Abstract code: B33D-0421

ENERGY AND MASS FLUX SIMULATIONS IN URBAN AREA USING THE ACASA MODEL

UNIVERSITÀ degli STUDI di SASSARI

Centro Euro-Mediterraneo per i Cambiamenti Climatici

S. Marras[1,2], D. Spano[1,2], R.D. Pyles[2,3], M. Falk[2,3], C. Sirca[1,2], F. Miglietta[4], R.L.Snyder[3], K.T. Paw U[3]

1. University of Sassari, Department of Economics and Woody Plant Ecosystem, Italy, serenam@uniss.it 2. EuroMediterranean Center on Climate Change (CMCC), Sassari, Italy, spano@uniss.it

3. University of California, Department of Land, Air and Water Resources, Davis, CA, USA, ktpawu@ucdavis.edu 4. National Research Council-Institute of Biometeorology CNR-IBIMET Florence, Italy,

Consiglio Nazionale delle Ricerche Ibimet

Department of Land, Air and Water Resources University of California, Davis

INTRODUCTION

Urban metabolism considers a city as a system and distinguishes between energy and material flows as its components. Today, the eddy covariance technique and accurate models are available to simulate these components in urban environments with a good spatial resolution. The Advanced Canopy-Atmosphere-Soil Algorithm (ACASA) model, developed by University of California, Davis, is a higher order closure model for estimating energy and mass fluxes between surface and the atmosphere. The model was used over forest and agricultural ecosystems in the past (Pyles et al., 2000; Marras et al., 2008). ACASA was recently modified to simulate energy and mass fluxes *in situ* in urban environments.

JUSTIFICATION

Because population and urban areas are expanding, it is important to provide quantitative estimates of the urban metabolism using both observations and modeling of physical flux exchanges.

Florence case study

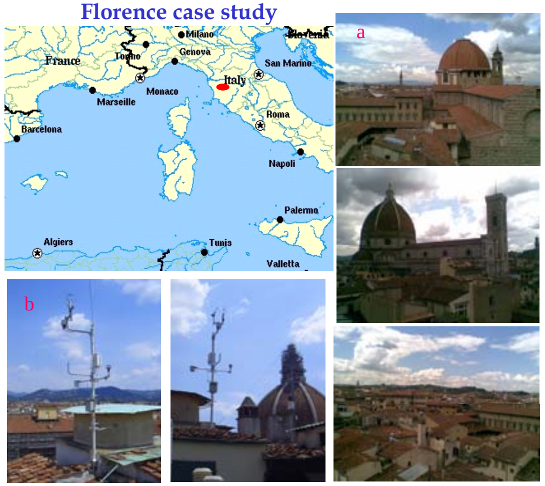

Figure 1. a) Florence measurement site; b) EC station: sonic anemometer, and IRGA analyser mounted on the roof of Osservatorio Ximeniano (36m) located in the city centre.

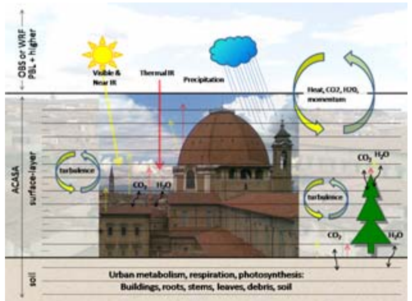

Figure 2. ACASA schematic representation. Soil, surface and atmosphere are considered as a multilayer system.

RESULTS AND DISCUSSION

In a city, most incoming energy is returned to the atmosphere as heat (conduction and convection). In Florence, results indicate that sensible heat flux density (H) and conduction storage flux density (S) (not shown) are the largest components of the energy budget.

In general, the model results indicate good agreement between simulated values and observed data (Figure 3). Observed vs. model composite estimates of fluxes were statistically indistinguishable at the 95% confidence level during the daytime. Small but statistically significant differences were evident at night.

Note: Error bars in the top two panels are large due to high variability in the observed data and meteorological forcing.

Although observed and modelled summertime carbon fluxes match well, model-underestimated wintertime values indicate the need to refine the parameterization of driving and street-level emissions, which become more intense during colder months.

