A parameterization of wildfire emission injection heights in North America: Analysis from satellite observations and models

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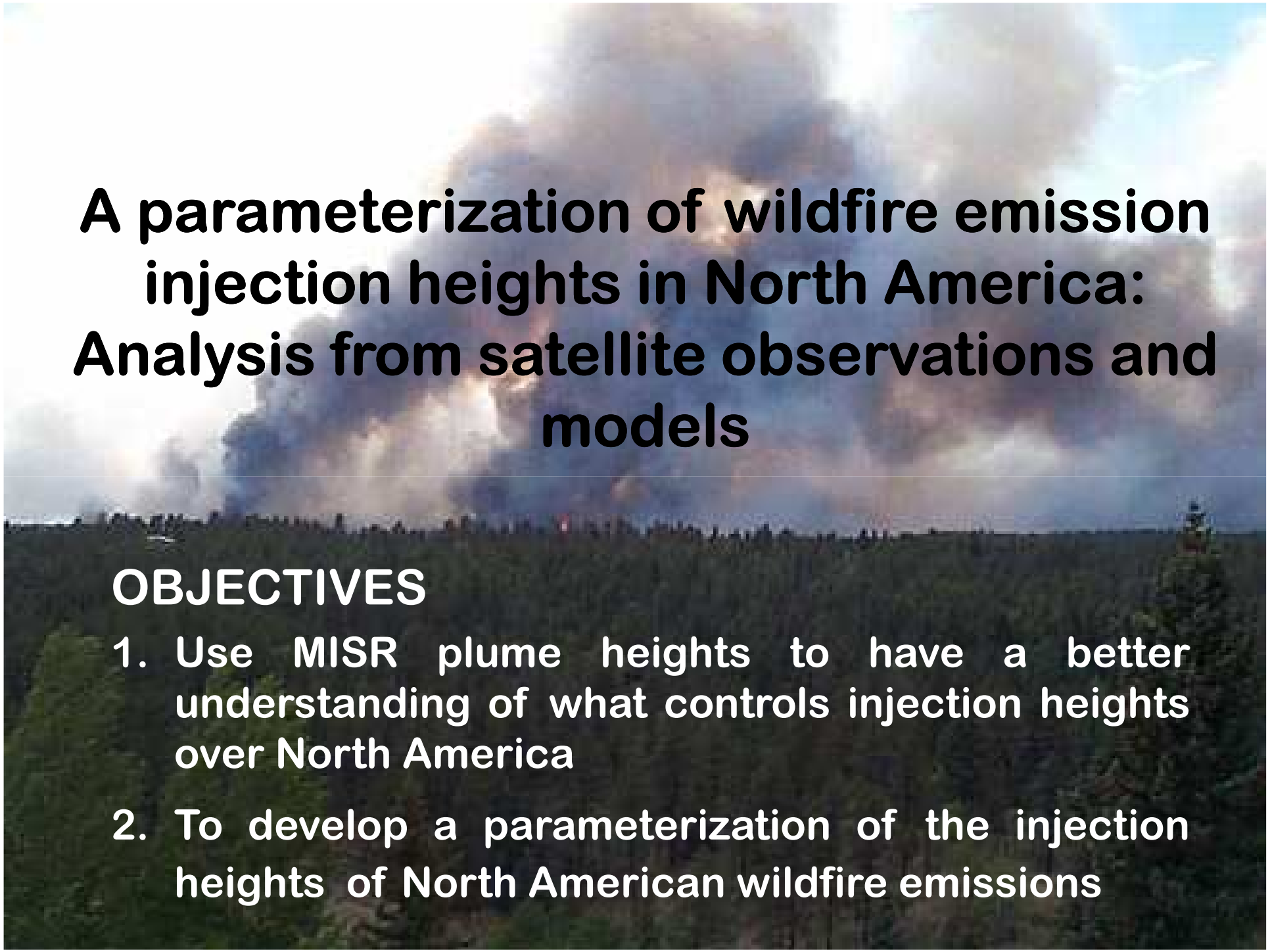

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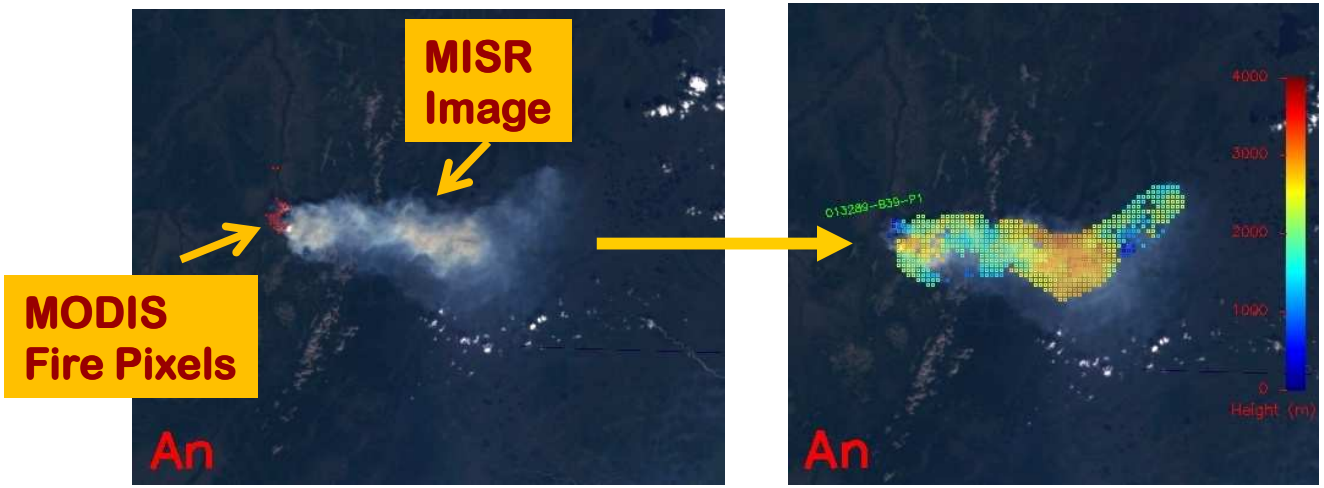
OBJECTIVES

