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Introduction

Photovoltaic technology plays an important role in the sustainable development of clean, reliable and affordable energy. In order to maximize land-use efficiency, photovoltaic technologies are prone to be integrated in agricultural lands. Alongside the benefits of agri-voltaic applications, its fundamental effect to microclimatology factors is not yet well understood. This could likely be of impact to agricultural yield and climate change.

Our study focuses on the influence of a simulated photovoltaic panel semi-shading cover, on the evapotranspiration, carbon dioxide and sensible heat fluxes as measured, using eddy correlation method.

Experimental Site

Eddy covariance station (LICOR eddy correlation LI7500 DS CO₂ and H₂O analyzer with a Windmaster PRO Gill Sonic Anemometer), 3.3 meters high, alternated between sunlit and paneled sections every 10-15 days.

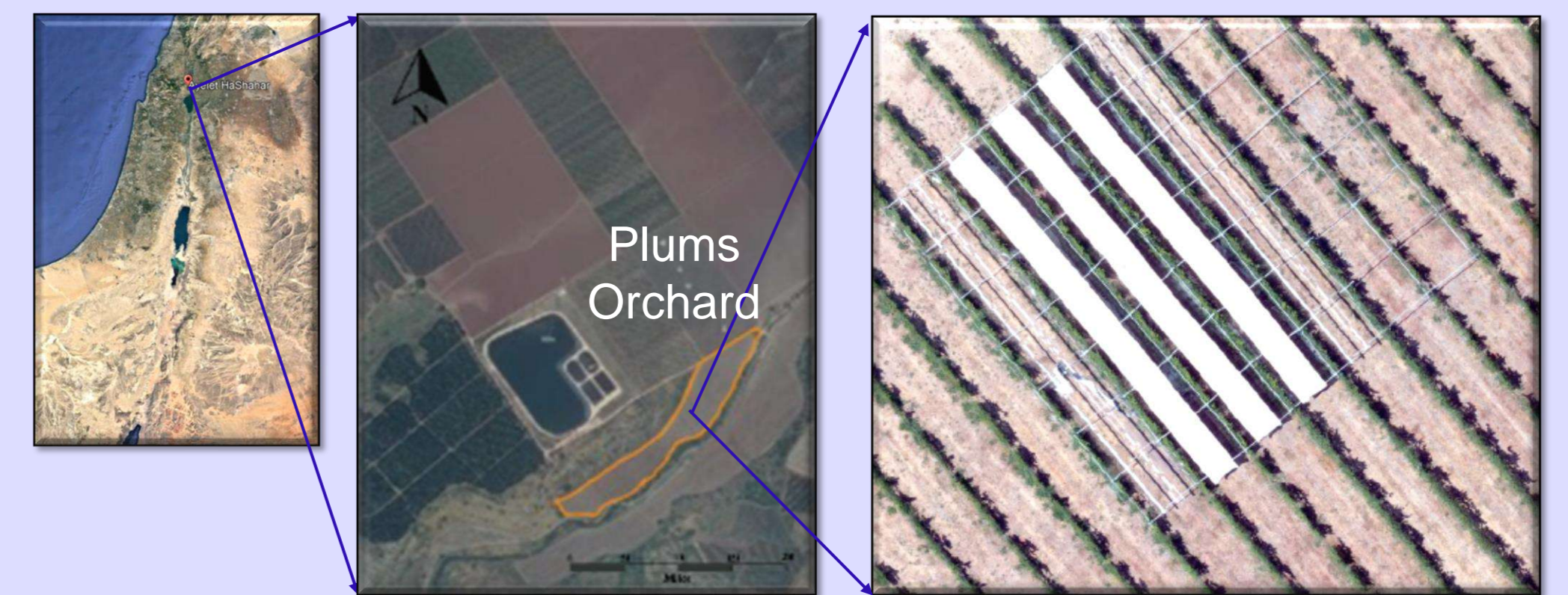


sunlit



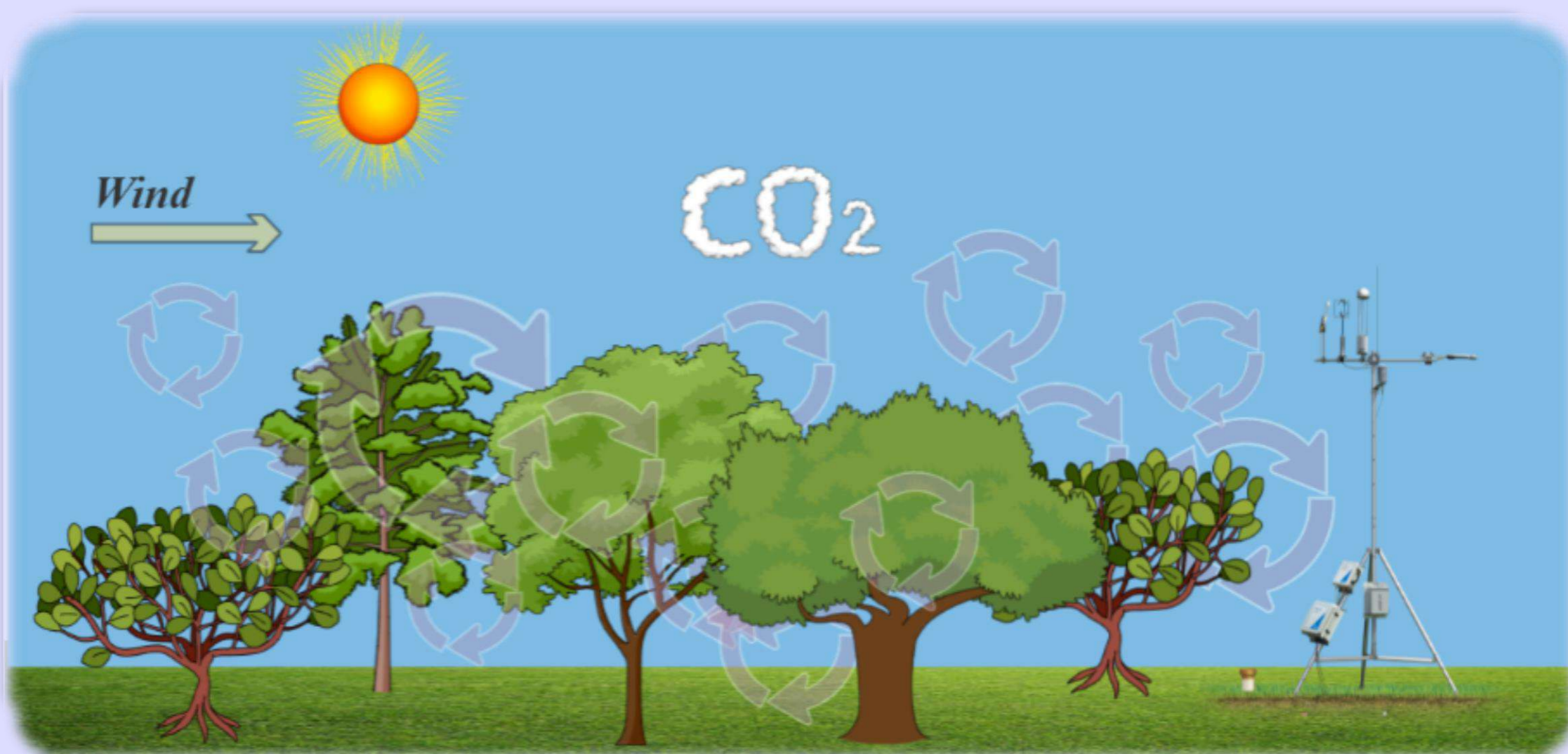
Paneled

- Site is located at Northern Israel, in a plum orchard that belongs to Kibbutz Ayelet HaShahar.
- Solar panels were constructed and then after removed following regulators order. Panels replaced with tarpaulin in 3 successive rows in order to simulate solar panels shading effect.
- Interval between tree rows 4.5 meters, tarpaulin width 2 meters, placed in the middle of rows interval, at approximately meters high.
- Meteorological station placed at the sunlit section.
- Canopy height is approximately 2.5 meters.



Method

Eddy covariance technique is a micrometeorological mass transfer method for measuring exchange rate of heat, gas and momentum across the interface between the surface and the overlying atmosphere by measuring covariance between fluctuations in vertical wind velocity and the gas of interest mixing ratio.



