

Land Surface Radiation/Albedo Focus Area



Angela Erb¹, Jorge Sánchez-Zapero², Zhuosen Wang^{3,4}

¹ **University of Massachusetts Boston, Boston MA, United States**

² **Earth Observation Laboratory (EOLAB), Valencia , Spain**

³ **University of Maryland College Park, College Park MD, United States**

⁴ **NASA Goddard Space Flight Center, Greenbelt MD, United States**

Completed Actions:

- Global Surface Albedo Product Validation Best Practices Protocol
- Surface ALbedo VALidation (SALVAL) Platform published within the CEOS WGCV CAL/VAL portal (<https://calvalportal.ceos.org/web/guest/salval>) → moves albedo validation to stage 4
- SALVAL paper on albedo validation and intercomparison published in Remote Sensing. Validation of 3 existing satellite albedo CDRs (MCD43A3 C6.1, C3S multi-sensor V2, GLASS V4)
- Validation of Landsat-8 Albedo product in circumpolar regions against tower sites published

Ongoing Action:

- Developing protocol for surface downwelling radiation product validation

Future Actions:

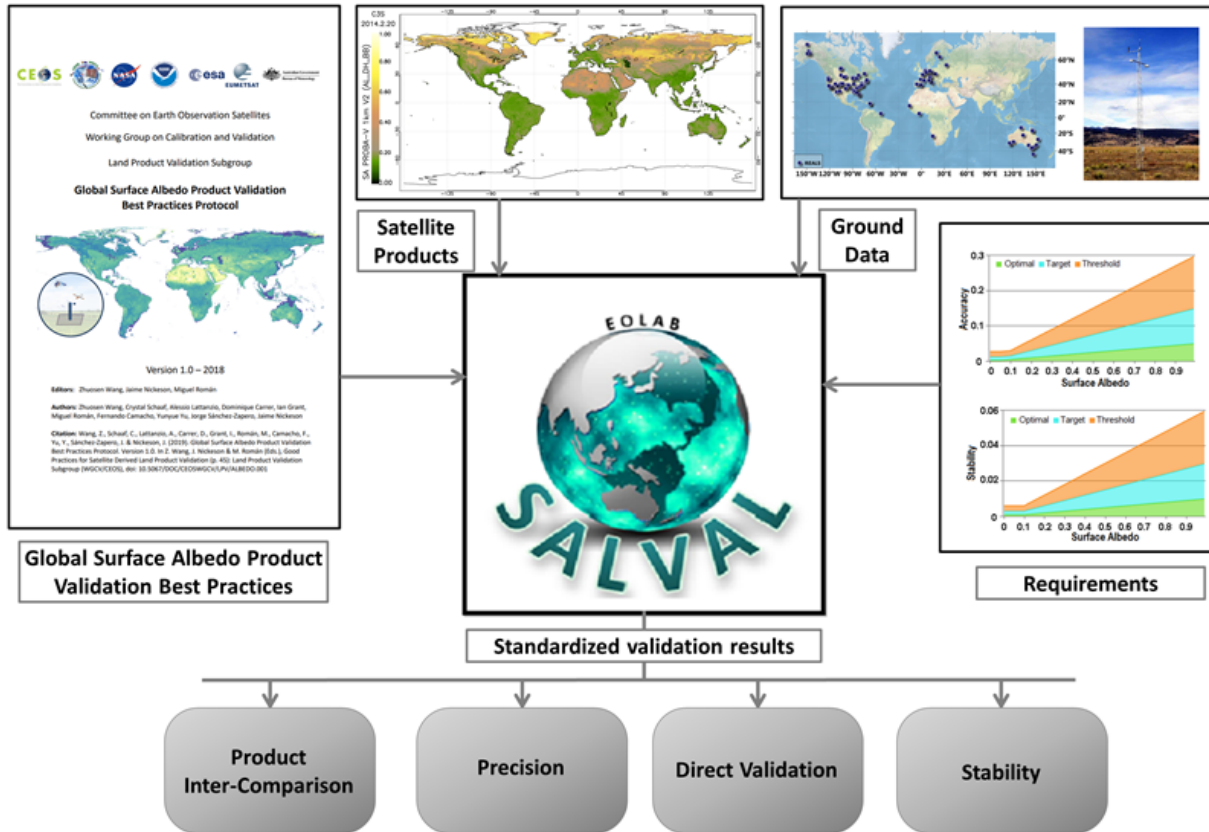
- Sentinel-3 based albedo product validation for the continuity of the Copernicus C3S Climate Data Record.
- Moderate spatial resolution albedo products (e.g. Landsat, Sentinel-2) validation
- Continued MODIS/VIIRS Albedo Validation Efforts

Global Downward Radiation Product Validation Best Practices Protocol *-First draft*

- 1. INTRODUCTION
- 2. DEFINITIONS
- 3. GENERAL CONSIDERATIONS FOR SATELLITE SURFACE DOWNWARD RADIATION PRODUCTS
- 4. GENERAL CONSIDERATIONS FOR DOWNWARD RADIATION REFERENCES (Leading author: Christian Lanconelli)
- 5. GENERAL STRATEGY FOR THE VALIDATION OF SURFACE DOWNWARD RADIATION PRODUCTS (Leading author: Dongdong Wang)
- 6. CONCLUSIONS

Green: completed Red: under development

SALVAL - current status



Existing datasets:

-Satellite products

SALVAL allows to incorporate new developed products

Product	Start period	End period
CGLS VGTI V1	2000-01-01	2014-05-31
C3S VGT V1	2000-01-01	2014-05-31
C3S VGT V2	2000-01-01	2014-05-31
C3S PBV V1	2013-12-23	2020-06-30
C3S PBV V2	2013-10-31	2020-06-30
C3S S3 V3	2018-06-01	2019-04-30
GlobAlbedo	2000-01-01	2011-12-31
GLASS V4	2000-01-01	2019-12-31
MCD43A3 C61	2000-02-24	2022-12-31
VNP43MA3 C1	2021-01-01	2022-12-31

-Ground data: Representativeness-Evaluated ALbedo Stations (REALS)

A unique high quality-controlled sub-set of **in situ measurements** selected from 99 tower-based stations that meet the CEOS LPV validation standards (including spatial representativeness)

Milestones:

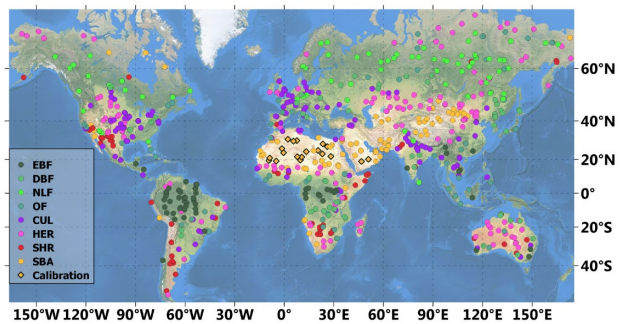
- Published within the CEOS WGCV CAL/VAL portal: <https://calvalportal.ceos.org/web/guest/salval>
- SALVAL paper recently published in Remote Sensing:

Sánchez-Zapero, J., Martínez-Sánchez, E., Camacho, F., Wang, Z., Carrer, D., Schaaf, C., García-Haro, F.J., Nickeson, J., Cosh, M., 2023. **Surface ALbedo VALidation (SALVAL) Platform: Towards CEOS LPV Validation Stage — Application to Three Global Albedo Climate Data Records.** *Remote Sens.* 2023, Vol. 15, Page 1081 15, 1081. <https://doi.org/10.3390/RS15041081>

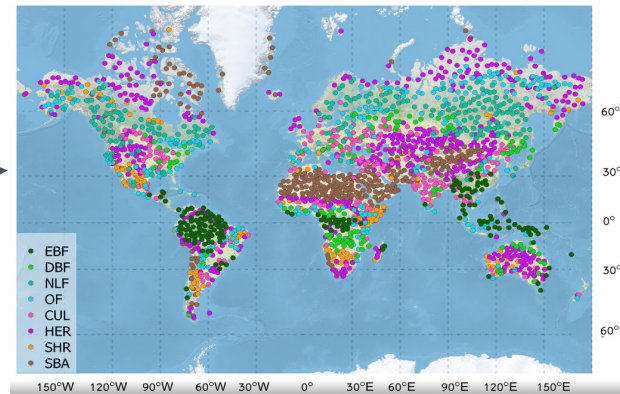
SALVAL - next steps

- Methodology improvements (e.g., include direct validation over snow)
- Annual updates of existing datasets (satellite products and ground data).
- Complete existing products (VNP43, Sentinel-3) and add new products (e.g., EUMETSAT LSA SAF).
- Improve the sampling (LANDVAL) for product intercomparison. Currently working on LANDVAL V2.

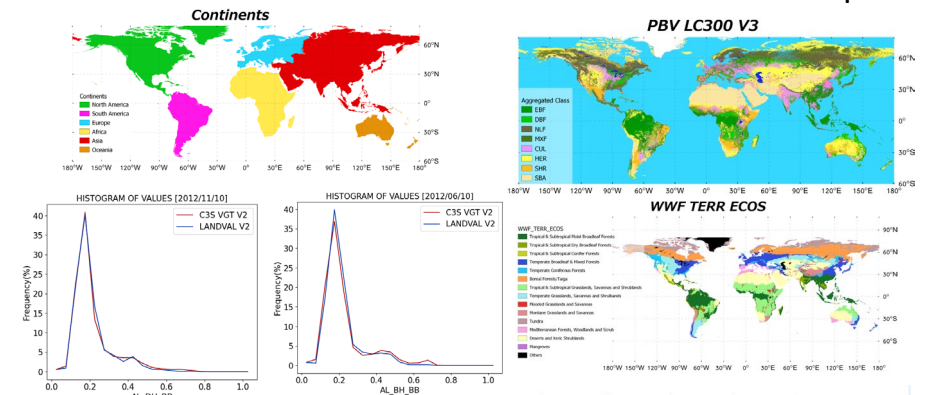
720 Sites LANDVAL V1



2000 Sites LANDVAL V2

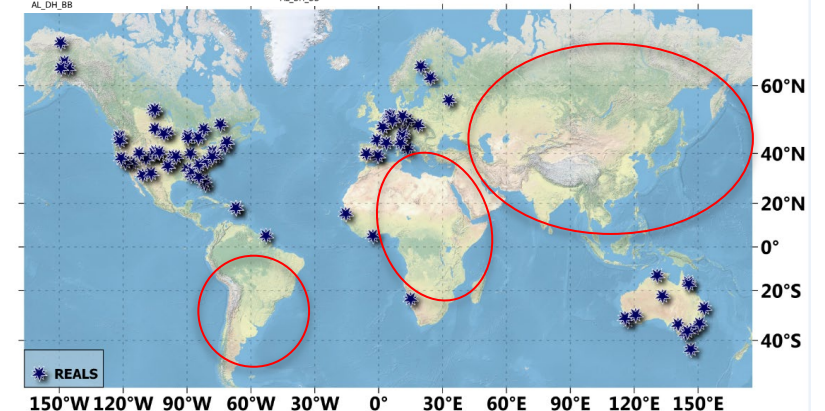


Global representation per biome, ecoregion and continental region. Homogeneous at 3 km x 3 km. Minimum distance between samples = 2°

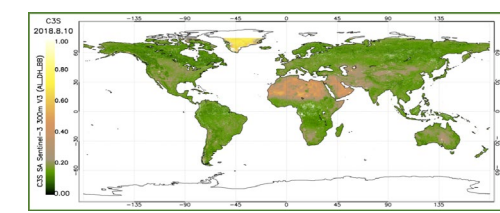


- Improve the number (99) of stations for direct validation (REALS database).
 - around 100 additional sites are under evaluation
 - the main limitation is the gap in under-sampled areas (South America, Africa, Asia)

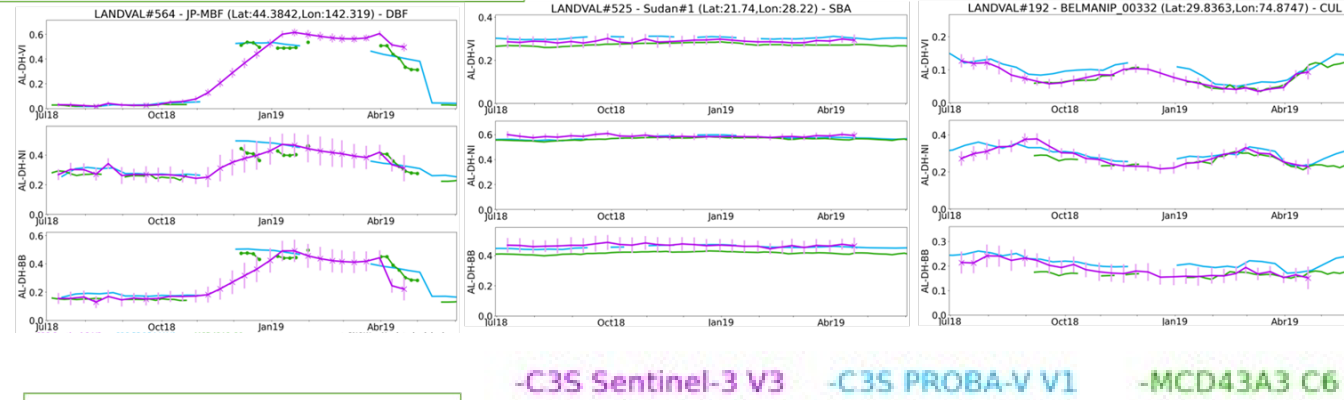
→ NEW PRODUCT INTERCOMPARISON AND VALIDATION EXERCISE:
C3S Sentinel-3, VNP43, EUMETSAT



