JPSS LAND SURFACE ALBEDO

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Outline

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  - Long term monitoring
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- ❑ Summary and Path Forward

Cal/Val Team Members

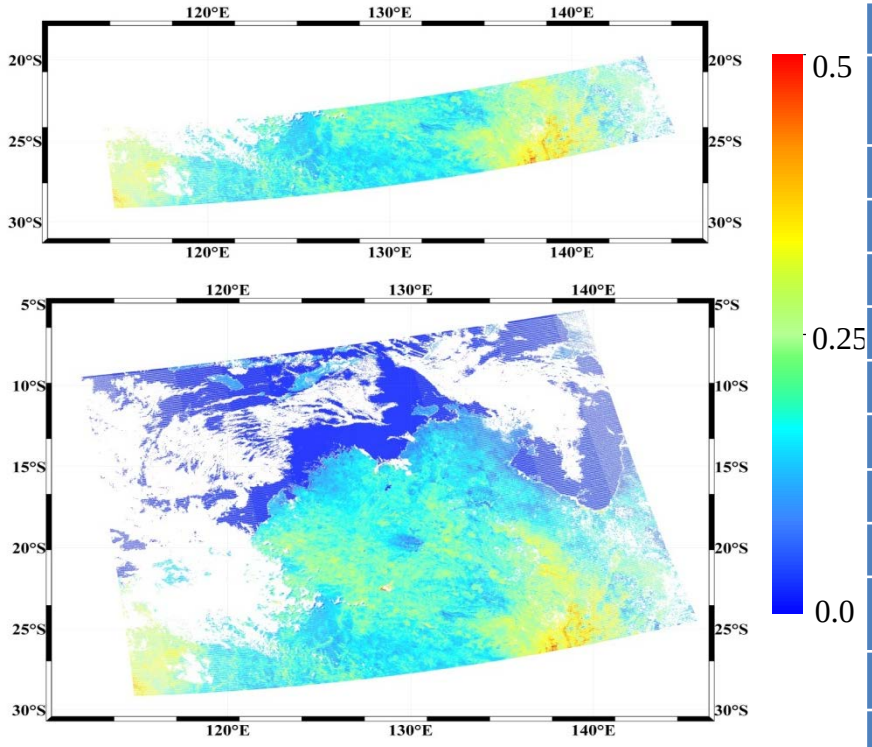
PI	Organization	Team Members	Roles and Responsibilities
Ivan Csiszar	NOAA/NESDIS/SATR		Land Lead, Project Management
Yunyue Yu	NOAA/NESDIS/SATR		EDR Lead, algorithm development, validation, team management
Shunlin Liang	UMD/CICS		Algorithm development, validation
		Dongdong Wang	Algorithm development, validation, monitoring
		Yuan Zhou	Algorithm development, validation, monitoring
Walter Wolf	NOAA/NESDIS/SATR		System Integration, Transition
		Valerie Mikles	System Integration, Transition
		Marina Tsidulko	STAR IT support
Michael EK	NOAA/EMC/NCEP		User readiness
		Weizhong Zheng	User readiness : Model albedo application, verification
		Yihua Wu	User readiness : Model albedo application, verification
Miguel Roman	NSAS/GSFC		NASA Land Science Investigator-led Processing System Lead
		Sadashiva Devadiga	System support, product monitoring

Current VIIRS LSA Algorithm Overview

$$LSA = a_0 + \sum_i a_i r_i$$

a_i is regression coefficient for Band i.

i is VIIRS band number, including the channels 1,4,5,7,8,10 and11.



