Modal Aerosol Module in CAM: Evaluation

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Scientific Discovery through Advanced Computing
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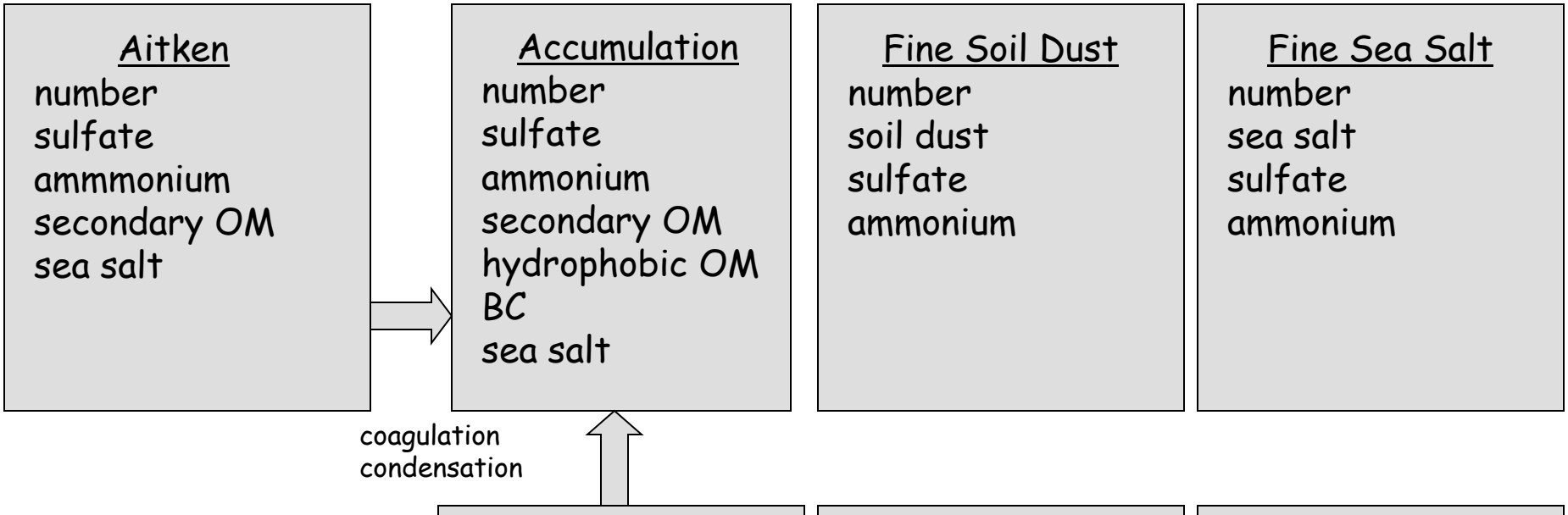
Benchmark 7-Mode Modal Aerosol Model (MAM)



All modes log-normal with prescribed width.

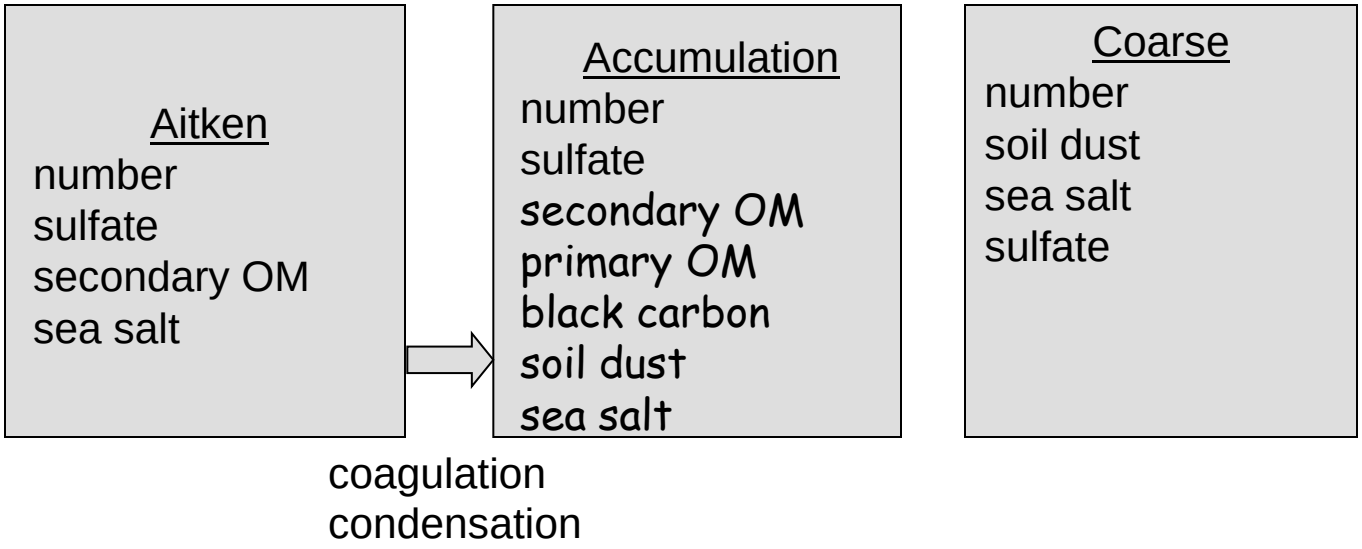
Total transported aerosol tracers: 31

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

Computer time is ~100% higher than BAM

Simplified 3-mode version of MAM

Assume primary carbon is internally mixed with secondary aerosol.
Sources of dust and seasalt are geographically separate
Assume ammonium neutralizes sulfate.



Total transported aerosol tracers: 15

Computer time is 30% higher than BAM

New Processes

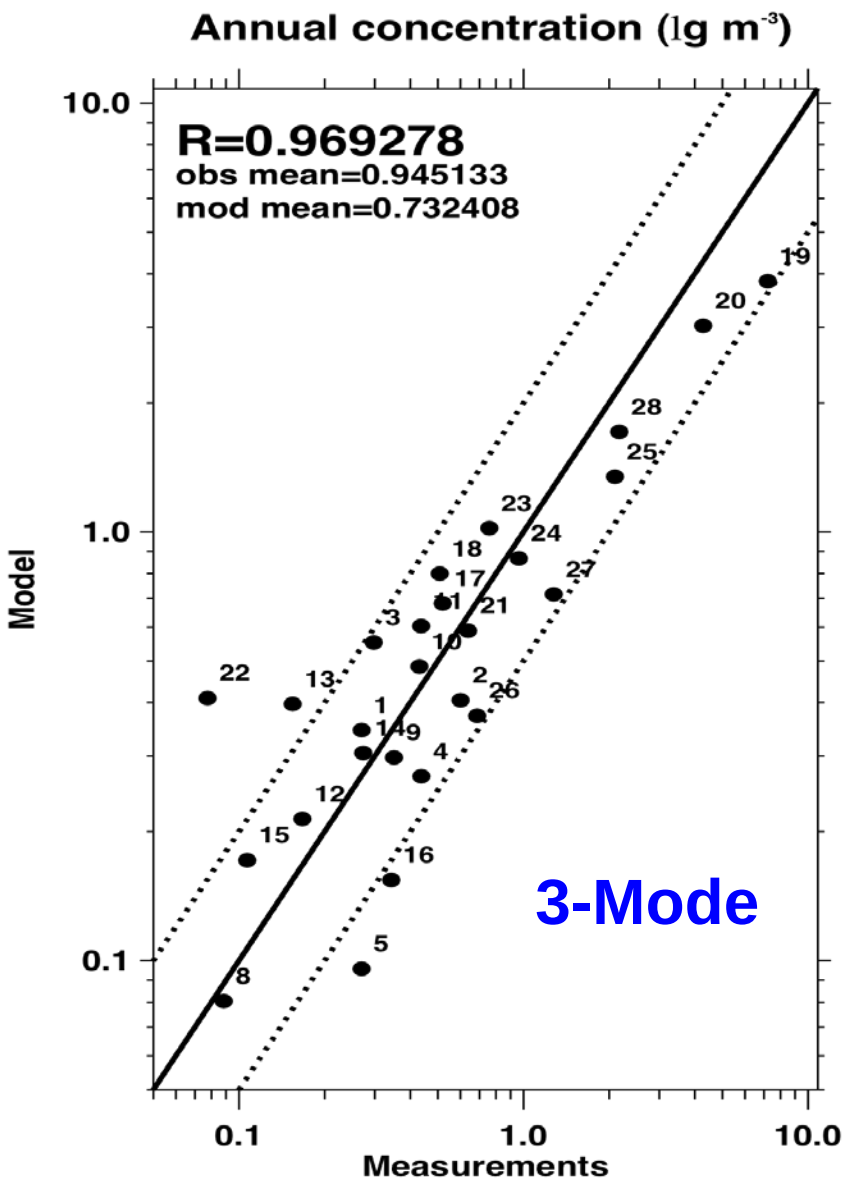
- New particle formation (in UT and BL)
- Coagulation within, between modes
- Dynamic condensation of trace gas (H2SO4, NH3) on aerosols
- Aging of primary carbon to accumulation mode based on sulfate coating from condensation & coagulation
- Ultrafine sea salt emissions from Martensson et al.
- A new secondary organic aerosol treatment: reversible condensation of SOA (gas)
- Aerosol optics from Ghan and Zaveri (JGR 2007)

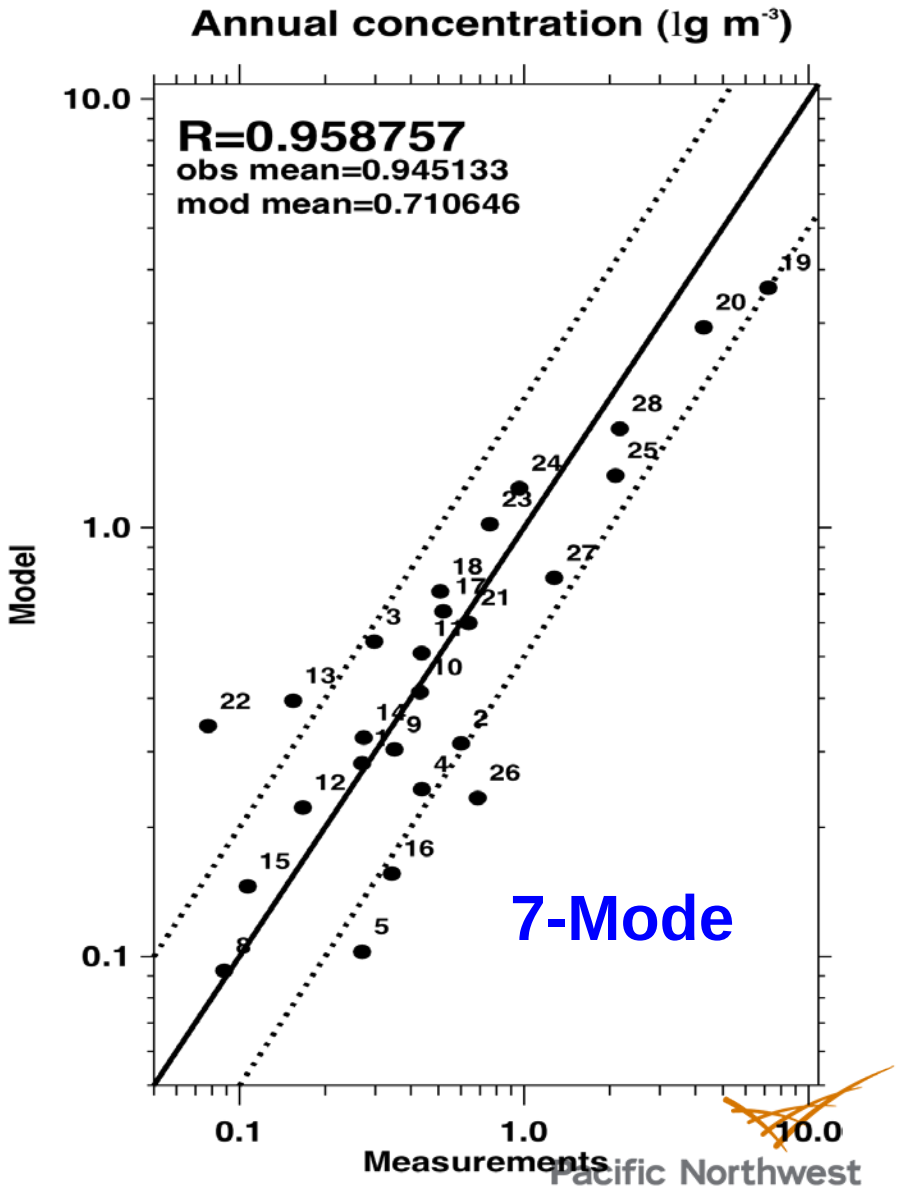
CAM Simulations (camdev55_CAM3.6.72)

- CAM Track 5 Physics
- 3-mode and 7-mode
- 5 years at 1.9° x2.5° resolution

- IPCC AR5 emissions for anthr. OM, BC, SO2, SO4 (Lamarque)
- AEROCOM emissions for natural DMS, SO2, SO4, injection heights and primary particle sizes
- Biogenic SOA(g) emission: apply yields on MOZART VOCs emissions

