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Influence of wind turbines on the local lightning flash density

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Lightning may cause severe damage to large size wind turbines because they are tall structures with a higher probability of being struck by normal negative cloud-to-ground lightning than their surroundings (Rachidi et al., 2008) and they include sensitive equipment. On the other hand, Montanya et al. (2014) showed that upward discharges of different types can develop from wind turbines, some leading to fully developed upward lightning discharges. This study aims to estimate the possible effect of the presence of such tall structures on lightning stroke location in areas where they are installed. For that, a test area is considered with several wind turbines farms presenting a diversity of number of turbines, of altitude and surrounding relief, of height of the structures, of distance between the turbines... The reference period is long enough to can consider several years before and after the installation of each farm. Thus, we analyse the cloud-to-ground (CG) lightning activity recorded by Météorage during 25 years (1995-2014) in a $0.5^\circ \times 0.5^\circ$ area in south-eastern France (2.5° E-3° E; 44° N-44.5° N that contains 9 farms of wind turbines. The number of turbines in these farms ranges between 1 and 25 and the installation dates from 2005 to 2010.
The methodology of the study consists in a comparison of the lightning flash (stroke) density calculated at different spatial resolutions, i.e. from a resolution corresponding to the size of the farms ($0.01^\circ \times 0.01^\circ$) to a high resolution ($0.002^\circ \times 0.002^\circ$) in the area around each turbine farm. This first approach allows us clearly identifying a reinforcing of the lightning flash (stroke) density within the perimeter of the wind turbine farms. The high resolution plots bring out the individual effect of the turbines. On the quantitative aspect, the ratios of stroke density calculated between the restricted area around the turbines when they are concerned by the thunderstorm and that out of this area and concerned by the same storm, can reach values around 5. Indeed, this effect is observed when the storm activity is close to the farms of wind turbines. The characteristics of the flashes (strokes) in the areas of the wind turbines are analyzed and compared to the average characteristics of those occurring in the rest of the test area.

References:

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