Black carbon emissions from forest fires in Arctic

Romanovskaya A.A.
Ginzburg V.A., Kostrykin S.V., Revokatova A.P.,
Pastukhova A.S., Ryaboshapko A.G., Korotkov V.N. , Polumieva P.D.

Yu.A. Izrael Institute of Global Climate and Ecology (IGCE)
Moscow, Russian Federation

The effect of black carbon on the climate is ambiguous:

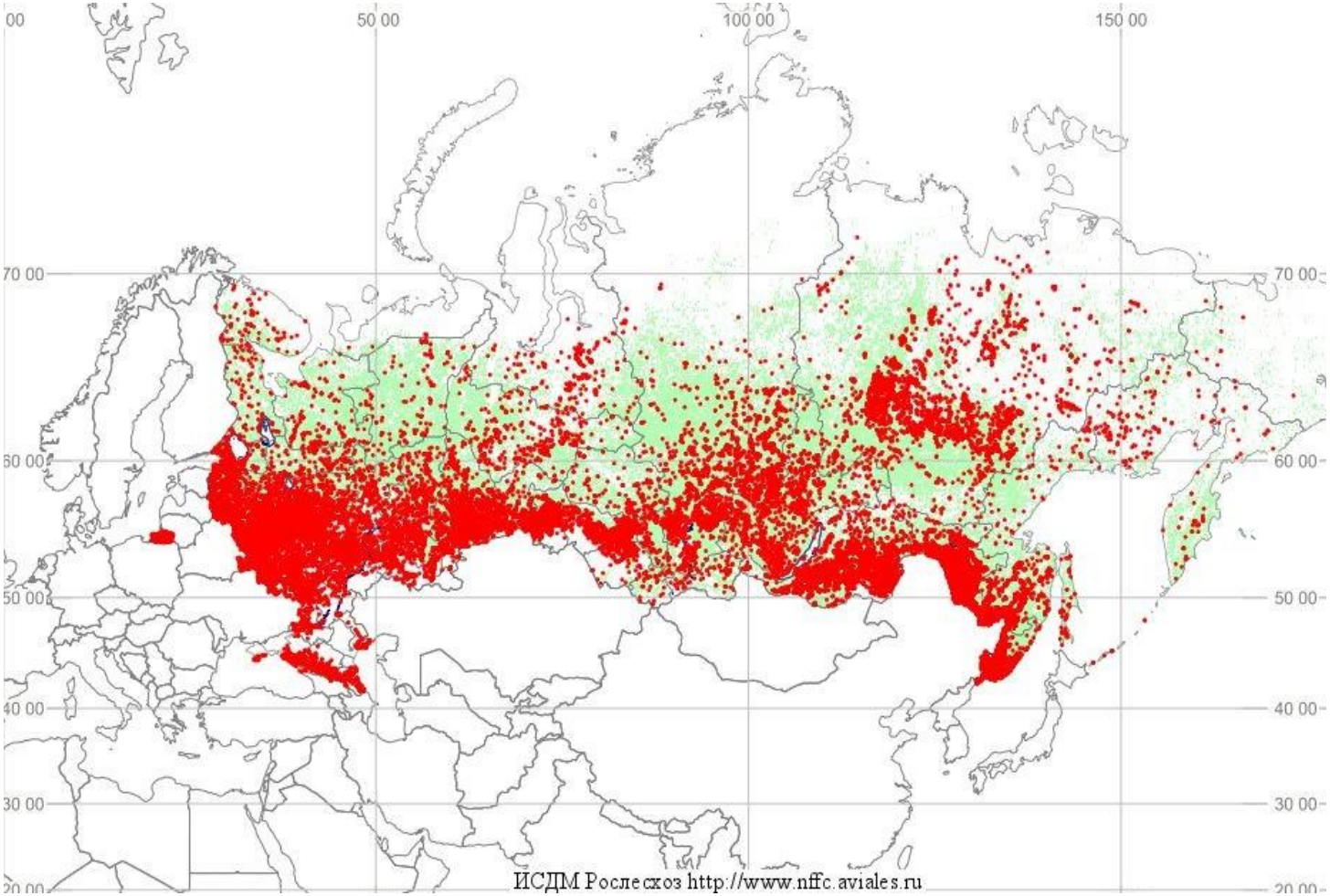
1) direct absorption of solar radiation
2) the pollution of the clouds, which leads to the absorption of solar radiation and the warming of the clouds
3) indirect effect of reducing the reflectivity of snow and ice, which is most important for the Arctic and for Russia
4) In the uncontaminated state snow and ice reflect approximately 98% of solar radiation. When it is contaminated with “black carbon”(BC), it reflects from 97 to 90%. The absorption increases from 2 to 3-10%.

