Year 1 – Interim Progress Report

Development of decision products for spatial quantification of carbon emissions from wildfire for North America

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Introduction

Michigan Tech Research Institute (MTRI) has teamed with specialists at the USDA Forest Service Pacific Northwest Research Center's Fire and Environmental Research Applications (FERA) lab to provide information for mapping fire-derived carbon emissions by adapting existing Forest Service fire information products and tools using NASA data and products. This work extends previous research of Dr. French's reviewed at: http://fireconsumption.mtri.org/.

The Goal of the proposed project is: To provide improved information on carbon emissions from wildfire to users who manage carbon or model the carbon cycle. The objectives are:

1. To develop a prototype information system for disseminating and using improved, user-accessible spatial information products for modeling and estimating fire emissions across North America.
2. To develop improved products to estimate carbon emissions from North American fires, including fuels maps and fire consumption estimates, based on:
    a. NASA-sponsored science and NASA-derived datasets and models; and
    b. The adaptation of USFS-FERA information products and models.

Estimating fire emissions from ground-based data requires calculation from four parameters (Figure 1; French et al. 2004): area burned, fuel loading (biomass per unit area), fuel

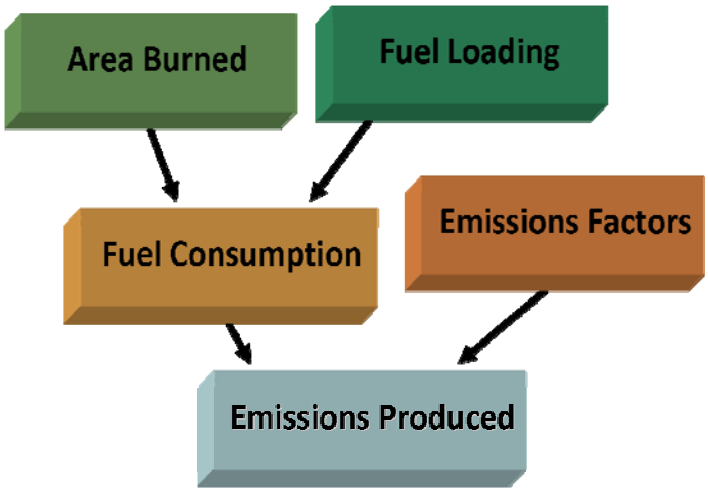

Figure 1. Factors used to estimate fire emissions.

consumption (fraction of biomass consumed), and emission factors (mass of a given chemical species emitted per mass of fuel/biomass consumed). The project planned will collect data for all of these factors so information users will have the latest and most accurate data for use in models and emissions estimations. The information will be provided at a 1 km spatial resolution and have relevance for understanding fire-affected carbon cycling at regional scales for the North American continent. Products and results will be consistent across international borders, although product reliability will inevitably vary due to availability of field

Progress in Year 1

The approach to achieving the proposed objectives was planned as five steps:

1. Coordination of user needs – *Obj. 1 & 2*
   (user advisory group meeting & surveys)
2. Building the information system – *Obj. 1*
3. Developing fire emission information products – *Obj. 2*
4. Testing the information system & emission products – *Obj. 1 & 2*
   (feedback from user advisory group)
5. Finalization of the prototype information system & products – *Obj. 1 & 2*

Steps 1-3 are underway and progressing; details are given below. Based on the planned project timeline provided in the final work plan, we are on or ahead of schedule for all of the tasks listed.

Coordination of User Needs

A user advisory group has been convened consisting of potential users of the system to help develop products and the information system. The targeted users for this project are carbon managers, who need to understand the ramifications of fire on the carbon pools they manage, and carbon modelers, who have built or are building systems to quantify and track carbon as it moves through the Earth system, particularly the North American Carbon cycle. Secondary users include representatives of management and regulatory groups who have requirements to quantify emissions of pollutants and other atmospheric constituents of interest.

User advisory group members have been identified (Table 1) and have been involved in the initial survey and a user advisory group meeting held in Ann Arbor in November of 2009. The final agenda of the meeting and a list of meeting participants are given in Appendix 1; additional meeting materials are archived at our internal planning wiki-based web site: http://wiki.mtri.org/display/WFEISadv/Home. Following these preliminary activities, the advisors will be called-upon to assess the information system periodically (remotely) to give feedback. A final review of the system will take place in the middle of year 3 of the project to allow final inputs of the advisors to be included in the final project deliverables.

