Characterization of local deep convection observed in the Sahel over Niamey during the early monsoon

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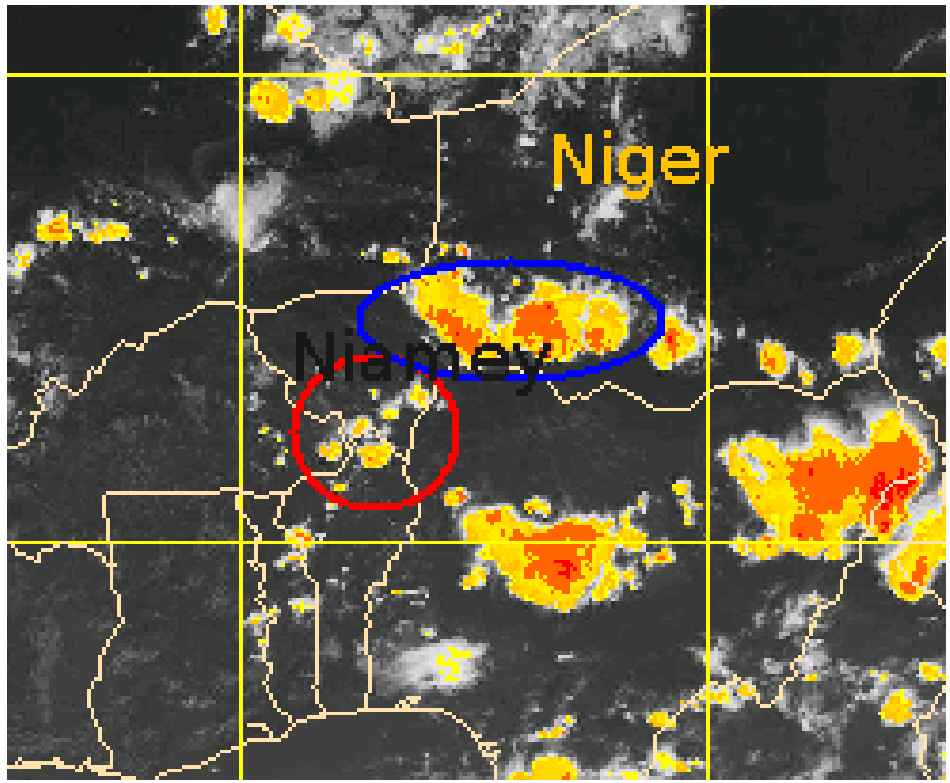
Pr.2C.3

July 2, 2012

Infrared brightness temperature from MSG
26 July 2006 at 17:00 UTC



Squall Lines and MCSs

Afternoon local deep convection

What are the triggering factors of local deep convection over Niamey?

Objective

- Based on the case study of 10 July 2006 (Lothon et al, 2011, Couvreux et al, 2012) to investigate the factors of convection.
- Analyse in a more systematic way the main features of the convection observed in Sahelian Africa during the early monsoon (6-31 July 2006)
- Understand the initiation factors and mecanisms of locally-initiated deep convection in the Sahel during the studied period.

Outline

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AMMA data used

⊕ MIT (Massachusetts Institute of Technology) C-band Doppler radar

- $\hookrightarrow$ 3D interpolation of reflectivity $\Rightarrow$ horizontal (100×100 km^2) and vertical cross sections every 10 min
- $\hookrightarrow$ VVP (Volume velocity processing) Waldteufel and Corbin 1979
- (R_{xy}=30 km, Δh= 100 m $\Rightarrow$ vertical profile of divergence every 10 min

⊕ Atmospheric Radiation Measurement (ARM) mobile facility:

- $\Rightarrow$ Radiosoundings **(CAPE, CIN)**
- $\Rightarrow$ UHF wind profiler **(diurnal cycle of CBL and wind)**
- $\Rightarrow$ Surface turbulent fluxes
- $\Rightarrow$ 95 GHz cloud-radar

⊕ Satellite data:

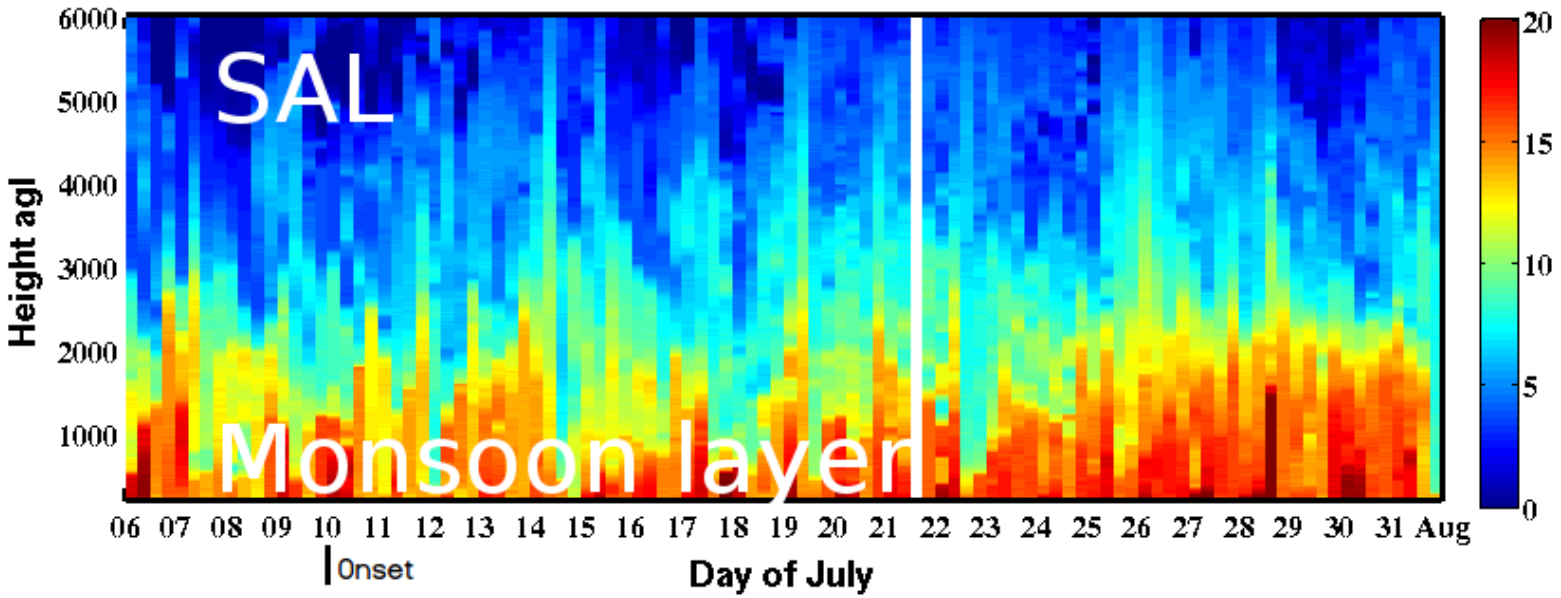
- $\Rightarrow$ Brigthness temperature of Meteosat Second Generation (MSG)

Overview

Onset (around 10 July 2006) Janicot et al, 2008

Low moisture in the pre-onset period

Higher depth of the monsoon at the end of the studied period



Time-height section of Mixing ratio (g kg^{-1})

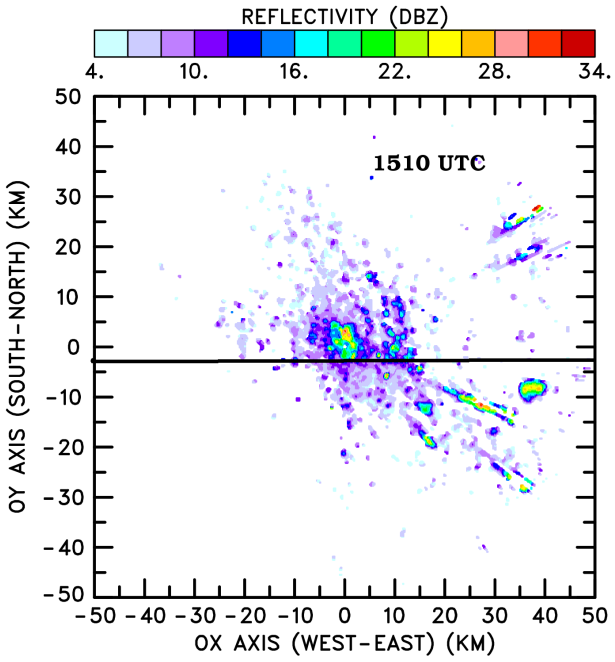
Outline

Classification of the convection

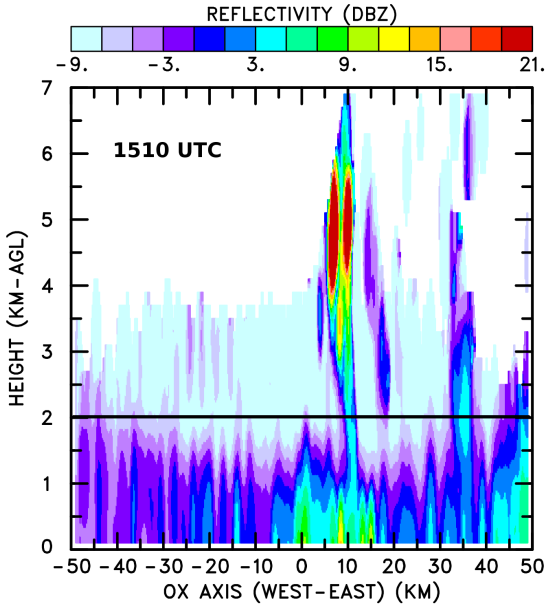
The classification of the convection is based on horizontal and vertical cross sections of reflectivity MIT radar

- **Locally-initiated deep convection (LC)**: reflectivity $>$ 30 dBz (Wilson and Schreiber 1986) and vertical extension $>$ 7 km in the area of 100 $\times$ 100 km^2, $T_b < 233$ k (Mathon et al 2001)
  9 cases found

