Albedo Data Sets for Bifacial PV Systems

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Introduction

- Albedo is important for estimating economic and performance benefits of bifacial PV systems

- In 2019, DOE funded NREL to establish a database of measured albedo data for various surfaces and locations

- Database includes existing measurement network data and data contributed by the PV industry

Albedo

- Albedo of a surface is the fraction of the incident sunlight that the surface reflects

- Not a constant for a surface

- Varies with spectral and angular distribution of light
  - Cloudy versus sunny
  - Sun position (time of day, season, latitude)

- Dry versus wet

- Roughness

Albedo = Reflected ÷ Incident

Incident
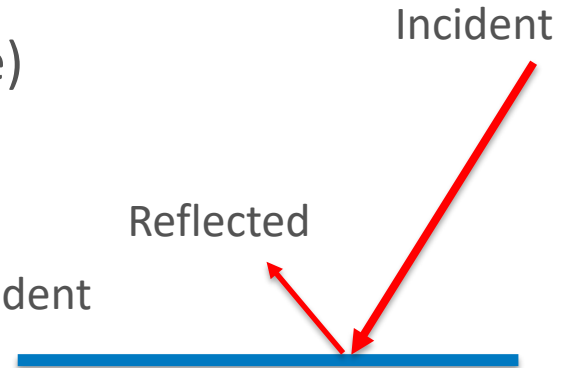
Reflected

Albedo Measurement

- Two pyranometers mounted horizontally, with one inverted to measure the ground-reflected irradiance (GRI)
- Mounting height is 1-2 meters for smooth surfaces
- Increased height for snow conditions, unchecked vegetation, and croplands

Database Elements

- Global horizontal Irradiance (GHI) and ground-reflected irradiance (GRI) for albedo.

- If available - direct normal irradiance, diffuse horizontal irradiance, dry bulb temperature, relative humidity, wind speed, wind direction, atmospheric pressure, and precipitation.

- Quality assessment flags assigned to data to indicate if within reasonable limits.

Albedo Data

- Time-series data at (1) the original temporal resolution (from 30 seconds to 30 minutes) and (2) reformatted to hourly data
- Albedo statistics – monthly and yearly means, medians, minimums, maximums, and standard deviations
- User's Guide – Describes available data sets, site information, and provides graphs of seasonal and diurnal variations
- Data products are available from: https://datahub.duramat.org/project/about/albedo-study
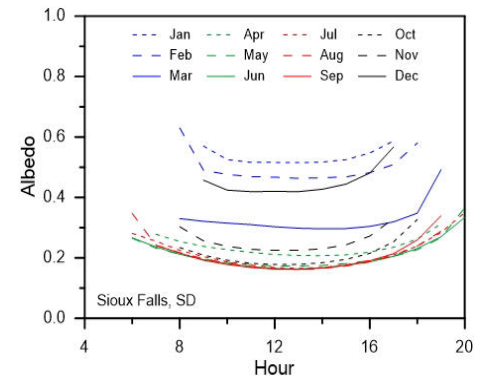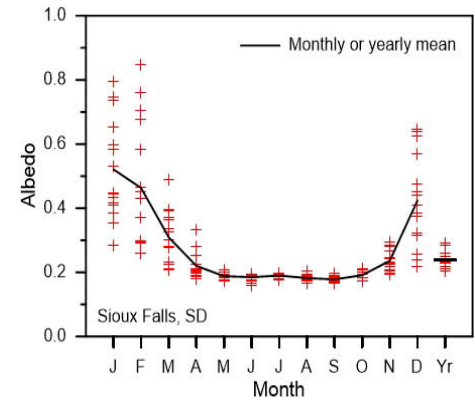
SURFRAD Network

Surface Radiation budget (SURFRAD) network

- Operated by National Oceanic and Atmospheric Administration (NOAA)

- High quality measurements to support climate research, weather forecasting, satellite and education communities