1. Use MISR plume heights to have a better understanding of what controls injection heights over North America
2. To develop a parameterization of the injection heights of North American wildfire emissions

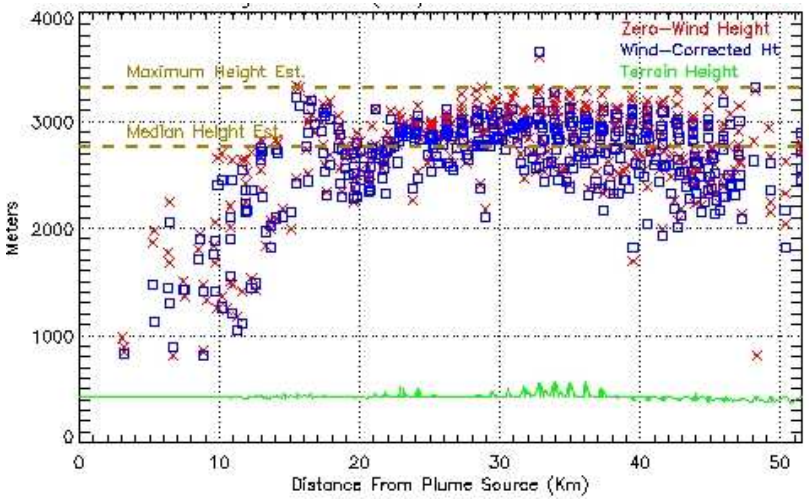
MISR Plumes: Overview of the MINX Tool (MINX = MIsr Interactive eXplorer)

Smoke plume over central Alaska in June 2002

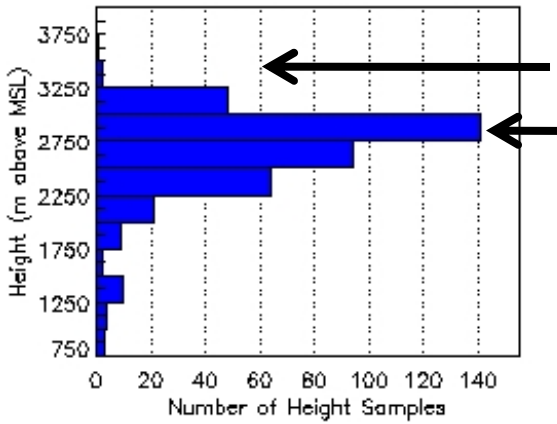


From MODIS:
Fire Radiative Power = 2500 MW;
Area = 50 ha

Cross-section of heights vs. distance from plume source (0-50 km)



