UNITED STATES
DEPARTMENT OF THE INTERIOR

BUREAU OF LAND MANAGEMENT
Fire and Aviation Directorate
National Interagency Fire Center
Lead Agency for the Joint Fire Science Program

Joint Fire Science Program

The Joint Fire Science Program provides funding for scientific studies to address problems associated with managing wildland fuels, fires, and fire-impacted ecosystems.

Department of the Interior and Related Agencies Appropriation Act for FY 1998 and subsequent years (P.L. 105-83; H.R. Report 105-163)

PROJECT ANNOUNCEMENT No. FA-FON0016-0004
Fire and Smoke Model Evaluation Experiment (FASMEE) (5 Task Statements)

CFDA No. 15.232
ISSUE DATE: September 11, 2015

JFSP Funding Opportunity Notice (FON) 2016-4

CLOSING DATE & TIME

November 13, 2015 5:00 p.m. MST

NOTE: There are many requirements specific to this FON please read requirements and templates carefully.

- Letters of support are required for this FON
- Specific requirements for C.V.s
- Note travel expectations in budget narrative template
- Projects funded from this FON must be completed by June 30, 2017. There will be no extension to this date.

Contact Information:

John Cissel	Ed Brunson	Becky Jenison
Program Director	Deputy Program Director	Program Analyst
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SECTION I. FUNDING OPPORTUNITY DESCRIPTION

A. Legislative Authority: Department of the Interior and Related Agencies Appropriation Act for FY 1998 and subsequent years (P.L. 05-83; H.R. Report 105-163).

B. Project Background Information: The Joint Fire Science Program (JFSP) is a partnership of six federal wildland management and research agencies with a need to address problems associated with managing wildland fuels, fires, and fire-impacted ecosystems. The partnering agencies include the U.S. Department of Agriculture, Forest Service and five

bureaus in the U.S. Department of the Interior: Bureau of Indian Affairs, Bureau of Land Management, National Park Service, Fish and Wildlife Service, and the Geological Survey.

For further background on the JFSP, those considering submitting proposals are encouraged to visit our website at www.firescience.gov

C. Program/Project Objective: The U.S. Congress directed the Department of the Interior and the USDA Forest Service to develop a Joint Fire Science Program and Plan to prioritize and provide sound scientific studies to support land management agencies. Current priorities are identified as task statements in the Funding Opportunity Notice (FON).

D. Statement of Joint Objectives/Project Management Plan: The JFSP Governing Board and Program Manager will establish an oversight relationship with the Principal Investigator on each funded project. Projects will be required, at a minimum, to provide a written progress report annually.

E. Period of Project: Proposal must be completed by June 30, 2017. No extensions will be granted. See task statement for specific information.

SECTION II. AWARD INFORMATION

A. Expected Number of Awards: Approximately 5-7

B. Estimated Total Program Funding: Approximately $700,000

C. Award Ceiling: None

D. Assistance Instrument: To be determined at a later date by the JFSP

SECTION III. ELIGIBILITY INFORMATION

A. Eligible Applicants: The JFSP encourages proposals from all interested parties. All selected awardees must provide a valid Dun & Bradstreet number (D&B) http://fedgov.dnb.com/webform and have a current registration with the federal System for Award Management (SAM) www.SAM.gov.

B. Funding Cooperator: JFSP will enter into only one agreement per project with the PI institution or the funding cooperator institution. The PI institution or funding cooperator institution will be responsible for entering into sub-agreements with collaborating institutions. Budgets must be reviewed and approved by your Budget contact and your Agreements contact prior to proposal submission. JFSP will not provide additional funds to cover budget errors discovered after the proposal submission deadline.

Funds will be awarded through a federal agency, a university, or a non-governmental organization (NGO). Proposals that included budgeted funds to be spent by a federal agency and that do not have a federal PI must list a funding cooperator from the federal agency requesting funds. Similarly, proposals with a university or NGO PI that do not include funding for federal agencies do not need a funding cooperator and funds will route through the PI's institution.

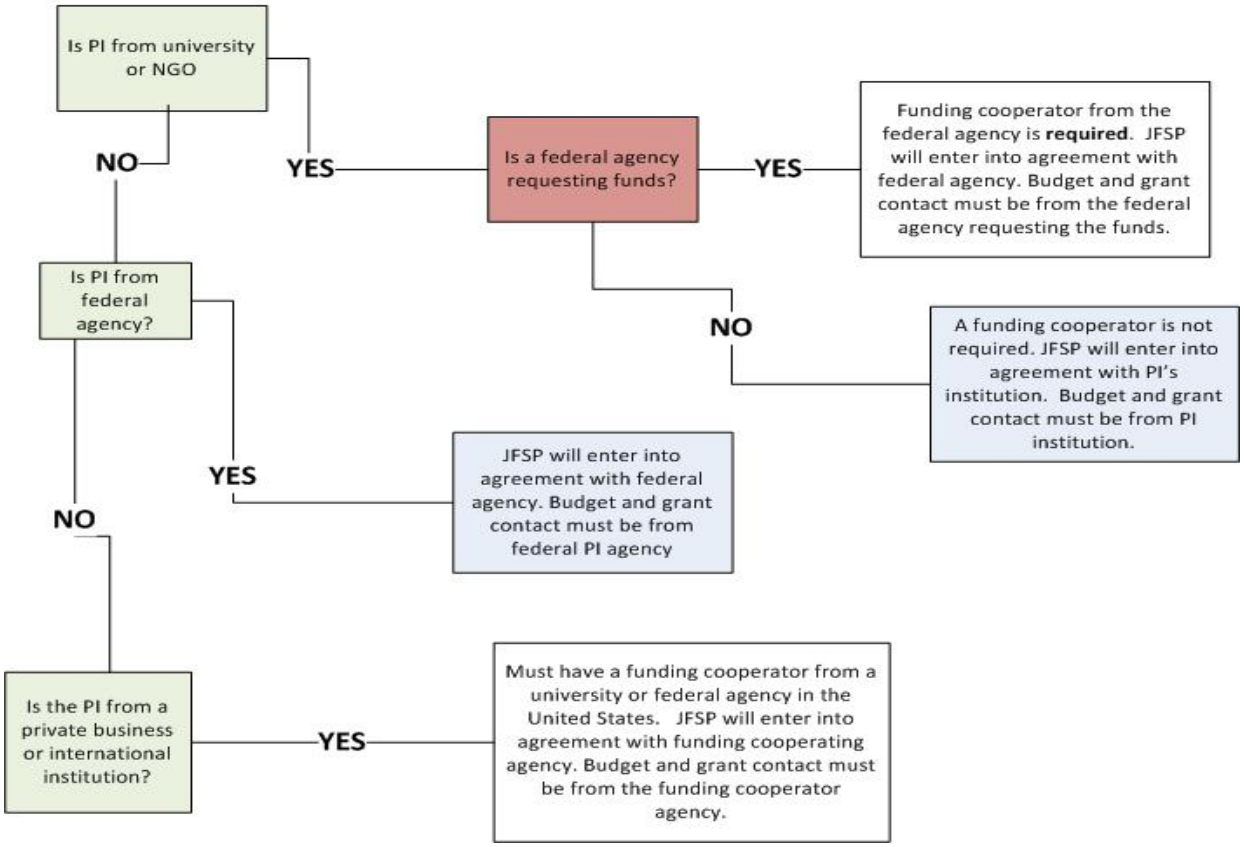
All proposals with a PI from other organizations, e.g., states or private business, or have any international funding, must also identify a funding cooperator from the United States to receive and process the funds. If the funding cooperator is from the Forest Service, the cooperator must be from a Forest Service research station. Please work with your station funding cooperator to ensure you meet the station requirements for submission. The Agreements contact and Budget contact must be from the funding cooperator's institution.

Proposals where the PI or funding cooperator is an employee of a university or NGO will be funded directly by an award document (e.g., a cooperative agreement) between JFSP and the PI's institution. The institution will be required to respond to a second non-competitive posting on grants.gov to initiate funding.

Upon receipt of a fully executed award document, the institution receiving funds from JFSP will be responsible for all sub-award transactions to cooperators or contractors related to the project. The end date and indirect costs for all sub-awards must match the end date and indirect costs in the original funding award document.

(See funding cooperator flowchart below)

Funding Cooperator Flowchart



C. Cost Sharing or Matching: This program has no matching requirements. However, contributed costs are desired and are an evaluation factor.

D. Scientific Integrity: Scientific integrity is vital to Department of the Interior (DOI) activities under which scientific research, data, summaries, syntheses, interpretations, presentations, and/or publications are developed and used. Failure to uphold the highest degree of scientific integrity will result not only in potentially flawed scientific results, interpretations, and applications but will damage DOI's reputation and ability to uphold the public's trust. All work performed must comply with the DOI Scientific Integrity Policy posted to http://www.doi.gov, or its equivalent as provided by their organization or State law

SECTION IV. APPLICATION AND SUBMISSION INFORMATION

A. Proposal Submission and Agency Contact

All proposals must be submitted by 5:00 p.m. MST November 13, 2015, using the electronic submission process provided on the JFSP website (www.firescience.gov). Proposals should not be submitted in Grants.gov. There will be no exceptions to this closing date and time.

