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Wildfire impact on atmospheric composition and post-fire changes of ecosystem carbon uptake in Central Siberia

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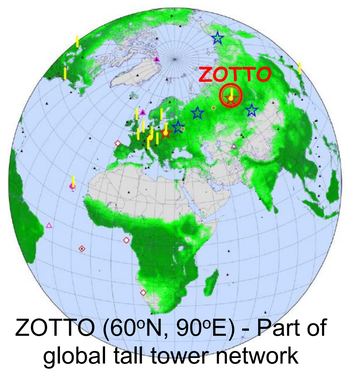
Introduction

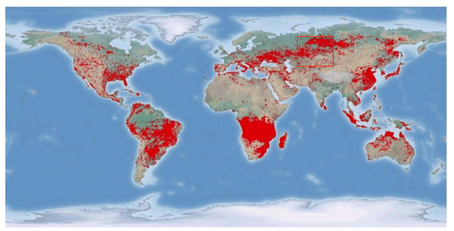
Calculations of direct emissions of greenhouse gases from boreal wildfires remain uncertain due to problems with emission factors, carbon stores, and imprecise estimates of burned areas. Even more varied and sparse are accurate *in situ* calculations of temporal changes in boreal forest carbon dynamics following fire.



ZOTTO (60ºN, 90ºE) - Part of global tall tower network

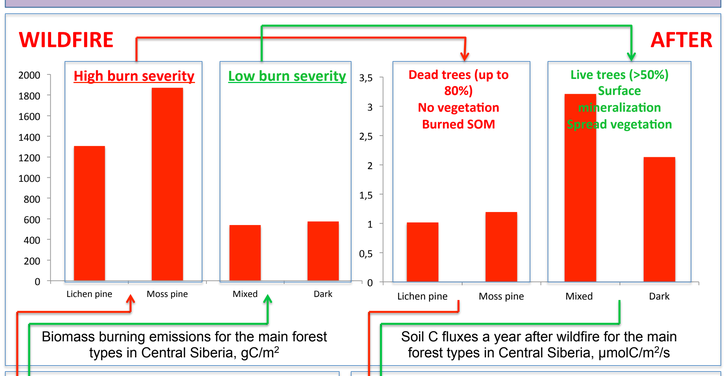
Methods and Materials

Since 2006 **ZOTTO** - a research platform for large-scale observations of greenhouse gases and aerosols is operational in Central Siberia. It benefits linking simultaneous instrumental atmospheric observations, remote sensing data analysis, and field investigations for comprehensive wildfire estimations. We present our contribution to studying of fire influence on atmospheric composition and ecosystem C flux deduced from the large-scale wildfires happened in Siberia in Jul-Aug 2012.



July 2012 MODIS Active Fire Detections from Aqua and Terra Satellites (FIRMS)

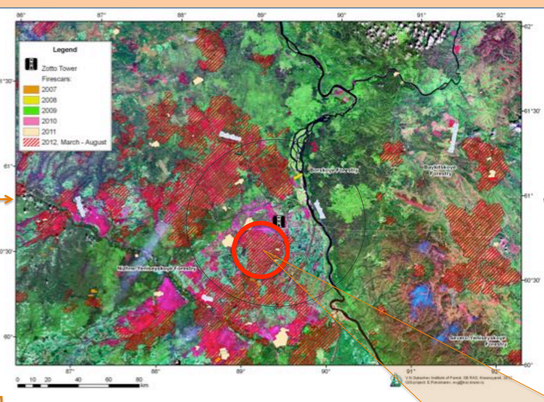
Synthesis and calculations - SC (IV)



Remote sensing data analysis - RS (I)

