Here we value respectful dialogue, please . . .

CGD's Vision: A Culture of Respect & Belonging

https://www.cgd.ucar.edu/about/diversity

Revised June 2023

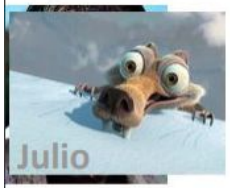
Norm	Meeting Agenda and Action
Share the Air OR Share Speaking Time	MEETING AGENDA: specify time for individuals with different and varied perspectives ACTION: Designate a facilitator (who encourages **sharing**). Speak **concisely** when it's your turn.
Show Appreciation & Acknowledge Teamwork	MEETING AGENDA: Include **bright spots** as an agenda item; create collaborative time during meetings ACTION: Include your **team member's name** on your slides, name who provided you with the idea
Listen to Understand	MEETING AGENDA: everyone **summarizes**; write and **share** meeting minutes ACTION: Ask real questions to **learn more**, not to argue - for example, "Tell me more"
Communicate Context	MEETING AGENDA: Items or discussion start with **background information** ACTION: Describe the **goal/purpose** of the conversation/meeting
Value New Ideas & Encourage Innovation	MEETING AGENDA: specify time for new ideas/innovation, ACTION: "Tell me more," and build on others ideas - "yes, that's great , **and…. (not but)"**
Offer Constructive Feedback	MEETING AGENDA: make time for **review and reflection** ACTION: ask "what worked well?" Check your understanding. Ask "what feedback would be meaningful?"

Julio's slide from CESM workshop, June 13, 2023

Co-chair rotation!!

I will be rotating off after 6 interesting and eventful years.

Peter Lauritzen will become the new internal AMWG co-chair, starting this week.

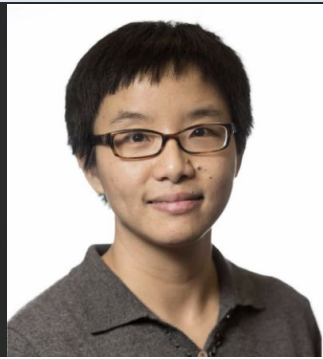


June 2017

late June 2023

AMWG overview
(incl. CAM-SIMA)

Kevin Reed
External AMWG co-chair
Stony Brook University



Hui Wan
External AMWG co-chair
PNNL

Peter Hjort Lauritzen
Internal (NCAR) AMWG co-chair

Cecile Hannay
AMWG Science Liaison

February 12, 2024

This material is based upon work supported by the National Center for Atmospheric Research, which is a major facility sponsored by the National Science Foundation under Cooperative Agreement No. 1852977.

Outline

- CAM code base: What CAM-SIMA means for CAM?
  (SIMA = System for Integrated Modeling of the Atmosphere)
- CESM3/CAM7 timeline
- CAM6 -> CAM7
- CESM3 coupled development

CAM-SIMA will replace CAM as the atmospheric component of CESM. CAM-SIMA will continue to be governed by the AMWG, but through its enabling applications outside CESM's current capabilities, CAM-SIMA will provide a means to pursue different and new types of scientific problems, while broadening the CESM user base and contributing to a more diverse community.

One motivation for CAM-SIMA: physics scheme “clarification” and flexibility

CAM4,5,6 and 7 (currently called cam_dev) physics uses the same “driver code”:

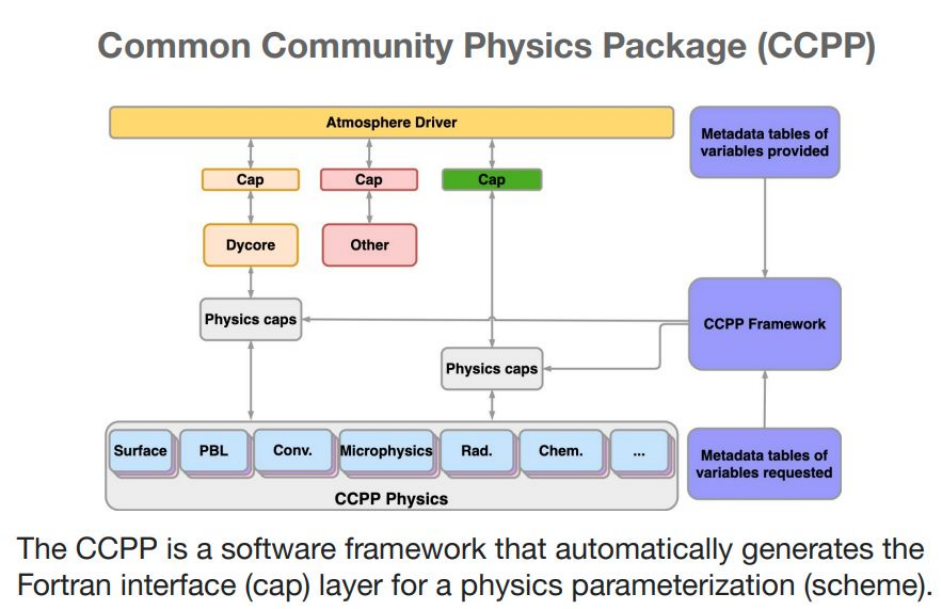
Complicated logic, “hidden” dependencies, hard to change physics scheme ordering (e.g., took months to move CLUBB call from after coupler to before), …

```
if( microp_scheme == 'RK' ) then

   !=================================================
   ! Calculate stratiform tendency (sedimentation, detrain, cloud fraction and microp
   !=================================================
   call t_startf('rk_stratiform_tend')

   call rk_stratiform_tend(state, ptend, pbuf, ztodt, &
        cam_in%icefrac, cam_in%landfrac, cam_in%ocnfrac, &
        cam_in%snowhland, & ! sediment
        dlf, dlf2, & ! detrain
        rliq  , & ! check energy after detrain
        cmfmc,  &
        cam_in%ts,      cam_in%sst,        zdu)

   call physics_update(state, ptend, ztodt, tend)
   call check_energy_chng(state, tend, "cldwat_tend", nstep, ztodt, zero, prec_str, s

   call t_stopf('rk_stratiform_tend')

elseif( microp_scheme == 'MG' ) then
   ! Start co-substepping of macrophysics and microphysics
   cld_macmic_ztodt = ztodt/cld_macmic_num_steps

   ! Clear precip fields that should accumulate.
   prec_sed_macmic = 0._r8
   snow_sed_macmic = 0._r8
   prec_pcw_macmic = 0._r8
   snow_pcw_macmic = 0._r8
```

```
physics/cam/zm_conv_intr.F90:  use phys_control,   only: phys_deepconv_pbl, phys_getopts, cam_physpkg_is
physics/cam/zm_conv_intr.F90:   use phys_control,  only: cam_physpkg_is
physics/cam/zm_conv_intr.F90:  if ( .not. cam_physpkg_is('cam3')) then
physics/cam/zm_conv_intr.F90:  use phys_control,   only: cam_physpkg_is
physics/cam/zm_conv_intr.F90:    else if (nbulk > 0 .and.  cam_physpkg_is('cam4')) then
physics/cam/original1.convect_shallow.F90:  use phys_control,      only : cam_physpkg_is
physics/cam/original1.convect_shallow.F90:      if( cam_physpkg_is('cam3') .or. cam_physpkg_is('cam4') ) then
physics/cam/original1.nucleate_ice_cam.F90:use phys_control,   only: cam_physpkg_is
physics/cam/original1.nucleate_ice_cam.F90:   if (cam_physpkg_is("cam_dev")) then
physics/cam/original1.nucleate_ice_cam.F90:      if (cam_physpkg_is("cam_dev")) then
physics/cam/original1.nucleate_ice_cam.F90:            if (cam_physpkg_is("cam_dev")) then
physics/cam/original1.nucleate_ice_cam.F90:            if (cam_physpkg_is("cam_dev")) then
physics/cam/original1.nucleate_ice_cam.F90:   if (cam_physpkg_is("cam_dev")) then
physics/cam/original1.nucleate_ice_cam.F90:      if (cam_physpkg_is("cam_dev")) then
physics/cam/cospsimulator_intr.F90:  use phys_control,         only: cam_physpkg_is
physics/cam/nucleate_ice_cam.F90:use phys_control,   only: cam_physpkg_is
physics/cam/nucleate_ice_cam.F90:   if (cam_physpkg_is("cam_dev")) then
physics/cam/nucleate_ice_cam.F90:      if (cam_physpkg_is("cam_dev")) then
```

One motivation for CAM-SIMA: physics scheme "clarification" and flexibility

Maintaining code base untenable (with current staffing levels): recommendation from large inter institutional group (NCAR, NOAA, NRL, …) of software engineers was to create CCPP



The CCPP is a software framework that automatically generates the Fortran interface (cap) layer for a physics parameterization (scheme).

