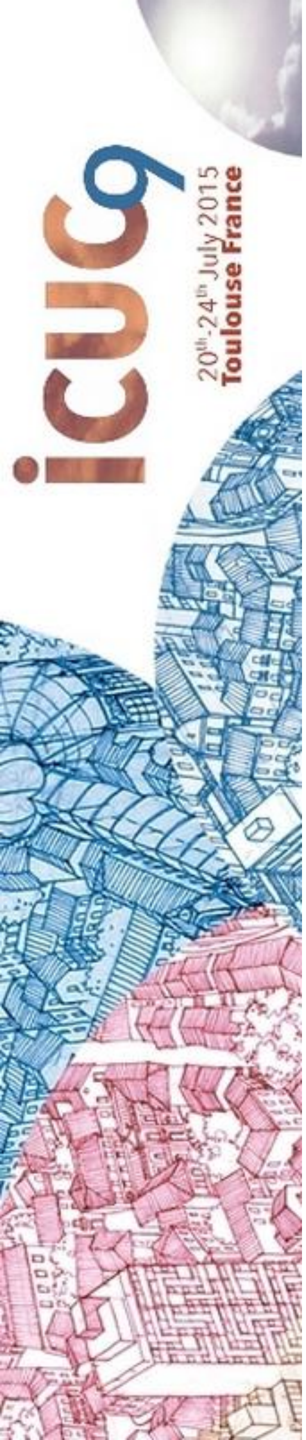

Department of Science for Nature and Environmental Resources
University of Sassari

A.D. MDLXII

AN EMPIRICAL APPROACH TO ESTIMATE THE BIOGENIC COMPONENTS OF URBAN CO_2 FLUX

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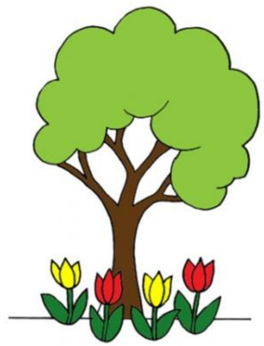
22/07/2015

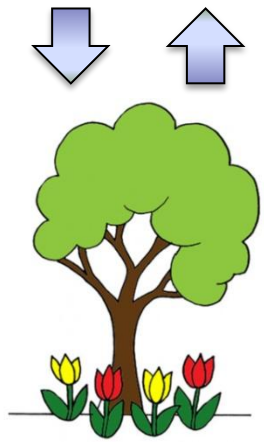
Urban Net Exchnge (UNE)

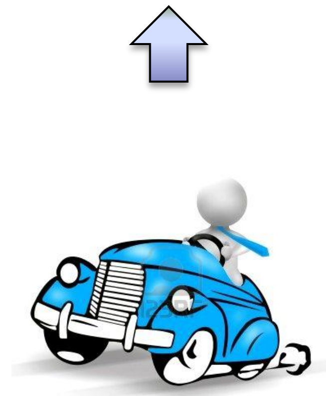


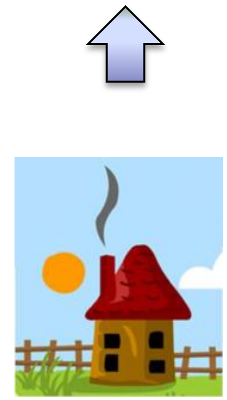
$$UNE = R_{eco} - GPP + E_T + E_B + R_A$$

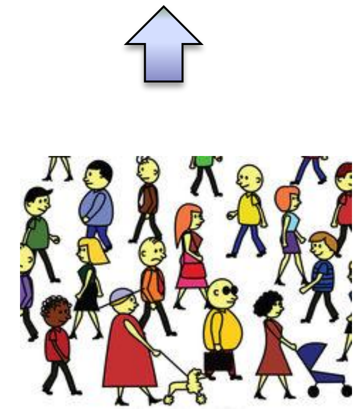
NEE

Urban Net Exchnge (UNE)









