# Reconstruction of meteorological environment leading to the deadliest Polish severe weather outbreak of July 4th, 1928

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## Introduction

On July 4, 1928, one of the most impactful severe weather events in Polish history developed ahead of an advancing cold front, causing over 60 fatalities, hundreds of injuries, and massive destruction across large parts of the country. Dozens of densely populated European cities, including Berlin, Poznań, Warsaw, and Katowice, as well as hundreds of smaller towns and villages, were significantly affected throughout the day. Most of the damage and casualties were caused by hurricane-force winds associated with straight-line gusts produced by thunderstorm downdrafts (Fig. 1). At least one tornado is suspected to have occurred, and other damaging weather phenomena, such as large hail, dust storms, and lightning-induced wildfires, were also reported.

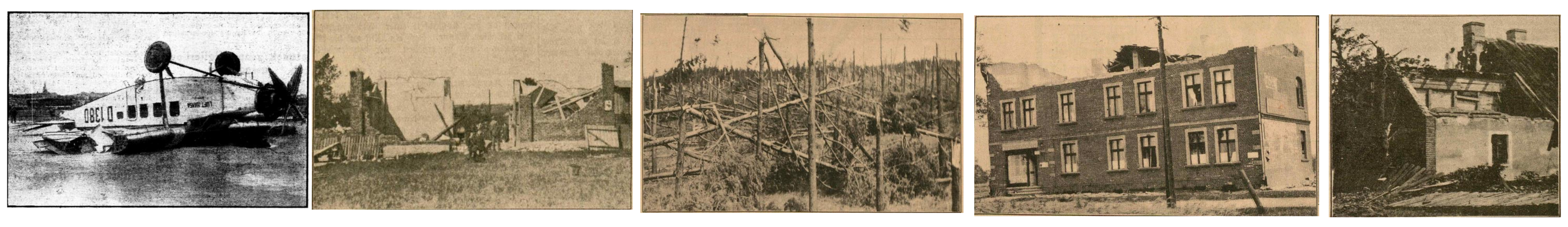

**Fig. 1.** Damage caused by severe convective windstorms on July 4th, 1928.

## Methodology

In order to recreate the atmospheric conditions that led to the formation of such intense storms, the NOAA–CIRES–DOE Twentieth Century Reanalysis (20CR) Project was utilized (Silvinski et al., 2019) and compared with archival data from several meteorological stations operating at that time (Fig. 2). Dozens of press reports covering the disaster and its consequences were gathered from Polish digital library datasets to better reconstruct the timeline, scale, and characteristics of this highly unusual and catastrophic weather event. The overall aim of this research is to identify similarities between this historic case and recent severe weather outbreaks, as well as to improve the ability to predict similar convective windstorms in the future.

