

用深度学习结合极轨和地球静止卫星数据 测 火蔓延期的火灾辐射功率

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摘 要:火灾辐射功率(FRP)是一种衡量野火强度的重要指标,相较于传统的实时火线或燃烧区域信息,FRP 能够提供更为详细和精确的火灾动态数据。这对于优化消防行动和评估环境污染具有至关重要的作用。传统方法只能提供二元的火灾存在与否的信息,而 FRP 可以定量地反映火灾的强度。因此,准确预测 FRP 数据成为了野火管理和响应中的关键任务。为了实现这一目标,我们利用了地球静止卫星和极轨卫星的数据融合来校正和优化 FRP 数据。地球静止卫星能够提供高时间分辨率的数据,而极轨卫星则能提供高空空间分辨率的数据,通过两者的互补结合,我们能够获取高质量的 FRP 数据。此外,我们还综合考虑了气象条件(如风速、湿度、气温等)、地形(如海拔、高差等)、植被指数(如 NDVI)、人口密度等多种影响野火蔓延的因素,从而构建了一个覆盖 2017 年以来加州野火的综合数据集。基于这些数据,我们开发了一个深度学习框架,该框架集成了多个模块以处理和分析多模态数据。我们研究了输入序列长度和损失函数设计对模型预测性能的影响。通过对这些参数的系统研究,我们逐步优化了模型,使其在 FRP 预测上表现出色。此外,我们的深度学习模型在迁移学习和多步预测方面也展示了良好的性能。这对于提前部署消防资源、制定应急响应计划具有重要意义。

关键词: 深度学习; 野火蔓延; 火辐射功率; 遥感

Predicting Fire Radiative Power From the Combination of Polar-Orbiting and Geostationary Satellite Data During Wildfire Spread by Using Deep Learning

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Abstract: Fire radiative power (FRP) is an important indicator for measuring the intensity of wildfires. Compared to traditional real-time fire line or combustion area information, FRP can provide more detailed and accurate fire dynamic data. This plays a crucial role in optimizing firefighting actions and assessing environmental pollution. Traditional methods can only provide information on the presence or absence of binary fires, while FRP can quantitatively reflect the intensity of fires. Therefore, accurately predicting FRP data has become a key task in wildfire management and response. To achieve this goal, we utilized data fusion from geostationary and polar orbit satellites to correct and optimize FRP data. Geostationary satellites can provide high temporal resolution data, while polar orbit satellites can provide high spatial resolution data. Through the complementary combination of the two, we can obtain high-quality FRP data. In addition, we also comprehensively considered various factors that affect the spread of wildfires, such as meteorological conditions (such as wind speed, humidity, temperature, etc.), terrain (such as altitude, altitude difference, etc.), vegetation index (such as NDVI), population density, etc., in order to construct a comprehensive dataset covering wildfires in California since 2017. Based on this data, we have developed a deep learning framework that integrates multiple modules to process and analyze multimodal data. We investigated the effects of input sequence length and loss function design on model predictive performance. Through systematic research on these parameters, we gradually optimized the model to perform well in FRP prediction. In

addition, our deep learning model has also demonstrated good performance in transfer learning and multi-step prediction. This is of great significance for the early deployment of fire resources and the development of emergency response plans.

Key words: deep learning; wildfire spread; fire radiative power; remote sensing