National Fire Plan
Research and Development Projects Funded
FY 2001
TOPIC A (Firefighting): $10,000,000

An Integrated Framework for Risk Assessment of Wildland Fire and Landscape-level Treatments on Fish and Wildlife Resources
PSW-4251-1 Ai $500,000

High-Resolution Model Predictions for Fire Weather and Smoke Impacts: The Southeastern Inter-Agency Modeling Consortium
SRS-4104-1 Ai $500,000

A Decision Support System for Spatial Analysis of Fuel Treatment Options and Effects at Landscape Scales
RMRS-MSO-14 Ai $375,000

Quantifying Trade-offs of Alternative Vegetation Management Strategies, Wildfire, and Suppression in Fire Prone Regions of the US
SRS-4851-1 Ai $300,000

Enhancing Southern Wildland-Urban Interface Firefighting Capacity and Collaboration
SRS-4XXX-1 Ai $250,000

Long-Range Forecasting of Fire Season Severity
SRS-4104-11 Ai $300,000

Impact of wildfire on local economies
SRS-4851-3 Di $150,000

A Nationwide Fire Monitoring System in Near Real-Time: Active Fires, Fire Severity, Burned Areas, and Smoke Dispersion
RMRS-MSO-1 Ai $500,000

A New Technology for Monitoring Smoke Characteristics Over a Large Area in Real-Time: Mobile LIDAR Instruments
RMRS-MSO-2 Ai $500,000

Remote Sensing, GIS, and Landscape Assessment Tools for Fire Management
RMRS-MSO-6 Ai $500,000

National and Regional Fire-Weather Dynamics: Improved Methods for High Resolution Forecasting of Fire-Weather Indices and Smoke Transport
NC-1.4 Ai $450,000

Assessing risk of wildfire and vulnerability of human populations and development in the North Central Region

NC-1.1 Ai $462,000

FIA Proof of Concept for Fuels Condition Monitoring
NC 1.3 Ai $350,000
Note: This project is assigned for NC to take national leadership in this issue.

Fire Management Strategies for Wilderness and Other Protected Wildlands
RMRS-MSO-10 Aii $500,000

An Initial Attack Service Delivery Simulation Model for Strategic Fire Management Planning
PSW-4402-8 Ai $500,000

Fire Behavior in Live Fuels
PSW-4403-1 Ai $500,000

Real Time Remote Sensing of Fire Properties
PSW-4403-6 Ai $500,000

Smoke modeling framework for real-time prediction of fire hazard and severity, air pollutant emissions, transport, and dispersion from wildland fires and prescribed fires ("BlueSky")
PNW-3 Ai $500,000

***FY 2001*Estimating natural and anthropogenic sources of visibility impairment and regional haze from prescribed and wildland fires**
PNW-2 Ai $500,000

MAPSS-Based Seasonal Prediction of National Fire Risks and Impacts
PNW-1 Ai $500,000

Fuel moisture mapping combustion limits mechanistic models, remote sensing, and mapping of fuel moisture and combustion potential for all fuelbeds in the United States
PNW-4 Aii $500,000

High Resolution Weather Models for Geographic Area Coordination Centers
PSW-4401-1 Aii $500,000

Southern regional models to predict smoke movement and mitigate impacts at the wildland urban interface
SRS-4104-2 Aii $250,000

National level science synthesis, technology transfer, and development of long range fire research strategy
WO Ci $113,000

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Station: Pacific Southwest Research Station (PSW)

Proposal Code: PSW-4251-1

Topic: C.iii

Proposal Title: An Integrated Framework for Risk Assessment of Wildland Fire and Landscape-level Treatments on Fish and Wildlife Resources

Other Proposals to which this is Linked: PSW-4355-3, 4, 5, 6

RWU: PSW-4251, Timber Management/Wildlife Habitat Interactions, Arcata, CA

Description:

Research or Development Question, Issue, or Need: Debate over how to manage Federal lands to accommodate conflicting resource objectives and the inevitable influence of wildland fire continues to escalate, driven in part by a lack of understanding of the relative risks to resources of different management strategies. Scientifically credible information is needed on the relative risk to all resources imposed by the interactions of infrastructure development, vegetation manipulation, wildland fire, and post-fire rehabilitation efforts. Furthermore, this information needs to be made available in a format that permits rigorous and consistent comparison of risks, and allows for the information base to be continuously updated as new knowledge is acquired through research and monitoring. Some progress has been made in the development of risk-assessment tools for predicting landscape-level effects of fire and vegetation treatments on vegetative structure, but the means of projecting the subsequent consequences to riparian and instream processes, water quality, and to fish and wildlife habitats and populations are inadequately developed to support management decisions.

Research and Development Approach: This project is envisioned as a integrative effort that has three major tasks: (1) modeling and software development to provide the tools for assimilating data and information and projecting risks, (2) compilation and meta-analysis of existing information to initially populate the models and information base for beta testing, and (3) empirical research studies that would provide specific information regarding high-priority information gaps. Initially, the research and development effort would be focused on forested ecosystems of inland California and southern Oregon and the Sierra Nevada. The analytical template that would be developed, however, could be more broadly applied both topically and geographically. Incorporation of social and economic components, for example, would significantly strengthen the utility of this framework.

Task 1, modeling and software development, would be a coordinated, multi-unit effort. RWU 4251 would lead in the development of an analytical template that would combine simulation models, GIS analyses, and decision-analysis models such as influence diagrams. The template would provide the structure for integrating modeling inputs and outputs, incorporating new data, and projecting relative risks in a quantitative, spatially explicit manner. Various research units would develop component models and databases within the template, based on their particular expertise. For example, RWU 4155 could develop vegetation models, RWU 4251 could develop the wildlife habitat and population dynamics components, and RWU 4351 could develop a riparian and instream processes component.

Task 2, meta-analysis of existing data, would necessarily follow the organizational structure of Task 1. Additional collaborators with programming and statistical expertise would be involved in this task.

Task 3, empirical research directed at important data gaps, would be funded and directed under separate efforts. Again, this task would be divided among various units depending on expertise. The role of the lead units(s) would be to assimilate the results of these empirical studies into the integrated framework.

Outcome or Products:

First Year: The general analytical template should be sufficiently developed and populated with existing information to allow beta testing of this approach in selected areas of the Sierra Nevada and southern Cascades within two years. Testing would occur through pre- and post-treatment analysis of actual planned fuels treatments by NFS partners. Task 2 should be nearly complete within this same timeframe. Full implementation of the analytical process, supported by planning and initiation of Task 3 research efforts is expected within 4 to 5 years for the targeted ecoregions.

Staffing Needs: Landscape Ecologist- GS-0408-13/14/15, and 3 technician years (Grades 9/11) per year for at least 5 years.

Description of Skills Required: Lead scientist must have extensive experience in integrative, quantitative research in modeling, landscape analyses, habitat relations, or risk assessment. Technicians must be proficient in GIS, remote sensing, modeling, or other data analysis techniques.

Potential Partners: NFS Regions 5 and 6, various universities, California state agencies, and DOI researchers.

Funding Requested: $500,000/yr

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STATION: SRS
Proposal Code: SRS-4104-1
Topics (from list): A-i,ii

Proposal Title: High-Resolution Model Predictions for Fire Weather and Smoke Impacts: The Southeastern Inter-Agency Modeling Consortium

Other proposals to which this is linked: This proposal is linked to other proposals regarding regional modeling consortia (Ferguson, PNW), (Warren Heilman, NC) NC-1.4, and (Francis Fujioka) and to other proposals that will make use of smoke modeling data (Achtemeier-SRS)-4104-2, (Tom Waldrop-SRS)-4104-4, (Ken Outcalt-SRS)-4104-3, (Dale Wade-SRS)-4104-10 and 4104-11.

RWU (or Program and Team) and location(s): Disturbance & Management of Southern Pine Ecosystems (4104), Smoke Management Team, Athens, GA
Description:
Research or development question, issue, or need: Mitigation of adverse smoke impacts in the South requires weather and fire models at finer resolution than currently available. Moreover, the modeling system developed to meet unique regional needs must link to the proposed national framework of modeling consortiums. Integration into the national framework will allow consistency in predictions of air quality and visibility impacts from fire, fire weather, preparedness, prevention, and use of prescribed fire. We propose to initiate and coordinate a Southern Inter-Agency Modeling Consortium (SMC) to develop and assimilate models, relying on the mesoscale MM5 model and to supply regional and local weather forecasts to foresters in the Southern Region (R-8), consisting of the 13 southern states from Virginia to Texas.

Research or development approach: The Southern Smoke Management Team (part of SRS-4104) in Athens, GA, is working with scientists at the University of Georgia (UGA) to use the mesoscale model MM5, which was acquired and installed at UGA. Graduate students are in training in use of the model. The Southern Interagency Modeling Consortium will collaborate with other scientists, local, state, and federal air quality and fire regulators, other interested parties, and colleagues at existing and planned modeling centers as part of a national framework of regional interagency modeling consortia. The Consortium will allow for advances in air quality, smoke impact mitigation, and fire control through the following outcomes.

Outcomes or products:
First Year:

- Expand Consortium and build consensus (SMC scientists will collaborate with other investigators within the National Framework of Regional Inter-agency Consortia to broaden agency participation in SMC.)
- Develop a framework for defining, ranking, and solving fire and air quality problems.
- Install and demonstrate MM5

Second Year:

- Verify MM5 model
- Modify MM5 model physics for unique regional geographic and meteorological characteristics.
- Develop research data set to validate local models designed to simulate and forecast smoke movement within the wildland/urban interface (urbanized areas plus roadways).
- Collaborate with other regional modeling consortia centers through the national framework for national consistency in assessing and predicting air quality and visibility impacts from fire.

Three to five years out:

- Transfer models and access to weather forecasts to field personnel
- Continue coordination of model development through Consortium members
- Develop new approaches and resources that can expand the modeling base
- Develop and transfer new products and improvements to existing products and transfer them to users.

Staffing needs (SY, technician Y, etc.) /series/grade: Current Staff: Atmospheric scientist 1340 (13-15); Systems Analyst 334(12); Computer Specialist/Electrical Engineer 856 (11). New Staff: Computer Specialist/ Image Analyst 334(11); Mathematical Statistician (11); Air Quality Tech Transfer Specialist 1340 (11-13)

Description of skills required: Meteorological modeling, air quality analysis, mathematical programming, telemetry electronics, remote sensing/image analysis, technology transfer, teamwork

Potential Partners: State forestry agencies in 13 Southern states; state air quality agencies in 13 southern states; DOE-Savannah River Technology Center; University of Georgia (UGA) Departments of Health Science, Geography, Statistics; US Forest Service Region 8 Fire & Aviation, US Forest Service Savannah River Institute; USEPA; USDOI-National Park Service, USDOI-Fish and Wildlife Service; NASA; NOAA; DOD military bases; NCASI; AF&PA.

Funding requested: $500,000/year. Includes scientist salary, support, equipment, travel, and intra-consortia support

Team Leader: Gary Achtemeier: Smoke Management Team Leader
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Station: RMRS

Proposal code: RMRS-MSO-14

Topic(s): C- i, ii, iii, iv; D-i.

Proposal title: *A Decision Support System for Spatial Analysis of Fuel Treatment Options and Effects at Landscape Scales*

Other proposals to which this is linked:

RWU and location(s): RWU-4802, RWU-4151, Missoula, MT

Description:

- Research or development question, issue, or need: The increase in fuel treatments investments that will follow the 2000 fire season need to be cost-effective with acceptable impacts on resource values. The issues facing land managers are enormous and the tasks overwhelming when one considers the large number of acres with fuel buildups, the budgets needed to treat all those acres, and resource and environmental issues. Only sound analysis to determine efficient and effective fuel treatment strategies will do the job. Intellectually rigorous but user-friendly decision support systems are the key to developing fuel treatment alternatives and quantifying the resource trade-offs. Two complementary modeling systems, MAGIS and SIMPPLLE, are being used to quantify trade-off costs associated with fuel treatments within the context of dynamic landscapes. MAGIS is designed to spatially schedule treatments that effectively meet resource and management objectives and compute trade-offs associated with those treatment schedules. MAGIS also addresses access issues, such as resource effects associated with roads and the effect of access on the ability to conduct vegetation treatments. SIMPPLLE is a spatially explicit, stochastic system that simulates disturbance processes with and without management treatments. Three landscape components (vegetation, aquatics, and landforms) provide the framework for projecting the risk of disturbance processes spatially on a landscape, as well as estimating vegetation conditions, fire suppression costs, and smoke emissions. SIMPPLLE is being used for decision support by the Forest Service (R1) and BLM in Western Montana. The combination of MAGIS with SIMPPLLE provides a powerful analytical methodology for: 1) analyzing the extent and likely location of disturbance processes (such as fire) both in the presence and absence of treatments, 2) developing spatial and temporal treatment alternatives for addressing fuels treatment along with other resource objectives, and 3) evaluating those alternatives in a manner that captures the combined effects of treatments and disturbances processes. Additional development and testing, however, is needed for both systems to reach their combined potential as a truly effective decision support system for spatially analyzing fuel treatment alternatives. But, this development has been hampered by the funding uncertainties associated with soft money and the lack of permanent staff to provide continuity in the development process.

