Convection Initiation Nowcasting and Verification

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Outline

Motivation

Cb-TRAM (**C**umulonim**b**us **TR**acking **A**nd **M**onitoring)

CI-Verification

Additional data sources

Summary

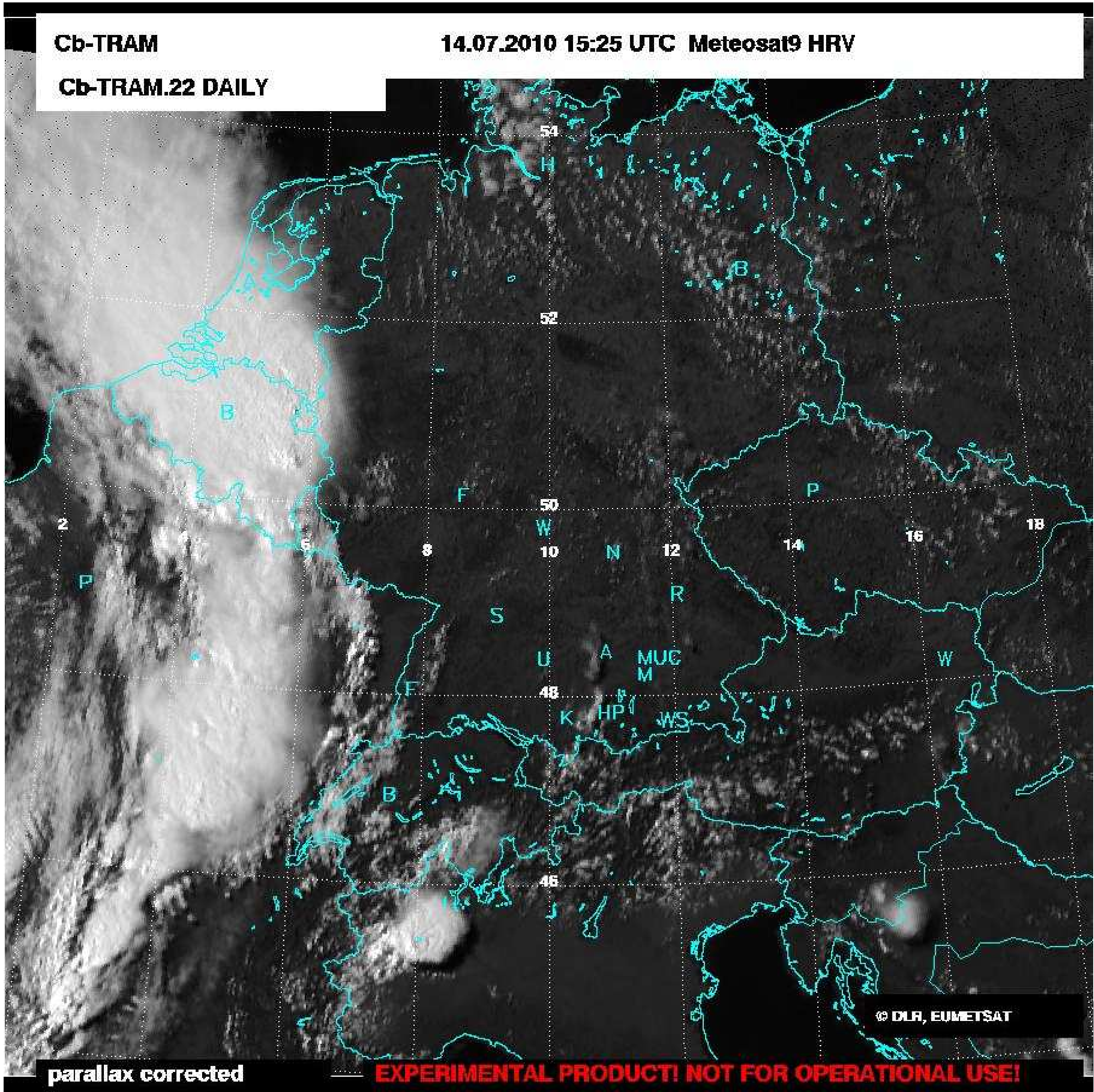
Motivation

Aviation purposes

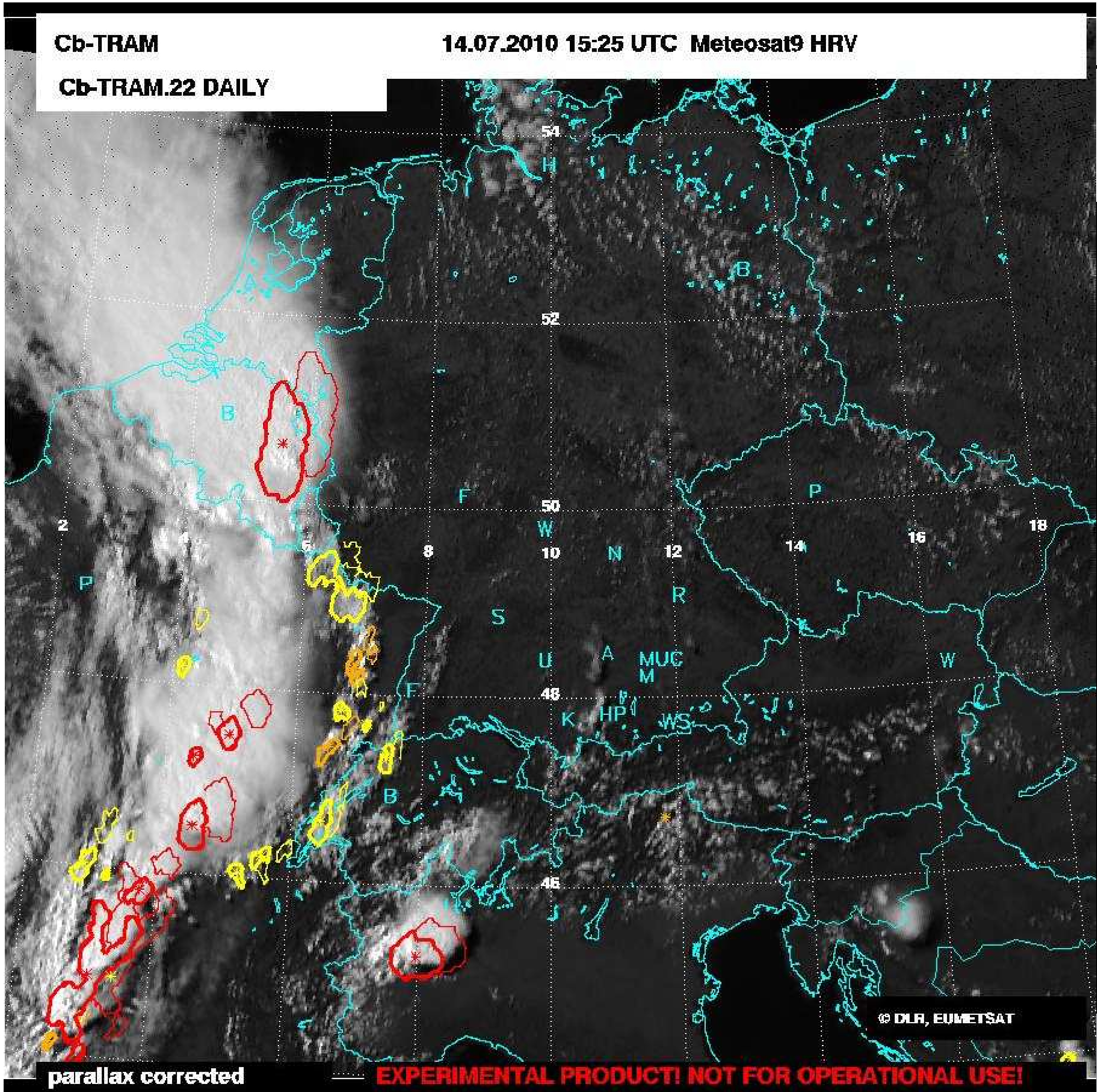
Cb-TRAM as basic tool

Adding non-satellite fields for further development

Cb-TRAM - Cumulonimbus TRacking And Monitoring



Cb-TRAM - Cumulonimbus TRacking And Monitoring



Used MSG (rapidscan) data:

WV 6.2	IR 10.8
IR 12.0	HRV

Detection stages:

1: Convection Initiation (CI)
- development in HRV
- IR 10.8 cooling

2: Rapid development
- WV 6.2 rapid cooling (> 1K/15min)

3: Mature storms
- T 6.2 - T 10.8
- HRV texture

Extrapolation up to 60 min
(here 30 minute nowcast plotted)

