Geophysical Research Abstracts,
Vol. 10, EGU2008-A-08296, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-08296
EGU General Assembly 2008

Roles of low-level thermodynamics on surface-convection interactions over West-Africa

F. Guichard(1), F. Couvreux(1), M. Nuret(1) and A. Agusti-Panareda(2)

(1) CNRM-GAME, CNRS and METEO-FRANCE, 42 avenue G. Coriolis, F-31057 Toulouse, FRANCE, (2) ECMWF, Shinfield Park, Reading, Berkshire, RG2 9AX, England(francoise.guichard@meteo.fr)

In this study, we make use of the several thousands of high-resolution soundings that have been collected across West Africa (WA) within AMMA in 2006, in order to precise basic properties of the low levels. For each sounding, we computed: (i) moist-convection related indexes, including LCL, LFC, CAPE and CIN, (ii) a set of boundary layer parameters (height, daytime mixed-layer properties...), and (iii) a combination of two indexes proposed by Findell and Eltahir (2003) (FE03) that are well suited for distinguishing between aspects of surface-atmosphere interactions involving atmospheric vertical structures.

The variability of the low levels is found to be stronger in the Sahelian zone than in the Soudanian zone, from daily scale up to the monsoon season (JJAS). FE03 indexes suggest that surface-atmosphere feedbacks are actually significantly operating over West-Africa, but that the feedback loops change sign with latitude and season. Thus, thermodynamic environment at low level is broadly consistent with the idea of daytime convection being either suppressed or favoured over wet surface versus dry ones, depending on latitude and seasonal variations. This finding is consistent with observations that daytime convection is not always favoured over wet land surfaces. It remains to assess the scale down to which the local thermodynamic environment is actually playing a role, and how it combines with other factors, such as turbulence, cloud amount and mesoscale circulations, to explain observations.

Variations along the season and with latitude of LCL and LFC are further consistent

with the previous analysis of FE03 indexes over West Africa. For instance, in Niamey(Sahelian), a strong diurnal cycle of LCL is found, especially early in the season, while the LFC does not fluctuates much with the hour in the day, but shifts downwards from June to August. In contrast, the LCL displays a much weaker diurnal cycle at Parakou (Soudanian), while the LFC now does, it is the lowest at night and the highest around noon. The LCL is however not such a good indicator of BL height when the low levels are the driest. This is particularly true early in the season in the Sahel, on days when none of the daytime BL convective plumes reach their LCL. In that case, moist convective development is limited by high convective inhibition (CIN) rather than CAPE. Indeed, no clear seasonal trend of CAPE is found in Niamey, while, interestingly, it actually decreases in Parakou during the core of the monsoon season. Consistently with the differences found for the LFC in Niamey and Parakou, the diurnal cycle of CAPE is less pronounced in Niamey than in Parakou, where it displays an evening to early-night maximum.

Eventually, relationships between convective indexes and low level properties are explored. CAPE is found to be simply and strongly linked to the low-level thetae across West Africa, along the whole monsoon season. Above a value of the low level thetae of approximately 340K, CAPE increases steadily from 0 at a rate of 200 J.kg-1 per 1 K of thetae increase. This finding shows and quantifies how the low levels represent the dominant driver framing atmospheric stability well beyond their diurnal fluctuations. At these scales, both low-level temperature and specific humidity contribute to the realization of this relationship, but in different ways according to the location, and latitude in particular.

The same indexes computed from the ECWMF analysis indicate similar seasonal and latitudinal trends, the intraseasonal and synoptic fluctuations are also reasonably reproduced. However, some quantitative differences persist, despite the assimilation of these same observations, and the analysis-derived indexes exhibit less small-scale variability than given by sounding data.