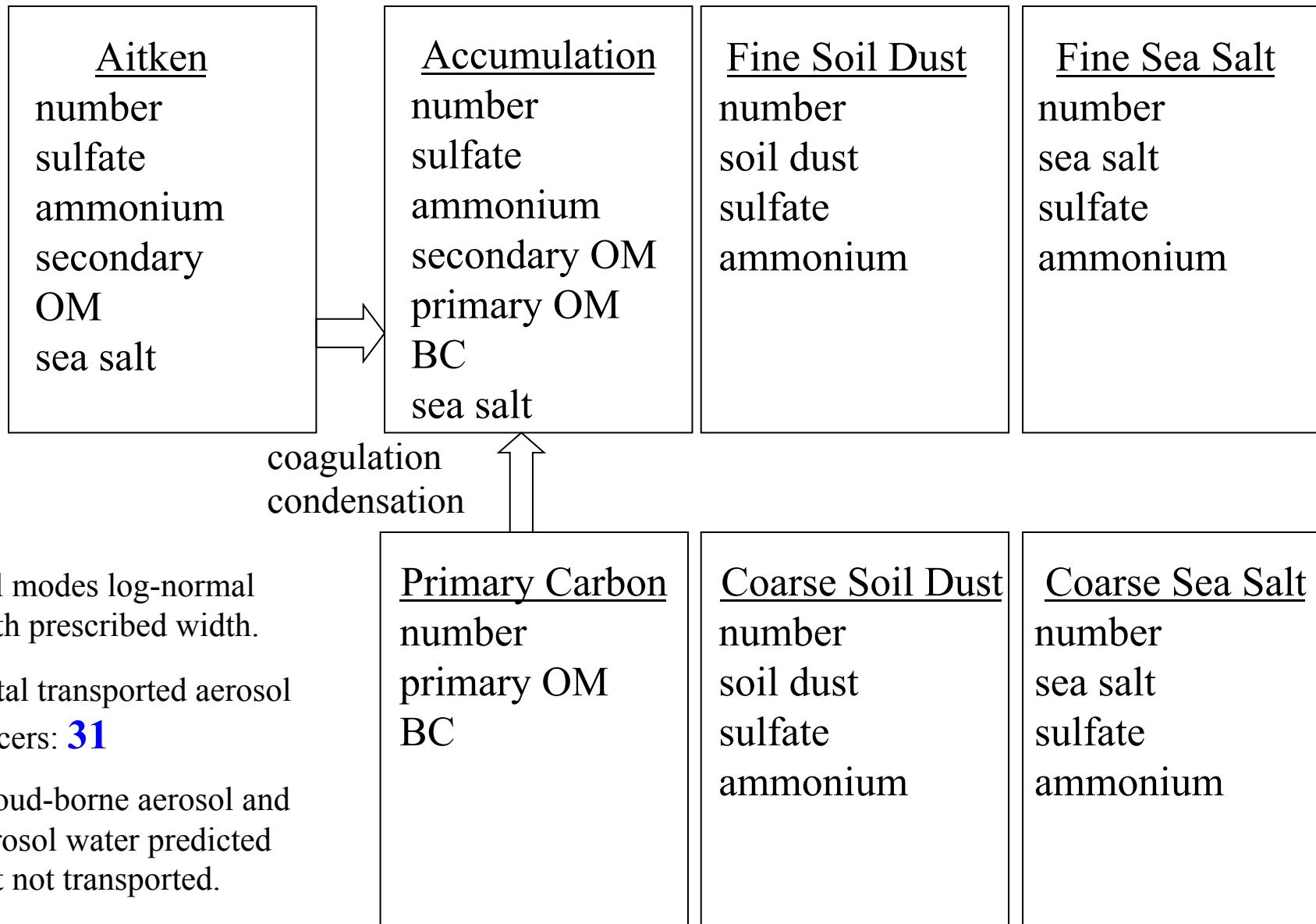


Development of a 4-Mode Version of Modal Aerosol Module for CAM5

**Xiaohong Liu, Hailong Wang, (other colleagues at
Pacific Northwest National Laboratory)**

With support from DOE Polar Project

Benchmark 7-Mode Modal Aerosol Model (MAM)

