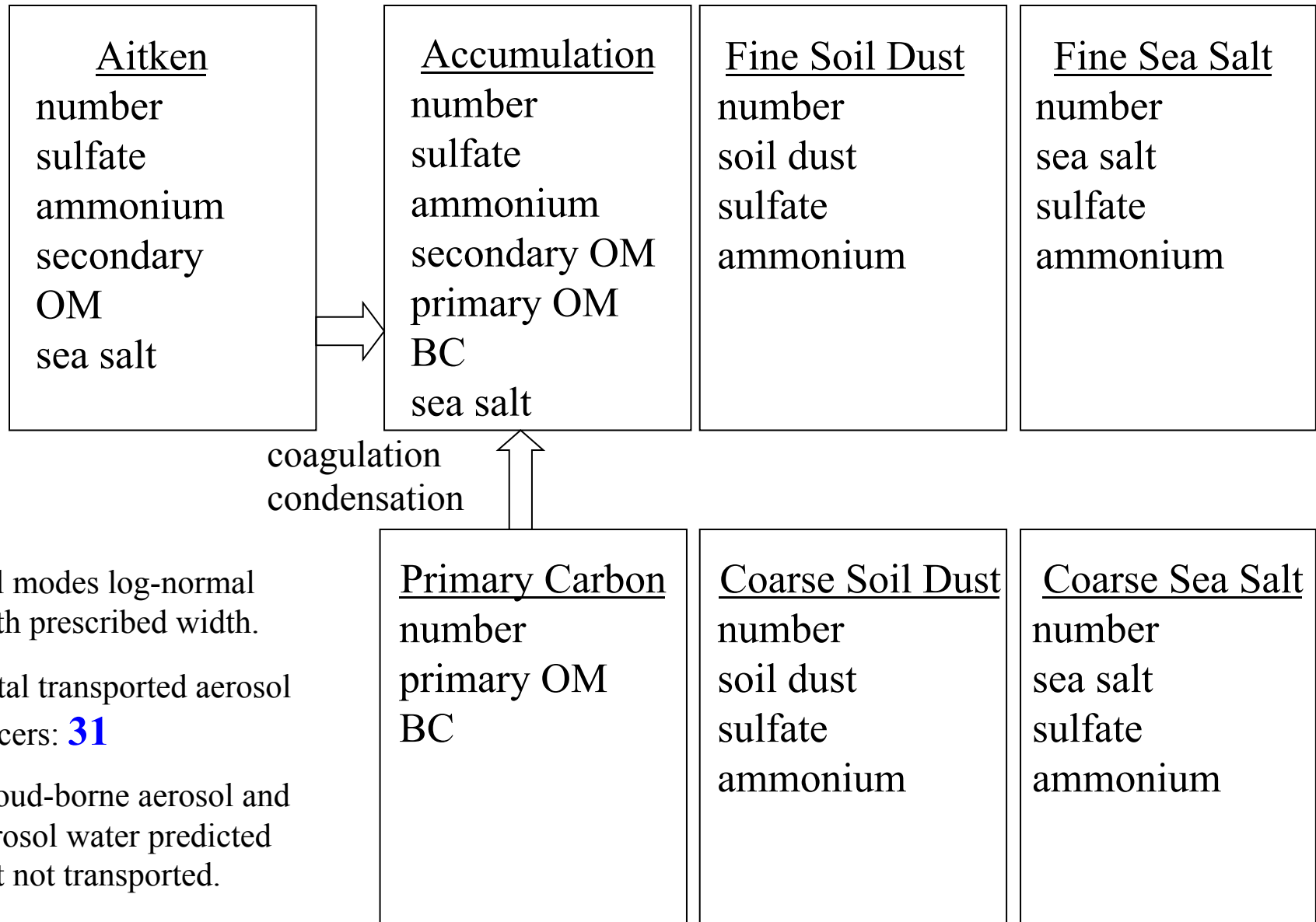


Development of a 4-Mode Version of Modal Aerosol Module for CAM5

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

With support from DOE Polar Project

Benchmark 7-Mode Modal Aerosol Model (MAM)



All modes log-normal with prescribed width.

Total transported aerosol tracers: **31**

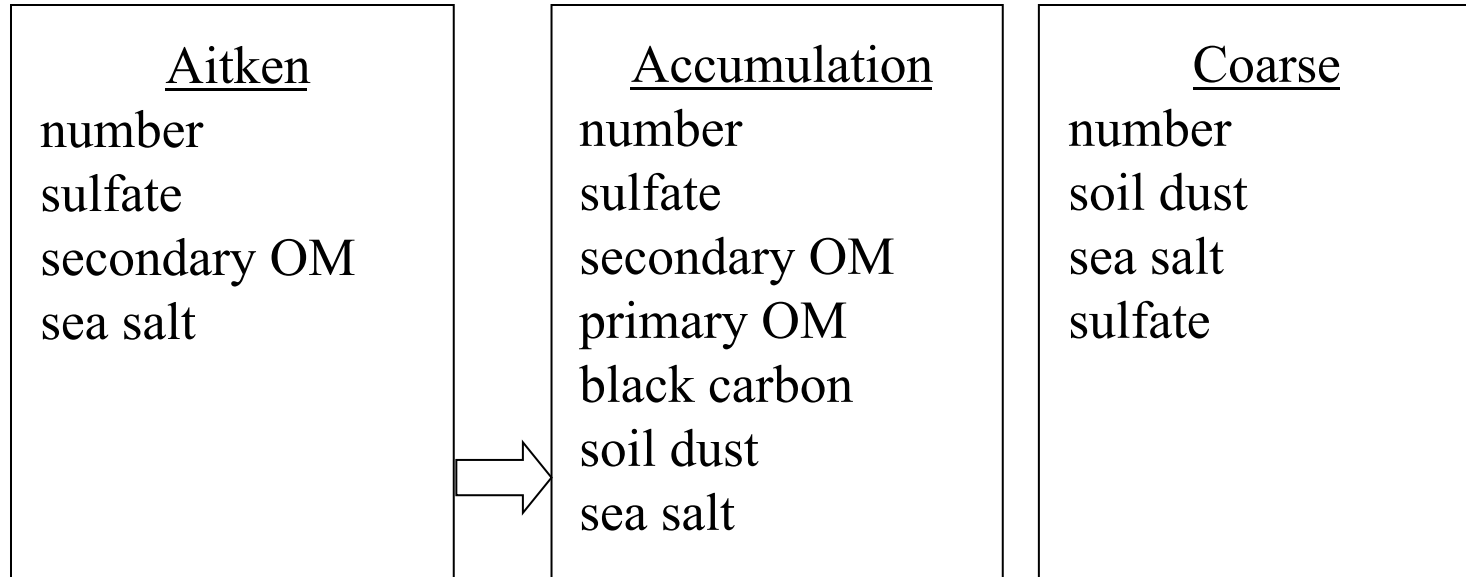
Cloud-borne aerosol and aerosol water predicted but not transported.