Feature	BC
Lifetime in the atmosphere	From several days to several weeks
Absorption capacity	Absorption of solar radiation in all spectra
Average global radiation forcing	+0.34-1 W m^{-2} - direct effect + 0.05 W m^{-2} - due to changes in albedo of snow and ice +/-? – interaction with clouds
Contribution to global warming	Probably the 3rd most influential factor after CO2 and CH4, but with high uncertainty

The aim of this work is to obtain estimates of the emission of BC from wildfires, as well as the probability of BC transport from conventional forest fires in areas of European and Asian boreal taiga, the determination of the fields of concentrations and deposition of BC on the ice-snow surface and an assessment of the possible contribution of BC to Arctic climate change.

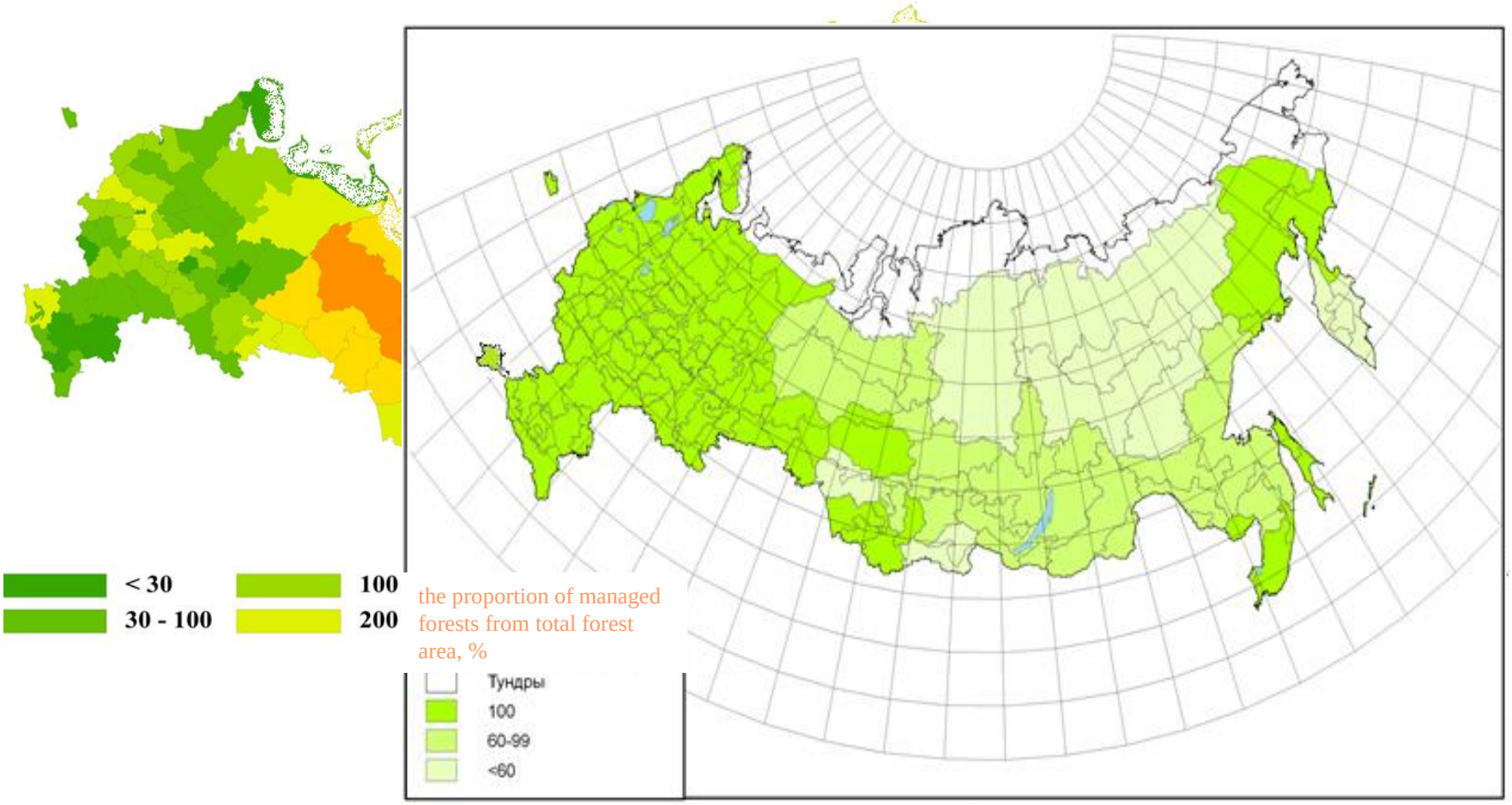
Estimation of black carbon emissions from forest and non-forest fires

