

Climatology of severe hail precursors in Czechia

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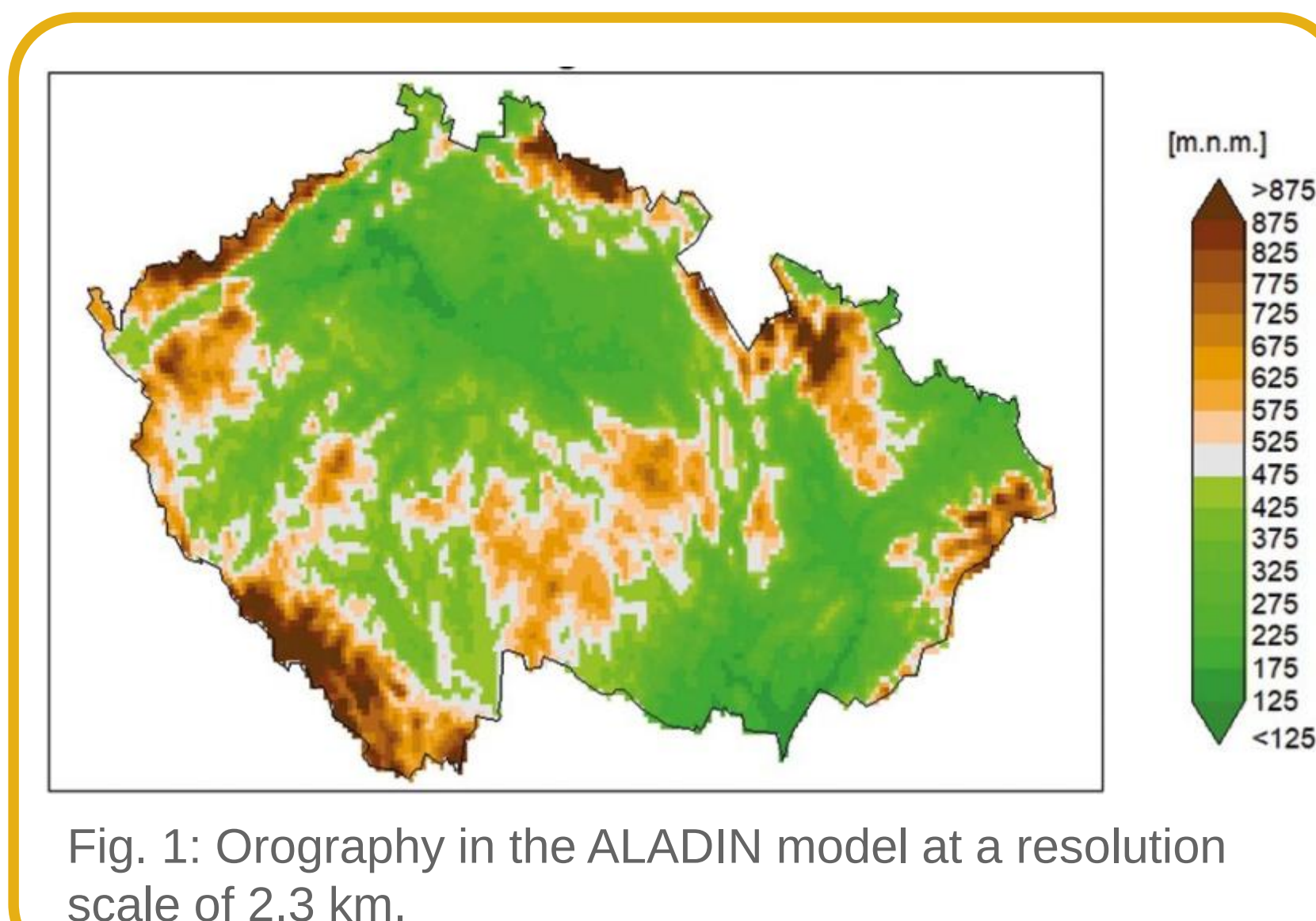


1. Introduction

Observations of severe hail in Czechia are primarily based on weather-station data and public reports. More comprehensive information can be obtained from weather radar measurements. A method based on single-polarisation techniques has been developed to detect severe hail causing significant damage on the Czech territory (Skripniková and Řezáčová, 2014). However, this is limited by the period of radar measurements. Insight into the climatology of severe hail is gained by studying the environmental conditions suitable for large hail development. The environmental parameters CAPE, CIN and wind shear are tested in this work as precursors of severe hailstorms. Precursor values that can be used to develop a climatology of hail hazard in Czechia are obtained by comparison with radar-based hail detections from the warm parts of 2007 - 2020.