Description: Zinner et al., 2008

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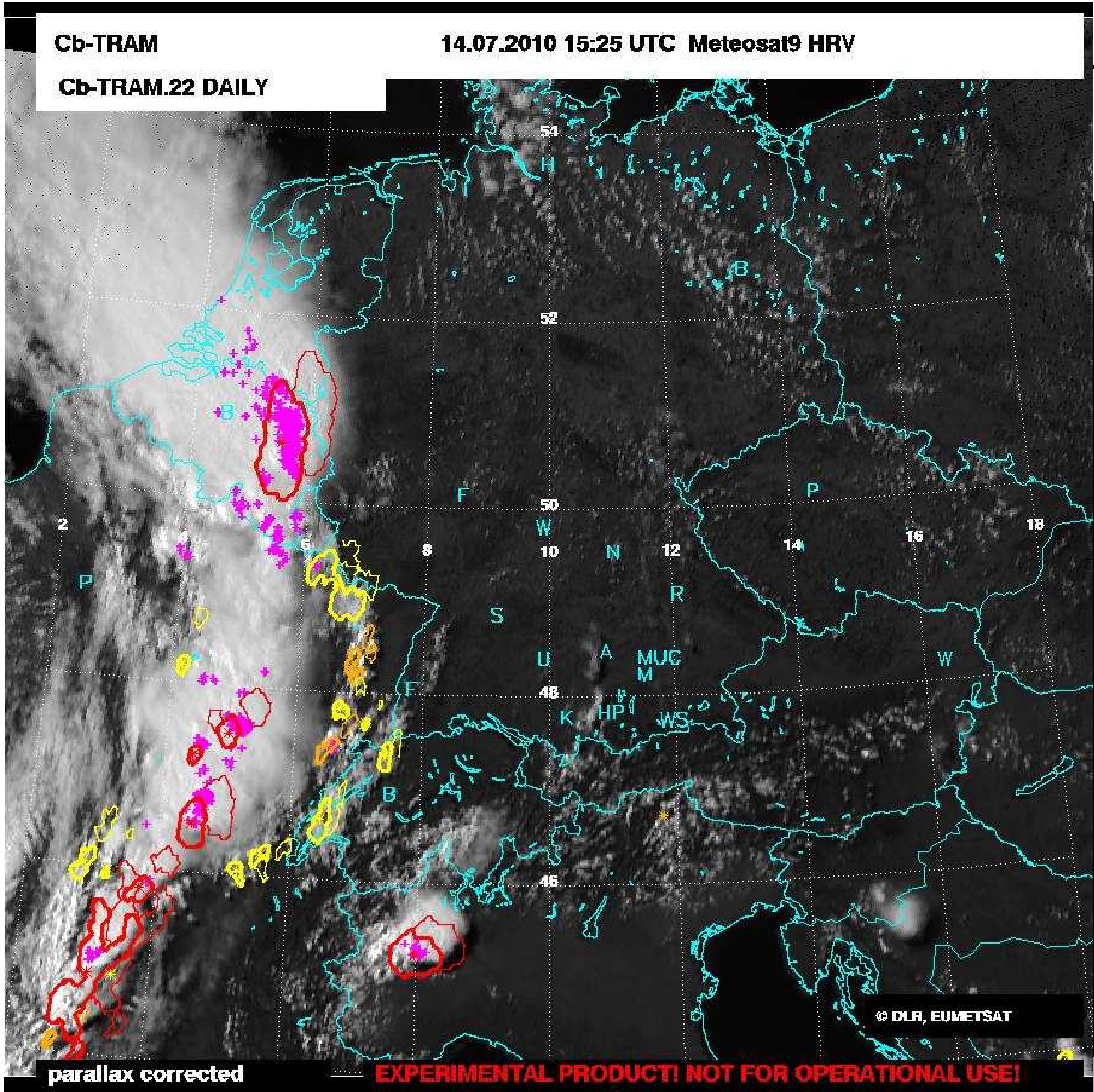

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Lightning (LINET)

Extrapolation up to 60 min
(here 30 minute nowcast plotted)

Description: Zinner et al., 2008

CI-Verification

How to verifiy CI?

Cutting edge of forecast verification!

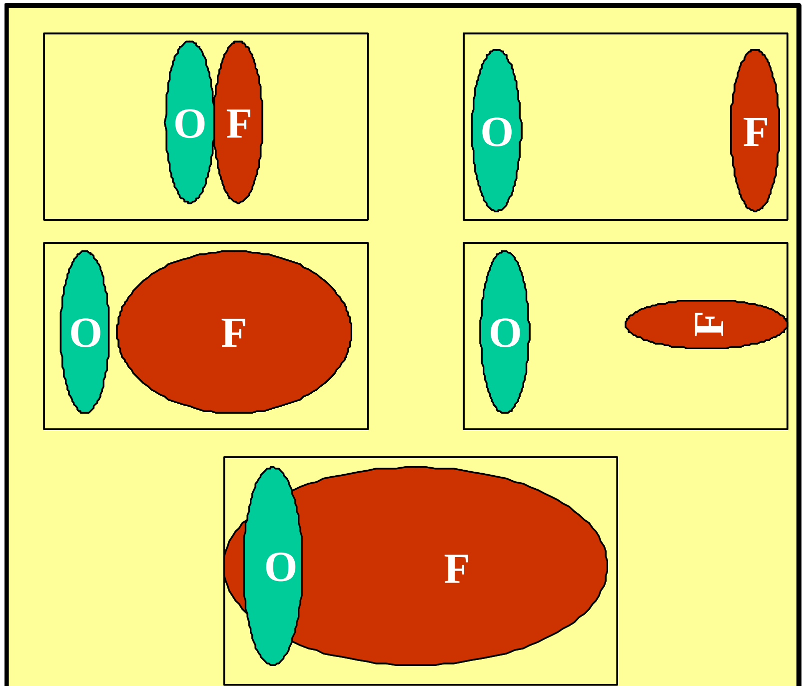
Difficult to match CI satellite indicators to lateron (30 – 60 min) existing storms, detected in radar, lightning or satellite data

Thunderstorms are relatively rare events!

How to deal with close nowcasts? What is close?

Contingency table

		Observed	
		yes	no
Forecast	yes	hit	false alarm
	no	miss	correct negative



Taken from Brown et al., 2004

CI-Verification

How is a “CI-event“ defined? Or: What‘s used as “truth“?

- radar echo ≥ 35 dBZ
  (e.g. Roberts & Rutledge, 2003; Mecikalski & Bedka, 2006)

- Lightning density / flash rate
  (e.g. Zinner & Betz, 2009; Donovan et al., 2008)

- Cb-TRAM “mature storm“-stage
  determined by IR 6.2 – IR 10.8 and HRV texture

CI-Verification

How is a “CI-event“ defined? Or: What‘s used as “truth“?

- radar echo ≥ 35 dBZ
  (e.g. Roberts & Rutledge, 2003; Mecikalski & Bedka, 2006)

Cb-TRAM analysis used for comparison with the 15, 30, 45, and 60 minutes CI-stage nowcasts

- Cb-TRAM “mature storm“-stage
  determined by IR 6.2 – IR 10.8 and HRV texture

CI-Verification

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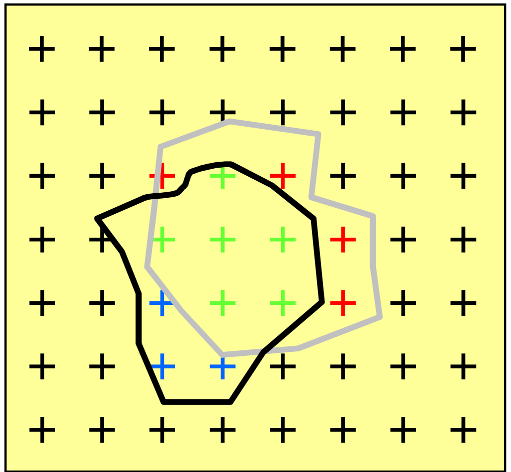

Pixel based

Requires perfect matching!

CI-Verification

Contingency table

		Observed	
		yes	no
Forecast	yes	hit	false alarm
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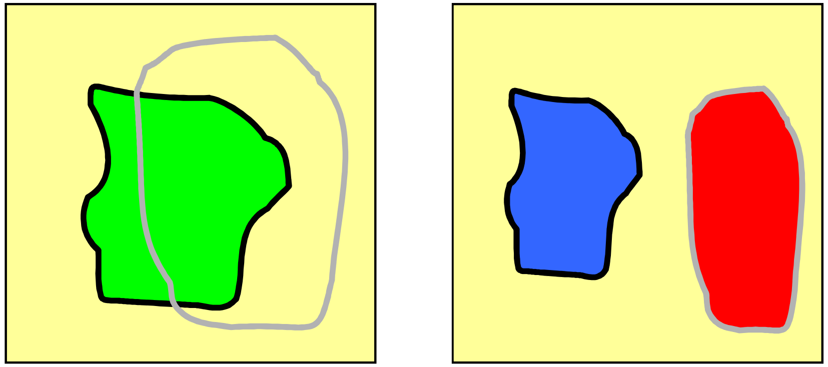
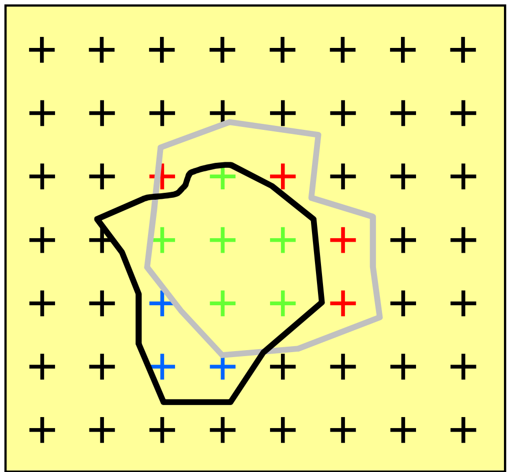
Object based



double penalty problem



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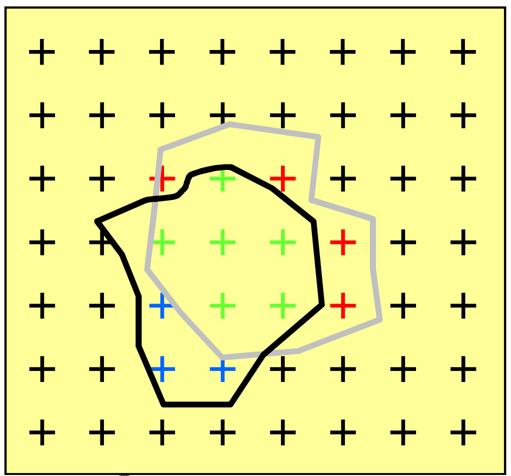

