Progress on Application of Modal Aerosol Dynamics to CAM

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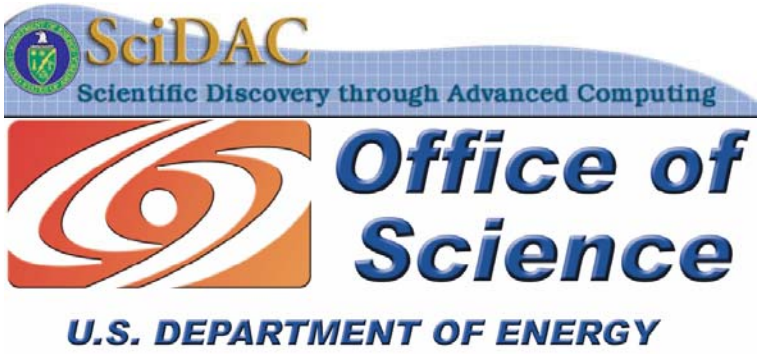

Current Aerosol Treatment in CAM3

sulfate	hydrophobic black carbon	sea salt 1	soil dust 1
ammonium	hydrophobic organic carbon	sea salt 2	soil dust 2
nitrate	hydrophilic black carbon	sea salt 3	soil dust 3
secondary organic carbon	hydrophilic organic carbon	sea salt 4	soil dust 4

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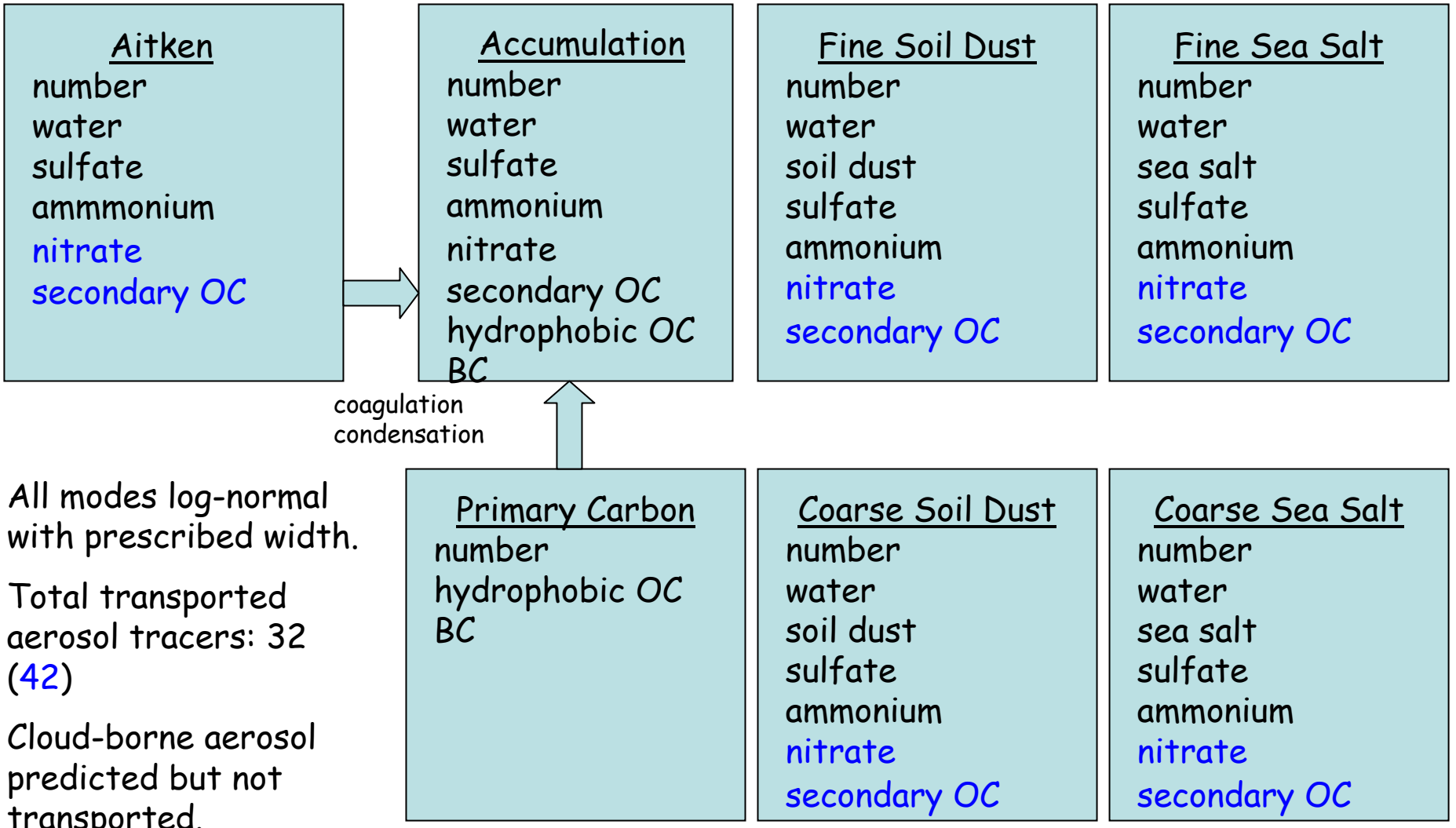
- Hydrophobic carbon ages to hydrophilic with prescribed timescale

Proposed Benchmark Aerosol Treatment for CAM4



All modes log-normal with prescribed width.

