Fire activity and Aerosol Optical Depth detected and retrieved from satellites over PEEX area for the last two decades

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Intro

Wildfires release large amounts of carbon dioxide, black carbon, brown carbon, and ozone precursors into the atmosphere. These emissions affect radiation, clouds, and climate on regional and even global scales. Satellite-based observations offer great opportunities to look for spatial and temporal variability patterns in aerosols, as well as in relation to fires. Increasing frequency and severity of wildfires are well known to enhance emissions of light absorbing carbonaceous aerosols. In current study we investigate how the fire activity over the PEEX area can be recognized in different quantities measured with satellites when looking at more than 20 years of satellite measurements. Study is done in the frame of the Pan-Eurasian Experiment Program (PEEX), which is an interdisciplinary scientific program bringing together ground-based in situ and remote sensing observations, satellite measurements and modeling tools aiming to improve the understanding of land-water-atmosphere interactions, feedback mechanisms and their effects on the ecosystem, climate and society in northern Eurasia, Russia and China.

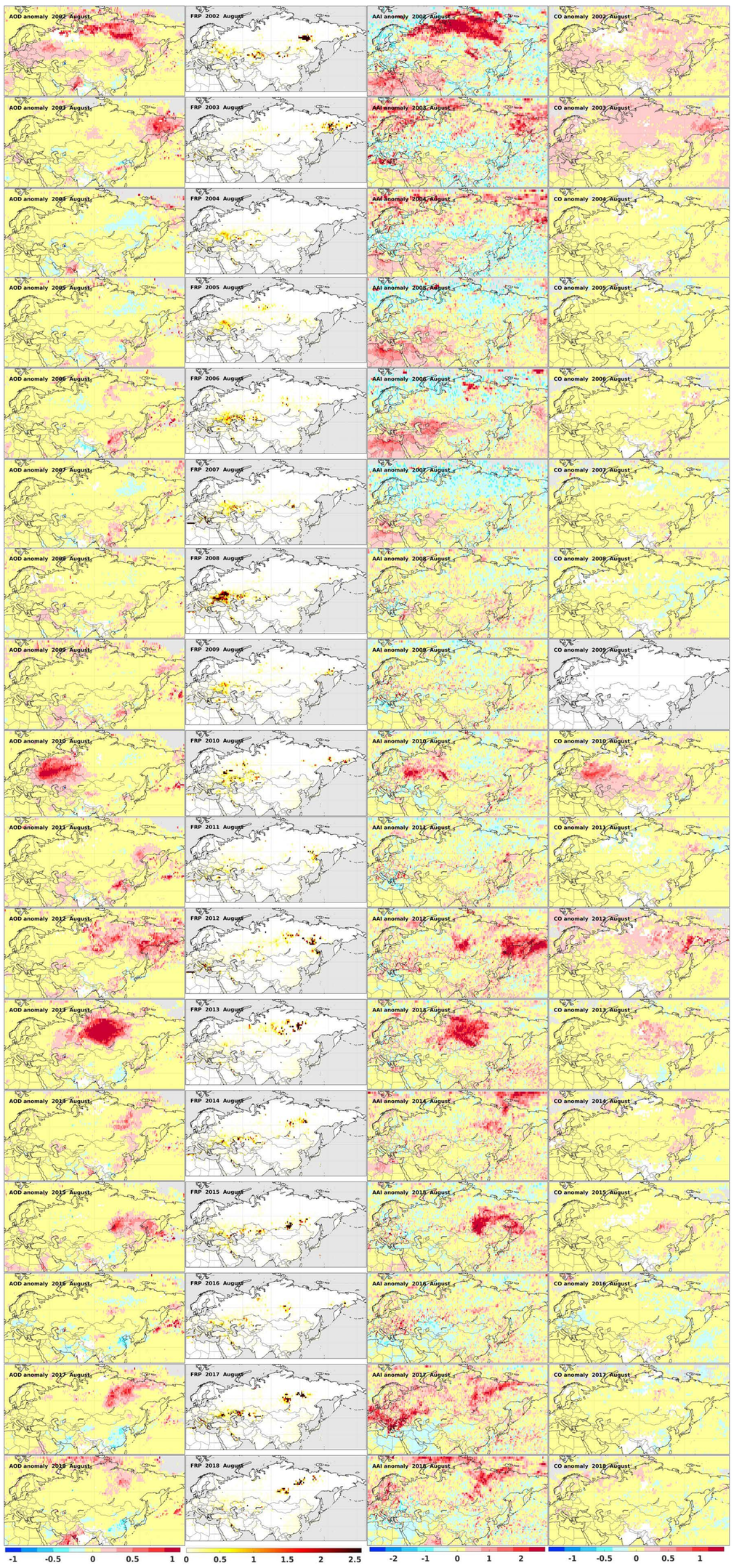
Definitions

