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Michigan (MTRI[1]) is a Key Provider of Alaska Wildfire Research

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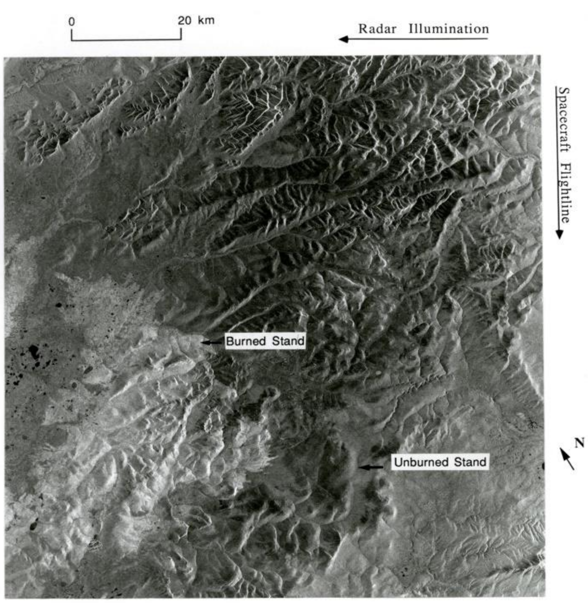
[1] *Michigan Tech Research Institute is a research center of Michigan Technological University based in Ann Arbor, Michigan.* http://www.mtri.org/

A History of Cooperation

In the early 1990's remote sensing experts from Michigan travelled to Alaska to investigate use of the new field of satellite remote sensing to study the Alaskan landscape. At the time, Eric Kasischke, Nancy French, and Laura Bourgeau-Chavez worked at the Environmental Research Institute of Michigan (ERIM). ERIM was at the forefront of development and applications of synthetic aperture radar (SAR) for earth remote sensing, and NASA had just opened the Alaska SAR Facility (now the Alaska Satellite Facility) at the Geophysical Institute on the University of Alaska, Fairbanks campus. Kasischke and his team wanted to explore the ways the European Remote Sensing (ERS) SAR, launched in 1991, might be used to improve our understanding of ecological systems and processes. It turned out that 1990 was a big fire season in Alaska, and burn scars showed up well on the new SAR imagery. This revelation that fire could be detected with a new satellite system provided the impetus for the researchers to connect to fire staff at the Alaska Fire Service. This connection led to improved maps of fires in Alaska and two papers covering the topic of Alaska fire history and trends (Murphy et al 2000; Kasischke et al. 2002).



ERS-1 SAR Image of the 1990 Bettles fire along the Dalton Hwy showing the fire as brighter than the surrounding terrain. The image was collected during the system's commissioning phase in the summer

Initial Fire Research Activities

The team's first fire research studied the extensive fires from the 1990 season, when over 3 million acres burned in the Interior. The fires appeared bright in the SAR backscatter images, and it was not known why. They determined that the enhanced backscatter seen initially after the 1990 Tok fire was the result of high soil moisture conditions at the surface. The loss of forest cover provided a clear view of the ground surface and created conditions of lower transpiration, causing initially wetter conditions visible by the space-based sensor (Kasischke et al. 1994).

At the same time, the team was exploring other ways to use remote sensing to map and monitor forest biomass and fire extent, and to develop methods to study fire effects on soil water status, surface fuel consumption, and post-fire vegetation recovery, resulting in many publications (Bourgeau-Chavez et al. 1997; French et al. 1995; Harrell et al. 1995; Kasischke and Stocks 2000; Kasischke et al. 1995a; Kasischke et al. 1995b; Michalek et al. 2000; O'Neill et al. 2003). During this effort, French and Kasischke worked with the late Don Barry and others from the Alaska Fire Service to digitize the fire perimeters from historical data records, creating the first state-wide digital map of wildland fire perimeters. The digital map database evolved into the current interactive Alaska Fire History Map product hosted by the Alaska Interagency Coordination Center, making spatial fire history and fire records data publicly available for management agencies and researchers alike. This fire history dataset is used extensively by managers today but has also been invaluable to many studying the pyrogeography of the far north (Kasischke et al. 2002).

Research Supporting Fire Management

Over the subsequent two decades, the Michigan-based team extended their Alaskan fire research to focus on the role of fire in carbon cycling. French and Bourgeau-Chavez have built an interdisciplinary fire research program at MTRI that involves eight investigators, plus coordination with geographers at the University of Maryland, where Kasischke is now based. Their research is still based in remote sensing methods and techniques, but focuses on ecologically-driven science inquiries, studies within the field of pyrogeography, and assessment of potential remote sensing applications for fire management.