Table 1. Members of the user advisory group (*attended the November, 2009 meeting).

Name	Affiliation	Relevant expertise	User need category
Beatriz Cardenas	National Inst. of Ecology, Mexico	Environmental management	Emissions inventory
Erik Christiansen	FWS; National fuels committee	Fire management	Carbon management (Fire/emissions)
Katharine Hetts*	USFS Unita and Wasatch-Cache NF	Fire management specialist	Carbon management (Fire/emissions)
Richard Honrath*	Michigan Tech. University	Atmospheric science	Quantifying atmospheric C source
Ed Hyer	Naval Research Lab	Emissions modeling (FLAMBE)	Carbon modeling; Quantifying atmospheric C source
Randi Jandt or alternate	BLM - Alaska	Fire ecologist	Carbon management (Fire/emissions)
David Lavoue*	Environment Canada	Emissions modeling	Emissions modeling; Carbon modeling
Eric Kasischke*	Univ. of Maryland	Fire/carbon research-Project collaborator	Carbon modeling
Jennifer Logan*	Harvard University	Atmospheric science	Quantifying atmospheric C source
Wouter Peters*	NOAA/ESRL	Emissions modeling (Carbon Tracker)	Carbon modeling
George Pouliot*	US EPA	Environmental management	Emissions inventory; Carbon modeling
Amber Soja*	National Inst. of Aerospace	Emissions modeling	Emissions inventory; Quantifying atmospheric C source

Objective 1: Development of a prototype information system

MTRI is in the process of developing an on-line geospatial information system that pulls together fire location data with corresponding fuel consumption and fuel loading data layers for fuel emission modeling. The geospatial data system will be built from open-source software components that work with open international standards developed by the Open Geospatial Consortium (OGC) such as Web Mapping Service (WMS),Web Feature Service (WFS), and the Keyhole Markup language (OGC KML) in order to facilitate future enhancements to the system. The system is named the *Wildland Fire Emissions Information System* (WFEIS).

The November User Advisor Group meeting helped set some of the system characteristics, including questions about available fire location datasets and desired output protocols, file formats, temporal resolution, and spatial resolution. The meeting also allowed for defining the

criteria on how users would like to be able to filter the dataset to their needs, such as filtering on an areas-of-interest, fire name/ID, of values exceeding a specified threshold.

The information system is being developed using open-source software components. The core application is the GeoDjango web framework, which queries data stored in a spatially-enabled relational database (PostGIS), processes the geospatial data, and provides output in a wide variety of output formats for client tools (Fig 2). The GeoDjango framework is python based, which allows for running external scientific models, such as the Consume emissions model.

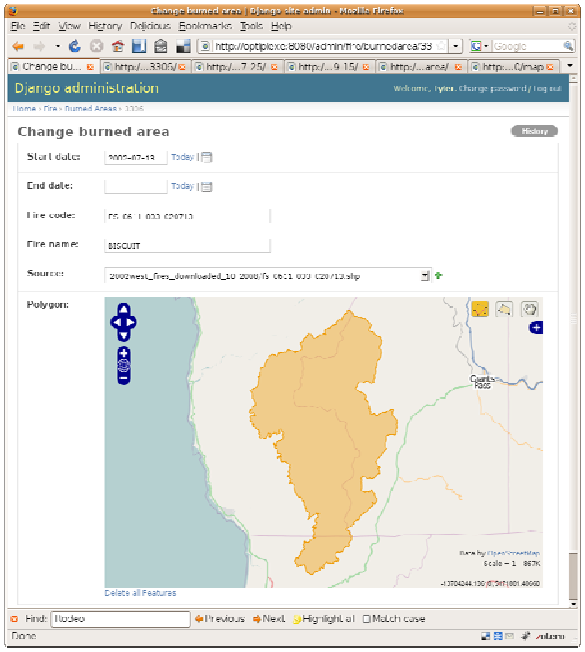

Figure 2. Example screen of the WFEIS.

