Sources of Carbonaceous Aerosol and Deposited Black Carbon in the Arctic in winter-spring

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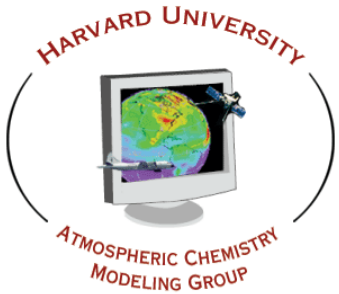
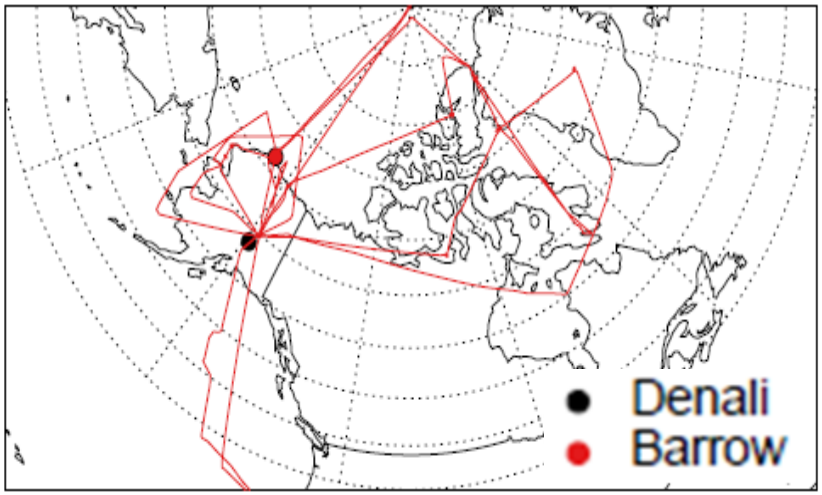
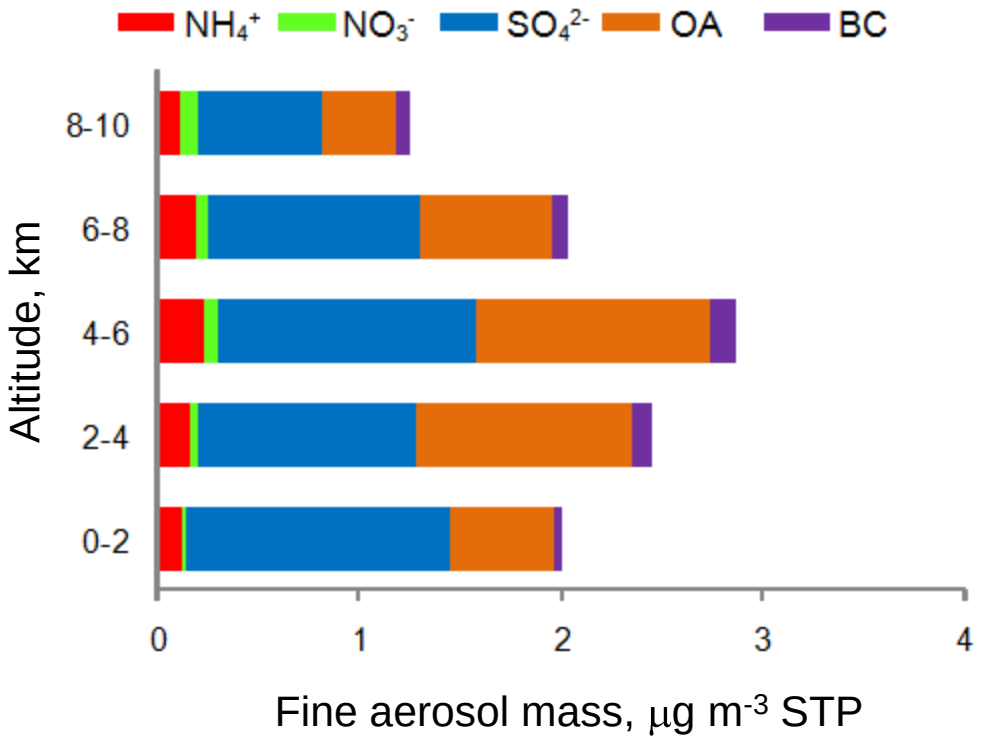


