

15.08.2010

Synoptic and aerologic analysis

Tomáš Púčik, Michaela Valachová, Martin Setvák

1. Introduction

- Extensive event involving variety of severe weather over large area
- „Storm of the day“: Prague hailstorm
- Complicated synoptic setup, difficulties with prediction
- „*Golden case*“ for Convection Working Group (EUMETSAT)
(<http://www.convection-wg.org/>)

reasons:

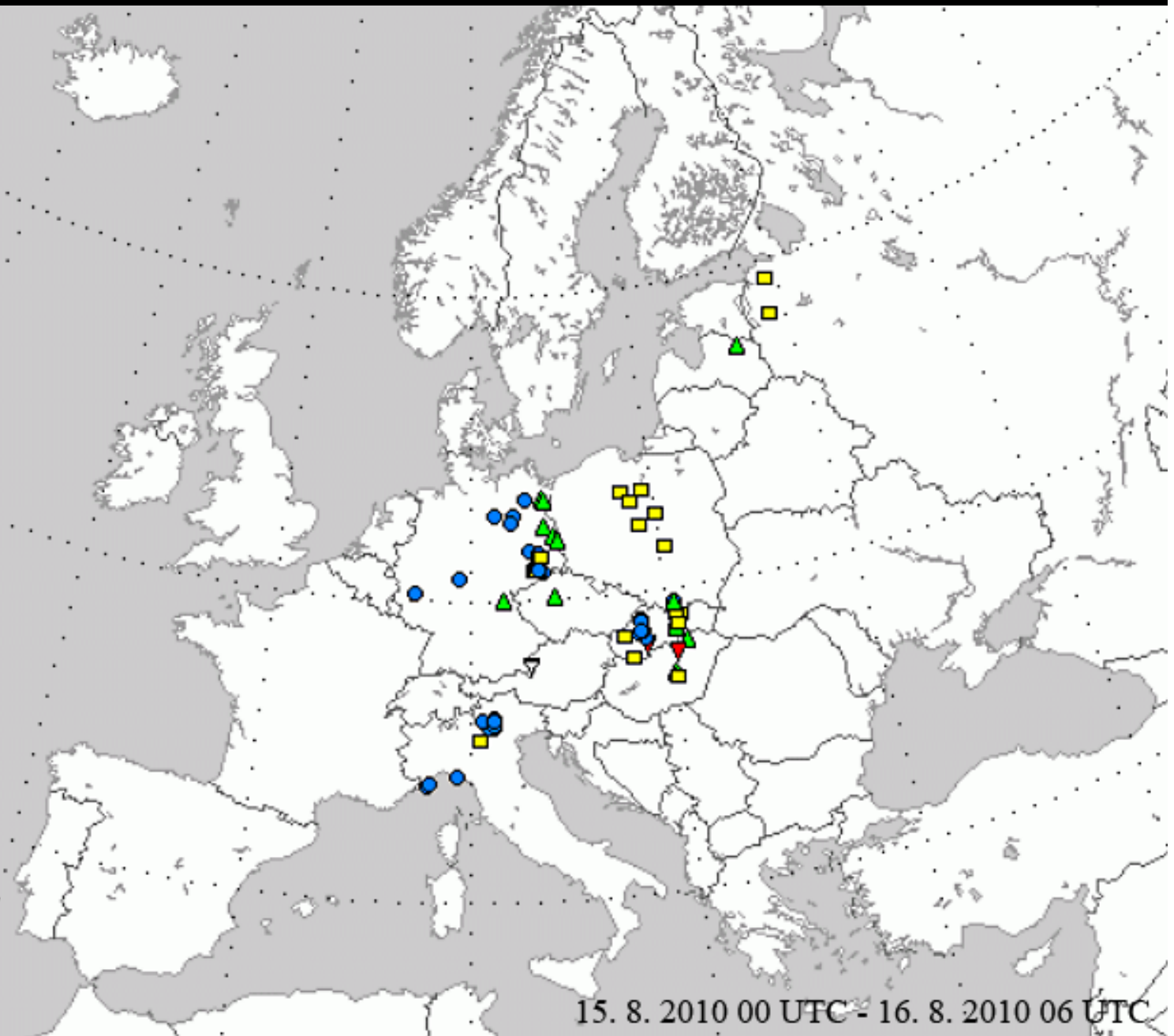
- Unusually warm top of Prague hailstorm
- Cold rings vs cold-U/V storms
- Variety of other storm-top features, known as “storm severity signatures”

ESWD 15. 8. 2010



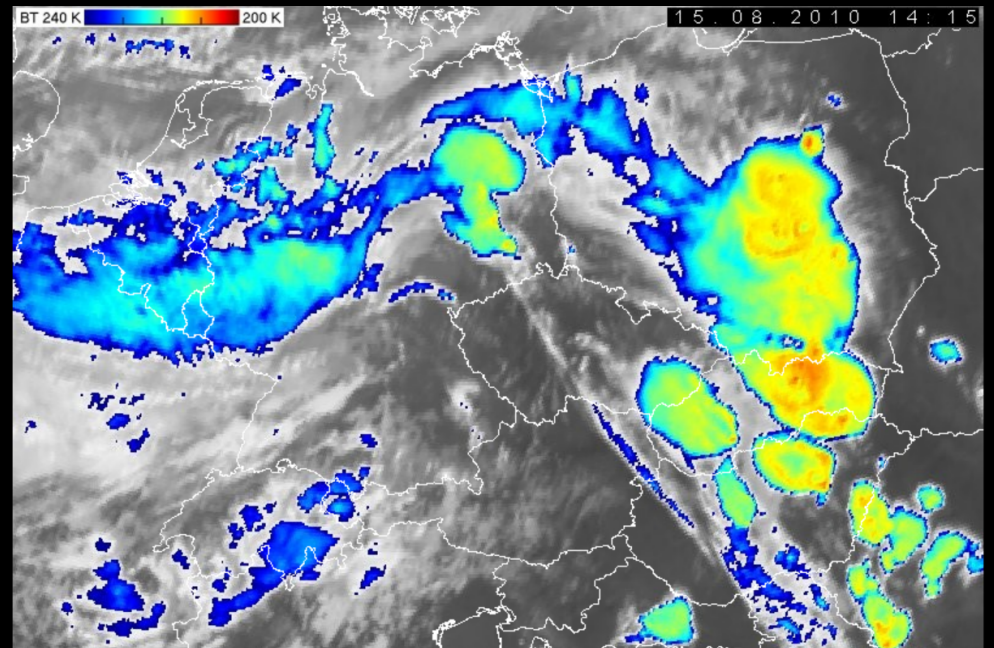
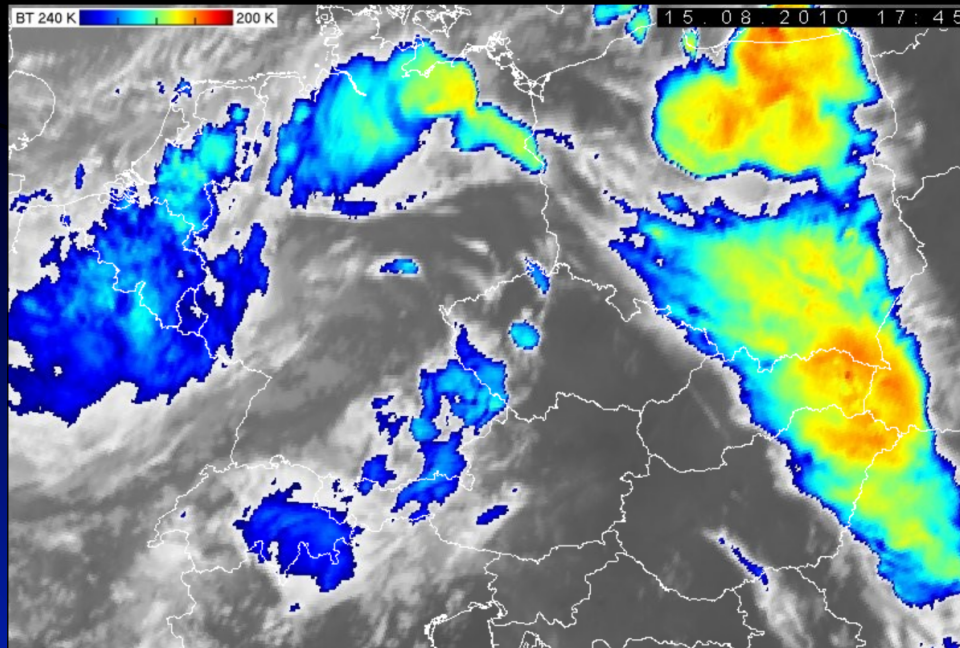
European Severe
Weather Database
www.eswd.eu
(c) ESSL

tornado
severe wind gusts
large hail
heavy rain
funnel cloud
gustnado
dust devil



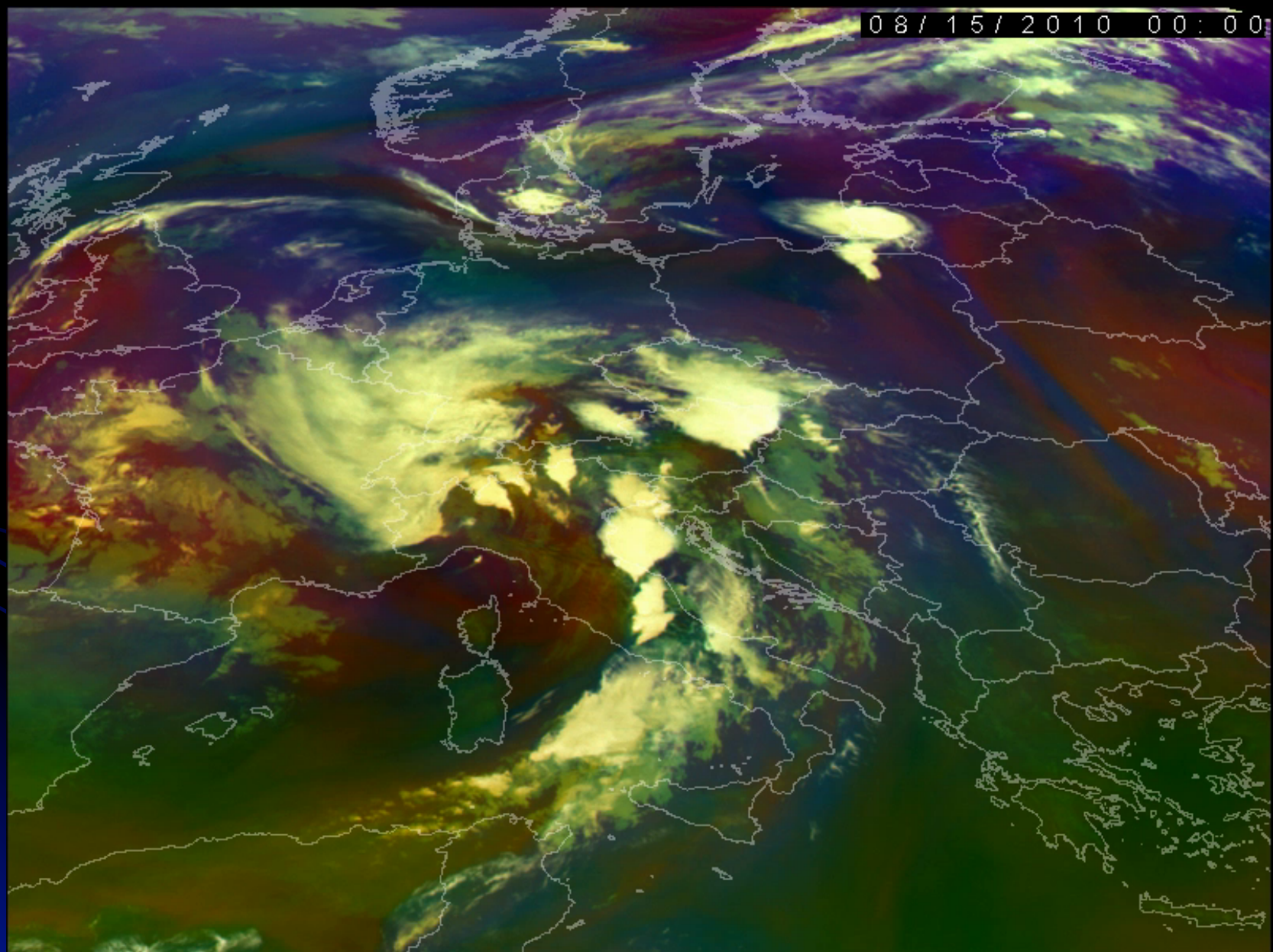
Outline

- Brief overview of synoptic setup
- Problem 1: Prague hailstorm on IR-BT channel
- Problem 2: Cold ring vs cold-U/V storms

