

New Product! Historic AVHRR-derived Burned Area product and validation for Siberia (1979 – 2000)

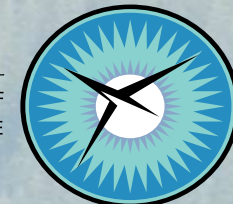
***Amber Soja – presenting for
Brian Stocks, Don R. Cahoon Jr., Stefano Potter,
Brendan Rogers, Natasha Jurko, Susan Conard, Emily
Gargulinski, and William ‘Bill’ deGroot***

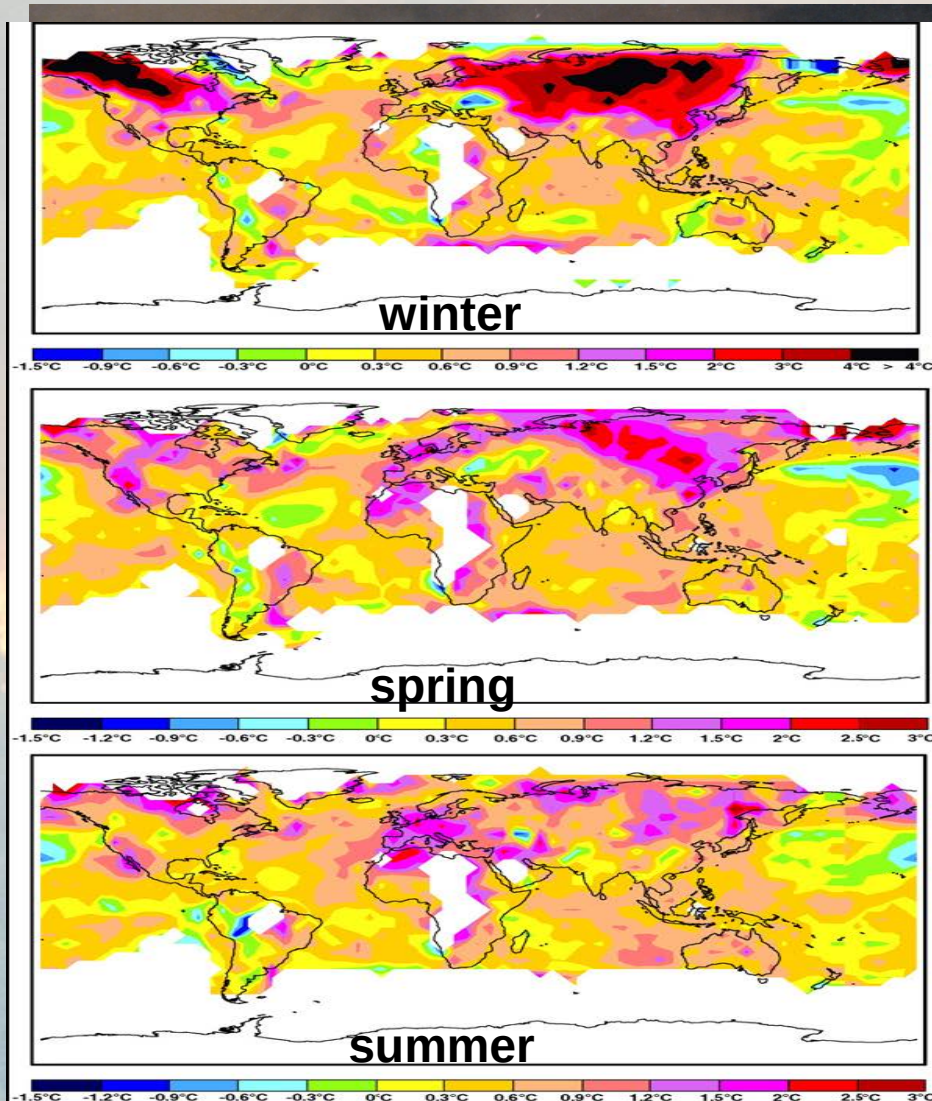
***With special thanks to Mike Fromm, Anatoly
Sukhinin, Randy Cofer, and many others***

**American Geophysical Union
9 – 13 December 2019 in San Francisco**



NATIONAL
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Mean seasonal temperature change (1965-2004)
(Groisman et al., 2007; Jones and Moberg, 2003, updated)

Temperatures are increasing, particularly in the Northern Hemisphere upper latitudes during the winter and spring, which is expected to lead to:
longer growing seasons;
an increase in lightning;
increased fire severity;
increased burned area;
increased fire frequency;
increased potential evapotranspiration;
increased extreme weather (drought, storm tracks) and increased fire weather.

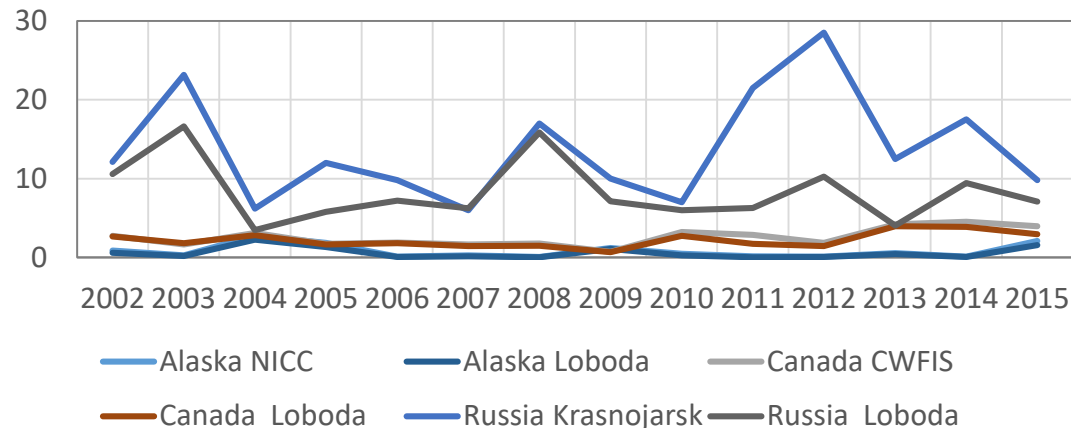
In some regions, temperature increases have already exceeded 2090 projections (Soja et al., 2004)

Overpeck et al., 1990; Flannigan and Van Wagner, 1991; Wotton and Flannigan, 1993; Fosberg et al., 1996; Stocks et al., 1998; Soja et al., 2007; Flannigan et al., 2001, 2009, 2013

Fire Activity and Justification

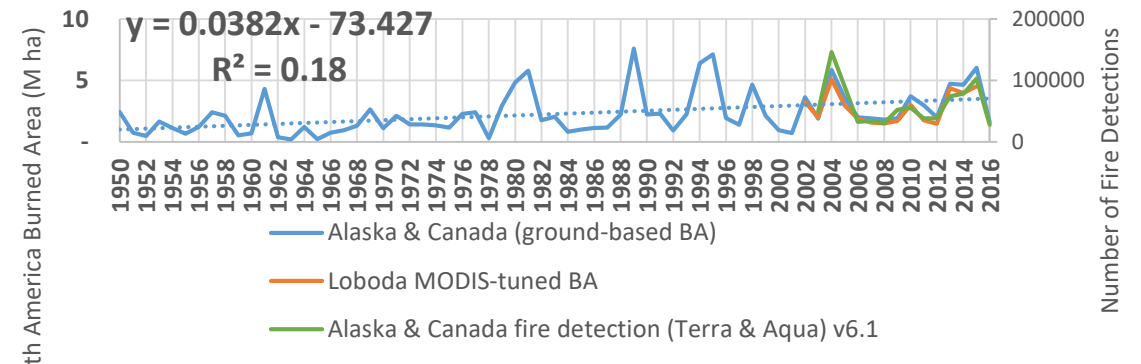
- Satellite data can provide an accurate circumboreal view.
- Russian statistics were underestimated, so we do not have good long-term fire data.
- Russian satellite data products differ substantially.
- **Verification and validation are essential.**
- Trend and climate analysis impossible without long term data.

