

BIFACIAL PV AND ALBEDO: HOW TO ADDRESS VARIABILITY

Background

Bifacial PV, which makes use of solar radiation reflected from the surface (albedo), has been increasing in use in recent years. Albedo is commonly measured in just one location for a period of a year or more; it varies seasonally due to changes in vegetation, temporally due to passing clouds, and spatially because of variable cover. Satellite pixel sizes are usually too large to capture the variability.

Methods

Several existing data sets, utilizing a variety of solar radiation instruments, were analyzed. Among these data sets were:

- Long-term radiation balance measurements at Harvard Forest, MA
- Multifilter rotating shadow band measurements, with reflected radiation in 7 wavebands
- Two seasons of radiation measurements in northern boreal forest, Manitoba
- Two years of albedometer measurements at a site in northern VT

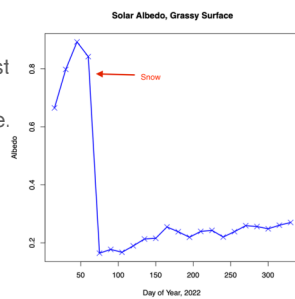
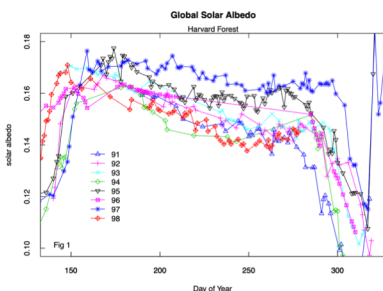
Drones are being deployed to survey spatial variation.

Results

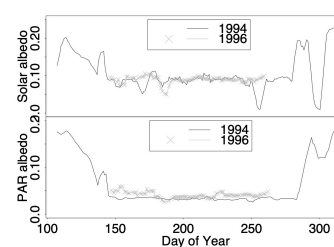
Over oak forest, there is a repeatable seasonal decrease in global (all solar wavelengths) albedo of as much as 25% (Fig1), associated with leaf aging and decreasing water content. The lichen-covered surface of the boreal forest site (NSA-OJP) did not show a growing season trend over two different seasons. A grassy site in northern VT had small changes associated with wetting and drying of the surface with rainfall

Conclusions

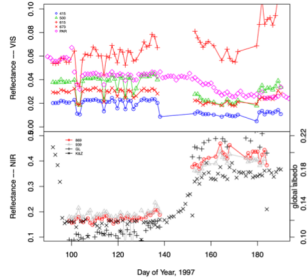
- Albedo (reflected/incoming sunlight) depends strongly on the type of surface (vegetated, soil type, etc.)
- Albedo of vegetated surfaces varies seasonally, within the growing season
- Albedo varies with the water status of vegetation or soil
- Reflection of solar radiation depends strongly on the wavelength of light
- Albedo varies spatially at satellite sub-pixel scales
- Spatial and temporal variation in albedo must be considered in order to accurately predict performance of bifacial PV in operational use.



NSA-OJP Albedo



Seasonal Albedo Over Forest



References

- Moore, K. E., D. R. Fitzjarrald, R. K. Sakai, and J.M. Freedman, 2000. Growing season water balance at a boreal jack pine forest. *Water Resources Research*, 36: 483-493.
- Moore, K. E., D. R. Fitzjarrald, R. K. Sakai, M. L. Goulden, J. W. Munger, and S. C. Wofsy, 1996. Seasonal variation in radiative and turbulent exchange at a deciduous forest in central Massachusetts. *J. Appl. Meteorol.*, 35: 122-134.