All proposals must meet all requirements in this FON (see especially Section IV. E below). Proposals that do not meet all requirements in this section will not be considered for funding.

Questions should be directed to:

Administrative questions:
Becky Jenison, Program Analyst
Phone: 208-387-5958
Email: bjenison@blm.gov

Task statement questions:

John Cissel, Program Director
Phone: 208-387-5349
Email: jcissel@blm.gov

Ed Brunson, Deputy Program Director
Phone: 208-387-5975
Email: ebrunson@blm.gov

B. Steps to Create and Complete a JFSP Proposal

There are multiple steps necessary to create a JFSP proposal, some of which are dependent on prior steps. We recommend that investigators plan ahead, start early, and use the following process to create a proposal:

Step 1 – PI establishes profile, updates password

Step 2 – PI initiates proposal (select task, receive proposal #, enter proposal title)

Step 3 – Enter contacts (all contacts establish profiles, update passwords; PI assigns roles). Once the PI enters a contact they will have access to sign into the database and access the proposal

Step 4 – Investigators develop proposal (templates, requirements)

Step 5 – Complete budget (template, narrative)

Step 6 – Attach all documents (proposal, budget, budget narrative, data management plan, CVs, support letters,

Step 7 – PI enters final details (project location, budget summary, start/end dates, abstract, project category)

Step 8 – Budget Contact and Agreements Contact certify review of budget and budget narrative

Step 9 – PI submits proposal (convert to Final Draft status first if not previously done)

Notes

- Many steps can be in progress concurrently
- All information, including attachments, can be saved as Draft and edited later

C. Background and Task Statement(s)

1. Description of FASMEE

1.1 FASMEE goals and objectives

The objective of the planned Fire and Smoke Model Evaluation Experiment (FASMEE) is to provide observational data necessary to evaluate and advance operationally used fire and smoke modeling systems and their underlying scientific understanding. FASMEE is targeting the following modeling areas as they provide operationally critical information:

- Fire growth;
- Fire effects, particularly fuel consumption and emissions;
- Coupled fire-atmosphere behavior, particularly fire behavior and plume development; and
- Smoke models, particularly those that provide smoke impacts.

The goal of FASMEE is to collect information that can be used to:

- Quantify operational modeling capabilities;
- Build confidence in operational modeling capabilities;
- Improve operational model application methodologies;
- Improve model parameterizations;
- Add capability to the models; and
- Validate the theory behind the models and model projections.

This will require a comprehensive field campaign designed to simultaneously measure fuels, fire behavior, plume development, consumption and emissions, and smoke chemistry.

1.2 Phases

FASMEE is designed to be conducted in two phases: a first organizational/planning phase (Phase 1) followed by the field campaign phase (Phase 2). FASMEE is currently in Phase 1, and this FON is designed to bring onboard scientific and modeling leadership to complete the comprehensive design for the Phase 2 field campaign. Phase 1 is expected to last until June 30, 2017, with Phase 2 occurring from 2017-2021. Burns are expected to occur during 2018-2020.

Phase 1 – Organization and Planning
Phase 1 will develop the coordinated plan for the field campaign, including the observational study plan as well as specific incident command, burn decision, safety, logistics, and data management plan components. For the observational study design, Phase 1 will bring together both observational specialists across a variety of disciplines as well as modelers and model developers to collaboratively develop an integrated study plan for Phase 2.

Together the Discipline Leads and Modeling Leads identified through this FON, along with the current FASMEE Project Leads will form the FASMEE Scientific Leadership Team and be charged with designing the observational field campaign. Once it is designed, a separate Funding Opportunity Notice will request proposals from observational groups to meet the specifications required in the observational study design. The Scientific Leadership Team will work to merge selected proposals into a comprehensive and unified study plan and proposal for the Phase 2 field campaign. A decision to implement Phase 2 will be made based on the final study plan and proposal.

Overall, Phase 1 is expected to progress as follows:

- January 2016 - Discipline Leads and Modeling Leads identified, and Scientific Leadership Team formed
- Spring 2016 - Site selection narrowed, initial combined observational study plan developed, and pre-burn simulations performed
- Summer 2016 - Site selection finalized, refined observational study plan developed, and additional modeling simulations performed
- December 2016 - Second FON open for observational groups interested in the Phase 2 field campaign
- Spring 2017 - Phase 2 deliverables in complete draft form including observational study plan, Incident Action Plan, budgets, logistics plan, data management plan, and other components. All Phase 2 participants identified.
- June 30, 2017 - All Phase 1 deliverables complete and submitted for funding agency review and funding decisions.

Phase 2 – Field Campaign
Once funded, the FASMEE field campaign will occur over calendar years 2018-2020 and involve multiple large (500+) burns across at least two locations. Field campaigns for each location are expected to occur in subsequent years with the first burn scheduled for the fall of 2018. One location is expected to be in the Southeastern U.S. and one location is expected to be in the Western U.S. or Canada. Multiple burns may be planned for each location. We expect one burn will be a stand replacement burn; other burns may be similar or spread over a gradient of intensities and conditions (e.g. fuel loading, fuel moisture, wind speed, terrain

complexity) as best meets the goals of FASMEE. Please refer to the FASMEE Burn Plan document (available at http://fasmee.net) for more details. Phase 2 is expected to end, with all data submitted to the data repository, in 2021.

2. Role of this FON

This FON is designed to bring onboard the scientific leadership required to create the FASMEE observational study plan, including Discipline Leads and Modeling Leads and their associated helpers. The overall observational study design will be developed as a cooperative product of the Scientific Leadership Team, with the Discipline Leads having primary responsibility for their discipline area, and the Modeling Leads having primary responsibility for producing pre-burn simulations and vetting the observational study design against their model results and model requirements. Discipline Leads and Modeling Leads selected through this FON will be funded only for FASMEE Phase 1.[1]

Once the study design is complete the Scientific Leadership Team will work with the Joint Fire Science Program to develop a separate Funding Opportunity Notice open to all observational groups. If Phase 1 Discipline or Modeling Leads wish to apply for the Phase 2 Funding Opportunity Notice to participate in observational teams, alternative Discipline Leads will need to be identified at that time. Project Leads and Phase 2 Discipline Leads will not be eligible for the observational group FON, but will be funded through the separate logistical plan for Phase 2. Scientists interested in participating as a Lead in Phase 1, but not interested in continuing through Phase 2 as a Lead, are still encouraged to apply to this FON.

3. Discipline Leads - description and responsibilities

There are four discipline areas identified in this FON (see Tasks 1-4):

- Fuels and consumption;
- Fire behavior and energy;
- Plume development and meteorology; and
- Smoke emissions, chemistry, and transport.

Proposals submitted under Tasks 1 through 4 are for Discipline Leads that will serve as part of the FASMEE Scientific Leadership Team and have primary responsibility for developing the observational study plan for their discipline area. One Discipline Lead will be selected for each area. Discipline Leads may identify additional personnel that will help with the study plan development, but the roles of these personnel should be well justified in the proposal, including identifying complementary expertise.

Discipline Leads are expected to fully participate as members of the Scientific Leadership Team, including working collaboratively with other Leads to develop an integrated observational study design. Discipline Leads will also validate this design against pre-burn model simulations provided by the Modeling Leads, and contribute towards development of the data management plan, the safety plan, and the scientific logistics plan. Scientific Leadership Team conference calls are expected to be monthly, and there are two site visits and three in-person project meetings planned.

[1] FASMEE Project Leads (Ottmar, Brown, Larkin) are ineligible for this FON.

Discipline Leads will be responsible for:

- Providing expertise to the Scientific Leadership Team for their discipline area;
- Reaching out to the larger scientific community in their area for additional information as needed;
- Proposing an observational study design for observations in their discipline area;
- Working in conjunction with the modelers and the rest of the Scientific Leadership Team to validate their proposed study design;
- Writing up the study design and creating a detailed set of required observational specifications;
- Helping develop a Funding Opportunity Notice to identify and select observational groups;
- Reviewing observational group proposals and integrating selected proposals into the final study plan; and
- Building the final Study Plan.

Discipline Leads should look at the observational specifications document (Appendix A) and include all relevant observations in their proposed plan as appropriate. Redundancies with observations listed for other Tasks will be resolved later.

In building their initial study design as part of responding to this FON, respondents are required to utilize the two conceptual burns described in the template. Respondents are also asked to detail what types of measurements and burns would work best for their discipline.

4. Modeling Leads - description and responsibilities

Modeling Leads need to explicitly identify the models that they propose to support with leadership and expertise from the list in the task statement. One or more Modeling Leads will be selected so there is coverage of all of the identified models listed under Task 5.

Proposals under Task 5 are for Modeling Leads that will serve as part of the FASMEE Scientific Leadership Team and have primary responsibility for performing pre-burn simulations and vetting the observational design based on their model results and model requirements. Modeling Leads will be responsible for a specific set of models as identified in their proposal. Modeling Leads may identify additional personnel that will help with simulations, analysis, and study plan development, but the roles of these personnel must be justified in the proposal.

Modeling Leads are expected to fully participate as a member of the Scientific Leadership Team including working collaboratively with other Modeling and Discipline Leads in the development of an integrated observational study design and validating this design against pre-burn model simulations. Modeling Leads will also contribute towards the development of other aspects of the Phase 2 plan to be created during Phase 1 including the data management plan. Scientific Leadership Team conference calls are expected to be monthly, and there are three planned in-person project meetings. Site visits are optional.

