Impact of summer heat waves on forest productivity in Southern Australia

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Heat waves

- heat waves are becoming hotter, they last longer and occur more often.

- many ecological processes are more sensitive to climate extremes than to changes in mean states

- The impact of climate extremes on terrestrial ecosystems is poorly understood but important for predicting feedbacks to climate and climate change

Take away point

Nature paper of Adriaan Teuling 2010 has shown that European forests reduce the impact of HW (compared to grass lands).

I will show that large areas of Southern Australia respond rapidly to HWs and have reduced carbon uptake, ET and WUE. This likely leads to a rapid amplification of HWs.

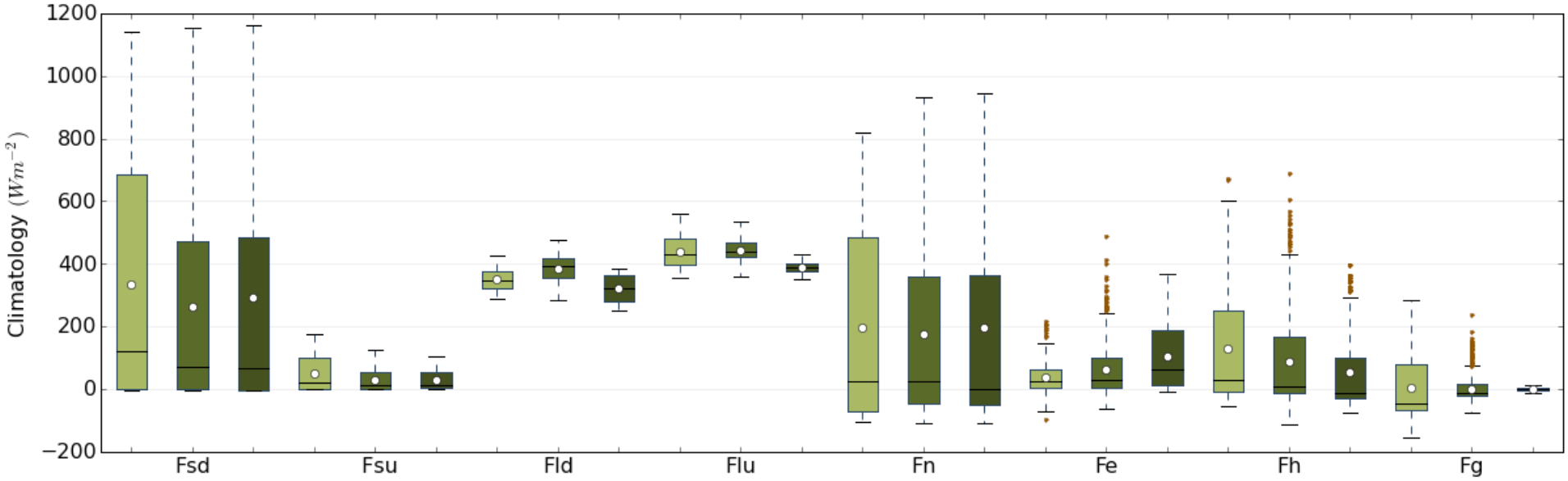
Sites used in Southern Australia - ES

MW - Mediterranean Woodlands
Gingin
Great Western Woodlands
Calperum

TW - Temperate Woodlands
Wombat
Whroo
Cumberland Plains

TF - Temperate Forests
Tumbarumba

Flux Climatology Background (2 – 6/1/2014)



Time Periods

heat wave
phase 1: 01/01/2013 - 09/01/2013
phase 2: 12/01/2013 - 18/01/2013

Reference Data

hourly - data from flux towers:
02/1/2014 - 08/1/2014

daily - Bios2 output:
phase 1: 01/01 - 09/01 [1982-2013]
phase 2: 12/01 - 18/01 [1982-2013]

Time Periods

heat wave
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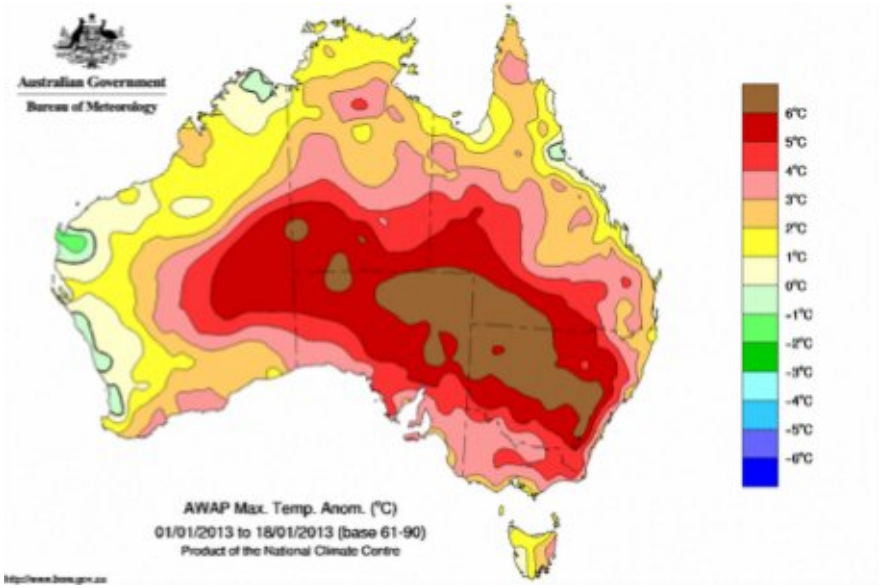
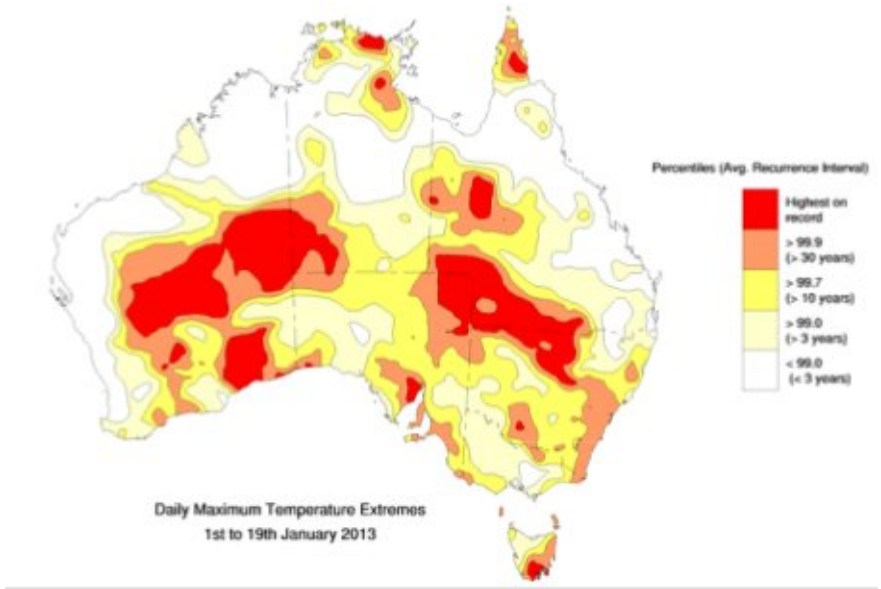
phase 2: 12/01/2013 - 18/01/2013