C3S Sentinel-3 albedo preliminary validation

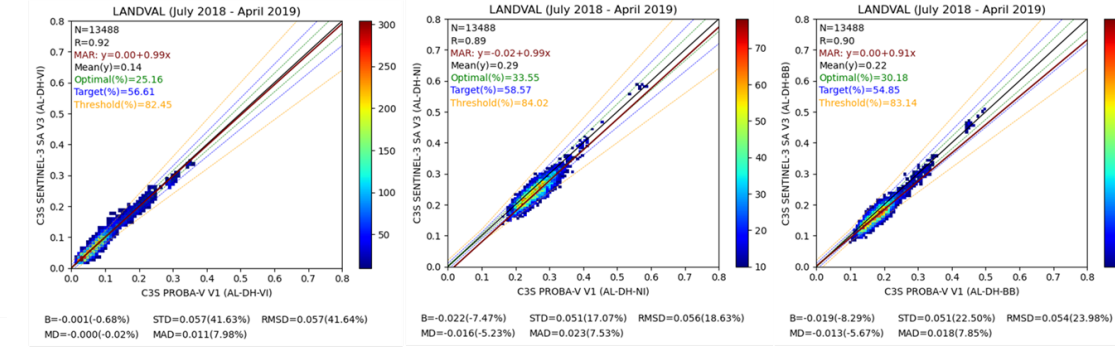


Temporal Consistency

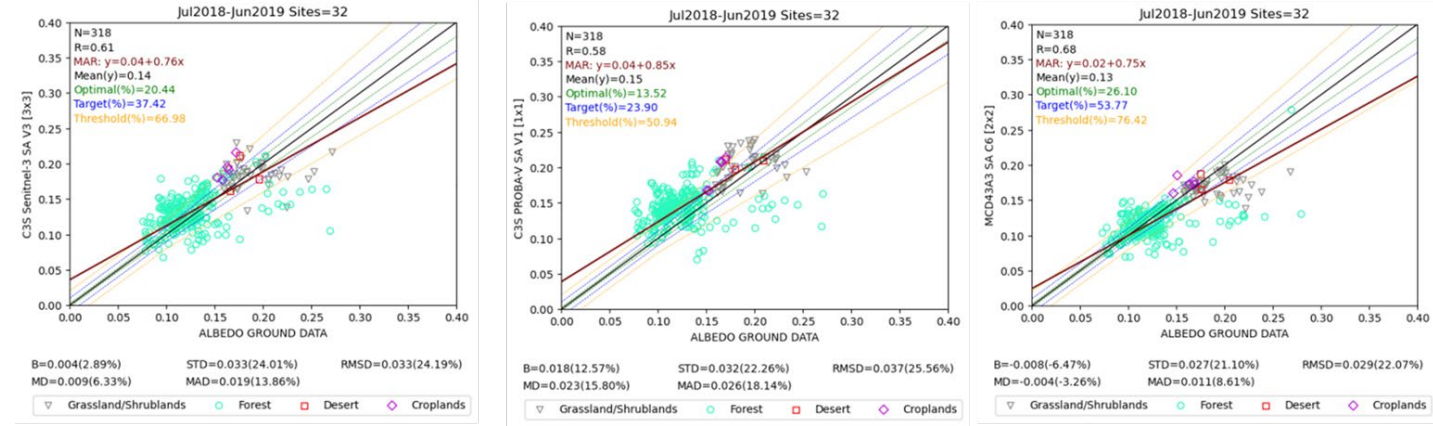


Product intercomparison

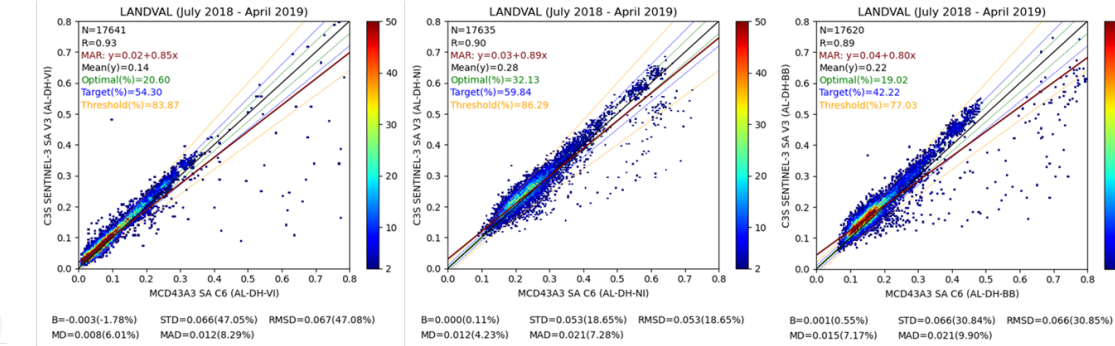
C3S Sentinel-3 SA v3.0 vs C3S PROBA-V v1.0