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.



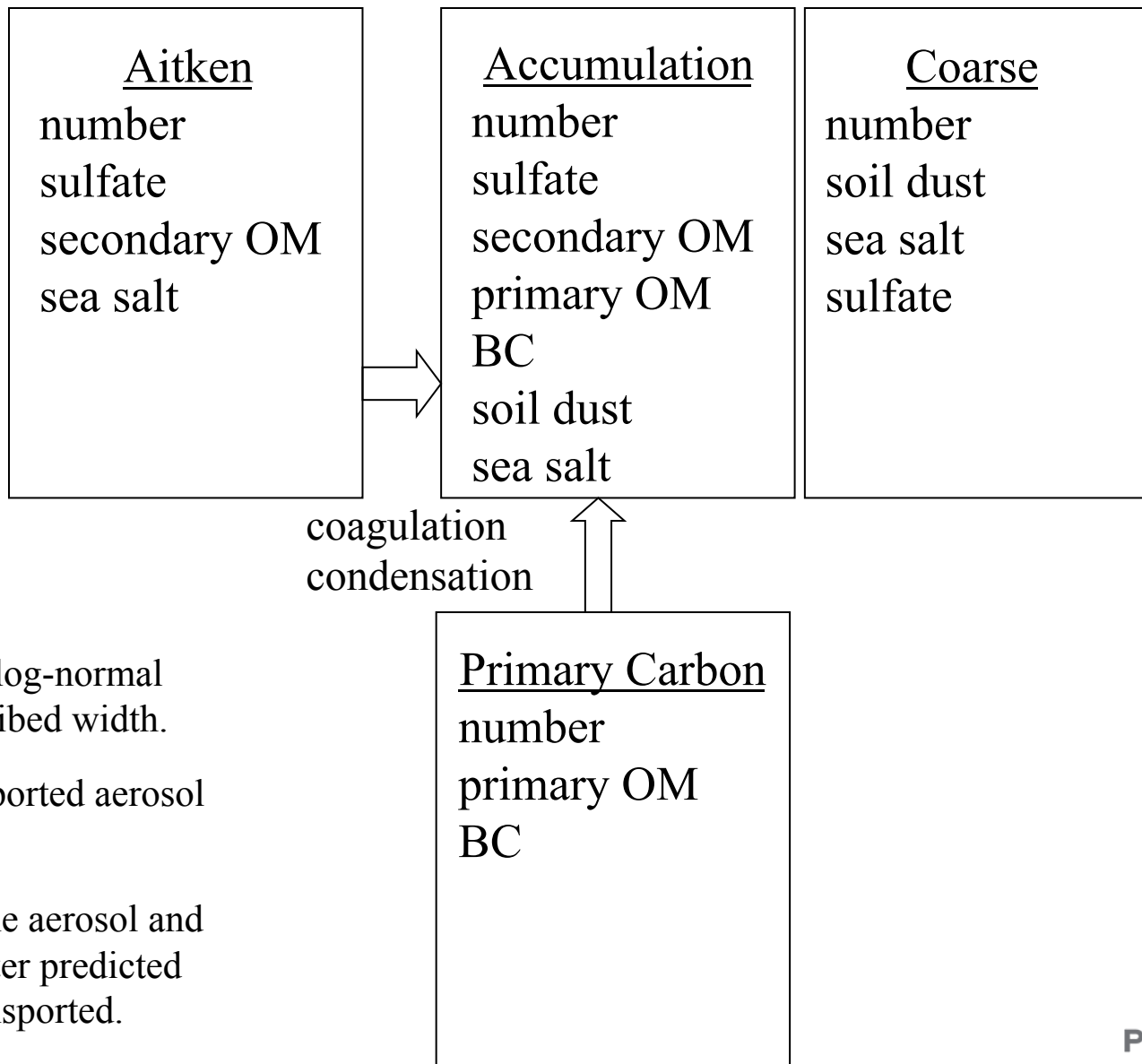
Total transported aerosol
tracers: **15**

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

4-Mode version of MAM



All modes log-normal
with prescribed width.

