Airborne Measurements of Fluxes of CO_2 and Water Vapour over sparse vegetation in a semi-arid region of Western Australia

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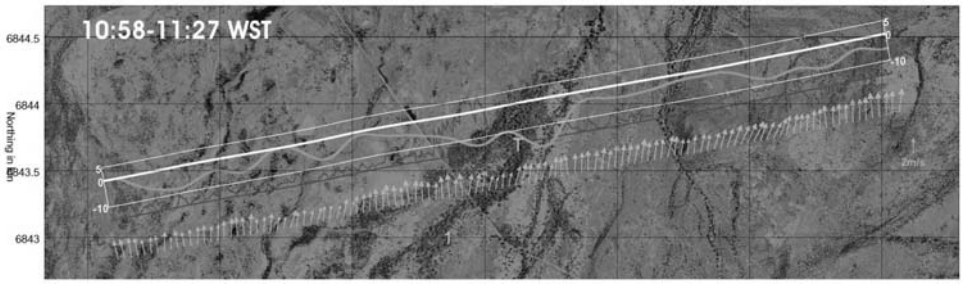
Estimating the uptake of CO_2 by vegetation is one of the hottest topics in land-surface research. Budgets of CO_2 emissions and uptake are a very important factor in all Global Change considerations and many countries are conducting large scale comprehensive studies and monitoring programs to establish such budgets. A special aspect is the issue of 'Carbon Credits', which form an important part of the Kyoto Protocol, or in other words the question, what is the net amount of CO_2 that a nation emits and how is this balanced by the CO_2 uptake in this country, or by activities within the country. Many human activities emit CO_2, but there are only a limited number of processes which remove CO2 from the atmosphere.

One option for considerable CO_2 uptake would be planting of trees on a large scale. Australia has vast areas which could potentially be used for such plantations. Yet, as most of these areas are either arid or semi-arid landscapes, it might be difficult to maintain such plantations.

To study the options for planting trees in semi-arid regions, an large-scale and long-term research project field observation program is being undertaken (funded nearly exclusively by the Japan Science and Technology Agency) on Sturt Meadows Station near Leonora/WA. The project studies all aspects of tree planting using engineering, hydrological, soil science, plant physiological and atmospheric sciences methods. A number of dedicated plots of trees were established and are being monitored, as well as plots of native trees.

One of the crucial parameters to be measured in the project obviously is the uptake of CO_2 by these plots of trees under the various conditions. This is a major challenge and a number of different approaches are being assessed, such as flux towers and airborne methods. ARA and Flinders University with its capabilities of airborne flux measurements was the obvious partner for the airborne measurements. In 2002 and 2003, three measurement campaigns were carried out using the ARA Grob G109B research aircraft.

While the first campaign had two aims, (1) to determine CO_2 fluxes and (2) to generate high resolution maps of the normalised differential vegetation index NDVI of the tree plots and surrounding areas, the second and third campaigns focused totally on CO_2 fluxes. A large number of aircraft transects was flown over the plots of trees, and also over some native vegetation along a creek bed and the spatial variation of fluxes of CO_2 and water vapour were determined. During the third field campaign, a substantial rain event changed the landscape considerably showing the strong interdependency between available surface and soil water and the fluxes.



CO_2 fluxes in µmol/m^2/s and related parameters along Doyle Creek transect. Data are averages over approximately 10 individual runs. Fluxes are averages over 500m. Flight track is shown in red. *ndvi* is shown in red on an arbitrary scale. Horizontal wind vectors are shown in light blue; the scaling arrow on the right shows a 2m/s southerly wind. Scale for the CO2 fluxes given by the grid shown in white.







Impressions from Sturt Meadows. Left to right, top to bottom: Plot of irrigated trees ('Site C'); Doyle Creek, where flights were carried out over native vegetation; Grob G109B aircraft and calibration van at Sturt Meadows Airstrip; NOAA IRGA and MetPod on the right-hand wing of the G109B.Right to left, top to bottom: Sturt Meadows signpost with Grob G109B in the background; BAT-Probe (for turbulence), UFT (Ultrafast temperature) sensor and LiCor 7500 mounted under the left-hand wing of the G109B aircraft.