

# The micro-climate of a mixed urban parkland environment

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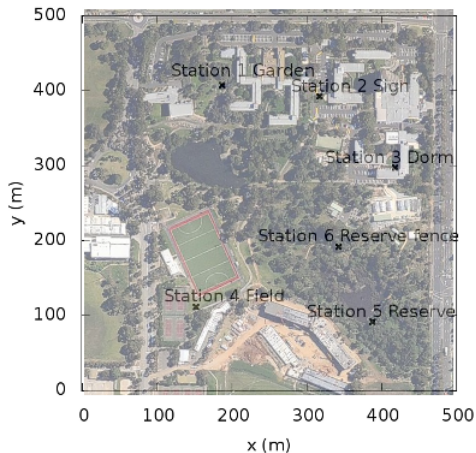
# Why look at urban-parkland environments?

- Global warming
- Increased urbanization
- Adaptation/mitigation strategies
- Mixed urban/park morphologies as mitigation
- Methods for researching urban/park morphologies

# Research questions

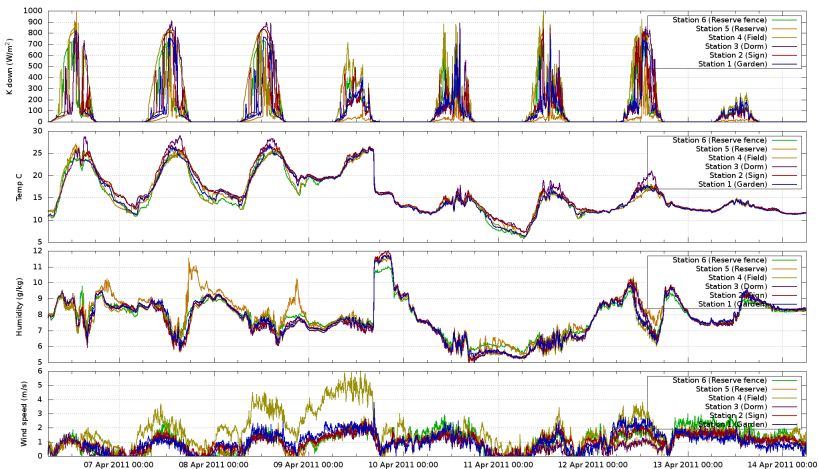
- What is the temperature variation across a mixed urban-parkland environment and is this significant enough to warrant adoption of morphologies suited to mitigate the UHI effects?
- Can an urban micro-climate model (ENVI-met) reproduce the observed temperature variation across a mixed urban-parkland environment?

# Monash Campus observation site locations

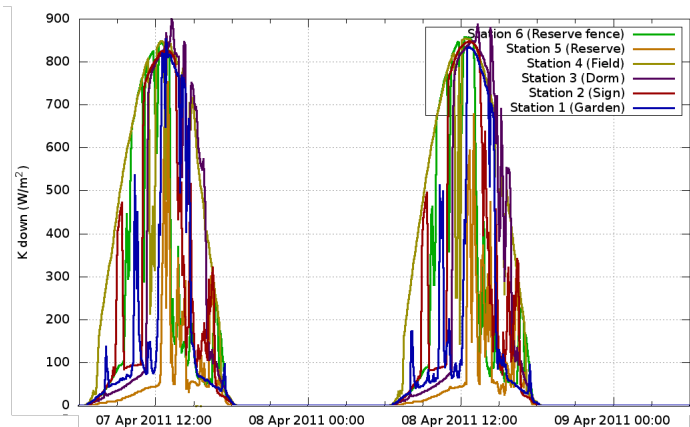


- 1-"Garden"-Grassy area, moderate tree cover
- 2-"Sign"-in car park, some tree cover, asphalt surfaces
- 3-"Dorm"-Grassy area nested in corner of building
- 4-"Field"-Grassy hill, no tree cover
- 5-"Reserve"-Under tree cover by pond, dirt understory area
- 6-"Fence"-In sloped grassy area on edge of reserve area under moderate tree cover

