Summary of Candidates, Tradeoffs

- ## Any track
  - Volcanic emissions
  - Assess with next generation aerosol emissions
- ## Track I
  - No AIE
  - Sea ice OK
- ## Track II
  - Sea ice too thick
  - Unknown climate sensitivity
  - AIE uncertain after bugfix
- ## Track V
  - Best Physics we know how to do
  - Many good features, but…
    - Sea ice too extensive
    - Atmosphere too moist, low clear sky OLR, low LWCF amplitude
    - Too few high clouds
    - Unknown climate sensitivity
    - Higher AIE

Critical Requirements – what is good enough?

- The Standard AMWG diag suite
- SST biases
- Sea Ice
- ENSO --- how long do we run
- Is precipitation over land critical? Have we looked enough?
- Reasonable combo of AIE and climate sensitivity to reproduce 20th Century T_S
- ?

Next steps for track 5?

- Deadlines
- How do we fix the critical issues?
  - Complete budget of water substances will help with eliminating water vapor bias
    - ➜ Clear sky OLR ➜ LWCF
    - What is responsible for overly moist troposphere?
    - What is responsible for high cloud fraction over the Arctic
  - How do we control the AIE?
    - Old drop activation vs new
    - Emissions
    - Scavenging
    - Lower bound (20, 30, …?)

Next steps for track 5?

– Are we doing the mandatory tests/runs? (PD=present day, PI=preindustrial)

- Fixed PD SST + PD Aer Emis. to assess CBI + climate
- Fixed PD SST + PI   Aer Emis to assess AIE
- Coupled PD (GHG+Aer Emis) to assess ENSO, SST drift, (30+ yrs, … then if all else OK, a few hundred?)
  - Long enough to generate SOM dataset?
- Assess climate sensitivity
  - SOM? (PD aer emis + 2xCO2?)
  - 1% CO2 (to 80 years)?
- Preindustrial GHG + Aer. Emis, retune
- Transient GHG + Aer Emis
- Transient GHG + Volc Emis + Sol Var + Land Use + xxx?

NOTES

Task teams

- A number of people have helped enormously over the last few months (Bill C., Andrew C., Chris B., David M., Steve K, Hugh M, Mike I.,Jen K, and I am certainly forgetting people)
- At the moment, the heavy lifting is done by Rich, Cecile, Sungsu, Steve G, Xiaohong, Andrew G., Phil,
- Does anyone want to volunteer to be really heavily involved? This means
  - Appropriate skills (scientific, programming) and interest
  - Writing code
  - Making daily runs
  - Grabbing history files
  - Looking, scripting on model output daily
  - Conference calls

Agenda

- Monday AM (joint with Chem-Climate WG)
  - CAM4 progress
- Monday PM
  - CAM in the near term
- Monday ~430-6PM
  - Reception – Damon Room
- Tuesday AM (joint with Chem-Climate WG)
  - CCSM, Chemistry and Climate Change
  - Updates by other WGs
- Tuesday PM
  - Miscellaneous Climate Modeling Activities
- Wed AM
  - Networking?
  - Access to runs, source code?
  - Meet with Phil, Cecile, Rich, Others?
- Wed PM
  - SSC meeting

CAM4 Development since Breckinridge, June 2008

Phil Rasch for the development team!

Progress on CAM4 (1/2)

- BAM (Bulk Aerosol Module)

  - merger of CGD & ACD bulk aerosol formulation

  - integrate with new microphysics & Ghan droplet activation

- Complete Assessment of UW PBL and Shallow convection

- Original Morrison/Gettelman scheme w/ BAM

- Revised gravity Wave Drag (Works, but not 100% compatible with UW scheme)

Done

- Modal Aerosol Module (MAM)

- Original Morrison/Gettelman scheme w/ Modal Aerosols

- New treatment for Ice in MG allowing

  - New nucleation formulation

  - New ice fraction formulation

  - Supersaturation

- New Ice Integrated with MAM

- Macrophysics integrated with UW scheme

- Modal+Ice Integrated with Macrophysics+UW

Progress on CAM4 (2/2)

- Revised surface exchange processes
  - Accommodates thinner layers
  - Physical & Numerical Consistency across models
  - Different formulas
- Superfast Chemistry
- Connecting Dust emissions from CLM to CAM
- Revised surface types providing dust in S. Hemisphere (Australia, S. America)
- Revised emissions (Aerosols, precursors, chemicals)
- Injection height of emissions
- Connecting deposition to surface models
- New optics for clouds and aerosols for RRTM
- Confidence building with RRTM
- Crude use of in-cloud water content, and cloud fraction from deep and shallow convection scheme for radiative transfer

The "Main Branches" of CAM

- "Cloud Branch"
  BAM + [RK or "old" MG microphysics] + UW parameterizations + Macrophysics

- "MAM branch"
  the modal aerosol module, originally 7 mode, then 5 mode, then 3 mode, + MG microphysics (originally "old", then with "new" ice) + RRTM

- "CLAM Branch"
  Cloud + MAM

Implementation Strategy

- It was impossible to tune and evaluate every aspect of any model configuration for all metrics we cared about (including coupled formulations, ENSO, climate sensitivity, etc) if we wanted to include all the physics. To do this would require at least a month of (real) time per configuration. Furthermore,
  - the surface models were also evolving…
  - Adding new physics after optimal tuning would mean repeating the whole exercise.
- Consequently, our strategy was to:
  - implement new physics
  - get some confidence in behavior of model
    - Tunable (but not optimally tuned!)
    - Physical response consistent with our physical intuition
    - Capable of a fully coupled simulation (but not a great simulation!)
    - Assess amplitude of the indirect effect in MAM and Early versions of BAM in fixed SST runs
  - Move on

The "Tracks"

- Track I – CAM3.5 physics (but modern code base) (no easy indirect effect)
- Track II -- + old MG microphysics + BAM (prescribed or predicted) Bugfix added last week
- Track III -- + RRTM + Ice
- Track IV -- ?
- Track V -- CLAM = Everything

No bugs in last 30 days, but this is is a completely new model. We are still learning about it

Things that don't fit neatly into the list

- Horizontal and vertical resolution

    - 3x4 for paleo? 1x1.125, 0.5x0.6, etc

    - Vertical resolution (30-50 layers)

        - Redistribute in lower troposphere

        - Modest increase in UT and particularly near tropopause

        - Low and middle stratosphere?

    - Nominal horizontal resolution?

- Prescribed MAM aerosol

Remaining Issues

- Final integration, Tuning, Configuration, Software Engineering
  - TOA radiative balance will be preindustrial, not present day (emissions 99% ready)
  - Time varying volcanic eruptions, solar variability
  - Horizontal and Vertical Resolution
- Hindcast 1870—2000 to see transient simulation character
- Chemistry
- Indirect Effect (and Lower Bound Limiter)
- Exploration by community?
- Little opportunity yet for assessment/validation "retuning" during development
- Water vapor vertical distribution high compared to many analysis products. Is this realistic? Near sfc? Upper trop?
- CERES picture of the radiative budget significantly different from ERBE. Related to water vapor?
- Ozone

IPCC run with 2 different models?

- CMIP runs for IPCC need to start almost NOW due in some part to needs of Carbon Cycle spin up (3000 year integrations to build up carbon pools)