Joint Fire Science Program
Smoke Management and Air Quality Roundtables
Research Needs Assessment

June 19-21 Arlington, Virginia
June 25-28 Seattle, Washington

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Prepared by:

SRA International, Inc.
Arlington, Virginia & Portland, Oregon

In collaboration with:
The Joint Fire Science Program &
Focused Science Delivery Program, Pacific Northwest Research Station

Table of Contents

Background

The Joint Fire Science Program (JFSP) was created by Congress in 1998 as an interagency research, development and application partnership between the U.S. Department of Interior and the U.S. Department of Agriculture. Funding priorities and policies are set by the JFSP Governing Board, which includes representatives from the Bureau of Land Management, National Park Service, U.S. Fish and Wildlife Service, Bureau of Indian Affairs, U.S. Geological Survey, and five representatives from the Forest Service.

The Joint Fire Science Program

- Provides credible research tailored to the needs of fire and fuel managers
- Engages and listens to clients and then develops focused, strategic lines of research responsive to those needs
- Solicits proposals from scientists who compete for funding through a rigorous peer-review process designed to ensure the best projects are funded
- Focuses on science delivery when research is completed with a suite of communication tools to ensure managers are aware of, understand, and can use the information to make sound decisions and implement projects.

About the Smoke Management and Air Quality Roundtables

To enhance the value of its work and work products, the JFSP is sponsoring a series of roundtables on key questions in order to better define and focus its lines of work. Results of these roundtables will be a topic-specific problem analysis that will inform the JFSP Governing Board's funding decisions and influence the scope, magnitude and direction of JFSP activities. In addition to the smoke management and air quality topic, the JFSP recently held a roundtable on biomass removal and is planning a future roundtable focused on the topic of risk.

In June 2007, the JFSP convened two roundtables – one in Arlington, Virginia and another in Seattle, Washington – on smoke management and air quality issues. The roundtables brought together incident commanders, wildland fire use managers, prescribed burn practitioners, air quality regulators and specialists, and non-governmental organizations interested in smoke management and air quality. Participants worked to articulate problems, develop possible solutions, and prioritize the most useful research needs.

This document provides an initial summary of the main problems identified during the workshop, as well as suggested strategies to fill data gaps and work towards solutions. Our intent is to accurately chronicle the full-range of the discussions and then seek a wider review by stakeholders.

The JFSP Governing Board intends to fund research projects related to smoke management and air quality in fiscal year 2008 based on the needs expressed in the smoke management and air quality roundtables.

Eastern Roundtable

Problem 1: Data Availability

No consistent set of nationwide fire activity information is available for decision-making. For example, managers do not know how much and the nature of what they are burning (e.g., rate, time). As a result, managers cannot make go/no-go decisions in the context of other fires or assess the likely impacts of multiple fires in context of other activities. This has several ramifications including: difficulty in assessing effects (positive or negative) of emissions such as health effects, visibility, ecological effects or overall emissions inventory; difficulty in complying with the Clean Air Act; difficulty in making burn management decisions; and difficulty in accurately calculating the likely impacts of smoke (especially at larger spatial scales). Other gaps relate to fire perimeters and acres burned (planned vs. blackened) which lead to inaccurate predictions.

These data gaps create a number of challenges for managers. Problems associated with cost allocation, implementation planning, compliance, data sharing, and competing regulatory authority all have some data availability component. New technologies (e.g., remote sensing) are promising, but do not currently meet managers' needs for decisions that depend on the severity of fires, consumption rates, speciation of smoke, or fuel structures.

What are some strategies to fill or address the gaps?

A. Develop a web-based, spatially capable, system for tracking all fires (e.g., prescribed/wildland use, wildfires, and agricultural fires).

Problem 2: Compatibility of Multiple Tools

It is difficult to match the model(s) or tool(s) to the questions asked by land managers and air quality specialists . Too many models add to the confusion and little consensus exists on the right tool for any given application. As a result, operational and policy decisions often get made through best professional judgment or the incorrect application of models.

Fire and air quality managers need tools to understand the impacts of multiple events, analyze the interactions of many factors (e.g., smoke dispersion, fire behavior) simultaneously, understand extreme events, account for boundary layer mixing, and forecast nighttime conditions. An array of tools is needed from straightforward decision-tree expert systems for private landowners to highly complex atmospheric models across broad regions. It also appears that existing tools may not be specifically calibrated for all the ecosystems within the United States. At the same time, these tools must be flexible so that managers can tailor them for specific user groups (e.g., managers vs. field crews) or simple versus complex fire situations. Information from one system should be integrated with other tools seamlessly.

