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Detection of burnt areas in Yakutia and the analysis of forest fires events using long-term (1985-2015) satellite observations

Tomshin O.A., Solovyev V.S.

Yu.G. Shafer Institute of Cosmophysical Research and Aeronomy SB RAS, Yakutsk

Motivation

Forest fires:

- Cause severe damage to forest ecosystems
- Pollute the atmosphere with combustion products
- Reduce earth's surface albedo and affect the temperature regime of soils

Climate change can affect forest fires regime. Available satellite estimates of the burnt areas cover the period **2001-2017** (MODIS).

The aim is to map the burnt areas in Yakutia with satellite observations data (AVHRR) for the period 1985-2015.

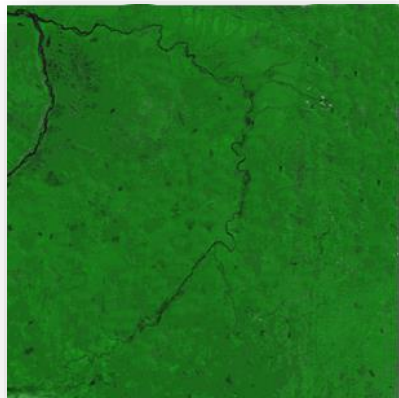
Data and Methods

Data:

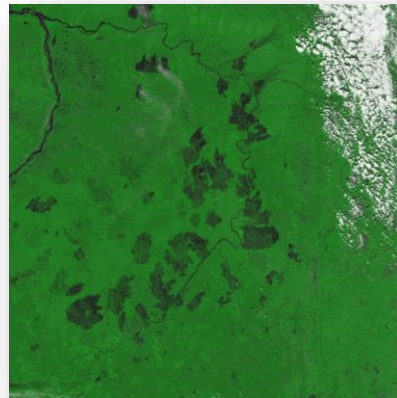
- **MODIS (Terra/Aqua)** → Burned Area MCD45 (500m) – 2001-2015
- **AVHRR (NOAA)** → NDVI (0.08°), LAC images (1km) – 1985-2015

$$NDVI = \frac{NIR - VIS}{NIR + VIS}$$

NearIR (NIR) — albedo in near infrared spectral region
VIS — albedo in visual spectral region

