



Natural Resources
Canada

Ressources naturelles
Canada



Infra-Red Satellite Data Simulation and Assimilation Using Prometheus

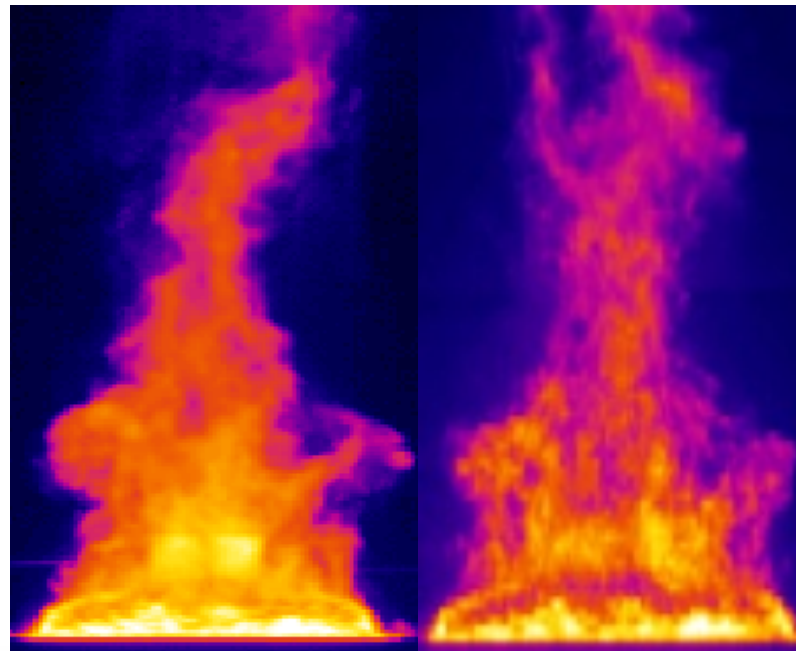
Joshua Johnston

Forest Fire Analyst

Canadian Forest Service

Great Lakes Forestry Centre
Sault Ste. Marie, Ontario

