15.08.2010

Synoptic and aerologic analysis

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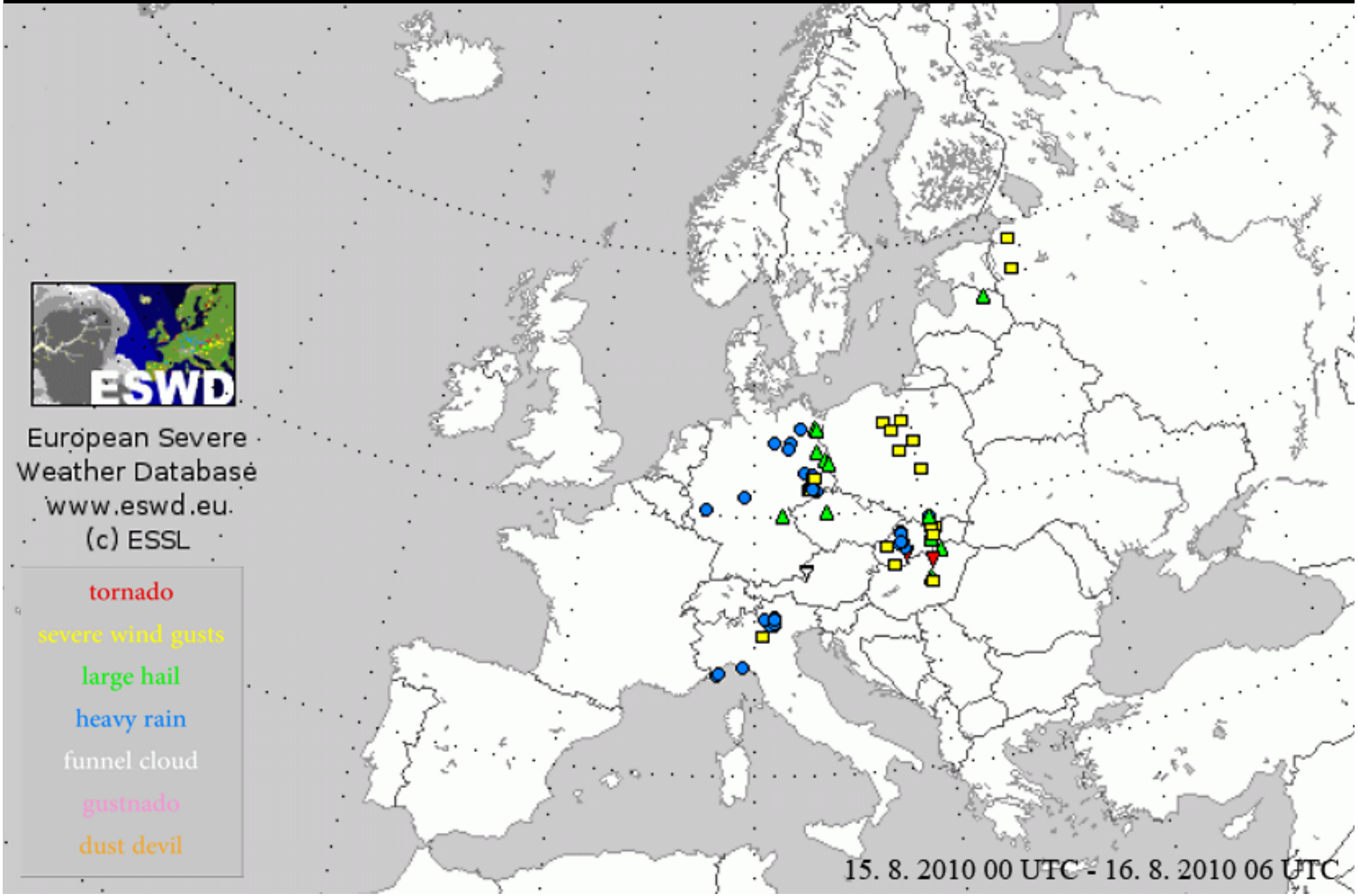
1. Introduction

- 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:

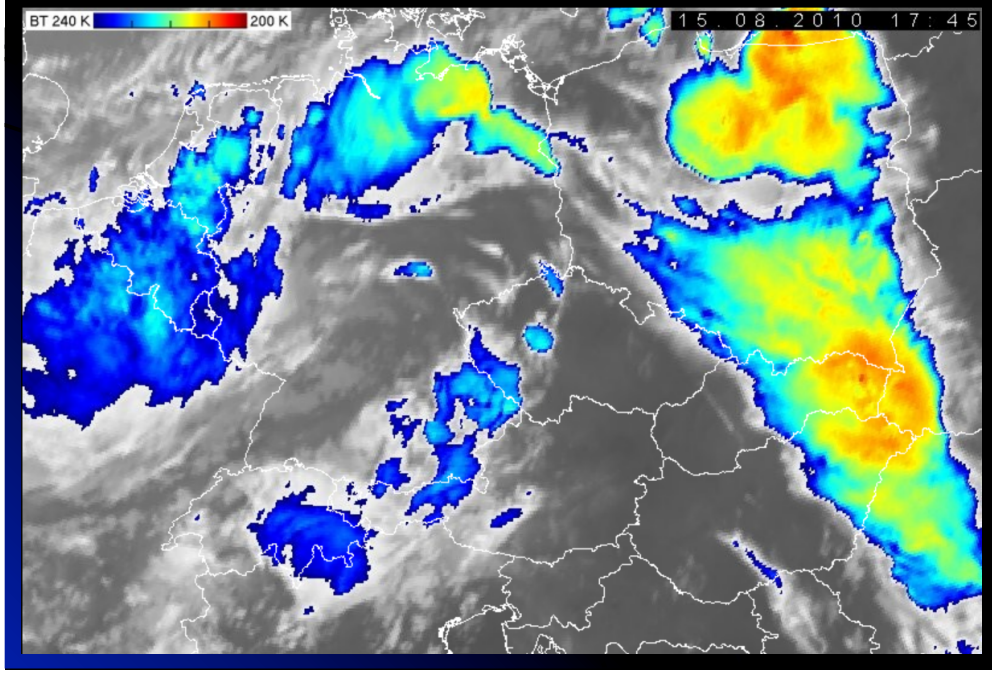
- Unusually warm top of Prague hailstorm
- Cold rings vs cold-U/V storms
- Variety of other storm-top features, known as “storm severity signatures”

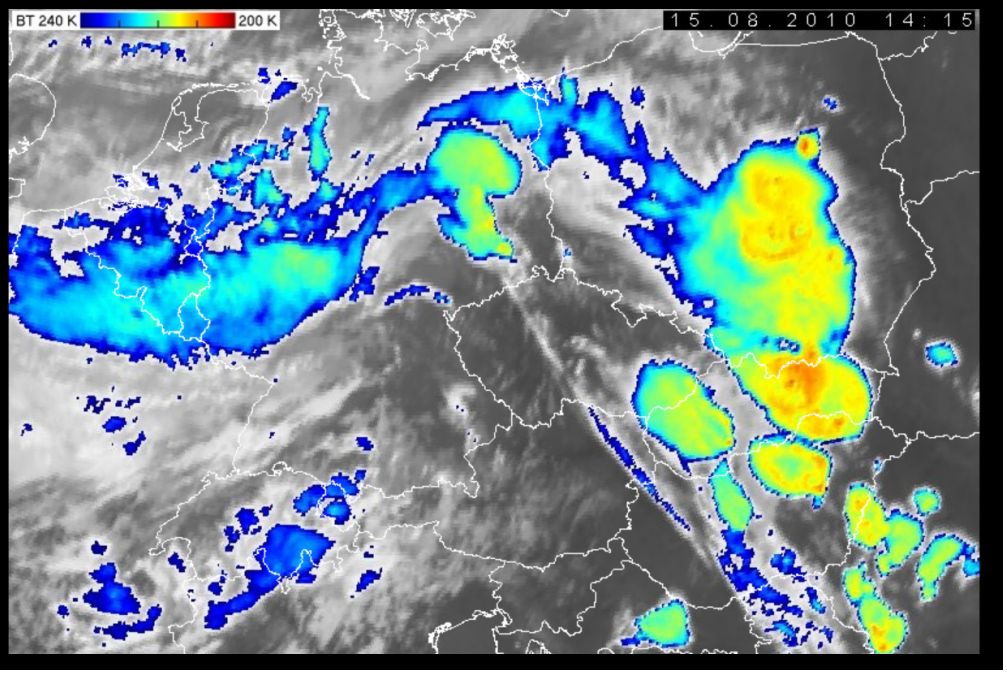
ESWD 15. 8. 2010



Outline

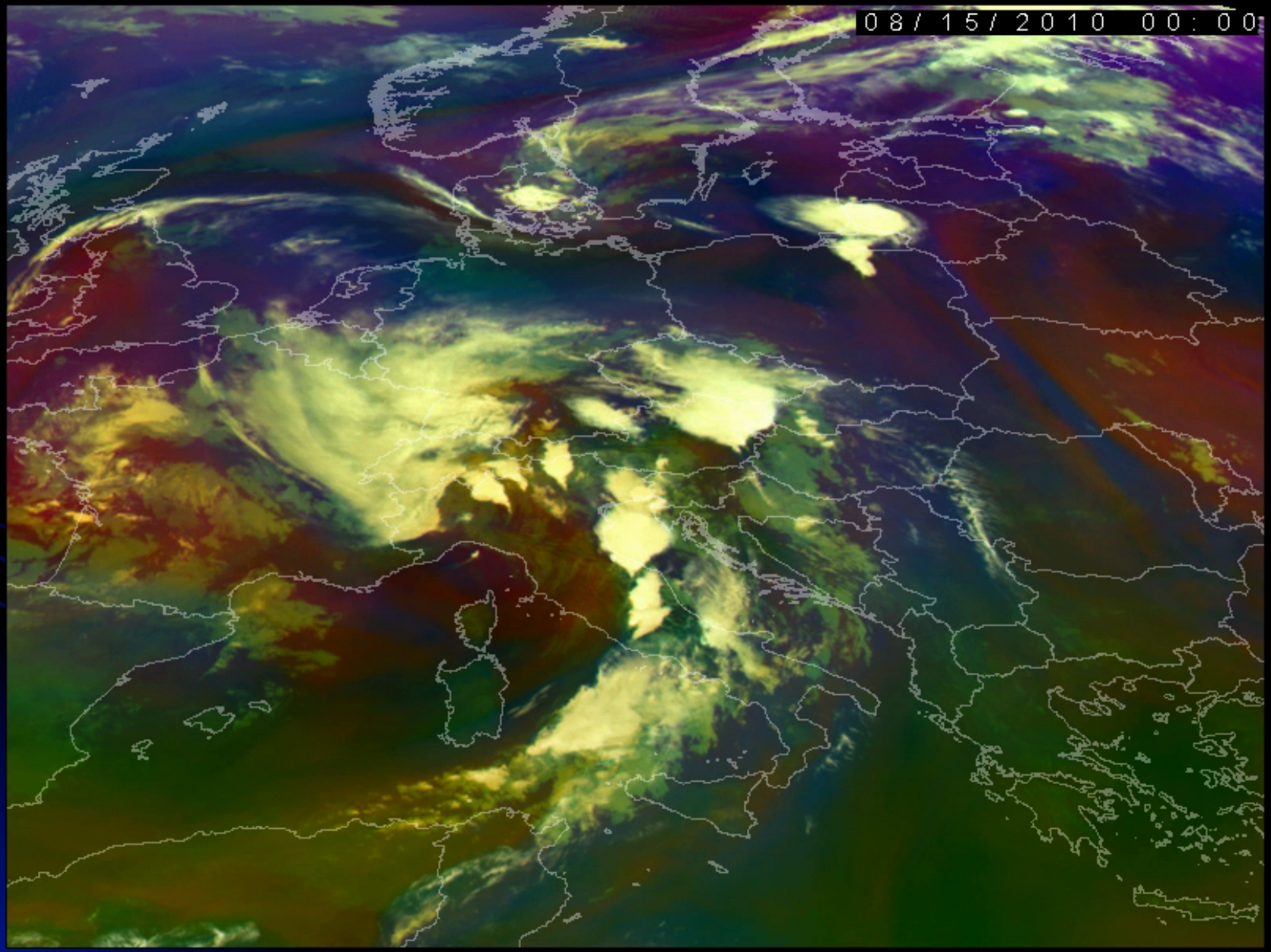
- Brief overview of synoptic setup
- Problem 1: Prague hailstorm on IR-BT channel
- Problem 2: Cold ring vs cold-U/V storms

