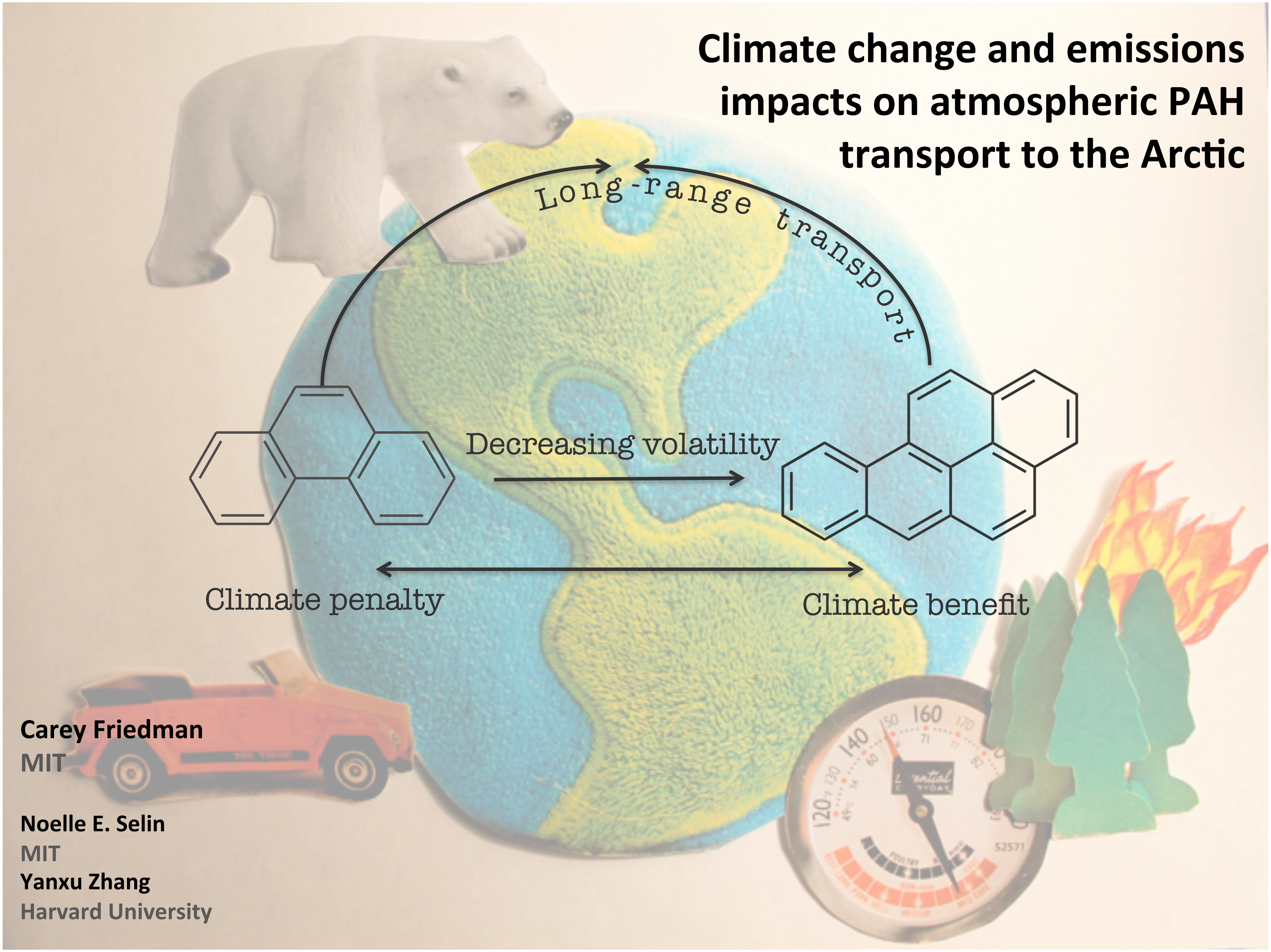
# Climate change and emissions impacts on atmospheric PAH transport to the Arctic