Jan – Nov 2018

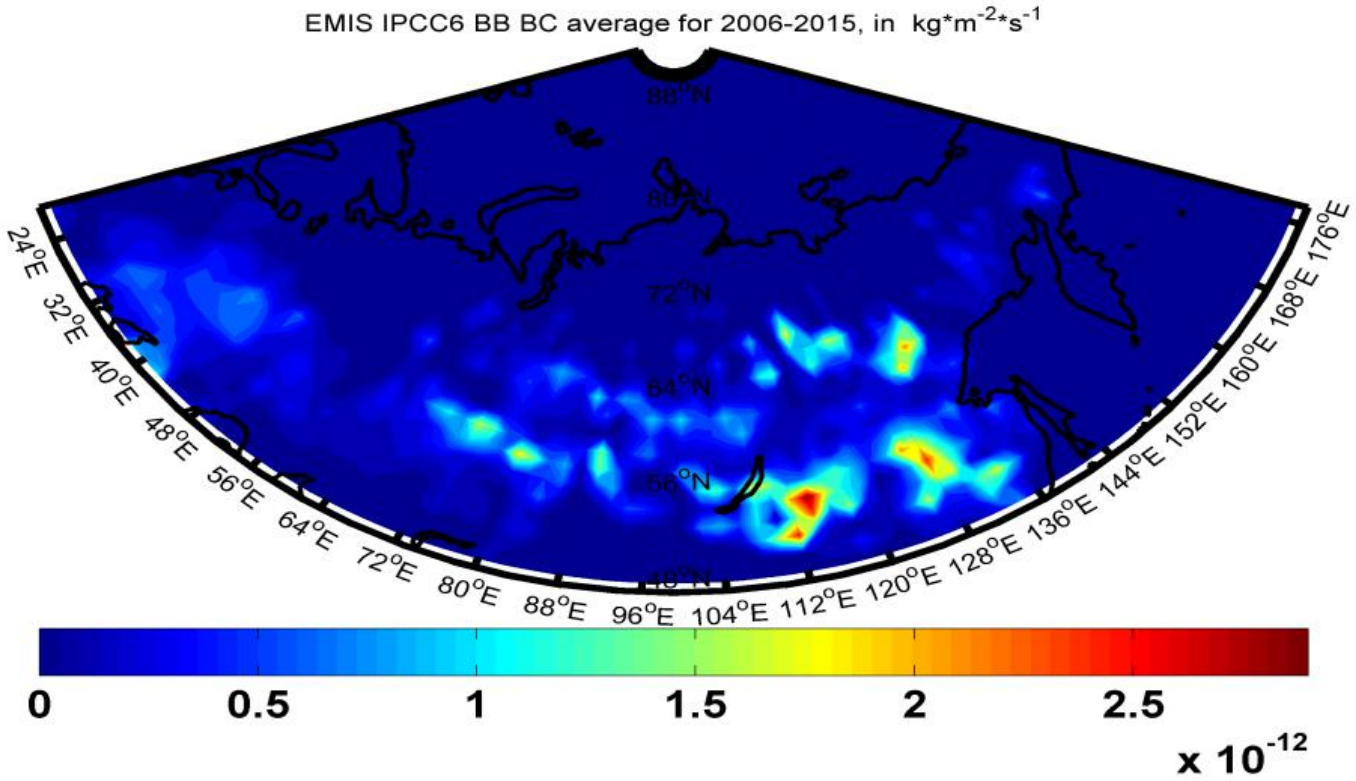


Estimation of average annual emissions of black carbon from forest and non-forest fires for the period 2000-2017, t yr^{-1}

