National Research Council
Institute of Agro-Environmental and Forest Biology

Ozone fluxes from an urban park: the unique station of Bosco di Capodimonte in Naples

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OUTLINE

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   - Objectives
2. MATERIAL & METHODS
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   - Eddy Covariance in Capodimonte
3. RESULTS
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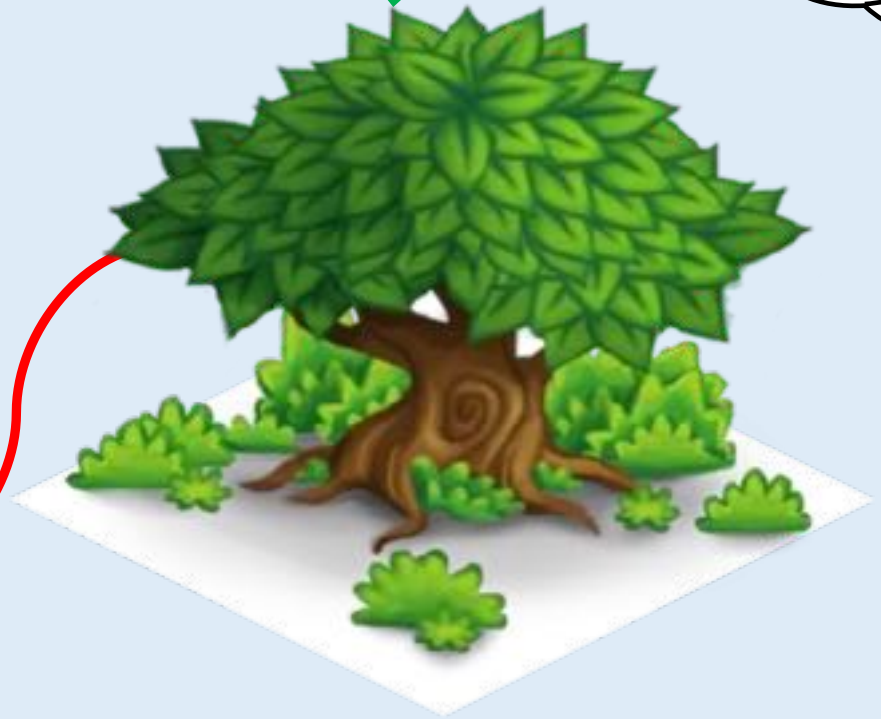
   - Preliminary results of O_3 fluxes
   - CO_2 fluxes
4. CONCLUSION and NEXT STEPS

Urban Park

URBAN FORESTS/PARKS ARE LIVING SYSTEMS INTEGRATED IN HIGHLY ANTHROPIC AREAS

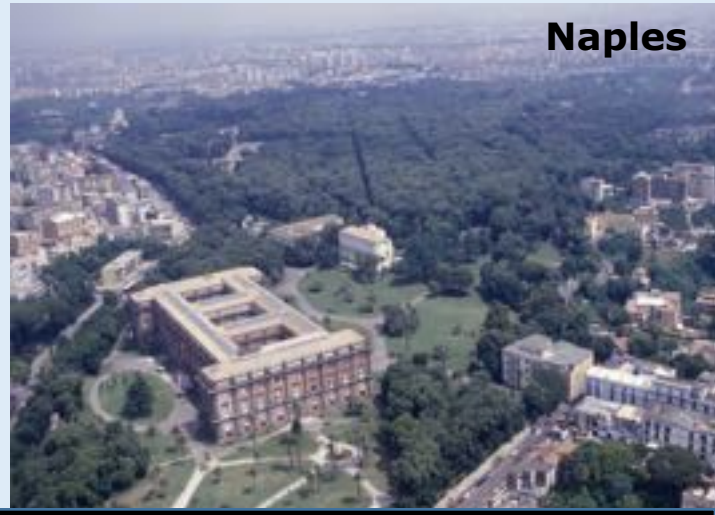
CH_4, H_2O, CO_2
(Nowak et al., 2008)

(VOC, O_3, NO_x, PM)
(Paoletti 2009; Manes 2012)



ENVIRONMENTAL SERVICES

AFFECTING URBAN AIR QUALITY
(Nowak et al., 2016)



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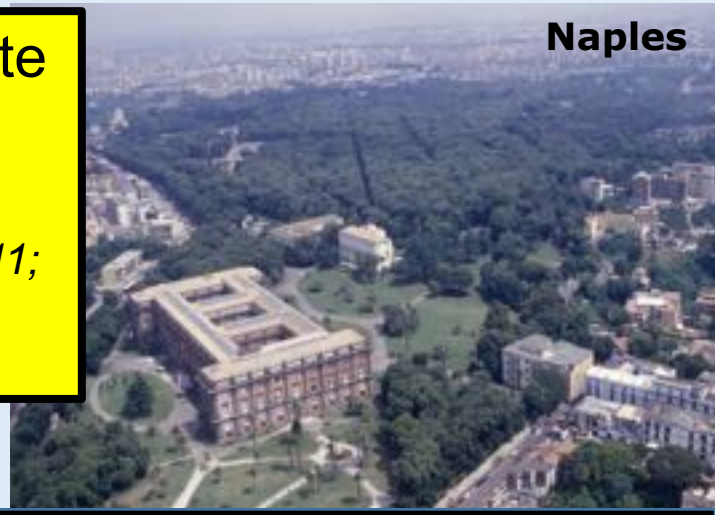
ENVIRONMENTAL SERVICES

AFFECTING URBAN AIR QUALITY
(Nowak et al., 2016)

MODELS are often used to estimate air pollutants removal capacity

(Escobedo and Nowak, 2009; Alonso et al., 2011; Barò et al., 2014; Kim et al., 2014, Guidolotti et al. 2016).



Urban Park

URBAN FORESTS/PARKS ARE LIVING SYSTEMS INTEGRATED IN HIGHLY ANTHROPIC AREAS
REPRESENTING A UNIQUE "*OPEN LAB*"

HIGH TEMPERATURES
'urban heat island effect'
(*Gillner et al. 2014*)

INCREASED CO_2 CONCENTRATION
(*Searle et al. 2012*)

INCREASED/DECREASED O_3 CONCENTRATION
(*Calfapietra et al. 2013*)

INCREASED N DEPOSITION
(*Rao et al. 2013*)

SPECIFIC AIR & SOIL POLLUTTANTS

Objectives

WE ESTABLISHED AN EDDY COVARIANCE URBAN FOREST STATION:

- **TO DIRECT MEASURE TRACE GASES FLUXES IN URBAN PARCK ECOSYSTEMS**

- **TO BETTER UNDERSTAND THE EFFECTS OF FUTURE ENVIRONMENTAL CHANGES ON PLANT AND ECOSYSTEM PERFORMANCES**
- **TO UNDERSTAND ENVIRONMENTAL EFFECTS OF URBAN PARCK ON URBAN AIR QUALITY AND QUALITY OF LIFE OF CITIZEN**

