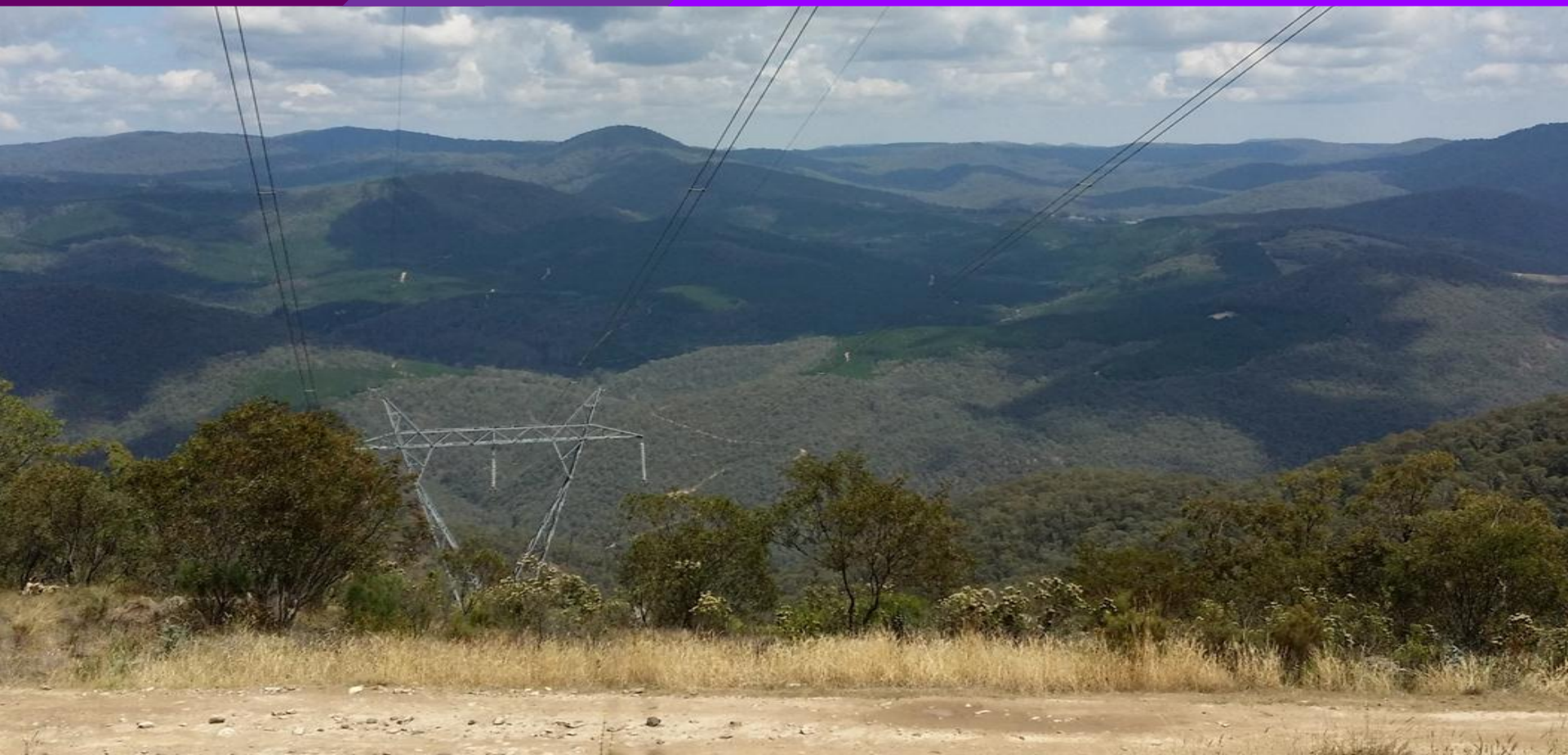
Monitoring winds over complex terrain with a PAWS anemometer array

Rachael Griffiths
PhD Candidate
Email: rachael.griffiths@student.adfa.edu.au
Supervisors: A/Prof Jason Sharples, Dr Leesa Sidhu, Prof. Graham Thorpe (BNHCRC)

Never Stand Still | UNSW Canberra | School of Physical, Environmental and Mathematical Sciences

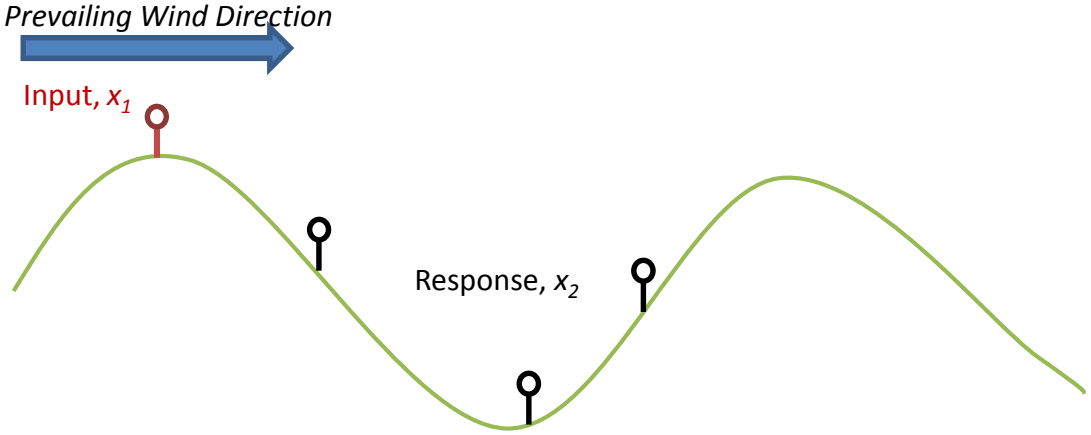


Research Aims

Characterising Wind Response

Never Stand Still | UNSW Canberra | School of Physical, Environmental and Mathematical Sciences

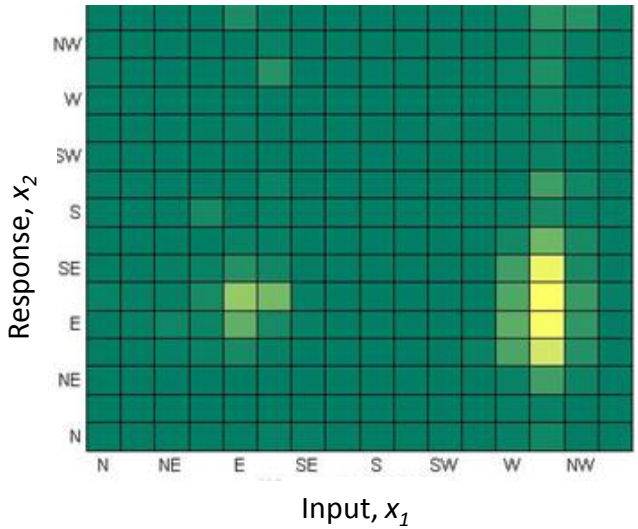
PhD Research: *Spatial-statistical characterisation of wind fields over complex terrain for bushfire modelling applications*

