Fire severity and ecosystem impacts immediately following an extreme fire event in northern Minnesota.

Phil Townsend *University of Wisconsin-Madison*
Brian Sturtevant, Randy Kolka, Shawn Fraver, Eric Gustafson & Jay Charney
USFS Northern Research Station
Peter Wolter *Iowa State University*
Lee Frelich *University of Minnesota*

Looking west from Lake Polly, 9/12/2011
Hans Martin, USGS,
http://www.inciweb.org/incident/photograph/2534/26/

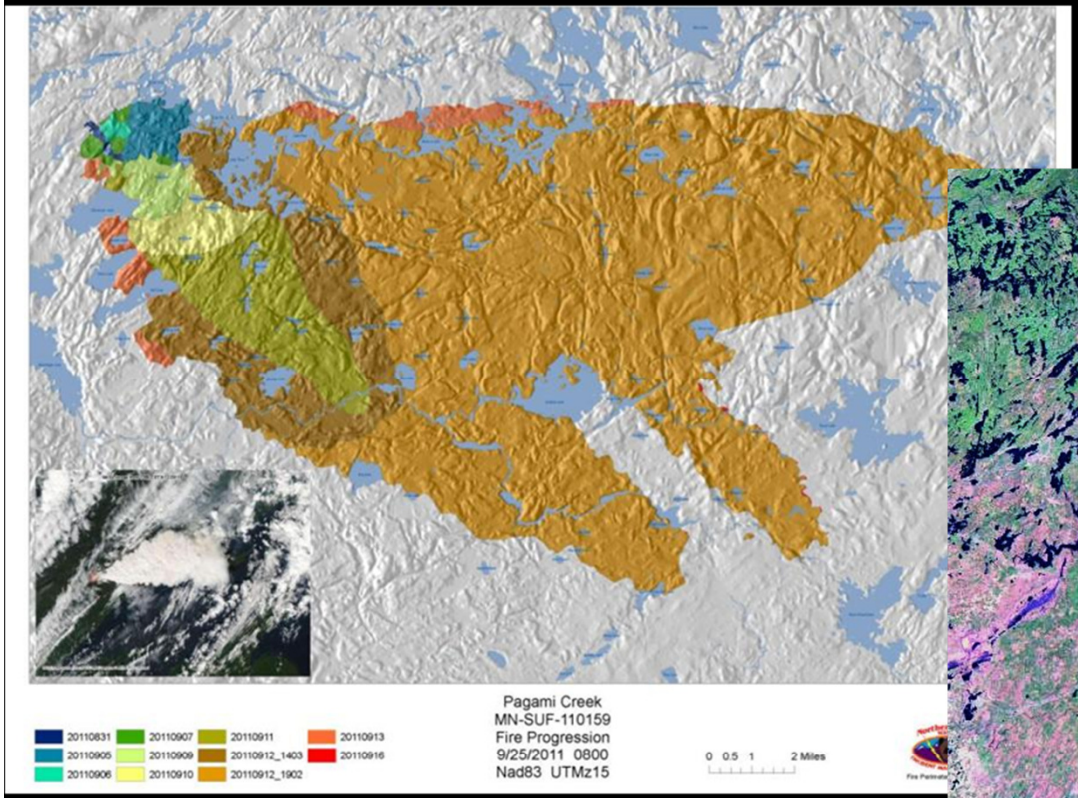
PAGAMI CREEK FIRE (biggest in Minnesota since 1894)

2011-08-18: Lightning strike starts fire

2011-09-10: Change in fire behavior to wind-driven crown fire

2011-09-11: Gusting north winds push fire 6 miles south

2011-09-12: 35mph PM wind gusts push fire 19 miles east, consuming ~75,000 acres in 5 hours!



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September 13, 2011 | By the CNN Wire Staff

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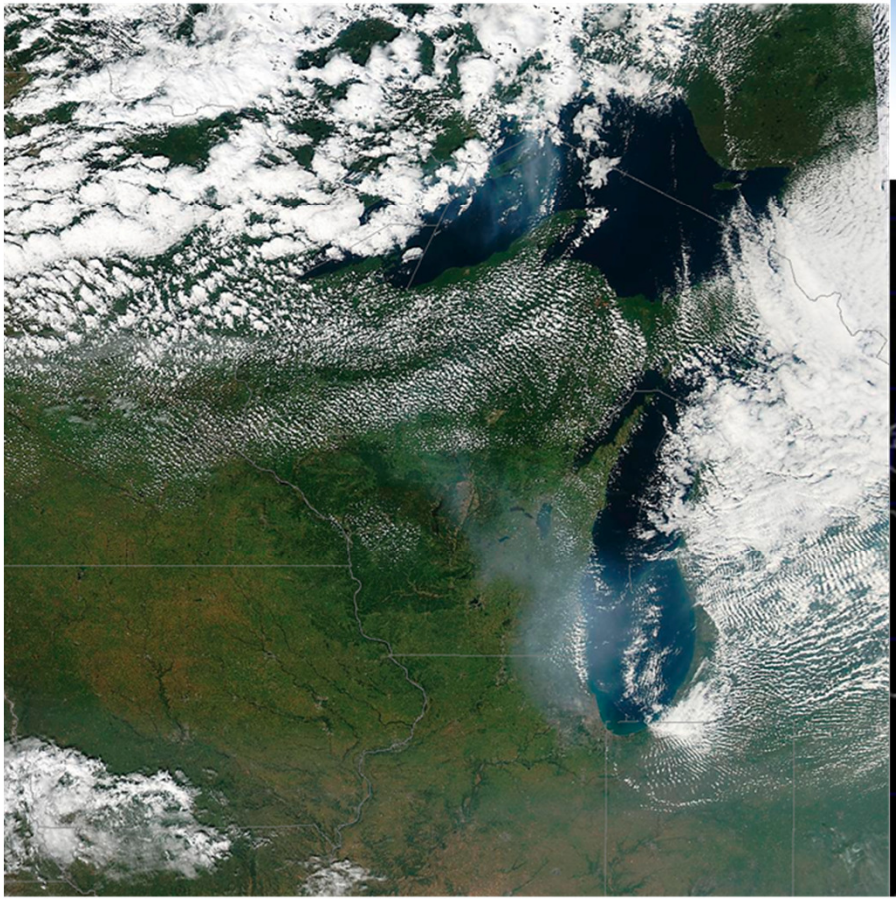
A wildfire in a northeast Minnesota woodland grew