# Observation data (Temperature, K (shortwave) down, humidity, wind speed) for study site 7-14 April 2011

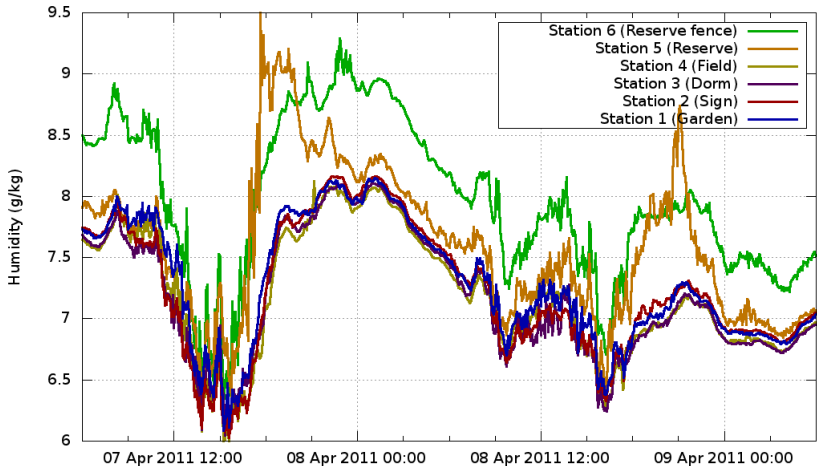


# Observation data (K (shortwave) down), 7-8 April 2011



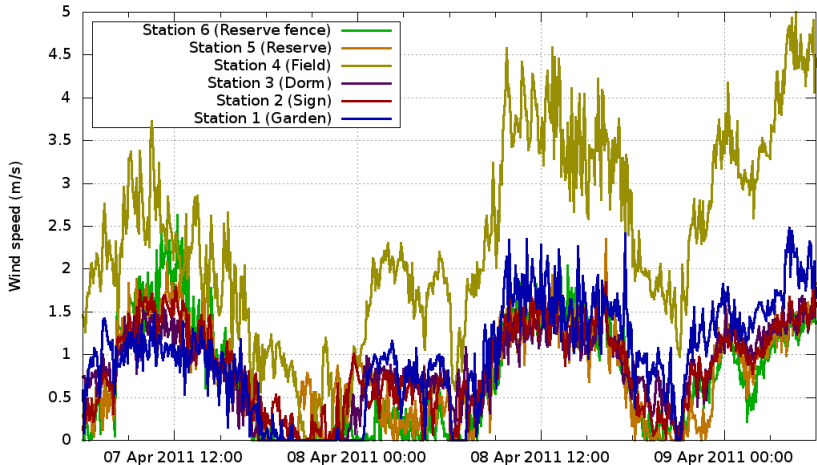
Highest at "Field", 1/2 those levels at "Garden", 1/3 at "Reserve Fence", 1/4 at "Sign" and "Dorm", 1/6 at "Reserve"

# Observation data (humidity), 7-8 April 2011



"Reserve" and "Reserve Fence" consistently higher than other sites

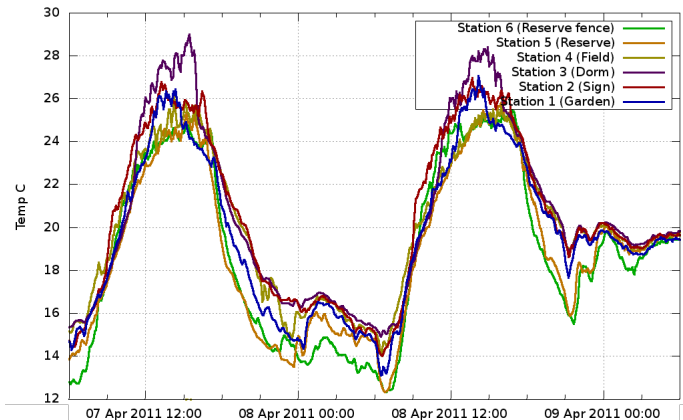
# Observation data (wind speed), 7-8 April 2011