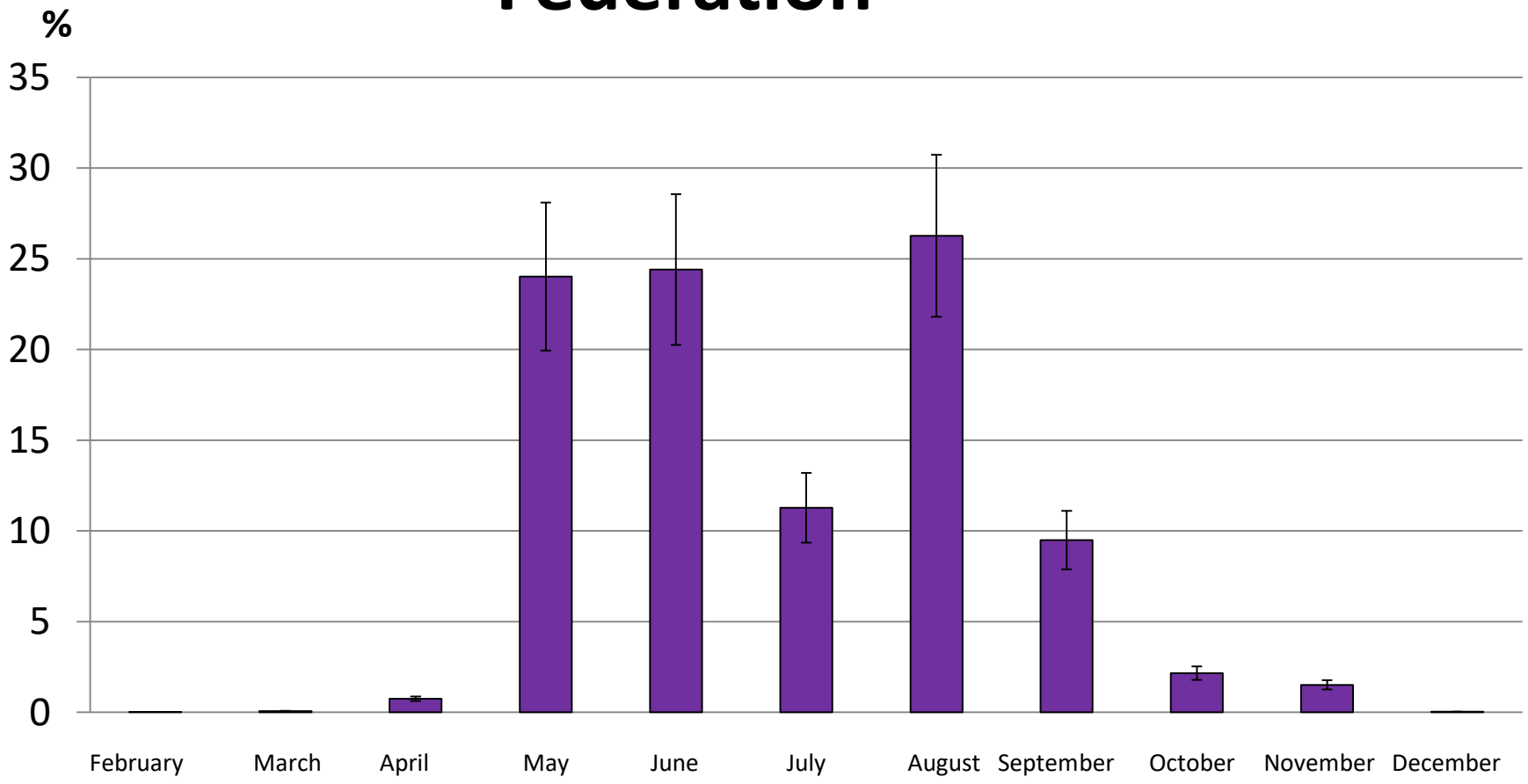
The average annual emission of BC from wildfires in the Russian Federation is 62,2 ± 8,4 thousand tons for 1990-2017 (about 1% of the global emission of BC (Wang et al., 2014))



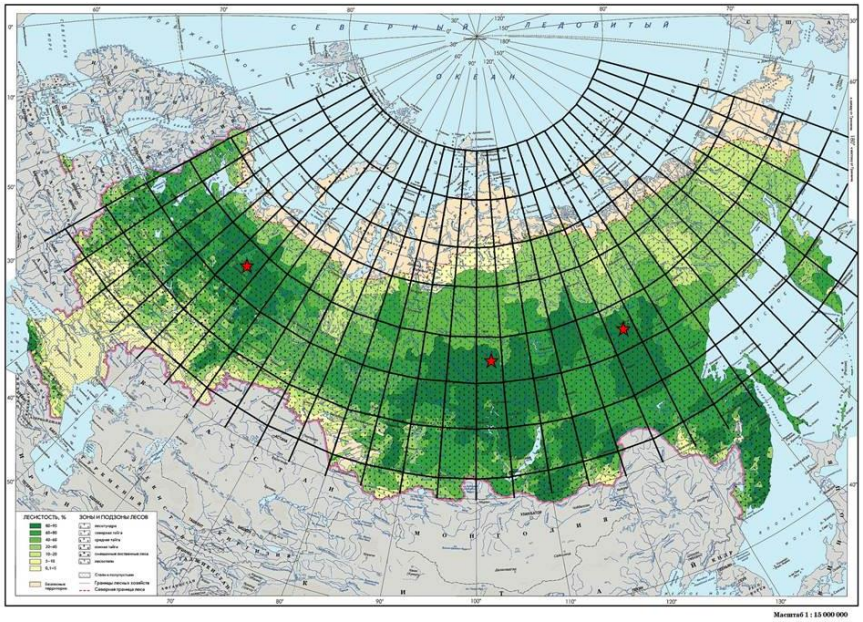
BC intensity in 2006-2015



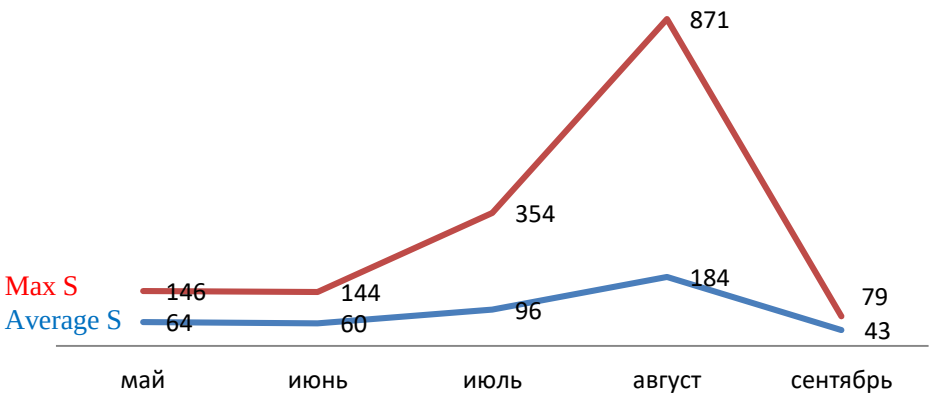
Seasonal dynamic of BC emissions from wildfires in the Russian Federation