Modeling Leads will be responsible for:

- Providing expertise to the Scientific Leadership Team for the specific set of models identified in their proposal;
- Performing pre-burn simulations using these models and guidance provided in the template;
- Using these results and working with the discipline leads to vet the observational design;
- Working in conjunction with the discipline leads and the rest of the Scientific Leadership Team in preparing the study design, including writing up the study design and creating a detailed set of required observational specifications;
- Reaching out to the larger scientific community in their area for additional information as needed;
- Helping develop a Funding Opportunity Notice to identify and select observational groups; and
- Assisting with building the final Study Plan.

Specific tasks expected of the Modeling Leads are:

- Perform simulations for each of up to eight identified potential burn sites;
- Help identify the best potential burn sites for validating their selected model(s);
- Provide simulation output to the various discipline leads;
- Work with the discipline leads to vet various observational plan ideas against the simulations;
- Once a final set of four burn sites are identified, perform an additional set of model runs to help prioritize potential prescription windows;
- Provide feedback on Phase 2 observational team proposals;
- Vet the final study plan;
- Help design the FASMEE data archive.

Pre-burn simulations are to be high-resolution, with the goal of resolving critical plume dynamics and the near-field plume structure. Multiple runs may be necessary to help identify prescription windows of interest. The pre-burn simulations will be archived within the FASMEE data archive.

Modeling Leads should look at the observational specifications document (Appendix A) and provide guidance on how these observations pertain to validating and improving their models.

In addition to working directly with the Discipline Leads on the FASMEE observational study plan, the Modeling Leads will be expected to work together to inter-compare their models and determine the areas of agreement and disagreement in their simulations. This work is expected to lead to a scientific journal publication to be written in late 2016.

5. Deliverables, timeline, and travel

This section describes expectations for all proposals including specific expectations concerning the deliverables, timeline, and travel to be done for the project.

5.1 Deliverables

The main final deliverable is the completed study plan. It is intended that elements of the final study plan, especially the observational specifications, will be published as a peer-reviewed General Technical Report.

The study plan design is to be:

- Integrated, with a single comprehensive design representing all disciplines
- Detailed, with specific measurements including instruments, timing, location, and setup/tear-down plans
- Fully implementable, including
    - Identifying the specific researchers and tasks that will perform the field campaign
    - Specific budgets for each institution to be involved
- Validated in the sense of being found to be useful for the model evaluation objectives identified based on the pre-burn simulations done as part of Phase 1.
- Integrated with the Incident Action Plan and other safety documents
- Integrated with the Data Management Plan

Additional deliverables include:

- Draft Funding Opportunity Notice language;
- Observational specifications required for the Funding Opportunity Notice;
- Reviews of observational group proposals;
- Draft documents including Study Plan sections on each discipline, draft budgets, draft appendices of measurements by discipline, and other documents detailing the design for review, including their relationship to the current state of the science; and
- Additional summary documents needed to explain the design to the funding agencies.

5.2 Timeline

Projects will run through June 30, 2017. No extensions will be granted. The integrated final deliverables across all projects funded through this FON are required at that time. Intermediate deliverables will be required in advance of this date.

Project calls will be held monthly or more often as necessary.

The current timeline including interim deadlines is:

- January 2016 – Phase 1 Modeling Leads and Discipline Leads identified
- March/April 2016 – Phase 1 Modeling Leads and Discipline Leads funded
- Summer 2016 – Initial integrated study design developed and initial model simulations complete.
- October 15 2016 – Integrated draft Study Plan complete and Observational Group FON drafted
- December 1, 2016 – Observational Group FON released
- February 1, 2017 – Observational Group proposals received
- March 15, 2017 – Observational Group proposals reviewed
- May 1, 2017 – Complete, near final draft of all Phase 1 Deliverables, including integrated budgets

- June 30, 2017 – All Phase 1 deliverables complete.

5.3 Travel

Attendance at three project meetings is expected for all Leads. Additionally, discipline teams are expected to do at least two site visits in preparing the study plan. Travel should be budgeted accordingly. See budget narrative template for specific information.

6. Task statements

Task Statement 1 - Fuels and consumption

The Joint Fire Science Program (JFSP) seeks proposals to select a Discipline Lead to guide the fuels and consumption discipline for the FASMEE project.

The Principal Investigator from one selected proposal will participate as Discipline Lead for fuels and consumption in the FASMEE Scientific Leadership Team. Principal responsibilities include final responsibility for the fuels and consumption portion of the Phase 2 observational study plan, interim deliverables, and the participation in all project meetings and conference calls. The fuels and consumption Discipline Lead will need to closely collaborate with other Discipline and Modeling Leads to plan measurements. Additionally, the fuel and consumption Discipline Lead is expected to provide information needed to allow later potential follow-on fire effect studies.

Responsive proposals should include a conceptual observational study design that covers the needs outlined below and in Section 2.1 of Appendix A (FASMEE Observational Specifications). Proposed study designs should layout the overall sampling approach to be used, including placement and types of measurements and their spatial and temporal extent and resolutions split out by measurement platform (e.g. ground sampling, tower-based measurements, aircraft-based measurements). Proposed study designs do not need to list exact instrumentation, but are encouraged to include as much detail as needed to describe the intent and effect of the measurements listed.

For fuels and consumption, proposed study designs should include an initial comprehensive plan for the collection of gridded, three-dimensional pre-fire and post-fire characterization of all fuels that have the potential to consume (e.g., tree canopies, shrubs, herbs, downed wood, litter and duff) at spatial scales relevant to fires and models to be evaluated. Multi-scaled characterizations are expected with coordination between ground-based and remotely sensed imagery. Proposed study designs for this discipline must include:

A. Gridded fuel mapping and properties of pre-fire and post fire of all fuels occurring on the research site that have the potential to burn.
B. Coordinated ground-based sampling and remotely sensed datasets to provide spatial mapping of pre- and post-fire loads, gaps, fuel moisture and fuel consumption at temporal and spatial scales relevant to the models being evaluated.
C. Characterization of live and dead fuel properties (i.e., bulk density, surface area to volume ratios, packing ratio, specific heat and fuel moisture content) by particle size class along with modeling strategies to assign subsample fuel properties to gridded fuels.

D. Fuel consumption by combustion phase and duration by fuel bed component.

In addition to the proposed study design, proposals should include a discussion of how the proposed study design can be beneficial for model validation, evaluation, and development. Discussions are encouraged to be specific about the models benefiting from the proposed observations.

Other research questions that proposals are encouraged to address include:

- How can FASMEE contribute to creation of a system for describing fuels and vegetation that can scale across the wide range of spatial scales needed for decision support (from fine scales to 30-m+ aggregate fuels)?
- How can FASMEE support development of new protocols that can better capture both the aggregate information and sub-grid variability needed by the next-generation of fire behavior and fire effects models?
- How can FASMEE advance the ability of remote sensing to be used to cheaply create stand and forest scale fuels and vegetation maps for land management?
- How can FASMEE advance the ability to predict unburned areas within larger fires?

Additional research questions may be identified and addressed, but these must be justified in the proposal.

Respondents should be aware of the responsibilities, timelines, deliverables, and travel requirements listed in Sections 3 and 5 and budget accordingly.

Task Statement 2 - Fire behavior and energy

The Joint Fire Science Program (JFSP) seeks proposals to select a Discipline Lead to guide the fire behavior and energy discipline for the FASMEE project.

The Principal Investigator from one selected proposal will participate as Discipline Lead for fire behavior and energy in the FASMEE Scientific Leadership Team. Principal responsibilities include final responsibility for the fire behavior and energy portion of the Phase 2 observational study plan, interim deliverables, and the participation in all project meetings and conference calls. The fire behavior and energy Discipline Lead will need to closely collaborate with other Discipline and Modeling Leads to plan measurements. Additionally, the fire behavior and energy Discipline Lead is expected to provide information needed to allow later potential follow-on fire effect studies.

Responsive proposals should include a conceptual observational study design that covers the needs outlined below and in Section 2.2 of Appendix A (FASMEE Observational Specifications). Proposed study designs should layout the overall sampling approach to be used, including placement and types of measurements and their spatial and temporal extent and resolutions split out by measurement platform (e.g. ground sampling, tower-based measurements, aircraft-based measurements). Proposed study designs do not need to list exact instrumentation, but are encouraged to include as much detail as needed to describe the intent and effect of the measurements listed.

For fire behavior and energy, proposed study designs should include an initial comprehensive plan for the collection of fire behavior information designed to validate and improve fire behavior modeling at scales relevant for operational fire support. Proposed study designs should also include:

A. Full field coverage of fire progression, including flame dimensions and patterns within the flame zone.
B. Fire depth and spatial evolution over the fire event.
C. Measurement of the spatial and temporal evolution of heat flux.
D. Detailed coverage of fine scale processes in specific areas.
E. Measurements to provide closure of the fire energy budget at least in specific locations.
F. Measurement of pre-frontal heating of fuels via convection, radiation, and ember transport.
G. A description of the needed spatial and temporal resolution of all measurements.
H. Discussion of how these measurements may be important for model development and validation.

