Impact of Background Model to the MSG Global Instability Indices (GII) Processing

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- The GII algorithm retrieves pre-convective environment parameters in clear-sky conditions:
  - Precipitable water, K-index, Lifted-index, KO-index, Maximum Buoyancy index
- It is a physical retrieval scheme, which needs background information.
  - the final solution will retain certain features of the background.
- The GII algorithm uses the following inputs:
  - SEVIRI IR channel measurements channel (WV6.2, WV7.3, IR8.7, IR10.8, IR12.0, IR13.4) and
  - NWP model data (short-term forecast data: moisture and temperature profiles, …)
  - Cloud mask
- We studied the impact of the forecast model to the GII results.

GII program was installed at the Hungarian Meteorological Service and adapted to be able to work with different NWP data

	ECMWF	**ALADIN**	**AROME**
	Hydrostatic	Hydrostatic	Non-hydrostatic
Area	Global	Central-Europe	Carpathian Basin
Horizontal resolution	0.25°	0.1°	0.025°
Vertical resolution (number of levels)	137	49	60
Run at ….	ECMWF	OMSZ	OMSZ

ALADIN/HU and AROME are run at the Hungarian Meteorological Service (with ECMWF as lateral boundary condition)

1. Analyse the effect of the **actual forecast differences** calculated by different NWP models (e.g. differences in the exact location of strong gradients, or convergence lines, or in the actual extreme values, …) We run the GII algorithm with three different NWP models (ECMWF, ALADIN, AROME) for selected cases - where the models produce significant differences in the moisture or instability fields in cloud free areas

We needed NWP data at fixed pressure levels

- ECMWF data were downloaded from ECMWF MARS database
- ALADIN/HU and AROME were re-run for the selected cases and post-processed to interpolate the data for the 25 fixed pressure levels

We used all three model data at the same 25 vertical levels:

1000, 950, 925, 900, 850, 800, 700, 600, 500, 400, 300, 250, 200, 150, 100, 70, 50, 30, 20, 10, 7, 5, 3, 2, 1 hPa

2. Analyse the effect of the **vertical resolution** of the NWP model

We run the GII algorithm with **ALADIN** model with different vertical resolutions.

To analyse the effect of the vertical resolution we used:

- ALADIN data at 25 levels and
- ALADIN data at 43 (RTTOV) levels

Strategy

To run the GII algorithm with different NWP inputs (ECMWF, ALADIN, AROME) for selected cases and analyse the differences.

Choosing test cases:

The forecasted Total Precipitable Water (TPW) and K-index fields were analysed looking for similarities and differences (at cloud-free areas)

For the test cases:

We run the GII algorithm with the

- (BT rms threshold) = 1000 to get the forecasted parameters in satellite projection and at the slot time
- (BT rms threshold) = 1.5 to get the satellite corrected parameters

Fields to compare:

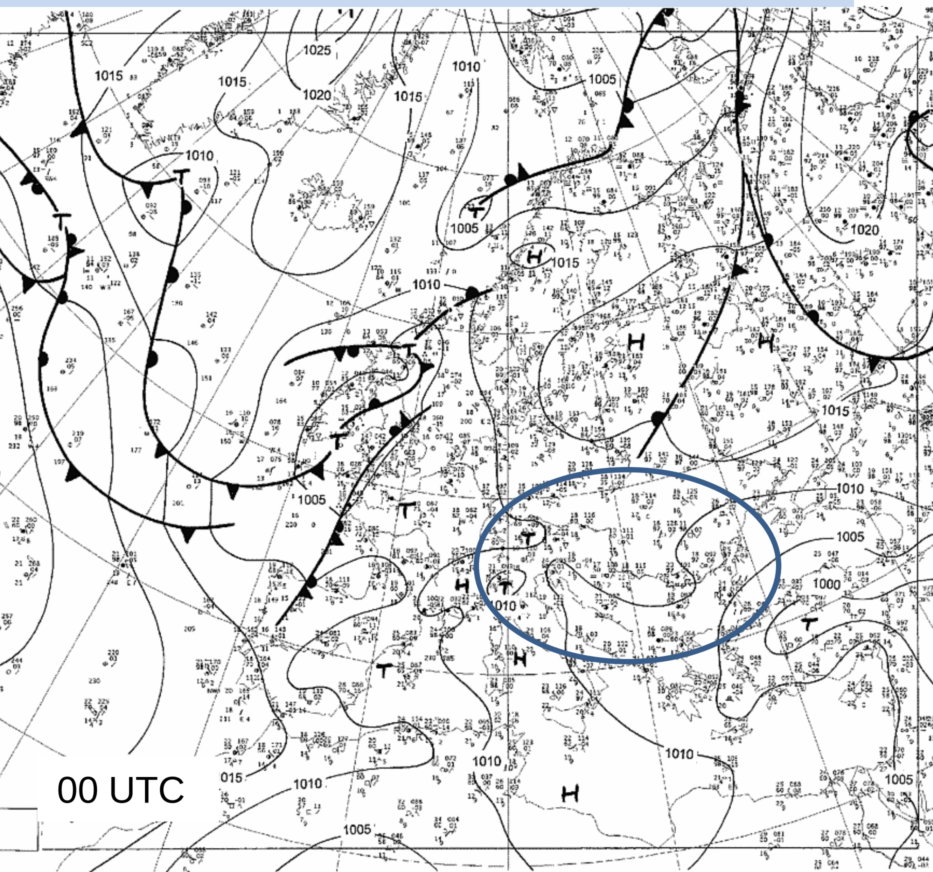
Total and Layer precipitable water and K-Index derived from the