Burned Area in Millions of Hectares

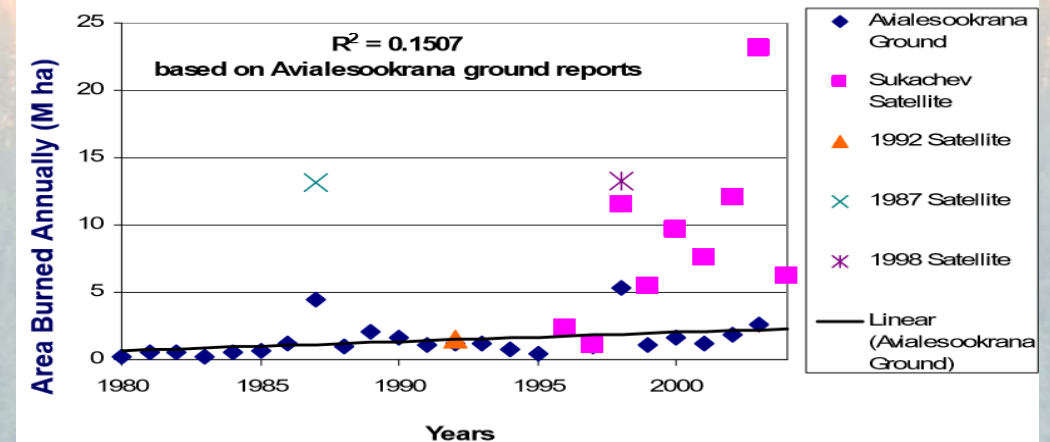


Laboda regionally-tuned product generally greater than MODIS burned area product

North American Burned Area (BA) and MODIS Active-fire Detection

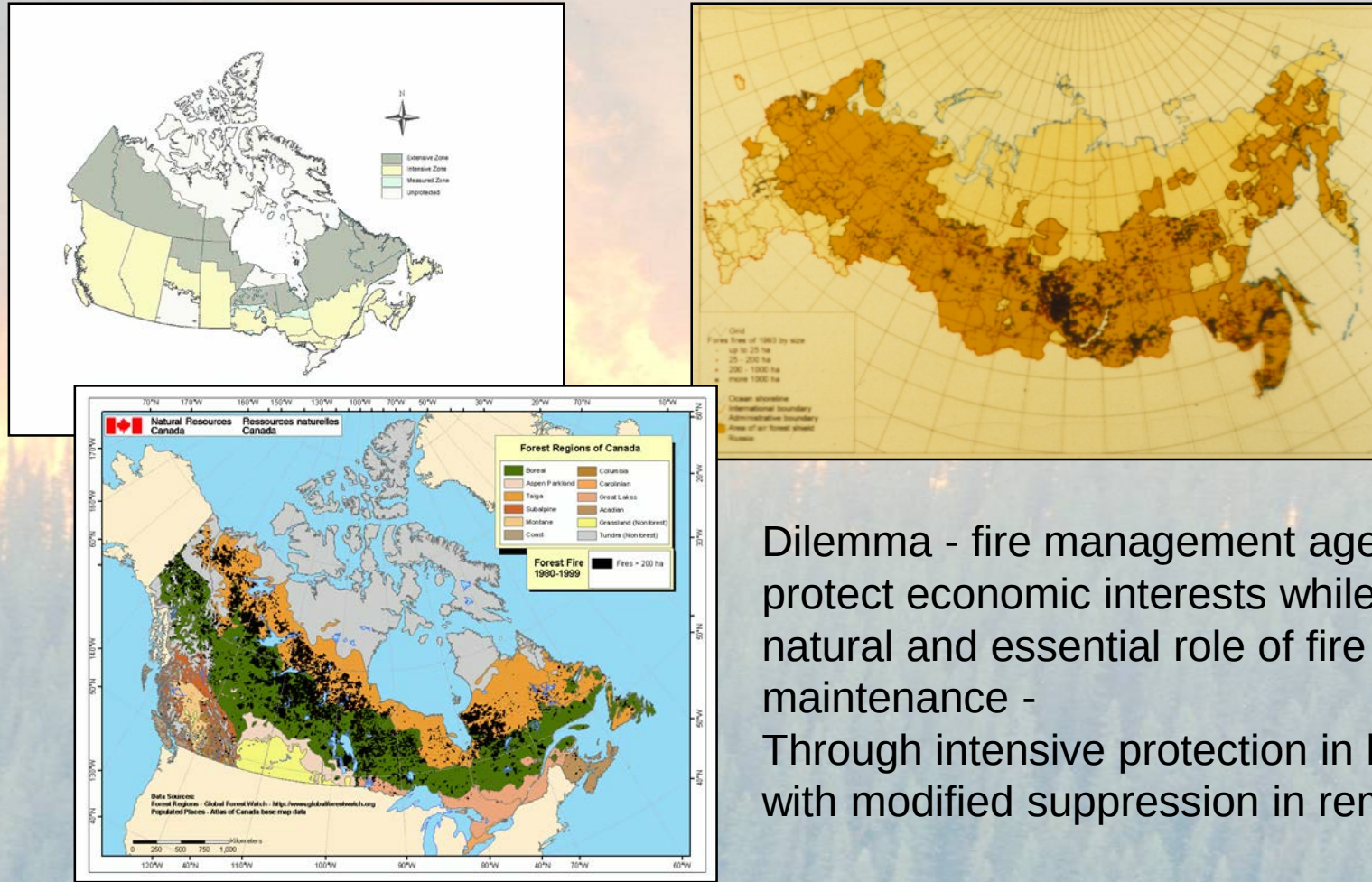


Area burned in Siberia



Cahoon et al., 1991, 1992, 1994; Kasischke et al., 1999; Soja et al., 2004; Sukhinin et al., 2004

