Overview of Recent Advancements in Convective Storm Nowcasting in the Czech Hydrometeorological Institute

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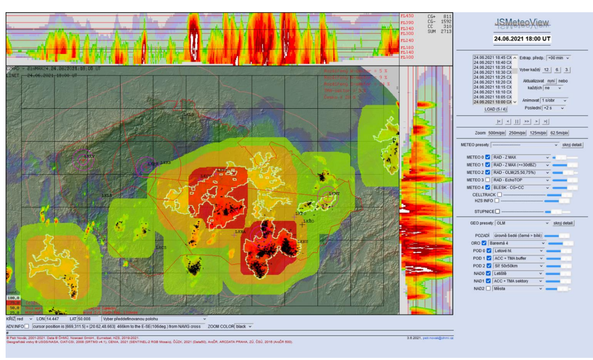
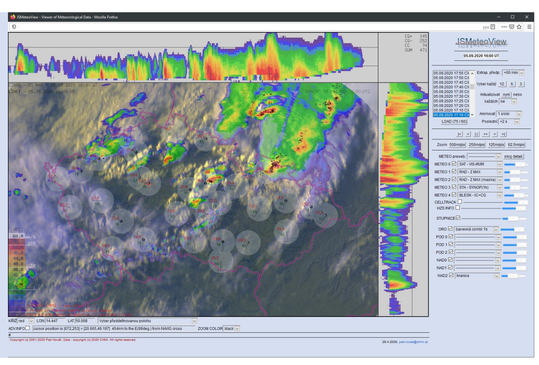
JSMeteoView2 application

- Primarily an application for displaying of various weather radar products
- 0,5 x 0,5 km horizontal resolution (previously 1 x 1 km)
- 5 min time step (previously 10 min time step)
- Various over- and underlays for easy geographical localization of meteorological data – highways, towns, rivers, orography, administrative borders, etc.
- Display of additional data from MSG satellites, SYNOP stations, Integrated Rescue System, lightning data



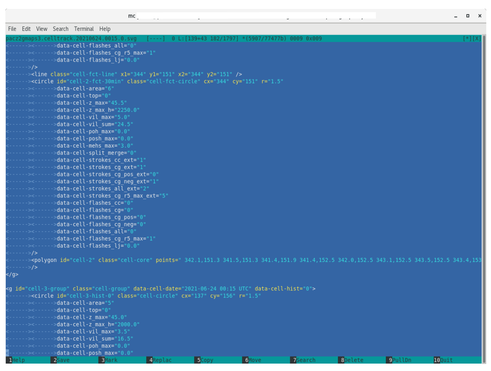
Example of JSMetoView2 output with products used in aviation: 50km squares filled with reflectivity values over 30 dBZ in over 25, 50, 75% (green, orange, red), lightning activity, reflectivity cells over 30 dBZ and max. size over 50 km.



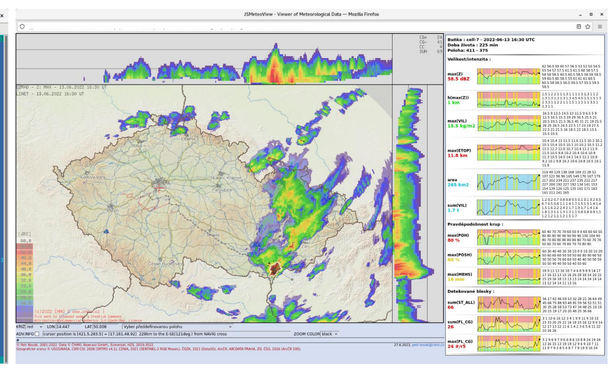
Example of JSMeteoView2 output combined with MSG satellite and SYNOP stations data