SO_4 compared with RSMAS data





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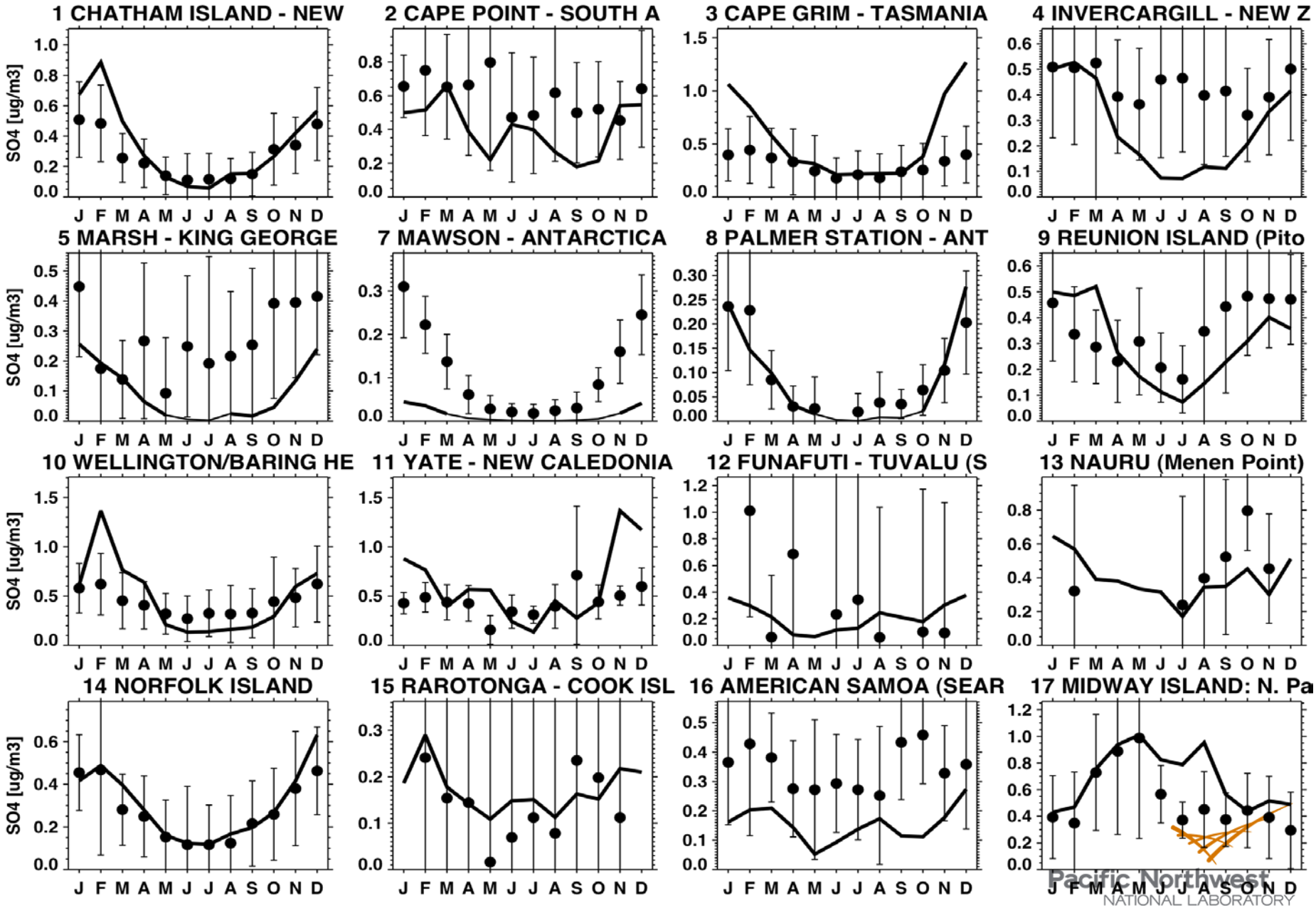
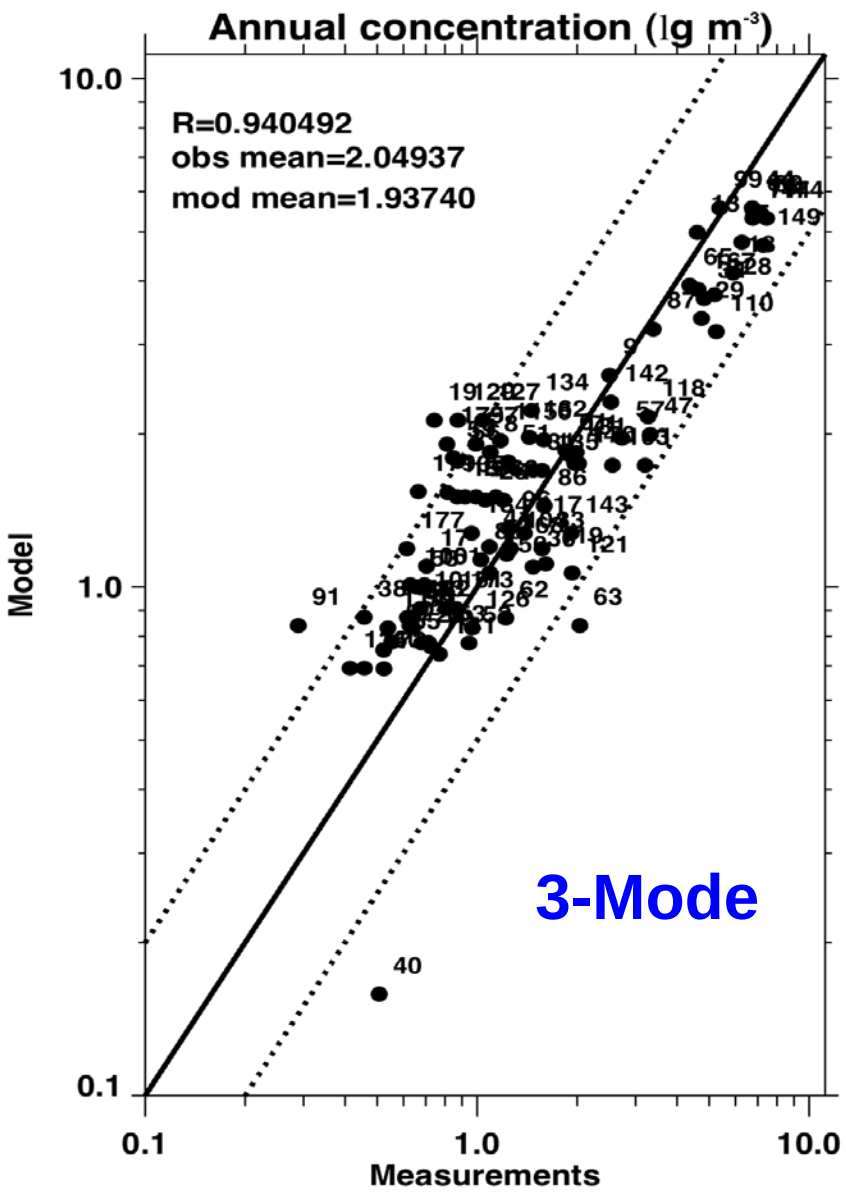
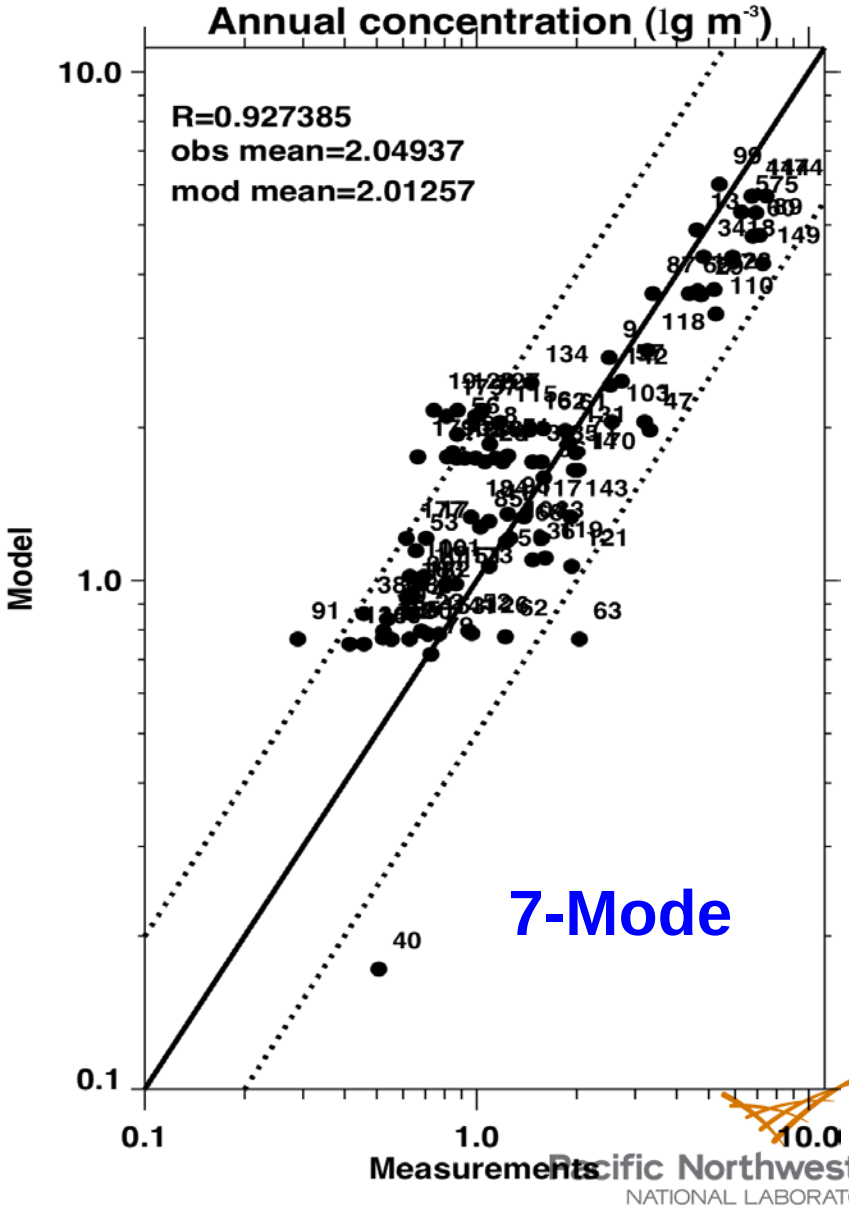
MAM3 - Compared with RSMAS SO4 Data