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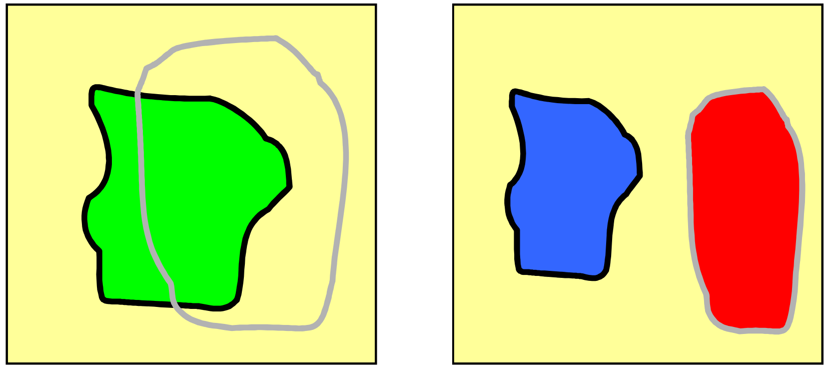
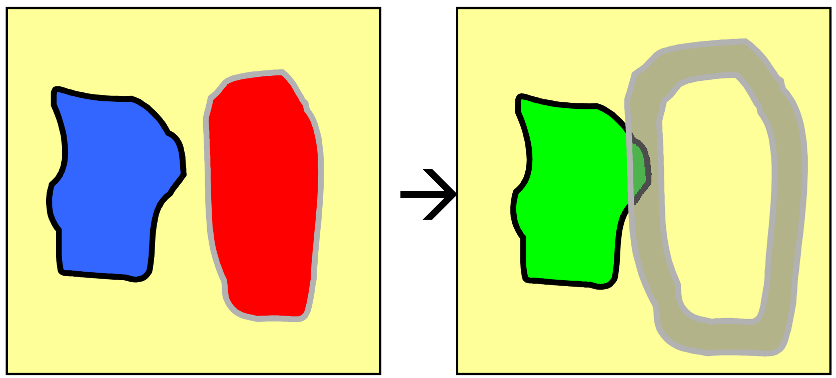
Object based



double penalty problem

Fuzzy + Object based



CI-Verification

Contingency table			
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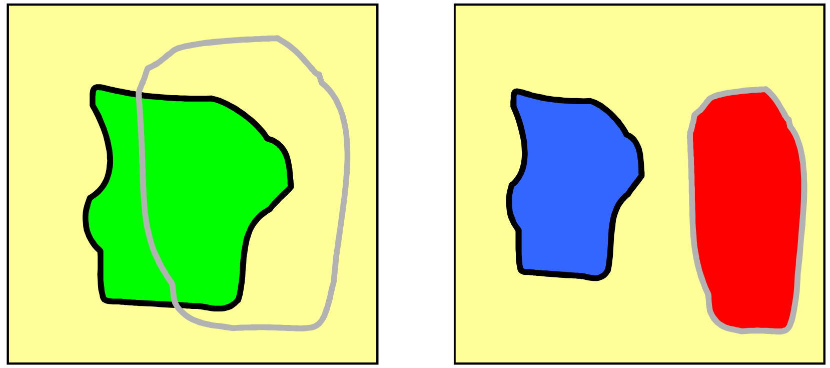


CI-Verification

Different versions shown:

Object based

with Cb stage 1 analysis objects for the nowcast overlap

Developing Object based

without Cb stage 1 analysis objects for the nowcast overlap
→ just developing cells

Results for the summer 2009, 15 May to 31 August

	15 min	30 min	acc 15-60 min
Object based POD	0,5919	0,4212	0,4093
Object based FAR	0,6109	0,7545	0,5448
Object based CSI	0,2737	0,1462	0,2489
Dev Object POD	0,2281	0,1992	0,1697
Dev Object FAR	0,8853	0,8841	0,8176
Dev Object CSI	0,0397	0,0393	0,0654

POD = hits / (hits + misses)

FAR = false alarms / (hits + false alarms)

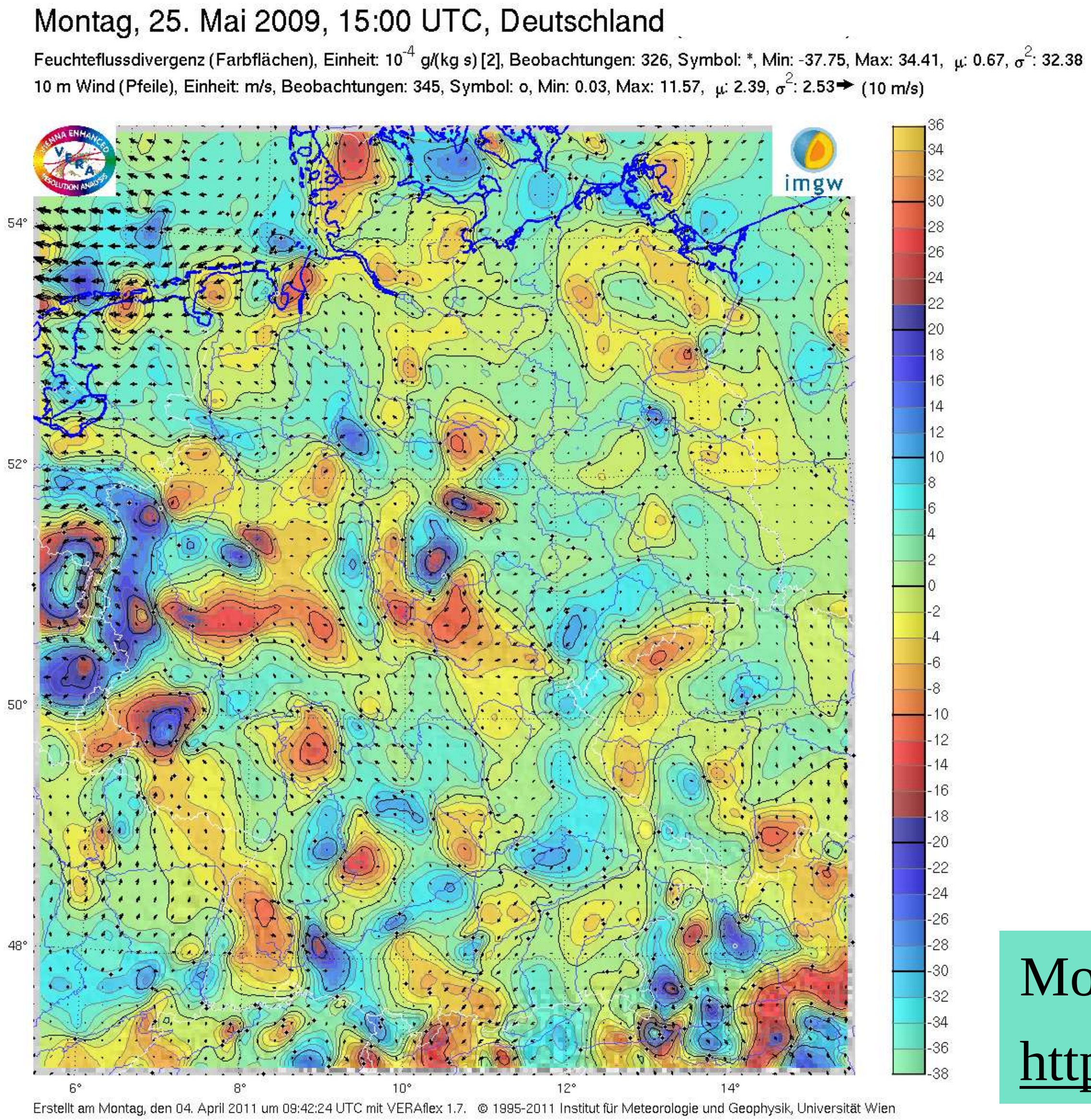
CSI = hits / (hits + misses + false alarms)

