Methane fluxes from the tropical savannas of Northern Australia: The role of mound-building termites

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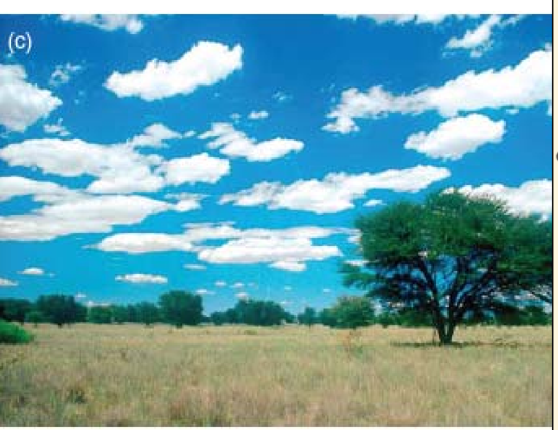
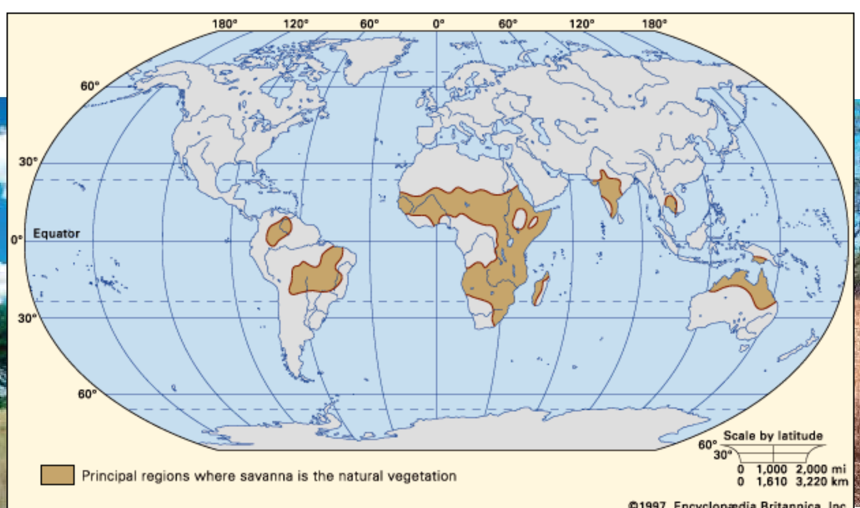
Savannas

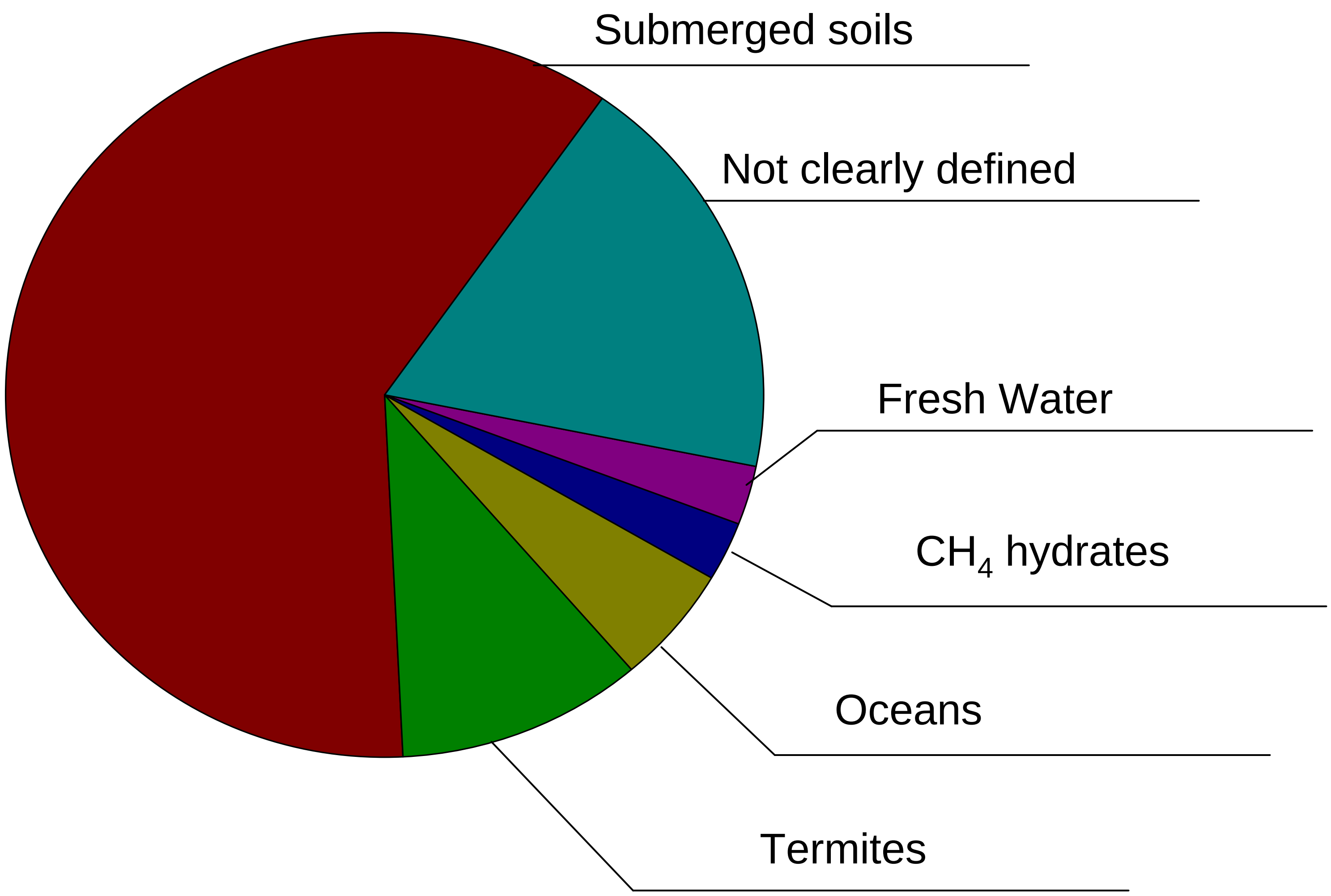
- One-sixth of the world's land cover
- One-fourth of the Australian land cover
- "Continuous / near-continuous C4 grass dominated understorey with discontinuous woody over-storey" (*Hutley & Setterfield 2007*)
- Wide range of tree-grass ratios; up to 80% woody cover
- Rainfall = 300-2000 mm
- Termites primary consumers (unless cattle)





