Environment and Natural Resources Trust Fund
2015 Request for Proposals (RFP)

Project Title: **ENRTF ID:** **120-F**

Forecasting the Intensity and Spread of Minnesotas Wildfires

Category: F. Methods to Protect, Restore, and Enhance Land, Water, and Habitat

Total Project Budget: $ 184,080

Proposed Project Time Period for the Funding Requested: 3 years, July 2015 - June 2018

Summary:

Wildfire spread is difficult to forecast because fires create their own weather. This project advances a weather and fire forecast model to safeguard Minnesota's natural resources from wildfires.

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Sponsoring Organization: U of MN

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Our project graphic illustrates that fire intensity and spread are influenced by weather and that fire, in turn, influences microclimate. This makes fire prediction using traditional models extremely difficult. Here, we illustrate how new state-of-the-art weather models can be used to forecast the intensity and spread of fire in Minnesota, which can be used to protect our natural resources.

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage		_____ TOTAL

PROJECT TITLE: Forecasting the Intensity and Spread of Minnesota's Wildfires

I. PROJECT STATEMENT

Why this project is important: Wildfire intensity and spread are difficult to forecast because fires "create their own weather". The intent of this project is to improve the accuracy of the Weather Research and Forecasting Wildland Fire (WRF-Fire) model to better predict the speed and direction by which wildfires spread. Wildfires are a common occurrence in Minnesota, and are essential in maintaining the biological integrity of ecosystems by returning nutrients to the soil, allowing for natural succession of plants and trees, and bringing back wildlife that rely on burned areas. However, they also pose potentially catastrophic threats to our natural resources and communities because uncontrolled wildfires can threaten natural resources such as timber and recreation areas. Fire frequency and the area burned are correlated with air temperature, relative humidity, and drought. Air temperatures have increased significantly over the last century and are expected to lengthen the fire season.

The Pagami Creek Wildfire of 2011 in the Boundary Waters Canoe Area Wilderness (BWCAW) revealed the impact that weather may have on wildfires and the influence fires have on the local weather. Lightning ignited the fire, and it burned less than a quarter acre while being monitored by fire management officials. However, just over one week later, humidity plummeted and a strong north wind quickly spread the fire to 130 acres. The US Forest Service described the change as "unexpected and very unusual." The fire continued *burning to its maximum at approximately 93,000 acres* on Sep 13. Wildfire specialists found the fire challenging to extinguish due to *"unprecedented conditions and the driest fall in 140 years"* (U.S. Forest Service). Suppression costs totaled over *$20 million* (MPR News View, http://minnesota.publicradio.org/display/web/2011/11/07/photos-pagami-creek-bwca-wildfire-aftermath).

On average, looking at the past 12 years of data from the Minnesota Interagency Fire Center, 1,895 wildfires burn each year, blazing over 66,300 acres of land.

Goals and outcomes of the project:

- Assess how fires create their own weather that influences the spread pattern
- Improve the WRF-Fire model to more closely predict wildfire intensity, spread rate, and direction
- Provide an advanced wildfire management tool that will safeguard natural resources, enhance wildland firefighter and public safety, as well as serve as a resource to those who operate prescribed burns

How to achieve these goals: We will analyze meteorological and fire data from controlled burns at a restored prairie site at the University of Minnesota Rosemount Research and Outreach Center (RROC) and other US Fish and Wildlife Service prescribed burns, as well as historical wildfire data for Minnesota. Using the WRF-Fire model we will take into account near-surface winds, fuel properties, and high resolution terrain elevation data using Minnesota's state-of-the-art LiDAR resources.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: ***Assess how fires create their own weather and influence the spread of fire*** **Budget: $61,360**

We currently operate the WRF model for studying the carbon, nitrogen, and water budgets of Minnesota. Here, we will implement the Wildland Fire component and begin testing it against field data collected during a prescribed burn within a restored prairie. This site is currently instrumented with sensors that allow us to study wind turbulence, and heat transfer, which are key factors controlling fire spread. We will also examine how different fuel categories used in other models influence model predictions of fire intensity and spread.