Intensive/Extensive Protection Zones



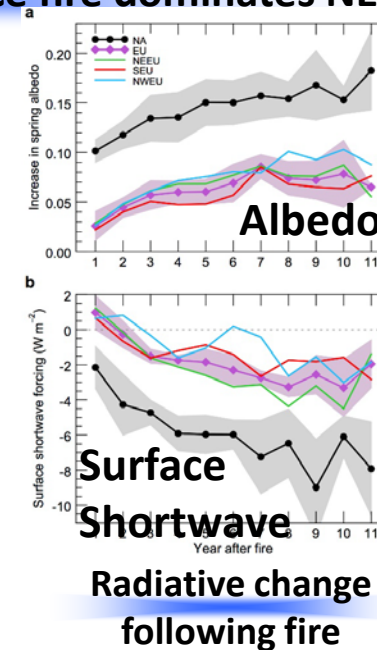
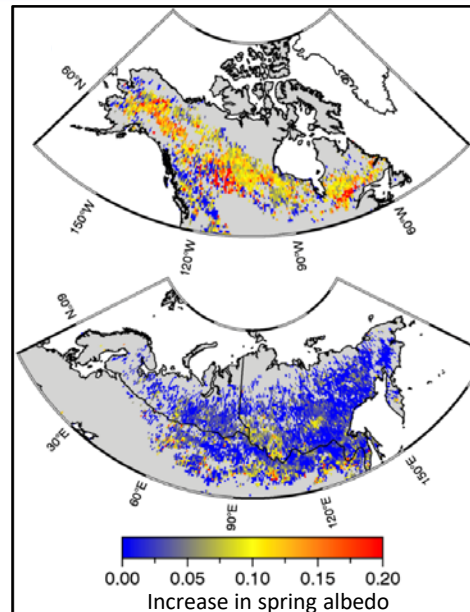
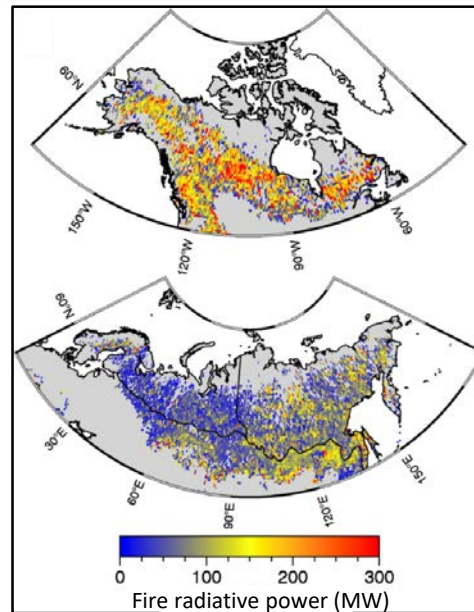
Dilemma - fire management agencies attempt to protect economic interests while permitting the natural and essential role of fire in ecosystem maintenance -
Through intensive protection in high value areas with modified suppression in remote regions

Influence of tree species on continental differences in boreal fires and climate feedbacks

Brendan M. Rogers^{1*}, Amber J. Soja², Michael L. Goulden¹ and James T. Randerson¹

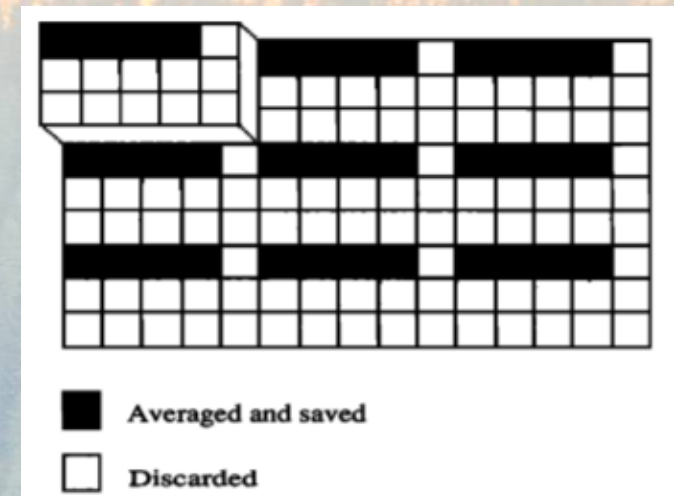
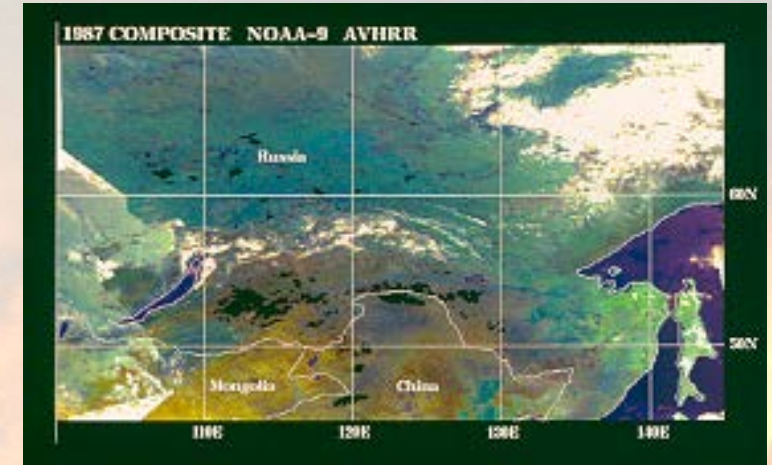
Eurasian and North American Ecosystems are Distinct. Understanding one does not translate to the other.

Remote sensing of fire intensity and severity: Surface fire dominates NE.



An Historic Advance Very High Resolution Radiometer (AVHRR) Burned Area Product

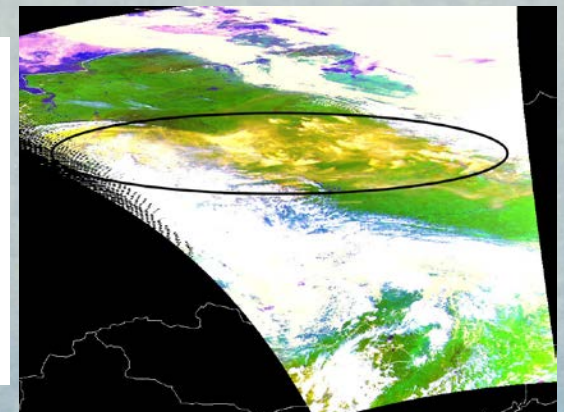
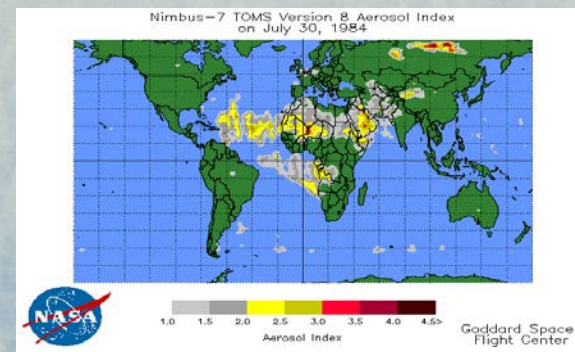
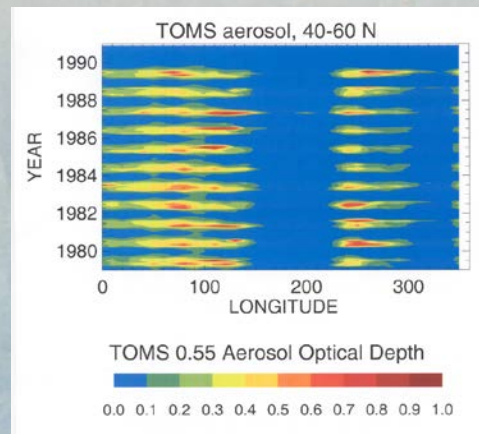
- History of this data product
 - Cahoon, Stocks, Cofer, and colleagues analyzed the extreme Chinese Dragon Fire that burned in 1987 and noticed the unreported amount of burning north of the border in Siberia (Cahoon et al, JGR 1994);
 - Don Cahoon traveled to Ashville NC and hand-picked these AVHRR Global Area Coverage data (easiest way to attain data at that time);
 - Cahoon, Stocks and others developed a methodology for defining burned area and verified the area product using Canadian bowl lakes – A Soja Cahoon's student (Cahoon et al, JGR 1992, Cahoon et al, 2000).
 - Under Conard's FIREBEAR project, the work continued. Cahoon and son led algorithm simulation; Cahoon and Stocks led verification; Jurko, Soja, Stocks, DeGroot and others continued, converting and verifying burned area.