Case of 27 July 2006



Z=2 km



Y=-3 km

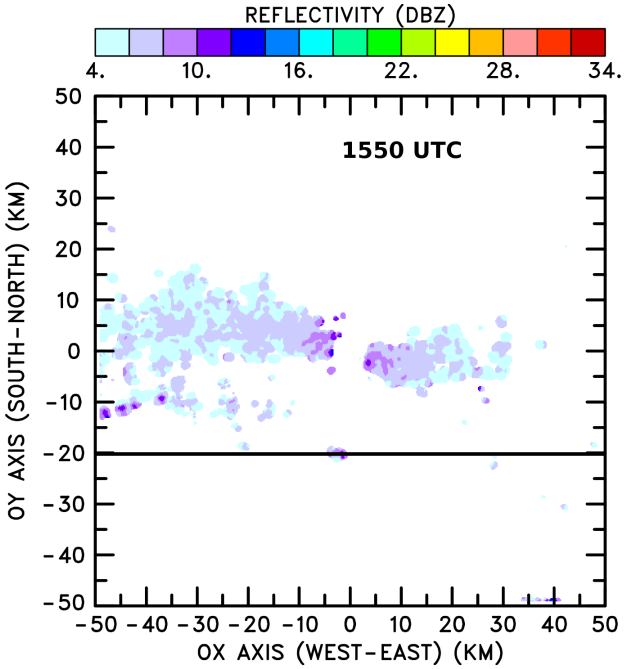
Day	06	08	10	11	12	20	26	27	28
Distance (km)	30 WNW	30(NW)	5(E)	20(S)	20(S)	50(E)	30(NW)	11(SE)	10(SW)
Hour UTC	1500	1540	1540	1510	1640	1620	1640	1510	1720

Classification of the convection

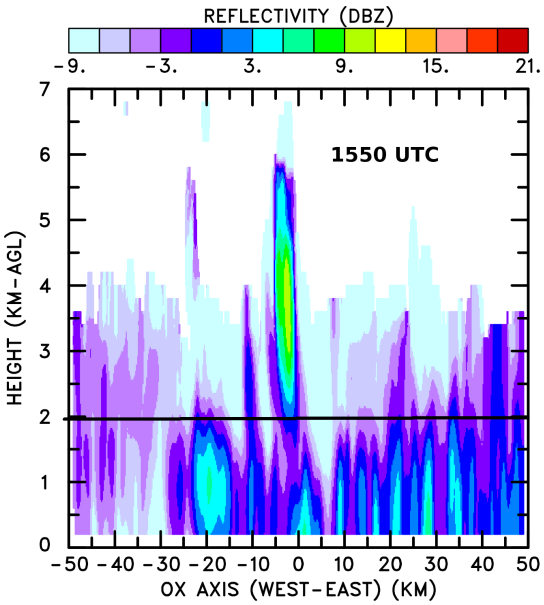
The classification of the convection is based on horizontal and vertical cross sections of reflectivity MIT radar

- **Shallow convection (SH)**: reflectivity $<$ 30 dBz and vertical extension $<$ 7 km
  4 cases found

