QA4SM: a service for transparent and reproducible evaluation of satellite soil moisture products

EGU 2023

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[1]TU Wien: www.climers.geo.tuwien.ac.at
[2]AWST: www.awst.at
[3]CESBIO: www.cesbio.cnrs.fr
[4]ESA: www.esa.int

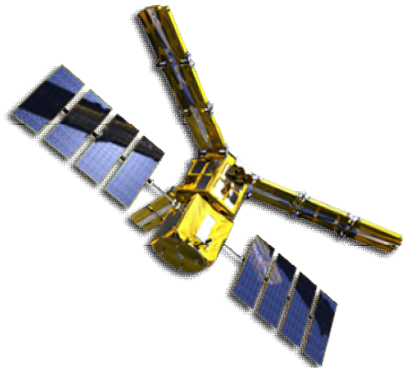
ISMN: ismn.earth
QA4SM: qa4sm.eu

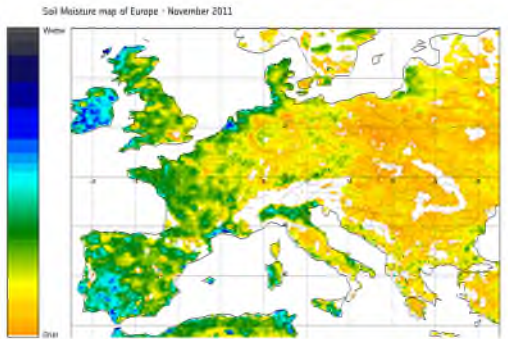
What is QA4SM?

Fiducial Reference Measurements for Soil Moisture (FRM4SM)

https://project-frm4sm.geo.tuwien.ac.at/

Suite of input data

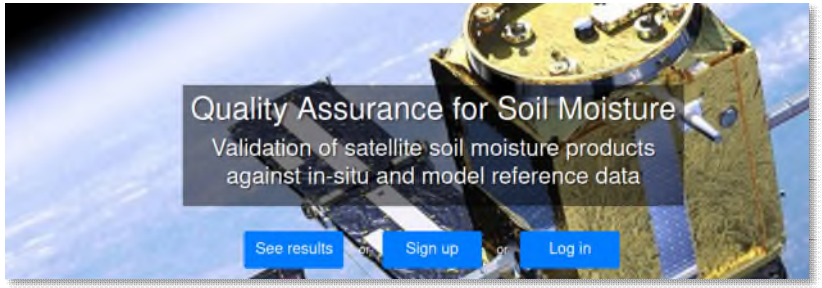




International Soil Moisture Network

Suite of reference data (in situ, model)

FRM protocols and procedures



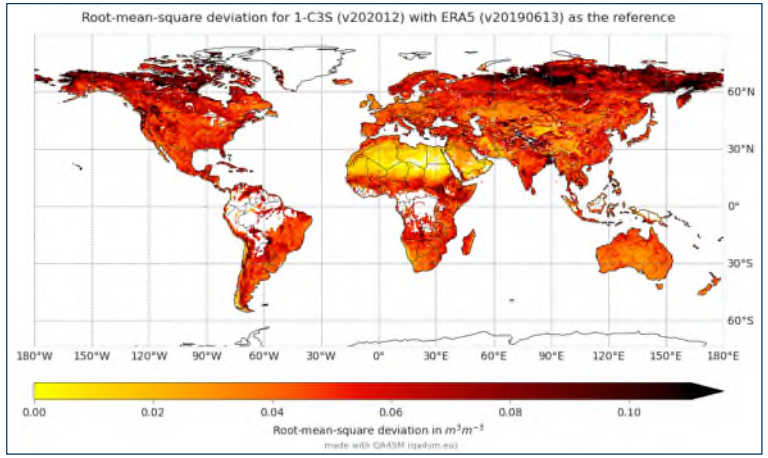
Committee on Earth Observation Satellites
Working Group on Calibration and Validation
Land Product Validation Subgroup

Soil Moisture Product Validation Good Practices Protocol

Version 1.0 – October 2020

Montzka et al., 2020 https://doi.org/10.5067/doc/ceoswgcv/lpv/sm.001

Standardized validation report



Framework for product intercomparison and validation as defined by LPV (https://lpvs.gsfc.nasa.gov/)

Challenges and best practices in satellite SM validation

- Applying metrological principles in satellite-retrieved SM has challenges
- **Validation strategies** designed to overcome challenges
- Best practices are provided by:
  - **Authorities** in the SM validation field (WMO, CEOS, working group on Calibration and Validation, ..)
  - the **scientific community** (e.g. Montzka et al., 2020; Gruber et al., 2020)
- QA4SM **adheres to these guidelines**

What is QA4SM?

