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Continuous, high-resolution spatial mapping of water isotopes: improving tools for quantifying local evaporation and residence times

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Stable isotopes of water (d2H, d18O) are unique tracers of many hydrological processes including evaporation, precipitation, reservoir mixing and residence time. Historically, discrete water samples have been collected and analyzed via either Isotope Ratio Mass Spectrometry, or more recently laser-based spectroscopic methods, such as Cavity Ring-Down Spectroscopy (CRDS). However, the analysis of discrete samples precludes the ability to construct high resolution water isotope data sets through time and space. By coupling a recently developed front-end peripheral device (Continuous Water Sampler or CWS) to a CRDS analyzer (Picarro L2130-i), we continuously measured and spatially mapped water isotopes on a transect of the Sacramento River Delta following an extended period of drought. More than two-thousand five-second average d18O and d2H measurements were made aboard the R/V King (USGS) over a six-hour period. In addition to water isotopes, nitrate, chlorophyll, dissolved organic matter (DOM) fluorescence, and other water quality parameters were also measured continuously. As you travel northeast up the delta, surface waters become progressively more enriched in 18O and 2H, while nitrate decreased in concentration and chlorophyll and DOM increased. We utilize the spatially-mapped isotope data within a single transect to understand local evaporation and residence time by (i) utilizing the secondary parameter, d-excess, and (ii) using a simple mass balance model of water moving through the system (inflow, outflow and evaporation). Additional transects, to be conducted during the rainy season, should highlight how the Delta system evolves seasonally. In concert with other data previously collected from the Sacramento River Delta, we suggest the lower region represents a mixture of river waters derived from the Sierra Nevada Mountains and the more marine waters from the mouth of the San Francisco Bay. Moving NE up the Delta into shallow sloughs through flooded wetlands, evaporative enrichment increases as shown by the increasing deviation of the real-time isotope data below the local mixing line constructed using discrete water samples from the Bay, Delta and river.