Methodology

- ❖ Acquired and processed all available scenes from the NOAA archive over Russia (east of Urals) for each fire season (April through September) for the 1979-2000 period (software written to facilitate downloading additional data);
- ❖ Each scene geocorrected to enhance for smoke, active fires, and burn scars;
- ❖ Fire scars tracked through the fire season to separate scars by years;
- ❖ Images composited to process an unlimited number of mapped images to maximize clear sky images to preserve burned area information at the individual pixel level;
- ❖ Cloud filtering and seasonal solar variation corrections applied to composite scenes;
- ❖ Composite scenes created for each month, then further composited into complete fire season (April -September).
- ❖ Each monthly composite constructed from daily quick look scenes that were enhanced for examining burned area;
- ❖ Most processing automated, final monthly composites did require manual effort for ~10-20 problematic images;
- ❖ Monthly and seasonal composites were created for the 1979-1995 period (large fire scars quite visible);
- ❖ Daily global Aerosol Index (AI) maps developed using Total Ozone Mapping Spectrometer (TOMS) to identify the exact timing of major fire events.

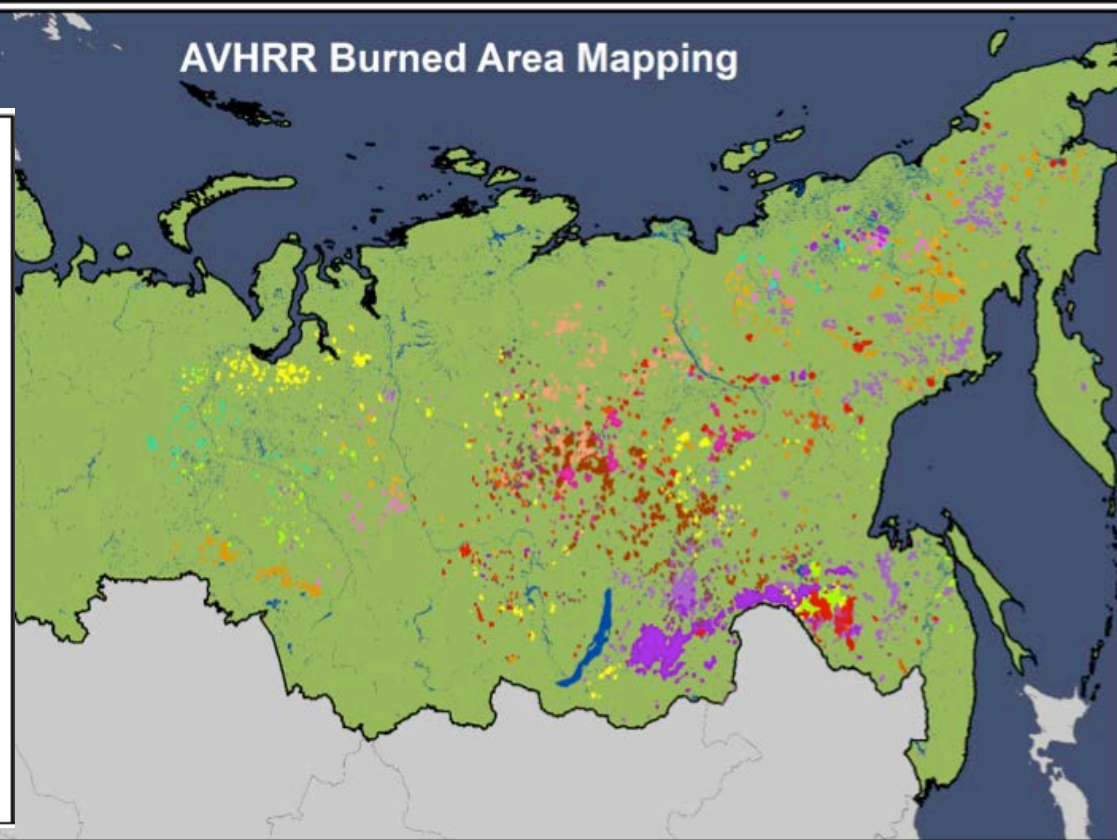
On average, there are about 260 individual scenes per month, and there are 5 months of data for each year.



AVHRR Burned Area Mapping



- 2002 fires
- 2001 fires
- 2000 fires
- 1999 fires
- 1998 fires
- 1997 fires
- 1996 fires
- Siberia



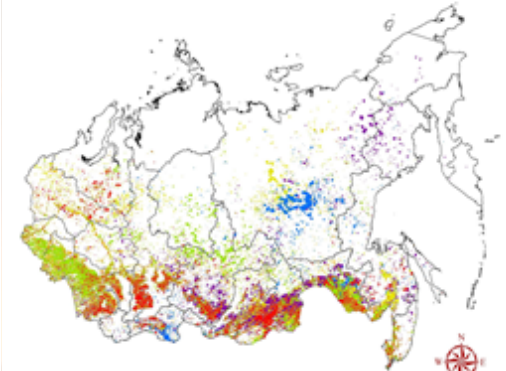
Burned Area Years

- 1993
- 1992
- 1991
- 1990
- 1989
- 1988
- 1987
- 1986
- 1985
- 1984
- 1983
- 1982
- 1981
- 1980
- 1979

Background Layers

- Waterbodies
- Russia
- World Boundaries

November 25 2014

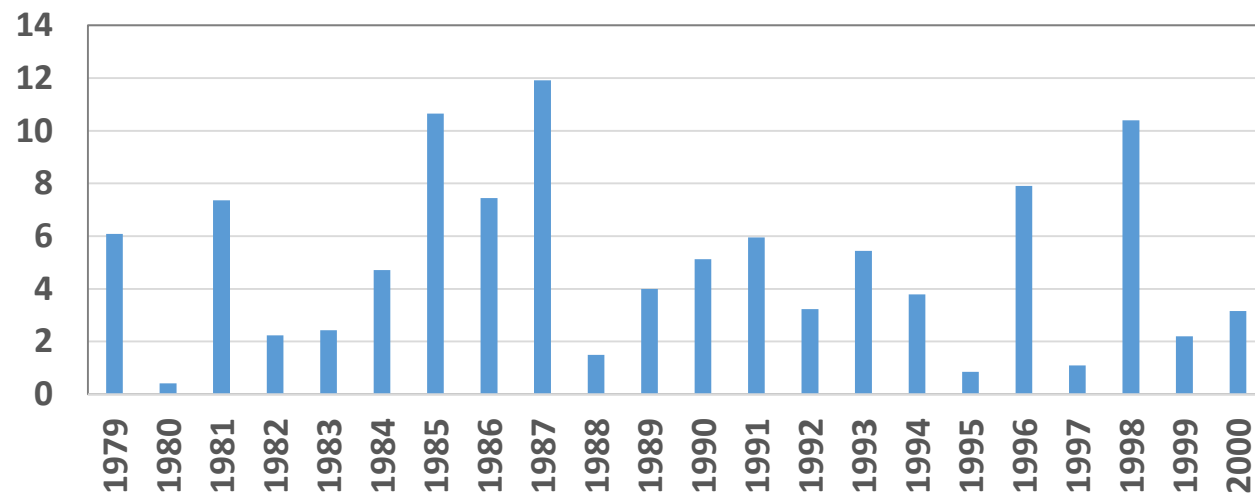


- 2007 fires
- 2006 fires
- 2005 fires
- 2004 fires
- 2003 fires
- 2002 fires
- Siberia