Aerosol composition during ARCTAS

ARCTAS
April 1-21, 2008





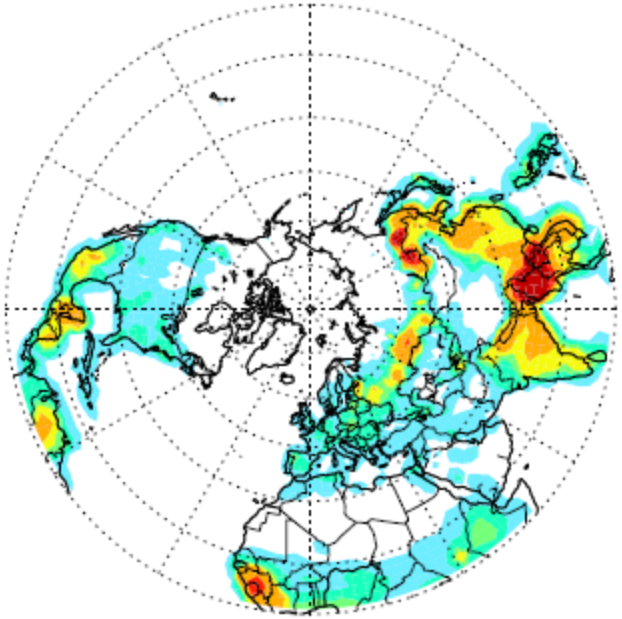
- Organic aerosol accounts for 23-38% of fine aerosol mass
- Median black carbon concentration of 55 ng m^{-3} (2-5%)

GEOS-CHEM

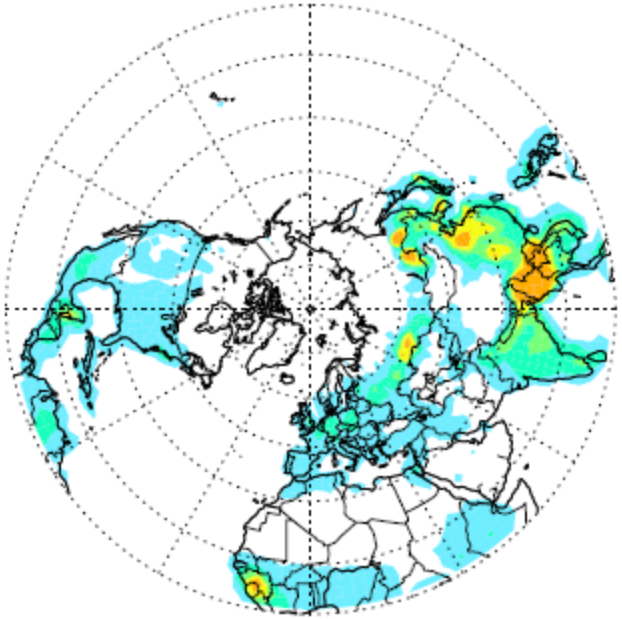
- Chemical transport model (2˚x2.5˚ with 47 vertical levels)
- Emission: FLAMBE for Biomass burning (Reid et al. 2009 and Fisher et al. 2010); Bond et al.[2007] for anthropogenic emission with doubled emission in Russia and Asia

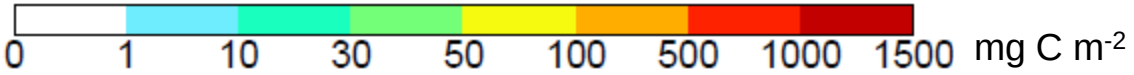
Emission in Apr, 2008

OC (6.7 Tg month^{-1})

