# JPSS LAND SURFACE ALBEDO EDR

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# Outline

- Cal/Val Team Members
- JPSS LSA Product Overview
- Validation and Monitoring
- Algorithm Improvement
  - Issues
  - New NDE Gridded LSA Product
  - Updates to Sea Ice Surface Albedo Algorithm
  - Validation
- User feedbacks
- Summary and Path Forward

# Cal/Val Team Members

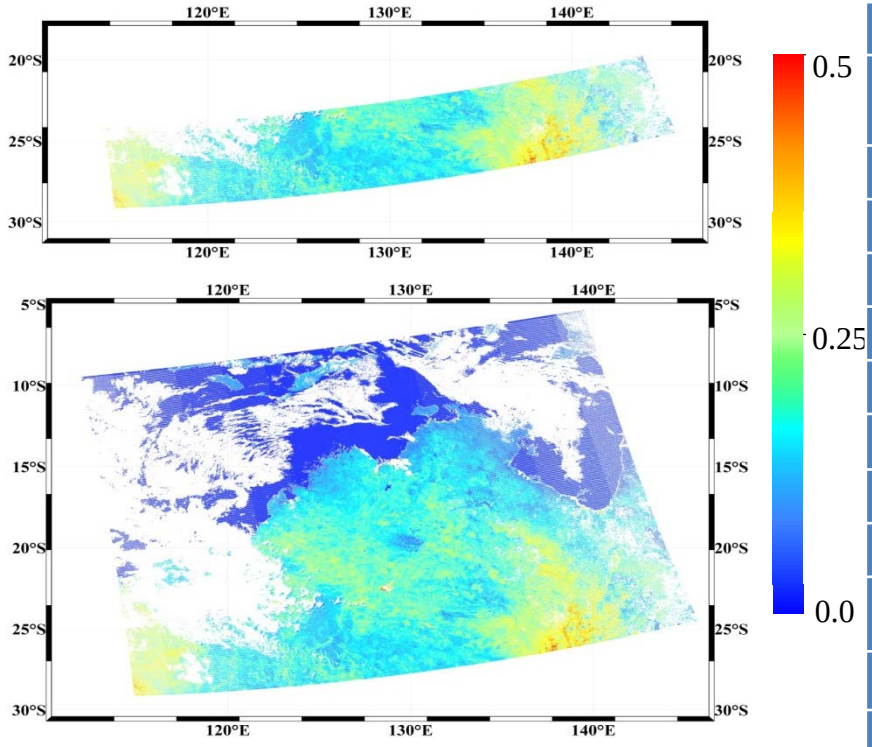
| PI | Organization | Team Members | Roles and Responsibilities |
|---|---|---|---|
| Ivan Csiszar | NOAA/NESDIS/SATR | | Land Lead, Project Management |
| Yunyue Yu | NOAA/NESDIS/SATR | | EDR Lead, algorithm development, validation, team management |
| | | Jingjing Peng | Algorithm development, validation, monitoring |
| 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 |

# Overview: Current VIIRS IDPS LSA Product

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

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

$a_i$ is regression coefficient for Band *i*.

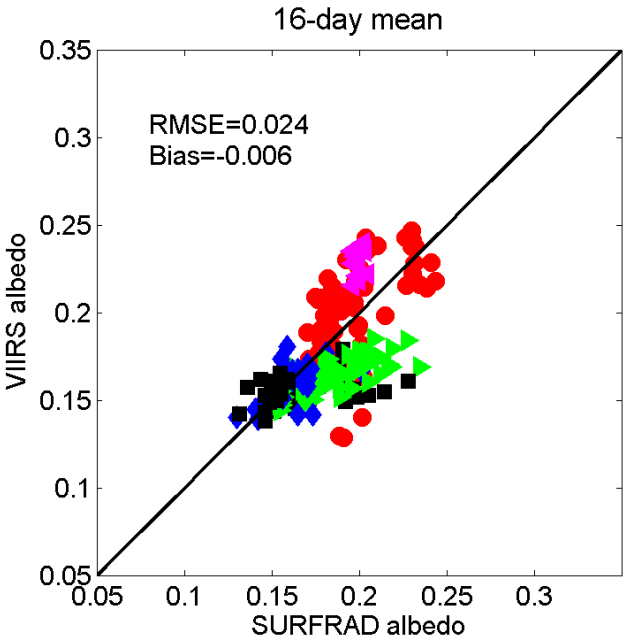


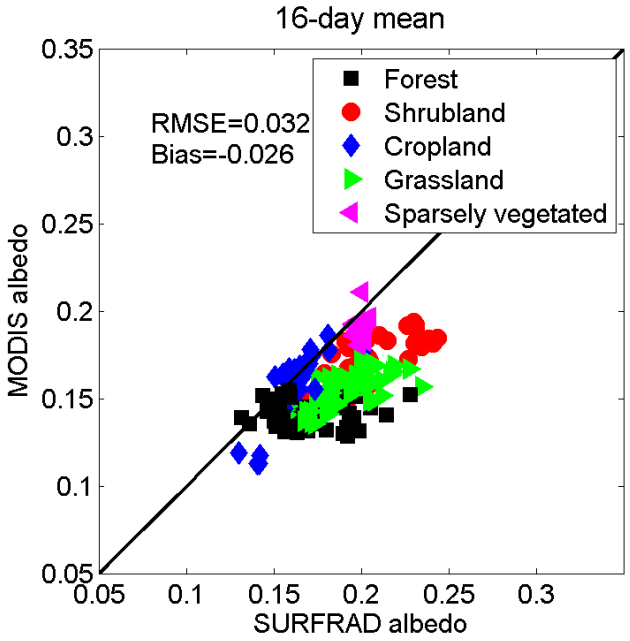

- Operational Products
  - Single 1.5 min granule data
  - Combined 4 x 1.5 min granule data
- Production team
  - STAR Science Team : Scientific development and validation
  - JPSS DPE (Data Product Engineering) : Production

| 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 |

# Overview: Performance of VIIRS IDPS LSA Product

- Several algorithm improvements have been made since S-NPP was launched.
- A set of surface-specific LUTs with consideration of surface reflectance anisotropy are used.
- Validation results suggest the VIIRS direct estimation approach can generate albedo retrievals with accuracy similar (or superior) to existing products.