Varied 0-2 m/s except "Field" peaking at 6 m/s, 1st evening calming, pre-dawn wind, 2nd day "Field" increase

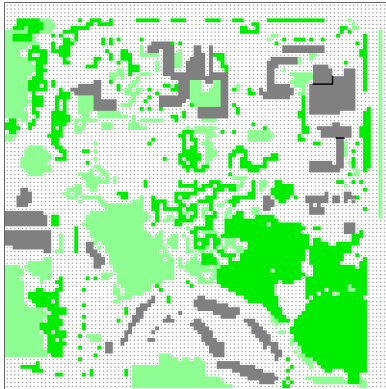


# Observation data (Temperature), 7-8 April 2011



Daytime 4.9°C difference between "Dorm" and "Reserve Fence", other sites vary by 2-3°C, Night time 3.2°C difference between "Sign" and "Reserve Fence" / "Reserve", "Reserve Fence" / "Reserve" cooled most rapidly at night

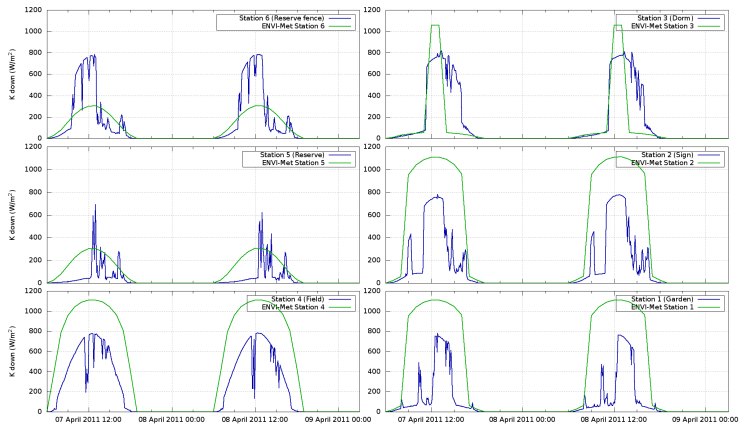
# ENVI-met urban micro-climate model setup



Setting	Value
Grid size	100x100x20
Grid resolution	5 metres
Nesting grids	9
Latitude and longitude	144.58 and -37.49
Initial wind direction	north (0°)
Initial wind speed	2 m/s
Initial temperature	288K
Soil moisture	30/30/50%
Simulation run dates	5-10 April 2011
Save state	60 minutes

ENVI-met v3 set-up values

# Comparison of K down (incoming shortwave radiation) of observation sites vs. ENVI-met model results, 7-8 April 2011



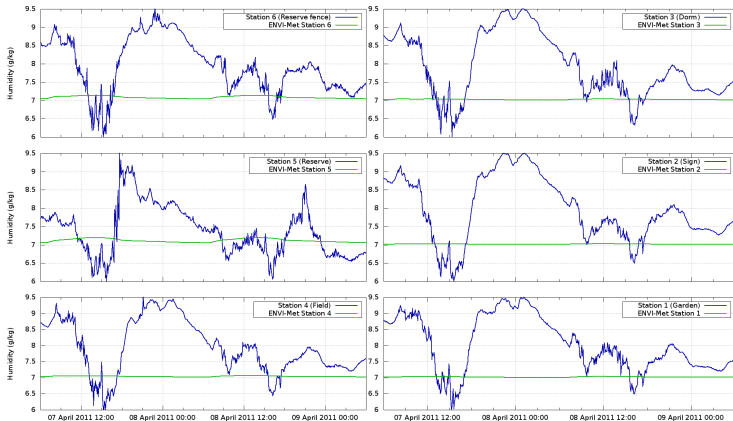
Shortwave radiation overstated, lacks variation seen in observations