- **AOD –** is a vertical column integral of spectral aerosol extinction coefficient. It is a quantitative estimate of the amount of aerosol present in the atmosphere
- **AAI -** The Absorbing Aerosol Index (AAI) indicates the presence of elevated absorbing aerosols in the Earth's atmosphere. The aerosol types that are mostly seen in the AAI are desert dust, biomass burning and volcano ash aerosols
- **CO -** Carbon monoxide, released by incomplete combustion and with an atmospheric lifetime of a few months, influences the atmospheric composition on the regional and global scale, through depletion of the main atmospheric oxidant, the OH radical.
- **FC –** active fire count
- **FRP -** Fire Radiative Power is a technique that uses remotely sensed data to quantify burned biomass. FRP measures the radiant energy released per time unit by burning vegetation.
- **BC, OC/BC** – black carbon and brown carbon to black carbon ratio

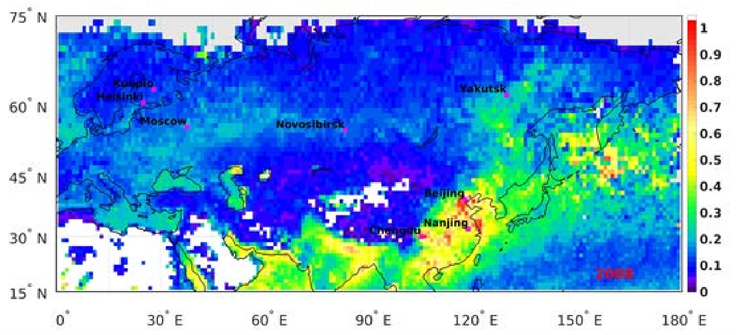
Data sets

- **AOD –** MODIS, Terra
- **AAI –** Gome-2
- **CO –** MOPPIT, Terra
- **FC –** MODIS
- **FRP -** MODIS

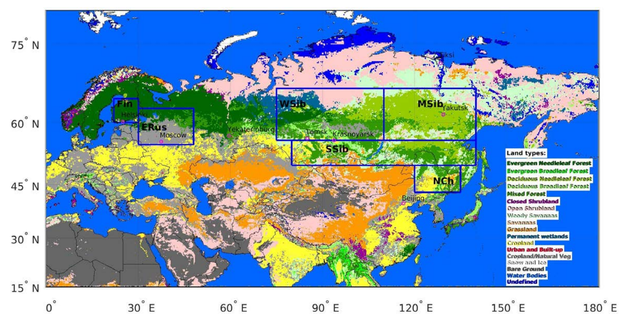
1. Aerosol optical depth (AOD), Absorbing Aerosol Index (AAI) and CO anomalies and Fire Radiative Power (FRP) over PEEX area for the period 2002-2018, August



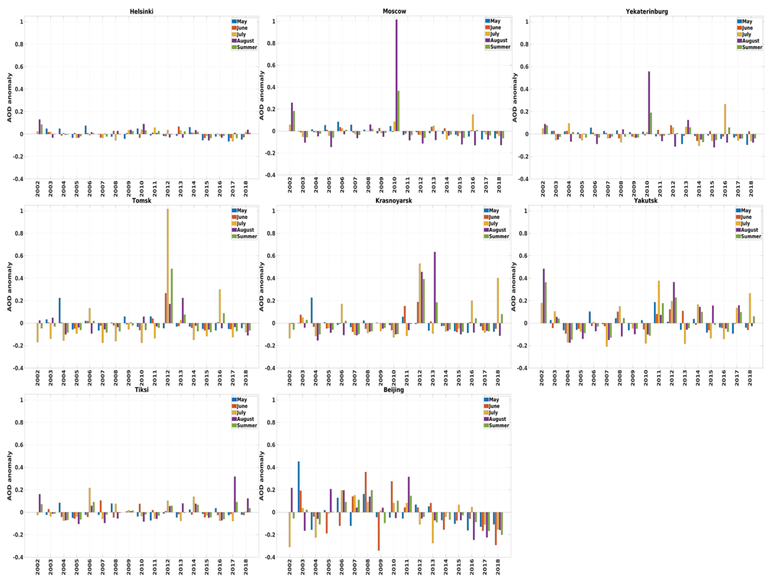
Selected locations and AOD for year 2008



