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RESEARCH ON LIGHTNING PHENOMENA IN THE ALPS

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Introduction

Cloud-to-ground flashes in the European Alpine Region show some specific characteristics not being observed in other regions of the world. One of them is the observation of a remarkable higher percentage of single stroke flashes during warm-season thunderstorms. This research project is divided in two parts

- Investigation of the high percentage of negative single stroke flashes
- Performance of a detailed study of flash and stroke parameters for the Alpine Region

For regions where cloud-to-ground flashes show untypical behavior, scientific based knowledge is of importance for the society in order to provide valid parameters for lightning protection as well as for engineering purposes.

Percentage of Single Stroke Flashes in the Alpine Region

Numerous studies to determine the number of strokes per flash (multiplicity) have been performed for many regions of the world. A comprehensive review of these studies leaded to percentages of single stroke flashes between 14 % and 20 % which are well established values in the lightning scientific community. Studies in the Alpine Region showed about 30 % single stroke flashes. Such high values of single stroke flash percentages are unique and to our best knowledge nowhere else observed in the world. Figure 1 shows the observed differences in the percentage of single stroke flashes in the eastern Alps [1] compared to Arizona and São Paulo as reported by Saraiva et al., 2010. [2]

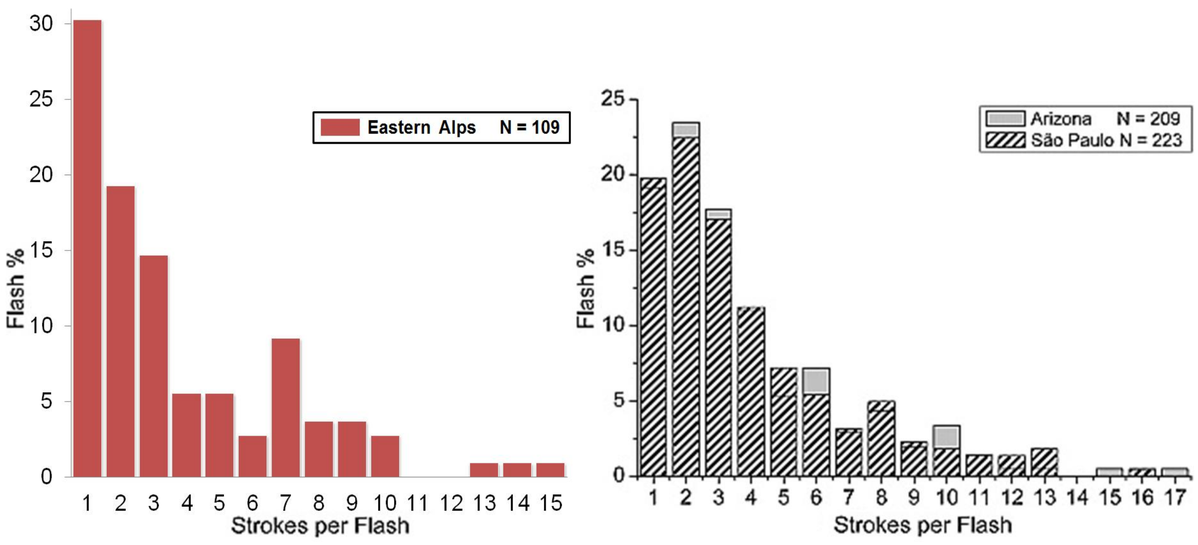

Figure 1: Percentage of flashes versus number of strokes per flash
Left: The eastern Alps [1], Right: Arizona and São Paulo [2]

Lightning Parameters

The basic parameters for lightning protection are to a high extend based on direct lightning current measurements such as

- Natural lightning to instrumented towers
- Artificial rocket triggered lightning

Direct current measurement is the main advantage of these methods but the local restriction and the typical attraction of upward flashes can be seen as disadvantages. Downward flashes, especially negative downward, typically occur during conventional thunderstorms. Further methods and new approaches are needed to derive reliable parameters from measurements which can be

- Conducted location independent
- Applied to all types of cloud-to-ground lightning

Instrumentation and Data

Within the context of our research work [3] we will now investigate cloud-to-ground flashes by using a mobile ground truth data providing system. Figure 2 shows the schematic of the applied Video and Field Recording System (VFRS) operated in the field.

