Productivity of an Australian mountain grassland is limited by temperature and dryness despite long growing seasons

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Outline

- Flux sites in the Snowy Mountains
- Carbon fluxes at the warmer site, Nimmo
- The relationship between phenology and productivity
- Future directions

"A closer cooperation between atmospheric scientists and ecologists should produce meaningful results."

Baldocchi et al. (1988) Ecology

OzFlux

Australia and New Zealand
Flux Research

Google Earth,
V 7.1.5.1557,
8 Mar 2016

www.ozflux.org.au/monitoringsites/index.html

Paired Site Comparison

	Dargo High Plains	Nimmo High Plains
Elevation	1520 m	1340 m
Annual temperature	6.7 °C	7.5 °C
Annual precipitation*	1250 mm	1100 mm
Parent material	Basalt	Granodiorite
Soil organic content	35 %	17 %
Total soil N	3.8 g m^{-2}	3.8 g m^{-2}
Total soil P	3.7 g m^{-2}	1.2 g m^{-2}
Total phytomass (biomass + necromass)	704 g C m^{-2}	347 g C m^{-2}

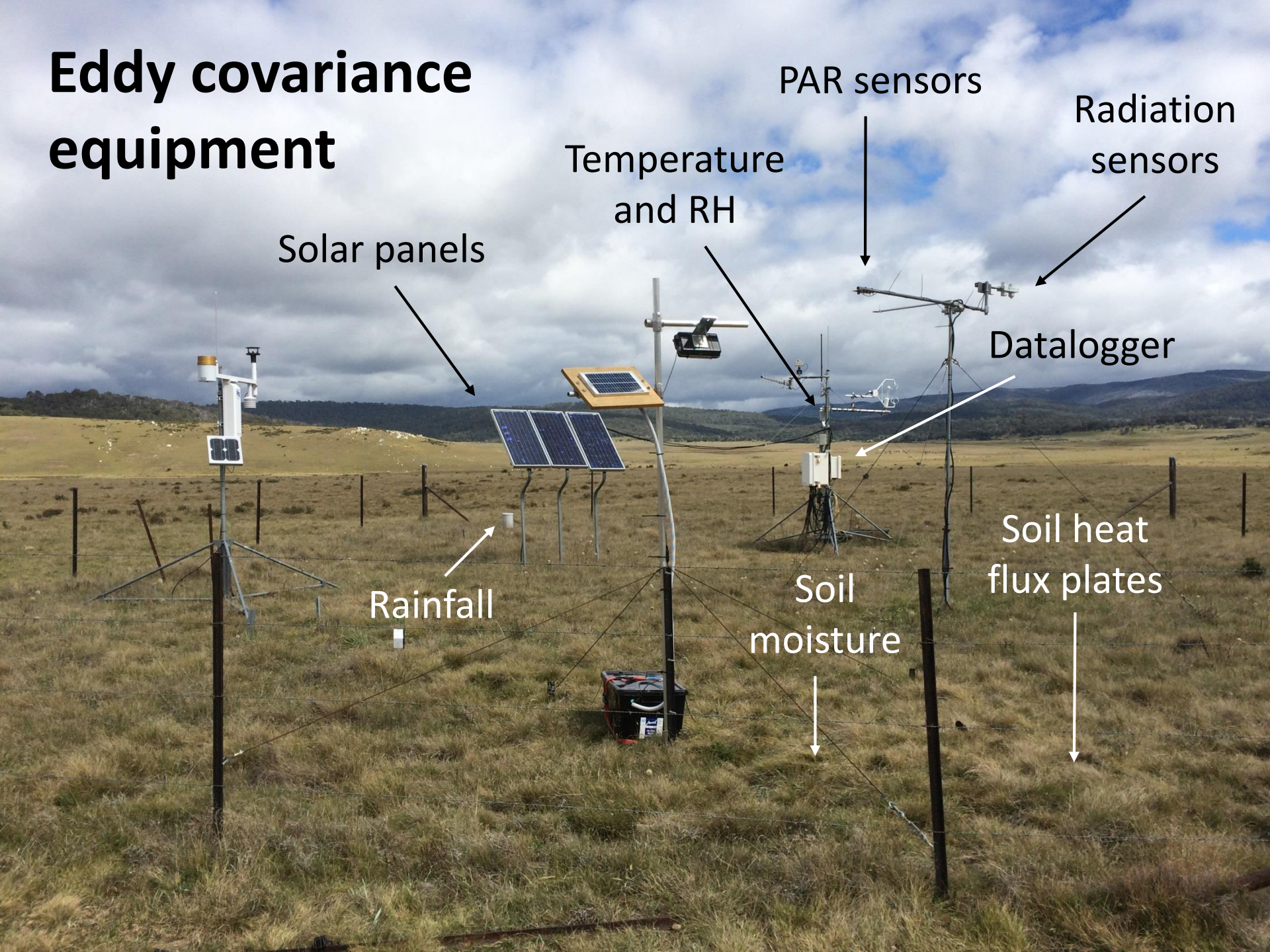
* Data obtained from the nearest AGBoM station.