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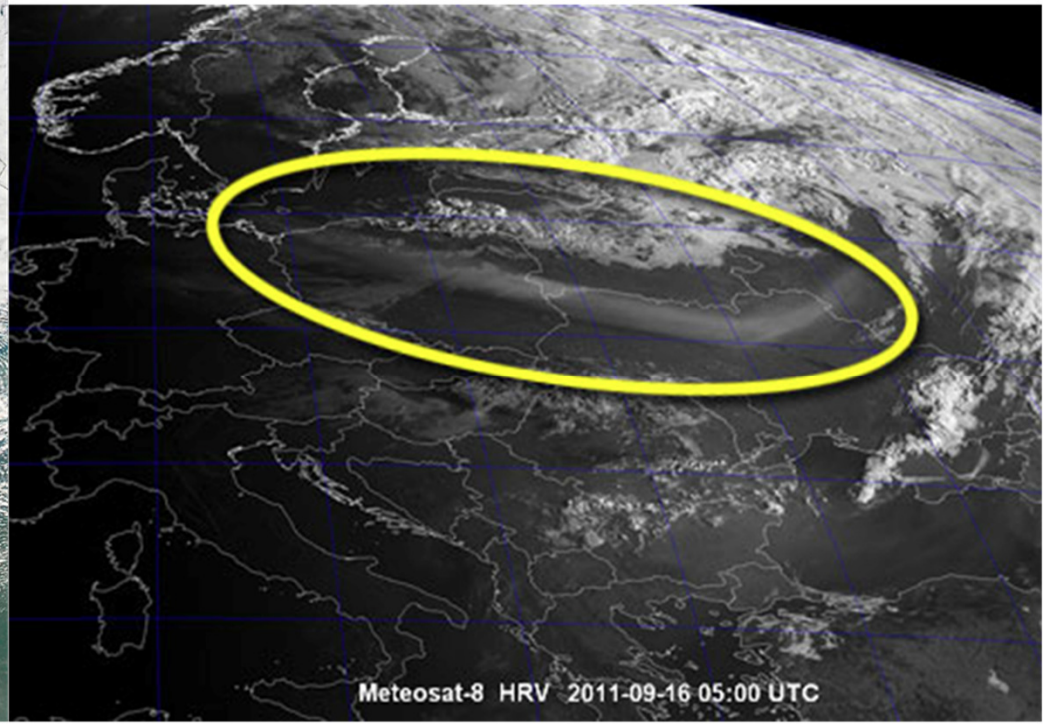
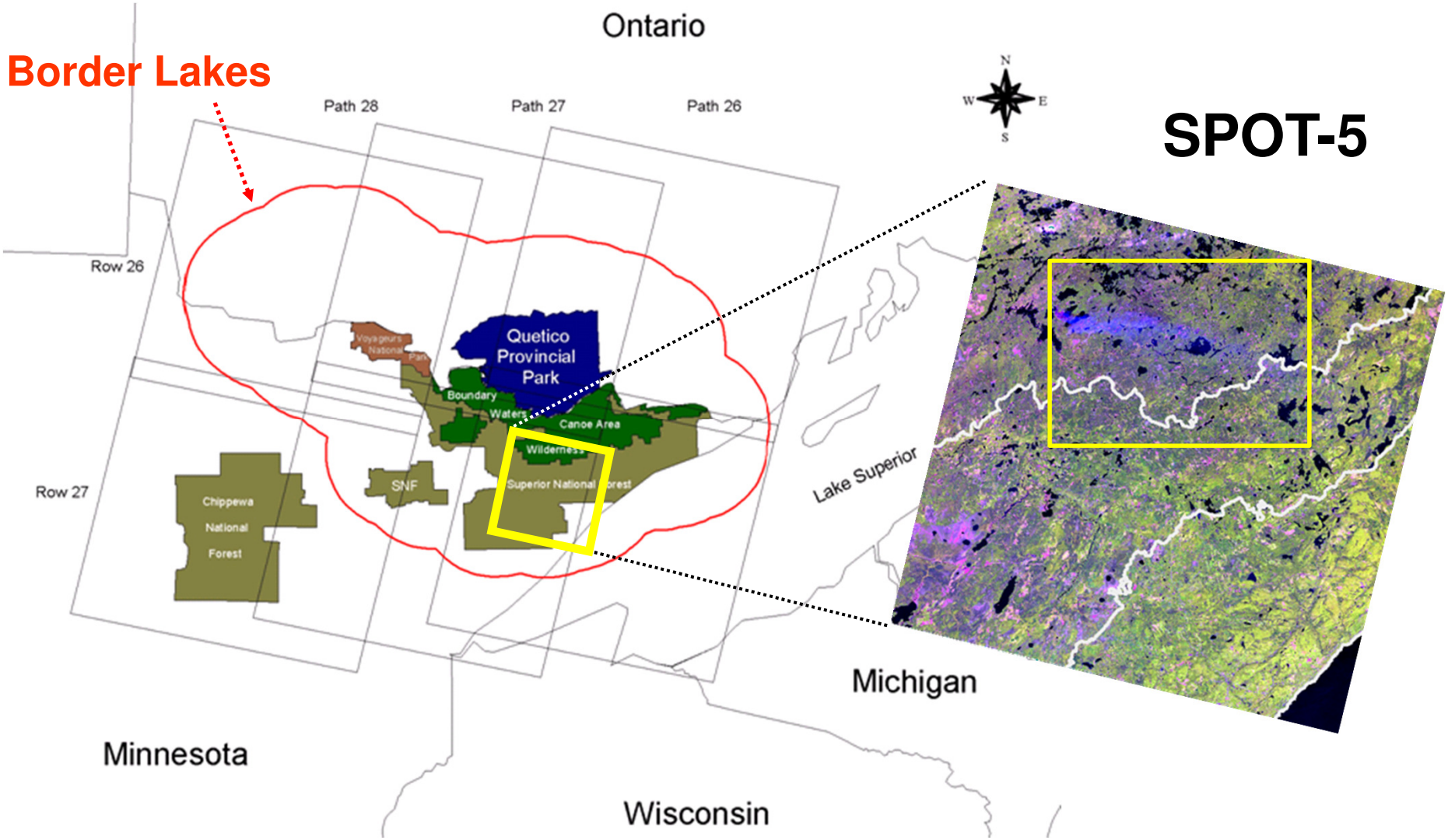
US Smoke Plume Travels Thousands of Miles to Europe

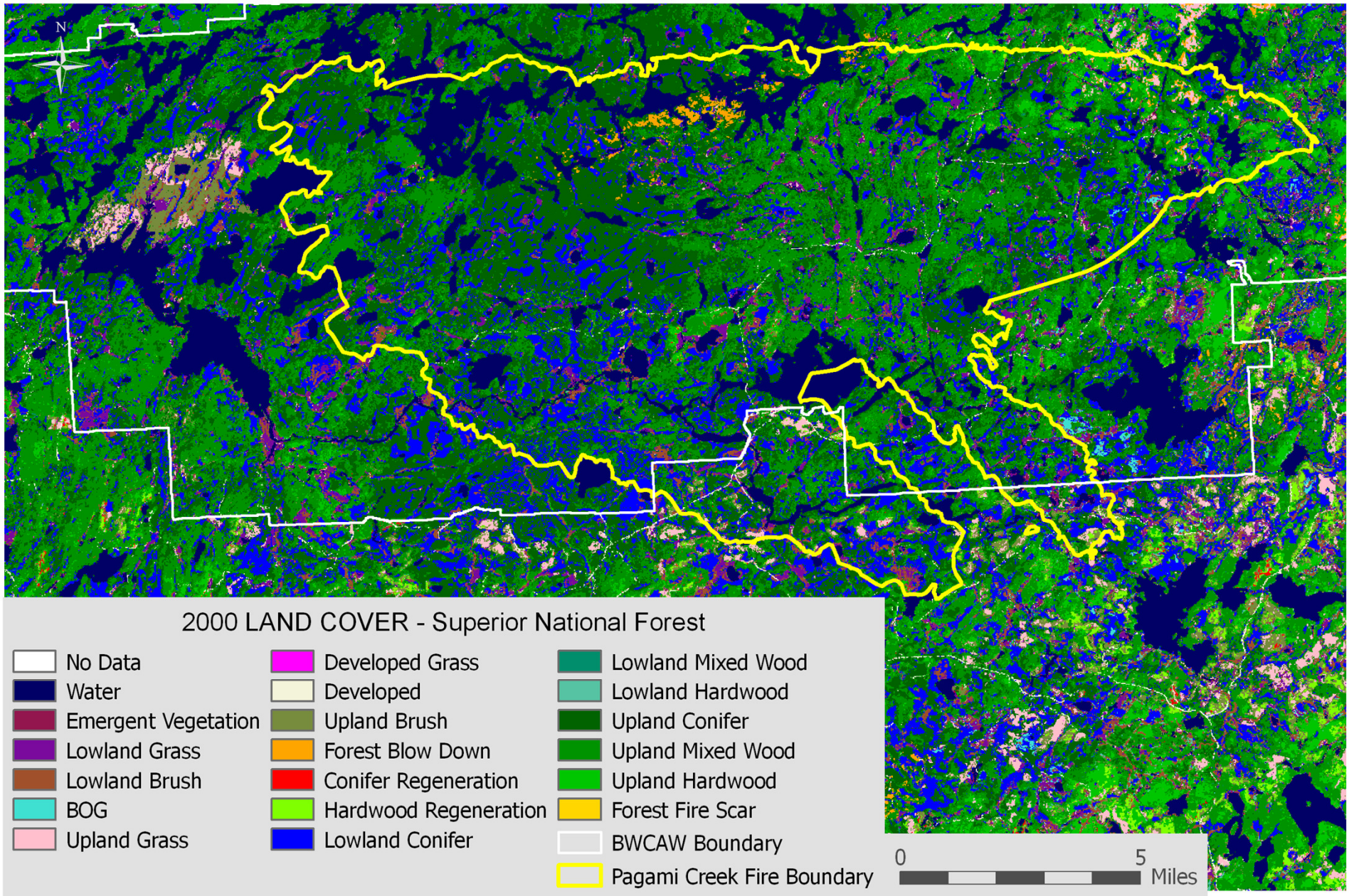
by **Tim Ballisty, Editorial Meteorologist**