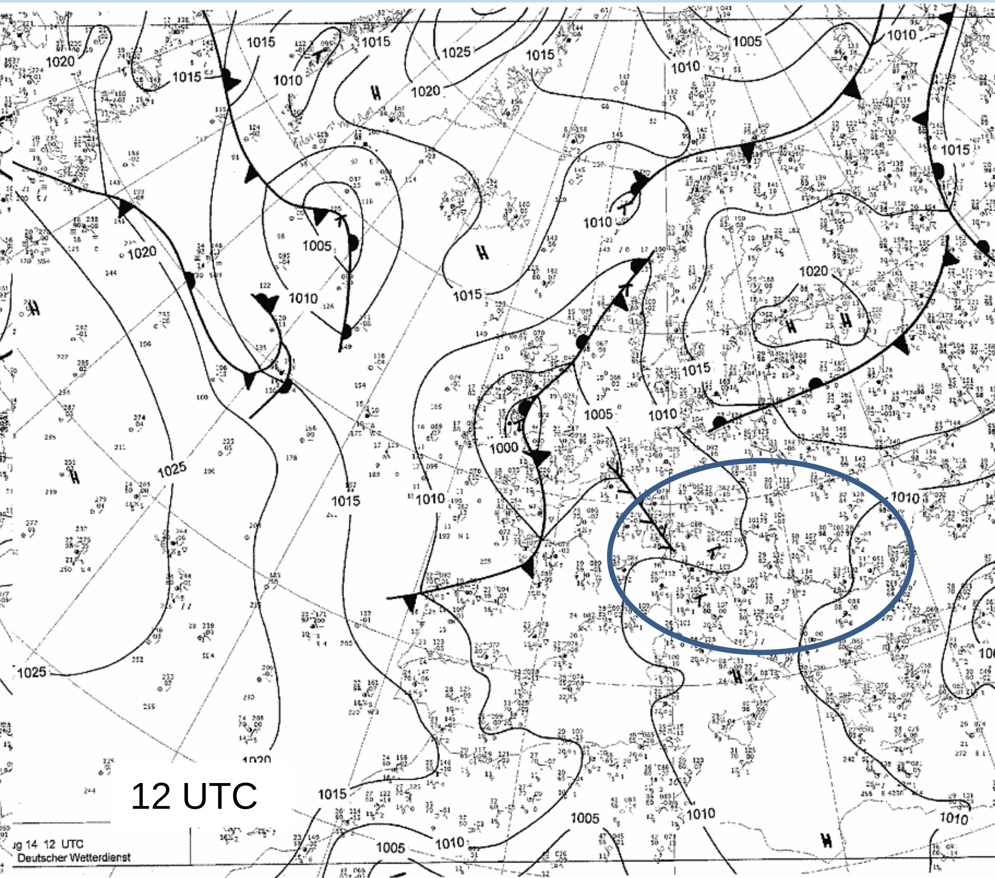
- NWP inputs,
- Satellite corrected fields,
- Radiosonde data.