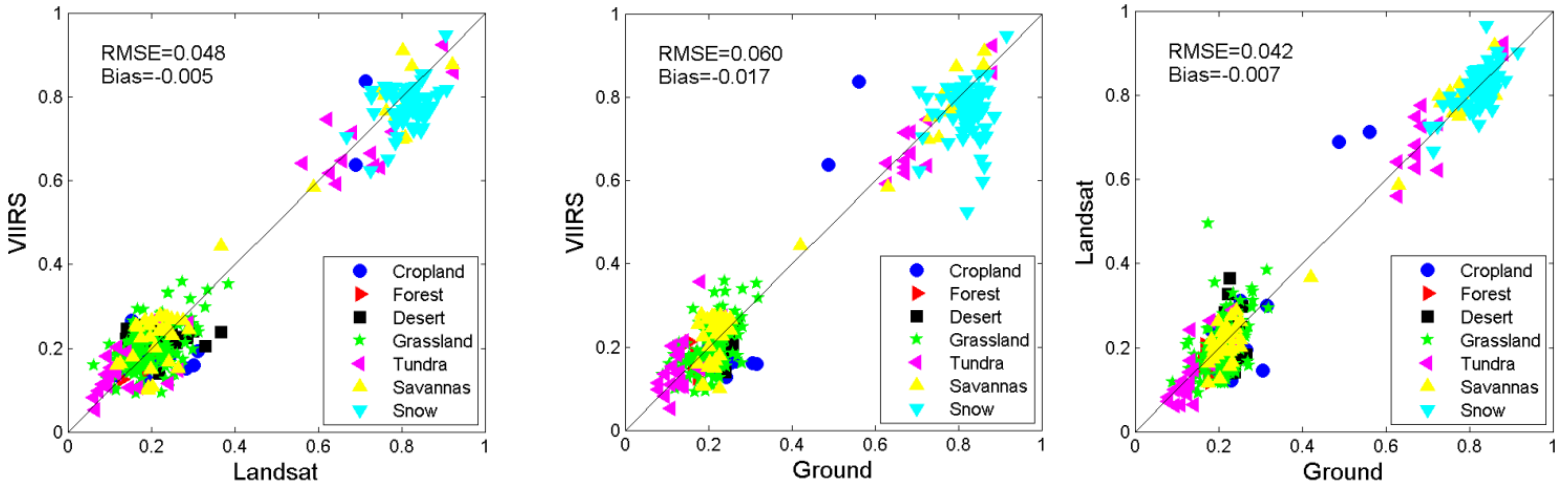



Wang, D., Liang, S., He, T., & Yu, Y. (2013). Direct Estimation of Land Surface Albedo from VIIRS Data: Algorithm Improvement and Preliminary Validation. *Journal of Geophysical Research, 118*, 12577-12586

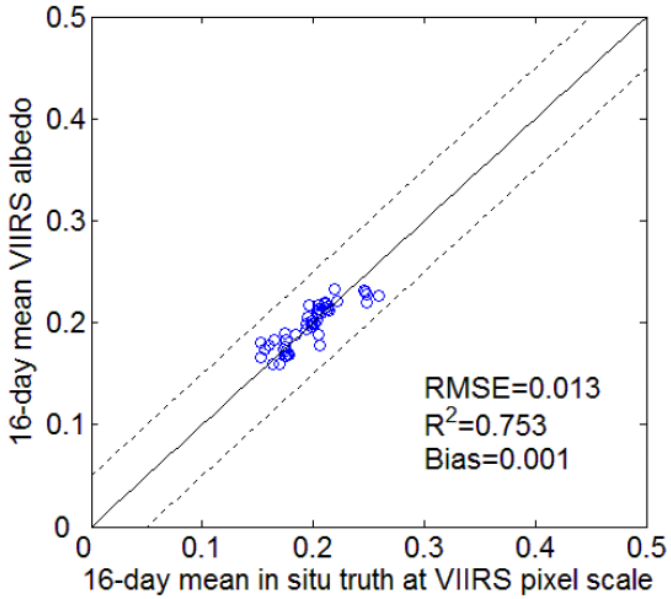
# Comprehensive Assessment of VIIRS LSA

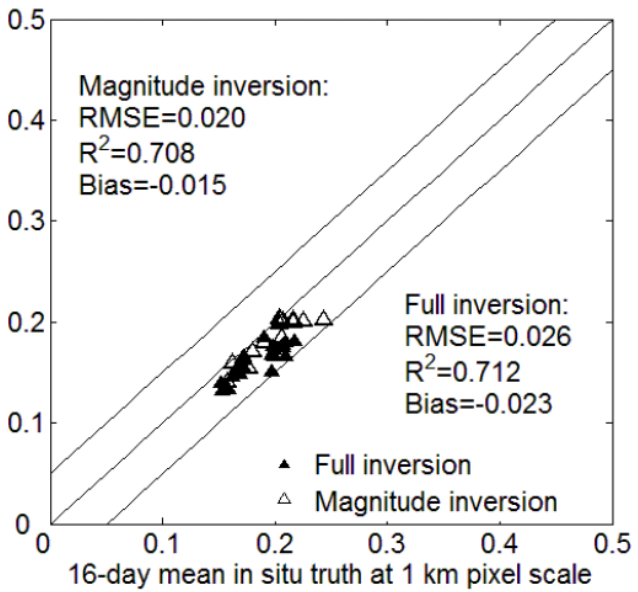
- Two years data over 23 sites
- Field measurements together with Landsat 7 ETM+ and Landsat 8 OLI maps (~3Tb)
- Intercomparison with MODIS product

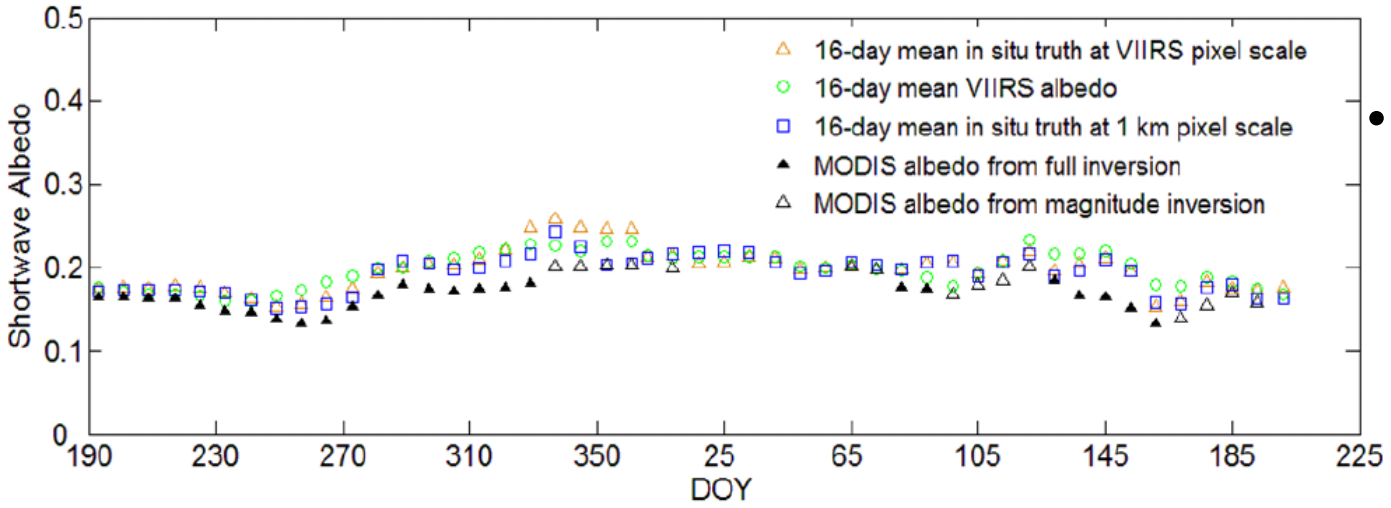



Zhou, Y., Wang, D., Liang, S., & He, T. (2016). Assessment of the Suomi NPP VIIRS land surface albedo data using station measurements and high-resolution albedo maps. *Remote Sensing*, 8, 137, doi: 10.3390/rs8020137.

