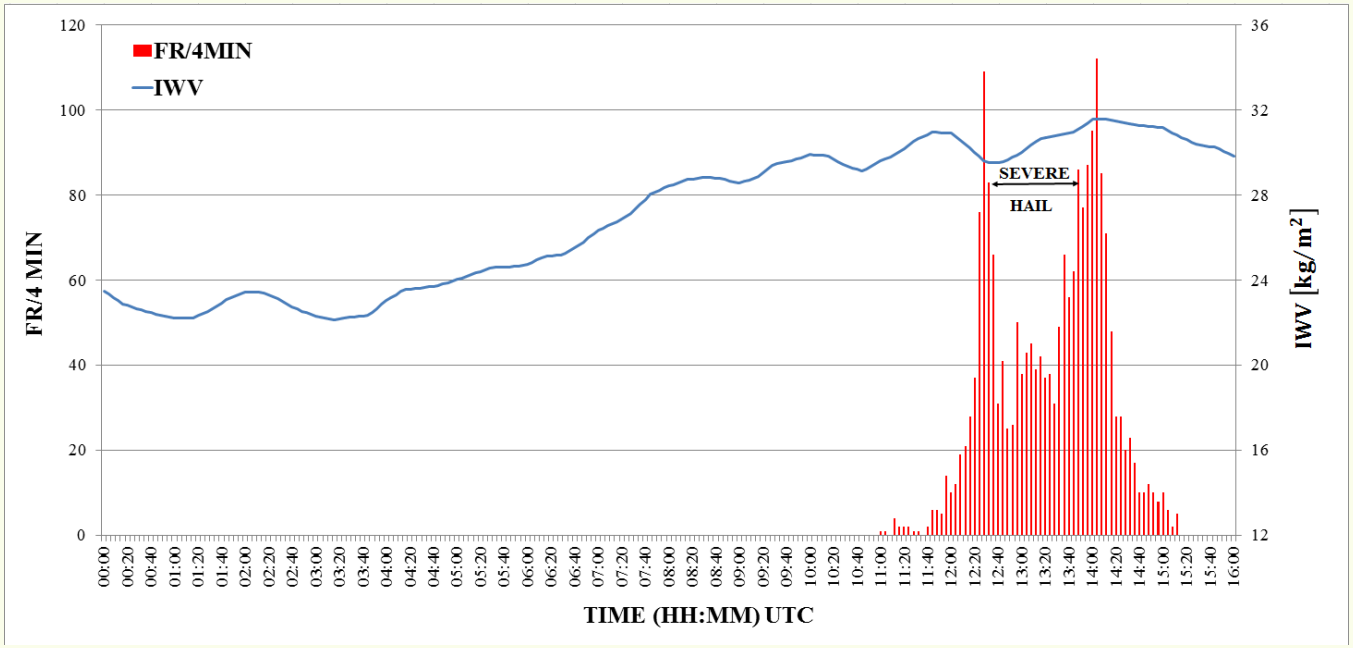
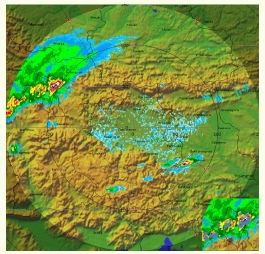
Bertiss | TropNET | Physon

Interreg Balkan-Mediterranean BeRTISS

IWV and lightening: 8 July 2014 hail storm*

- IWV increase before the lightning and hail detection
- lightening number jump observed before the hail start
- drop of the number of lightening during hail storm

