Understanding tree-grass dynamics in Australian savanna

Caitlin Moore

Supervisory Team: *Jason Beringer, Nigel Tapper, Lindsay Hutley, Bradley Evans*

Charles Darwin University Australia

MONASH University

MACQUARIE UNIVERSITY

Outline

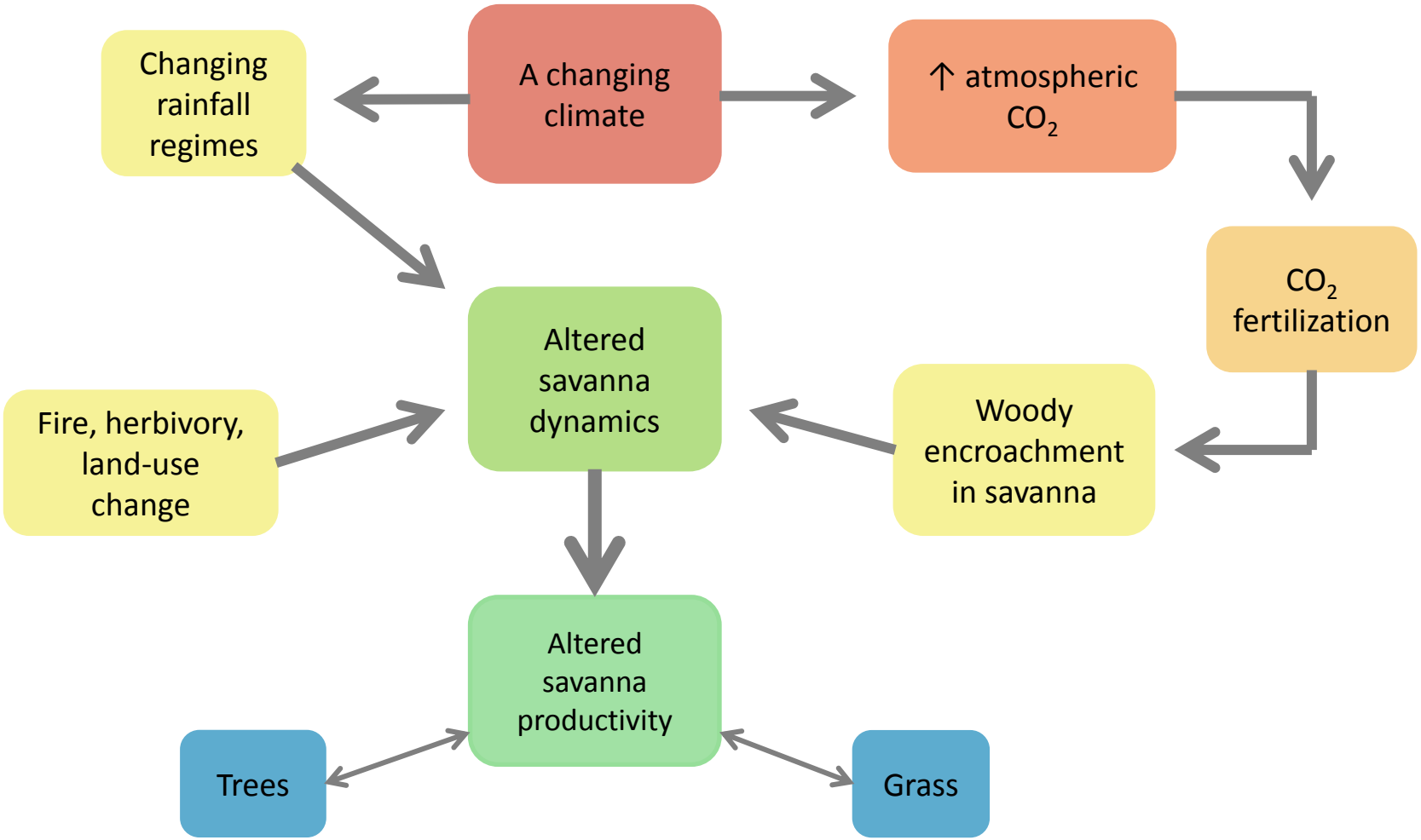
- Research Rationale
- Aims and Objectives
- Scientific Background
- Proposed Methods
- Some Results

