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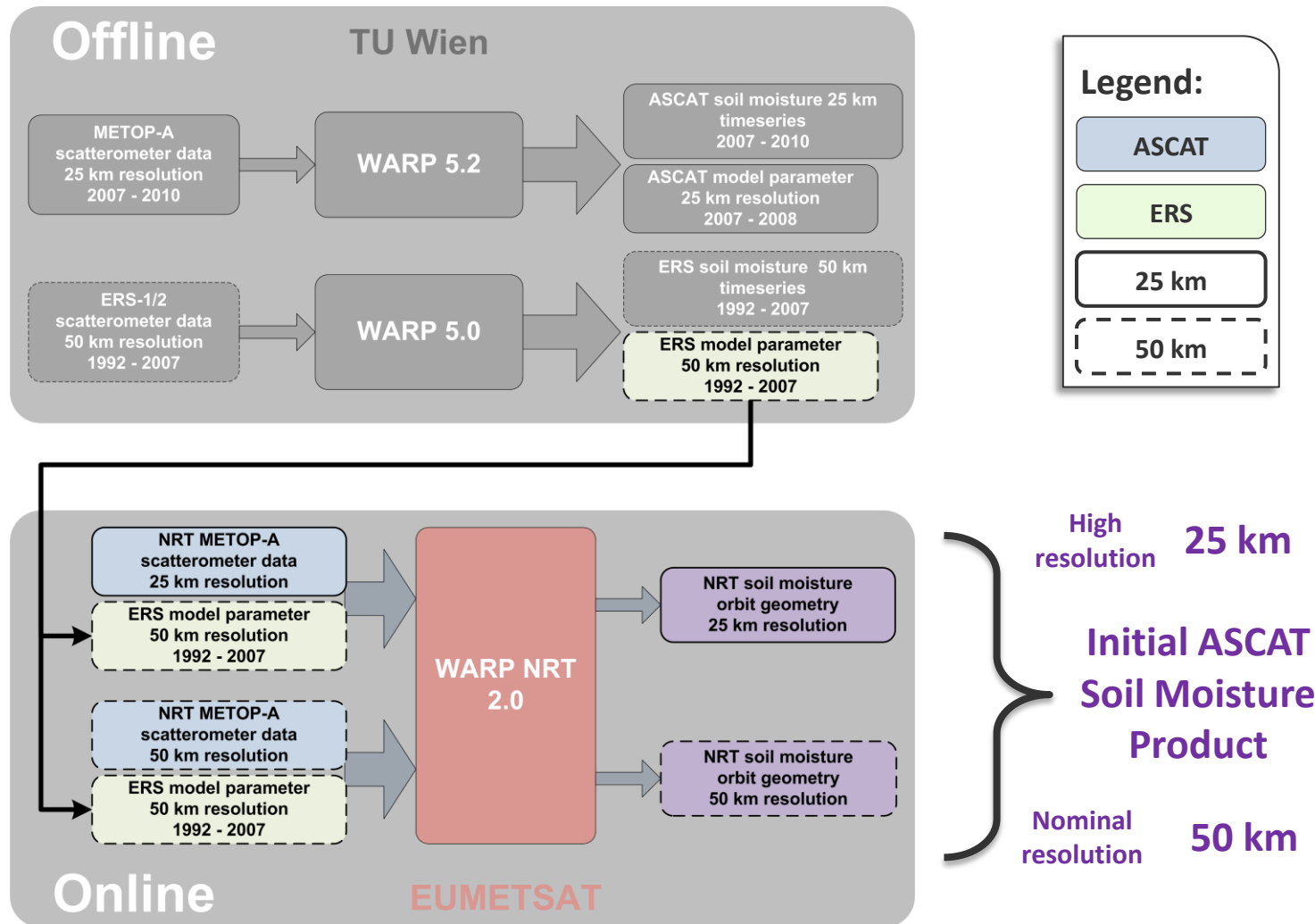
Characterisation of Calibration-Related Errors of the Initial METOP ASCAT Soil Moisture Product

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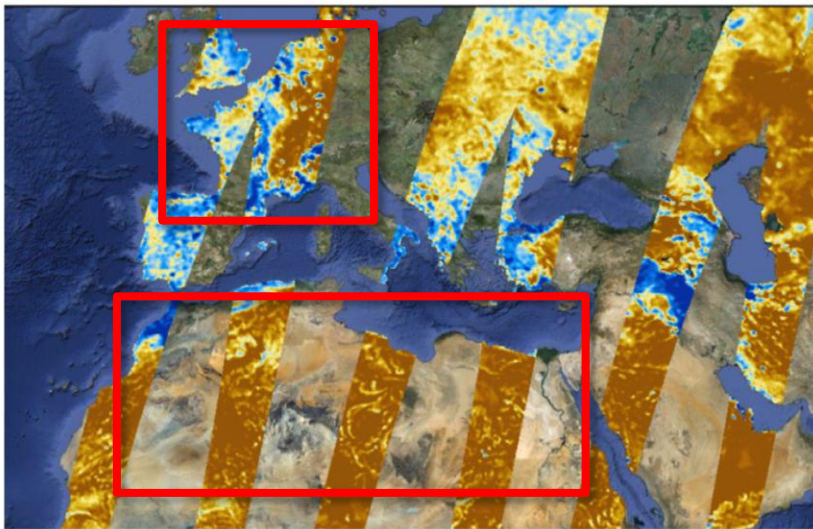
The initial ASCAT Soil Moisture Product



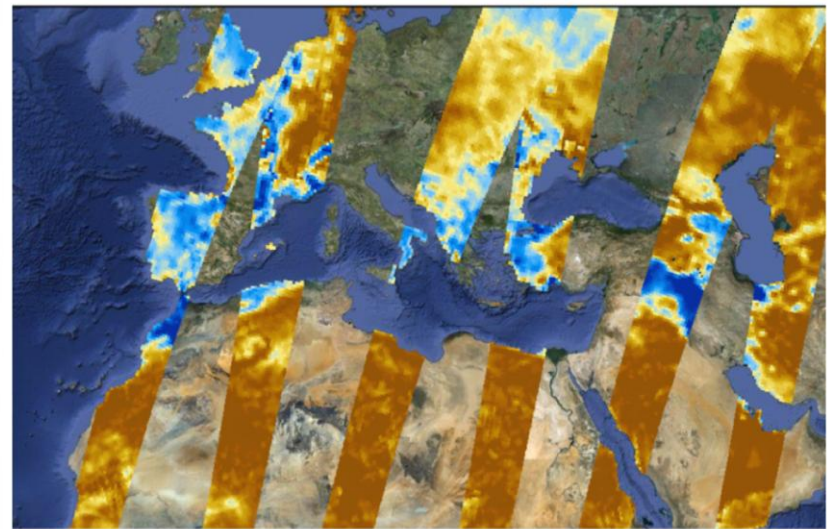
The initial ASCAT Soil Moisture Product II

