

Spectral and Microclimate Measurements in Relation to Gold-Standard Methods Field Campaign Report

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Acronyms and Abbreviations

ARM	Atmospheric Radiation Measurement
EC	environmental conditions
IOT	Internet of things
MERIS	Medium-Resolution Imaging Spectrometer
SGP	Southern Great Plains

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1.0 Summary

Arable is an agricultural data and analytics company offering an Internet of things (IOT)-enabled irrigation management tool, weather station, and crop monitor: the Arable Mark. The device synthesizes both climate and plant data to produce actionable insights on natural resource management, mainly commercial agriculture at any scale.

Arable collected 11 months of microclimate and radiometric data at the U.S. Department of Energy's Atmospheric Radiation Measurement (ARM) Southern Great Plains (SGP) observatory to compare measurements of the Arable Mark to the ARM-SGP gold-standard sensors, and for demonstrating the ease of installation and system value to stakeholders. A member from Arable labs installed the device on January 10, 2018, at the ARM facilities and the site managers were in charge of maintaining the sensors in a clean state until the unit's removal on January 15, 2019.

The sampling was positively uneventful, except for a period during the winter when the device stopped posting data for about one week. The verdict was that the equipment required an external solar panel to stay powered through the shorter days of winter. A solar panel was shipped to the SGP, and the unit came back to full charge to continue sending data for the rest of the sampling period.

The main goal of the project is to use the data collected by the Arable Mark and build a model that can establish a close relationship with the current methodologies applied to measure ecosystem response to environmental changes. During the sampling period, our team discovered that there was a drift in some of the meteorological data and also in the radiometry, so all efforts are focused into the development of models that would reduce the errors in the reported values.

2.0 Results

For now, our results only include a description of the values recorded with the Arable Mark at the SGP site. We have not developed the algorithm to compare our environmental conditions (EC) models with those created at ARM-SGP. As can be seen in Figure 1, our upwelling shortwave measurements need to be adjusted, but the downwelling measurements are very similar to those from the ARM data set.

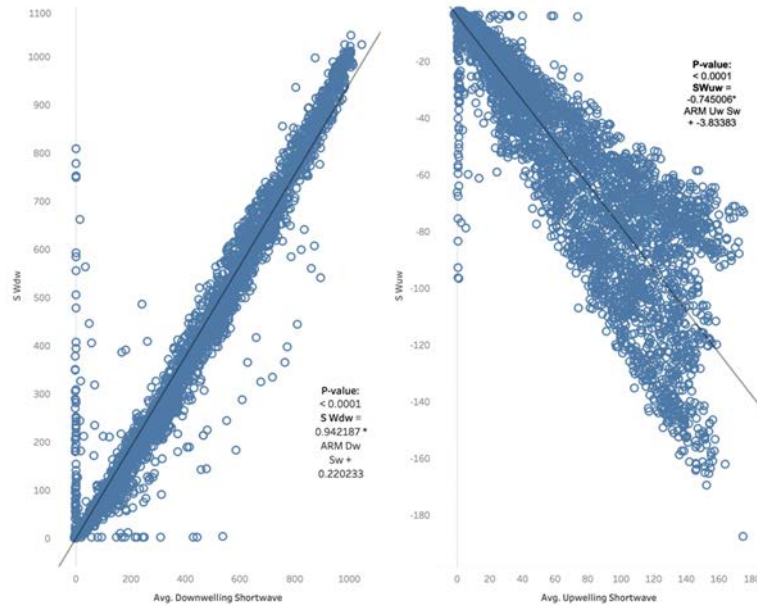


Figure 1. Arable Mark downwelling and upwelling shortwave radiation measurements from the SGP site.

We have created a library of spectral indices that can be useful to determine diseases and plant water stress, among other factors. These indices are not in production yet, but will be released upon the release of the spectrometer calibration.