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# PAHs in the future

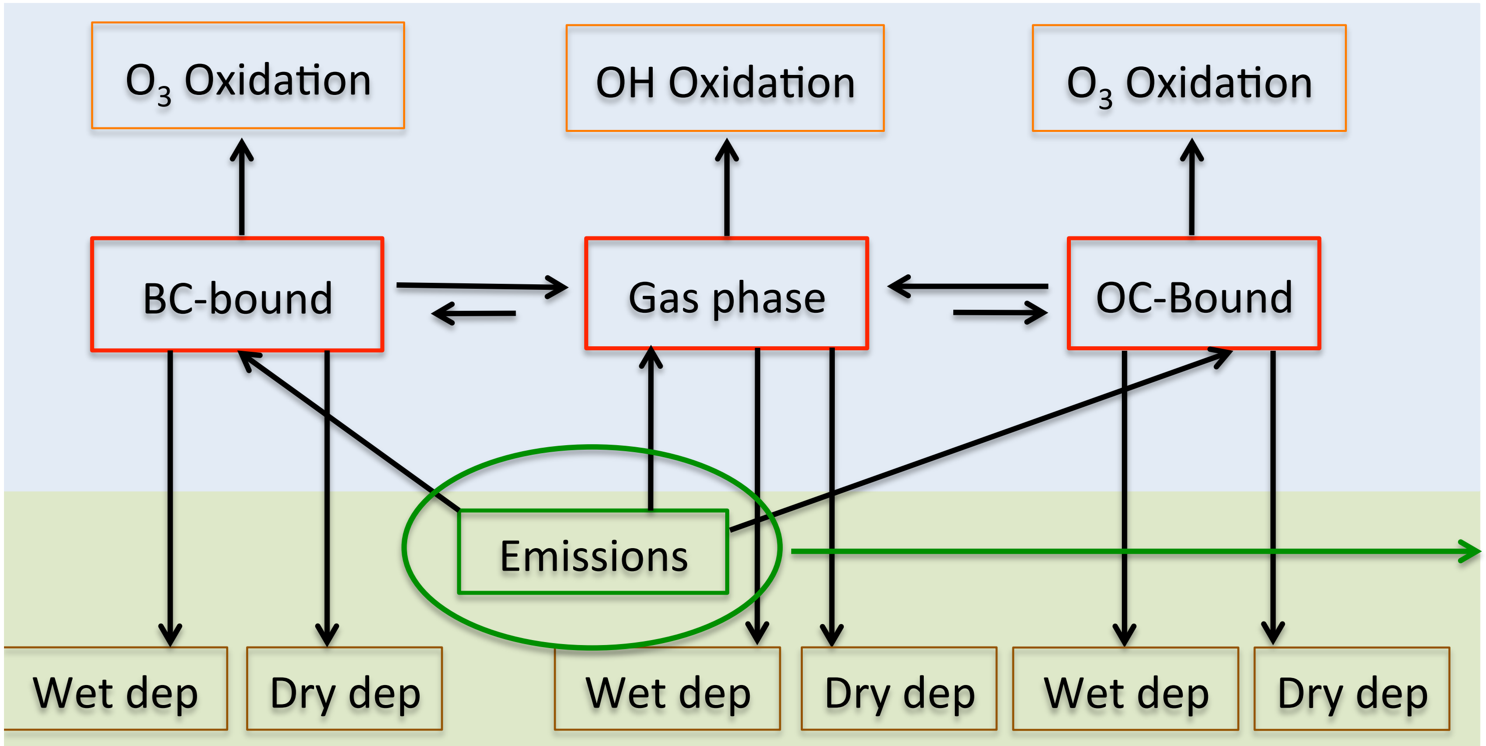
- Previous studies suggest efforts to reduce POPs in the environment may be undermined by future climate
- PAHs have on-going emissions
- What are the relative influences of future emissions/climate to PAH long-range atmospheric transport?
- Can we resolve climate versus emissions influences?

# PAHs in the Arctic

- PAHs termed "Arctic emerging contaminants"
- Long-range transport accounts for majority of PAHs in Arctic air
- Arctic conditions are becoming favorable for local emissions
- How will PAH transport to the Arctic change in the future?

| | Anthropogenic Emissions | |
|---|---|---|
| Climate | *2000* | *2050* |
| *2000* | Control | ✓ |
| *2050* | ✓ | ✓ |

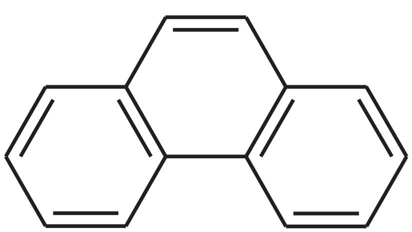
# The GEOS-Chem PAH model



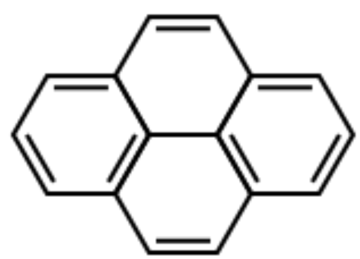

Friedman and Selin
ES&T 2012

Emissions:
1) Primary
2) Secondary

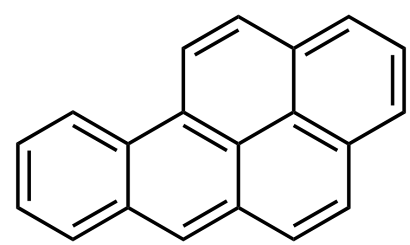
Phenanthrene (PHE)



Pyrene (PYR)



