

Completion Report for Project 5-300430

Yampa/White Roundtable Lysimeter Project: “Improvement of lysimeter operations and consumptive use quantification in high-altitude, irrigated meadows in the Yampa/White Basin”

Performance Period: 8 December 2010 – 30 June 2015

Summary of outputs and accomplishments:

Introduction

To better define the consumptive use of applied irrigation water in the Yampa River Basin, the Yampa/White roundtable provided support for instrumentation, operations and maintenance for an integrated data collection system consisting of an automated weather station specifically designed for estimating evapotranspiration and small lysimeters designed to directly measure the amount of water lost from the soil due to evapotranspiration. The idea was proposed early in 2010 and funding from the Roundtable became available in December 2010. This report summarizes project accomplishments.

Weather Station

A high quality CoAgMet (Colorado Agricultural Meteorological Network) weather station was purchased in 2011 and installed over an irrigated grass high meadow on the Carpenter Ranch near Hayden, CO. There was a period of missing data the first winter (2011-12) and a few weeks of unstable temperature readings in spring of 2012. Since that time, the weather station has performed flawlessly with complete records, by hour and daily summaries including temperature, humidity, solar radiation, wind speed, (the 4- parameters needed to compute evapotranspiration rates) along with wind direction, precipitation and soil moisture. The precipitation gauge uses tipping bucket technology – which is reliable and low cost but which is best suited for light to moderate intensity rain. It does not measure the water content of snow well, but this was not considered a priority for this project. The Colorado Climate Center at Colorado State University has been responsible for the installation, operations, maintenance and data collection from this station. All data were successfully transmitted, archived and are available via the CoAgMet web interface.

<http://ccc.atmos.colostate.edu/~coagmet/>

These data are also now routinely collected and available through the Colorado Division of Water Resources “Hydrobase” where many individuals, organizations and decision support systems access and use the data. The meteorological data collection has been a huge success.

