

REMOTE SENSING SUPPORT FOR THE NORTHERN ROCKIES MAC GROUP – 2003 FIRES

MAC Remote Sensing Group

Colin C. Hardy

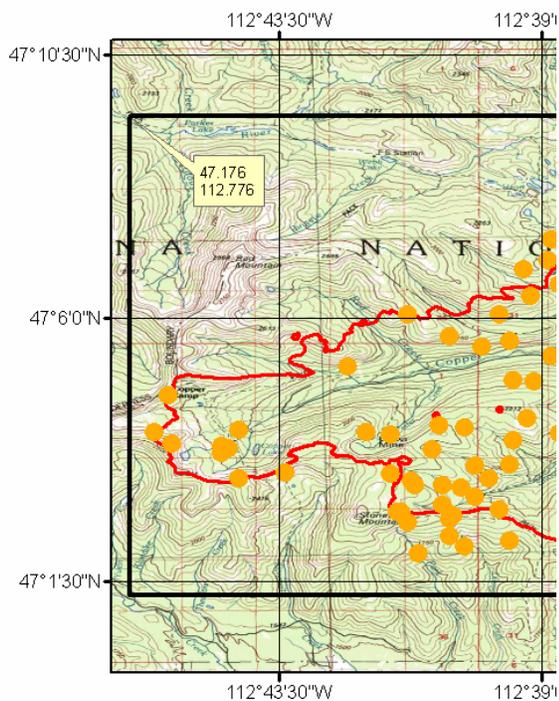
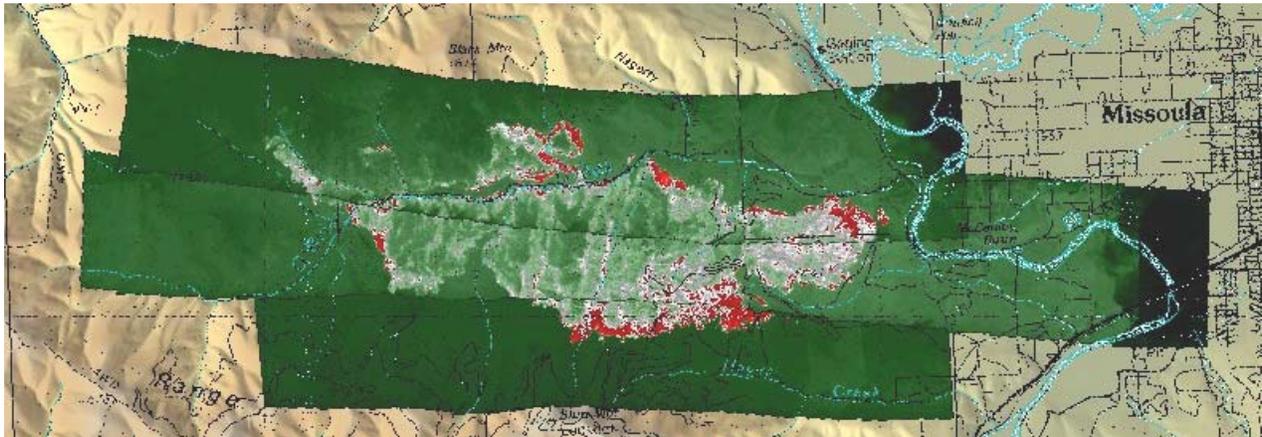
USDA Forest Service, Missoula Fire Sciences Laboratory

Lloyd P. Queen

University of Montana, National Center for Landscape Fire Analysis

Final Report to MAC

Submitted to Bill Adams--September 11, 2003



Executive Summary

This final documentation package was prepared on request from Bill Adams, Northern Rockies 2003 MAC Group. It includes all relevant data forms, organizational charts, descriptions of data and processing flows, and summaries of all components of the Thermal Infrared Remote Sensing Group's activities in support of MAC. The documentation is organized into individual *Exhibits*, and each lettered *Exhibit* is listed on the *Contents* page following this summary. An overall summary of activities is provided in the form of a briefing paper prepared for an August 29 visit to the Northern Rockies by USDA Forest Service Chief Dale Bosworth (*Exhibit A*).

The Remote Sensing Team was one of five formal Teams assembled at the Missoula Fire Sciences Laboratory in response to the MAC request for intelligence and projections on all large fires in the Northern Rockies (*Exhibit C*). The Team efforts were coordinated and fully integrated with MAC GIS staff (Ann Rys-Sikora), the 14th and Catlin IRIN pod and GIS technicians (Don Patterson), the MAC Group, Area Commands, and even individual incidents. Our success was due in large part to a strong, effective collaboration between the federal partners and the University of Montana's National Center for Landscape Fire Analysis (LLoyd P. Queen, PhD. — Director).