- Soil moisture conditions over Europe and North Africa from 2011/01/30 (descending passes only) overlaid on Google satellite imagery

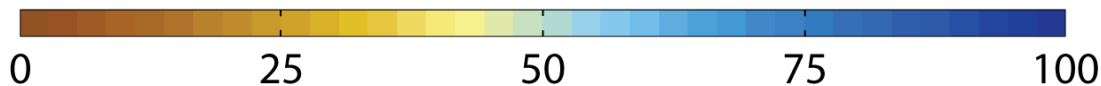
ASCAT soil moisture product 25 km



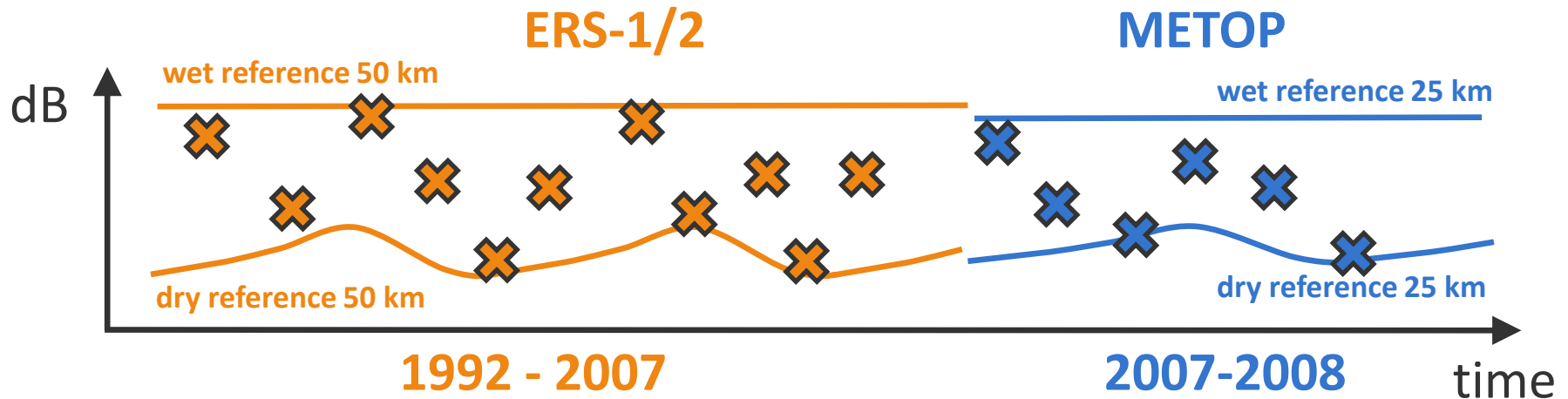
ASCAT soil moisture product 50 km



Relative surface soil moisture (%)

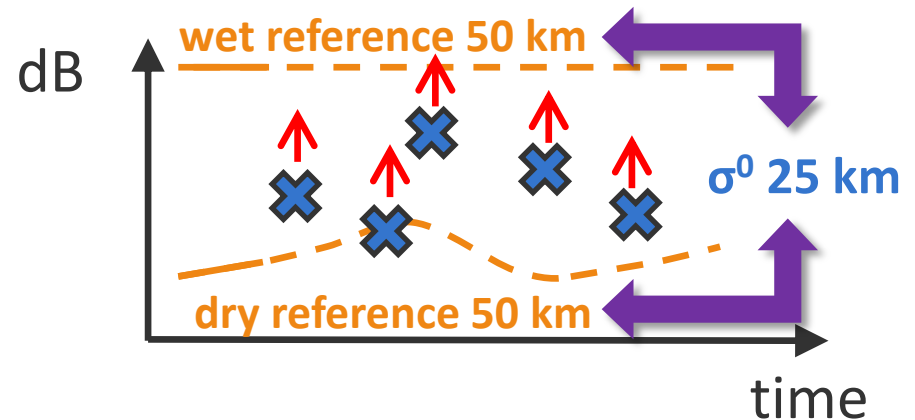


Reason of the Artefacts?



Scaling equation:

$$m_s(t) = \frac{\sigma^0(t, 40^\circ) - \sigma_{\text{dry}}^0(t, 40^\circ)}{\sigma_{\text{wet}}^0(t, 40^\circ) - \sigma_{\text{dry}}^0(t, 40^\circ)}$$



- 1) **Resolution difference** between measurements and model parameters
- 2) **Absolute calibration difference** in raw measurements σ^0



Error model

Current NRT situation

$$m_s(25,50) = \frac{\sigma^0(25) - \sigma_{\text{dry}}^0(50)}{\sigma_{\text{wet}}^0(50) - \sigma_{\text{dry}}^0(50)}$$

ERS – 1/2 model parameter

Optimal solution

$$m_s(25,25) = \frac{\sigma^0(25) - \sigma_{\text{dry}}^0(25)}{\sigma_{\text{wet}}^0(25) - \sigma_{\text{dry}}^0(25)}$$

ASCAT model parameter

Percentage of
incorrect soil
moisture
estimation

Resolution of
measurement (km)

Resolution of model
parameter (km)

$$\Delta m_s = m_s(25,50) - m_s(25,25)$$

$$\Delta m_s = m_s(25,25) \cdot \left(\frac{\sigma_{\text{wet}}^0(25) - \sigma_{\text{dry}}^0(25)}{\sigma_{\text{wet}}^0(50) - \sigma_{\text{dry}}^0(50)} - 1 \right) + \frac{\sigma_{\text{dry}}^0(25) - \sigma_{\text{dry}}^0(50)}{\sigma_{\text{wet}}^0(50) - \sigma_{\text{dry}}^0(50)}$$