In addition to the proposed study design, proposals should include a discussion of how the proposed study design can be used for model validation, evaluation, and development. Discussions are encouraged to be specific about the models benefiting from the proposed observations.

Other research questions that proposals are encouraged to address include:

- How can FASMEE work with the Tactical Fire Remote Sensing Advisory Committee (TFRSAC) and the operational remote sensing community to advance sensing and calibration of remotely sensed fire detections, fire radiative energy, and burn scars?
- How can FASMEE work to bridge the scale difference between fine-scale laboratory experiments designed to advance fire behavior theory and coarse scale operational models?
- How can FASMEE work to advance methods and procedures for operational modeling where fine scale fuel measurements (such as those to be collected for FASMEE) are not available?
- How can FASMEE advance methods for measuring the amount and pattern of heat flux?
- How can FASMEE advance methods for measuring convective heat flux?

Additional research questions may be identified and addressed, but these must be justified in the proposal.

Respondents should be aware of the responsibilities, timelines, deliverables, and travel requirements listed in Sections 3 and 5 and budget accordingly.

Task Statement 3 - Plume development and meteorology
The Joint Fire Science Program (JFSP) seeks proposals to select a Discipline Lead to guide the plume development and meteorology discipline for the FASMEE project.

The Principal Investigator from one selected proposal will participate as Discipline Lead for plume development and meteorology in the FASMEE Scientific Leadership Team. Principal responsibilities include final responsibility for the plume development and meteorology portion of the Phase 2 observational study plan, interim deliverables, and the participation in all project meetings and conference calls. The plume development and meteorology Discipline Lead will need to closely collaborate with other Discipline and Modeling Leads to plan measurements.

Responsive proposals should include a conceptual observational study design that covers the needs outlined below and in Section 2.3 of Appendix A (FASMEE Observational Specifications). Proposed study designs should layout the overall sampling approach to be used, including placement and types of measurements and their spatial and temporal extent and resolutions split out by measurement platform (e.g. ground sampling, tower-based measurements, aircraft-based measurements). Proposed study designs do not need to list exact instrumentation, but are encouraged to include as much detail as needed to describe the intent and effect of the measurements listed.

For plume development and meteorology, proposed study designs should include an initial comprehensive plan for the collection of plume development and meteorology information designed to validate and improve coupled fire-atmosphere and plume development models at scales relevant to both operational fire behavior modeling and smoke modeling. Proposed study designs should also include:

A. Measurements of the state variables and their evolution within the plume.
B. The specific ambient weather conditions to be measured including:
    i. Surface and upper level parameters; and
    ii. Pre-burn and day of burn parameters.
C. A framework for measuring advective (vertical and horizontal) and radiative heat fluxes over the duration of the fire events.
D. Discussion of methods used to quantify turbulence.
E. Estimates of plume dimensions over time, including from simple techniques that can potentially be widely applied.

In addition to the proposed study design, proposals should include a discussion of how the proposed study design can be beneficial for model validation, evaluation, and development. Discussions are encouraged to be specific about the types of models benefiting from the proposed observations.

Other questions that proposals are encouraged to address include:

- How can FASMEE advance the underlying conceptual models of wildland fire plumes?
- How can FASMEE advance a new generation of improved plume models usable for operational smoke prediction modeling?
- How can FASMEE advance the operational coupling of coupled fire-atmosphere models with smoke models to improve smoke predictions?
- How can FASMEE advance the ability to correctly allocate smoke emissions between lofted emissions and non-lofted emissions?
- How can FASMEE help close the overall fire energy balance budget?

- How can FASMEE help develop simple and inexpensive protocols for measuring plumes that can be deployed widely?

Additional research questions may be identified and addressed, but these must be justified in the proposal.

Respondents should be aware of the responsibilities, timelines, deliverables, and travel requirements listed in Sections 3 and 5 and budget accordingly.

Task Statement 4 - Smoke emissions, chemistry, and transport
The Joint Fire Science Program (JFSP) seeks proposals to select a Discipline Lead to guide the smoke emissions, chemistry, and transport discipline for the FASMEE project.

The Principal Investigator from one selected proposal will participate as Discipline Lead for smoke emissions, chemistry, and transport in the FASMEE Scientific Leadership Team. Principal responsibilities include final responsibility for the smoke emissions, chemistry, and transport portion of the Phase 2 observational study plan, interim deliverables, and the participation in all project meetings and conference calls. The smoke emissions, chemistry, and transport Discipline Lead will need to closely collaborate with other Discipline and Modeling Leads to plan measurements.

Responsive proposals should include a conceptual observational study design that covers the needs outlined below and in Section 2.4 of Appendix A (FASMEE Observational Specifications). Proposed study designs should layout the overall sampling approach to be used, including placement and types of measurements and their spatial and temporal extent and resolutions split out by measurement platform (e.g. ground sampling, tower-based measurements, aircraft-based measurements). Proposed study designs do not need to list exact instrumentation, but are encouraged to include as much detail as needed to describe the intent and effect of the measurements listed.

For smoke emissions, chemistry, and transport, proposed study designs should include an initial comprehensive plan for the collection of smoke emissions, chemistry, and transport information designed to validate and improve smoke modeling at scales relevant to operational smoke prediction. Proposed study designs should also include:

A. The characterization of smoke emissions at or near the source (include non-lofted smoke emissions).
B. Measurements and methodology needed for smoke plume evolution for evaluation of smoke plume and dispersion modeling.
C. Relationship among within plume concentration profiles and meteorological variables.
D. Physical and chemical evolution of smoke throughout the lofting plume.
E. Description of needed vertical and horizontal profile transects starting at the fire source and extending down-wind.
F. Characterization of smoke impacts such as:
    i. Non-lofted smoke in nearby drainages;
    ii. Nighttime smoke settling; and

iii. Downwind surface concentrations.

In addition to the proposed study design, proposals should include a discussion of how the proposed study design can benefit model validation, evaluation, and development. Discussions are encouraged to be specific about the models benefiting from the proposed observations.

Other research questions that proposals are encouraged to address include:

- How can FASMEE advance the estimation of emissions and lofting smoke from satellite products?
- How can FASMEE advance the modeling of nighttime detrainment of smoke in valleys and advance the understanding of smoke drainage flows and pooling?
- How can FASMEE advance our ability to correctly allocate lofted and non-loft smoke emissions?
- How can FASMEE be used in conjunction with laboratory experiments to better characterize smoke emissions by phase from various fuelbed types?
- How do emissions components and ratios vary over the lifetime of a fire and across fire scales?
- How can FASMEE improve the estimation of uncertainties in emission production models?
- How can FASMEE help inform the sensitivities and uncertainties in operational models of PM2.5?
- How can FASMEE develop information useful for air resource advisors, air regulators, and public health officials in creating better health advisories for both firefighters and the public?

Additional research questions may be identified and addressed, but these must be justified in the proposal.

Respondents should be aware of the responsibilities, timelines, deliverables, and travel requirements listed in Sections 3 and 5 and budget accordingly.

Task Statement 5 - Modeling leads

The Joint Fire Science Program (JFSP) seeks proposals to select FASMEE Modeling Leads for specific models listed below.

Principal Investigators from selected proposals will participate as Discipline Leads for various models in the FASMEE Scientific Leadership Team. Principal responsibilities include pre-burn simulations to evaluate the Phase 2 observational study plan, other interim deliverables, and the participation in all project meetings and conference calls. Modeling Leads will need to closely collaborate with Discipline Leads to develop a validated observational study plan.

FASMEE will use the results of pre-burn simulations to help select burn locations and ignition methodologies, and to help refine the observational plan in order to ensure that the data collected will be of value in validating specific models. A wide range of model simulations will be performed by the existing FASMEE project team as part of Phase 1 including fire behavior

modeling, fuel consumption and emissions modeling, and smoke dispersion modeling. Modeling Leads will:

- Provide modeling expertise;
- Do pre-burn simulations for their identified models; and
- Work with the observational Discipline Leads and FASMEE Project Leads to vet the draft and final study plans.

Responsive proposals need to identify one or more of the following models that will be covered by their proposal (listed alphabetically):

A. DAYSMOKE plume model
B. FIRETEC coupled fire-atmosphere model
C. WFDS coupled fire-atmosphere model
D. WRF–FIRE coupled fire-atmosphere model
E. WRF-CHEM (preferentially WRF-FIRE-CHEM) coupled photochemical model

Note that model simulations using other relevant models will be executed by the Phase 1 Project Leads. Modeling Leads selected through this FON will also need to coordinate with these model results to fully meet Phase I planning needs.

Respondents are asked to detail their modeling system(s), and to examine the applicability of their modeling system(s) to two hypothetical burn sites as described in the template. (Note: these are not the specific FASMEE burn sites, but are selected to be representative of potential burn types/sites.)

Specific questions to be addressed in the proposal are:

- What are the key issues facing these types of models?
- How can the observational campaign proposed by FASMEE address these issues?
- What kind of burn sites, fire types, and fire conditions would work best for collecting data to address these issues?
- How can the pre-burn simulations be used to improve the observational design and specifications for FASMEE?

Respondents should be aware of the responsibilities, timelines, deliverables, and travel requirements listed in Sections 4 and 5 and budget accordingly.

D. Budget and Funding Policy

1. Funding Cooperator

Proposal may require a funding cooperator. See Section III.B above.

