

Introductory remarks for joint AMWG/ESPWG/CVCWG/CCWG/WAWG winter meeting

AMWG = ATMOSPHERIC MODEL WORKING GROUP

- WAWG = WHOLE ATMOSPHERE WORKING GROUP
- CCWG = CHEMISTRY CLIMATE WORKING GROUP

ESPWG = EARTH SYSTEM PREDICTION WORKING GROUP CVCWG = CLIMATE VARIABILITY AND CHANGE WORKING GROUP February 3, 2025

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.

Why combine the 5 working group winter meetings into one?

• Increase collaboration across working groups:

model developers <-> model users

- Joint discussion on model performance
- Get community input to inform model development and experiment design in CESM3 and beyond (configurations, bias reduction, ...)
- Reduce meeting load



Structure of joint sessions:

- Overview from "model development" heavy working groups
- Coupled model evaluation
- Specific features of new model

Monday, February 3rd, Main Seminar Room

* All times are MST; Speakers: please leave 5 min at the end of your slot for questions.

Time		Торіс	Speakers
	13:00	Overview of what's new in CAM7	Peter Lauritzen
	13:20	Overview of what's new in Chemistry/aerosols	Simone Tilmes
J	13:40	Overview of what's new in high top modeling	Nick Pedatella/Martina Bramberger
		Coupled model evaluation	
	14:00	Current status of CESM development simulations	Isla Simpson
\sum	14:20	High frequency variability	Rich Neale
	14:40	Assessing the El Niño Southern Oscillation in development versions of the Community Earth System Model (CESM)	Meg Fowler
	15:00	BREAK	
	15:30	AERO-MAP: A data compilation and modelling approach to understand spatial variability in fine and coarse mode aerosol composition	Natalie Mahowald
		Specific features of new model	
	15:50	Update on gravity wave sources for CAM	Julio Bacmeister
	16:10	New developments of modeling mineral dust cycle in CESM3/CAM7	Danny Leung
	16:30	Impact of vertical resolution and model top height on stratospheric large-scale circulation	Martina Bramberger
	16:50	Adjourn to Southern Sun for Happy Hour	



Structure of joint sessions:

 Updates from "model evaluation" and "model user" heavy working groups and talks of interest to all working groups

Tuesday, February 4th, Main Seminar Room

* All times are MST; Speakers: please leave 5 min at the end of your slot for questions.

Time	Торіс	Speakers		
9:00	CVCWG updates	Isla Simpson/Aixue Hu/Sarah Larson		
u 201	9:20 An introduction to MethaneMIP: Investigating the climate and health benefits of methane mitigation			
9-201	Future International Assessment Exercises using the Whole Atmosphere Community Climate Model	Doug Kinneson		
10:00	Introduction to ESPAT	Yaga Richter		
10:20	ESPWG updates	Steve Yeager/Kathy Pegion		
10:20	BREAK			
م 11:10	Predictability of Temperature Extremes in Multi-Annual Forecasts.	Eirini Tsartsali		
11.50	Seasonal Predictability of Vapor Pressure Deficit in the western United States	Melissa Breeden		
11.20	Advancing Long-Range ENSO Prediction through Large Ensemble Data and Transfer Learning with AI/ML Approaches	Sathish Chandra Akula		
	Diagnosing Land-Atmosphere Coupling Strength from MPAS-NoahMP in S2S forecasts	Zhe Zhang		



Structure of joint sessions:

 High resolution projects in CESM

 Machine learning in/with CESM

Tuesday, February 4th, Main Seminar Room

* All times are MST; Speakers: please leave 5 min at the end of your slot for questions.