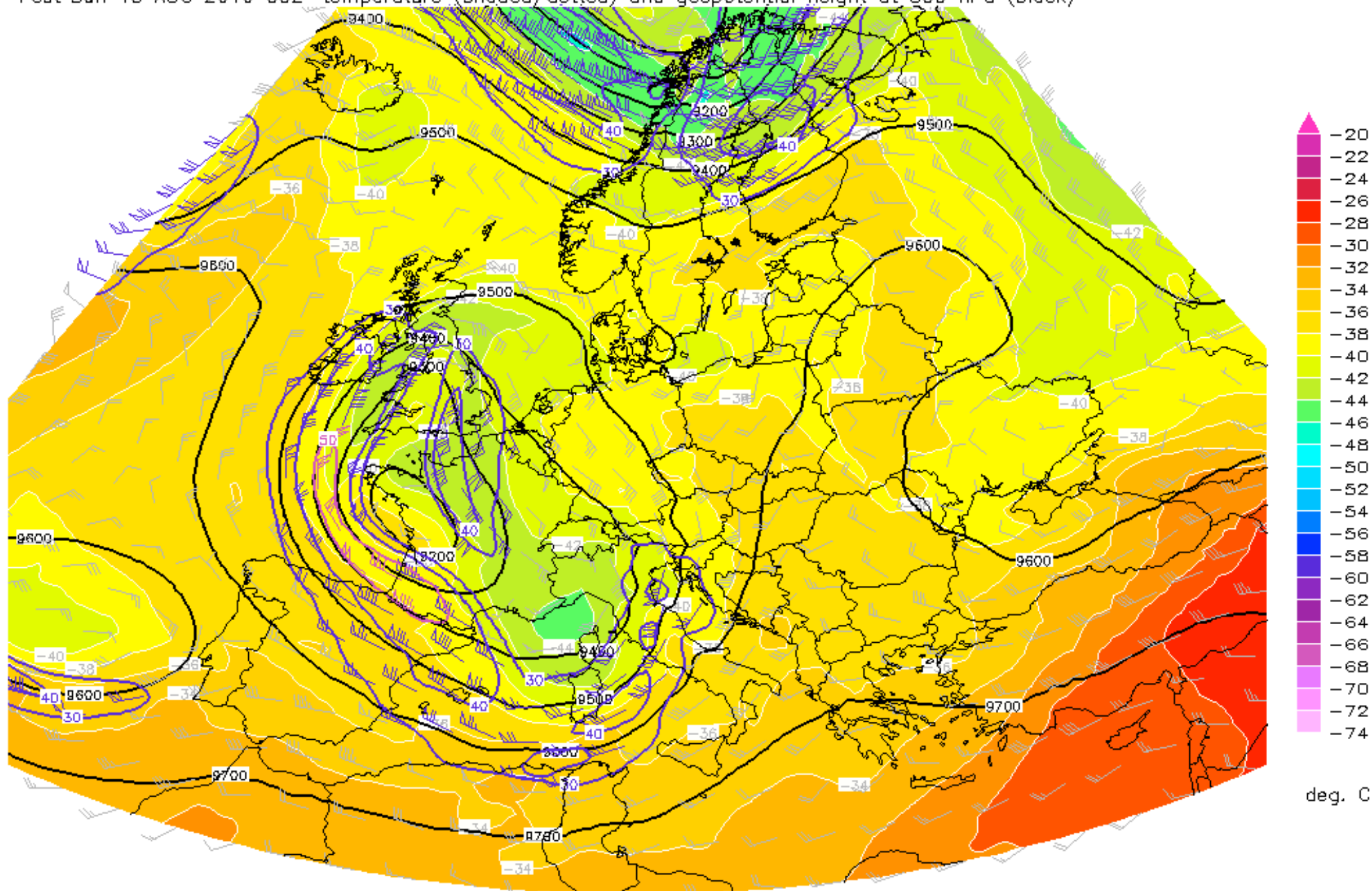


Synoptic setup

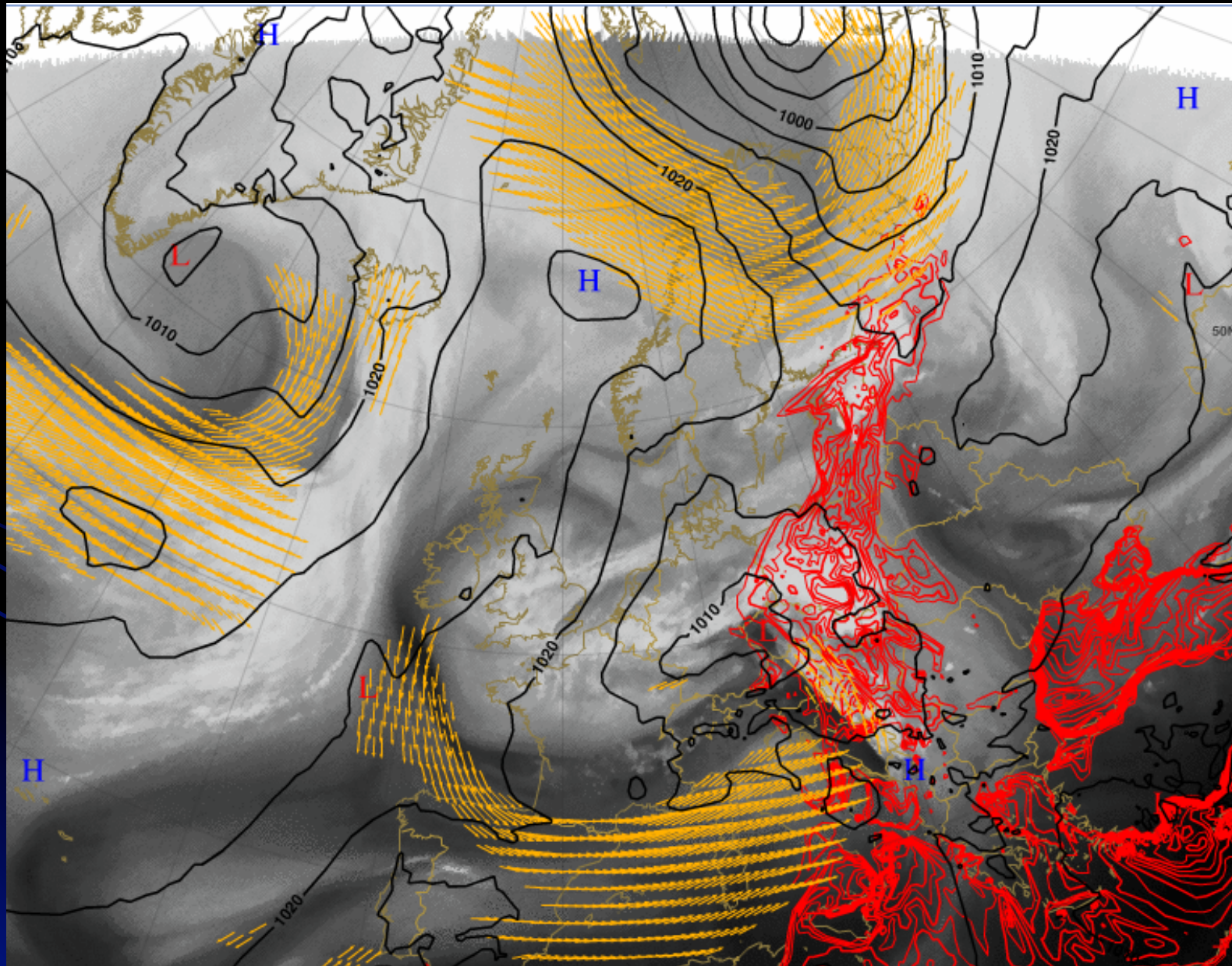
- Mid and upper level cyclonic vortex centered initially over SW France
- Two branches of jet-stream – on the S and NE flanks of the low
- Significant dry intrusion behind the NE jet-stream
- Composite and fractured frontal system
- Ahead of NE jet-stream, warm, very moist airmass with high values of latent instability
- Surface low „rotating“ around the mid-level vortex across Bohemia into NE German



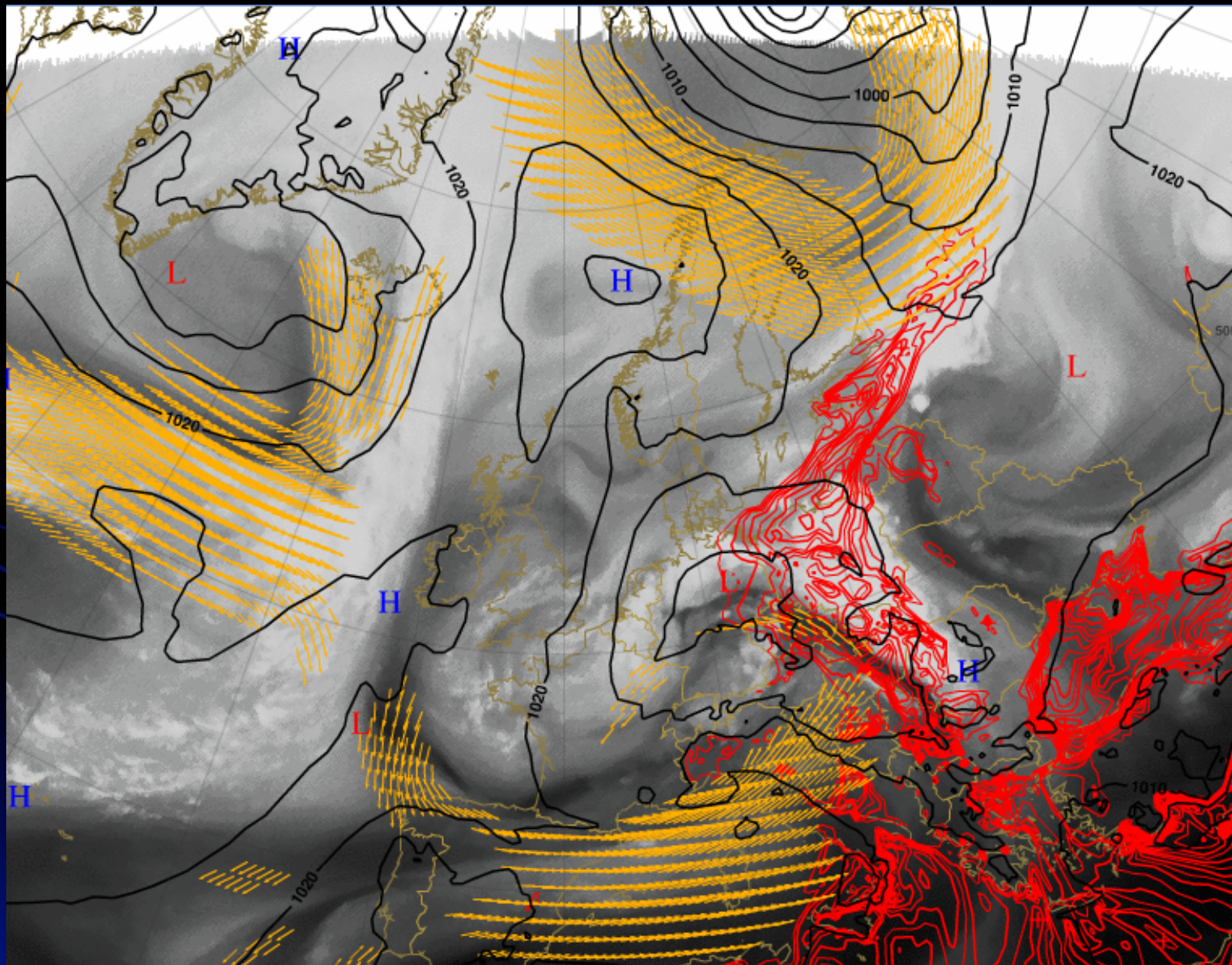
AGIF-UNREGISTERED 2010 00Z NCEP GFS wind speed at 300 hPa in m/s (contours/barbs)
Fcst Sun 15 AUG 2010 00Z temperature (shaded/dotted) and geopotential height at 300 hPa (black)



