Validating HL-RDHM Estimates of Evapotranspiration in the Russian River Basin

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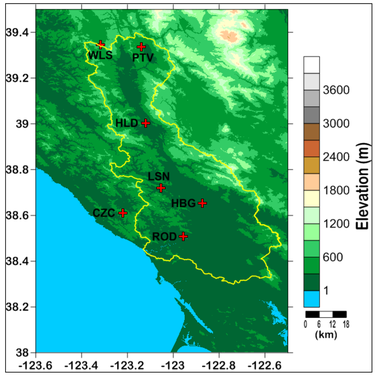
1. Overview

The NOAA Hydrometeorological Testbed Program (HMT) has deployed a network of soil moisture stations and a surface flux observing platform in the Russian River basin located in Northern California. Our goals include evaluating the evapotranspiration and soil moisture parameterizations utilized in the NWS/RFS HL-RDHM hydrological model. In this presentation high quality observations of the radiative, sensible, latent, ground heat flux, and soil moisture are compared with evapotranspiration output from the HL-RDHM model. High quality observations of each component of the surface energy balance have a made a detailed evaluation of HL-RDHM evapotranspiration performance possible.

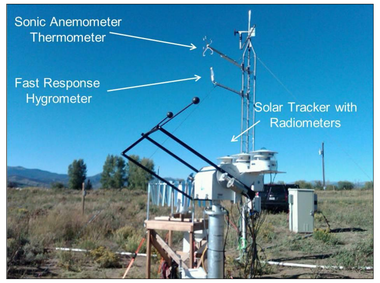
2. Observations, Instrumentation, HL-RDHM Configuration



Red crosses show the locations of the soil moisture observing stations at Cazadero, (CZC) Rio Nido (ROD), Lake Sonoma (LSN), Healdsburg (HBG), Hopland (HLD), Potter Valley (PTV), and Willits (WLS). The surface flux observatory is located at Cazadero. Austin Creek sub basin outlined in yellow.

Variables and Instrumentation

- Wind and Temperature: Applied Technology Incorporated Sonic Anemometer/Thermometers
- Water Vapor: Licor LI-7500 fast response gas analyzer
- Direct beam solar radiation: Eppley Normal Incidence Pyroheliometer
- Incoming diffuse solar radiation: Eppley Black and White Pyranometer
- Outgoing diffuse solar radiation: Eppley Black and White Pyranometer
- Incoming IR radiation: Eppley Precision Pyrgeometer
- Outgoing IR radiation: Eppley Precision Pyrgeometer
- Ground Heat Flux: Radiation Energy Balance System soil heat flux plates
- Soil Moisture: Campbell Scientific Water Content Reflectometers
- Soil Temperature: Campbell Scientific 107 Thermistors
- Aerosol Optical Depth: Carter-Scott sun photometer
- Irradiance calculated using Baseline Surface Radiation protocols