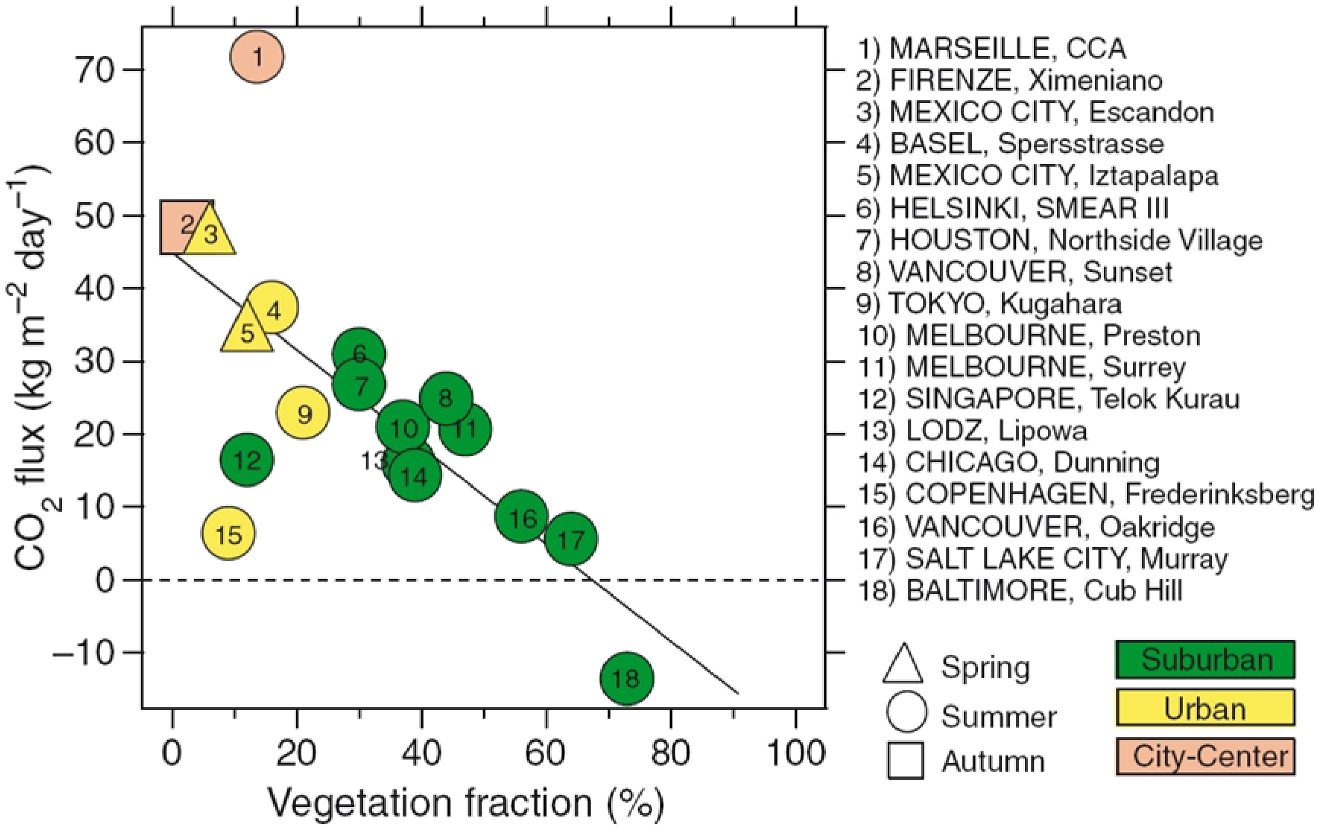
$$UNE = R_{eco} - GPP + E_T + E_B + R_A$$

NEE

- is it possible to develop an empirical model based on relations among different ecosystems ?
- is it possible to simulate carbon exchanges of urban and non-urban ecosystems based on land cover fractions and environmental variables?