Joshua.Johnston@NRCan-RNCan.gc.ca



Canada

KING'S
College
LONDON

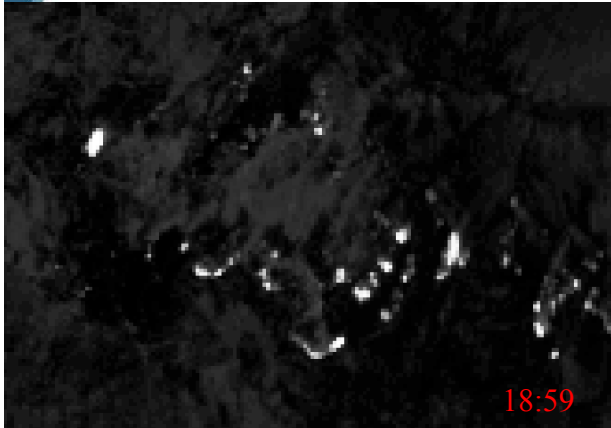
University of London



Canada



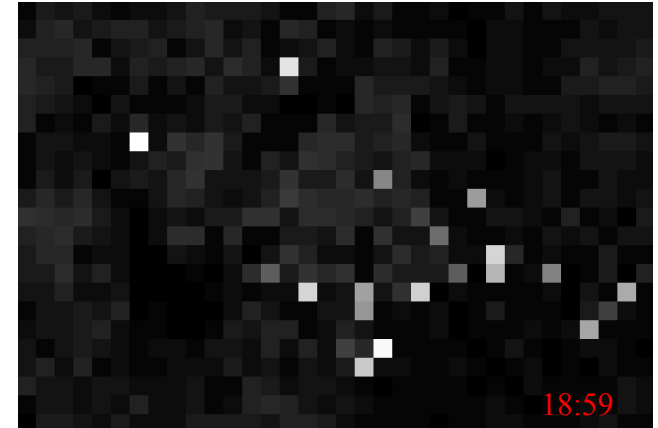
Traditional Satellite Data Simulation



Pixel size: 50 m



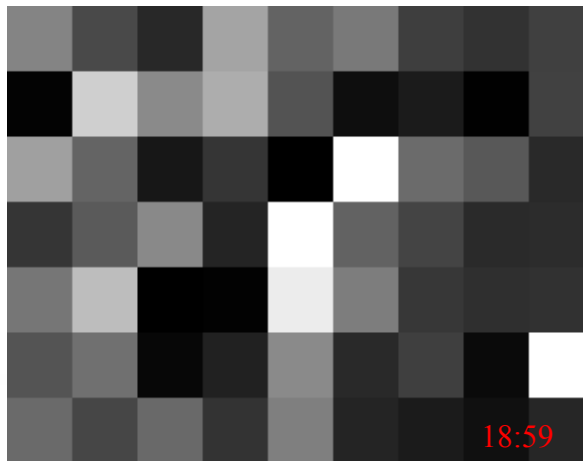
Pixel size: 100 m



Pixel size: 250 m

