Determining carbon pool turnover rates in semi-arid biomes of Australia as drivers of global carbon cycle inter-annual variability

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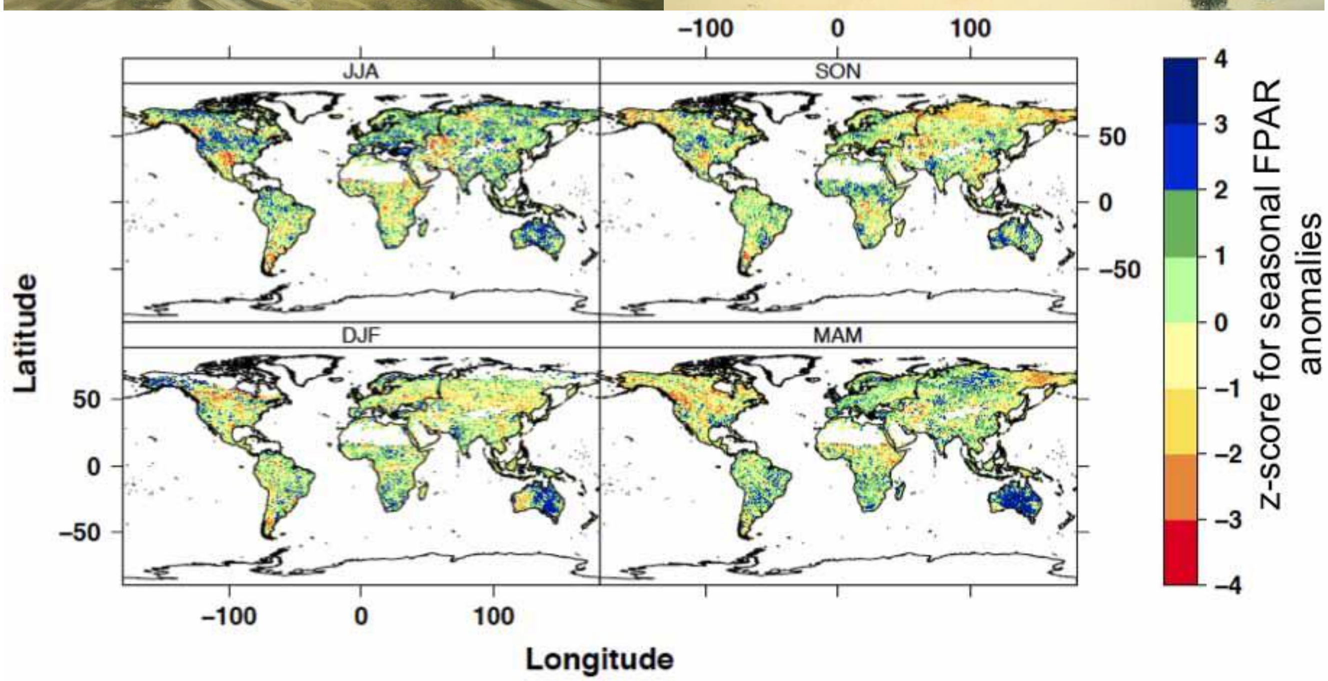

Rangers station in Diamantina National Park in dry (Jan 2015) and wet (Feb 2015) conditions (photo credits J Leys/C Strong). Seasonal global photosynthesis anomalies for 2011. Note the significant anomaly in Australia. Poulter et al., 2014.

The atmospheric carbon component exhibits large interannual variability primarily driven by terrestrial processes, some of which are poorly understood. Global monitoring has highlighted the important role of semi-arid ecosystems in Australia as a significant carbon sink anomaly, accounting for almost 60% of global carbon uptake when La Niña conditions resulted in consecutive seasons of increased precipitation in 2011 (Poulter *et al*., 2014). This raises the question of where this carbon is going, and whether it is stable enough to be considered a significant terrestrial carbon pool (which might help explain some of the observed large interannual variability).

Australia is the driest inhabited continent on the planet and its rivers are characterised by low-gradient systems, many of which drain to the continental interior Kati Thanda – Lake Eyre. The Lake Eyre Basin drains 1.14 M km^2, one-seventh of the entire continent. The rivers of Queensland's Channel Country, notably Cooper Creek and the Diamantina, are 1000 km in length and they lose large volumes of discharge as they traverse major dunefields on the way to Lake Eyre. Rare (once a decade) rainfall events (fed by the Indo-Australian monsoon) are sufficient to overcome these losses and the floodwaters fill Lake Eyre (most recently in 2019). When this happens the desert is transformed to a temporary green oasis, characteristic of the boom and bust ecosystems of Australia's deserts. What is not properly understood is the impact of these events on the longer-term carbon budget, and we propose a project incorporating time series analysis of long term satellite data archives and targeted field surveys to quantify the significance of these greening events.

This project will address the following questions:
- How spatially extensive is this greening and how long lived?
- How do amount and spatio-temporal distribution of rainfall control the hydrology of the flood wave and consequent greening in these remote (and poorly gauged) fluvial systems?
- Can we link the flood event record to the longer term sediment record using sediment cores from the key drainage basins and Lake Eyre?
- What is the impact of the above on the soil carbon pool, and how resistant is it to decomposition?

This project includes a significant field component to understand the relationship between satellite estimates of riparian vegetation (including both vascular plants and microphyte soil components), net primary productivity, and catchment hydrology. Field collection of soil carbon samples at key sequestration locations, and topographic profile collection in natural 'gauge' locations along both the Cooper and Diamantina rivers, will be undertaken. The results will provide new insights into the role these large semi-arid biomes play in the global carbon cycle.

Training opportunities:
Project-specific training will include remote fieldwork logistics and offroad driving. While in Australia, the student will be based within the Centre for Australian Biodiversity and Heritage (CABAH) on a visiting basis and will be eligible for support to visit any of the eight CABAH nodes across Australia (see https://epicaustralia.org.au/about/).

Student profile:
This project would be suitable for students with a degree in either geography, physics, ecology or a closely related environmental or physical science. They should be prepared to undertake fieldwork in challenging and remote desert areas.

References: (optional)

Poulter, B., Frank, D., Ciais, P., Myneni, R.B., Andela, N., Bi, J., Broquet, G., Canadell, J.G., Chevallier, F., Liu, Y.Y., Running, S.W., Sitch, S. and van der Werf, G.R. 2014. Contribution of semi-arid ecosystems to interannual variability of the global carbon cycle. Nature, 509, pp. 600-603..

http://www.reading.ac.uk/nercdtp