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

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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

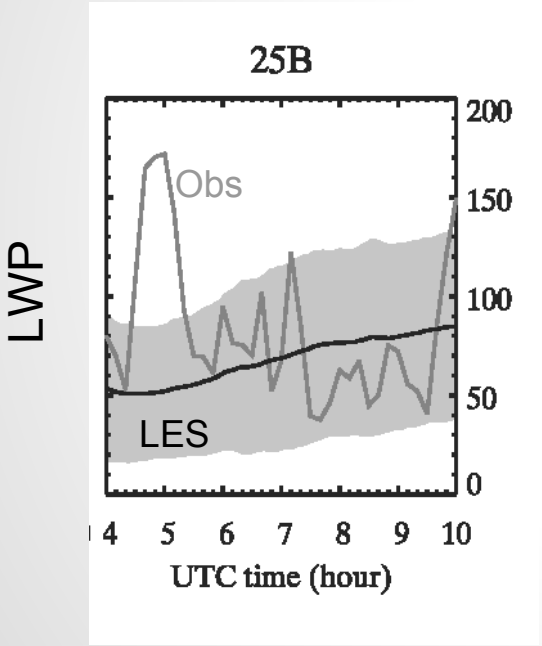
LES modelers: Tak Yamaguchi, Seoung-soo Lee, Graham Feingold

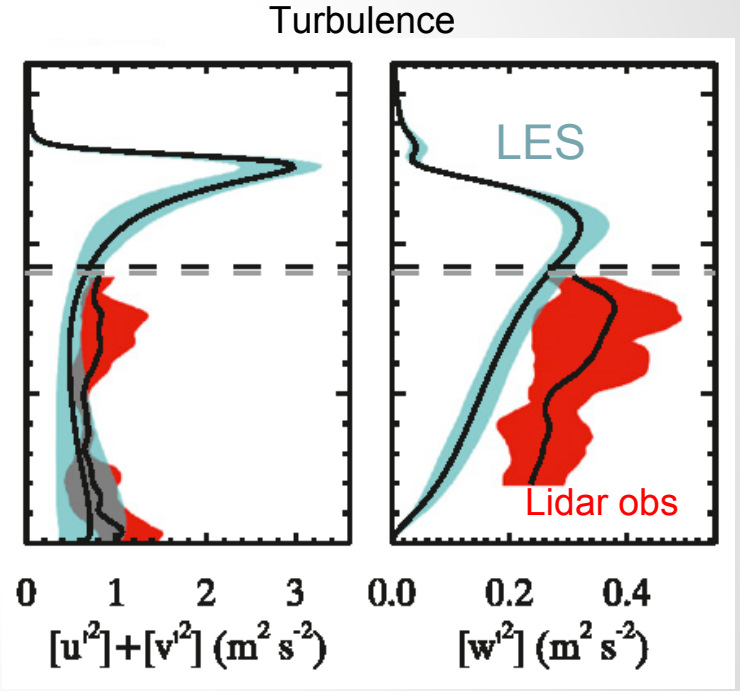
Observationalists: Dan Grosvenor, Matt Wyant, Rob Wood, Terry Kubar, Matt Lebsock, Graeme Stephens

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

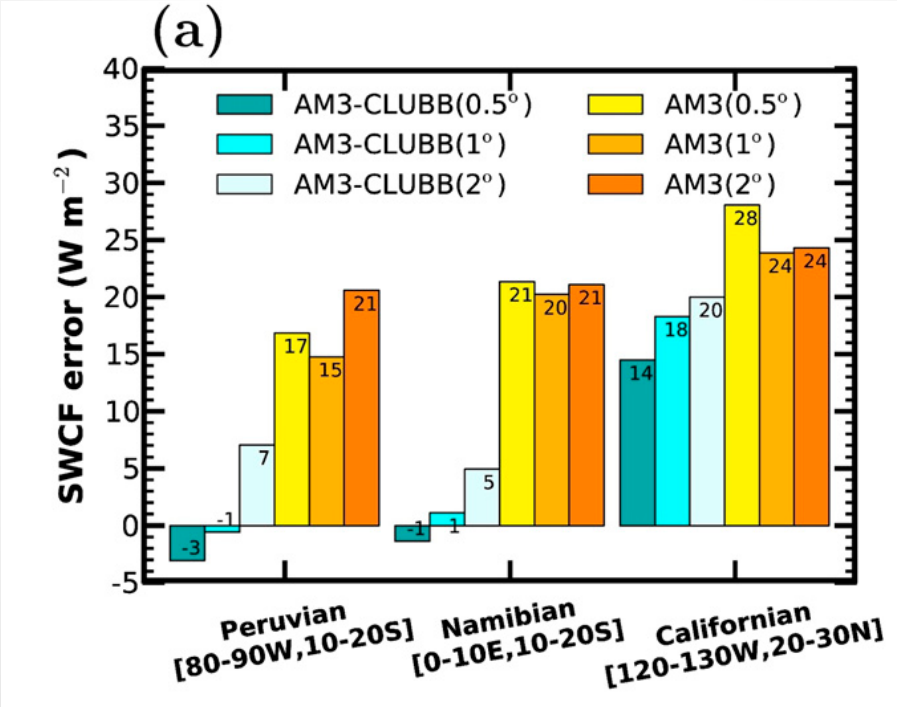
Even if a LES model predicts the correct liquid water path (LWP), it may underpredict turbulence:





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:

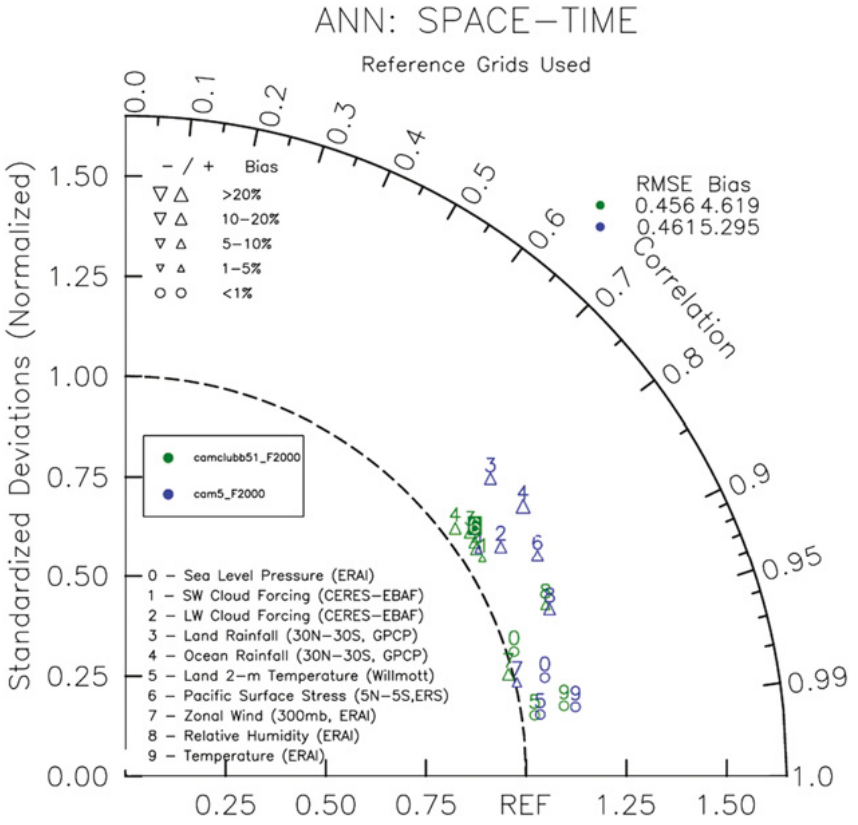


FIG. 9. Taylor diagram comparing scoring metrics of CAM5 (blue) and CAM–CLUBB (green) for the 5-yr simulation.

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**

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3 **Problems**

4 Amy McGovern *

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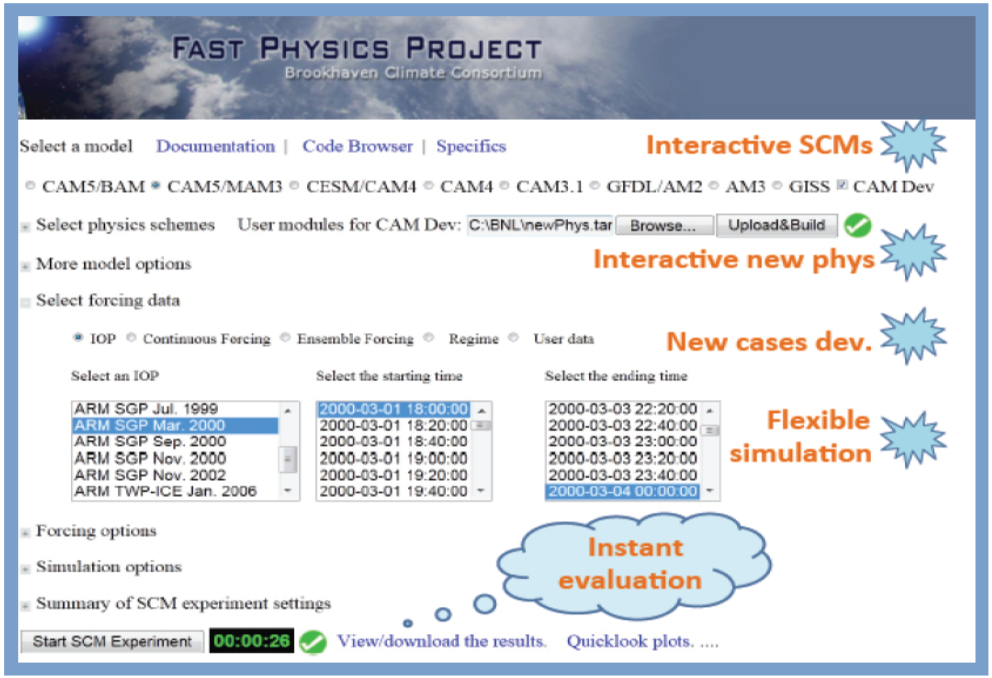
There are also parameterization testbeds, e.g. FASTER



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