

## INTRODUCTION

The emission of carbon-based gases from biomass burning is an important factor in the global carbon cycle. Carbon emissions from wildfire is also a topic of current interest because of concerns about increases in atmospheric carbon and its impact on global climate change. Recent studies have refined the methods for assessing the impact of wildland fire on the atmosphere originally presented in the early 1980's to account for variability in burning between various geographic regions and vegetation zones and other factors (French et al. 2002). Models used in estimating levels of carbon-based gases released to the atmosphere during biomass burning need to account for variations in forest structure, soil organic carbon, weather, fuel moisture, and fire behavior, either by directly including the variable in the model or by acknowledging the inherent variation within each model parameter. The basic model and approaches currently used for estimating fire carbon emissions was developed and used by Michigan Tech Research Institute (formerly Altarum) researchers in several studies to make estimates of fire's impact on atmospheric carbon in the boreal regions of North America and Russia (Kasischke et al. 1995, French et al. 2000, Michalek et al. 2000, French et al. 2002, Isaev et al. 2002, French et al. 2004).

Previous work by MTRI researcher Dr. Nancy French and others provided the methodology for making spatially-defined estimates of carbon released from fires (French et al. 2000, French et al. 2002). In a subsequent study, a Monte Carlo simulation technique was employed to propagate the uncertainty attached to the different parameters of the basic equation to yield a distribution of possible values for total carbon released during burning (output uncertainty). The relative impact of each input parameter on the output uncertainty was also quantified (sensitivity analysis) to identify priorities in terms of data collection and information accuracy. Based on results of this research, it has been hypothesized that the variability in biomass consumption during burning is the main driver of uncertainty in the emission of carbon-based greenhouse gases from wildland fires in temperate and boreal forest regions (French et al. 2004).

## MTRI'S CURRENT RESEARCH

The uncertainty analysis presented in this earlier work highlighted the fact that variability in consumption is not well documented; in particular, the range of values and the shape of the uncertainty distribution have not been described well enough to properly account for the impact of consumption variation on fire emissions. Under a grant provided through the NASA New Investigator Program in Earth Science (NASA-NIP), Dr. French and her assistants are performing further research to better quantify the variability in the amount of biomass consumed during forest fires. For this Earth System Science research project, biomass consumption levels in forested regions of northern and western North America are being documented with a goal of learning how variable consumption can be within a given ecoregion.

The approach being used to assess biomass consumption variability involves combining field-based measurements of consumption with remote sensing-based estimates of burn severity (Figure 1). The field data allows the quantification of the consumption, while the remote sensing-derived patterns of burn severity provide a means to assess the variability in levels of burning across landscape and regional spatial scales.

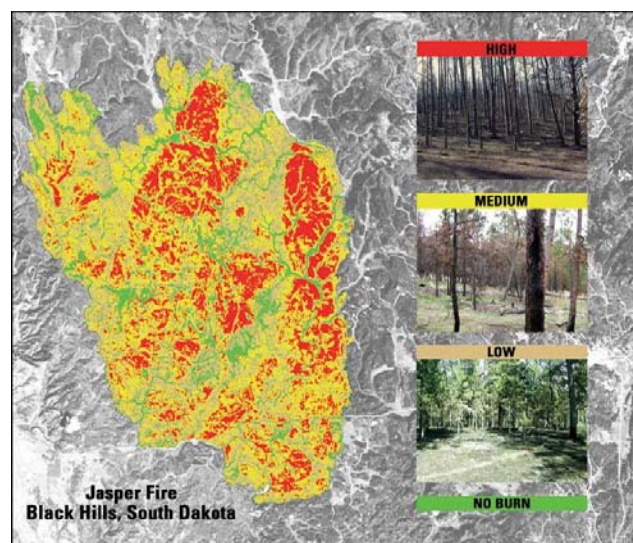


Figure 1. Example of Landsat-derived Normalized Burn Ratio (NBR) map, a method of mapping burn severity using satellite images Developed by the National Park Service and U.S. Geological Survey.