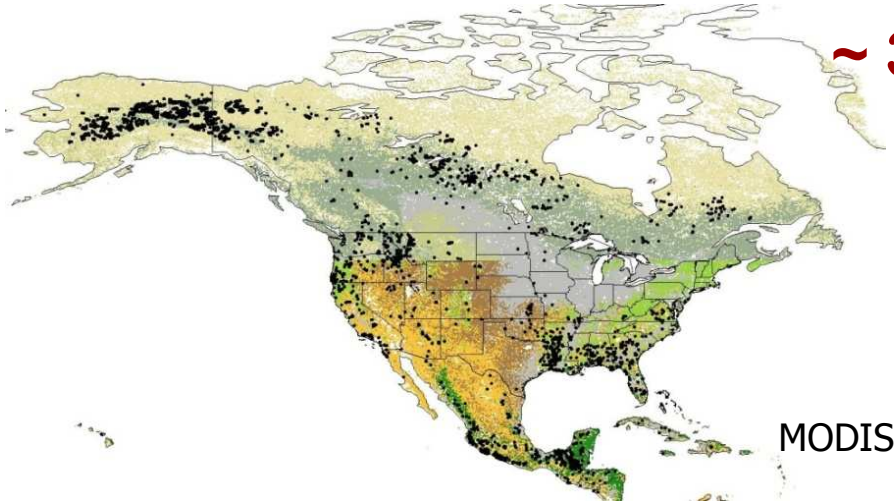
Histogram of heights



Max Height

Median Height

North America Plume Climatology

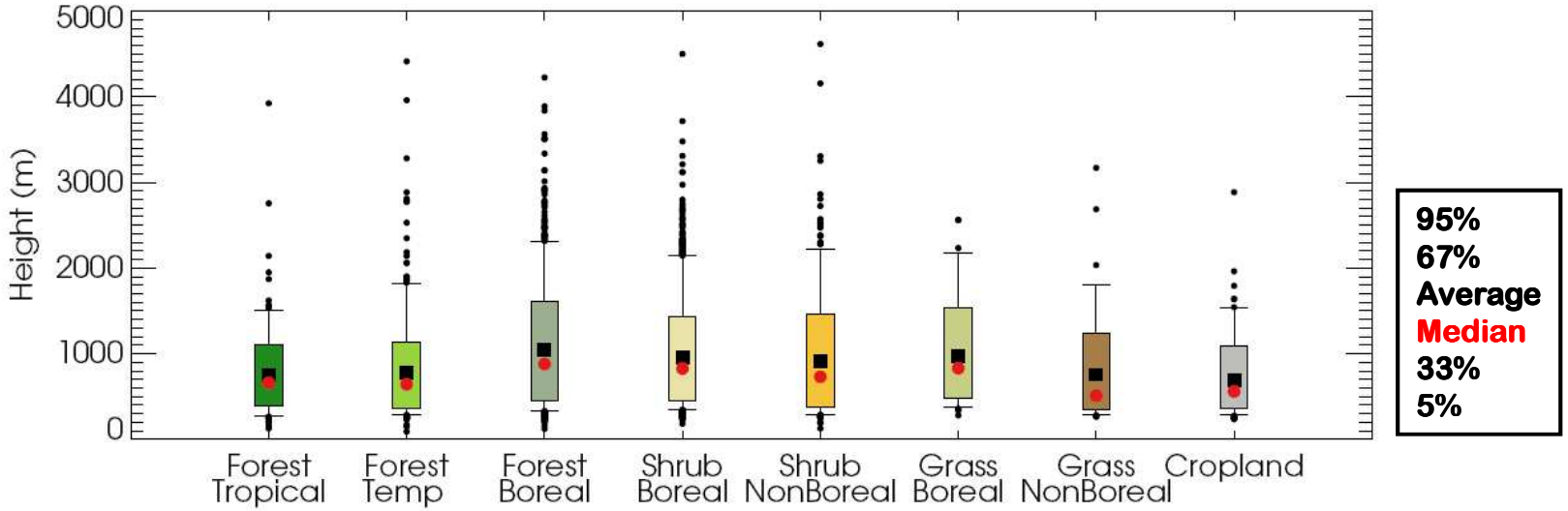


MODIS IGBP land cover map
(1x1 Km res)

~ 3400 plumes digitized over North America in 2002, 2004-2007

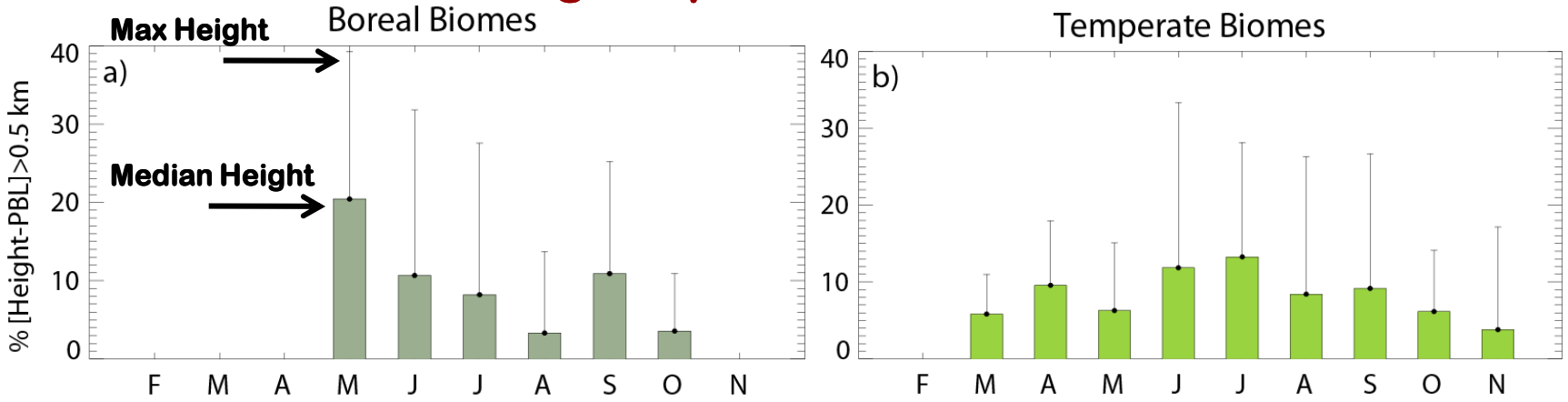
- Tropical Forest
- Temperate Forest
- Boreal Forest
- Boreal Shrubland
- Non-Boreal Shrubland
- Boreal Grassland
- Non-Boreal Grassland
- Cropland

MISR Plume Median Heights

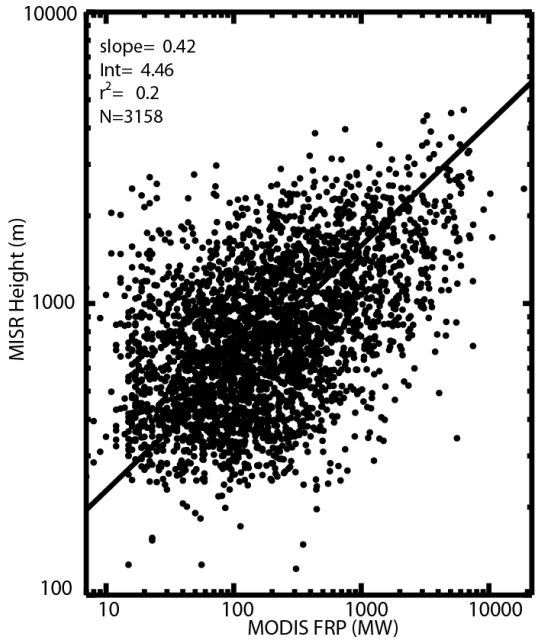


Plume heights depend on atmospheric stability and fire intensity (Val Martin et al, ACPD 2009)

