Update on CAM development.
Recent activities and near-term priorities.

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Mark Taylor, Peter Lauritzen, Sungsu Park,

Julio Bacmeister, Joe Tribbia, Rich Neale,

and many others.

The CAM family

Model	CAM3 CCSM3	CAM4 CCSM4	CAM5 (CAM5.1) CESM1.0 (CESM1.0.3)	CAM5.2 CESM1.1
Release	**Jun 2004**	**Apr 2010**	**Jun 2010 (June 2011)**	**Nov 2012**
PBL	Holtslag-Boville (1993)	Bretherton et al (2009)	Bretherton et al (2009)	Bretherton et al (2009)
Shallow Convection	Hack (1994)	Hack (1994)	Park et al. (2009)	Park et al. (2009)
Deep Convection	Zhang-McFarlane (1995)	Neale et al. (2008)	Neale et al. (2008)	Neale et al. (2008)
Microphysics	Rasch-Kristjansson (1998)	Rasch-Kristjansson (1998)	Morrison-Gettelman (2008)	Morrison-Gettelman (2008)
Macrophysics	Rasch-Kristjansson (1998)	Rasch-Kristjansson (1998)	Park et al. (2011)	Park et al. (2011)
Radiation	Collins et al. (2001)	Collins et al. (2001)	Iacono et al. (2008)	Iacono et al. (2008)
Aerosols	Bulk Aerosol Model	Bulk Aerosol Model BAM	Modal Aerosol Model Ghan et al. (2011)	Modal Aerosol Model Ghan et al. (2011)
Dynamics	Spectral	Finite Volume	Finite Volume	Spectral element

[shaded box] = New parameterization/dynamics

What's in CAM5.2 ?

- New dynamical core: Spectral Element (CAM-SE)
  - Improves scalability of CAM (no polar filter)
- New topography for CAM-SE
- 6 bug fixes
  - Fix for the land scaling of dust
  - Fix to wet radius calculation in the modal_aero_wateruptake module.
  - Fix for the value for the Obukhov length used in dry deposition calculations.
  - Fix in zm_conv to fix some inconsistency in the initialization of moist static energy.
  - Fix in uw_shallow for the unreasonable concentration of some species in WACCM.
  - Mods in MAM to generalize the method for calculating pH value of cloud water.
- Tuning for CAM-SE (dust and stratocumulus)

Coupled simulations with CAM5.2 (CESM1.1)

CAM5.2-FV 1 degree: 50 years

CAM5.2-FV 2 degree: 70 years

} similar to CESM1.0
=> bugfixes have small impact

CAM5.2-SE ne30 (~1 deg): 25 years } Competitive with FV
except for stratocumulus

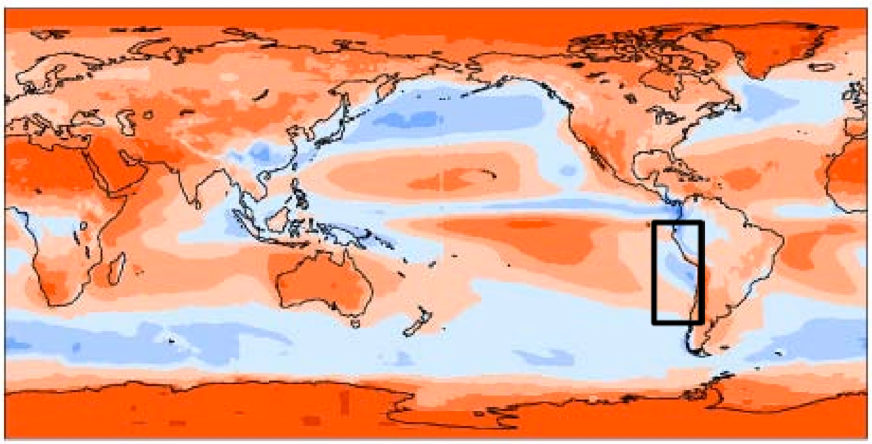
Diagnostics:

