Estimation of all-sky instantaneous surface incident shortwave radiation from Moderate Resolution Imaging Spectroradiometer data using optimization method

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Overview

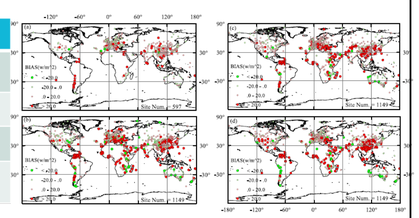
- Surface incident solar radiation (ISR) is a crucial parameter in the land surface radiation budget (SRB)
- Existing products and algorithms have insufficient spatial resolution and accuracy

Background

- Existing methods have some limitations
- Parameterization methods have uncertainties from input parameters
- Look up table(LUT) based methods uses linear interpolation. It also have relatively low efficiency or limited dimensions.
- Machine learning(ML) based methods are based on statistic relationship and are lack of physical basis
- Existing products have insufficient accuracy and resolution for land surface models and other applications.

		Spatial Resolution (km)	Uncertainty (Bias, in Wm-2)	Temporal Resolution
Global NWP	Goal	10	1	60 min
	Threshold	100	20	12 h
Agricultural Meteorology	Goal	1	N/A	24 h
	Threshold	20	N/A	7 d
Climate-AOPC	Goal	25	5	24 h
	Threshold	100	10	5 d

Products	Resolution	Temporal Res.
GEWEX-SRB	1°	3-hour, daily, monthly
ISCCP	~280km	3-hour
CERES-EBAF	1°	Monthly
UMD-SRB V3.3.3	0.5°	Monthly

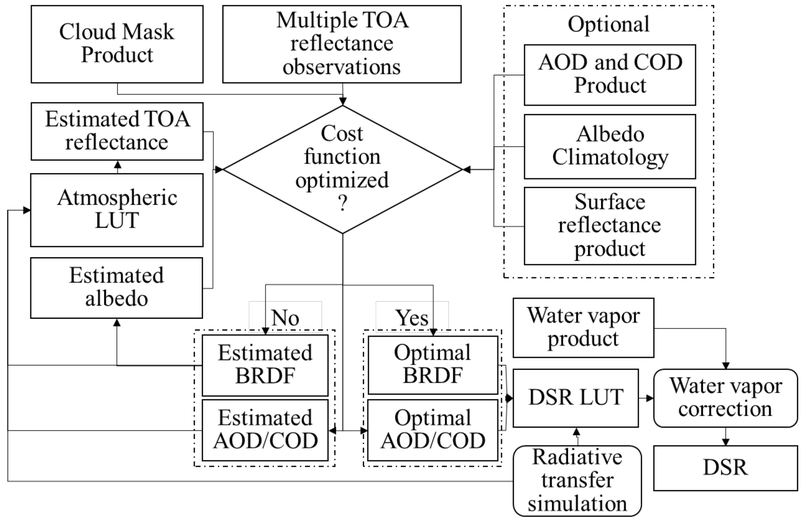


Zhang, X., Liang, S., Wild, M., & Jiang, B. (2015a). Analysis of surface incident shortwave radiation from four satellite products. Remote Sensing of Environment, 165, 186-202

Optimization based algorithm

A new optimization based algorithm for estimation ISR and DSR was developed:

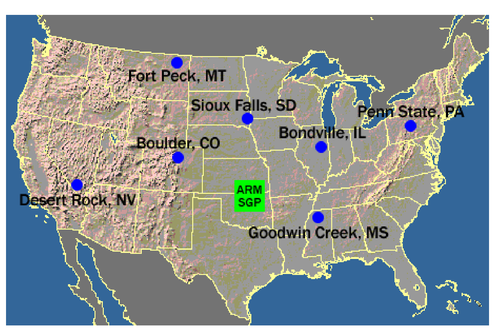
- 1. Retrieve surface BRDF, AOD and COD
- 2. Calculate surface ISR and PAR

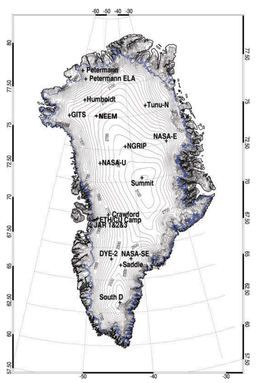


A brief flowchart showing how the proposed algorithm

Algorithm validation

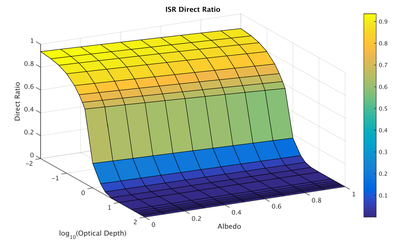
- 1. MODIS data in the year 2013
- 2. Validation sites
  - Seven Surface Radiation Budget Network (SURFRAD) sites
  - Eight Greenland Climate Network (GC-Net) sites



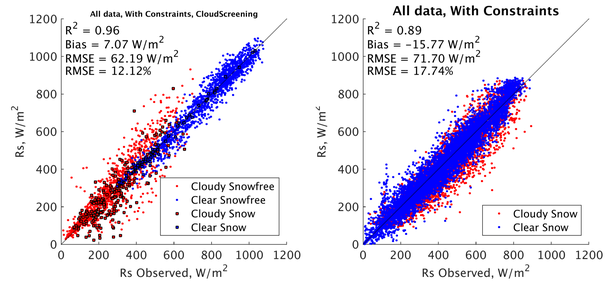


Cloud Screening

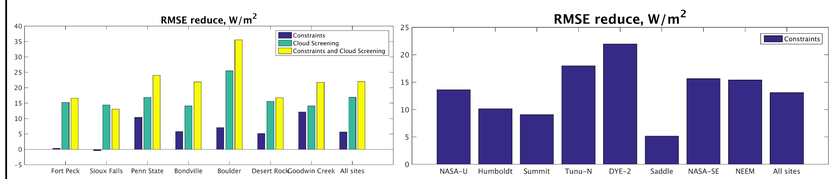
- The 3-D structure of clouds may cause different views from the sensor and the site tower.
- We calculated the "cloud mask" for each SURFRAD observation based on site-observed direct/total ISR ratio and radiative simulation.
- If the MODIS cloud mask data product differed from the cloud mask of the corresponding SURFRAD observation, the observation was not included in the validation.



Validation Results



Instantaneous ISR in 2013 at SURFRAD sites (left) and GC-net sites (right)



Impact of constraints and cloud-screening on the validation RMSE at SURFRAD sites (left) and GC-net sites (right)

Summary

- Algorithm can simultaneously estimating cloud mask, AOD, COD and surface reflectance/albedo
- Inclusion of high level products and cloud-screening process will increase the accuracy

Acknowledgement

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