- Operational Products
  - 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

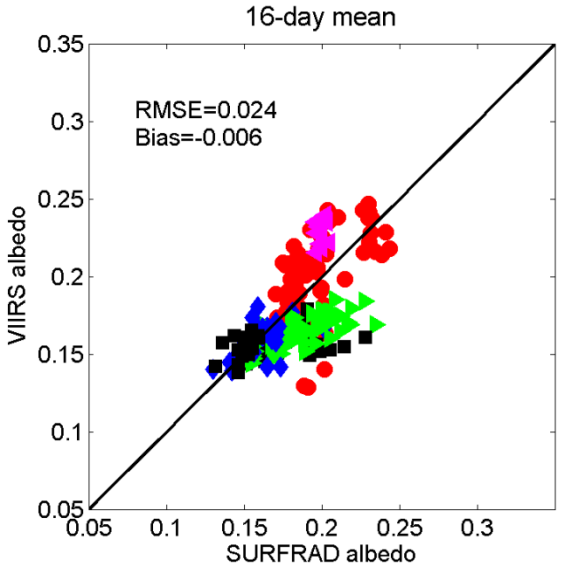
Name	Type	Description	Dimension	Unit
Primary Sensor Data(SDR)				
Spectral reflectance	input	TOA spectral reflectance at M1, 4,5,7,8,10,11	grid (xsize, ysize)	unitless
Solar zenith	input	Solar zenith angles	grid (xsize, ysize)	Degree
View zenith	input	Satellite view zenith angle	grid (xsize, ysize)	Degree
Solar azimuth	input	Solar azimuth angles	grid (xsize, ysize)	Degree
View azimuth	input	Satellite view azimuth angle	grid (xsize, ysize)	Degree
SDR QC flags	Input	Level 1b data quality	grid (xsize, ysize)	unitless
Derived Sensor Data				
Cloud mask	Input	Cloud mask data	grid (xsize, ysize)	unitless
Snow mask	Input	Level 2 snow/ice mask data	grid (xsize, ysize)	unitless
Surface type	Input		grid (xsize, ysize)	unitless
LUT and Configuration File				
Coefficients LUT	Input	Regression coefficients for BPSA	2(two surface types)*18(sza) *18(vza)*23(raa)* 8(coef items)	Unitless
Output				
LSA	Output	LSA values	grid (xsize, ysize)	Unitless
QF	Output	Associated pixel quality flags	grid (xsize, ysize)	Unitless

Product Performance Overview

Current VIIRS Surface albedo EDR is a full resolution granule instantaneous product. LSA is only generated for clear-sky land pixels.

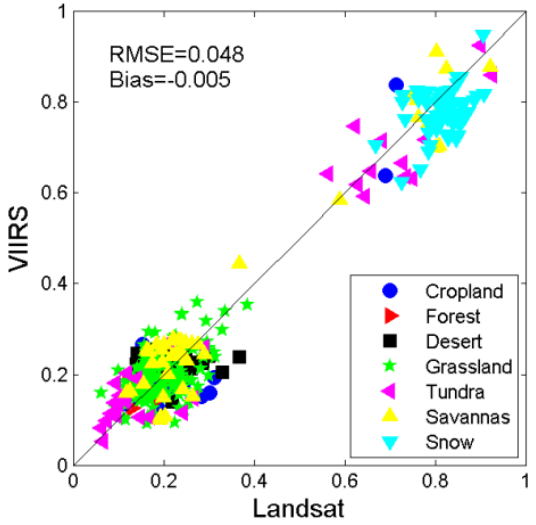
Product	L1RDS APU Thresholds	Performance
VIIRS LSA	Precision: 0.05	RMSE: 0.05
VIIRS LSA	Accuracy: 0.08	Bias: 0.01

- Comprehensive evaluation was conducted using field measurements and high-resolution LSA reference maps
- The current LSA data can meet the requirements for snow-free cases.



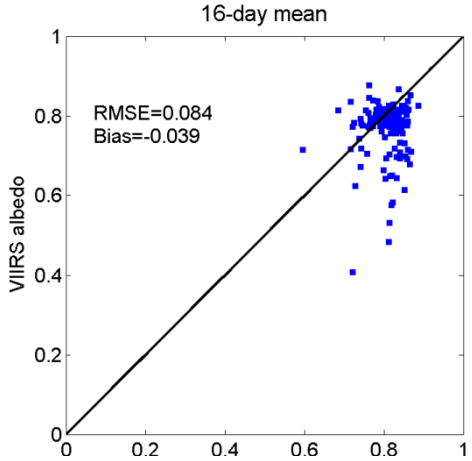
Left: Comparison of snow free albedo with SURFRAD measurements.

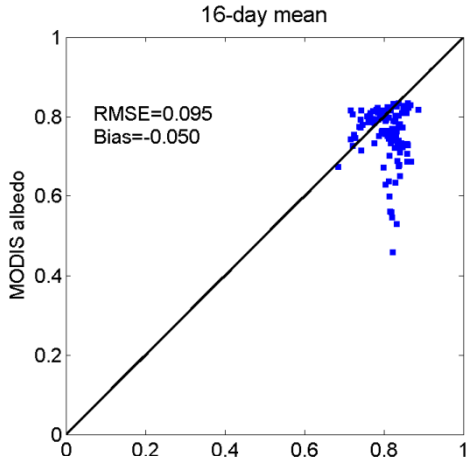
Right: Validating snow-free and snow albedo using Landsat albedo maps

