Poster 313

Controls on interannual variation in Evapotranspiration and Water Use Efficiency in a mature, furrow-irrigated peach orchard

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Introduction

-Understanding peach water use, efficiency, and productivity is critical for the increasingly water stressed San Joaquin Valley.

-Most studies have focused on young orchards in plot settings for characterizing water use and productivity. Very little work with mature orchards despite significant differences in canopy height, stature, and potential root distribution.

-Need to understand commercial "Business As Usual" approaches to develop baseline to optimize water use.

Study Region and Data

-Open-path eddy covariance tower established in mature (13 year old) peach orchard southwest of Kingsburg, California, USA. Tower established April 5, 2012 and continuously operated since then.

Ancillary soil moisture observations made at tower along with non-destructive LAI observations (Licor LAI 2200) made on ~16 day intervals coincident with Landsat 7/8 overpasses.

-Reference ET from Spatial CIMIS (http://wwwcimis.water.ca.gov/SpatialData.aspx)

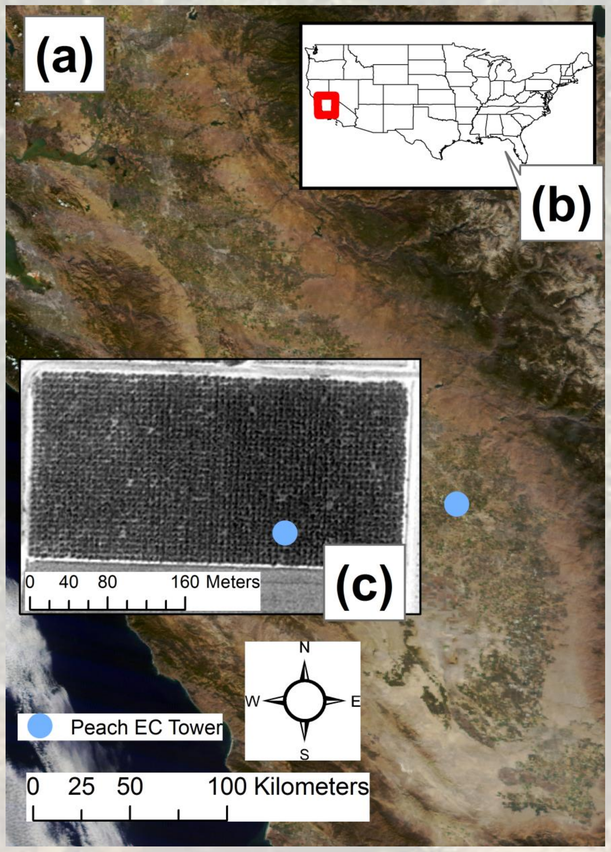


Figure 1: (a) MODIS true color image of California's San Joaquin Valley. (b) Map of contiguous United States with extent of (a) shown in red. (c) Aerial map of 8.1 ha. Peach orchard showing location of EC tower and soil instrumentation in relation to whole orchard.

Results

Table 1 (below): Peak season cumulative (April 10-September 30) Evapotranspiration (ET), Gross Productivity (GPP), Net Ecosystem Productivity (NEP), and Ecosystem Respiration (Re).

Year	ET (mm)	GPP (g C m^{-2})	NEP (g C m^{-2})	Re (g C m^{-2})
2012	1127	2311	750	1561
2013	1176	2074	694	1380
2014	891	1693	716	977

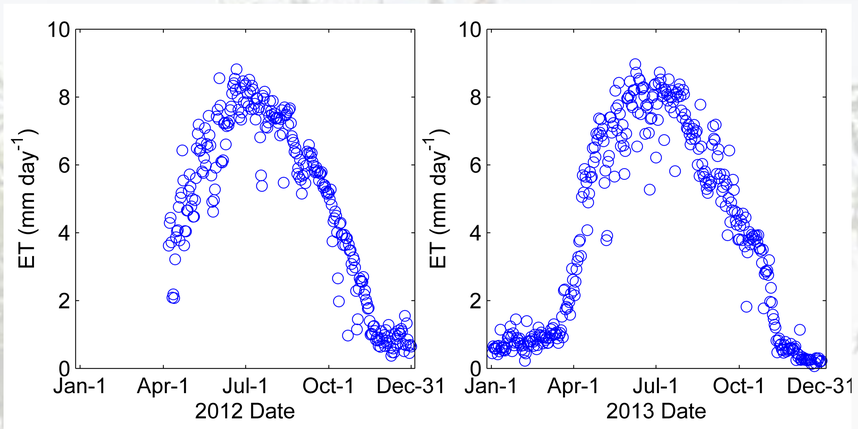


Figure 2 (left and above): Daily Eddy Covariance (EC) Evapotranspiration (ET) for 2012, 2013, and 2014 observations. Maximum daily ET for 2012 and 2013 exceeded 9 mm-1 day while 2014 ET was lower due to irrigation issues due to the farmer's well running dry. Winter ET (reflective of soil evaporation) approached 0 during the extremely dry early winter of 2013-2014. All fluxes are corrected for energy budget closure on a daily basis following Anderson and Wang (2014) and gap filled (Reichstein et al., 2005) during unsuitable micrometeorological conditions or wind direction.