    - Research and development approach: Expand existing partnerships with National Forest Systems staffs and forest managers for input on the design and capabilities for data input, scenario specification, and display of results. Pre and post burn data sets will be developed for recent fire complexes to validate model behavior and test the ability to model fuel treatment impacts on fire behavior. In cooperation with a Joint Fire Sciences study these two systems are being applied in seven geographic locations across the US. Workshops will be held with other RWUs to incorporate their latest research results regarding interactions among fire, other disturbance processes, and management treatments.

- Outcomes or products**:**
- First year: Testing and debugging will be completed for the current versions of both systems. New processes for quickly and easily moving information between MAGIS and SIMPPLLE will be completed and documented. Workshops will be held with other RWUs to capture research results as soon as available.
- Second year: GIS interfaces will be developed to: 1) enter area data; 2) build management alternatives; and 3) display the location and timing of treatments, road activities, and likely disturbance processes. A version of SIMPPLE that can be executed on any computer platform will be completed.
- Three to Five years out: MAGIS and SIMPPLLE will be integrated into a fully-functioning decision support system for use by land managers to analyze and display disturbance processes, fuel treatment alternatives, and resource trade-offs. Versions including sample datasets that test a number of treatment scenarios will be available for a number of geographic locations in the country.

Staffing needs by series and grade:
Existing workforce: RWU-4802: One PFT GS-460-13, two part-time Term GS-334-9 Computer Specialists. RWU-4151: One PFT GS-460-13, one PFT GS-401-9 Biologist, one Term GS-334-11 Computer Analyst.
New position(s): RWU-4802: Two PFT GS-334-9/11 Computer Programmer Analysts, one GS-334-7/9 Computer Programmer Analyst. RWU-4151: One PFT GS-334-11 Computer Analyst.

Description of skills required: Programming, modeling and data handling, developing user applications, ability to work with others, geographic information systems, relational databases, basic knowledge of resource management.

Potential Partners: The University of Montana, Bitterroot Ecosystem Management Research Project, PSW Station Riverside Fire Lab., Northern Region, Planning Analysis Group of the Inventory & Monitoring Institute at Ft. Collins, CO, and the BLM.

Funding requested: $375,000/year (RWU-4802: 225K; RWU-4151: 150K)

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Station: SRS
Proposal code: **SRS-4851-1**
Topics: Aii, with additional relevance to Ai, Di and Ciii

Proposal title: **Quantifying Trade-offs of Alternative Vegetation Management Strategies, Wildfire, and Suppression in Fire Prone Regions of the US**

Other proposals to which this is linked (Proposal code): Gonzalez-Caban (PSW-4402), Holmes (SRS-4851), Loomis (RMRS-4851), "Understanding public and community values regarding wildfire characteristics, fuel reduction programs, and restoring fire-damaged landscapes: a conjoint analysis"; Gonzalez-Caban, Holmes, and McCollum (RMRS-4851), "Economic valuation of species viability for fire response preparedness, fire response, and species habitat and population recovery"

RWU: SRS-4851, Research Triangle Park, North Carolina; PSW-4402, Riverside, California; RM-4851, Fort Collins, CO

Description:
Research and Development Question Addressed: Events of the current year have prompted policy makers and the public to question what is the appropriate amount and combination of wildland fire actions and policies. However, analytical tools for evaluating the trade-offs between fuel reduction, fire suppression, and wildfire damages are not available at regional scales. We propose to develop a set of statistical models that relate wildfire extent and severity to prescribed burning, stand density management, other pre-suppression efforts, patterns of human development, and eco-physical variables including plant communities, topography, and broad climatic patterns and their links to fire weather. These models would build upon similar models developed by the Disturbance Economics Research Team in modeling of the 1998 catastrophic Florida wildfires and would draw upon the extensive abilities of an experienced ocean-climate researcher and an experienced western fire behavior researcher. We will gather data and estimate models that provide information about the net value changes of wildfire, including timber market losses, suppression costs, property damages, and ecosystem services, conditional on climatic conditions both historical and predicted. We will also obtain data and estimate the costs—economic and social—of alternative fuel treatments; these will include the revenues obtained from the removal of small diameter trees. This value and cost information will then be used in conjunction with wildfire risk models that include expected climate/fire weather conditions to evaluate the economic, ecological, and managerial trade-offs of alternative vegetation management strategies, by region. In addition, this research will be linked with research on the economic benefits of fuel reduction and restoring fire damaged landscapes as described in the proposal entitled "Understanding Public and Community Values Regarding Wildlife Characteristics, Fuel Reduction Programs and Restoring Fire Damaged Landscapes: A Conjoint Analysis" that is being jointly proposed by scientists in SRS-4851 and PSW-4402. The linkage of cost and benefit information for alternative vegetation management strategies will improve the efficiency of potential fire management programs and policies, especially if we are able to include long-range climate forecasts in the models.

Outcomes: The models that we develop could be used to identify combinations of pre-suppression activities that minimize the net damages of wildfires. Because broad climatic patterns are somewhat predictable on a monthly or annual basis through links to ocean temperature oscillations, and because developed models will be dynamic, broad-scale wildfire risk measures could be developed that will enhance long range planning. Models may also be used in a simulation mode to evaluate the trade-offs among the various suppression and vegetation management strategies. The wildfire models would allow more precise evaluation of the long-term impacts of fuel management and other pre-suppression activities, identify areas where greater or lesser vegetation control activities would result in lowered net damages from wildfire, and permit better assignment of suppression or pre-suppression resources across regions. Incorporating broad-scale climate predictions would further help in regional and national targeting of suppression resources, by placing the management decisions in terms of conditional probabilities associated with expected climatic conditions.

- **First year**: Models of wildfire spatial and temporal dynamics by wildfire cause for Florida
- **Second year**: Models of wildfire spatial and temporal dynamics for other regions of the US; Net value change and vegetation management net unit cost estimates for wildfire by region and by severity and by climate state;
- **Three to five years**: Computer models to evaluate economic, ecological, and management trade-offs of alternative vegetation management strategies conditional on observed/predicted climate conditions.

Staffing: 1 ecologist, 2 economist, 1 forester, 2 GIS specialists, 1 ocean-climate researcher, 1 fire behavior researcher

Skills required: GIS, Ecology, Fire Behavior, Economics, Climatology

Partners: Dr. Timothy Barnett, Scripps Institute of Oceanography; Dr. Philip Omi, Western Forest Fire Research Center (WESTFIRE), Colorado State University.

Funding requested: $300,000
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Station: SRS
Proposal code: SRS-4XXX-1
Topic(s): Ai, Aii

Proposal title: Enhancing southern wildland-urban interface firefighting capacity and collaboration.

Other proposals to which this is linked: SRS-4XXX-2, SRS-4XXX-3, SRS-4XXX-4, SRS-4104-1, SRS-4104-2

RWU and location: SRS-4XXX, Human Influences on Southern Forest Ecosystems: Research in the Wildland-Urban Interface, Proposed new research work unit in Gainesville, FL

Description:
RD&A Issue and Need: With the steady rise of new homes in southern forestlands, forest managers face the potential loss of prescribed fire as a management tool. New neighbors may not understand the benefits of prescribed fire and may oppose its use. Fire behavior and smoke production and dispersion models are important prediction tools for fire managers, but are yet to be validated, adapted, and widely disseminated for use in the southern states. Irrespective of existing models, fire managers have also experienced the need to develop additional models. The ability to predict fire behavior and smoke production and dispersal could greatly reduce the potential risks associated with prescribed burning. Specific modeling needs are to: (1) develop models for fire behavior and smoke production for different southern fuel types; (2) validate and incorporate these models into current fire behavior programs, such as FARSITE and equivalent modeling programs; and (3) link these models with prescribed burning-smoke management models and weather forecasting models. These models will have regional applications and could be adapted to meet national needs.

The southern wildland-urban interface also presents unique challenges for firefighters, combining aspects of both wildland and structural firefighting. Federal, state and local firefighters must be prepared not only to protect natural resources but also life and individual properties. They must be equipped to do so in a timely manner, requiring collaborative efforts and increased capacity. The Florida fire season in 1998 demonstrated the complexity of the numerous agencies involved - eight different fire complexes were established to effectively manage an emergency response of 145 different fire departments to fight fires that burned almost 500,000 acres across the state. Across the South there is a need to share fire prevention and pre-suppression information, learn from others' successes and failures, and enhance procedures and efforts to coordinate the actions of federal, state, local and private sector organizations.

RD&A Approach: This RD&A project will include development of a center of fire prevention and pre-suppression information for Federal, state and local firefighting entities in the South that could serve as a template for a national model. This will involve cooperative agreements for development of a southern WUI fire information website and hiring a technology transfer specialist to assess firefighting information needs and facilitate exchange of information among firefighting entities. The technology transfer specialist will also provide technical assistance and facilitate the application of refined and developed fire and smoke behavior models to local organizations and communities. Refinement and development of models will involve Forest Service scientists and cooperative agreements with universities and other research institutions.

Outcomes or Products:
First year:

- Identify fire fighting informational and training needs
- Establish technology service center, including development of informational website
- Evaluate existing models and researching emerging models to determine those that can be adapted to southern conditions
- Begin collection of data for use in models

Second year:

- Revise existing models
- Continued collection of data for use in models
- Validate data

Three to five years out:

- Develop new models as needed

Staffing needs by series and grade: One GS-401/408/460-12/13 Modeler

Description of skills required: Modeler – working knowledge of fire and smoke behavior models, including adapting existing models to the conditions of the South. Modeler will work with universities for data collection and validation based on southern conditions.

Potential partners: Positive expressions of interest in collaborating in wildland-urban interface research and technology transfer have already been discussed with several organizations. The University of Florida has laid plans for the establishment of a wildland-urban interface center for the South, with budget proposals that would leverage these Forest Service funds. Other potential collaborators are the University of Georgia, and other southern universities, Fire Chiefs Association, local and state firefighting agencies, FL Department of Community Affairs, cooperative extension service, water management districts, local units of government, State & Private Forestry, National Forests, The Nature Conservancy (Disney Wilderness Preserve), and the FL Center for Wildland Fire and Forest Resource Management.

Funding requested: $500,000 Funded for $250,000

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Station: SRS

Proposal Code: SRS-4104-11
Topics (from list): A i, ii

Proposal Title: Long-Range Forecasting of Fire Season Severity

Other proposals to which this is linked: SRS-4104-1

RWU (or Program and Team) and location(s): Disturbance and Management of Southern Pine Ecosystems (4104), Fire Management Team, Athens, GA and Clemson, SC

Description:
Research and development question, issue or need:
Assessing the severity of the upcoming fire season is key to efficiently allocating suppression resources on both a statewide and a national basis. Previous studies have linked wildfire season severity to climatic patterns such as the El Nino Southern Oscillation (ENSO) with good skill. However, most of these studies have focused on directly relating the climatic conditions to some measure of fire activity (number of fires or acres burned). While at first glance this appears to be a natural way to evaluate the connection, the data can be skewed by effective suppression. A better approach is to examine the relationships between the climatic indicators (i.e. ENSO, North Pacific oscillation, etc) and factors that contribute to a severe fire season. Currently, long-range predictions of temperature and precipitation are produced by the Climate Prediction Center, but knowledge of whether the temperature or precipitation is above/below normal is of only limited value. Other questions need to be addressed, such as changes to the frequency of precipitation, and number of Haines class 6 days expected. We propose to investigate the potential linkages between climatic indicators and various measures of the fire environment (precipitation frequency and intensity, Keetch-Byram Drought Index and Haines Index) for the Southern Region (R-8), which consists of the 13 southern states from Virginia to Texas. Such research would not only provide a useful management tool for assessing potential wildfire conditions, but also for the management of prescribed burning activities.