Reference Data

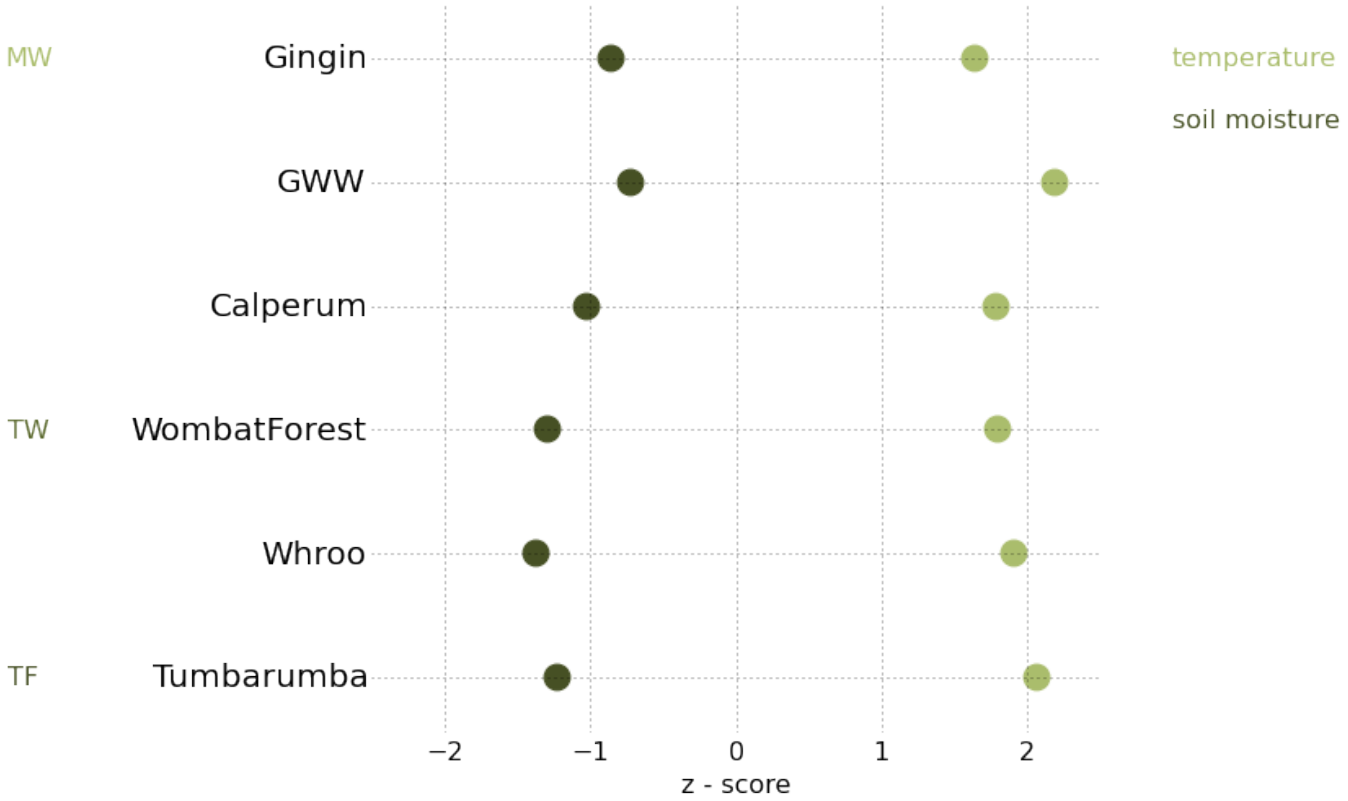
02/1/2014 - 08/1/2014

Heat wave summer 2013

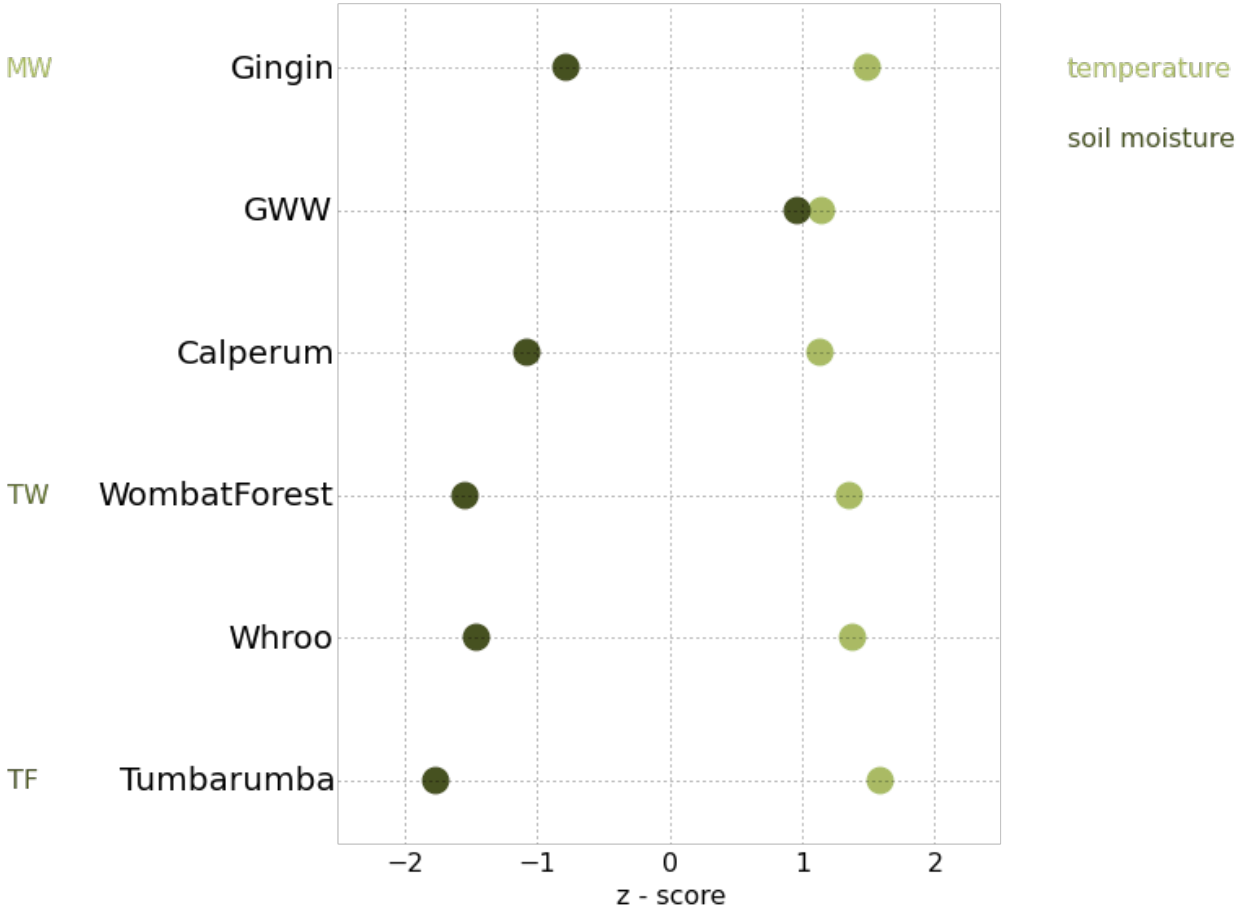




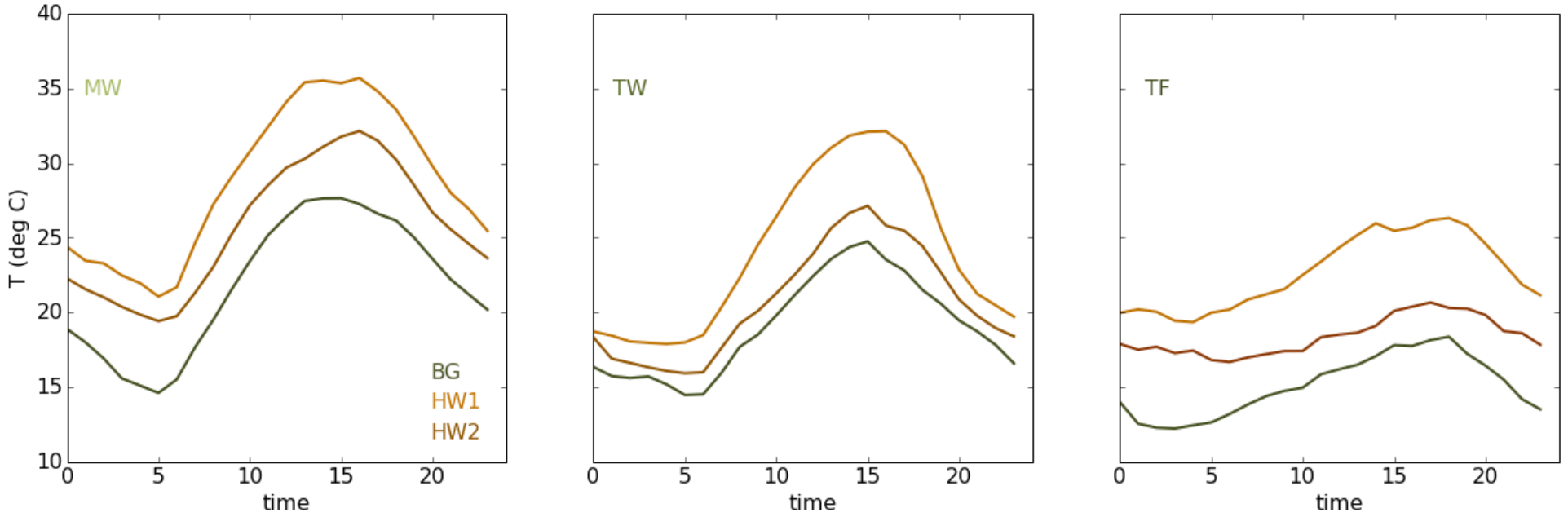
Heat wave summer 2013 – phase 1



