

Radarové odhady srážek a jejich užití v meteorologii a hydrologii

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Green Bay, WI Homepage through 08:18 AM CDT Tue Aug 12th 2003

GRB

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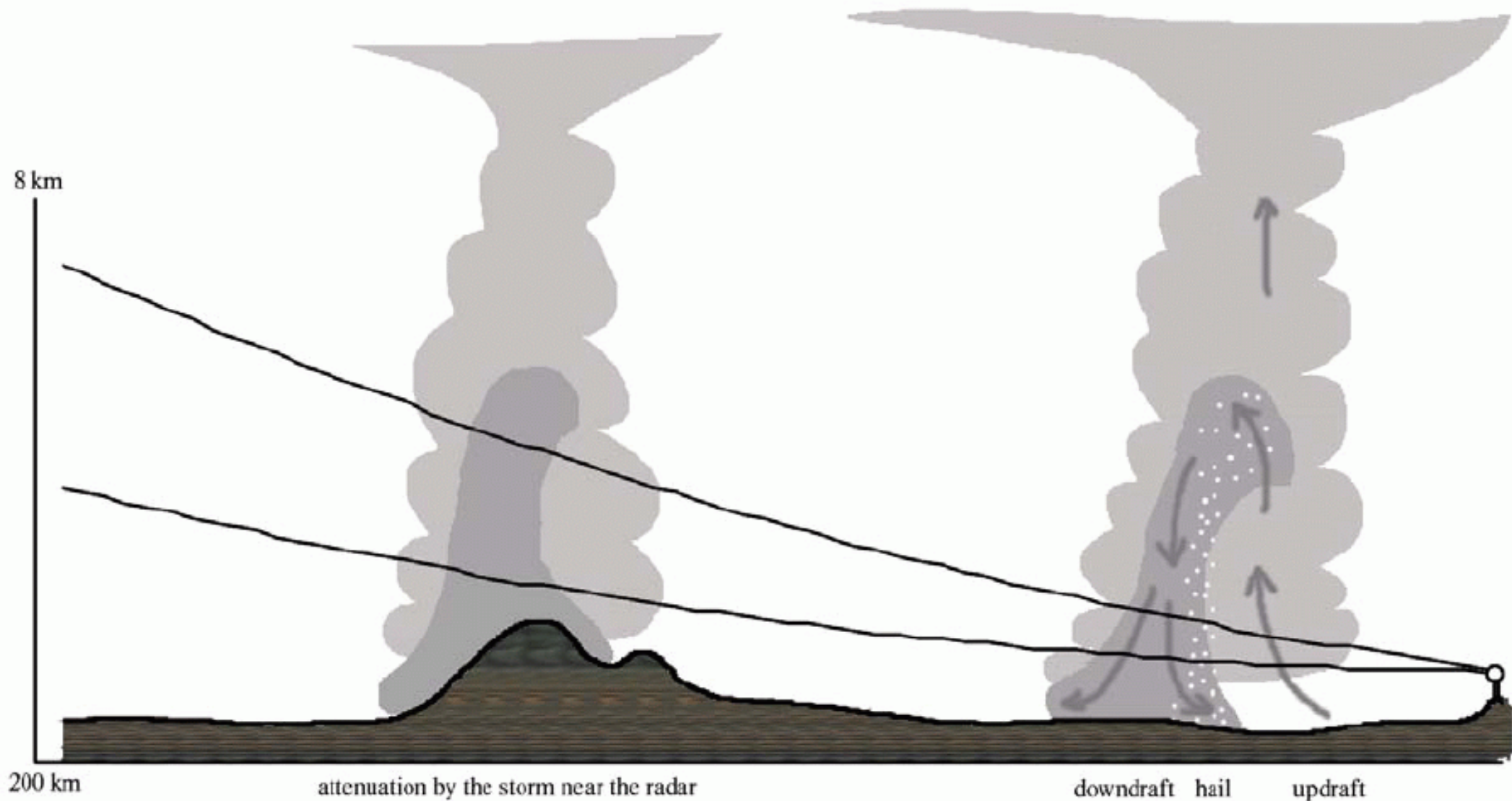
Radar Image from National Weather Service: KGRB 09:47 UTC 08/12/2003

Ashland Ironwood Marquette
Park Falls Iron Mountain Escanaba
Rhinelanders Menominee
Wausau Sturgeon Bay
Marshfield Green Bay
Stevens Point Appleton
Oshkosh
Sheboygan
Portage Beaver Dam
Madison Milwaukee
Janesville Kenosha
South Haven

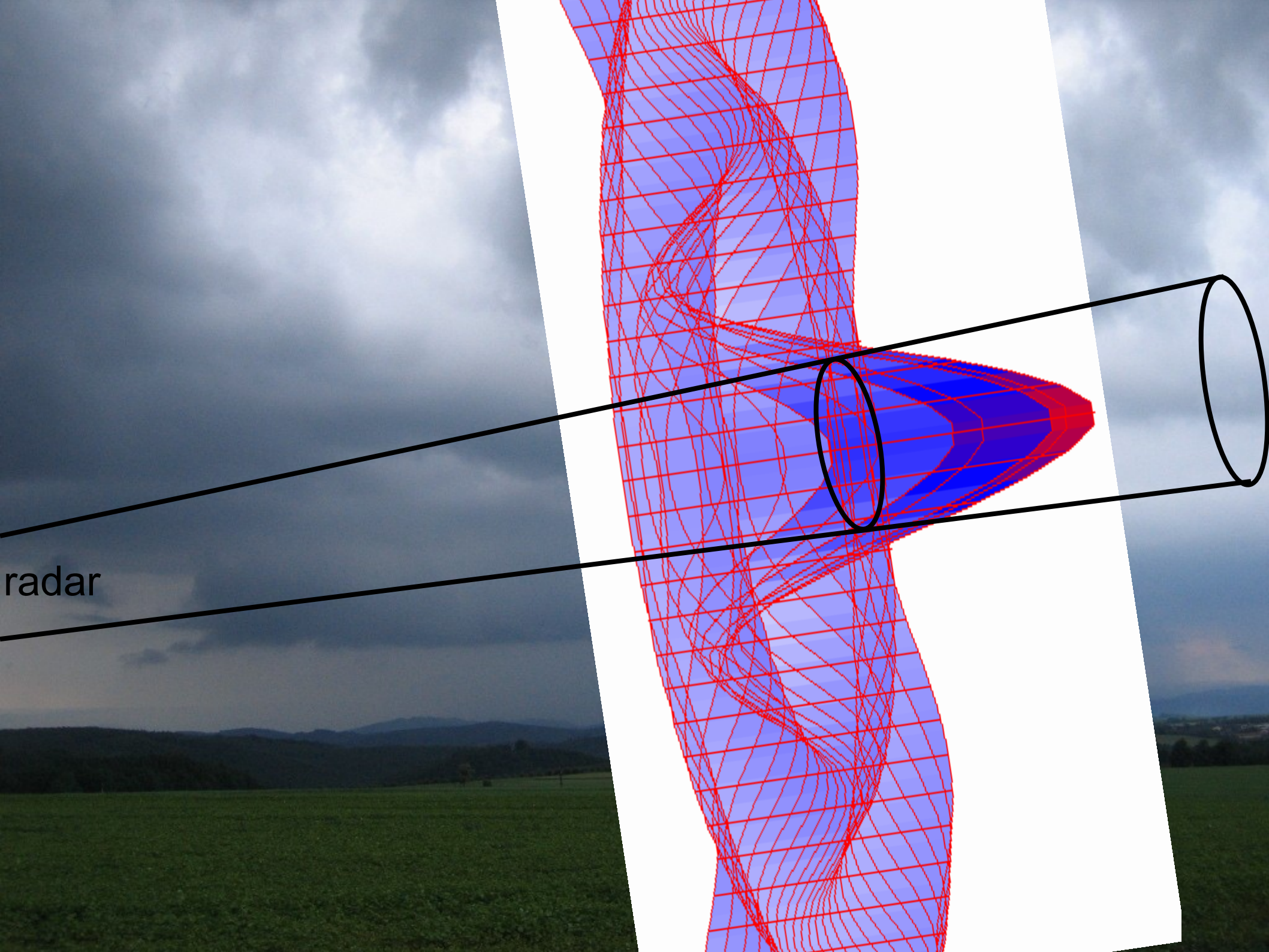
Manistee
Ludington
Muskegon

Radar Image from National Weather Service: KGRB 09:47 UTC 08/12/2003

Chyby radarových odhadů při silné konvekci



radar



Srážkoměry:

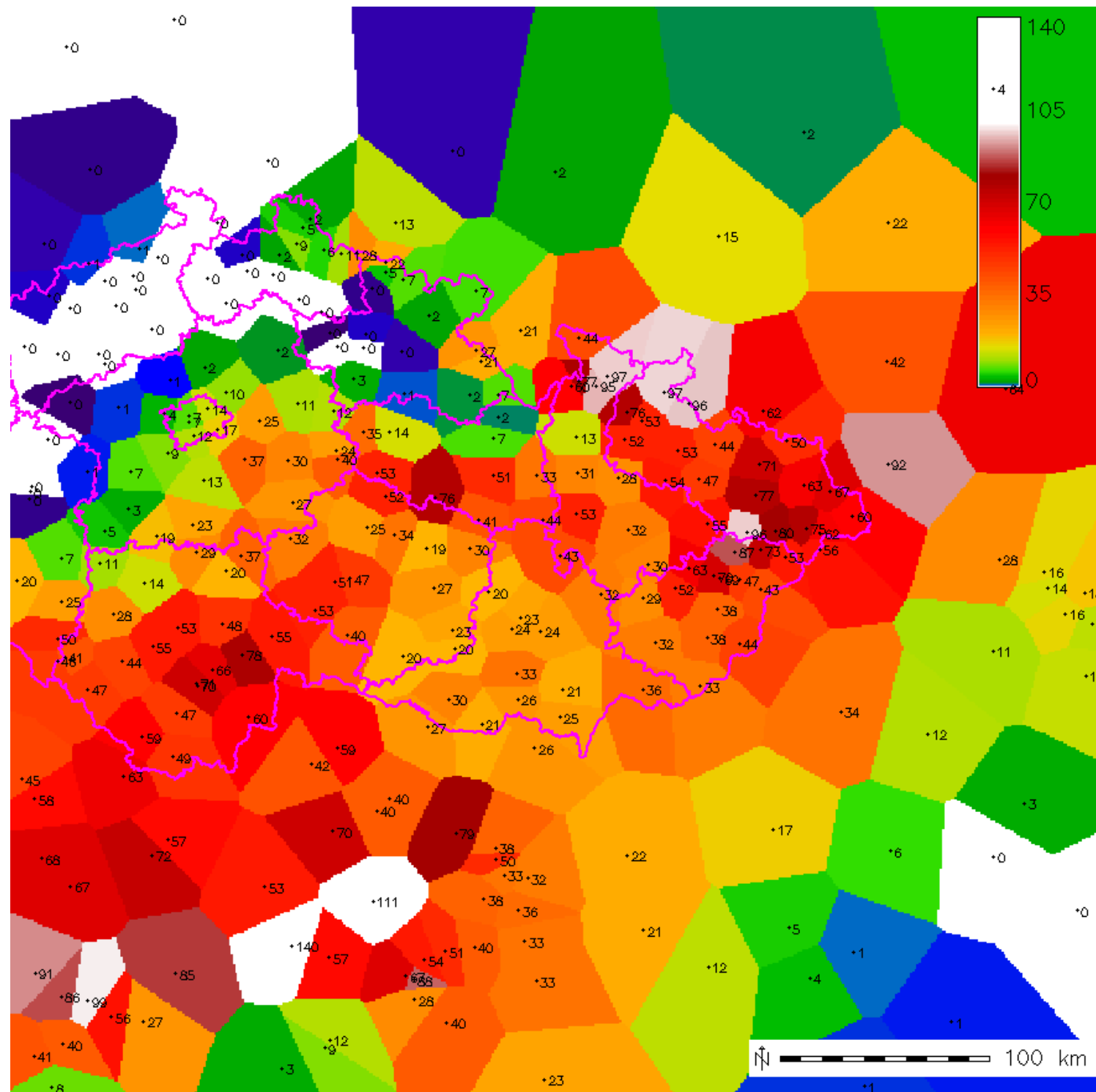
- Výhody: přijatelná přesnost pro dané místo
- Nevýhody: omezení pouze na danou lokalitu, jistá komplikovanost přenosu aktuálních dat.
- Metody odhadu plošných srážek: Thiessenovy (*Hortonovy*) polygony, metoda izohyet, geostatistické metody





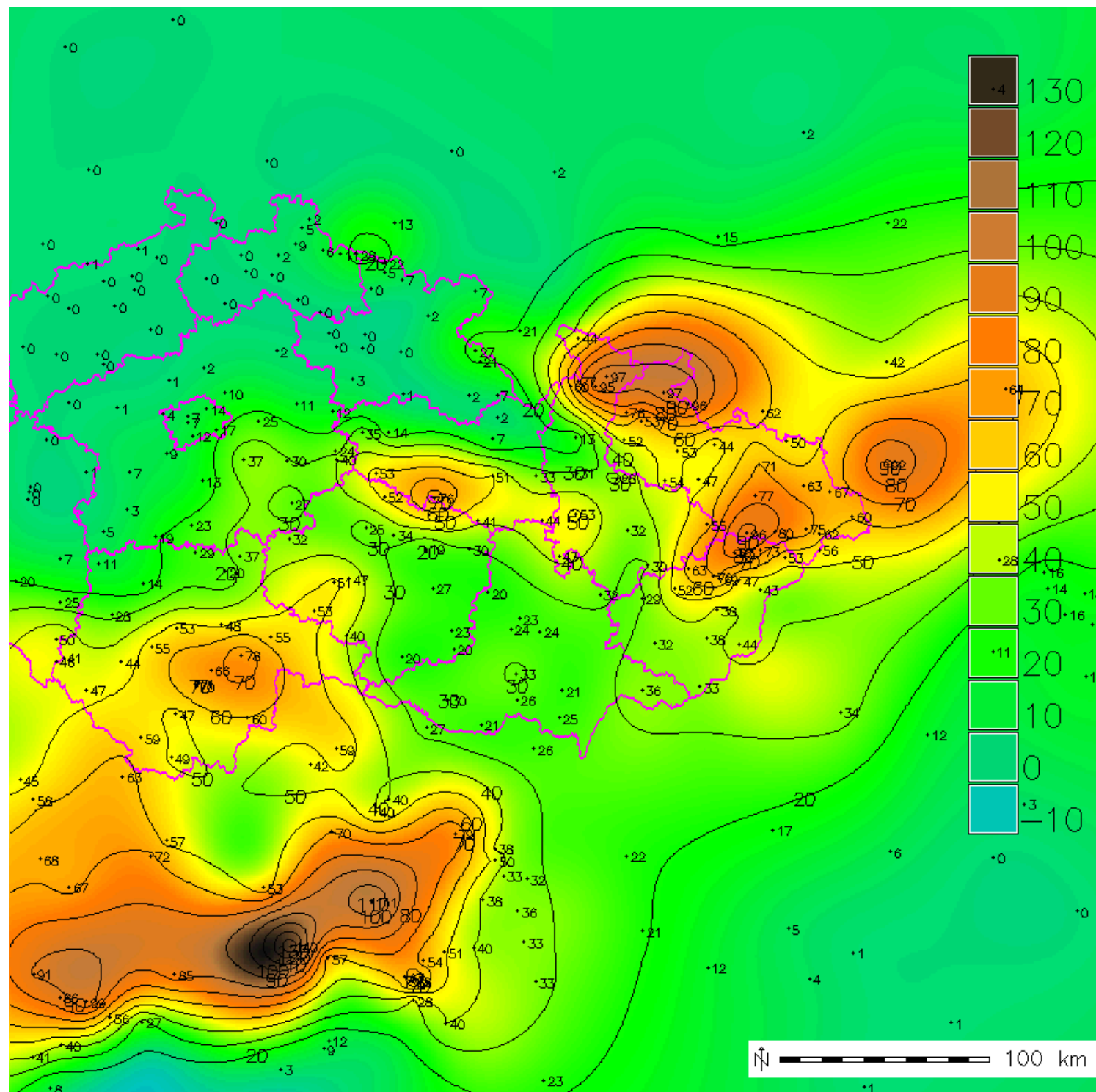
Thiessenovy polygony

GIS GRASS



Regularizovaný
splajn s tenzí
(barva) vs.
obyčejné
krigování
(izolinie)

GIS GRASS



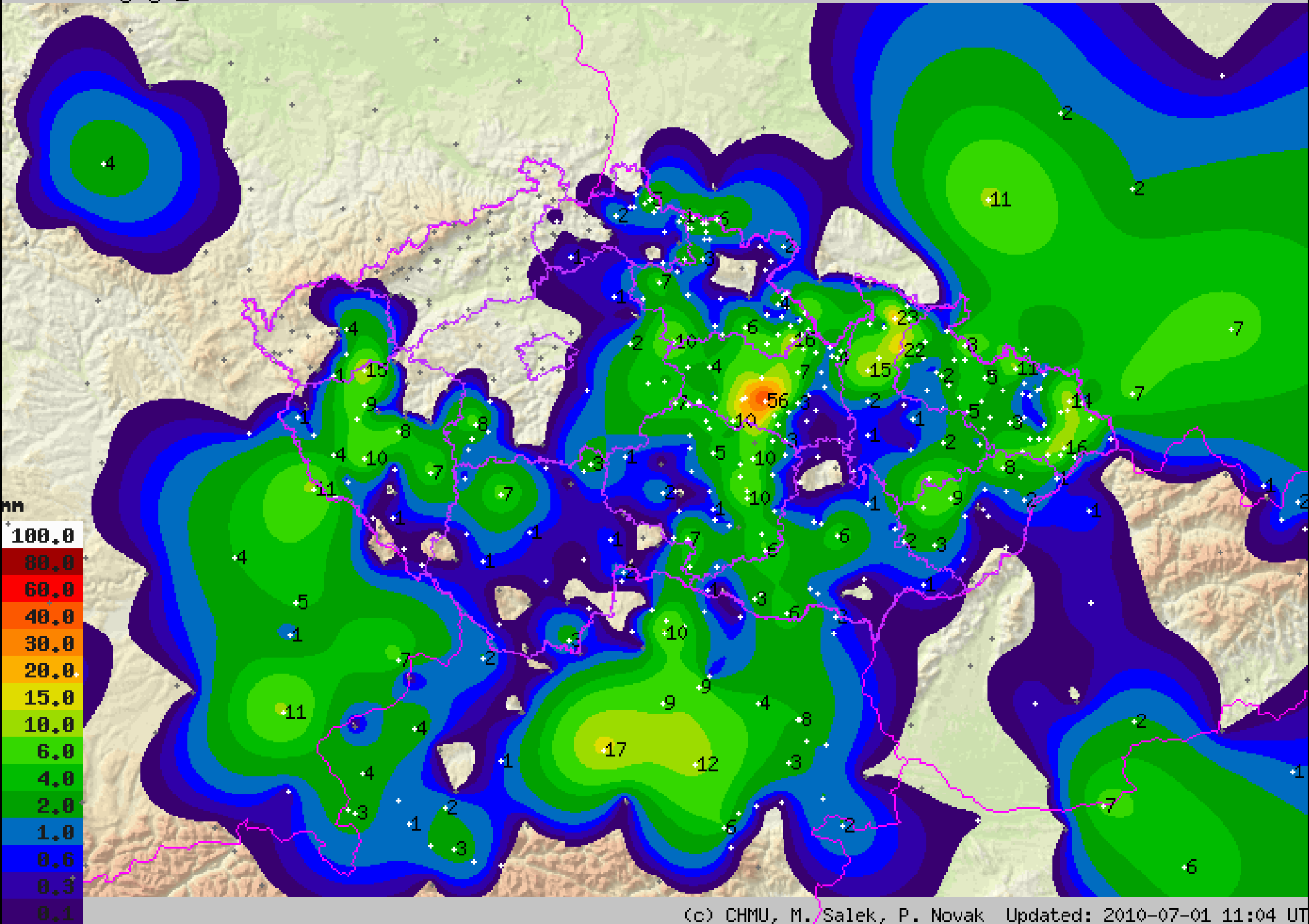
Kombinovaná informace radar-srážkoměr

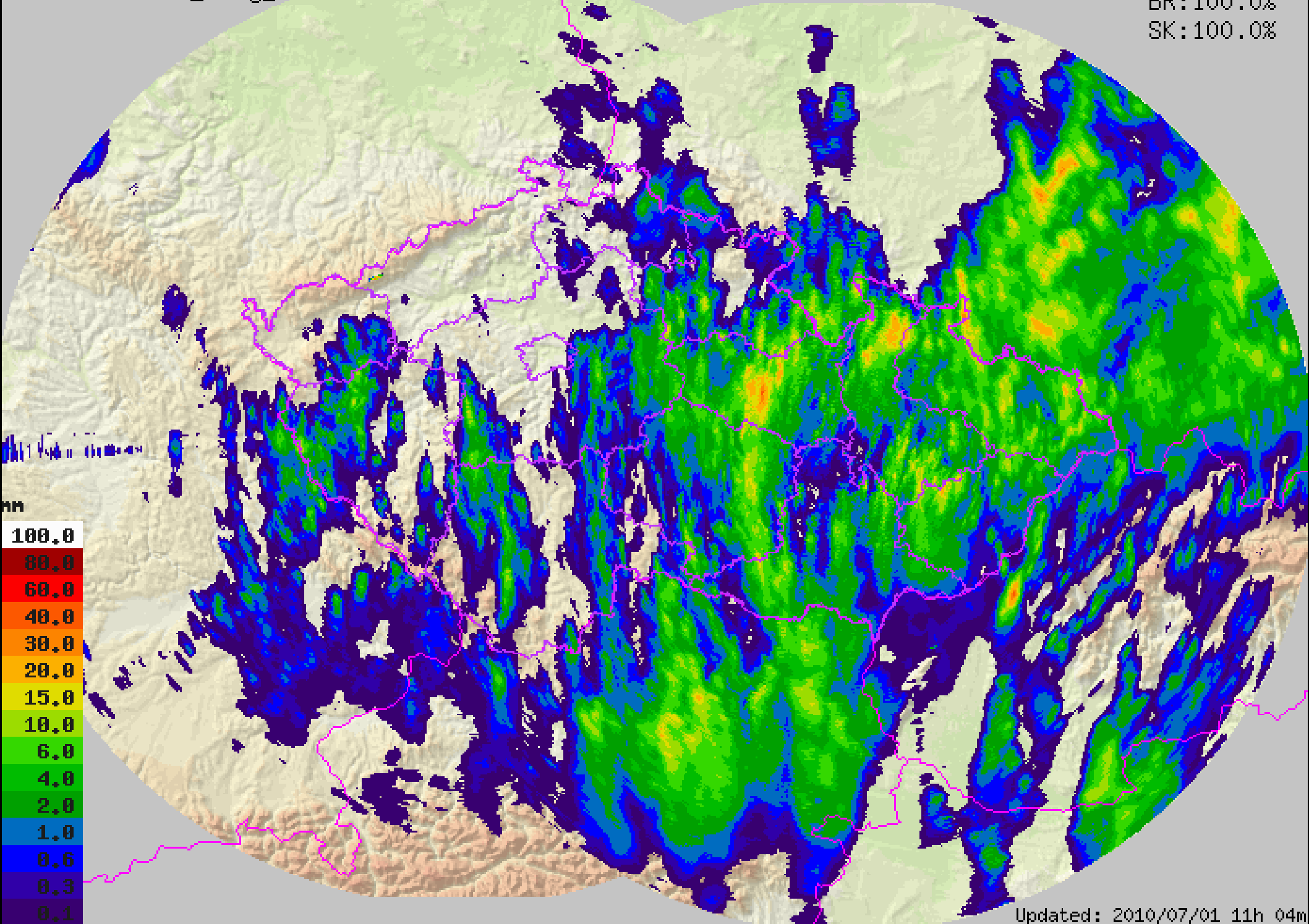
- Kombinace obou typů měření a odhadu srážek za předpokladu minimalizace chyb
- Do roku 2009 byla v ČHMÚ v provozu procedura podle koncepce autora D.-J. Seo
 - Adjustace pomocí jednoho koeficientu pro celou radarovou doménu
 - Kombinace metodou Double optimum estimation

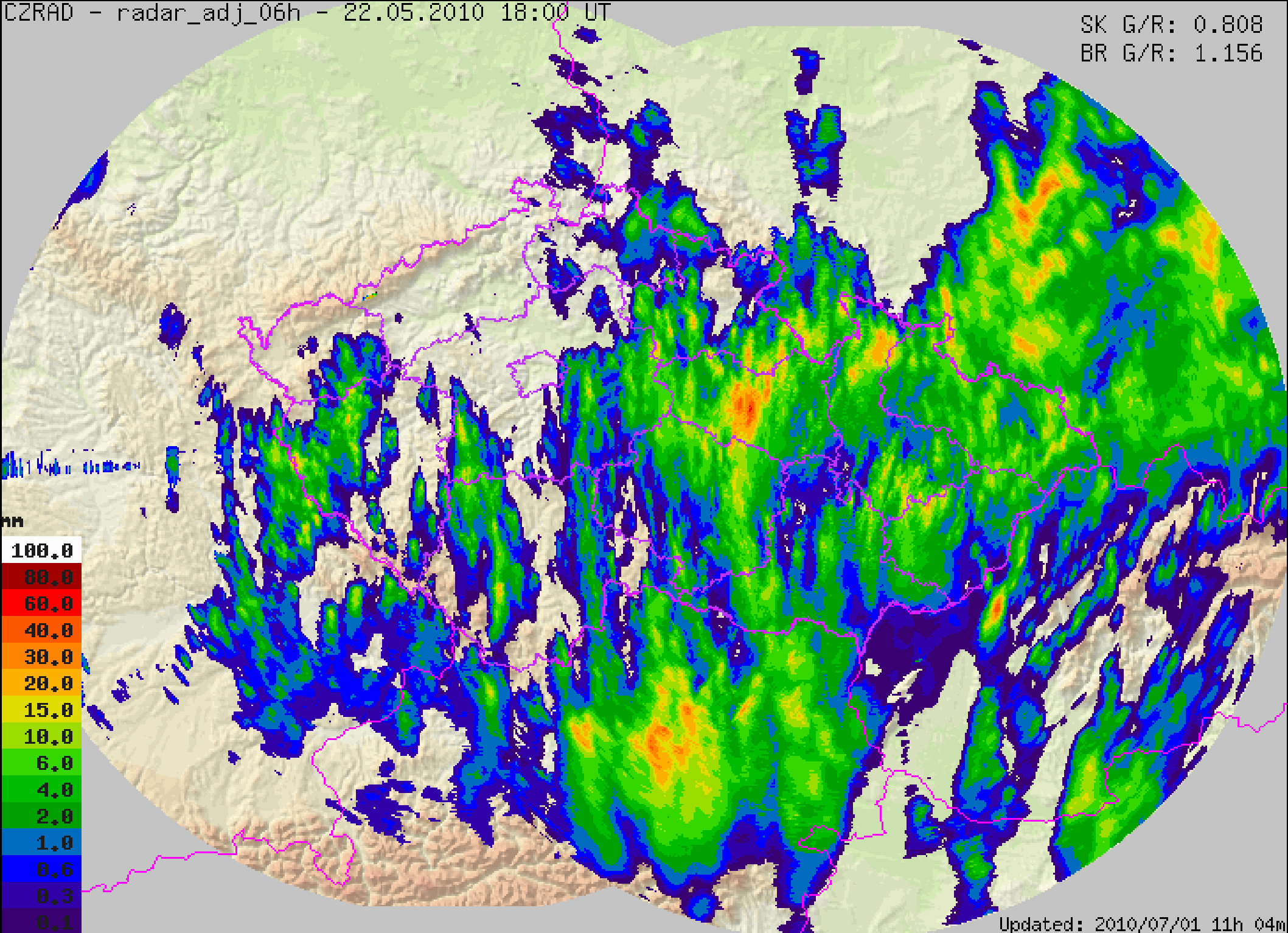


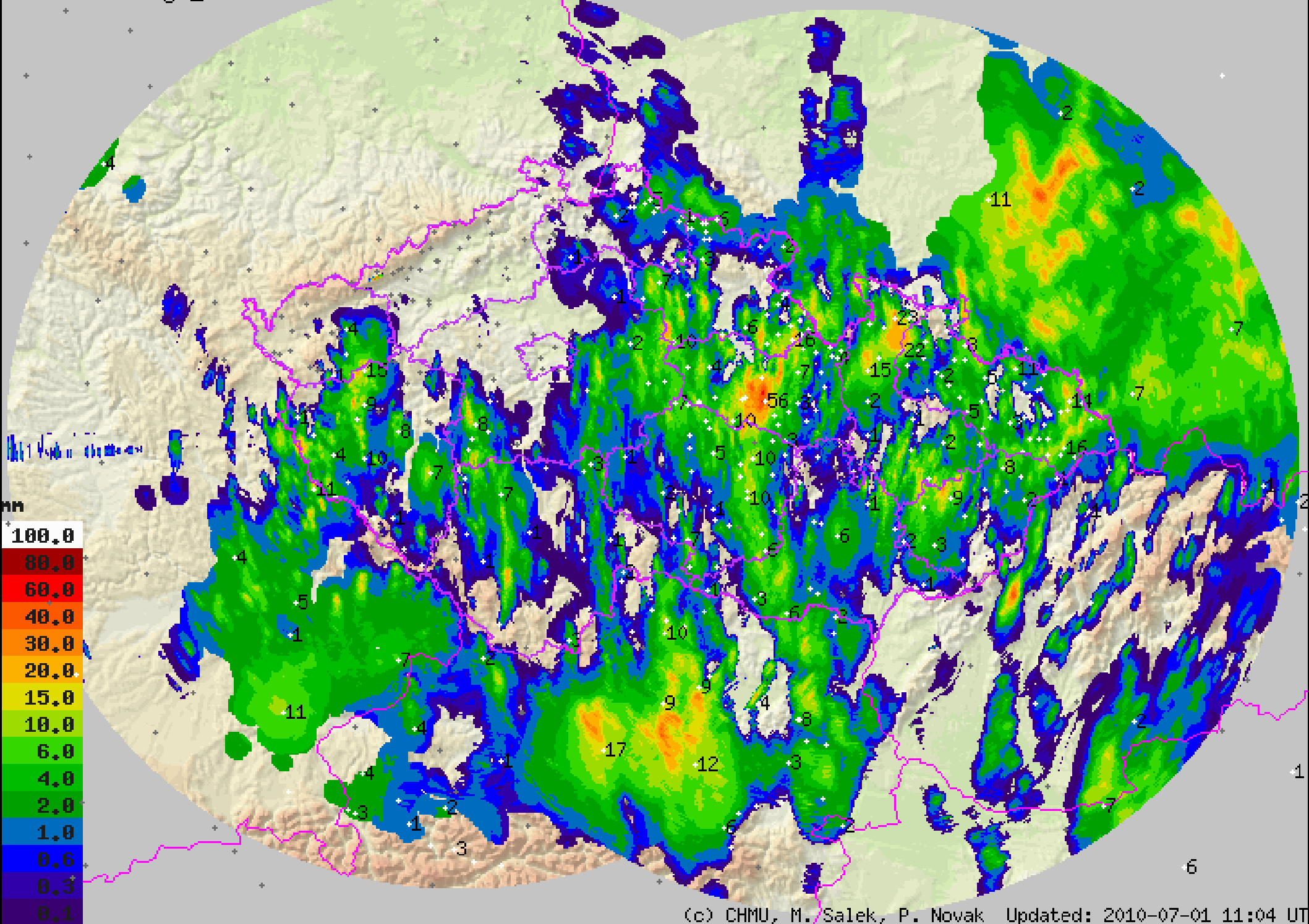
Kombinovaná informace radar-srážkoměr (pokr.)

- Od roku 2009 je v ČHMÚ v provozu nový algoritmus kombinovaného odhadu srážek
 - Adjustace pomocí územně proměnlivého (zhlazeného) adjustačního koeficientu
 - Kombinace metodou regresního krigování
 - (příspěvek na Výročním semináři ve Křtinách)

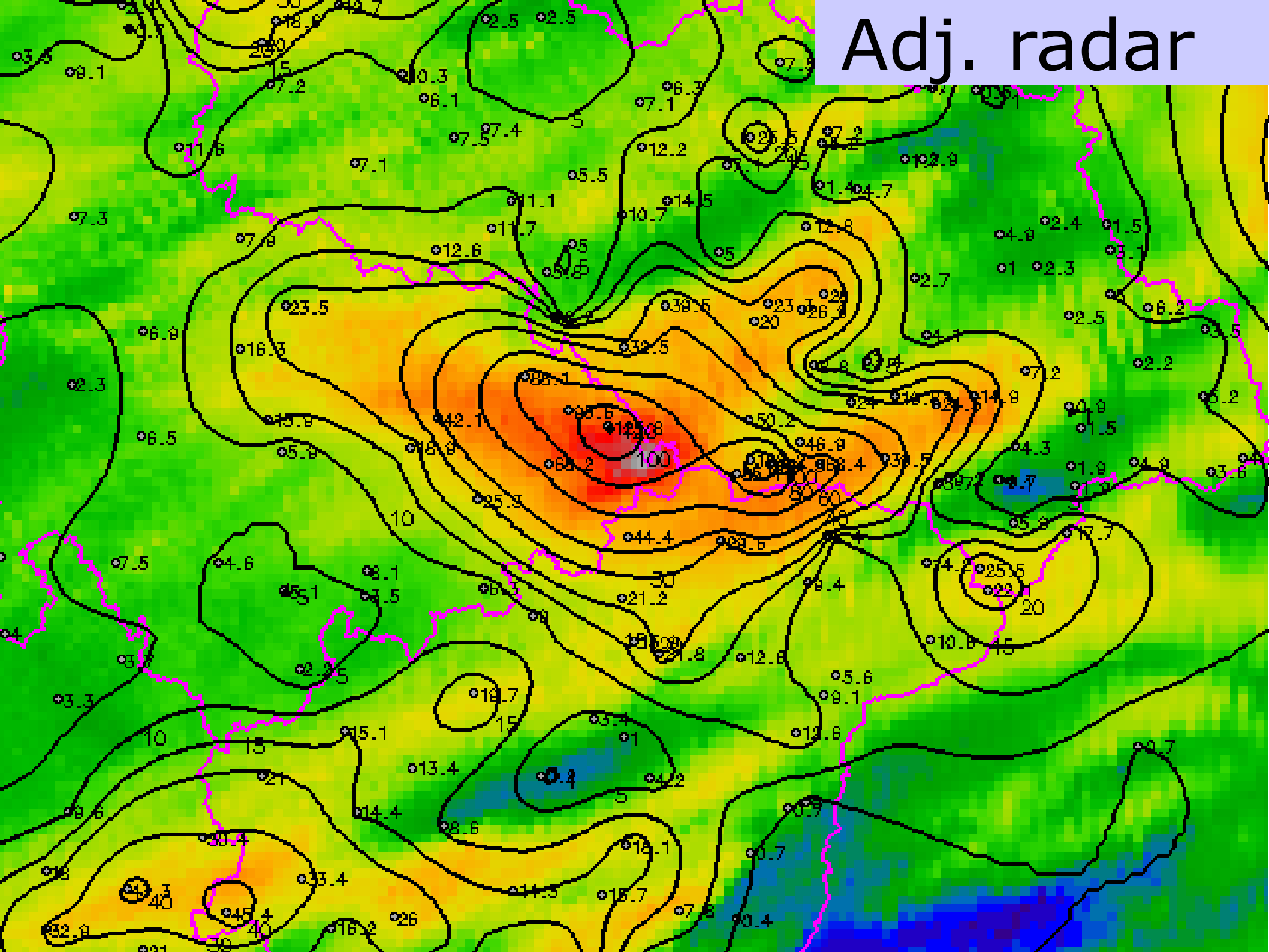




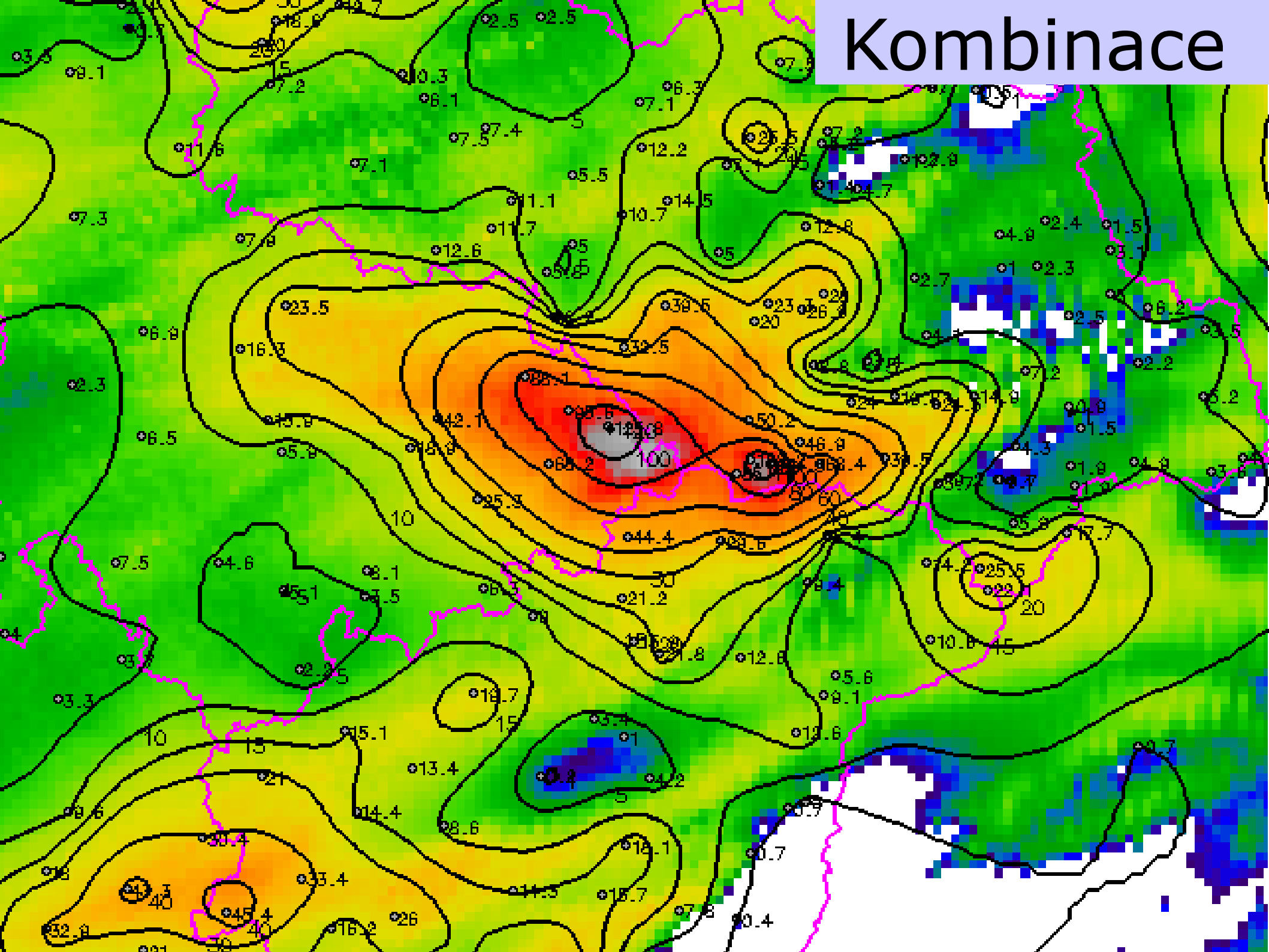


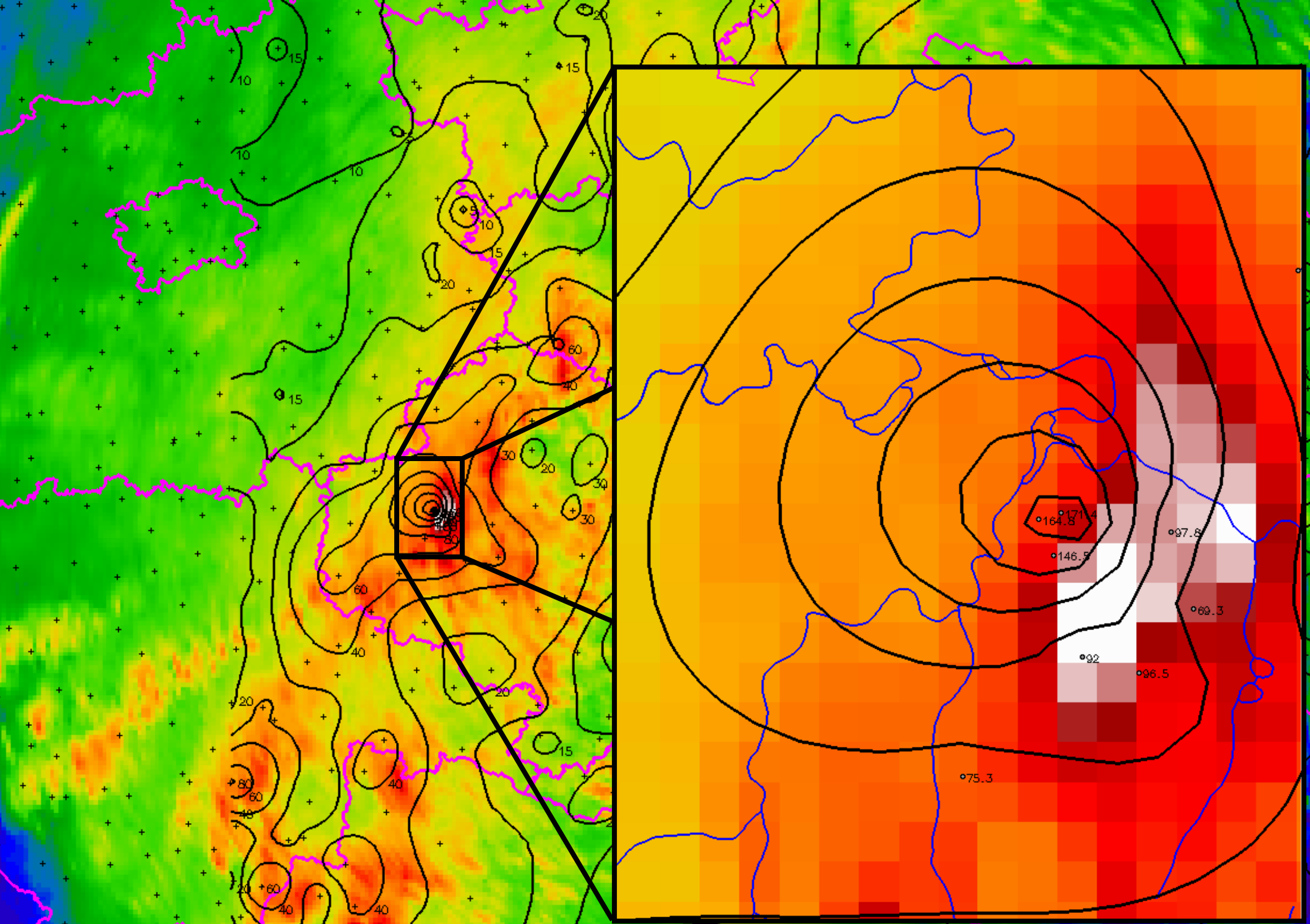


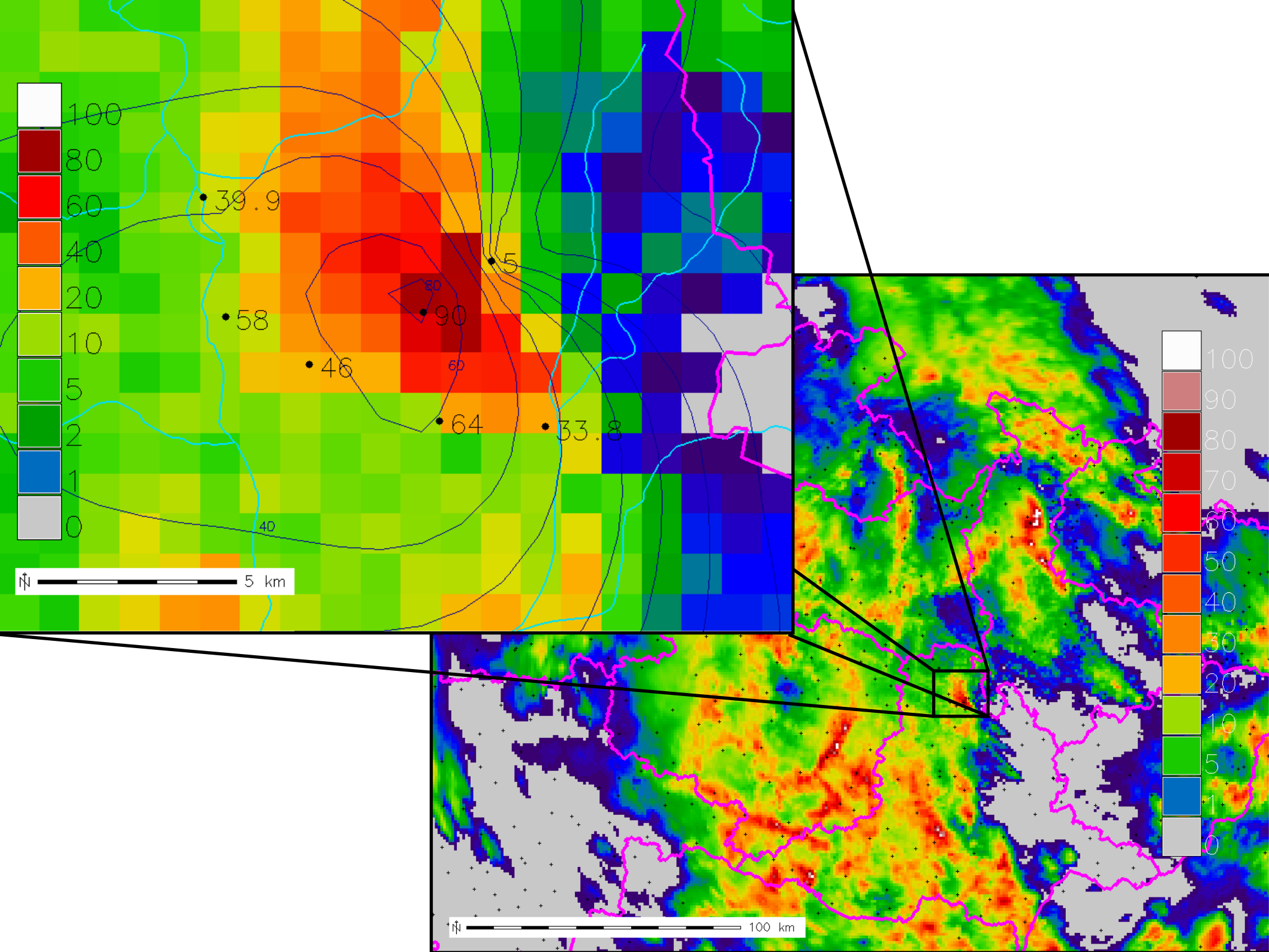
Adj. radar



Kombinace







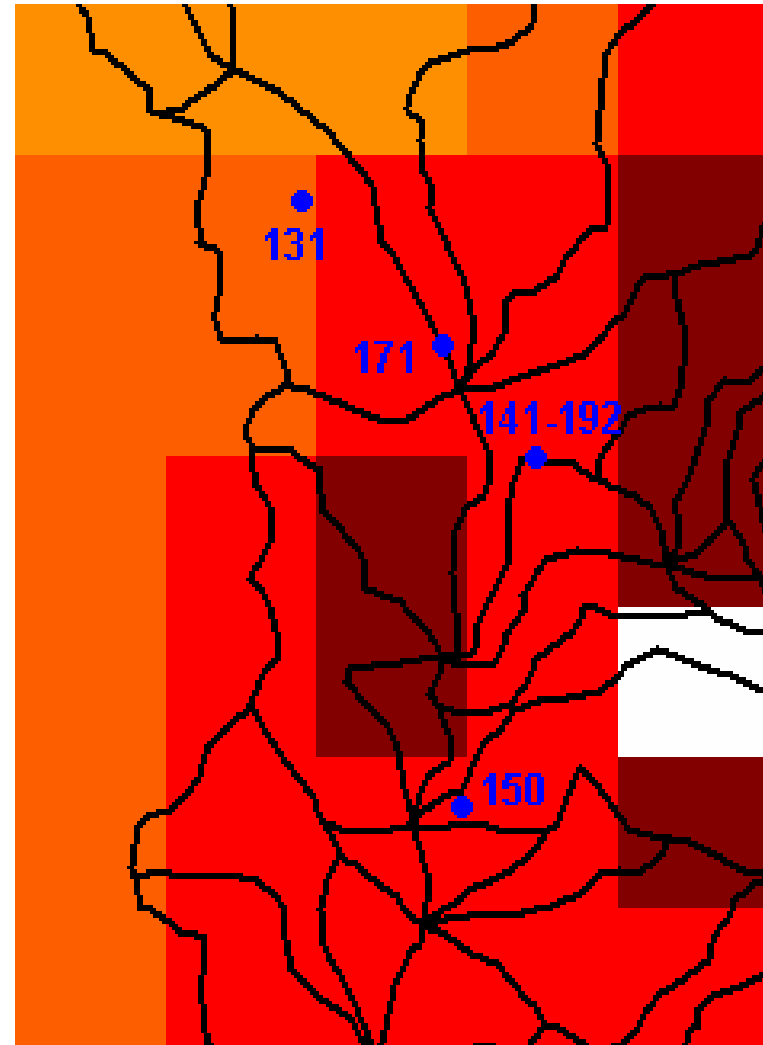
Verifikace odhadů

- Provedena pro denní srážky pro období 19.6.-23.7.2009 (silné srážky, převážně konvektivní)
- Ve výpočtech využity pouze telemetrické srážkoměry
- Pro verifikaci použity manuální srážkoměry (kritériem byla též rozdílność lokality)
- Spočtená střední absolutní chyba a systematická odchylka

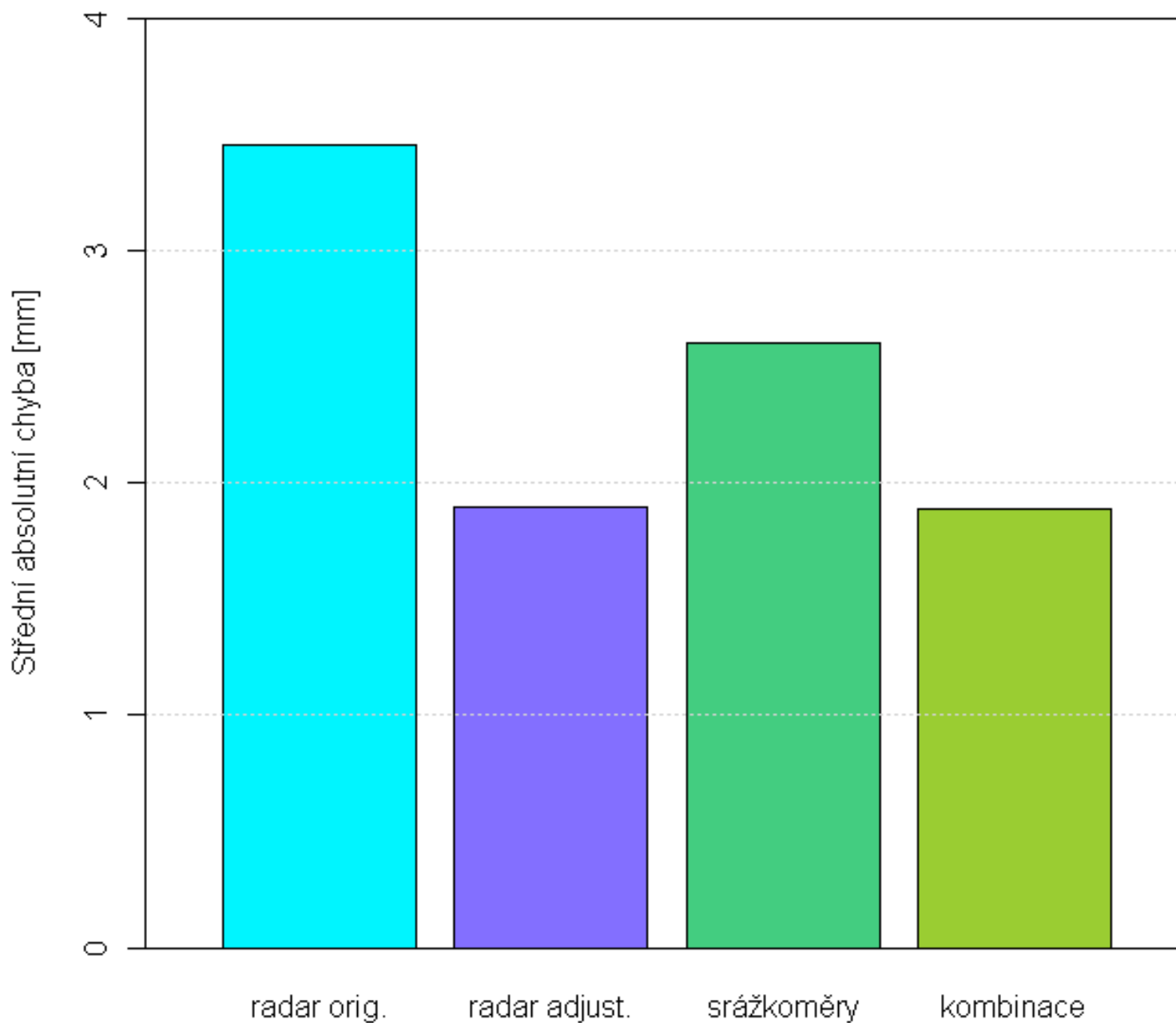


Reprezentativnost stanic

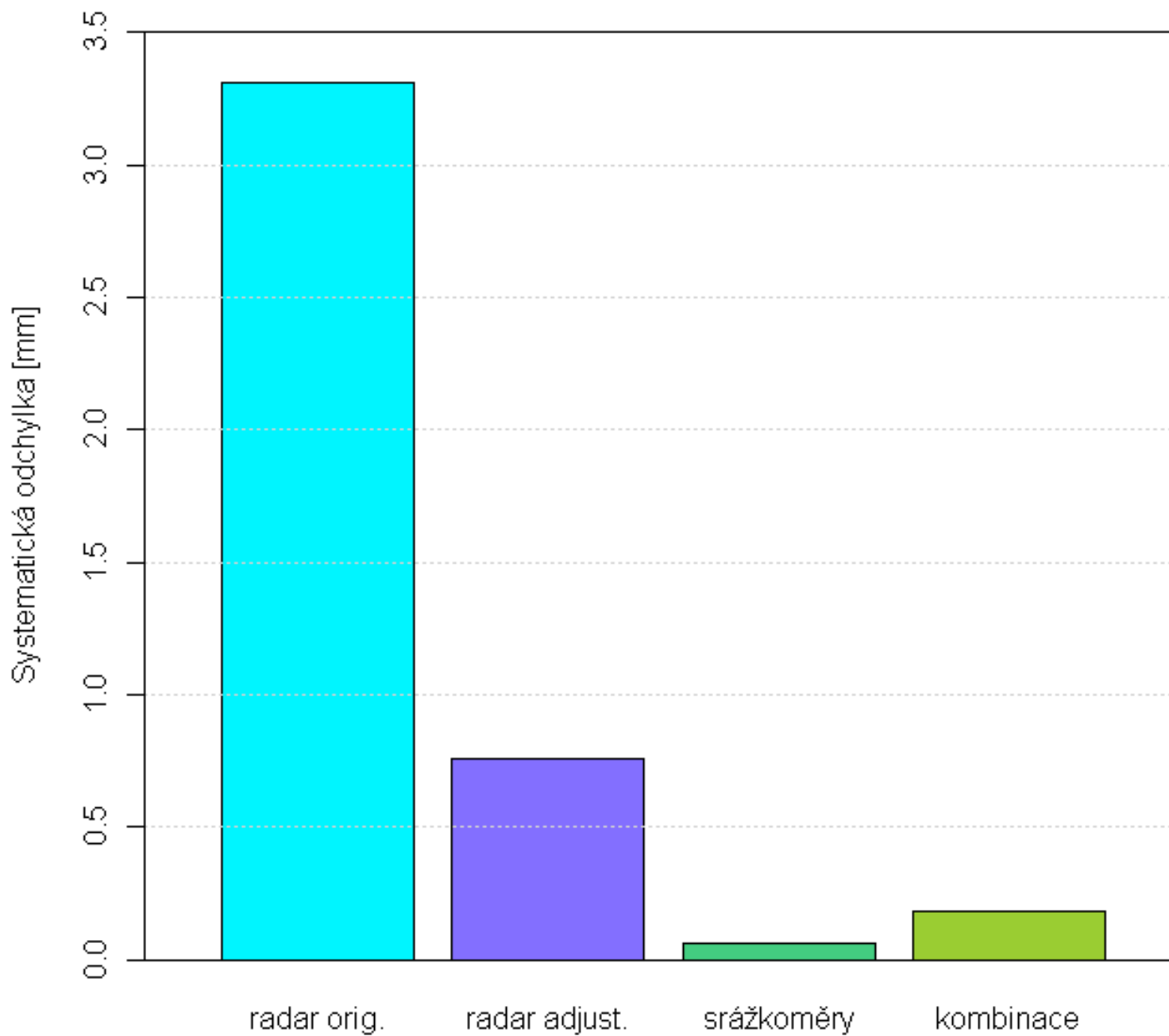
- Přijímán předpoklad reprezentativnosti srážkoměrné stanice pro územní element (pixel) 1 km².
- Možné, ale nepoužité řešení: Na každý pixel rozmístit 8 stanic podle optimálního schématu (Project HYREXn HESS, No 4, 2000)



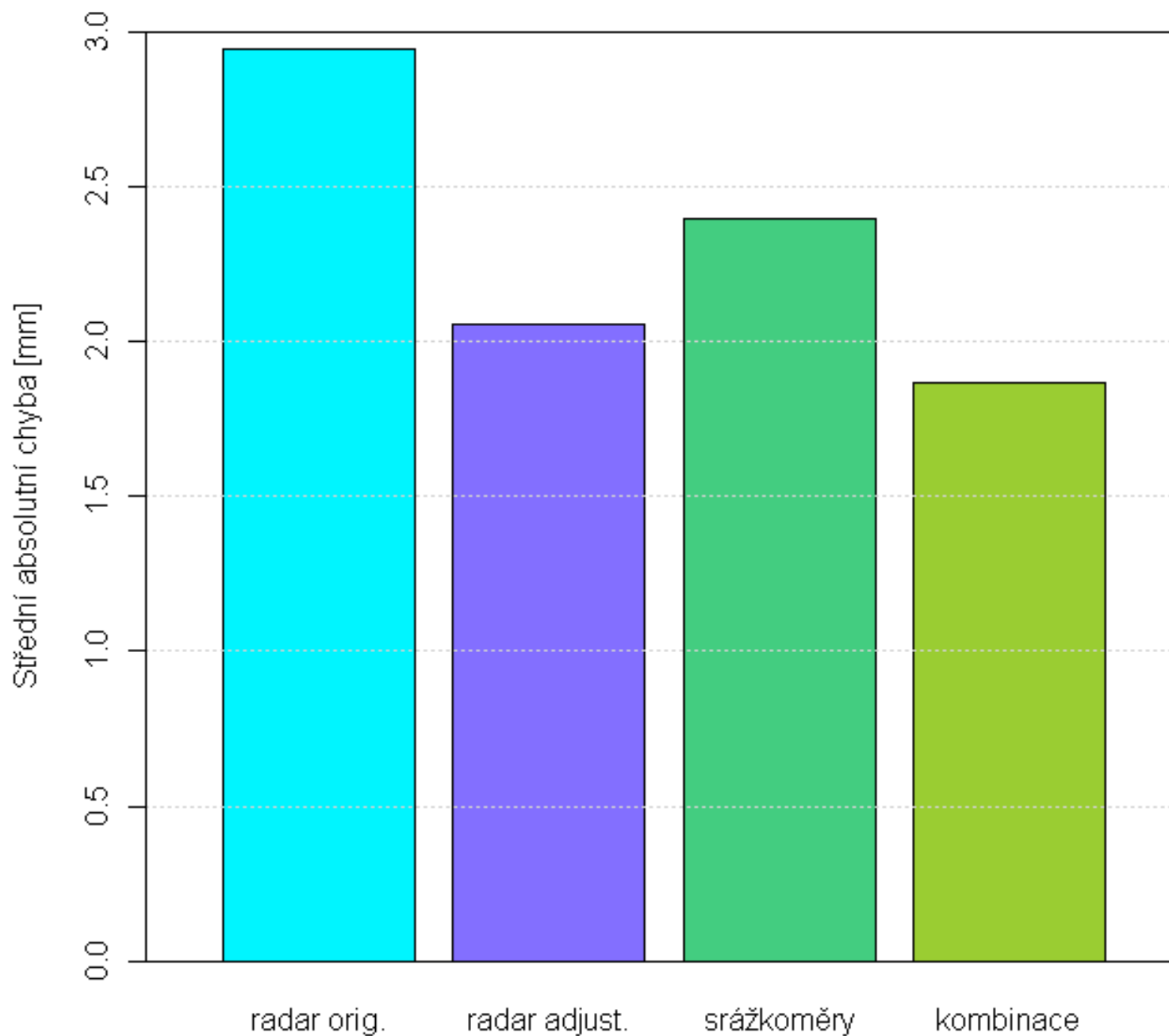
Střední absolutní chyba - radar Brdy



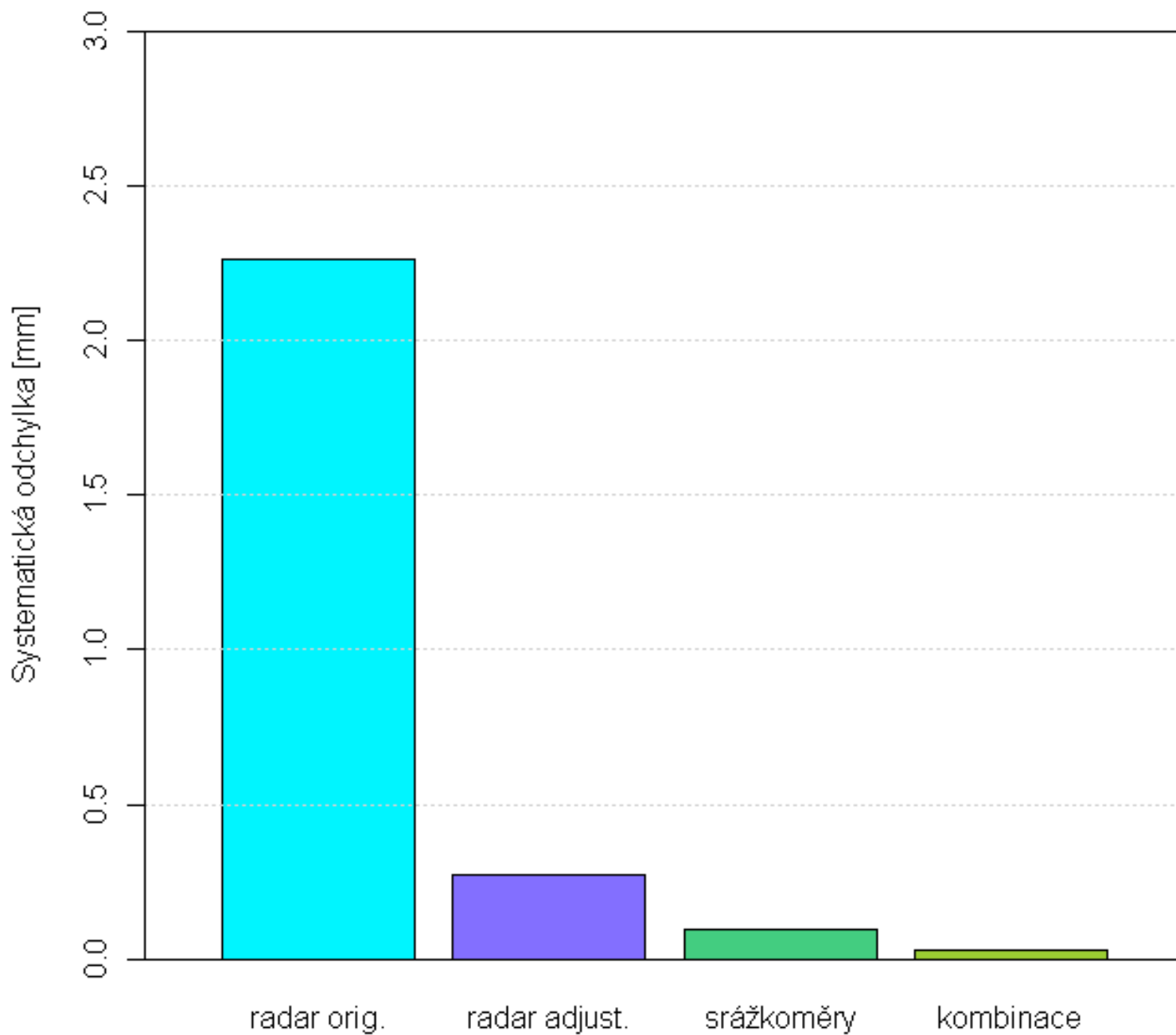
Systematická odchylka - radar Brdy



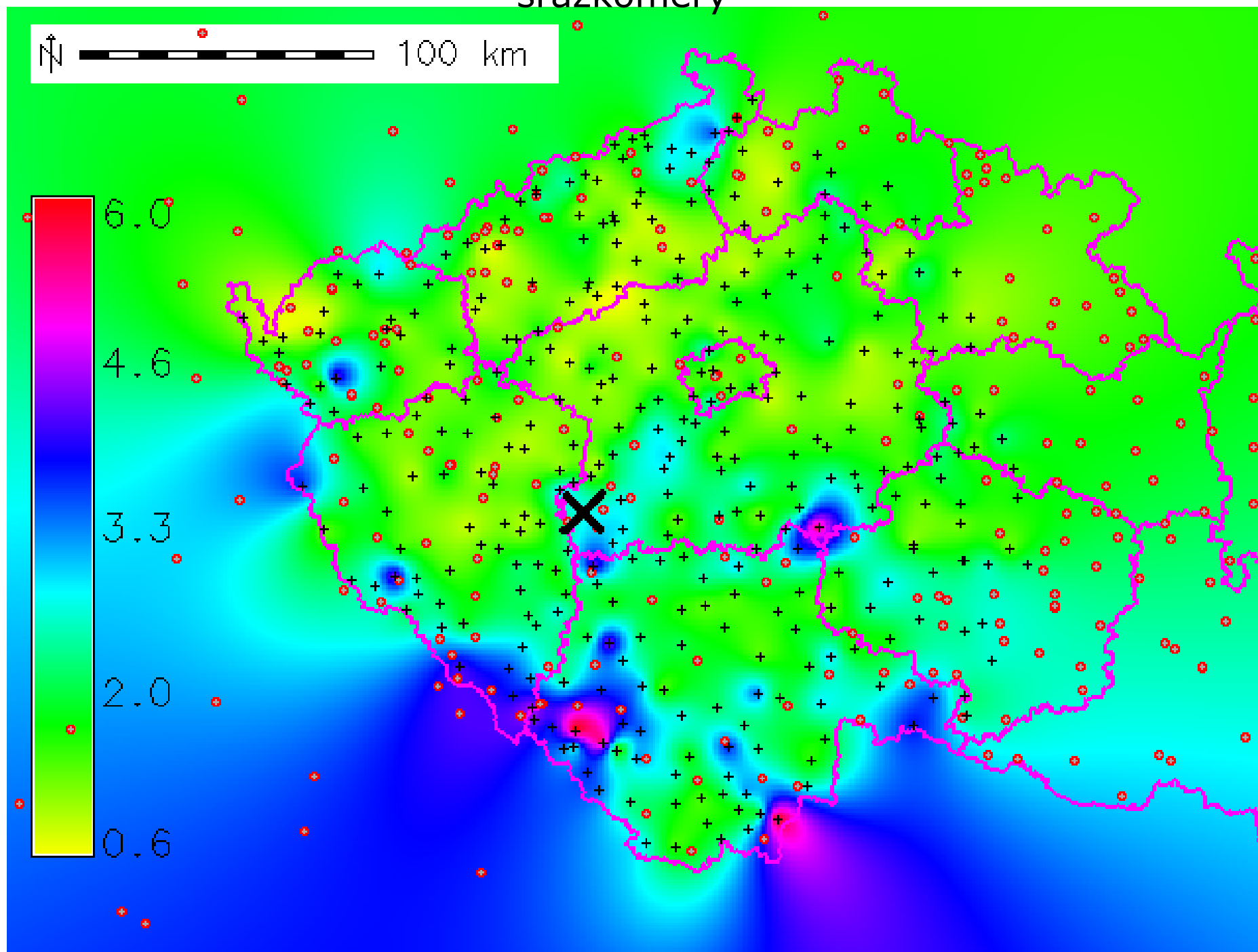
Střední absolutní chyba - radar Skalky



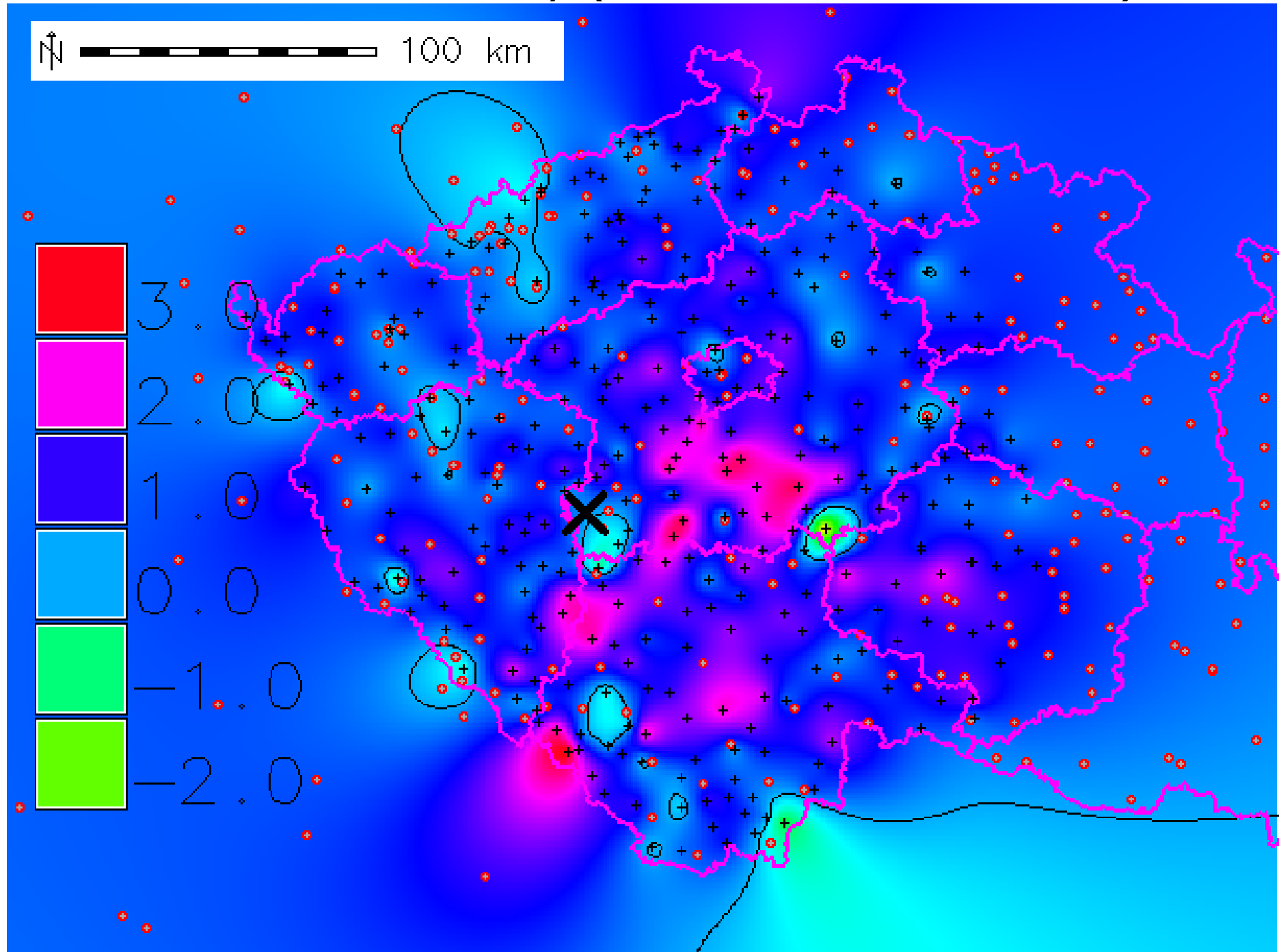
Systematická odchyłka - radar Skalky



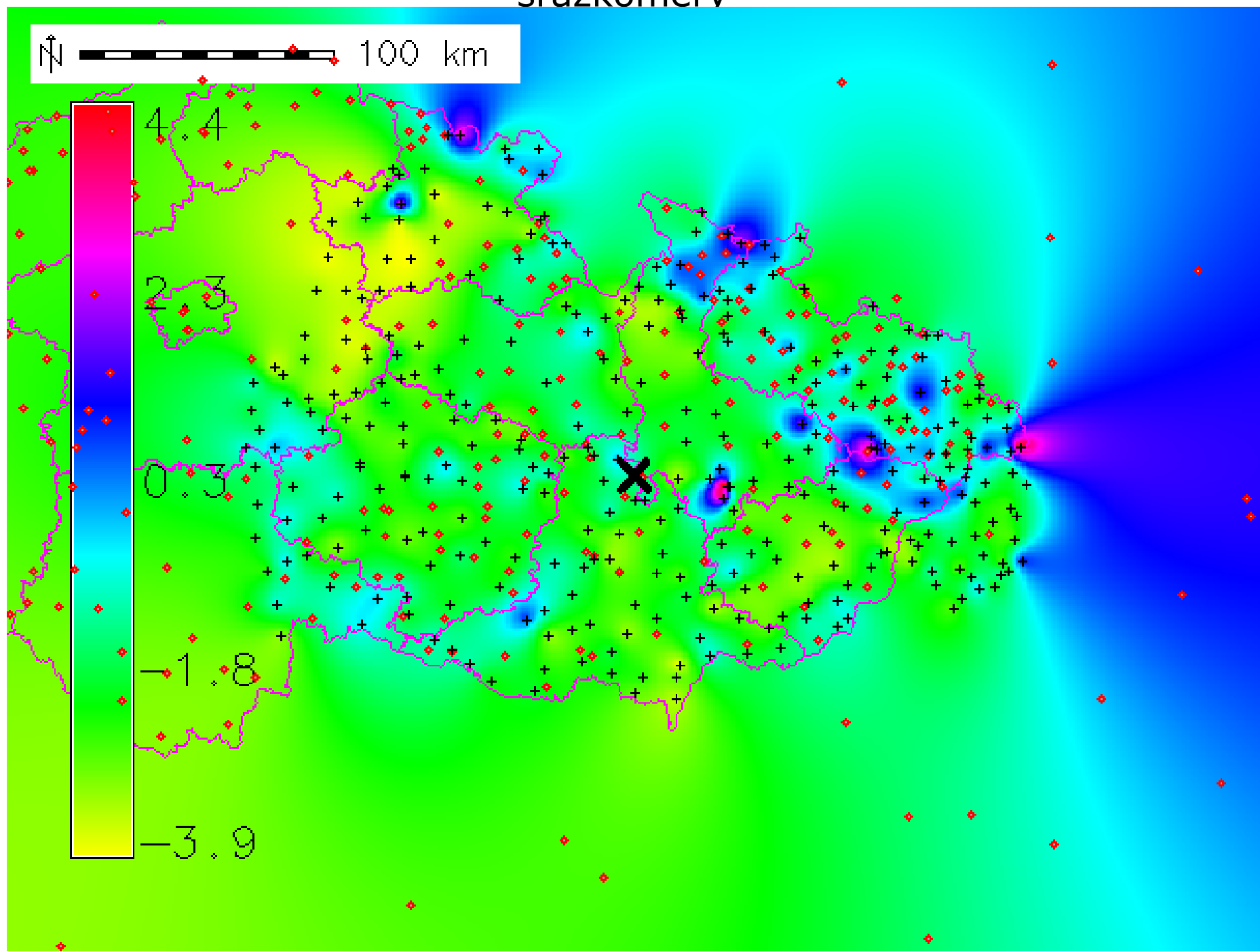
Chyby denních odhadů srážek v doméně radaru Brdy. Červeně - stanice použité v operativních výpočtech, malými černými křížky verifikační srážkoměry



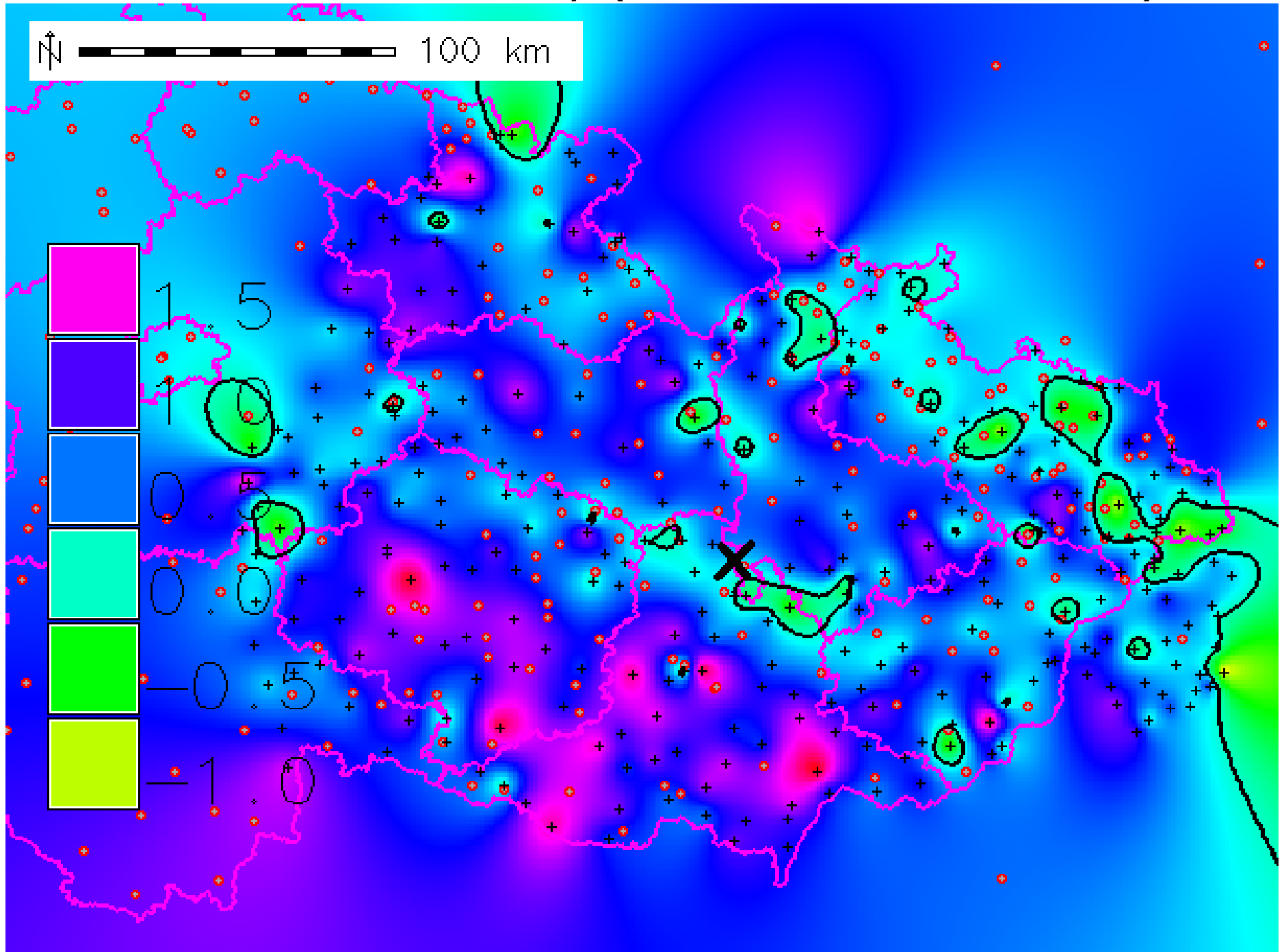
Rozdíl chyby srážkoměrných a kombinovaných odhadů v doméně radaru Brdy (ERR_SRA - ERR_KOMB)



