Energy, H_2O and CO_2 fluxes in a Mediterranean savannah ecosystem during the transition from wet to dry season

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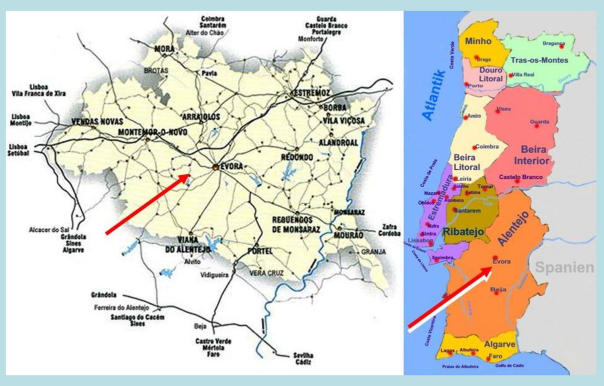
Motivation

Although turbulent fluxes of energy, H2O and CO2 have been measured in savannah ecosystems in the past, little is known about the relative flux contribution of the two dominant plant types, trees and grasses, and about the temporal flux dynamics of the two. Measurements have to precede the modelling of partitioned grass' and trees' turbulent fluxes. Since the assumptions leading to the EC method (e.g. stationarity, horizontal homogeneity) are valid for homogeneous surfaces only, in a heterogeneous oak savannah site their fulfilment has to be tested and data be footprint controlled and quality checked.



Realisation

The MITRAEX-Experiment, March to May, 2006, Central Portugal: To study the flux contribution of the grasses, eddy covariance (EC) flux measurements were set up at a 2.25 m height in a savannah clearing to compliment existing long term measurements of the nearby MITRA II FLUXNET station at a height of 30 m (over a mixture of trees and grasses). Footprint analysis based on a forward Lagrangian model was performed for both towers and allowed to test the representativity of measurements for the intended surface cover. A quality flagging scheme was applied on measured data and combined with footprint results (Göckede et al., 2006). This allows the selection of trusted data for further study.

Results

Footprint isolines show the footprint well within the intended surface cover type for four different classes of atmospheric stability.