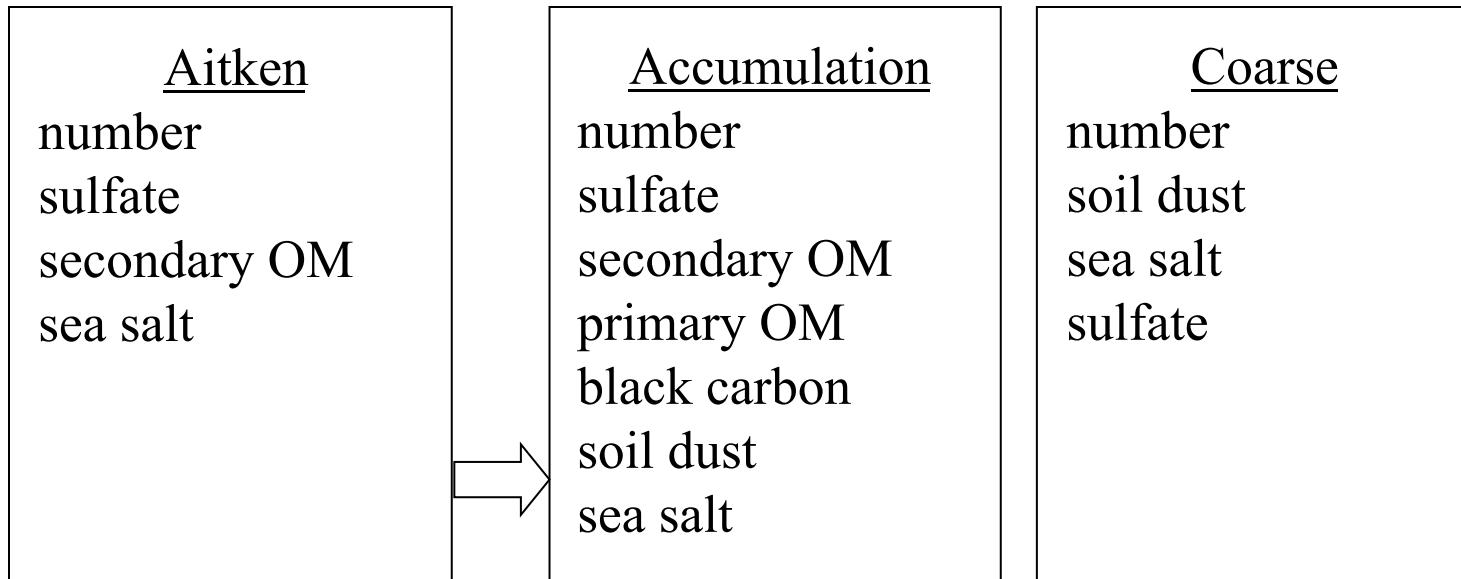


3-mode version of MAM

Assume primary carbon is internally mixed with secondary aerosol.

Sources of dust and sea salt are geographically separate

Assume ammonium neutralizes sulfate.



Total transported aerosol
tracers: **15**

coagulation
condensation

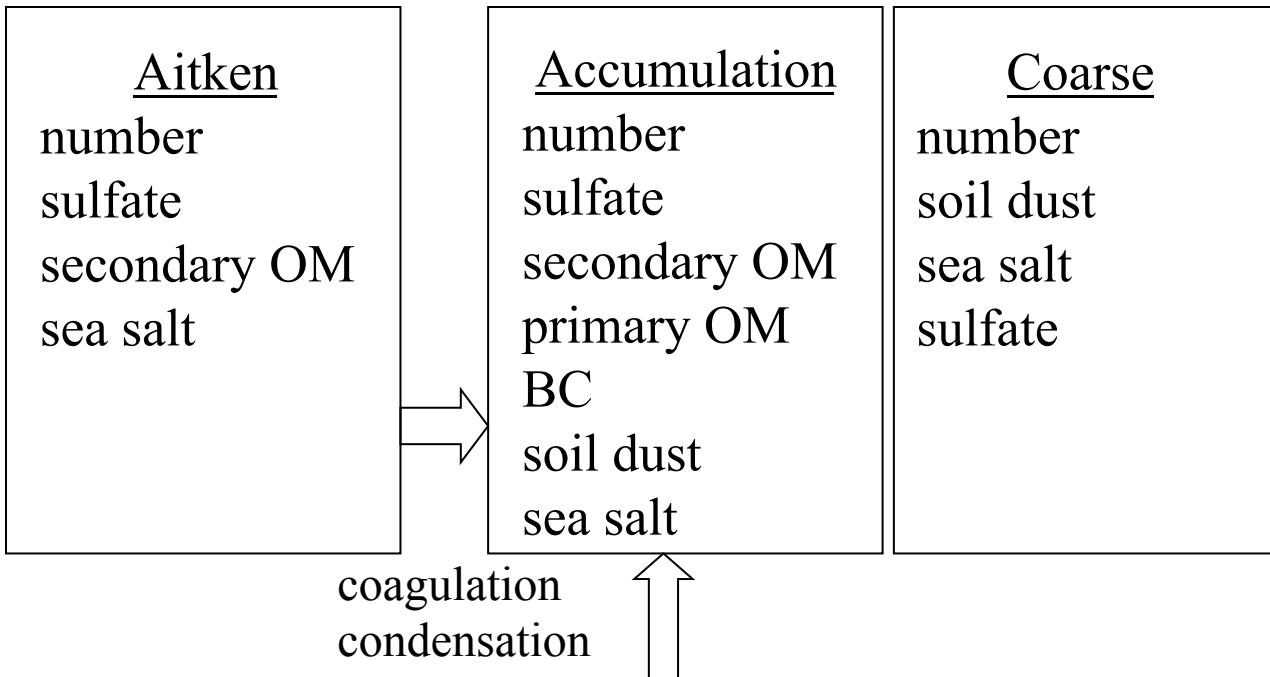
Goal

- Improve the treatment of aging (mixing state) of black carbon (BC) and primary organic matter (POM)
- Reproduce the results of MAM7 for BC and POM, but with a small increase in computer time



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4-Mode version of MAM



All modes log-normal
with prescribed width.

Total transported aerosol
tracers: **18**

Cloud-borne aerosol and
aerosol water predicted
but not transported.