Vegetation cover fraction (λ_V)

(from Velasco and Roth, 2010)



λ_V > 70% – 80% cities can be considered sinks at annual scale
(Velasco and Roth, 2010; Nordbo et al., 2012)

λ_V > 34% vegetation offsets emissions due to other sources
(Bergeron and Strachan, 2011; Velasco and Roth, 2010)

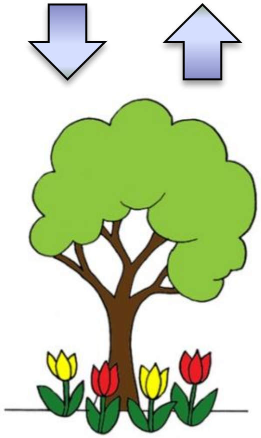
λ_V < 5% soil and vegetation exchanges can be neglected
(Matese et al., 2009; Moriwaki and Kanda, 2004; Velasco et al., 2009)

Sites description and analysis

Site	*Area*	*Latitude*	*Period*	λ_V
Morgan Monroe State Forest[L] **(MMSF), IN, USA** (Schmid et al., 2000)	Deciduous forest	39.32° N 86.42° W	May–September (1998)	100%
Baltimore, MD, USA[L] (Crawford et al., 2011)	Suburban	39.41° N 76.52° W	Summer (2002–2006)	67%
Swindon, UK[L] (Ward et al., 2013)	Suburban	51.58° N 1.80° W	Summer (2011)	45%
Serdiana, Italy[or] (Marras et al., 2012)	Vineyard	39.36° N 9.12° E	Summer (2009–2011)	~50%
Montalcino, Italy[or] (Marras, 2008)	Vineyard	43.08° N 11.80° E	Summer (2005–2006)	~50%
Capocaccia, Italy[or] (Marras et al., 2011)	Mediterranean Maquis	40.61° N 8.15° E	Year (2005–2010)	~70%

[L]*literature dataset*, [or]*original dataset*

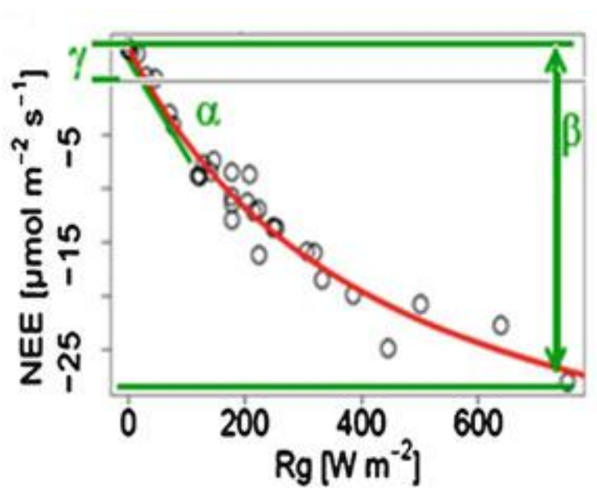
Model development



✓ Daytime data (R_g > 5 W m^{-2}),

✓ fit of the light-response curve with LOESS regression (Cleveland et al., 1992),

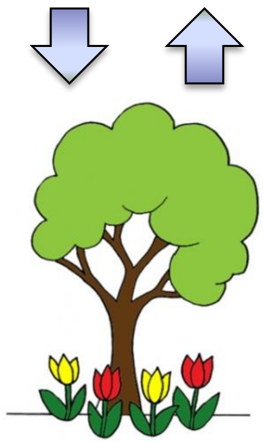
✓ fit of the light-response curve using the **Non-Rectangular Hyperbola** (NRH) (Rabinowitch, 1951) and estimation of its α, β, γ, and θ coefficients through the non-linear least square regression.



