Sea Surface Salinity variability and error maps of satellite observations in the Inter Tropical Convergence Zone

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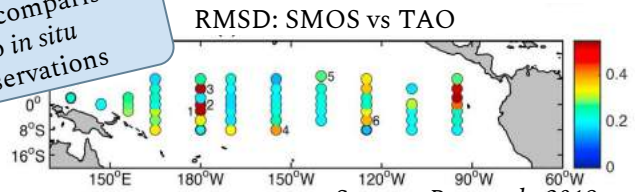
Barcelona Expert Center

Motivations - Satellite data validation

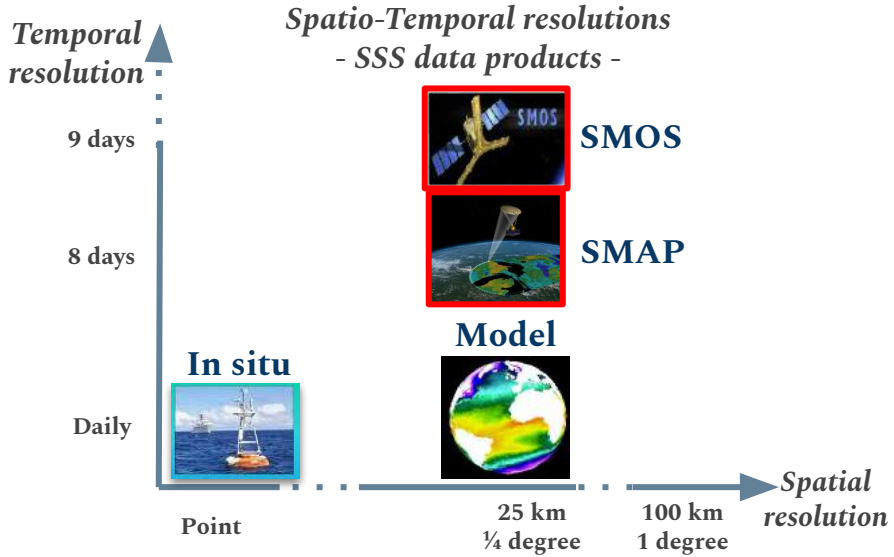
The concept of **data validation** refers to the **post-processing methodologies** that **measure** how well the **retrieved information** represents the **geophysical signal** at a **given spatial** and **temporal scale**.

Direct comparison to in situ observations



Source: *Bao et al., 2019*

- **Relative error**
- **Different spatio- temporal representation**



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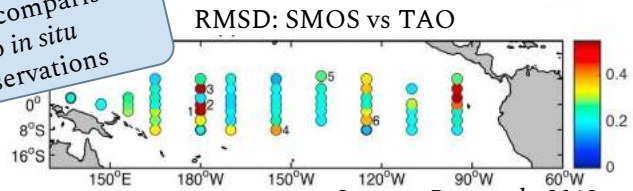