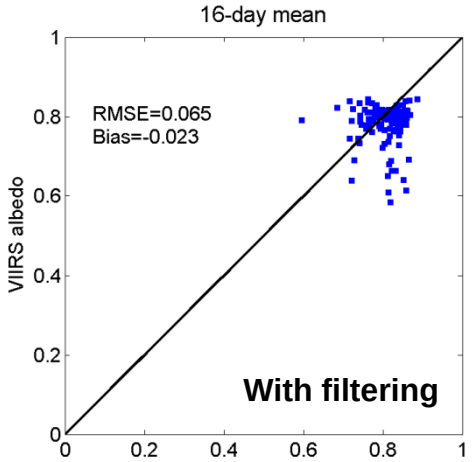


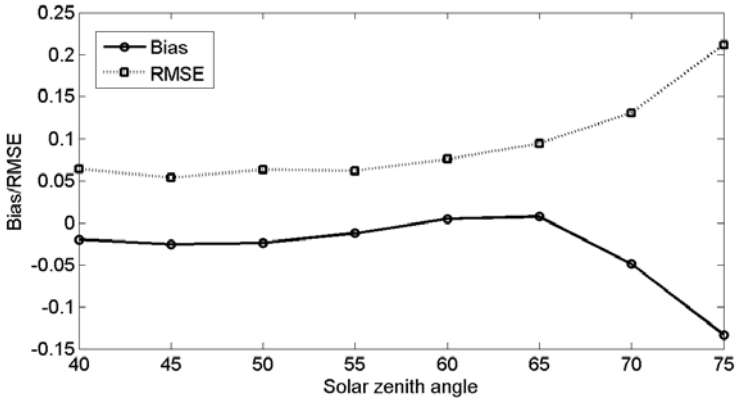
Product Performance: snow albedo

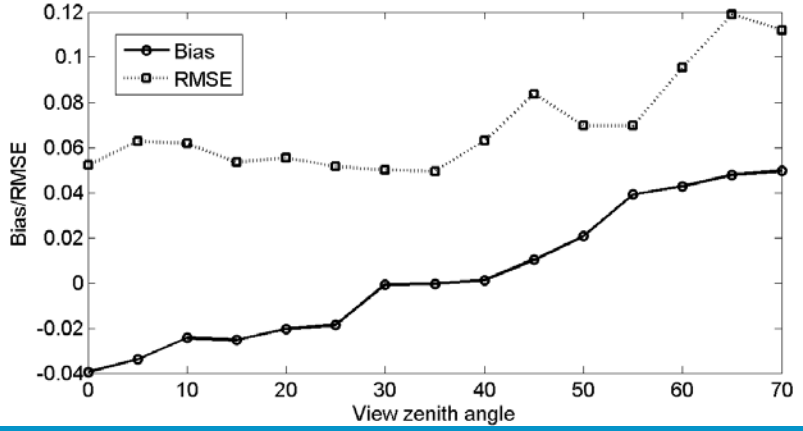
- Accuracy of estimating snow albedo was evaluated at GC-Net stations.
- VIIRS generally has improved results.
- Retrieval accuracy is strongly dependent on quality of cloud detection.
- RMSE varies with solar and view zenith angles.
- Temporal filtering can improve retrieval quality and data continuity.







