

EGU2020-8347

<https://doi.org/10.5194/egusphere-egu2020-8347>

EGU General Assembly 2020

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Wildfire Detection Probability of MODIS Fire Products under the Constraint of Environmental Factors: A Study Based on Confirmed Ground Wildfire Records

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The Moderate Resolution Imaging Spectroradiometer (MODIS) has been widely used for wildfire occurrence and distribution detecting and fire risk assessments. Compared with its commission error, the omission error of MODIS wildfire detection has been revealed as a much more challenging, unsolved issue, and ground-level environmental factors influencing the detection capacity are also variable. This study compared the multiple MODIS fire products and the records of ground wildfire investigations during December 2002–November 2015 in Yunnan Province, Southwest China, in an attempt to reveal the difference in the spatiotemporal patterns of regional wildfire detected by the two approaches, to estimate the omission error of MODIS fire products based on confirmed ground wildfire records, and to explore how instantaneous and local environmental factors influenced the wildfire detection probability of MODIS. The results indicated that across the province, the total number of wildfire events recorded by MODIS was at least twice as many as that in the ground records, while the wildfire distribution patterns revealed by the two approaches were inconsistent. For the 5145 confirmed ground records, however, only 11.10% of them could be detected using multiple MODIS fire products (i.e., MOD14A1, MYD14A1, and MCD64A1). Opposing trends during the studied period were found between the yearly occurrence of ground-based wildfire records and the corresponding proportion detected by MODIS. Moreover, the wildfire detection proportion by MODIS was 11.36% in forest, 9.58% in shrubs, and 5.56% in grassland, respectively. Random forest modeling suggested that fire size was a primary limiting factor for MODIS fire detecting capacity, where a small fire size could likely result in MODIS omission errors at a threshold of 1 ha, while MODIS had a 50% probability of detecting a wildfire whose size was at least 18 ha. Aside from fire size, the wildfire detection probability of MODIS was also markedly influenced by weather factors, especially the daily relative humidity and the daily wind speed, and the altitude of wildfire occurrence. Considering the environmental factors' contribution to the omission error in MODIS wildfire detection, we emphasized the importance of attention to the local conditions as well as ground inspection in practical wildfire monitoring and management and global wildfire simulations.