BRIDGE Sustainable Urban Planning Conference

Energy and Carbon Dioxide

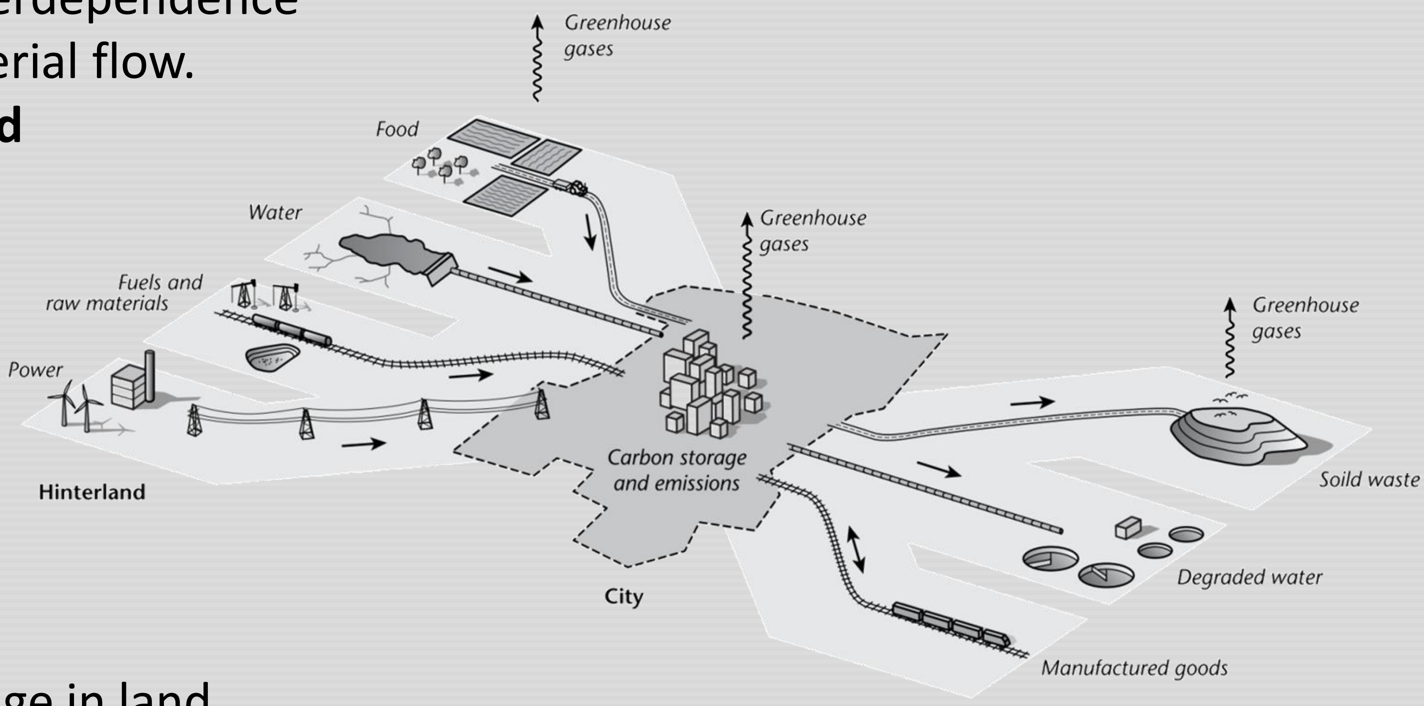
ECWP

Energy Carbon Water Pollutants

BRIDGE mission: to define urban metabolism by means of ECWP

The concept of urban metabolism

….is a system-based approach to describe complexity and interdependence of energy **and** material flow. Neighbourhood **and** greater scales necessary



Answer questions:
How does the change in land use and resources affect fluxes of ECWP?

Christen et al. (2010) modified from Oke et al. (2011)

Urban planning – Diversity of desires and needs

Increase energy efficiency of urban structure
Minimize energy demand of settlements
Increase share of renewable energy
Minimize the carbon emission to the atmosphere

Measures are as diverse as the different cities are
Different climates, different needs

Common sense offers many solutions:

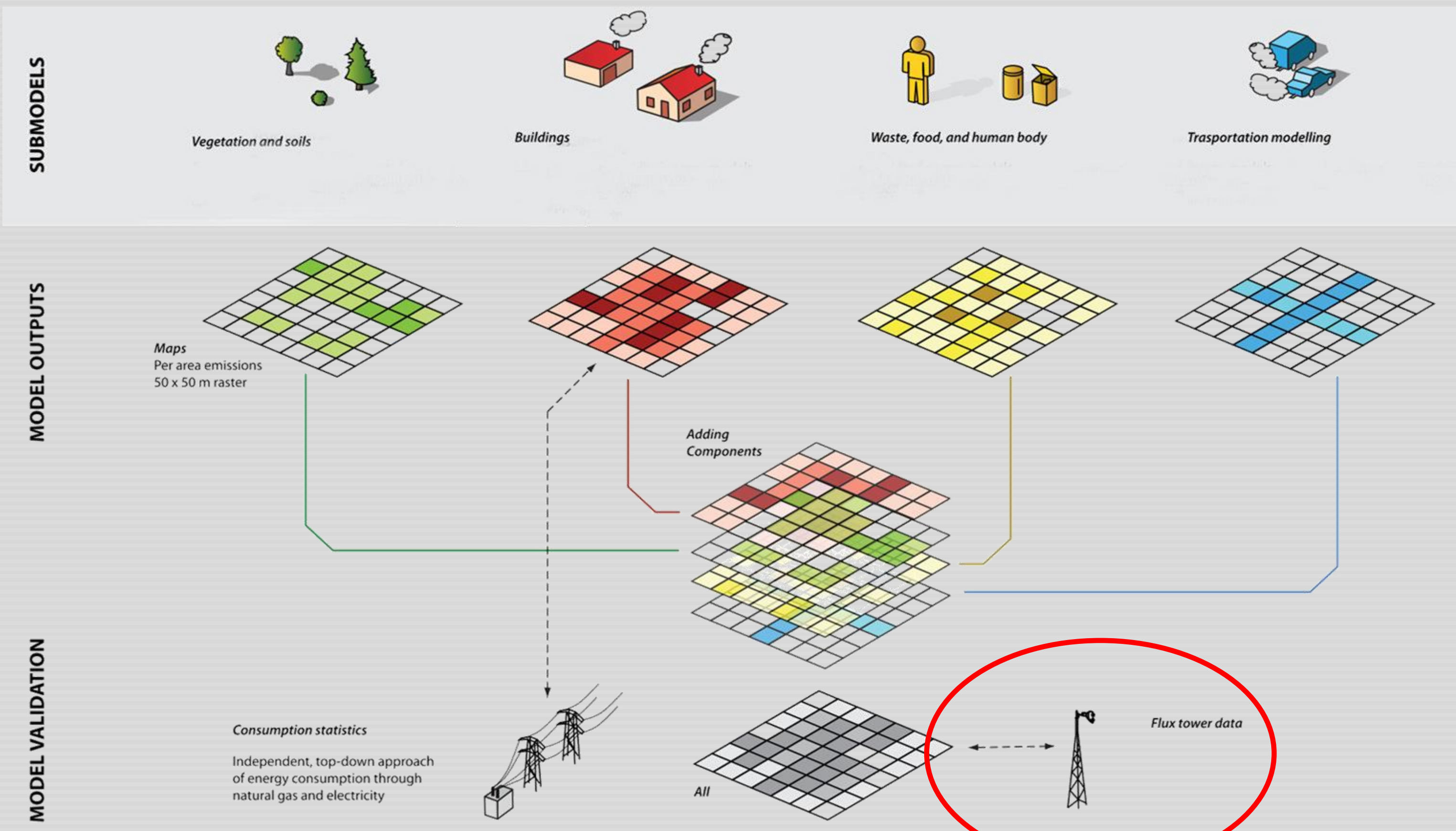
Improve infrastructure (insulate buildings, new windows, insulate pipe-lines of central heating system)
Zero emission buildings in new settlings. Decentralized energy networks. Improve public transport.
Reduce distance between living and working. ....

Mitigation of urban heat island

Influence Urban Energy Balance to improve individual thermal comfort
Increase urban green space (trees, lawns, green roofs?). Alter albedo?

