DACCIWA Nocturnal boundary layer (NBL) observation in Kumasi during the DACCIWA field campaign

Geoffrey Bessardon[1], Barbara Brooks [1,2], Victoria Smith [1,2], Jeffrey Aryee [3], Kwabena Fosu-Amankwah [3], Fred Cayle-Aethelhard [3], Leonard Amekudzi [3], and Sylvester Danuor [3]

1 Institute for Climate and Atmospheric Science , University of Leeds, Leeds, United Kingdom,
2 National Centre for Atmospheric Science , University of Leeds, Leeds, United Kingdom,
3 Department of Physics, Kwame Nkrumah University Of Science and Technology, Kumasi, Ghana

Introduction

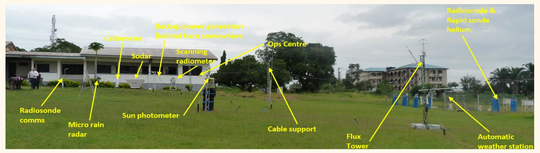
- Most nights of the summer monsoon are characterized by the formation of low-level continual stratus and strato-cumulus
- The formation of low-level stratiform clouds during the night at the Guinea Coast is connected with the occurrence of Nocturnal Low Level Jet (NLLJ)
- The questions of the formation of an NLLJ in southern west Africa SWA and the presence of clear nights with an NLLJ remain unclear
- We use data from the Kumasi supersite to study 3 different cases

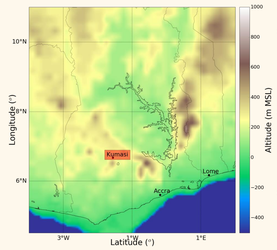
Kumasi ground station

Measurement period 11 June-30 July 2016

	Ceilometer	Automatic weather station	Sodar	Radio soundings	Micro rain radar	Scanning Microwave Radiometer	Cloud camera	Energy balance station	Sun photomer
Model/ Fabricant	Campbell CS135 lidar	Vantage Pro 2 wireless weather station	Scintec MFAS	Vaisala RS92 or RS 41 Windsond S1H1	METEK MRR-2	Radiometer Physics HATPRO	outdoor HD Pro	CR 5000 logger, 6 x Campbell HFP01 Self calibrating Heat Flux Plates, 6 x Campbell 107 Temperature Probe, 6 x Campbell 253 Soil Matric Potential Sensor METEK uSonic-3, LI-COR LI-7500	Cimel sunphotometer
Measured quantity	Aerosol Backscatter	T, P, RH, Wind speed, Wind direction, Longwave radiation, Solar radiation, precipitation rate/ accumaltion	Wind components	P, T, RH, wind speed, wind direction	Precipitation rate, reflectivity	P, T, RH, Integrated water vapour, liquid water path	Camera images	H20 C02 fluxes, Soil temperature, Radiative components, Flux components	Aerosol properties

List of instrument deployed on the Kumasi ground station



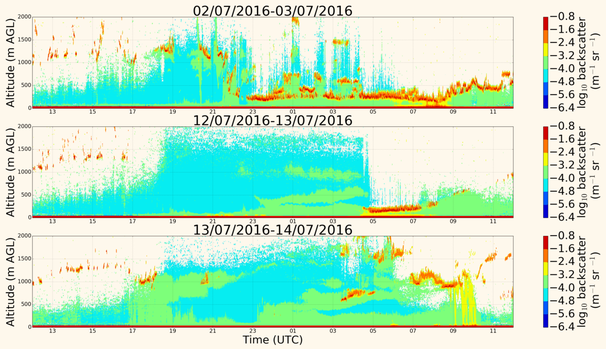


Orographic map of Kumasi and its surrounding

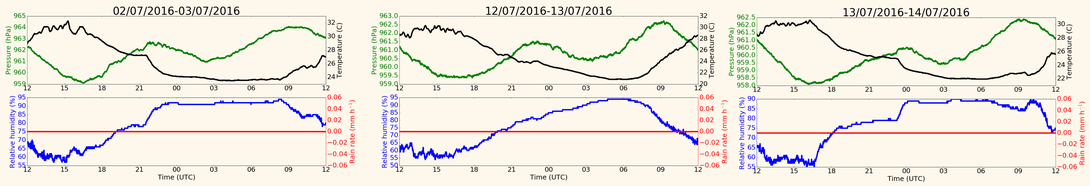
- 200 km north-West from Accra
- 180 km north from the Guinea Gulf
- 40 km South-west from the Kwahu Plateau (~500 m elevation)

