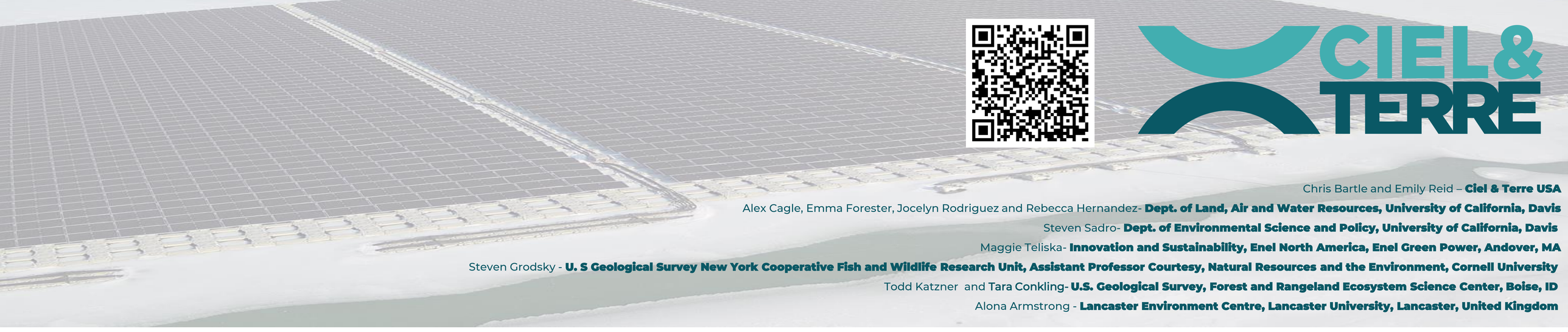


Chris Bartle and Emily Reid – **Ciel & Terre USA**

Alex Cagle, Emma Forester, Jocelyn Rodriguez and Rebecca Hernandez- **Dept. of Land, Air and Water Resources, University of California, Davis**

Steven Sadro- **Dept. of Environmental Science and Policy, University of California, Davis**

Maggie Teliska- **Innovation and Sustainability, Enel North America, Enel Green Power, Andover, MA**

Steven Grodsky - **U. S Geological Survey New York Cooperative Fish and Wildlife Research Unit, Assistant Professor Courtesy, Natural Resources and the Environment, Cornell University**

Todd Katzner and Tara Conkling- **U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID**

Alona Armstrong - **Lancaster Environment Centre, Lancaster University, Lancaster, United Kingdom**

THE FINDINGS

- Overall, we found near-surface water temperatures to be reduced within ponds with high coverage FPV
  - Average decrease in temperature beneath FPV's was 1.0°F with maximum decreases of 3.9°F beneath FPVs compared to open water during the warmest months
- For water bodies with low FPV coverage, we found a slight increase in near-surface water temperatures beneath FPV installations, however this is most likely due to external inflow near sampling locations
- FPVs installed on ponds with significant aeration did not impact aeration operations and provided a slight cooling effect to the water beneath FPV
- Percent coverage of the water body plays major roles in cooling experienced with FPV deployment
- Decreases in near-surface water temperature measured here, coupled with decreases in wind speed (V), reduce the difference between saturated vapor pressure (e_s) and actual vapor pressure (e_a), reducing evaporation conditions beneath the FPV

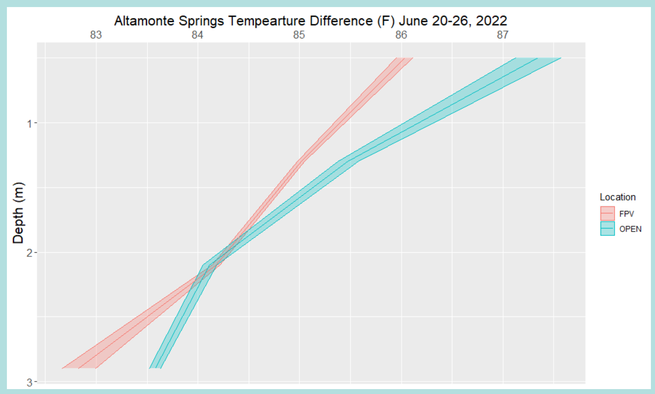
Basic Evaporation Equation (Fitzgerald)