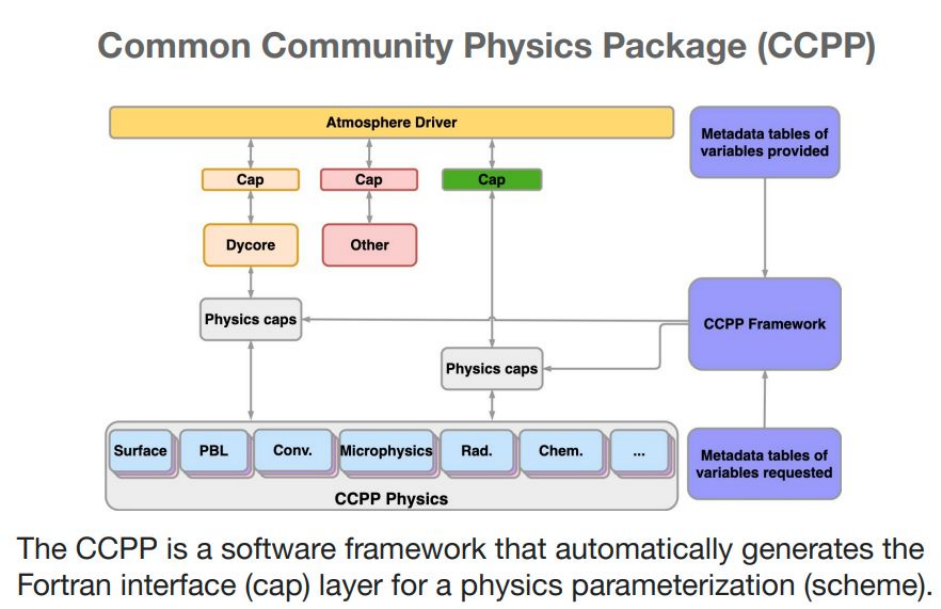
Note:

- The CCPP will always reside in a host model. For example, the host model is responsible for how tendencies from physics are added to the model state (conservation!!!).
- The dycore is not part of the CCPP!
- Once a parameterization is ported we pull it into cam_development (i.e. no duplication of physics schemes in the repositories)

See Jesse Nusbaumer's presentation from last AMWG winter meeting

One motivation for CAM-SIMA: physics scheme "clarification" and flexibility

Maintaining code base untenable (with current staffing levels): recommendation from large inter institutional group (NCAR, NOAA, NRL, …) of software engineers was to create CCPP



The CCPP is a software framework that automatically generates the Fortran interface (cap) layer for a physics parameterization (scheme).

Status of CCPP'ization of CAM:

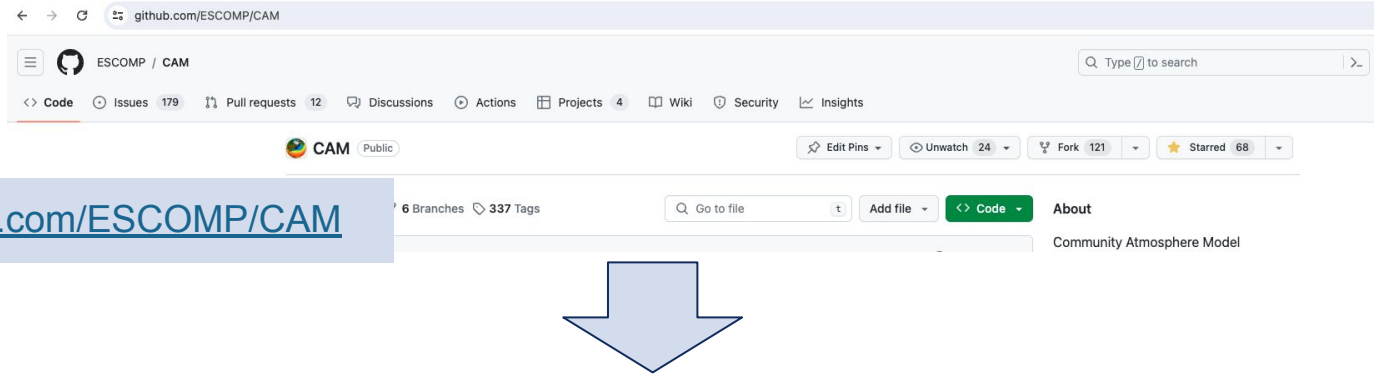
- Close to done with porting CESM simpler models physics to the CCPP
- CAM7 physics to be ported by end of FY25. Full chemistry and aerosols will be ported by end of FY25 or soon afterwards
- Funded NSF CSSI proposal for porting CAM4,5,6ish

See Jesse Nusbaumer's presentation from last AMWG winter meeting

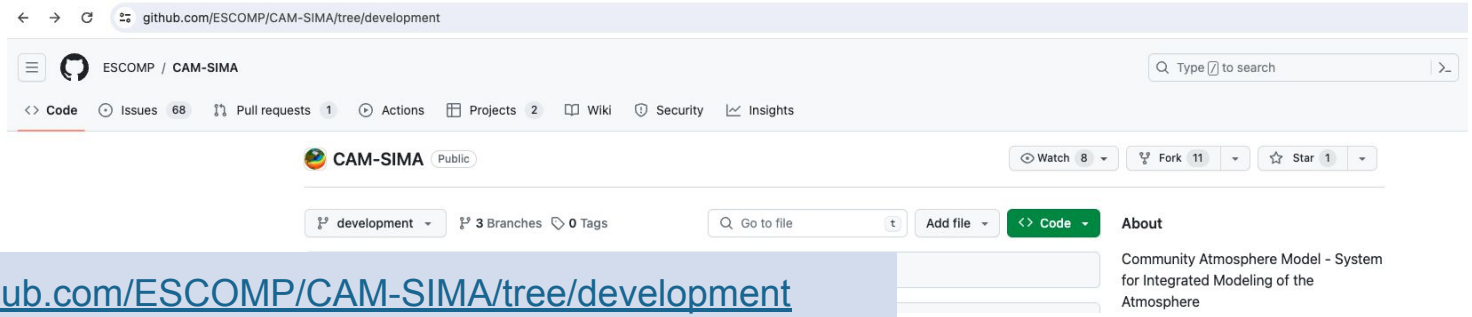
For example, not porting old radiation package (will use RRTMG-P), …

CAM-SIMA: New infrastructure to support CCPP and other functionality

A new code repository for CAM (to be released with CESM3.x where x>0):



https://github.com/ESCOMP/CAM



https://github.com/ESCOMP/CAM-SIMA/tree/development

CAM-SIMA: New infrastructure to support CCPP and other functionality

A new code repository for CAM (… release … CESM3.x where x>0):

https://github.com/E…

Very important for developers and users of CAM: What is not ported to CAM-SIMA will not be available and supported long term …

Note that standard configurations of CAM4,5,6,7, CAM-Chem, WACCM, WACCM-x will be supported

https://github.com/ESCOMP/CAM-SIMA/tree/development

Note: Our policy is that we support released code for 5 year:

Hence cam_development (part of CESM3.0 release) will be supported for 5 years after the release date!