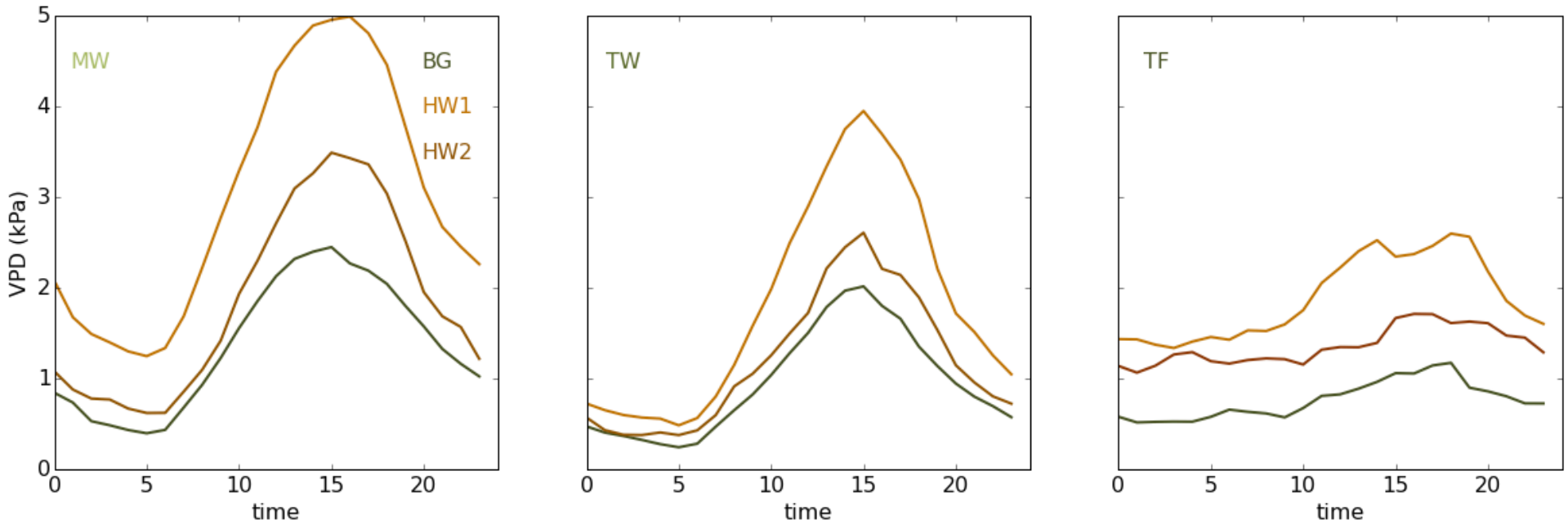
Heat wave summer 2013 – phase 2



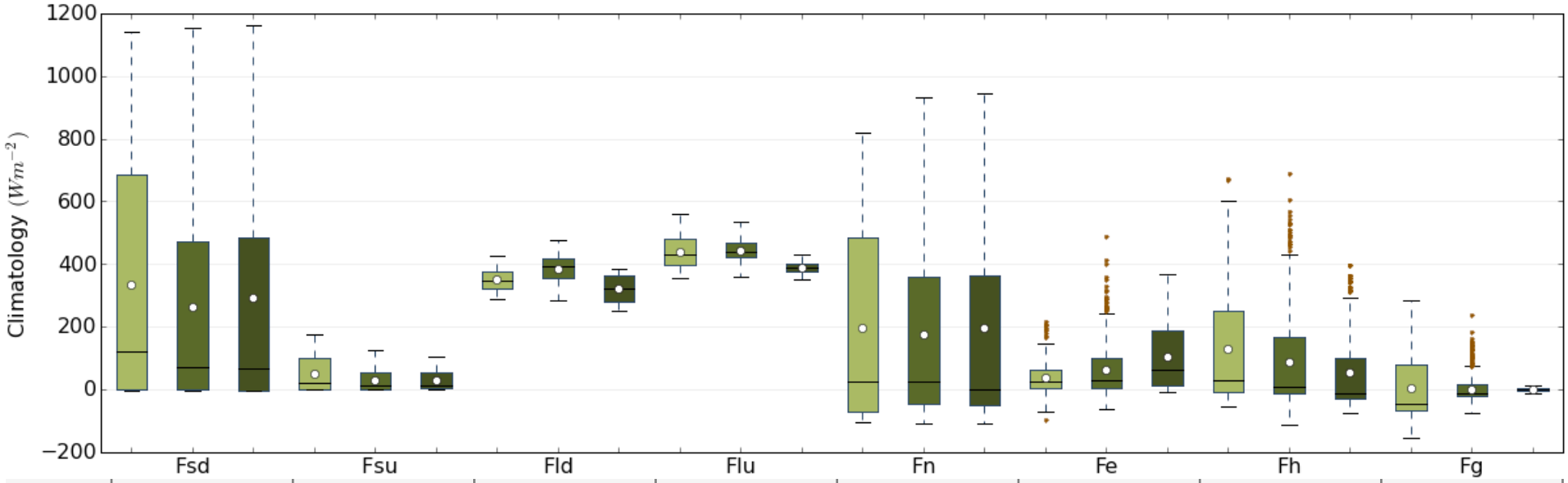
Temperatures



VPD

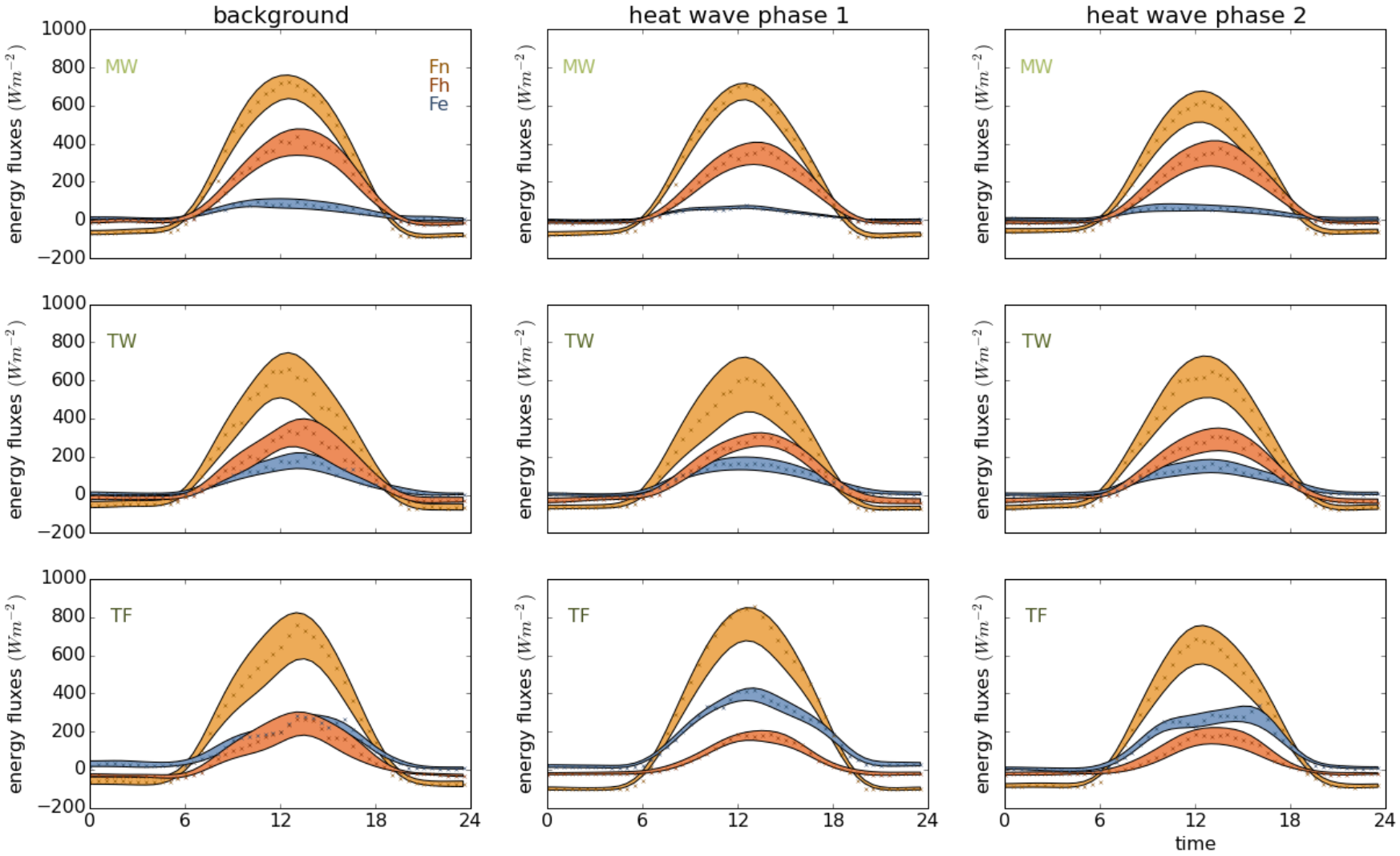


Flux Climatology Background (2 – 6/1/2014)

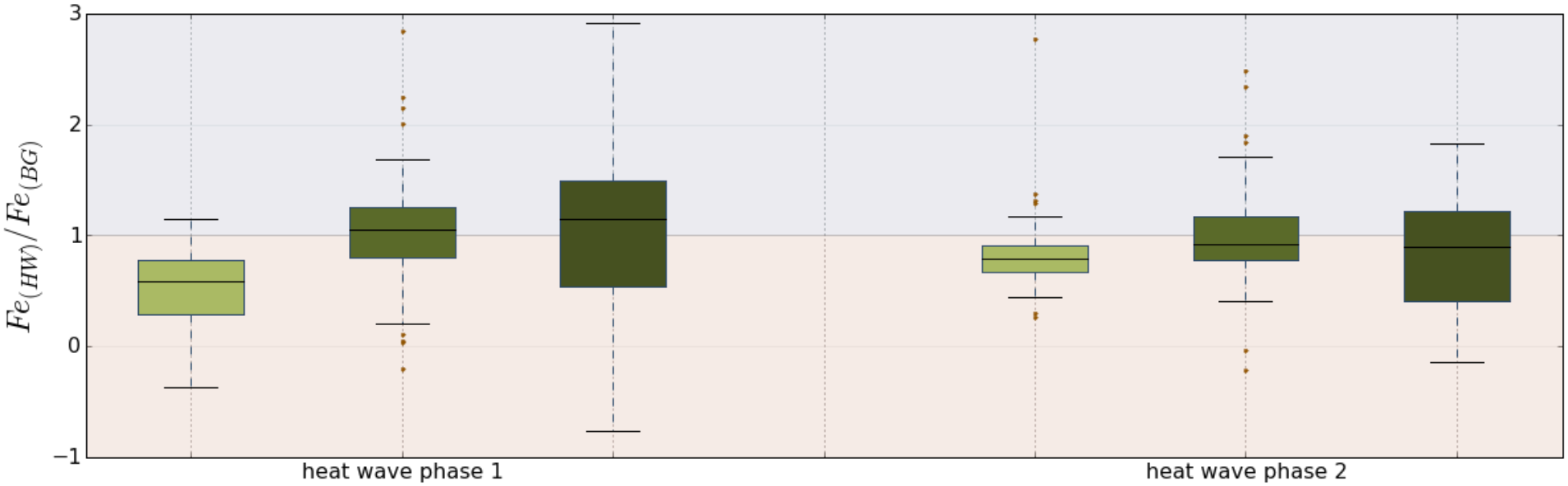


BG	337	265	294	50	30	31	350	386	323	439	444	387	198	176	199	38	63	103	131	90	55	6	2	0
DHW1	-10	4	70	-1	0	3	38	9	0	49	33	41	-19	-20	26	-12	2	52	-5	30	-8	6	4	5
DHW2	-80	10	-7	-13	1	-4	42	0	-11	17	12	10	-41	-2	-24	3	-4	9	-41	-8	-15	-6	0	0