2. ALADIN reanalysis

- regional atmospheric reanalysis ALADIN (Bližňák et al., 2026)
- includes outputs describing the convective environment
- CAPE, CIN and wind speed are available for the 1991-2021 time span
- high horizontal (2.3 km) and temporal (1h) resolution



3. Precursor values x radar based hail

Parameters MUCAPE, MUCIN, deep layer shear (DLS, 0-6 km) together with derived parameter WMAXSHEAR (Taszarek et al., 2017) were selected to find environmental conditions prone to severe hail development. Daily maximum parameter values were compared for areas with detected severe hailstorms. The radar-based COMBI criterion was used (Skripniková and Řezáčová, 2014). In Fig. 2 the scatterplot shows the daily maximums of CAPE and DLS for areas with detected hailstorms. The values are shown for days with different area sizes of detected hailstorms. In Fig. 3 the boxplots illustrate the selection of relevant threshold values.

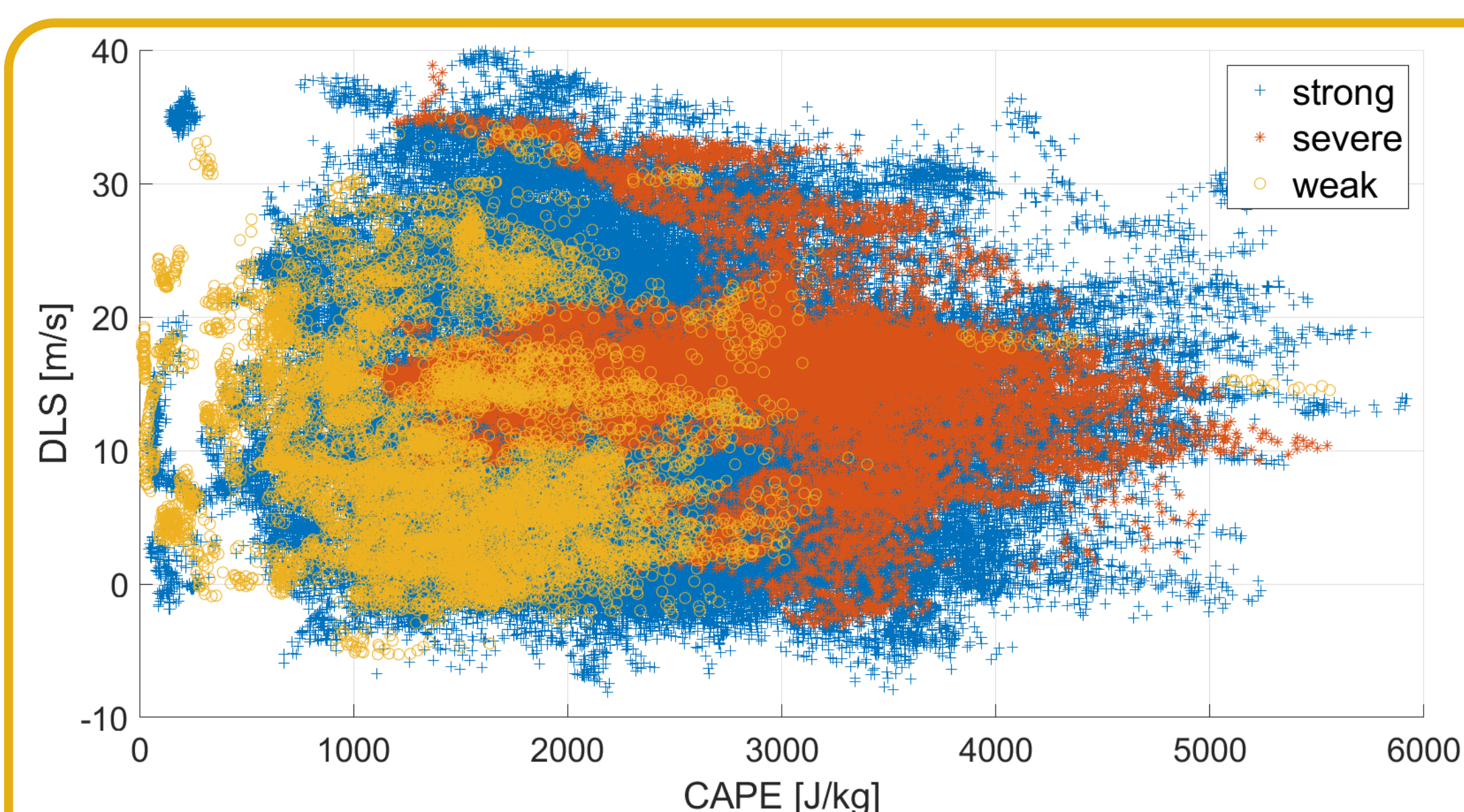


Fig. 3: Scatterplot of MUCAPE and DLS for days with radar detected more than 2000 hail pixels, 100 pixels and less than 9 pixels over Czechia.

The following combination of threshold values was selected as conditions favouring the occurrence of severe hail:

- MUCAPE > 2462 J/kg;
- MUCIN < 542 J/kg and > 191 J/kg;
- DLS > 11 m/s;
- WMAXSHEAR > 628 m²/s²

The severe hail prone conditions are indicated if at least 3 of the 4 criteria are met.