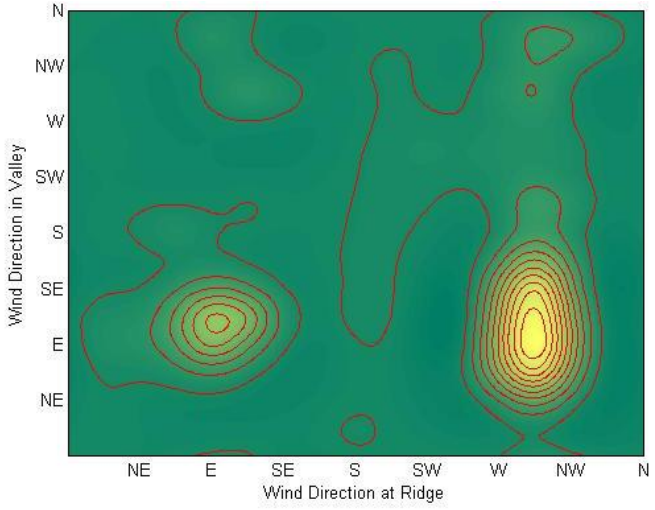


$$Y(X_j) = m(X_j) + \varepsilon(X_j)$$

$$X_j = (x_1, x_2)$$

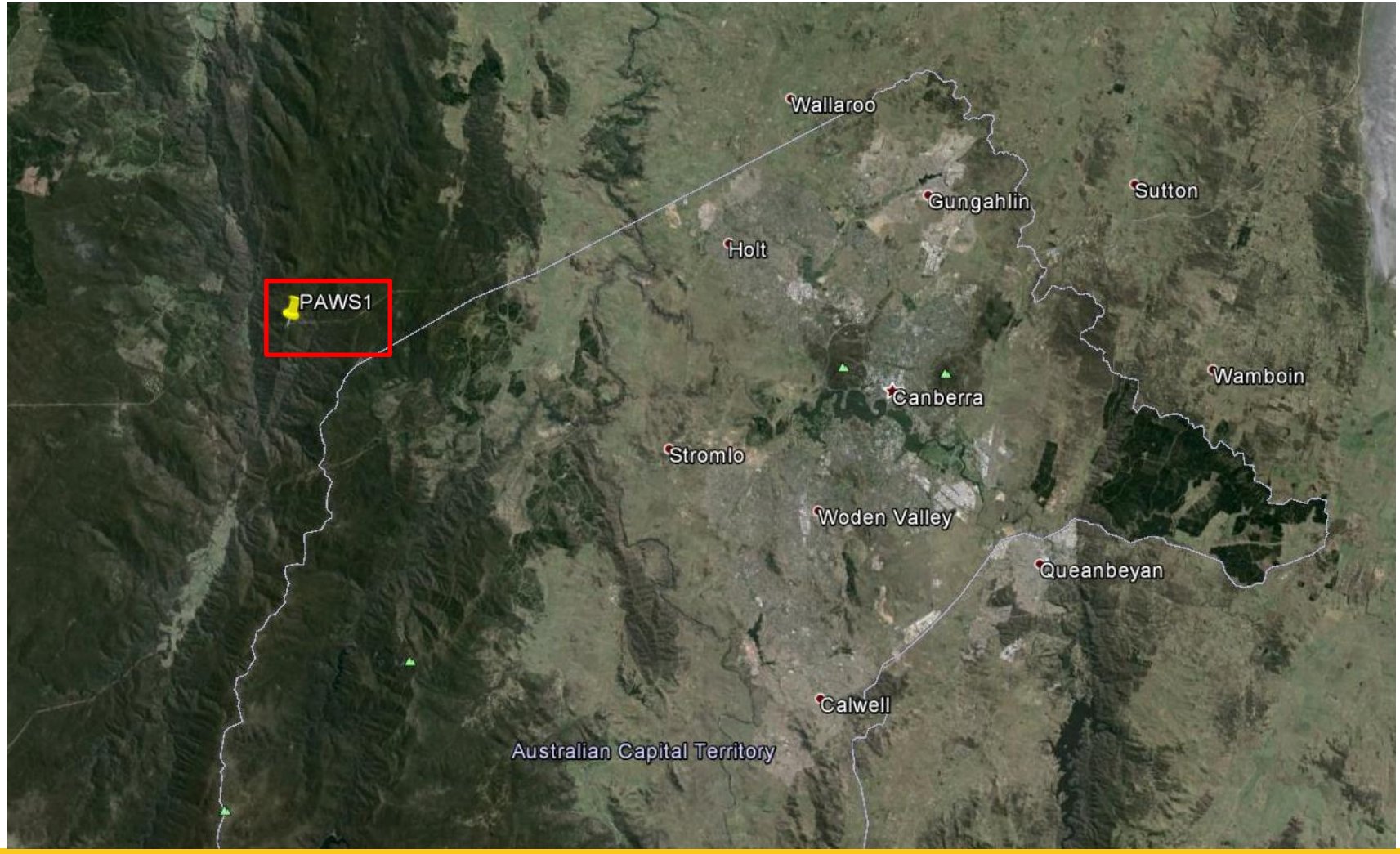
$$x_1, x_2 \in (0^\circ, 360^\circ]$$





Flea Creek Valley

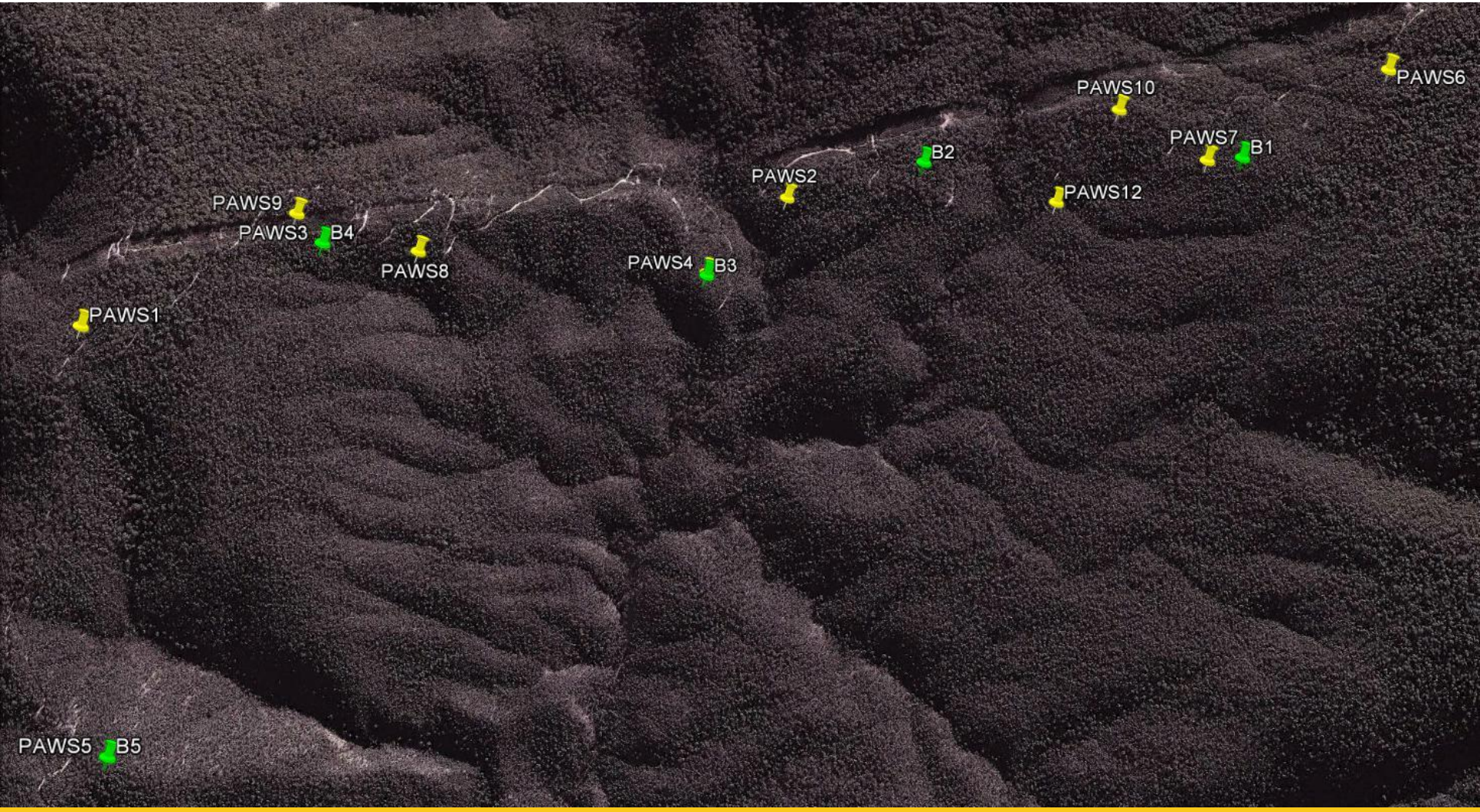
Brindabella National Park, NSW



Flea Creek Valley

Brindabella National Park, NSW

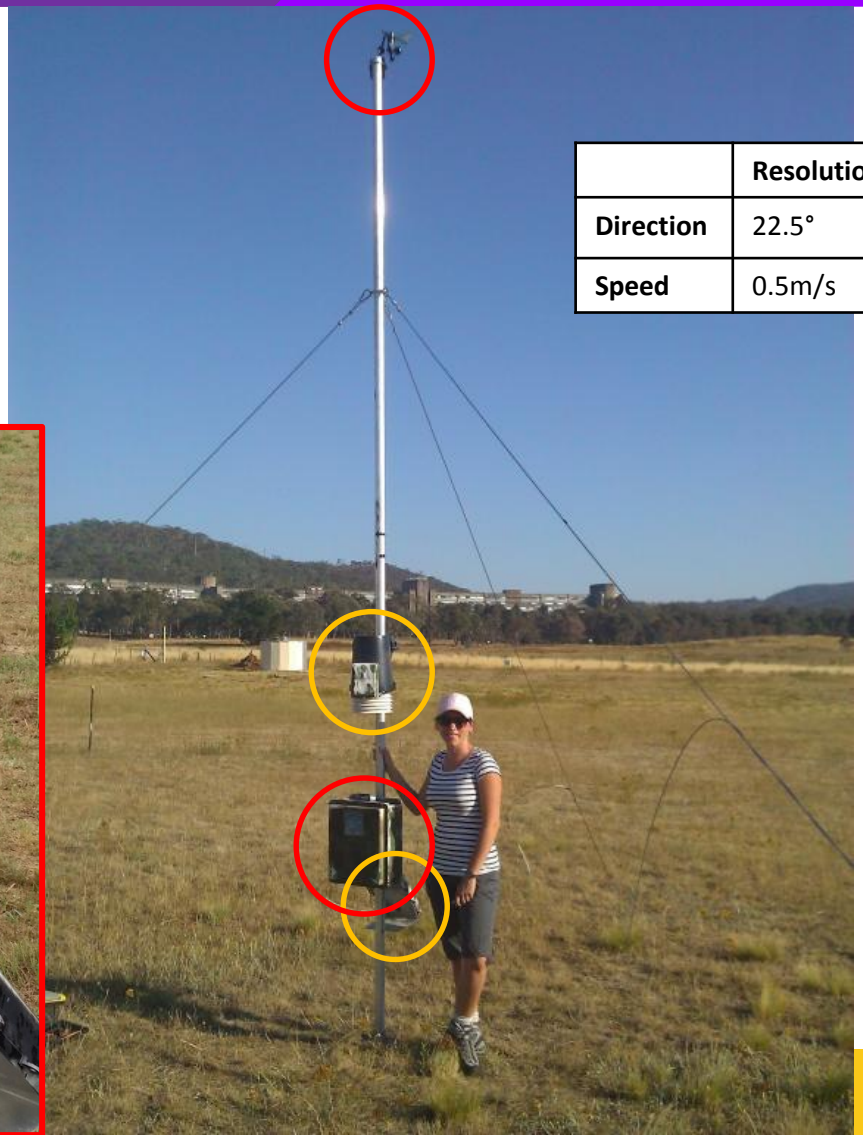
Never Stand Still | UNSW Canberra | School of Physical, Environmental and Mathematical Sciences



Portable Automatic Weather Stations (PAWS)

Davis Vantage Pro 2

