



A Semi-empirical Cellular Automata Model for Wildfire Monitoring From a Geosynchronous Space Platform

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Abstract

The environmental and human impacts of wildfires have grown considerably in recent years due to an increase in their frequency and coverage. Effective wildfire management and suppression requires real-time data to locate fire fronts, model their propagation and assess the impact of biomass burning. Existing empirical wildfire models are based on fuel properties and meteorological data with inadequate spatial or temporal sampling. A geosynchronous space platform with the proposed set of high resolution infrared detectors provides a unique capability to monitor fires at improved spatial and temporal resolutions.

The proposed system is feasible with state-of-the-art hardware and software for high sensitivity fire detection at saturation levels exceeding active flame temperatures. Ground resolutions of 100 meters per pixel can be achieved with repeat cycles of less than one minute. Atmospheric transmission in the presence of clouds and smoke is considered. Modeling results suggest fire detection is possible through thin clouds and smoke. A semi-empirical cellular automata model based on theoretical elliptical spread shapes is introduced to predict wildfire propagation using detected fire front location and spread rate. Model accuracy compares favorably with real fire events and correlates within 2% of theoretical ellipse shapes. This propagation modeling approach could replace existing operational systems based on complex partial differential equations. The baseline geosynchronous fire detection system supplemented with a discrete-based propagation model has the potential to save lives and property in the otherwise uncertain and complex field of fire management.