Research and development approach:
This research will develop and compare statistical and neural network models that will be used to assess the potential severity of the upcoming fire season. Relationships between major climatic patterns (such as ENSO, the North Pacific and North Atlantic oscillations) and environmental parameters that indicate severe wildfire conditions will be examined for both direct and multivariate correlations such that the combined impact of the climate parameters can be assessed. The region will initially be divided at the state level (giving 13 regions), but further subdivision of the states into smaller management units will be investigated to try to identify more local relationships.

Outcomes or products:
First year:

- Data for climate indicators and fire parameters will be collected and processed.
- Initial statistical and neural network models will be developed for the 13 states.

Second year:

- Investigate the potential of local relationships.
- Refine the statistical models based on historical fire activity.

Three to five years out:

- Provide land managers at the Federal and State levels with a management tool that can reliably assess the upcoming fire season with a lead-time of 3 to 6 months for planning of wildfire suppression resource needs and prescribed fire activity.

Staffing needs (Scientist years, technician years, etc) by series and grade: (a) = new position, (b) = existing position, (c) Wade replacement:
(a) GS-12 1340 Atmospheric Scientist, (b) portion of GS-14 460 Research Forester; and (c) portion of GS-12-14 460/408 Research Forester/Ecologist.

Description of skills required:
Meteorological analysis, mathematical programming, multivariate statistical methods.

Potential Partners (universities, federal agencies and labs, national forests, states, private companies, etc):
PSW-4401, State forestry agencies and state climatologists in 13 southern states; Florida State University Center for Oceanic-Atmospheric Prediction Studies; USDI National Park Service and FWS-R4, Florida Division of Forestry.

Funding requested: $300,000. Includes salary, data, support, equipment, travel, and cooperative agreements with partners.

Project Leader John Stanturf
Team Leader: Dale Wade
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Station: RMRS

Proposal code: RMRS-MSO-1

Topic(s): A-i, A-ii, B-i, C-i, C-iii, D-i

Proposal title: *A Nationwide Fire Monitoring System in Near Real-Time: Active Fires, Fire Severity, Burned Areas, and Smoke Dispersions*

Other proposals to which this is linked: RMRS-MSO-2, 4, 5, 6, 7, 9, 13; RMRS-FLG-1, 2, 3, 4, 5; RMRS-ABQ-2, 5; RMRS-FTC-2; RMRS-BOI-3

RWU and location(s): RWU-4404, Fire Chemistry Unit, Fire Sciences Laboratory, Missoula, Montana

Description:

- Research or development question, issue, or need:
  We propose to develop a nationwide system to monitor in near real-time the spatial and temporal distribution of active fires, fire severity, burned areas, and smoke dispersions. Current daily intelligence on fire locations and burned areas is compiled from ground surveys conducted by individual Geographic Area Coordination (GAC) centers; the information is reported the next day. There is also no systematic method of compiling fire data and presenting it in a coherent way with a short delay. A nationwide fire monitoring system will compile and disseminate updated information on the extent of fires over a large region. The information is critical for the GAC's success in formulating daily firefighting strategies and resource allocation. The system also provides necessary daily information on fire severity and burned areas for other proposed projects listed above.

  In addition to broadcasting the fire situations, the nationwide fire monitoring system will quantify smoke concentrations and display smoke dispersions. Smoke from wildfires can last for days or weeks and have severe effects on visibility, air quality, and public health. There are only limited environmental monitoring stations throughout the U.S. Current measurement techniques are costly, inefficient, time-consuming, and the results are often reported several days or weeks later. Timely smoke information will enable land and fire managers, air quality managers, and public health officials to assess and predict visibility, air quality, and the effects of smoke on human health in near real-time.

  - Research and development approach:

  The measurements of active fires, fire severity, burned areas, and smoke concentrations and dispersions at 1-km x 1-km resolution will be carried out using mostly the NASA Terra and Aqua satellites and the NOAA AVHRR satellite. The results will be broadcast four times daily with two hours' delay after the satellite overpass time. The locations of active fires, fire severity, and burned areas monitored by satellites will be validated by using Forest Service and BLM fire reports from ground and aerial surveys. The Fire Chemistry Unit has been working closely with the NASA Goddard Space Flight Center to develop fire and smoke detection algorithms. Ground and airborne measurements of air pollutants will be conducted to validate smoke concentrations and dispersions measured by instruments on the satellites.

The Fire Chemistry Unit successfully used this near real-time method during the 2000 fire season to provide satellite images of fires in Montana and Idaho to the Northern Rockies Coordination Center, Missoula, Mont. with a 12-hour delay. Our fire images were used by the Center in its daily morning briefings for developing fire attack strategies.

- Outcomes or products:

- First year:
  - (a) Assess daily the locations of fires, the sizes of burned areas, and smoke concentrations in Montana and Idaho during the 2000 fire season.
  - (b) Formulate strategy for building the nationwide fire monitoring system.
- Second year:
  - (a) Develop an integrated system for satellite data acquisition and processing.
  - (b) Validate satellite measurements.
- Three year:
  - (a) Test the nationwide fire monitoring system.
  - (b) Validate satellite measurements.
- Fourth and Fifth years:

  Transfer the fire monitoring system to operating agencies, including the National Interagency Fire Center (NIFC) and Geographic Area Coordination centers.

Staffing needs by series and grade:
- GS-14 Remote Sensing Scientist (new)
- Two GS-11 Remote Sensing/GIS analysts (new)

Description of skills required:
- The remote sensing scientist must have at least five years of experience in remote sensing. It is highly desirable that the scientist have experience in developing fire and smoke algorithms for NASA Terra satellite data. The scientist also will supervise two staff members.
- The remote sensing/GIS analysts should have experience in processing satellite data.

Potential Partners: NASA/Goddard Space Flight Center; University of Wisconsin at Madison, Space Science and Engineering Center; NOAA/NESDIS; National Interagency Fire Center; Northern Rockies Coordination Center; Forest Service Regions -1 and -3 air quality and smoke managers, Fire Sciences Laboratory, Fire Behavior and Fire Effects units.

Funding requested: $500,000/year

Team Leader: Dr. Wei Min Hao, Project Leader, Fire Chemistry Unit (RWU-4404)
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Station: RMRS

Proposal code: RMRS-MSO-2

Topic(s): A-i, A-ii, B-i, C-i, C-iii, D-i

Proposal title: *A New Technology for Monitoring Smoke Characteristics Over A Large Area in Real-Time: Mobile LIDAR Instruments*

Other proposals to which this is linked: RMRS-MSO-1, 4, 5, 13, 18

RWU and location(s): RWU-4404, Fire Chemistry Unit, Fire Sciences Laboratory, Missoula, Montana

Description:

- Research or development question, issue, or need:
  Particulates emitted by wildfires and prescribed burning can severely affect visibility and air quality, resulting in car accidents, airport and road closures, and public health problems. In addition, land and fire managers face constraints when conducting prescribed burns - especially near urban and wildland interfaces - because high particulate emissions can violate federal, state, and local air quality regulations. We propose to develop mobile LIDAR (light detection and ranging) instruments to measure in real-time vertical profiles of particulate concentrations and size distributions emitted by fires over a large area. Real-time smoke information especially in non-attainment areas will enable land and fire managers, air quality managers, and public health officials to assess and predict visibility, air quality, and the effects of smoke on human health. Smoke characteristics determined from airborne measurements are essential for validating (1) smoke dispersion models and (2) satellite measurements proposed by other investigators.

  Conventional technologies for measuring particulate concentrations and size distributions using gravimetric or light-scattering methods can provide data only at a single point; they cannot provide integrated spatial measurements over a broad area. Gravimetric methods are also inefficient and may take many days, which can delay prescribed burning and assessment of fire impacts on the environment. In addition, there is no information available to provide particulate concentrations in smoke plumes for developing plume dispersion models.

- Research and development approach:
  We propose to develop a series of mobile LIDAR instruments to measure vertical profiles of particulate concentrations and size distributions emitted by fires over a large area. We have already conducted extensive evaluations of different state-of-the-art LIDAR technologies and will adapt the most appropriate technology for smoke measurements. A research-grade mobile LIDAR instrument will be built and tested for ground and airborne measurements. Then we will build a portable, reliable, and low-cost LIDAR system for air quality managers to deploy in the field. The measurement results will be transmitted through wireless Internet and broadcast in real-time at a website.

The Fire Chemistry Unit (RWU-4404) has been using conventional methods of measuring particulate concentrations emitted by fires in the past ten years. Particulate concentrations were also measured daily in western Montana during the 2000 fire season. The information was provided to the Region-1 air quality managers for assessing daily air quality.

- Outcomes or products:

- First year:
  - (b) Evaluate daily air quality in Montana during the 2000 fire season using particulate concentrations data collected by conventional technologies.
  - (c) Select the most appropriate LIDAR technology.
- Second year:
  - (c) Build a research-grade LIDAR instrument.
- Third year:
  - (c) Test the LIDAR instrument for ground and airborne measurements.
  - (d) Measure smoke characteristics of wildfires and prescribed burning using the new instrument.
  - (e) Initiate construction of a simplified LIDAR instrument.
- Fourth year:
  - (a) Build a simplified LIDAR instrument.
  - (b) Test the equipment for ground measurements.
- Fifth year:
  Transfer the technology to air quality managers in Regional offices.

Staffing needs by series and grade:
- GS-12/13 research physicist or chemist (new)
- Two GS-9/11 physicists or chemists (new)

Description of skills required:
- The research physicist or chemist must be experienced in chemical or physical instrumentation. The scientist will also supervise two supporting staff members.
- The supporting physicists or chemists must be experienced in chemical measurements in trace quantities and be knowledgeable in electronics.

Potential Partners: NASA/Goddard Space Flight Center; NOAA Environmental Technology Laboratory; Forest Service Regions-1 and -3 air quality managers; Fire Sciences Laboratory, Fire Behavior Unit.

Funding requested: $500,000/year

Team Leader: Dr. Wei Min Hao, Project Leader, Fire Chemistry Unit (RWU-4404)
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Station: RMRS

Proposal code: RMRS-MSO-6

Topic(s): A-i, C-i, C-iv

Proposal title: *Remote sensing, GIS, and landscape assessment tools for fire management*

Other proposals to which this is linked: RMRS-MSO-8, RMRS-MSO-1, RMRS-MSO-19

RWU and location(s): RWU-4403, Fire Effects, Missoula

Description:

- Research or development question, issue, or need: Recent wildfires demonstrated that fire management decisions during major fire episodes are hindered by the lack of good spatial data on fuels, fire potential, values at risk, and fire damage. Managers need improved tools for assessing current fuel conditions and fire potential; mapping and modeling active fire behavior; and rapid assessment of burn severity and fire effects.

  Research and development approach: We propose to accelerate and extend current remote sensing/fuel modeling research by Keane et al. to develop protocols for mapping fuels at scales appropriate for input to fire behavior and effects prediction models. The RWU previously conducted major landscape-scale assessments in the Northern and Southern Rockies. We used LANDSAT-TM and ground reference data, and gradient modeling to map fuels and vegetation. New NASA-EOS data will be used to remap these areas and determine the accuracy gained by new sensors. Most of the burned land in the Bitterroot-Salmon-Challis and Gila areas is included in our data. We will test the accuracy of the Normalized Difference Burn Index (NDBI)(Key et al., USGS-BRD in press) across multiple fires in multiple vegetation types; and to develop protocols for rapid mapping of burn severity for input to BAER and monitoring and evaluation activities. We will develop spatially explicit variants of the First Order Fire Effects Model (FOFEM) and the WEPP erosion model and couple these models to predict changes in erosion potential as a function of fire severity and geomorphology. We will develop baseline data then remotely monitor and validate insect attack and delayed tree mortality. We will use remote sensing to monitor leaf area change and use Fire-BGC to model hydrologic recovery. Fuel and vegetation data collected by this project will serve as inputs to WFAS (Andrews et al.) and real time fire monitoring research by Hao et al.. If real time fire monitoring data are demonstrated to be valid they will be used to evaluate potential improvements over the NDBI logic. We will use the previously collected fuel, vegetation, and archived MSS data to determine if the size, severity and mosaic of wildfires has changed in recent years. We will initiate research using new NASA-EOS sensors to monitor live fuel moisture.

  - Outcomes or products: General - Protocols for developing spatial inputs for fire behavior and effects models; spatially explicit fire effects models; assessment of erosion potential, tree mortality, early vegetation recovery, and hydrologic recovery on select 2000 fires; assessment of temporal changes in fire size, severity, and patchiness.