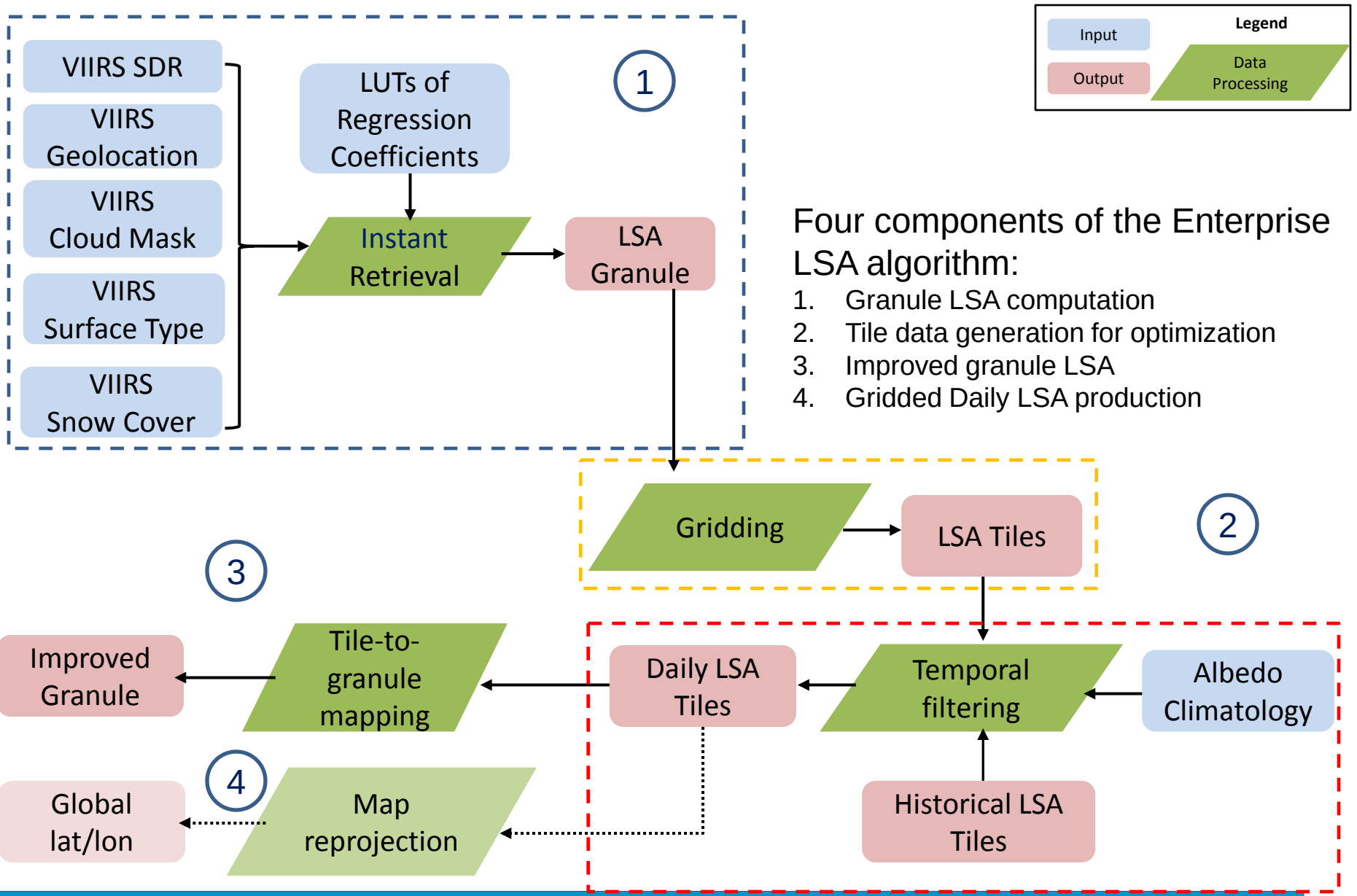




Enterprise Algorithm Development

- Substantial improvement needs on the basis of the current IDPS LSA algorithm.
  - Missing values
    - Current product: granule instantaneous, for clear-sky pixels only
  - Intraday residual variations
    - A direct estimation method is used for VIIRS to capture LSA variations of rapidly-changing surfaces.
    - Meanwhile, the albedo retrieved from a single observation may contain some levels of random noises.
  - Possible gridded product
    - End users need gridded product with common map projection.
- We propose to develop a new high-level LSA product on the basis of VIIRS SA EDR, which has the following features:
  - Gap-filled
  - Noise-reduced
  - Having potential of generating gridded product, which is desired by user community.
- The prototype system in IDL language is ready.
  - We are developing the operational system in C language to improve efficiency.
- Critical Design Review is planned for August 2016.

Enterprise Algorithm Development



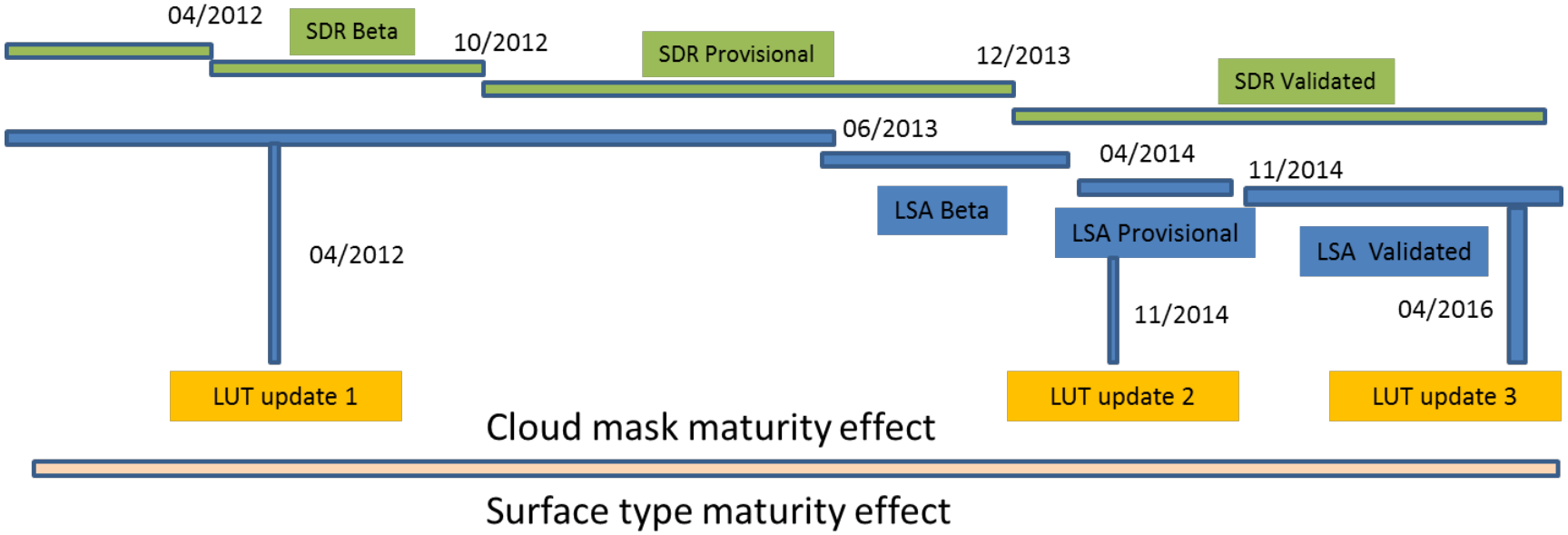
Input Data of Enterprise Albedo Algorithm

