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Integration of observations, modelling approaches and remote sensing to address ecosystem response to climate change and disturbance in Africa

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African societies face growing global change challenges and several associated risks. These include rapidly changing patterns of human settlements and an intensified use of ecosystem services. At the same time, climate variability and change are amplifying stress on the functionality of ecosystems and their critical role as important greenhouse gas sinks. A recent review (Valentini et al. 2014) attests Africa a key role in the global carbon cycle contributing an absolute annual carbon sink (-0.61 $\pm$ 0.58 Pg C yr^{-1}), which may partly been offset through understudied emissions of CH_4 and N_2O. The net sink strength is characterized by a substantial sub-regional spatial variability due to biome distribution and degree of anthropogenic influences. 52% of the global carbon emissions by fire are due to African wildfires, which contribute with 1.03 $\pm$ 0.22 Pg C yr^{-1} twice the emissions caused by land use change in Africa (0.51 $\pm$ 0.10 Pg C yr^{-1}). Moreover, a quarter of the interannual variability of the global carbon budget is due to the year-to-year variation ($\pm$ 0.5 Pg C yr^{-1}) of carbon fluxes on the African continent.

Among the archetypes to address the above-mentioned challenges in an integrated and multidisciplinary way are better data bases which serve as constraints for atmospheric data and models, thorough attempts to reduce GHG flux uncertainties, or enhanced understanding of climatic, hydrological, and socio-economic drivers of temporal and spatial variability of GHG balances. Some examples from the ARS-AfricaE project that will serve to illustrate the wide range of such activities include:

- Measurements of CO_2 exchange, ecosystem structure and eco-physiological properties at paired sites with natural and managed vegetation,
- Further development and application of the adaptive Dynamic Global Vegetation Model 2 (aDGVM2) to investigate the influence of different atmospheric CO_2 scenarios on carbon pools and fluxes of a selected ecosystem in Skukuza, Kruger National Park, South Africa,
- Setting up individual-based models to predict ecosystem dynamics under (post-) disturbance management,
- Monitoring vegetation amount and heterogeneity using remotely sensed images and aerial photography over several decades to examine time series of land cover change, and
- Investigations of livelihood strategies with focus on carbon balance components to develop sustainable management strategies for disturbed ecosystems and land use change.

Despite recent advances, major innovations in understanding carbon cycle, greenhouse gases, air quality and measures of adaptation to and mitigation of climate change are still limited by the lack of global accessibility and comparability of relevant data (open data issues), long-term and sustainable interdisciplinary and trans-institutional research collaborations, and ongoing effective dialogues on multiple levels (policy, science, society).