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Influence of *in-situ* probes characteristics on SMOS validation results

François Gibon[1*], Arnaud Mialon[1], Philippe Richaume[1], Yann H. Kerr[1], Nemesio Rodriguez-Fernandez[1], Ali Mahmoodi[1], Wouter A. Dorigo[2], Alexander Gruber[2], Alexander Boresch[3], Irene Himmelbauer[2], Daniel Aberer[2], Raffaele Crapolicchio[4], Roberto Sabia[4]

[1] CESBIO, Université de Toulouse, CNES/CNRS/INRAe/IRD/UPS, Toulouse, France
[2] Technische Universität Wien, Department of Geodesy and Geoinformation, Vienna, Austria
[3] Applied Science, Software and Technologie (AWST) gmbh, Vienna, Austria
[4] ESRIN - ESA Center for Earth Observation, Frascaty, Italy
* francois.gibon@univ-tlse3.fr

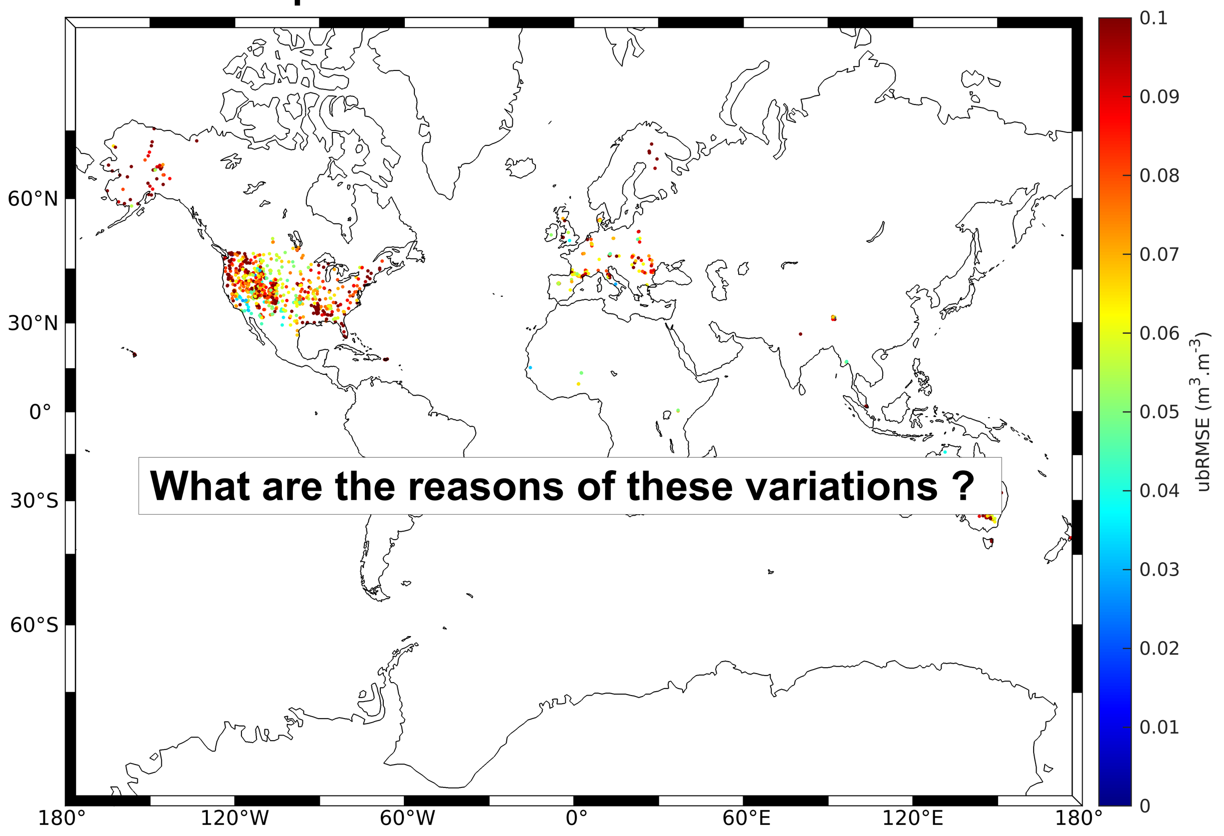
1. Context

Fiducial Reference Measurement for Soil Moisture (**FRM4SM**) is an **ESA** project focusing on the validation strategy of satellite based soil moisture. In this context, a partnership between the reference network **ISMN** (**TUWIEN**), the validation platform **QA4SM** (**AWST**) and the **SMOS** team (**CESBIO**) is conducted to investigate : the