

Incentivizing research on model development: Experiences from a Climate Process Team project on cloud macrophysics and aerosol indirect effects

V. Larson, with contributions from CPT members

10 Jul 2014, Clivar Summit

The goals of our CPT project on clouds and aerosol indirect effects:

1. Implement a new parameterization of subgrid variability of clouds and turbulence into two climate models (NCAR's CAM and GFDL's AM3).
2. Improve aerosol indirect effects in climate models.

Our parameterization of subgrid variability (“CLUBB”) is based on probability density functions (PDFs)

CLUBB prognoses various subgrid moments involving moisture, temperature, and turbulence.

Closure is achieved with a subgrid PDF.

The PDF method is relatively general and rigorous.

CLUBB has benefited from collaboration among CPT members

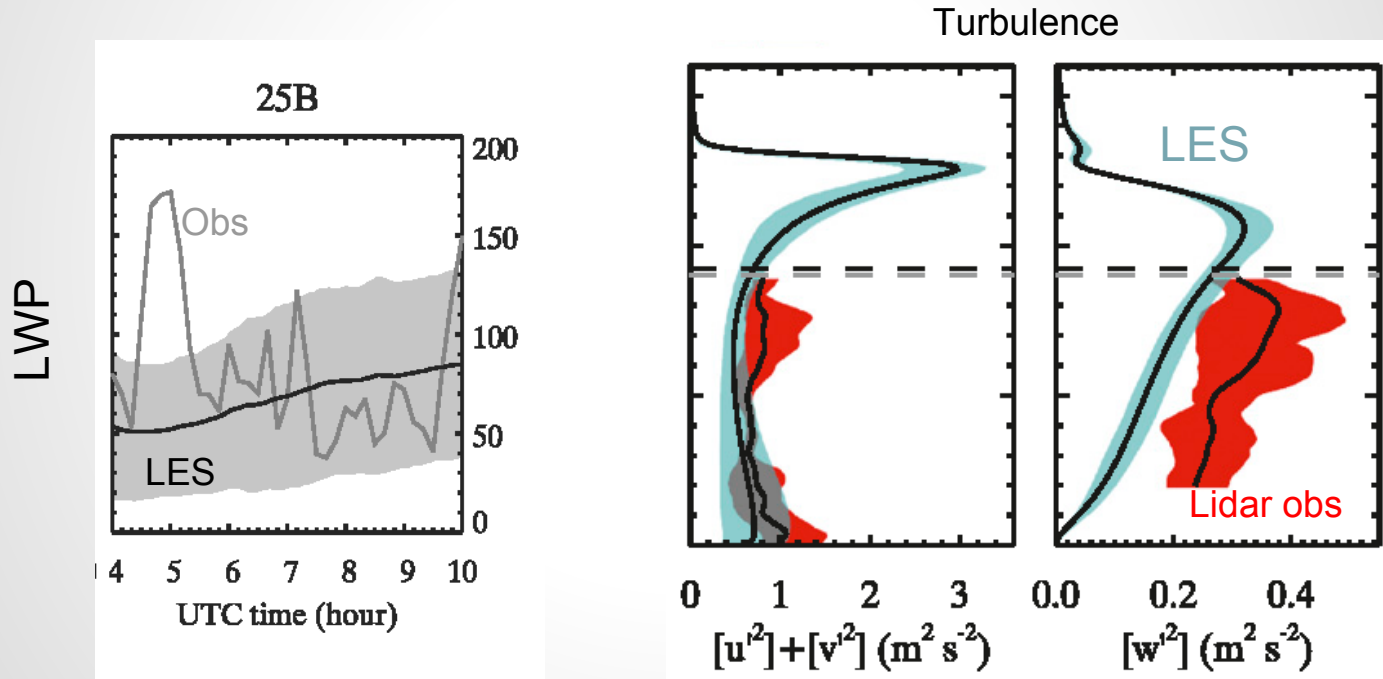
LES modelers: [Tak Yamaguchi](#), [Seoung-soo Lee](#), [Graham Feingold](#)

Observationalists: [Dan Grosvenor](#), [Matt Wyant](#), [Rob Wood](#), [Terry Kubar](#), [Matt Lebsock](#), [Graeme Stephens](#)

Parameterization developers: [David Schanen](#), [Brian Griffin](#), [Jan Hoft](#), [Eric Raut](#), [Vince Larson](#)