02 August 2014

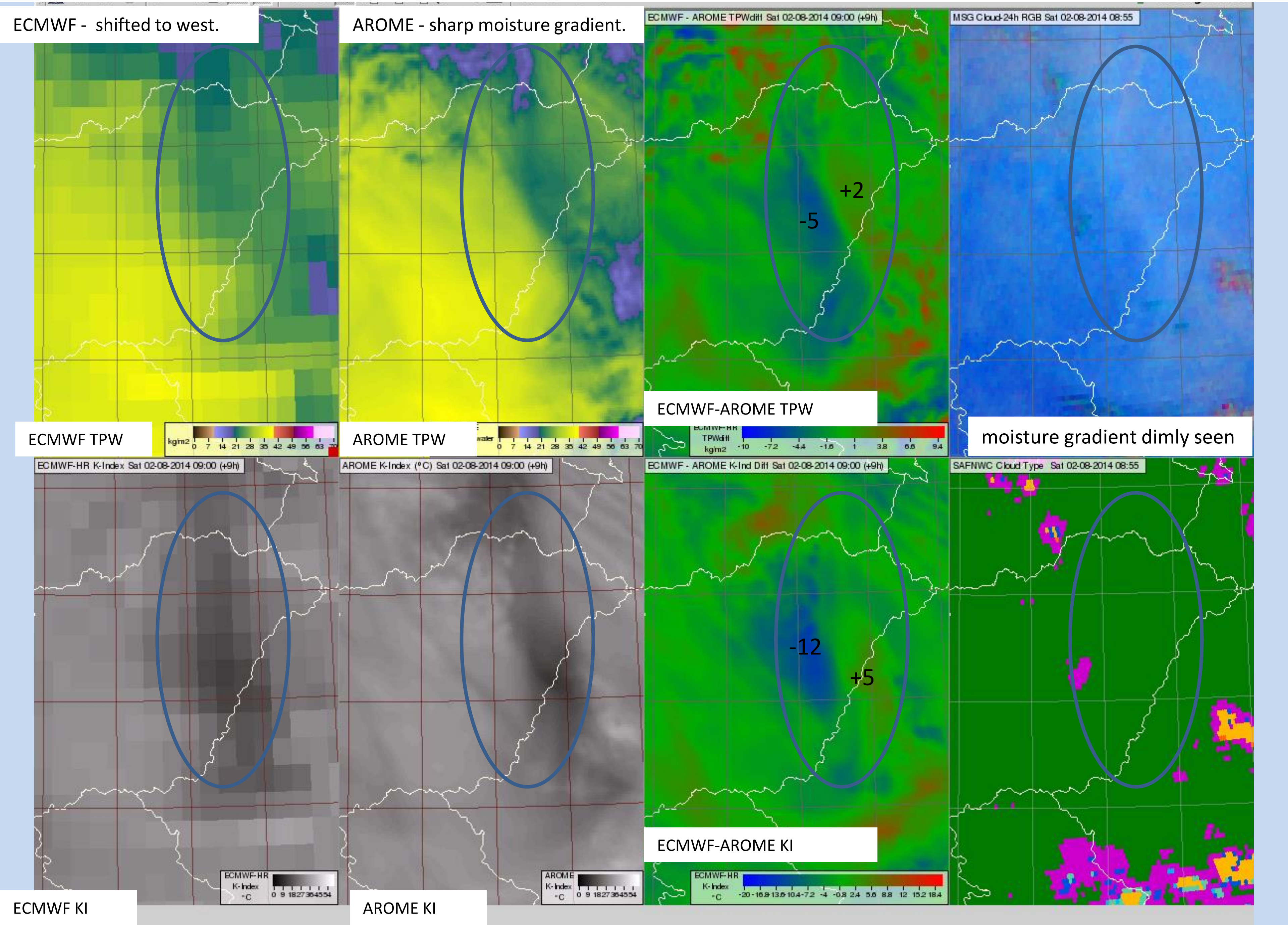
No fronts in the Carpathian basin
Synoptic environment characterized by weak pressure gradient forces, anticyclone to the northeast
(upper air vortex)