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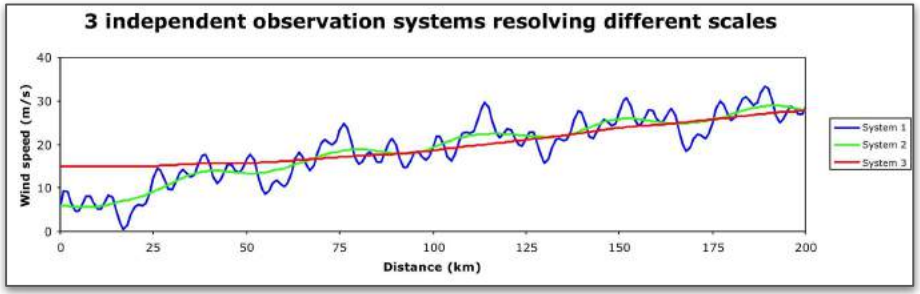
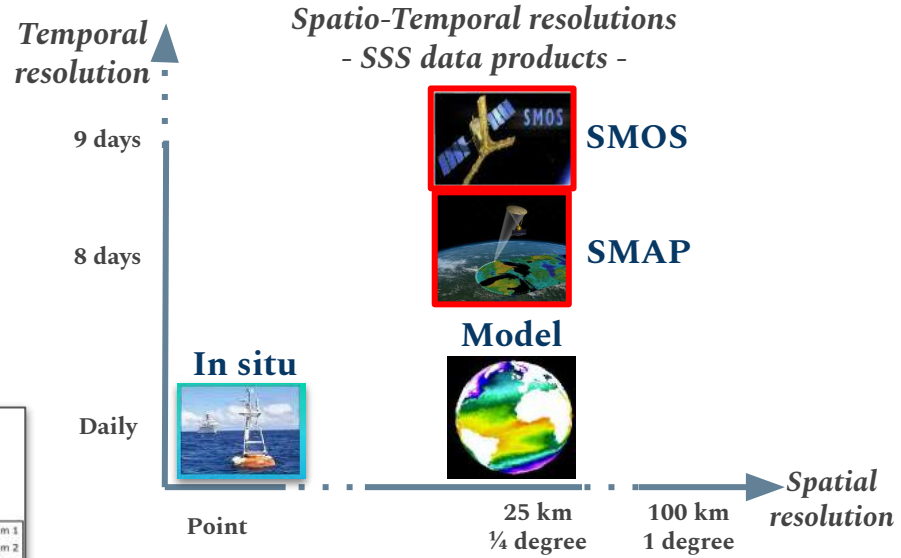
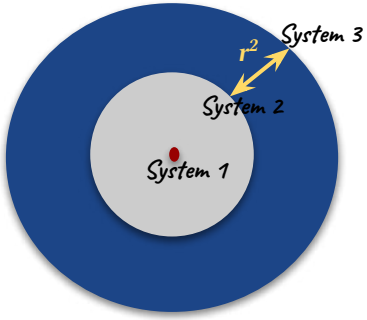




Important to account for spatio-temporal representation

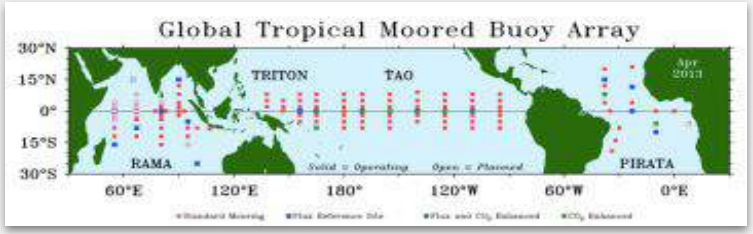
Objectives

- In ***Hoareau et al., 2018***, **error characterization** of different SSS data sources **at satellite scales** was performed over **all Tropical buoys** using **Triple collocation** (*Stoffelen, 1998*), taking **into account the different spatio-temporal resolution**



Representativeness error (r^2) corresponds to the **common true variance** of Systems 1 and 2, not resolved by system 3

e_i, a_3 *depend on* r^2

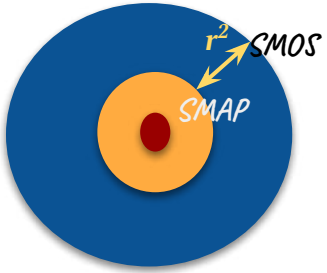


Estimated SD ***error*** *of the different salinity measurements at the* ***satellite scales***

	In Situ	*GLORYS*	*AV4*	*SMOS*
Aquarius scale	0.18	0.18	0.17	0.24
SMOS scale	0.22	0.21	0.21	0.20