Case of 13 July 2006



Z=2000 m



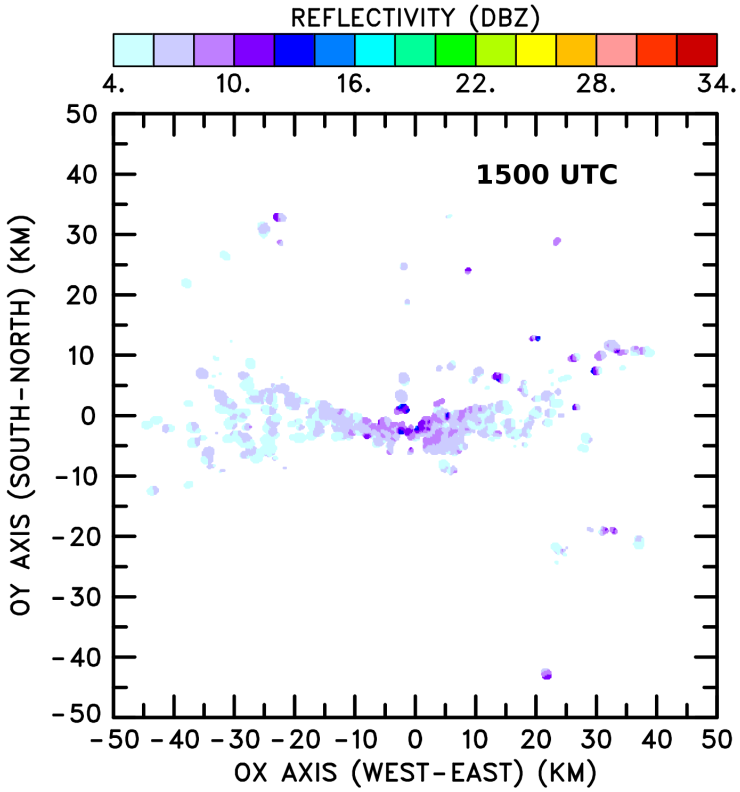
Y=-20 km

Classification of the convection

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

- **Dry convection (FW)**: fair weather in the scan area
  4 cases found

Case of 16 July 2006



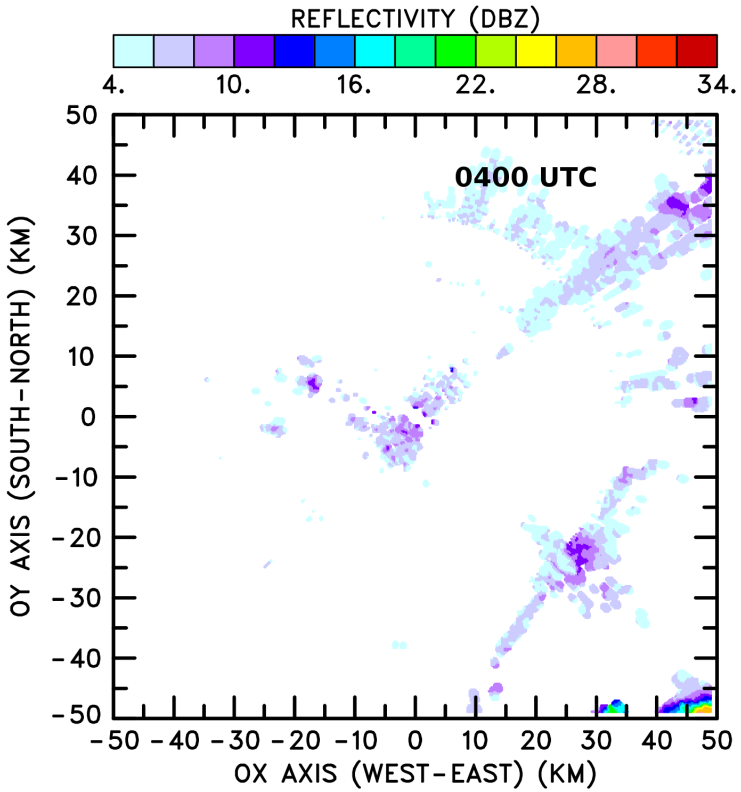
Horizontal cross section at Z=2000 m

Classification of the convection

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

- **Propagating convection (PC)**: deep convection formed outside and moving through the studied area.
  Case of propagating deep convection on 14 July 2006
  10 cases found

Case of 14 July 2006



Horizontal cross section at Z=2000 m

Classification of the convection: Summary

July 2006

Mon	Tues	Wed	Thu	Fri	Sat	Sun
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26/26	27	28	29	30
31						

9 cases of locally-initiated convection

4 cases of shallow convection

4 Cases of dry convection

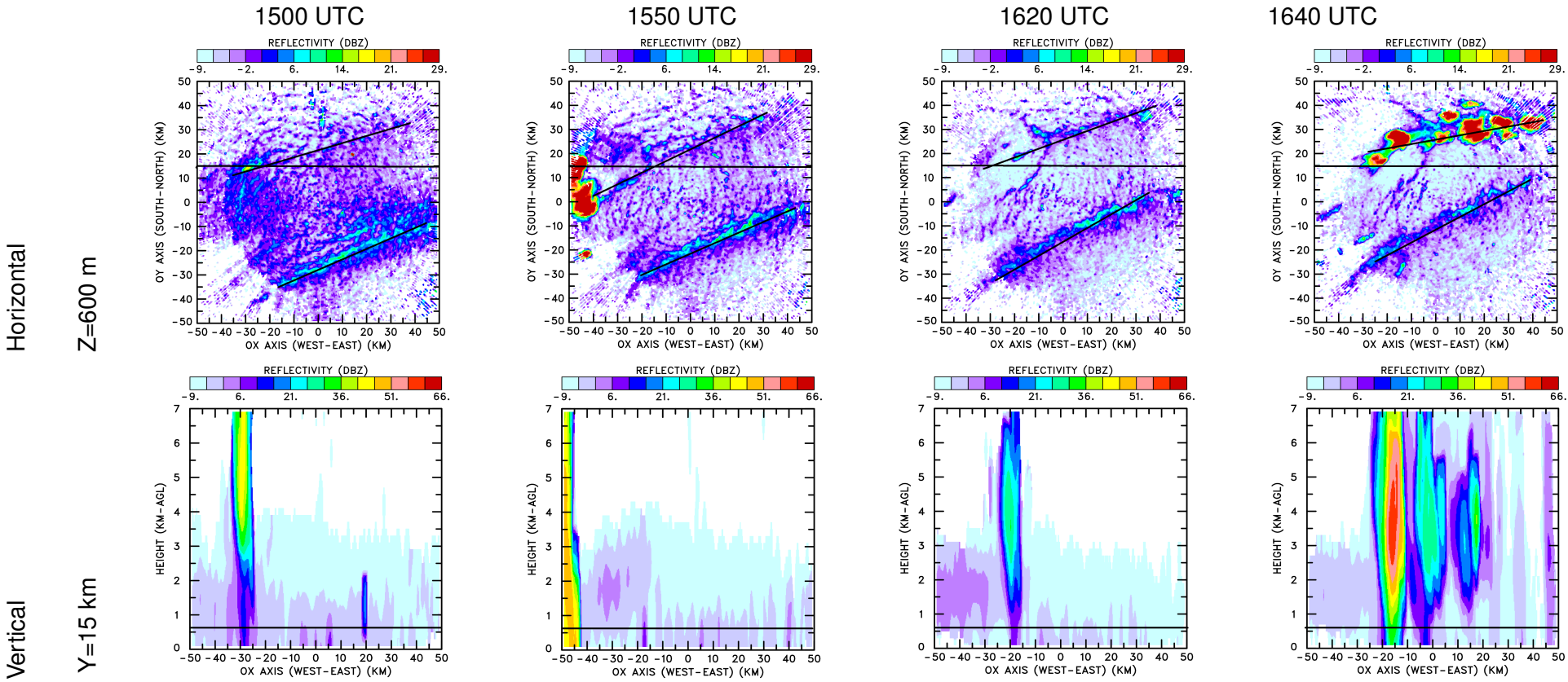
10 cases of propagating convection

Outline

convection lines

Convection lines precursors of deep convection (Wilson et al. (1992))