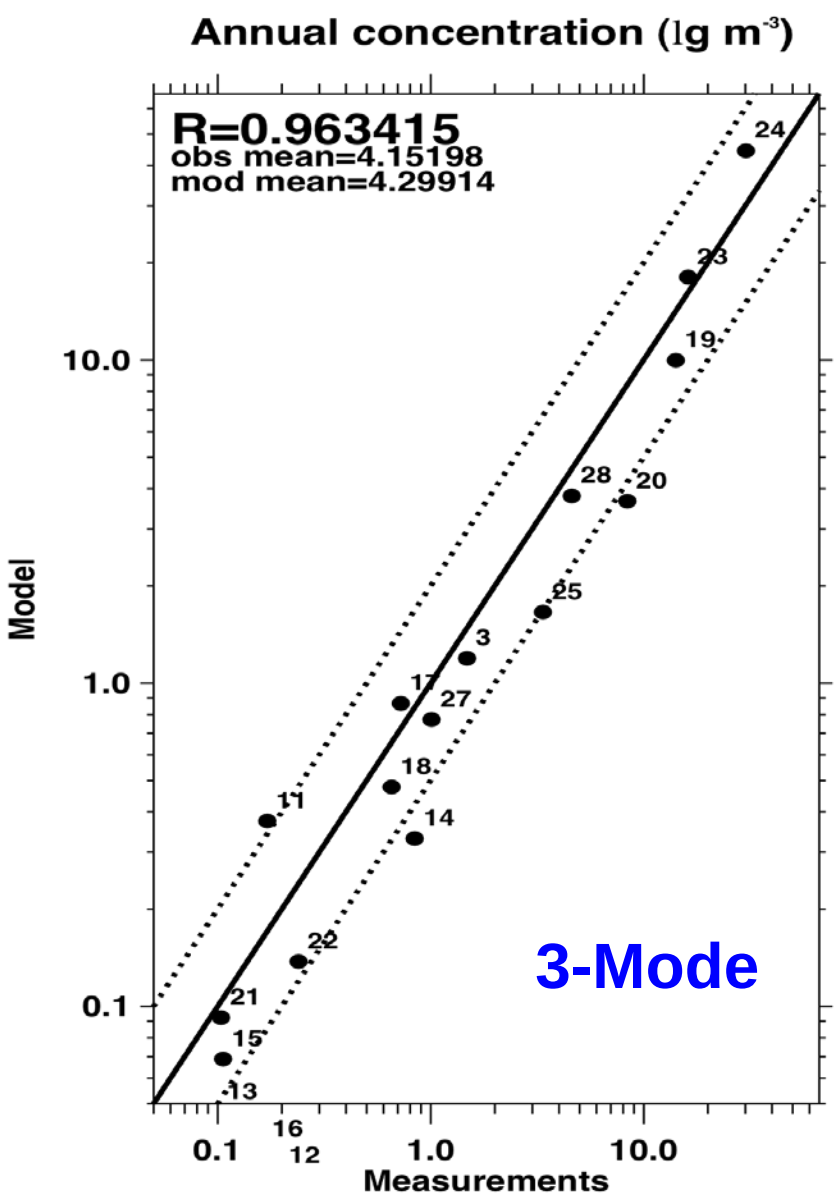


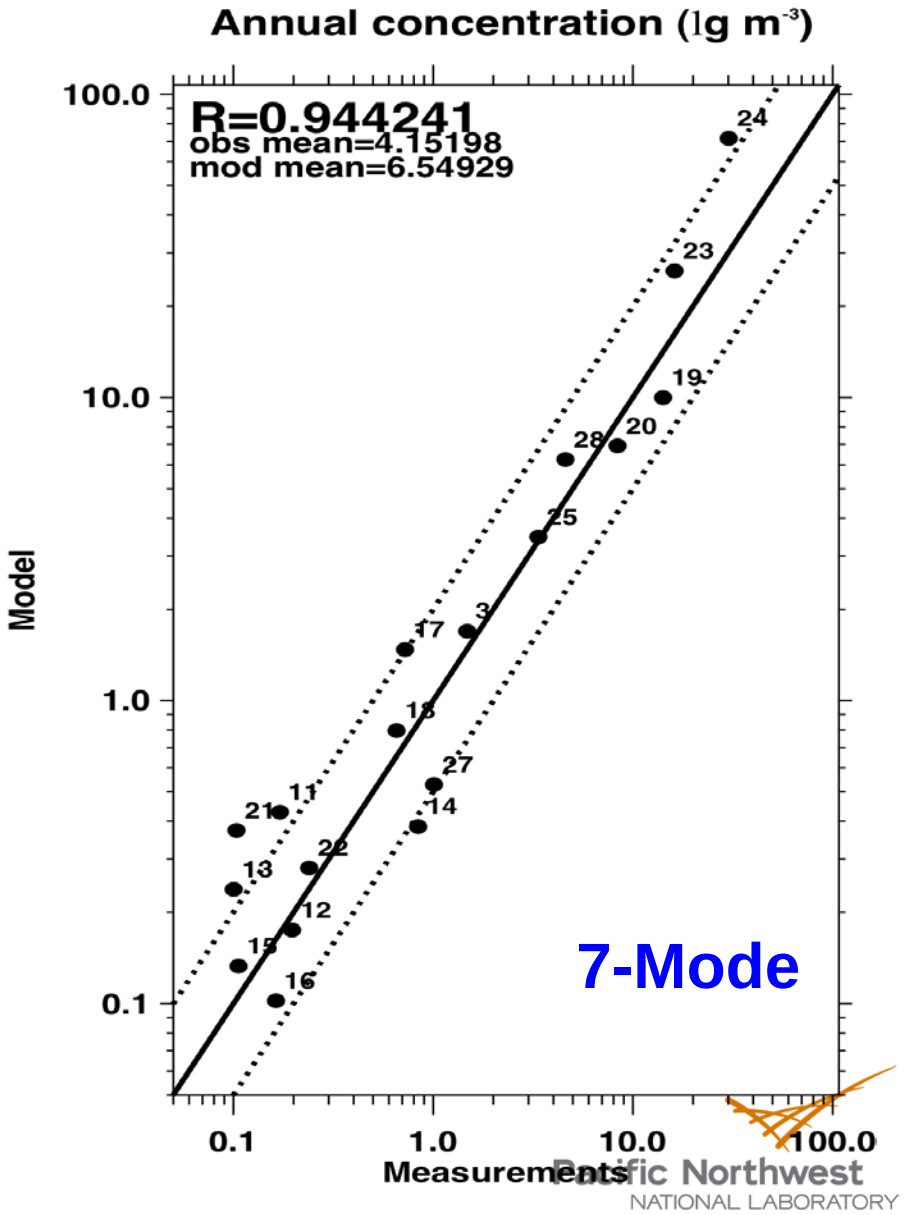
SO_4 compared with IMPROVE data



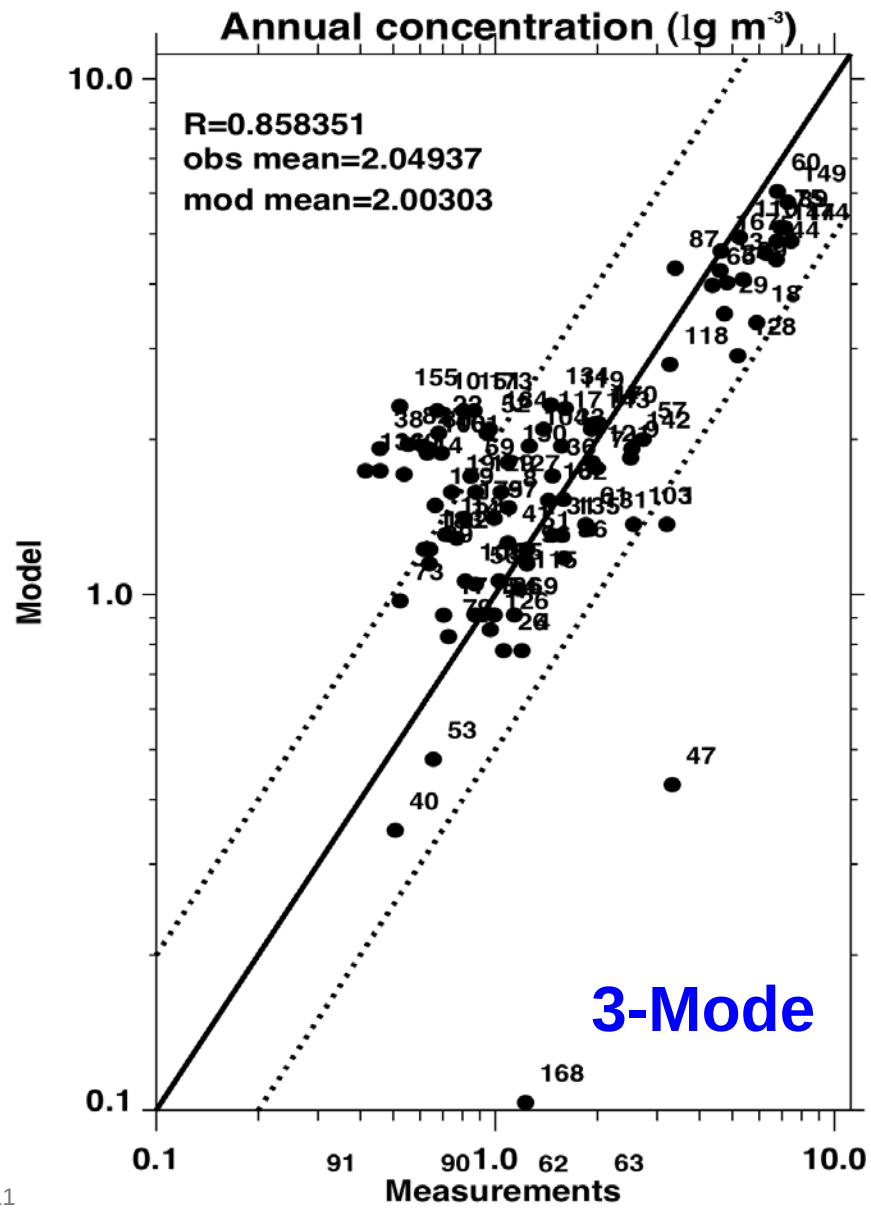


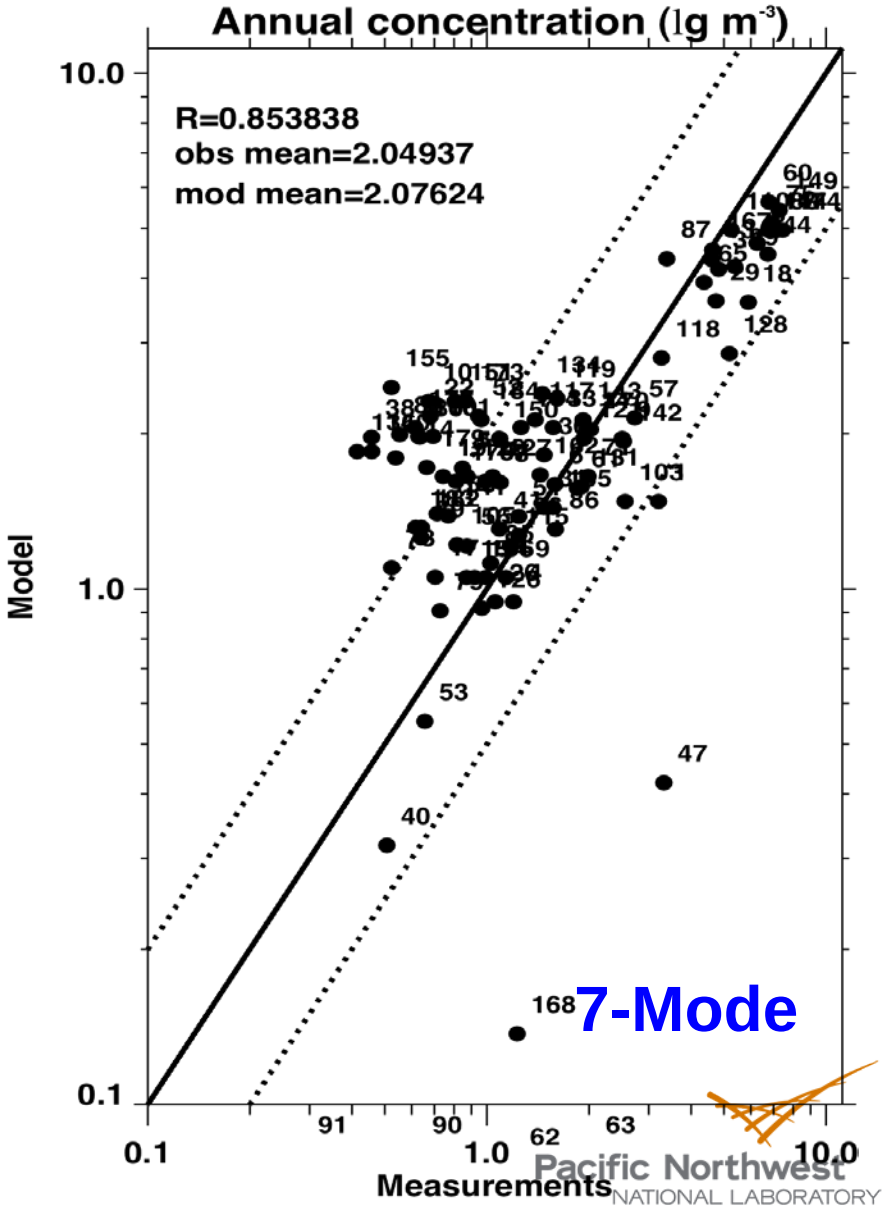
Dust compared with RSMAS data





OC compared with IMPROVE data





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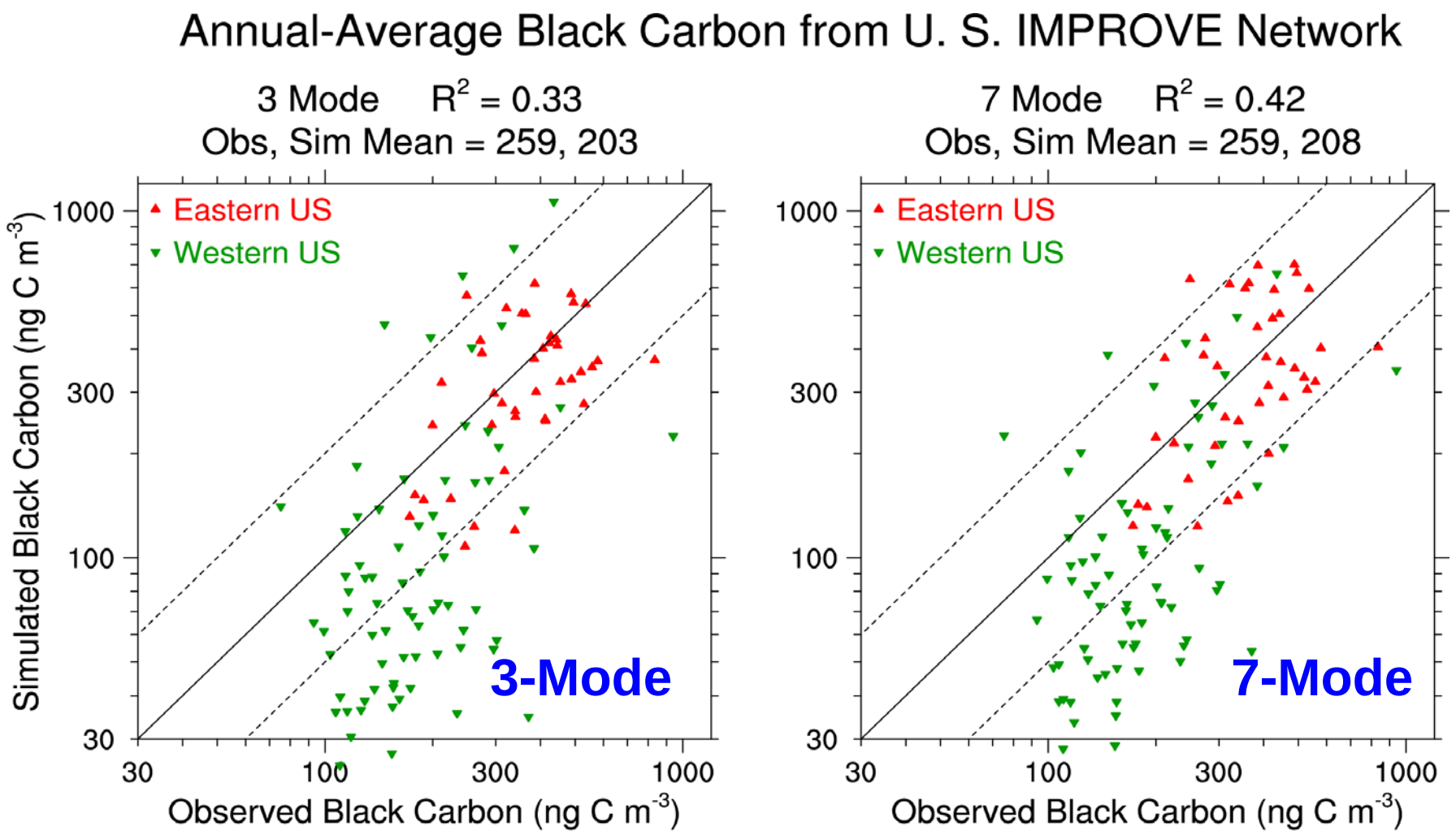