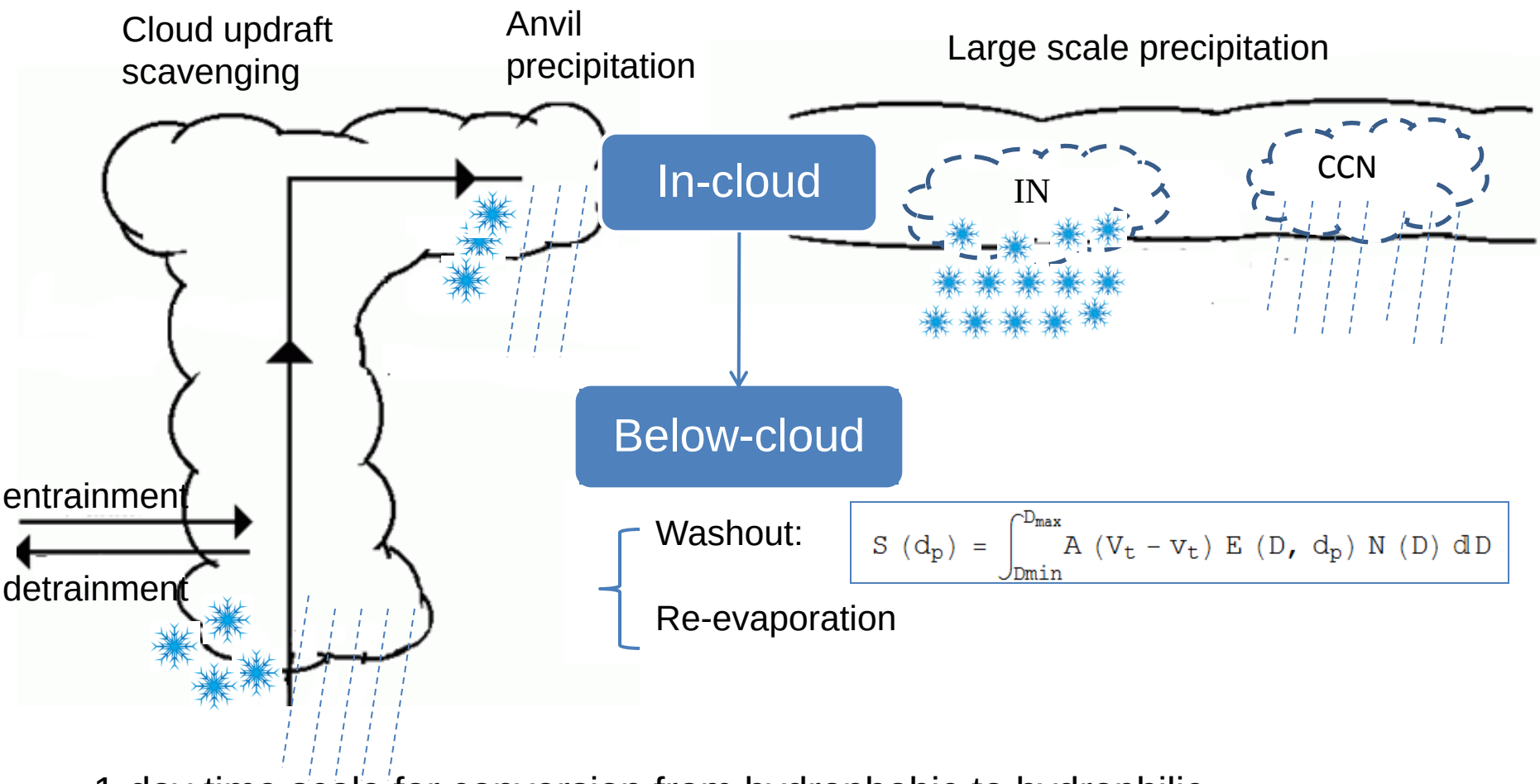


BC (1.3 Tg month^{-1})