https://www.cesm.ucar.edu/about/support

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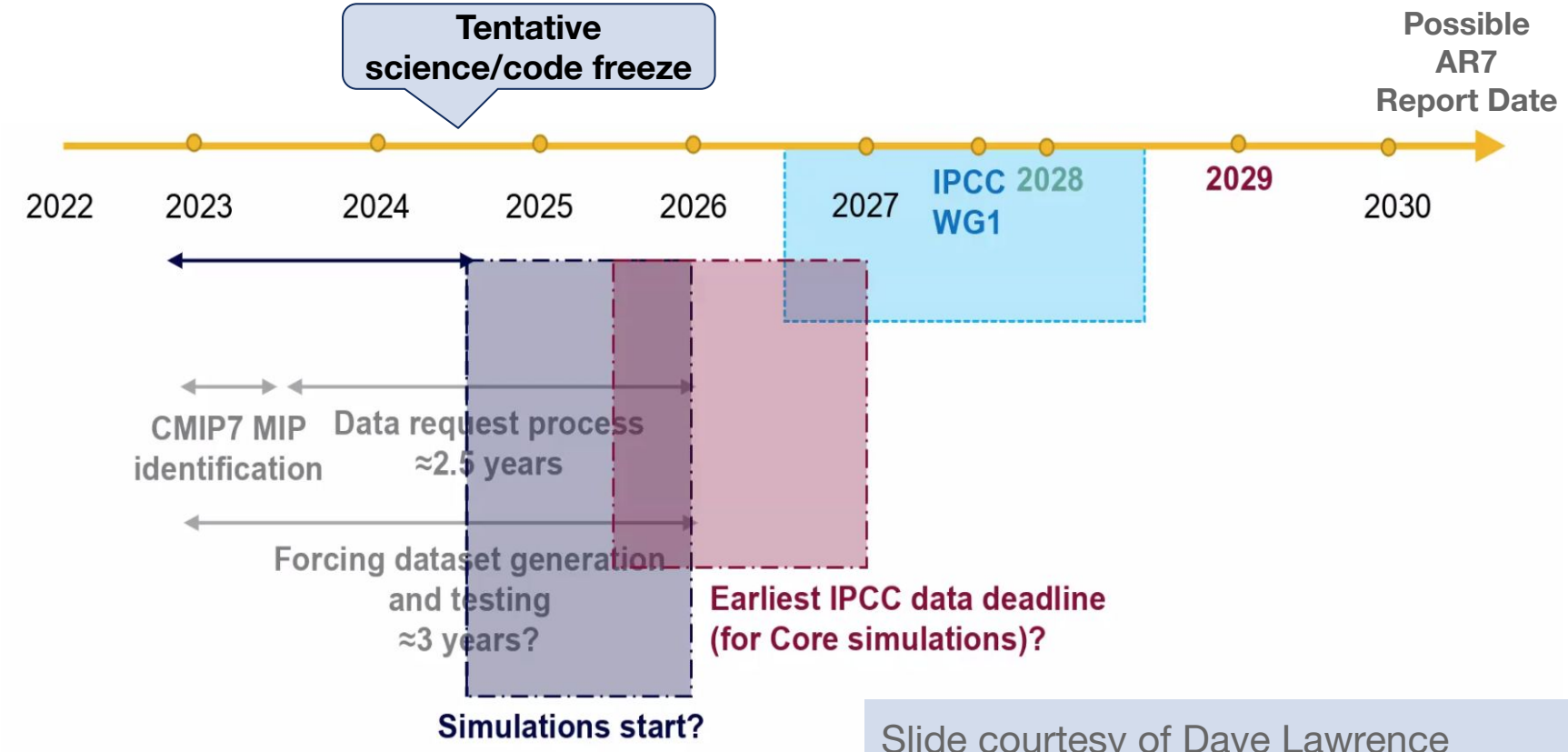
Draft CMIP7 Timeline



Slide courtesy of Dave Lawrence

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From CAM6 towards CAM7: what is already part of CAM7?

Increase vertical resolution (~93 levels; incl. extra layers in boundary layer) and raise model top to ~80km (new COMPSET name FMTHIST, low top version FLTHIST with 58 levels)

Some WACCM settings now default in FMT/FLT: Same simplified chemistry in low and high top (CO_2 is advected and radiatively active), unified treatment of gravity waves

Changed dynamical core from FV (used for CAM4,5,6) to spectral-elements (SE): lots of changes to the original HOMME dynamical core (dry-mass vertical coordinate, incl. condensates in pressure and energy, reference profiles to alleviate noise of steep orography, physics grid, CSLAM transport scheme, …

Switched from MG to PUMAS microphysics code base (incl. several science changes)
Updated L-scale CLUBB code with prognostic momentum transport

From C

PUMAS v1

Fall speed correction for rain/snow/graupel

Adjust ice number limiter (independent of aerosols, at end of scheme)

Adds in vapor deposition onto snow as a process

Implicit fall speed for sedimentation

Accretion to see newly autoconverted rain (liquid only)

PUMAS is an external to CAM: https://github.com/ESCOMP/PUMAS

See more details from A. Gettelman's presentation from last AMWG winter meeting
https://www.cesm.ucar.edu/sites/default/files/2023-03/2023-AMWG-A-Gettelman.pdf

M7?

