modeling stratocumulus in GFS

S. Moorthi, R. Sun, H. Xiao, and C.R. Mechoso, H. Pan
The shallow convection parameterization is applied wherever the deep convective parameterization is not active.

- Shallow convection is enhanced vertical diffusion in the cloud layers.
- Cloud top is defined as the layer above the highest positive buoyant layer below $P_t$ ($P_t = 0.7 \times P_{sfc}$).
- Background diffusion.
A simple method to improve stratocumulus representation

- The background vertical diffusion coefficient is set to zero above inversion (ZeroBD)
- If the condition for cloud top entrainment instability (CTEI) is not satisfied the top of the shallow convection is set to just below inversion. If satisfied operational method is used to determine cloud top (CTEI)
- CTEI condition: \( C_p \Delta \bar{\theta}_e < 0.7 L \Delta \bar{q}_t \)
Experiments

- **Ctl** (operational GFS with RAS)
- **New** (CTEI + zeroBD)
- **ZeroBD** (Ctl + zeroBD)
- **CTEI** (CTEI)

General settings used in all experiments:

1. resolution: T126 and 64 levels
2. observed SST
3. two-month simulations started at 2008061300
Total cloud (July)

Ctl

ZeroBD

CTEI

ISCCP
Low cloud

Ctl

New

ZeroBD

CTEI

ISCCP

set31pc GFS low cld (07/2008)

set31p1 GFS low cld (07/2008)

set31p0 GFS low cld (07/2008)

set31p3 GFS low cld (07/2008)

ISCCP JU01 06clcl CLM (1985-1993)
xz cloud water (20S)
xz shallow moistening (20S)

- Ctl
- New
- ZeroBD
- CTEI
xz LS condensation (20S)

Ctl

New

ZeroBD

CTEI
xz conv heating RAS (20S)
Summary

- Zero background diffusion above inversion is important in producing the stratocumulus clouds.
- The method of determining cloud top in the current operational shallow convection scheme tends to set the cloud tops too high and hence produce too thick mixing layers and destroy the stratocumulus.
- Large scale condensation is the main process to produce stratocumulus clouds.
- RAS takes care of some shallow convection and produce shallow clouds.
xz shallow heating (20°S)

CTEI

ctl

New

ZeroBD

CTEI
xz conv moistening (20S)

Ctl

New

ZeroBD

CTEI