Development and application of spatially refined remote sensing active fire data sets in support of fire monitoring, management and planning*

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ABSTRACT:

In the U.S., wildfires burn an average of 2.6 million hectares of land each year. Large catastrophic wildfires have become commonplace, especially in association with extended drought and extreme weather. The demand for timely, consistent and quality fire information is high and peaks each summer when interagency fire operations and resource requests are maximized in response to multiple large wildfires. Wildfire response at all government levels requires current and predictive fire information for tactical firefighting, evacuation, and strategic planning to avert or mitigate impacts. In this context, remote sensing active fire datasets, fire modelling tools, and associated geospatial products are essential to Forest Service and interagency fire operations. They provide critical support to fire managers and help inform the public in areas threatened by wildfires. Here we explore recent advances in satellite-based fire detection and mapping, airborne fire mapping and measurement, and coupled weather-wildland fire modelling to routinely map fire extent and progression, examine active fire areas in greater detail, and predict fire growth, intensification, and extreme behaviors of wildfires lasting several days. We used the new Visible Infrared Imaging Radiometer Suite (VIIRS) 375 m active fire detection product for early detection of small fires and improved mapping of large wildfires. These data are complemented by other spatially refined airborne (e.g., NIROPS, FireMapper) and spaceborne (e.g., Landsat-8) fire data sets of more limited geographic and/or temporal coverage. In addition to that, NCAR's Coupled Atmosphere-Wildland Fire Environment (CAWFE) model and the Weather Research and Forecasting (WRF) model with WRF-Fire are used to simulate fire behavior. These not only predict a fire's shape and extent, but extreme behaviors such as fire whirls, blow-ups, flank runs, and pyrocumulus, all resulting from a fire's interaction with its environment, i.e. how the fire creates its own weather. The coupled models were evaluated on numerous cases capturing overall unfolding of events, locations where fires intensified and accelerated, splitting of the head, and flank runs. CAWFE was successfully initialized and validated using the new VIIRS 375 m fire data, enabling accurate simulation of complex fire behavior during long-lasting wildfires. Compared to traditional models, this approach can now be applied to monitor and predict the growth of a fire or a group of simultaneous wildfires in a management unit from first detection until containment – a previously unattainable goal due to accumulation of model error. Combined application of these refined fire remote sensing and modeling technologies improves and extends current fire mapping, monitoring, and prediction tools. In particular: (i) new VIIRS and Landsat-class fire products can routinely monitor the extent of larger fires, (ii) CAWFE uses these data, providing a detailed understanding and prediction of how fires evolve, and (iii) FireMapper data enable detailed mapping of fire behavior and surface temperatures associated with fire intensity on selected fires, while validating both satellite fire maps and CAWFE. Decision support applications include managing wildland fires, estimating emissions of carbon, trace gases, and particulates, and anticipating air quality, watershed, and land surface impacts.