Increase ve
(new COM

odel top to ~80km

Some WAC
(CO2 is ad

igh top

Changed d
original HC
reference p

f changes to the
ssure and energy,
scheme, …

Switched from MG to PUMAS microphysics code base (incl. several science changes)
Updated L-scale CLUBB code with prognostic momentum transport

From CAM6 towards CAM7: almost or maybe in CAM7

CLUBB taus code (science evaluation ongoing): L-scale or taus for CAM7? It's decision time ...

Convective gustiness parameterization (PR submitted)

New gravity wave drag parameterizations (not in code base yet; science evaluation ongoing)

New radiation code base (RRTMG-P) (PR almost done)

Thermodynamically more advanced coupling between MOM6 and CAM7: Enthalpy fluxes
(code almost ready for science evaluations; code changes involve coupler code CMEPS)

One presentation per arrow* this afternoon …

14:05	The impact of vertical resolution on the representation of the large scale circulation within CAM	Isla Simpson
14:20	Changes to the hydrostatic spectral-elements dynamical core for CESM3: SE-CSLAM	Peter Lauritzen
14:35	**Break**	
14:50	Assembling tropospheric physics in a pre-industrial coupled setup	Adam Herrington
15:05	Comparing the CLUBB-L and CLUBB-taus damping algorithms in CAM and CESM experiments	Ben Stephens
15:20	Convective gustiness	Meg Fowler
15:35	Drag parameterizations and stratospheric wind biases	Julio Bacmeister
15:50	RRTMG-P update	Brian Medeiros

*SE dycore and enthalpy flux arrows in same talk (because they are intrinsically related!)

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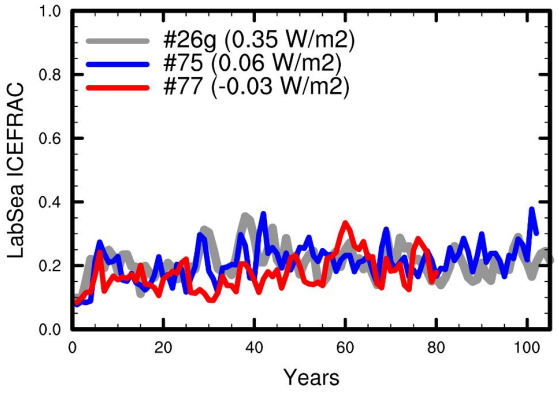
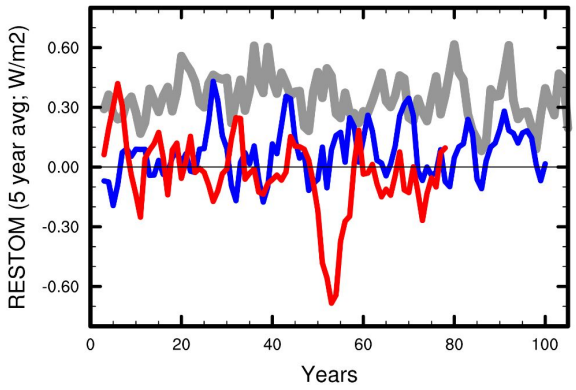
Two candidate CAM7 configurations based on two versions of CLUBB: L and taus





Configurations

#26g: Coupled Evaluation 1

- L58, ZM2, physics reordering, subcycle surface fluxes in macmic loop
- MOM6, CICE5/6