What are some strategies to fill or address the gaps?

A. Provide a service-oriented architecture from which appropriate models and be selected and interpreted by smoke experts throughout the smoke management community.

B. Develop a "smoke portal" that provides access to model information and sample outputs to ease tool choice.

Problem 3: Accuracy and Application of Tools

Practitioners often do not know the accuracy of models they are using. As a result, they have a difficult time calculating uncertainty and incorporating that uncertainty into their operational and policy decision-making. Some managers assume that the models are accurate, which can lead to unintended consequences.

Managers need to know, and understand the implications of, the range of uncertainty in data that feeds the models and sub-models. In addition, to use tools appropriately, managers must understand the model or tool's sensitivity to inputs (e.g., How important is the lack of certainty?).

What are some strategies to fill or address the gaps?

A. 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.

Problem 4: Fire and Climate Change

Climate change will result in changing ecosystems, and this will impact fire management practices in a variety of ways. From a short-term perspective, the nature of fires is changing due to drought situations, changes in fuel composition, longer growing seasons, earlier snow melt, and increasing climate variability. This is contributing to larger fires that are increasingly difficult to manage.

From a long-term perspective, there is a lack of information about the impact of burning on greenhouse gas emissions, especially in comparison to the relative contribution of prescribed fires, wildland fire use, and wildfires. As regulators place a greater emphasis on managing and regulating greenhouse gases, ozone, and toxics, it is essential that there is a solid understanding of wildland fire's contribution and impact.

What are some strategies to fill or address the gaps?

A. Develop a synthesis to identify what information is currently available regarding the carbon balance at a global level.
B. Identify the Greenhouse gas emissions from all fires in the U.S.
C. Develop a predictive analysis of regulatory changes as a result of climate change.

Problem 5: Outreach

Managers clearly understand that there are public health risks associated with smoke. Certain demographic groups are particularly sensitive to smoke. In addition, there is misunderstanding by stakeholders about both the actual health risks and potential benefits (resulting from fire's natural role in the landscape) related to prescribed burning and wildland fire use. The smoke impact tradeoffs from prescribed fire, wildland fire use, and exempted wildfires needs to be clearly understood.

To remedy the existing outreach problem, managers face a variety of challenges. Managers need a better understanding of air quality impacts and mitigation measures. The public needs notification systems that use technical experts who can convey information in a way that helps people understand the benefits and potential risks of fire and smoke. Outreach materials must be mindful of how geographic and cultural

factors influence the intended audience. Both parties would benefit from a way to quantify and compare the costs and benefits of prescribed burns and wildland fire use versus wildfires. Managers know intuitively that prescribed burning provides benefits such as ecological restoration, reduced emissions overall, and an increased ability to mitigate smoke impacts, but need to quantify these outcomes to better reach stakeholders.

What are some strategies to fill or address the gaps?

A. Develop best practices and guidance for informing public of health risks (e.g., reverse 911 and PSAs).
B. Campaign to educate in schools about fire and effects.
C. Hold annual "local" summits to share information and get contacts to start the relationship network needed to address all fire and smoke issues.

Problem 6: Contingency Planning and Mitigation

Smoke management needs to include robust contingency planning and smoke mitigation techniques similar to escaped fire contingency planning. Regardless of the type of ignition source or appropriate management response, there needs to be a focus on minimization of impacts and consistent contingency planning. These plans need to be scalable based on the severity of the situation. Managers need to know how to identify smoke-sensitive populations, including information on where they are located, how sensitive they are, and how to communicate with them quickly.

This problem occurs at multiple scales. On one hand, managers need to better aggregate smoke impact data so that choices can be made when giving permits for private prescribed fires. Currently they are all evaluated as individual events. On the other hand, managers and regulators need a real-time database to see where burns are happening nationally and regionally to better understand cumulative impacts.

In terms of mitigation, managers need to understand the feedback loops between monitoring, prediction models, contingency planning, and mitigation tools. Knowing which tools are effective in different situations is another challenge. Finally, managers need a better understanding of who are the relevant partners and stakeholders (including private land owners) for effective mitigation.

