Assessment of black carbon in Russia using GEOS-Chem

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The results presented here are the views of the authors and not the official views of the US Department of Energy

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Motivations

Arctic black carbon simulation problems:

- **Large diversity of modeling BC from different models (Shindell et al., 2008)**
- **Strong underestimation of BC in Arctic (Shindell et al., 2008; Koch et al., 2009)**
- **Improper wet scavenging parameterizations (Bourgeois et al., 2011)**

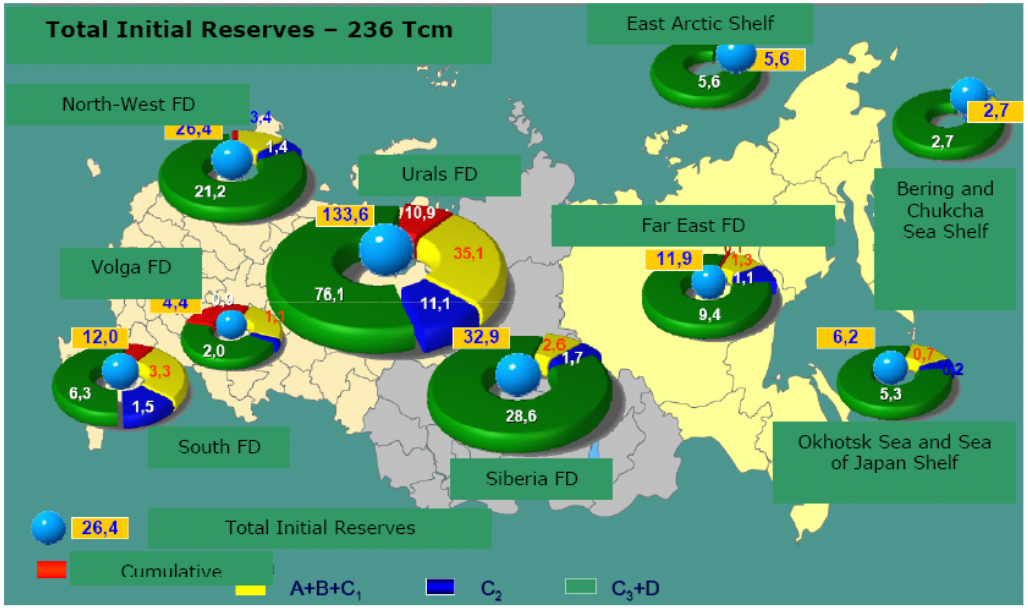
Arctic Black Carbon (BC) Initiative: A project funded by U.S. DOE

- **Activity #1:**
  Arctic BC Identification: Receptor modeling: Potential Source Contribution Function (PSCF) ***(ORNL)***

- **Activity #2:**
  Establish BC Emissions Inventory of Russia: Improve estimates of BC emissions in Russia and evaluated by using GEOS-Chem *(Univ. TN)*
  Tasks: **Gas flaring BC emission; Power plants BC emission**
  Industrial BC emission; Transportation BC emission; Residential BC emission

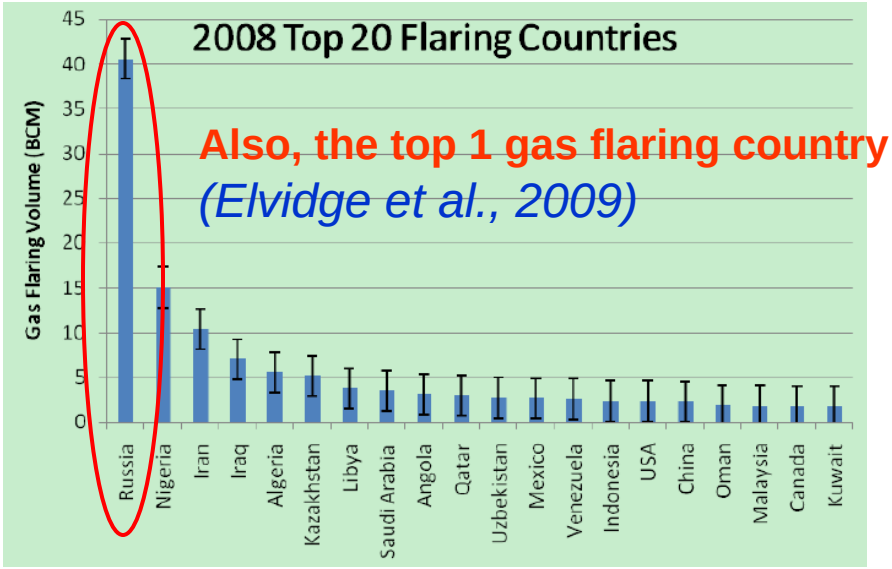
- **Activity #3:**
  Demonstration of BC Emissions Reduction Technologies:
  Demonstrate the best-available emissions reduction technologies for a subset of the identified sources in Russia. ***(ORNL)***