Total transported aerosol
tracers: **18**

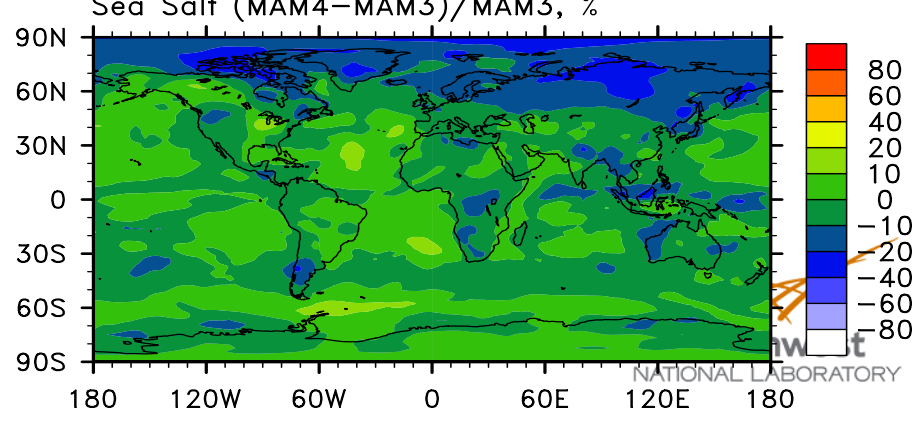
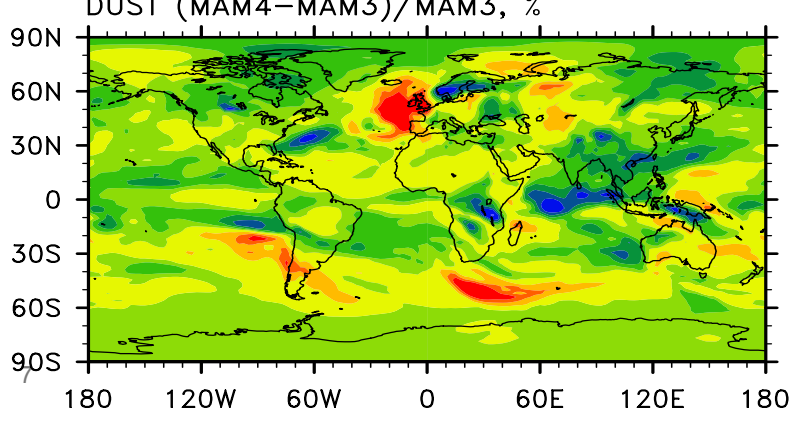
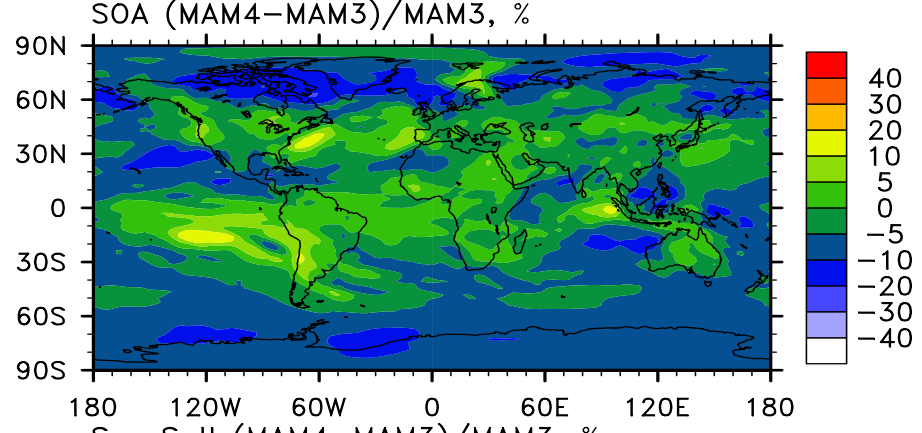
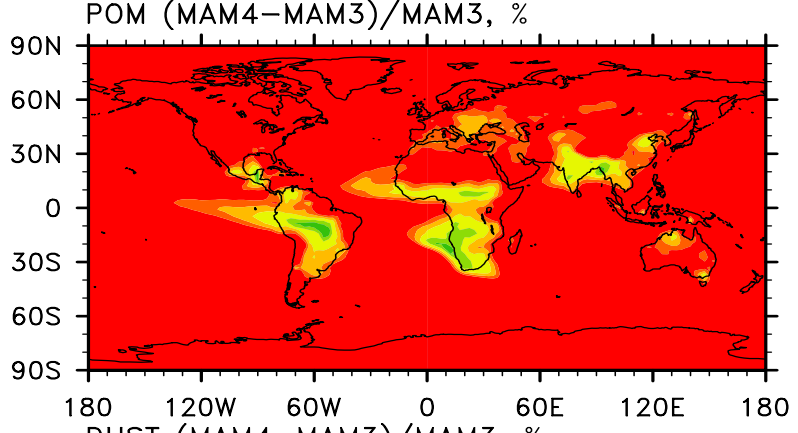
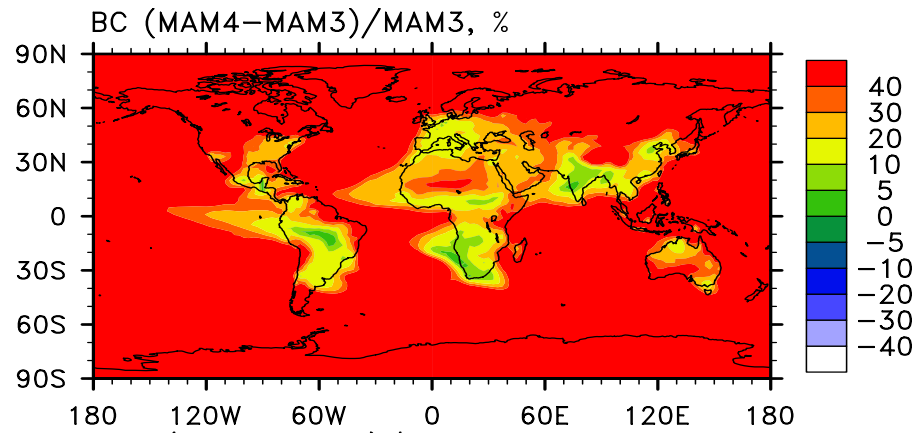
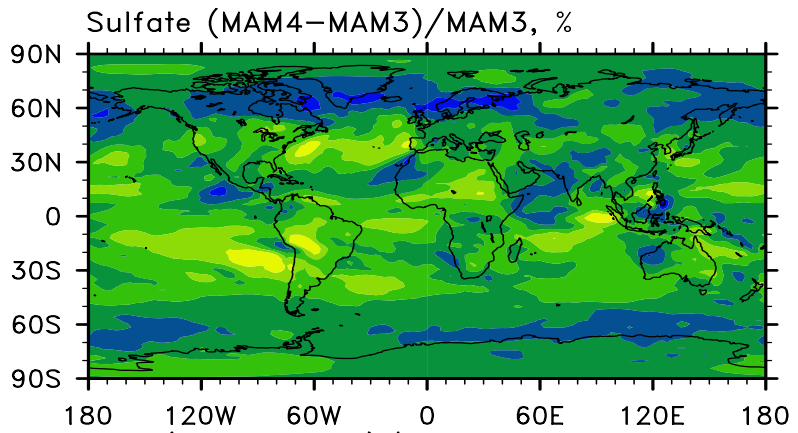
Cloud-borne aerosol and
aerosol water predicted
but not transported.