Percentage of plumes above the BL



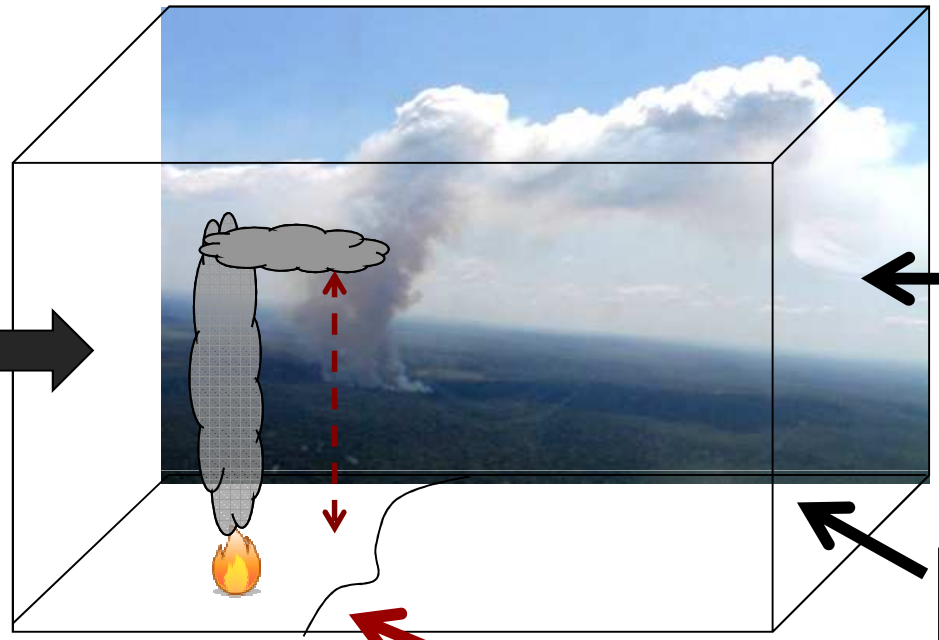
MISR height versus MODIS FRP



- 10-20% plumes in FT at the fire season peak
- Plumes above the BL tend to get trapped in stable layers
- Plumes without stable layers get more dispersed in the FT

- There is a connection between height and fire intensity

Merging MODIS and MISR into a 1-D plume-rise model



Effect of Horizontal Wind

RH, Press, Temp and Wind Speed
GEOS meteo fields

Fuel moisture content
Canadian FWI Model

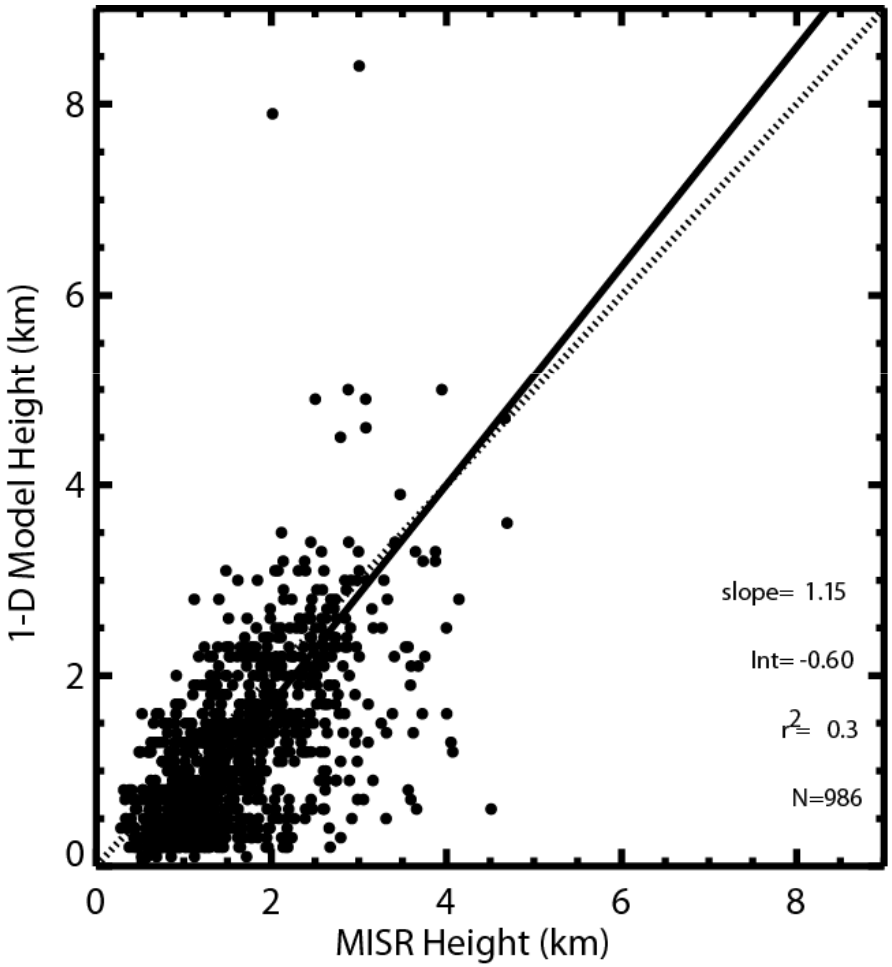
Total Heat Flux
Total MODIS FRP x 10
(Wooster et al., 2005; Freeborn et al., 2008)

Instant fire size
scaled MODIS FRP
(C. Ichoku personal communication)

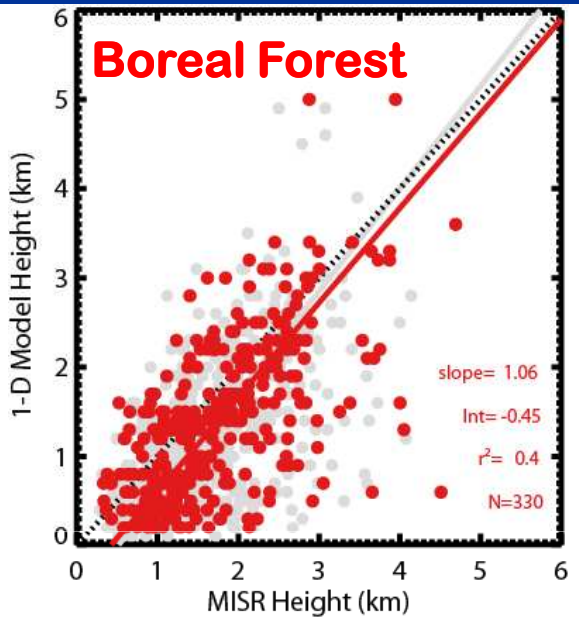
Model description in Freitas et al., 2006, 2007, 2009