What are some strategies to fill or address the gaps?

A. Create a scalable decision tree to rationalize and provide options for contingencies planning, public notification and mitigation approaches.

Eastern Problem Weighting Exercise

Participants were asked to identify the one problem that would provide the greatest advance in their ability to manage smoke. The results were as follows:

Question	*1*	*2*	*3*	*4*	*5*	*6*
Solving which problem would give us the biggest increase in our ability to manage smoke?	15	7	11	6	5	3

Eastern Recommendation Weighting Exercise

For each of the strategies to fill the data gaps, participants were asked to identify that which was most promising, which would most help with go/no-go decisions, and which would best improve communication. The results were as follows.

Question	*1.A*	*2.A*	*2.B*	*3.A*	*4.A*	*4.B*	*4.C*	*5.A*	*5.B*	*5.C*	*6.A*
Which tool is the most promising in terms of increased ability to manage smoke?	12	4	5	10	2	1	0	2	0	3	4
Which tool most increases your ability to make go/no go decisions?	11	5	8	7	0	0	0	2	0	0	9
Which tool increases your ability to communicate with stakeholders?	10	4	6	3	0	0	0	8	1	5	9

Problems

1. **Data Availability**
   - A. Develop a web-based, spatially capable, system for tracking all fires (e.g., prescribed/wildland use, wildfires, and agricultural fires).
2. **Compatibility of Multiple Tools**
   - A. Provide a service-oriented architecture from which appropriate models and be selected and interpreted by smoke experts throughout the smoke management community.
   - B. Develop a "smoke portal" that provides access to model information and sample outputs to ease tool choice.
3. **Accuracy and Application of Tools**
   - A. 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.
4. **Fire and Climate Change**
   - A. Develop a synthesis to identify what information is currently available regarding the carbon balance at a global level.
   - B. Identify the Greenhouse gas emissions from all fires in the U.S.
   - C. Develop a predictive analysis of regulatory changes as a result of climate change.
5. **Outreach**
   - A. Develop best practices and guidance for informing public of health risks (e.g., reverse 911 and PSAs).
   - B. Campaign to educate in schools about fire and effects.
   - C. Hold annual "local" summits to share information and get contacts to start the relationship network needed to address all fire and smoke issues.
6. **Contingency Planning and Mitigation**
   - A. Create a scalable decision tree to rationalize and provide options for contingencies planning, public notification and mitigation approaches.

Western Roundtable

Problem 7: Tracking Emissions

Managers need to be able to estimate emissions from all types of fires; prescribed burn, wildland fire use, and wildland fires. They need more accurate emissions data to predict future impacts as well as effectively participate in regulatory discussions. Without this information, it is difficult to demonstrate tradeoffs between wildfire and prescribed fire and between alternative emission reduction techniques. Furthermore, burners need to take credit for enhanced smoke management activities and accomplishments, including emissions averted.

There is widespread agreement that a better emissions tracking system is needed. The fire emissions tracking system (FETS) is currently being developed to help fill this gap. Still, managers need to take credit for emission reductions resulting from current management techniques, but need better data to do so. Relatively speaking, we know the least about: emission reduction factors, consumption, fuel loading, and emission factors. Remote sensing is just one promising technology that may provide some useful data. Finally, managers need a consistent reporting standard across agencies. There should be one tracking system and a procedure for measuring daily blackened acres, estimated fuel loadings, and consumption per day.

What are some strategies to fill or address the gaps?

A. Determine the benefits by applying one or more emission reduction techniques at a time.
    1. Improve the accuracy of emission reduction factors.
B. Develop a tool to allow comparison of emission results using different emission reduction techniques.
C. Perform more field validation work in fuel consumption modeling to improve estimates of fuel consumption in multiple ecosystems and fuel conditions.
D. Develop consistent daily reporting approach with common data elements to meet interagency smoke needs.
E. Determine the appropriate tool to define accurate fire location, perimeter, and daily blackened acres.

Problem 8: Communication and Sharing Perspectives with the Public

Proactive, effective communication with the public and partners is challenging on many levels. By articulating different goals and using incompatible terminology, regulators and fire managers strain relationships. Simultaneous, but conflicting, outreach efforts can create more confusion. This leads to mistrust and impedes effective communication within agencies, between agencies, and with the general public.

