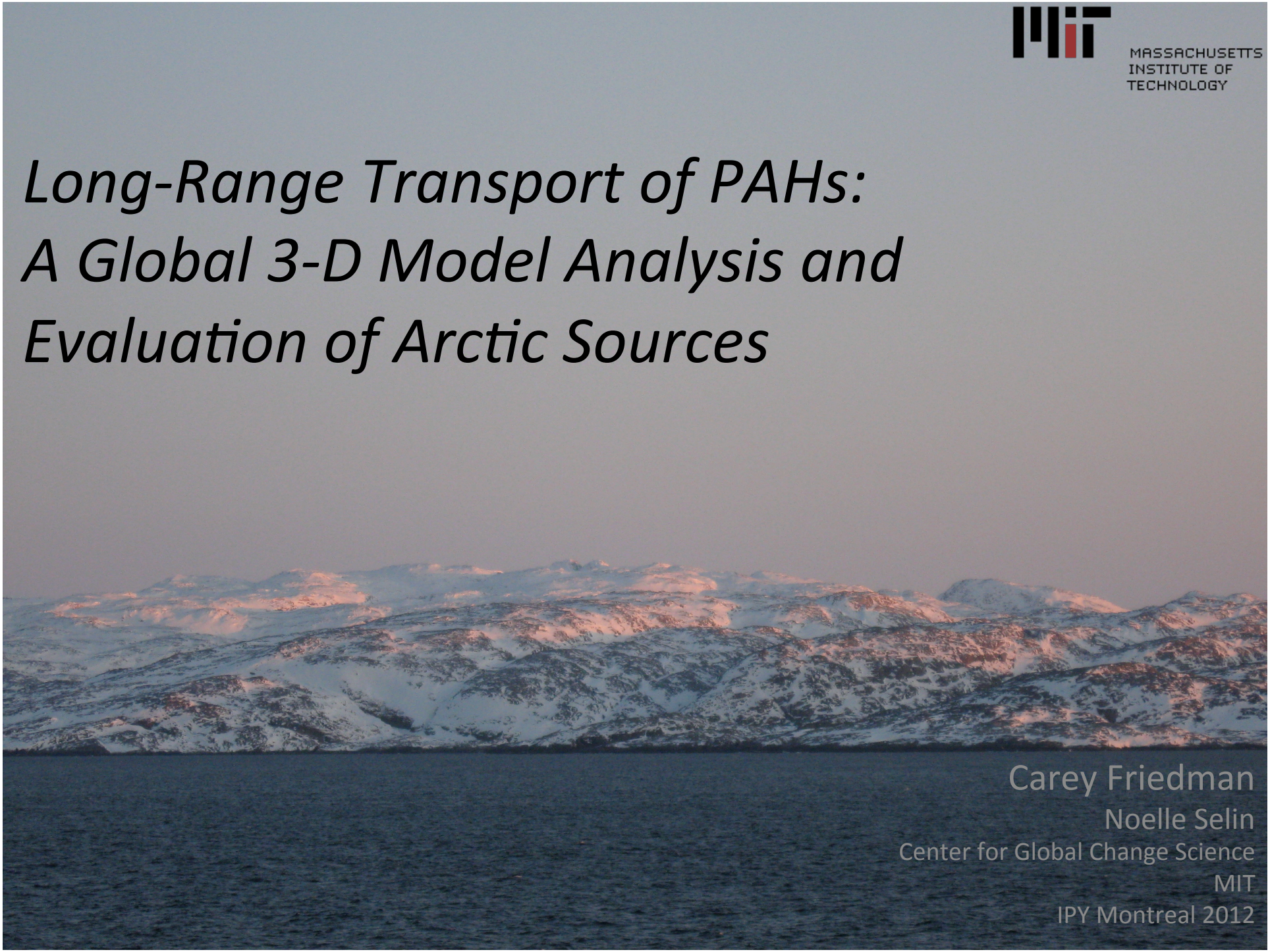

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Long-Range Transport of PAHs: A Global 3-D Model Analysis and Evaluation of Arctic Sources

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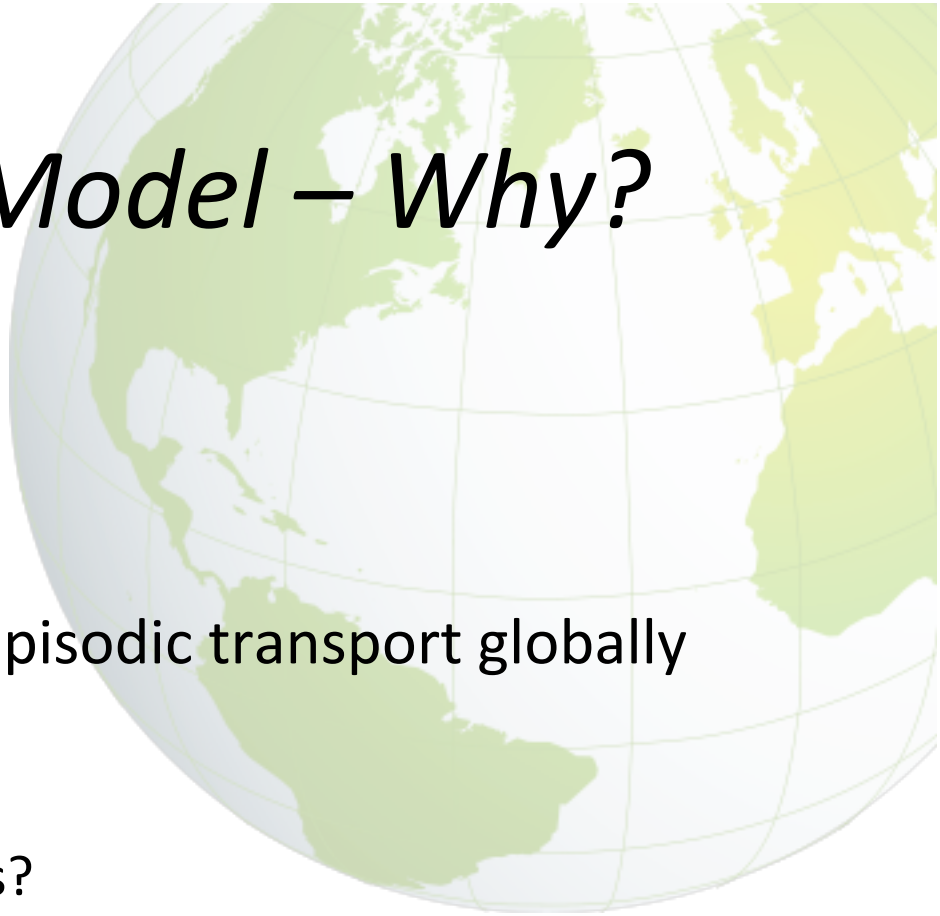
IPY Montreal 2012

A Global PAH Model – Why?