Chyby denních odhadů srážek v doméně radaru Skalky. Červeně - stanice použité v operativních výpočtech, malými černými křížky verifikační srážkoměry



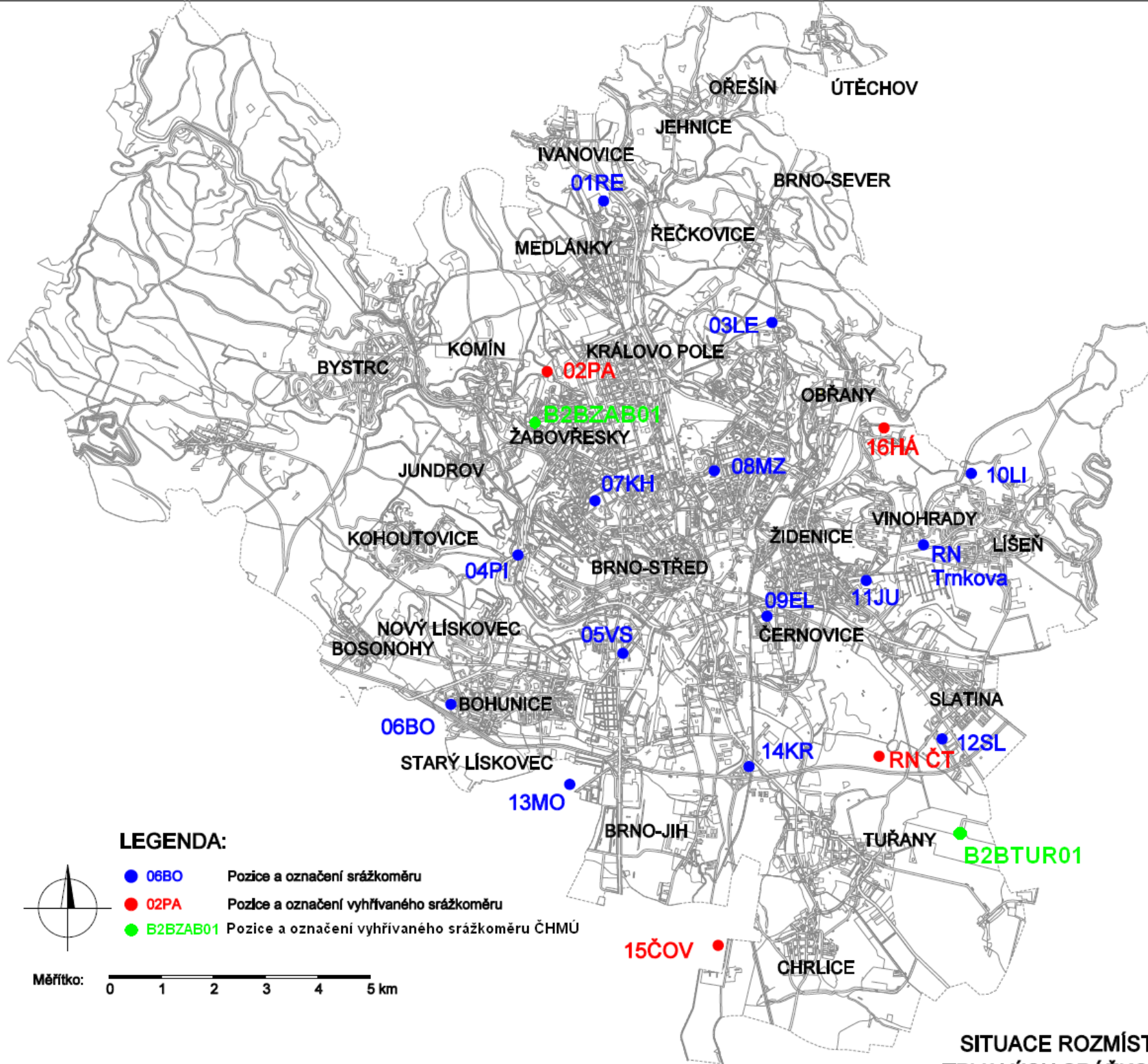
Rozdíl chyby srážkoměrných a kombinovaných odhadů v doméně radaru Skalky (ERR_SRA - ERR_KOMB)





Verifikace na hodinových srážkoměrných úhrnech v městě Brně

- Stanice Brněnských vodovodů a kanalizací (BVaK)
- 18 srážkoměrných stanic (bez operativního přenosu) + 2 stanice ČHMÚ (použité ve výpočtech)
- Hustota stanic v městě **Brně: 1 stanice na 8 km²**
- Hustota srážkoměrů v ČR:
 - **1 stanice na 70km²**
 - **s přenosem: 1 stanice na 200-240 km²**



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12SL

SLATINA

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05VS

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BOSONOHY

BRNO-STŘED

KOHOUTOVICE

JUNDOV

KOMÍN

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ŽABOVŘESKY

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08MZ

VINOHRADY

RN

LÍŠEŇ

16HÁ

OBRÁNY

03LE

ŘEČKOVICE

MEDLANKY

IVANOVICE

01RE

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OREŠÍN

ÚTĚCHOV

BRNO-SEVER

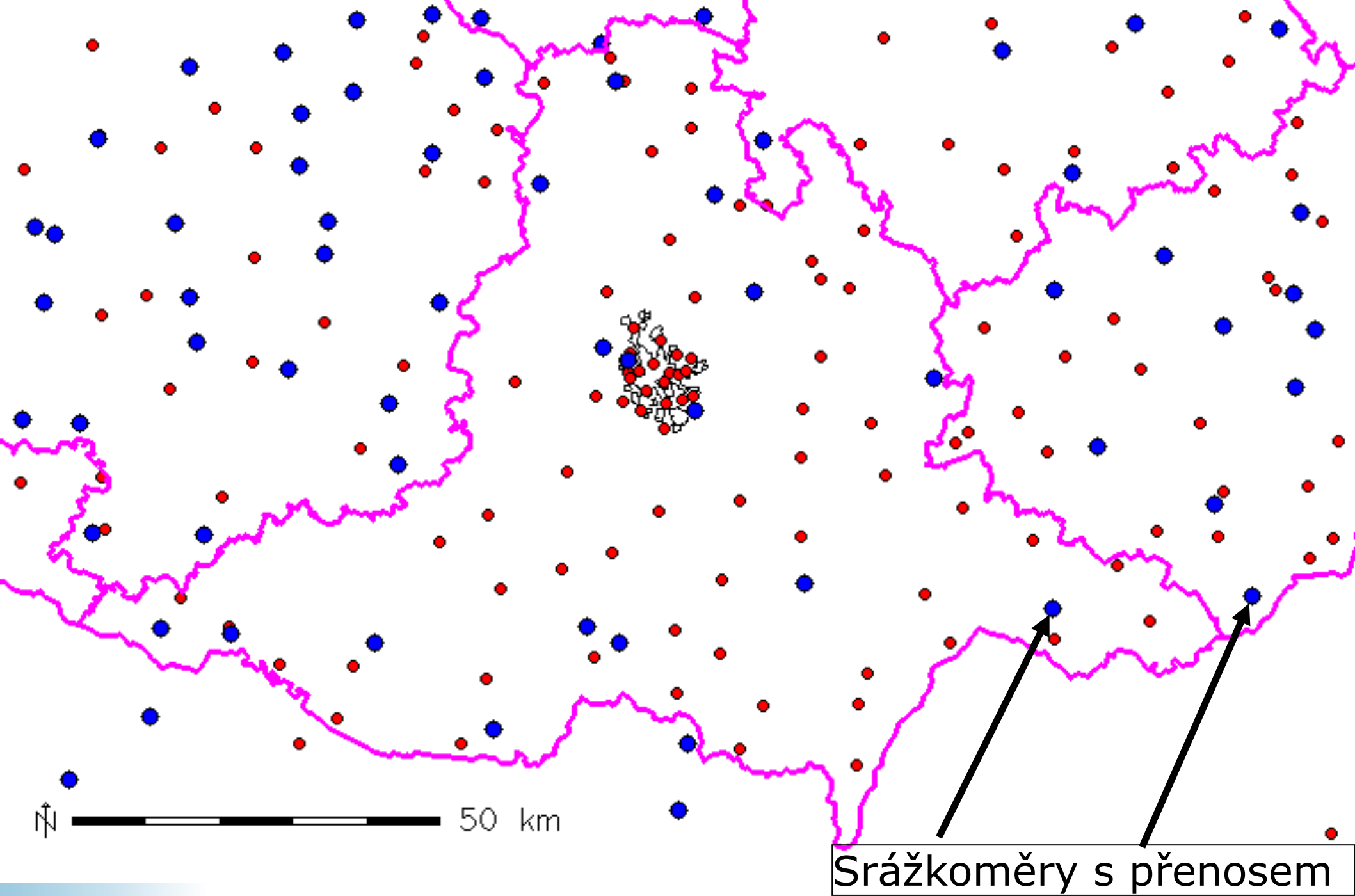
BRNO-JIH

TUŘANY

CHRLICE

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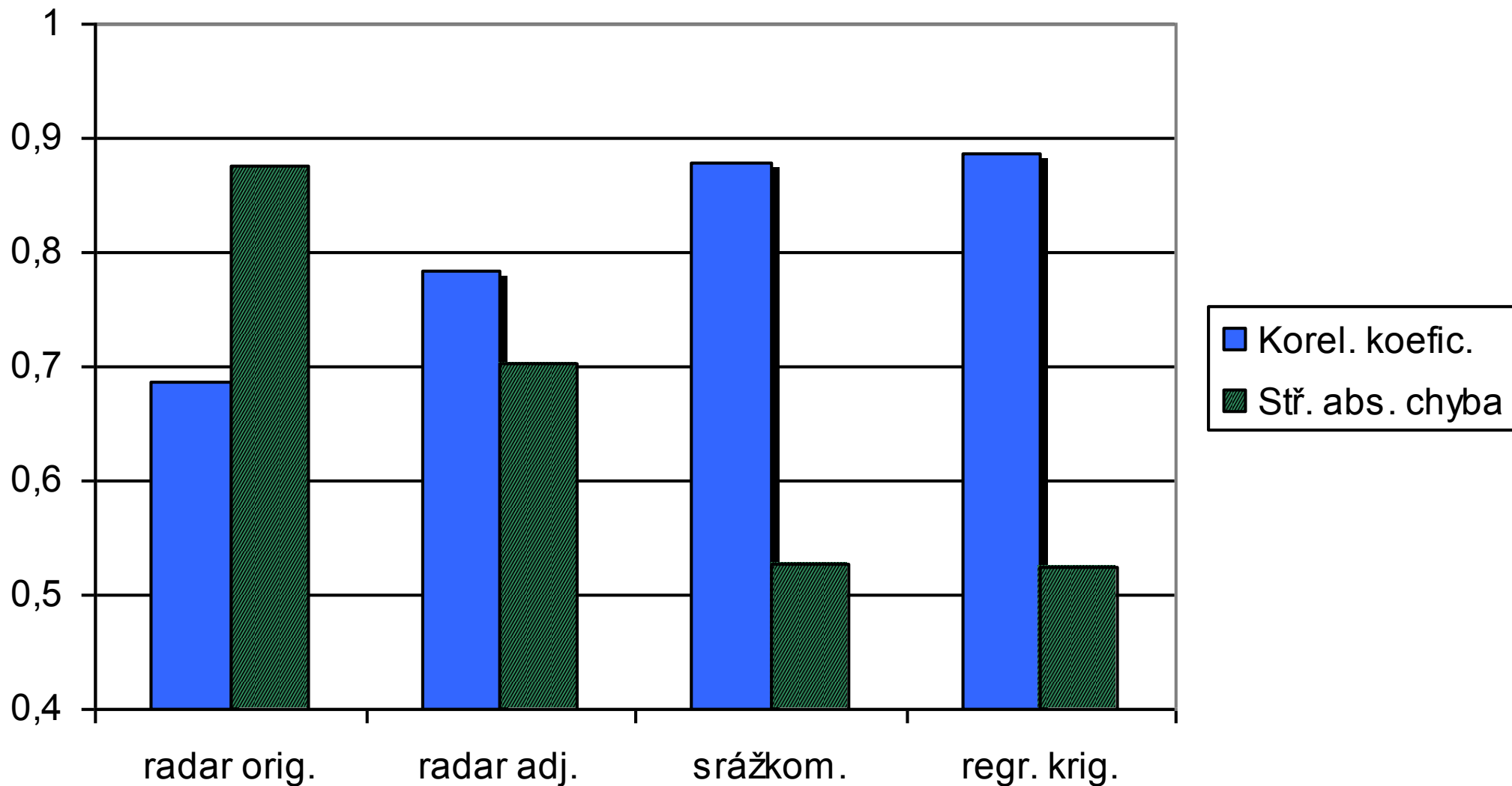
KRÁLOVO POLE



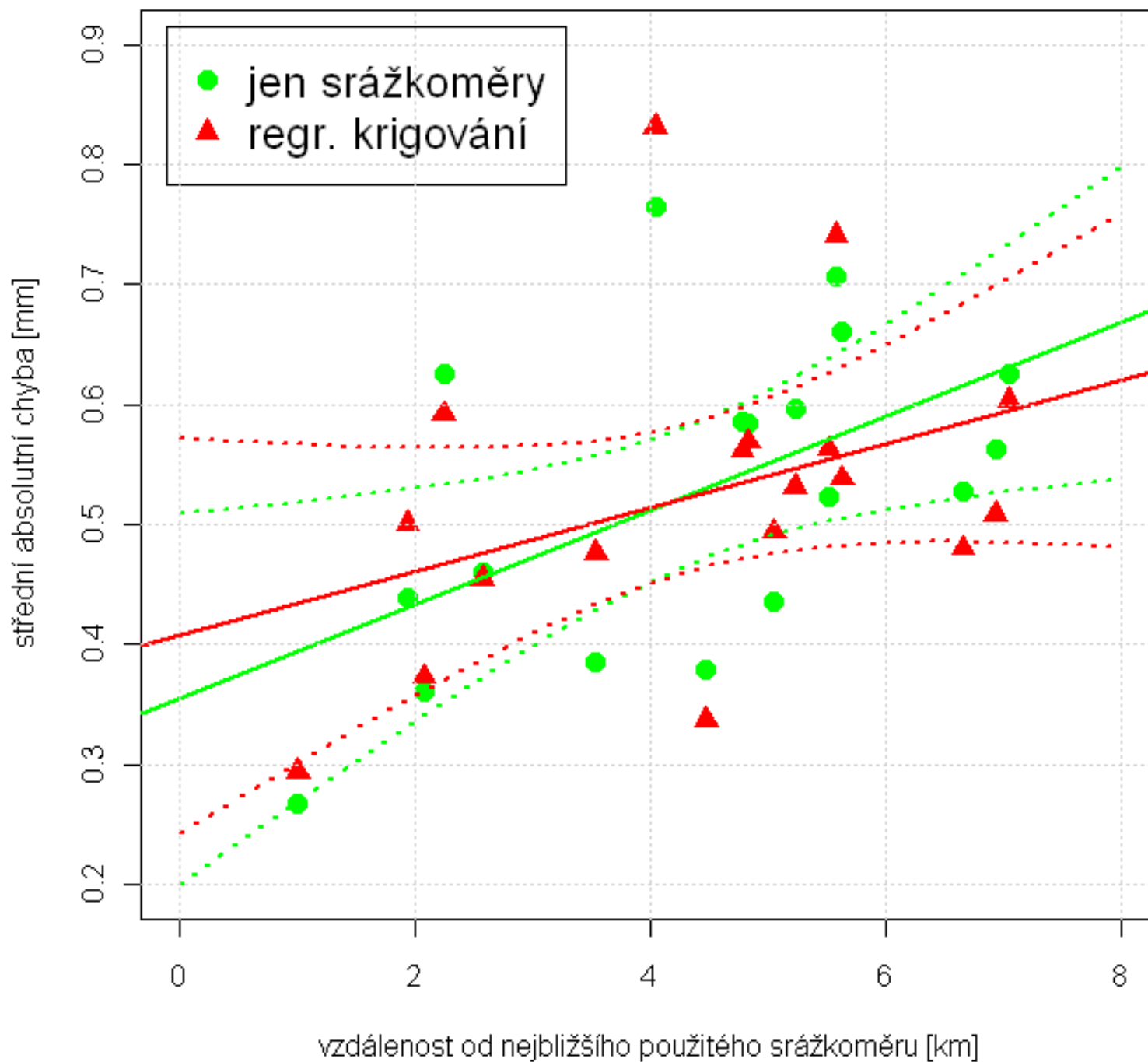
Verifikační soubor

- 208 srážkově významných epizod (hodinových akumulací)
 - kritérium byla přítomnost srážek na všech stanicích v městě Brně
- Pro všechny stanice vypočteny korelační koeficienty a střední absolutní chyba

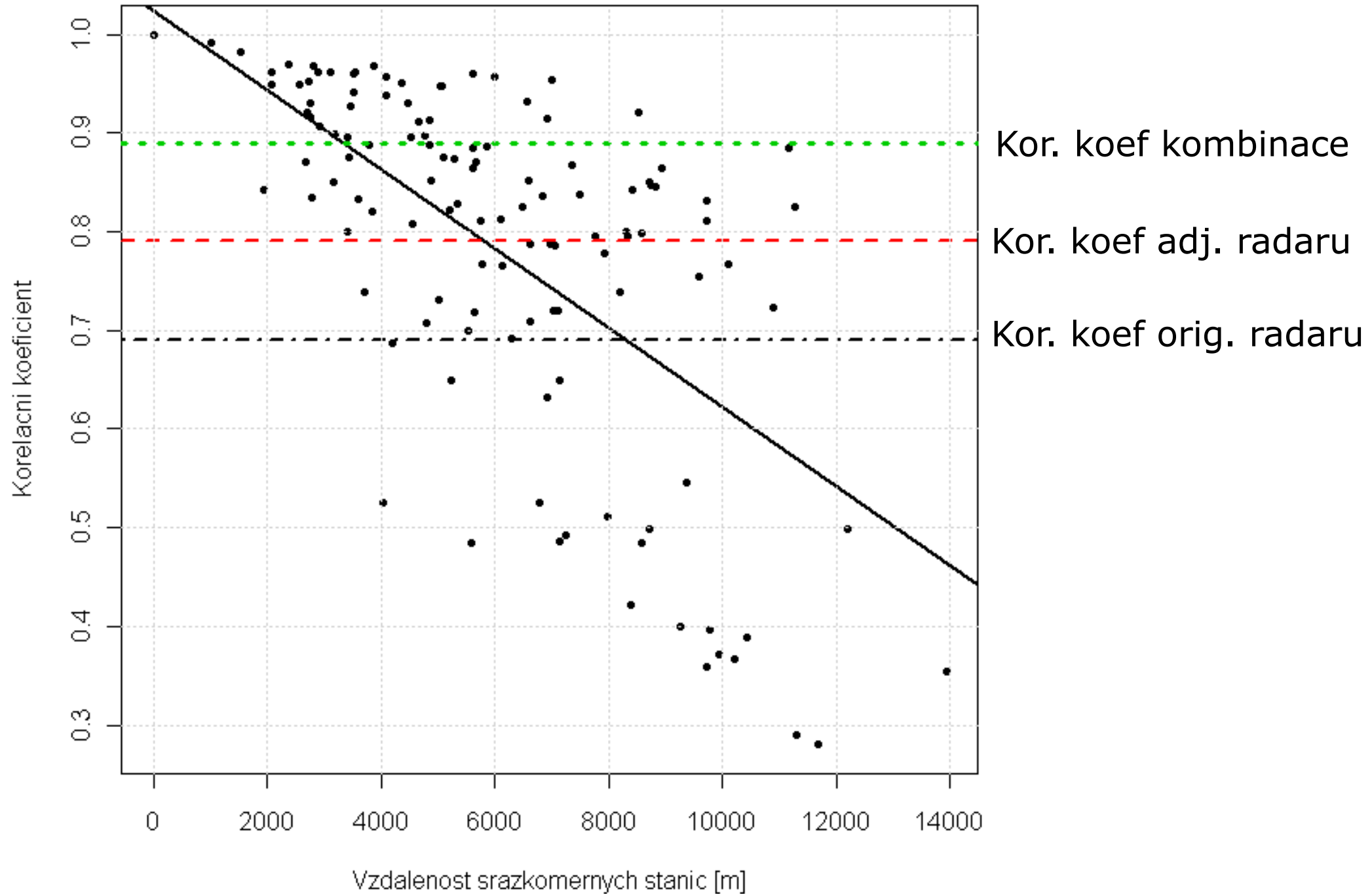
Výsledky



Závislost abs. chyby srážkoměrných a kombinovaných odhadů na vzdálenosti od nejbližšího použitého srážkoměru



Korelogram hodinových srážkových úhrnů



Praktické využití operativního radaro-srážkoměrného odhadu

- Rychlý přehled dat o srážkách (kolik spadlo srážek)
- Varovná protipovodňová služba
- Verifikace meteorologických předpovědních modelů
- Srážkový vstup do hydrologických modelů

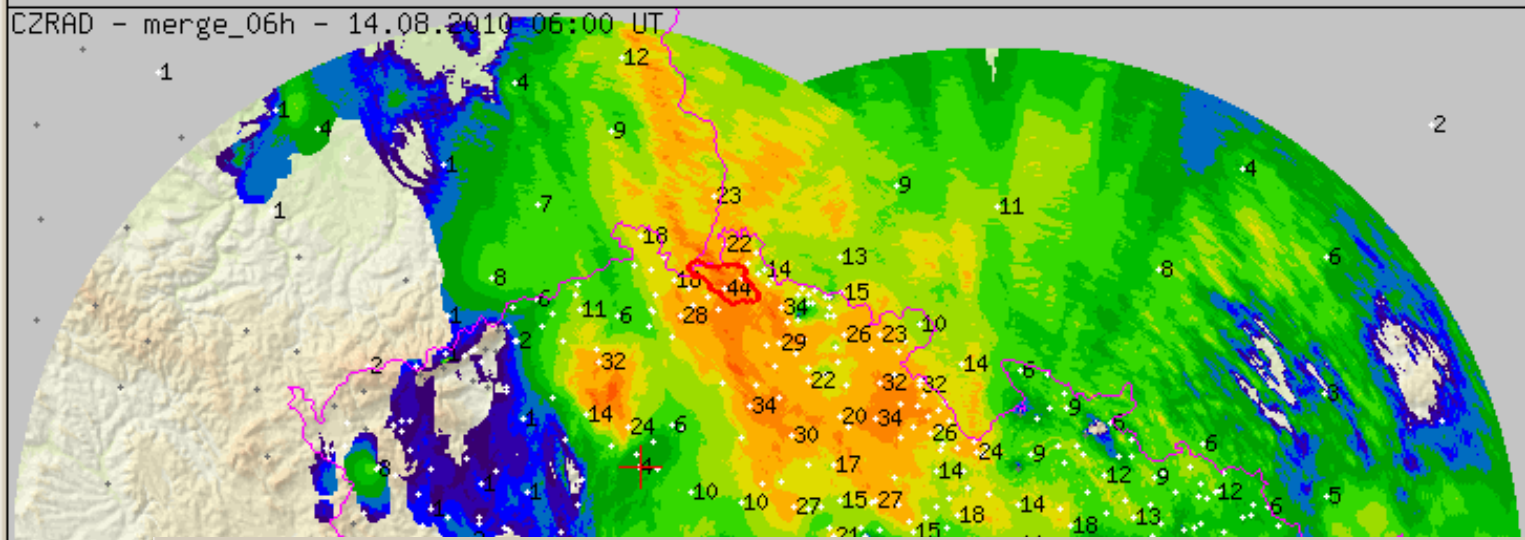


6h Precipitation Estimates:

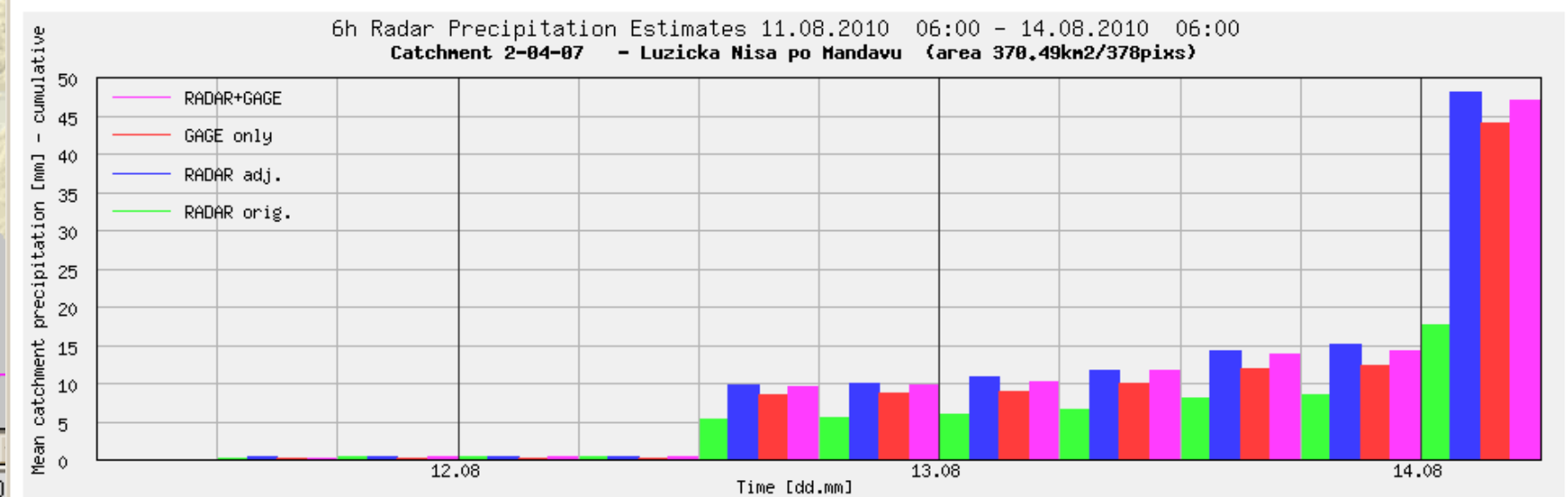
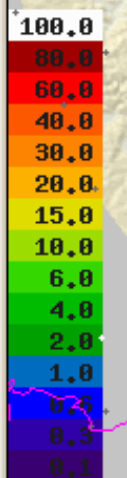
- RADAR original
- RADAR adjusted
- GAGE only
- RADAR+GAGE**

- 14.08.2010 06:00**
- 14.08.2010 00:00
- 13.08.2010 18:00
- 13.08.2010 12:00
- 13.08.2010 06:00
- 13.08.2010 00:00
- 12.08.2010 18:00
- 12.08.2010 12:00
- 12.08.2010 06:00
- 12.08.2010 00:00
- 11.08.2010 18:00
- 11.08.2010 12:00

JOINED IMAGE

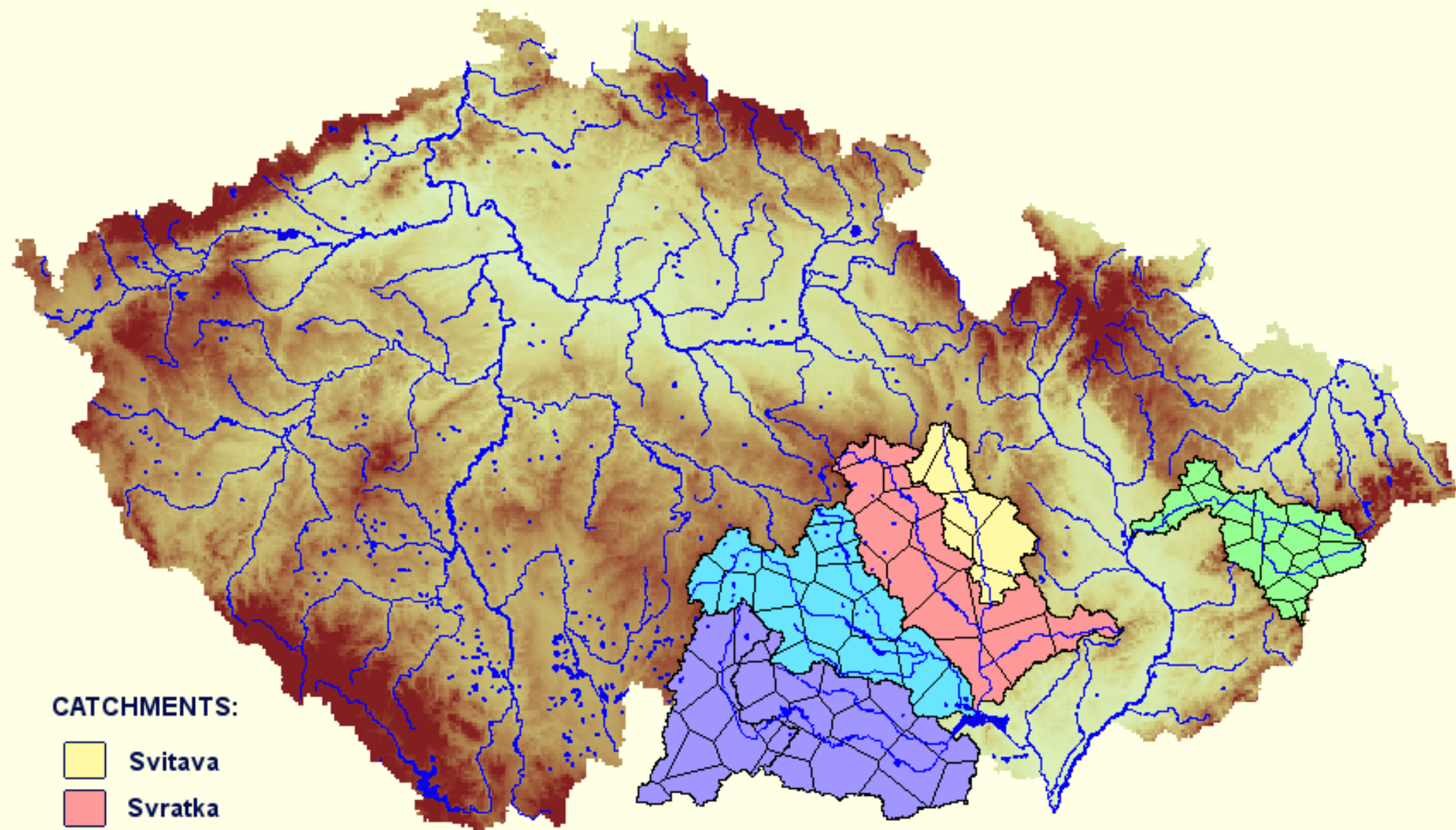


show_cat_plot.php (PNG obrázek, 950x300 bodů) - Mozilla Firefox








ORO col
CAT 2-04-0
NAVIG. red
cursor posi





CATCHMENTS:

-  Svitava
-  Svratka
-  Jihlava
-  Dyje
-  Bečva

Příklady Thiessenových polygonů, pro vybraná povodí, pro které je možné počítat plošné odhady srážek

Závěry

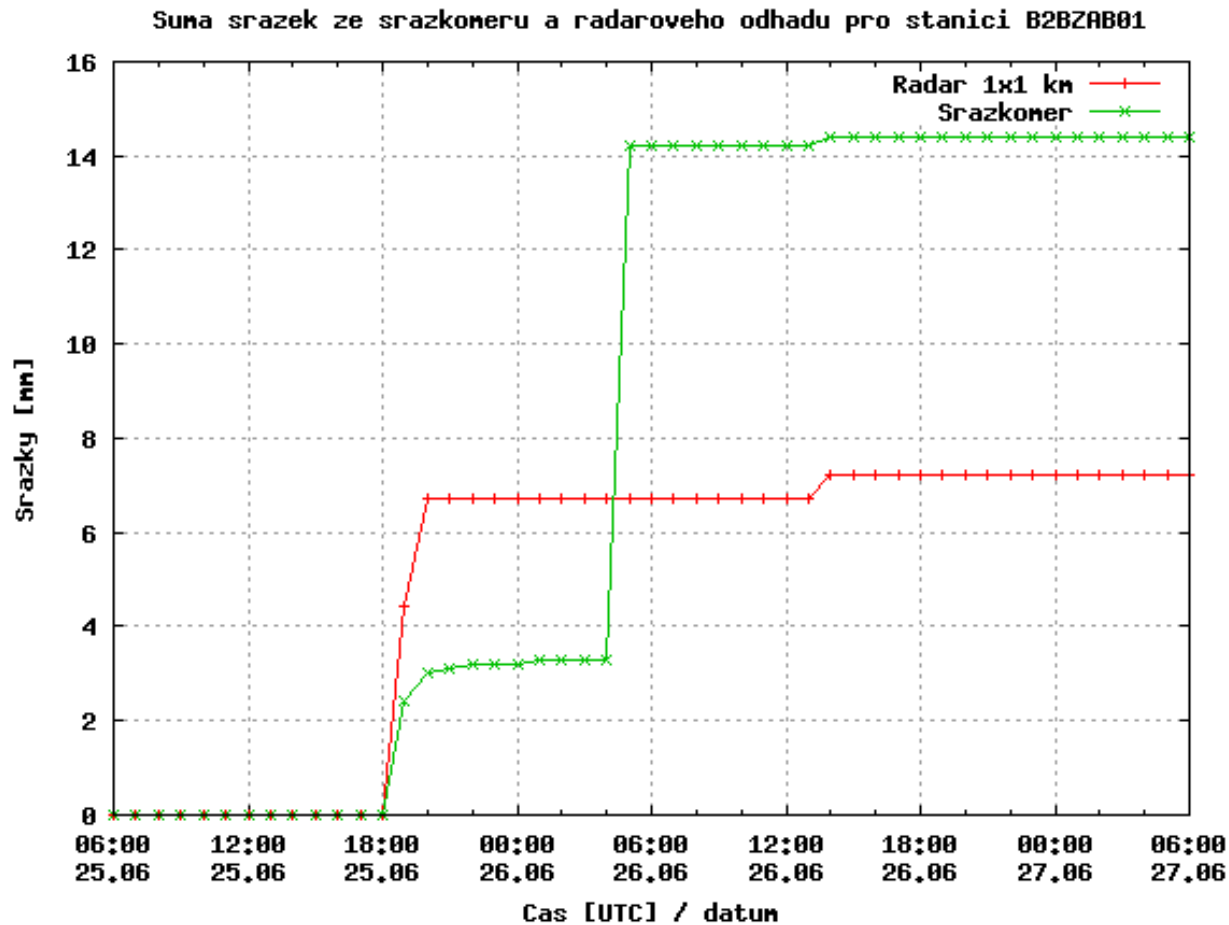
- Nekorigovaná radarová měření srážek jsou nepřesná, odhady vyžadují korekce
- Adjustace územně proměnným koeficientem přesnost významně zvyšuje
- *Průměrně* nejlepším odhadem je kombinace (např. regresní krigování)

Závěry (pokr.)

- Verifikace na denních úhrnech ukázala i místa, kde radar k přesnosti odhadu srážek nepřispívá (zejm. horské oblasti)
- Výpočty hodinových úhrnů pro město Brno indikují, že radar pozitivně přispívá k hodinovým odhadům srážek až od vzdálenosti asi 4 km od nejbližší stanice (nejbližších stanic) použité ve výpočtech.

Závěry (pokr.)

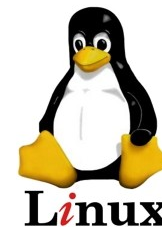
Radarové odhady mohou sloužit ke kontrole (člunkových) srážkoměrů



Použité informační technologie

Při tvorbě a provozu kombinované informace byly a jsou použity tyto technologie:

- Jazyk R + modul gstat
- GIS GRASS, knihovna proj
- OS GNU Linux a příslušné vývojové nástroje (C, Perl, ...)
- ArcGIS

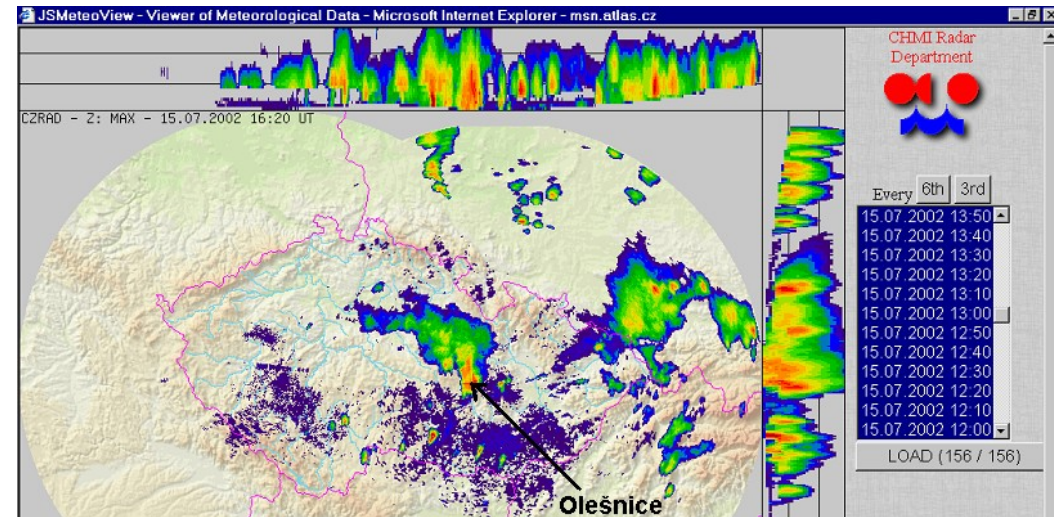


Case studies of flash floods

- **Flash flood at Hodonínka river basin**
 - Catchment area: 67.9 km²
 - Number of radar areal elements: 9
 - Average area of the radar areal elements: 7.5 km²

Basic facts of the flash flood at Hodonínka

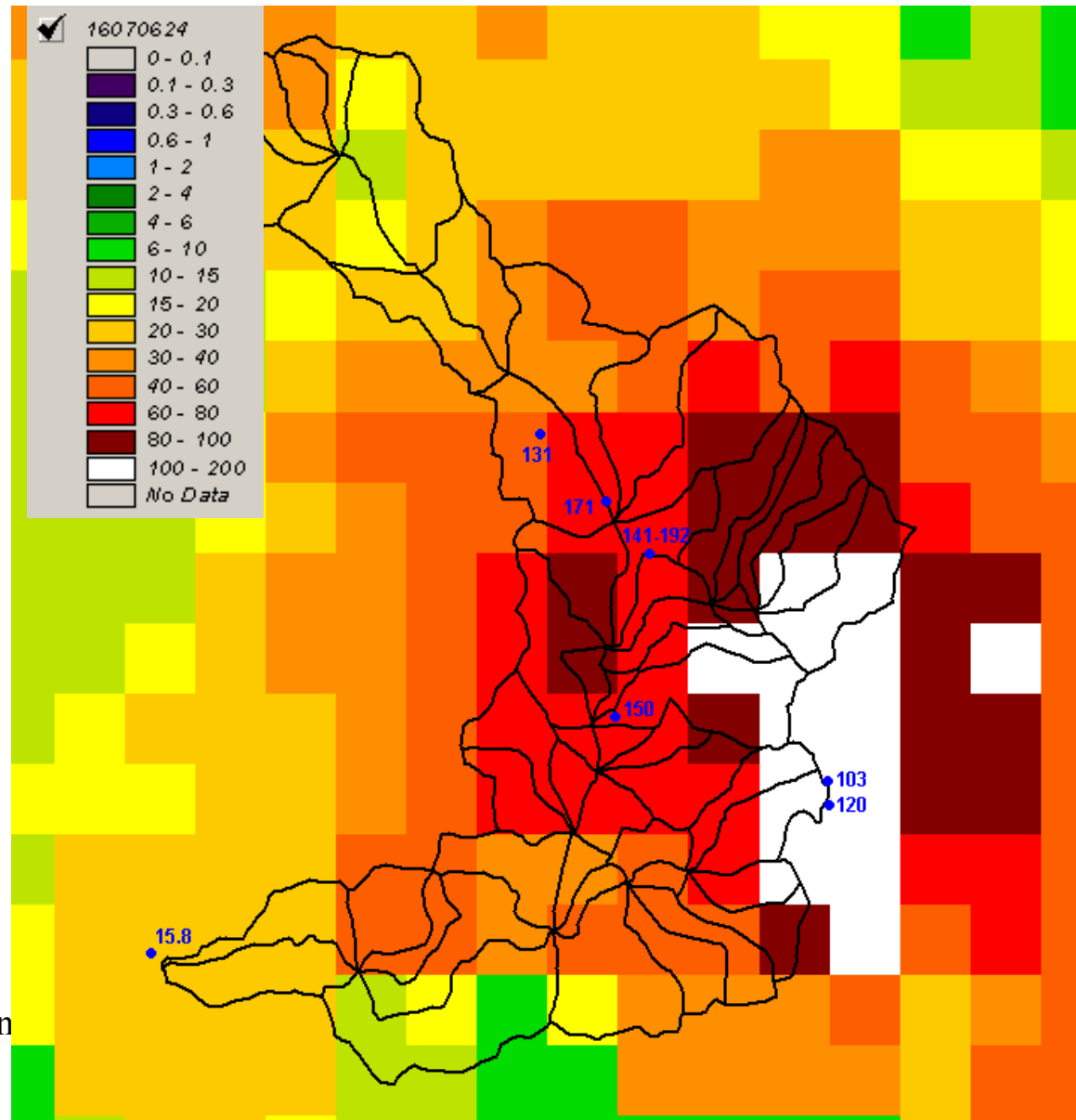
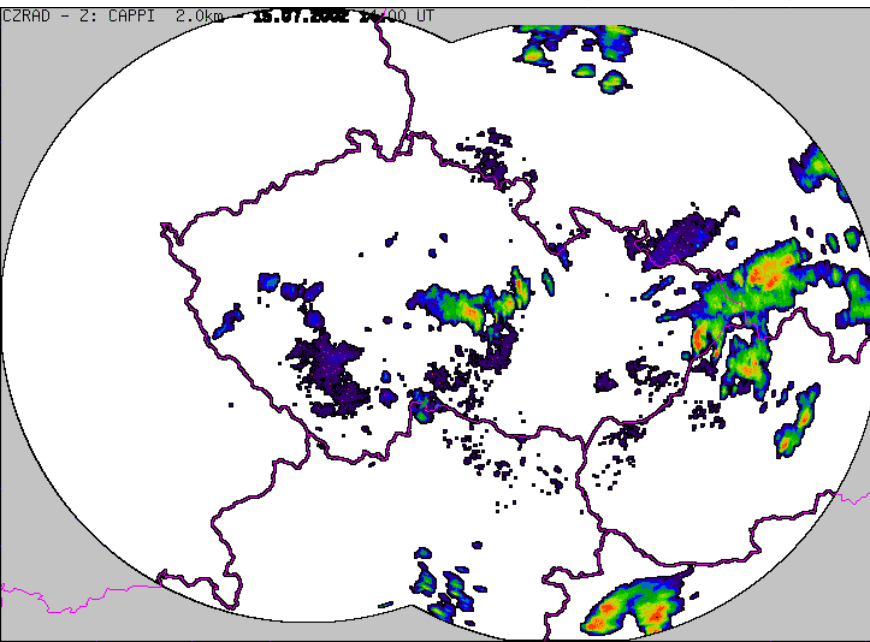
- Occured at small river Hodonínka on July 15, 2002 in evening hours
- one of the worst convection-related disasters in 15 years
- Return period: > **200 years**
- Damage: 5.5 mil EUR
- 2 fatalities
- Cause: Heavy rainfall lasting 1.5 hour, train effect



Hydrological model

Hydrog 'forecasted' the discharge at *the Štěpánov village* using 10-minute radar-based QPE, 2-hour COTREC-based nowcasting and 1-hour *persistence forecast* of the 10-minute values

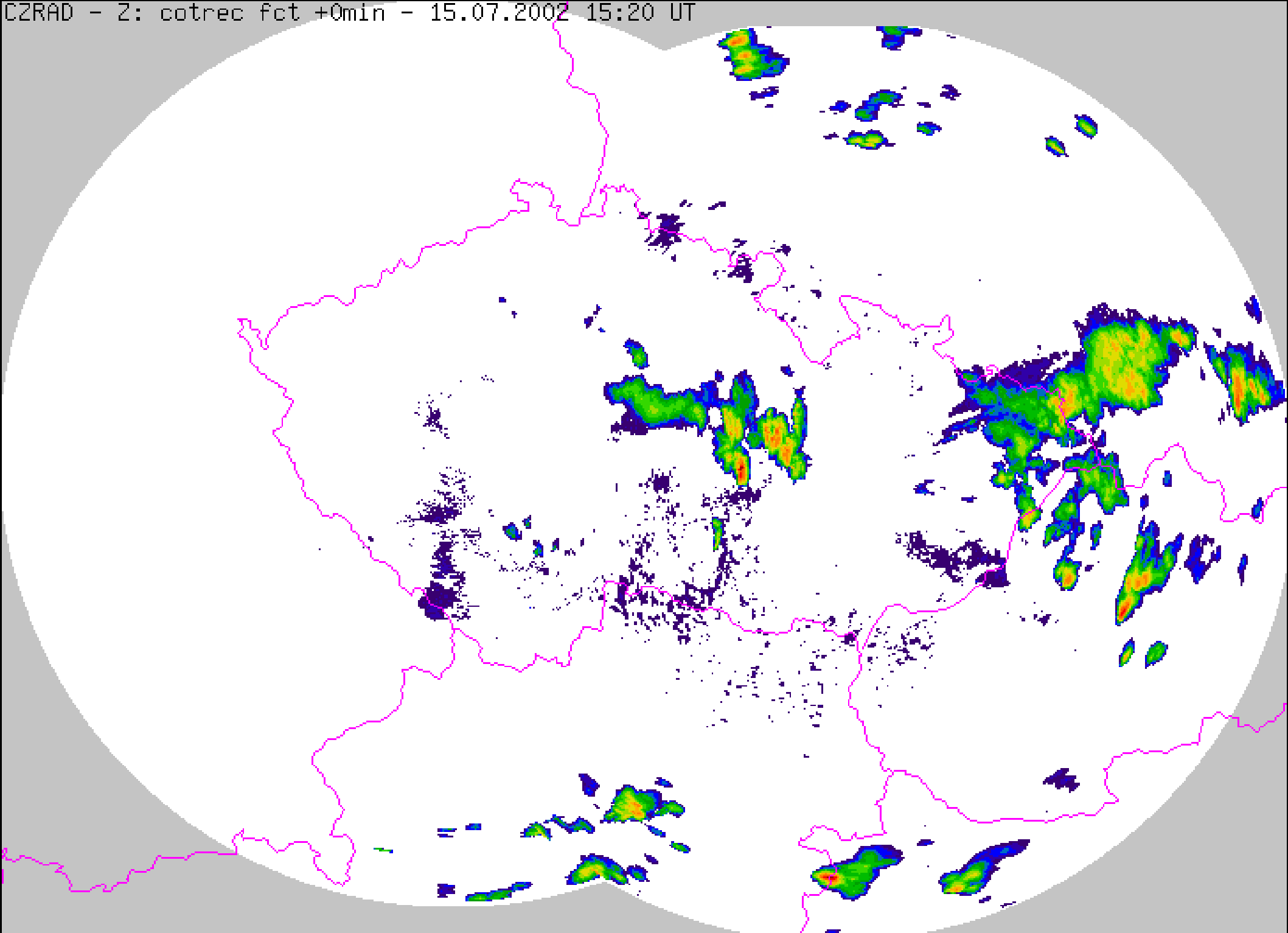
Radar-based QPE (from Max Z, grid 1km) and precipitation measurements (catchment size: 67.9 km²)



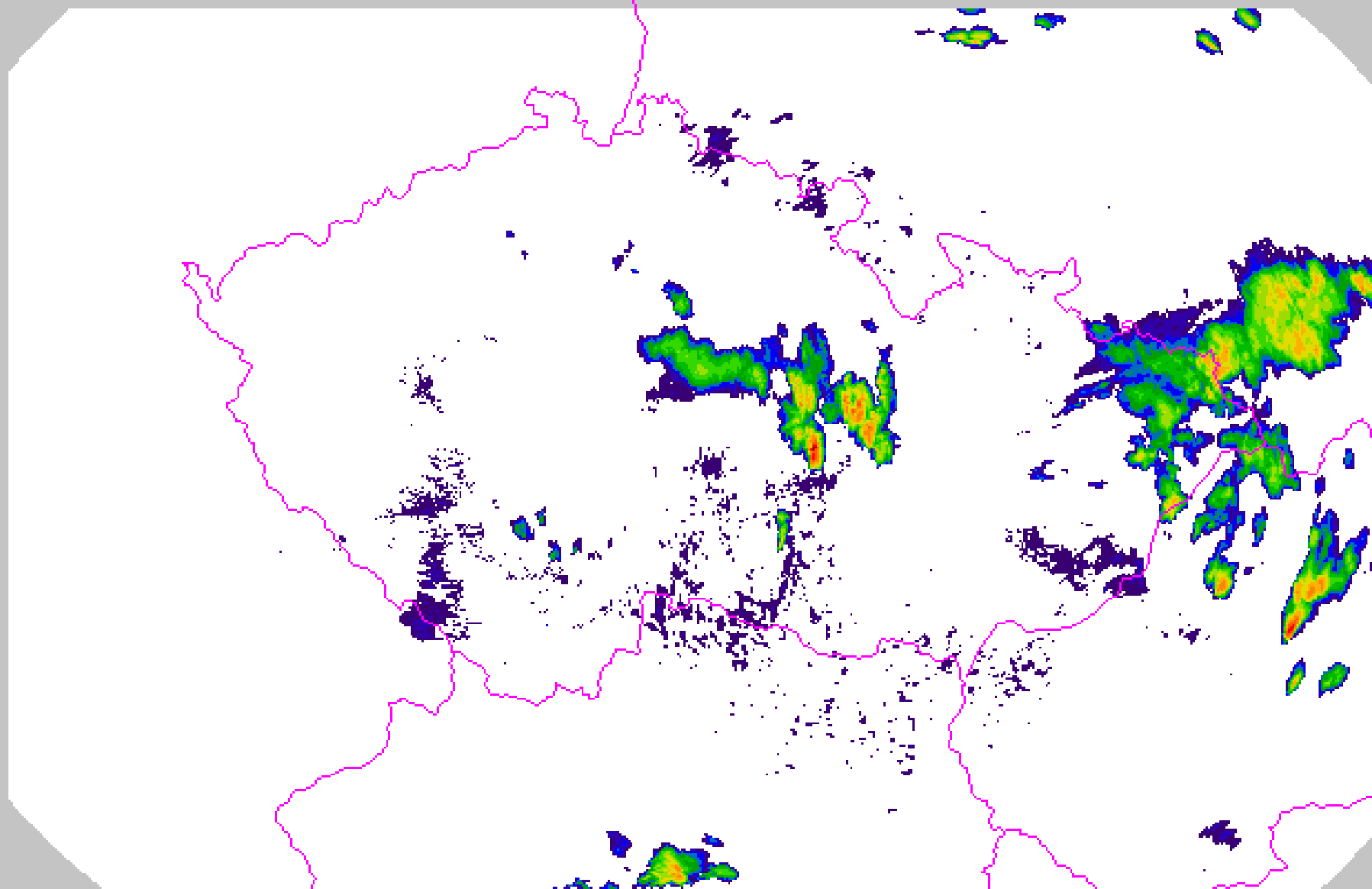
Example of COTREC nowcasting performance

COTREC is more suitable for *linear*
movement ...

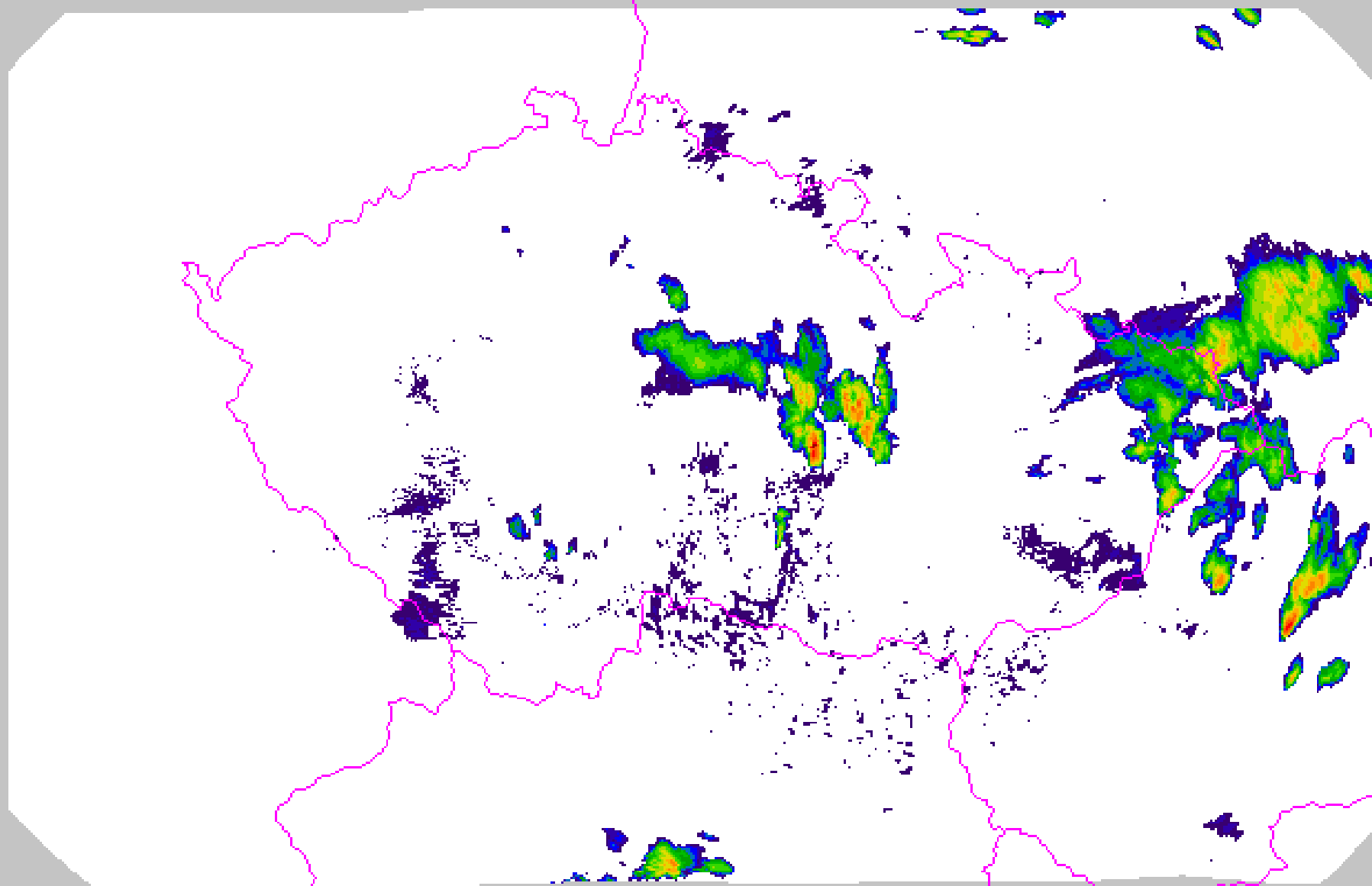
CZRAD - Z: cotrec fct +0min - 15.07.2002 15:20 UT



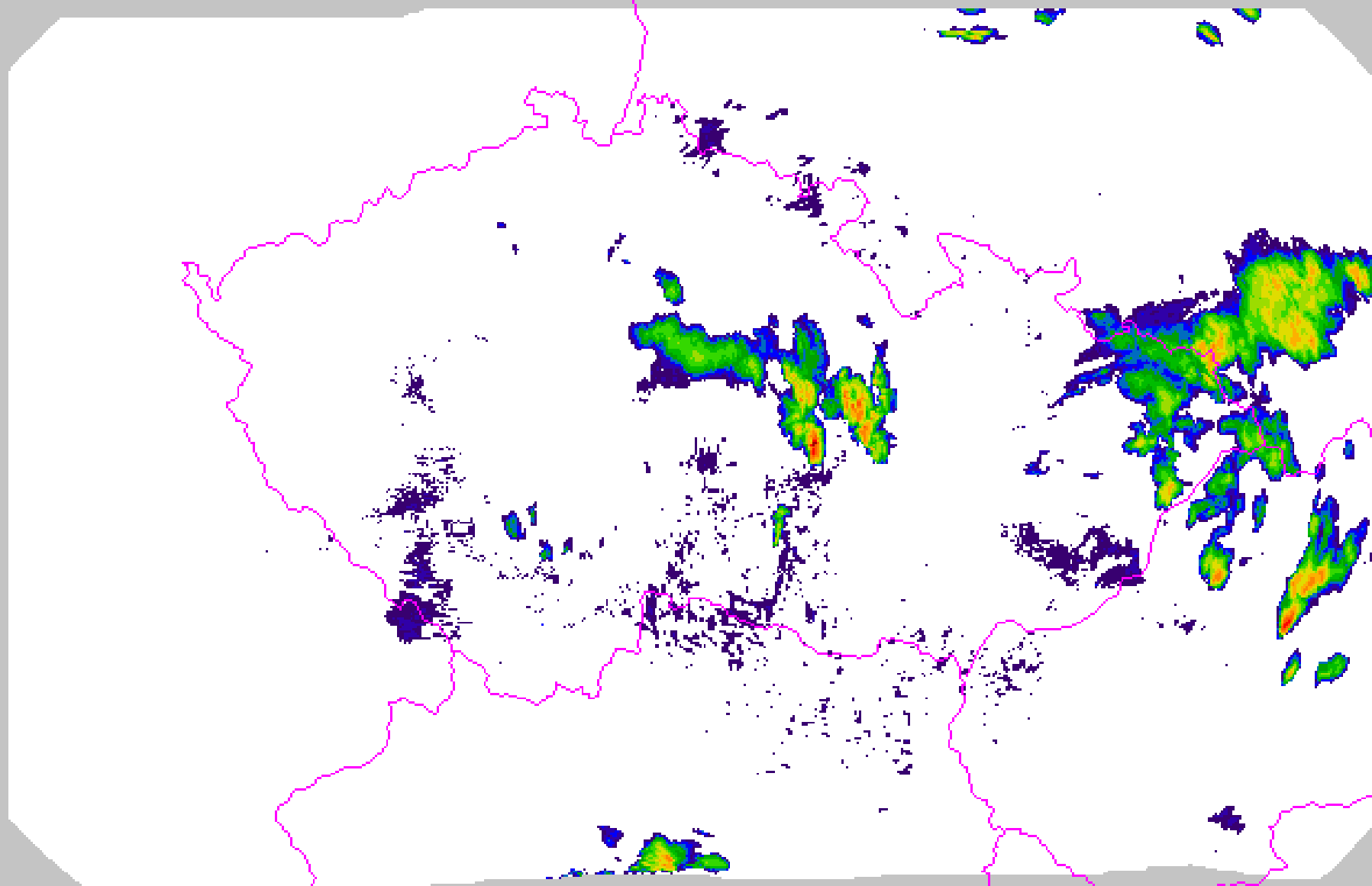
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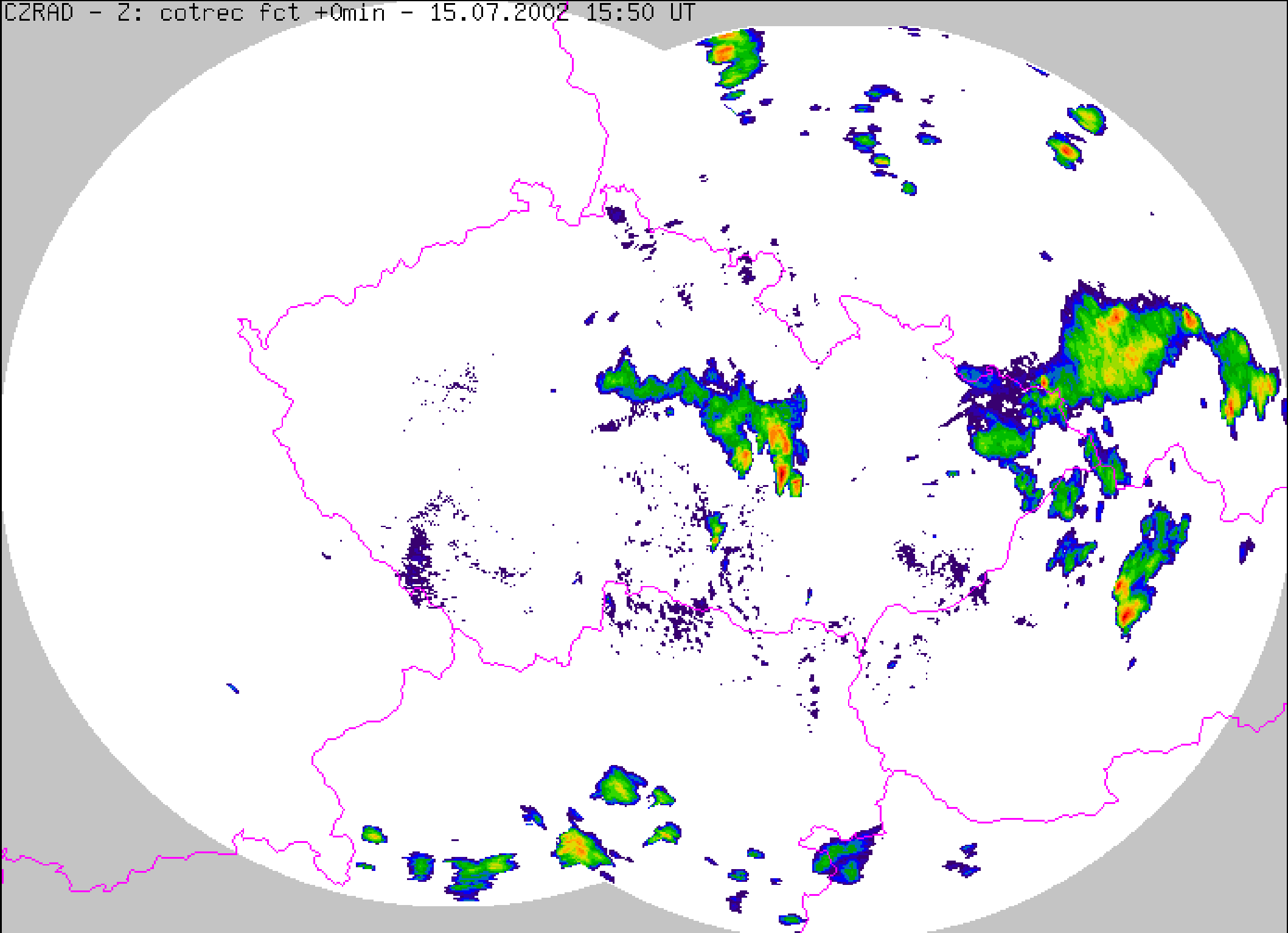
CZRAD - Z: cotrec fct +20min - 15.07.2002 15:40 UT



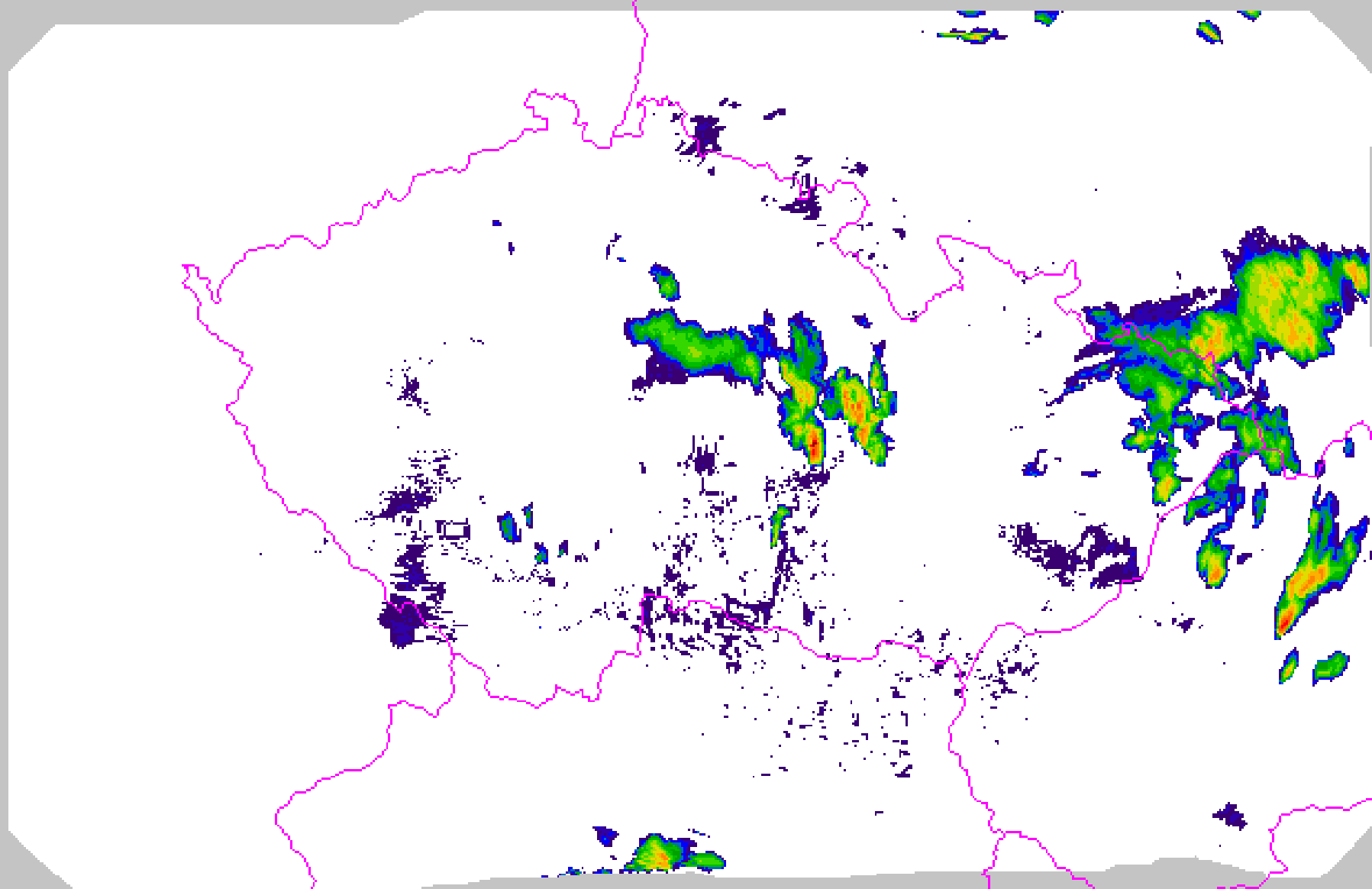
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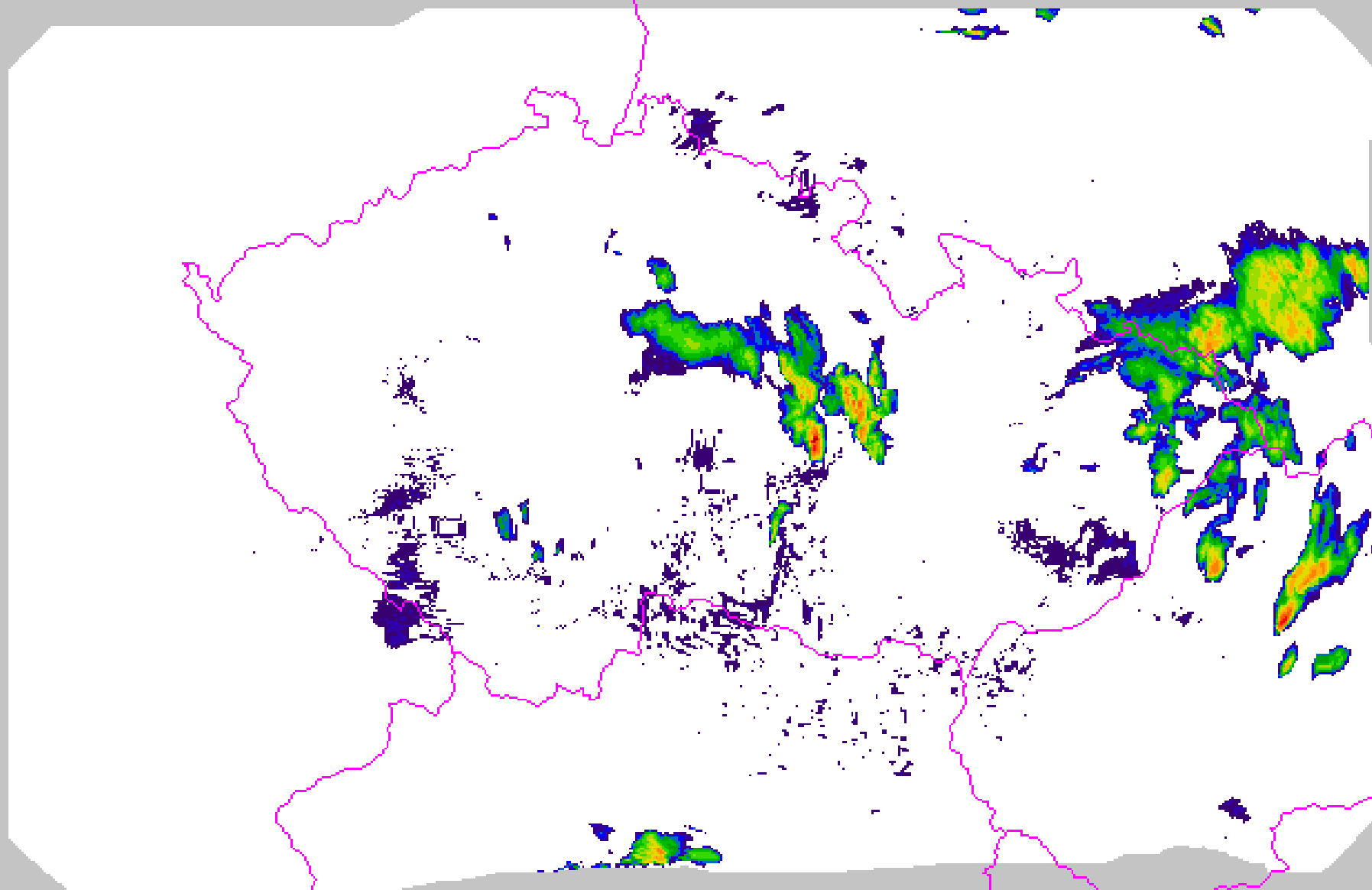
CZRAD - Z: cotrec fct +0min - 15.07.2002 15:50 UT



