



International Soil Moisture Network (ISMN): Status and pathway towards FRM

IDEAS-QA4EO Cal/Val Workshop#4

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- 1 Short introduction
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- 4 ESA's Fiducial Reference Measurement for Soil Moisture (FRM4SM)

**ISMN: Short introduction - project
overview - last status (at TUW)**

The International Soil Moisture Network

ISMN = a global **in situ** (surface and subsurface) soil moisture database.

- Established in 2009
- International cooperation (ESA, GCOS, WCRP GEWEX, CEOS, etc.)
- Hosted by Technical University Vienna, Austria (TUW)
- Funded by ESA ever since : SMOS, Ideas+, QA4EO

Idea: Reliable and consistent insitu datasets \Rightarrow crucial for validation of satellite soil moisture products

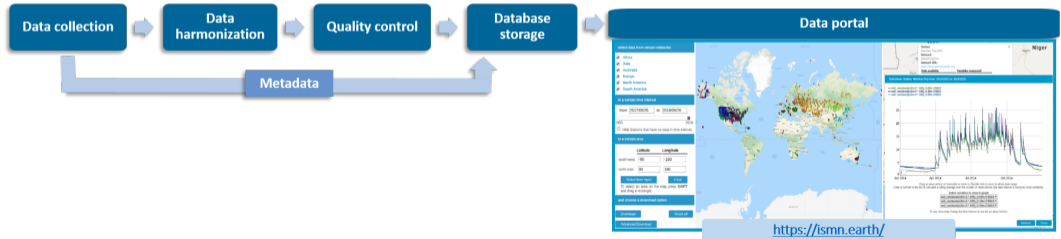


Figure 1: Diagram of workflow of the ISMN.

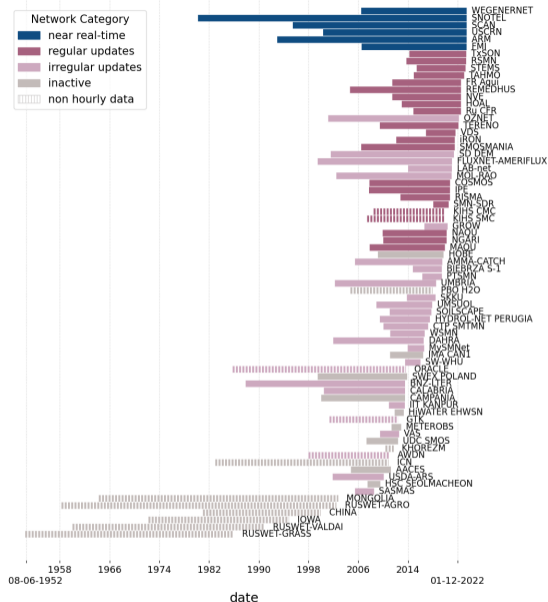
Last TUV status December 2022

⇒ QA4EO Phase 2 CCN 7 months (May - Dec 2022)

⇒ Last status at TUV:

- 74 Networks
- 2949 Stations
- 22000 timeseries
- > 3800 users
- 700 downloads (2022)
- 1750 peer-reviewed citation (since 2009)
>230 (since May 2022)

⇒ 12.12.2022 - Successful transfer to new host



Transfer of ISMN operations to new host

New funder and hosts:

- Funder: German Federal Ministry for Transport and Digital Infrastructure
 - * Stephan Dietrich (GTN-H [1]): Negotiations with German Ministry since 2017
- Hosts: BfG [3] connected to ICWRGC [2]

5 full time positions

- Matthias Zink: Management and coordination (ICWRGC [2])
- Tunde Olarinoye: PR and frontend (ICWRGC [2])
- Fay Böhmer: Data management (BfG [3]) [3]
- Kasjen Kramer: IT (BfG [3])
- Wolfgang Korres: Research and Science (BfG [3])

20 month transfer phase (May 2021 - December 2022)

Delays:

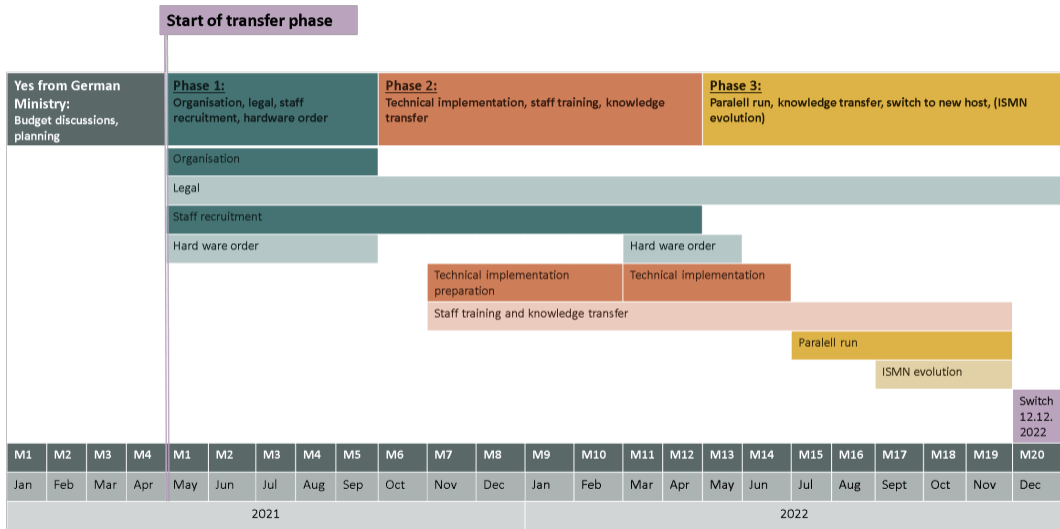
- Staff recruitment (last position May 2022 - IT)
- Corona