Case of deep convection triggered on a convection line: 06 July 2006

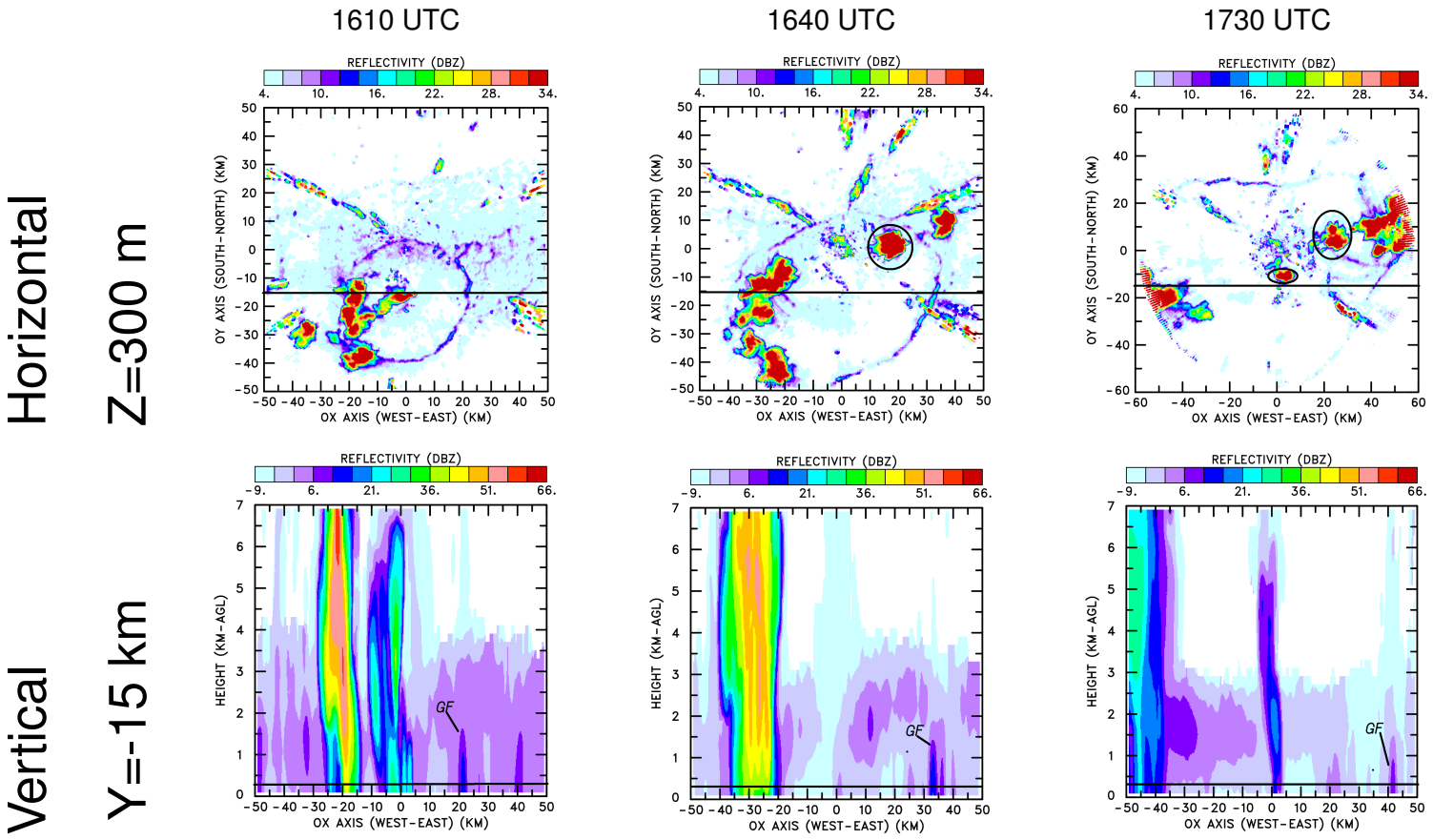


- Cumulus clouds slowly developed along the convective line
- 2 other cases are found during the study period

Gust fronts

Deep convection triggered by gust fronts (Weckwerth and Wakimoto 1992)