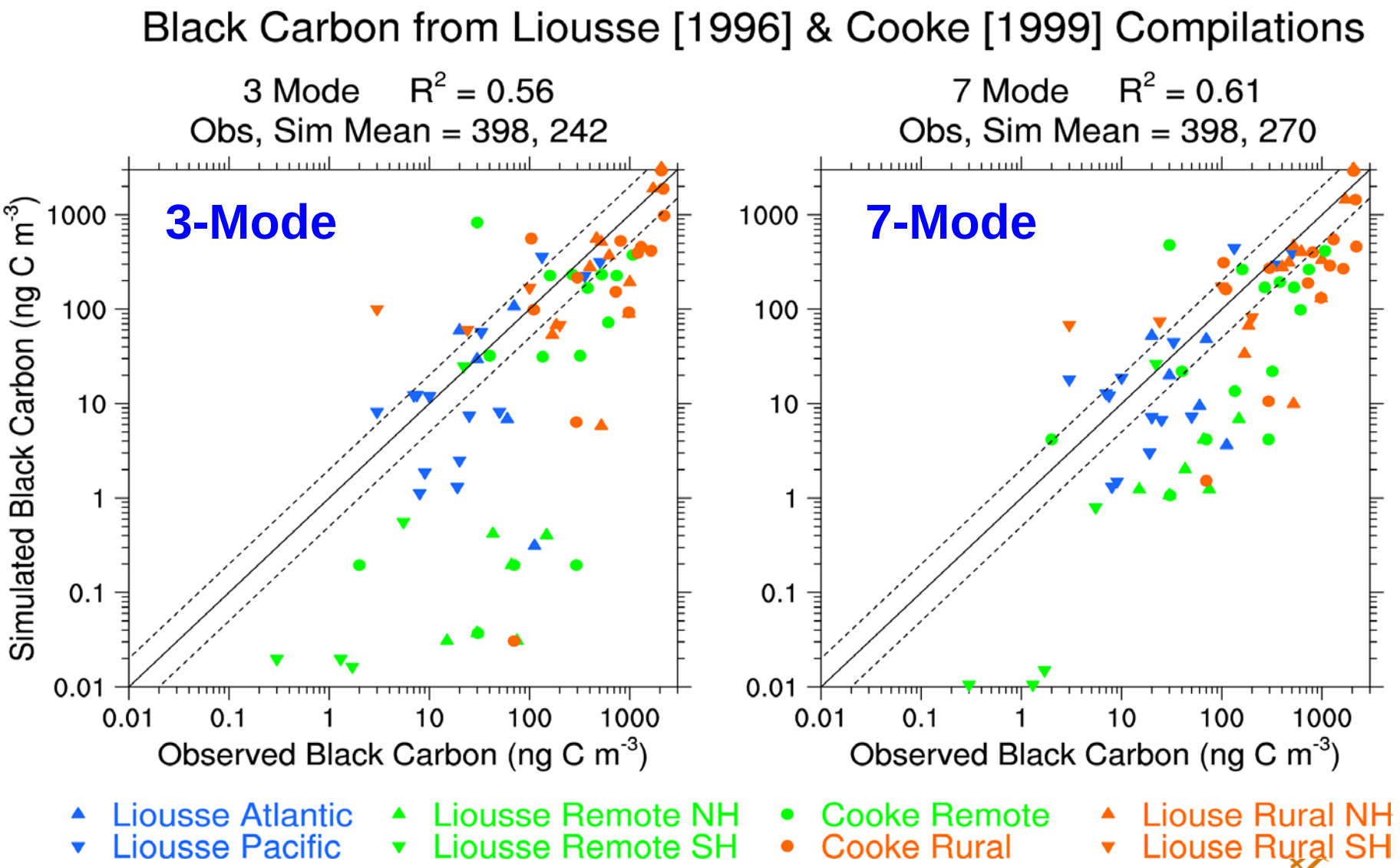
BC compared with IMPROVE data



BC compared with global data



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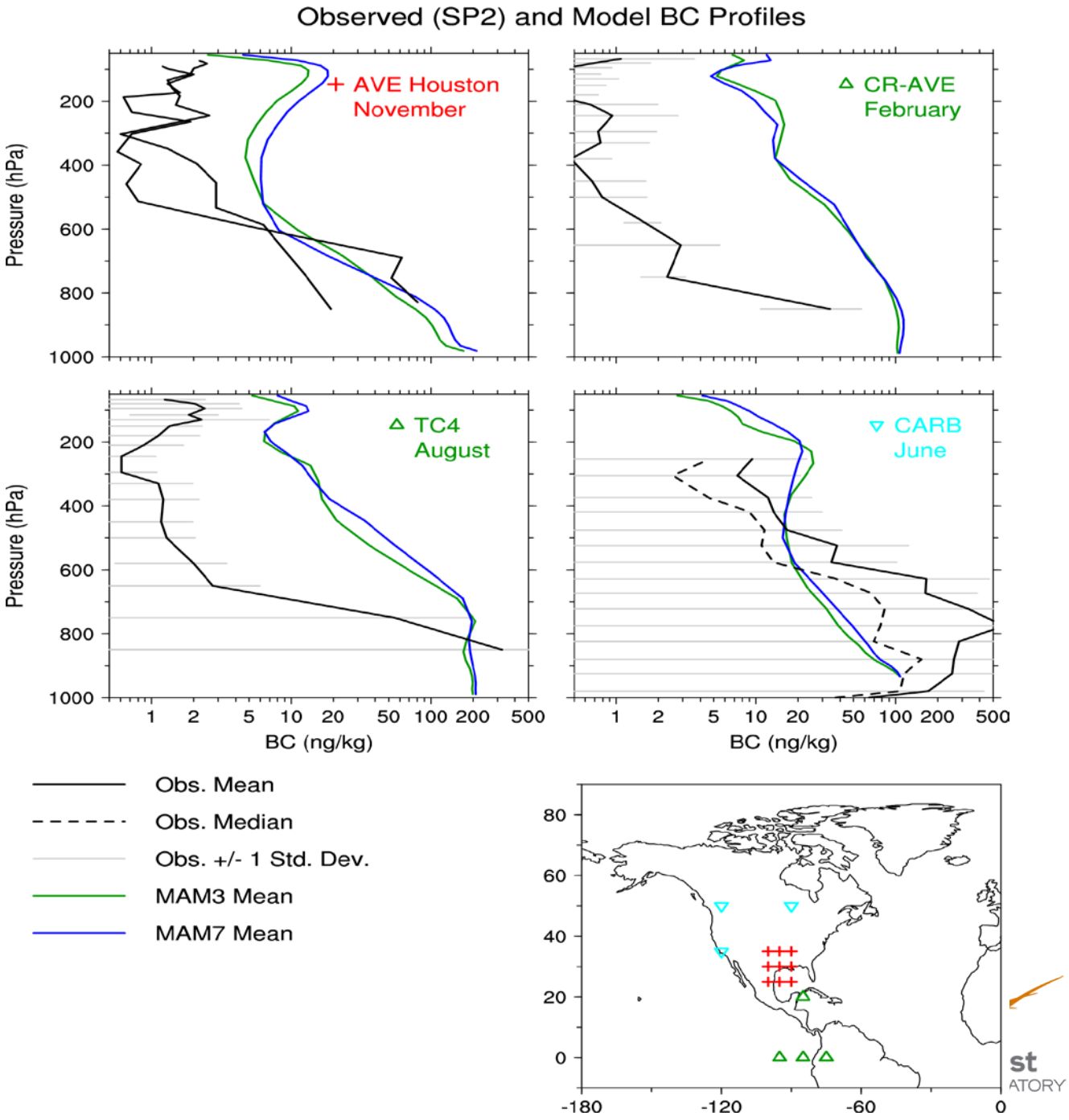
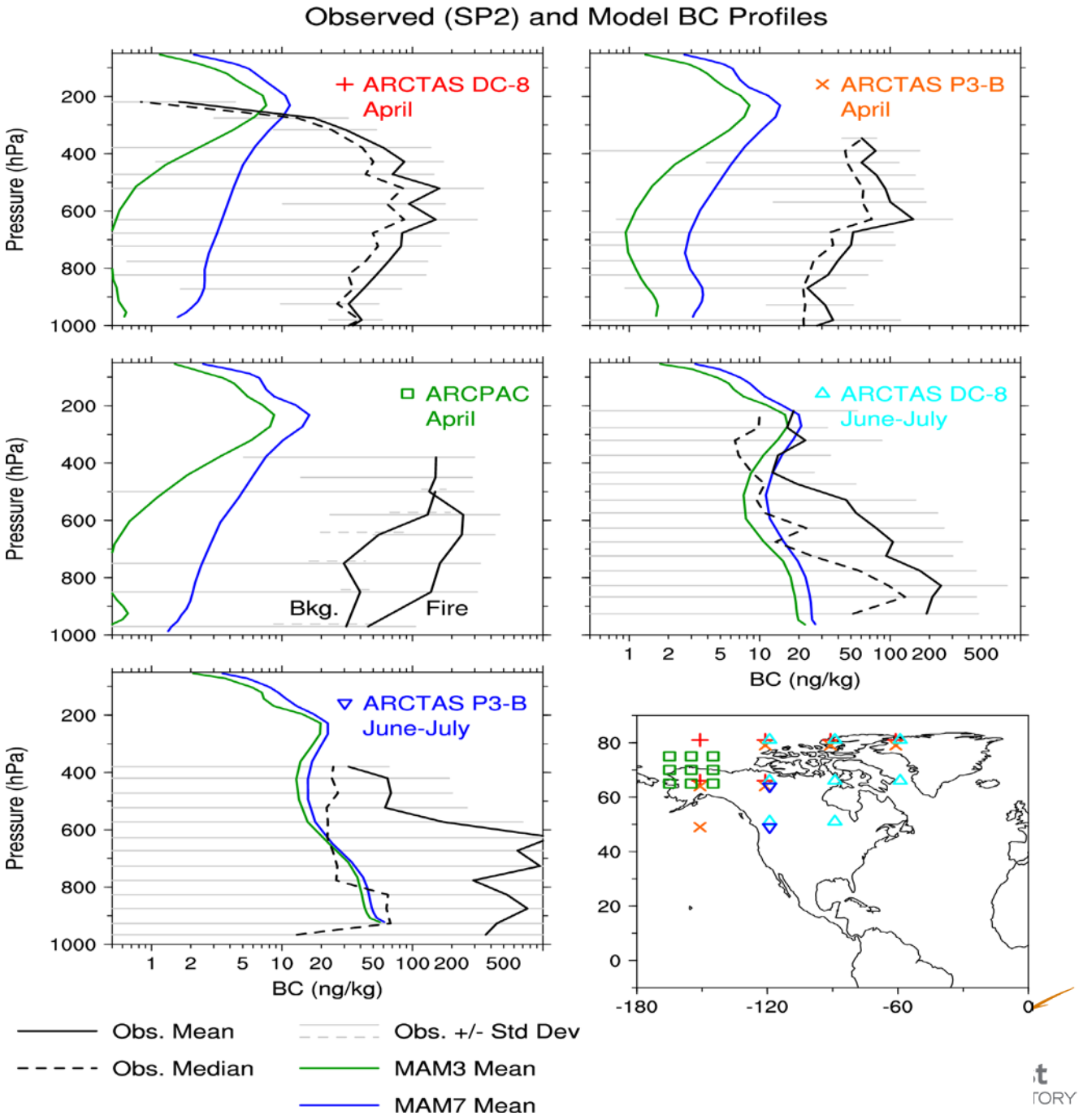
BC compared with SP2 (tropics and midlat.)

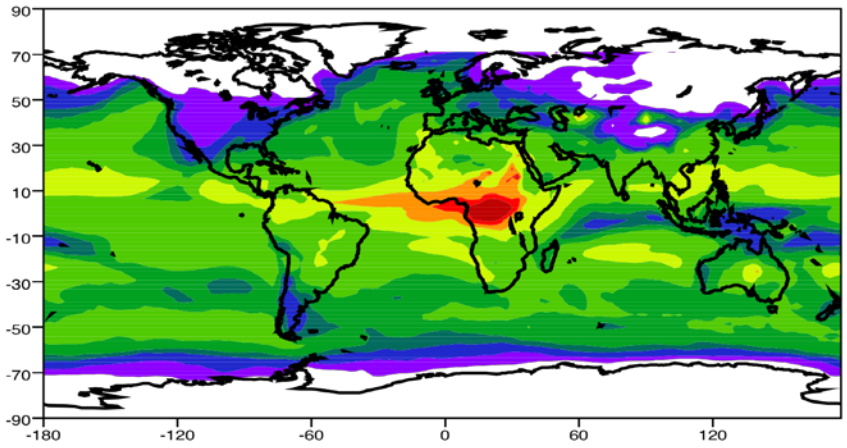


BC compared with SP2 (highlat.)

