Scientific Review of JFSP Smoke Roundtable Research Needs: Initial Assessment

Brian Potter, Miriam Rorig, Tara Strand, Scott Goodrick, and Diana Olson

Summary
The Roundtables, taken in conjunction with the OFCM Summary of Fire Weather User Needs and Issues, and viewed in light of current science, point strongly towards a single dominating need: a comprehensive synthesis of existing models and sub-models for all stages of the life cycle of smoke. This synthesis should include quantitative information on appropriate time and spatial scales, regional variations, and model uncertainty. This quantitative information should address the needs of the various user communities, specifically land managers, air quality regulators, and policy makers. Execution of this synthesis is a major endeavor that will require substantial resources in time, personnel, and money. It should not be undertaken piece-meal. Rather, JFSP needs a master study plan to address the many models and their evaluation, including logical steps and dependencies among the steps. This study plan should then guide JFSP's annual topics and selection of studies to fund.
Development of this study plan will require significant time. Until that is complete, there are areas identified in the Roundtables that JFSP can pursue. Some of these are more related to technology transfer than scientific research, but are equally critical. Areas with potential for immediate work include:

- Quantifying perimeter and black area within perimeter in ways that support smoke management
- Development of a web-based tracking system for fires
- Development of a "Smoke Portal" web site that would provide access to smoke tools and assist users in selecting the most appropriate tool for their needs.
- Development of tools that provide higher resolution meteorological data.

Methods
The Smoke Roundtables, East and West, produced lists of Problems and proposed Tools to address those Problems. The goals of the Scientific Review team were to

(1) identify the tools that involved a component of researchable science;
(2) determine any similarities or dependencies among those tools;
(3) cross-reference the researchable tools with the results of the Summary of Fire Weather User Needs and Issues recently compiled by the Office of the Federal Coordinator of Meteorology;
(4) recommend priority topics for JFSP to address in the next 5 years.

We classified each Tool as primarily Communication/Coordination, a Policy or Social issue, Researchable, or a matter of Tech Transfer/Tool Development. While doing this, we also noted which Tools Roundtable attendees had identified as (1) most promising in terms of increased ability to manage smoke, (2) most increases their ability to make go/no-go decisions, or (3) increases their ability to communicate with stakeholders. We will refer to these as "Valued" Tools. We then took the Researchable Tools and evaluated their scientific importance or

value, grouping Tools into three general classes and collecting like Tools within those classes.
To complete the classification of Tools, we identified any specifically smoke-related topics in the OFCM report. We looked for commonality between the OFCM and JFSP topics and noted them where they existed. We made particular note of topics OFCM identified as "urgent."
After examining Roundtable rankings, Tools scientific value, and the OFCM topics, we generated a summary statement of the Tools most useful to managers and most scientifically researchable.
While our original mandate focused solely on research issues, we felt that there were significant ties between many of the research issues and technology transfer (TT) issues. We did not apply all of the above steps to the TT issues, but we do note them in our results and subsequent discussion.

Results
Of the 42 Tools identified in the Roundtables, we felt that 15 were Research Tools. Our attempt to group topics by scientific value and priority produced the following grouping of the 15 Research Tools (Text is copied verbatim from Roundtable summary notes). Original Roundtable Solution designations are included in brackets here, but tools/solutions will be identified according to scientific ranking hereafter. Valued Tools are listed in bold.

I. High Scientific Value
   A. Model evaluation
      1. Create a study plan to collect data and validate existing models and sub-models for smoke. This should help refine the models used in the future and would involve all aspects of fire activity including fire behavior, fuels and upper air and be ecosystem specific. [3A]
      2. Perform more field validation work in fuel consumption modeling to improve estimates of fuel consumption in multiple ecosystems and fuel conditions. [7C]
      3. Look at the fuel models and recommend a preferred approach for tracking trends in smoke or other emissions. This may assist in informing impact on climate change. [10C]
      4. Do qualitative assessment of models.[1] [10D]
   B. Scalable, probabilistic decision support
      1. Create a scalable decision tree to rationalize and provide options for contingencies planning, public notification and mitigation approaches. [6A]
      2. Develop and use more probabilistic approaches. A probabilistic approach will provide a range of options throughout the decision making process. In particular, a probabilistic approach during the planning process may provide options that will help refine a decision-maker's choices when making go/no-go decisions. [10A]