- 7 stations, 15 to 24 years of data
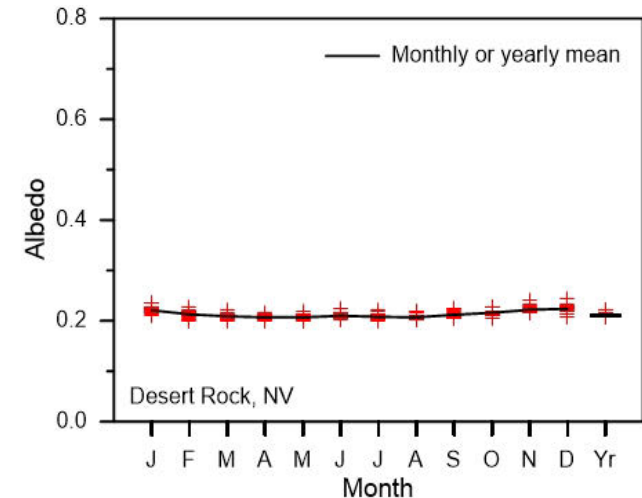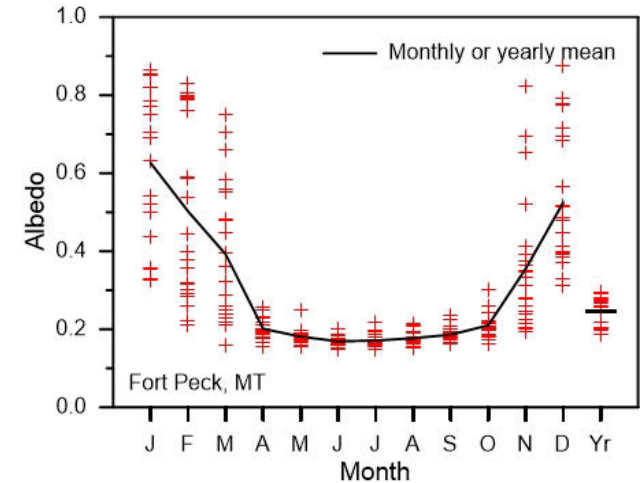
AmeriFlux Network

- Network managed by the Lawrence Berkeley National Laboratory
- Stations managed by individual scientists in North, Central, and South America
- Purpose is measuring ecosystem CO_2, water, and energy fluxes
- We used a subset of 28 stations (grasslands, deserts, low brush or crops)
- From 1 to 15 years of data, information on equipment and maintenance varies by station
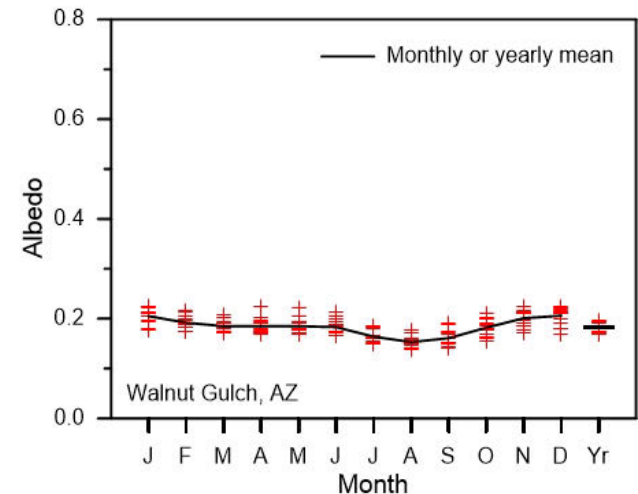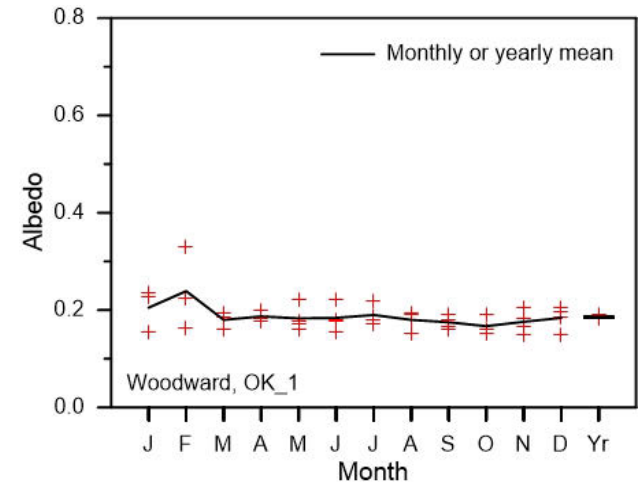
PV Industry Contributions