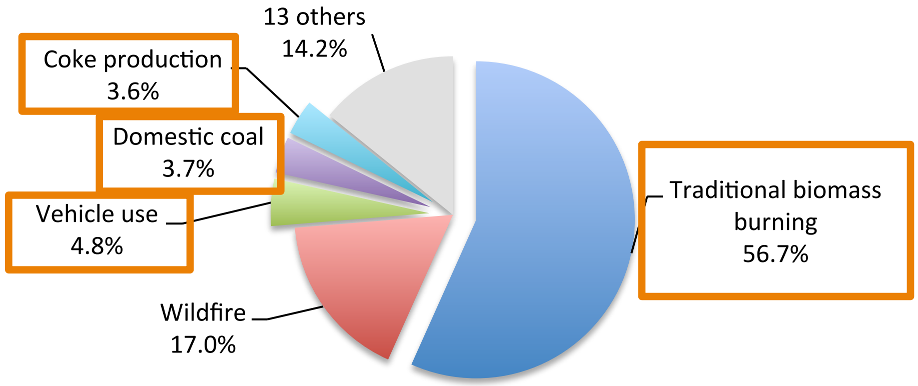
Benzo[a]pyrene (BaP)

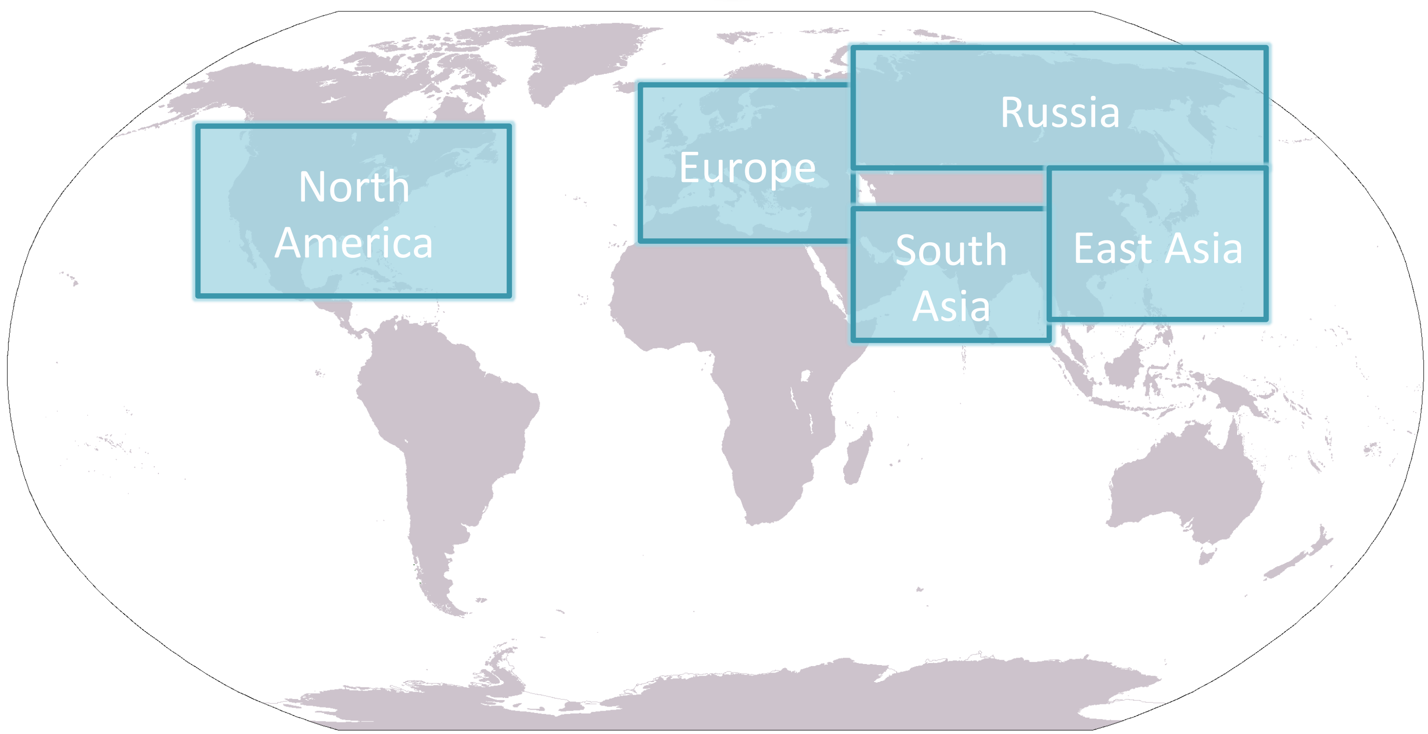


Gas ↔ Particulate

We scale the top (70%) global anthropogenic sources from the Zhang and Tao (*Atmos. Environ.*, 2009) inventory from ~2000 to 2050:

Top global source activities for U.S. EPA Σ16PAH (2004):