The Royal Forest of Capodimonte in Naples

The Real Bosco di Capodimonte, a green area of **125 ha** located inside the urban area of Naples

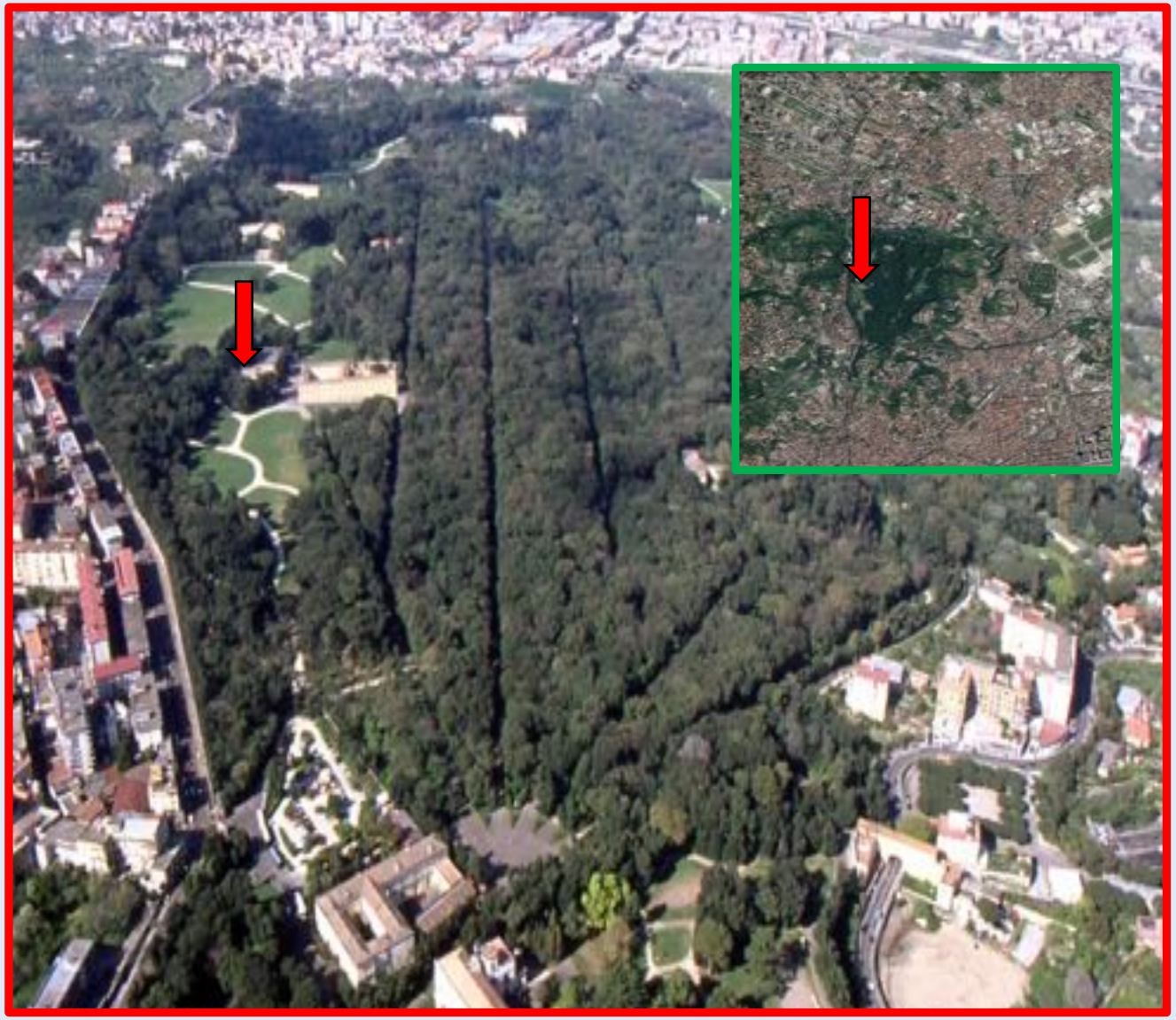
16.3 °C Mean annual temperature
8.4 °C Mean Temperature of coldest month
24.7 °C Mean Temperature of warmest month
855 mm Mean annual precipitation

Mixed Mediterranean forest dominated by:

- *Quercus ilex (**22 m** mean height)*
- *Pinus pinea*

Meadows: *Trifolium* and *Medicago.*

Several autochthonous and exotic tree species



Eddy Covariance in Capodimonte

FRAMEWORK OF EDDY TRANSPORT *(from Burba et al. 2008)*

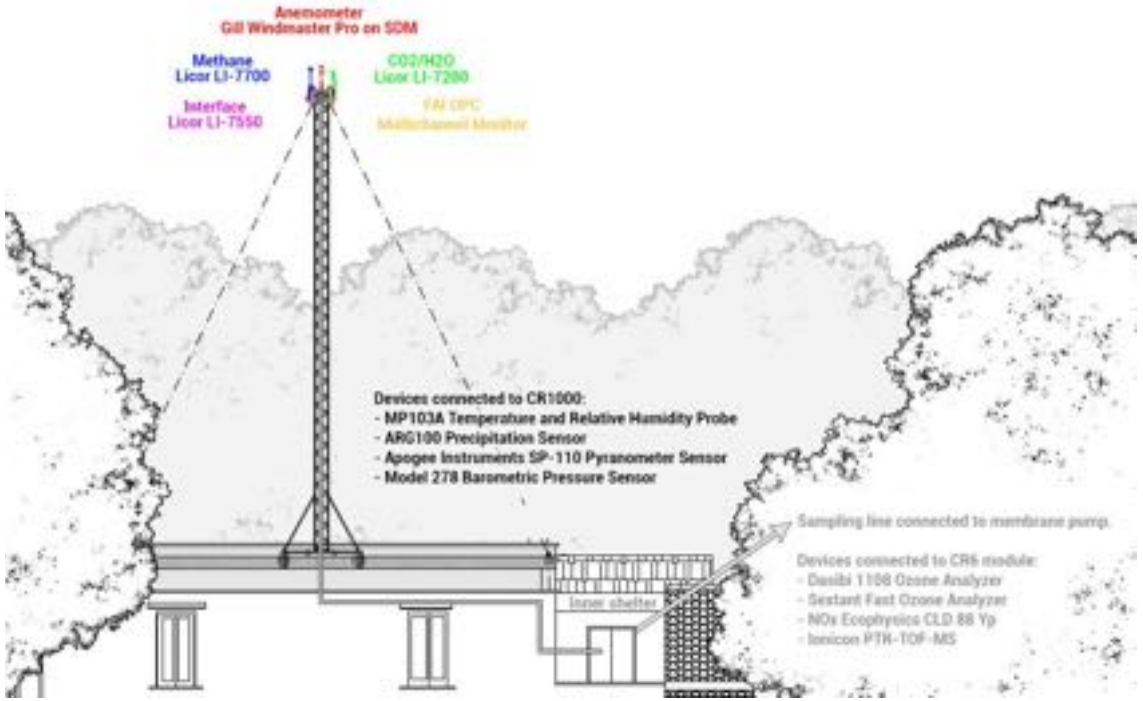
- micro-meteorological technique, based on the turbulent upward and downward movement of the air (eddies) transporting masses (gases, PM).
- It is a reliable method to assess exchange of masses between biosphere and atmosphere.