Natural sources of CH4

One-third of global CH_4 sources are natural and two-thirds anthropogenic



CH_4 exchange in savannas

- CH_4 is consumed in the well aerated parts of soil by methanotrophic bacteria
- CH_4 is produced in the anaerobic parts of soil by methanogenic bacteria
- CH_4 is produced by termites as a result of metabolism by methanogenic bacteria in their hindguts
- >2650 known species of termites all over the world
- >350 species in Australia

- Termites can contribute < 5% up to 17 % of global CH_4 budget (Eggleton et al. 1995)
- Large uncertainties in these estimates due to:
  - seasonal variations
  - diurnal variations
  - species variation
  - issues of up-scaling

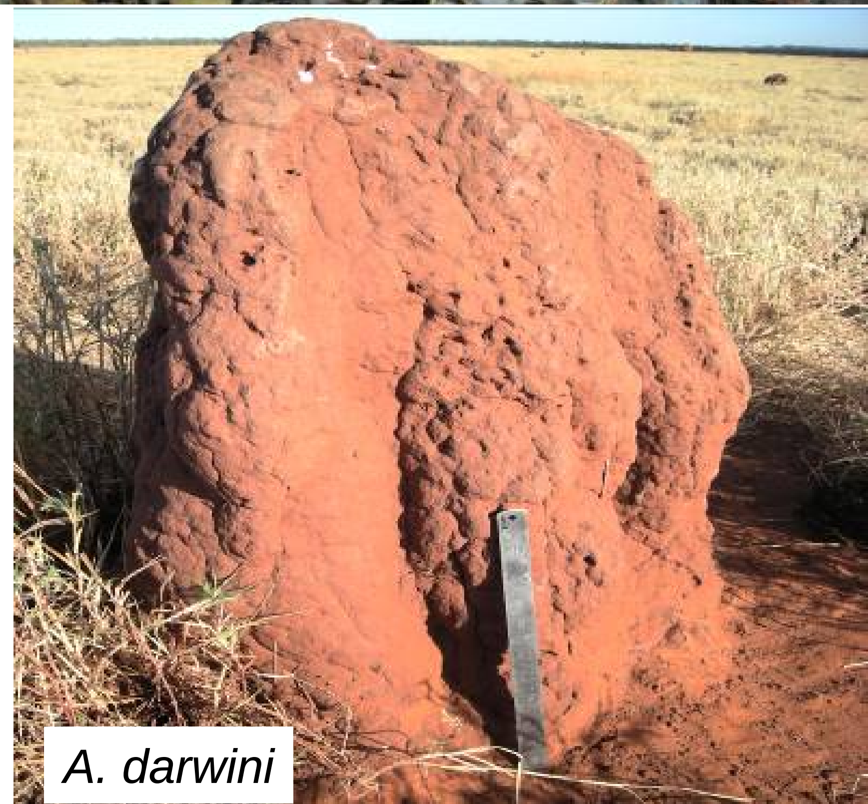
Objectives

- Diurnal CH_4 flux variations
- Seasonal CH_4 flux variations
- Factors causing diurnal and seasonal variations
- Species variation in CH_4 fluxes
- Soil CH_4 fluxes
- Net Ecosystem CH_4 flux


