HyspIRI Mission Applications – Fire Behavior

Application Question/Issue

Accurate predictions of fire behavior (e.g. fire intensity and spread) are crucial to support operational fire management and firefighting decisions. Fire behavior depends on topography, weather, and fuels. Fire behavior predictions are based on relationships with these environmental variables. High spatial resolution measurements of fire intensity are required to evaluate and improve these relationships in order to effectively protect real estate and human lives at the wildland-urban interface.

Who cares and Why?

Increasingly, man-made structures are developed within the wildland-urban interface posing significant risk for both property and human lives within reach of wildfires. In many countries the forest service is mandated to protect life and property at risk due to wildfires. Homeowners at the wildland-urban interface, fire managers and firefighters benefit from highly accurate fire behavior predictions. For example, recent estimates show that both suppression cost and property loss values amount up to several million US dollars per single fire in Southern California, an area with recurring fires in a densely populated wildland fire-urban interface. Measurements of fire intensity can help fire management personnel determine flame height, or where and how fast the fire front is spreading, so that they can determine where to put in fuel breaks. Fire intensity predictions need to be based on relationships between fire behavior and environmental variables that were observed at high spatial resolution.

Needed Measurement(s)

Measurements of the energy emitted by fires at a spatial resolution capable of characterizing the flaming fire front are required to derive fire intensity. The 4 μm thermal infrared region is ideally suited to detect and characterize hot targets. To date, no satellite sensors provide these measurements at a desired spatial resolution of less than 100 m pixels. In current coarser resolution satellite images (e.g. from the Moderate Resolution Imaging Spectroradiometer (MODIS) or the Visible Infrared Imaging Radiometer Suite (VIIRS)), the fire front only represents a small fraction of the entire pixel. This compromises the relationships between fire intensity and environmental variables (topography, fuels, weather) that are critical for accurate fire behavior predictions.

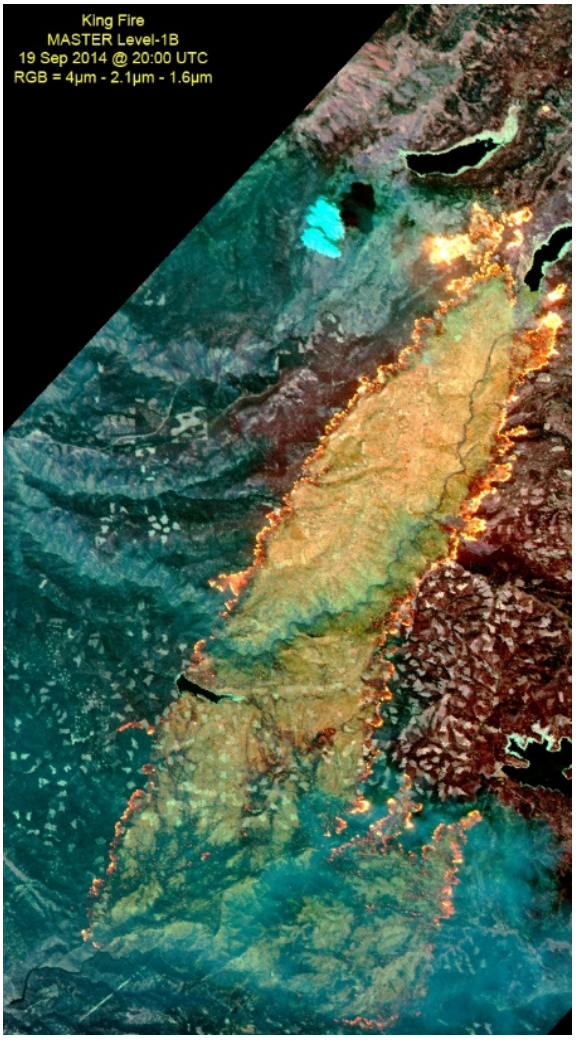
For proactive fire management, we must understand how fuels affect fire behavior. Fuels can be characterized by amount, condition (e.g., live or dead), and fuel moisture content. We can derive fuel characteristics using spectral information from visible to thermal infrared (0.38 to 12 μm) measured by HyspIRI. By understanding how fuels

relate to fire behavior we can manage the land and fuels accordingly, thus providing fuel breaks and fire corridors directing fires away from areas we wish to protect.

The NASA Response

HyspIRI will provide unprecedented global measurements of fire intensity based on fire-emitted radiance in the 4 μm region with high spatial resolution (60 m) across ecosystems and fire types. The 60 m resolution will allow characterization of nearly pure to pure active fire pixels, and thus the flaming front of the fire, which is currently impossible from coarser scale sensors. The saturation temperature for the 4 μm channel is optimized for hot target characterization and set high at 1200 Kelvin. These high quality fire intensity measurements will allow optimized relationships between environmental factors and fire behavior, ultimately providing better predictions of fire behavior and aiding active fire management.

HyspIRI will also continuously monitor fuel conditions. HyspIRI's imaging spectrometer in the visible to shortwave infrared (0.38 to 2.5 μm) will allow detailed characterization of fuel types and composition, while the multispectral thermal (4 to 12 μm) imager will provide information on drought stress and fuel moisture content. This detailed information on fuel conditions from before the fire can then be linked to active fire characteristics.



Comments or Thoughts?

The HyspIRI website is designed to engage the community of practice, accept and process feedback and queries, support interactive workshops and disseminate user tutorials and other pertinent information. Comments and feedback can be sent to hyspiri@jpl.nasa.gov.

Figure 1. MODIS-ASTER (MASTER) airborne simulator image over the 2014 King fire in California, USA, with a spatial resolution similar to that HyspIRI will provide. The active fire front can be clearly distinguished by using the 4 μm band (here input as the red band in the color composite)