CELLTRACK implementation in JSMeteoView2

- New operational implementation of cell-tracking algorithm CELLTRACK (Kyznarová, Novák, 2009)
- Change from raster to vector imaging (*.svg files)
- Additional verification of derived products (primarily hail detection products) so they can be reliably used by forecasters
- Probability of hail (POH, based on Waldvogel et al., 1979), probability of severe hail and maximum estimated hail size (POSH, MEHS, based on Witt et al., 1998) and DPOLH product based on Vaisala HYDROCLASS product were tested in order to evaluate their performance
- DPOLH product is created as a composition of HYDROCLASS product from lowest PPI (0,1°) from individual radars. When there is a difference between HYDROCLASS values from individual radars the greater value is used for composition (there are 6 available values: nomet < rain < wet snow < snow < graupel < hail)



Example of CELLTRACK .svg file



Example of CELLTRACK output in JSMeteoView2: a case with occurrence of a weak tornado

Summary and outlook

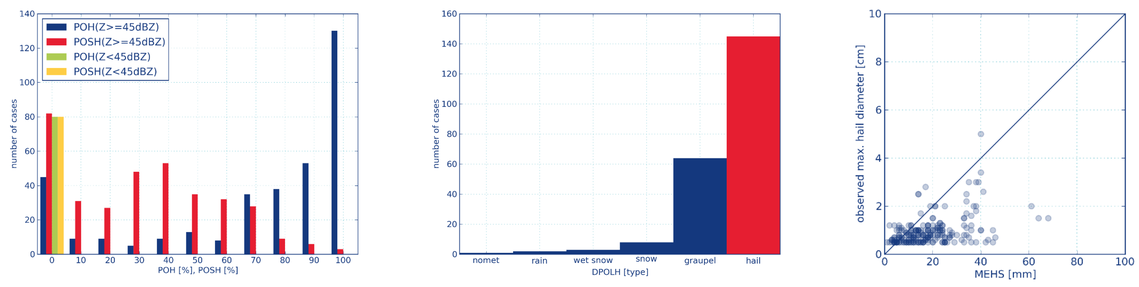
- From last season a new version of JSMeteoView2 with implementation of CELLTRACK has been used by forecasters in CHMI forecasting offices
- Quality of hail probability detection products is sufficient, comparison of MEHS and real max. hail diameters looks rather scattered
- DPOLH product based on HYDROCLASS isn't currently used operatively for hail detection → based on these results it will be added to JSMeteoView2
- A case study on shifting radar echo in individual PPIs during radar measurement using velocity data is planned in order to evaluate its influence on vertically integrated products such as POSH.

Evaluation of implemented hail detection algorithms

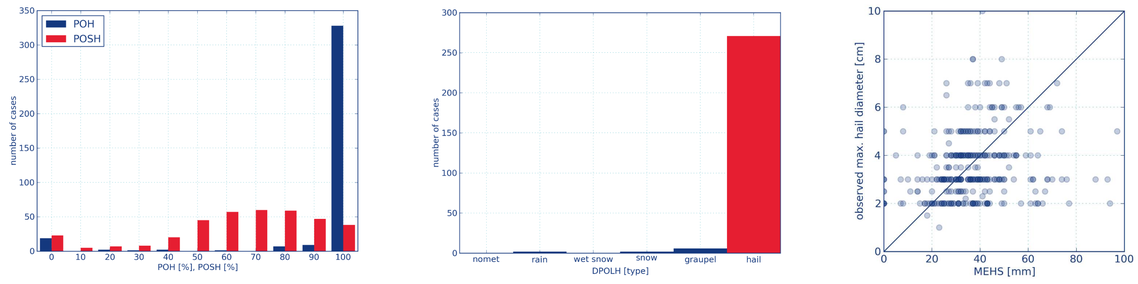
- Hail records from years 2010-2014, 2016-2021 were used for evaluation of POH and POSH
- Hail records from 2016-2021 were used for evaluation of DPOLH
- ESWD and CHMI CLIDATA database records were used as true values
- Individual reports were compared to radar products from 3 km surrounding during hail occurrence and up to 10 minute time span before it. COTREC (Novák et al., 2009) field was used for shifting radar product field from previous measurements to the area of interest.
- Records from CHMI professional stations stored in CLIDATA were used in order to evaluate also amount of false alarms. If no hail record is available from a professional station with the presence of an observer (6-20 UTC)/7, it is considered as if no hail has occurred.
- Only those no-hail cases were evaluated when rain rate, recorded on professional station, corresponded to reflectivity values equal or greater than 45 dBZ
- MEHS was evaluated for CLIDATA and ESWD records where maximum hail size was reported

