Remote Sensing Methods to Assess Post-fire Effects

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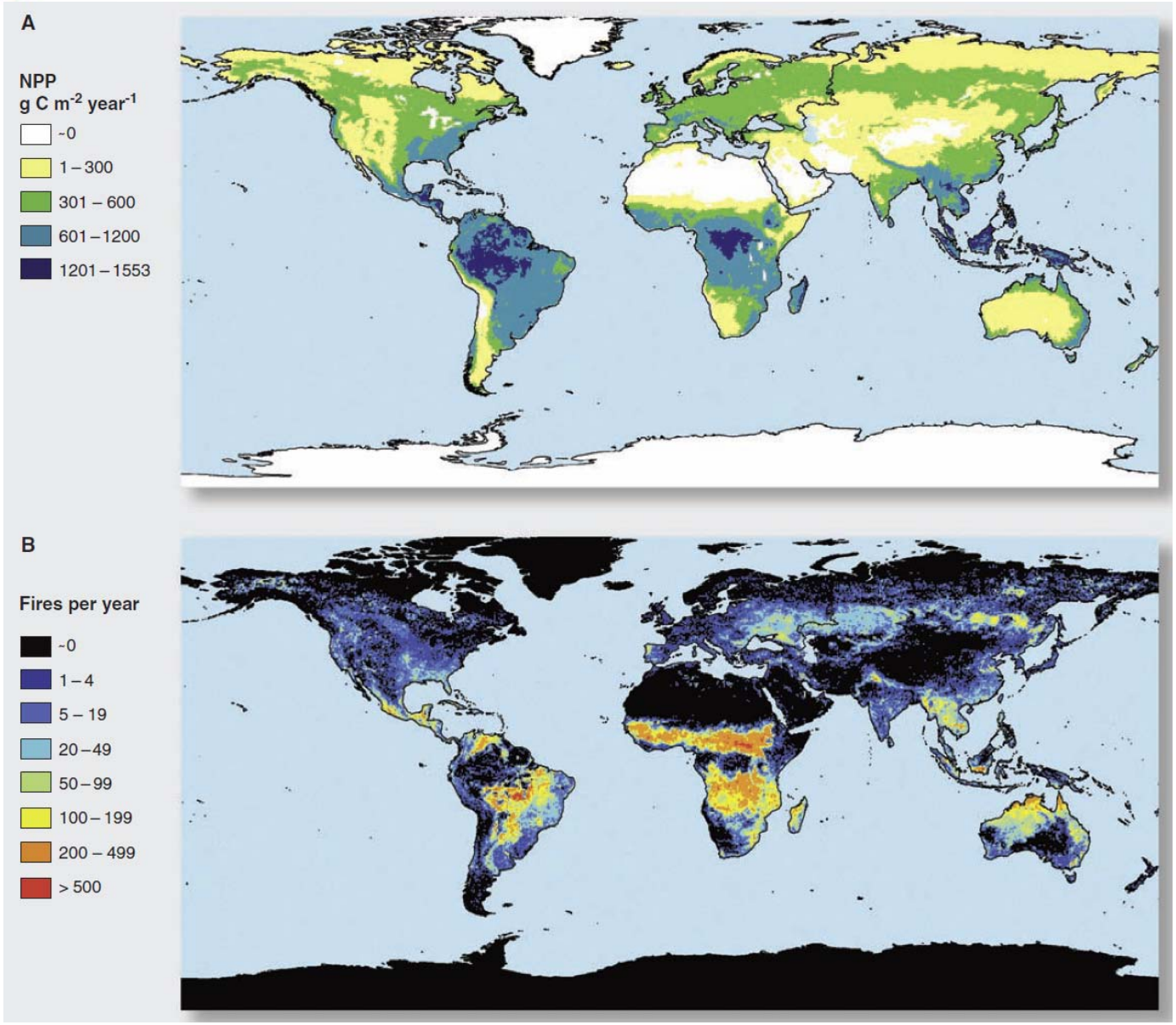
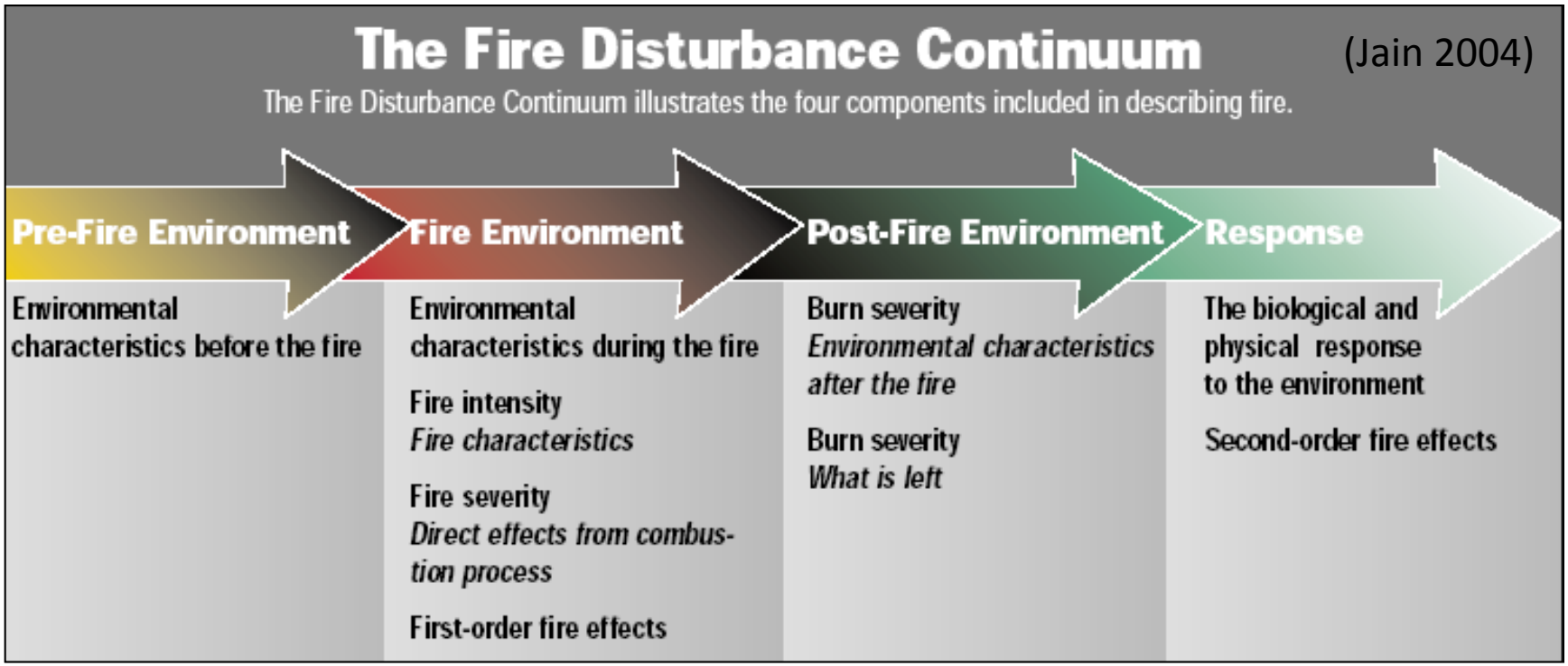
Fire in the Earth System



