Missing black carbon emissions in Russia - new BC emissions for GEOS-Chem

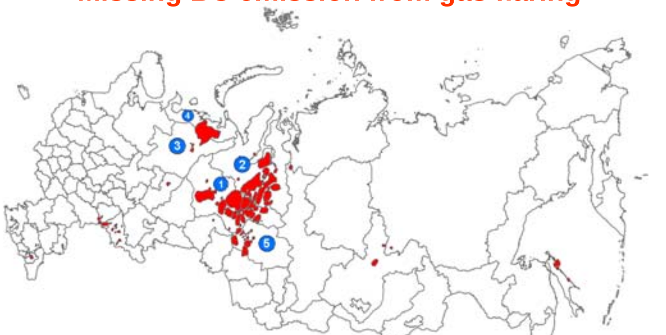
Kan Huang, Joshua S. Fu (jsfu@utk.edu), and Xinyi Dong

Department of Civil and Environmental Engineering, The University of Tennessee, Knoxville, Tennessee, USA

Introduction

Anthropogenic emissions of black carbon (BC) contribute to global warming, and that effect is most pronounced in the Arctic where both atmospheric heat retention and deposition to the ice promote warmer temperatures and snow melt. The Arctic Circle includes parts of Alaska, Europe and vast regions of Canada and Russia. Of which, the BC emission from Russia is most uncertain. In 2011, the U.S. Department of State initiated the Arctic Black Carbon project at three U.S. government agencies. Of which, U.S. Department of Energy is responsible for BC emissions from heating, power generation, and industrial applications. The role of UTK in this project is to improve the BC emission inventory in Russia and use a 3-D chemical transport model GEOS-Chem to verify its accuracy.

Missing BC emission from gas flaring



Five major flaring areas:

①Khanty-Mansiysk ②Yamal-Nenets ③Komi ④Nenets ⑤Tomsk

Data source: NOAA NGDC (National Geophysical Data Center)

Emission factors of gas flaring

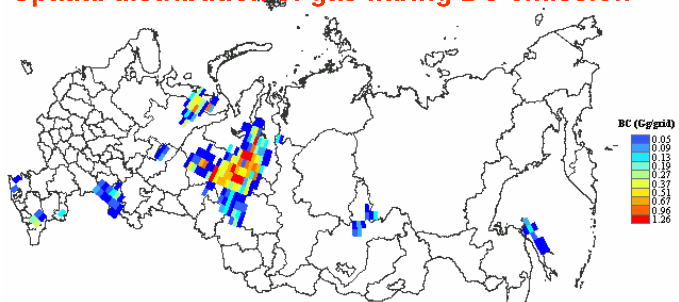
Species	Original Emission Factor ($lb/10^6 Btu$)	Converted Emission Factor (kg/m^3) [a]	References
PM (soot)	0.0, 0.027, 0.12, 0.19 [b]	0, 0.001, 0.0045, 0.0071	RTI International, 2011
CO	0.28-0.55 [c]	0.010 - 0.02	TCEQ (Texas Commission on Environmental Quality) 2008 Emissions Inventory Guidelines (TCEQ, 2009)
NOx	0.049-0.14 [c]	0.0018 - 0.0052	Same as above

[a]Emission factors are converted based on a fuel heating value of 87 MJ/m^3 (1 Btu = 1055.06 J)

[b]Calculated from the soot concentrations using F-factor method on a dry basis, assuming 3% O_2 in exhaust (RTI, 2011). Four different soot concentrations in flare: non-smoking flares, 0 μg/L; lightly smoking flares, 40 μg/L; average smoking flares, 177 μg/L; and heavily smoking flares, 274 μg/L (U.S. Environmental Protection Agency, 1995).