http://www.cesm.ucar.edu/experiments/cesm1.1

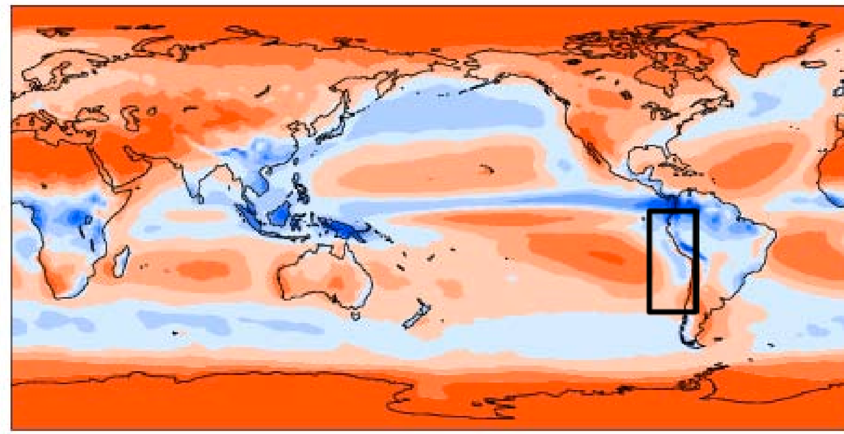
Stratocumulus are degraded in CAM-SE

SWCF (W/m2)

