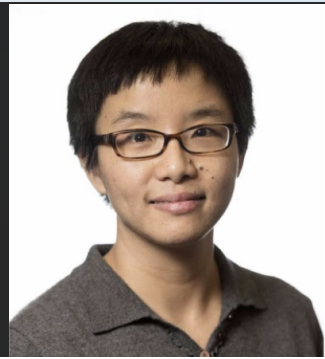
Atmosphere Model Working Group (AMWG)

Welcome!



Kevin Reed
External AMWG co-chair
Stony Brook University

Peter Hjort Lauritzen
Internal (NCAR) AMWG co-chair

Cecile Hannay
AMWG Science Liaison

Hui Wan
External AMWG co-chair
PNNL

June 9, 2025

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Model	CCM2/3 CSM1	CAM2 CCSM2	CAM3 CCSM3	CAM4 CCSM4	CAM5 CESM1	CAM6 CESM2	CAM7 CESM3
Release	**June 1998**	**May 2002**	**June 2004**	**Apr 2010**	**June 2011**	**June 2017**	
PBL	HB	HB	HB	HB	UW	CLUBB	CLUBB updated
Shallow conv.	Hack	Hack	Hack	Hack	UW	CLUBB	CLUBB updated
Deep conv.	ZM	ZM	ZM	ZM_mod1	ZM_mod1	ZM_mod2	ZM_mod3
Microphysics	RK	RK	RK	RK	MG1	MG2	PUMAS
Macrophysics	Sundqvist	Zhang	Zhang	Zhang	Park	CLUBB	CLUBB updated
Radiation	Briegleb	Briegleb	CAMRT	CAMRT	RRTMG	RRTMG	RRTMG**P**
Aerosols	Uniform	Uniform	BAM	BAM	MAM3	MAM4	MAM4 (/w strat. chem. MAM5)
Drag/Gravity waves	IsoOGW				NOGW/TMS	AnisoOGW/ Beljaars	Moving mountains source
Dynamics	Spectral	Spectral	Spectral	FV	FV	FV	SE
Levels	18	26	26	26	30	32	(58)/93
Model top	~42km	~42km	~42km	~42km	~42km	~42km	(~42km)/~80km
Horiz. res	~3 degree	~3 degree	~3 degree	~1 degree	~1 degree	~1 degree	~1 degree/(~0.25 degree)
Land/Ocn	LSM/NCOM	CLM2/POP	CLM3/POP	CLM4/POP2	CLM4/POP2	CLM5/POP2	CLM6/MOM6

Prognostic momentum fluxes

Modifications primarily for increased boundary layer resolution

Ice number limiter
Fall speed correction
…

Unification CAM <->WACCM in treatment of gravity waves

New dycore

Increased boundary layer resolution

Raise model top to ~80km for well resolved stratosphere

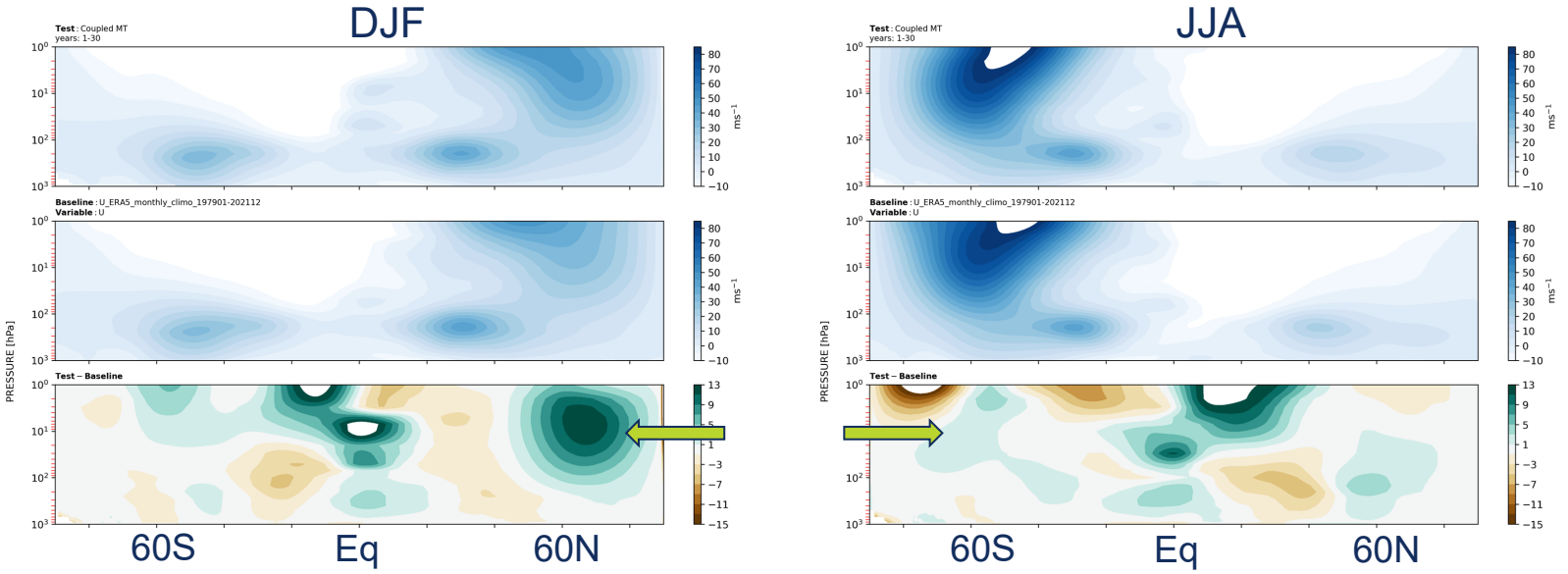
TMS – Turbulent Mtn Stress
NOGW – non-orographic GW
{Iso/Aniso}OGW – isotropic/anisotropic orog. GW

