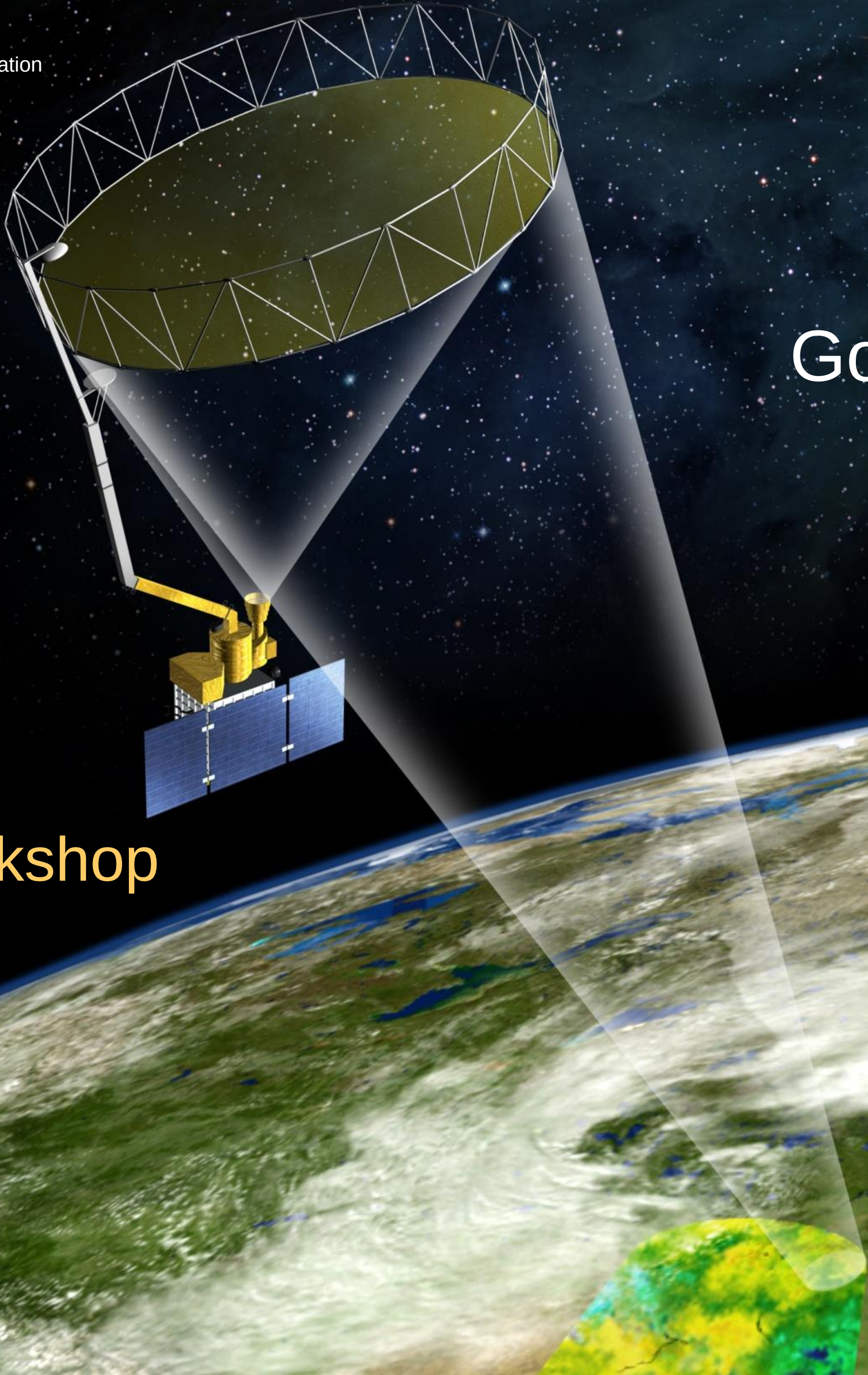
National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology

Soil Moisture
Active Passive
Mission

SMAP



Good Practices in SM Validation

Tom Jackson

6th Cal/Val Workshop

Sept1-3, 2015

6th SMAP Cal/Val Workshop Agenda-Day 3

Thursday		
	Improving and Continuing Validation Resources	
0800	Field Experiment Planning	T. Jackson
0815	SMAPEx-4 Report and SMAPEx-5 Plan	J. Walker
0845	SMAPVEX15 Report	T. Jackson/M. Cosh/A. Colliander
0915	Canada 2016 Planning	J. Powers
0930	SMAPVEX16 and Beyond Planning	T. Jackson
1000	***Break***	
1015	Core Validation Sites Issues	T. Jackson/A. Colliander
1030	ARS Watershed Sites	M. Cosh
1040	AARC Sites	A. Pacheco
1050	Argentina	M. Thibeault
1100	Australia	J. Walker
1110	Austria	M. Vreugdenhil
1120	Italy	F. Greifeneder
1130	Additional Texas Sites	B. Mohanty (C)
1135	Good Practices for Soil Moisture Validation	T. Jackson/M. Cosh/A. Berg/J. Walker
1215	***Lunch***	
0115	Sparse Networks in SMAP L2-L4 Cal/Val	W. Crow
0200	Model-based products in SMAP L2-L4 Cal/Val	D. Entekhabi
0230	*Break*	
0245	Satellite-based products in SMAP L2-L4 Cal/Val	T. Jackson/M. Burgin
0330	***Summary***	
0400	***End***	

Good Practices for Soil Moisture Cal/Val

- SMAP has implemented one of the most rigorous and robust Cal/Val programs of any soil moisture mission.
- The techniques used in all phases can contribute to standardization and data quality that can benefit a range of disciplines.
- The CEOS Working Group on Cal/Val Land Product Validation is promoting the development of Good Practices documents.
- Today: Initial discussion and scope
- Organizing the Feb 2016 Int. Soil Moisture Validation Workshop to develop the pieces needed for the document.

LAI Validation Good Practices

Citation:
Fernandes, R., Plummer, S., Nightingale, J., Baret, F., Camacho, F., Fang, H., Garrigues, S., Gobron, N., Lang, M., Lacaze, R., LeBlanc, S., Meroni, M., Martinez, B., Nilson, T., Pinty, B., Pisek, J., Sonnentag, O., Verger, A., Welles, J., Weiss, M., & Widlowski, J.L. (2014). Global Leaf Area Index Product Validation Good Practices. Version 2.0. In G. Schaepman-Strub, M. Román, & J. Nickeson (Eds.), Best Practice for Satellite-Derived Land Product Validation (p. 76): Land Product Validation Subgroup (WGCV/CEOS), doi:10.5067/doc/ceoswgcv/lpv/lai.002

Committee on Earth Observation Satellites
Working Group on Calibration and Validation

Land Product Validation Sub-Group

Global Leaf Area Index Product Validation Good Practices

Editors: Gabriela Schaepman-Strub, Miguel Roman, Jaime Nickeson

Authors: Richard Fernandes, Stephen Plummer, Joanne Nightingale, Fred Baret, Fernando Camacho, Hongliang Fang, Sebastien Garrigues, Nadine Gobron, Matt Lang, Roselyn Lacaze, Sylvain LeBlanc, Michele Meroni, Beatriz Martinez, Tiit Nilson, Bernard Pinty, Jan Pisek, Oliver Sonnentag, Alexander Verger, Jon Welles, Marie Weiss, Jean-Luc Widlowski

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LAI Validation Good Practices: Summary

The Global Climate Observing System (GCOS) has specified the need to systematically produce and validate global leaf area index (LAI) products. This document provides recommendations on good practices for the validation of global LAI products. Internationally accepted definitions of LAI and associated quantities are provided to ensure thematic compatibility across products and reference datasets. A survey of current validation capacity indicates that progress is being made towards the use of standard spatial sampling and in situ measurement methods, but there is less standardisation with respect to performing and reporting statistically robust comparisons. Three comparison approaches are identified: direct validation, indirect validation, and completeness. Direct validation, corresponds to the comparison of temporally and spatially concurrent satellite-derived product and up-scaled in situ reference LAI estimates.Indirect validation, consisting of inter-comparisons of products with ensembles of other products, using a stratified spatial sampling is proposed as a means for quantifying product precision as well as the representativeness of direct validation sites for a given biome. Completeness, corresponding to the frequency and continuity of LAI products, is quantified using a standard set of metrics applied to multi-year products. Finally, the need for an open access facility for performing validation as well as accessing reference LAI maps and ensemble LAI estimates from products is identified.