Successful communication requires buy-in from everybody involved. By presenting a unified position, managers and regulators can make a stronger case to the public. This is complicated by the fact that many managers rely on personal experience in dealing with the public and with other agencies. Furthermore, the public is not always receptive to the messages. People sometimes maintain unrealistic expectations that when not met, lead to larger perception problems.

What are some strategies to fill or address the gaps?

A. Good facilitation can be a helpful translator.
    1. Subject matter expertise is not the same as effective communication. Managers should understand the value of a facilitator as a go-between to get the right message from the subject matter experts to the public.
    2. Managers need to build respect through ongoing personal relationships.
    3. Tools have to be applied at the proper time, when audiences are receptive. For example, you can't talk with burners in the middle of fire season; however, that is the time when the public is concerned about this issue.
B. Visualization techniques to assist with communication.
    1. Managers must engage stakeholders even when they don't have a definitive answer.
        a. The lack of good impact assessments of what the smoke is going to do make this communication difficult.
        b. Managers need to provide some general information that they know (e.g., what air quality standards we are operating under, etc.).
    2. Managers also need to look at how to counter the institutional assumption that controversial efforts or topics are to be avoided because their Agencies do not like to fund projects or efforts that put them in this position.
C. Develop scenarios and case studies to "practice" interagency communication.
    1. Another way to do training would be to do regionally specific case studies and force different stakeholders to process communications. That would help them practice how to make decisions together in a more coordinated fashion.
D. Ensure that existing forums/meetings/workshops are set up to increase communication and include target audiences.
    1. In the professional arena, there are a lot of ongoing forums, where interactions should be happening. But we need to look at whether the communication is effective (2-way) and whether it includes the target audience. For example, talking to county commissioners might not help you reach the public.
    2. A long-term goal is developing respect for differing views.
    3. Tools must be applied at the proper time (to the appropriate audiences).

Problem 9: Effectively Using Weather Information

Forecasters are expected to communicate and summarize an enormous amount of information, including a sense of uncertainty, to a range of users. Forecasters and fire managers know a lot about the weather and how it affects fire and smoke, but they don't always express it in the same terms. It is common for both parties to end up frustrated and unsure whether they were understood. Accurate information is critical to sound decision making, firefighter safety, and development of trust and confidence between weather forecasters and users.

A practitioner brings local knowledge of fuels, topography, history, management objectives, and past weather observed on a site. Meteorologists bring understanding of weather, access to and understanding of a large amount of weather data and forecast information. Both want to understand and be understood, but need to determine what the right amount of information is and how it should be communicated. For a forecast to have value it must be timely, relevant, easily understood, and communicated well. To do this, forecasters need to understand operational and management concerns and how to provide the right information; land managers need to be able to ask the right questions.

What are some strategies to fill or address the gaps?

A. Promote more face-to-face coordination between meteorologists, land managers, and air quality regulators.
B. Increase Communication between meteorologists at all levels.
    1. Need to be consistent and use the same language to provide better forecasts, rather than several competing forecasts.
C. Develop a simple way of describing confidence.
    1. Need to know what information is best suited to each purpose.
D. Hold shared training on uncertainty and probabilistic forecasting.
    1. Need shared training for meteorologists, smoke managers, practitioners on uncertainty and probabilistic forecasts.
        a. If you put people in a class together, they will start to use the same terms.
E. Embed people in different offices (e.g., professional/rotational exchange).
    1. Need to embed people in different offices/lines of work (e.g., send forecaster to fire, etc.). Staff would learn goals, objectives, and help inform communication.
F. Improved design and format of smoke forecasts based on solid user requirements.
    1. People in the field have different ways of receiving forecasts (e.g., radio, phone, high-speed internet). Managers need to tune products, based on how people will receive them, in order to utilize all available tools.
    2. Clear requirements must be provided by smoke managers, for forecast design at multiple scales – from the incident to national scale.
    3. A close partnership must be established to design products, mesh requirements with available information and create a product improvement forum.
G. Better design fire weather products to meet user needs.
    1. Study to better design fire weather products so that they actually meet the needs of the users (e.g., meteorologists, fire managers, and the public).
H. Provide better and additional on-site support. This could come in the form of a meteorologist going to the incident and collecting information
I. Hold cross-discipline training. This would get everybody speaking the same language, allow them to learn from each other, and help understand roles. Possible formats could include:
    1. Putting fire managers and meteorologists together for a 2-3 day course/workshop in the winter.
    2. Ongoing fire, weather, smoke forecasting training, similar to the "6-minutes for safety" format as a way to update and continue learning.
    3. Training on probabilistic versus deterministic forecasts.
J. Develop glossary that cross-walks fire and weather terms, so you could have a reference for field staff in each discipline. This would need to address three communities: Smoke management (including AQ), meteorologists, and fire community.
    1. Link that to basic training that's out there.
    2. Could be a dictionary (translation) of weather and fire terms. Would consolidate the 3 languages (and acronyms). Link to a smoke "101"