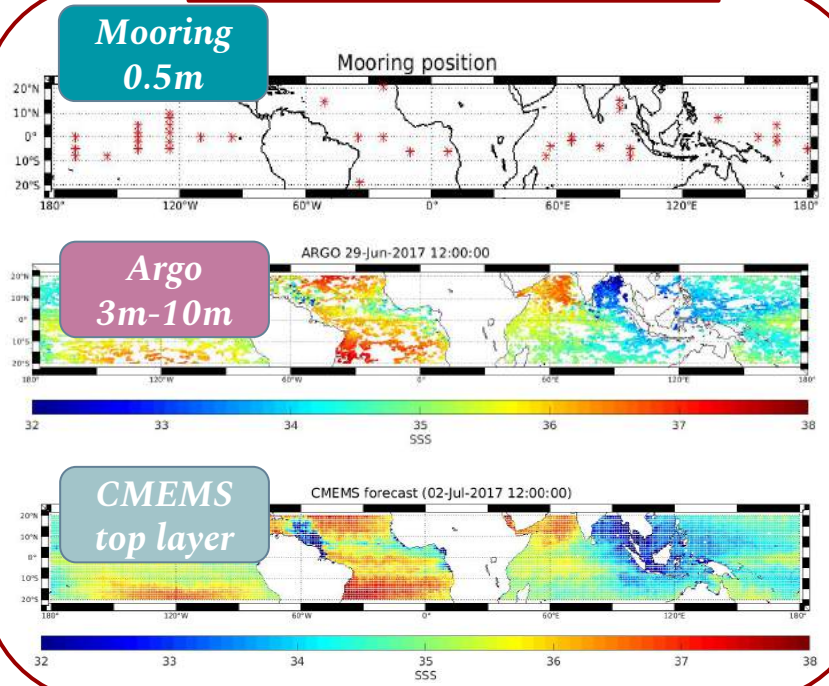
The aim of this study is to **use model gridded data** instead of in situ observations to **create error maps**

TC Triplets: *year 2017* - Inter Tropical Band

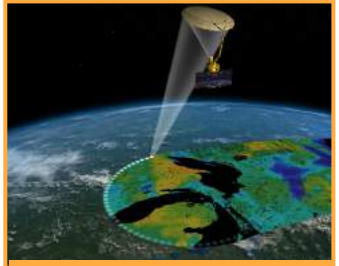


Satellite SSS
1st cm

System 1

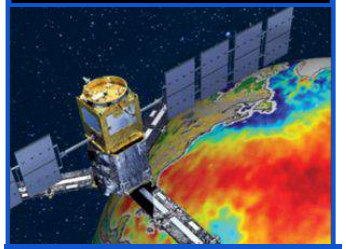


SMAP L3 RSS v4
(8 days running)



System 2

SMOS L3 BEC v2
(9 days)



System 3

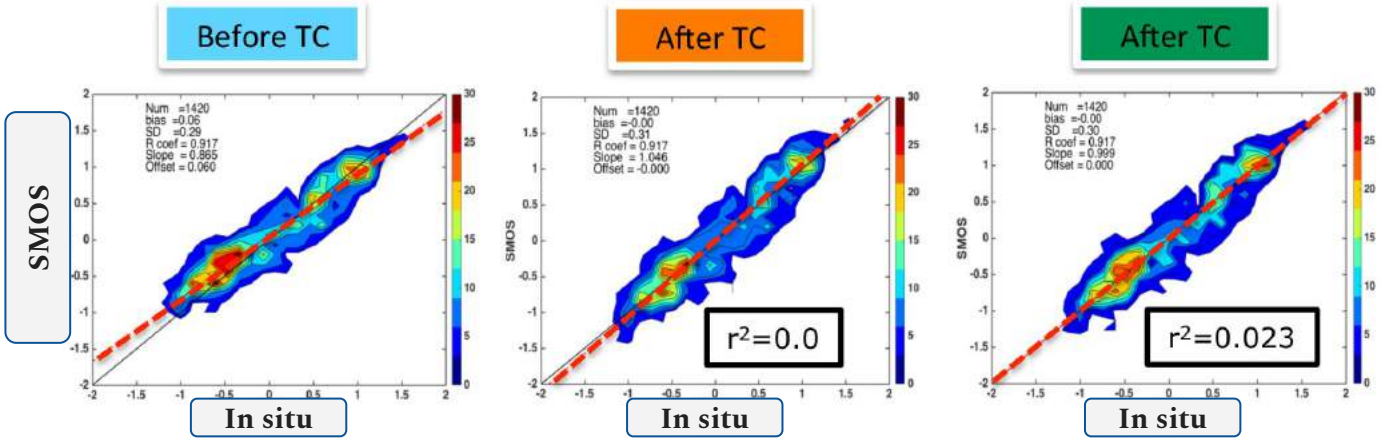
Triplets from different sources imply **different sampling** (horz. & vert.)