Several thunderstorms occurred in the Carpathian basin

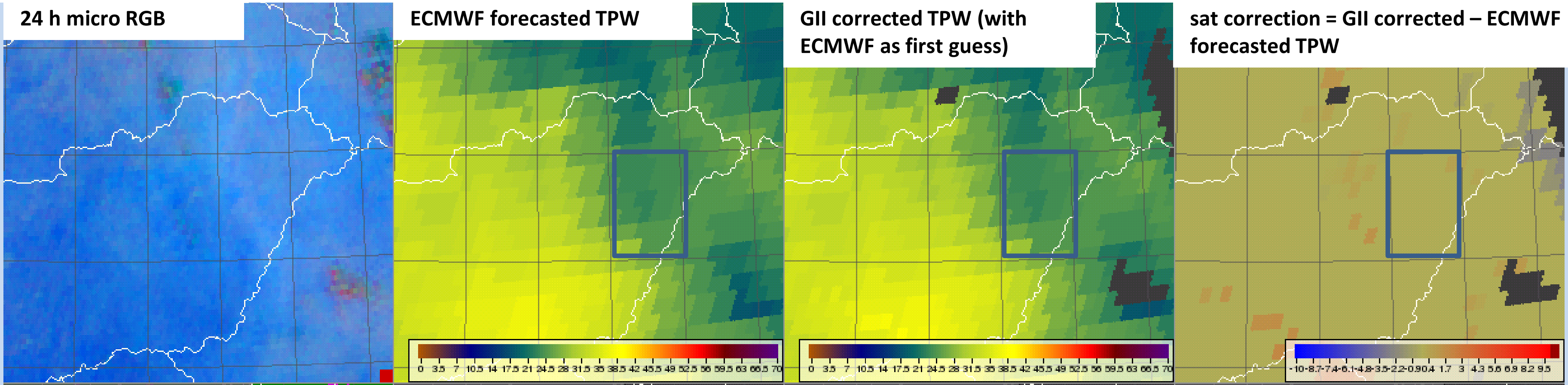


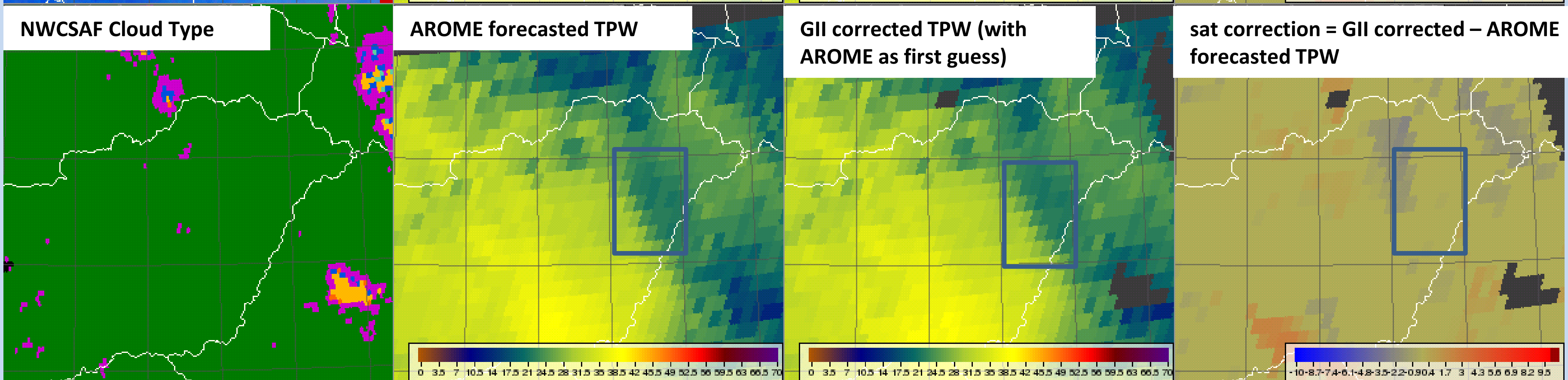


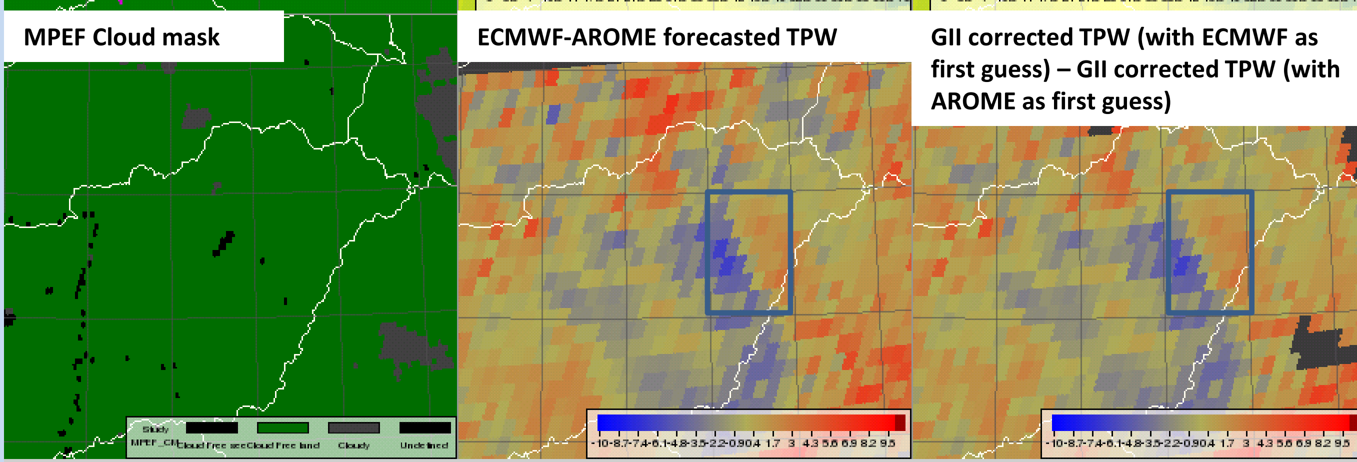
ECMWF and AROME in their original spatial resolution. This was used to select this day as a test case.   09 UTC



ECMWF and AROME forecasted and GII corrected TPW, 09 UTC





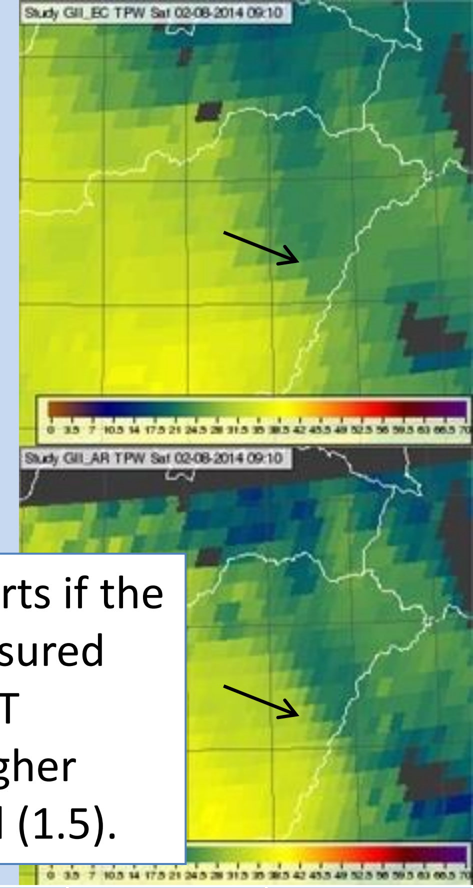


<u>About the area in the square:</u>
We expected that the satellite retrieval would modify this region.
However, …

GII algorithm **does** correction in **some areas**.
It **does not correct all differences**