Name	Type	Description	Dimension	Unit
Primary Sensor Data(SDR)				
Spectral reflectance	input	TOA spectral reflectance at M1,2,3,4,5,7,8,10,11	grid (xsize, ysize)	unitless
Latitude	input	Pixel latitude	grid (xsize, ysize)	Degree
Longitude	input	Pixel longitude	grid (xsize, ysize)	Degree
Solar zenith	input	Solar zenith angles	grid (xsize, ysize)	Degree
View zenith	input	Satellite view zenith angle	grid (xsize, ysize)	Degree
Solar azimuth	input	Solar azimuth angles	grid (xsize, ysize)	Degree
View azimuth	input	Satellite view azimuth angle	grid (xsize, ysize)	Degree
SDR QC flags	Input	Level 1b data quality	grid (xsize, ysize)	unitless
Derived Sensor Data				
Cloud mask	Input	Cloud mask data	grid (xsize, ysize)	unitless
Snow/ice mask	Input	Level 2 snow/ice mask data	grid (xsize, ysize)	unitless
Surface type	Input		grid (xsize, ysize)	unitless
Climatology data for temporal filter				
Climatology	input	Correlation and variance of historical climatology	grid (xsize, ysize)	unitless
LUT and Configuration File				
Coefficients LUT	Input	Regression coefficients for BPSA	2(two surface types)*18(sza) *18(vza)*23(raa)*8 (coef items)	Unitless

VIIRS LSA Reprocessing Plan

- LSA algorithms have been updated several times.
- Reprocessing is in urgent need to provide users with consistent and high-quality albedo data.
- Based on the reprocessing of upstream data: SDR, cloud mask, surface type.
- The reprocessing is intended for VIIRS data using the IDPS algorithm (granule product) with the latest LUT.
- A new gridded daily LSA product will be generated separately.
- The reprocessing is expected to cover the time period from 11/19/2012 to present.