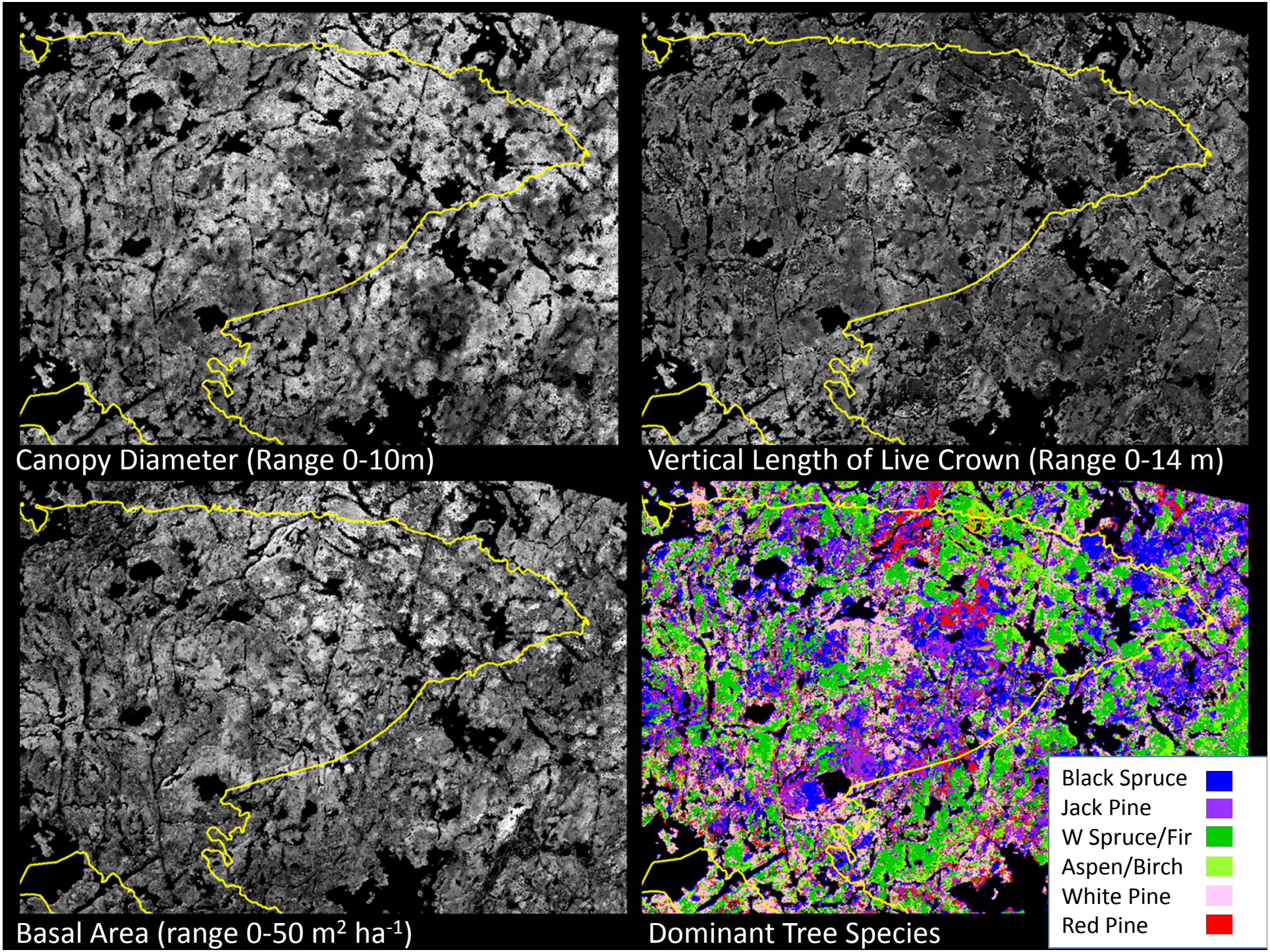
TODAY



Remote Sensing History

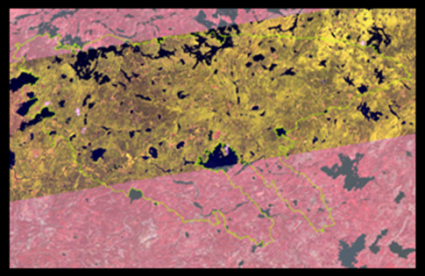



N
2000 LAND COVER - Superior National Forest
No Data
Water
Emergent Vegetation
Lowland Grass
Lowland Brush
BOG
Upland Grass
Developed Grass
Developed
Upland Brush
Forest Blow Down
Conifer Regeneration
Hardwood Regeneration
Lowland Conifer
Lowland Mixed Wood
Lowland Hardwood
Upland Conifer
Upland Mixed Wood
Upland Hardwood
Forest Fire Scar
BWCAW Boundary
Pagami Creek Fire Boundary
0
5
Miles


Canopy Diameter (Range 0-10m)
Vertical Length of Live Crown (Range 0-14 m)
Basal Area (range 0-50 m² ha⁻¹)
Dominant Tree Species
Black Spruce
Jack Pine
W Spruce/Fir
Aspen/Birch
White Pine
Red Pine