2014.08.02. 09:10 UTC

	TPW [mm]	Sat corr TPW
EC	**26.2**	0
ALADIN	29.1	0
AROME	**30.5**	0

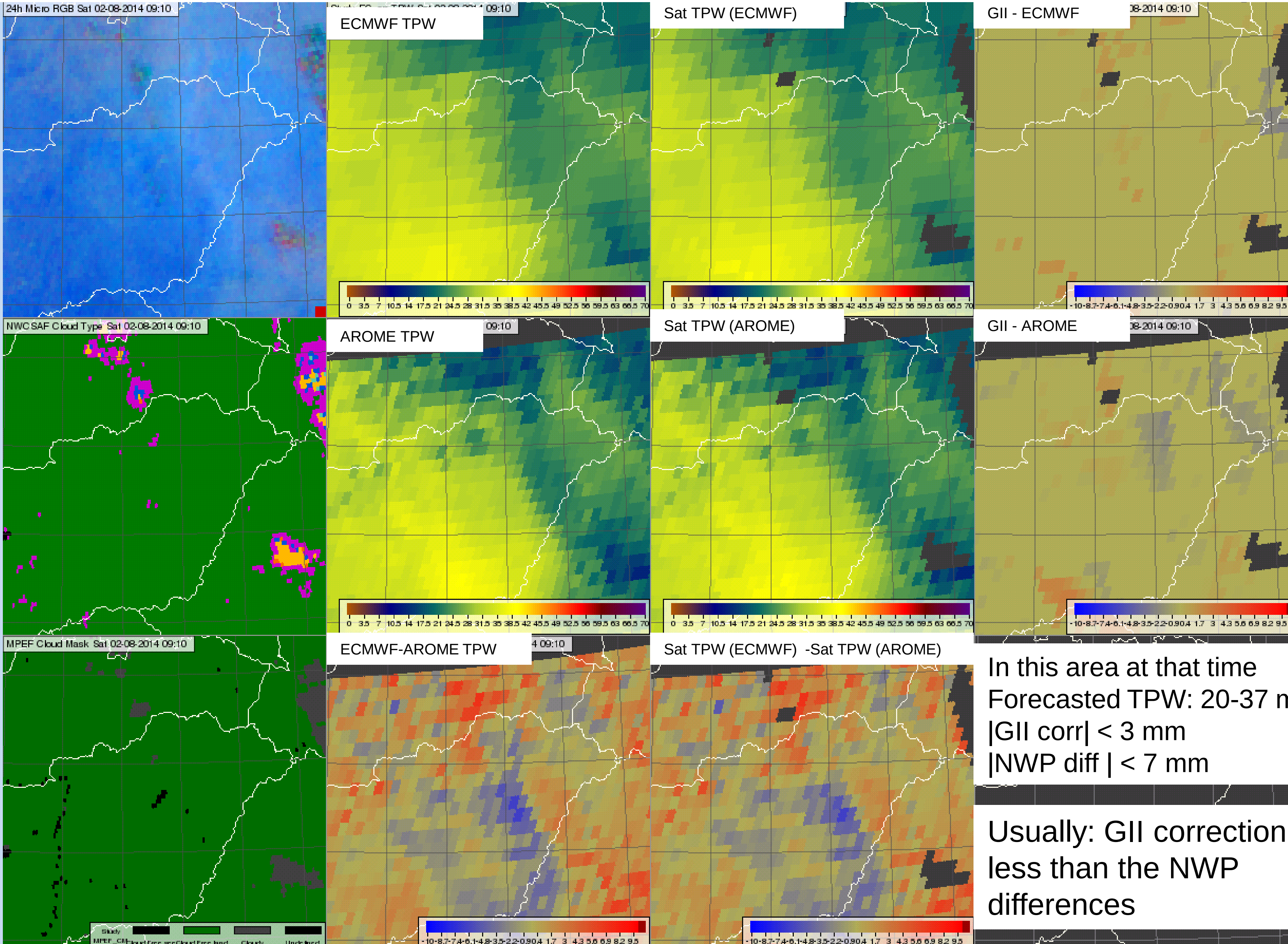


In the pixel indicated by the arrow the forecasted TPW differe
However, NO correction was performed as the simulated BTs
channels were close to the measured ones.

The itaration starts if the RMS of the measured and simulated BT differences is higher than a threshold (1.5).

	WV6.2	WV7.3	IR8.7	IR10.8	IR12.0	IR13.4	RMS
Measured BT	**240.5**	**258.3**	**294.8**	**297.4**	**294.4**	**266.0**	
Simulated BT using ECMWF profiles	240.9	259.3	294.8	297.8	295.0	267.6	0.83
Simulated BT using ALADIN profiles	241.0	258.1	294.1	296.7	293.0	266.4	0.74
Simulated BT using AROME profiles	239.8	259.2	294.6	296.9	293.3	266.4	0.71

