

CEOS LPV Soil Moisture

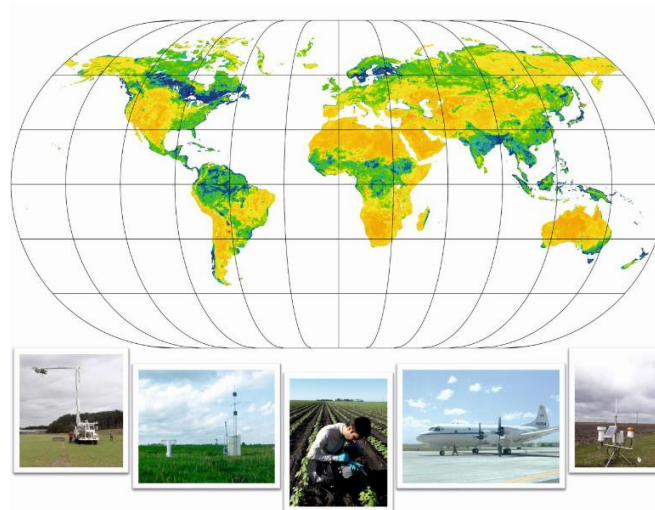
John Bolten and Carsten Montzka

Good Practices Document

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

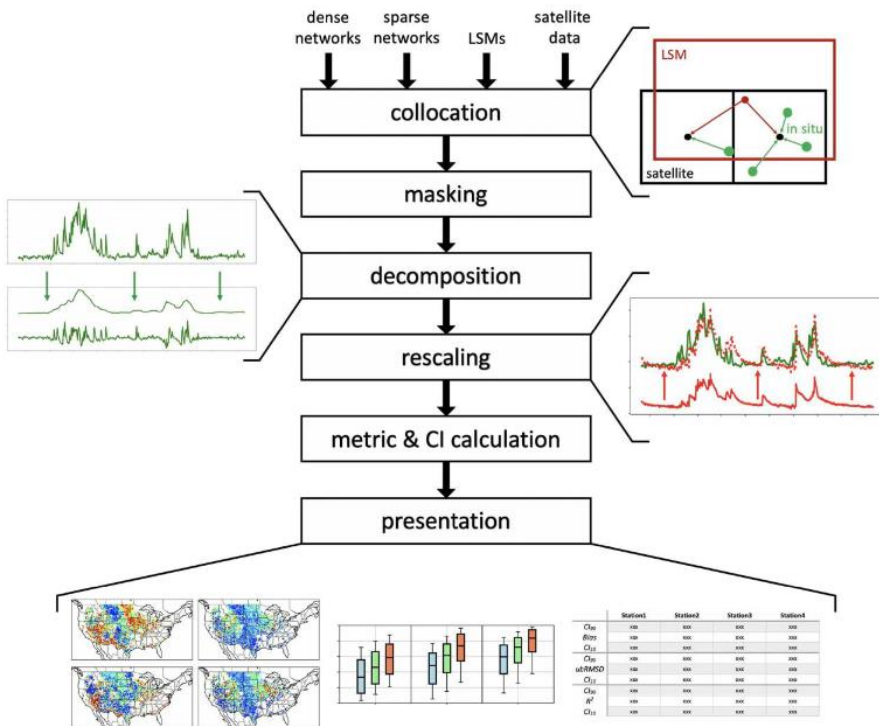
Soil Moisture Product Validation Good Practices Protocol