MG – Morrison Gettelman
UW – U. Washington
CLUBB - Cloud Layers Unified By Binormals

ZM – ZhangMcFarlane
HB – HoltslagBoville

RRTMGP – Rapid Radiative Transfer Model
MAM – Model Aerosol Model
RK – RaschKristjánsson

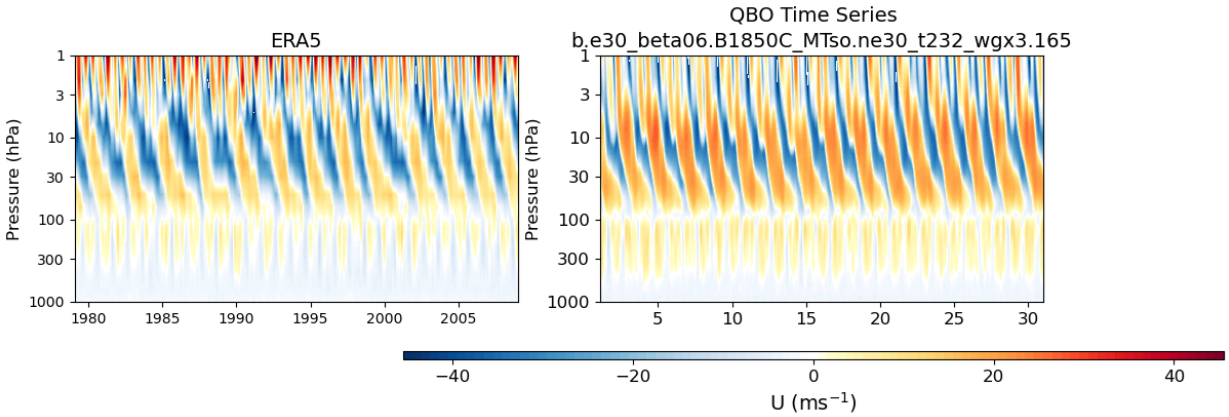
CAM7: zonal mean zonal winds

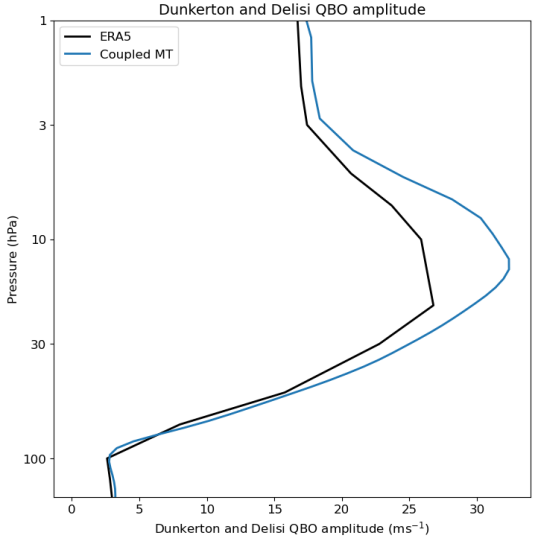


- Very good agreement of SH polar vortex with ERA5 (only about 3m/s difference to ERA5!)
- NH polar vortex still needs tuning