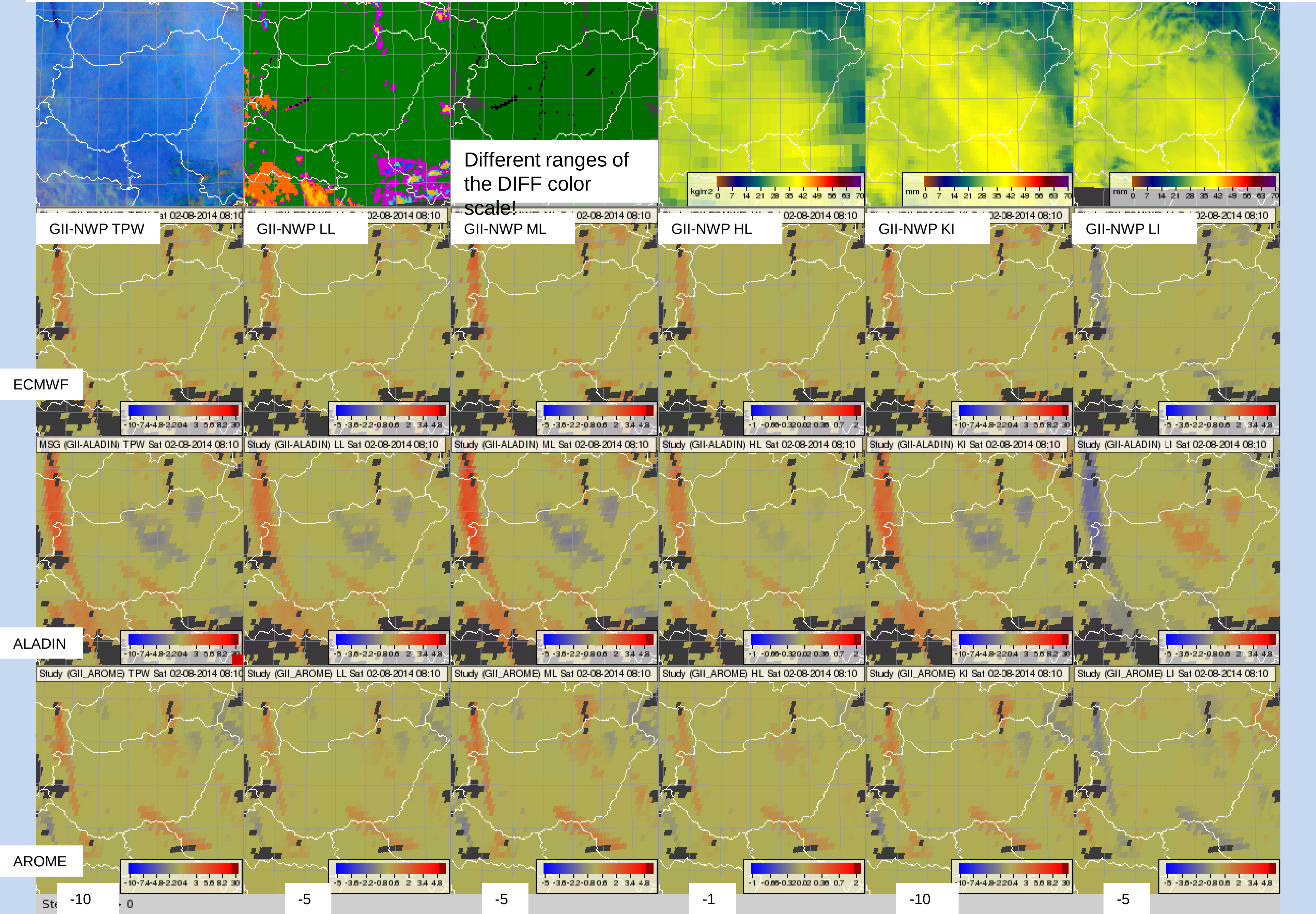
ECMWF and AROME forecasted and GII corrected TPW, 09 UTC



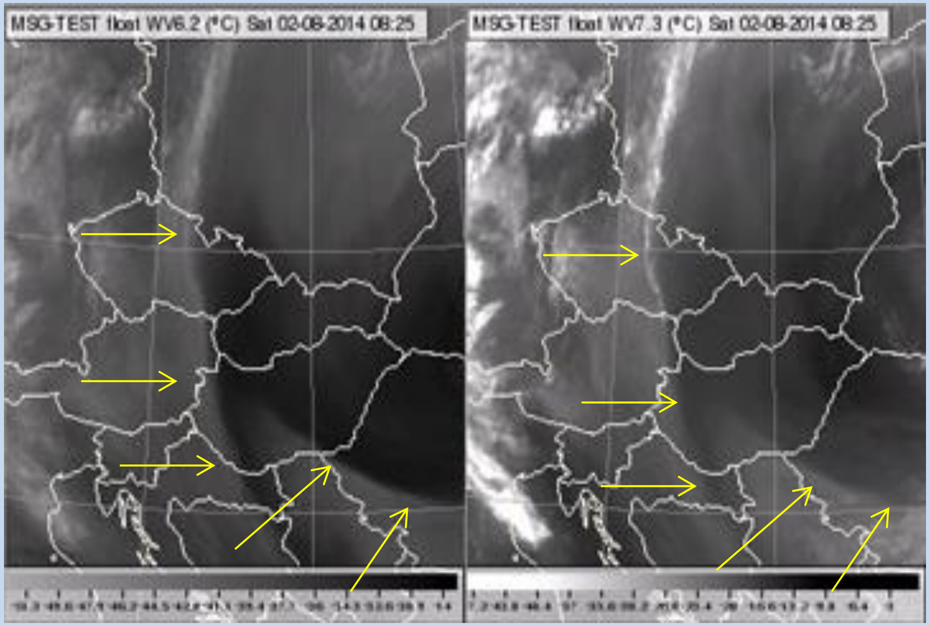
In this area at that time
Forecasted TPW: 20-37 mm
|GII corr| < 3 mm
|NWP diff | < 7 mm