Direct validation



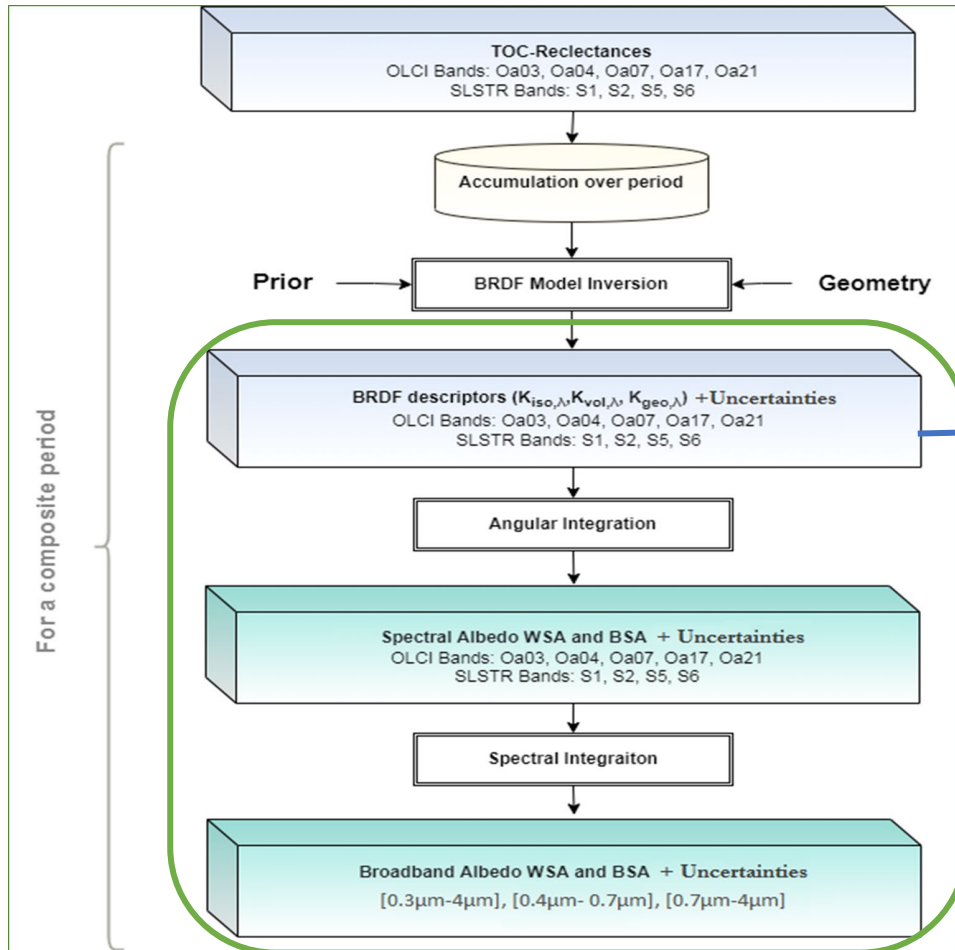
C3S Sentinel-3 SA v3.0 vs MCD43A3 C6



- C3S CDR continuity (NOAA/AVHRR, SPOT/VT, PROBA-V) is ensured thanks to the switch to Sentinel-3.
- Preliminary validation over 10-months demonstration period (July 2018-April 2019).
- The main drawback is the underestimation of snow albedo values, due to the current limitation related to input data from the ESA Sentinel-3 mission (IdePix).
- A reprocessing is expected using improved Sentinel-3 TOC input data to complete the time series and perform the full validation.

albedo validation gaps

Surface albedo validation is commonly focused on broadband albedos, but spectral albedos and BRDF parameters should be validated in response to CGOS, as they are included in the ECV definition

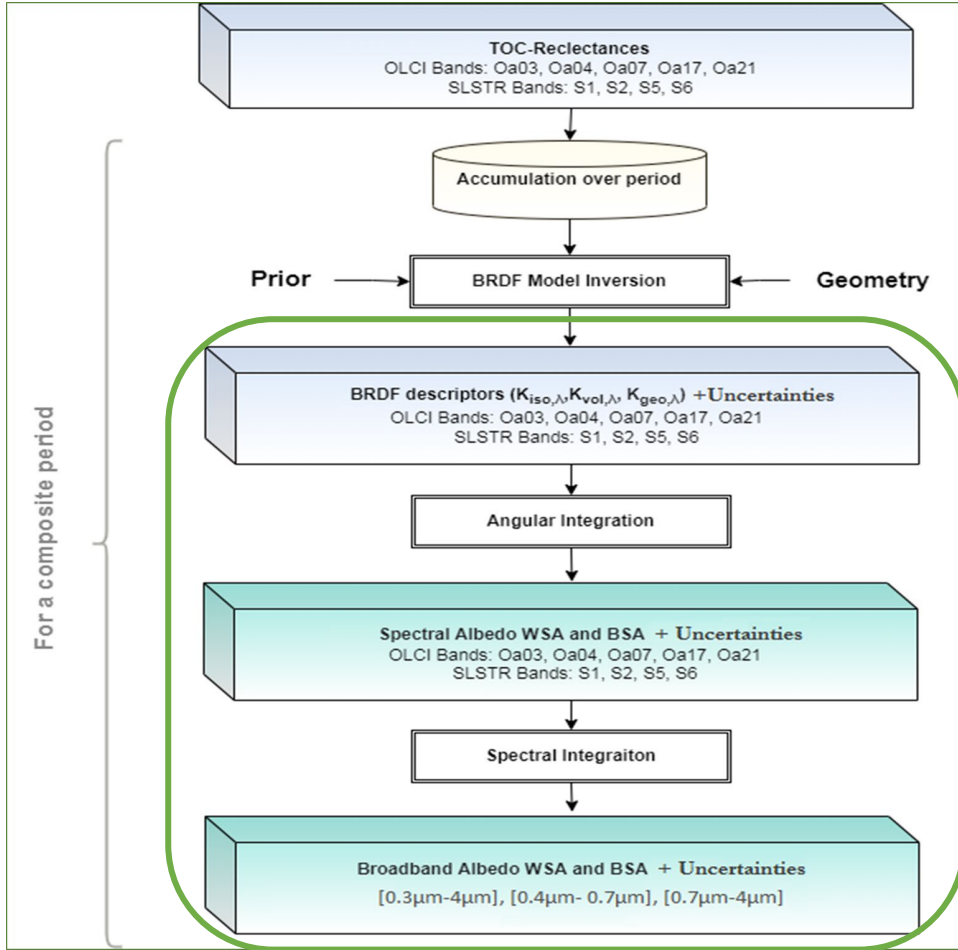


BRDF validation can be based on:

- satellite product intercomparison
- new approaches based on ground data: **Eric Vermote et al., LPVE23**
- New approaches such as Synergetic retrieval of AERONET and satellite measurements: **Pavlo Lytvynov et al., LPVE23**

GCOS ECV definition: BRDF param. + spectral albedo + broadband albedo

albedo validation gaps



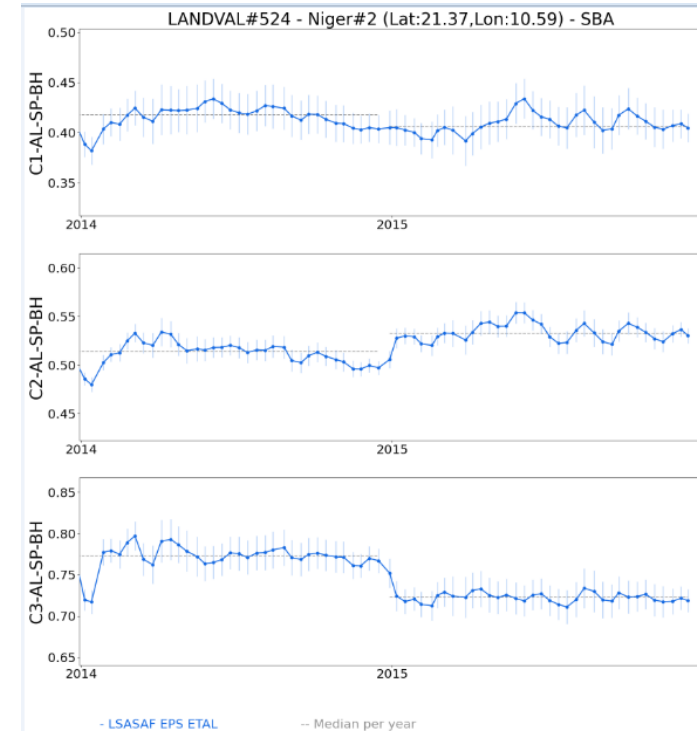
GCOS ECV definition: BRDF param. + spectral albedo + broadband albedo