Understand and model the system

↓ MODEL ↓ INPUTS ↓



Christen et al. (2010)

Concept of urban metabolism - the meteorological view

Energy

Q^* = Net radiation

Q_H, Q_E = Sensible, latent heat flux

Q_F = Anthropogenic heat flux

ΔQ_S = Storage

Carbon

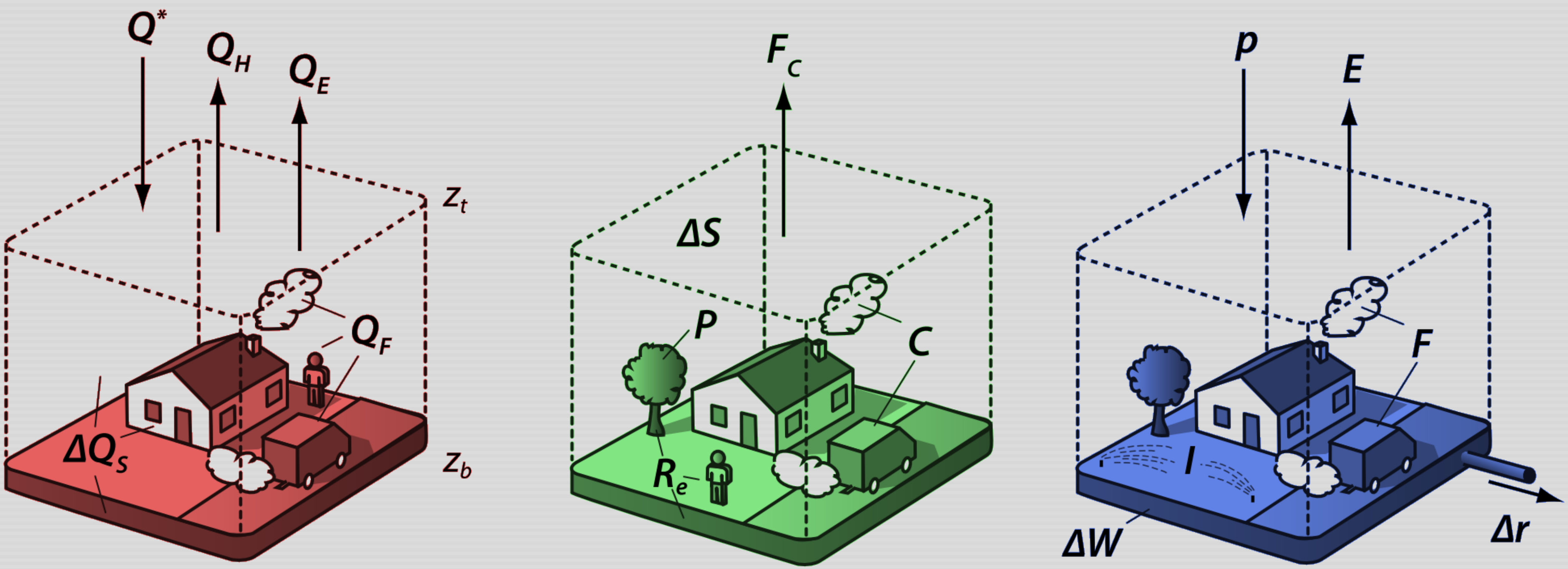
C = CO_2 emission

P = Photosynthesis

R_e = Respiration

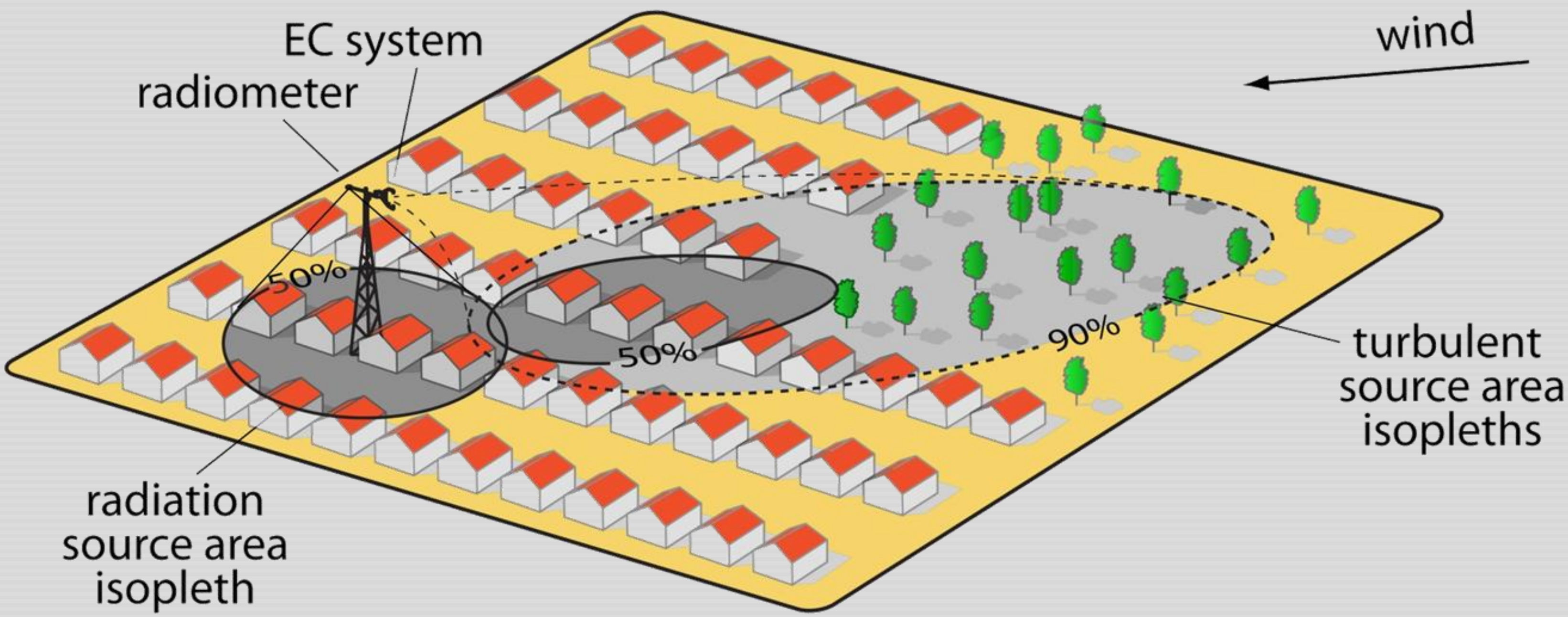
ΔS = Storage

Water



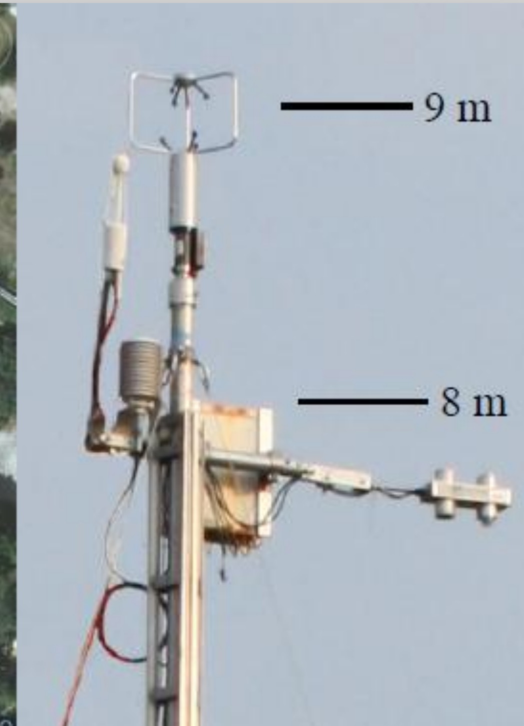
Feigenwinter et al. (2011)