Selected areas and land types

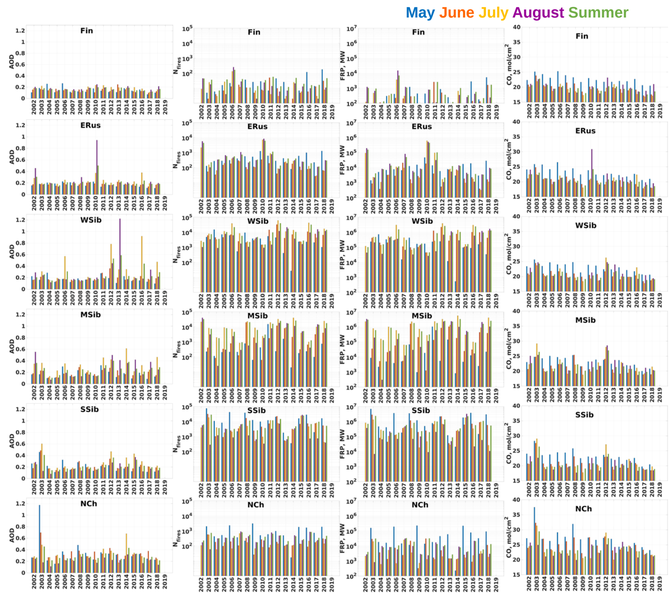


2. AOD anomalies time series for selected locations



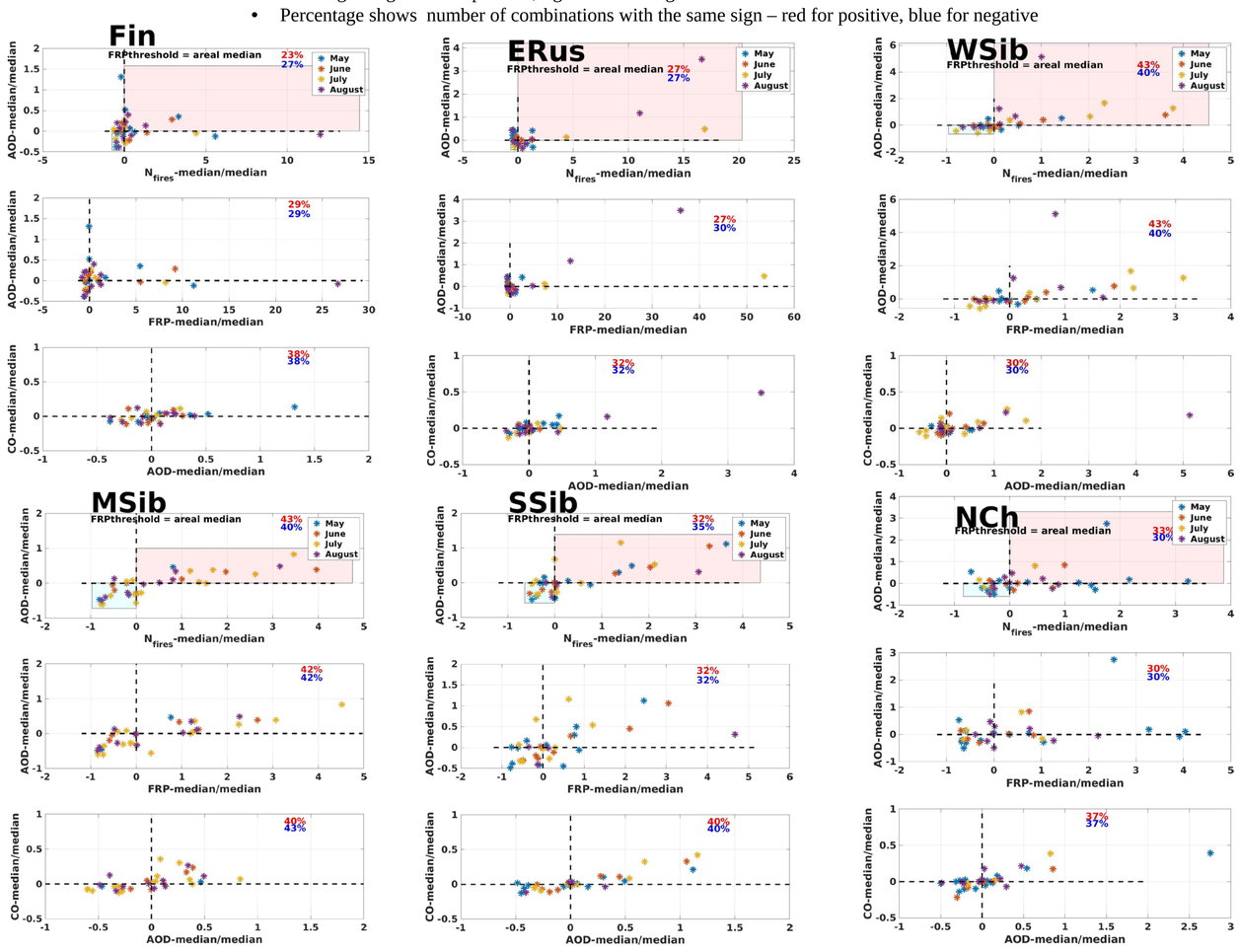
3. AOD, FC (Nfires), FRP and CO time series for selected areas