Never Stand Still | UNSW Canberra | School of Physical, Environmental and Mathematical Sciences



Anemometer at 5m

	Resolution	Range	Accuracy
Direction	22.5°	16 compass pts	0.3 compass pt
Speed	0.5m/s	1 to 68 m/s	1 m/s

Console Box

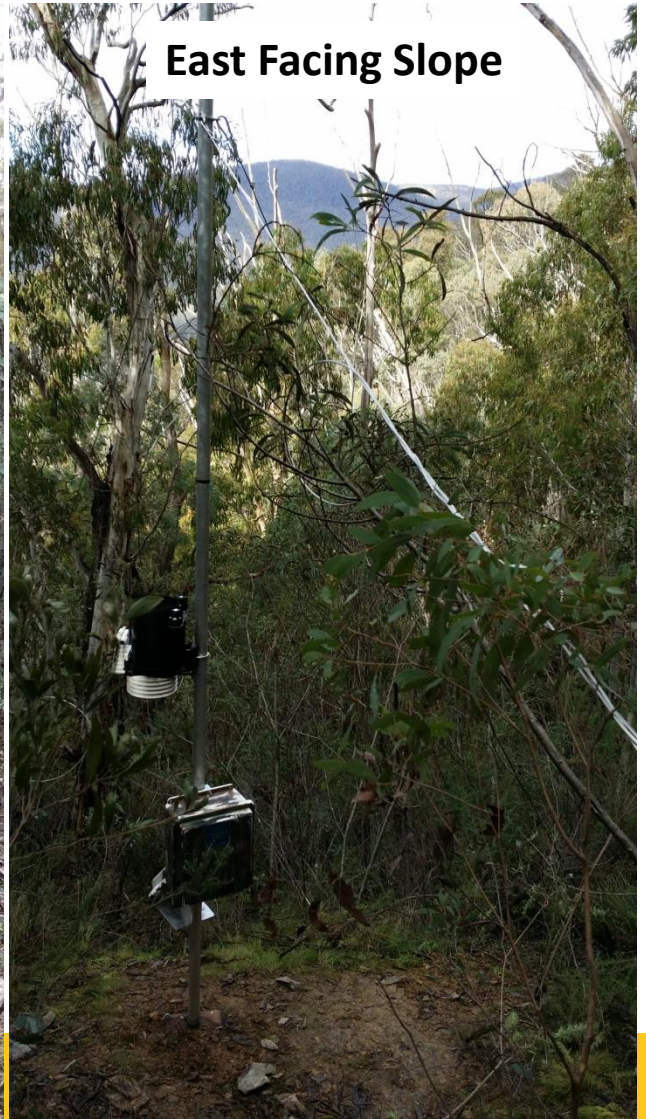
Sensor Array at 2m: Rainfall, Temperature, Relative Humidity, Solar Radiation, UV

Solar Panel for power recharge

Portable Automatic Weather Stations (PAWS)

Davis Vantage Pro 2

Never Stand Still | UNSW Canberra | School of Physical, Environmental and Mathematical Sciences



Portable Automatic Weather Stations (PAWS)