**SATREP 12 UTC MSG VW 6.2, surface pressure, 300 hPa winds,
CAPE (ECMWF prediction)**

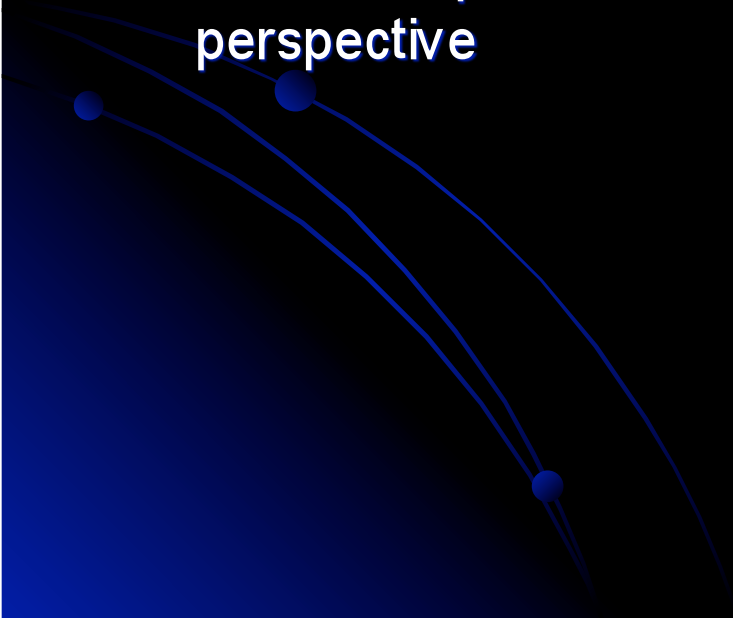


**SATREP 18 UTC MSG VW 6.2, surface pressure, 300 hPa winds,
CAPE (ECMWF prediction)**

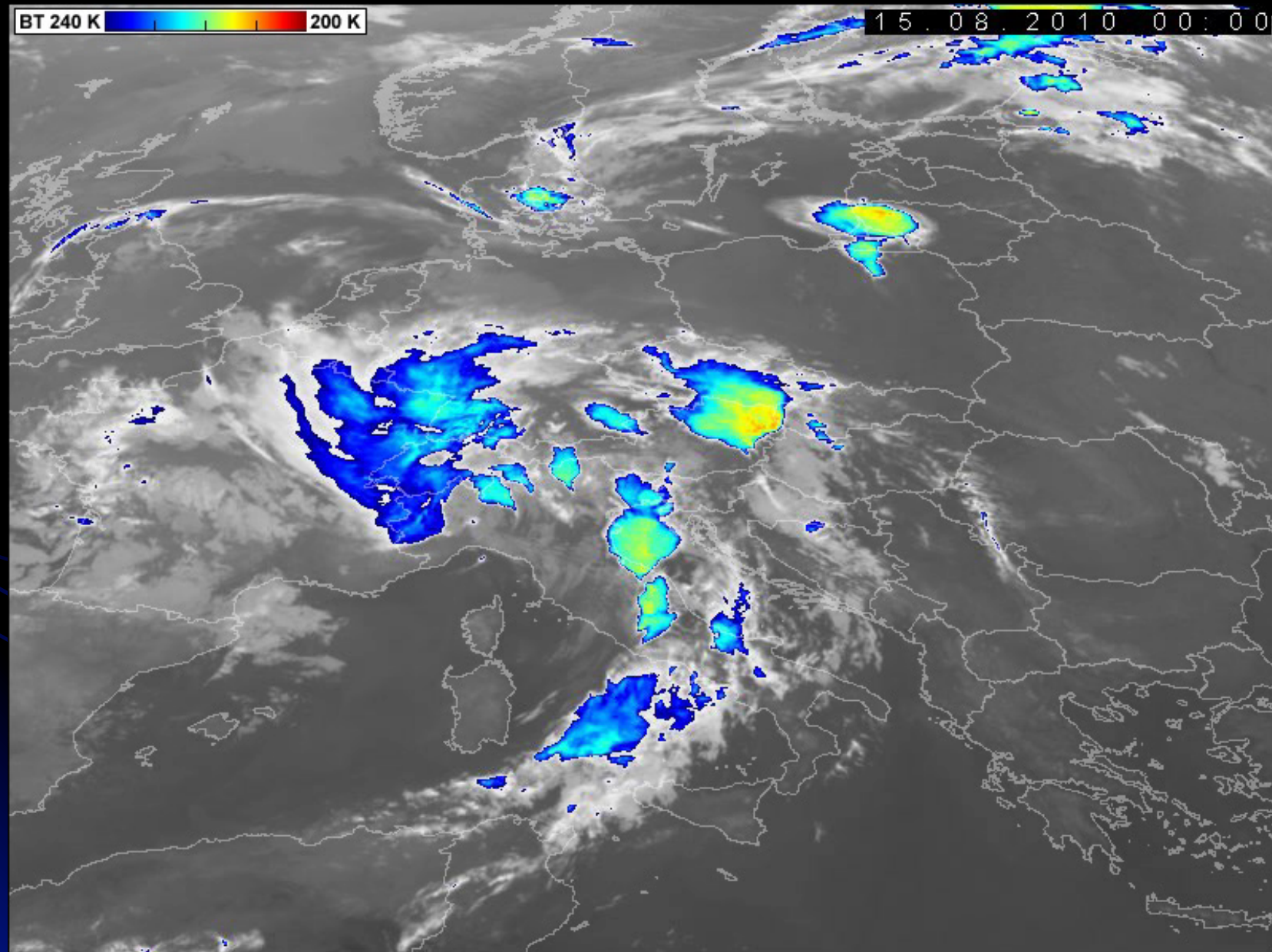


Problem 1

- Relatively warm appearance of Prague hailstorm compared to the other storms of the region
- → storm looks rather „insignificant“ (using the standard IR-BT enhancement)
- Several supercellular characteristics both from radar and visual perspective



IR-BT animation



Storm from visual perspective



Normal IR-BT palette (200-240 K) vs shifted (210-250 K) MSG Rapid-scan

BT 240 K



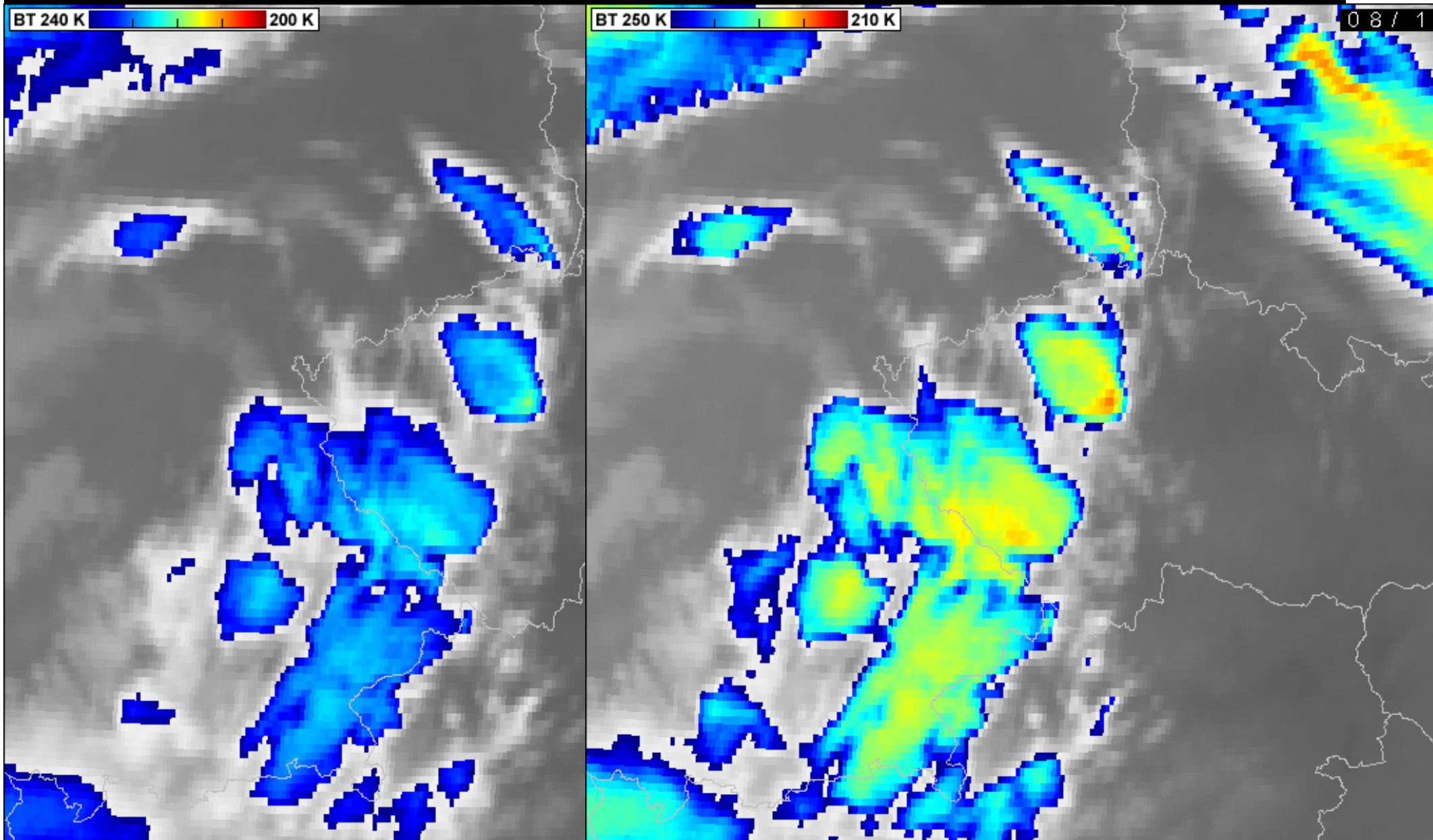
200 K

BT 250 K

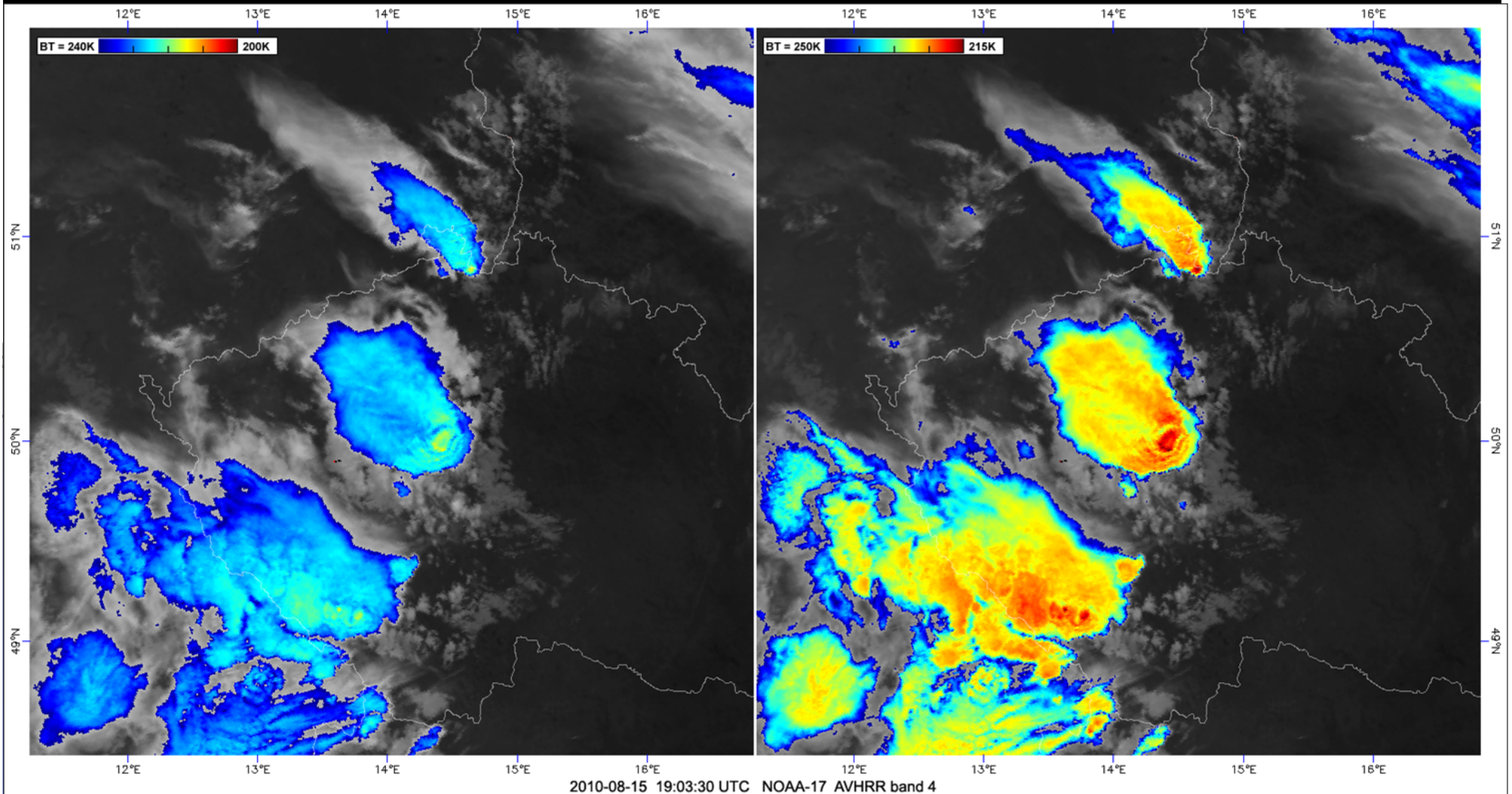


210 K

08 / 1



NOAA-17 AVHRR band 4 19:03 UTC - a distinct cold-V feature and a huge overshooting top



Visual of overshooting top



David Rýva

CZRAD composite - 15.08.2010 19:05 - VERT. CUT + Z_MAX3D

[300,232]... [300,352]