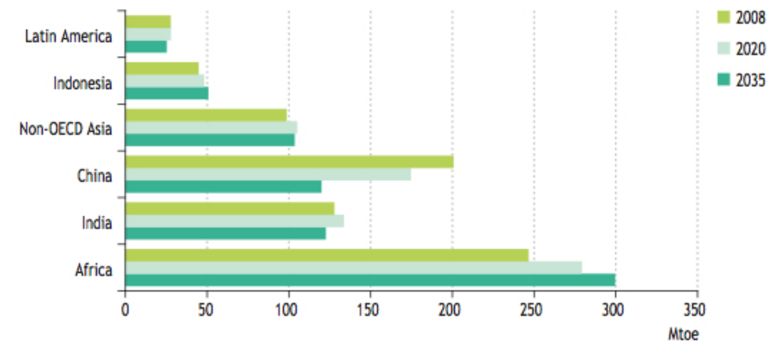
# Emissions are scaled according to a related activity

Present day emissions (2000) ➔ Future emissions (2050)

Traditional biomass burning
Domestic coal burning

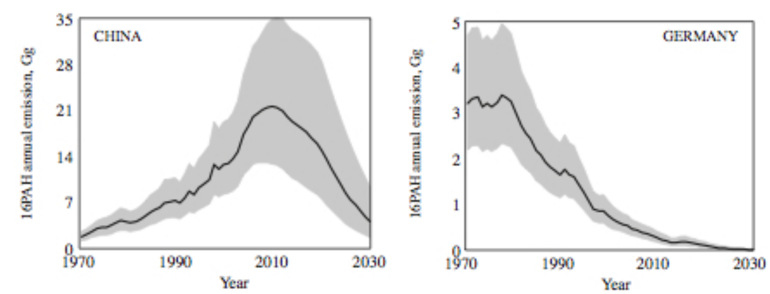
Scale with the IEA's projections of traditional biomass demand

**Figure 11.4** • Traditional biomass demand by region in the New Policies Scenario




Vehicle use

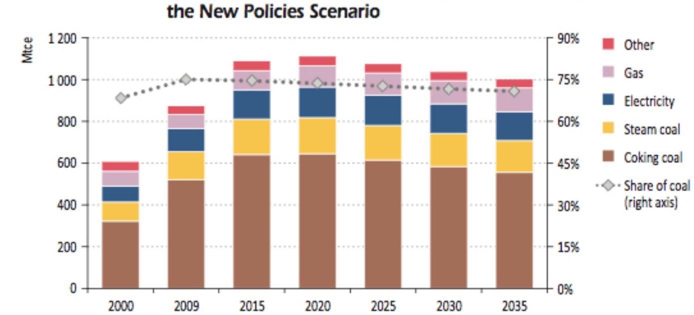
Scale with Shen et al., 2011, Global time trends in PAH emissions from motor vehicles. *Atmos. Environ.* 45:2067.




Coke production

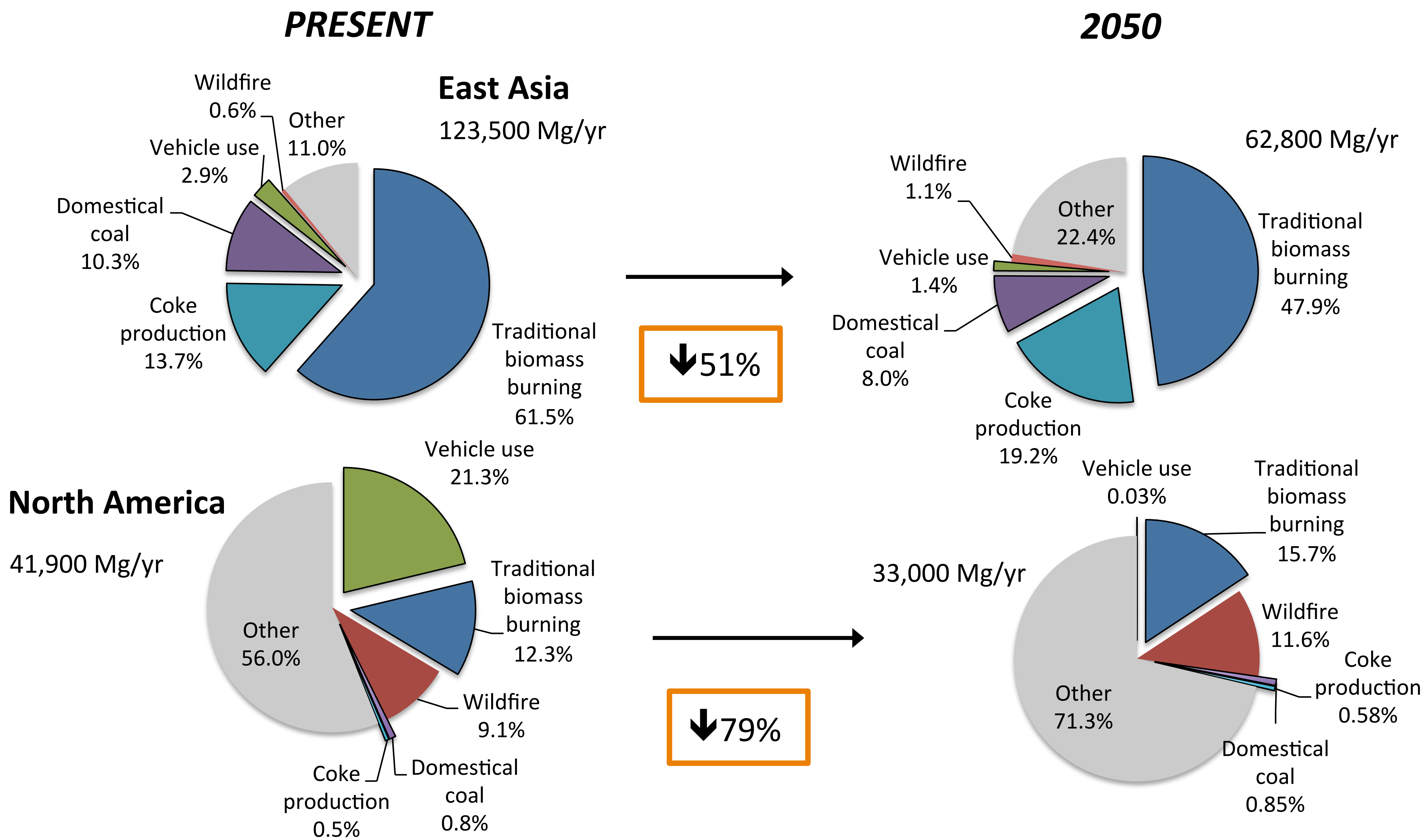
Scale with the IEA's projections for energy consumption in the iron and steel production sector

