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Detection of possible shifts in the European cyclone tracks and analysis of changes in the corresponding frontal activity based on ERA-40 datasets

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Based on four main geopotential height fields (i.e., AT 500, AT 700, AT 850, and AT 1000) of ECMWF (European Centre for Medium-range Weather Forecast) reanalysis datasets (ERA-40), the North-Atlantic/European region has been selected in this paper. Detailed analysis has been accomplished for the period between 1957 and 2002 on a 2.5-degree and a 1-degree horizontal resolution grid. Four geopotential fields are available daily (i.e., 00 UTC, 06 UTC, 12 UTC, 18 UTC) for each level. Annual, seasonal, and monthly mean geopotential heights have been determined for all the gridpoints, furthermore, the standard deviation fields have been calculated. Decadal scale variability and tendency have been analysed and compared for all levels. Then, cyclone centers have been identified on each geopotential level using anomaly fields. The paths of these mid-latitude cyclone centers have been tracked with a time step of 6 hours. Detailed statistical analysis of cyclone tracks have been accomplished, including the location of cyclone centers, the shape of their tracks, frequency and durations of cyclones, seasonality of occurrences, etc. Our research focuses on the analysis of cyclones, which may significantly affect the weather in the Carpathian Basin located in Central/Eastern Europe. Since the climate of this region mainly depends on the mid-latitude cyclones passing the basin, it is especially important to know whether or not the frequency or intensity of cyclones occurred in the region has been changed, and if the answer is yes, then how. Therefore, significant frontal events (e.g., frontal precipitation, wind, and temperature changes) have also been analyzed, i.e., how often and how intense they occurred in the last few decades, whether or not any tendency may be detected.