CAPPI-based 1-14km

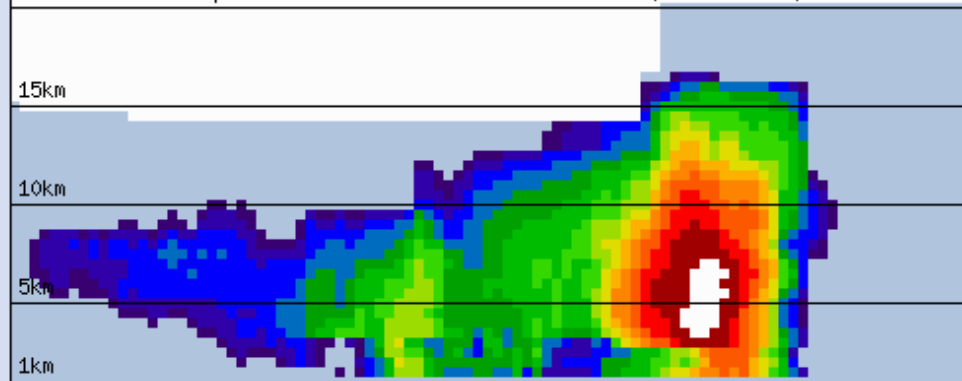
20km CZRAD composite - CAPPI - 20100815.1905 - [300,232]...[300,352]

15km

10km

5km

1km



CZRAD composite - 15.08.2010 19:05 - VERT. CUT + Z_MAX3D

[301,232]... [301,352]

CAPPI-based 1-14km

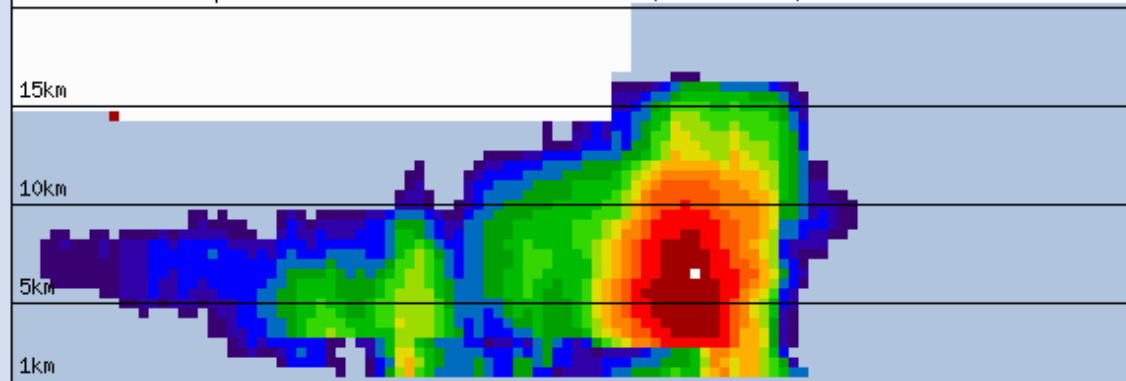
20km CZRAD composite - CAPPI - 20100815.1905 - [301,232]...[301,352]

15km

10km

5km

1km



PPI-based (Brdy only) 1-20km

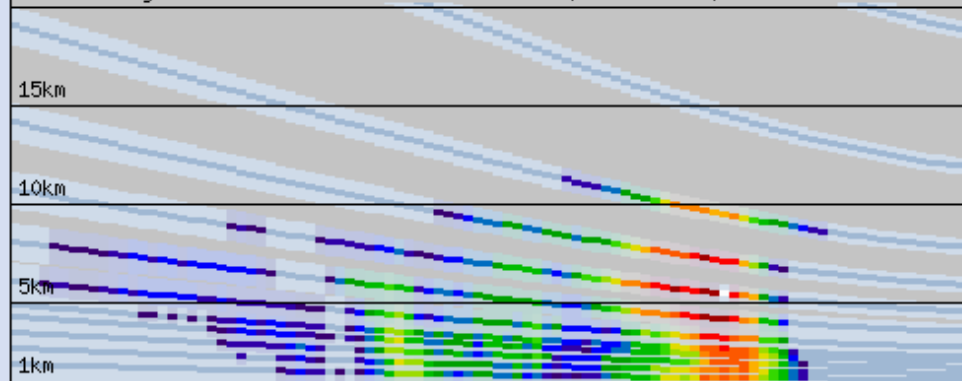
20km Brdy-Praha - PPI - 20100815.1905 - [300,232]...[300,352]

15km

10km

5km

1km



PPI-based (Brdy only) 1-20km

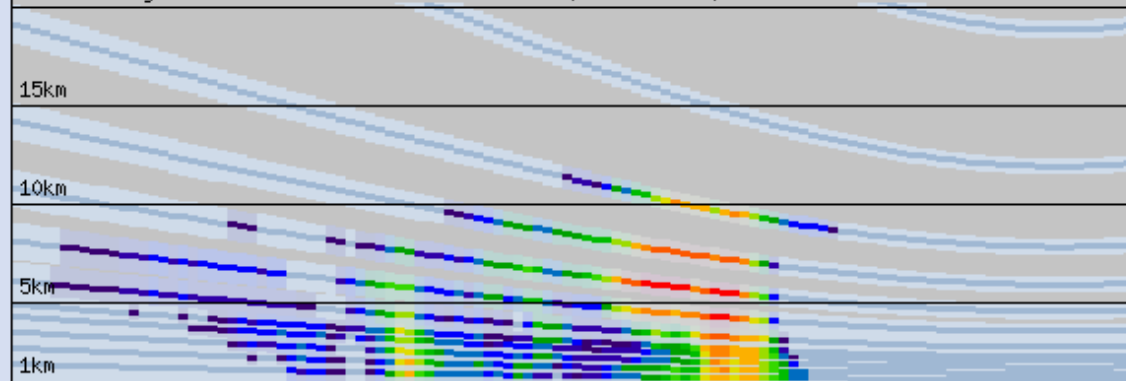
20km Brdy-Praha - PPI - 20100815.1905 - [301,232]...[301,352]

15km

10km

5km

1km



PPI-based (Skalky only) 1-20km

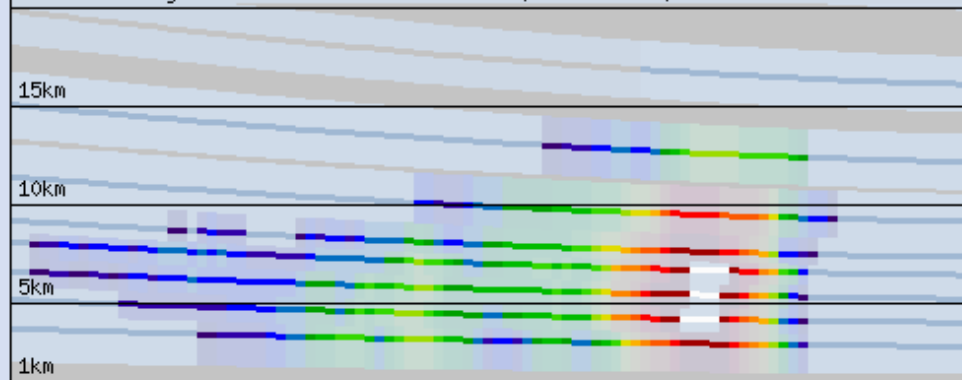
20km Skalky - PPI - 20100815.1905 - [300,232]...[300,352]

15km

10km

5km

1km



PPI-based (Skalky only) 1-20km

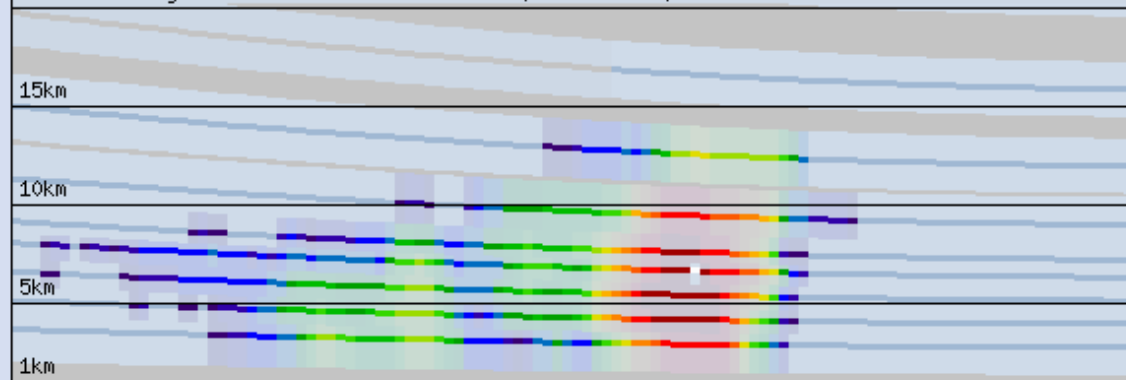
20km Skalky - PPI - 20100815.1905 - [301,232]...[301,352]

15km

10km

5km

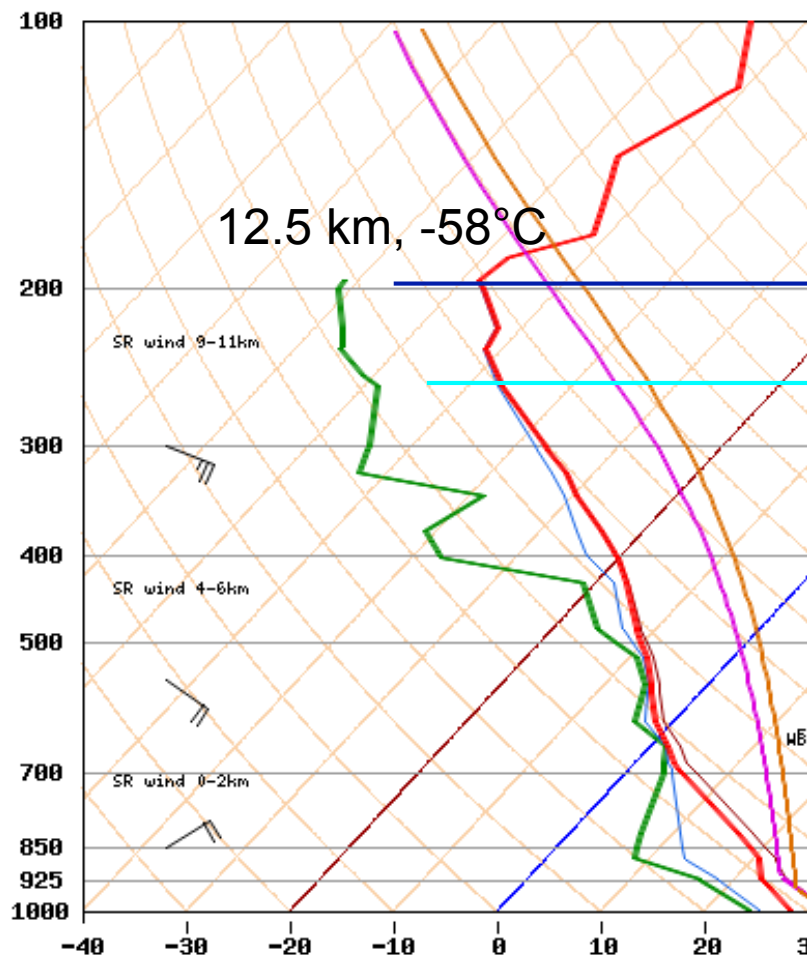
1km



Prague 18 UTC sounding vs Budapest 12 UTC

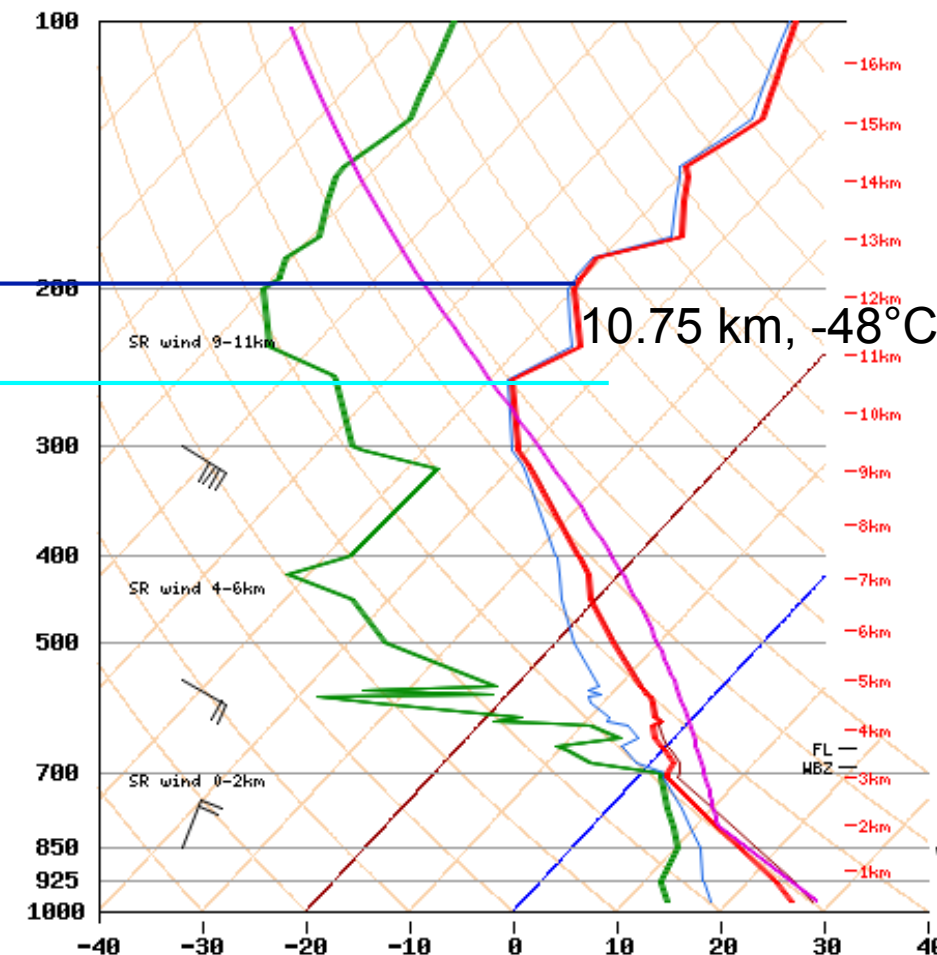
Clear difference both at tropopause height and temperature