M. nervosus


M. serratus


T. pastinator

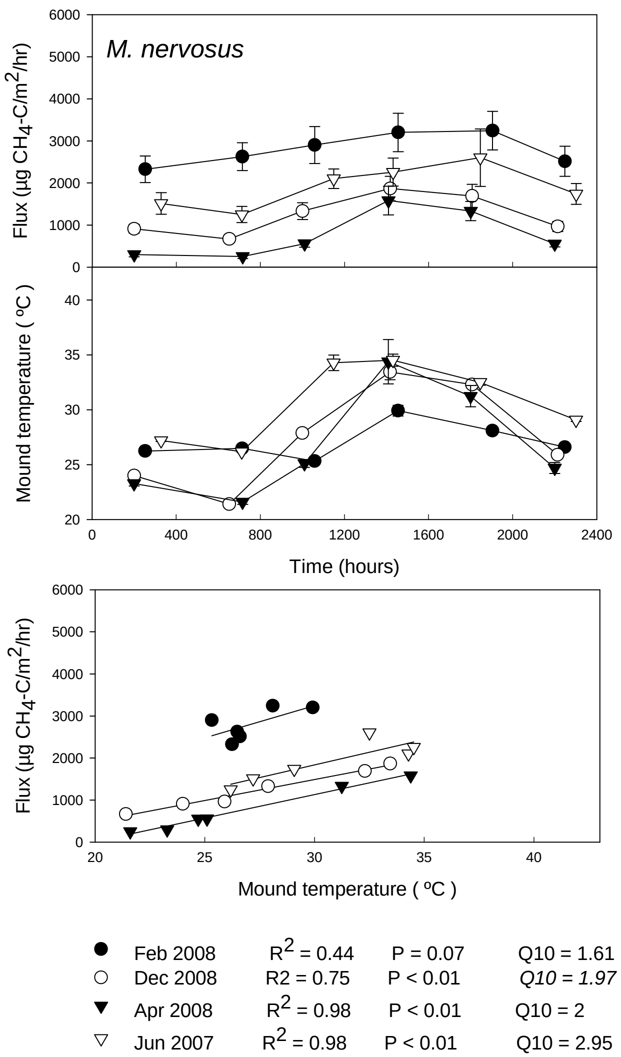

A. darwini

Materials and methods

- Four sites:
  - CSIRO Tropical Ecosystems Research Center, Darwin
  - Charles Darwin National Park
  - Howard Springs
  - Douglas-Daly

- Diurnal and seasonal CH_4 flux measurements using manual chambers
- Mound and soil temperature
- Mound and soil moisture content
- Termite and vegetation surveys