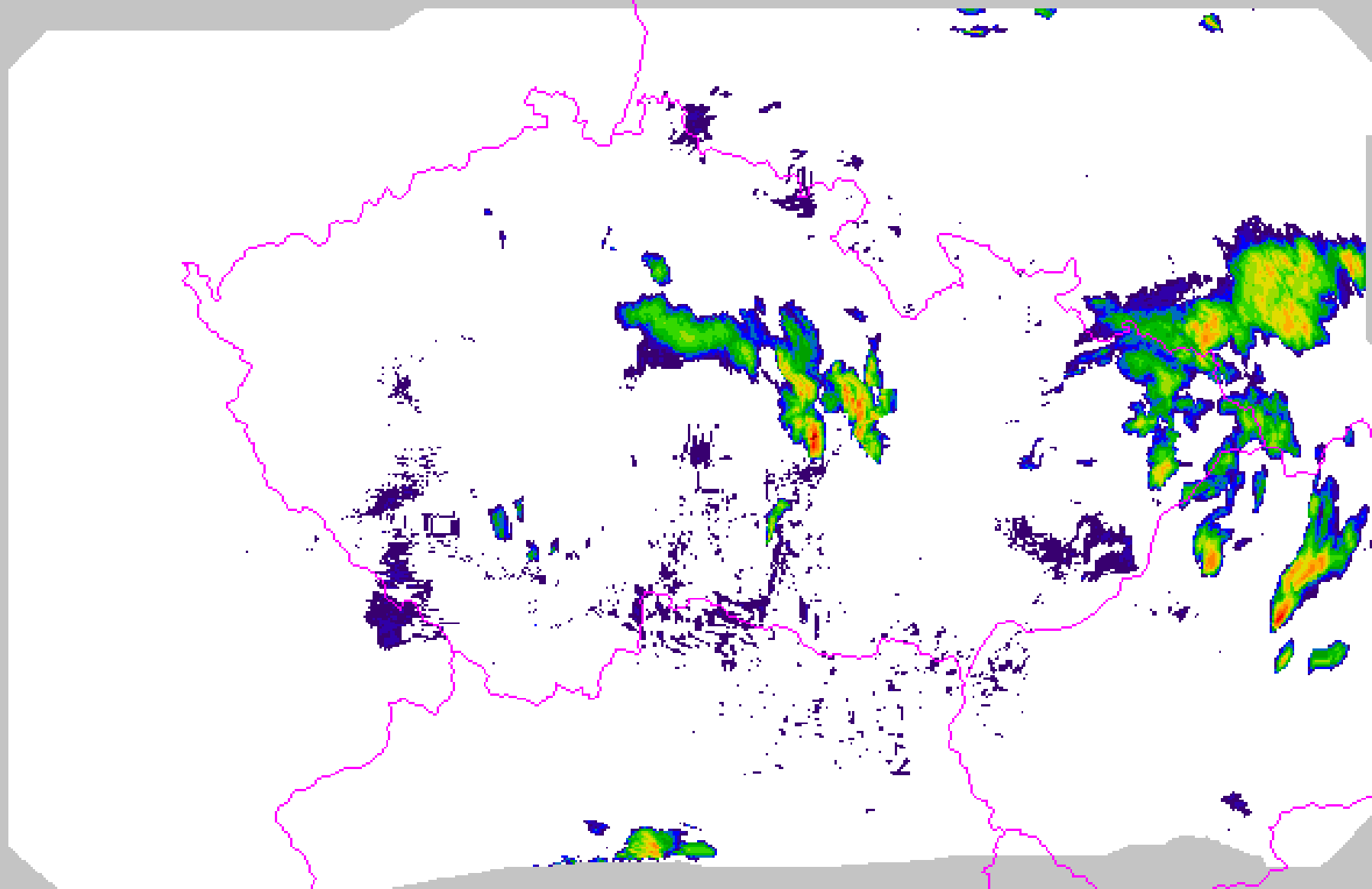
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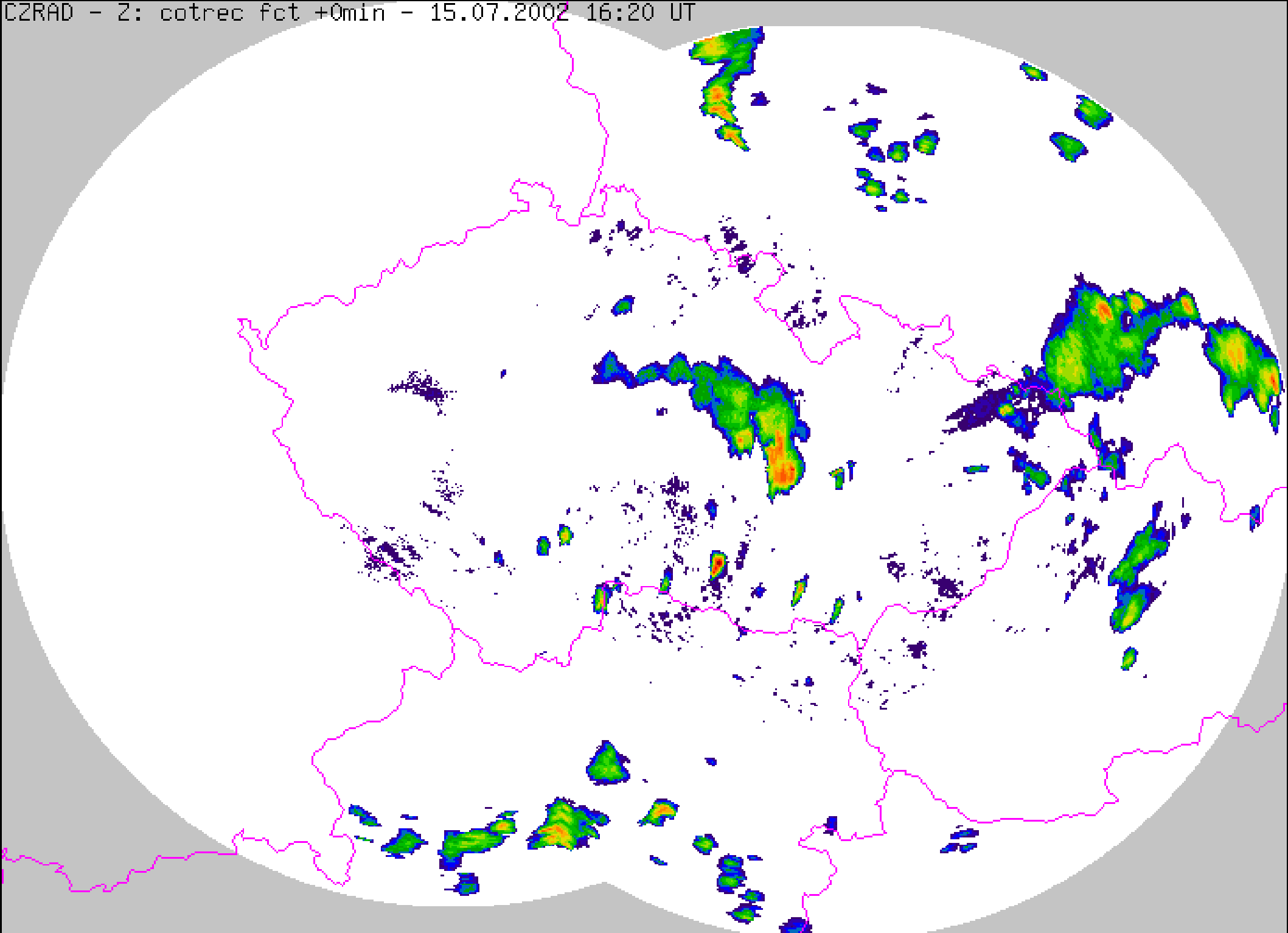
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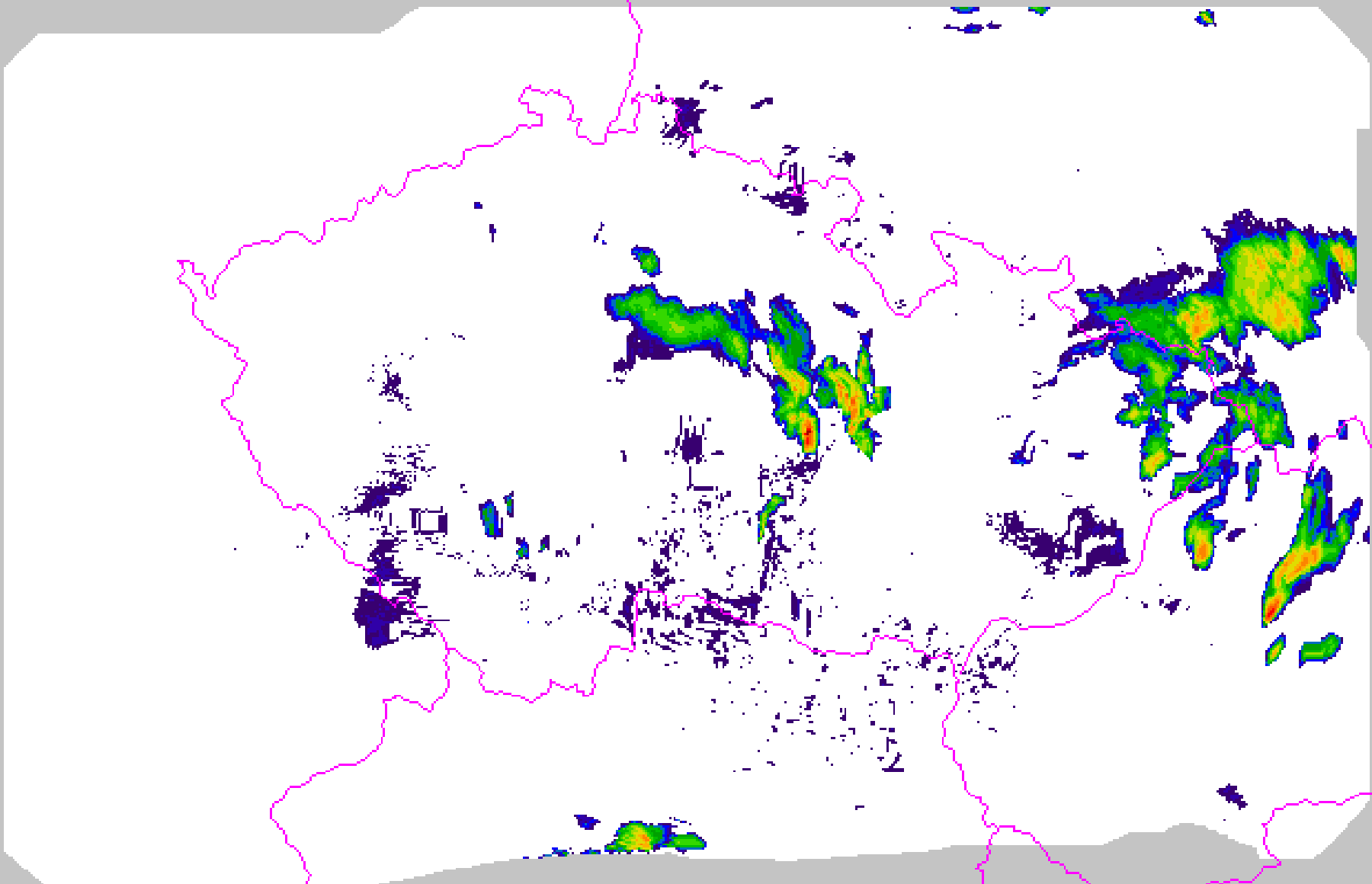
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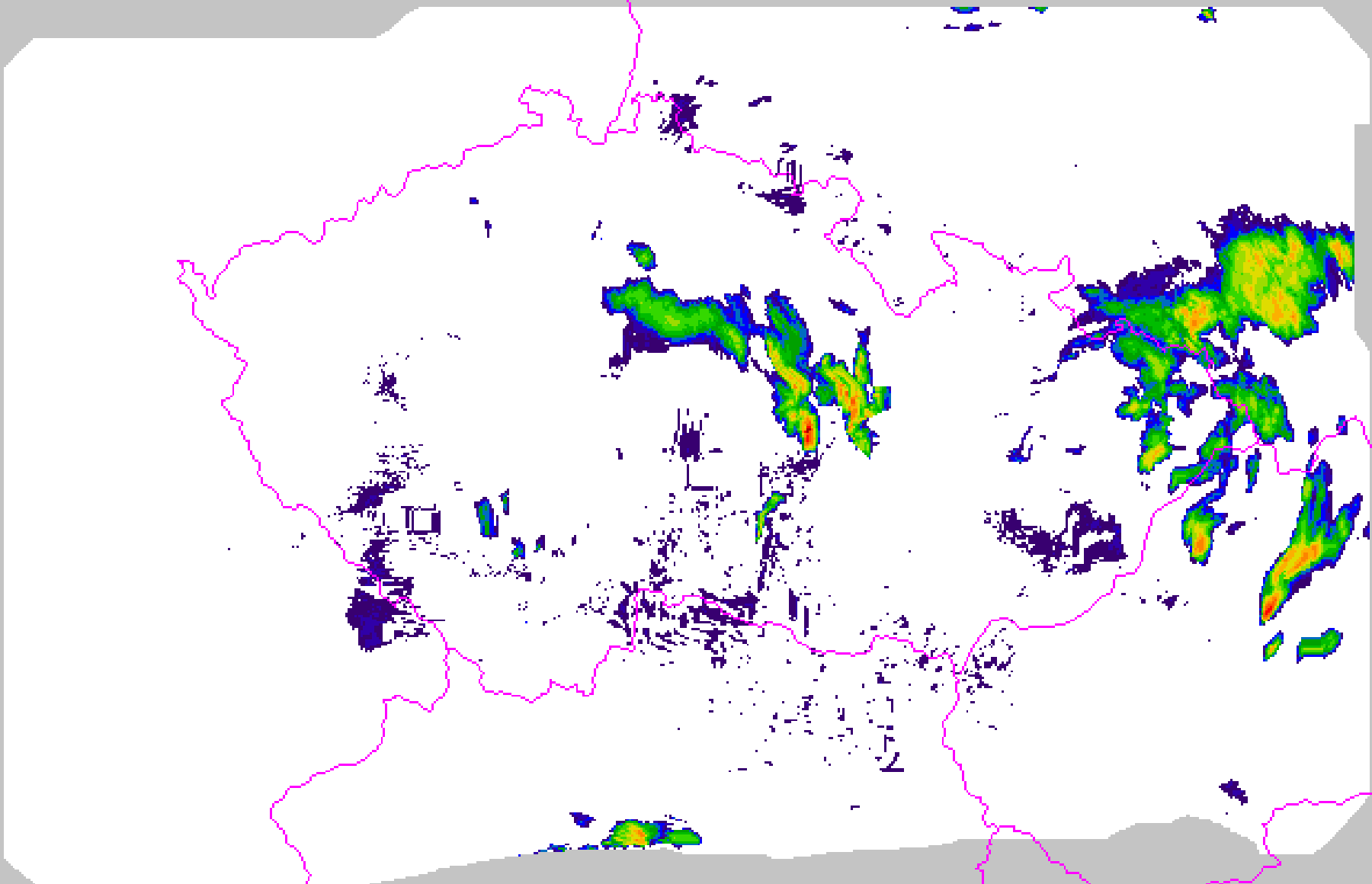
CZRAD - Z: cotrec fct +0min - 15.07.2002 16:20 UT



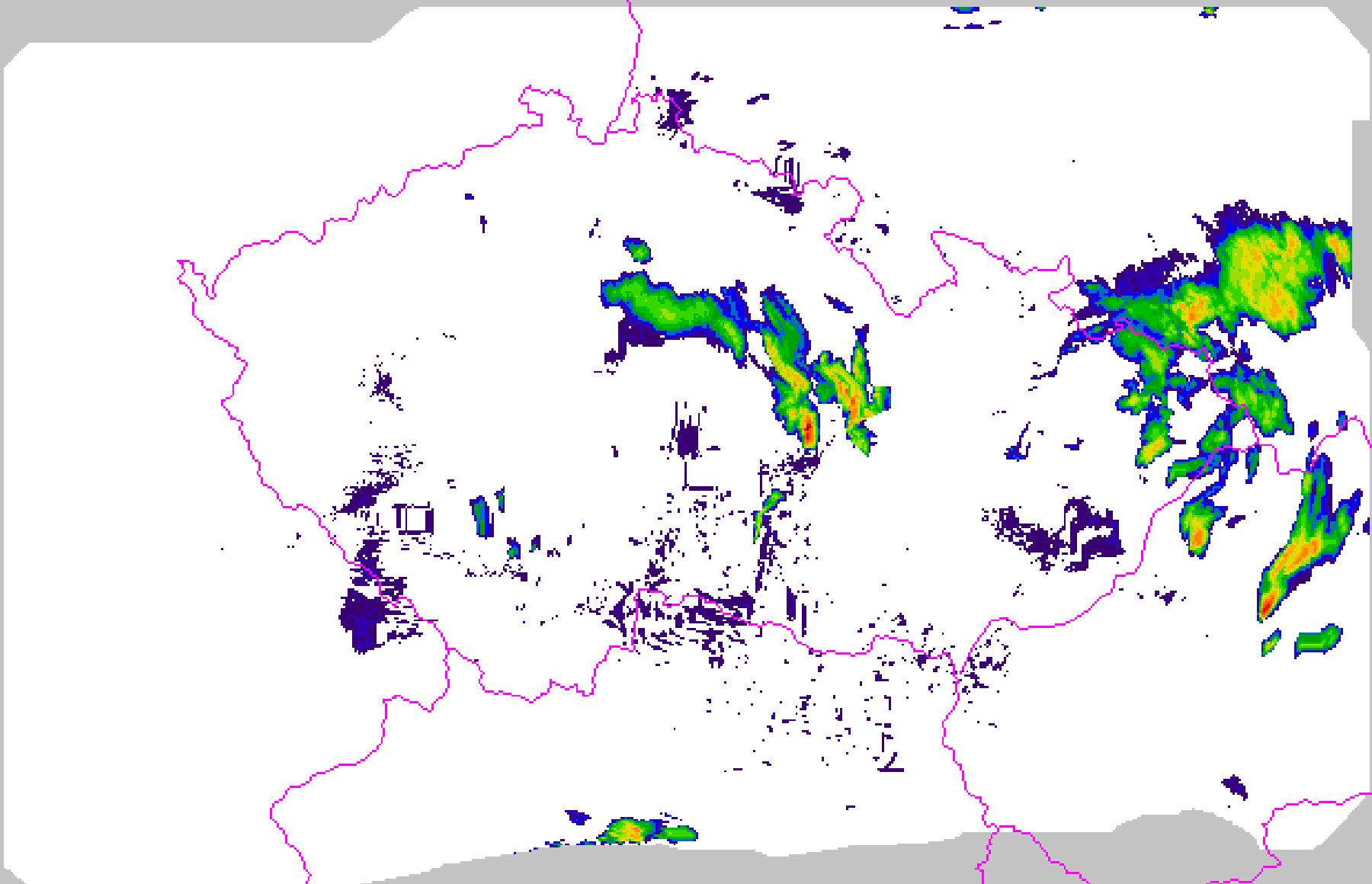
CZRAD - Z: cotrec fct +70min - 15.07.2002 16:30 UT



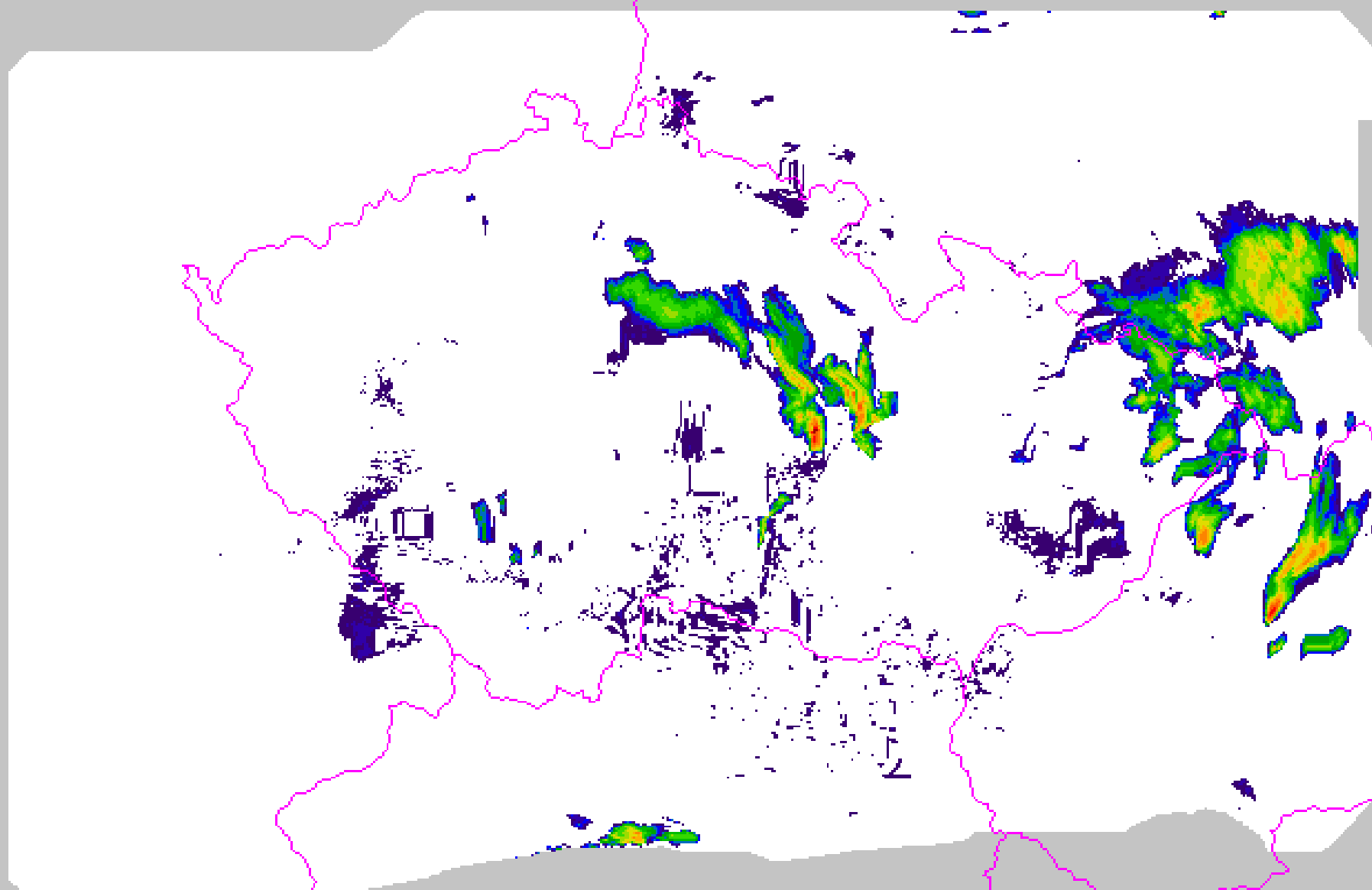
CZRAD - Z: cotrec fct +80min - 15.07.2002 16:40 UT



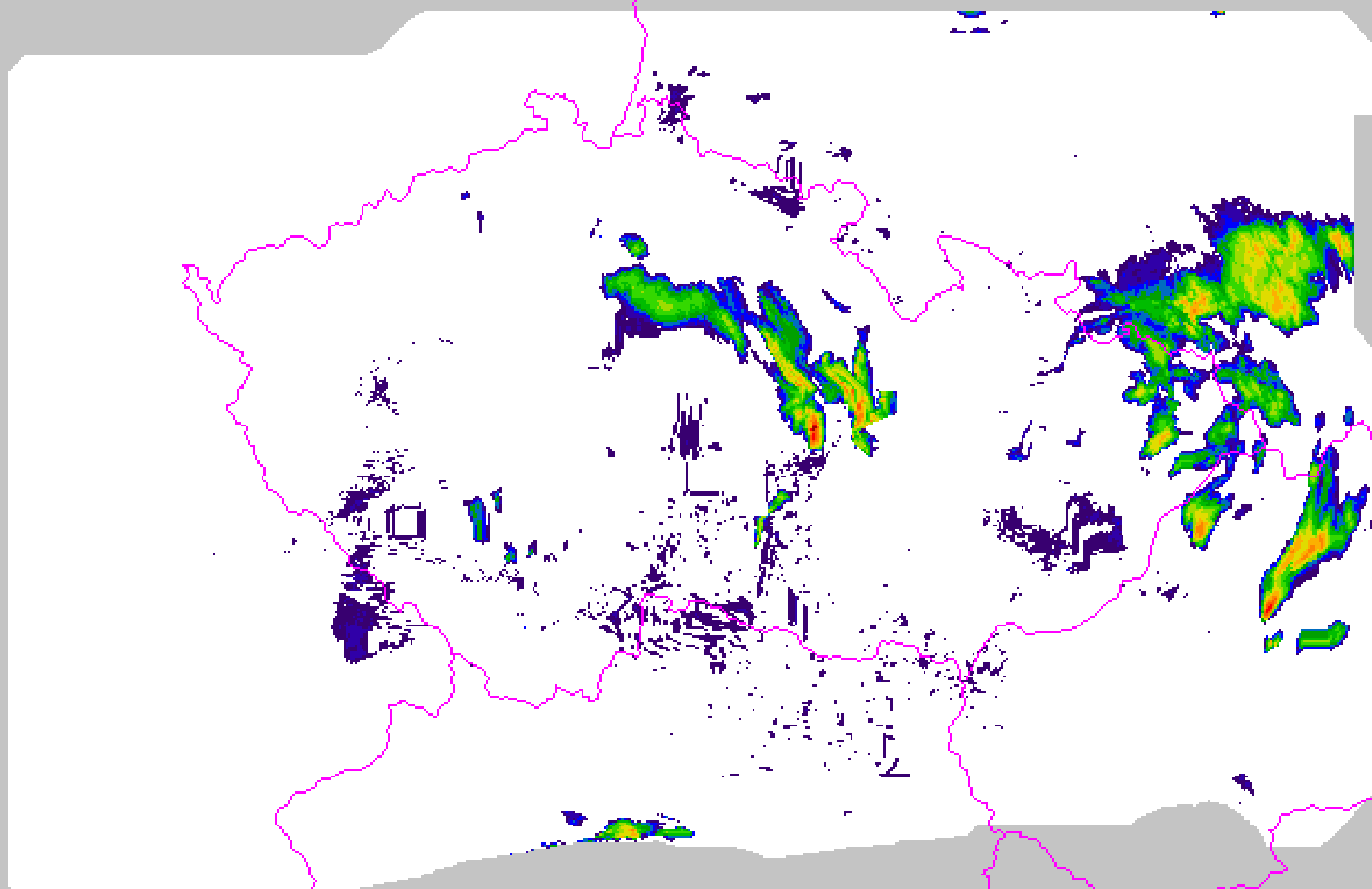
CZRAD - Z: cotrec fct +90min - 15.07.2002 16:50 UT



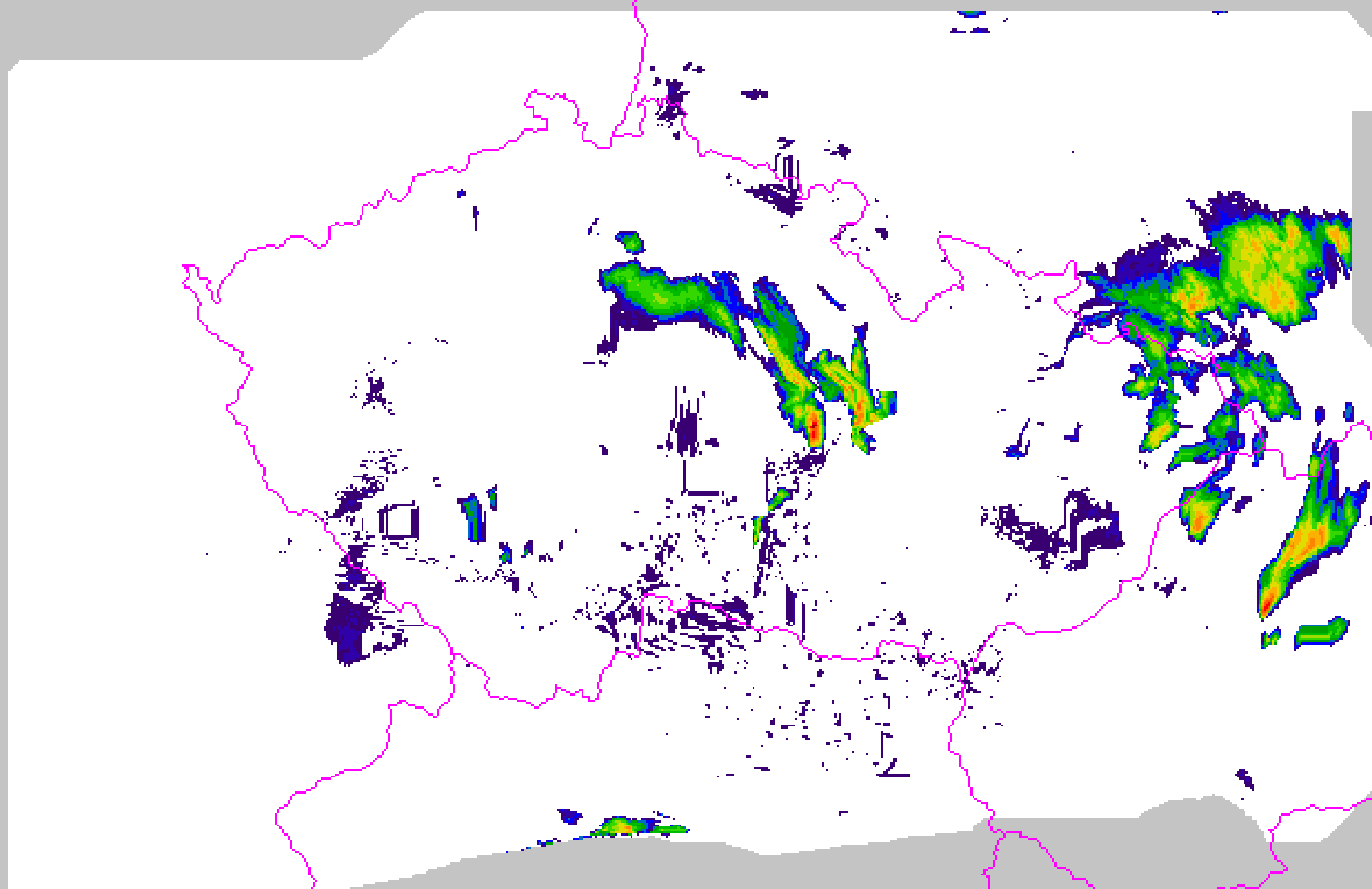
CZRAD - Z: cotrec fct +100min - 15.07.2002 17:00 UT



CZRAD - Z: cotrec fct +110min - 15.07.2002 17:10 UT



CZRAD - Z: cotrec fct +120min - 15.07.2002 17:20 UT



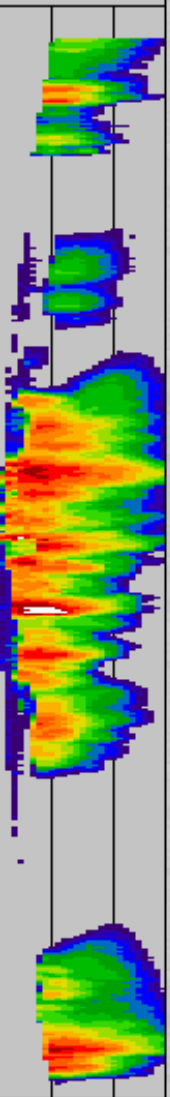
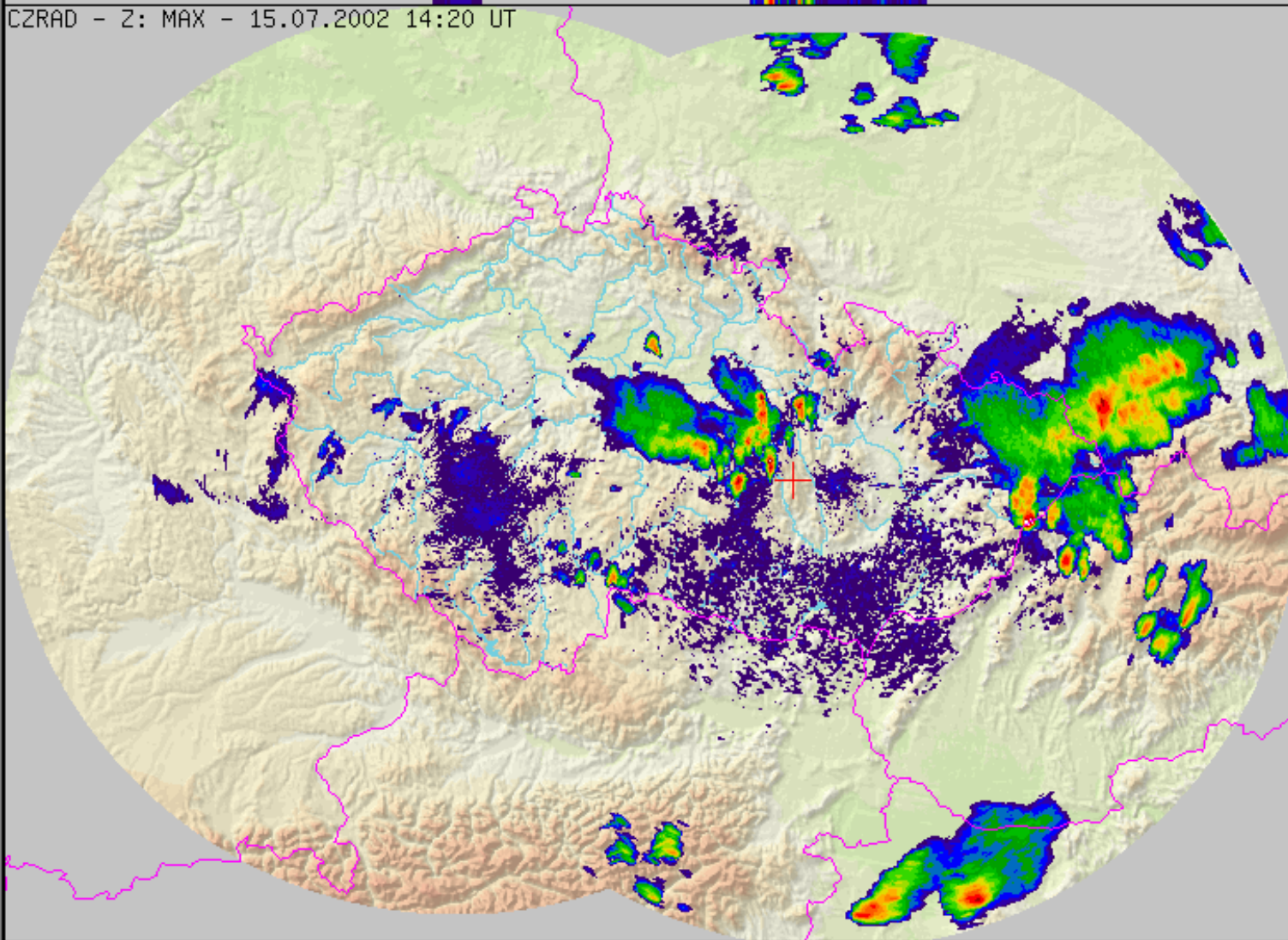
Overview of the convection development along with discharge forecasts

- radar reflectivities (10 minute measurement)
- discharge forecasts for Štěpánov profile

CHMI Radar
Department



CZRAD - Z: MAX - 15.07.2002 14:20 UT



Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20
- 15.07.2002 12:10
- 15.07.2002 12:00 ▼

LOAD (156 / 156)

| dBZ | °C |
|------|-------|
| 60.0 | -90.0 |
| 56.0 | -80.0 |
| 52.0 | -70.0 |
| 48.0 | -60.0 |
| 44.0 | -50.0 |
| 40.0 | -40.0 |
| 36.0 | -30.0 |
| 32.0 | -20.0 |
| 28.0 | -10.0 |
| 24.0 | 0.0 |

ANIM: 1 s/img LAST: +2 s AUTO UPDATE Do not update

ORO col UND riv PDUS RAD LIGHTNING NWP none OVR none

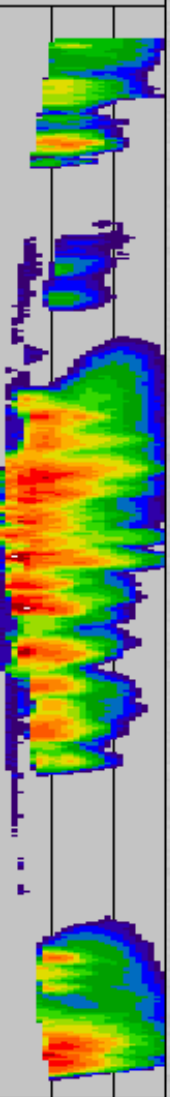
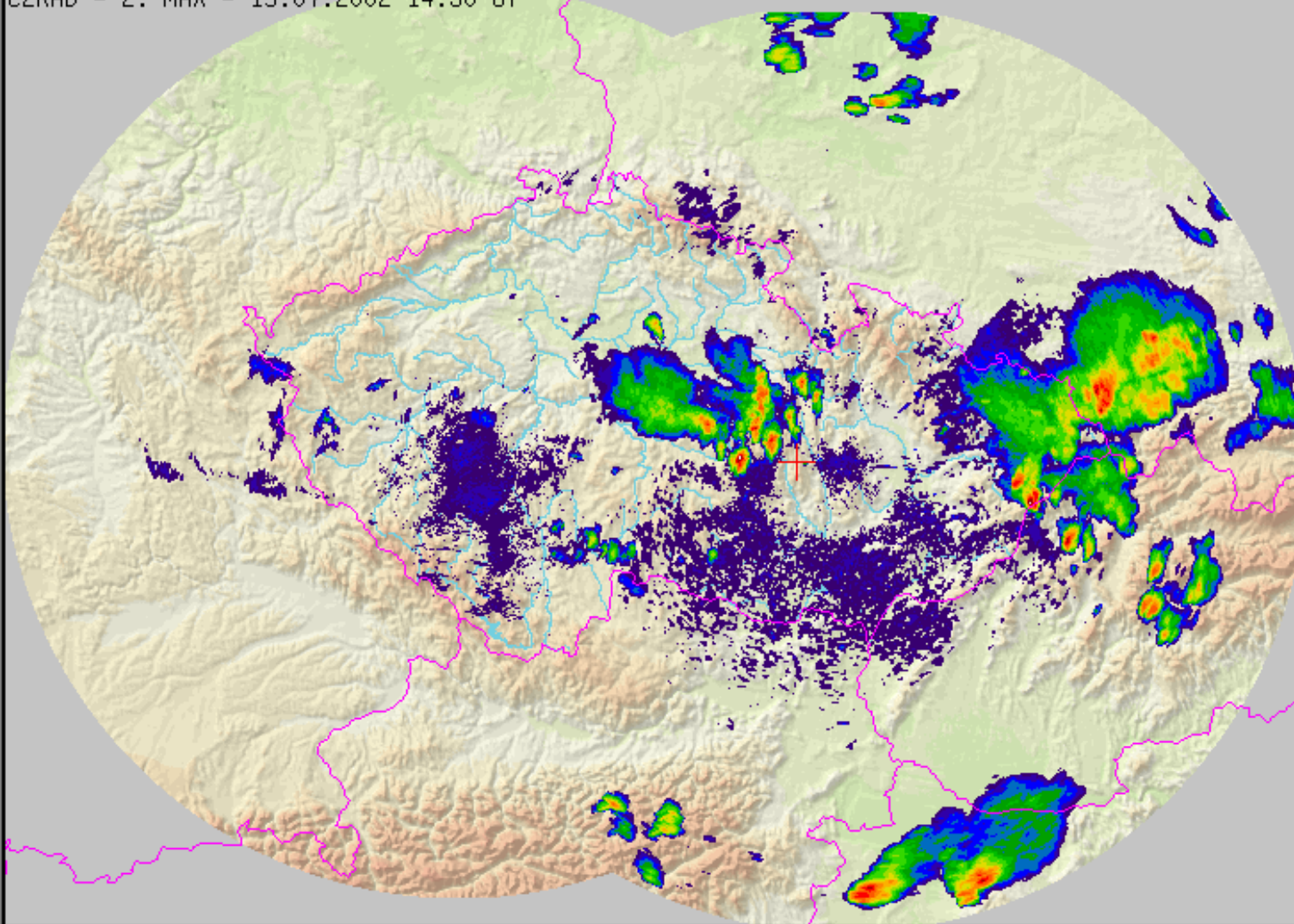
NAVIG. red LON. 16.432 LAT. 49.549 Choose predefined position

- CG neg
+ CG pos
| CC

CHMI Radar
Department



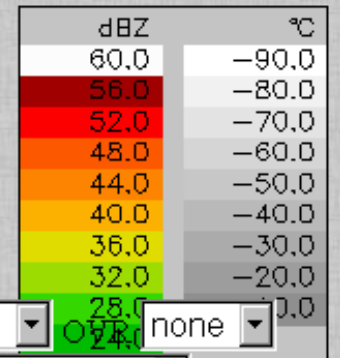
CZRAD - Z: MAX - 15.07.2002 14:30 UT



Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20
- 15.07.2002 12:10
- 15.07.2002 12:00 ▼

LOAD (156 / 156)



ANIM: 1 s/img LAST: +2 s AUTO UPDATE Do not update

ORO col UND riv PDUS RAD LIGHTNING NWP none

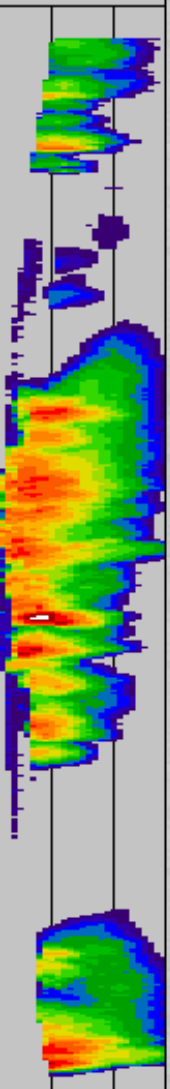
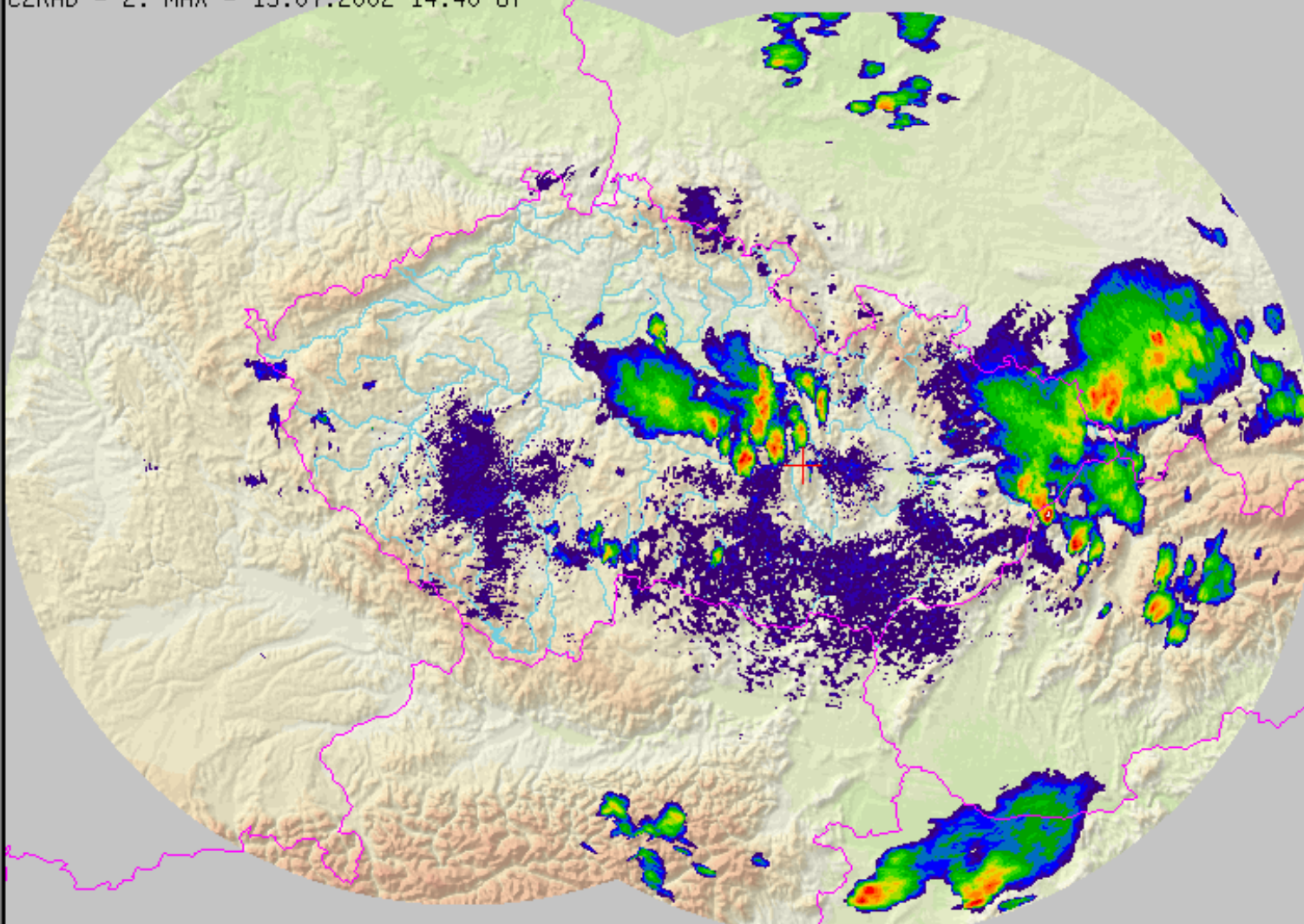
NAVIG. red LON. 16.432 LAT. 49.549 Choose predefined position

CG neg
CG pos
CC

CHMI Radar
Department



CZRAD - Z: MAX - 15.07.2002 14:40 UT



Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20
- 15.07.2002 12:10
- 15.07.2002 12:00 ▼

LOAD (156 / 156)

| dBZ | °C |
|------|-------|
| 60.0 | -90.0 |
| 56.0 | -80.0 |
| 52.0 | -70.0 |
| 48.0 | -60.0 |
| 44.0 | -50.0 |
| 40.0 | -40.0 |
| 36.0 | -30.0 |
| 32.0 | -20.0 |
| 28.0 | -10.0 |
| 24.0 | 0.0 |

<< || >> > ANIM: 1 s/img LAST: +2 s AUTO UPDATE Do not update

ORO col UND riv PDUS RAD LIGHTNING NWP none OVR none

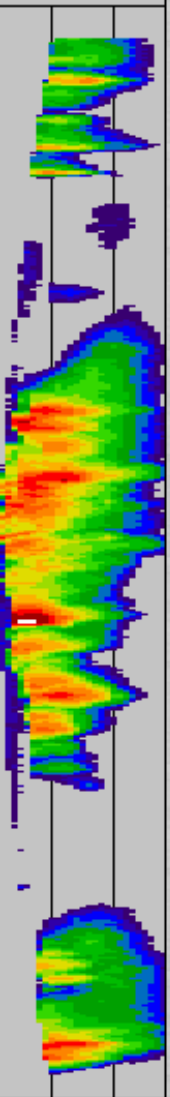
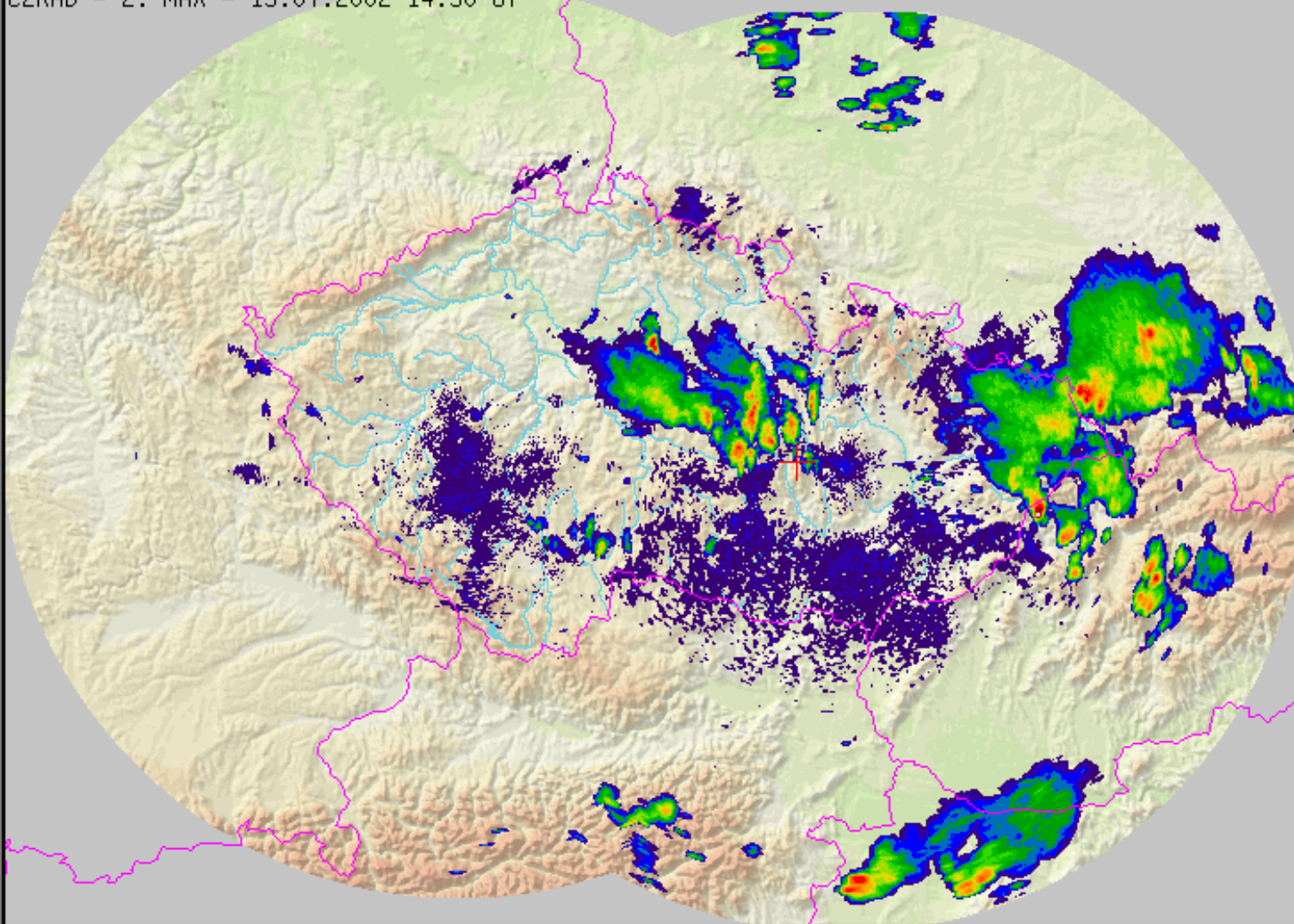
NAVIG. red LON. 16.432 LAT. 49.549 Choose predefined position

- CG neg
+ CG pos
| CC

CHMI Radar
Department



CZRAD - Z: MAX - 15.07.2002 14:50 UT



Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20
- 15.07.2002 12:10
- 15.07.2002 12:00 ▼

LOAD (156 / 156)

| dBZ | °C |
|------|-------|
| 60.0 | -90.0 |
| 56.0 | -80.0 |
| 52.0 | -70.0 |
| 48.0 | -60.0 |
| 44.0 | -50.0 |
| 40.0 | -40.0 |
| 36.0 | -30.0 |
| 32.0 | -20.0 |
| 28.0 | -10.0 |
| 24.0 | 0.0 |

<< || >> > ANIM: 1 s/img LAST: +2 s AUTO UPDATE Do not update

ORO col UND riv PDUS RAD LIGHTNING NWP none OVR none

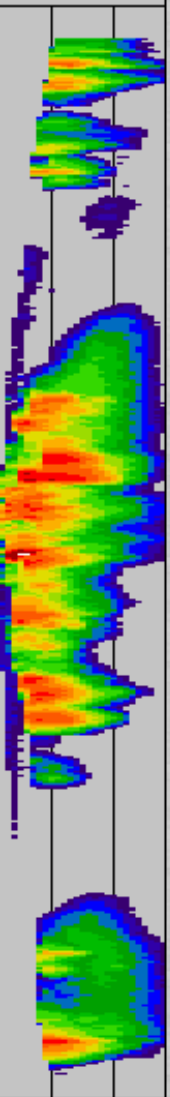
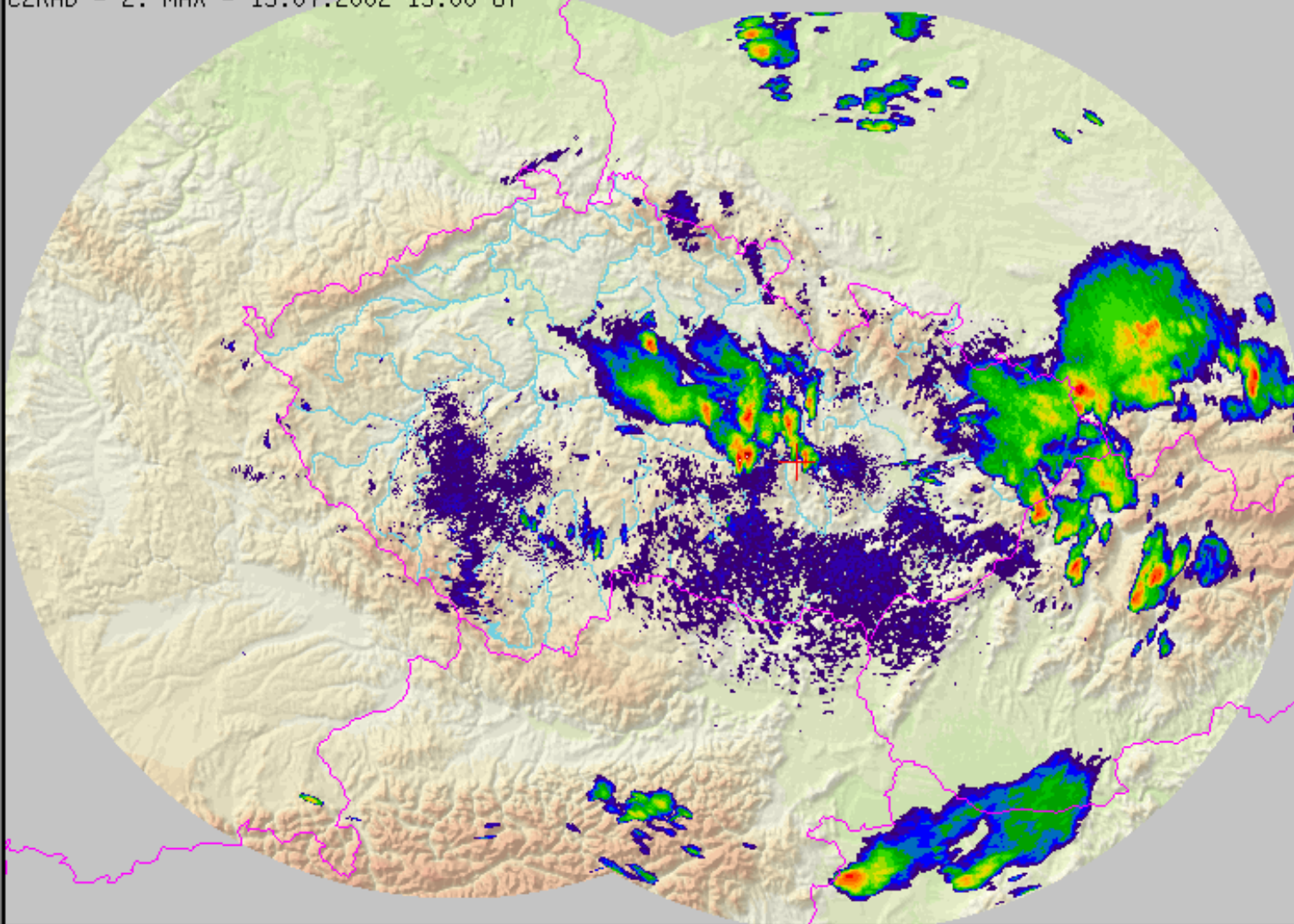
NAVIG. red LON. 16.432 LAT. 49.549 Choose predefined position

- CG neg
+ CG pos
| CC

CHMI Radar
Department



CZRAD - Z: MAX - 15.07.2002 15:00 UT



Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20
- 15.07.2002 12:10
- 15.07.2002 12:00 ▼

LOAD (156 / 156)

| dBZ | °C |
|------|-------|
| 60.0 | -90.0 |
| 56.0 | -80.0 |
| 52.0 | -70.0 |
| 48.0 | -60.0 |
| 44.0 | -50.0 |
| 40.0 | -40.0 |
| 36.0 | -30.0 |
| 32.0 | -20.0 |
| 28.0 | -10.0 |
| 24.0 | 0.0 |

ANIM: 1 s/img LAST: +2 s AUTO UPDATE Do not update

ORO col UND riv PDUS RAD LIGHTNING NWP none OVR none

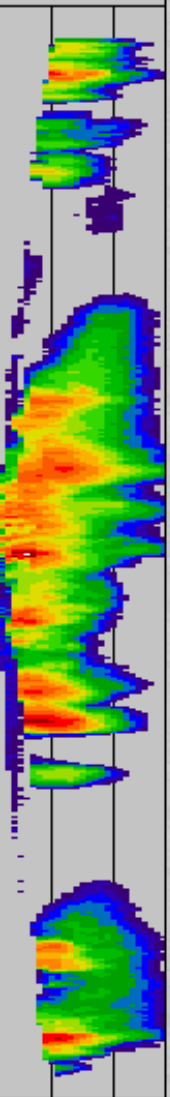
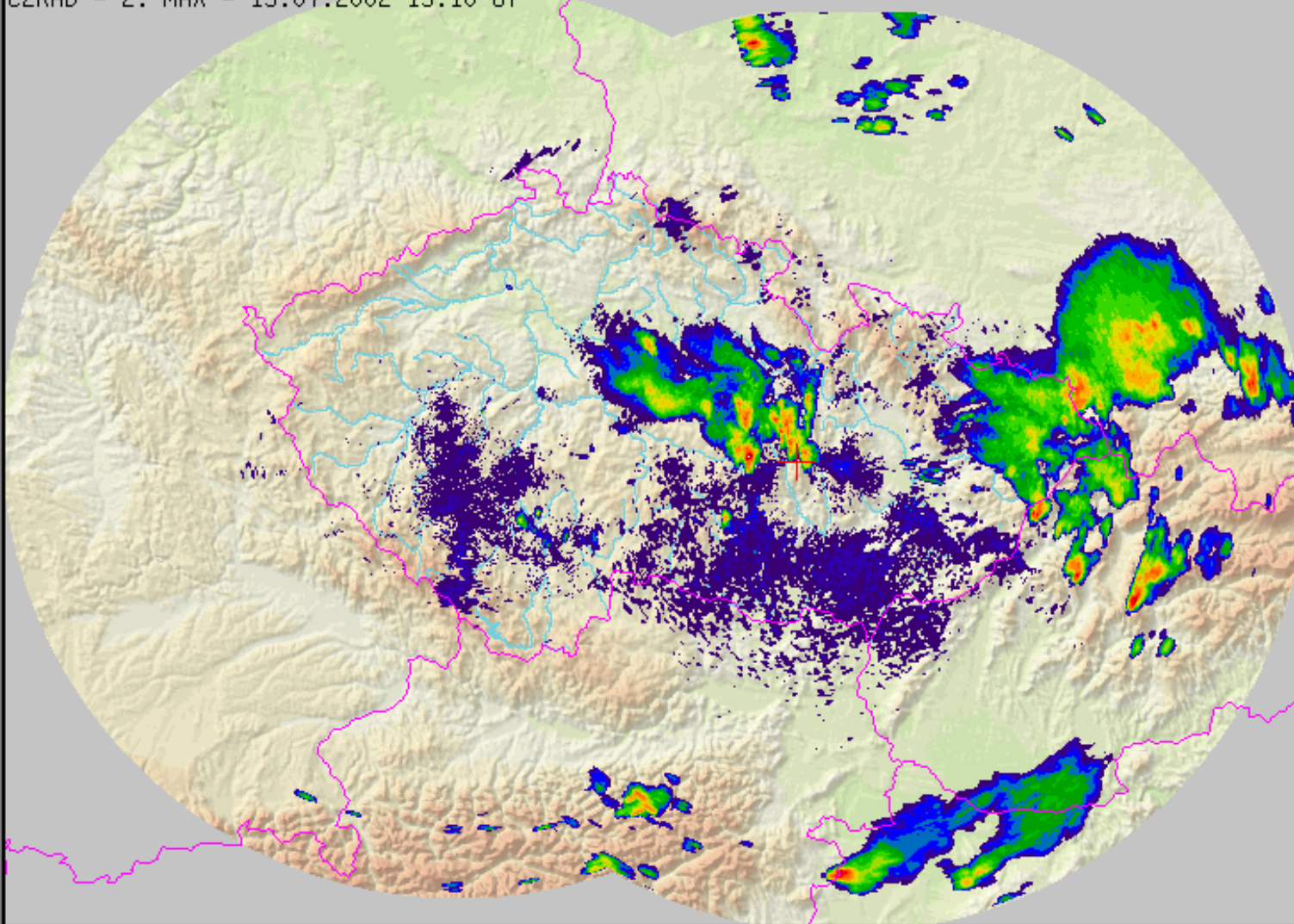
NAVIG. red LON. 16.432 LAT. 49.549 Choose predefined position

- CG neg
+ CG pos
| CC

CHMI Radar
Department



CZRAD - Z: MAX - 15.07.2002 15:10 UT



Every

- 15.07.2002 16:00 ▲
- 15.07.2002 15:50
- 15.07.2002 15:40
- 15.07.2002 15:30
- 15.07.2002 15:20
- 15.07.2002 15:10
- 15.07.2002 15:00
- 15.07.2002 14:50
- 15.07.2002 14:40
- 15.07.2002 14:30
- 15.07.2002 14:20
- 15.07.2002 14:10 ▼

LOAD (99 / 99)

| dBZ | °C |
|------|-------|
| 60.0 | -90.0 |
| 56.0 | -80.0 |
| 52.0 | -70.0 |
| 48.0 | -60.0 |
| 44.0 | -50.0 |
| 40.0 | -40.0 |
| 36.0 | -30.0 |
| 32.0 | -20.0 |
| 28.0 | -10.0 |
| 24.0 | 0.0 |

ANIM: 1 s/img LAST: +2 s AUTO UPDATE Do not update

ORO col UND riv PDUS RAD LIGHTNING NWP none OVR none

NAVIG. red LON. 16.432 LAT. 49.549 Choose predefined position

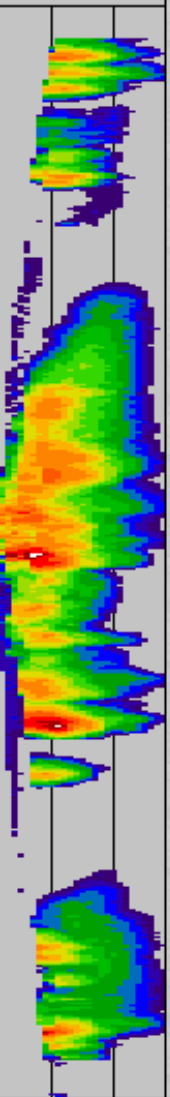
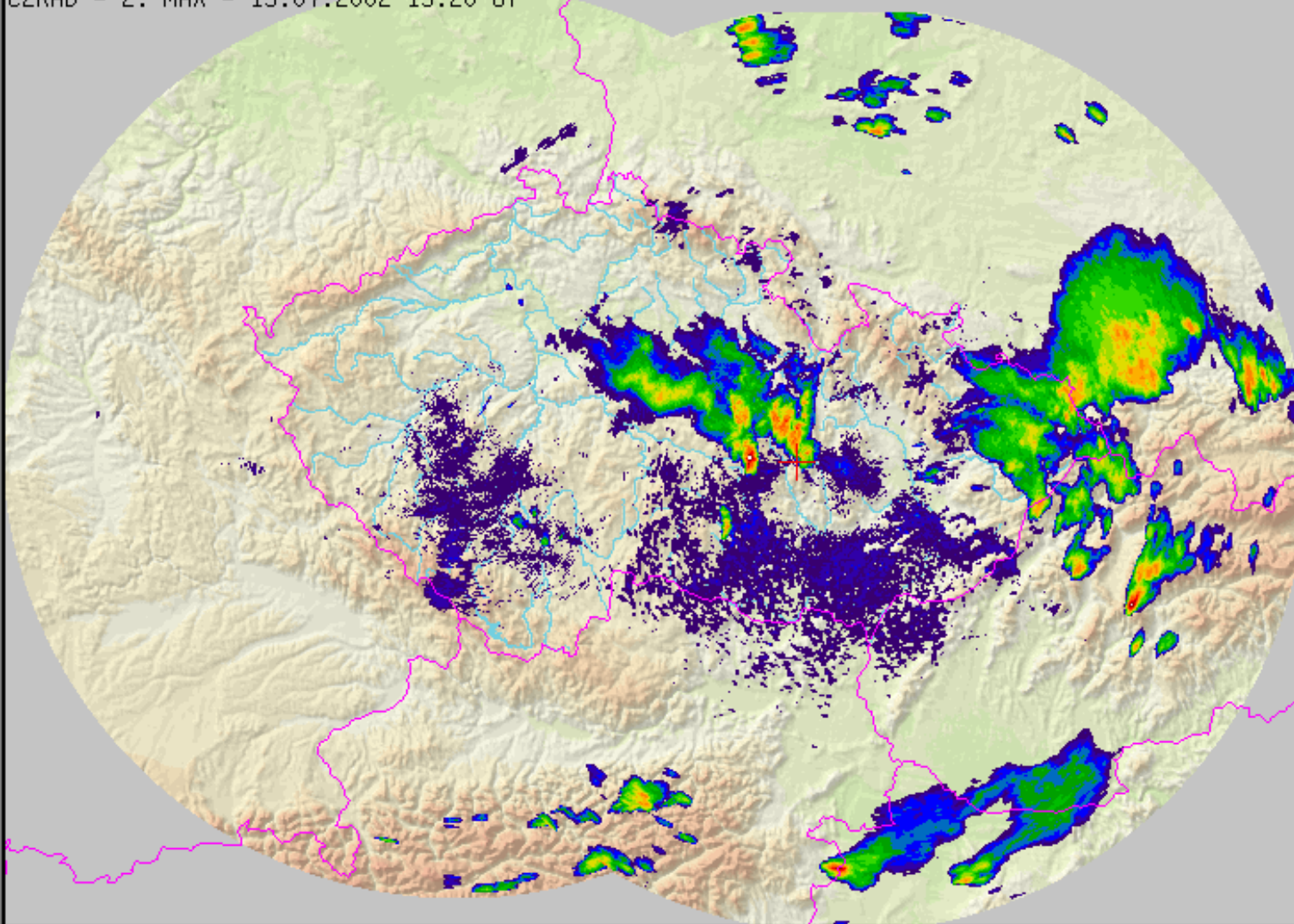
CG neg
+ CG pos
CC

Last update: 15.07.2002 15:10

CHMI Radar
Department



CZRAD - Z: MAX - 15.07.2002 15:20 UT



Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20
- 15.07.2002 12:10
- 15.07.2002 12:00 ▼

LOAD (156 / 156)

| dBZ | °C |
|------|-------|
| 60.0 | -90.0 |
| 56.0 | -80.0 |
| 52.0 | -70.0 |
| 48.0 | -60.0 |
| 44.0 | -50.0 |
| 40.0 | -40.0 |
| 36.0 | -30.0 |
| 32.0 | -20.0 |
| 28.0 | -10.0 |
| 24.0 | 0.0 |

ANIM: LAST: AUTO UPDATE

ORO UND PDUS RAD LIGHTNING NWP OVR

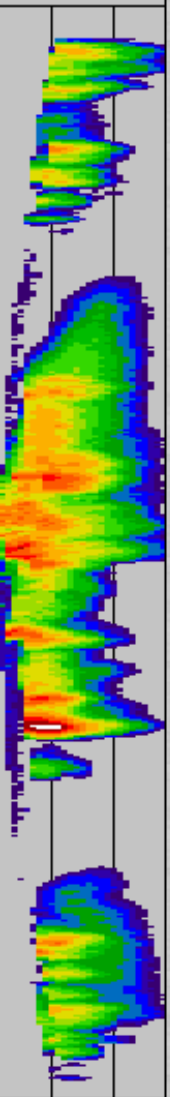
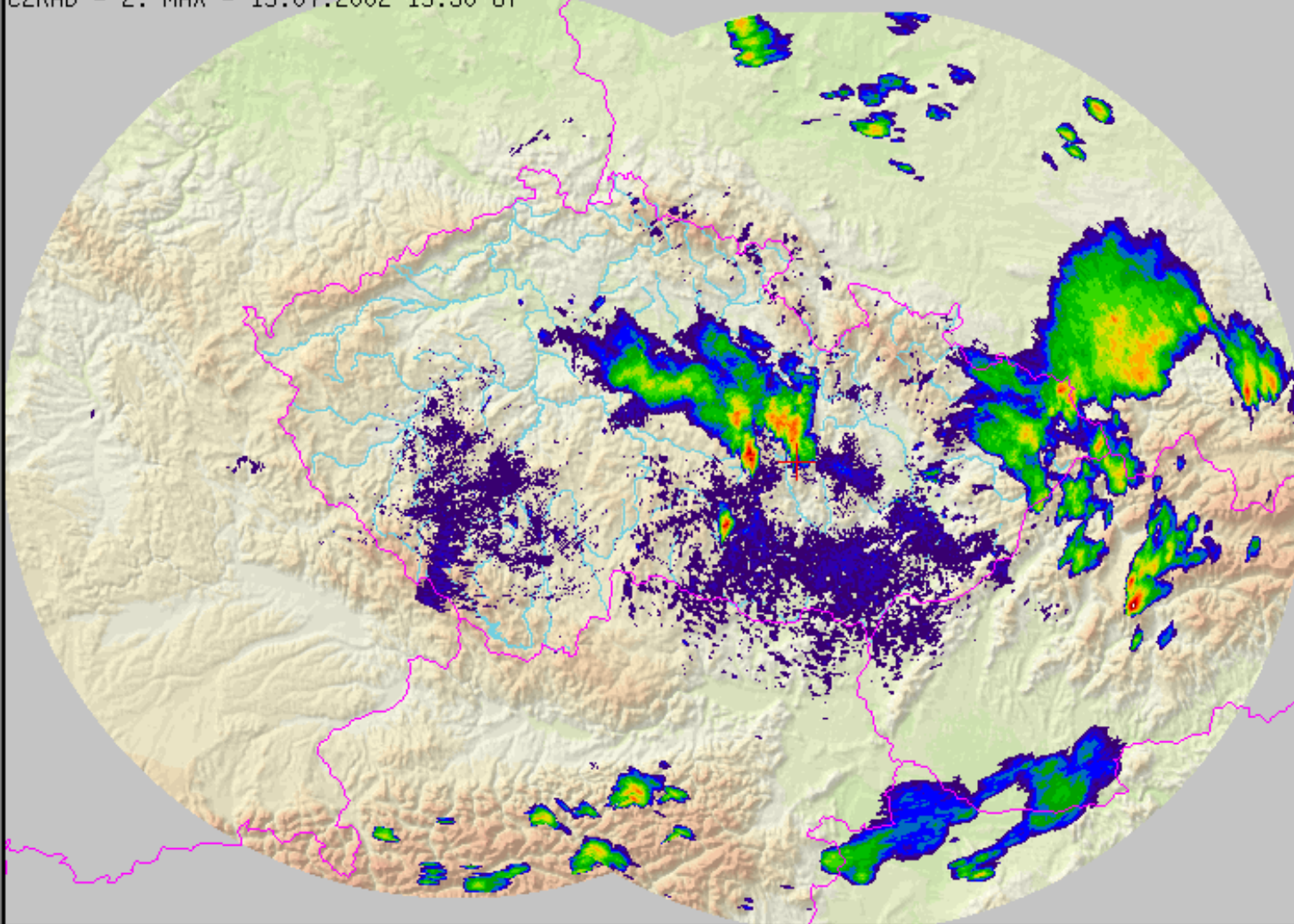
NAVIG. LON. LAT. Choose predefined position

- CG neg
+ CG pos
| CC

CHMI Radar
Department



CZRAD - Z: MAX - 15.07.2002 15:30 UT



Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20
- 15.07.2002 12:10
- 15.07.2002 12:00 ▼

LOAD (156 / 156)

| dBZ | °C |
|------|-------|
| 60.0 | -90.0 |
| 56.0 | -80.0 |
| 52.0 | -70.0 |
| 48.0 | -60.0 |
| 44.0 | -50.0 |
| 40.0 | -40.0 |
| 36.0 | -30.0 |
| 32.0 | -20.0 |
| 28.0 | -10.0 |
| 24.0 | 0.0 |

<< || >> > ANIM: 1 s/img LAST: +2 s AUTO UPDATE Do not update

ORO col UND riv PDUS RAD LIGHTNING NWP none OVR none

NAVIG. red LON. 16.432 LAT. 49.549 Choose predefined position

- CG neg
+ CG pos
| CC

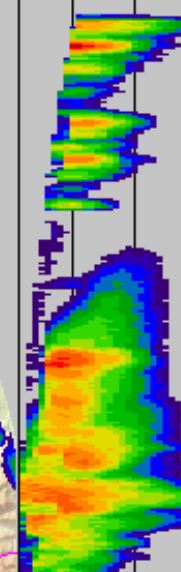
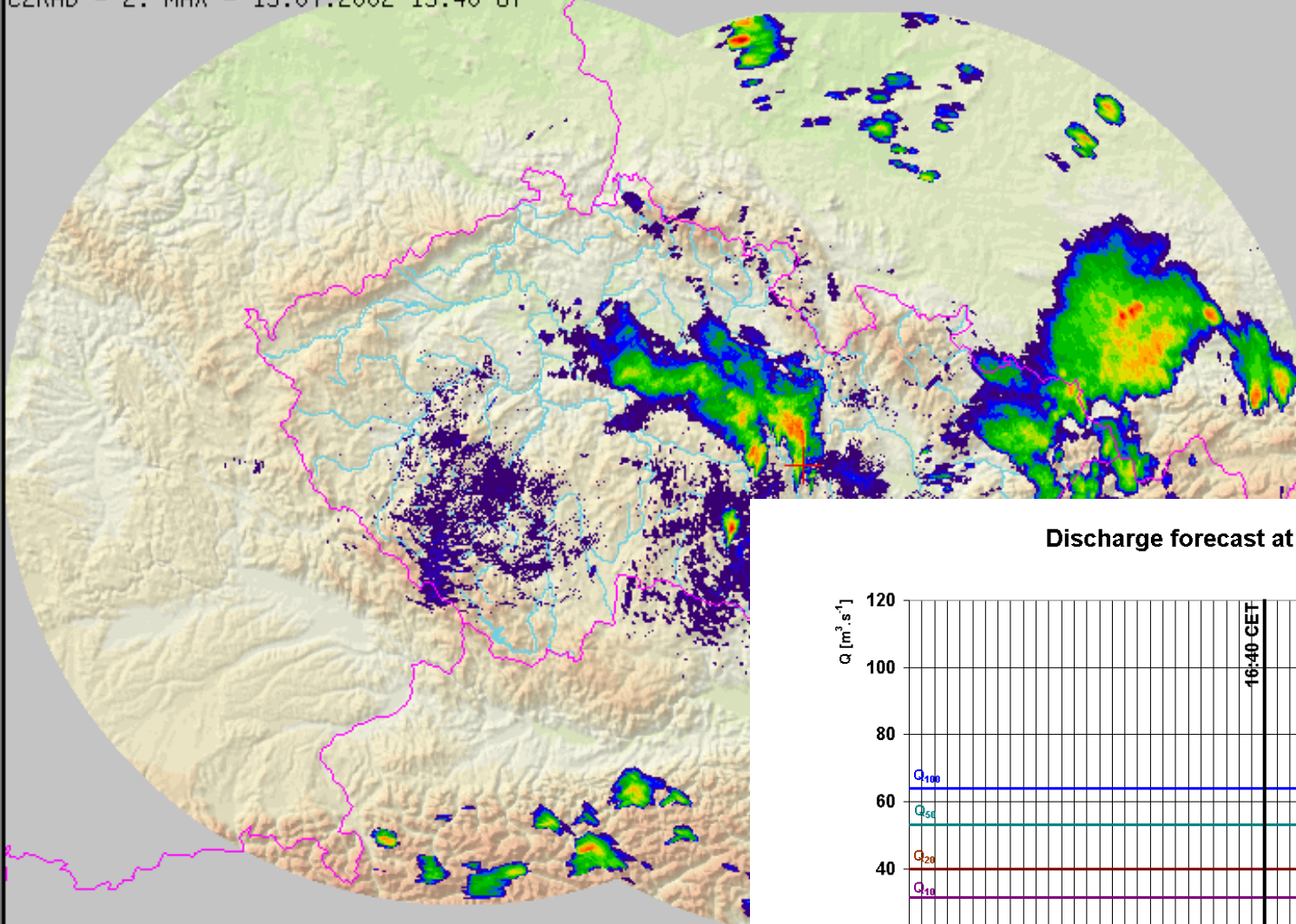
CHMI Radar
Department



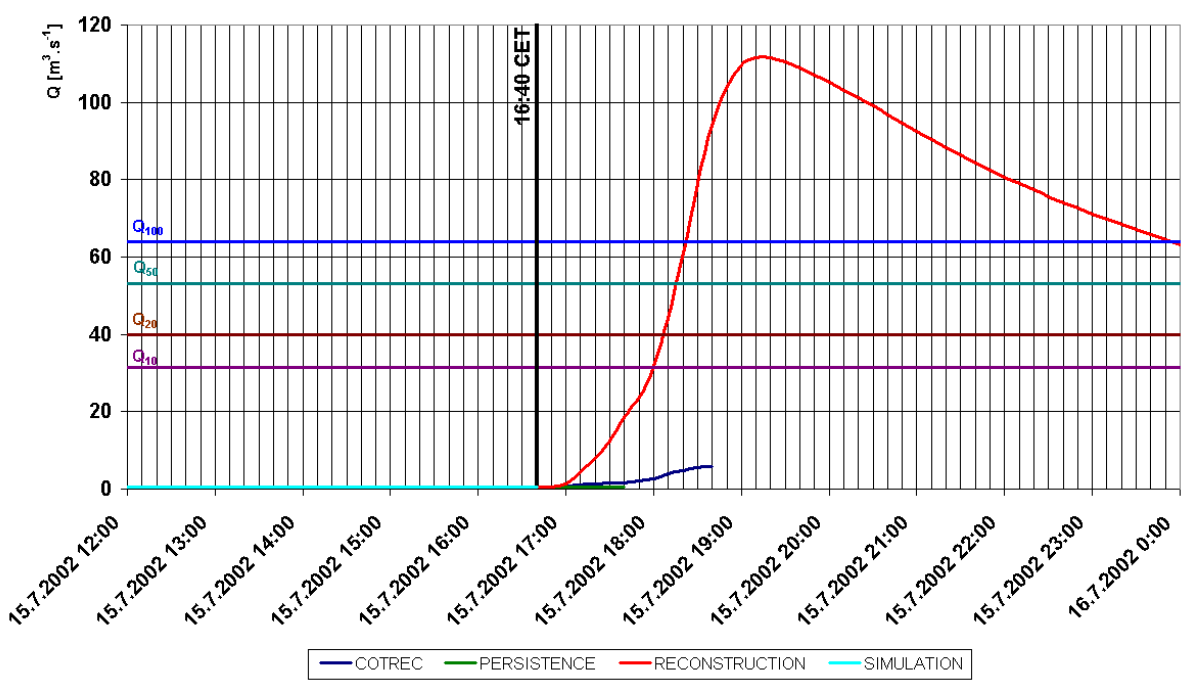
Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20

CZRAD - Z: MAX - 15.07.2002 15:40 UT



Discharge forecast at Štěpánov, 16:40 CET

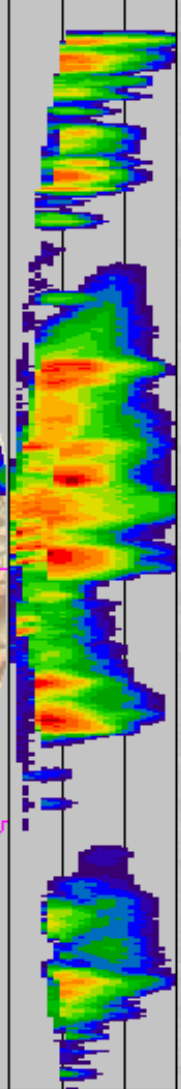
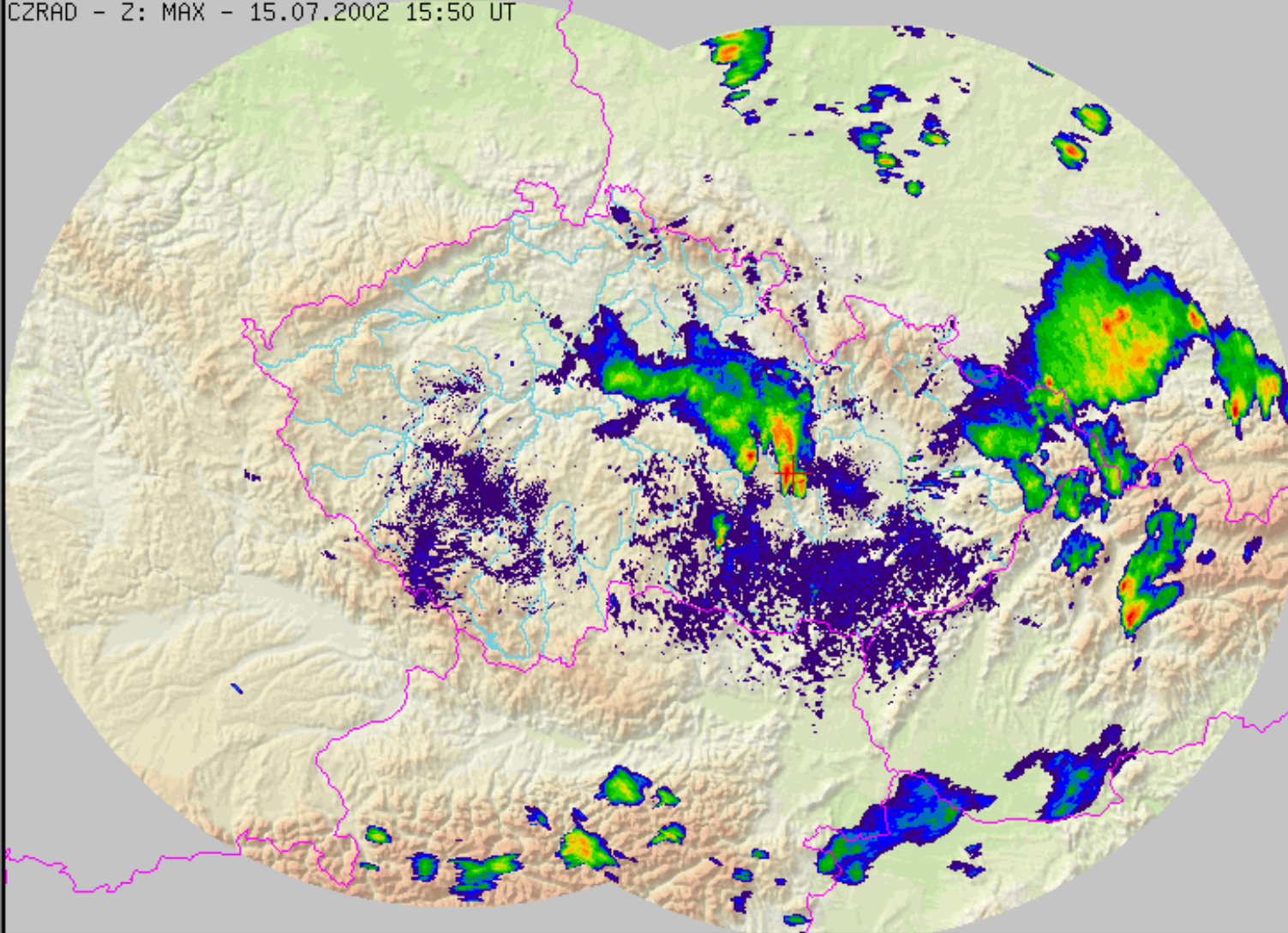


ANIM: 1 s/img LAST: +2 s
 ORO col UND riv PDUS RAD LIGHTND
 NAVIG. red LON. 16.432 LAT. 49.549

CHMI Radar
Department



CZRAD - Z: MAX - 15.07.2002 15:50 UT



Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20
- 15.07.2002 12:10
- 15.07.2002 12:00 ▼

LOAD (156 / 156)

| dBZ | °C |
|------|-------|
| 60.0 | -90.0 |
| 56.0 | -80.0 |
| 52.0 | -70.0 |
| 48.0 | -60.0 |
| 44.0 | -50.0 |
| 40.0 | -40.0 |
| 36.0 | -30.0 |
| 32.0 | -20.0 |
| 28.0 | -10.0 |
| 24.0 | 0.0 |