- First year: Use NDBI to conduct rapid assessment of burned areas, develop spatially explicit linked FOFEM and WEPP models
- Second year: Remotely monitor change on 2000 fires, remap Northern and Southern Rockies areas, assess temporal changes in role of fire
- Three to Five years out: Determine improved accuracy, monitor change on 2000 fires, validate models and protocols on new fires, publish results

Staffing needs by series and grade: Research Ecologist GS-408-12/13; GS-334-11/12 Computer Specialist; GIS/Resource Analysist GS -0401-11; Forester GS-460-9

Description of skills required: landscape ecology and spatial statistics, software engineering and systems management, GIS/image analysis to compliment unit and cooperator's existing ecological modeling, remote sensing, and field skills.

Potential Partners: U. Montana, U. Arizona, RMRS-4351, RMRS-4401, RMRS-4404, RMRS-4702; USDI, Aldo Leopold Wilderness Research Institute.

Funding requested: $500,000/year

Team Leader: Hardy / Keane
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Station: **<u>North Central Research Station</u>**

Proposal code <u>NC-1.4</u>

Topic(s): <u>A-i</u> Resource allocation and decision support; <u>A-ii</u> Predictive models

Proposal title: National and Regional Fire-Weather Dynamics: Improved Methods for High Resolution Forecasting
of Fire-Weather Indices and Smoke Transport

Other proposals to which this is linked (Proposal code): NC-1.1, NC-1.2, NC-1.3, Achtemeier SRS-4104-1, RMRS-MSO-4, PNW-3, PSW-Fujioka.

Research Work Units: RWU NC-4401, Atmospheric-Ecosystem Interactions and the Social Aspects of Managing Ecosystems, East Lansing, MI

Description: Research or Development Question, Issue, or Need: Fine spatial and temporal resolution weather forecasts are needed to develop useful predictions of fire-weather and smoke transport and dispersion. The National Weather Service does not produce such tools. Fortunately, however, high-resolution atmospheric mesoscale and boundary-layer models are currently being used within the USDA Forest Service and at universities, other federal, state, and private agencies, and modeling centers throughout the country for both research and operational applications. The availability of these high-resolution modeling tools provides an opportunity to develop new and improved models and decision support systems related to fire-weather and smoke transport. Internal capacity building in the Forest Service and external collaboration with these modeling centers can lay the foundation for a new national framework of regional interagency atmospheric modeling consortia focused on fire-atmosphere interaction research and the development of decision support tools for the fire management community. Efforts are already underway within the USDA Forest Service to develop these regional consortia. There is clearly a need to build a north central and northeastern U.S. component to this national framework, where regional and national fire-weather and smoke transport issues are addressed and new and improved fire-related predictive models and decision support systems can be built.

Research and Development Approach: As part of a proposed USDA Forest Service national framework for regional atmospheric modeling, as described in companion proposals from fire/atmosphere research work units in the Southern, Pacific Southwest, Pacific Northwest, and Rocky Mountain Research Stations, this North Central Research Station (NCRS) proposed research will focus on the following objectives: (1) Developing effective atmospheric mesoscale model predictions of fire-weather and fire-weather indices at the national and regional level, (2) Linking fire-weather forecast information with data obtained from the proposed Forest Inventory and Analysis' (FIA) strategic monitoring of fuel loadings and fire potentials in U.S. forests (see proposal NC-1.3) to provide improved estimates of daily wildland fire potential, and (3) Developing improved atmospheric mesoscale model predictions of smoke transport and diffusion under different prescribed and wildland fire scenarios. For objective (1), potential refinements in current fire-weather indices (e.g. Haines Index) will be explored via climatological assessments of the indices and simulations of regional fire-weather episodes. State-of-the-art atmospheric mesoscale models (e.g. MM5, RAMS, HOTMAC, UW-NMS) and computing hardware available internally or externally through consortium partners will be utilized in this effort. After testing the refined indices and assessing how well they work through fire-occurrence correlations, the refined indices will be made available for integration into operational atmospheric mesoscale forecast models (e.g. MM5, UW-NMS) that can provide forecasts out to 48 hours and possibly longer. For objective (2), daily fire-weather index forecast maps will be integrated with FIA fuel loading maps or other derived estimates of fuels loading, within a GIS framework to provide improved GIS visualization of wildland fire risk at regional and national scales. For objective (3), new smoke transport modeling techniques developed within other Forest Service modeling consortia (see proposals from SRS and PNW cited above) will be incorporated into appropriate mesoscale models for predicting smoke transport during wildland and prescribed fire episodes in the north central and northeastern U.S.

Objectives (1)-(3) are designed to address the critical need for better predictive models and decision support tools for the fire management community. Both regional and national fire-weather and smoke transport research and development needs are addressed. In recognition of the need for consistency in fire-weather and smoke transport models and decision support tools for fire managers across the U.S., the models and decision support tools developed in this effort will be compatible with similar models and tools developed within other Forest Service sponsored regional consortia. Achieving objectives (1)-(3) will also provide valuable information for companion social-science-related research proposals from the NCRS that seek to assess perceptions of fire risk and the vulnerability of rural communities to wildland fire.

Outcomes or products:

First year: (1) A climatological assessment of the Haines Index for the U.S. that will describe the temporal and spatial trends and patterns of the Index across the U.S. (2) Development of a North Central Interagency Modeling Consortium composed of internal and external partners and modeling tools for addressing fire-weather and smoke transport issues.

Second year: (1) A refined Haines Index for fire-weather that can be incorporated into operational mesoscale forecast models. (2) Full integration of the refined Haines Index into an operational mesoscale forecast model. (3) Maps of 24- and 48-hour refined Haines Index forecasts available as part of the North Central Research Station's Atmospheric Disturbance Climatology System (http://climate.usfs.msu.edu/climatology/). (4) Publish one or more papers related to fire weather, index climatology for the United States.

Three to five years out: (1) Potential refinements of other fire-weather indices. (2) A GIS component within the NCRS's Atmospheric Disturbance Climatology System displaying fire-weather index forecast maps and fuel loading maps for estimating short-term wildland fire risk. (3) Mesoscale smoke transport and diffusion model capable of predicting smoke transport scenarios for the north central and northeastern U.S. (4) Web-based visualizations of different smoke transport and diffusion scenarios in the north central and northeastern U.S. (5) Publish several papers related to refined fire-weather indices, fire-weather and fuel loading patterns and trends, and smoke transport and diffusion scenarios in the north central and northeastern U.S.

Staffing needs: 1 GS-12/13 Research Meteorologist; 1 GS-9 Meteorological/Computer Technician

Description of skills required: Expertise in atmospheric mesoscale and boundary-layer modeling, including atmospheric turbulence and diffusion processes.

Potential Partners: This fire-atmosphere interaction research will be carried out in collaboration with Forest Service and external partners around the U.S., including fire and atmospheric scientists in the Southern Research Station (RWU SRS-4104), Pacific Southwest Research Station (RWU PSW-4401), Pacific Northwest Research Station (Managing Natural Disturbance Regimes Program – 4577), and the Rocky Mountain Research Station (RWU RMRS-4401). Other potential partners in carrying out the research and developing a regional modeling consortium include Dr. Paul Croft from Jackson State University, Dr. Jon Martin from the University of Wisconsin, Dr. Jerome Fast from the DOE/Battelle Pacific Northwest National Laboratory, and Dr. Gene Takle from Iowa State University.

Funding requested: $330,000 per year

Leveraging: Current work on the climatological assessment of the Haines Index will substantially speed development of first year products.

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Station: **North Central Research Station**

Proposal code: NC-1.1

Topic(s): A-i Developing improved tools for risk assessment and decision support

Proposal title: Assessing risk of wildfire and vulnerability of human populations and development in the North Central Region.

Other proposals to which this is linked (Proposal code): NC 1.2, 1.4, 1.5, 2.1, 2.2.4, 2.4, 3.2.2

Research Work Units: RWU NC-4153, Rhinelander, WI, RWU NC-4803, St. Paul, MN; RWU-NC-4401, East Lansing, MI, RWU-NC-4902, Chicago, Landscape Change Integrated Program.

Research or development question, issue, or need: This research will develop new approaches to regional fire risk assessment that couple ecological and social factors into a fire risk and consequence model, with an emphasis on reducing the potential for loss of life and property. The overall goal is to provide managers with a scientifically based decision support tool for prioritizing fire risk reduction activities in a regional, landscape, and local context. Specific goals are to:

1. Conduct a fire risk assessment within the 7-state region of the north central United States.
2. Develop methods of assessing the vulnerability of rural communities, dispersed primary and seasonal homes, recreational areas, and private and industrial land holdings with respect to degree of fire risk.
3. Provide decision support tools to managers for prioritizing locations and sequence of fuel treatments at landscape and local levels based fire risk and vulnerability of humans to loss of life and property.
4. Transfer these tools for applications elsewhere in the eastern United States.

The risk of wildfire within the seven states comprising the North Central region is high. This region has large numbers of fire ignitions, with more than 97% of all ignitions caused by humans. The extensive areas of fire-prone forest types, and the large number of permanent residents and tourists occupying these forests, compound the risk of fire. Moreover, fire suppression and forest management have led to uncharacteristically expansive tracts of fire-susceptible ecosystems with altered age-class distributions of short-lives species (e.g., jack pine and balsalm fir). These changes produced serious forest health concerns including insect infestations and natural senescence resulting in increased fuel loadings and extent of fuels, hence fire risk. The vulnerability of human populations in the North Central region is also high. Embedded in these pyrophilic forests are large numbers of rural homes and businesses that serve large populations of permanent and seasonal residents.

This research is responsive to needs identified in the Interagency (DOI and USDA) Report to the President in Response to the Wildfires of 2000. Recommendations included conducting research "regarding relationships between land management practices and the occurrence and intensity of fires," and "setting of regional priorities for land restoration, {and} fuels treatment…" This research will assist managers in making decisions for prioritizing treatments, and provide information needed for environmental analyses required under the National Environmental Policy Act.

Research and development approach: Conduct a fire risk assessment based on interactions of climate, ignition sources, and fuel type. Use multivariate and regression analyses of data on historical and modern wildfires, and ecological factors affecting the likelihood and potential extent of a conflagration. These factors include the spatial and temporal variability of macro-climatic gradients; meso-scale patterns in land use, road densities, landforms, and lakes; and fine-scale patterns in forest composition and patch size, topography, hydrography, and edaphic conditions. Georelational databases that will be analyzed include locations and extent of modern and historical fires, 30-meter resolution remotely-sensed vegetation (LANDSAT TM), interpolated climatic data, NRCS soil surveys, digital elevation models, roads, hydrography, and maps of the densities and locations of primary and seasonal homes, campgrounds, and other rural developments.

Movement of people into forested landscapes as seasonal or permanent residents is a major factor to be considered in predicting the risk of loss of property and lives from catastrophic wildfire. We will document current (year 2000) settlement patterns including housing and population densities across the landscape at the partial block group level using U.S. Census data. Partial block groups are subdivisions of counties based on U.S. Census block group and municipal area boundaries. We will also project current settlement patterns to the year 2020 using observations of past growth and models of population and housing density change. Settlement patterns and campgrounds will be overlaid with fire risk maps based on ecological factors and interactions to identify human populations and developments that are most at risk.

Outcomes or products:

First year: *Within Michigan, Minnesota, and Wisconsin, (1) Data assemblage and development; (2) Multivariate and regression analyses of ecological factors affecting incidence and extent of wildfires, (3) Production of first approximation fire risk maps, (4) Production of first approximation human vulnerability maps, (5) Delivery of data, maps, and interpretations to the fire management community.*

Second year: *(1) Further analysis and refinement of models, maps, and supporting documentation within the Lake States, (2) Completion of reports and publications on findings, (3) Recommendations on fuel treatment priorities.*

Three to five years out: *Complete first and second year tasks in Illinois, Indiana, Iowa, and Missouri.*

Staffing needs: 1 Research Ecologist (GS 408-12/13); 1 Management Scientist (GS-12/13), 1 GS-9 Meteorological/Computer Technician, 1 GS-9/11 GIS specialist, 2 GS-4/5 temporary positions/data digitizing.

Description of skills required: Ecologist and Management Scientist with expertise in spatial analysis, GIS, risk analysis, and the ability to work with human demographers. Meteorological technician with expertise in analysis of climate data.

