Jet Propulsion Laboratory
California Institute of Technology

A Unified Multi-Plume Jet Propulsion Laboratory (JPL) Eddy-Diffusivity/Mass-Flux Parameterization Model

Kay Suselj, Marcin Kurowski and Joao Teixeira

- Suselj, K., M. J. Kurowski, and J. Teixeira, 2019. On the Factors Controlling the Development of Shallow Convection in Eddy-Diffusivity/Mass-Flux Models. J Atmos Sci 76 (2), pp. 433-456.
- Suselj, K., M. J. Kurowski, and J. Teixeira, 2019. A Unified Eddy-Diffusivity/Mass-Flux Approach for Modeling Atmospheric Convection. J Atmos Sci 76 (8) , pp. 2505-2537.
- Suselj, K., J. Teixiera, M. Kurowski and A. Molod, 2021. Improving the representation of subtropical boundary layer clouds in the NASA GEOS model with the Eddy-Diffusivity/Mass-Flux parameterization. Mon Weather Rev 149(3) 703-809

A unified stochastic multi-plume JPL EDMF model for PBL, shallow and deep convection

Jet Propulsion Laboratory
California Institute of Technology

1. Locally-driven turbulence

- Prognostic TKE eddy-diffusivity and PDF cloud macro-physical models

2. Convective updrafts

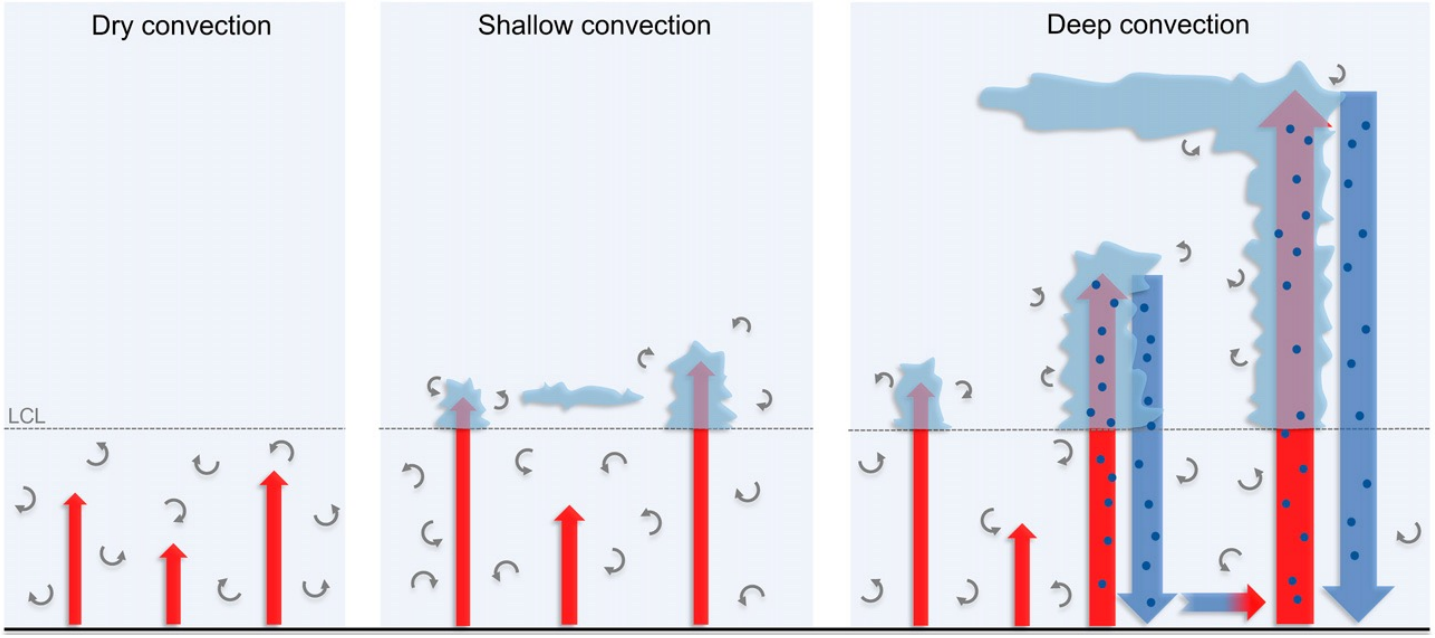
- Multiple, surface buoyancy driven updrafts, stochastic entrainment rate
- Kessler type microphysical parameterization (warm, mixed and ice phase)