- Purple arrow represent the **air flow** as a horizontal flow of numerous rotating eddies
- Each **eddy has 3-D components**, that can be measured from the tower
- At a single point on the tower vertical flux can be represented as a **covariance between measurements of vertical velocity**, the up and down movements, and **concentration of the entity of interest**.

Eddy Covariance in Capodimonte

….IN CAPODIMONTE

The flux tower (**25 m**) is above a small building



(from Guidolotti et al. 2017)

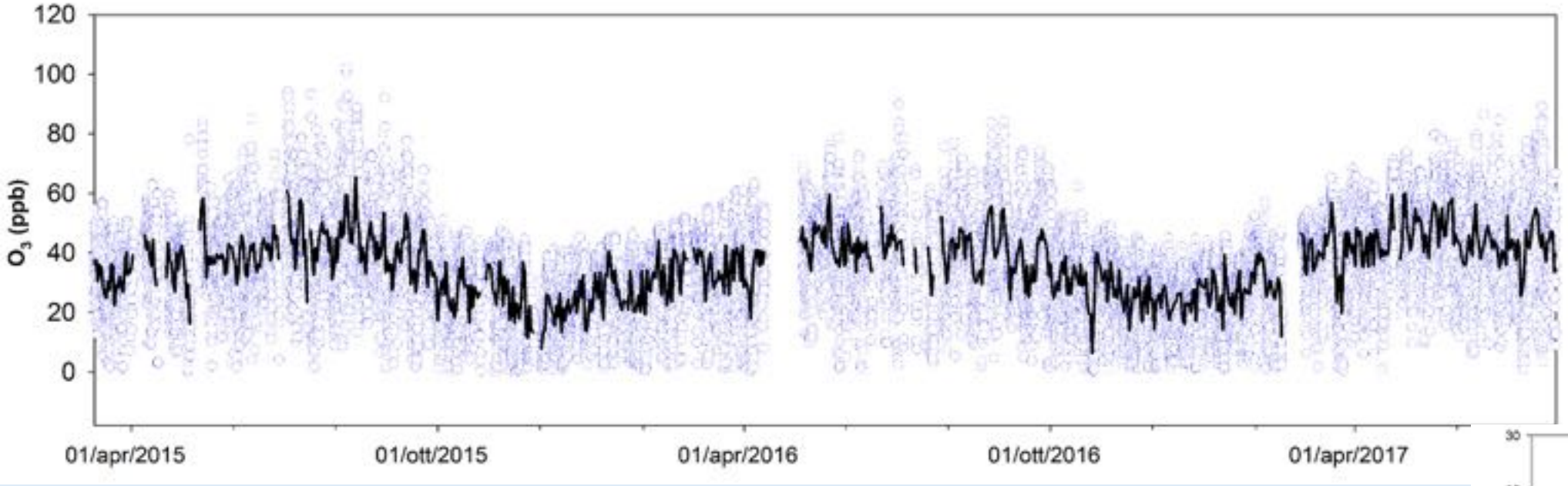
Equipped with instruments
to measure concentrations/exchanges of:

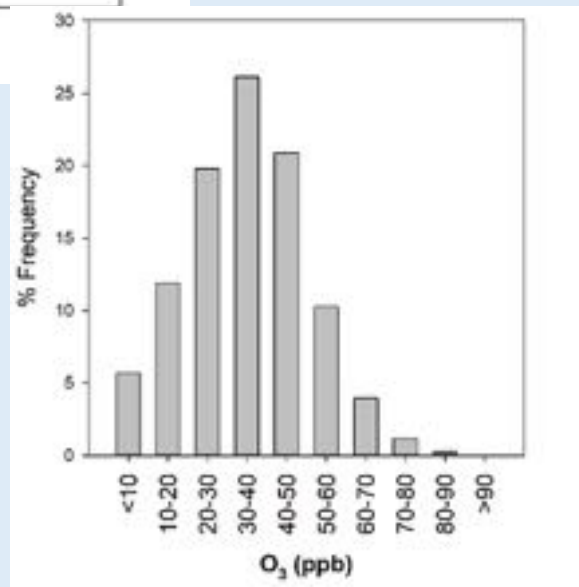
CO_2
H_2O
CH_4
O_3

PM
VOCs
NO_X

O_3 Concentration

(from March 2015 to July 2017)



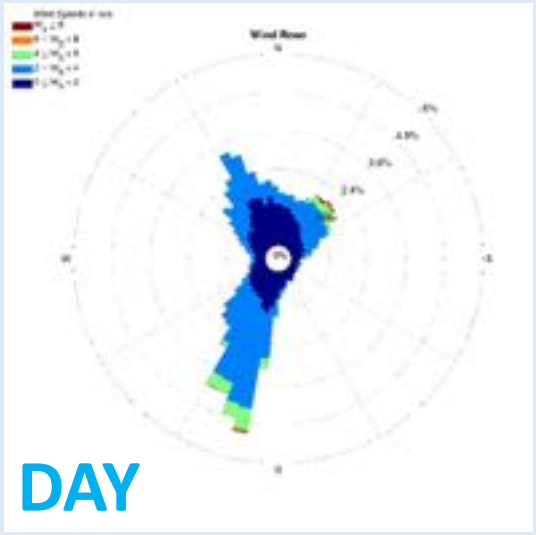


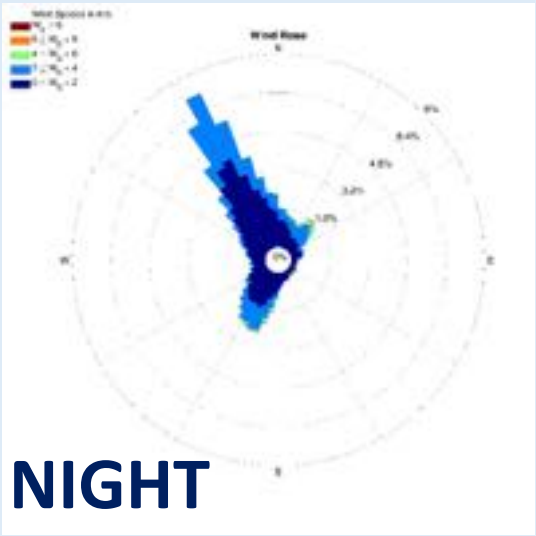
- Daily ozone concentrations frequently exceed **70 ppb** during the summer and are rarely below **25 ppb** during the cold season

- High ozone concentrations occur at this site for the transport of polluted air from the city

Footprint Analysis

(from March 2015 to September 2017)