Missing BC sources from gas flaring



Russia possess the largest natural gas reserves of **24%** in the world as of 2009.

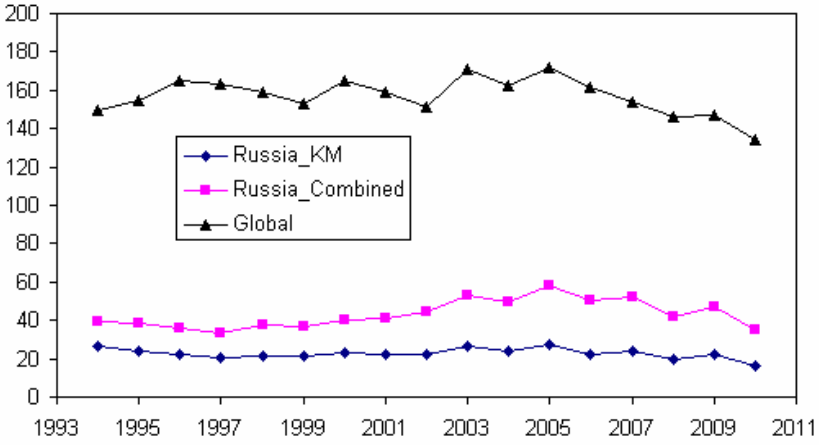
(Dmitry Volkov, 2008)



Also, the top 1 gas flaring country

(Elvidge et al., 2009)

Annual gas flare volume in the global scale and in Russia



Estimation of gas flaring emission and associated uncertainties

Estimation of gas flaring BC emission:

$BC_{flaring}$ = Volume * PM_{EF} * (BC/PM fraction)

Volume : Gas flaring volume of Russia in 2010 was **35.6 BCM** (billion cubic meters)

PM_{EF} : 0.00315 kg/m^3 (average value from previous table)

BC/PM fraction from Natural Gas Combustion : 38.4% (USEPA SPECIATE data profile)