# Accumulated shortwave radiation (in MJ/m<sup>2</sup>/day) received over 7-8 April 2011, observations vs. ENVI-met

Sites	ENVI-met	Observed
Garden	30.7	7.7
Sign	30.6	11.2
Dorm	8.9	12.6
Field	38.6	18.1
Reserve	7.6	3.0
Reserve fence	7.6	9.3

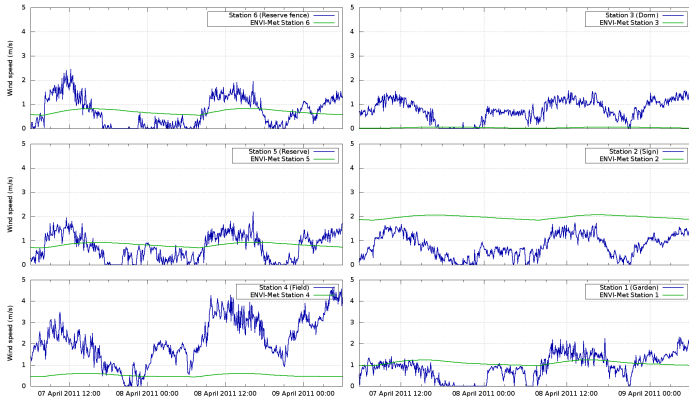
Shortwave radiation overstated, in some cases 2-3X

# Comparison of humidity (g/kg) of observation sites vs. ENVI-met model results, 7-8 April 2011



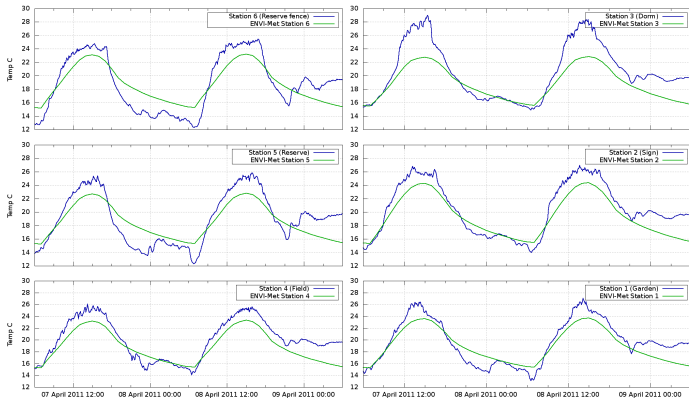
Humidity predictions lacks variation seen in observations

# Comparison of wind speed of observation sites vs. ENVI-met model results, 7-8 April 2011



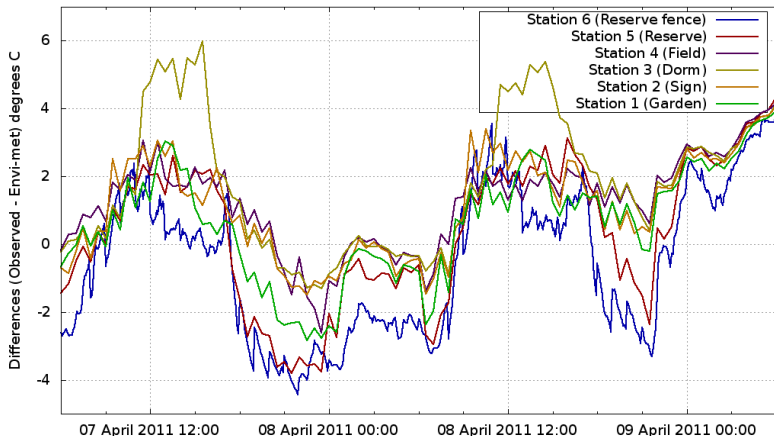
Static wind speeds, model misses calming winds in evening, rising winds through night, temperature variation greatest during calm winds