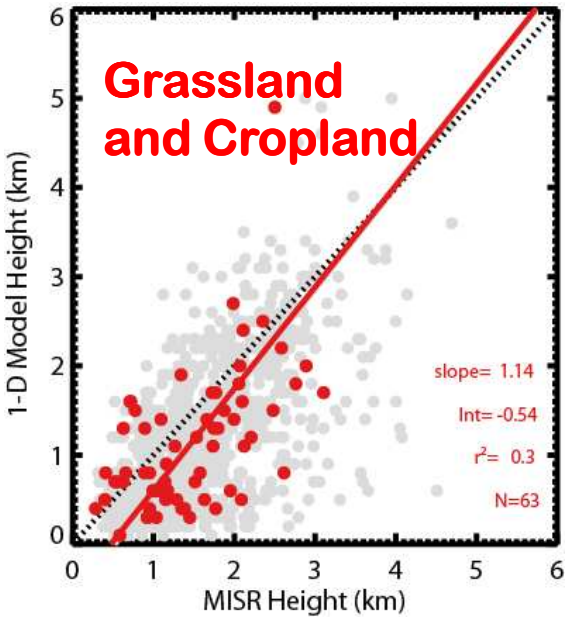
Overall evaluation of the model

MISR Max Height vs. Model Height



by vegetation

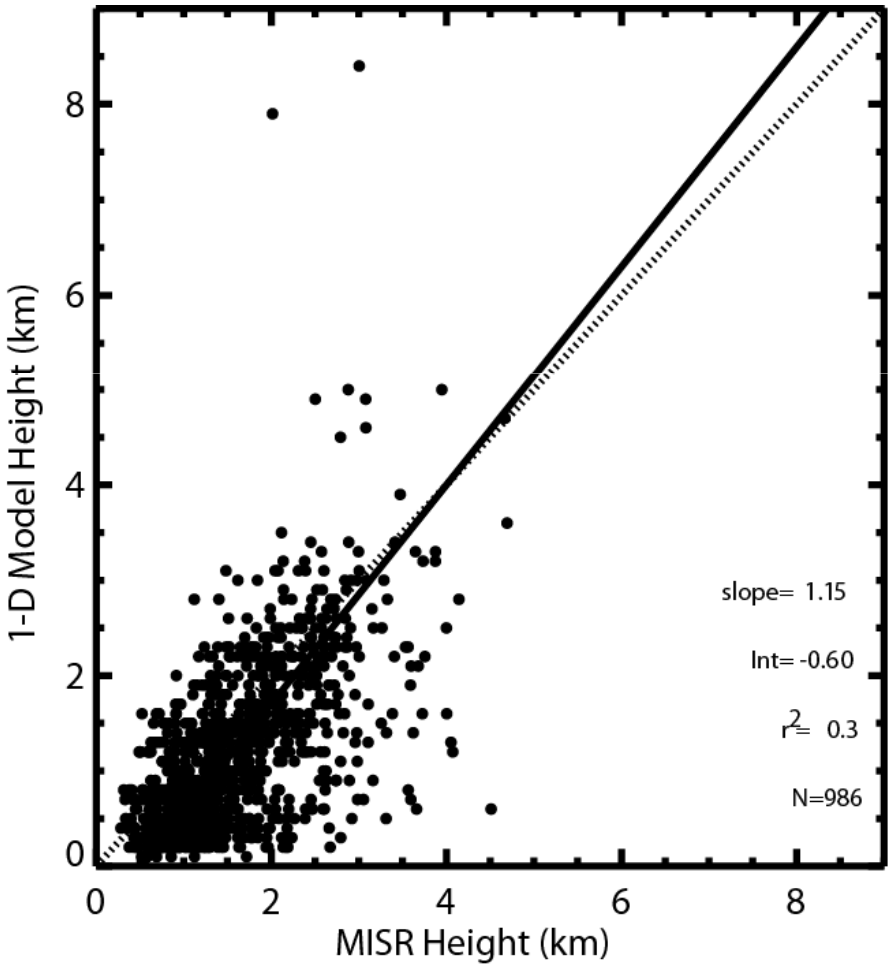




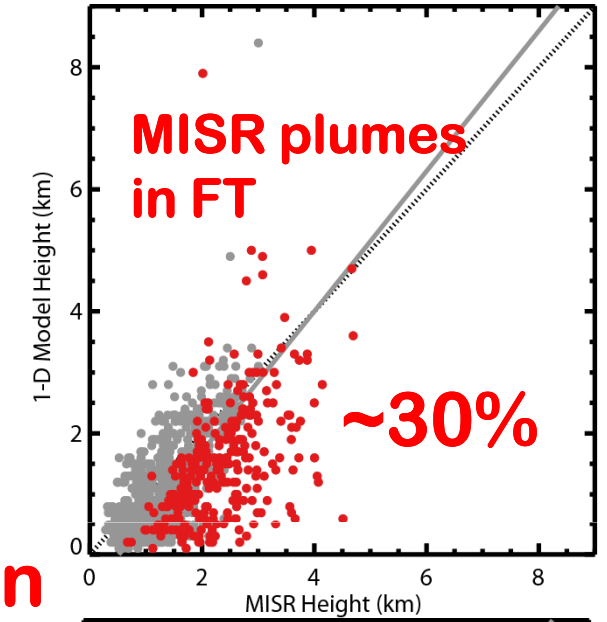
Val Martin et al., in prep., GRL

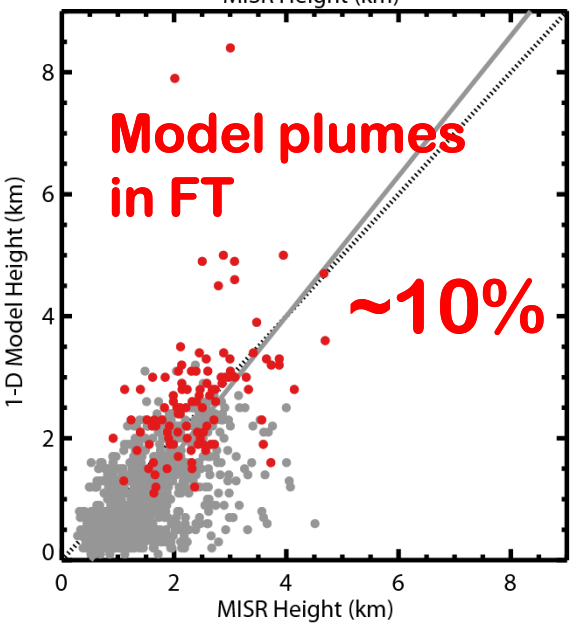
Overall evaluation of the model

MISR Max Height vs. Model Height



by location