#75: Coupled Evaluation 2 - CLUBB-L

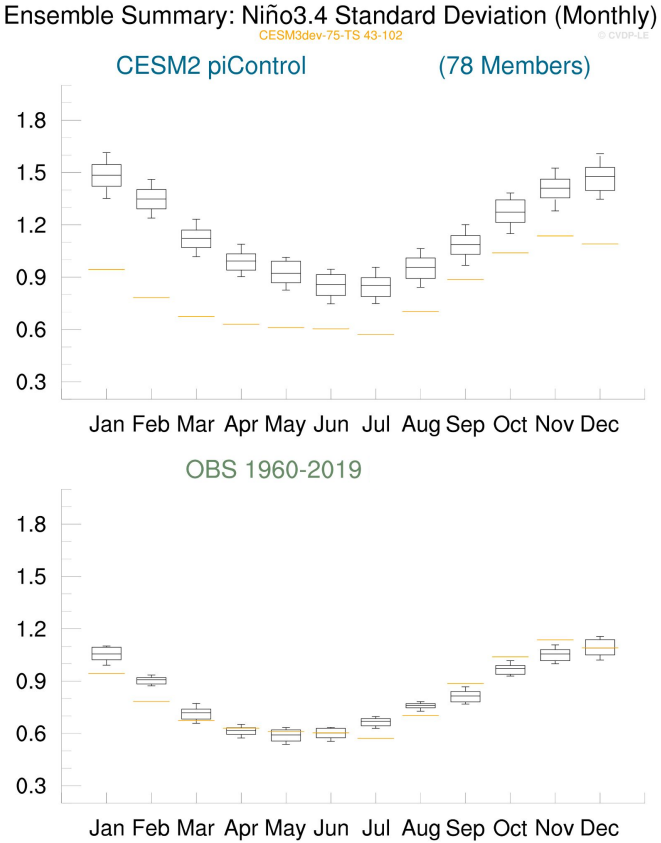
- Update PUMAS, update CLUBB, update MAM, HB above diff.

#77: Coupled Evaluation 2 - CLUBB-taus

- Same as #75 but using CLUBB taus code

More details in Adam Herringtons talk later today …

Nino3.4 index

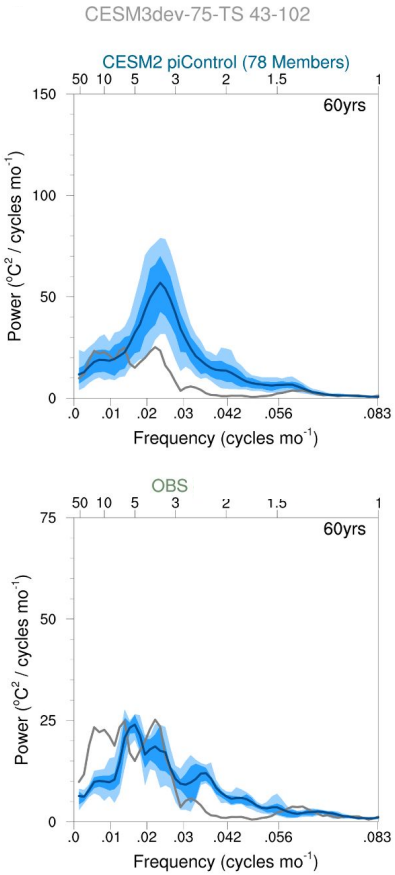


Left: The orange lines represent values from CLUBB-L configuration (#75), and are the same for both panels. The top panel box plots (showing 10%/25/median/75/90% values) represent the spread seen in the 78 60yr slices from the CESM2 piControl. The bottom panel box plots represent the spread seen in 13 overlapping 60yr periods from observations.

"The match between CLUBB-L config. and observations seen in the bottom panel is likely the best I've ever seen from a CESM run." A. Phillips

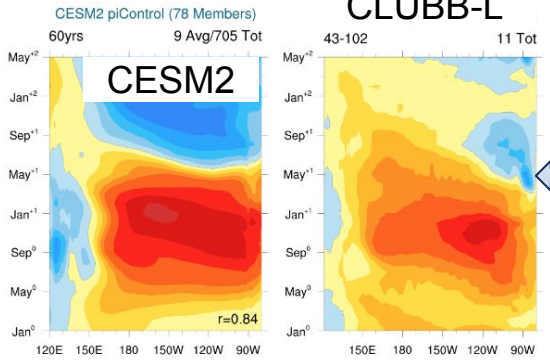
Right: Frequency analysis

Disclaimer: #75 is only 60 years!



