Geophysical Research Abstracts,
Vol. 10, EGU2008-A-10484, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-10484
EGU General Assembly 2008

Response of sensible, latent and CO2 fluxes to lateral water redistribution and vegetation development in a Sahelian landscape at 15.3 N

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The West African monsoon has been shown to significantly depend on surface-atmosphere interactions, at the large scale as well as at the meso-scale. Land is thought to act as a strong amplifier of the WAM inter-annual variability because of variable surface energy and mass fluxes. Unfortunately, our current understanding is severely limited by a lack of observations, West Africa being one of the world less instrumented area. The AMMA project provides dataset, which can be used to scrutinize land surface fluxes with unprecedented focus and accuracy.

Here we report on surface fluxes measured at 15.3 ˚N, over the northernmost AMMA meso-scale site in Mali. Due to the relatively simple landscape, fluxes from the main surface types can be sampled and compared to gain a regional scale view of the surface fluxes. The meso-scale site is a 60 km x 60 km area. 60% of this area is covered by grasslands growing on sandy dunes, 35 % is bare soil, rocks or gravels, and 5% is made of depressions with more clayed soil. Ponds and seasonally flooded woodlands are found in these depressions. Tree cover is low or non existent over bare soil. It is low over grasslands (between 0 end 5 %). It can reach 60% in flooded woodland in the clayed depressions.

Three flux stations were installed in 2005 and 2006 to sample the three main surface types. Edgerit is a bare, dark and gravelly soil site. Agoufou is a grassland site dominated by annual grasses and forbs with 2% tree cover. Kelma is a flooded open forest site, with a tree cover of 40 %. Vegetation leaf area index was monitored on a 10 day

basis along 1 km line. Soil moisture profiles were measured at the three sites. The turbulent fluxes were computed following the CarboEurope recommendations.

No seasonal cycle emerges from the time series at Edgerit. This is consistent with the water regime and lack of vegetation of this site. The fluxes over the grassland site show a marked seasonal variation caused by both water availability and vegetation growth. The seasonal cycle of the fluxes is even far more contrasted for the open woodland site. In particular, a dramatic change occurs when the site is flooded, with very high latent heat and CO2 fluxes.

The flux data collected over the three main landscape units provide a comprehensive but contrasted view of the sensible heat, latent and CO2 fluxes of this typical Sahelian landscape. The bare soil site maintains high sensible heat flux over the year, whereas the grassland site shows a drastic reduction during the rain season. Since such surface types form large landscape units, typically bands 15 km wide and 40 km long, such a contrast has the potential to create horizontal gradients of surface heat flux. In turn, this gradient may translate into differential boundary layer growth, meso-scale circulations. The flooded area has a more limited extension, covering approximatively 5% of the landscape. However, its behaviour, in terms of flux partitioning, is extremely singular.

Overall, the sensible and latent heat fluxes of the main components of the landscape strongly react to the water regime, which is largely driven by the lateral redistribution at two of the sites. In that respect, this Sahelian landscape mirrors the so called ‘tiger bush’, with areas of bare soil generating runoff and areas collecting water as run-on allowing important vegetation developments, the scale of this ‘super tiger bush’ being much larger, though.