(from Reichstein et al., 2012)

$$R_{eco} - GPP = \gamma - \frac{1}{2\theta}\left(\alpha PAR + \beta - \sqrt{(\alpha PAR + \beta)^2 - 4\alpha\beta\theta PAR}\right)$$

Biogenic empirical model



Environmental variable

Vegetation cover fraction

Relation among different ecosystems

R_g → PAR

λ_V → $\alpha(\lambda_V)$, $\beta(\lambda_V)$, $\gamma(\lambda_V)$, $\theta=0.96$

$$\gamma - \frac{1}{2\theta} \cdot \left(\alpha PAR + \beta - \sqrt{(\alpha PAR + \beta)^2 - 4\alpha\beta\theta PAR}\right)$$

→ **NEE**

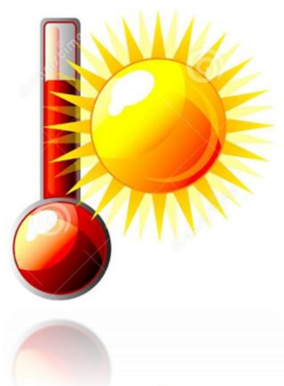
BELLUCCO et al., 2014. 31st Conference on Agricultural and Forest Meteorology, AMS, Portland

Biogenic empirical model test

Helsinki
(Kumpula suburban site, Finland)

λ_V = 52% (all sectors)

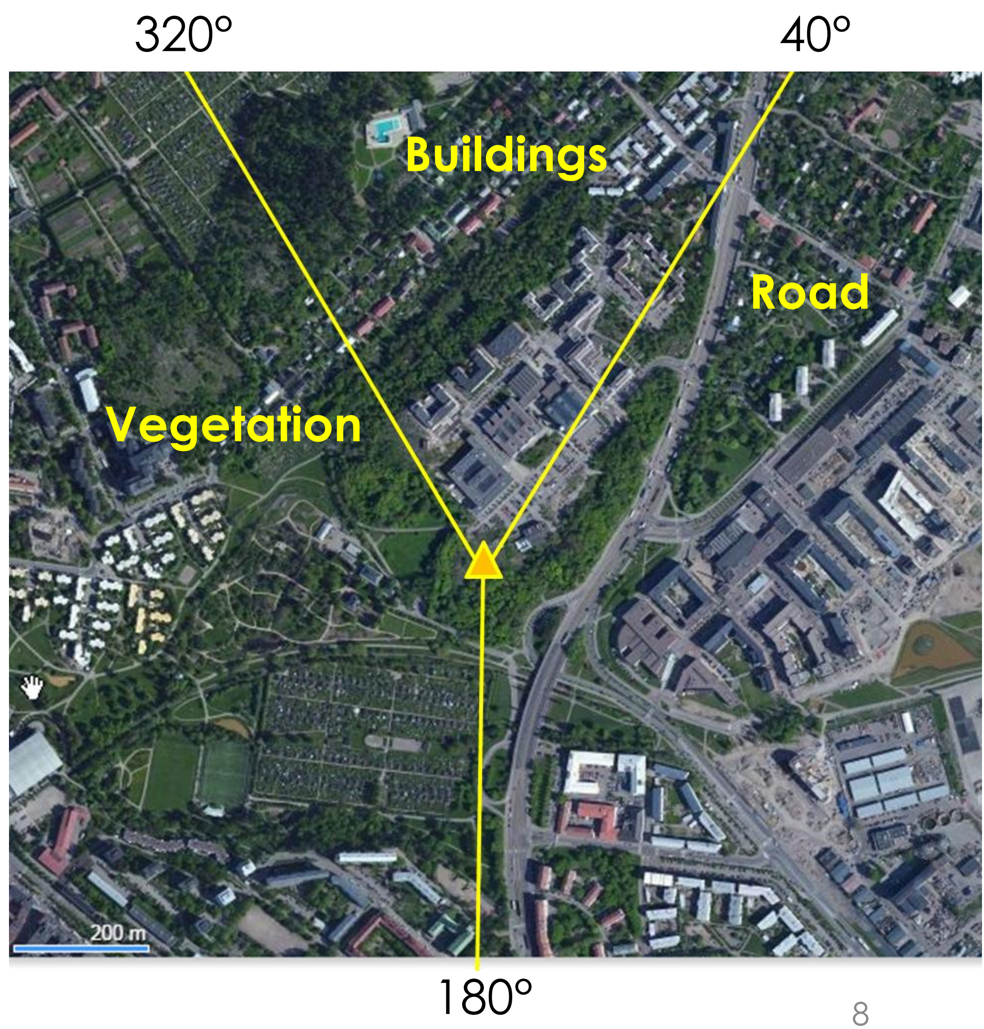
λ_V = 59% (vegetation sector, 180° - 320°, Järvi et al., 2009**)**