r^2 estimation method (Lin *et al.*, 2015)

A **successful TC** provides three data sets well **intercalibrated** *(Lin et al., 2015)*
➔ TC **calibration coefficient** a_3, b_3, are related to the value of r^2

An effective way of estimating r^2 is to repeat the TC analysis for different r^2 values until an **optimal intercalibration** of the different data sources is reached.

Check the data scatterplots after each intercalibration



Wrong r^2 ⇨ Not well inter-calibrated

Correct r^2 ⇨ Well inter-calibrated

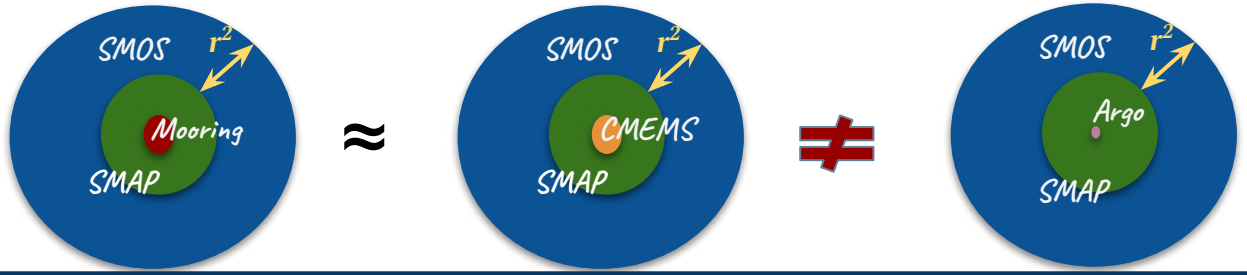
r^2 estimation for the different triplets of SSS data

Acronyms:
M - Mooring
A - ARGO
C - CMEMS
Cm - CMEMS at mooring positions
Ca - CMEMS at argo positions
Sp - SMAP RSS v4
Ss - SMOS BEC v2

r^2 should not depend on the highest resolution system (*In Situ* or CMEMS)

Representativeness Error (r^2) for the different triplets of SSS data

	MSpSs	***CmSpSs***	***CSpSs***	***CaSpSs***	***ASpSs***
r^2	0.015	0.015	0.014	0.018	0.025



***Argo** measures a **much more different** salinity than that of **Satellite** (3m-10m vs 1cm depth)*
*=> **Mooring** salinity **more representative** to **satellite measurement** than Argo floats*

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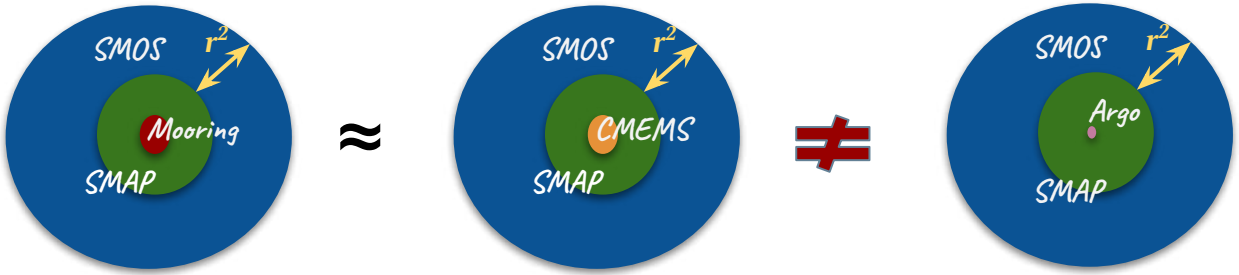