Computer time is ~10% higher than MAM3

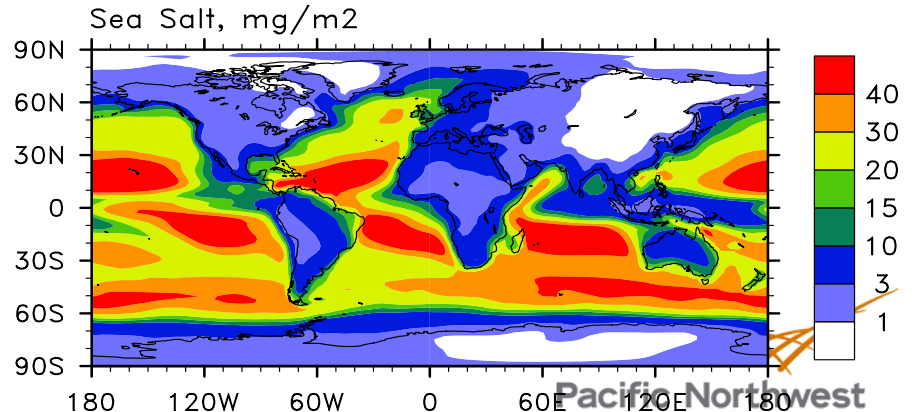
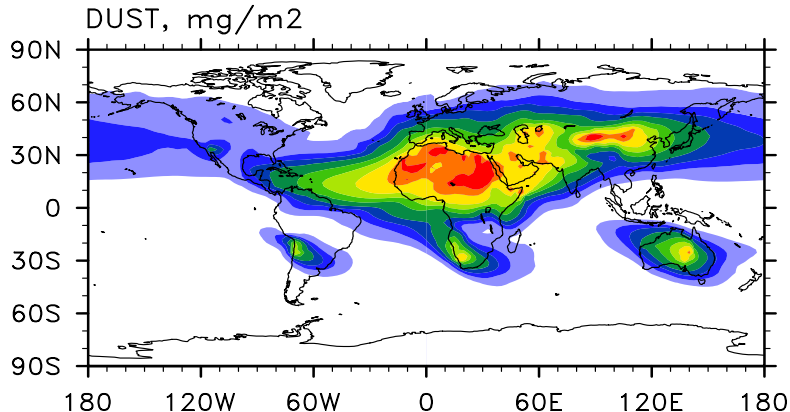
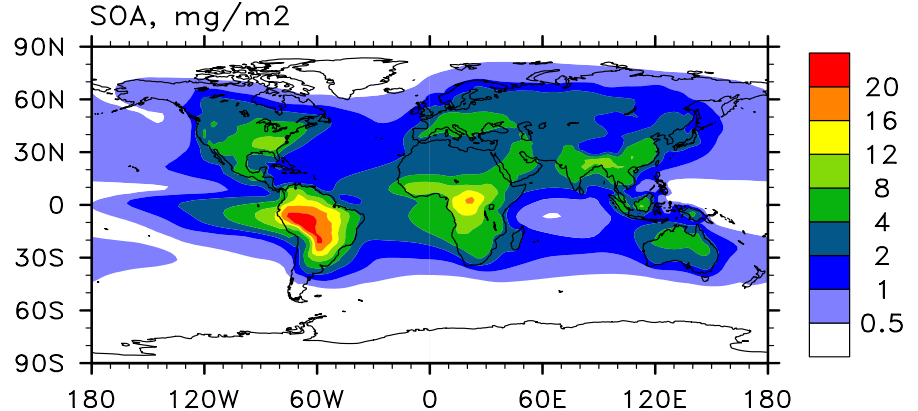
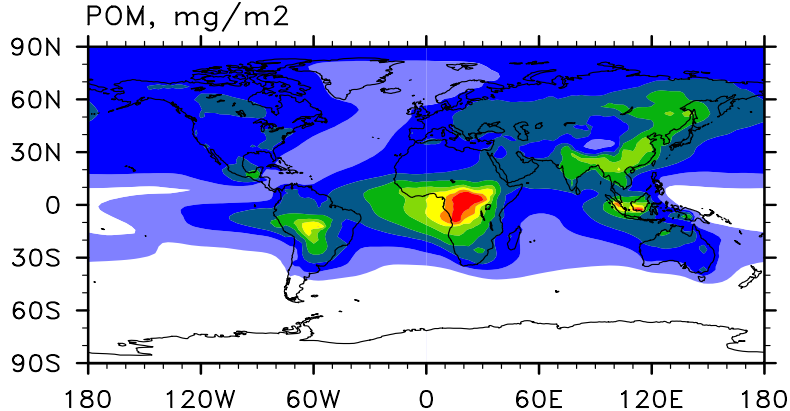
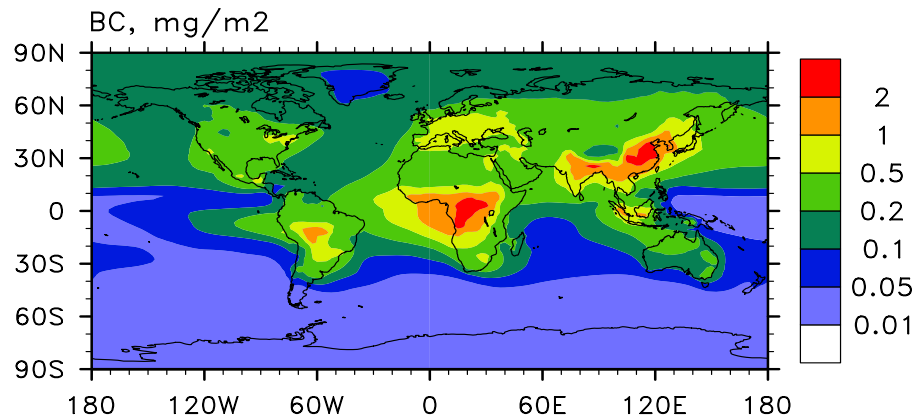
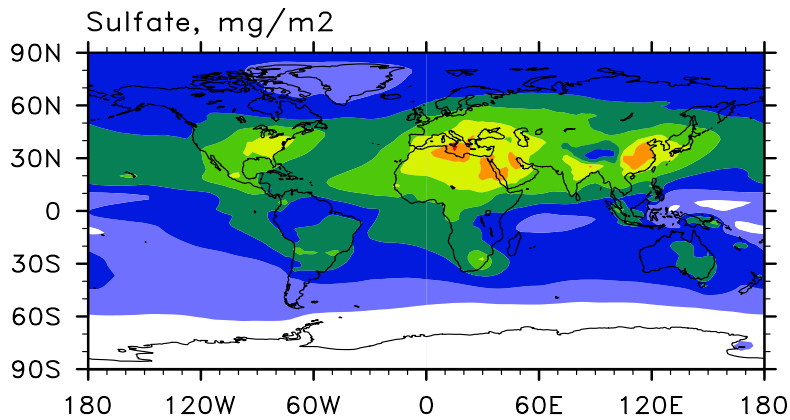
CAM5 Simulations (CAM5.1)

