APPENDIX E. CAL-SIMETAW (CALIFORNIA SIMULATION OF EVAPOTRANSPIRATION OF APPLIED WATER)

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SUMMARY

Cal-SIMETAW was designed to estimate daily soil water balance to determine crop evapotranspiration (ETc) and evapotranspiration of applied water (ETaw) for 132 individual crops, 20 crop categories, and four land-use categories by DAU/county for use in California Water Plan. The model requires weather data, soils, crop coefficients, rooting depths, seepage, etc., that influence crop water balance. The model uses daily weather data, derived from monthly PRISM climate data and daily US National Climate Data Center climate station data to cover California with 4×4 km grid spacing. From the PRISM data, reference evapotranspiration (ETo) is estimated using the Hargreaves-Samani equation that was calibrated to estimate regional Penman-Monteith equation ETo to account for spatial climate differences. In addition to using historical data, Cal-SIMETAW can use near-real-time data from Spatial CIMIS, which is a model that combines weather station data and remote sensing to provide a statewide grid of ETo information.

CalSIMETAW estimates ETc as the product of ETo and a crop coefficient (Kc) value. Crop coefficients are commonly developed by measuring ETc, calculating ETo, and determining the ratio Kc = ETc / ETo. Most of the crop coefficients used in CalSIMETAW were developed in California. Some were adopted from the literature Doorenbos and Pruitt, (1977) and Allen et al., (1998). Also, Kc values need adjustment for microclimates, which are plentiful and extreme in California. A microclimate Kc correction based on the ETo rate is included in the CalSIMETAW model. CalSIMETAW also accounts for the influence of orchard cover crops on Kc values and it accounts for immaturity effects on Kc values for tree and vine crops. It also uses daily rainfall data to estimate bare soil evaporation as a function of mean ETo and wetting frequency in days. A bare soil Kc value is calculated to estimate the off-season evapotranspiration and a baseline for in-season Kc calculations. The Kc values and corresponding growth dates are included by crop in the model. These dates and Kc values are used to estimate daily Kc values during a season.

The model uses SSURGO soil characteristic data and crop information with precipitation and ETc data to generate hypothetical water balance irrigation schedules to determine ETaw, which is an estimate of the seasonal irrigation requirement assuming minimal water stress and 100% application efficiency.

DETAILED ANALYSIS UNITS/COUNTY (DAU/COUNTY)

Department of Water Resources (DWR) has subdivided California into study areas for planning purposes. The largest study areas are the ten hydrologic regions (HR), which are composed of detailed analysis units (DAU). The DAUs are often split by county, which are the smallest study areas used by DWR. The DAU/counties are used for estimating water demand by agricultural crops and other surfaces for water resources planning.

SOILS CHARACTERISTICS

A database containing the soil water holding capacity and soil depth information for all of California was developed from the USDA-NRCS SSURGO database (SSURGO, 2011). The developed database covers all of California on the same 4×4 km grid for all locations that are included in the PRISM database, which covers most of California.

DAILY SOIL WATER BALANCE CALCULATIONS

Although CalSIMETAW has soil characteristic information and computes ETo on a 4×4 km grid, crop planting information is limited to the detailed analysis unit (DAU)/county. Therefore, the DAU/county is the smallest unit for calculation of the water balance and thus ETaw. Using GIS, a weight mean value is determined by DAU/county for the soil water holding characteristic, soil depth, root depth, and ETo. The smaller of the soil and root depth and the weighted mean water holding characteristics are used to determine the plant available water (PAW). A 50% allowable depletion is used to estimate the readily available water (RAW) for the effective rooting zone. A management allowable depletion (MAD) is determined by comparing the RAW with the cumulative ETc during the season. The MAD is always less than or equal to RAW, and it is set so that the soil water content at the end of the season is between RAW and PAW.

Weighted crop coefficient curves for each land-use category are used with the daily ETo estimates to calculate daily ETc. The ETc is subtracted from the soil water content on each day until the soil water depletion (SWD) exceeds the MAD. Then an irrigation is applied and the soil water depletion goes back to zero (i.e. back to field capacity). Similarly, rainfall will decrease the soil water depletion to zero but never negative. When rainfall depths are greater than the SWD, the rainfall is only effective up to a depth equal to SWD. There is not correction for runoff or runon to the field. It is assumed that if rainfall is sufficient to have appreciable runoff, then the soil will be filled to field capacity and our assumption that effective rainfall cannot exceed SWD still applies. This method works because the water balance calculations are daily. It might fail for intervals longer than daily.

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