

Relationships between the cyclones of southern origin and thunderstorms in Estonia

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This study presents relationships between the frequency and duration of southern cyclones and thunderstorms over Estonia during the period 1950-2010. Three different databases are used in this study. The first of them characterizes the occurrence of southern cyclones, the second one describes the appearance of thunderstorms and the third database describes the appearance of lightning strikes. All of the databases are presented with a daily accuracy. Cyclones of southern origin were filtered out from the database of cyclones in the Northern Hemisphere. In this study, “southern cyclones” are defined as lows that have formed south of 47°N, east of the 0° meridian, west of 60°E, and have entered into the circle of 1000-km radius around Estonia.

557 southern cyclones were detected during the 61 years under observation. It was found that 159 cyclones (28.5%) of all southern cyclones induced a thunderstorm in Estonia. Based on the data of five meteorological stations, on an average 1039 days with thunderstorms were detected in Estonia during this time. 9.4% of all observed thunder days were associated with southern cyclones. One clear peak is visible in 1972, when there were 15 thunder days related to southern cyclones in Estonia (Figure 1).

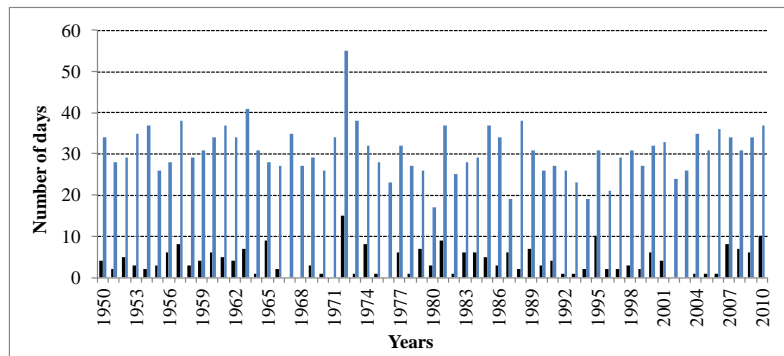


Figure 1. Number of days with a southern cyclones (black) and other events (blue) in the 1000 km circle around Estonia, which were associated with thunderstorms during the period 1950-2010.

During the thunder season from April to October, 40.6% of southern cyclones were related to thunder. Monthly distribution of southern cyclones related thunder days (Figure 2) demonstrates a sharp maximum in summer months when 60-80% of southern cyclones caused thunder. The highest counts (62 thunder days per 61 years) were recorded in August. Almost as high numbers of thunder days were detected in other summer months. The largest number of thunder days was detected when southern cyclones passed a station at a closer distance than 500 km. At two stations, the annual average number of thunderstorms induced by southern cyclones has increased in the cases when the cyclones passed Estonia from the east within the distance up to 500 km. In the cases when the cyclones passed Estonia from the west at a longer distance than 500 km, the annual length of a thunderstorm increased by 1.5 hours in one station.

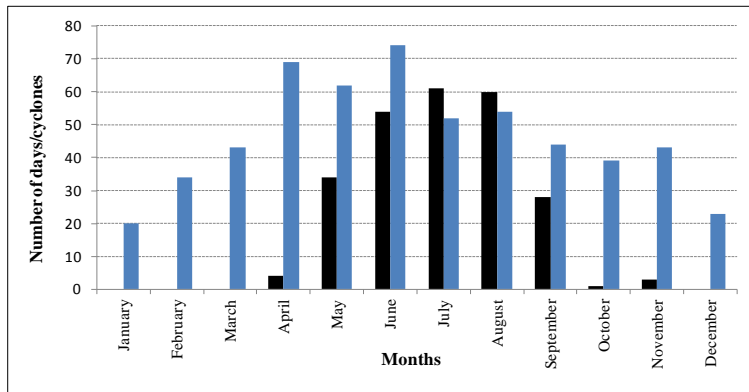


Figure 2. Monthly numbers of thunder days associated with southern cyclones (black) having caused a thunder at least at one station and number of southern cyclones (blue) during the period 1950-2010

Annual mean duration of thunderstorms caused by southern cyclones is about 3 hours. It constituted 9.3 per cent of the annual duration of all thunder events. This percentage was 9-12 for coastal and inland stations but only 3 for the maritime Vilsandi station. Comparing the duration of thunderstorms associated with southern cyclones and other thunder events, the duration of southern cyclones-related thunderstorms was clearly higher at three stations: Pärnu, Tallinn, and Tartu. A general regularity appeared that a longer duration of thunderstorms was detected when the central point of a SC passed Estonia at a distance less than 500 km. Sometimes southern cyclones can cause very long thunders, for example in Vilsandi on 1 July 1970 thunderstorm lasted 9h 12 min and on 27 August 1972 9h 6min. There were no statistically significant changes in the spatial mean annual duration of thunderstorms caused by southern cyclones during 1950-2010 but in some years thunderstorm duration of southern cyclones constitute 30-40% from thunderstorm duration of other events(Figure 3).

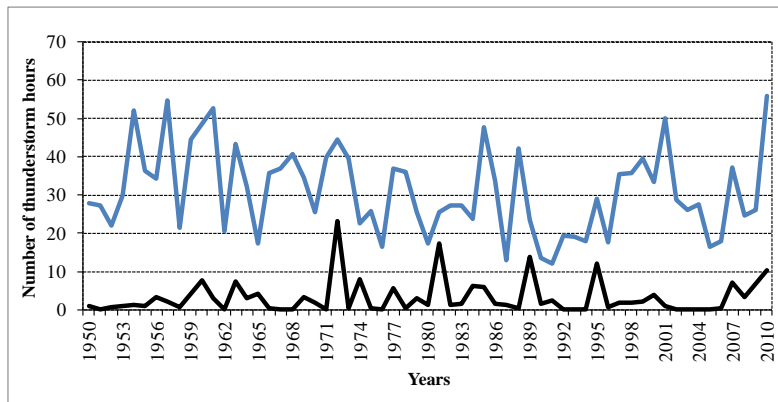


Figure 3. Annual spatial average duration of thunderstorms related to southern cyclones (black line) and not related to them (blue line) in Estonia in 1950-2010.

The number of cloud-to-ground lightning strikes, induced by southern cyclones, was about three times larger than that of any other thunder events. The numbers of cloud-to-ground lightning strikes caused by southern cyclones have been much higher in 2007, 2009 and 2010. In 2009, the number of southern cyclones induced lightning strikes has

been almost ten times higher than that of the lightning strikes initiated by other thunder events. Despite of very short time series of NORDLIS thunderstorms related to southern cyclones clearly stands out by much higher counts of lightning strikes than other thunder events.