# Independent Validation Study



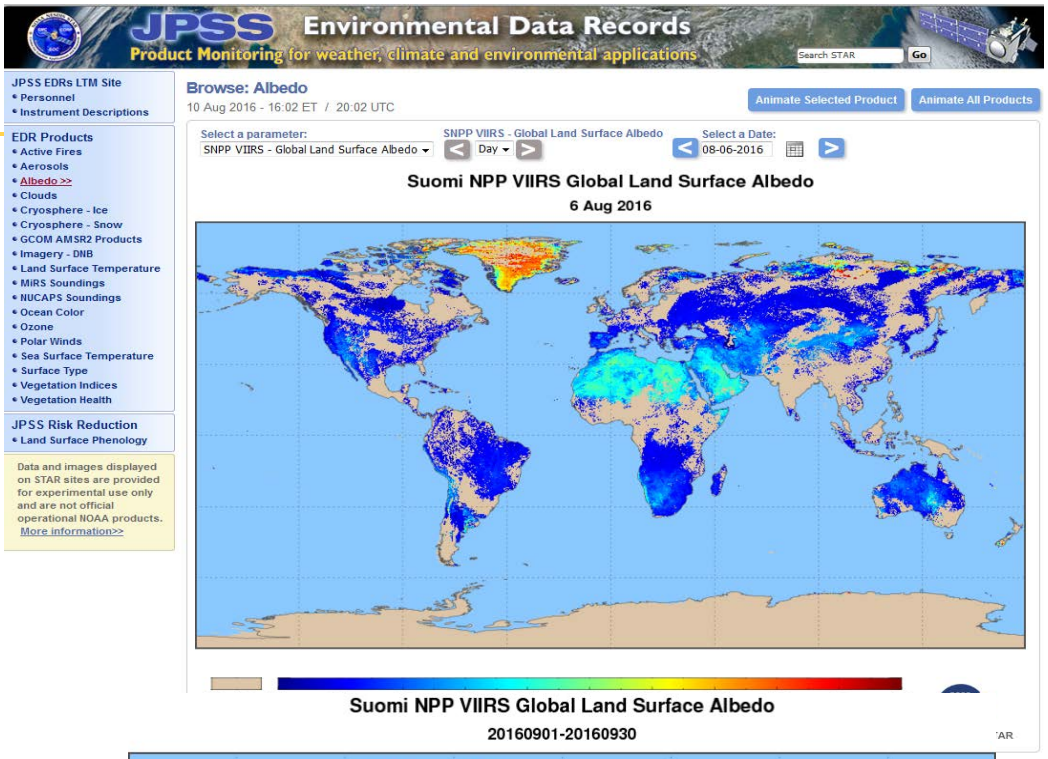



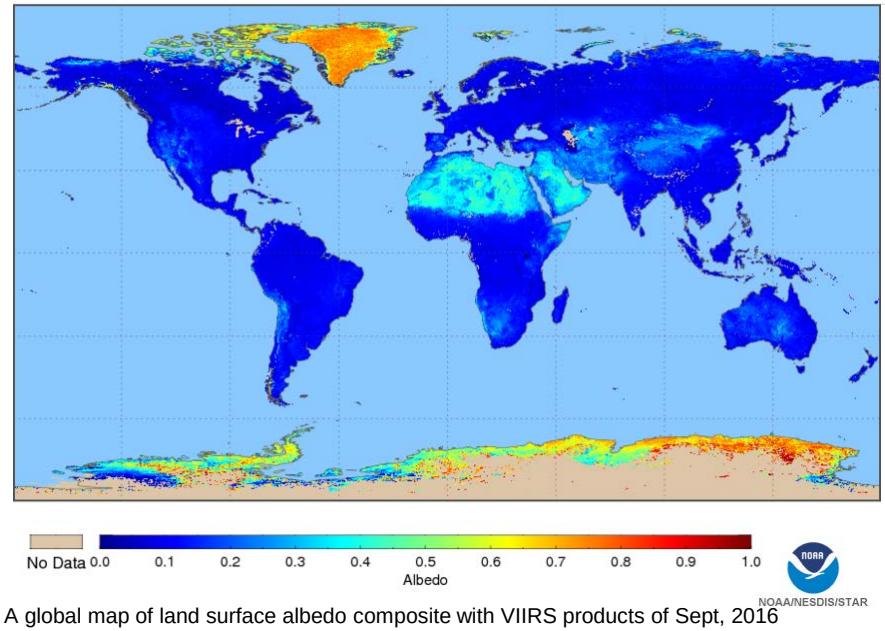

- Investigators from CAS used sophisticatedly-designed spatial sampling technique to address issues of spatial scaling in validating coarse spatial resolution LSA products
- Validation results suggested superior quality of VIIRS data.

# 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 Sept, 2016

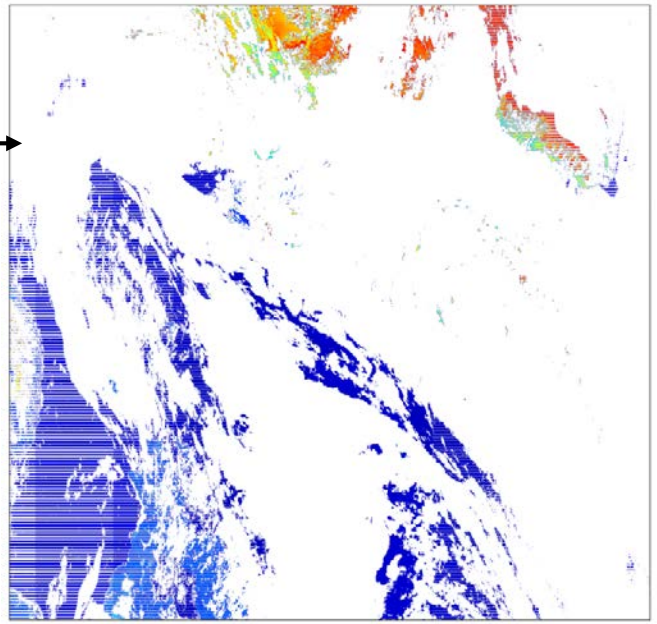
# Issues of IDPS LSA Granule Product

- Issues of the current IDPS granule 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.
  - Un-gridded product
    - End users need gridded product with common map projection.

# Issues of IDPS LSA Granule Product: Illustration

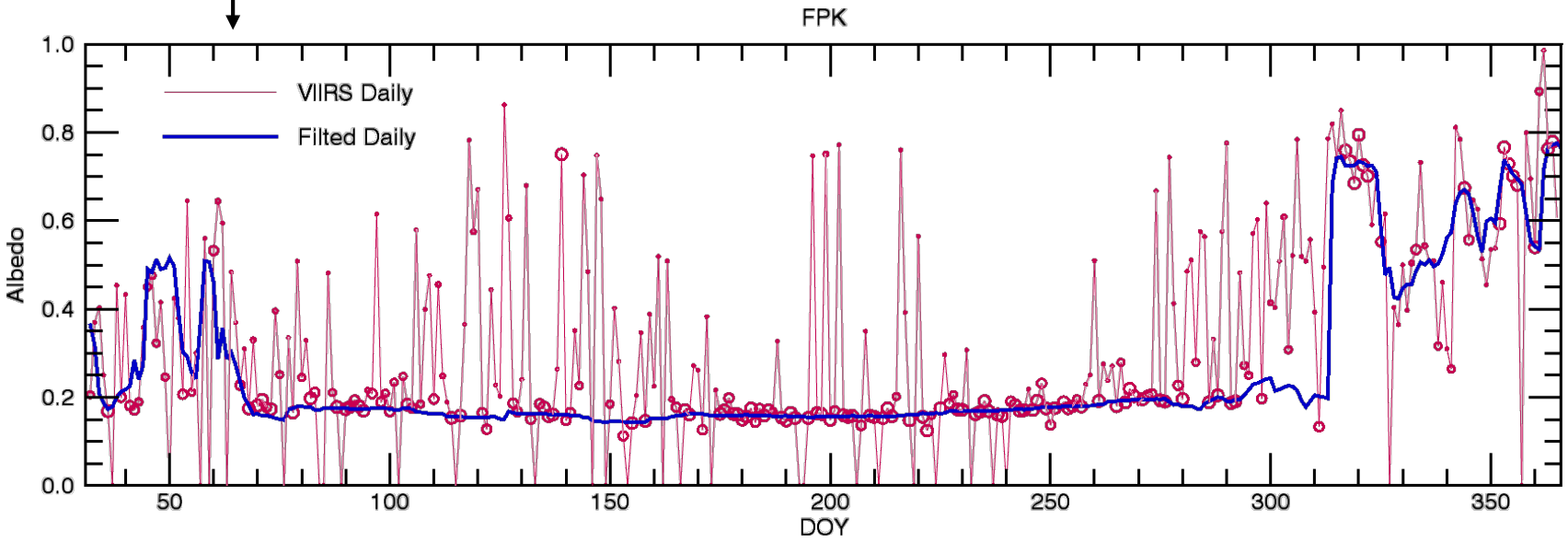
**Features of current algorithm**
- Using single overpass
- Needing clear-sky pixels