Version 1.0 – October 2020



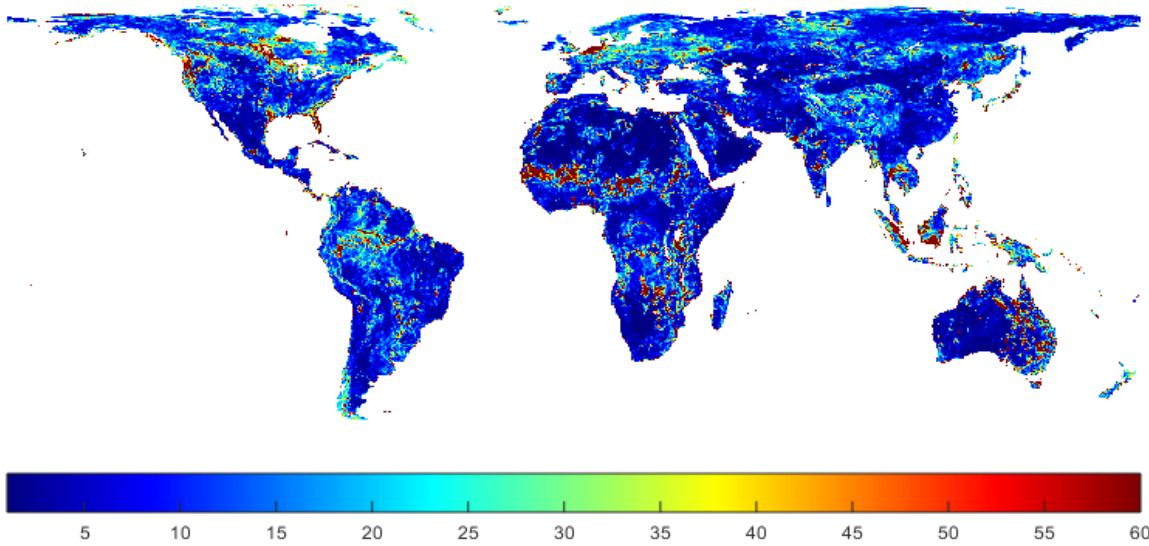
Montzka, C., M. Cosh, B. Bayat, A. Al Bitar, A. Berg, R. Bindlish, H. R. Bogaena, J. D. Bolten, F. Cabot, T. Caldwell, S. Chan, A. Colliander, W. Crow, N. Das, G. De Lannoy, W. Dorigo, S. R. Evett, A. Gruber, S. Hahn, T. Jagdhuber, S. Jones, Y. Kerr, S. Kim, C. Koyama, M. Kurum, E. Lopez-Baeza, F. Mattia, K. McColl, S. Mecklenburg, B. Mohanty, P. O'Neill, D. Or, T. Pellarin, G. P. Petropoulos, M. Piles, R. H. Reichle, N. Rodriguez-Fernandez, C. Rüdiger, T. Scanlon, R. C. Schwartz, D. Spengler, P. Srivastava, S. Suman, R. van der Schalie, W. Wagner, U. Wegmüller, J.-P. Wigneron, F. Camacho, and J. Nickeson (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://doi.org/10.5067/doc/ceoswgcv/lpv/sm.001)

Good Practices Paper

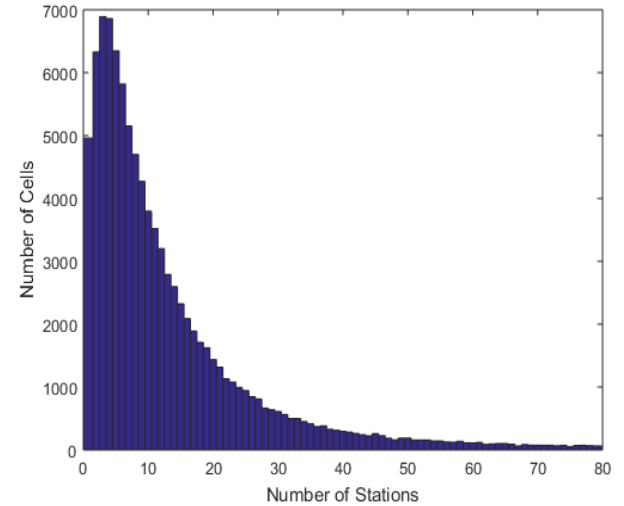


Gruber, A., G. De Lannoy, C. Albergel, A. Al-Yaari, L. Brocca, J.-C. Calvet, A. Colliander, M. Cosh, W. Crow, W. Dorigo, C. Draper, M. Hirschi, Y. Kerr, A. Konings, W. Lahoz, K. McColl, C. Montzka, J. Muñoz-Sabater, J. Peng, R. Reichle, P. Richaume, C. Rüdiger, T. Scanlon, R. van der Schalie, and W. Wagner (2020): Validation practices for satellite soil moisture retrievals: What are (the) errors? *Remote Sensing of Environment* 244, 111806. DOI:10.1016/j.rse.2020.111806