Simulating different soil moisture conditions

Error model – split up

Simulating calibration and resolution impact:

$$\Delta m_{s \text{ CAL+RES}} = m_s(25,25) \cdot \left(\frac{\sigma_{\text{wet}}^0(25) - \sigma_{\text{dry}}^0(25)}{\sigma_{\text{wet}}^0(50) - \sigma_{\text{dry}}^0(50)} - 1 \right) + \frac{\sigma_{\text{dry}}^0(25) - \sigma_{\text{dry}}^0(50)}{\sigma_{\text{wet}}^0(50) - \sigma_{\text{dry}}^0(50)}$$

Simulating only resolution impact:

$$\Delta m_{s \text{ RES}} = m_s(25,25) \cdot \left(\frac{\sigma_{\text{wet}}^0(25) - \sigma_{\text{dry}}^0(25)}{\sigma_{\text{wet}}^0(50) - \sigma_{\text{dry}}^0(50)} - 1 \right) + \frac{\sigma_{\text{dry}}^0(25) - \sigma_{\text{dry}}^0(50)}{\sigma_{\text{wet}}^0(50) - \sigma_{\text{dry}}^0(50)}$$

Simulating only calibration impact:

$$\Delta m_{s \text{ CAL}} = \Delta m_{s \text{ CAL+RES}} - \Delta m_{s \text{ RES}}$$

Legend:

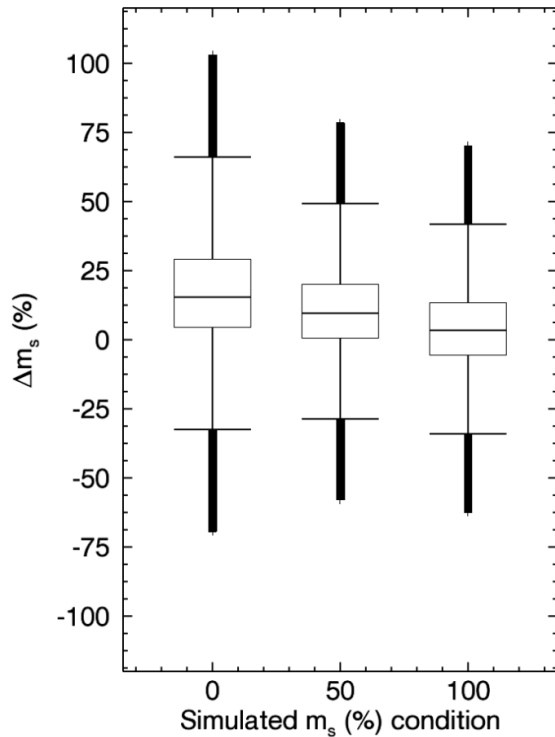
ASCAT model parameter

ERS-1/2 model parameter

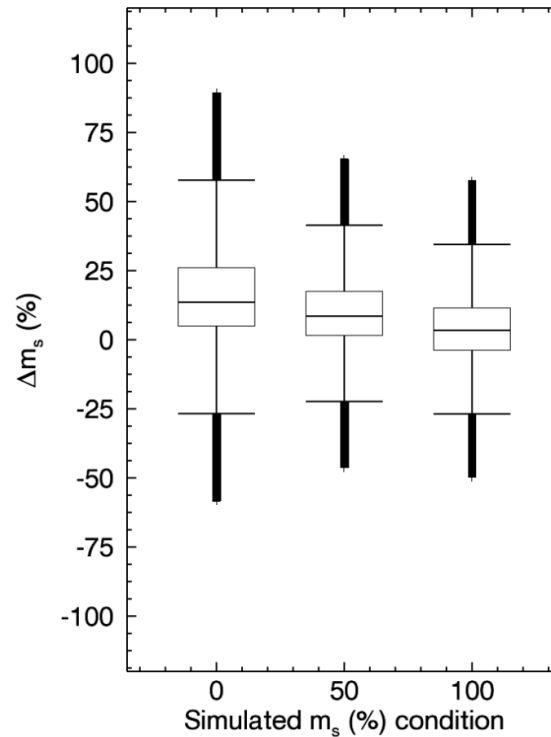


Global Δm_s statistics

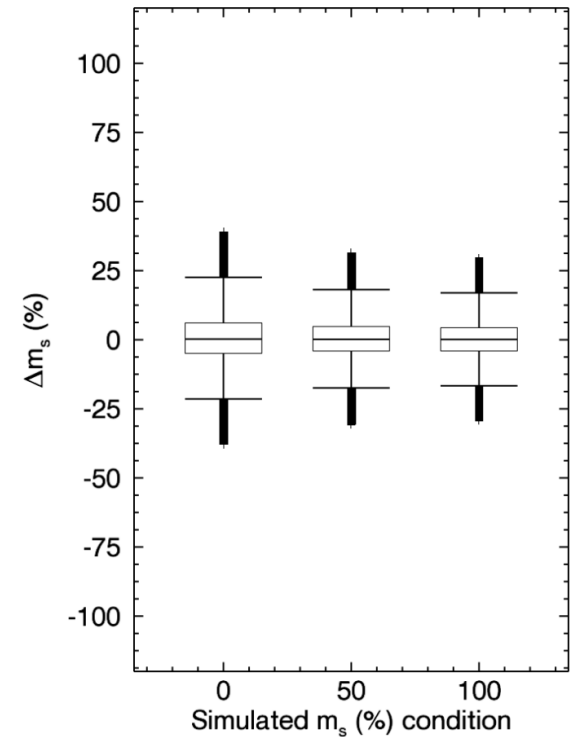
Δm_s CAL+RES



Δm_s CAL



Δm_s RES



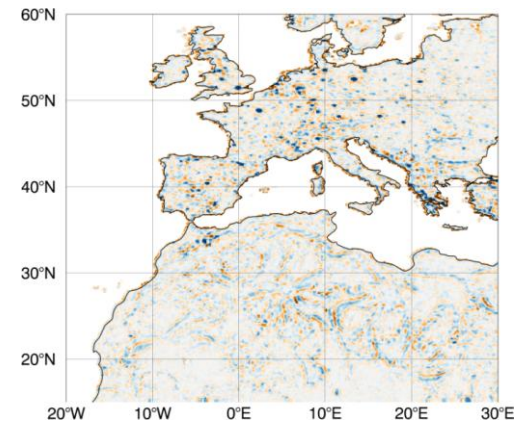
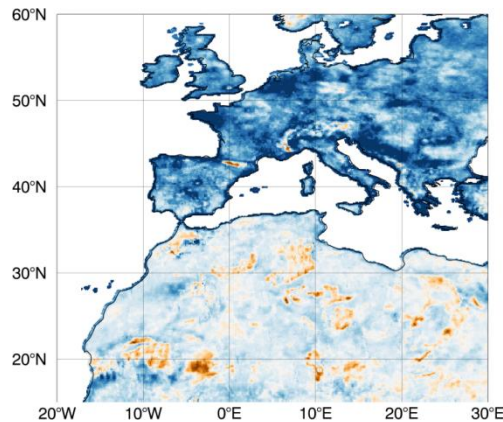
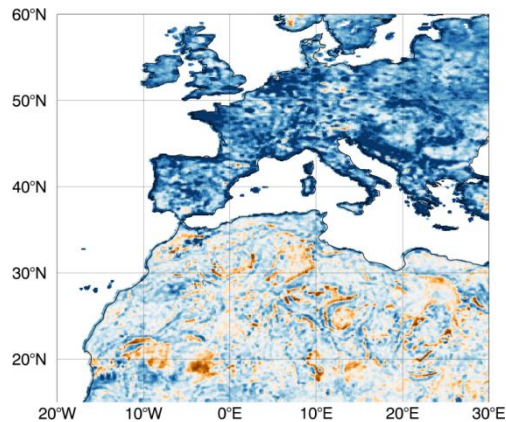
Closer look on Europe and North Africa

$\Delta m_{s \text{ CAL+RES}}$

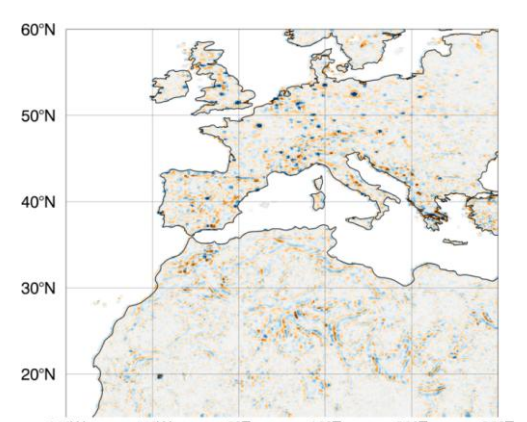
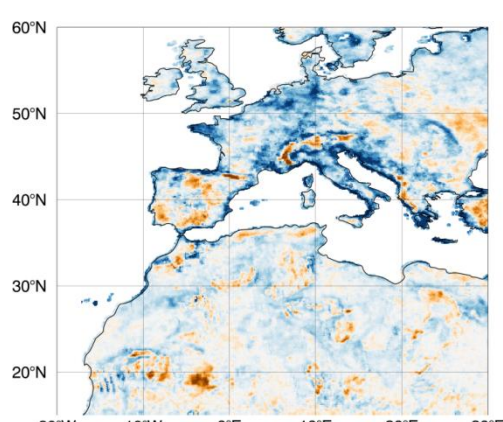
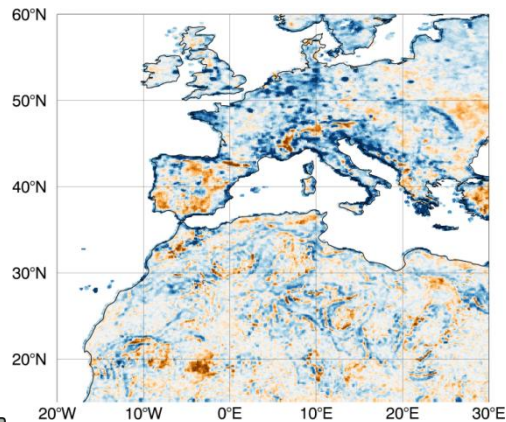
$\Delta m_{s \text{ CAL}}$

$\Delta m_{s \text{ RES}}$

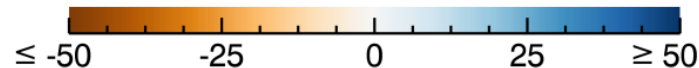
0 %



100 %

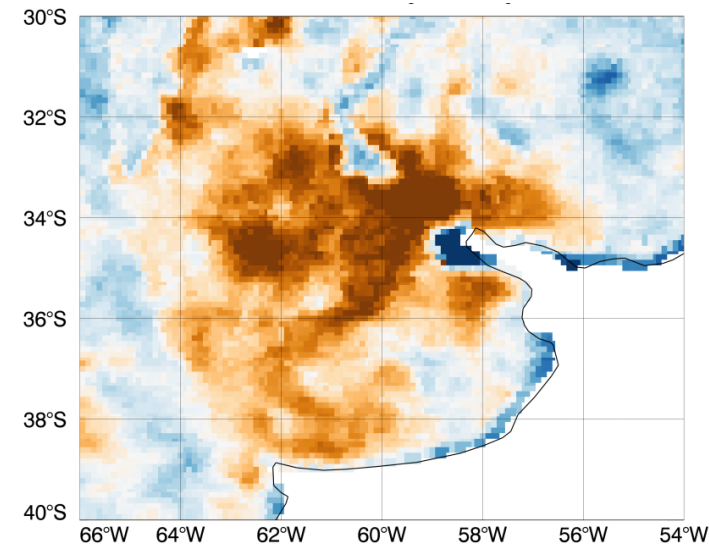


Δm_s (%)

