

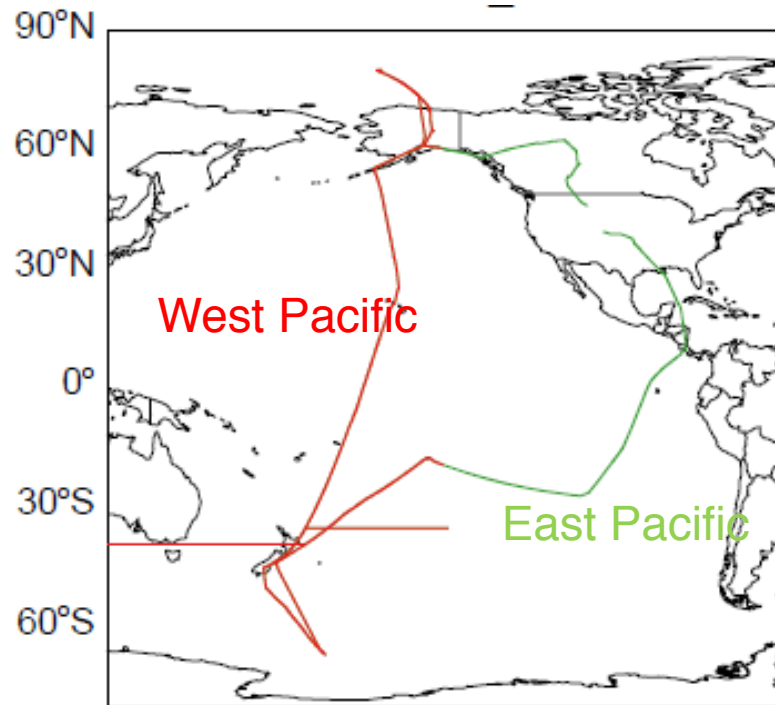
altitude-dependent sources and export efficiency of BC over the Pacific

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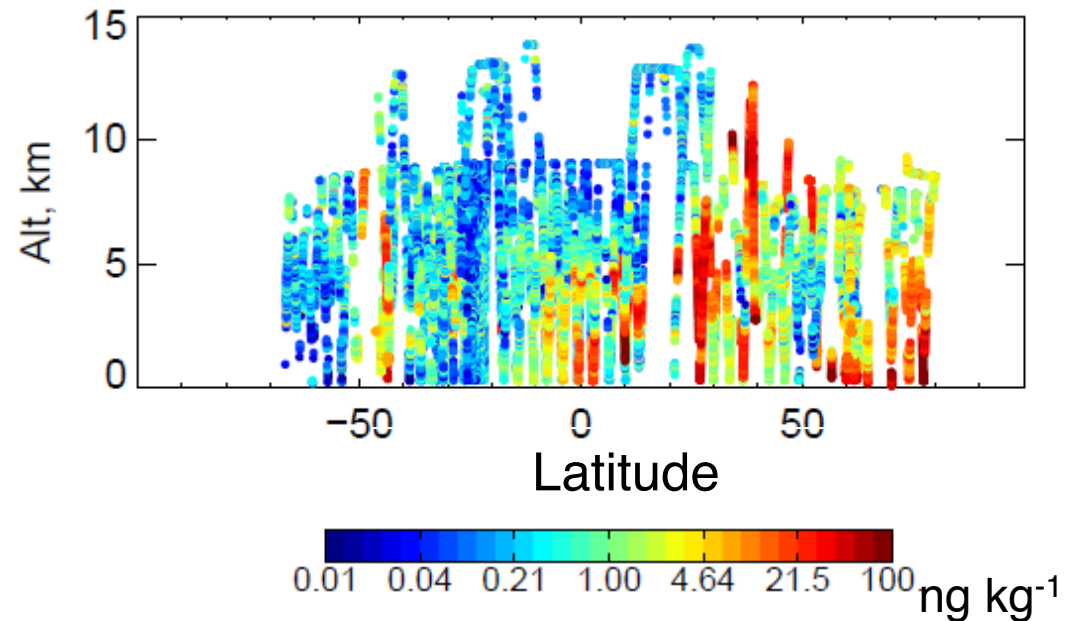
Research funded by the NSF (National Science
Foundation)

BC concentrations during HIPPO-I

HIPPO-I
Jan 9-30, 2009



Observed BC concentrations



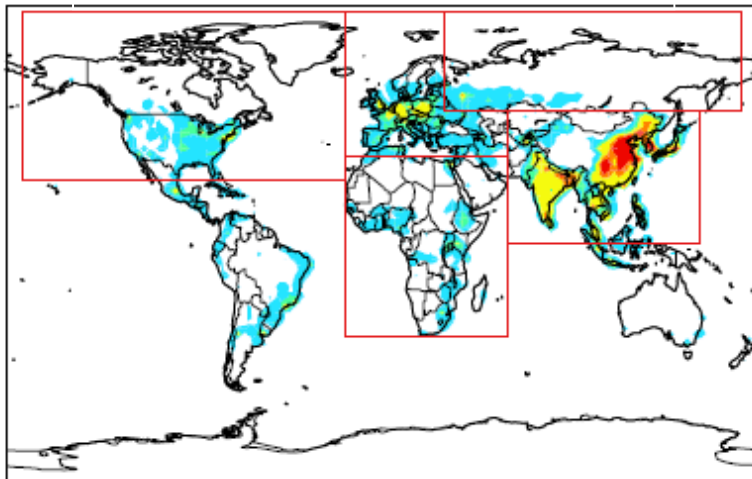
- BC concentrations range from 0.01 to 100 ng kg^{-1}