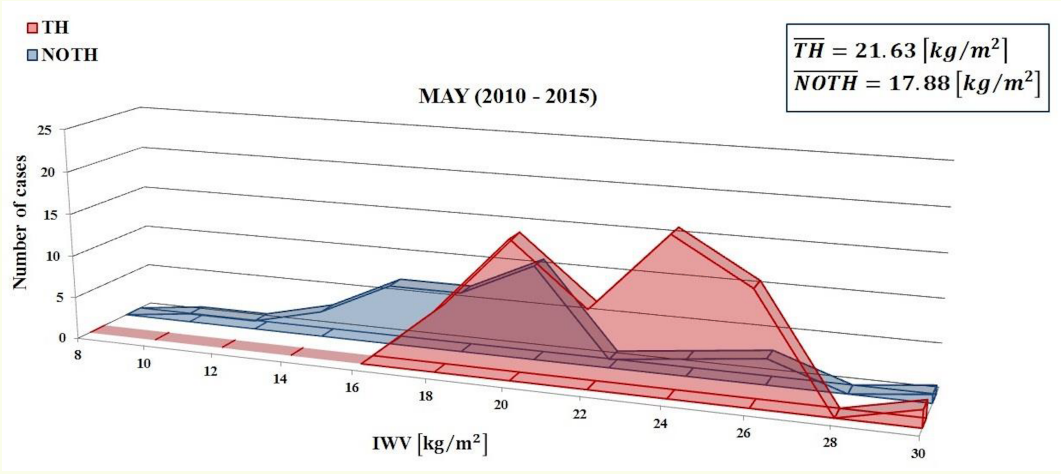


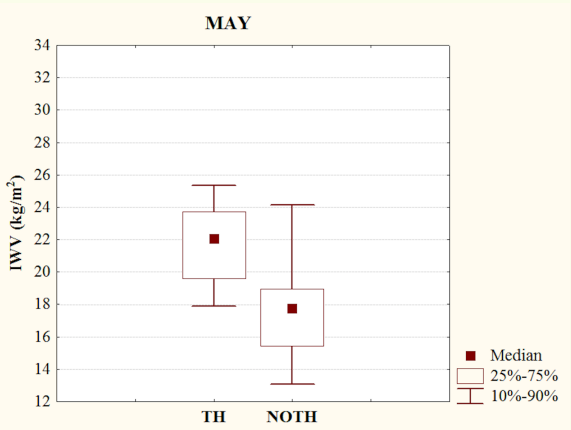


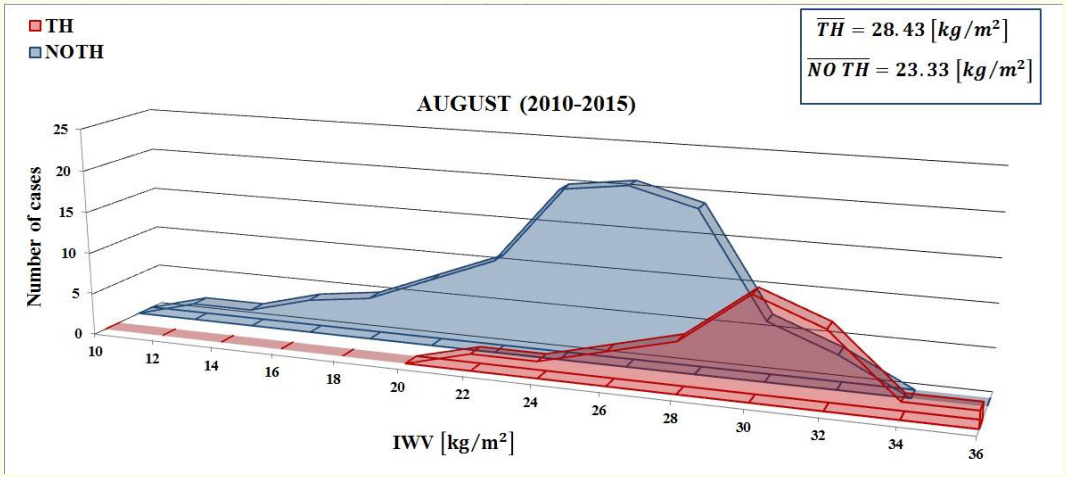
* Guerova et al. 2019. Thunderstorm Classification Functions Based on Instability Indices and GNSS IWV for the Sofia Plain, Remote sens., 11(24).

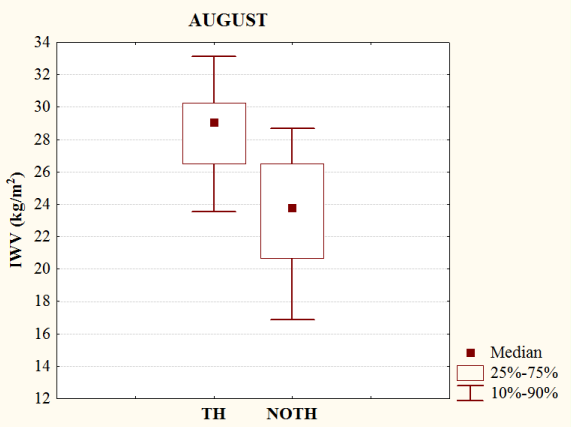
GNSS IWV and thunder storms: May & August 2010-2015*

- clear difference between IWV and thunder (TH) / no-thunder (NOTH) events in May