summer season
(June – July 2010)

reduced vehicular traffic rates

maximum ecophysiological activity



Biogenic empirical model test

Capo Caccia → λ_V = 70%

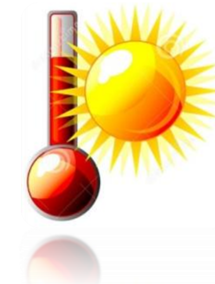
(Alghero,
Mediterranean maquis site, Italy)

winter season
(Jan – Feb – Mar 2011)

Drought periods affect ecophysiological processes

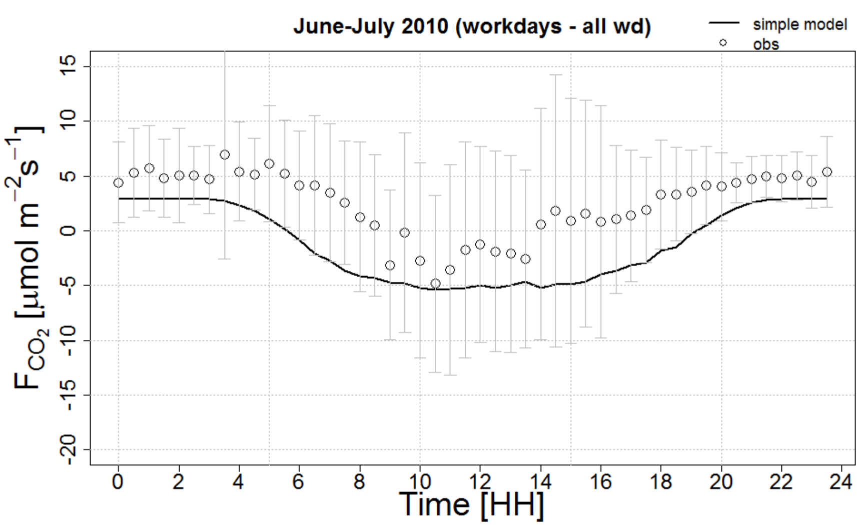
well watered conditions

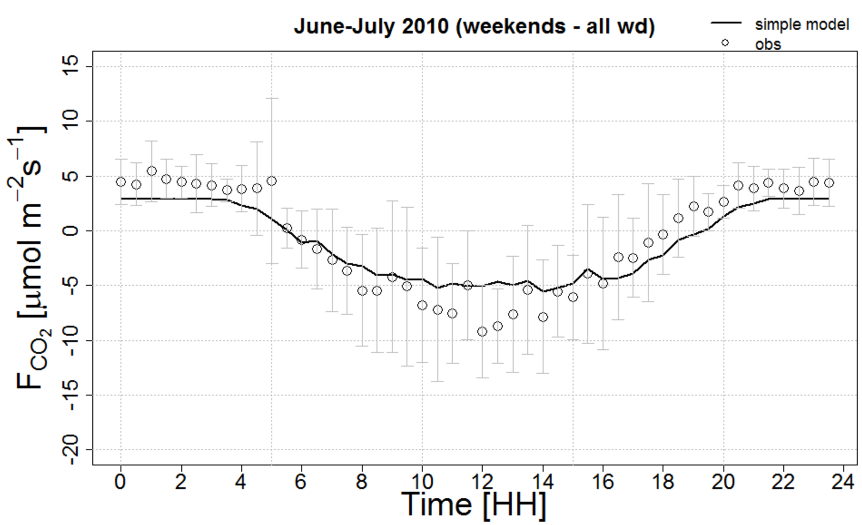
Biogenic empirical model test: Helsinki (suburban)