different validation strategies (spatial sampling, temporal aliasing), evaluate the SMOS performance regarding different validation conditions, quantify errors due to the spatiotemporal difference SMOS vs. *in-situ*...

2. Objectives

- Better understand and represent the SMOS SM uncertainties
- Quantify on SMOS performances of :
  - the probes set-up;
  - the SMOS footprint content;
  - the geophysical process scale difference.

Comparaison of SMOS vs. ISMN

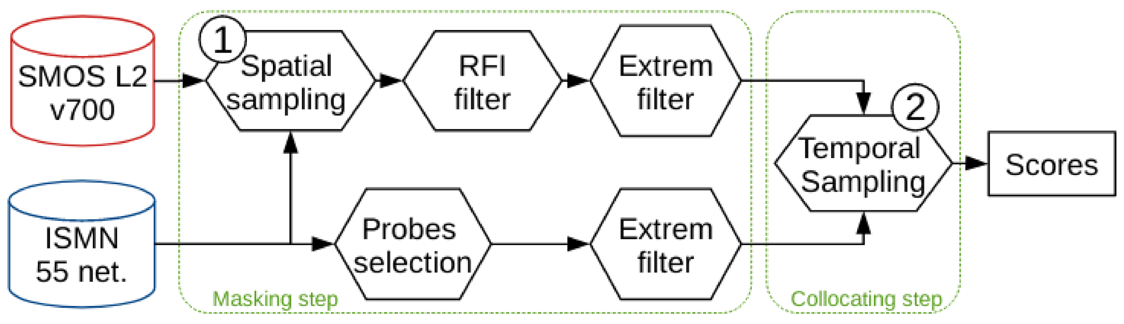


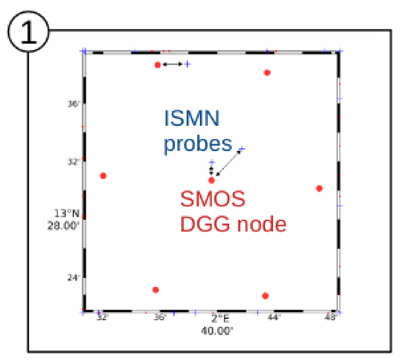
3. Data & methods

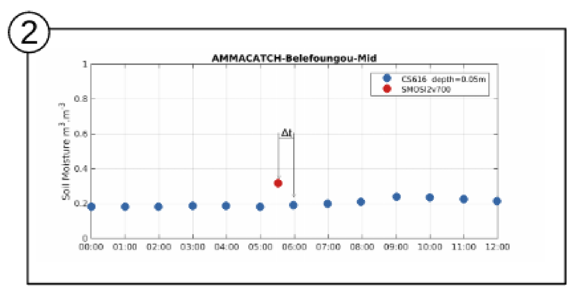
- One aim of this project is to evaluate the SMOS Level 2 v700 soil moisture product with the ISMN network used as ground reference (see table →)

Data	Spatial resolution	Temporal resolution	Potential validation issues
SMOS L2V700	Ø43km in average	2/3days	Sensitive to the footprint content, RFI
ISMN	cm² to m² depending on the technology, location	~min	Quality of the calibration, Installation, technology representativeness

- To quantify the agreement between SMOS and the ISMN network a validation process is proceeded as follows :