Introducing the moving mountain parameterization greatly improved SH polar vortex in CESM

CAM7: The Quasi-biennial Oscillation (QBO)





- QBO amplitude in good agreement with ERA5 below 30hPa
- QBO period too fast and westerly phase too strong

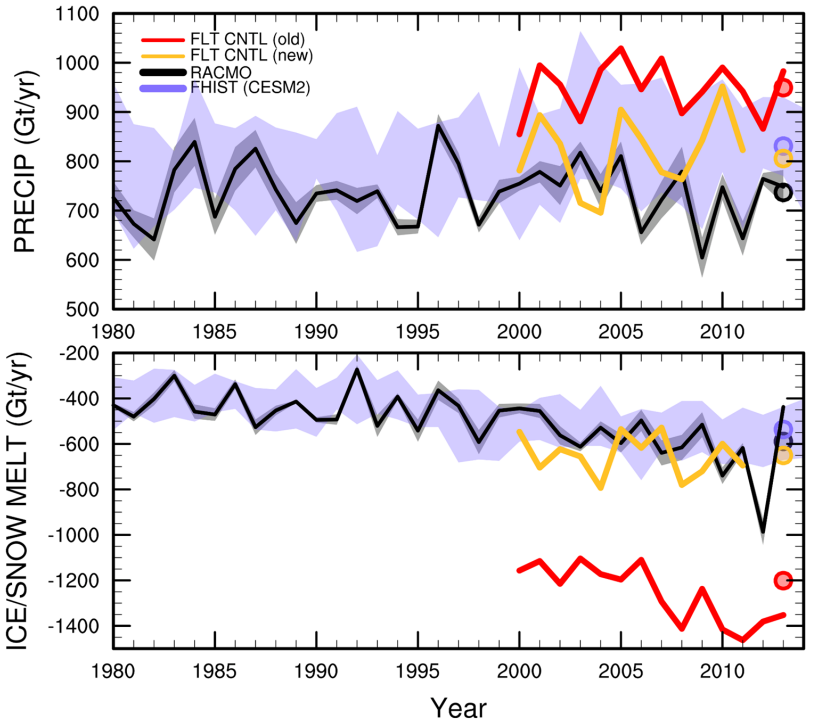
working on new low-frequency gravity wave parameterization in the tropics to mitigate the westerly bias

CAM7: Greenland surface mass balance

Improving biases in precipitation and melting over the Greenland Ice Sheet

- Greenland is not well resolved at 1˚, requiring tuning of CESM3 to bring it closer to observations (***compare red to gold***)
- As in CESM2, artificially enhance sub-grid orography along the Greenland coasts to ***reduce excessive precipitation***
- ***Reduced excessive melting*** through switching to the Jordan snow conductivity scheme over ice sheets

Ice Sheet-wide precipitation and ice+snow melt



Community simulations: “CAM7” high resolution simulations

10-year F-cases:

- ne120/ne30 horizontal grids
- L93, L58, L32 vertical grids
- Sensitivity test with Prognostic CLUBB momentum flux replaced by diagnostic
- SST scenarios: SST and SST+4K
- details in https://github.com/NCAR/amwg_dev/ discussion #706

Some key Characteristics:

- Reasonable tropical cyclone track climatology
- Improved simulations of southern hemisphere polar vortex
- Some degradation in seasonal means (e.g., monsoon systems, double ITCZs)

Contact

- More questions: Cecile Hannay (hannay@ucar.edu)