Data

- ISMN / 20230110 global / soil_moisture (spatial reference)
- ERA5 / v20190613 / swvl1 (temporal reference)
- SMOS Level 2 / v700 / Soil_Moisture

Dataset: SMOS Level 2

Version: v700

Variable [units]: Soil_Moisture [m³/m³]

- [x] Variable in valid geophysical range
- [ ] High confidence filtering of RFI
- [x] Good confidence filtering of RFI
- [x] Exclude strong topography in scene
- [x] Exclude presence of frozen ground in scene
- [x] Exclude presence of ice in scene
- [x] Exclude presence of dry/wet/mixed snow in scene
- [x] Exclude open water in scene
- [x] Set retrieval quality threshold: 0.05 [-]

Remove dataset

Add dataset

Reference

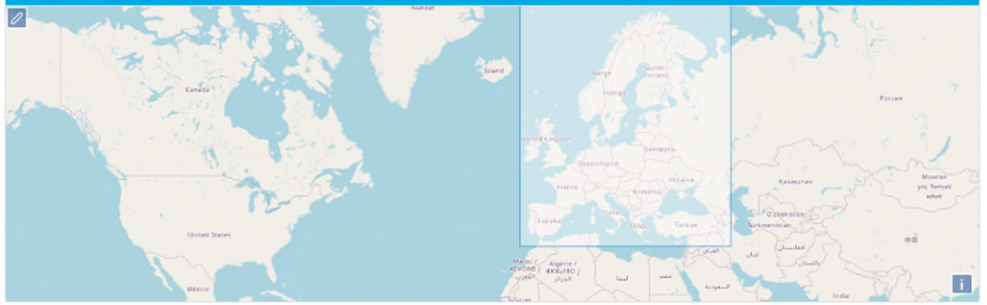
Spatial reference
Select dataset (version): ISMN (20230110 global)

Temporal reference
Select dataset (version): ERA5 (v20190613)

Scaling

Method:
Select scaling method: No scaling

Map



Spatial Subsetting

	Min. Latitude	Min. Longitude		Max. Latitude	Max. Longitude
Lower left	34.0	-11.2	Upper right	71.6	48.3

Temporal Subsetting

Validation Period

	Choose a date		Chose a date
From	2010-07-01	To	2019-03-31

Temporal matching

Select a size: Window size 12 hours

Metrics

- [ ] Include Triple Collocation Metrics
- [ ] Bootstrap Triple Collocation metric confidence intervals (Warning: very slow)