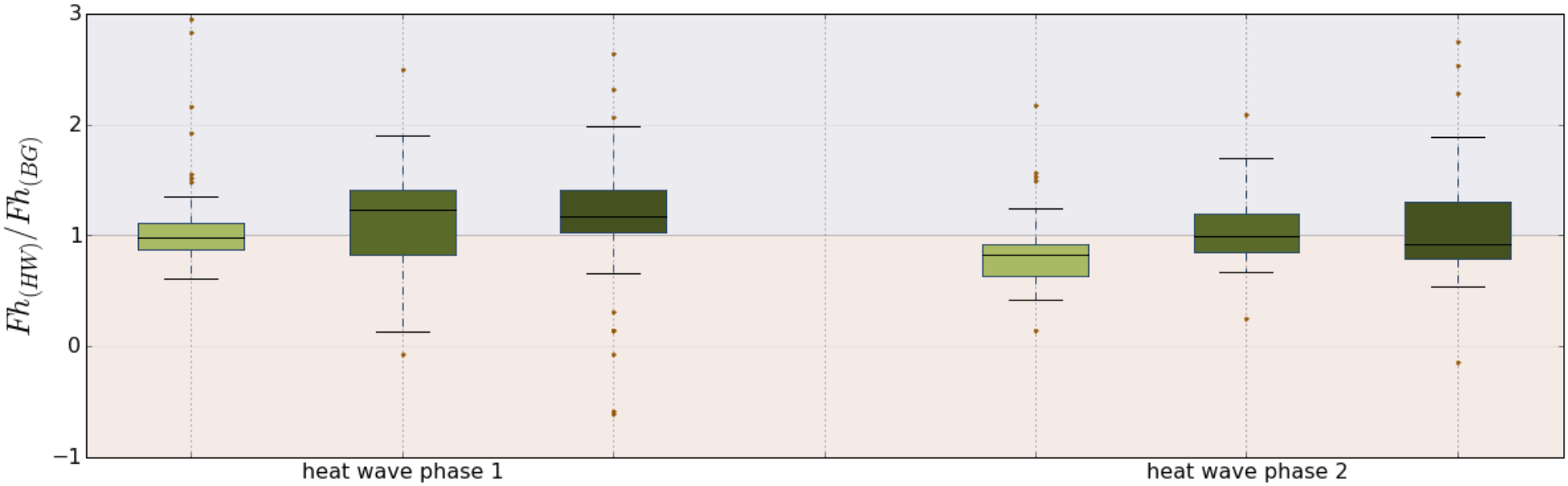
Energy Fluxes



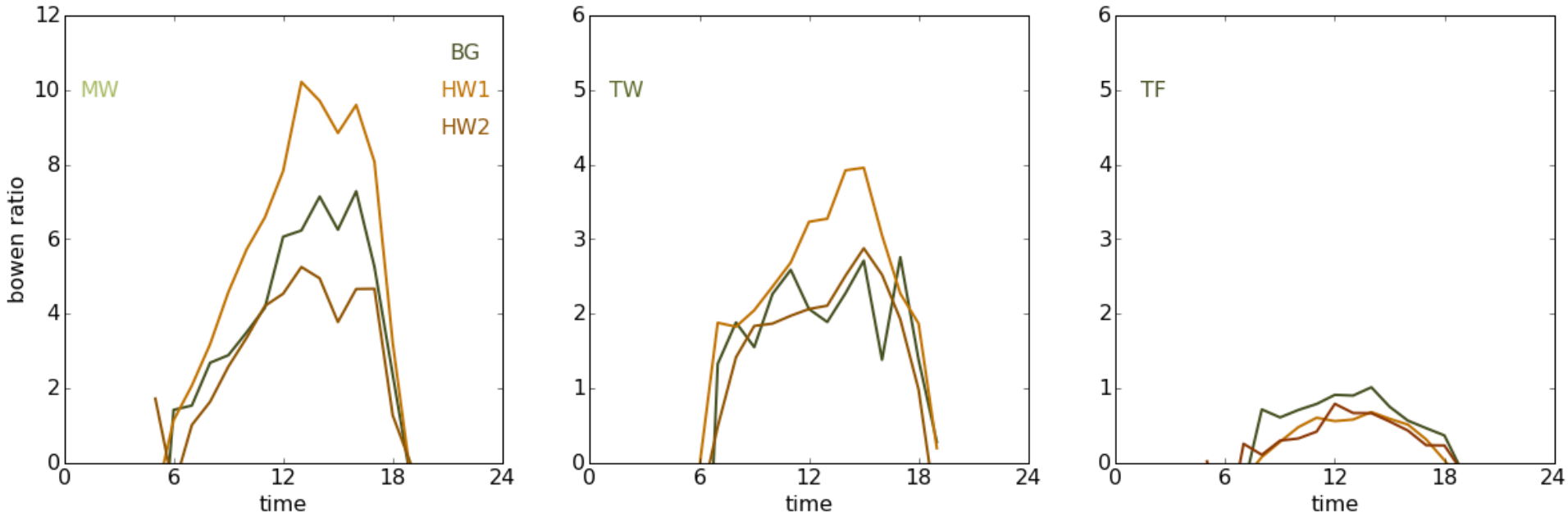
Latent Heat Flux HW / BG



Sensible Heat Flux HW / BG

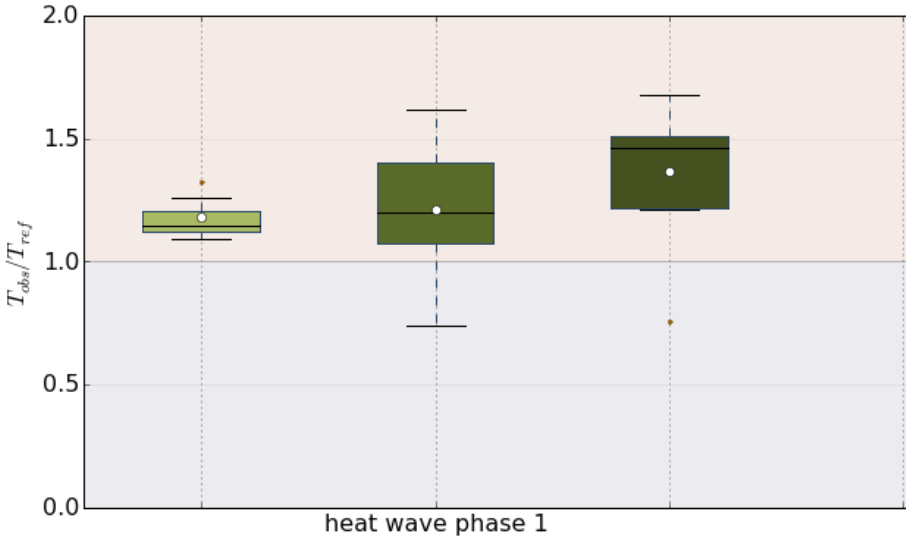


Bowen Ratio