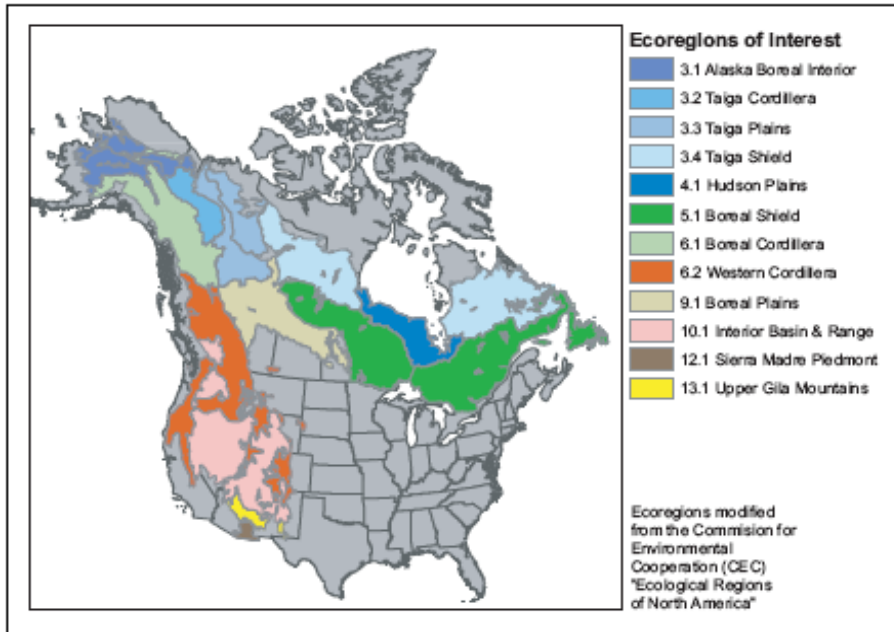


Figure 2. Fire affected ecoregions being assessed for biomass consumption under the NASA-NIP grant study. Ecoregions are defined based on landscape physiography, vegetation, and climate. These are derived from the ecoregion map developed by the Commission for Environmental Cooperation (Commission for Environmental Cooperation 1997).

Under the NASA-NIP grant project, currently in the first year of a three-year grant, biomass consumption will be assessed for 13 ecoregions in northern and western North America, regions of historically large fire disturbance (Figure 2). The project relies on data collected by collaborating groups, including:

- Canadian Forest Service
- U.S. Forest Service
- U.S. Geological Survey
- National Park Service
- Joint Fire Science Program (a US interagency program)
- Other NASA investigators and university researchers



Figure 3. Field data collection of burn severity and fuel consumption in July of 2005 at the 2004 Taylor Highway burn, Alaska.

Field data for regions in Alaska and Canada are available, while data collected for regions in western United States are few. In the summer of 2005, MTRI staff helped in field data collections in Alaska at sites which had burned in 2004, the largest fire year in recorded history for Alaska (Figure 3).

**Research Significance**  
By combining remote sensing outputs with field measurements, information on biomass consumption can be assessed over spatial scales not feasible using field technique alone. The research presented here

uses the expertise of MTRI by combining our abilities in Earth science applications, field data collection, remote sensing data analysis, and GIS. The result of the study will be a more complete view of the amount of biomass consumed during burning so that estimates of carbon emissions from wildfire can be better quantified. The significance of these results lies in the need to fully understand the impact of naturally occurring fires on atmospheric carbon in the context of increased fossil fuel emissions from anthropogenic sources. To fully understand and mitigate for fossil fuel carbon emissions, the Natural sources need to be accounted for through accurate quantification methods. Furthermore, evidence of increased wildfire activity, especially in the Boreal

regions of the Earth, may lead to significant impacts of wildfire on atmospheric carbon levels. A full understanding of these mechanisms, through robust methods of modeling and quantification, is necessary. With this project, MTRI researchers are working to develop and refine these methods.

**For additional information contact:**

Dr. Robert Shuchman  
Institute Co-Director  
(734) 913-6860  
shuchman@mtu.edu

Dr. Nancy French  
(734) 913-6844  
nancy.french@mtu.edu

Gregory Leonard  
Business and  
Operations Director  
(734) 913-6871  
greg.leonard@mtu.edu

**MTRI**  
3600 Green Court  
Suite 100  
Ann Arbor, MI 48105  
(734) 913-6840