

CAM and AMWG activities towards CESM2

Rich Neale and many, many others!

AMP/CGD

*National Center for Atmospheric Research
Boulder, Colorado*



U.S. DEPARTMENT OF
ENERGY





Boulder Weather

Today

Tonight

Tuesday

Tuesday
Night

Wednesday

Wednesday
Night

Thursday

Thursday
Night

Friday



Mostly Sunny

Mostly Clear

Sunny

Clear

Sunny

Mostly Clear

Sunny

Mostly Clear

Sunny

High: 51 °F

Low: 32 °F

High: 58 °F

Low: 34 °F

High: 63 °F

Low: 36 °F

High: 58 °F

Low: 32 °F

High: 57 °F

Agenda and Local Arrangement

- **Mesa Lab:** AMWG Sessions (Mon PM and Tues)
- **Foothills Lab:** Joint AMWG/WACCM/ChemClim session (Weds AM)
- **Center Green Lab:** Joint WG sessions (Weds PM, Thurs)

<https://www2.cesm.ucar.edu/events/meetings/20160208>

Google: 'CESM Working Groups 2016'

Includes bus schedule

- CESM Tutorial details (Aug 8-12, NCAR)
- Web-release forms (post to the web)
- Lunch in the cafeteria (follow locals)
- We are webcasting: Microphone and same laptop
- No Collins talk