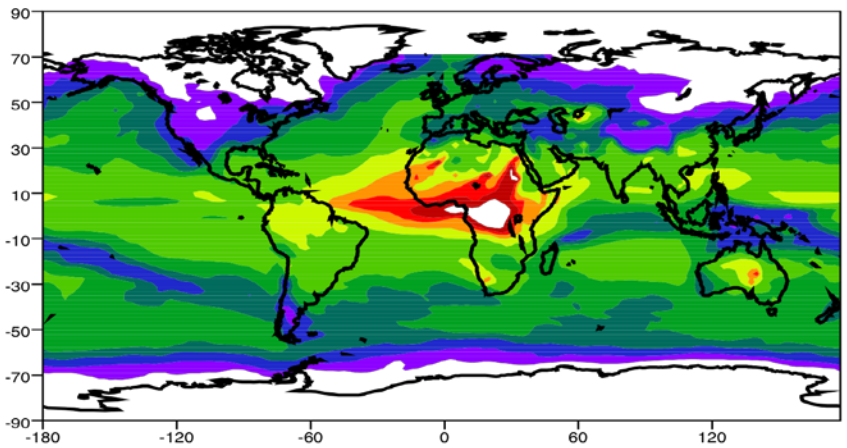


Aerosol Optical Depth - January

MAM3 AOD=0.12



MAM7 AOD=0.12



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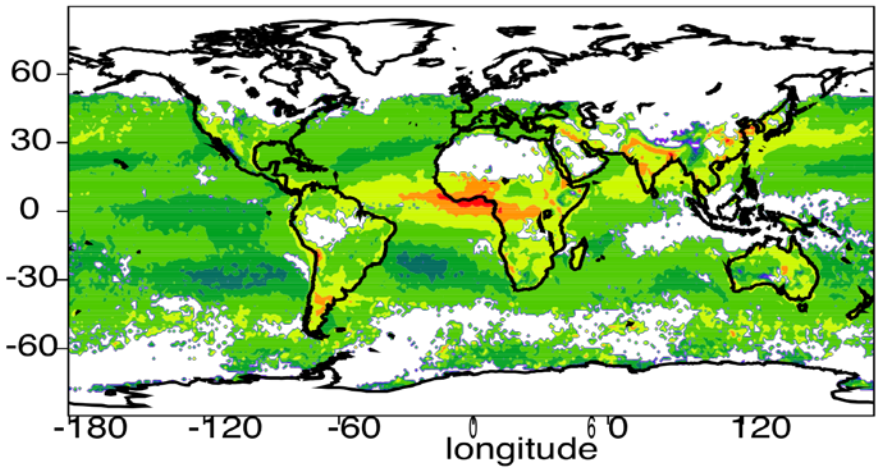

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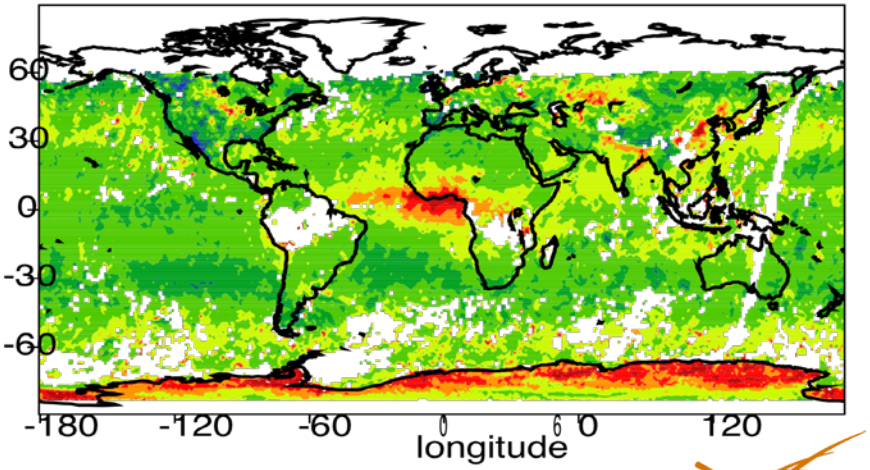

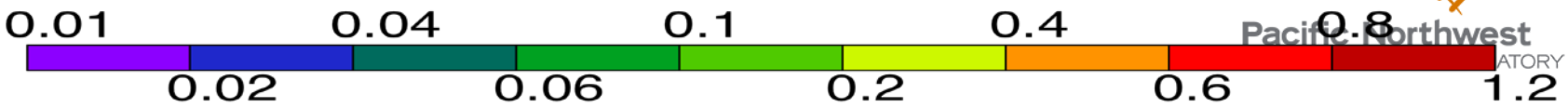

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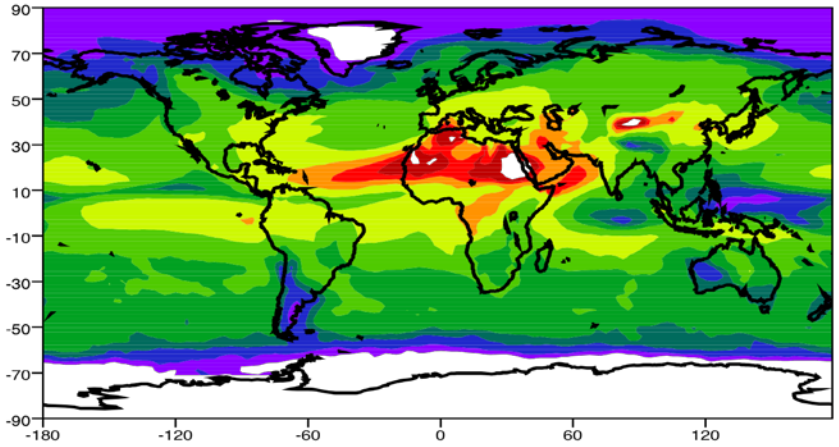
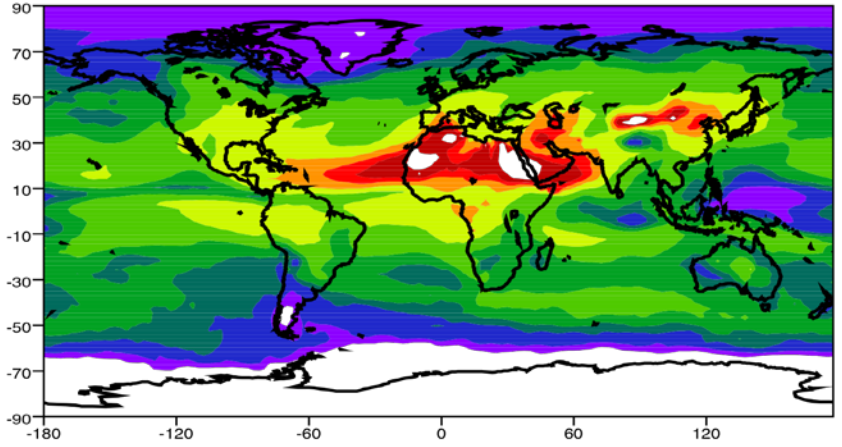
Aerosol Optical Depth - July

MAM3 AOD=0.16



MAM7 AOD=0.16



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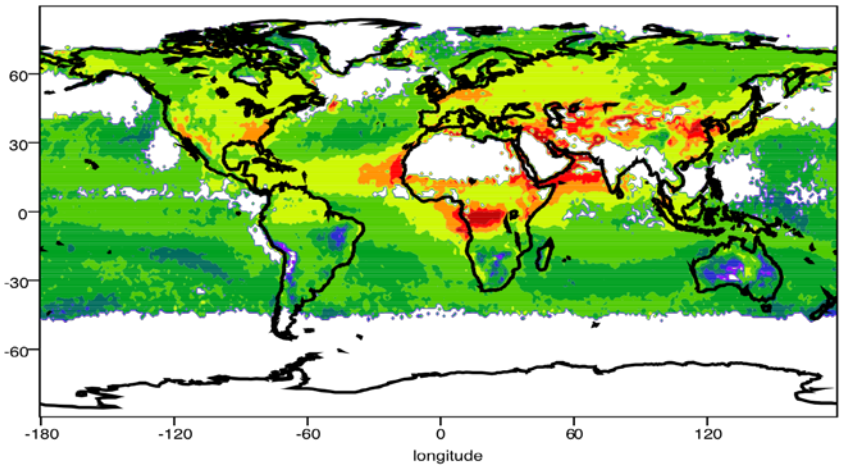

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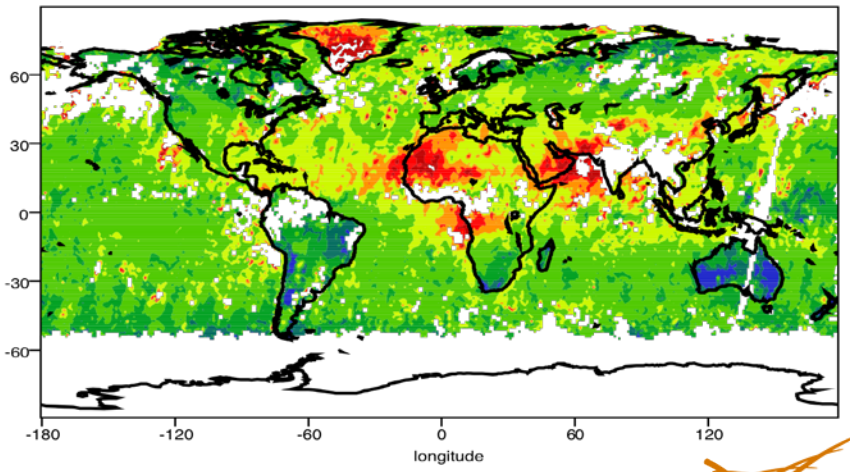