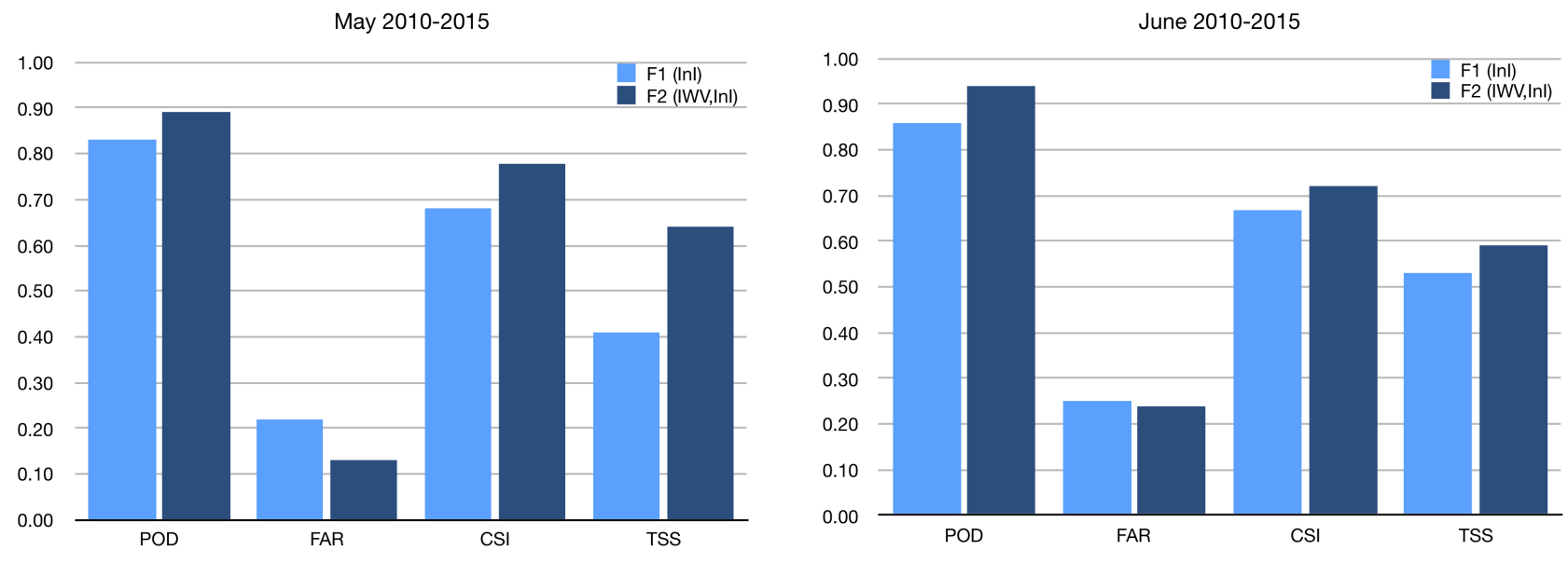


* Guerova et al. 2019. Thunderstorm Classification Functions Based on Instability Indices and GNSS IWV for the Sofia Plain, Remote sens., 11(24).

Classification function: THunder (TH)/ No THunder (NTH)