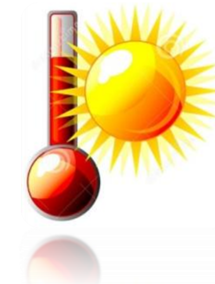
June+July	Wind sector (λ_V)	RMSE	MAE	MBE	IOA	R^2
All days	All (0.52)	2.72	2.47	-2.46	0.86	0.89
Workdays		3.97	3.62	-3.62	0.71	0.77
Weekend		1.79	1.52	-0.28	0.95	0.93

Significant values with P<0.001



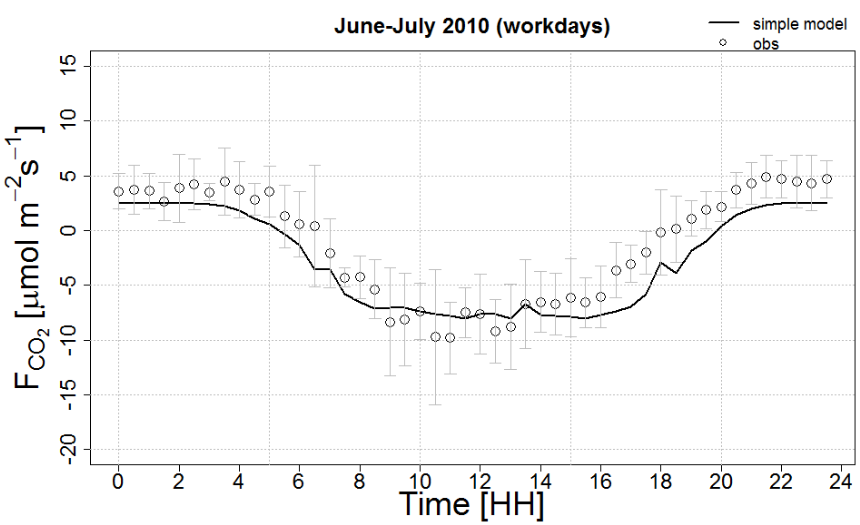


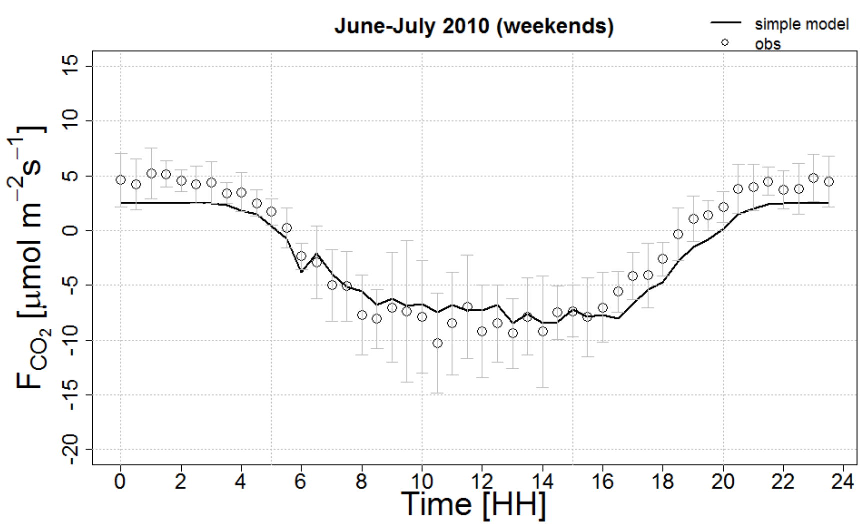
Biogenic empirical model test: Helsinki (suburban)



June+July	Wind sector (λ_V)	RMSE	MAE	MBE	IOA	R^2
All days	Vegetation(59%)	1.77	1.58	-1.16	0.97	0.95
Workdays		2.11	1.86	-1.49	0.95	0.92
Weekend		1.71	1.53	-0.78	0.97	0.96