Spectral albedo validation



0.8μm

1.6μm



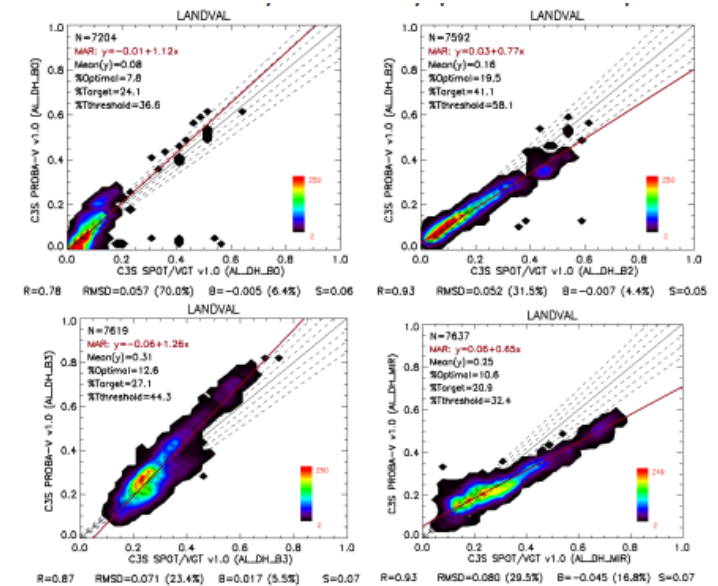
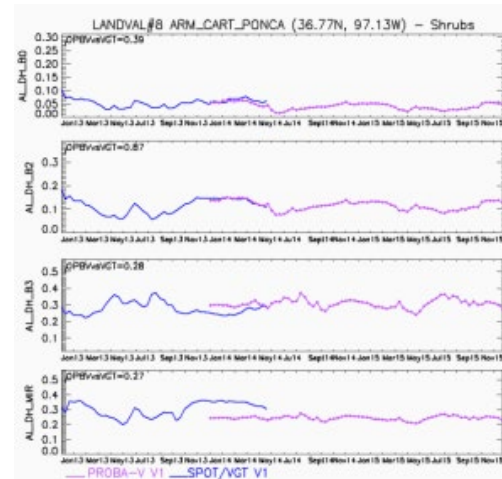
transition SPOT/VGT to PROBA-V

blue

red

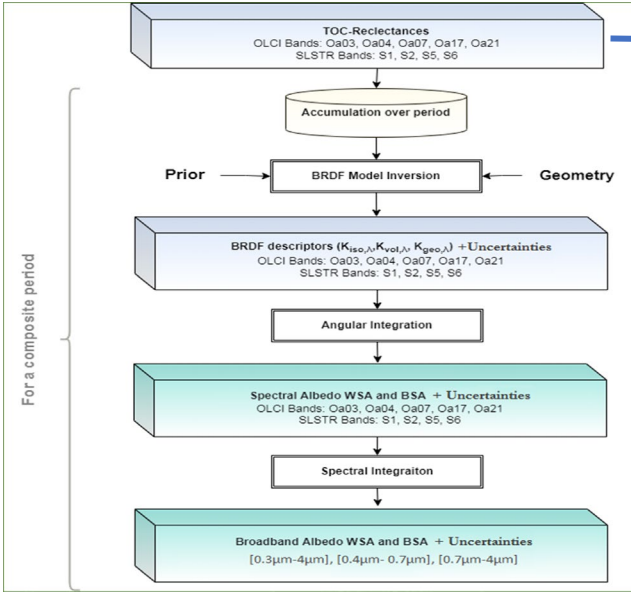
NIR

SWIR



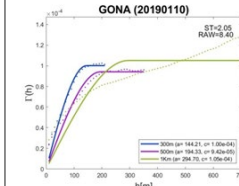
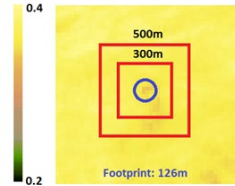
albedo validation gaps

TOC reflectance validation is needed to characterize uncertainties associated to albedo input data. Apart from ACIX, other suitable data could be used to validate TOC reflectances, following similar approach than albedo for direct validation (including spatial representativeness of measurements).

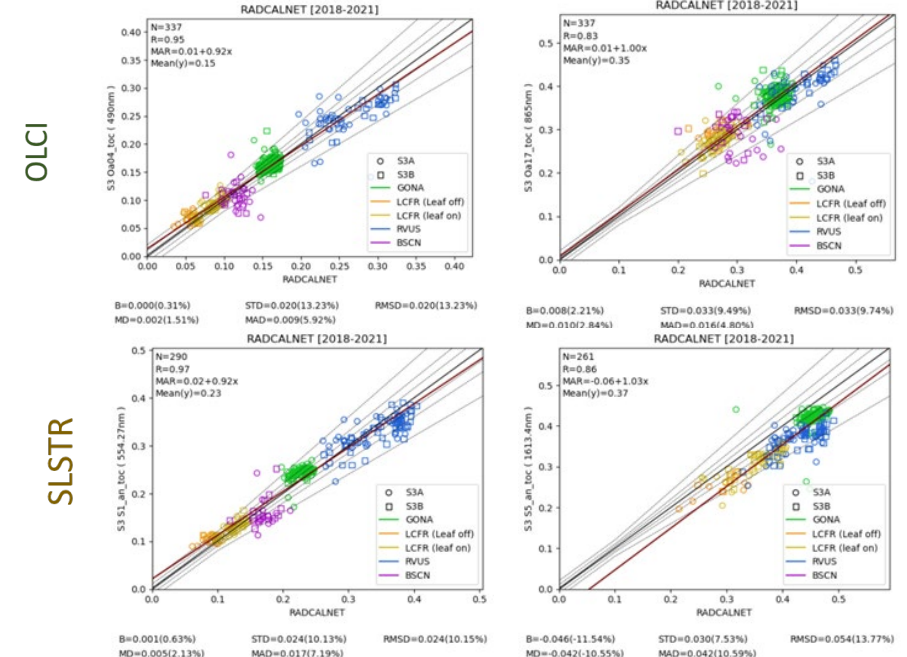


Copernicus Global Land Service
 Providing bio-geophysical products of global land surface