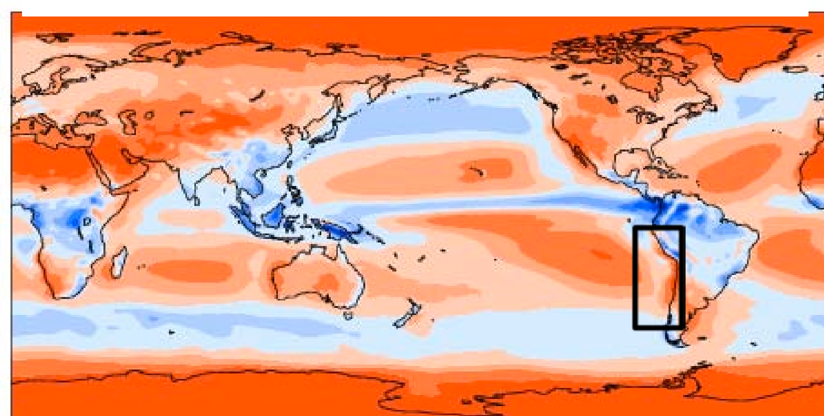
CERES-EBAF
mean = -47.1 W/m^2

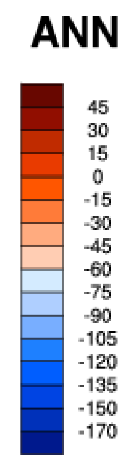


FV 1deg
mean = -48.9 W/m^2



SE ne30
mean = -47.7 W/m^2



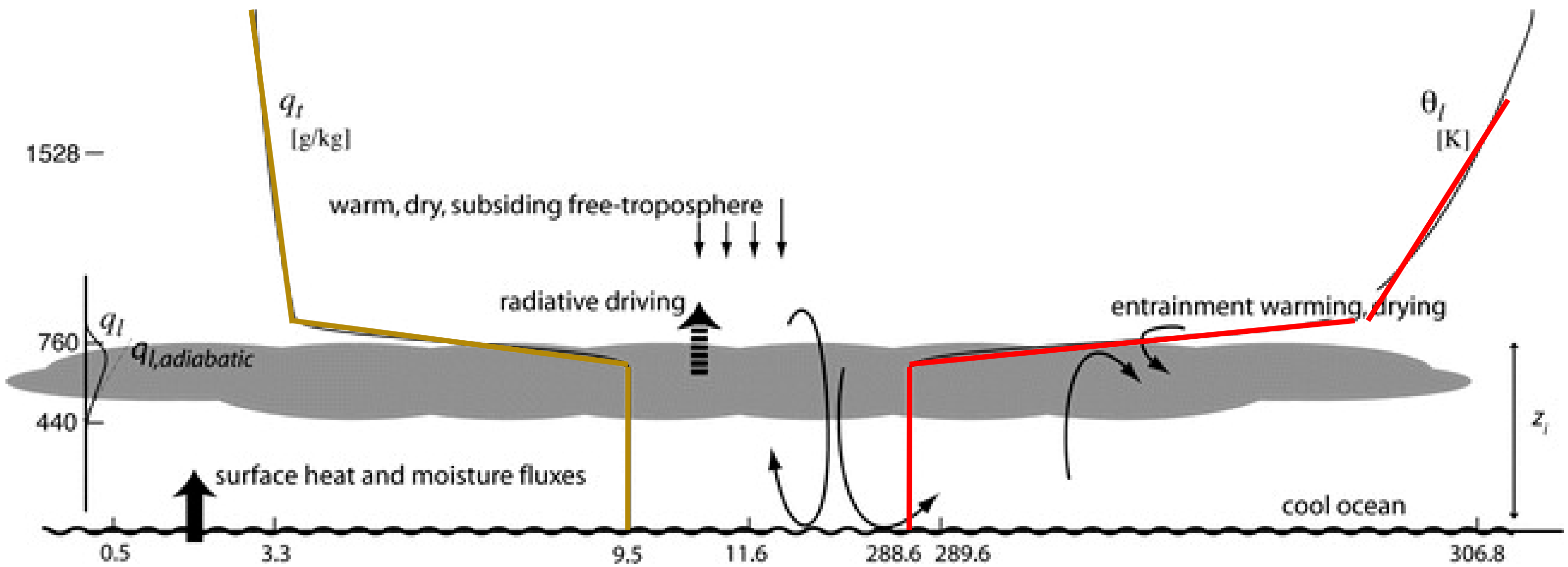


Vertical transport in CAM-SE

CAM-SE

Vertical advection of tracers (q, …)
(Lagrangian method)

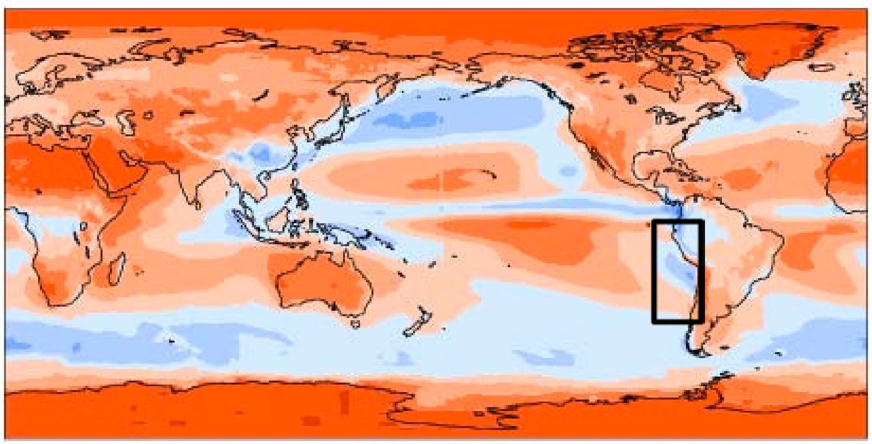
Vertical advection of T
~~(Eulerian method)~~
(Lagrangian method)