The Team's objectives were to: 1. Support the mission and objectives of the MAC Group; 2. Develop an efficient processing stream to derive a variety of thermal image-map products; 3. Document the practices and procedures developed to manage the deployment of technologies; 4. Develop a documented record of data flows and data management; and 5. Explore the fusion of ground, airborne, and satellite thermal data (*Exhibit D*).

During the period August 16 – August 30, we tasked 52 incident-specific missions to acquire thermal infrared imagery over 23 separate incidents in the Northern Rockies (*Exhibit K*). Imagery from all successful missions were processed and posted on a Northern Rockies ftp site for use by the other MAC Support Teams (*Exhibits B, E*). During each daily operations cycle (*Exhibits E, F*), each mission was tasked with explicit flight boxes (*Exhibits G, H, I*), the flight crew was briefed (*Exhibit J*), and the status of mission data were logged throughout the work flow (*Exhibit K*). We are currently developing a JAVA-based database both to archive the current data and to be used in future efforts (*Exhibit L*).

Any questions or comments should be directed to:

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Fire Season 2003

Fire Sciences Laboratory Support to Northern Rockies MAC

Chief's Briefing

August 29th, 2003

Intense lightning storms the week of August 4th ignited hundreds of fires in the Northern Rocky Mountains. By Monday August 11th it was apparent that a major fire emergency was developing throughout the Region. Rodd Richardson, Northern Regional Fire Director, requested that the Missoula Fire Sciences Laboratory (Fire Lab) provide fire intelligence and conduct a long range assessment of potential fire behavior and effects. National Fire Plan funded research prior to the 2003 fire season positioned Fire Lab scientists and technicians to immediately respond. We identified and collected the necessary data and models. By Thursday August 14th the level of fire suppression operations in the Northern Rockies had increased to the point that all management activities were centralized under a Multi-Agency Coordination (MAC) Group. MAC was responsible for over eighty large fires (>100 acres), and was operating out of the Northern Region Coordinating Center adjacent to the Fire Lab. The MAC group identified a primary, short-term objective: model and evaluate potential spread and impacts of all fires in the Northern Rockies under a suite of weather scenarios. A suite of new data were required to fulfill this objective:

1. **Fuels** - A fuel layer derived from recent Thematic Mapper (TM) satellite scenes;
2. **Values at Risk** - Resource and risk data (e.g. power-grid, communities);
3. **Weather** - Both archived weather data and modeled wind flows;
4. **Fire Intelligence** - Incident intelligence data such as field observations and perimeters data acquired daily by satellite and airborne thermal infrared systems.

To fulfill these needs, we formed a cadre of experts from the Fire Lab, the University of Montana's National Center for Landscape Fire Analysis (NCLFA), and Systems for Environmental Management (SEM). The cadre functions in five distinct Teams, organized per the table below.

The Fuel and Resources Team used recent satellite data and field data provided by Forest Inventory and Analysis (FIA) staff assigned to the Fire Lab to map over 70 million acres of fuels in less than a week. All necessary vegetation, fuels, and resource data have been provided by the Fuel and Resources Team to the FARSITE Team. Real-time MODIS data from NASA's Terra and Aqua satellites played a key role, providing perimeter estimates in the absence of other data. The Wind Flow Modeling Team simulated numerous wind scenarios on all of the major incidents. Two Remote Automatic Weather stations were deployed and are providing real-time weather data to incidents. The Airborne Remote Sensing Team has tasked, flown, and processed 39 missions, supporting the MAC group, five Area Commands, and 25 incidents. Personal visits were made to two Area Commands, five incidents, one Forest Supervisor's Office, and one District. At least six broad-scale (regional) FARSITE model scenarios were provided to the MAC Group. These data products are critical to MAC Group prioritization of