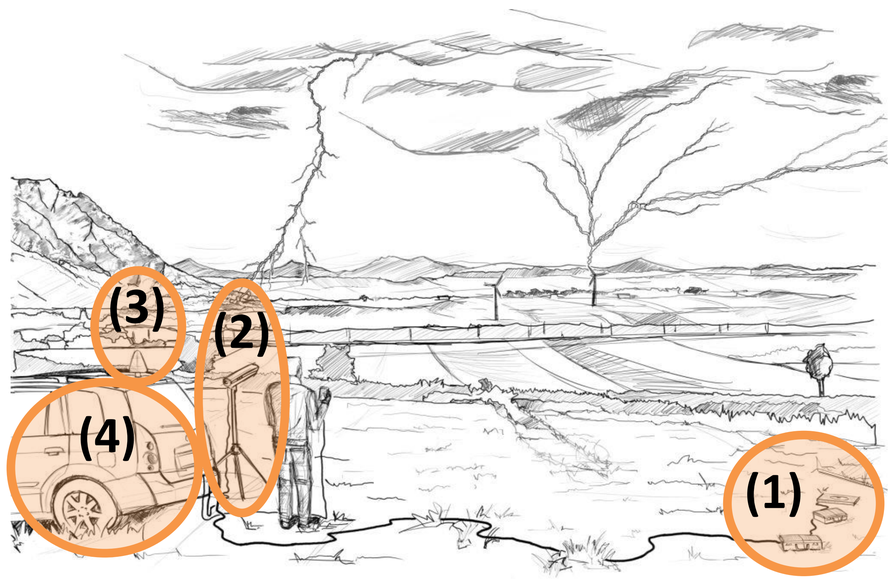

Figure 2: Schematic of the Video and Field Recording System operated in the field: (1) Electric field sensor, (2) Camera, (3) GPS antenna, (4) Car with inside components (e.g. data acquisition)

The VFRS allows the recording of optical and electromagnetic properties of cloud-to-ground flashes at high time resolution. The sensors of this system are designed to be sensitive to particular processes of cloud-to-ground flashes. Figure 3 shows the electric field record including the time-corresponding video frames for a negative cloud-to-ground flash return stroke measured with the VFRS in May 2015.

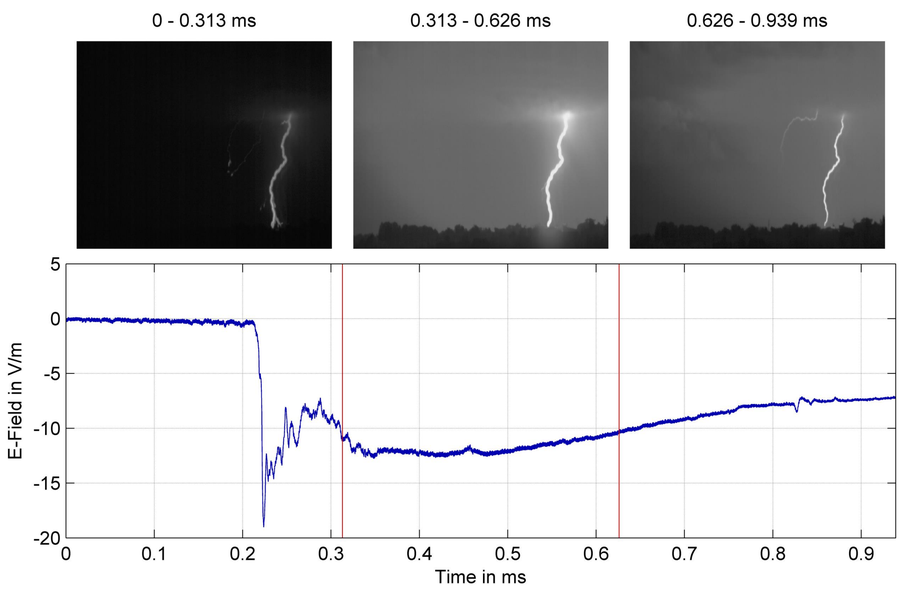

Figure 3: Electric field record with the corresponding video frames of a negative cloud-to-ground flash return stroke sequence measured with the VFRS
Top: Electric field vs. time, Bottom: Time corresponding video frames

Outlook

Starting in 2015, the VFRS will be carried out for a two year period in order to observe natural cloud-to-ground flashes during warm-season thunderstorms throughout the Alpine Region. Lightning location data and meteorological data will also be collected for each observation day in order to get information about each observed storm and its characteristics. Based on the expected comprehensive high resolution data we will find reasons for what makes the Alpine Region more attractive for negative single stroke flashes. Additionally we will introduce new approaches and develop alternative methods to derive and estimate lightning parameters by using indirect measurements. Our fundamental and comprehensive study on cloud-to-ground flashes in complex terrain, such as the Alpine Region, will lead into new insights and will help to improve our understanding of the physical processes of lightning.

References:

[1] C. VERGEINER: “Diplomarbeit – Elektrische Feldmessungen atmosphärischer Entladungen“, Technische Universität Graz, 2011

[2] A. C. V. SARAIVA, M. M. F. SABA, O. JR. PINTO, K. L. CUMMINS, E. P. KRIDER, L. Z. S. CAMPOS: "A comparative study of negative cloud-to-ground lightning characteristics in São Paulo (Brazil) and Arizona (United States) based on high-speed video observations", Journal of Geophysical Research, Vol. 115, D11102, doi:10.1029/2009JD012604, 2010

[3] W. SCHULZ., C. VERGEINER, H. PICHLER, G. DIENDORFER, S. PACK: “Validation of the Austrian Lightning Location System ALDIS for negative flashes”, CIGRE C4 Colloquium on Power Quality and Lightning, Sarajevo, Bosnia and Herzegovina, 2012