- Previous models –
  - Multimedia box models[1]
  - Back-trajectory[2]
  - Regional[3]

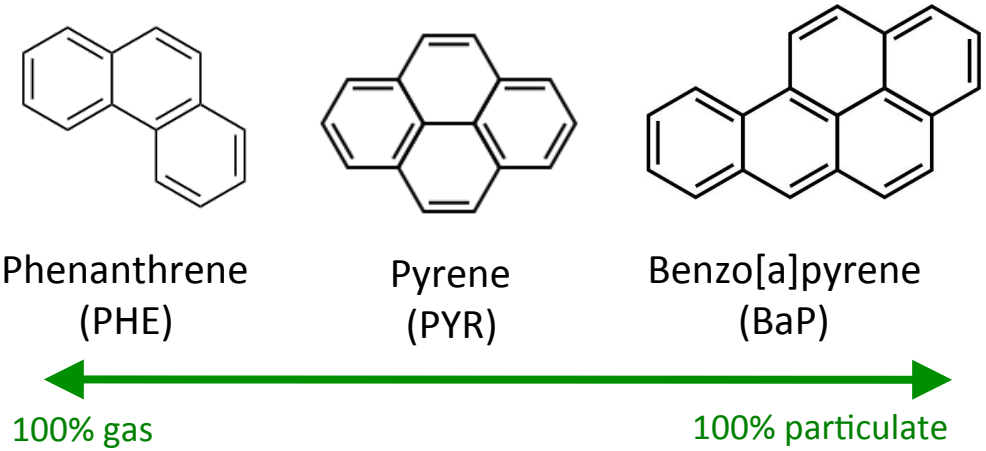
  do not resolve meteorology/episodic transport globally

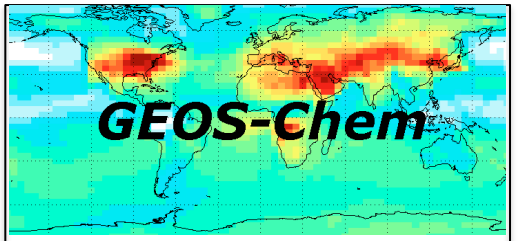
- In the Arctic
  - Are PAHs global contaminants?
  - Can we identify sources?
  - What will happen under a future climate?
    - "Emerging" Arctic contaminants[4]

References:

1. *Wania et al. 1995, Scheringer 2002, Den Hollander et al. 2004...*
2. *Genualdi et al. 2009*
3. *Lang et al. 2008, Zhang et al. 2011*
4. *De Laender et al. 2011*

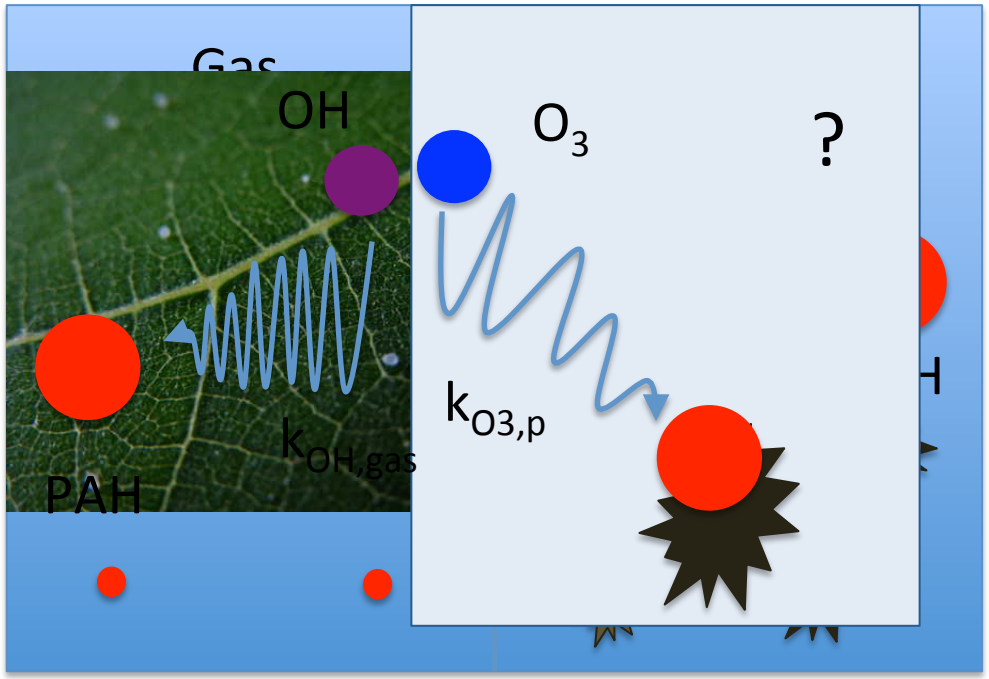
Model parameterization

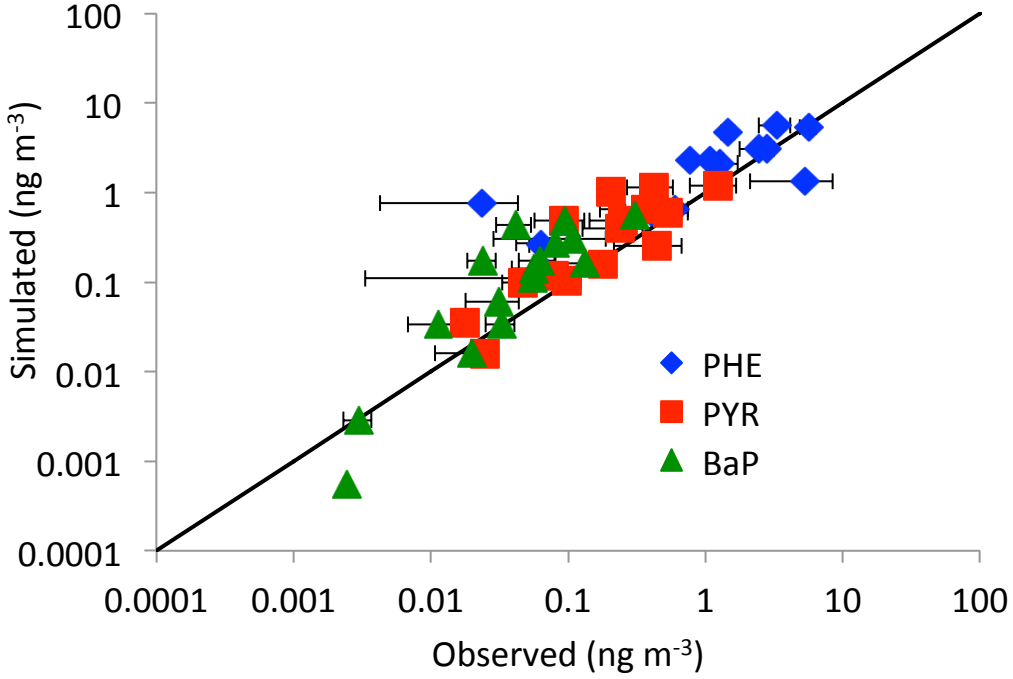


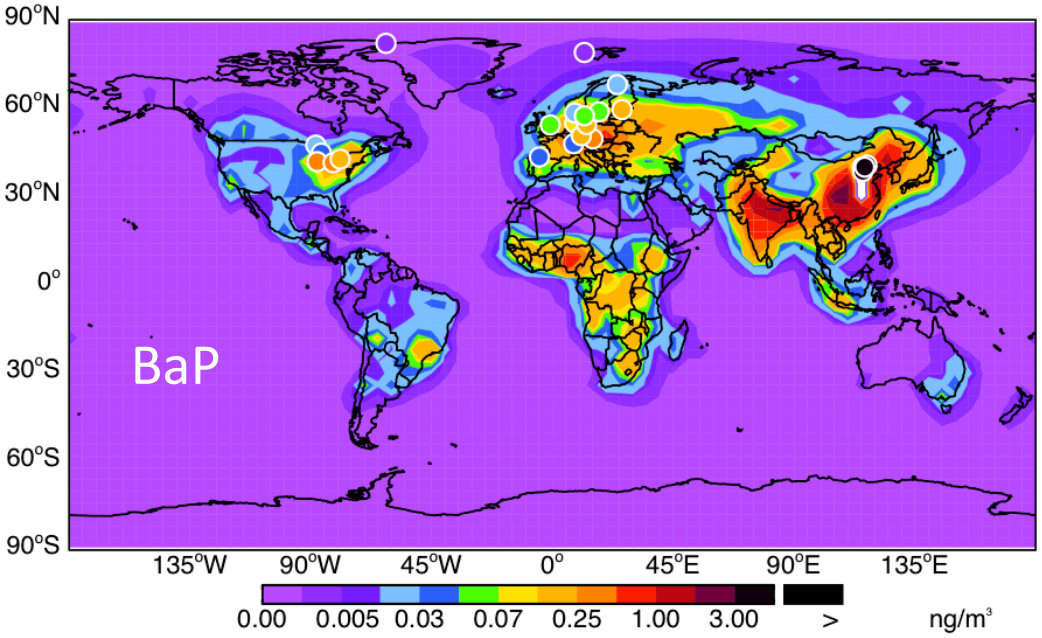


4°×5°
47 vertical levels
6 or 3 hr
Emissions from Zhang & Tao
(*Atmos. Environ.* 2009)
Monthly OC/BC from 2008
2005-2009