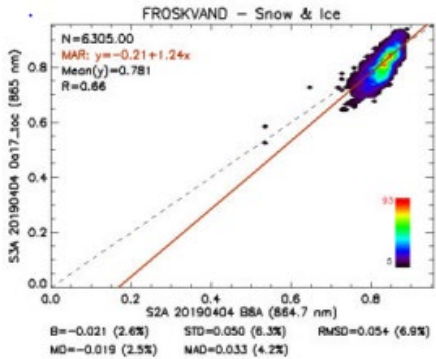
Sentinel-3
 TOC-r direct
 validation



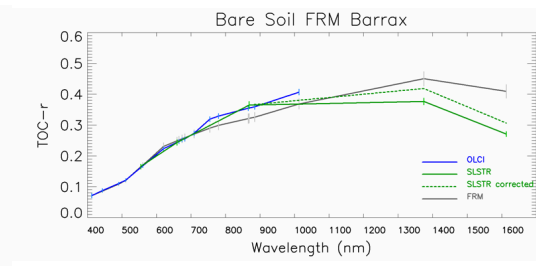
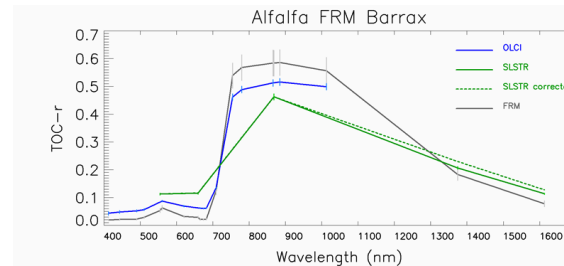
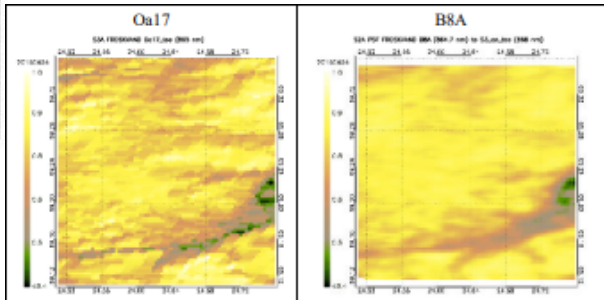
4 homogeneous stations
 where the spatial
 representativeness is
 evaluated



Sentinel-3 TOC-r vs Sentinel-2 product
 intercomparison over selected AOIs



Sentinel-2 PSF
 aggregation to 300m



Other suitable datasets: HYPERNET, other campaign data (ESA CHIME), NEON Airborne Observation Platform.

Continued MODIS/VIIRS Albedo Validation Efforts

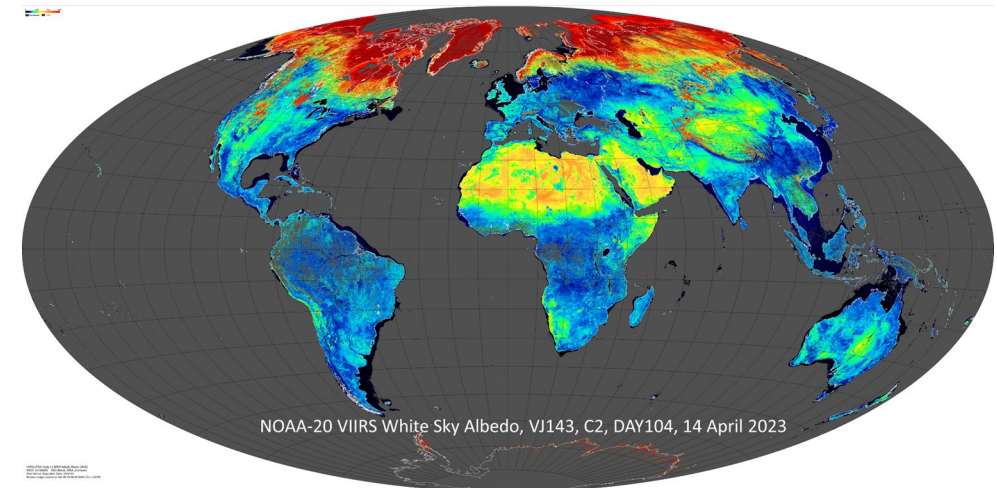
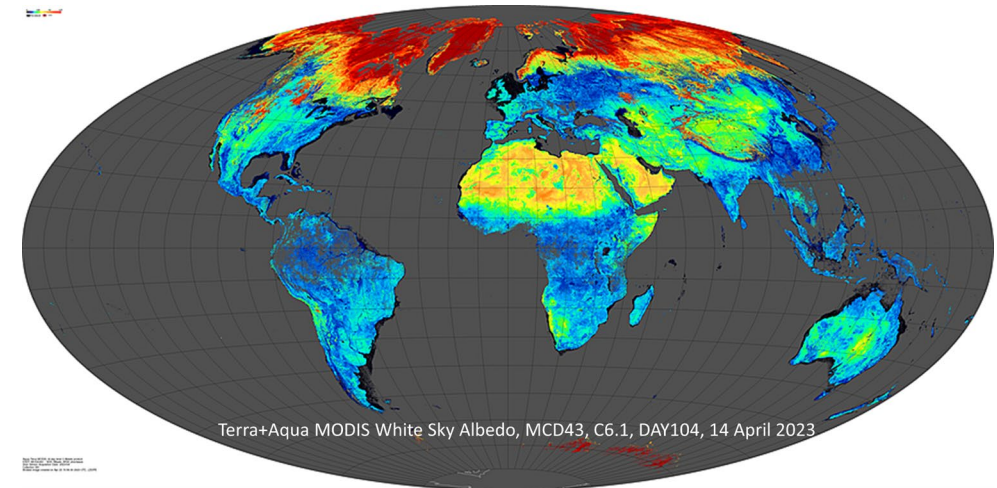
The current MODIS reprocessing (C6.1) and VIIRS reprocessing (C2) are

- Generated by the Level-1 and Atmosphere Archive & Distribution System (LAADS) Distributed Active Archive Center (DAAC) at the Goddard Space Flight Center
- Distributed to the public through the Land Products Distribution System Distributed Active Archive Center (LPDAAC) at the USGS Eros Data Center (EDC), Sioux Falls, South Dakota.
- Daily near-real time products (which emphasize the most recently acquired data) are available through the LANCE (Land, Atmos NRT Capability for EOS) facility at GSFC
- Gap-filled snow-free versions of the products (30arc-second resolution - MCD43GF) are also created in-house from temporal fits of the BRDF parameters over 15 months and then delivered to the LPDAAC.

These include daily global 500m gridded BRDF models, NBARS, and White Sky and Black Sky Albedos (provided at a sinusoidal projection on 10degree tiles (MCD43A*/ VNP43* / VJ143* / VJ243).

The BRDFs, NBARS, and Albedos are generated for spectral bands while narrow-to-broadband coefficients are used to also generate broadband albedo values. In addition, 30arc-second products are provided on a global lat/long projection (MCD43D*) and also averaged to 0.05degree products (for use by climate modelers, MCD43C*). Extensive quality information is provided with each of the products.