The initial roll-out of the WFEIS is planned for the first half of 2009. The initial version will cover just the conterminous US (and possibly Alaska), so the system can be reviewed by our Canadian partners. The final version of the WFEIS will be a North America-wide system to access emissions data products that will be consistent across international borders.

Objective 2: Development of fire emissions products

The information system will provide access to data representing all four of the data layers needed for estimating fire emissions (see Figure 1). Information products will be provided as GIS-based and tabular products at a 1-km cell-size covering North America, including Alaska, Canada, the conterminous United States, and Mexico. US model-based emissions products will be provided for the US and Canadian model-based estimates for Canada. Estimates for Mexico will likely be derived using Mexican fuels data in conjunction with US-developed emissions modeling.

During the November User Advisory meeting and the November meeting with the Canadian Forest Service (CFS), several characteristics of the planned data products were refined. Progress has been made in development of data sets that were not available before the project started. Specific details follow.

Fire perimeter maps:

Several fire perimeter data sets have been identified to be used in the WFEIS. Historic fire maps exist for much of the region with varying level of completeness. Current fire perimeter maps derived from MODIS fire products are desirable because they contain information on fire timing. A list of fire products being investigated for the WFEIS is given in Attachment 2. The three primary burn area datasets currently being considered for use in the information system are NASA's MODIS 500m Monthly Burned Area Product, Louis Giglio's Direct Readout MODIS 500m product, the Monitoring Trends in Burn Severity (MTBS) burn severity vector perimeters, and the arechived fire perimeter data held in the Alaska and Canada Large Fire Databases (LFDB).

NASA's MODIS Level 3 Monthly Tiled 500m Burned Area Product (MCD45A1) is a grid product that provides the Julian day of burning and pixel quality information for areas detected by MODIS (Moderate Resolution Imaging Spectroradiometer) TERRA and AQUA satellites. Fires are detected via an algorithm that utilizes a bi-directional reflectance (BRDF) model-based approach to target rapid reflectance changes in a time-series. The product is produced for global land surfaces and is available from year 2000/2002 (TERRA/AQUA) to present. It is available for download from the University of Maryland FTP server (see Roy et al. 2008).

Like NASA's MCD45A1, Louis Giglio's Direct Readout MODIS product provides the Julian day of burning and covers global land surfaces. However, Giglio uses a modified the algorithm that uses Vegetation Index (VI) time-series instead of BRDF. Additionally, the algorithm takes advantage of MODIS active fire data to develop conditional probability density functions from which prior burn probabilities can be assigned. The algorithm is intended to be more accurate, less computationally demanding, and is to be available at shorter time intervals than NASA's MODIS product (Giglio, 2006; Giglio, in review).

Monitoring Trends in Burn Severity(MTBS) is an interagency effort between the USDA Forest Service Remote Sensing Applications Center (RSAC) and the US Geological Survey National Center for Earth Resources Observation and Science (EROS) to map burn severity across the U.S. From 1984 to present. Burn severity (dNBR or Differenced Normalized Burn Ratio) is a remote sensing change detection technique utilizing the two Landsat TM/ETM+ bands most responsive to fire-induced environmental change. The perimeter polygons that are derived from these burn severity measurements will be processed to remove unburned areas within the outer perimeters for use in the information system. This data provides a higher resolution (30m) alternative to the MODIS data, although it is available on a two year delay and will not contain all fires due to limited coverage of the Landsat sensor. See http://mtbs.gov for more information.

The Canada large Fire Database and an equivilent database of historic fire perimeters for Alaska is available covering northern regions of North America form pre-satellite era (1950's to the present for Alaska, and 1920's to 2006 for Canada). These databases represetn most fires of size for the era, but have limited inforamtion on fire timing (Stocks et al. 1989; Kasischke et al. 2002). Fires in Canada after 2006 are mapped by the CFS and Provincial Governments; these records may be available to this project in the future.