**Figure 10.11** • World iron and steel sector energy consumption by type in the New Policies Scenario



*Methods – projecting 2050 anthropogenic emissions*

# EMISSIONS GO DOWN



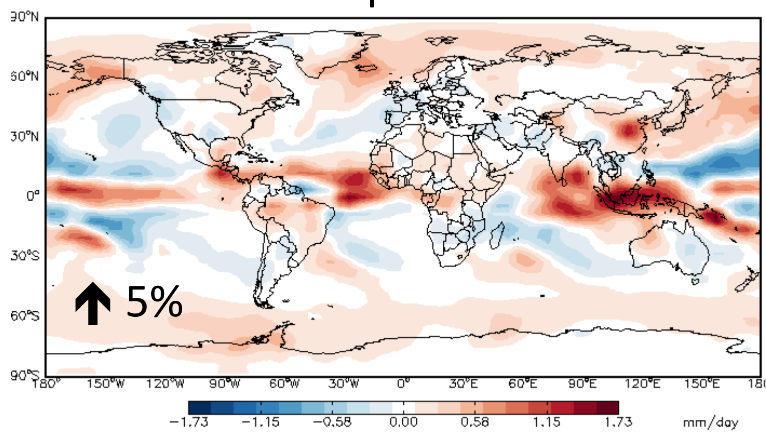

Particles: OC -22%, BC -30% Oxidants: OH +4%, $O_3$ +16%

*Methods – projecting 2050 climate/natural emissions*

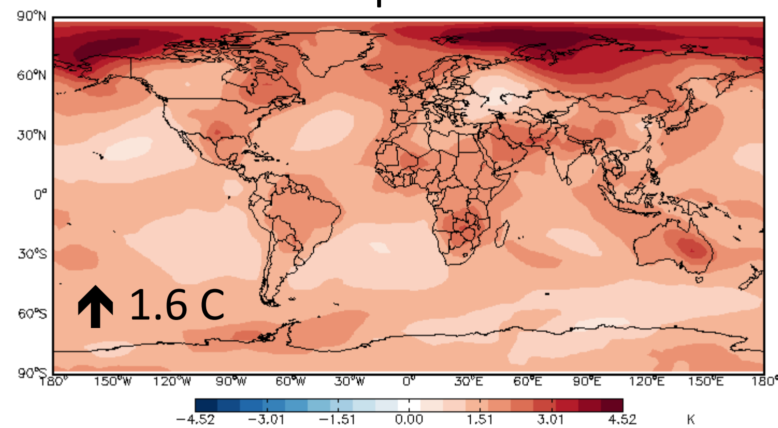
*We simulate present and future climate with NASA GISS GCM meteorology:*

| | Present climate | Future climate (IPCC A1B) |
|---|---|---|
| Mean of simulated years: | 1997-2003 | 2047-2053 |

Precipitation




Temperature




Wildfire emissions (17%) } ↑ 0-16%

Particles: OC -18%, BC -7%   Oxidants: OH -1%, $O_3$ -2%

*Results*

# Volatility Matters

Change in mean northern hemisphere concentrations

2050-2000:

Emissions

Climate

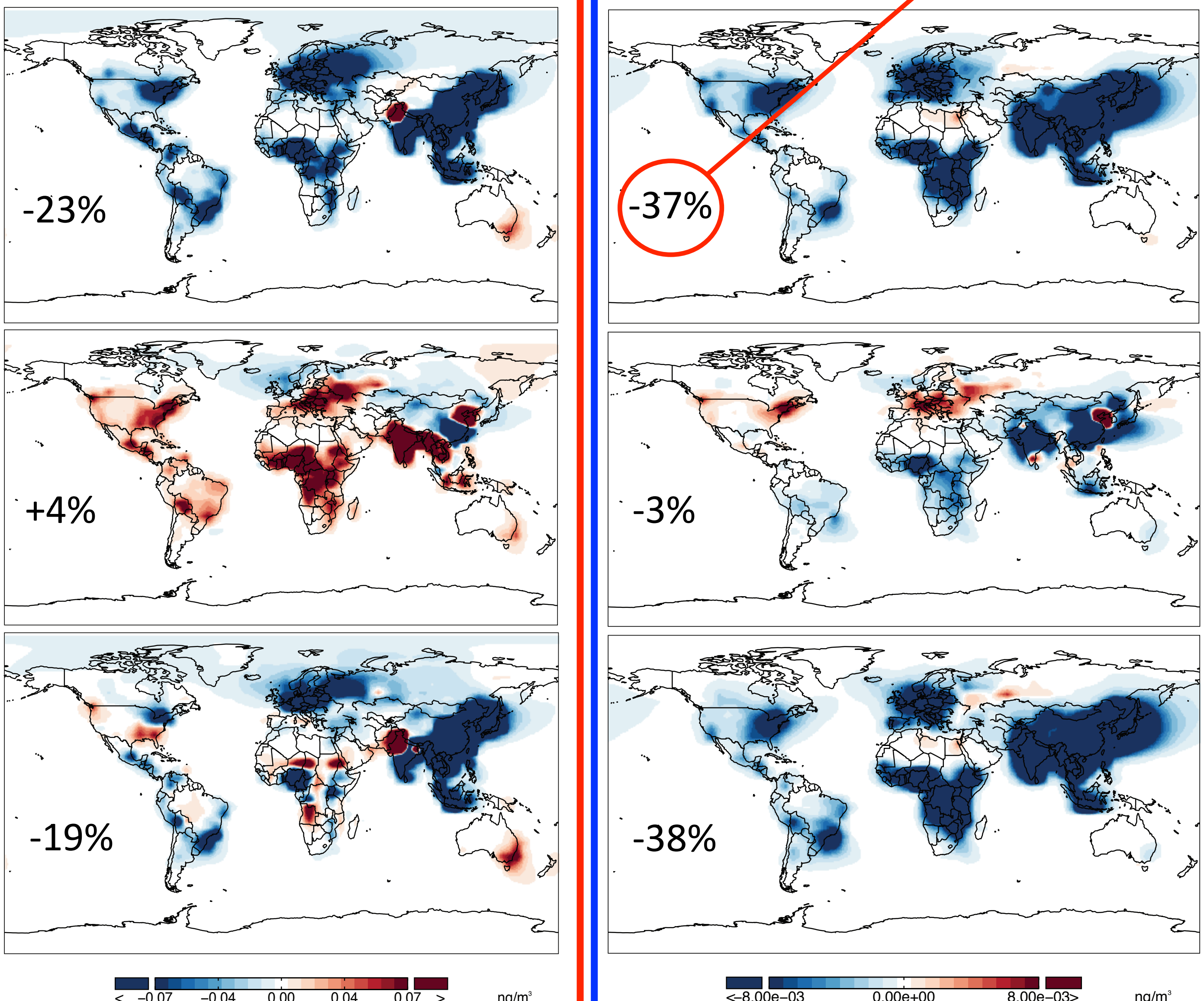
Emissions & Climate

CLIMATE PENALTY: 19%