Where is the flux coming from? The source area



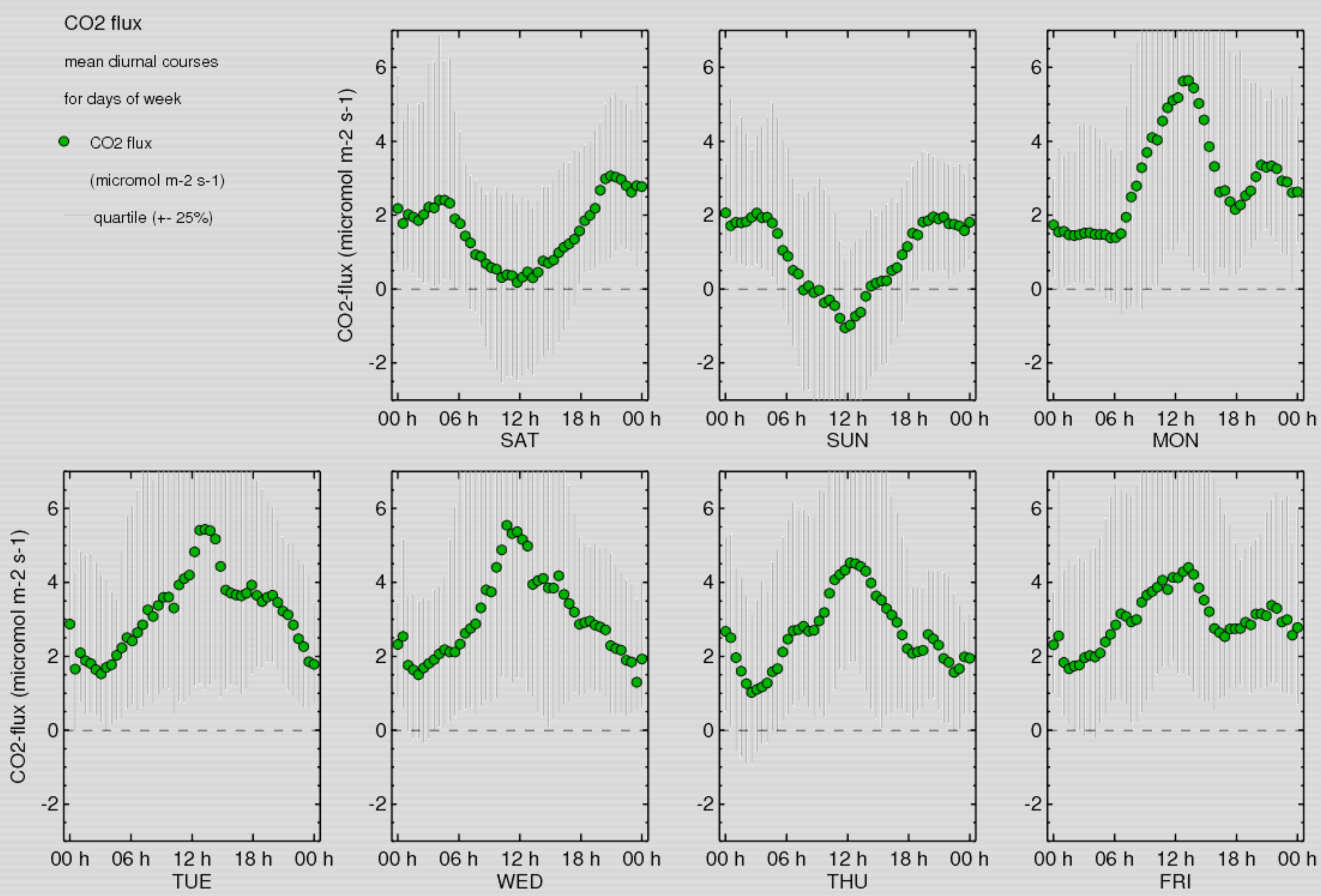
Graph: Andreas Christen

Gliwice case study
Measurement of turbulent fluxes - the site

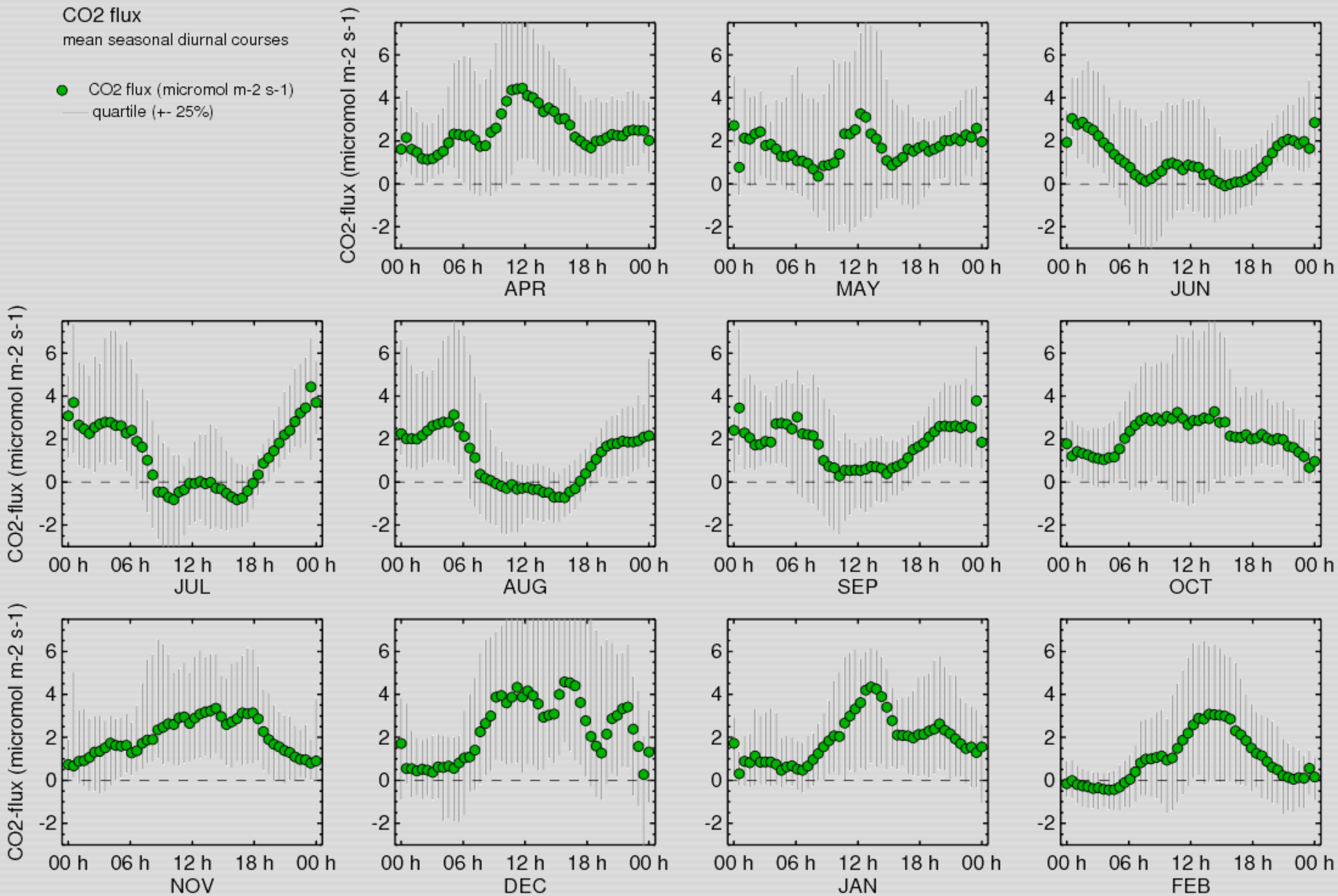


Eddy-Covariance system		CS Data-Logger CR1000
Wind vector (u,v,w)	10 Hz	Young 81000V
Temperature fluctuations	10 Hz	Young 81000V
Conc. of H_2O and CO_2	10 Hz	LiCor LI-7500
Air Temp. and humidity	1 min	Vaisala HMP45
Components of net radiation	1 min	Kipp & Zonen CNR1