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, CO_2 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 & Archer1997, Beer et al., 2010, House & Hall 200, Grace et al., 20061

Rationale & Significance



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*

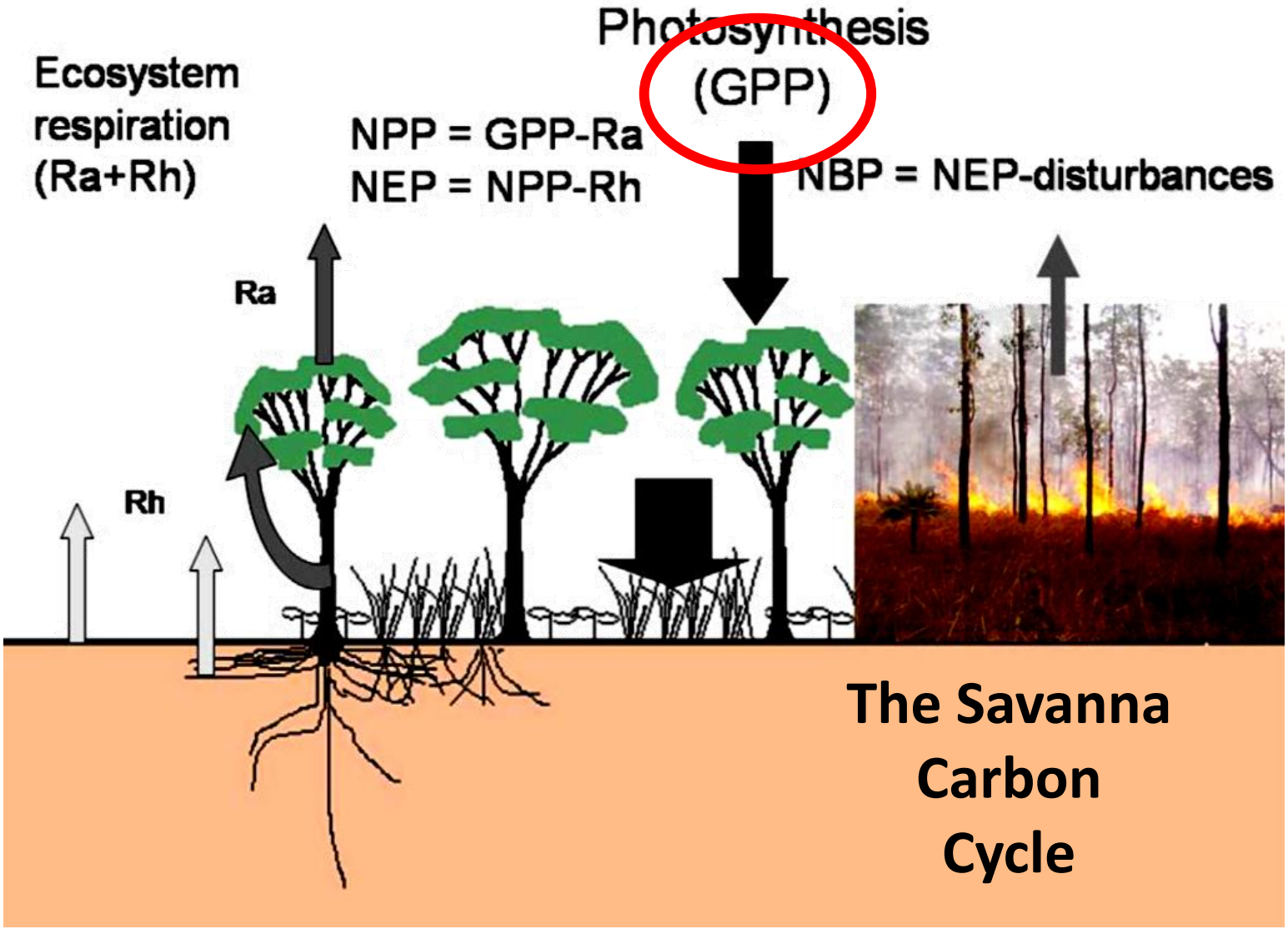
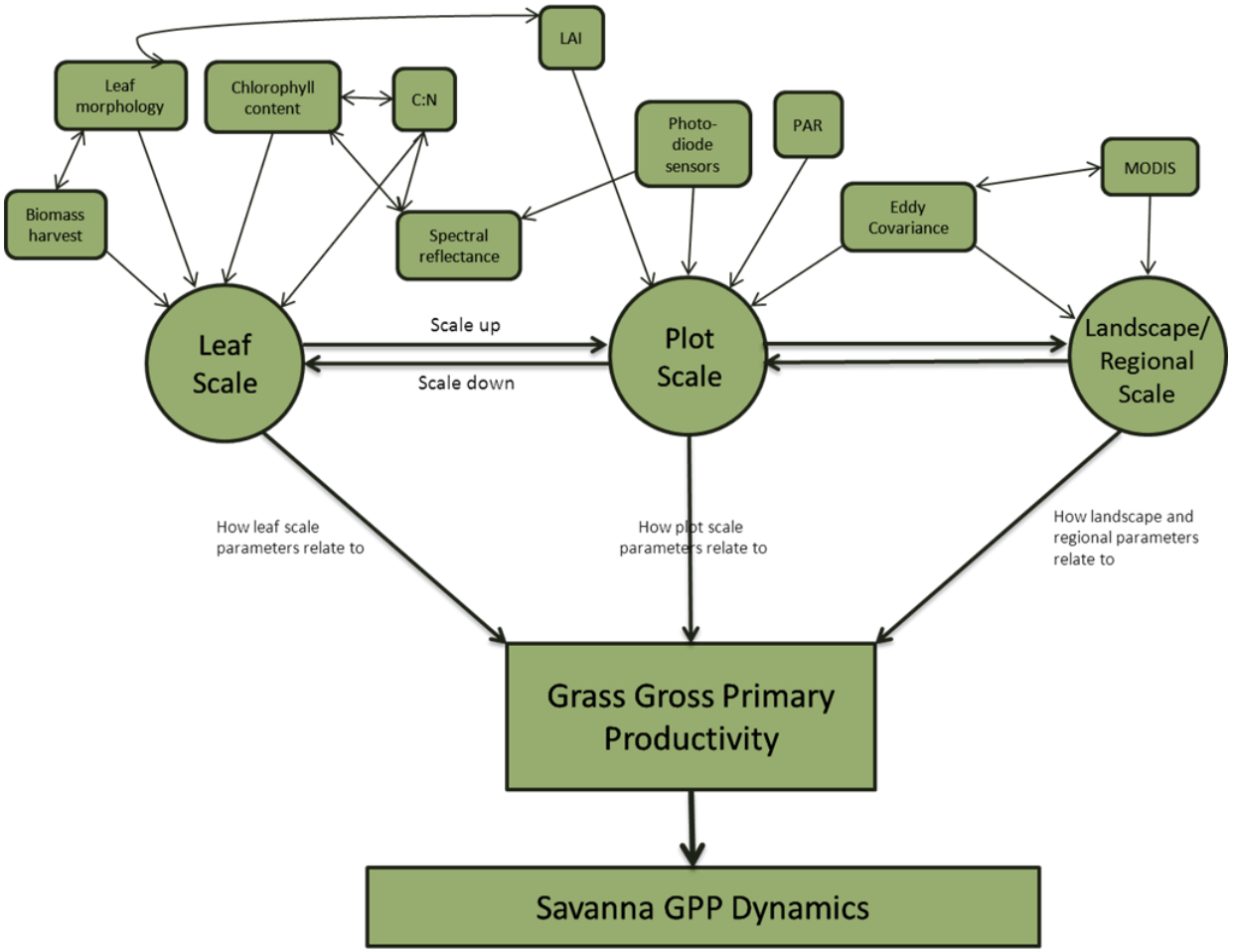