GEOS-CHEM

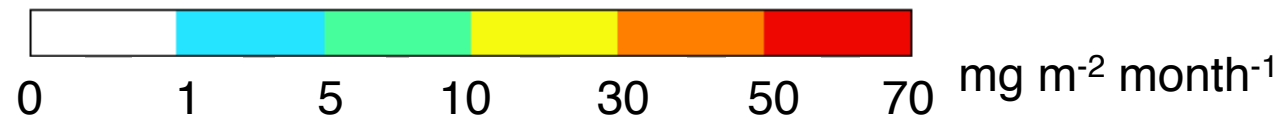
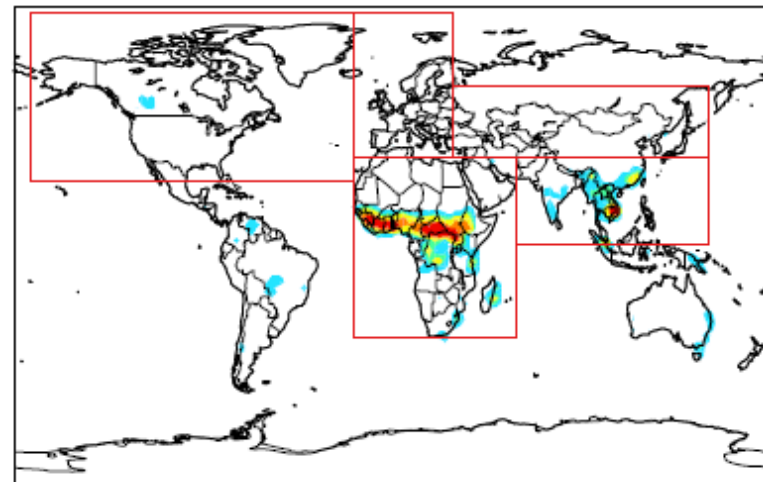
- Chemical transport model ($2^\circ \times 2.5^\circ$ with 47 vertical levels)
- Emission: FLAMBE for Biomass burning (Reid et al. 2009 and Fisher et al. 2010) and Bond et al. [2007] for anthropogenic emission, with modifications in Wang et al. [2011]

BC emissions in Jan, 2009

Anthropogenic (0.6 Tg)



Open fires (0.3 Tg)