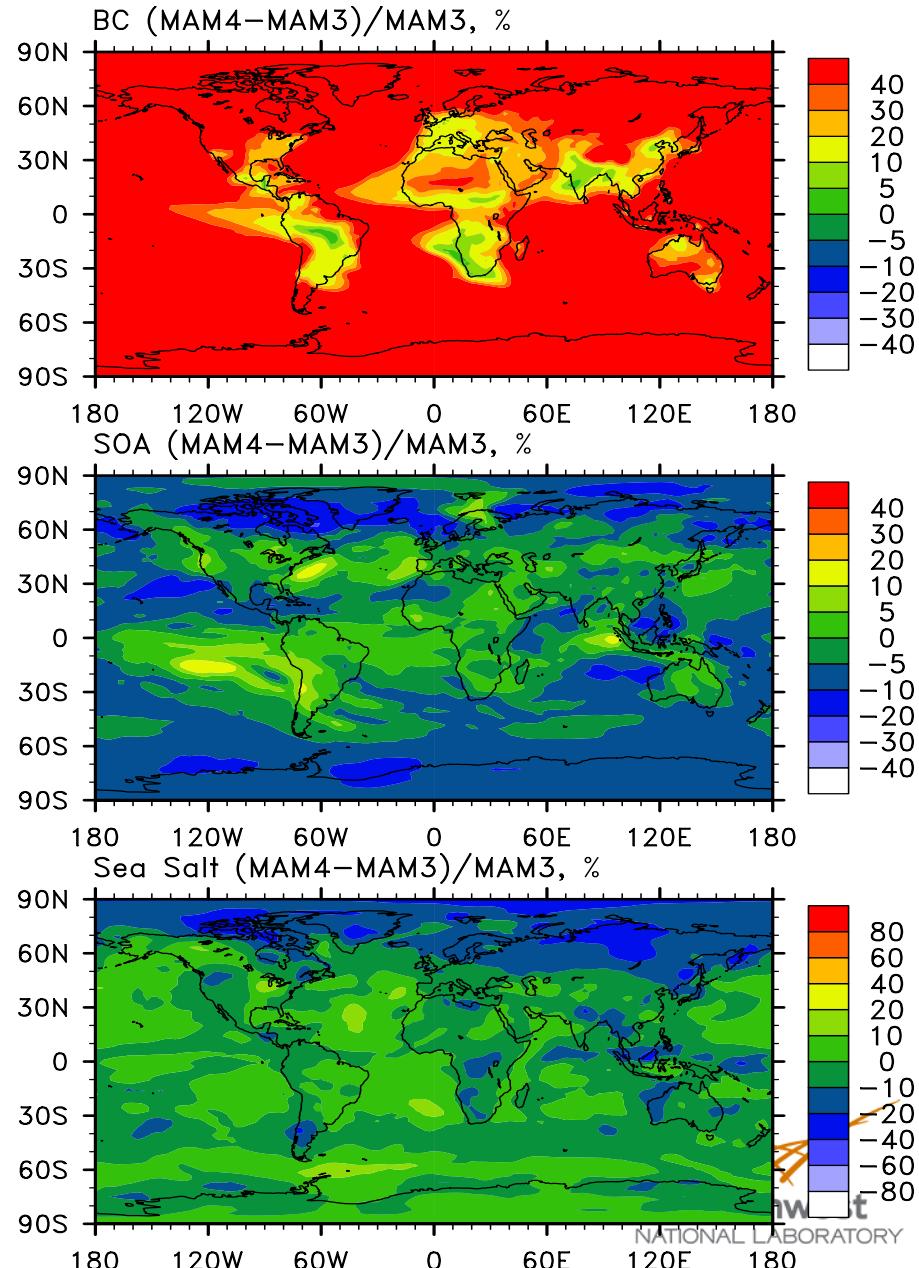
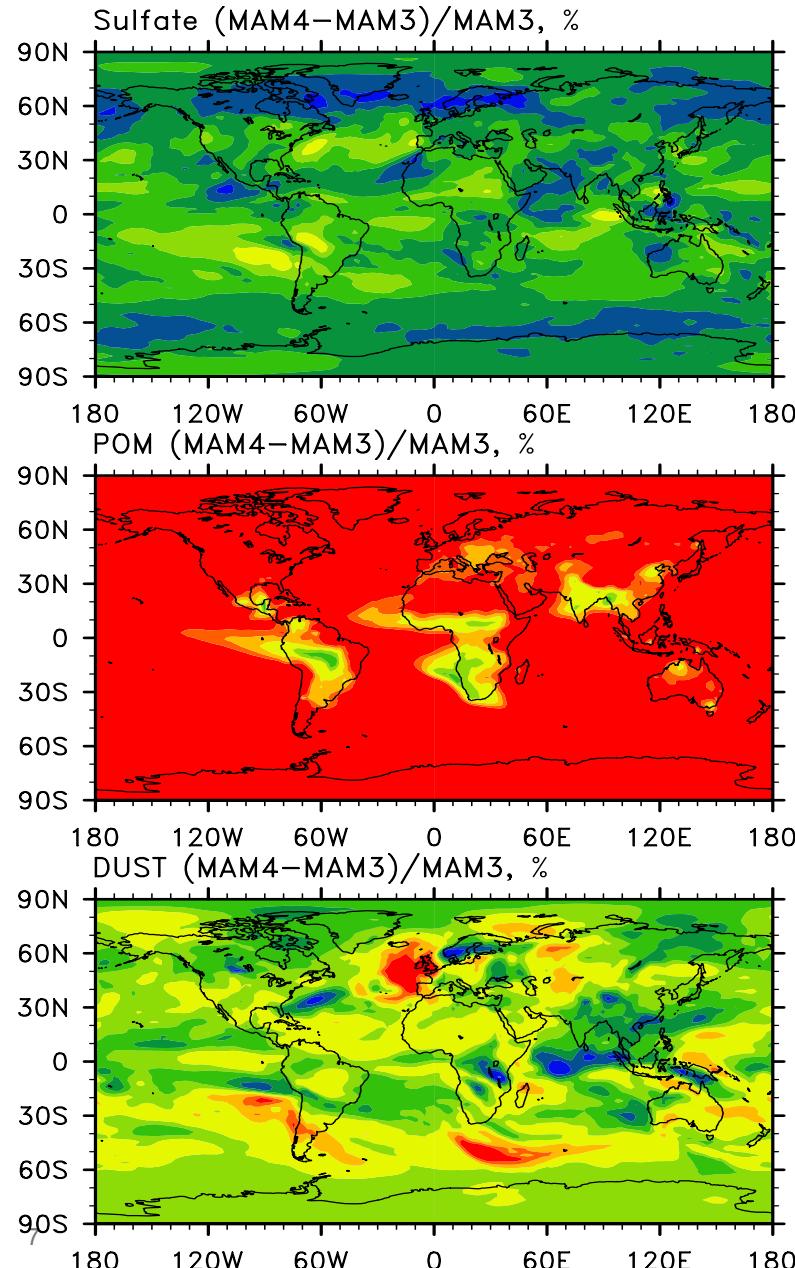