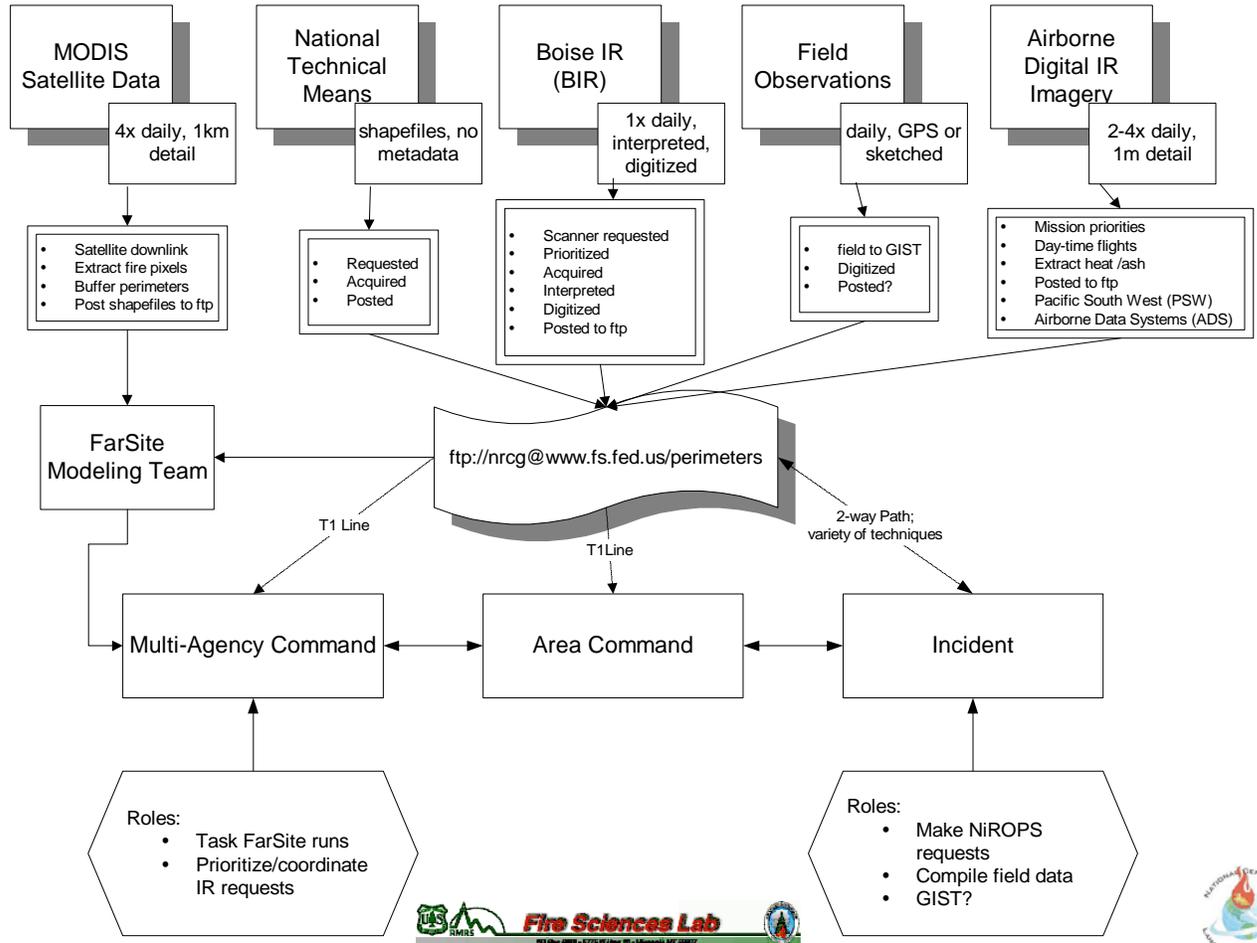
resources. More than 25 FARSITE runs were provided to individual incidents, including consultations.

MAC Support Team	Team Function
Fuel & Resources	<ul style="list-style-type: none"> ▪ Create fuels information from satellite and FIA data ▪ Acquire and map values at risk ▪ Build FARSITE fuel layers.
MODIS Satellite	<ul style="list-style-type: none"> ▪ Download and process MODIS fire detects; identify new starts and build fire perimeters.
Airborne Remote Sensing	<ul style="list-style-type: none"> ▪ Administer and task IR providers. ▪ Process imagery: derive fire perimeters and heat polygons; post data and maps to ftp site.
Wind Flow Modeling	<ul style="list-style-type: none"> ▪ Model wind flows in complex terrain using computational fluid dynamics model.
FARSITE Modeling	<ul style="list-style-type: none"> ▪ Construct weather data and develop synthetic weather scenarios. ▪ Model fire spread under synthetic scenarios. ▪ FARSITE modeling for incidents

Additional Fire lab personnel have supported the 2003 Fire Season:

- **Smoke** - During 14 consecutive days of air alerts, aerosol specialists from the Fire Chemistry Project worked with the Northern Region and others to monitor the degradation of air quality due to the dense smoke in the Region. Air quality monitoring stations that provide on-line PM2.5 concentrations have been set up in the most severely impacted areas. Scientists established an air quality monitoring station near the Black Mountain 2 fire camp to provide air quality information for the camp personnel.
- **Initial Attack** - Fire Lab personnel conducting fuels research at the Tenderfoot Experimental Forest, Lewis and Clark National Forest, took initial attack action, controlled, and mopped a tenth-acre lightning fire.
- **Fire Suppression** – Ed Mathews, of the Fire Effects Project was assigned to the Blacks Mountain 2 Fire west of Missoula where his local knowledge and experience (former Type 1 Fire Behavior Analyst, Type II Incident Commander) aided the California Incident Command Team (ICT). Ed worked as an FBAN and Field Observer, and led a strike team into O’Brien Creek to conduct a burn out to protect homes during the 6,000 acre run on Saturday, August 16th.
- **Fire Management** - Wayne Cook, Fire Use Team Leader has had an active summer managing several fire use fires in western states.