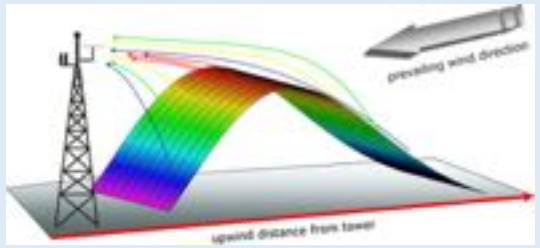
- White border represent up to **80%** of accumulated flux footprint
-the distance of 80% of accumulated footprint was about **100 m** around the tower

Land Cover Contribution

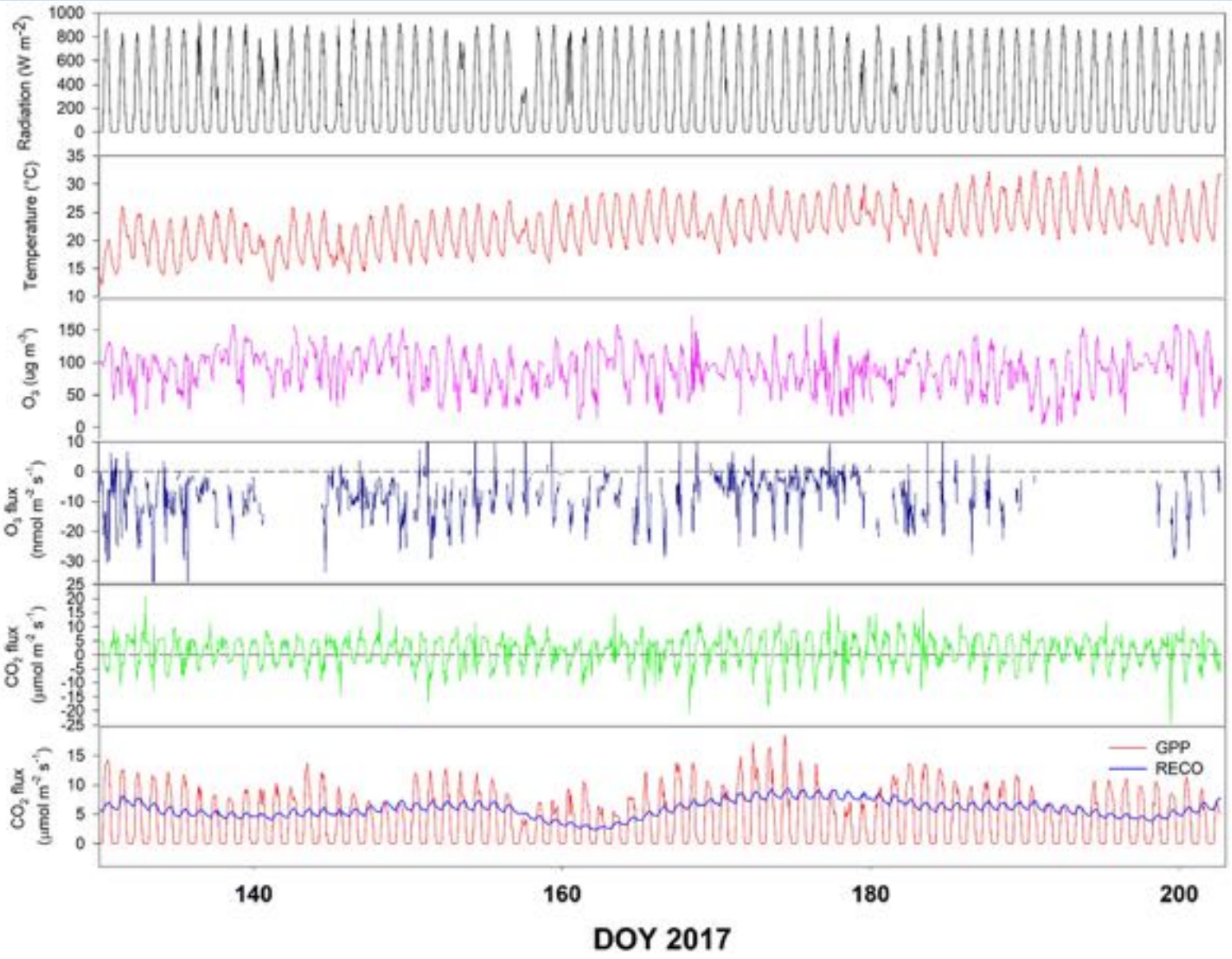
41 % from the mixed forest

13 % from the meadow

46 % from the buildings



Flux Pattern



Stable Radiative period

High temperature