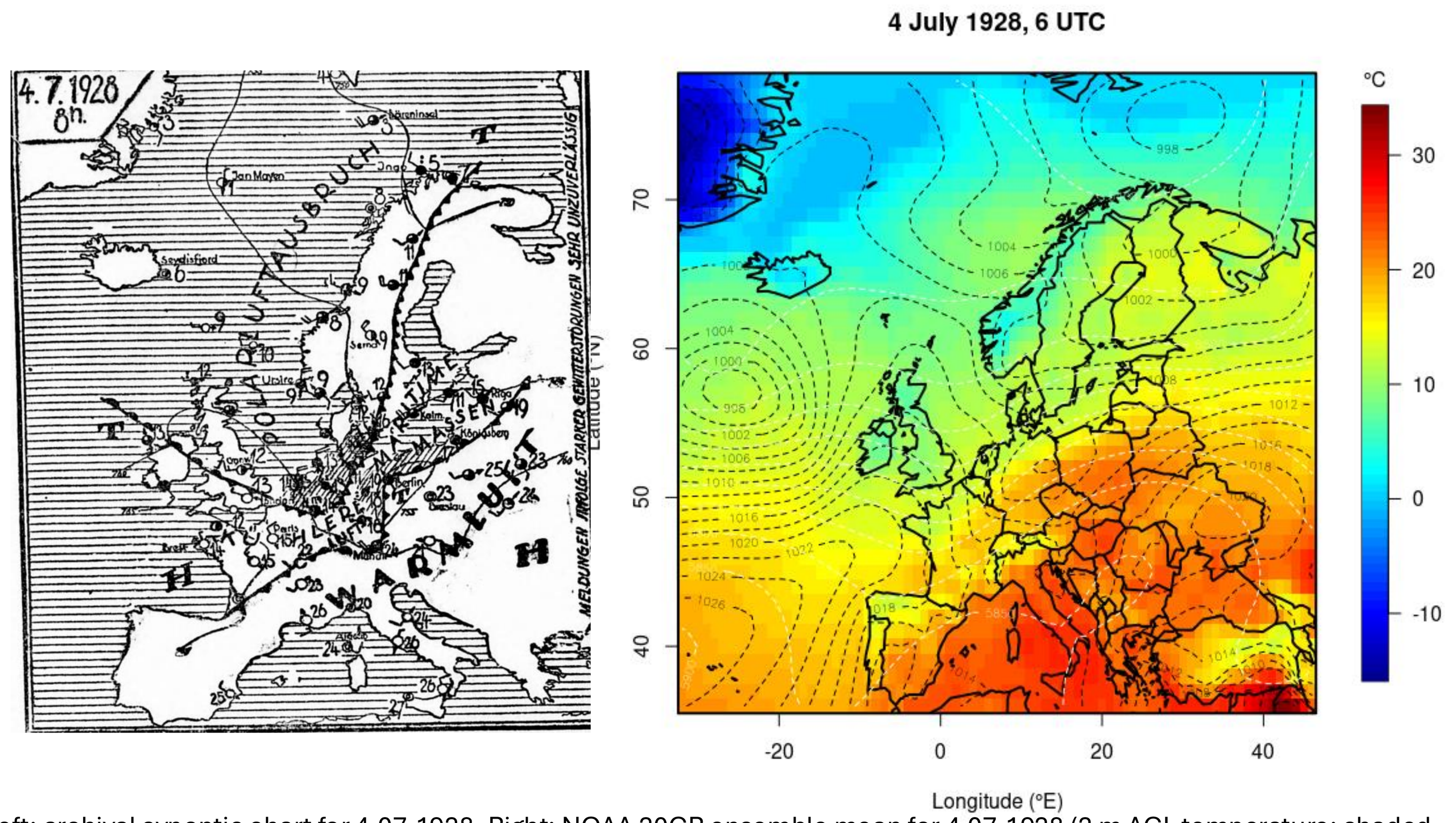


**Fig. 2.** Left: archival synoptic chart for 4.07.1928. Right: NOAA 20CR ensemble mean for 4.07.1928 (2 m AGL temperature: shaded, mean sea level pressure: black dashed contours, 500 mb geopotential height: white dashed contours).

## Results

Most of the damage was caused by severe winds (Fig. 3a), with maximum gusts reaching 40 m s$^{-1}$ at the Gliwice Airport station. Isolated cases of large hail (up to 5 cm in diameter) were reported in southern Poland. The highest precipitation amounts, locally exceeding 40 mm, occurred over northern Poland and were associated with a quasi-stationary frontal zone rather than with convective phenomena (Fig. 3b). Most of the fatalities (>20) occurred in the highly populated and industrialized cities of the Upper Silesia region (Fig. 3c). Reported damage paths suggest that three separate convective systems were responsible for the majority of the devastation (Fig. 3d). The thunderstorms were moving extraordinarily fast by European standards (Surowiecki et al., 2024), with speeds of around 100–120 km h$^{-1}$ (Fig. 3), which was likely caused by an intense Rear Inflow Jet (RIJ) within the most vigorous mesoscale convective systems (Weisman, 1992). One of the convective systems traveled an estimated distance of over 600 km, suggesting that it might have met the derecho criteria (Squitieri et al., 2023).