1 Fire detection

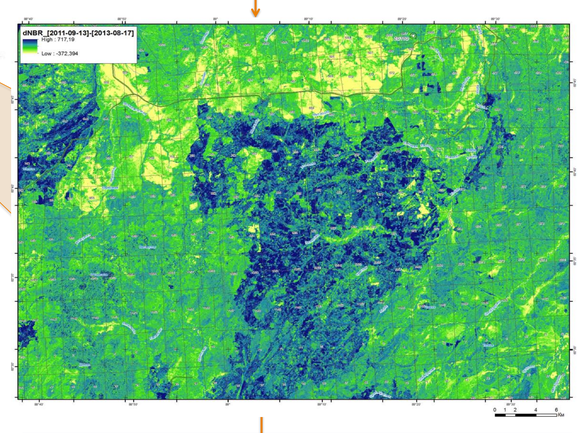
Active fire spots in the tall tower footprint area were detected by Terra/Aqua MODIS data and burned areas and land cover disturbances estimated based on Landsat ETM 5, 8 satellite images. The burned area in 2012 reached 10600 km².



Study region with tall tower footprint and fire scarce areas (red circle - study area for this study shown – 730874 ha)

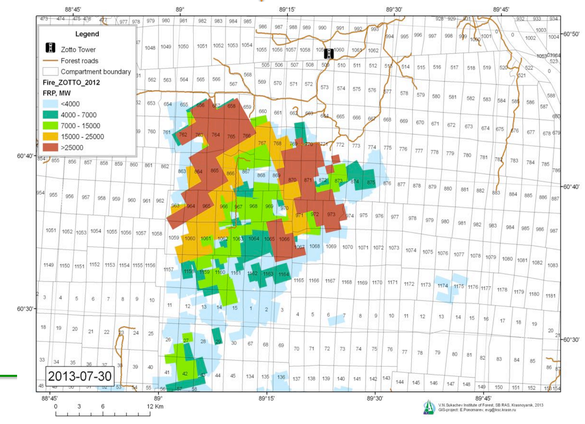
2 Burn severity

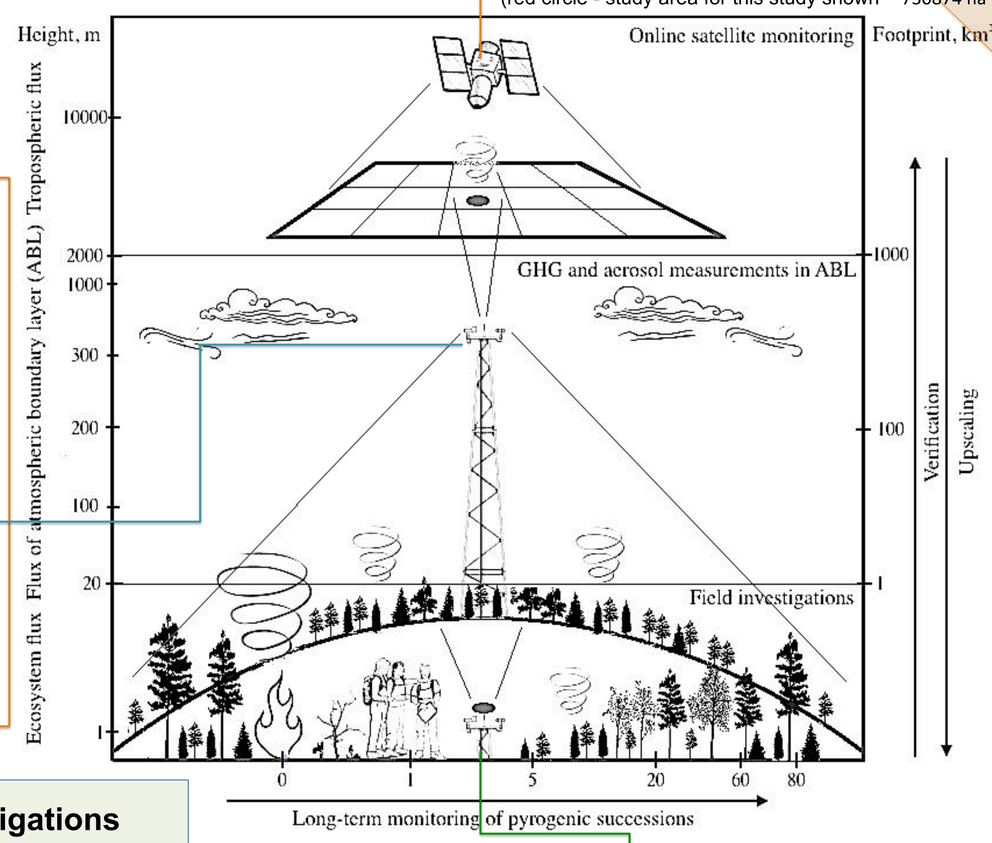
The magnitude of land cover change caused by fires for selected area was obtained using Normalized Burn Ratio (*dNBR*) index and elaborated to map. The *dNBR* values ranged from 500 to 720 (rel.units) depending on land cover type.