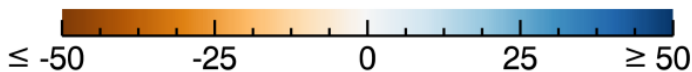


Exceptional environmental conditions

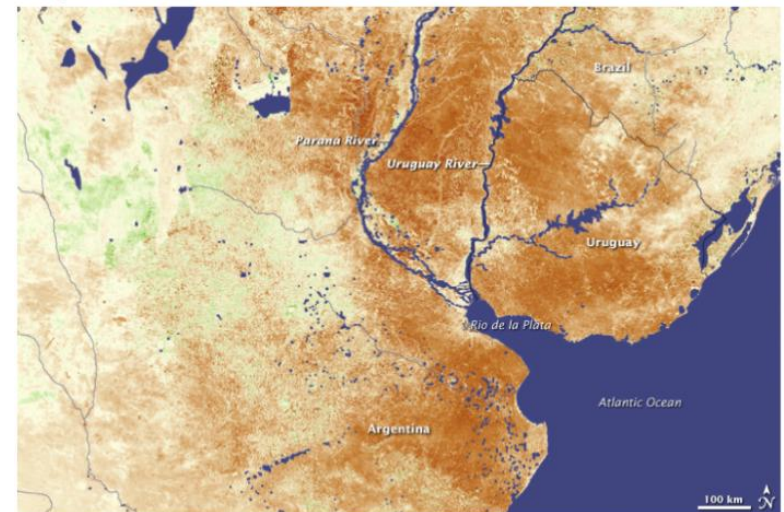
$\Delta m_{s\text{ CAL}}$



Δm_s (%) at 0%



NDVI anomaly derived from MODIS on
NASA's Terra satellite (JAN 17 - FEB 1, 2009)



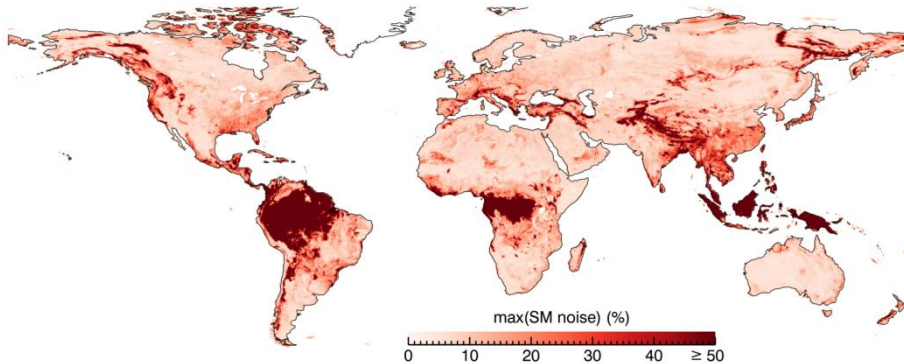
Vegetation Anomaly (NDVI)



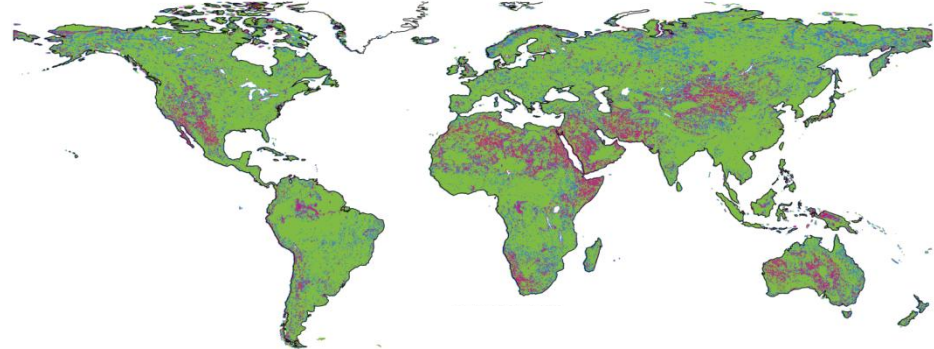
...From mid-November 2008 through mid-February 2009, unusual weather patterns brought extreme temperatures and low rainfall to this normally productive agricultural region. The period is critical for many crops, including cotton, wheat, soy, and corn. As a result, crop yields in the three countries were expected to dip, with Argentina suffering the worst blow, said the U.S. Department of Agriculture's Foreign Agricultural Service (FAS)...

Comparison to soil moisture noise

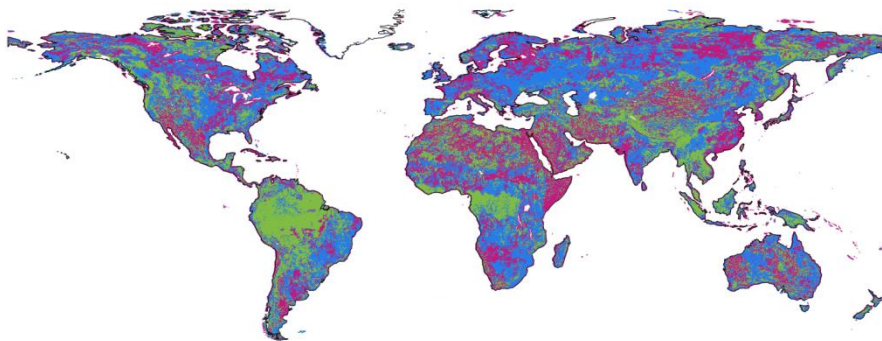
max(soil moisture noise)



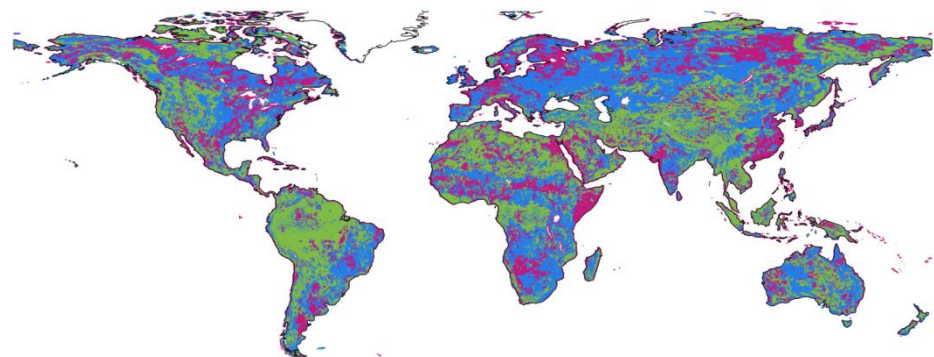
RESOLUTION



CALIBRATION + RESOLUTION



CALIBRATION



- always below max(SM noise)
- always above max(SM noise)
- above and below max(SM noise) dependent on SM



Summary

- The METOP ASCAT soil moisture product is still in its **initial state!**
- A simple model has been used to simulate the remaining artefacts due to a **spatial resolution** mismatch and an **absolute calibration** difference between measurements and model parameters.
- The unexpected decrease of calibration-related features with increasing soil moisture needs a closer examination.
- Further research on ERS - METOP **inter-calibration** is planned.