Computer time is ~10% higher than MAM3

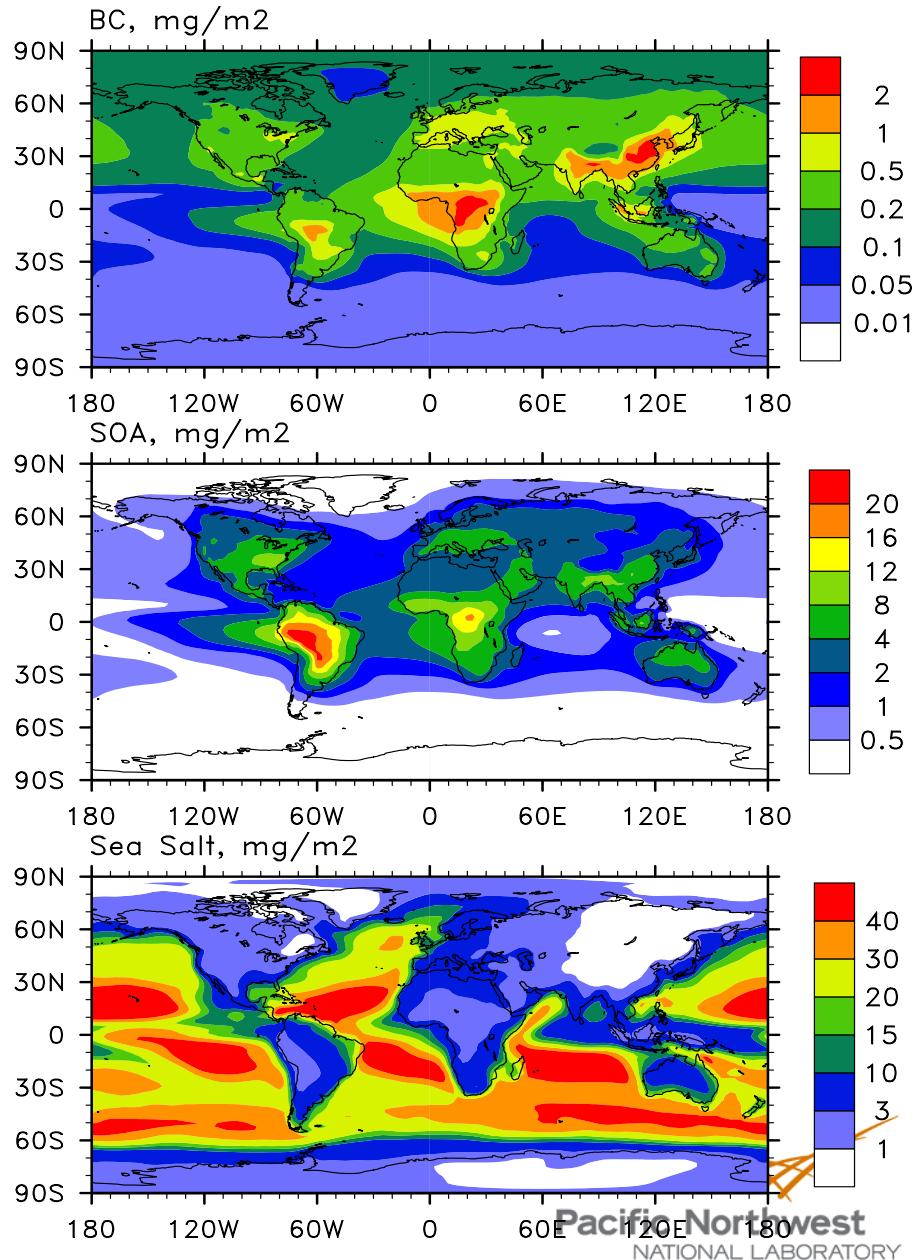
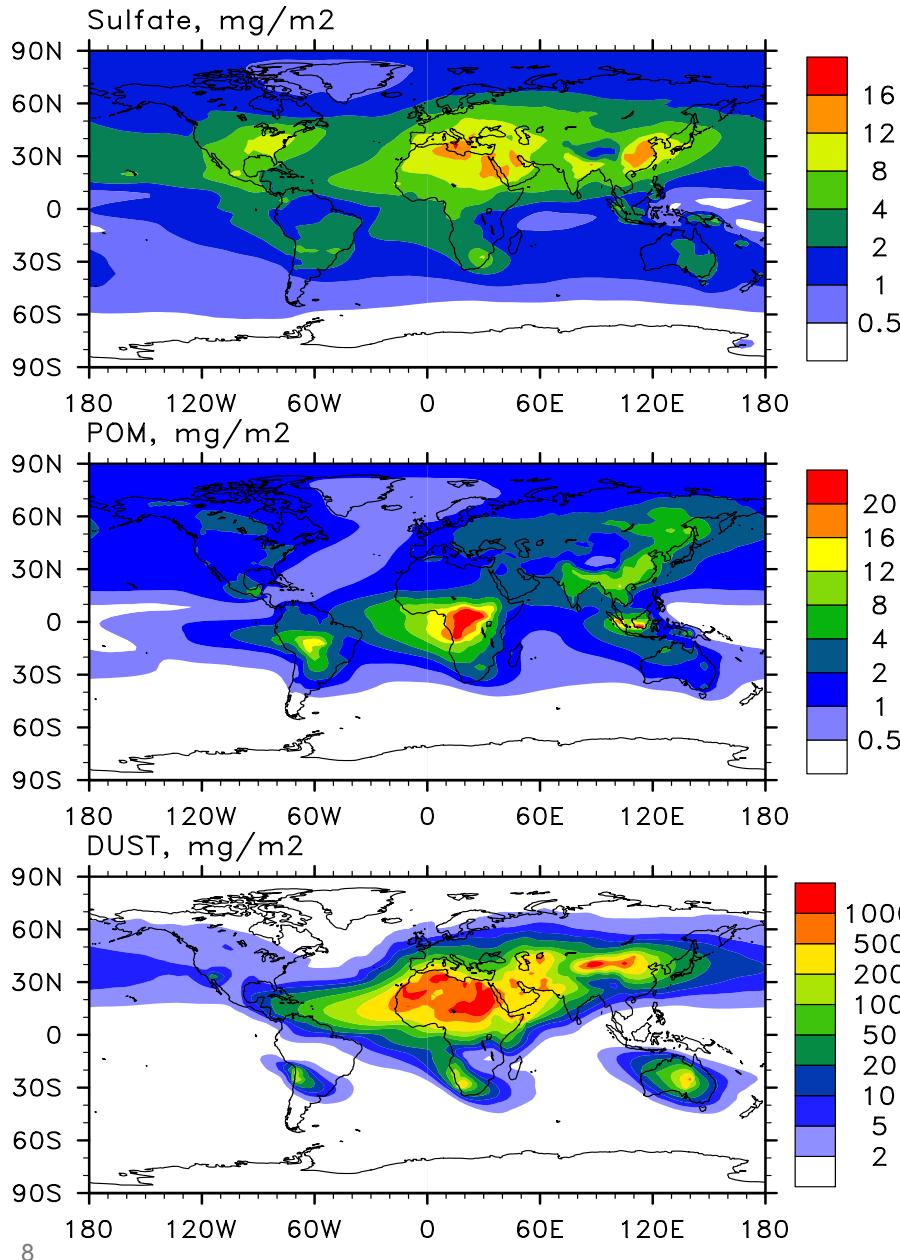
CAM5 Simulations (CAM5.1)