MASTER airborne scan
Arizona, June 15th 2011

Overpass: 18:59

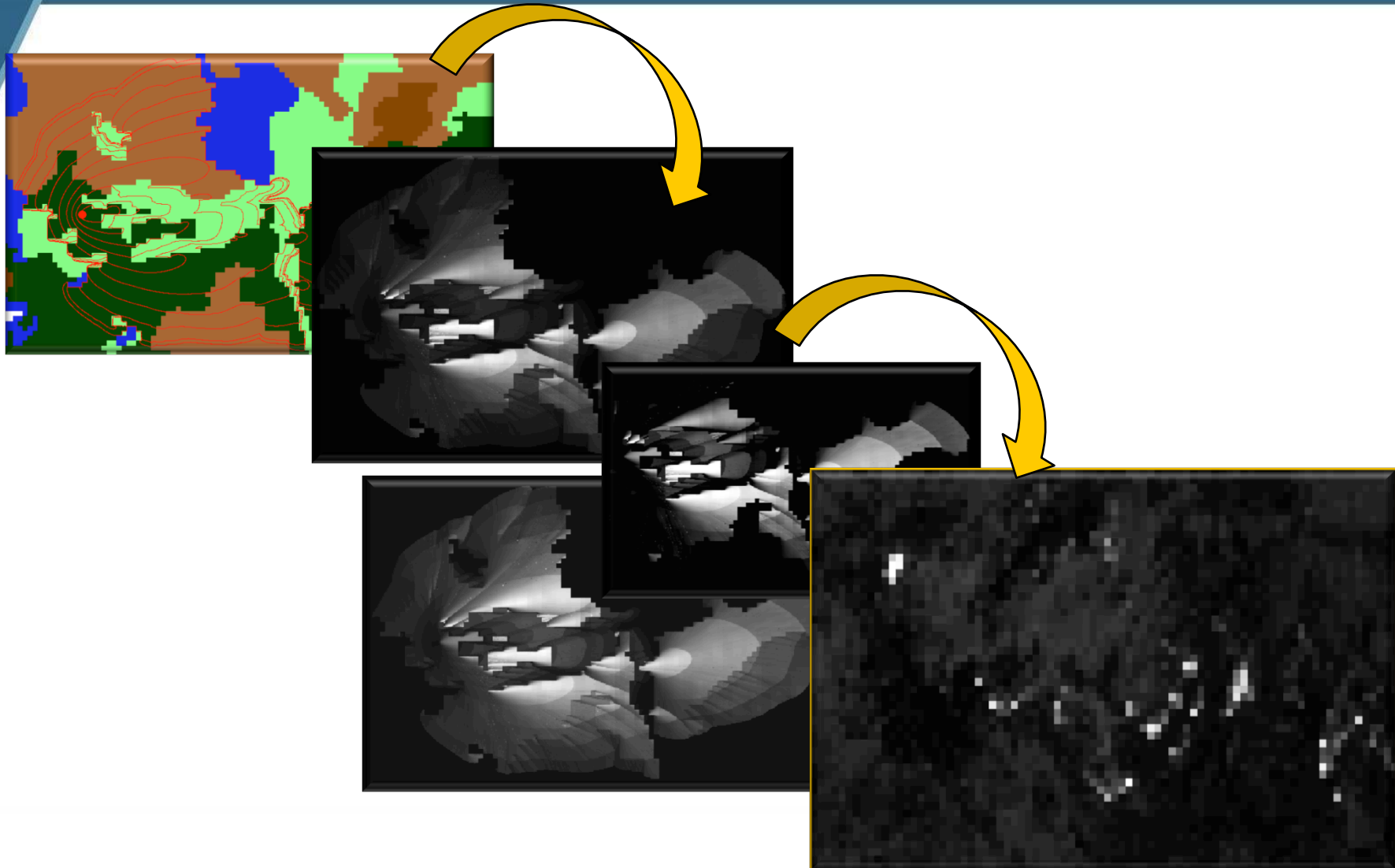


Pixel size: 1000 m



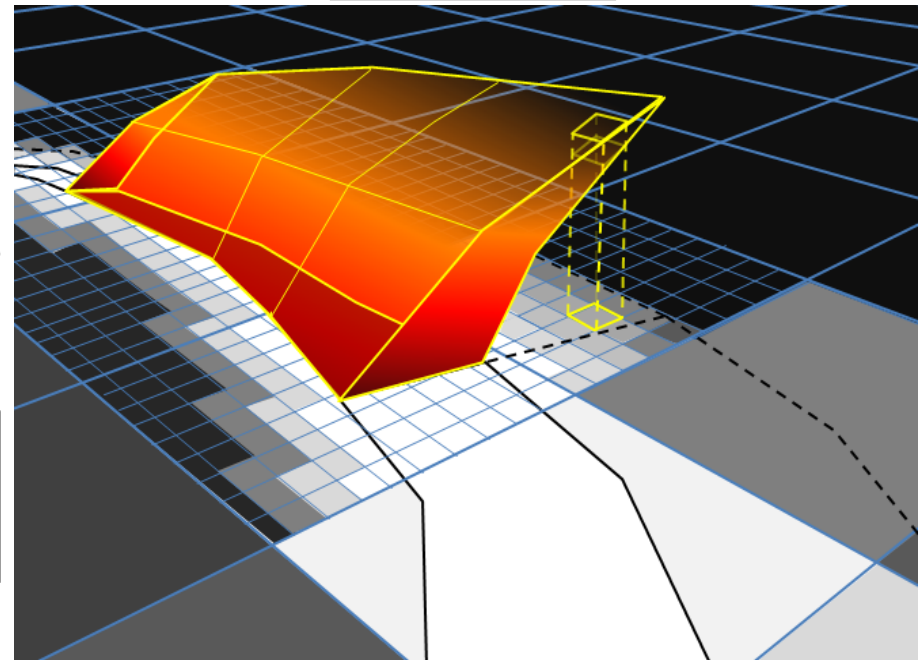
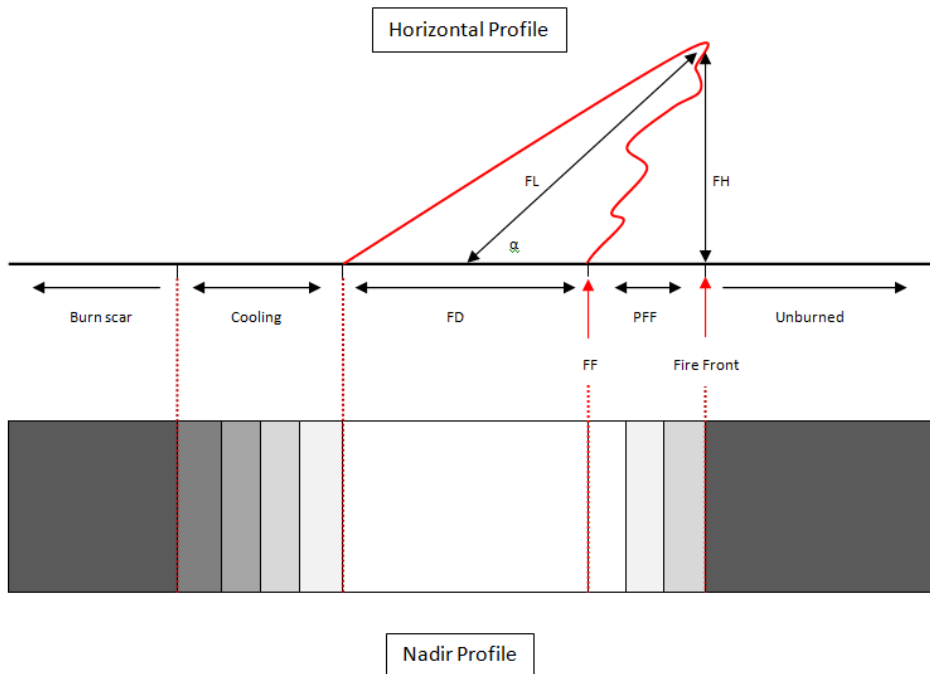
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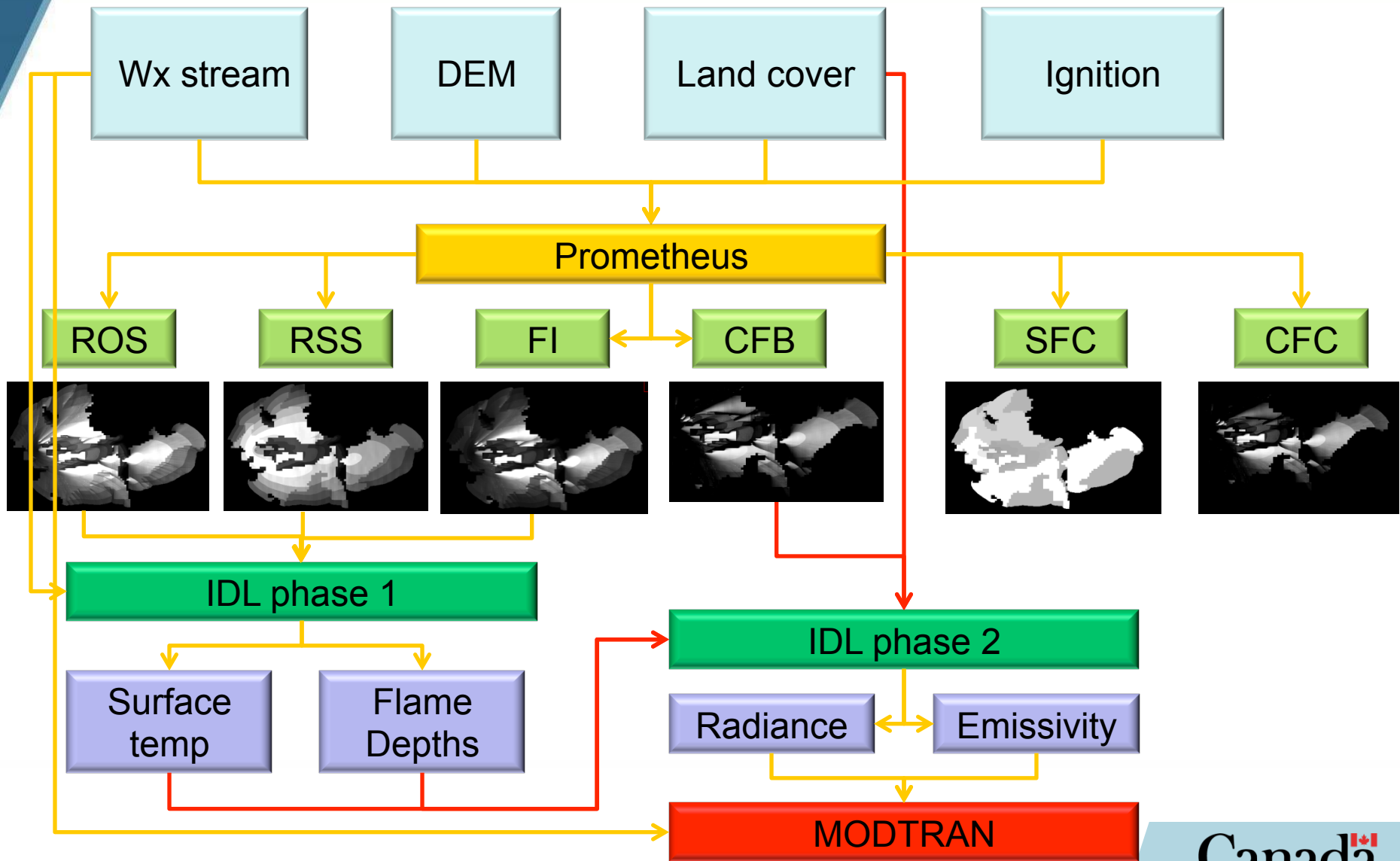