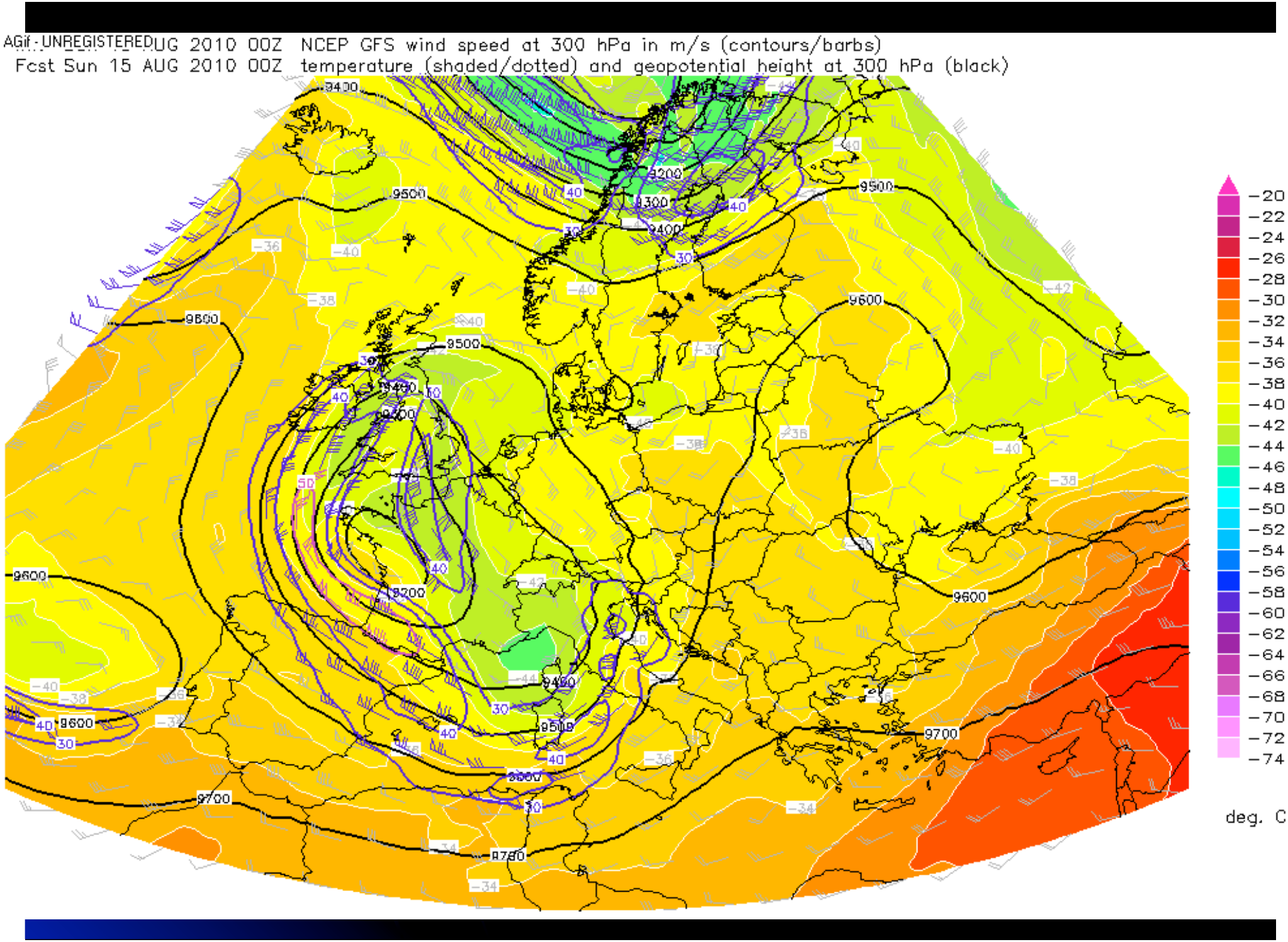




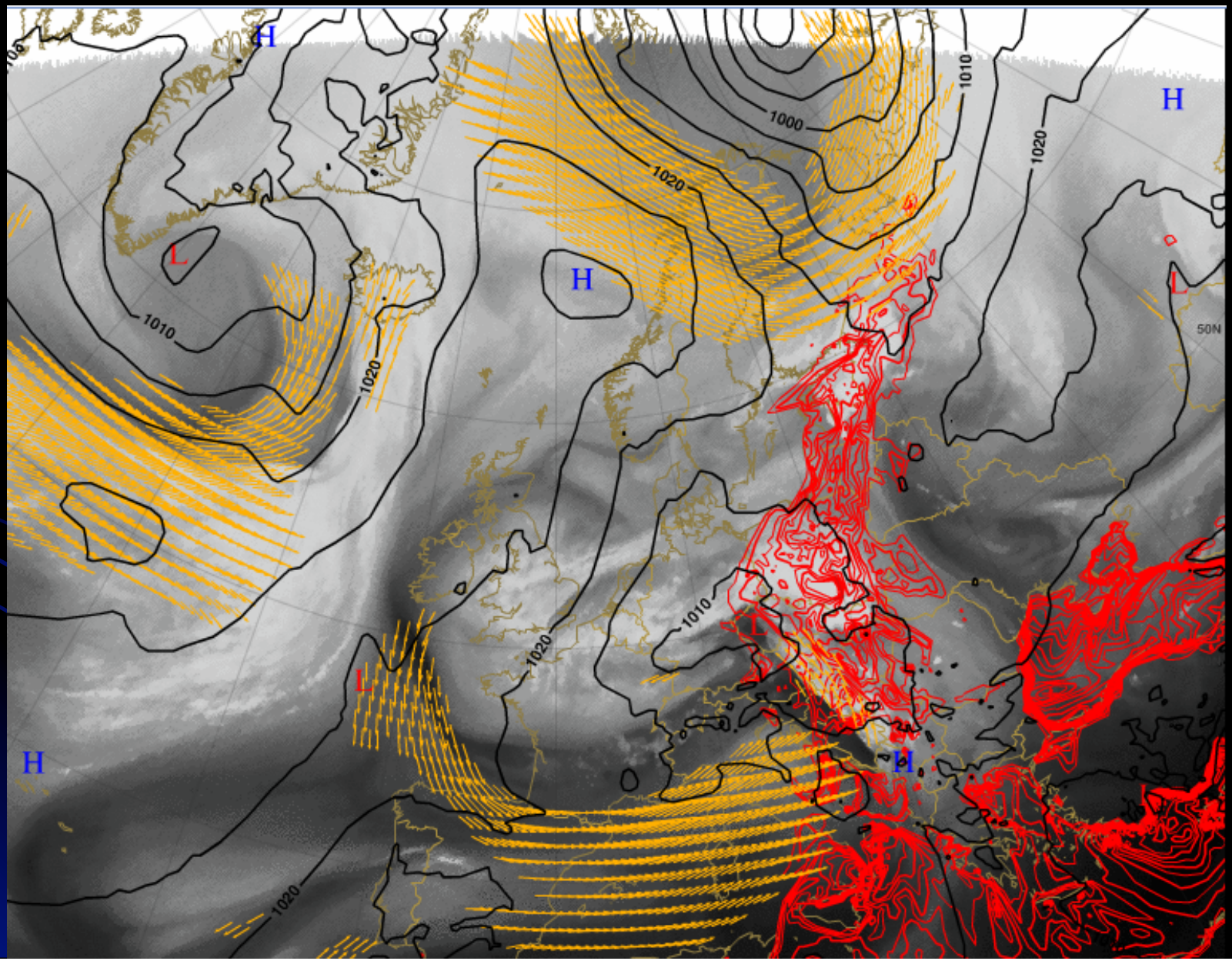
Synoptic setup

- 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

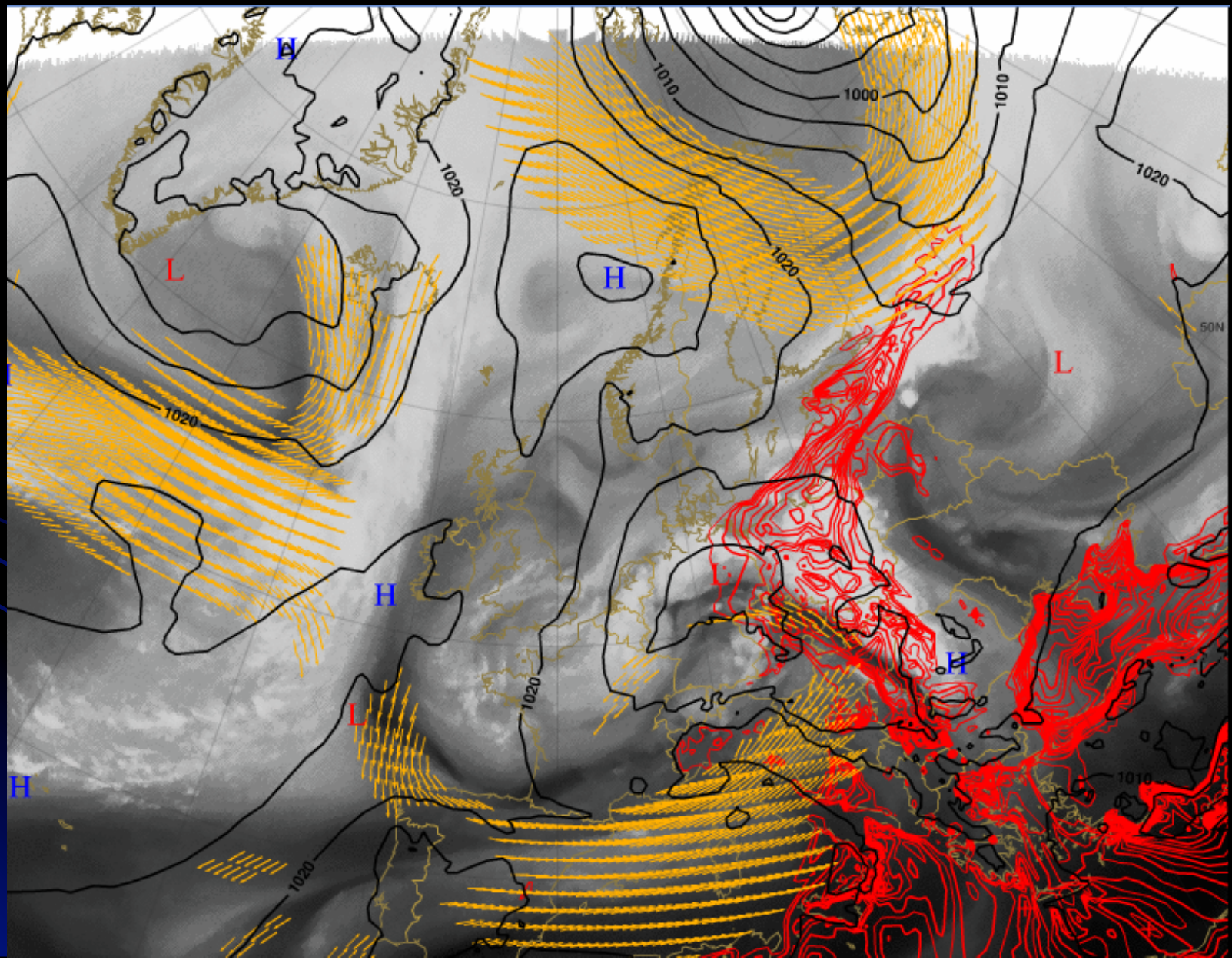

08/15/2010 00:00


AGif - UNREGISTERED
UG 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)
9400
9500
9600
9700
9800
9200
9300
−20
−22
−24
−26
−28
−30
−32
−34
−36
−38
−40
−42
−44
−46
−48
−50
−52
−54
−56
−58
−60
−62
−64
−66
−68
−70
−72
−74
deg. C