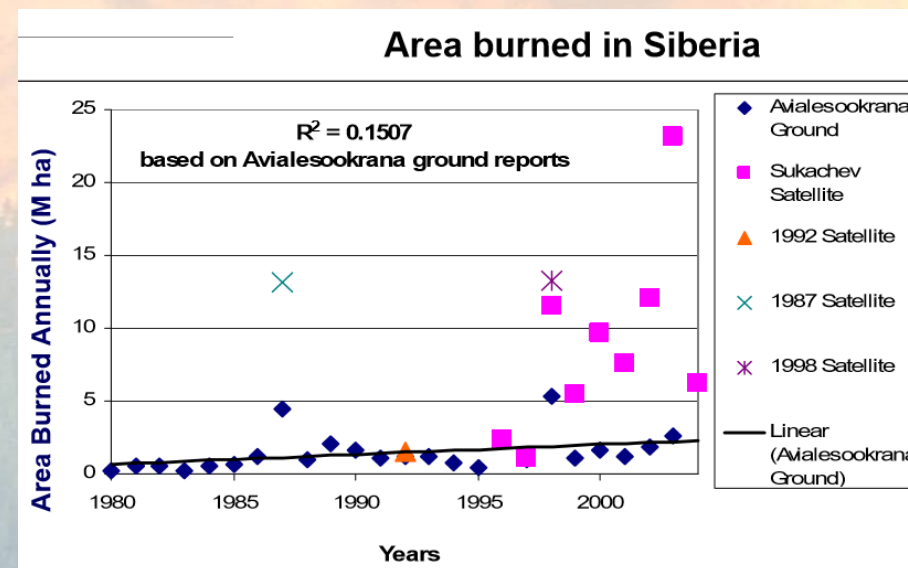
Quantification of AVHRR Burned Area Mapping

Our New Product

Burned Area in Millions of Hectares
per Year
East of the Urals to the Far East



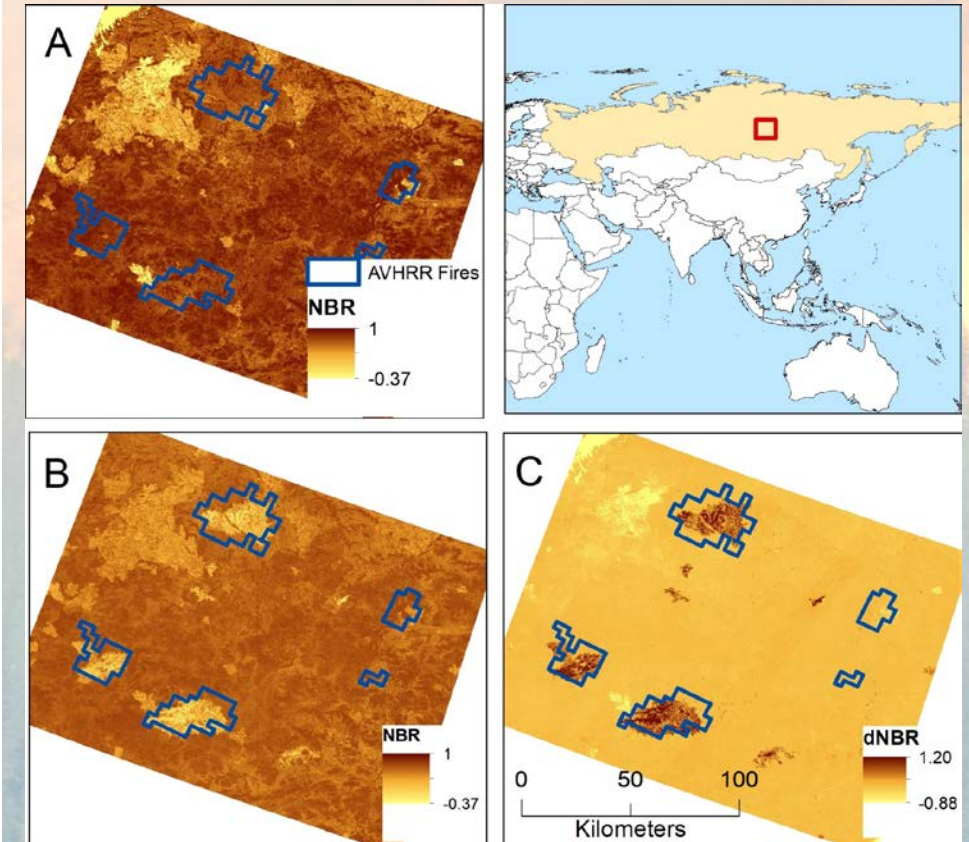
Aviallesookrana and other Satellite Assessments



Cahoon et al., 1991,1992,1994;
Kasischke et al., 1999; Soja et al., 2004;
Sukhinin et al., 2004

Validation (reality -- available Landsat data are limited)

- ❖ Two full-year validation, 1987 and 1996, using all the available Landsat data.
 - ❖ In 1996 there are 20 Landsat scenes that intersect with AVHRR data, so all 20 of these scenes are selected. Additionally, 20 scenes are selected that do not coincide with Landsat data.
- ❖ Stratified random sample every 5 years, excluding full years analyzed
- ❖ Scars in Landsat data are hand digitized.
- ❖ Validation includes: (1) omission error; (2) commission error; and (3) area to area comparison of individual burn scars.
- ❖ AVHRR data has already been verified with TOMS data. Landsat data are limited, so additional care is taken in regions where large AVHRR scars are identified and not found in Landsat data (e.g., steppe burning).