Additional data sources

Testing the additional information provided by:

- more satellite channels
- VERA data (e.g. MFC/MFD, equivalent potential temperature)
-
-

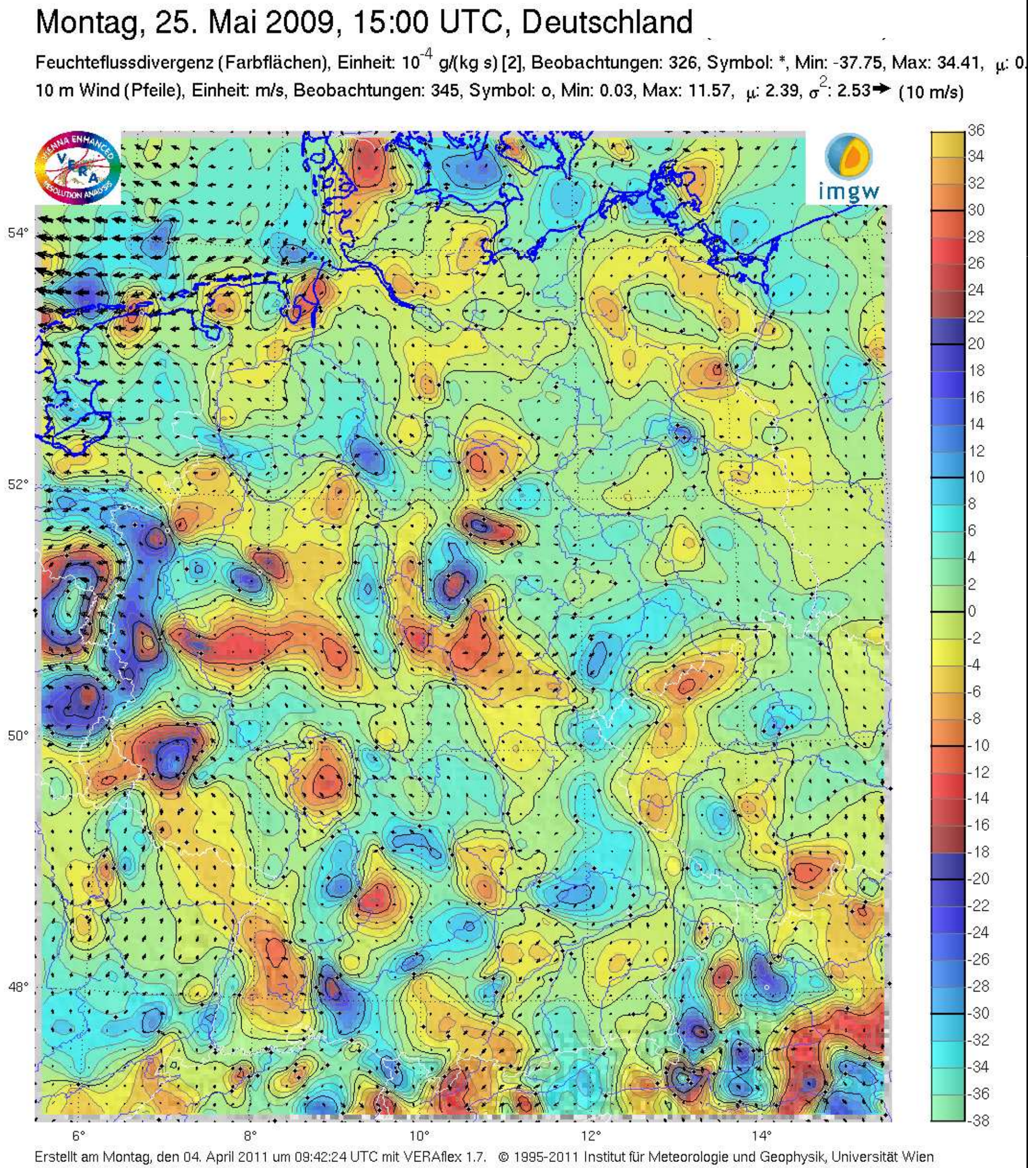
V ienna E nhanced R esolution A nalysis

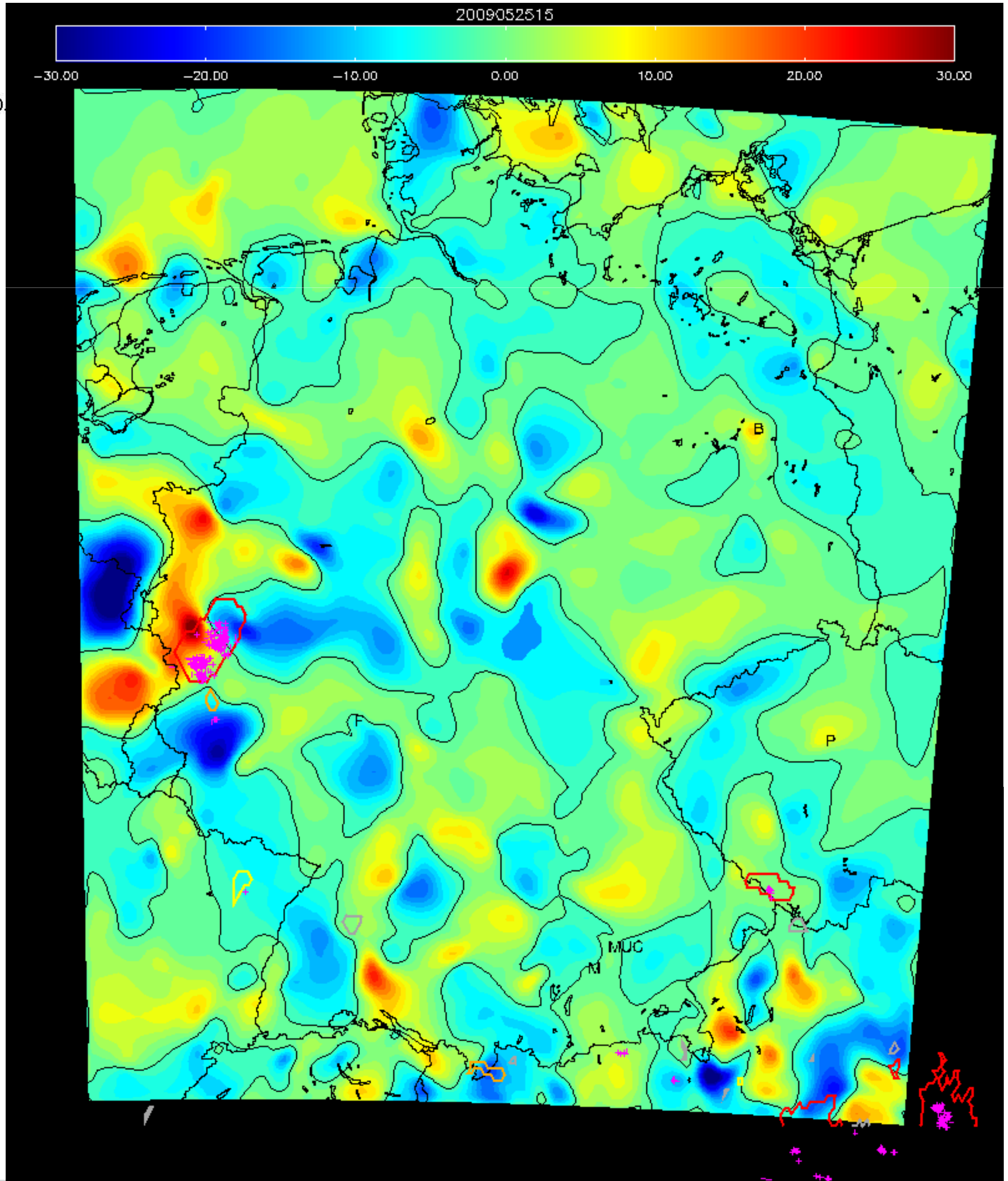


More information and references:

http://www.univie.ac.at/amk/vera/

Vienna Enhanced Resolution Analysis





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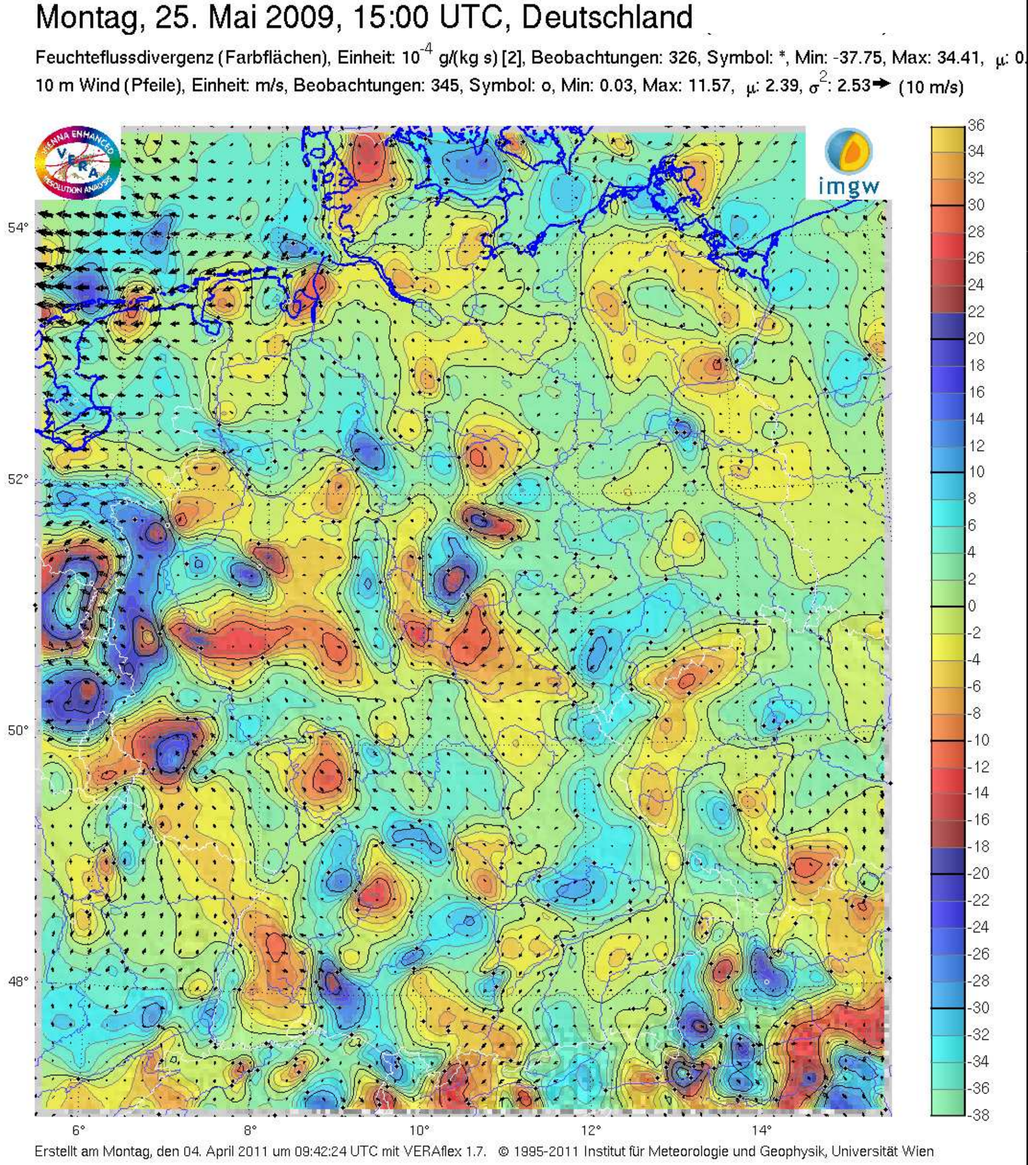
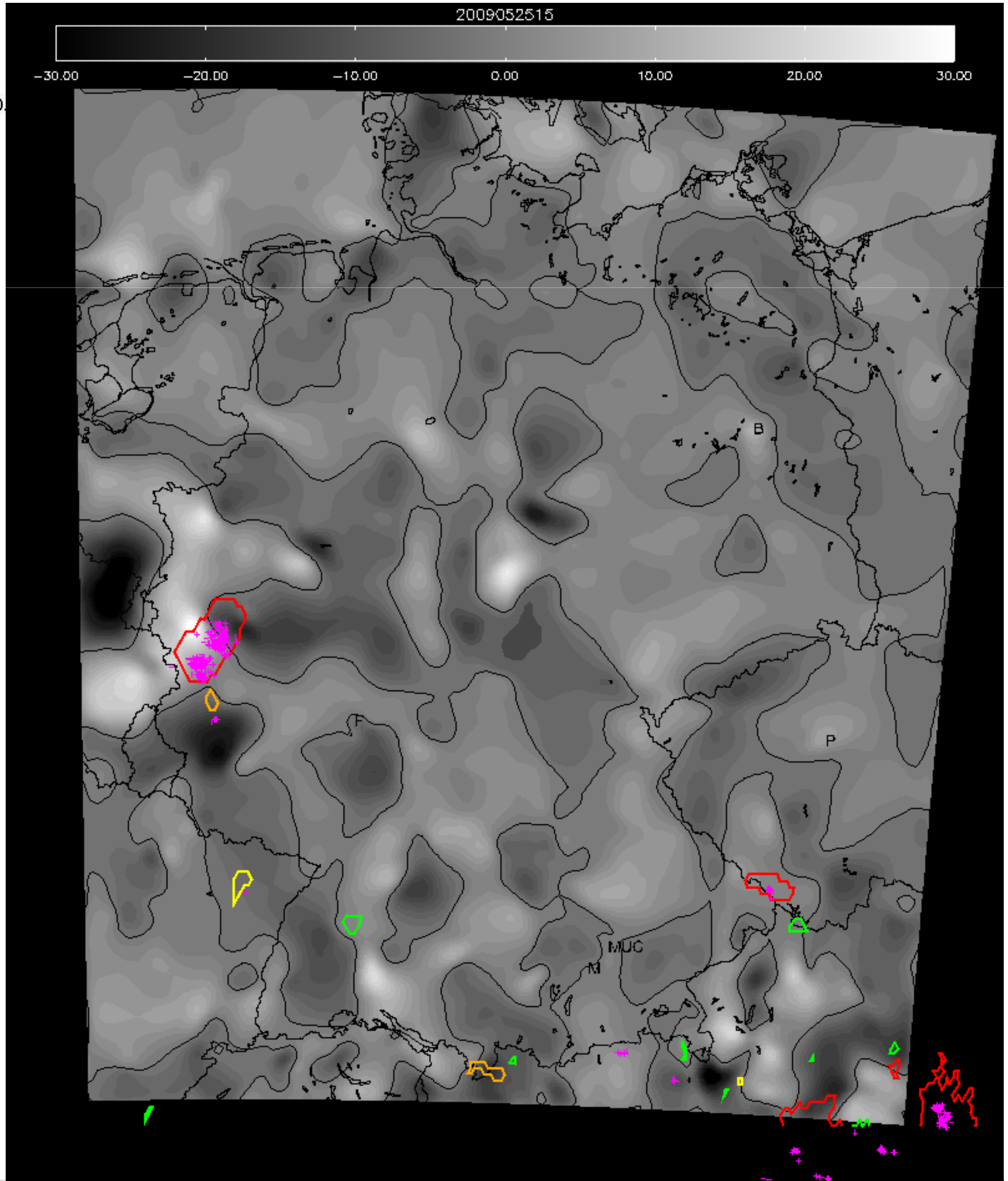