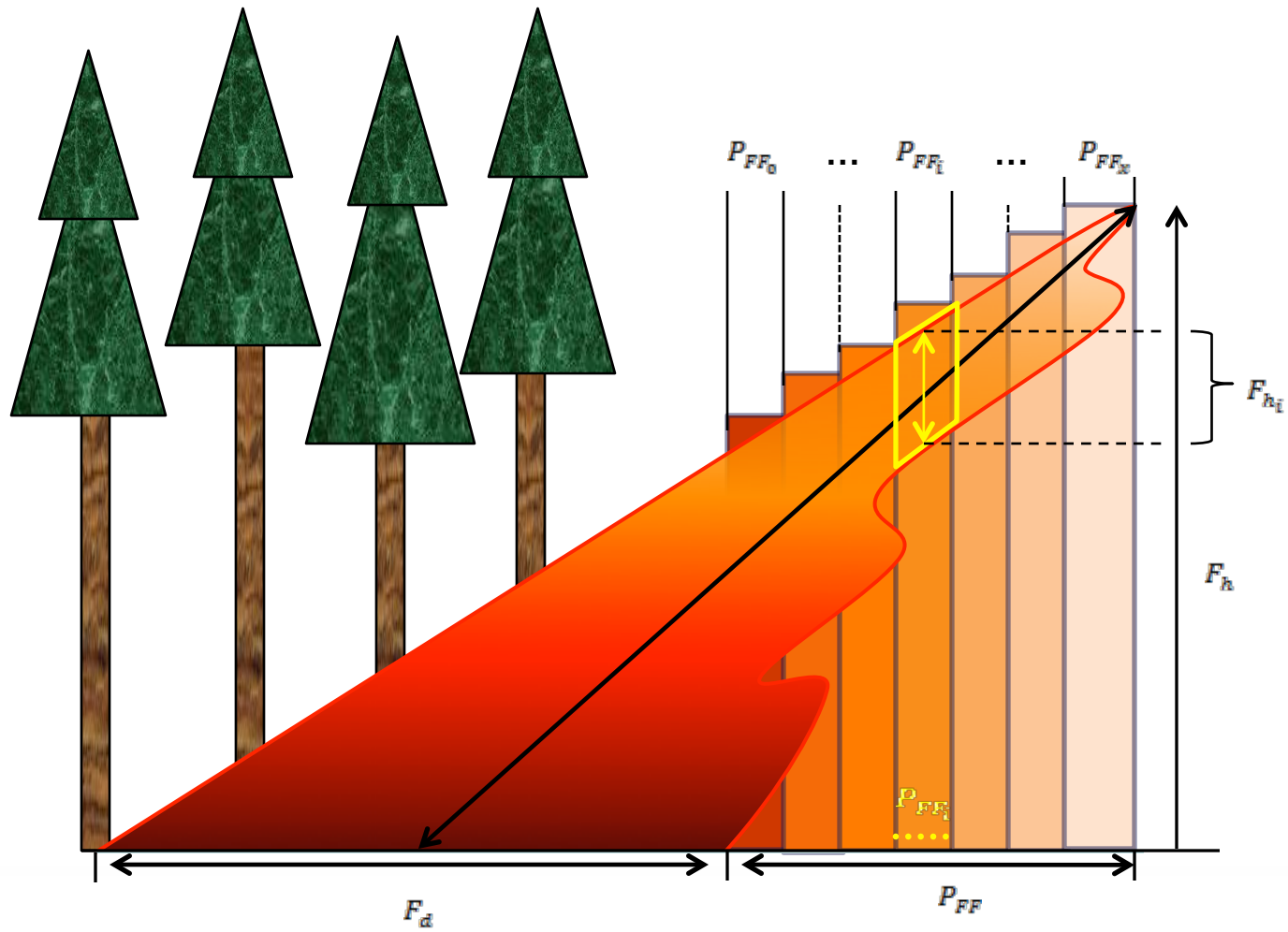


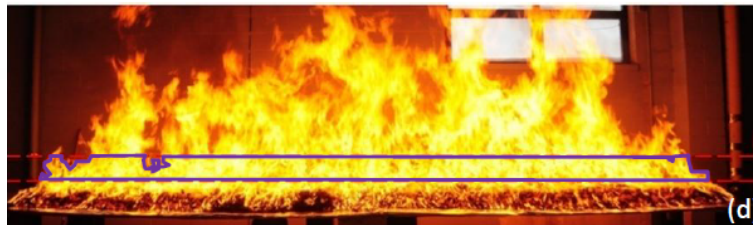
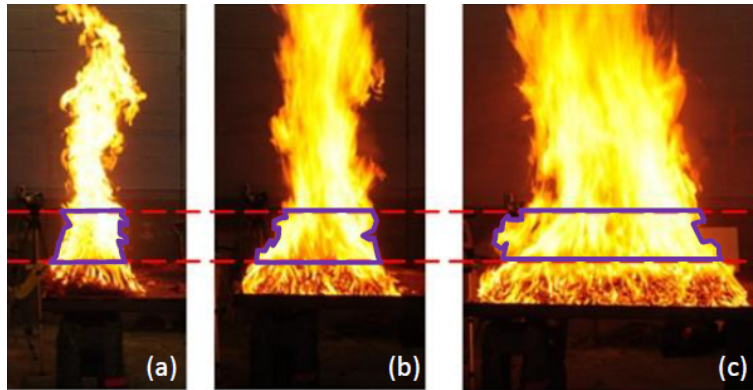
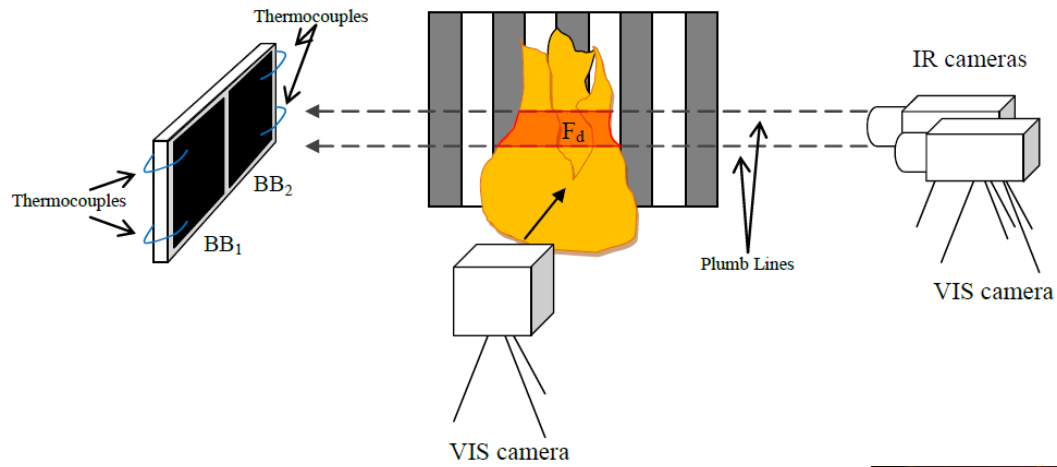
Raster Projection



(Anderson 1964; Byram *et al.* 1966; Anderson 1969; Van Wagner 1975; Tunstall *et al.* 1976; Albini 1981; Williams and Black 1981; Nelson and Atkins 1986; Carrier *et al.* 1991; Forestry Canada Fire Danger Group 1992; Wotton and Martin 1998; Kremens *et al.* 2003; Butler *et al.* 2004; Whang *et al.* 2009; Wotton *et al.* 2012)