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



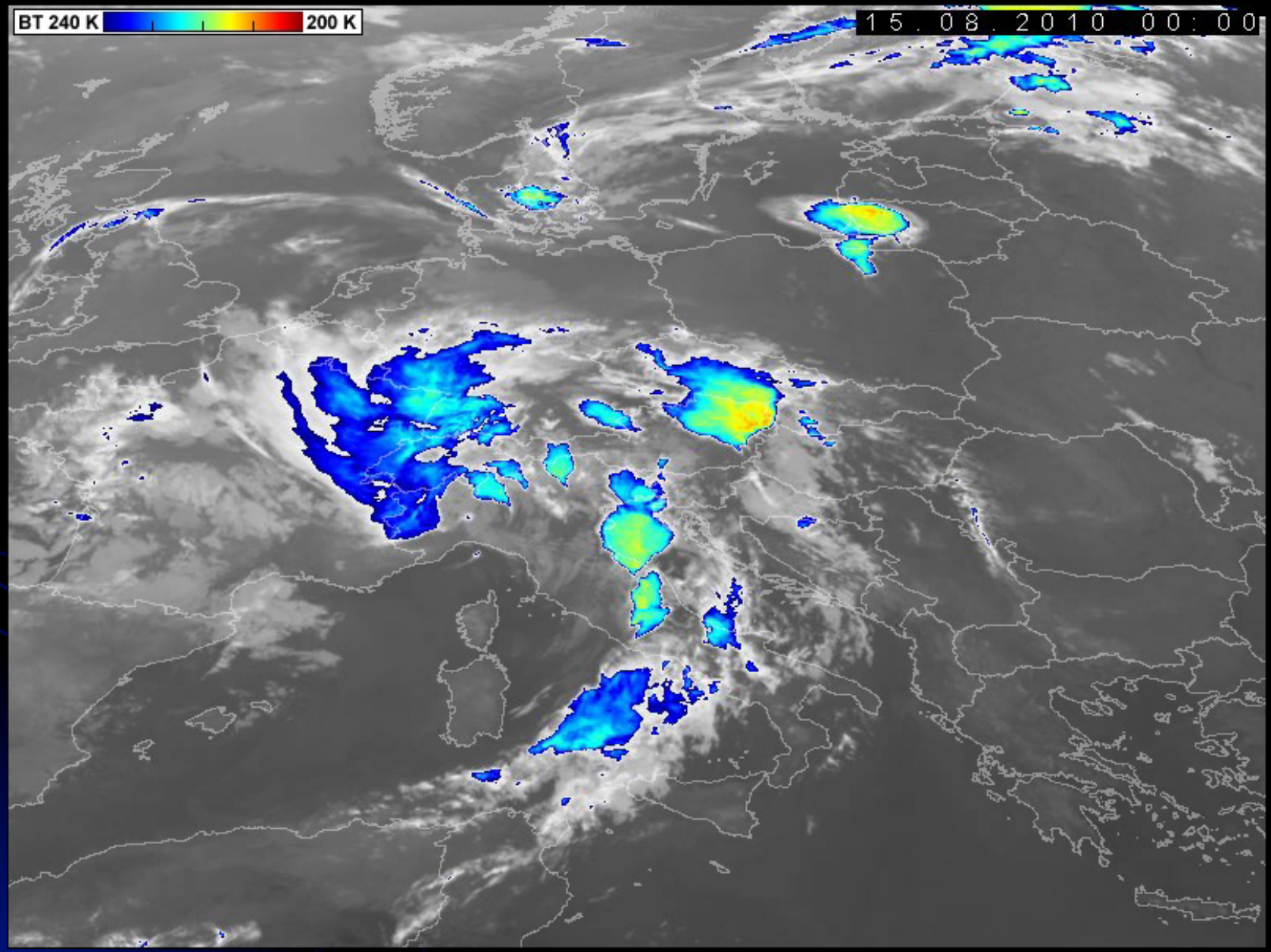
SATREP 18 UTC MSG VW 6.2, surface pressure, 300 hPa winds, CAPE (ECMWF prediction)



Problem 1

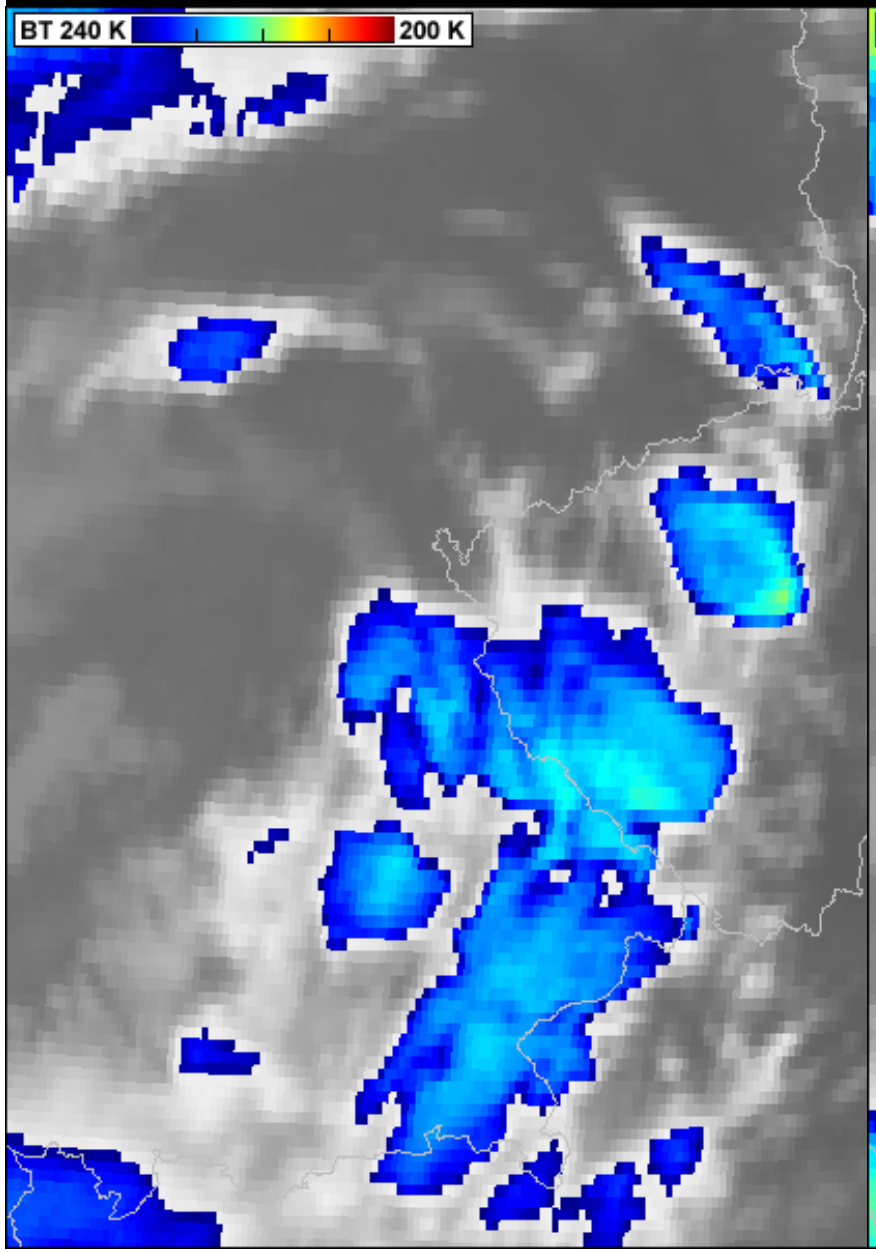
- Relatively warm appearance of Prague hailstorm compared to the other storms of the region
- → storm looks rather „insignificant“ (using the standard IR-BT enhancement)
- Several supercellular characteristics both from radar and visual perspective