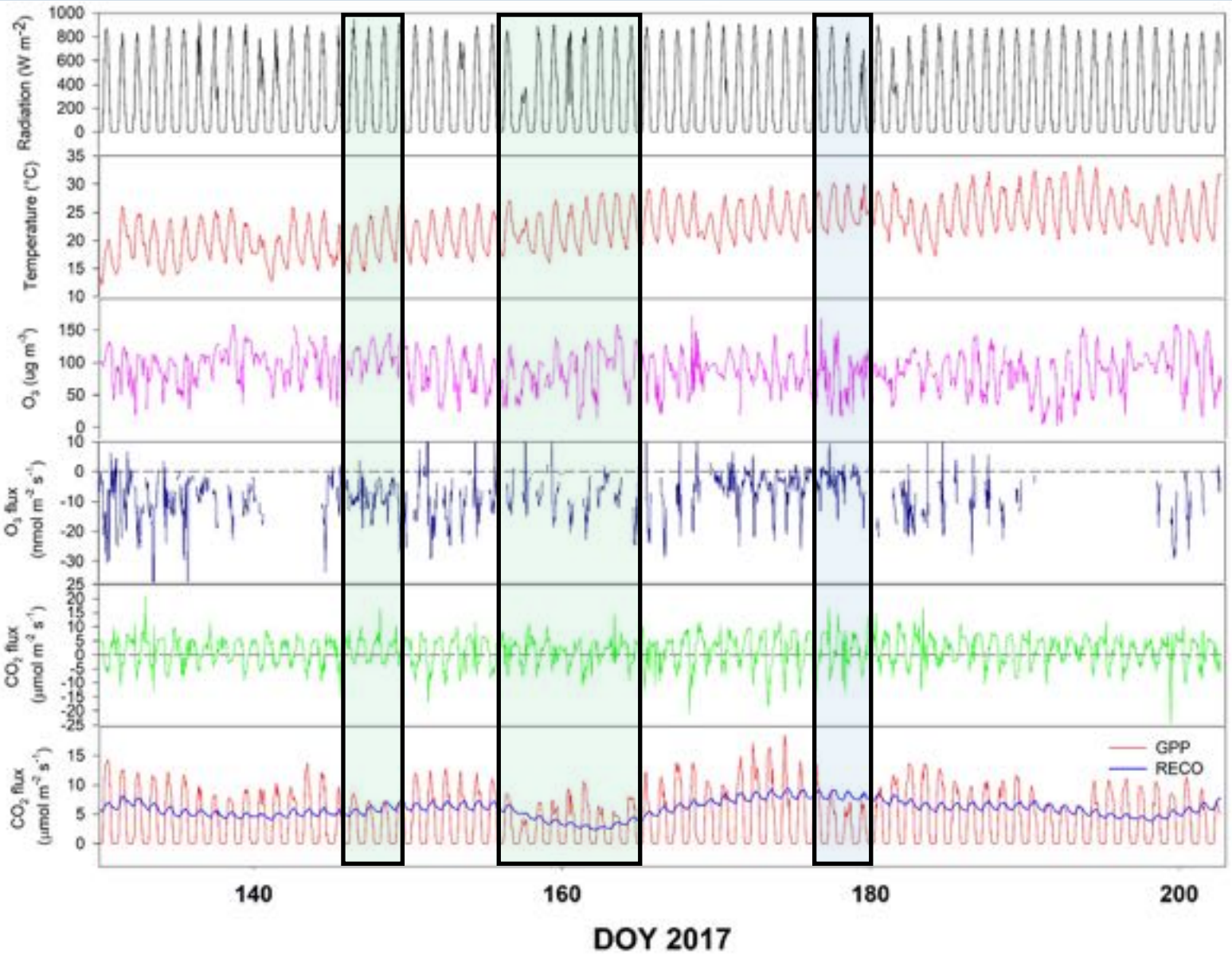
Stable O_3 concentration range

O_3 Fluxes up to – 30 nmol $m^{-2}s^{-1}$

CO_2 Fluxes
from -15 to +10 µmol $m^{-2}s^{-1}$

GPP/RECO Partitioning

Flux Pattern



REDUCTION OF O_3 DEPOSITION

COUPLED WITH

REDUCTION OF

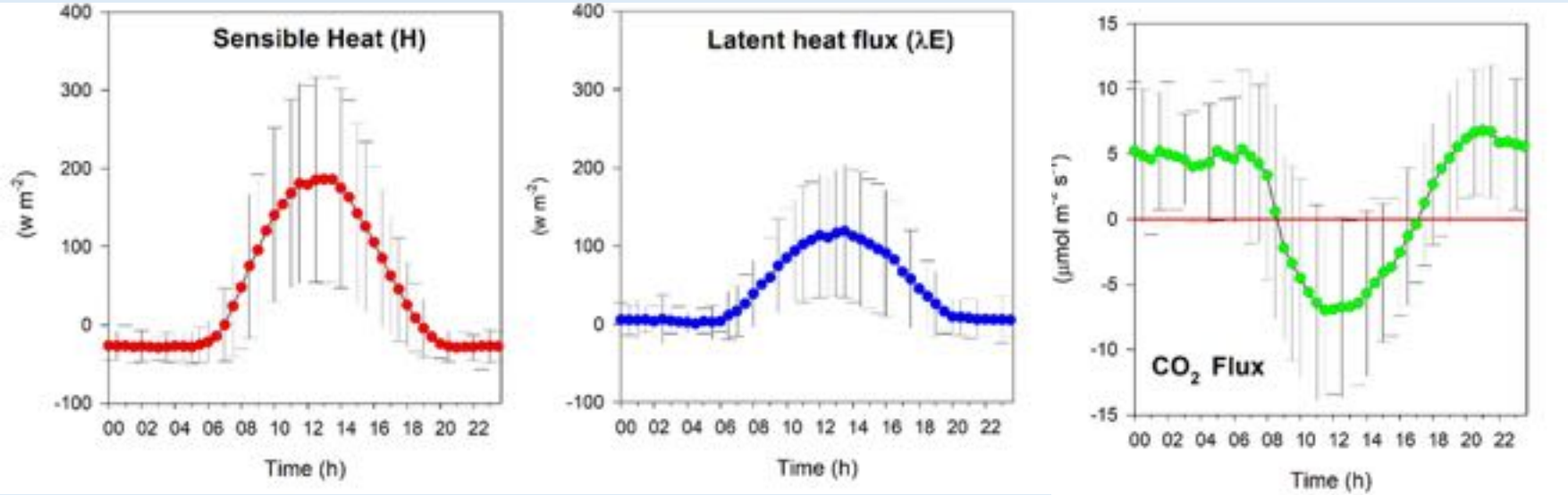
NEE

GPP

SUGGESTS

LARGE EFFECT OF STOMATA

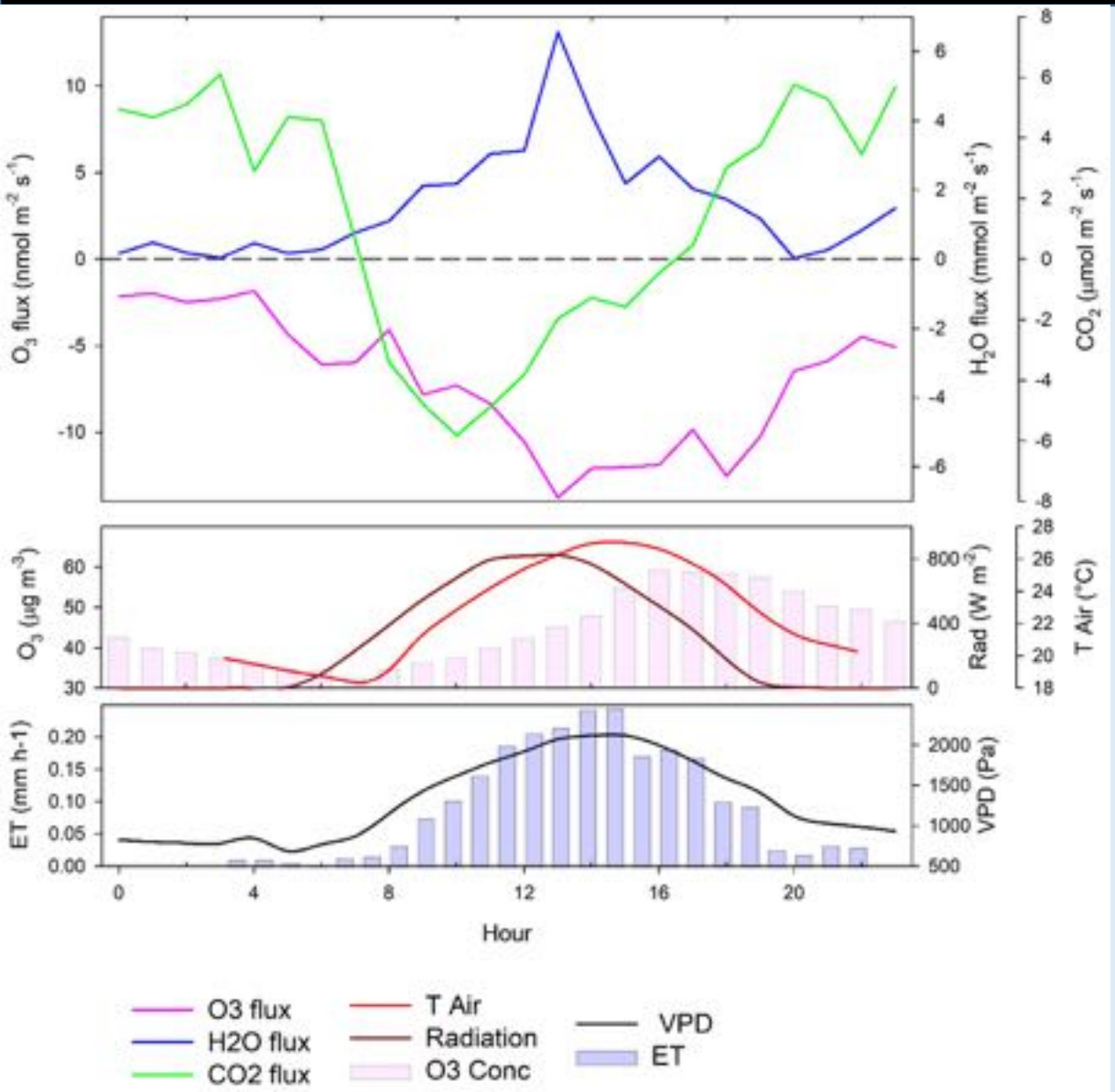
Diurnal Pattern