Monday, June 9th, 1:30 - 5pm

** All times are MDT; **Speakers**: 10 min. talk. Please leave 2 min at the end of your slot for questions.*

Time	Topic	Speakers
01:30	CAM7 development update	Peter Lauritzen
01:36	Use of tuning diagnostics to understand CAM behavior	Vincent Larson
01:48	Cyclones at Quarter-Degree Resolution: Updated CAM with Prognostic Vs. Diagnostic Momentum Fluxes Compared to CAM5 and CAM6	Ben Stephens
02:00	The CLUBB+MF Approach: Results from the Unified Mixing Parameterization CPT Project	Adam Herrington
02:12	Aerosol Effects on Ice Clouds in a CAM6 Perturbed Parameter Ensemble	Brandon Duran (remote)
02:24	The impact of model resolution on climate in NorESM3	Ada Gjermundsen (remote)
02:36	Enhancing CAM Microphysics: BOSS Warm Rain and Unified Ice Options in PUMAS	Trude Eidhammer
02:48	Development of High-resolution Taiwan Earth System Model	Wei-Liang Lee (remote)
03:00	**Break**	
03:30	Using an Aqua-planet Model to Understand Future Changes in the Quasi-Biennial Oscillation	Aaron Johnson
03:42	Insights from the 2025 Dynamical Core Model Intercomparison Project (DCMIP-2025)	Christiane Jablonowski
03:54	QBO, gravity wave, and deep convection responses to surface warming in GFDL AM5 simulations	Lan Luan
04:06	EarthWorks Update	Dave Randall
04:18	Linear stability of divergence and vorticity damping on gnomonic cubed-sphere grids.	Timothy Andrews
04:30	Deep-atmosphere dynamics in Aquaplanets: an E3SM/CESM intercomparison	Owen Hughes
04:42	Mitigation of the double-ITCZ bias by inclusion of the nontraditional Coriolis terms	Hing Ong
04:54	Discussion	
5:00	Adjourn	

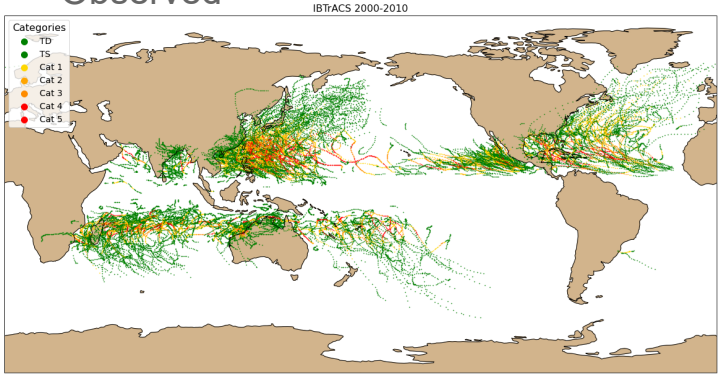
No posters

Group photo

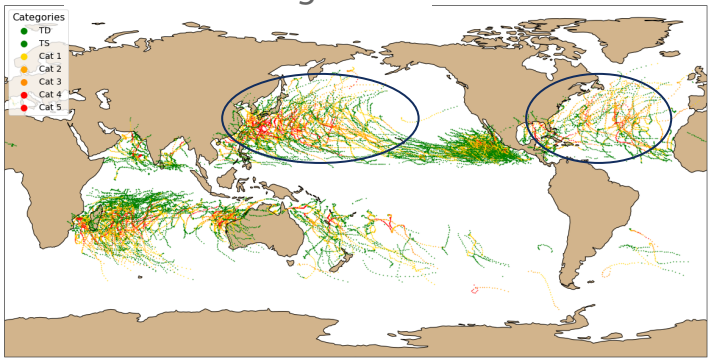
Extra slides

Tropical Cyclone tracks (2000-2010)

Observed

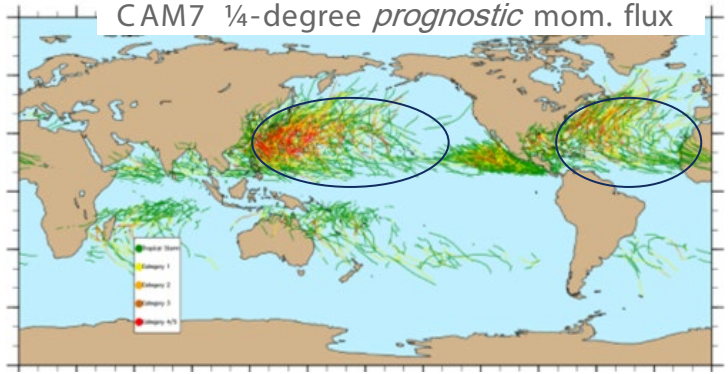


CAM5 ¼-degree



- Action in these basins is shifted west and south w/resp to what it was in CAM5
- Recurvature is better simulated in CAM7
- Implies landfall/impact statistics might be better in CAM7
- TC counts too high: ~160% of obs

CAM7 ¼-degree *prognostic* mom. flux



Thanks to:
Ben Stephens, Cecile Hannay (CGD)
Colin Zarzycki (PSU)