Number of needed stations



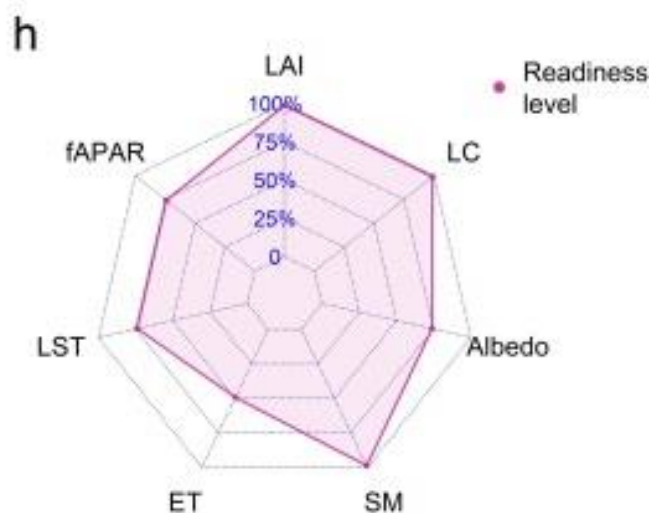
Number of stations required for adequate validation of coarse soil moisture products (here the SMAP 36km example).



Histogram of global number of stations required to adequately estimate the mean soil moisture in a SMAP 36 km grid cell.

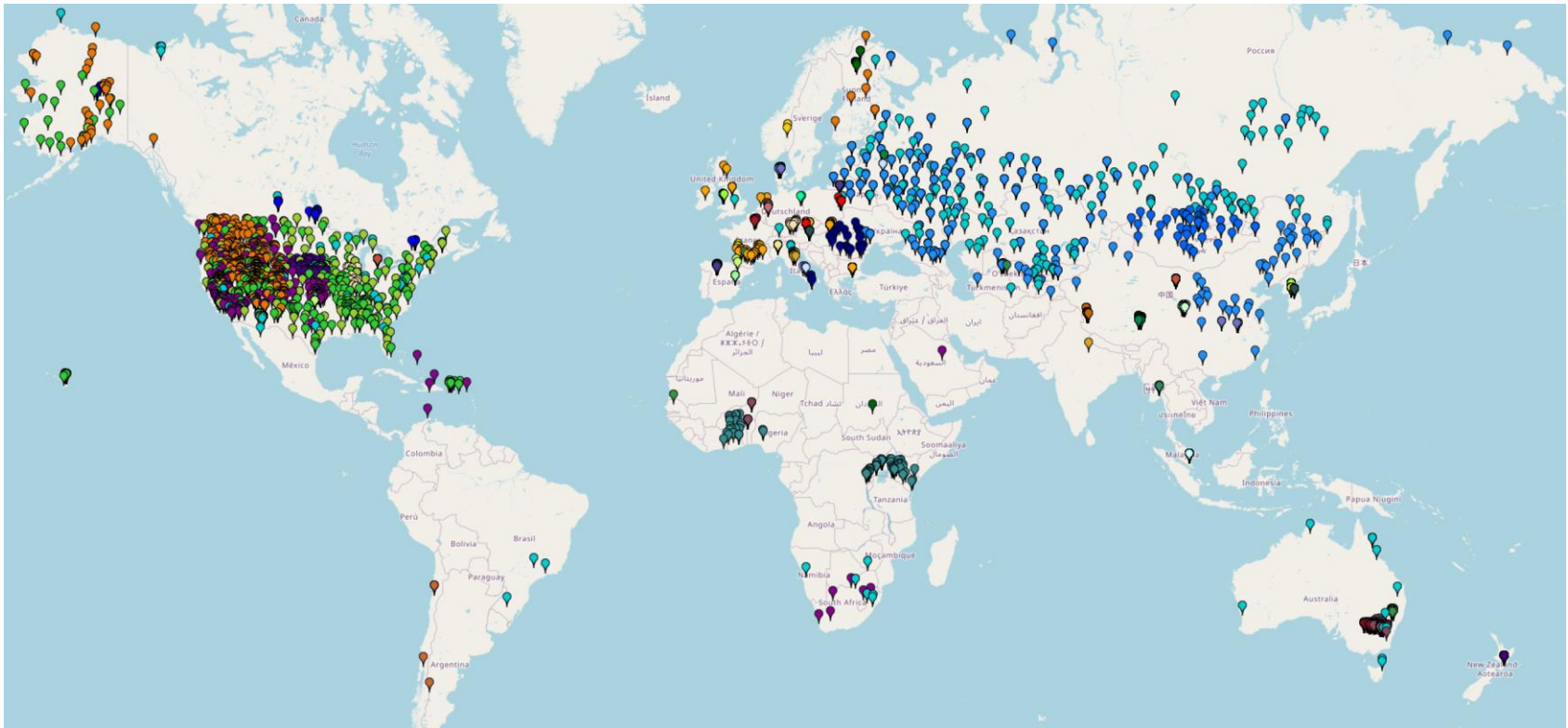
Montzka, C., H. R. Bogena, M. Herbst, M. H. Cosh, T. Jagdhuber, and H. Vereecken (in press): Estimating the number of reference sites necessary for the validation of global soil moisture products. IEEE Geoscience and Remote Sensing Letters. DOI:10.1109/LGRS.2020.3005730