3 Fire intensity

Fire radiative power (FRP) index provided information on fire heat release intensity and on the amount and completeness of biomass combustion. Average values ranged from 2100 in pine forests up to 3200 MWatt in dark taiga, representing different fire regimes.

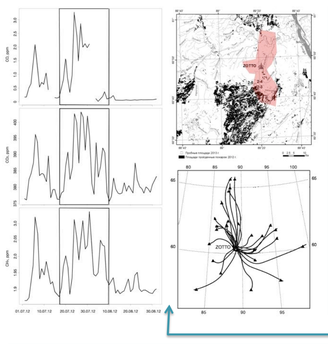




Atmospheric composition – AC (III)

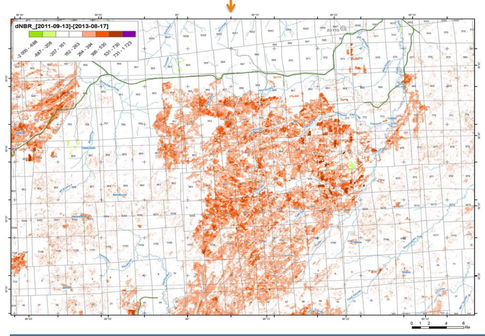
7 Atmospheric signal

GHG data series at ZOTTO (Jul-Aug 2012) were combined with LANDSAT, meteorological observations, and backward trajectory analysis to detect wildfire signals from study area.



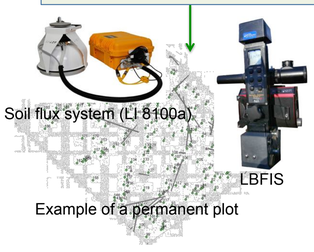
6 GIS validation

The *dNBR* index was calibrated by a complementary field based Composite Burn Index (*CBI*). Average burn severity ranged from 25 to 50% in different ecosystem types.



5 Field investigations

Major ecosystem C pools were assessed within the plots, and mapped by a laser-based field instrumentation system (LBFIS). Soil fluxes - an automated soil flux system (LI 8100A).



4 Permanent plot network

Plots within the fire scarce areas were established in dominant ecosystem types to serve for validation and further long-term monitoring of biogeochemical processes during ecosystem post-fire restoration.

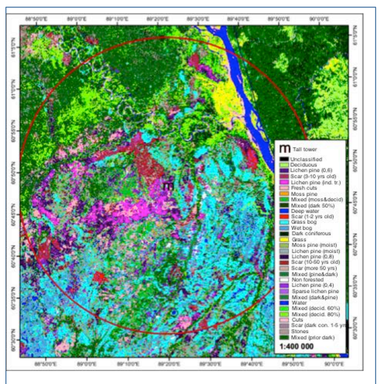
Lichen pine forest
12% of area

Moss pine forest
14% of area

Mixed forest
35% of area

Dark coniferous
6% of area

Wetland
13% of area



Land cover classification
(ZOTTO footprint area)

Long-term and comprehensive field assessment of element fluxes – FA (II)

Conclusions

Based on the combination of remote sensing, field investigations, and atmospheric measurements the wildfire emissions for the main Central Siberian forest types have been calculated. Plots established in the key ecosystems in the ZOTTO footprint area are to be studied in terms of temporal changes in carbon dynamics following fire and linked with ZOTTO measurements.

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ZOTTO