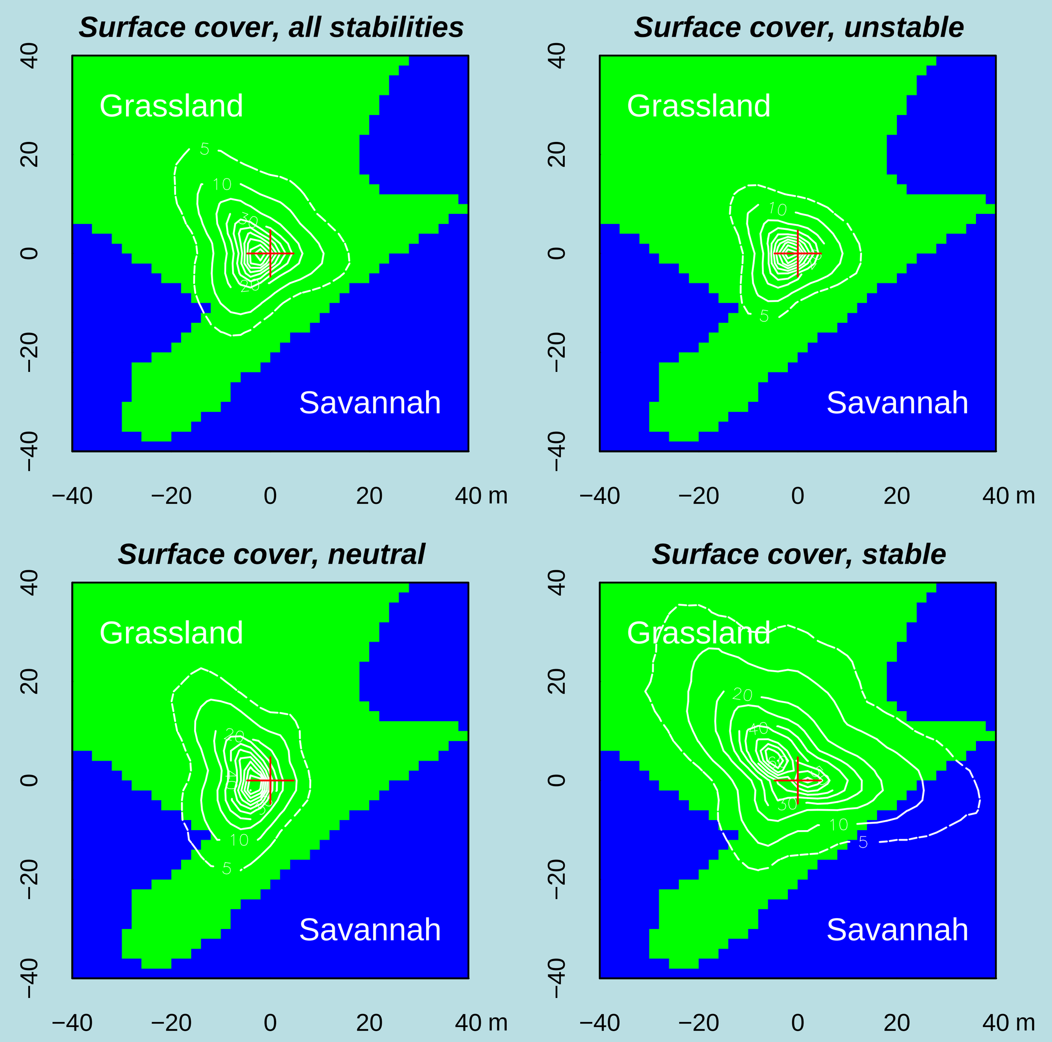


Figure 2: Grassland site.