Potential Partners*: National Forests and DNR's in each state, Michigan Technological University, Michigan State University, University of Minnesota at Duluth, Applied Population Laboratory at University of Wisconsin, Madison, Louisiana Pacific Corp, Mead Corp, Michigan and Wisconsin Timber Producer's Association, Sierra Club.*

Funding requested: *$462,000 total per year*

Leveraging: *This research will build upon a Joint Fire Science Program funded research project that is characterizing historic and contemporary fire regimes in the Lake States ($300,000), and mapping landscape ecosystems of varying susceptibility to fire disturbance. Data assembled by the Great Lakes Ecological Assessment will be used (supported by previous NPR award of $337,000). Scientists in each RWU will assist in analyses and reporting.*

Team Leader(s:) *Drs. David T. Cleland, Robert G. Haight, and Warren E. Heilman*
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Station: <u>NC submitting for 5 Stations with Forest Inventory and Analysis (FIA) Programs.</u>

Proposal code: <u>NC-1.4 (special National submission)</u>

Topic(s): A-i. Fire Fighting Capacity and Preparedness-Resource allocation and decision support; C-i. Reducing Hazardous Fuels and Fire Risk-Assessment; and the ability to directly and indirectly benefit, support, and monitor activities and impacts of A-ii, B-i, B-ii, C-iii, C-iv, and D-i.

Proposal title: Strategic monitoring of fuel loadings and fire potentials in US forests through the Forest Inventory and Analysis (FIA) program.

Other proposals to which this is linked: NC-1.1 Fire risk assessment; NC-1.2 Public/community perceptions of risk; NC-1.5 Fire weather forecasting; NC-3.3 Wildland-urban interface.

RWU (or Program or Team) and location(s): NC-4801 St. Paul, MN; NE-4801 Newtown Square, PA; PNW-4801 Portland, OR; RMRS-4801 Ogden, UT; SRS-4801 Asheville, NC.

Description: FIA proposes collecting detailed fuel loading data (forest vegetation composition and structure, and coarse woody debris {CWD}) on ~1800 of its systematic sampling plots each year, developing correlations to its remaining ~28,000 annual sample plots, and then extrapolating those relationships across the forested landscape using remote-sensing and GIS modeling techniques. The results will provide an empirical, field-validated baseline snapshot and annual assessment of the fuel loading situation in US forests.

Research or development question, issue, or need: Strategic inventory and monitoring provides baseline data for good policy formulation, and provides the means to judge the success, progress, and benefits of policies and resulting practices by capturing deviations from the baseline over time. The annual assessments resulting from this effort will provide baseline information on the current forest fuels situation in the US to help in formulating fire and fuels management policy and future direction, and provide information on how the US fuels situation is changing over time. As a result, these assessments will provide the gauge for determining if fire and fuels policies and practices are having the desired effect: are forest fuel loadings going up or down; are abatement practices having a significant impact; are opportunities being missed; are hot spots developing? Such information is of critical importance, and such information can only be gathered through a comprehensive, consistent, and reliable strategic-level inventory and monitoring system.

Research and development approach: FIA will leverage its extensive network of field sites by augmenting currently collected information on forest condition with extensive sampling and analysis of fuels across ecoregions, forest types, ownerships, stand sizes, slopes, aspects, and other site and stand characteristics.
The relationships between forest conditions and forest fuels on the geo-referenced sample plots will be extrapolated across the forested landscape using remote-sensing and GIS modeling techniques, such as k-nearest neighbor. FIA will then work with both internal and external partners to expand the relevance of the fuels data by providing strategic assessments of fire and

smoke risk, fuel abatement opportunities, high risk communities (life, property, or dollar loss), and by providing the baseline data for developing, calibrating, and validating various fire, fuels, and smoke predictive models.

First year outcomes: Methods development; collection of baseline forest vegetation and CWD data for national fuels assessment; regional fuel assessments and other value-added assessments, analyses, and map products.

Second year outcomes: Continued annual fuels data collection to build baseline and track trends; initial national fuel assessment and other value-added assessments, analyses, and mapped products.

Three to Five years outcomes: Continued annual fuels data collection to build baseline and track trends; annually updated national fuels assessment and other value-added assessments, analyses, and mapped products. Detailed reports by area, location, ownership, forest type, etc. on status and trends in fuel loads and fire/smoke/community risk as well as impacts of and recommendations for fuel/fire/smoke risk abatement.

Staffing needs (Scientist years, technician years, etc) by series and grade: 3 scientist year equivalents GS-12/13; 15 technician year equivalents GS-5/7/9.

Description of skills required: Senior-level scientists/analysts with specialties in fire/fuels/CWD. Technicians skilled in vegetation sampling, processing, etc.

Potential Partners (universities, federal agencies and labs, national forests, states, private companies, etc):
5 regional FIA units, individual State forestry agencies, various RWU within each Station, University of Minnesota.

Funding requested: A total of $1.7 million to be distributed across the 5 FIA Units based on workloads. Needs to be available annually to move from baseline snapshot to annual monitoring of trends.

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Station: RMRS

Proposal code: RMRS-MSO-10

Topic(s): C-iii, C-iv, C-i, B-ii

Proposal title: *Fire Management Strategies for Wilderness and Other Protected Wildlands*

Other proposals to which this is linked: RMRS-MSO-8, MSO-9, FTC-6

RWU and location(s): ALWRI (4901), Missoula, MT

Description:

- Research or development question, issue, or need:

Wilderness and similarly managed ecosystems constitute a significant proportion of all federal lands. Although policy dictates that these protected areas be managed to maintain or restore fire as a natural ecological process, the ability to accomplish this is often severely compromised by unnatural fuel accumulations, wildland/urban interface and air quality concerns, and limitations on access as well as the use of either mechanical or prescribed fire fuel treatments. To effectively manage fuels and fire in wilderness and adjacent wildland interface areas, the following questions need to be addressed: 1) How have management activities affected natural fire regimes in wildland ecosystems? 2) What factors limit the restoration of natural fire regimes? 3) What are the factors that control the frequency, severity, and spread of natural fires across landscapes and how have these factors changed during the past 100 years? 4) How can fire and fuels be most effectively managed along the wilderness interface zone (both within and adjacent to wilderness)? 5) How do fire and fuel management options affect wilderness values (e.g., naturalness)? 6) What are the tradeoffs of using naturally ignited wildland fire as opposed to prescribed fire or mechanical treatments in wilderness? 7) What are the effects of wildland fire management options on exotic weeds?

In addition to the management challenges, wilderness provides a valuable natural laboratory for learning about fire regimes, effects of fuel management options, and how best to restore natural fire.

- Research and development approach:

This program would provide the staff expertise to develop the understanding needed to effectively restore fire as a natural process to wilderness ecosystems across the country. A combination of in-house and cooperative studies will improve understanding of the effects of 20^{th} Century fire management on natural ecosystems and evaluate options for effectively restoring fire and its effects through various management actions. Special emphasis would be given to the unique challenges posed by wilderness designation and the management of fire within and adjacent to wilderness boundaries. In addition, the Institute's interagency mandate provides unique opportunities to coordinate studies and findings with the other federal agencies. This is of particular value in issues related to wilderness fire since fire burns across boundaries and there has been a noticeable lack of interagency coordination in management, planning and science. New permanent positions would be created for a research scientist and ecologist to expand the Institute's fledgling wilderness fire research program. An existing partially soft money funded application specialist would be converted to full time. Specific projects would be developed with other FS, DOI and university scientists with expertise in the understanding and restoration of fire to natural systems. Scientists and the application position would coordinate with boundary spanner positions throughout the Forest Service to assure maximum applicability to management issues.

- Outcomes or products: Understanding developed would be transferred to managers at workshops, conferences, and in technical and peer review publications. The application specialist would work closely with managers to assure findings are incorporated into management programs that reflect public values and priorities.
- First year: Build on existing relationships to prioritize information needs and develop effective working relationships with local managers of wilderness and adjacent non-wilderness lands. Evaluate the effectiveness of existing wilderness fire programs and assess actions needed to maximize ability to restore natural fire.
- Second year: Produce 1) an evaluation of the most significant factors limiting the restoration of natural fire regimes, and methodologies to prioritize fuel treatment options along wilderness and wildland urban interface boundaries so as to most effectively restore natural fire and minimize risks outside the boundaries.
- Three to Five years out: Produce methodologies for evaluating the risks, benefits and consequences of using naturally ignited wildland fire as opposed to prescribed fire or mechanical treatments, and evaluate impacts of wilderness and other roadless classifications on the ability to manage wildland fire.

Staffing needs by series and grade:
Existing workforce: 0.4 401/408 Research Biologist/Ecologist, GS 15 (Parsons), GS 13 (Landres)
New position(s):
1.0 401/408 GS 12/13/14 Research Biologist/Ecologist
1.0 408 GS 7/9 Ecologist
0.4 401/408 GS 9/11 Application Specialist

Description of skills required: Understanding of fire and its effects on natural systems; skills in field biology, quantitative and spatial analysis/modeling, communication with non specialists.

Potential Partners: RMRS Fire Lab and 4151, USGS, NPS, BLM, University of Arizona, Northern Arizona University, University of Idaho, Montana State University

Funding requested: $500,000/year

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Station: Pacific Southwest Research Station (PSW)
Proposal Code: PSW-4402-8
Topic: A-i
Proposal Title: An Initial Attack Service Delivery Simulation Model for Strategic Fire Management Planning

Other Proposals to which this is Linked: PSW-4402-4
RWU: PSW-4402, Fire Management Research, Development, and Application, Riverside, CA

Description: The 1995 Federal Fire Policy Review called for the development of a common approach to strategic wildland fire planning. The objective was not a single fire planning model but a framework within which a number of tools or modeling components could link to provide information in support of evaluating fire programs for effectiveness and efficiency. New technology modeling efforts are needed to provide the flexibility and diverse data required by federal agencies with differing missions and goals.

Research or Development Question, Issue, or Need: The wildfire initial attack system is and will remain a critical component in firefighting capability and preparedness, even with the prospective reduction in hazardous fuels. Current presuppression initial attack planning decisions are based on 1970s technologies originally designed to address budgetary accounting issues associated with the goal of suppression of all wildfires. These budgeting tools were not designed to address strategic planning or policy questions and are ill-equipped to address program needs, performance, and policy issues presented by existing environmental conditions and new wildland fire policy. These budgetary models provide incomplete and inaccurate information when used as analytical tools.

Operations research technology has advanced significantly since the 1970s. System simulation has become the 21st century tool of choice in both industry and government to model a range of complex systems such as road transportation systems, emergency services delivery, mining operations, and military supply systems. Use of these new and powerful simulation techniques would allow a more accurate model representation of the initial attack delivery system. The resulting model, in turn, would provide fire managers a powerful tool to explore more options more quickly and identify with greater confidence the best level of investments in the fuels treatment, prevention, and initial attack programs at the local, regional, and national levels. This behavioral-based system simulation model would allow addressing many policy questions not addressable by existing technology. To fulfill the need of a modern planning and policy analysis tool, this research project proposes development of a new initial attack simulation model based on state of the art simulation technologies to replace the aging initial attack model now contained in the National Fire Management Analysis System (NFMAS).

Research and Development Approach: State of the art systems simulation techniques will be used to develop a hierarchical initial attack simulation model that is capable of addressing strategic planning questions at the local, regional, and national levels. Accomplishment will be made through a nested model design that has a strong focus on service degradation associated with the spatial and temporal clustering of fires. Nesting has the feature of allowing high-resolution analysis of investments in and use of specific local resources while recognizing the implications of competition for use of shared resource in the competitive subregional, regional, and national fire environment. Local program analysis will be conducted in a subregional, regional or national fire environment. This design is necessary for several reasons. First, it allows local fire planners to recognize the potential and economic implications of shared resource preemption caused by concomitant fire activity at the subregional, regional, and national levels. Second, this model design allows local planners to more effectively evaluate the implications of changes in national and regional shared resource programs. Third, it permits tracking individual resource movement over time and space.

The model will have the capability to operate at the national and regional level to focus on shared resource program issues. Reversing the resolution levels and modeling local resource use with low resolution will accomplish this. The contribution of local resource to the initial attack effort will be handled abstractly to keep the dimensions of the simulation model within operational proportions when evaluating shared resources over the regional and national landscape. Operating in this mode, the model will only track shared resource movements over space and time.

Outcome or Products:

First Year: Develop study plan. Determine with field personnel specific model features to be incorporated in various model components. Complete prototype model component for national and regional shared resource analysis. Develop and test abstract model for handling local resources.

Second Year: Complete high-resolution prototype model component for addressing local resource program analysis. Complete final share resource component of systems simulation model.

Three to Five Years Out: Test and complete local resource model component. Integrate local resource component with share resource component to complete total system simulation model. Test and complete combined system simulation model. Interface model with existing National Fire Management Analysis System and develop windows based user interfaces, reporting system, user's manual, and system documentation for simulation model.

Staffing Needs: 2 scientists, Economist GS-110-12, and Operations Research Scientist GS-1515-12; 1 Master Level Professional (Fire management, economics, fire suppression); 1/2 Computer Programmer; 1/2 GIS; and clerical support.