GEOSPATIAL DATA FLOWS
August, 2003



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MAC Support Team	Team Function	Team Leader and Staff Composition
Fuel & Resources	<ul style="list-style-type: none"> ▪ Derive veg. and fuels from TM. ▪ Acquire and map resources. ▪ Build FARSITE fuel layers. 	Lead: Cameron Johnston Staff: 9 Fire Lab
MODIS Satellite	<ul style="list-style-type: none"> ▪ Download and process MODIS fire detects; identify new starts and build fire perimeters. 	Lead: Bryce Nordgren Staff: 2 Fire Lab
Airborne Remote Sensing	<ul style="list-style-type: none"> ▪ Administer and task IR providers. ▪ Process imagery: derive fire perimeters and heat polygons; post data and maps to ftp site. 	Lead: Colin Hardy Lead: LLoyd Queen Staff: 1 Fire Lab 4 UM NCLFA
Wind Flow Modeling	<ul style="list-style-type: none"> ▪ Model wind flows in complex terrain using computational fluid dynamics model. 	Lead: Bret Butler Staff: 4 Fire Lab
FARSITE Modeling	<ul style="list-style-type: none"> ▪ Construct weather data and develop synthetic weather scenarios. ▪ Model fire spread under synthetic scenarios. ▪ FARSITE modeling for incidents 	Lead: Mark Finney Staff: 1 Fire Lab 1 SEM

MAC Remote Sensing Group

Missoula, MT
16 August, 2003

Thermal Infrared Group Objectives

1. Support the mission and objectives of the MAC Group.
2. Develop an efficient processing stream to derive a variety of thermal image-map products:
 - Provide fire perimeter and heat source maps in R1 Albers shape file format for input to FarSite
 - Generate fire perimeter and heat source maps where possible
 - Distribute image maps via NRCG ftp site for Area Command and IMT use (“always the priority”)
 - Supplement NiROPS where appropriate
 - Be ready to deploy R5 aircraft as a rapid response asset
3. Document the practices and procedures developed to manage the deployment of technologies.
4. Develop a documented record of data flows and data management.
5. Explore the fusion of ground, airborne, and satellite thermal data; including NiROPS, FireMapper, MODIS, FireBall, RAM, and other imagery.

Participants:

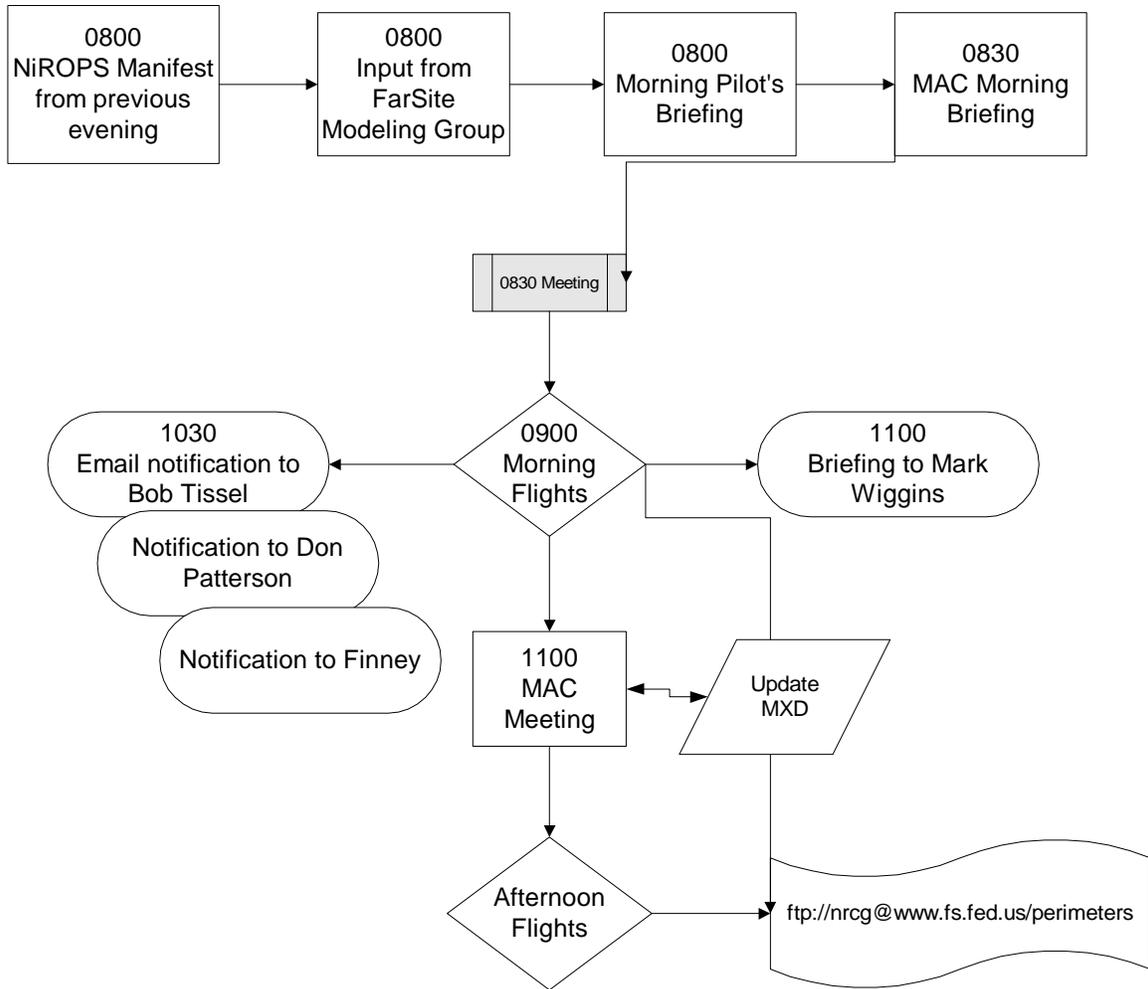
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Missoula Fire Sciences Laboratory

Jim Riddering, Carl Seielstad, Don Helmbrecht, LLOYD Queen
UM National Center for Landscape Fire Analysis

Phil Riggan
Riverside Fire Sciences Laboratory
Pacific Southwest Research Station