→ Data gaps →



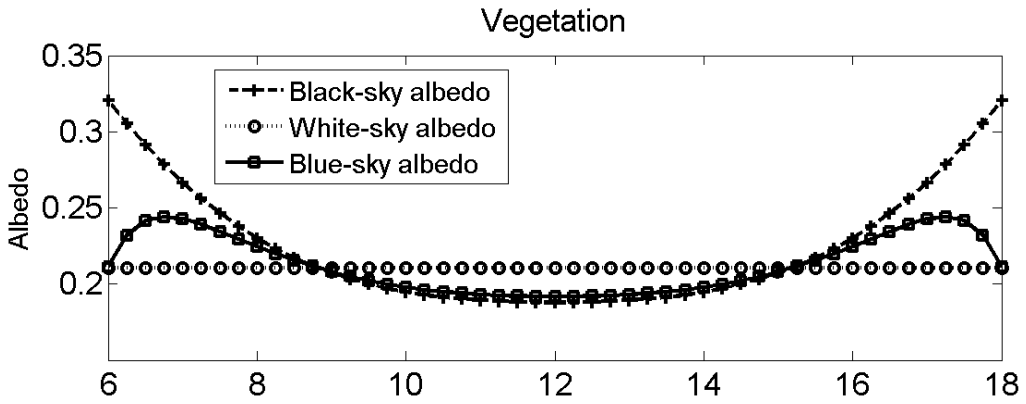
↓ Residual noise

↘ Possible multiple values for a day

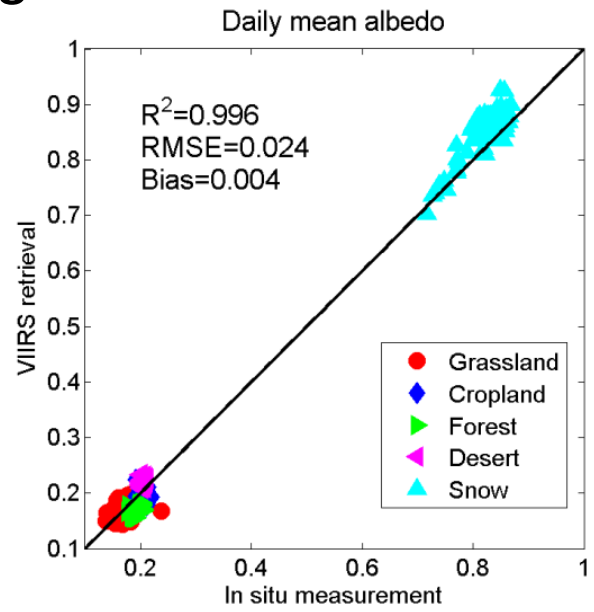


# New Method for Daily Mean Albedo

- Use of instantaneous albedo to calculate daily surface radiation budget may result in ~10% bias.
- We developed a method to estimate daily mean albedo directly from VIIRS data.
- The new method uses similar LUTs of regression coefficients, but considers variations of albedo and diffuse radiation ratio with solar angles.

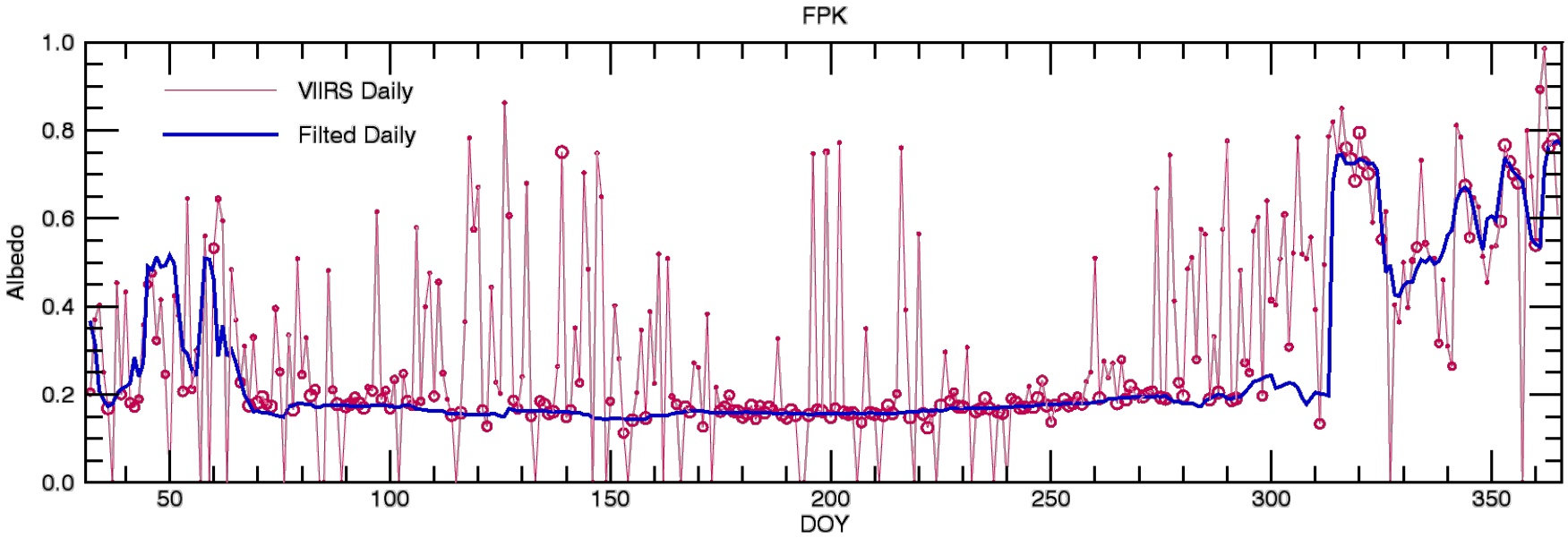



*Wang et al. 2015, JGR;*
*Wang et al. 2017, TGRS*



# Advanced Statistics-based Temporal Filtering

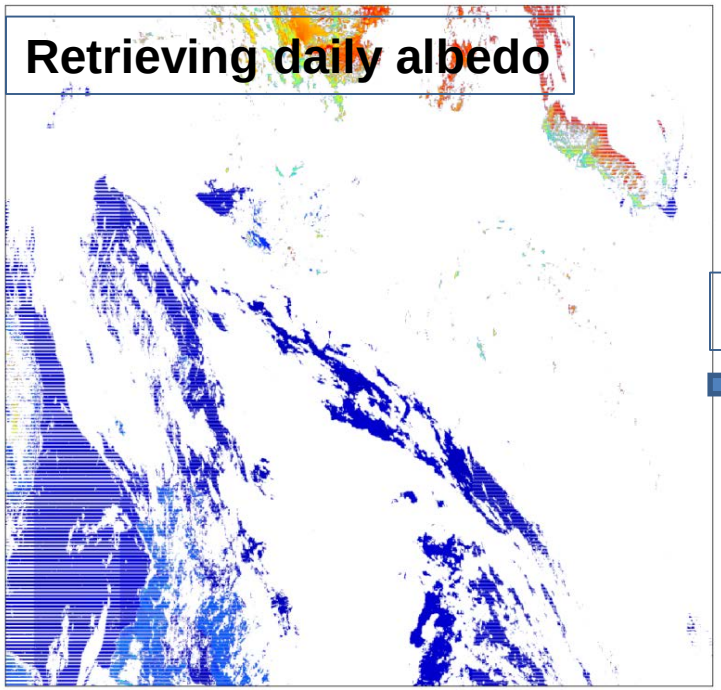
- Temporal filtering is a key step of the NDE LSA algorithm:
  - Improve accuracy
    - Reduce temporal variations
    - Exclude undetected cloud and shadow
  - Fill data gaps
- A sophisticated statistical based filtering approach was developed
- Capable of integrating multisource of information
  - VIIRS retrieval and its QF
  - Climatology (mean and variance)
  - Temporal correlation (historical observation)