http://www.inciweb.org/incident/photograph/2534/12/

QUESTIONS



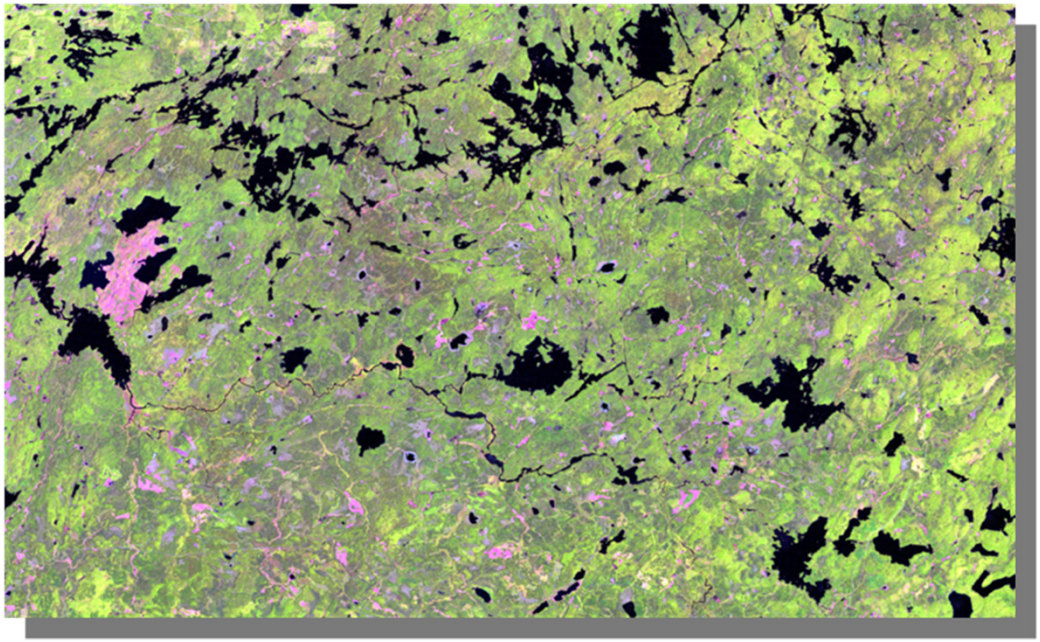
To what extent do remotely-sensed (hyperspectral) fire severity estimates reflect field-based severity indices in both the overstory and the understory?

How do overstory and understory fire severities interact to influence soil carbon (C), nitrogen (N), and mercury (Hg) loss immediately after a fire in comparison with those in the first growing season after the fire?

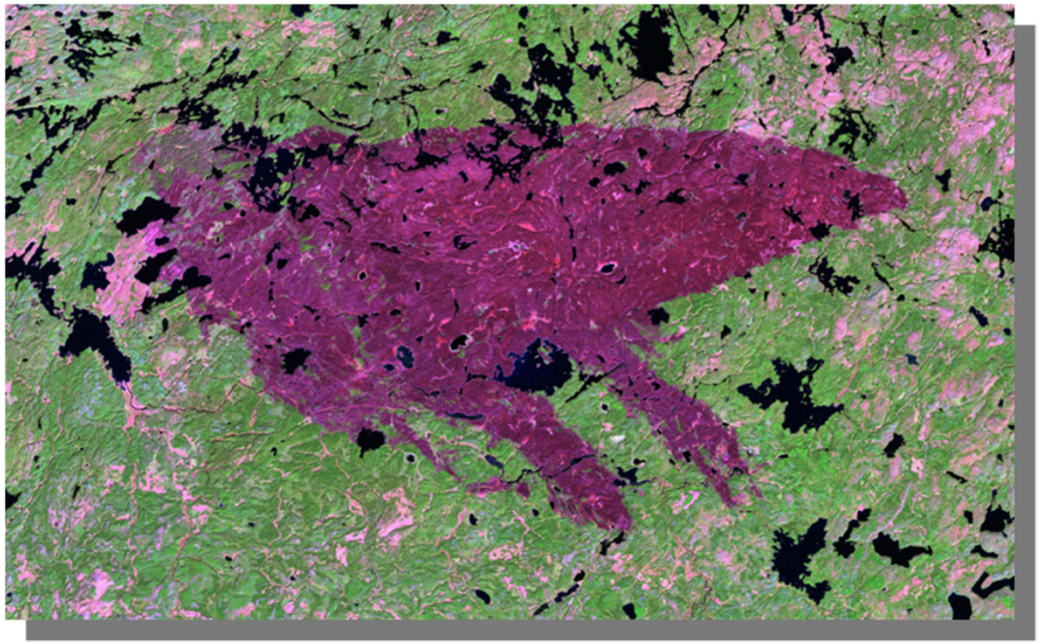
To what extent does pre-fire forest condition affect post-fire nutrient, decomposition and regeneration dynamics?

Photos from: http://www.inciweb.org/incident/photograph/2534/

2009-06-26 Prefire



2011-10-06 Postfire



Normalized Burn Ratio *(Key & Bensen 2005)*

$$NBR = \frac{Band4 - Band7}{Band4 + Band7}$$

NBR primarily sensitive to:

-living chlorophyll

-water content (soils and vegetation)

-lignin, hydrous minerals, ash and char

(Elvidge, 1990; Key, 2006; Kokaly et al., 2007)

Differenced NBR used to detect change:

dNBR = prefireNBR – postfireNBR

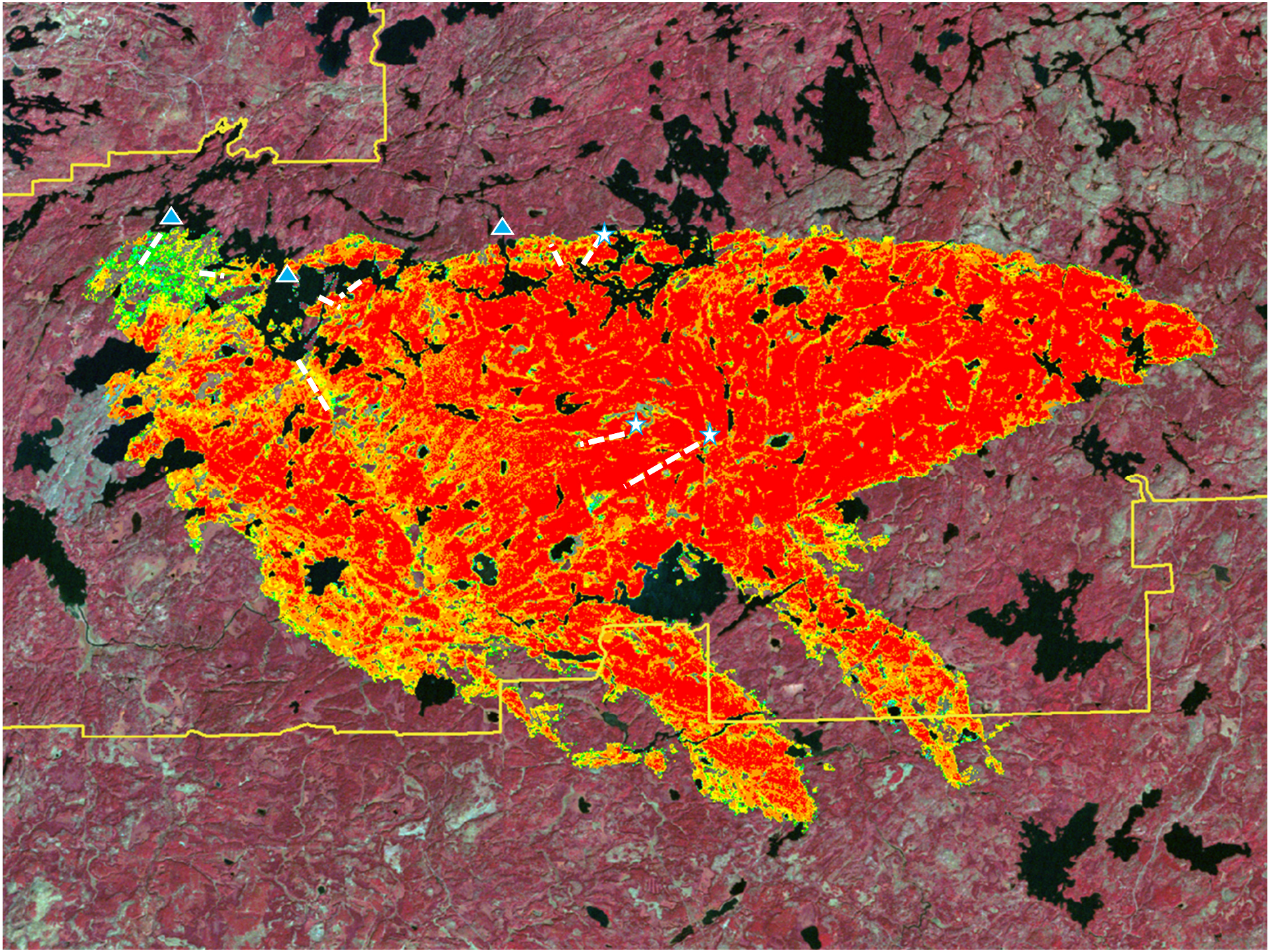
But…chlorophyll contents vary by veg type & density ➔ bias