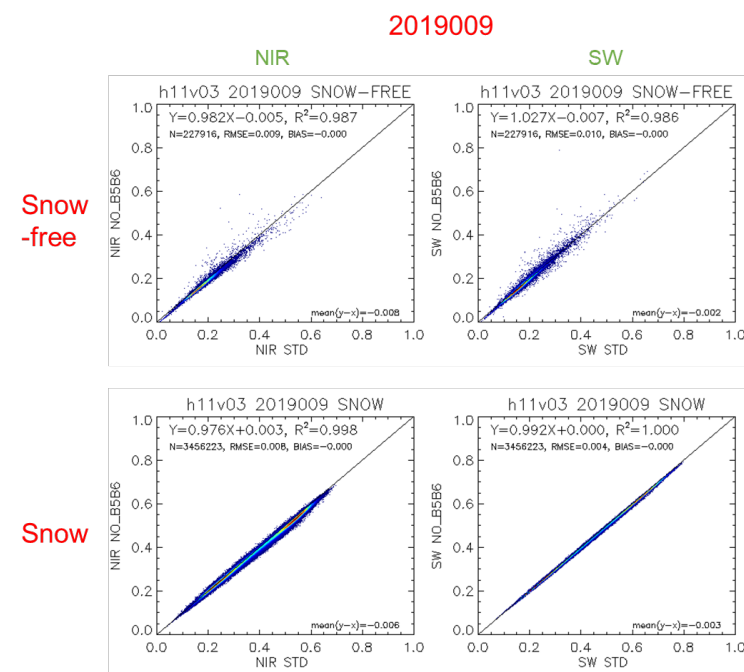
These are in demand as model initiation fields for various climate models (e.g. ECMWF). Therefore, a great deal of emphasis is being placed on providing comparable and consistent versions of these products from the VIIRS C2 processing to extend the long-term record, begun by MODIS, into the future



Continued MODIS/VIIRS Albedo Validation Efforts

MODIS BRDF/Albedo/NBAR Product MCD43: Movement from Collection 6 to Collection 6.1

- Update QA and narrow to broadband coefficients: Due to partially failed detectors in Band 5 and Band 6, these bands are not always available for product retrieval or narrow-to-broadband conversion. New coefficients were derived in cases where bands were missing and the mandatory QA flags embedded within the MCD43 updated. (Qingsong Sun, Jia Tian)
- With the publication of SALVAL paper, MODIS Albedo achieved Validation Status Level 4



Open Access Article

Surface ALbedo VALidation (SALVAL) Platform: Towards CEOS LPV Validation Stage 4—Application to Three Global Albedo Climate Data Records

by Jorge Sánchez-Zapero ^{1,*}, Enrique Martínez-Sánchez ¹, Fernando Camacho ¹, Zhuosen Wang ^{2,3}, Dominique Carrer ⁴, Crystal Schaaf ⁵, Francisco Javier García-Haro ⁶, Jaime Nickeson ^{7,8} and Michael Cosh ⁹

¹ Earth Observation Laboratory (EOLAB), C/ Savina 8–A4, 46980 Paterna, València, Spain

² Earth System Science Interdisciplinary Center, University of Maryland College Park, College Park, MD 20742, USA

³ Terrestrial Information Systems Laboratory, NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA

⁴ CNRM—Centre National de Recherches Météorologiques (CNRM), Université de Toulouse, Météo France, CNRS, 42 Avenue Gaspard Coriolis, 31057 Toulouse, France

⁵ School for the Environment, University of Massachusetts Boston, Boston, MA 02125, USA

⁶ Earth Physics and Thermodynamics Department, Faculty of Physics, Universitat de València, Dr. Moliner, 46100 Burjassot, València, Spain

⁷ Science Systems and Applications, Inc., 10210 Greenbelt Rd., Lanham, MD 20706, USA

⁸ NASA Goddard Space Flight Center (GSFC), Biospheric Sciences Laboratory, 8800 Greenbelt Rd., Greenbelt, MD 20771, USA

⁹ USDA Agricultural Research Service, Hydrology and Remote Sensing Laboratory, 10300 Baltimore Ave., Beltsville, MD 20705, USA

* Author to whom correspondence should be addressed.

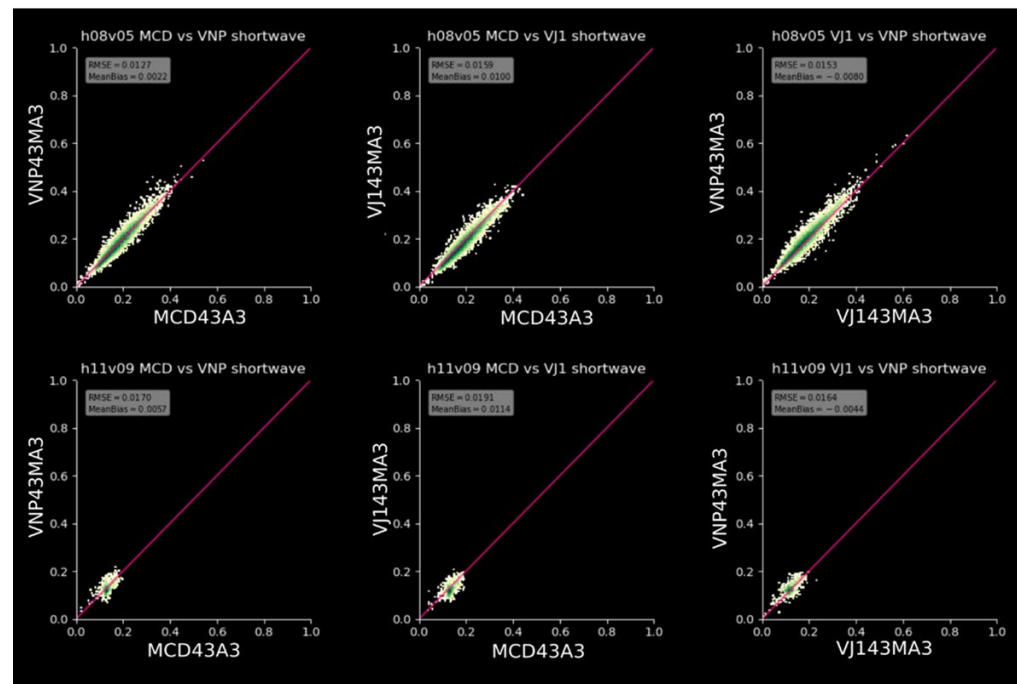
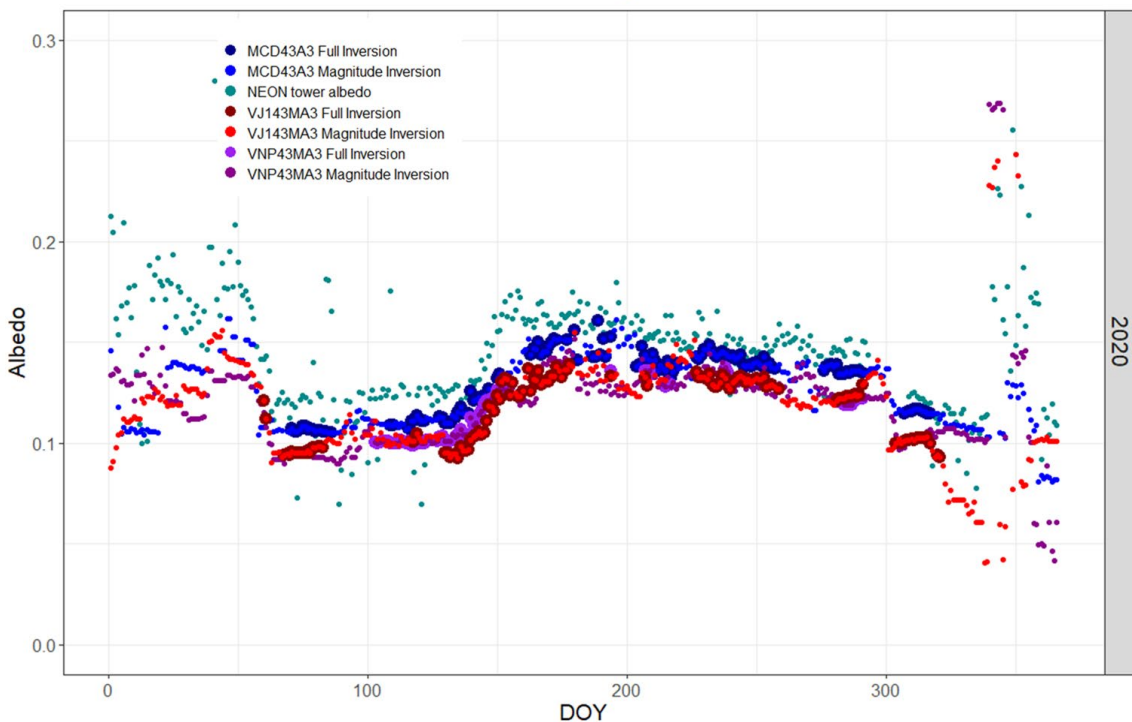
Continued MODIS/VIIRS Albedo Validation Efforts