Analyzed Operational Readiness



Bayat, B., F. Camacho, J. Nickeson, M. Cosh, J. Bolten, H. Vereecken, and C. Montzka (2021): Toward Operational Validation Systems for Global Satellite-Based Terrestrial Essential Climate Variables. *International Journal of Applied Earth Observations and Geoinformation* 95, 102240. DOI:10.1016/j.jag.2020.102240

International Soil Moisture Network (ISMN)



- 71 networks contributed so far with 2843 stations!
- Developing methods that allow to qualify as Fiducial Reference Measurements

QA4SM Online Validation Tool

Overview QA4SM

The Quality Assurance for Soil Moisture (QA4SM) service provides the user with:

- › An easy-to-use interface for comparing satellite soil moisture data against land surface models and the [international soil moisture network](#)
- › A traceable and consistent methodology for all comparisons
- › Various filtering and scaling options to assess the impact of these on the validation results
- › Traceable validation results in netCDF format and as visualisations (graphs and maps)

The overall aim is to **bring together methodologies and protocols** used for the validation and quality control of soil moisture data products and provider users with **traceable validation results**.

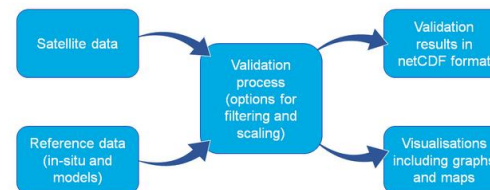
QA4SM is supported by the [Austrian Space Application Programme](#).

News

2021-05-05

- › Version v1.5.1 released

For all changes see the [release notes](#)



Traceability from input data to output results



QA4SM Online Validation Tool

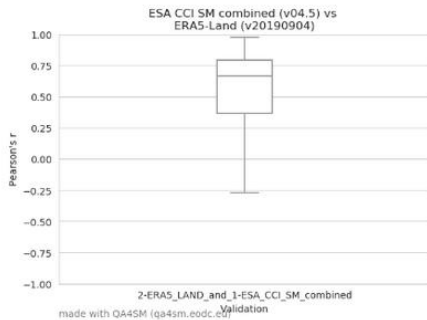
Summary

- Started validation on March 14, 2020, 1:23 p.m. UTC, finished on March 15, 2020, 2:23 p.m. UTC.
- Validation name: CCI SM combined vs. ERA5-Land 2018, Europe
- Compared 2 datasets:
 - Dataset 1: ESA CCI SM combined (v04.5, sm) [Filters: Variable in valid geophysical range;]
 - Reference: ERA5-Land (v20190904, swvl1) [Filters: Variable in valid geophysical range;]
- Spatial filter bounding box: [28.6014780676497, -25.8393014366076, 72.9030658946902, 49.1957890784358].
- Validation period / temporal filter: Jan. 1, 2018, midnight UTC to Dec. 31, 2018, 11:59 p.m. UTC.
- Validation metrics calculated from absolute values.
- Scaling reference: ERA5-Land (v20190904, swvl1) [Filters: Variable in valid geophysical range;]
- Scaling method: Mean/standard deviation.
- Processing took 1500 minutes (wall time).
- 0% (0 of 165778) of the processed locations (grid points) produced errors during calculation.
- 🗑️ This validation will be automatically removed during cleanup on Aug. 30, 2020, 5:21 p.m. UTC.