- Gas-particle partitioning
- Oxidation
- Wet deposition
- Dry deposition







Model Performance

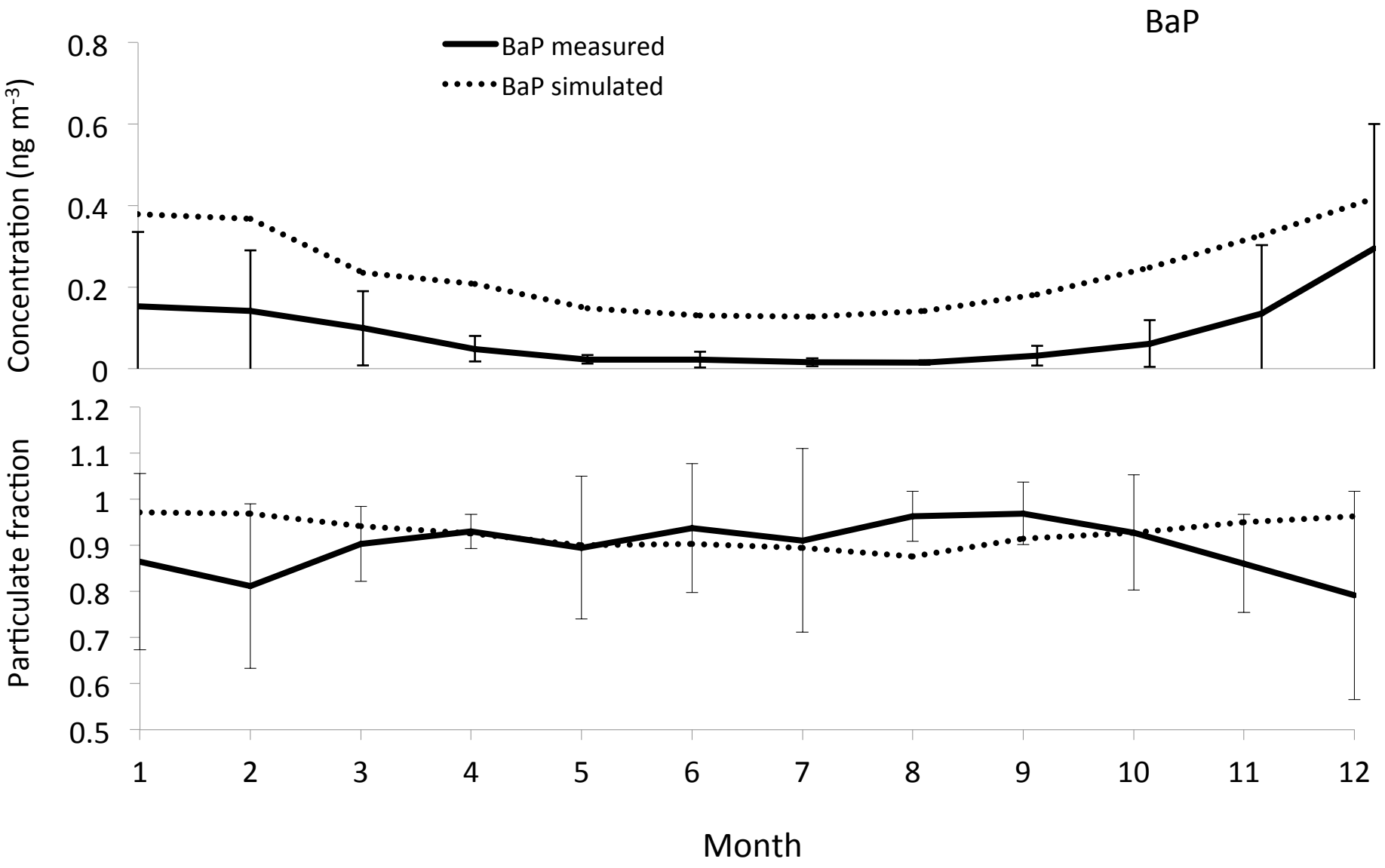
Mean total (gas + particulate) concentrations at background locations (2005-2009)

PHE: r = 0.64
PYR: r = 0.72
BaP: r = 0.74

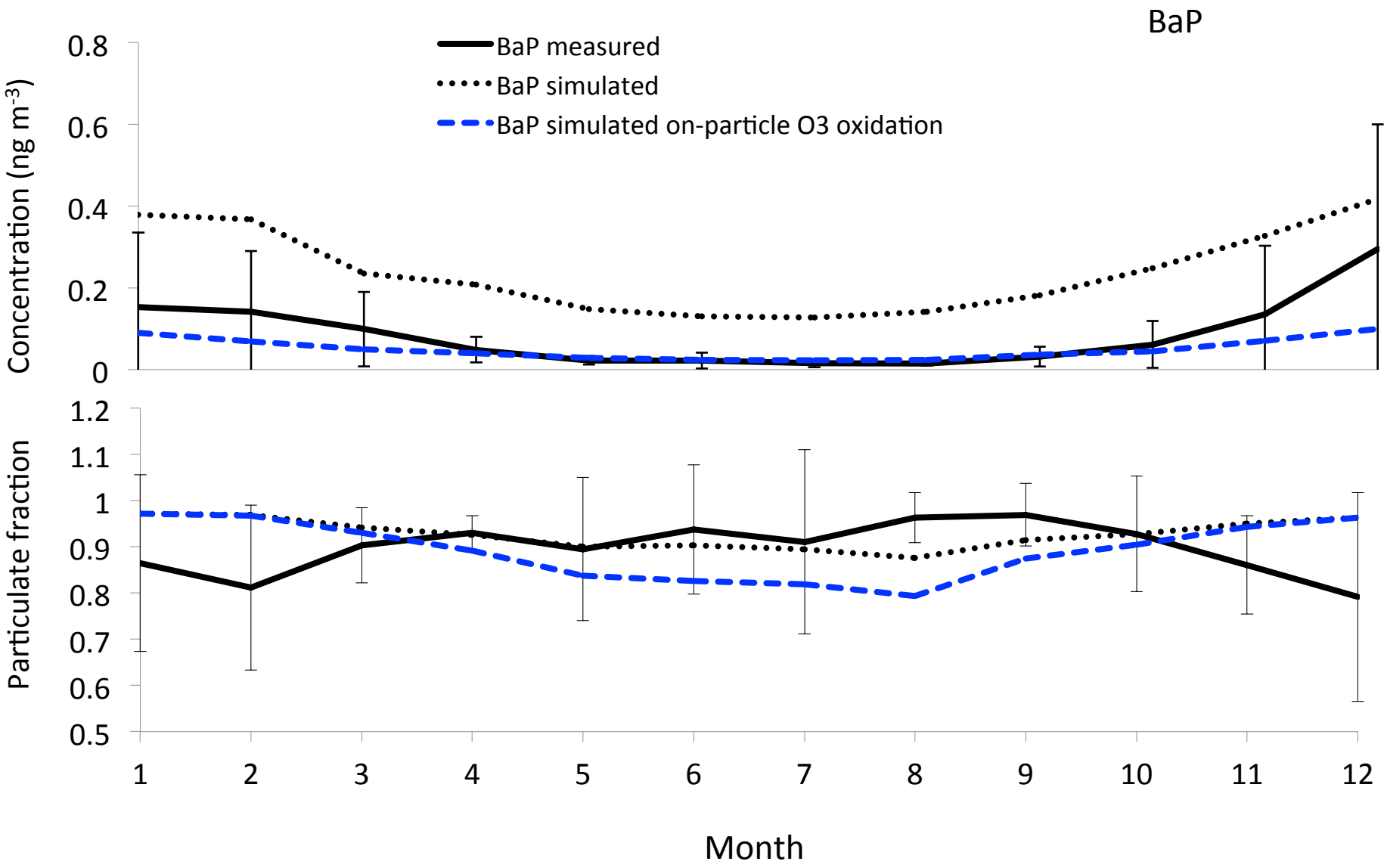
Atmospheric lifetimes (days):
PHE: 0.65
PYR: 0.52
BaP: 0.70