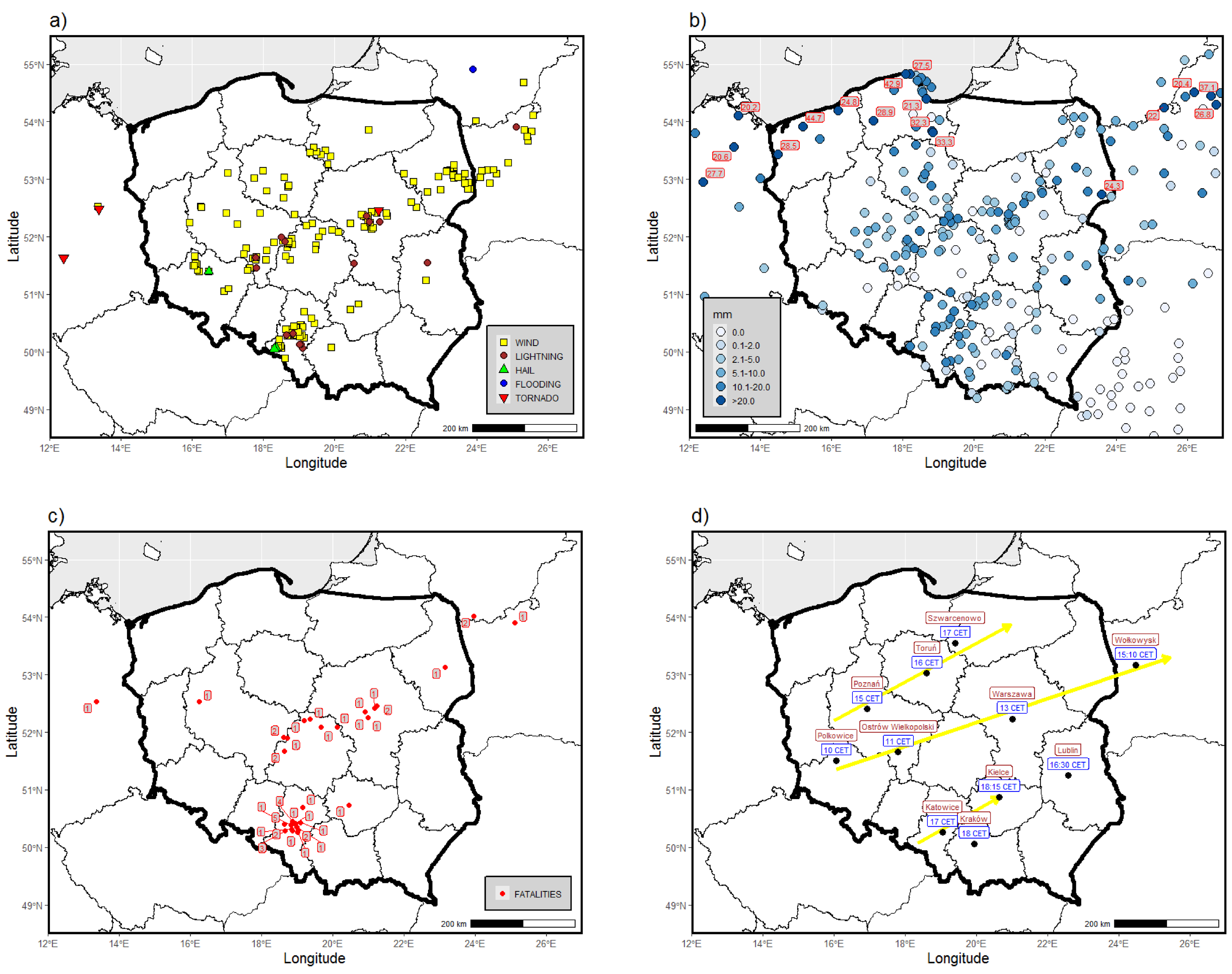


**Fig. 3.** a) Severe weather reports on July 4th, 1928, b) daily rainfall accumulation for obtained weather stations, c) location of confirmed fatalities, d) approximate paths of convective systems and time of their arrival in different cities.