Problem 10: Measuring Impacts

10.1 Different model expectations lead to different interpretations and misuse of results.

There are different expectations about models, which lead to different interpretations or misuse of results. In an era where air quality standards are getting more restrictive, managers need models to understand how emissions from prescribed burning, wildland fire use, and wildland fires fit into overall air quality.

Yet, managers tend to use models way too late in the process and often do not understand the gaps in available data, proper uses and limits of models, or uncertainty of results.

10.2 Tools to assess impacts have deficiencies and are not reliable for decision making (e.g., models, monitoring network).

Tools used (e.g., models and monitoring networks) to assess the impacts of wildland fires have deficiencies and are not fully reliable for decision making. Most models currently available have a more deterministic design, which may not provide sufficient information or accuracy for go/no-go decision making. Probabilistic models give a range of outcomes that could better inform decisions about what outcomes we might have.

In addition, monitoring networks do not provide enough time, special coverage, and chemical species information to determine the cause of the observed pollutant levels. Managers know about average conditions over long periods of time, but have trouble predicting site specific impacts. Data gaps in emissions, plume rise, smoldering die down, fuel types, and loading variability further complicate any accurate air quality analysis.

What are some strategies to fill or address the gaps?

A. 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.
B. Develop new ways to predict black acres within perimeter.
    1. (e.g., Do simple surveys across burned areas and take spot measurements about what burned or not and compare it with moisture and fuel type, and ignition technique. The Monitoring Trends In Burns project is doing this already.)
C. 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.
    1. There is a wide variety of models used across the fuels process. It would be nice to know which is the best model or combination for looking at long term trends. Then as future models come out, you can relate them to consistent trend information.
D. Do qualitative assessment of models.
    1. There are a variety of models out there (e.g., emissions, impacts, etc.). They should be assessed to see what the best models are for various regions of the country or for different applications. Some may be more reliable or may have undergone more rigorous review. Laying out pros and cons also may be helpful.

Problem 11: Policy and Process

A number of policy and regulatory challenges make it difficult to do prescribed burning. Fire managers, line officers, fire fighters, and air regulators confront an increasing array of regulations to implement prescribed fire projects. These not only include air quality constraints, but other regulatory requirements and policies are continually becoming more complex.

Managers face a number of additional challenges when doing prescribed burning. Some crews are more reluctant to work on prescribed fires because of lower pay or potential lost opportunities to work on wildfires, so resources become more difficult to secure. Personal liability is driving qualified managers away from working on prescribed burning and making recruiting more difficult. Meanwhile, managers under pressure to meet targets often treat "easy" acres, rather than more difficult or controversial units

where threats may be much greater. Managers have trouble quantifying the long-term results for prescribed fire treatments. As a result, managers are neither keeping up with ecosystem change nor gaining ground on ecosystem backlog from suppression.

What are some strategies to fill or address the gaps?

A. Have federal agencies make it mandatory, and pay for, liability insurance for burn bosses.
B. Provide equality in pay (and hazard pay) for all fire - prescribed fire vs. wildland fire use vs. wildfire.
    1. That way, staff would be more motivated to work on prescribed burns.
C. Develop better performance metrics (not treatment/black acres).
    1. Treatment acres are an inadequate metric of accomplishment.
        a. National interagency fuels coordination group has been tasked to find a better metric(s). There might be potential for research or some other factor analysis. This measure doesn't reflect the complexity of terrain, vegetation, etc.
        b. People burn the easy acres to meet targets, rather than the hard burns in the WUI or where the ecological goals need it.
            i. You could make emissions and air quality, a factor in how you get credit.
        c. Black acres do not reflect all treated areas (e.g., you might only burn 50-75% of the area).
D. Hold annual policy refresher for burn bosses.
    1. Need annual burn boss refresher to keep people on the same page with policy and process changes.
        a. Exceptional events rule, pm 2.5, ozone regulation, state regulations and rules.
        b. Need mechanism to ensure that bosses understand new developments.
        c. Could be regional. You could have smoke managers and fire use managers attend as well.
E. Better information about tradeoffs would help fire managers get more fire on the ground in the right places.
    1. People are being risk averse. This would help get people on the same page (e.g., biologists, regulators).
F. Examine successful prescribed fire and air programs (e.g., Florida) and determine what lessons could be applied to the rest of the US.
    1. How to burn in urban areas?
    2. How to streamline process? (E.g., 4-page burn plan, permitting, meet air quality requirements, provide a 30-second answer, liability legislation.)