2. Indirect Costs

The JFSP Governing Board recognizes the need of agencies and organizations participating in the program to recover reasonable indirect costs. However, cost effectiveness of the individual projects is a determining factor in the final selection process. JFSP has an approved indirect cost rate exception that limits proposals to a maximum of twenty (20)

percent of the direct costs for each institution. Proposals requesting funds for indirect rates higher than twenty (20) percent will not be considered. This memo can be found on the JFSP website at this link:
http://www.firescience.gov/documents/BLM_Iindirect_cost_rate_exception_signed.pdf

The maximum indirect rate that a funding cooperating institution may charge for pass-through costs is ten (10) percent. Proposal funding through a federal funding cooperator must reflect either the prevailing indirect rate for the cooperating federal agency or the JFSP maximum limit of twenty (20) percent, whichever is less. Unrecovered indirect costs can be used as contributed funds in the budget.

Pass-through costs are charged only by the PI institution or funding cooperator institution for administrative costs associated with managing sub-agreements. Pass-through costs are limited to ten (10) percent of the sub-agreement direct charges.

(See indirect cost example below)

Indirect costs example

Scenario

- The PI is from a university or federal agency (lead institution)
- Co-PI is from a cooperating university or NGO (cooperating institution)
- The calculated expenses in the Budget for the lead institution are $200,000 (salary, fringe benefits, travel, equipment, etc.)
- The calculated expenses in the Budget for the cooperating institution are $40,000

Calculation of indirect costs

1. Cooperating institution

Maximum allowed indirect costs (20%)

$40,000 * 0.20 = $8,000

Total Budget for cooperating institution

$40,000 + $8,000 = $48,000

Note: If there are multiple cooperating institutions this calculation would be performed for each institution.

2. Lead institution

Maximum allowed indirect costs (20%) on own Budget

$200,000 * 0.20 = $40,000

Maximum allowed pass-through indirect costs (10%) on cooperating institution Budget

$48,000 * 0.10 = $4,800

Total Budget for lead institution

$200,000 + $40,000 + $4,800= $244,800

3. Total Budget = $244,800 + $48,000 = $292,800

Points of emphasis

- Lead institutions can include pass-through costs for each cooperating institution in their Budget
- Pass-through costs are calculated based on the total Budget for each cooperating institution, including the indirect costs calculated by the cooperating institution
- Cooperating institutions do not include pass-through costs in their Budgets
- Institutions should use their negotiated indirect cost rates with their cooperating institutions, but cannot exceed JFSP maximums

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3. SBIR Costs

Certain proposals may be required to pay a percentage of the project's costs into the Small Business Innovation Research (SBIR) program. Proposals where the funds are transferred to a Forest Service institution and subsequently award a portion of the total budget to a non-federal entity through a sub-agreement or sub-contract may be required to pay the prevailing rate of the total funds awarded externally to the SBIR program. Check with your Agreements contact to determine if this applies to your proposal and to determine the current rate.

4. Equipment Policy

Investigators are encouraged to contribute equipment to conduct studies funded by JFSP from existing equipment inventories. Contributed equipment should be included as "contributed costs" in JFSP budget spreadsheets and on the budget tab.

If necessary equipment is not available, JFSP will partially or fully fund equipment needed to conduct research funded by JFSP. If newly purchased equipment has an expected lifespan extending beyond the life of the project, the owner of the equipment is expected to contribute a portion of the purchased equipment costs in approximate proportion to the remaining lifespan. E.g., if a needed piece of equipment costs $1,000 and will have a 50% lifespan at the end of the project, then the owner of the equipment is expected to contribute $500.

In no case will JFSP pay more than $5,000 for a piece of equipment. If a new piece of equipment costing more than $5,000 is needed for the proposed project, proposal investigators are expected to contribute the remaining costs in excess of $5,000.

This criterion is to be applied for each and every piece of equipment.

5. Salary Policy

Salaries of permanent full-time employees are not covered by JFSP and must be provided by your institution. This includes university faculty on 12-month tenure-track appointments.

JFSP will provide funding for part-time, temporary, term employees, post-doctoral employees, graduate, or undergraduate students. JFSP will cover salary for employees on a 9-month appointment, but only for the months they are not funded by their institution and only for the time focused on their JFSP project. JFSP will not pay salary for other personnel to fill in for employees working on a JFSP project.

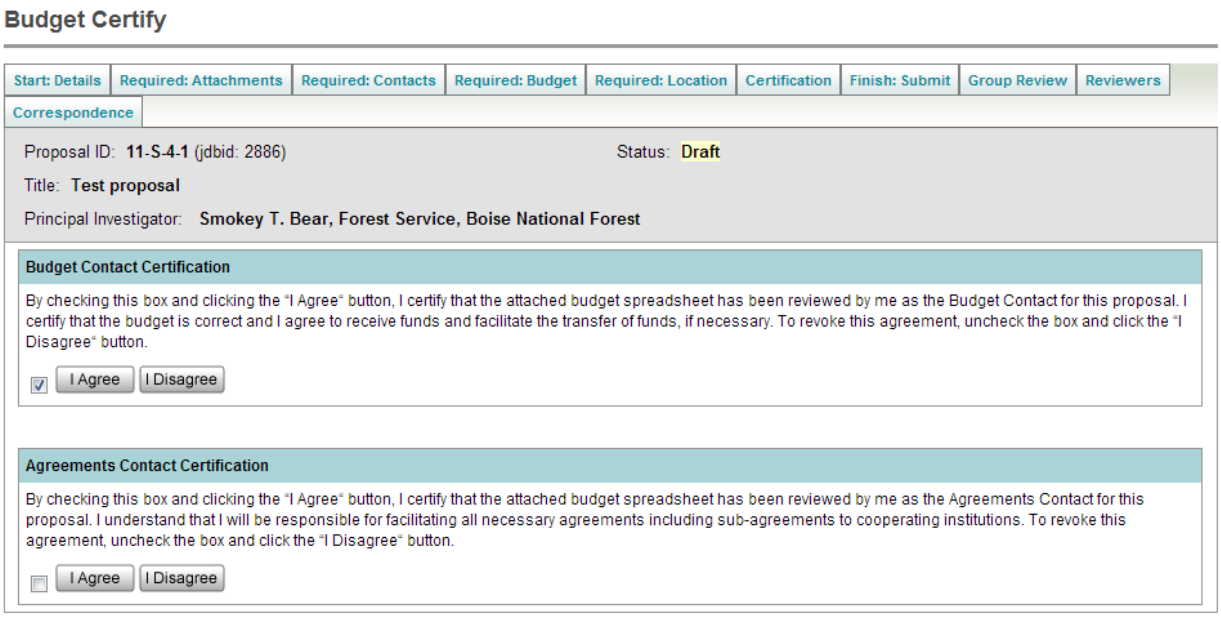
Stipends are normally funded, but **tuition and other university fees will not be funded**.

6. Budget

Budget spreadsheet and narrative must be reviewed by your Budget contact and your Agreements contact to ensure all costs have been included and the budget is correct including indirect charges. JFSP will not provide additional funds to cover errors discovered after the proposal submission deadline.

Budget spreadsheet must use the provided template and have a separate worksheet for each institution requesting or contributing funds including contracts. Budget narratives must detail all costs in the budget spreadsheet. We highly suggest you use the format provided in the example for the budget narrative. Funded proposals will be closely scrutinized for allowable and reasonable costs before award is issued.

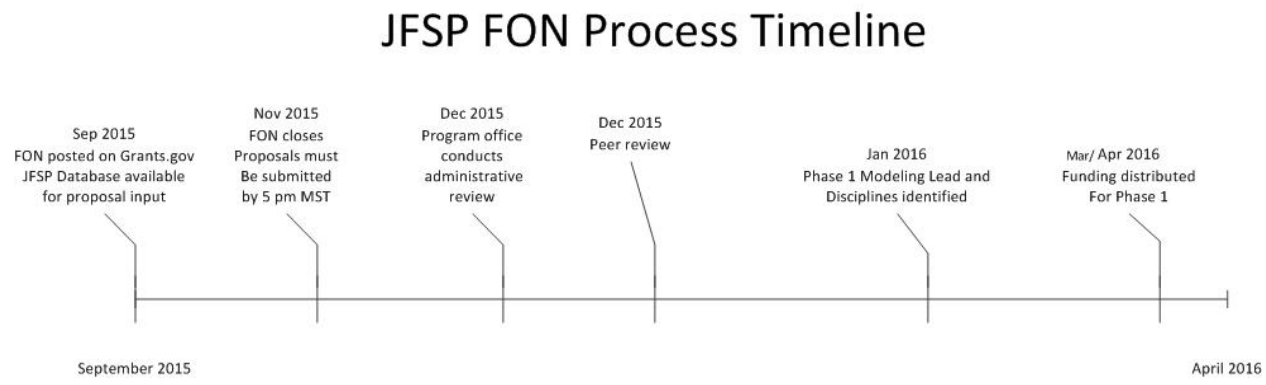
The Budget contact and Agreements contact must sign in to the JFSP system and certify the budget is correct and they understand their role in receiving funds and facilitating agreements. Proposals cannot be submitted by the PI if both contacts have not completed this task in the database. (**See screen print below**)



Proposals will be funded via Inter-agency agreement, cooperative agreement, or budget transfer. Please talk to your Budget contact and Agreements contact to ensure your budget has the correct indirect rates for your circumstances.