- Data is measured since July 1st 2021 and logged every 30 minutes.
- Data measured - CO₂ & H₂O fluxes, evapotranspiration, latent heat, bowen ratio, sensible heat, air temperature, wind speed and direction, relative humidity, net radiation etc.
- Statistical analysis was performed using mixed model regression

Instruments

Eddy Covariance Station



Open Path LI-7500DS

SmartFlux 3

Net Radiometer

Sonic Anemometer

Wind Vane

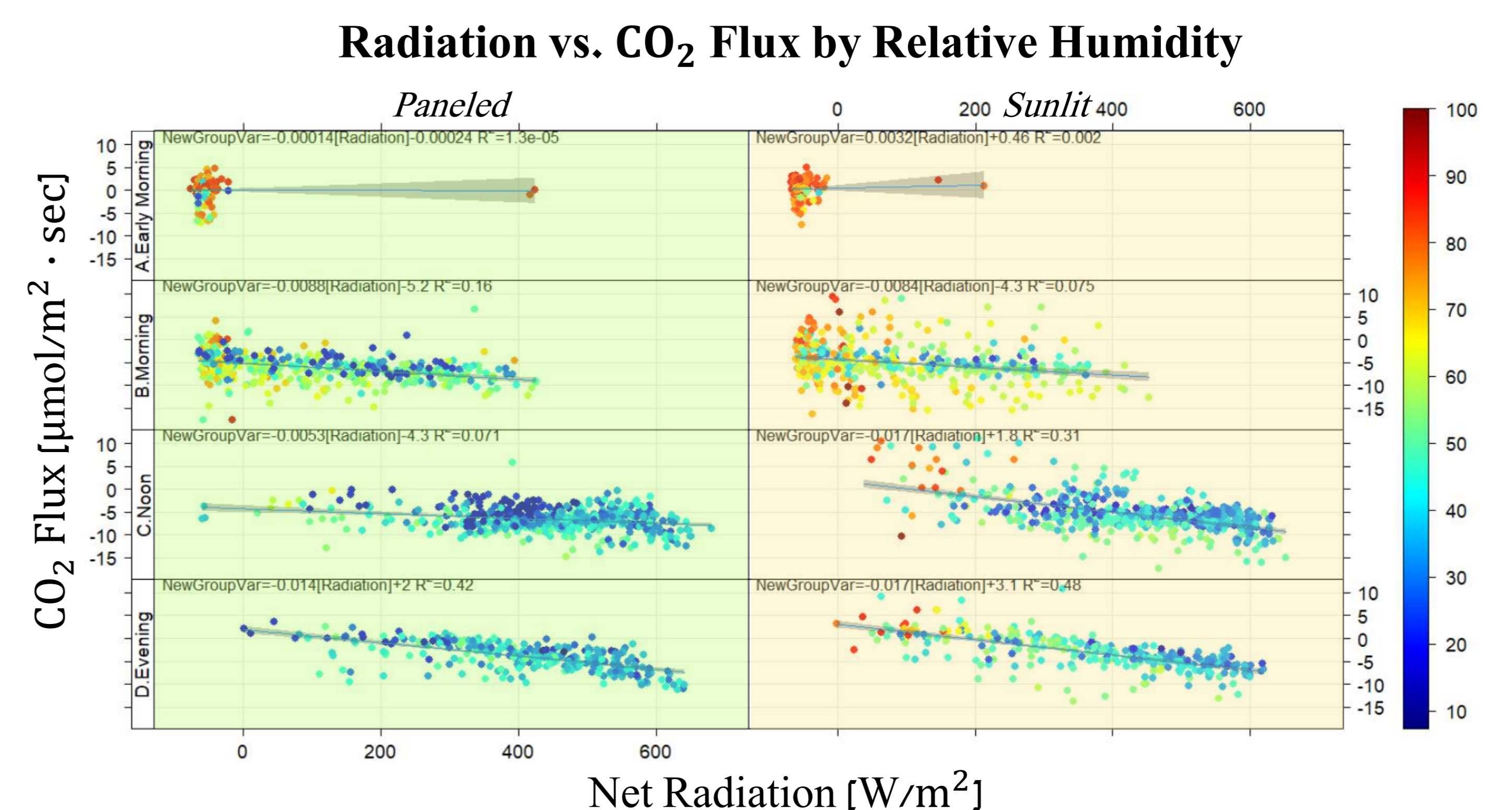
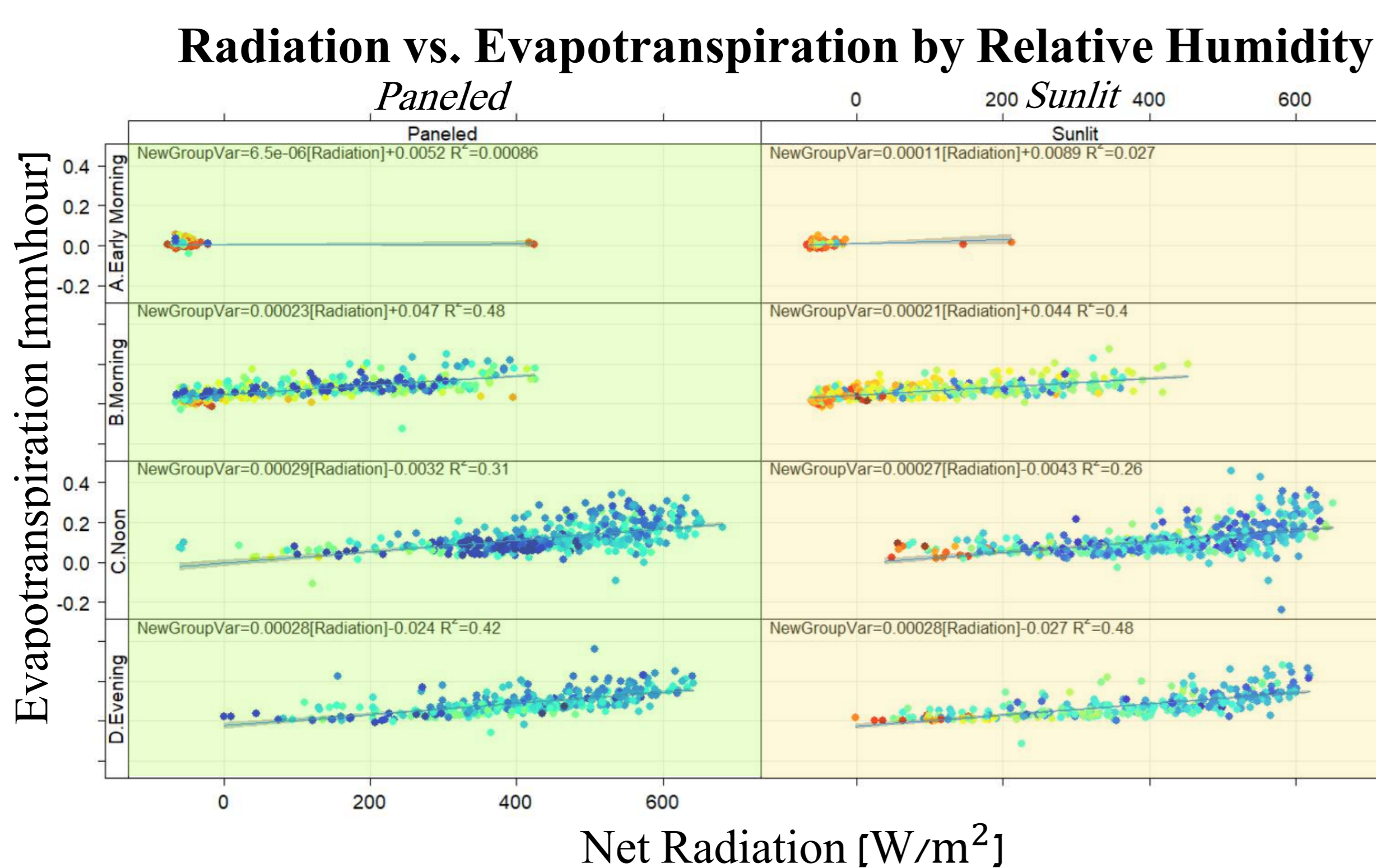
Meteorological Station