AVHRR Russia Fire Validation

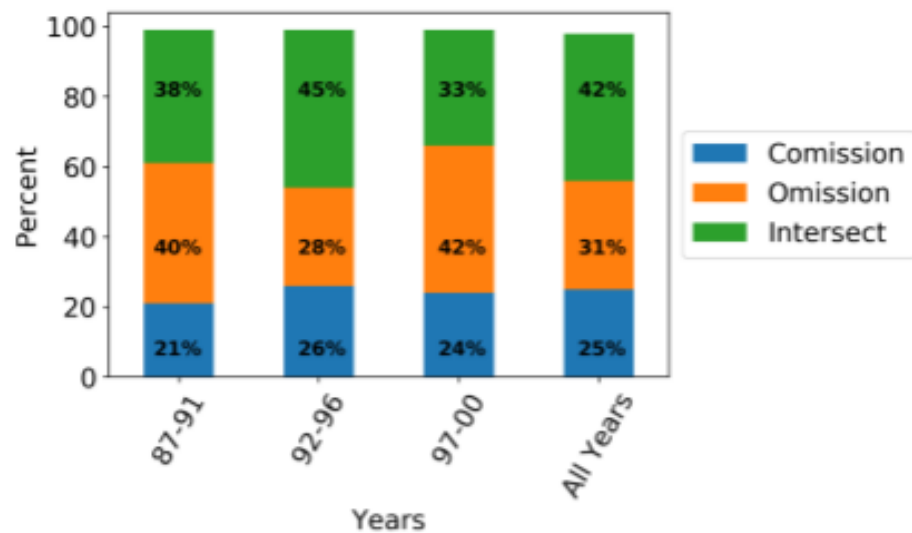
- 74 scenes in 1996
- 12 scenes in 1987
- 74 scenes in all other years
- 160 scenes digitized in total
- Pre-burn imagery acquired up to two years prior in the months of May to August
- Post-burn imagery acquired one year after, in most cases
- If no burn could be detected one year after, then imagery in the year of fire was acquired
- If no image in the year of fire could be attained, the AVHRR polygon was removed from analysis

Final Validation Statistics

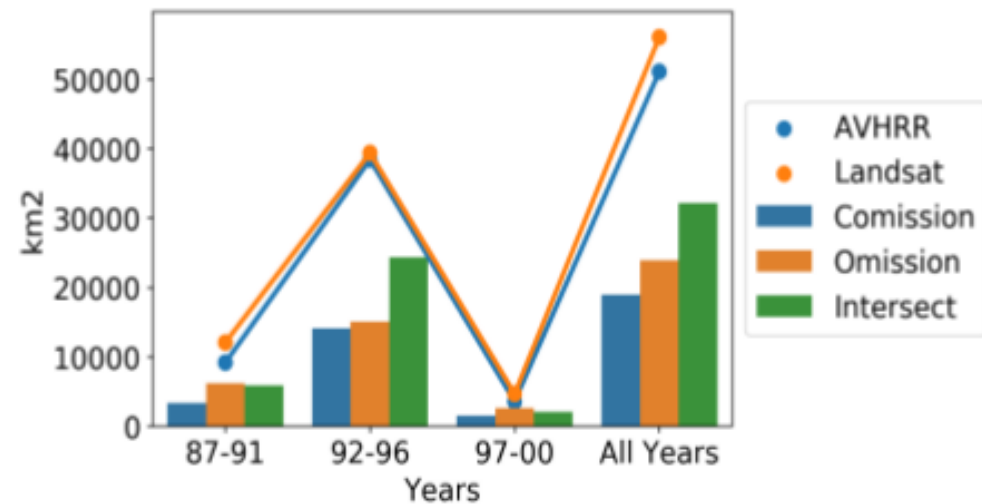
Metric	Total area (km2)
Intersected	32,193
Omission	24,688
Commission	18,929
Total AVHRR	51,122
Total Landsat	56,881

- Of all commission area, 85% is from fires which also intersected with the Landsat digitized fires

Temporal Assessment of Error



Percentage derived by dividing each metric by the combined km² from intersected, omission and commission area



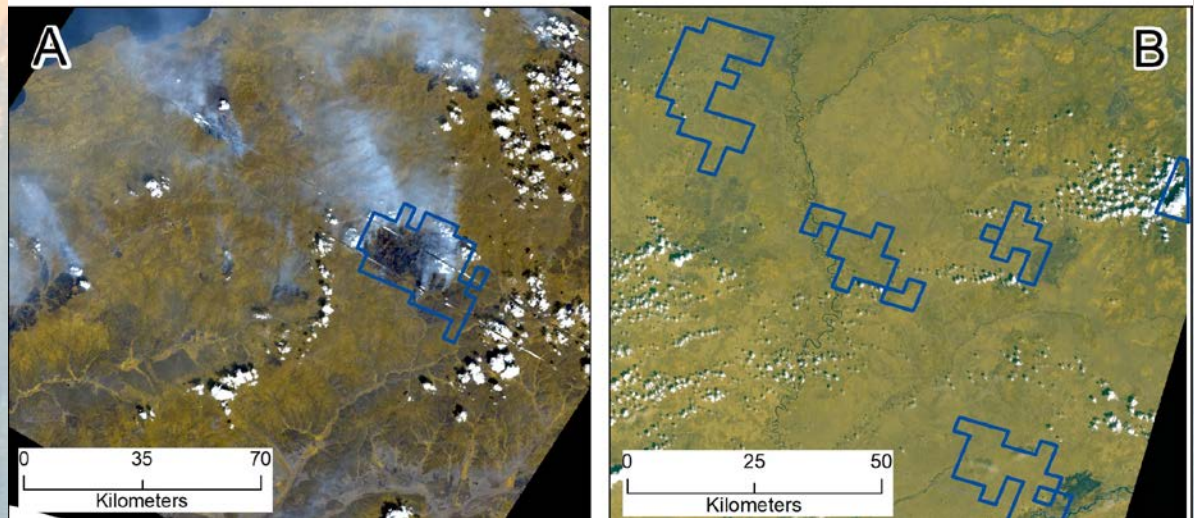
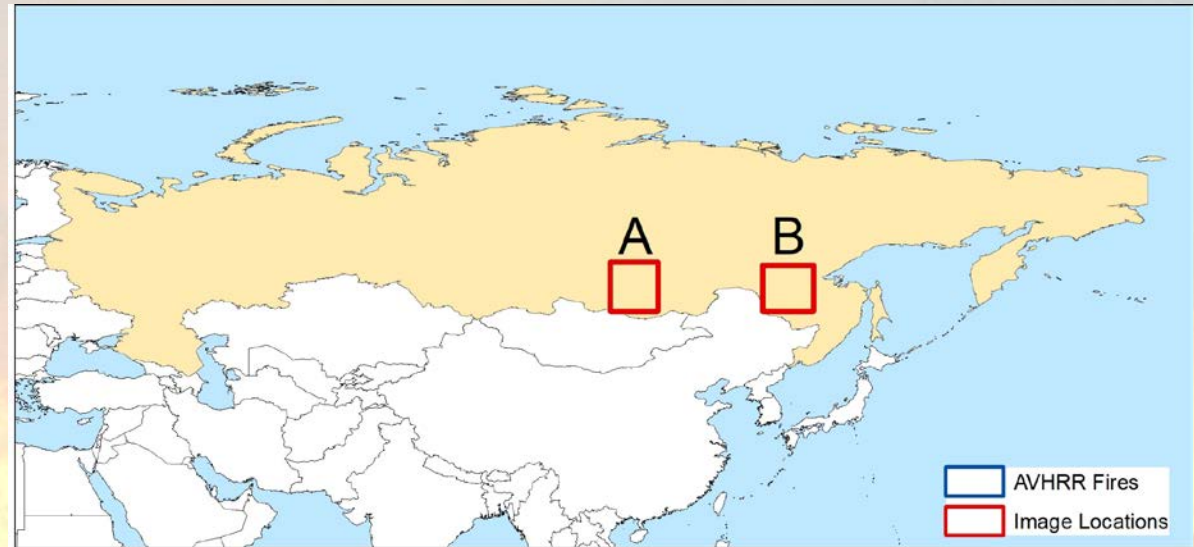
Raw area comparisons in each time frame