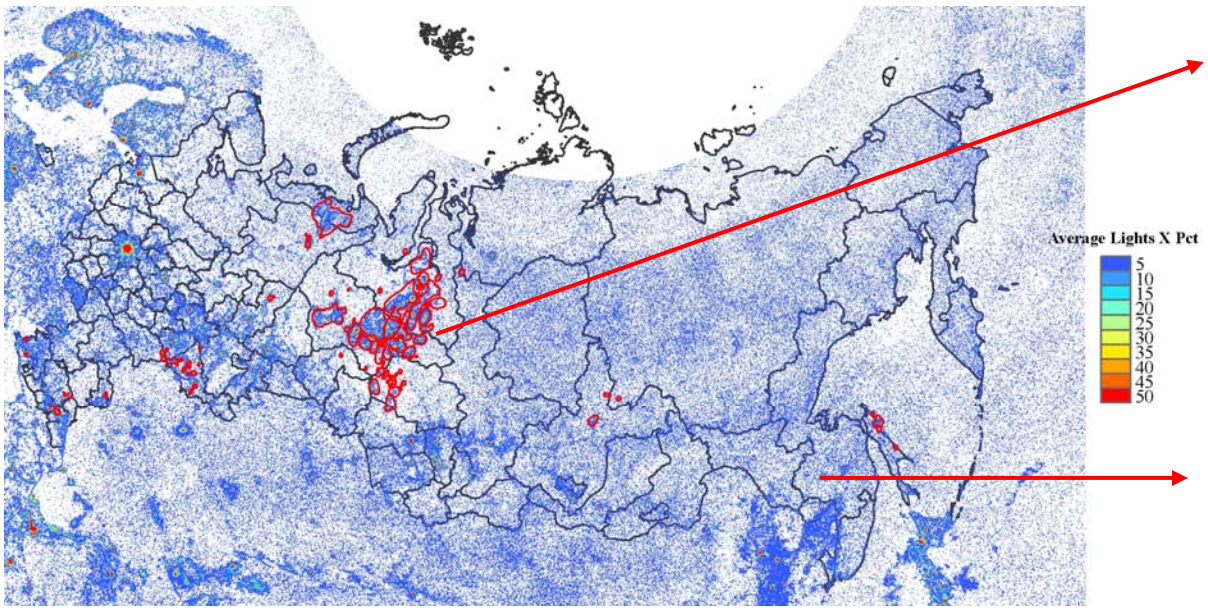
The BC emission from Russia's gas flaring in 2010 is estimated to be **43.25 Gg**.

Uncertainties:

1. **Uncertainty from EFs**
   The standard deviation of EFs reached 0.00326 kg/m^3, even higher than its average value.

2. **Uncertainty from satellite retrieved gas flare volume**
   The error from satellite is estimated to be +/- 2.98 BCM (Elvidge *et al.*, 2009). Compared to the total Russia's flaring volume, the uncertainty caused by retrieve methodology is much smaller than from EF.

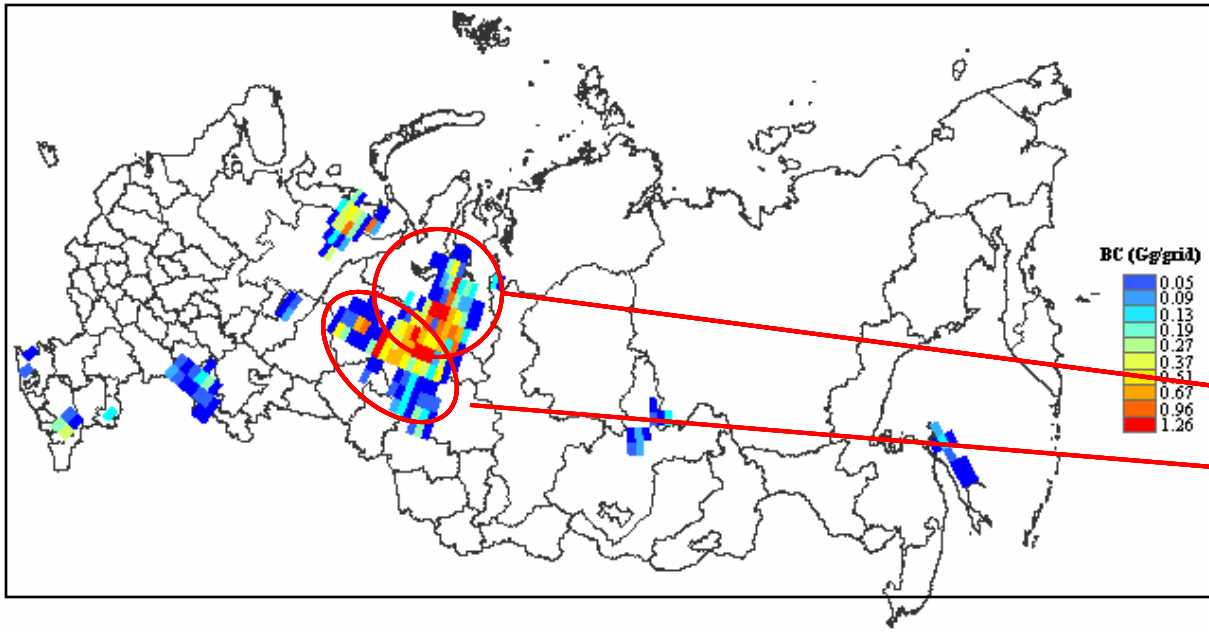
Spatial distribution of gas flaring BC emission