Davis Vantage Pro 2

Console, with data logger

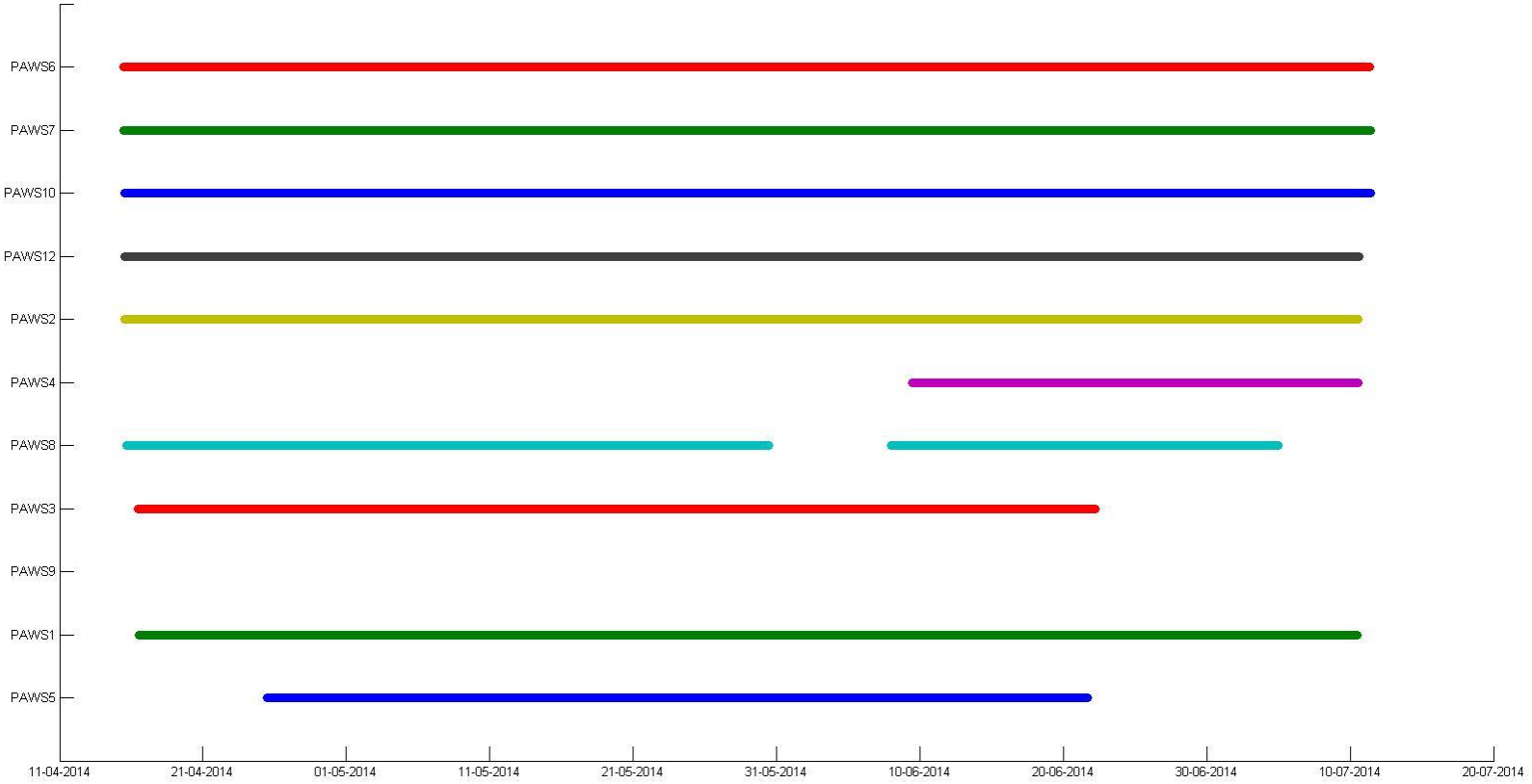
Battery, with Solar recharge

USB connection from Console to Laptop, using Weatherlink software.

Autumn 2014

30 Minute Data from April to July

Never Stand Still | UNSW Canberra | School of Physical, Environmental and Mathematical Sciences

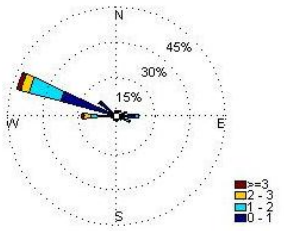


Autumn 2014

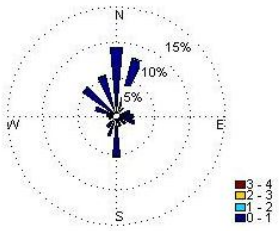
30 Minute Data from April to July

Never Stand Still | UNSW Canberra | School of Physical, Environmental and Mathematical Sciences

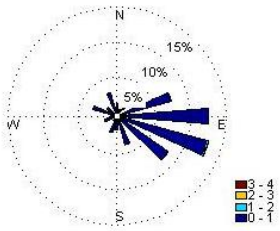
PAWS1



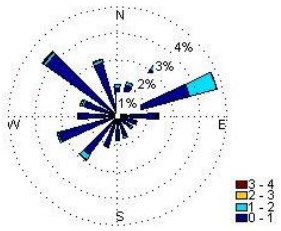
PAWS2



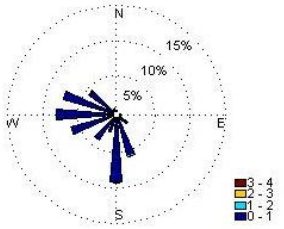
PAWS3



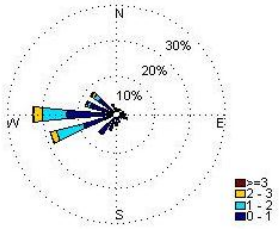
PAWS4



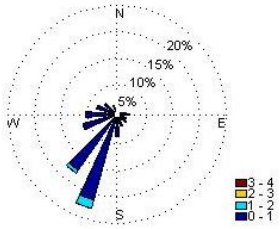
PAWS5



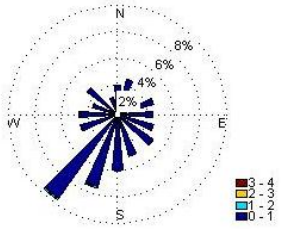
PAWS6



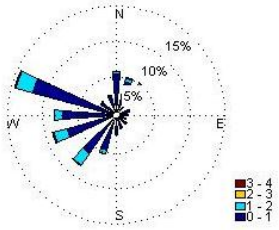
PAWS7



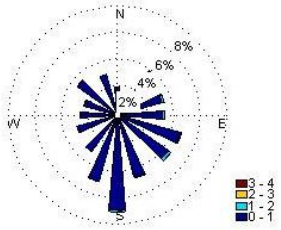
PAWS8



PAWS10



PAWS12

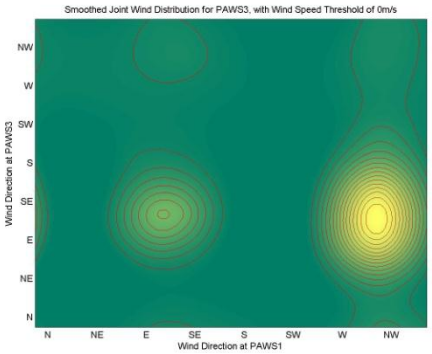


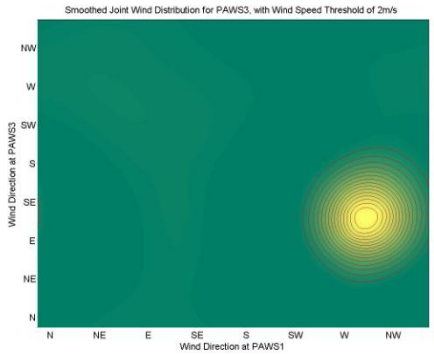
Autumn 2014

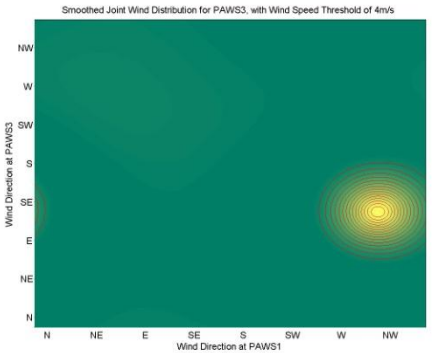
30 Minute Data from April to July

Never Stand Still | UNSW Canberra | School of Physical, Environmental and Mathematical Sciences

