WACCM vs CAM Issues

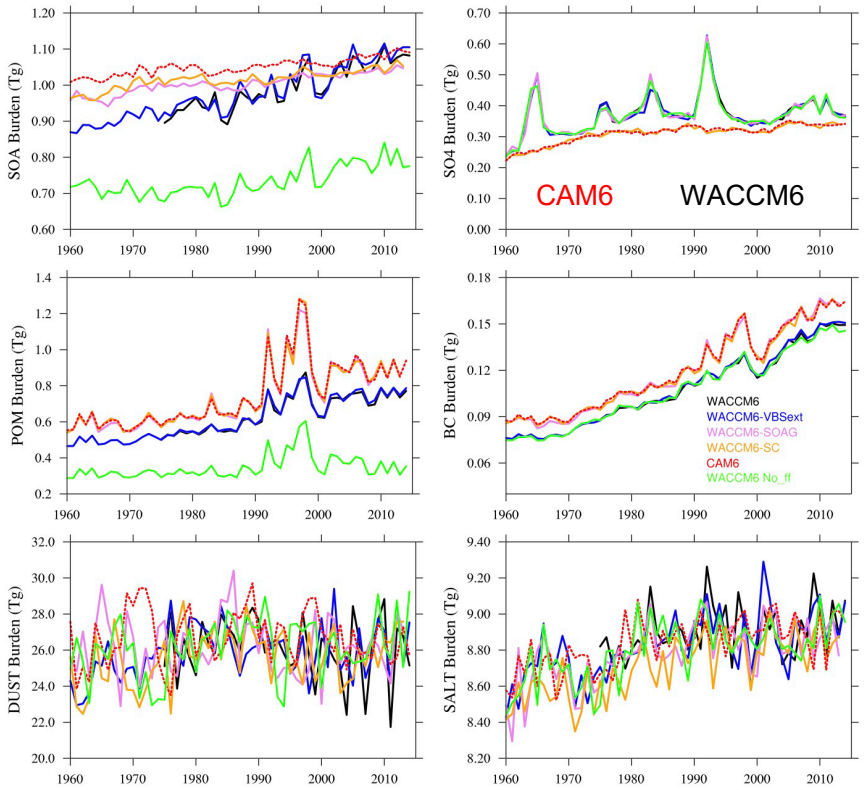

Figure 1. Annually and globally averaged aerosol burden for simulations (see legend, and Table 2), SOA (top left), SO_4 only for altitudes below 500 hPa (top right), POM (middle left), BC (middle right), dust (bottom left), and sea salt (bottom right).

- CAM6 requires oxidant fields (O3, OH, HO2, NO3) from corresponding full chemistry simulations
- Even with same configuration, CAM6 and WACCM6 have different aerosol burdens, particularly SOA, but also sulfate, POM, BC
- To simulate ammonium and nitrate aerosols, interactive chemistry is required
- SOA simulations need to be driven by online biogenic emissions tied to climate conditions

SOA burden: MAM-SOA minus VBS-SOA in WACCM

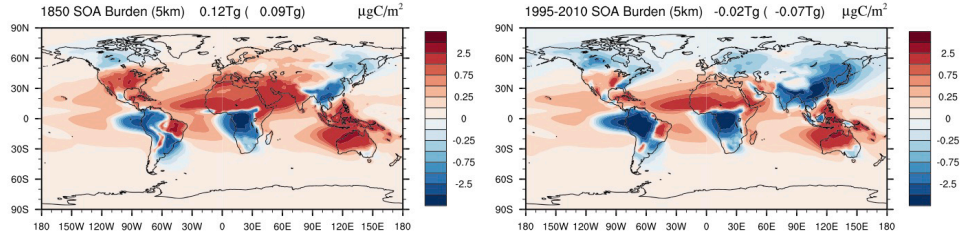

Figure 4. Annual averaged SOA burden within the lowest 5 km of the model for preindustrial conditions (left) and present day (right), and for WACCM6-SOAG (top panels) and WACCM6-VBSext (middle panels). (bottom panels) Differences between WACCM6-SOAG and WACCM6-VBSext.

Tilmes et al., JAMES, 2019

Comparison of chemical mechanisms

Current number of compounds

(all include MAM4)	# species	# transported	# reactions	Specified species
CAM6	26	26	8	O3, OH, HO2, NO3, O2, N2
CAM6-chem (TS)	221	187	528	O2, N2
WACCM6 (TSMLT)	231	189	583	N2
WACCM-MA	98	84	298	N2

This is the main cost
More reactions or non-transported species are not significant in cost

Secondary Organic Aerosols (SOA):

MAM-soa (in CAM6, MA, WACCM-SC): **2 species**

VBS-SOA (5 volatility bins, in CAM-chem, WACCM): **17 species**

MAM4 and MOSAIC-MAM4 (nitrate and ammonium aerosol) transported tracers

	BC	POM	SOA	SO4	NH4	NO3	Cl	Na	Dst/ OIN	Ca	CO3	Total MAM	Total MOSAIC
Accum. (a1)	X	X	X	X	X	X	X	X	X	X	X	6	11
Aitken (a2)			X	X	X	X	X	X		X	X	3	8
Coarse (a3)				X	X	X	X	X	X	X	X	3	8
Primary Carbon (a4)	X	X										2	2

Red crosses: new aerosol tracers in MAM4-MOSAIC

14	29

Alternatives for providing oxidants to CAM

Immediate Solution:

- Use CAM6-chem instead of WACCM6 to generate oxidants for CAM6
- Cheaper: 32 vs 70 levels, slightly fewer tracers
- Very similar results for tropospheric composition and climate

Longer -term Solution:

Improve CAM so offline oxidants are not needed

Use simplified online chemistry which will allow simulation of sulfate, SOA, and nitrate aerosols

- Chemistry needs to be sufficient to calculate OH, O3, NOx
- Would be connected to online biogenic emissions (for SOA)
- Include full stratospheric chemistry to get stratospheric ozone (MA)
- A reduced hydrocarbon oxidation scheme should be sufficient for troposphere for climate (not air quality) studies
- Beijing ESM (BCC-ESM1) uses MOZART-2 chemistry (66 gas species; 13 bulk aerosol) [T.Wu et al., GMD, in review]