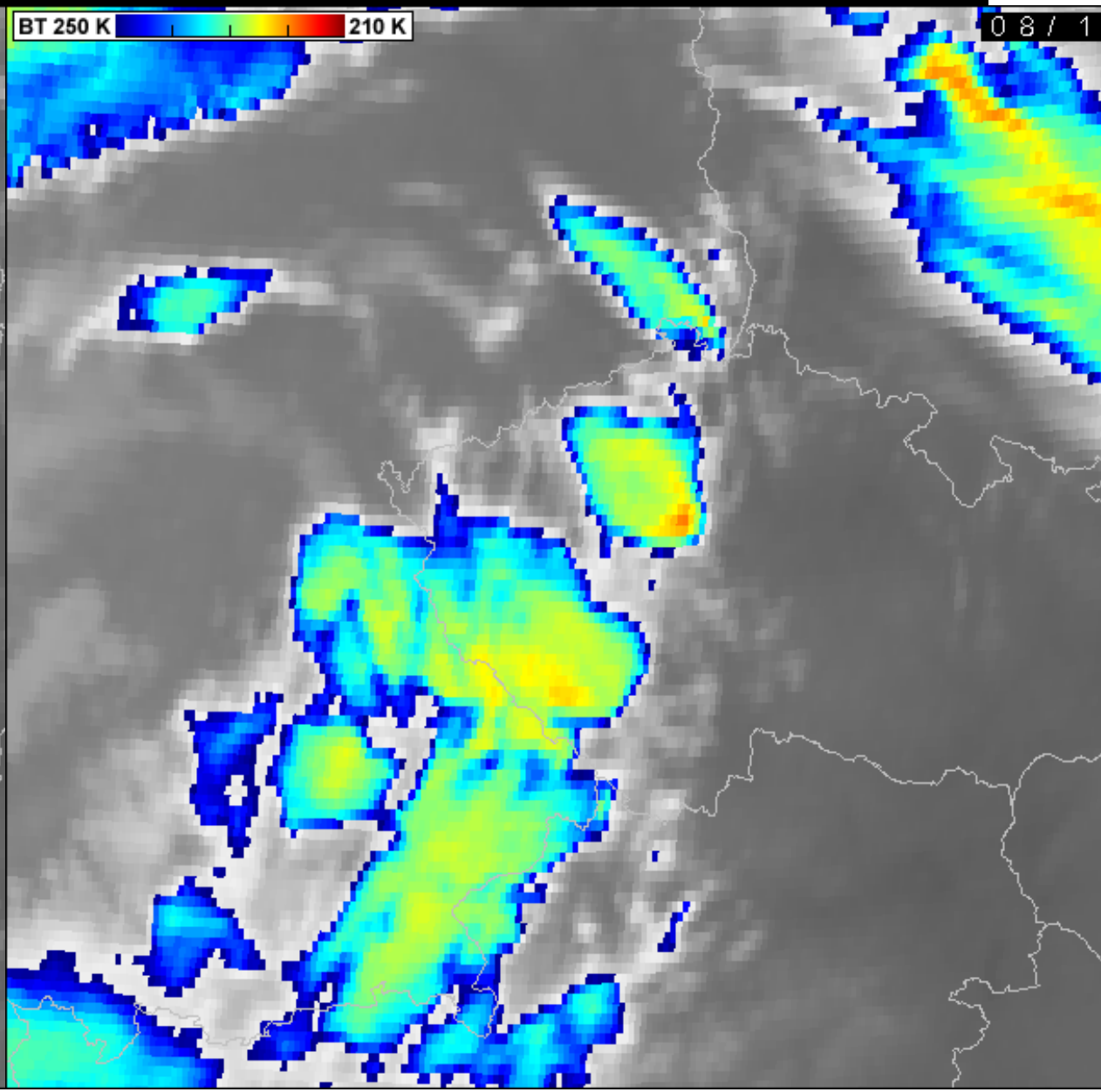
IR-BT animation



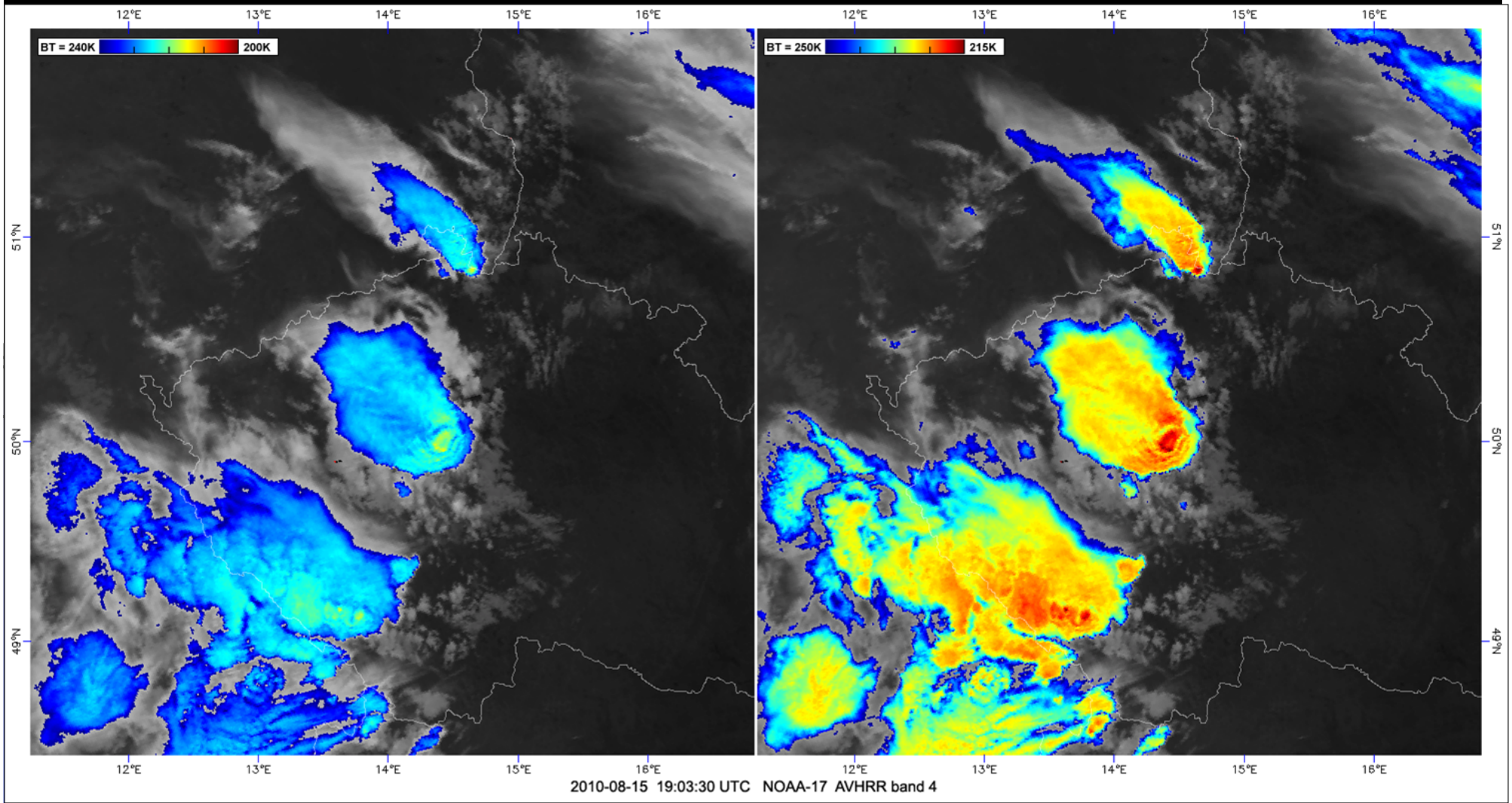
Storm from visual perspective

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





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

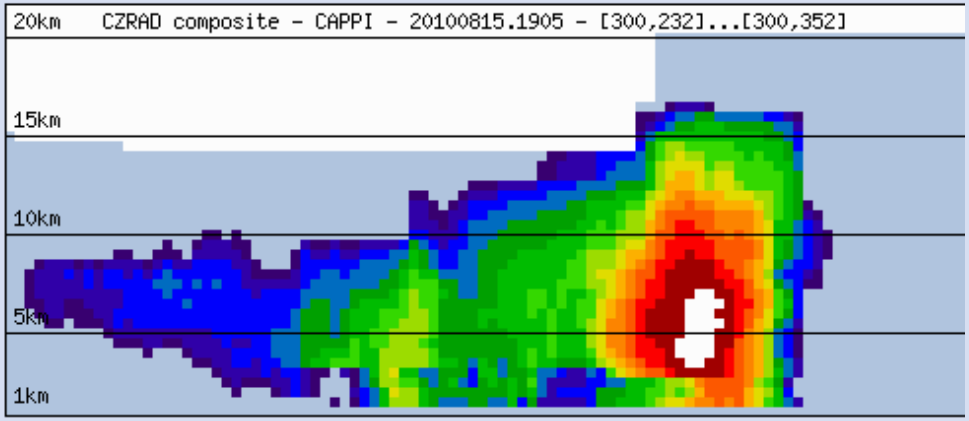


Visual of overshooting top

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

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

CAPPI-based 1-14km



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

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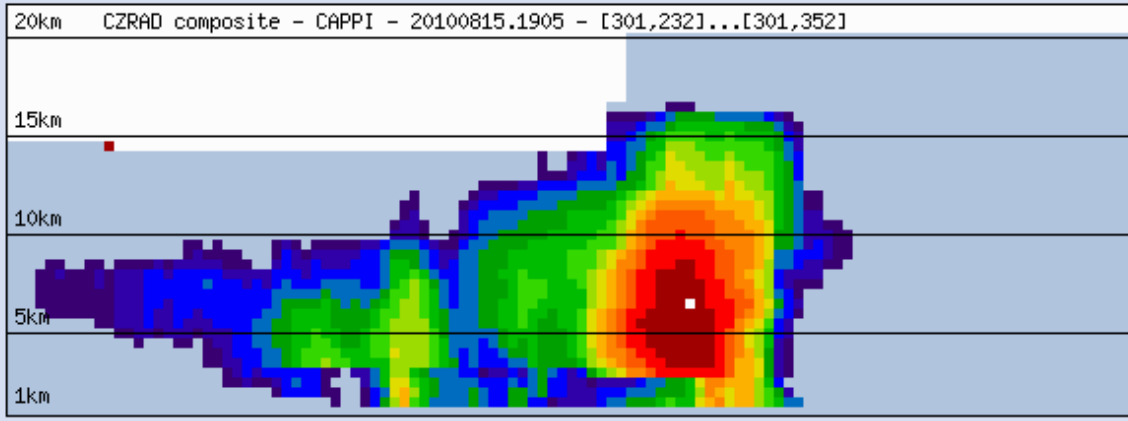
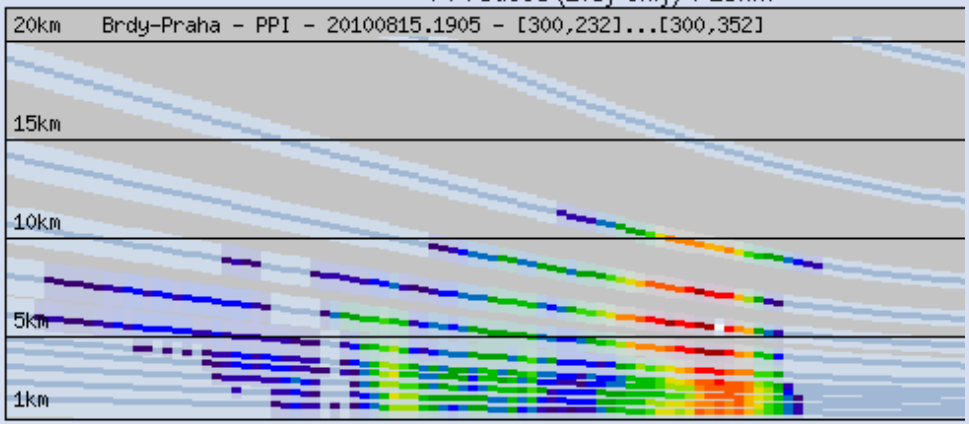
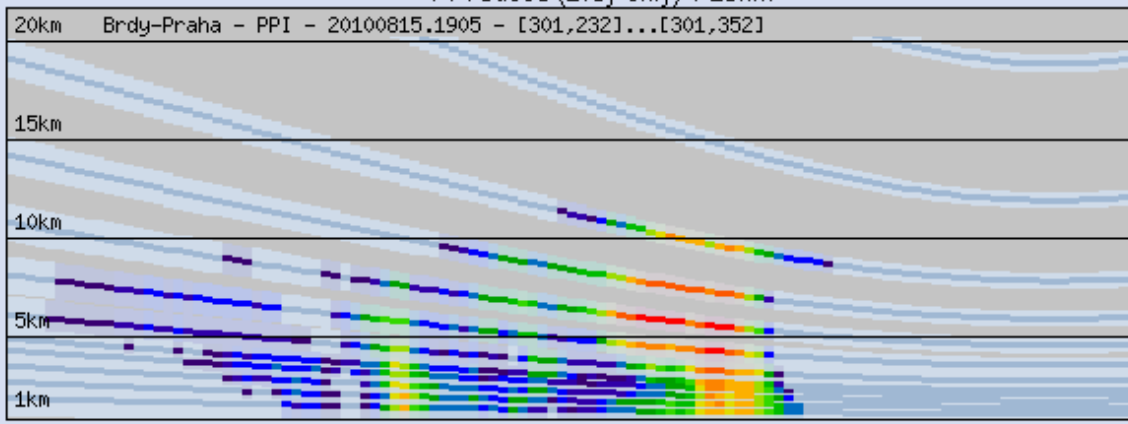