ANIM: 1 s/img LAST: +2 s AUTO UPDATE Do not update

ORO col UND riv PDUS RAD LIGHTNING NWP none OVR none

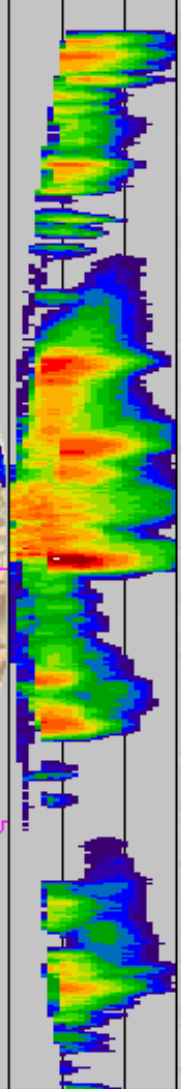
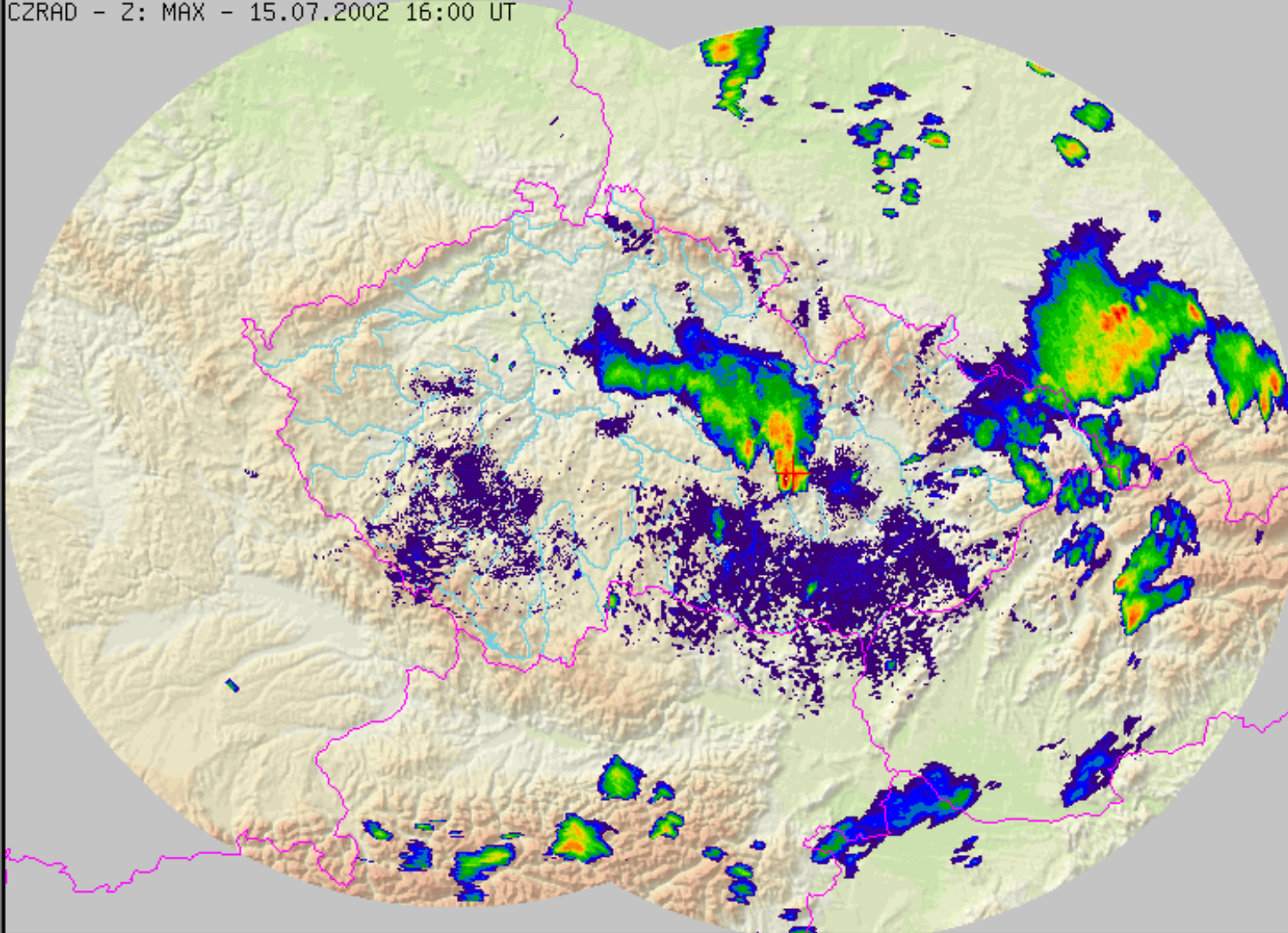
NAVIG. red LON. 16.432 LAT. 49.549 Choose predefined position

- CG neg
+ CG pos
| CC

CHMI Radar
Department



CZRAD - Z: MAX - 15.07.2002 16:00 UT



Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20
- 15.07.2002 12:10
- 15.07.2002 12:00 ▼

LOAD (156 / 156)

| dBZ | °C |
|------|-------|
| 60.0 | -90.0 |
| 56.0 | -80.0 |
| 52.0 | -70.0 |
| 48.0 | -60.0 |
| 44.0 | -50.0 |
| 40.0 | -40.0 |
| 36.0 | -30.0 |
| 32.0 | -20.0 |
| 28.0 | -10.0 |
| 24.0 | 0.0 |

< < || >> > ANIM: 1 s/img LAST: +2 s AUTO UPDATE Do not update

ORO col UND riv PDUS RAD LIGHTNING NWP none OVR none

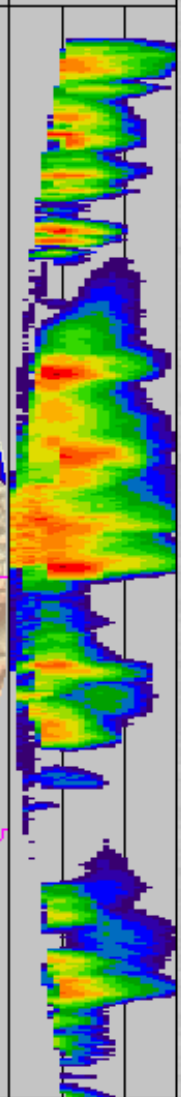
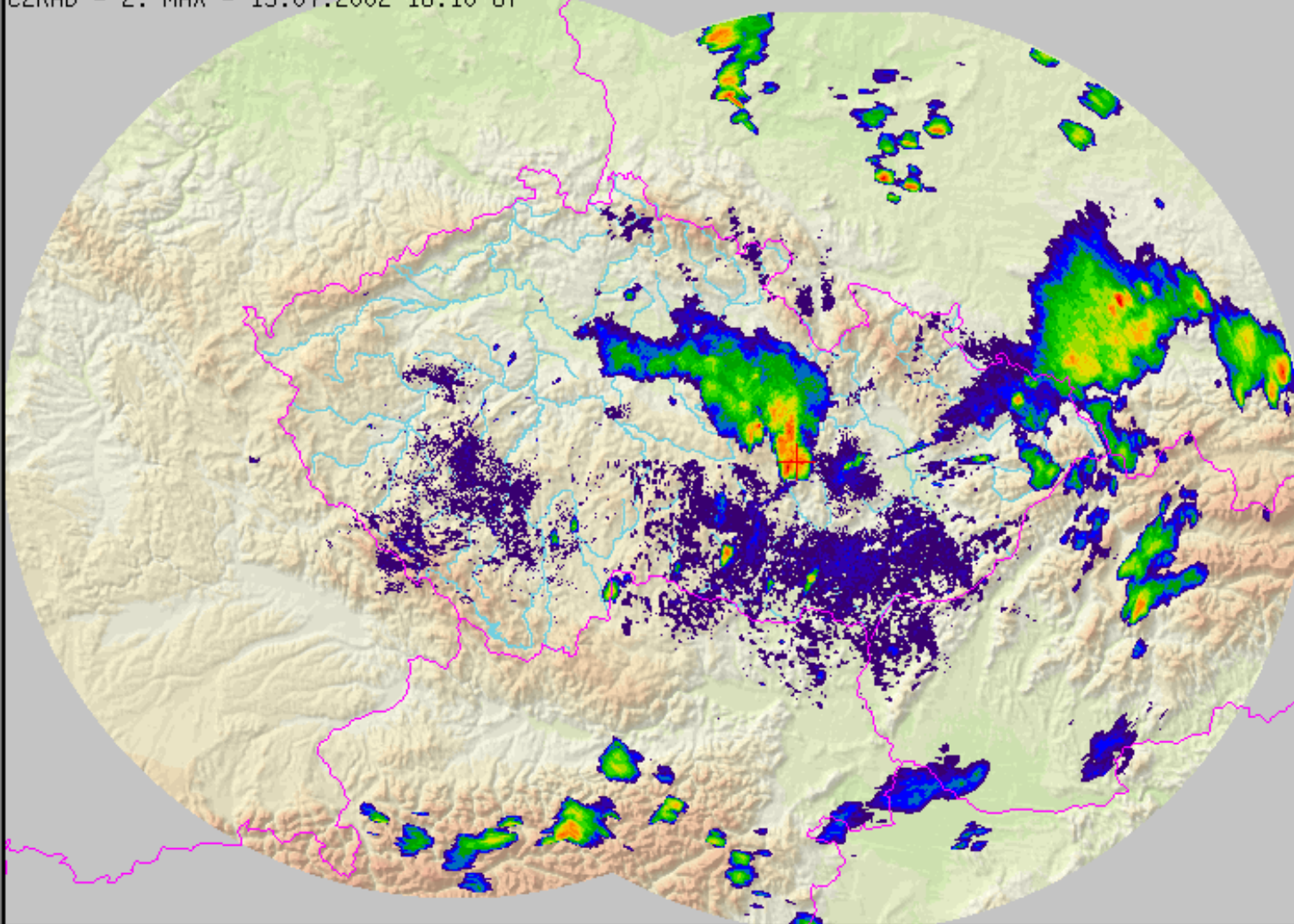
NAVIG. red LON. 16.432 LAT. 49.549 Choose predefined position

CG neg
CG pos
CC

CHMI Radar
Department



CZRAD - Z: MAX - 15.07.2002 16:10 UT



Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20
- 15.07.2002 12:10
- 15.07.2002 12:00 ▼

LOAD (156 / 156)

| dBZ | °C |
|------|-------|
| 60.0 | -90.0 |
| 56.0 | -80.0 |
| 52.0 | -70.0 |
| 48.0 | -60.0 |
| 44.0 | -50.0 |
| 40.0 | -40.0 |
| 36.0 | -30.0 |
| 32.0 | -20.0 |
| 28.0 | -10.0 |
| 24.0 | 0.0 |

< < || >> > ANIM: 1 s/img LAST: +2 s AUTO UPDATE Do not update

ORO col UND riv PDUS RAD LIGHTNING NWP none OVR none

NAVIG. red LON. 16.432 LAT. 49.549 Choose predefined position

CG neg
CG pos
CC

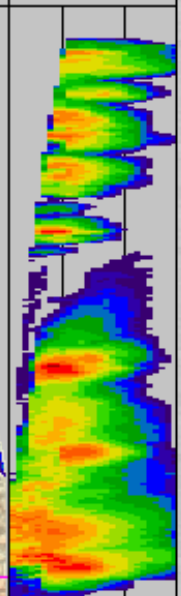
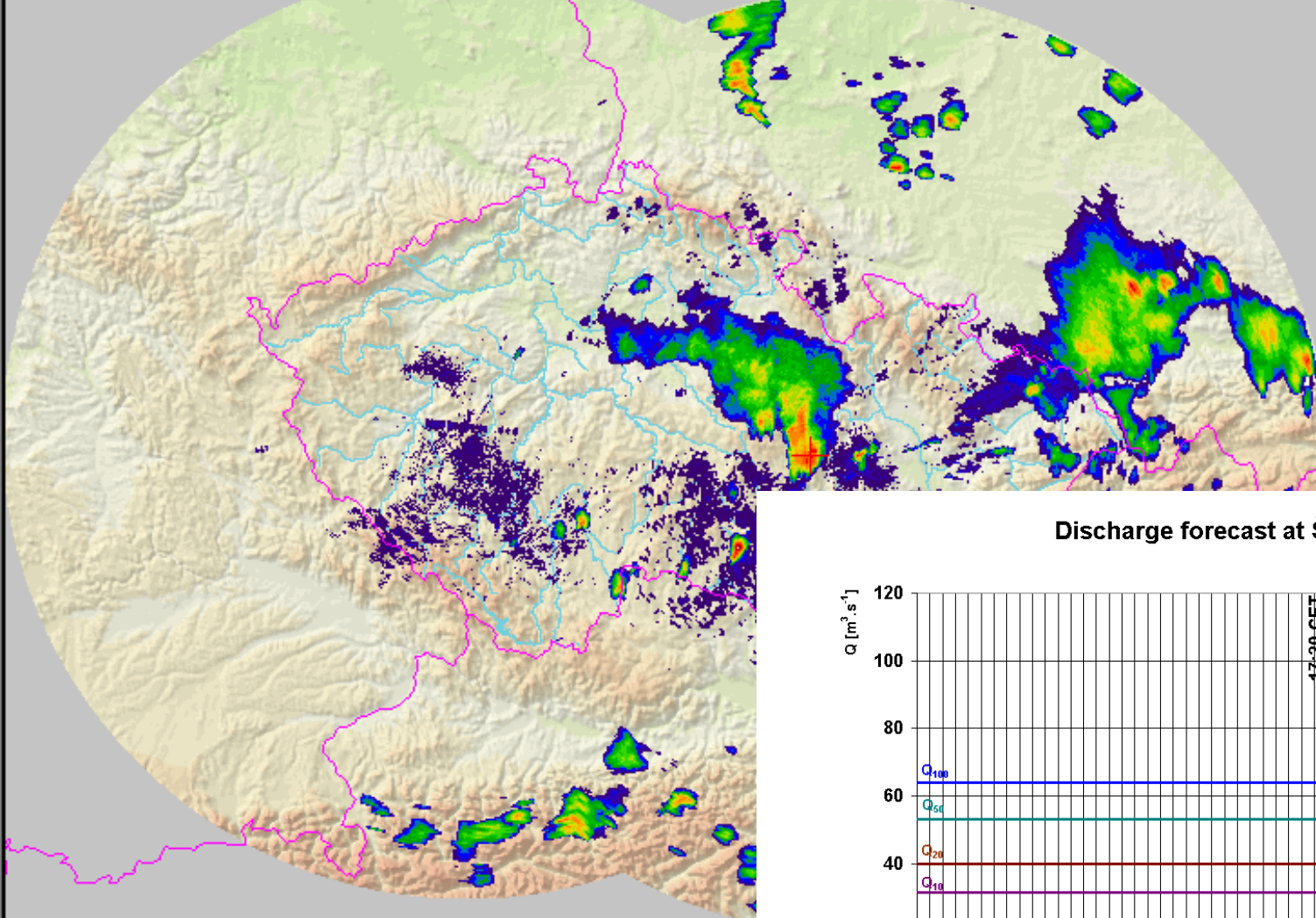
CHMI Radar
Department



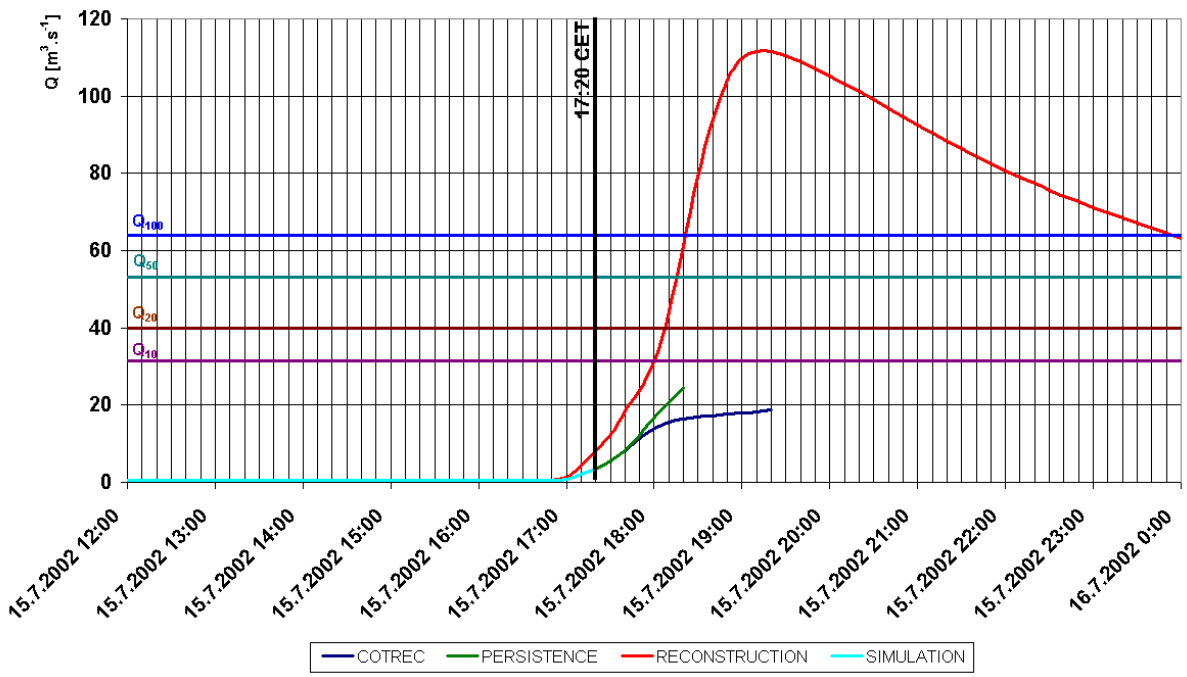
Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20

CZRAD - Z: MAX - 15.07.2002 16:20 UT



Discharge forecast at Štěpánov, 17:20 CET



ANIM: 1 s/img LAST: +2 s
 ORO col UND riv PDUS RAD LIGHTND
 NAVIG. red LON. 16.432 LAT. 49.549

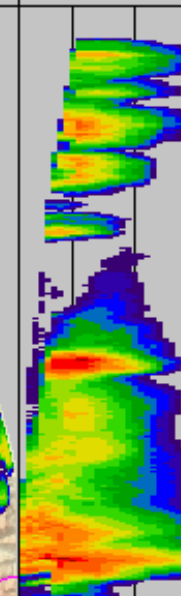
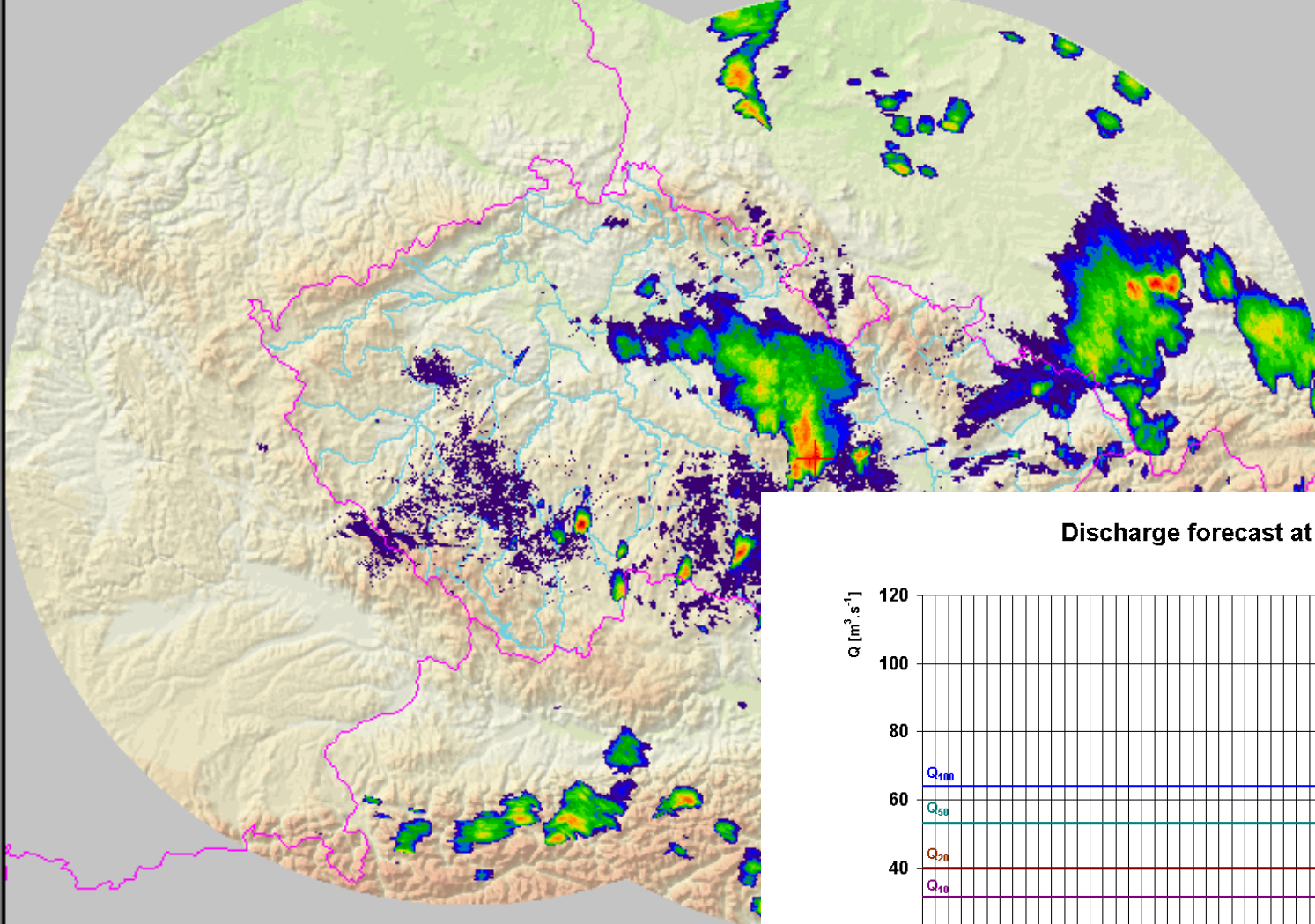
CHMI Radar
Department



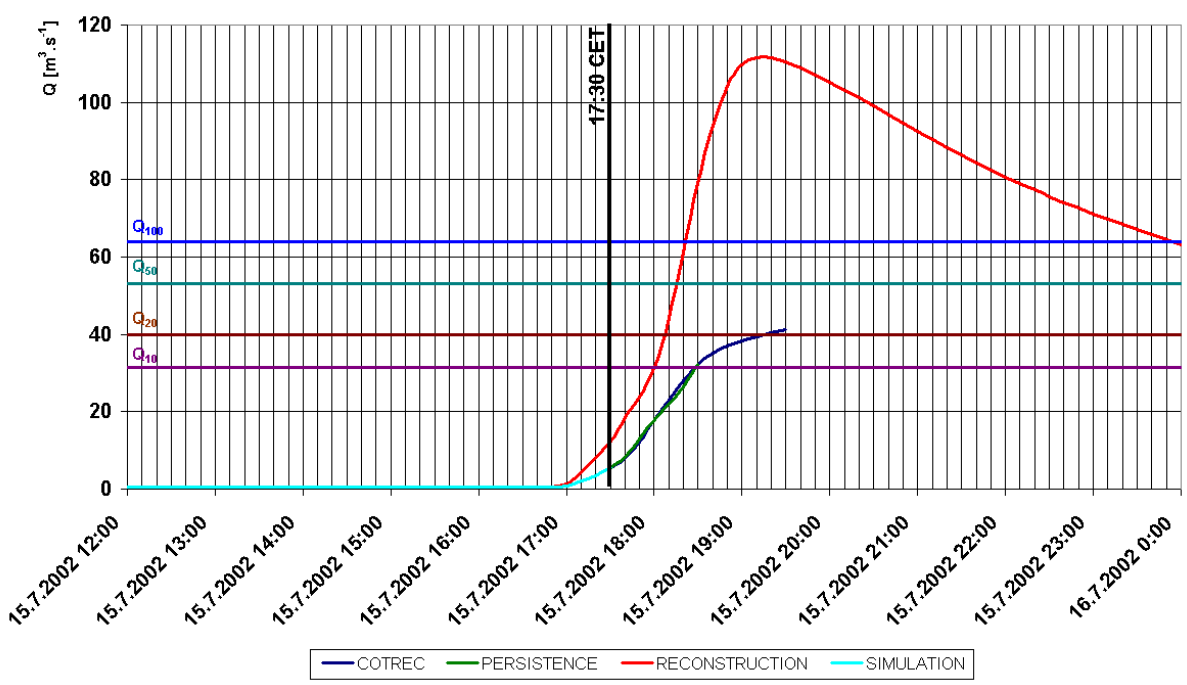
Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20

CZRAD - Z: MAX - 15.07.2002 16:30 UT



Discharge forecast at Štěpánov, 17:30 CET

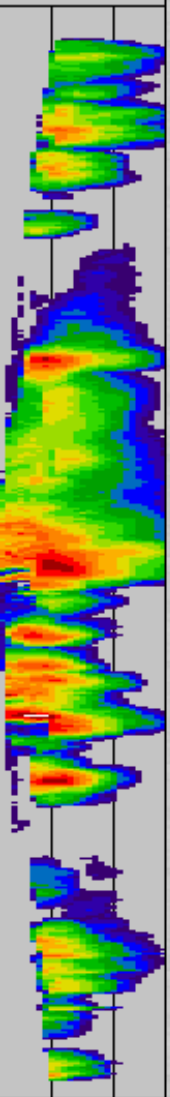
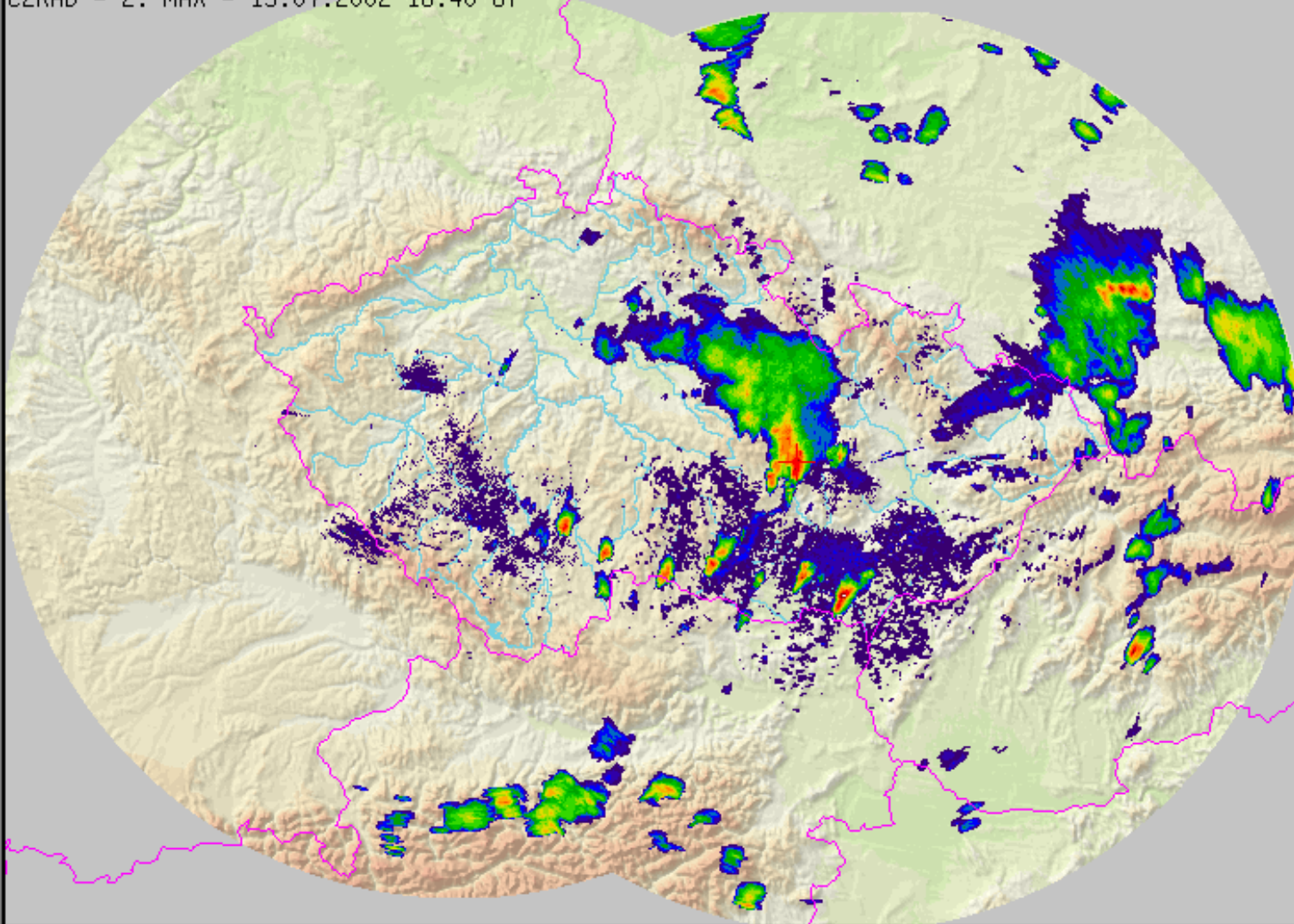


ANIM: 1 s/img ▾ LAST: +2 s
 ORO col ▾ UND riv ▾ PDUS RAD LIGHTND
 NAVIG: red ▾ LON: 16.432 LAT: 49.549

CHMI Radar
Department



CZRAD - Z: MAX - 15.07.2002 16:40 UT



Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20
- 15.07.2002 12:10
- 15.07.2002 12:00 ▼

LOAD (156 / 156)

| dBZ | °C |
|------|-------|
| 60.0 | -90.0 |
| 56.0 | -80.0 |
| 52.0 | -70.0 |
| 48.0 | -60.0 |
| 44.0 | -50.0 |
| 40.0 | -40.0 |
| 36.0 | -30.0 |
| 32.0 | -20.0 |
| 28.0 | -10.0 |
| 24.0 | 0.0 |

ANIM: 1 s/img LAST: +2 s AUTO UPDATE Do not update

ORO col UND riv PDUS RAD LIGHTNING NWP none OVR none

NAVIG. red LON. 16.432 LAT. 49.549 Choose predefined position

- CG neg
+ CG pos
| CC

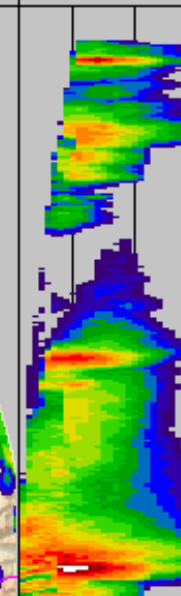
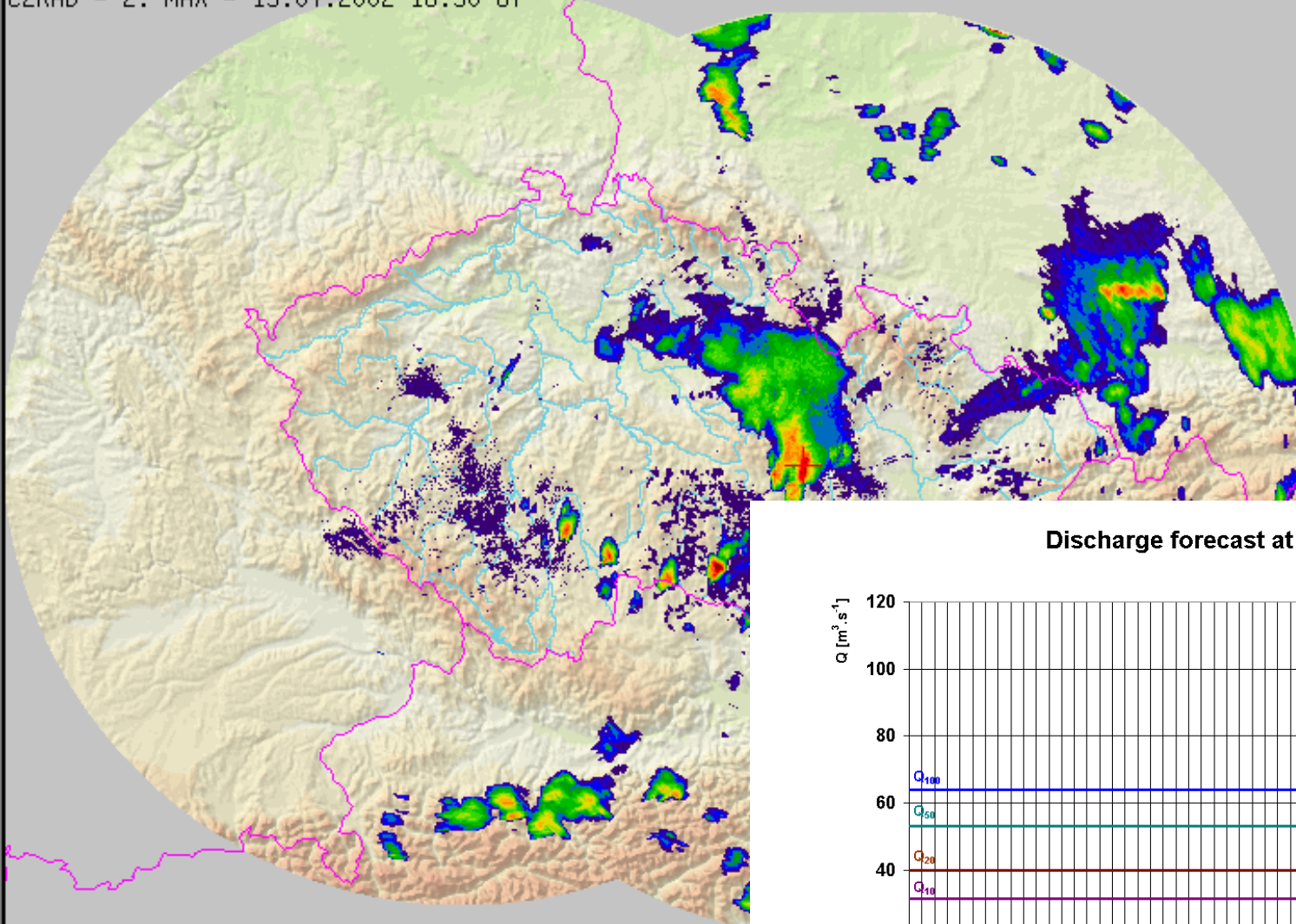
CHMI Radar
Department



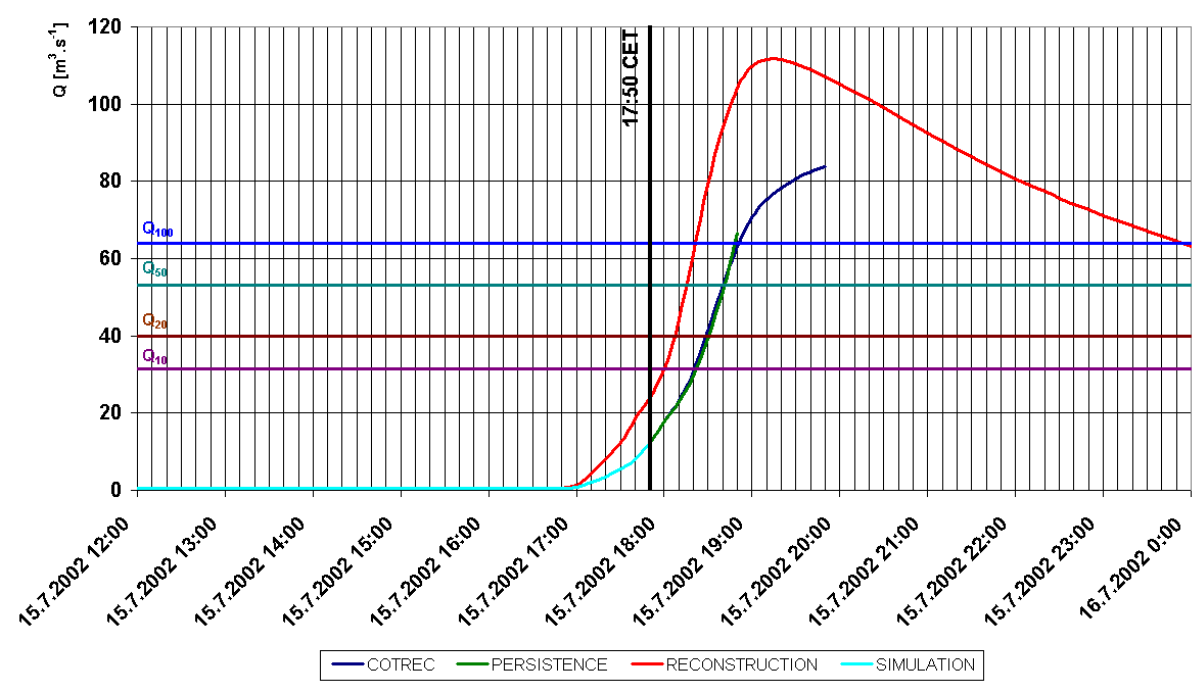
Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20

CZRAD - Z: MAX - 15.07.2002 16:50 UT



Discharge forecast at Štěpánov, 17:50 CET

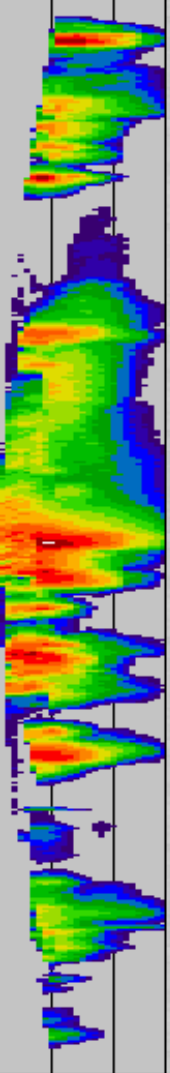
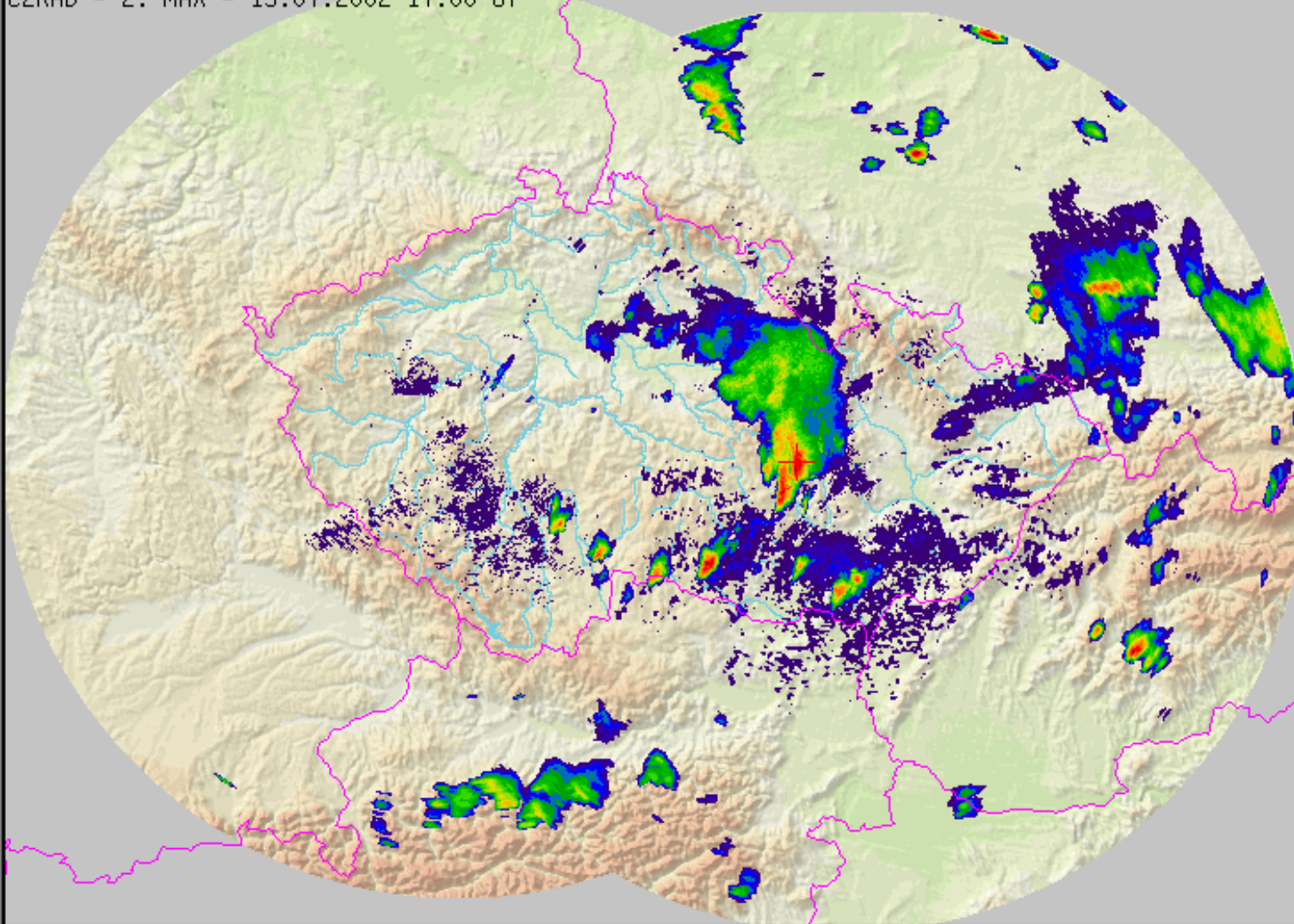


ANIM: 1 s/img LAST: +2 s
 ORO col UND riv PDUS RAD LIGHTND
 NAVIG. red LON. 16.432 LAT. 49.549

CHMI Radar
Department



CZRAD - Z: MAX - 15.07.2002 17:00 UT



Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20
- 15.07.2002 12:10
- 15.07.2002 12:00 ▼

LOAD (156 / 156)

| dBZ | °C |
|------|-------|
| 60.0 | -90.0 |
| 56.0 | -80.0 |
| 52.0 | -70.0 |
| 48.0 | -60.0 |
| 44.0 | -50.0 |
| 40.0 | -40.0 |
| 36.0 | -30.0 |
| 32.0 | -20.0 |
| 28.0 | -10.0 |
| 24.0 | 0.0 |

ANIM: 1 s/img LAST: +2 s AUTO UPDATE Do not update

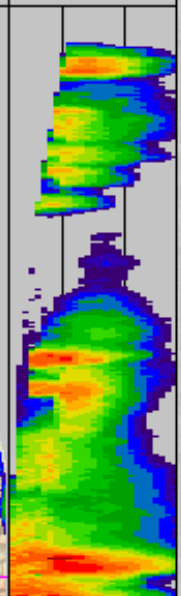
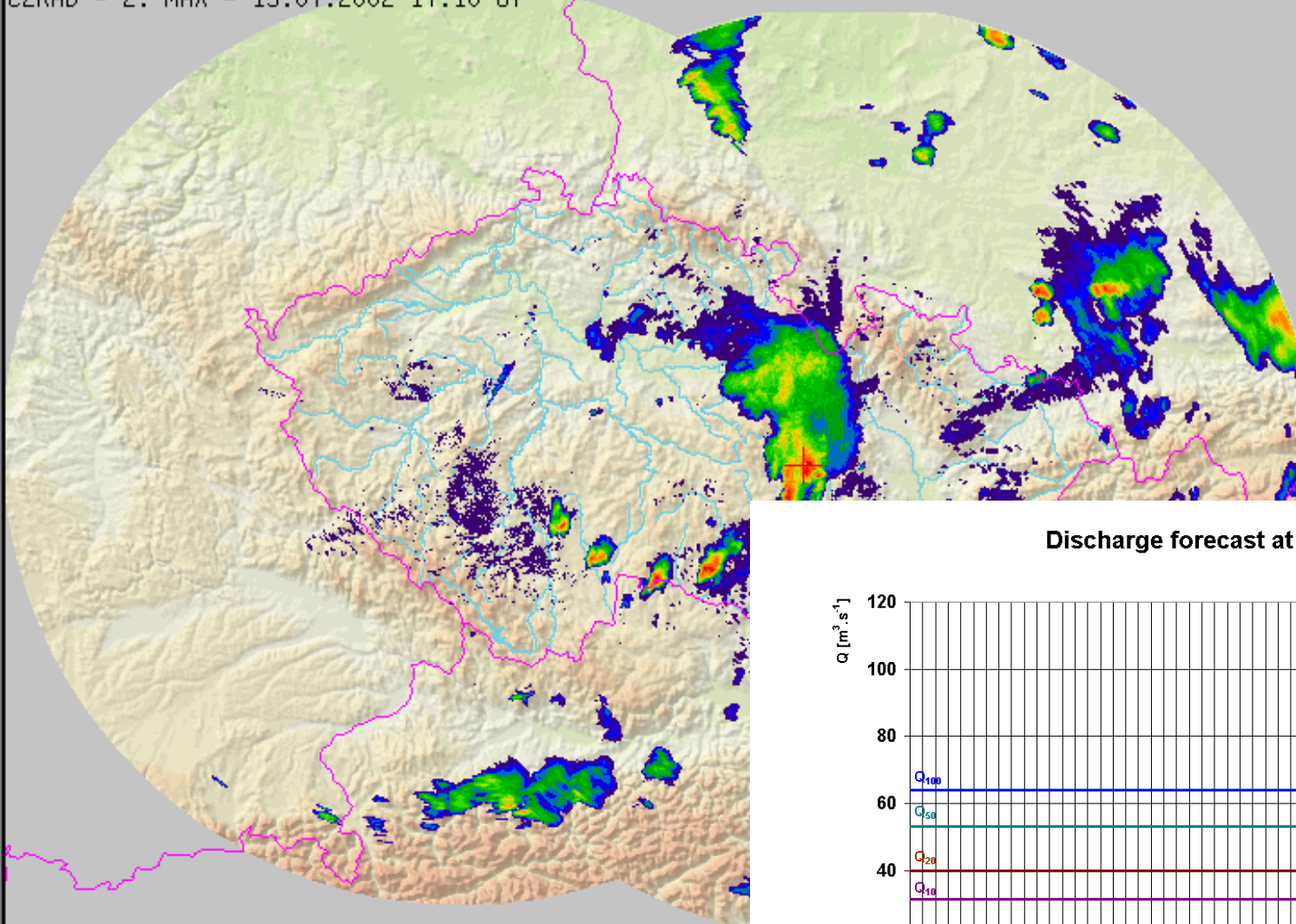
ORO col UND riv PDUS RAD LIGHTNING NWP none OVR none

NAVIG. red LON. 16.432 LAT. 49.549 Choose predefined position

- CG neg
+ CG pos
| CC



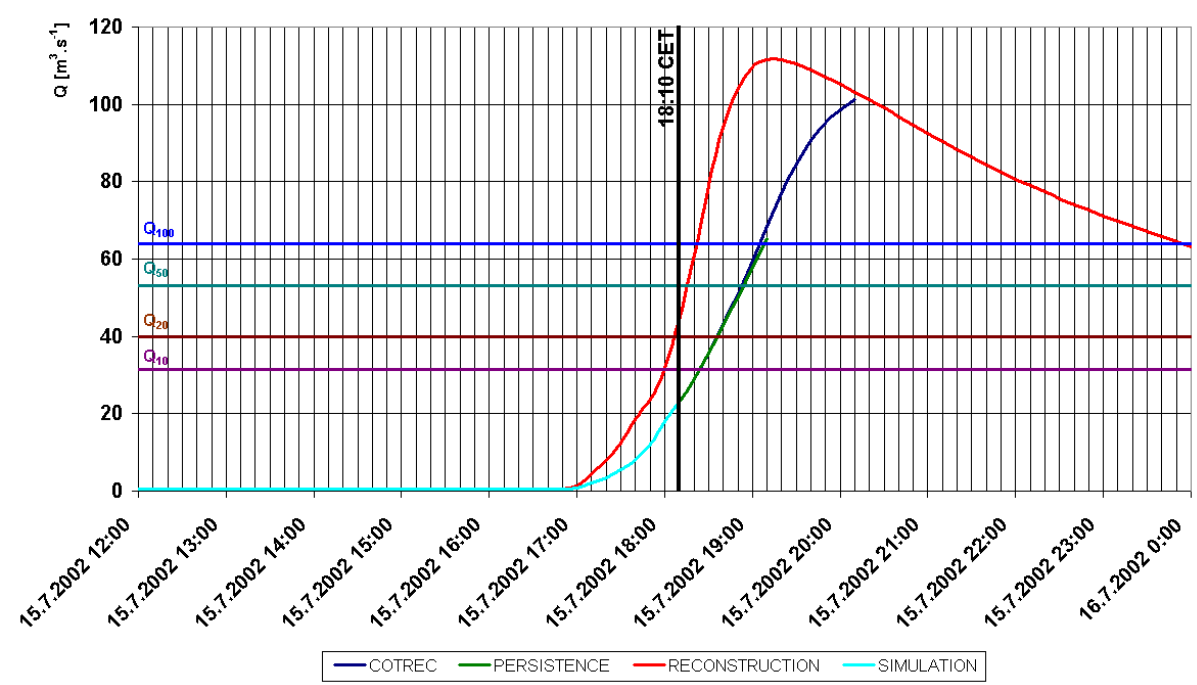
CZRAD - Z: MAX - 15.07.2002 17:10 UT



Every

- 15.07.2002 13:50
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20

Discharge forecast at Štěpánov, 18:10 CET

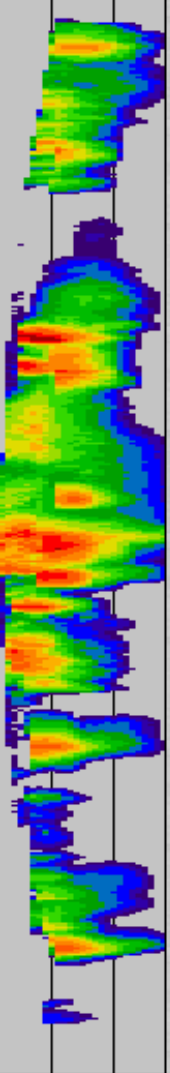
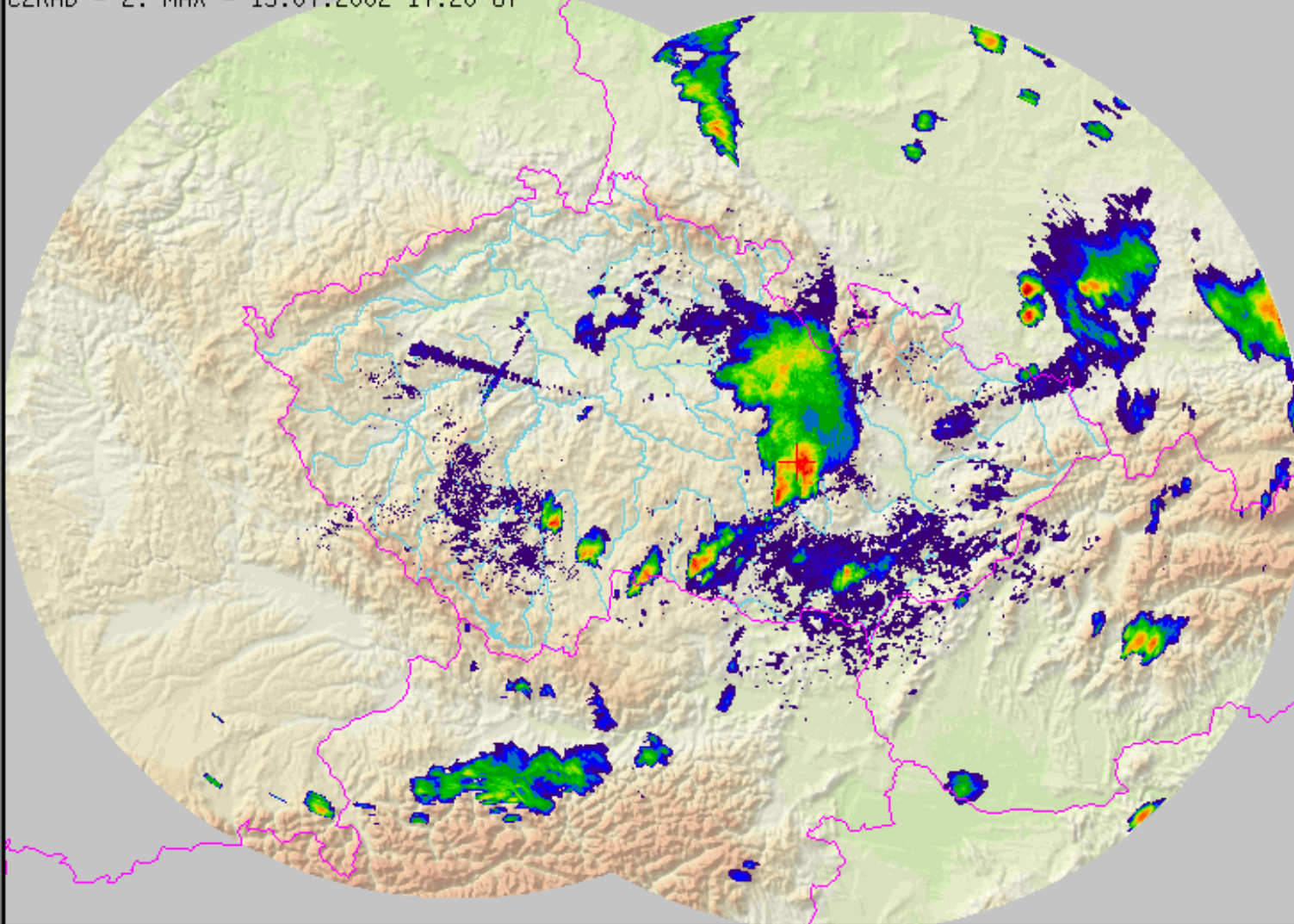


ANIM: 1 s/img LAST: +2 s
 ORO col UND riv PDUS RAD LIGHTND
 NAVIG. red LON. 16.432 LAT. 49.549

CHMI Radar
Department



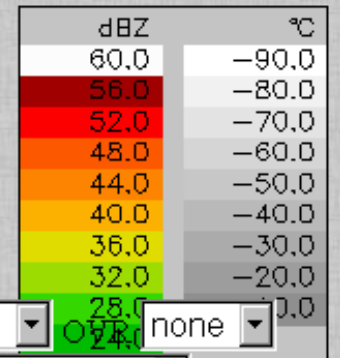
CZRAD - Z: MAX - 15.07.2002 17:20 UT



Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20
- 15.07.2002 12:10
- 15.07.2002 12:00 ▼

LOAD (156 / 156)



Navigation controls: < < || >> > ANIM: 1 s/img LAST: +2 s AUTO UPDATE Do not update

ORO: col UND: riv PDUS: RAD: LIGHTNING: NWP: none

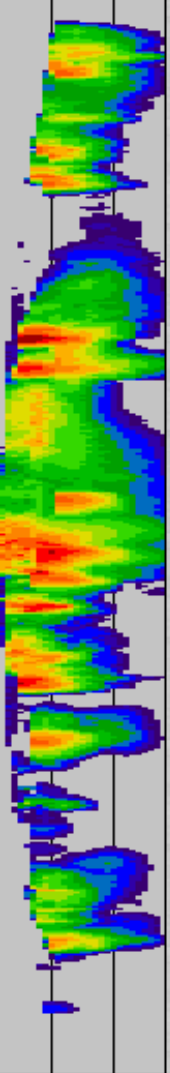
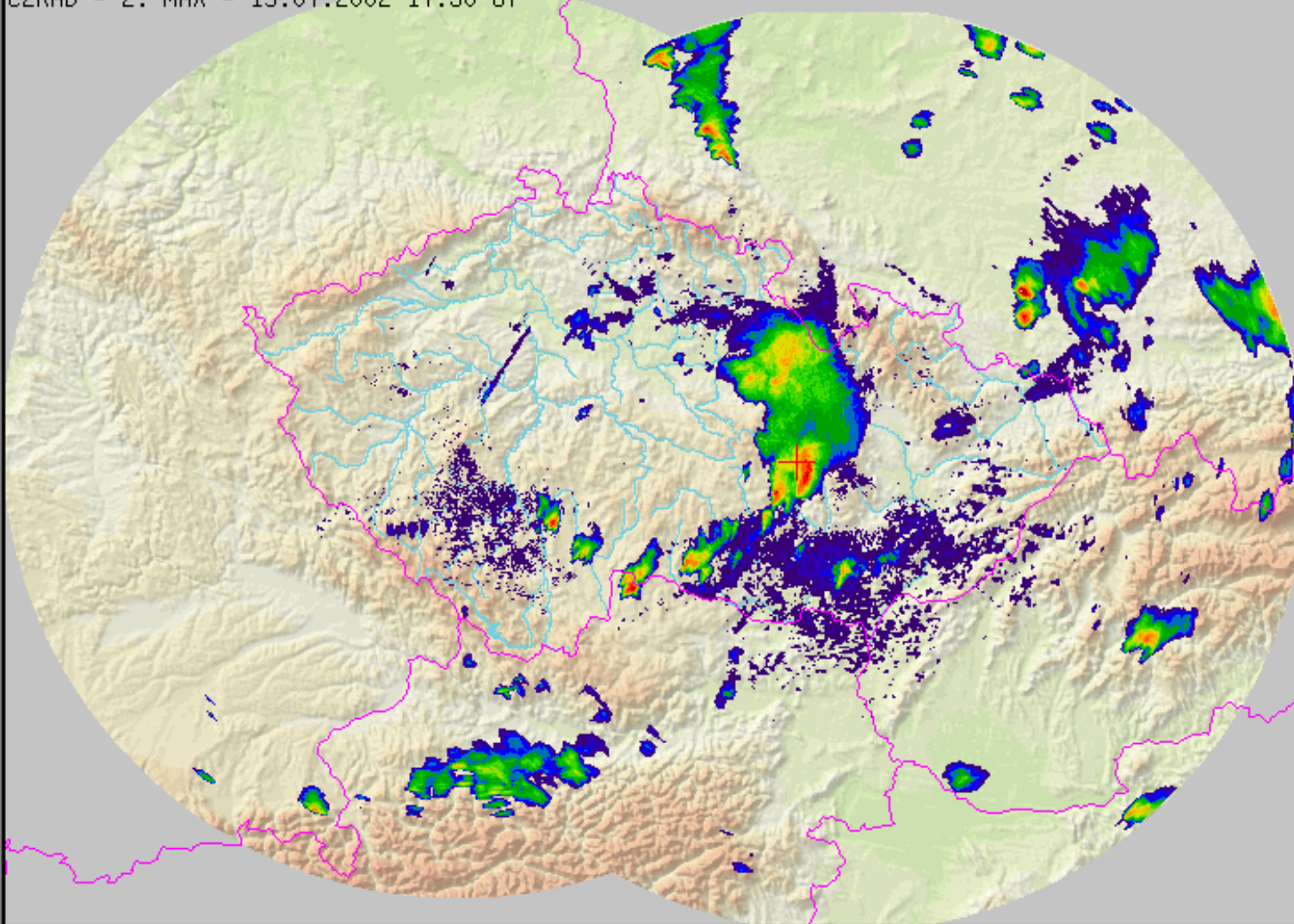
NAVIG: red LON: 16.432 LAT: 49.549 Choose predefined position

CG neg
+ CG pos
CC

CHMI Radar
Department



CZRAD - Z: MAX - 15.07.2002 17:30 UT



Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20
- 15.07.2002 12:10
- 15.07.2002 12:00 ▼

LOAD (156 / 156)

| dBZ | °C |
|------|-------|
| 60.0 | -90.0 |
| 56.0 | -80.0 |
| 52.0 | -70.0 |
| 48.0 | -60.0 |
| 44.0 | -50.0 |
| 40.0 | -40.0 |
| 36.0 | -30.0 |
| 32.0 | -20.0 |
| 28.0 | -10.0 |
| 24.0 | 0.0 |

< < || >> > ANIM: 1 s/img LAST: +2 s AUTO UPDATE Do not update

ORO col UND riv PDUS RAD LIGHTNING NWP none OVR none

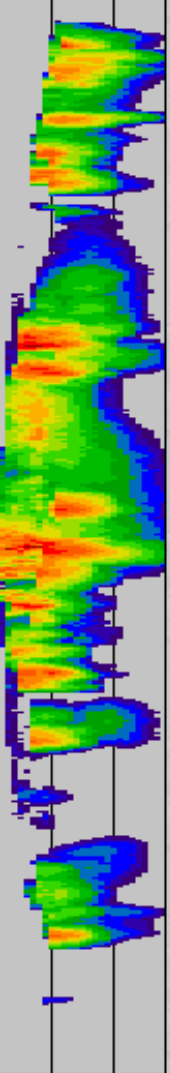
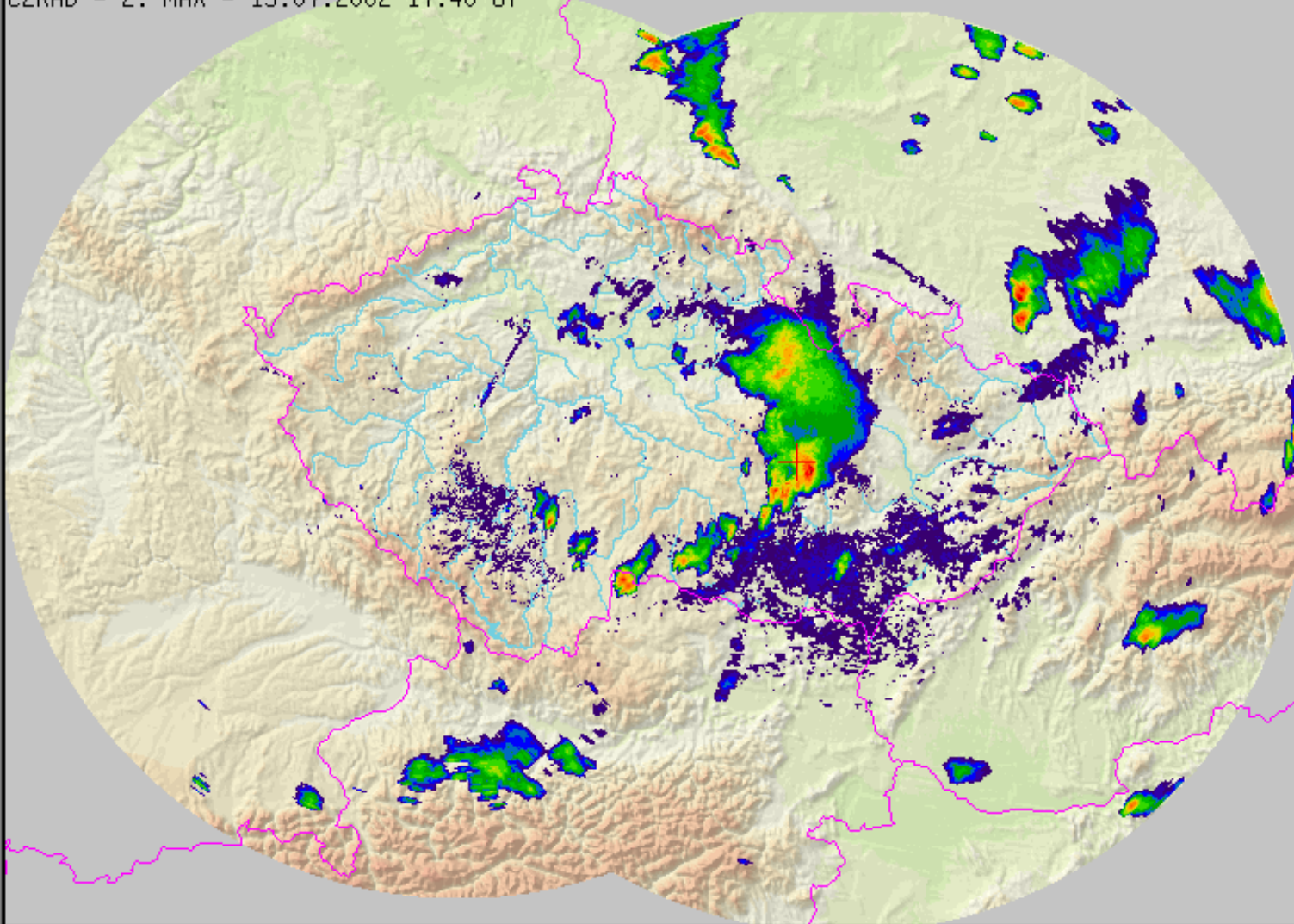
NAVIG. red LON. 16.432 LAT. 49.549 Choose predefined position

- CG neg
+ CG pos
| CC

CHMI Radar
Department



CZRAD - Z: MAX - 15.07.2002 17:40 UT



Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20
- 15.07.2002 12:10
- 15.07.2002 12:00 ▼

LOAD (156 / 156)

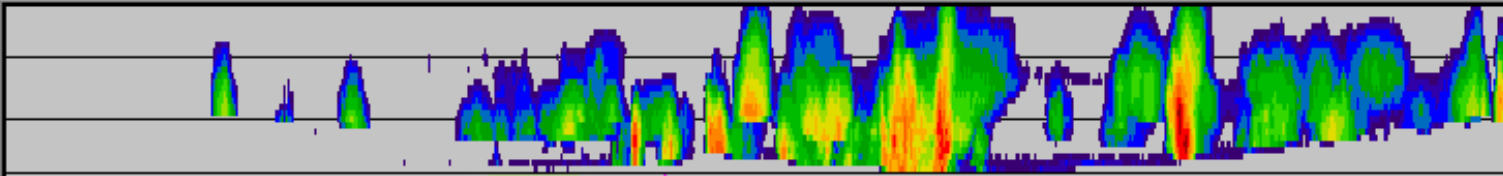
| dBZ | °C |
|------|-------|
| 60.0 | -90.0 |
| 56.0 | -80.0 |
| 52.0 | -70.0 |
| 48.0 | -60.0 |
| 44.0 | -50.0 |
| 40.0 | -40.0 |
| 36.0 | -30.0 |
| 32.0 | -20.0 |
| 28.0 | -10.0 |
| 24.0 | 0.0 |

<< || >> > ANIM: 1 s/img LAST: +2 s AUTO UPDATE Do not update

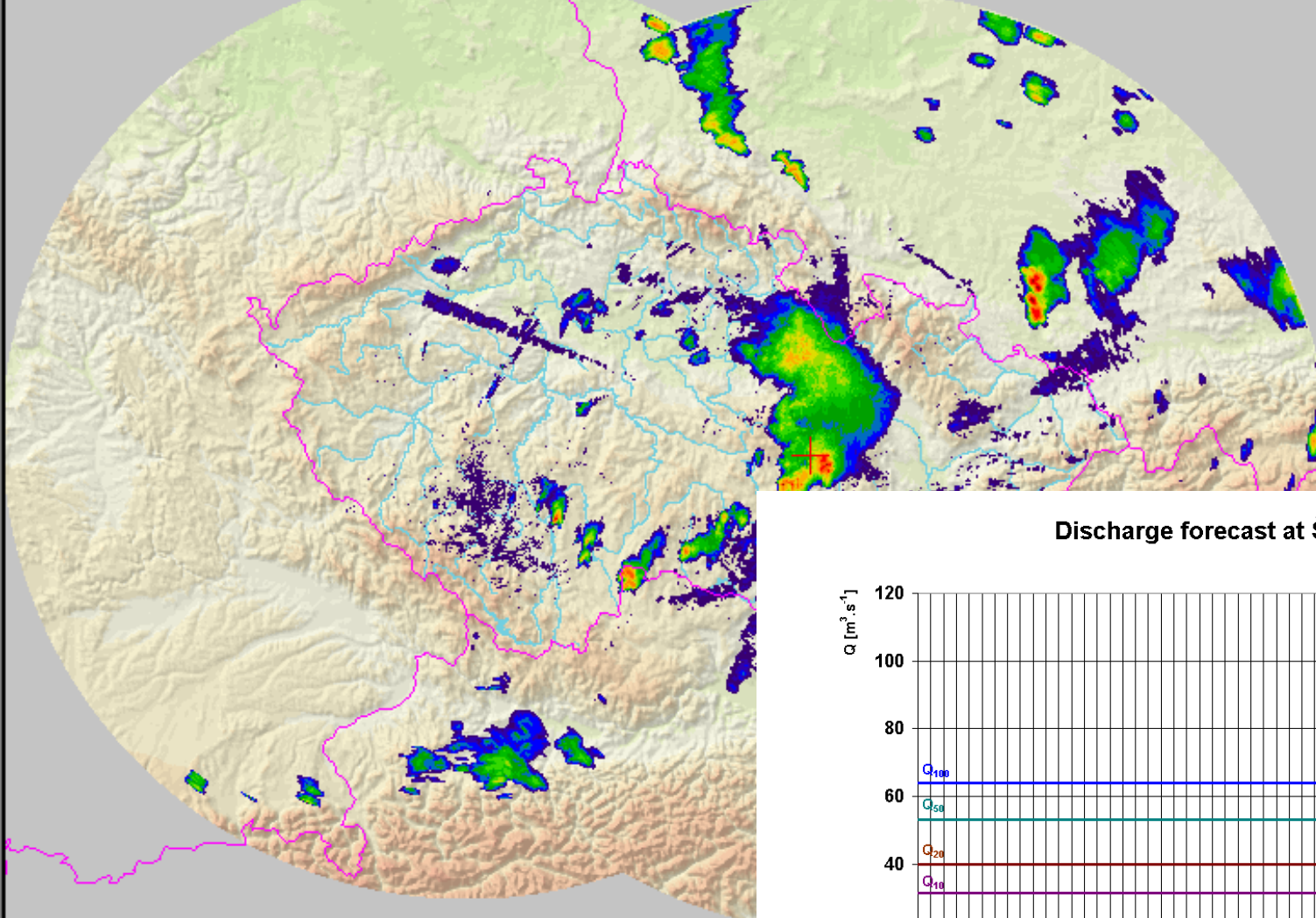
ORO col UND riv PDUS RAD LIGHTNING NWP none OVR none

NAVIG. red LON. 16.432 LAT. 49.549 Choose predefined position

- CG neg
+ CG pos
| CC



CZRAD - Z: MAX - 15.07.2002 17:50 UT

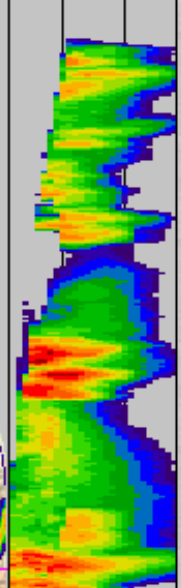


CHMI Radar Department

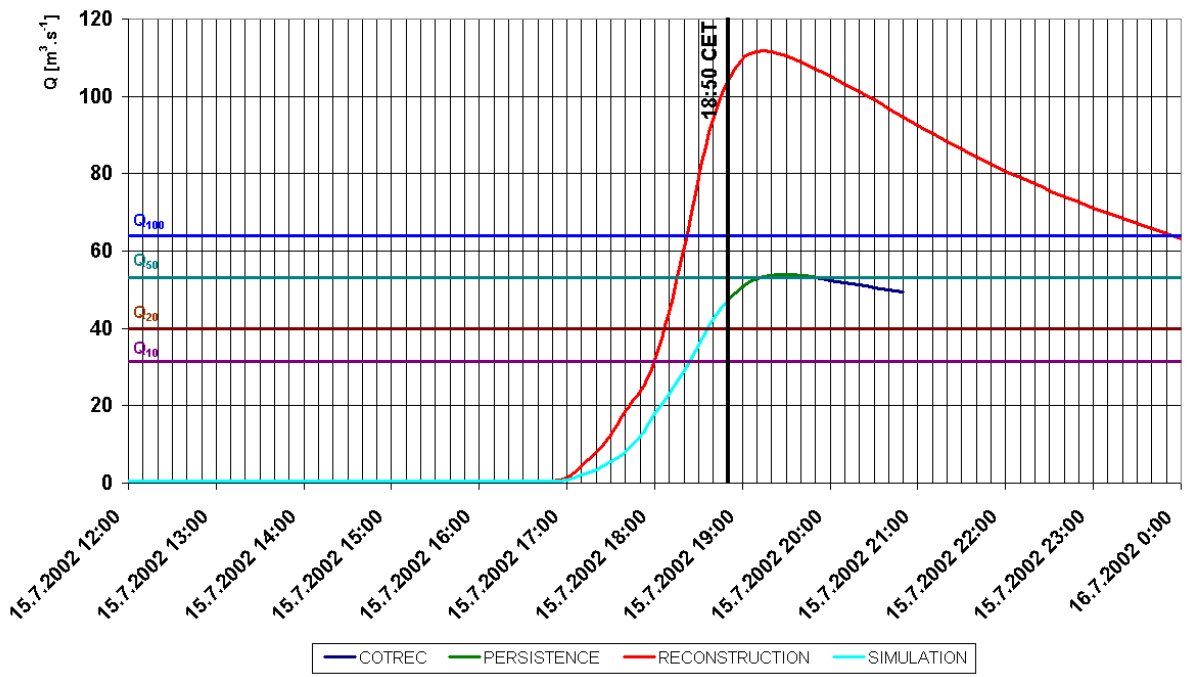


Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20



Discharge forecast at Štěpánov, 18:50 CET



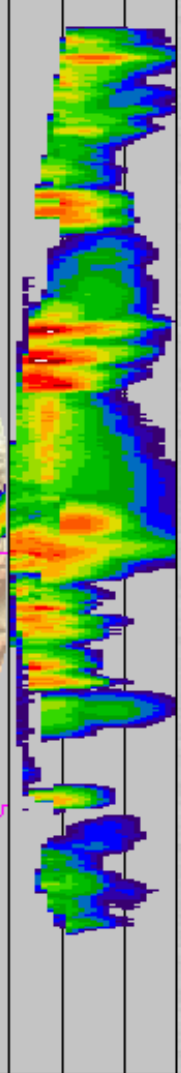
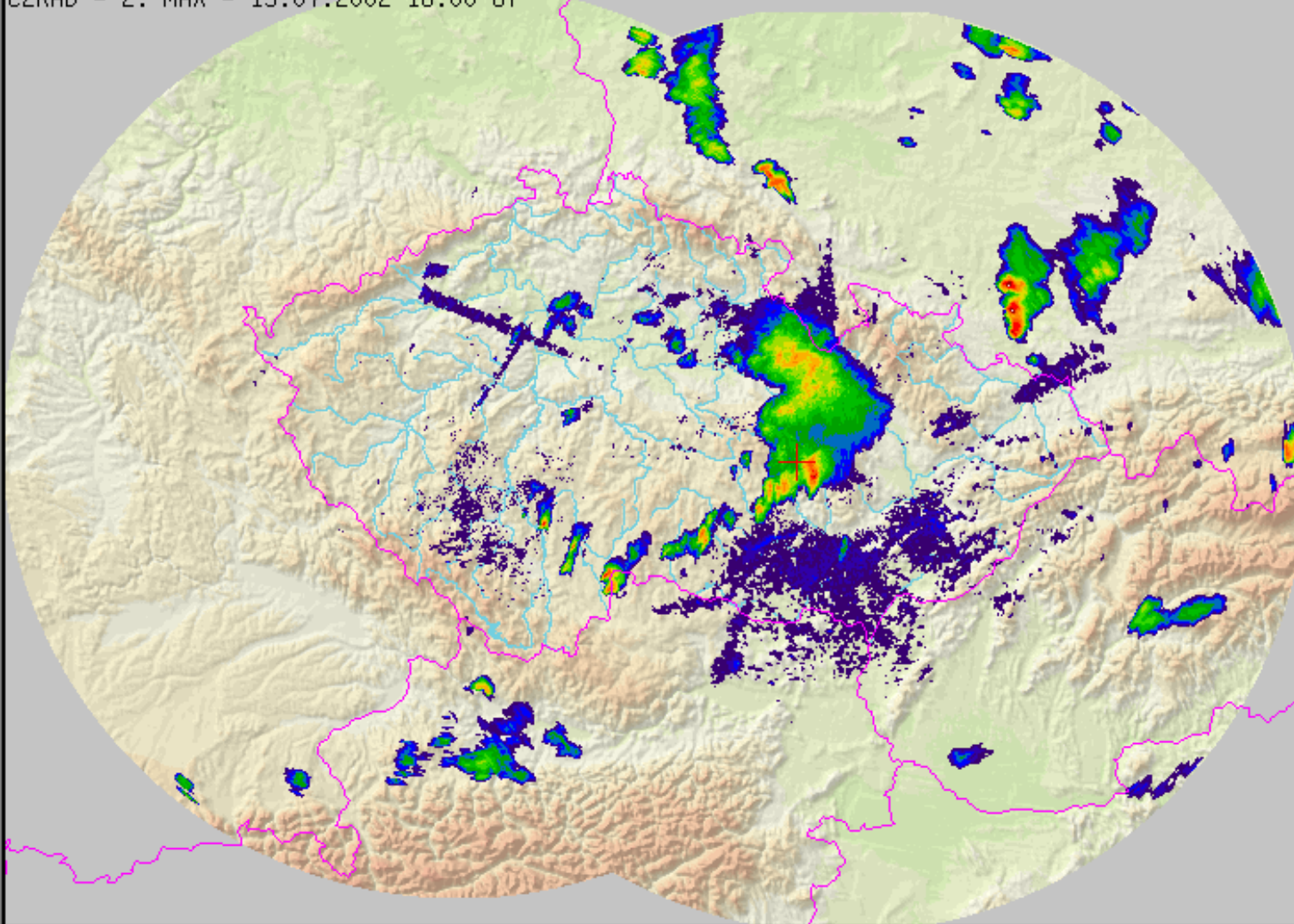
ANIM: 1 s/img LAST: +2 s
 ORO col UND riv PDUS RAD LIGHTND
 NAVIG. red LON. 16.432 LAT. 49.549

— COTREC — PERSISTENCE — RECONSTRUCTION — SIMULATION

CHMI Radar
Department



CZRAD - Z: MAX - 15.07.2002 18:00 UT



Every

- 15.07.2002 13:50 ▲
- 15.07.2002 13:40
- 15.07.2002 13:30
- 15.07.2002 13:20
- 15.07.2002 13:10
- 15.07.2002 13:00
- 15.07.2002 12:50
- 15.07.2002 12:40
- 15.07.2002 12:30
- 15.07.2002 12:20
- 15.07.2002 12:10
- 15.07.2002 12:00 ▼

LOAD (156 / 156)

| dBZ | °C |
|------|-------|
| 60.0 | -90.0 |
| 56.0 | -80.0 |
| 52.0 | -70.0 |
| 48.0 | -60.0 |
| 44.0 | -50.0 |
| 40.0 | -40.0 |
| 36.0 | -30.0 |
| 32.0 | -20.0 |
| 28.0 | -10.0 |
| 24.0 | 0.0 |