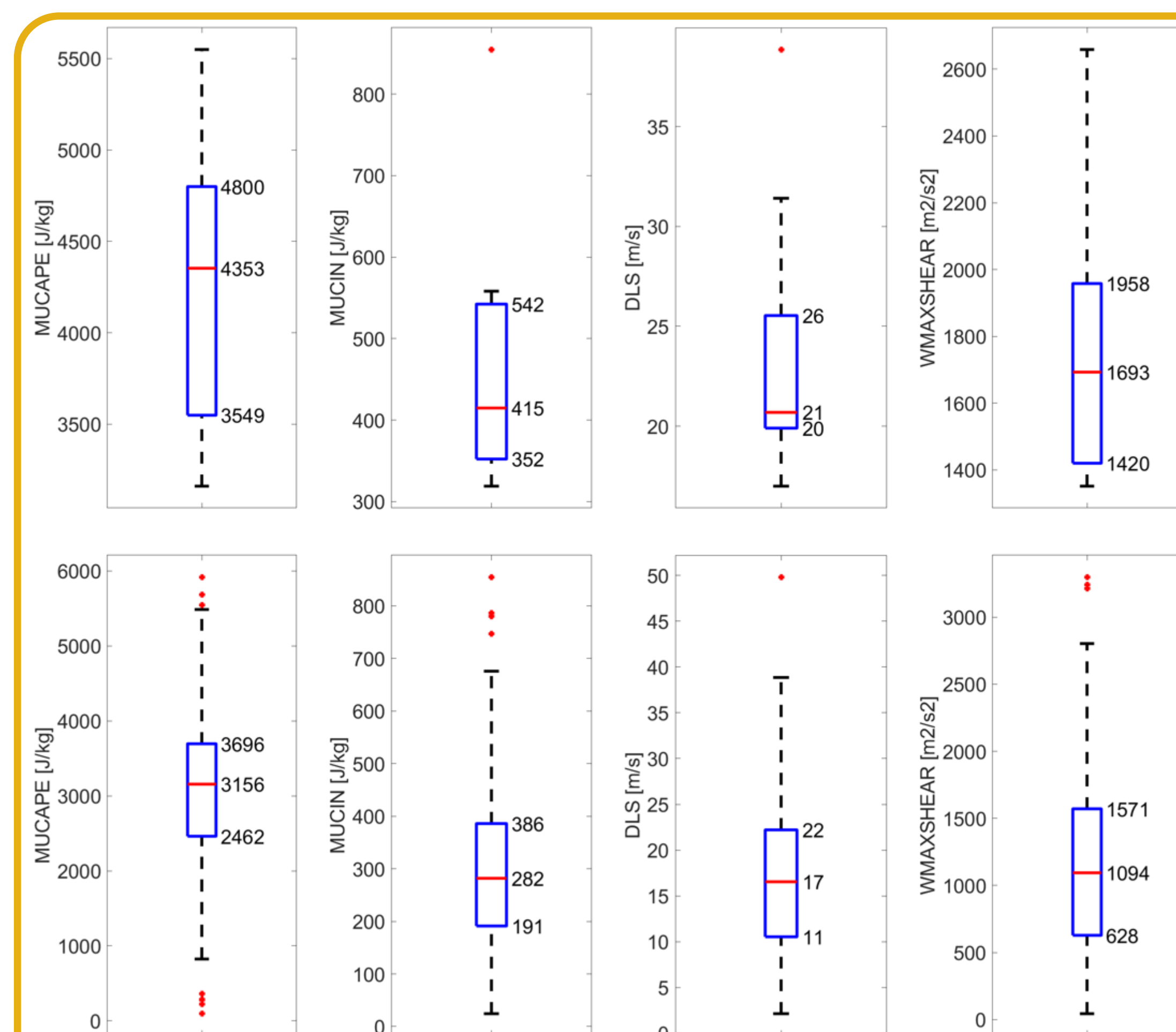


Fig. 2: Boxplots for daily maximum values of MUCAPE, MUCIN, DLS and WMAXSHEAR for days with more than 2000 detected hail pixels (upper part) and with more than 100 detected hail pixels (lower part).