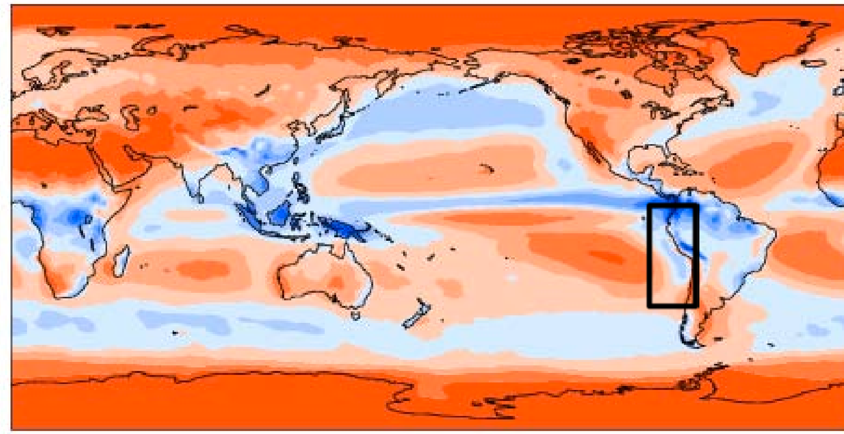
Lagrangian code improves stratocumulus deck

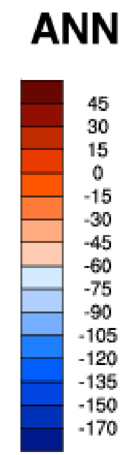
SWCF (W/m2)

CERES-EBAF
mean = -47.1 W/m^2

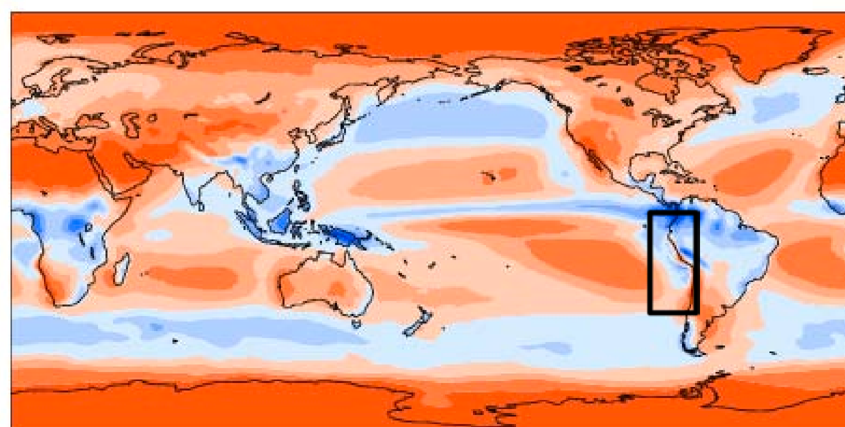


FV 1deg
mean = -48.9 W/m^2





SE ne30 + Lagrangian code
mean = -48.1 W/m^2



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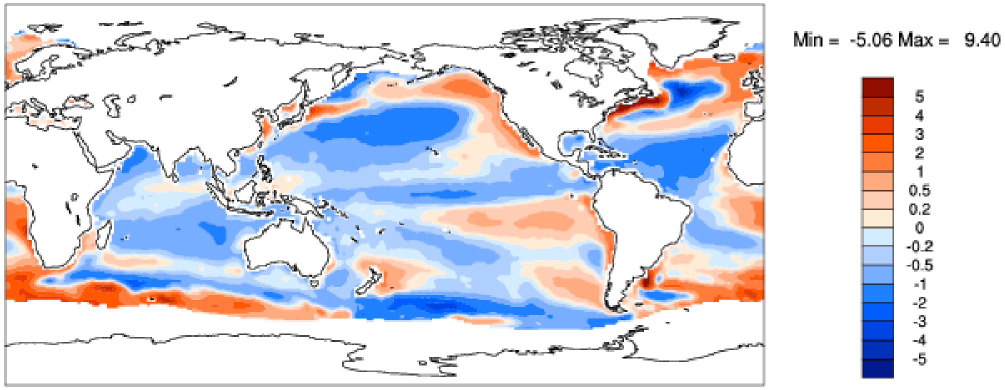
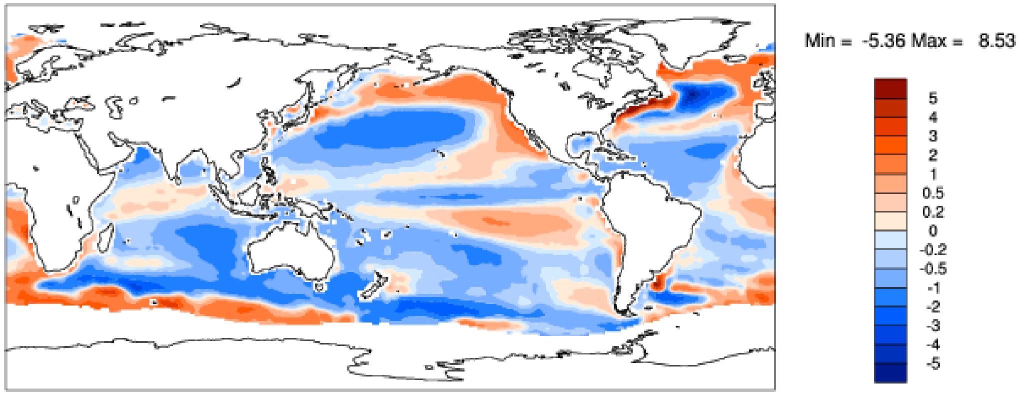
CAM5.2-SE ne30 (~1 deg): 50 years
+ Lagrangian code