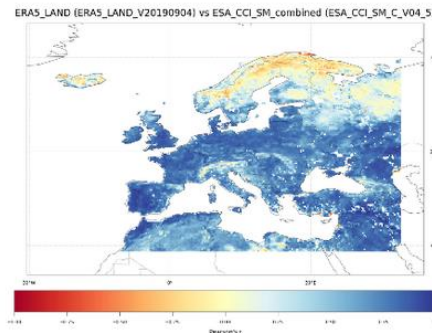
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- Based on ISMN and SM simulations (ERA5_Land, GLDAS, ESA CCI)
- Traceable and consistent methodology
- Various filtering and scaling options
- Standardized validation reports (provided in netCDF format and as visualisations)

Result files



Boxplot of the distribution of Pearson's r for all evaluated locations.



made with QGIS (qgis.org)

The distribution of Pearson's r for dataset pair 2-ERA5_LAND_and_1-ESA_CCI_SM_combined values plotted on a map.

[Download all graphs](#)

Pearson's r

2-ERA5_LAND_and_1-ES

[Download NetCDF](#)

Python toolbox for validation

The screenshot shows the GitHub repository page for 'pytesmo'. The left sidebar contains a navigation menu with the following items: README, Introduction, Examples, License, Authors, Changelog, and Module Reference. The main content area displays the repository name 'pytesmo - a Python Toolbox for the Evaluation of Soil Moisture Observations' with a link to 'Edit on GitHub'. Below the title is a row of badges: 'Automated Tests passing', 'coverage 88%', 'pypi package 0.11.2', and 'docs failing'. The main text describes 'pytesmo' as a Python toolbox for evaluating soil moisture observations. A section titled 'Documentation & Software Citation' includes a DOI badge for '10.5281/zenodo.596422' and provides instructions on how to cite the software in publications, including a link to the Zenodo DOI and a link to the developers guide.

pytesmo
latest

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Module Reference

» pytesmo - a Python Toolbox for the Evaluation of Soil Moisture Observations [Edit on GitHub](#)

pytesmo - a Python Toolbox for the Evaluation of Soil Moisture Observations

Automated Tests **passing** coverage **88%** pypi package **0.11.2** docs **failing**

pytesmo, the Python Toolbox for the Evaluation of Soil Moisture Observations, is a package/python toolbox which aims to provide a library that can be used for the comparison and validation of geospatial time series datasets with a (initial) focus on soil moisture.

Documentation & Software Citation

DOI [10.5281/zenodo.596422](https://doi.org/10.5281/zenodo.596422)

To see the latest [full documentation](#) click on the docs badge at the top.

If you use the software in a publication then please cite it using the Zenodo DOI. Be aware that this badge links to the latest package version.

Please select your specific version at <https://doi.org/10.5281/zenodo.596422> to get the DOI of that version. You should normally always use the DOI for the specific version of your record in citations. This is to ensure that other researchers can access the exact research artefact you used for reproducibility.

You can find additional information regarding DOI versioning at <http://help.zenodo.org/#versioning>

If you want to contribute, take a look at the [developers guide](#) .

Workshops

- 6th Satellite Soil Moisture Validation and Application Workshop, likely postponed to Spring 2022, Perugia, Italy (now planned to be in person and virtual). Details TBD.
- 7th Satellite Soil Moisture Validation and Application Workshop, Fall 2022, New Orleans, USA
- 2021 National Soil Moisture Workshop Virtual. August 18-19, 2021. US-focused workshop to discuss applications research and new concepts related to soil moisture monitoring. [National Coordinated Soil Moisture Monitoring Network](#).

Other

- National Coordinated Soil Moisture Monitoring Network (NCSMMN) Strategy document was formally approved by NOAA, will be available soon on drought.gov.