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Exploring environmental factors driving wildfire occurrences in Alaskan tundra

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Tundra fires are common across the pan-Arctic region, particularly in Alaska. Fires lead to significant impacts on terrestrial carbon balance and ecosystem functioning in the tundra. They can even affect the forage availability of herbivorous wildlife and living resources of local human communities. Also, interactions between fire and climate change can enhance the fire impacts on the Arctic ecosystems. However, the drivers and mechanisms of wildland fire occurrences in Alaskan tundra are still poorly understood. Research on modeling contemporary fire probability in the tundra is also lacking. This study focuses on exploring the critical environmental factors controlling wildfire occurrences in Alaskan tundra and modeled the fire ignition probability, accounting for ignition source, fuel types, fire weather conditions, and topography. The fractional cover maps of fuel type components developed Chapter 2 serve as input data for fuel type distribution. The probability of cloud-to-ground (CG) lightning and fire weather conditions are simulated using WRF. Topographic features are also calculated from the Digital Elevation Model (DEM) data. Additionally, fire ignition locations are extracted from Moderate Resolution Imaging Spectroradiometer (MODIS) active fire product for Alaskan tundra from 2001 to 2019. Empirical modeling methods, including RF and logistic regression, are then utilized to model the relationships between environmental factors and wildfire occurrences in the tundra and to evaluate the roles of these factors. Our results suggested that CG lightning is the primary driver controlling fire ignitions in the tundra, while warmer and drier weather conditions also support fires. We also projected future potential of wildland fires in this tundra region with Coupled Model Intercomparison Projects Phase 6 (CMIP6) data. The results of this study highlight the important role of CG lightning in driving tundra fires and that incorporating CG lightning modeling is necessary and essential for fire monitoring and management efforts in the High Northern Latitudes (HNL).