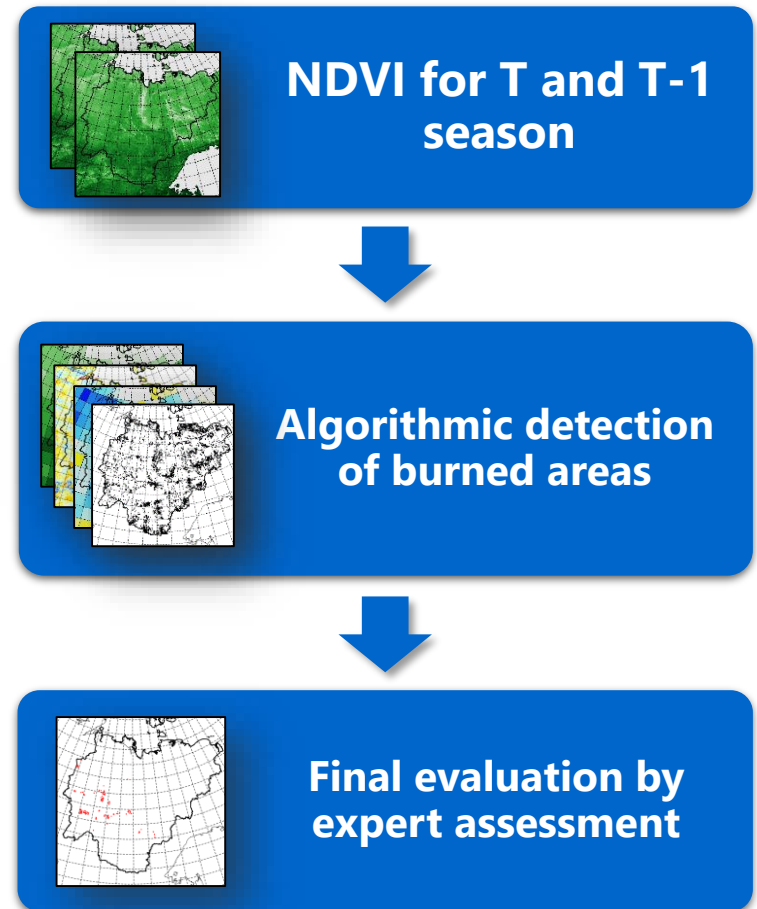


NOAA-18 14.08.2011



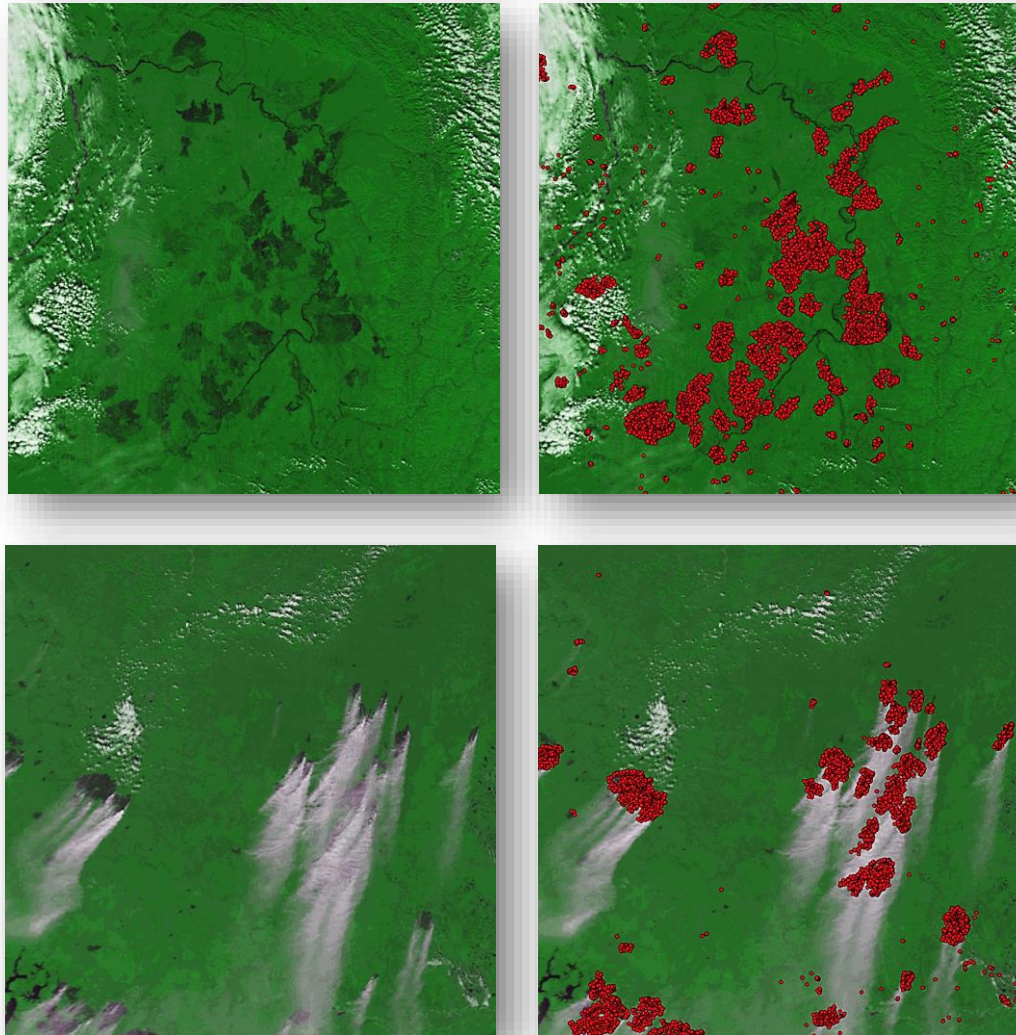
NOAA-19 08.08.2012

Burned area mapping algorithm

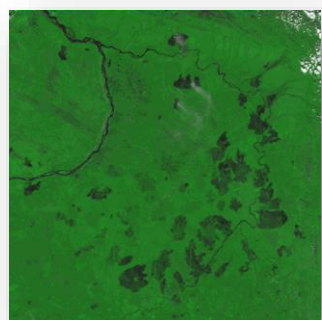


Data and Methods

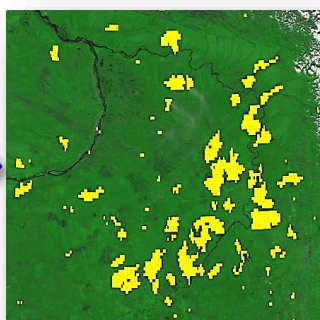
Verification with multispectral images and active fire's hotspots