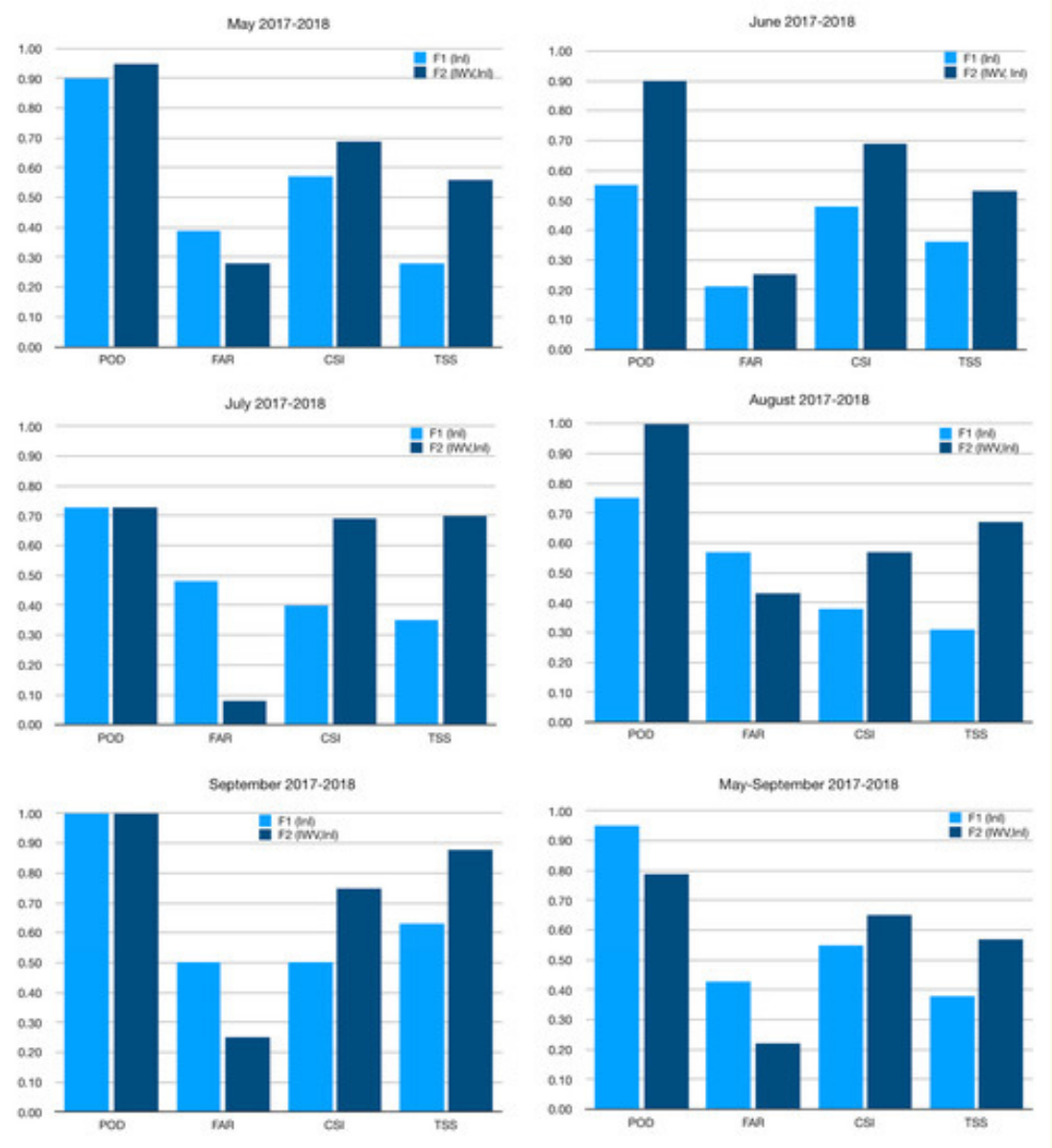
Month	F1 (Inl)	F2 (IWV,Inl)
May	0.15×K + 0.32×LI + 0.01×SWEAT − 5.355	0.54×IWV + 1.36×SHI + 0.74×TT + 0.07*K − 51.16
June	0.11×K + 0.57×TT + 0.97×SHI + 0.01×SWEAT − 33.35	0.16×IWV + 1.24×SHI + 0.08×K + 0.75×TT + 0.24×T_{LCL} − 110.97
July	0.06×K + 0.80×TT + 0.79×SHI + 0.34×T_{LCL} + 0.44×LI − 136.17	0.16×IWV + 0.45×SHI + 0.27×LI + 0.02×K + 0.58×TT + 0.16×T_{LCL} − 78.34
August	1.43×SHI – 0.34×LI + 0.03×SWEAT – 0.01×K + 0.77×TT – 40.92	0.28×IWV + 0.99×TT + 1.72×SHI + 0.03×SWEAT – 59.33
September	0.03×SWEAT + 0.06×K + 1.35×SHI -0.59×LI +0.40×TT – 26.12	0.83×IWV + 1.48×SHI + 0.01×SWEAT – 0.06K + 0.64×TT - 52.54
May–September	0.63×TT + 0.05×K + 0.74×SHI + 0.21×T_{LCL} + 0.01×SWEAT + 0.32×LI – 92.12	0. 24×IWV + 0.85×TT + 1.44SHI + 0.01×SWEAT + 0.11×T_{LCL} + 0.02×K – 81.57