3. Convective downdrafts

- Govern by equations similar to updrafts
- Driven by evaporation of precipitation entrained from updrafts

4. Cold pools

- Driven by subcloud flux due to downdrafts
- Modify updraft surface conditions and their size distribution (and entrainment rate)

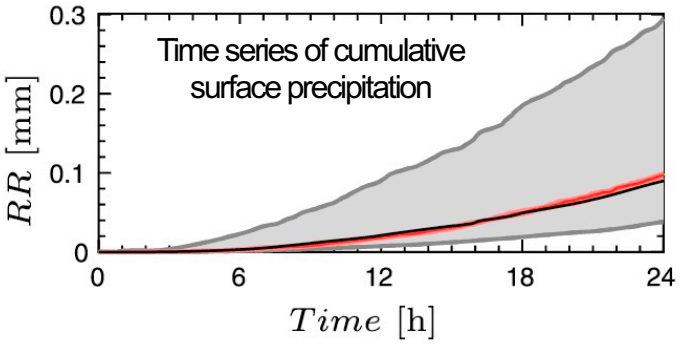


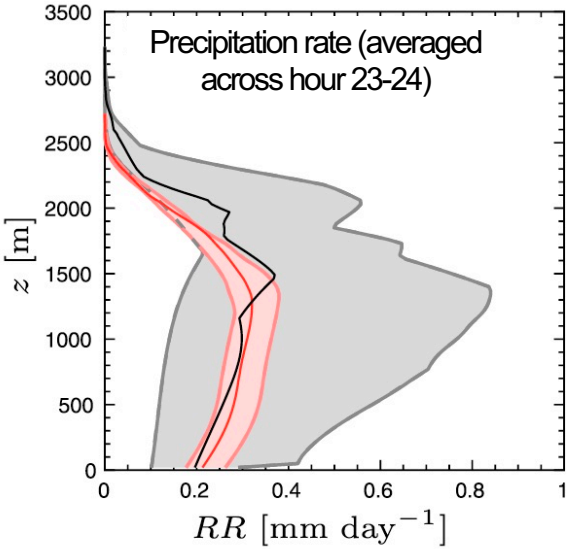
Schematic representation of dry, shallow and deep convective boundary layers by the JPL-EDMF model

JPL-EDMF in single-column-model, comparison against large-eddy-simulations

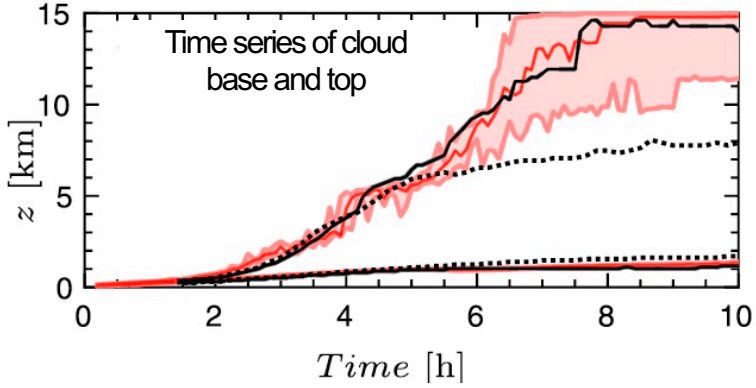
Jet Propulsion Laboratory
California Institute of Technology

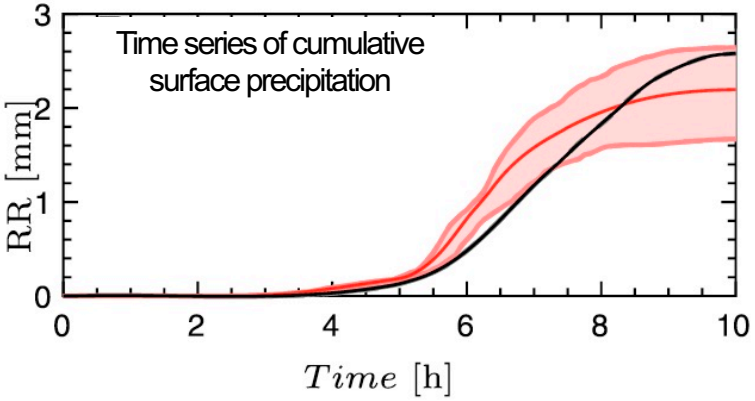
Marine precipitating convection (RICO case)