Anomalies

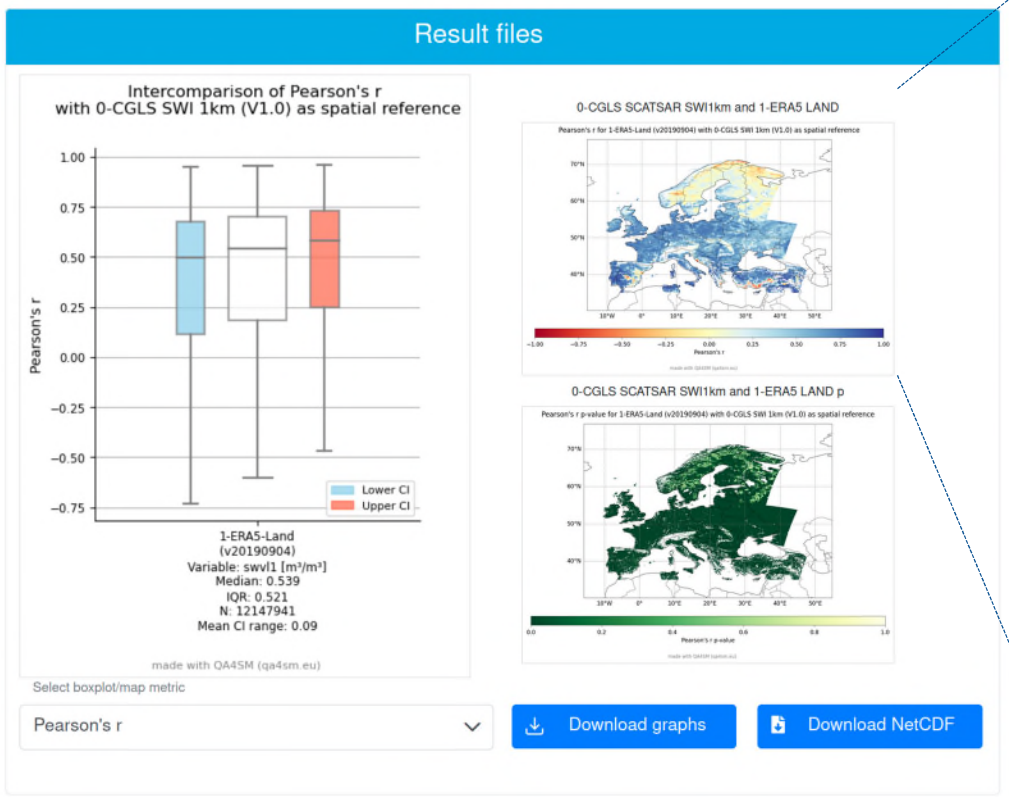
Select: Method: Do not calculate

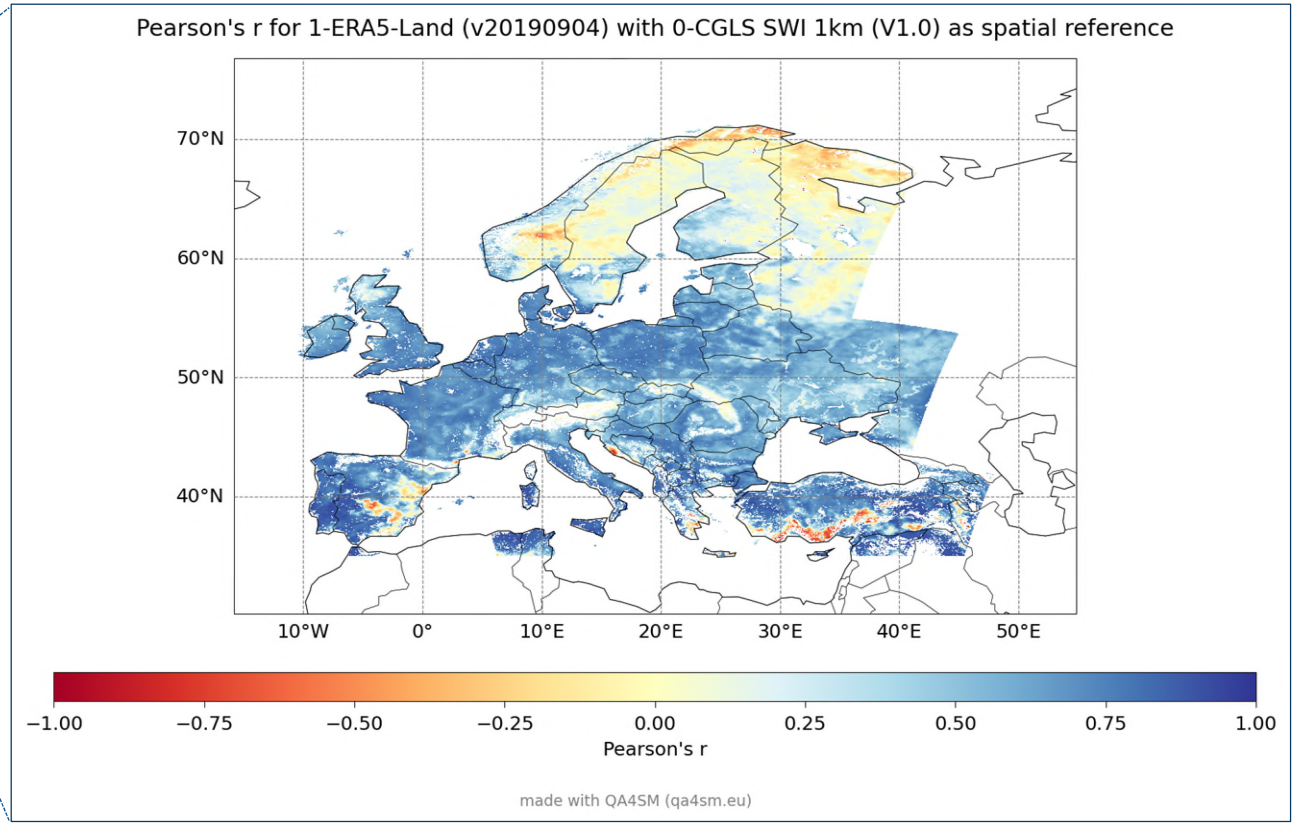
Name your validation

Validate

What is QA4SM?

- **Graphics** are ready to be downloaded directly and embedded in your documents (e.g. in your paper or reports)