McHugh, I. (2016) Ph.D. dissertation, Monash University

Nimmo High Plains, New South Wales

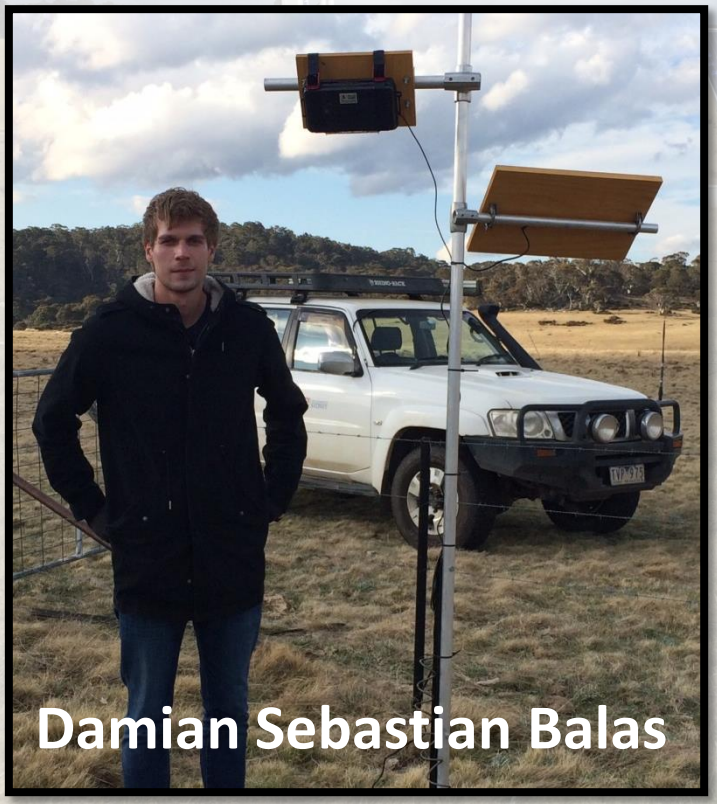
Photo by: R. Marchin

Eddy covariance equipment



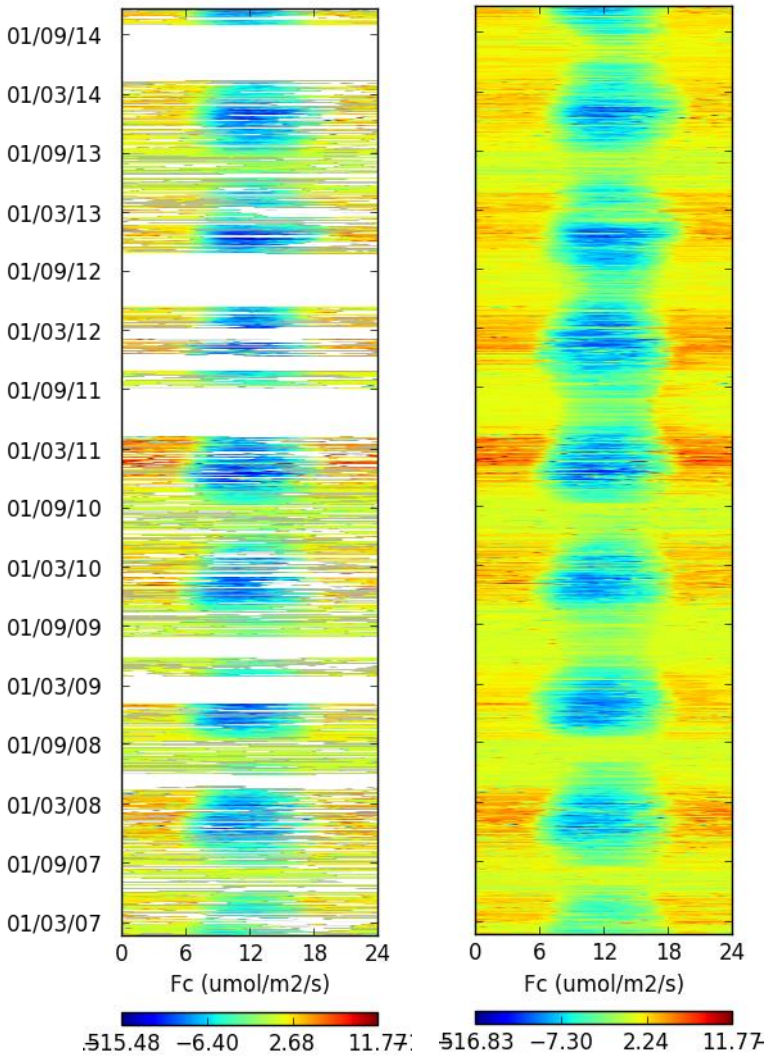
Eddy covariance equipment

PhenoCam

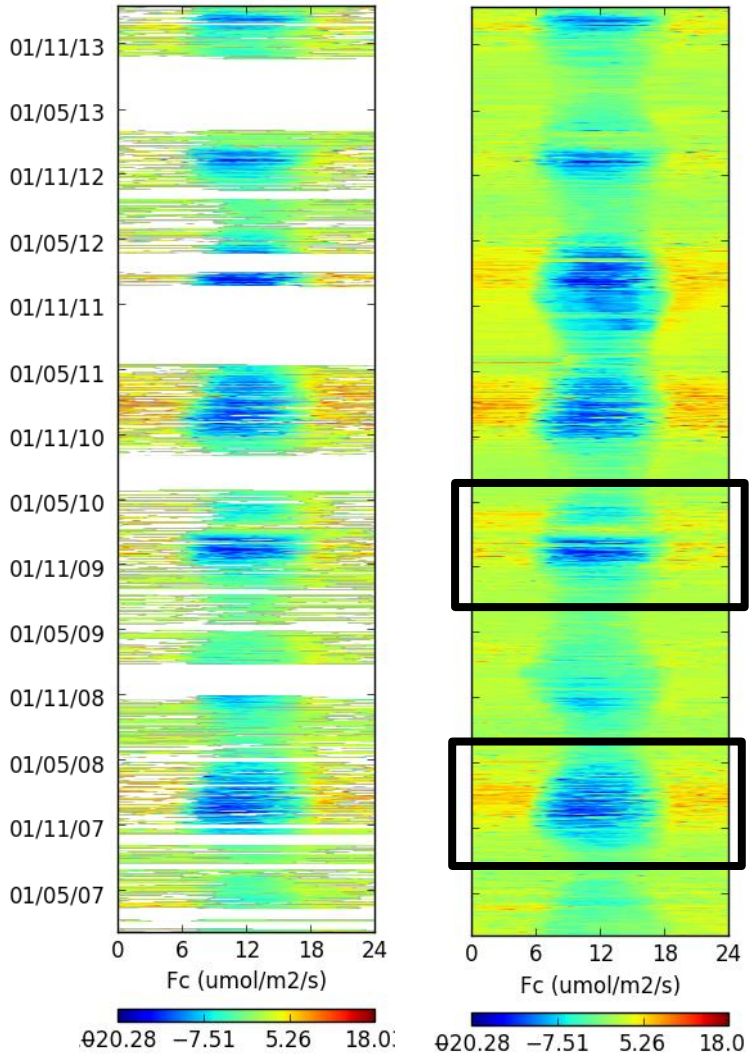


Gaps in the 7-year datasets

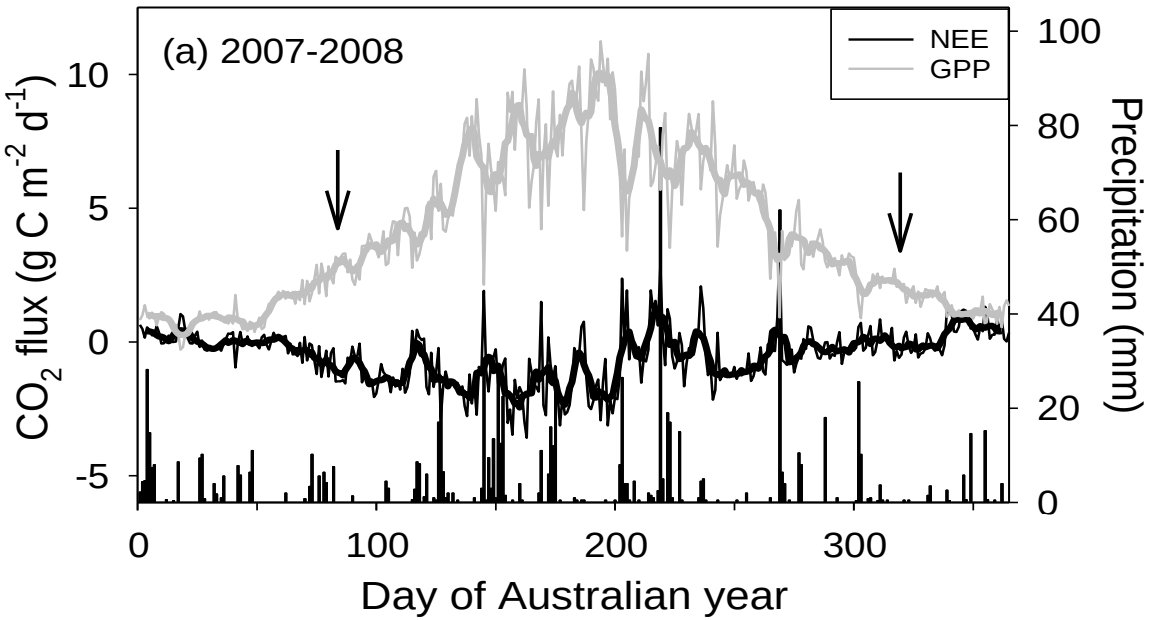
Dargo High Plains:

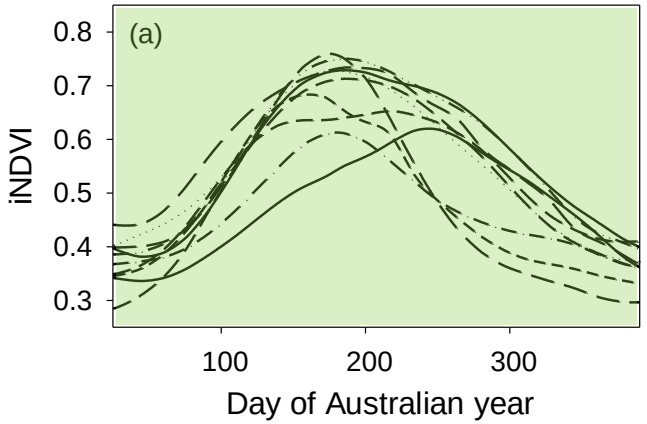


Nimmo High Plains:

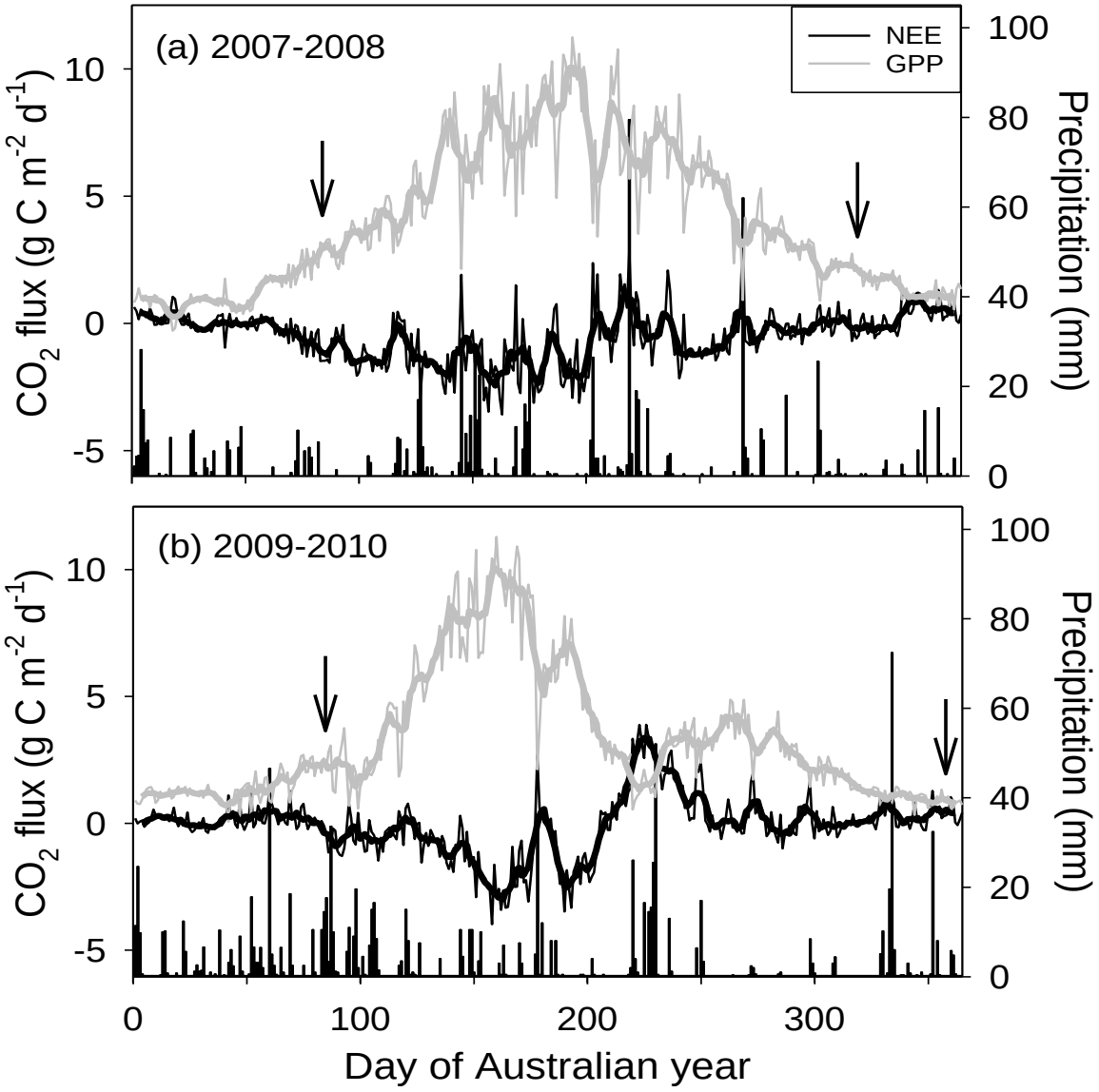


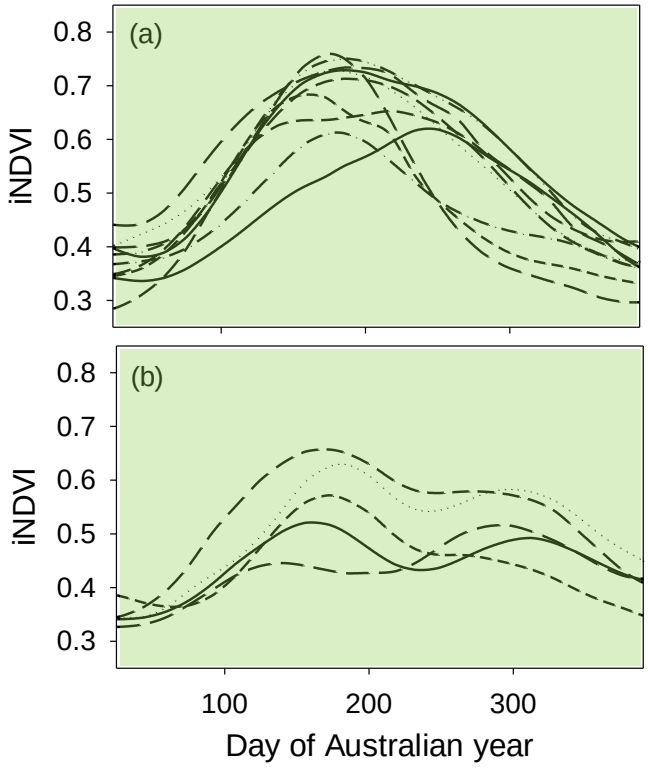
Figures produced with: OzFluxQC





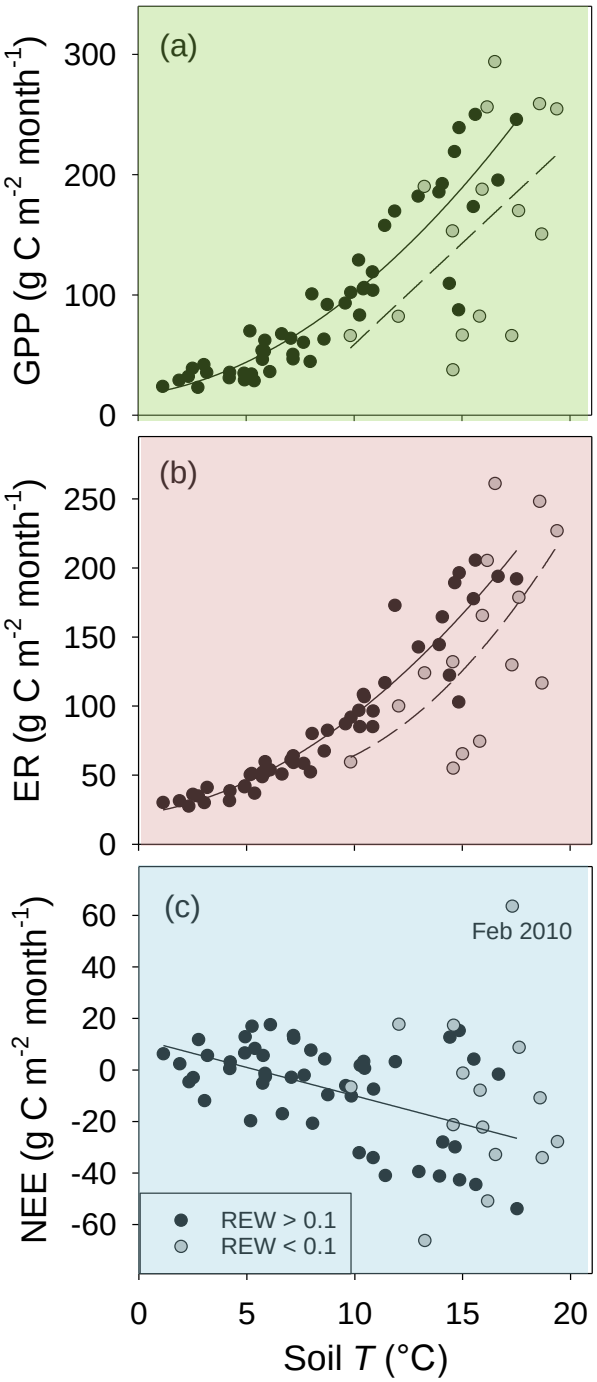
Annual patterns of carbon uptake

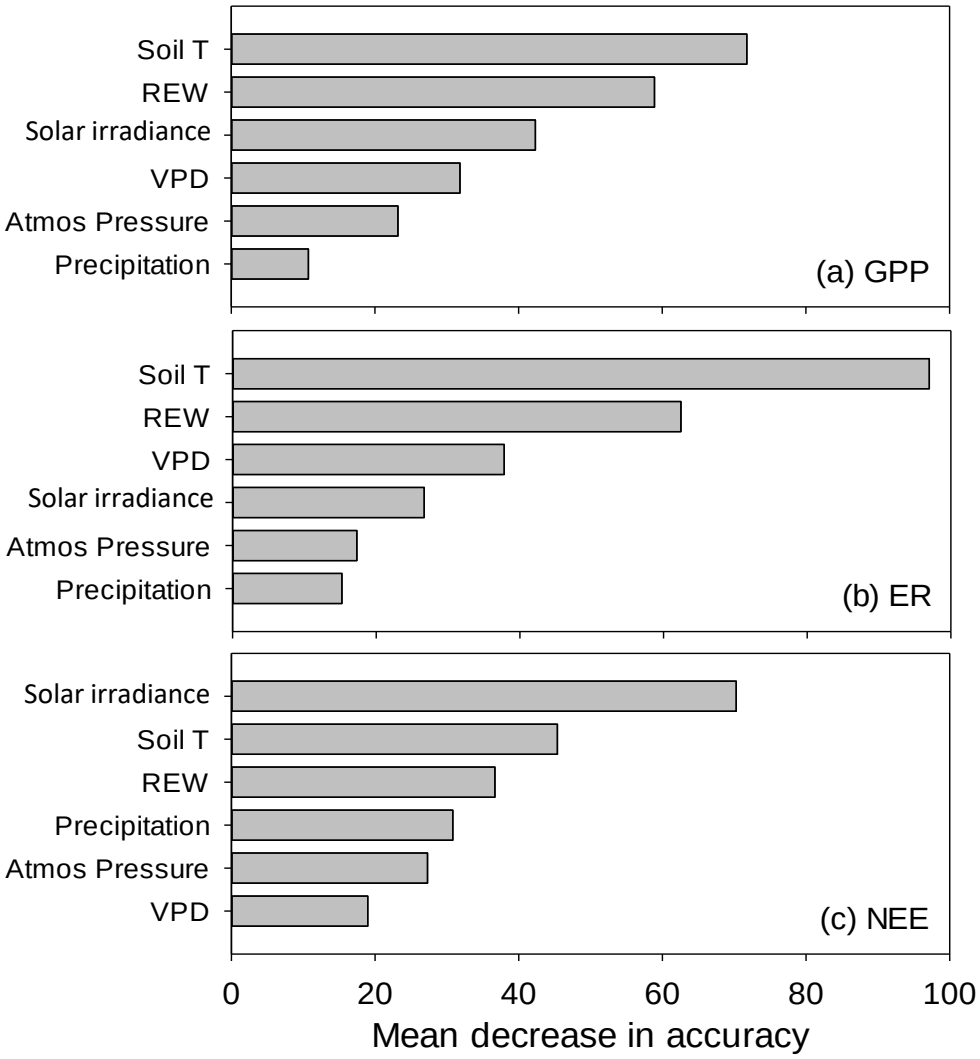




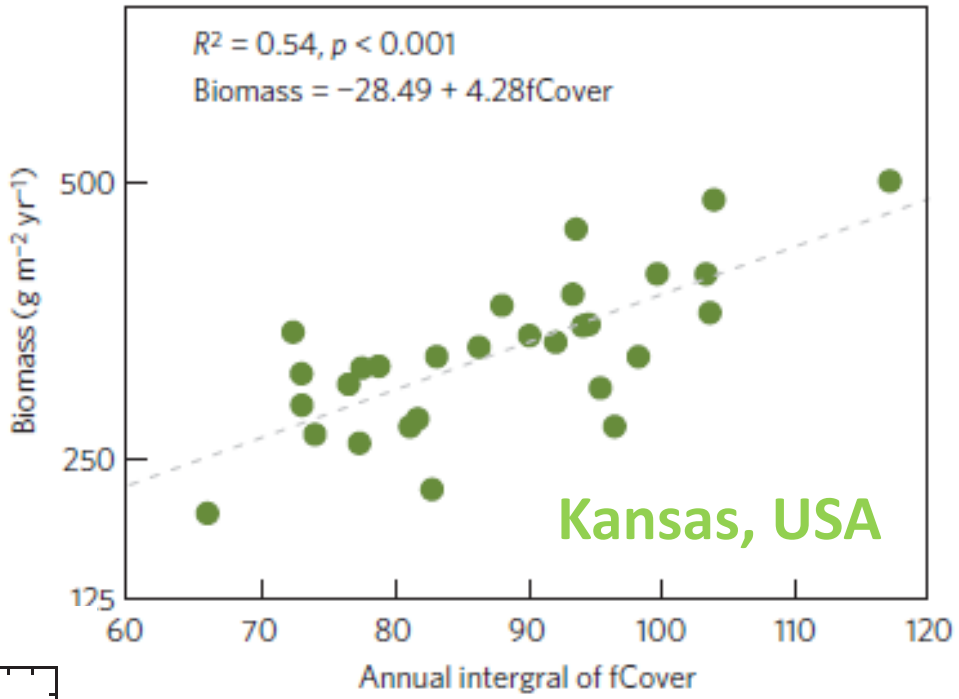
NEE ranged from –185 to –26 g C m^{-2} yr^{-1}

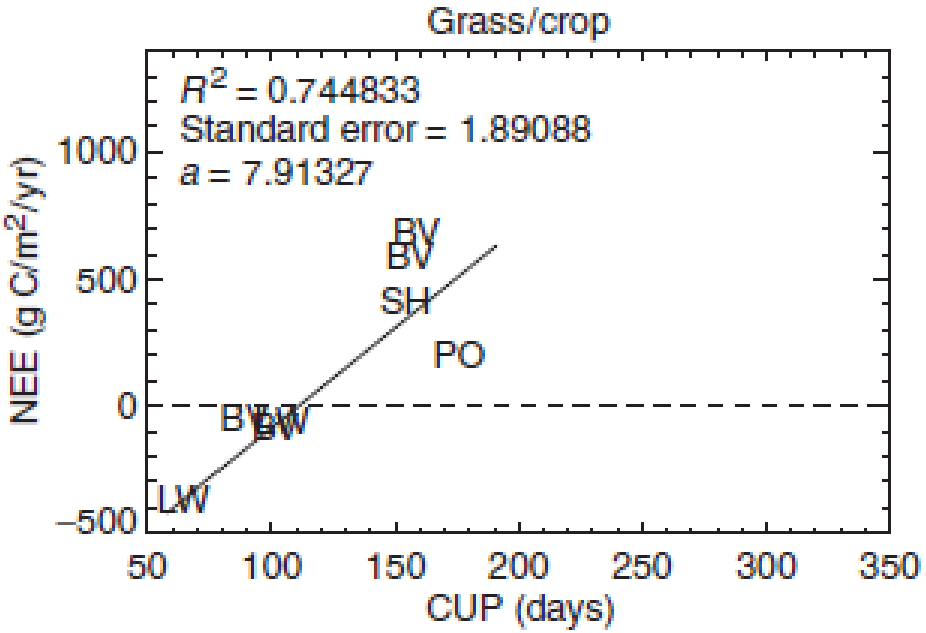
Temperature limits carbon fluxes at Nimmo





Productivity is closely related to growing season length in many northern grasslands;



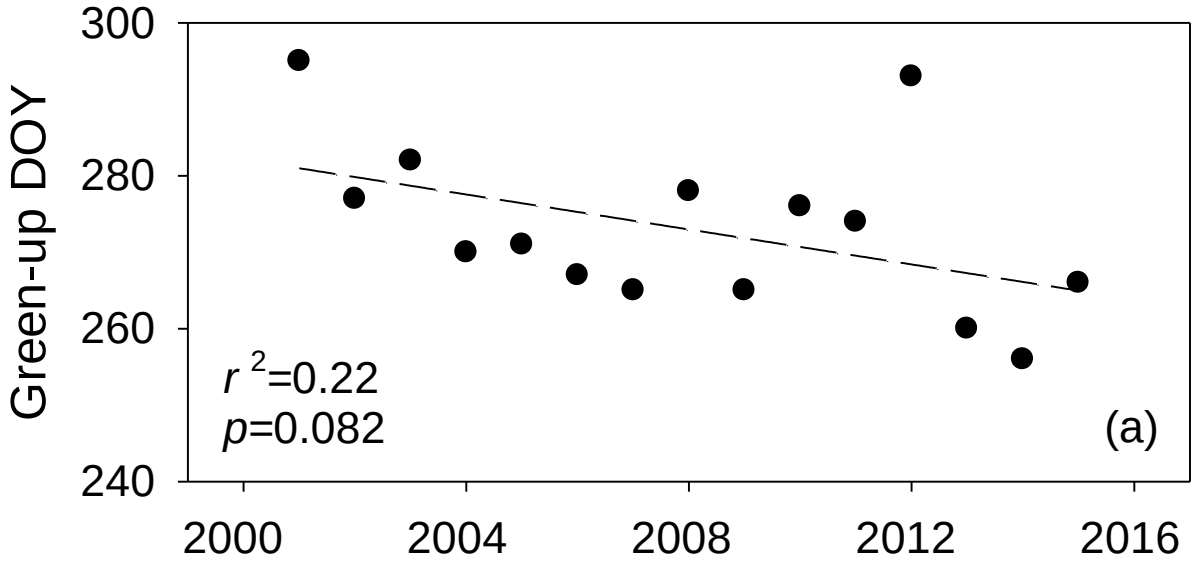


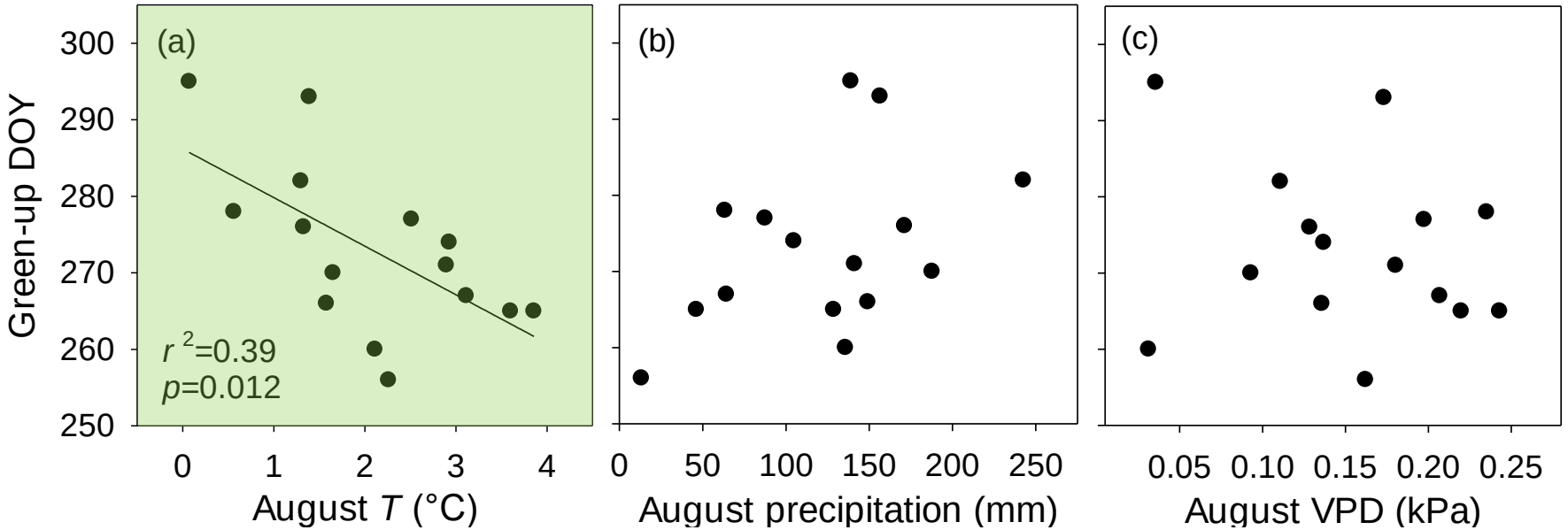
Churkina *et al*. (2005) Glob Chang Biol
Hufkens *et al*. (2016) Nature Clim Chang