Jay Fuhr, Dan Fuhr, Chad Donner
Fuhr Flying Service

**MAC Remote Sensing Group
Daily Cycle**

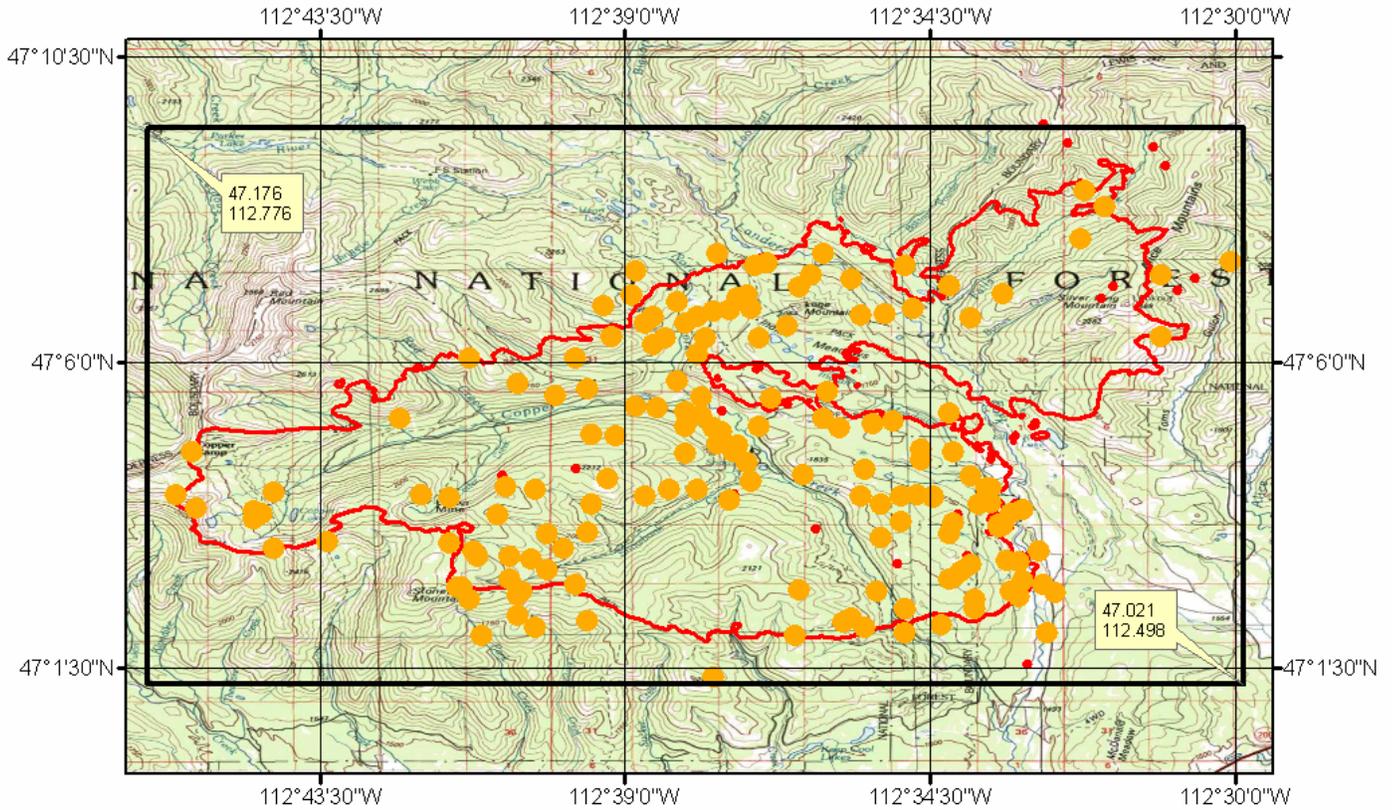


- DATA COLLECTION:**
- Pick small fires that are manageable
 - Capture data not processed
 - Consider "land and process" in addition to satellite download
 - Be clear on PERIMETER vs HEAT mapping objectives
 - Restricted 1900-0300 due to NiROPS operations
 - Attend 0800 pilot briefing
 - Provide lat/lon box to supplement initial point
 - Have ArcView project with DEMs to review local terrain
 - Turn bad box off during data transmissions

**MAC Remote Sensing Group
Daily Operations Cycle**

- 0800 Contact Aircraft desk at NICC to get Morning Summary of NiROPS coverage
- 0815 Obtain daily fire priorities from FarSite group
- 0830 Planning meeting to task flight crew for morning flights
- 1100 Deliver flight crew task plan to NiROPS Coordinator at MAC
- 1300 MAC PSC conference call with IMT PSC's
- 1400 Deliver shape files from morning flight to FarSite group
- 1430 Post shape files to NRCG ftp site:
<ftp://nrcg@www.fs.fed.us>
- 1600 Compile daily summary, update calendar, contact list, data inventory
- 1800 Complete processing of afternoon flight and deliver shape files to FarSite group
- 1830 Post shape files to NRCG ftp site
- 1900 Planning meeting for morning flight orders and daily debrief

SnowTalon Flight Box
August 26, 2003



- IR Perimeter as of 8/25/03
- MODIS detects as of 8/26/03

Building from #7 in the middle; build 21 lines that extend 2.5 nautical miles and that add lines to the north and south. Points (UL, LR) shown in callouts are from the SITL; actual corner points for this flight are given in the Daily Mission Log.

**MAC Remote Sensing Mission Log
ADS CREW**

Date:				
Time:				
Mission Objective:			Aircraft Tail#: N8487F	
			Airport: MSLA	
Weather over Incident:				TFR:
Fire Name	Latitude	Longitude	Notes	Data Status:
	UL			
	UR			
	LL			
	LR			
	UL			
	UR			
	LL			
	LR			
	UL			
	UR			
	LL			
	LR			
Comments:				

NOTES:	
Take off:	Height AGL:
Arrive at incident:	Range:
Depart Incident:	Nominal swath width:
Land MSLA:	Pixel size:

**MAC Remote Sensing Mission Log
PSW CREW**

Date:					
Time:					
Mission Objective:					Aircraft Tail#: N70Z
					Airport: MSLA
Weather over Incident:					Elevation/Terrain Notes:
Fire Name	Order	Latitude	Longitude	Notes	Data Status (# lines, transmitted, pre-processed, heat/perimeter extracted, posted to ftp...):
Comments:					

NOTES:	
Take off:	Height AGL:
Arrive at incident:	Range:
Depart Incident:	Nominal swath width:
Land MSLA:	Pixel size:

MAC Remote Sensing Group
Flight Crew Briefing Checklist

Flight Crew Briefings:

- 800 Pilot's briefing NRCC
- 900 Review prior day's operations
- 915 Complete data summary sheets (see the wall)
- 930 Present NewDay mission log to flight crews
- 945 Confirm flight lines and boxes: review priorities
- 1000 Confirm mission plans with Wiggins
- 1015 Complete daily summary
- 1030 Dispatch crews
- 1045 Copy daily summary to Missoula Area Command and MAC GIS (14th/Catlin)
- 1100 Daily meeting with MAC Plans (Fire Lab)
- 1200 Confirm data summary with UofM Lab