< < || >> > ANIM: 1 s/img LAST: +2 s AUTO UPDATE Do not update

ORO col UND riv PDUS RAD LIGHTNING NWP none OVR none

NAVIG. red LON. 16.432 LAT. 49.549 Choose predefined position

- CG neg
+ CG pos
| CC

Flash flood at Sloup the 26 May 2003

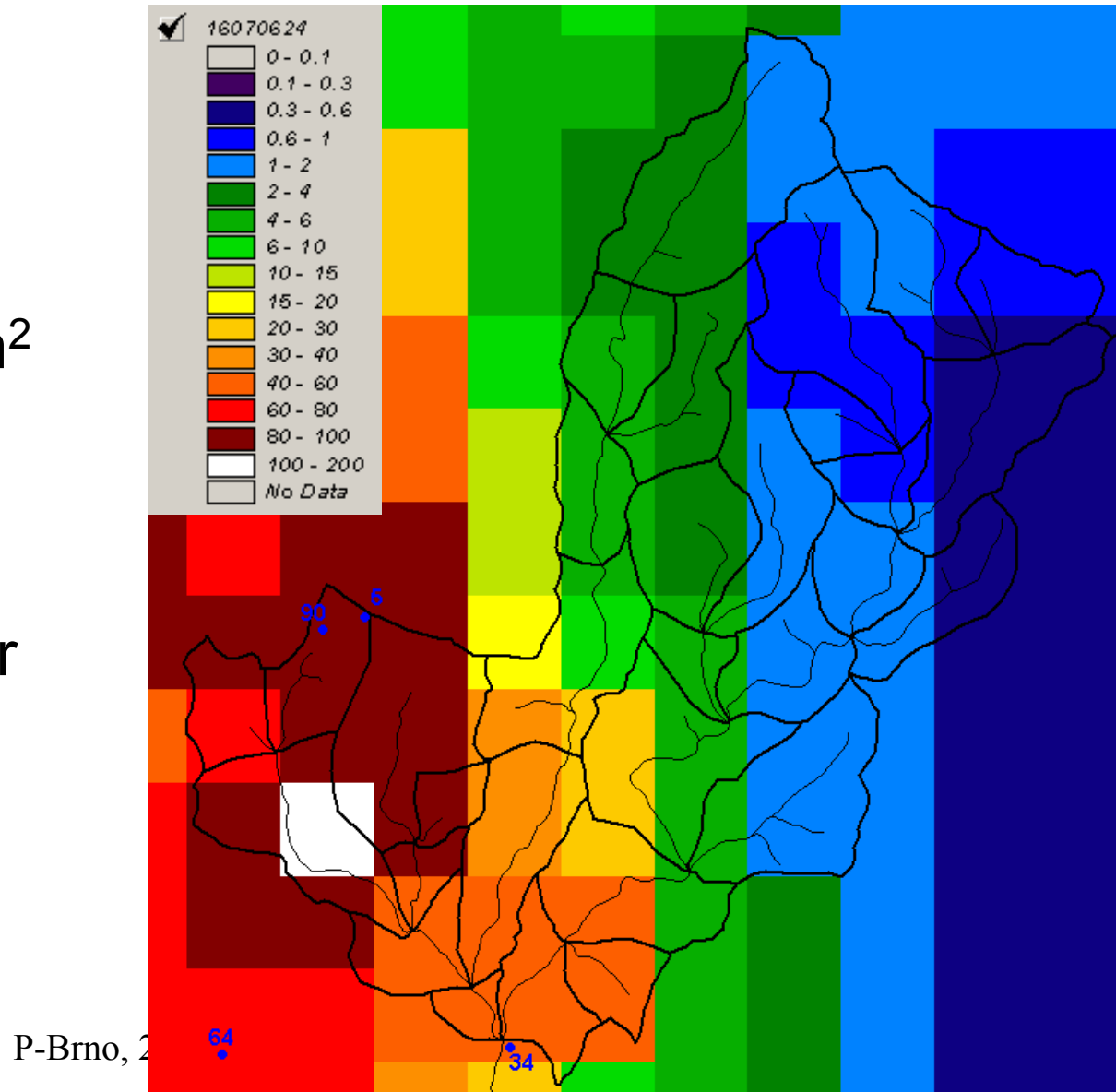
Sloup:

return period: 50-100
years

Catchment area: 49.9 km²

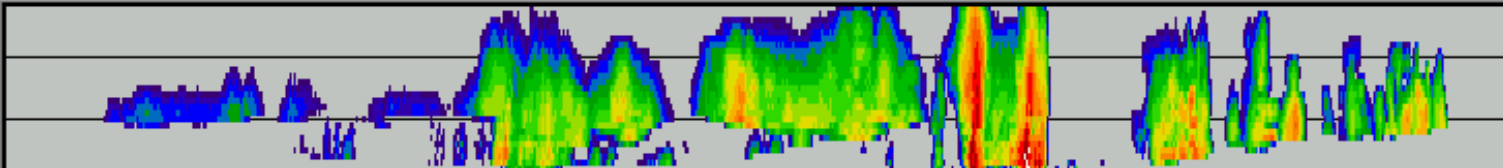
Number of radar areal
elements: 8

Average area of the radar
areal elements: 7.1 km²



Flash flood at Sloup the 26 May 2003



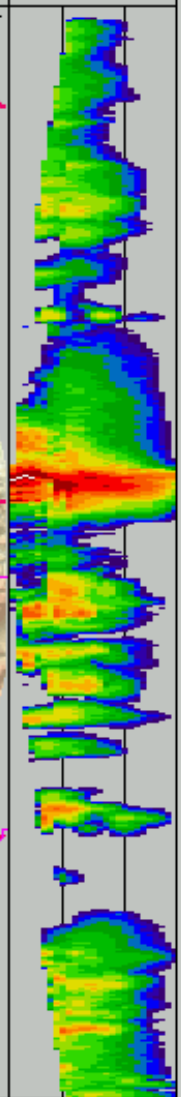
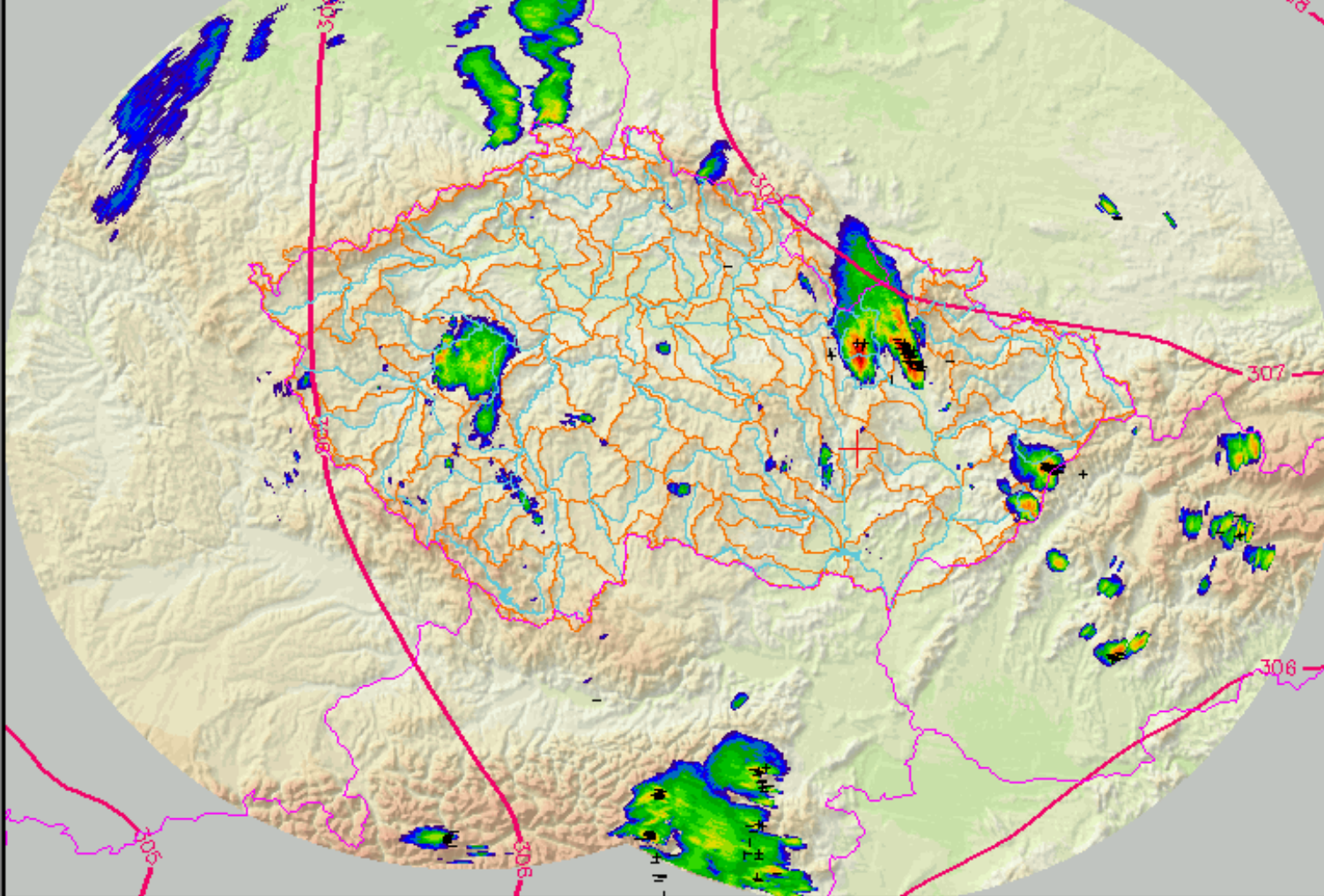


CG+ 20
CG- 179
CC 17
SUM 216



CZRAD - Z: MAX - 26.05.2003 11:00 UT ALADIN_GP_700 - 26.05.2003 12:00 UT +00hr

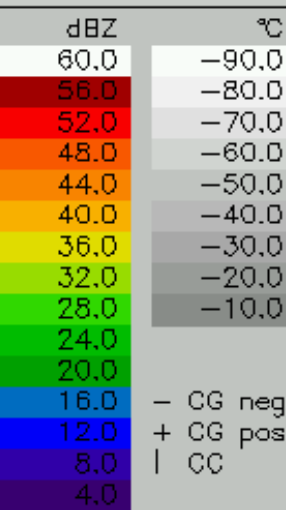
CELDN - 26.05.2003 11:00 UT



Forecast
 Cotrec Aladin
 Persistence True

- Every
- 26.05.2003 06:20 CA ▲
 - 26.05.2003 06:10 CA
 - 26.05.2003 06:00 CA
 - 26.05.2003 05:50 CA
 - 26.05.2003 05:40 CA
 - 26.05.2003 05:30 CA
 - 26.05.2003 05:20 CA
 - 26.05.2003 05:10 CA**
 - 26.05.2003 05:00 CA
 - 26.05.2003 04:50 CA
 - 26.05.2003 04:40 CA
 - 26.05.2003 04:30 CA ▼

LOAD (258 / 258)

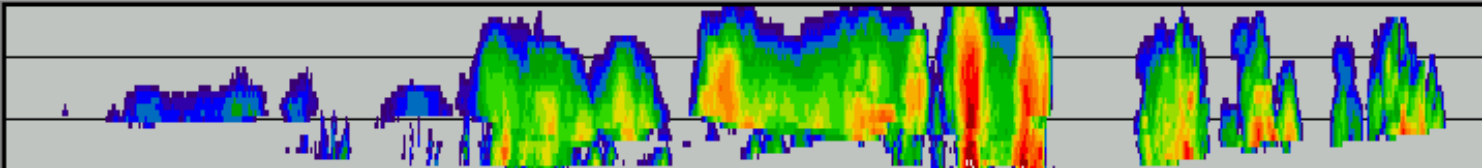


ANIM: LAST: AUTO UPDATE

PDUS RAD LIGHTNING WIND METEO

ORO UND OVR NAVIG LON LAT

cursor position is [517,366] = [17.375,48.637] ZOOM COLOR

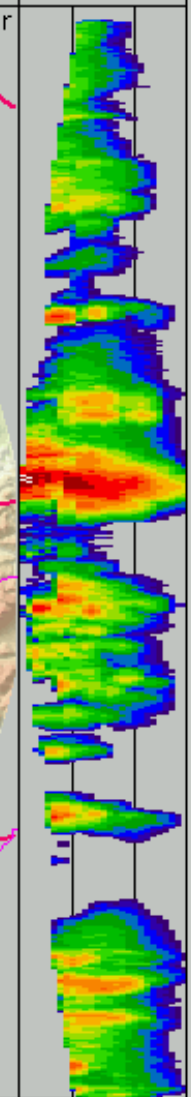
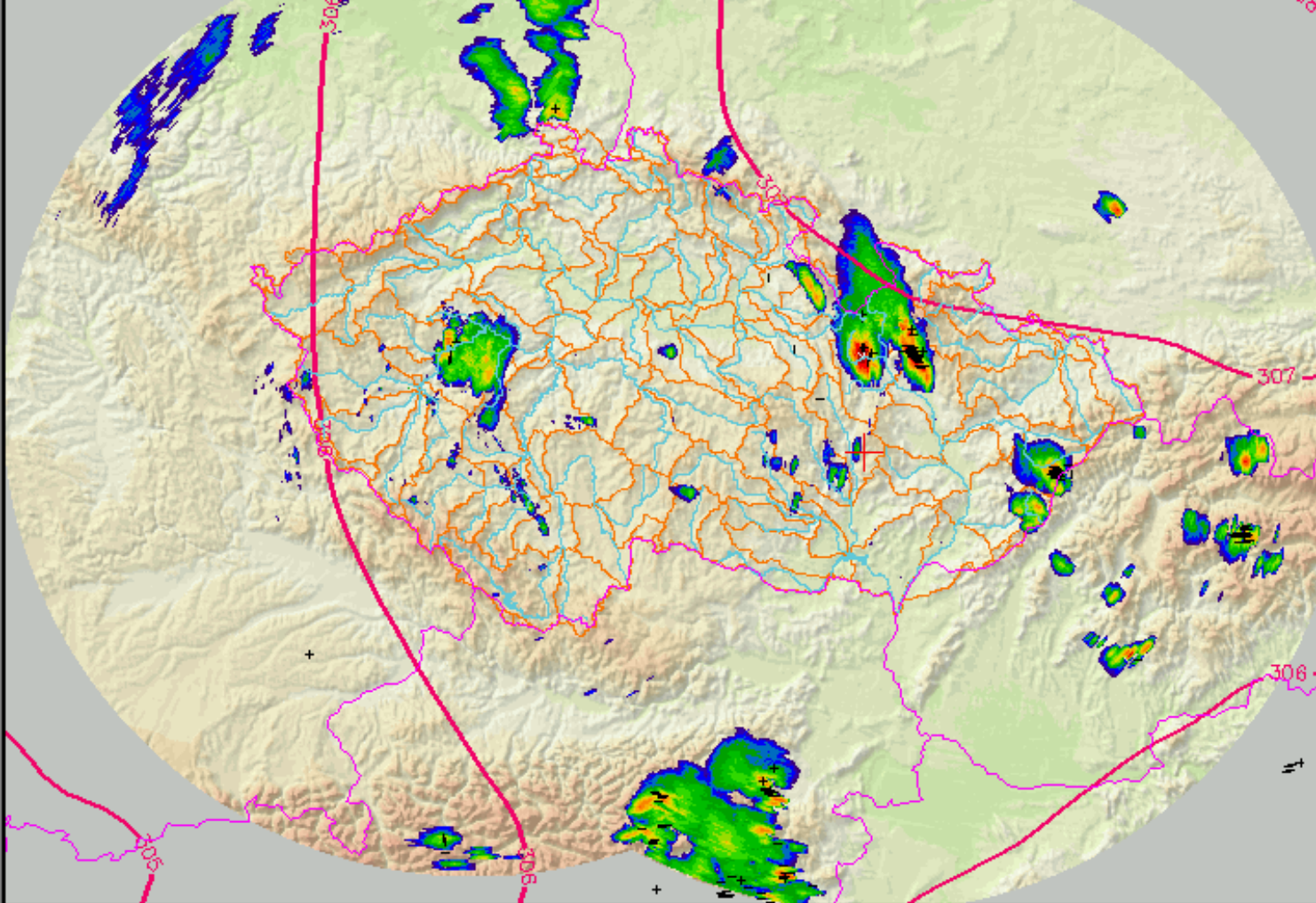


CG+ 12
CG- 210
CC 32
SUM 254



CZRAD - Z: MAX - 26.05.2003 11:10 UT ALADIN_GP_700 - 26.05.2003 12:00 UT +00hr

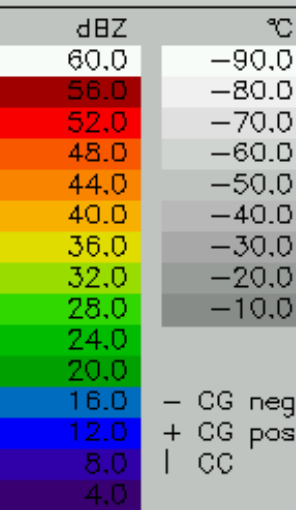
CELDN - 26.05.2003 11:10 UT



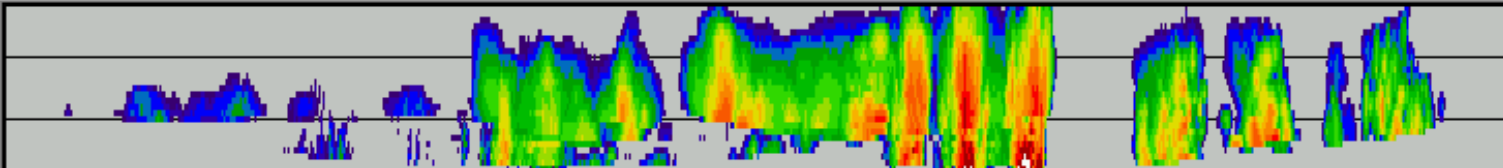
Forecast
 Cotrec Aladin
 Persistence True

- Every
- 26.05.2003 06:20 CA ▲
 - 26.05.2003 06:10 CA
 - 26.05.2003 06:00 CA
 - 26.05.2003 05:50 CA
 - 26.05.2003 05:40 CA
 - 26.05.2003 05:30 CA
 - 26.05.2003 05:20 CA
 - 26.05.2003 05:10 CA**
 - 26.05.2003 05:00 CA
 - 26.05.2003 04:50 CA
 - 26.05.2003 04:40 CA
 - 26.05.2003 04:30 CA ▼

LOAD (258 / 258)



ANIM: 1 s/img LAST: +2 s AUTO UPDATE Do not update
 PDUS RAD LIGHTNING WIND none METEO ALADIN GP700 - 26.05.2003 12:00 +0h
 ORO col UND catchments OVR rivers NAVIG red LON 16.739 LAT 49.414 Choose predefined locations
 cursor position is [345,525] = [15.022,47.246] ZOOM COLOR black

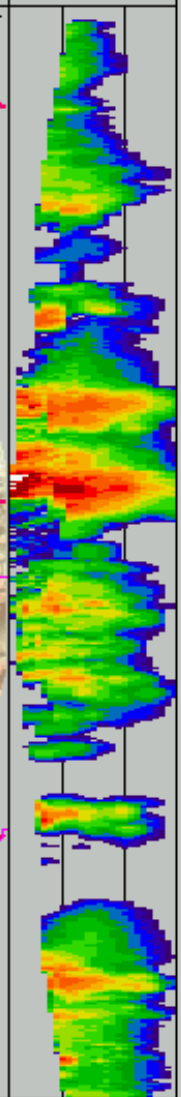
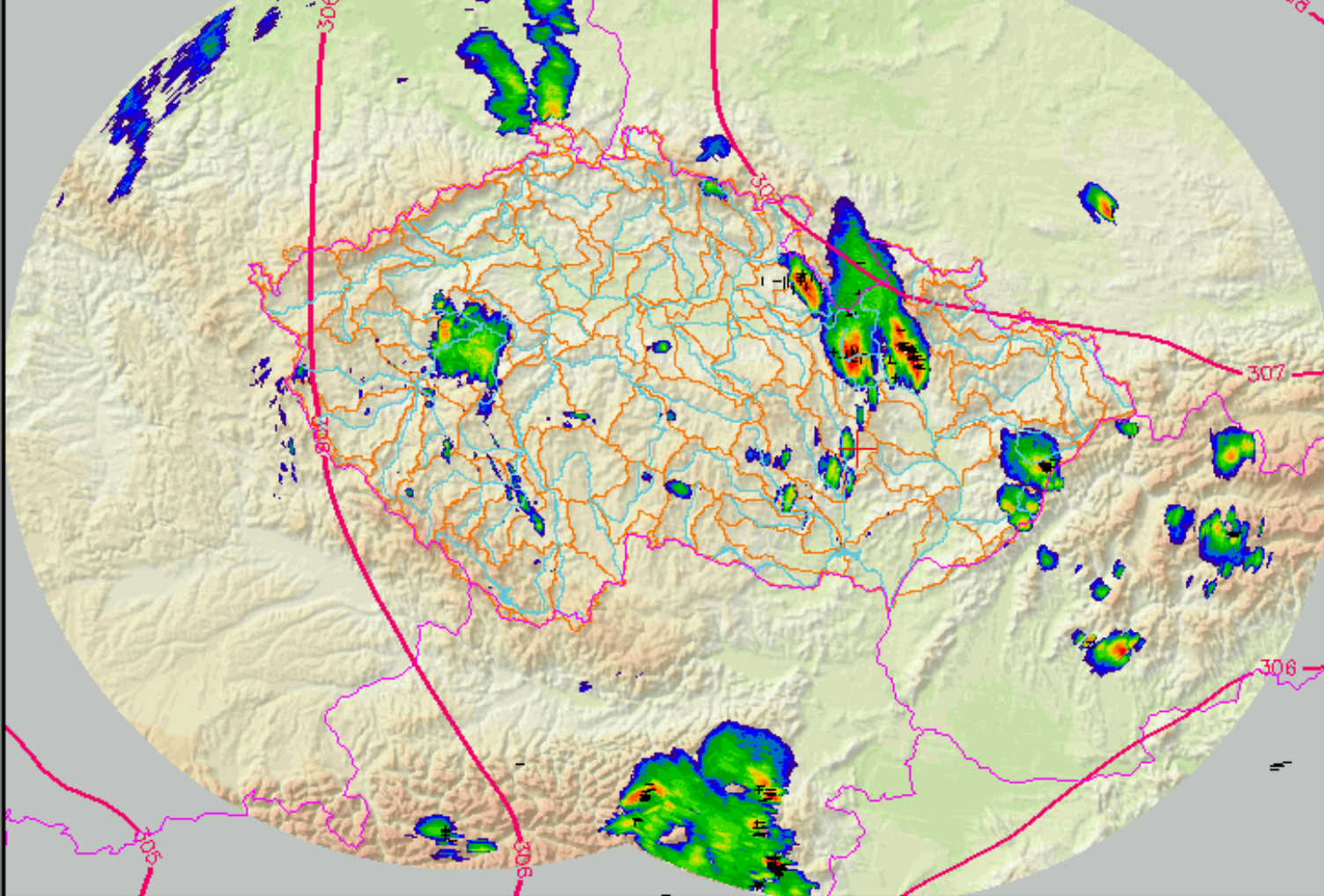


CG+ 11
CG- 194
CC 30
SUM 235



CZRAD - Z: MAX - 26.05.2003 11:20 UT
ALADIN_GP_700 - 26.05.2003 12:00 UT +00hr

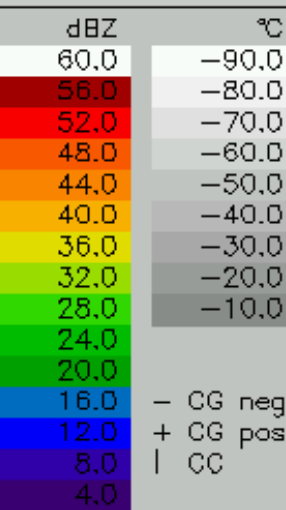
CELDN - 26.05.2003 11:30 UT



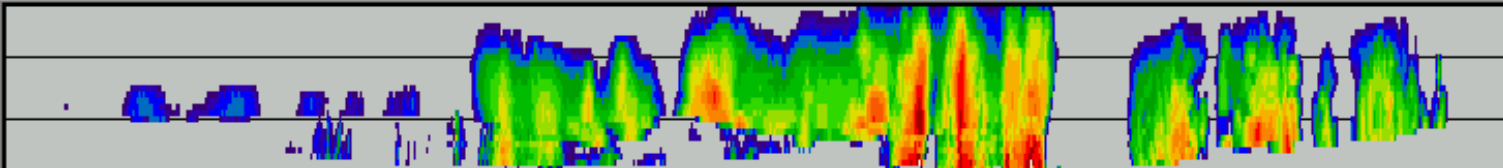
Forecast
 Cotrec Aladin
 Persistence True

- Every
- 26.05.2003 06:20 CA ▲
 - 26.05.2003 06:10 CA
 - 26.05.2003 06:00 CA
 - 26.05.2003 05:50 CA
 - 26.05.2003 05:40 CA
 - 26.05.2003 05:30 CA
 - 26.05.2003 05:20 CA
 - 26.05.2003 05:10 CA**
 - 26.05.2003 05:00 CA
 - 26.05.2003 04:50 CA
 - 26.05.2003 04:40 CA
 - 26.05.2003 04:30 CA ▼

LOAD (258 / 258)



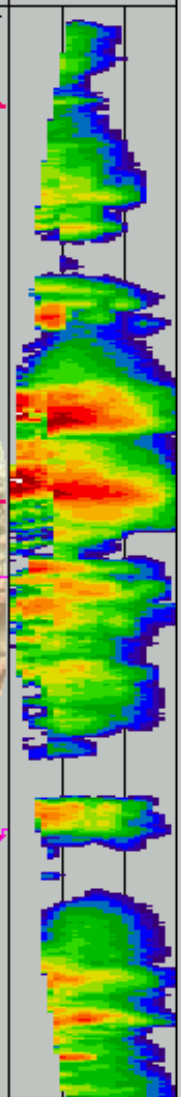
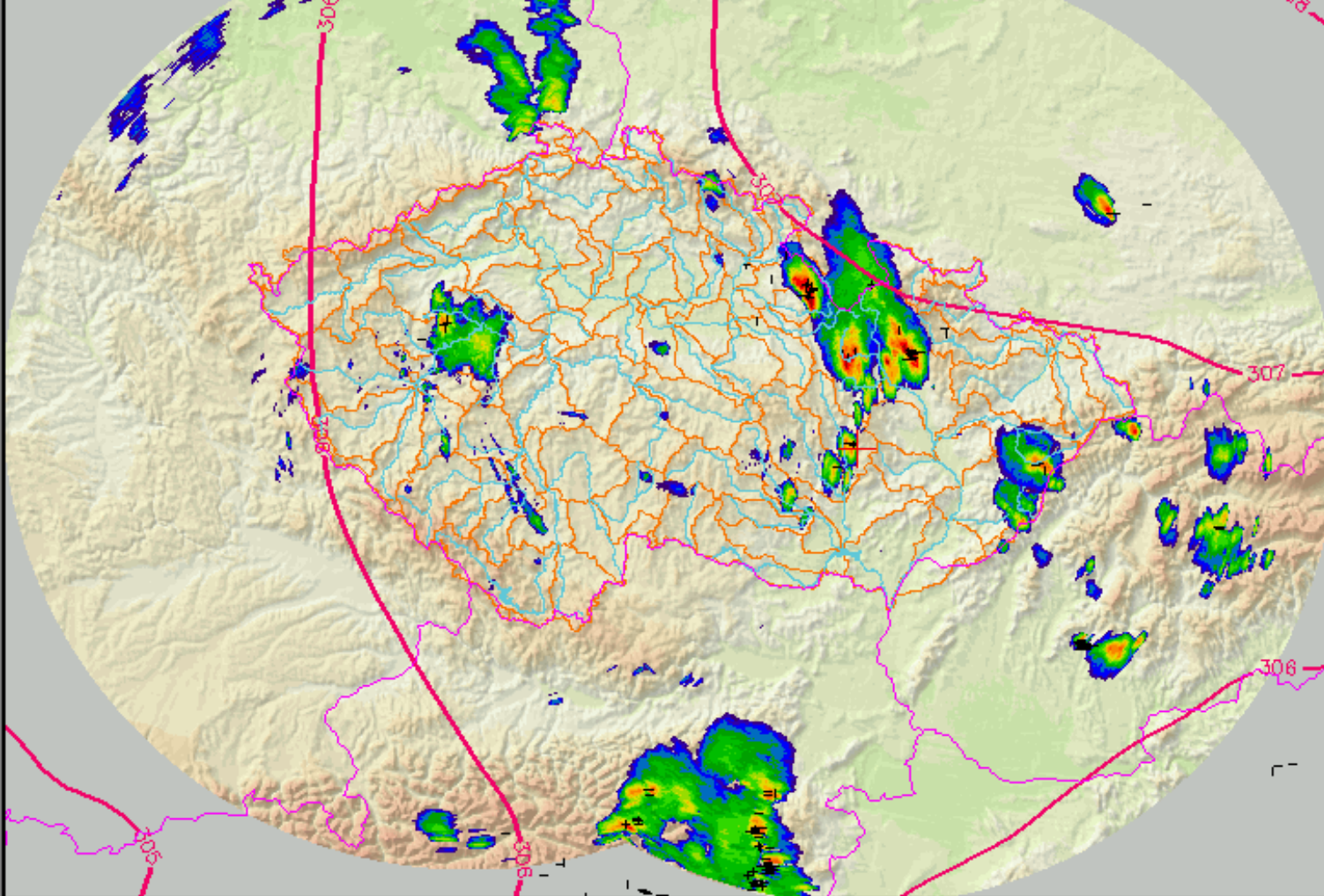
ANIM: 1 s/img LAST: +2 s AUTO UPDATE Do not update
 PDUS RAD LIGHTNING WIND none METEO ALADIN GP700 - 26.05.2003 12:00 +0h
 ORO col UND catchments OVR rivers NAVIG red LON 16.739 LAT 49.414 Choose predefined locations
 cursor position is [416,484] = [15.971,47.605] ZOOM COLOR black



CG+ 11
CG- 164
CC 25
SUM 200



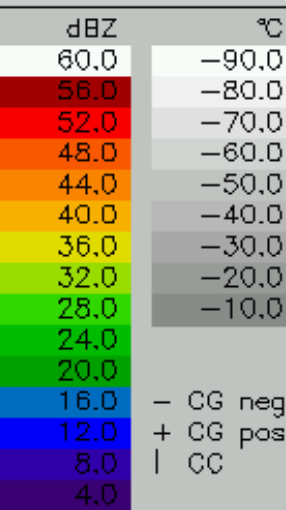
CZRAD - Z: MAX - 26.05.2003 11:30 UT
ALADIN_GP_700 - 26.05.2003 12:00 UT +00hr
CELDN - 26.05.2003 11:30 UT



Forecast
 Cotrec Aladin
 Persistence True

- Every
- 26.05.2003 06:20 CA ▲
 - 26.05.2003 06:10 CA
 - 26.05.2003 06:00 CA
 - 26.05.2003 05:50 CA
 - 26.05.2003 05:40 CA
 - 26.05.2003 05:30 CA
 - 26.05.2003 05:20 CA
 - 26.05.2003 05:10 CA**
 - 26.05.2003 05:00 CA
 - 26.05.2003 04:50 CA
 - 26.05.2003 04:40 CA
 - 26.05.2003 04:30 CA ▼

LOAD (258 / 258)



ANIM: LAST: AUTO UPDATE

PDUS RAD LIGHTNING WIND METEO

ORO UND OVR NAVIG LON LAT

cursor position is [136,527] = [12.261,47.209] ZOOM COLOR

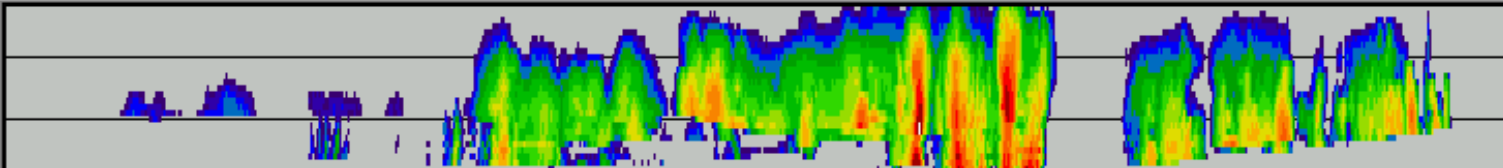


CG+ 14
CG- 132
CC 27
SUM 173

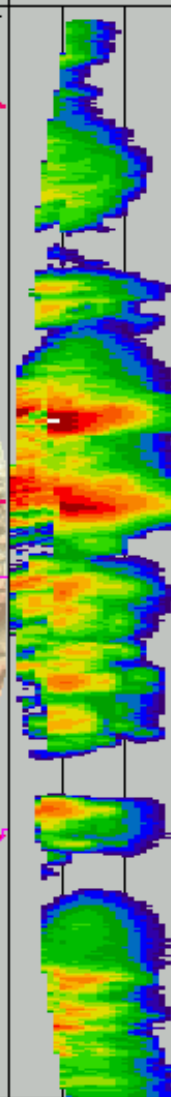
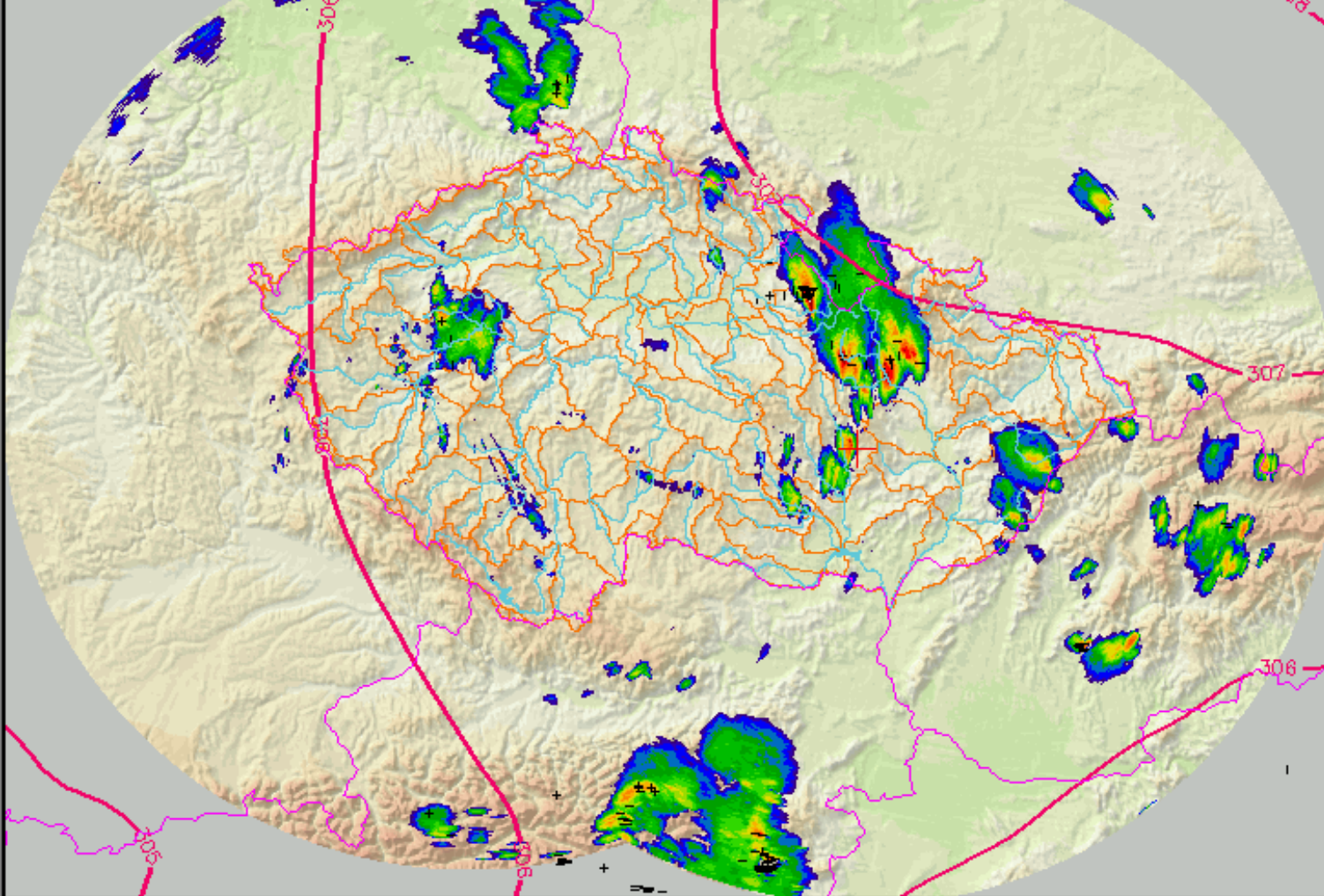
Forecast
 Cotrec Aladin
 Persistence True

- Every
- 26.05.2003 06:20 CA ▲
 - 26.05.2003 06:10 CA
 - 26.05.2003 06:00 CA
 - 26.05.2003 05:50 CA
 - 26.05.2003 05:40 CA
 - 26.05.2003 05:30 CA
 - 26.05.2003 05:20 CA
 - 26.05.2003 05:10 CA**
 - 26.05.2003 05:00 CA
 - 26.05.2003 04:50 CA
 - 26.05.2003 04:40 CA
 - 26.05.2003 04:30 CA ▼

LOAD (258 / 258)



CZRAD - Z: MAX - 26.05.2003 11:40 UT
ALADIN_GP_700 - 26.05.2003 12:00 UT +00hr
CELDN - 26.05.2003 11:40 UT



ANIM: LAST: AUTO UPDATE

PDUS RAD LIGHTNING WIND METEO

ORO UND OVR NAVIG LON LAT

cursor position is [792,119] = [21.397,50.686] ZOOM COLOR

CG+ 5
CG- 70
CC 13
SUM 88

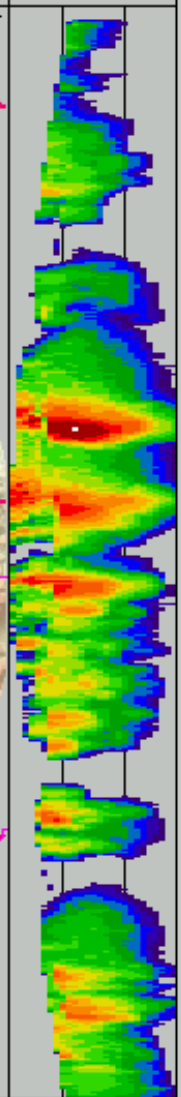
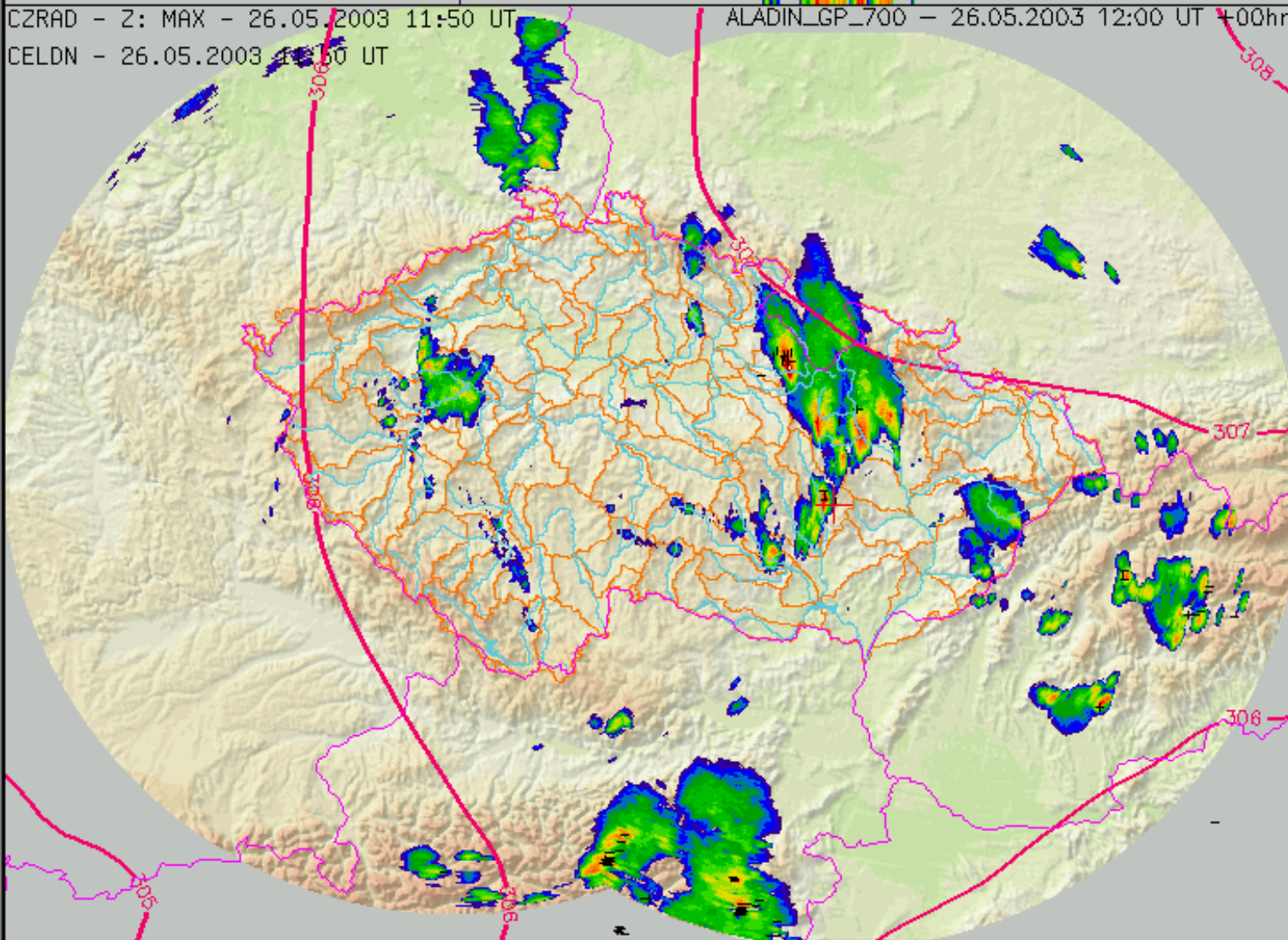
Forecast
 Cotrec Aladin
 Persistence True

- Every
- 26.05.2003 06:20 CA ▲
 - 26.05.2003 06:10 CA
 - 26.05.2003 06:00 CA
 - 26.05.2003 05:50 CA
 - 26.05.2003 05:40 CA
 - 26.05.2003 05:30 CA
 - 26.05.2003 05:20 CA
 - 26.05.2003 05:10 CA
 - 26.05.2003 05:00 CA
 - 26.05.2003 04:50 CA
 - 26.05.2003 04:40 CA
 - 26.05.2003 04:30 CA ▼

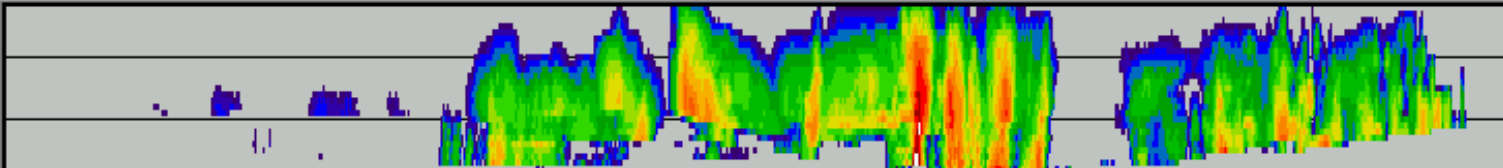
LOAD (258 / 258)



CZRAD - Z: MAX - 26.05.2003 11:50 UT
ALADIN_GP_700 - 26.05.2003 12:00 UT +00hr
CELDN - 26.05.2003 11:50 UT



ANIM: 1 s/img LAST: +2 s AUTO UPDATE Do not update
 PDUS RAD LIGHTNING WIND none METEO ALADIN GP700 - 26.05.2003 12:00 +0h
 ORO col UND catchments OVR rivers NAVIG red LON 16.739 LAT 49.414 Choose predefined locations
 cursor position is [805,366] = [21.262,48.473] ZOOM COLOR black

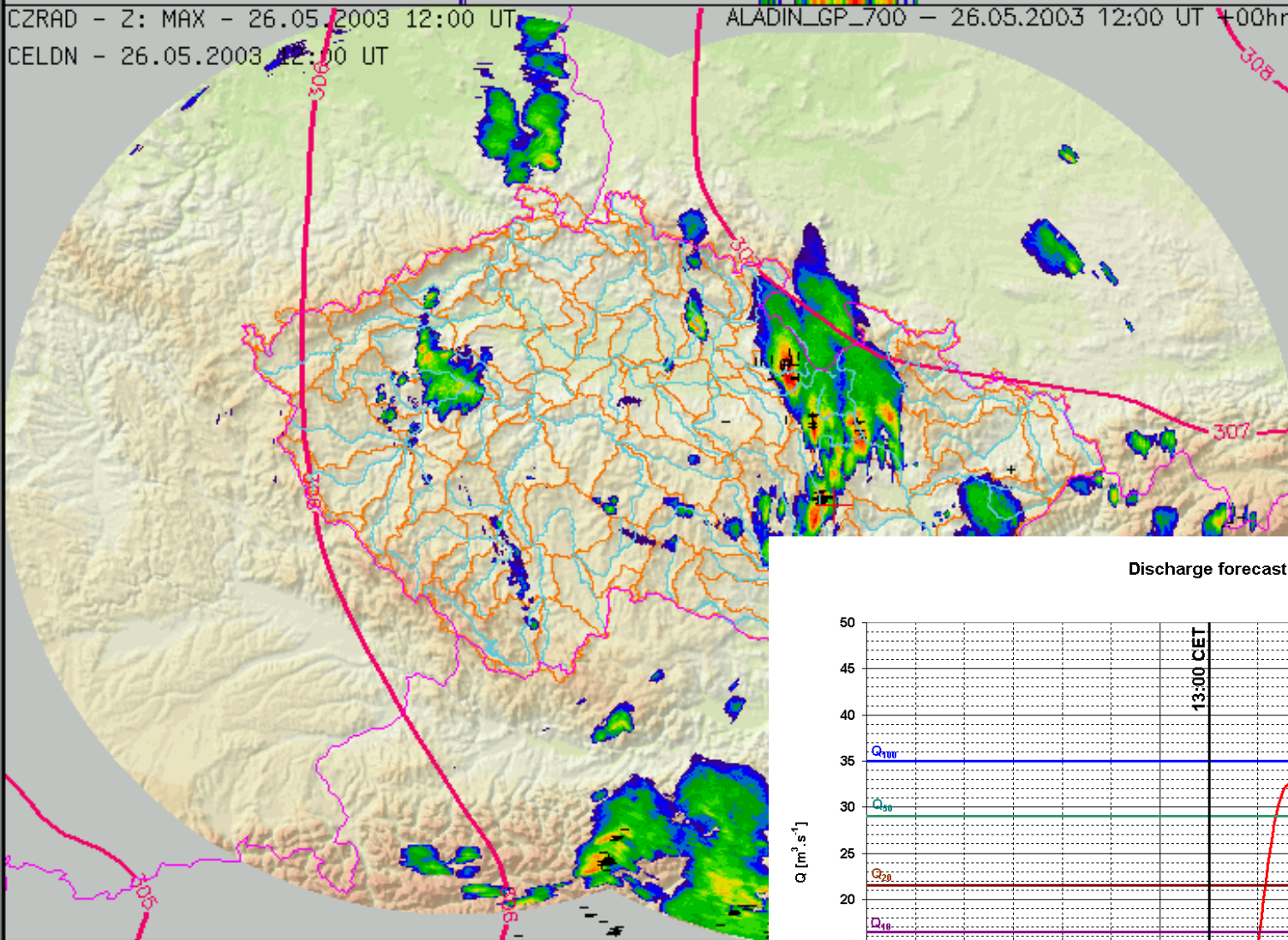


CG+ 4
 CG- 174
 CC 21
 SUM 199



Forecast
 Cotrec Aladin
 Persistence True

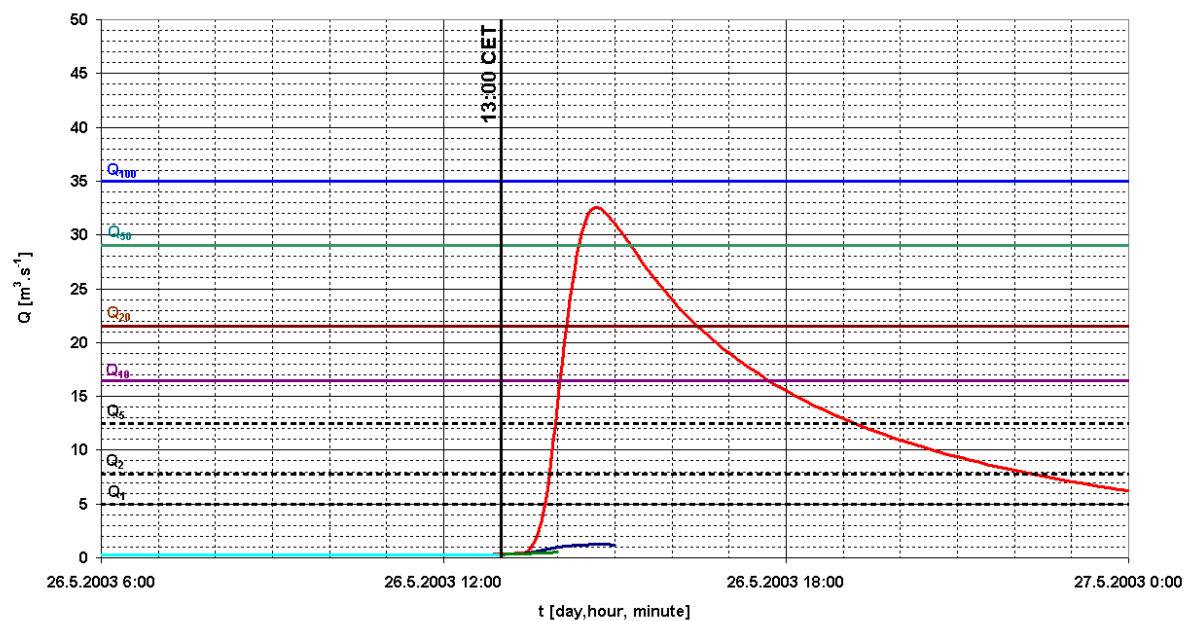
- Every
- ▲
 -
 -
 -
 -
 -
 -
 -
 -
 -
 -
 - ▼
-



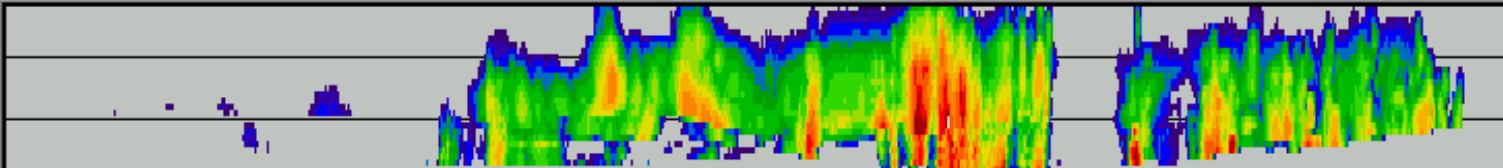
Navigation and display controls:

ANIM: 1 s/img LAST: +2 s AUT
 PDUS RAD LIGHTNING WIND none
 ORO col UND catchments OVR rivers NAVIG red
 cursor position is [784,246] = [21.125,49.56]

Discharge forecast at Sloup, 13:00 CET



— RECONSTRUCTION — SIMULATION — COTREC — PERSISTENCE



CG+ 10
 CG- 136
 CC 37
 SUM 183

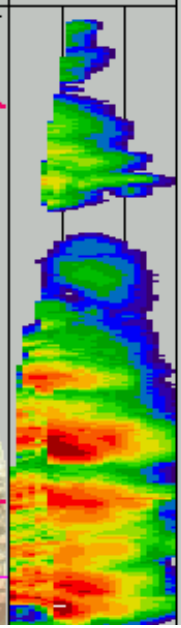
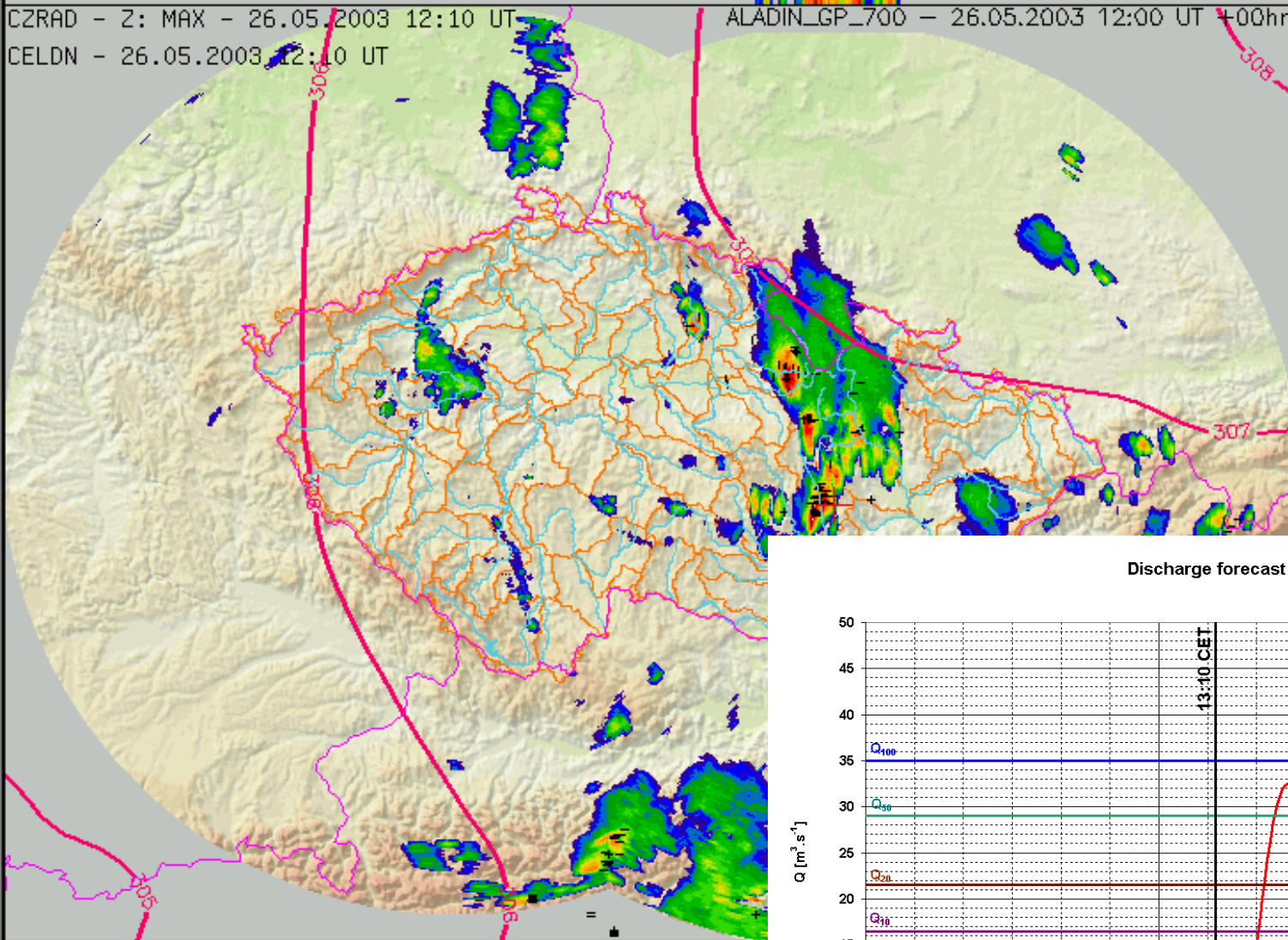


Forecast

Cotrec Aladin
 Persistence True

Every

- ▲
-
-
-
-
-
-
-
-
-
-
- ▼

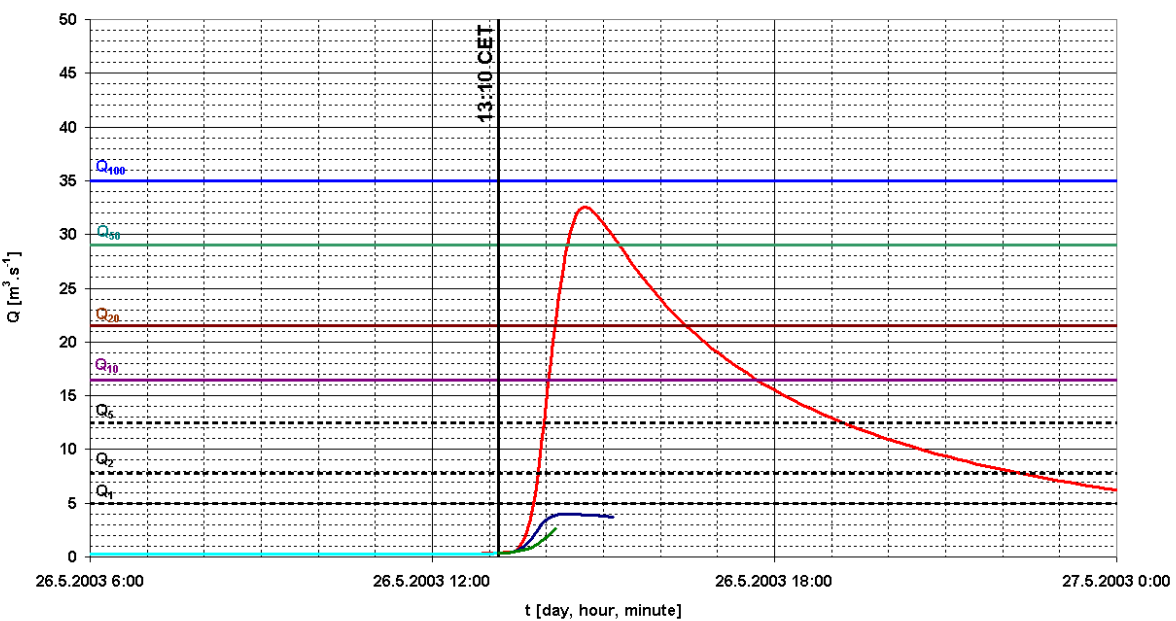


Navigation and display controls:

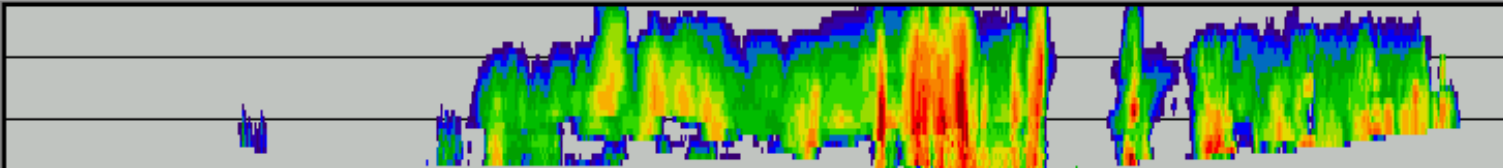
-
- ANIM: 1 s/img
- LAST: +2 s
- AUT PDUS RAD LIGHTNING WIND none
- ORO col
- UND catchments
- OVR rivers
- NAVIG red

cursor position is [184,525] = [12.894,47.237]

Discharge forecast at Sloup, 13:10 CET



— RECONSTRUCTION — SIMULATION — COTREC — PERSISTENCE



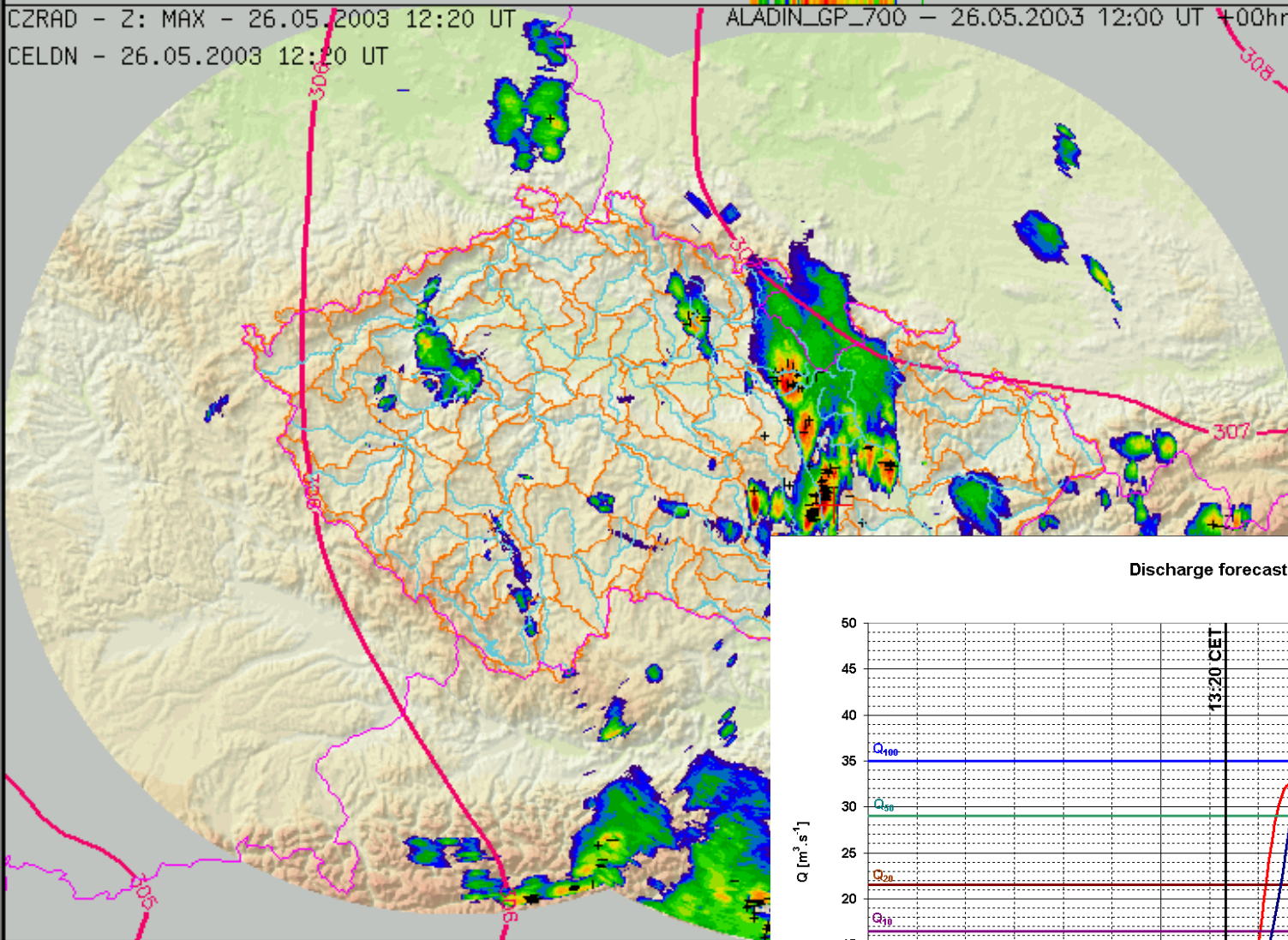
CG+ 22
 CG- 236
 CC 40
 SUM 298



Forecast
 Cotrec Aladin
 Persistence True

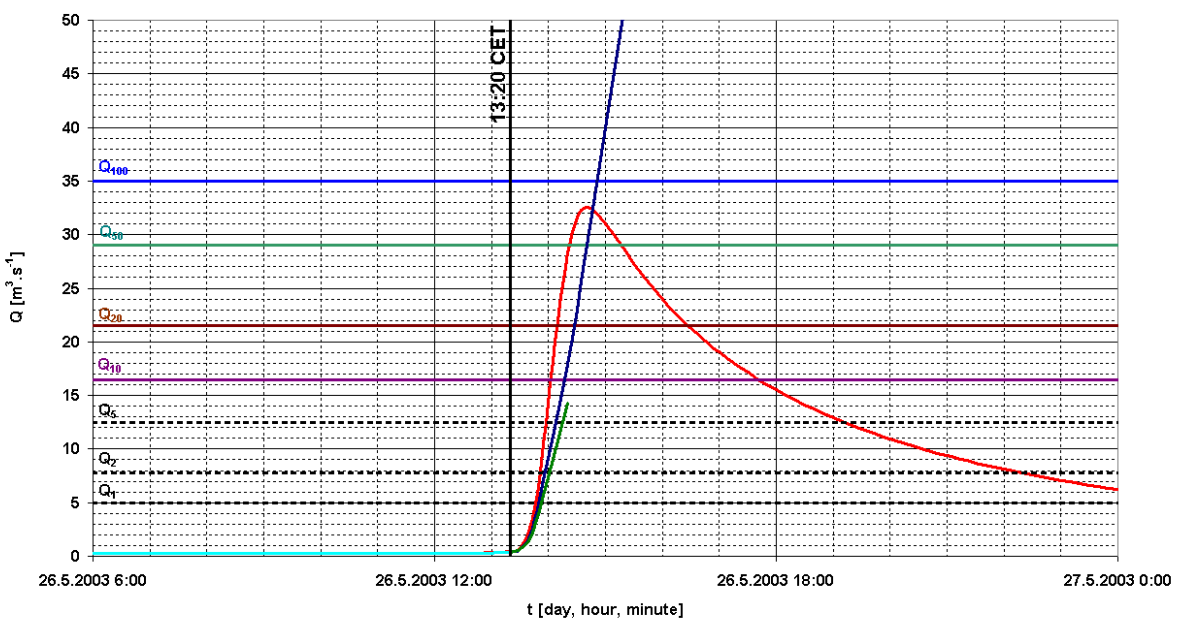
- Every
- 26.05.2003 06:20 CA ▲
 - 26.05.2003 06:10 CA
 - 26.05.2003 06:00 CA
 - 26.05.2003 05:50 CA
 - 26.05.2003 05:40 CA
 - 26.05.2003 05:30 CA
 - 26.05.2003 05:20 CA
 - 26.05.2003 05:10 CA
 - 26.05.2003 05:00 CA
 - 26.05.2003 04:50 CA
 - 26.05.2003 04:40 CA
 - 26.05.2003 04:30 CA ▼

LOAD (258 / 258)

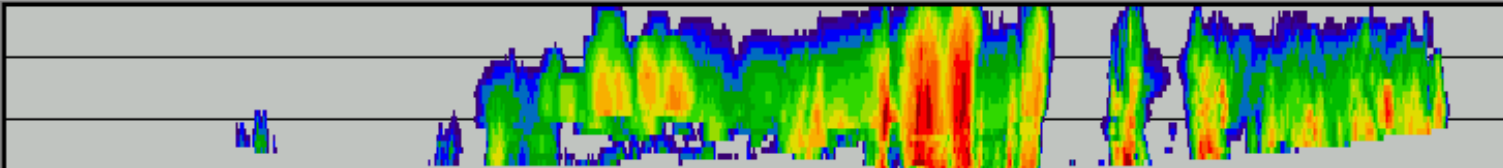


Navigation controls: |< < || >> >| ANIM: 1 s/img LAST: +2 s AUT
 PDUS RAD LIGHTNING WIND none
 ORO col UND catchments OVR rivers NAVIG red
 cursor position is [790,207] = [21.256,49.903]

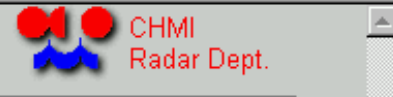
Discharge forecast at Sloup, 13:20 CET



RECONSTRUCTION SIMULATION COTREC PERSISTENCE



CG+ 15
CG- 237
CC 45
SUM 297



Forecast +00 min

- Cotrec Aladin
- Persistence True

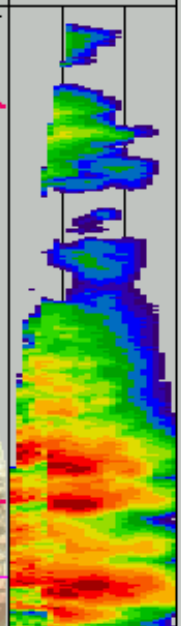
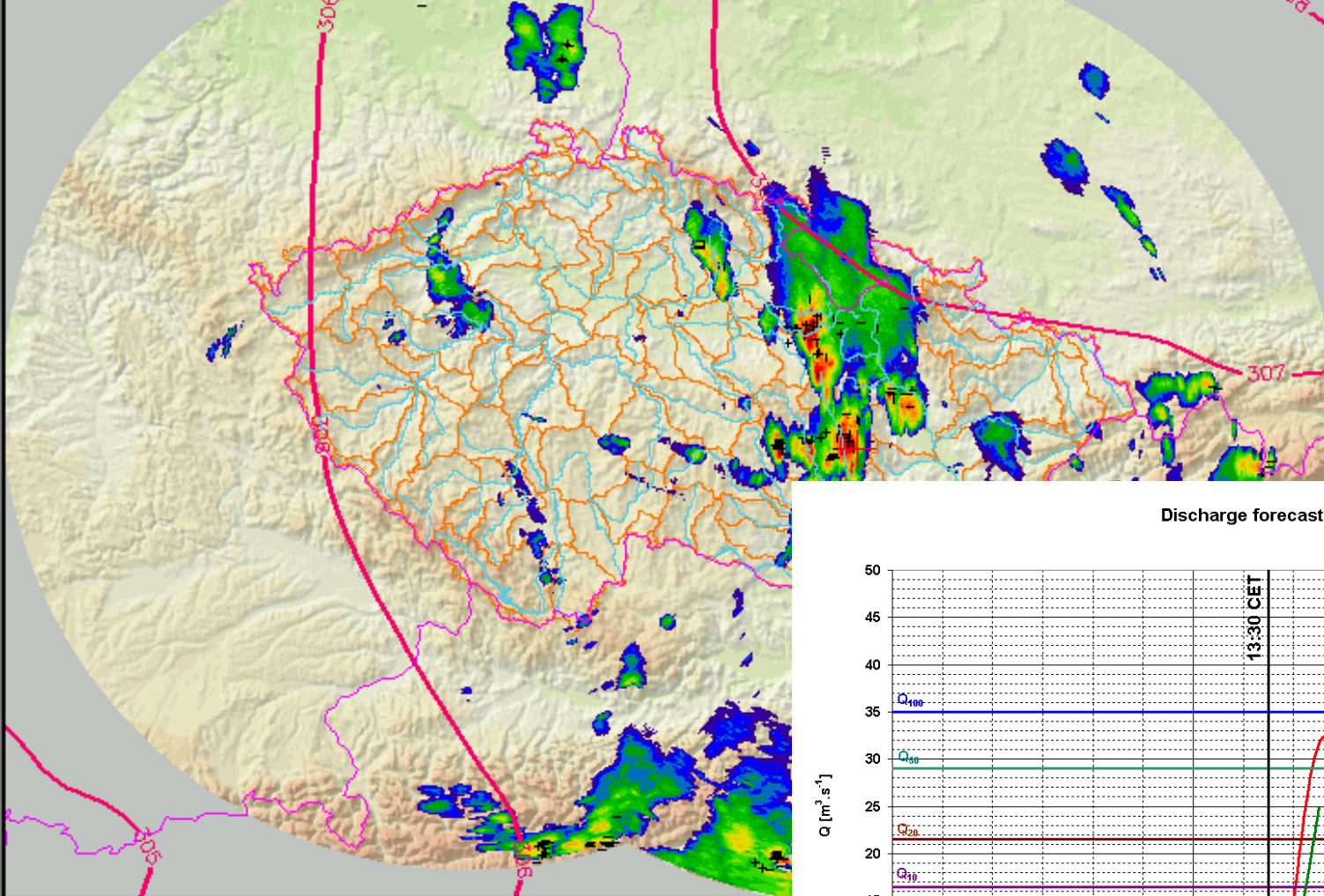
Every 6th 3rd

- 26.05.2003 06:20 CA
- 26.05.2003 06:10 CA
- 26.05.2003 06:00 CA
- 26.05.2003 05:50 CA
- 26.05.2003 05:40 CA
- 26.05.2003 05:30 CA
- 26.05.2003 05:20 CA
- 26.05.2003 05:10 CA
- 26.05.2003 05:00 CA
- 26.05.2003 04:50 CA
- 26.05.2003 04:40 CA
- 26.05.2003 04:30 CA

LOAD (258 / 258)

CZRAD - Z: MAX - 26.05.2003 12:30 UT ALADIN_GP_700 - 26.05.2003 12:00 UT +00hr

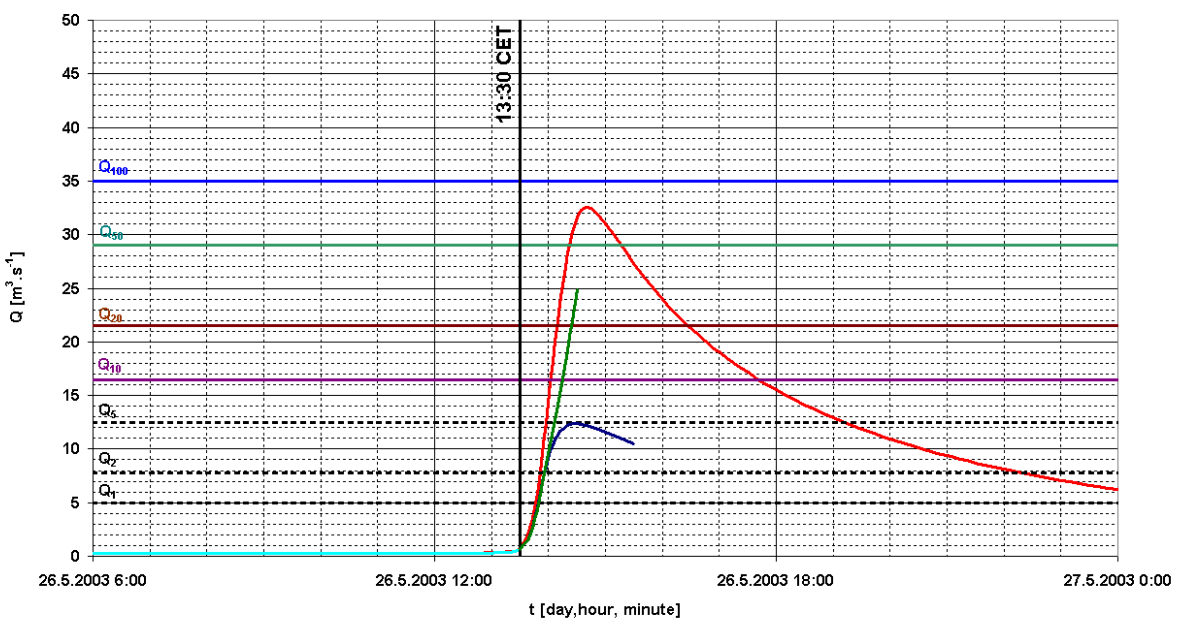
CELDN - 26.05.2003 12:30 UT



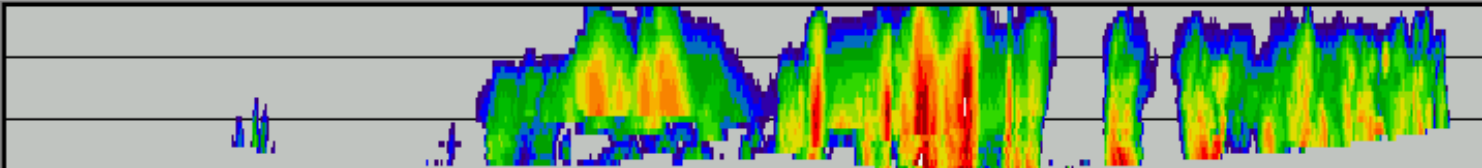
Navigation and display controls:

- ANIM: 1 s/img
- LAST: +2 s
- AUT
- PDUS RAD LIGHTNING WIND none
- ORO col UND catchments OVR rivers NAVIG red
- cursor position is [796,177] = [21.378,50.165]

Discharge forecast at Sloup, 13:30 CET



RECONSTRUCTION SIMULATION COTREC PERSISTENCE



CG+ 18
 CG- 212
 CC 32
 SUM 262



Forecast +00 min

- Cotrec Aladin
- Persistence True

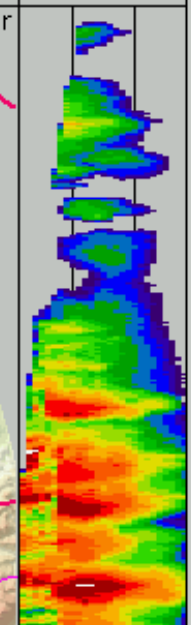
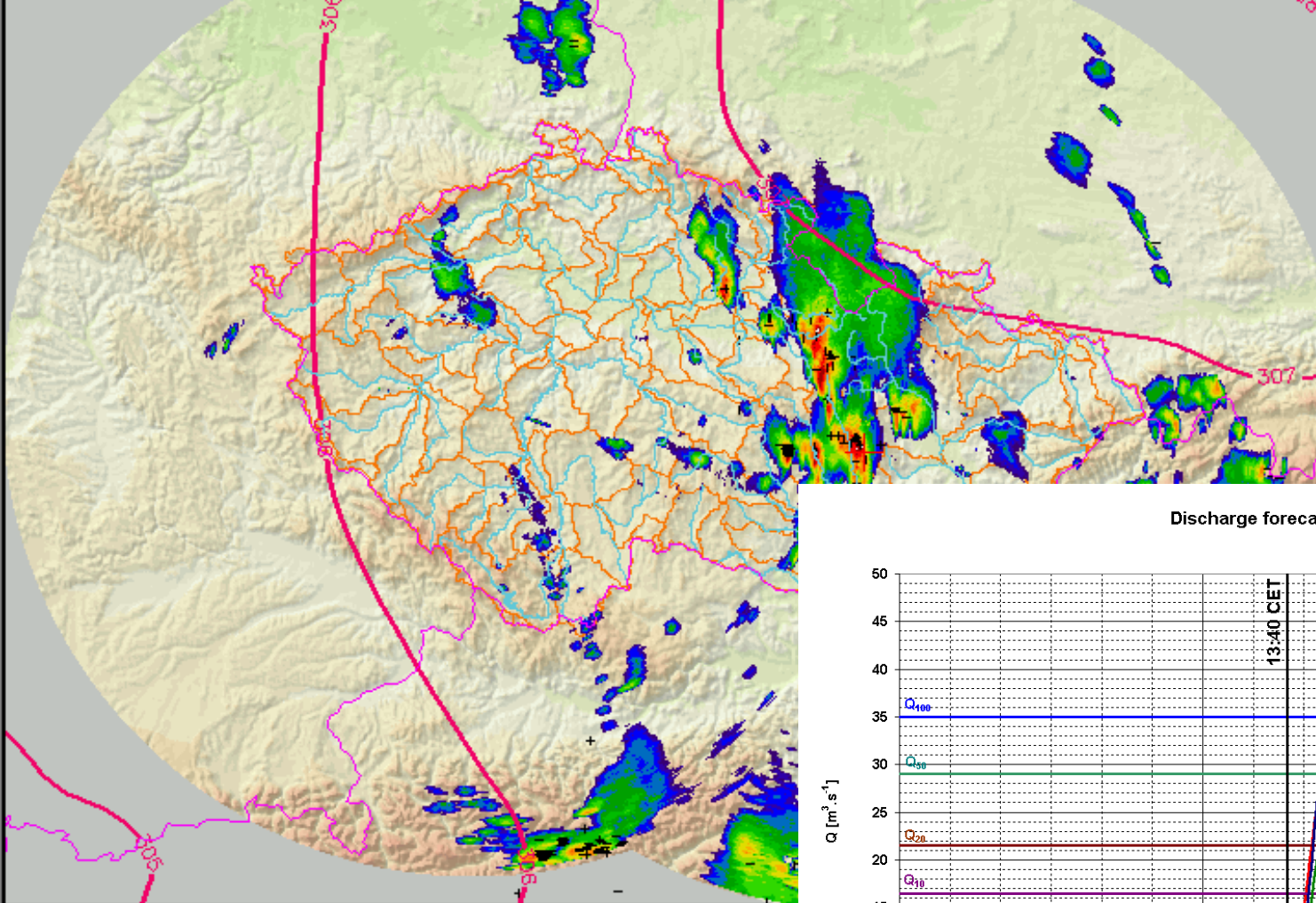
Every 6th 3rd