Prefer a relative difference measure to remove vegetation biasing…

Relative difference NBR *(Miller & Thode 2007)*

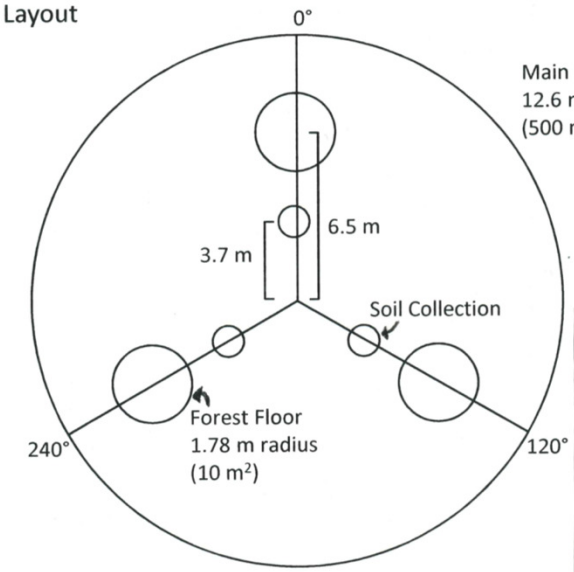
$$RdNBR = \frac{dNBR}{\sqrt{ABS(prefireNBR/1000)}}$$

J.D. Miller et al. / Remote Sensing of Environment 113 (2009) 645–656



Joel Flory Alex Brito Rob Focht Jason Sedin Peter Wolter
Amy Milo Heather Fox Brian Sturtevant Mike Reinikainen
Bernie Isaacson Shawn Fraver Clayton Kingdon Phil Townsend
Not Shown: Dan Baumann & Hans Casperson

Plot Layout


0°
Main Plot (Trees)
12.6 m radius
(500 m²)
6.5 m
3.7 m
Soil Collection
Forest Floor
1.78 m radius
(10 m²)
240°
120°


Smokey Prevent Forest Fires!

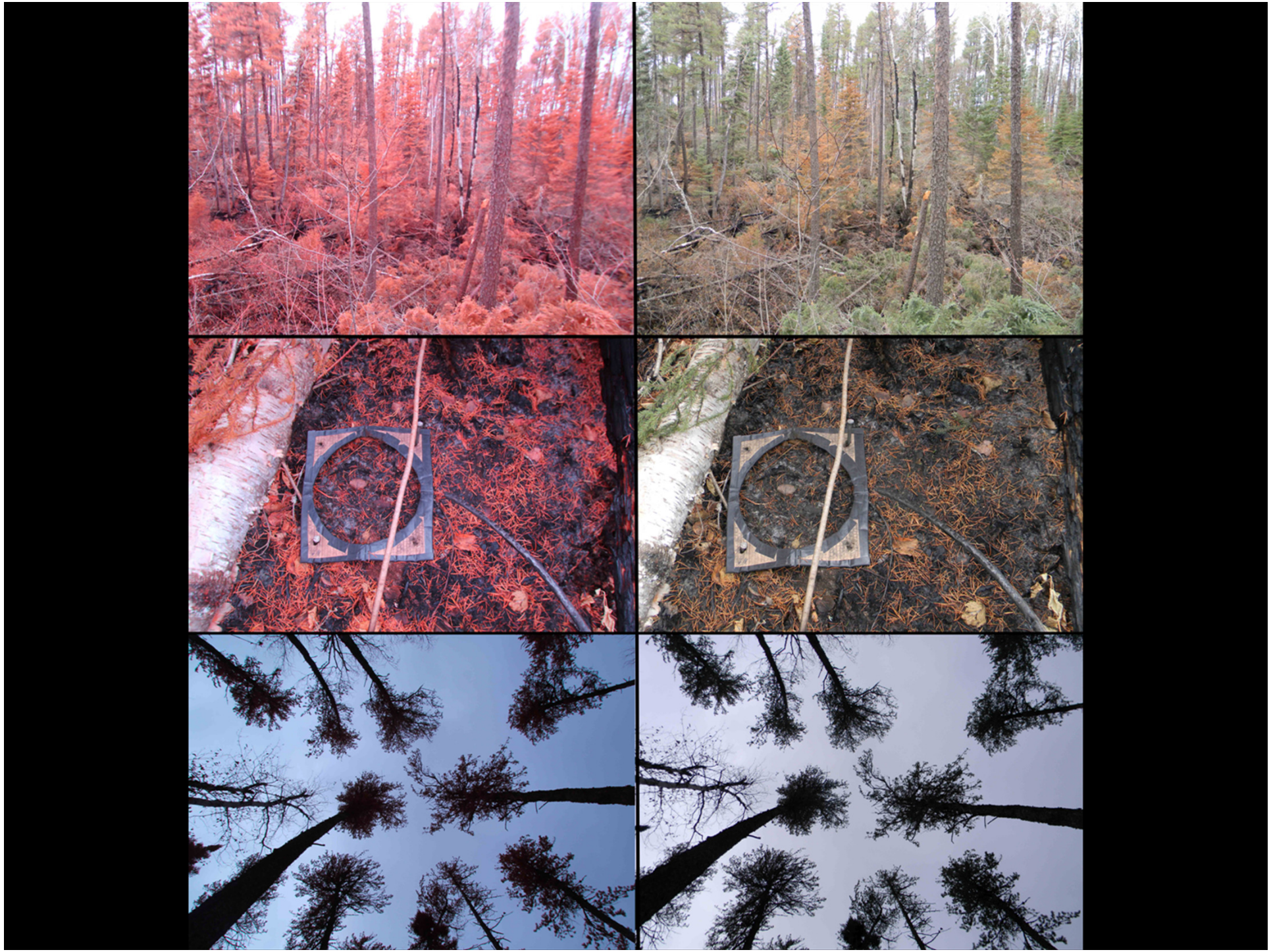

Help Smokey Prevent Forest Fires!


