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Coastal Fog Enhances Crop Water use Efficiency in a California Agricultural System

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ABSTRACT

In coastal California, the growing season of economically important crops overlaps with the occurrence of coastal fog, which buffers the summer dry season through shading effects and direct water inputs. The objective of our study was to develop relationships between coastal fog and the energy, water, and carbon budgets of croplands in order to improve estimates of crop-scale evapotranspiration (ET) rates, which has potential to reduce groundwater use based on local cloud meteorology. Our study site was a coastal strawberry farm located in fog-belt of the Salinas Valley, California. We installed an eddy covariance tower to quantify surface energy budgets, actual ET, and gross primary productivity at the field scale from July-September 2016. We also measured leaf and canopy-scale strawberry physiology on foggy and clear-sky days. Flow meters and soil moisture probes were installed in drip lines to quantify irrigation amount, timing, and soil wetting depth. We found that downward longwave radiation was higher on foggy compared to clear-sky days, indicating that emission of longwave radiation from the surface was absorbed by water droplets and vapor in the fog. Midday latent heat flux decreased by 125 W m-2 from a clear to foggy day, suggesting that water loss from the surface to the atmosphere decreases substantially during fog events. Likewise, we found a decrease in leaf and canopy-level transpiration on foggy compared to clear-sky days. While drawdown of CO2 at the field-scale decreased from -1.2 to -0.6 gC m-2 s-1 during fog events, canopy-level carbon and water vapor flux measurements show that water use efficiency (carbon gain per water loss) increased significantly on foggy days. Our results show that strawberry crops do not demand as much water during fog events, yet still maintain relatively high levels of carbon uptake. Therefore, the amount of irrigation could potentially be reduced during foggy periods without sacrificing yield.

BIO:

Sara Baguskas is an Assistant Professor in the Department of Geography & Environment at San Francisco State University. She is a plant ecophysiologist broadly interested in how local meteorology and climate variability impact plant function and distributions. The focus of Sara's research is on understanding the influence of coastal fog on plant water and carbon relations in both natural and managed ecosystems. She uses a variety of research techniques, including field-based ecological approaches, controlled manipulative experiments, and spatial analyses to address research questions at multiple spatial and temporal scales.