Campbell CR1000 Data Logger

Temperature & Relative Humidity

Results



The influence of net radiation on evapotranspiration and CO₂ flux by percentages of relative humidity.

Preliminary Conclusions and Future Work

- The graphs show a similar daily trend with differences between the sunlit and paneled areas. We notice larger variation and dispersion of data in the paneled area, which could be an indication on influences caused by the shading effect.
- Higher relative humidity is measured in the sunlit area, probably due to lower evapotranspiration at the paneled area, yielding lower relative content of water vapor.
- The statistical model used in this study is “mixed model regression”. The covariates are the meteorological factors with interactions among themselves, the dependent variable is CO₂ flux/ evapotranspiration and cluster variable is the treatment type – sunlit or paneled. We evaluated a statistical significance between treatment types ($P < 0.001$, $R^2 = 0.541$ / $P < 0.001$, $R^2 = 0.566$).
- This is a preliminary model and results, even-though significant- still require additional evaluations probably applying PCA analysis.
- Since eddy-covariance delivers measurements of latent and sensible heat fluxes, in the future work we are interested in adding soil/plants heat flux in order to evaluate energy balance closure (Mahrer & Rytwo, 1991). A re-evaluation of the correlations will be performed after the installation of actual photovoltaic panels for further research and comparison. A possibility of conducting EC measurements in a lychee greenhouse during winter time is being considered (see additional poster by Rytwo & Stern, in this session).

References

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Acknowledgments

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