- 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)

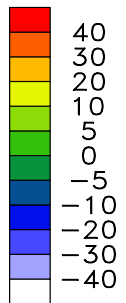
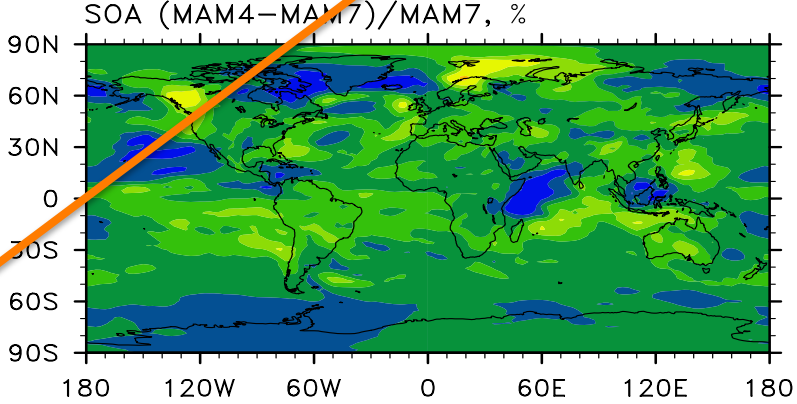
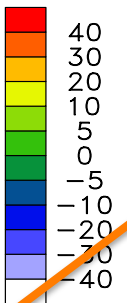
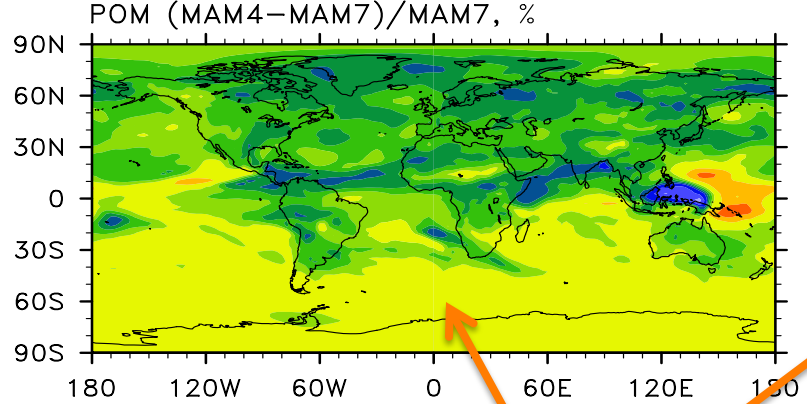
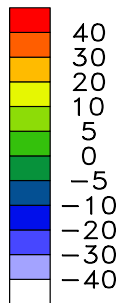
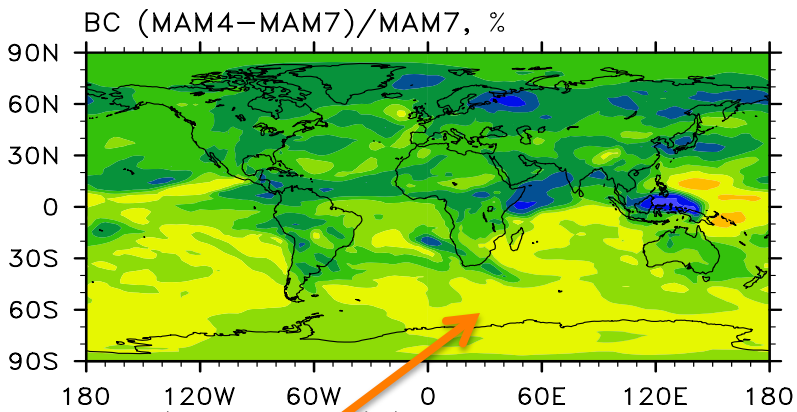
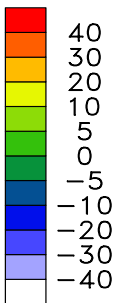
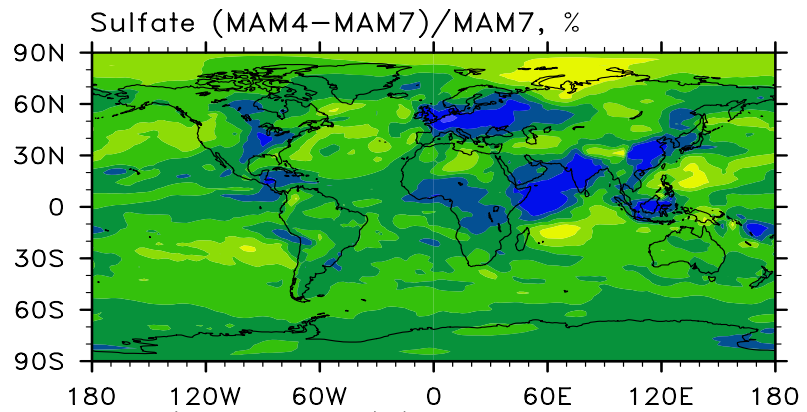
Aerosol mass burden %diff. (MAM4-MAM3)/MAM3