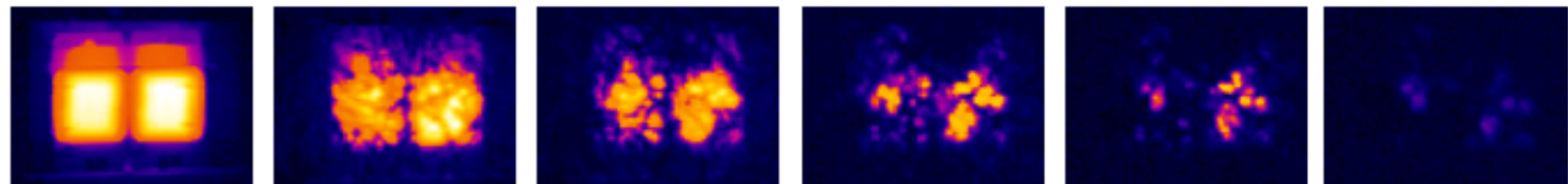








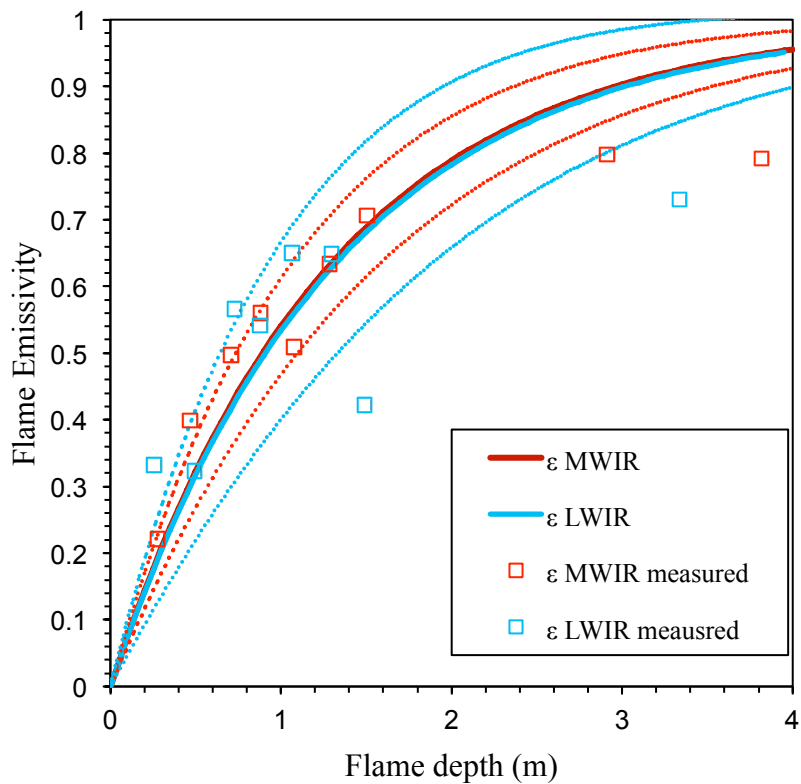
CANOPY DENSITY



RADIATION INTENSITY



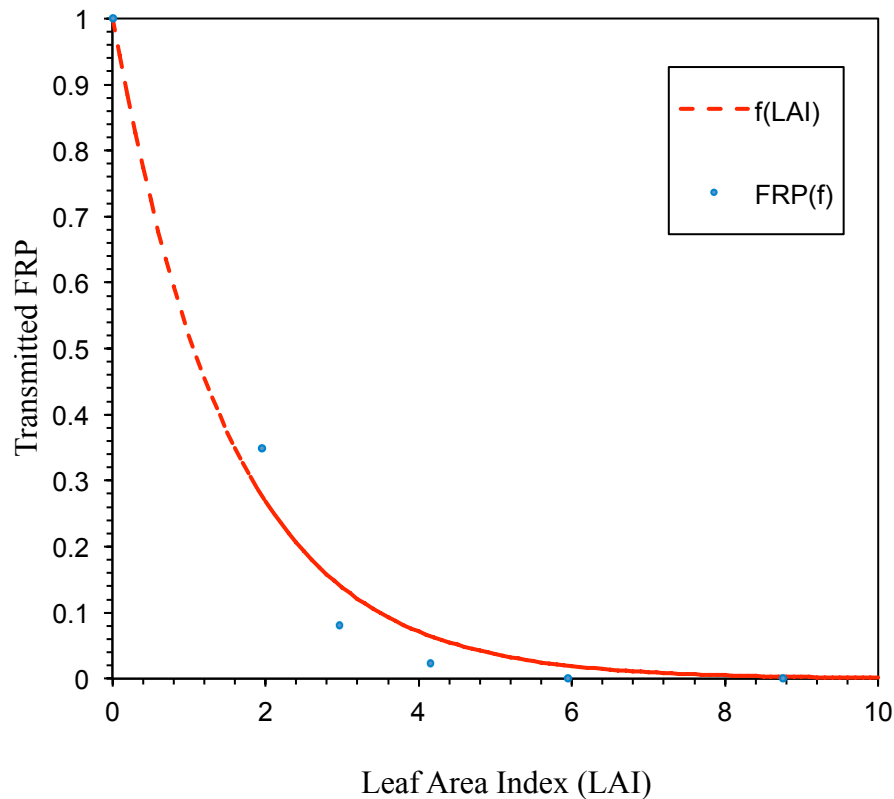
Flame Emissivity



$$\epsilon = 1 - e^{-k Fd}$$

MWIR: $k = 0.78$; $R^2 = 0.90$
 LWIR: $k = 0.76$; $R^2 = 0.61$

Canopy Interception



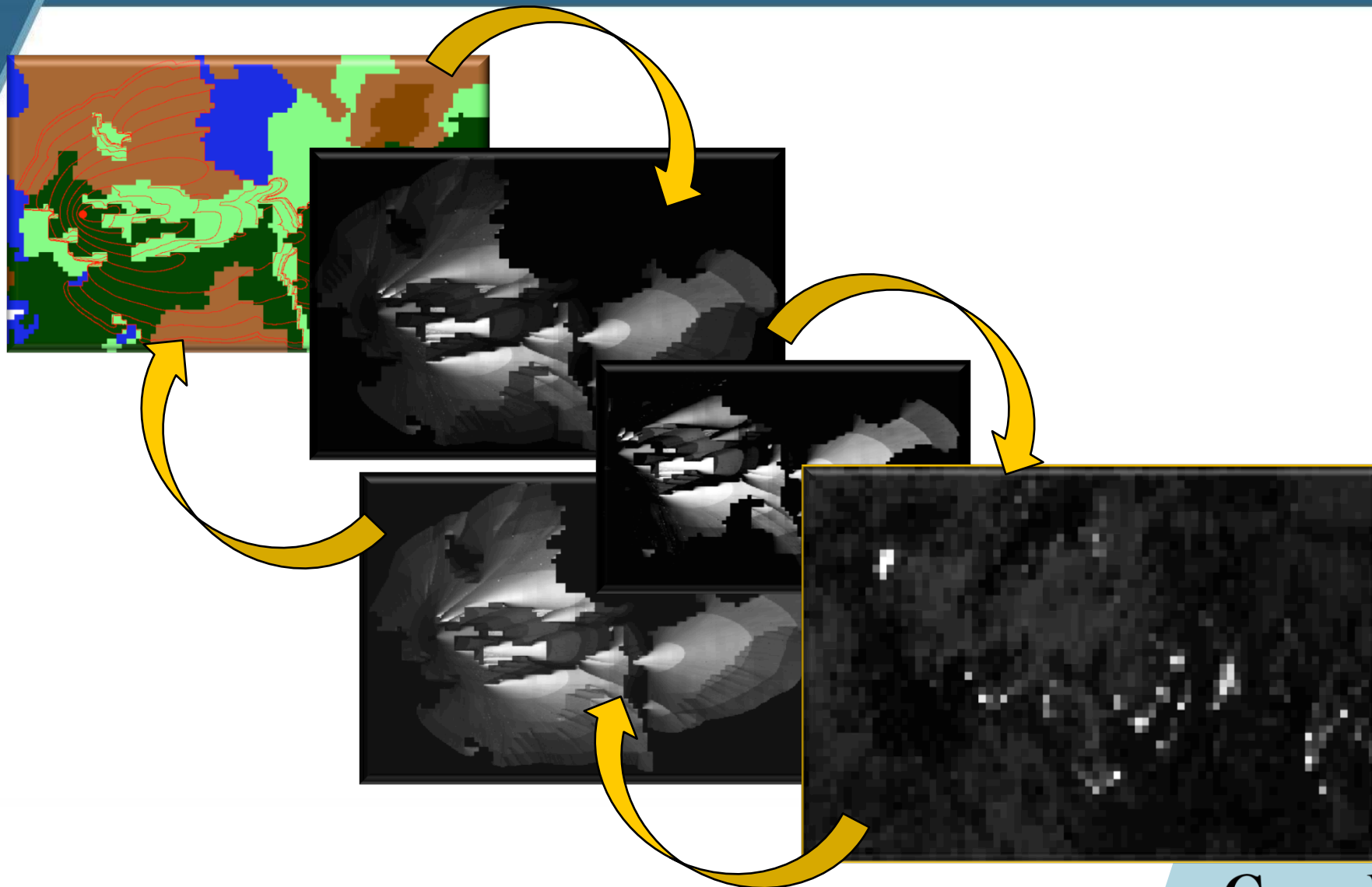