The JFSP Governing Board does not fund projects that are, or should be, funded internally from existing accounts (such as routine agency monitoring) or operational portions (such as the installation of fuels treatments or development of fire management plans) of other projects.

Funding is usually distributed in late summer; please plan budgets accordingly (**See proposal timeline below**).



E. Data Management Plan (DMP)

No data management plan required for this FON.

F. Additional Application Requirements

Proposals must meet all of the following requirements to be considered. Incomplete proposals will not be considered. There will be no exceptions to either the submission deadline or other submission requirements. If you have questions about these requirements, please contact the JFSP Program Office for clarification (Becky Jenison 208-387-5958, John Cissel 208-387-5349, or Ed Brunson 208-387-5975).

1. Proposal Submission

Proposals must be submitted electronically via the JFSP website (www.firescience.gov). Proposals should not be submitted in Grants.gov. Hard copy, email, or facsimile proposals will not be accepted. Proposals can be created in the database at any time and saved for submission any time prior to the closing date & time.

- Proposers must have a JFSP database login and password to submit a proposal. Requests for access will be processed in approximately 24 hours.
- The Budget contact must sign into the system and certify the budget is correct before proposal can be submitted. Note that the PI will not be able to complete this task for the Budget contact. PI must assign this contact on the contact tab before the Budget contact can sign in to complete this process.
- The Agreements contact must sign into the system and certify the budget is correct before proposal can be submitted. Note that the PI will not be able to complete this task for the Agreements contact. PI must assign this contact on the contact tab before the Agreements contact can sign in to complete this process.
- Only the PI can submit the proposal.
- Proposals can be saved in the JFSP system and submitted prior to the closing date and time. Submitted proposals can be reverted back to final draft by the PI prior to the closing date. If you revert a proposal back to draft you must resubmit the proposal before the closing date and time.
- The JFSP proposal submittal system will not allow proposals to be submitted after the closing date and time.

2. **Profiles**
    - **All** contacts must have a profile in the JFSP database and must be entered on the contacts tab.
    - Proposals cannot be submitted if all required contacts (see Contacts below) are not entered on the contacts tab by the PI.
    - It can take up to 24 hours to get a profile created. It is advisable to request profiles early in the process.
    - To request a profile or password resets go to the JFSP website and click on the sign in link. Use the appropriate link for requesting a password reset or requesting a new user registration.

3. **Contacts**

    Proposals may be required to have the following contacts (see Section VI. Definitions to understand the role of each contact) assigned to a proposal:
    - Principal Investigator (required, only one Principal Investigator can be assigned)
    - Funding Cooperator (may be required, see Section III.B. funding cooperator)
    - Budget Contact (required) in some cases this may be the same as the Agreements contact
    - Agreements Contact (required) in some cases this may be the same as the Budget Contact
    - Co-PIs and Collaborators (options)

    It is the PI's responsibility to ensure all correct contacts are entered into the proposal database. Please read Section VI. Definitions carefully to ensure you have the correct contact from the correct institution listed.

4. **Confirmation Page**

    When you submit your proposal you will receive a confirmation page. We highly recommend that you save or print this page for your records. If you do not receive this confirmation page you have not submitted your proposal correctly.

    You should receive an email from the JFSP Program Office letting you know that your proposal has either been forwarded for review, or rejected for not meeting administrative requirements. If you do not receive this email by the end of December, you should fax or email your confirmation to Becky Jenison at bjenison@blm.gov or fax: 208-387-5960.

5. **Attachments**

    All required documents and templates must be attached before the proposal can be submitted. All attachments except the budget must be attached as a pdf document; the budget template is in an Excel format. Attachments over the page limit cannot be submitted. All information in a template must be included as part of that attachment and must be within the page limit. Extraneous materials (e.g., extra graphs and text) are not permitted and will not be reviewed.

    Required attachments for all proposals must use templates provided to be considered:
    - Proposal body

- C.V.s (PI: two-page maximum, Co-PI(s): one-page maximum). C.V.s for this FON have specific requirements see template for details.
- Budget spreadsheet (Excel spreadsheet, includes a separate worksheet for each institution requesting funding)
- Budget narrative (explanation of specific budget assumptions and costs)
- Letter(s) of support (required for this FON). Letters of support have specific requirements for this FON see template for details.

Additional attachments:

- Specific to a task statement (check the applicable task statement for additional requirements)

6. Data Management Plan

Not required for this FON.

7. Budget

Budget summary numbers summarized by institution type requesting funds must be input in the JFSP database on the Budget tab. The budget spreadsheet and budget narrative must be attached on the attachments tab using the spreadsheet template provided. Proposals cannot be submitted without completing these required fields and attachments. Do not edit spreadsheet formulas and formatting without contacting Becky Jenison first (bjenison@blm.gov).

8. Task Statement Intent

Proposals that do not clearly and directly meet the intent of the task statement selected will not be reviewed or considered for funding. Please make sure you are submitting your proposal for the correct task statement.

9. Format

Proposals not following the required template(s) will not be considered. Proposals must use an 11 point font or larger. Additional guidance is included in the beginning of each template.

10. Page Limits

Attachments exceeding the page limit cannot be submitted. Page limits may vary by task statement and attachment; check the page limit in the template and JFSP database for each specific task statement. Everything in the template is included in the page limit.

11. Project Location

Project location fields must be completed on the location tab for a proposal to be successfully submitted. Instructions are listed on the project location tab.

12. Signatures

Handwritten signatures are not required. When Principal Investigators (PIs) submit proposals they will be prompted to input their password. By typing in the password and submitting a proposal, PIs are certifying that all contacts on the proposal have reviewed the proposal and understand what their role requires.

13. Indirect Costs

Proposals must follow JFSP indirect cost guidelines. (See Section III. B above)

14. Contributed Costs

See Section III. C above.

15. Support Letters

Support letters are required for this FON. For tasks 1-4 letters of support are sought from the observational science community and from management partners discussing the proposed Discipline Lead's experience and suitability to lead field campaigns.

For task 5 letters of support are sought from observational groups that have worked successfully to utilize or integrate their observations with the proposed Modeling Lead's models.

16. Past-Due Projects

No proposals will be considered if the work includes a PI or Co-PI who is a PI or Co-PI on a JFSP project that is past due as of the closing date of this announcement. See the JFSP website for the complete JFSP past-due and extension request policy.

SECTION V. APPLICATION REVIEW AND EVALUATION

Overview

Proposals will be reviewed in four stages: OK

1. JFSP Program Office – Administrative requirements and task statement intent
2. Peer Review – Relevancy, technical merit, products, and feasibility
3. Governing Board Review – Funding decisions
4. Statistical Review (optional) – Adequacy of study design and analysis methods

Note: All proposals are expected to be directly and clearly responsive to the task statement questions. Proposals that are not sufficiently responsive, as judged by the Joint Fire Science Program, will not be reviewed.

Review Criteria

Note: Review criteria are not arithmetically scored or weighted. However, applicants should note that the technical merit criterion is given particular attention. Proposals that do not receive strong technical merit reviews are unlikely to be funded.

Task statement responsiveness

- Does the proposal directly address the task statement?
- Are there significant elements of the proposal that are off-task?
- Will the intended results be useful to the development of the FASAMEE study plan?

Technical merit

- Does the proposal address scientifically important questions identified in the discipline and modeling tasks?

- Are objectives, questions and hypotheses clearly articulated?
- Can the questions or hypotheses be answered with the proposed design and analysis?
- Are the methods sufficiently rigorous to produce credible results?

Deliverables

- Are the deliverables and outcomes adequately described in the context of the FASMEE study plan?
- Is the scope and scale of deliverables sufficient to be meaningful for the FASMEE project?

Budget

- Is the requested budget reasonable and realistic for the scope and scale of the proposed work?
- Does the proposal budget contain substantial contributed costs?
- Does the budget narrative provide sufficient explanation and justification for the requested budget?

Feasibility

- Does the project team have the skills and qualifications to execute the proposed work?
- Is the proposed schedule reasonable and meet the FASMEE timeline?
- Have all likely barriers been identified and mitigated?
- Have managers, other scientists, and modelers been involved where appropriate?
- Is the probability of success high?

SECTION VI. DEFINITIONS

Funding Opportunity Notice (FON): The official label for the Joint Fire Science Program method of requesting project proposals. The FON includes task statements for which proposals are sought, instructions for proposal submission, and related information.

Principal Investigator (PI): The individual identified in a proposal who is the research lead for the project. This individual is responsible for coordinating all research related activities and will be the primary science contact for the project. In addition the PI is responsible for communicating and coordinating with Co-PIs and others on the research team. The PI is responsible to JFSP for completion of the project.

Funding Cooperator: The funding cooperator receives funds from JFSP and is responsible for distributing funds to other cooperators. A funding cooperator is only required if the PI is non-federal and a federal institution is requesting funding, or if the work is being completed through a private business, or requests international funding. The funding cooperator is responsible for coordinating with the PI, the Agreements contact, and the Budget contact on administrative activities for this project. The funding cooperator will be one of the primary contacts for the project and should stay informed and involved in project activities. If a federal agency is requesting funds the funding cooperator must be from the federal cooperating agency.