Problem 12: Tradeoffs

Managers need ways to describe the long-term smoke effects of alternative fire management programs (e.g., prescribed burning treatments vs. suppression) to justify why these programs serve the public interest. These must recognize the variability of fuel types and the potential effects of climate change. Smoke effects include such things as: health, worker productivity, recreation, aesthetics, closures, soil impacts, and economic impacts of smoke (especially industrial). Some models (e.g., FETM) attempt to compare emissions with management strategies. Still managers are unclear about the societal willingness to pay in the short-term for long-term benefits.

Managers are unable to fully explore the impacts of different magnitude events on communities and to people. EPA has looked at industrial sources, but not episodic wildfire smoke impacts, so the impacts of events of that magnitude are poorly understood. If managers could compare the costs from not allowing

smoke in prescribed fire environments with equivalent reductions from industry they could determine the least-cost way to achieve air quality goals.

What are some strategies to fill or address the gaps?

A. 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).
    1. Use existing landscape models to look at aggressive fuel treatment programs with wildland fire use vs. responding to episodic wildfire event.
        a. Could include smoke into one of these models.
        b. The usefulness would be enhanced by including climate change and variability into these models, or to develop models that can include climate change.
            i. Also, could look at including carbon.

Western Problem Weighting Exercise

Participants were asked to identify the one problem that would provide the greatest advance in their ability to manage smoke. The results were as follows:

Question	***7***	***8***	***9***	***10.1***	***10.2***	***11***	***12***
Solving which problem would give us the biggest increase in our ability to manage smoke?	13	6	1	3	14	7	7

Problems

7. Tracking Emissions
8. Communication and Sharing Perspectives with the Public
9. Effectively Using Weather Information
10. Measuring Impacts
    - 10.1 Different model expectations lead to different interpretations and misuse of results
    - 10.2 Tools to assess impacts have deficiencies and are not reliable for decision making (e.g. models, monitoring network)
11. Policy and Process
12. Tradeoffs

Western Recommendation Weighting Exercise

For each of the strategies to fill the data gaps, participants were asked to identify that which was most promising, which would most help with go/no-go decisions, and which would best improve communication. The results were as follows.

Problem 7: Tracking Emissions	***7A***	***7B***	***7C***	***7D***	***7E***
Which tool is the most promising in terms of increased ability to manage smoke?	7	3	14	7	4
Which tool most increases your ability to make go/no-go decisions?	2	3	13	2	
Which tool increases your ability to communicate with stakeholders?		3		10	1

A. Determine the benefits by applying one or more emission reduction techniques at a time.
    1. Improve the accuracy of emission reduction factors.
B. Develop a tool to allow comparison of emission results using different emission reduction techniques.
C. Perform more field validation work in fuel consumption modeling to improve estimates of fuel consumption in multiple ecosystems and fuel conditions.

D. Develop consistent daily reporting approach with common data elements to meet interagency smoke needs.
E. Determine the appropriate tool to define accurate fire location, perimeter, and daily blackened acres.

Problem 8: Communication and Sharing Perspectives with the Public	***8A***	***8B***	***8C***	***8D***
Which tool is the most promising in terms of increased ability to manage smoke?		2	7	5
Which tool most increases your ability to make go/no-go decisions?	2	4	6	5
Which tool increases your ability to communicate with stakeholders?	12	7	1	15

A. Good facilitation can be a helpful translator.
B. Visualization techniques to assist with communication.
C. Develop scenarios and case studies to "practice" interagency communication.
D. Ensure that existing forums/meetings/workshops are set up to increase communication and include target audiences.