- 26.05.2003 06:20 CA
- 26.05.2003 06:10 CA
- 26.05.2003 06:00 CA
- 26.05.2003 05:50 CA
- 26.05.2003 05:40 CA
- 26.05.2003 05:30 CA
- 26.05.2003 05:20 CA
- 26.05.2003 05:10 CA**
- 26.05.2003 05:00 CA
- 26.05.2003 04:50 CA
- 26.05.2003 04:40 CA
- 26.05.2003 04:30 CA

LOAD (258 / 258)

CZRAD - Z: MAX - 26.05.2003 12:40 UT ALADIN_GP_700 - 26.05.2003 12:00 UT +00hr

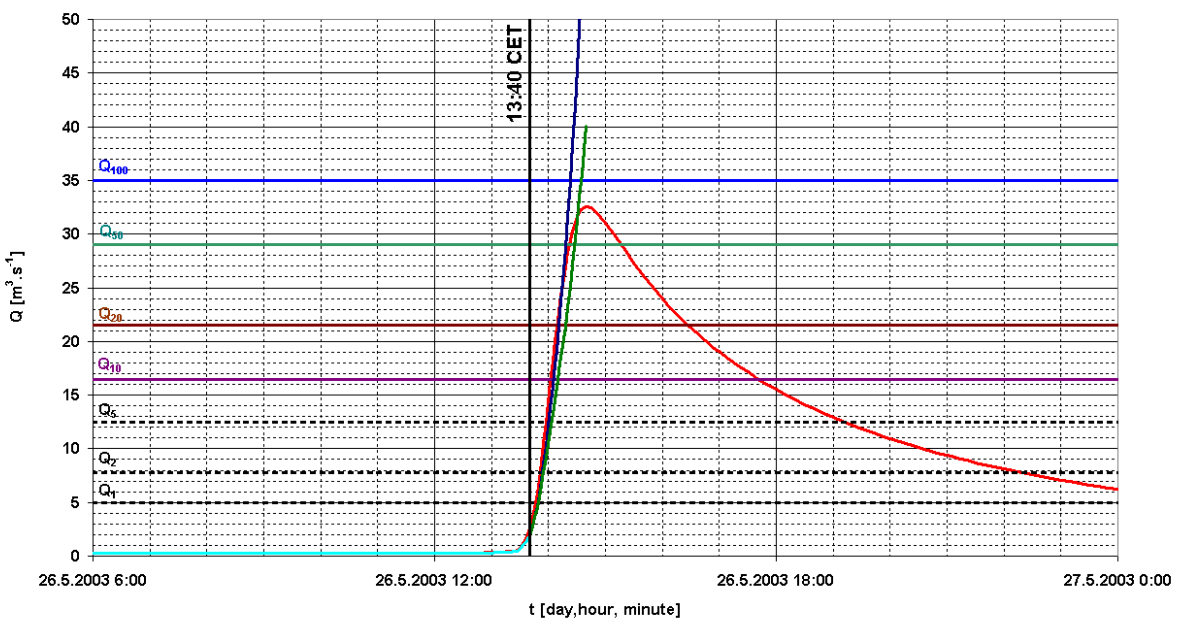
CELDN - 26.05.2003 12:40 UT

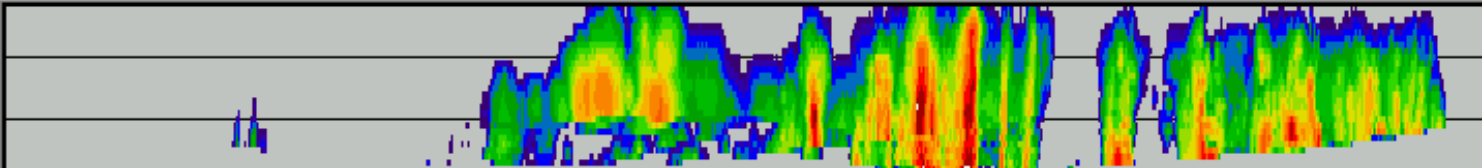


Navigation and display controls:

- ANIM: 1 s/img
- LAST: +2 s
- AUT
- PDUS RAD LIGHTNING WIND none
- ORO col UND catchments OVR rivers NAVIG red
- cursor position is [359,524] = [15.207,47.254]

Discharge forecast at Sloup, 13:40 CET





CG+ 19
 CG- 391
 CC 52
 SUM 462



Forecast

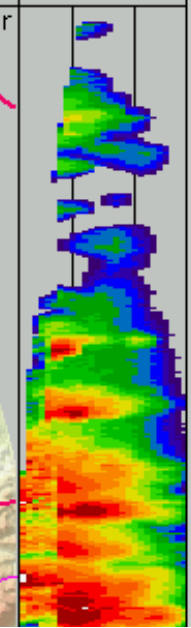
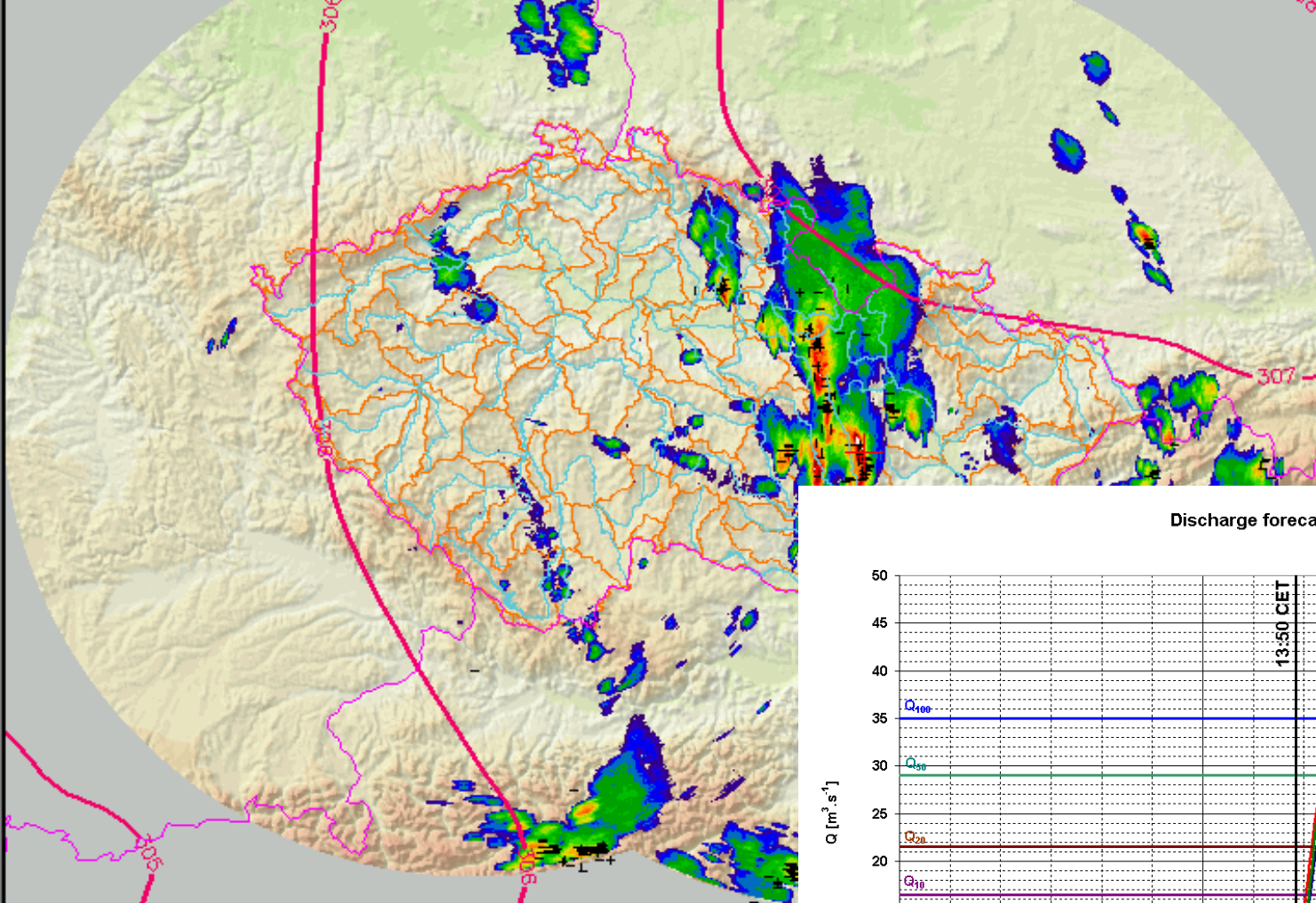
Cotrec Aladin
 Persistence True

Every

- 26.05.2003 06:20 CA ▲
- 26.05.2003 06:10 CA
- 26.05.2003 06:00 CA
- 26.05.2003 05:50 CA
- 26.05.2003 05:40 CA
- 26.05.2003 05:30 CA
- 26.05.2003 05:20 CA
- 26.05.2003 05:10 CA
- 26.05.2003 05:00 CA
- 26.05.2003 04:50 CA
- 26.05.2003 04:40 CA
- 26.05.2003 04:30 CA ▼

CZRAD - Z: MAX - 26.05.2003 12:50 UT ALADIN_GP_700 - 26.05.2003 12:00 UT +00hr

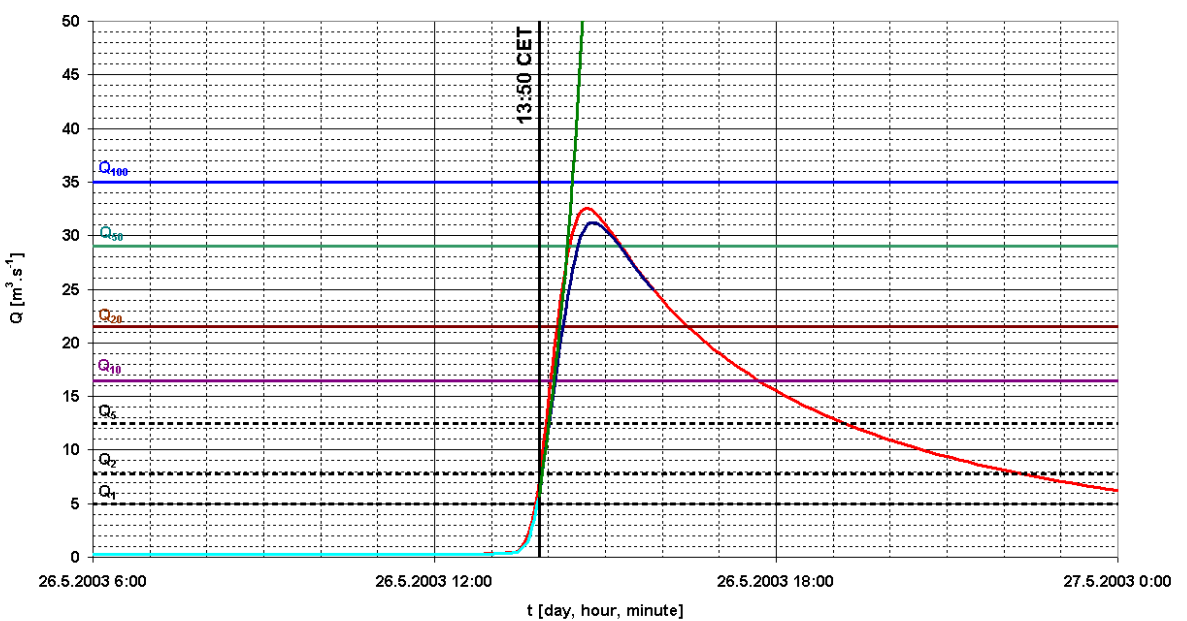
CELDN - 26.05.2003 12:50 UT



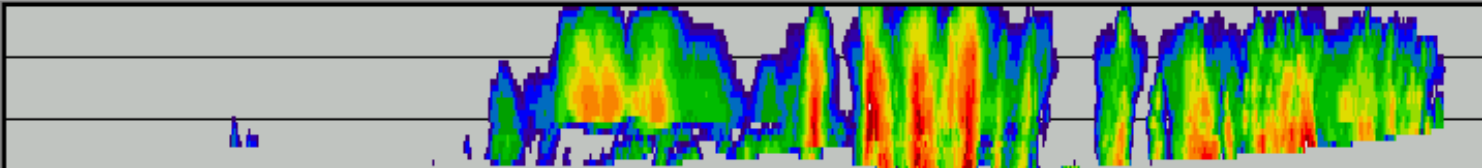
ANIM: 1 s/img LAST: +2 s AUT
 PDUS RAD LIGHTNING WIND none
 ORO col UND catchments OVR rivers NAVIG red

cursor position is [362,526] = [15.246,47.236]

Discharge forecast at Sloup, 13:50 CET



— RECONSTRUCTION — SIMULATION — COTREC — PERSISTENCE



CG+ 12
 CG- 267
 CC 37
 SUM 316



Forecast

- Cotrec
 Aladin
 Persistence
 True

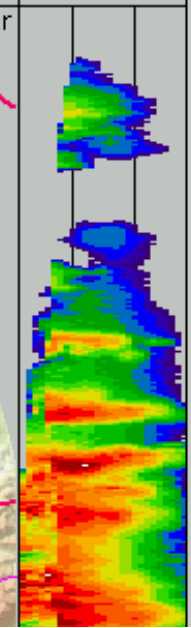
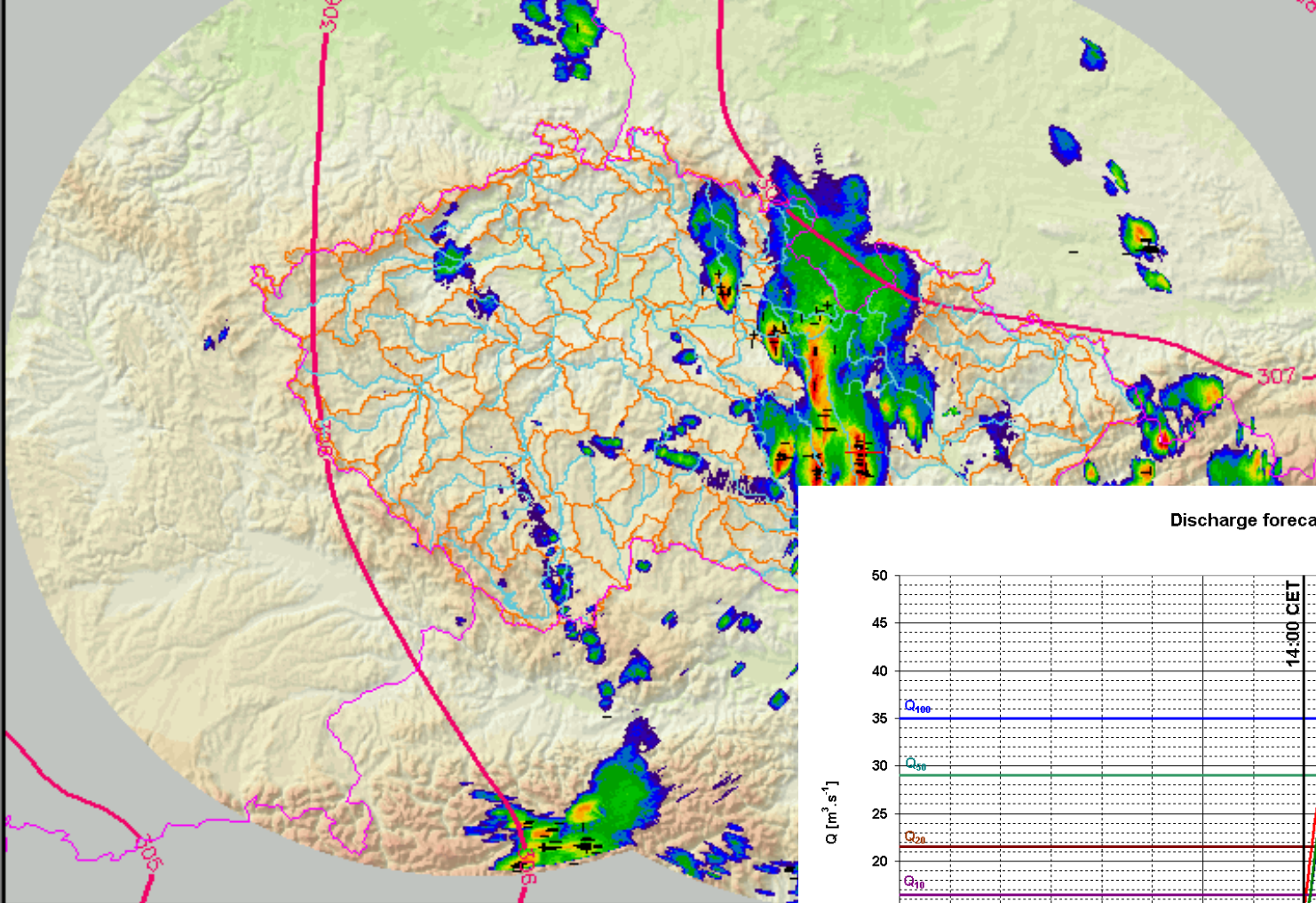
Every

- 26.05.2003 06:20 CA ▲
- 26.05.2003 06:10 CA
- 26.05.2003 06:00 CA
- 26.05.2003 05:50 CA
- 26.05.2003 05:40 CA
- 26.05.2003 05:30 CA
- 26.05.2003 05:20 CA
- 26.05.2003 05:10 CA**
- 26.05.2003 05:00 CA
- 26.05.2003 04:50 CA
- 26.05.2003 04:40 CA
- 26.05.2003 04:30 CA ▼

LOAD (258 / 258)

CZRAD - Z: MAX - 26.05.2003 13:00 UT ALADIN_GP_700 - 26.05.2003 12:00 UT +00hr

CELDN - 26.05.2003 13:00 UT



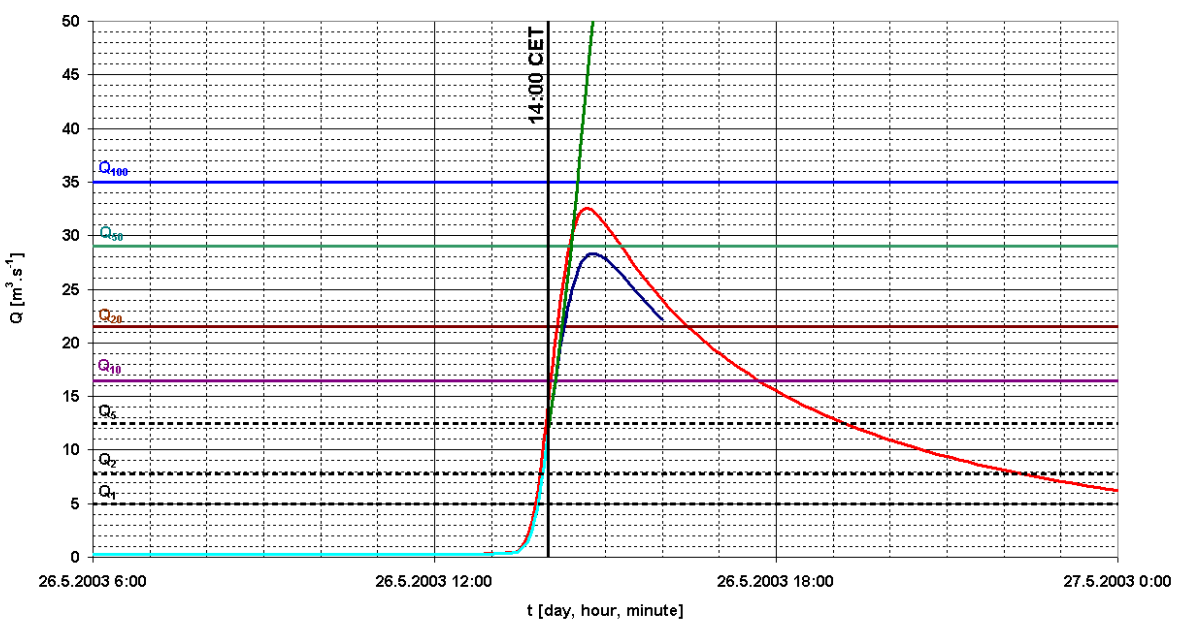
ANIM: 1 s/img LAST: +2 s AUT

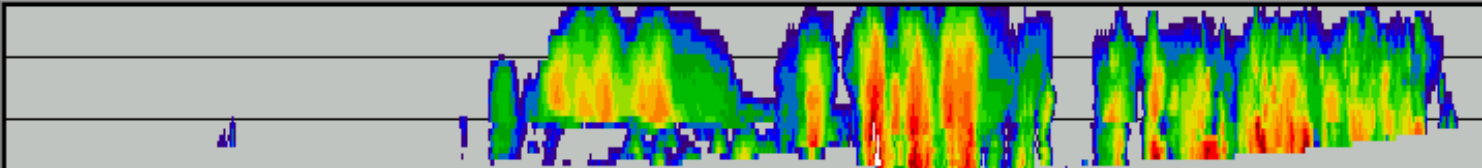
PDUS RAD LIGHTNING WIND none

ORO col UND catchments OVR rivers NAVIG red

cursor position is [799,254] = [21.321,49.476]

Discharge forecast at Sloup, 14:00 CET





CG+ 30
 CG- 298
 CC 66
 SUM 394



Forecast

- Cotrec
 Aladin
 Persistence
 True

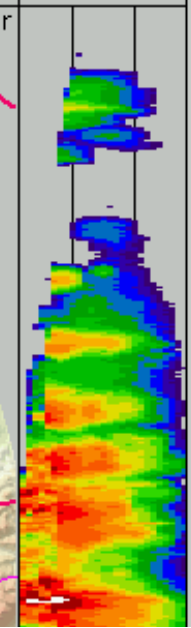
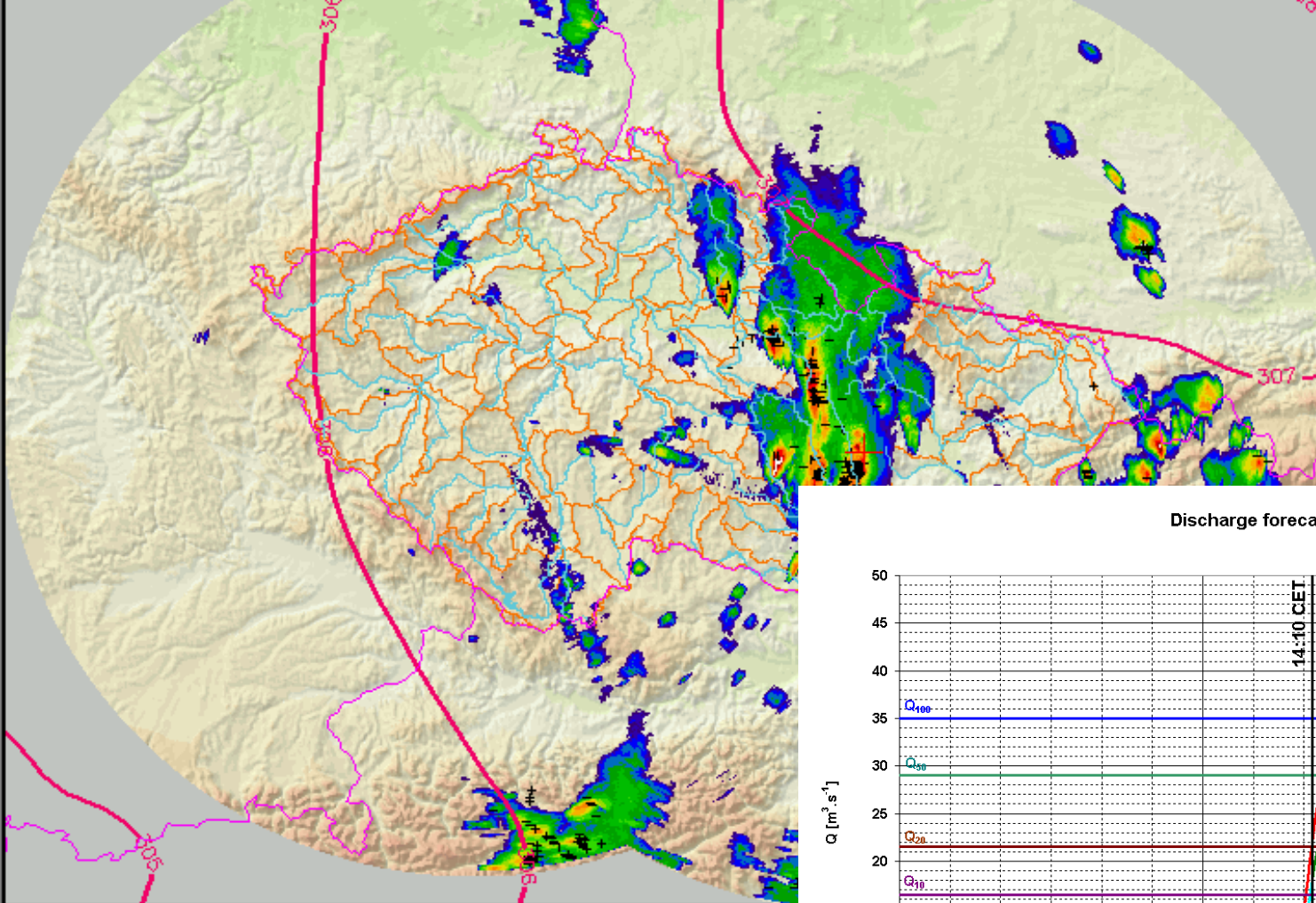
Every

- 26.05.2003 06:20 CA ▲
- 26.05.2003 06:10 CA
- 26.05.2003 06:00 CA
- 26.05.2003 05:50 CA
- 26.05.2003 05:40 CA
- 26.05.2003 05:30 CA
- 26.05.2003 05:20 CA
- 26.05.2003 05:10 CA
- 26.05.2003 05:00 CA
- 26.05.2003 04:50 CA
- 26.05.2003 04:40 CA
- 26.05.2003 04:30 CA ▼

LOAD (258 / 258)

CZRAD - Z: MAX - 26.05.2003 13:10 UT ALADIN_GP_700 - 26.05.2003 12:00 UT +00hr

CELDN - 26.05.2003 13:10 UT



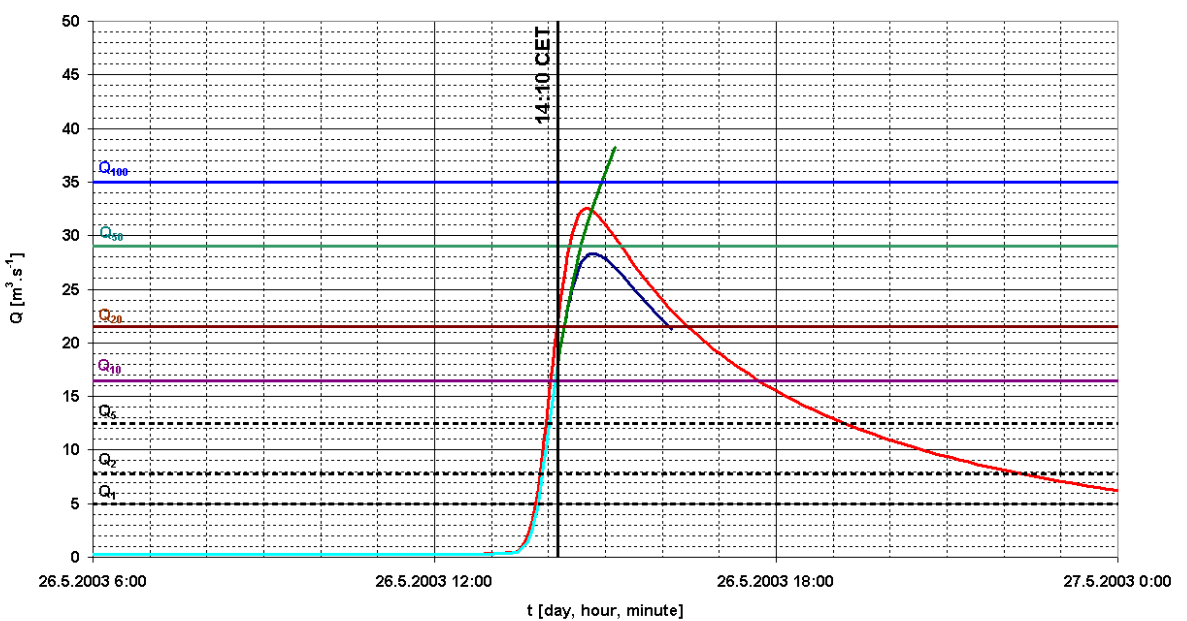
ANIM: 1 s/img LAST: +2 s AUT

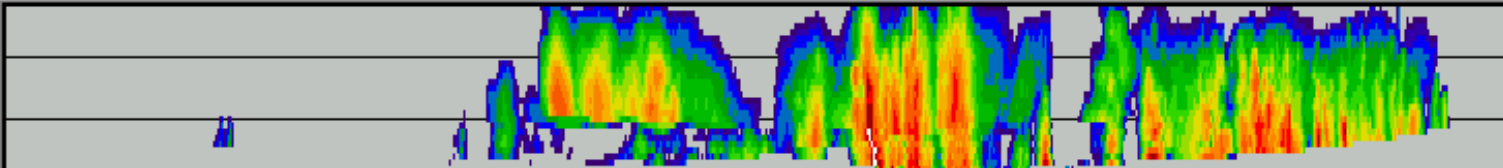
PDUS RAD LIGHTNING WIND none

ORO col UND catchments OVR rivers NAVIG red

cursor position is [524,309] = [17.502,49.146]

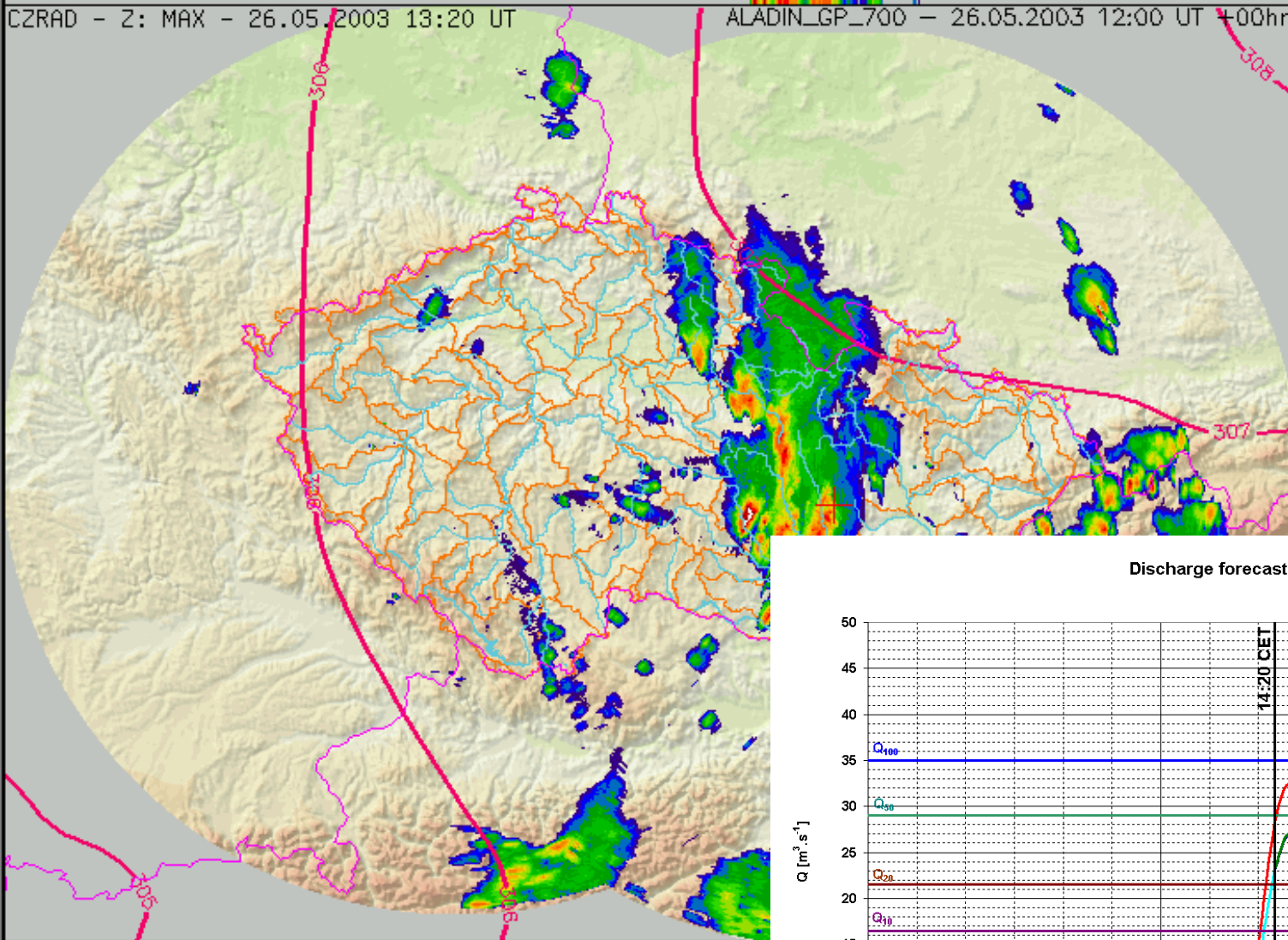
Discharge forecast at Sloup, 14:10 CET





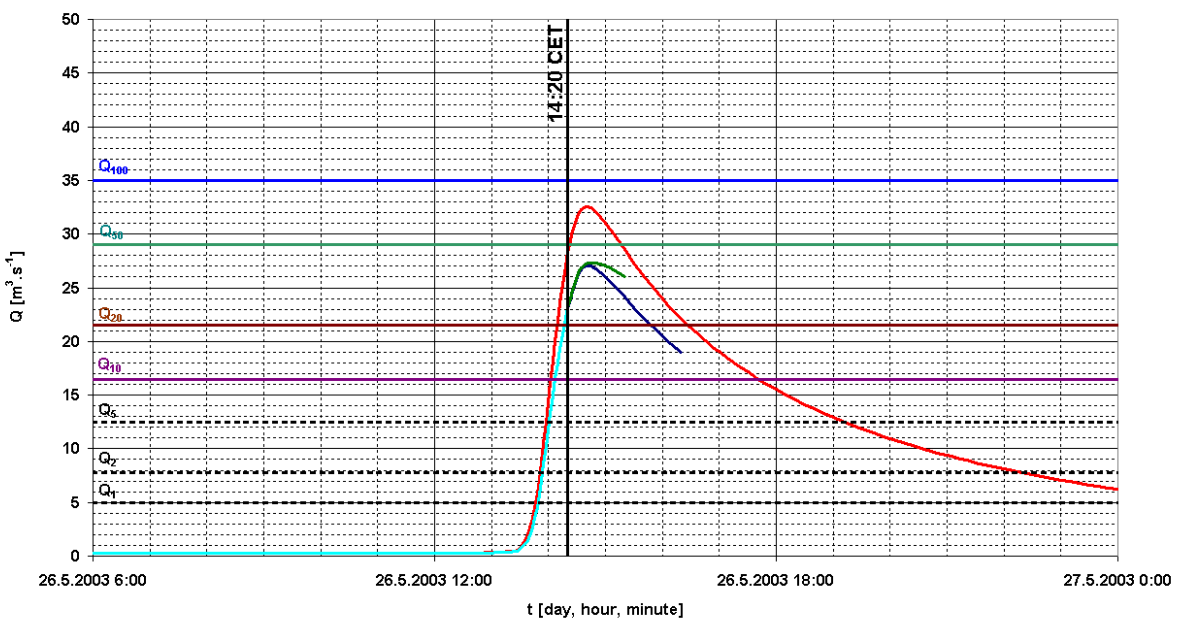
Forecast
 Cotrec Aladin
 Persistence True

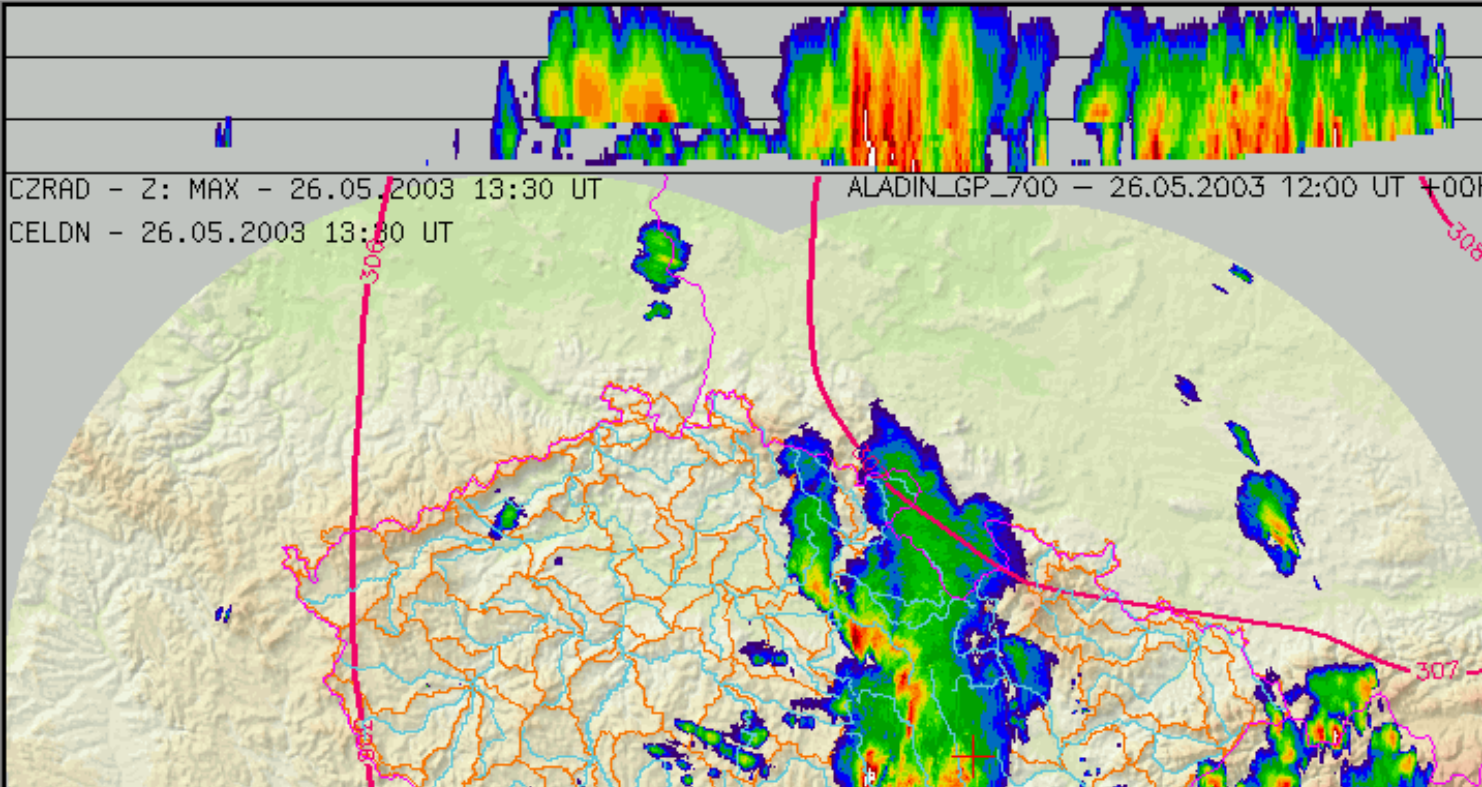
- Every
- 26.05.2003 06:20 CA
 - 26.05.2003 06:10 CA
 - 26.05.2003 06:00 CA
 - 26.05.2003 05:50 CA
 - 26.05.2003 05:40 CA
 - 26.05.2003 05:30 CA
 - 26.05.2003 05:20 CA
 - 26.05.2003 05:10 CA**
 - 26.05.2003 05:00 CA
 - 26.05.2003 04:50 CA
 - 26.05.2003 04:40 CA
 - 26.05.2003 04:30 CA
- LOAD (258 / 258)



Navigation and display controls:
[<] [<] [||] [>>] [>] [>] ANIM: 1 s/img LAST: +2 s AUT
PDUS RAD LIGHTNING WIND none
ORO col UND catchments OVR rivers NAVIG red
cursor position is [104,527] = [11.839,47.2]

Discharge forecast at Sloup, 14:20 CET





NO CELDN DATA !!!

CHMI Radar Dept.

Forecast

Cotrec Aladin
 Persistence True

Every

- 26.05.2003 06:20 CA ▲
- 26.05.2003 06:10 CA
- 26.05.2003 06:00 CA
- 26.05.2003 05:50 CA
- 26.05.2003 05:40 CA
- 26.05.2003 05:30 CA
- 26.05.2003 05:20 CA
- 26.05.2003 05:10 CA**
- 26.05.2003 05:00 CA
- 26.05.2003 04:50 CA
- 26.05.2003 04:40 CA
- 26.05.2003 04:30 CA ▼

LOAD (258 / 258)

Navigation and control panel:

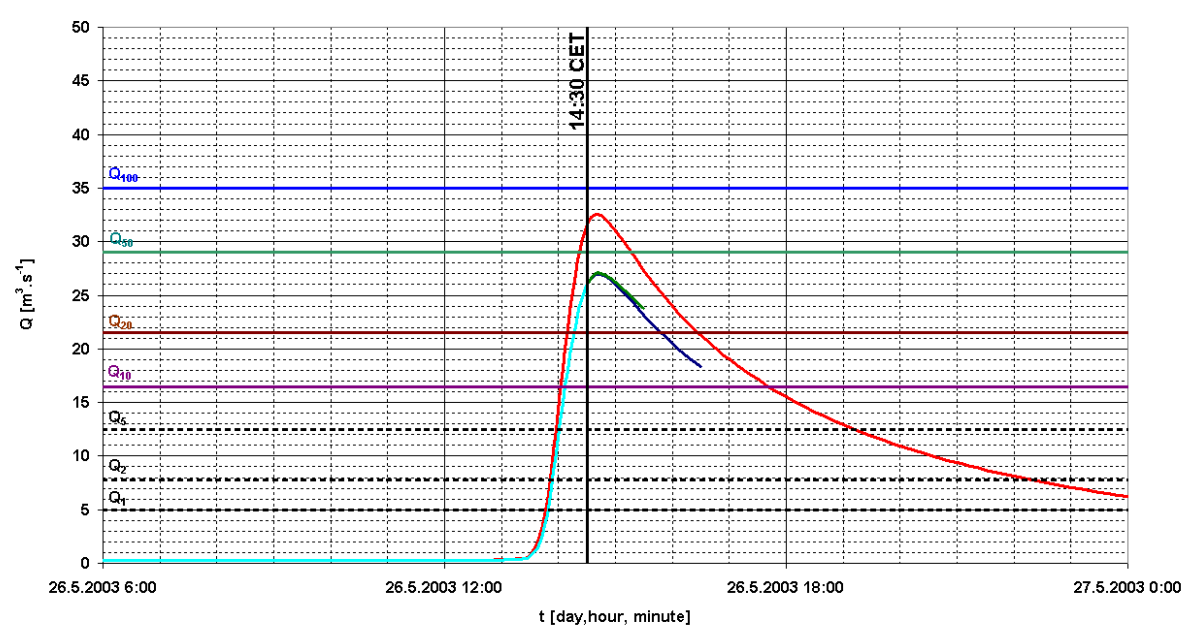
ANIM: 1 s/img LAST: +2 s AUT

PDUS RAD LIGHTNING WIND none

ORO col UND catchments OVR rivers NAVIG red

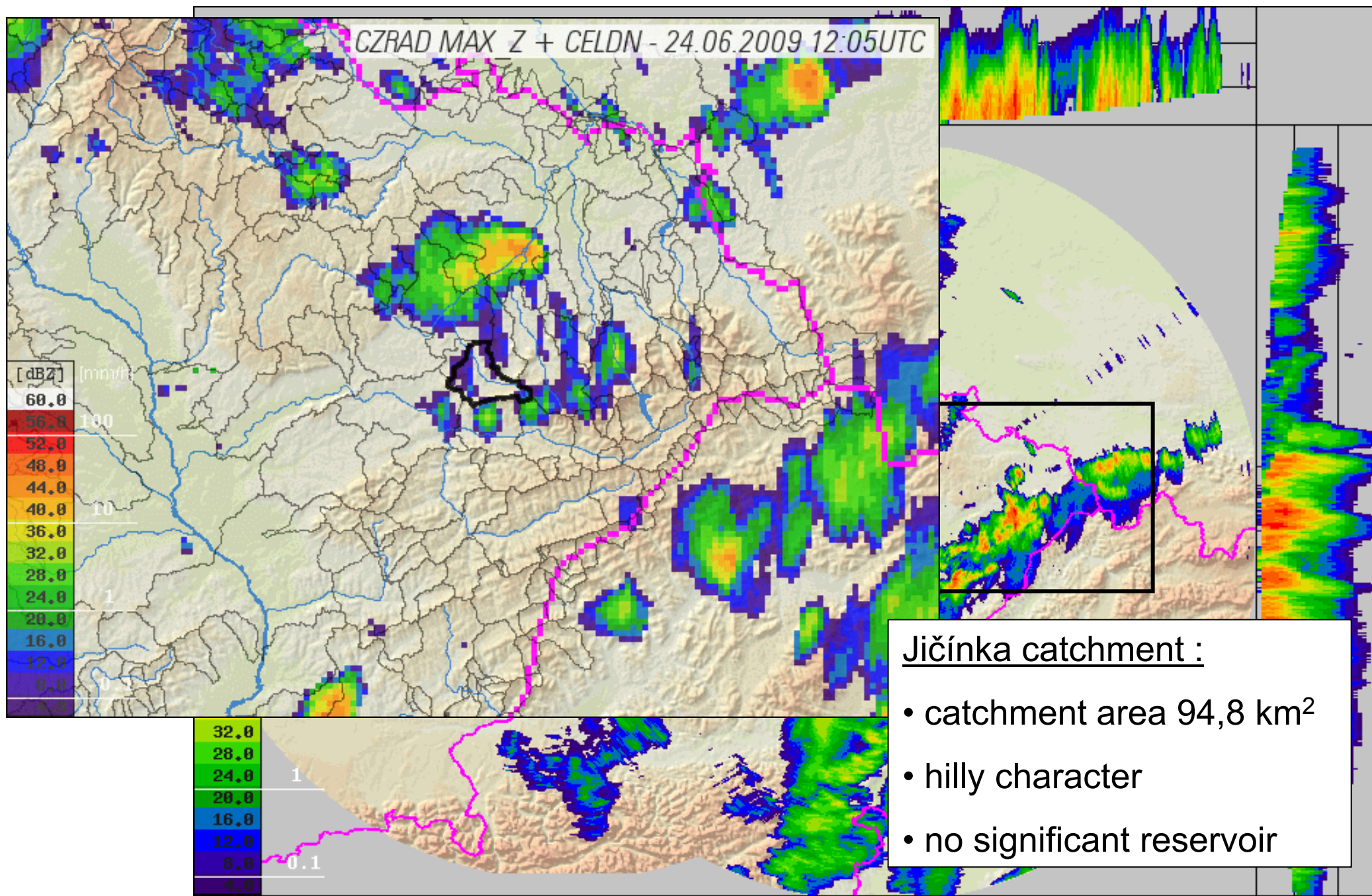
cursor position is [272,525] = [14.057,47.247]

Discharge forecast at Sloup, 14:30 CET



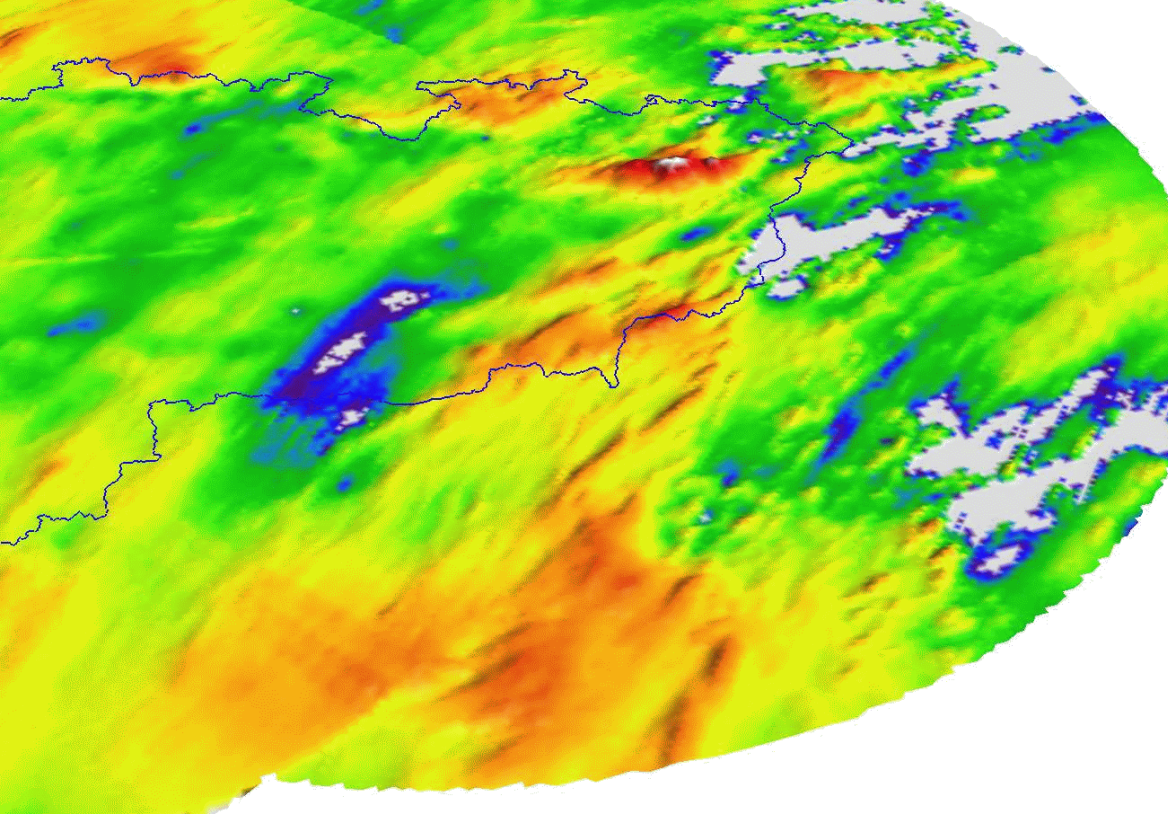
RECONSTRUCTION SIMULATION COTREC PERSISTENCE

Jičínka flash flood – radar observation





Flash floods in the Czech Republic in summer 2009



Long-lasting convective activity in Central Europe since 22th June until 22nd July 2009, heavy precipitation

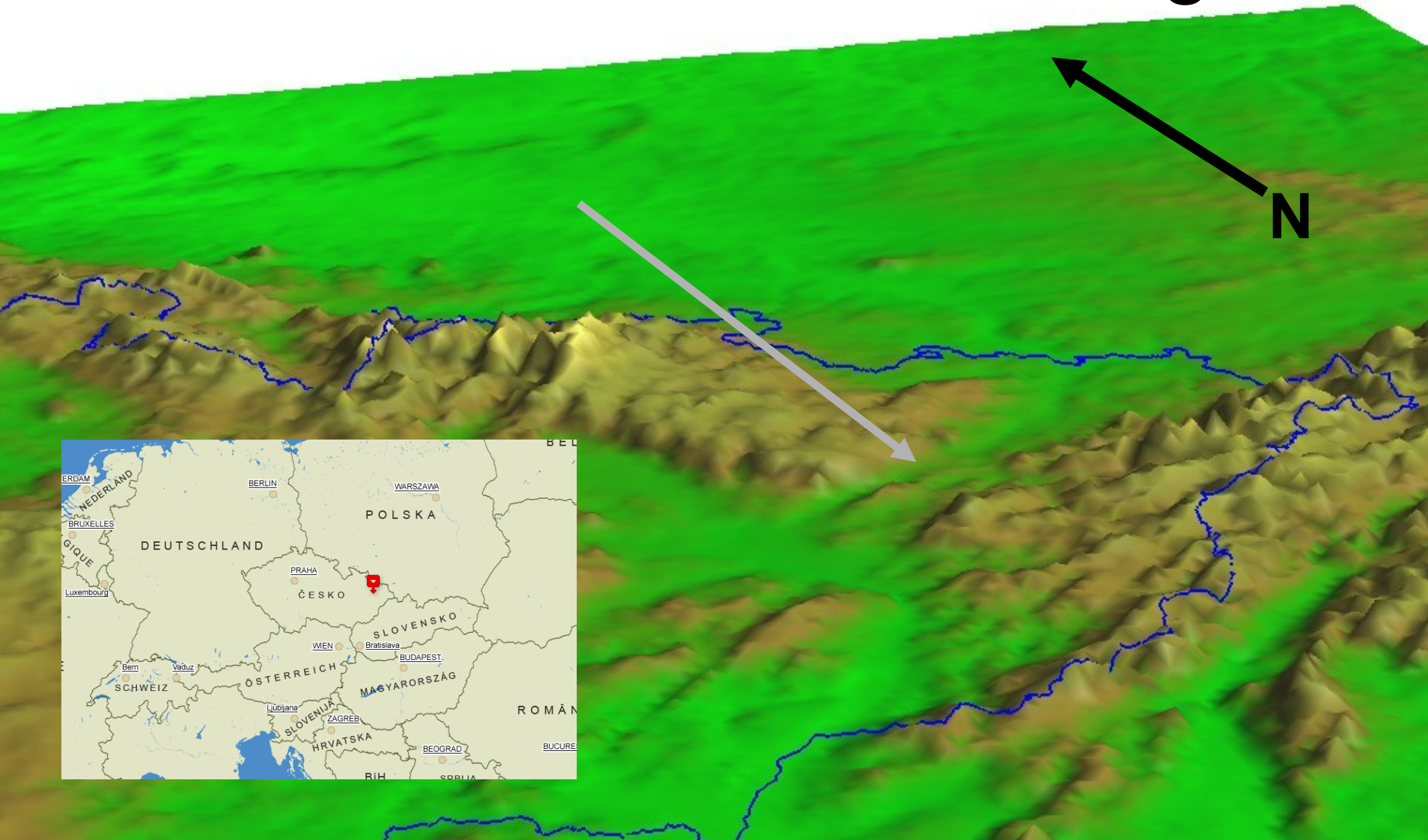
Series of flash flood

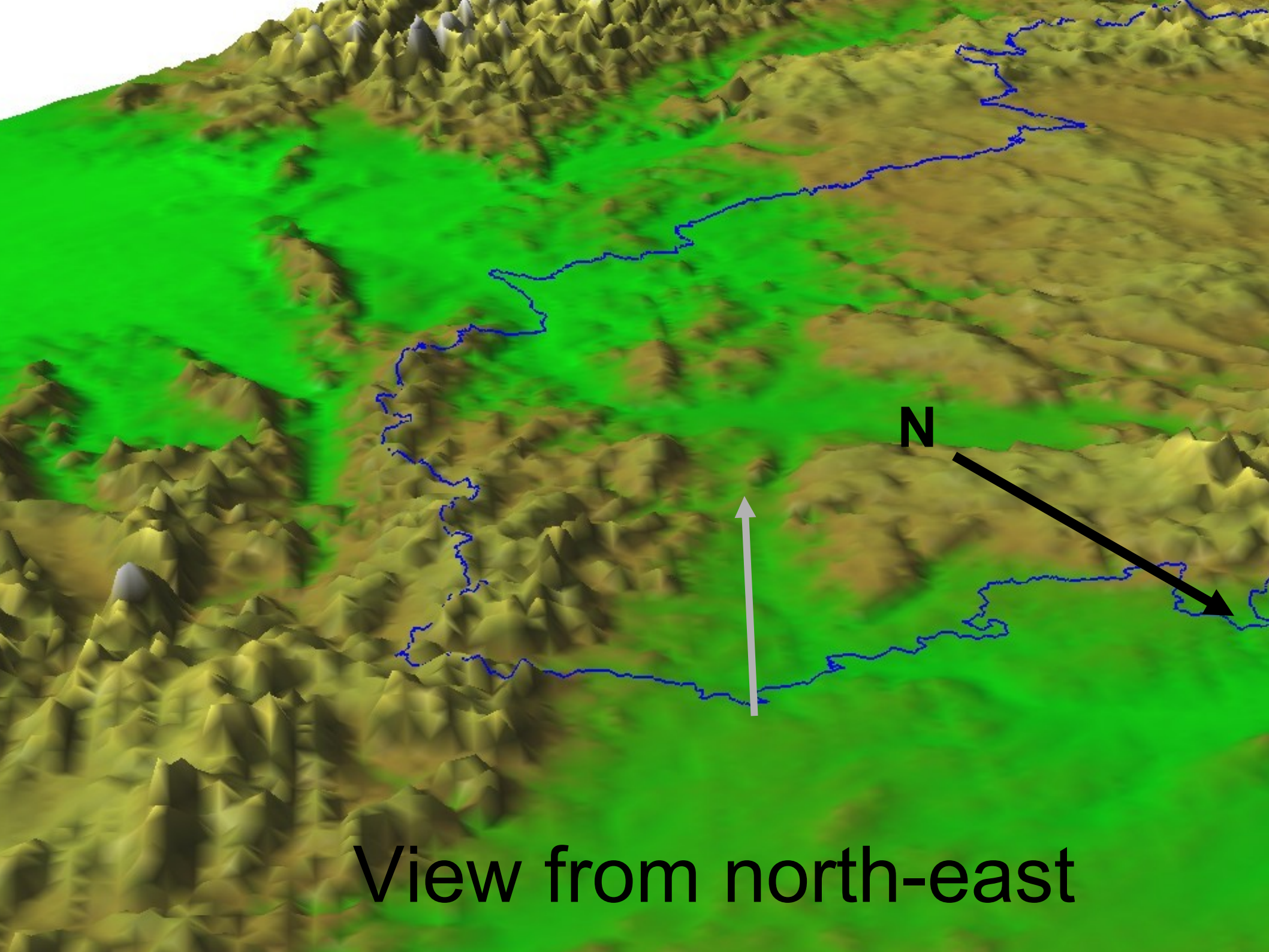
Estimated total damage over the period: 200 mil EUR

12 fatalities

Worst flash flood: June, 24th, NE part of the Czech Republic

The area of flash flooding

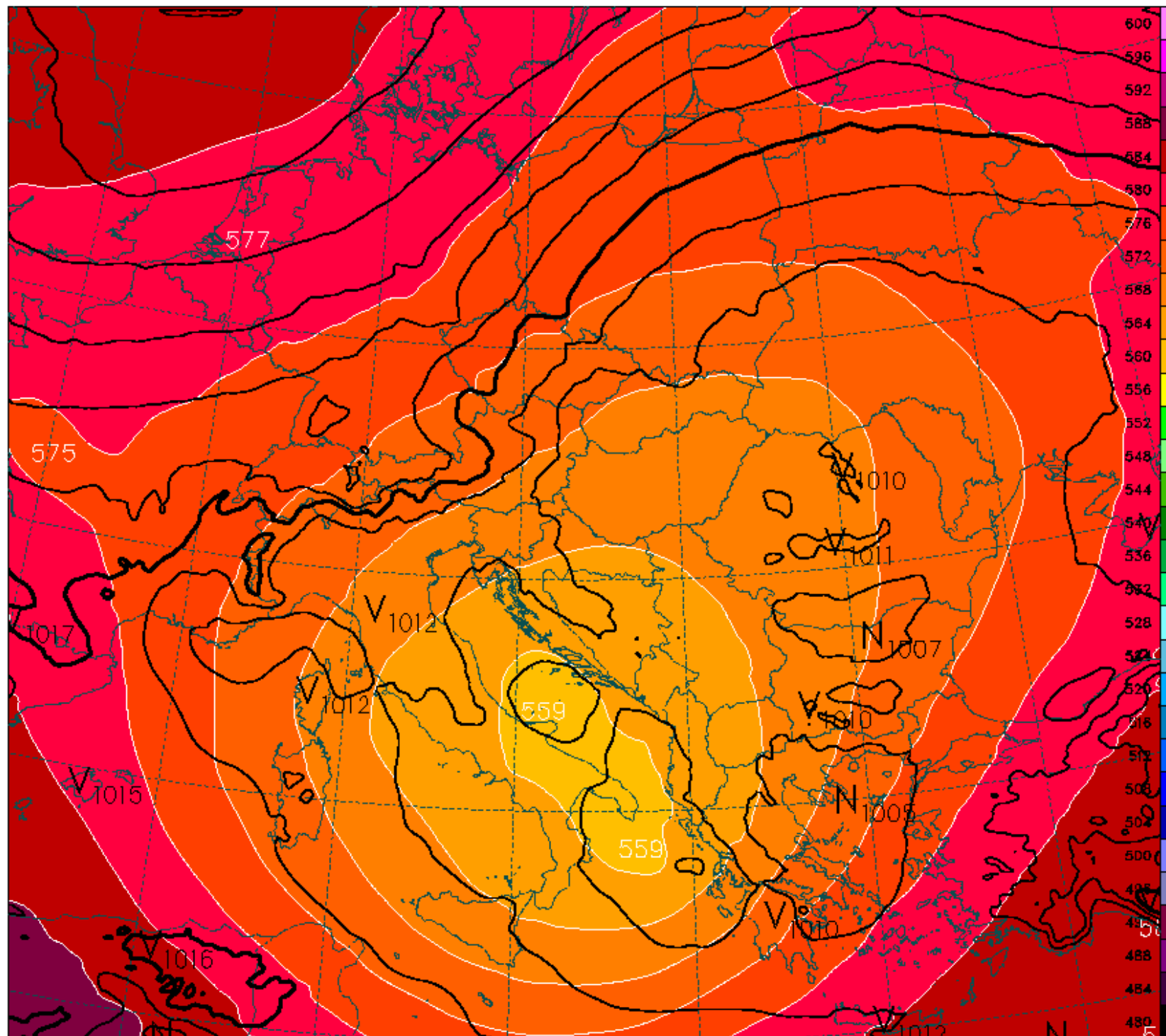




View from north-east

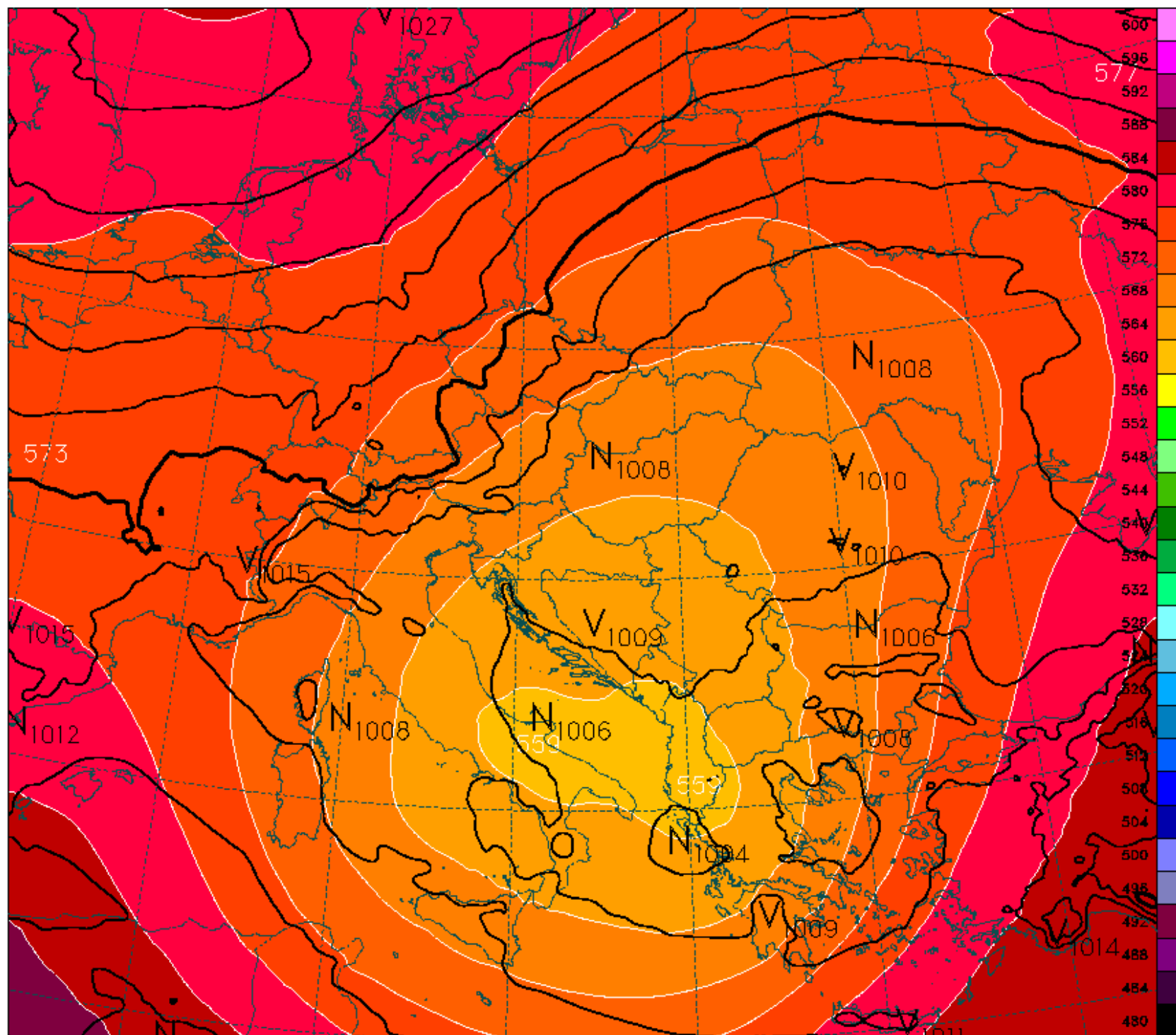


Geopotential
500 hPa
(color)
+
Mean sea
level
pressure
(isolines)



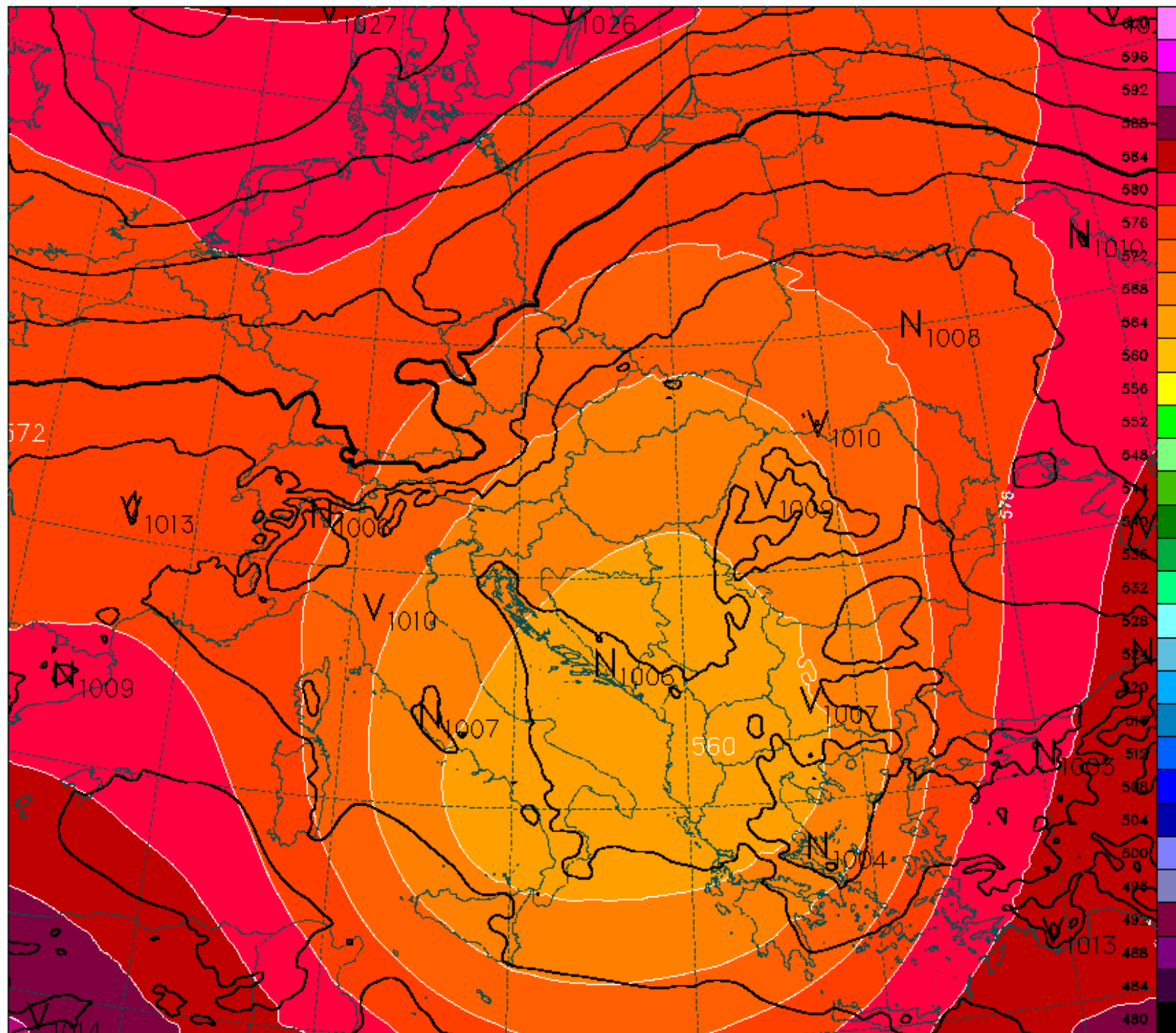


Geopotential
500 hPa
(color)
+
Mean sea
level
pressure
(isolines)



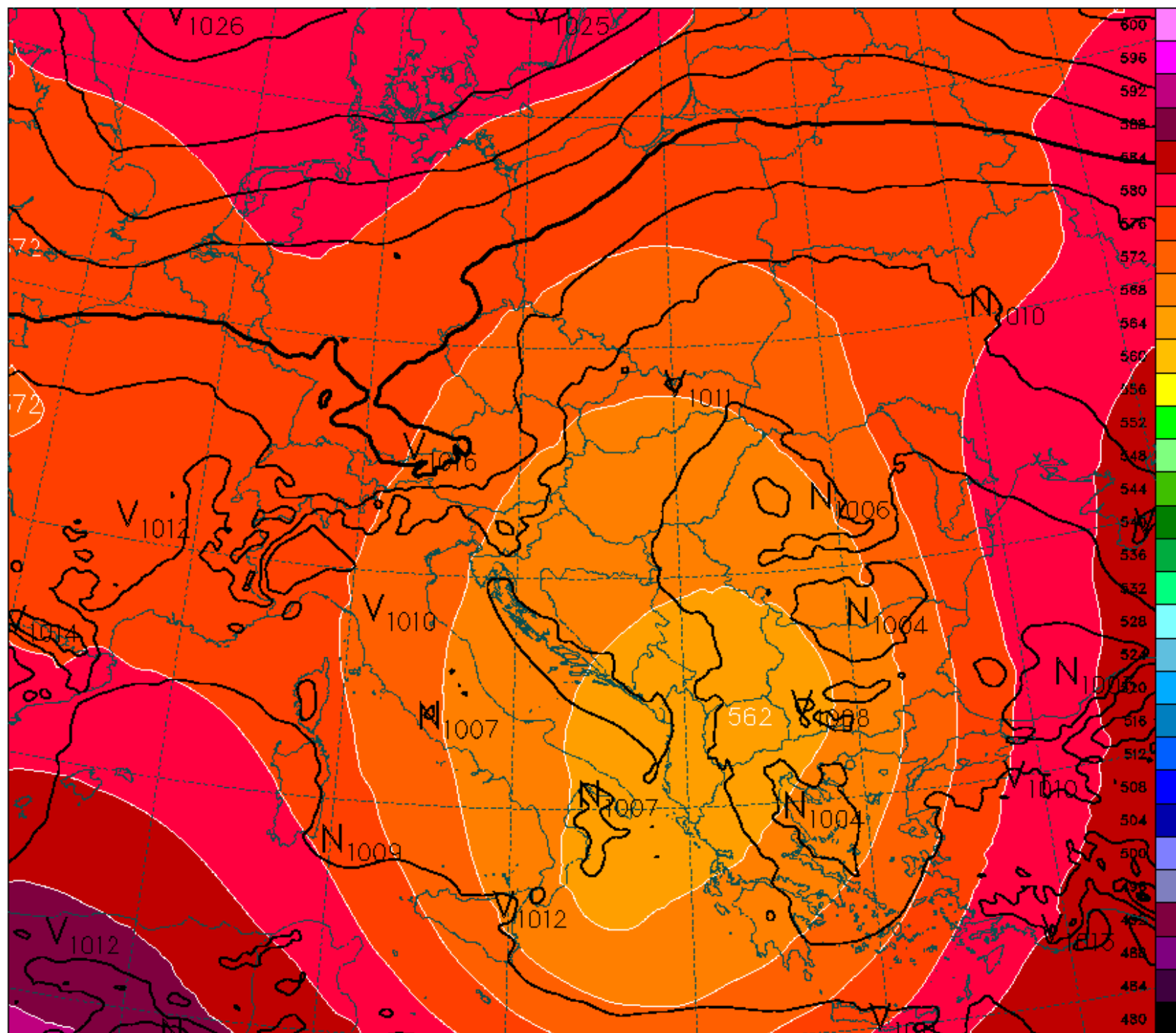


Geopotential
500 hPa
(color)
+
Mean sea
level
pressure
(isolines)





Geopotential
500 hPa
(color)
+
Mean sea
level
pressure
(isolines)

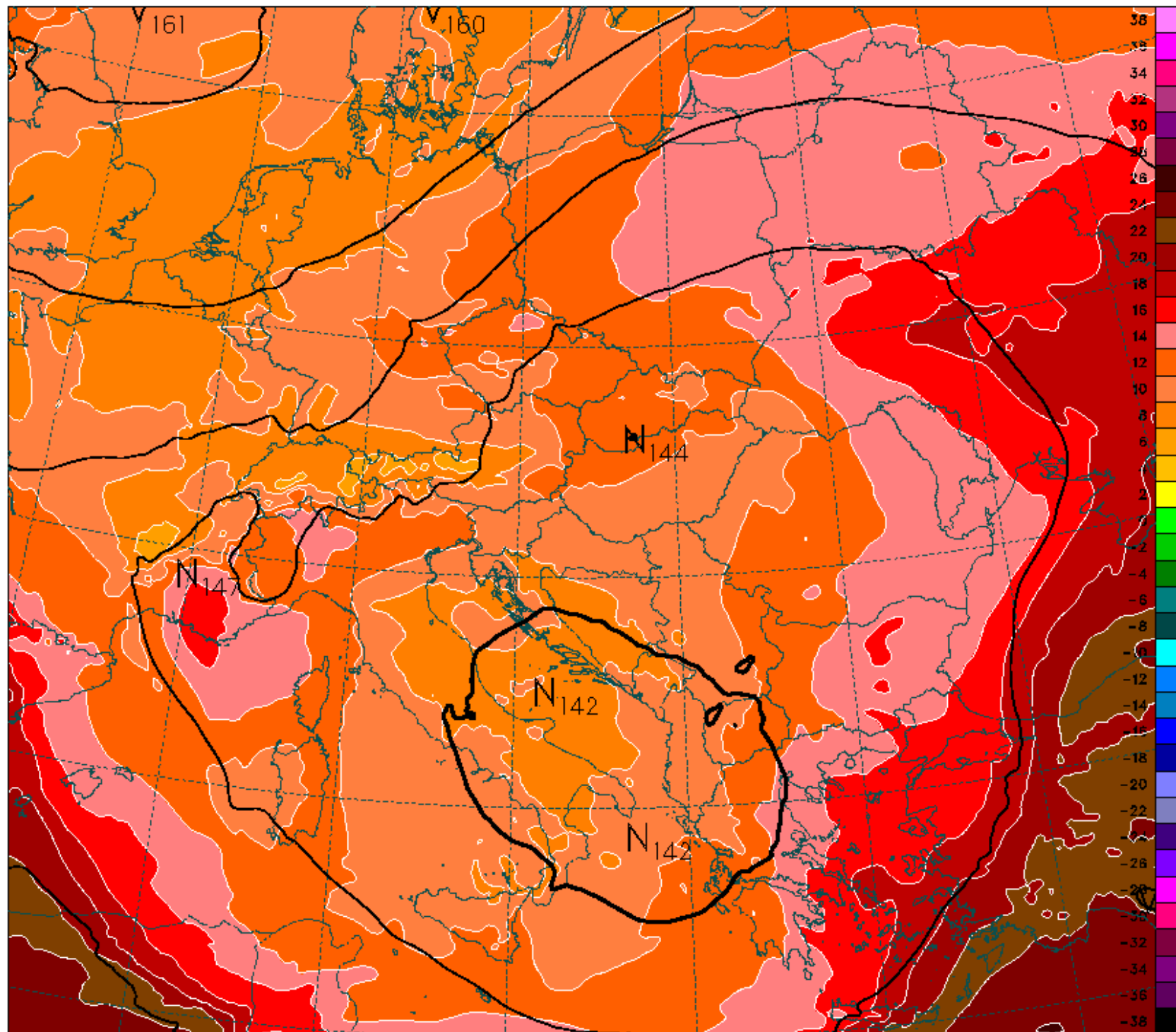




Temperature
(color)

+

Geopotential
850 hPa
(isolines)

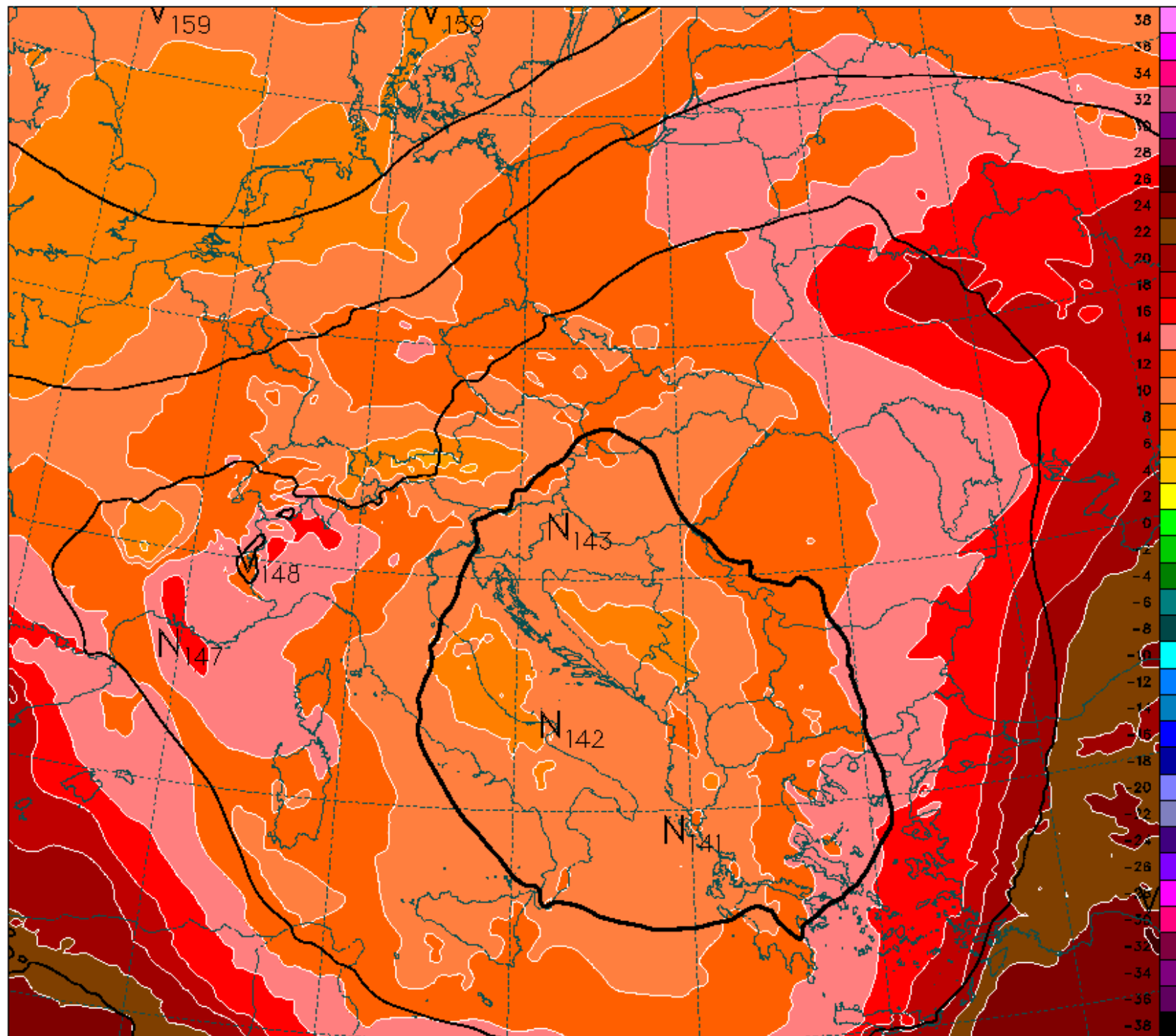




Temperature
(color)

