Status of land surface albedo production from the JPSS Mission

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Outline

- ✓ VIIRS LSA Basics
- ✓ Current Operational Products
- ✓ Validation Status
- ✓ Issues and improvement Needs
- ✓ International Cooperation
- ✓ Long-term Monitoring
- ✓ J1 CalVal Plan

VIIRS LSA Basics

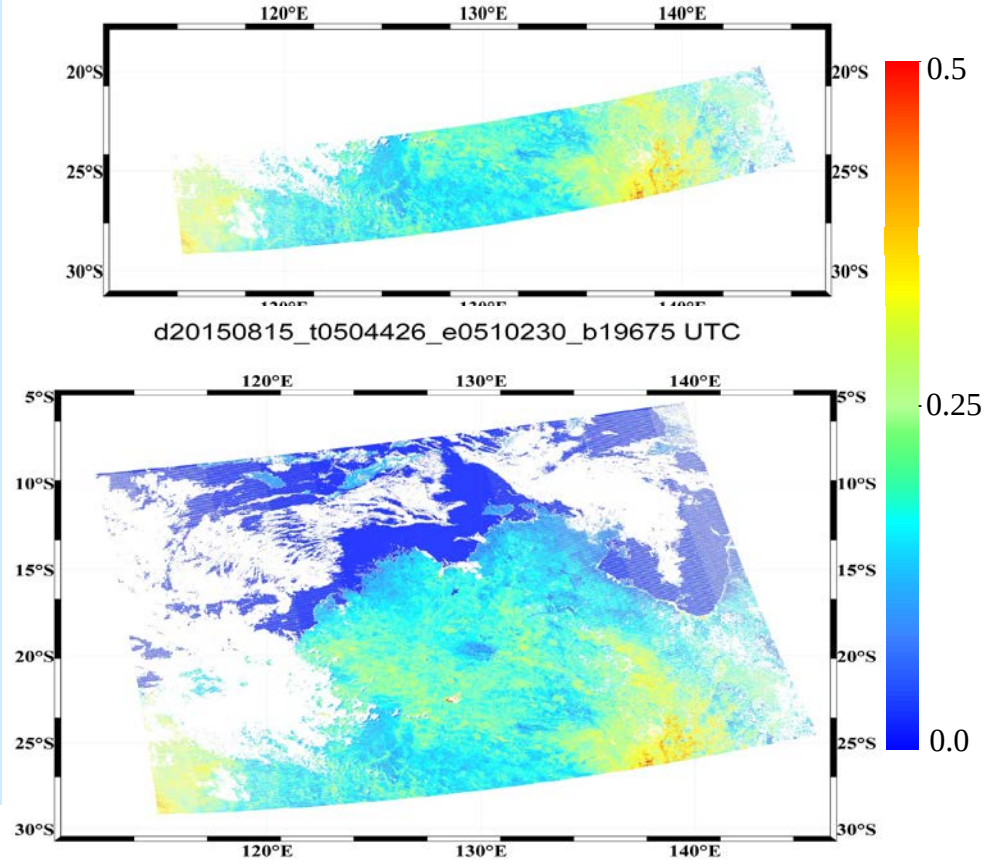
- Surface albedo is the ratio between outgoing and incoming shortwave radiation at the Earth surface. It is an essential component of the Earth's surface radiation budget.
- Surface albedo is produced from S-NPP VIIRS as Environmental Data Record (EDR). Surface albedo EDR has the global coverage, including land surface albedo (LSA) and sea ice surface albedo (ISA).
- Bright Pixel Sub-Algorithm (BPSA) is currently used to generate LSA and ISA from VIIRS data. Several improvements have been made since the S-NPP launch.
- Surface albedo EDR is a full resolution ***granule instantaneous*** product. LSA is only generated for ***clear-sky*** pixels.