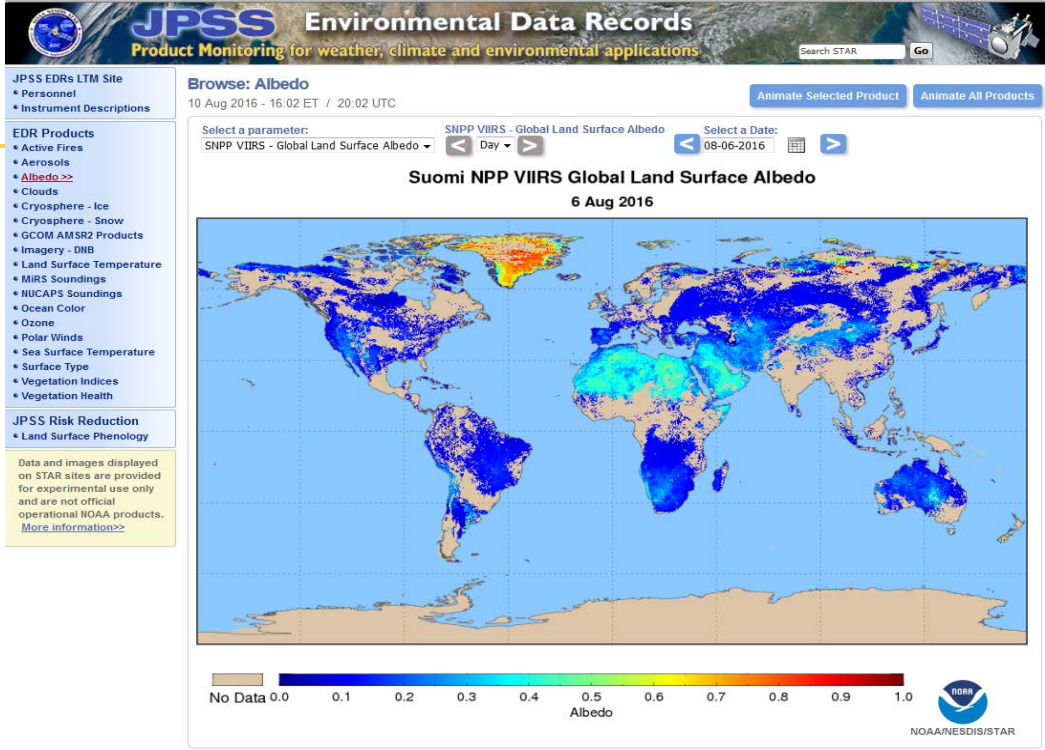
Impact of upstream data changes

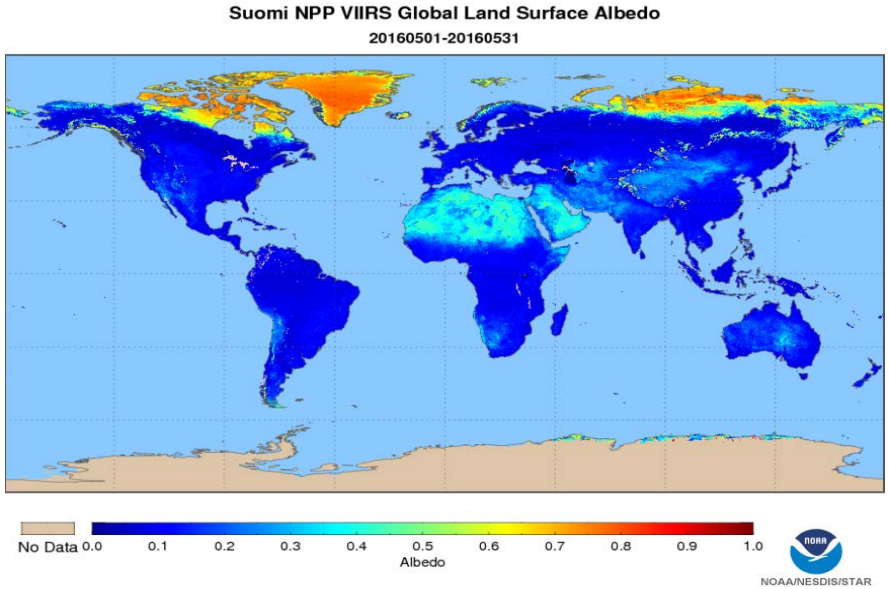


VIIRS LSA Long-term Monitoring

Developed a long-term monitoring tool

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





A global map of land surface albedo composite with VIIRS products of May, 2016

Issues of current LSA algorithm

Major issues of existing VIIRS albedo product:

1. Missing values
2. Intraday residual variations
3. Possible gridded product

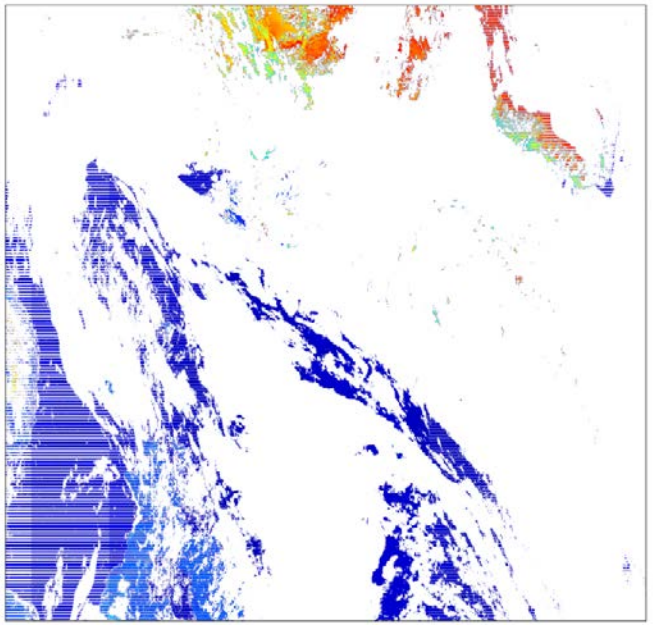
Features of current algorithm

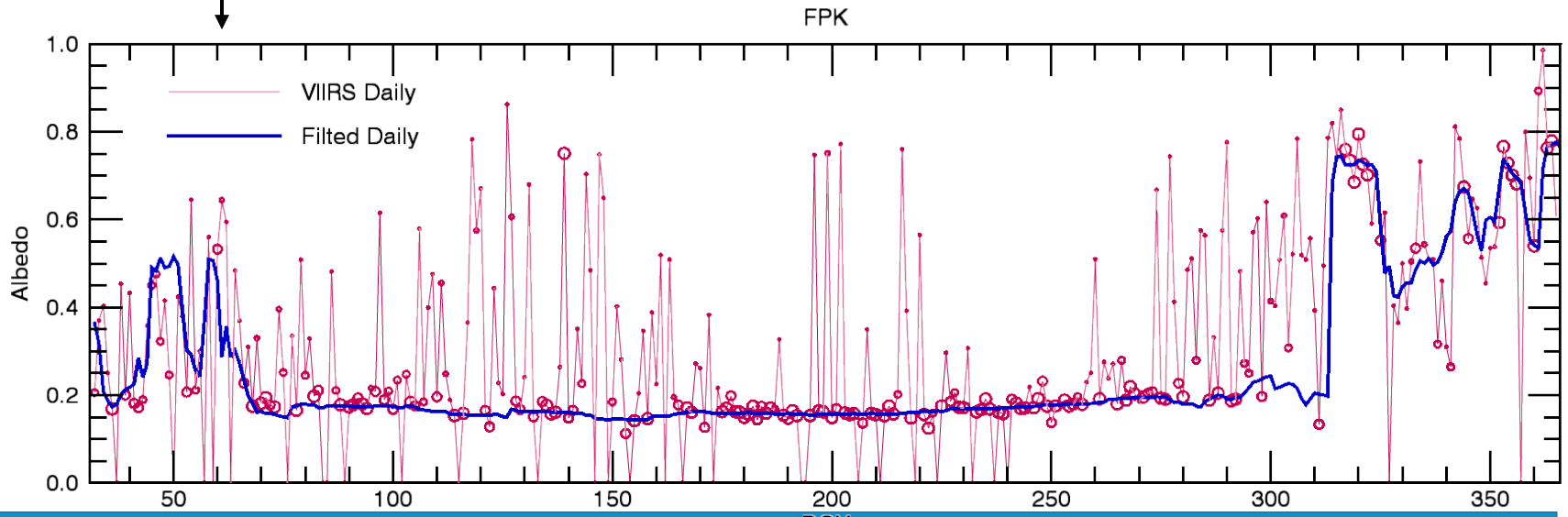
- Using single overpass
- Needing clear-sky pixels

Data gaps

Residual noise

Possible multiple values for a day



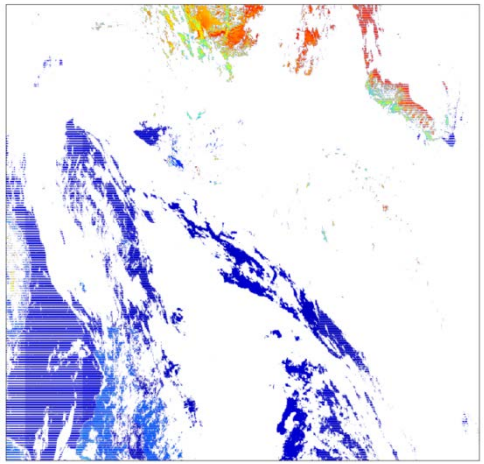


External Users of Albedo product

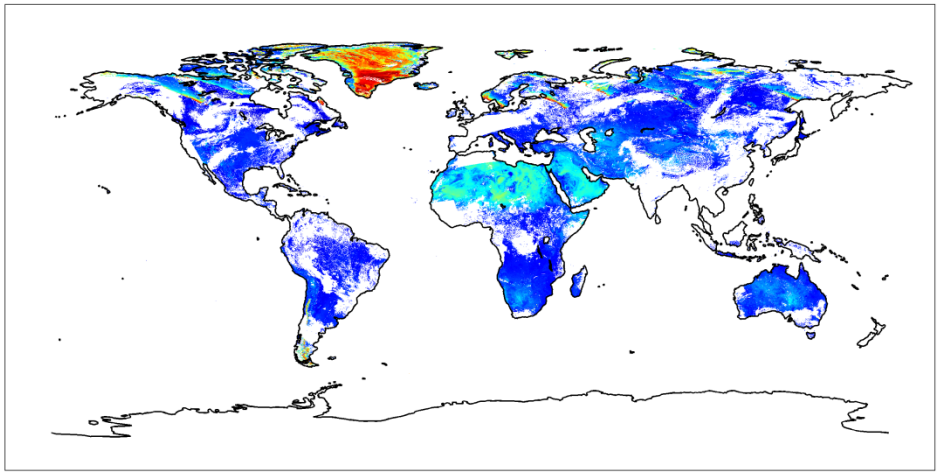
- **U. S. Users:**
  - NOAA National Weather Service Environmental Modeling Center (Michael EK, Jesse Meng, Weizhong Zheng)
  - USDA Agricultural Research Services(Martha Anderson)
  - USDA Forest Service (Brad Quayle)
  - NOAA/NESDIS Center for Satellite Applications and Research (Jerry Zhan)
  - NOAA/NESDIS National Climate Data Center (Peter Thorne)
  - Academy -- University of Maryland (Konstantin Vinnikov, Shunlin Liang, Cezar Kongoli)
  - Army Research Lab (Kurt Preston)
- **Foreign Users**
  - EUMETSAT (Yves Govaerts)
  - Météo France (Jean-Louis Roujean)
  - Academy: Italy IASMA Research and Innovation Centre (Barbara Marcolla), Beijing Normal University (Qiang Liu)