Emission evaluation

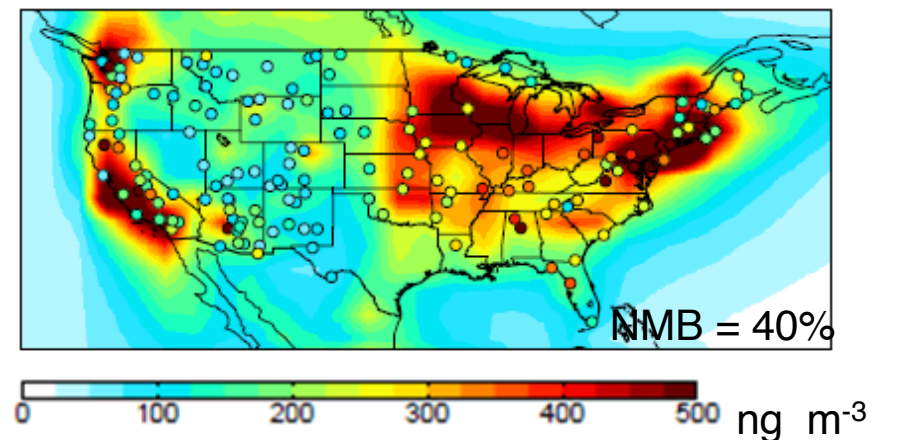
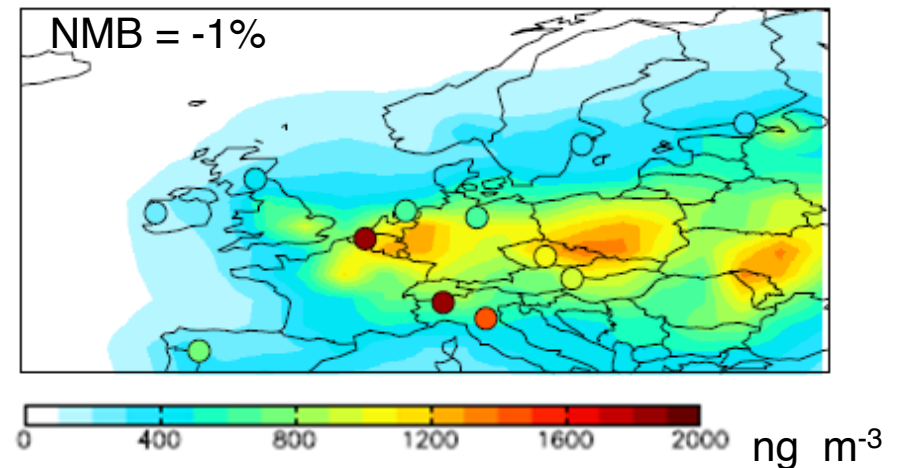
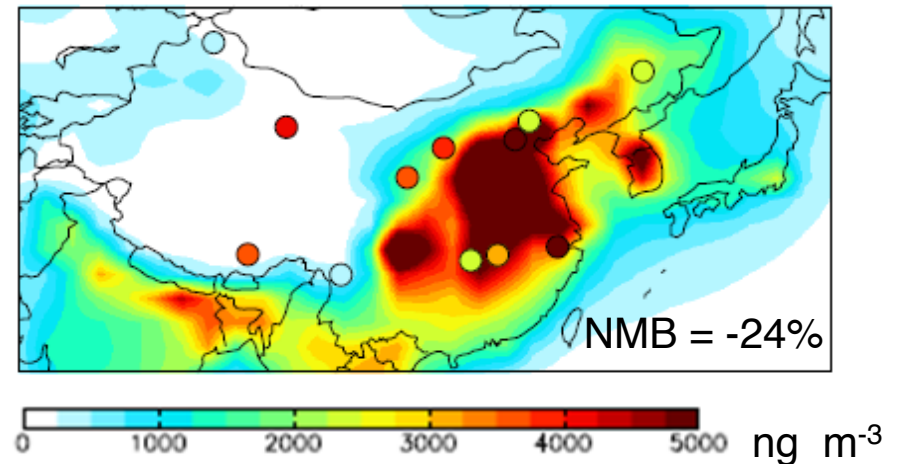
- Annual mean surface concentrations in China 2006 (Zhang et al. [2008], Europe 2002-2003(EMEP) and US 2008 (IMPROVE)