Usually: GII correction is less than the NWP differences

The GII corrections (the location and the shape of the patches) are similar in all tree layers and also for the instability indices. → The 'satellite corrections' seem to be 'smoothed' - for the same NWP model

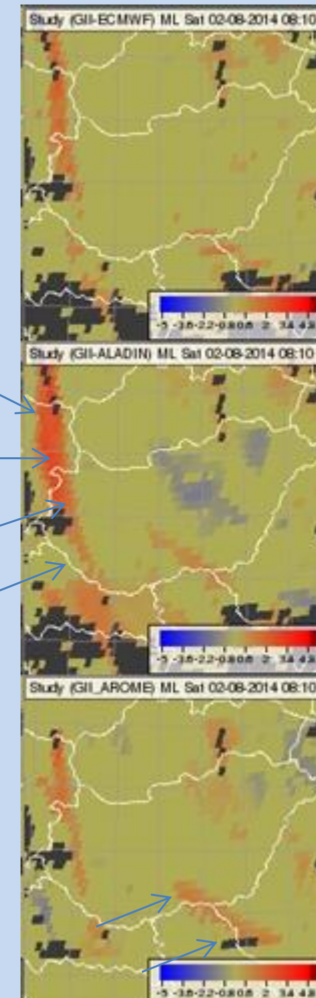


Why do these ‘red band’ appear in the difference images?



Do they indicate some features which are missing or shifted in all three NWP models?

WV images - visual information on high-, mid-layer moisture structure.



See the <u>moisture boundaries</u> indicated by <u>yellow arrows</u> in the WV6.2 and WV7.3 images.
These boundaries are about the same locations (shapes) as the ‘red bands’ indicated by blue arrows in the difference images.

Comparison with radiosonde measurements

3 days 12 UTC radiosonde data were collected from cloud-free areas

TPW and K-index derived from 27 soundings were compared with GII corrected data using ECMWF and ALADIN as first guess

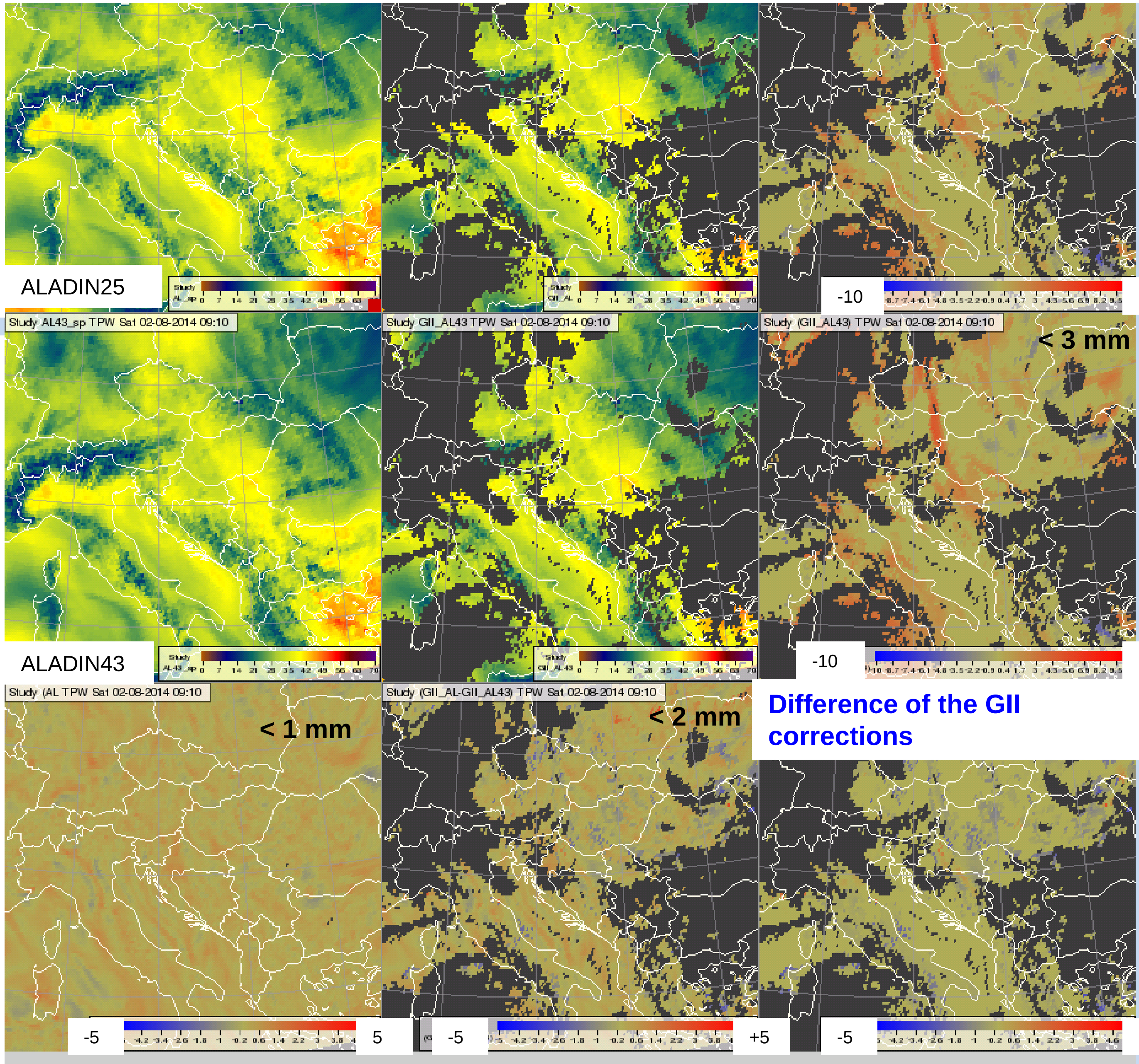
	Radiosonde derived minus			
TPW difference	ECMWF forecasted TPW	GII corrected TPW with ECMWF as first guess	ALADIN forecasted TPW	GII corrected TPW with ALADIN as first guess
< 1 mm	**6**	**12**	**4**	**6**
< 2 mm	13	15	11	12
< 3 mm	16	16	16	17