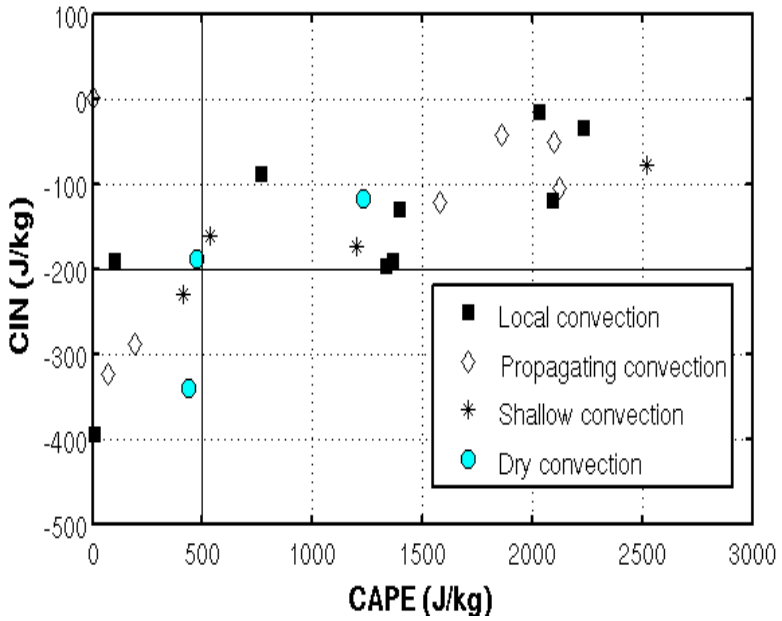
case of 11 July 2006



7 cases of local deep convection are associated with gust fronts

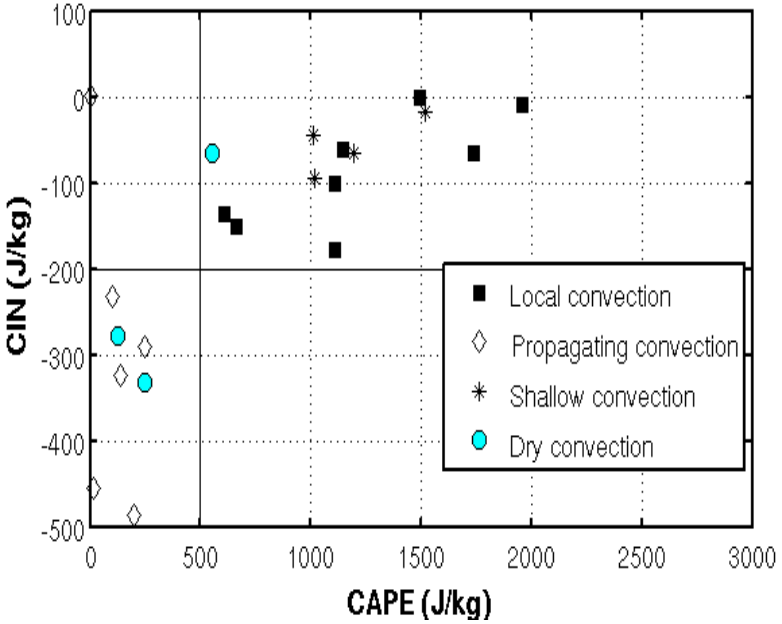
All gust fronts except one triggered new deep convective cells