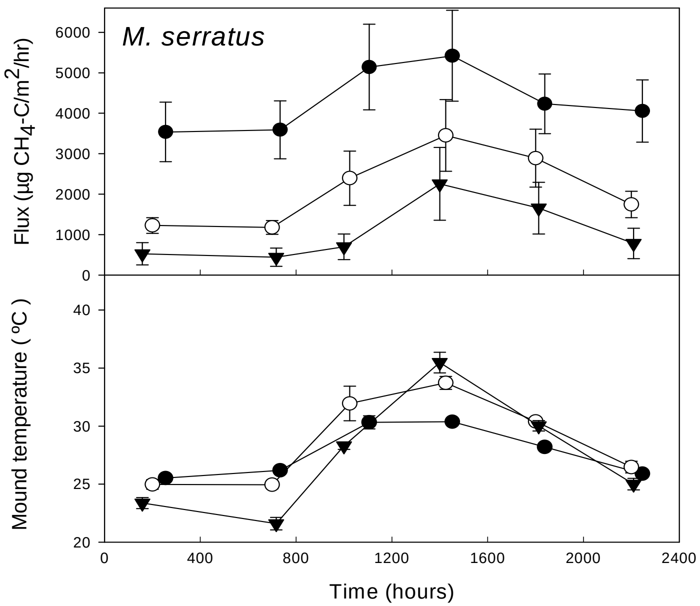
Results

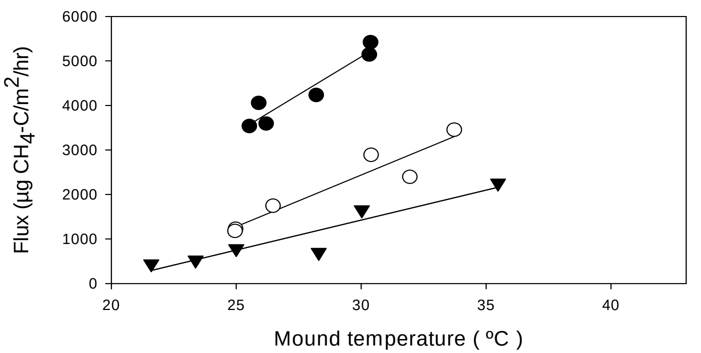


Diurnal CH_4 flux variations

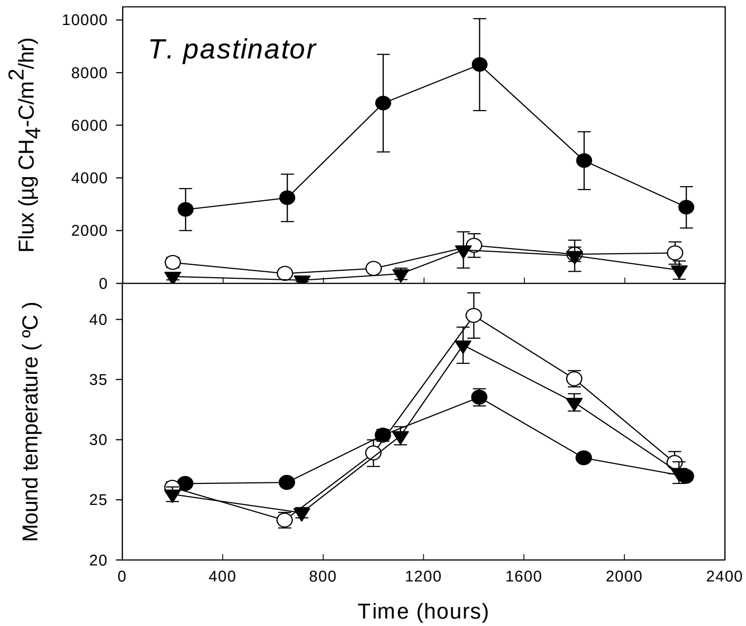
- Significant diurnal variations in all species
- Significant correlation between CH_4 flux and mound temperature

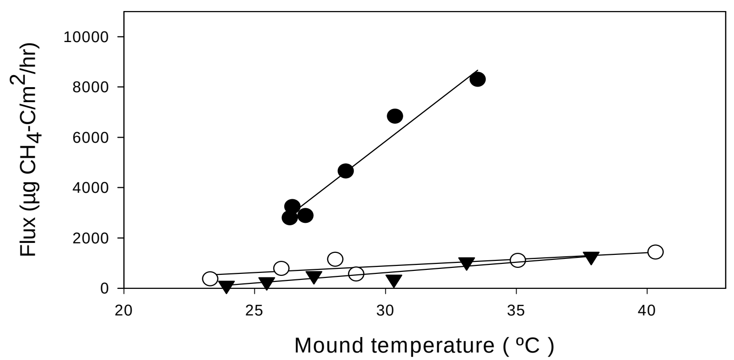
Diurnal CH_4 flux variations





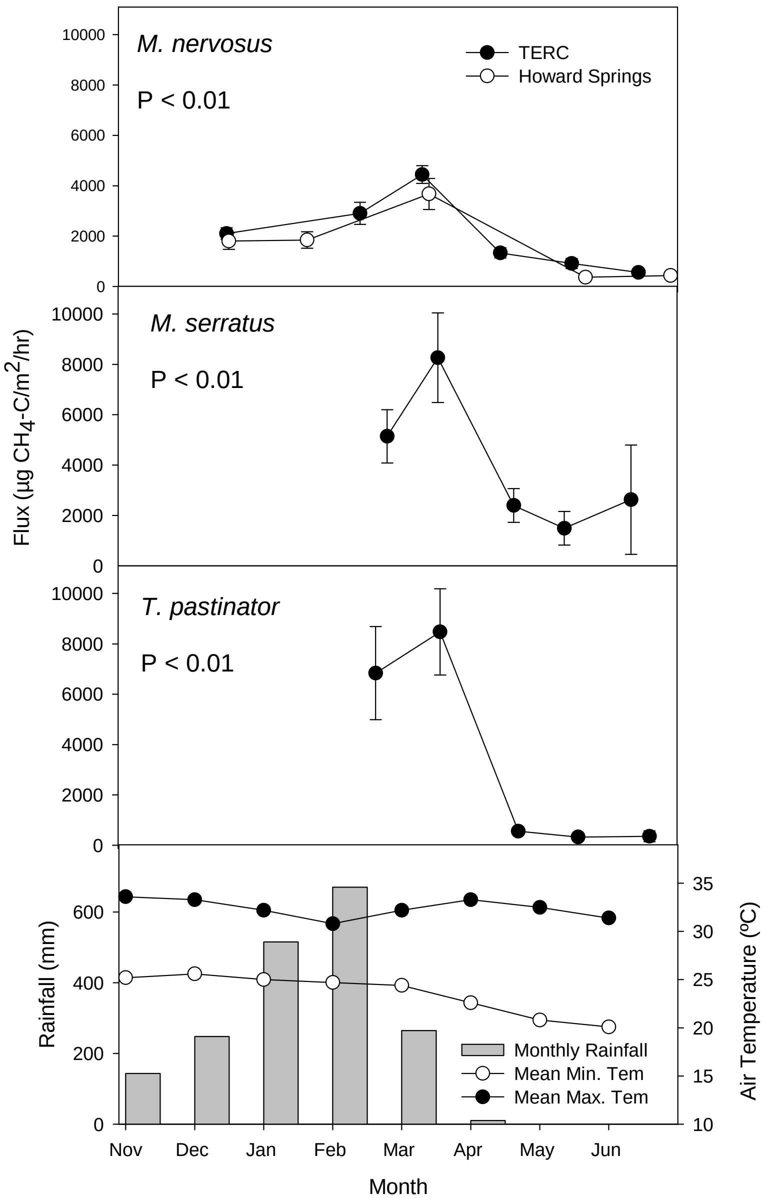
●	Feb 2008	$R^2 = 0.91$	$P = 0.051$	Q10 = 2
○	Apr 2008	$R^2 = 0.90$	$P < 0.01$	Q10 = 2.81
▼	Jun 2008	$R^2 = 0.88$	$P < 0.01$	Q10 = 2.79