- $$\text{NMB} = 100\% \times \sum_i (M_i - O_i) / \sum_i O_i$$

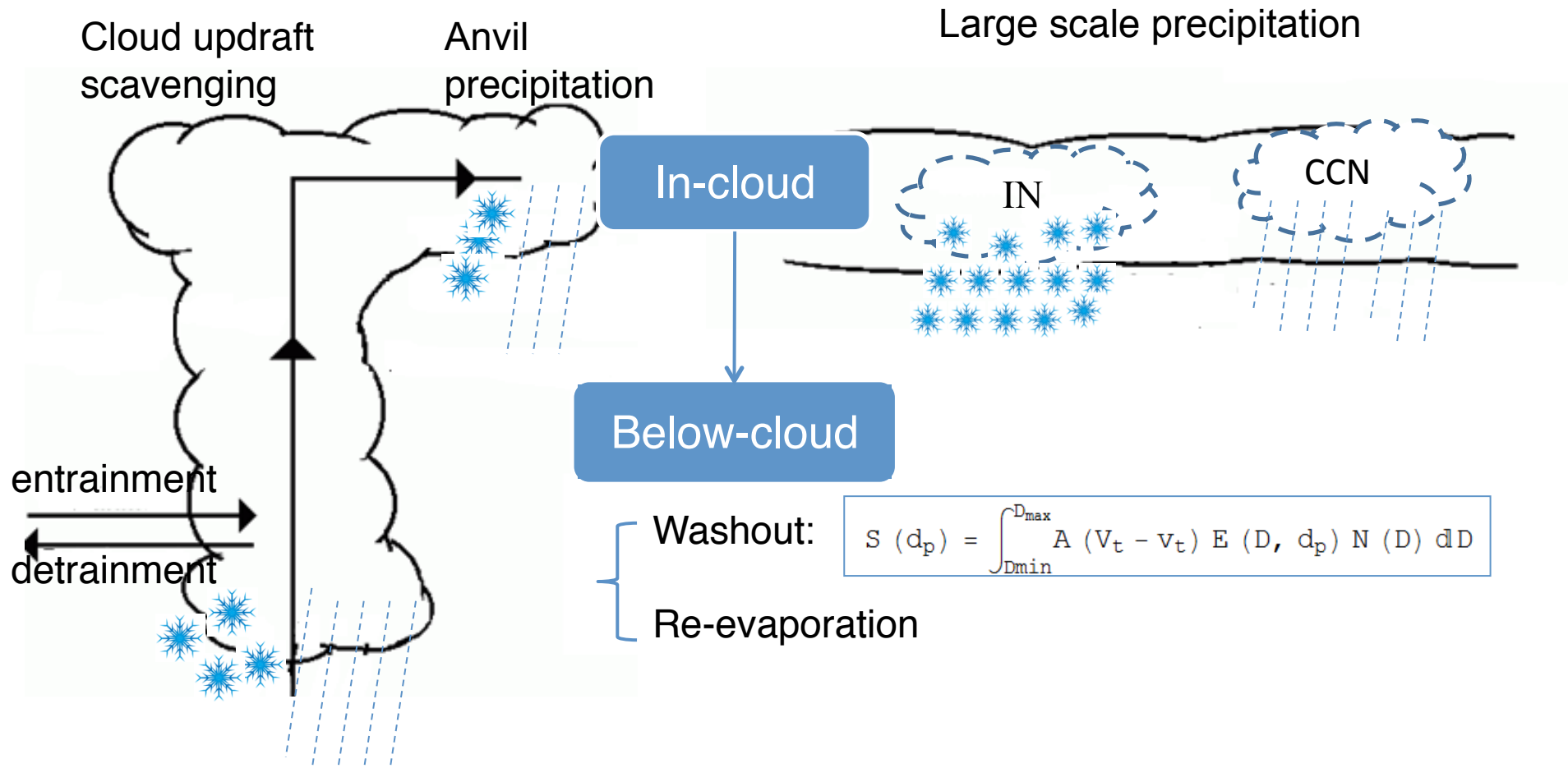
i : index of sites

M_i : modeled value

O_i : observed value

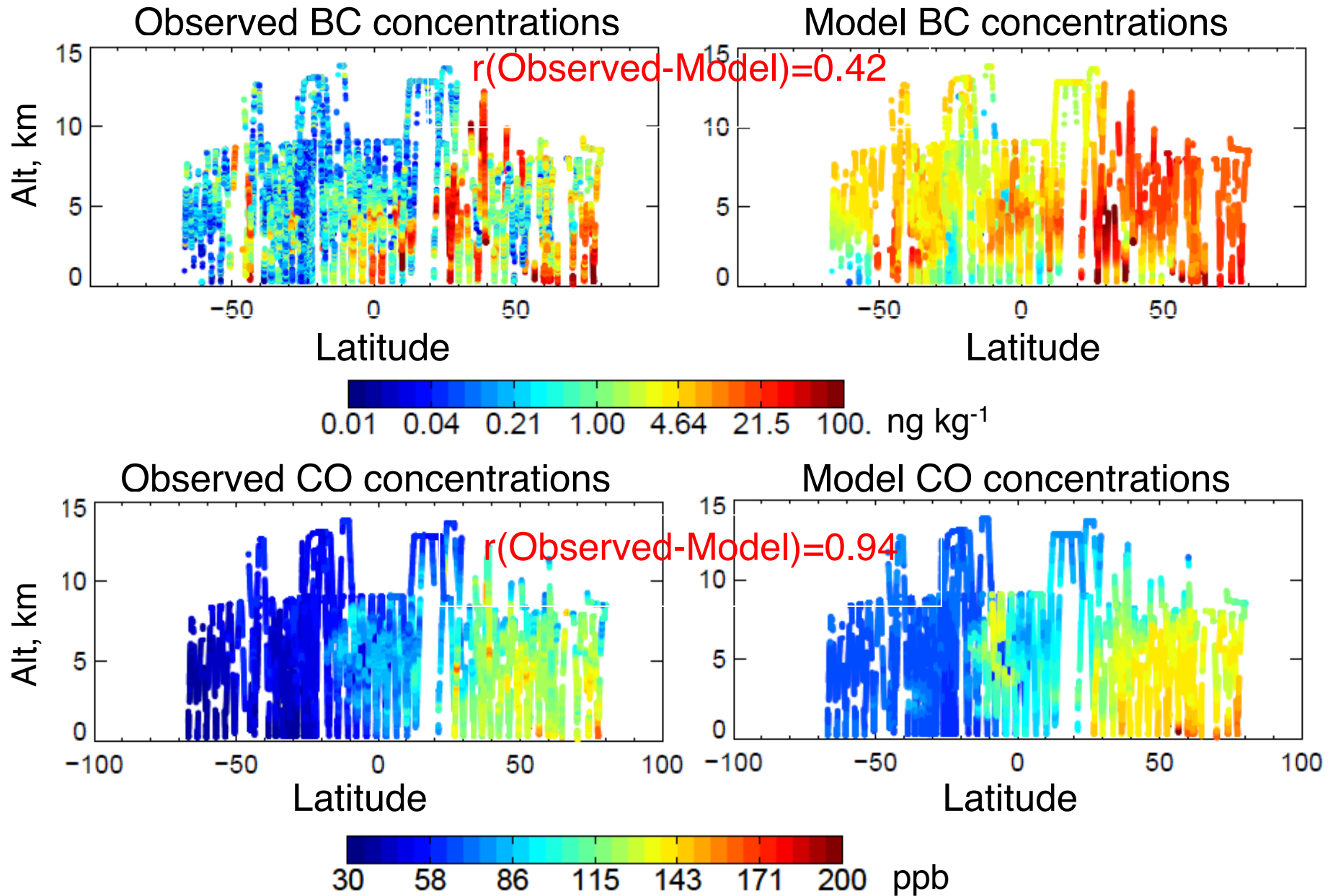


Wet deposition in GEOS-CHEM



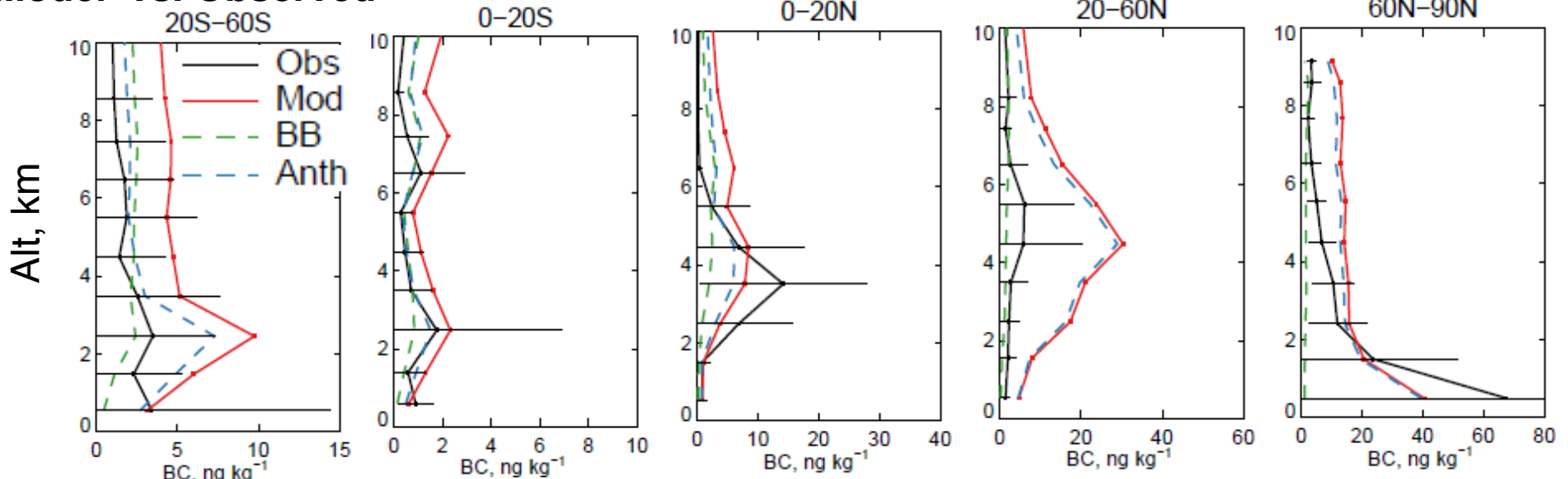
- 1-day time scale for conversion from hydrophobic to hydrophilic
- Water-soluble compounds for CCN and water-insoluble BC +dust for IN
- Use scavenging coefficient for accumulation aerosol mode instead of the bulk parameterization for the whole aerosol size range