➔ *Less than 2.8 day threshold!*

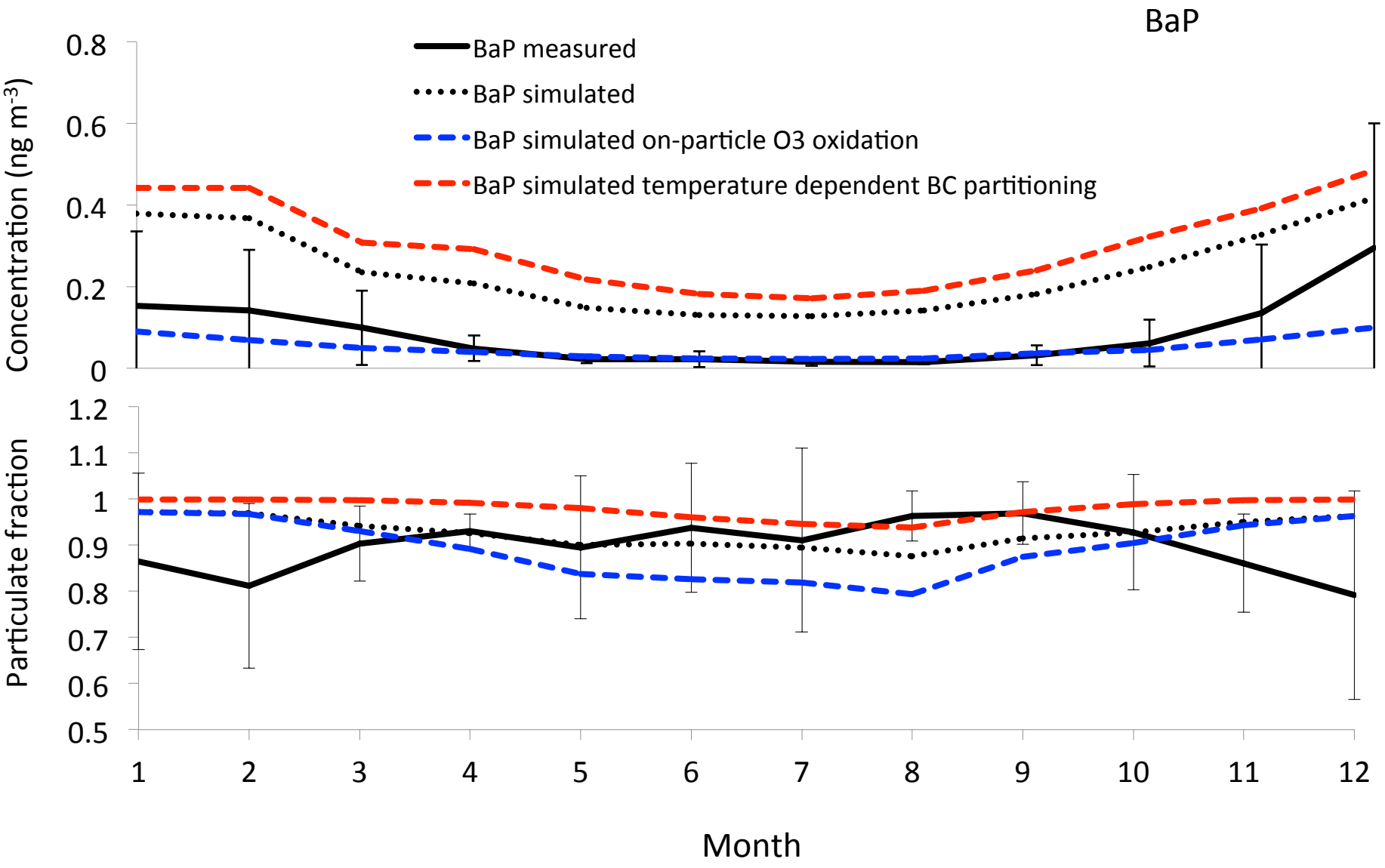
The model captures seasonal variation at nonurban mid-latitude sites



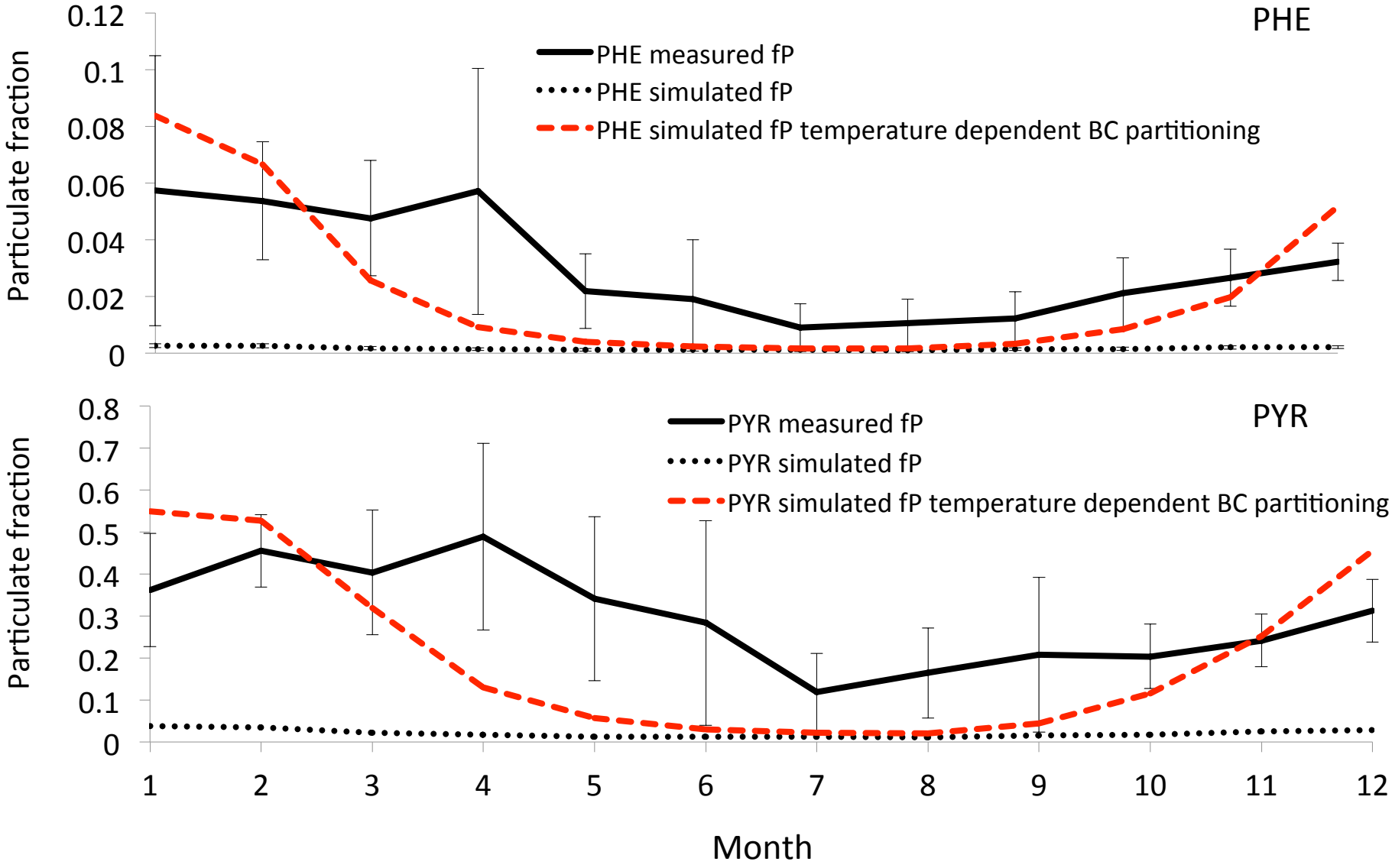
Oxidation of particulate PAHs by O_3 improves simulated concentrations