VIIRS BRDF/Albedo/NBAR Product: Movement from Collection 1 to Collection 2

- Suomi NPP : VNP43 - Launched in 2012
- JPSS-1: VJ143 - Launched in 2017
- JPSS-2 : VJ243 - Launched 2022 (Should start processing soon)

Continuity Paper in progress.

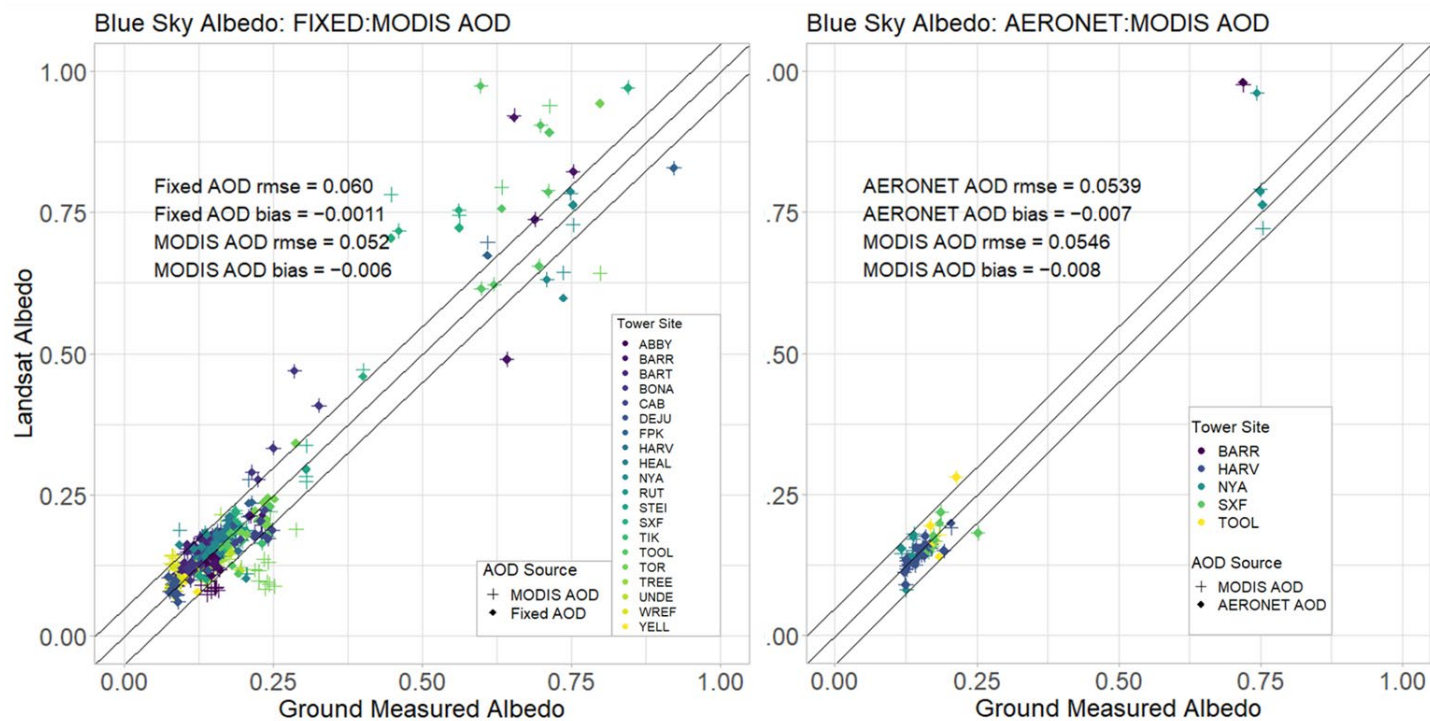
MCD43A3v61 : VNP43MA3c2 : VJ143MA3c2 Blue Sky Albedo at NEON Harvard Forest Tower



Top: Southwestern US tile h08v05 for 2019, comparisons between the MODIS MCD43 (V006.1) and VIIRS VNP43 (C2) White Sky Albedos, between the MCD43 and VJ143 values, and between the VJ143 and VNP43 values.
Bottom: Amazonia tile h11v09 comparisons.

Landsat / Sentinel-2 / HLS Albedo Validation

Landsat-8 Full Expression Blue Sky Albedo



** Landsat code delivery to USGS pending further evaluation of Collection 2 surface reflectance products.

Strategic Plan and actions for 2023-2025

- Promoting new validation and intercomparison exercises (VNP43, VJ143, VJ243, C3S Sentinel-3, EUMETSAT, ...)
- Annual updates of SALVAL to allow reaching LPV validation stage 4.
- Improving LPV communication (dedicated workshop/conference surface radiation community).
- Update product list, website, newsletters,
- Review albedo protocol and update, if needed, in response to the latest GCOS requirements.
- Spectral albedo validation