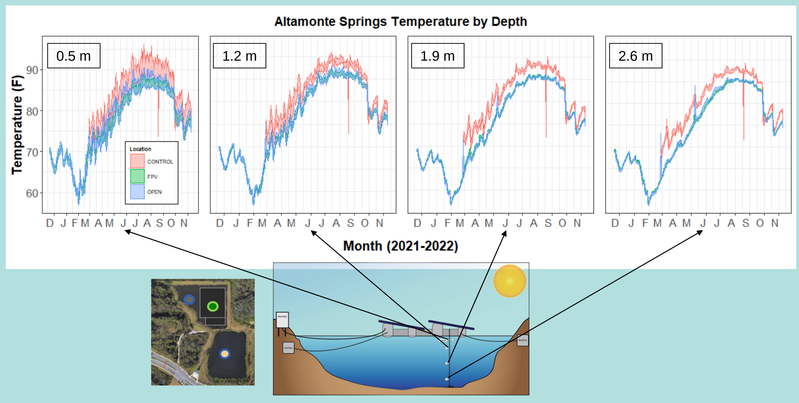
$$E_r = (0.4 + 0.124V)(e_s - e_a)$$

E_r = Evaporation rate (mm/day)
V = Mean wind speed
e_s =Saturated vapor pressure (dependent of surface water temperature)
e_a =Actual vapor pressure (air)
⇩ = Term Reduced with FPV

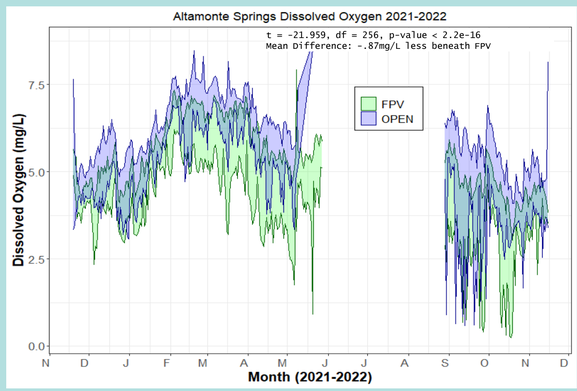
ALTAMONTE SPRINGS

Altamonte Springs, FL





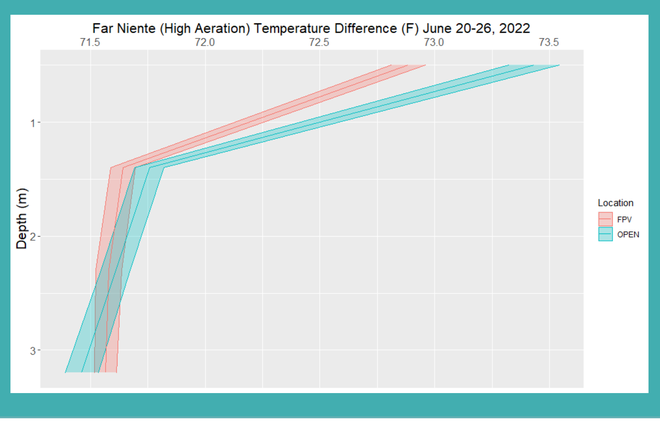
Compared to the control pond at the Altamonte Springs site, the maximum daily surface temperature average is 8 degrees Fahrenheit lower beneath the FPV installation. Owing to the large surface coverage (%70), the FPV installation at this location provides significant cooling to the water body. Additionally, beneath the FPV installation also is lower in daily temperature than the open water body of the same pond. This site demonstrates the cooling abilities of FPV installations. An important caveat, the inflow to the control pond may be significantly warmer than the pond. However, the persistence of cooler temperatures beneath the FPV demonstrates the cooling impact on the water body.

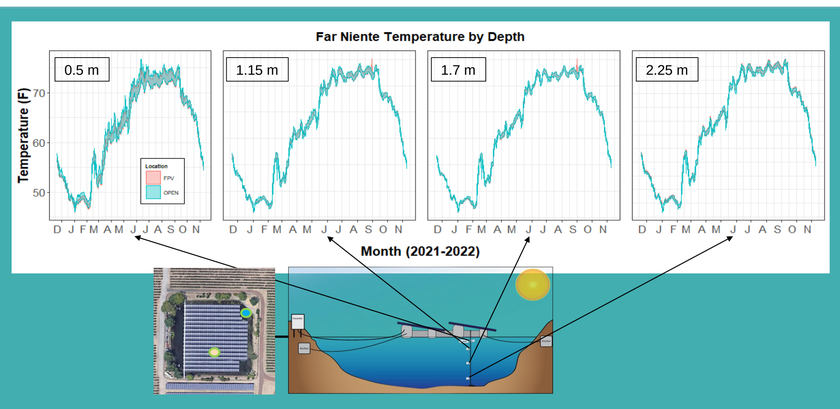


Dissolved Oxygen is statistically significantly less beneath the FPV installation than in the open water body near the surface. This is owing to decreased wind mixing and decreased direct irradiance.