- Sensible Heat (H) is dominant with a maximum average of about 200 W m^{-2}

- CO_2 fluxes averages ranged from – 5 to +5 µmol CO_2 m^{-2} s^{-1}

Diurnal Pattern



- Peak of CO_2 assimilation at **10:00**

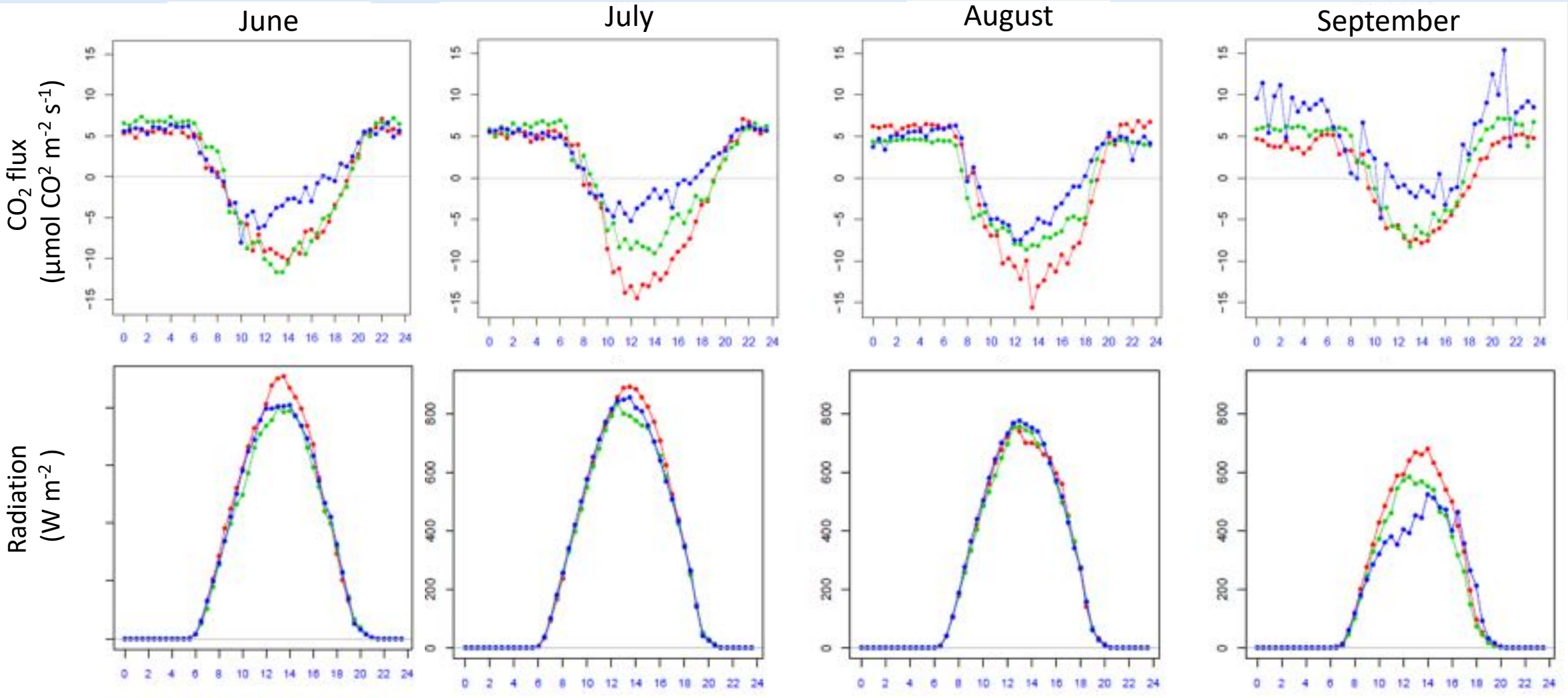
- H_2O flux and ET
- O_3 deposition
- Radiation

} **Peak at 13:00**

SUGGESTING A MINOR EFFECT OF STOMATA

Interannual Variability of CO_2 fluxes (from June to September)