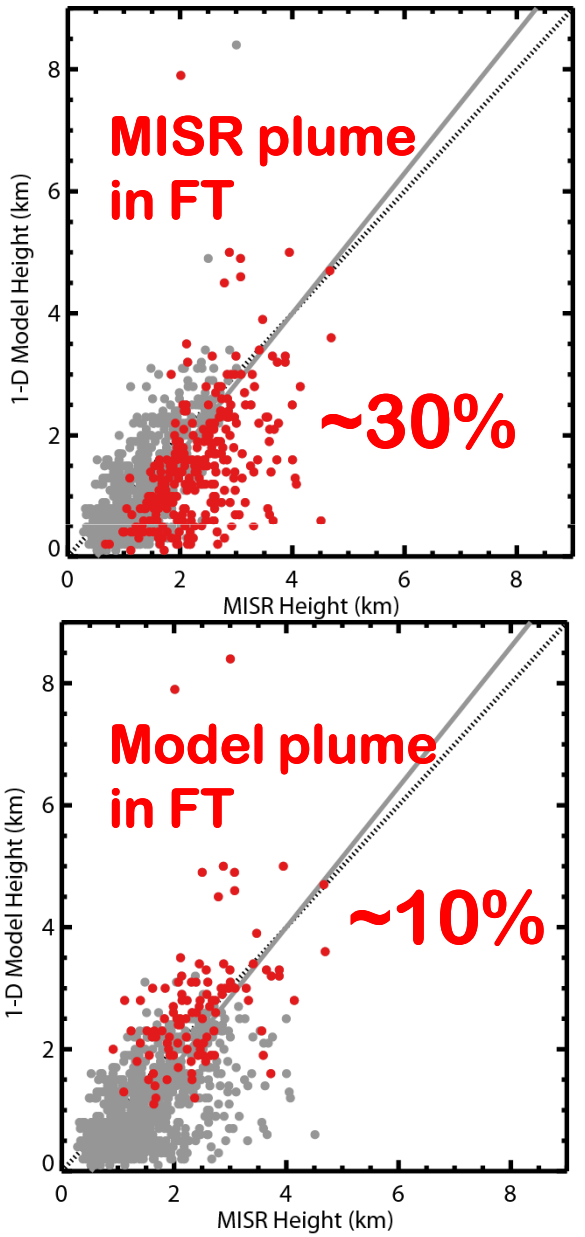
Val Martin et al., in prep., GRL

Limitations of the approach

- Inadequate estimation of total fire heat flux and area of the fire?
- Obscuration of MODIS fire pixels by dense smoke
- Different fire emissivity (smoldering vs flaming)
- Wrong assumptions within the model, e.g., entrainment coefficient

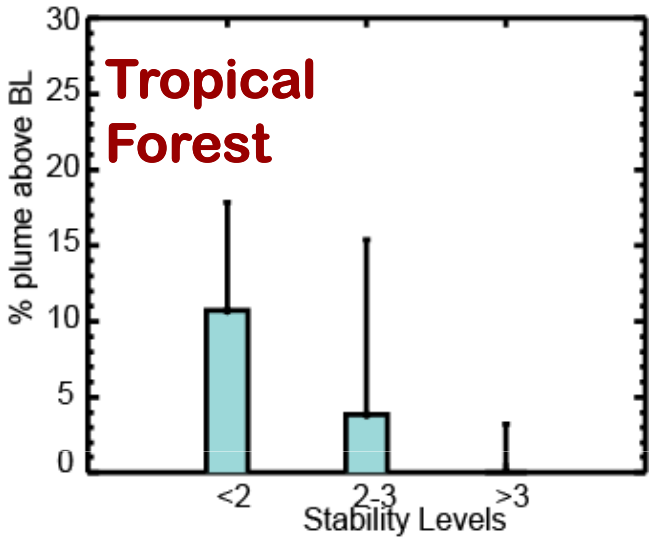
etc, etc, etc, etc….