Research on using remote sensing to map the extent and severity of fire has included assessing the efficacy of Landsat-derived dNBR and field metrics like the Composite Burn Index (CBI) for assessing boreal fire severity (French et al. 2008) and the value of these techniques in other settings, including tundra and peatlands (Loboda et al. 2013). To determine the impact of fire on carbon cycling, the team developed methods to quantify duff consumption and understand the variables that drive consumption and emissions in boreal systems (French et al. 2011; Kasischke and Hoy 2012). These studies are important to fire and fuels management in designing ways to improve fuels mapping and fire behavior and fire danger modeling and forecasting.

The team has also become a leader in developing ways to use SAR for monitoring fuel moisture for fire danger across the boreal and tundra ecosystems of Alaska and western Canada (Bourgeau-Chavez et al. 1999; Bourgeau-Chavez et al. 2013; Bourgeau-Chavez et al. 2007). The bright SAR signal seen in burned areas was shown to be correlated to the Canadian Fire Weather index for deep duff moisture (the Duff Moisture Code). Based on this work, operational use of SAR for fire danger monitoring and validation of Duff Moisture Codes used in fire management decisions has been shown to have real potential. Fire danger validation studies are a top research priority for member agencies of the Alaska Wildland Fire Coordinating Group.

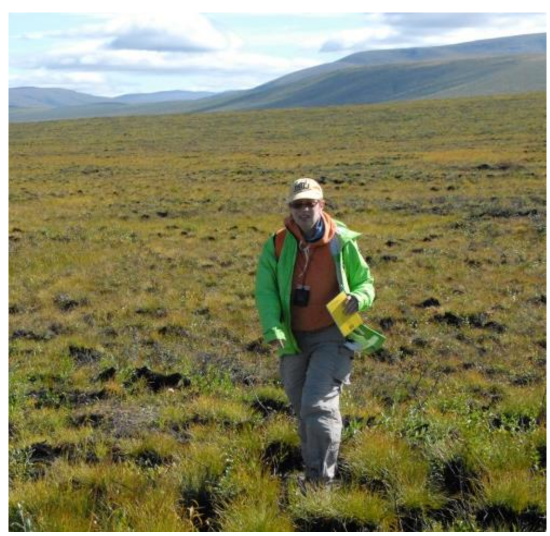
Future Work and the ABoVE Field Campaign

The use of remote sensing and other geospatial tools for characterizing fire in order to understand fire effects, fire extent, and the potential for future fires within Alaska is supported by the the Arctic Boreal Vulnerability Experiment (ABoVE), a new project within the NASA Terrestrial Ecology Program. Members of the Michigan team and collaborators have competed successfully to fund wildfire research for boreal regions under this initiative. Projects by French, Bourgeau-Chavez, and Liza Jenkins at MTRI with Tatiana Loboda at the University of Maryland have focused on using remote sensing for mapping and understanding fire in remote tundra

French and Bourgeau-Chavez collecting ecological data along the Dalton Hwy in the mid-1990's (*Photo by E. Kasischke*)

regions of North America (Jenkins et al. 2014; Loboda et al. 2013; French et al. 2015). Mapping in arctic tundra has not been done as extensively as in the boreal forest and detection flights can be costly. This work will include field-based assessments of fire sites in Alaska and western Canada.

Bourgeau-Chavez and French are also funded through the ABoVE program to consider impacts and implications of the extensive fires that covered the Northwest Territories in 2014. The work includes teaming with ecologists from Canada and fire management personnel from the NWT government. The project will focus on remote sensing methods to assess fires in peatlands and uplands, with the goal of improving our knowledge base of fuels and fuel consumption along with post-fire regeneration.



Nancy French at the 2010 Kaluktavuk Fire in Noatak National Preserve (*Photo by R. French).*

Finally, with a project funded by the Joint Fire Science Program (JFSP), French is leading the development of new methods to characterize fuels to improve spatial modeling of emissions across the US, including boreal and tundra ecosystems of Alaska. This effort connects the research to real management needs. As these projects move forward, the team is planning to further develop methods to map fire danger with SAR-derived information, a research initiative that shows promise for operational application.

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For more information, send inquiries or feedback to the *Alaska Fire Science Consortium* : ayork@alaska.edu

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