Albedo EDR Cal/Val Team Membership

	Name	Institute	Function
JPSS-STAR	Land Lead: Ivan Csiszar	NOAA/NESDIS/SATR	Project Management
	EDR Lead: Yunyue YU	NOAA/NESDIS/SATR	Team management, algorithm development, validation
	Shunlin Liang	UMD/CICS –project PI	algorithm development, validation
	Dongdong Wang	UMD/CICS	algorithm development, validation, monitoring
	Yuan Zhou	UMD/CICS	algorithm development, validation, monitoring
	Marina Tsidulko	IMSG	STAR AIT support: product verification, testing
	Mike Ek' team	NOAA/NWS/NCEP	User readiness
	Weihong Zheng	NOAA/NWS/NCEP	User readiness
JPSS DPA			
	Leslie Belsma	JPSS/DPA	algorithm Manager (JAM) for Land
NASA S-NPP Science Team			
	Robert Wolf' team	NASA/GSFC	Cal/Val support
	Miguel Roman	NSAS/GSFC	algorithm (DPSA) development, product validation
	Crystal Schaaf	UMB	algorithm (DPSA) development, product validation

Basics: Current Operational Product

- Operational Product
  - Single 1.5 min granule data
  - Combined *4 x 1.5* min granule data
- Production team
  - STAR Science Team : Scientific development and validation
  - JPSS DPE (Data Product Engineering) : Production



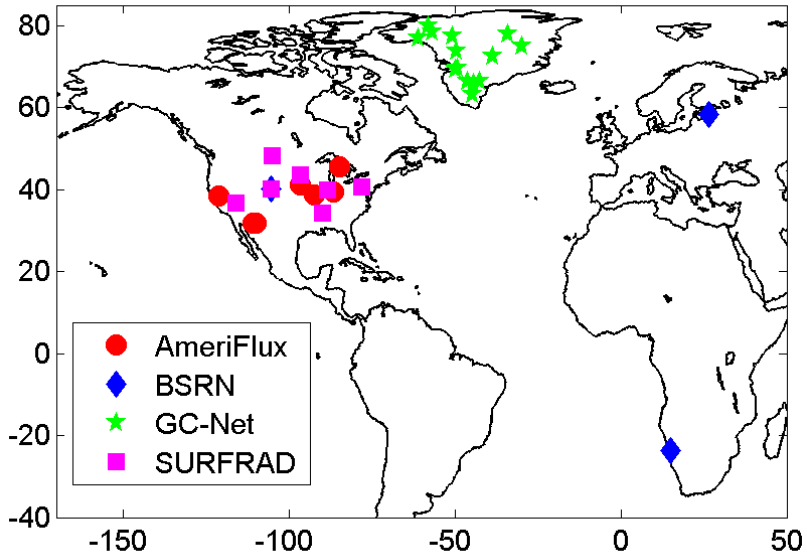
- Archive site
  - CLASS: http://www.nsof.class.noaa.gov/saa/products/welcome (search for JPSS VIIRS EDR)
  - Team site : http://www.star.nesdis.noaa.gov/jpss/albedo.php
  - NASA site: http://viirsland.gsfc.nasa.gov/Products/AlbedoEDR.html
- Monitoring: http://www.star.nesdis.noaa.gov/jpss/EDRs/products_LST.php

Validation status

Site	RMSE		Bias	
	VIIRS	MODIS	VIIRS	MODIS
AZ_Kendall_Grassland	0.042	0.062	-0.030	-0.057
AZ_Lucky_Hills_Shrubland	0.025	0.042	0.001	-0.039
AZ_Santa_Rita_Creosote	0.044	0.048	0.003	-0.035
AZ_Santa_Rita_Mesquite	0.026	0.033	0.007	-0.028
IN_Morgan_Monroe_State_Forest	0.043	0.063	-0.032	-0.058
MI_UMBS	0.200	0.028	0.136	-0.028
MI_UMBS_Disturbance	0.243	0.039	0.171	-0.032
MO_Missouri_Ozark_Site	0.025	0.041	-0.012	-0.035
NE_Mead_irrigated	0.032	0.141	0.007	-0.047
NE_Mead_Rainfed	0.209	0.184	0.088	0.096
Boulder	0.051	0.117	-0.017	-0.049
GITS	0.112	0.761	-0.057	-0.570
Humboldt	0.114	0.112	-0.071	-0.096
Summit	0.106	0.074	-0.028	-0.061
DYE-2	0.152	0.059	-0.009	0.027
Saddle	0.094	0.104	-0.028	-0.039
South-Dome	0.109	0.095	0.055	0.046
NASA-SE	0.142	0.241	-0.043	-0.086
Sioux_Falls	0.114	0.078	0.048	0.009
Table_Mountain	0.050	0.163	0.020	-0.019
Desert_Rock	0.038	0.011	0.029	-0.009
Fort_Peck	0.042	0.258	-0.006	-0.131
Penn_State	0.081	0.073	-0.066	-0.035
Goodwin_Creek	0.037	0.045	-0.031	-0.042