Description of Skills Required: Fire management, planning, and operations experience; operations research, economics, knowledge of current models of wildfire management, programming.

Potential Partners: This will be a collaborative project between Pacific Southwest Research Station RWU 4402; Klamath NF and two other administrative sites as potential development and testing site; the University of Toronto and Ontario Province currently working in a similar area; Missoula Fire Lab for fire environment modeling and GIS; Canadian Forest Service-Edmonton currently working in a similar area.

Funding Requested: $500,000/year for 5 years

Team Leader: Dr. Marc Wiitala
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Station: Pacific Southwest Research Station (PSW)

Proposal Code: PSW-4403-1

Topic: A-i

Proposal Title: Fire Behavior in Live Fuels

Other Proposals to which this is Linked: PSW 4401-1, RM-MSO-1, RM-MSO-2, FPL-4723-1, and RMRS-FLG-6

RWU: PSW-4403, Prescribed Fire and Fire Effects, Forest Fire Laboratory, Riverside, CA

Description:

Research or Development Question, Issue, or Need: Fire occurrence in living fuels such as coniferous forests, sagebrush, and chaparral account for a significant proportion of the area burned annually in the United States. Since many communities live in close proximity to, if not within, these flammable vegetation types, millions of dollars of damage to residences has occurred. However, little fundamental research has been performed to understand the dynamics of fire initiation and spread in these fuel types since the 1960s. We need to fill this critical gap in our understanding of fire behavior in living fuels in order to better describe conditions when live vegetation poses a fire risk.

In current fire spread models such as BEHAVE, live fuels are modeled as dead fuel with higher moisture content. While basic work examining the chemical composition of live fuels occurred 20-30 years ago and is used in current models, understanding the mechanics of heat transfer and combustion in these porous fuels is lacking. We do not understand the mechanisms that govern the transition from no fire spread to marginal fire spread to active spread through the shrub canopy. In order to use prescribed fire as a fuel management tool or to design mechanical methods of fuel manipulation to reduce fire risk, we need to understand these transitions theoretically.

Research and Development Approach: Since little recent work has taken place in live fuel fire behavior, a combination of laboratory and field based experimentation is necessary. Chemical and physical analysis and modeling of combustion processes will be performed at laboratory-scale to understand and describe heat transfer dynamics and chemical kinetics in these fuels. Current cooperative work at the FS Forest Products Lab on vegetation flammability will be extended to further describe energy requirements for ignition of live fuels. Ground-based measurement of fuels, weather, chemical and physical processes on field-scale experimental fires will be performed to understand these same processes at the actual scale of the fuel matrix since the relative importance of the physical mechanisms may change as scale changes. Airborne measurement of the experimental fires (see PSW-4403-6) will be coupled with ground-based measurement to understand larger-scale fire dynamics. The fuel types of emphasis will be southwestern shrub fuels such as California and Arizona chaparral, and Gambel oak with possible inclusion of sagebrush and pinyon-juniper. This work will complement and supplement the crown fire modeling work currently being conducted at the RMRS Fire Sciences Lab.

Outcome or Products:

First Year: Preliminary understanding of factors governing fire ignition and spread based on empirical studies at both the Forest Products Lab and PSW Fire Lab.

Second Year: Data describing physical processes from lab and field-scale experimental fires in selected live shrub fuel types. Expanded experimental database of lab-scale empirical studies. Preliminary testing of existing models of these same physical processes.

Three to Five Years Out: Improved understanding and description of fire behavior in live shrub fuels. Ground-based data necessary to calibrate airborne and perhaps space-borne measurement of fire properties. Joint development (with RM-4401) of a preliminary model of live fuel fire behavior or validation of use of existing fire behavior models in live fuels.

Staffing Needs:
GS-830/1300-12/13 Research Mechanical Engineer or Physical Scientist (1 SY per year)
2 GS-1311-7/9 Physical Science Technicians (2 TY per year)

Description of Skills Required: Scientist will need to have ability to design and instrument lab and field-scale experiments to measure the pertinent physical (heat transfer) and chemical processes associated with fire in live fuels. Knowledge of combustion and heat transfer processes and models. Ability to understand and/or develop models of fire behavior processes.

Potential Partners: UC Berkeley, UC Riverside, Los Alamos National Lab, Lawrence Livermore National Lab, Sandia National Laboratory, FS, NPS, BLM, BIA, States of CA, AZ, NV, NM, CO, UT, Southwestern Borderlands Project

Funding Requested: $500,000

Team Leader: David R. Weise
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Station: Pacific Southwest Research Station (PSW)

Proposal Code: PSW-4403-6

Topic: A-i

Proposal Title: Real Time Remote Sensing of Fire Properties

Other Proposals to which this is Linked: PSW 4401-1, PSW 4403-1, FPL-4723-1, RMRS-FLG-6, RMRS-MSO-1, and RMRS-MSO-2

RWU: PSW-4403, Prescribed Fire and Fire Effects, Forest Fire Laboratory, Riverside, CA

Description:

Research or Development Question, Issue, or Need: Energy release and heat transfer affect all aspects of a wildland fire ranging from immediate fire behavior and spread to long-term ecological effects on the landscape. Our current research ability to quantify energy release is typically limited to a few, spatially concentrated instrument packages. Remote sensing techniques can potentially provide instantaneous extensive measurement of the entire fire area. Equipment and techniques that have been developed using external funding and primarily applied in the Brazilian savanna need to be tested and evaluated for potential application in temperate forests, shrublands, rangelands, and grasslands. Our ability to evaluate the equipment has been limited by our inability to link the remotely sensed data with intensive, ground-based data. Once the techniques have been validated, the instrumentation can be used to provide extensive description of fire phenomena that can be used to develop improved fire behavior models (including smoke transport) and test existing models.

Research and Development Approach: Various theoretical assumptions have been made to enable remotely deployed sensors to estimate the energy release and hence temperatures from wildland fires. Some of these assumptions relate to the spectral qualities of a wildland fire flame and areas of residual combustion. Verification of these assumptions will be made by collecting ground-based data from wildland fires. Within cooperating proposals, we propose to conduct a series of prescribed fires in various fuel types in order to measure various fire behavior phenomena to develop improved fire behavior models for live and dead fuel complexes. As a component of these experimental fires, we propose to use our existing equipment and aircraft to collect airborne measurements of various variables including flame radiance, vertical velocity, and smoke characteristics. These same variables will be measured from the ground using various techniques. The ground-based data will be used to validate the airborne estimates. Once validated, the remotely-sensed data will be used by several other collaborators to develop new models and test existing models.

Outcome or Products:

First Year: Development of sufficient ground-based fire behavior data sampling techniques. Deployment of aircraft on available fire experiments and wildfires. Planning of large-scale prescribed fires for remote measurement.

Second Year: Processing of 1st year data and comparison between ground and aircraft data. Refinement of data collection procedures. Deployment of aircraft on available fire experiments and wildfires Nation-wide. Begin development of real time data system.

Three to Five Years Out: Improved ability to characterize fire behavior at the scale of the fire using remote sensing data. Extensive data sets available for development and testing of various fire behavior models. Real time data delivery system implemented.

Staffing Needs:
1 GS-460-12 Research Forester (1 SY/yr)
1 GS-7/9 Physical Science Technician (1 TY/yr)
1 GS-9 Geographer (1 PY/yr)
1 GS-7/9 Computer Specialist (1 PY/yr)

Description of Skills Required: Ability to collect physical measurements of fire phenomena using various ground-based sensors in a variety of vegetation types. Ability to integrate ground-based data spatially to georeferenced airborne data. Ability to maintain and upgrade computer systems and process large amounts of remotely sensed data using computer technology.

Potential Partners: UC Berkeley, UC Riverside, Los Alamos National Lab, Lawrence Livermore National Lab, Sandia National Laboratory, FS Regions 3 and 5, State of CA, Southwestern Borderlands Project

Funding Requested: $500,000

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Station: PNW

Proposal code: PNW-3

Topic(s): A-i (C-i, C-iii)

Proposal title: Smoke Modeling Framework for Real-Time Prediction of Fire Hazard and Severity, Air Pollutant Emissions, Transport, and Dispersion from Wildland Fires and Prescribed Fires ("BlueSky")

Other proposals to which this is linked (Proposal code): PNW-1, -2, -4, -7. Also, RMRS-MSO-4, Achtemeier-SRS-4104-1, PSW, NCRS high-resolution regional modeling proposals, and RMRS and PSW fire behavior and fire danger proposals. Modeling of smoke effects requires integration of fuel structure, fuel condition, fire spread, fuel consumption, and emissions. Proposed improvements to each of these components by other scientists and teams within this Station and at other stations are critical to the success of this project. Once developed and verified, the smoke modeling framework can be adapted in any high-resolution, model-prediction system.

RWU (or Program or Team) and location(s):
Managing Disturbance Regimes Program (4577)
Fire and Environmental Research Applications Team (FERA) Seattle, Washington

Description:

- **Research or development question, issue, or need:**

To implement the Clean Air Act and new Regional Haze Rule, regulatory agencies require that the Forest Service become more active in smoke modeling and real-time emission tracking to better understand the impact of prescribed fire and wildfire on air quality and visibility. In addition, implementing the National Fire Policy and Cohesive Strategy requires improved understanding of smoke impacts that often limit our use of fire. We have the needed tools to address these concerns but they are underutilized or inappropriately linked.

Accurate**,** real-time, automated prediction of air pollutant emissions and impacts is needed. During the 2000 fire season thousands of people were affected by harmful smoke concentrations for long periods of time, but citizens tolerate very little smoke from prescribed burning. How can we more effectively inform and warn of impending impacts from smoke? Will smoke impacts from the wildfires affect people's acceptance of an aggressive prescribed fire program? How can we use fire without filling the airshed with smoke, violating NAAQS, imposing health hazards, or degrading visibility? How much smoke contributes to regional haze?

- **Research and development approach:**

We will design and build a prototype smoke-modeling framework as an automated, real-time, web-based system. The framework will be developed within an interagency, cooperative environment that addresses concerns from air regulators, smoke managers, and fire operations and planning. The functioning system will eliminate the burden on users for copious inputs, provide immediate feedback on accuracy, show cumulative effects of smoke from prescribed agriculture and forest burning across land ownerships, and create an efficient emission tracking system. In addition, the system will offer a framework for developing and testing model components that include fuel condition, fuel structure, fire spread, consumption, and emissions. All of these components need to be modified and improved for real-time, automated application. Continuous technical improvement of component source strength and dispersion models, including the Emission Production Model (EPM), is part of this proposal.

Blue Sky will take advantage of real-time, high-resolution, meteorological model (MM5) predictions that are being supported by regional, inter-agency consortia across the country. This is the same modeling environment being proposed for high-resolution fire behavior, severity, and danger prediction. Once operational and verified, the modeling framework can be adapted for use nationwide. Initially it will link FASTRACS fuel inventory system, EPM emission production model, CALPUFF dispersion model, and MM5 by following recommendations from the Express Team and TASET. Although design will focus on prescribed fire applications, we will use the 2000 fire season as a case study to assess the feasibility of automating smoke modeling components for wildfire and wildland-fire use, build initial verification data links, and test potential modeling components such as FARSITE/BURNUP. We will design the framework to accommodate other regionally-specific components such as the PFIRS fuel inventory system to ensure national application. Also, we will use data from satellites, aircraft, field observations, and measured smoke concentrations to tune and validate modeling components. We have created an interagency, ad-hoc smoke modeling committee that includes state and federal air regulators and fire and smoke managers who will act to guide development, review output products, and assess value. Seed money for MM5 support, 2000 fire data collection, and initial model linkage already has been committed from Region 6, and Watershed & Air Management.

- **Outcomes or products**:
- ❑ **First year:** (1) Documentation of smoke impacts from the 2000 fire season in Montana and Idaho; (2) guidelines for monitoring and assessing emissions from wildfires; (3) an automated smoke observation database; (4) a test of real-time smoke modeling for prescribed fires; and (5) new algorithms for estimating surface smoke concentrations from satellite observations.
- ❑ **Second year:** (1) An automated system for predicting and cataloguing emissions, and predicting and monitoring cumulative smoke impacts from prescribed fire.
- ❑ **Three to Five years out:** (1) A prototype smoke modeling system for nationwide application; (2) a framework for integrating new modeling components such as mapped Fuel Characteristic Classes (FCCs); (3) an on-going framework to test new knowledge in fuels, combustion, emission, and dispersion; and (4) linkage with the EPA’s one-atmosphere modeling system, Models-3, for regional haze assessment and tracking.