Phil Townsend

Joel Flory

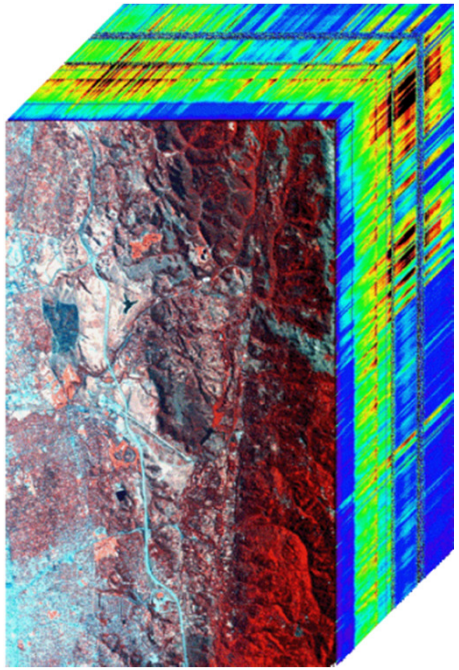

Phil Townsend

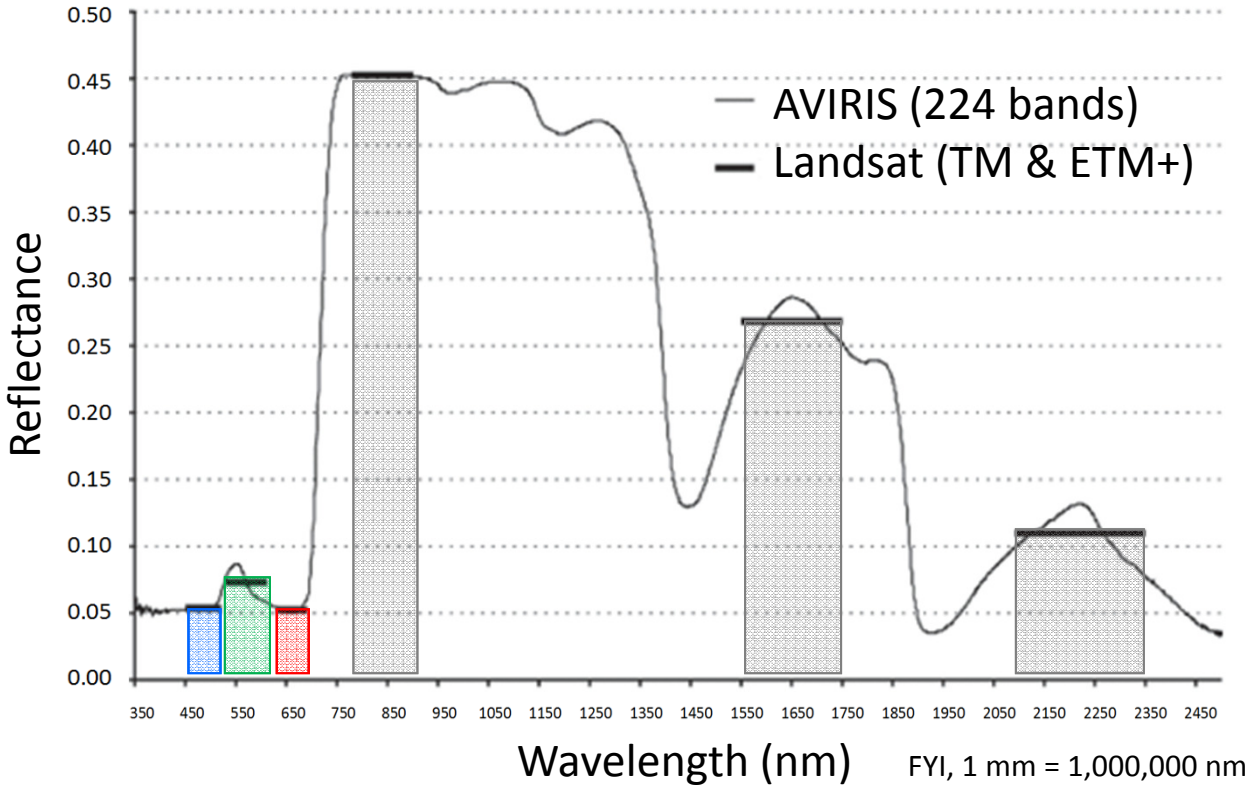
Phil Townsend



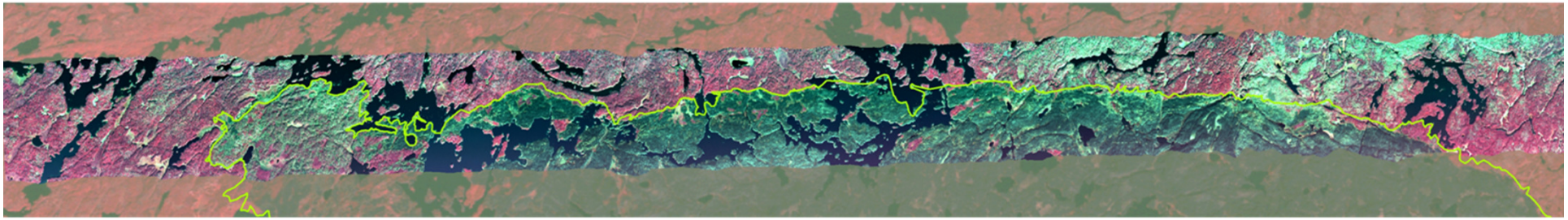
NASA flew its AVIRIS sensor over the site on October 20-21

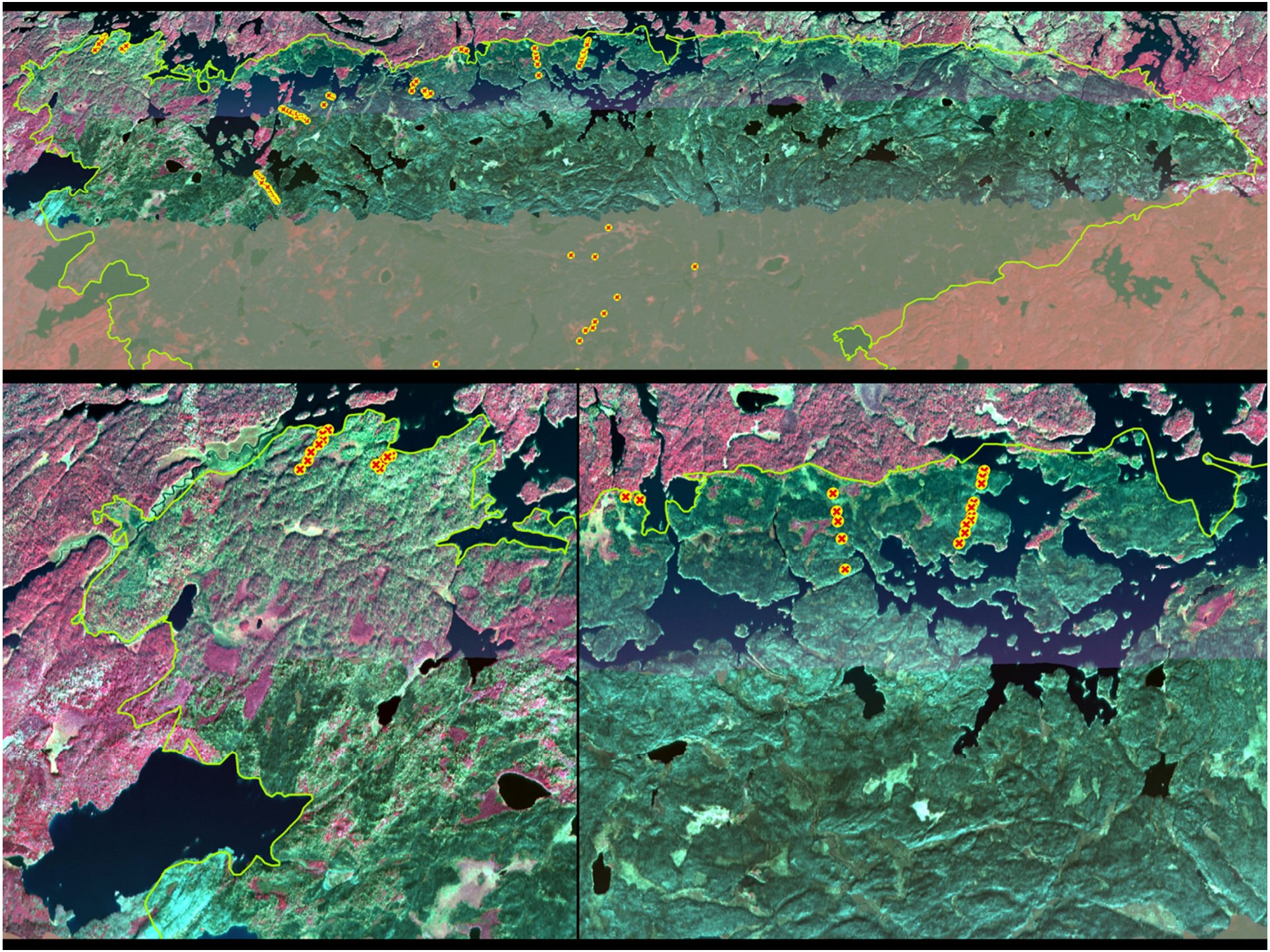
What is AVIRIS imagery?