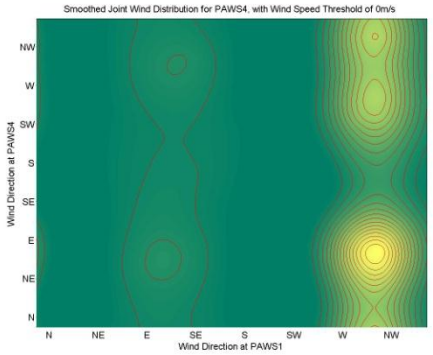
East-Facing Valley Wall

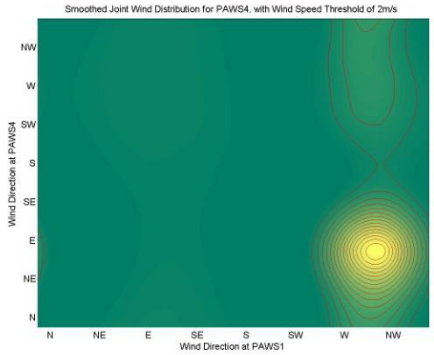


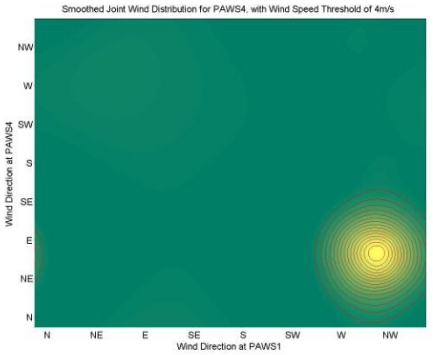




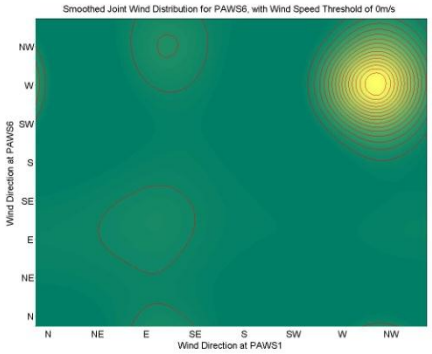
Valley Floor

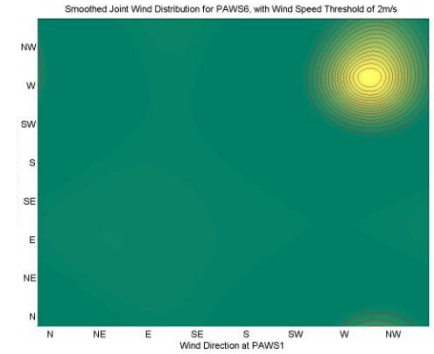


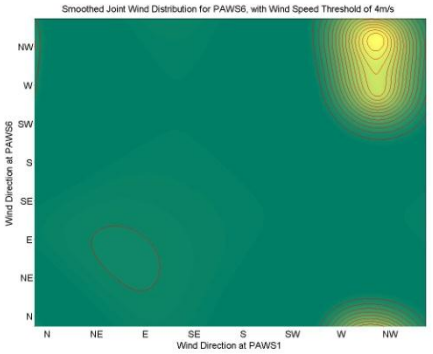




West-Facing Valley Wall



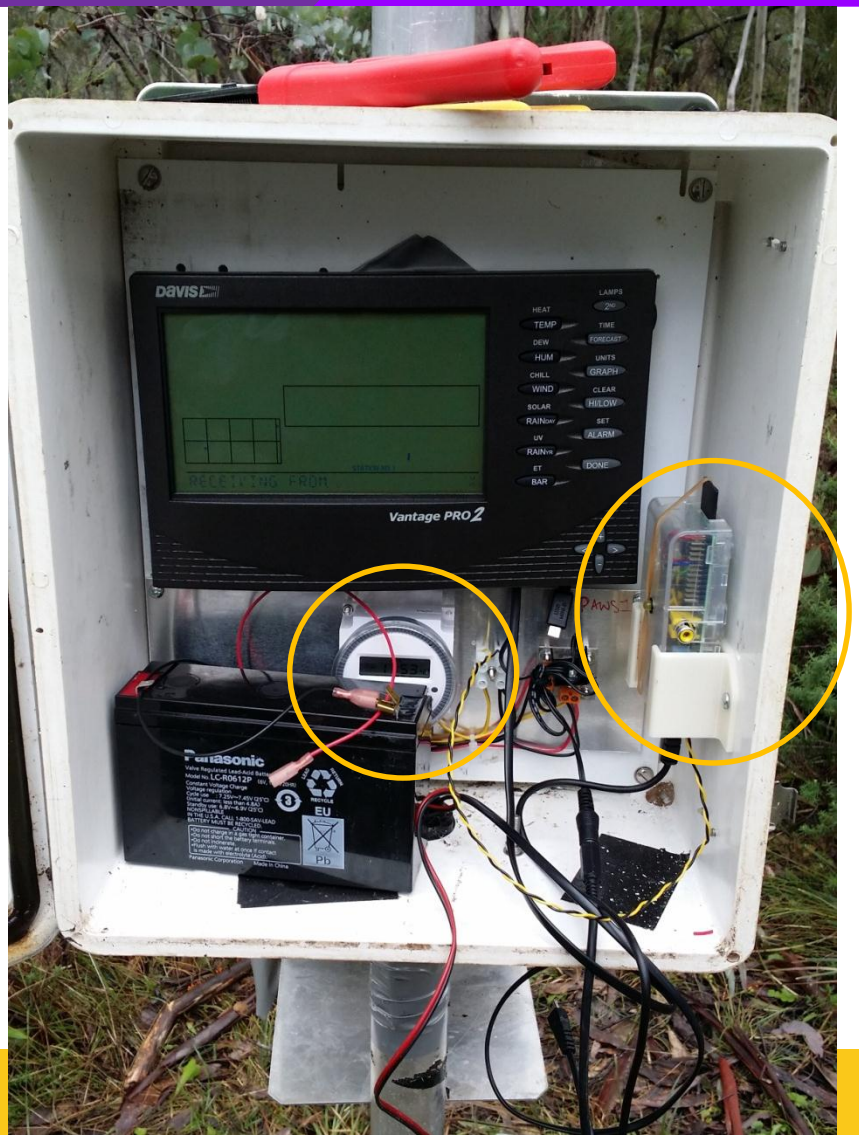




Portable Automatic Weather Stations (PAWS)

