A better way to see fires from space

By Sarah Witman
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Tackling big issues like climate change, air pollution, and forest fires is hard enough without unsightly pixels clouding your view.

Edward Hyer, a member of NASA's Air Quality Applied Sciences Team and scientist with the U.S. Naval Research Laboratory (NRL), is helping to clear up some of the problems plaguing wildfire researchers worldwide with his contribution to a recent study.

The NRL group, led by Hyer and National Research Council Postdoc David Peterson and University of Nebraska Professor Jun Wang, set out to investigate improved methods for measuring wildfire intensity from space. They managed to develop an algorithm that could one day be commonplace in this type of research, leading to more accurate fire data. They hope it will also improve forecasts of smoke emissions from large fire events, such as the string of wildfires that impacted thousands of residents along Colorado's Front Range in the summer of 2012.

"There is a growing need for a near real-time fire intensity rating system," the authors of the study say.

The algorithm would, in effect, provide a more precise rating system for wildfires, by using a fire area- and temperature-based measurement of fire intensity. This would allow firefighting teams and air quality forecasters to manage their resources more efficiently during a fire emergency.

The sensors onboard NASA's Terra and Aqua satellites currently allow scientists to keep an eye on wildfires all over the world. But the problem with sensors—now and for the past several decades—is their lack of precision. Researchers have been forced to ask: Is that area on fire, or is that just the smoldering remains of an old blaze? Does this pixel illustrate a small, intense fire or a large, low-intensity fire?

It is not difficult to see how this would be a problem for researchers trying to keep accurate records of wildfires in different regions, not to mention when applying that data to other, related topics like air quality and climate.

All sorts of things can get convoluted when a satellite "sees" a fire ablaze on the Earth's surface: data pertaining to the fire area, the temperature of the fire, the background (non-fire) temperature, or smoke plumes and clouds obscuring the burn site. That's not to mention scientists having to decipher a smoldering versus an actively burning fire, or inconsistencies caused by sunlight or darkness.

What Hyer, Peterson, Wang, and the rest have come up with, then, is a way to create a mosaic of sorts made up of pixel information taken from different tools and programs commonly used in the field, such as the NASA-developed Autonomous Modular Sensor (or AMS). With a very high resolution (3-50 meters), the AMS can be used to produce an unprecedented validation of satellite-retrieved fire area.

A model was used “to account for atmospheric effects,” the authors explain. This allows the satellite to provide a more accurate representation of fire area and temperature, which are then used to calculate fire radiative power—the amount of radiation released by a fire.

They call it a sub-pixel retrieval algorithm, and although it is currently used with MODIS (a measurement instrument aboard the Aqua satellite) it was designed with the intent that it could be adapted to future sensors.

“Over the next decade, the new generation of satellite sensors … will replace the current generation sensors,” the study’s authors say, adding that if their algorithm becomes operational, “the approximate size of the fire front could be calculated at each observation time,” which currently occur up to four times per day. So, scientists would regularly, and much more accurately, be able to analyze meteorological impacts on fire intensity, size and temperature, which are directly related to smoke emissions.

The study also shows that the idea of “pixel clustering” should be used to reduce errors that would otherwise be difficult to characterize from a single pixel. To think of it another way, on a smartphone screen, each pixel contains visual information (most often just a color) that comes together to form something with meaning, like the letters of a text or an image of a friend’s face.

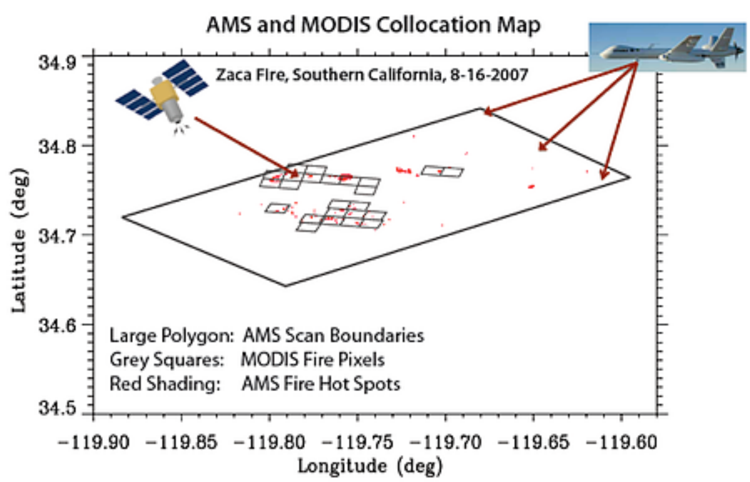
The pixels that come from satellites contain a whole host of data. With the sub-pixel retrieval algorithm, scientists can get information from many sources, correct for overlapping pixels, and result in a clearer idea of where a fire is, its temperature, and even try to calculate an estimate of the amount of trace gasses and particles emitted by the fire, which affect air quality in the atmosphere.

The result is making researchers’ work a whole lot easier, and, it would seem, of a higher quality.

Hyer was able to contribute to the project with support from NASA AQAST. He is one of 19 scholars appointed to AQAST to receive these research funds from NASA for applied sciences. In fall of 2012, he released a new MODIS Level 3 aerosol product that has now been transitioned to NASA LANCE (Land Atmosphere Near real-time Capability for Eos). He is likely to contribute his time to more studies on this subject in the near future.

The full study was published as a two-part series, called "A sub-pixel-based calculation of fire radiative power from MODIS observations," in Remote Sensing of Environment (February 2013).

The first part, entitled "1: Algorithm development and initial assessment," may be found at http://acmg.seas.harvard.edu/aqast/publications.html *and the second part, entitled "2. Sensitivity analysis and potential fire weather application," may be found at* http://www.sciencedirect.com/science/article/pii/S0034425712004087.



The above image depicts an example of the AMS (NASA-developed airborne sensor) and MODIS (NASA satellite sensor) working in conjunction to collect data on a large California wildfire in August 2007. The high-resolution data provided by airborne sensors, such as the AMS, are essential to understanding sub-pixel fire behavior, which can be used to validate satellite fire products.

*NASA AQAST member **Edward Hyer** and his team at the U.S. Naval Research Lab hope that the technology will be accessible for other researchers to use in real-time in the near future.*

Sources

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