	ESWD	CLIDATA	CLIDATA (45 dBZ)	CLIDATA (with hail size)	CLIDATA (45 dBZ) (with hail size)	CLIDATA (45 dBZ) (without hails)
Total selected cases	370	434	354	257	217	949
Selected cases 2016–2021	282	224	188	131	103	502

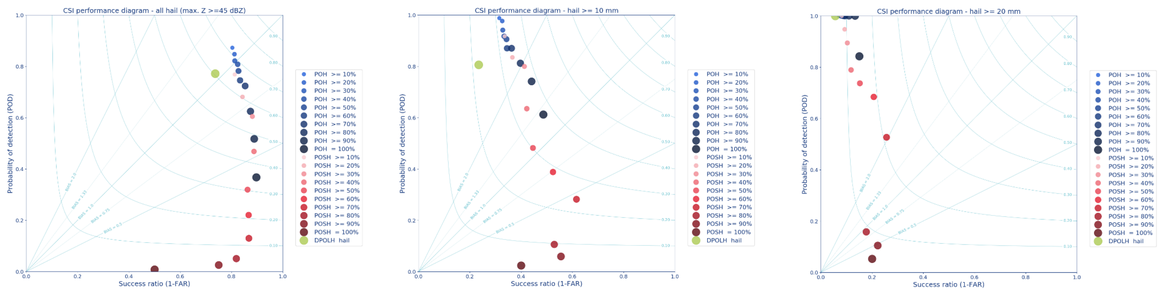
Numbers of hail events processed from ESWD and CLIDATA databases. Column CLIDATA (45 dBZ) shows selection of CLIDATA events where maximum reflectivity reached values >=45 dBZ, next two columns show events with recorded maximum hail size and without and with lower reflectivity limit of 45 dBZ. Last column CLIDATA (45 dBZ) (without hails) shows hail events on professional stations in investigated time period with 10 min rain sums corresponding to reflectivity >= 45 dBZ and with no recorded hail event.



(left) Frequency distribution of POH and POSH for hail events on professional stations selected from CLIDATA database. Yellow and green colors show events when radar reflectivity didn't reach minimum value of 45 dBZ. (middle) Frequency distribution of DPOLH for hail events on professional stations selected from CLIDATA database. (right) Scatter plot of MEHS and measured maximum hail size. Intensity of blue color in scatter plot corresponds with number of events.



(left) Frequency distribution of POH and POSH for hail events selected from ESWD database. (middle) Frequency distribution of DPOLH for hail events selected from ESWD database. (right) Scatter plot of MEHS and measured maximum hail size for hail events selected from ESWD database. Intensity of blue color in scatter plot corresponds with number of events.



CSI, FAR and POD for hail events selected from CLIDATA database. (left) hail events with reflectivity >= 45 dBZ, (middle) hail events with reflectivity >= 45 dBZ and hail size >= 10 mm, (right) hail events with reflectivity >= 45 dBZ and hail size >= 20 mm.

Literature:

Kyznarová H., Novák P., 2009: CELLTRACK - Convective cell tracking algorithm and its use for deriving lifecycle characteristics. Atmos. Res., 93, pp. 317-327.

Novák, P., Březková, L., Frolík, P., 2009: Quantitative precipitation forecast using radar echo extrapolation, Atmos. Res., 93, pp. 328-334.

Waldvogel, A. et al., 1979: Criteria for the Detection of Hail Cells, Journal of Applied Meteorology, 18, pp. 1521-1525.

Witt, A. et al., 1998: An Enhanced Hail Detection Algorithm for the WSR-88D, Weather and Forecasting, 13, pp. 286-303.