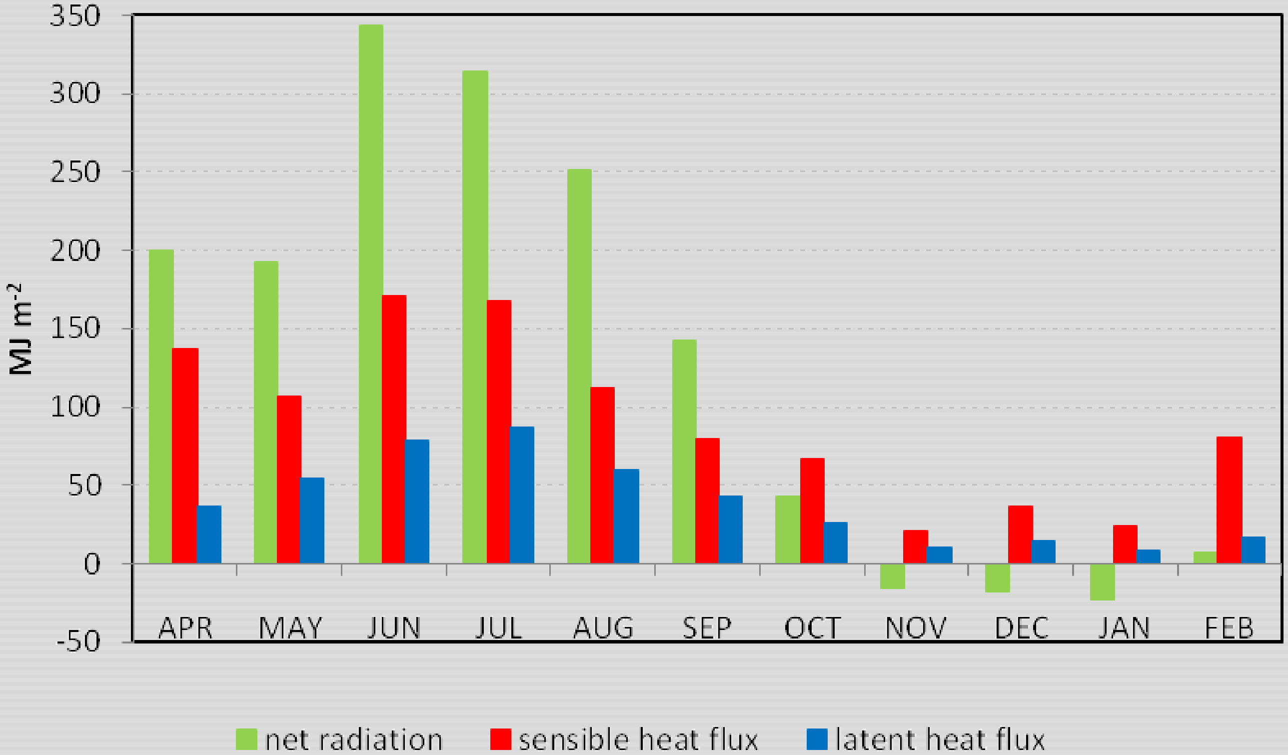
Gliwice case study
Mean diurnal courses of CO_2 flux, day of week



Gliwice case study
Mean monthly diurnal course of CO_2 fluxes

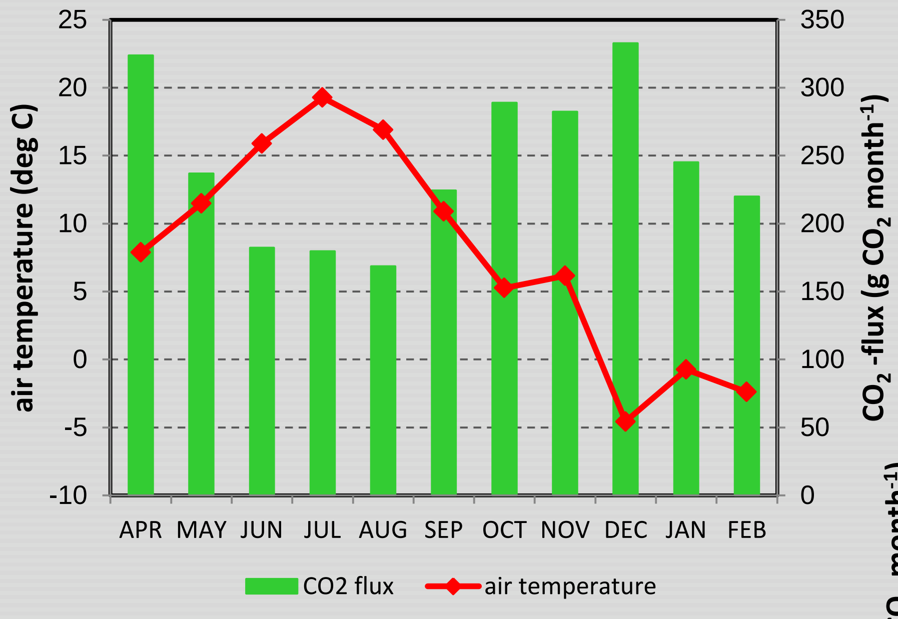


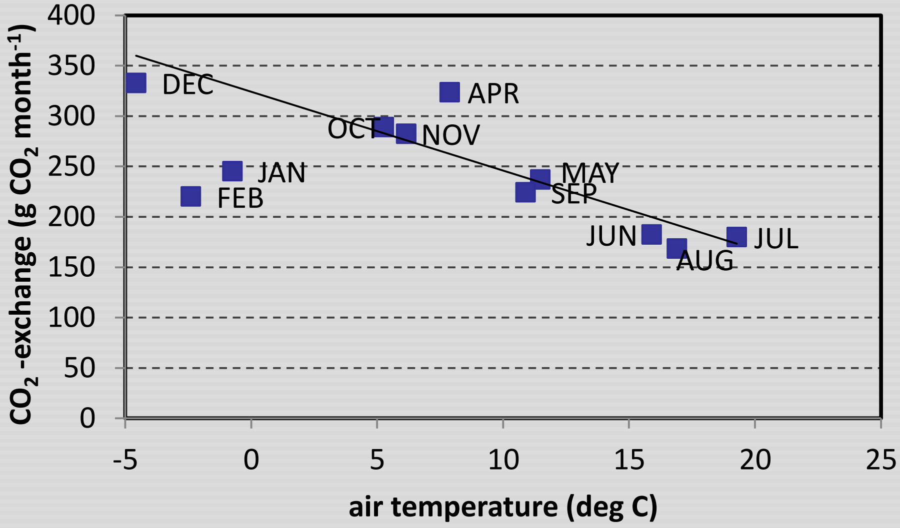
Gliwice case study
Monthly sums of energy fluxes



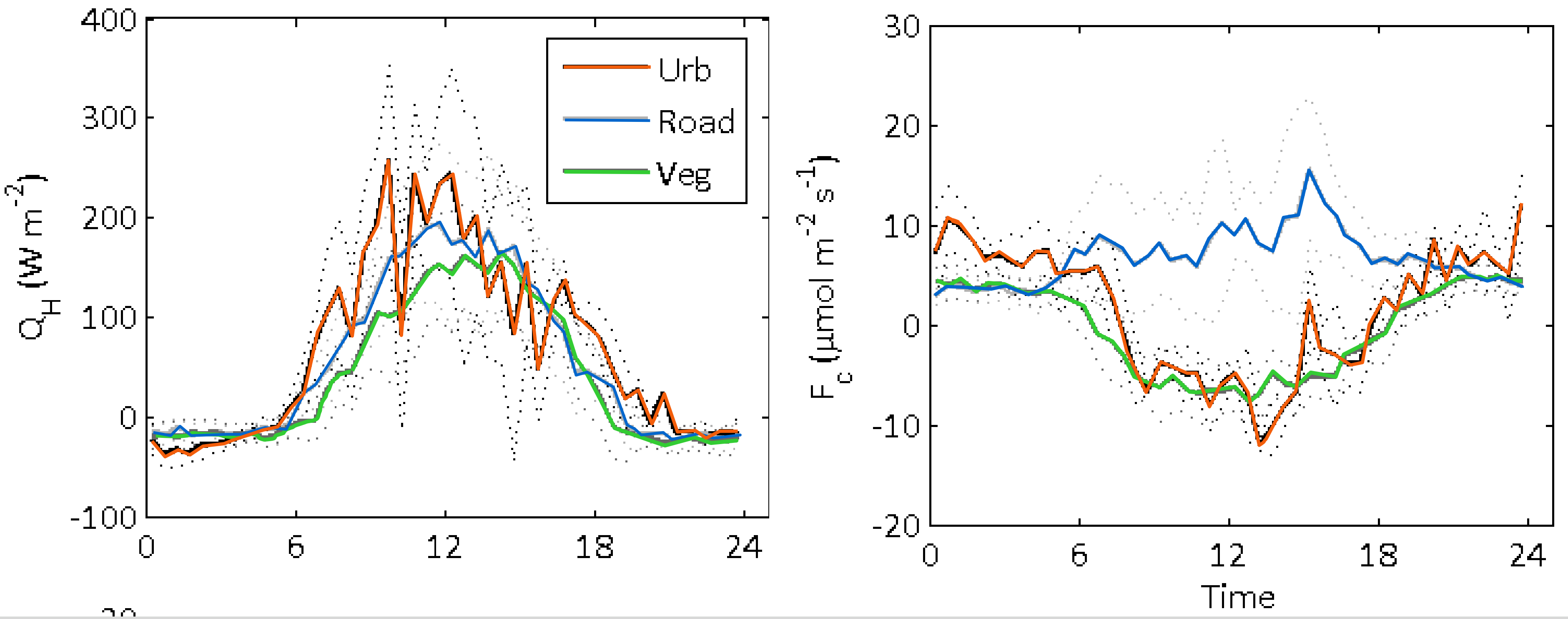
	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	AVG
H/Rn	53%	43%	41%	42%	36%	42%	51%	58%	91%	54%	74%	53%
LE/Rn	11%	18%	14%	19%	15%	17%	12%	11%	23%	13%	10%	15%