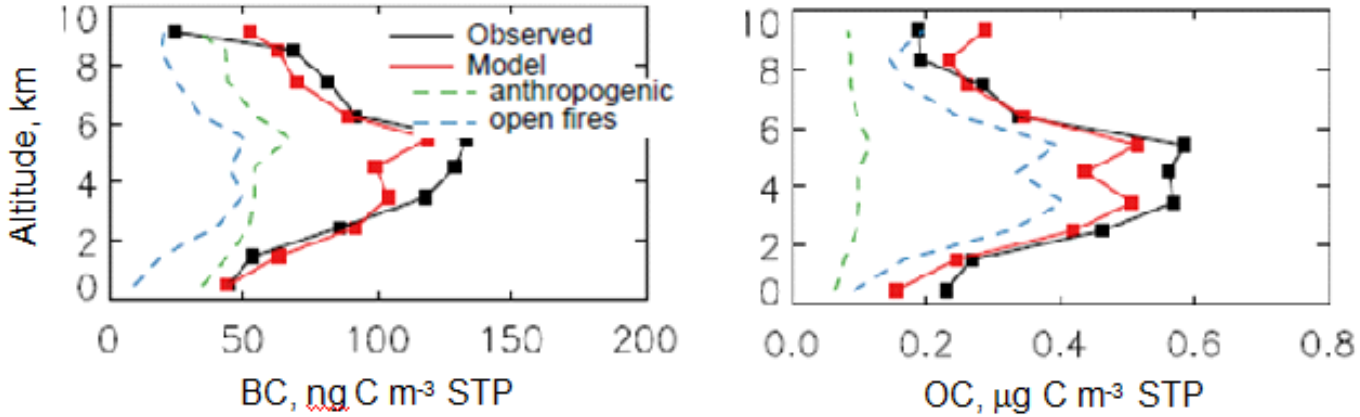
Wet deposition in GEOS-CHEM



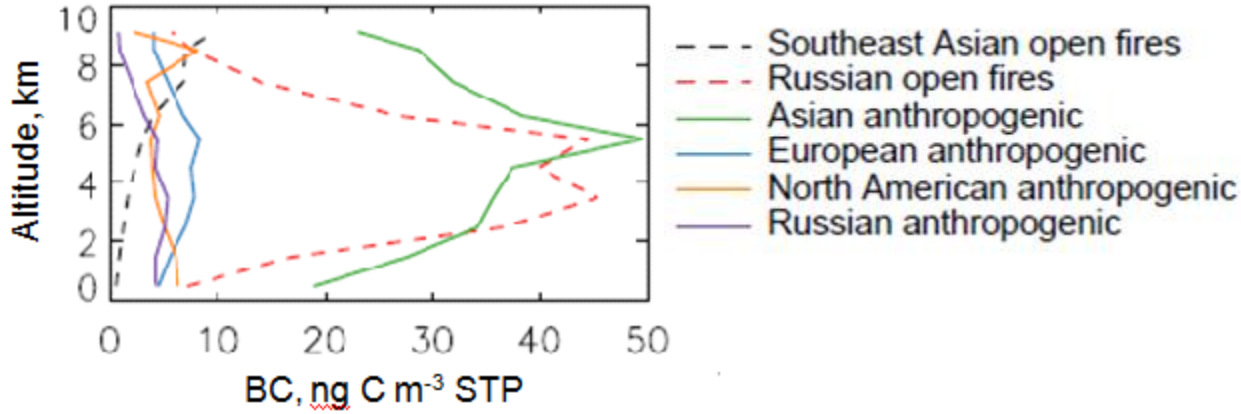
- 1-day time scale for conversion from hydrophobic to hydrophilic
- Water-soluble compounds for CCN and water-insoluble BC + dust for IN
- Use scavenging coefficient for accumulation aerosol mode instead of the bulk parameterization for the whole aerosol size range

Sources of carbonaceous aerosol during ARCTAS

Model (red) vs. observations (black)