## Synoptic situation

On the 4th of July, a warm, tropical air mass was advected over Poland, resulting in air temperatures locally exceeding 32 °C. A cold front approaching from the west caused a large temperature and pressure gradient between Poland and Germany (Fig. 4). A cut-off low formed ahead of the cold front and deepened during the day. Based on a comparison of 80 ensemble members of the reanalysis with observed values, the root mean square error (RMSE) and mean absolute error (MAE) were lowest at 6 UTC (7 CET) and highest at 12 UTC (13 CET) for both 2 m AGL temperature (TMP2m) and mean sea level pressure (MSLP).. Both TMP2m and MSLP were mostly overestimated by the ensembles at 6 UTC and 12 UTC, while MSLP was underestimated at 20 UTC (21 CET). The median correlation coefficient for both TMP2m and MSLP ranged from 0.8 to over 0.95 (Fig. 5).

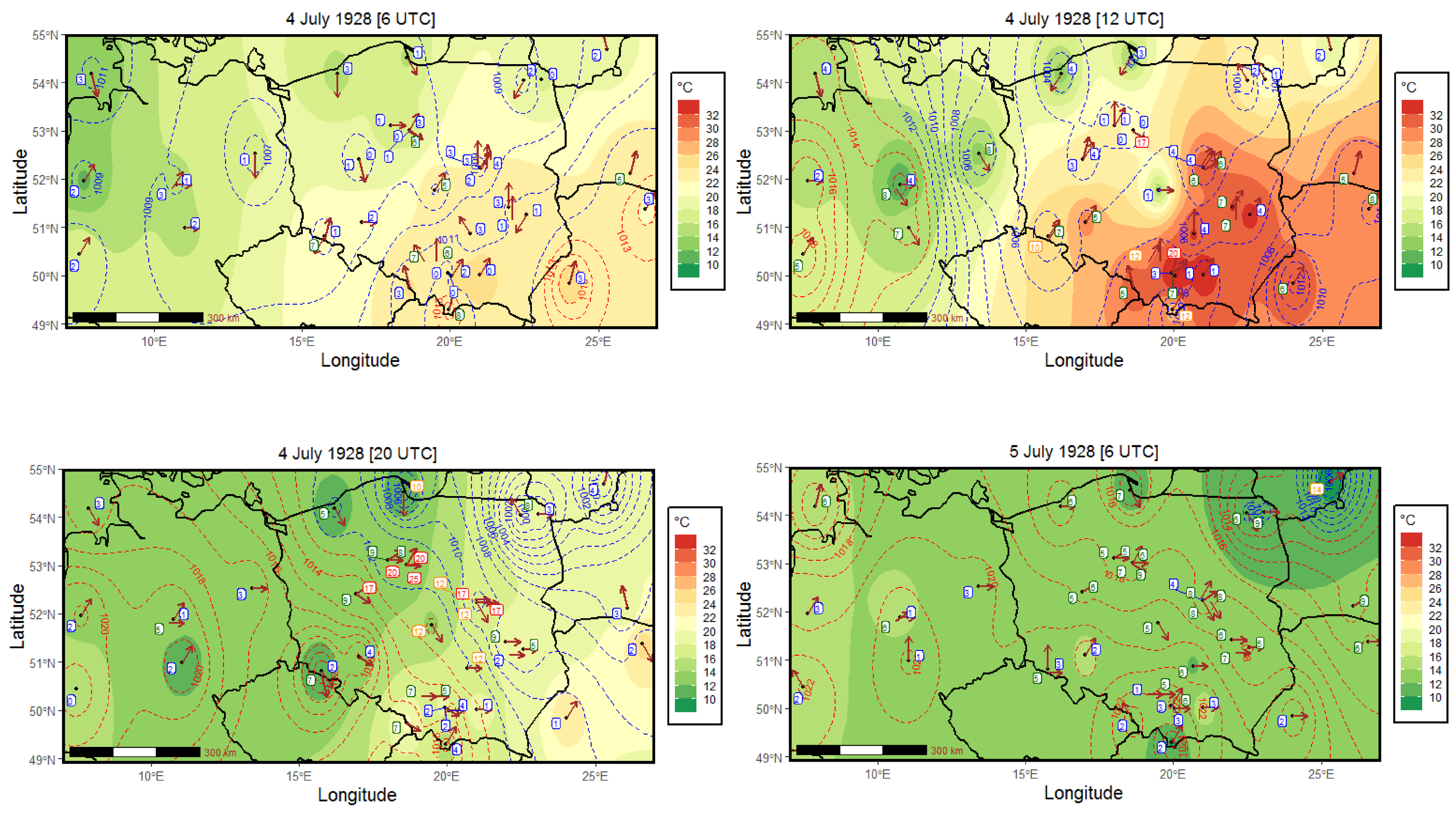


**Fig. 4.** Measured 2 m AGL air temperature (shaded), mean sea level pressure (hPa, dashed contours), wind direction (brown arrows) and wind speed (m s$^{-1}$, polygons).