Instability factors



0530 UTC

Difficult to predict the type of convection that will occur in the afternoon

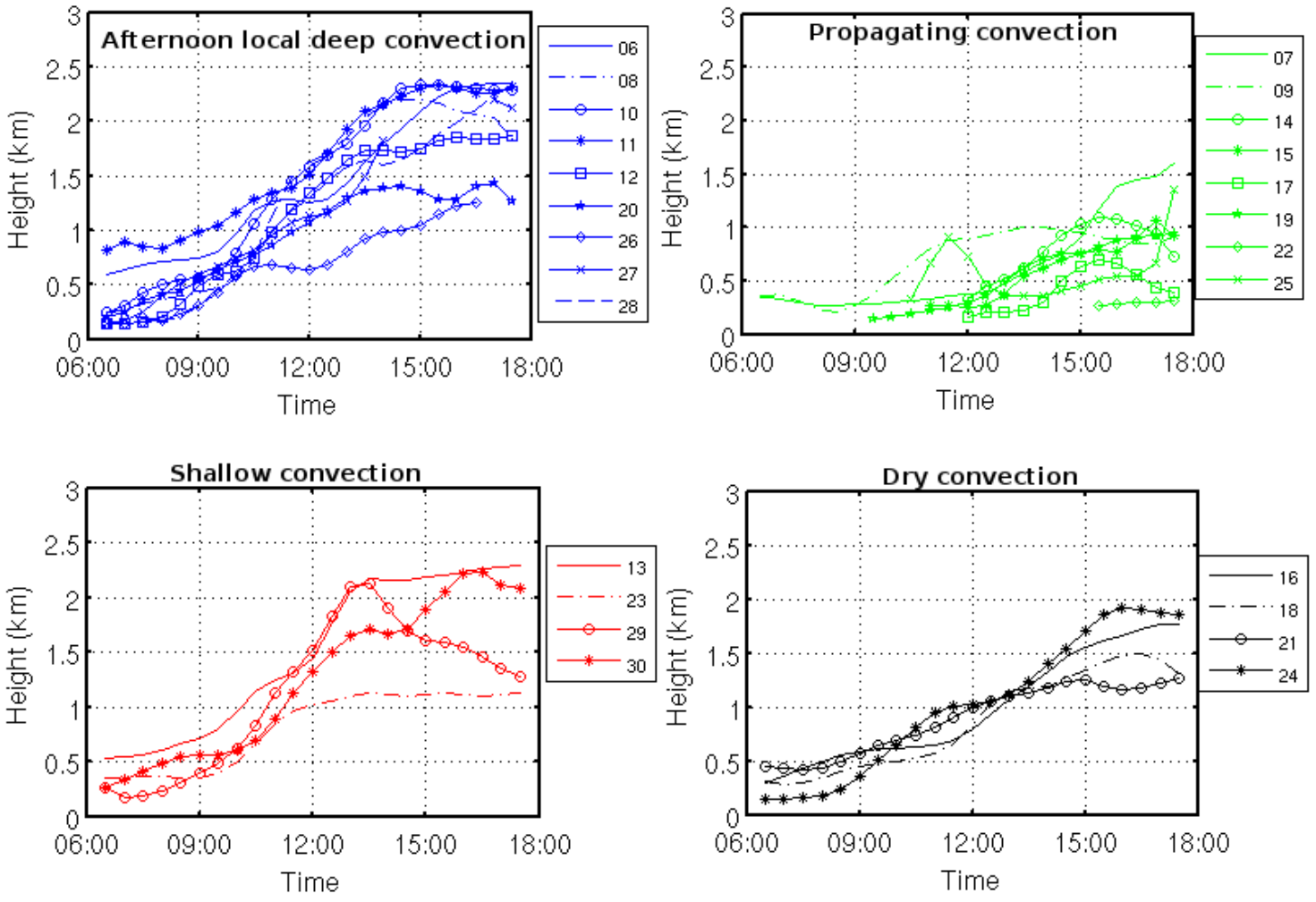


1130 UTC

Two groups are distinguished: (LC and SH) and (PC and FW)

Cases of classes FW and PC are all un-favorable for convection.

Role of the convective boundary layer growth

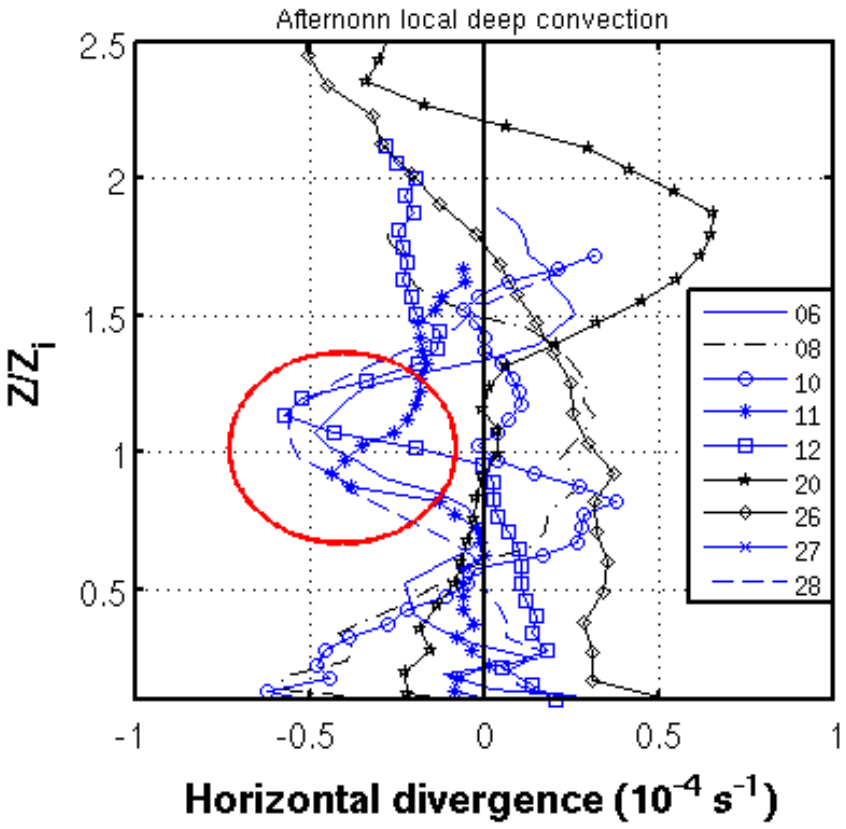


- Low convective boundary-layer height for classes “dry convection" and “propagating convection"
- High convective boundary-layer height for classes “local convection" and “shallow convection"