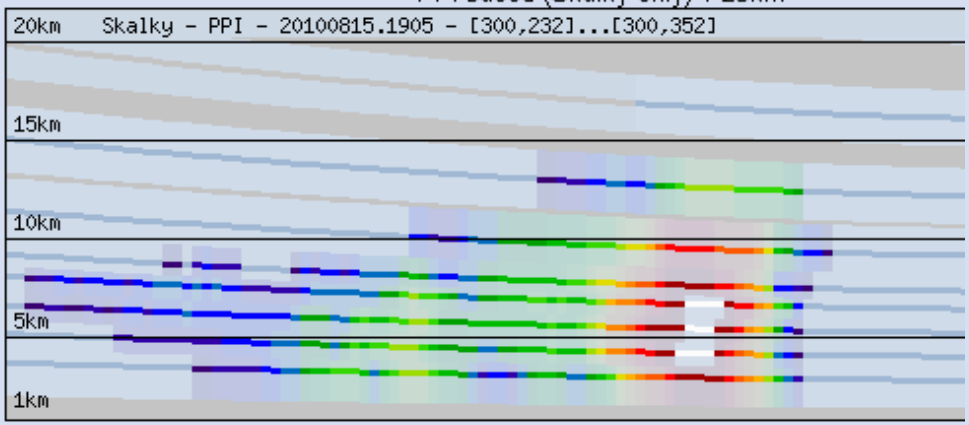
PPI-based (Brdy only) 1-20km



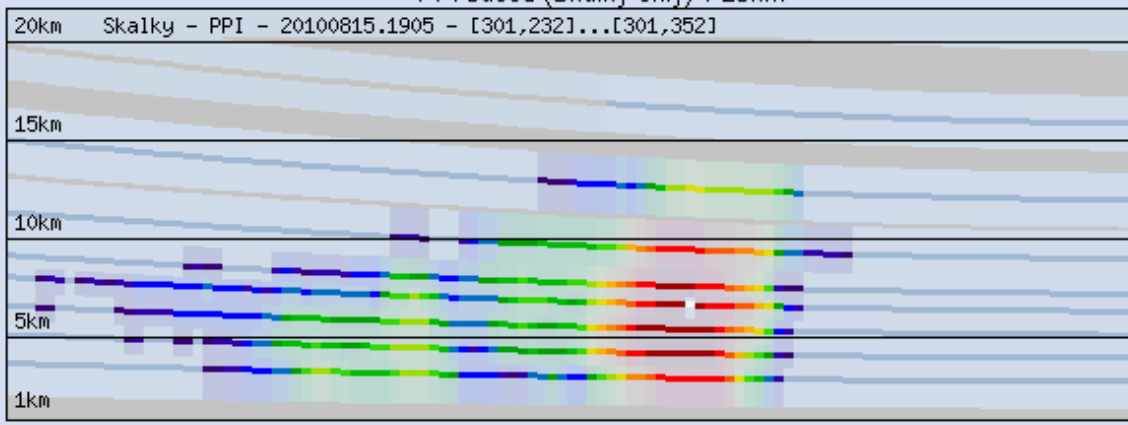
PPI-based (Brdy only) 1-20km



PPI-based (Skalky only) 1-20km

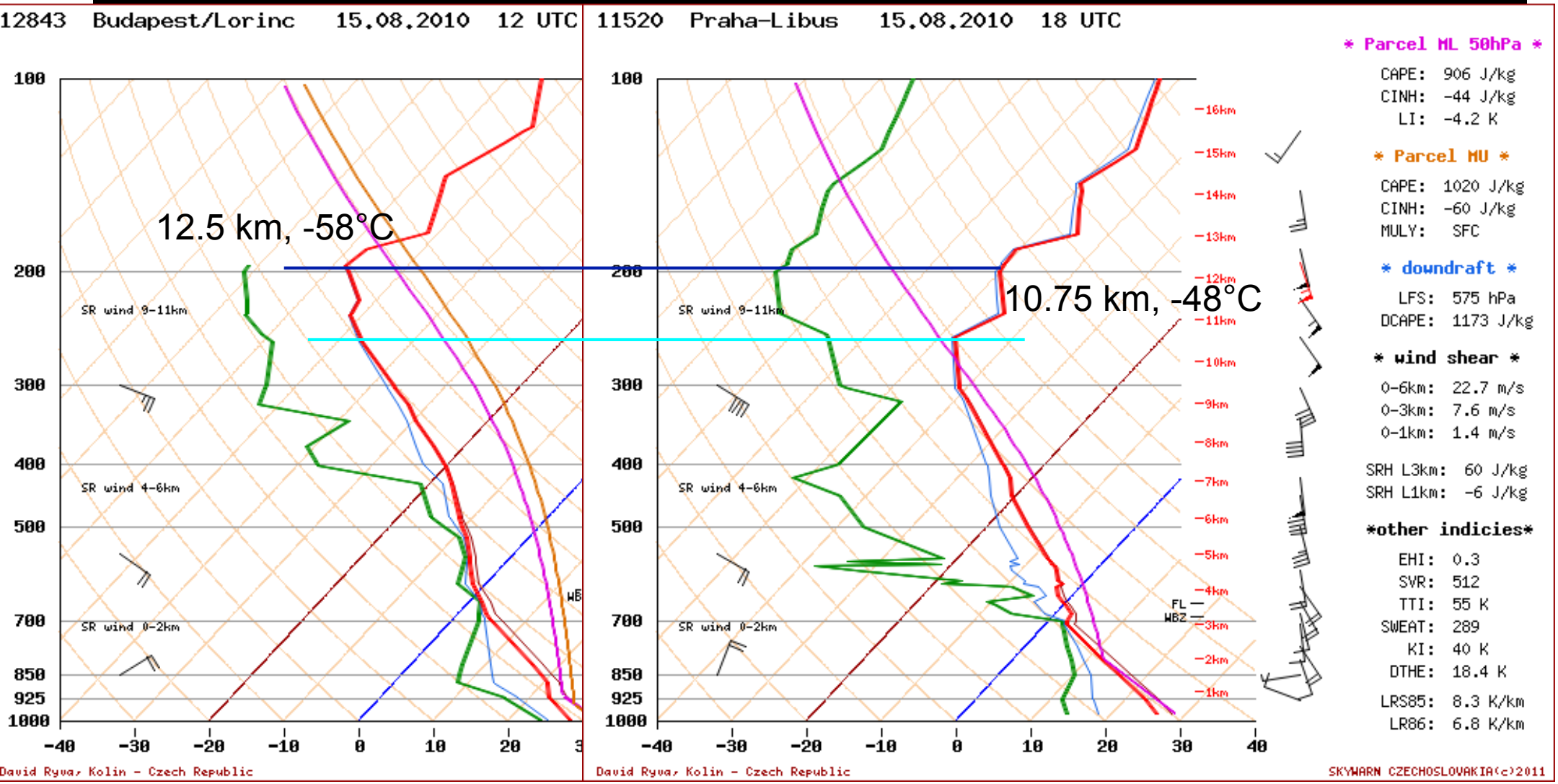


PPI-based (Skalky only) 1-20km

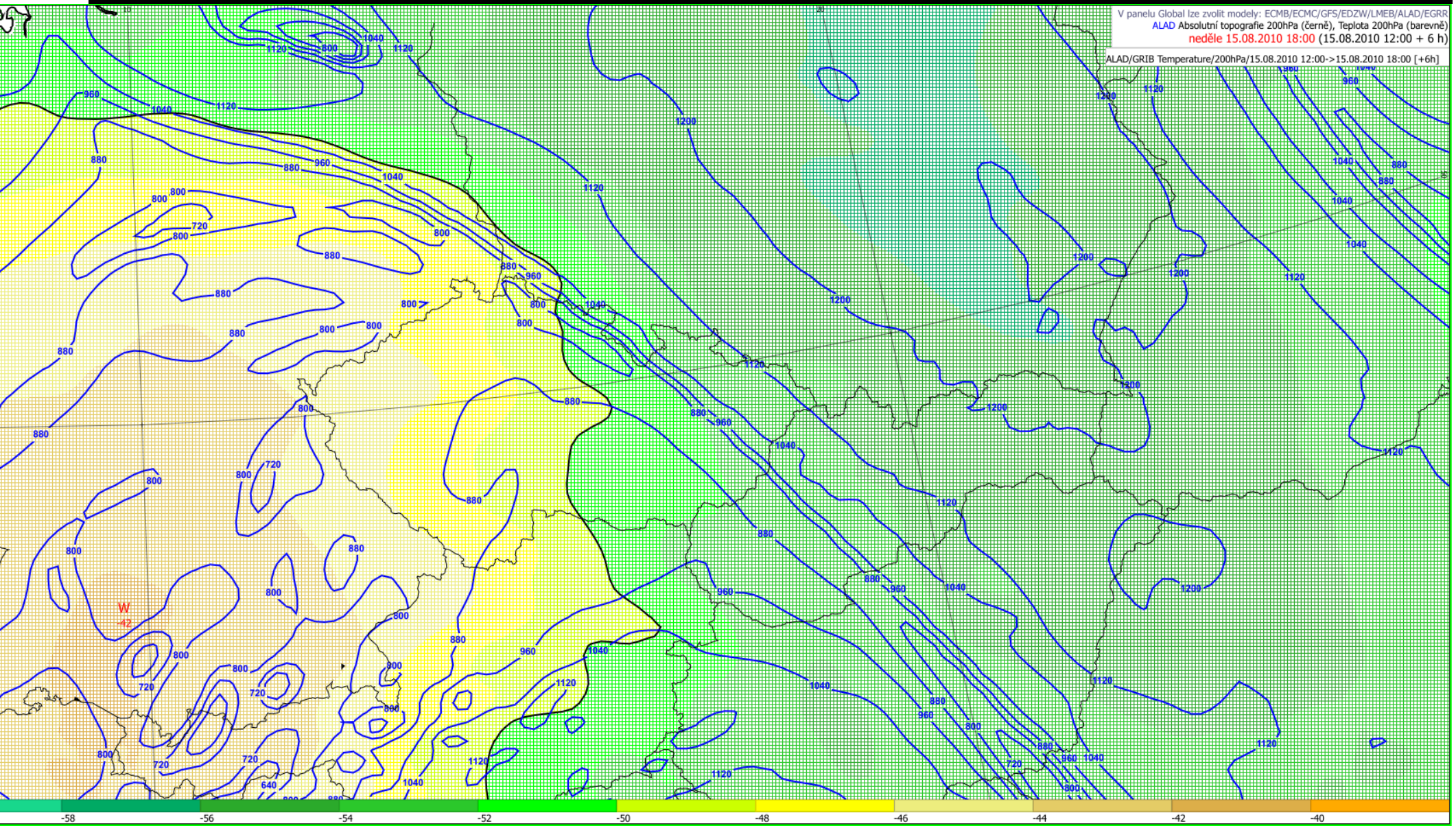


Prague 18 UTC sounding vs Budapest 12 UTC

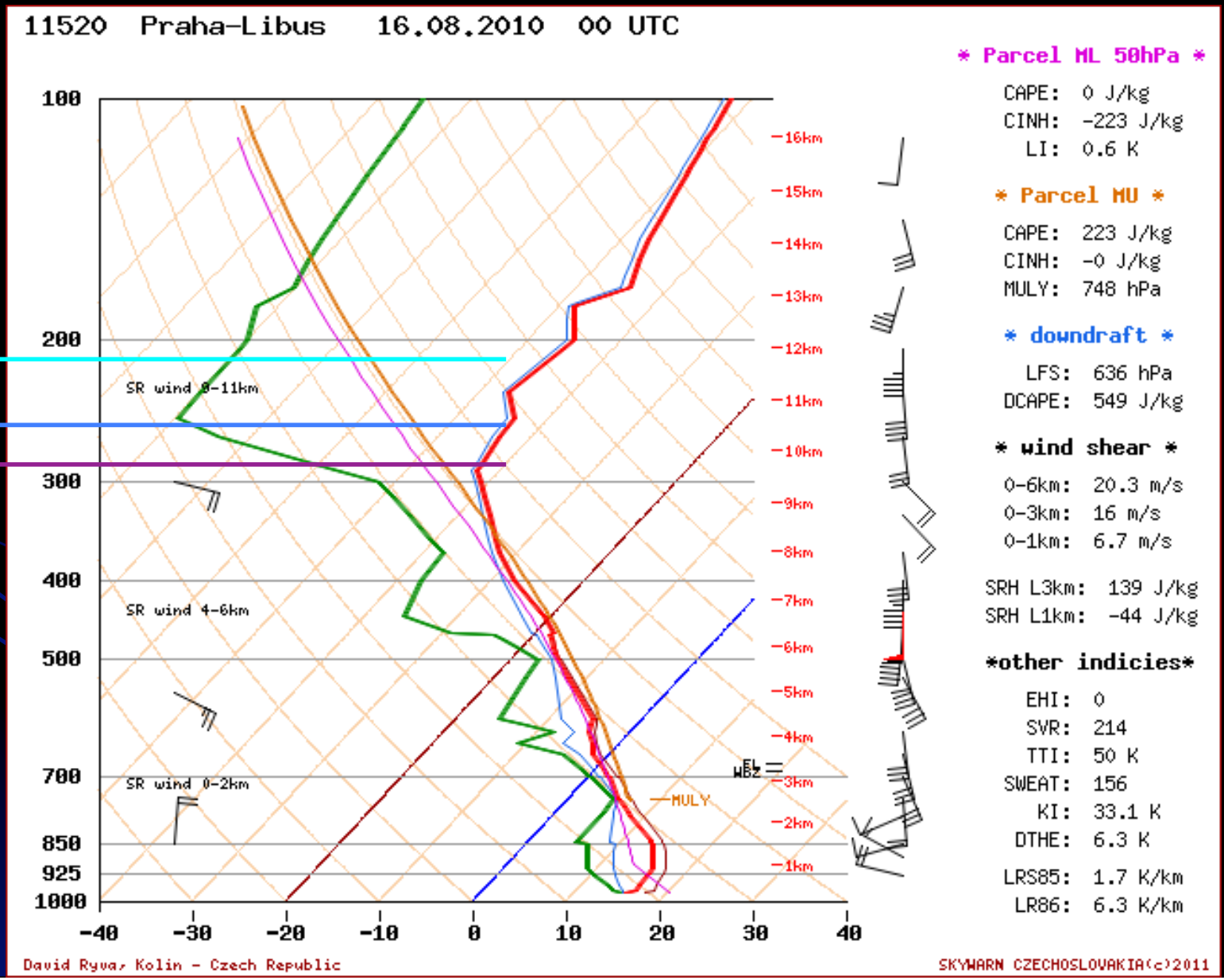
Clear difference both at tropopause height and temperature



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



Prague soundings (12-00 UTC)