MATERIALS AND METHODS

Eddy Covariance (EC) technique was used to collect continuous data from 2006 in the Florence city center (43°46′07.44′′ N, 11°15′24.84′′ E) (Fig. 1a,b). ACASA simulates fluxes and profiles of heat, water vapor, carbon and momentum within and above canopy using third-order closure equations applied to multiple layers. (Fig.2). ACASA input files include: (1) surface characteristics, (2) meteorological data above the city, and (3) initial conditions. Building surfaces are modeled in a similar manner as for leaves and branches, with "leaf-scale" physical parameters representing urban materials. In addition, street-level fluxes of water, heat and carbon are proportional to population density, known estimates of human and mechanical basal metabolism, time of day (peaks at sunrise and sunset), and time of week (peaks on Monday and Tuesday).

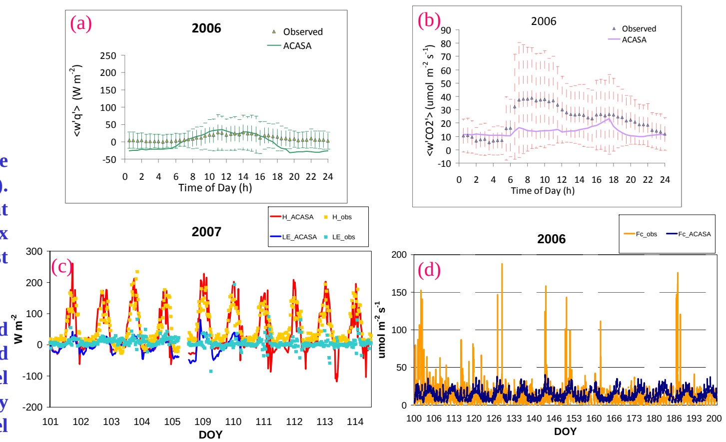

Figure 3. Comparison between simulated and observed fluxes: Composite diurnal cycles of: a) latent heat flux (2006); b) carbon heat flux (2006). Plot c) shows the latent and sensible heat flux time series (2007) and plot d) shows the carbon flux time series (2006).

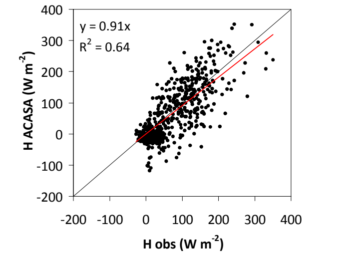

Figure 4. Linear regression for simulated and observed half-hourly sensible heat flux data for different periods in 2006 and 2007.

ACASA model accuracy was evaluated using linear regression, the root mean squared error, the mean absolute error, the mean bias error, and the index of agreement. Regression significance between simulated and measured fluxes was evaluated by the F test. Statistical significance was tested.

Shown here is a scatter diagram for observed vs. modelled sensible heat flux density (H). We place high confidence in using H for this kind of comparison due to its large range of values and observational integrity.

CONCLUSIONS

The use of ACASA to predict energy and mass fluxes between the urban environment and the atmosphere appears promising.

Simulations of carbon exchange will likely improve by including 'vehicle flux density' as an input parameter to better represent the diurnal cycle of simulated carbon fluxes.

REFERENCES

Pyles R.D. Weare B.C., Paw U K.T., 2000. *The UCD Advanced Canopy-Atmosphere-Soil Algorithm: Comparison with observations from different climate and vegetation regimes*. Q.J.R. Meteorol. Soc.,126: 2951-2980.

Marras S., Spano D., Sirca C., Duce P., Snyder R.L., Pyles R.D., Paw U K.T., 2008. *Evaluation of the Advanced-Canopy-Atmosphere-Surface Algorithm (ACASA) Model using Eddy Covariance technique over sparse canopy*. American Geosciences Union Fall Meeting. San Francisco, California (USA) 15-19 December 2008.

ACKNOWLEDGEMENTS

This research was funded form the European Community's Seventh Framework Program (FP7/2007-2013) under grant agreement n° 211345.