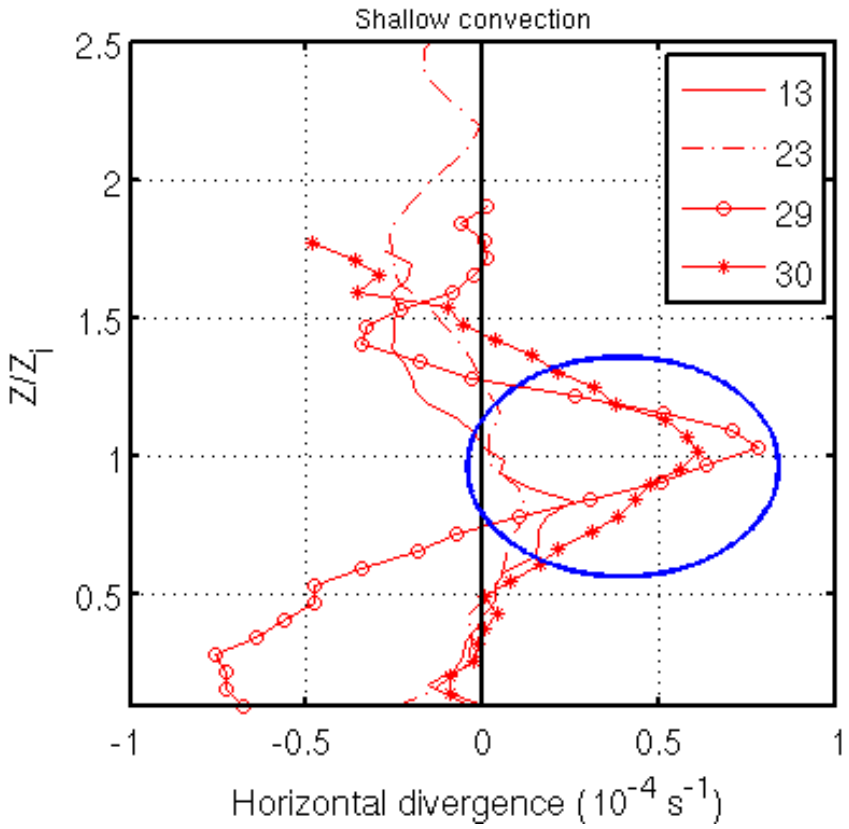
Divergence

Vertical profile of horizontal divergence between 1100 and 1500 UTC

Afternoon local deep convection



Shallow convection



Convergence in low-levels for most cases of classes LC and SH

Divergence above the boundary-layer height for class SH.

Convergence above the boundary-layer height for class PC

Outline

Conclusions

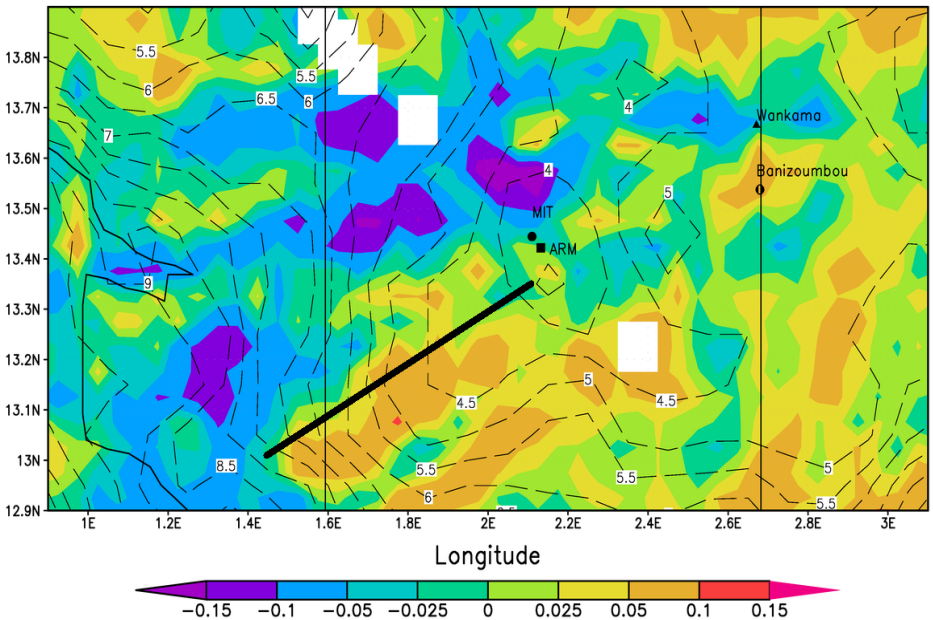
- Large occurrence of locally-initiated deep convection and gust fronts.
- Daytime growth of the atmospheric boundary layer and vertical profile of divergence in low-levels play an important role on the type of moist convection observed during that period.
- Convection lines, growing within the morning clear air roll-organizations, and gust fronts are found to be precursors of local deep convection.

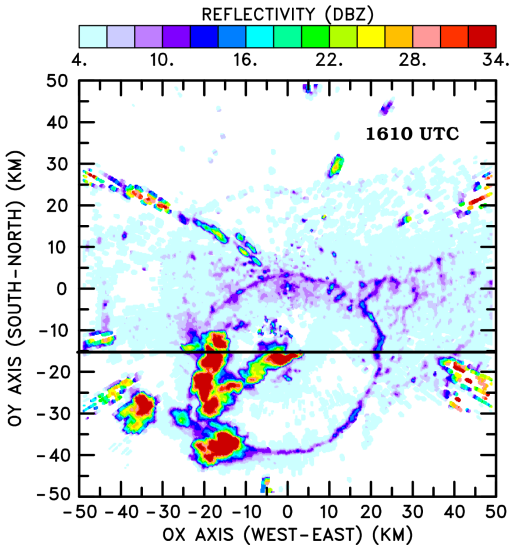
Outline

Prospectives

Role of surface temperature and moisture heterogeneities on deep convection initiation

LSTa between 1100 and 1500 UTC, on 11 July 2006





Initiation over warm and dry surfaces

Propagation of the cell along the AEJ favoured over warm surfaces?

Faster propagation of the density current on warm surfaces ?

Thank you for your attention