R: Deep Convection Modifications for Gustiness, Entrainment and Timescale

Richard Neale, Cecile Hannay, Julio Bacmeister and John Truesdale

National Center for Atmospheric Research

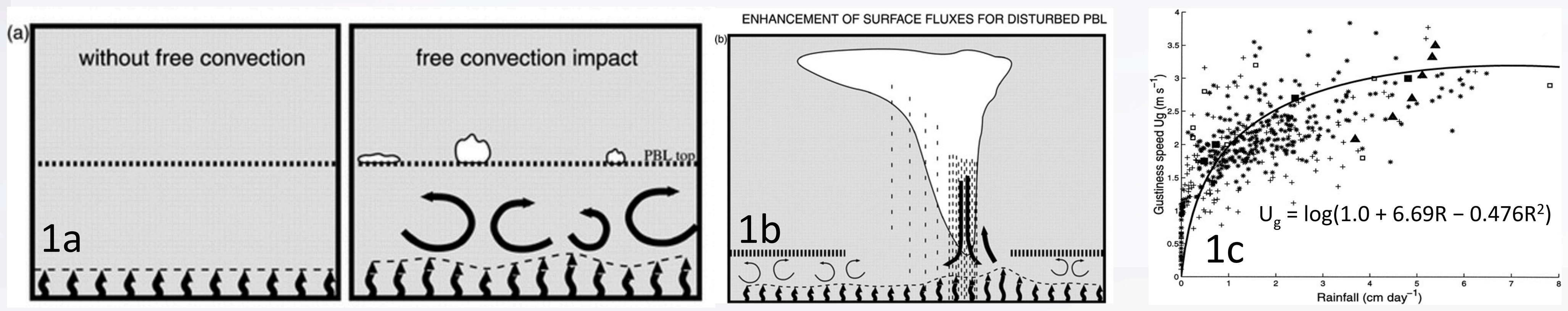
Objective and Approach

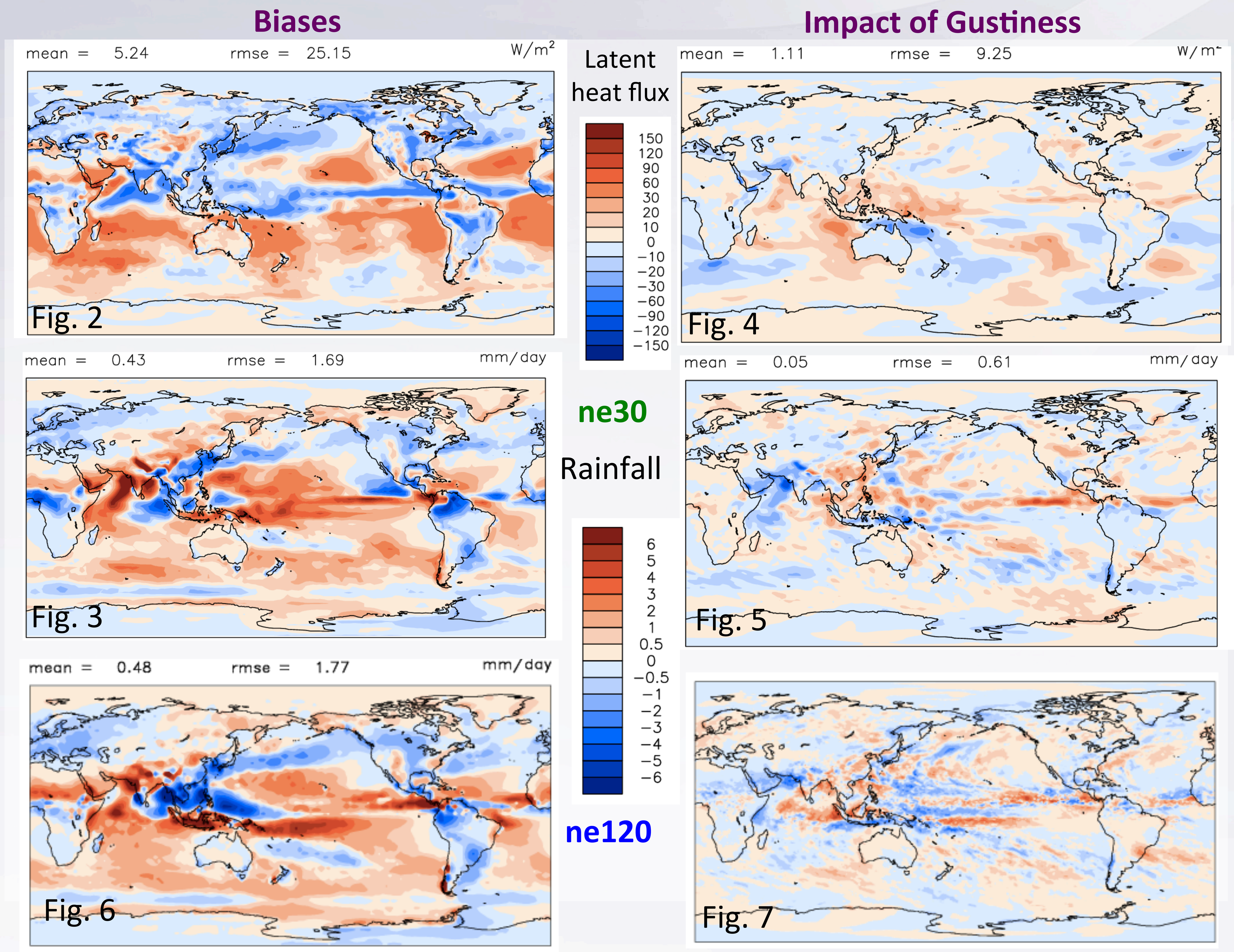
Overview

- Surface fluxes due to sub-grid scale surface wind variations within the boundary layer are implicitly calculated as part of the surface flux parameterization (Fig. 1a)
- However, CAM does not currently parameterize sub-grid scale downdraft effects at the surface including ***sub-grid scale convective gustiness*** and its impact on surface fluxes (Fig. 1b)
- This could have important impacts in the convecting tropics where mean wind speeds are low