12843 Budapest/Lorinc 15.08.2010 12 UTC



David Ryva, Kolin - Czech Republic

11520 Praha-Libus 15.08.2010 18 UTC



David Ryva, Kolin - Czech Republic

* Parcel ML 50hPa *

CAPE: 906 J/kg
CINH: -44 J/kg
LI: -4.2 K

* Parcel MU *

CAPE: 1020 J/kg
CINH: -60 J/kg
MULY: SFC

* downdraft *

LFS: 575 hPa
DCAPE: 1173 J/kg

* wind shear *

0-6km: 22.7 m/s
0-3km: 7.6 m/s
0-1km: 1.4 m/s

SRH L3km: 60 J/kg

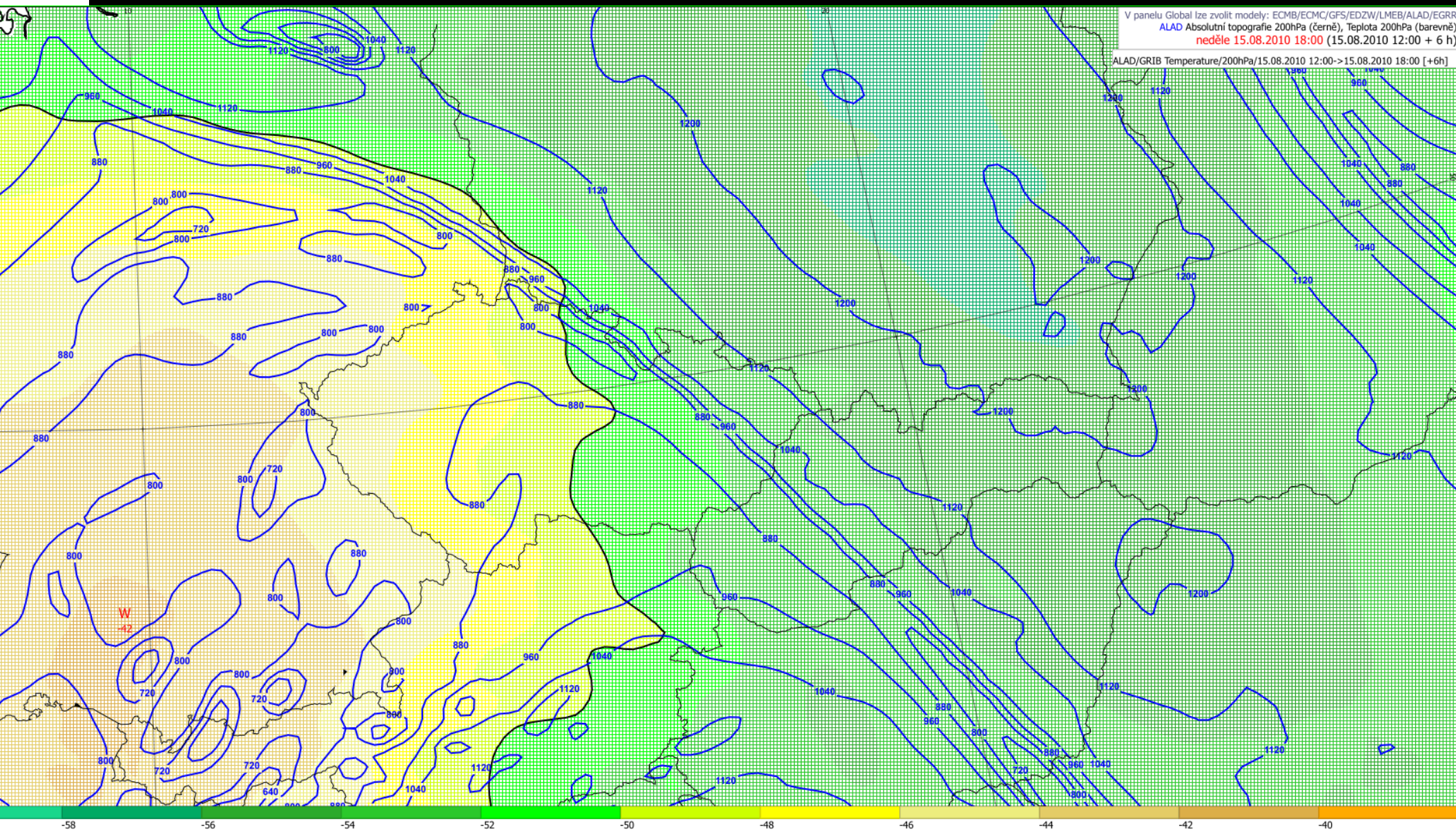
SRH L1km: -6 J/kg

other indicies

EH1: 0.3
SVR: 512
TTI: 55 K
SWEAT: 289
KI: 40 K
DTHE: 18.4 K
LRS85: 8.3 K/km
LR86: 6.8 K/km

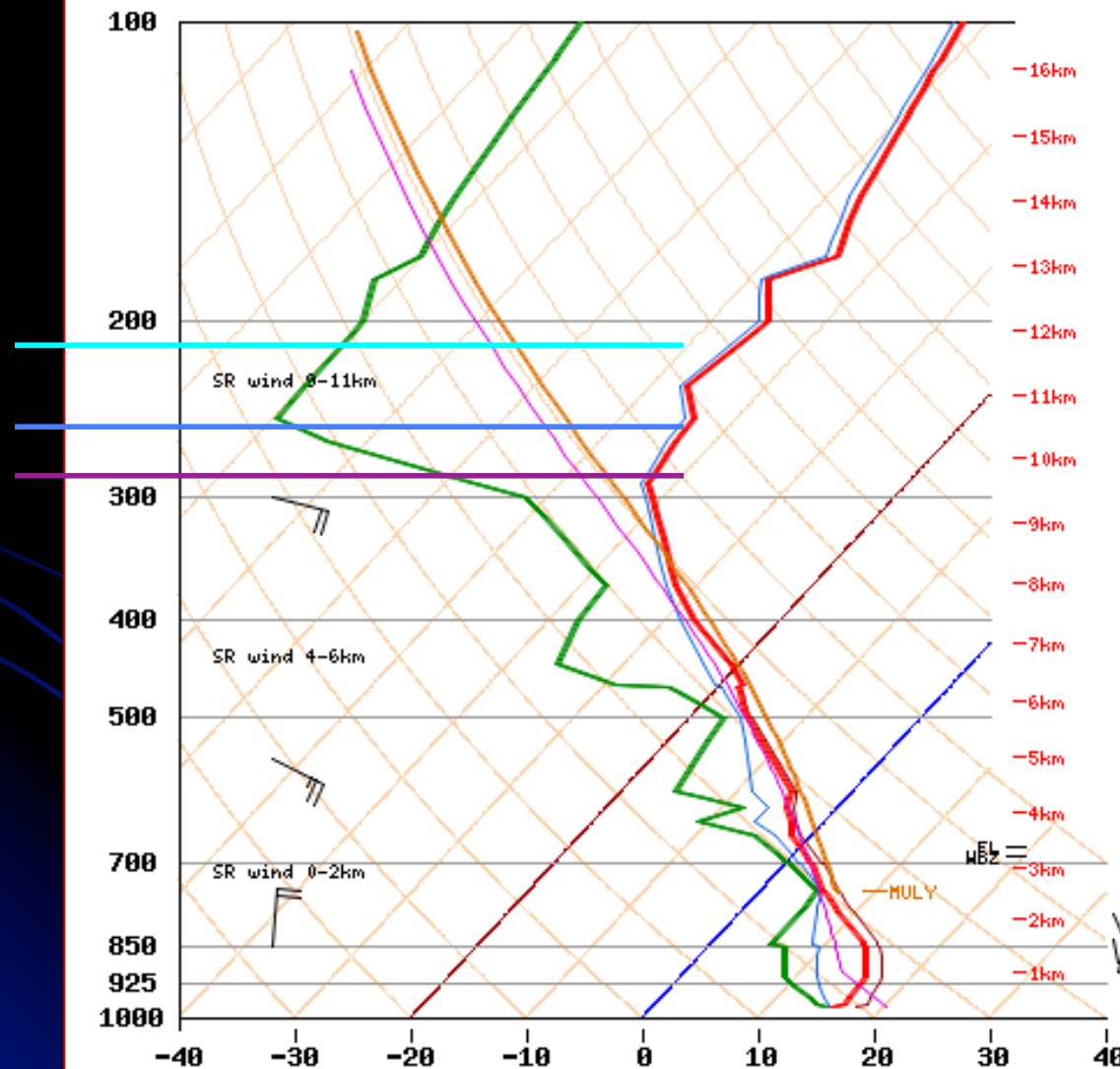
SKYWARN CZECHOSLOVAKIA(c)2011

Dynamic tropopause height (ALADIN 12 UTC run) at 18 UTC + temperature at 200 hPa level



Prague soundings (12-00 UTC)

11520 Praha-Libus 16.08.2010 00 UTC



* Parcel ML 50hPa *

CAPE: 0 J/kg
CINH: -223 J/kg
LI: 0.6 K

* Parcel MU *

CAPE: 223 J/kg
CINH: -0 J/kg
MULY: 748 hPa

* downdraft *

LFS: 636 hPa
DCAPE: 549 J/kg

* wind shear *

0-6km: 20.3 m/s
0-3km: 16 m/s
0-1km: 6.7 m/s

SRH L3km: 139 J/kg

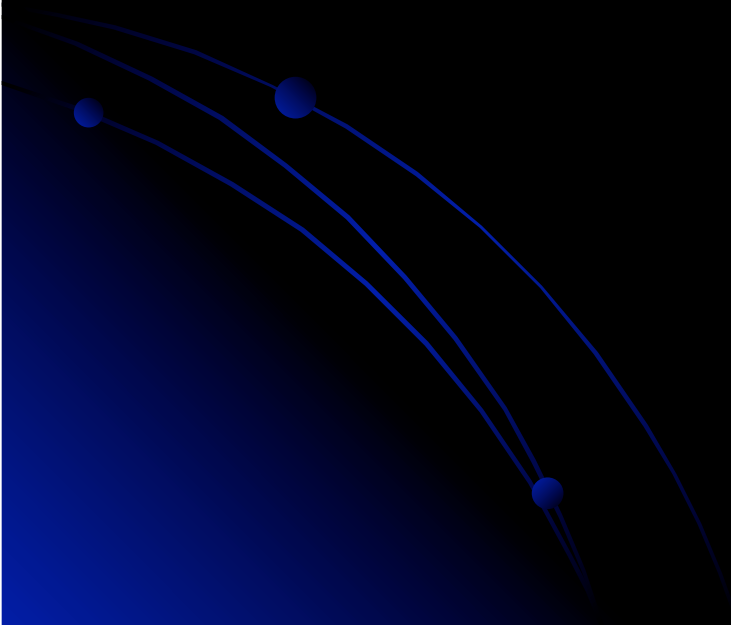
SRH L1km: -44 J/kg

other indicies

EHI: 0
SVR: 214
TTI: 50 K
SWEAT: 156
KI: 33.1 K
DTHE: 6.3 K
LRS85: 1.7 K/km
LRS86: 6.3 K/km

Quick summary

- Primary cause: tropopause depression in connection to the dry intrusion behind the south-easterly jet-stream
- Tropopause dropped by more than 2 km and warmed up by 10°C