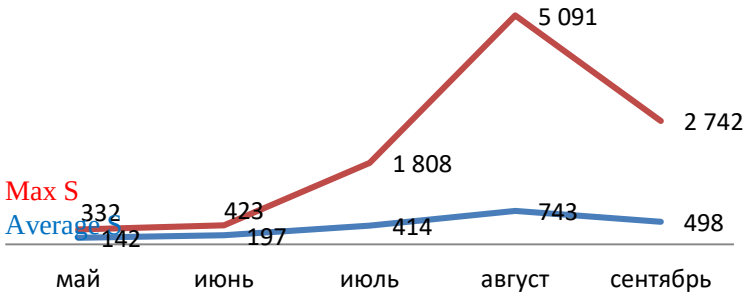
Selection of model cells



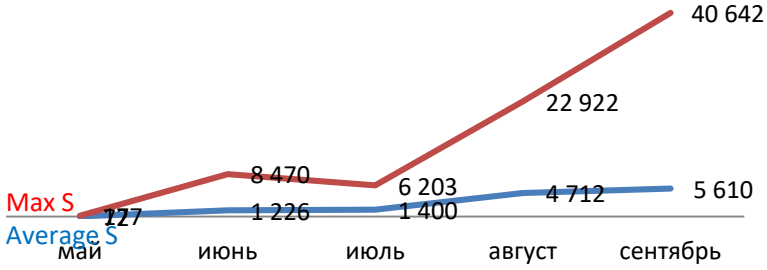
Komi

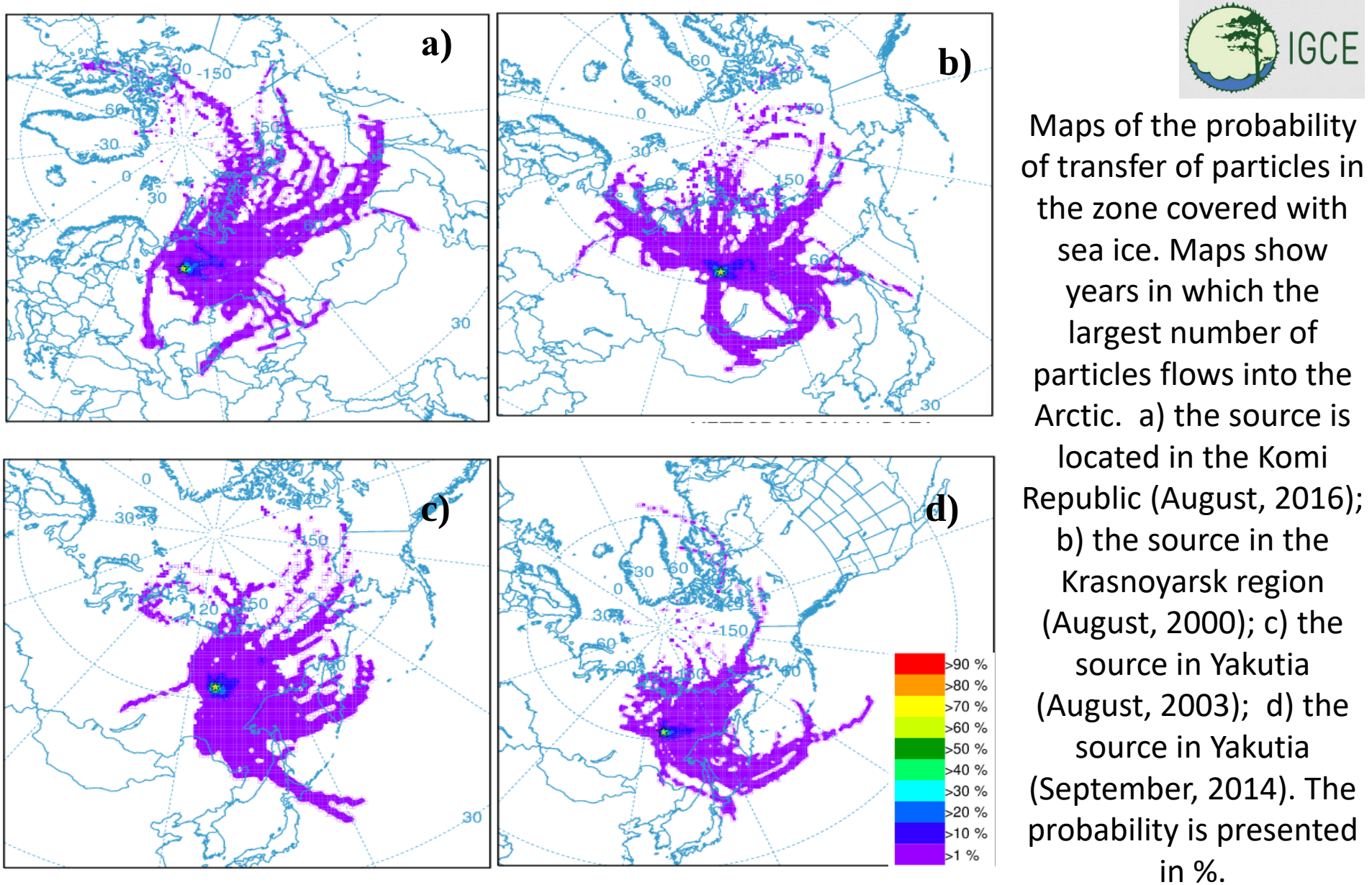


Krasnoyarskii region



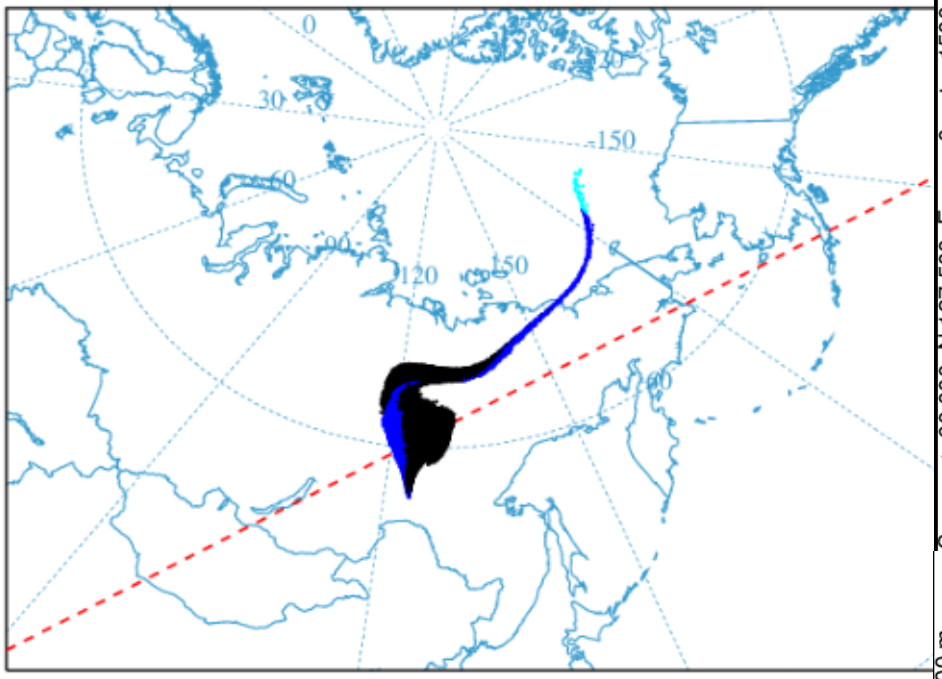
	Komi	Krasnoyarskii region	Yakutia
	Average number of fires		
май	1	122	21
июнь	2	91	23
июль	4	47	41
август	25	46	75
сентябрь	1	18	29



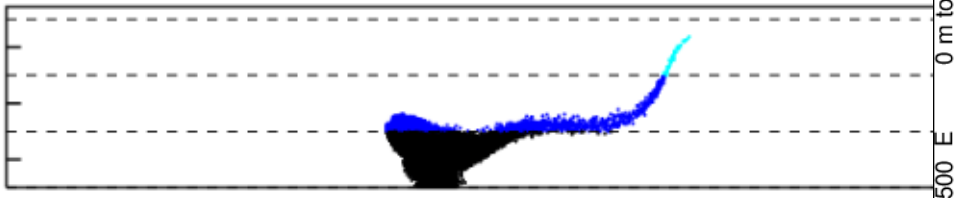


Maps of the probability of transfer of particles in the zone covered with sea ice. Maps show years in which the largest number of particles flows into the Arctic. a) the source is located in the Komi Republic (August, 2016); b) the source in the Krasnoyarsk region (August, 2000); c) the source in Yakutia (August, 2003); d) the source in Yakutia (September, 2014). The probability is presented in %.