[1] GTN-H ... Global Terrestrial Network Hydrology

[2] ICWRGC ... International Center for Water Resources and Global Change - under auspicy of WMO and UNESCO

[3] BfG ... German Federal Office of Hydrology

Original plan for transfer (first row) PLUS realization due to delays (rows 2 - 10 below)



Legal matters:

- Transfer phase contract
- Take over contract
- Provider consent via prepared document (EU General Data Protection Regulation GDPR law)
 - * All 74 networks could be transferred
- User consent via login/ new registration (GDPR)
 - * Integrated for 11 months
 - * 1000 users transferred (3800 at TUW) - spring clean

Information exchange - transfer status:

- Provider
 - * 3 provider reports (1/2 yearly)
 - * 2 provider workshops
- User
 - * 3 newsletter (1/2 yearly)
 - * Webpage entries and information per e-mail

Contact and training of new team:

- 2 full training weeks (TUW and online - COVID)
- Webex chat (daily availability of TUW team)
- Up to 3 meetings a week (12 months)
- Direct access to TUW infrastructure
 - * Task taken over by new team gradually
 - * August 2022 - all tasks full filled by new team

Parallel run:

- Since August 2022
- ISMN at TUW infrastructure public
- ISMN at BfG infrastructure running but in developer mode
 - * Stress testing system
 - * Setting firewall restrictions
 - * Testing full functionality of ISMN operations step by step

⇒ 12.12.2022 - ISMN operations running on BfG infrastructure

**ESA'S Fiducial Reference
Measurements for Soil Moisture
project (FRM4SM) -
(May 2021 - May 2023)**

Fiducial Reference Measurements (FRMs) are:

- Fully characterized & traceable in situ measurements following community-agreed guidelines (GEOS/CEOS QA4EO framework)
 - * Easily & openly accessible (FAIR)
 - * Including Quality Indicators (QIs) to evaluate fitness for purpose
 - * Uncertainties traceable back to internationally agreed reference standards (SI if possible)

ESA's FRM activities typically comprise activities for:

- Establishing ground-based FRM networks for a particular variable
- Specifying the protocols and procedures to establish and use such FRM data
- Validating relevant satellite products against established FRM data within case studies

The goals of the FRM4SM project are:

- The evolution of ISMN and the development of new Quality Indicators (QIs)
- The evolution of the Quality Assurance for Soil Moisture (QA4SM) online validation platform
- The development of "FRM Protocols and Procedures" for soil moisture
- The execution of SMOS validation case studies

[Partner 1] Applied Science Software and Technology (AWST)

[Partner 2] Centre d'Etudes Spatiales de la Biosphère (CESBIO)

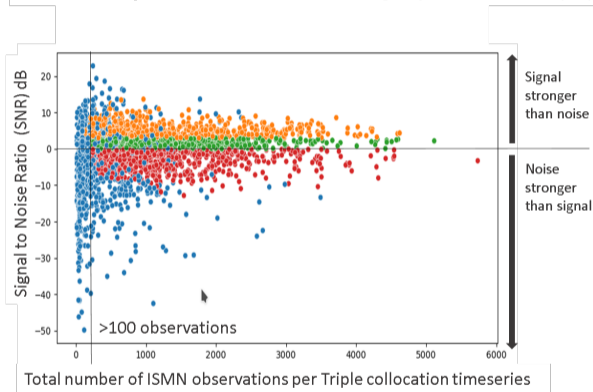
[Partner 3] TUV

FRM4SM structure (May 2021 - May 2023)



FRM Qualification for ISMN sensors in top layer:

→ ISMN Representativeness QI using Triple Collocation (TC) = error estimates for time series



Methodology:

1. TC (CCI passive, ERA5 land and ISMN)

$Tc = \text{in situ error} + \text{representativeness error}$

2. Signal to Noise Ratio (SNR)

$$\text{SNR(dB)} = 10 \log_{10} \frac{P_s}{P_N} \cdot \begin{matrix} P_s \dots \text{Signal} \\ P_N \dots \text{Error} \end{matrix}$$

