Projecting Long-Term Reservoir Evaporation on Catalina Island, California Using an Open Water Evaporation Model and Downscaled Global Climate Model Projections

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Background

Catalina Island (CI) is a popular tourist destination off the coast of Southern California that draws over 1 million visitors per year but has limited freshwater resources. Solar panels were installed over a portion of the main reservoir on CI used for groundwater recharge to reduce evaporative loses and provide renewable energy. However, officials want to know if more panels should be built to mitigate potential future increases in reservoir evaporation due to climate change.

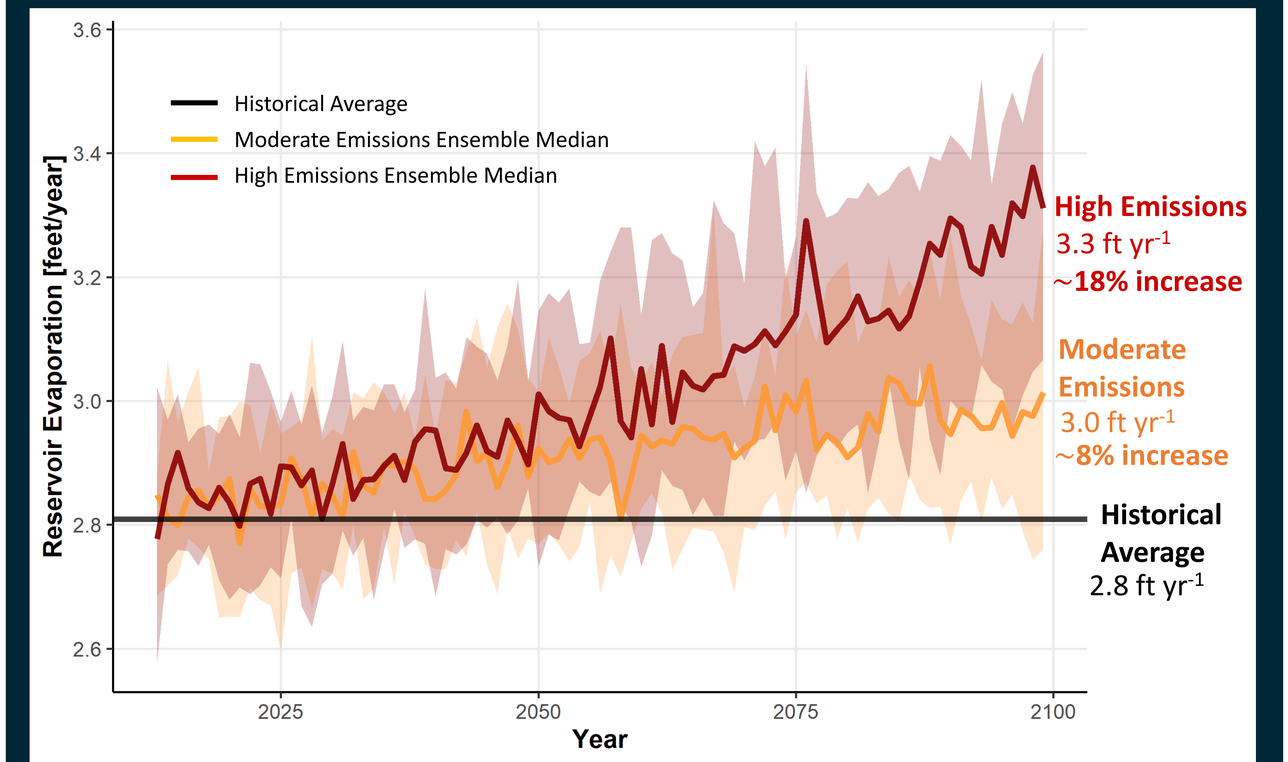
We applied downscaled global climate model projections to an open water reservoir evaporation model to estimate mid- and end- of century evaporation rates. Projected evaporation rates can be used to determine how much more of the reservoir needs to be covered with solar panels to keep evaporation rates at current levels.

Middle Ranch Reservoir on Catalina Island, CA

Middle Ranch Reservoir at full capacity
Image source: https://thecatalinaislander.com/catalina-to-exit-mandatory-water-conservation/

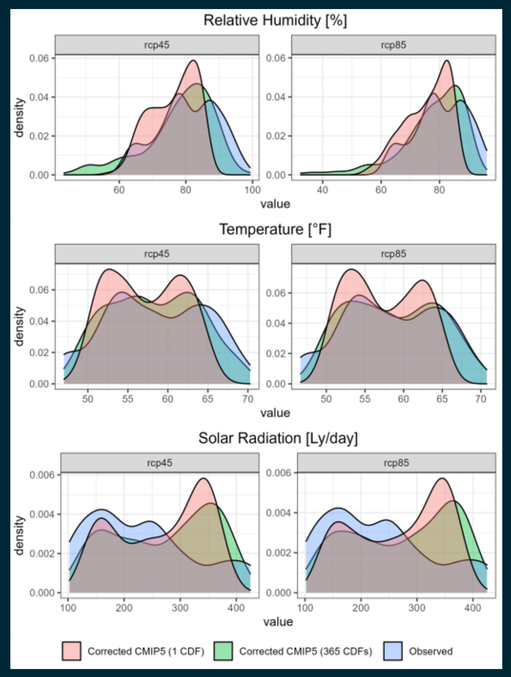
Example of 'floatovoltaics' in Colorado
Image source: https://energynews.us/2021/09/07/ponds-reservoirs-could-host-floating-solar-in-space-constrained-massachusetts/