Image Source: *Hutley & Beringer 2010*

Research Approach



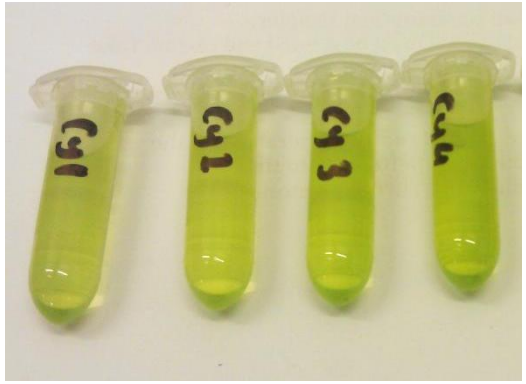
Study Site: Howard Springs

- Long-term (1982-2006) rainfall = 1782 mm
- Open savanna woodland dominated by eucalyptus woody overstory and C_4 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/)

Map Source: www.maps.google.com

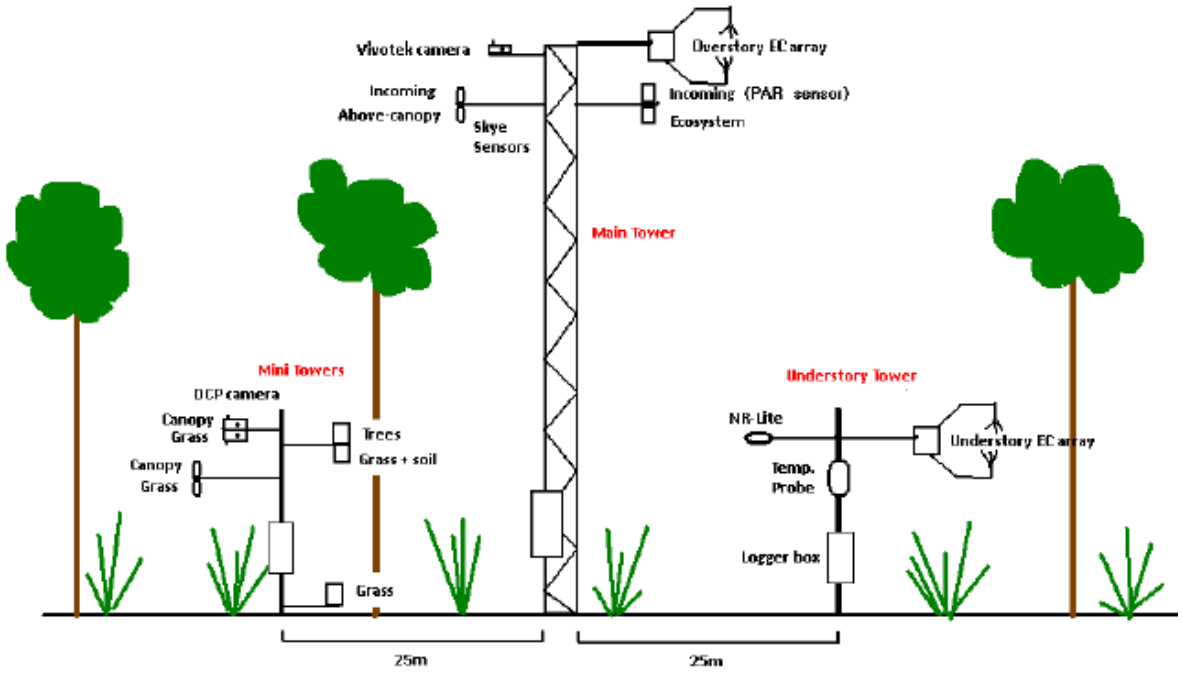
Leaf Level Observations



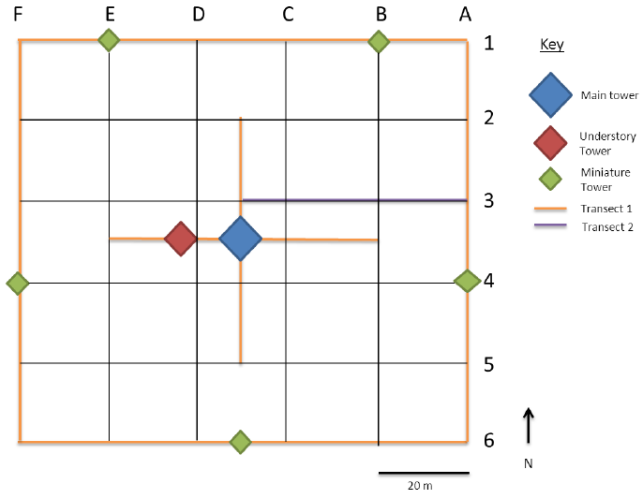
- Biomass Harvest
- Leaf morphology
- Leaf chemistry: Chlorophyll & Nitrogen
- Leaf spectra

