Initiation of deep convection during the early-monsoon sahelian convective boundary layer: an observational study

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Objective
This study aims at analyzing the factors of deep convection to better understand the transition from dry convection to shallow convection and from shallow to local deep convection.

Based on the AMMA (African Monsoon Multidisciplinary Analysis) dataset, the characterization of the atmospheric convection which occurred over Niamey (Niger) during the early African monsoon (26 days in July 2006) was made.

Data and Methods

- MIT (Massachusetts Institute of Technology) C-band Doppler radar
- 3D interpolation of reflectivity → horizontal and vertical cross-sections
- VVP (Volume velocity processing) → vertical profile of divergence
- Atmospheric Radiation Measurement (ARM) mobile facility:
  - Radiosoundings (CAPE, CIN, TKE, H_2O, and θv)
  - UHF wind profiler (diurnal cycle of Convective boundary-layer (CBL))
- Surface turbulent fluxes
- Satellite data (MSG)

The classification of convection day is based on the PPI and horizontal cross sections of reflectivity MIT radar

- Deep convection: reflectivity > 30 dBz and vertical extension > 7 km, T_θ < 235 K (Mathon et al 2001)
- Shallow convection: reflectivity < 30 dBz and vertical extension < 7 km
- Dry convection: fair weather
- Propagating convection: deep convection formed outside and moved in the scope of the MIT radar

Classification

- Local deep convection (LC): 9 cases
- Propagating deep convection (PC): 9 cases
- Shallow convection (SH): 4 cases
- Dry convection (FW): 4 cases

Local deep convection is common during this period

- All cases of class LC, SH, and FW except one in class LC start with organization in rolls in the CBL
- 7 cases of local deep convection are associated with gust fronts
- All gust fronts except one triggered new deep convective cells
- 3 cases of local convection are triggered on a convection line

Convection initiation factors

Based on 0300 UTC CTP/H_2O/APE/CIN, it is difficult to predict that the deep convection will occur in the afternoon

- 3 LC, 2 SH, 3 FW and 2 PC: CPE < 1000, CIN < 100 J kg^{-1}
- 4 LC, 1 FW, 1 SH, and 2 PC: Larger CPE, 100 < CIN < 200 J kg^{-1}

Large surface Fluxes are necessary for deep convection (Couvreux et al, 2012)

Low sensible heat flux and significant latent heat flux for PC
Low sensible heat flux for LC, SH than FW
Increasing latent heat flux for LC in afternoon by convection
LC and SH are similar on diurnal cycle of turbulence heat fluxes

Futur works
We will consider the same set of cases to further analyze the role of the surface temperature and moisture heterogeneity
LES (Large Eddy-Simulations) studies to further understand the triggering factors of afternoon deep convection.

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