$$FRP_{TRANS} = e^{-0.66 LAI}$$

$R^2 = 0.98$



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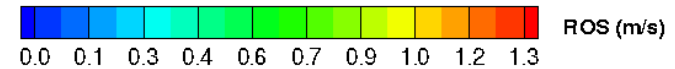
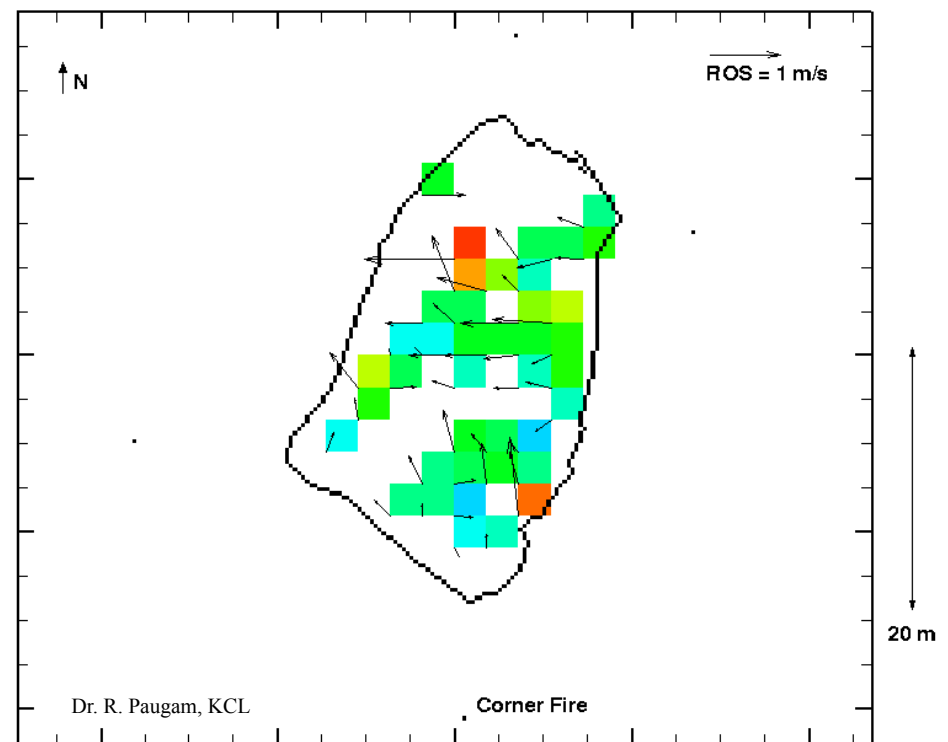
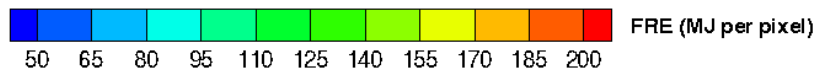
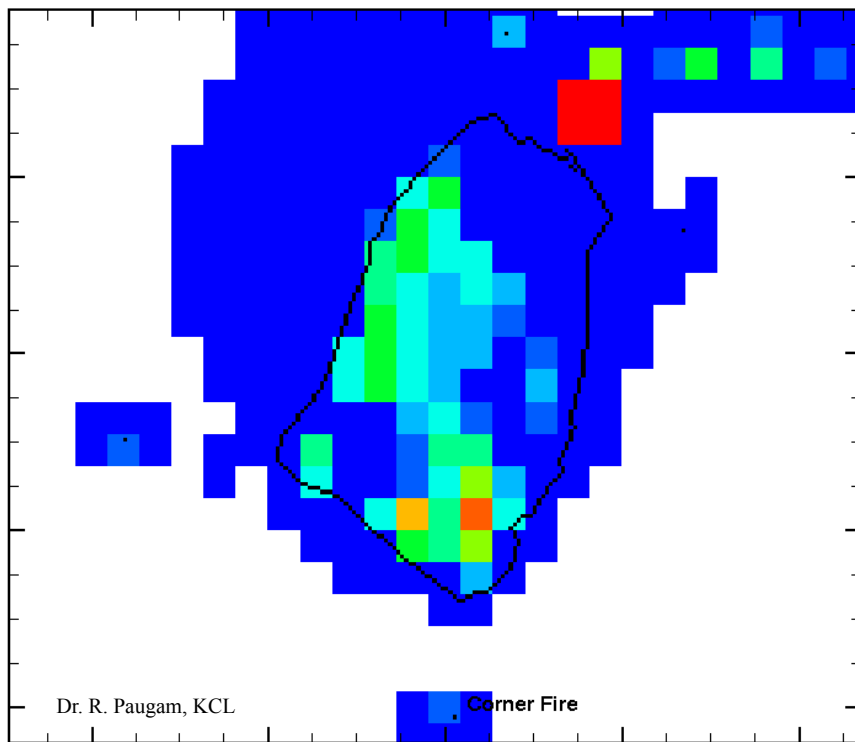
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Shoals Provincial Park LCPB