Budget Contact: Budget contact must be from the institution receiving funds from JFSP. This person is responsible for ensuring the budget details are correct prior to proposal being submitted and agrees to receive funds and facilitate the transfer of funds, if necessary. Budget contact must be from the institution receiving funds from JFSP. If a federal agency is requesting funds the Budget contact must be from the federal cooperating agency.

Agreements Contact: Person from institution receiving funds from JFSP that is responsible for facilitating the receipt of funds and the execution of any agreements or contracts necessary for a proposal if it is selected for funding. If a federal agency is requesting funds the Agreements contact must be from the federal cooperating agency.

Co-Principal Investigator (Co-PI): The individual(s) identified in a proposal who will work with the research lead on the project and makes a substantial contribution to the project. Co-PIs are responsible for communicating and coordinating with the PI.

Collaborator/Contributor: An individual that advises investigators, but is not involved at a level expected of a Co-Principal Investigator. For example, a collaborator may make recommendations on how best to involve fire and fuels managers in a project, or consult regarding the statistical design of a study. Individuals that serve as an author or co-author of a manuscript for a scientific journal are normally a Co-Principal Investigator.

Student Investigator (relevant to the GRIN announcement only): A current student with an approved dissertation or thesis plan responsible for leading and delivering the research proposed in a GRIN proposal.

Indirect Costs: Those costs used to pay for overhead/administrative costs attributable to a specific research project. Examples include the costs of operations and maintenance such as janitorial, phone, and clerical services. The Joint Fire Science Program recognizes two types of indirect costs: 1) "in-house" costs incurred by the agency, institution, or unit requesting funds; and 2) Pass-through costs are charged only by the PI institution or funding cooperator institution for administrative costs associated with managing sub-agreements.

Joint Fire Science Program Governing Board: An appointed 12-person Board representing the JFSP partnering agencies. The Board provides strategic direction and oversight to JFSP, identifies important research questions, selects proposals for funding, supervises the JFSP Program Manager, and conducts related business.

Science Exchange and Application: The exchange of information, materials, models and other research deliverables to end users, along with adequate information and training to apply the deliverables. Examples of active methods include workshops, training sessions, guided field tours, conferences, meetings, and symposia. Examples of passive methods include published papers and websites. A combination of active and passive methods is preferred. Collaboration with the JFSP Fire Exchange Network is recommended.

Task Statement: A specific area of interest identified in the FON, for which project applications are sought.

APPENDIX A. FASMEE SPECIFICATIONS

1. Introduction

The observational requirements specification details the measurements that should be taken as part of the FASMEE experimental burns within four main discipline areas: (1) fuels and consumption, (2) fire behavior, (3) meteorology and plume development, and (4) smoke emissions and chemistry.

The primary objective of the FASMEE project is to provide novel and critical observational data necessary to evaluate and advance fire and smoke modeling systems and their underlying scientific models from on-the-ground fuels characterization to fuel consumption, fire behavior, plume dynamics, dispersion and fire effects. The FASMEE field campaign will be conducted on two to four large operational prescribed burns in the southeastern and western United States, or potentially Canada. The research burns are expected to occur between 2018 and 2020.

This document will be used as an initial specification for ensuring a sufficient set of minimum measurements will be taken to assist in fire and smoke model evaluation and development and is designed to function in conjunction with the Joint Fire Science Program Funding Opportunity Notice FA-FON0016-0004 (http://www.firescience.gov).

Observational requirements for the FASMEE field campaign are primarily based on consultations with fire scientists, measurement experts, and practitioners. The measurements are designed as a minimum set required by the particular goals of FASMEE, with the additional goal of providing an opportunity for other programs to join to meet additional objectives, such as the long-range ageing of smoke plumes (e.g. FIREX), and the validation of operational satellite products (e.g. NASA ROSES). Specifications were also drawn from the:

- RxCadre Experiment (JFSP Project 11-2-1-11: Data Set for Fuels, Fire Behavior, Smoke and Fire Effects Model Development and Evaluation; Ottmar et al. 2014),
- JFSP Smoke and Emissions Modeling Intercomparison Project (JFSP #08-1-7-10; Larkin et al. 2014),
- Reno Smoke Modeling workshop (JFSP Project#13-S-01-01: Validating the Next Generation of Wildland Fire and Smoke Models for Operational and Research Use – A National Plan; Brown et al. 2014), and
- A special session, “Fire Behavior Models and Smoke” hosted by the Department of Defense SERDP\ESTCP program at the 2012 International Smoke Symposium in College Park, Maryland (Prichard and Ottmar 2013).

2.1 Fuel Characterization and Consumption

Pre-burn and post-burn measurements of fuel characteristics are necessary to estimate fuel consumption and are critical for fire and smoke modeling. Fuel consumption is the basic process that drives fire behavior and produces heat and smoke. Accounting for smoke generation and

heat release along with other fire effects such as carbon reallocation, tree mortality, and soil heating all depend on detailed measures of fuel consumption.

Wildland fuels can be characterized by traditional measurement methods such as line intercept (Brown 1974) and clip plots. There are also biometric equations, photo series, pile loading, photo load (Sikkink et al. 2009) and ground- and aerial-based LiDAR (Seielstad et al. 2011) techniques that can be used to characterize fuels. Additionally, satellites provide maps of remotely sensed variables that have been related to vegetation type and quantity, and are used to extrapolate plot measurements into fuels maps.

Coupled fire-atmosphere models with physics-based models of fire spread and plume dynamics require detailed, three-dimensional characterization of the physical properties and spatial distribution of the fuels. There is an increasing need for high-resolution gridded fuel mapping, which often rely on a combination of fine-scale ground sampling and remote sensing techniques. New measurement techniques and protocols are likely necessary to fully develop these observations.

Minimum observations types identified:

Purpose of observation	**Details**	**Potential measurement techniques**
Ground-based measurements to quantify fuel characteristics as inputs to operational and physics-based fire-atmosphere models.	- Pre- and post-fire fuel loading (Mg ha^{-1}) by fuelbed category including live and dead shrubs, grasses and other herbs, fine wood, large wood, litter, and duff - Fuel properties (i.e., bulk density, fuel moisture content, surface area to volume ratios, packing ratio, char fraction)	- Clip plots, line inventory for live and dead fuels by category - Destructive sampling of live and dead vegetation for fuel properties by size class
Additional ground-based measurements of fuel characteristics are necessary for interpretation and calibration of LiDAR and other remote sensing datasets.	- Canopy and surface vegetation cover (%) and height (m) - Litter and duff cover (%) and depth (cm) - Mineral soil exposure (%)	- Canopy cover: imagery and hemispherical photos - Canopy height: lasers / hypsometers. - Surface vegetation cover and height: plot estimates or line transects - Surface fuel and forest floor measurements (i.e., litter and duff): standard plot or line intercept sampling methods - Soil exposure: line inventory and forest pin plots

Purpose of observation	Details	Potential measurement techniques
Terrestrial and airborne LiDAR datasets to provide gridded 3D inputs to coupled fire-atmosphere models.	- Terrestrial and airborne LiDAR scans and interpretation for gridded fuels mapping	- Coordinated ground and airborne measurements may be necessary to represent canopy and surface fuels - Grid size dependent on planned size of burn (e.g., surface or crown fire)
Additional inputs required for fuel mapping may be taken from aerial photos and satellite imagery.	- Vegetation cover, status (L/D)	- Hyperspectral imagery, true-color aerial photographs, and satellite imagery may be used for species designations, status (live or dead) and canopy cover estimation
Fuel mapping to assign intrinsic fuel properties (i.e., particle size classes, bulk density, fuel moisture and surface area to volume ratios) to model spatially explicit fuels from interpreted LiDAR scans.	- Mapping will require a combination of fine-scale sampling of fuel properties, coarser scale LiDAR mapping and fuel modeling to assign fuel properties to gridded fuels data.	- Fine-scale sampling of fuel properties - Coarse-scale validation of mapping assignments
Spatially-explicit fuel consumption by combustion phase to estimate the source of emissions from flaming and smoldering combustion, which often occur simultaneously. Also used for fire effects model evaluation.	- Combustion by flaming, smoldering and long-duration (residual) smoldering - Measures of canopy consumption	- Combustion by phase can be estimated by the difference of pre- and post-burn fuels by fuel category, assuming high surface to volume ratio fuel categories (e.g. grass, leaves, fine wood) will consume during flaming stage and low surface to volume ratio fuels (e.g. logs, duff) will burn during smoldering phase - IR sensors can be calibrated to measure heat from flaming combustion - Measures of canopy consumption are uncommon and may require careful coordination of ground-based sampling and pre- and post-burn LiDAR interpretation

2.2 Fire Behavior and Energy

To support the application and advancement of operational fire behavior models as well as advanced coupled fire-atmosphere models, observations are needed of real-time fire behavior, heat release, and the complete fire energy balance across a variety of scales. Fire and wind interact at multiple scales, and coupled fire-atmosphere models attempt to resolve these interactions. Physics-based models of fire combustion, spread and plume development explicitly model the processes of the thermal degradation of vegetation, gas phase combustion and char oxidation, smoke generation and transport, terrain influence on the ambient wind, and the interaction of the fire and surrounding atmosphere through buoyancy induced turbulent mixing. Fundamental to this is the simulation of convective and radiative heat transfer. New measurement techniques are likely necessary to fully develop these observations.