AMWG co-chairs



Mark Taylor
Sandia



Christiane
Jablonowski
University of Michigan



Minghua Zhang
Stony Brook

Please send us suggestions
for a new AMWG co-chair

This could be you



New AMWG co-chairs



Christiane Jablonowski
University of Michigan



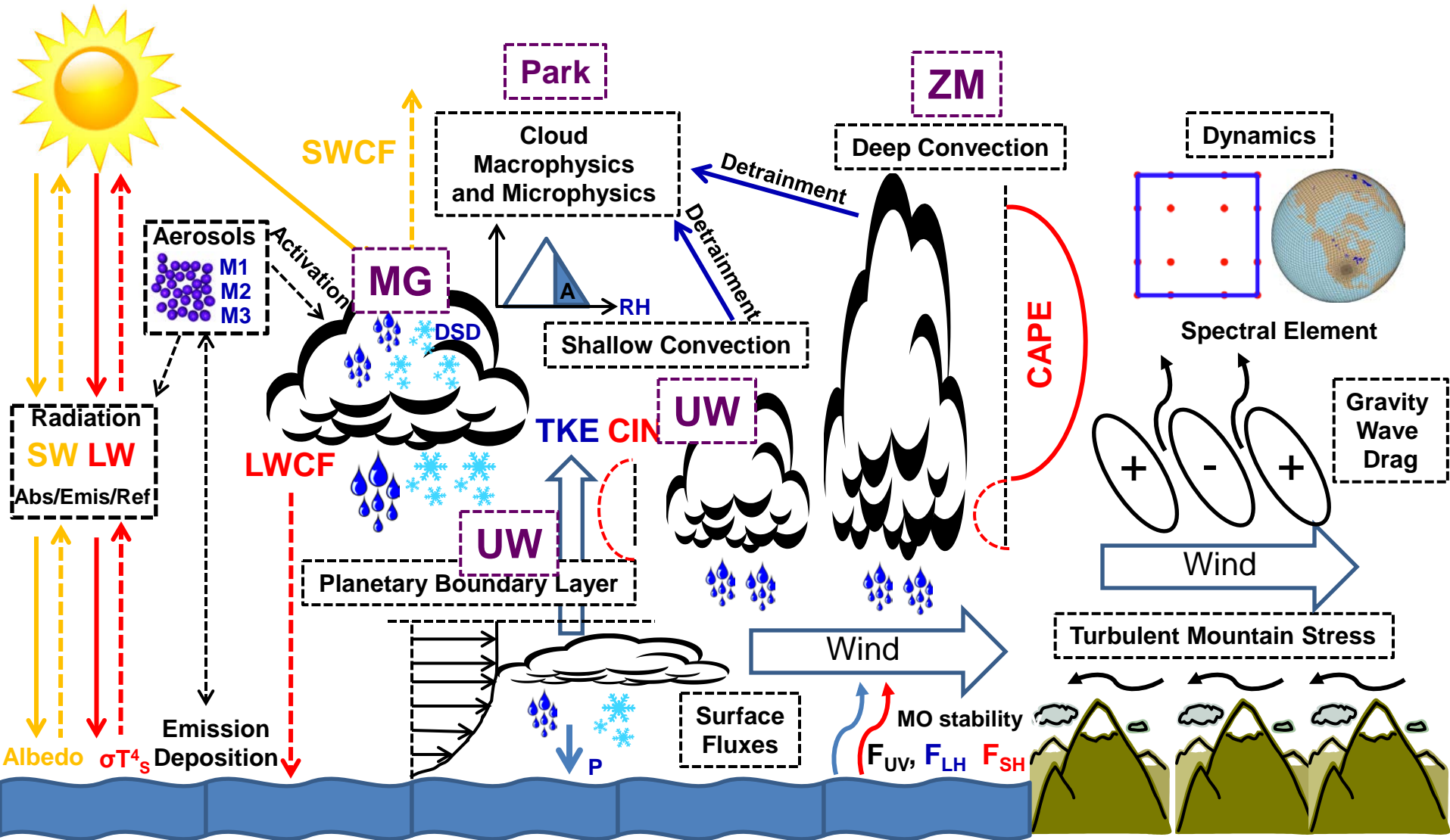
Peter Caldwell
Lawrence Livermore/DOE

Model Changes from CAM5 to CAM5.5

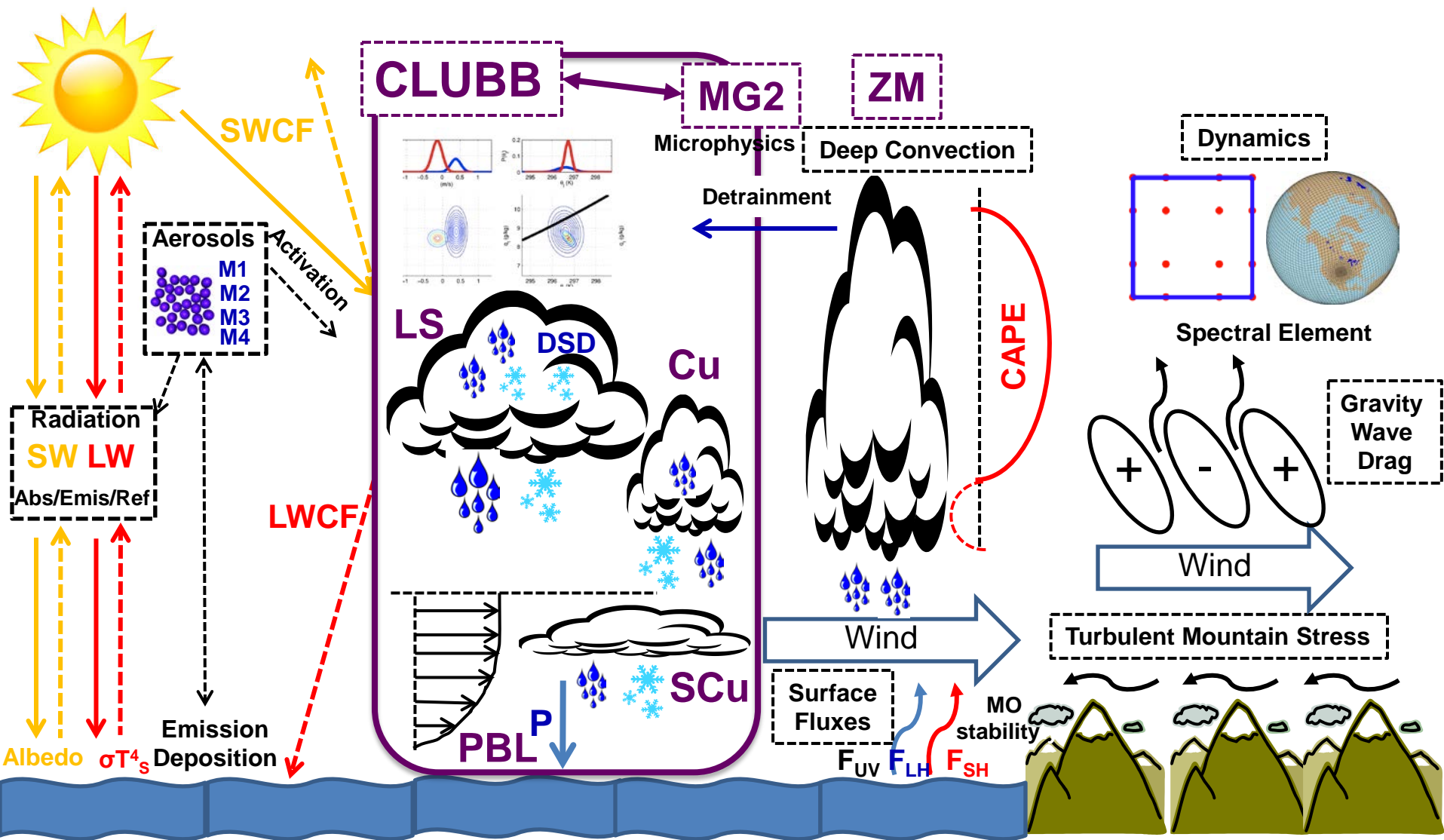
- **CAM5.1**
 - Bug fixes (assumed snow particle sizes)
- **CAM5.2**
 - Bug fixes (ZM inconsistencies, cloud optics++)
 - Testing SE configuration
 - ASD run (ne120/0.1 deg ocean)
- **CAM5.3**
 - Bug fixes
 - SE climate testing (switch from Eulerian to Lagrangian vertical advection)
 - Large-ensemble (LENS) configuration
- **CAM5.4 (L32)**
 - Morrison Gettelman (MG2) microphysics (Gettelman)
 - Modal Aerosol Model (MAM3->MAM4)
 - Mixed phase cloud ice nucleation dependence on aerosols (Liu)
- **Pre CAM5.5:** Panel recommendation: Move forward with CLUBB+CAM5.4
- **CAM5.5 (CESM1.5 testing)**
 - CLUBB (Bogenschutz/Larson/Gettelman)
 - Dust retune/erodibility
 - New orography specification (GTOPO30 (1996)->GMTED2010)
- **CAM6 (CESM2)**
 - Simple models (Polvani/Simpson/Medeiros)

Running CAM5 from the trunk is no longer CMIP5 CAM5.