Fuels maps:

We are improving the Fuel Characterization and Classification (FCCS) fuelbed descriptions and maps for the US (Co-Is McKenzie and Ottmar). The fuelbed database and GIS layer for the American West have been upgraded using the LANDFIRE vegetation layers; a similar upgrade for the East is underway. Over the next year, we will also extend this to Alaska. Fuelbeds are currently being developed for Mexico (Co-I Alvarado), using inventory data from both northern Mexico and the tropical regions, combined with a vegetation classification provided by the Mexican Forest Service. All new fuelbeds (descriptions of fuels) are created based on the procedure developed by the US Forest Service (McKenzie et al. 2007; Ottmar et al. 2007).

Our original goal was to include an FCCS data layer for Canada in the WFEIS, but in our meetings with partners in the Canadian Forest Service (CFS), we concluded that the fire emissions prepared for the WFEIS over Canada will be derived using the procedures employed by the Canadian Forest Service's Forest Carbon Accounting Program, which accounts for fire disturbance in estimating total carbon budgets for Canada (see http://carbon.cfs.nrcan.gc.ca/

index_e.html). This decision means using a fuels map created using Canada-specific protocols rather than one based on FCCS, and that a full map of FCCS fuelbeds across Canada will not be developed in the course of this project. The CFS, however, is interested in learning how the FCCS fuelbed system may help improve on their current method of describing fuels, so we are working on developing a limited set of FCCS fuelbeds for Canada and comparing them to the Canadian fuels map with respect to consumption and emissions.

Fuel consumption modeling:

Two fuel consumption/fire emissions models will be employed for the WFEIS, the CONSUME 3.0 model developed by the US Forest Service (Co-I Ottmar) and BORFIRE, developed by the CFS (Co-I de Groot). Fuel consumption will be estimated by employing the CONSUME 3.0 fuel consumption model in the US and Mexico, which works from estimated fuel loads mapped from FCCS fuel bed descriptions. From the meeting in Victoria, BC and during a subsequent technical meeting with the CFS, it was decided that fire emissions will be estimated with the Canadian Forest Service's BORFIRE model for Canada (de Groot et al. 2007). Fuel consumption (and emissions) is strongly driven by the moisture conditions of the fuel at the time of the fire. We will be exploring a variety of options for assigning fuel moisture conditions for implementation within the WFEIS. One possible option is to model a set of scenarios (dry, moderate, wet) to provide to the WFEIS user. Another is to include weather-based estimates of fuel moisture based on the timing (day) of the fire event, similar to the method used to derive BORFIRE-based emissions in Canada.

Since two models will be employed to estimate emissions, and consistency of data across North America was one of the goals of this project, we have started conducting an analysis using the CONSUME 3.0 and BORFIRE fire emissions models within the same fuel types. The two models use the same basic approach to consumption and emissions modeling, so it is expected that the results from the two models will be comparable. Variations in fuel load and moisture are being tested using both models at sites with the same fuel type and fire size to estimate fire emissions using each model. By varying input data, we are assessing how the two models compare. Differences will then be considered and models modified, if needed.

Emissions factors:

Development of new emissions factors is not part of this project. Emissions factors (information to partition total carbon into specific emissions gases and aerosols) are available and are used in the CONSUME 3.0 emissions model (Attachment 3). These are inconsistently reported in the literature, so the WFEIS will provide access to these data in a consistent format and will employ them in final emissions outputs. The BORFIRE model will adopt these emissions factors to model a set of trace gases for the WFEIS.

Project administration and coordination

Year 1 Project meetings and workshops:

December 2007 – Pre-award meeting of all PI's and Co-I's to discuss general plans for project – San Francisco, CA as a side meeting to the AGU Fall'07 Meeting.

April 2008 – Informal kickoff meeting joint with Kasischke NASA-CCE project ("Impacts of fire and disturbance on Carbon Cycling in Western North America") – College Park, MD as a side meeting to the NASA-CCE meeting.

November 2008 – User Advisor Group meeting (Attachment 1) – MTRI, Ann Arbor, MI.

November 2008 – Joint meeting of French & Kasischke NASA-CCS projects – Canadian Forest Service, Victoria, BC (Attachment 4).

Project web sites:

Three web sites, which operate as wiki-based interactive sites, have been created for the project. At this time all are password protected. One "public" site will be put in place soon to provide a report-out on progress.

