A Study of Upward Flashes Initiated at the Säntis Tower

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Abstract— In this paper, we present an analysis on upward negative flashes recorded at the Säntis Tower. The effect of time and distance constrains on the percentage of other-triggered versus self-triggered events is discussed. The results show that the majority of the upward flashes are self-triggered which is in agreement with previous studies conducted for towers located in the Alps region. The study features in addition a test of the causality relation between upward flashes and preceding nearby lightning activity. Investigation on correlated meteorological measurements reveals on average higher temperature values for flashes preceded by prior activity (other-triggered events) compared to self-triggered flashes.

Keywords- Upward lightning, self-triggered flashes, other-triggered flashes, Säntis Tower, lightning current measurement

I. DATA

Upward lightning flashes originated from tall elevated objects are classified into the so-called self-triggered and other-triggered events (e.g., [1][2]). A 'self-triggered' flash is a tower flash that is not preceded by lightning within a predefined area around the tower and within a given time interval prior to the tower flash. An 'other-triggered' flash is a tower flash preceded by cloud-to-ground or cloud flash activity within a predefined distance to the tower and within a prior time interval. The causality relation between other-triggered flashes and the preceding activity has not been established [3]. The recorded upward negative flashes recorded at the Säntis Tower [4] in the time period from 2010 to 2013 were analyzed in this study. The preceding events are determined using the provided data by European Lightning Location Network (EUCLID) [5].

II. RESULTS

Using a time interval of 5 s and a circular area of 30 km around the Säntis Tower, 92 out of the 118 (78%) analyzed upward flashes were found to be self-triggered while 26 (22%) were classified as other-triggered.

Concerning the polarity of the flashes, 24 out of the 26 other-triggered flashes were initiated by discharges of the opposite polarity (positive), which is consistent with the observations at the Gaisberg Tower [1].

In addition, the causality relation between preceding nearby flashes and upward flashes from the tower was tested by examining the events that occurred after the tower flash as proposed in [3]. Using the same time and space constraints chosen for the preceding flashes, 12 out of the 118 (10%) upward events exhibited post-tower-flash lightning activity.

Interestingly, only 4 out of the 92 (5%) self-triggered flashes were followed by lightning discharges. This leads to the conclusion that it is less likely for post-tower-flash lightning activity to occur if the tower flash was self-triggered. However, due to insufficient number of other-triggered events with post-flashes (flashes occurring after an upward tower discharge) in the period of analysis, no definitive conclusion can be made concerning any causality relation between upward flashes and nearby lightning activities.

The meteorological conditions at the time of the tower strikes were also investigated, with a focus on temperature variation, precipitation and wind speed. It was found that most of the other-triggered flashes occurred during warmer weather than self-initiated ones (mean temperature of $+8.7^{o}$C and $+2.1^{o}$C, respectively), which is similar to the analysis performed on the Gaisberg Tower in Austria [1].

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