Additional Slides



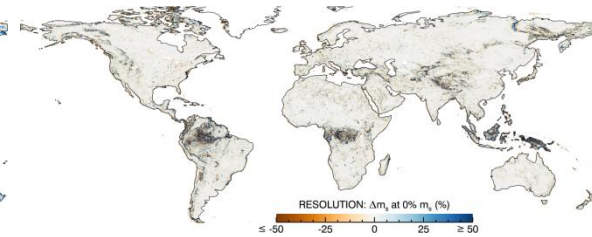
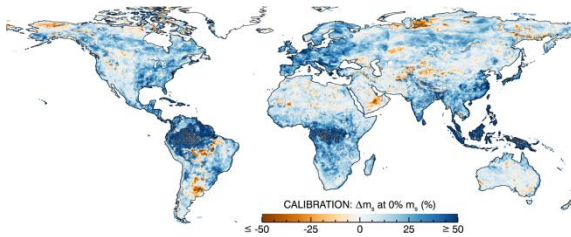
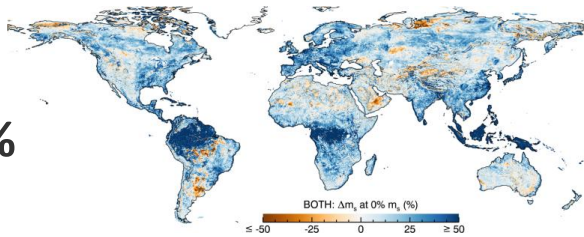
Global Δm_s

$\Delta m_{s \text{ CAL+RES}}$

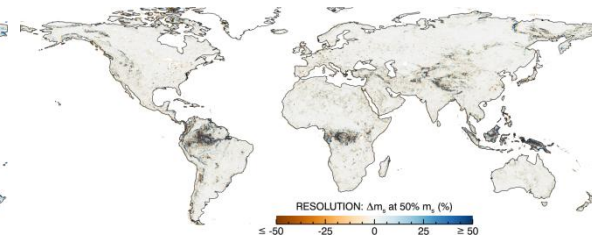
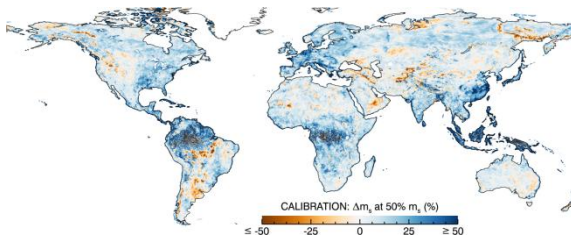
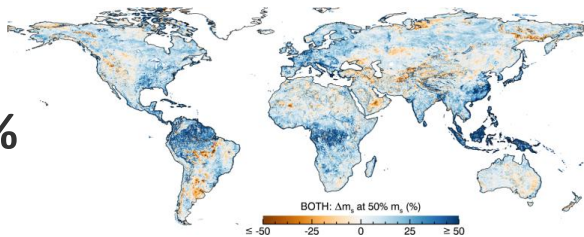
$\Delta m_{s \text{ CAL}}$

$\Delta m_{s \text{ RES}}$

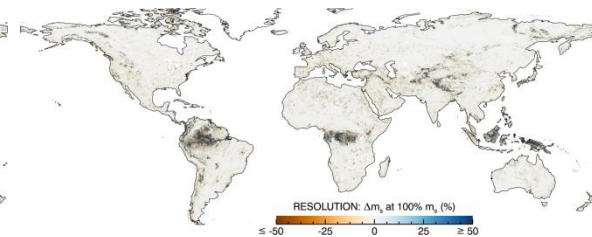
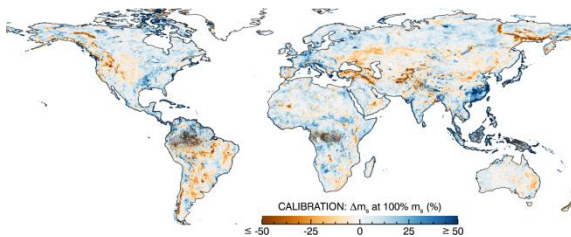
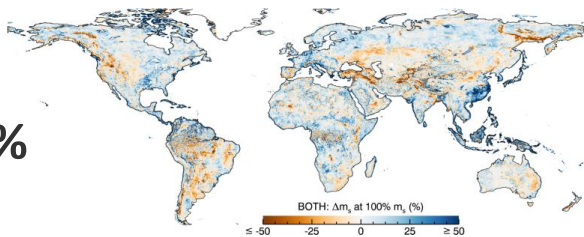
0 %



50 %



100 %



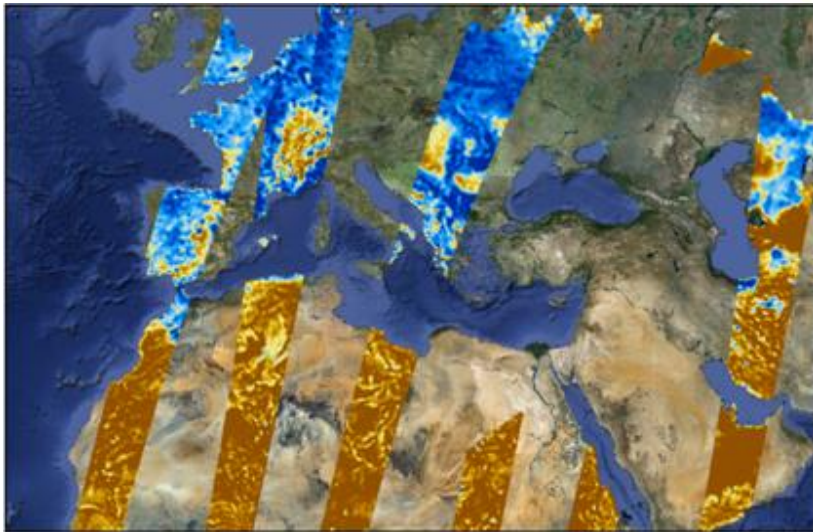
Δm_s (%)