II. Moderate Scientific Value
- A. Greenhouse Gases
  - Identify the Greenhouse gas emissions from all fires in the U.S.[2] [4B]
- B. Emissions Reduction Tools
  - 1. Determine the benefits by applying one or more emission reduction techniques at a time. Improve the accuracy of emission reduction factors. [7A]
  - 2. Develop a tool to allow comparison of emission results using different emission reduction techniques. [7B]
- C. Quantify Fire Effects
  - 1. Determine the appropriate tool to define accurate fire location, perimeter, and daily blackened acres. [7E]
  - 2. Develop new ways to predict black acres within perimeter. [10B]
- D. Tradeoffs
  - **Use existing landscape models to look at aggressive fuel treatment programs (with wildland fire use) versus responding to episodic wildfires (e.g., carbon, smoke, climate change).** [12A]

III. Lower Scientific Value
- A. Confidence
  - Develop good, simple way of describing confidence. [9C]
- B. Management Science
  - Examine successful prescribed fire and air programs (e.g., Florida) and determine what lessons could be applied to the rest of the US. [11F]
- C. Carbon
  - Develop a synthesis to identify what information is currently available regarding the carbon balance at a global level.[2] [4A]

[1] – The short description of this tool refers to qualitative comparison. However, the detailed comments in the Roundtable Assessment suggest that participants actually meant quantitative, and that the tool is quite similar to I.A.1.
[2] – These two tools are closely related, as both deal with issues tied primarily to climate change and greenhouse emissions. Tool II.A.1 is a major focus of work done by the Intergovernmental Panel on Climate Change.

The OFCM Summary included 7 Needs that relate to these 15 Research Tools.

2.1.b. A better understanding of wildland fire smoke is needed, and smoke prediction tools need to be refined and perfected.

2.1.c. Wildland fire and climate change/climate variability is and issue of high concern, for which more understanding is a priority.

4.1.a. Users overwhelmingly need higher resolution meteorological model fields in complex terrain and the tools and input data to understand fire behavior and smoke dispersion. (urgent)
4.1.b. Users need model accuracy and confidence information presented to them in an understandable format.
7.3. Users need more smoke management decision support tools. (urgent)
9.1. The fire community needs to tap into state-of-the-art socioeconomic tools to reach out to the public to better inform and educate them on the importance of understanding, mitigating, and preparing for wildland fire.

The table below cross references these Needs and the Roundtable Tools, with Urgent Needs and Valued Tools highlighted in red. Cells marked "x" indicate an OFCM Need that matches with a JFSP Tool. Rows closer to the top are those with higher scientific value. Cells that are in red rows *and*, have an "x" and are closer to the top, are therefore those cells that indicate Tools identified as important in both the JFSP Roundtables and the OFCM Needs Study, and are scientifically important.

	2.1.b	2.1.c	4.1.a	4.1.b	7.3	9.1
I.A.1	**x**					
I.A.2	**x**					
I.A.3	**x**					
I.A.4	**x**					
I.B.1					**x**	
I.B.2					**x**	
II.A						
II.B.1					**x**	
II.B.2					**x**	
II.C.1					**x**	
II.C.2					**x**	
II.D		**x**				
III.A				**x**		
III.B						**x**
III.C		**x**				

While all of the tools in this table have been identified as important, different assessments identified different tools or questions as highest priority. There are two tools that rank highly in all assessments: "Create a scalable decision tree to rationalize and provide options for contingencies planning, public notification and mitigation approaches**" (**I.B.1) and "Develop and use more probabilistic approaches…" (I.B.2).

Discussion

All of the “Valued Tools” are either part of I.A or depend on it being completed before they can begin. Tools I.B.1, II.B.1, II.B.2 and II.D depend on knowledge that would come out of the study in I.A. As such, they cannot logically proceed until that study plan is developed and the study well under way.

The tools in I.A are closely related, if not inseparable. As a whole, they describe the development of a study plan that would have two key components. One component would involve evaluation of the spatial accuracy, useful precision, regional character, known uncertainty, and limitations of smoke decision support tools. Tools with similar output characteristics could then be tested using a common input data set, subjectively compared and applied operationally, targeted for research to improve these qualities, or used as tools within future research projects. The second component of this study plan would collect information on data available from previous studies or identify gaps in data, so that these data could be used in evaluation of tools. The study plan must recognize that the operational land management and air regulatory communities need different things from models. Evaluation and comparison work must provide useful results for both of these groups.