4. Climatology of severe hail precursors

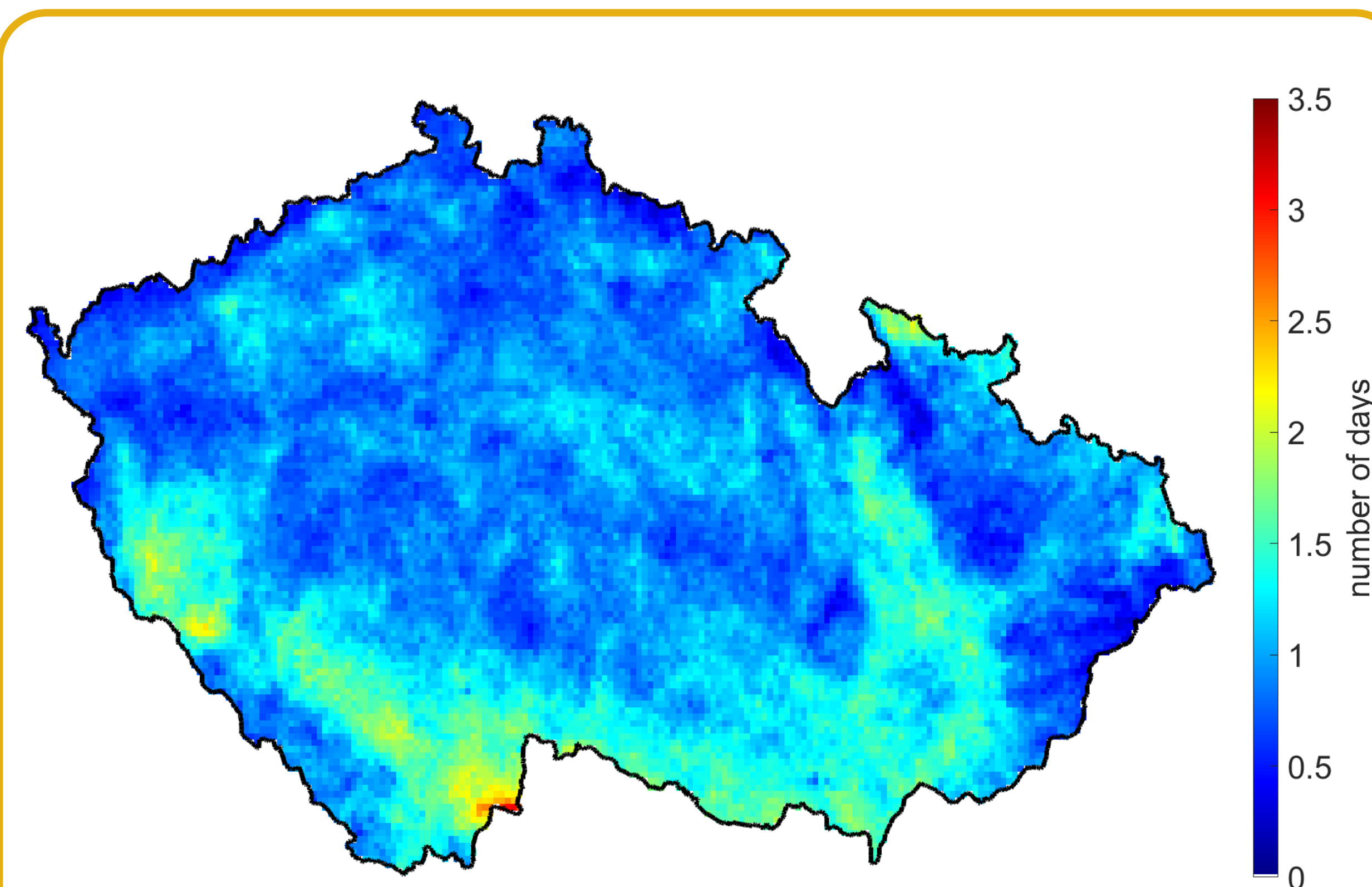


Fig. 4: Distribution of severe hail prone conditions over the Czech territory for the period 1991-2021.