Time	Торіс	Speakers
r		
	high resolution modeling	
13:30	MESACLIP project and update	Gokhan Danabasoglu
13:50	D EarthWorks Progress	Dave Randall
14:10	Atmospheric rivers driven precipitation extremes in non-hydrostatic CESM simulations over the Western US	Xingying Huang
14:301	Al-empowered Next-generation Multiscale Climate Modeling for Mitigation and Adaptation	Veronika Eyring
14:50	LEAP/M2LInES overview	Dave Lawrence
15:10	BREAK	
	Machine learning	
15:30	CAMulator: Fast Emulation of the Community Atmosphere Model	Will Chapman
15.501	A Roadmap for ML-assisted Ice Microphysics Parameterizations in PUMAS	Joseph Ko
16:10	Implementation of a neural-network convection scheme in the Community Atmosphere Model	Paul O'Gorman
	Probabilistic Machine Learning for Stochastic Parameterization of Deep Convection Triggering	Greta Miller
16:50	Adjourn	



Wednesday AM:

ESPWG/CVCWG (Main seminar room) & AMWG (Damon room) parallel sessions

Wednesday PM:

Thursday AM:

CCWG/WAWG (Damon room)

ESPWG/CVCWG (Main seminar room), CCWG/WAWG (Damon room) & AMWG (CLUBB tutorial in ML-Chapman room) parallel sessions

CGD seminar Thursday at 11AM (Main seminar room):

Skillful high-resolution seasonal climate forecasts using model-analogs

Dillon Amaya (NOAA)





What is new in CAM7?

Peter Lauritzen on behalf of all CAM developers (Adam Herrington, Ben Stephens, Brian Eaton, Brian Medeiros, Cheryl Craig, Christina McCluskey, Colin Zarzycki, Courtney Peverley, Dan Marsh, Douglas Kinnison, Francis Vitt, Hanli Liu, Isla Simpson, Jack Chen, Jesse Nusbaumer, Jiang Zhu, Jim Edwards, John Truesdale, Julio Bacmeister, Katherine Thayer-Calder, Keith Lindsay, Martina Bramberger, Meg Fowler, Mijeong Park, Patrick Callaghan, Patrick Callaghan, Qingyuan Yang, Rich Neale, Rolando Garcia, Simone Tilmes, Thomas Toniazzo, Vince Larson, Yuanpu Li, ...)

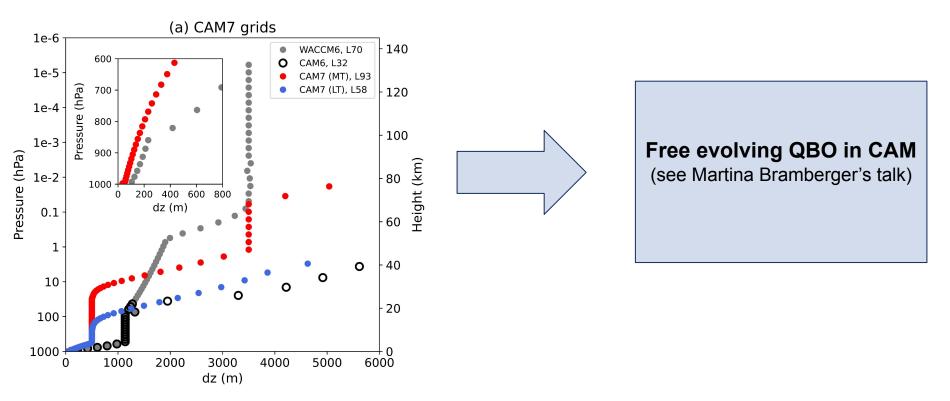
February 3, 2025

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- raise lid and have sufficient resolution for a well-resolved stratosphere
- increase boundary layer resolution
- adopt scalable dynamical core and non-hydrostatic dycore options
- advance existing boundary layer and microphysics schemes
- adopt new parameterizations (e.g., convective gustiness parameterization, new gravity wave source, new dust emission scheme)
- re-ordering physics time-loop
- major steps towards generalized thermodynamics in CAM physics
- continued expansion of simpler models effort
- constantly improving our code base and trying to reduce scope!
- much improved workflow (both simulation tracking, diagnostics and software development, ...)
- adoption of RRTMG-P radiation package
- — and a lot more …