	Radiosonde derived minus			
K-index difference	ECMWF forecasted K-index	GII corrected K-index with ECMWF as first guess	ALADIN forecasted K-index	GII corrected K-index with ALADIN as first guess
1 °C	7	8	**6**	**9**
2 °C	14	14	9	10
3 °C	18	18	11	14

Analysing the effect of the vertical resolution of the NWP forecast

8 UTC | forecasted TPW | GII corrected TPW | GII correction

The satellite retrieving modifies the ALADIN25 TPW and ALADIN43 TPW fields in **similar** ways, but **NOT identically**. Higher differences between GII corrected fields than between the forecasts.



Reasons:

- GII algorithm interpolate the profiles from the 'X' input levels to the 43 RTTOV levels. The uncertainty of this interpolation impact the exact shape of the forecasted profiles
- GII correction is performed if the RMS of the simulated BTs are higher than a fix threshold.

Conclusions

The satellite correction is usually small, but comparable to the forecasted value.
->
The NWP fields have big influence on the GII results. The GII corrected field has usually similar structure as the forecasted field, except the areas where the GII algorithm modifies it. These are not strong modifications, and the majority of the image is not corrected.

However, this little modification can be important. GII can improve the shape of some mesoscale features: like the exact location of a moisture boundary, and local moisture gradient.

Undetected thin cirrus clouds cause error in the retrieval. It increases the TPW value.

The GII corrections (the location and the shape of the patches) are similar in all tree layers and also for the instability indices. The corrected profiles seem to be strongly constrained to the first guess humidity profile. (Due to the few measurements against the many unknowns.)

Conclusions 2.

The GII algorithm **does not correct all differences** between the NWP models. (This can happen even with 4-5 mm TPW differences.)

The satellite correction are usually smaller, but comparable to the differences between ALADIN, ECMWF and AROME forecasted fields.

The moisture (instability) fields forecasted by different models often became **closer** to each other due to the GII correction.

Comparisons with radiosonde data showed that

- the GII algorithm corrected the TPW values in good direction in more than 70 % of the cases
- The GII corrected TPW and K-index was more often close (within 1/2/3 mm/°C to the radiosonde derived TPW than the forecasted ones.

Using the same NWP model with different **vertical resolution** as first guess the GII correction will be very **similar**, but **NOT identical.** Neither the extension nor the values will be exactly the same.

-> Higher differences between the GII corrected fields than between the forecasts. The difference could be doubled. - Altogether this is not a strong effect.

Thank you for the attention!

Test cases			
29	July	2012	Convergence line ahead front, severe convective system
05	August	2012	weak pressure gradient forces, severe convection
20	June	2013	Germany: Convergence line + front, severe convection Carpathian basin: edge of a NE-European cyclone
02	**August**	**2014**	Weak pressure gradient forces, anticyclone to the northeast (upper air vortex)
14	August	2014	Front across the Carpathian Basin
20	August	2014	Front across the Carpathian Basin
22	August	2014	Post-frontal situation
03	September	2014	Convergence line over Spain, weakening cyclon to east
08	September	2014	Carpathian basin: Convergence line, single cell convection, weak pressure gradient forces
09	September	2014	weak pressure gradient forces, waving frontal zone approaching in the evening

Several slots were processed per day.

Ranges of the values for this day (Europe 8-20 UTC).

	TPW range [mm]		ML range [mm]		K-index range [C]	
forecasted	17	43	9	26	16	40
GII correction	-7	+4	-4	+3	-6	+5
Difference between the forecasted fields	-10	+13	-10	+7	-12	+8

The ranges were similar for the other days as well.

The satellite correction is

- not huge compared to the forecasted values.
- smaller than, (comparable to) the differences between ALADIN, ECMWF and AROME forecasted fields.