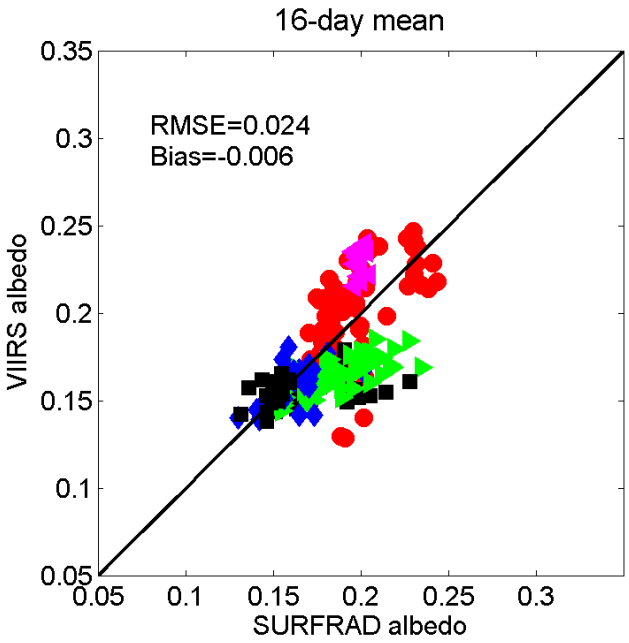
Validation data period: 2012 , 2013, 2014

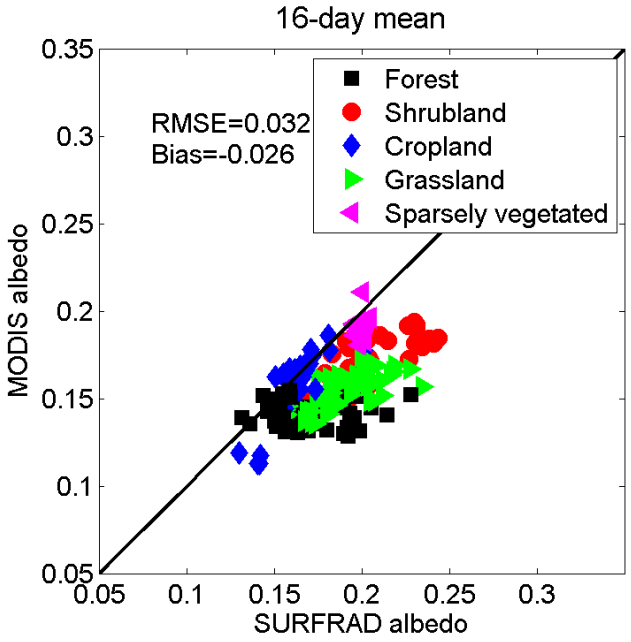
- Data of 35 stations are collected, which include measurements of recent three years.
- VIIRS data are generally better than MODIS products, with smaller RMSE and bias.
- Both data sets have high accuracy for snow-free cases.
- Large RMSE usually occurs at the cases of snow pixels and ephemeral snow.



Validation results for non-snow albedo

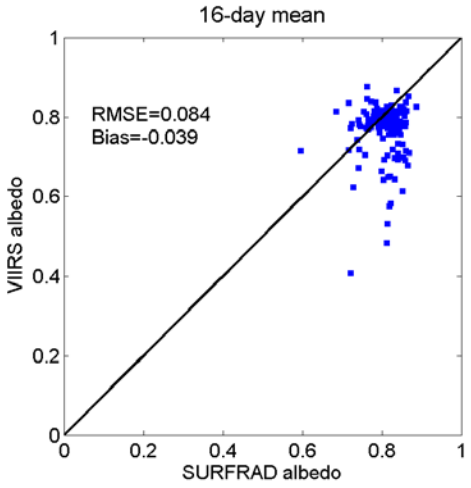
- Further analyzing accuracy of non-snow albedo
- Data over non-snow sites during non-snow seasons were used.
- 16-day mean was calculated to compare with MODIS data
- VIIRS data have smaller bias and RMSE, well below the product threshold.