Community Atmosphere Model, version 5 (CAM5)

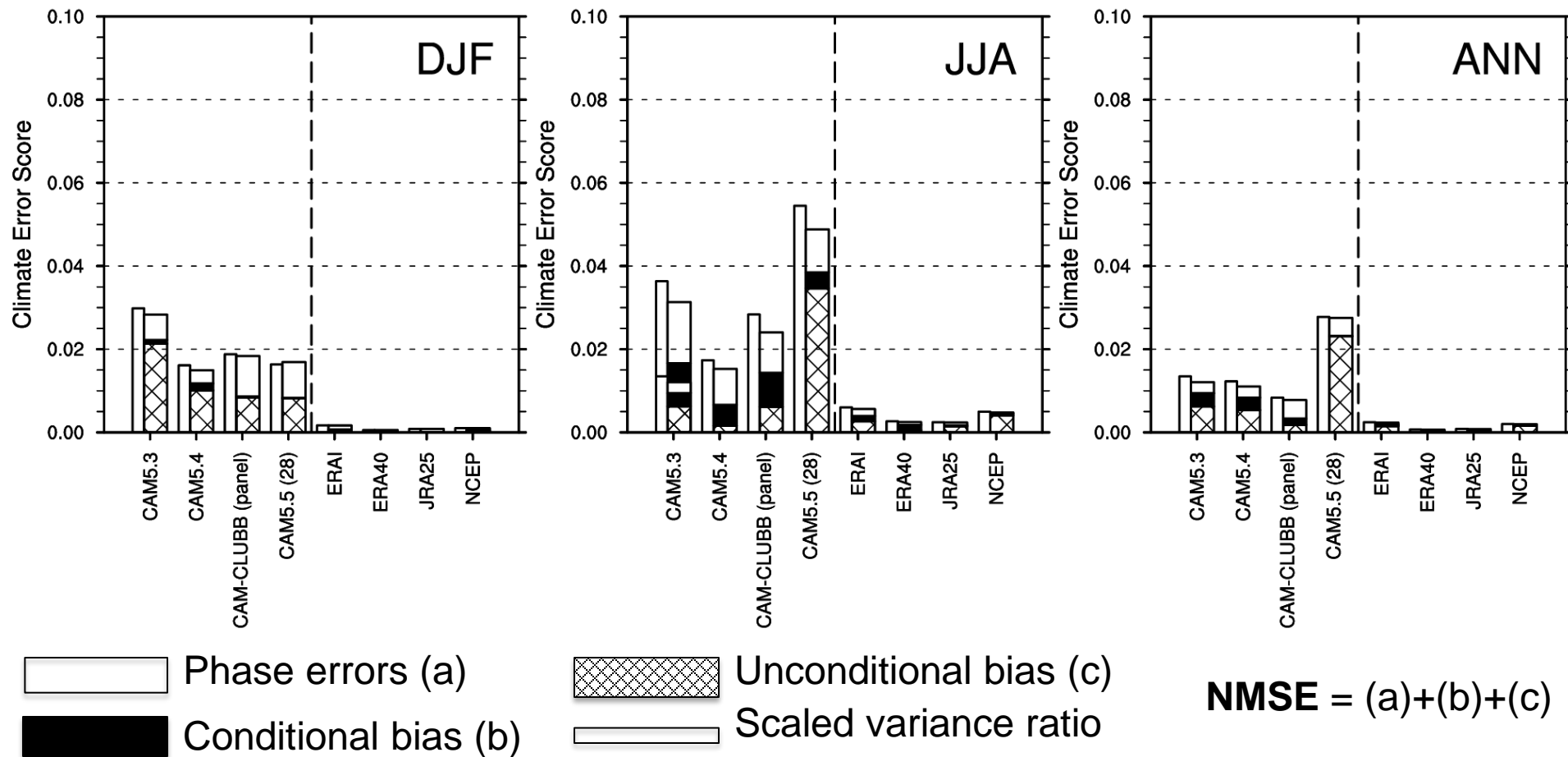


Community Atmosphere Model, version 5.5 (CAM5.5)