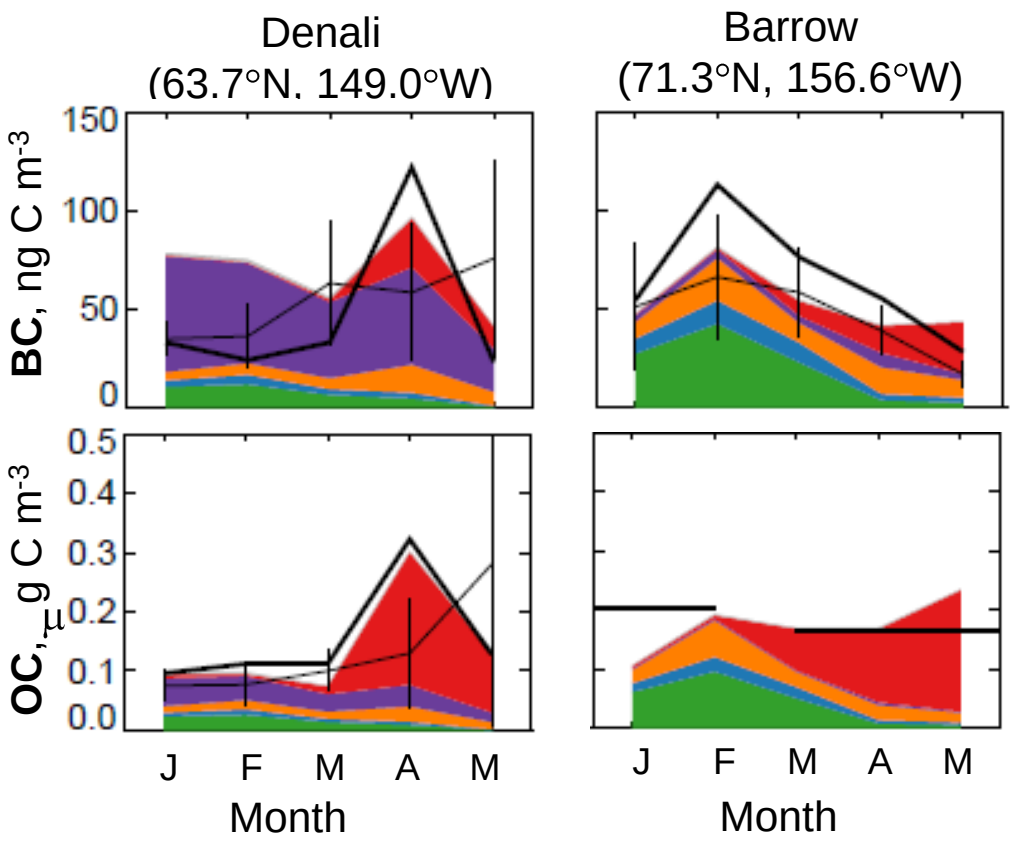


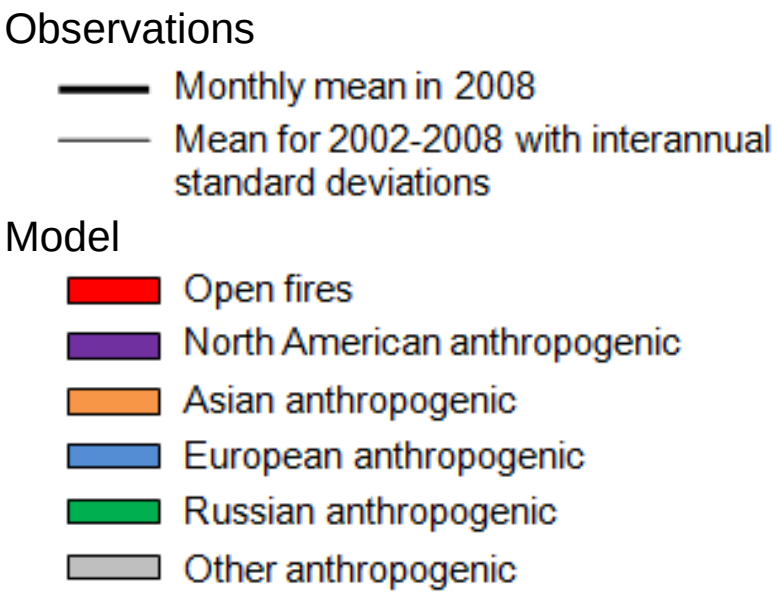
Model source attribution for BC



- Dominance of anthropogenic emission for BC: Asia is the main anthropogenic source in the free troposphere but other anthropogenic source regions are of comparable importance in the boundary layer where deposition takes place
- Russian fire emissions account for most of OC