We are working towards accurately portraying the data

Validation examples

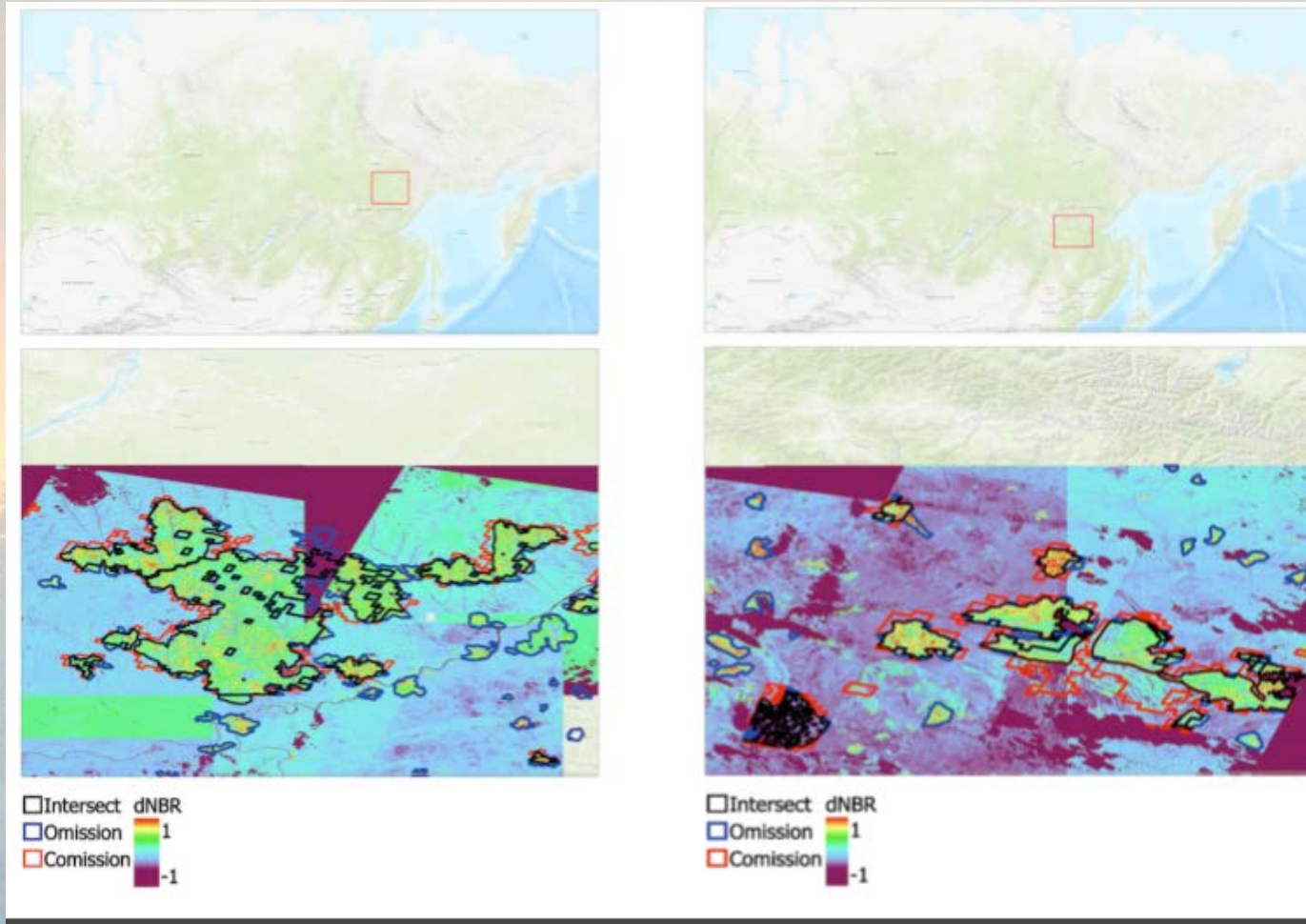
Reason for exception and extra care:
Often fires that are verified as burning through other means in region B. Here scars green up within months, so these do not meet our stick criteria but are reality.