3. Bootstrapping → Confidence Interval 80%
4. Classification of Representativeness classes for ISMN time series

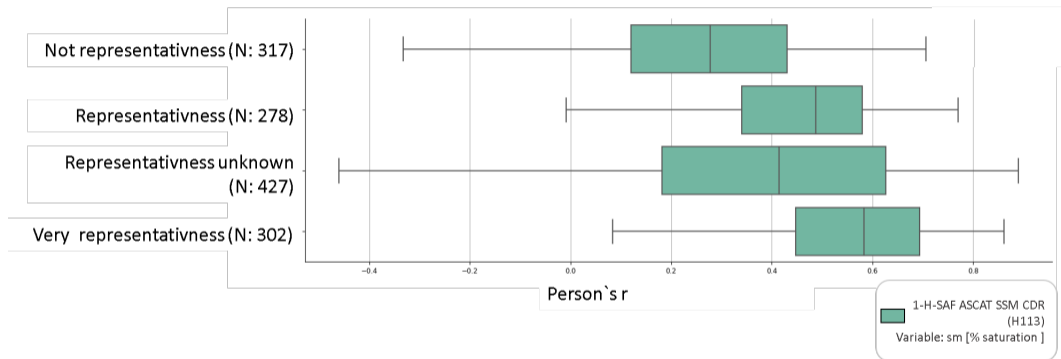
Estimated SNR*	QI class
NaN	representativeness unknown
< 0 dB	not representative
0 - 3 dB	representative
> 3 dB	very representative

Set SNR to NaN if:
 # samples < 100
 CI(80%) > 3dB

[1] Scipal et al., 2010, <https://doi.org/10.1109/IGARSS.2010.5652128>

[2] Gruber et al., 2016, <https://doi.org/10.1016/j.jag.2015.09.002>

HSAF ASCAT SSM (USA)



ISMN Downloads

Dataset 20.07.2022 (01.01.2018-01.01.2021)

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Metadata

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1	Identifier	10.5281/zenodo.6778672	<input type="checkbox"/>
2	Creator	Tobias Hajszan	
2.1	nameType	Personal	
2.2	givenName	Tobias	
2.3	familyName	Hajszan	
2.4	nameIdentifier	0000-0002-7143-0353	
2.4	schemeURI	https://orcid.org	<input type="checkbox"/>
2.5	affiliation	Technische Universität Wien	

⇒ In - house versioning [1] and DOI system for ISMN downloads:

- ISMN on copyright licence “no onward” distribution
- Solution: in-house versioning & DOI system
 - * Students [2]: Moritz Staudinger & Tobias Hajszan
 - * Findable, Accessible, Interoperable and Reproducible (FAIR)
 - * Research Data Alliance (RDA)
 - * Recommendations of Working Group on Data Citation (WGDC) [3]
 - * ISMN DOI creation/ retrieval / re-execution [4]

[1] Rauber et al. 2021, <https://doi.org/10.1162/99608f92.be565013>

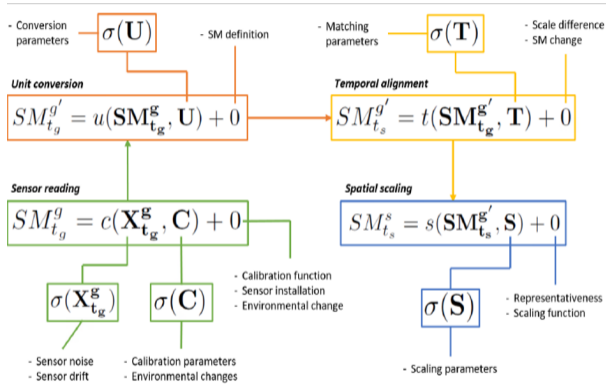
[2] Information and Software Engineering Group of the Department for Informatics at TUW, Austria

[3] WGDC recommendations <https://doi.org/10.15497/RDA00016>

[4] Datacite metadata schema v4.4, <https://doi.org/10.14454/3w3z-sa82>

Traceability of in situ soil moisture measurement - uncertainty budget calculation

Traceability diagram



Effects table

Effect	Type	Correlated	Magnitude	Confidence
Sensor noise	R	N		
Sensor drift	S	N		
Calibration parameters	S	P		
Calibration function	S	P		
Sensor installation	S	P		
Environmental factors	R+S	P		
Conversion parameters	S	P		
SM definition	S	P		
Matching parameters	S	P		
Scale difference	R+S	P		
SM decorrelation	R+S	P		
Scaling parameters	R+S	P		
Spatial representativeness	R+S	P		
Scaling function	R+S	P		

Figure 2: Traceability Diagram: 0=no uncertainty attached (assumption); **Effects table:** R=Random, S=Systematic; Correlated: Y=Yes, N=No, P=Potentially; 1=Estimates only; 2: Some analysis performed to evaluate; 3: Rigorous analysis performed. Magnitudes are given in $\text{m}^3 \text{m}^{-3}$.



Thank you for your attention!

ISMN: <https://ismn.earth>

QA4SM: <https://qa4sm.eu>

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