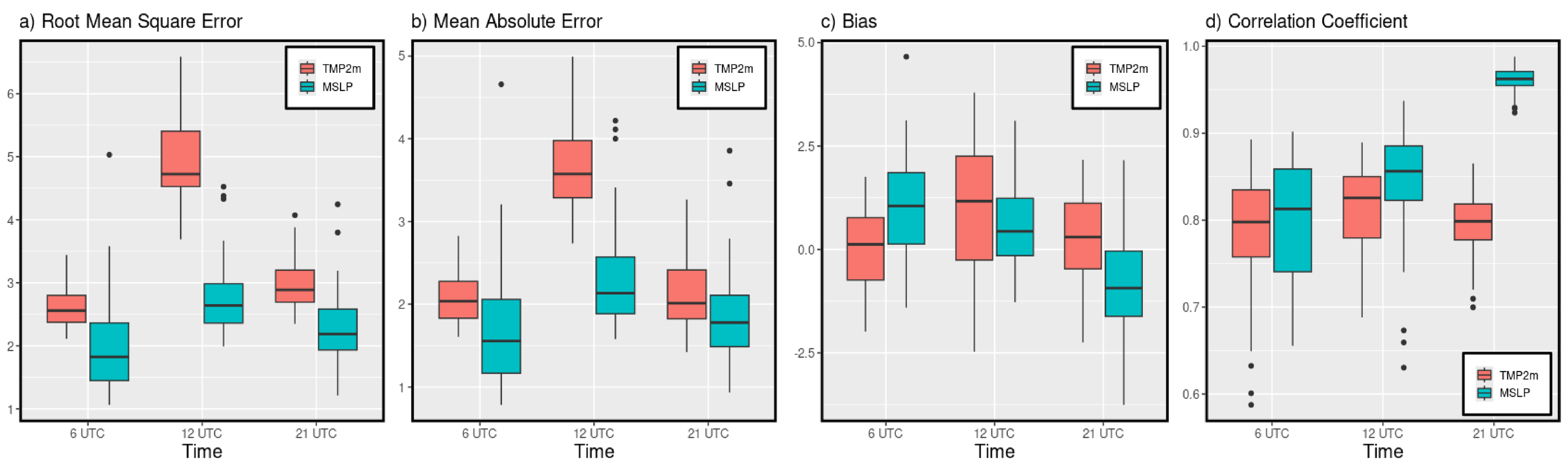


**Fig. 5.** a) Root Mean Square Error, b) Mean Absolute Error, c) Bias, d) Correlation Coefficient of 80 ensembles of NOAA 20CR reanalysis compared to measured air temperature (°C) and mean sea level pressure (hPa) in Poland.

## Tropospheric profile

The vertical tropospheric profile simulated for central Poland based on the ensemble-mean version of the 20CR reanalysis suggests the presence of an environment supportive of severe weather (Fig. 6; Taszarek et al., 2023). A moderate amount of Convective Available Potential Energy (CAPE) supported the formation of intense updrafts within storm clouds (Markowski and Richardson, 2011). A high Lifted Condensation Level (LCL), together with significant Downdraft Convective Available Potential Energy (DCAPE) and steep low-level lapse rates, favored damaging wind gusts associated with intense convective downdrafts (Markowski and Richardson, 2011; Pilguj et al., 2025). Moderate to strong wind shear, especially within the 0–3 km and 0–6 km AGL layers, along with relatively straight hodographs, allowed for the development of organized convective systems. However, recent research (Pilguj et al., 2025) indicates that much stronger wind shear is typically required for the formation of high-end QLCS and derecho systems, suggesting a significant underestimation of these parameters by the ensemble-mean version of the reanalysis.