Problem 9: Effectively Using Weather Information	***9A***	***9B***	***9C***	***9D***	***9E***	***9F***	***9G***	***9H***	***9I***	***9J***	***9K***
Which tool is the most promising in terms of increased ability to manage smoke?	5		6	3	2			5	2	1	
Which tool most increases your ability to make go/no-go decisions?	9	4	7		3	2	14	12			1
Which tool increases your ability to communicate with stakeholders?	12			7		3		1		3	

A. Promote more face-to-face coordination between meteorologists, land managers, and air quality regulators.
B. Increase Communication between meteorologists at all levels.
C. Develop good, simple way of describing confidence.
D. Hold shared training on uncertainty and probabilistic forecasting.
E. Embed people in different offices (e.g., professional/rotational exchange).
F. Improved design and format of smoke forecasts based on solid user requirements.
G. Format forecast for the appropriate delivery media.
H. Better design fire weather products to meet user needs.
I. Provide better and additional on-site support. This could come in the form of a meteorologist going to the incident and collecting information
J. Hold cross-discipline training. This would get everybody speaking the same language, allow them to learn from each other, and help understand roles. Possible formats could include:
K. Develop glossary that cross-walks fire and weather terms, so you could have a reference for field staff in each discipline. This would need to address three communities: Smoke management (including AQ), meteorologists, and fire community.

Problem 10: Measuring Impacts	***10A***	***10B***	***10C***	***10D***
Which tool is the most promising in terms of increased ability to manage smoke?	13	1	2	
Which tool most increases your ability to make go/no-go decisions?	9	1	3	7
Which tool increases your ability to communicate with stakeholders?	6		1	

A. 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.
B. Develop new ways to predict black acres within perimeter.
C. 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.
D. Do qualitative assessment of models.

Problem 11: Policy and Process	***11A***	***11B***	***11C***	***11D***	***11E***	***11F***
Which tool is the most promising in terms of increased ability to manage smoke?	4	5	1		1	9
Which tool most increases your ability to make go/no-go decisions?					3	3
Which tool increases your ability to communicate with stakeholders?			6		10	7

A. Have federal agencies make it mandatory, and pay for, liability insurance for burn bosses.
B. Provide equality in pay (and hazard pay) for all fire - prescribed fire vs. wildland fire use vs. wildfire.
C. Develop better performance metrics (not treatment/black acres).
    a. Treatment acres are an inadequate metric of accomplishment.
D. Hold annual policy refresher for burn bosses.
E. Better information about tradeoffs would help fire managers get more fire on the ground in the right places.
F. Examine successful prescribed fire and air programs (e.g., Florida) and determine what lessons could be applied to the rest of the US.

Problem 12: Tradeoffs	***12A***
Which tool is the most promising in terms of increased ability to manage smoke?	10
Which tool most increases your ability to make go/no-go decisions?	3
Which tool increases your ability to communicate with stakeholders?	14

A. 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).

Additional Items for Consideration

Participants were given an opportunity to offer their personal priorities and they are listed below. The JFSP considers both the ideas listed below and the group ideas for research funding consideration.

East

1. Develop a fire activity database that houses all fire related data and could be used to support Agencies in their decision making.
2. Develop a free resource webpage that integrates all existing tools for assessing fire (i.e. fuel models) as well as new tools to be developed, like emissions information.
3. Develop web-based, regionally focused smoke emissions models that can be used by people in the field. The website would include model tutorials.
4. Develop a coordinated outreach methodology coordinating the air quality and fire communities. This outreach methodology should include outreach tools like reverse 911 and coordinating tools like summits.

5. Develop a geo-map-like application that tracks what burns are occurring in what locations. For example, track where states have authorized prescribed burns. This should have an archival function.
6. Develop an emissions profile model that ties to existing fire activity models.
7. Web-based emissions estimation model to be used by the public. It would inform the public and help them mitigate the effects of smoke.
8. Validate the effectiveness and accuracy of existing models.
9. Perform fundamental research to identify reasonable emissions and heat release rates during fires. This research should reflect the range of vegetation types.
10. Develop an emissions model that includes information on the type and quantity of emissions, where the smoke goes, and how it interacts with other atmospheric components (chemical interactions).
11. Design and carry-out a study to provide quantitative evidence that prescribed burns release less emissions, heat intensity, etc. than a wildfire. Validate this assumption.
12. Assess different impact mitigation techniques such as ventilation technology.
13. Create an assessment tool for unplanned ignitions that would characterize their effect on human heath and the economy and help inform decisions regarding what to do with these unplanned fires.
14. Assess effectiveness of different emission reduction technologies.
15. Research the effects of fire on both ozone production and interactions with downwind surface level ozone.
16. Collect data for web-based fire activity tool for tribal lands and provide tribal emissions inventory software support.
17. Regionally place mobile air quality (PM and ozone) monitors on tribal land.
18. Assess long time fire crew members' health. How are they impacted by exposure to emissions?
19. Have the National Weather Service develop a 1-5 day forecast for smoke.
20. Hire more air-focused staff.
21. Ensure that current capabilities and equipment were leveraged to include air monitoring (RAWS stations).
22. Study the carbon balance and climate change effects on the types of fire.