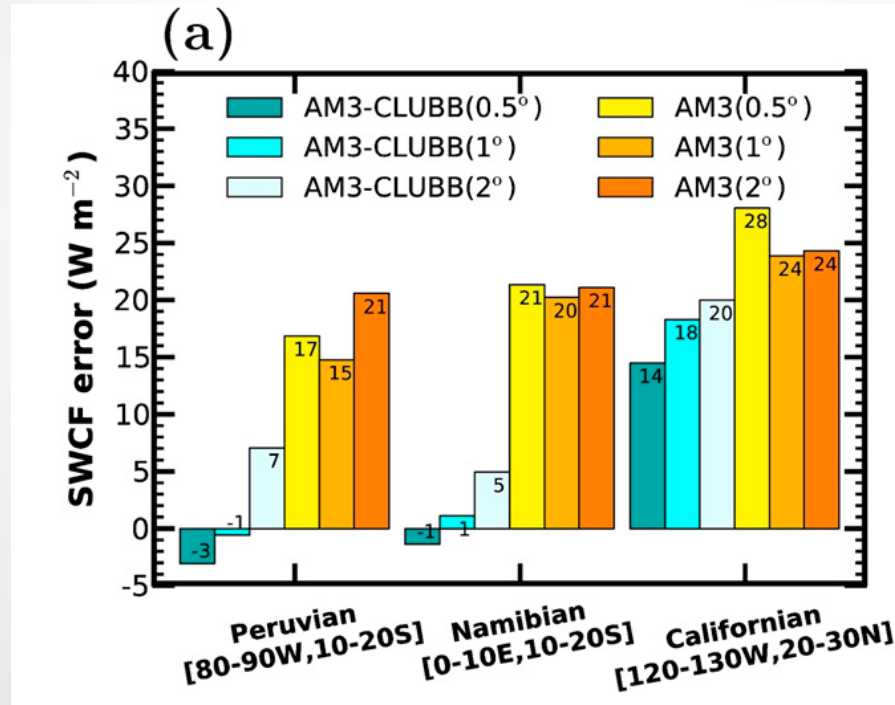
Climate modelers: [Huan Guo](#), [Chris Golaz](#), [Leo Donner](#), [Peter Bogenschutz](#), [Hugh Morrison](#), [Andrew Gettelman](#)

Even if a LES model predicts the correct liquid water path (LWP), it may underpredict turbulence:



Yamaguchi et al. (2014)

CLUBB can be tuned to improve marine Sc in GFDL's AM3 model



Guo et al. (2014)

**CAM-CLUBB
has better
precipitation
skill scores than
does CAM5,
without other
degradations:**

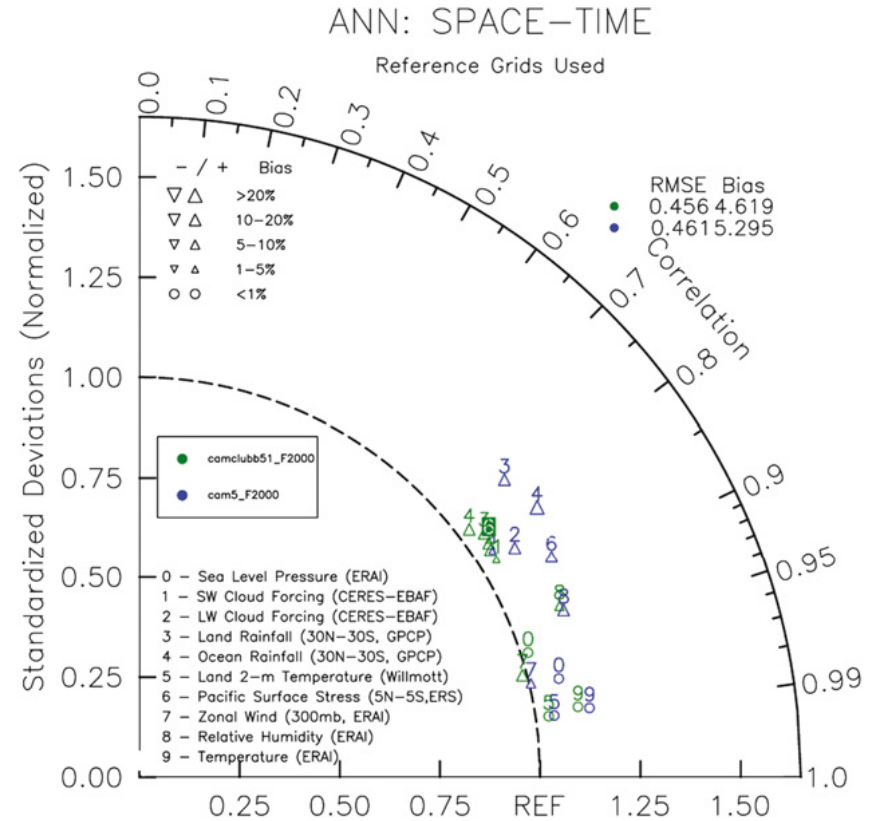


FIG. 9. Taylor diagram comparing scoring metrics of CAM5 (blue) and CAM-CLUBB (green) for the 5-yr simulation.