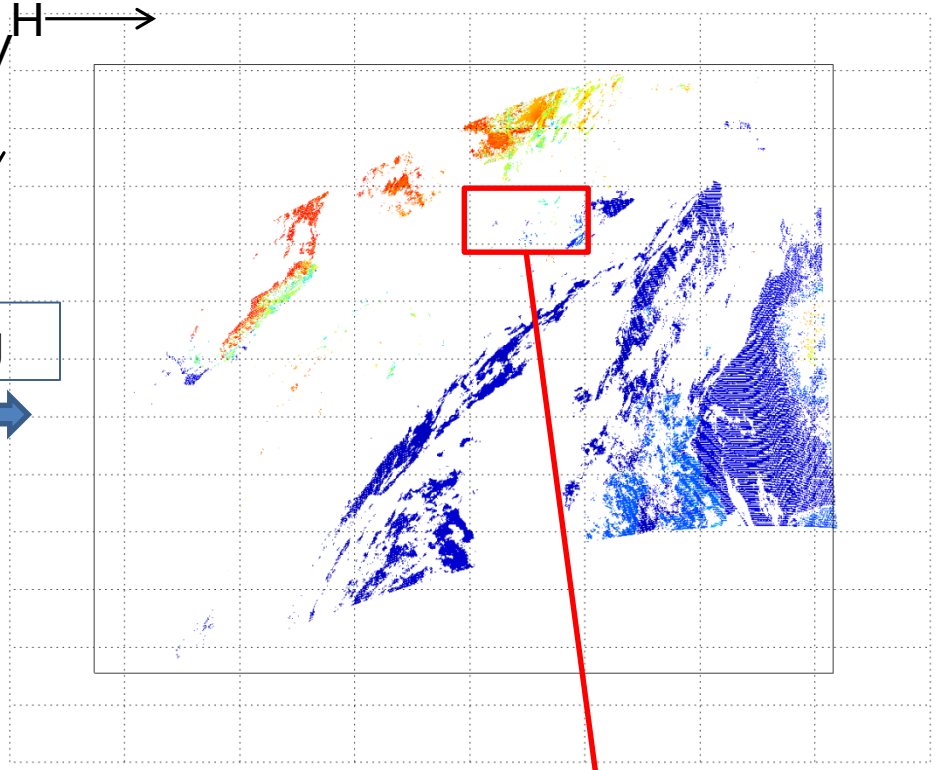
# Developing Gridded NDE LSA Product

- We developed 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 software package in C programming language has been delivered.
  - C source codes
  - LUTs
  - Climatology data
  - Documents
- Improved Granule LSA product in NDE
  - **Critical Design Review** was passed in **Sept. 2016**.
  - **Test Readiness Review** is scheduled for **August 2017**.