- Latent heat fluxes are low in the tropics in CAM (Fig 2.) and are often co-located with low rainfall (Fig 3)

Methodology

- Gustiness is calculated following a simple empirical relationship with convective precipitation (derived from the TOGA-COARE experiment in Redelsperger et al., 2000, Fig 1c)
- Sub-grid scale gustiness is applied to the surface latent heat flux calculation





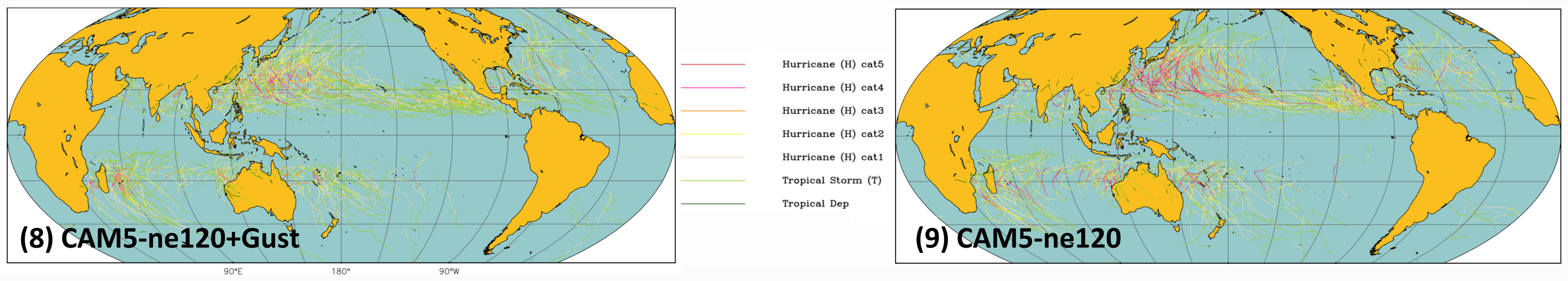
Results

1 deg (ne30) simulations (AMIP)

- The flux modifications were applied in version v0.2 of the ACME model
- JJA has the largest response, where enhanced fluxes (Fig. 4) shift the Monsoon precipitation center of action to the East (Fig. 5). This improves existing biases
- East Pacific ITCZ biases are moderately degraded.