Gliwice case study
Monthly CO_2 fluxes and average temperature

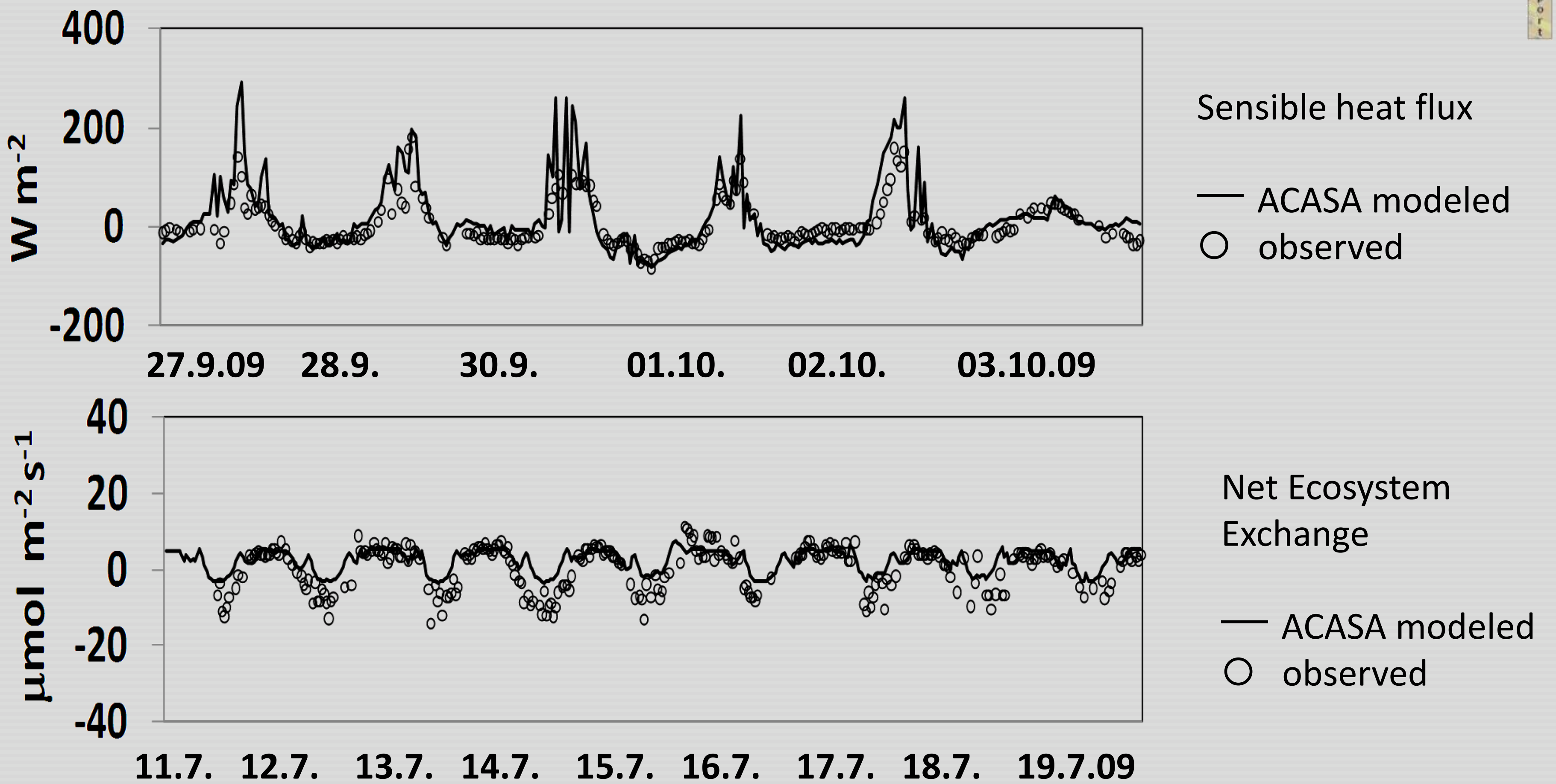




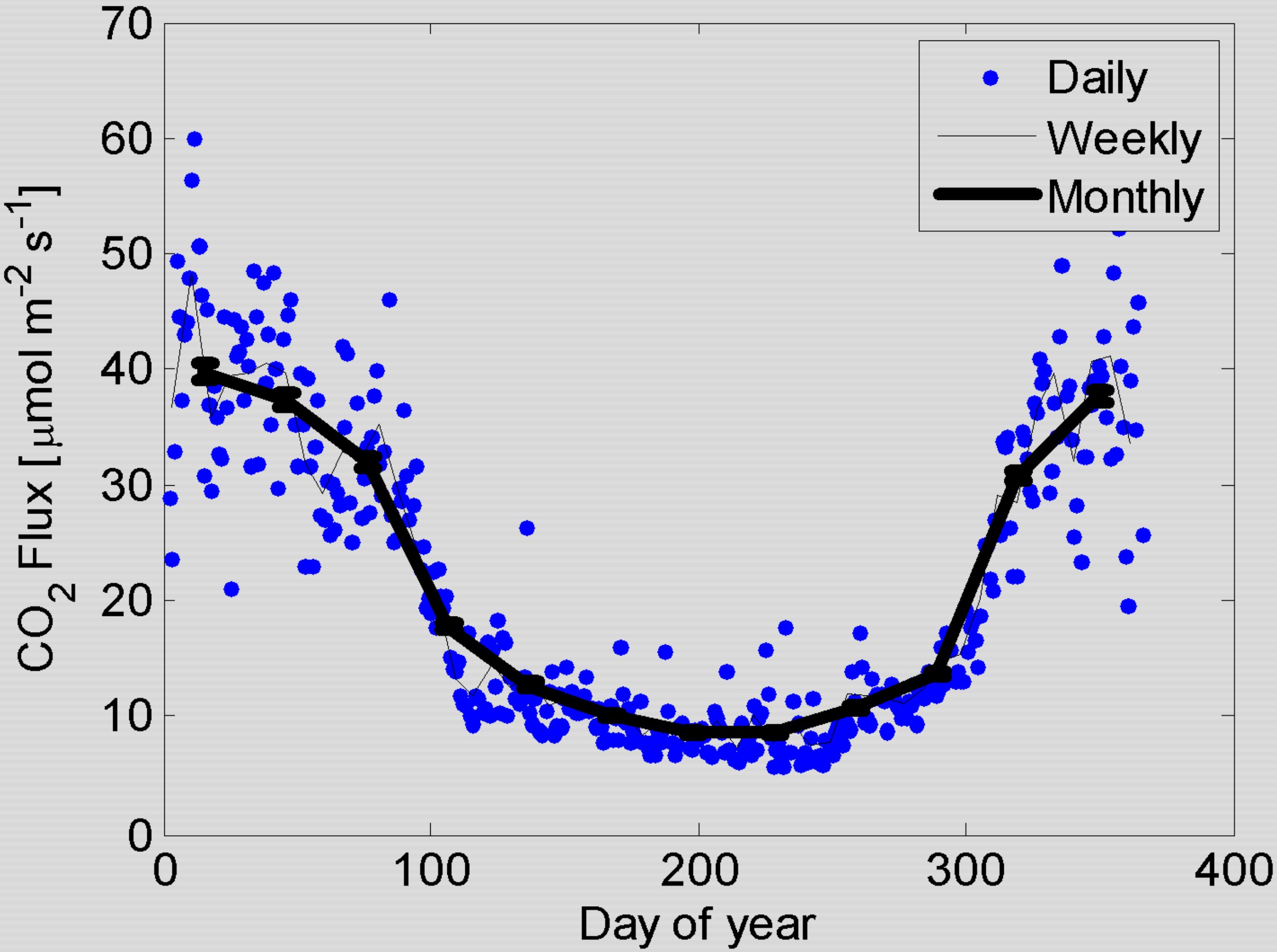
Helsinki case study
Mean diurnal courses sensible heat and CO_2