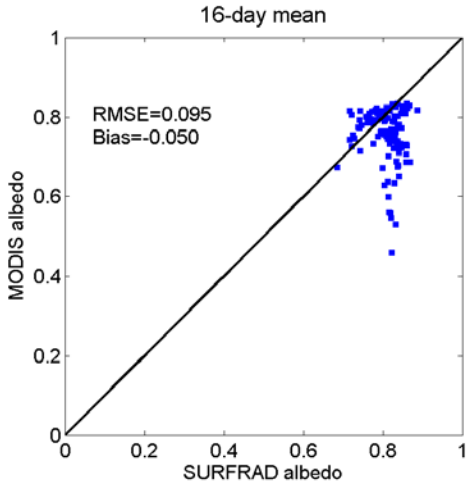




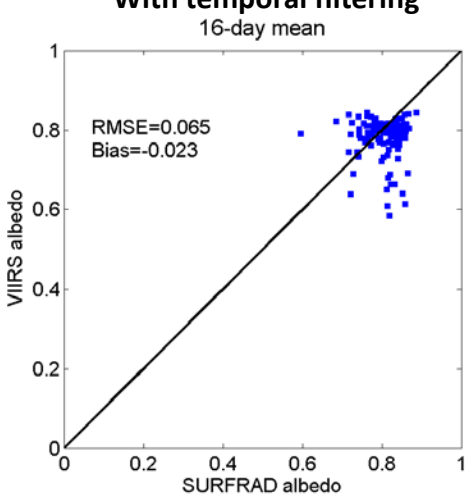
Validation results for snow albedo

- Accuracy of estimating snow albedo was evaluated at GC-Net stations.
- VIIRS generally has improved results.
- Retrieval accuracy is strongly dependent on quality of cloud detection.
- Temporal filtering can improve retrieval quality and data continuity.