What is QA4SM?

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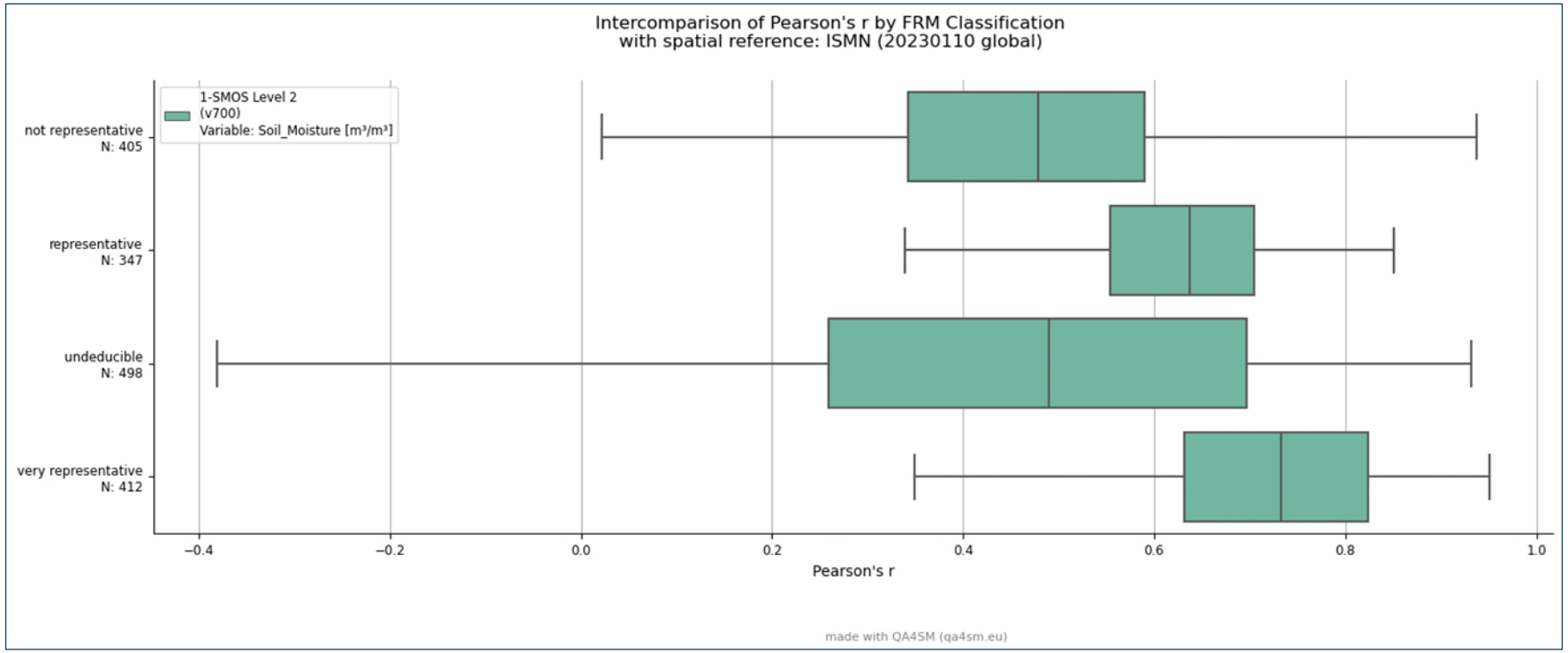
Stratify results by FRMs



- ...or you can download a **netCDF file** with the results and explore them yourself

Why QA4SM?