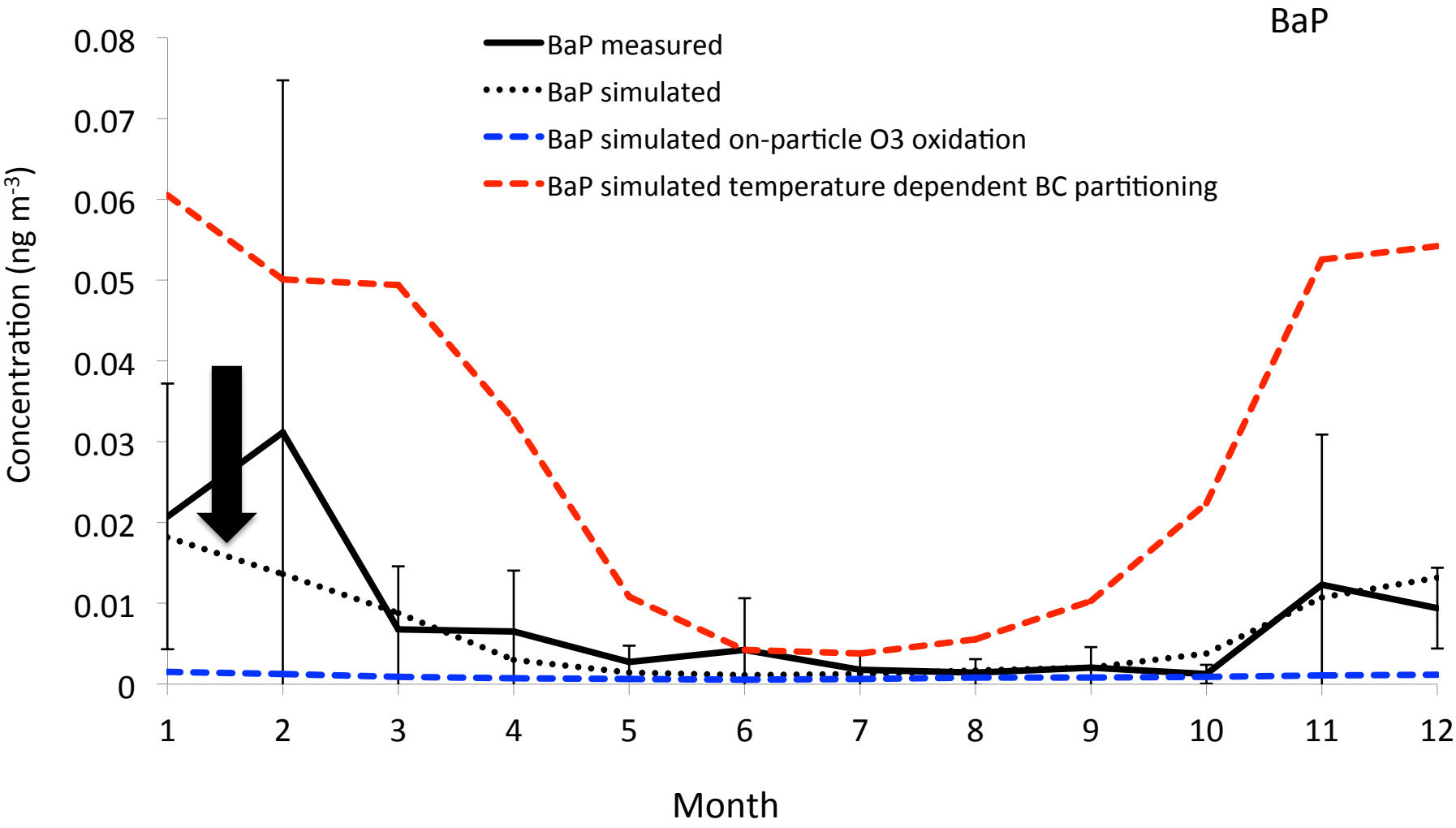
Temperature dependent BC-gas partitioning diminishes match to observed concs…



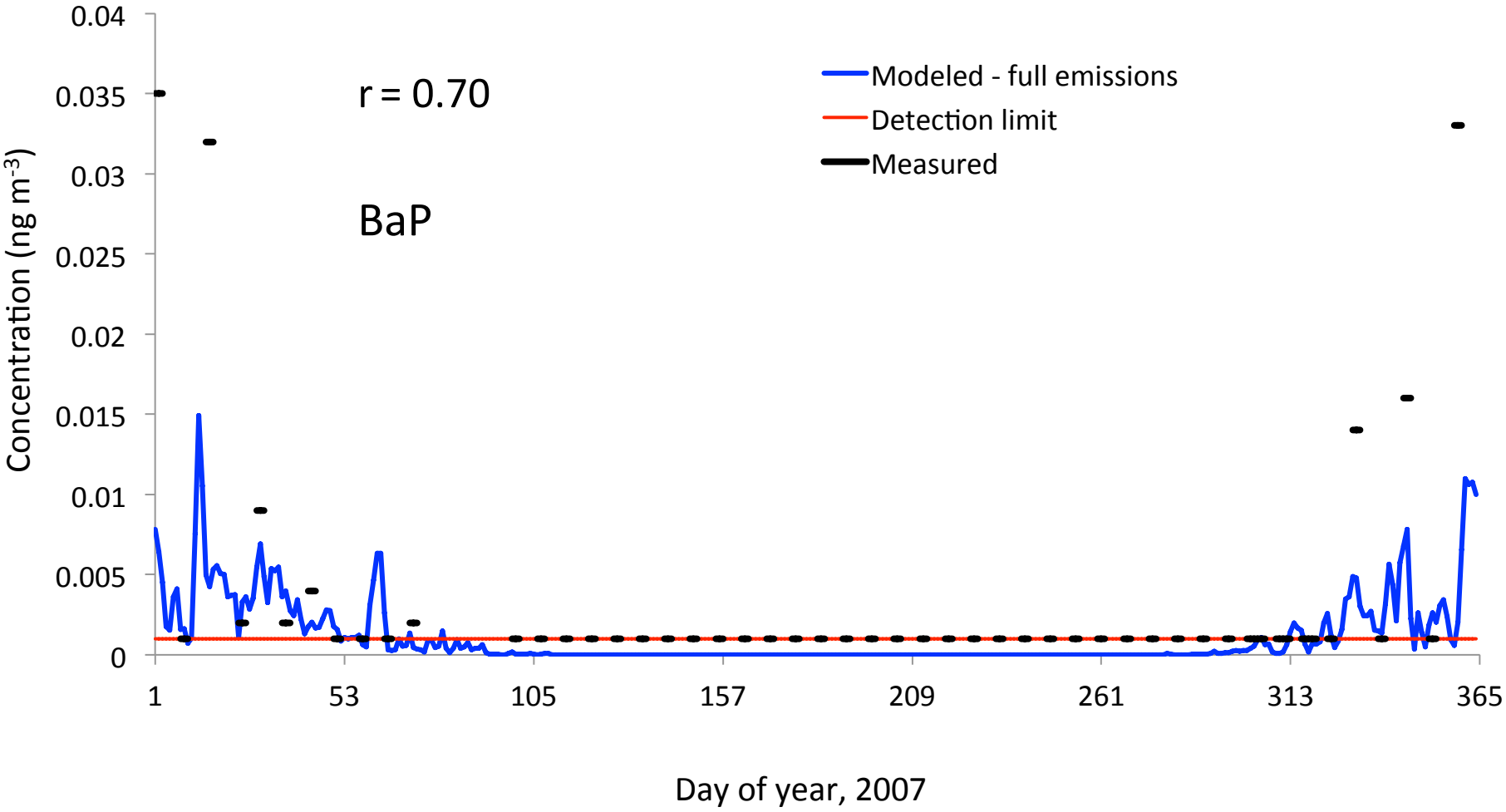
…but improves match to observed particulate fractions



