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Response of Carbon Fluxes to Water Relations in a Savanna Ecosystem

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One of the few infrastructures enabling the study carbon and water relations of African savannas is the flux tower in the Kruger National Park, South Africa, installed between Skukuza and Pretoriuskop in 2000 as part of the Safari 2000 campaign. The site is located at the boundary of two plant communities, representative of the main division within African savannas between broad-leafed eutrophic and fine-leafed dystrophic savannas. When the wind blows from the SE (105° - 196°), a fine-leaf Acacia savanna is sampled, and when it blows from the N (270° - 76°), a broad-leaf Combretum savanna is sampled. These two wind directions are approximately balanced, and contribute over 80% of wind movement at the site. In addition to the eddy covariance measurements, process studies of soil respiration and leaf gas exchange were conducted.

Since the annual drought and rewetting cycle is a major factor influencing the function of savanna ecosystems, the principal mechanisms that connect carbon fluxes with water relations in savanna ecosystems are described. This talk is focused on two questions concerning water relations: (1) How do water availability and seasonality drive ecosystem respiration? and (2) how does the close inter-connection between canopy conductance and photosynthesis, influence the carbon uptake by the vegetation during times of different water availability?

The analysis of night time fluxes revealed a clear exponential increase of ecosystem respiration with increasing temperature and also a positive influence of soil moisture.

In addition, the data showed that the temperature response was modified by soil moisture: at low soil moisture the Q10-value of the temperature function was reduced in comparison to high soil moisture.

The conductance of the canopy for water vapour (gC) exhibited a hyperbolic decrease with increasing vapour pressure deficit (VPD). Low canopy conductance strongly limited canopy photosynthesis. The sensitivity of stomatal regulation changed throughout the vegetation period as a result rainfall pattern and of plant phenology. It was also responding to short periods of drought (2 - 3 weeks) tat occurred during the top of the wet season.

The measurements at a flux tower close to Skukuza revealed the strong influence of water relations on the carbon fluxes in savanna ecosystems. It also gave useful insights into the acclimation of the plant canopy to changing conditions.