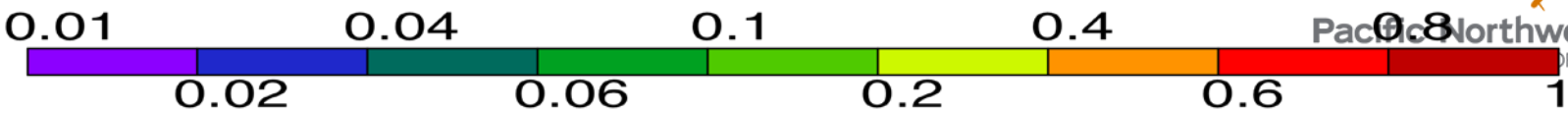

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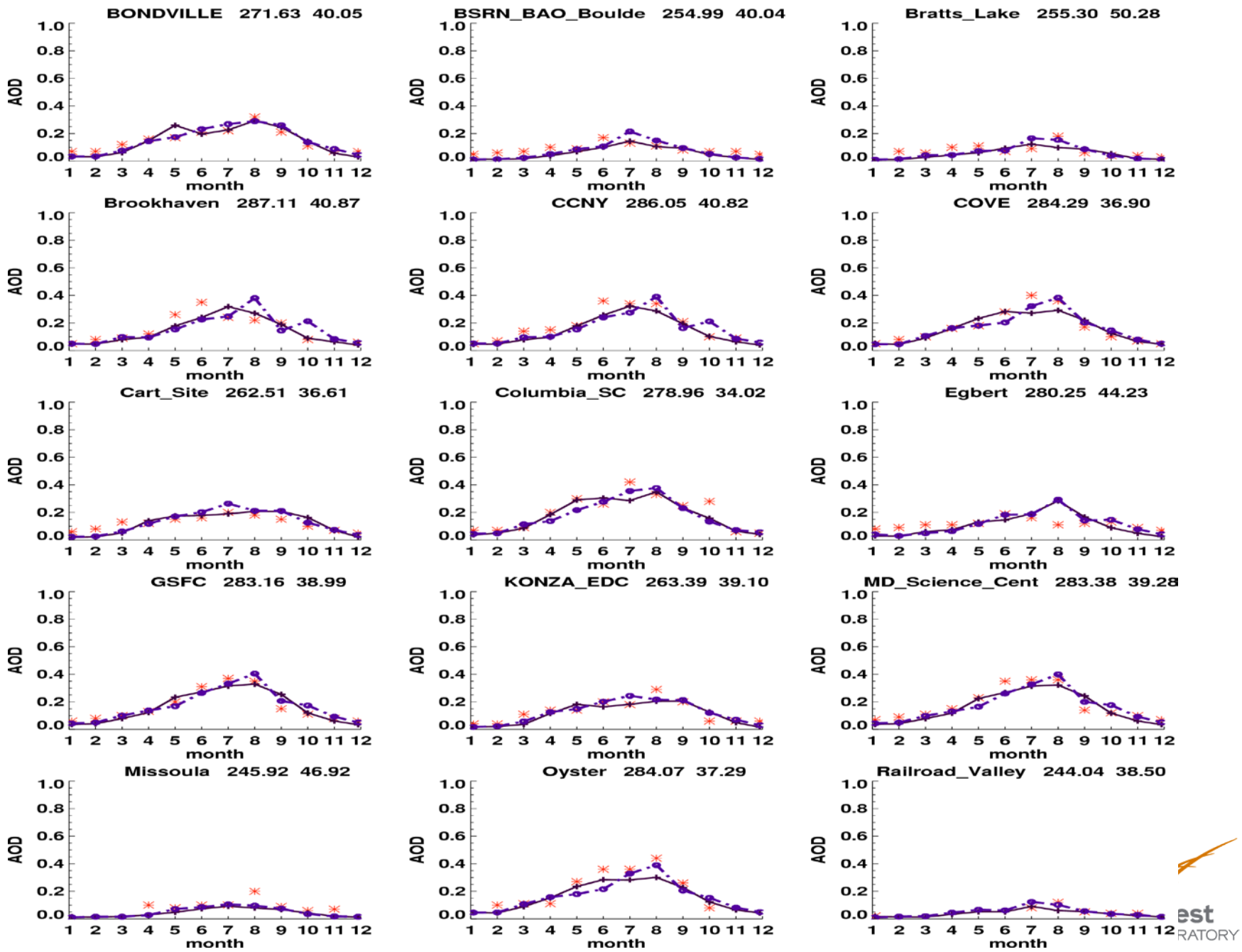
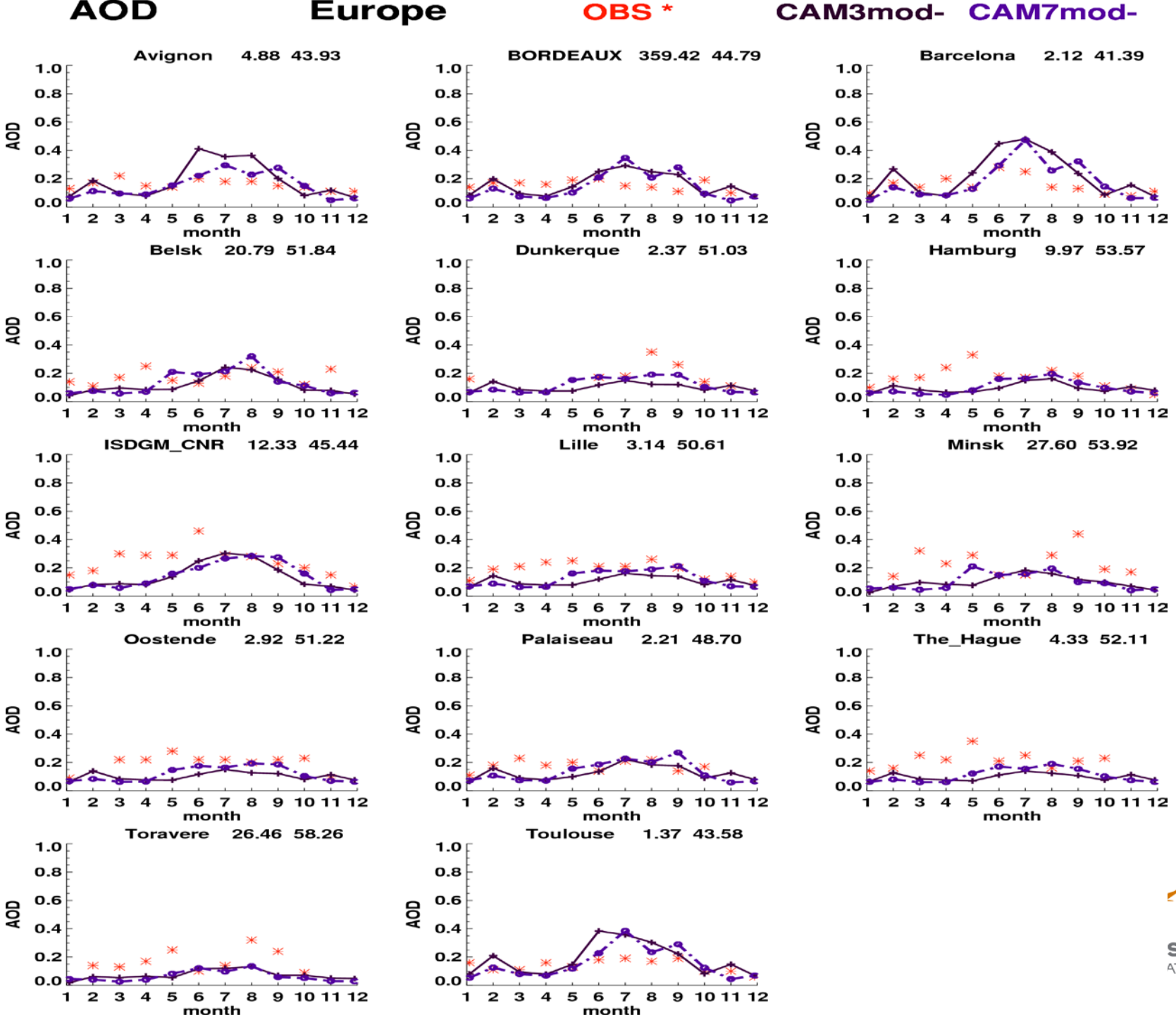
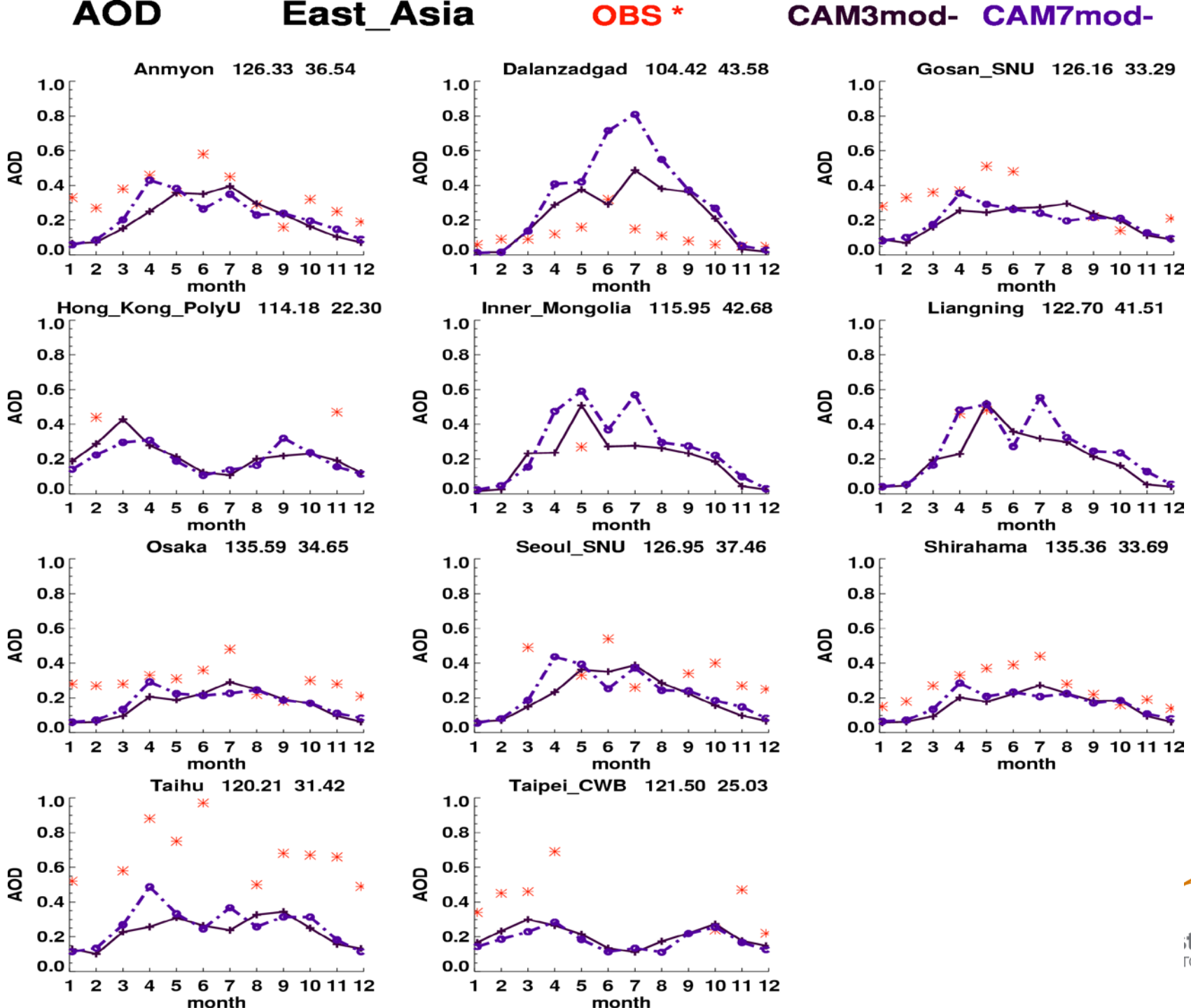

AOD North_America OBS * CAM3mod- CAM7mod-
BONDVILLE 271.63 40.05
BSRN_BAO_Boulde 254.99 40.04
Bratts_Lake 255.30 50.28
Brookhaven 287.11 40.87
CCNY 286.05 40.82
COVE 284.29 36.90
Cart_Site 262.51 36.61
Columbia_SC 278.96 34.02
Egbert 280.25 44.23
GSFC 283.16 38.99
KONZA_EDC 263.39 39.10
MD_Science_Cent 283.38 39.28
Missoula 245.92 46.92
Oyster 284.07 37.29
Railroad_Valley 244.04 38.50
AOD
month


AOD
Europe
OBS *
CAM3mod-
CAM7mod-
Avignon 4.88 43.93
BORDEAUX 359.42 44.79
Barcelona 2.12 41.39
Belsk 20.79 51.84
Dunkerque 2.37 51.03
Hamburg 9.97 53.57
ISDGM_CNR 12.33 45.44
Lille 3.14 50.61
Minsk 27.60 53.92
Oostende 2.92 51.22
Palaiseau 2.21 48.70
The_Hague 4.33 52.11
Toravere 26.46 58.26
Toulouse 1.37 43.58
AOD
month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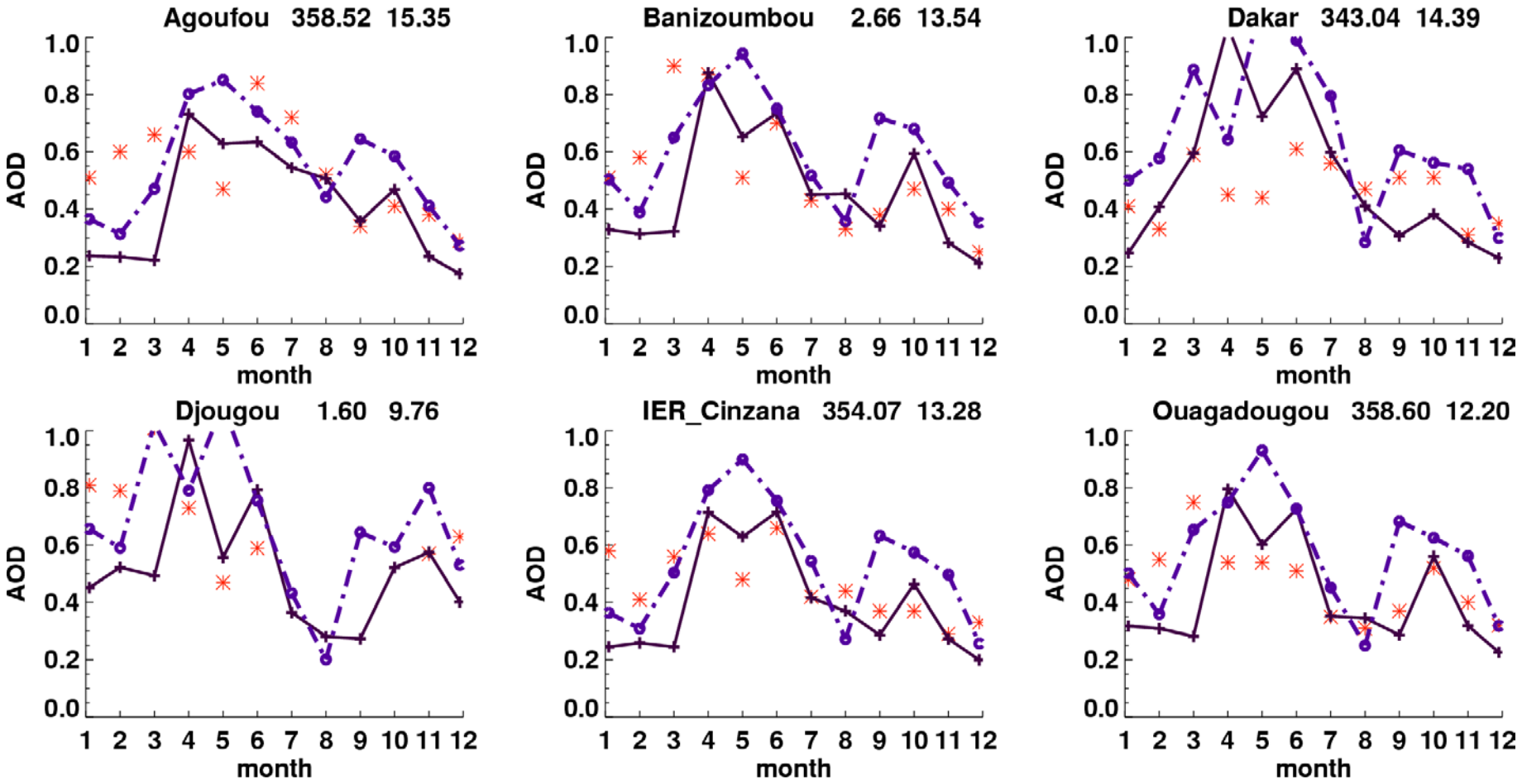
Anmyon 126.33 36.54
Dalanzadgad 104.42 43.58
Gosan_SNU 126.16 33.29
Hong_Kong_PolyU 114.18 22.30
Inner_Mongolia 115.95 42.68
Liangning 122.70 41.51
Osaka 135.59 34.65
Seoul_SNU 126.95 37.46
Shirahama 135.36 33.69
Taihu 120.21 31.42
Taipei_CWB 121.50 25.03
AOD
month