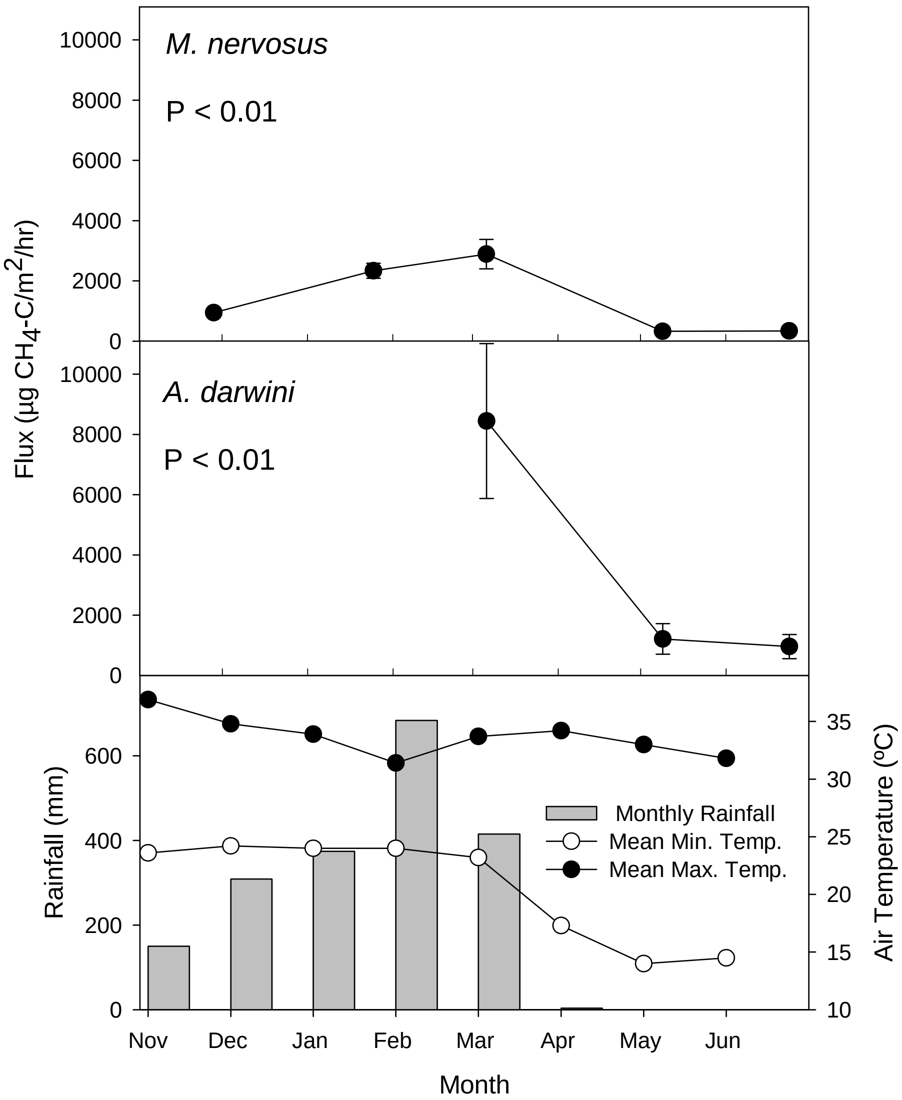
●	Feb 2008	$R^2 = 0.96$	$P < 0.01$	Q10 = 5.36
○	Apr 2008	$R^2 = 0.69$	$P = 0.01$	Q10 = 1.85
▼	Jun 2008	$R^2 = 0.88$	$P = 0.01$	Q10 = 5.05

Seasonal CH_4 flux variations



- Significant seasonal variations
- Higher fluxes in wet season
- Significant correlation between CH_4 flux and moisture
- Moist conditions result in higher termite activity