Significant values with $P<0.001$

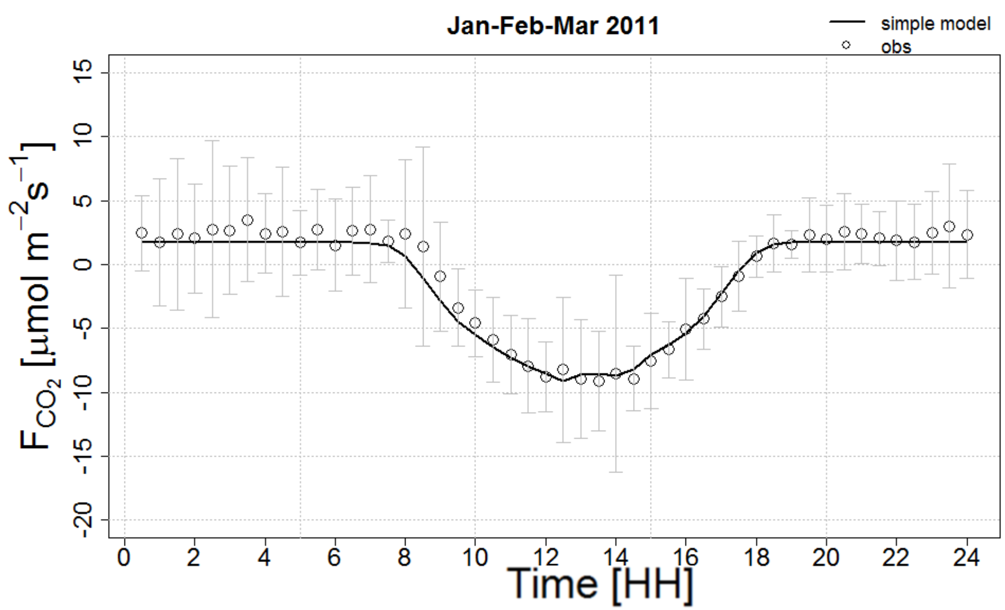


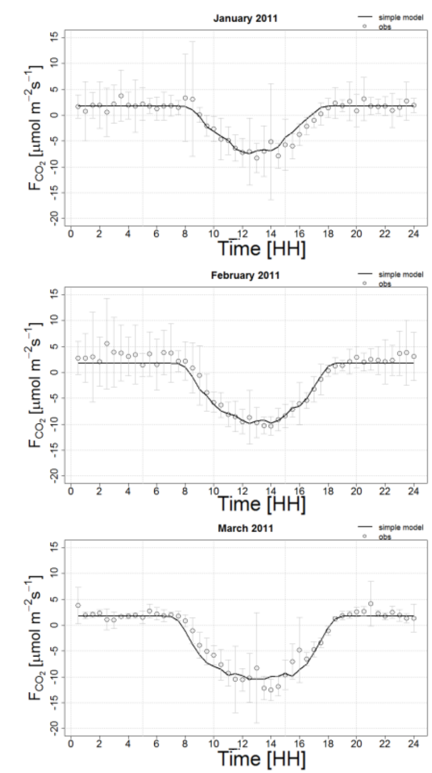


Biogenic empirical model test: Capo Caccia (rural)

	Wind sector (λ_V)	RMSE	MAE	MBE	IOA	R^2
January	All (70%)	0.99	0.72	0.09	0.98	0.93
February		1.25	0.97	-0.70	0.98	0.96
March		1.34	0.98	-0.48	0.98	0.94
Jan+Feb+Mar		0.82	0.63	-0.46	0.99	0.98

Significant values with $P<0.001$





Conclusions

- First step in the development of a simple empirical model based on land cover fraction and environmental variables.

- Good agreement between modelled and observed data (R^2 up to 96% and 98%).

- **General utility:** capture the general behaviour of different ecosystems.

New approach in the study of relations among different ecosystems and the role of vegetation in urban areas.

To increase the robustness of the relations used by this empirical model, and to include a second anthropogenic module, a greater number of sites will be considered.

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