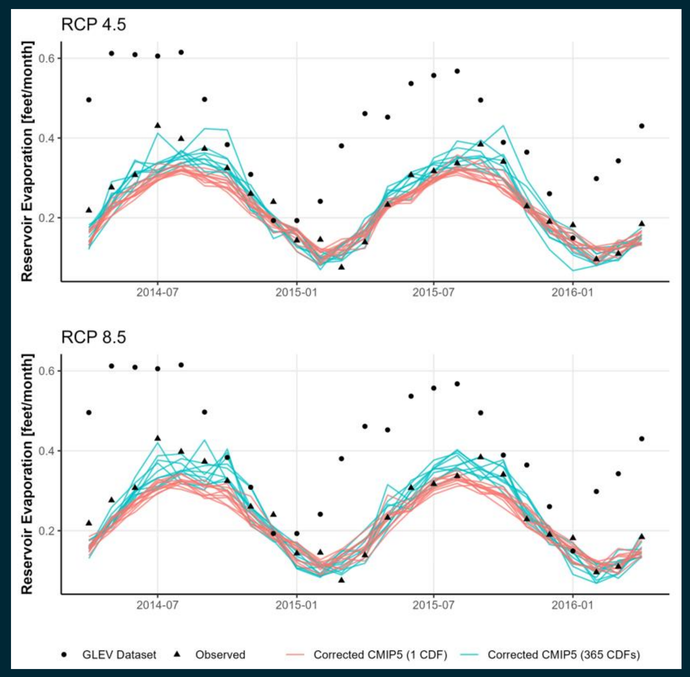
By 2100, annual lake evaporation at Middle Ranch Reservoir, a key water supply source for Catalina Island, could increase by 8% (0.2 ft/yr) under a moderate greenhouse gas emissions scenario and 18% (0.5 ft/yr) under a high emissions scenario.



An existing 4-acre solar array over MRR will mitigate expected evaporation increases under a moderate GHG emissions scenario through 2099, but under a high emissions scenario, another 3.4-acres of solar panels would be required to mitigate the expected end of century increases.

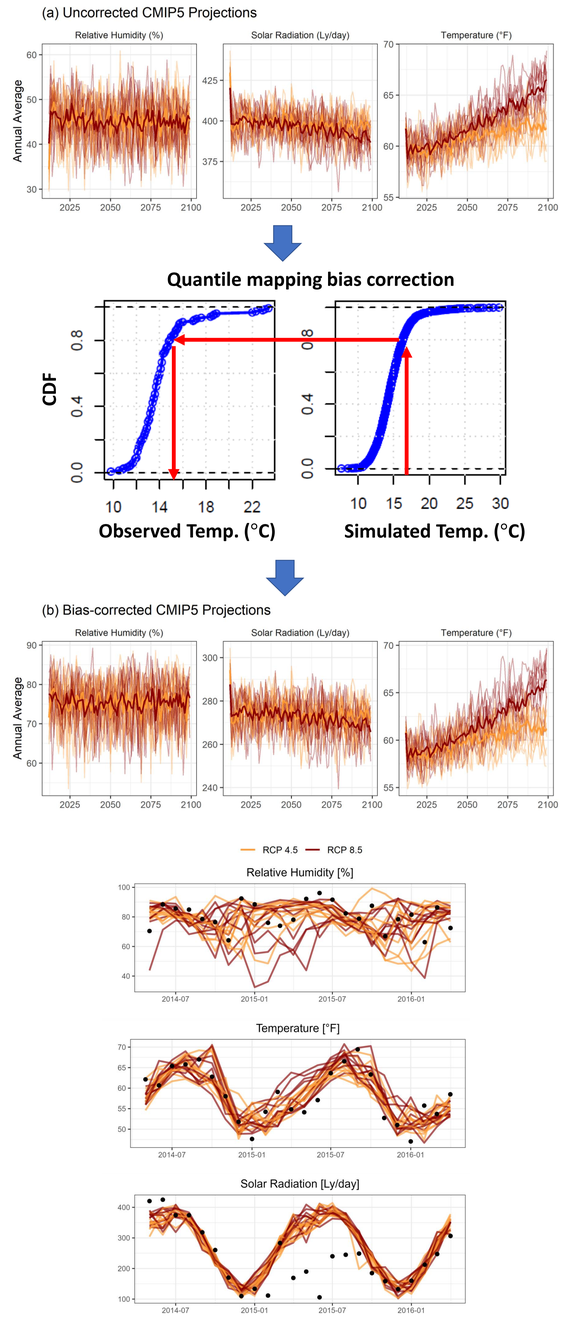
Comparing Bias Correction Methods, Other Evaporation Datasets





Methods

To estimate evaporation at Middle Ranch Reservoir, we used the Complementary Relationship Lake Evaporation (CRLE) model. Required inputs for the CRLE include temperature, relative humidity, and solar radiation. To estimate future evaporation, we use climate model projections of temperature, humidity, and radiation from the Coupled Model Intercomparison Project Phase 5 (CMIP5). Prior to using in CRLE, the CMIP5 projections must first be bias corrected. A quantile mapping approach was used to bias correct these variables based on local observations.



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