Outcome	Completion Date
1. *High frequency heat fluxes and* wind measurements obtained at multiple locations within	*Aug 1, 2015*

prescribed burn sites	
2. Heat and moisture fluxes obtained from fire observations	*Oct 1, 2015*
3. Begin running WRF-FIRE test cases and sensitivity analyses to evaluate model performance at high spatial (i.e., 10 m), and temporal resolution	*Mar 1, 2015*

Activity 2: *Assess how past fires have spread using observations and models* **Budget: $61,360**

We will identify historical wildland fires, such as the Pagami Creek Wildfire of 2011, and conduct a retrospective analysis to examine if WRF-Fire can accurately forecast fire direction and rate of spread. We will examine model biases associated with numerous cases in order to improve WRF-Fire's forecast capability.

Outcome	Completion Date
1. Identify historical wildland fires within Minnesota as potential test cases	*Jun 1, 2016*
2. Compile meteorological, vegetation, and land fuel data products to conduct simulations	*Sept 1, 2016*
3. Evaluate WRF-Fire model performance for each test case, examine biases, performance statistics, and optimize model for forecasting in the forward mode	*Jan 1, 2016*

Activity 3: *Produce real-time forecasts of wildfire intensity and spread in Minnesota* **Budget: $61,360**

In order to implement the WRF-Fire model in forecast mode it must be provided real-time boundary conditions associated with land surface conditions, fire potential, and meteorological and climate conditions. Here we will work with the Department of Natural Resources (DNR) and other agencies to acquire key data for forecasts. Further, we will work to develop mechanisms for providing the DNR with real-time forecasts of wildfire spread.

Outcome	Completion Date
1. Develop capacity for near real-time acquisition of data products for boundary conditions for WRF-Fire forecasts	*Feb1, 2017*
2. Evaluate the WRF-Fire forecast model output using the above boundary conditions for future prescribed fires at DNR prairie sites	*April 1, 2017*
3. Launch the WRF-Fire model as a DNR user product	*Jun 1, 2017*

III. PROJECT STRATEGY

A. Project Team/Partners

1) Tim Griffis, Micrometeorologist, Professor, Dept. Soil, Water, and Climate, University of Minnesota, will oversee all aspects of the project. He will take the lead role in acquiring the measurements, overseeing data quality control, and will organize the WRF modeling activities.
2) Mark Seeley, Extension Climatologist, Professor, Dept. Soil, Water, and Climate, University of Minnesota, will assist with project outreach and incorporating research findings into his extension program.
3) Doug Miedtke, Fire Management Specialist, Minnesota DNR and Interagency Fire Center, will provide his expertise on fire-weather dynamics, fuel sources, fire probabilities, etc.

B. Project Impact and Long-Term Strategy

The proposed project is leveraged heavily against meteorological equipment obtained from the National Science Foundation, Department of Energy, and Department of Agriculture and computing resources provided by the University of Minnesota Supercomputing Institute. Our long-term goal is to provide a high temporal and spatial resolution fire forecasting tool as a means to protect the natural resources of Minnesota. Funding through LCCMR can help us meet those important goals.

C. Timeline Requirements

A three-year project duration is estimated based on the extensive data analyses and modeling activities outlined above.

2014 Detailed Project Budget

Project Title: Forecasting the Intensity and Spread of Minnesota's Wildfires

IV. TOTAL ENRTF REQUEST BUDGET *[3]*

BUDGET ITEM *(See "Guidance on Allowable Expenses", p. 13)*	**AMOUNT**	
Personnel: Tim Griffis holds a 9-month appointment at the University of Minnesota and is requesting 1 month of summer salary. Griffis will oversee all aspects of this project. Griffis is requesting a total of $35,280 salary plus $11,466 fringe.	$ 46,746.00	
PhD student (to be named) will analyze the data and assist Griffis with the modeling component of this project. The student salary will be $66,129 plus $53,205 fringe for the three year study period. They will join the Graduate program in Land and Atmospheric Science.	$ 119,334.00	
Supplies: Supplies are requested to maintain micrometeorological equipment used in the field studies and for computing supplies.	$ 9,000.00	
Travel: funds are requested for the purpose of traveling within state to gather wildland fire data and to validate model observations	$ 9,000.00	
Equipment:		
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	**$184,080**	