Similar results for Arctic means



We capture episodic transport to Spitsbergen



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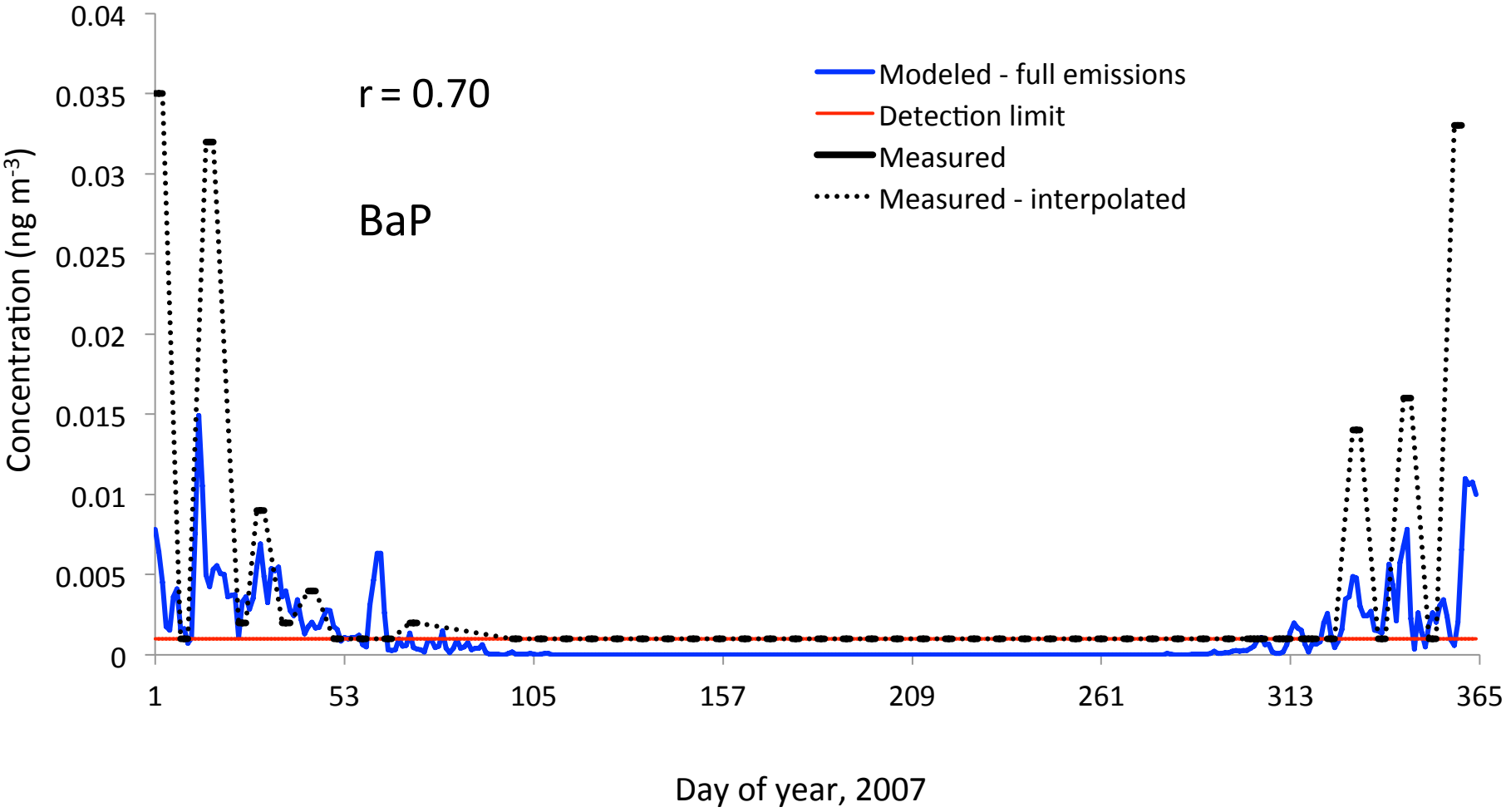
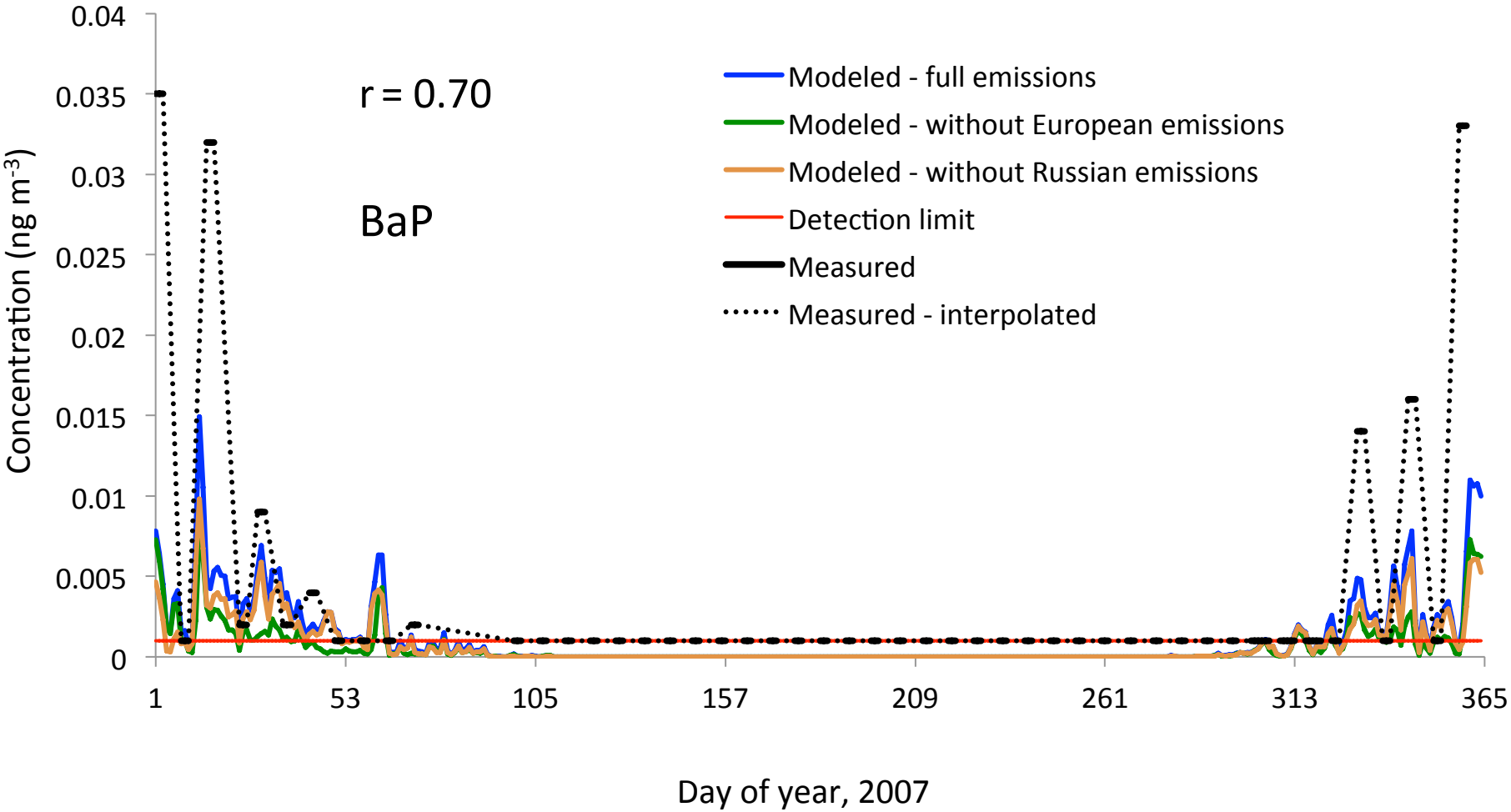
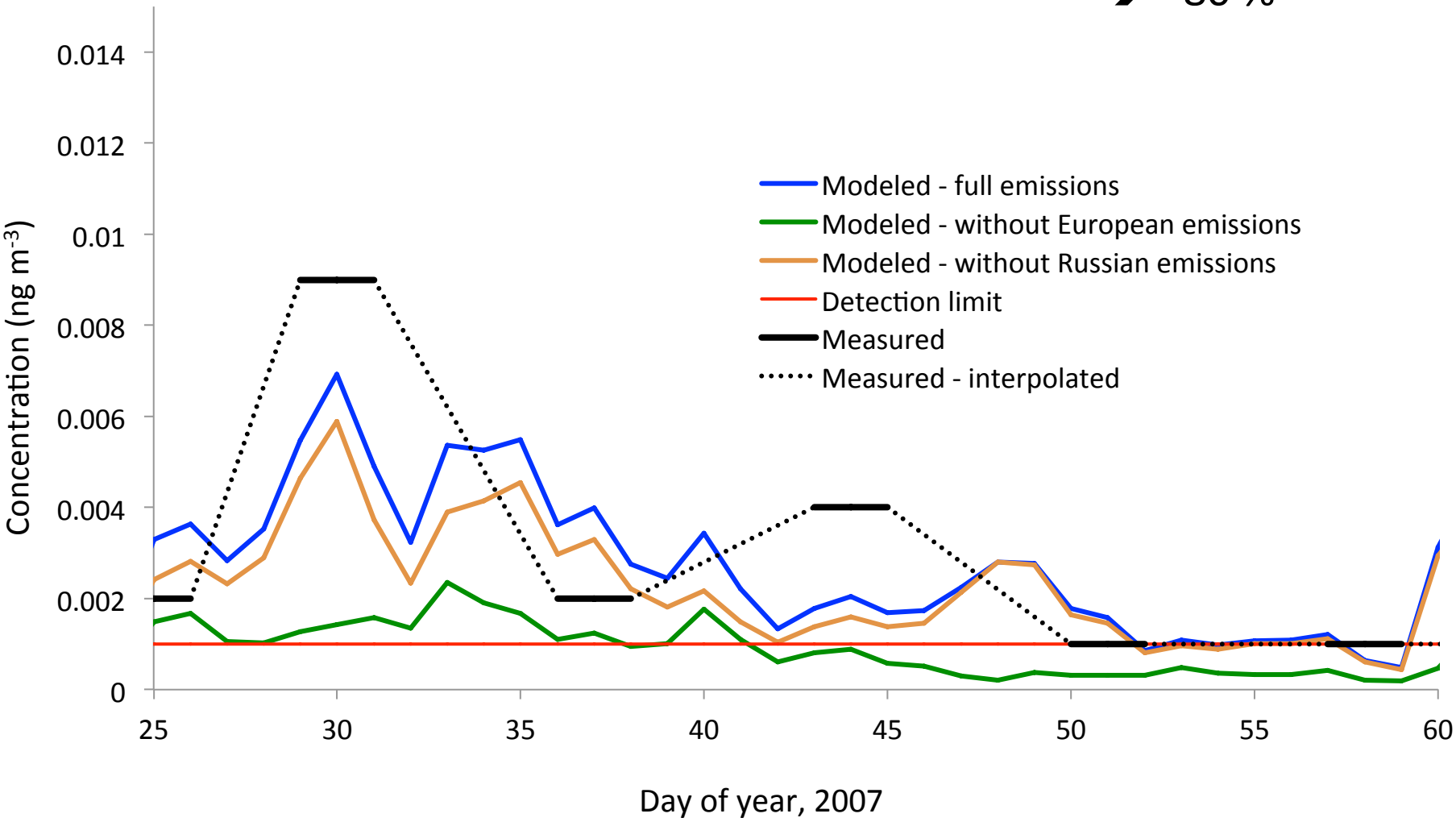