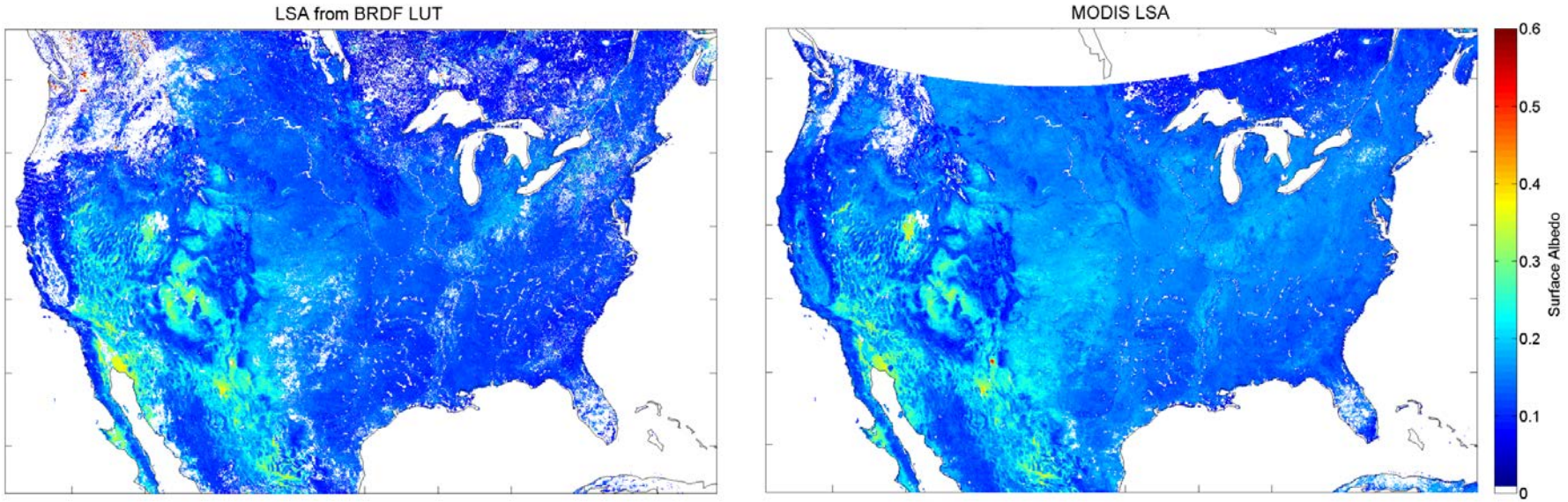




With temporal filtering

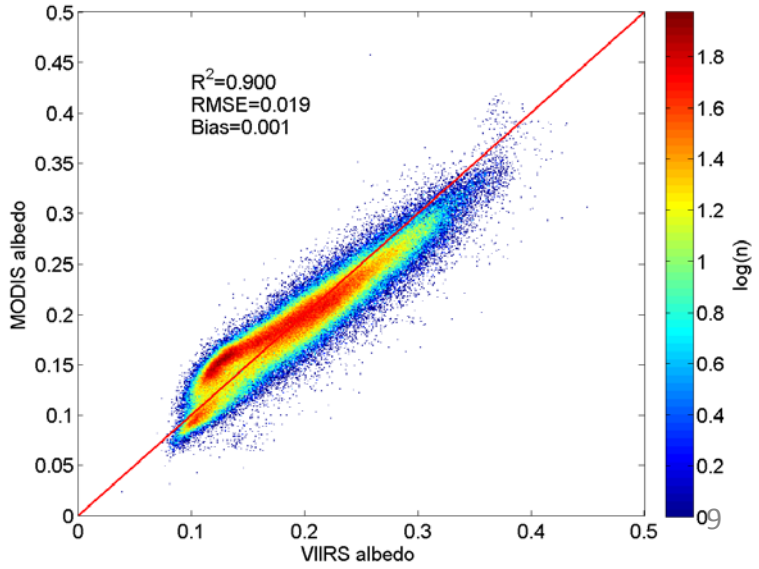


Inter-comparison with MODIS albedo



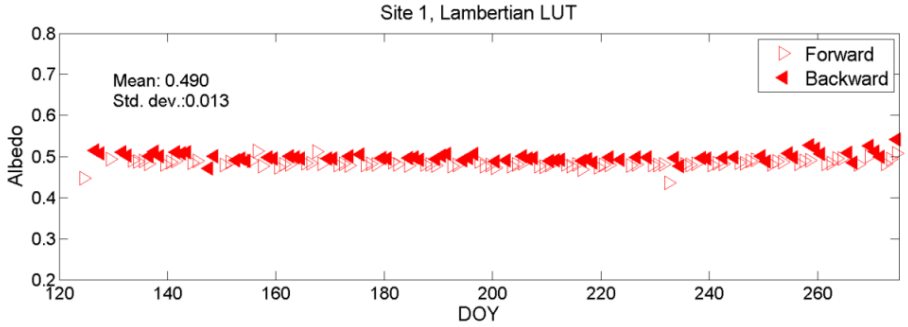
Contiguous US maps of 16-day mean LSA from VIIRS and MODIS, during DOY 145-160, 2012

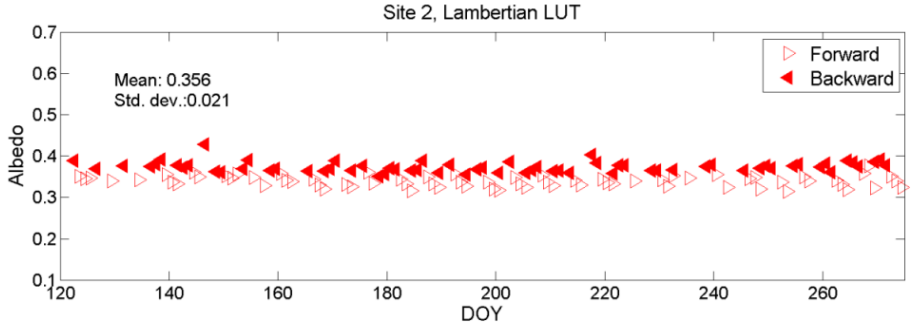
Comparing 16-day mean VIIRS albedo from BRDF-impacted LUT with MODIS blue-sky albedo. Data are limited to those with at least 8 clear-day observations during the composite period of 16 days.