Peninsula Plot, April 30th 2012



Pixel Size = 2.4 m



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SHOALS PB

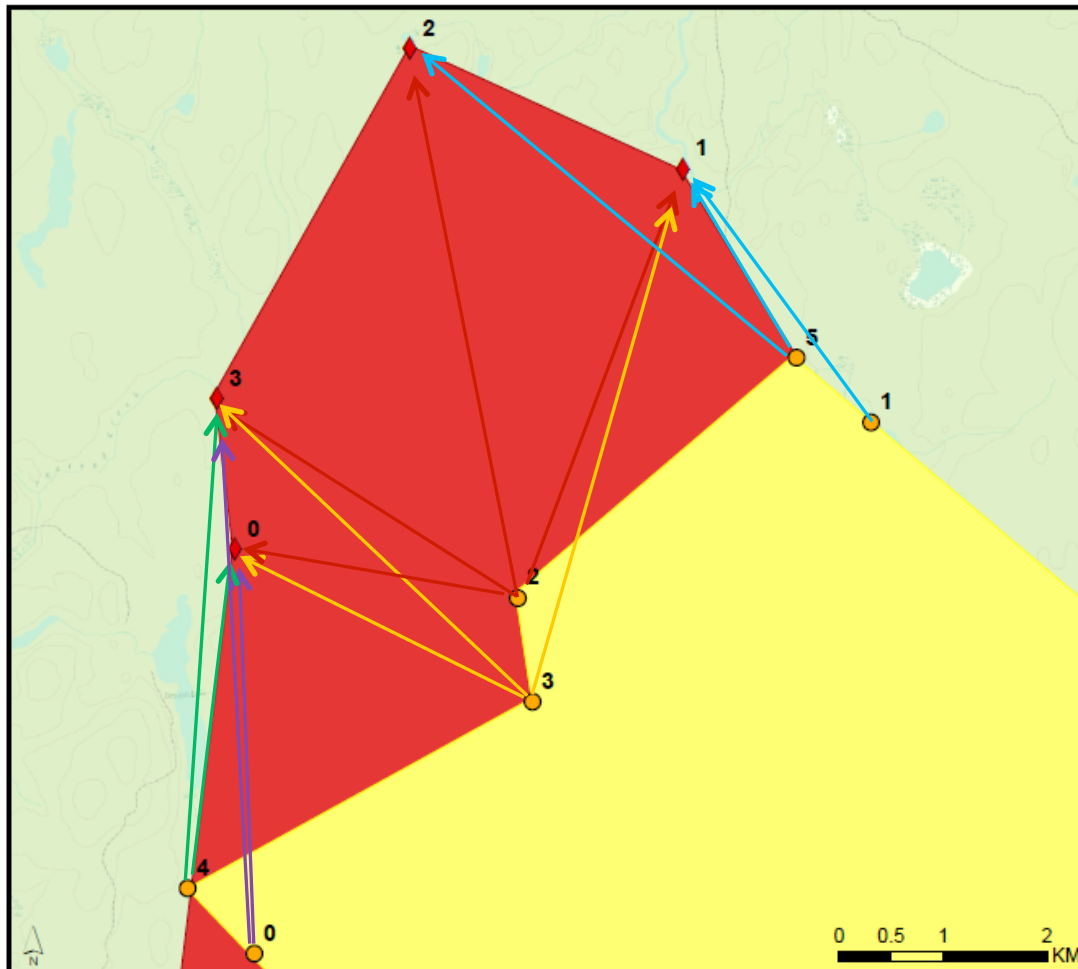
Peninsula Plot
April 30, 2012

Canada 

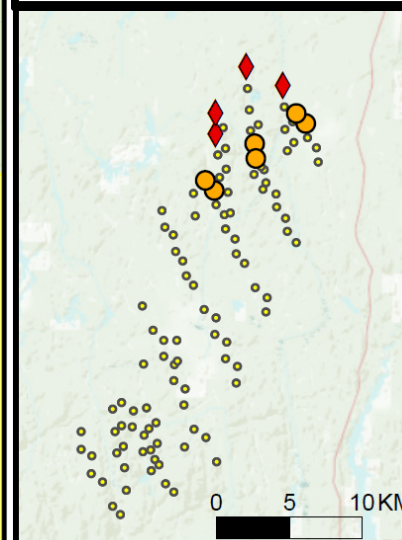


Timmins 9

May 21st, 2012



T1	T2	ROS (m/min)	HFI (kW/m)
0	0	40.11	12060.51
0	3	55.00	14127.68
1	1	31.29	12860.48
2	0	28.45	12152.92
2	3	35.76	13708.39
2	1	45.48	24208.33
2	2	55.43	21777.38
3	0	33.18	25583.64
3	3	43.34	31522.69
3	1	54.75	47969.37
4	0	33.94	4973.4
4	3	48.51	4984.007
5	1	21.88	4913.716
5	2	49.01	4177.261



Mean Values:

All Points

ROS = 41.2 (m/min)

HFI = 16,787.1 (kW/m)