Aerosol mass burden MAM4

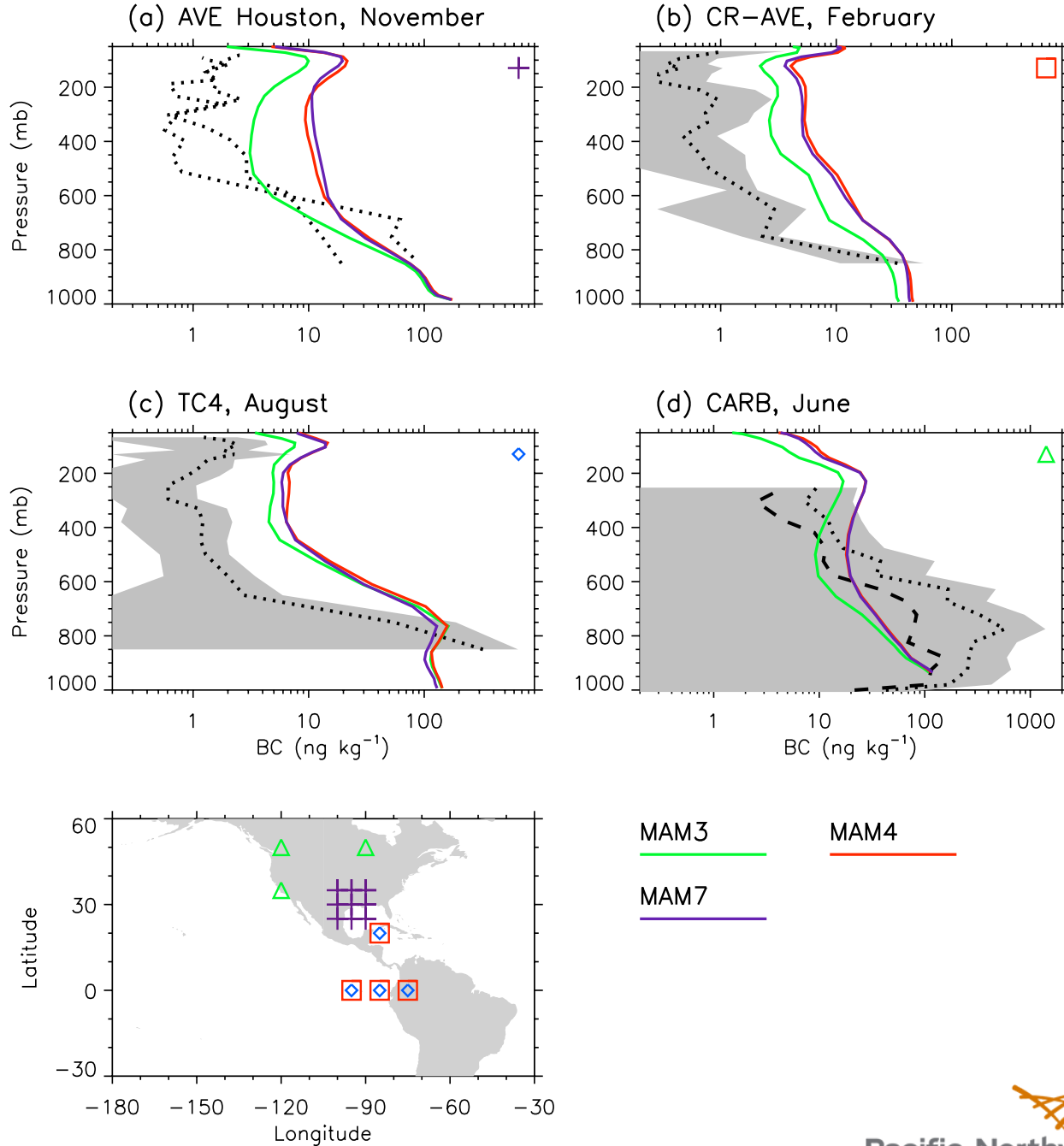


Aerosol mass burden %diff. (MAM4-MAM7)/MAM7

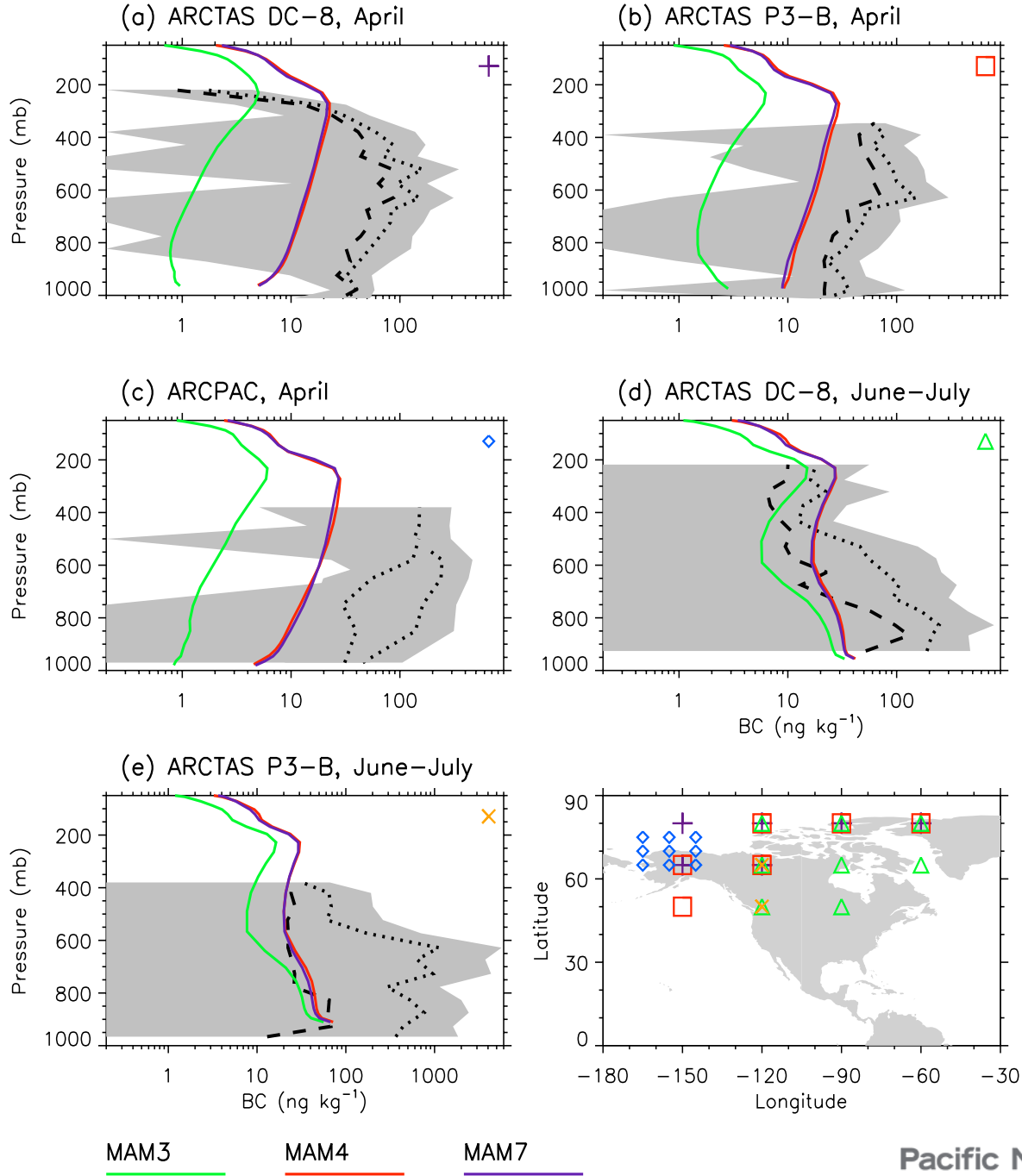