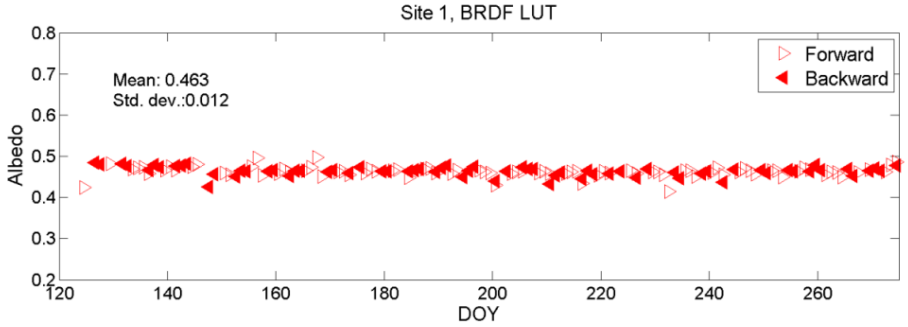


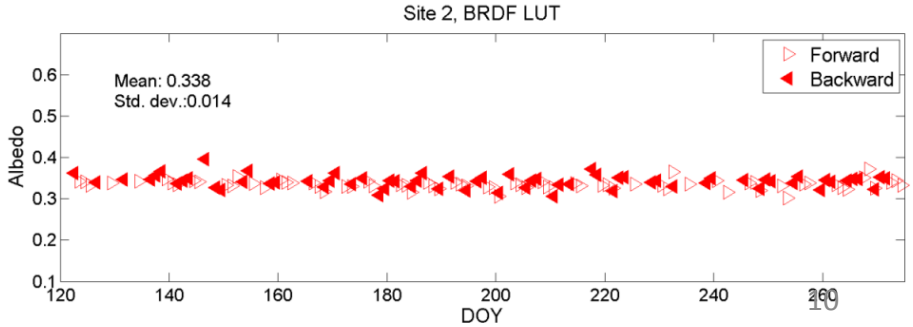
Temporal variability of LSA retrievals

- The VIIRS LSA algorithm uses one observation to estimate LSA. Angular dependency has been substantially reduced by incorporation of surface BRDF in model construction.
- Residual variations still exist after algorithm improvement, though they are comparable to results of other methods.
- The LSA retrievals over two Libya desert sites (Site 1: 24.42˚N 13.35˚E and Site 2: 26.45˚N, 14.08˚E) are used to illustrate the issue of temporal variability of LSA retrievals.







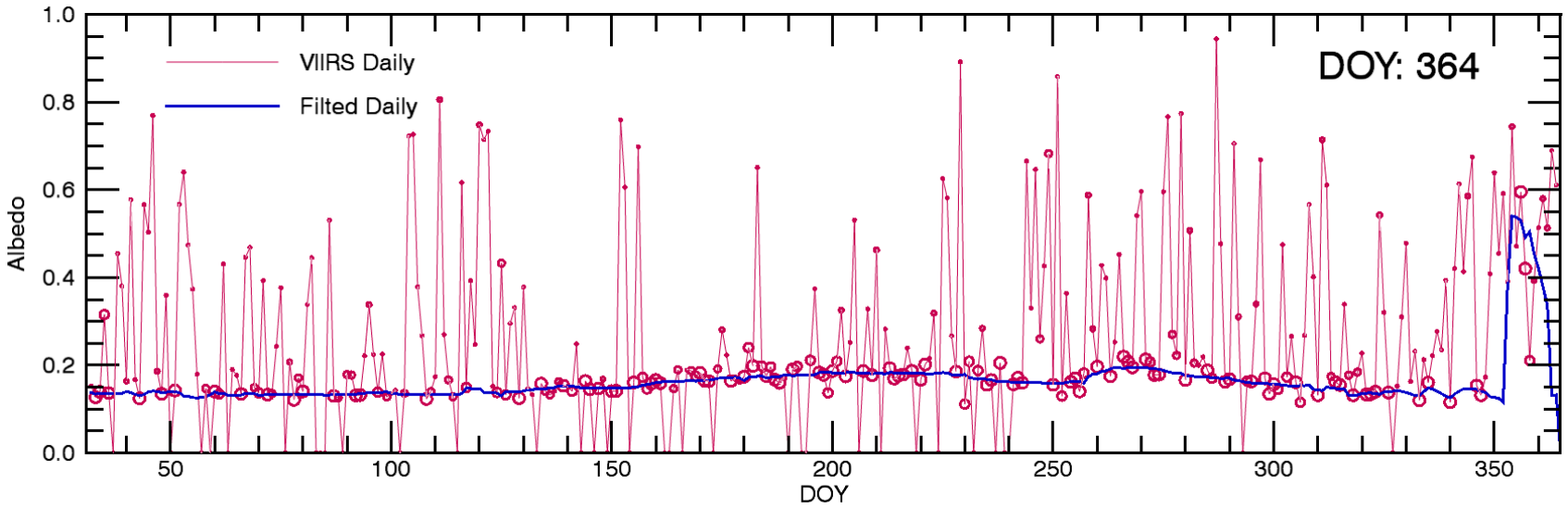


Issues and Improvement Needs

- **LUT of sea ice albedo** is out of date. Evaluation of current sea ice albedo data and development of a new LUT is greatly needed.
- The current BPSA algorithm estimates albedo from a single clear-sky observations. It is sensitive to errors in cloud mask and random effects. **Temporal filter** is proposed to generate smoother and gap-free albedo with improved accuracy.
- Land surface is currently divided into two categories (desert and non-desert). We plan to further separate surface types and develop a new version of **surface-specific LUTs**.
- **Comprehensive validation and intercomparison** is essential for both algorithm developers and end users. Limited validation has been done so far.