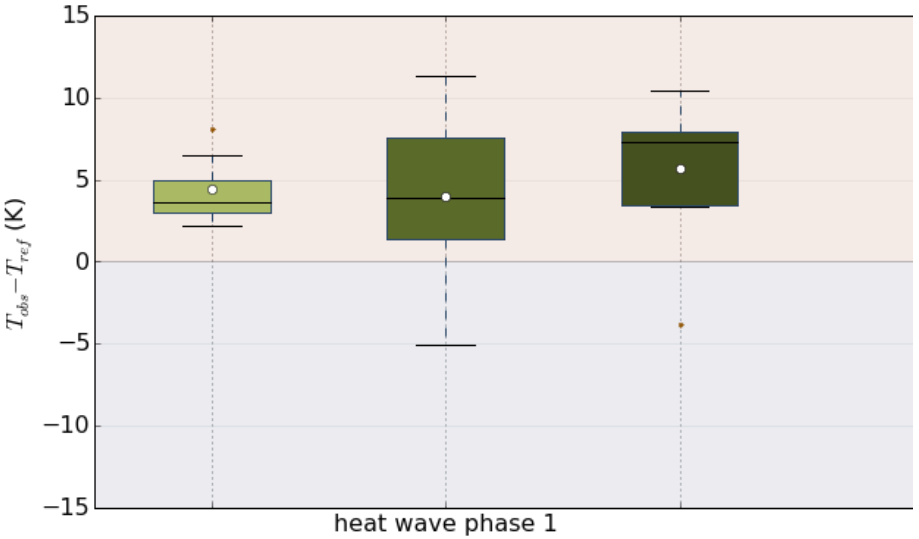


Feedback on Temperature

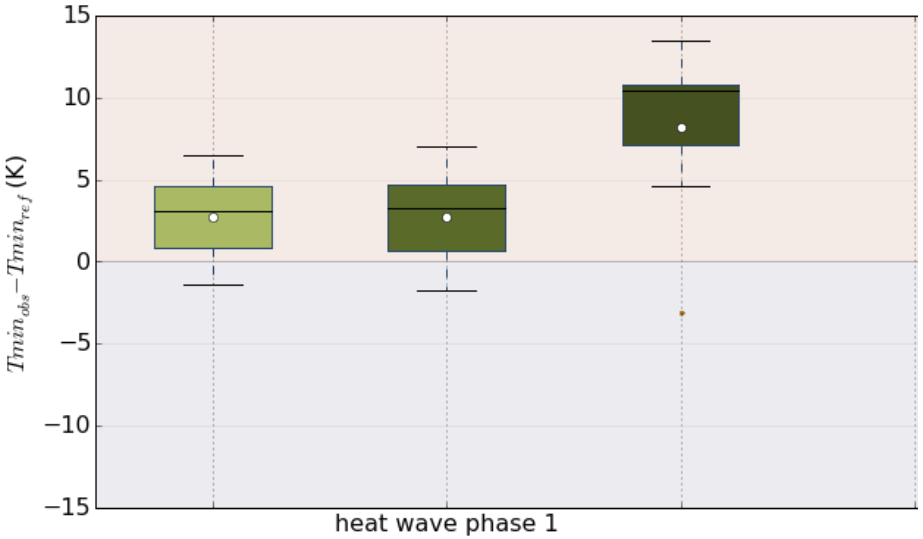
T_HW: T_BG



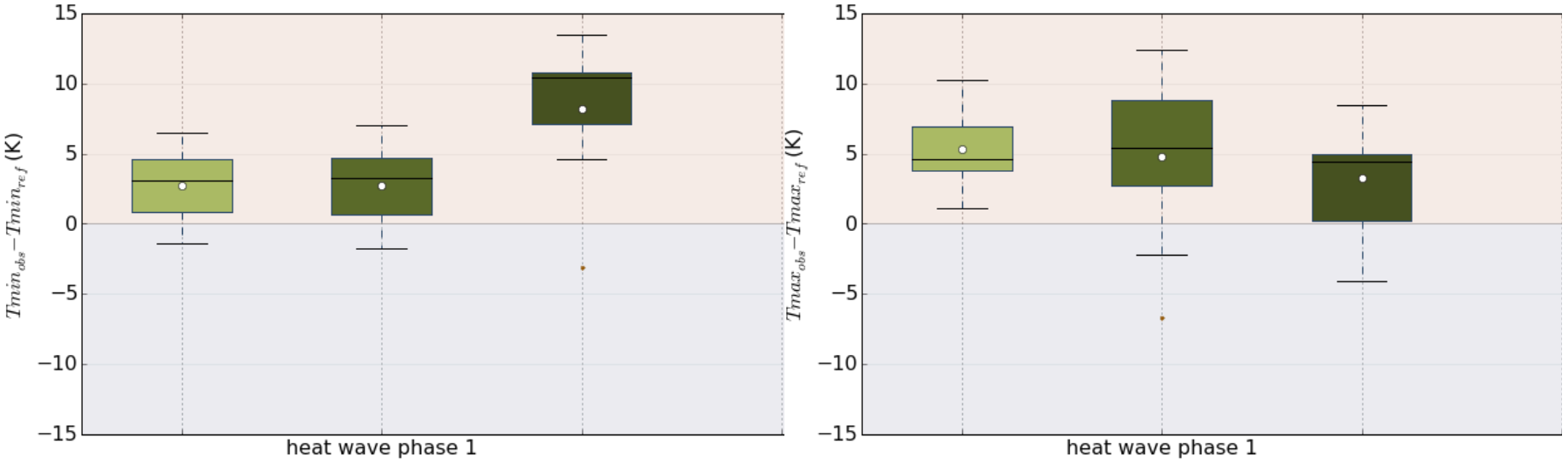
T_HW-T_BG



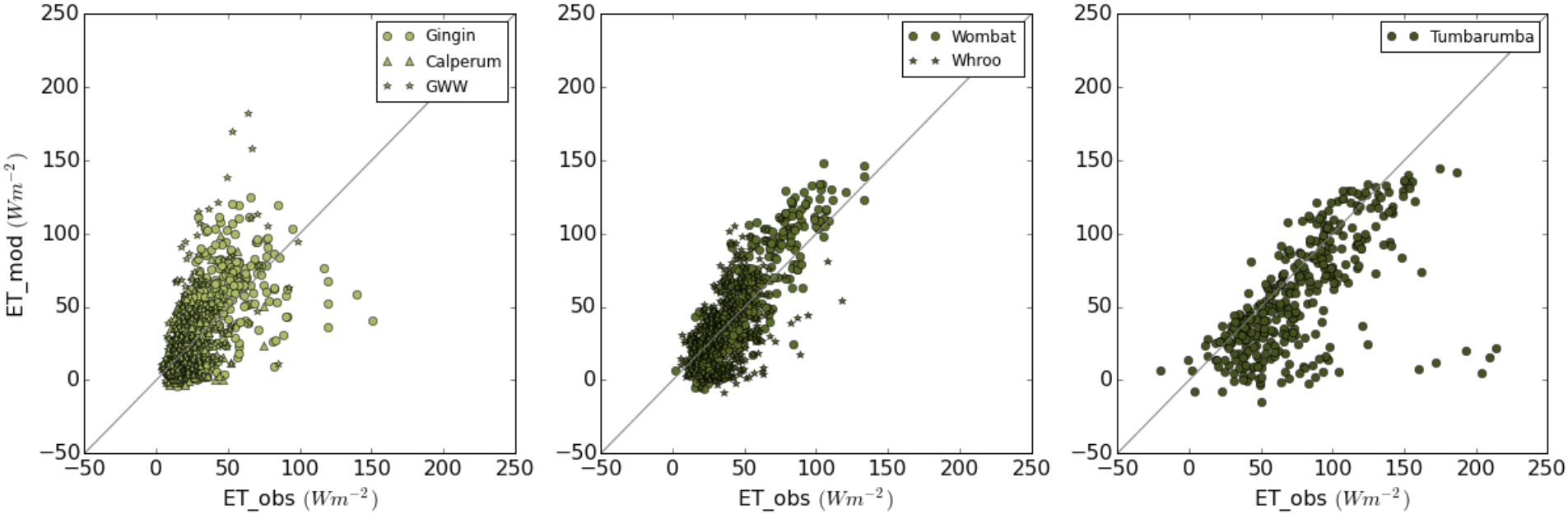
Feedback on Temperature