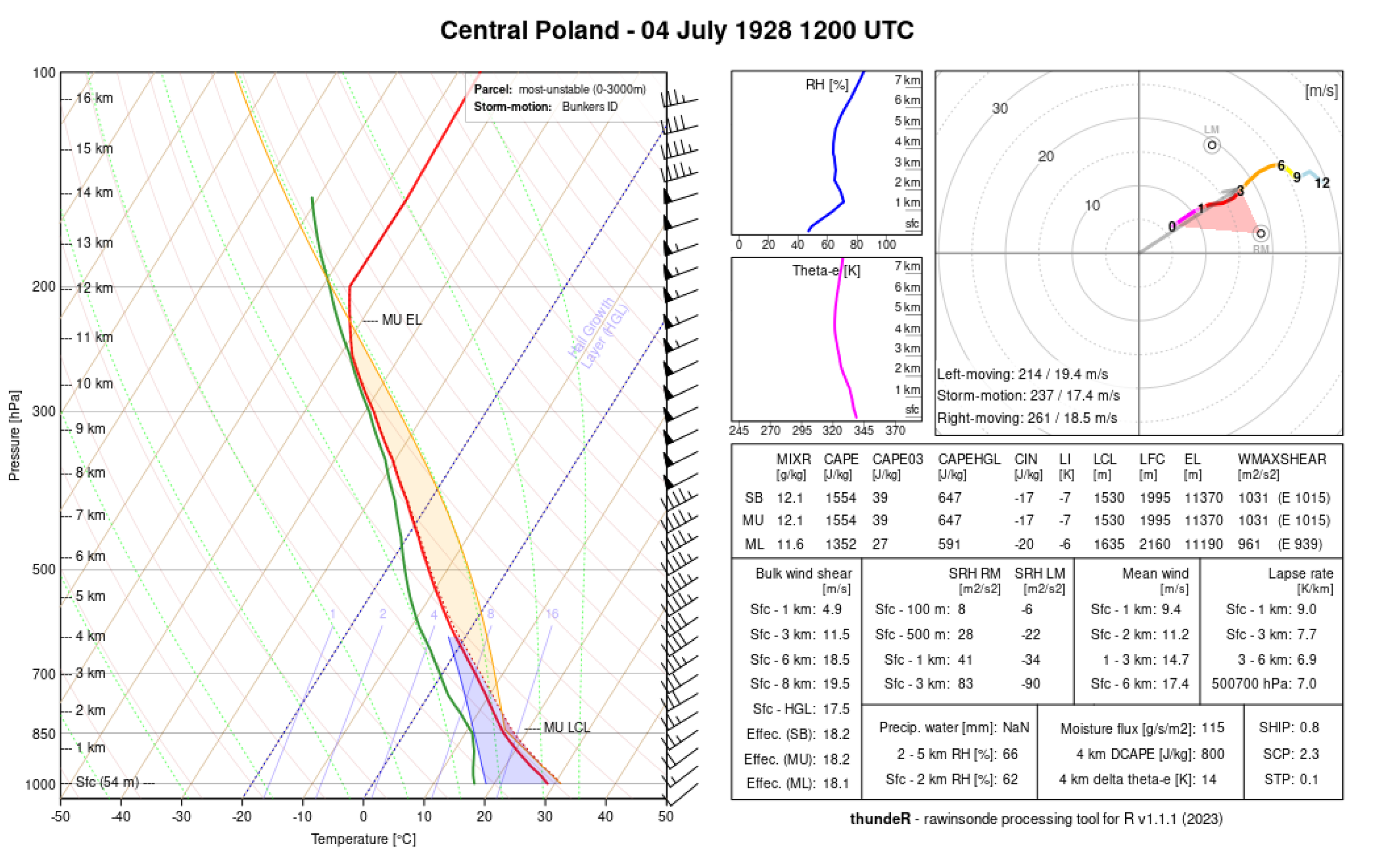


**Fig. 6.** Atmospheric sounding and hodograph, simulated for Central Poland, based on NOAA 20CR reanalysis.

### Bibliography

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