Bogenschutz et al. (2013)

In other work, prognostic precipitation (“MG2”) has been shown to produce more realistic (lesser-magnitude) values of the aerosol indirect effect (AIE)

Simulation	Radiative flux perturbation	Change in shortwave cloud forcing	Change in longwave cloud forcing
CAM5-MG1	-1.4 W m ⁻²	-1.6 W m ⁻²	0.5 W m ⁻²
CAM-CLUBB-MG2	-1.1 W m ⁻²	-0.7 W m ⁻²	0.1 W m ⁻²

Bogenschutz (2014); Gettelman et al. (2014)

**Another way to accelerate
parameterization development is
competitive intercomparisons**

E.g., CLUBB has benefited from participating in GCSS intercomparisons:

CGILS: Shallow Cu and Sc

DYCOMS-II: Stratocumulus

GABLS: Stably stratified layer

TWP-ICE: Deep convection

There are other kinds of intercomparisons, such as forecast competitions, e.g. Kaggle

1 Solar Energy Prediction: An International Contest to Initiate
2 Interdisciplinary Research on Compelling Meteorological
3 Problems

4 AMY MCGOVERN *

School of Computer Science, University of Oklahoma, Norman, Oklahoma

There are also parameterization testbeds, e.g. FASTER

The screenshot shows the FAST PHYSICS PROJECT web interface. The header includes the project name and the Brookhaven Climate Consortium. The main content area has several sections for configuring a simulation. Annotations with starburst icons highlight key features: 'Interactive SCMs' points to the model selection dropdown; 'Interactive new phys' points to the physics scheme selection; 'New cases dev.' points to the forcing data selection; 'Flexible simulation' points to the time selection dropdowns; and 'Instant evaluation' is shown in a thought bubble above the 'Start SCM Experiment' button.

FAST PHYSICS PROJECT
Brookhaven Climate Consortium

Select a model [Documentation](#) | [Code Browser](#) | [Specifics](#)

Interactive SCMs

☐ CAM5/BAM ☒ CAM5/MAM3 ☐ CESM/CAM4 ☐ CAM4 ☐ CAM3.1 ☐ GFDL/AM2 ☐ AM3 ☐ GISS ☒ CAM Dev

Select physics schemes User modules for CAM Dev: C:\BNL\newPhys.tar ☒

More model options

Select forcing data

☒ IOP ☐ Continuous Forcing ☐ Ensemble Forcing ☐ Regime ☐ User data

Interactive new phys

New cases dev.

Select an IOP

ARM SGP Jul. 1999
ARM SGP Mar. 2000
ARM SGP Sep. 2000
ARM SGP Nov. 2000
ARM SGP Nov. 2002
ARM TWP-ICE Jan. 2006

Select the starting time

2000-03-01 18:00:00
2000-03-01 18:20:00
2000-03-01 18:40:00
2000-03-01 19:00:00
2000-03-01 19:20:00
2000-03-01 19:40:00

Select the ending time

2000-03-03 22:20:00
2000-03-03 22:40:00
2000-03-03 23:00:00
2000-03-03 23:20:00
2000-03-03 23:40:00
2000-03-04 00:00:00

Flexible simulation

Forcing options

Simulation options

Summary of SCM experiment settings

00:00:26 ☒ [View/download the results.](#) [Quicklook plots.](#)

Instant evaluation

Competitions align interests

Observationalists can use their datasets to evaluate a variety of models, without having to bet on a winner.

Parameterization developers don't need to spend time developing evaluation datasets, and receive plaudits if they win.

Climate modeling centers would receive an independent “rating” of models. Or they could conduct their own competitions.

**Competitions place focus on
important metrics of progress in the
field**

Improvement in skill scores is a more important
metric for the community than papers or
citations.

How can program managers foster competitions?

1. Fund scientists to organize intercomparisons, forecast competitions, and testbeds.
2. Reward the winners (and runners-up!) of competitions.
3. Require host models to have documentation and be user friendly.

How can program managers make competitions more beneficial to the community?

1. Require winners of competitions to release their source code and a description of their method.
2. Fund a group to archive results of competitions so that progress can be assessed over time.

Thanks for your time