AVI	Arable vegetation index
Avi2	Arable vegetation index 2
CIG	Green chlorophyll Index
CRI	Carotenoid index
Cire	Red edge chlorophyll index
CI	Chlorophyll index
Mari	Anthocyanin index
Mcari	Modified chlorophyll in absorption index
Msavi2	Modified soil-adjusted vegetation index
Mtc	MERIS terrestrial chlorophyll index
Ndvi	Normalized difference vegetation index
Ndwi	Water index
Ndwi2	Water index 2
Npci	Normalized pigment chlorophyll index

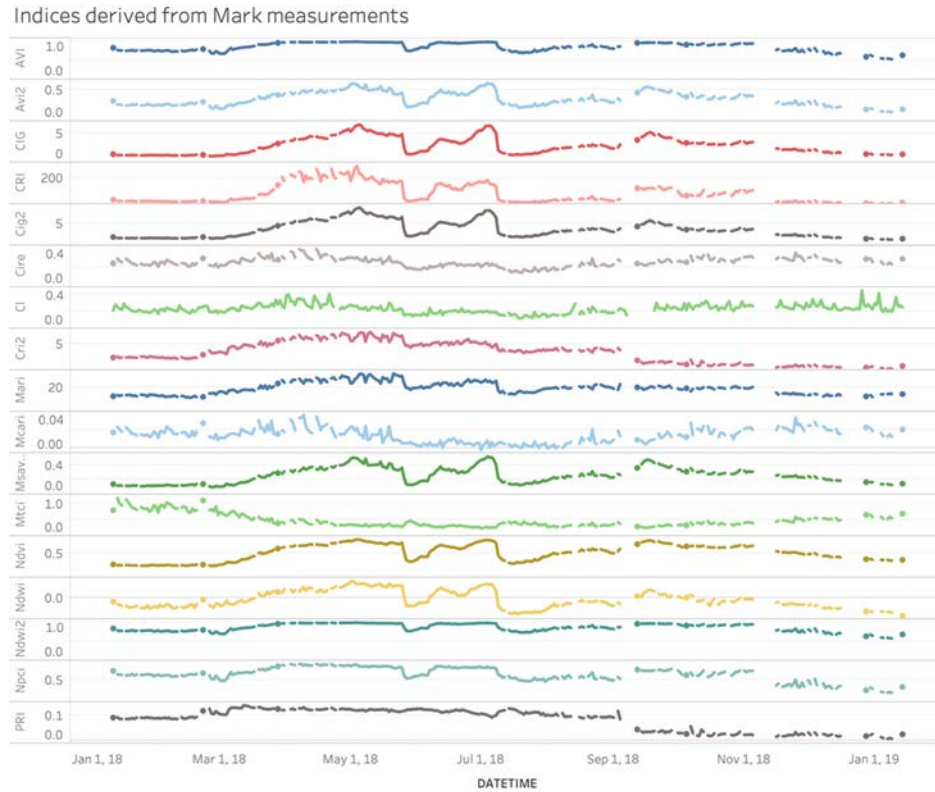


Figure 2. Spectral indices derived from Arable Mark measurements.

The upcoming work with the ARM-SGP/Arable Mark data set will focus on an approach to measure carbon cycle, as our device measures the drivers of photosynthesis, including light, temperature, humidity, and the plant itself. All of those variables provide a measure of photosynthetic carbon uptake.



Figure 3. Meteorological measurements from the Arable Mark at SGP.

The other area of interest is to refine our current water budget model. Our estimates of evapotranspiration do not account for measured wind speed; instead, we use a constant that induces a small error in our measurements.

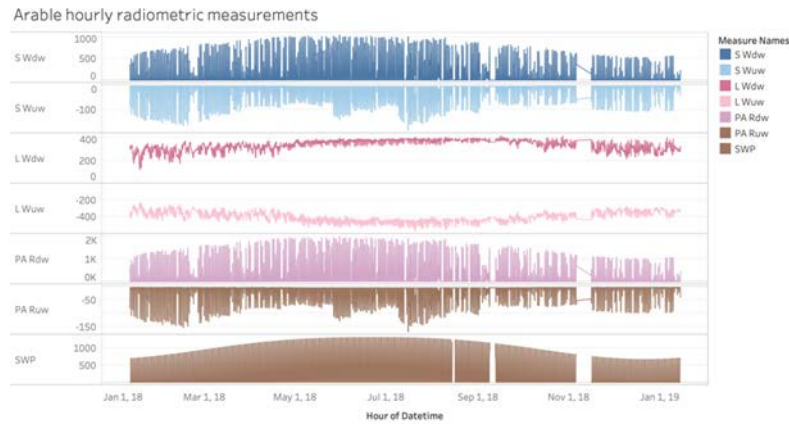


Figure 4. Arable Mark hourly radiometric measurements at the SGP.

3.0 Publications and References

None have been submitted at this time.



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