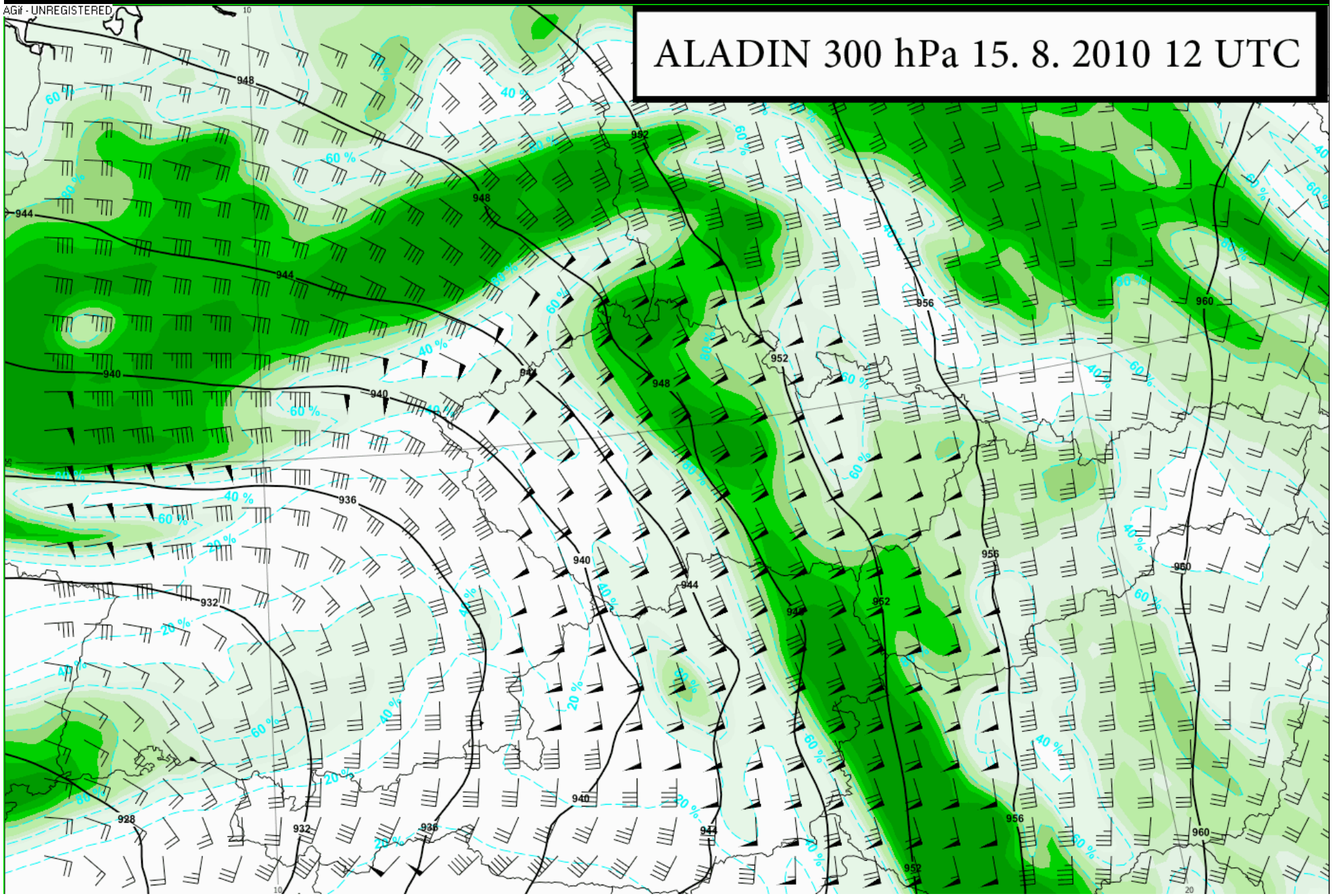
Quick summary

- 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

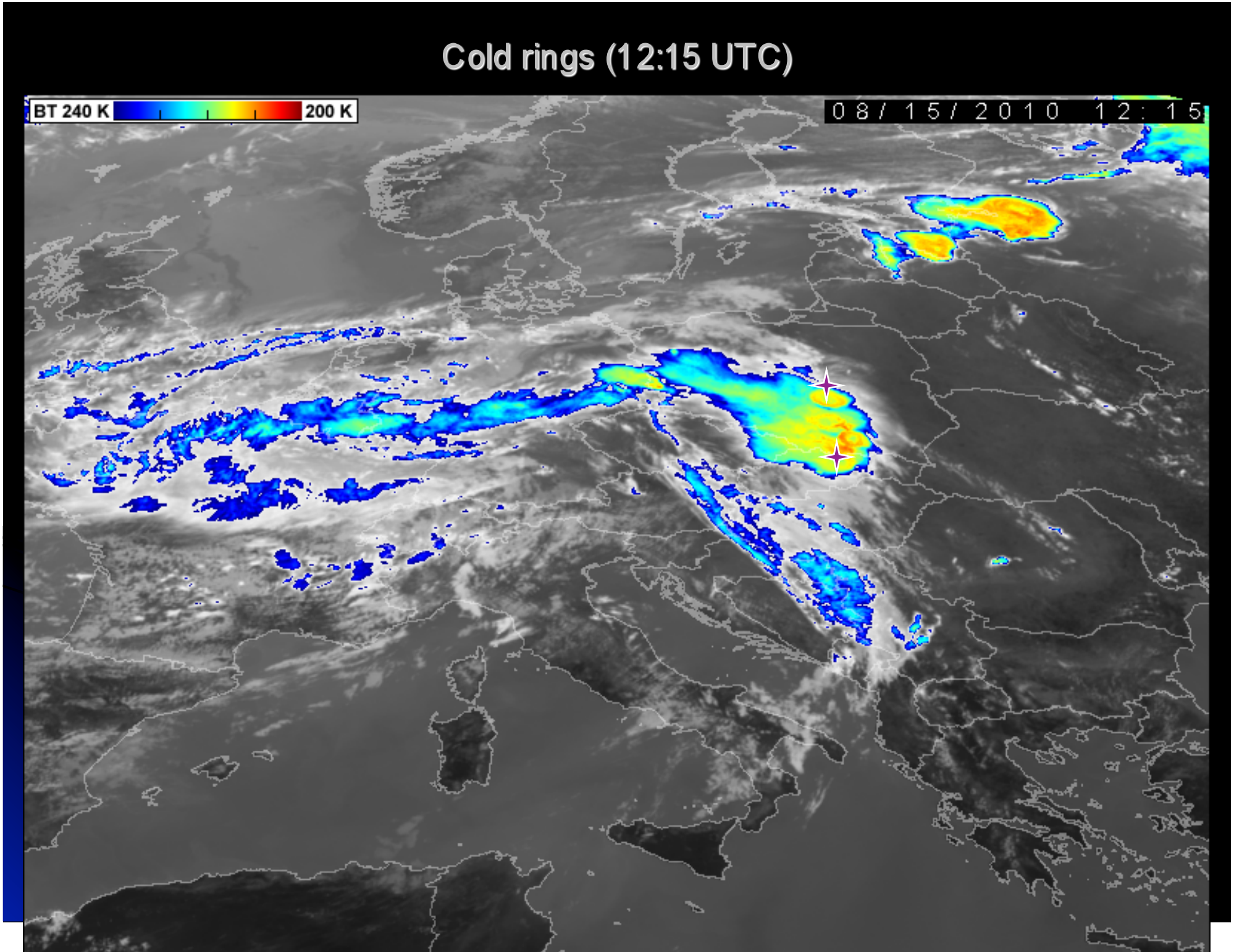
Problem 2

- 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, combinate cases: Northern Hungary and Southwestern Slovakia
- Perspective of storm-relative winds

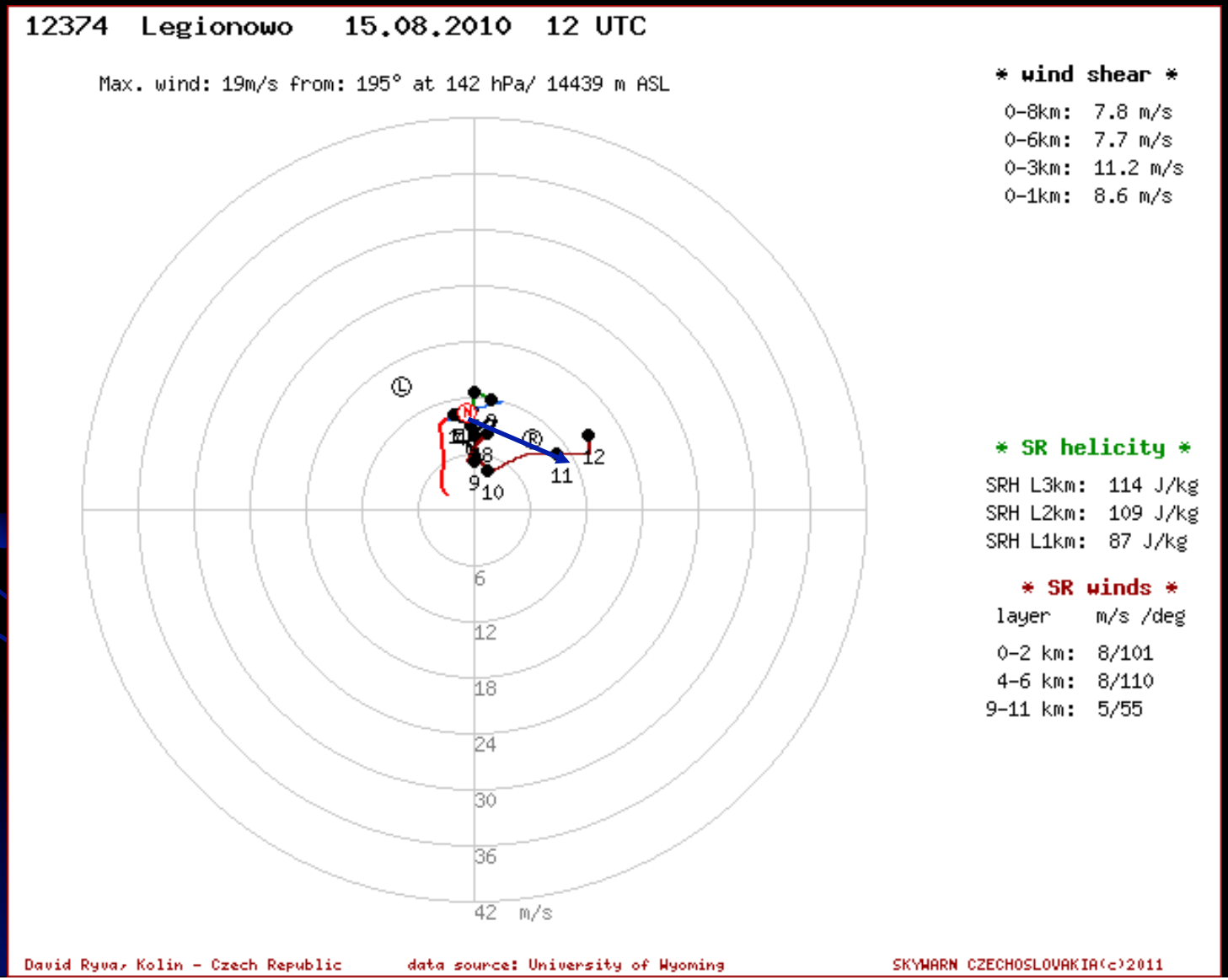
300 hPa winds (12 UTC run Aladin)



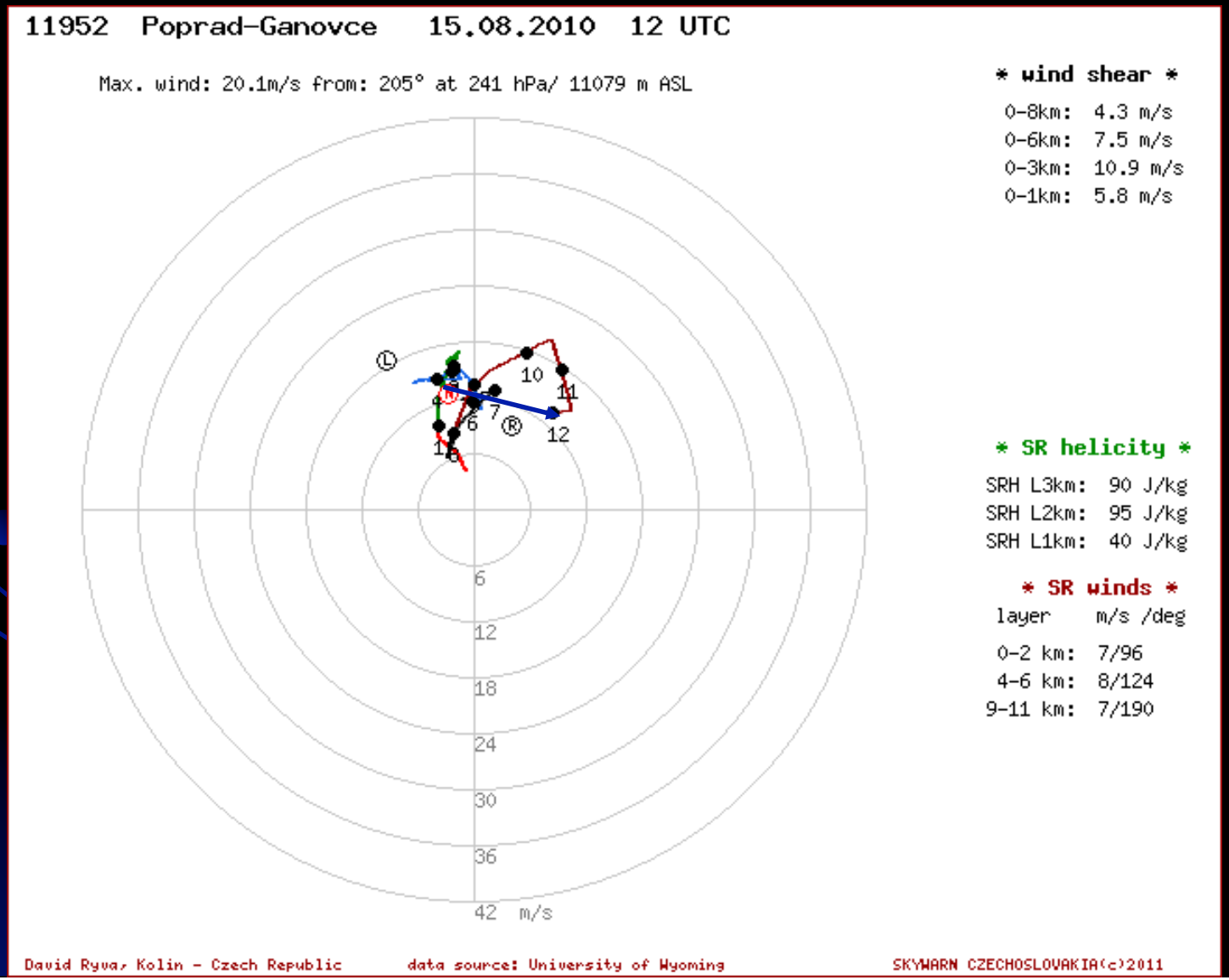
Cold rings (12:15 UTC)