CLIMATE BENEFIT: 5%

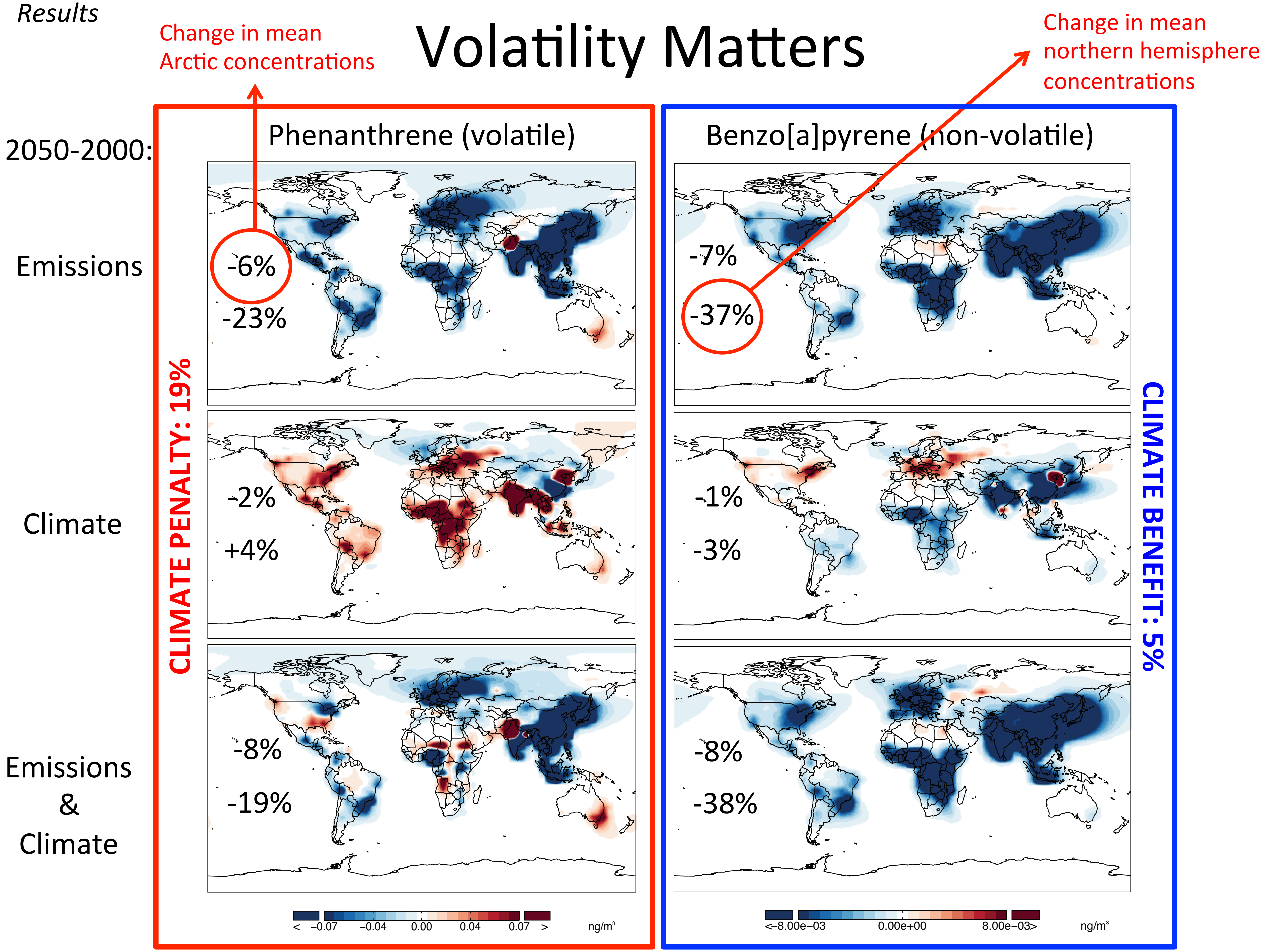
Phenanthrene (volatile)

Benzo[a]pyrene (non-volatile)