Case selection

- 3 nights during the DACCIWA field campaign have been picked 2nd ,12th and 13th of July
- These 3 nights are dry but present different low-level clouds configurations :
  - Low level clouds occurring at sunset and lasting until early afternoon 2nd of July
  - Clouds appearing at the end of the night 12th of July
  - No low level clouds 13th of July

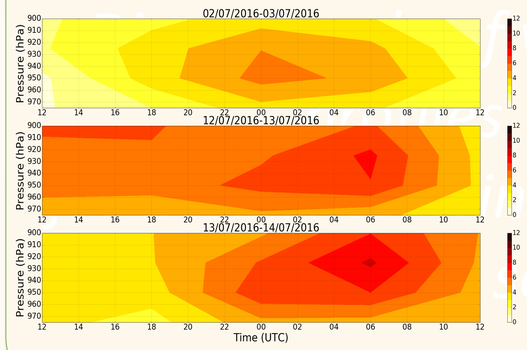


Backscatter profile from ceilometer, Kumasi supersite



Automatic weather station Pressure (green), Temperature (black), Relative humidity (blue), Rain rate (red) time series

ERA-I observations

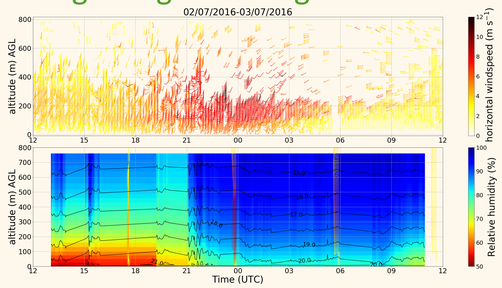


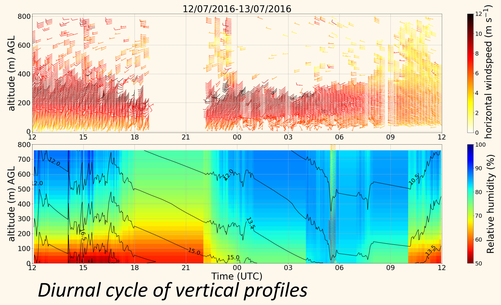
Diurnal cycle of vertical profiles for horizontal wind from ERA-I

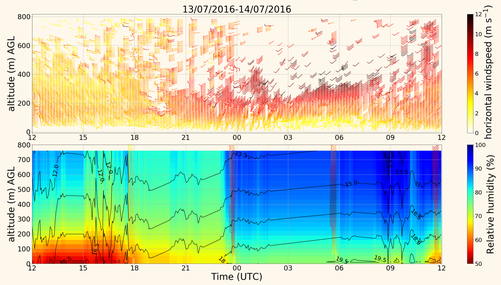
- ERA-I represents well the shape of the NLLJ profile
- However it underestimates the wind speed

SODAR and microwave radiometer observations

- 2nd of July: humid cold front arriving in the first part of the night with a NLLJ forming at the beginning of the night
- 12th of July: Consistent low level winds during day and night
- Humidity drops around 3 UTC when the wind slows down
- 13th of July: Humid cold front arriving at 00 UTC
- NLLJ stronger than the 2nd of July and lasts in the morning







Diurnal cycle of vertical profiles for horizontal wind (upper panel) from sodar, relative humidity (colours) and absolute humidity (contours g.m^{-3}) from radiometer (lower panel)

Conclusions

- 3 interesting clouds situations have been identified
- The NLLJ behaves differently in this 3 cases
- The NLLJ strength does not seem to affect cloud formation
- ERA-I underestimates the NLLJ
- Fluxes estimates and turbulence evaluation from the energy balance station are under investigation

References and Acknowledgements

Schuster, R., Fink, A.H. & Knippertz, P., 2013. Formation and Maintenance of Nocturnal Low-Level Stratus over the Southern West African Monsoon Region during AMMA 2006. *Journal of the Atmospheric Sciences*, 70(8), pp.2337–2355.
Schrage, J.M. & Fink, A.H., 2012. Nocturnal Continental Low-Level Stratus over Tropical West Africa: Observations and Possible Mechanisms Controlling Its Onset. *Monthly Weather Review*, 140(2007), pp.1794–1809.
Adler, B., Kalthoff, N. & Gantner, L., 2016. The life cycle of nocturnal low-level clouds over southern West Africa analysed using high-resolution simulations. *Atmospheric Chemistry and Physics Discussions*, 2016, pp.1–21.

DACCIWA has received funding from the European Union 7th Framework Programme (FP7/2007-2013) under the Grant Agreement no. 603502 .

Contact: eegb@leeds.ac.uk