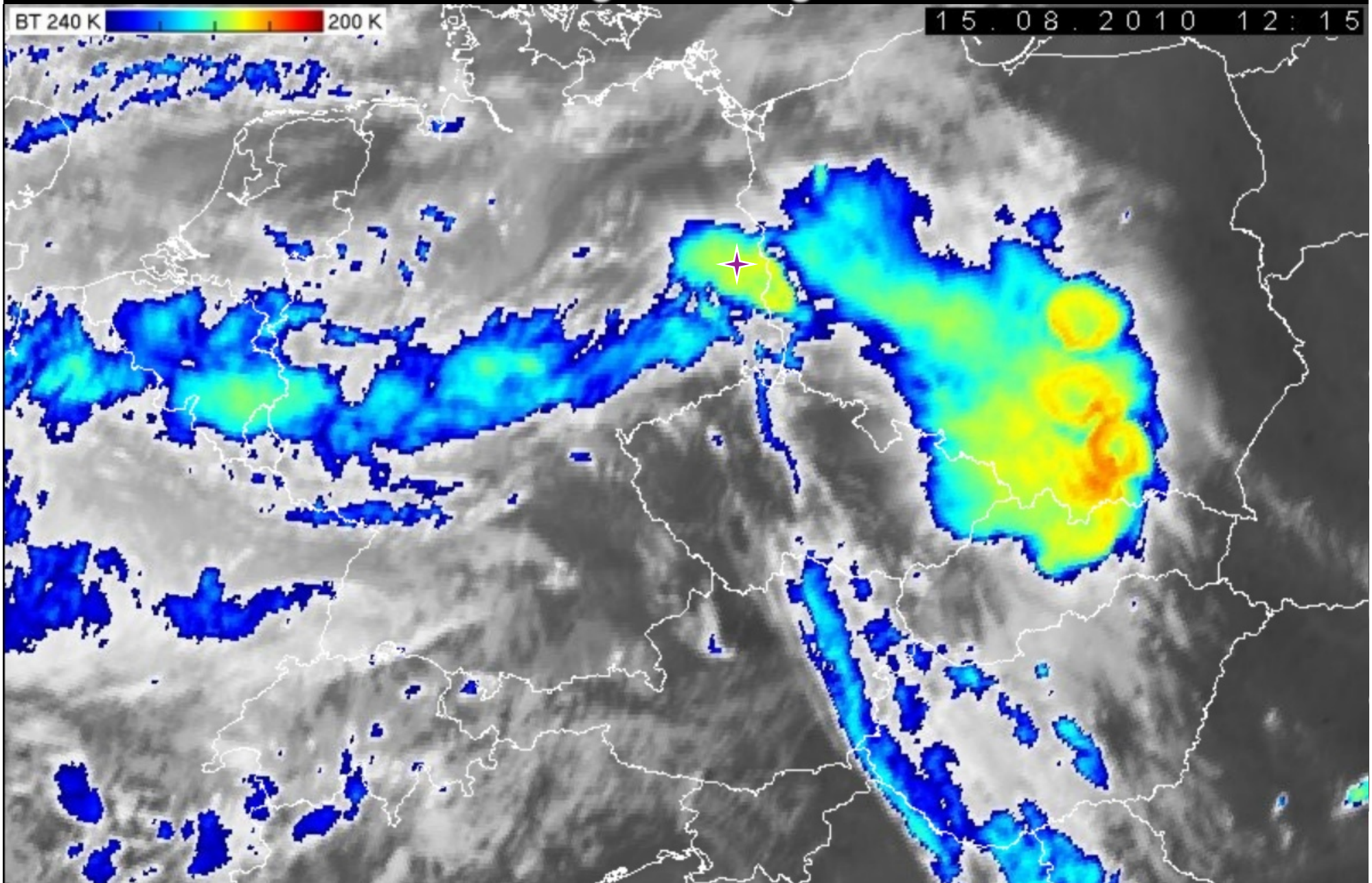
Legionowo 12 UTC
- very weak S-R winds at anvil level (5-8 m/s)



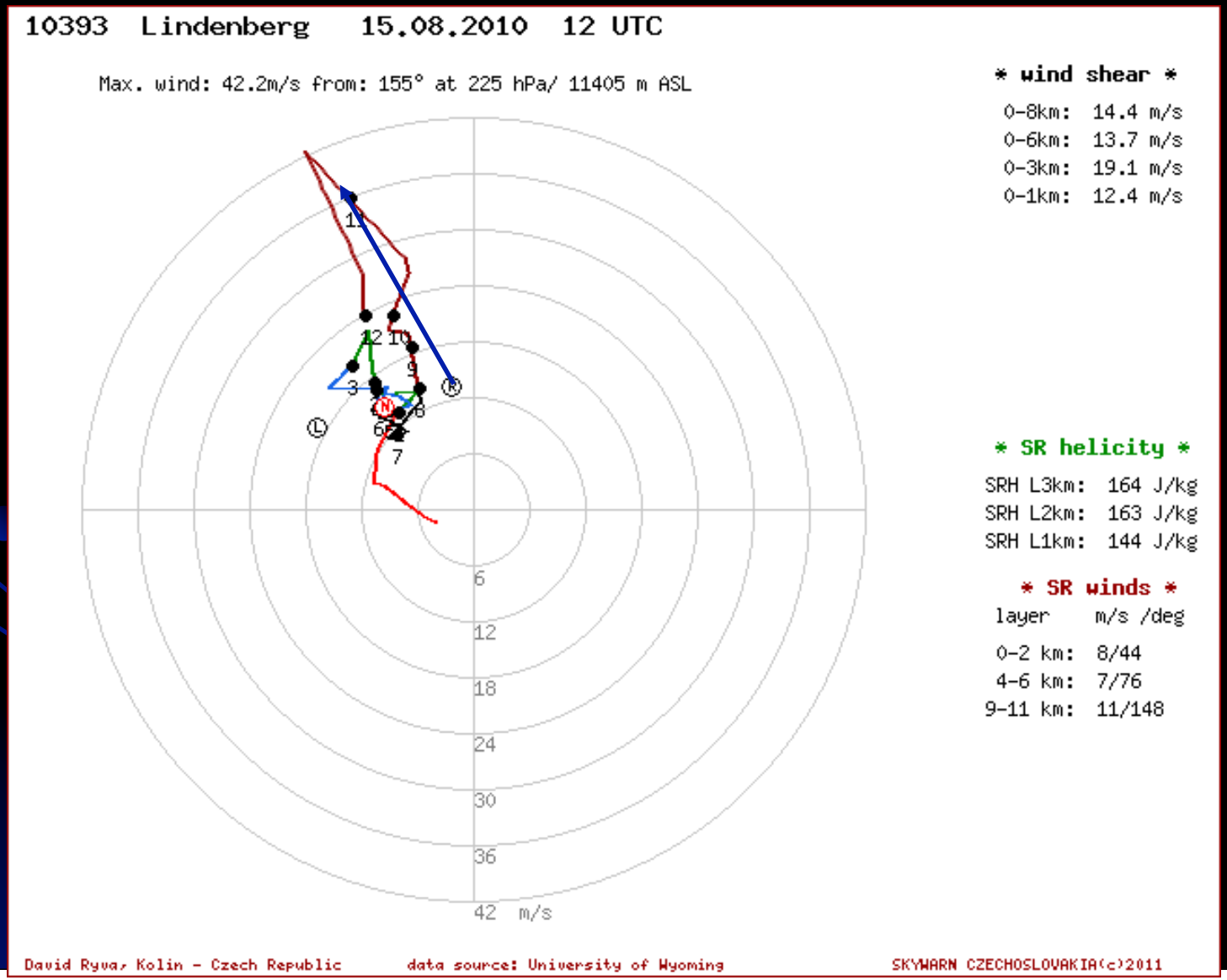
Poprad 12 UTC
- also weak S-R winds (5-11 m/s)



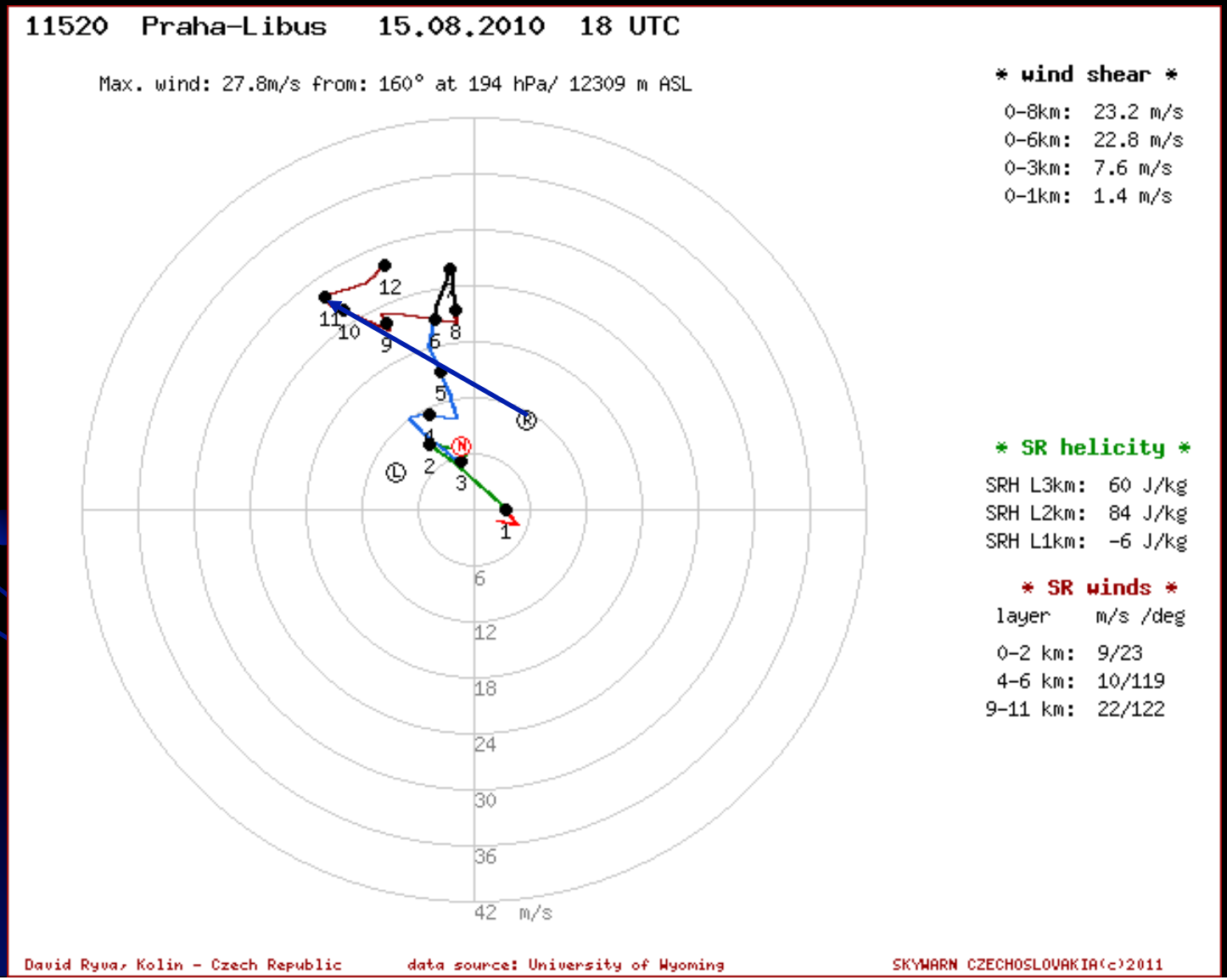
Cold V (12:25 UTC)
- on a right-moving storm