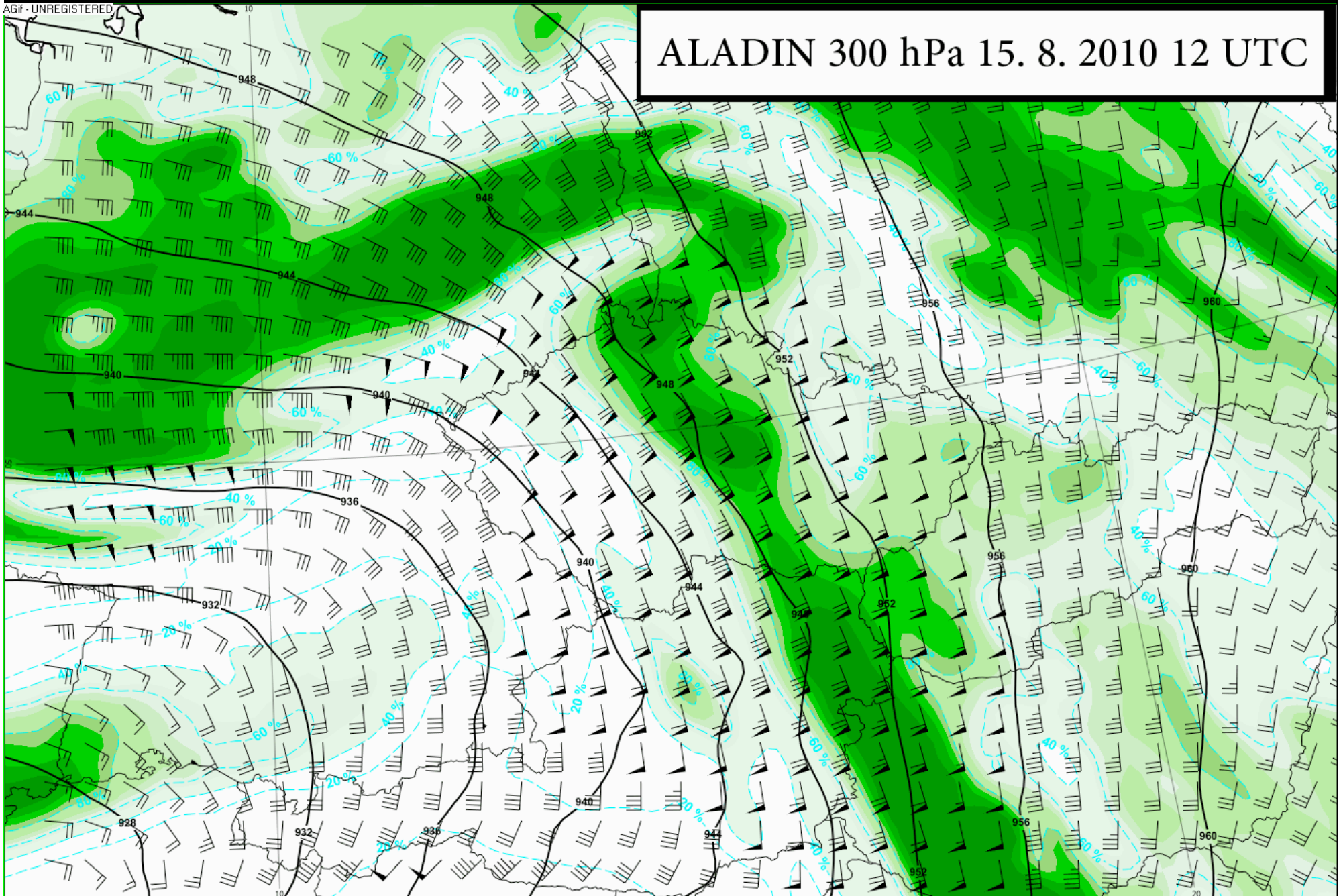


Problem 2

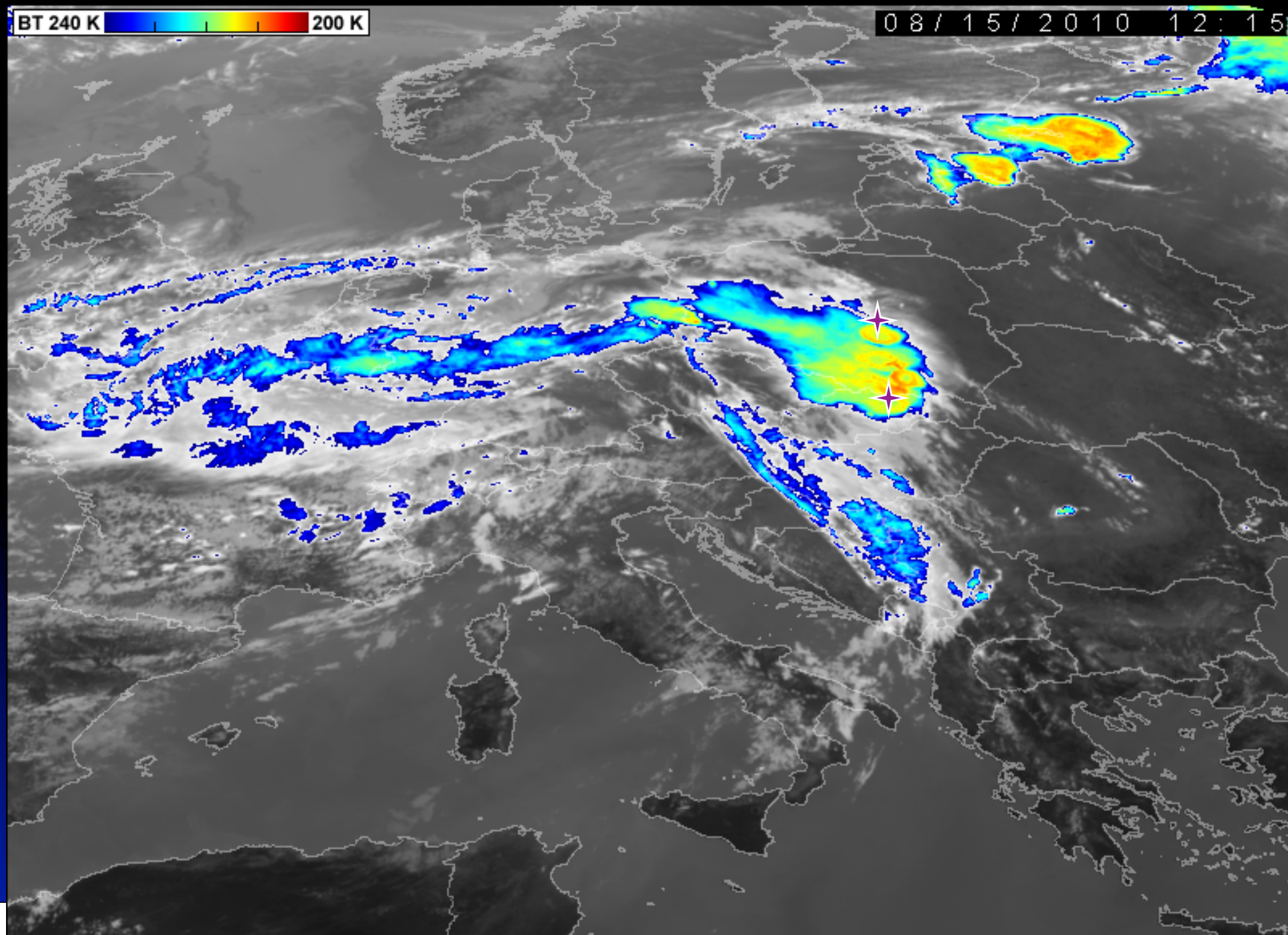
- Variety of shapes of storm tops from IR-BT channel
- Cold-rings: mostly observed over Slovakia and Poland or Baltic states
- Cold-U/V: several such features over Czech Republic, E Germany
- Intermediate, combine cases: Northern Hungary and Southwestern Slovakia
- Perspective of storm-relative winds

300 hPa winds (12 UTC run Aladin)

ALADIN 300 hPa 15. 8. 2010 12 UTC



Cold rings (12:15 UTC)

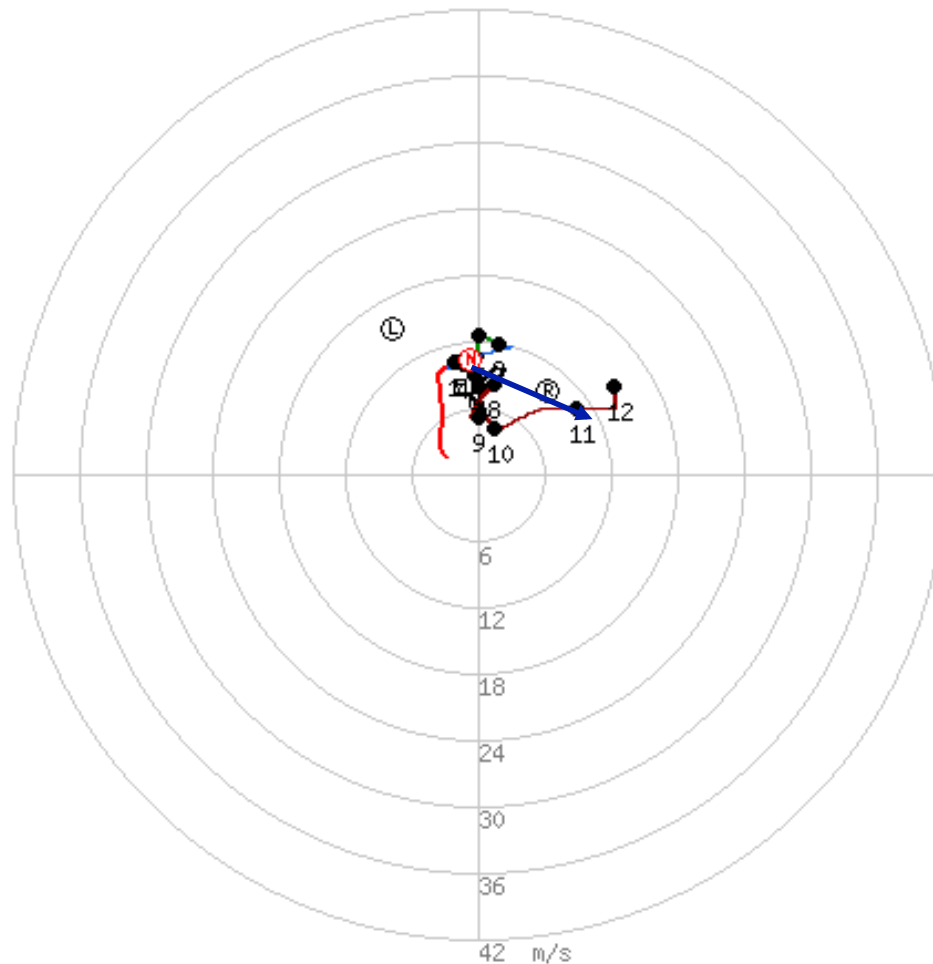


Legionowo 12 UTC

- very weak S-R winds at anvil level (5-8 m/s)

12374 Legionowo 15.08.2010 12 UTC

Max. wind: 19m/s from: 195° at 142 hPa/ 14439 m ASL



* wind shear *

0-8km: 7.8 m/s
0-6km: 7.7 m/s
0-3km: 11.2 m/s
0-1km: 8.6 m/s

* SR helicity *

SRH L3km: 114 J/kg
SRH L2km: 109 J/kg
SRH L1km: 87 J/kg

* SR winds *

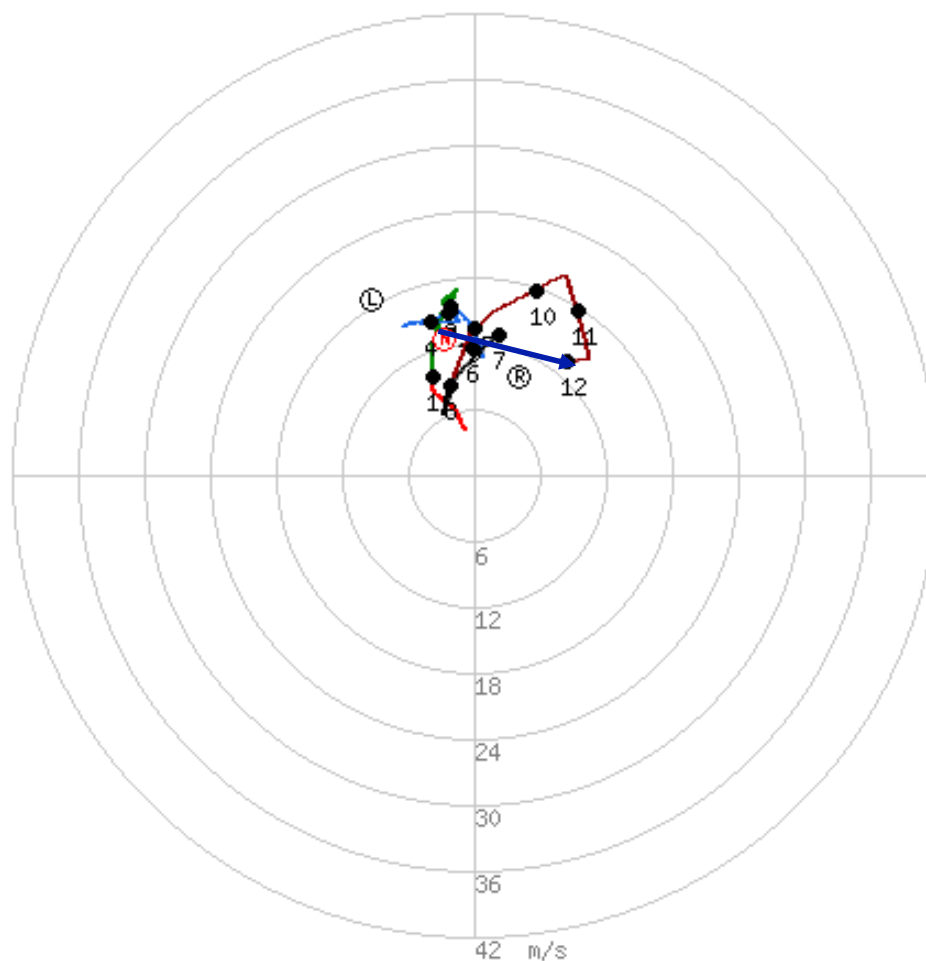
layer	m/s /deg
0-2 km	8/101
4-6 km	8/110
9-11 km	5/55