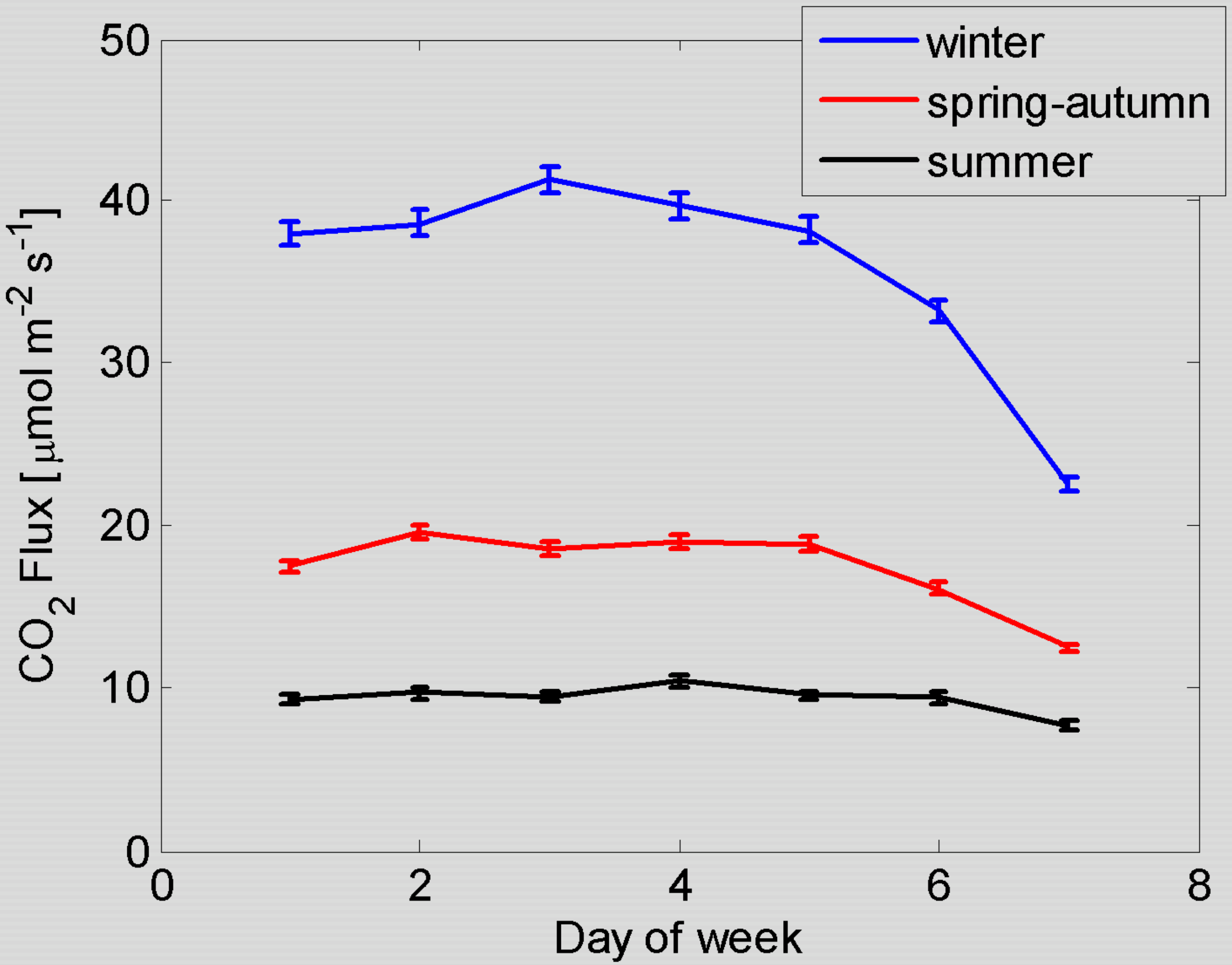
Helsinki case study
Modeled versus measured fluxes