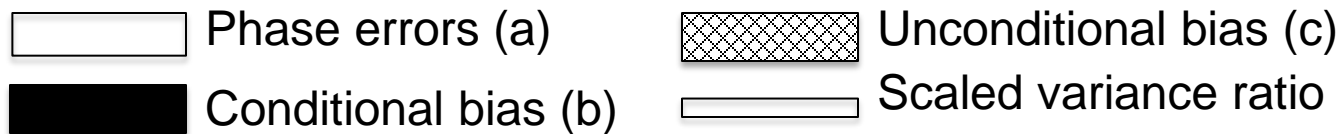
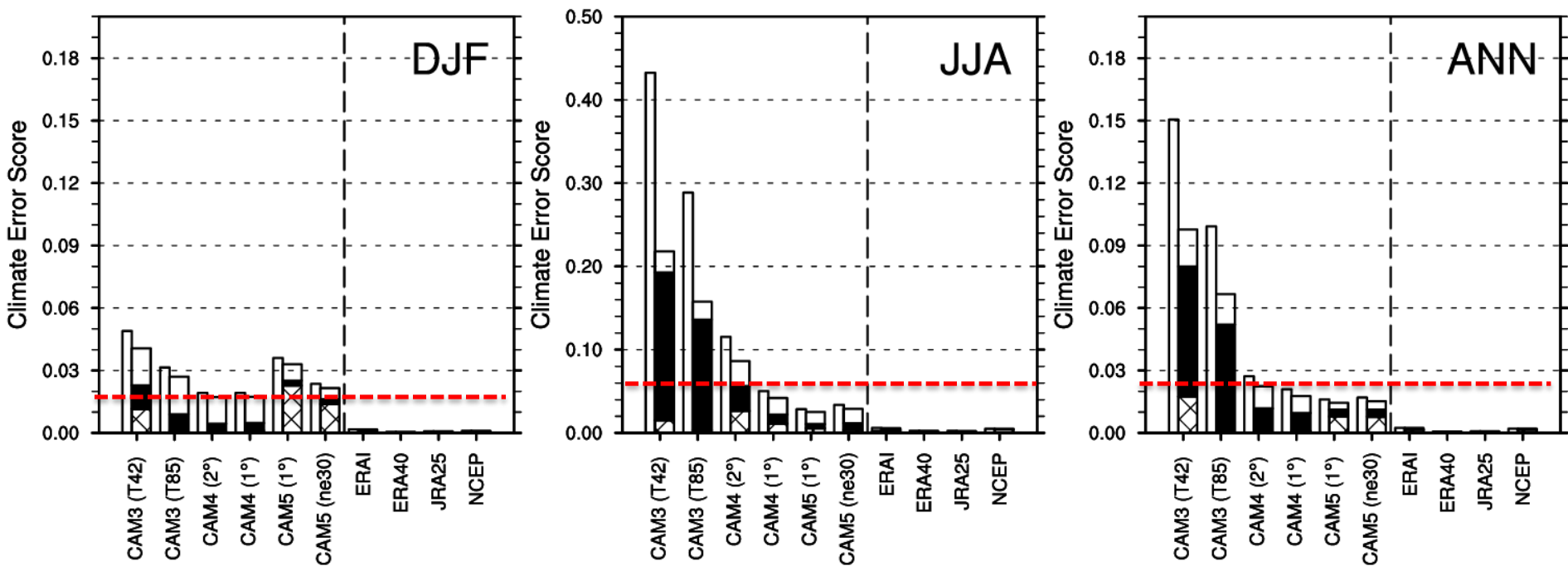
CAM5.5 summary performance

Mean 500-mb height based skill metric (CCSM3/4 papers)



CAM5.5 summary performance

Mean 500-mb height based skill metric (CCSM3/4 papers)



$$\text{NMSE} = (a) + (b) + (c)$$

CAM Development Timelines

The path towards CESM2 and beyond (as of February 2016)

2015 (CAM5.5)

- CAM5.4
- CLUBB
- New orography

CAM5.5

CESM1.5

CICE5 CLM5 POP2

- Focus on 1850/20th C simulations
- Simulation concerns

Building Coupled System

2016 (->CAM6)

- Coupled system tuning
- CLUBB tuning
- Auto-conversion
- Ridging/drag/momentum (TMS?)
- Convective gustiness
- ZM modifications
- Integration with WACCM
- Update sfc. components

CAM6 model in CESM2 for CMIP6

Release

2017 (CAM6+)

- Scale-aware physics
- CLUBB-SIHLS
- UNICON
- Convective microphysics
- Stochastic physics
- SE at low resolution
- CSLAM
- MPAS
- Increased vertical resolution
- Regionally-refined cases