Temperature biases (Model – HadISST)

FV 1deg
mean = -0.13 K
RMSE = 0.97 K



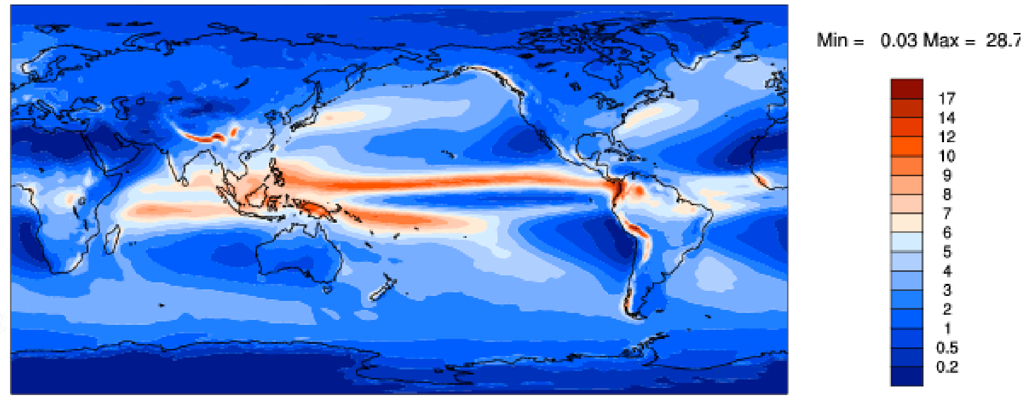
SE ne30 + Lagrangian code
mean = -0.21K
RMSE = 0.92 K