V. OTHER FUNDS

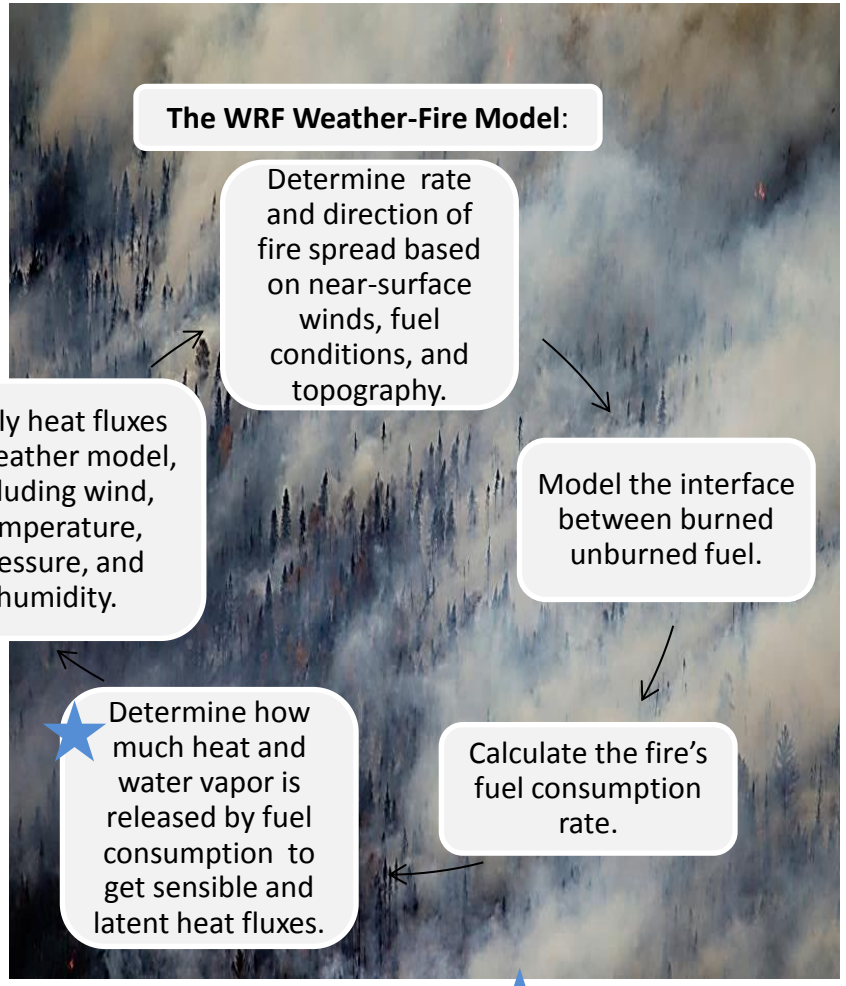
SOURCE OF FUNDS	**AMOUNT**	**Status**
Other Non-State $ Being Applied to Project During Project Period: *Indicate any additional non-state cash dollars to be spent on the project during the funding period. For each individual sum, list out the source of the funds, the amount, and indicate whether the funds are secured or pending approval.*	NA	
Other State $ Being Applied to Project During Project Period: *Indicate any additional state cash dollars (e.g. bonding, other grants) to be spent on the project during the funding period. For each individual sum, list out the source of the funds, the amount, and indicate whether the funds are secured or pending approval.*	NA	
In-kind Services During Project Period: Computing resources will be provided by the U of MN Supercomputing Institute - *dollar amount used is amount of unrecovered F&A - Supercomputing Institute services are provided free of charge to U of MN employees - their services are paid for by the F&A recovered on sponsored projects at the U of MN.*	$ 70,149	*secured*
Remaining $ from Current ENRTF Appropriation (if applicable): *Specify dollar amount and year of appropriation from any current ENRTF appropriation for any directly related project of the project manager or organization that remains unspent or not yet legally obligated at the time of proposal submission. Be as specific as possible. Describe the status of funds in the right-most column.*	NA	
Funding History: *The research site and facility to be used in this research project has been funded since 2004 by NSF, DOE, and USDA. Proposals are pending to continue the support.*	$ 2,250,000	past funding