(Bowman 2009)

Temporal Dimension of Fire Effects

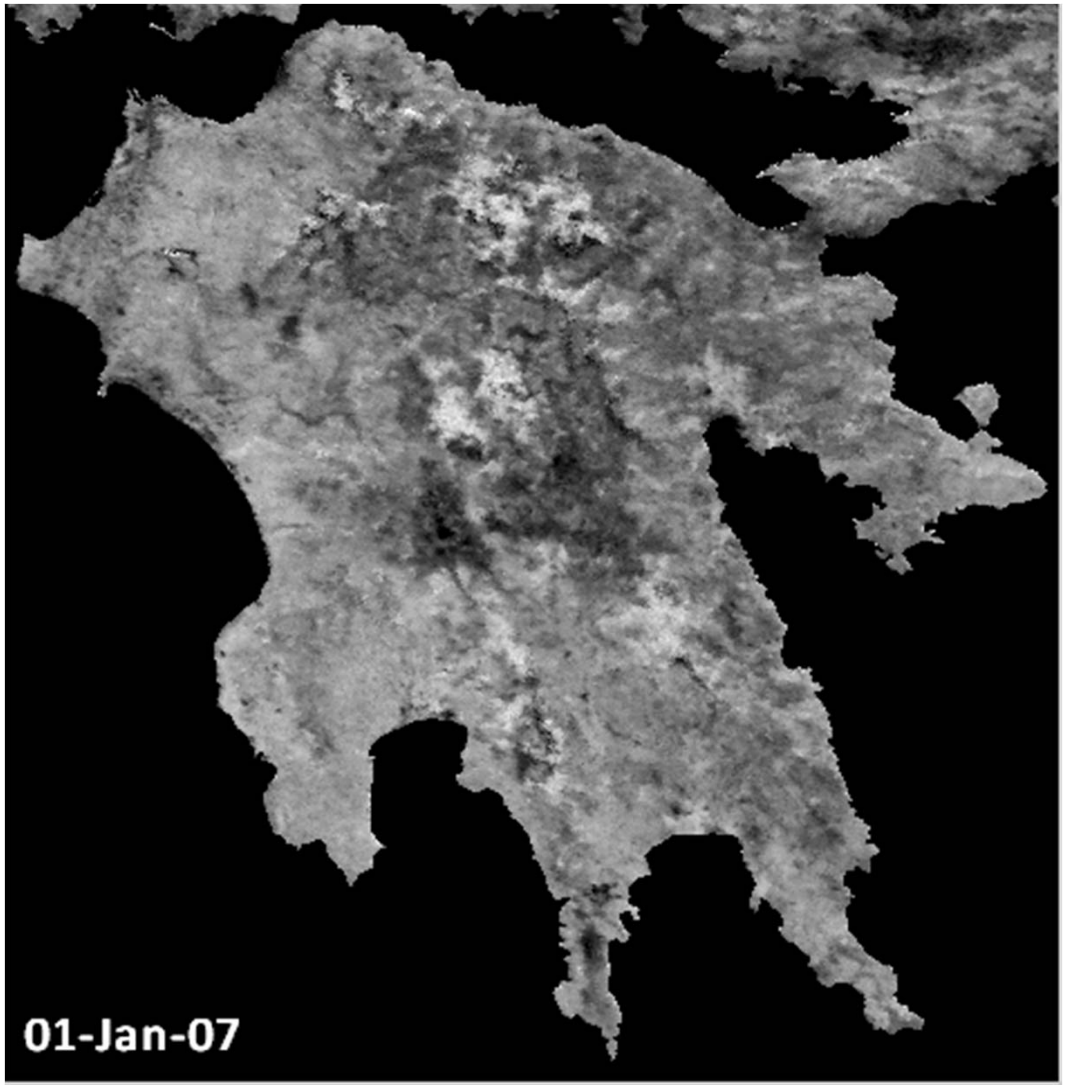


Fire risk

Fire progression

Recovery

Temporal Dimension of Fire Effects



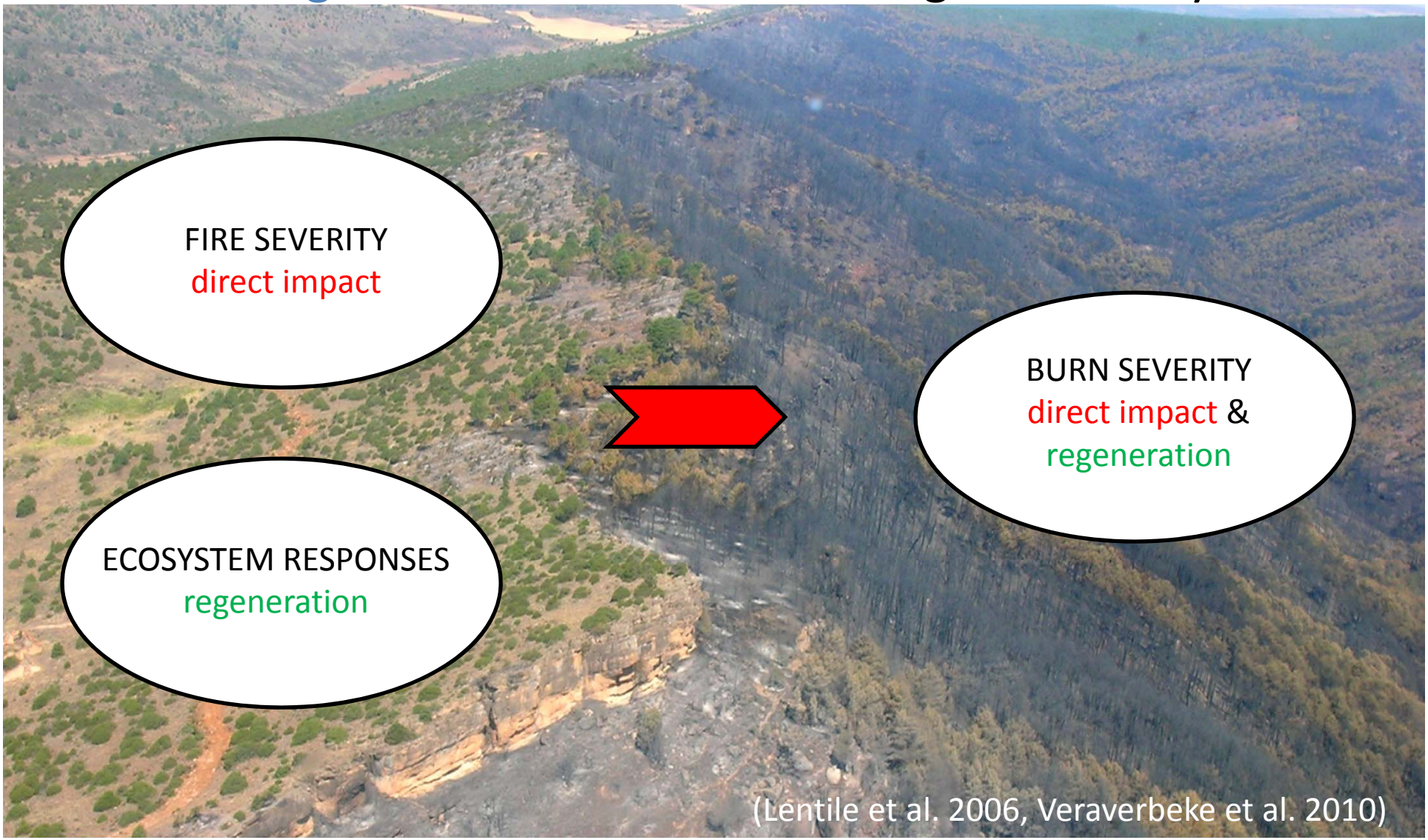
Fire

Seasonality

Recovery

Fire or Burn Severity?

SEVERITY: degree of environmental change caused by a fire



Why Measure Fire Severity?

1) Post-fire management

Erosion control
Rehabilitation

OPERATIONAL

1) Wildfire emissions

CARBON

large uncertainty!

Wildfires account for 20-40% of all global carbon emissions

Emission = Area X Mass X Combustion factor X Emission factor

WAY-TO-GO?