Gas flare areas (red polygon) retrieved from satellite (U.S. Air Force Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS))

Spatial allocation proxy (contour) nighttime lights product

Data source: NOAA NGDC



Spatial distribution of gas flaring BC emission (1.0*1.0 degree)

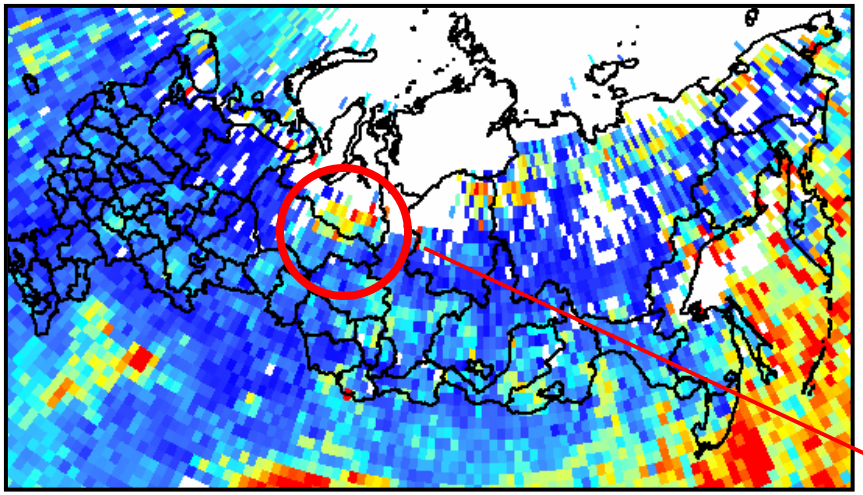
Major gas flaring regions:

Yamal-Nenets

Khanty-Mansiysk

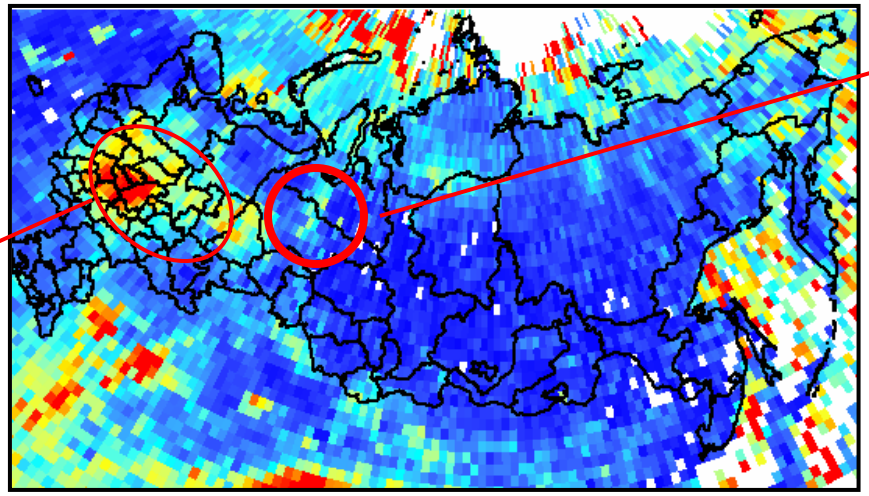
Absorption aerosol optical depth (500 nm) retrieved from OMI

2010 Spring (MAM)



Autumn and Winter are not plotted due to snow cover at high latitudes.