2015
2016
2017



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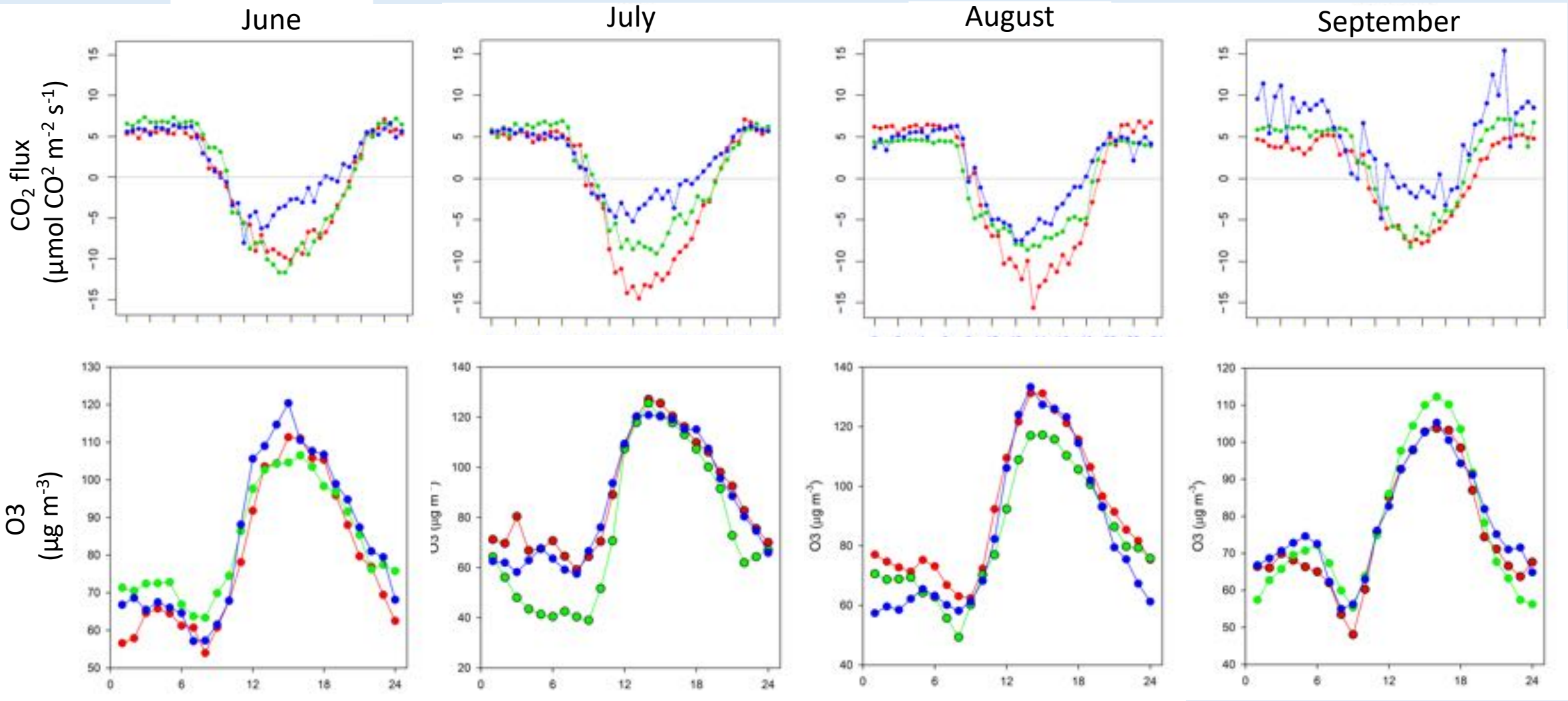

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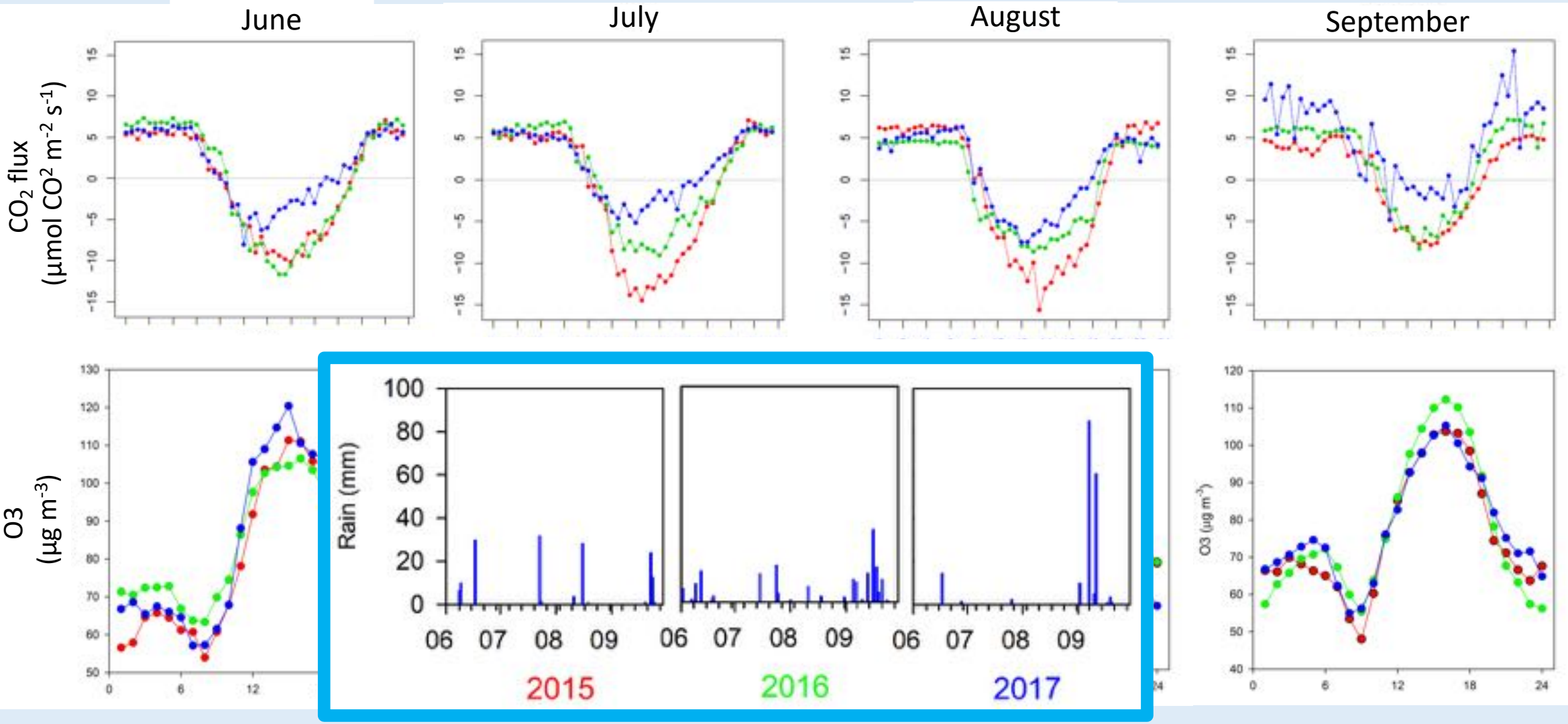