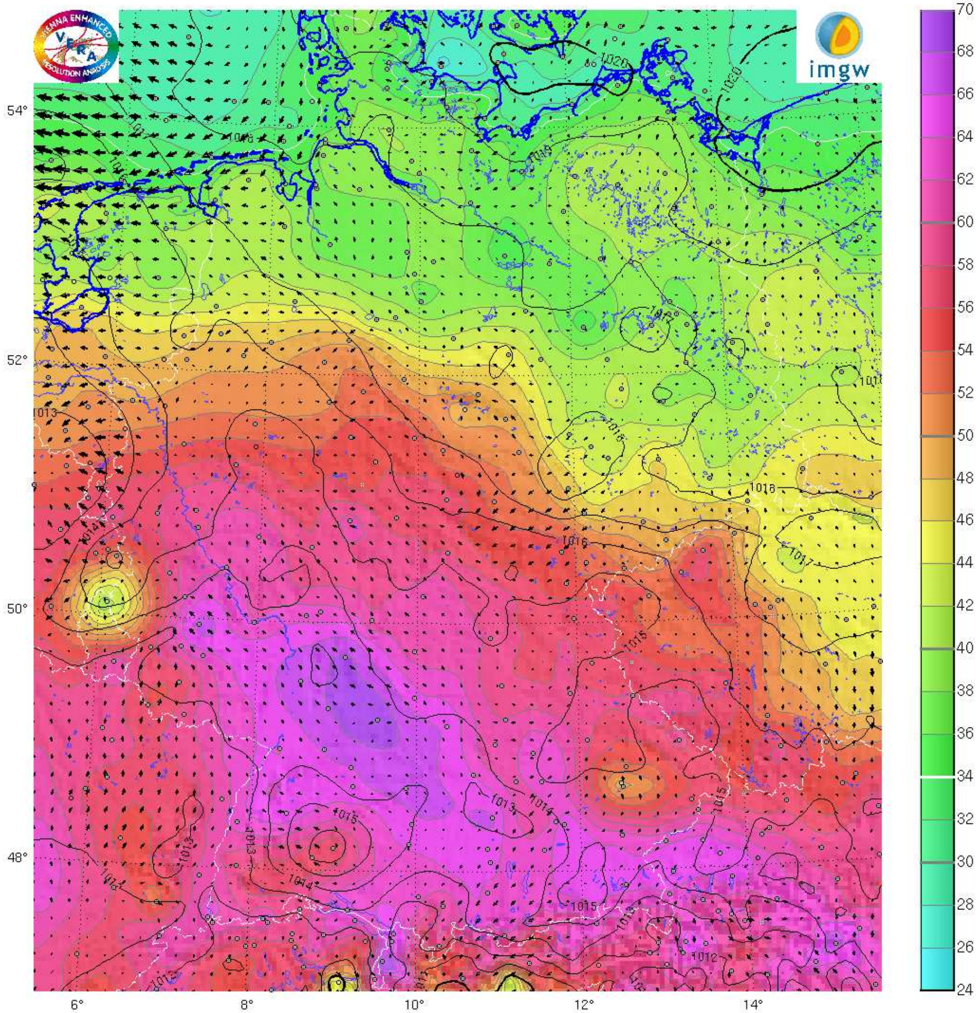


MFD May 25 2009 15 UTC

V ienna E nhanced R esolution A nalysis

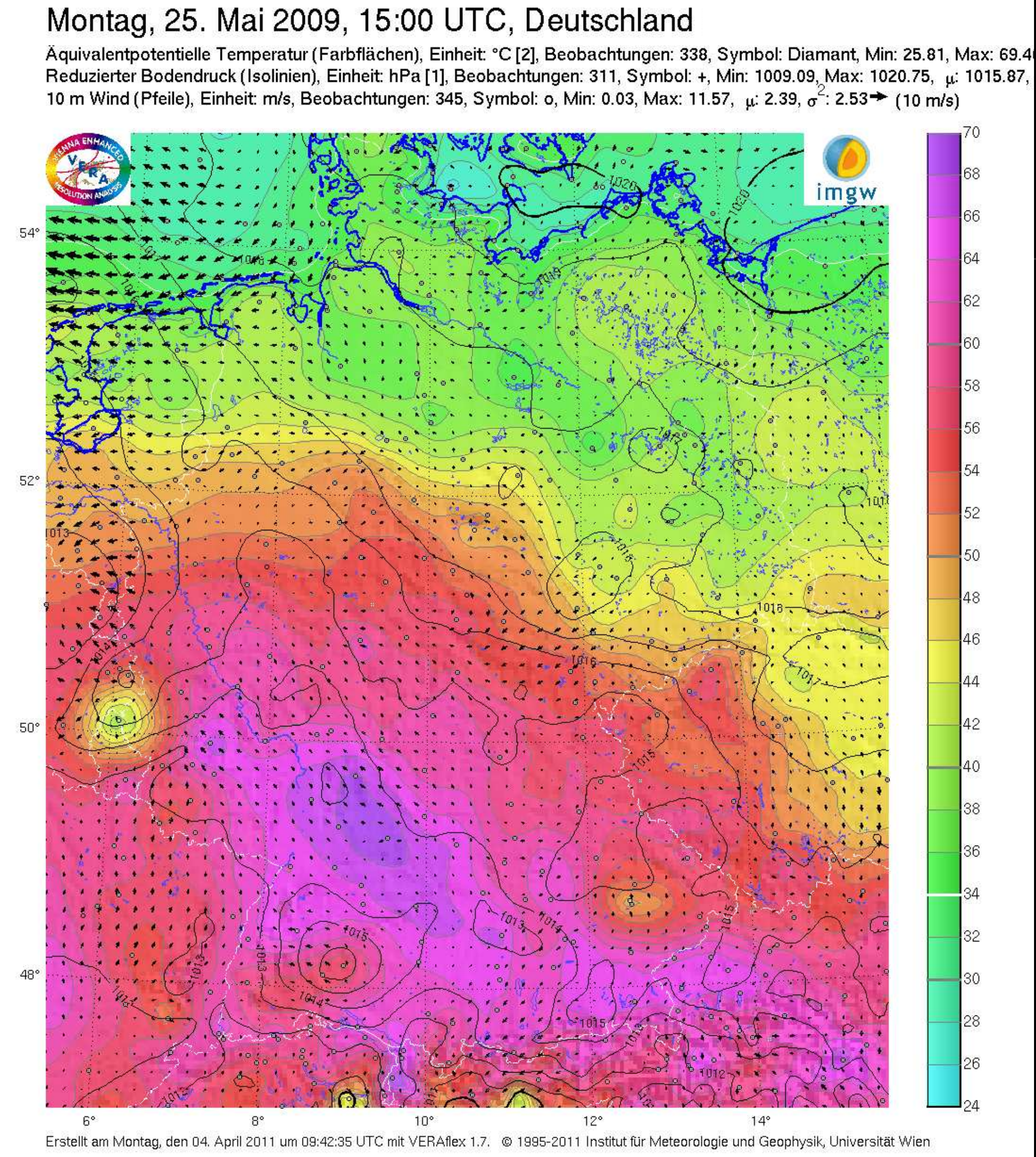
Montag, 25. Mai 2009, 15:00 UTC, Deutschland

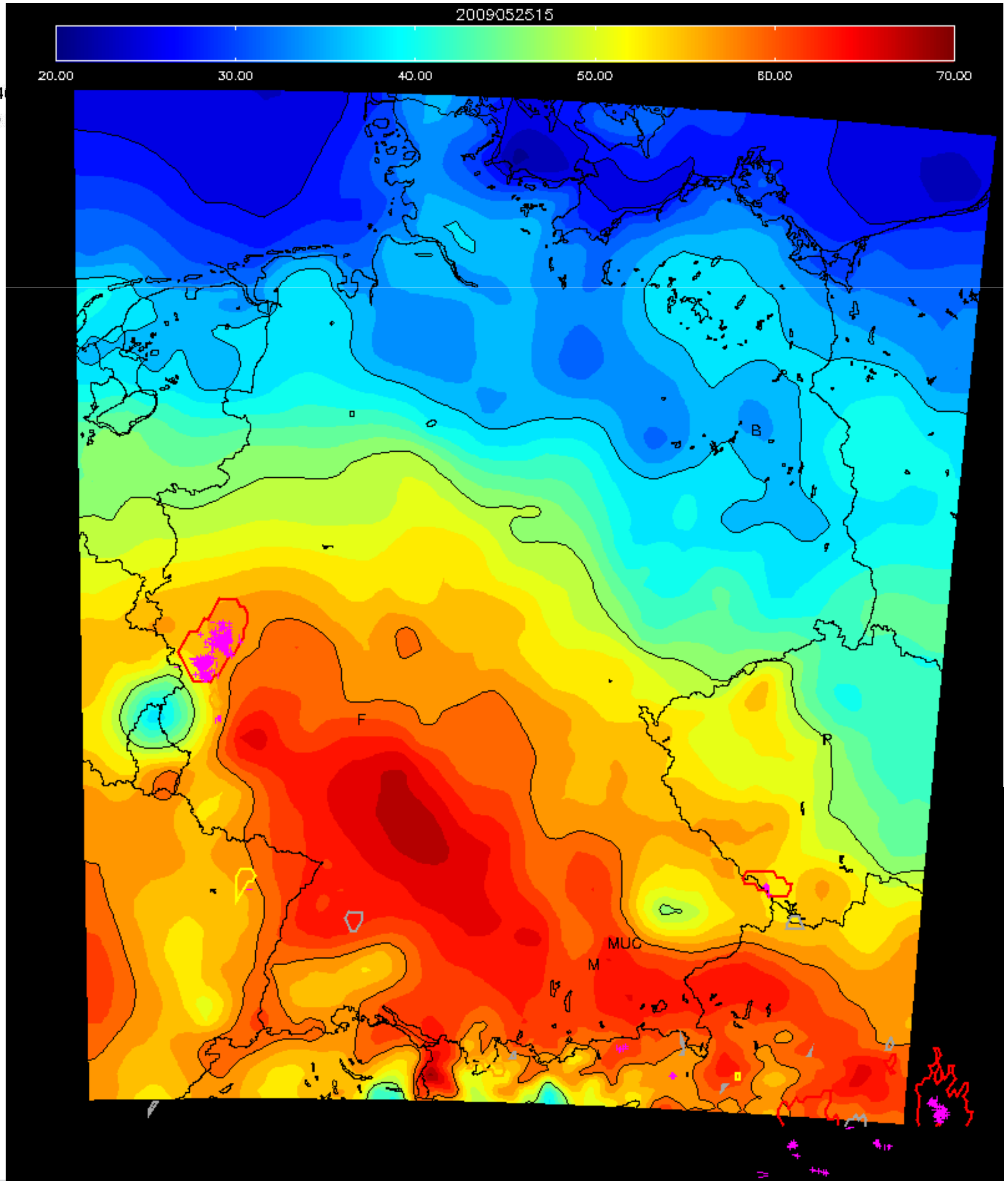
Äquivalentpotentielle Temperatur (Farbflächen), Einheit: °C [2], Beobachtungen: 338, Symbol: Diamant, Min: 25.81, Max: 69.46, μ: 49.34, σ^2: 124.65
Reduzierter Bodendruck (Isolinien), Einheit: hPa [1], Beobachtungen: 311, Symbol: +, Min: 1009.09, Max: 1020.75, μ: 1015.87, σ^2: 5.84
10 m Wind (Pfeile), Einheit: m/s, Beobachtungen: 345, Symbol: o, Min: 0.03, Max: 11.57, μ: 2.39, σ^2: 2.53 → (10 m/s)