Davis Vantage Pro 2 with Raspberry Pi

Data logger has <u>128kb</u> non-volatile memory



Timer

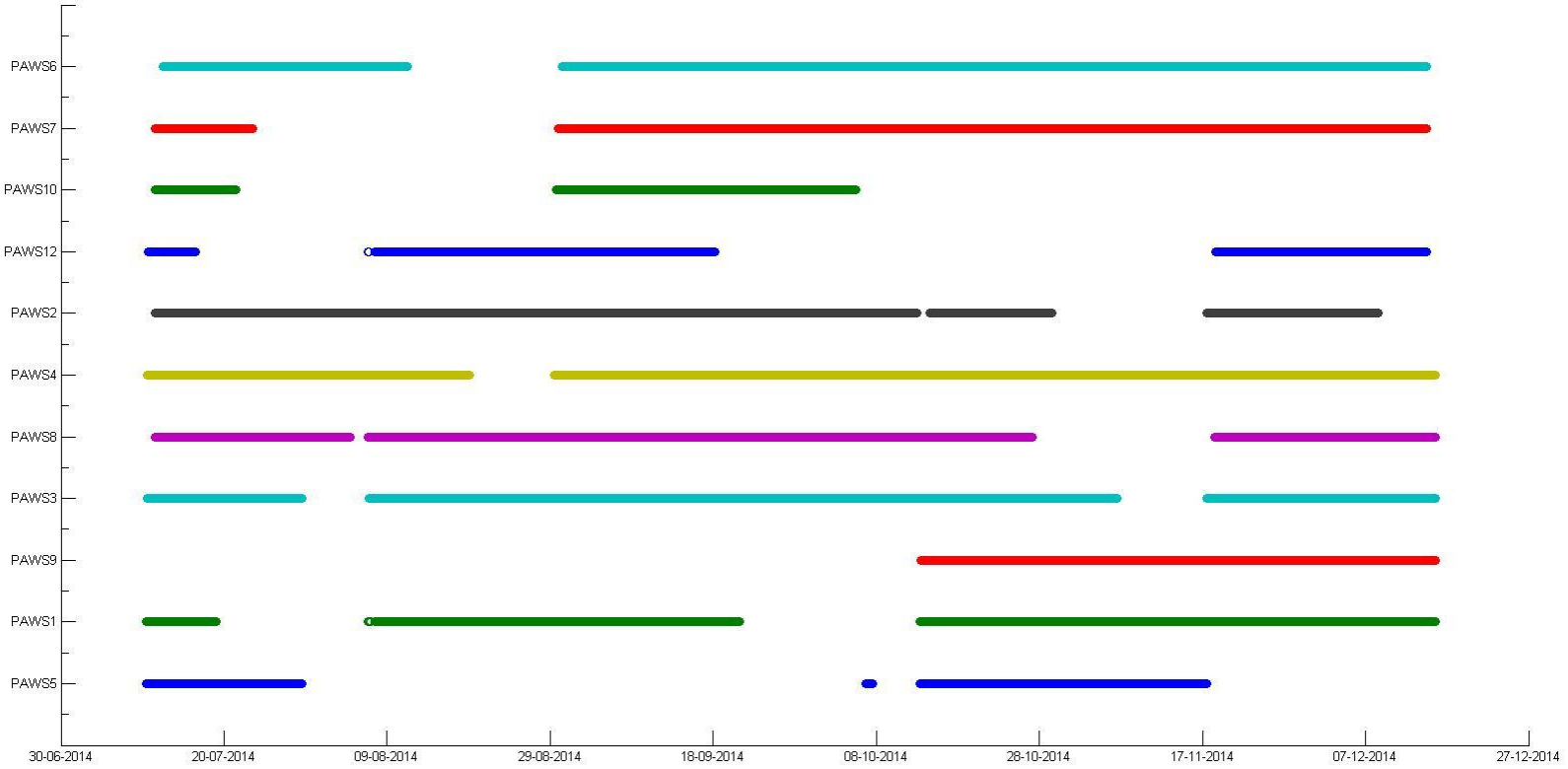
Raspberry Pi micro-computer with SD Card

Extra batteries needed for some stations

Winter-Spring 2014

1 Minute Data from July to December

Never Stand Still | UNSW Canberra | School of Physical, Environmental and Mathematical Sciences

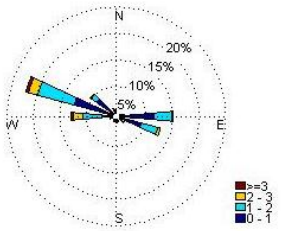


Winter-Spring 2014

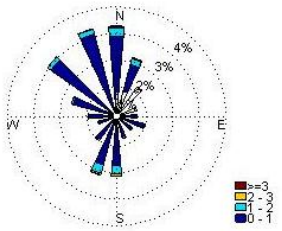
1 Minute Data from July to December

Never Stand Still | UNSW Canberra | School of Physical, Environmental and Mathematical Sciences

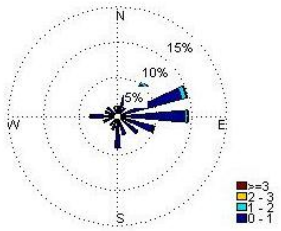
PAWS1



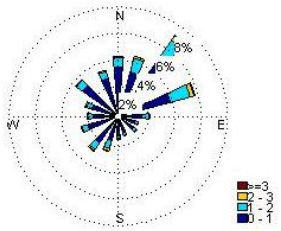
PAWS2



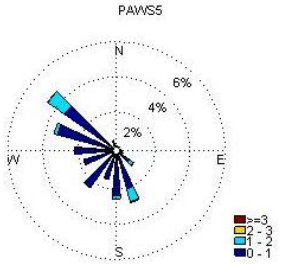
PAWS3



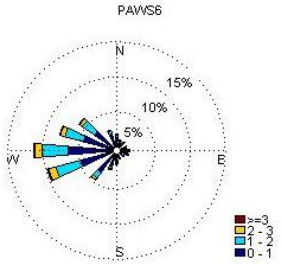
PAWS4



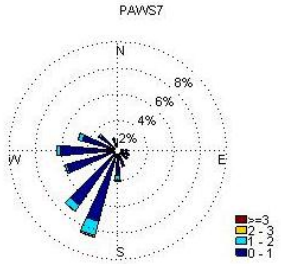
PAWS5



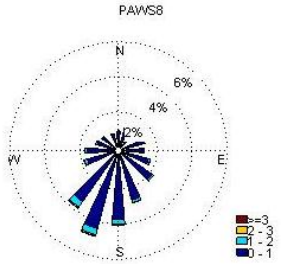
PAWS6



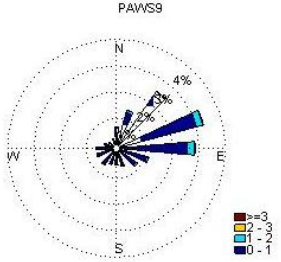
PAWS7



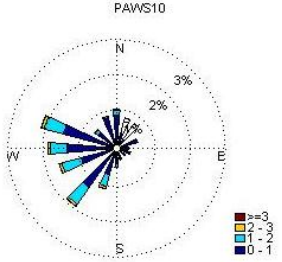
PAWS8



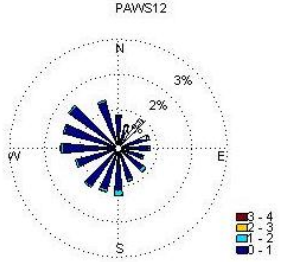
PAWS9



PAWS10



PAWS12

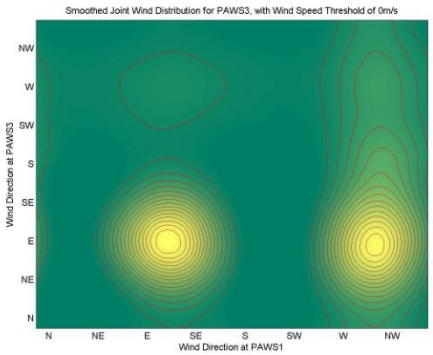


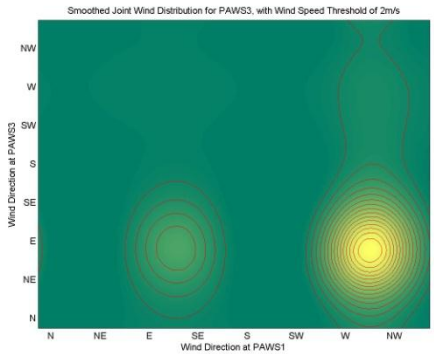
Winter-Spring 2014

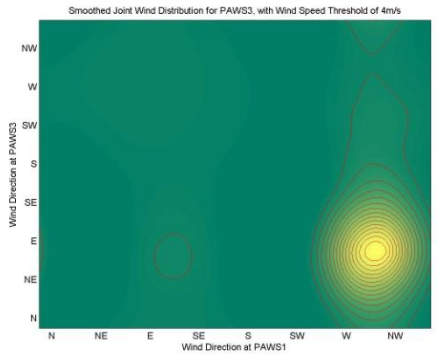
1 Minute Data from July to December

Never Stand Still | UNSW Canberra | School of Physical, Environmental and Mathematical Sciences

