

## DESCRIPTION FOR THE GENERAL PUBLIC

The goal of the project is to conduct research on atmospheric electricity. The project focuses on atypical atmospheric discharges, which were recently discovered. As opposed to the well-known cloud-to-ground discharges (often called lightning strikes or flashes), they do not strike the ground, but occur during the thunderstorms above the cloud tops. They are called upper discharges. This type of atmospheric discharges was first captured accidentally by a video camera. The following aircraft missions over the thunderstorms provided a number of video images of these unusual phenomena. They have huge sizes and various forms. Typically, they look like massive light objects going from the cloud tops towards space. The visual phenomena associated with them are called Transient Luminous Events. The most common is Sprite, Elves and Blue Jet. Rare but very spectacular event is called the Gigantic Jet, and it generates a huge amount of energy. Sprite is usually caused by a particularly strong positive cloud-to-ground discharge, in which the fast return stroke is followed by a continuing current between the cloud and the ground. Such discharge causes large destruction in the place it strikes (buildings, trees, towers, people).

The knowledge of upward discharges is still not very extensive. The research conducted by the authors of this project will broaden the knowledge about their physical parameters (e.g., how large was the electrical current between the cloud and the ionosphere during the discharge, and how much charge was transferred from the cloud). We will also find out how often these discharges occur close to us, in central Europe. To study them from a long distance, the authors will use electromagnetic waves generated by atmospheric discharges. Upward discharges generate most of the energy in the extremely low frequency (ELF) range of radio waves, from below 1 Hz up to a few hundred Hz. Therefore, the authors will study these waves in their research. ELF radio waves feature a very low attenuation. That is why it is possible to record upward discharges from distances as long as a few thousand kilometers.

To obtain the physical parameters of upward discharges, the authors will build an innovative broadband ELF radiolocation system, which will enable them to monitor both cloud-to-ground and upward discharges. The system will consist mainly of three ELF receivers and three sets of antennas. Each set of antennas will have two magnetic antennas, one directed north-south and the other east-west. Simultaneously the authors will conduct optical observations using high sensitivity cameras. The main problem when recording extremely low frequency signals is to find location, where the level of electromagnetic noise is low enough to enable high data quality. For that reason, the authors will first make short reconnaissance expeditions with hand-held equipment. This will allow them to preselect the locations. Next, they will lead measurement campaigns using the developed stations.

Next, the authors will conduct continuous observations. High accuracy in the calculation of the discharge parameters will also be possible thanks to experience that the authors have in the modeling of radiowave propagation and in the signal processing. Within the project the models will be improved further, to enable their use in a much wider frequency range than it is possible with the current models.

The experimental system built within the project will set a new standard for future lightning monitoring systems. It will record both the cloud-to-ground lightning discharges and the upward discharges. Building first such system by Polish researchers will be of great importance for the science.