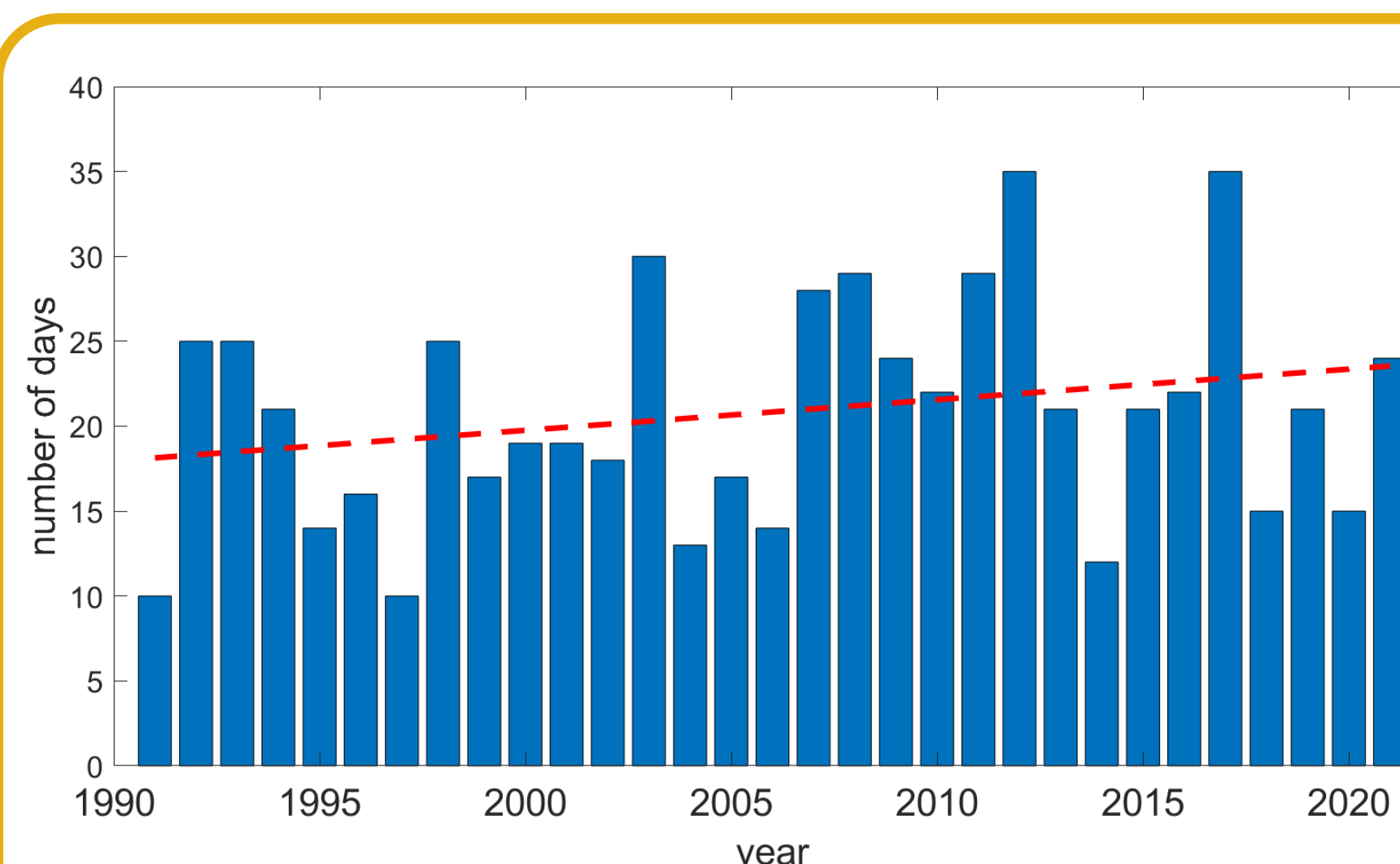


Fig. 5: Number of days with severe hail prone conditions.