0.25 deg (ne120) simulations (AMIP)

- Preliminary results with short ne120 simulations show similar effects to the ne30 simulations
- Fluxes are enhanced in the tropics and improvements are made to the Monsoon precipitation hole (Fig. 7) which is probably the most concerning atmospheric bias in ne120 simulations (Fig 6.).
- The number of the most intense North Pacific hurricanes is reduced with gustiness included (Fig. 8) compared to the excessive number of strong hurricanes produced in CAM5 (Fig. 9)



(8) CAM5-ne120+Gust (9) CAM5-ne120

Further Proposed Convection Modifications

Overview

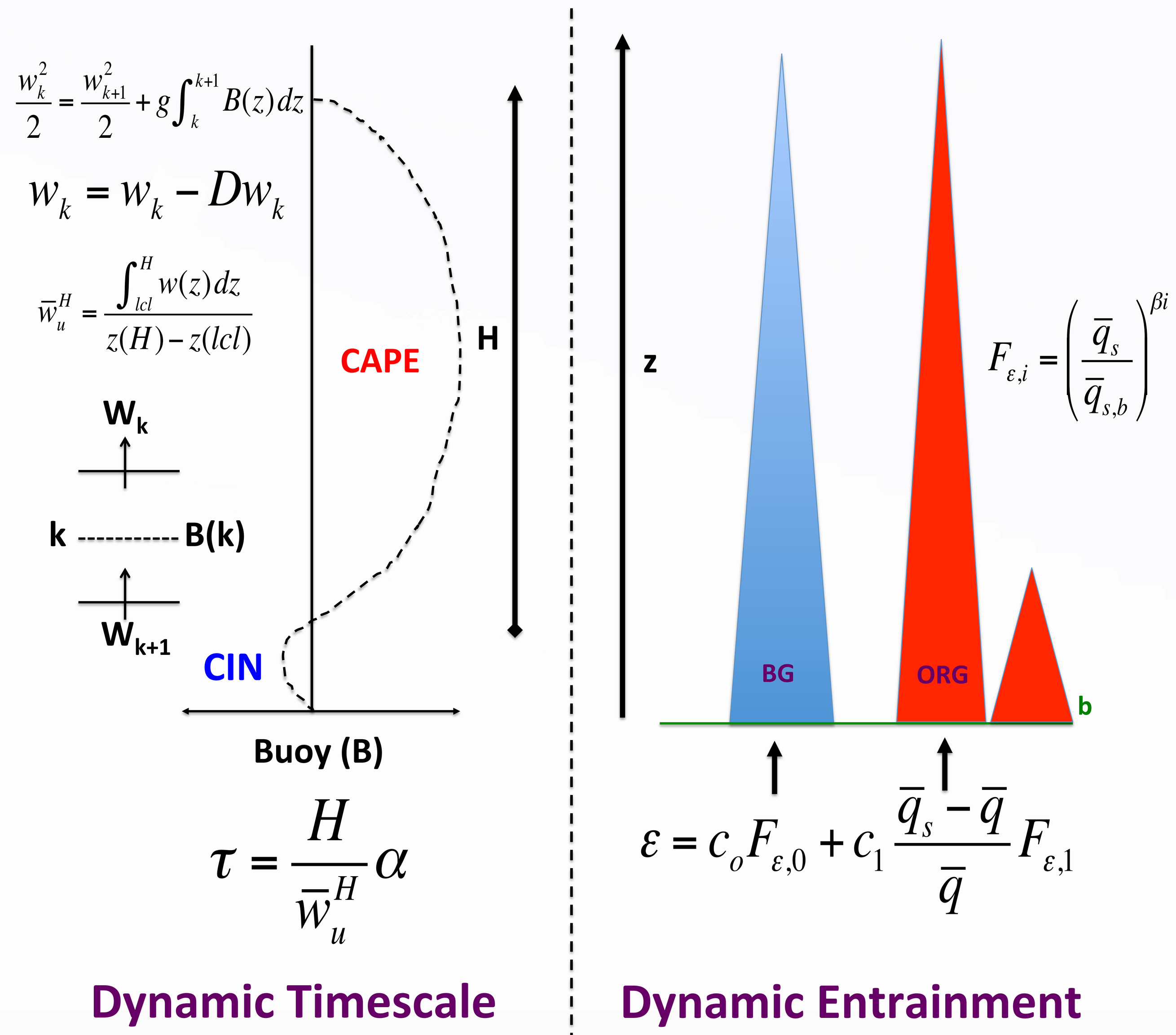
- Approaches follow the work of Bechtold et al. (2008)

Dynamic Timescale

- Currently set to a constant
- Modified based on implied depth of convection and buoyancy-derived vertical velocity
- Longer timescale for deep convection and shorter timescale for shallow.

Dynamic entrainment

- Currently set to a constant
- Stronger entrainment in a dry atmosphere (unorganized)
- Weaker entrainment in a moist atmosphere(organized)



ACME Accelerated Climate Modeling for Energy

For additional information, contact:
Rich Neale
Project Scientist

National Center for Atmospheric Research
(303) 497-1380
rneale@ucar.edu

climatemodeling.science.energy.gov/acme

U.S. DEPARTMENT OF ENERGY