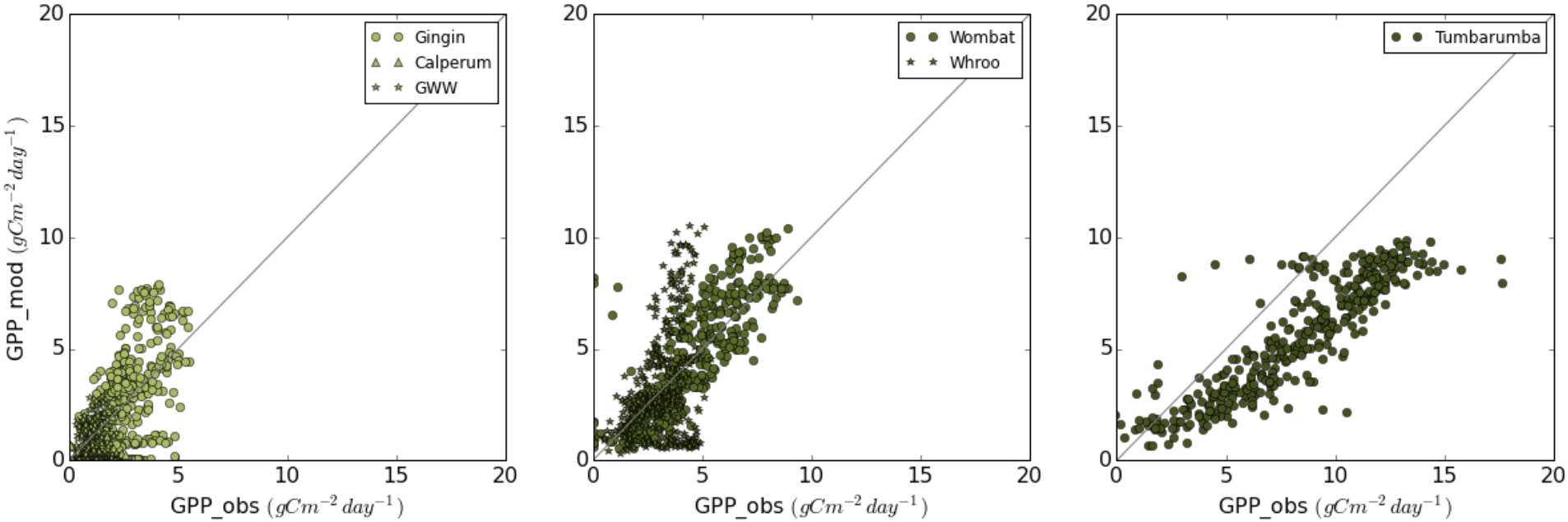
Feedback on Temperature



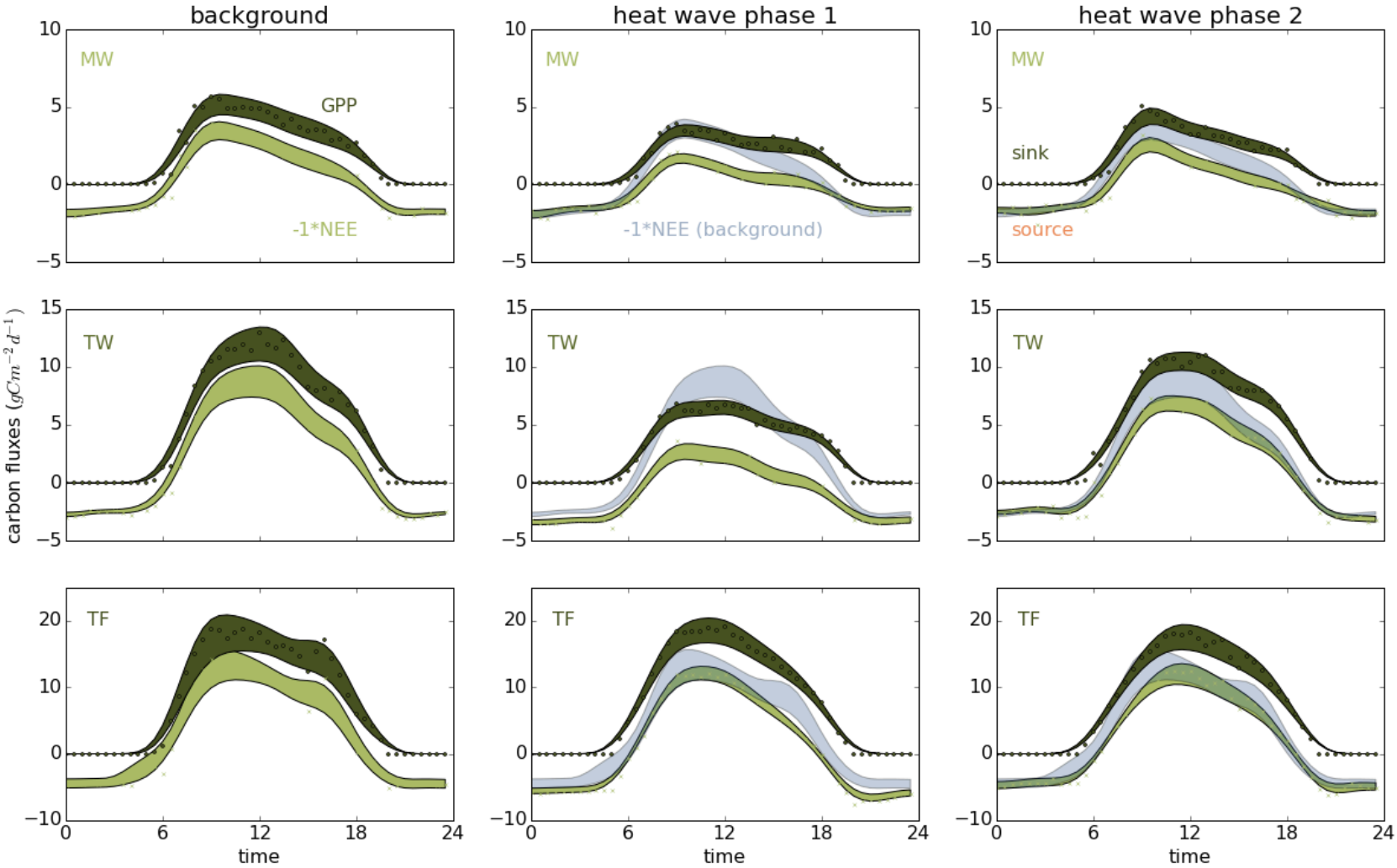
Energy Fluxes Bios2 – obs (2013)



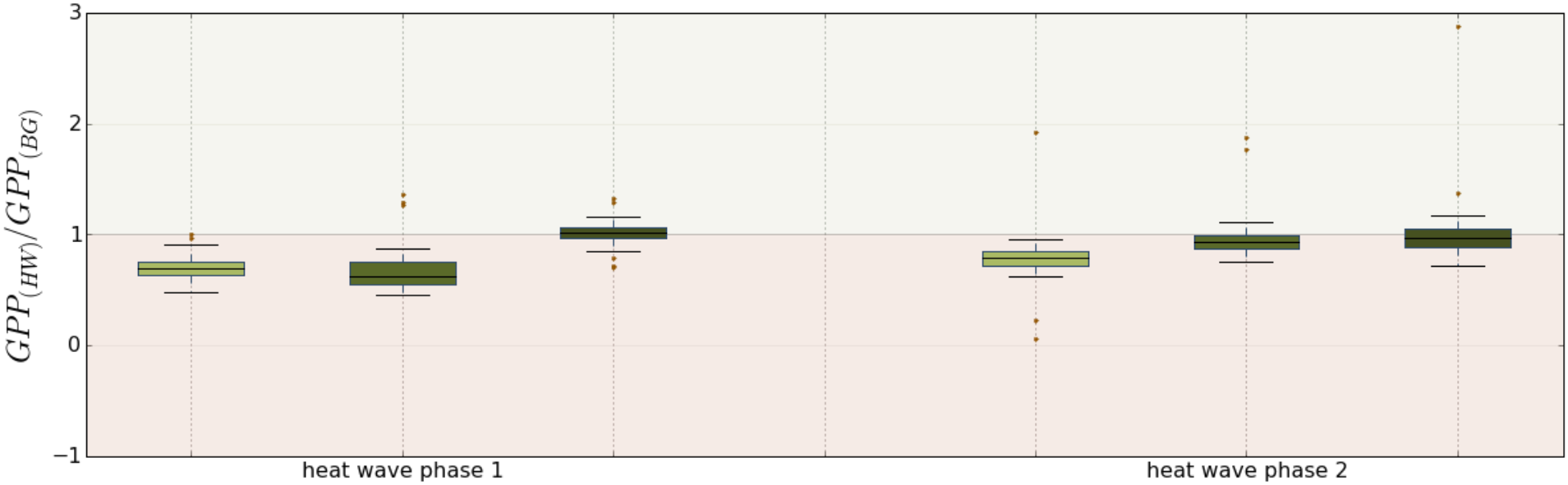
Carbon Fluxes Bios2 – obs (2013)