As r^2 is positive, the **effective spatial-temporal resolution of SMAP RSS v4 data is finer than SMOS BEC v2 data.**

r^2 estimation - Depending on the region/season

Acronyms:
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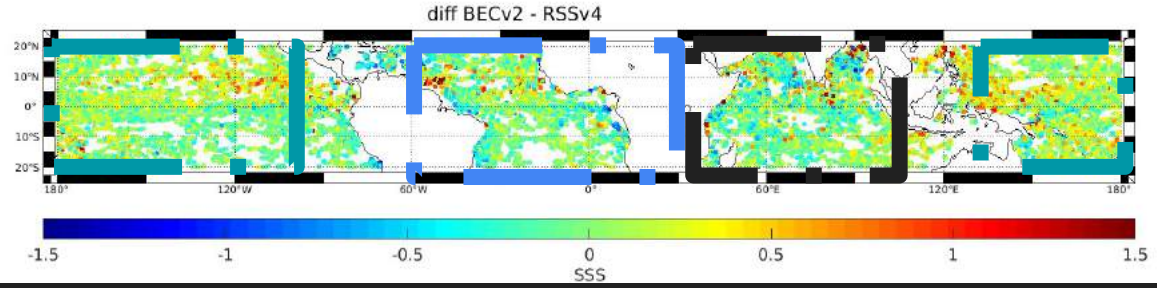
Spatio-temporal SSS variability differs depending on the region and/or the season

r^2 represents the SSS variability at scales resolved by SMAP but not SMOS



Representativeness Error (r^2) for the different triplets of SSS data.

r^2 similar !
=> CMEMS can be used in TC

Monsoon:
Indian ocean
+
Jun-Sep

	InterTrop band	*Pacific*	*Atlantic*	*Indian*	*May-Oct*	*Nov-Apr*	*Monsoon*
MSpSs	0.015	0.009	0.020	0.022	0.014	0.014	0.018
CmSpSs	0.015	0.009	0.020	0.021	0.014	0.016	0.022
CSpSs	0.014	0.009	0.008	0.028	0.011	0.016	0.025

To Summarize

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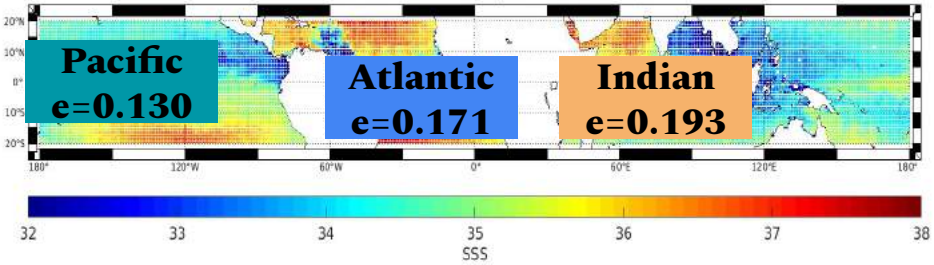
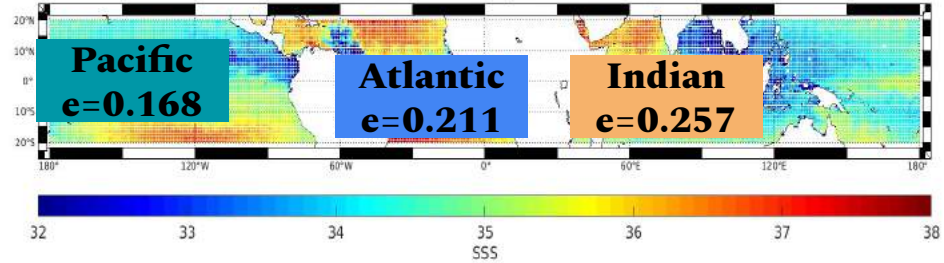
SMAP RSS v4 error