Tool I.B.2 deals with development of probabilistic tools for decision support. The members of the review panel are concerned that the concept of a probabilistic tool is not fully understood by most users. Conversations at the Western Roundtable suggested that users were willing to work with deterministic fire behavior forecasts but felt the needed a probabilistic smoke forecast, a situation that would be logically inconsistent. Discussion suggested that the real desire might go back to the idea of confidence (see Tool III.A) or model uncertainty, which can be expressed in forms other than probabilities.

Tool II.A, “Identify the Greenhouse gas emissions from all fires in the U.S.” and tool III.C, “Develop a synthesis to identify what information is currently available regarding the carbon balance at a global level”, are, as noted above, well studied by the Intergovernmental Panel on Climate Change (see Climate Change 2007: The Physical Science Basis. Cambridge University Press, Cambridge UK.) This area does not necessarily need to be studied further by JFSP.

Tools II.C.1, “Determine the appropriate tool to define accurate fire location, perimeter, and daily blackened acres,” and II.C.2, “Develop new ways to predict black acres within perimeter,” are the only Tools that appear as OFCM Urgent Needs and are not dependent on the study plan under I.A. These tools would appear the most logical candidates for research topics in the near future.

The original wording of Tool II.D was too narrow for some management reviewers. Based on discussion and reviewer comments, it could perhaps be better stated as “Use existing landscape models to look at fire management programs (including mechanical fuel removal, prescribed fire, wildland fire use, and wildland fire suppression) and compare their carbon, smoke, carbon dioxide production, and climate change impacts.”

While the items listed in group III are identified as having “Lower Scientific Value,” they have significant value for management. Land managers and air quality regulators require some measure of error or uncertainty in the output from scientific tools in order for those tools to be useful. And clearly management

would benefit from study of successful fire and air programs to replicate that success in other regions.
It is notable that OFCM Need 4.1.a (the need for higher resolution meteorological model fields) is Urgent, yet failed to appear in the Tools. We do not know why this is, but it suggests that this Need may also be a valuable area for an AFP. If it is used as the basis for an AFP, recognize that the "best" resolution of meteorological data can depend on the tool it is driving. Some tools may do better with coarser resolution data, either by intent or accident of design, or chance. Such dependencies would not necessarily be clear initially and may become clear from the work in Tool I.A.1.

Technology Transfer Tools
One of the primary problems identified by the Roundtables was a lack of easy access to existing data on fuels, emissions, fire locations, and smoke impacts. Closely related to this problem is the need for effective technology transfer, both to land managers and to the public at large. There is a wealth of data currently available, but there is not an easy way for users to know what is available, where to find it, and how to use it.

To address these needs, a "smoke portal" should be developed. Careful thought should go into the design of this website because as data is collected to address the other problem areas defined by the Smoke Roundtables, this will be the site where the results of those studies will be made available. The smoke portal will initially have two pathways – one taking the user to links to existing data, and one taking the user to existing smoke modeling output.

As a first step, all available data will be identified. These include:

- Fuels – what fuels are on the landscape, fuel loadings, fuel consumption, etc.
- Emissions inventories for different fuel types, burn types, etc.
- Fire database – locations of existing and proposed burns, perimeters, acres burned, etc.
- Receptors – where are the sensitive receptors/populations, how sensitive are they, who to communicate with quickly when sensitive areas are impacted, etc.

Currently available model output should also be identified and included in the model pathway. For example, include links to BlueSky and NOAA Hazard Mapping System output.

Secondly, the effort should be made to obtain data and model output that are not currently available, but can be made available at minimal cost and effort. For example, many states do not have burn permitting and reporting information readily available in digital format. A generic burn reporting system should be developed to import these data when they are made available.

Third, the advantages from putting all the available data and models in one location (website) will not be realized unless land managers know where to find it and how to use it. Therefore, funding should be made available for training and tech transfer activities insofar as where to find the website and how to use it.

Finally, the development of this smoke portal website should be an ongoing effort while the projects that are funded to solve the problems identified by the roundtables are underway, continuing to completion. One of the primary issues not identified by the roundtables is that the results from all the research projects funded to fill in the gaps identified in the problem areas are rarely, if ever, put into one easily accessible location. We envision the “final version” (quotes used because it will always be evolving) of the smoke portal to be similar to a FAQ page, but rather than just answering questions, all of the problem areas identified in the smoke roundtables will be listed, along with the links to the data and/or models that were developed.