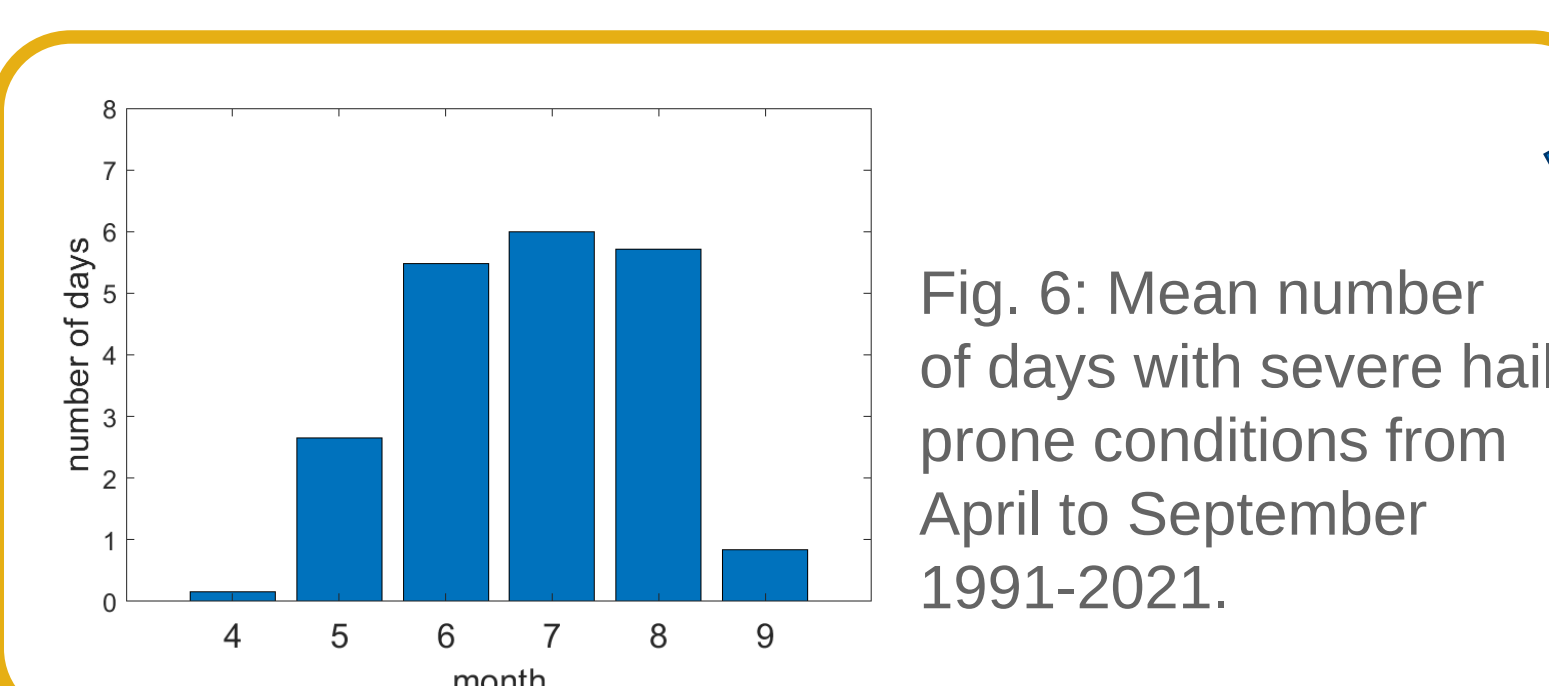


Fig. 6: Mean number of days with severe hail prone conditions from April to September 1991-2021.

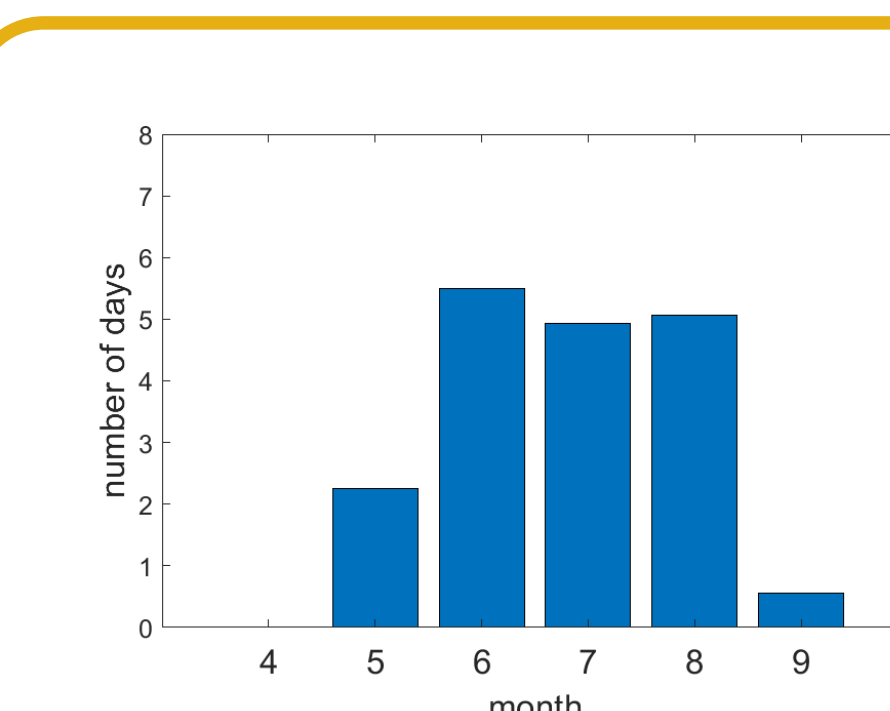


Fig. 7: Mean number of days with severe hail prone conditions from April to September 1991-2006 (at the top) and 2007-2021 (at the bottom).

5. Conclusions

Based on environmental parameters from the ALADIN reanalysis, the potential for severe hailstorms shows the highest number of days in southern and southwestern Bohemia, which corresponds well with previous findings. The average annual number of days with hailstorms in Czechia for 2007-2014, based on radar information, also shows that the maximum occurs in the foothills of the Šumava mountains (Skripniková et al., 2017). Furthermore, the trend in the number of days with severe hail potential is increasing. The annual cycle of days with favourable conditions peaks in July across the entire period. However, a notable shift in the annual maximum is evident between the first and second half of the review period.

References

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