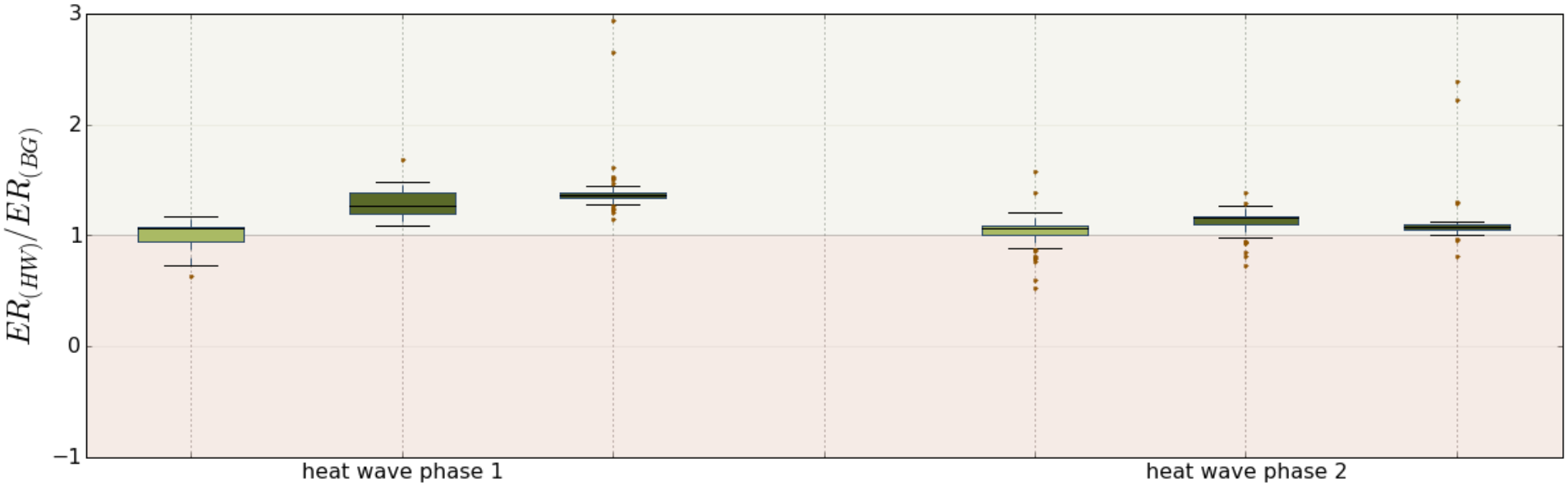
Carbon Fluxes



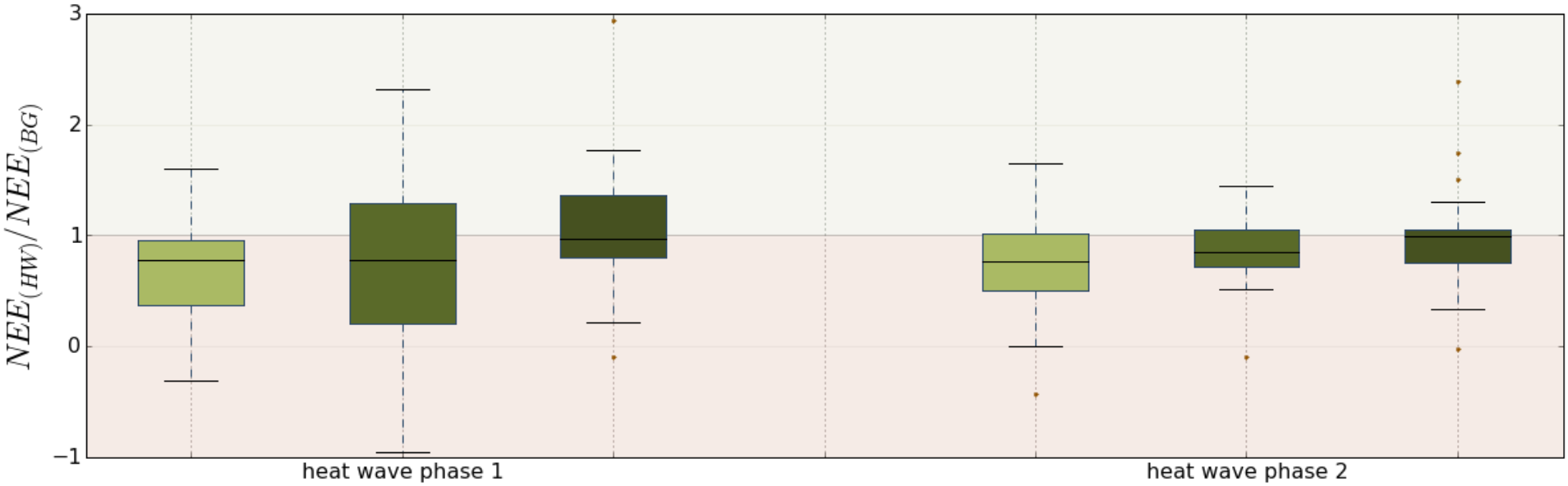
Gross Primary Productivity HW / BG



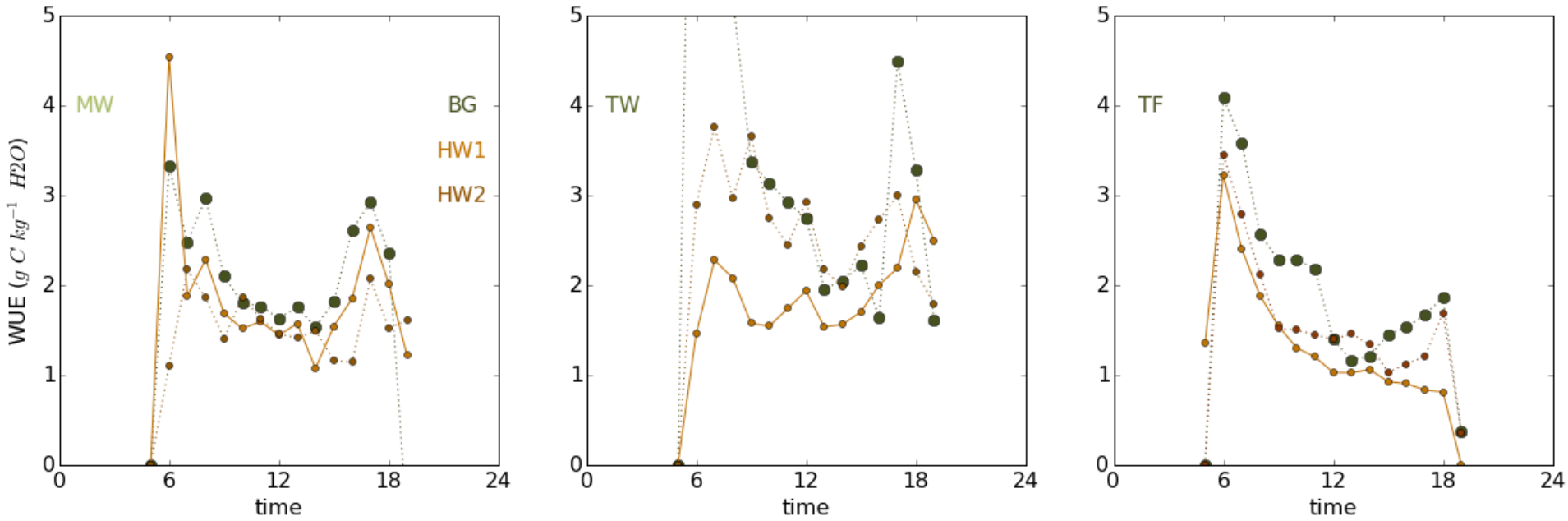
Respiration HW / BG



Net Ecosystem Exchange HW / BG



Carbon and Water Fluxes: ecosystem Water Use Efficiency



Conclusions

ENERGY

- most excess energy leaves the system through long-wave outgoing radiation and is not available to be partitioned into turbulent heat fluxes

WATER

- If water is available (radiation limited ecosystem, rain) ET is increased compared to background. In water limited ecosystems the Bowen Ration is increased

CARBON

- Respiration generally increased
- Carbon uptake more reduced in water limited ecosystems
- Greater reduction of sink strength in water limited ecosystems

COUPLED WATER AND CARBON

- WUE generally decreased during heat wave

Conclusions

large areas of Southern Australia respond rapidly to HWs and have reduced carbon uptake, ET and WUE. This likely leads to a rapid amplification of HWs.

Thank you

to Lawrie Rikus for access to ACCESS-R
to the flux tower PI's for the observations
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