May June July August Summer



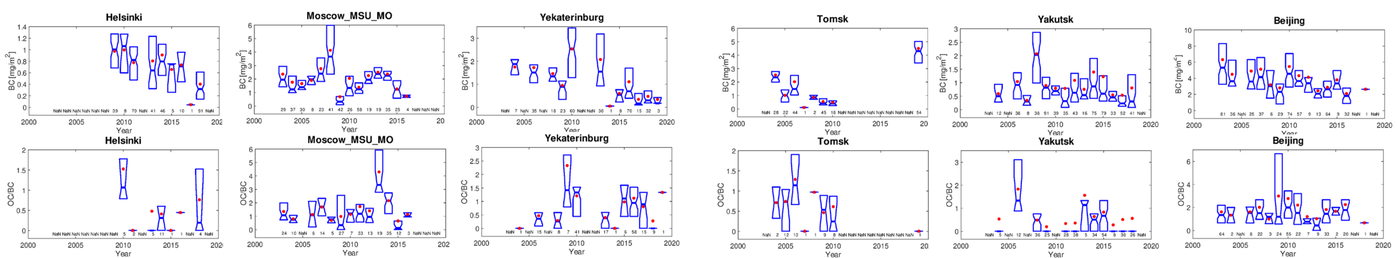
4. Tendencies for combination of relative anomalies related for selected locations

- Areal FRP median is considered as a FRP threshold
- Colored background shows cases when relative anomalies for two chosen combinations are of the same sign – light red for positive, light blue for negative
- Percentage shows number of combinations with the same sign – red for positive, blue for negative



5. BC and OC/BC ratio from AERONET (https://aeronet.gsfc.nasa.gov/) measurements

- Carbonaceous aerosols are composed of both light-absorbing black carbon (BC) and absorbing brown carbon (OC)
- OC/BC ratio determines the relative amounts of scattering and absorption; it is often used to estimate the radiative forcing due to aerosols.
- BC and OC data are described in Arola et al, 2011, https://www.atmos-chem-phys.net/11/215/2011/
- Box plots are calculated form data available during May-August
- Note: different scale



6. Conclusions

Section 1: FRP released by burning vegetation shows the intensity of the forest fires. AOD, AAI and CO anomalies often strongly correspond to the intensity of the forest fires. Note, that FRP is reported for burning locations, while aerosol particles and gases are also a subject of the long-range transport further from the sources along the prevailing wind direction.
Section 2: AOD positive anomalies in clean and relatively clean areas correspond mostly to intensive forest fire episodes. In the areas of high industrial pollutions, the impact of biomass burning episodes to total AOD is less visible.
Section 3: Months and years of intensive forest fires episodes can be clearly identified from the time series of AOD and CO in different areas. Though, AOD increase is May in the Southern Siberia (SSib) and Northern China (NCh) is caused mostly by the dust transport from the Gobi and Taklamakan deserts
Section 4: In 60-84% (depending on the chosen area and combination of variables), relative anomalies show similar tendencies – positive or negative, depending on the fire activity (intensive and less intensive, as compare to median, respectively)
Section 5: substantial year-to-year variability is observed in BC and OC/BC ratio; decrease of BC in Beijing is apparent.

WORK IN PROGRESS