Raise lid and have sufficient resolution for a well-resolved stratosphere

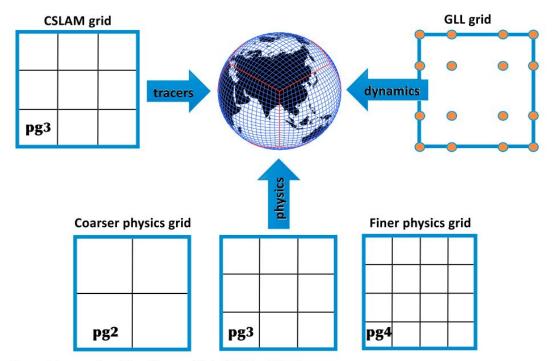


[Isla Simpson has submitted manuscript on behalf of the vertical resolution task force]



Adopt scalable dynamical core and non-hydrostatic dycore options

Spectral-element dynamical core using separate physics grid and conservative semi-Lagrangian transport scheme



Highly scalable

- More advanced thermodynamics (variable latent heats, molecular diffusion operators, ...)
- Mesh-refinement capability
- Excellent conservation properties (mass, angular momentum, ...)

Figure 1. An overview of the different grids in CAM-SE-CSLAM.



Adopt scalable dynamical core and non-hydrostatic dycore options

Model for Prediction Across Scales (MPAS):

- Non-hydrostatic dynamical core developed by NCAR's MMM
- Sustainable implementation (i.e. dynamical core pulled as an external to CAM)
- Being used in EarthWorks project and NCAR's ESPAT initiative.

(see presentations by Dave Randall and Yaga Richter)

- Deep atmosphere option being developed/explored
- GPU version exists



DOE's E3SM non-hydrostatic dynamical core:

- Being imported into CAM under <u>StormSPEED</u> project
- Similar to NCAR's CAM-SE dycore in terms of cubed-sphere grid and separate physics grid capability but:

*Non-hydrostatic *Ultra-fast semi-Lagrangian transport scheme *C++ version with Kokkos support GPU's *Separate physics grid and semi-Lagrangian transport supported for mesh-refinement

NSF StormSPEED

The 'Storm-resolving SPEctral Element Dycore' for CESM3



Adopt new parameterizations

 Missing process: Convective gustiness parameterization (capture impacts of convective outflows on surface meteorology)

See Meg Fowler's talk

 Missing source of gravity waves: "Moving mountains" (major improvements in stratospheric jet biases)

See Julio Bacmeister's talk

• New dust emission scheme: Adding surface rocks and vegetation on inhibiting emission, wind gusts on dust episodes (fixing regional dust biases)

See Danny Leung's talk



Much improved workflow: Simulation tracking and diagnostics

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f.e30_alpha04a.FMTHIST.ne30_L93_tuning.010 #616				diagnos	This repository contains the Atmosphere Model Working Group (AMWG) Diagnostics Framework (ADF) diagnostics python package, which includes numerous different averaging, re-gridding, and plotting scripts, most of which are provided by users of CAM itself.			
	cecilehannay opened on Nov 8, 2024			two diff	Specifically, this package is currently designed to generate standard climatological comparisons between either two different CAM simulations, or between a CAM simulation and observational and reanalysis datasets. Ideally this will allow for a quick evaluation of a CAM simulation, without requiring the user to generate numerous different figures on their own. Currently, this package only uses standard CAM monthly time-slice (h0) outputs or single-variable monthly time series files. However, if there is user interest then additional model input options can be added.			
	Purpose: seasalt tuning with new dust			Current				
	Description: same as <u>#612</u> except				Finally, if you are interested in general (but non-supported) tools used by AMP scientists and engineers in their work, then please check out the <u>AMP Toolbox</u> .			
	<pre>seasalt_emis_scale = 1.5D0</pre>				https://github.com/NC	CAR/ADF		
https://github.com/NCAR/amwg_dev (AMIP-like runs)					optionally run CVDP and MDTF,			
https://github.com/NCAR/cesm_dev (coupled runs)					and is getting integrated with the CUPiD workflow.			