Post-fire Substrate and Vegetation Variability

Substrate

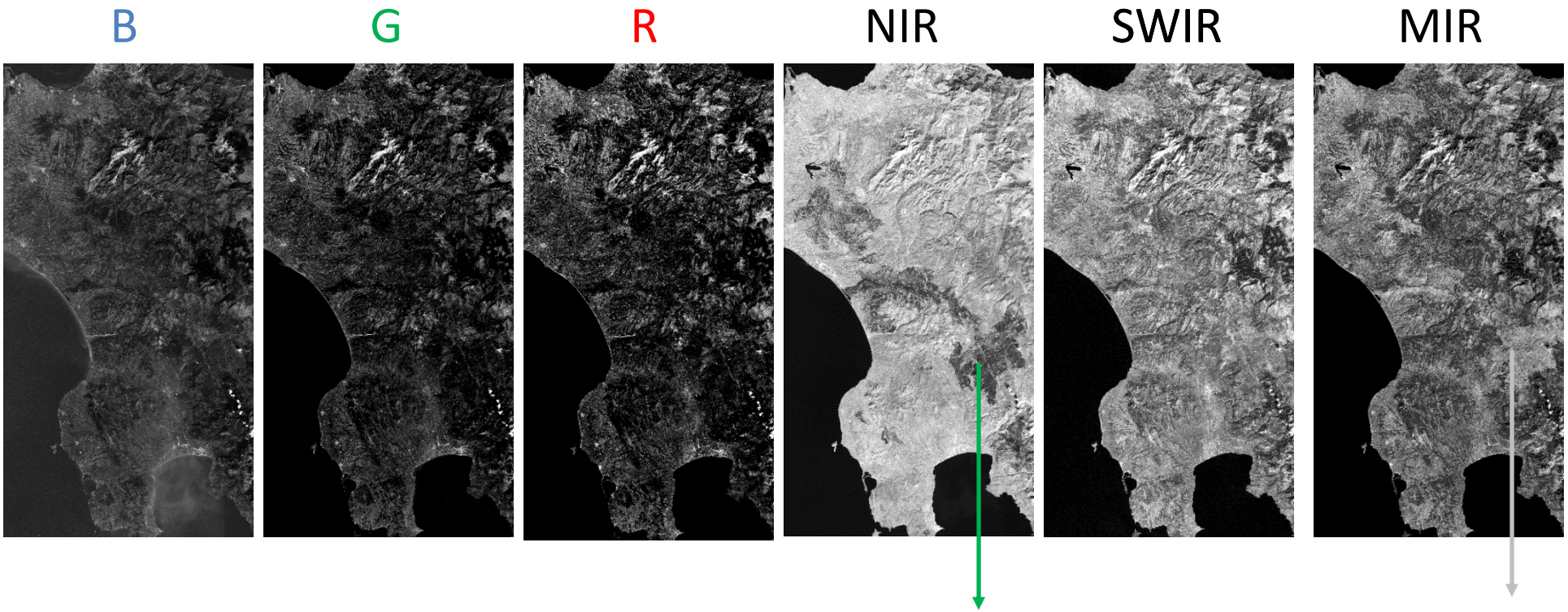
Understory

Overstory

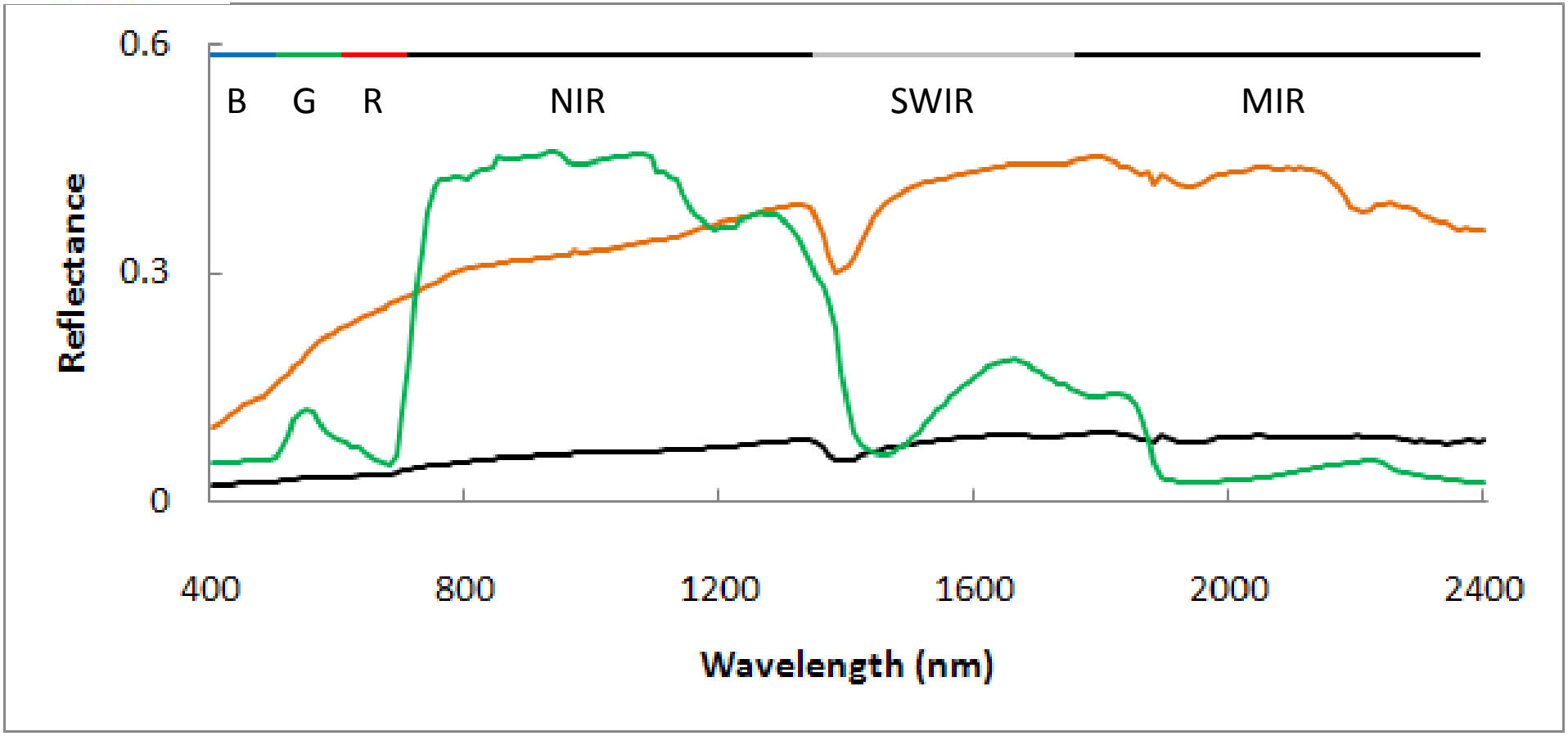
(De Santis 2009)