Notes:

- * Each crew must complete previous day's summary sheets before departure
- * Confirm flight following and/or FAA Flight Plan
- * PSW check for text messaging
- * Be clear on perimeter and/or heat mapping objectives

- * ALL flights must be approved by Hardy and Wiggins

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MAC Remote Sensing Group

Data Summary
 18 August 2003
 1800hrs

DATE	FIRE NAME	PRIORITY	DATA STATUS	NOTES
08.16	Black Mountain 2	1	Have BBTIR ¹ ; need 1 more line processed	PSW
08.16	Beaver Lake Complex	2	Not processed	PSW
08.16	Cooney Ridge Complex	3	Not processed	PSW
08.16	Boles/Rattlesnake Complex	4	No data	PSW
08.16	Black Mountain 2	N/A	Flown @ 2200; shapefiles posted	PSW
08.17	Fish Creek	1	Clouds, no acquisition	PSW
08.17	East Fork Petty Creek	2	Clouds, no acquisition	PSW
08.17	North Howard	3	Clouds, no acquisition	PSW
08.17	Cooney Ridge Complex	4	?	PSW
08.17	Black Mountain 2	N/A	Cloudfree, have BBTIR, shapefiles	PSW
08.17	Mineral/Prim	N/A	2 unique lines; shapefiles posted	PSW
08.18	Lincoln Complex	1	Appeared on web site @ 1400; have BBTIR; Only got fire south of Lincoln (not Talon)	PSW
08.18	Burnt Ridge Complex	2	On ftp site; 1 fire	PSW
08.18	Sheep Complex	3	On ftp site; 1 fire	PSW
08.18	Windmill Complex	4	Passed optical data to Bob T. evening of 8/19	PSW

¹ N/A = not assigned. BBTIR = broad-band thermal infrared.

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MAC Remote Sensing Group

Data Summary
 20 August 2003
 1136hrs

DATE	FIRE NAME	PRIORITY	DATA STATUS	NOTES
08.19	Cathedral Peak	1	Weathered out @16500; flew below 165 and may have image issues	PSW
08.19	Rough Draw	2	2 passes on Slippery Rock posted; Rough Draw showed little heat but mapped ash layer	PSW
08.19	Hobble	3	5 lines; Posted 2100	PSW
08.19	Milepost 59	4	Weathered out	PSW
08.19	Lincoln Complex	N/A	Flew 2 sides of plume and one pass over Talon?	PSW
08.20	Black Mountain 2	1	Processed and posted to ftp	ADS
08.20	Cooney Ridge	2	Posted to ftp	ADS
08.20	Snow/Talon	1	Posted to ftp	PSW
08.20	Moose/Wasson	2	posted	PSW
08.20	Beta Lake	3	posted	PSW
08.20	Recon around Beta Lake	4		

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MAC Remote Sensing Group
Data Summary 23 August 2003 1215hrs

DATE	FIRE NAME	PRIORITY	DATA STATUS	NOTES
08.21	Snow Talon	1	IMU issues—did not fly (DNF)	ADS
08.21	Cathedral Peak	2	DNF	ADS
08.21	New Fire NNE of Cherry	3	DNF	ADS
08.21	Fish Creek	4	DNF	ADS
08/22 All weathered out				
08/23	Burnt Ridge	1	No fire to see...	PSW
08/23	Sheep Fire	1	Out but mapped as of 1810-- posted	PSW
08/23	Ant Hill Fire	1	Posted; not full fire coverage as of 1810	PSW
08/23	Black Mountain 2	2	No data as of 1300	PSW
08/23	Slippery	N/A	Did not acquire	PSW
08/23	Rough Draw	N/A	Sent to CAS, 0.66 of the fire' 8/16 field data overlay. Talked to IMT; not posted, all interior heat	PSW
08/23	Cathedral	N/A	Burning, heli below. 1 flight line, no context. Will pull other frames today and see if workable	PSW
08/23				
08/23	Snow/Talon	1	Landed 1815; posted to ftp	ADS
08/23	Moose/Wasson	2	Dropped due to re-tasking	ADS
08/23	High Fire*	3	Dropped due to re-tasking	ADS
08/23	Fish Creek Complex	4	Wheels up 1830; 2 new boxes from IMT/OPS Posted 0300; need to deliver H/C today 24th	ADS