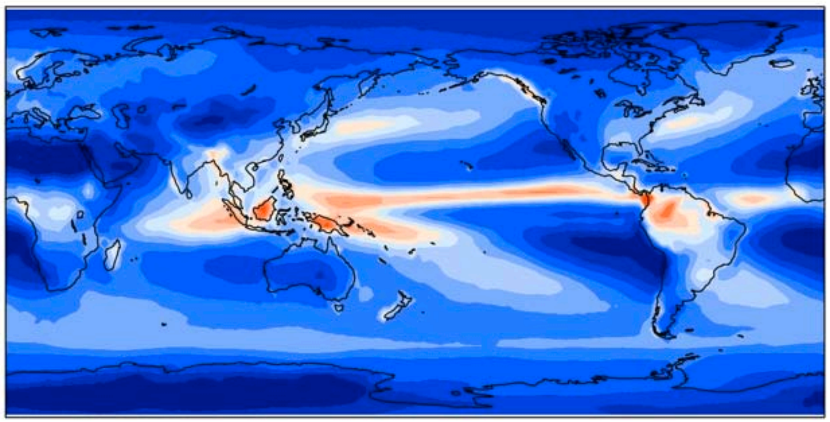
Precipitation

FV 1 deg
mean = 3.06 mm/day

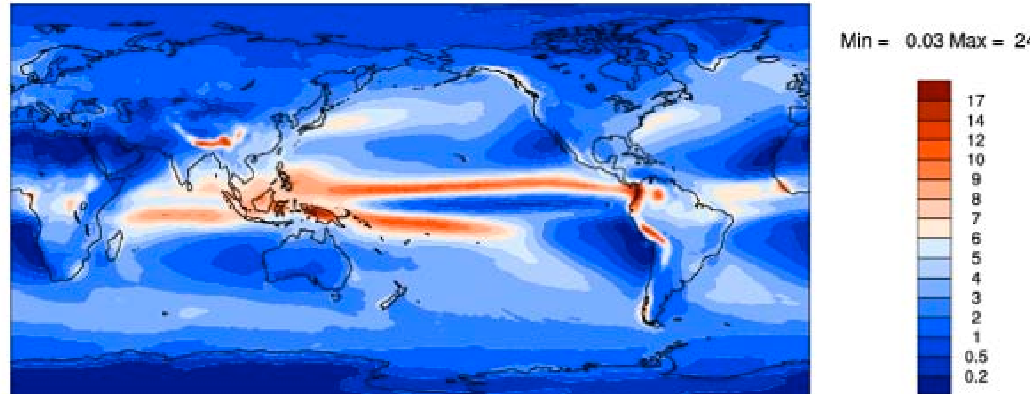
ANN



GPCP
mean = 2.67 mm/day

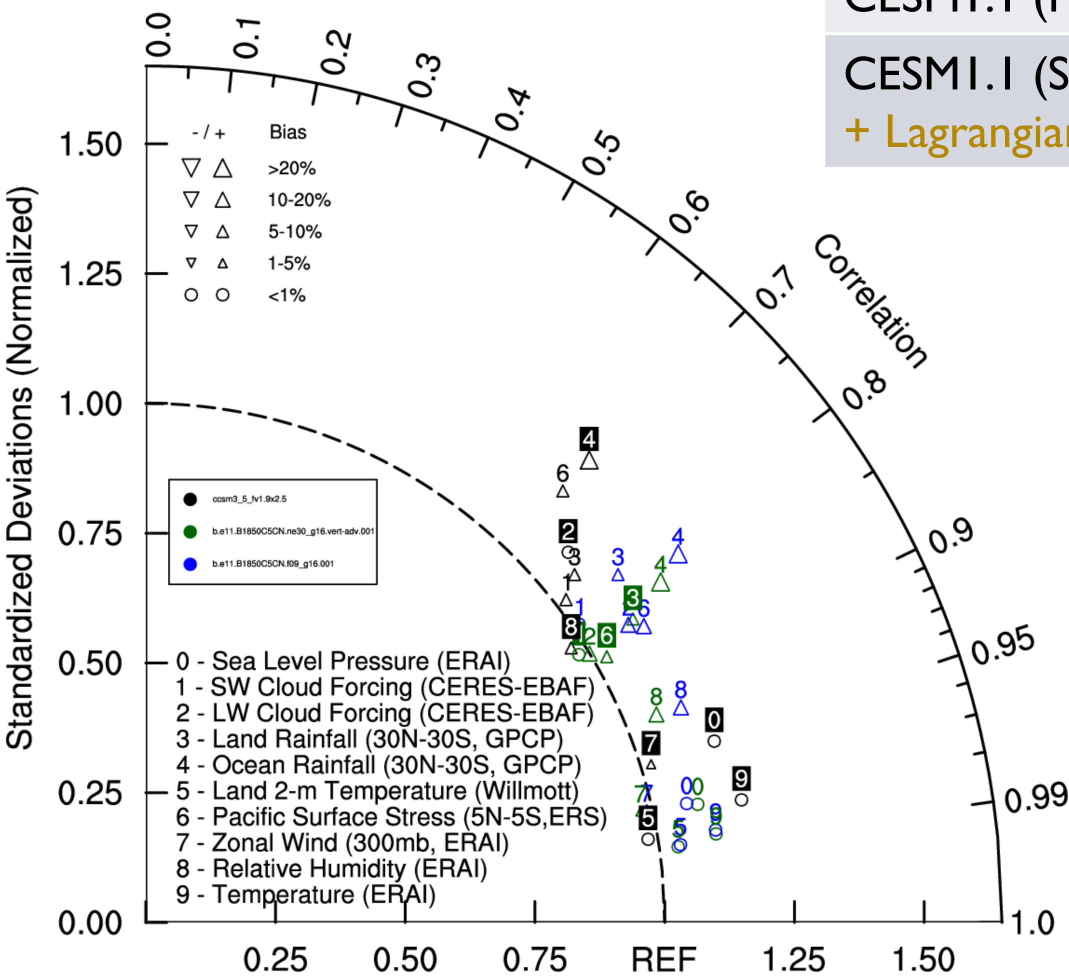


SE ne30 + Lagrangian code
mean = 3.07 mm/day



Taylor diagram

	RMSE	Bias
CCSM4 (FV 1 deg)	0.883	0.78
CESM1.1 (FV 1 deg)	0.791	1.58
CESM1.1 (SE ne30) + Lagrangian code	0.735	1.34



- CCSM3.5
- CESM1.1 (FV 1deg)
- CESM1.1 (SE ne30)

In summary (so far)

- CAM5.2 was released in November 2012
    - Spectral Element (SE) dycore (improves scalability of CAM)