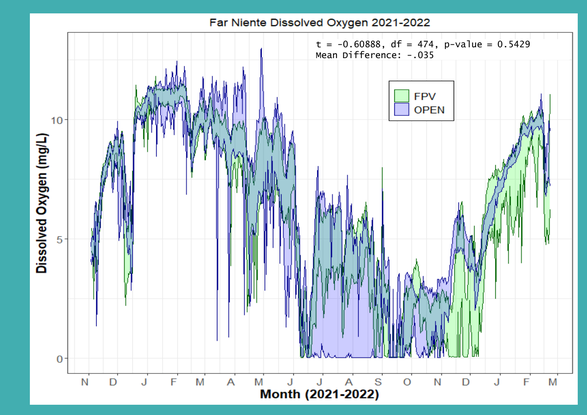
FAR NIENTE

Napa, CA





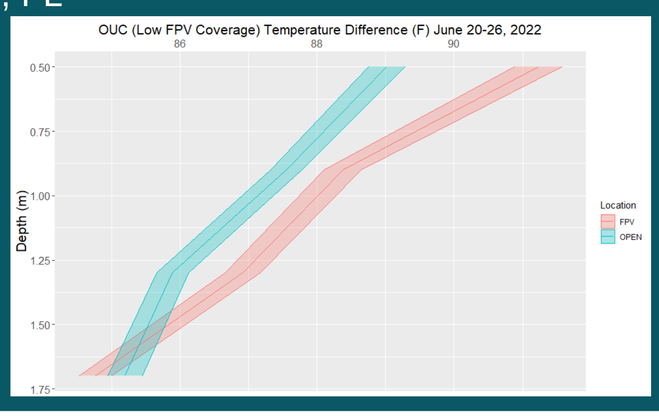
There is no statistical difference between temperature or dissolved oxygen at Far Niente because it is fully aerated. This goes to show that FPV does not inhibit aeration from working on waterbodies hosting FPV installations.

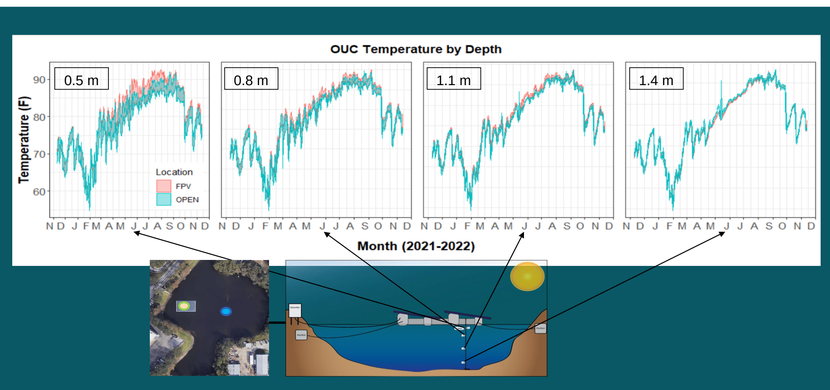


There is no discernable difference in Dissolved Oxygen at Far Niente owing to the massive mechanical aeration processes in place

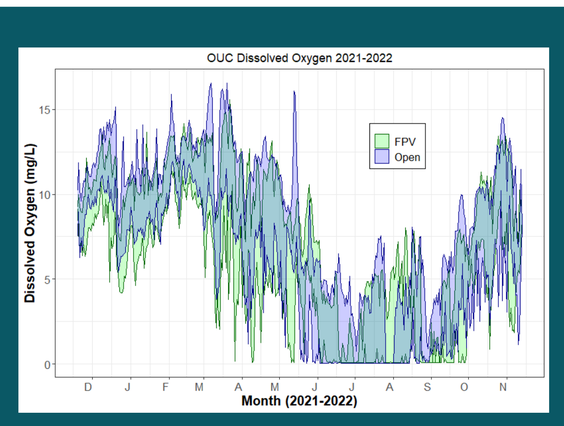
OUC

Orlando, FL





Where surface coverage of the water body is minimal (in this case, less than 5% coverage), the water temperature may be more subjected to inflow/outflow influences. This location is a stormwater runoff pond where the FPV is located very near to the inflow where stormwater runoff temperature can be much higher than the pond itself.



Dissolved Oxygen is statistically significantly less beneath the FPV installation than in the open water body near the surface. This is owing to decreased wind mixing and decreased direct irradiance.

MAXIMUM TEMPERATURE DIFFERENCES

Surface-Level statistical analysis for Temperature (F)

	OUC	Far Niente	Altamonte Springs
FPV	81.1	61.32	77
OPEN	80.67	61.9	78.2
CONTROL	-	-	86.1
p value	2.20E-04	2.20E-16	2.20E-16
df	368	425	366

NEXT STEPS

- Following the findings on temperature dynamics, three main future research objectives will be pursued:
  - Quantifying direct evaporation from FPV water bodies, compared to control, open surface ponds
  - Technical performance analysis on how the reduced water temperatures impact panel operating temperatures and efficiencies
  - Pre-installation of FPV water temperature and light dynamic research to understand how FPV installations impact thermal regimes compared to historical thermal dynamic properties