Poprad 12 UTC

- also weak S-R winds (5-11 m/s)

11952 Poprad-Ganovce 15.08.2010 12 UTC

Max. wind: 20.1m/s from: 205° at 241 hPa/ 11079 m ASL



* wind shear *

0-8km: 4.3 m/s
0-6km: 7.5 m/s
0-3km: 10.9 m/s
0-1km: 5.8 m/s

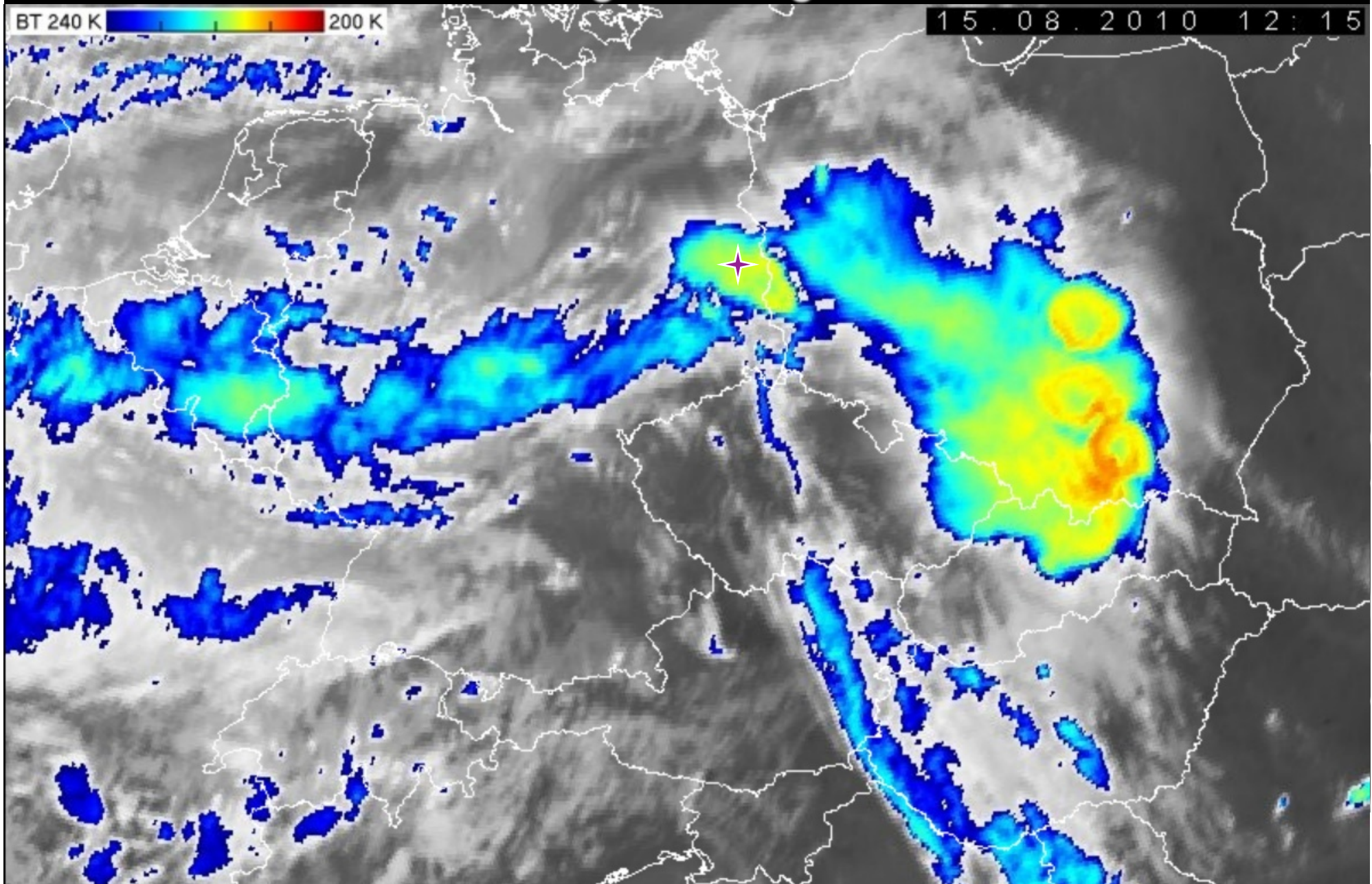
* SR helicity *

SRH L3km: 90 J/kg
SRH L2km: 95 J/kg
SRH L1km: 40 J/kg

* SR winds *

layer	m/s /deg
0-2 km	7/96
4-6 km	8/124
9-11 km	7/190

Cold V (12:25 UTC) - on a right-moving storm

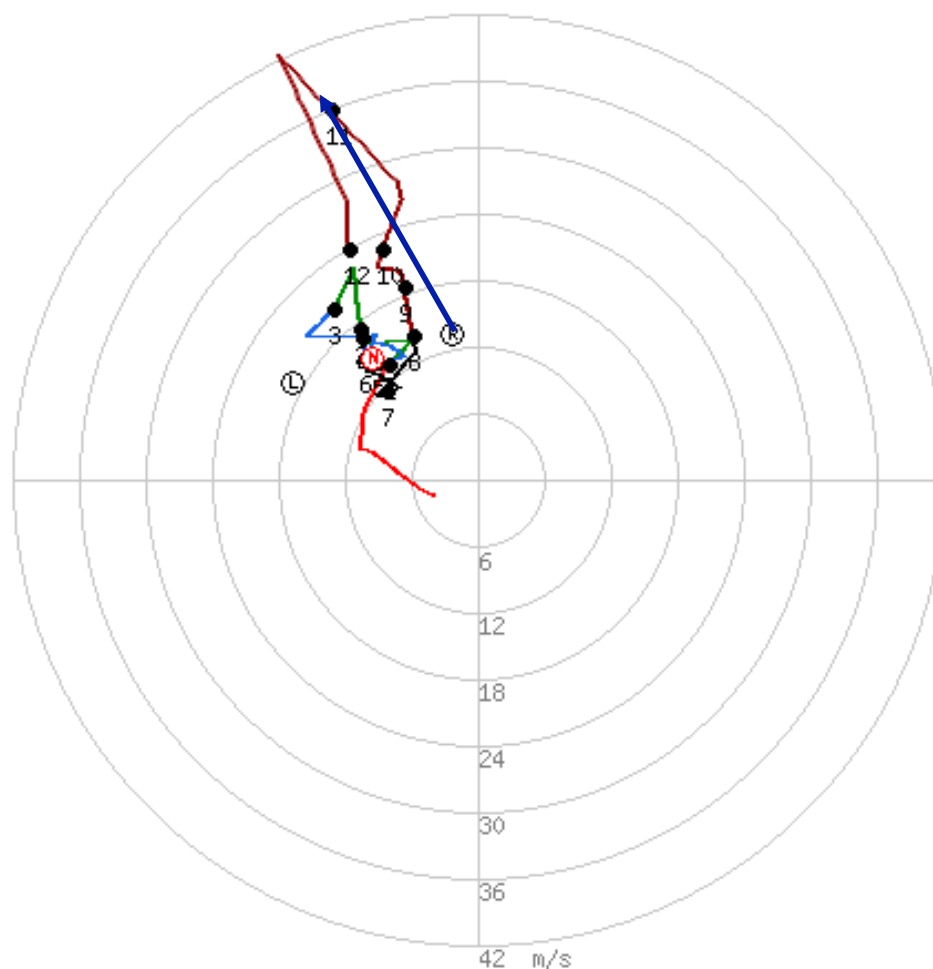


Lindenberg 12 UTC

- strong SE flow at the tropopause level
- significant S-R anvil level winds (22-25 m/s)

10393 Lindenberg 15.08.2010 12 UTC

Max. wind: 42.2m/s from: 155° at 225 hPa/ 11405 m ASL



* wind shear *

0-8km: 14.4 m/s
0-6km: 13.7 m/s
0-3km: 19.1 m/s
0-1km: 12.4 m/s

* SR helicity *

SRH L3km: 164 J/kg
SRH L2km: 163 J/kg
SRH L1km: 144 J/kg

* SR winds *

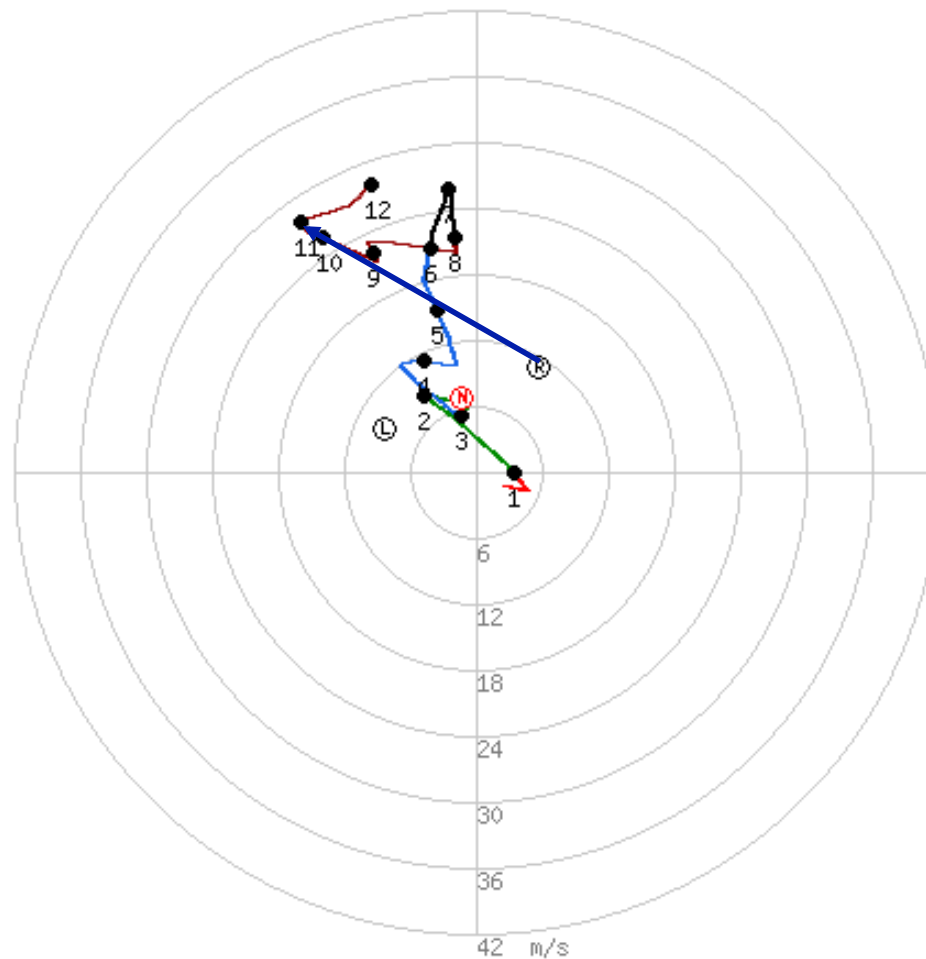
layer	m/s /deg
0-2 km	8/44
4-6 km	7/76
9-11 km	11/148

Prague 18 UTC

- Right moving storm and strong flow at the anvil level
- SR anvil level winds around 20 m/s