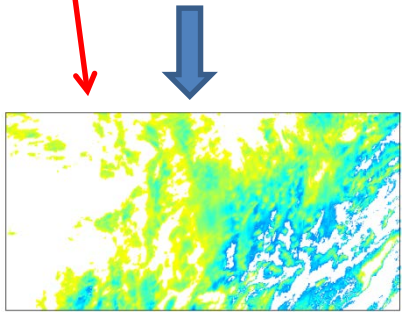
# Major steps of generating NDE LSA



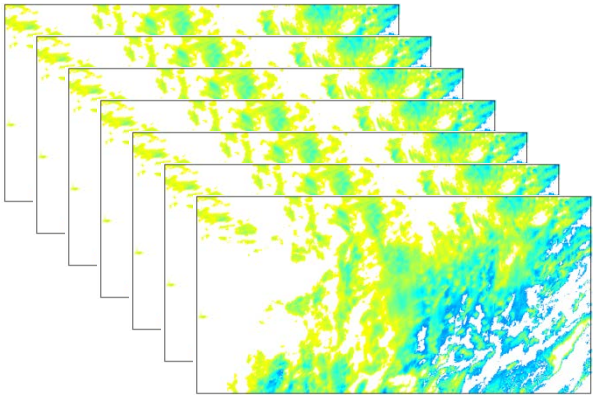

Gridding



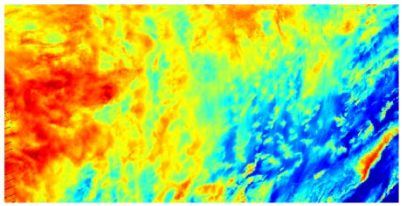

Cutting into tiles



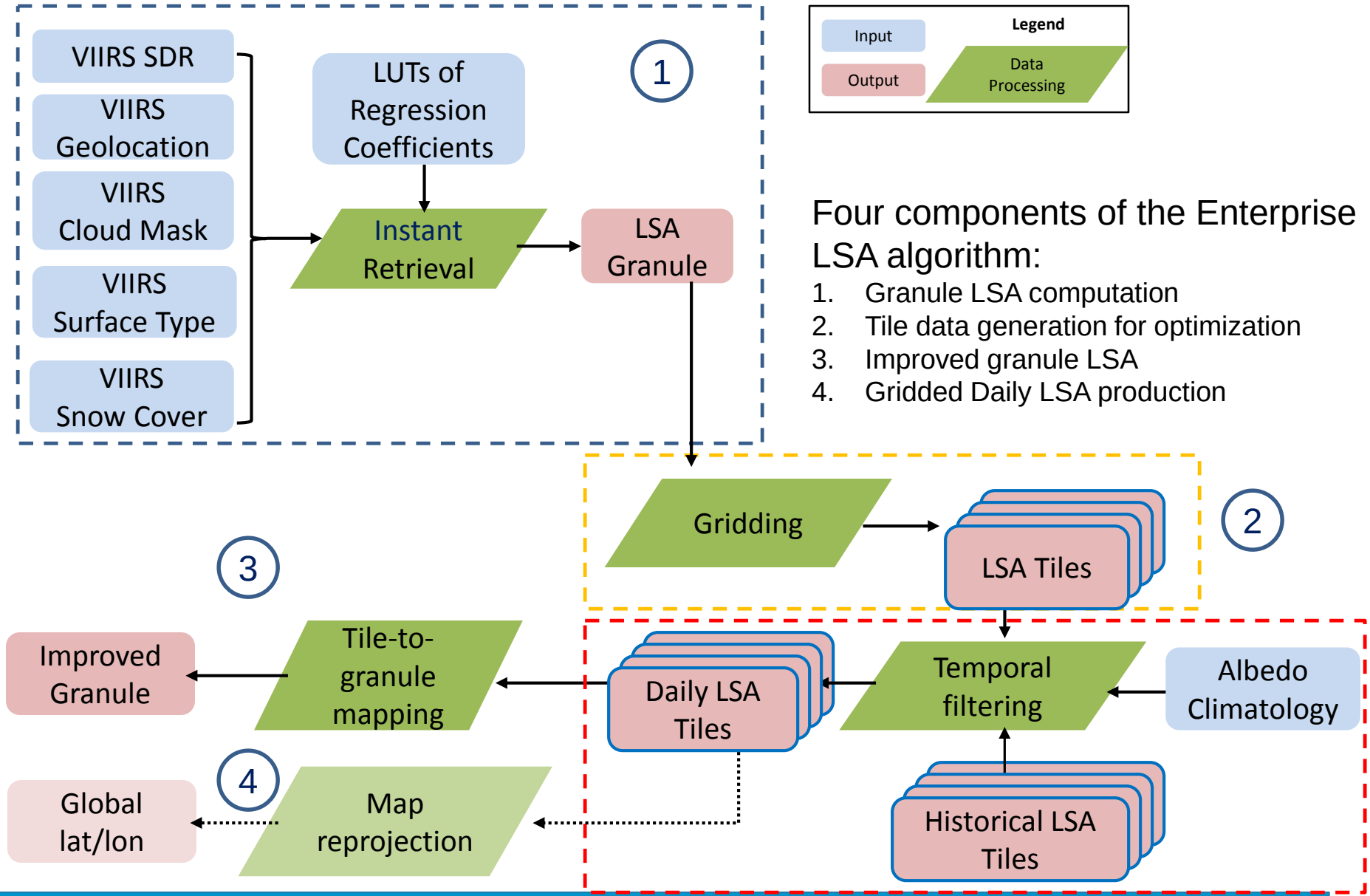
Preparing time series



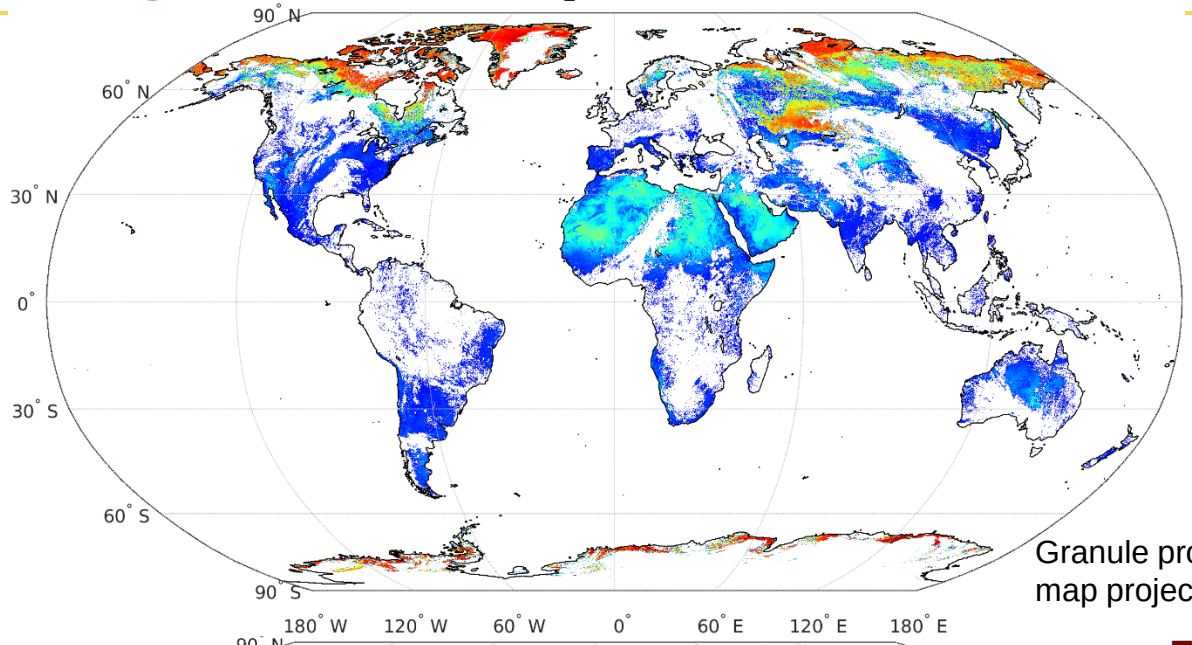
Temporal filtering



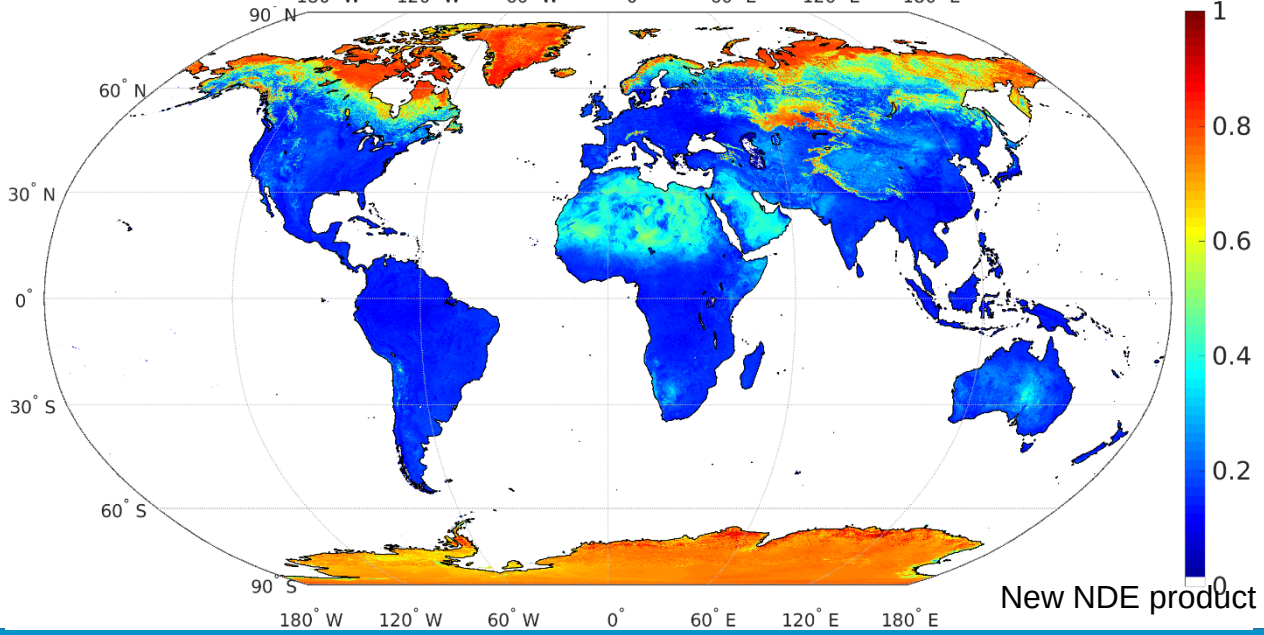
# Enterprise Algorithm Development



# Example of NDE Gridded LSA




Granule product after map projection

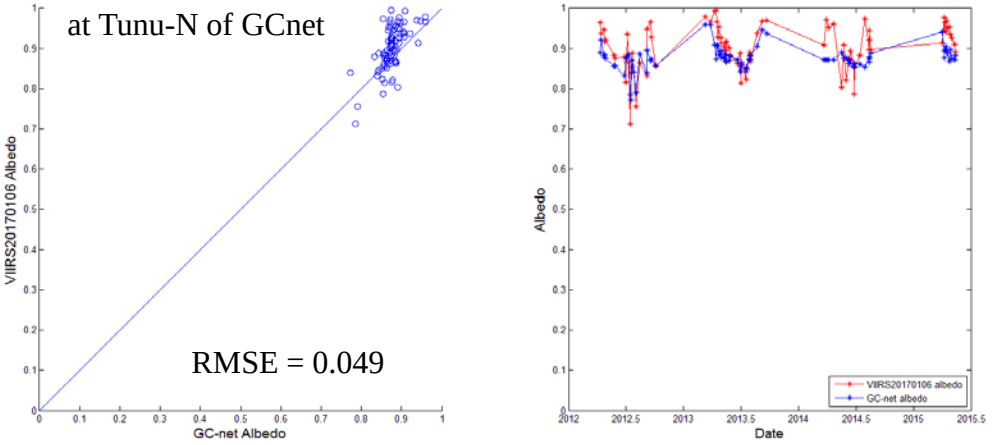



New NDE product

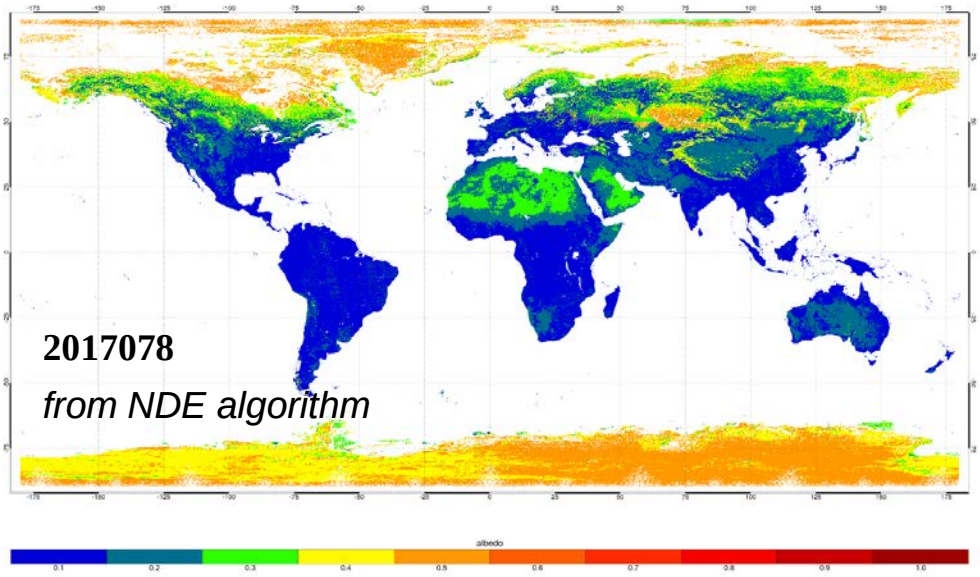
- Two global products of VIIRS LSA on April 1 2015 were shown here.
- Compared to the current granule product, the newly-developed NDE product represents several substantial major improvements:
  - Gap-filled: continuous map
  - Noise-reduced: higher accuracy
  - Gridded: ready to user

# Update to Sea Ice Surface Albedo Algorithm

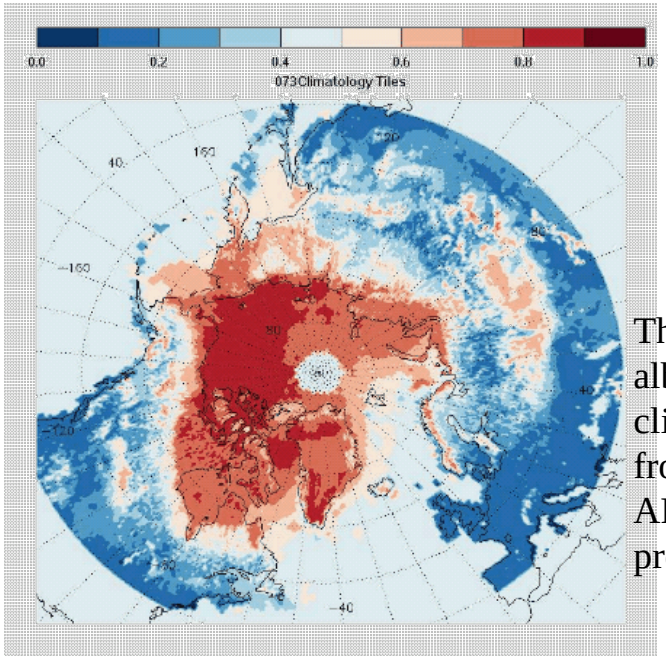