AOD North_Africa OBS * CAM3mod- CAM7mod-



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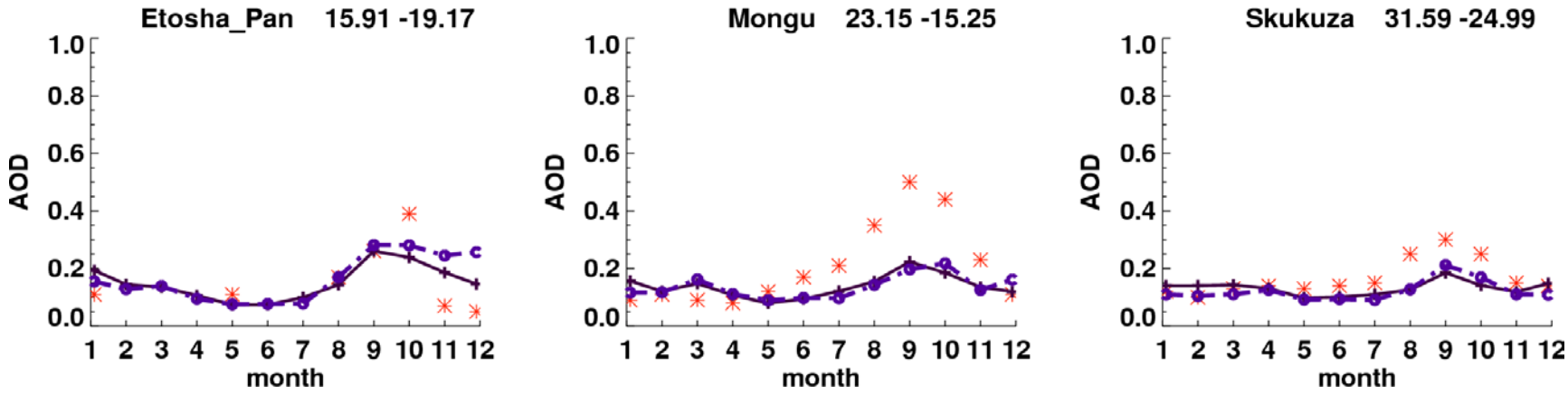

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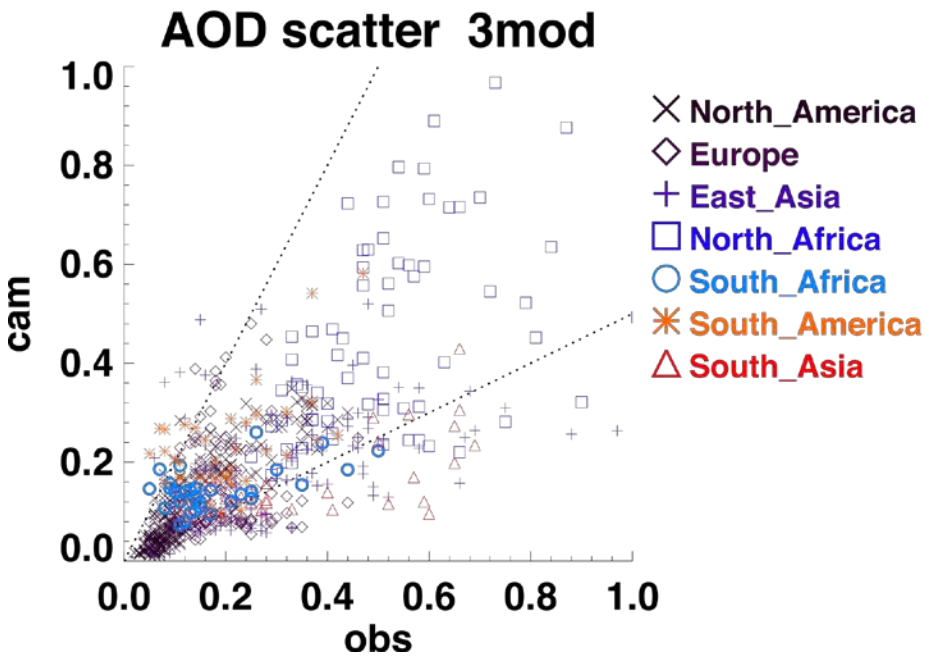

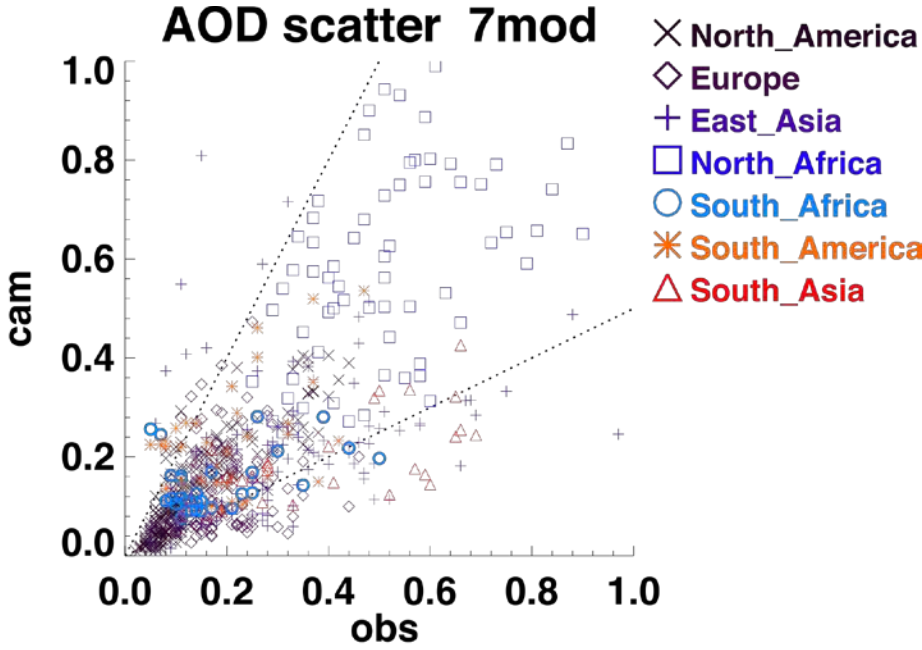

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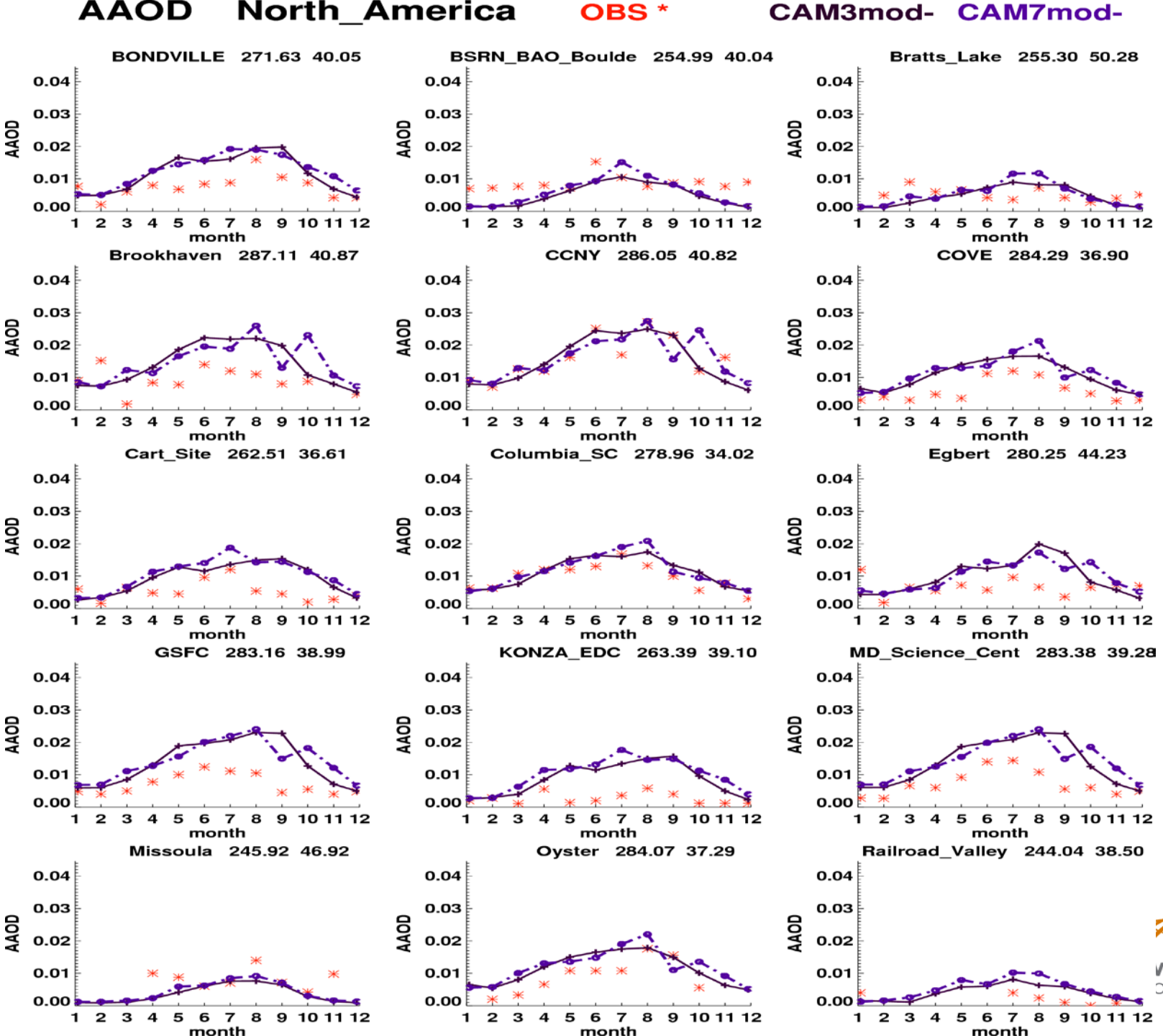
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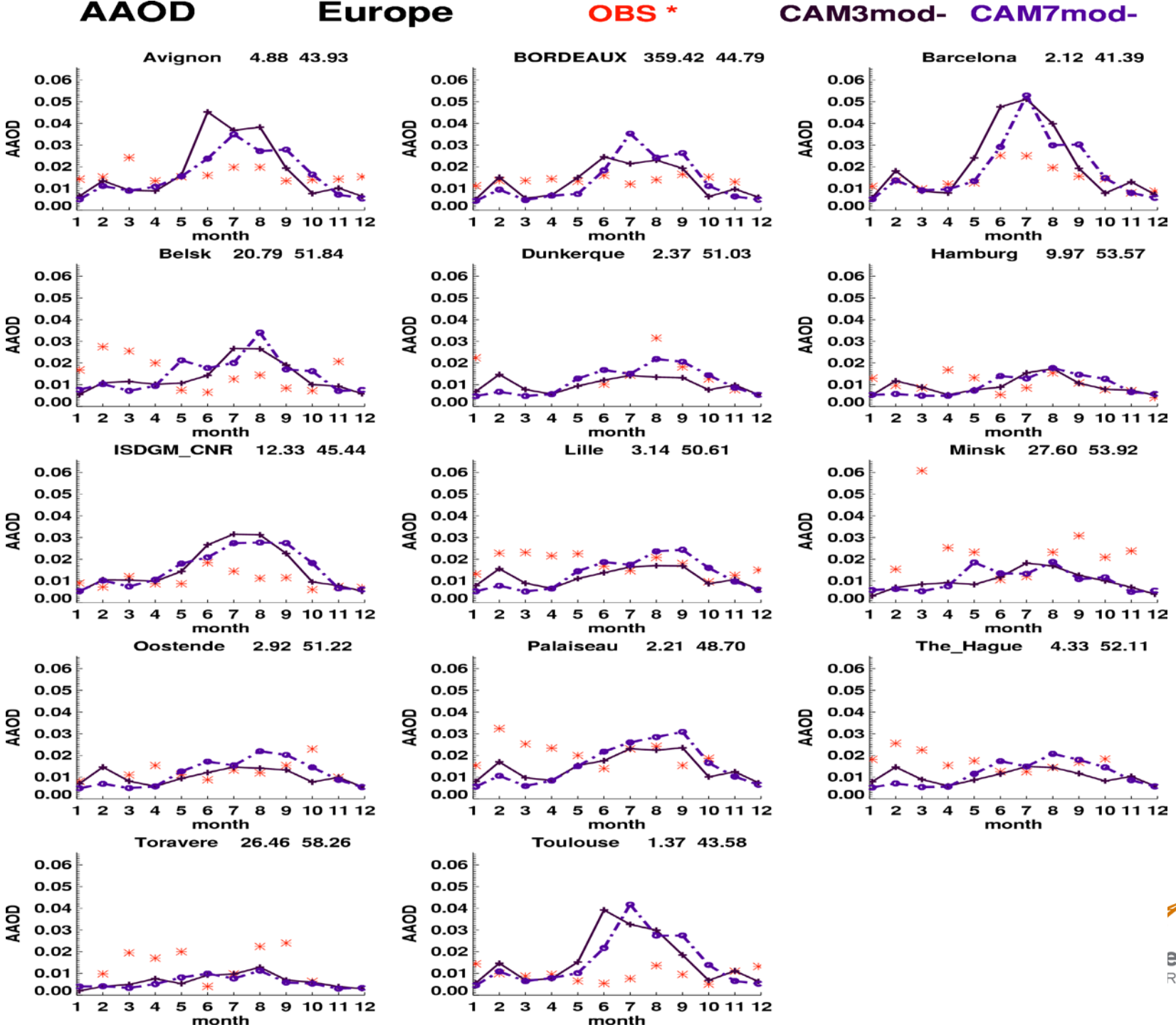
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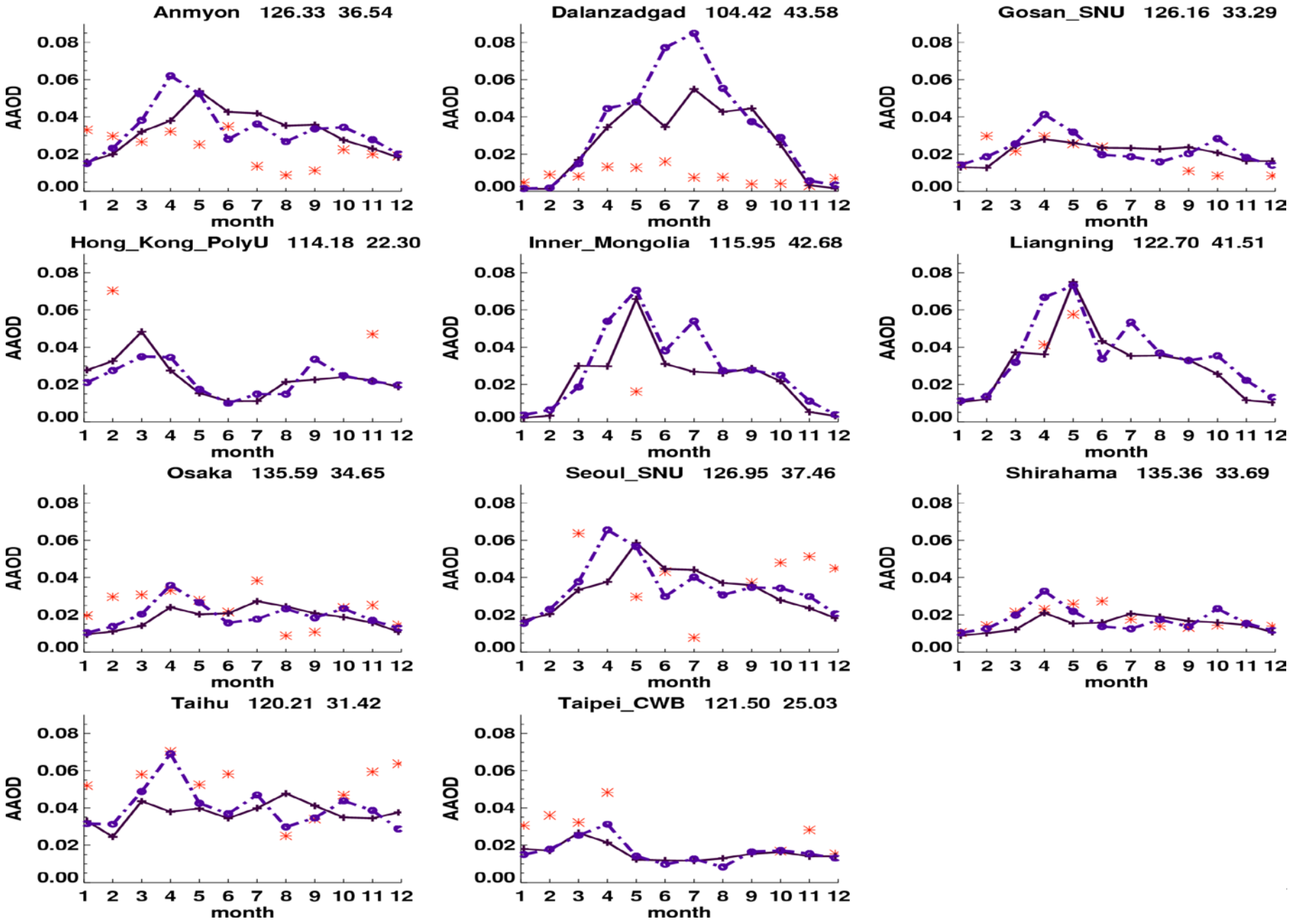
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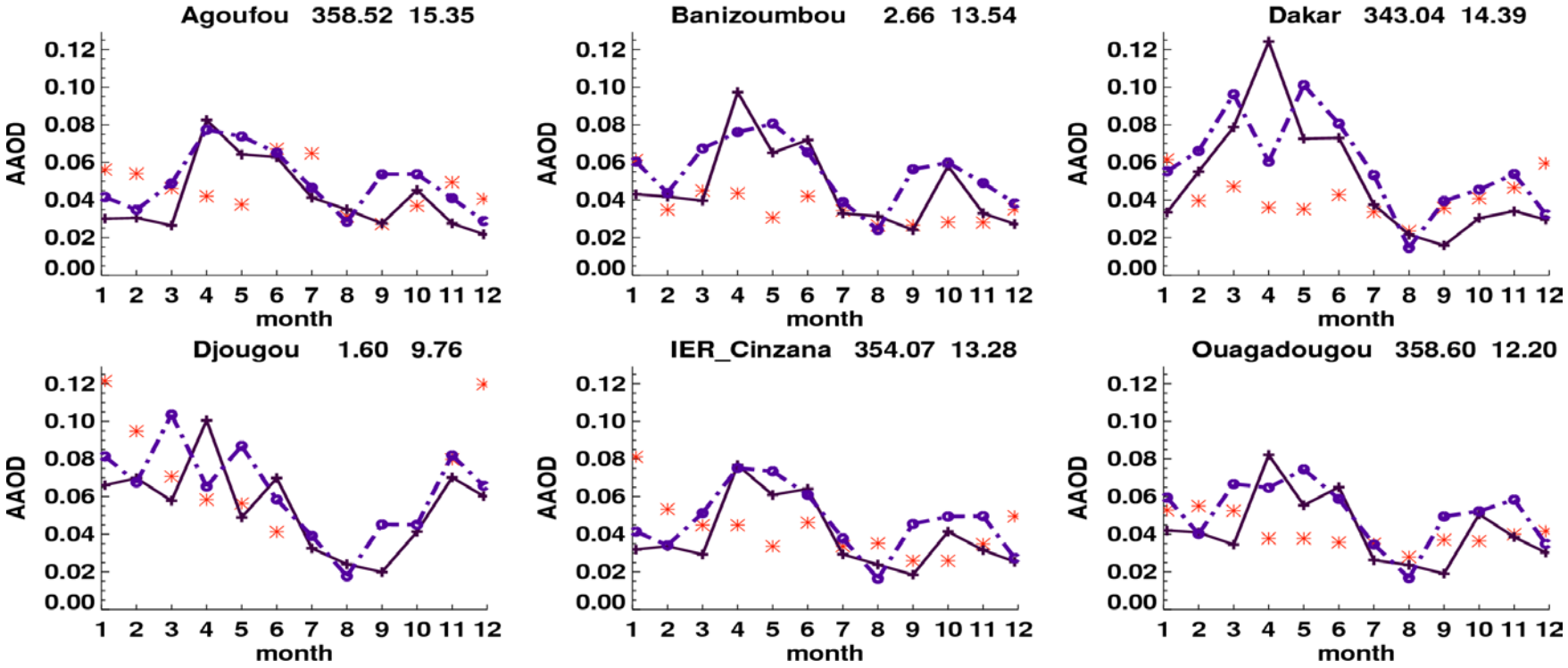
AAOD
month
0.00
0.02
0.04
0.06
0.08
1 2 3 4 5 6 7 8 9 10 11 12