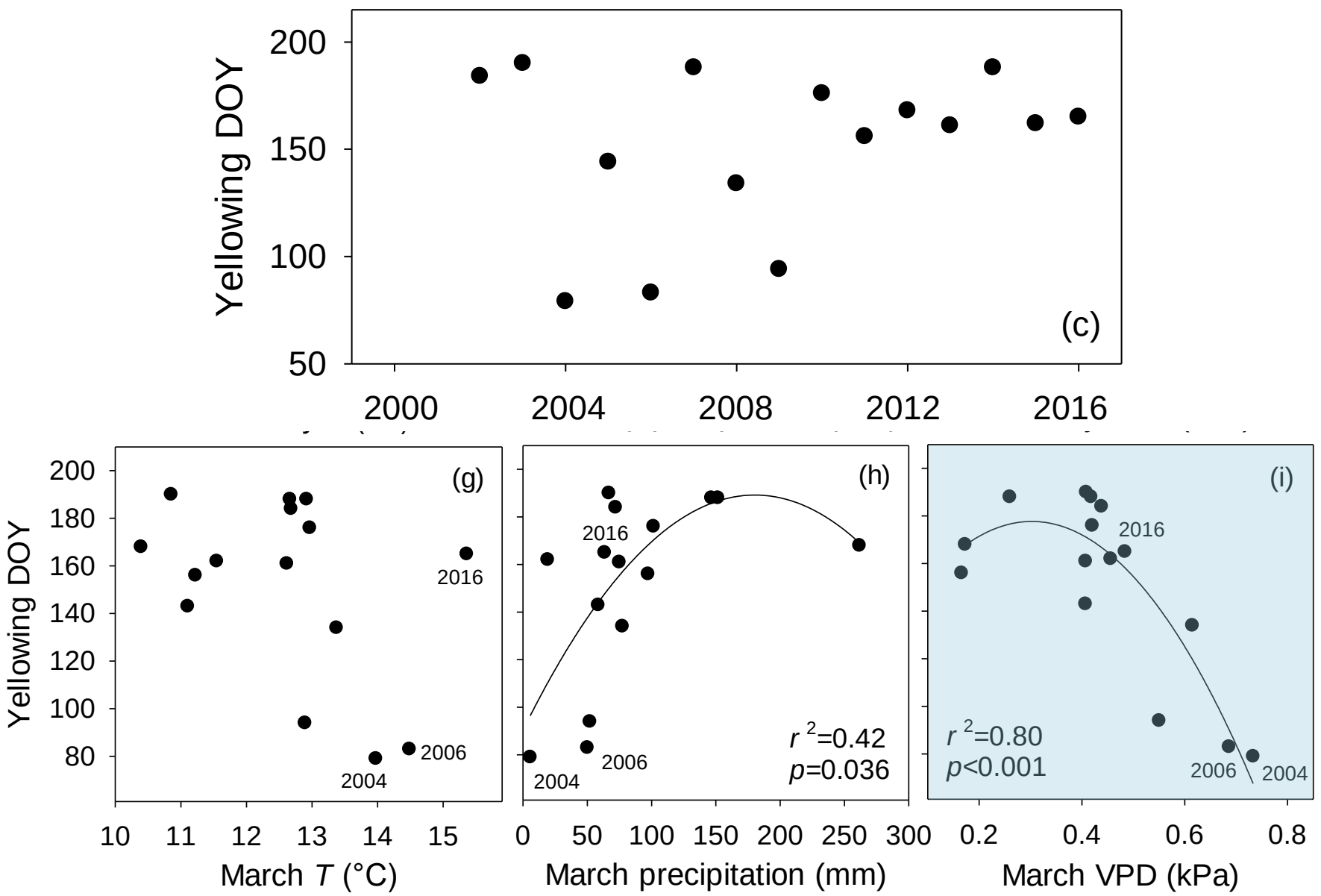
less is known about southern grasslands

Shorter GSL → **Longer GSL**

Warming has advanced green-up

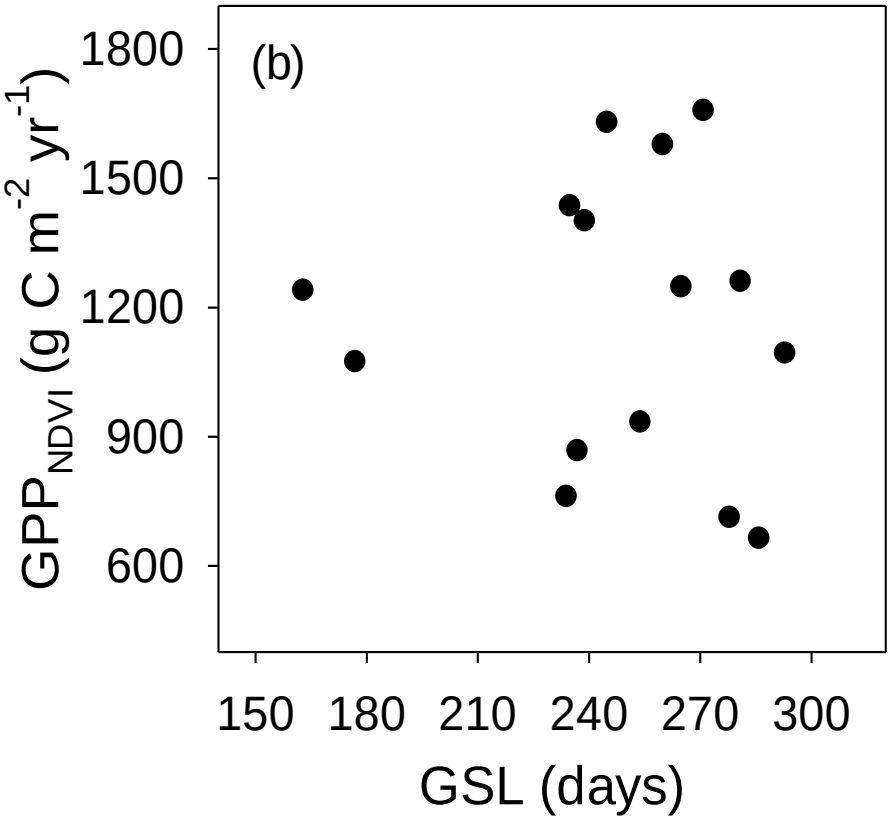


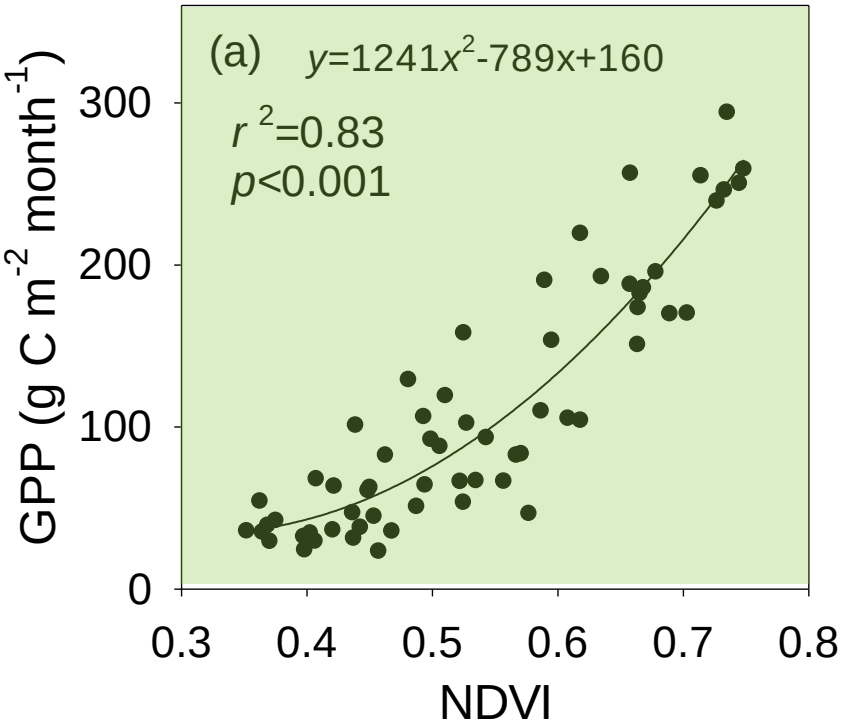


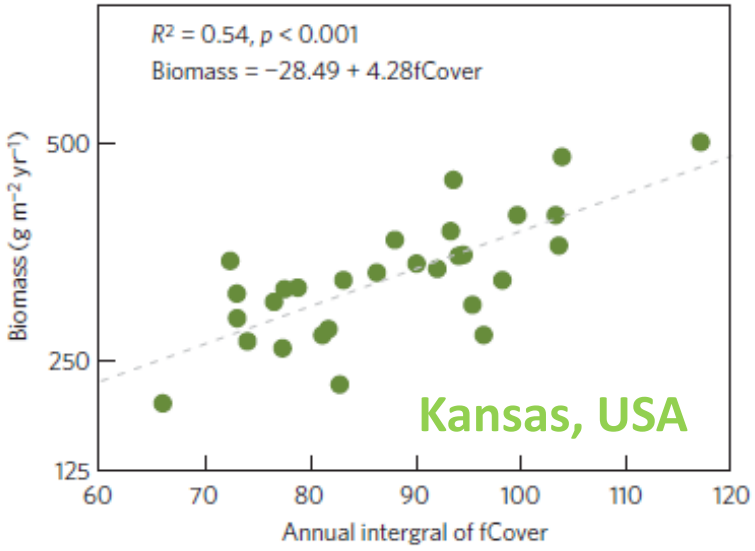


Grass yellowing is correlated with VPD

GSL of Nimmo is not correlated to productivity

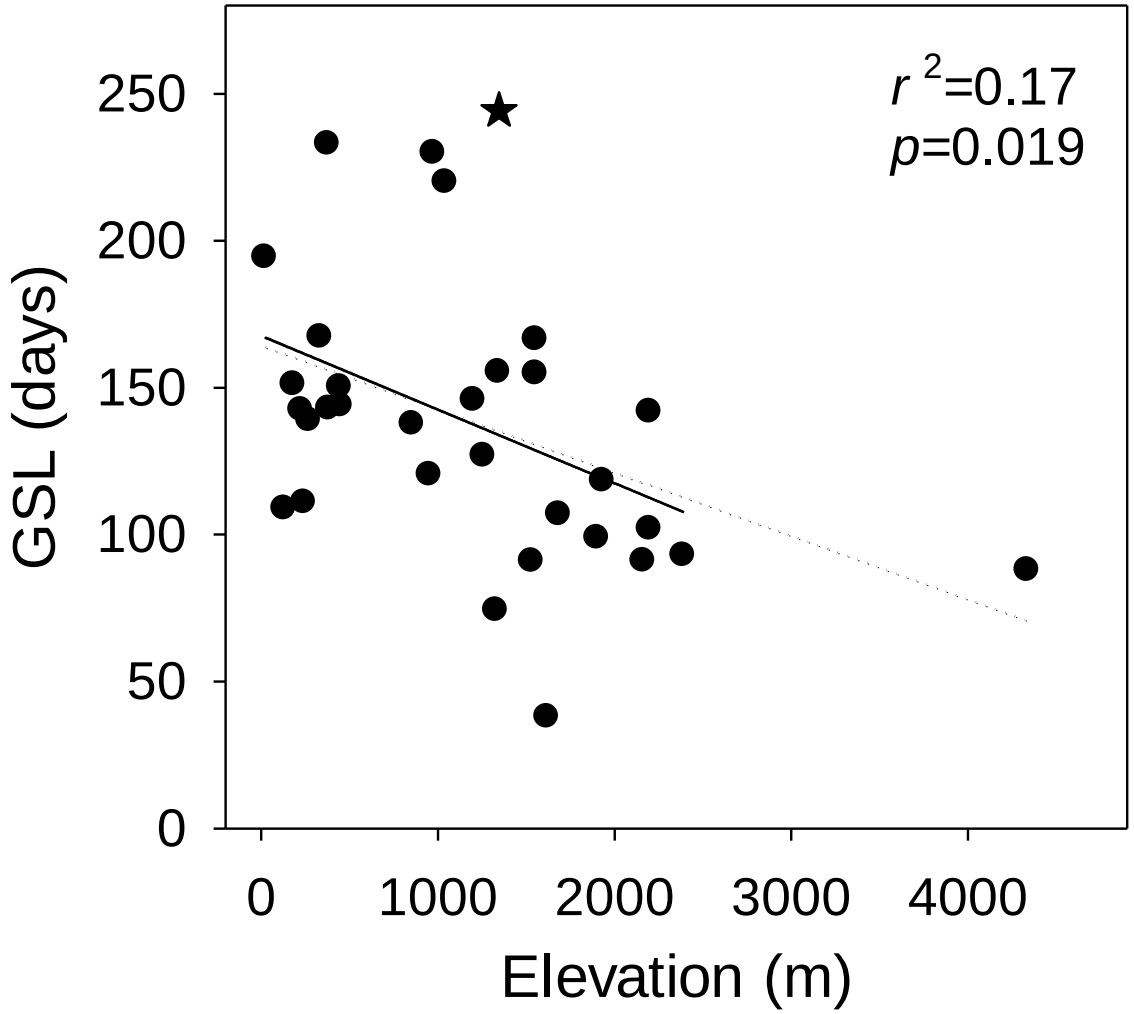


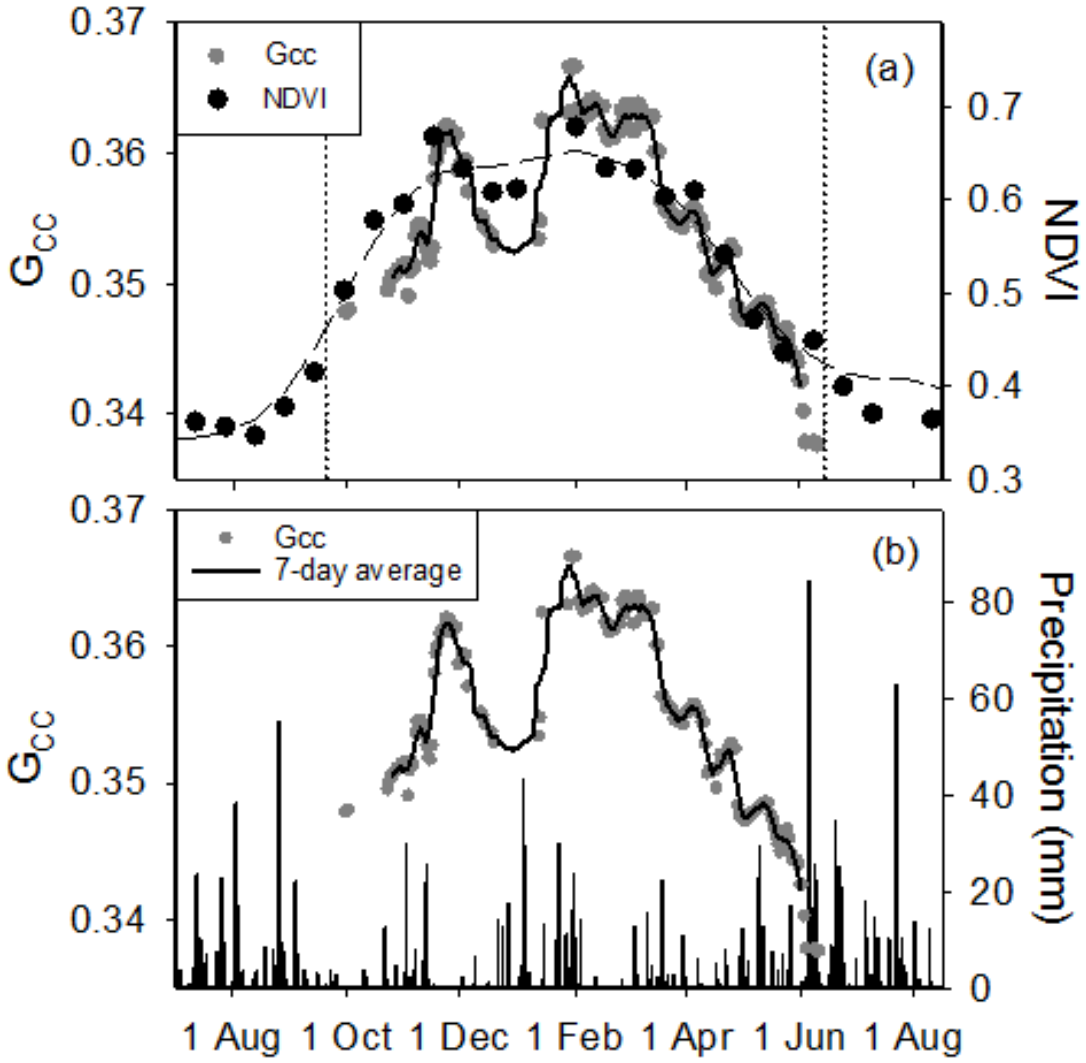




Hufkens *et al*. (2016) Nature Clim Chang

Nimmo has a longer growing season than other high-elevation northern grasslands