- We applied a new sea-ice albedo LUT in NPP VIIRS albedo calculation. The sea-ice albedo become available in the NDE LSA product. The coverage is consistent with the sea ice concentration product.
- We generated a 5-km daily sea-ice albedo climatology and used it as background information for temporal filtering of sea-ice albedo.




Comparison between VIIRS sea-ice albedo and GC-net albedo

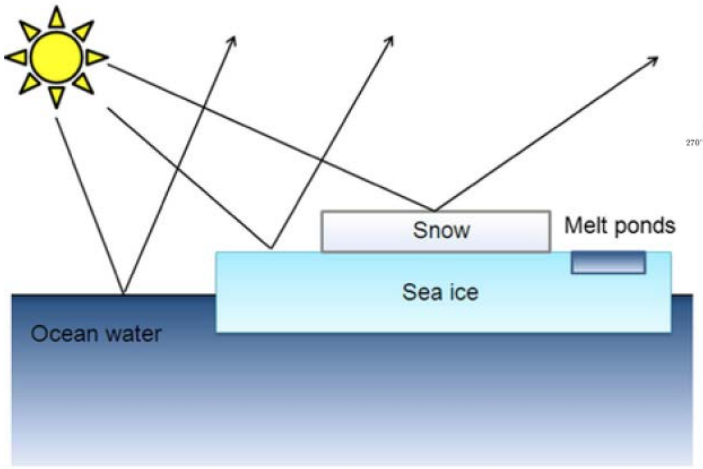



global albedo map (sea-ice included)




The sea-ice albedo climatology from AVHRR APP-x albedo product

# Continued Improvement of Sea Ice Surface Albedo



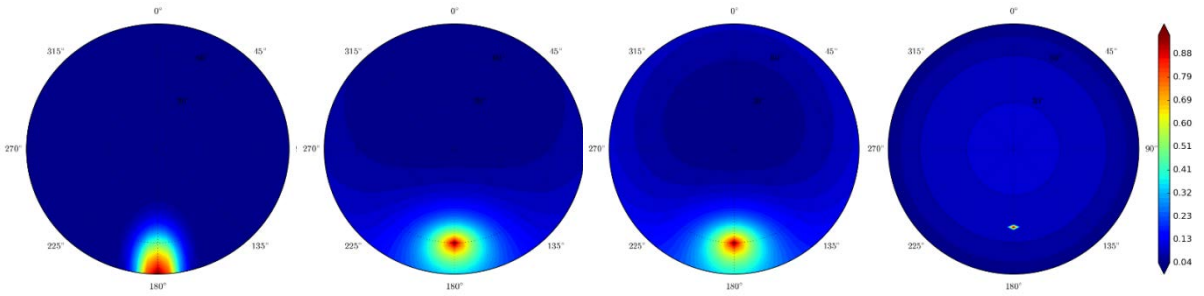
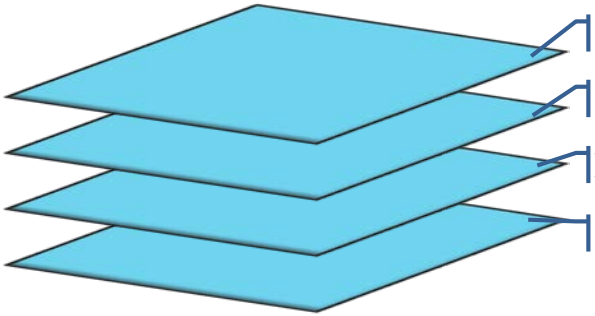




Figure Examples of BRDFs of sea water (a), snow (b), ice (c), pond (d) at 672nm (blue band) and 60˚ SZA.

component models

For further improvement the VIIRS sea-ice albedo LUT, we are working on enhancing the representativeness of the training data by building a spatio-temporal representative sea-ice BRDF database. The Ice concentration, Snow fraction and Snow parameters would be deployed as knowledge database for BRDF simulation and compositing.