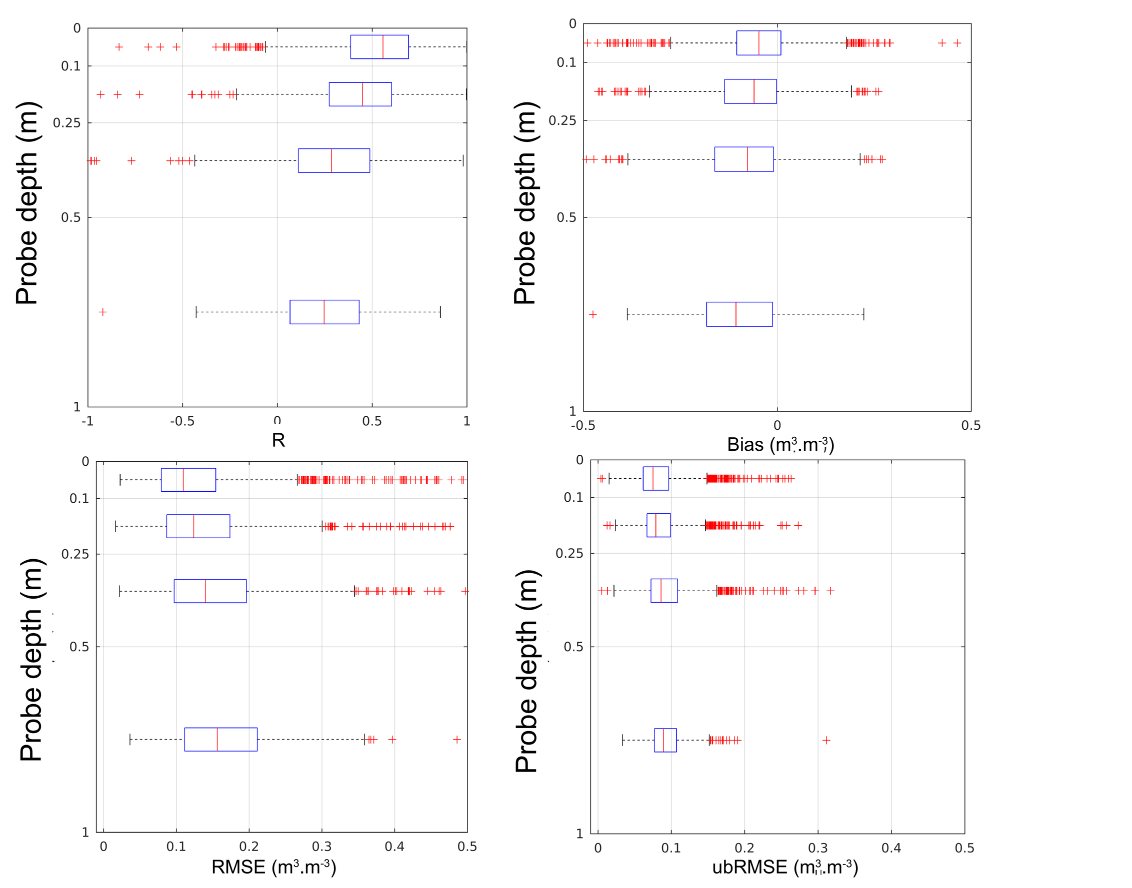
With ① the spatial collocation between the *in-situ* probes and the SMOS node defined as the nearest neighbor, and ② a limit of $\Delta t \leq 30$min for the time collocation of the two data.

- The statistical scores (R, RMSE, bias, ubRMSE) are analysed according to :
  - **a)** Probes depth influence ;
  - **b)** SMOS footprint content influence;
  - **c)** Relations were defined between the surface conditions and the validation scores in order to map range of expected uncertainties