Much improved workflow: Software-science workflow & reduce scope

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O PR - Review Not Started 11	O PR - Initial Review 2 ····	O PR - Full Review 6	O Next Tag 8	O CAM Tags 350
C Draft New PRs Since Last Meeting	Image: CAM #1210 Image: CAM #1210 New CARMA trop_strat aerosol model Image: CARMA trop_strat aerosol model Image: Treviewer Image: CARMA trop strategies	C Draft This week's prioritized list for upcoming tags- To Do	Oraft Preferred CAM tag ordering:	\$ CAM #1194 cam6_4_057: Restore spectral scaling to RRTMGP Tag answer changing CoupledEval3
1 CAM #1226 Fix broken GPU tests for CLUBB code IBB (bugrin Coxpleditval) © 1 reviewer 1 CAM #1214) Draft PRs on hold To Do	CCPP fization round 4 (completes CCPP conversion of ZM) CCPP conversion CCPP	CAM #1231 Cam 6.4_058: Fix Exner bug in CLUBB interface and change CLUBB namelist In Progress Coupledizal X 1 reviewer	C Draft
Clean up (all SE dycore) Done CoupledEval3 @ 1 reviewer CoupledEval3 @		Th CAM #1114 Pertlim fix for MPAS CoupledEval3 % 1 reviewer	12 CAM #1242 part of cam6_4_058: Switch to correct tape for tphysac/tphysbc snapshot bug-fik 22 1 reviewer	S= CAM #1216 cam6_4_056: Nitrogen deposition fluxes Tag T2 2 reviewers
Remove SPCAM GEB CoupledExal3 (\$ 1 reviewer)		Draft Reviews completed - blocked To Do	11 CAM #1230	<pre>\$* CAM #1203 cam6.4_055: Add QPLT and QPMT com plus misc. Tag BFB enhancement 22 1 review</pre>
Update externals to match beta05 externals Th CAM #1221 Fix HEMCO ERS tests Th reviewer		Draft Progress: PRs on HOLD → ESCOMP/CAM #628 [replaces ESCOMP/CAM #595 (SCAM forcing)] - John will work on this after his upcoming SCAM tag To Do	CoupledEval3 & 1 reviewer CoupledEval3 & 1 reviewer CAM #1234 Cam6,4_060: Preserve constant dry mixing ratios in gw_drag and vertical diffusion code CoupledEval3 & 1 reviewer	part of cam6.4.055: add clim_modal_aer around aero prop call in cam7 Done bug CoupledEval3
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https://github.com/ESCOMP/CAM



Q Search

Much improved workflow: Software-science workflow & reduce scope

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New product available: "CAM7" high resolution simulations

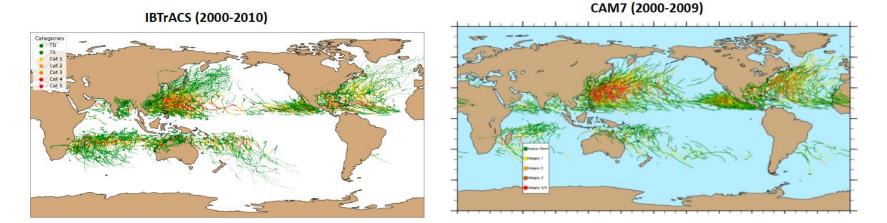
- We have performed "quarter degree" / ne120 / 27km runs with CAM7
- 10 year F-cases with (see <u>https://github.com/NCAR/amwg_dev/</u> for details):
 - L93, L58 vertical grids, as well as L32 (i.e. CAM6 vertical grid)
 - Sensitivity test with Prognostic CLUBB momentum flux replaced by diagnostic
 - SST and SST+4K
- More questions? Contact Cecile Hannay (<u>hannay@ucar.edu</u>)





Quarter degree CAM7

• Reasonable **tropical cyclone track** climatology (more from Ben Stephens Wed 11:20)



- Improvement in southern hemisphere polar vortex simulation
 - **Degradation in some seasonal means** (i.e. monsoon, double ITCZs)