The Pagami Creek Wildfire in the BWCA in 2011 burned over **93,000 acres** and cost over **$20 million** in suppression efforts.

This project will improve the accuracy of the WRF-FIRE model by looking at microclimatological data to better predict the direction and speed of wildfire spread.

Outcome:
Provide a DNR tool to forecast the spread of MN's wildfires. The model will protect MN's natural resources and may decrease future suppression costs.

Wildfires ''create their own weather'' by releasing heat and moisture into the atmosphere. This feedback creates strong winds that dominate ambient winds, making wildfires difficult to forecast by local weather alone.



★ Critical steps that we aim to study and optimize

Project Manager Qualifications

Dr. Tim Griffis is a professor in the Department of Soil, Water, and Climate at the University of Minnesota (www.biometeorology.umn.edu). He has been a faculty member at the University of Minnesota since 2002. He teaches courses in micrometeorology and climatology and specializes in boundary-layer meteorology and biometeorology. His research involves the use of boundary layer theory, isotope techniques, and land-atmosphere modeling to study atmospheric transport processes and the greenhouse gas budgets of natural and managed ecosystems at the field to regional scales. He has managed several large scale projects funded by the National Science Foundation, Department of Energy, and United States Department of Agriculture. In the proposed project he will oversee all of the measurement and modeling activities and will ensure that all reporting requirements are met and the project stays on schedule.

Professional Preparation

2002	NSERC Postdoctoral Fellow, Biometeorology, Univ, of British Columbia, BC, Canada
2000	Ph.D., School of Geography and Earth Sciences, McMaster University, ON, Canada
1995	B.Sc., Physical Geography, Brock University, ON, Canada

Appointments

2012-	Professor, Department of Soil, Water, and Climate, University of Minnesota- Twin Cities, USA
2006-2012	Associate Professor, Department of Soil, Water, and Climate, University of Minnesota-Twin Cities, USA
2002-2006	Assistant Professor, Department of Soil, Water, and Climate, University of Minnesota-Twin Cities, USA
2000-2002	Natural Sciences and Engineering Research Council Postdoctoral Fellow, Biometeorology and Soil Physics Group, University of British Columbia, Canada
1997-2001	Research Assistant, Canadian Land-Atmosphere Surface Scheme Project, Meteorological Service of Canada

Synergistic activities:

- Co-Director of Graduate Studies in Land and Atmospheric Science, Dept. of Soil, Water, and Climate, University of Minnesota, 2009-present
- Member of the National Ecological Observatory Network (NEON Inc.)- Fundamental Instrument Unit, Working Group, 2009-present
- Associate Editor, Agricultural and Forest Meteorology, 2008 to present
- Associate Editor, Journal of Geophysical Research-Biogeosciences, 2007 to 2011

Organizational Description

The proposed research will be conducted in the Department of Soil, Water, and Climate at the University of Minnesota. The field research will take place at the Rosemount Research and Outreach Center of the University of Minnesota. Additional field data will be acquired from wildfire sites throughout Minnesota with the assistance of the Minnesota DNR and Interagency Fire Center (Doug Miedtke). All of the proposed data analyses and modeling activities will rely on the University of Minnesota Supercomputing Institute (https://www.msi.umn.edu/). All project personnel are members of the Land and Atmospheric Science program of the University of Minnesota. We will recruit one PhD student to assist with the data analyses and modeling activities proposed in this study. The student will be mentored by Griffis and Mark Seeley. All of the research will be performed within the guidelines of the University of Minnesota's Responsible Conduct of Research (RCR).