Observed vs. model curtain for BC and CO

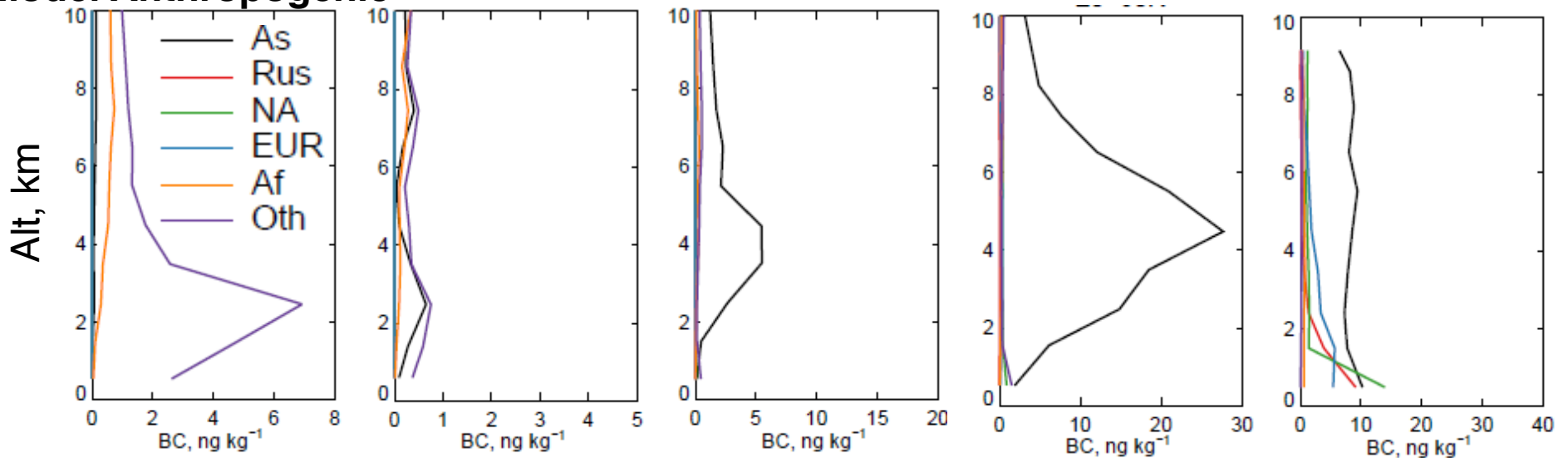


Model vs. Observations – West Pacific

Model vs. Observed



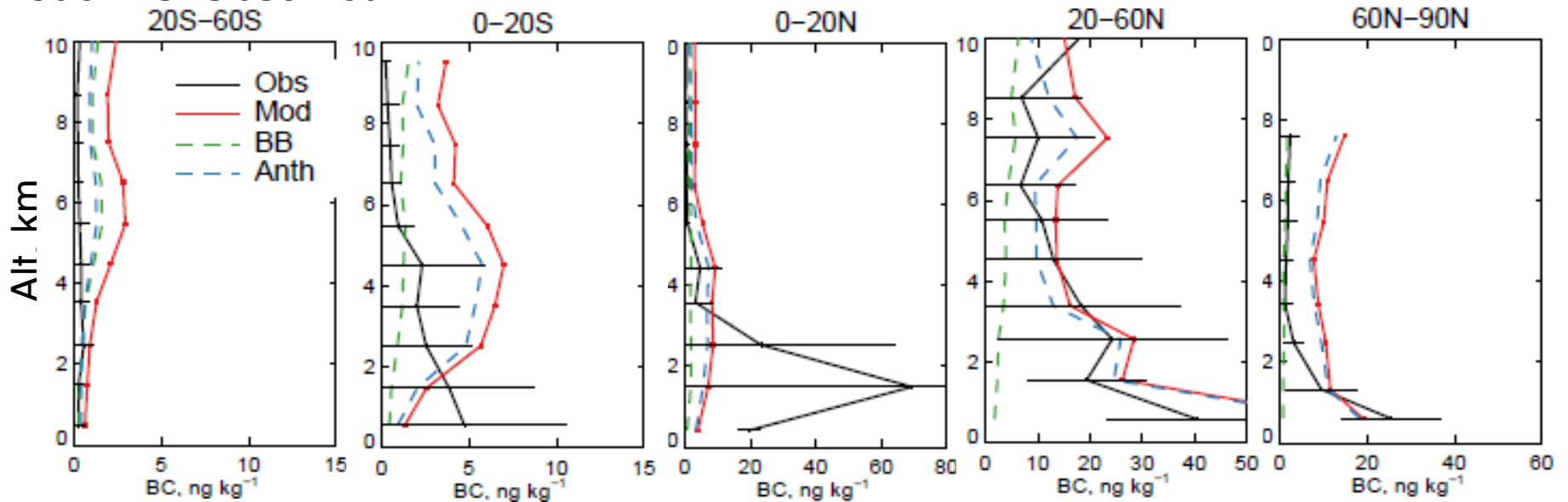
Model Anthropogenic



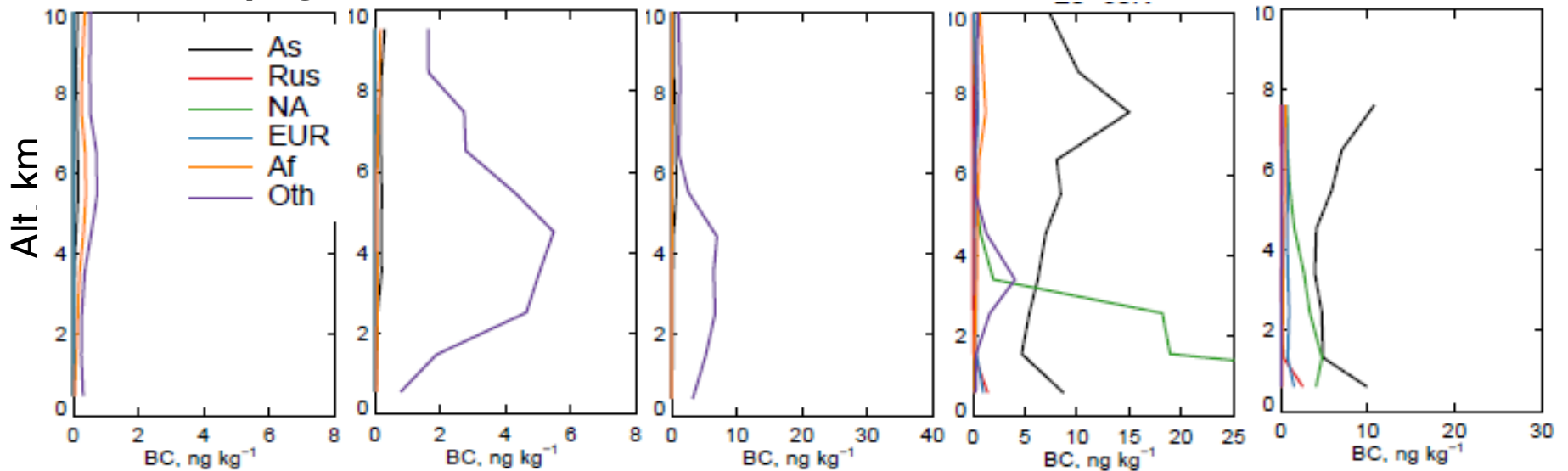
- Asia dominates anthropogenic BC in Northern Hemisphere
- Insufficient removal of Asian BC during ventilation to the free troposphere