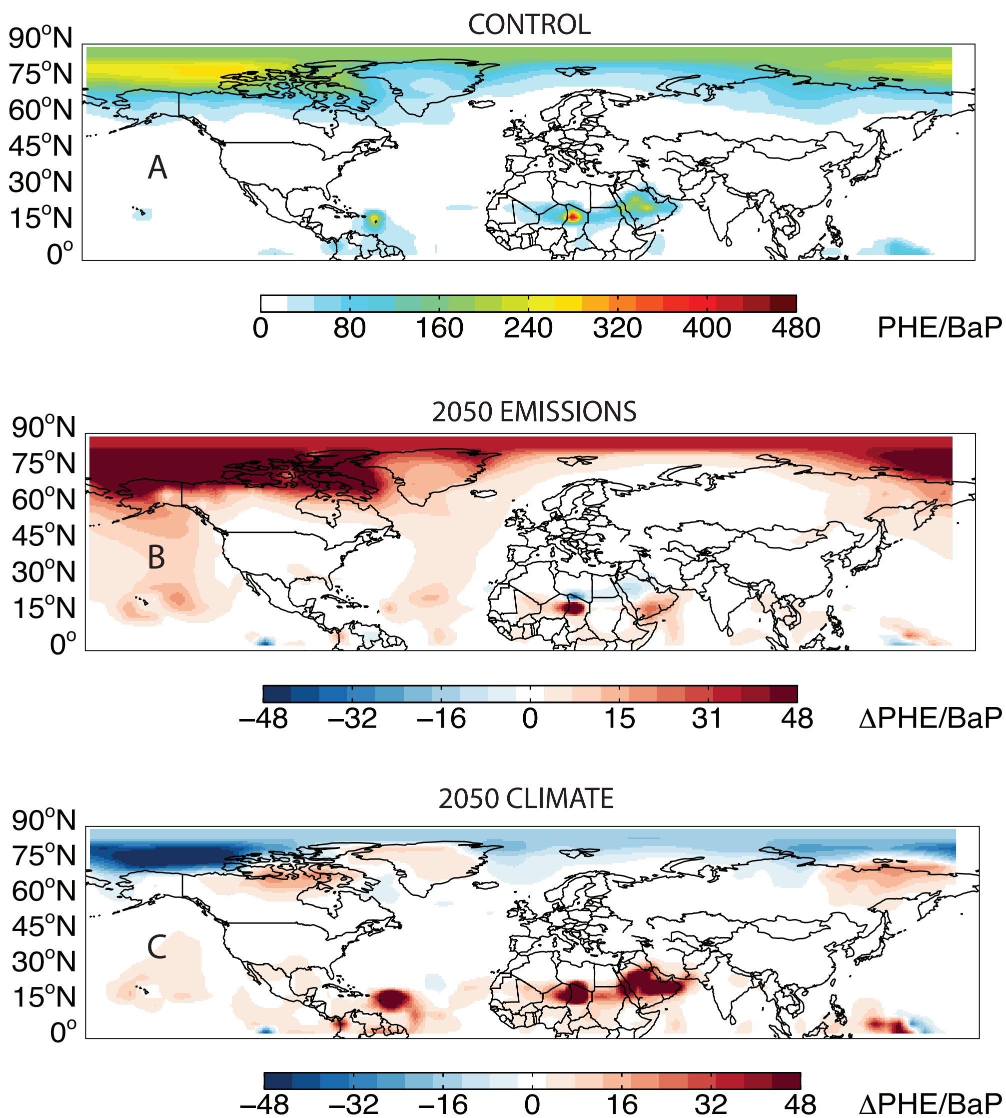
*Results*

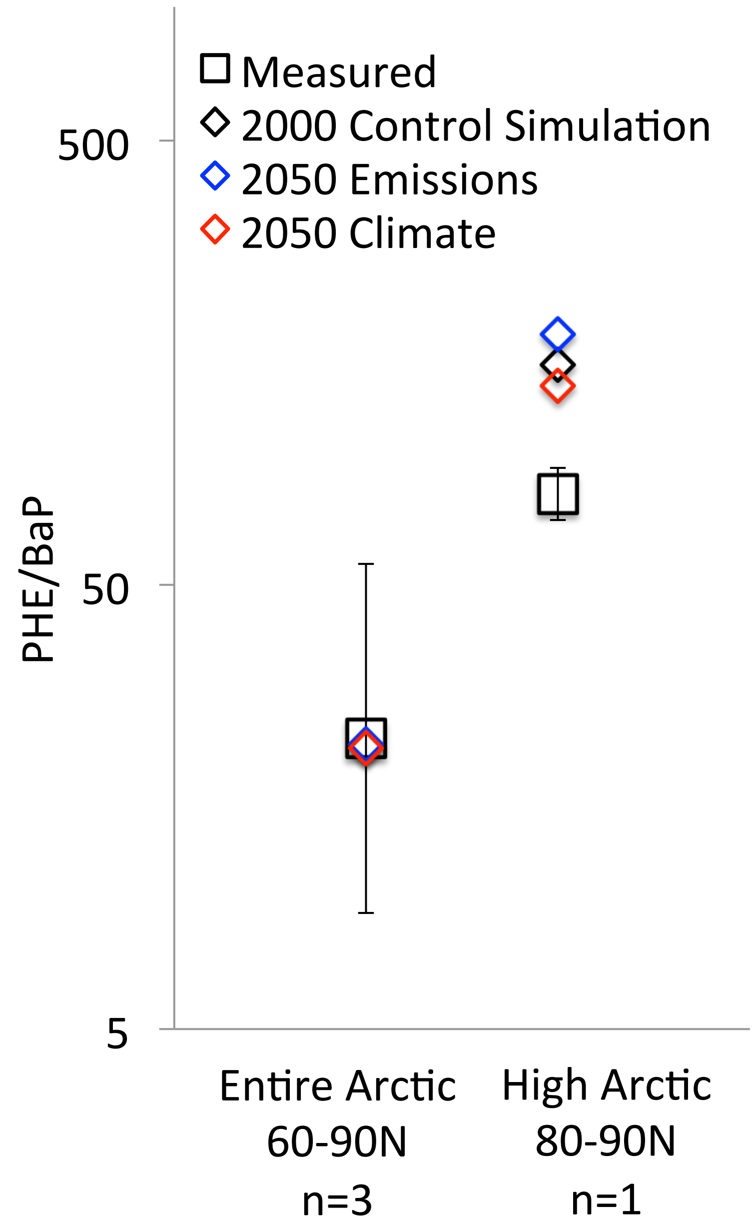
# Volatility Matters



*Results*

# The Arctic is a priority area for resolving climate vs. emissions influences



# *Take-home messages*

2050 emissions have a greater influence than 2050 climate on PAH long-range transport

Volatile PAHs will be more strongly impacted by climate (i.e., greater "climate penalty")

The Arctic atmosphere is slow to respond to changes in the mid-latitudes

Arctic monitoring may help us diagnose climate versus emissions influences

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Related literature:

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