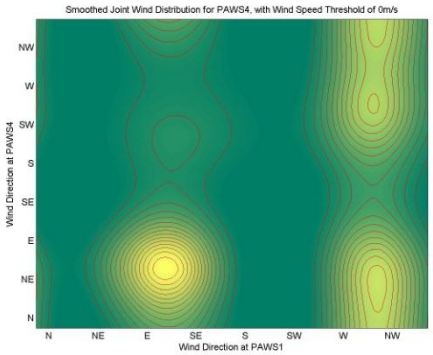
East-Facing Valley Wall

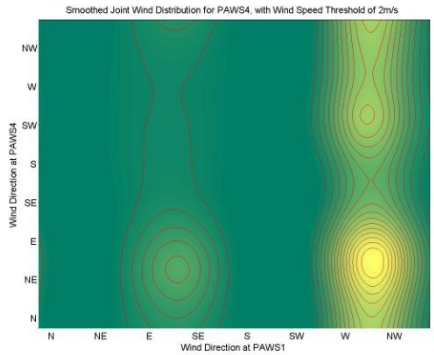


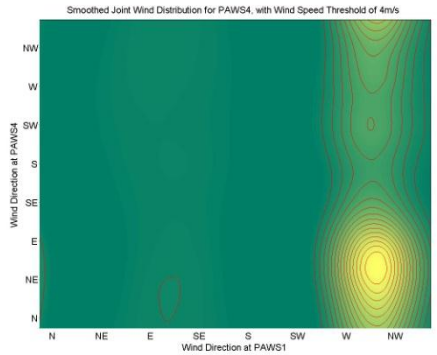




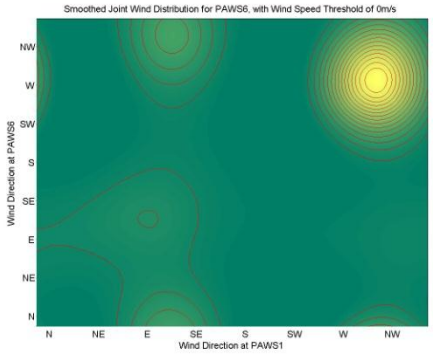
Valley Floor

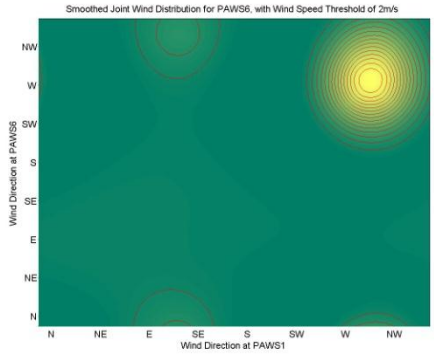


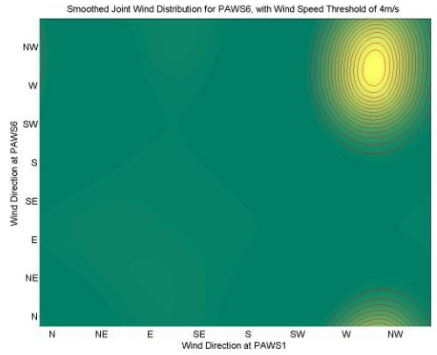




West-Facing Valley Wall





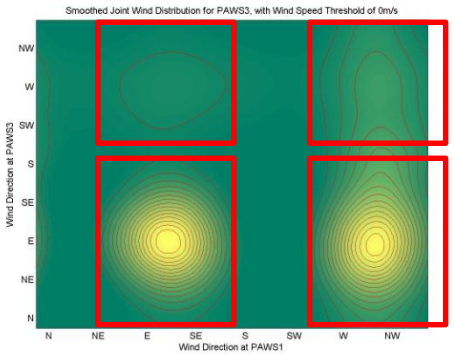


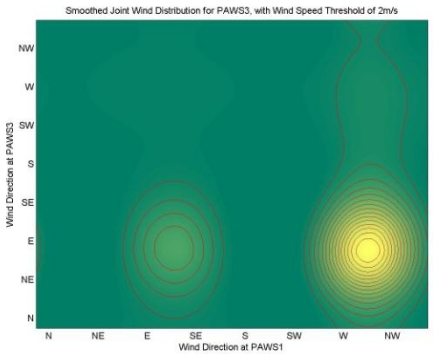
Winter-Spring 2014

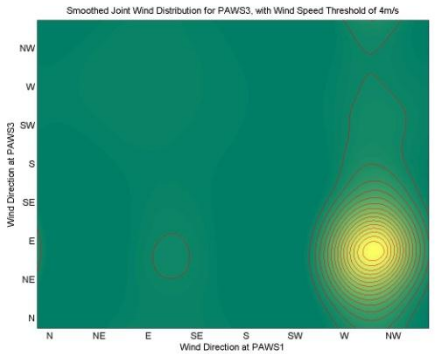
1 Minute Data from July to December

Never Stand Still | UNSW Canberra | School of Physical, Environmental and Mathematical Sciences