- Free CAM5 run with prescribed climatological SST and sea ice
- 6 years at $1.9^\circ \times 2.5^\circ$ resolution with 1-year spin-up
- Emissions: IPCC AR5 emissions for anthr. OM, BC, SO₂
- 3-mode, 4-mode and 7-mode version of MAM
- Low hygroscopicity of POM ($\kappa=0$) and slow aging of primary carbon mode for MAM4 and MAM7 (coating thickness = 8 monolayers)
 - MAM3 ($\kappa=0.1$)
 - MAM4 and MAM7 ($\kappa=0$ and slow aging)

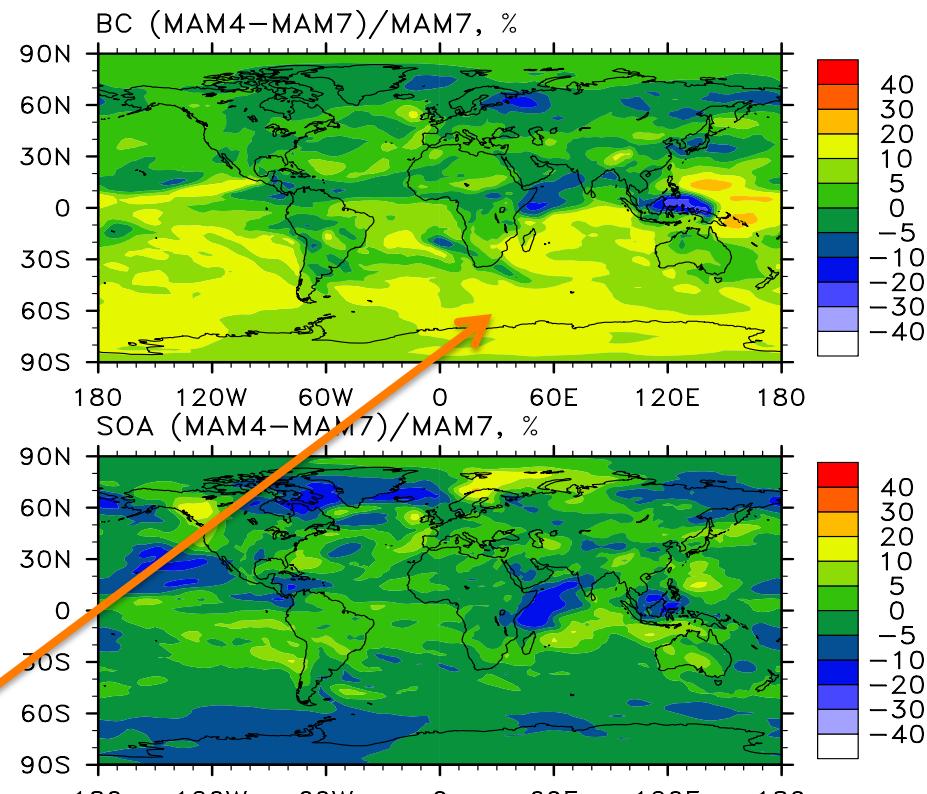
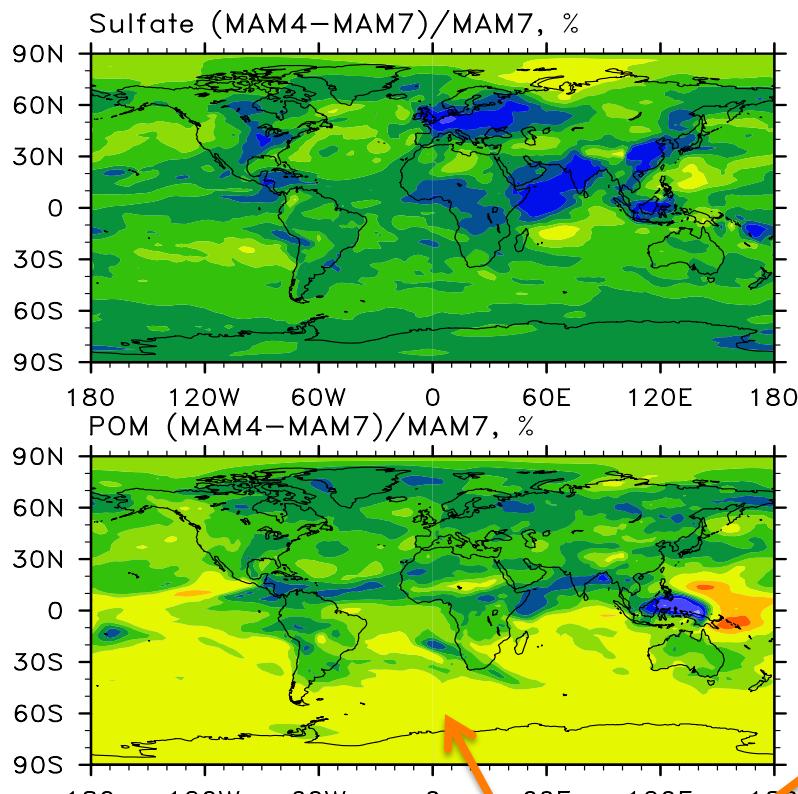
Aerosol mass burden %diff. (MAM4-MAM3)/MAM3