Model vs. Observations – East Pacific

Model vs. Observed



Model Anthropogenic



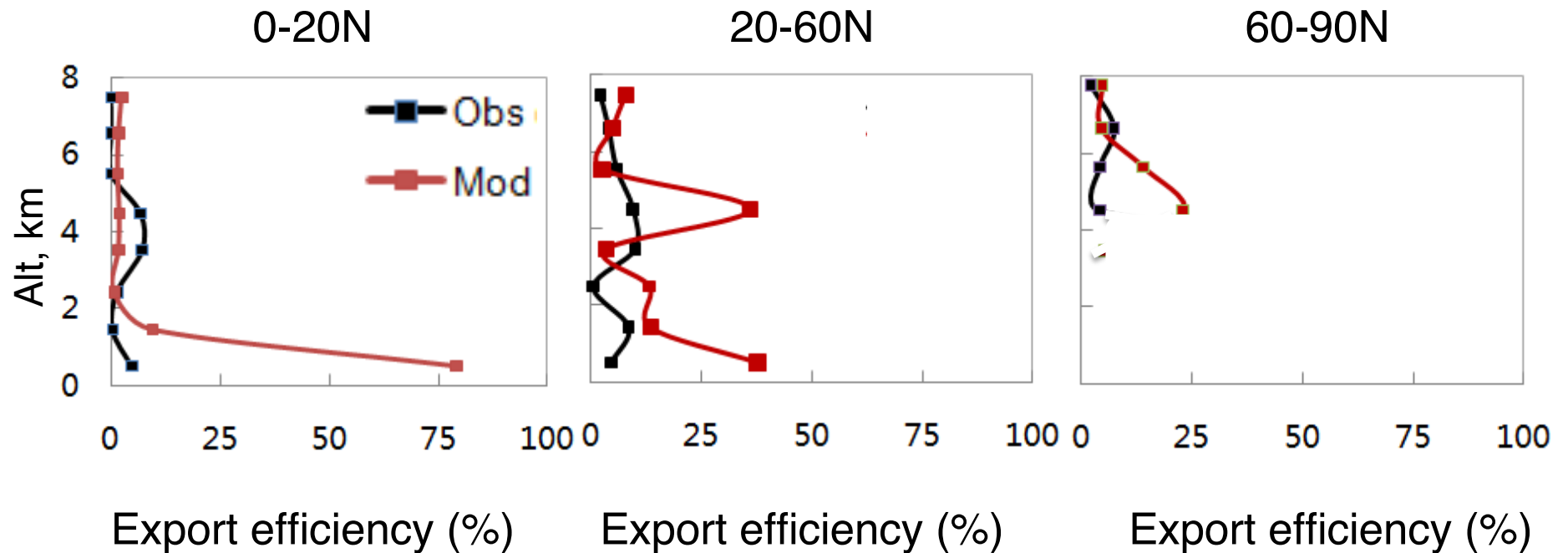
- Asia & NA dominates anthropogenic BC in Northern Hemisphere
- Insufficient removal of Asian BC during ventilation to the free troposphere

Export efficiency of Asian Anthropogenic BC in West Pacific

- Export efficiency (f)

$$f(z) = \frac{1}{R} \left(\frac{\Delta[BC]}{\Delta[CO]} \right)_z$$

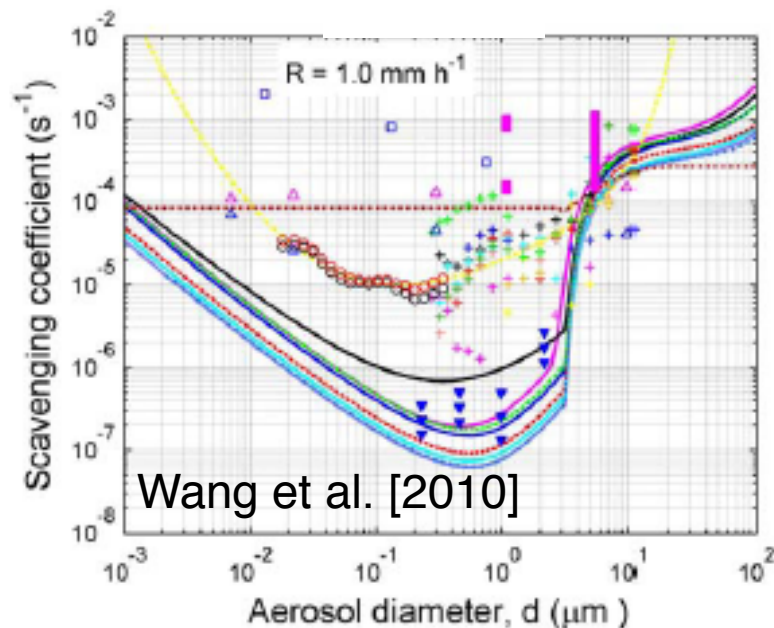
R: emission ratio of Asian anthropogenic source (0.6 Tg BC/53 Tg CO)