Erstellt am Montag, den 04. April 2011 um 09:42:35 UTC mit VERAflex 1.7. © 1995-2011 Institut für Meteorologie und Geophysik, Universität Wien

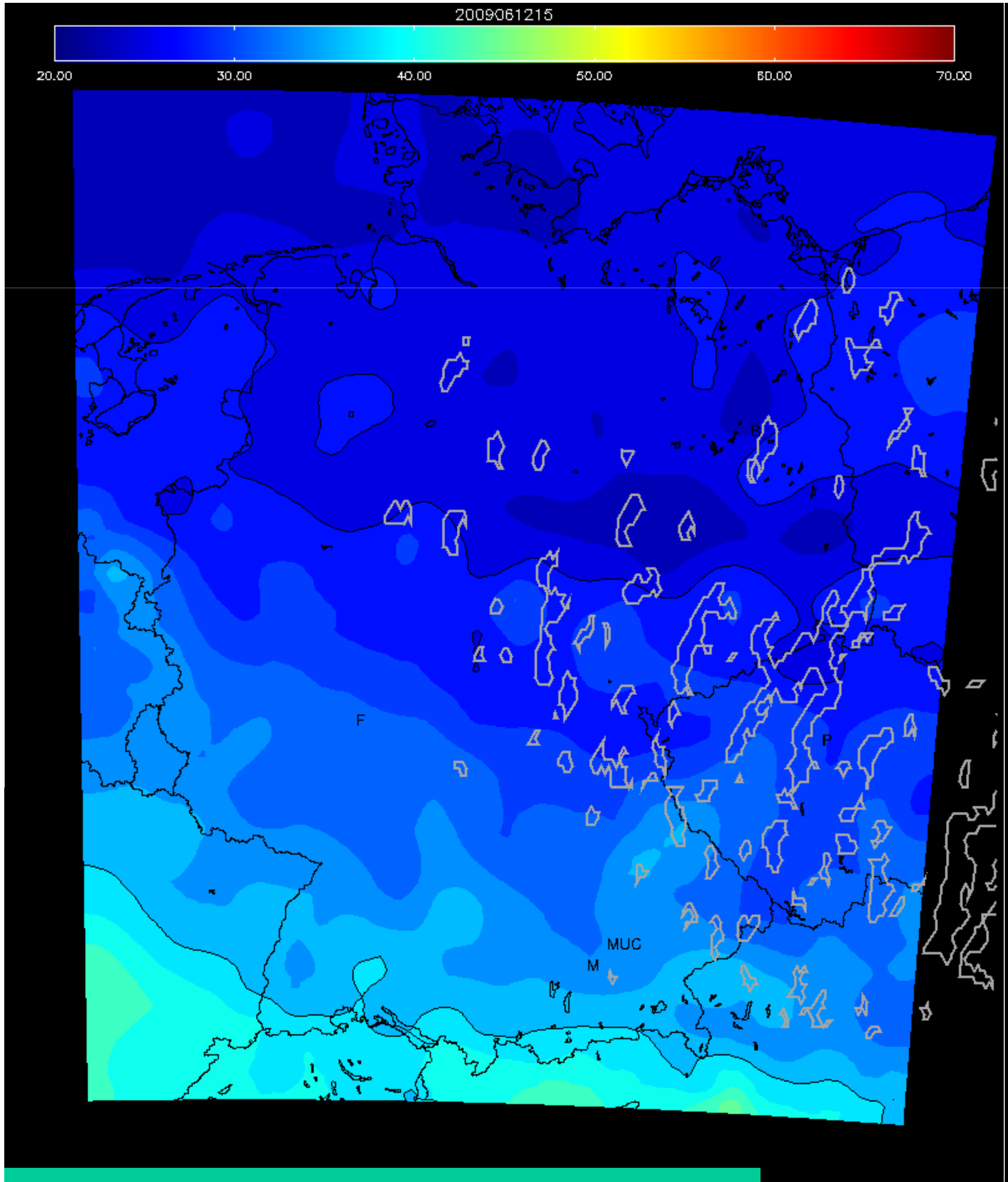
V ienna E nhanced R esolution A nalysis



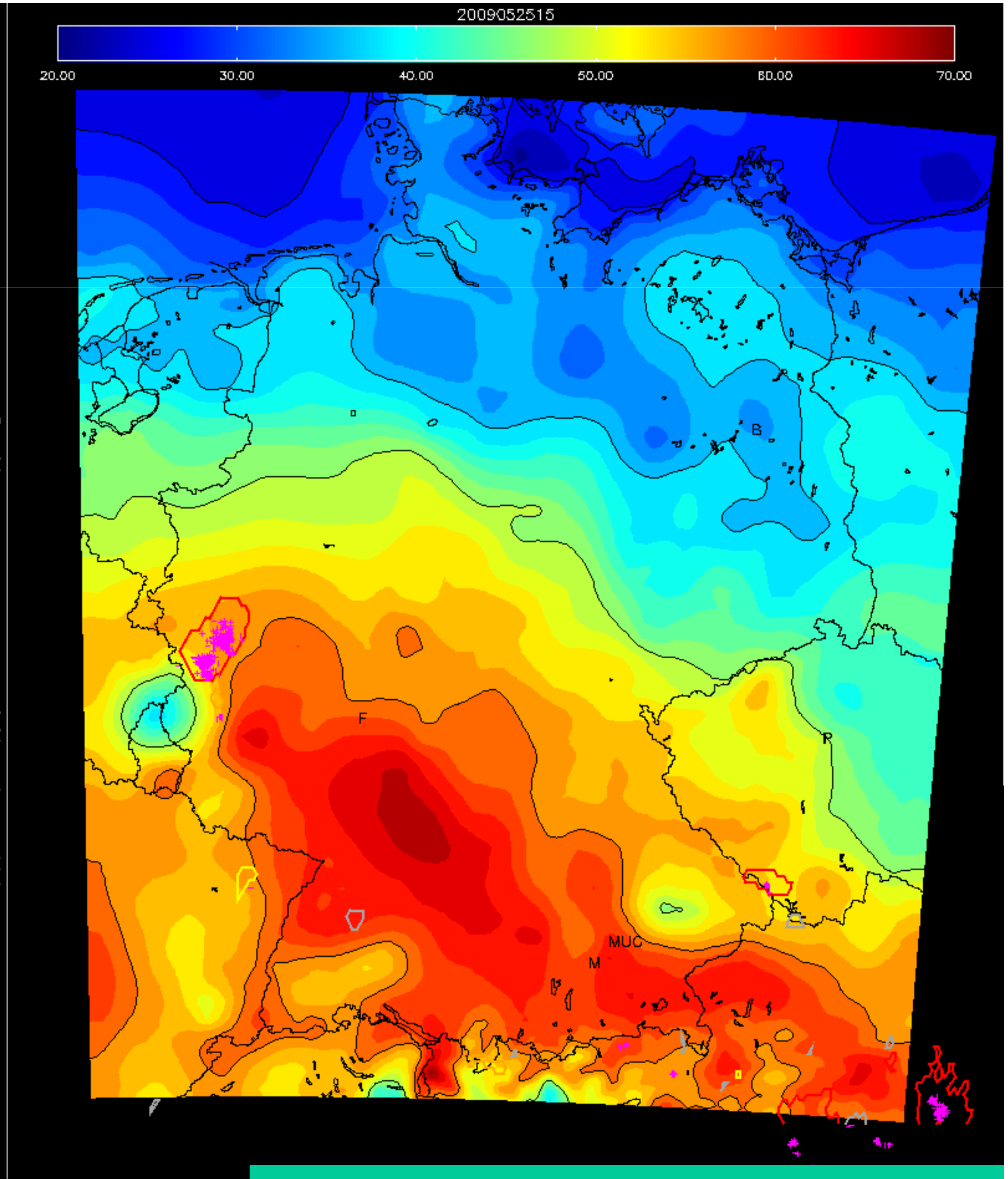


EPOT May 25 2009 15 UTC

V ienna E nhanced R esolution A nalysis



EPOT June 12 2009 15 UTC



EPOT May 25 2009 15 UTC

Additional data sources

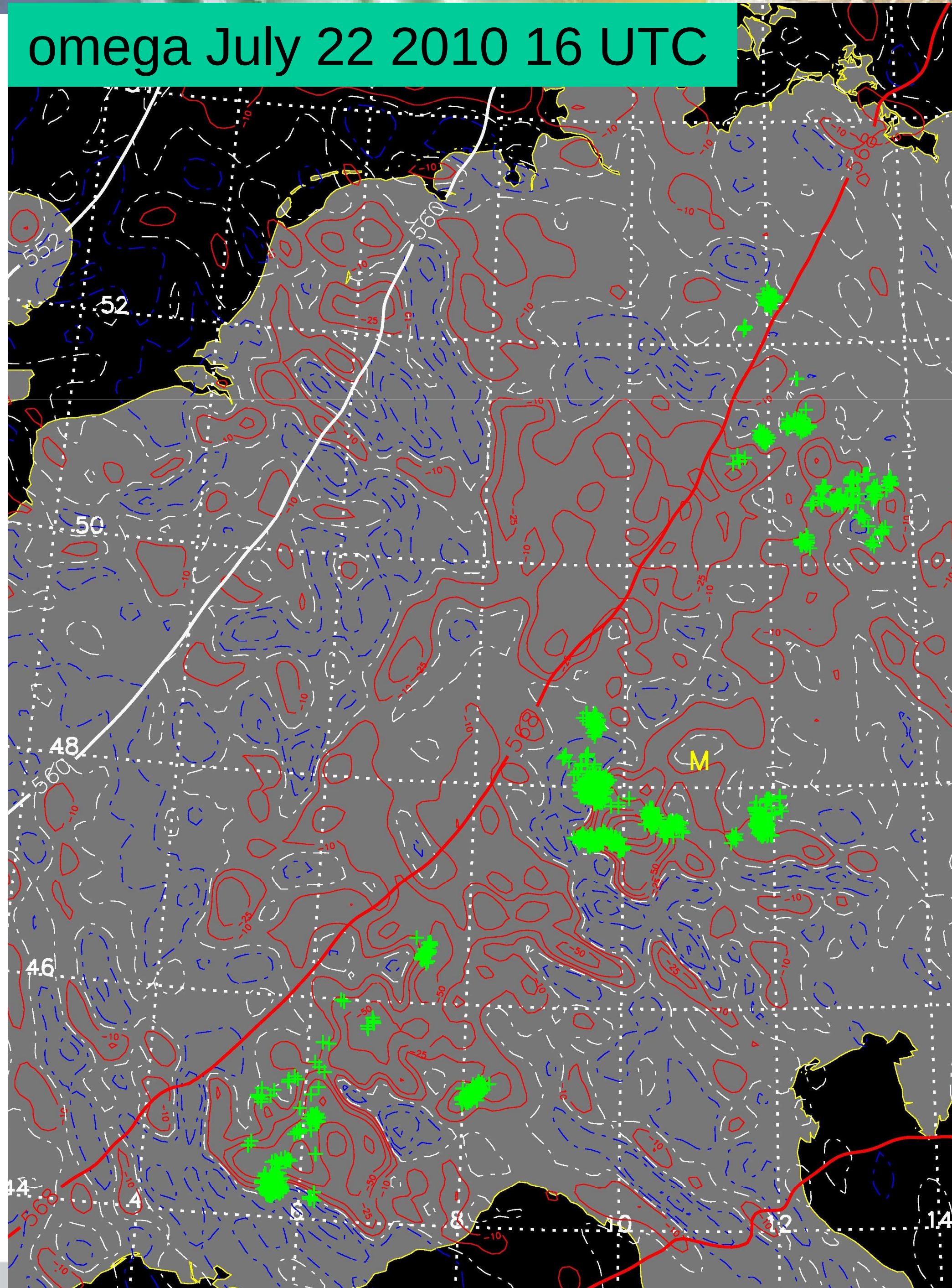
Testing the additional information provided by:

- more satellite channels
- VERA data (e.g. MFC/MFD, equivalent potential temperature)
- COSMO-EU data (e.g. updraft, an instability measure)
- COSMO-DE data (e.g. thunderstorm probability)

COSMO-EU

Updrafts in vertical velocity of COSMO-EU and LINET lightning detections often correlated

(Figure courtesy of M. Köhler, DLR)



Correlation between COSMO-EU updrafts and favoured thunderstorm areas already before lightning initiation?

→ ongoing work!

Additional data sources

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- COSMO-EU data (e.g. updraft, an instability measure)
- COSMO-DE data (e.g. thunderstorm probability)

Data fusion (e.g. fuzzy logic)