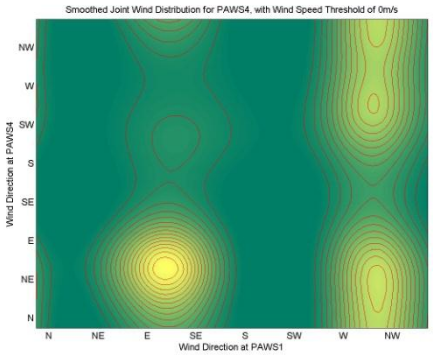
East-Facing Valley Wall

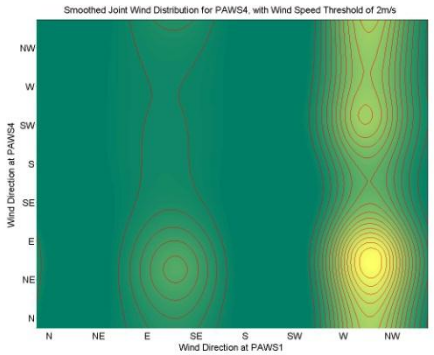


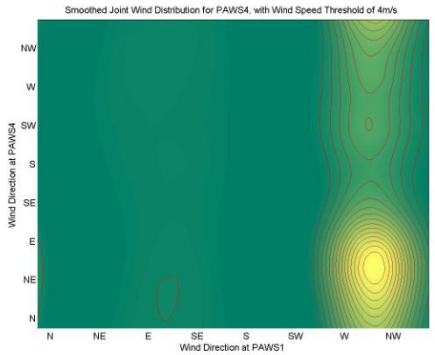




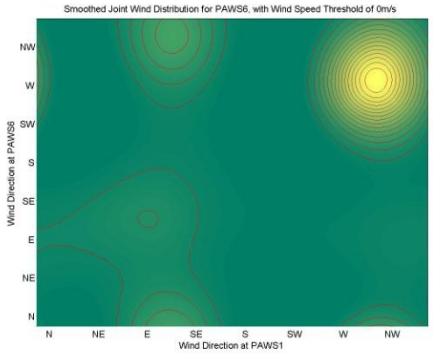
Valley Floor

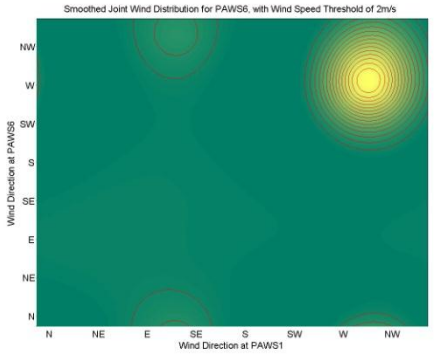


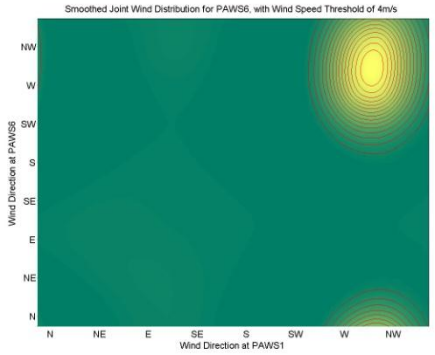




West-Facing Valley Wall

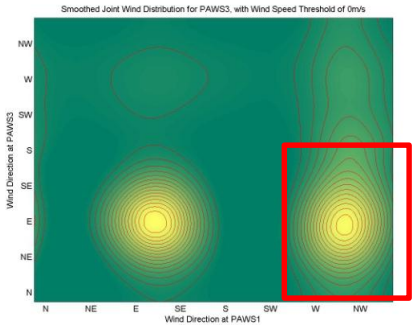


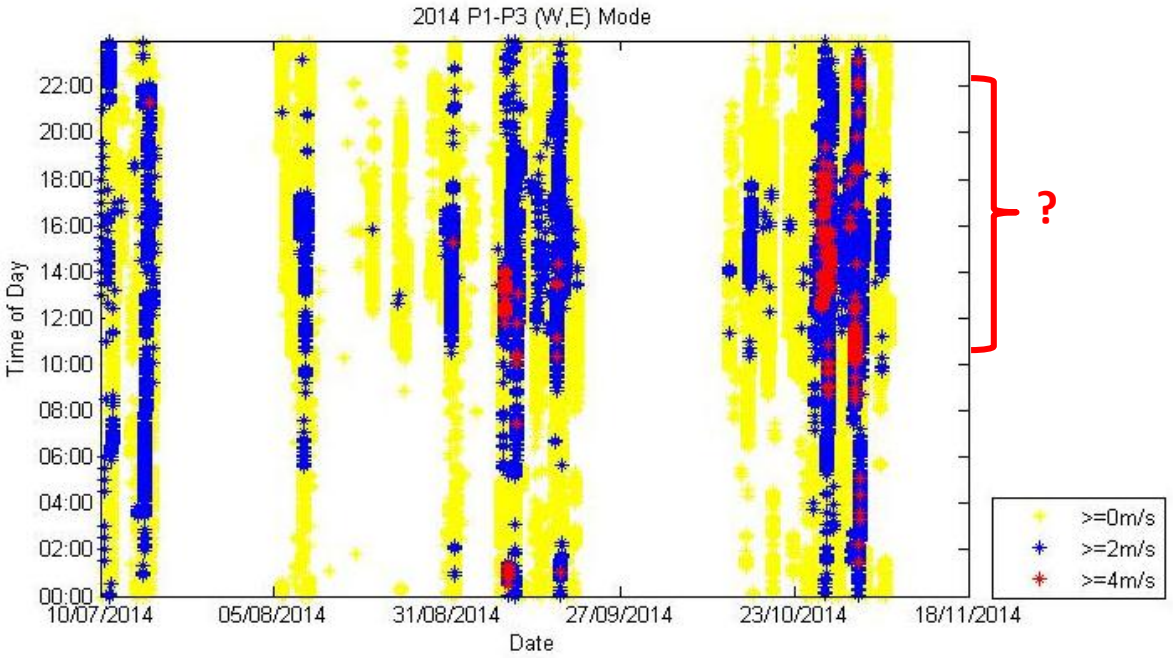




Winter-Spring 2014: 1Minute Data

Modal Timings





Future Directions

Data Analysis

- Time lag on 1 minute interval data
- Modal probabilities
- Analyse specific events
- Analysis of secondary variables
- Modelling wind response distributions

Data Collection

- Improve battery life with RPi
- **Second Location in 2015?**

Acknowledgements

Thanks to **Jason Sharples** and **Leesa Sidhu** for supervision, access to previous work and data, and help with initial deployment.

Thanks also to **Bob Cechet** and **Ben Quill**, as well as **Peter**, **Nick**, **Katie**, **Barbara** & **Tim** for help with initial deployment and continued data collection. Thanks to **Colin Symons** for work in developing and deploying the Raspberry Pi system.

Thanks to **NSW National Parks & Wildlife Service** for allowing the research to be conducted in Brindabella National Park.

Final thanks to the **Bushfire & Natural Hazards CRC** for funding and support for my PhD project.

Any Questions?

Data Specifications

	Sensor Type	Resolution	Range	Accuracy	Update Interval
Barometric Pressure		0.1hPa/mb	540 to 1100 hPa/mb	±1.0hPa	1 min
Clock		1 minute		±8 sec/month	
Humidity	Film capacitor element	1%	1 to 100%	±3% (0 to 90% RH), ±4% (90 to 100% RH)	50sec to 1min
Rainfall	Tipping bucket, 0.2mm per tip, 214cm^2 collection area	0.2mm	0 to 999.8mm	±3% of total or ±0.2mm (1 tip), whichever greater	20 to 24 sec
Solar Radiation		1W/m^2	0 to 1800W/m^2	±5% of full scale	50sec to 1min (5min when dark)
Temperature	PN Junction Silicon Diode	0.1°C	-40 to +65°C	±0.5°C (above-7°C), ±1°C (below-7°C)	10 to 12 sec
Wind Direction	Wind vane with potentiometer	1°	0 - 360°	±3°	2.5 to 3 sec
Wind Direction Display		22.5°	16 compass points	0.3 compass point	
Wind Speed	Solid state magnetic sensor	0.4m/s	0.5 to 89m/s	± 5% or ±1m/s, whichever greater	2.5 to 3 sec

WeatherLink with USB Data Logger (#6510USB)

Data Logger Archived Data

The Data Logger stores up to 2560 archive records (one 52-byte record per archive interval) for later transfer to your computer. The archive records are stored in 128K of non-volatile memory; protecting the data even if the console loses power. Maxima, minima, averages, and totals are taken over the archive interval.

Archive Record Data	Time/Date of Record, Inside Temperature (last or average), Outside Temperature (last or average), Maximum Air Temperature, Minimum Air Temperature, Wind Direction (dominant), Wind Speed (average), Maximum Wind Speed, Wind Direction at Maximum Wind Speed, Rainfall (total), Rain Rate, Inside Humidity (last), Outside Humidity (last), Barometric Pressure (last), Solar Radiation, Hi Solar Radiation, UV, Hi UV, Evapotranspiration, Leaf Temperature (2), Leaf Wetness (2), Extra Humidity (2), Extra Temperature (3), Soil Temperature (4), Soil Moisture (4), Wind Samples, Wind Transmitter ID, Length of Archive Interval, ISS Reception
Archive Interval	User-selectable from the following intervals (in minutes): 1, 5, 10, 15, 30, 60, or 120

Archive Storage Capacity (the amount of time before the archive is completely filled):

1 Minute Archive Interval	42 hours
5 Minute Archive Interval	8 days
10 Minute Archive Interval	17 days
15 Minute Archive Interval	26 days
30 Minute Archive Interval	53 days
60 Minute Archive Interval	106 days
120 Minute Archive Interval	213 days