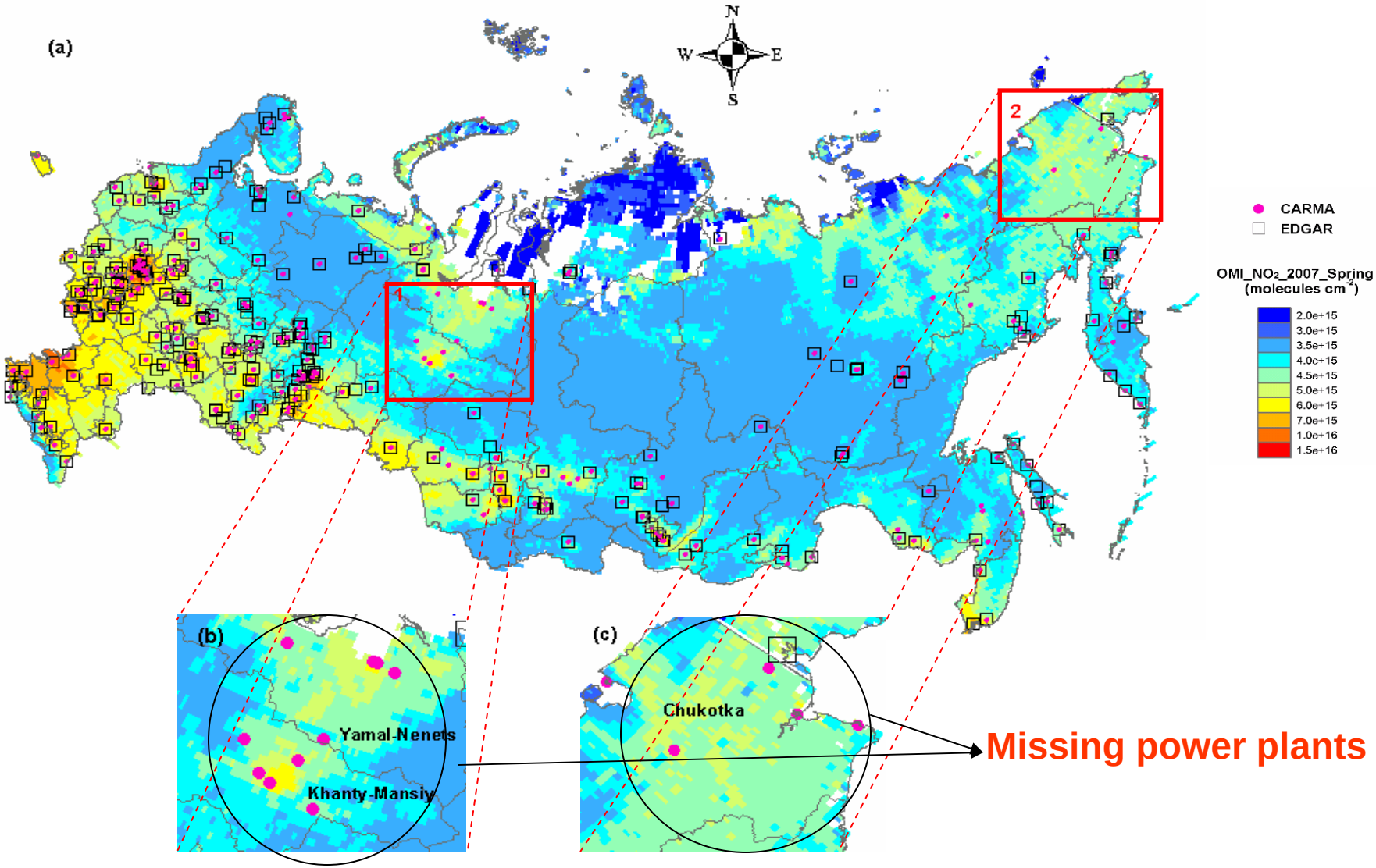
2010 Summer (JJA)