PhenoCam highlights the importance of rainfall during the growing season

Summary and Future Work

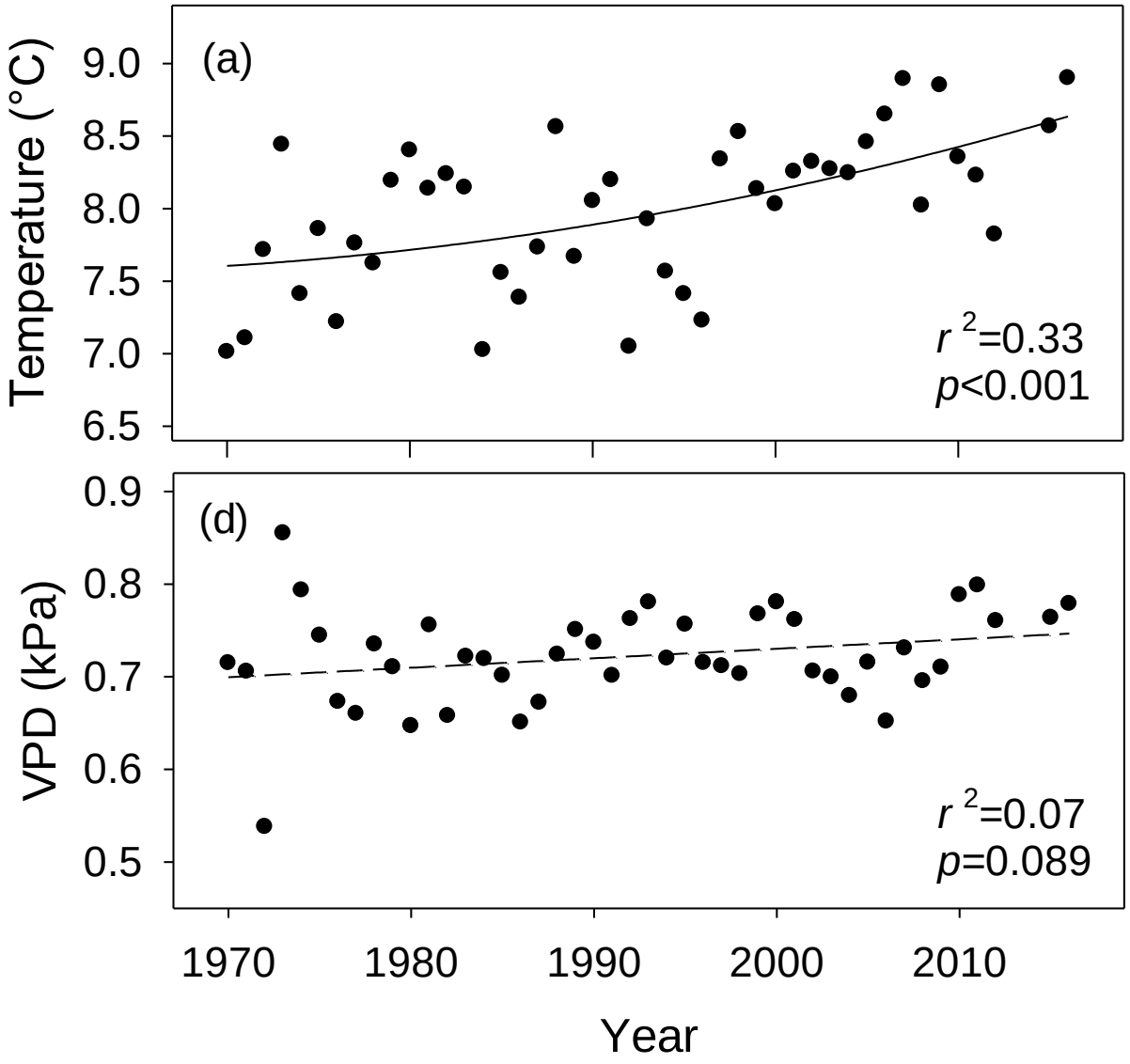
- Warming will likely increase carbon uptake of mountain grasslands in Australia, provided growing season precipitation does not decrease in the future
- Australian mountain grasslands function differently than many northern grasslands
- PhenoCams can be used to quantify vegetation dynamics of Australian grasslands
- Future work will examine differences between Nimmo and the cooler site, Dargo

Funding

- Bushfire CRC
- OzFlux, TERN, & NCRIS
- Coolringdon Pastoral Company


Questions?