Seasonal CH_4 flux variations



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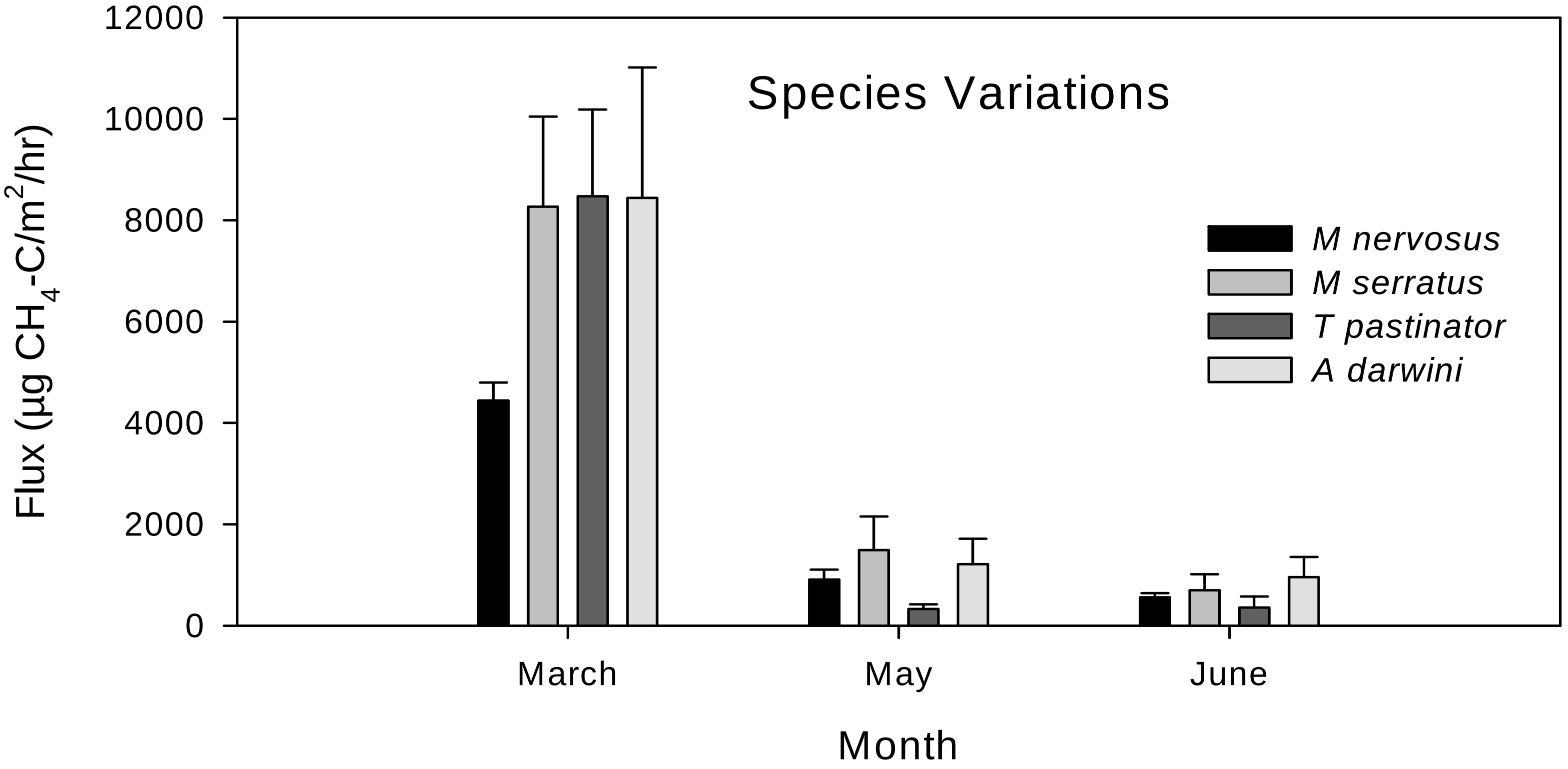
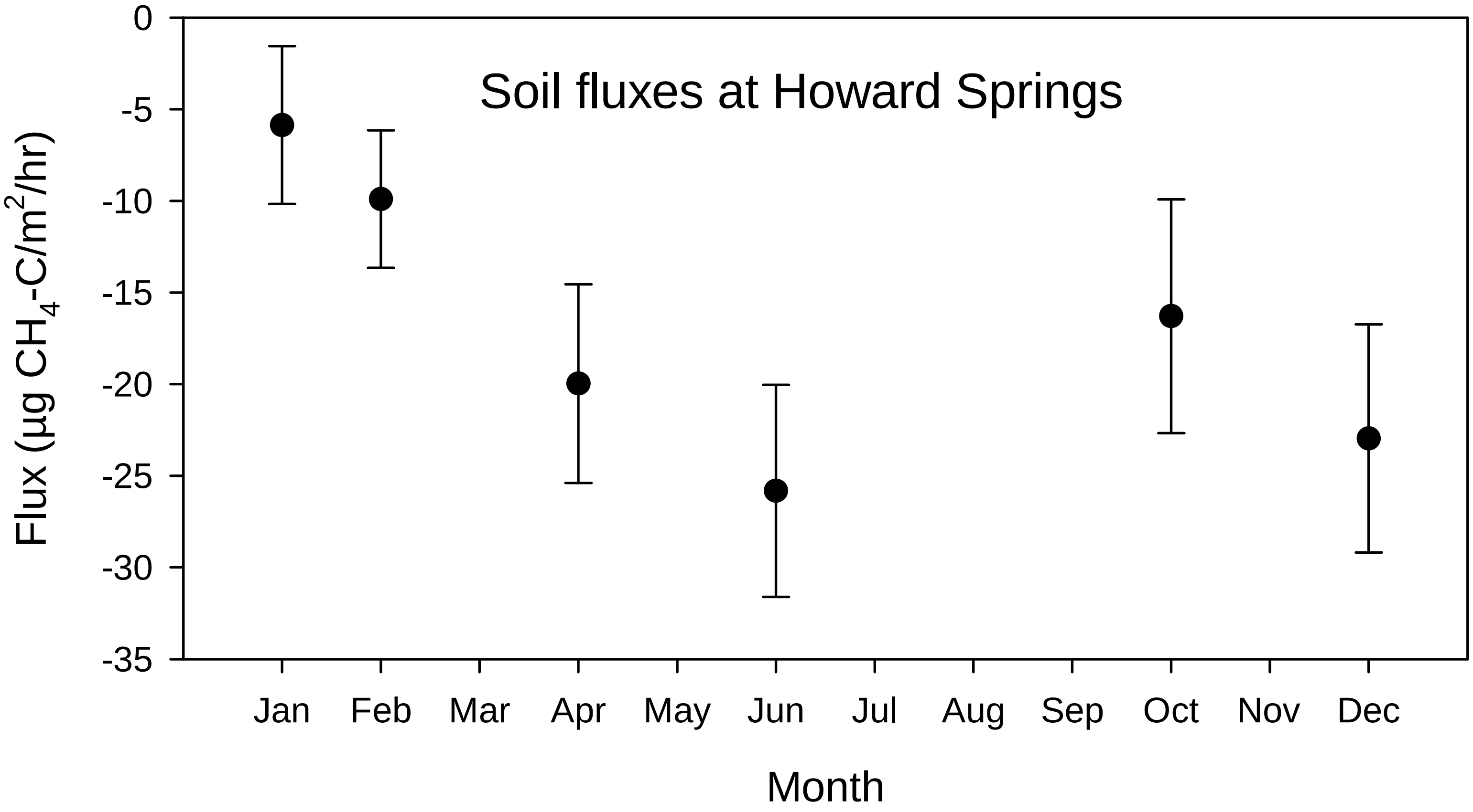
Species variation in CH_4 flux



