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April 27-30, 2020
Broomfield, Colorado, USA

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Analyses of Ground Truth Positive Flash Data and Corresponding Lightning Location System Performance

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Abstract

This paper presents recent analyses of positive cloud-to-ground flashes recorded in the Austrian Alps during warm thunderstorm season from May to August in 2015, 2017 and 2018. Measurements and analyses were carried out by Graz University of Technology in collaboration with the operator of the Austrian lightning location system ALDIS. The project "Lightning Observation in the Alps – LiOn" was initiated to get ground truth data of atmospheric discharges for different measurement sites in the Alpine region. Lightning discharges were observed at 21 different measurement locations using a Video and Field Recording System (VFRS). This system consists of a high speed video camera (2000 frames per second) and a flat plate antenna to measure the electric field. Both systems are synchronized to GPS time and can therefore be correlated with Lightning Location System (LLS) data. The recorded data sets are used to better understand the atmospheric discharges, especially in the alpine area. Furthermore, LLS performance evaluations have been carried out.

The data set of positive flashes was analyzed regarding the percentage of single stroke flashes, multiplicity, LLS return stroke peak currents of all strokes and the detection efficiency (DE). The overall data set for measurements in 2015, 2017 and 2018 showed 59 positive flashes comprised of 71 strokes.

The percentage of positive single stroke flashes for the VFRS data and the LLS data is 83 % and 75 %, respectively, for the merged dataset from 2015, 2017 and 2018. This is a rather low single stroke flash percentage compared to previous analyses for Austria but the percentage is situated within the range of previously published values for other countries. For the analyzed VFRS data the mean multiplicity for positive flashes is 1.2. This is higher than the mean multiplicity of 1.1 obtained in a previous study based on VFRS data recorded between 2008 and 2012 in Austria. The median return stroke peak current of all positive strokes in Austria is 43.8 kA (peak currents estimated by the LLS) for the merged dataset of 2015, 2017 and 2018, which is again higher than reported for previous investigations with a VFRS in Austria (34 kA) and for a merged dataset from the U.S., Austria and Brazil (39.4 kA).

The DE of correctly detected positive flashes and strokes (i.e. every assignment of the LLS detection, e.g., polarity, IC/CG stroke categorization, can be confirmed as correct with the VFRS data) is 93.2 % and 83.1 %, respectively, for the merged dataset. Former investigations on the DE for positive flashes resulted in higher values for data from Austria (97 % for flashes and 92 % for strokes; data from 2008 to 2010 and 2012). Results for data from the U.S. showed lower values for the flash DE but higher values for the stroke DE (89 % for flashes and 88 % for strokes; data from 2009) compared to present findings.

Results of this report shall contribute to a better understanding of lightning processes in general and in the Alpine region in particular.

Topic Areas

Lightning Physics, Characteristics and Measurements, Lightning Detection Systems
Technology and Performance

Submission Format

Oral