Fire Emissions Project wiki
URL: http://wiki.mtri.org/display/FIRE/Home
Audience: Internal project members (password protected)
Purpose: internal development content

WFEIS Advisory Group
URL: http://wiki.mtri.org/display/WFEISadv/Home
Audience: WFEIS Advisory Group (password protected)
Purpose: enables sharing of content with the advisory group WFEIS Users

WFEIS Web site (not yet on-line)
URL: http://wiki.mtri.org/display/WFEIS/Home
Audience: Users of the WFEIS
Purpose: public-facing website that describes WFEIS

References

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North America Wildland Fire Emissions Information System User Advisor Group Meeting

Wednesday-Thursday, November 5-6, 2008 Michigan Tech Research Institute Ann Arbor, Michigan

FINAL AGENDA

(meeting as conducted with approximate times)

Wednesday, Nov 5th

8:45 – 9:00	**Arrive**
9:00 – 9:15	Welcome & overview of meeting agenda and goals – N. French
9:15 – 9:45	Introductions – Participation by group members
9:45 – 10:15	Review of project goals, fire emissions modeling, & information system expectations – N. French
10:15 – 10:45	**Break**
10:45 – 11:15	Continue review of project goals, fire emissions modeling, & information system expectations – N. French
11:15 – 11:45	Review of user advisor group survey & user needs – N. French & participation by group members
11:45 – 1:00	**Lunch – At Holiday Inn; Laura Bourgeau-Chavez, Guest Speaker**
	"Utility of Satellite Imaging Radar for Assessment of Post-Fire Conditions in Alaskan Boreal Forests"
1:15 – 1:45	Continue review of user advisor group survey & user needs – N. French & participation by group members
1:45 – 2:30	Improvements in fuelbeds: FCCS description & mapping – D. McKenzie
2:30 – 3:00	Research for improved fuel consumption & emissions – E. Kasischke
3:00 – 3:15	**Break**
3:15 – 4:15	Fuel consumption: CONSUME 3.0 – D. McKenzie & N. French
4:15 – 5:00	Review of WF-EIS incl. review of initial data inputs – T. Erickson
6:30	**Meet for dinner at Gandy Dancer**

Thursday November 6th

8:45 – 9:00	Review of Wednesday meeting activities and Friday goals – N. French
9:00 – 9:15	Filling out and submitting travel reimbursement forms – M. Wienert
9:15 – 10:30	Continuation of WFEIS demonstration – T. Erickson
10:30 – 10:45	**Break**
10:45 – 12:00	Discussion of changes/improvementsto WFEIS – T. Erickson & All
12:00 – 1:00	**Lunch break**
1:00 – 2:30	Questions/discussion regarding input data plans – N. French & All
2:30 – 3:00	Meeting wrap-up

Meeting Participants

Katharine Hetts
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Project Team Participants

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Don McKenzie, FERA
Tyler Erickson, MTRI
Mike Billmire, MTRI
Michelle Wienert, MTRI
Eric Kasischke, UMd (serving as Advisor group member)

Appendix 2

Burn perimeter data sets available

Product Name	Satellite Source	Reso-lution	Format	Spatial Coverage	Temporal Coverage	Temporal Frequency	Availability	Notes
MODIS Level 3 Monthly Tiled 500m Burned Area Product	MODIS	500m	grid,HDF	global	2000 - present	monthly	U Maryland FTP server	Quality untested
MODIS Level 3 8-Day Composite Fire Product	MODIS	1km	grid, HDF	global	2000 - present	weekly	WIST	Good quality
Direct Broadcast, Louis Giglio's product	MODIS	500m	grid, ENVI	global	2004 - present	on request	via personal correspondence	Stable, good quality
Hazard Mapping System, NOAA	MODIS/AVHRR/GOES	NA	vector, point	NA	8-2003 - present	daily	HMS Viewer	Emphasis on real-time data vs. scientific quality
SMARTFIRE	HMS data, 209 reports	Na	txt, lat-long	NA	1-2008 - present	daily	BlueSky Gateway	Like HMS, emphasis is more on management need
Global Fire Product 1996-1999	AVHRR LAC	1km	grid,???	global	1996 - 1999	10-day comp.	DVD request page	
Global Burnt Surfaces 1982-1999	AVHRR GAC	8km	grid,???	global	1982 - 1999	daily	GBS Download Request Form	Based on course res
Monitoring Trends in Burn Severity fire perimeters	Landsat	30m	vector, polygon	US	1984 - present	annual	MTBS Data Access	USGS product; not all fires covered
Alaska & Canada Large Fire Databases (LFDB)	State/provincial/Federal records	variable	Vector, polygon	Alaska, Canada	Can: 1980 - 2006 AK: 1950 - present	annual	Alaska updates avail on public web site annually in Oct.	Best archive fire data avail for north Canada no longer avail

