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Abstract

High-Resolution Modeling of Lightning Ignition Likelihood in Spain †

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Lightning-caused fires are comparatively rare in Europe, but they may affect remote forested areas and result in large-scale burnings. One of the major hot-spots of lightning fires in Europe lies in Spain, with remarkable ignition counts in the northwest part of the country (el Bierzo) and along certain Mediterranean mountain ranges (Sistema Ibérico). These regions experience frequent thunderstorms and host dense vegetation communities that lead to high rates of natural fires (30% versus the 10% national average).

Here we analyze a large and comprehensive record of hourly cloud-to-ground lightning strikes (>17,000,000), coupled with historical records of lightning fires (>11,000) to determine the biophysical controls (relief, fuel moisture and vegetation structure) and lightning characteristics (flash intensity, polarity and density of discharges) behind natural fires in Spain (2009–2015). The modeling approach combines machine learning techniques and high-resolution proxies (30 m in vegetation height and elevation; 9 km in daily fuel moisture estimates) of the listed variables to train a predictive model encompassing mainland Spain. Relief features (elevation, topographic position index and relief curvature) were computed from the NASADEM global DEM. Tree height was retrieved from the Global Forest Canopy Height. The necessary weather-related inputs to calculate FMC were obtained from the C3S. We tested multiple configurations of strike-to-fire associations and resampling techniques to explore different binary response variables.

The final model was subsequently applied to produce broad- (upscaling into 1 km) and local-scale predictions of daily lightning fire likelihood. The model attains a good predictive performance with a median AUC of 0.82. Lightning-related ignitions triggered preferably under low dead (dFMC8%) and moderate alive (DC > 250) fuel moisture conditions. Lightning strikes with negative polarity were found to trigger fires more frequently when the average density of discharges is higher than 5 at higher altitudes, especially above 500 m.a.s.l.

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