Minimum observations types identified:

Purpose of observation	**Details**	**Potential measurement techniques**
Basic fire behavior	- Basic observation of the fire behavior throughout the burn	- Multi-spectral video (visible and infrared)
Basic fire spread and flame dimensions for evaluating operational fire behavior models and coupled fire-atmosphere models.	- Local fire rate of spread (m s^{-1}) - Flame dimensions: length (m), height (m)	- Continuous airborne video - Satellite imagery - Ground-based thermocouples and video can be used to calibrate timing of fire passage across sensors, for rate of spread estimates, flame residence time and fire depth
Gridded temperature fields over the duration of the fire event related to heat transfer, plume evolution and Dynamics.	- Gridded temperature field (K)	- Fire scene radiances with IR imagery coordinated with high-resolution video - Satellite imagery - Gridded network of ground sensors
Fire depth and flame residence time for heat release, plume evolution and fire effects.	- Time evolution of fire depth and progression over the entire perimeter (m) - Fireline intensity (kW/min) - Flame residence time (min)	- IR imagery - Continuous, high-resolution video over the duration of the fire event - Ground and tower-based thermocouple grids (likely requires new instrumentation) - Intensity can be derived from heat of combustion, fuel consumption and ROS

Purpose of observation	Details	Potential measurement techniques
Flaming consumption rate	- IR measurement of flaming consumption - Ground based consumption of fuels that burned in the flaming phase of combustion	- Flaming consumption can be measured directly using IR video with sensor calibrated to detect only flaming consumption
Mass loss rate	- Flaming consumption rate is the best approximation of mass loss rate - Fire depth and spread rate also can be used to approximate mass loss rate	- IR video with sensors calibrated to detect only flaming consumption - Novel measurement techniques may be required, including possibly burning of landing piles over scales - Coordination with laboratory measurements may be necessary for this measurement.
Heat flux, or heat release rate, over the duration of the fire, to evaluate coupled fire-atmosphere models. These measures can be used to characterize the fire line and intensity.	- Total incident flux (kW m^{-2}) or heat flux (kW m^{-3}) - Radiant incident heat flux (kW m^{-2}) - Convective flux (kW m^{-2}) - Flame radiative power (MW) - Nadir fire radiative power (MW)	May require novel techniques. - Tower-based thermal imagery can be used to measure the total incident energy and radiant incident heat flux emitted by the fire over space and time. Infrared sensors should cover the entire combustion range. Temporal frequency 1-10Hz. - Narrow angle radiometers on towers can be used to estimate energy emitted by flames in a specific direction - Several satellites (MODIS, VIIRS, GOES) measure FRP; burns could be coordinated with satellite overpass for this and other measures
Characterize convective heating flux around spreading flames	- Air temperature (°C) - Air velocity (m s^{-1})	- Temperature sensors - Fine-scale measurements to characterize horizontal and vertical air flow.
Soil heat flux (part of fire energy budget)	- Soil heat flux (kW m^{-2})	- In-ground thermocouple grids along a depth profile

Purpose of observation	**Details**	**Potential measurement techniques**
Fire heat budget	- Combustion efficiency (CO/CO_2) - Fire radiative flux density ($kW\ m^{-2}$) - Fire convective flux density ($kW\ m^{-2}$) - Soil heat flux ($kW\ m^{-2}$) - Fire latent heat flux density ($kW\ m^{-2}$)	- Measurements can be sampled as part of the Fire Heat Budget Package sensor array (mostly tower) - Soil heat flux sampled with thermocouple probe arrays coordinated with tower measurements - Fire radiative flux density co-measured via tower and aircraft
Measures of fire behavior during transition of surface to crown fire.	- Critical fireline intensity - Surface and canopy characteristics - Spatially explicit fire spread	IR camera observations could provide opportunities to assess transition fire
Ember transport close to the fire front.	- As a component of fire spread	May require novel techniques

2.3 Plume Development and Meteorology

Meteorological measures of ambient boundary conditions and fire-atmosphere interactions are critical elements of plume-rise models. In-situ monitoring is now possible with available technologies and offers promising advances in observations to evaluate and inform models of fire behavior and plume dynamics. Some key measurement needs include 1) measurement strategies for state variables and other quantities as they relate to plume dynamics and wind field monitoring (e.g. through dual or tri-Doppler LiDAR three-dimensional wind profiles), 2) mean flow and turbulence field analyses (e.g. through coupled LiDAR and in-situ towers), 3) fire behavior measurements at high temporal and spatial resolution simultaneous with measurements of fire-atmospheric interactions, 4) measurements of turbulent spectra associated with the interaction between the forest canopy and both the ambient and fire-driven wind field, and 5) plume entrainment. Additional meteorological measurements are also anticipated to support fire behavior modeling including measurements of in-canopy wind fields and upwind flow characterization. Measurements via manned and unmanned aircraft may be required to characterize the 3-dimensional plume.

Minimum observation types identified:

Purpose of observation	**Details**	**Potential measurement techniques**
Pre-burn and day-of burn weather profiles to establish boundary conditions.	- Pre-burn and day-of-burn weather - Temperature - Relative humidity - Ambient wind field - Pressure - Vegetation-mediated boundary conditions (subcanopy, above canopy)	- In-situ tower(s) to measure profiles (e.g., 2-, 10-, 20- and 32-m above ground level)
Wind fields for fire behavior and plume development model prediction and evaluation.	- 3-D winds - Turbulence - Effect of vegetation on wind field	- Gridded, tower and tripod sonic anemometers - Doppler wind LiDAR - SODAR upwind of burn block to establish boundary conditions
Plume heat and moisture fluxes for model evaluation and development.	- High resolution (spatial and temporal) wind, thermodynamic, and radiative heat fluxes	- In-situ tower and tripod - UAS - Remote sensing
Characterize plume structure and development over the duration of the burn to assist in model evaluation and	- Plume evolution (size and shape, temperature, wind and humidity profiles within and around the plume)	- High frequency, multi angle LiDAR to measure plume evolution - Ceilometer measurements

Purpose of observation	Details	Potential measurement techniques
development.		
Vertical profiles characterizing upwind and downwind meteorological structures.	- Temperature - Pressure - Water vapor content - Liquid water content - Wind speed and direction	- Radiosondes - Tethersondes - Profilers
Vertical profiles and near-surface measurements of nearby drainage basins, particularly at night, for characterizing inversions and settling.	- Temperature - Pressure - Water vapor content - Liquid water content - Wind speed and direction	- Radiosondes - Tethersondes - Profilers
Video	- Digital stills and video observing in the visible and IR wavelengths	- High-resolution cameras including potentially from UAS and aircraft

2.4 Smoke Emissions, Chemistry, and Transport

Smoke emissions measurements provide a quantitative characterization (quantity and chemical composition) of the gases and aerosol. Because smoke quickly evolves both chemically and physically, this is needed both close to the source (fresh smoke) and further downwind (as the smoke ages). Further ageing of the plume with its complex chemical evolution and interaction with other in-situ compounds occurs for hours and days downwind. While FASMEE focuses primarily on the early plume through neutral buoyancy and nearby, one goal is to collect detailed chemical and particulate characterizations that can match up with other efforts to examine the downwind ageing of the plume. Detailed precursor and chemical product measurements are needed in the near-field and at different downwind distances up to 20km from the fire in order to define emission rates of key precursors as well as provide a specific signature for any fast chemical processing of fresh emissions. Additionally FASMEE seeks to examine the issues surrounding non-lofted smoke (primarily smoldering emissions) and the nighttime settling of smoke in nearby drainage basins that pose particular issues to operational smoke management.

Minimum observations types identified:

Purpose of observation	**Details**	**Potential measurement techniques**
Characterization of smoke emissions at and near source.	- Speciation of both gases and particulates	- Towers - Mobile lab (GCMS) - Tethersonde - UAS packages - Beta attenuation or nephelometer particle sensors - Particle counters by size - Ozone sensors - Filter sampling - Canister samples
Characterization of non-lofted smoke emissions in nearby drainage basins for nighttime smoke issues.	- Speciation of gases and particulates - Meteorological profiles and wind measurements	
Downwind surface impacts	- Focus on NAAQS pollutants and related chemicals - Resolve overall spatial and temporal impact pattern	
Within plume concentration profiles of major pollutant species for evaluation of near-field smoke chemistry models.	- Vertically and horizontally resolved - Smoke plume injection height - Includes relevant meteorological variables - Minimum set of measurements: CO_2, CO, CH_4, NO, NO_2, NO_X, NO_Y, SO_2, O_3, black and brown carbon, particulates by size class - Characterization of aerosols	- Aircraft and UAS in-situ measurement packages - Remote sensing - Coordinated satellite measurements

Purpose of observation	Details	Potential measurement techniques
Smoke plume evolution for evaluation of smoke plume and dispersion modeling.	- Stereoscopic imagery - Visible - IR	- LIDAR - Ceilometers - Cameras
Vertical profiles and horizontal transects of meteorological variables at the fire source and downwind for evaluating wind fields used with smoke models.	- Meteorological state variables - Winds - Long- and shortwave radiative heat fluxes	- Airborne meteorological probe - Radiometers

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