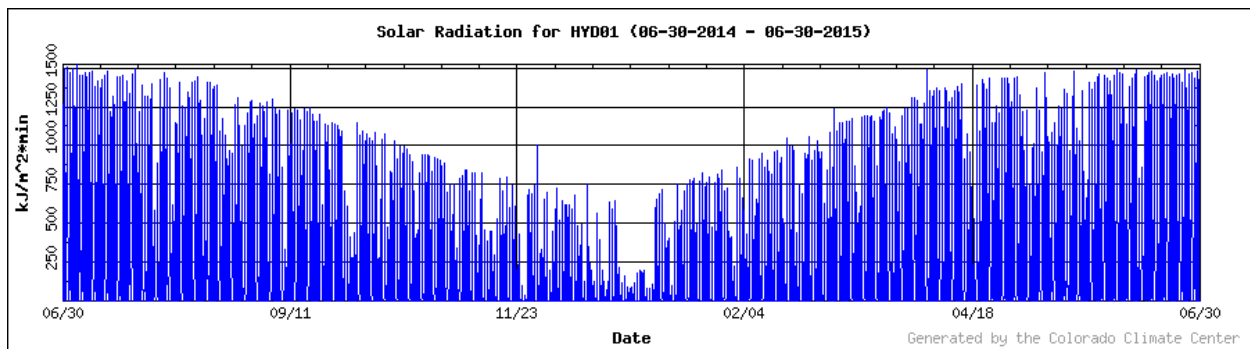
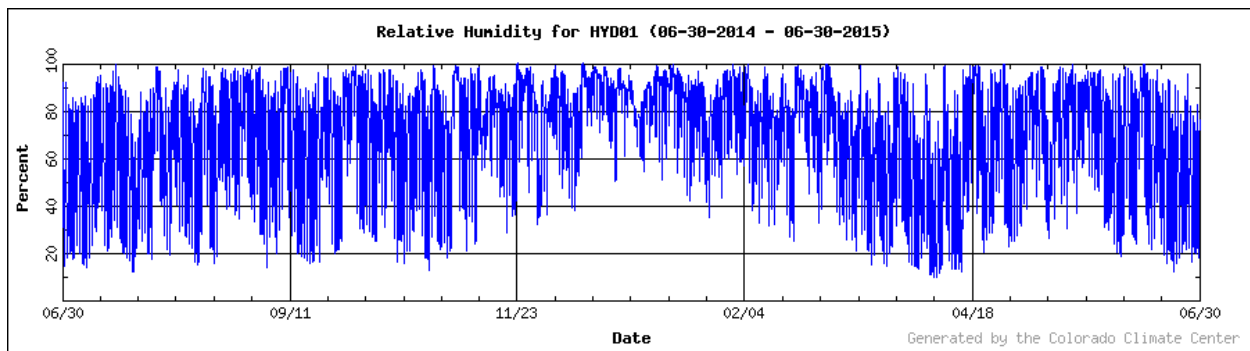
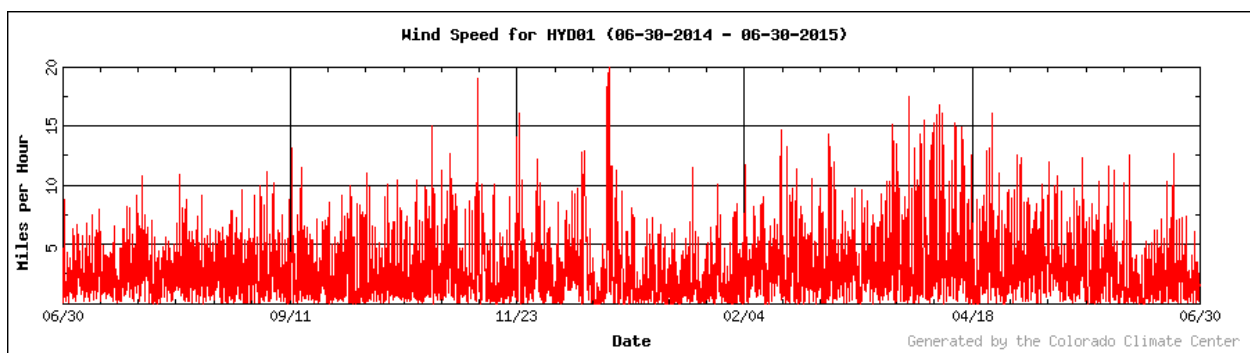
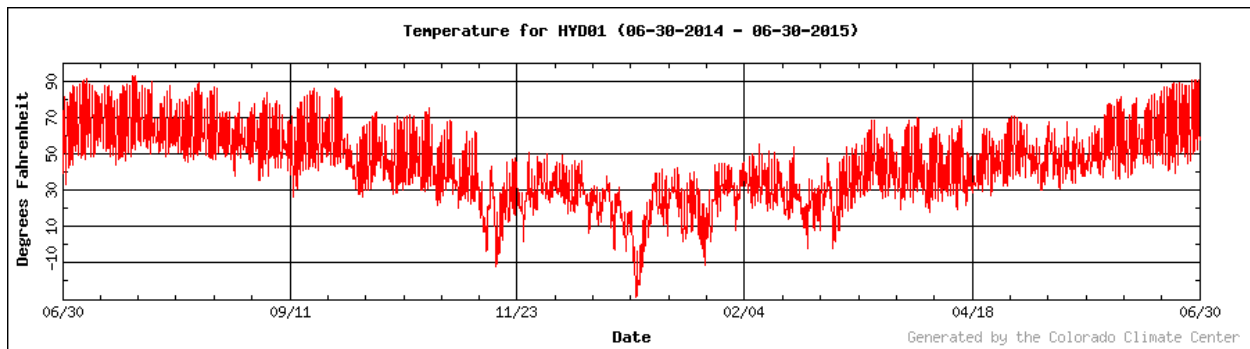


Figure 1: Hourly temperature, wind speed, relative humidity and solar radiation for the Hyaden CoAgMet station for July 2014-June2015