Appendix 3

Emissions factors used in Consume

Emissions Factors by Pollutant (lb/ton)

Fuel Type	Combustion	PM	PM10[b]	PM2.5	CO	CO2	CH4	NMHC
Default	Flaming	23	15	13	90	2522	3	5
(Average of all	Smoldering	34	24	19	209	2285	11	10
factors)	Residual	34	24	19	209	2285	11	10
BROADCAST-BURNED SLASH (Ward et al. 1989)								
Douglas-fir/hemlock	Flaming	24.7	16.6	14.9	143	3385	4.6	4.2
(n=12)	Smoldering	35	27.6	26.1	463	2804	15.2	8.4
	Residual	35	27.6	26.1	463	2804	15.2	8.4
Hardwoods	Flaming	23	14	12.2	92	3389	4.4	5.2
(n=8)	Smoldering	38	25.9	23.4	366	2851	19.6	14
	Residual	38	25.9	23.4	366	2851	19.6	14
Ponderosa & lodgepole pine	Flaming	18.8	11.5	10	89	3401	3	3.6
(n=3)	Smoldering	48.6	36.7	34.2	285	2971	14.6	9.6
	Residual	48.6	36.7	34.2	285	2971	14.6	9.6
Mixed conifer	Flaming	22	11.7	9.6	53	3458	3	3.2
(n=3)	Smoldering	33.6	25.3	23.6	273	3023	17.6	13.2
	Residual	33.6	25.3	23.6	273	3023	17.6	13.2
Juniper	Flaming	21.9	15.3	13.9	82	3401	3.9	5.5
(n=6)	Smoldering	35.1	25.8	23.8	250	3050	20.5	15.5
	Residual	35.1	25.8	23.8	250	3050	20.5	15.5
BROADCAST-BURNED BRUSH (Hardy et al. 1998)								
Sagebrush	Flaming	45	31.8	29.1	155	3197	7.4	6.8
(n=4)	Smoldering	45.3	29.6	26.4	212	3118	12.4	14.5
	Residual	45.3	29.6	26.4	212	3118	12.4	14.5
Chaparral	Flaming	31.6	16.5	13.5	119	3326	3.4	17.2
(n=9)	Smoldering	40	24.7	21.6	197	3144	9	30.6
	Residual	40	24.7	21.6	197	3144	9	30.6
NEW EMISSIONS FACTORS (S. Baker personal communication, Missoula Fire Laboratory)								
Western Pine	Flaming	na	na	13.82	81.65	1663.32	2.89	2.77
(n=53, n=57)[c]	Smoldering	na	na	14.43	141.47	1551.59	6.25	3.77
	Residual	na	na	14.43	141.47	1551.59	6.25	3.77
Minnesota Oak	Flaming	na	na	10.02	61.19	1709.21	1.66	1.92
(n=7)	Smoldering	na	na	10.45	109.06	1609.45	6.64	3.75
	Residual	na	na	10.45	109.06	1609.45	6.64	3.75
Minnesota Pine	Flaming	na	na	11.71	64.62	1694.33	2.03	2.03
(n=4, n=5)[c]	Smoldering	na	na	13.44	90.77	1644.78	3.09	2.61
	Residual	na	na	13.44	90.77	1644.78	3.09	2.61
Southern Pine	Flaming	na	na	11.44	72.79	1680.72	2.04	2.48
(n=77, n=78)[c]	Smoldering	na	na	9.91	119.34	1601.54	3.76	4.04
	Residual	na	na	9.91	119.34	1601.54	3.76	4.04
Sage	Flaming	na	na	12.92	126.35	1589.82	3.12	4.35
(n=8)	Smoldering	na	na	8.36	184.22	1452.55	11.92	14.28
	Residual	na	na	8.36	184.22	1452.55	11.92	14.28
Minnesota Grass	Flaming	na	na	12.18	61.35	1698.00	2.12	3.82
(n=16, n=7)[c]	Smoldering	na	na	10.75	109.37	1629.92	4.32	4.25
	Residual	na	na	10.75	109.37	1629.92	4.32	4.25
Arizona Piles	Flaming	na	na	7.74	52.66	1714.61	3.28	3.56
(n=49, n=27)[c]	Smoldering	na	na	21.05	130.37	1544.93	11.03	6.78
	Residual	na	na	21.05	130.37	1544.93	11.03	6.78