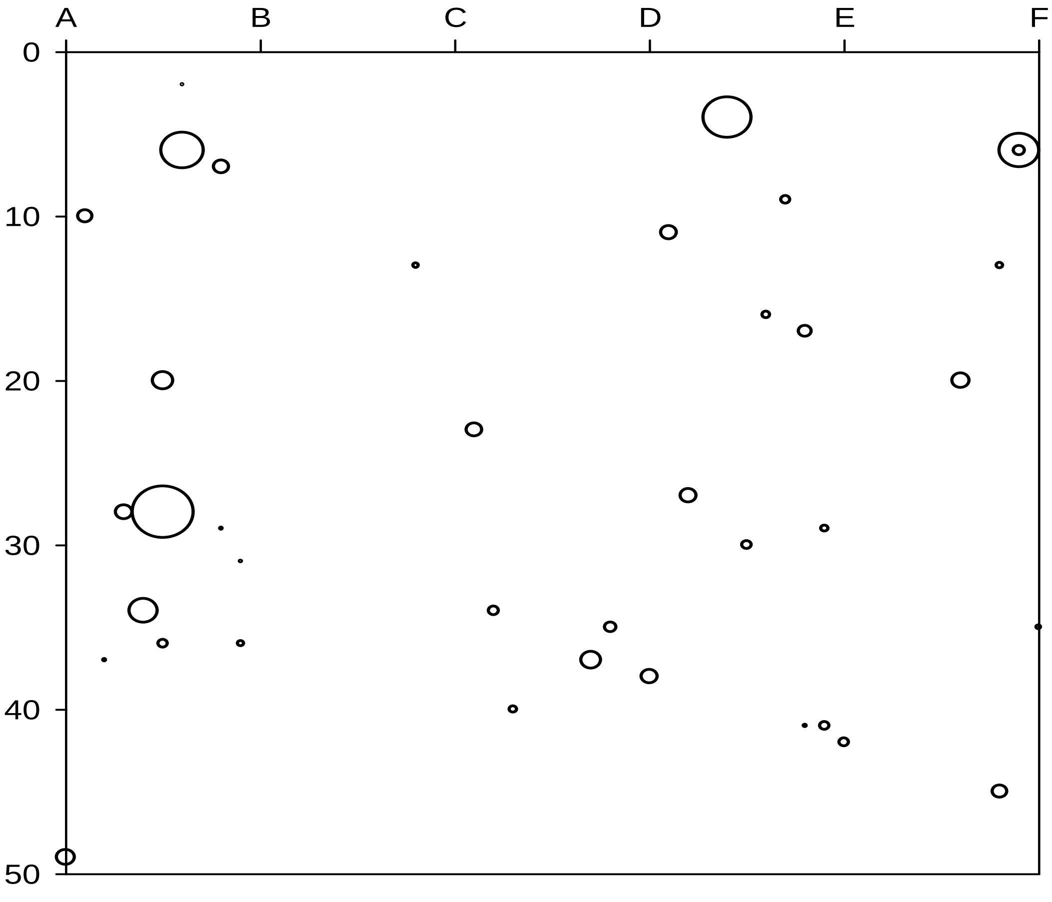
Significant variations in CH_4 fluxes from different termite species