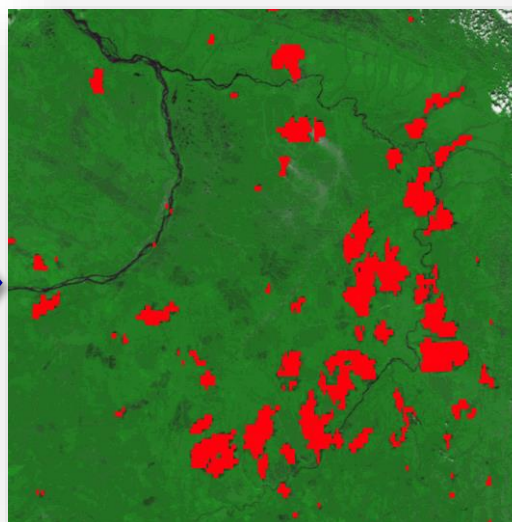
Comparison with MODIS



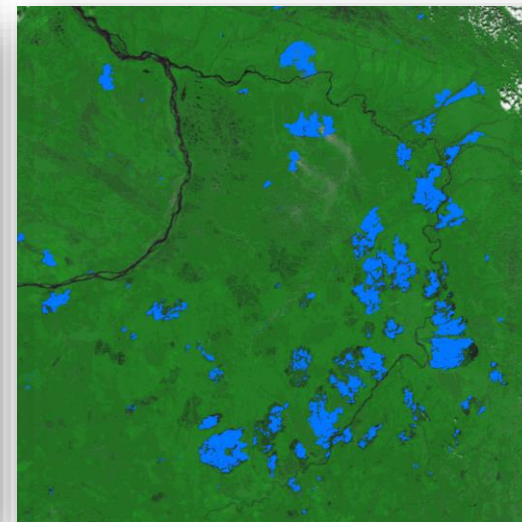
RGB image
Sept. 2012



Algorithm results



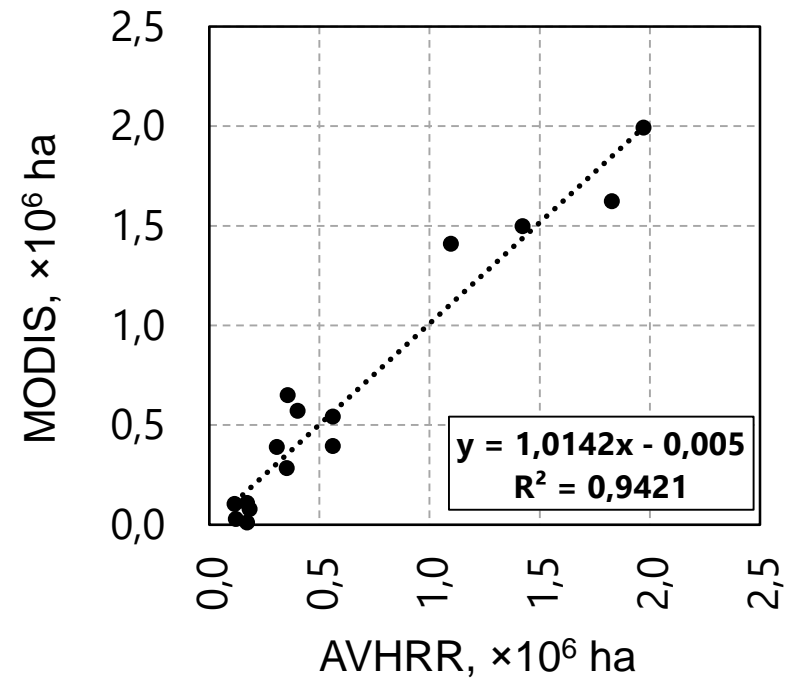
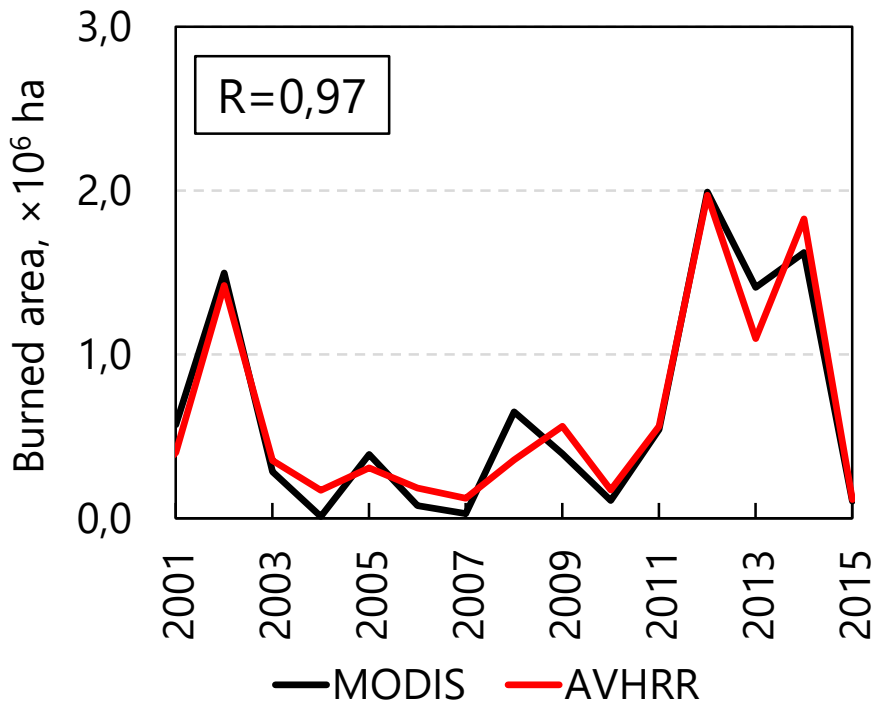
Final product after expert evaluation



