Science and functionality changes for the Dec 1, CAM6/CESM2 release

Currently the proposed baseline configuration of CAM6 is 1º finite volume with MG2+MAM4+CLUBB major physics change from CAM5.

Between March 1st and July 1st the main focus will be on developing and implementing code changes that primarily target the major outstanding coupled biases identified at the CESM joint working group meetings. Given the need to interact with other working groups and provide stable coupled simulations prior to the code freeze, release priority developments should be near final by May 1st.

Coupled Features/Biases to be targeted

1. Insufficient Tropical Sub-Seasonal Variability
2. Poor global precipitation features (Amazon, USA)
3. Weak surface winds
4. Strong indirect effects
5. Coupling that leads to globally cool SSTs

Release Priorities (by July 1st)

Cloud Microphysics: (a) A new auto-conversion scheme with implied time and pre-existing rain dependence (Seifert and Beheng, 2001) will be further tested. The expectation is a reduced indirect effect, but this still needs to be tested to avoid any adverse impacts on the coupled climate; (b) New ice microphysics (from WACCM: Bardeen) to make sure the uppermost tropospheric cirrus and ice (Type-2) Polar Stratospheric Clouds (PSCs) are appropriate to drive chemistry in the lower stratosphere. The changes will also make sure that we are conserving total water in the ice phase appropriately with CLUBB.

Momentum Tendency Formulation: Non-isotropic orographic and form drag (Beljaars) schemes (from: Bacmeister) will be developed and further tested. This will replace or supplement the existing turbulent mountain stress (TMS) scheme, due to low wind speeds and poor flow around orography. The momentum diffusion may need to be reformulated in CLUBB, after assessment in dry PNL conditions, in order to accommodate these changes. Due to the existing dependence of vertically propagating gravity waves and the frequency of Sudden Stratospheric Warmings (SSWs) in WACCM, frequent testing and coordination with the WACCM group will be needed.

Tropical Convection Formulation: Potential adjustments to the Zhang-McFarlane (ZM) deep convection will be investigated in order to address new and existing tropical coupled-climate biases including mean rainfall (implications for biogeochemistry) and equatorial wave variability (implications for tropical coupled climate). Changes could include combinations of entrainment, timescale, gustiness and convective organization (from: Neale, Sanderson, Bogenshutz, Bacmeister, Tawfik, Tomiazzo). Changes will be modest, as the existing coupled climate cannot be compromised. Will need to work with other working groups to ensure this. In particular changes to tropical convection will impact gravity wave forcing for WACCM, which should be closely monitored.

Aerosol Tuning: The need to check and retune aerosol optical depths (AOD) and sulfate levels again may arise due to (a) surface wind changes (for dust); (b) SOA changes

(chem only); (c) Separate fire emissions based on the CLM fire model and (d) the addition of nitrate aerosols to the modal aerosol model (MAM4). Steve Ghan (PNNL) is finalizing this development, and Xiaohong Liu (U.Wyo.) will assist in implementing it in CESM. We might want to re-tune aerosol scavenging. We will make a final assessment for configurations to be included in any model release.

Code Priorities (by July 1st)

CLUBB Energy and Water conservation: Recent improvements will be included in an experimental tag and are needed for more sensible energy/water conservation and fixes.

Optimization: We have an optimized version of MG2 currently nearing completion, which needs to be fully implemented in the code. It would be desirable to get some help with optimizing the CAM-CLUBB interface. Since the CAM6 configuration is largely finalized we would request CISL's help in providing further optimizations by July 1.

Release Options (September 2nd)

These options are secondary compared to the priority activities.

Convective Microphysics: We have final code for a version of MG2 in ZM. This is ready for code review, and we aim to put this option on the trunk as an option. It is turned on with a namelist switch and has minimal fingers into MG or ZM now, so I think it is clean. There is desire to use this formulation by some in the community (Guang Zhang, Xiaohong Liu, etc), and we have promised to do it to complete an ASR project.

SPCAM: Super-parameterized CAM (SPCAM) is now close to the head of the trunk and will hopefully go on as soon as we complete scientific testing and a final merge. Testing is being done by CSU, PNNL and U. Nanjing. This will be a functional release. We hope to include one or two compsets only as a functional release.

Convective Transport and Scavenging: This is currently on the trunk, but not used. It is available within the ZM scheme only, so it may not have a long lifetime. Problems still exist in trying to reconcile the performance in CAM versus the better performance in ACME. If we identify problems soon then we may be able to move forward with this by Sep 2.

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Ideally this will be an option in CESM2 as I think this would be the only way for it to have any longevity in the code. Of course that is easily said than done, but we may be able to negotiate support through ACME, but that is yet to be determined. A version does exist on the trunk, but needs to be updated.

Release Infrastructure (September 2nd)

SimpleR models

- Aqua-planet with slab ocean model (Medeiros, Benedict)
- Idealized Dynamic Core Test Cases (Polvani, Simpson)
- Single-Column Model (SCAM): Updated IOPs and functionality to create IOPs. Update SCAM compset used with CESM scripts (Gettelman, Truesdale)

Hi-Res CAM/CESM (0.25 deg): We will aim to deliver a uniform 0.25 deg version. The default version will be CAM6 physics out of the box. With some 'traditional' retunings for resolution using a uniform mesh AMIP setup. Scripts to build variable mesh versions (Zarzycki) should be made available. If resources allow we will deliver a variable mesh over CONUS that goes from ne30→ ne120 (0.25 deg) with compset for this. Likely this will have existing CAM6 physics. Will have options and settings for CAM6-DEEP (no ZM scheme, CLUBB does it all) and perhaps CAM6-SILHS (no ZM, CLUBB does it all with SILHS sub-column generator).

Low-Res CAM/CESM (2 deg): Some effort will be invested in a low-resolution (2 deg) version of CAM6 for resource-limited users. Tuning simulations will be minimal (Hannay, Neale) with AMIP and 1850 coupled controls.

Spectral Element (SE) optimized code, SE physgrid and SE CSLAM: SE will not be the default core for CAM6 at low resolution, but datasets will be available to run some simulation configurations. The CSLAM (Lauritzen) tracer-advection code is maturing and a version should be available in the SE core, along with optimizations that will significantly improve performance for the SE core. A separable physics-dynamics grid capability (Goldhaber, Lauritzen) may also be merged onto the trunk for the code freeze, if resources allow. Supporting simulations and default configurations would be needed.

Isotopes This is desirable and resources are being applied to this, but we need to think about how this code will be suitably supported, maintained and developed going forward given past difficulties (Craig, Gettelman, Otto-Blisner). Issue to be overcome with passing isotopic quantities through coupler.