Firenze case study
Seasonality of CO_2 fluxes

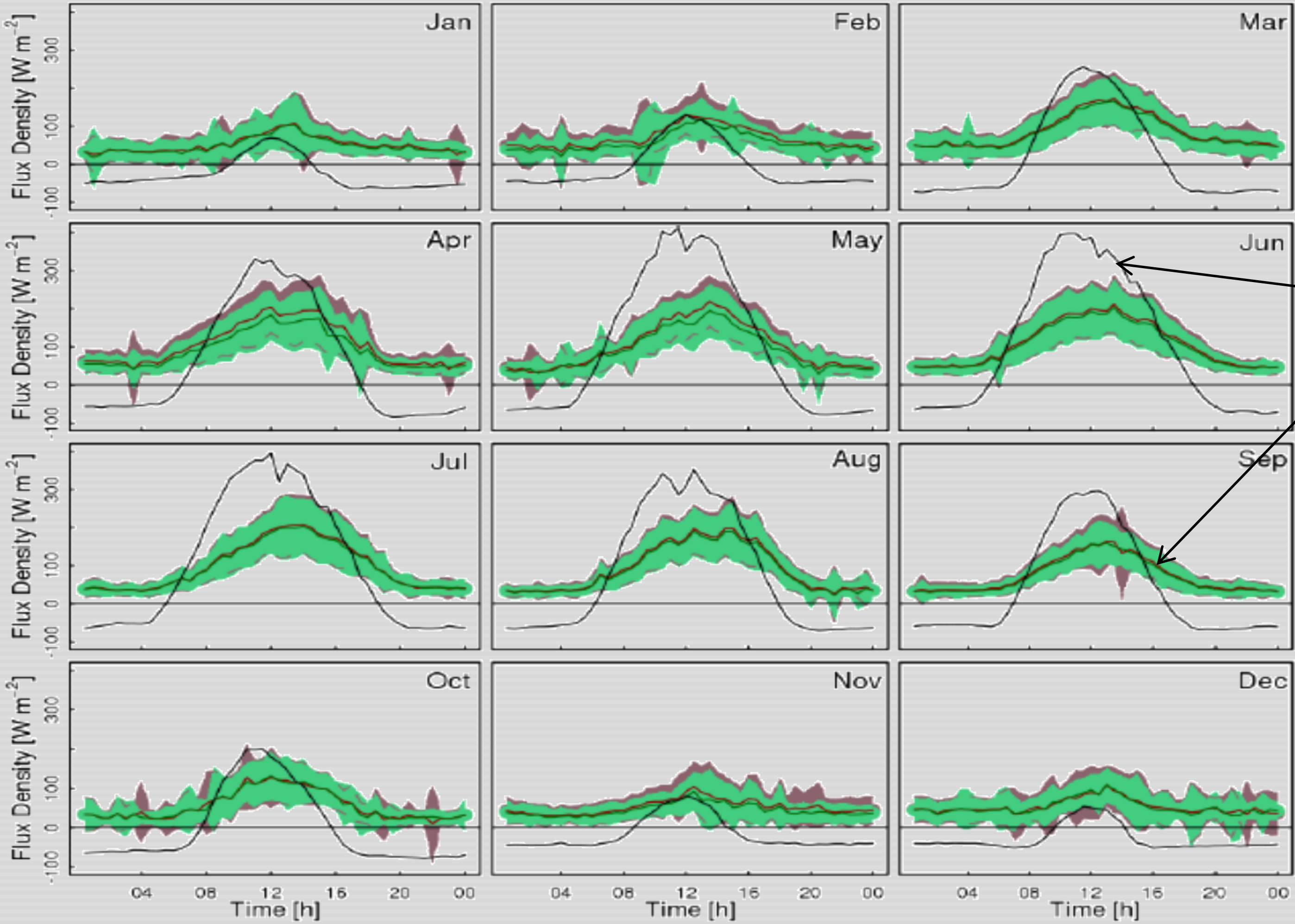


Firenze case study
CO_2 fluxes, dependence on day of week



London case study

CO_2 fluxes, mean monthly diurnal courses



Monthly averaged diurnal cycles

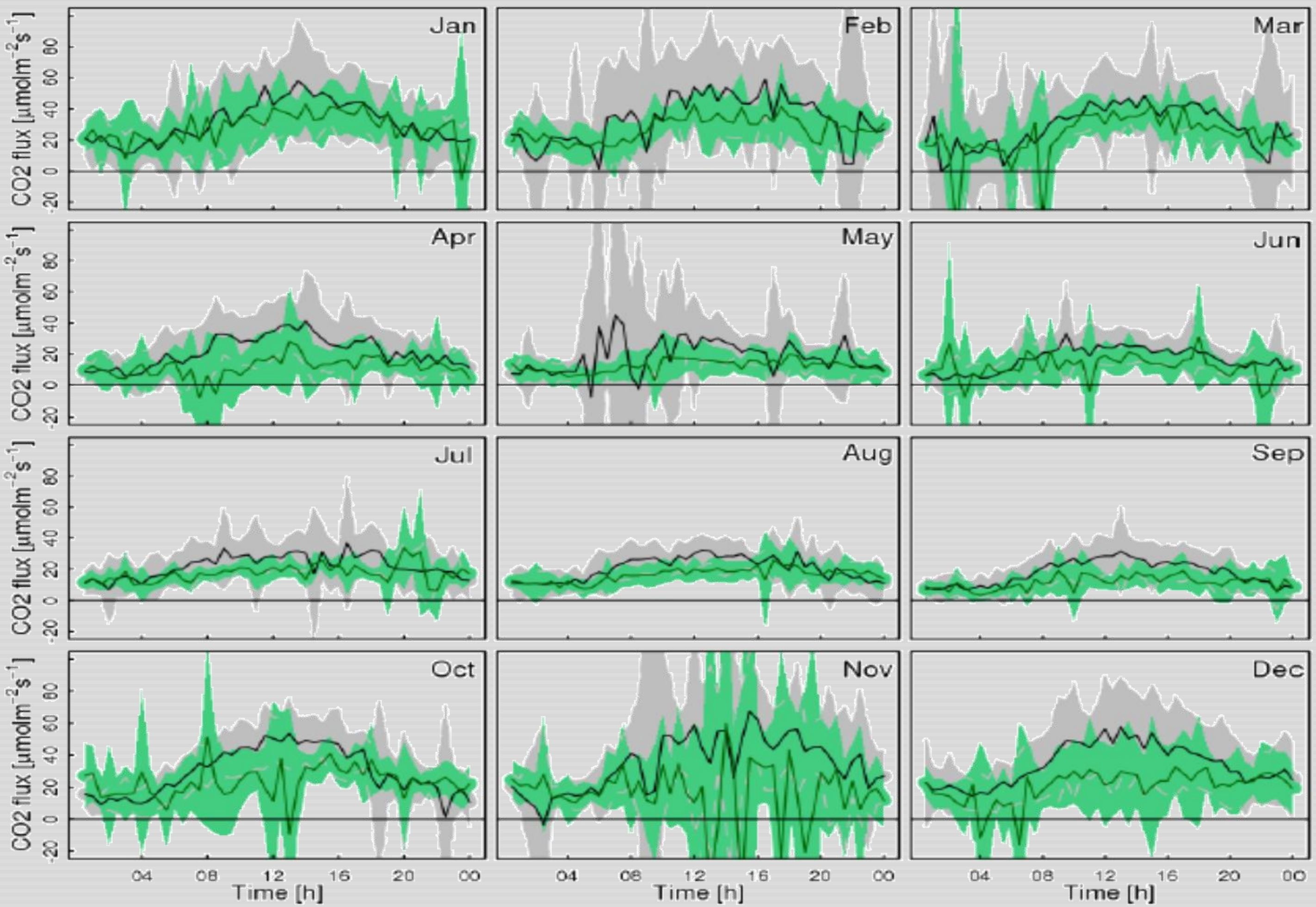
Net radiation (black)

Sensible heat flux

shaded:
Standard deviation
Sensible heat flux

London case study

CO_2 fluxes, mean monthly diurnal courses, day of week



Monthly averaged diurnal cycles of CO_2 fluxes

Weekdays = black

Weekends = green

shaded:
Standard deviation

Finally an example from Florence

Influence of two planning scenarios on air temperature.

Scenario 1

Complete reforestation of a green area and a sport arena in the Cascine park in Florence. Increase of deciduous trees.

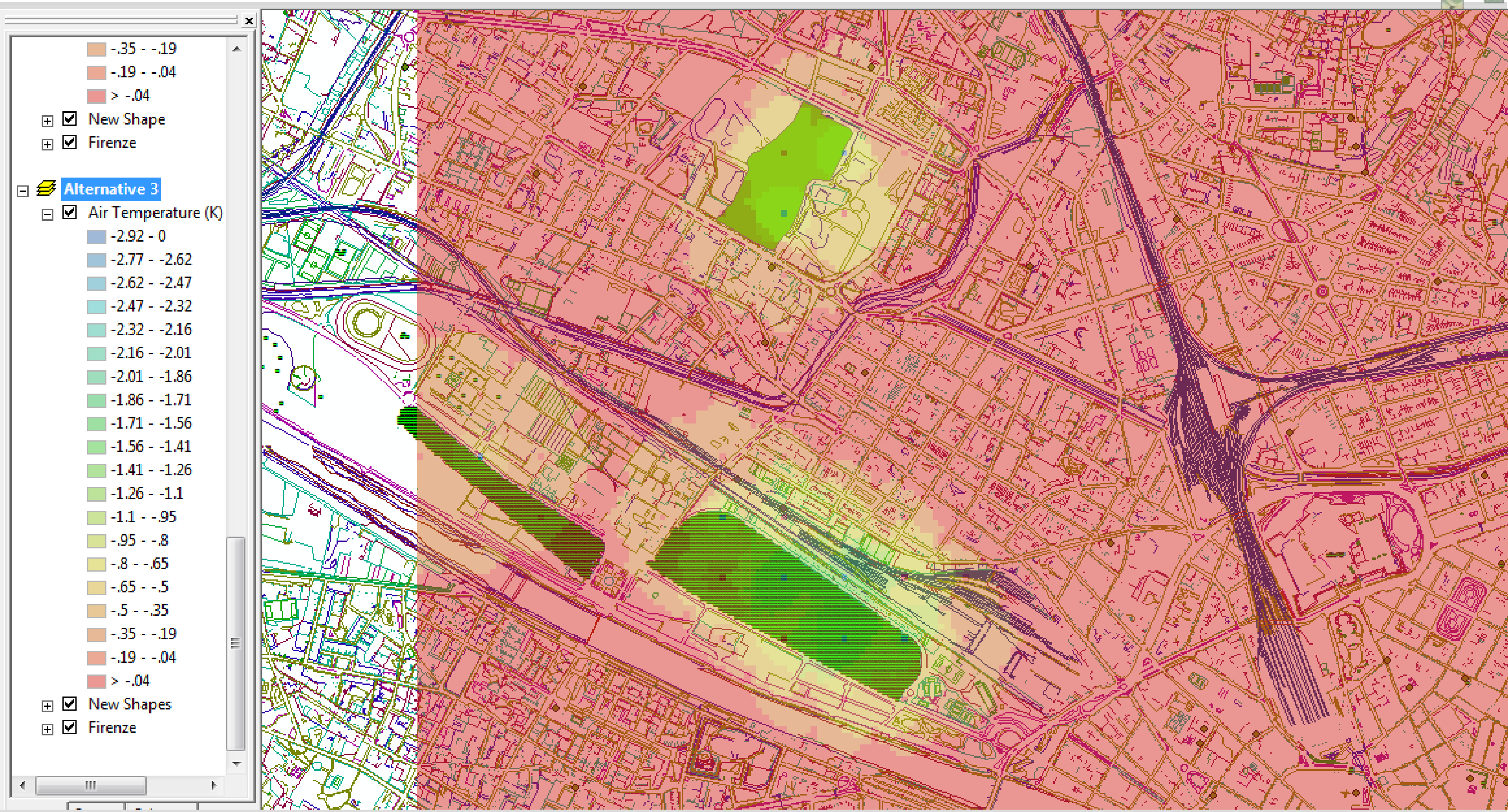
Scenario 2

Redevelopment of a former industrial area (FIAT) in the North of the Cascine park of Florence.