    - Includes 6 bugfixes (minor impact)
    - CAM-SE competitive with CAM-FV except for stratocumulus
- Implementation of Lagrangian vertical transport for all variables
    - Fixes stratocumulus
    - Taylor score is better than CAM-FV

CAM5.2 + Lagrangian code => This will become CAM5.3

Code will be released in May 2013

Earlier for developers

CAM5.3 will also include

Prescribed aerosol

Reduced size history files (namelist flags for extra output)

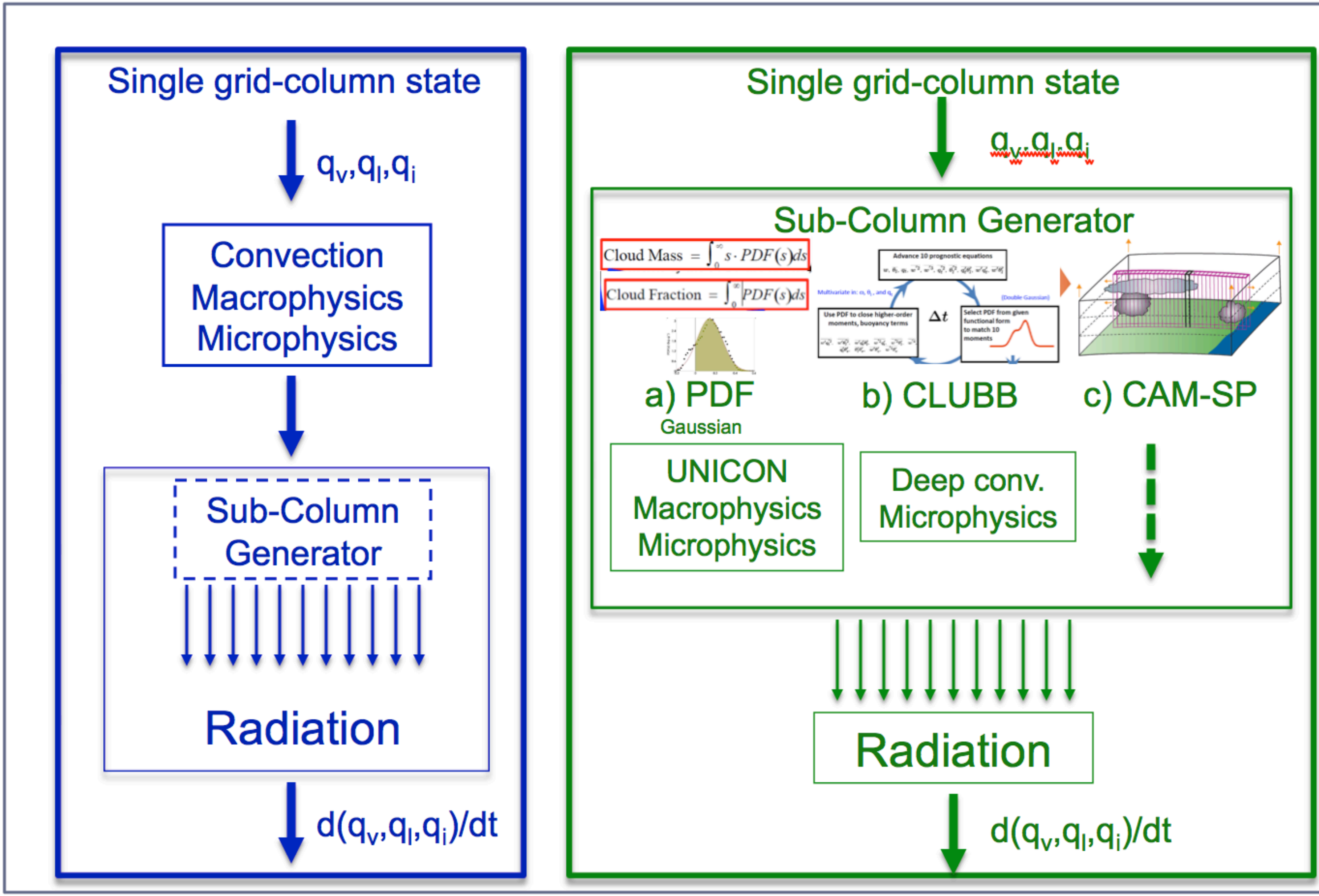
Too many versions of CAM…
What should I use ?