# Comparison of temperature of observation sites vs. ENVI-me model results, 7-8 April 2011



Under-prediction of daytime temperatures, slow to heat up,  
over-predicts night-time temperatures, slow to cool down

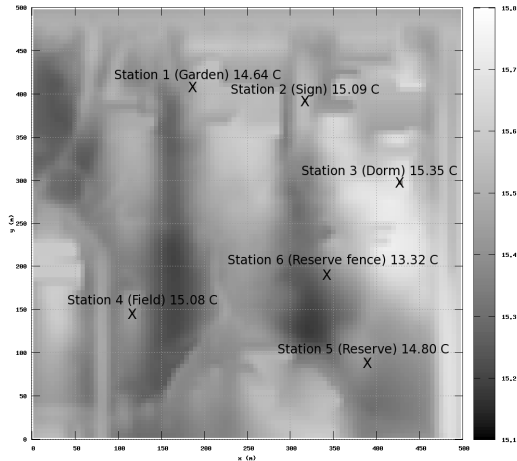
# Differences in temperature between observation sites and ENVI-met model results, 7-8 April 2011



Divergences of  $+6^{\circ}\text{C}$  to  $-4^{\circ}\text{C}$ , in some cases, and  $+2^{\circ}\text{C}$  to  $-2^{\circ}\text{C}$  in all cases.

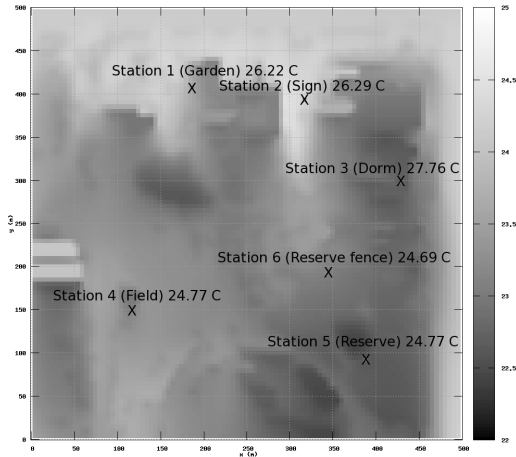


# Temperature (in °C) results for ENVI-met model run with observational site data points, 8 April 2011 6:00 am.



15.1°C to 15.8°C, compared to the observed range of 13.3°C to 15.4°C but with some reasonable predictions of broad features

# Temperature (in °C) results for ENVI-met model run with observational site data points, 8 April 2011 2:00 pm.



22°C to 25°C. compared to the observed range 24.7°C to 27.8°C but with some reasonable predictions of broad features

# Observations conclusions

- Daytime variations of up to  $4.9^{\circ}\text{C}$  between "urban" and "parkland" areas
- General daytime variations of  $2\text{-}3^{\circ}\text{C}$
- Night time  $3.2^{\circ}\text{C}$  variations between "urban" and "parkland" areas
- "Parkland" areas cooled most rapidly at night
- Humidity consistently higher in "parkland" areas
- Higher wind speeds moderated temperatures in highly solar exposed "Field" site
- Sheltered "Dorm" site allowed daytime temperatures to build
- Rising and falling winds created temperature variations over day and nights
- The variations found could be useful in addressing UHI effects

# Model conclusions

- Simplistic modelling of canopy leads to inaccurate shortwave predictions
- ENVI-met hampered by static and inaccurate meteorological predictions missing variations due to mechanical mixing, i.e. cooling of highly solar and wind exposed "Field" site
- Observed sharp drops in temperature after dusk and slight rises before dawn not predicted by model
- Warming and cooling lags behind observed values
- Maximum and minimum values under-predicted
- Edge cases ("Dorm", "Reserve") not predicted accurately
- ENVI-met predicts large scale features, but given the resolution of observed data (6 observation sites), it isn't possible to determine if they are accurate
- Work to be done on future ENVI-met versions (and other micro-climate models)