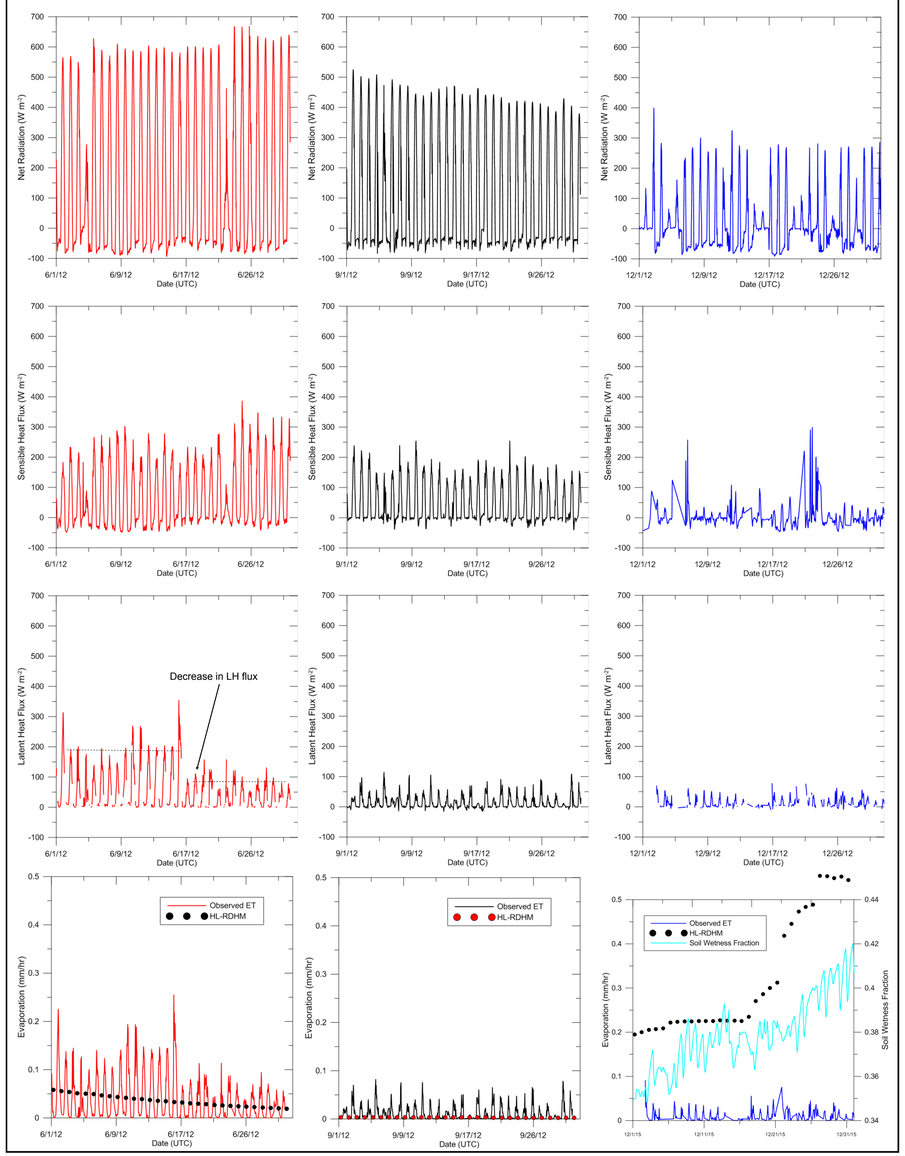


NOAA PSD Surface Flux Observatory

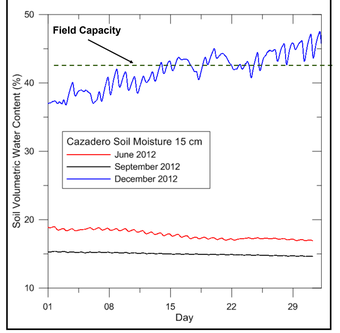
HL-RDHM Configuration

- Sacramento Model Heat Transfer version (Koren et al. 2007)
- HRAP 4-km grid. NOAA/NWS/OHD routing
- Soil hydraulic properties assigned using SSURGO Sonoma and Mendocino county soil surveys
- Upper zone, lower zone tension, free water, and December potential evaporation parameters were calibrated to the hydrograph in the Austin Creek sub basin using USGS streamflow gauge USGS 11467200
- Precipitation and surface air temperature forcing fields provided by the NWS California Nevada River Forecast Center at 6-h intervals
- SAC-HT run using 6-h time step

3. Flux and ET Observations June, September, and December 2012



4. Soil State



5. Conclusions

- Spring and summer evapotranspiration controlled primarily by soil moisture
- Observations show that evaporation is energy limited during the month of December, However, SAC-HT overestimates evapotranspiration when compared with the observations.
- Saturated soil conditions and SAC-HT manual calibration may account for this discrepancy
- SAC-HT underestimates evapotranspiration in late summer
- SAC-HT evapotranspiration values showed the best agreement during spring dry-down
- SAC-HT systematically underestimated peak daily evapotranspiration due to 6-hr time step

6. Summary

Typical forcing fields used in hydrological modeling are surface air temperature and precipitation. These parameters are routinely reported at standard meteorological surface observing locations. However, numerous assumptions must be made in order to specify evapotranspiration using surface air temperature observations.

They include ignoring the difference between surface air temperature and skin temperature, using climatological values of 10 m wind speed to specify the near surface wind speed, and making a priori assumptions about the Bowen ratio. Thus, the entire surface energy balance is specified using a single variable (air temperature). In reality estimating the surface energy balance requires observations of net irradiance, sensible heat flux, latent heat flux, and ground heat flux.

Evaporation estimated using surface air temperature observations can increase the level of uncertainty in hydrological model simulations of streamflow and soil moisture. Evaporation estimated from a fully observed surface energy balance can be used to quantify this uncertainty. The results shown in this study suggest that arbitrary manual calibration of SAC-HT to the hydrograph can lead to unrealistic values of evapotranspiration.

One of the most accurate methods of estimating net irradiance uses solar irradiance observed using component summation. This method measures the direct and diffuse components of the global solar irradiance independently. Direct eddy correlation observations of water, and temperature avoid the errors introduced into surface energy budget calculations when bulk flux methods are used. The results presented here suggest that the HMT flux observations can play an important role in hydrological model evaluation and development.

References:

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