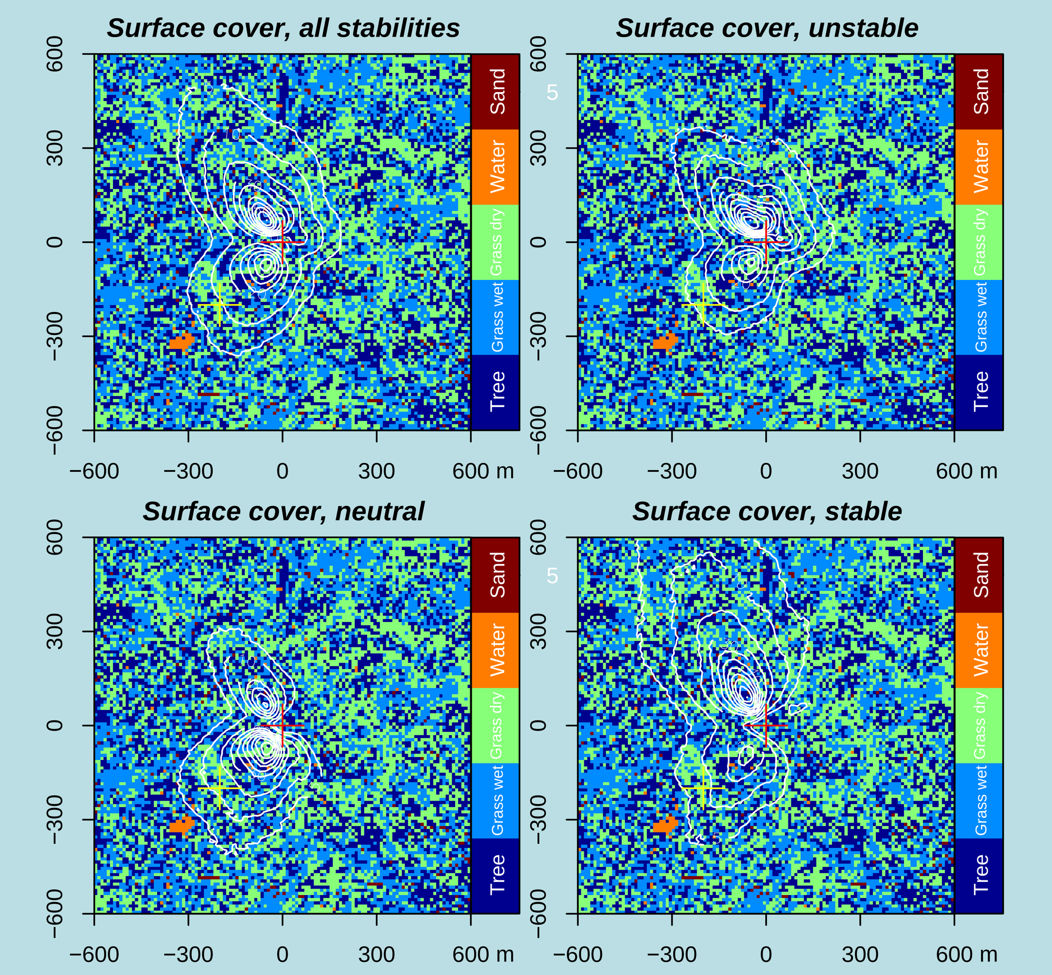


Figure 3: Savannah site.

Figure 4: CSAT3, LICOR-7500

Figure 4: Oak savannah: "Montado".

Footprint isolines combined with quality flags (here CO_2-flux) (colours: 1 best to 5 worst, Fig. 2; 1 to 9, Fig. 3) show at large good quality for the grassland tower (except reduced quality in SE-sector due to terrain effects) (Fig 5) and medium quality for the savannah tower with low quality in the N-SE sector, which seems to be related to instrument setup (Fig. 6).

