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Understanding the Nexus of Lightning Characteristics and Wildfire Ignition in a Changing Climate

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Wildfires are a key element of ecosystems, contributing to their equilibrium. However, the recent increase in large wildfire occurrence in some areas poses a challenge to both humans and nature. Lightning is the main source of natural wildfires and produces some of the largest wildfires in the world. Climate projections and measurements indicate a future increase in lightning over intact forests, especially at high latitudes.

In this study, we investigate the relationships between lightning and wildfires. Specifically, we systematically analyze the role of lightning continuing currents in wildfire ignitions. Continuing currents, which persist for more than 10 ms, are present in approximately 10% of lightning flashes. However, their occurrence rates differ between negative and positive lightning, while positive lightning are less common than negative. Positive lightning with continuing currents is preceded by a large peak current, whereas negative lightning with continuing currents lacks a high peak current, which makes their detection difficult. In turn, continuing currents are more common in positive lightning. We combine ground-based Extremely Low Frequency (ELF) sensors, ground-based Very Low Frequency (VLF) sensors, and the optical space-based instrument Geostationary Lightning Mapper (GLM) to analyze the role of continuing currents in wildfire over United States [1]. In turn, we analyze the ELF signal and the recorded video of a flash producing a wildfire in the Alps. We confirm that lightning with continuing current have a higher probability than typical lightning to produce a wildfire.

Apart from the characteristics of lightning producing wildfires, meteorology and fuel availability play a key role in the probability of wildfire ignition and detectability [2]. We analyze the preferential meteorological conditions of lightning-induced wildfires in different ecoregions and perform projected simulations with a chemistry-climate model to determine the role of total lightning and lightning with continuing currents in wildfire ignitions under climate change. According to our modeling results, lightning will increase globally, but lightning with continuing currents could decrease or stay constant in some regions. Together with obtained non-homogeneous variations in precipitation and humidity, we obtain that climate change can produce a significant change in the global pattern of lightning-ignited wildfires. These results underscore the importance of investigating the characteristics of thunderstorms that produce lightning with continuing currents and their role in the ignition of wildfires. This research is essential for enhancing models of wildfire occurrence.

1. F. J. Pérez-Invernón, J. V. Moris, F. J. Gordillo-Vázquez, M. Füllekrug, G. B. Pezzatti, M. Conedera, J. Lapierre and H. Huntrieser, “On the Role of Continuing Currents in Lightning-Induced Fire Ignition”, J. Geophys. Res. Atmos., 128, October 2023, e2023JD038891, doi: 10.1029/2023JD038891.

2. F. J. Pérez-Invernón, F. J. Gordillo-Vázquez, H. Huntrieser and P. Jöckel, “Variation of lightning-ignited wildfire patterns under climate change”, Nature communications, 14(1), February 2023, 739. doi: 10.1038/s41467-023-36500-5