0.25 deg SE

CMIP6 High-res MIP

1 deg FV

CMIP6 Deck

2 deg FV

CMIP6 Paleo+

Mar: CAM6 outline

Jul: Define CESM2

Sep: Code freeze

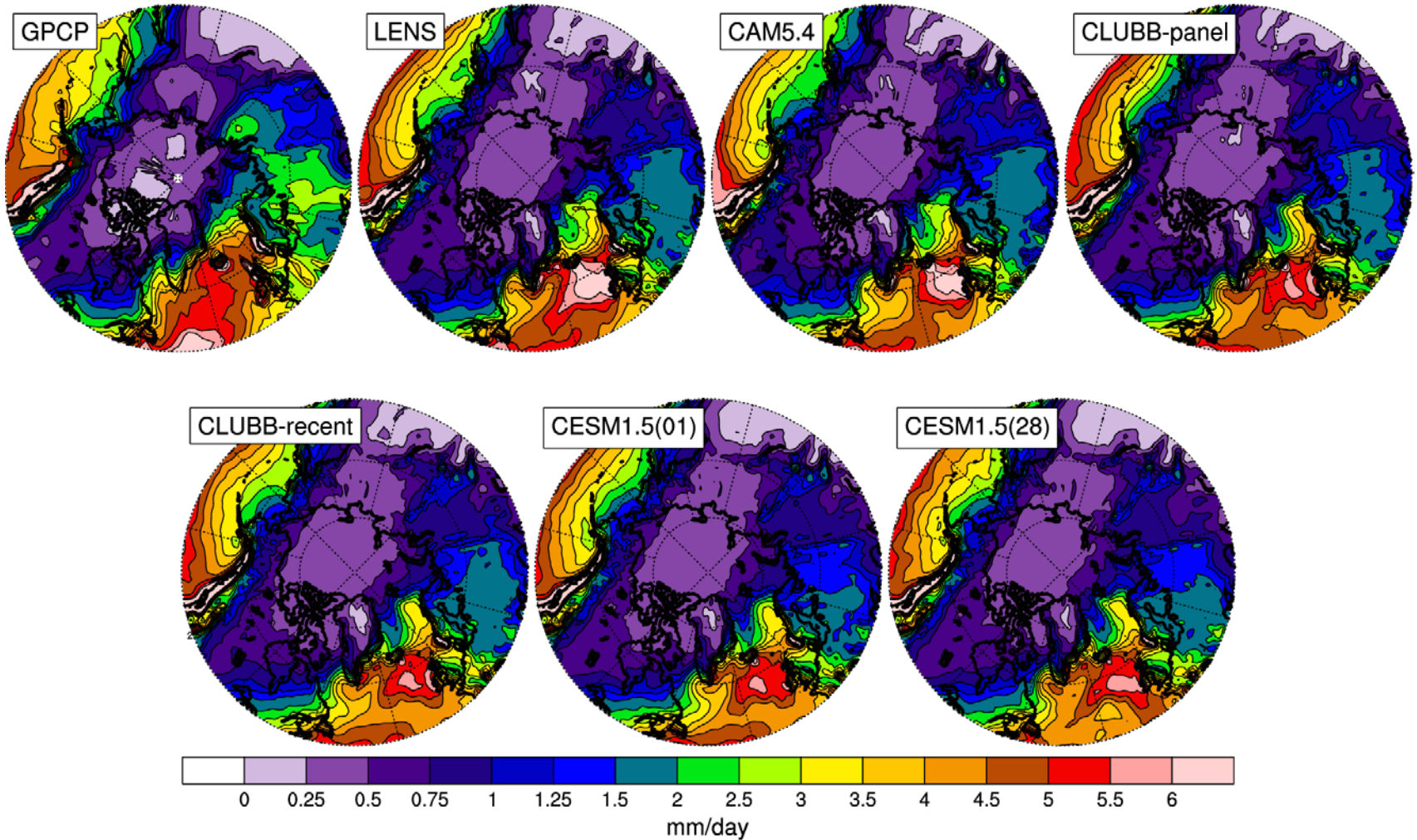
2015 (CESM1.5)

2016 (CESM2)

2017 (CESM2+)