+

Geopotential
850 hPa
(isolines)

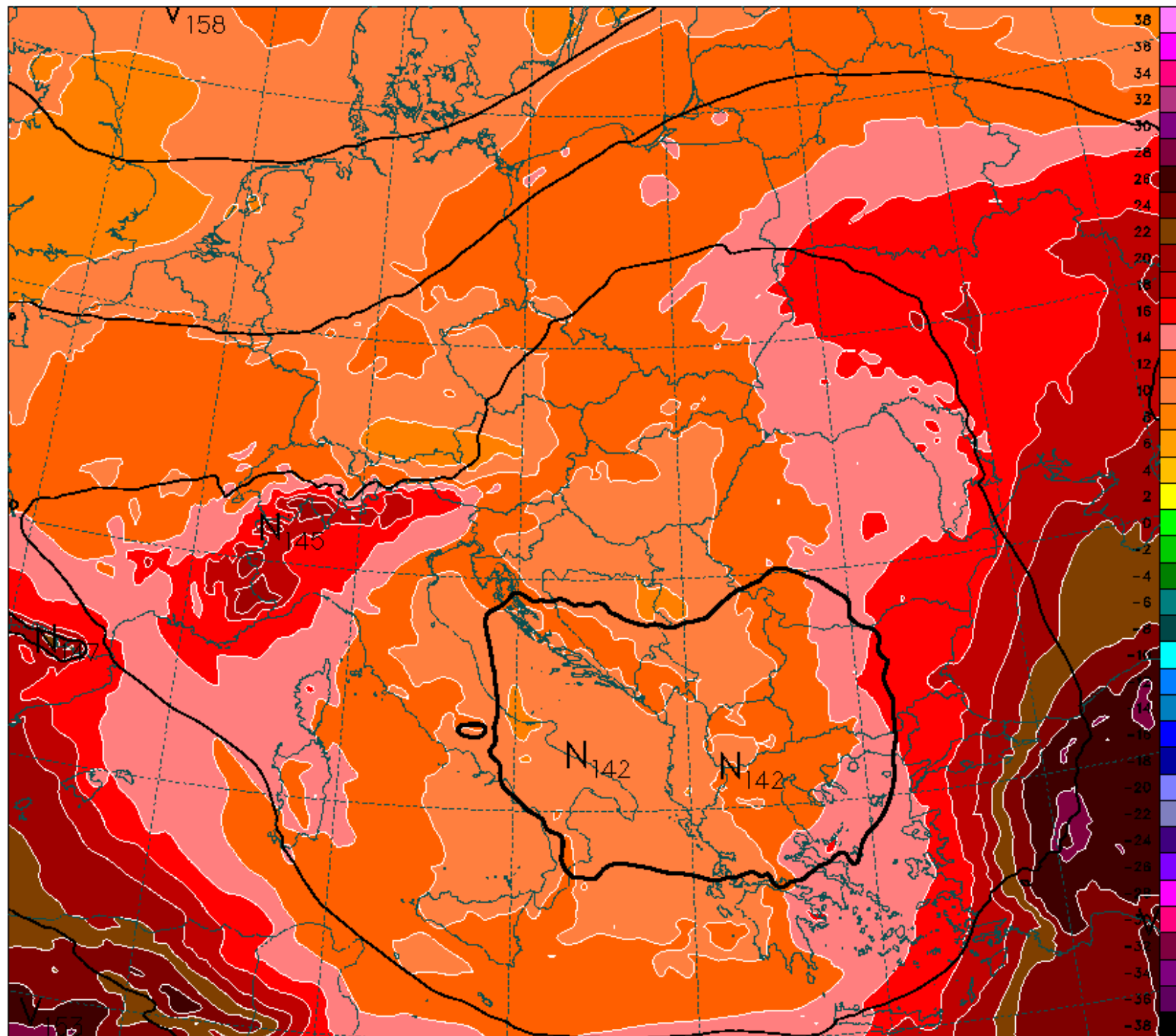




Temperature
(color)

+

Geopotential
850 hPa
(isolines)

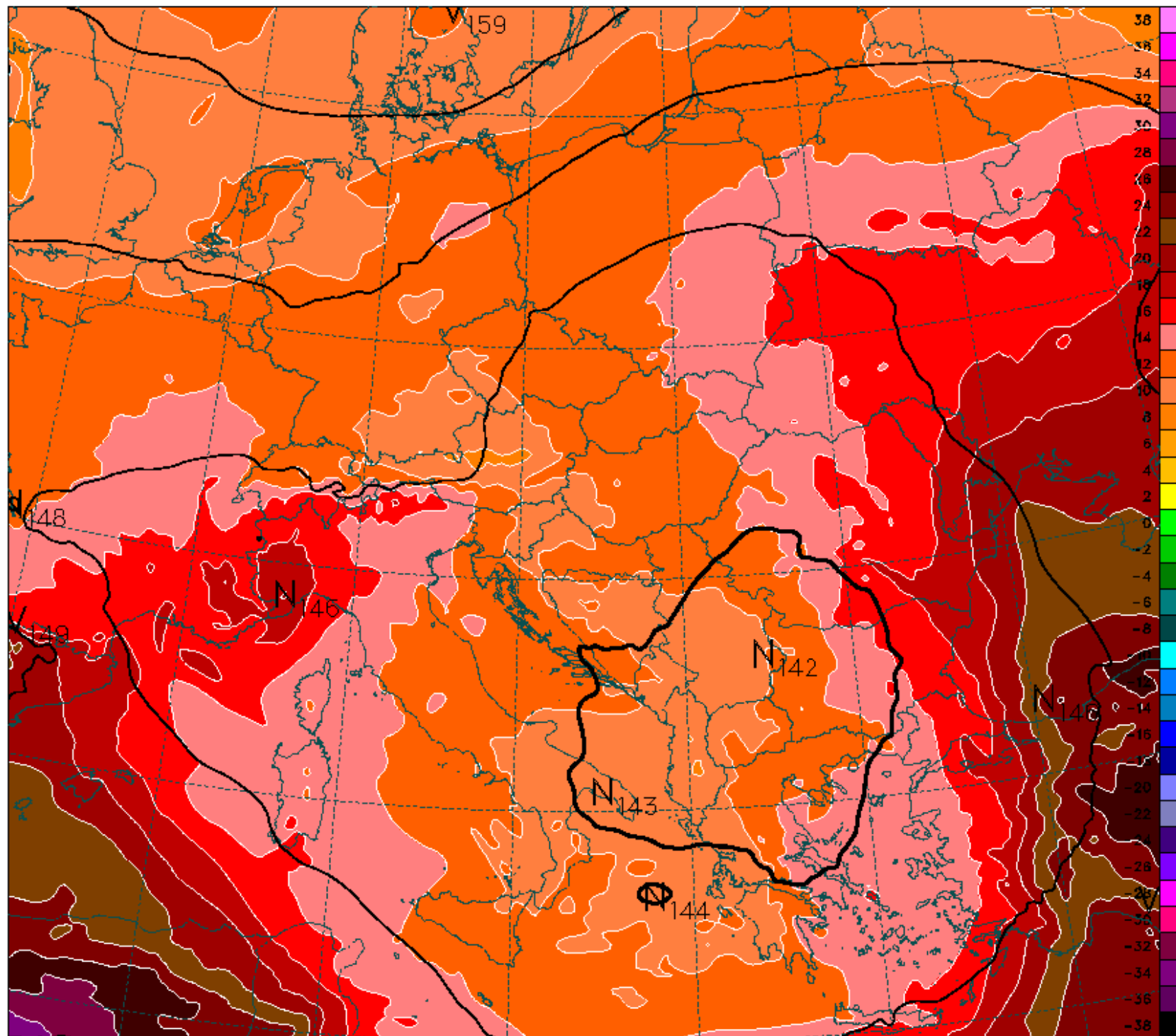




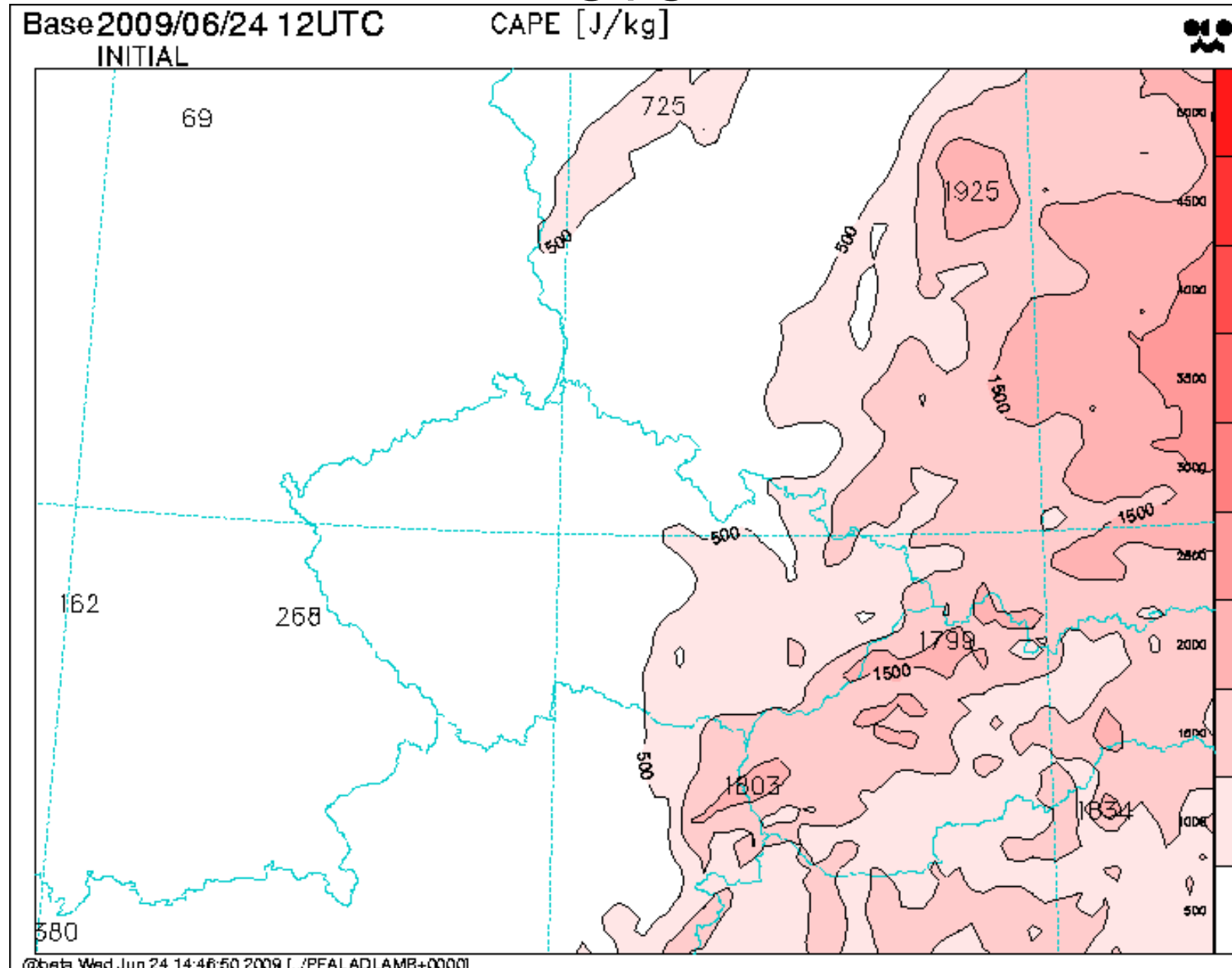
Temperature
(color)

+

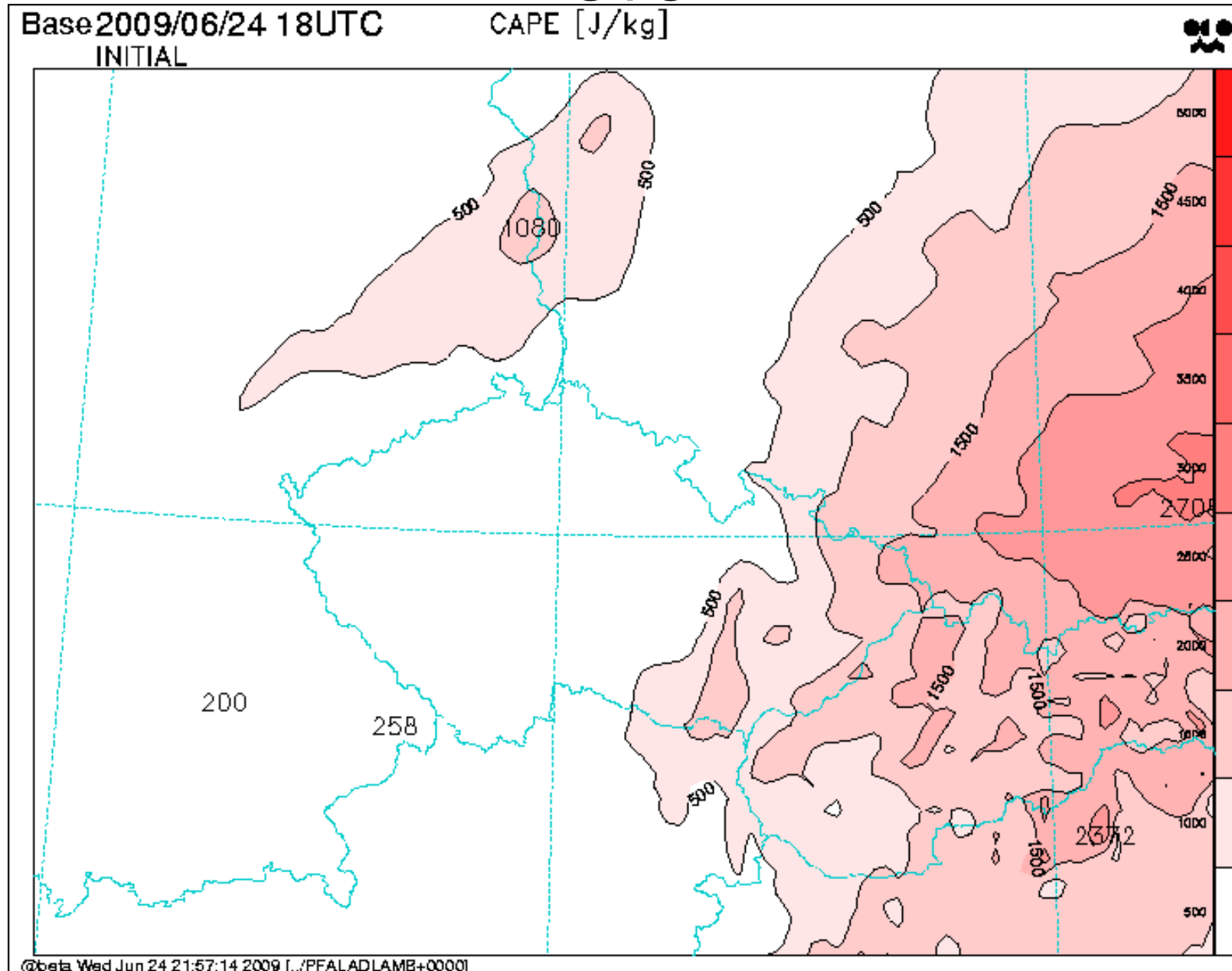
Geopotential
850 hPa
(isolines)



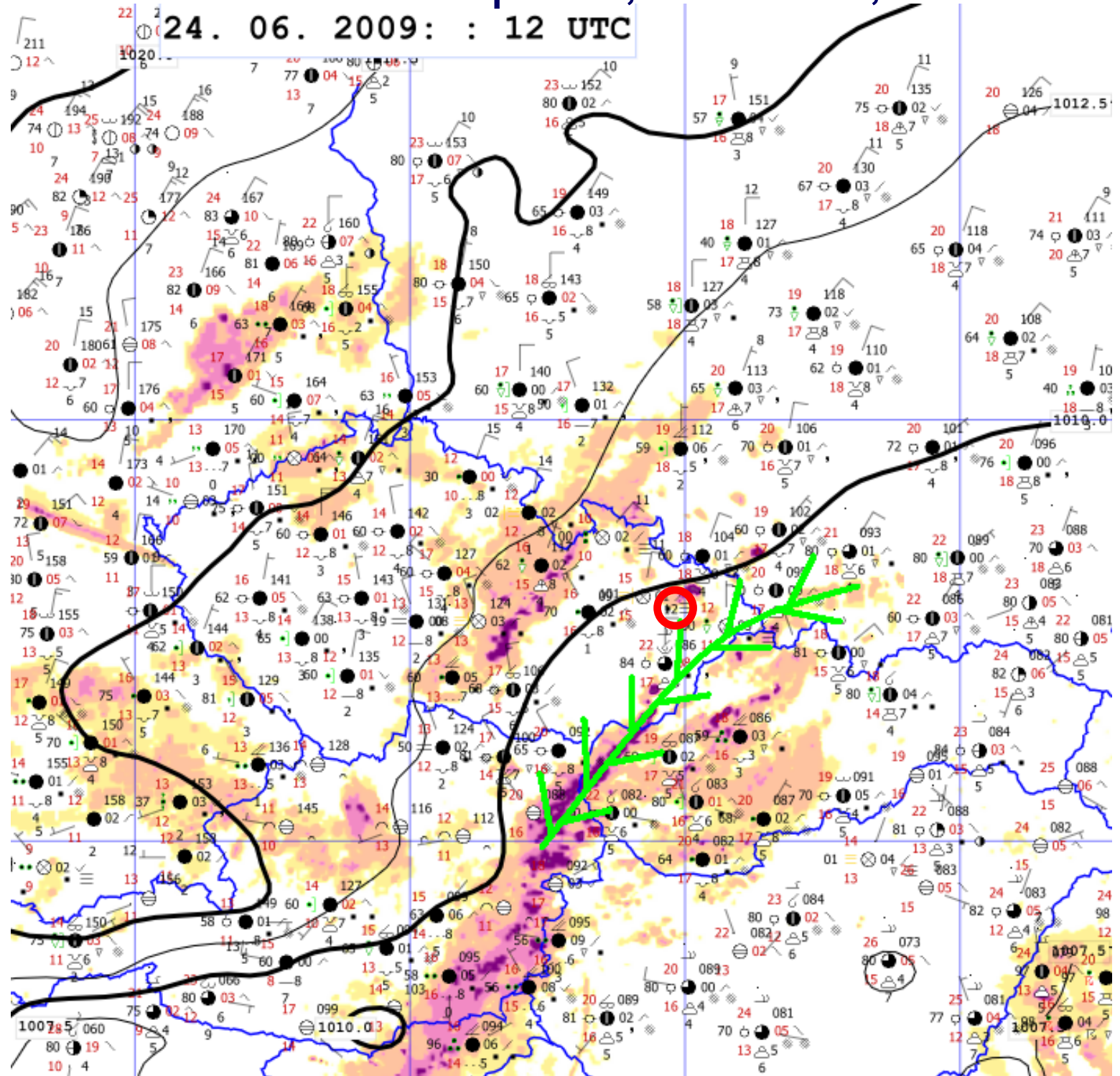
CAPE (MUCAPE), ALADIN analysis, June 24 2009, 12 UTC



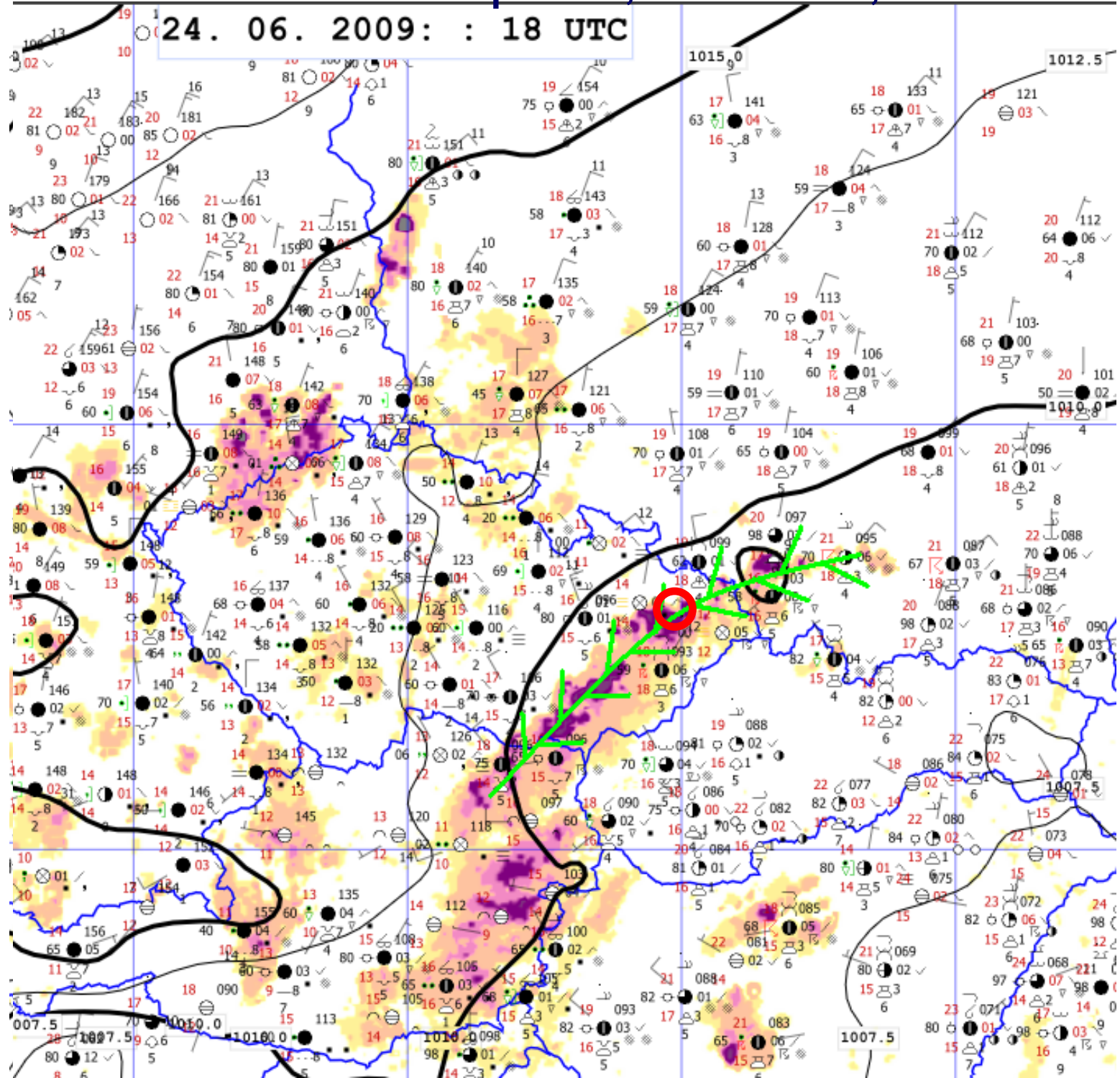
CAPE (MUCAPE), ALADIN analysis, June 24 2009, 18 UTC

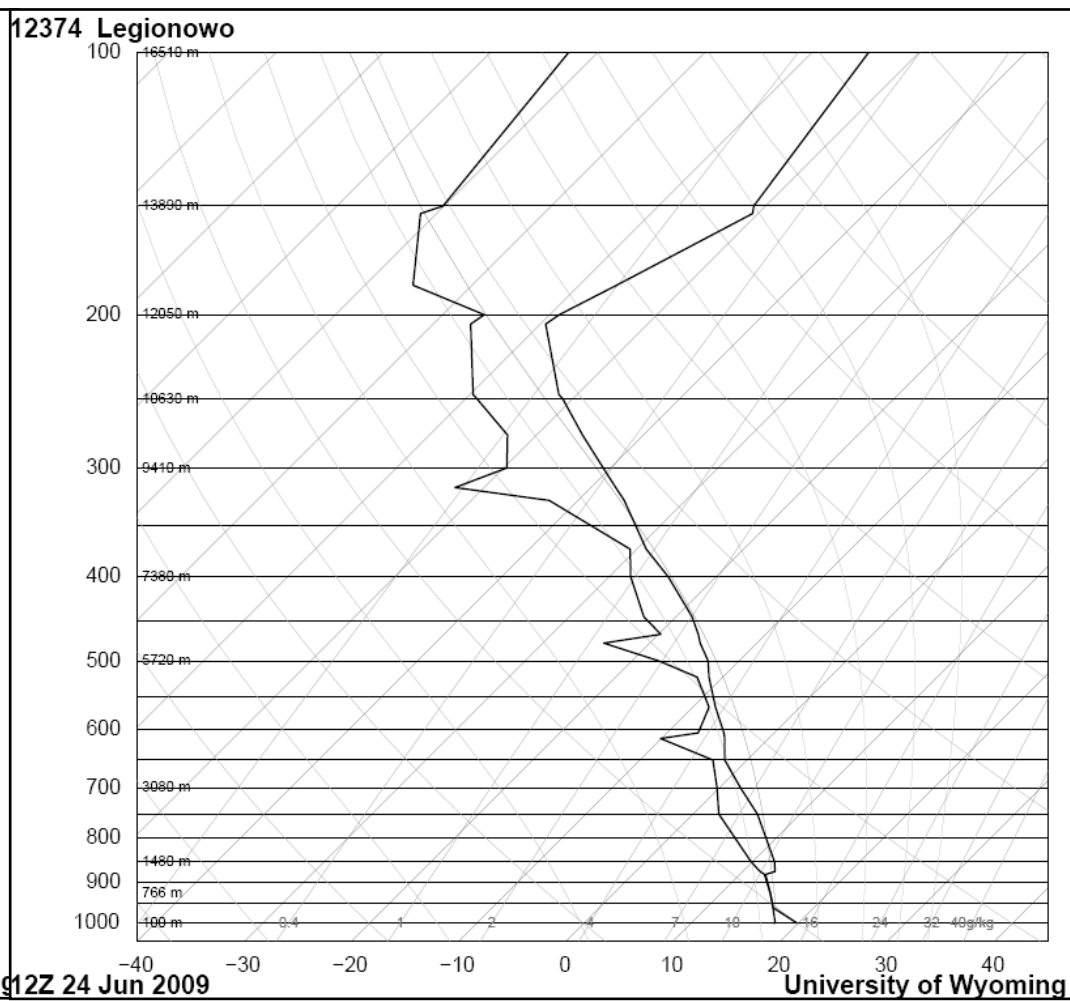
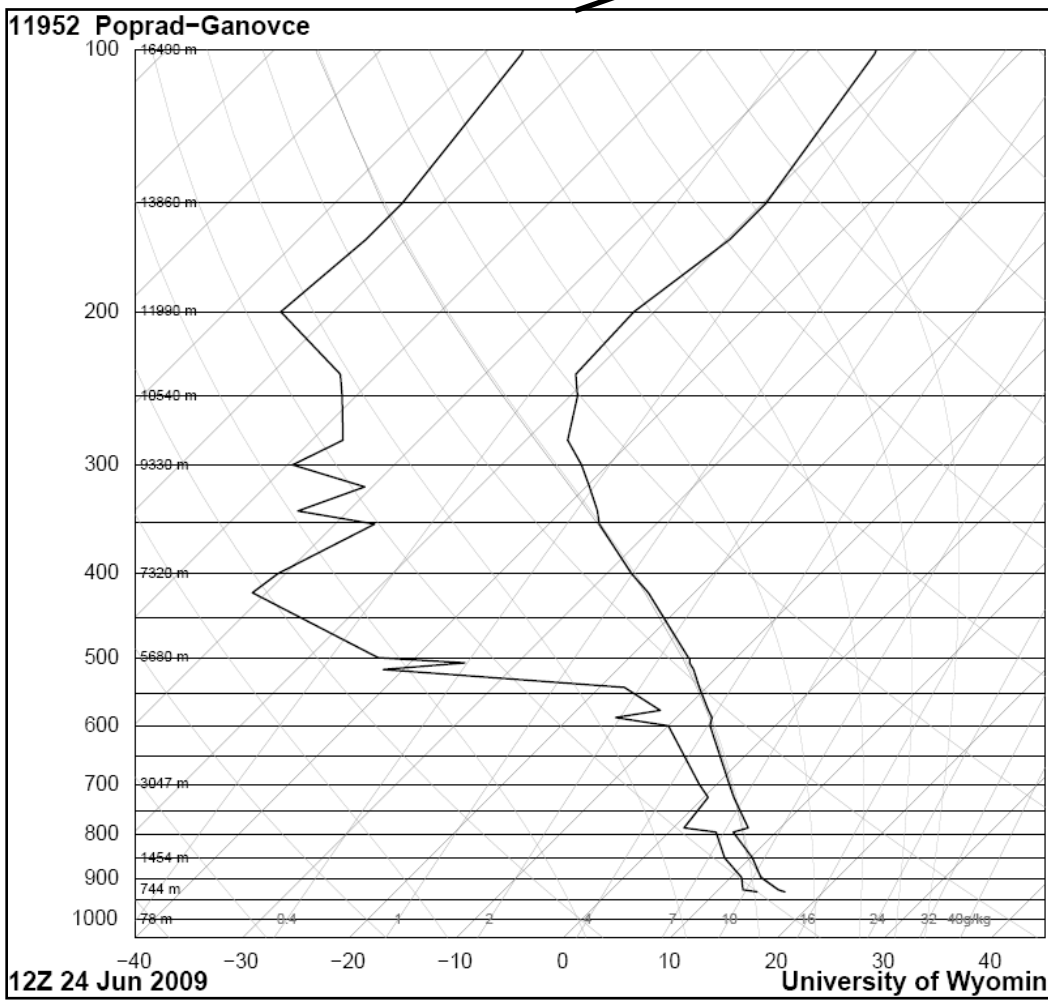


Weather station reports, 24 June, 12 UTC



Weather station reports, 24 June, 18 UTC





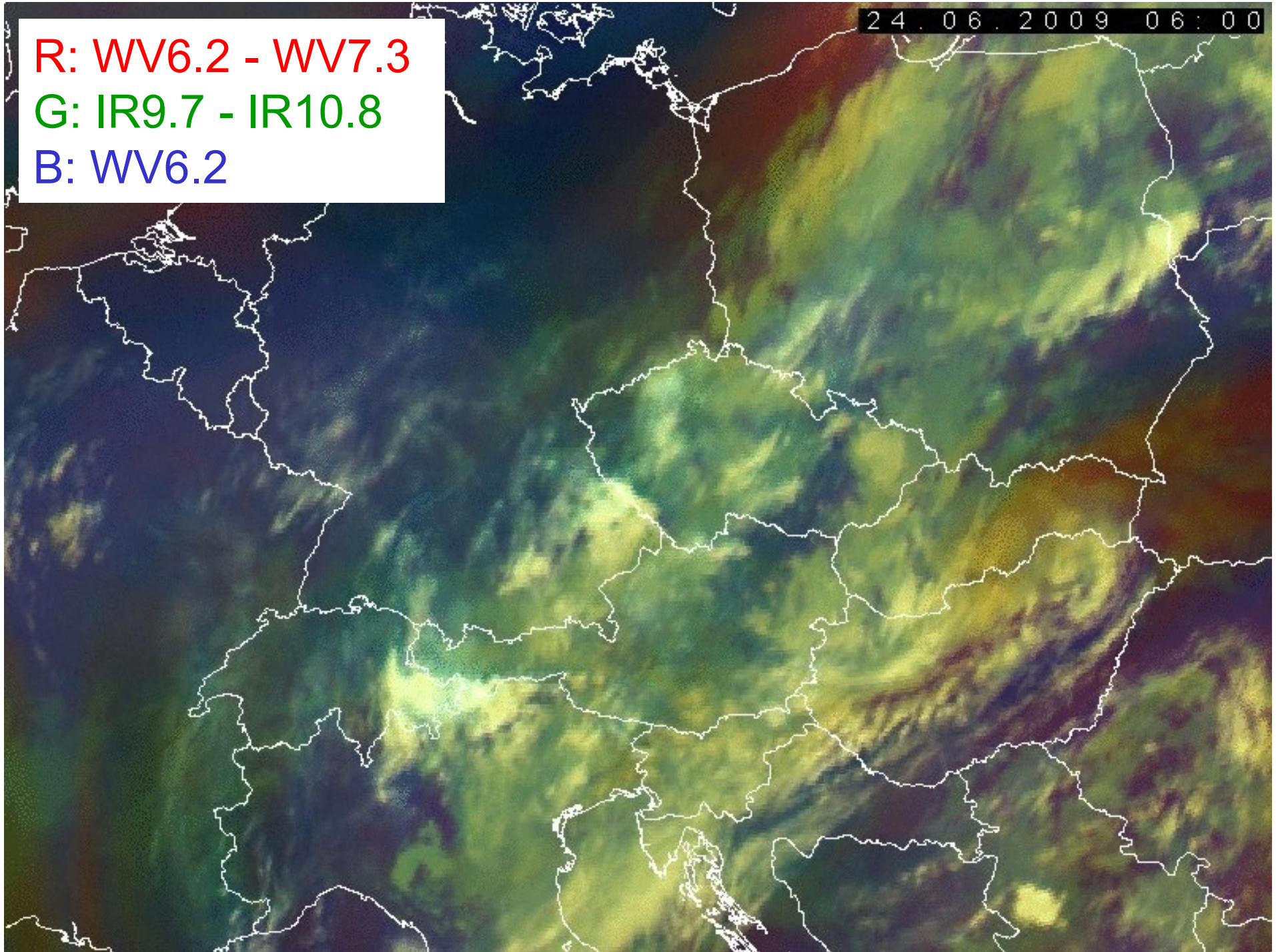
Meteosat 9, SEVIRI, Airmass

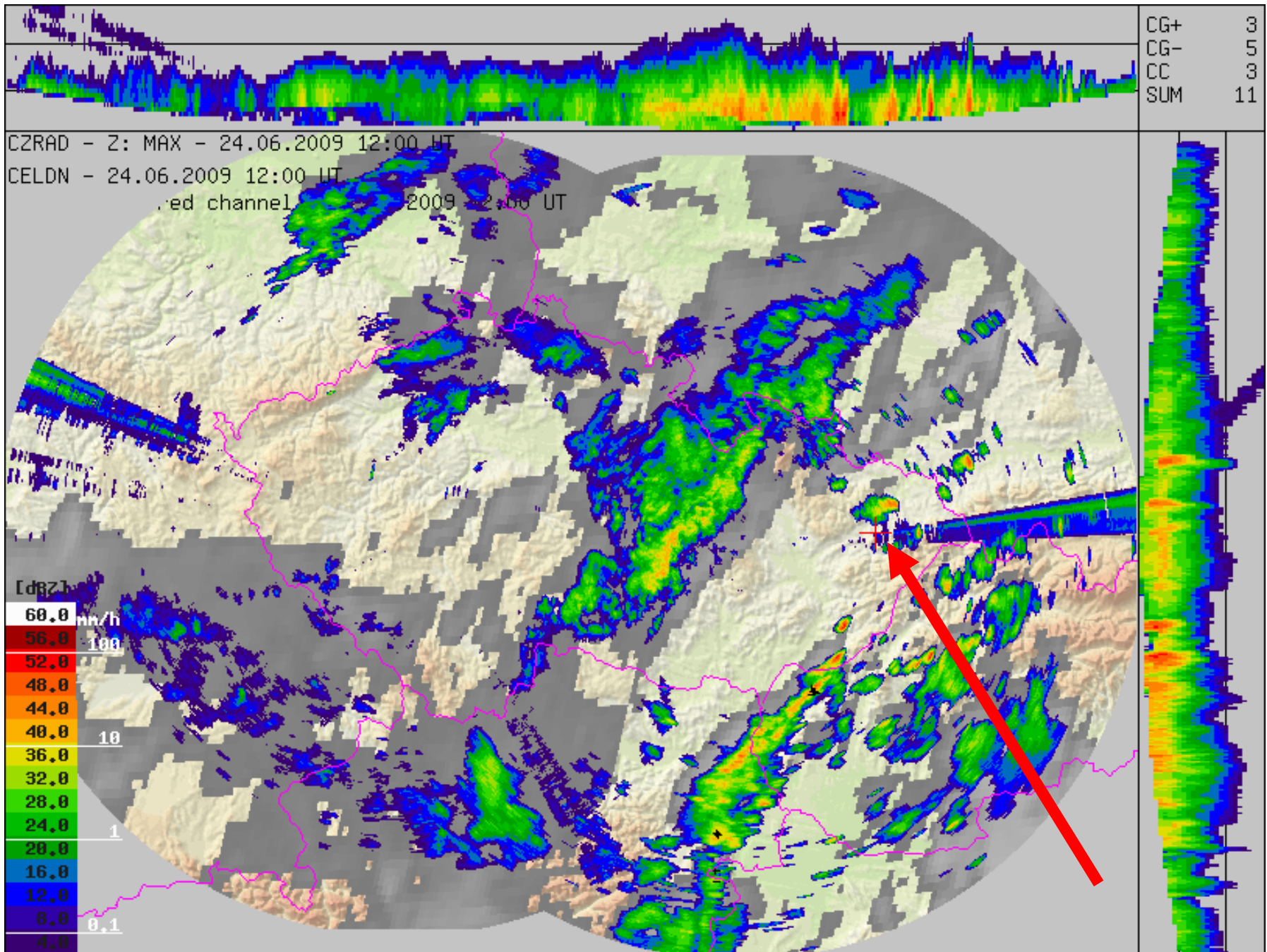
24.06.2009 06:00

R: WV6.2 - WV7.3

G: IR9.7 - IR10.8

B: WV6.2





P-Brno, 28.2. 2011

Radar precipitation estimate without correction - 24h accumulation

CZRAD - radar_orig_24h - 25.06.2009 06:00 UT

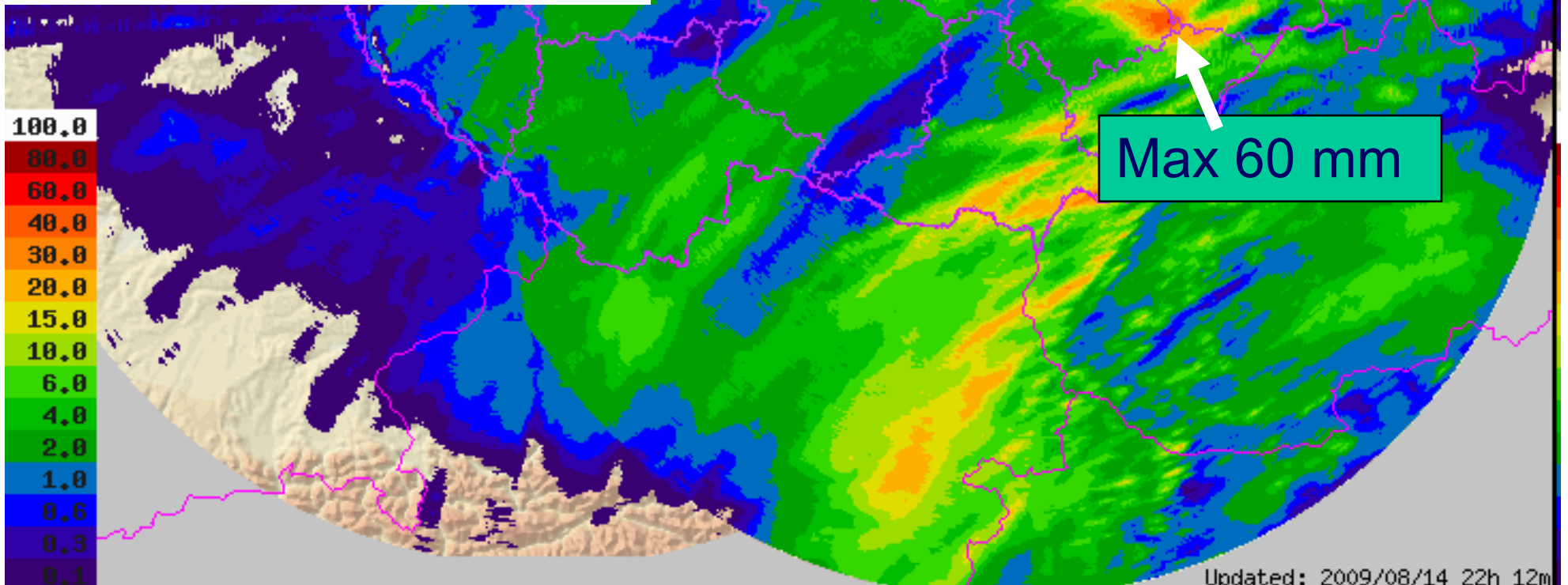
SK:100.0%
BR:100.0%

[mm]

Z-R relationship

$$Z=200R^{1.6}$$

5 minute data, C band



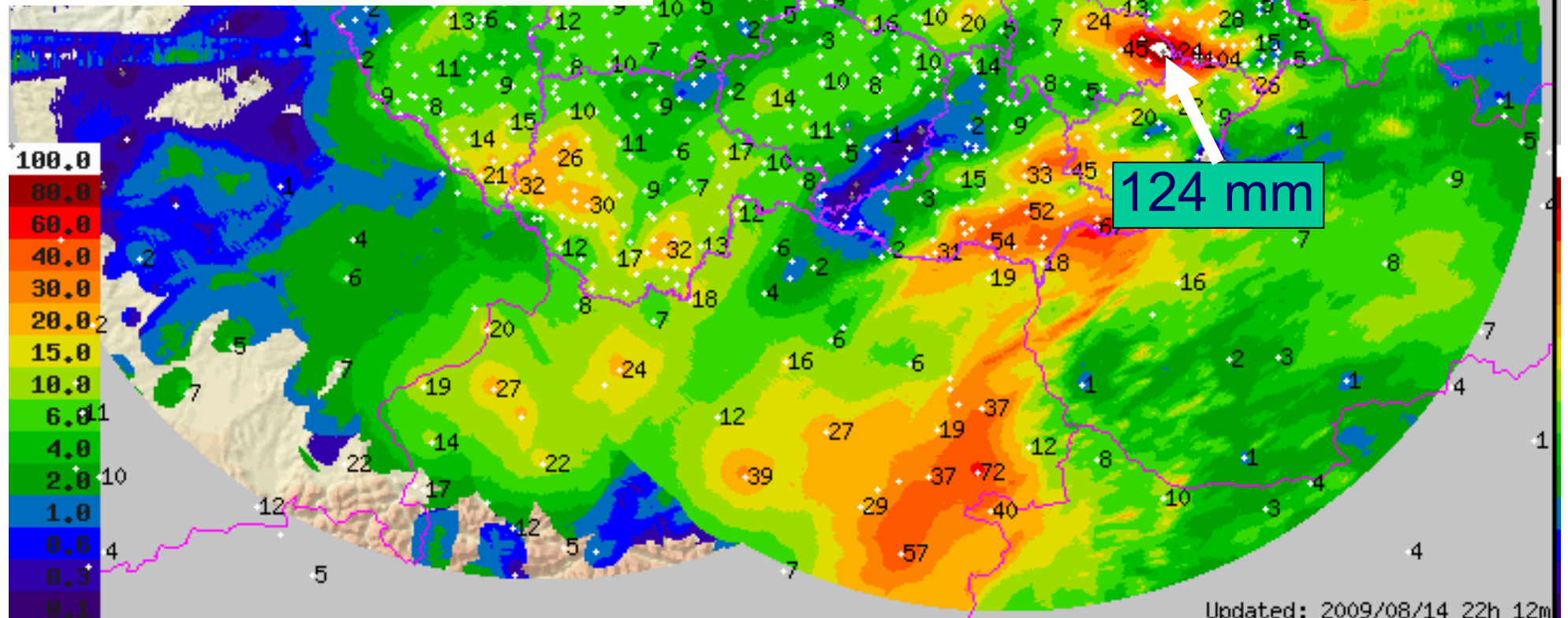
Radar precip estimate merged with raingauges - 24h totals

CZRAD - merge_24h - 25.06.2009 06:00 UT

[mm]

Merging algorithm

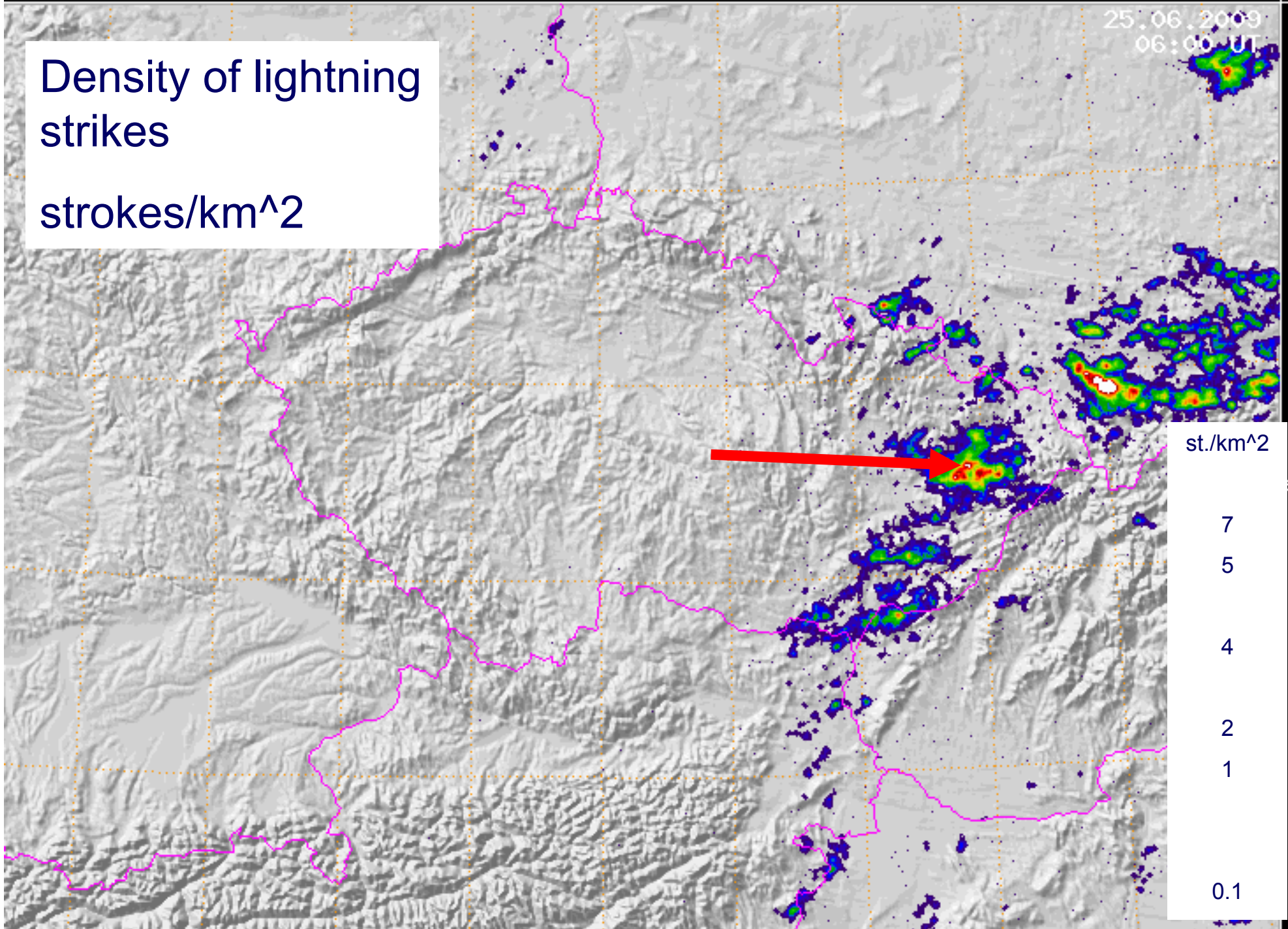
A modified version of
D-J Seo, 1998



Density of lightning strikes

strokes/km²

25.06.2009
06:00 UT



st./km²

- 7
- 5
- 4
- 2
- 1
- 0.1

strol



Original precipitation estimate from the radar (color) and precipitation from the raingauges (isolines; interpolation made by Universal kriging)

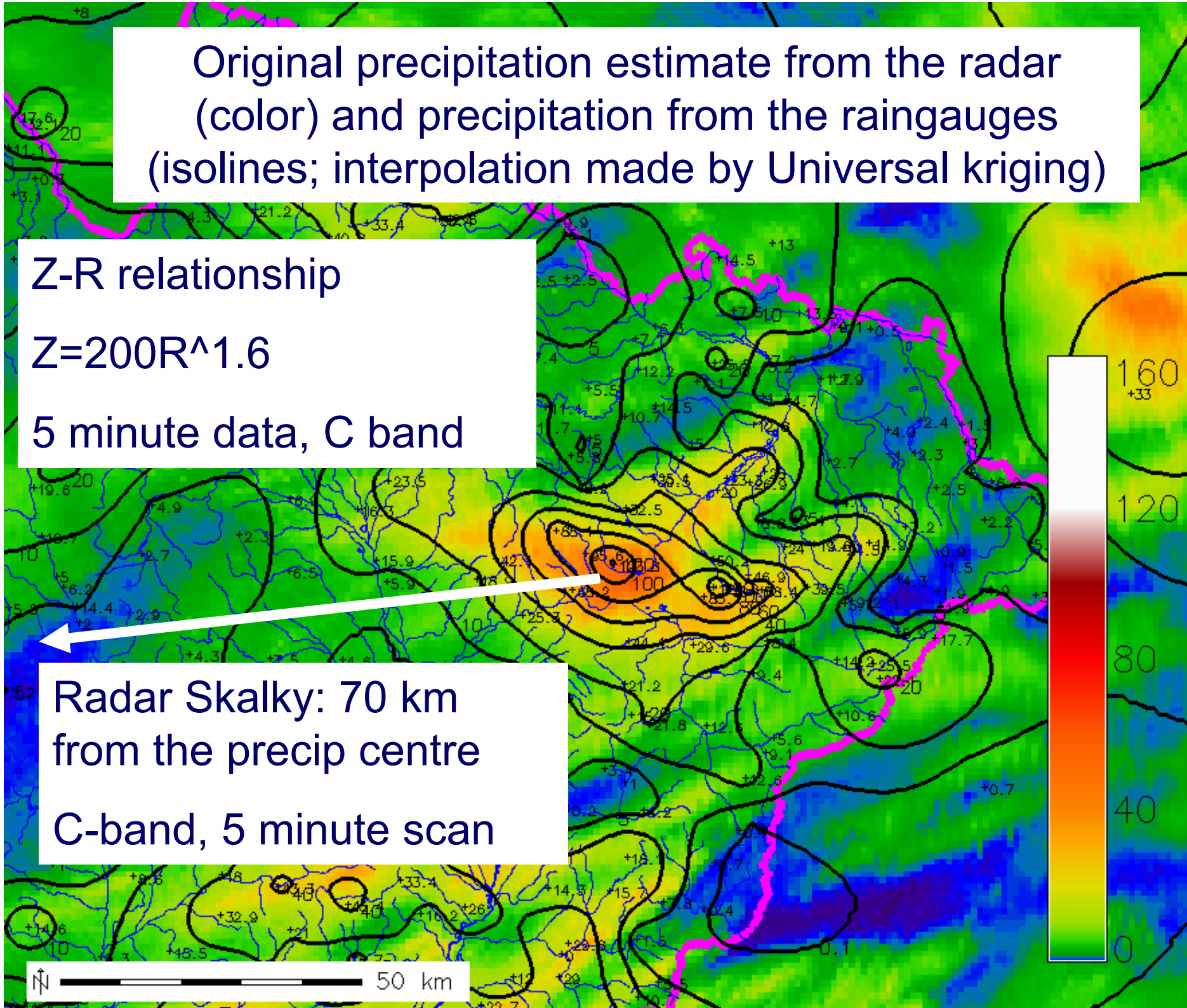
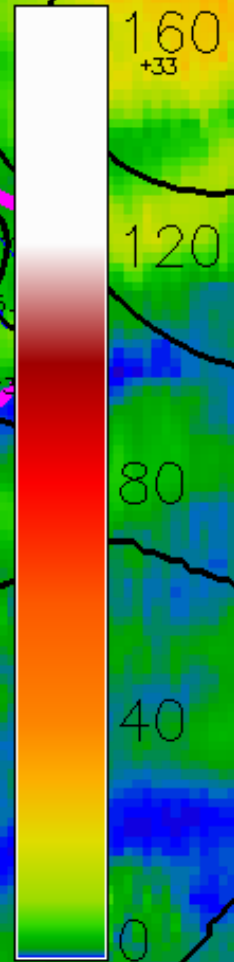
Z-R relationship

$$Z=200R^{1.6}$$

5 minute data, C band

Radar Skalky: 70 km from the precip centre
C-band, 5 minute scan

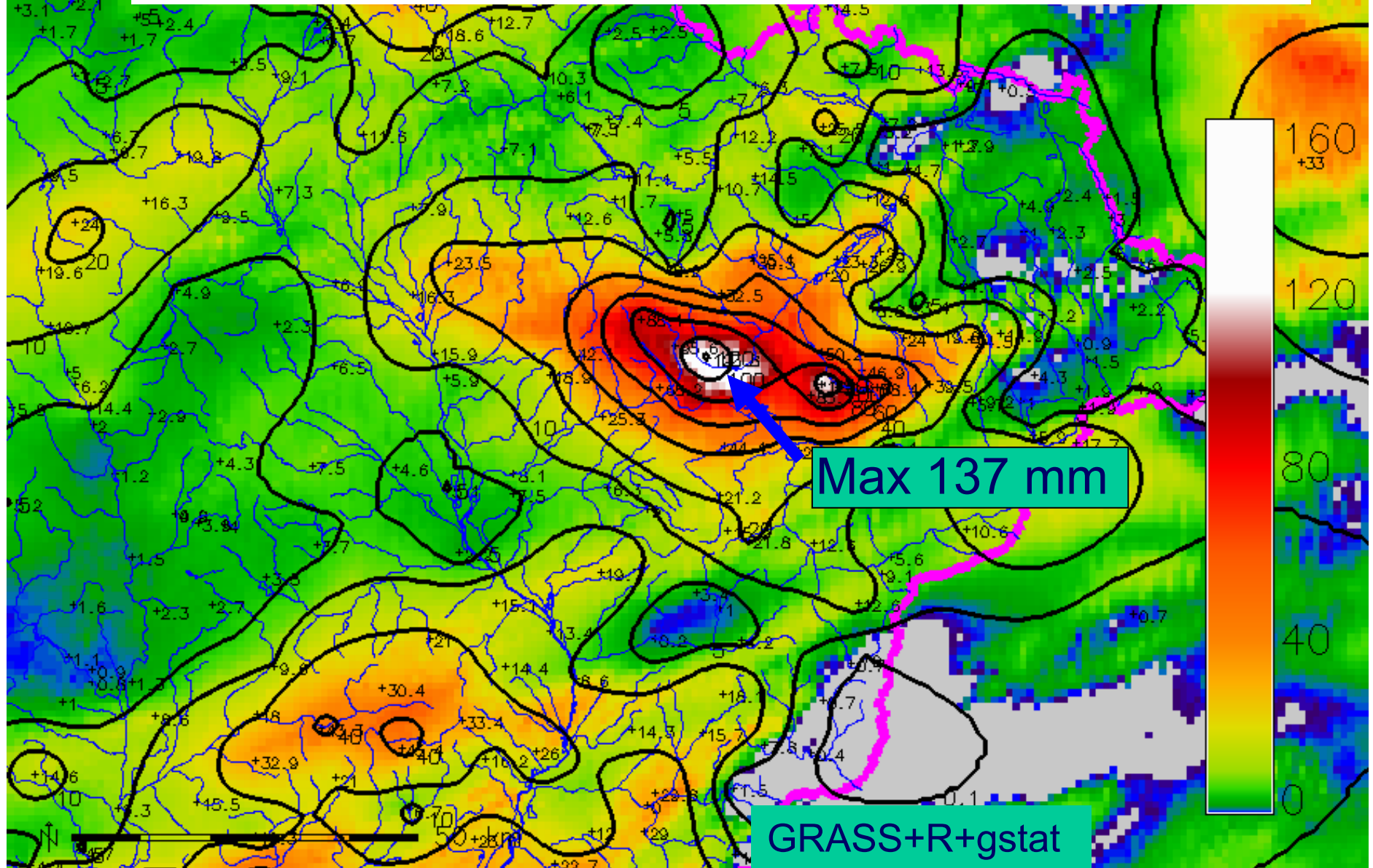
50 km



Possible reason of the severe underestimation of the storm rainfall

- Attenuation (C-band)
- Different Z-R relationship - ?
 - (significant contribution of “warm” coalescent processes - ???)

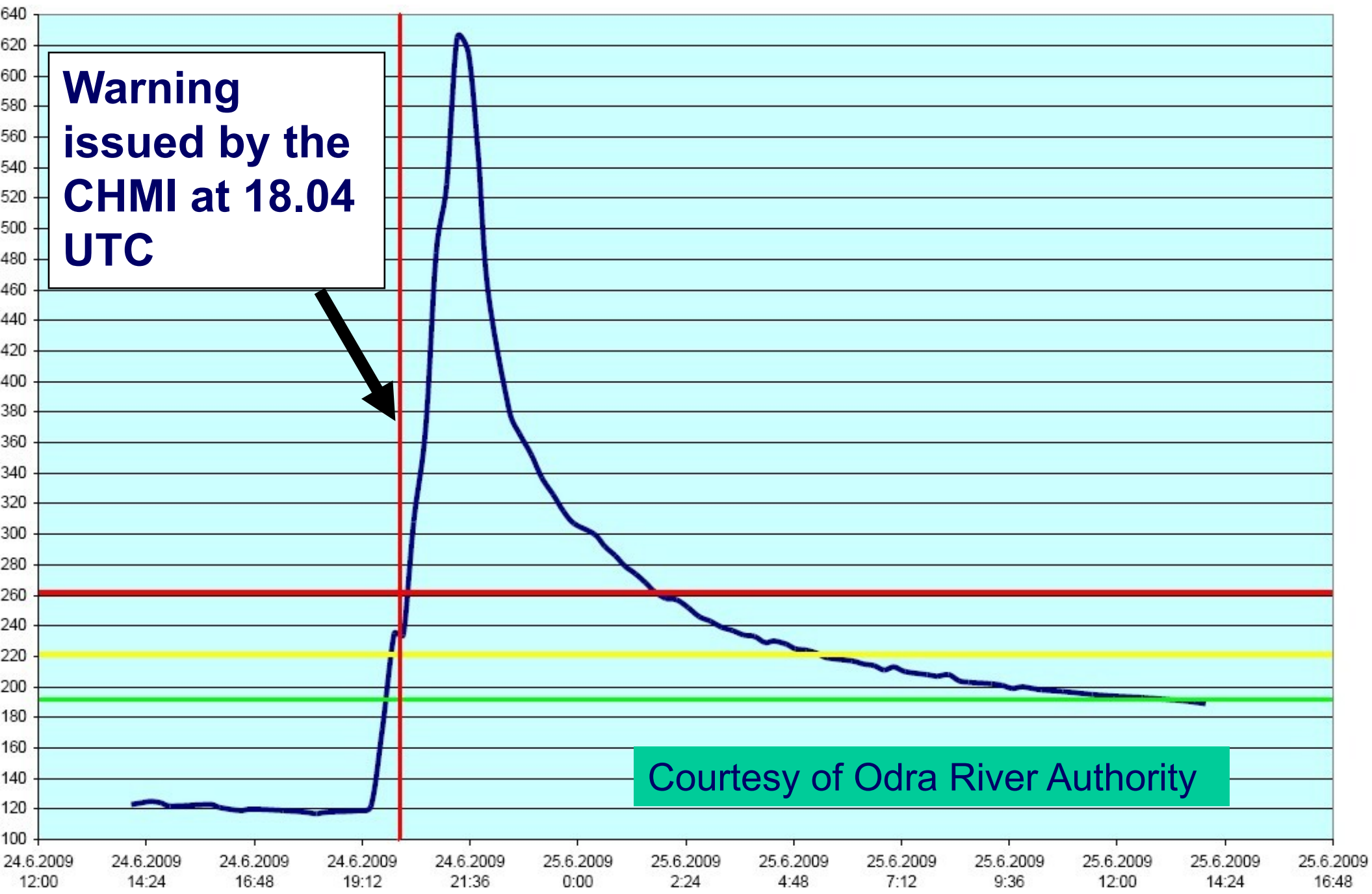
Merged radar and raingauge precipitation estimate
(color, by Regression Kriging) and precipitation
from the raingauges (isolines; interpolation made
by Universal kriging)



Precipitation and hydrological response

- Maximum precipitation measured by the raingauges: 124 mm
- Precipitation estimated by the method of Regression kriging: 137 mm
- Flood with peak water level exceeding all historical records

River stage at Nový Jičín, stream Jičínka





Warnings of the Czech Hydrometeorological Institute

- June, 24th, 08.30 UTC: Flood alert over most areas of the Czech Republic
- June, 24th, 18.04 UTC: Warning against heavy rain in the area of the squall line
 - Based on the raingauge reports and radar
- June, 24th, 20.00 UTC: Warnings against heavy rain AND FLOOD in the area of the squall line

Were the warnings of CHMI successful?

According to the logbook of the Flood emergency committee, the flood had started dozens of minutes before the **CHMI warning** was issued.

Identified shortcomings of current warning systems against flash floods

- Precipitation accumulation (integrated estimate from radar and raingauges) available only in hourly intervals
- Warnings not localized enough
- Warnings distributed according to the (rather big) administrative regions

Identified shortcomings of current warning systems against flash floods

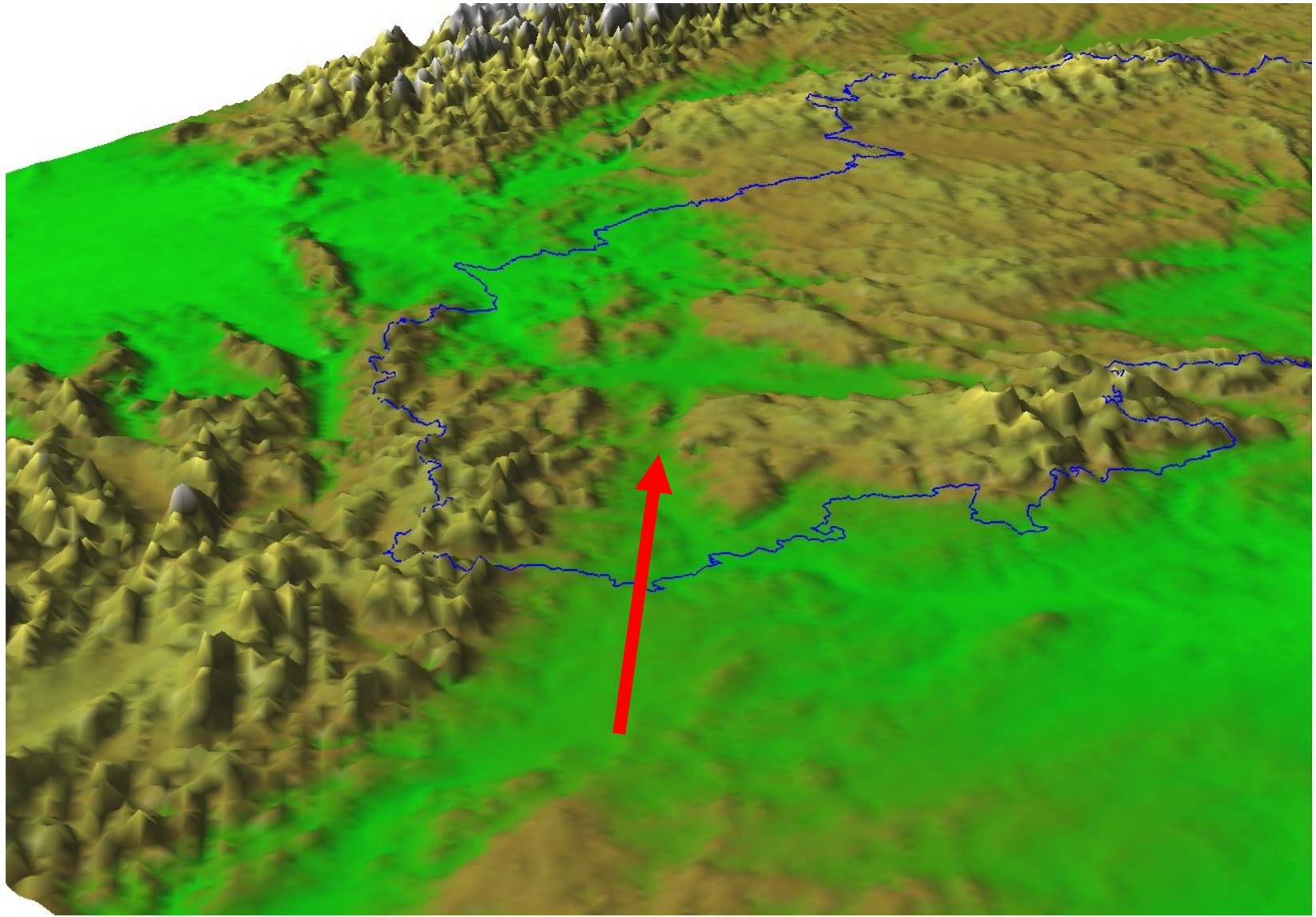
(cont'd)

- Existing gap between the (hydro)meteorological community and the decision makers, emergency managers and the public
- To address the problem: Better education of the public concerning the inherent uncertainty and probabilistic nature of the flash flood forecasting

Performance of the meteorological information systems

- **NWP prediction of the precipitation of the event:**
 - Rather poor (not surprisingly; not shown)
- **Monitoring of the heavy rain by remote sensing:**
- Meteorological satellites (MSG):
 - Detection of the dry intrusion associated with the PV anomaly and of the plume-like structure indicating the upward motion and partially the ***training effect*** over the area
- Weather radars
 - Detection of the storm development and ***training effect***
 - Severe underestimation of the precipitation accumulation
- Important role of the automatic (telemetric) raingauges

Role of the orography?