Plots courtesy of Adam Phillips

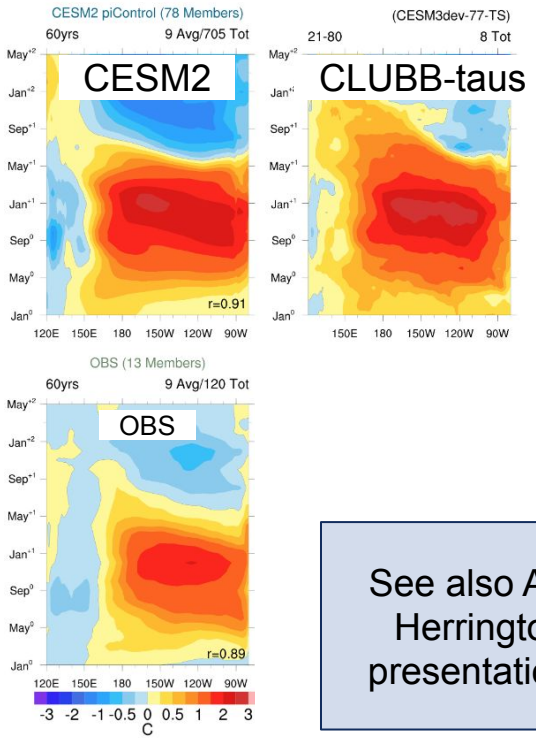
Hovmoller diagrams



El Nino's not transitioning to La Nina's in 75 (similar to other CESM developmen versions)

CLUBB-L configuration

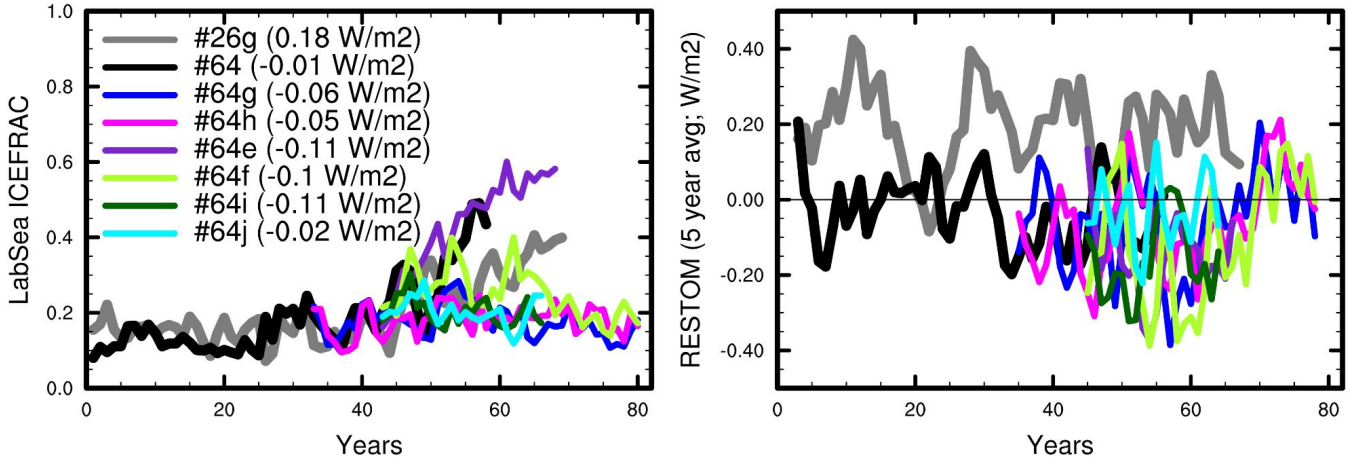
CLUBB-taus configuration



See also Adam Herrington's presentation …

Plots courtesy of Adam Phillips

Labrador sea freeze: Perturbation experiments



Perturbations of 64 (total 7 runs):
64e,64f,64i,64j: starting from 64 at yr 43
64g,64h: starting from 64 at yr 33
Only 64, 64e has frozen

Disclaimer: Sample size is small …