4. Results & discussions

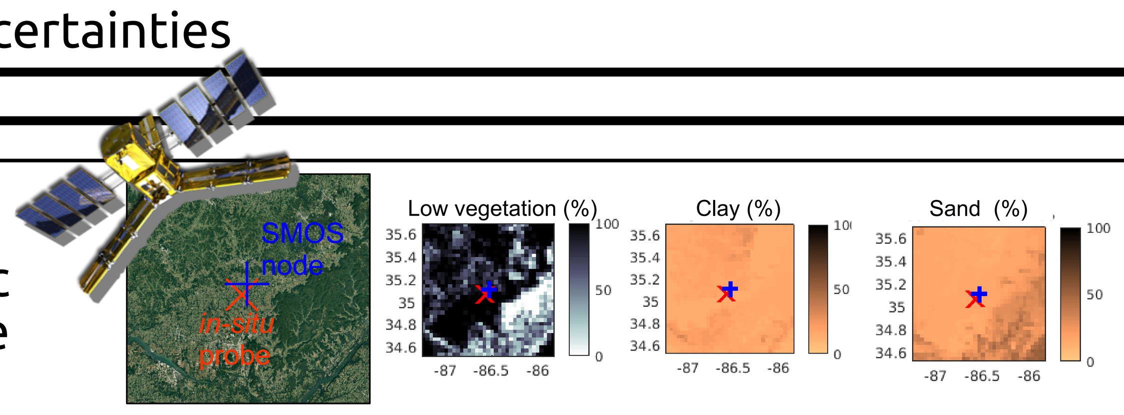
a) Probes depth influence

- The analyses of the scores as a function of the probes depth show a better agreement when the probes are within the first 10 centimeters of the soils, in respect to L-band soil penetration.

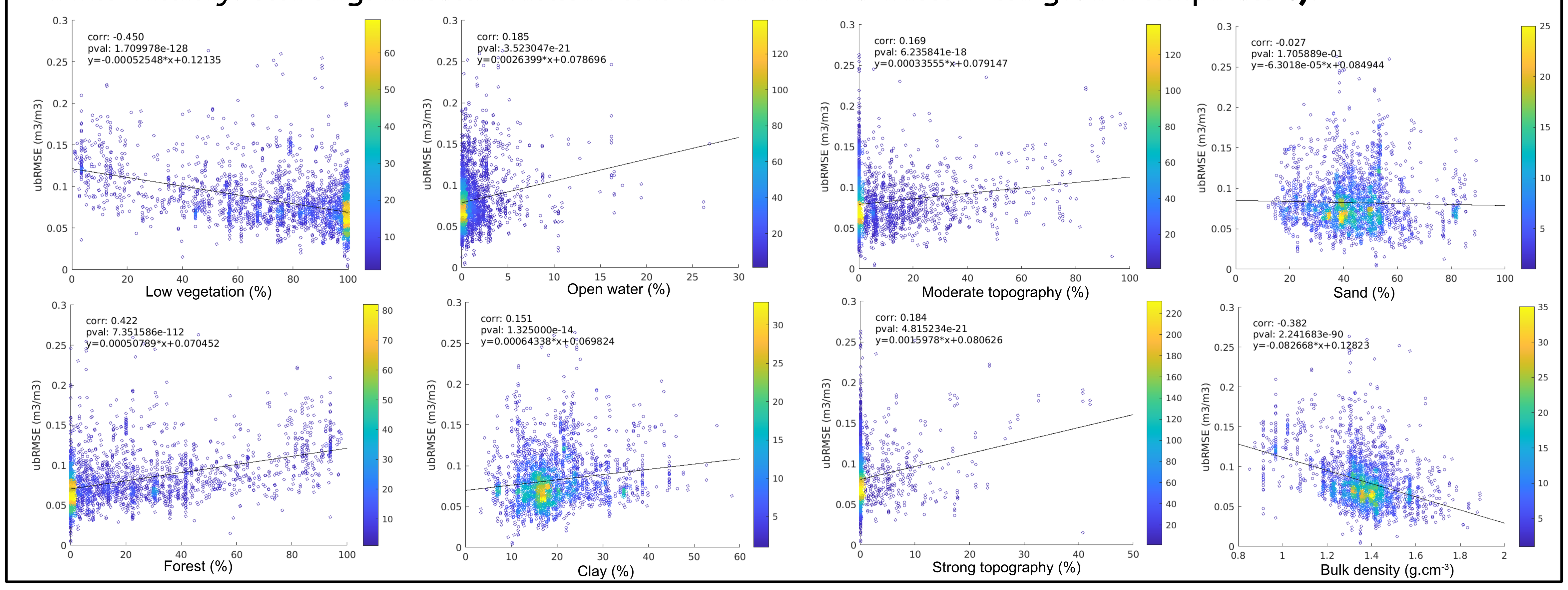


b) SMOS footprint content influence

- Each validation scores are related to a specific surface conditions, described using the auxiliary database of the SMOS L2 processor →