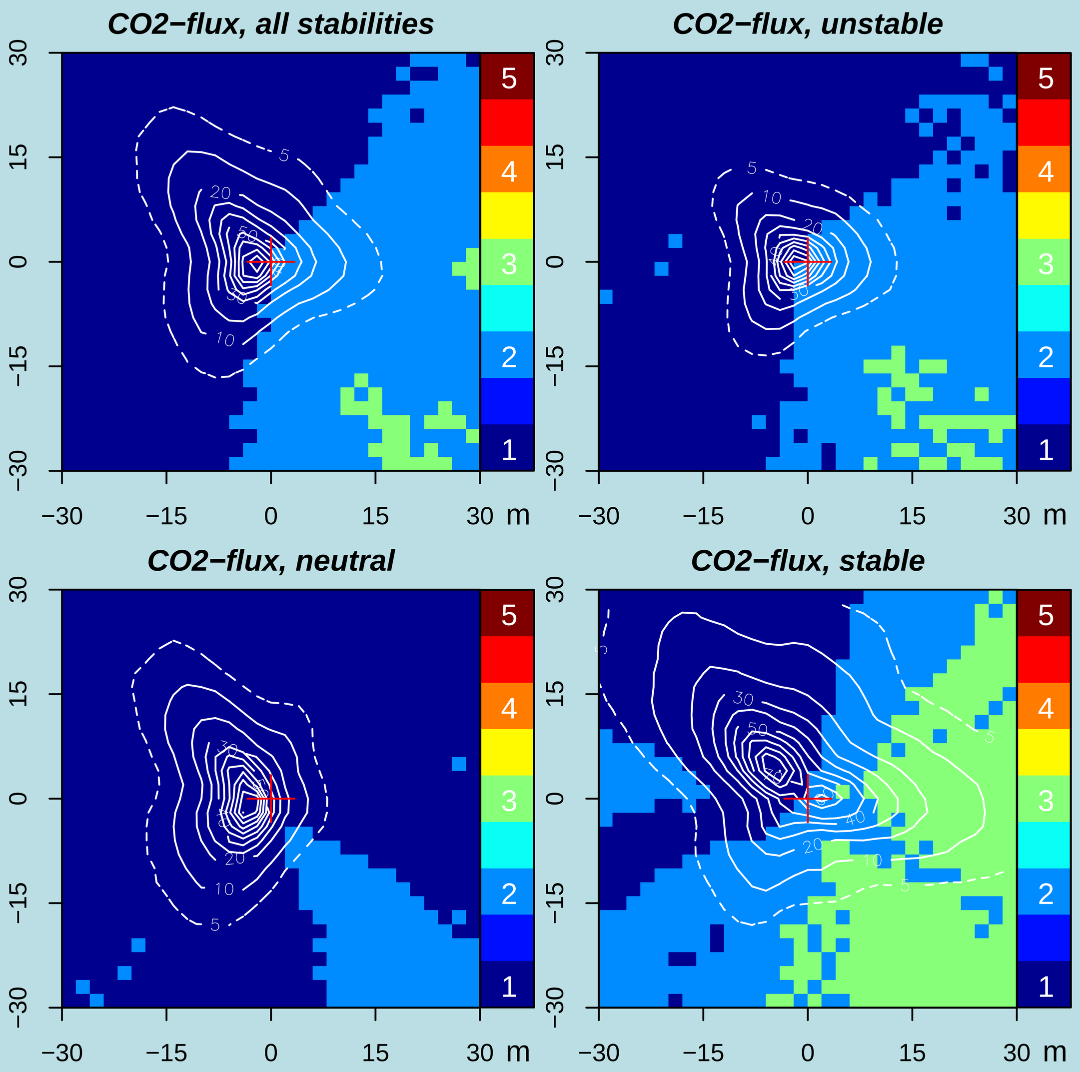


Figure 5: Footprint and quality flags for CO_2-flux, grassland site.