- Canadian Solar, Inc (contributed by Jean-Nicolas Jaubert and Baohua He)
  - Concrete surface albedo in Changshu, Jiangsu, China
  - Desert sand-wheatgrass surface albedo near Wuhai, Inner Mongolia, China
- SunPower Corp (contributed by Ben Bourne, Fabrizio Farina, and Adam Hoffman)
  - Gray gravel surface albedo in Davis, CA
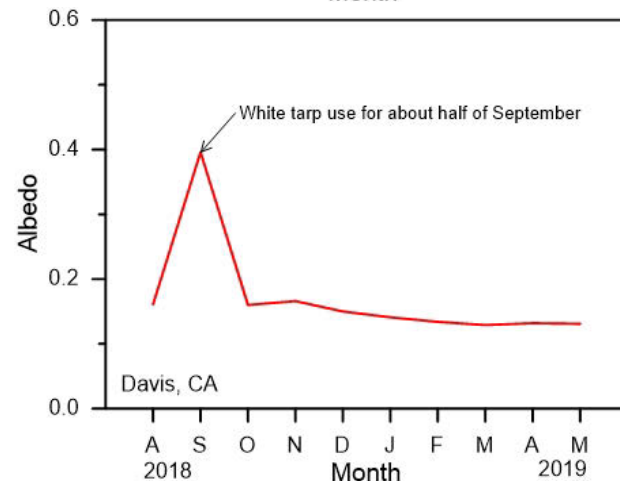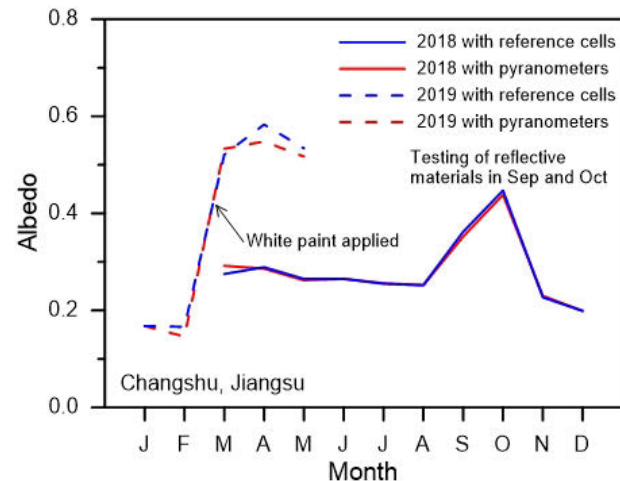
Interannual Variability

SURFRAD Network Annual Albedo Statistics

Location	Mean	Standard Deviation
Bondville, IL	0.247	0.015
Boulder, CO	0.199	0.011
Desert Rock, NV	0.211	0.004
Fort Peck, MT	0.247	0.037
Goodwin Creek, MS	0.200	0.006
Penn State Univ, PA	0.252	0.019
Sioux Falls, SD	0.238	0.025

Summary

- Database of measured albedo values compiled
  - Time series data, hourly and sub-hourly
  - Monthly and annual means and statistics
- Data and a user's guide describing the data are available for download from NREL's DuraMAT website at https://datahub.duramat.org/project/about/albedo-study.
- More albedo data will be added when available

Thank you

www.nrel.gov

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