On-going work:

- Exploring sensitivity to convective time scale
- NH focused variable resolution domain (⅓ cost)
- Recent results in excellent agreement w/ NH TC counts ~50/year

Ultra high resolution CAM7

DYAMOND = DYnamics of the Atmospheric general circulation Modeled On Non-hydrostatic Domains

- Provides a framework for the intercomparison of global storm-resolving models (Stevens et al., 2019)

- DYAMOND1 (summer) 40-day run starting on 1 August 2016
  - Completed
  - Bug in diagnostic pressure field, add'l sponge layer diffusion
- DYAMOND2 (winter) 40-day run starting on 20 January 2020
  - 30 of 40 days completed
  - Snow depth bug in CLM
- DYAMOND3 (annual) 1-year run starting on 1 March 2020
  - NSC allocation awarded (A. Herrington, Y. Tian, H. Li, D. Leung, P. Lauritzen, F. Judt)
  - Plan to start in the winter, after an extensive tuning & calibration phase

Adam Herrington (CGD, NCAR)
Brian Dobbins (CGD, NCAR)

CESM3 km-scale configuration:

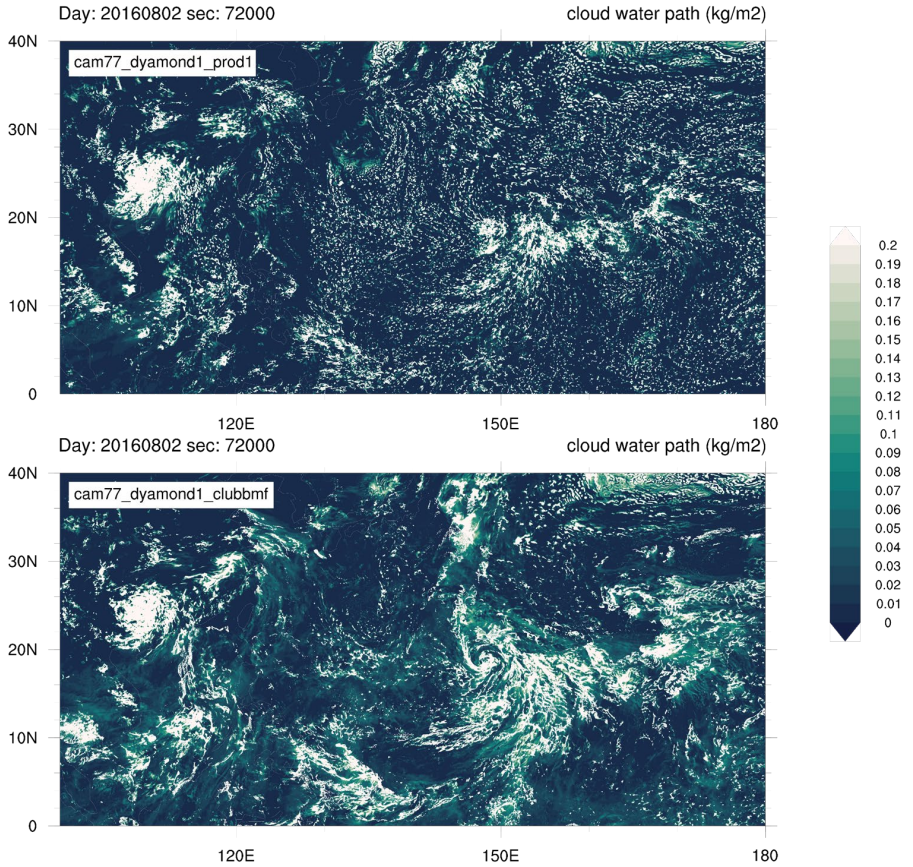
- dx = 3.75 km CAM-MPAS (58 vertical levels)
- dx = 3.75 km CLM6
- dx = 3.75 km data ocean and sea-ice

Ultra high resolution CAM7

Using *CLUBB+MF in 3.75 km CAM-MPAS improves transitional cumulus regimes

- ❑ CLUBB is the only convection scheme active (shallow convection)
- ❑ Running with CLUBB+MF results in **less ‘patchy’ deep convection and a more realistic spectrum of clouds**

*CLUBB+MF is CLUBB augmented with an ensemble of stochastic mass flux plumes (Suselj et al. 2019; Witte et al. 2022)



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