Total transported aerosol tracers: 32 (42)

Cloud-borne aerosol predicted but not transported.

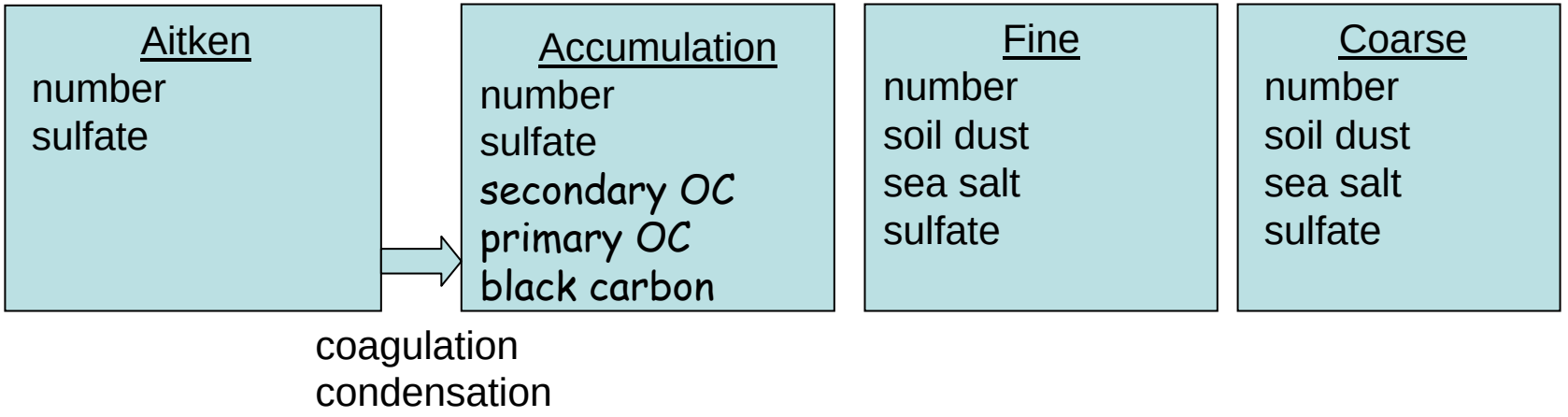
Proposed Simplified Aerosol Treatment for CAM4

Assume aerosol are hydrated for RH > crystalization RH.

Carry soil dust and sea salt in same mode because sources are separate.

Assume primary carbon is internally mixed with secondary aerosol.

Assume ammonium neutralizes sulfate, and neglect nitrate.



All modes are log-normal with prescribed width.

Total transported aerosol tracers: 15

Cloud-borne aerosol are predicted but not transported.

Progress

- Emissions (size-resolved) **(done)**
  - ✓ Fossil fuel SO2 emissions over 0-100 m and >100 m based on EDGAR-2000;
  - ✓ 3% (by mole) of fossil fuel SO2 emissions goes to SO4 (Aitken & Accu. modes, mass & number, Whitby 1978);
  - ✓ OM and BC to primary carbon mode (mass & no.);
  - ✓ Sea salt emission based on Gong et al (1997) to fine and coarse sea salt modes (mass & no.);
  - ✓ Dust emissions to fine and coarse dust modes (mass & no.).

Progress

- Aerosol activation and droplet nucleation (Ghan scheme) **(done)**
- Wet scavenging **(done)**
  - ✓ In-cloud rainout based on activated aerosol;
  - ✓ Below-cloud impaction scavenging rates (mass & no.) using a look-up table (wet size, precipitation rate) .
- Dry deposition (based on Zhang et al., 2001) & gravitational settling **(done)**
- Cloud sulfur chemistry **(done)**
  - ✓ Bulk sulfate chemistry based on calculated pH
  - ✓ Sulfate mass produced distributed to modes based on number of activated aerosols in modes.
  - ✓ Include contribution from H2SO4 (g) uptakes

Progress

- New particle formation: binary nucleation (H2SO4-H2O) parameterization (Vehkamaki et al., 2002) **(done)**
- Coagulation: Brownian within, between modes. **(done)**
- Water vapor and trace gas (H2SO4 & NH3) uptake **(done)**
- Intermode transfer (renaming) due to condensation, coagulation, and cloud chemistry **(done)**
- **Compile OK**

Works in Progress

- Trace gas and water vapor uptake (with hysteresis dependent on previous aerosol water) will be replaced with MOSAIC module (consider gas-particle transfer)
- Aerosol optical properties: parameterization in terms of wet refractive index and wet surface mode radius.

CAM Simulations

- Benchmark modal present-day
  - On-line oxidants (HO_x,O_3 chemistry)
  - Off-line oxidants (input HO_x,O_3)
- Benchmark modal pre-industrial
- Simplified modal present day, offline oxidants
- Simplified modal pre-indu., offline oxidants
- Offline benchmark present day (interpolation from monthly mean of on-line benchmark)
- Offline benchmark pre-industrial

Testing

- Evaluate on-line benchmark treatment using *in situ* (surface and aloft) and remote aerosol measurements (mass, number, size, CCN, AOD, ...). Utilize AEROCOM and other model evaluation efforts.
- Evaluate approximations used in on-line simplified treatment by comparing direct and indirect aerosol effects with on-line benchmark treatment.
- Evaluate off-line benchmark treatment by comparing with on-line benchmark treatment.