Understanding tree-grass dynamics in Australian savanna

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Outline

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Some Results
Why are savannas important?

• Savannas dominate 25% of the global land surface and 20-25% of Australia.

• They sequester c. 31.3 Pg C y⁻¹ & account for c. 25% of global GPP

• They support 20% of the world’s human population

• In Australia, savanna accounts for 33% of terrestrial carbon stores: they are a sink for carbon

• Savanna structure and productivity is influenced by annual rainfall, soil nutrients, CO₂ fertilisation, herbivory and fire.

• The Northern Territory comprises c. 33% of total savanna cover in Australia.

• Australian savannas are unique due to their minimal fragmentation, low human population density and vegetation structure.

Information sourced from: Hutley & Beringer 2012, Scholes & Archer 1997, Beer et al., 2010, House & Hall 200, Grace et al., 20061
Rationale & Significance

- Changing rainfall regimes
- Altered savanna dynamics
- A changing climate
- ↑ atmospheric CO₂
- Fire, herbivory, land-use change
- Woody encroachment in savanna
- Altered savanna productivity
- Trees
- Grass
- CO₂ fertilization
- Changing rainfall regimes
Research Aim and Objectives

How does the grassy understory of an Australian woody savanna contribute to annual productivity?

1. To quantify the temporal dynamics of GPP of an open woodland savanna in Australia and how it is partitioned between trees and grass

2. To understand how grass eco-physiological characteristics such as green biomass, chlorophyll and nitrogen content relate to GPP of the savanna as well as how they can be related to spectral reflectance

3. To develop and test tools using moderate resolution remote sensing of savanna GPP to partition between trees and grass

4. To identify the annual productivity/biomass of the grasses in the savanna and relate this to historical climate data in the context of a changing climatic regime
The Savanna Carbon Cycle

- **Photosynthesis (GPP)**
  - NPP = GPP - Ra
  - NEP = NPP - Rh

- Ecosystem respiration (Ra + Rh)

- NBP = NEP - disturbances

Image Source: Hutley & Beringer 2010
Research Approach

Leaf Scale
- Leaf morphology
- Chlorophyll content
- C:N
- Biomass harvest
- Spectral reflectance

Plot Scale
- LAI
- Photosynthetic active radiation (PAR)
- Eddy covariance
- MODIS

Landscape/Regional Scale

Grass Gross Primary Productivity

Savanna GPP Dynamics
Study Site: Howard Springs

- Long-term (1982-2006) rainfall = 1782 mm
- Open savanna woodland dominated by eucalyptus woody overstory and C4 grassy understory
- Canopy height 14-16 m and coverage 50-60 %

- Wet Season: Dec-Apr, ~95 % rain falls
- Dry Season: May-Sep
- Transition: Oct-Nov
- Site is a listed OzFlux site (http://www.ozflux.org.au/)
Leaf Level Observations

- Biomass Harvest
- Leaf morphology
- Leaf chemistry: Chlorophyll & Nitrogen
- Leaf spectra

Courtesy of J. Pettigrew
Plot Level Observations

- Photosynthetically Active Radiation (PAR) sensors
- 4-channel Light sensors
- Digital cover photography (DCP) cameras
- Flux towers
The mini towers tell a story...
Flux Towers on Site

• 2 x flux towers measure fluxes from the ecosystem (at 23 m) and the understory (at 10 m) to record actual GPP of trees and grass.

• Core instrumentation on each tower includes a 3D sonic anemometer and an infra-red gas analyser.

• Supported by range of meteorological instrumentation

• Data collected every 30 mins and sent to us via the internet in real time.
Validating the understory data

Averaged Spectra -Velocity components

Averaged Spectra -Scalar components

With help (lots) from James Kathilan & Israel Begashaw
Ecosystem Scale

- Moderate resolution remote sensing: To add a wider spatial context to the study → Link observations with RS

- Powerful, long-term MODIS satellite record.

- MODIS satellites pass over the NT area twice daily, the best time being the 11:00 day pass.

www.fsl.orst.edu/larse/bigfoot
- Partition savanna GPP from observations
- Compare observations to MODIS
- Test algorithms
- Extrapolate grass productivity back in time using long-term records
- Identify long-term drivers of savanna productivity
Thanks to my helpers so far...
References


Questions...