[a] Fire-average values are weighed-averages based on measured carbon flux.
[b] PM10 values are calculated, not measured, and are derived from known size-class distributions of particulates using PM and PM2.5.
[c] Flaming and smoldering sample sizes, respectively

Attachment 4

Workshop – Impacts of fire and disturbance on Carbon Cycling in Western North America
Canadian Forest Service, Victoria, BC
20-21 November 2008

Thursday, 20 November
9:00 Meeting Overview, Introduction of Participants

9:20: Session 1: Review of Ongoing Projects (15 minutes each)

1. Impacts of Insects on the Canadian Forest Carbon Budget – Werner Kurz and colleagues
2. Mapping and monitoring of disturbances using satellite imagery – Ron Hall
3. Canadian Wildfire Information System – Bill deGroot
4. PEATFIRE – Impacts of fire on peatlands – Merritt Turetsky, Mike Flannigan, Mike Waddington
5. Impacts of Fire on Organic Soils and Ground-Layer Temperature and Moisture – Jennifer Harden

10:45 Coffee Break

11:15 Session 1: Continued

6. Mapping of deforestation
7. Assessing the impacts of fire severity on post-fire regeneration and carbon cycling – Kirsten Barrett and Eric Kasischke
8. Modeling of the impacts of disturbance and climate change on boreal ecosystems – Dave McGuire et al. (Dan Hayes, new post doc)
9. Mapping fuel characteristics and fuel consumption in US forests – Don McKenzie and Roger Ottmar

12:15 Catered Working Lunch: Complete Session 1

10. Developing of system for estimating emissions from NA wildland fires – Nancy French
11. Analyzing the Characteristics of the Alaskan Fire Regime - Kasischke et al. (Elizabeth Hoy and Tatiana Loboda)

1:15 Session 2: Direct, short-term impacts of fire on carbon cycling (estimating fuel consumption and emissions) – Leaders: N. French and B. de Groot

3:00 Break

3:15 Session 3: Indirect, longer term impacts of fire on carbon cycling – Leader: E. Kasischke and B. de Groot

5:00 Adjourn

6:30 Dinner (venue TBD)

Attachment 4

Friday, 21 November

9:00 Session 4: Impacts of insects on carbon cycling – Leader: W. Kurz and T. Loboda

10:45 Coffee Break

11:15 Session 5: Impacts of forest management on carbon cycling (part 1) - Leader: D. McGuire and W. Kurz

12:15 Catered Lunch

1:15 Session 5: Impacts of forest management on carbon cycling (part 2)

2:00 Discussion and Summary of Meeting Results
Areas of collaboration
Action Items

3:00 Adjourn

Process to be used for Sessions 2 to 5

Each session will have two leaders (the first person is the primary leader and the second is the assistant leader). Prior to the meeting, the primary leader will request that each participant provide information/slides in the following categories for each session:

a. Summary of models currently being used by members of the working group
b. Spatial data sets currently used in these models
c. Spatial data sets not being used but available (especially from remote sensing)
d. Availability of field observations and data to improve modeling

The primary leader will collate this information and then present it in the session, allow the participants to discuss the material.

Based on these discussions, the meeting participants will then:

a. Identify areas of collaborative research between ongoing projects
b. Discuss the steps needed to implement such collaborations
c. Develop action items required for implementation of collaborations

As participants in the workshop, we are asking you to provide information that you have to the leaders of the sessions for which your information is pertinent.