

# Chemistry-Climate Working Group Current Status – Feb/March 2017

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# CESM2 Release and other Versions

**CESM2** finalized configuration, 1850 runs will follow for scientific release

**CMIP6 runs will be performed using WACCM**

- TSMLT (troposphere/stratosphere/mesosphere/lower thermosphere), can be run with slight modification in CAMchem, 228 species
- Expanded tropospheric chemistry (“TS1” - speciated aromatics, terpenes, updated isoprene oxidation, organic nitrates)
- New SOA-VBS framework
- Prognostic volcanoes
- Closed nitrogen budget
- CMIP6 emissions with updated biomass burning injection heights (for aerosols)
- Single emission files for different sector
- Updated postprocessing (in progress)
- WACCM and CAM-chem compsets will be provided

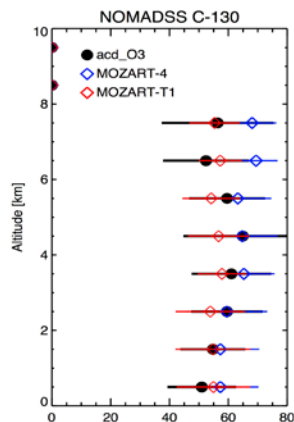
**Code updates (not applied for CMIP6 runs)**

- New nitrate scheme
- Interactive fire module

# CESM2 Tropospheric Chemistry (TS1)

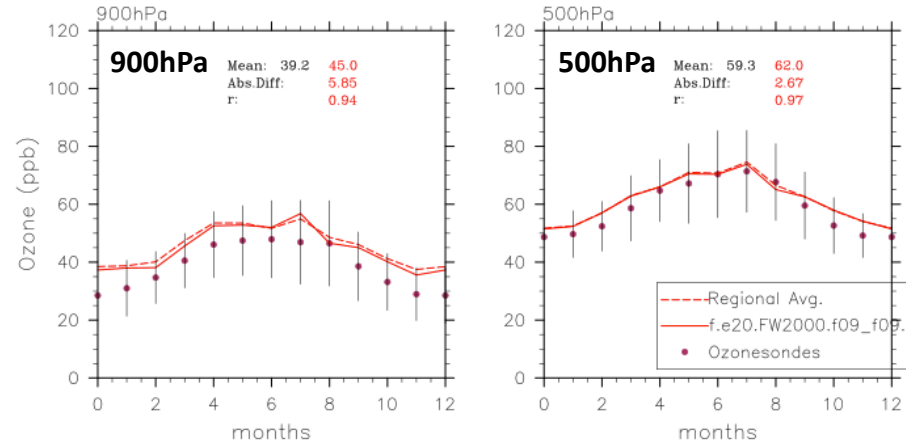
## State of the art tropospheric chemistry

- Provide more detailed representation of **SOA precursors** (terpenes, aromatics, glyoxal)
- Update isoprene oxidation based on recent research to include **OH recycling**
- Include specific species that are observed, allowing for **more precise model evaluation** (benzene, toluene, xylenes, individual terpenes, organic nitrates, glyoxal, etc.)
- Improved treatment of organic nitrates (replace ONIT with more specific nitrates)