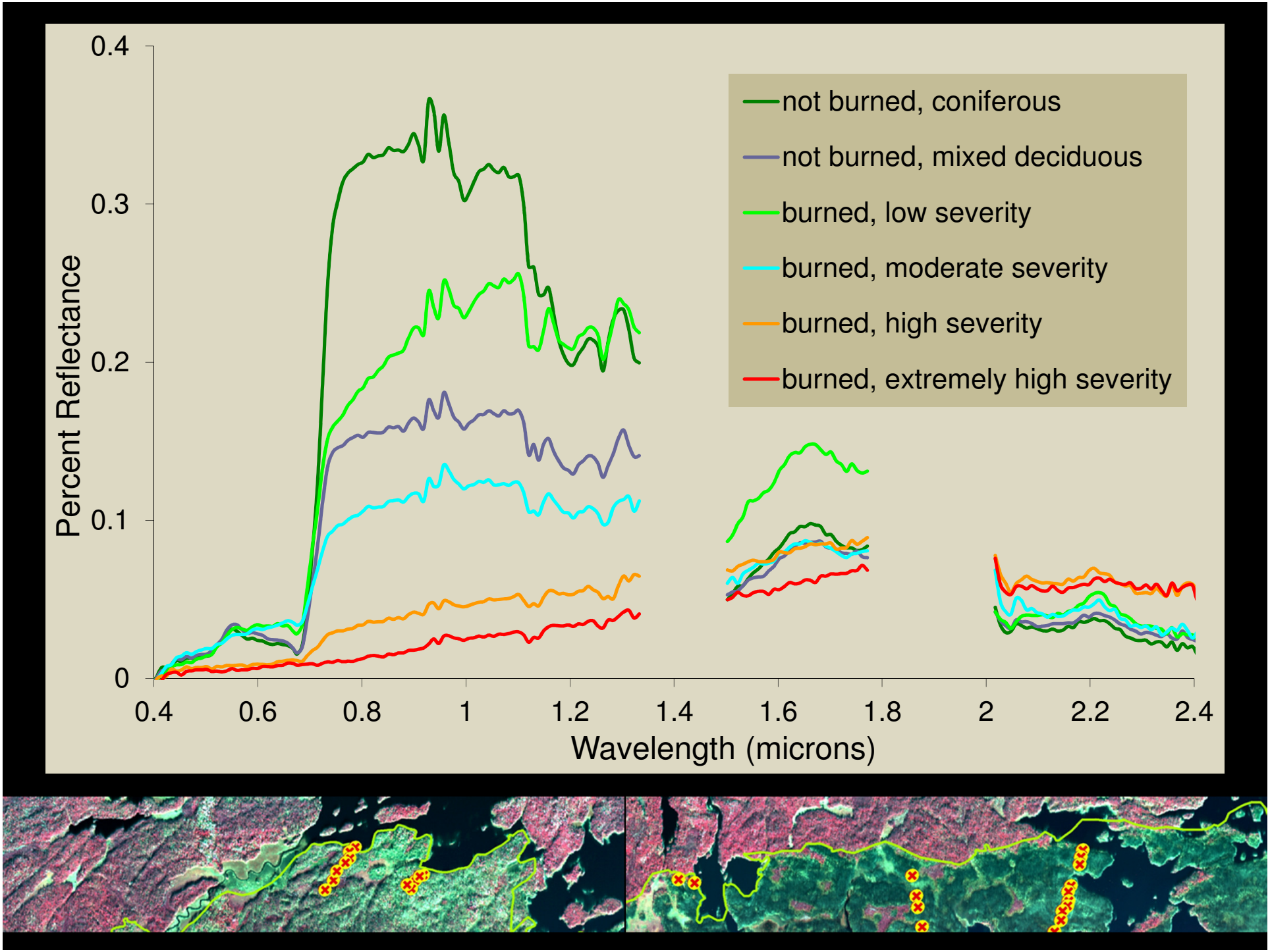


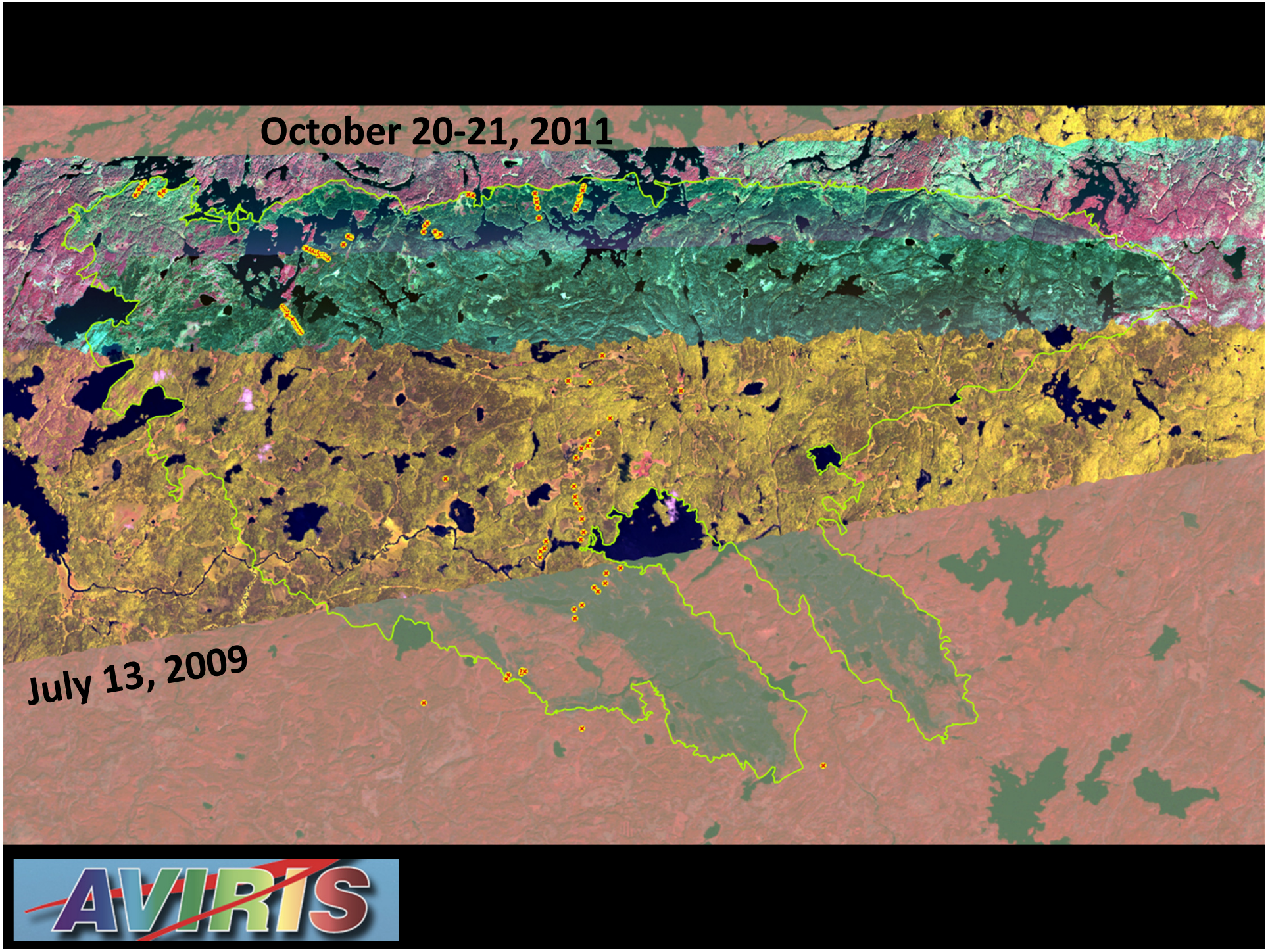


FYI, 1 mm = 1,000,000 nm






0.4
0.3
0.2
0.1
0
Percent Reflectance
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
Wavelength (microns)
not burned, coniferous
not burned, mixed deciduous
burned, low severity
burned, moderate severity
burned, high severity
burned, extremely high severity