Recent Climate Change at Nimmo



Climate Change Impacts on Snow in Victoria

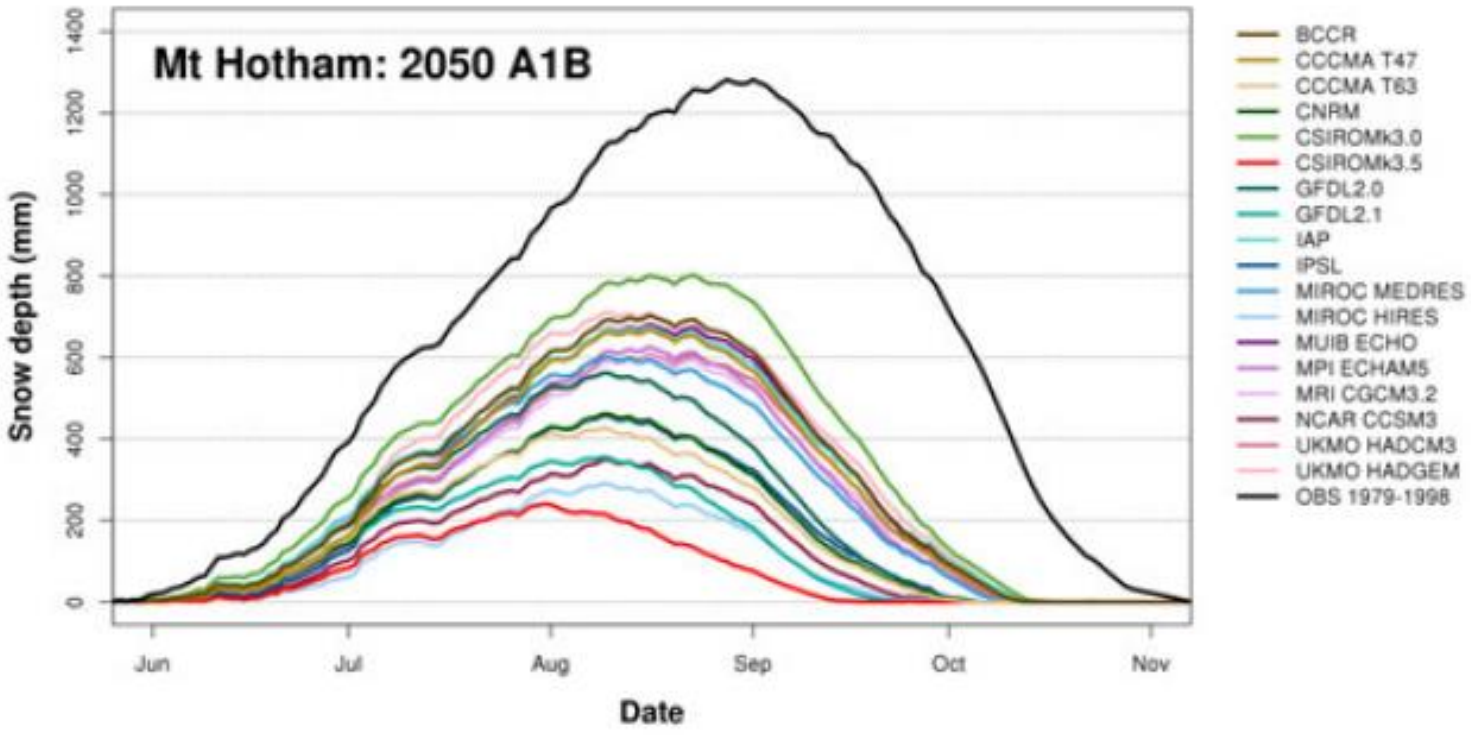
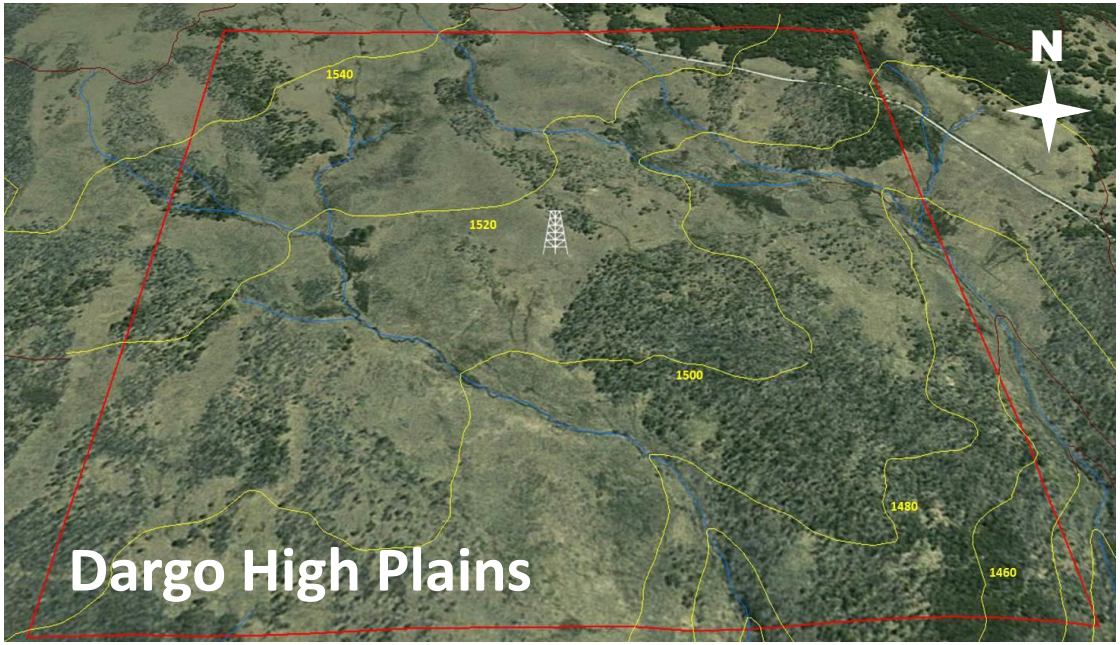


Figure 12: Simulated snow depth profiles for 20-year periods centred on 1990 (black line) and 2050 (coloured lines) for 18 climate models and the medium (A1B) emissions scenario at Falls Creek and Mt Hotham.

Centre for Australian Weather and Climate Research

CSIRO

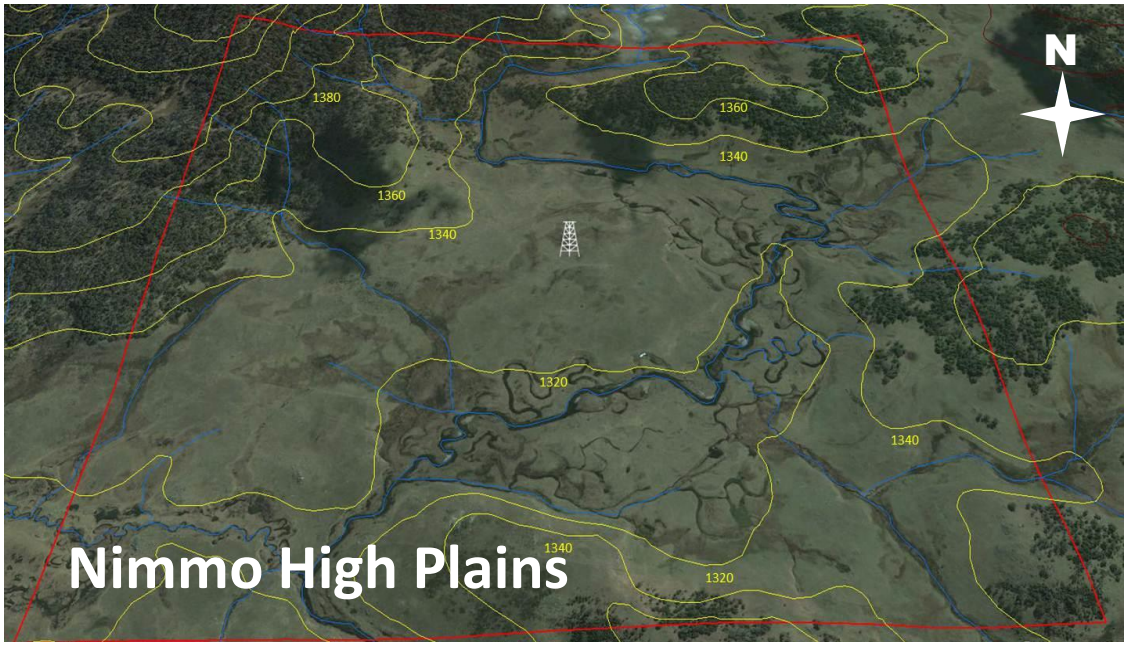
Australian Government
Bureau of Meteorology



Local Topography

The Dargo site is on a relatively flat plain, and the tower is located near snow gum woodlands.

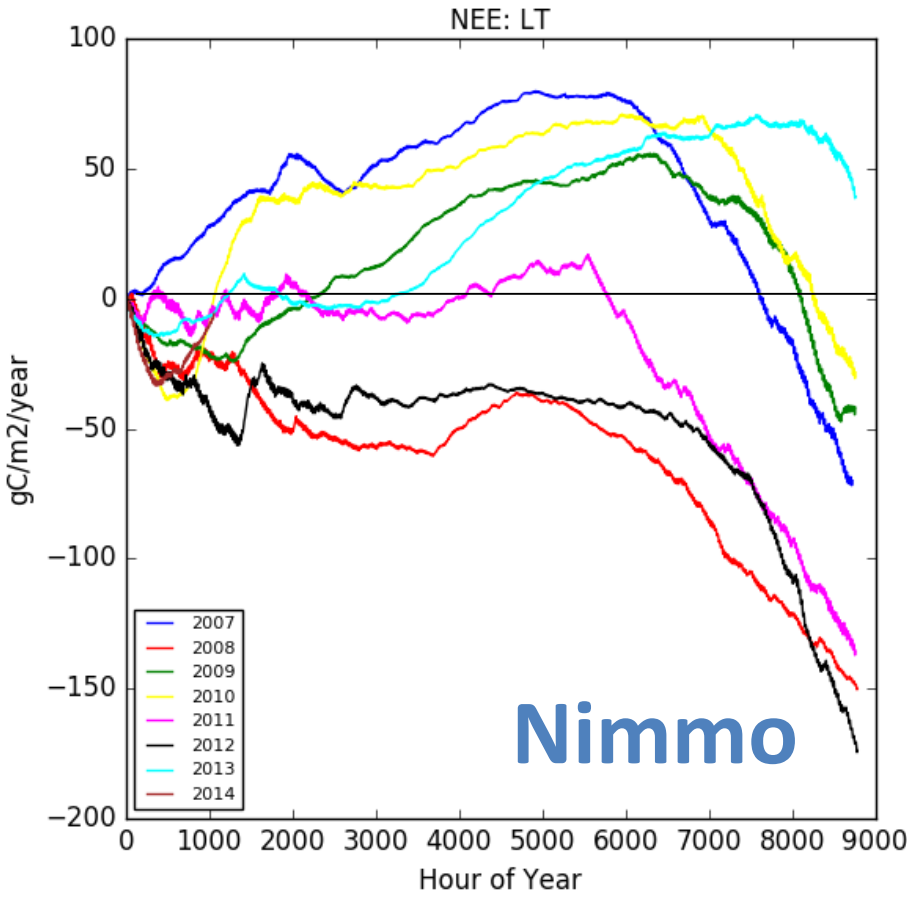
The Nimmo site is located on a river valley floor, with stable atmospheric surface conditions frequently occurring at night.