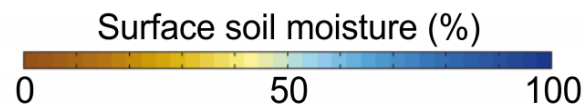
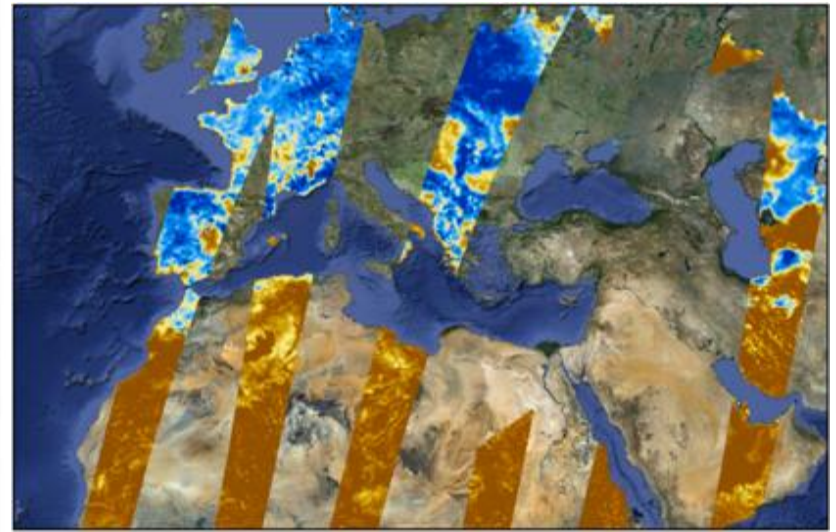
Update of Model Parameters

- Soil moisture conditions over Europe and North Africa from 2010/03/22 (descending passes only) overlaid on Google satellite imagery