IWV and Instability Indices*: training May-June 2010-2015

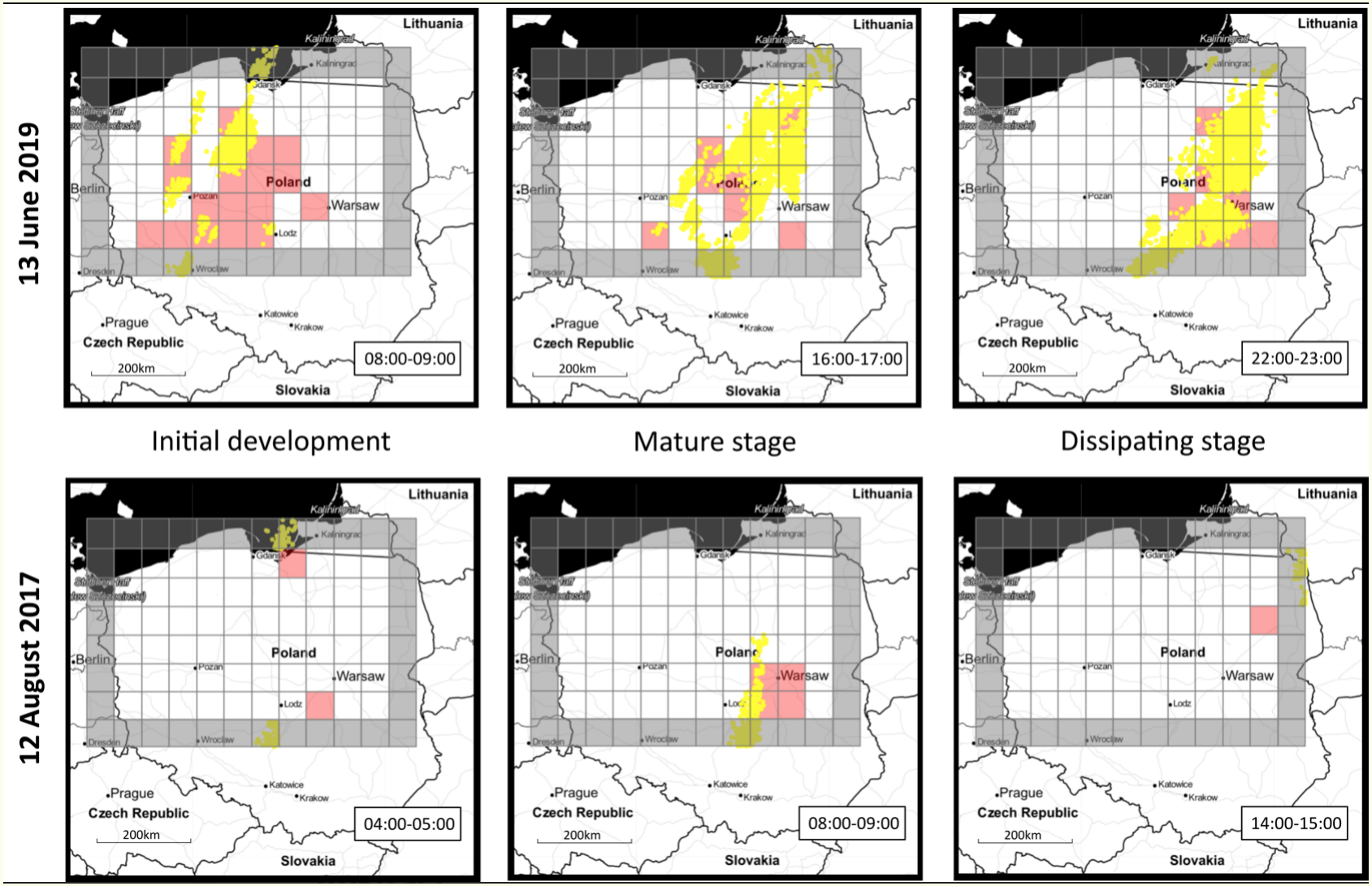


* Guerova et al. 2019. Thunderstorm Classification Functions Based on Instability Indices and GNSS IWV for the Sofia Plain, Remote sens., 11(24).

POD, FAR: May & September 2017-2018



GNSS machine learning thunderstorm forecasting: Poland*



* Los et al. 2020. GNSS-Based Machine Learning Storm Nowcasting, Remote Sens., 12(16), 2536.

Conclusions

- Thunderstorm in the Sofia plain rapid increase in April/May and decreases after October
- Statistical analysis separation of GNSS IWV between thunder and no thunderstorm days
- Classification functions using IWV and 7 instability indices superior performance: May, June and September

Acknowledged is funding by Sofia University Project Grant 80-10-237.

THANK YOU!