How to Measure This Spatial Variability?

What's in an Image?



What's in an Image?



vegetation char soil

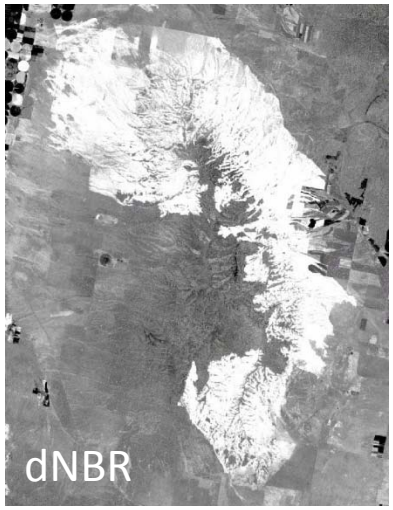
Two processes govern the spectral response of a post-fire landscape:

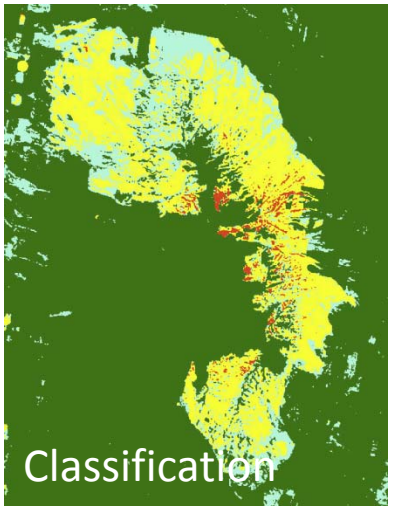
- Vegetation removal
- Char and soil exposure

Remote Sensing Solution for Fire Severity so Far?

the Normalized Burn Ratio (NBR)

(Hinkley 2011)





$$NBR = \frac{NIR - MIR}{NIR + MIR}$$

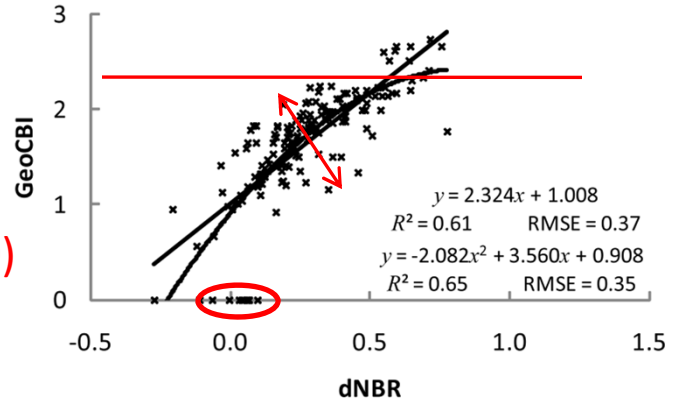
$$dNBR = NBR_{pre} - NBR_{post}$$

BAER
BURNED AREA EMERGENCY RESPONSE

Criticism on the (d)NBR

Saturation for high severity plots (a.o. van Wagtendonk et al. 2004, Veraverbeke et al. 2010)

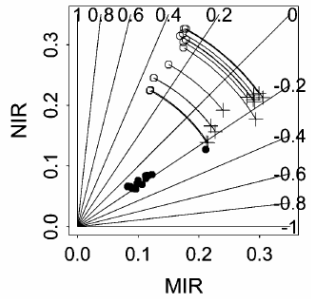
Sub-optimal index design (Roy et al. 2006)



Sensitive to soil brightness variations (Smith et al. 2010)

Sensitive to illumination effects and phenological mismatch (Key et al. 2006, Verbyla et al. 2008, Veraverbeke et al. 2010)

dNBR does not account for pre-fire landscape heterogeneity (Miller and Thode 2007)



Results are site-specific (a.o. French et al. 2008)