Courtesy of J.Pettigrew

Plot Level Observations

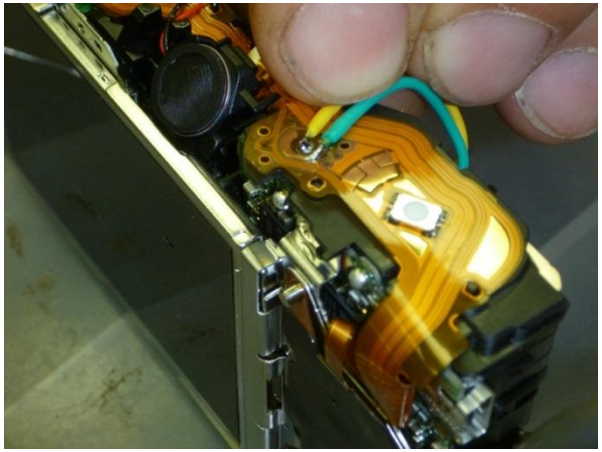


- Photosynthetically Active Radiation (PAR) sensors
- 4-channel Light sensors
- Digital cover photography (DCP) cameras
- Flux towers



Hemispheric photography LAI Image

Digital Cover Photography Image




Canon

Wet Season - Growth

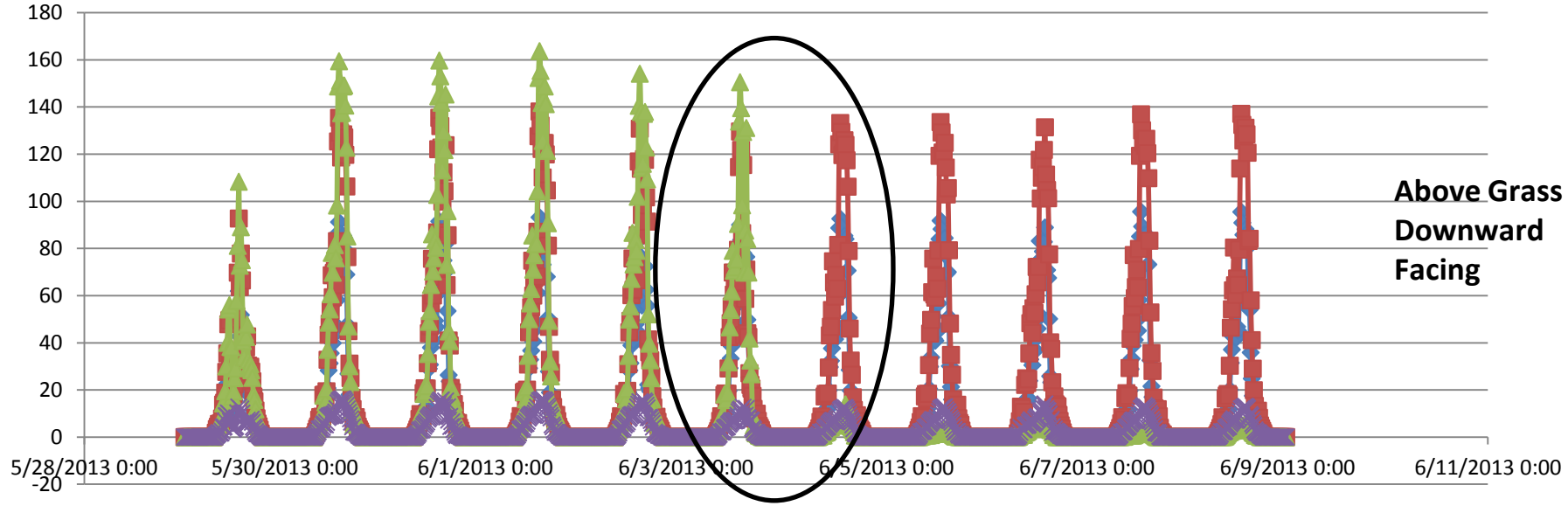
Wet Season - Seeding

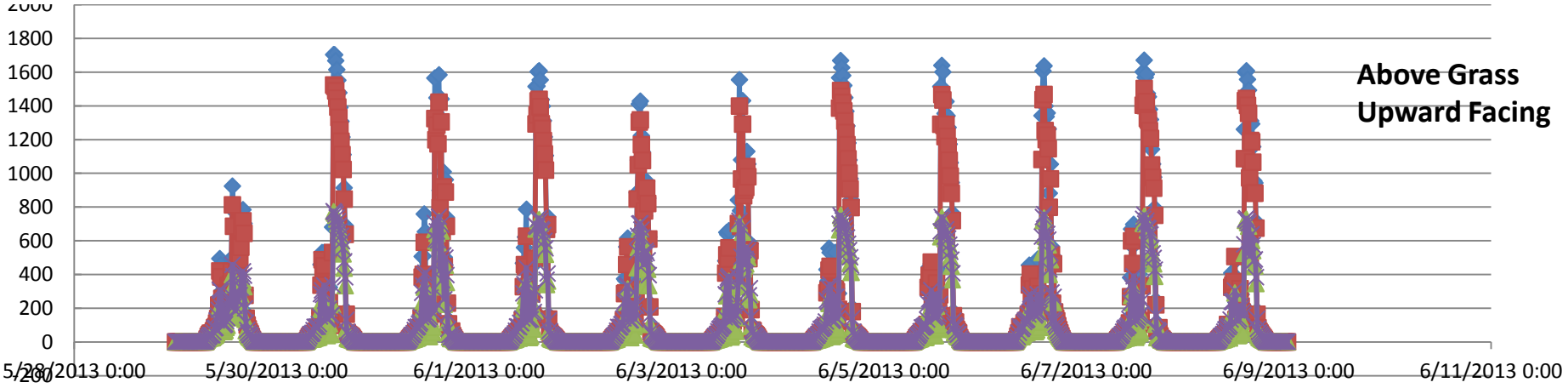
Dry Season

Courtesy J. Beringer

Courtesy L. Hutley

The mini towers tell a story…

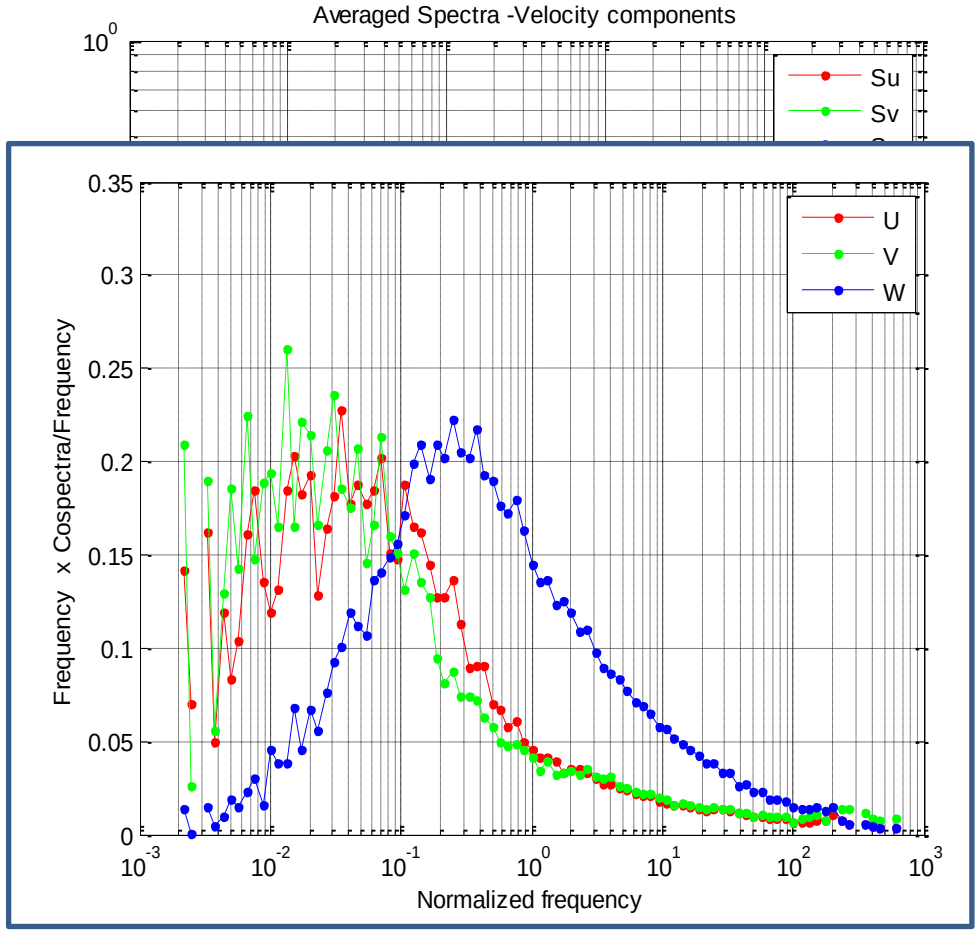