AAOD North_Africa OBS * CAM3mod- CAM7mod-



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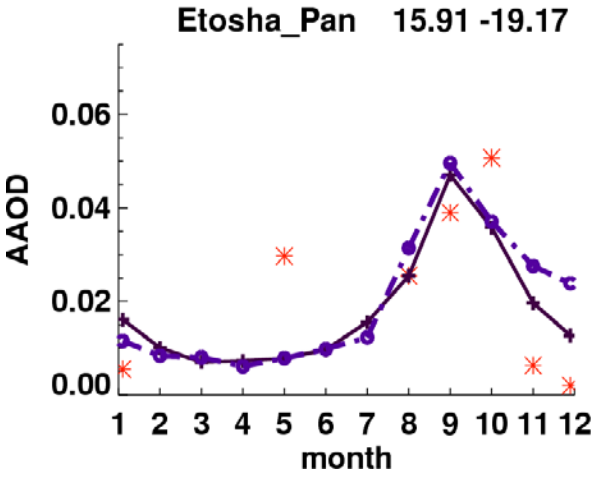
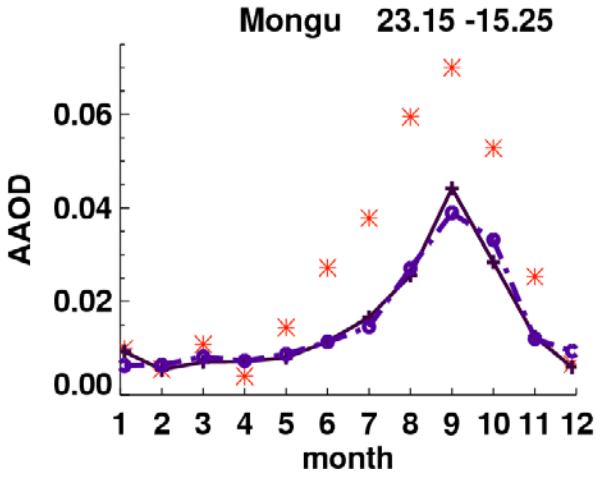
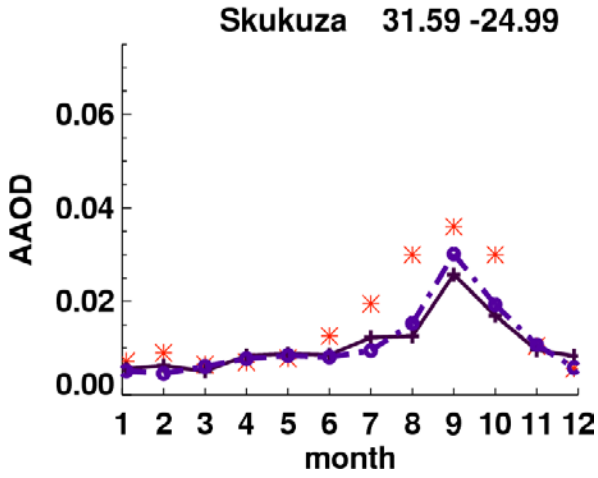
AAOD South_Africa OBS * CAM3mod- CAM7mod-







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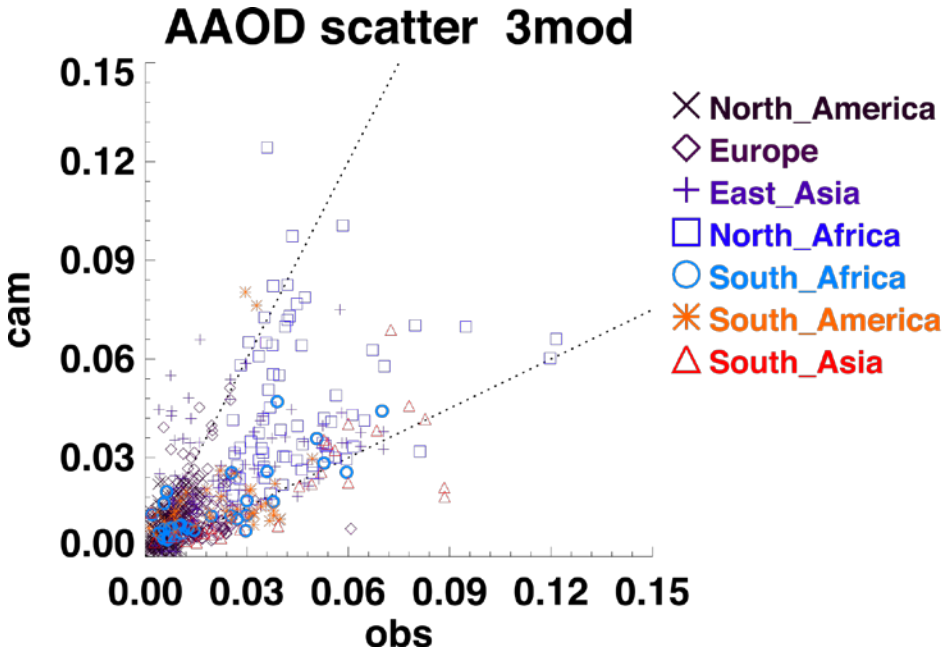

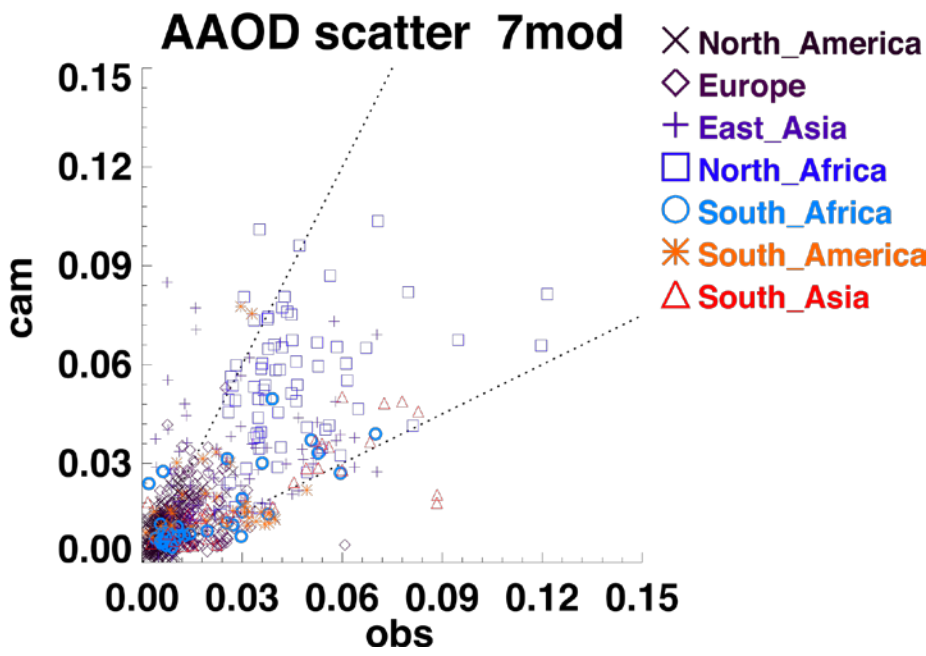

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Summary

- MAM has many new physics with only a moderate increase in computer time (~30% compared to prognostic BAM)
- It has a good simulation of aerosol based on evaluation with observations
- The model underestimates BC concentration near the surface, especially in 3-mode version; however, it overestimates BC in the free troposphere, probably due to the wet scavenging.
- Emission (biomass burning, fossil fuel and biofuel in East and South Asia) needs to be improved.

THANKS!

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