NOAA HYSPLIT MODEL
PARTICLE CROSS-SECTIONS
PARTICLE POSITIONS AT 12 00 04 Aug 03



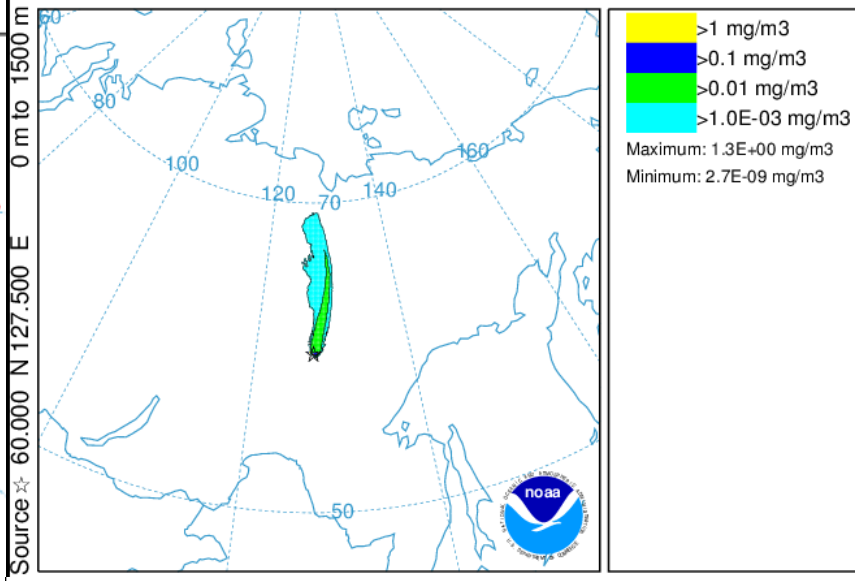
LAYER (m): < 2000 < 4000 < 6000 < 8000 <1000



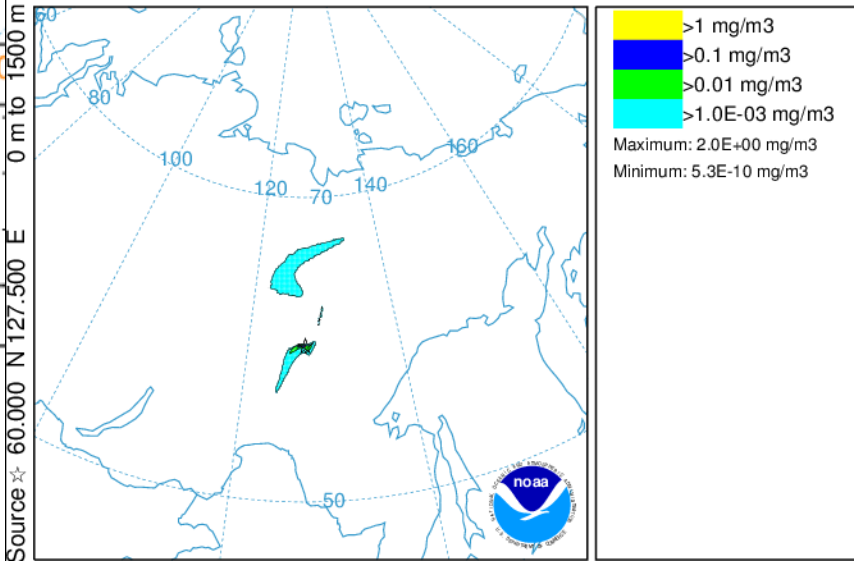
NUMBER OF PARTICLES PLOTTED: 95000

Job ID: 23068 Job Start: Fri Nov 24 14:13:43 UTC 2017
Release: lat.: 60.000000 lon.: 127.500000 Hgt: 0 to 1500 m
Pollutant: Mass - Unspecified
Release Quantity: 7913219 mass Start: 03 08 01 00 0 Duration: 84 hrs, 0 min
Pollutant Averaging/Integration Period: 2 hrs and 0 min
Dry Deposition rate: 0.1 cm/s Wet Removal (below/in-cloud): 8.0E-05 / 8.0E
Meteorology: 0000Z 1 Aug 2003 - reanalysis
This is not a NOAA product. It was produced by: unknown

Concentration (mg/m3) averaged between 0 m and 3000 m
Integrated from 1800 02 Aug to 2000 02 Aug 03 (UTC)
Mass Release started at 0000 01 Aug 03 (UTC)