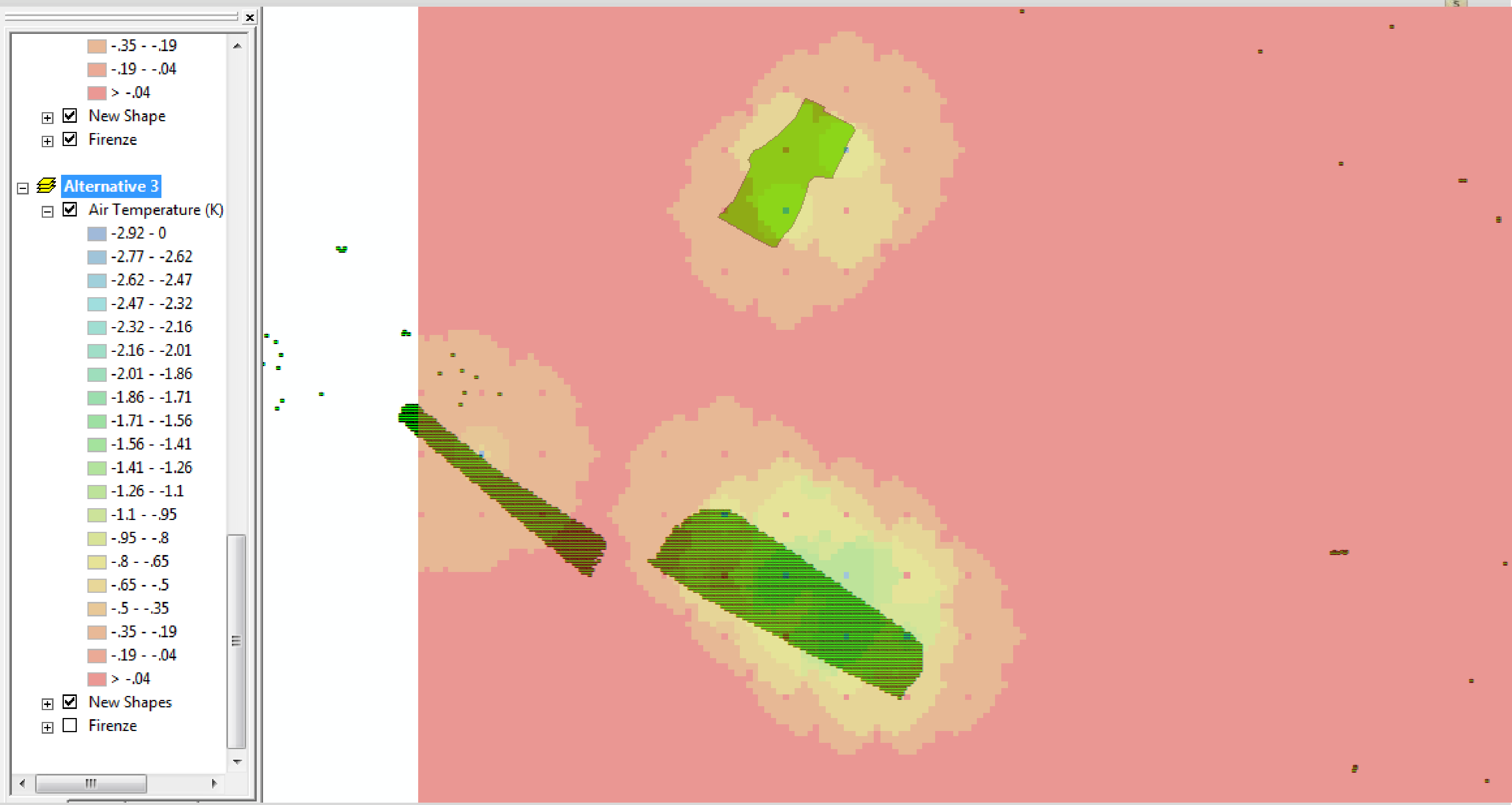
Results are displayed as a differences to the base situation
Average nocturnal temperatures from 0 to 6h for July

Florence example

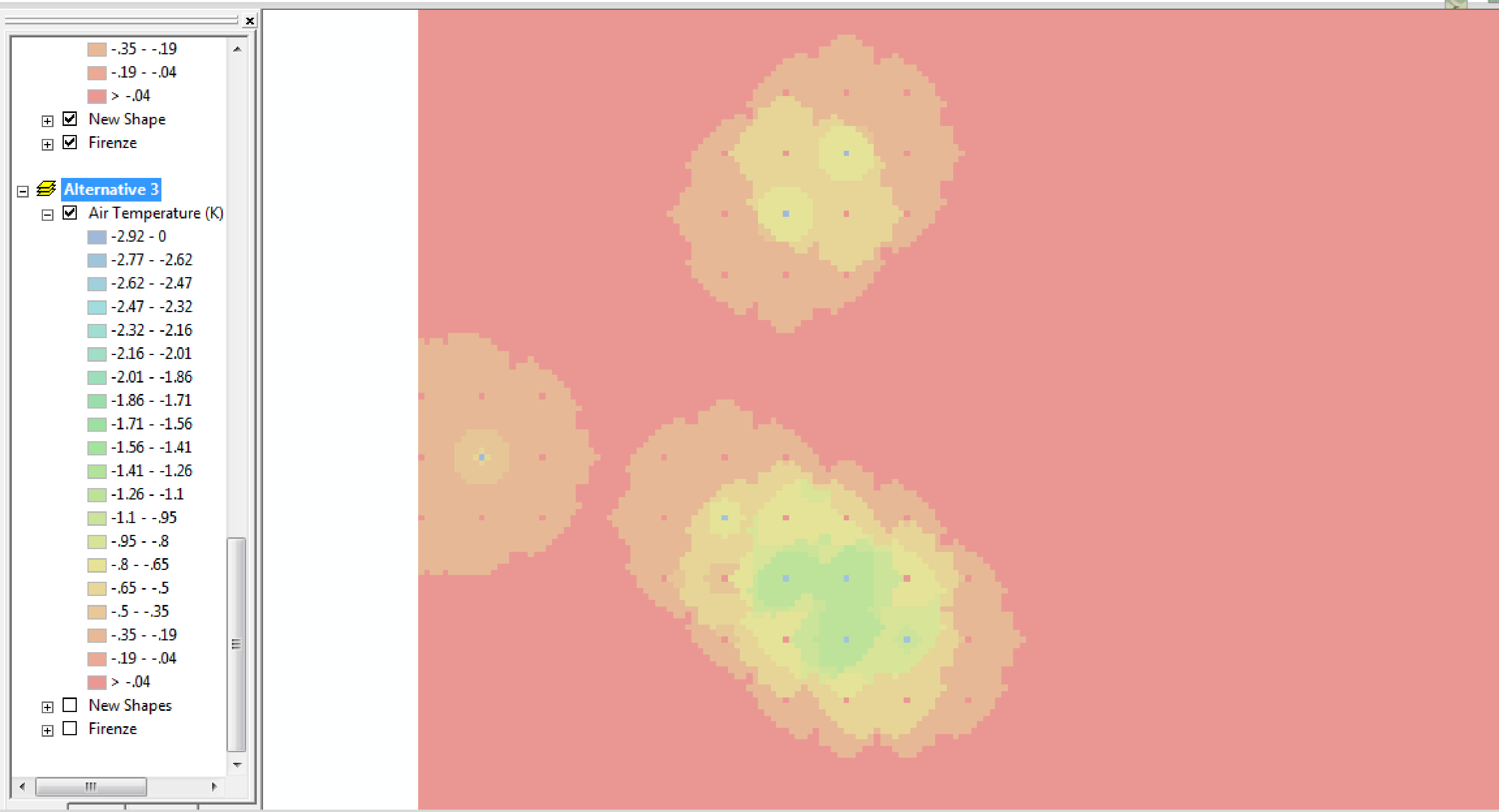
Florence example



Florence example



Florence example



Finally….

Go and check out the DSS….

…… and give it a hard time