Aerosol mass burden MAM4

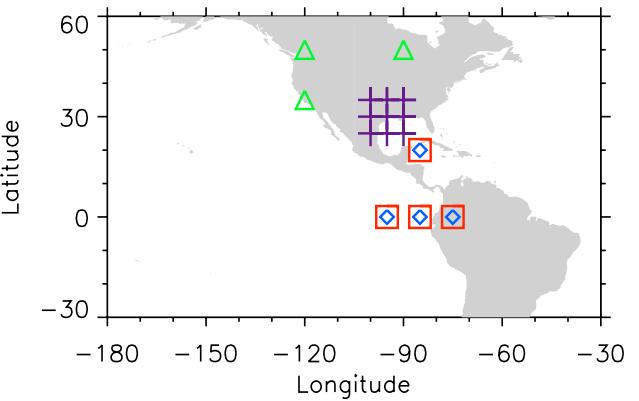
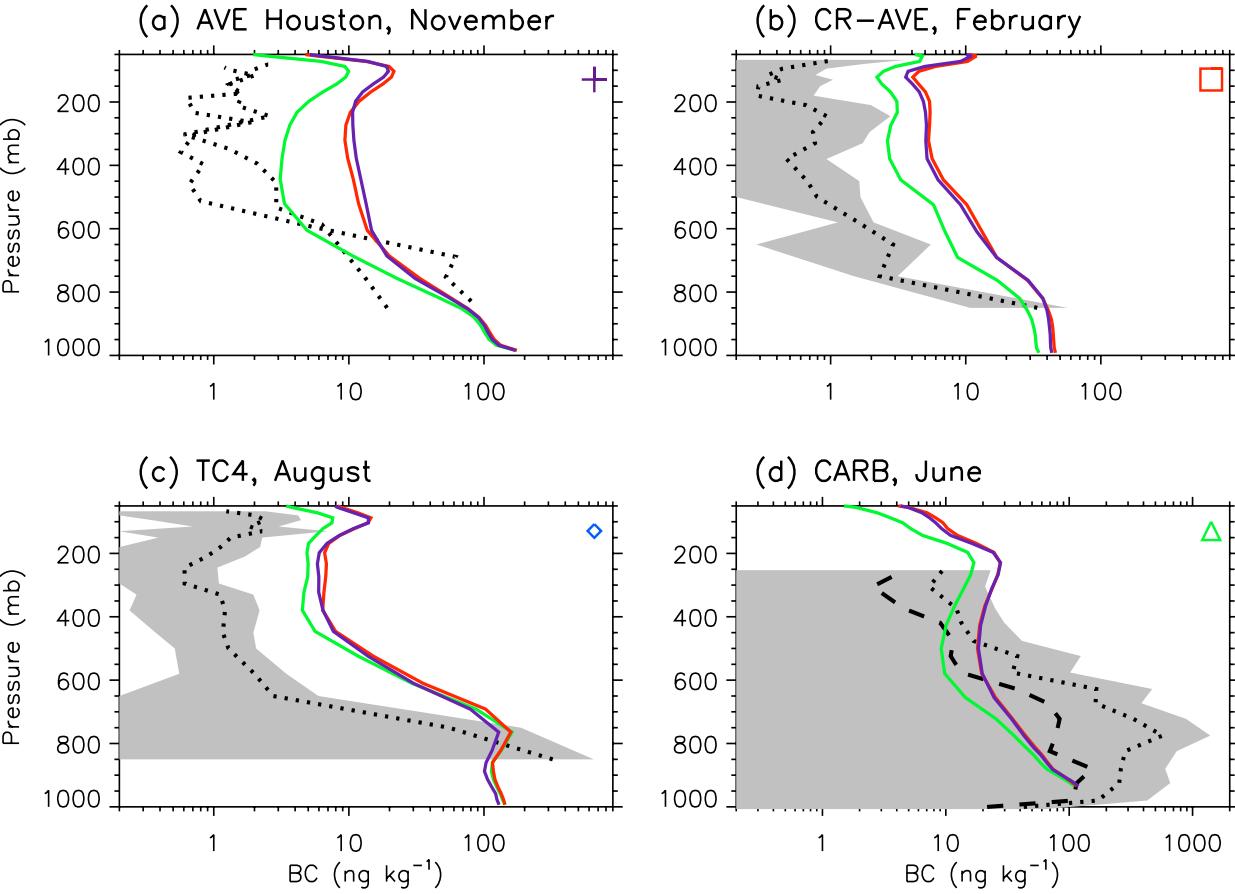


Aerosol mass burden %diff. (MAM4-MAM7)/MAM7



10-20% higher than MAM7, but
concentrations there are very low

BC compared with SP2 (tropics and midlat.)