Verify the abilities for the different products and their fusion

Summary

Basic Tool
(Cb-TRAM) ⟷ Verification

Summary

Basic Tool (Cb-TRAM) ⟷ Verification

Data Fusion

Summary

Basic Tool (Cb-TRAM) ⟷ Verification

↓ Data Fusion

Cb-TRAM + Additional data ⟷ Verification

Summary

Basic Tool
(Cb-TRAM) ⟷ Verification

↓ Data Fusion

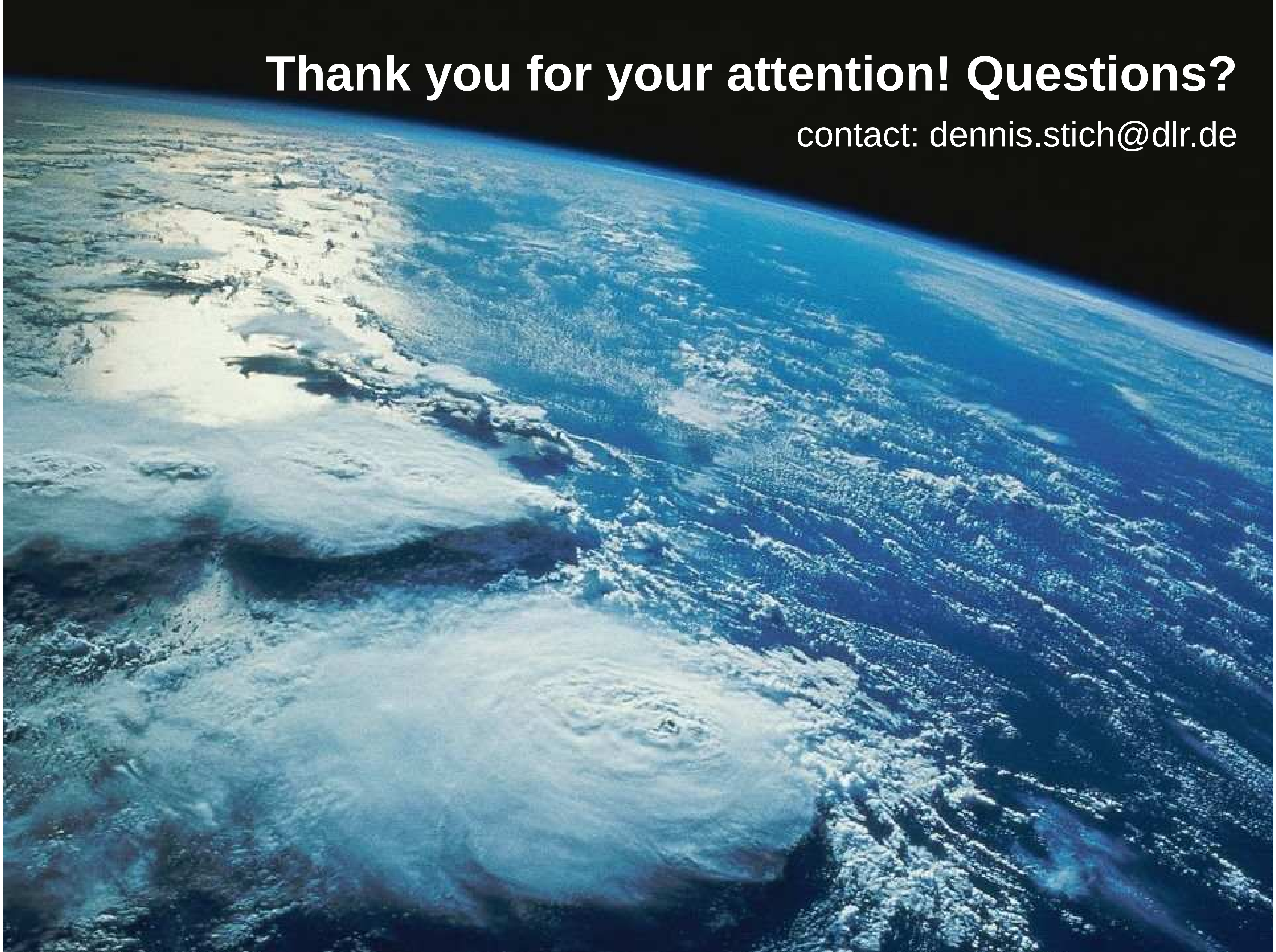
Cb-TRAM +
Additional data ⟷ Verification

↓

CI-NOW – a CI detection and nowcasting tool

Thank you for your attention! Questions?

contact: dennis.stich@dlr.de



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Vienna Enhanced Resolution Analysis

Objective high resolution analysis of meteorological fields based on surface observations

Thin plate smoothing spline interpolation of surface synop station observations on a 2 D grid

Additional information via so called "fingerprints" (a priori knowledge for areas with complex terrain or sparse data)

Quality control of the data

Output: e.g. u- & v-component of wind, potential temperature, equivalent potential temperature, pressure reduced to MSL, 6hourly accumulated precipitation, moisture flux convergence

More information and references on http://www.univie.ac.at/amk/vera/