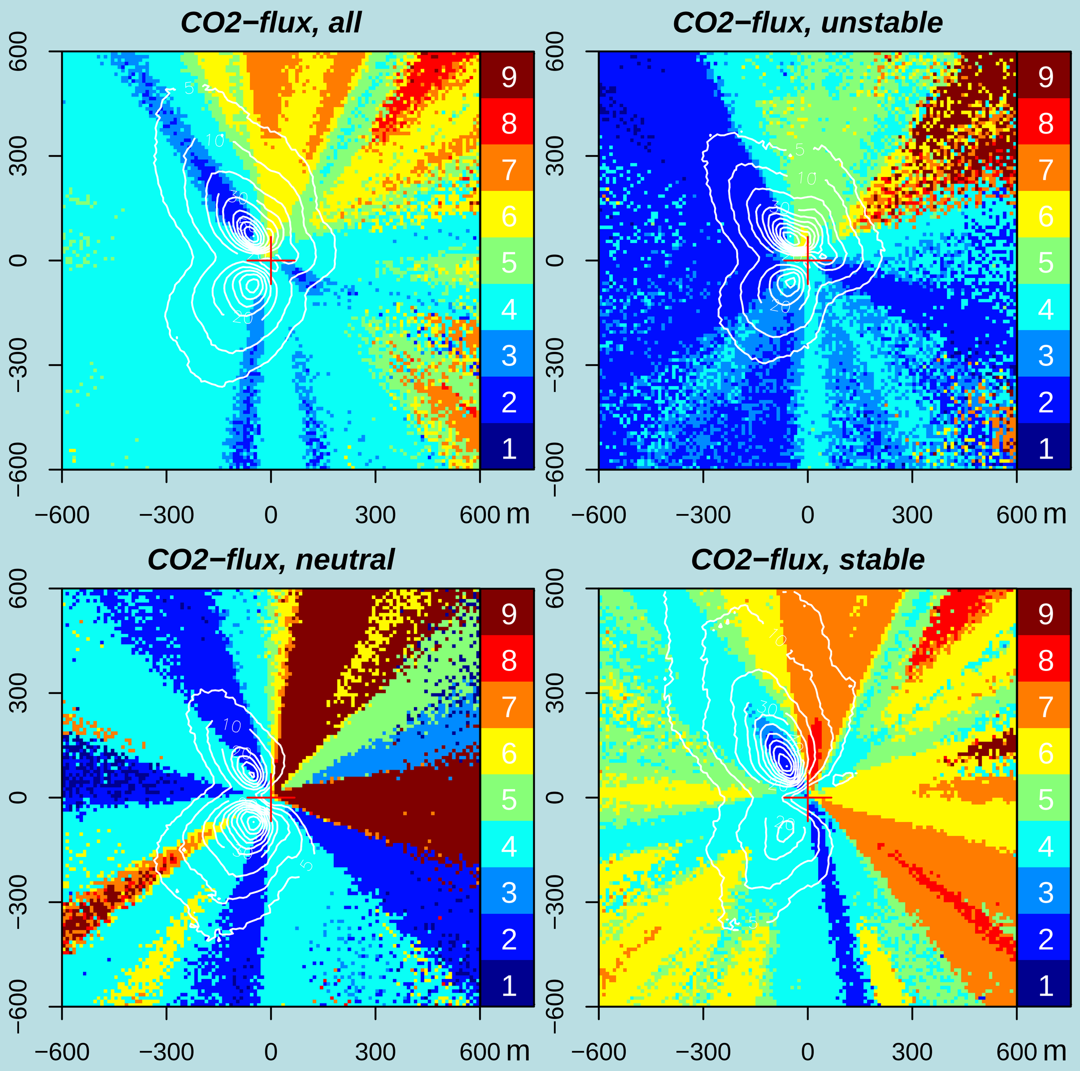


Figure 6: Footprint and quality flags for CO_2-flux, grassland site.

Latent heat and CO2 flux is much higher over grass than over savannah during the day, the opposite is the case for the sensible heat flux. In addition, the grass shows more pronounced seasonal dynamics (Fig. 8 and 9).