10-20% higher than MAM7, but concentrations there are very low

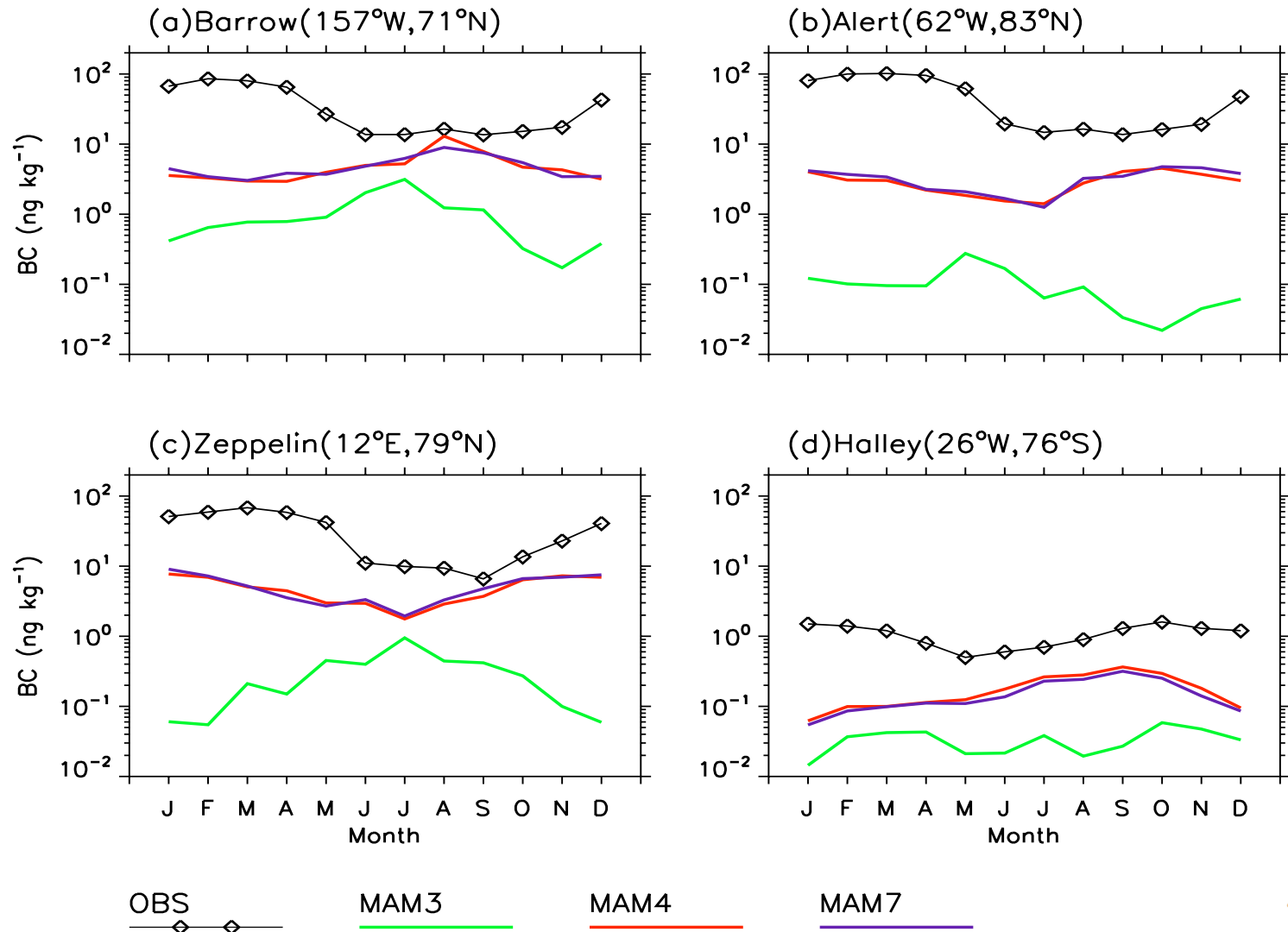
BC compared with SP2 (tropics and midlat.)