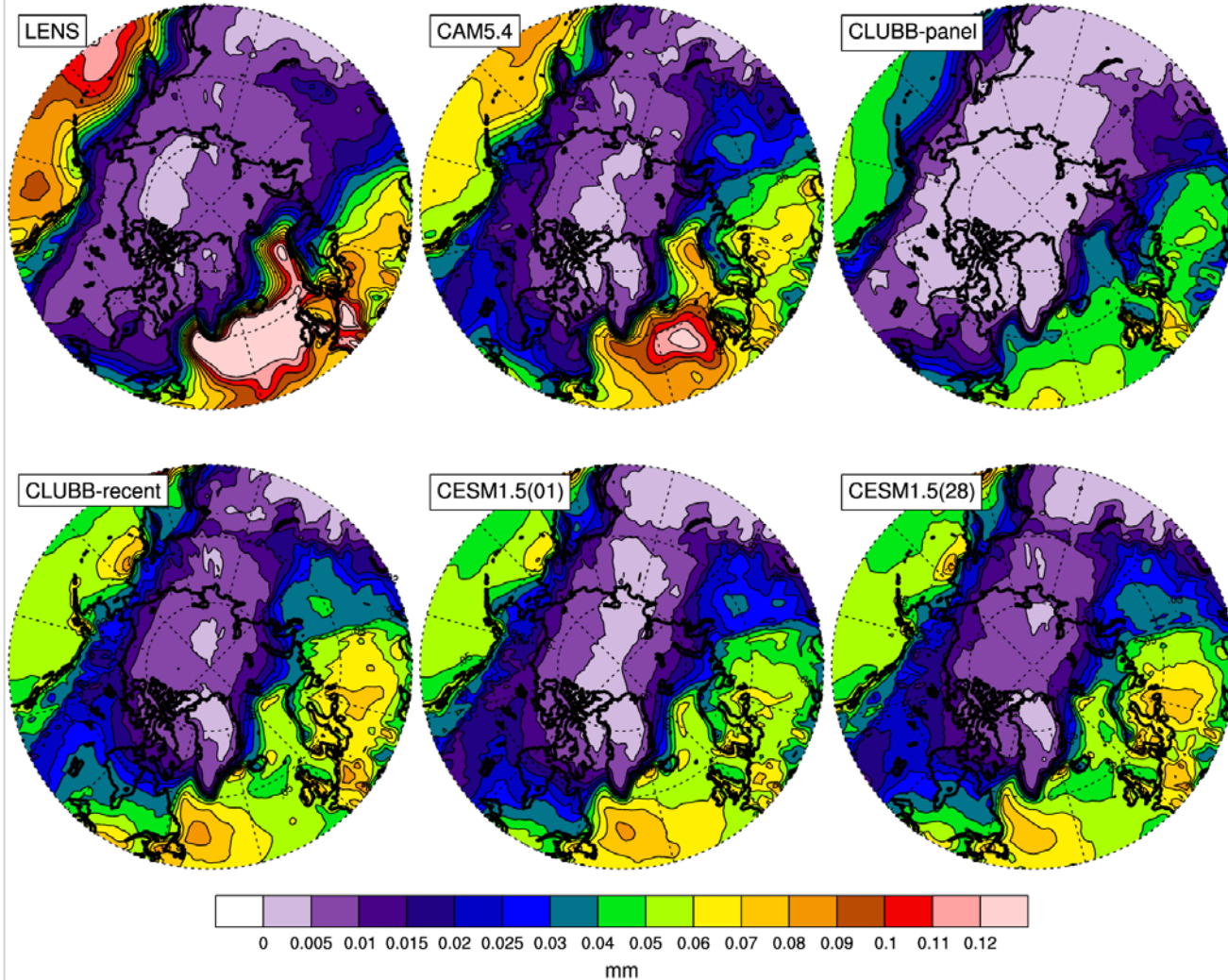
Coupled simulation progress (Cecile)

DJF Total Precipitation Climatology



Coupled simulation progress (Cecile)

DJF Cloud Total Water Path (grid-box average) Climatology



Do we leave anything behind?

- **Dynamical cores**
 - Spectral Eulerian and Semi-Lagrangian
 - Finite volume (after CMIP6)
- **Physics packages**
 - CAM3/CAM4/ (CAM5!)/CAM5.4
- **Levels of support**
 - Scientific (gold)
 - Functional/tested (silver)
 - Use a release tag (bronze)
 - Wait until it irreparably breaks (aluminum)
 - Purge (lead)

AMWG Web page

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earth • modeling • climate

Search

Atmosphere Model

Home » Working Groups » Atmosphere Model

AMWG

Welcome to the AMWG webpage.

The Atmosphere Model Working Group (AMWG) is a broad collection of researchers across university and federal institutions engaged in atmospheric science research using the [Community Earth System Model \(CESM\)](#). The overarching goal is to continually develop the [Community Atmosphere Model \(CAM\)](#) in order to periodically provide new versions for use by the wider CESM community.

The AMWG sets short and long term [development](#) targets to guide community research. Development focuses on research into new and existing physical parameterizations, dynamical cores and added functionality for CAM. To this end close interactions exist with the [Chemistry–Climate Working Group \(Chem–ClimWG\)](#) and the [Whole Atmosphere Working Group \(WAWG\)](#). Ultimately, we aim to deliver the best representation of the atmosphere to be used in multiple applications for climate, climate variability and climate change research.

COMMUNITY ATMOSPHERE MODEL (CAM)

The Community Atmosphere Model (CAM) is the latest in a series of global atmosphere models developed at NCAR for

Community Earth System Model
Community Atmosphere Model
Representing the key atmospheric processes in CAM5