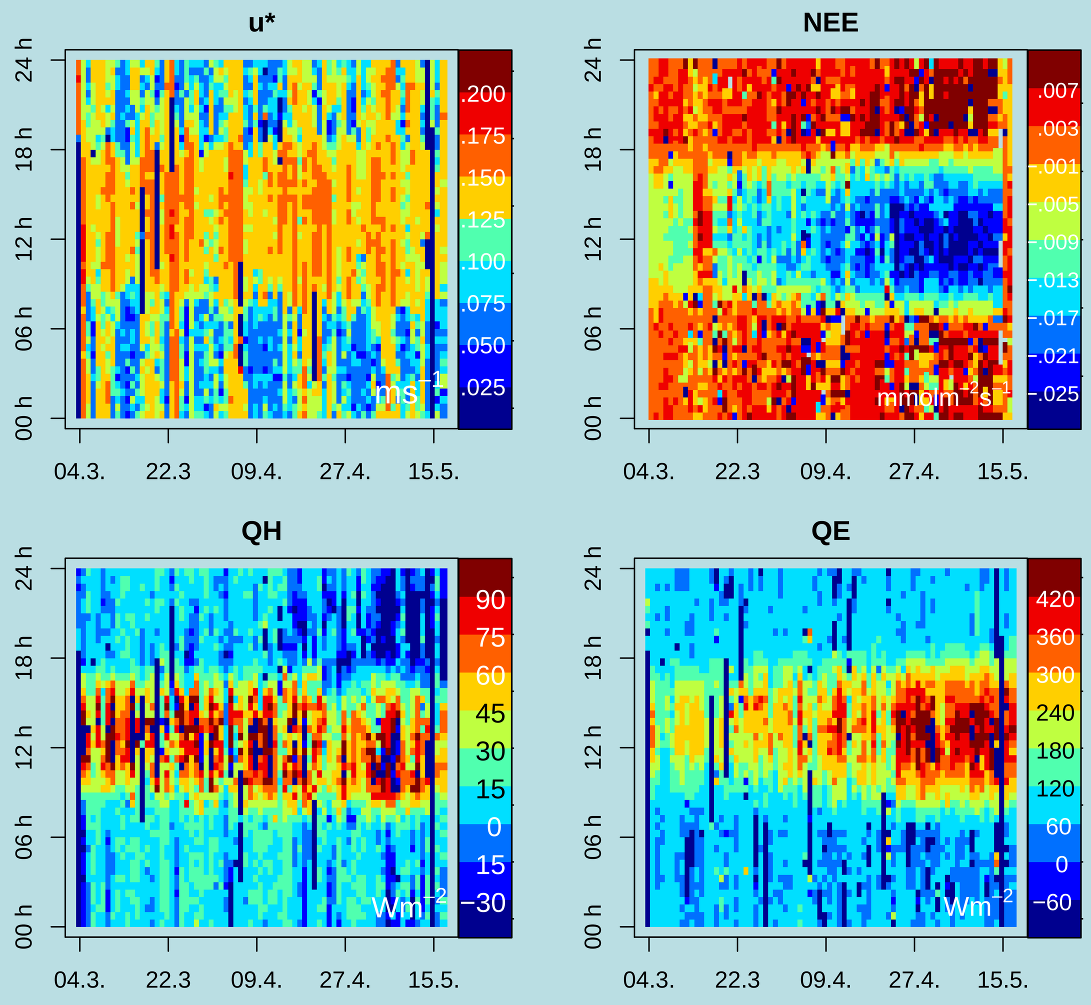


Figure 8: Seasonal course of fluxes in spring, grassland.

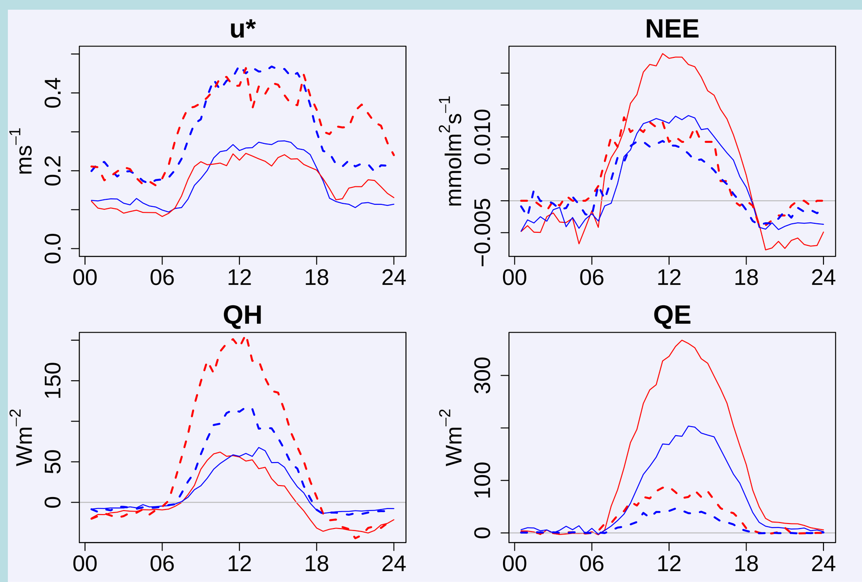


Figure 9: Mean diurnal course of fluxes over grass (solid) and savannah (dashed) for two periods: 03.03. - 23.4.2006 (blue); 24.04. - 17.5.2006 (red)

Conclusions

- Footprint conditions were suitable for the intended measurements,
- theoretical assumptions of the EC method are fulfilled to a satisfactory degree even in a heterogeneous savannah for a large portion of the measurements,
- the partitioning of available energy into turbulent fluxes shows considerable differences over grass and over savannah as well as during two time periods from spring to summer.
- the drying-up towards summer did not reach a physiologically critical level during the measurement period.

References

Göckede, M., T. Markkanen, C. B. Hasager, and T. Foken: 2006, 'Update of a footprint-based approach for the characterisation of complex measurement sites'. *Boundary-Layer Meteorology* **118**, 635–655.

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