- Overestimation in export efficiency in mid- and high latitude

Uncertainties in wet deposition

- e-folding time-scale for the conversion from hydrophobic to hydrophilic
several hours -- one day??
- In-cloud scavenging
hydrophobic BC serves as IN ??
- Below-cloud scavenging

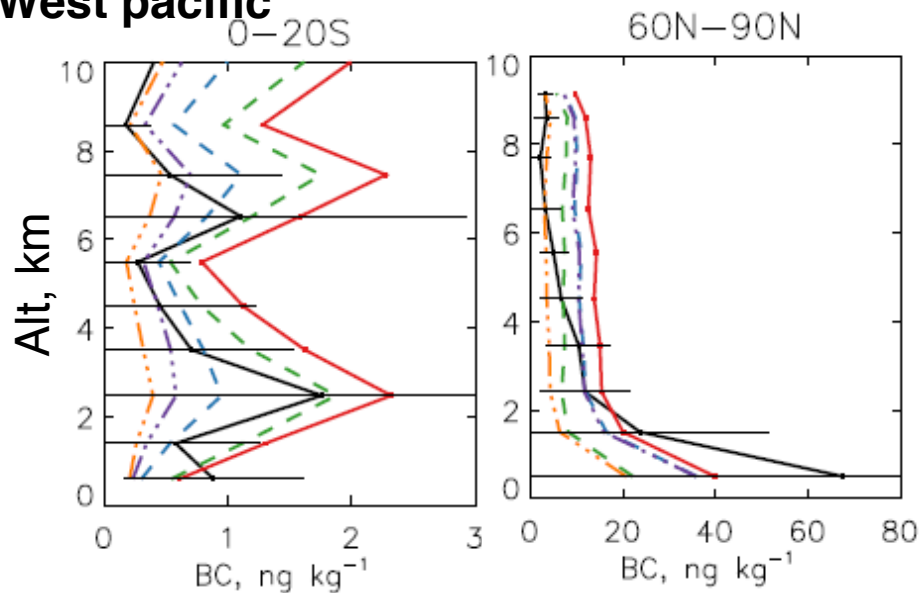


1-2 orders of magnitude for accumulation-mode aerosols

- Transition from liquid to ice cloud??

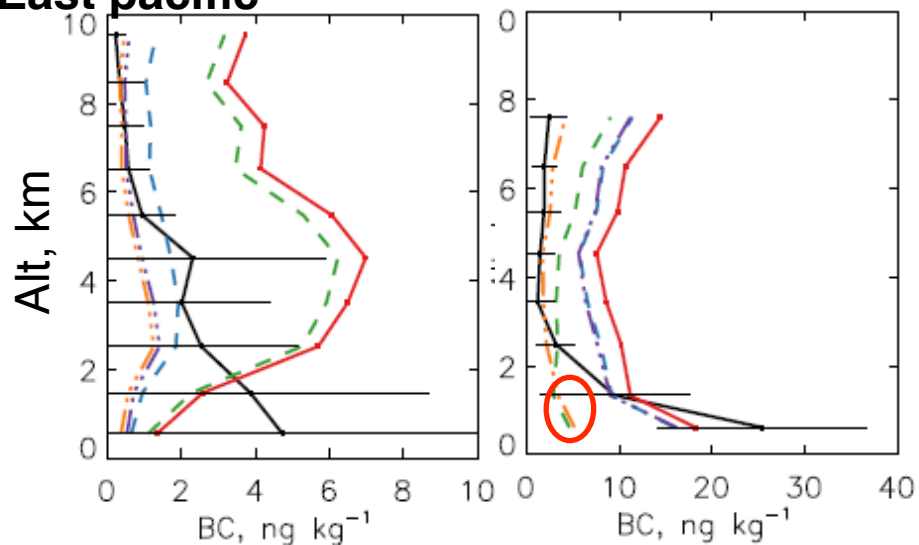
Sensitivity test-II

West pacific



- Obs
- Std
- ~~--- Increase washout coefficient by a factor of 10~~
- ~~--- e-folding time of 0.1 day~~
- ~~--- scavenging hydrophilic BC in cold cloud in convection updrafts~~
- scavenging hydrophilic BC in cold cloud in all scavenging events

East pacific



Further work

- Temperature dependent Fraction of hydrophilic BC incorporated into ice
 - more fraction at lower temperature in cold cloud?
- Sensitivity of BC scavenging to model resolution
- Tagged CO simulation to derive export efficiency of BC from different source types and source regions