LAI Validation Good Practices: Outline

1. INTRODUCTION
2. DEFINITIONS
3. GENERAL CONSIDERATIONS FOR SATELLITE-DERIVED GLOBAL LAI PRODUCT
4. GENERAL STRATEGY FOR VALIDATION OF GLOBAL LAI PRODUCTS
5. RECOMMENDED APPROACH FOR GLOBAL LAI PRODUCT VALIDATION

LAI Validation Good Practices: Outline

- 1 INTRODUCTION
  - 1.1 Importance of LAI
  - 1.2 The UNFCCC and the Global Climate Observing System
  - 1.3 The Role of CEOS WGCV
  - 1.4 GCOS IP Action Items
  - 1.5 LAI Requirements
  - 1.6 Goal of this Document
- 2 DEFINITIONS
  - 2.1 Definition of LAI
  - 2.2 Definitions of Associated Physical Parameters
    - *2.2.1 Projected LAI*
    - *2.2.2 Plant Area Index (PAI)*
    - *2.2.3 Effective LAI (LAIe) or Effective PAI (PAIe)*
    - *2.2.4 Clumping Index*
  - 2.3 Definition of Other Key Terms
  - *2.3.1 Elementary Sampling Unit (ESU)*
    - *2.3.2 Local Horizontal Datum*
    - *2.3.3 Ground Projected Instantaneous Field of View of Measurement (PIFOV)*
    - *2.3.4 Effective Ground Projected Instantaneous Field of View of Measurement (EPIFOV)*
    - *2.3.5 Satellite Measurement Geolocation Uncertainty*
    - *2.3.6 Mapping Unit*

LAI Validation Good Practices: Outline

3 GENERAL CONSIDERATIONS FOR SATELLITE-DERIVED GLOBAL LAI PRODUCT VALIDATION

- 3.1 CEOS Validation Stages
- 3.2 Reference LAI Estimates
  - *3.2.1 ESU Mapping Unit*
  - *3.2.2 In situ Reference LAI over an ESU*
  - *3.2.3 ESU LAI Accuracy*
  - *3.2.4 ESU LAI Precision*
  - *3.2.5 Upscaling of Reference LAI Estimates*
  - *3.2.6 Sample Size*
  - *3.2.7 Sampling Design*
  - *3.2.8 Reference Map Accuracy*
  - *3.2.9 Reporting of Statistics*

LAI Validation Good Practices: Outline

4 GENERAL STRATEGY FOR VALIDATION OF GLOBAL LAI PRODUCTS
- 4.1. Current Products
  - *4.1.1 Uncertainties Related to Input Data*
  - *4.1.1.1 Sensor Noise*
    - *4.1.1.2 Clear Sky Uncertainty*
    - *4.1.1.3 BRDF Modelling Uncertainty*
    - *4.1.1.4 Canopy and Understory Modelling Uncertainty*
  - *4.1.2 Geometric Considerations*
  - *4.1.3 Temporal Considerations*
  - *4.1.4 LAI Product Definitions*
- 4.2 Status of Current Validation Capacity
- 4.3 Validation Requirements
  - *4.3.1 Direct Validation on a Global Basis Representative of Seasonal Conditions and Estimation of Accuracy in LAI Units*
  - *4.3.2 Quantify the Representative LAI Accuracy Estimate Over Areas or Time Periods Without Reference Datasets*
  - *4.3.3 Quantify the Intra-Annual Precision of LAI Estimates Over Space and Time on a Globally Representative Basis*
  - *4.3.4 Quantify the Long Term (Inter-Annual) Stability in LAI Products*
- 4.4 Challenges to Validation Strategy
  - *4.4.1 Insufficient Reference Data*
  - *4.4.2 Insufficient Products to Generate an Unbiased Ensemble*
  - *4.4.3 Thematic Differences in LAI Definitions*
- 4.5 Status of Current Validation Capacity
  - *4.5.1 Data*
  - *4.5.2 Methods*
  - *4.5.2. In Situ Reference Estimates*
  - *4.5.2.2 Statistics Used for Performance Assessments*

LAI Validation Good Practices: Outline

5 RECOMMENDED APPROACH FOR GLOBAL LAI PRODUCT VALIDATION

- 5.1 Reference Data Sets
  - *5.1.1 Reference Estimates Traceable to In situ Measurements*
  - *5.1.2 Heuristic Reference Estimates*
  - *5.1.3 Co-location of LAI Estimates*
  - *5.1.3.1 Geolocation Uncertainty*
  - *5.1.3.2 Binning Uncertainty*
- 5.2 Validation Metrics
  - *5.2.1 Definitions*
  - *5.2.2 Stratification of Performance Statistics*
  - *5.2.3 Validation Statistics*
    - *5.2.3.1 Measurement Uncertainty*
    - *5.2.3.2 Precision*
    - *5.2.3.3 Completeness*
    - *5.2.3.4 Ensemble Inter-comparison*
- 5.3. Reporting Results of LAI Validation