- QA4SM collects the best validation practices in a **single, open access tool**
- Provides a **powerful computing environment** and high storage capacity
- Guarantees **transparency and traceability**:
  - Validation source code is open access
  - Validations can be **archived or published with a DOI**
  - Data sets are referenced with version control

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  - Data sets are referenced with version control
- Provides **flexibility** for the users:
  - **Validations of own data sets** are possible

To sum up..

Contact us @:

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QA4SM helpdesk: support@qa4sm.eu

- **QA4SM** implements the best practices in satellite SM validation
- Computational and programming resources are **freely at the disposal of the community**
- **Transparency and traceability** of validation results
- Much more to come from the FRM4SM project!

Try it yourself!

Feedback and recommendations are very welcome

References

Gruber, A., De Lannoy, G., Albergel, C., Al-Yaari, A., Brocca, L., Calvet, J.C., Colliander, A., Cosh, M., Crow, W., Dorigo, W., and others 2020. Validation practices for satellite soil moisture retrievals: What are (the) errors?. Remote Sensing of Environment, 244, p.111806.

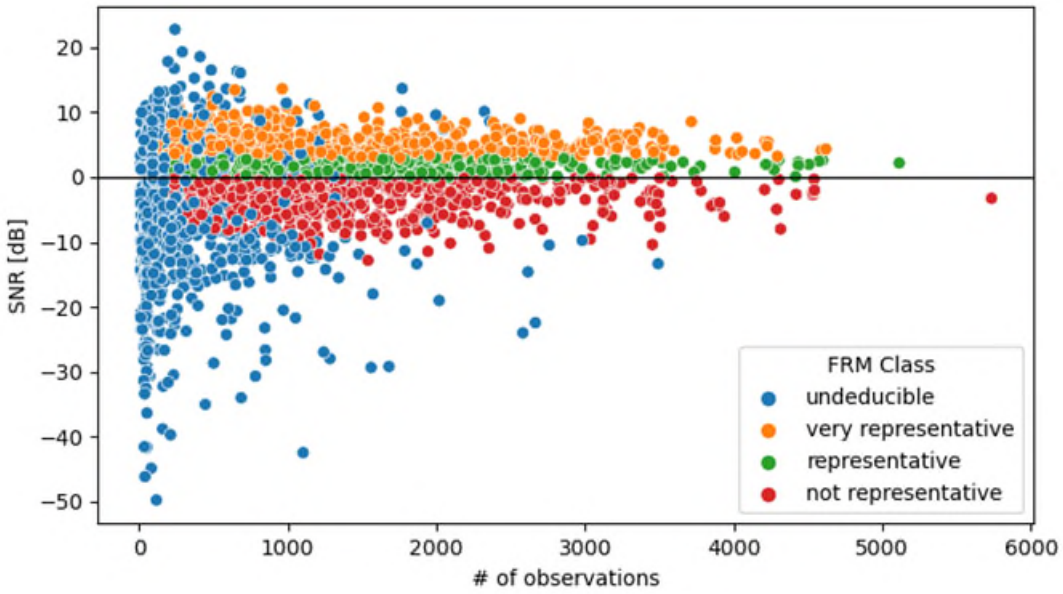
Montzka, C., et al. (2020): Soil Moisture Product Validation Good Practices Protocol Version 1.0. In: C. Montzka, M. Cosh, J. Nickeson, F. Camacho (Eds.): Good Practices for Satellite Derived Land Product Validation (p. 123), Land Product Validation Subgroup (WGCV/CEOS), doi:10.5067/doc/ceoswgcv/lpv/sm.001