SMOS BEC v2 error



- SMOS and SMAP errors are larger in the Indian than Atlantic or Pacific intra-tropical band.
- In general SMOS BEC v2 error is larger than SMAP RSS v4.
- The **effective resolution of RSS v4 data is finer than BEC v2**
- **Error** estimation **depends** on the SSS variability of the **region** & the **season**
- **CMEMS** can be used **to create error maps**
- Error maps should **help in data assimilation**

On going work:

➔ Extend this methodology to produce gridded error maps

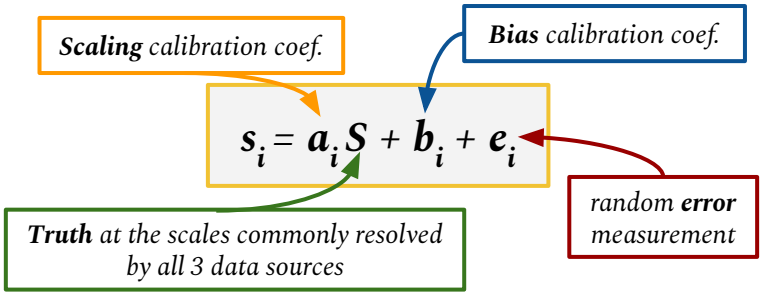
➔ Include **gridded error maps** in the satellite SSS products at BEC

MORE MATERIAL

Triple Collocation - Representativeness error, r^2

Triple Collocation (*Stoffelen, 1998*)

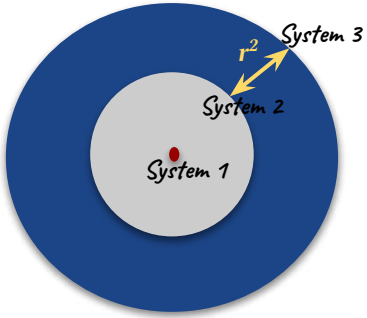
Triple collocation (TC) was conceived as a tool for the simultaneous **intercalibration** of **three independent collocated** data sources, while providing an **estimate** of their **accuracy** with respect to **the truth at a given scale.** The 3 measurement systems have **different spatial resolution** (buoy, model, satellite), s_i, i=1,2,3



Representativeness error (*Stoffelen, 1998*)

$r^2 = \langle e_1 e_2 \rangle$

a_3, e_i depend on r^2



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$\langle e_1 e_3 \rangle = \langle e_2 e_3 \rangle = 0$

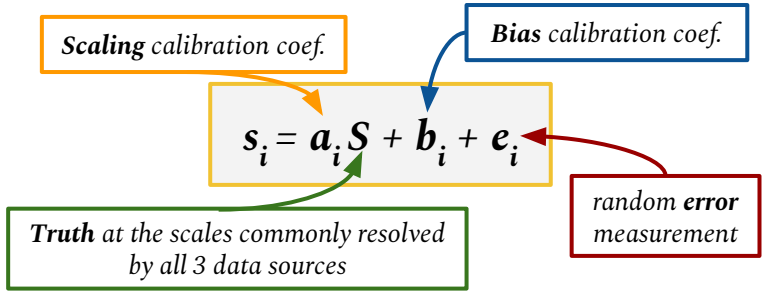
TC **calibration coefficient** a_3, b_3, are related to the value of r^2

➔ A **successful TC** provides three data sets well **intercalibrated**
(Lin et al., 2015)