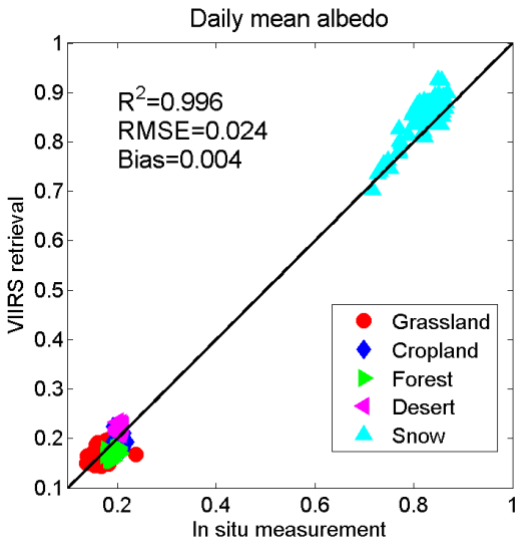
New development: temporal filter

- An algorithm based on temporal autocorrelation and climatology is developed.
- Objectives
  - Improve accuracy
    - Reduce temporal variations
    - Exclude undetected cloud and shadow
  - Fill data gaps
- Integrate multisource of information
  - VIIRS retrieval and its QF
  - Climatology (mean and variance)
  - Temporal correlation (historical observation)



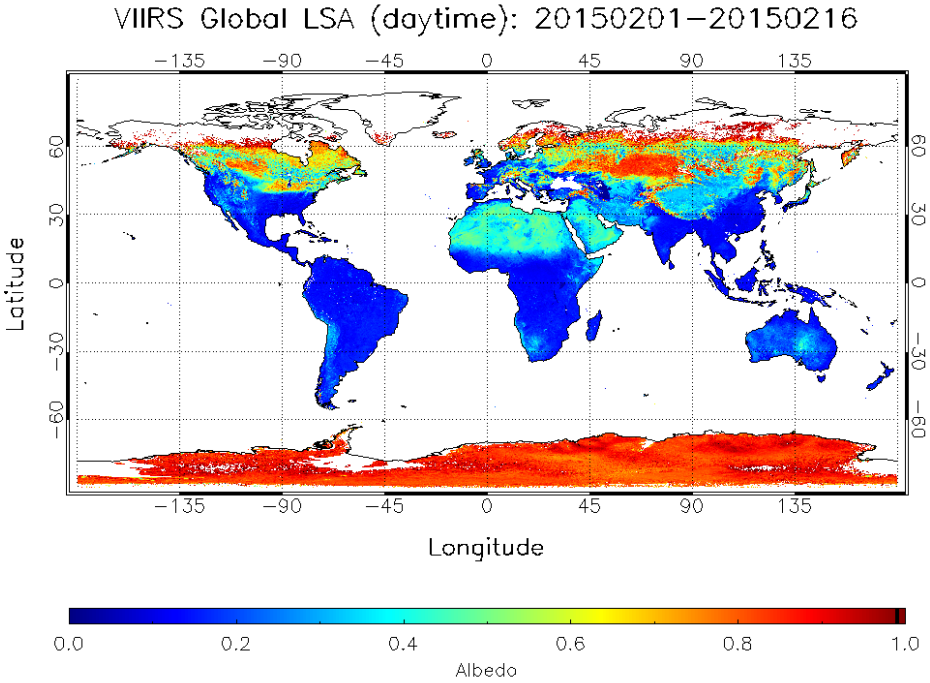
New development: gridded LSA product

- We proposed to develop a Level-3 LSA product on the basis of VIIRS SA EDR, which has the following features:
  - Gridded
  - Noise-reduced
  - Gap-filled
  - Diurnal variations being considered
- Use of instantaneous albedo to calculate daily surface radiation budget results in ~10% bias for snow-free conditions.
- We develop a new method to estimate daily mean albedo directly from VIIRS data.