Landsat MSS data

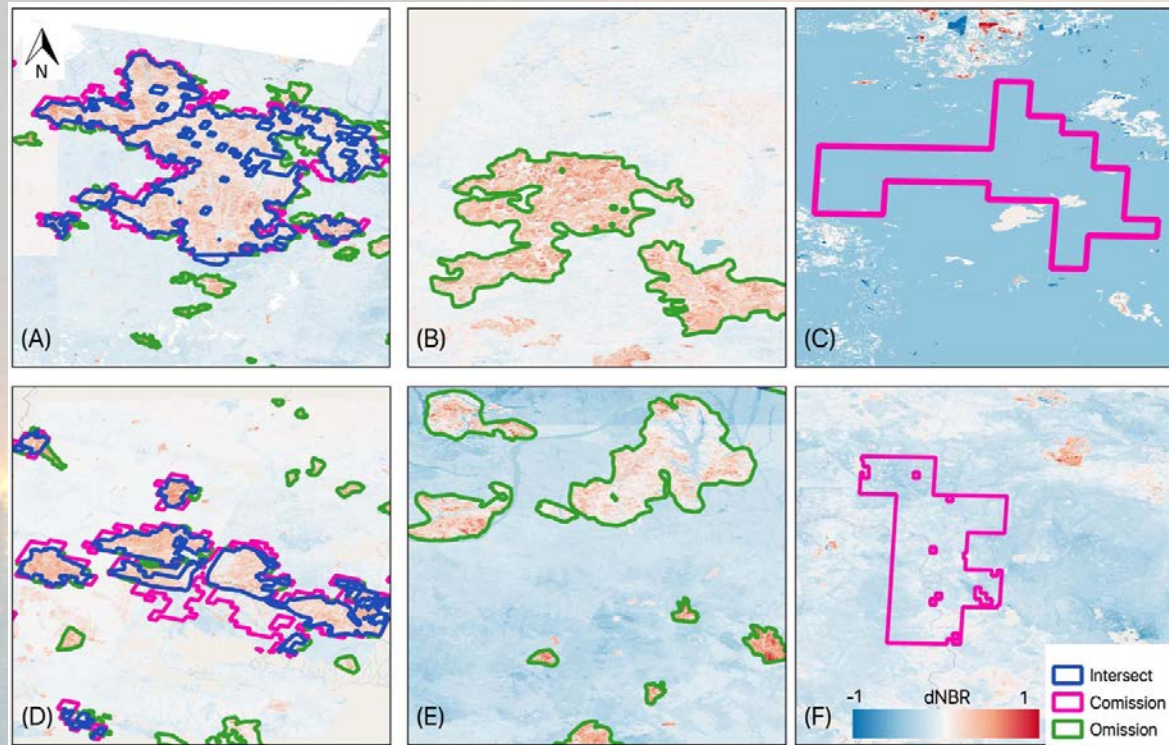


Validation examples

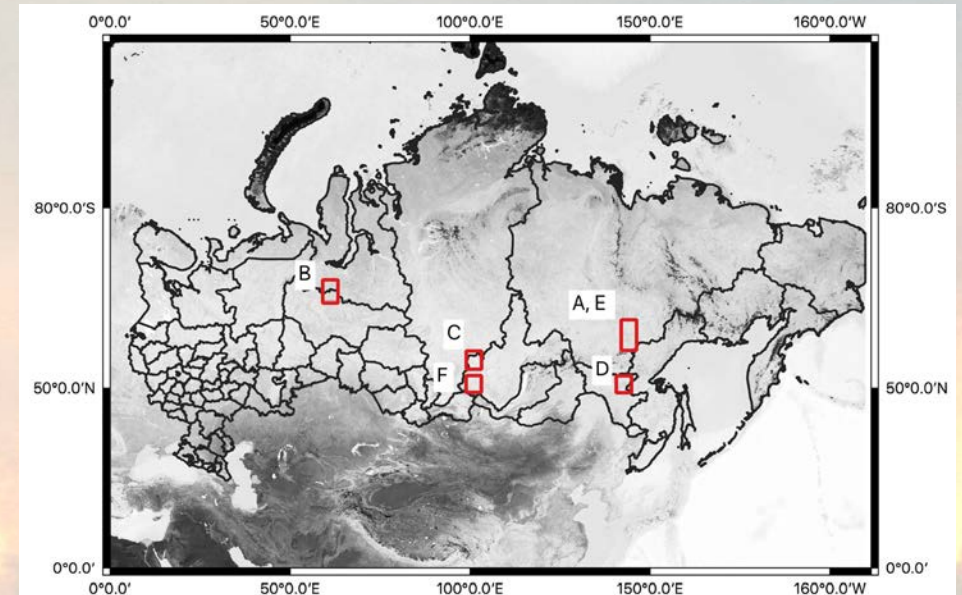
Of all the commission error, 85% is from fires that also intersect the Landsat digitized fire.



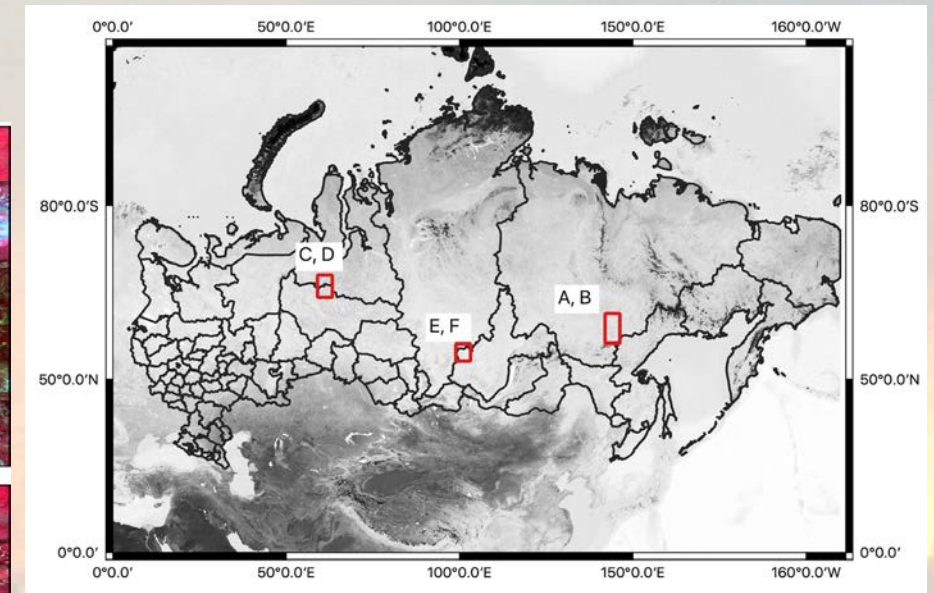
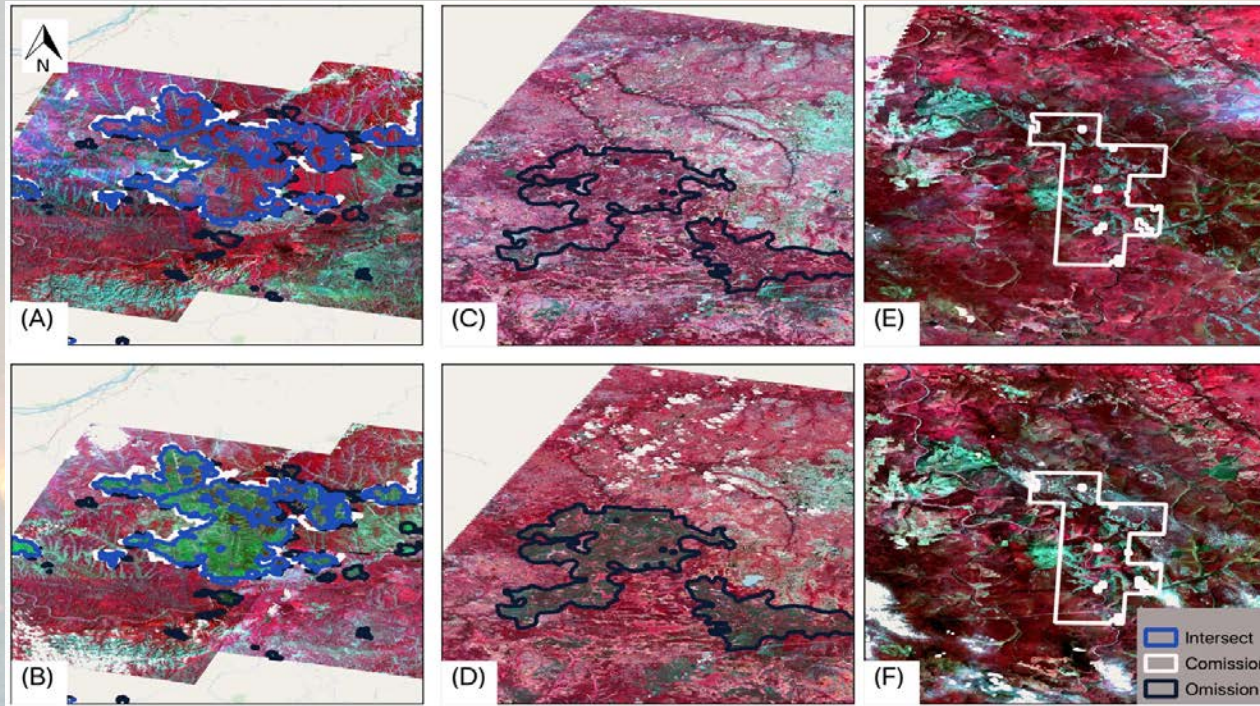
Validation examples



dNBR values from pre- and post-fire image pairs acquired from Landsat data. Omission and commission error and areas of AVHRR and Landsat intersection.



Validation examples



The band combination shown is Near Infrared-Red-Green.



Pre- and post-fire image pairs acquired from Landsat data. Omission and commission error and area of AVHRR and Landsat intersection.

The top row is pre-fire images and the bottom row is post-fire images.

AVHRR- to Landsat- Burned Area Comparisons per Size Class