https://zenodo.org/record/7151956

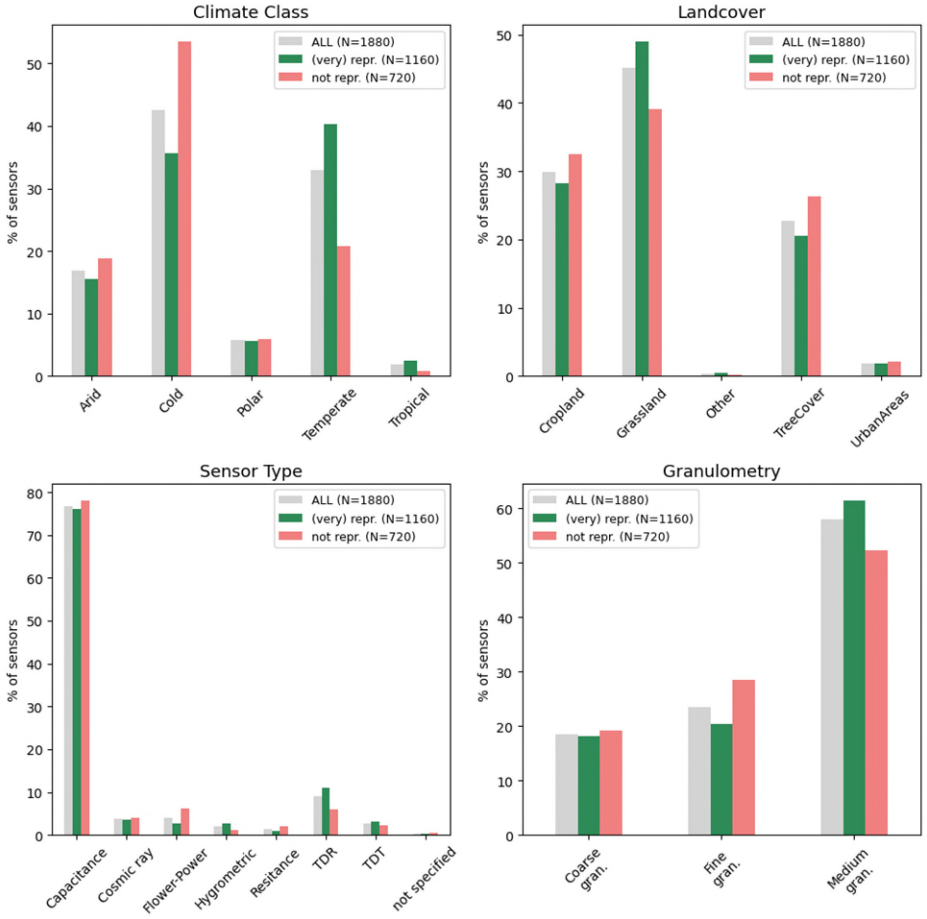
Appendix

FRM flags

FRMs selection methodology



Stratified FRMs abundance



Appendix: Validation levels for ECVs

CEOS defined validation hierarchy (https://lpvs.gsfc.nasa.gov/)

Level	Validation Stage - Definition and Current State
0	No validation. Product accuracy has not been assessed. Product considered beta.
1	Product accuracy is assessed from a **small (typically < 30) set of locations** and time periods by comparison with in-situ or other suitable reference data.
2	Product accuracy is estimated over a **significant (typically > 30) set of locations** and time periods by comparison with reference in situ or other suitable reference data. **Spatial and temporal consistency of the product**, and its consistency with similar products, has been evaluated over globally representative locations and time periods. Results are **published** in the peer-reviewed literature.
3	**Uncertainties in the product and its associated structure are well quantified** over a significant (typically > 30) set of locations and time periods representing global conditions by comparison with reference in situ or other suitable reference data. Validation **procedures follow community-agreed-upon good practices**. Spatial and temporal consistency of the product, and its consistency with similar products, has been evaluated over globally representative locations and time periods. Results are published in the peer-reviewed literature.
4	Validation results for stage 3 are **systematically updated when new product versions are released or as the interannual time series expands**. When appropriate for the product, uncertainties in the product are quantified using fiducial reference measurements over a global network of sites and time periods (if available).