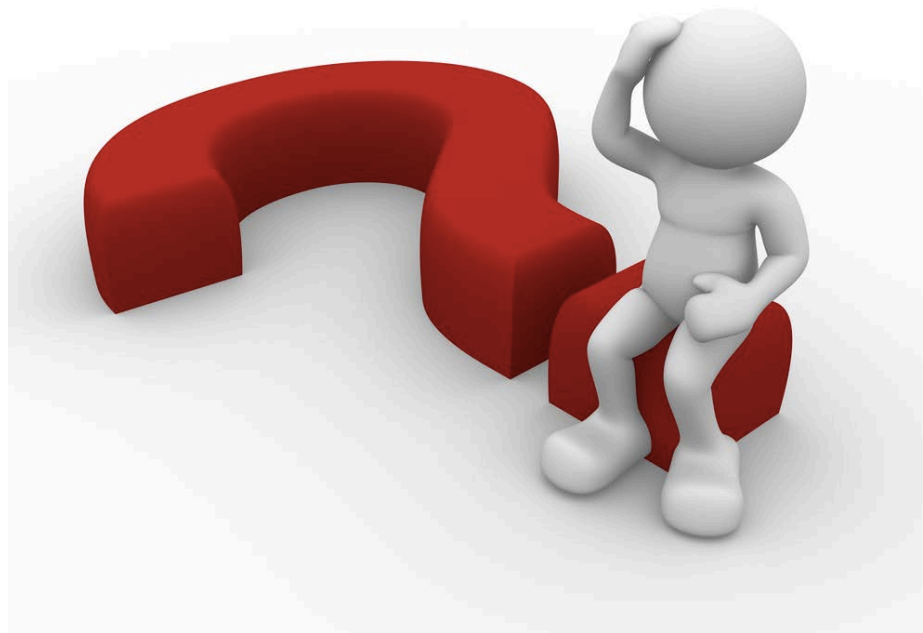
AMWG INFORMATION

- AMWG Priorities
- AMWG Metrics and Diagnostics
- CAM development
- CAM simulations
- Developers' Guidelines
- AMWG News
- Upcoming Meetings
- Past Meetings
- Research Highlights
- AMWG Diagnostics Package

http://www.cesm.ucar.edu/working_groups/Atmosphere

- Developments
- Control simulations
- Diagnostics
- Meetings + presentations

Questions?



CAM5.3 (FV not SE)

CAM development

Bug fixes	Dust (erod.+bin)
MG2	Conv. Scav.+Tr.
MAM4	New orog.
Ice+mix. phase	L32
Energy changes	CLM4.5
Volcanic aero.	GWD

CAM6 dev. Web page

CAM5.4

ⓔ

CLUBB+MG2

Bogenschutz
Gettelman

Simulations

CAM5.3+C/M

ⓔ

UNICON

Park

Simulations

CAM5.3+U

ⓔ

Dec 1

**Analysis Panel
(5 members)**

- Code, Pubs., Data, Simulations (AMIP, coupled, AIE, 20th other)?
- Provide document proposing candidate to analysis team.

AMWG Feb 15

CAM5.5

WACCM5

Criteria?
Combinations?
Recommendations?

Simulations

Breck

RELEASE

High-res (SE)

2016

CAM6



The Recommendations

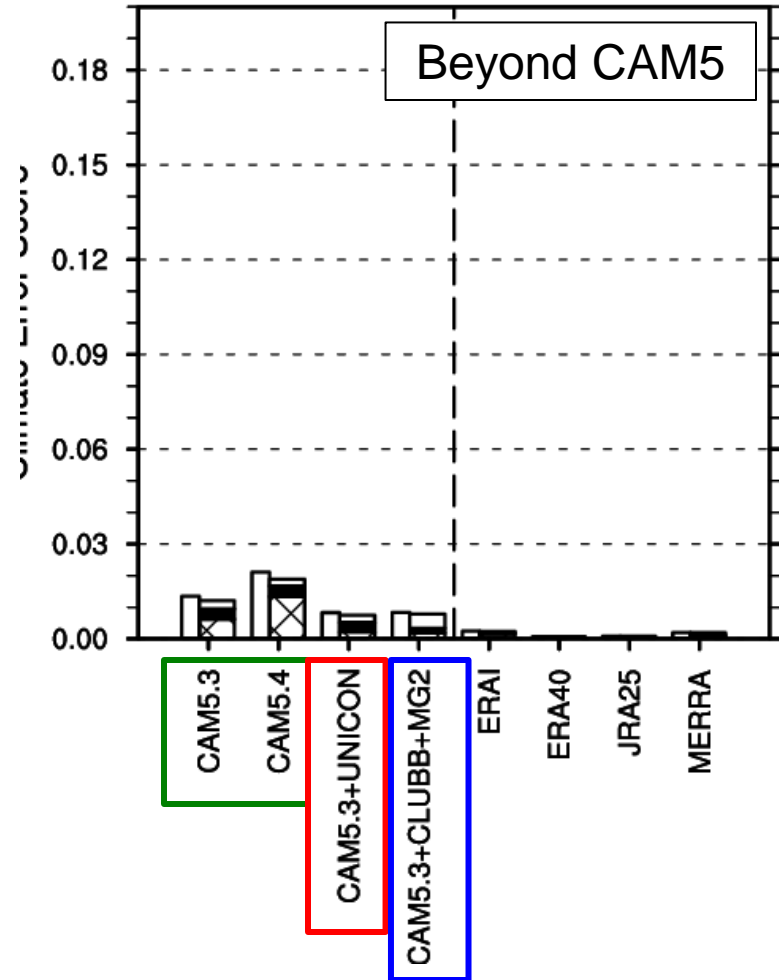
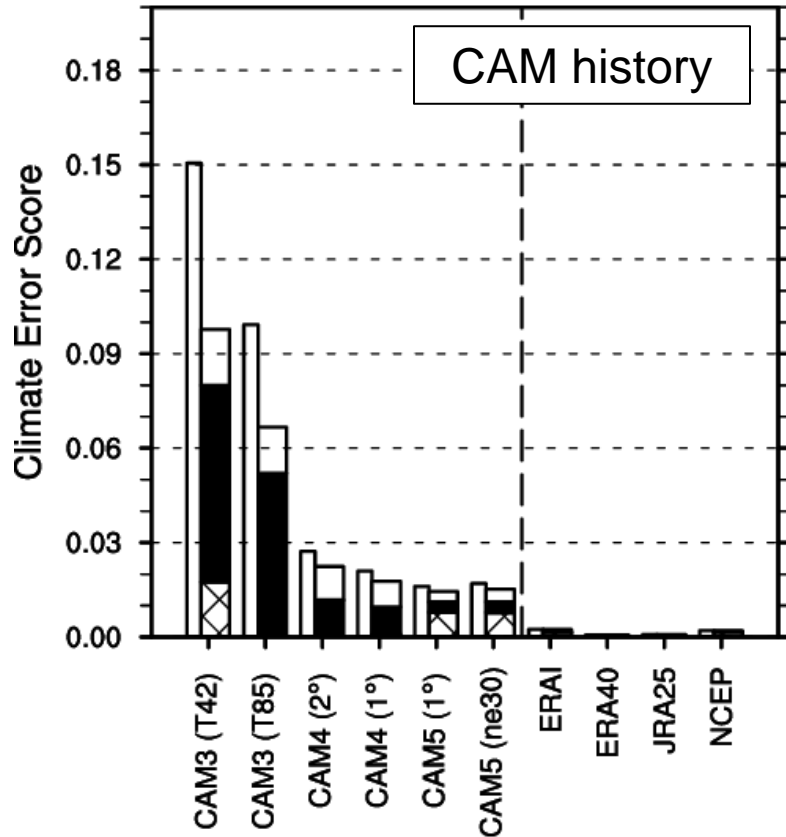
1 Model Choice and ENSO