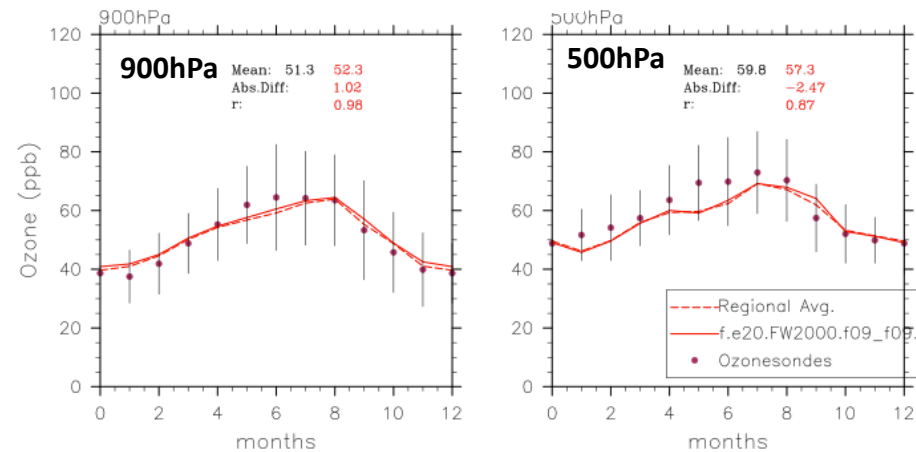


New  
Chemistry

## Western Europe



## Eastern US



# Secondary Organic Aerosols

## 1. SOA scheme updated to include volatility basic set (VBS)

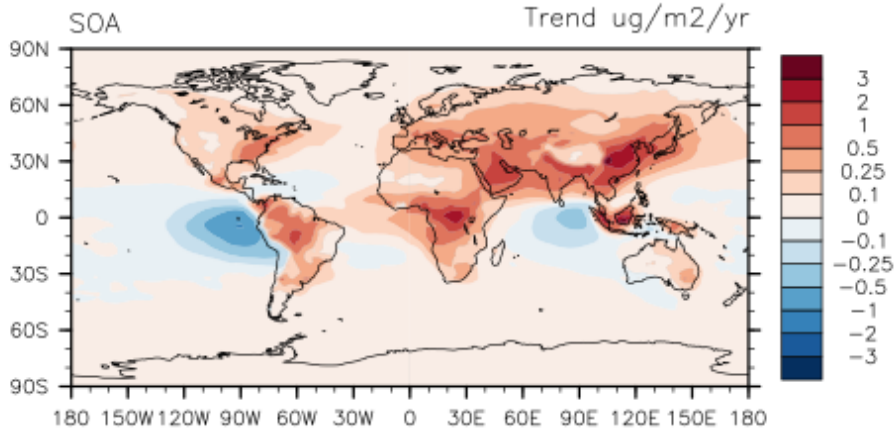
- Gas (SOG) and aerosol (SOA) species in 5 volatility bins (Hodzic et al., 2016 ACP), implementation based on Shrivastava et al., 2015
- 1 semi-volatile (SVOC) = 0.6\* POM emissions
- 1 intermediate volatile precursor (IVOC); 0.2 \*NMVOC emissions
- SOAG production different for biomass burning, fossil fuel and biogenic emissions
- 47 new species, 20% increase in computer time from base description

## 2. Simplified SOA scheme updated to include volatility basic set (VBS)

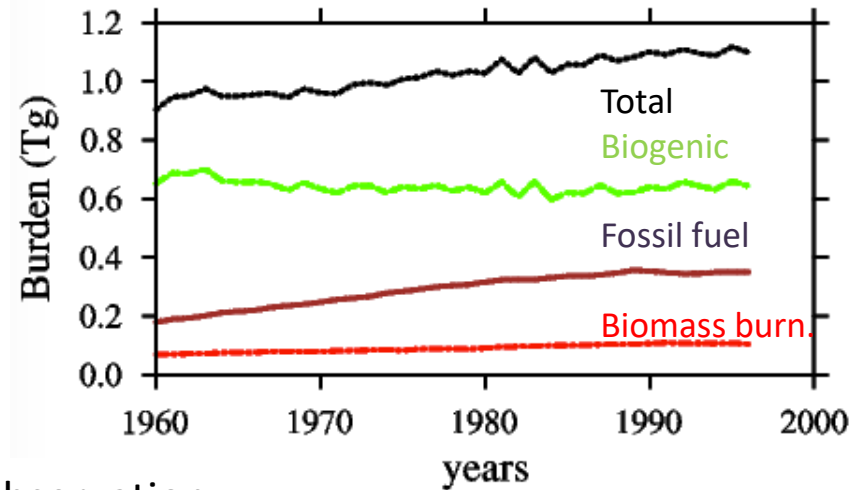
- Merge 3 different categories (biomass burning, fossil fuel and biogenic) SOAG into one category. Average Henry's law coefficient for different categories.
- 12 new species, significant reduction in computer time, 5-7% increase from base description.