Directional

ROS = 43.1 (m/min)

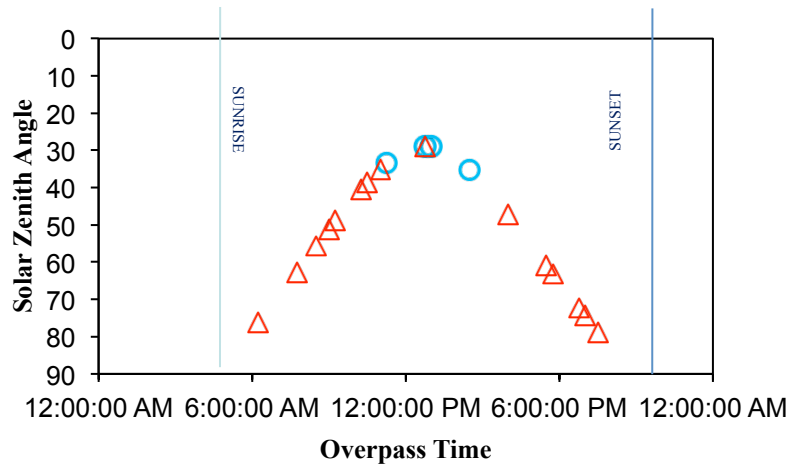
HFI = 21,630.5 (kW/m)

SOP description:

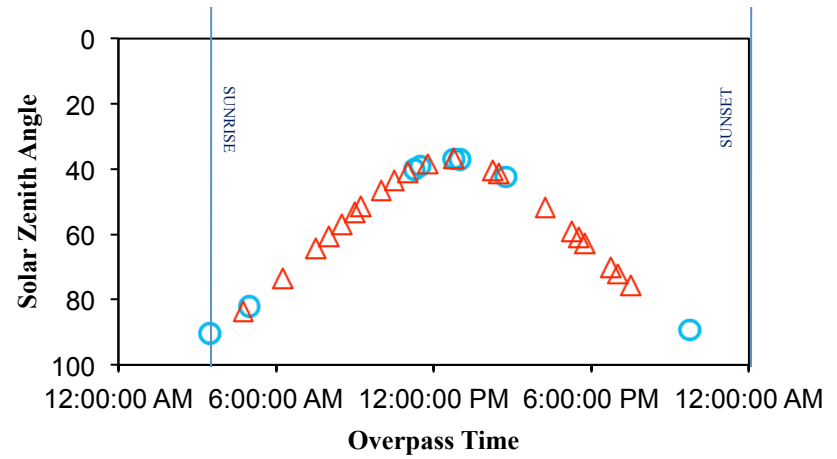
“In very quick period of time, fire quickly grew in size and report of AAO indicated IC 5, 21,000 ha IC 5 in C2 spotting 1 km”



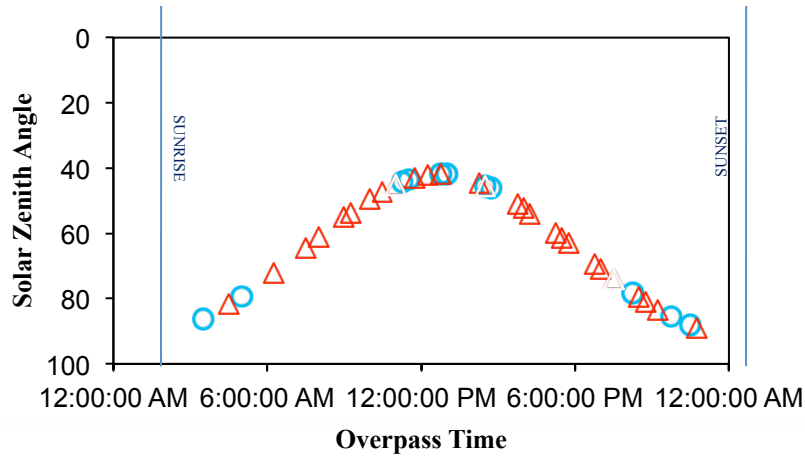
52° Latitude



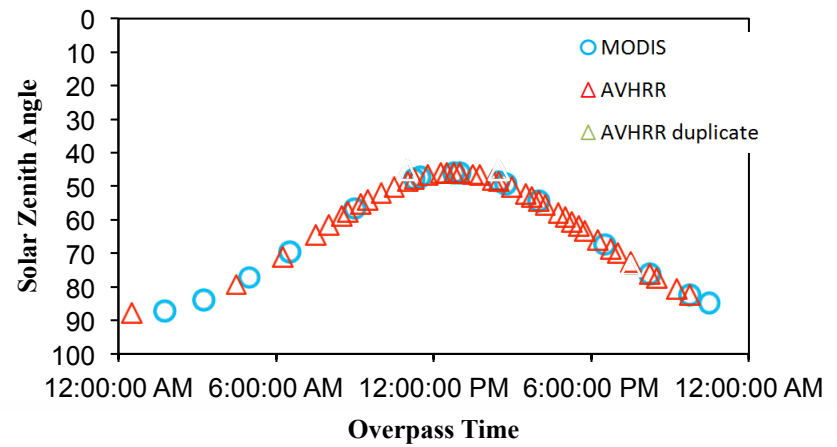
60° Latitude



65° Latitude



69° Latitude



* Overpass times for July 1st 2011 at -100° Longitude

A firefighter in an orange uniform and yellow helmet stands in a charred forest. The ground is covered in dark, charred debris, and wisps of white smoke rise from the ground. The background is filled with thin, black, charred tree trunks, creating a dense, somber atmosphere. The firefighter is looking to the right.

Thank you

Questions?



HFI Calculations

$$FI = \left(\int_{\tau} FRP dt \right) \times \left(\frac{D}{\tau} \right) \quad \approx \quad FI \approx FRE \times ROS$$

FI = Head Fire Intensity (kW/m)

FRP = Fire Radiative Power

τ = time domain of analysis

Shoals: τ = fire residence time

MODIS: τ = time lapse between overpasses

D = sample depth

Shoals: D = flame depth

MODIS: D = distance traveled between overpasses

Camera Assumption:

- FRP and flame depth are roughly constant for each 40cm pixel over the residence time

Satellite Assumption:

- The fire remains in a steady state between overpasses



References

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