Users Feedback

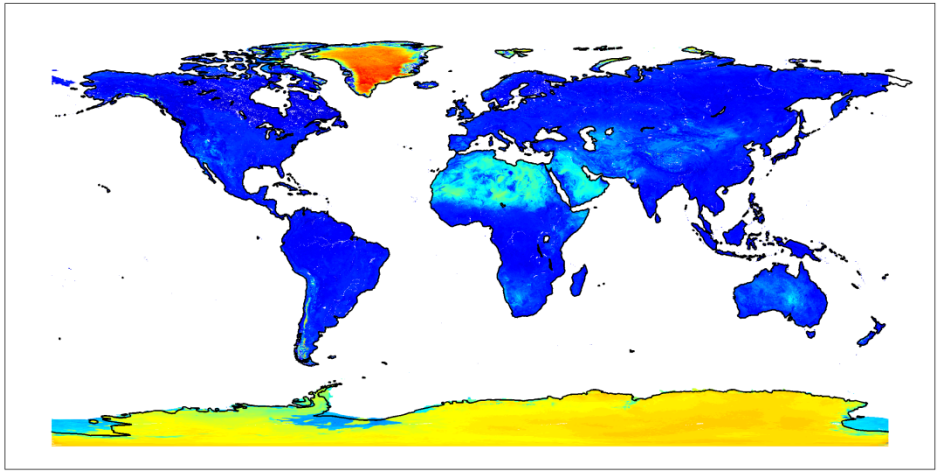
- Granule-based files are not ready-to-eat
  - First convert map-projection
  - Conduct “temporal composite” before they can actually use the granule data in their modeling or analysis.
- Current data are not continuous
  - The issue of missing values limits the application of albedo in modelling and analysis
- Residual noise
  - Retrievals from individual observation are not stable over “pseudo-invariant” surfaces



Example of a single granule



Original map of July 17 2015



Map of July 17 2015 after temporal filtering

JPSS-1 Readiness

- No significant algorithm changes for LSA from S-NPP to JPSS-1.
- The transition of LSA product from SNPP to J1 is expected to be smooth and the data will be consistent.
- Pre-launch Characterization
  - Conducted simulations of atmospheric radiative transfer to generate new LUTs of regression coefficients for J1.
  - Calibration/validation/monitoring tools developed for SNPP are applicable for J1 mission
  - SNPP data serves as proxy of JPSS-1
- Post-Launch Cal/Val Plans
  - GOES-R Field Campaign data will used for J1 mission as well
  - In-situ validation: existing + new site data; domestic + international
  - Cross comparisons: S-NPP, MODIS, GOES-R
  - Schedules and Milestones: based on the mission requirement

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
- Correlative Data Sources
  - Ground stations
  - Airborne multi-angular 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

Summary

- Quality of LSA retrievals have been significantly improved, after three updates of LUTs of regression coefficients since launch. However, gridded daily albedo rather needed for users.
- Accuracy of the current non-snow LSA retrievals are smaller than the L1RD threshold. The performance of snow LSA is also comparable (slightly better) than the existing albedo product, although RMSE of current snow retrievals are greater than the precision requirement.
- An improved enterprise albedo algorithm is currently under development.
- The enterprise algorithm will be also applied to J1 and future J2 missions.

Future Plans/Improvements

- LUTs update for sea ice albedo production
- Land-cover-specific LUT will further improve quality of albedo retrieval.
- Enterprise LSA development and framework test
- Reprocessing LST data when the upstream data are ready.
- JPSS-1 LSA product evaluation and monitoring
- Level-3 gridded data production
- Further interactive with EMC/NCEP model team: intensive LSA model assimilation