Abstract

A thunderstorm is an extreme atmospheric phenomenon belonging to the electrometeors. The geographical location of Poland, terrain, variable atmospheric circulation, transient climate, or the complexity of atmospheric processes define thunderstorms as a local phenomenon, conditioned by many variables. This results in significant variability in the number of thunderstorm days and lightning in Poland from year to year and throughout the year. Progressive climate change manifested by rising air temperatures affects the frequency and intensity of thunderstorms. Every year, the phenomena accompanying thunderstorms pose a real threat to human life and health and cause significant property damage. As with in the case of other meteorological phenomena, long-term monitoring is necessary to observe this type of phenomenon. This research is also necessary to understand the principles of the convective environment system, necessary for reconstructing the conditions of the atmosphere. Defining the parameters of the atmospheric state will enable better and more precise forecasting of such phenomena in the future. In order to define the convective environment generating the occurrence of cloud-to-ground (CG) lightning flashes in Poland, data from the from the PERUN lightning detection and localization system (IMGW-PIB) from 2002-2020. On this basis, the spatial-temporal distribution of CG flashes occurrence and the number of thunderstorm days in Poland were examined. A detailed analysis of days with increased electrical activity and the number of CG flashes generated was also carried out. On the basis of ERA5 (ECMWF) reanalyses, the parameters of the convective environment favorable for CG flashes were defined. A constant increase in the temperature of the globe also affects the convective environment, as presented by an apparent increase in the WMAXSHEAR parameter. As a result of the analysis, it was found that the changing climate affects the increase in the number of CG flashes and the number of thunderstorm days. The most favorable conditions for the development of Cumulonimbus clouds occur at a CAPE of about 1300 $J \cdot kg^{-1}$ and the simultaneous presence of wind shear of about 15 $m \cdot s^{-1}$ in the profile 0-6 km AGL. Additional factors supporting convection are the maintenance of a water vapor mixing ratio of 13 $g \cdot kg^{-1}$ and an air temperature of about 28-29°C and a dew point temperature exceeding 18°C. Maintaining and/or exceeding the values of the given parameters resulted in the occurrence, over the 2002-2020 period, of eight thunderstorm days during which more than 60.000 CG flashes/day occurred. Further increases in air temperature may contribute to an increase in the frequency and violence of thunderstorm events, also due to a significant weakening of the impact of the jet stream in mid-latitudes.

Keywords: thunderstorm, lightning, convection, CAPE