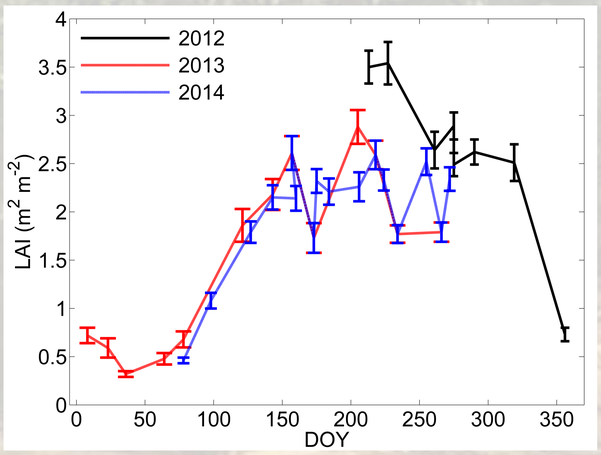


Figure 3 (left): Mean and standard error (bars) of leaf area index (LAI) for the peach orchard for 2012-2014.

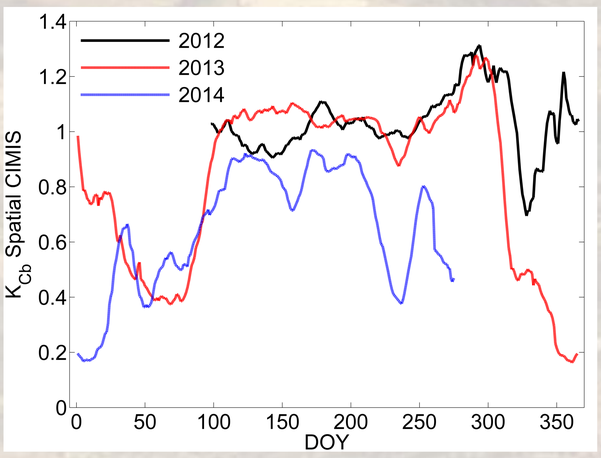
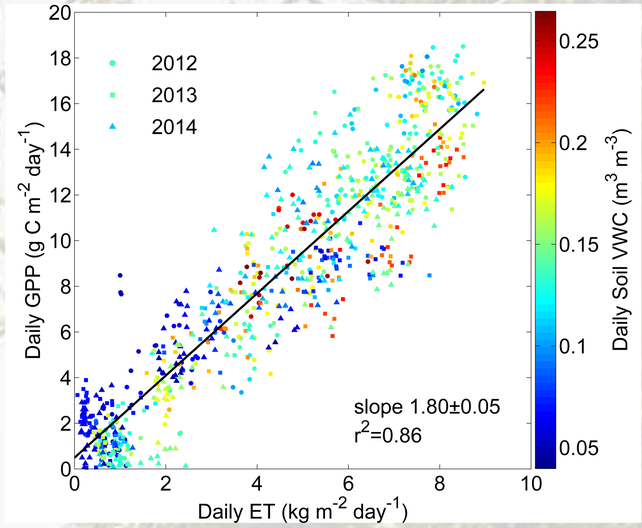


Figure 4 (left): Two-week, unweighted, running mean for crop ET coefficient (Kcb) as determined by dividing Daily EC ET by Daily Spatial CIMIS reference ET (ET_0) – see CIMIS website or Hart et al., (2009) for details on Spatial CIMIS data and algorithm.



Figures 4 and 5 (left): Figure 4 – Water Use Efficiency plot, Daily ET versus Daily GPP (days where Daily GPP is greater than 0). Color of symbols indicate daily mean soil volumetric water content (VWC). Symbols indicate year. VWC was taken as average of sensor readings 8 cm below bottom of shaded irrigation furrow.

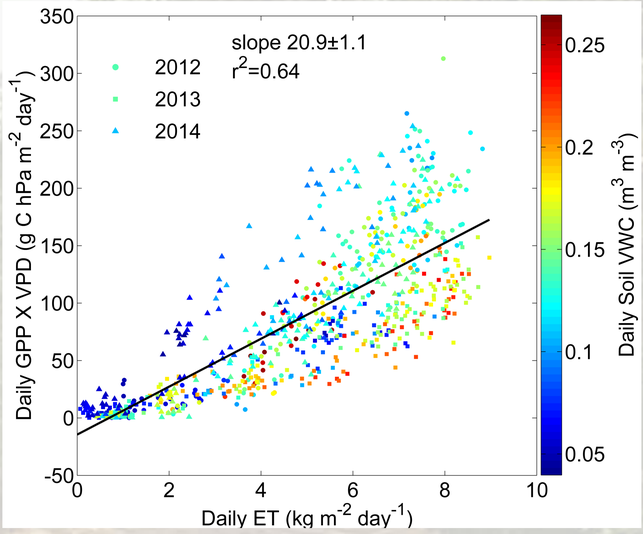


Figure 5 – Daily Inherent Water Use Efficiency (Beer et al., 2009), Daily ET versus Daily GPP*Daily VPD (days where Daily GPP is greater than 0). Inherent Water Use Efficiency can provide a measure of crop or ecosystem productivity resilience to short term drought.

-Daily ET showed consistent patterns in 2012 and 2013, but was lower in 2014 due to farmer irrigation issues.

-Crop coefficient also showed consistent and high values in 2012-2013, with mid season Kc of 1-1.1 (running average). Kc in 2014 was lower and more variable. LAI in 2013-2014 showed very similar patterns between seasons. Daily Kc was high in fall 2012 and 2013 with higher residual soil moisture and lower ET_0.

-Peak season NEP was relatively consistent (695-750 g C m^{-2}) among all three years, but GPP, Re, and ET were significantly lower in 2014.

-WUE showed tight relationship with Daily ET and VWC (Fig. 4). Inherent WUE appeared to be higher with stressed trees in 2014 (Fig. 5).

-Results show very high ET for peak productivity in mature peach.

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