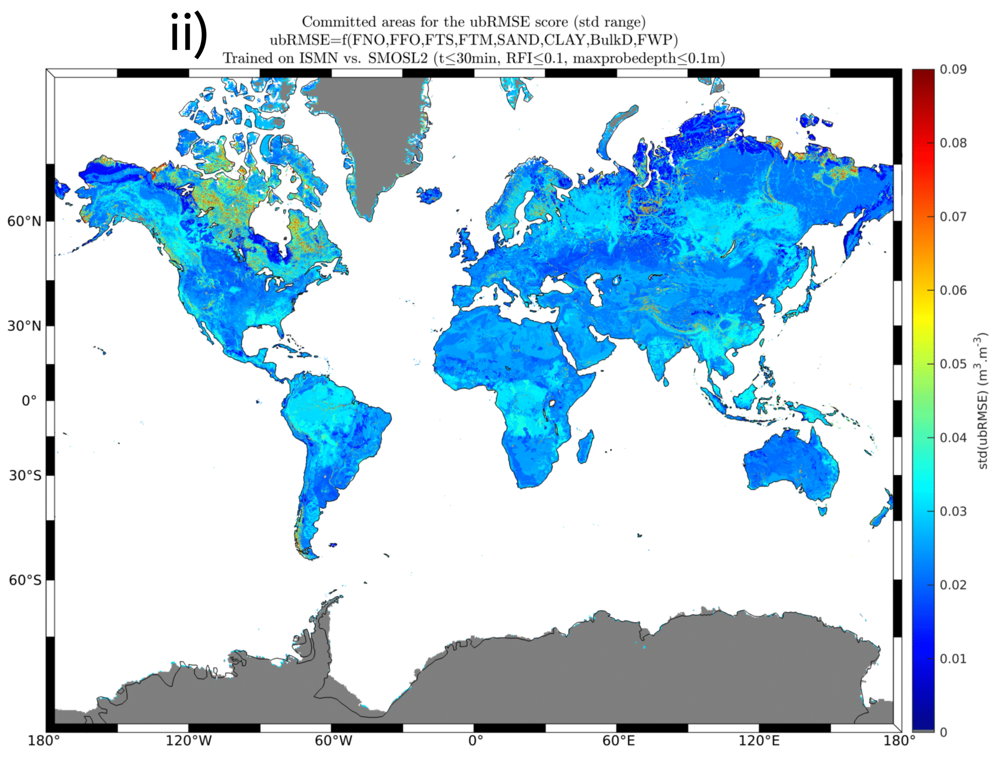
- The analyses ↓ show scores performances improvement when the footprint contains a minimum of vegetation, topography, and water, and when the soil has more sand than clay and with a high bulk density. The regressions defined here are used to derive the global maps on **c)**.