Jičínka flash flood – catchement overview



Jičínka flash flood – warning discussion

SOME products were used for warning

SOME products were available, but not used

SOME products were not available, but are in development

Jičínka flash flood – warning discussion

SOME products were used for warning

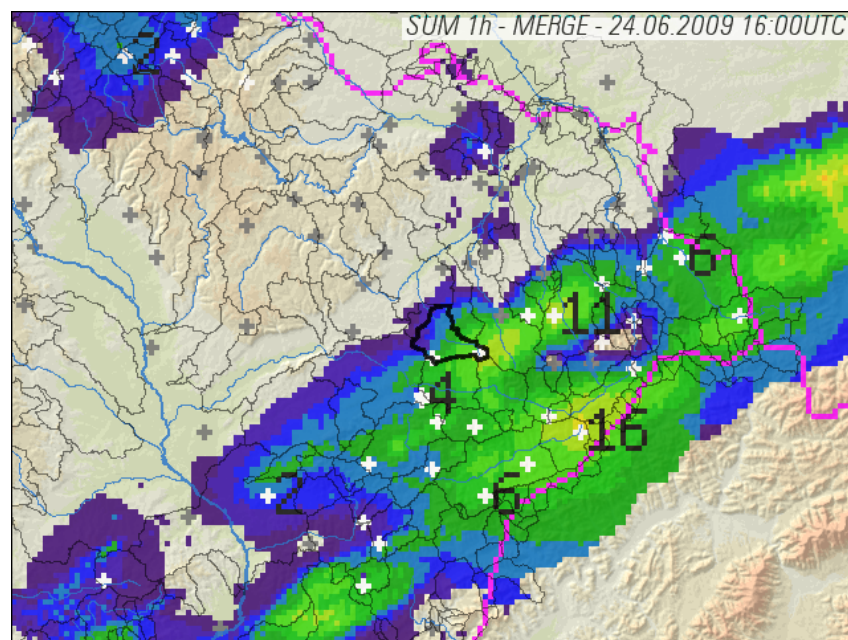
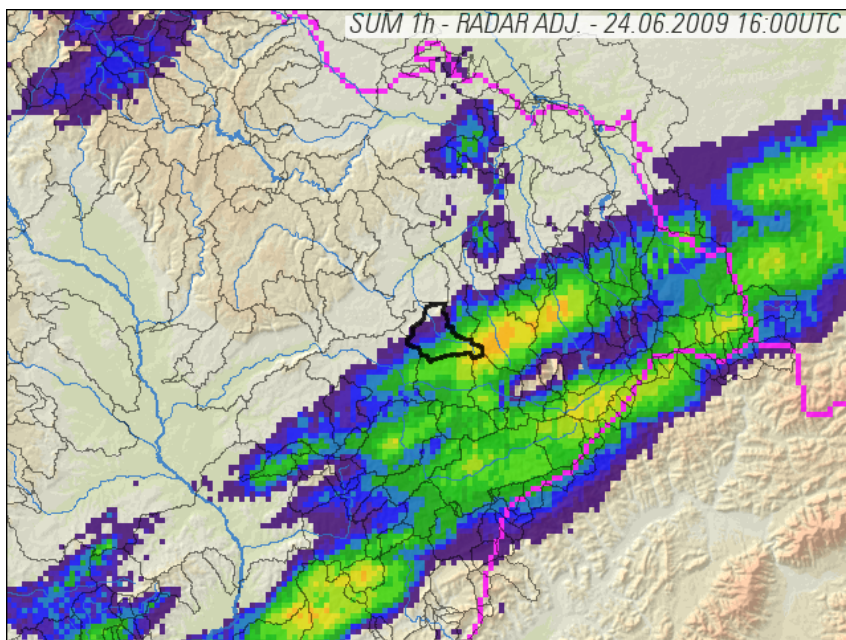
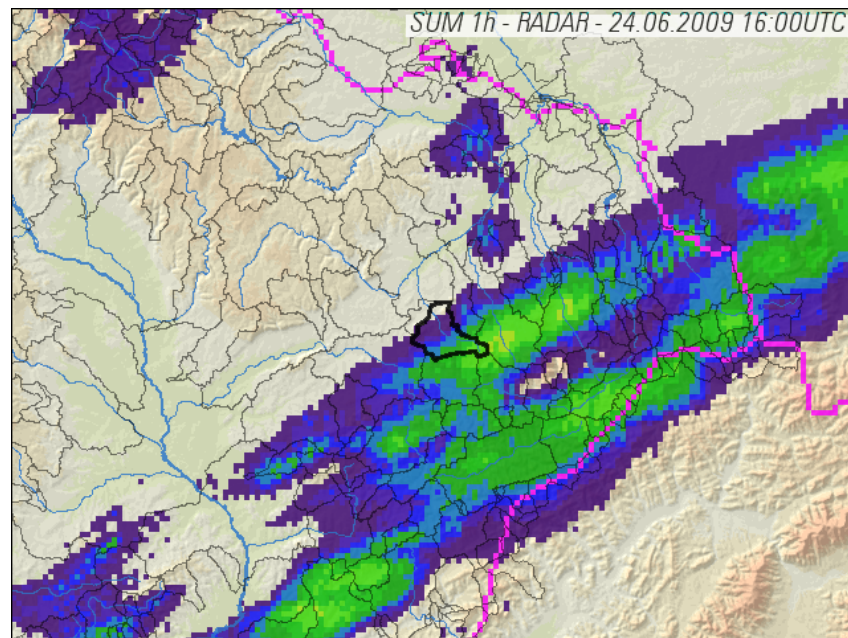
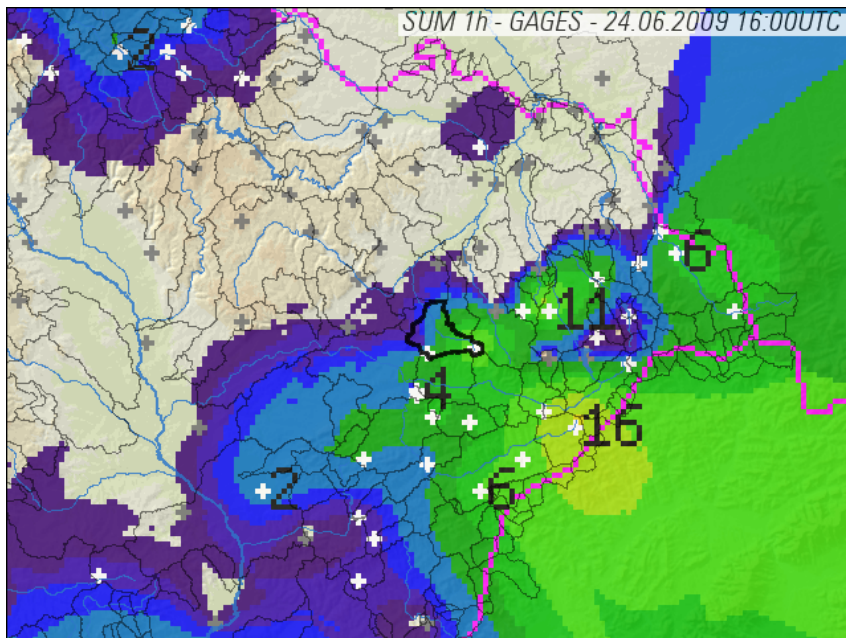
SOME products were available, but not used

SOME products were not available, but are in development

Products used for warning:

- Radar images (dBZ) in 5 min step
- QPE images 1-hour step
- Raingauge data usually in 1 hour step, for some raingauges in 15 min step

Jičínka flash flood – radar-raingauge QPE



[mm]

100.0

80.0

60.0

40.0

30.0

20.0

15.0

10.0

6.0

4.0

2.0

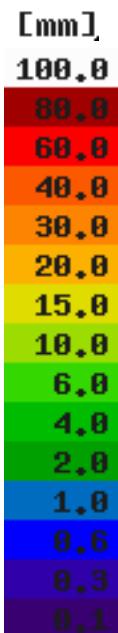
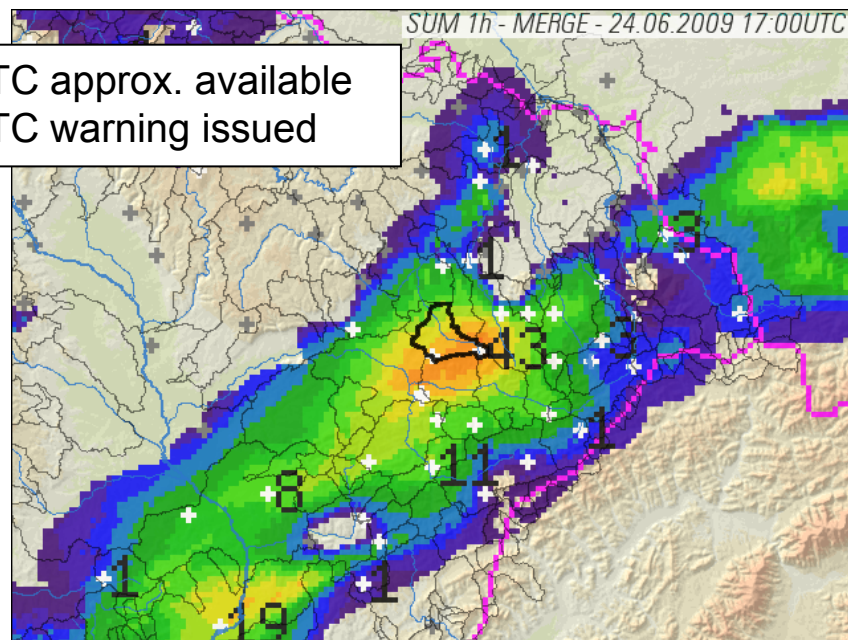
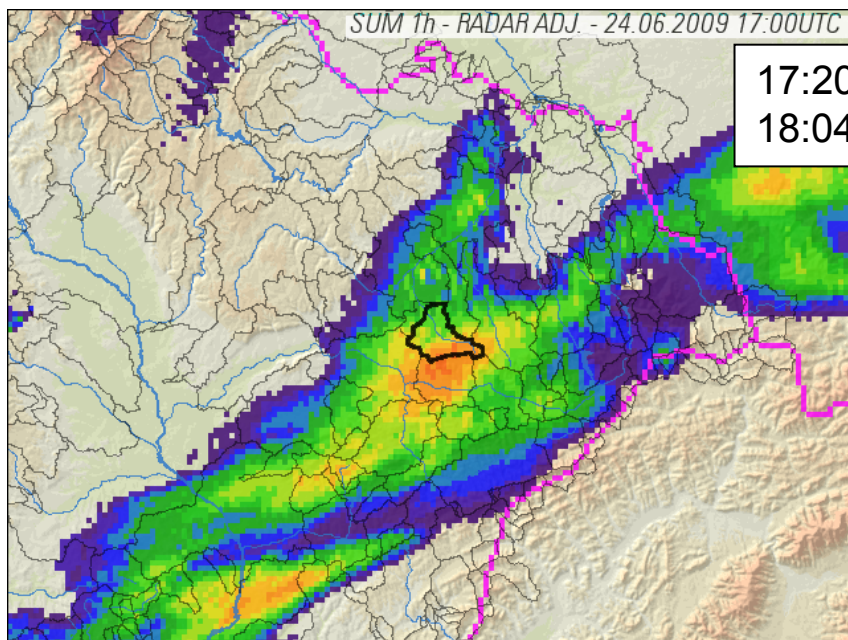
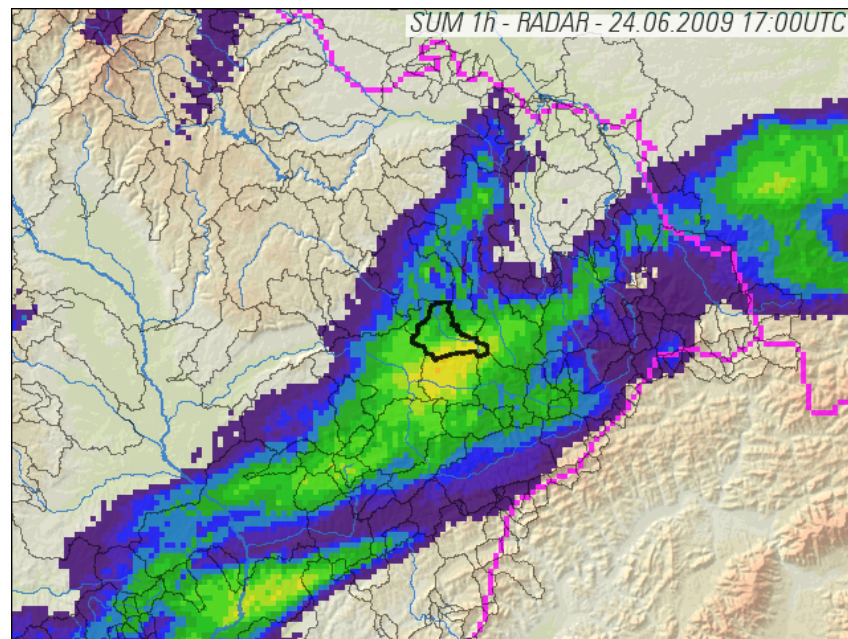
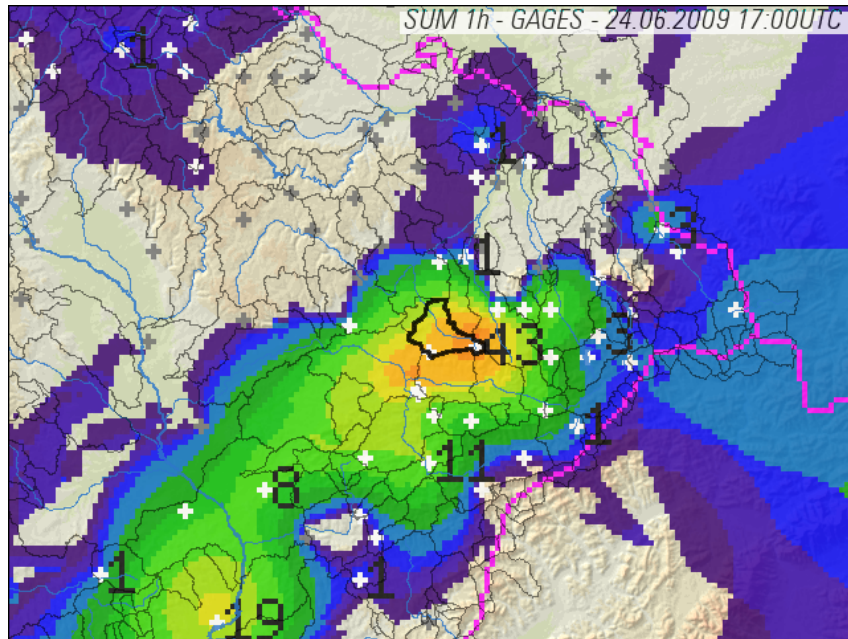
1.0

0.6

0.3

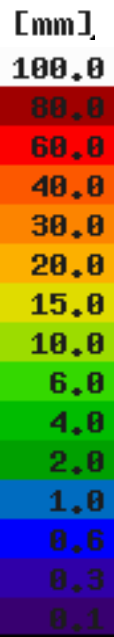
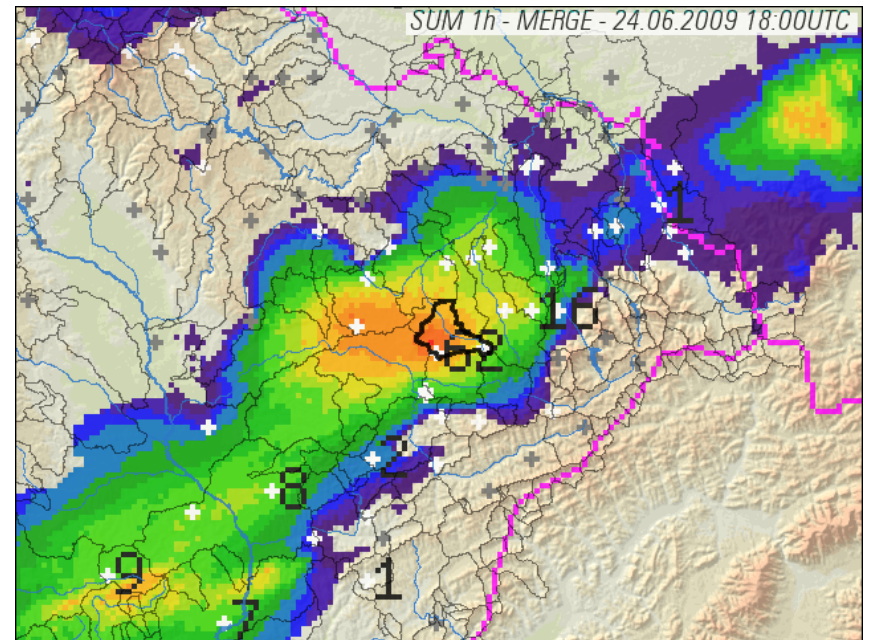
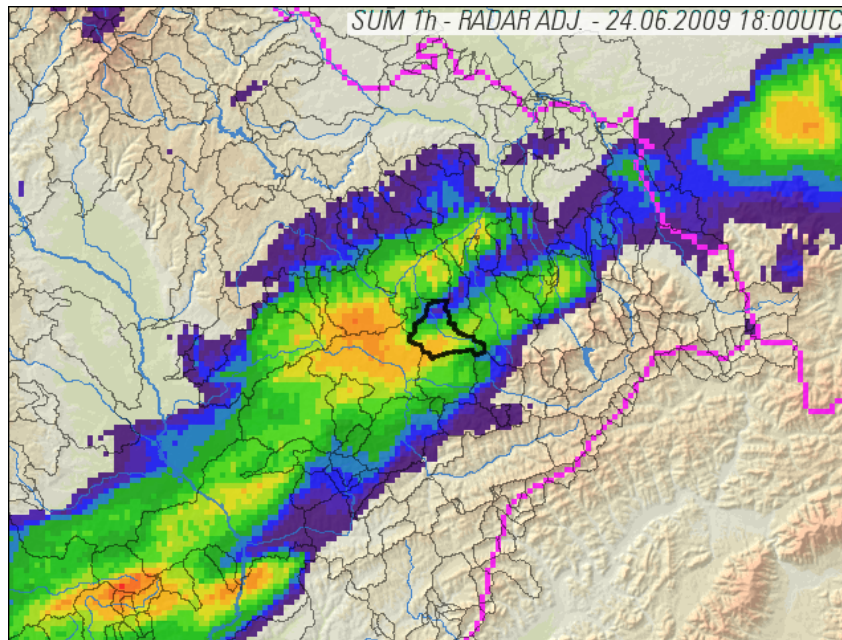
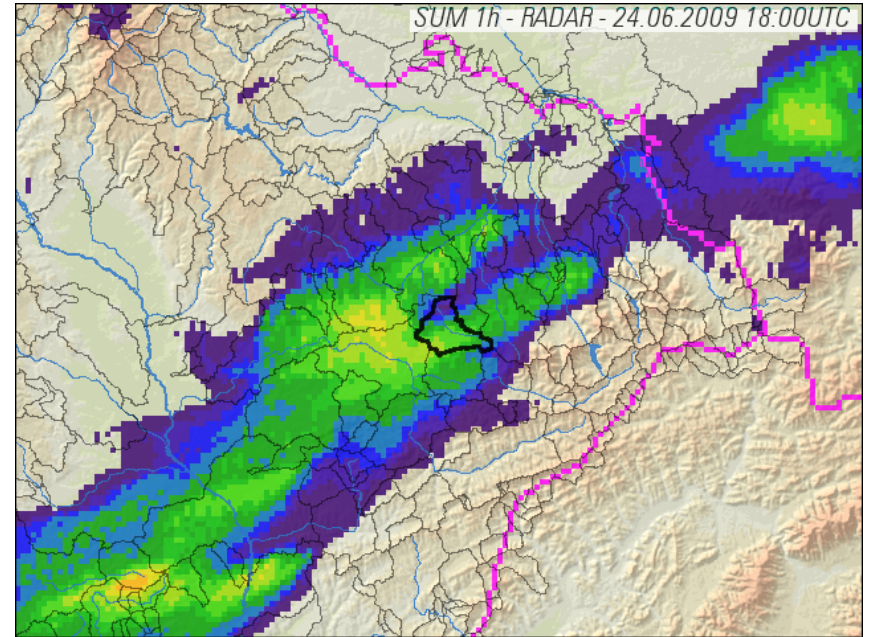
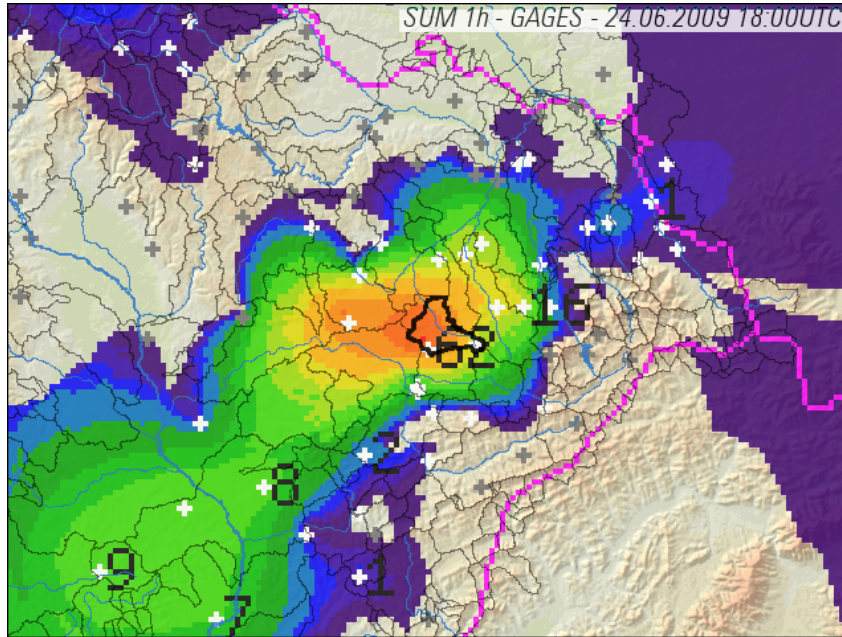
0.1

Jičínka flash flood – radar-raingauge QPE

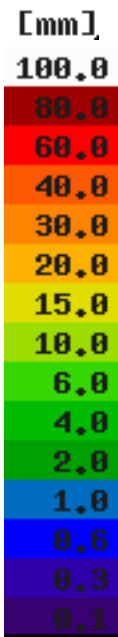
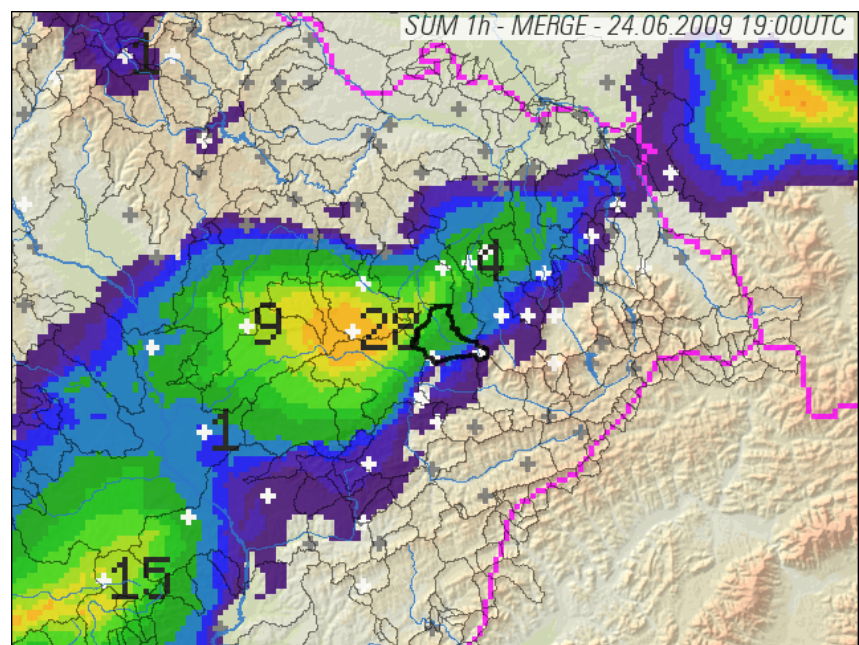
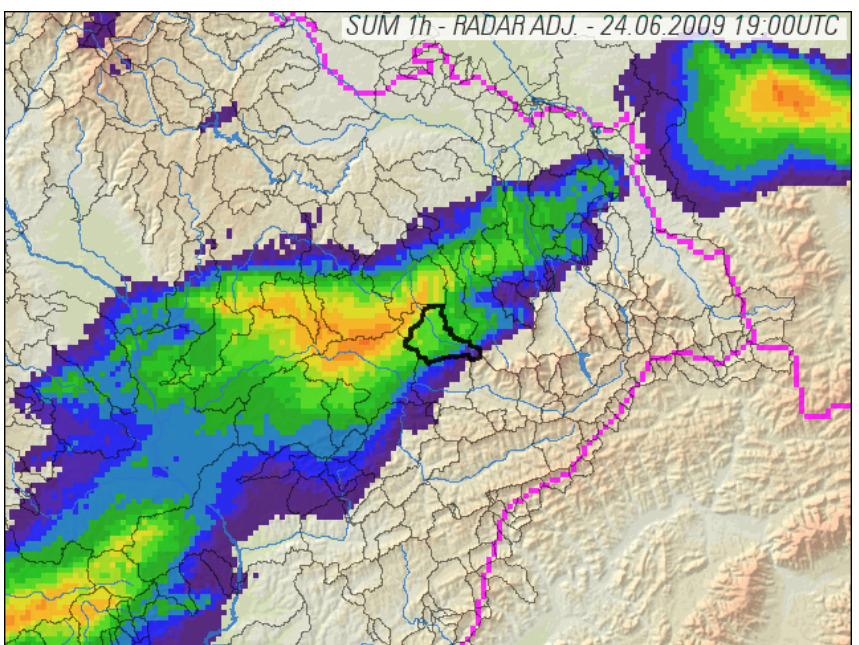
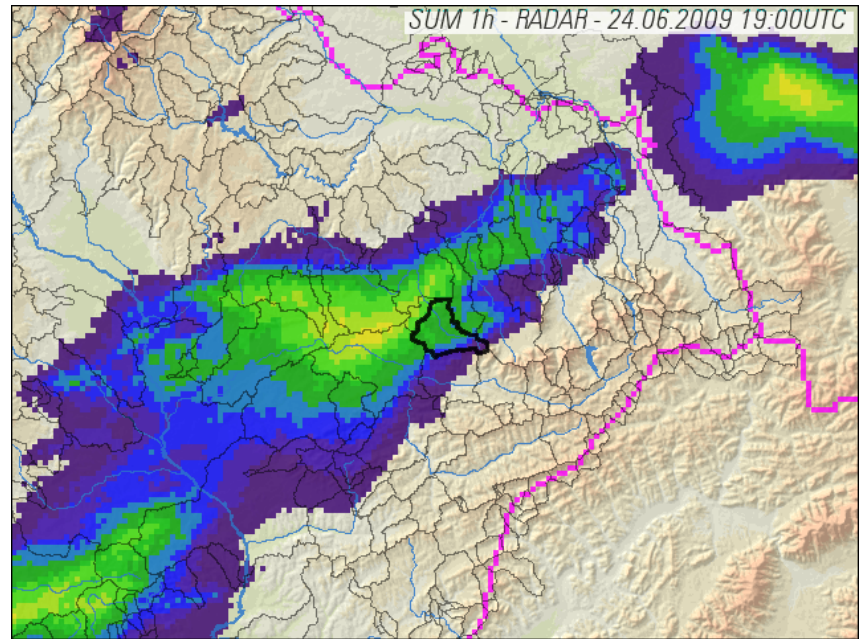
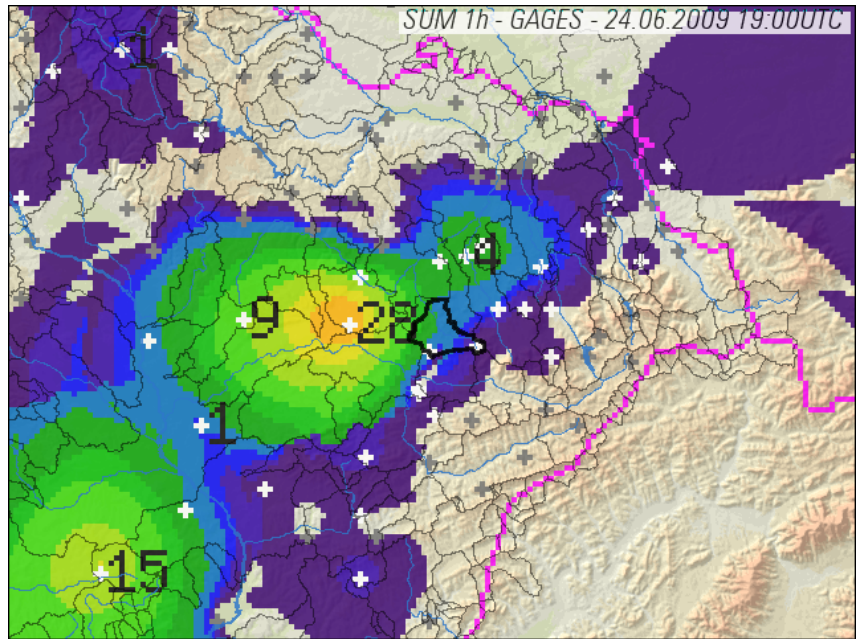


17:20 UTC approx. available
18:04 UTC warning issued

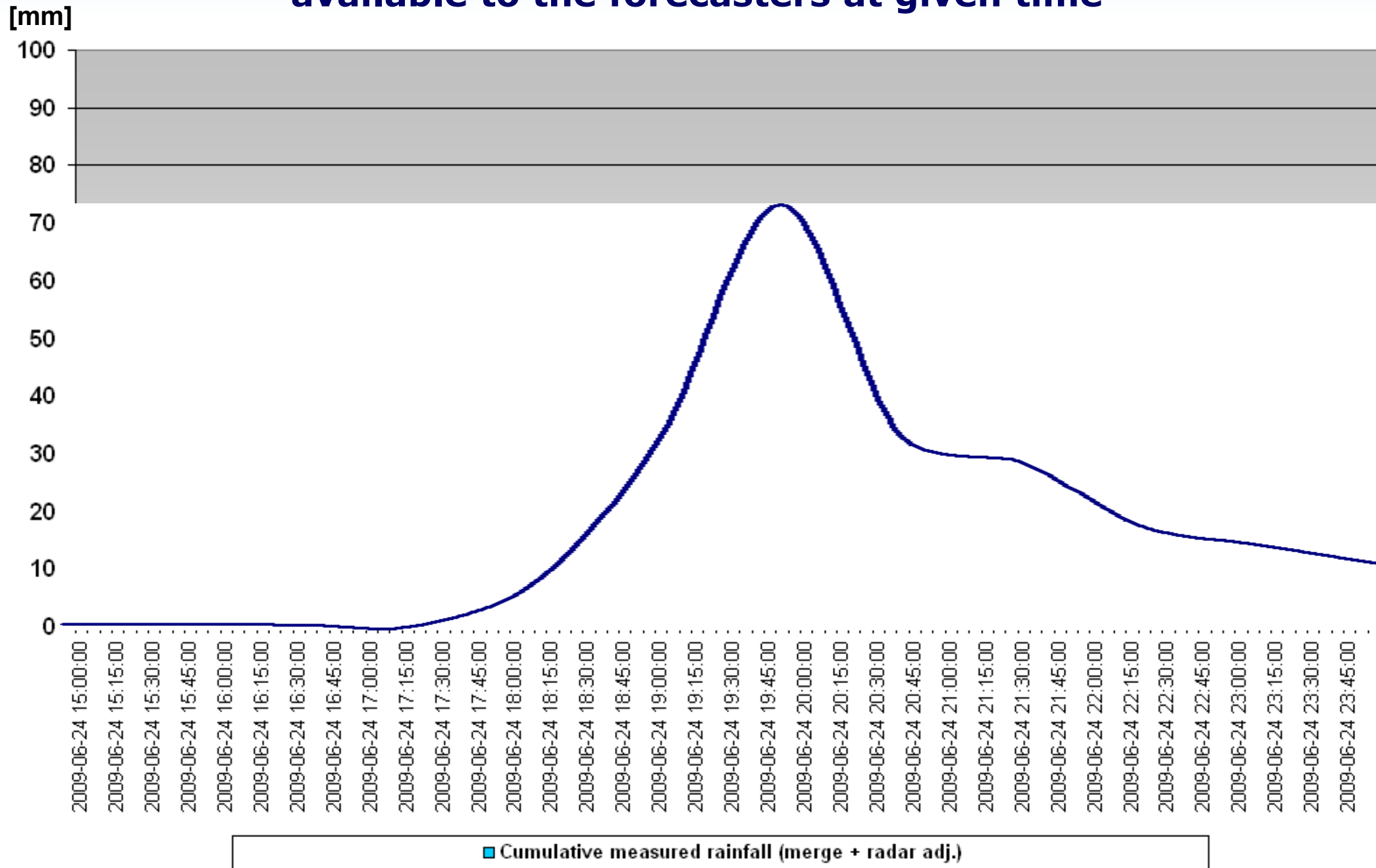
Jičínka flash flood – radar-raingauge QPE



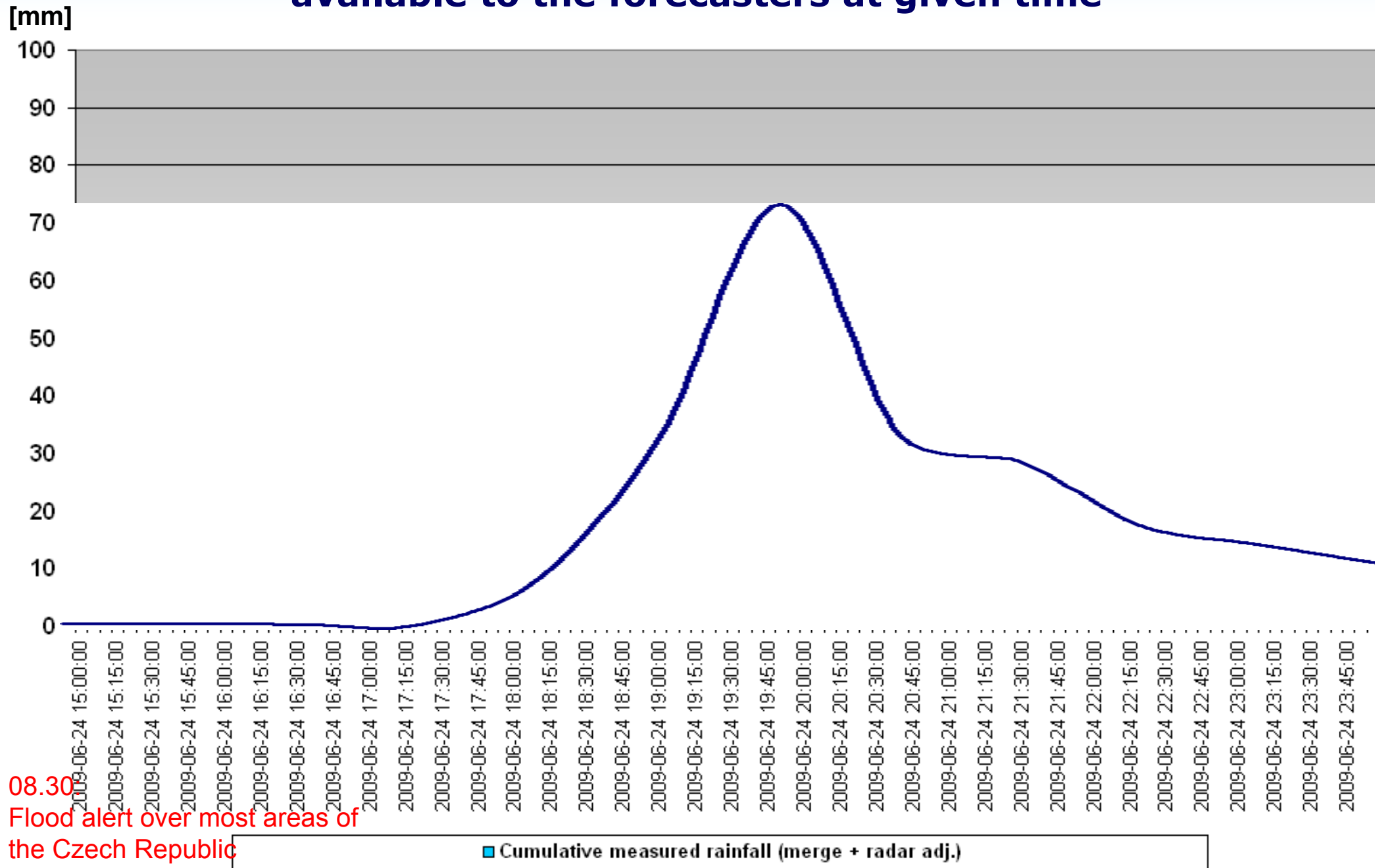
Jičínka flash flood – radar-raingauge QPE



Jičínka flash flood – average catchment rainfall information available to the forecasters at given time



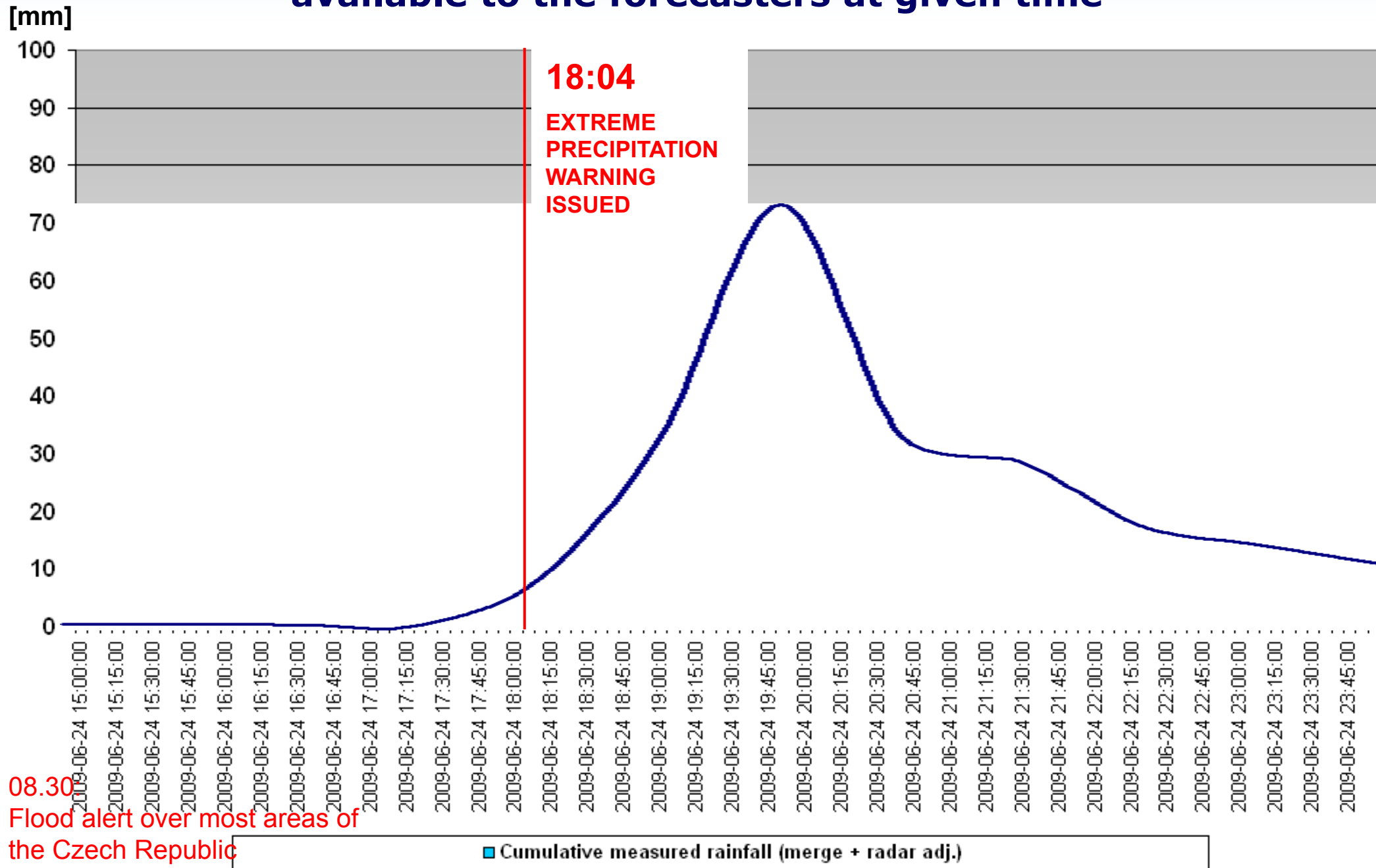
Jičínka flash flood – average catchment rainfall information available to the forecasters at given time



08.30
Flood alert over most areas of
the Czech Republic

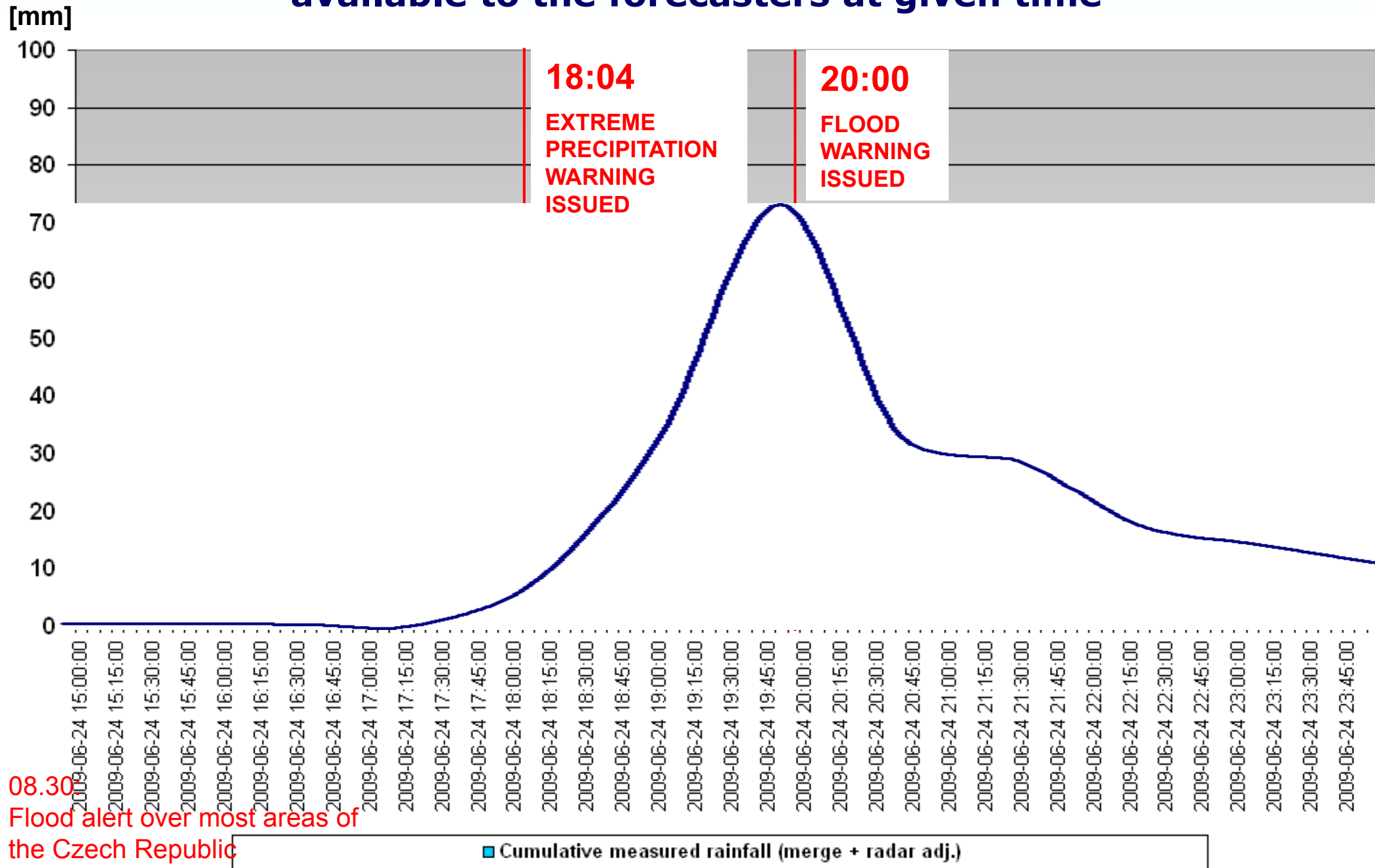
■ Cumulative measured rainfall (merge + radar adj.)

Jičínka flash flood – average catchment rainfall information available to the forecasters at given time



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Jičínka flash flood – average catchment rainfall information available to the forecasters at given time



Jičínka flash flood – warning discussion

SOME products were used for warning

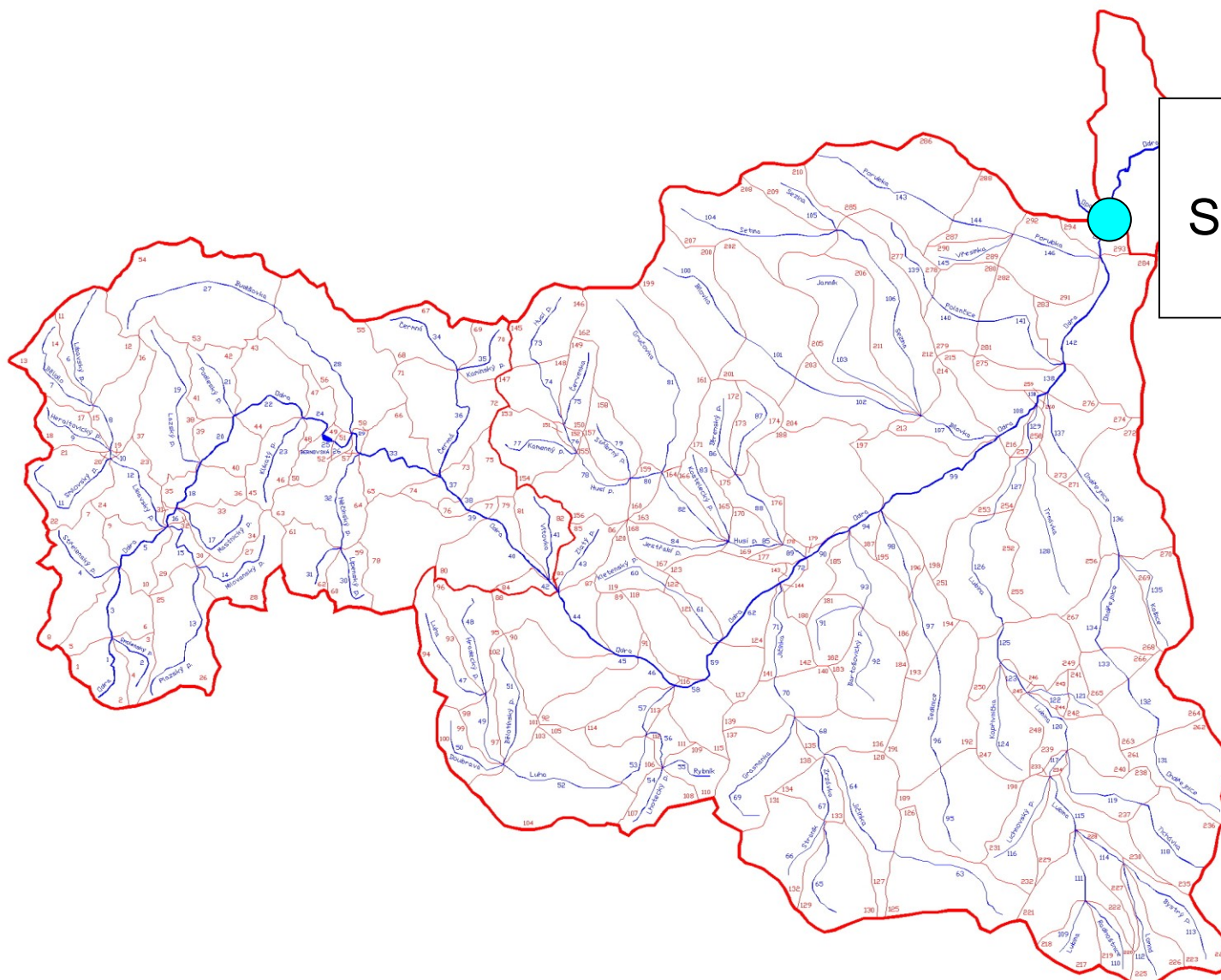
SOME products were available, but not used

SOME products were not available, but are in development

Hydrological modelling:

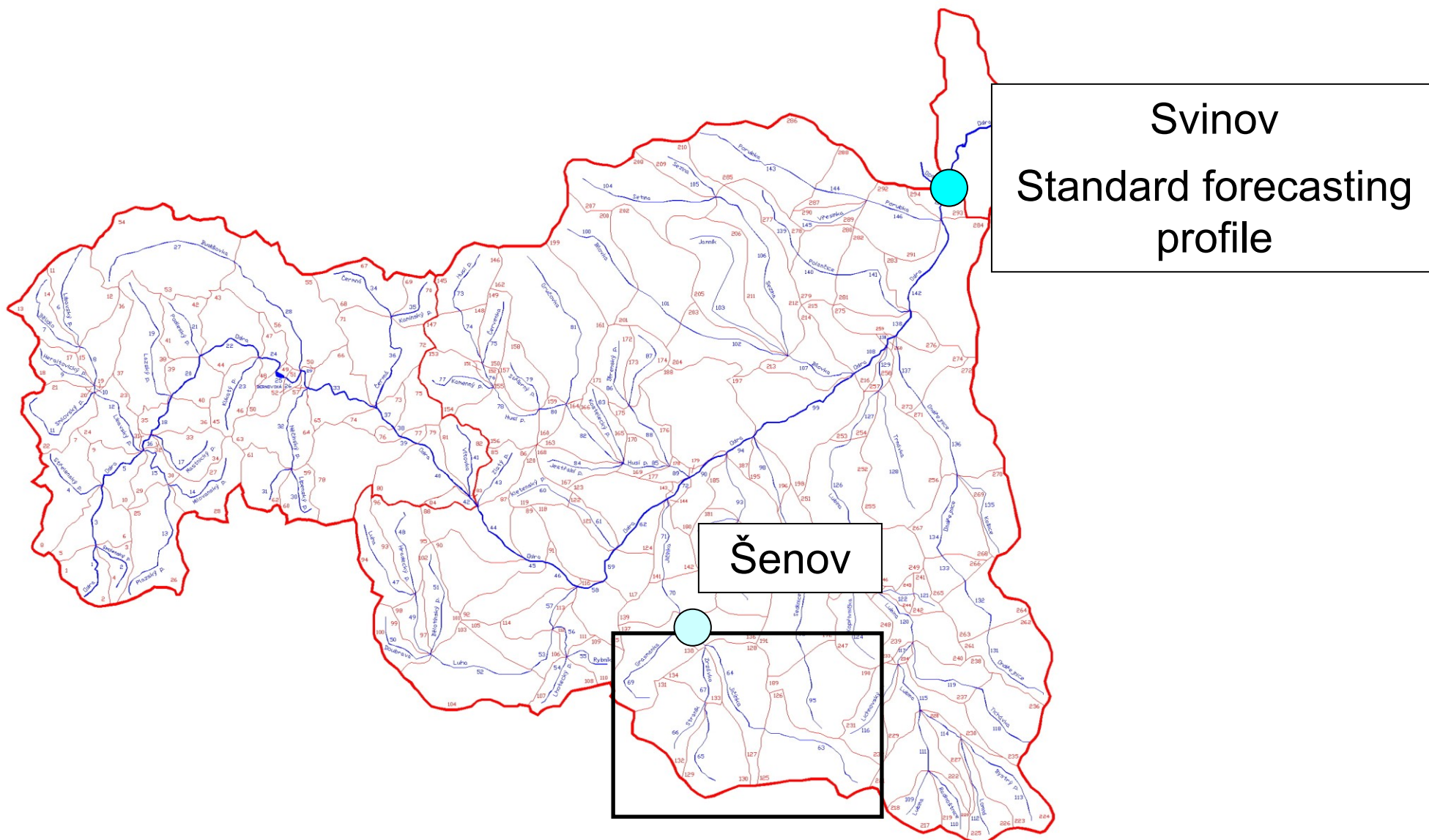
- small catchments are parts of „standard“ hydrological models with „middle-sized catchment“ resolution
- small catchments are usually not monitored, sometimes there's a watergauge station, only very seldom watergauge station with automatic data transmission
- theoretically it is possible to calculate discharge forecast also for small catchments, even if the input resolution is insufficient

Odra catchment – model schematization

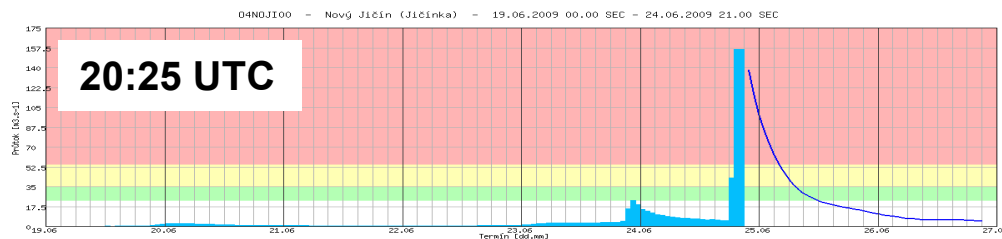
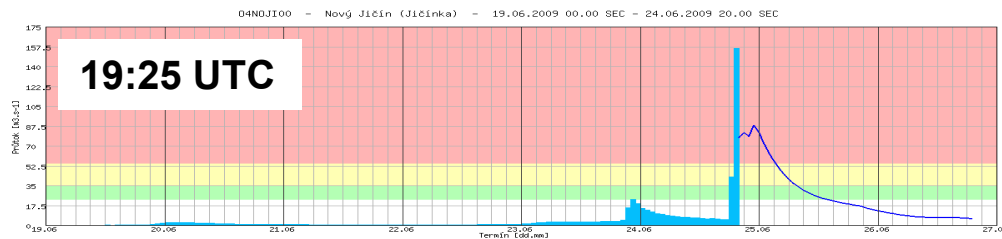
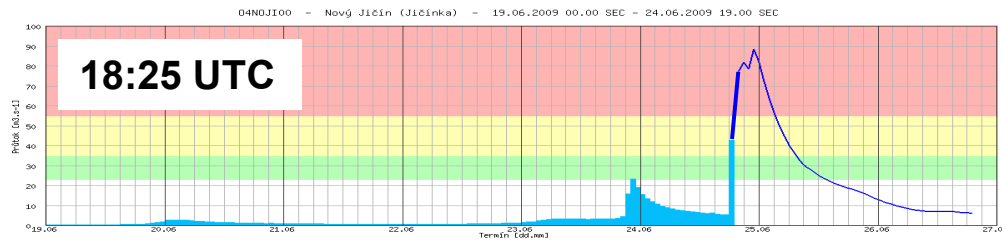
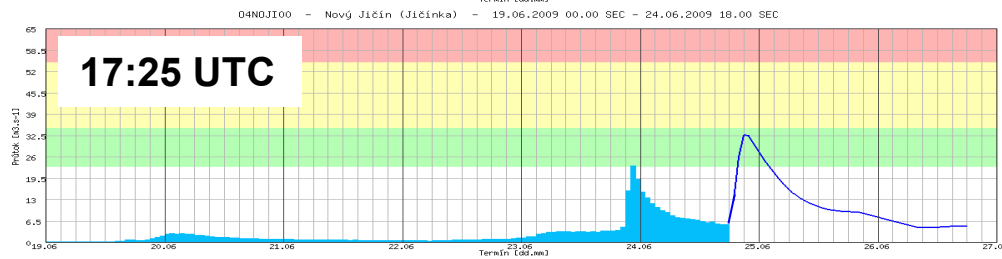
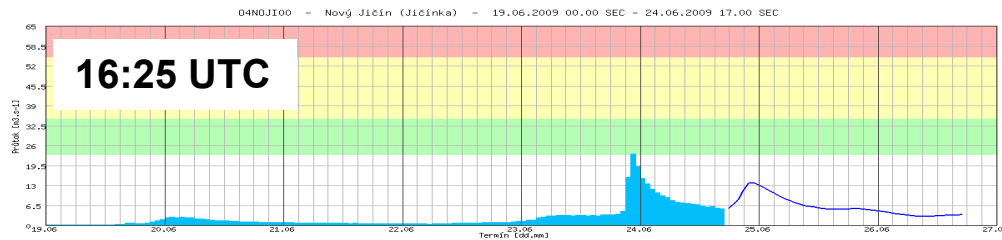


Svinov
Standard forecasting
profile

Odra catchment – model schematization

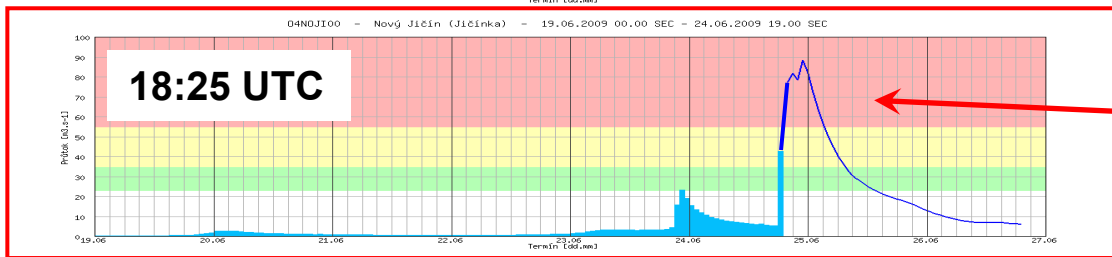
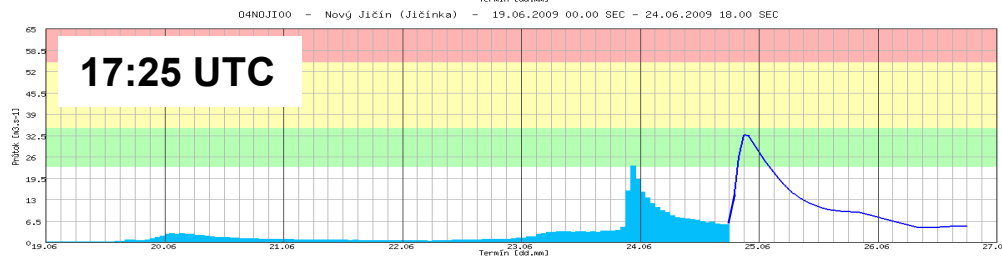
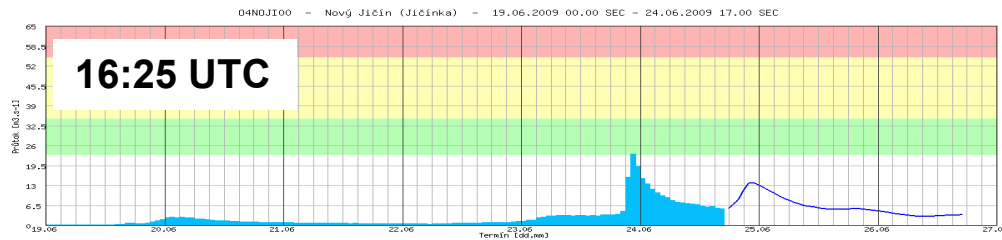


Jičínka Flood – hydrological forecast

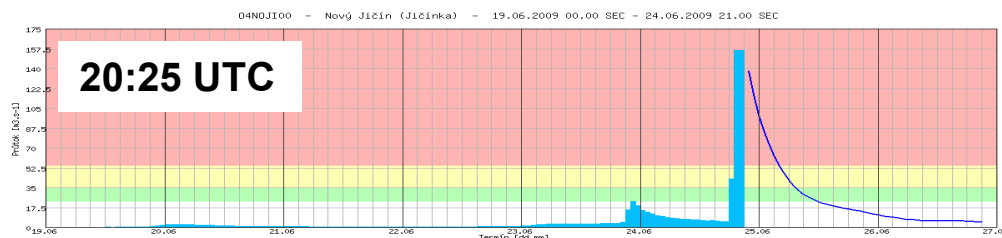
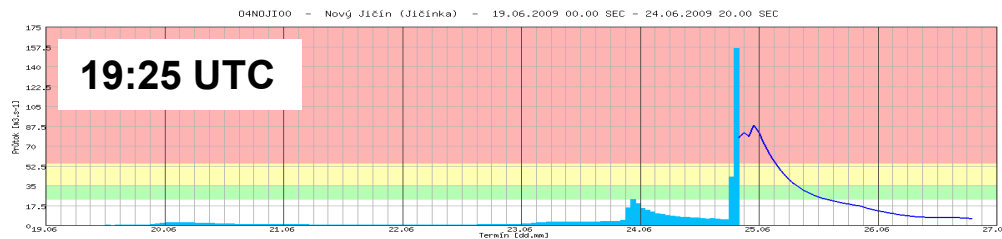


Hydrological forecast:
QPE + COTREC QPF
Hourly update

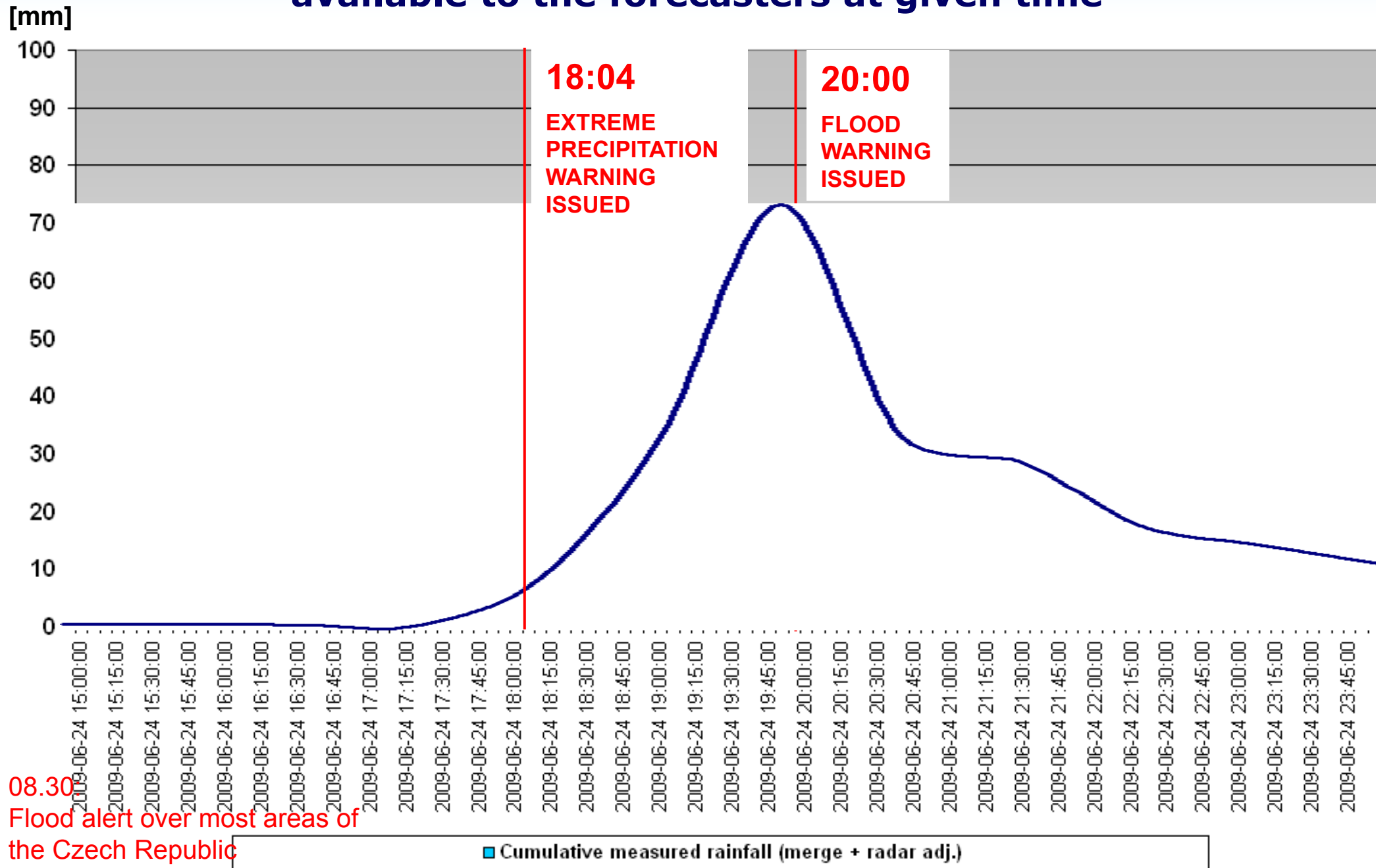
Jičínka Flood – hydrological forecast



Potential flood warning



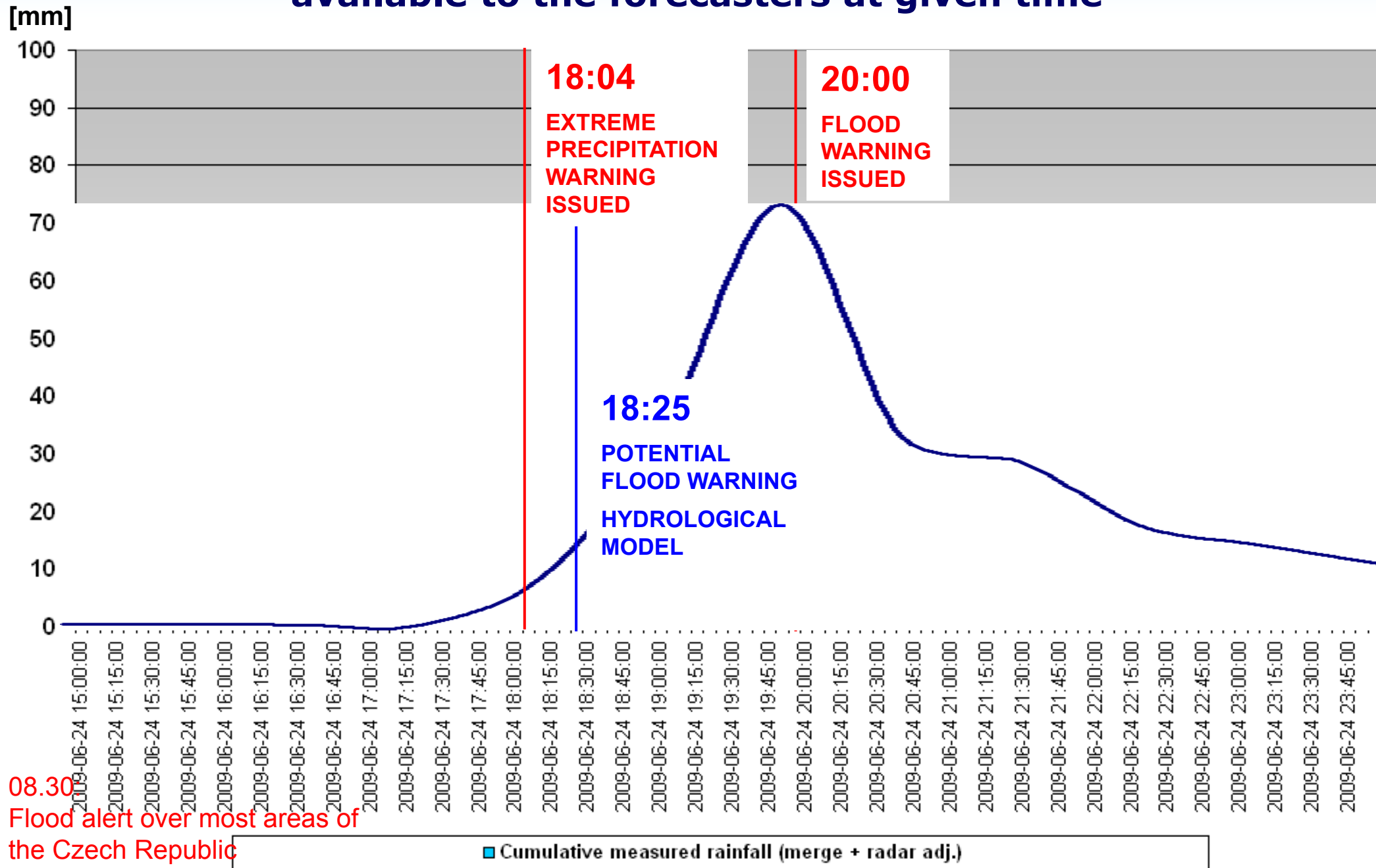
Jičínka flash flood – average catchment rainfall information available to the forecasters at given time



08.30
Flood alert over most areas of
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■ Cumulative measured rainfall (merge + radar adj.)

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Jičínka flash flood – warning discussion

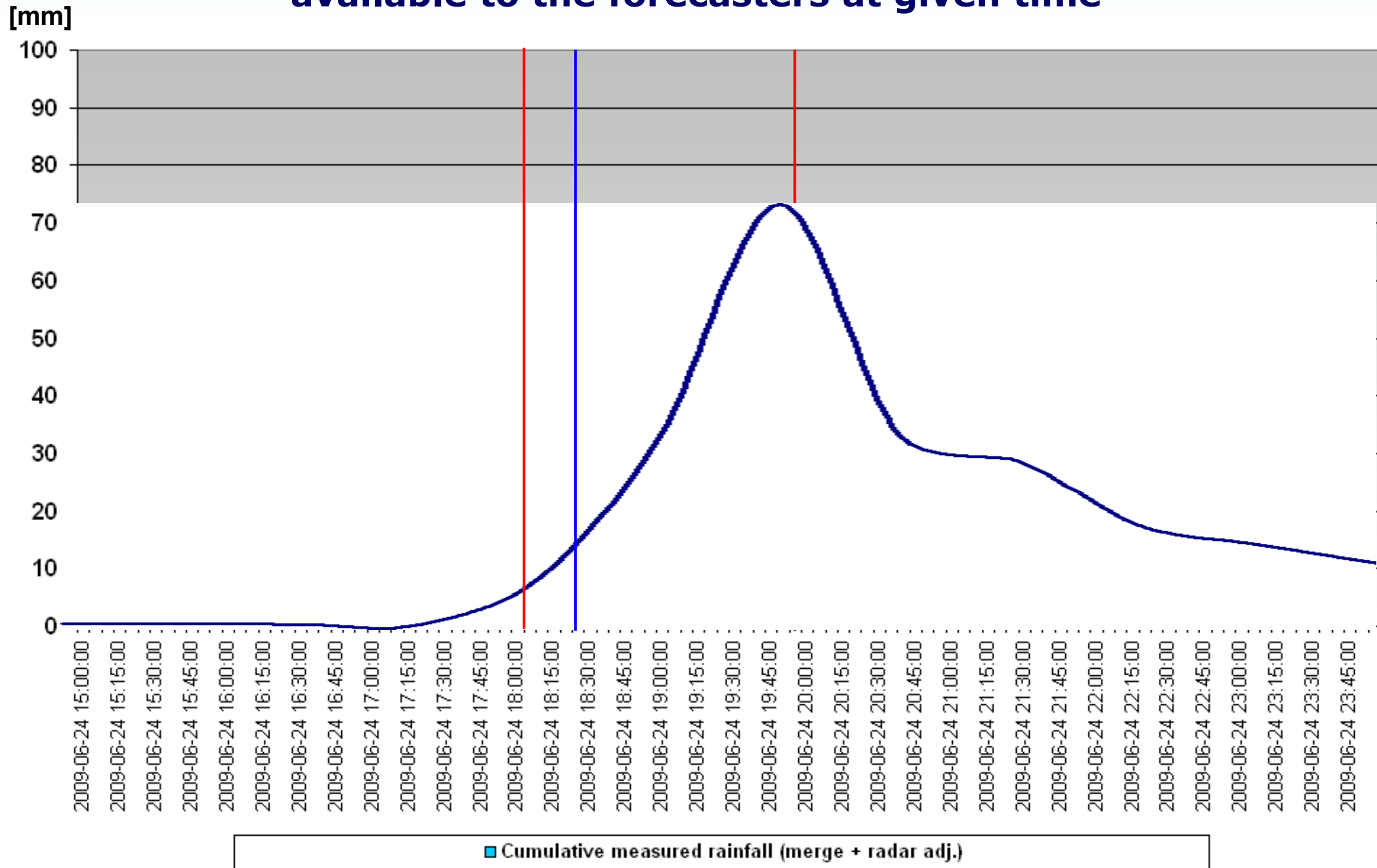
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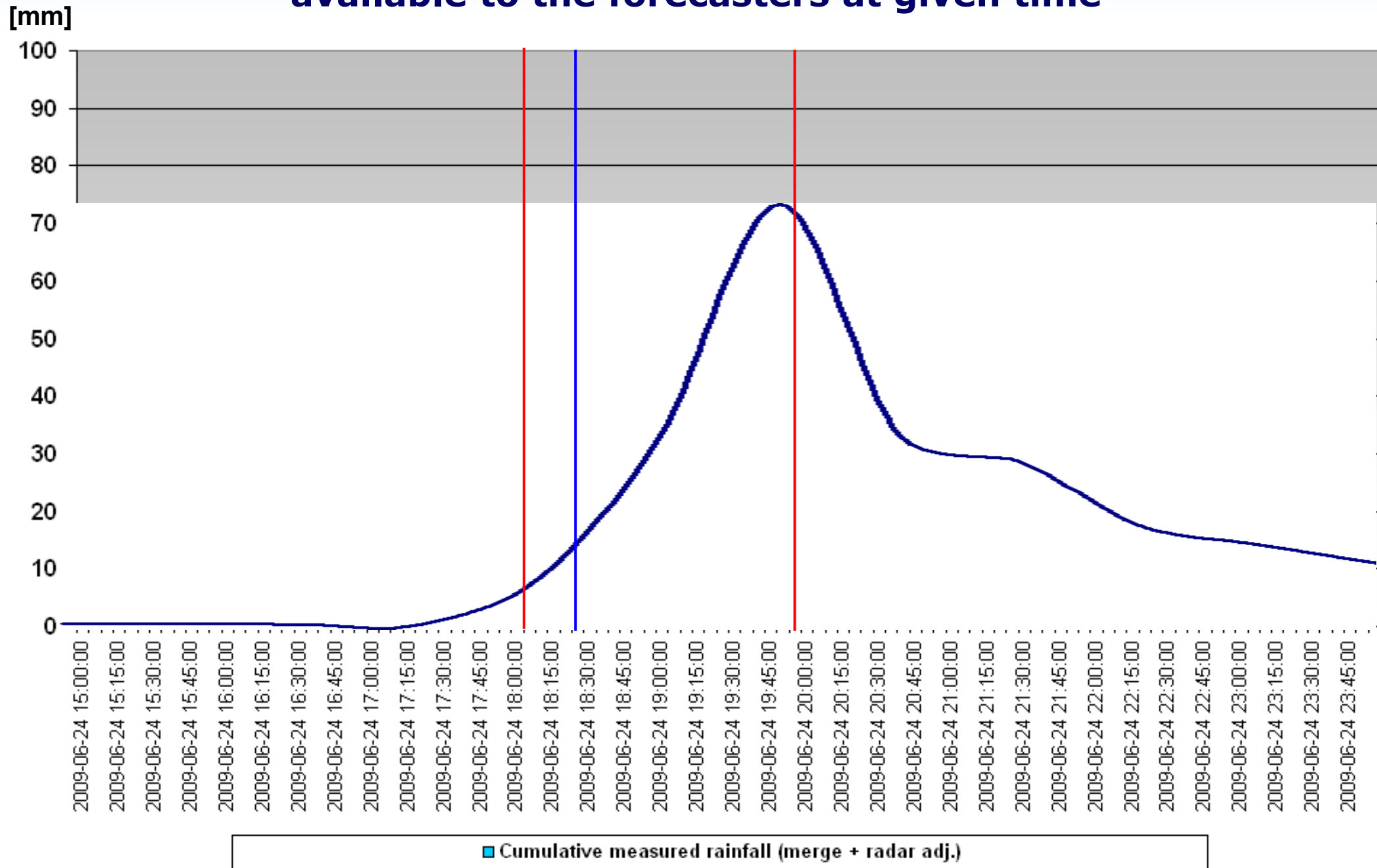
SOME products were not available, but are in development

- Increasing frequency of QPE/QPF calculation – newly in 5 min step (QPE combined with QPF) – detail rainfall analysis
- New methods of hydrological forecasting – fuzzy model for flash flood warning
- *Janal P., Starý M, 2009:Fuzzy model evaluation of peak outflow from a river basin during flash flood. CCWI 2009, Sheffield, ISBN 978-0-415-54851-9.*

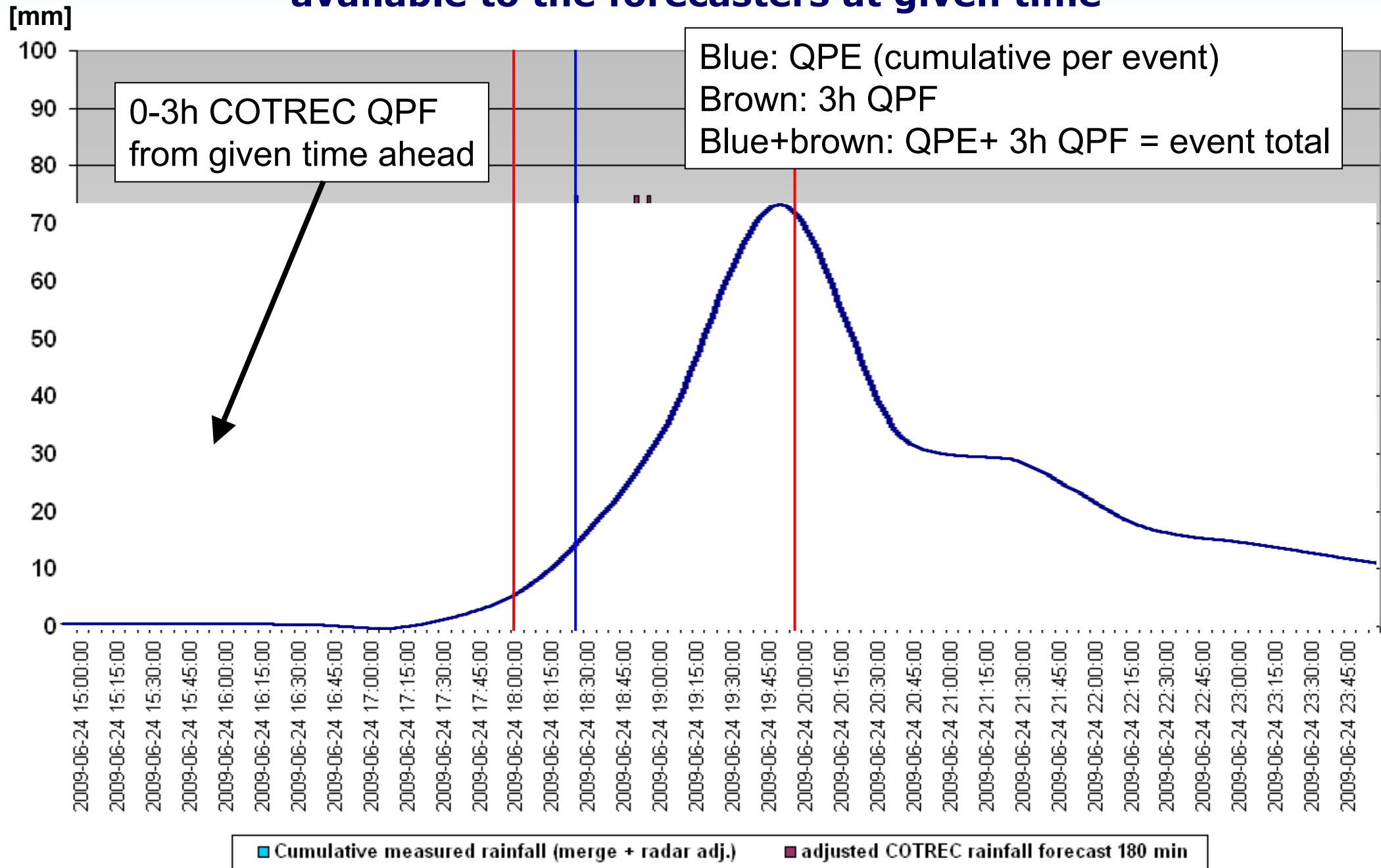
Jičínka flash flood – average catchment rainfall information available to the forecasters at given time



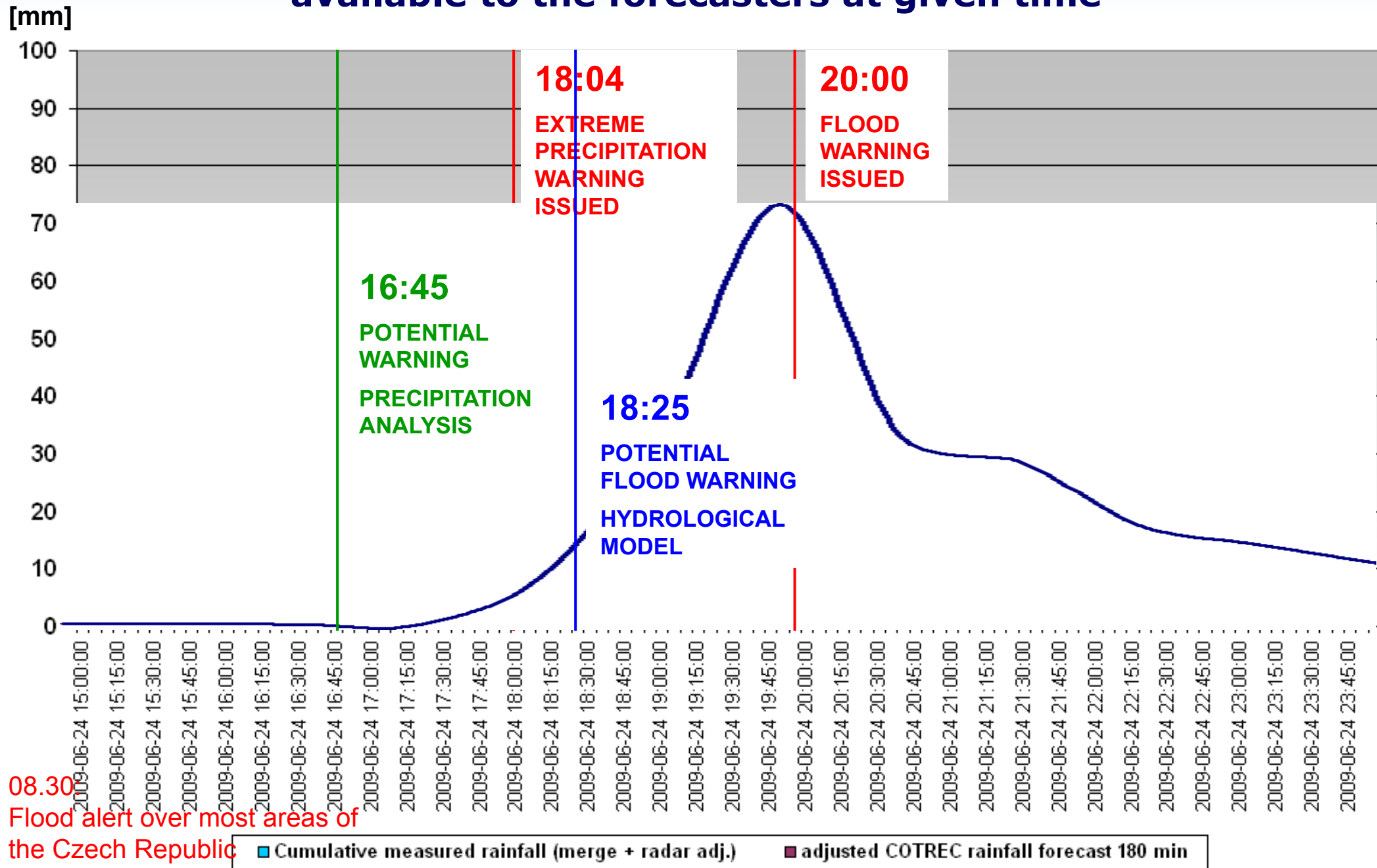
Jičínka flash flood – average catchment rainfall information available to the forecasters at given time



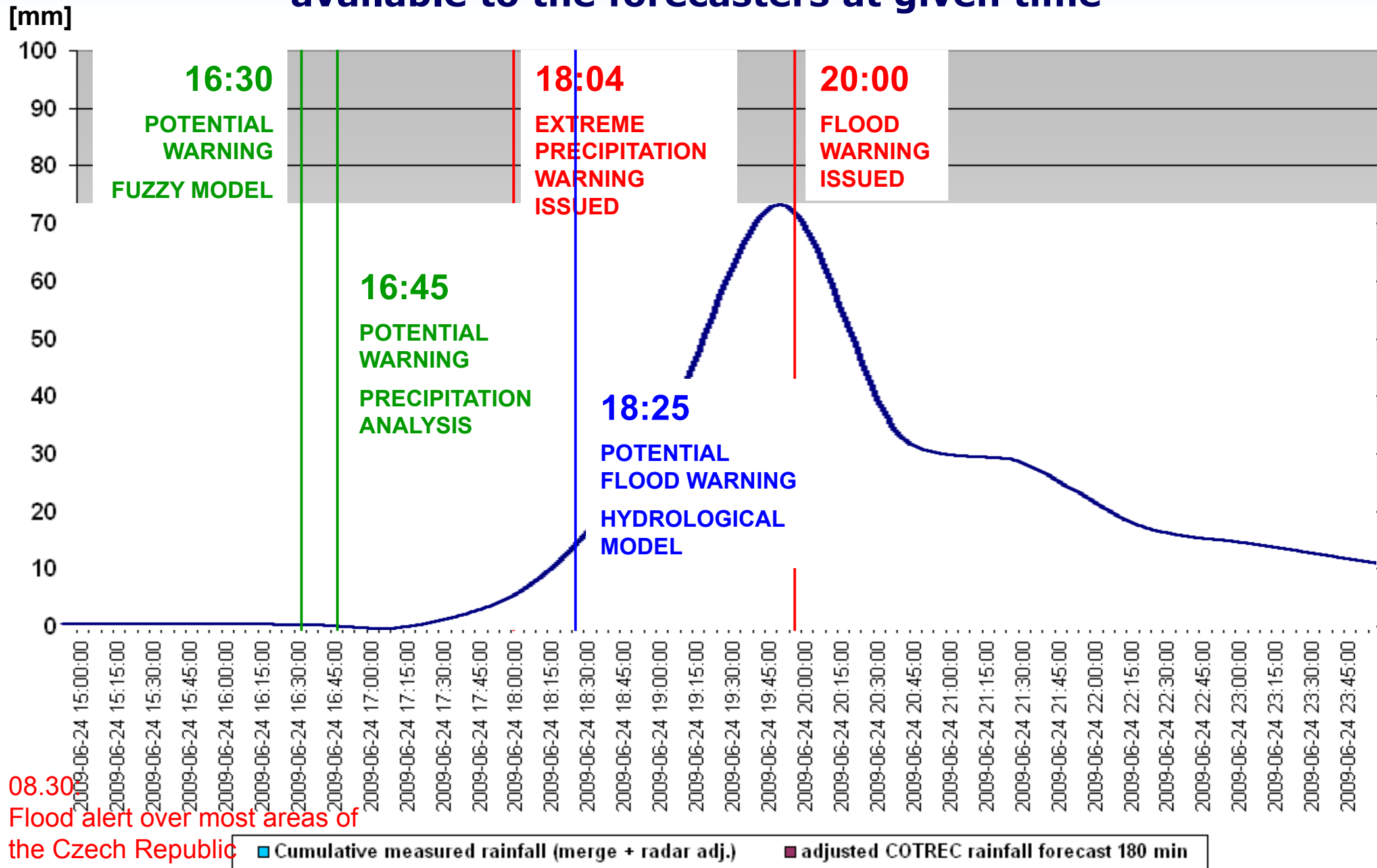
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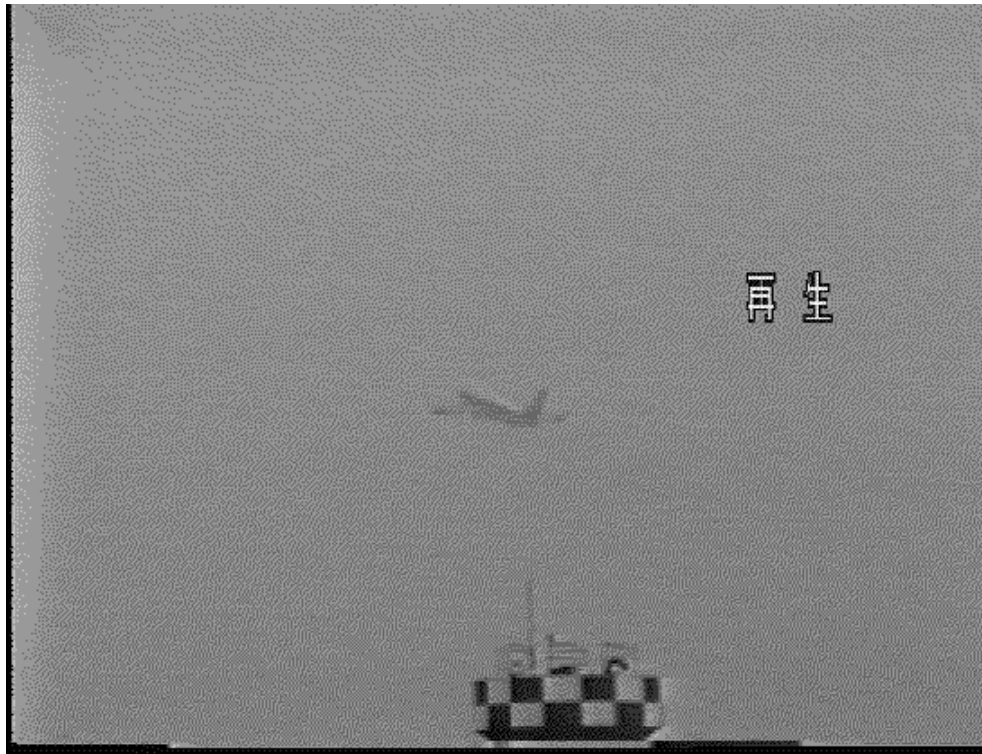
Jičínka flash flood – average catchment rainfall information available to the forecasters at given time



Planned improvement of the flash flood warning systems

- Shortening the time interval for accumulation of the precipitation from radar (adjusted by raingauges)
- Improving the flow of information (forecasts, warnings, map products) towards customers (Fire and Rescue Service, municipalities, emergency managers, public)
- Training of the forecasters
- Education of the public, organizing active monitoring at the regional and local level at the alert stage

Thank you for your attention



P-Brno, 28.2. 2011