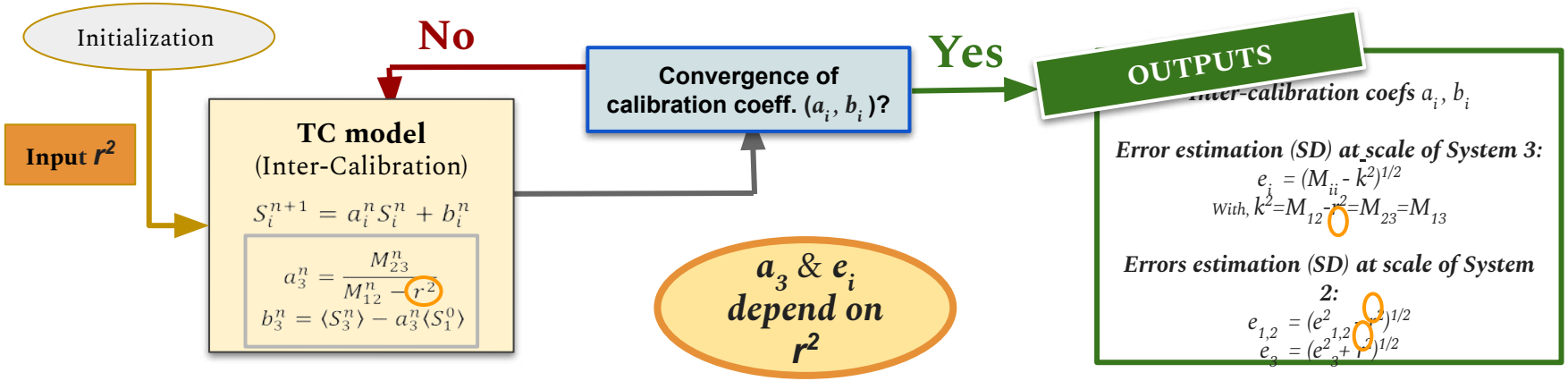
TC algorithm - Representativeness error, r^2 (Stoffelen, 1998)

Given **3 measurement systems** with **different spatial resolution** (buoy, model, satellite), $\mathbf{s_i}$, i=1,2,3

The **measurement**, including its **individual error**, is modelled by the following linear equation



The system of equations is **solved** in an **iterative way**



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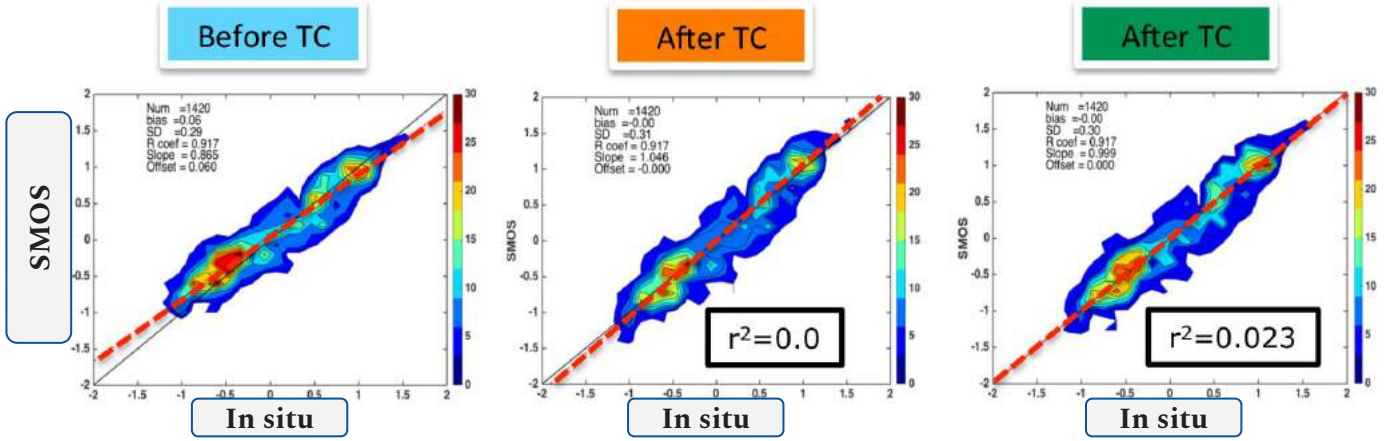

