CAM update

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Tunings, bug fixes, a few minor modifications to formulations

"CAM4"

- Essentially CAM3.5 ('Modifications to convection (Neale et. Al., Richter et. Al.)
- Substantial code revisions (Eaton et. Al.)
- The rest of the parameterizations are as in CAM3, but…
  - FV dynamical core becomes default
  - Polar filters + GW Froude#
  - All aerosols can be interactive (for CAM3, only Sulfur and Soot were calculated) Hess, Vitt, Mahowald, Rasch, Lamarque)
  - New aerosol emissions (Lamarque) or prescribed aerosol datasets
  - Revised aerosol optics (Ghan)
  - New solar constant, GHG conc, and O3
  - Probably a few small bugs found
- Coupled to new surface models in CCSM

"CAM5"

- CAM3.5+
- New cloud microphysics (Morrison, Gettelman)
- Revised ice clouds (Gettelman, Liu, Park, Mitchell)
- PDF based warm cloud fraction (Park)
- New Radiative Transfer (Iacono, Collins, Conley, Mitchell, Ghan)
- New PBL and Shallow convection (Bretherton and Park)
- New "macrophysics" (Park, Bretherton, Rasch with contributions from Morrison and Gettelman)
- New aerosol formulation (Ghan, Liu, Easter with contributions from Hess, Mahowald, Lamarque and Rasch)
- Tweaks to GWD and Mountain form drag (Sassi and Richter)
- Volcanic Aerosols (Conley, Ammann, and others Kinnison? Gettelman?)
- Radiatively active + consistent convective clouds (Neale, Rasch, Park)

# From Breckenridge, June 2009, Differences in Simulation characteristics

- ▶ Track 1
- ▶ Much more experience with this model
- ▶ Cheaper
- ▶ Better Standalone simulation than CAM3
- ▶ Better Coupled simulations than CCSM3
- ▶ Good simulations for the "wrong" reasons?
- ▶ Multiple, century+ simulations with PD, PI, and transient

- Track 5
- More flexibility, power
- More expensive
- More realistic simulation of subtropical clouds, arctic cloud
- Condensed water paths lower than track 1, more like retrievals
- Higher burdens of water vapor
- Lower Clearsky OLR
- Lower Longwave Cloud Forcing
- Excessive precipitation over tropical land
- Better Standalone Simulations than Track 1 (both RMS and Bias errors)
- First really encouraging coupled simulations last week. No transient runs yet.
- Currently worse coupled simulations than Track 1 (better RMS, worse Bias)
    - Thinner sea ice
    - Too high precip over tropical land

CAM Evolution

Model	CCSM3 *(2004)*	CCSM3.5 *(2007)*	CCSM4 *(Apr 2010)*	CESM1 *(Jun 2010)*
Atmosphere	CAM3 (L26)	CAM3.5 (L26)	CAM4/Track 1 (L26)	CAM5/Track5 (L30)
Boundary Layer	Holtslag and Boville (93)	Holtslag and Boville	Holtslag and Boville	UW *Diagnostic TKE* Park et al. (09)
Shallow Convection	Hack (94)	Hack	Hack	UW *TKE/CIN* Park et al. (09)
Deep Convection	Zhang and McFarlane (95)	Zhang and McFarlane Neale et al.(08), Richter and Rasch (08) mods.	Zhang and McFarlane Neale et al., Richter and Rasch mods.	Zhang and McFarlane Neale et al., Richter and Rasch mods.
Stratiform Cloud	Rasch and Kristjansson (98) *Single Moment*	Rasch and K. *Single Moment*	Rasch and K. *Single Moment*	Morrison and Gettelman (08) *Double Moment* Park Macrophysics Park et al. (10)
Radiation	CAMRT (01)	CAMRT	CAMRT	RRTMG Iacono et al. (2008)
Aerosols	Bulk Aerosol Model (BAM)	BAM	BAM	Modal Aerosol Model (MAM) Ghan et al. (2010)
Dynamics	Spectral	Finite Volume (96,04)	Finite Volume	Finite Volume
Ocean	POP2 (L40)	POP2.1 (L60)	POP2.2 - *BGC*	POP2.2
Land	CLM3	CLM3.5	CLM4 - *CN*	CLM4
Sea Ice	CSIM4	CSIM4	CICE	CICE

Things to think about

▶ We are a bit puzzled by the signal from big volcanoes

▶ Revisions to the flux stabilizer and flux averager not included in transient runs

▶ 4th Order Laplacian not included in transient run

▶ Minor tweaks to microphysics not in transient run

▶ We know about an "issue" in the convective scavenging
   - We know how to "solve" it, but no perfect outcome yet evident

▶ Current simulations provide a pretty nice transient simulation

▶ Lots of software engineering still needed
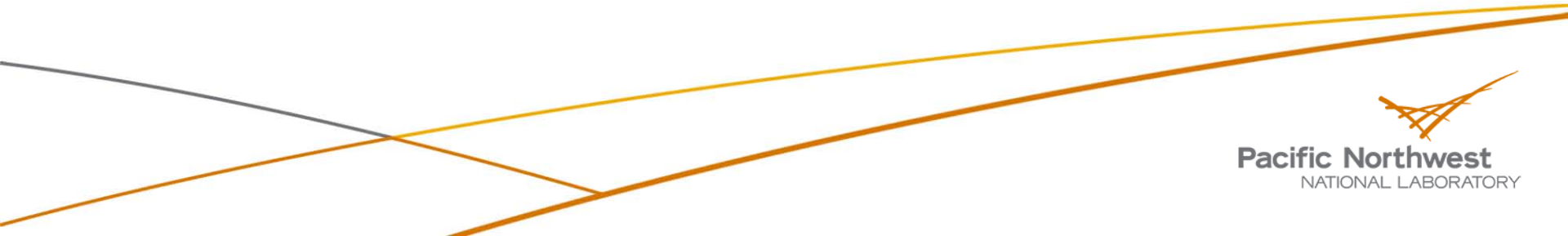
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