October 20-21, 2011
July 13, 2009
AVIRIS

PAGAMI CREEK FIRE SEVERITY PROJECT

- What are the patterns of burn severity following the fire?
- How are nutrient transformations related to burn severity and pre-fire conditions?
- COMPLETED
  - NASA AVIRIS partial coverage
  - Over 110 plots established
  - Initial data analysis – in progress

http://nrs.fs.fed.us/disturbance/fire/extreme_fire_effects_mn/

PAGAMI CREEK FIRE SEVERITY PROJECT

- NEXT PRIORITIES

- Complete NASA AVIRIS coverage in Spring, 2012

- Use existing maps and forest history information to target under sampled areas (Forest Type × Fire Severity)
  - Early May

- Re-sample our all plots for SOILS after the first growing season
  - August – September

http://nrs.fs.fed.us/disturbance/fire/extreme_fire_effects_mn/

PAGAMI CREEK FIRE SEVERITY PROJECT

- FUTURE WORK

- One Year of Funding
  - Goal – Establish a baseline of fire severity & initial impacts
- Seek Additional Funding
  - Vegetation Recovery Patterns
  - Carbon & Nitrogen Dynamics
  - Other Research Priorities?

http://nrs.fs.fed.us/disturbance/fire/extreme_fire_effects_mn/

Questions?

Phil Townsend

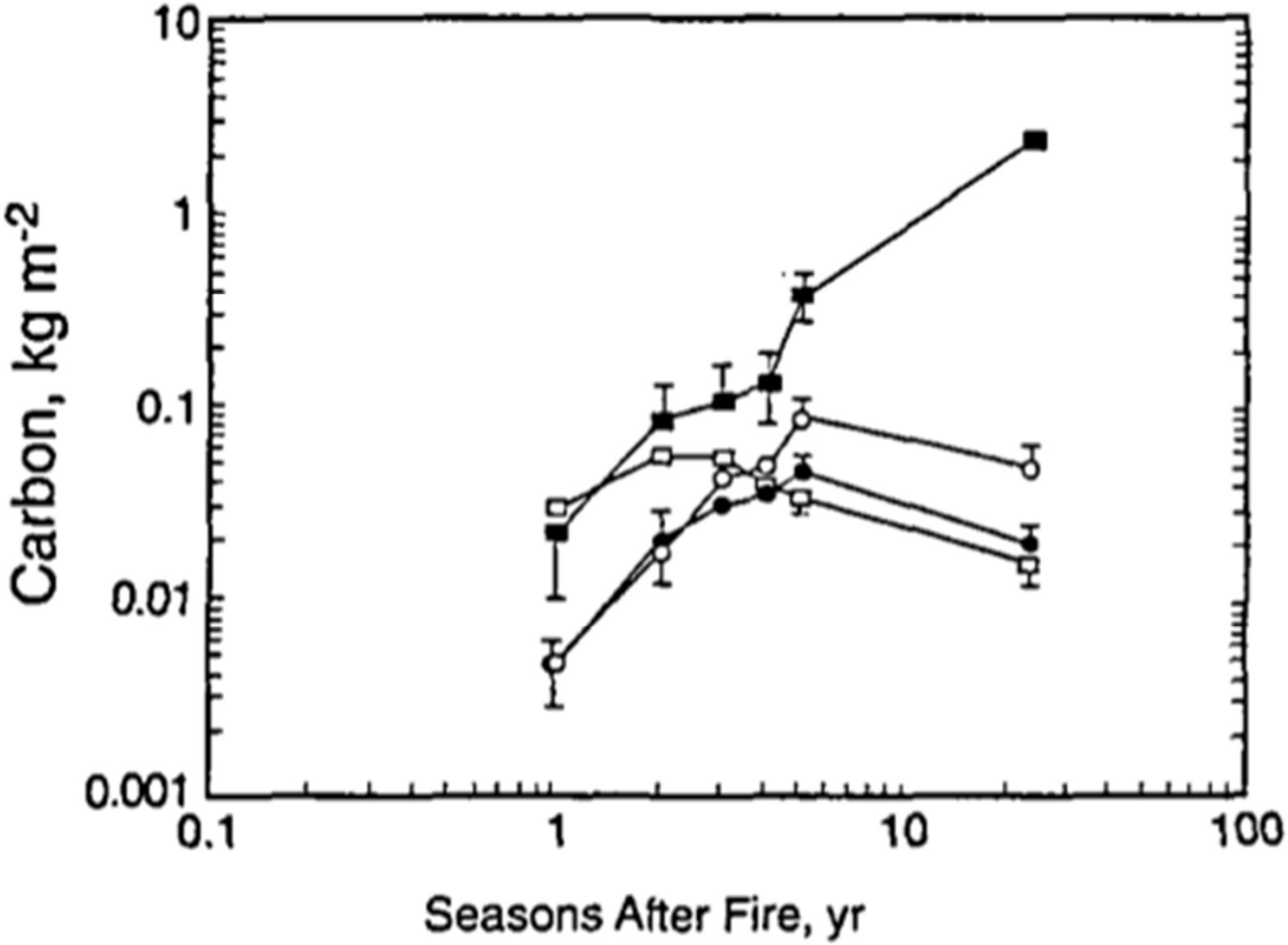
Scand. J. For. Res. 13: 119–127, 1998

Carbon Storage in Southern Boreal Forests Following Fire

KENT W. SLAUGHTER[1], D. F. GRIGAL[2] and L. F. OHMANN[3]

[1]*Department of Forest Resources, University of Minnesota, St. Paul, Minnesota 55108 USA,* [2]*Department of Soil, Water, and Climate, University of Minnesota, St. Paul, Minnesota 55108, USA.* [3]*USDA Forest Service, Grand Rapids, Minnesota 55744, USA*

Scandinavian Journal of Forest Research



Little Sioux Fire 1971

5-2007 Ham Lake Fire 6-2008

From powerpoint by: Mark Van Every, District Ranger, of the Kawishiwi Ranger District, http://www.inciweb.org/incident/article/2534/13493/

One Week After Cavity Fire

From powerpoint by: Mark Van Every, District Ranger, of the Kawishiwi Ranger District, http://www.inciweb.org/incident/article/2534/13493/

One Year After Cavity Fire

From powerpoint by: Mark Van Every, District Ranger, of the Kawishiwi Ranger District, http://www.inciweb.org/incident/article/2534/13493/

Five Years After Cavity Fire

From powerpoint by: Mark Van Every, District Ranger, of the Kawishiwi Ranger District, http://www.inciweb.org/incident/article/2534/13493/