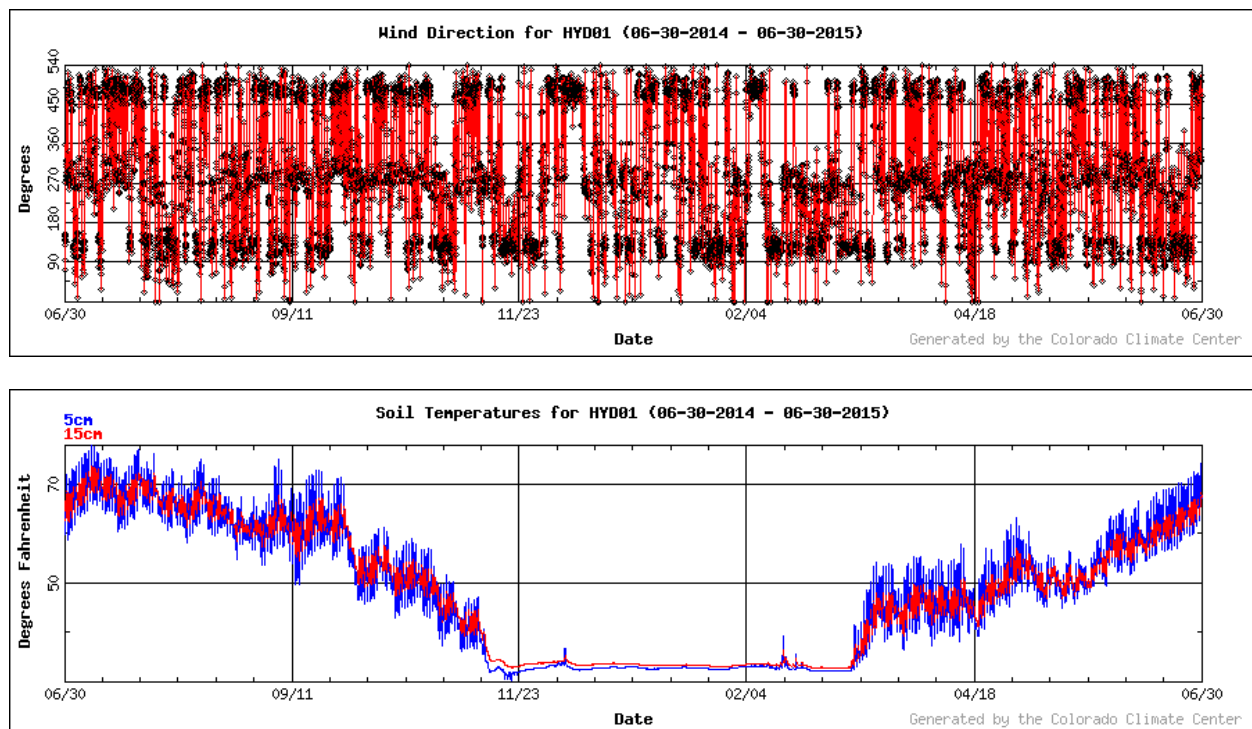


Figure 2: Hourly wind direction and soil temperature from the Hayden CoAgMet station for July 2014-June 2015

The weather station was visited and serviced each year. Calibration of the solar sensor and temperature/humidity probe was performed every two years while wind sensor bearings were replaced annually. Based on data comparisons, no drift or biases in any of the sensors was noted, and data quality appear excellent for each of the past three years.

Lysimeter installation, operation and findings

The second part of this project was the installation and operation of a set of bucket lysimeters. The Colorado Division of Water Resources Division 6 offices had been maintaining a simple spill tank lysimeter for several years on a tributary to the Yampa River. However, the location was not representative of most hay meadow environments in the basin. Having both an ET (evapotranspiration) weather station and a set of more quantitative weighing bucket lysimeters looked like an excellent and relatively low cost opportunity to refine methods for estimating CU (consumptive use).

Bucket lysimeters were installed in 2012 based on design and recommendations from grass meadow ET expert, Dr. Danny Smith. This consisted of a replication of a set of two lysimeters for a total of four separate buckets (Figure 3). These are weighing lysimeters but not the expensive automated weighing

devices. Rather, the low-cost lysimeters require the bucket being lifted out of the ground and weighed in place using a lifting tripod and a precision scale. The scale that was purchased for this project and used in the summer of 2012 was found to be inoperative, so the first season of data was lost. This was not a large problem, though, as the vegetation was still being established. By 2013, with more precipitation and better irrigation management than the previous year, vegetation was established and more representative ET measurements could be taken.



Figure 3: Site photo (looking South) with the lysimeter plots behind the station. Note the established grass within the lysimeter plots.

Lysimeter operation and data collection were administered by the Division 6 office of the State Engineer in Steamboat Springs. Manual measurements were performed by summer interns working on the Carpenter Ranch.

As of the completion of this report, the lysimeter data for 2013, 2014 and 2015 are in the hands of Colorado Division of Water Resources Division 6 and may be available on request after data quality control has been completed. Lysimeter readings have not yet been fully processed for comparison with computed evapotranspiration. 2013 data did not appear to be useful. 2014 was better, but still problematic as interns collecting the data may not have been adequately trained. A further challenge

was the departure of Wendy Ryan in spring 2015, who left the Colorado Climate Center for employment in the private industry. Wendy had tried to maintain close ties with the Roundtable, Carpenter Ranch and the Division 6 Engineer. Zach Schwalbe has now taken over her responsibilities but is not yet completely up to speed on this project.