# CESM2 Secondary Organic Aerosols

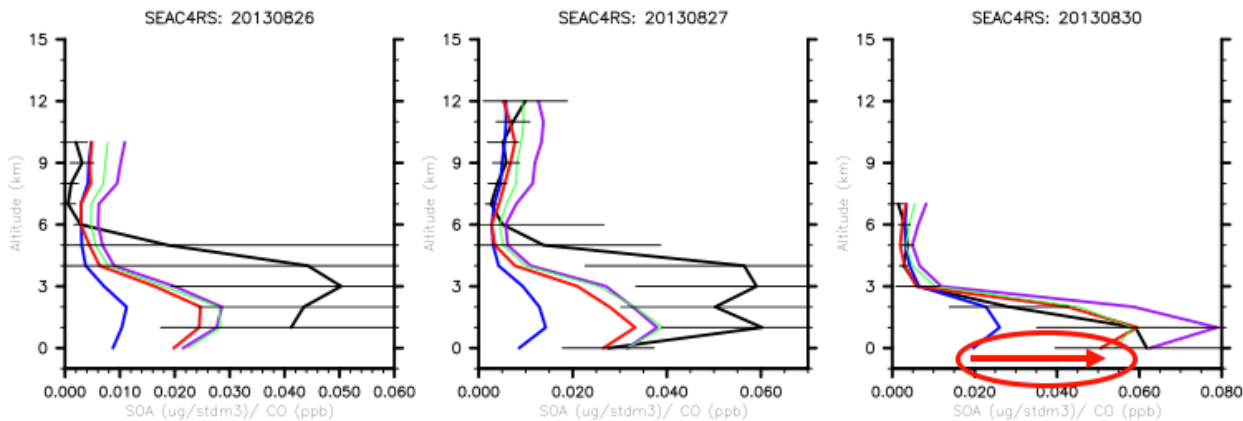
## SOA Trend between 1960 and 2000



## SOA Burden



## Comparison to Aircraft observation



# Tropospheric Chemistry Mechanism

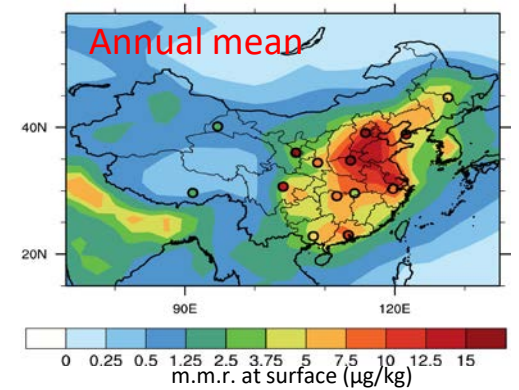
## Extended development work on tropospheric chemistry

- Improved halogen chemistry (Doug Kinnison)
- Simple chemistry (Ben Brown-Steiner)
- Extended Tagging (Tim Butler)
- Aerosol dry deposition (Mingxuan Wu)

# Nitrate and MOSAIC in CAM5

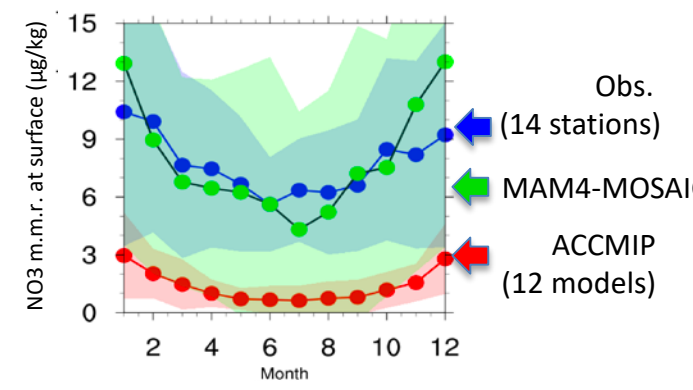
- In order to better treat NO<sub>3</sub> aerosols, Model for Simulating Aerosol Interactions and Chemistry (MOSAIC) module [Zaveri et al., 2008] is coupled with MAM7 and MAM4 in CAM model.
- In the version of MAM coupled with MOSAIC, gas-aerosol exchange is treated by MOSAIC. The other processes are handled by MAM

