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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

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”
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
NCEP GFS wind speed at 300 hPa in m/s (contours/barbs)
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
Storm from visual perspective
NOAA-17 AVHRR band 4 19:03 UTC
- a distinct cold-V feature and a huge overshooting top
Visual of overshooting top
Clear difference both at tropopause height and temperature

12.5 km, -58°C

10.75 km, -48°C
Dynamic tropopause height (ALADIN 12 UTC run) at 18 UTC + temperature at 200 hPa level
**Prague soundings (12-00 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: 740 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
- LR86: 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-UV: several such features over Czech Republic, E Germany
- Intermediate, combine cases: Northern Hungary and Southwestern Slovakia
- Perspective of storm-relative winds
Legionowo 12 UTC
- very weak S-R winds at anvil level (5-8 m/s)

12374 Legionowo 15.08.2010 12 UTC

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

* wind shear *
0-6km: 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: 5/95
Poprad 12 UTC
- also weak S-R winds (5-11 m/s)

11952 Poprad-Ganovce 15.08.2010 12 UTC

Max. wind: 20.1 m/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: 42.2 m/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: 27.8 m/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-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 UV
- 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 15.08.2010 12 UTC
Max. wind: 41.2 m/s from: 170° at 3 km

12843 Budapest/Lorinc 15.08.2010 12 UTC
Max. wind: 24.2 m/s from: 195° at 147 hPa/ 14239 m ASL

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

* SR helicity *
SRH L3 km: 134 J/kg
SRH L2 km: 124 J/kg
SRH L1 km: 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
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Thank you for your attention 😊