SM Validation Good Practices: Outline

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3. GENERAL CONSIDERATIONS FOR SATELLITE-DERIVED GLOBAL SM PRODUCT
4. GENERAL STRATEGY FOR VALIDATION OF GLOBAL SM PRODUCTS
5. RECOMMENDED APPROACH FOR GLOBAL SM PRODUCT VALIDATION
6. GOOD PRACTICES

SM Validation Good Practices: Outline

1 INTRODUCTION
- 1.1 Importance of SM
- 1.2 The UNFCCC and the Global Climate Observing System
- 1.3 The Role of CEOS WGCV
- 1.4 GCOS IP Action Items
- 1.5 SM Requirements
- 1.6 Goal of this Document

2 DEFINITIONS
- 2.1 Definition of SM
- 2.2 Definitions of Associated Physical Parameters
- 2.3 Definition of Other Key Terms
- *2.3.1 Sampling Unit*
  - *2.3.2 Footprints, grids, depths,….*

SM Validation Good Practices: Outline

3 GENERAL CONSIDERATIONS FOR SATELLITE-DERIVED GLOBAL SM PRODUCT VALIDATION

- 3.1 CEOS Validation Stages
- 3.2 Reference SM Estimates
  - *3.2.1 Validation sites*
  - *3.2.2 In situ Reference SM*
  - *3.2.3 SM Accuracy*
  - *3.2.4 SM Precision*
  - *3.2.5 Upscaling of Reference SM Estimates*
  - *3.2.6 Sample Size*
  - *3.2.7 Sampling Design*
  - *3.2.8 Reporting of Statistics*

SM Validation Good Practices: Outline

4 GENERAL STRATEGY FOR VALIDATION OF GLOBAL SM PRODUCTS

- 4.1. Current Products
  - *4.1.1 Uncertainties Related to Input Data*
  - *4.1.1.1 Sensor Noise*
  - *4.1.2 Geometric Considerations*
  - *4.1.3 Temporal Considerations*
  - *4.1.4 SM Product Definitions*
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- 4.4 Challenges to Validation Strategy
  - *4.4.1 Insufficient Reference Data*
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SM Validation Good Practices: Outline

5 RECOMMENDED APPROACH FOR GLOBAL SM PRODUCT VALIDATION

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  - *5.1.1 Reference Estimates Traceable to In situ Measurements*
  - *5.1.2 Heuristic Reference Estimates*
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    - *5.2.3.3 Completeness*
    - *5.2.3.4 Ensemble Inter-comparison*
- 5.3. Reporting Results of SM Validation

SM Validation Good Practices: Outline

6 GOOD PRACTICES
- 6.1 In Situ Sensor Installation and Calibration
- 6.2 Soil Moisture Network Design
- 6.3 Utilizing Sparse Networks
- 6.4 Upscaling Points and Networks
- 6.5 Satellite-based Comparisons
- 6.6 Model-based Comparisons

Sections

Section	Lead	Team
INTRODUCTION		
DEFINITIONS		
GENERAL CONSIDERATIONS FOR SATELLITE-DERIVED GLOBAL SM PRODUCT		
GENERAL STRATEGY FOR VALIDATION OF GLOBAL SM PRODUCTS		
RECOMMENDED APPROACH FOR GLOBAL SM PRODUCT VALIDATION		
GOOD PRACTICES		

Timeline: Good Practices for Soil Moisture Cal/Val

- Sept. 2015: Discuss committing to a SMAP-centric effort at the CV Workshop. Outline and leads identified.
- Oct. 2015: Webex with European/Other groups to organize the Int. SM Workshop to support the effort.
- Nov. 2015: Task Int. SM Workshop leads for drafting sections.
- Feb. 2016: Int. SM Workshop and SMAP CV Workshop.
- June 2016: First draft
- January 2017: Final version

Example of a Good Practice: Protocol for Selecting a Core Validation Site

Step	Task
1	Develop and implement the validation grid
2	Assessment of site for conditions that would introduce uncertainty
3	Is the number of points large enough?
4	Are the *in situ* points geographically distributed?
5	Has the instrumentation been either 1) widely used and known to be well-calibrated or 2) site calibrated?
6	Quality assessment of each point in the network using temporal stability
7	Established scaling function (default average)
8	Conduct pre-launch assessment using surrogate data appropriate for the grid product (i.eSMOS and GCOM-W soil moisture for km,)
9	Has a supplemental study been performed to verify that the network represents the SMAP product over the grid domain?

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