I. McHugh (2016)
Ph.D. dissertation,
Monash University

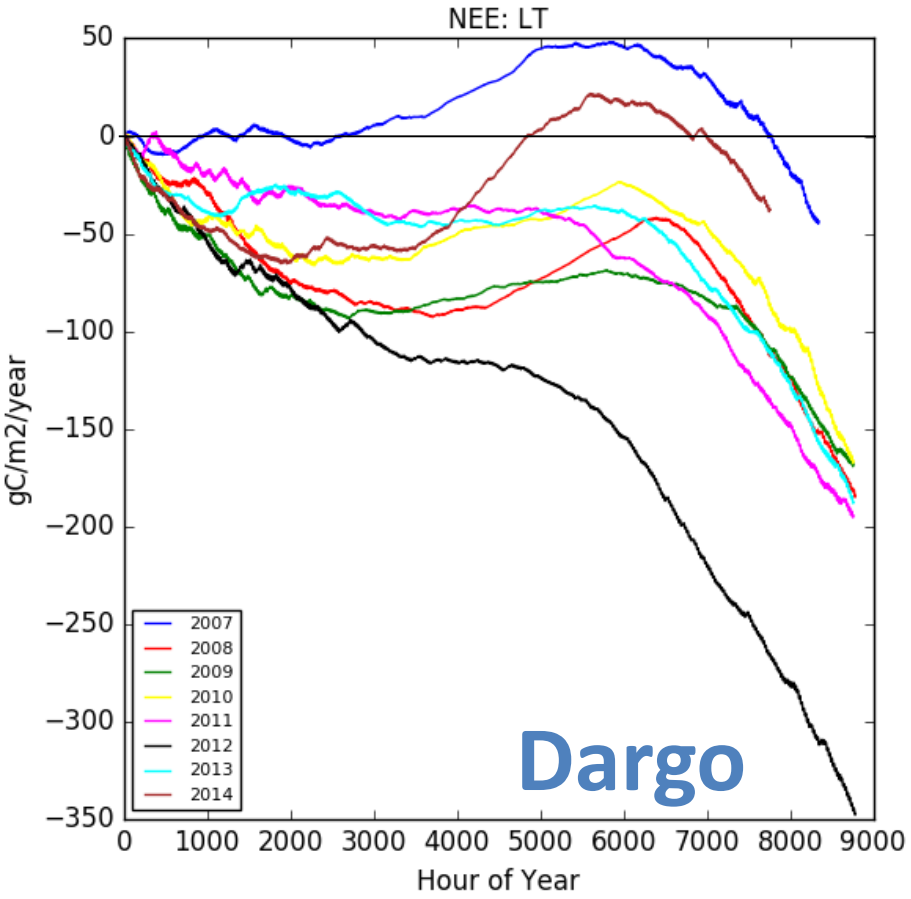
Dargo High Plains, Victoria

Photo by: T. Salter

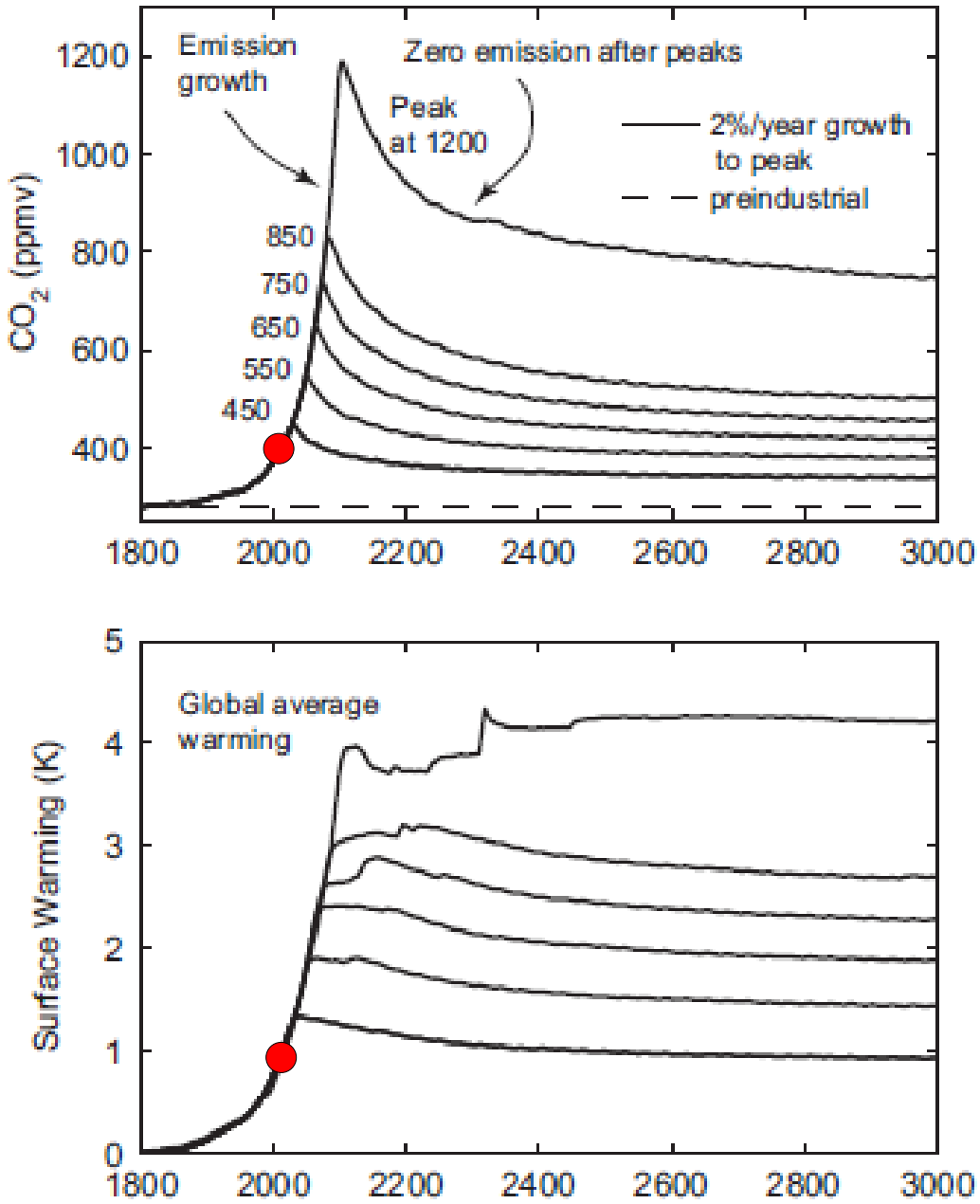


CO_2 release

CO_2 uptake

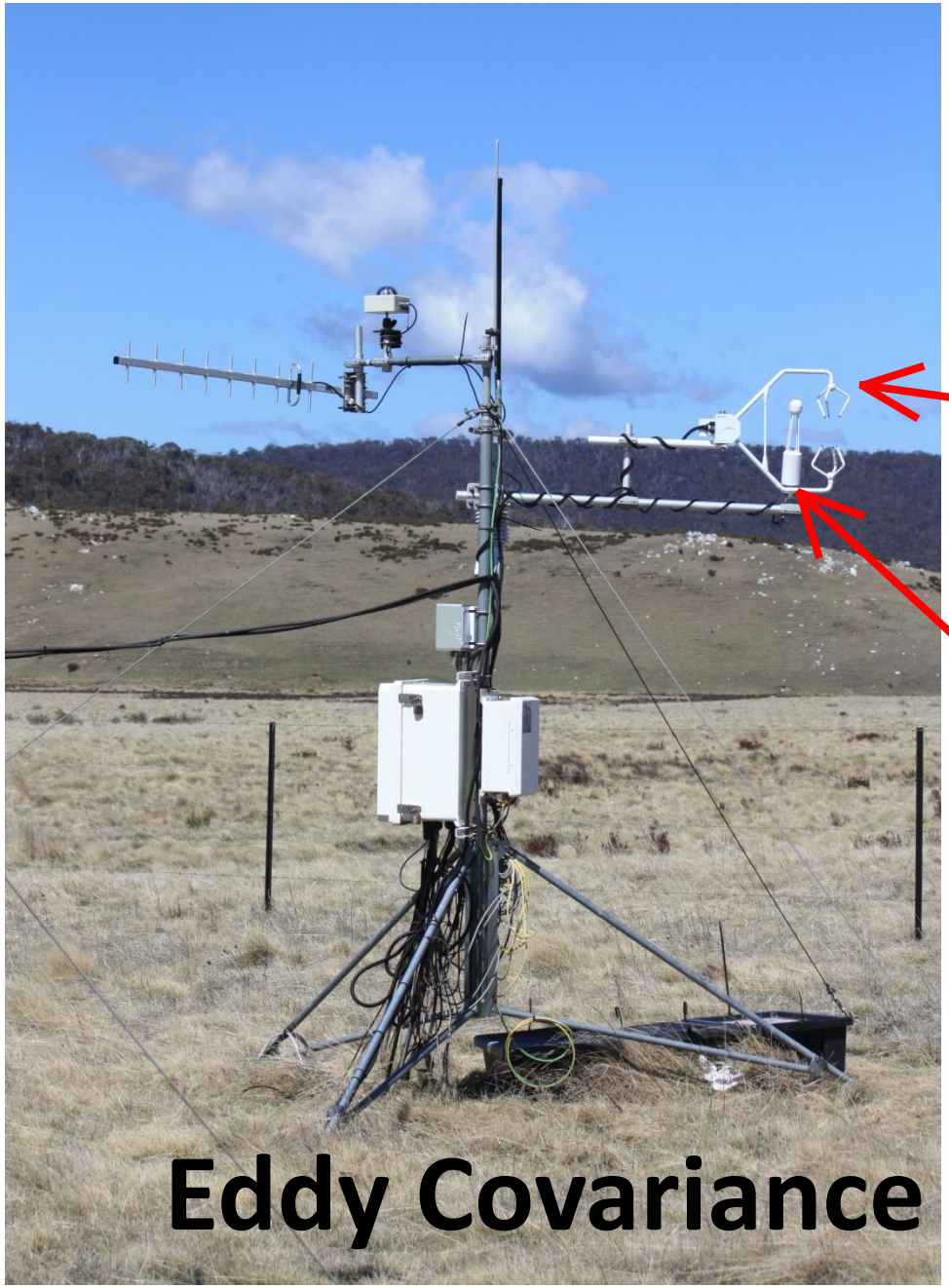


Carbon fluxes from 2007-2014



Climate change due to CO_2 emissions is irreversible for at least 1000 years

Solomon *et al*. (2009) PNAS



These long-term sites were established in 2007 and are still collecting data.

3D Sonic anemometer
(CSAT3)

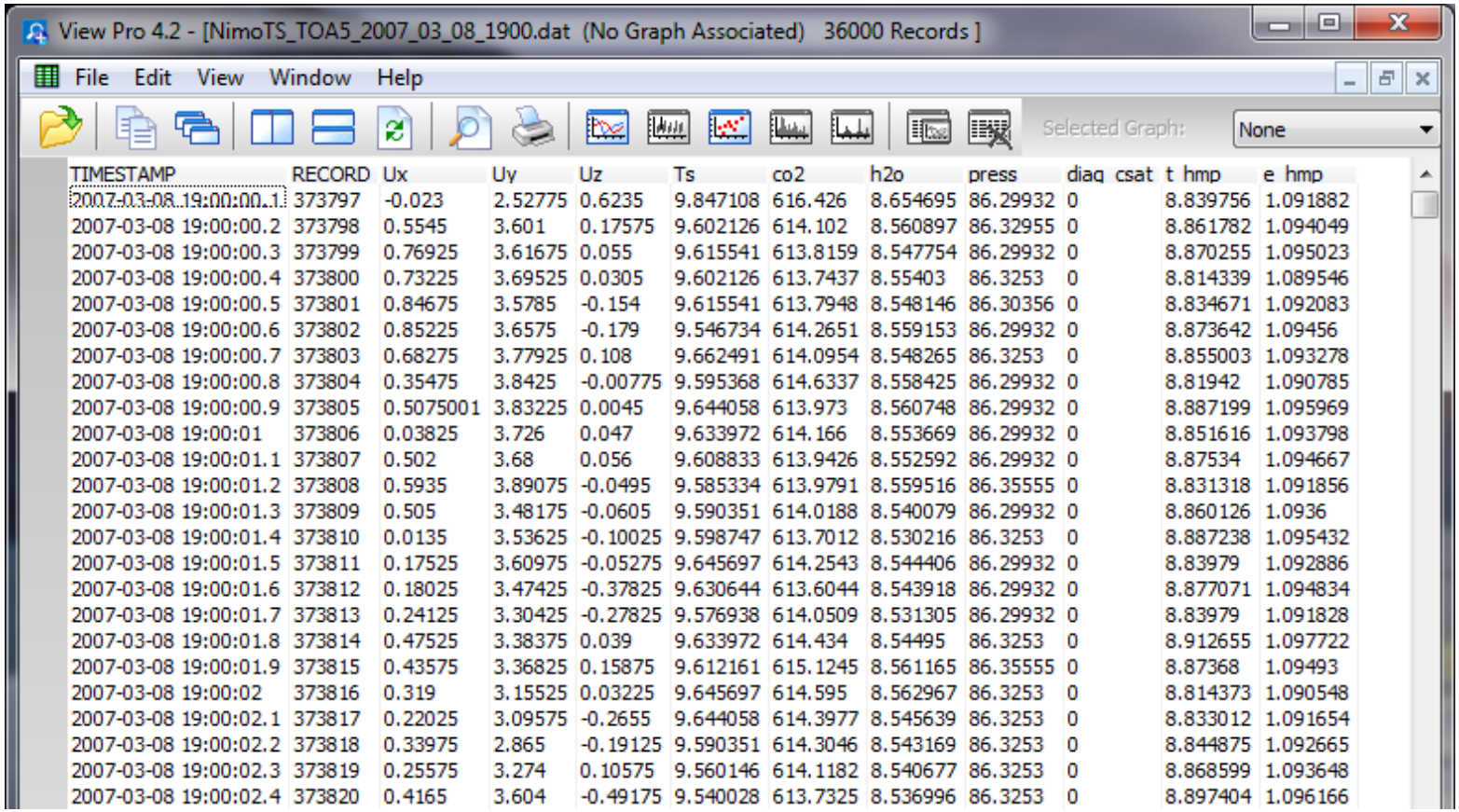
Open-path infrared gas analyzer
(LI-7500)

Eddy Covariance Instrumentation

Field Data Collection

Raw 10-Hz Eddy Covariance Time Series

Flux data is collected 10 times per second and later converted to half-hourly averages for analysis.