Hotspots in the gas flaring fields

Biomass burning

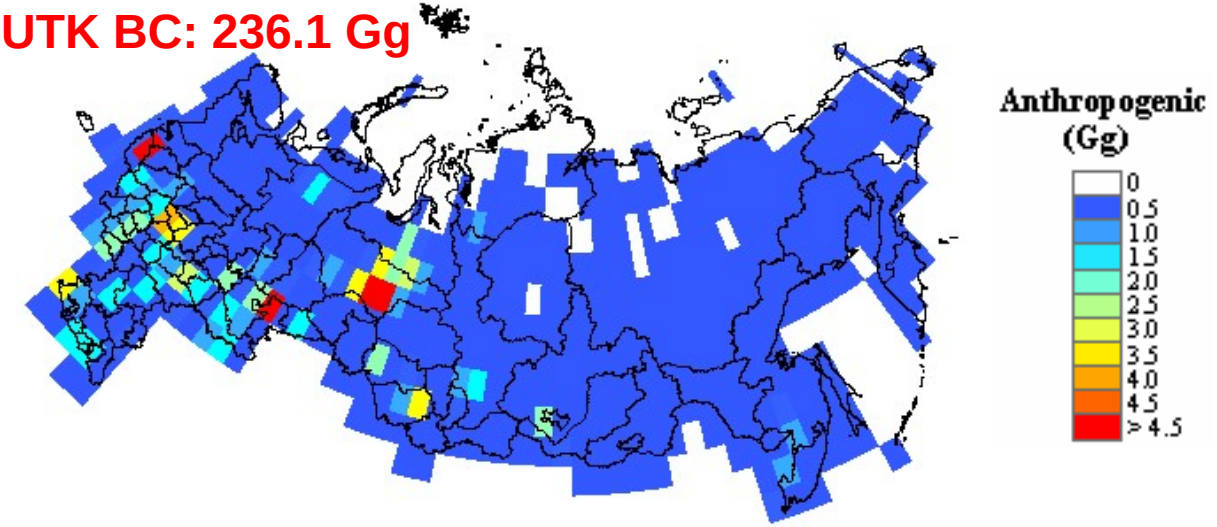
Detection of missing power plants in EDGAR from CARMA and OMI



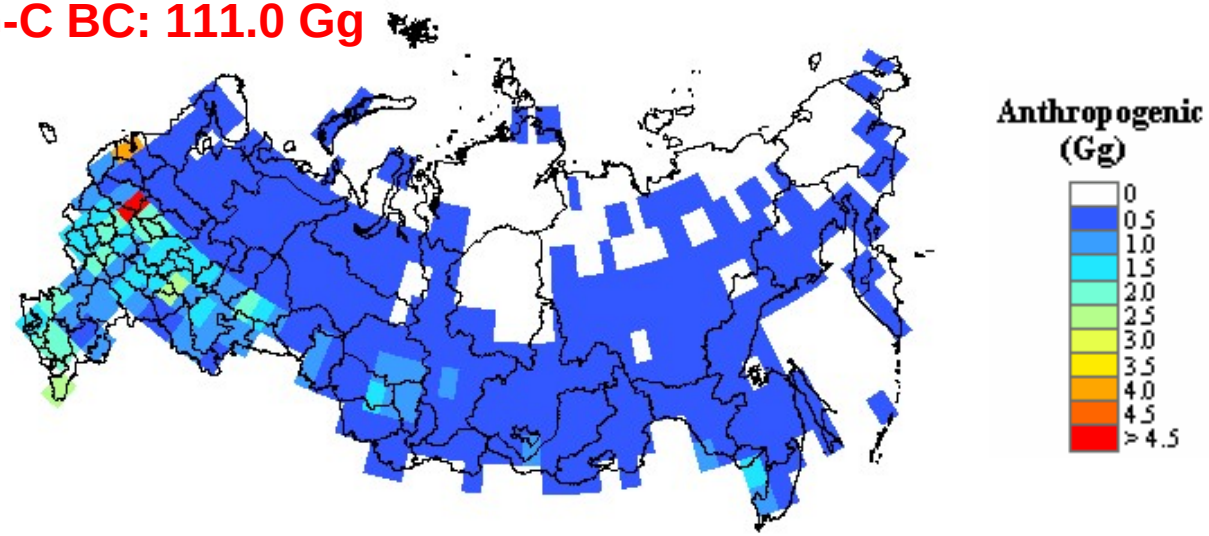
Comparison to the default BC emission used in GEOS-Chem

BC emission from other sources such as industry, transportation and residential are also re-constructed.