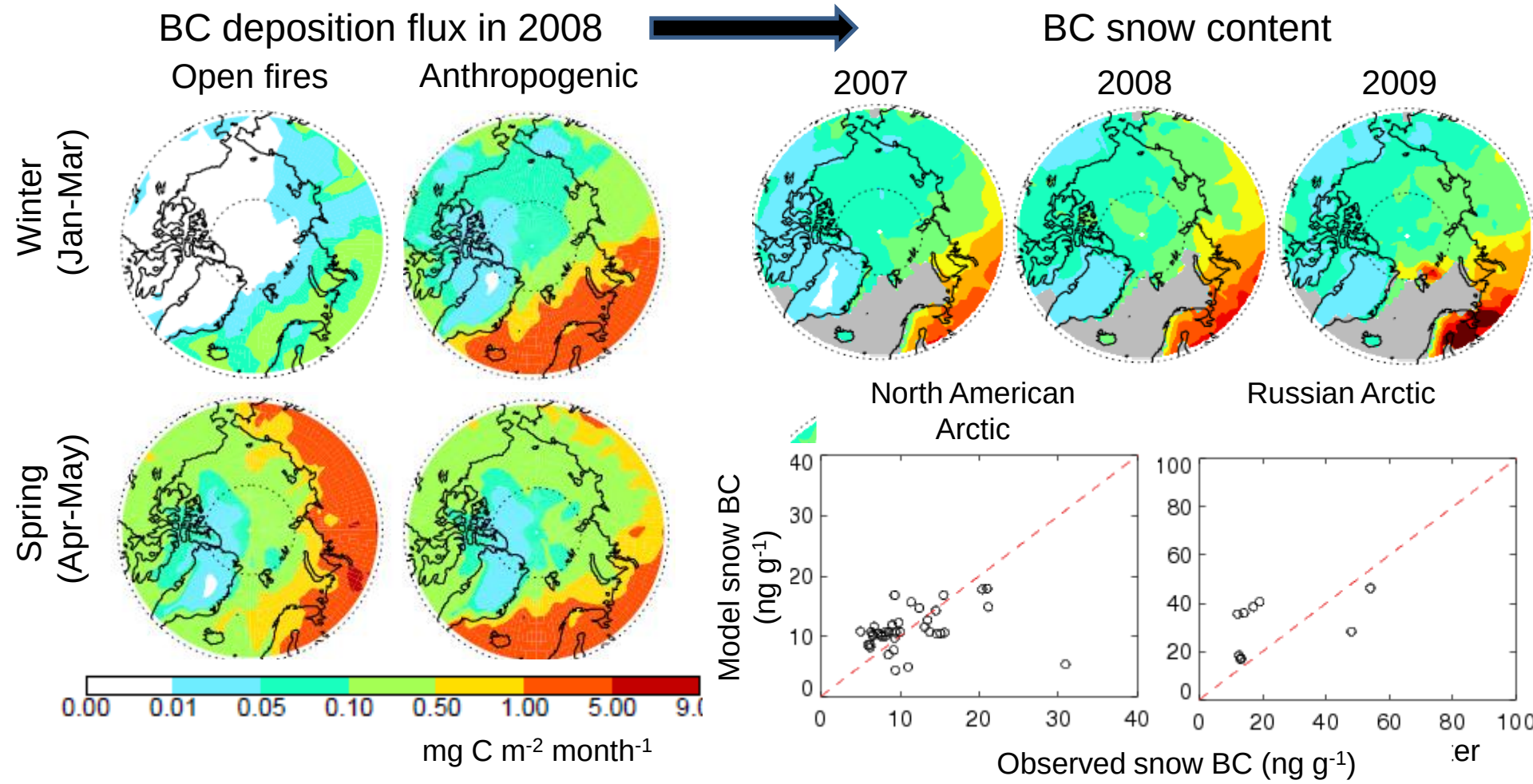
Seasonal and interannual context from surface sites





- Dominant Russian anthropogenic influence in winter at Barrow
- Strong open fire influence in Apr-May