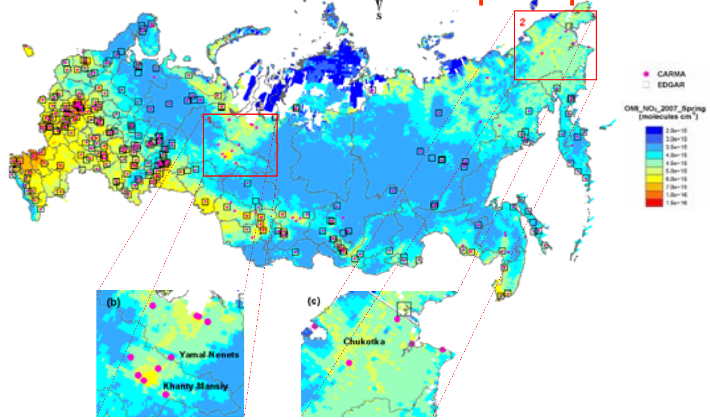
In 2010, the amount of gas flaring from Russia is estimated as about 35.6 BCM (billion cubic meters). This results in an estimated BC emission of **43.25 Gg**.

Spatial distribution of gas flaring BC emission



Allocation proxy: Nighttime light intensity from NOAA NGDC

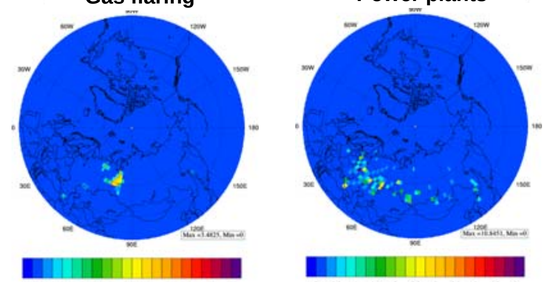
Underestimated BC emission from power plants

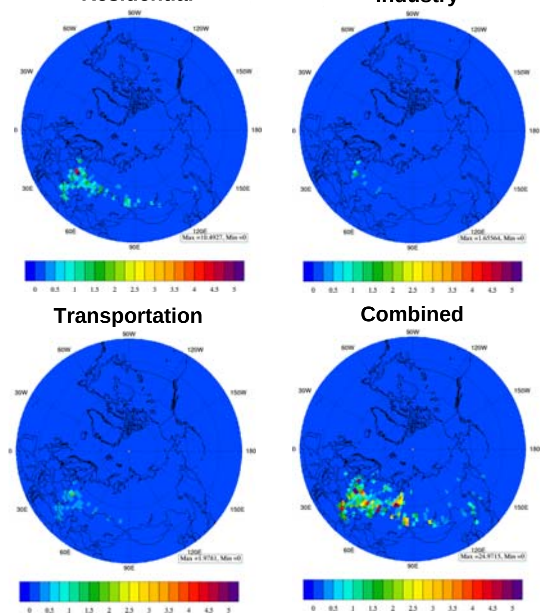


Compared to a global power plant dataset CARMA, a considerable amount of power plants is found missing in the power grid sector from the EDGAR emission inventory.

New BC emission inventory (2010) prepared for GEOS-Chem (2 * 2.5 degree, units: Gg/grid/year)

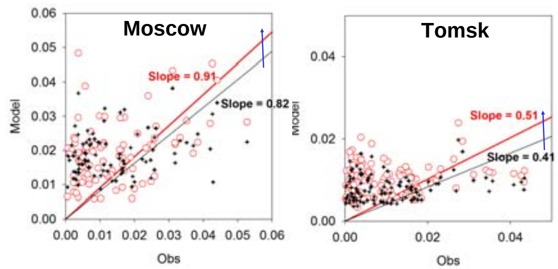
BC emission from the other sectors, e.g. industries, residential, transportation, are also reconstructed based on recent activity data and local emission factors (very rare).





GEOS-Chem modeling evaluation of AAOD

Evaluated parameter: **AERONET absorption AOD**
Black scatter: simulation using **EDGAR**; Red scatter: simulation using **new BC emission**



Model evaluation of AAOD using new BC emission and the default emission is compared at 8 AERONET sites. Generally, model performance using new emission improves. More detailed local information of Russia such as emission factor is needed in the futuer work.

Acknowledgements

This research is funded by State Department Climate Change Assistance Programs, DOE Energy Efficiency and Renewable Energy Office. Computation is supported by Newton HPC at UT. We also thank PI of AERONET for establishing and maintaining the sites.