West

23. Develop a wildland fire reporting system. Unified method of quantifying fire activity, with appropriate smoke-related features.
24. Develop a media campaign to increase public acceptance of smoke impacts prescribed fire.
25. $700K – Develop a workshop for air quality, land managers, policy makers, and meteorologists to include topical lessons, new science, new tools, and a practical application test at the end.
    a. $1.3M – field study with fuel measurements, surface and airborne, remote sensing of meteorology, and fuels.
26. Study whether various methods of communicating (inter-agency meetings, collaborative decision-making processes, negotiated rulemaking) result in:
    a. More uniform data/rule/policy development and implementation;
    b. Better compliance with regulations; and
    c. Fewer public complaints.
    d. Also, use performance indicators familiar to social scientists.
27. Support the development of a probabilistic smoke impact system and look at providing means of correctly interpreting results and evaluating or quantifying uncertainty associated.
28. Develop consensus (interagency, federal, & state) on tools and an ongoing process to provide integrated assessment of landscape change, fire emissions, air quality, and climate change at

NEPA step, to assist land managers, air quality regulators, policy makers, fire managers with emissions management over long time frames.

29. Spend the money to look at the deficiencies the models have with the goal that Blue Skies will work in a manner that the regulators can use it.
    a. Spend money on improving modeling to the point where the authorization can occur with very little chance of violating standards.
30. Get ahead of curve by doing research (new, or data mining) on contributions of smoke to national PM levels, relationship to new ozone standards, air toxics, and greenhouse gas emissions to justify/dodge criticisms that we'll receive in the future.
31. Improve the smoke and weather measuring network (more, and better-sited, automated weather stations with smoke monitoring instruments).
32. Review and synthesize smoke impact literature (economic) from EPA whenever there are rule changes. Look at what is the relationship that can be applied to wildfire smoke and what's missing.
    a. Improve data and models to predict magnitude of smoke reduction, so that the data from the first part could help understand the economic impacts of wildfire smoke.
33. Purchase enough smoke monitors (E-BAMs) to establish a thorough monitoring system in the southern Sierras (big field lab) and adjacent sensitive targets to measure and quantify smoke effects in real-time data from burning, fire use, wildfires and compare it to background pollutants. Also try to attempt the contributions of other sources.
34. Conduct a small, but intense, field campaign designed to reconcile all components of smoke, fire, air, weather prediction (e.g., Frank Church campaign but increase the instrumentation and the observations). Pick x acres to burn, completely map the fuel load, record and measure all parameters (e.g., soil moisture, canopy metrics). Include media – perhaps do a film for the Banff film festival and youtube.com. Set out instruments to measure WS, T, humidity, PM – an advance array of instruments. Use the models to predict forecast and then compare the actual measurements. Measure plume height, buoyancy, area, etc. This can then be used as training.
35. Gather data on actual emissions so that we can actually quantify what we are emitting to discuss what/where we are no, so that we cam make knowledgeable decisions in the future.
    a. Intermountain working group, consisting of participants from air quality regulators, burners/FMOs, meteorologists, land managers to work on smoke/air quality issues.
36. Complete and implement a smoke monitoring strategy that helps states and land managers inform the public when there are health concerns where smoke impacts occur.
37. Study and understand the dynamics of plume rise.
38. What can you do to reduce the emissions? Improve accuracy of emission reduction factors and figure out how to use more than one at a time, so we can demonstrate on a case-by-case basis what we're doing to reduce emissions.
39. Find out what my actual emissions are so that I can compare to industrial contributions because right now, I can't even do that.