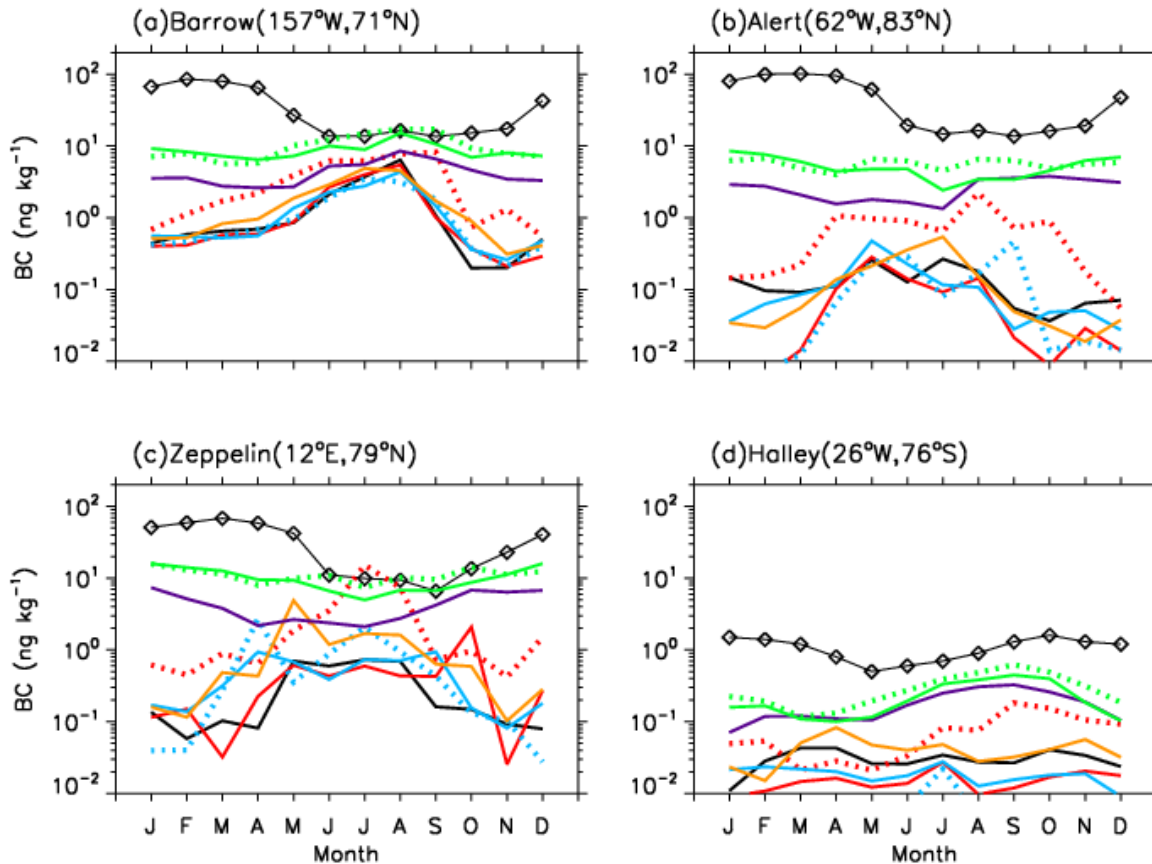
BC compared with SP2 (highlat.)



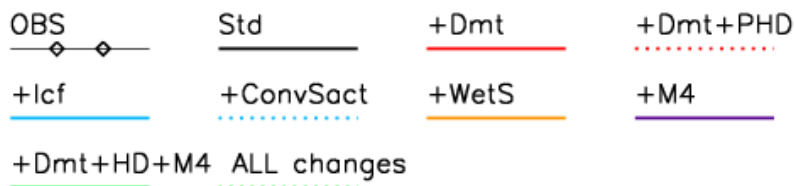
Seasonal BC at surface (highlat.)



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

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