Left: validation of daily mean albedo

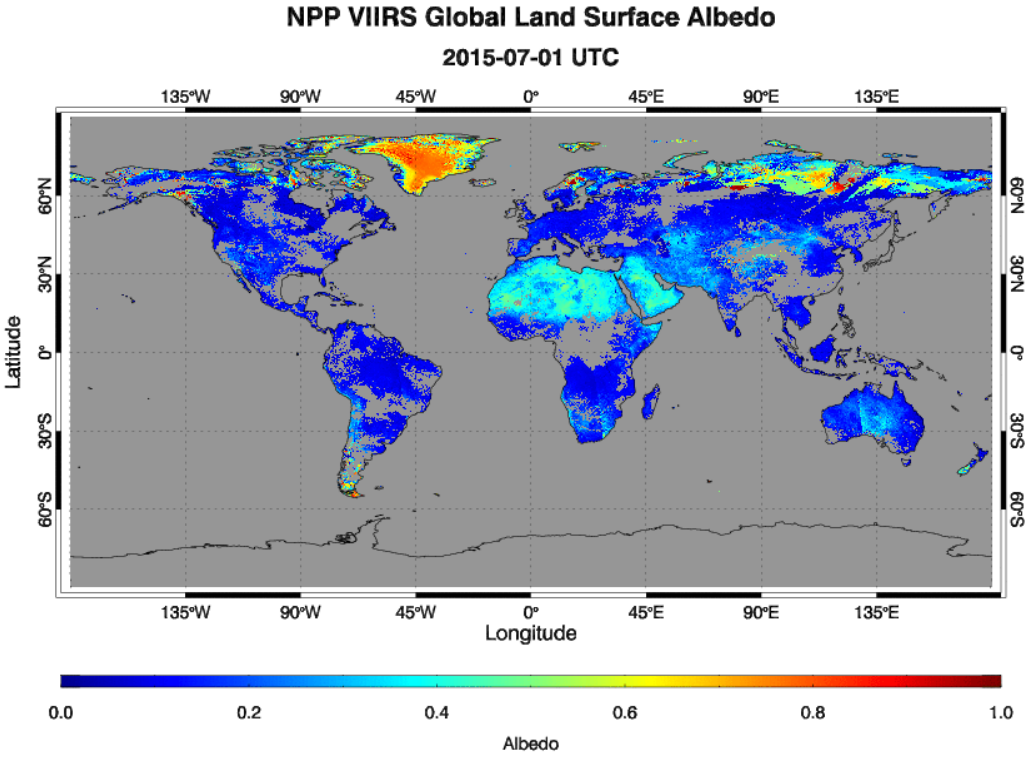
Right: gridded global albedo data



Long-term monitoring tool

Working on a long-term monitoring tool

- Automatically validate against field measurements;
- Generate global composite maps on a regular basis ;
- Send alerts when abnormal results occur;
- Update maps through WWW
- http://www.star.nesdis.noaa.gov/jpss/EDRs/products_LST.php



Animation of global albedo map composed from the VIIRS albedo EDR, shown through the VIIRS Albedo production long-term monitoring website at STAR.

Data re-processing

- The S-NPP VIIRS LSA algorithm has gone through several updates for algorithm improvement and refinement.
- The updated algorithms were applied only for data acquired after the algorithm's effective dates.
- To generate consistent LSA product with highest quality possible, we need to re-process all the historical VIIRS data with the latest LSA algorithm.
- VIIRS TOA reflectance SDR and cloud mask IP are the major upstream inputs of the albedo algorithm. Such data with the latest version will be used during the data re-processing.

J1 Cal/Val plan

- Comprehensive evaluation of the J1 LSA product
  - Spatial scaling problem
  - Dependency of LSA retrievals on solar and view angles
  - Global accuracy of both snow-free and snow-covered data
  - Capability of capturing rapidly-changing surfaces
- Long-term monitoring
  - A web-based product monitoring interface
  - In-situ validation alerting/notification
- Correlative Data Sources
  - Ground stations
  - Airborne multiangular measurements
  - High resolution reference maps
  - Other albedo products
- Development of cal/val tool
  - Generating quality metrics commonly used by the international land community
  - Participating in the international cooperation on validation of satellite land products