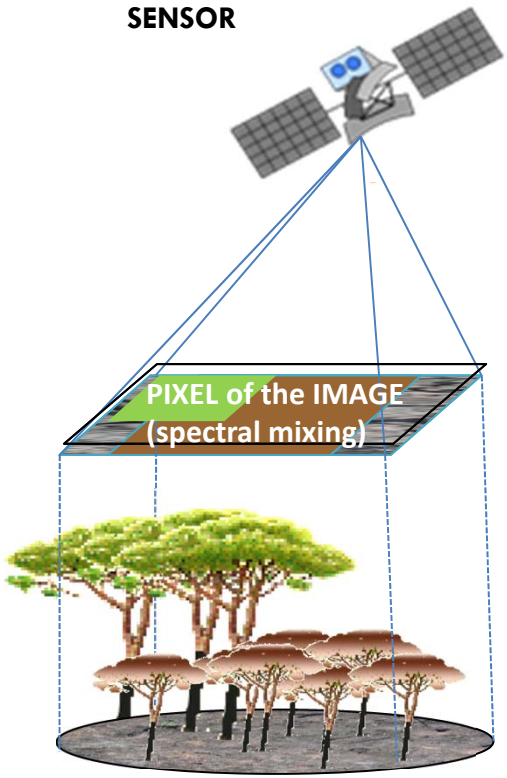
dNBR values have no biophysical meaning (Lentile et al. 2006, Smith et al. 2007)

Spectral Unmixing

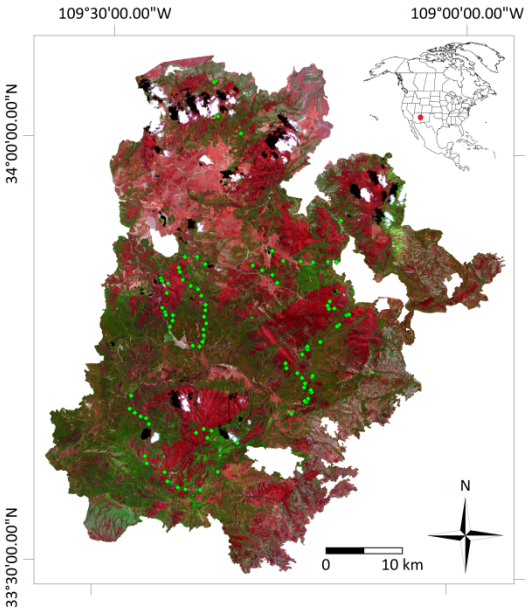
Retrieval of char, green vegetation, brown vegetation and soil fraction

$$Burned\ fraction = \frac{Combusted\ material}{Combustible\ material}$$

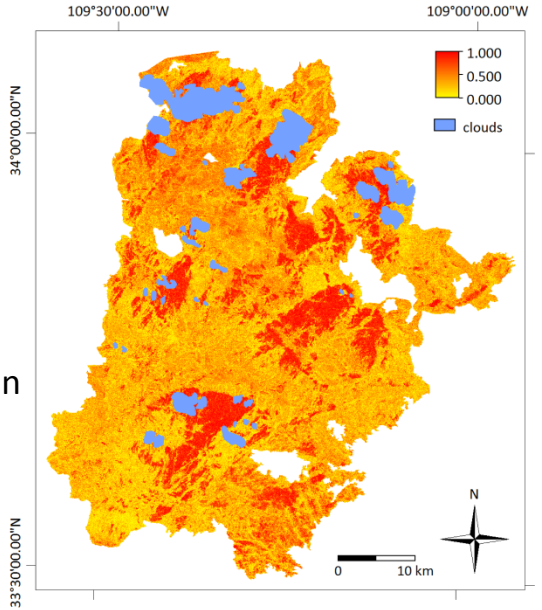
$$Burned\ fraction = \frac{char}{char + vegetation}$$



(De Santis 2009)



Burned fraction



(Veraverbeke and Hook 2012)

Link with Carbon

Emission = Area X Mass X Combustion factor X Emission factor

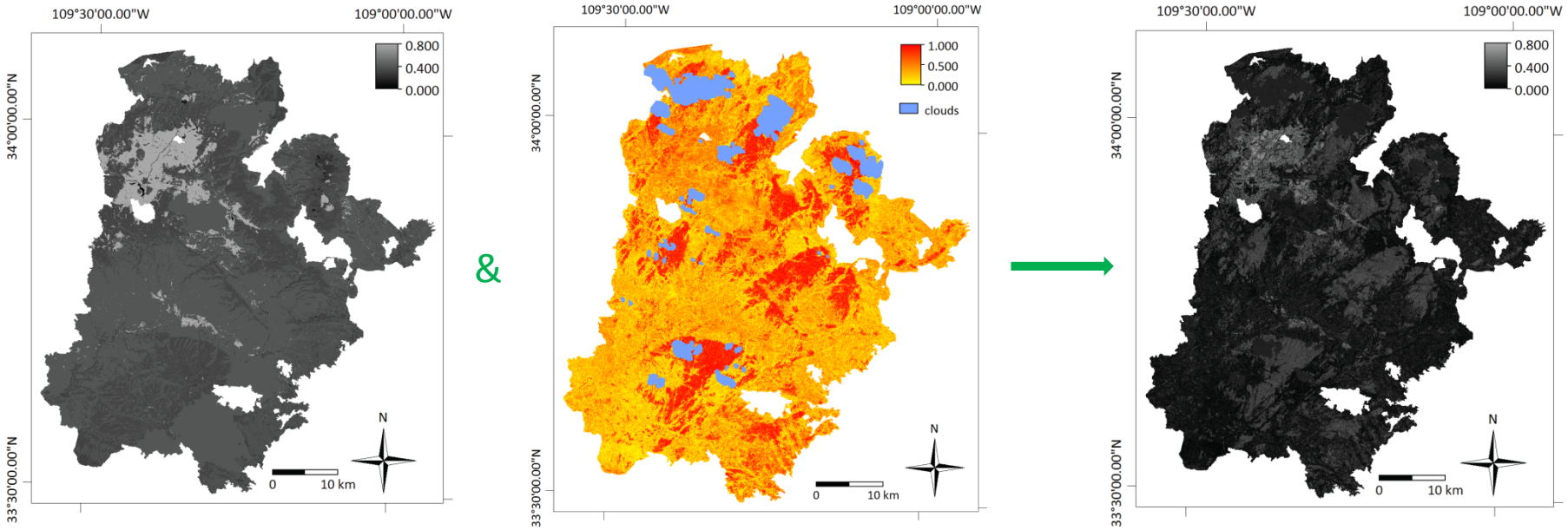
Combustion factor depends on:

- Fuel type
- Fuel moisture
- Fire severity

} Modeling

→ Remote sensing

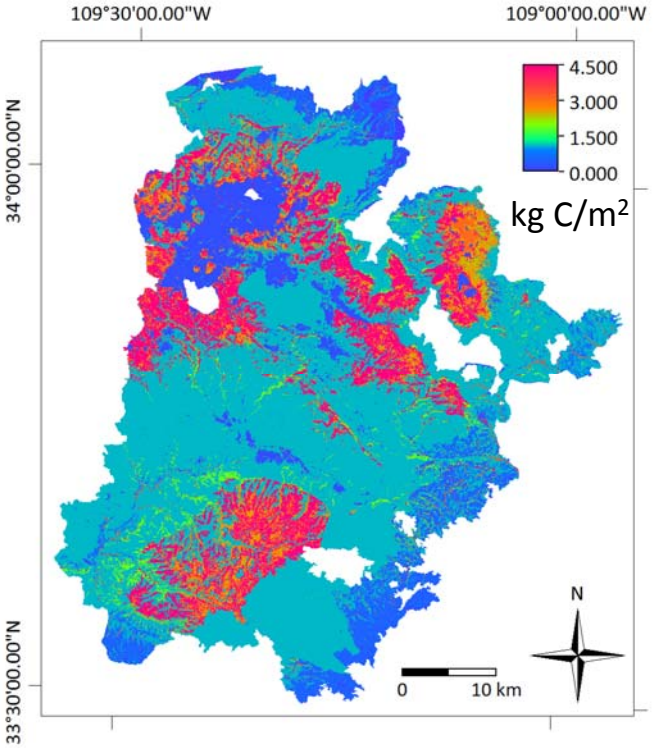
MODELING & FIRE SEVERITY → COMBUSTION



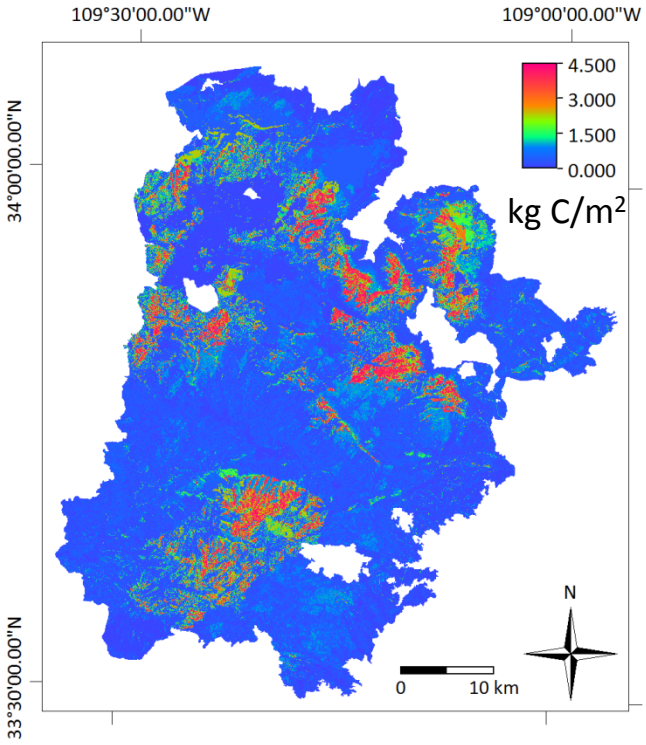
(Veraverbeke and Hook 2012)