Lindenberg 12 UTC
- strong SE flow at the tropopause level
- significant S-R anvil level winds (22-25 m/s)



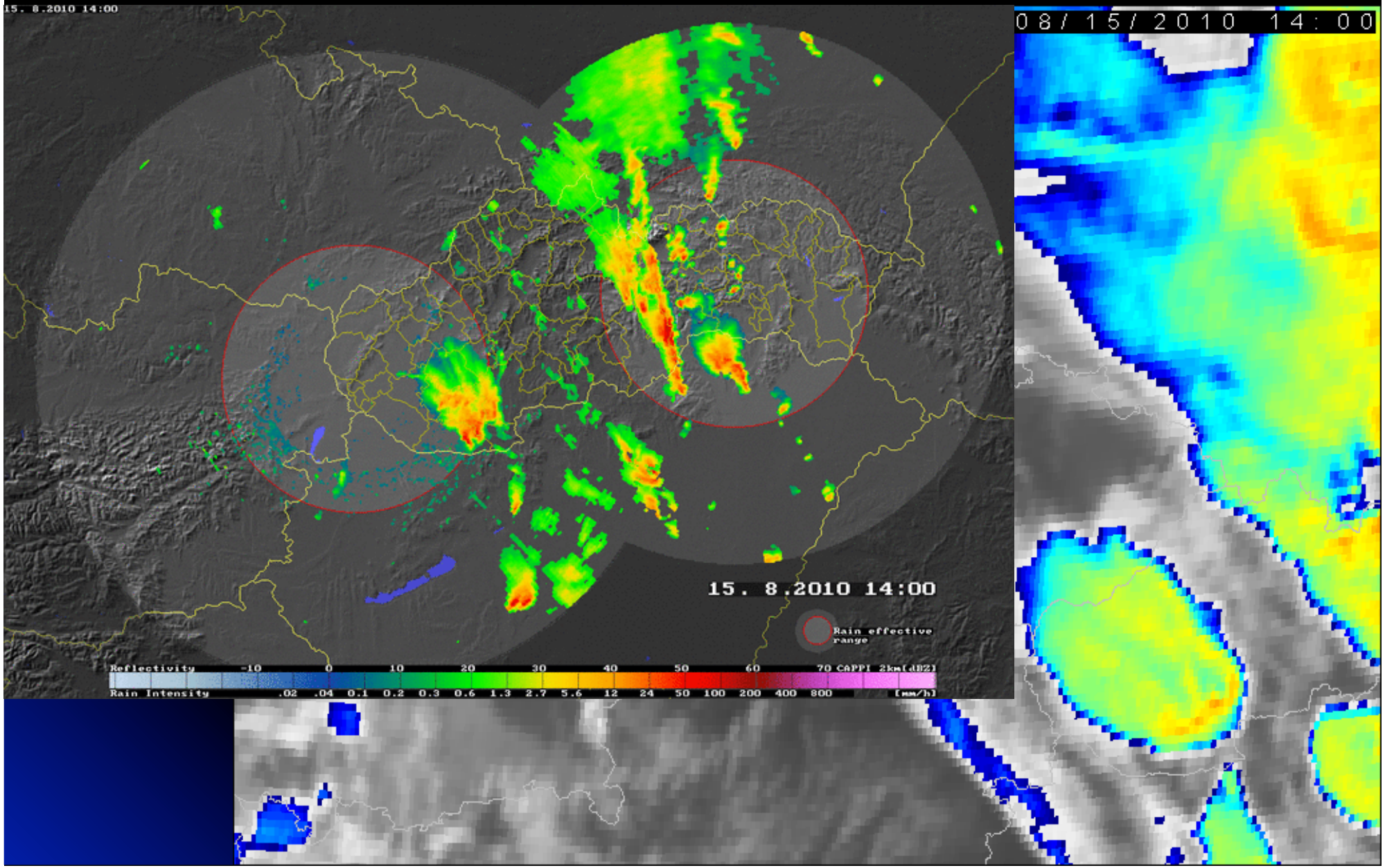
Prague 18 UTC
- Right moving storm and strong flow at the anvil level
- SR anvil level winds around 20 m/s



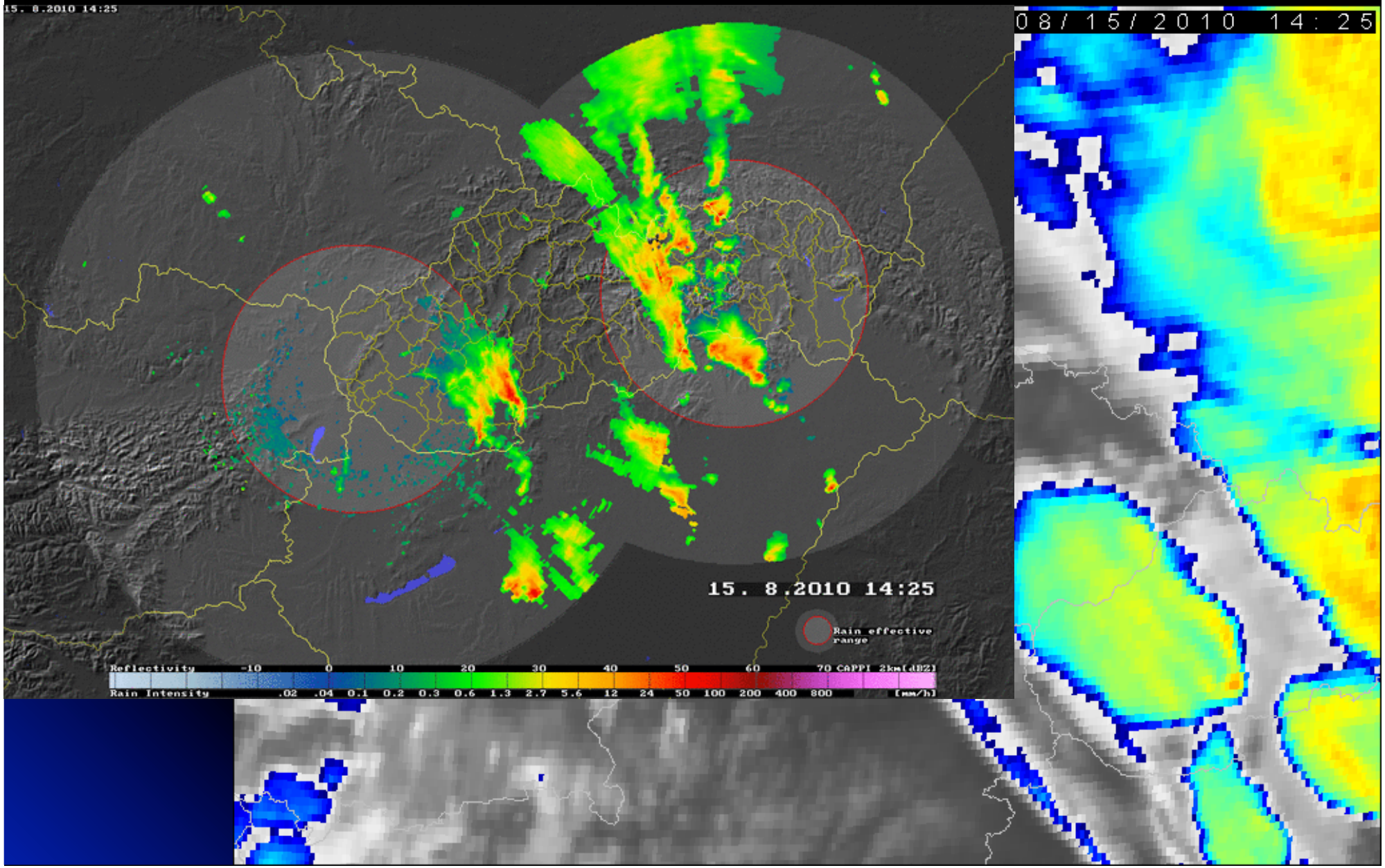
Intermediate cases

- Cold rings and cold-U/V structures occurring close to each other
- SW Slovakia and Northern Hungary
- Cold-U/V 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

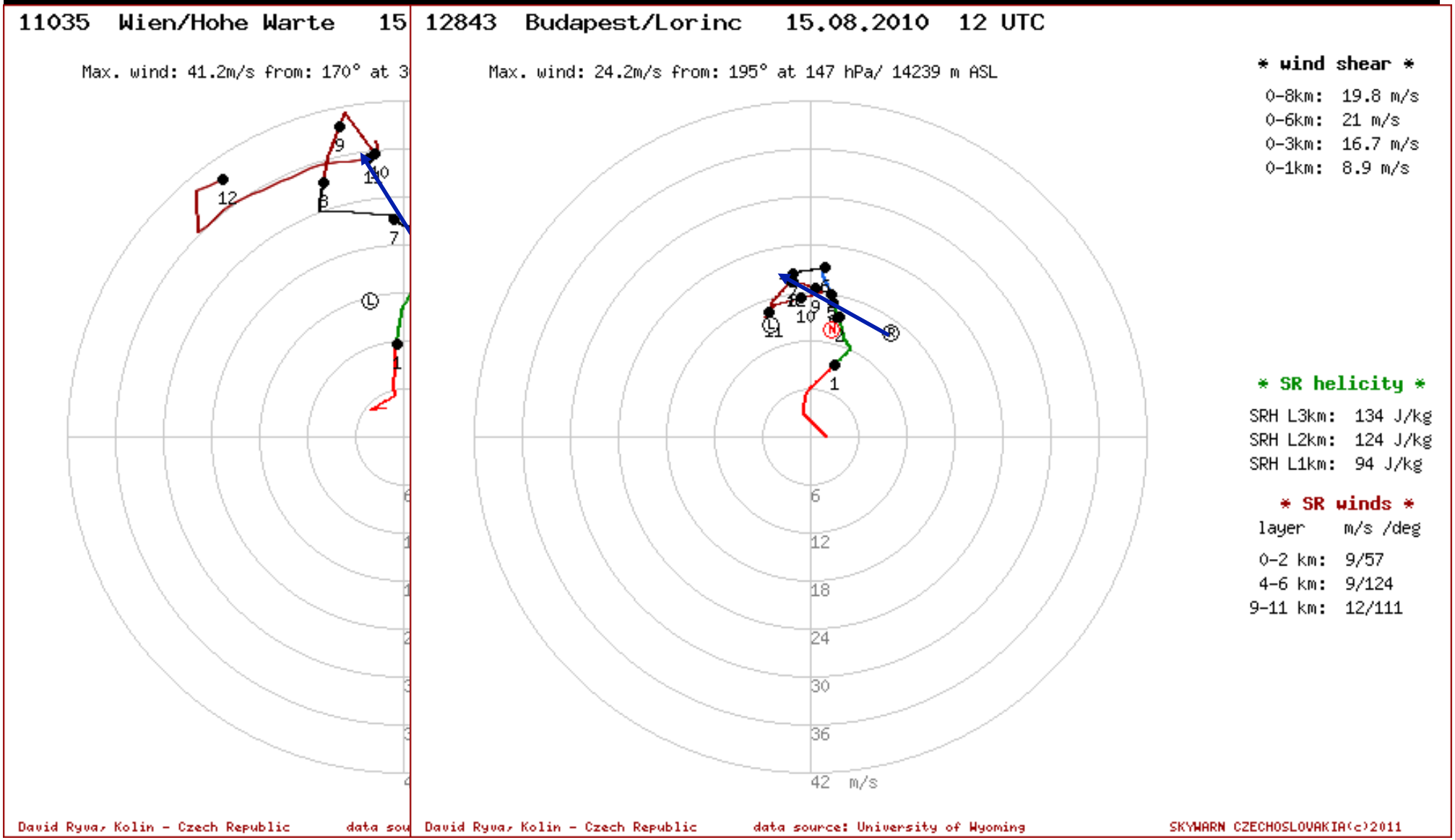
A ring-like structure
- on multicellular system, right mover in development



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)



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

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Thank you for your attention ☺