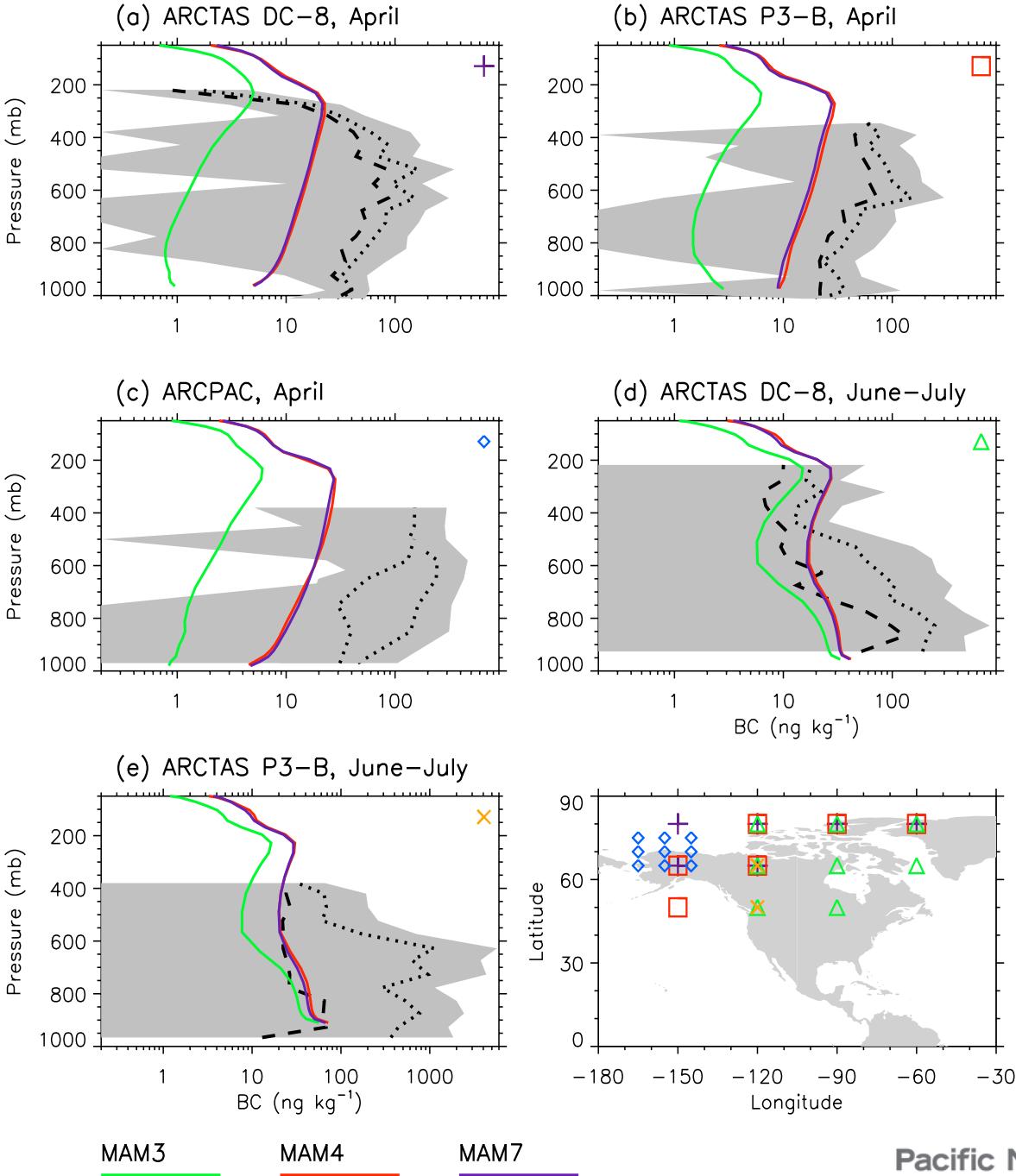


MAM3
MAM4
MAM7

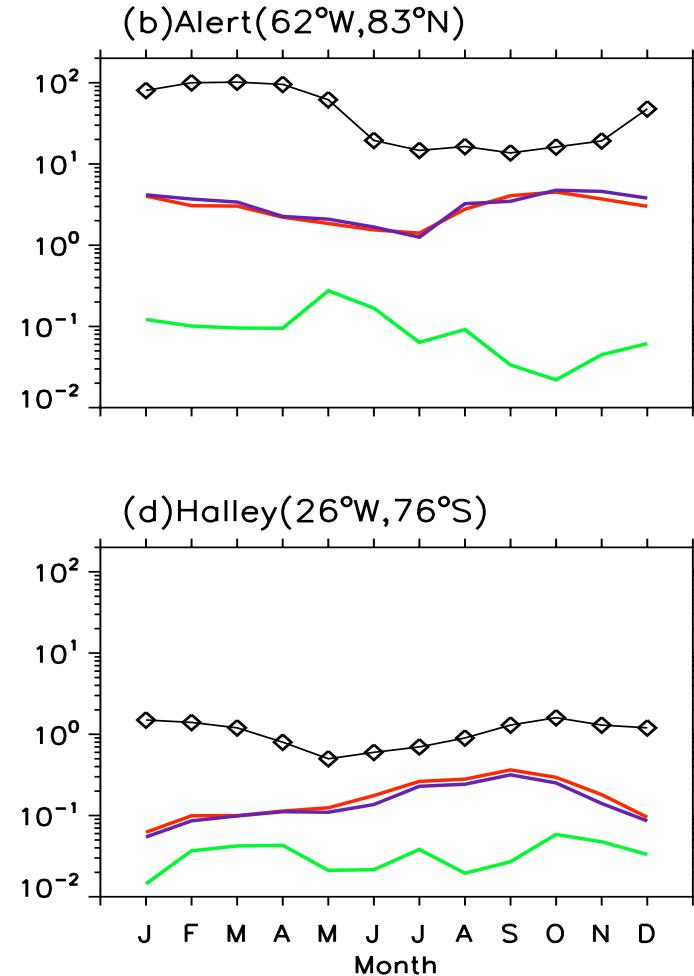
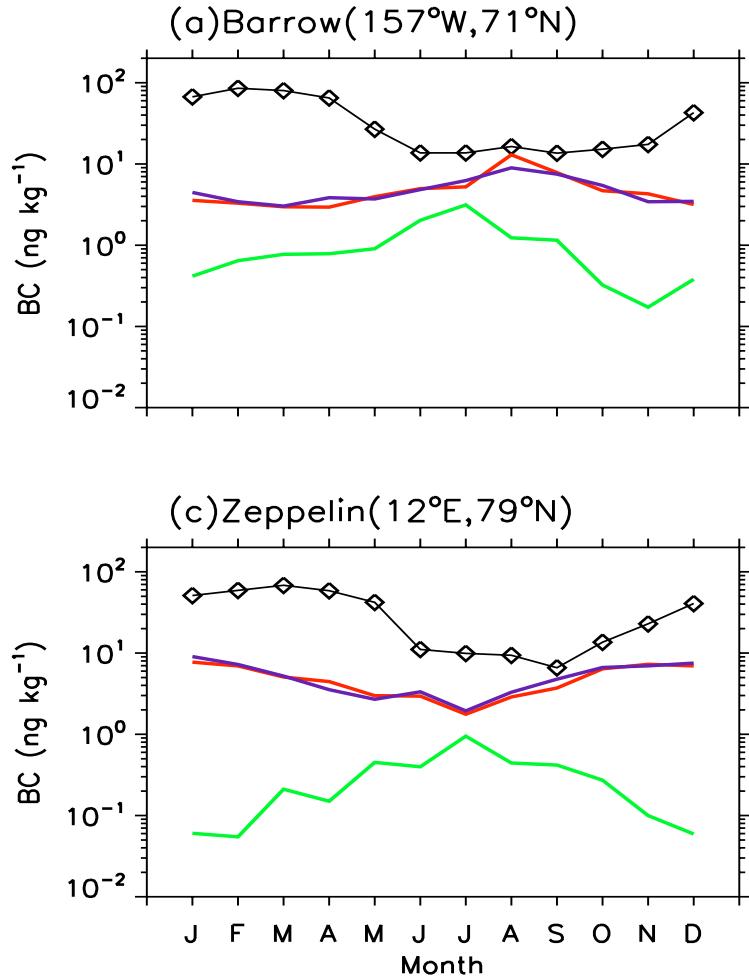