MODIS Product

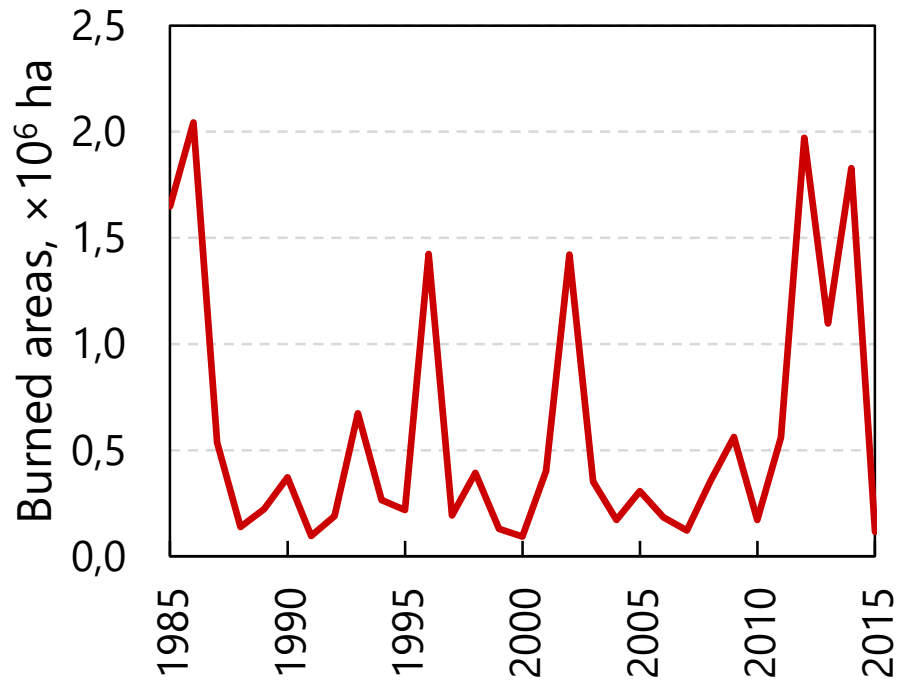
Comparison with MODIS

MODIS and AVHRR Burned Areas 2001-2015

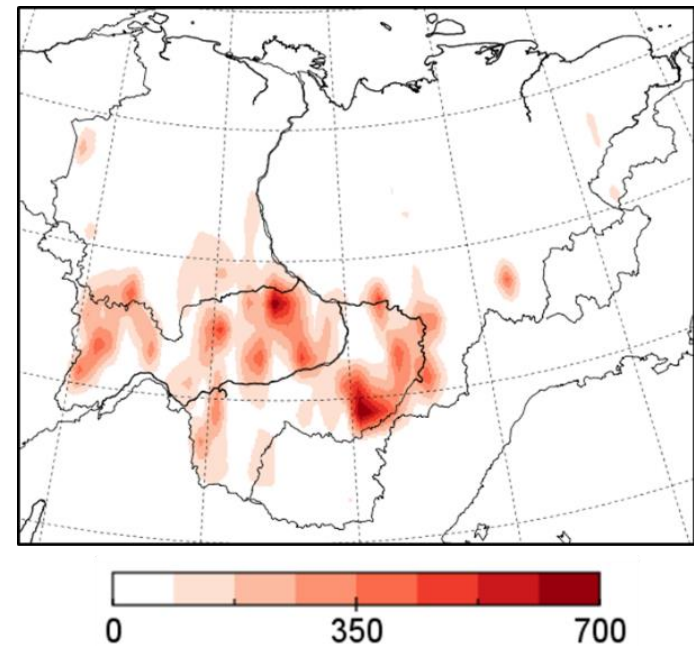


Results

AVHRR Burned areas 1985-2015



Burned areas per 1000 ha, AVHRR 1985-2015



Emissions

$$E = A B C D$$

A – burned area [m²];

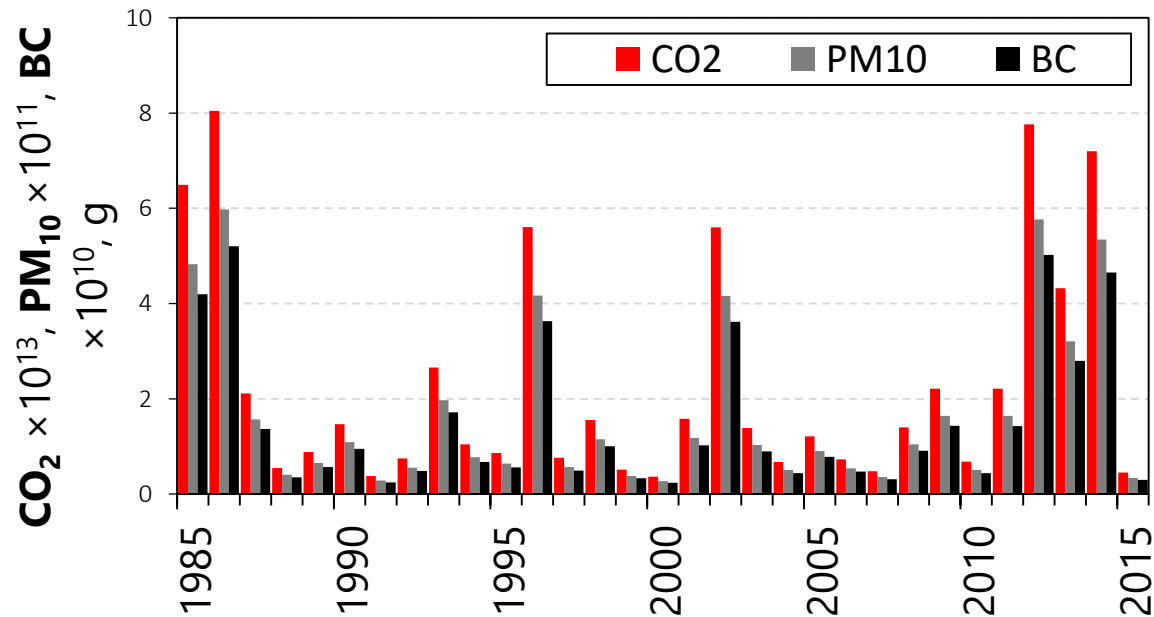
B – density of the burned biomass [kg/m²];

C – proportion of biomass burned [%];

D – mass of the material ejected from the combustion of 1 kg of biomass [g/kg];

E – total emission.

** Seiler W., Crutzen P. J. Estimates of gross and net fluxes of carbon between the biosphere and atmosphere from biomass burning // Climate Change. 1980. V. 2. P. 207-247.*



Summary

- The algorithm for detecting the burned areas by comparison of inter-seasonal changes of NDVI was developed and adapted to the conditions of forest fires in Yakutia (Eastern Siberia).
- The results of fire scars detection with the adapted algorithm showed good agreement with the MODIS data (2001-2015), $R=0.97$, which justifies the use of the algorithm for the entire AVHRR data set.
- The summary map of the forest fire in Yakutia, plotted according to AVHRR (1985-2015), shows the presence of two regions in central Yakutia with higher forest burning ratio (Leno-Vilyui interfluve and along the coast of Aldan).