parameters and compositing weight

Sea-ice BRDF database

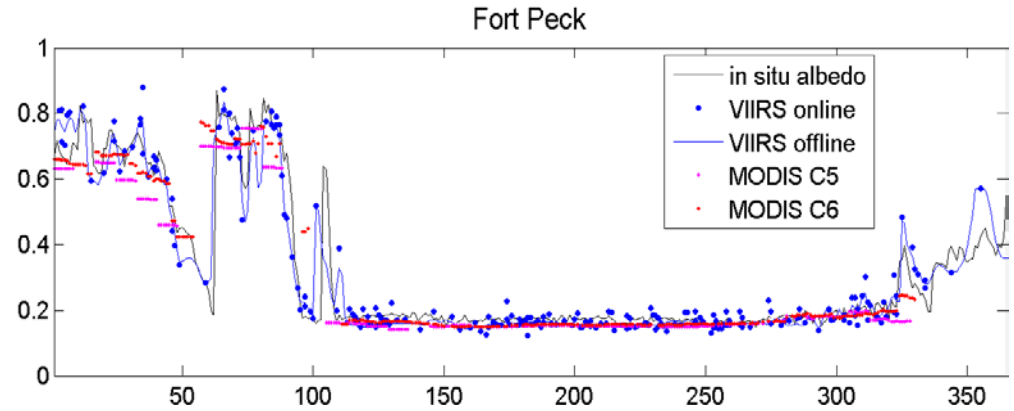
Atmospheric simulation

regression

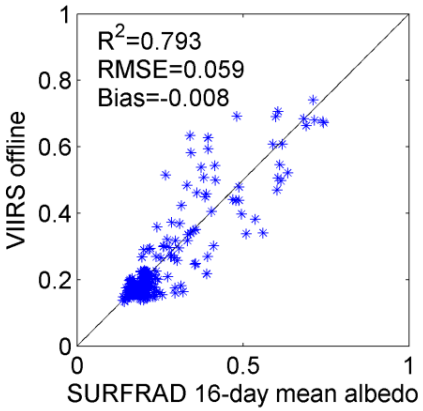
Improved sea-ice LUT

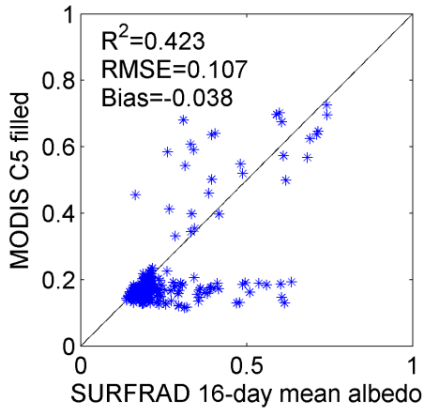
# Validation of NDE LSA data

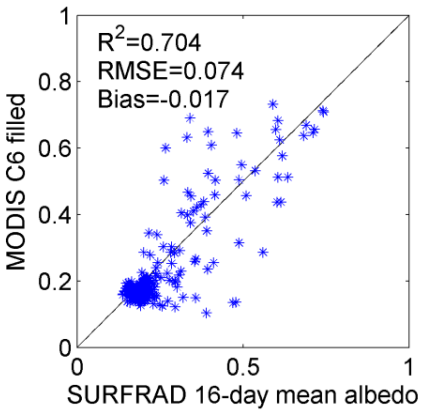
- The new NDE albedo was validated using field measurements and inter-compared with other albedo products.
- Preliminary assessment results suggested substantial improvement over existing datasets:
  - Gap-free continuous data
  - Higher accuracy:
    - Snow-covered and snow-free
    - Better prediction over ethereal snow cases

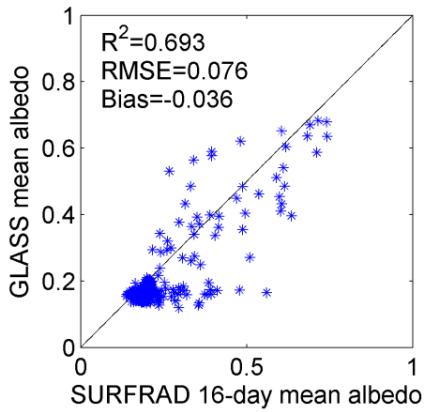



Example of time series of one year VIIRS NDE albedo at Fort Peck



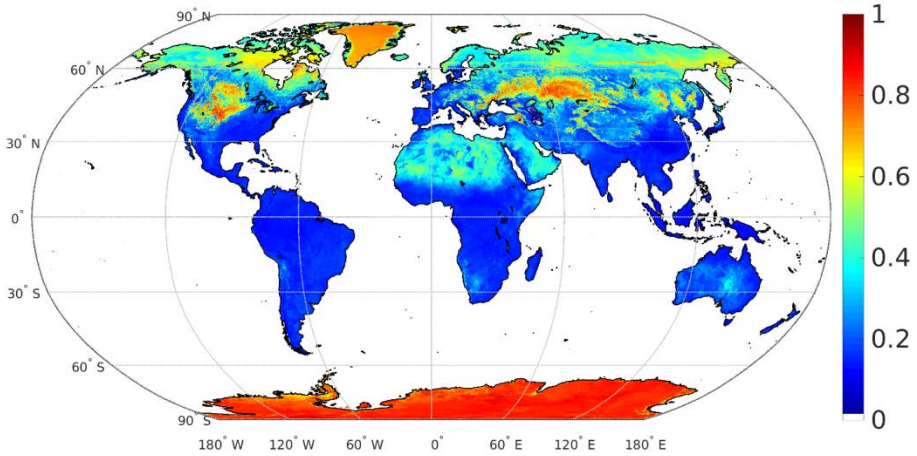

Comparison of snow-free and snow-covered VIIRS albedo with gap-filled MODIS C5 and C6 data, and GLASS albedo data

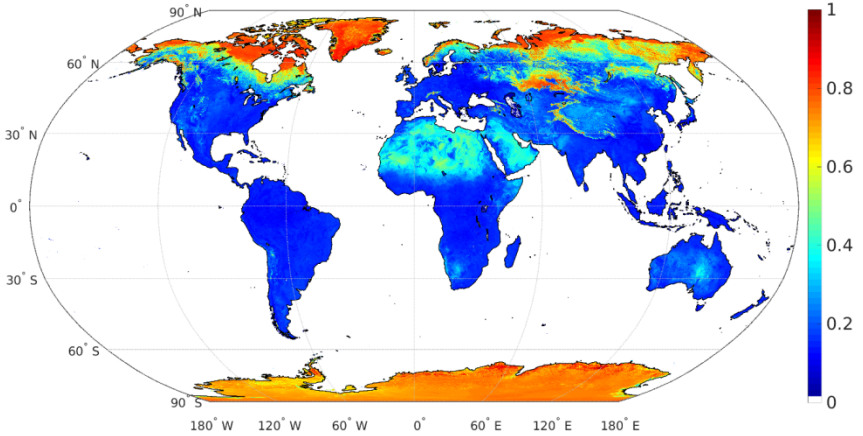
# External Users of Albedo Product

- **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)

# Collaboration with EMC/NCEP Team

- The new gridded, gap-filled, noise-reduced product is developed to meet the requirements of modeling team and data analysis.
  - Working with the modeling team to test the application of new product
  - Customized the codes to generate tailored data sets.




Examples of albedo data customized for modeling team

# Summary

- 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 NDE albedo product was developed.
- Initial evaluation suggested this new gridded, gap-filled, noise-reduced NDE product represent substantial improvements over previous granule product and other existing products.
- LUT of retrieving sea ice surface albedo was updated.
- Additional maintenance and further algorithm refinement is critical to assure the production of high-quality gridded LSA product.

# Future Plans/Improvements

- Land-cover-specific LUT will further improve quality of albedo retrieval.
- Enterprise LSA development: TRR and ARR preparation
- 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