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MAC Remote Sensing Group

Data Summary
 30 August 2003
 0835hrs

DATE	FIRE NAME	PRIORITY	DATA STATUS	NOTES
08/24	Black Mountain 2	1	Posted @ 1855	ADS
08/24	Fish Creek Complex	2	Posted @ 1300 on 25th	ADS
08/24	High Fire	1	Clouded out	PSW
08/24	Moose/Wasson	2	Little heat; not posted	PSW
08/25	Black Mountain 2	1	Posted @ 1855	ADS
08/25	Fish Creek	2	Delivered to ICP ~ 1600 on 26th	ADS
08/25	Black Mountain 2	3	Posted @ 0100	ADS
08/25	Cooney Ridge	1	Clouded out; tried High Fire	PSW
08/25	Snow Talon	2	“found little heat”	PSW
08/26	Snow Talon	1	Posted; plume problems during fire run	ADS
08/26	Black Mountain 2	2	Posted @ 2149	ADS
08/27	Ant Park	1	0030 posted	ADS
08/27	Moose Wasson	2	0126 posted	ADS

MAC Remote Sensing Group – Final Documentation Package

MAC Remote Sensing Group

Data Summary
31 August 2003
1008hrs

DATE	FIRE NAME	PRIORITY	DATA STATUS	NOTES
08/28	Mineral Prim	1	Posted @ 2019	ADS
08/28	Boles	2	Posted @ 1640	ADS
08/28	Fish Creek	3	Posted @ 0125	ADS
08/29 Did not Fly				
08/30	Fish Creek Complex	1	Posted perimeter and heat @ 0005 on 31 st .	ADS

IR Flight Database

The IR Flight Database is currently under construction and is designed to organize the IR flight information gathered by the MAC Remote Sensing Group this fire season. The mission log information from this season is being compiled, including flight times, flight box coordinates, and processed data location (when centralized data access is available). Features will also be included to help structure the flight tasking and data management for future fire seasons. The features for flight tasking include storing and modifying flight box coordinates, setting flight priorities, and potentially allowing web-based tasking requests from the IR coordinator. Mission log information will also be stored in the database after fires are flown. As data is received and processed, the data turn-around time will be recorded and a web-based application will direct users to the location of the processed data.

MAC GIS/Remote Sensing IMT Visits 8/21-8/22/03

Anne Rys-Sikora, Colin Hardy, LLoyd Queen

Visited:

- 93-East Area Command
- 93-West Area Command
- Black Mountain 2 IMT
- Fish Creek Complex IMT
- 9-Mile Ranger District
- Mineral/Prim IMT
- Lincoln Complex IMT
- Lewis and Clark NF SO
- Burnt Ridge/Sheep Ridge/Ant Hill IMT

What we heard:

- Most IMT's had GIS support on-site; Fish was the exception
- Plotters and networking are a persistent and consistent problem
- More plotters/equipment are being rented from "local" sources
- Districts are providing considerable support to IMT's in certain cases
- Base layers were often hard to derive; roads seemed most problematic
- The NRCG ftp site was being well used; some clarification on naming/filing conventions might be helpful
- Bottleneck still exists getting IR esp. on smaller/lower priority fires
- Gave a heads-up that there are now opportunities to task ADS or PSW to complement BIR ship
- Formatting heat and perimeter data so that they are the same format as the BIR products presents no problem to the user
- Prefer to get "where the fire went" to "where the fire is" (perimeter vs hot-spot flying)
- Heard some negative feedback regarding FLIR balls
- IMT's are using some alternative map layouts (e.g., DOQQ back-drape) and are interested in continued production of those outputs
- Confidence in map products is lower when current IR data are not available
- Overall level of sophistication is quite high with a small number of notable exceptions
- Chains of data custody and authority seem well-defined within the IMT; there was a positive reaction to the "centralization" of data management and IR
- Uploads from the IMT to the ftp site are much less frequent than the down-load pathway
- There were some connections that have been made between the IMTs and the remote sensing/GIS group
- Looks like we can expect a visit from 93E A/C to the remote sensing group

MAC GIS/Remote Sensing IMT Visits 8/21-8/22/03, cont'd

- Specification of “Standards” for data would most likely affect the flow upwards—given that the “down-wards” flow seems to be more consistent under the centralized model being used now
- Projection and other base map parameters seem to always be an issue—doesn't seem to affect efficacy as much as efficiency
- There is interest in use of optical image data from the daytime flights for assessing vegetation as well as management activities; *fire severity*
- DPRO's are still being utilized—and the filtering/synthesis process by them and SITL are important to data use (we can't map a helispot given a GPS from Air Ops unless SITL approves it first)—this suggests that PSC's and SITL's need to be in the loop as regards “new” IR alternatives
- Area Commands do not appear to have a clear role in the flow of intelligence... e.g., both Incidents and MAC seem to have unfulfilled expectations of A/C role in Intel.