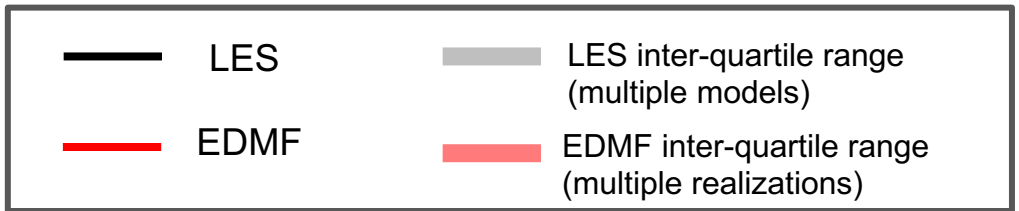




Diurnal cycle of continental convection (LBA case)







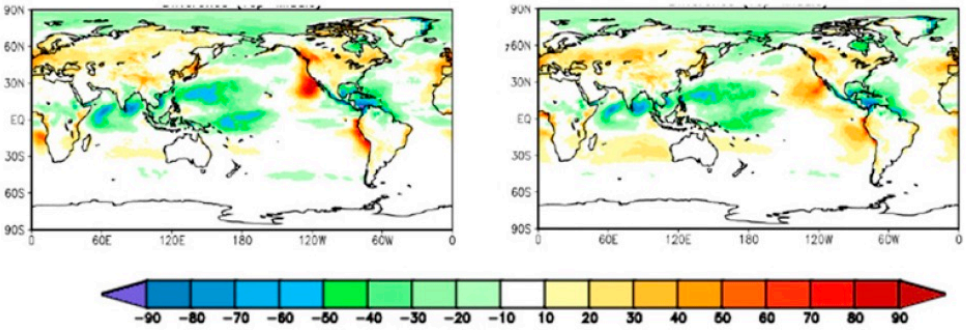
Non-precipitating version of JPL-EDMF parameterization in NASA GEOS model

Jet Propulsion Laboratory
California Institute of Technology

Numerical experiments:

- 5 year long, free-running, atmosphere-only simulations (observationally prescribed SST and sea ice extent), 1 degree horizontal resolution
- CONTROL (original) and EDMF (shallow convection EDMF) simulations.

TOA net SW flux:
CONTROL - OBSERVATIONS

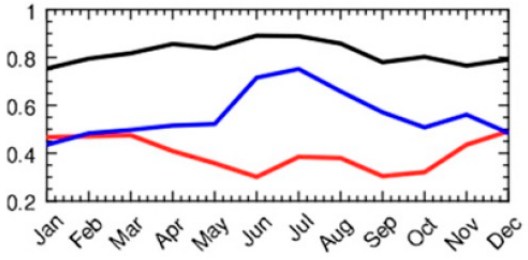


TOA net SW flux:
EDMF - OBSERVATIONS

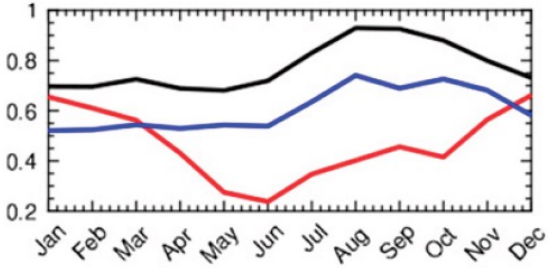
5 year averaged JJA top of the atmosphere net shortwave radiative flux [W m^{-2}] difference between CONTROL and OBSERVATIONS and EDMF and OBSERVATIONS.

OBSERVATIONS are from CERES-EBAF.

Total cloud cover:
Californian stratocumulus



Total cloud cover:
Namibian stratocumulus



Seasonal cycle of total cloud cover [-] over offshore Californian and Namibian stratocumulus regions.

Observations are from CERES SYN1deg-Level3.

CONTROL EDMF Observations