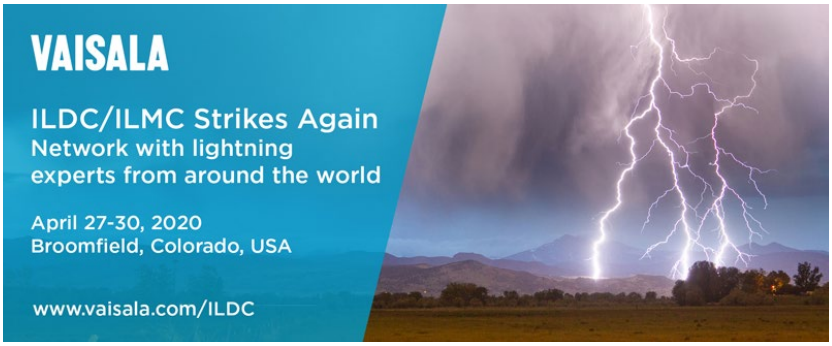

Supercharging lightning data with distributional regression

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Abstract

Data collected with lightning locations systems (LLS) contain rich information which distributional regression techniques can efficiently extract. They improve upon classical methods for compiling lightning climatologies and make probabilistic forecasting of lightning possible. We demonstrate these applications with data from the Austrian Lightning Detection and Information System (ALDIS) for the years 2010 through 2017.

Having eight years of data for a climatology is a fairly small sample size. Consequently, using the classical approach of averaging counts in space-time pixels will lead to noisy results since variance increases when sample size decreases. Noise increases further when pixel size decreases, e.g. to 1 km^{-2} day^{-1}. A way out of this problem is to use not only information of each pixel individually but to add information from other pixels that share some characteristics. Distributional regression with generalized additive models (GAMs) allows one to decompose the space-time field into smooth effects of these characteristics, e.g. elevation, season, and geographical location. As GAMs are able to deal with the noisy lighting data effectively, climatologies can be obtained with higher resolutions in space and time. Further, this technique allows one to examine the separate contributions of elevation, season and location. We demonstrate the advantages of the regression method over the classical method with a 1 km^{-2} day^{-1} climatology for a region in the Eastern Alps. Moreover, stratifying the results by typical weather patterns allows to study the effects of different synoptic conditions leading to thunderstorms. We derive these weather patterns from analyses of the European Centre for Medium-Range Weather Forecasting (ECMWF).

Forecasts from ECMWF have until recently not included lightning. We show how to employ distributional regression for automatic selection of skillful predictors from a candidate pool of ECMWF ensemble parameters. The resulting scheme produces skillful probabilistic forecasts of both lightning occurrence and intensity for up to 5 days in advance on a scale of 18 km x 18 km. Predictability is higher over the complex terrain of the Eastern Alps than over surrounding lowlands. This is due to frequent forcing by orographic lifting, lee effects and thermally-induced circulations, all of which are common in regions of complex topography.

Using distributional regression and GAMs thus extracts further information about the spatio-temporal distribution of lightning both in the past and the future.

Topic Areas

Meteorology: Numerical Modeling and Nowcasting, Lightning Climatology

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