MID-PROJECT PROGRESS REPORT

THE UNIVERSITY OF ARIZONA
Yuma Center of Excellence for Desert Agriculture

Arizona Iceberg Lettuce Research Council

Project Title & number	**Satellite Measurement of Evapotranspiration (ET) from Desert Iceberg Lettuce Production Systems (19-03)**
Project Timeline	September 1, 2018 – August 31, 2019
Principal Investigator	Paul Brierley *Yuma Center of Excellence for Desert Agriculture* *University of Arizona*
Co-Investigator(s)	Dr. Charles Sanchez *Soil, Water, and Environmental Sciences* *University of Arizona*
Cooperating Investigator(s)	Dr. Andrew French *U.S. Arid-Land Agricultural Research Center* *USDA-ARS*

Progress Report (as of May 2019)

During 2018-2019 we collected ground-based data using Eddy Covariance Systems from two additional lettuce sites. These were to augment data already collected in 2016-2018.

Eddy Covariance instrumentation (ECV) is one of the best ways to accurately measure evapotranspiration (ET) over crops such as lettuce. ECV obtains ET by measuring incoming and outgoing energy fluxes over the cropped landscape. The ECV measures four energy flux components- net radiation (Rn), ground heat flux (G), sensible heat flux (H), and latent heat flux (LE). Rn represents absorbed solar and infrared radiation, G is heat transported into the soil, H is turbulent heat above the crop due to air temperature gradients, and LE is latent heat energy due to ET. ECV data values are reported in energy flux units (W/m^2), with water-specific quantities also reported as depths over time (e.g. mm/day).

Each ECV deployed over a lettuce crop required an array of sensors, data loggers, power supplies, and mechanical supports. Sensors measured air temperature, humidity, wind speed, wind direction, water vapor concentration, CO2 concentration, soil temperatures, soil moisture, solar and infrared radiation, all at sample rates up to 20 Hz. Data loggers collected, analyzed, and stored analog and digital signals from the sensors; in most cases they were connected to a cellphone modem for transmitting synopses of data and system health information to one of our home offices. Power supplies consisted of 12V batteries, voltage regulators, grounding rods, and solar panels. The mechanical supports included tripods, masts, lightning rods, anchors, and guy wires to ensure the sensors, loggers, and power supplies remain accurately aligned in all weather conditions.

We also monitored irrigation water inputs in all lettuce experiments. For sprinkler irrigation systems we used in-line meter (i.e. ESSFIFLO Ultrasonic Flowmeter) and pressure data logging instruments (i.e. Pollardwater Pres/Temp logger). For surface irrigation we used flumes with depth sensors and data loggers to measure in-flow hydrographs and water depth sensors (Troll 100 water depth sensor and logger) to measure water depth profiles in transects along the irrigation run (inlet to downstream border). Data were downloaded and processed after each irrigation event.

As part of our research to develop methods and software tools to improve monitoring and forecasting of water used by lettuce, we have been obtaining and processing remote sensing data provided by NASA/JPL, USGS, the European Space Agency, and the French Space Agency (CNES). Images include 60-m ECOSTRESS thermal infrared data, 30-m Landsat 8 multispectral data, and weekly 10-m visible near infrared (VNIR) data from Sentinel2a/2b. Noteworthy for Yuma lettuce cropping has been the special availability, 2-day 5-m 12-band VNIR images from Venus.

During the remainder of the project, the satellite remote sensing data will be analyzed and correlated to the ground-based data that has been collected in order to calibrate and validate the satellite data for use in estimating lettuce ET.