Modeled NO<sub>3</sub> vs. observation over China



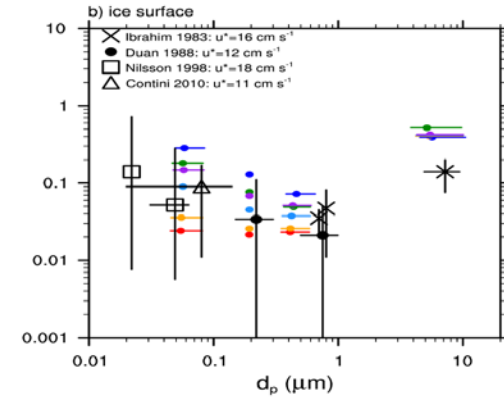
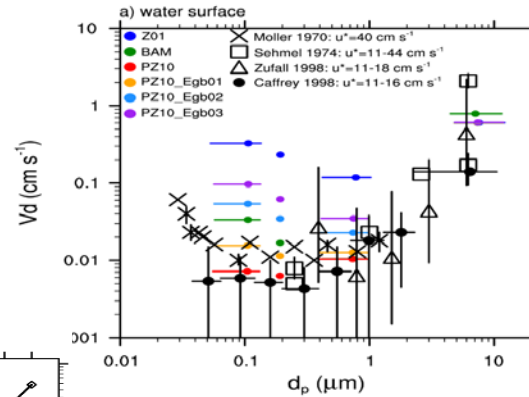
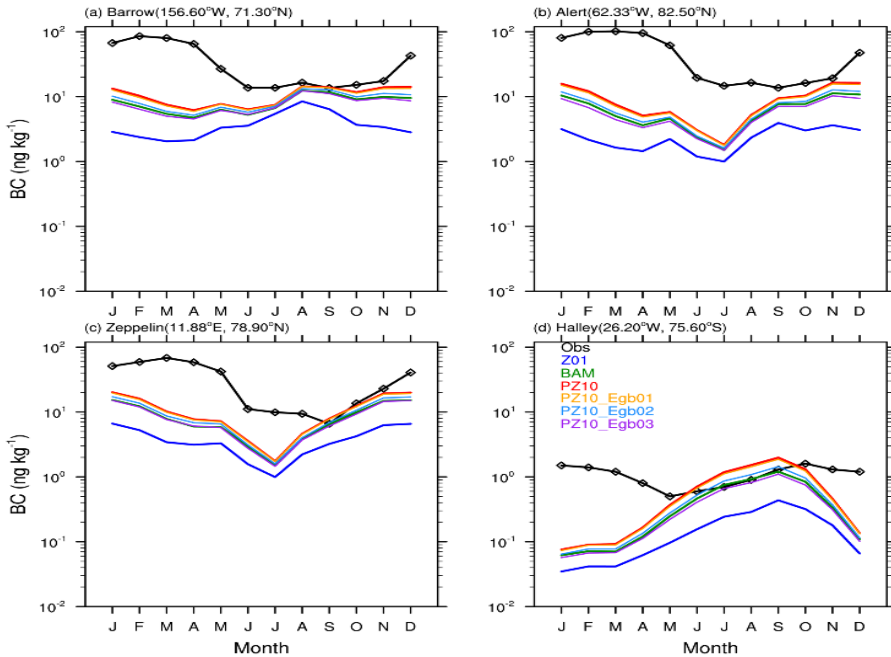
	BC	POM	SOA	SO4	NH4	NO3	Cl	Na	Dust	Ca	CO3	total
Accum.	X	X	X	X	X	X	X	X	X	X		11
Aitken			X	X	X	X	X	X				6
Coarse				X	X	X	X	X	X	X		8
P-carbon	X	X										2

Red crosses: new aerosol tracers in MAM4-MOSAIC



# New Aerosol Dry Deposition Scheme

- Current aerosol dry deposition scheme in CAM5 by **Zhang et al. (2001)** tends to overestimate the particle deposition in the fine mode significantly.



- We introduce a new aerosol dry deposition scheme by **Petroff and Zhang (2010)** into CAM5.
- The new scheme predicts smaller dry deposition velocity for fine particles in accumulation, Aitken, and primary carbon mode.
- Seasonality of BC concentration at Polar regions is improved.



# CESM2 Release and Versions

**What compsets do we want for the release?**

**CESM2 release compsets:**

**FC2000, FCHIST, FSDCHIST, BTSCHIST** standard chemistry

**FCVBSHIST,**

- Do we want a TROP MOZART compset (TS1) with prescribed stratosphere: yes
- Resolutions 0.9x1.25deg, 2degree?

**CESM122 Version: CAM4chem and CAM5chem**

**CCMI Version (CESM111 code base)**

- CAM4chem all new science is in CESM2
- Should it be released?

**Development will be continued based on CESM2**

# Development Plans

## Refine and test:

- SOA-VBS in CESM2 (including differences for low and high NO<sub>x</sub>)
- Nitrate aerosol in MAM
- Specified Dynamics Simulations (issues with mass transport), MERRA2
- Interactive fire emissions
- Further improve isoprene, terpenes, aromatics chemistry
- Update chemistry postprocessing
- Move halogen chemistry to CESM2 version

## New developments:

- Add polar halogen chemistry
- FAST-J/CLOUD-J / TUV online
- Test next generation dynamical cores: Spectral Element/CSLAM and CESM-MPAS
- Improved MEGAN biogenic emissions (in CLM) and adapt to Ecosystem Demography representation in CLM (Alex Guenther, UCI)
- Brown Carbon and improved dust?
- Interactive methane?