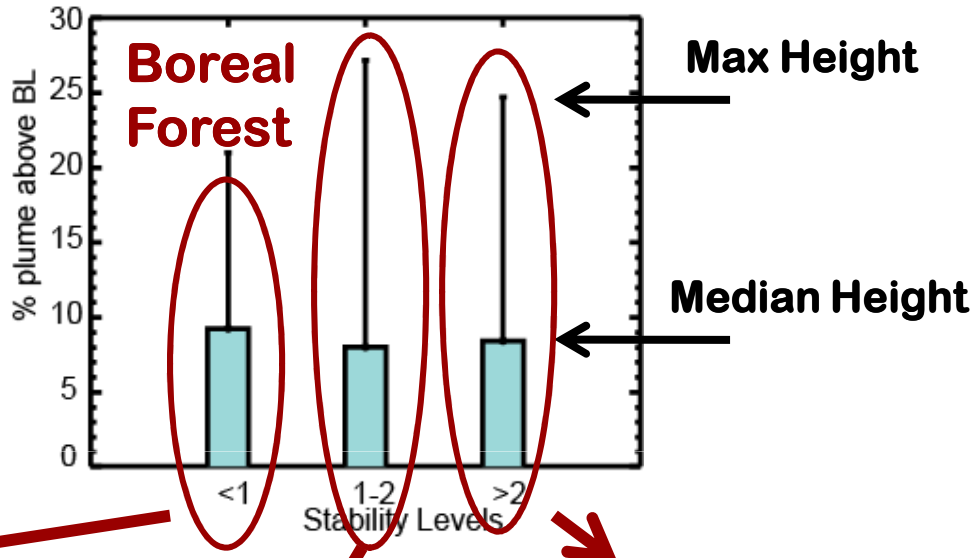
- Terra overpass time (~12:00) is not at the max fire intensity



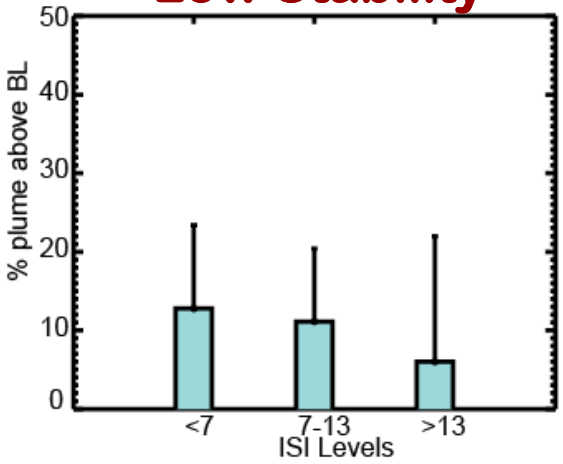
An empirical approach…..

Percentage of plumes in the FT by stability of the BL

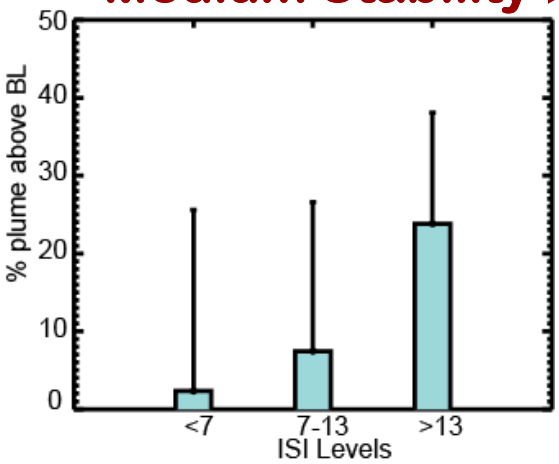




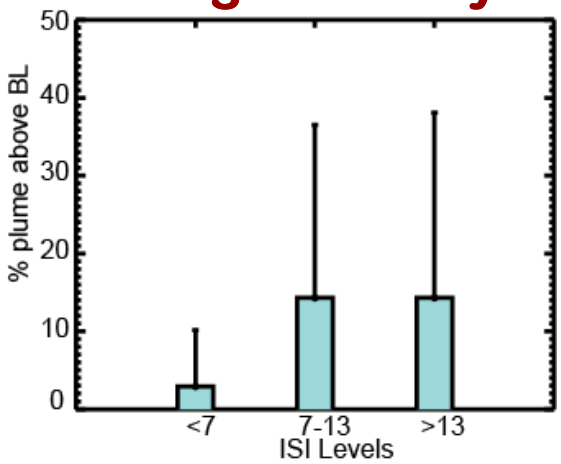
Low Stability



Medium Stability



High Stability



ISI = Initial Spread Index = f (wind speed, fine fuel layer moisture)

Towards a parameterization of injection heights

Fire Weather Model (e.g., ISI, FWI)

Vegetation Type e.g., MODIS land cover

Met. fields (e.g., GEOS, ECMWF)

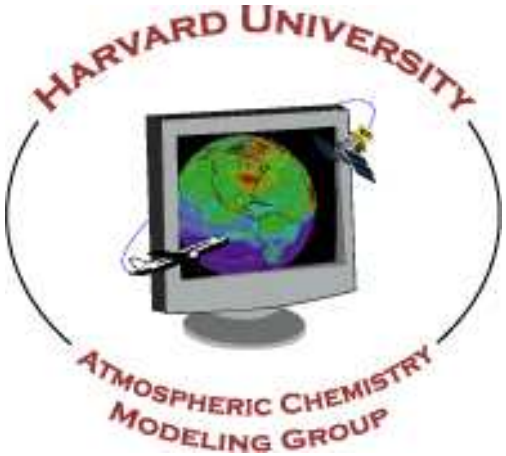
Met. fields or surface obs.