Staffing needs by series and grade:
NEW PERMANENT SCIENTIST:
Atmospheric Scientist (100%) 1340/0819/1313(11-12)
NEW PERMANENT TECHNICIANS
Remote Sensing-GIS Specialist (70%) 0150 (9-11)
Computer Programmer (70%) 1550/0334(9-11)

[We now have term-staff in these positions].

NEW TEMPORARY/TERMS:

Computer Assistant (20%) 0334 (7-9)

Data Analyst (20%) 1531 (7-9)

EXISTING TERMS: Meteorological Technician (20%) 1340(9-11)

EXISTING PERMANENT: Atmospheric Scientist (20%) 1340(13-15)

Description of skills required: Atmospheric and air pollution modeling, analysis, and assessment; statistical and spatial analysis; data acquisition and formatting; object-oriented programming; coordination between management, regulatory, and research partners

Confirmed Partners: Washington Departments of Ecology and Natural Resources, Oregon Departments of Environmental Quality and Forestry, Montana/Idaho Airshed Group (includes private, state, and federal agencies), EPA, WRAP, WESTAR, NASA, University of Washington, Washington State University, Puget Sound Clean Air Agency, BLM, NPS, Forest Service Regions 6,1, and 4, and the Rocky Mountain Research Station.

Funding requested: $500,000 per year

Team Leader: David V. Sandberg (Contact: Sue A. Ferguson (206)732-7800, sferguson@fs.fed.us)

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Station: PNW

Proposal code: PNW-2

Topic(s): A-i

Proposal title: Estimating Natural and Anthropogenic Sources of Visibility Impairment and Regional Haze from Prescribed and Wildland Fires

Other proposals to which this is linked: PNW-1,3,7,16,18; SO (unknown codes) RM (unknown codes)

RWU (or Program or Team) and location(s):
Managing Disturbance Regimes Program (4577)
Fire and Environmental Research Applications Team (FERA)
Corvallis, Oregon and Seattle, Washington

Description:

- **Research or development question, issue or need:**

The Regional Haze Rule promulgated in 1999 under the Clean Air Act presents challenging science and policy questions for air resource management and ecosystem management. The rule allows some level of prescribed fire to impact visibility in Class I areas provided that the impact does not exceed what would occur naturally. EPA recognizes that natural impacts are episodic and that fuel buildup requires fuel treatment to return and restore the natural role of fire in ecosystems. However, the goal of removing anthropogenic sources of visibility impairment by 2064 presents a serious challenge for the Cohesive Strategy for fuels management that can only be met by new research.

What are the natural and background levels of regional haze and Class I visibility impacts that can be expected from current and future wildland fires and prescribed fires needed to restore and sustain ecosystems? What level of emissions and impact above current levels is necessary to restore ecosystem function? What level of prescribed fire can be considered a substitute for visibility impairment from natural sources because it offsets natural impacts or is necessary to sustain healthy ecosystems? What level of visibility impairment can be considered natural because it would occur naturally in the absence of fire management in healthy ecosystems? What is the likely visibility impairment from natural and anthropogenic sources in the year 2064 that is the Federal Clean Air Act goal to eliminate anthropogenic impacts? What mechanism is available to track emissions, impacts and progress toward the national goal? How can fire managers and air resource regulators establish what sources are to be considered "natural" and what fires are to be classified and inventoried as anthropogenic? What limits, if any, does the national visibility goal place on prescribed burning?

- **Research and development approach:**

Form research and policy analysis partnerships with the EPA and state agencies, the Western Regional Air Partnership, Western States Air Resource Consortium, Forest Service Fire and Air Management, Interior agencies, and regional consortia that include universities such as the University of Washington. Determine the level of disturbance necessary to sustain current and future ecosystems. Estimate the visibility impairment from natural and anthropogenic fire sources. Predict the severity of fires and visibility impairment under several climate and management scenarios. Predict the rate of visibility improvement over time during a period of ecosystem restoration and during ecosystem maintenance. Design an emission inventory and fire classification system to track progress toward the visibility goal.

- **Outcomes or products:**

    - **First year:** Classification of natural and anthropogenic sources of visibility impairment. First estimates of the emission inventory from prescribed fires and wildfires. Engineering estimate of natural visibility impairment from fires on the 20 percent of worst days over long term averaging periods in large regions.

    - **Second year**: Emission inventory system for natural and anthropogenic fire sources. Prediction of future emissions from fires under current management strategies and under implementation of the cohesive strategy. Improved estimates of visibility impairment on selected Class I Areas. Initial gridded national maps of emissions source estimates for use in Models3 and other analysis systems. Design modeling system for average and episodic emissions.

    - **Three to five years out**: Completion of source classification, emission inventory, and progress-tracking systems for prescribed fires and wildland fires. Gridded national source maps for fire emissions from natural and anthropogenic sources under a variety of future management and climate scenarios.

Staffing needs by series and grade:

- Fire Scientist GS-460-15 (0.2 FTE)—Existing
- Technical Information Specialist (.2 FTE) -- Existing
- Fire Scientist GS-401-12 (0.3 FTE)—New Scientist
- Environmental Engineer GS-0819-12 (0.3FTE)—New Scientist
- Data Analyst GS-343-12 (0.5 FTE)—New Technical

Description of skills required:

Knowledge of air resource management principles and regulatory strategies; quantitative modeling skills; knowledge of fire ecology and fuels treatment options and strategies.

Confirmed Partners:

Form or strengthen research and policy analysis partnerships with:

- EPA OAQPS, Region 10
- State agencies (Alaska, Washington, Oregon, California, Wyoming, Florida)
- Western Regional Air Partnership (WRAP)

- Western States Air Resource Consortium
- Forest Service Fire and Air Management (F&AM)
- Interior agencies such as BLM, Alaska Fire Service, Fish and Wildlife Service, NPS
- Regional consortia that include universities such as the University of Washington

Funding requested: $500,000 per year

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Station: PNW

Proposal code: PNW-1

Topic(s): A-i

Proposal title: MAPSS-Based Seasonal Prediction of National Fire Risks and Impacts

Other proposals to which this is linked (Proposal code): PNW-4, PNW-18, PSW-4401-2 (Fujioka)

RWU (or Program or Team) and location(s):
Managing Disturbance Regimes Program (4577)
Mapped Atmosphere-Plant-Soil System Team (MAPSS)
Fire and Environmental Research Applications Team (FERA)
Corvallis, Oregon and Seattle, Washington

Justification, statement of proposed research, expected deliverables and applications:

- **Research or development question, issue, or need:**

Enhanced predictive capability of fire risks and impacts is needed over the entire U.S. of near-term fire risks, both within the upcoming seasons of the 'current' year and over the next several years. The predictive capability is needed for estimating fire fighting needs, as well as the risks of prescribed-fire 'escapes.' How does fire weather affect fire occurrence and what is the relationship between ecosystem condition, fuel loadings and fire severity over large scales?

- **Research and development approach:**

(1) Extend existing technology to produce continental-scale spatially explicit weather timeseries from 1895 to the 'current' month (using PRISM and related technology). This is largely a technology transfer component.
(2) Develop continuing future 3-12 month forecasts (from climate models and El Nino-La Nina projections, e.g. from Scripps, see PSW-Fujioka proposal). Climate models, combined with empirical techniques have shown skill in 3-12 month forecasts when linked to Sea-Surface Temperature anomalies and other climate patterns. These skills will be additionally improved.
(3) Validate and enhance existing continental-scale fire/ecosystem models using actual fuel loadings and characteristics such as those provided by the USFS Wildland Fire Assessment System (WFAS) and compare model output to spatially explicit fire size and distribution data provided by satellite imagery (e.g., from NOAA's Operational Significant Event Imagery program). The current fuel and ecosystem characteristics will also be based on other Joint Fire Science Project outputs (Sandberg et al.). The new dynamic general vegetation models (DGVM) are hybrids between the MAPSS vegetation distribution model and each of two different vegetation productivity models (CENTURY and BIOME-BGC). They incorporate U.S. and Canadian National Fire Danger Rating

Systems and Rothermel and VanWagner fire algorithms and others, all of which will be updated. The current technology accurately simulated both the 1910 fires and the 1988 Yellowstone fires, based on observed spatially explicit climate timeseries.

(4) Although long-term historical climate timeseries and near-future predictions have shown value in predicting fire danger and impacts, they must be enhanced to improve prediction of fire starts. Innovative down-scaling techniques will be developed that relate large-scale climate forcing patterns to weather events, such as lightning, convective precipitation, and wind gusts. The resulting tools will be used with the new DGVMs to help define fire starts under large-scale climate anomalies.

- **Outcomes:**

- **First year:** Hire staff and begin development of historic to 'current' and near-future spatially explicit climate technology using partnerships. Begin ecosystem model validation and incorporation of updated fire and fuel algorithms and data. Formalize collaborations and begin preliminary assessment of the effects of ENSO on weather events that control fire starts.

- **Second year:** Validation and enhancement of large-scale fire and ecosystem processes predictive capabilities. Preliminary downscaling of large-scale climate features to local events for assisting in fire starts in the DGVMs.

- **Three to Five years out:** Test and begin implementation of rolling 3-12 month continentally-mapped projections of potential fire risk and impacts. Integration of 'current' and forecast climate and fire ignition forecast products with DGVMs for improved understanding of variations in ENSO and its relation to fire patterns in all parts of the United States. Develop the new technology for transfer to natural resource management community.

Staffing needs:
- Fire ModelerGS-401-12/13
- Technician GS-1550-9/11

Description of skills required: **Fire Modeler, Ph.D; Biogeochemist, Ph.D.; GIS/Programmer/Disturbance Modeler, M.S./Ph.D.; Climatologist, Ph.D.**

Potential Partners:
- Wildland Fire Lab, Missoula, MT
- NOAA and Oregon State University for 3-24 month, spatially-explicit weather forecasts
- NOAA Climate Diagnostics Center (CDC)
- Scripps Institute
- PSW
- NASA
- NSF/Integrated Research Challenges Project P.I.s (Title: 'Biological Control of Terrestrial Carbon Fluxes' for historical and current land cover/land-use databases; R.P. Neilson is a collaborator on this project)

Funding requested: $500,000 per year

Team Leader: Ronald P. Neilson
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Station: PNW

Proposal code: PNW-4

Topic(s): A-ii

Proposal title: Fuel Moisture Mapping and Combustion Limits: Mechanistic Models, Remote Sensing, and Mapping of Fuel Moisture and Combustion Potential for All Fuelbeds in the United States

Other proposals to which this is linked: PNW-3, 7; Fire modeling proposals from RM (codes unknown)

RWU (or Program or Team) and location:
Managing Disturbance Regimes Program (4577)
Fire and Environmental Research Applications Team (FERA)
Corvallis, Oregon and Seattle, Washington

Description

- **Research or development question, issue, or need:**

Current fire danger and fire behavior prediction focuses on the flaming stage of combustion, while fire effects and resistance to control are governed by smoldering and residual combustion in heavy fuels and organic soil layers. Fuel combustion algorithms in current use are based on exchange of moisture between sound, cylindrical woody fuels and the atmosphere, and are inadequate to predict moisture transport in porous fuels such as duff and moss layers. Flaming combustion in shrub types, and smoldering propagation in large rotten logs, older stumps, and deep organic layers, are poorly understood and not modeled. This research will (1) provide a national fuel moisture and danger rating system that includes modeling of duff and moss moisture dynamics; (2) provide a simulation model of smoldering propagation in rotten and ground fuels; (3) assess the limits of flaming, smoldering, and residual combustion of shrub biomass, rotten woody logs, stumps, and ground fuels (moss, duff); (4) model heat and moisture transport within porous fuels and between fuels and the atmosphere, and (5) design and develop the next version of Consume software (version 4) for managers and scientists containing the new theoretical and empirical fuel consumption models formulated from this project.

- **Research and development approach**:

Develop a consistent mechanistic model of duff and moss moisture dynamics in all organic soil layers in boreal, temperate, and tropical ecosystems. Replace or improve KBDI, NFDR-Th, DMC, and DC with a national system of predictive algorithms that rate the flammability and consumption of organic layers. Test remote sensing and automated *in situ* moisture measurement systems. Test electronic fixed-site duff moisture sampling instruments, methods, and protocols. Provide a national protocol and program of sampling fuel moistures *in situ* across the United States, including Alaska. Investigate micro-, meso-, and large-scale variability in fuel moisture. Re-examine the concept of timelag response and other bases of current moisture modeling.   Test the usefulness of synthetic aperture radar and other remote-sensing applications to map surface fuel moistures across large regions between fixed sampling locations.

