Lightning Mapping and Electric Field Observations of Naturally Induced Upward Positive Leaders from Wind Turbines

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During the 2013 summer season several instruments were deployed in and around a wind farm in Kansas to study upward leaders from wind turbines. Among these were a ten-station compact Lightning Mapping Array (LMA), an eight-station slow antenna network, two continuously-recording electric field mills, two fixed continuously-recording video camera, and several mobile high-speed video cameras. Data is also available from the Duke charge moment change network, which was enhanced for this project by a broadband B-field sensor located near the wind farm, and another sensor located about 100 km away.

Previous studies have documented the fact that upward leaders develop from tall structures in response to nearby natural lightning discharges. In particular, the local field change at a tall structure due to a nearby positive cloud-to-ground stroke will often induce an upward positive leader (UPL) from the tall structure, which can be followed by negative dart leader-return stroke sequences to the structure. One goal of the project was to quantify the conditions which induced the formation of such UPLs from wind turbine generators. The slow antennas in this project were able to quantify the field changes created by nearby natural lightning which led to UPLs.

During the project there were three video captures of UPLs from wind turbines. In two of the three cases, nearby positive CG discharges induced UPLs from several nearby turbines. In both of these cases, turbines were struck by strokes which developed from dart leaders propagating down one of the UPL channels.

In the third case, an intra-cloud (IC) discharge induced a UPL from one of the turbines. The LMA shows that a lower positive charge region above the wind farm was discharged by IC activity. The field change from this induced the UPL, which was visible on a high-speed (9,900 fps) video for about 300 ms. Two M-components temporarily brightened the UPL channel. The closest slow antenna showed that the M-components were due to pulses of negative charge travelling down the UPL channel.

We will discuss the data from the slow antenna network, as well as the field mills and charge-moment-change instruments, and quantify the conditions which induced the UPLs, in the context of the lightning channels documented by the LMA.