Soil CH_4 fluxes



Soils consumed CH_4 in all the plots studied

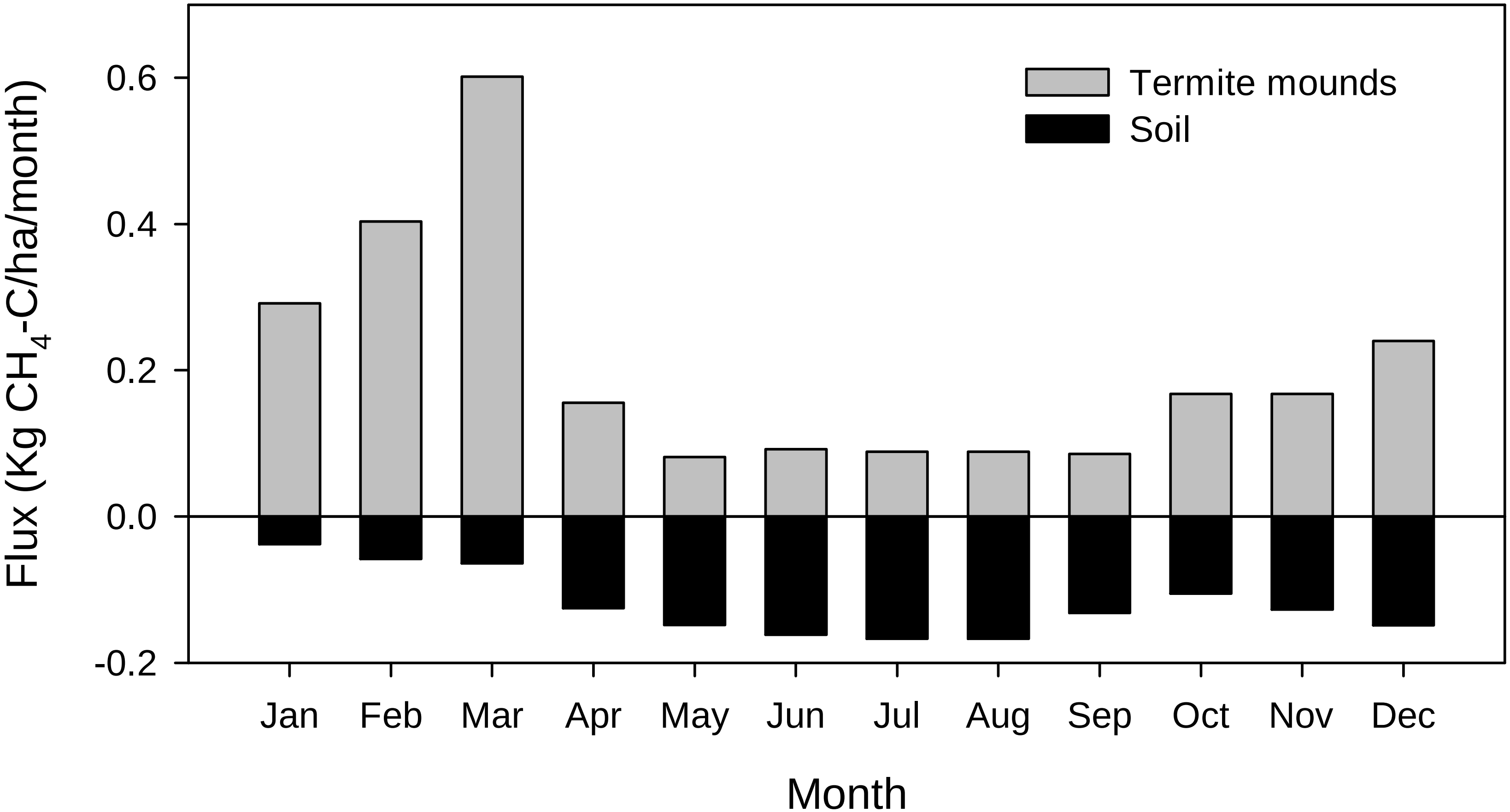
Mound distribution in a 50 X 50 m plot at Howard Springs



Total area:	2500 m^2	=	100 %
Area covered by mounds:	46 m^2	=	1.8 %
Area covered by trees:	279 m^2	=	11.2 %

Net ecosystem CH_4 exchange

M. nervosus, Howard Springs



Net ecosystem CH_4 exchange

Termites		Soil		NET	
↑↑↑ 2.46	−	↓↓↓ 1.44	=	↑↑↑ 1.02	kg CH_4-C/ha/yr

Net ecosystem exchange (NEE) = -4300 kg C/ha/yr

Net biome productivity (NBP) = -2000 kg C/ha/yr

(Beringer et al, 2007, GCB)

CH_4 produced by mound-building termites offsets 0.5 % of NEE and 1.1% of NBP of savannas at Howard Springs when expressed as CO_2-e

Conclusions

Diurnal CH_4 fluxes:

- Diurnal variations in CH_4 fluxes significantly correlated to mound temperature

Seasonal CH_4 fluxes:

- Seasonal variations in CH_4 fluxes significantly correlated to moisture

Species variation:

- Significant variations in CH_4 fluxes among different species
- Varying seasonality response for different species

Termite-produced CH_4 in ecosystem

- Savannas at Howard Springs are a net source of CH_4
- Important to account for savanna CH_4 exchange

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- Australian Research Council for funding
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Questions