Combine theoretical heat-balance modeling, laboratory experiments, and field measurements to develop a reliable method of predicting combustion limits and consumption for shrubs, duff, and rotten logs and stumps.   Theoretical modeling has already begun though a port-doctorate appointment working with combustion sciences in the Oregon State University Mechanical Engineering Department, the Combustion and Propulsion Laboratory of the Brazilian Space Agency (INPE) in Sao Paulo, and the Rocky Mountain combustion science laboratory.

- **Outcomes or products**:

  - **First year:** Test the accuracy of the Canadian Fire Weather Index Duff Moisture Codes, the Keetch-Byram Drought Index and the National Fire Danger Rating System 1000-hr. moisture index as a predictor of duff and moss moisture in the boreal forest of Alaska, moist temperate forests of the Pacific Northwest and Rocky Mountain states, in pine forests and mixed forests of the Southeast United States, and muck soils of Florida. Formulate a theoretical model of shrub flaming combustion and smoldering combustion heat transfer and exchange. Initiate laboratory experiments.

  - **Second year**: Test initial formulations in the laboratory and field.   Refine sampling protocols in the laboratory and field. Identify physical processes that are and are not adequately modeled mechanistically or statistically by current predictive algorithms. Design manipulative experiments and field sampling to formulate new mechanistic models and test hypotheses. Begin system design of Consume v.4 fuel consumption software.

  - **Three to five years out**: Provide mechanistic models for thawing, liquid movement, wetting, and drying phases in organic layers across all forest types in North America. Map fuel moisture and fire hazard changes across the United States, using a network of fixed stations, remote sensing, meteorological models and direct measurement techniques. Establish flammability limits for combustion of shrubs and smoldering in rotten woody debris and organic soil layers. Provide mechanistic of heat transfer and propagation of flaming and smoldering fires in shrubs, duff and rotten woody fuelbeds. Finalize design and development of Consume v.4 software with user manual and training package.

Staffing needs by series and grade:
New Permanent Scientist:
    Combustion Engineer GS-13
New Permanent Technician:
    Engineering Technician GS-0801-09 (1.0 FTE); Programmer GS-1550-11 (0.3FTE)
New Temporary Technicians:
    GS-09 (1.0 FTE); GS-05 (3.0 FTE)

Existing Terms

GS-09 (1.0 FTE)

Existing Permanent Employees:

Forester GS-12 (.50 FTE), Research Forester GS-14 (0.20 FTE), Physical Scientist GS-15 (0.20 FTE)

Description of skills required: Atmospheric scientist or physical scientist specializing in moisture and heat exchange and transport in porous media. Forestry technicians with expertise in field measurement of fuels

Confirmed Partners:

- Rocky Mountain Research Station
- NASA and other engineering/aeronautics/space institutes
- Fire management agencies including Forest Service WO, R-6, R-8, R-3, R-9, R-4; BLM, USFWS; NPS and Alaska Fire Service

Funding: $500,000 per year

Team Leader: David V. Sandberg
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Station: Pacific Southwest Research Station (PSW)

Proposal Code: PSW-4401-1

Topic: A ii

Proposal Title: High Resolution Weather Models for Geographic Area Coordination Centers

Other Proposals to which this is Linked: NC-1.4, PNW-3, RMRS-MSO-4, SRS-4104-1

RWU: RWU-4401, Meteorology for Forest & Brushland Management, Riverside, CA

Description:

Research or Development Question, Issue, or Need: High resolution weather analyses and forecasts are needed to drive fire behavior and smoke dispersion models, and for better fire danger rating. The increased resolution is particularly important in complex terrain, which can induce significant weather/climate gradients over short distances. Prescribed fire operations require high resolution wind and temperature profile information to provide air quality regulators with the best predictions possible of potential impacts. Ultrafine grids are required to model interactions between the atmosphere and fire; knowledge of these interactions is necessary to understand the erratic fire behavior that threatens firefighters on the line.

Research and Development Approach: We will use mesoscale weather models such as MM5 and a mesoscale spectral model to generate 24-72 hr weather forecasts at grid intervals of 1-10 km. Initially, we will work with fire meteorologists at the Riverside and Redding fire coordination centers in California, to put high resolution forecasts on a fast track for fire operations. We will also coordinate with similar regional modeling centers established by PNW,SRS, and NC Stations, to unify these efforts nationally. The state-of-the-art is not yet capable of sub-kilometer grid spacing weather simulations, which we know from current research are important for some fire applications. Therefore, research will be conducted simultaneously on hybrid prognostic/diagnostic and dynamic/statistical modeling schemes, to generate the desired resolutions operationally. Data assimilation methods will use observed weather from mesoscale networks such as fire weather remote automatic weather stations (RAWS), to enhance analysis of local effects. With respect to dispersion modeling, we will initially adopt the protocol established by the PNW consortium.

Outcome or Products:

First Year: Develop and test high resolution weather forecast graphics for geographic area coordination centers, in concert with operational fire weather forecasters. Working with PNW, California air quality regulators and fire weather forecasters, describe and begin implementation of protocol for air quality forecasts. Work with RM Missoula to support high resolution modeling for atmosphere-fire interaction research at the National Center for Atmospheric Research (a multiyear effort).

Second Year: In conjunction with RM and PSW fire behaviorists, describe and begin implementation of protocol for fire behavior and fire danger forecasts driven by mesoscale weather models. Couple this effort with research and development of near real-time fire monitoring methods aimed at validating the modeling schemes and quantifying prediction uncertainties.

Three to Five Years Out: Capitalize on advances in computing technologies to drive the model grid spacings down to sub-kilometer scales, and assess the operational performance of such improvements. Provide continuing R&D support to cooperating fire weather forecasters.

Staffing Needs: (1) GS-1340-12/13/14 Research Meteorologist, (1 sY/yr), (2) GS 11-13 Computer Specialist, 0.5 PY/yr, and (3) GS 07-11 GIS Specialist, 0.5 PY/yr

Description of Skills Required: (1) Knowledge and ability to conduct research and development of mesoscale weather models for application to air quality, fire behavior and fire danger forecasting. Work with fire weather forecasters in geographic area coordination centers to implement weather models. (2) Provide programming and computing systems support to project scientists. Coordinate computing activities with computer specialists at cooperating locations. (3) Design and implement GIS interface for display of model output with relevant geographic information. Coordinate GIS needs of team members and cooperators.

Potential Partners: A weather modeling consortium based on past and present partnerships may include UC San Diego/Scripps Institution of Oceanography, University of Hawaii, University of New Mexico/Maui High Performance Computing Center, NWS National Centers for Environmental Prediction, National Center for Atmospheric Research, and the Naval Postgraduate School, Monterey. Other potential partners are the Los Alamos National Lab, Lawrence Livermore National Lab, University of Nevada Desert Research Institute, and NOAA Air Resources Lab. User partnerships include the FS Pacific Southwest Region, California Department of Forestry, Los Angeles County Fire Department, California Air Resources Board, National Park Service, Hawaii Division of Forestry, Pacific Disaster Center, and the US Army-Hawaii.

Funding Requested: $500,000/yr, including $25,000/yr to support consortia collaboration at the national level.

Team Leader: Francis Fujioka, Forest Fire Laboratory, Riverside, CA
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Station: SRS
Proposal code: SRS-4104-2
Topic (from list): A-i,ii

Proposal Title: Southern regional models to predict smoke movement and mitigate impacts at the wildland urban interface

Other proposals to which this is linked: SRS-4104-1

RWU (or Program and Team) and location(s):
Disturbance & Management of Southern Pine Ecosystems (4104), Smoke Management Team, Athens, GA

Description:
Research or development question, issue, or need: Prescribed fire is used routinely in the South to reduce fuel loading and decrease the risk of catastrophic wildfires; to improve forest health; and to manage threatened and endangered species. With rapid human population growth, and increasing urban/wildland interface, the inability to predict and manage smoke movement limits the use of prescribed fire. Efforts to increase the acreage annually treated with prescribed fire have increased use of “rapid ignition,” a technique that uses the heat released from multiple small fires to loft smoke above nearby sensitive targets. Nevertheless, smoke occasionally is remixed to the surface (plume collapse), sometimes over heavily populated urban centers. Another critical problem is smoke moving along the ground at night, crossing roadways, and causing motor vehicle accidents resulting in injuries and fatalities. Resource managers need the ability to predict if, when, and where plume collapse will occur; near-ground smoke movement at night as smoke moves through complex terrain of the Piedmont; and smoke transport by complex wind systems near heavily populated coastal areas. There is an urgent need to complete simulation models and implement predictive models for all 13 southeastern states; to initiate research to determine the amount of smoke that impacts local sensitive targets and the conditions under which plume collapse occurs; and to provide measurements to connect PM2.5 smoke concentrations with routinely observed environmental variables and to validate smoke models.

Research and development approach:
The research and development approach addresses questions regarding local smoke movement at night over the Piedmont and lower coastal plains of the southern U.S and other areas of the country with similar terrain. (1) On-going research and development of prescribed burning-smoke management models, one each for the Piedmont and coastal plain regions, will be completed and products transferred to users. (2) New research will be initiated to address questions regarding local patterns of smoke transport and dispersion from prescribed burns conducted with several different firing techniques. A network of PM2.5 samplers will be stationed downwind from test burns to record total particulate matter from burns with differing firing techniques. These data will be used to address local air quality issues such as daily PM2.5 smoke concentrations above background within the sensitive target burn restriction cone from 1/4 mile to 5 miles downwind from the burn and how PM2.5 measurements compare between rapid ignition and traditional low-intensity burns. (3) Volunteers from the burn crews will be equipped with portable PM2.5 samplers that will record their personal exposure to fine

particulates in a study of fire fighter health. (4) In another study, an aircraft will be instrumented to measure smoke within the plume as it drifts down wind. These data will be coupled with proximity weather data to determine atmospheric conditions that favor plume collapse. Once these conditions are known, techniques will be developed to advise forest managers of where and when plume collapse will be likely to occur. Both models will be available to prescribed fire practitioners as real-time simulations that use hourly weather observations to show where smoke is currently going, and to prescribed fire planners as 24-48 hr predictions linked to National Weather Service forecast models to show where smoke from a planned burn is likely to go. (5) These studies will include designing and implementing experiments to gather smoke data that can be used to validate the regional models. Sites representative of differing geography and terrain areas to be modeled will be located. Validation will be done through user surveys and conventional weather data, special weather networks such as the Oklahoma Mesonet, and aircraft overflights. Aircraft overflight data collection will be coordinated with US NFS and Region 8 Fire & Aviation. Actual model validation will be done through the planned Southeastern Inter-Agency Modeling Consortium described in another proposal (SRS-4104-1).

Outcomes or products:

First Year: •Completion of smoke movement simulation models for the remaining nine Southeastern states

- Implementation of the predictive models for all 13 Southeastern states. Seminars and training sessions.
- Complete & in-field test equipment & initial data collection for plume collapse experiment

Second Year: • Completion of predictive models for all 13 Southern states

- Validation of Piedmont and Coastal Plain models in connection with the proposed Southern Inter-Agency Modeling Consortium.
- Initiate nighttime smoke models for mountainous areas in conjunction with the modeling consortium
- Full implementation of plume collapse experiment

Three to Five years out: • Finish plume collapse experiment

- Statistical models for PM2.5 and other routine variables to enable smoke concentration prediction
- Build plume collapse into smoke models, validate and make predictive for preburn planning
- Complete fire crew health study

Staffing needs: Atmospheric scientist 1340 (13-15) 5Y; Systems Analyst 334(12) 5Y; Computer Specialist/Electrical Engineer 856(11) 5Y; Computer Specialist/ Image Analyst 334(11) 2Y; Mathematical Statistician (11) 2Y; Air Quality Specialist 1340 (11-13) 3Y

Description of skills required: Meteorological modeling, air quality analysis, mathematical programming, telemetry electronics, remote sensing/image analysis

Potential Partners: State forestry & air quality agencies; DOE-Savannah River Technology Center; University of Georgia, Depts. of Health Science, Geography, Statistics; USFS Region 8 Fire & Aviation, USFS Savannah River Institute; USEPA; National Park Service, Fish and Wildlife Service; NASA; NOAA; military bases; NCASI; AF&PA; Univ OK, OK State Univ Mesonet; RM4404.

Funding requested: $500,000/year. Includes scientist salary, support, equipment, travel, and aircraft operating expenses

Team Leader: **Gary Achtemeier:** Phone: **706-559-4239** E-mail: **gachtemeier@fs.fed.us**