	Release date	FV dycore	SE dycore
CAM 5.1 (in CESM1.0)	June 2011	Don't use (6 known bugs)	N/A
CAM 5.2 (in CESM1.1.1)	Nov 2012	**YES** (bugfixes)	Don't use (bad stratocumulus)
CAM 5.3 (in next release)	May 2013	**YES** (FV 2 deg only)	**YES** (Lagrangian vertical transport for T)

Near-term model development

- Unified Convection (UNICON)
  - unifies treatment deep + shallow
- Cloud Layers Unified By Binormals (CLUBB)
  - third-order turbulence closure centered around an assumed double Gaussian PDF
  - treatment for shallow+PBL+macrophysics
- PDF-based macrophysics
- SP-CAM: super-parameterization on branch
- Next generation MG microphysics
  - prognostic precipitation, mixed phase ice nucleation and convective microphysics
- Aerosol scheme
  - Prescribed Aerosol (BAM /MAM)
  - MAM4 ("aging" black carbon)
- Sub-columns infrastructure
  - all schemes see the same sub-columns: consistency among processes

Physics framework in CAM5+



Slide courtesy: Rich Neale

Near-term model development

- Dynamics
  - Conservative Semi-LAgrangian Multi-tracer (CSLAM) advection
  - MPAS dycore and regional mesh refinement in CAM-SE
- Address systematic precipitation biases
  - double ITCZ, Asian monsoon, summertime US rainfall
  - CAPT framework, high-resolution, UNICON, …
- Resolution
  - High resolution runs (0.25 and finer). Horizontal resolution dependence (climate change response).
  - Vertical resolution dependence (L30 -> L31, L60)
- Diagnostics (http://www.cgd.ucar.edu/amp/amwg/diagnostics)
  - Refactored diagnostics package (compatible with CAM-SE history files)
  - New diagnostics sets for aerosol, chemistry, WACCM
  - COSP cloud phase diagnostics
- Documentation
  - Moving from latex file to web-based documentation
  - Guidelines for developers (http://www.cesm.ucar.edu/working_groups/Atmosphere/)

Thanks