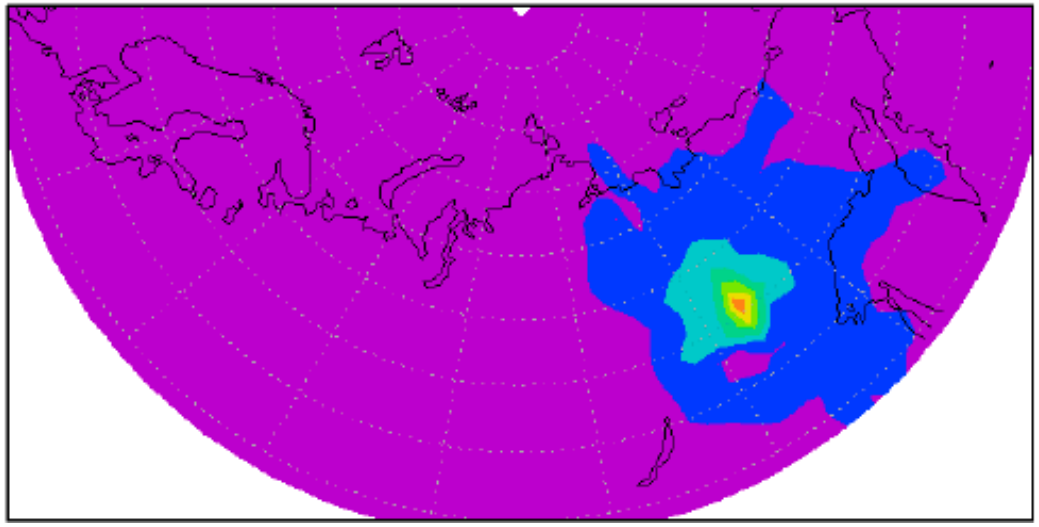


Concentration (mg/m3) averaged between 0 m and 3000 m
Integrated from 0200 04 Aug to 0400 04 Aug 03 (UTC)
Mass Release started at 0000 01 Aug 03 (UTC)



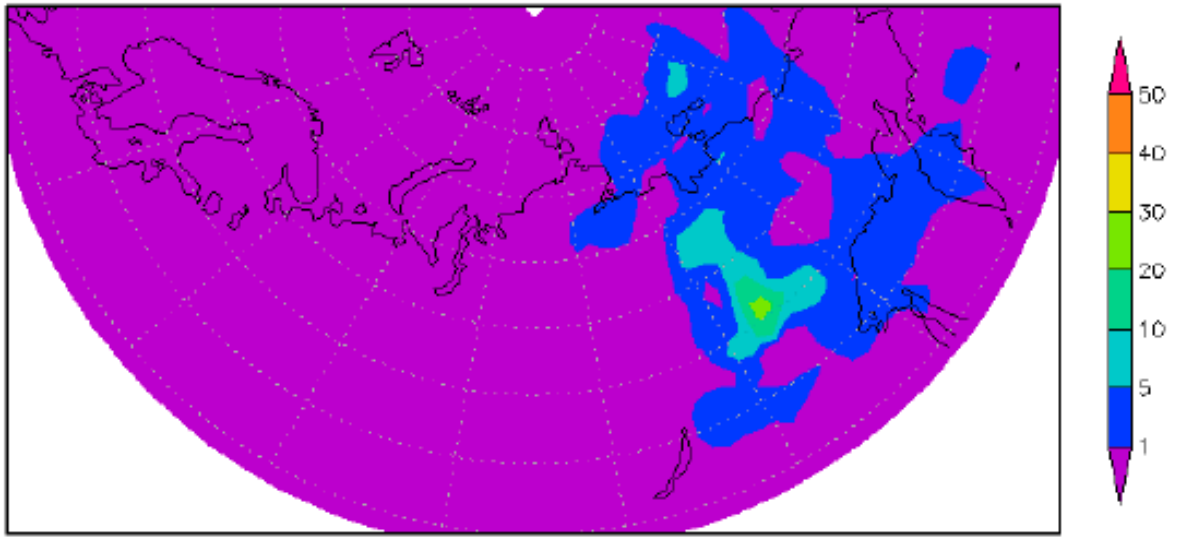
Amount of BC deposited on the surface of the Arctic in mg / m^2
Model INMCM5

Mean



Black carbon emissions from a model forest fire reproducing the emission rate corresponding to about 50 fires with a maximum observed spreading area of 12 days leads to a total deposition in the Arctic region on average less than 1 mg / m^2, and at a maximum distribution of up to 10 mg / m^2, which can form a layer thickness from 1 to 10 nm

Maximum distribution



Conclusions and further research

- Spring wildfires are minimal and do not exceed 1% of the total annual emissions in the Russian Federation .
- In spring time mostly non-forested lands burn with a low altitude of BC emission into the atmosphere (less than 3 km), but the probability of transfer to the Arctic is higher (the greatest impact on the albedo of snow and ice during the period of thawing)
- Carbon deposition in the Arctic zone from intense model fires at a latitude of 60 ° N do not exceed 10% (<1mg / m^2)
- The impact of fires on the territory of the Russian Federation on the intensity of ice melting in Artic seems to be overestimated.
- <u>Further research areas:</u>

1. modeling of transfers from other regions with large fires (Krasnoyarsk region, Amur region, Baikal territory)
2. simulation of spring fires
3. including in the calculation of emissions of black carbon from the burning of fossil fuels
4. assessment of the effect on changes in snow albedo

Thank you for your attention!