11520 Praha-Libus 15.08.2010 18 UTC

Max. wind: 27.8m/s from: 160° at 194 hPa/ 12309 m ASL



* wind shear *

0-8km: 23.2 m/s
0-6km: 22.8 m/s
0-3km: 7.6 m/s
0-1km: 1.4 m/s

* SR helicity *

SRH L3km: 60 J/kg
SRH L2km: 84 J/kg
SRH L1km: -6 J/kg

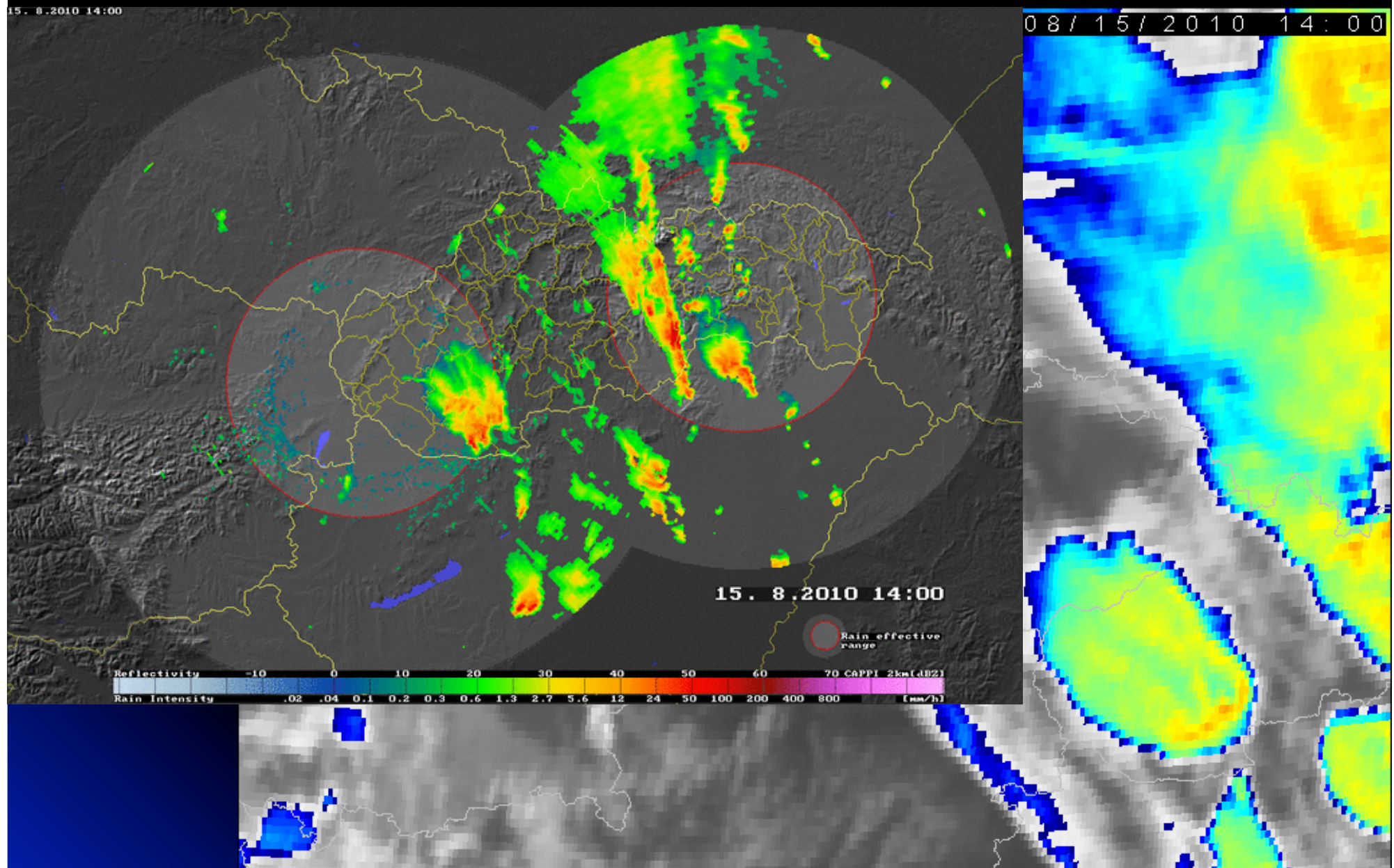
* SR winds *

layer	m/s /deg
0-2 km	9/23
4-6 km	10/119
9-11 km	22/122

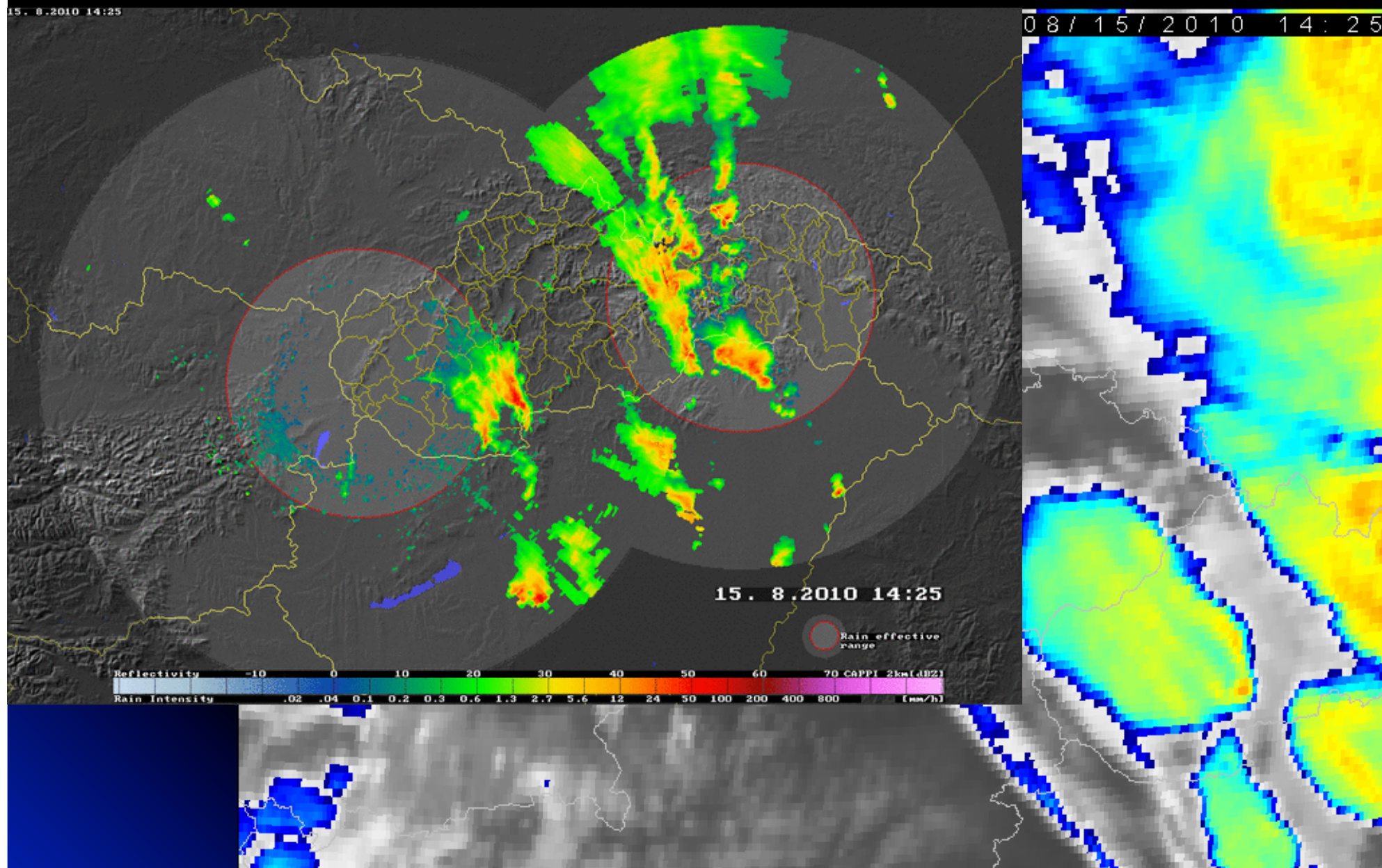
Intermediate cases

- Cold rings and cold-UV structures occurring close to each other
- SW Slovakia and Northern Hungary
- Cold-UV structures developing *exclusively on the right movers*
- Right movers exhibited more of a multicellular nature
- In case of SW Slovakia possible influence from the SE jet as well

A ring-like structure - on multicellular system, right mover in development



A well developed Cold U/V - strong right moving multicellular system



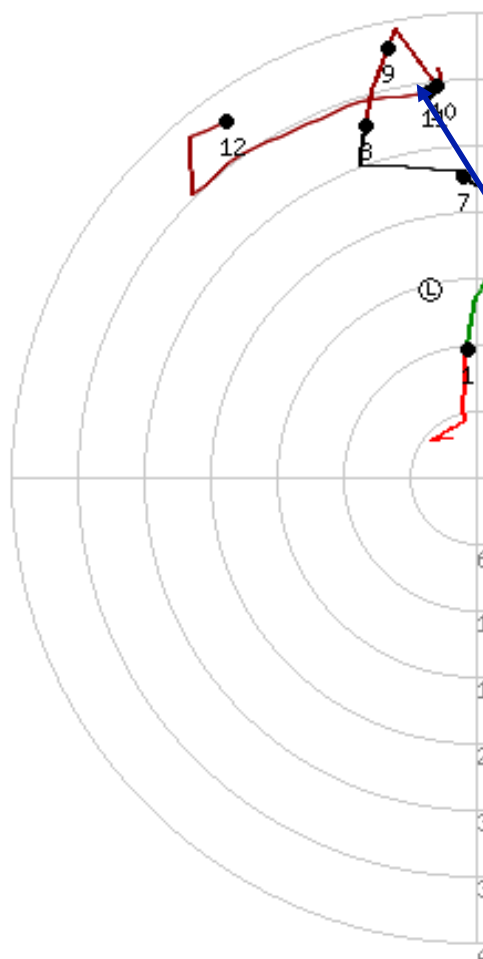
Wien 12 UTC vs Budapest 12 UTC hodographs

- strong gradient in the upper level flow

Wien (21-28 m/s), Budapest (5-12 m/s)

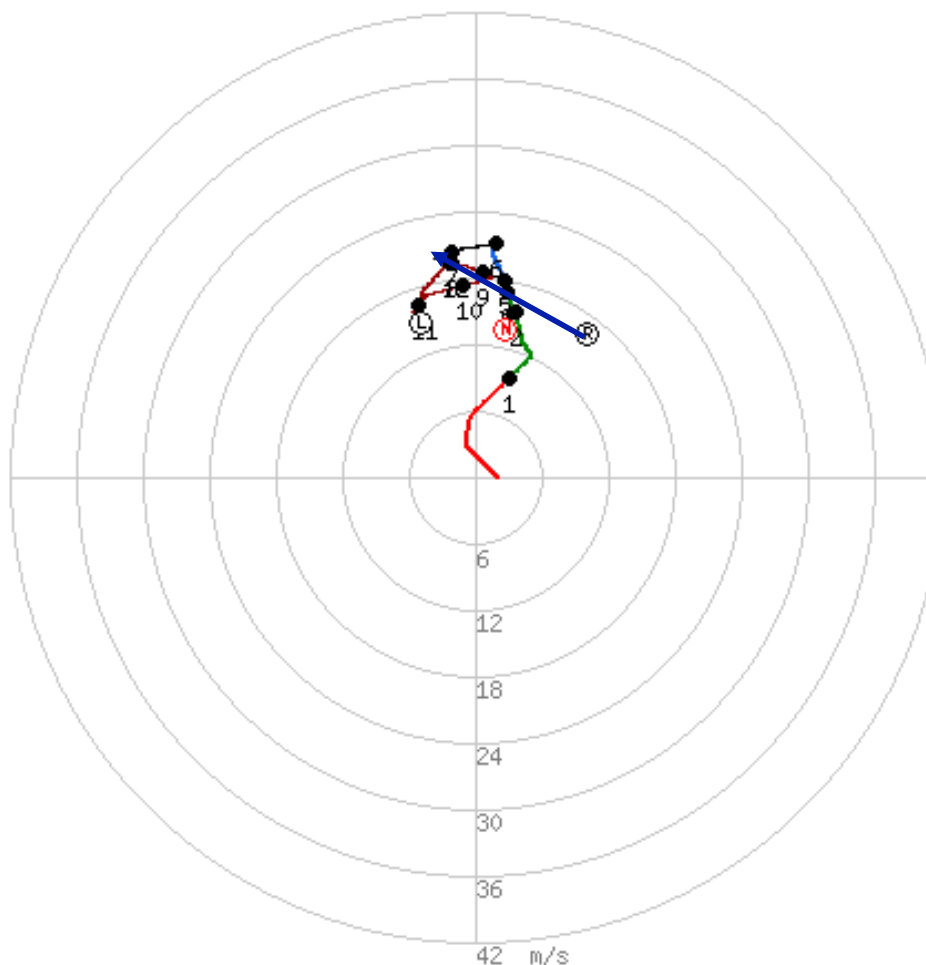
11035 Wien/Hohe Warte 15

Max. wind: 41.2m/s from: 170° at 3



12843 Budapest/Lorinc 15.08.2010 12 UTC

Max. wind: 24.2m/s from: 195° at 147 hPa/ 14239 m ASL



* wind shear *

0-8km: 19.8 m/s
0-6km: 21 m/s
0-3km: 16.7 m/s
0-1km: 8.9 m/s

* SR helicity *

SRH L3km: 134 J/kg
SRH L2km: 124 J/kg
SRH L1km: 94 J/kg

* SR winds *

layer m/s /deg
0-2 km: 9/57
4-6 km: 9/124
9-11 km: 12/111

Quick summary

- All of the storms that exhibited cold-U/V structures were right-movers and had strong relative flow at the anvil level (generally over 20 m/s)
- Cold symmetrical rings had generally weak relative flow (around or under 10 m/s) - in agreement with previous model studies (e.g. P.Wang, D.Lindsey, ...)
- Intermediate cases had cold-U/V structures only in connection to the deviantly right motion, probably promoting stronger relative flow at the anvil level

Acknowledgements

- Project no. MUNI/A/0966/2009 "Expression of Global Environmental Change in Component Earth's Spheres,, of the Masaryk University, Brno, Czech Republic
- Grant no. SVV-2011-263308 of the Faculty of Mathematics and Physics at the Charles University, Prague, Czech Republic
- Project no. 205/07/0905 of the Grant Agency of the Czech Republic
- Authors would like to thank CHMI and SHMI for providing radar images, EUMETSAT for satellite images, David Rýva for providing hodograph visualisation software and Pieter Groenemeijer for his GFS maps visualisation tool

Thank you for your attention 😊



Tomáš Chlibec