BC deposition and snow content

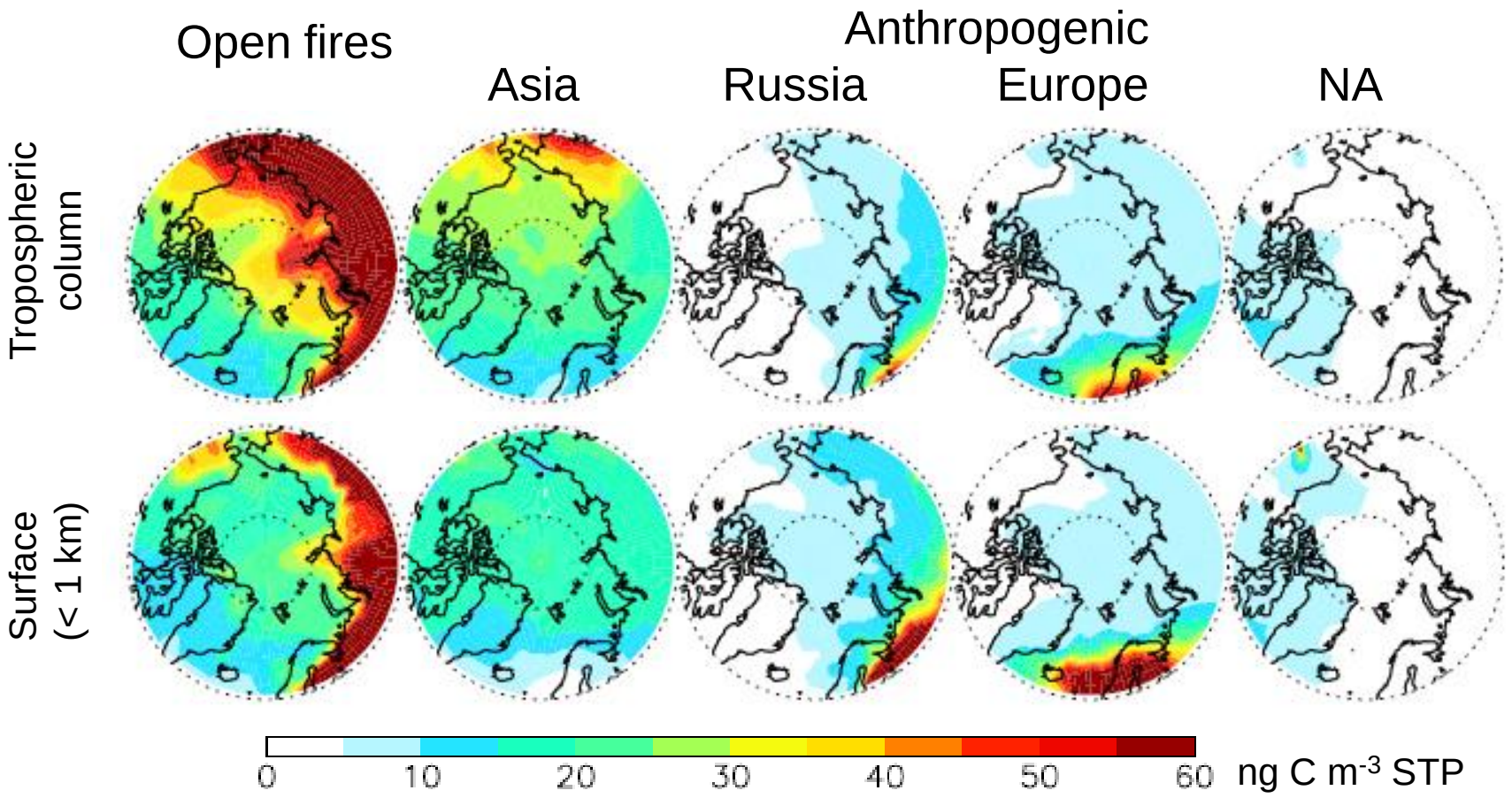


- Significant enhancement of deposition flux in spring due to open fires
- Consequent surface radiative forcing of 1.1 W m^{-2} (including open fires) and 0.6 W m^{-2} (anthropogenic only) for the Arctic in spring 2007-2009 (0.1 0.1W m^{-2} in IPCC 2007)

Conclusions

- OC in ARCTAS originated mainly from Russian biomass burning but BC was mostly anthropogenic
- Asian emissions are the main anthropogenic source of BC in the free troposphere but other anthropogenic source regions are of comparable importance in the boundary layer in spring
- Russian emissions appear to dominate the Arctic source of BC in surface air in winter
- Fires double BC deposition to the Arctic in spring relative to winter when the influence of fires is small
- Snow BC is found highest in Russian Arctic and lowest in Greenland, consistent with observations
- Implied surface radiative forcing of 1.1 W m^{-2} for the Arctic in spring due to BC snow content

Pan-Arctic perspective for BC in April 2008



- Open fires account for half of total BC burden in the Arctic tropospheric column
- Dominant Asian influence on anthropogenic BC through the Arctic troposphere