UTK BC: 236.1 Gg

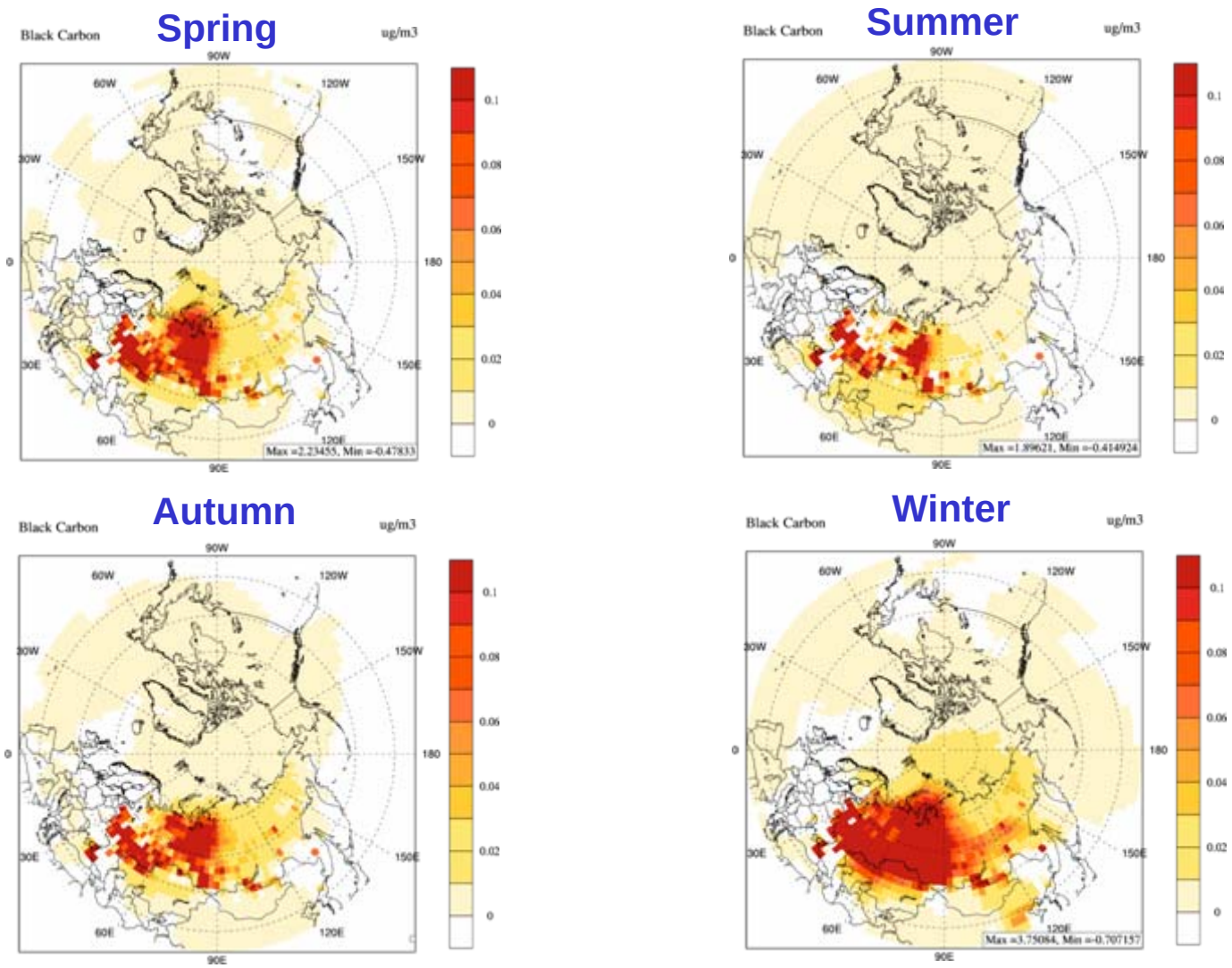


G-C BC: 111.0 Gg



Impact from increased BC emission

Surface BC from the difference between simulation with new emission and the base case



The impact of the new emission on the increased surface BC concentration could reach over 2 μ g/m^3 in Russia and over 20 ng/m^3 over the Arctic Circle.


Thanks!