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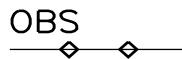
BC compared with SP2 (highlat.)



Seasonal BC at surface (highlat.)



OBS



MAM3



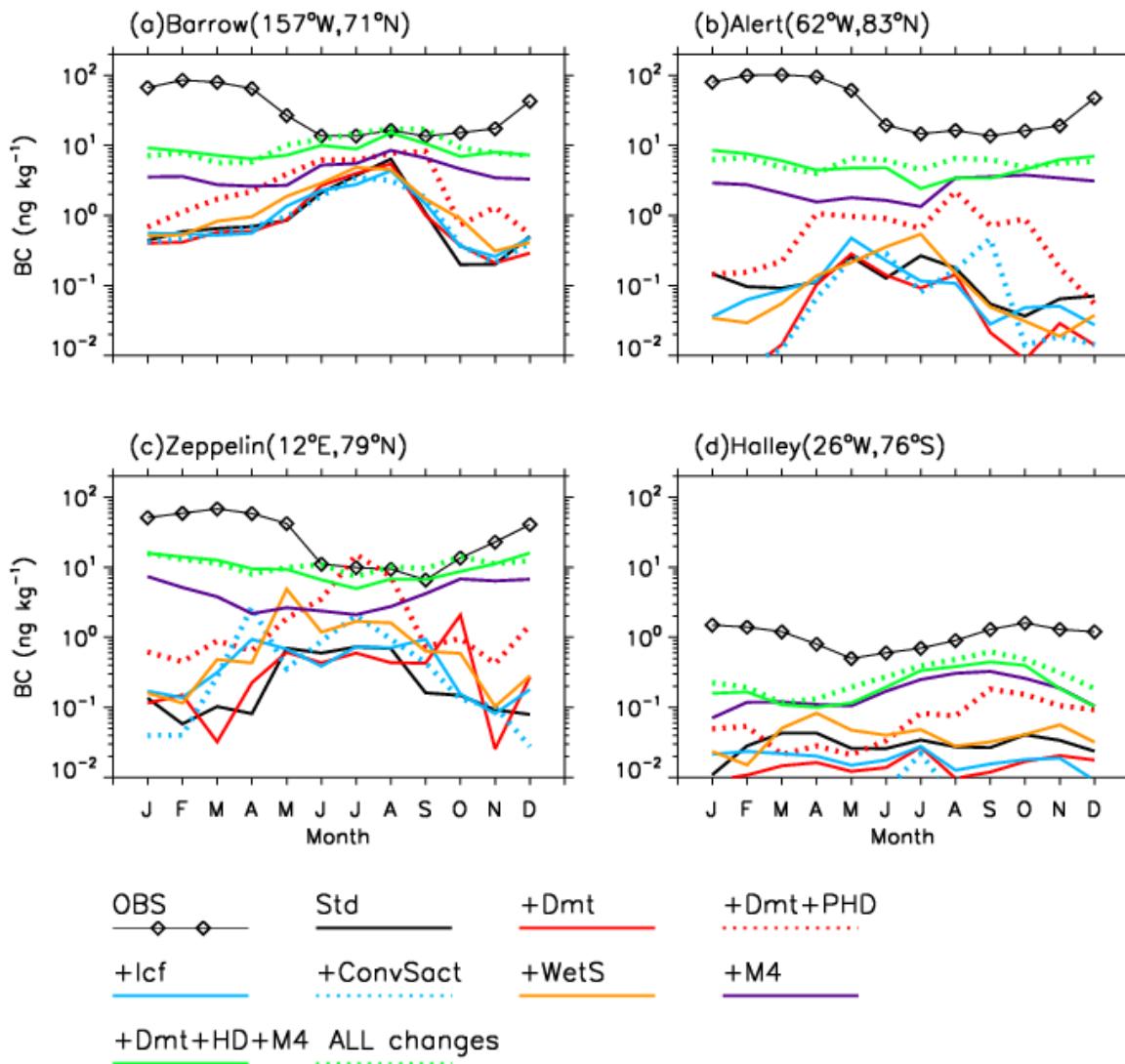
MAM4



MAM7



Arctic BC:



► As we found in the Berkeley mtg, MAM4 is the critical thing.

Code Changes

- Add configuration option “**trop_mam4**”
- Merge the code changes to CAM5.2



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Summary

- ▶ MAM4 reproduces BC and POM simulations from MAM7 with an increase in computer time by ~10%
- ▶ MAM4 (and MAM7) significantly increase (and improve) BC concentration in Arctic compared to MAM3
- ▶ The remaining underestimation of BC concentration in Arctic in MAM4 is very likely due to wet scavenging by precipitation and/or emission



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