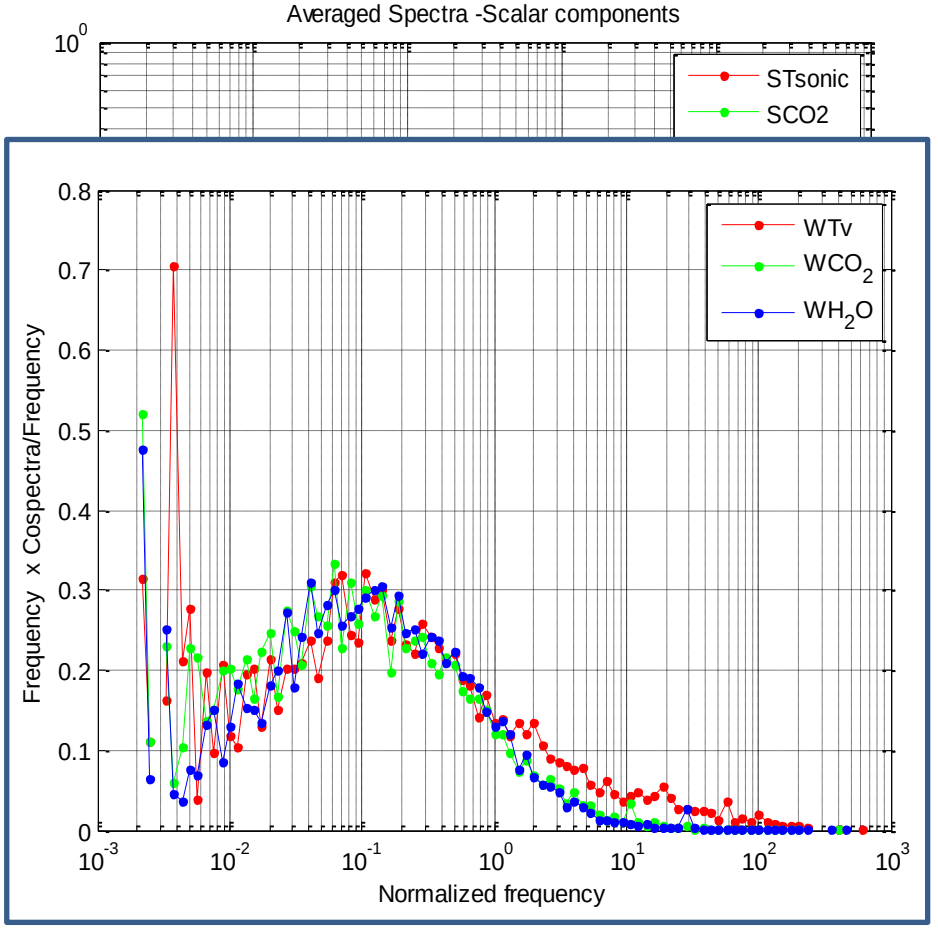


Flux Towers on Site

- 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





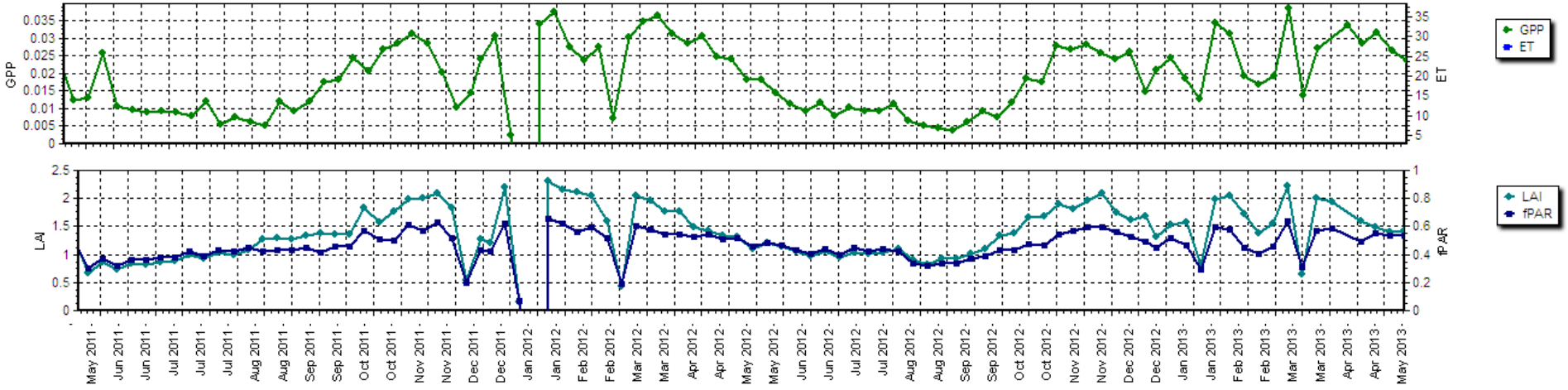
With help (lots) from James Kathilan & Israel Begashaw

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

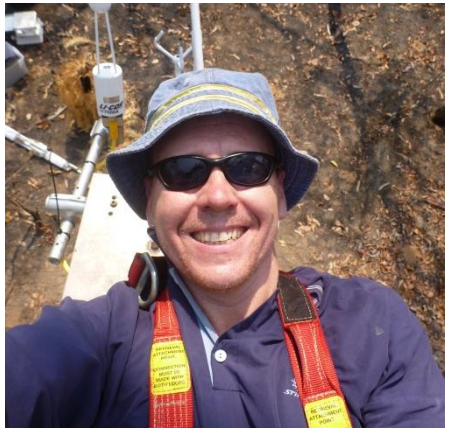
Remote sensing data



www.arts.monash.edu.au/ges/research/climate/howard/

- 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

- BEER, C., REICHSTEIN, M., TOMELLERI, E., CIAIS, P., JUNG, M., CARVALHAIS, N., RÖDENBECK, C., ARAIN, M. A., BALDOCCHI, D., BONAN, G. B., BONDEAU, A., CESCATTI, A., LASSLOP, G., LINDROTH, A., LOMAS, M., LUYSSAERT, S., MARGOLIS, H., OLESON, K. W., ROUPSARD, O., VEENENDAAL, E., VIOVY, N., WILLIAMS, C., WOODWARD, F. I. & PAPALE, D. 2010. Terrestrial gross carbon dioxide uptake: Global distribution and covariation with climate. *Science,* 329**,** 834-838.
- GRACE, J., JOSÉ, J. S., MEIR, P., MIRANDA, H. S. & MONTES, R. A. 2006. Productivity and carbon fluxes of tropical savannas. *Journal of Biogeography,* 33**,** 387-400.
- HOUSE, J. I. & HALL, D. O. 2001. Productivity of Tropical Savannas and Grasslands. *In:* SAUGIER, B., ROY, J. & MOONEY, H. A. (eds.) *Terrestrial Global Productivity.* San Diego: Academic Press.
- HUTLEY, L. B. & BERINGER, J. 2010. Disturbance and Climatic Drivers of Carbon Dynamics of a North Australian Tropical Savanna. *In:* HILL, M. J. & HANAN, N. P. (eds.) *Ecosystem Function in Savannas: Measurement and modelling at landscape to global scales.* Boca Raton, FL, USA: CRC Press.
- SCHOLES, R. J. & ARCHER, S. R. 1997. Tree-grass interactions in Savannas. *Annual Review of Ecology and Systematics,* 28**,** 517-544.

Questions…