% plumes in FT

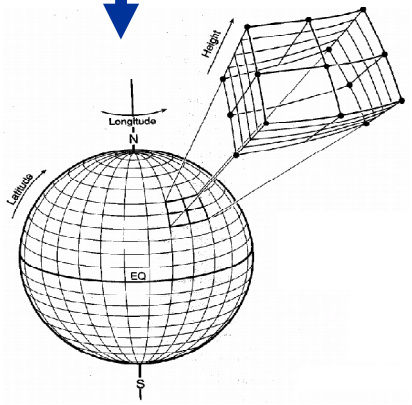
Atmospheric Stability

Stable Layer?

Injection Height

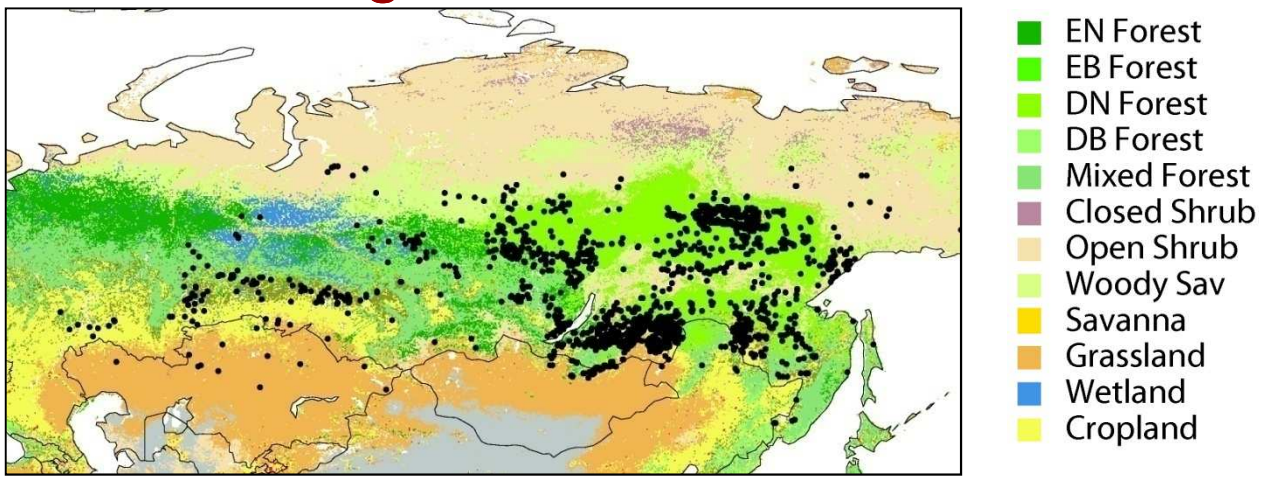


GEOS-Chem
2 x 2.5 resolution

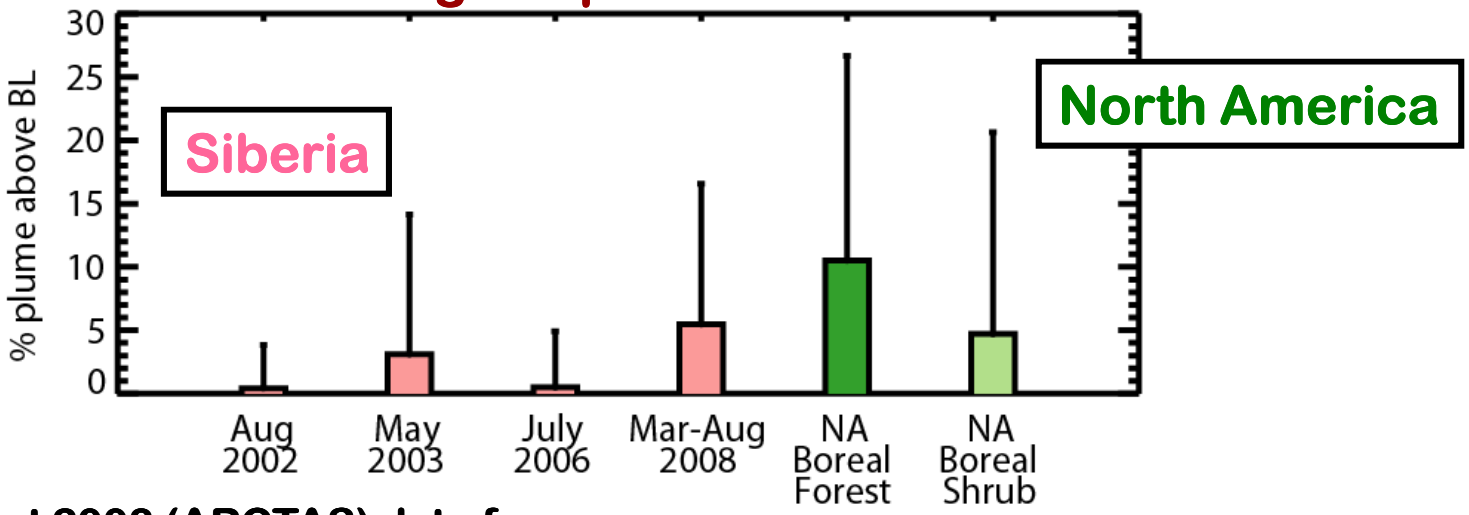


MISR plume heights for Siberia (New!)

Plumes digitized over Siberia



Percentage of plumes above the BL



March-August 2008 (ARCTAS) data from
Ralph Kahn and Matthew Davis [See poster A51I-0224 Friday]

For more information

Val Martin et al., ACPD, Smoke injection heights from fires in North America: Analysis of 5 years of satellite observations.
http://www.atmos-chem-phys-discuss.net/

The MINX tool can be downloaded from:
http://www.openchannelsoftware.org

The North American plume data base is available from:
www-misr2.jpl.nasa.gov/EPA-Plumes

Thank you to the JPL summer students that digitized the North America and Siberia plumes!!