- At this point CAM5.4 will form contingency version for CAM5.5
- This is because ENSO will be unacceptable with either UNICON or CLUBB
- However, UNICON and CLUBB developers should work towards improving ENSO by May 15 deadline
- At that time the panel will make a recommendation whether to continue with the contingency or to proceed with UNICON or CLUBB if they have an acceptable ENSO

2 Model understanding and development

- All code should be made available to developers after AMWG
- Due to scheme complexity greater effort should be applied to understand parameter sensitivities of schemes
- Each candidate scheme has desirable aspects the should be actively combined beyond CAM5.5 toward CAM6
- Therefore developers should plan for scheme intergration

Climate error score: First measure of skill (NH Z500, ANN)



AMWG Summary

- CAM5.5 decision
 - Panel recommendation was to have CLUBB form the main part of CAM5.5, with UNICON as an option, and CAM5.4 as a backup
 - Significant challenges remain for CAM5.5 before a final version is delivered; tropical Kelvin waves and Atlantic Meridional Overturning Circulation biases
 - Need to get prototype components for coupling sooner rather than later
 - Similar DOE/ACME efforts ongoing for choosing moist physics changes
- Model analysis
 - Novel model diagnostics can validate processes, e.g., Convective humidity relationships-> validate convective entrainment and timescale
 - Stochastic parameterization showing promise -> move away from pure deterministic parameterization
- Discussion for CAM6
 - Not stuck on ne120 (25km) for CAM6 resolution, but it is most likely
 - Combination of vertical/horizontal increases in resolution to best match resources and resolved phenomena (e.g., tropical cyclones, PBL)
 - Objectively investigate increases in vertical levels (where is resn. needed?)
 - Will need to consider non-hydrostatic options sooner rather than later

Supported and Included Dynamical Cores

- **Spectral Element (cubed sphere)**
 - Significant experience with CAM, particularly at high resolutions (ne120/0.25)
 - Significant challenges remain for CAM5.5 before a final version is delivered; tropical Kelvin waves and Atlantic Meridional Overturning Circulation biases
 - Need to get prototype components for coupling sooner rather than later
 - Similar DOE/ACME efforts ongoing for choosing moist physics changes
- **Model for Prediction Across Scales (MPAS, icosahedral)**
 - Novel model diagnostics can validate processes, e.g., Convective humidity relationships-> validate convective entrainment and timescale
 - Stochastic parameterization showing promise -> move away from pure deterministic parameterization
- **Finite Volume**
 - Need to keep at least 2 years due to CMIP6 commitment
 - Combination of vertical/horizontal increases in resolution to best match resources and resolved phenomena (e.g., tropical cyclones, PBL)
 - Objectively investigate increases in vertical levels (where is resn. needed?)
 - Will need to consider non-hydrostatic options sooner rather than later

CAM Development Timelines

The path towards CESM2 and CMIP6 (as of May 2014)