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2007-03-08 19:00:00.2	373798	0.5545	3.601	0.17575	9.602126	614.102	8.560897	86.32955	0	8.861782	1.094049
2007-03-08 19:00:00.3	373799	0.76925	3.61675	0.055	9.615541	613.8159	8.547754	86.29932	0	8.870255	1.095023
2007-03-08 19:00:00.4	373800	0.73225	3.69525	0.0305	9.602126	613.7437	8.55403	86.3253	0	8.814339	1.089546
2007-03-08 19:00:00.5	373801	0.84675	3.5785	-0.154	9.615541	613.7948	8.548146	86.30356	0	8.834671	1.092083
2007-03-08 19:00:00.6	373802	0.85225	3.6575	-0.179	9.546734	614.2651	8.559153	86.29932	0	8.873642	1.09456
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2007-03-08 19:00:00.8	373804	0.35475	3.8425	-0.00775	9.595368	614.6337	8.558425	86.29932	0	8.81942	1.090785
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2007-03-08 19:00:01	373806	0.03825	3.726	0.047	9.633972	614.166	8.553669	86.29932	0	8.851616	1.093798
2007-03-08 19:00:01.1	373807	0.502	3.68	0.056	9.608833	613.9426	8.552592	86.29932	0	8.87534	1.094667
2007-03-08 19:00:01.2	373808	0.5935	3.89075	-0.0495	9.585334	613.9791	8.559516	86.35555	0	8.831318	1.091856
2007-03-08 19:00:01.3	373809	0.505	3.48175	-0.0605	9.590351	614.0188	8.540079	86.29932	0	8.860126	1.0936
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2007-03-08 19:00:01.9	373815	0.43575	3.36825	0.15875	9.612161	615.1245	8.561165	86.35555	0	8.87368	1.09493
2007-03-08 19:00:02	373816	0.319	3.15525	0.03225	9.645697	614.595	8.562967	86.3253	0	8.814373	1.090548
2007-03-08 19:00:02.1	373817	0.22025	3.09575	-0.2655	9.644058	614.3977	8.545639	86.3253	0	8.833012	1.091654
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Post-processing of data

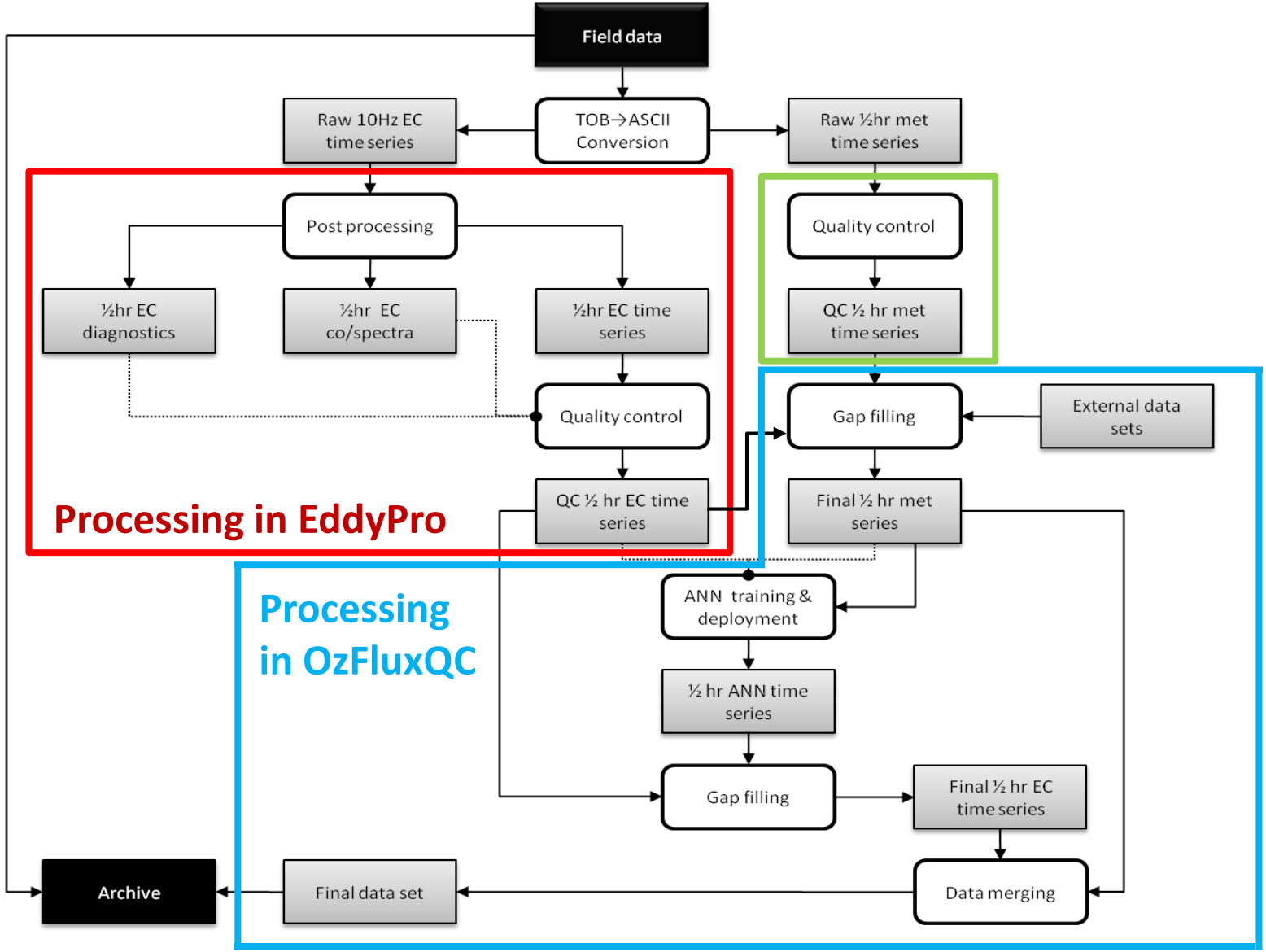
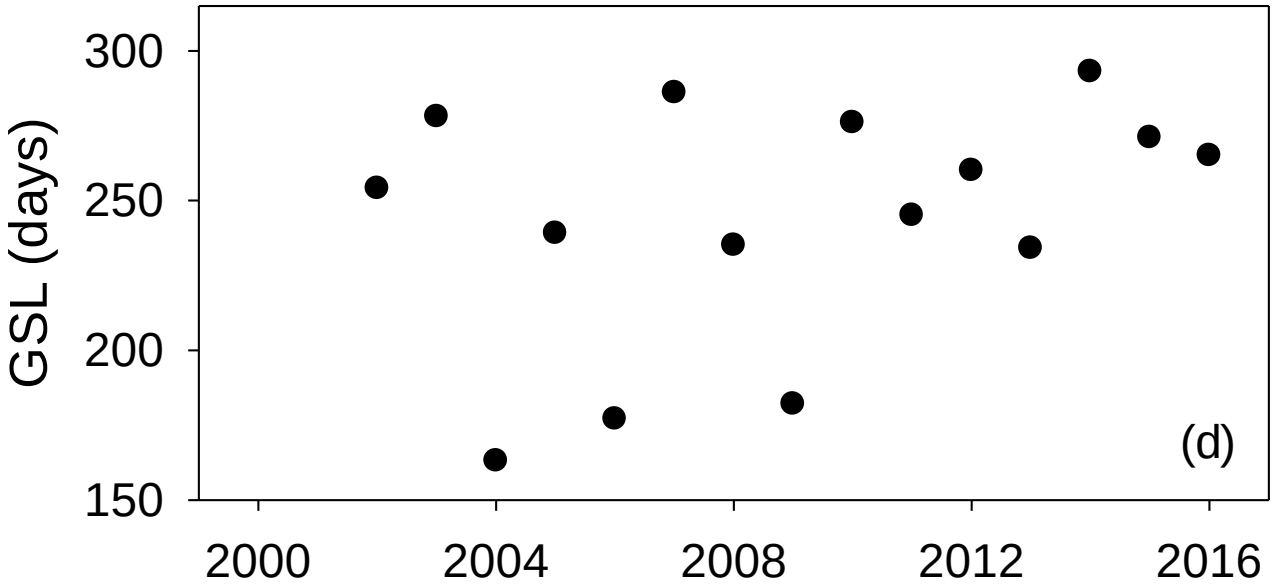
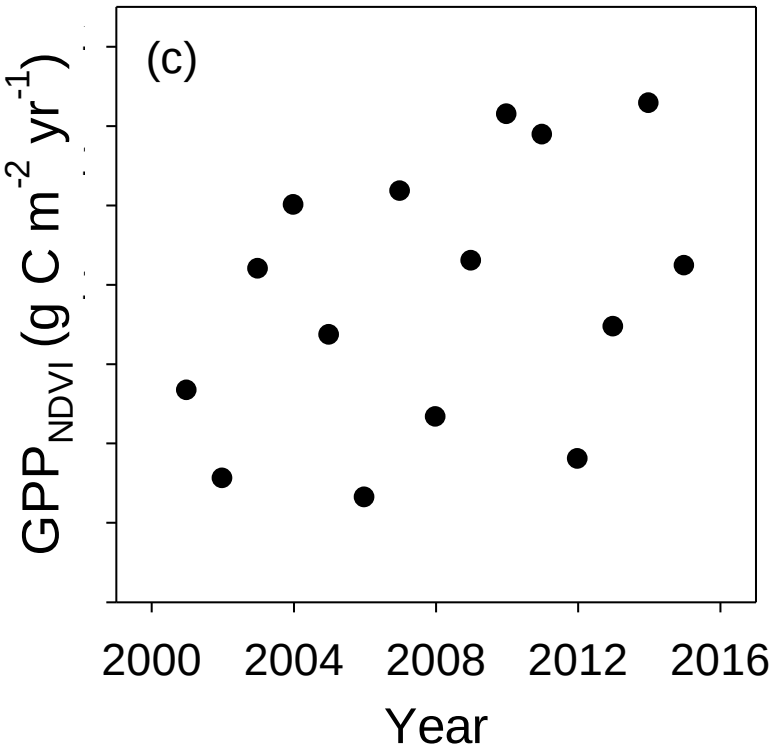


Figure by: I. McHugh


GSL (days)
300
250
200
150
2000
2004
2008
2012
2016
(d)


(c)
GPP NDVI (g C m-2 yr-1)
2000
2004
2008
2012
2016
Year