Link with Carbon

C emission from modeling only



C emission from modeling and RS

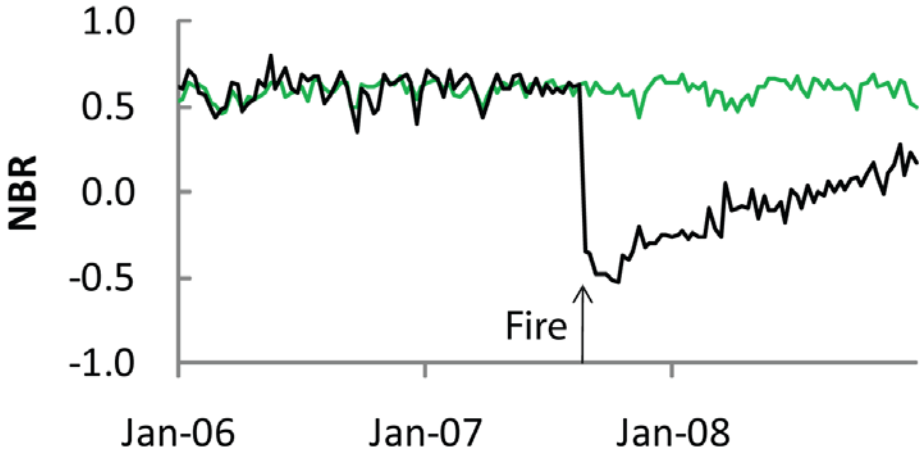


Fire	Burned area (ha)	CC estimation methodology	Total C emission (Tg)	Area normalized C emission (kg/m^2)	% carbon emitted relative to modeling approach
Wallow	218 000	Modeling	3.44	1.57	1
Wallow	218 000	Modeling and RS	1.52	0.70	0.45

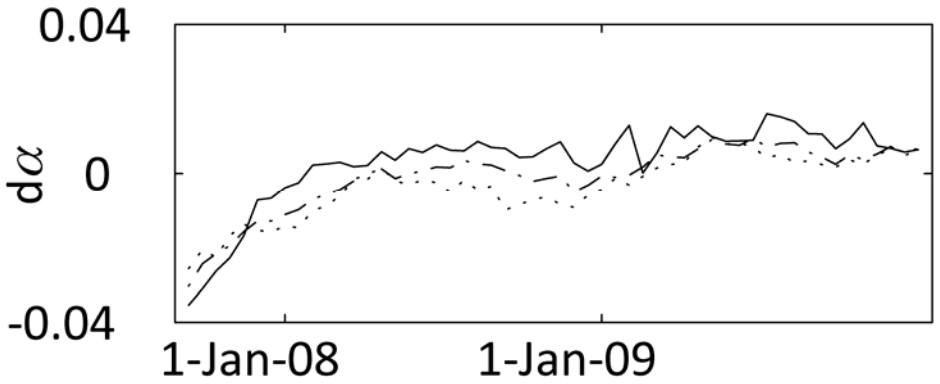
(Veraverbeke and Hook 2012)

Monitoring Recovery

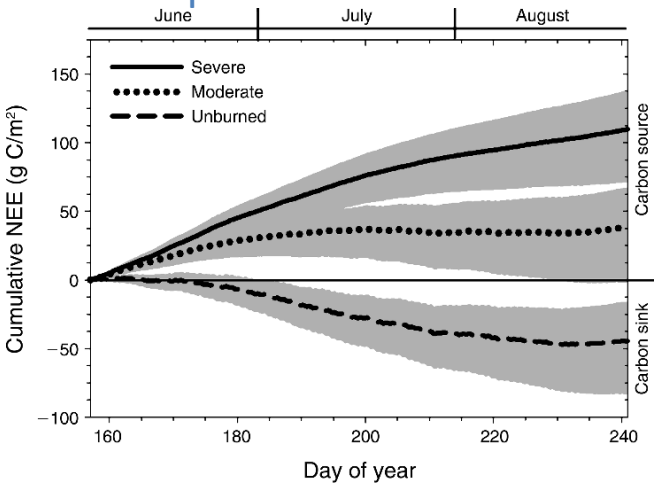
Control plots (Lhermitte et al. 2010)



Albedo

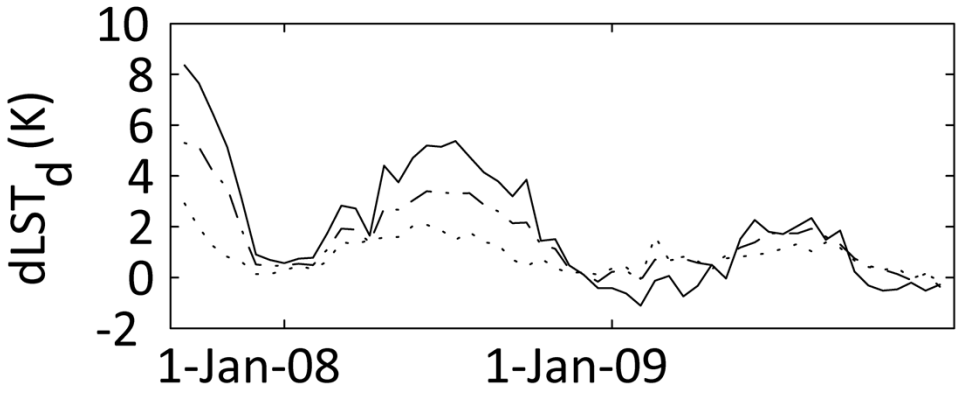


Carbon uptake



(Rocha and Shaver 2011)

Surface temperature



(Veraverbeke et al. 2012)

Where should fire research with RS head?

Make it ECOLOGICALLY relevant (or: go beyond just indices):

- Go global: use of fire severity data for global wildfire emission estimates

- Go hyperspectral: monitor biodiversity and succession after a fire

- Go LiDAR and SAR: monitor structural changes caused by fire

DON'T START FIRES YOU CAN'T STOP.
BE FIREWISE.
FIREWISE
WILDFIRE
MOVES
QUICKER
THAN YOU
THI