European and Russian sources contribute the most to [BaP] at Spitsbergen

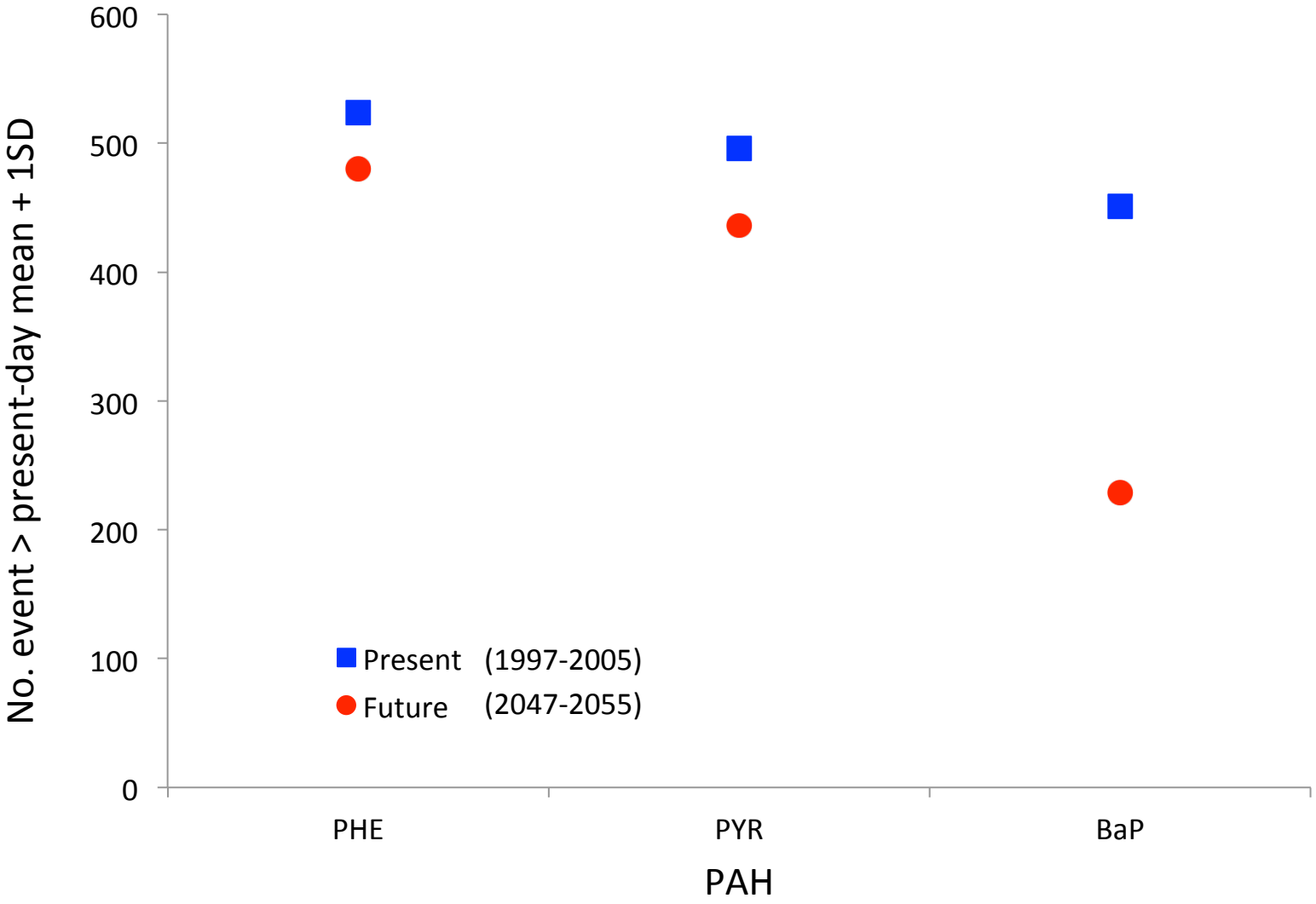


European and Russian sources contribute the most to [BaP] at Spitsbergen

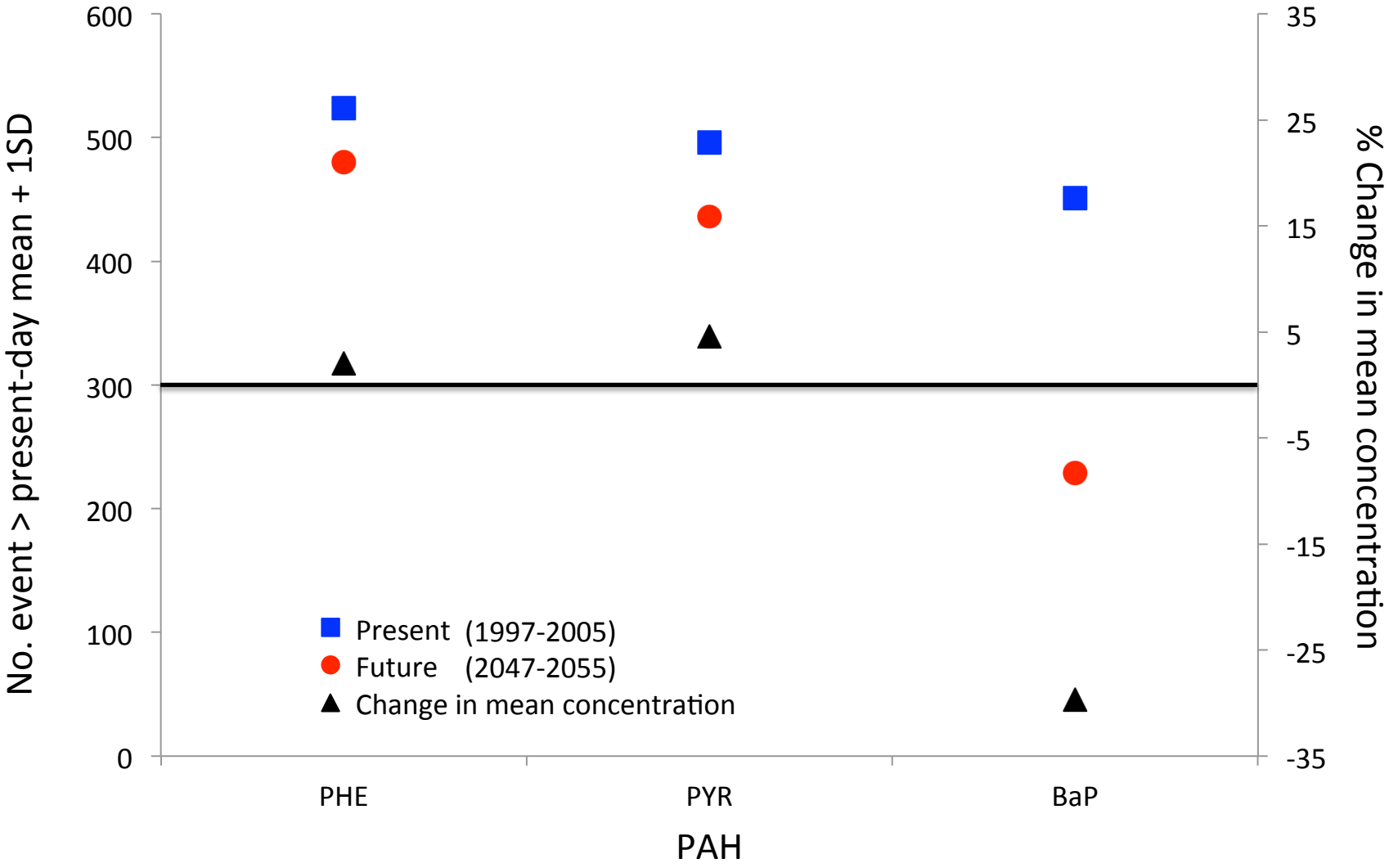
➔ ~80 %



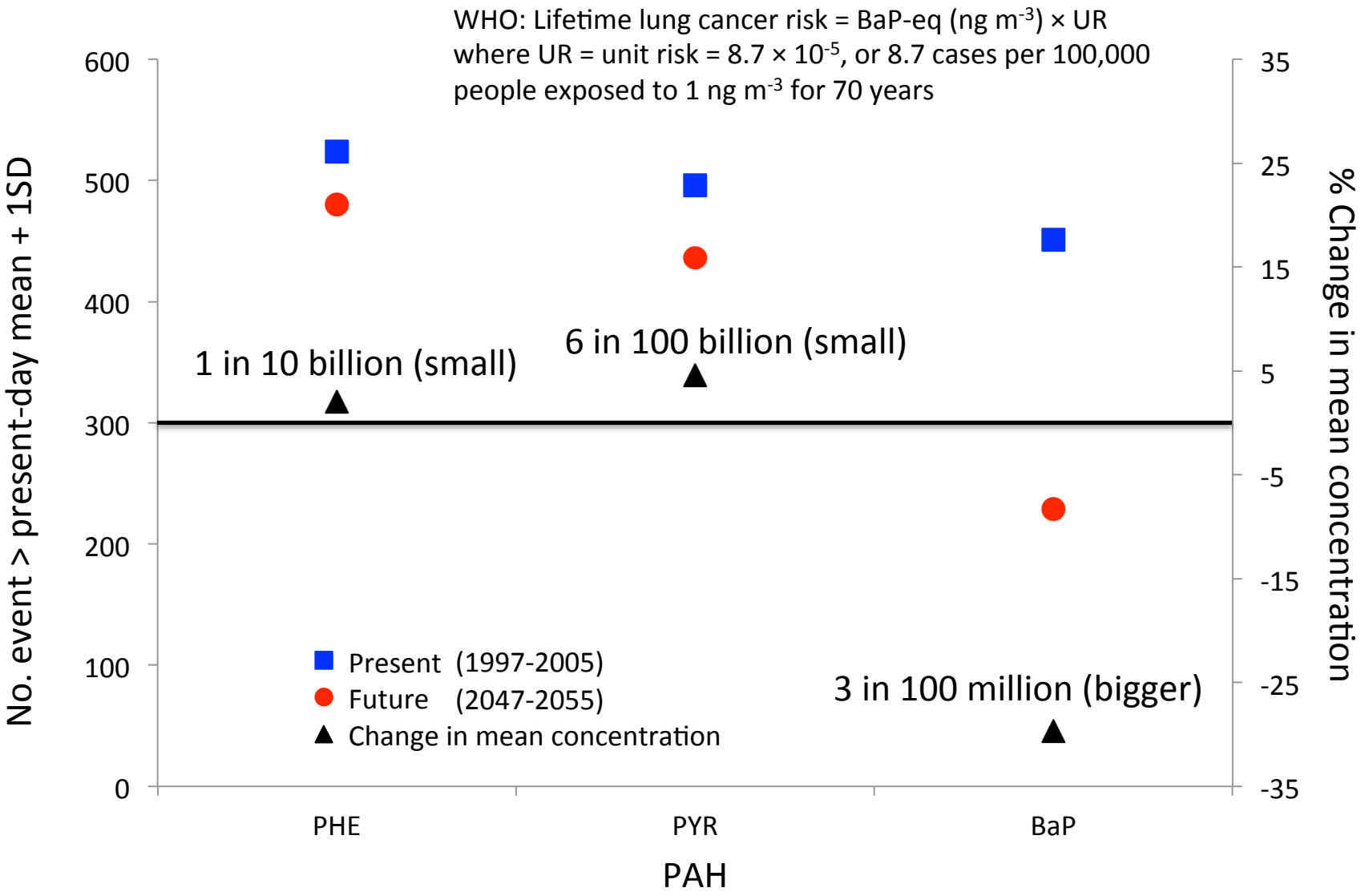
Future climate will have the greatest impact on the number of BaP high pollution events



Future climate will have the greatest impact on atmospheric BaP concentrations



Future climate will have the greatest impact on BaP health risks



Take-home points

- Regulatory lifetime thresholds may not adequately protect the Arctic
- Particulate PAH oxidation and temperature-dependent partitioning are important processes for long-range transport
- European and Russian emissions account for ~80% of PAHs at Spitsbergen
- A future climate will have little effect on transport of primary PHE and PYR to the Arctic, but will reduce BaP

Looking ahead

- Transport under a future climate
  - Where is BaP going?
    - Higher deposition at lower latitudes?
    - What has a greater influence: [OC/BC] or changes in transport?
  - What is the effect of shipping and oil/gas exploration emissions (OC, BC, and PAH)?

Questions?

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*Undergraduate