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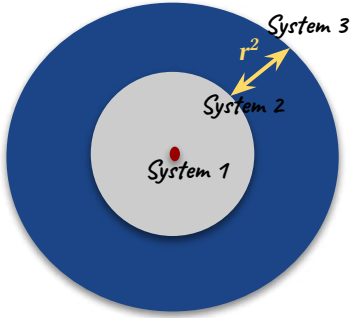

$r^2 = \langle e_1 e_2 \rangle$

part of the measurement errors e_1 and e_2

is the **correlated part** of the errors of s_1 and s_2

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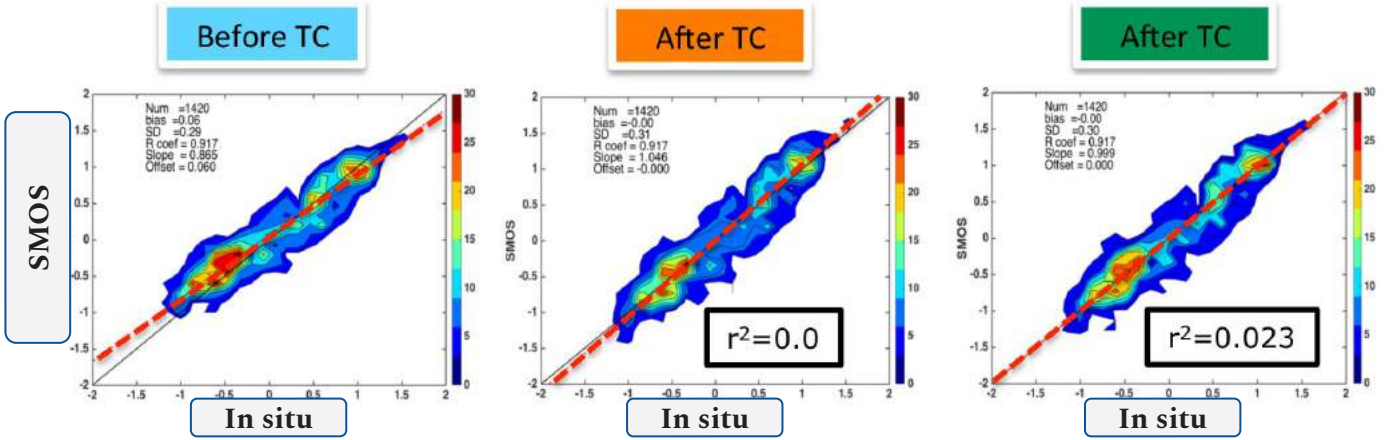

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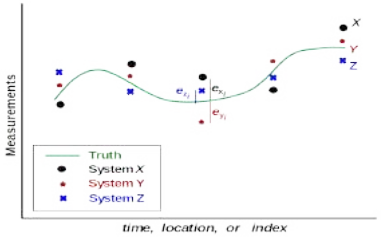
r^2 estimation method

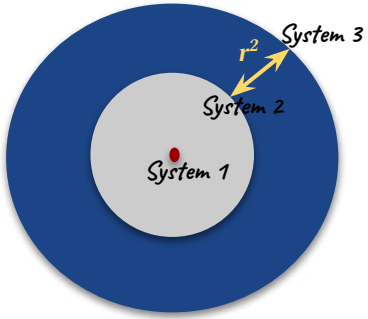
Triple Collocation (*Stoffelen, 1998*)

Representativeness error, r^2

Truth *at the scales commonly resolved by all 3 data sources*



★ Estimate the **absolute error** taking into account the **different spatio-temporal representations**



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