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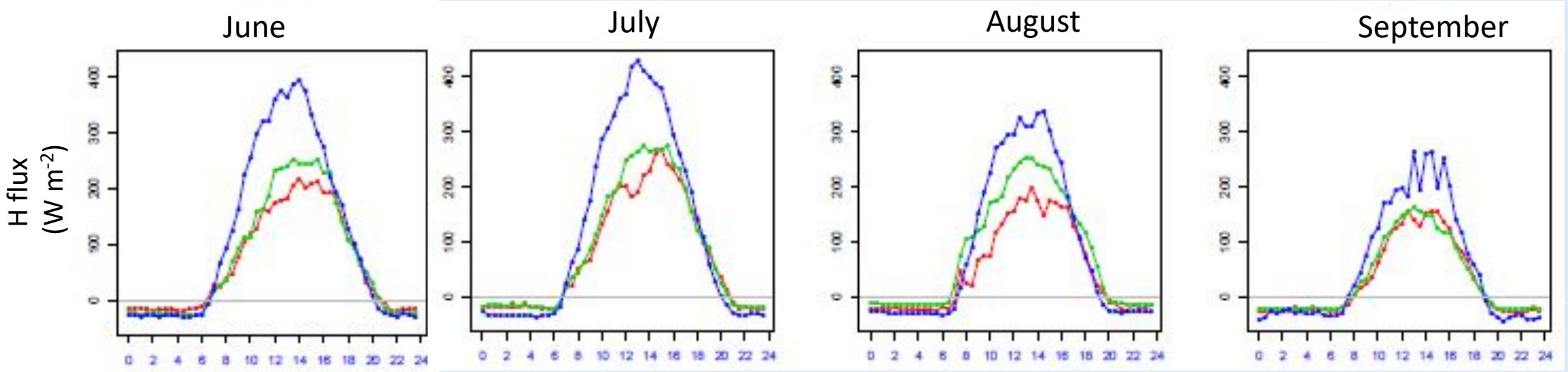
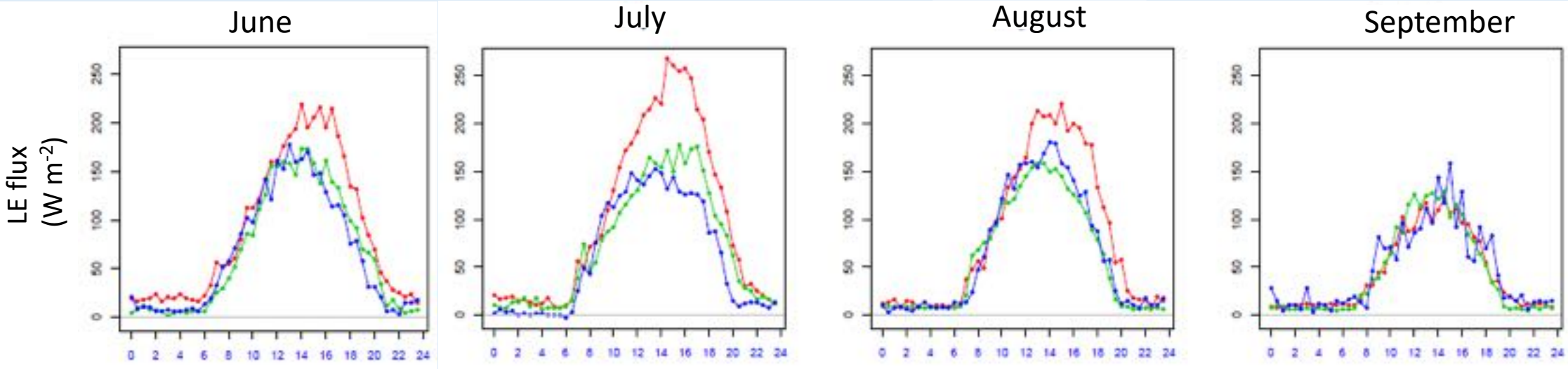
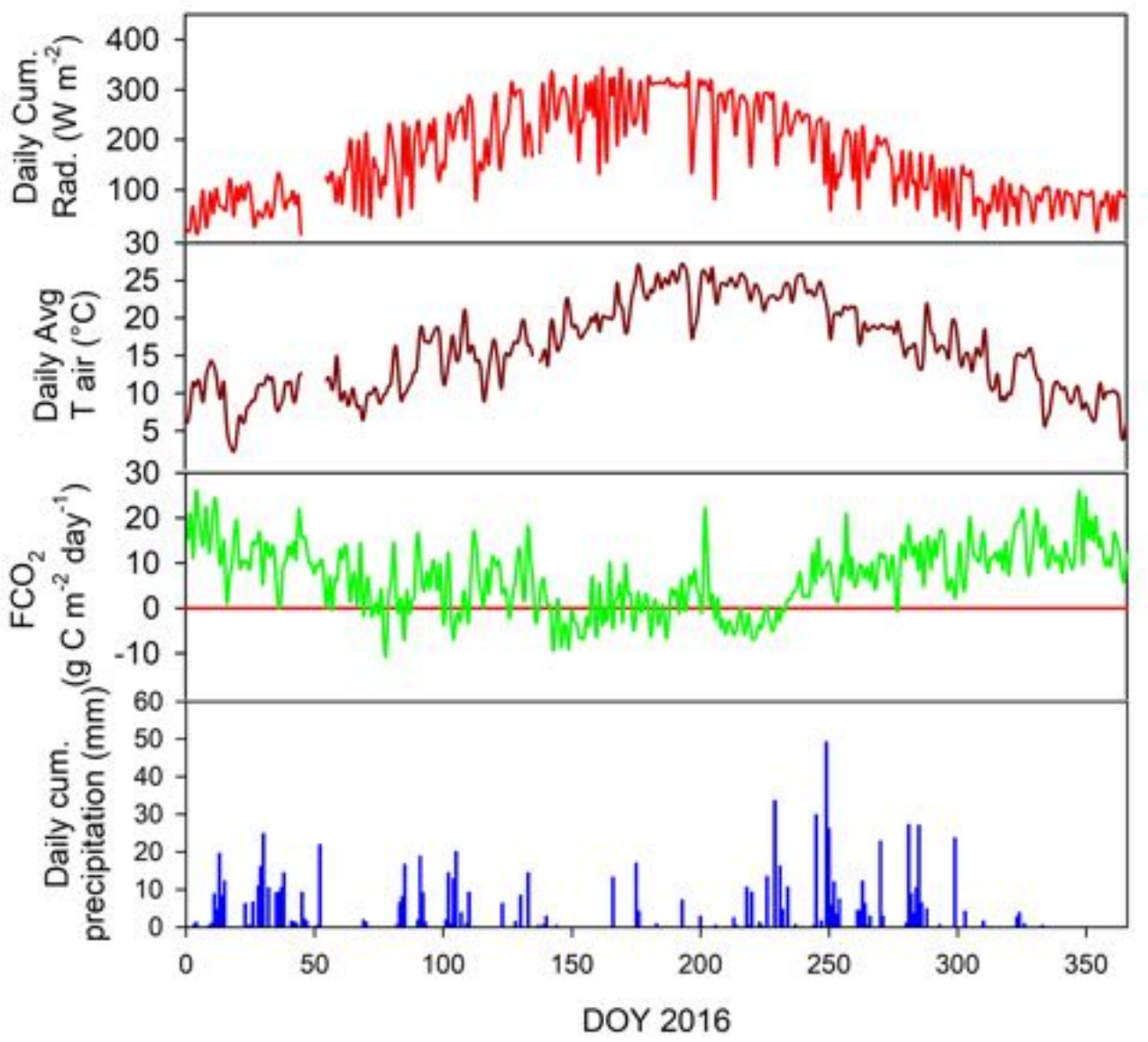


2015
2016
2017



Carbon Balance 2016



NET LOSS OF **2400** g m^{-2} $year^{-1}$

4 CONCLUSIONS & NEXT STEPS

- **High ozone concentrations occur at this site for the transport of polluted air from the city**
- **Enlarge the dataset to better understand the O_3 flux dynamics and the role of stomata**
- **Summer GPP seems be affected by precipitation more than elevated O_3 concentrations**
- **The vegetation of the Capodimonte park can only offset city carbon losses**

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THANK YOU!

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