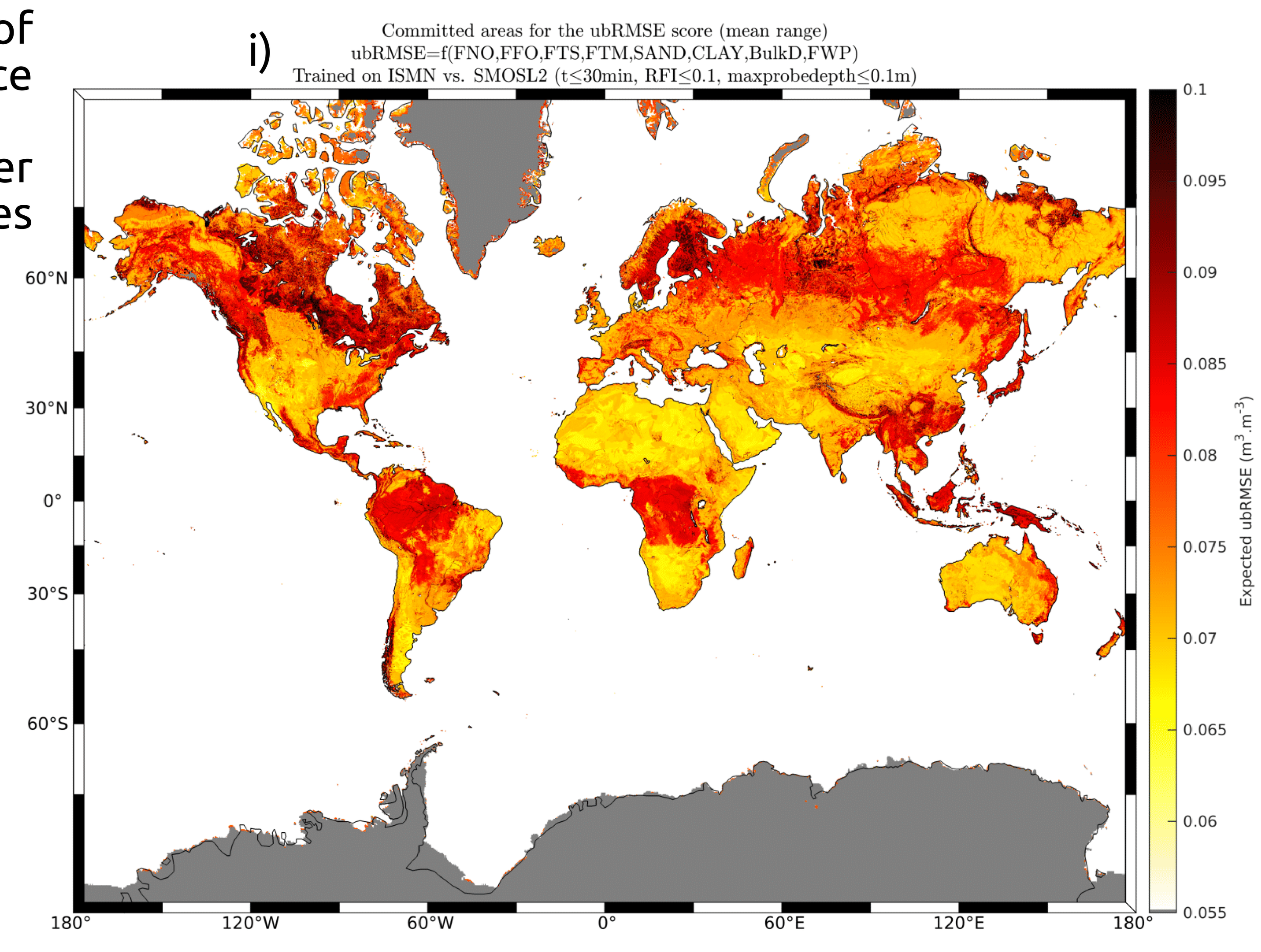
c) Maps of expected uncertainties

- The relations in **b)** are used to derive a map of expected ubRMSE as a function of the surface conditions (mean ubRMSE in I) and std in ii)).
- On map i) yellow areas are expected with better SMOS uncertainties (ubRMSE) than the red ones (and with more confidence, as shown map ii)).

ii)



i)



5. Take home message

- SMOS performance assessment is sensitive to the *in-situ* probe set-up and surface conditions in the footprint.
- SMOS and all microwaves SM missions pretend to reach 4-5% uncertainties. The surface conditions to reach this performance are limited to: low vegetation, no topography, no water, high bulk density and sandy soil.
- This is the first study to evaluate the uncertainties of SMOS SM at global scale.

6. Reference

- Gibon et al. 2022, Validation conditions influence the evaluation of satellite-based soil moisture: the SMOS and ISMN case study, in prep.