Figure 4 (below) shows the comparative results of accumulated alfalfa-reference ET computed from the Hayden Carpenter Ranch CoAgMet station. As of project completion ET rates for summer 2015 were running below previous years. The drought year of 2012 was the highest ET year.

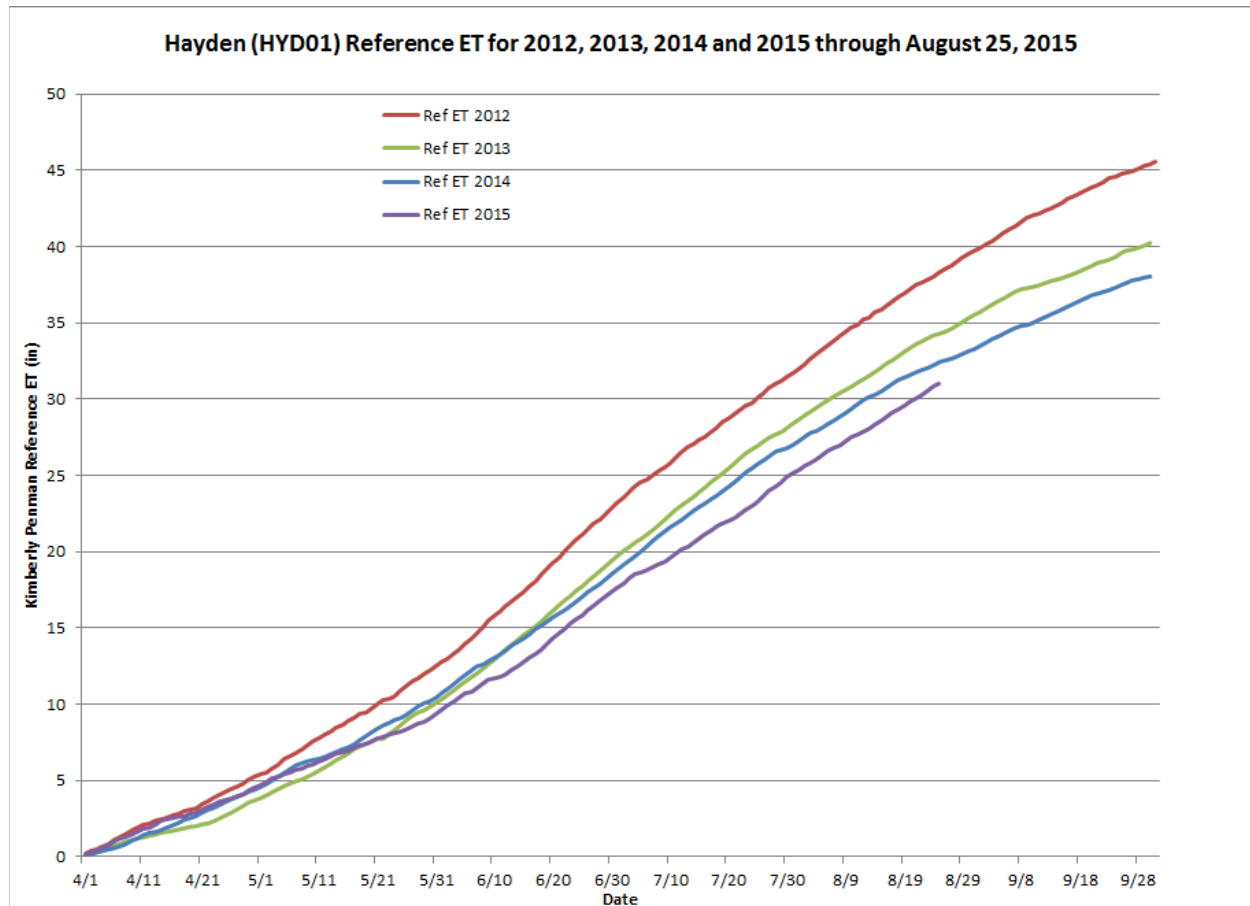


Figure 4: Kimberly-Penman reference ET from the Hayden CoAgMet station for 2012, 2013, 2014 and 2015 through August 20, 2015.

If the lysimeter data processing and quality control leads to a robust data set for 2014 and 2015, it may be possible to begin to estimate the relationship between bucket lysimeter ET rates and computed alfalfa reference ET rates. If satisfactory relationships are found, an initial hay meadow grass crop coefficient could be determined. However, with this relatively short record we would highly recommend continued operation of both the weather station and the bucket lysimeters in order to better refine the relationship and understand the uncertainties.