ASCAT soil moisture product 25 km



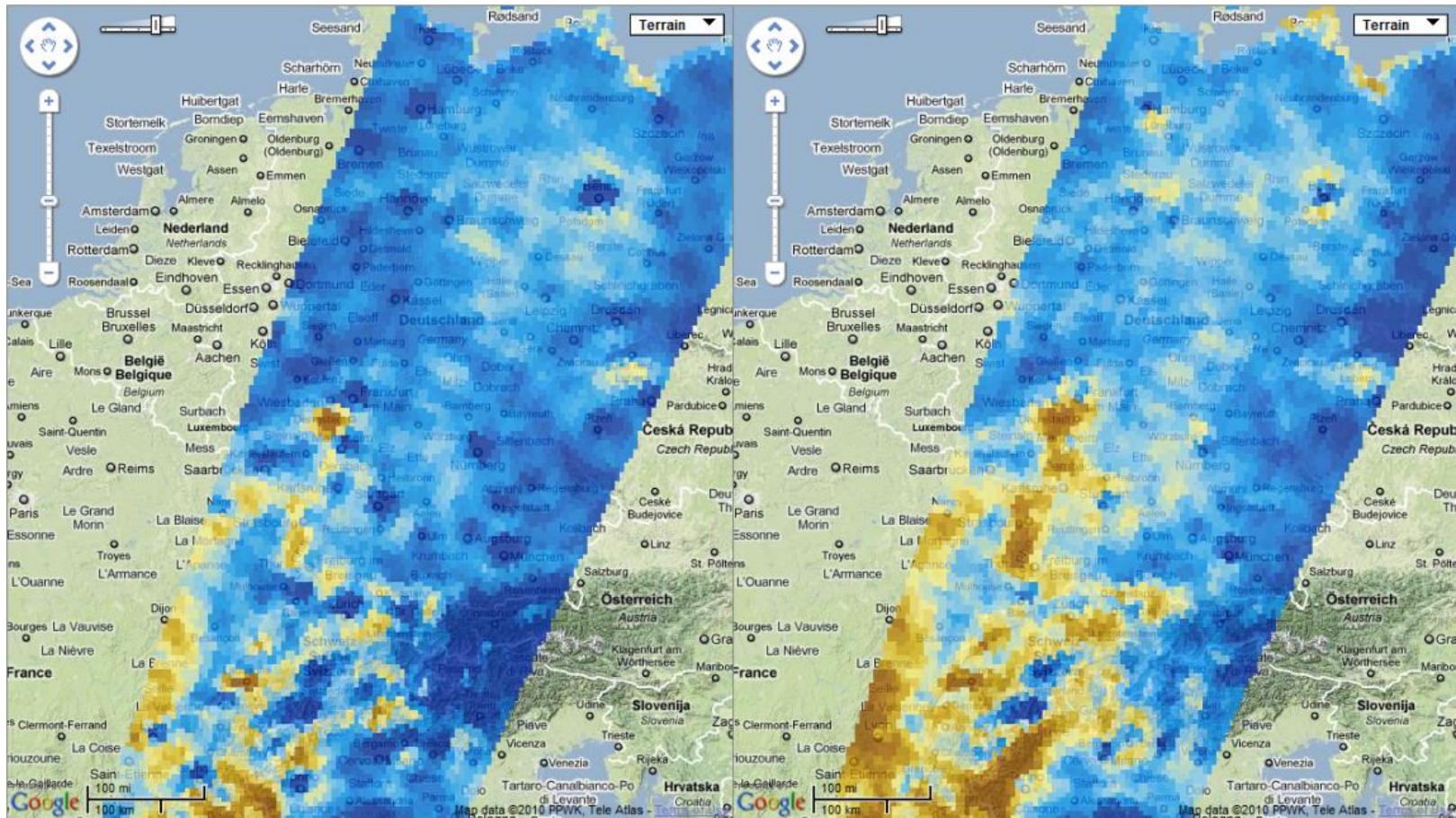
With updated Model Parameters



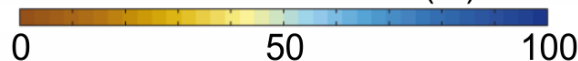
Update of Model Parameters II

Old parameter database

New parameter database



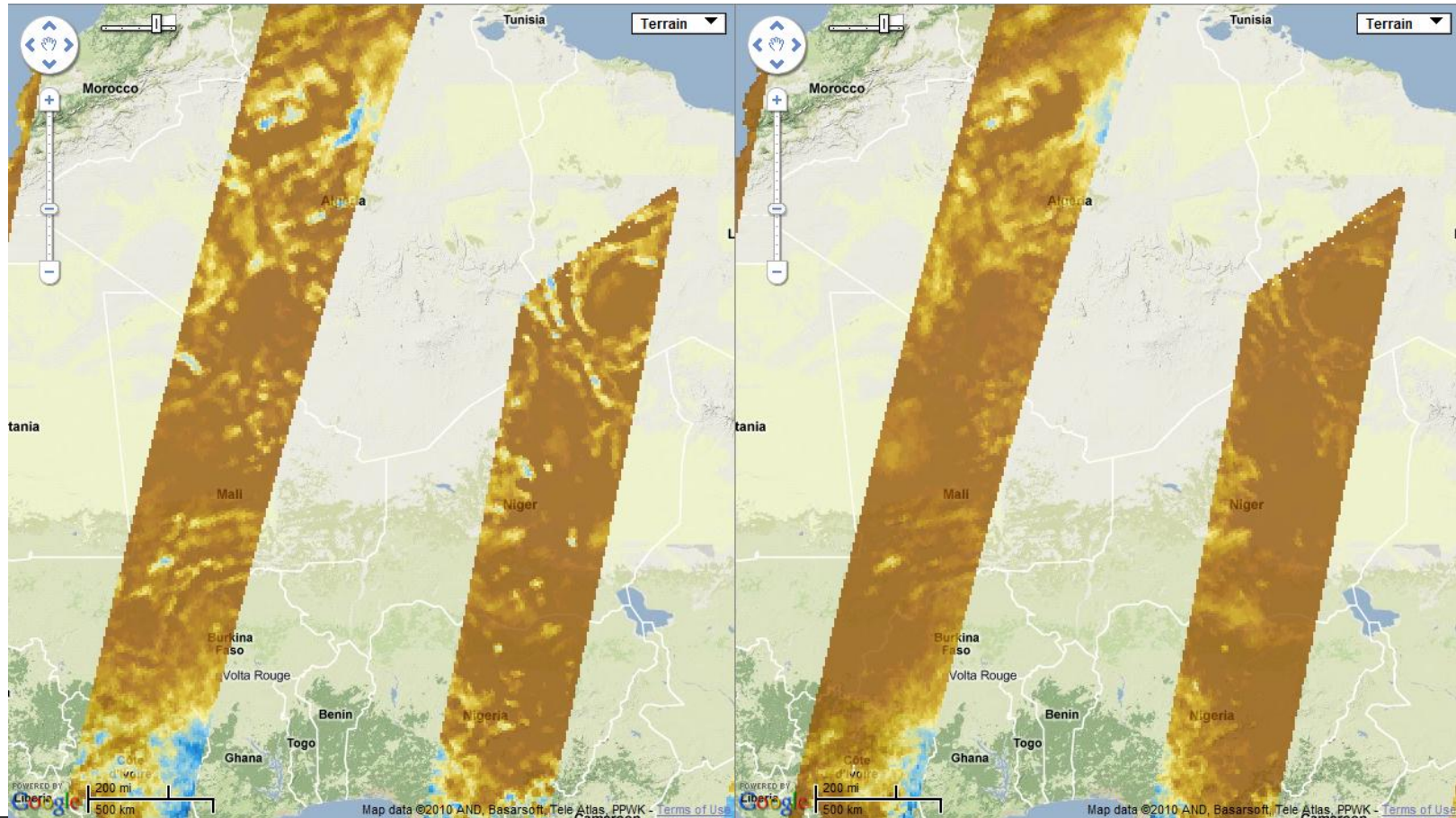
Surface soil moisture (%)



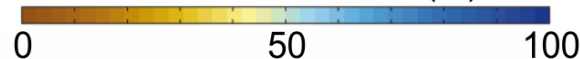
Update of Model Parameters III

Old parameter database

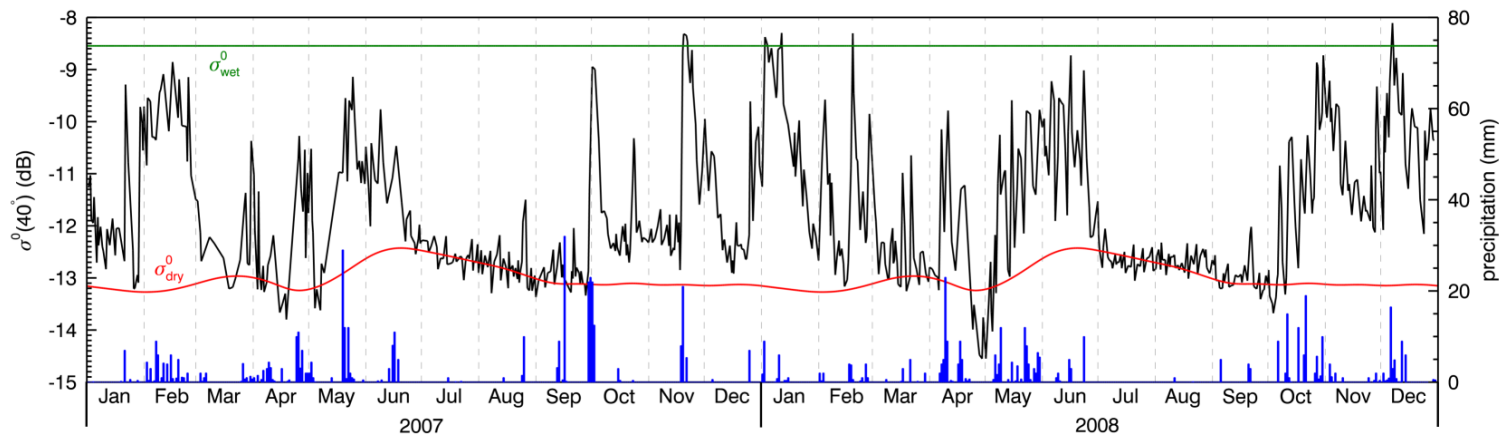
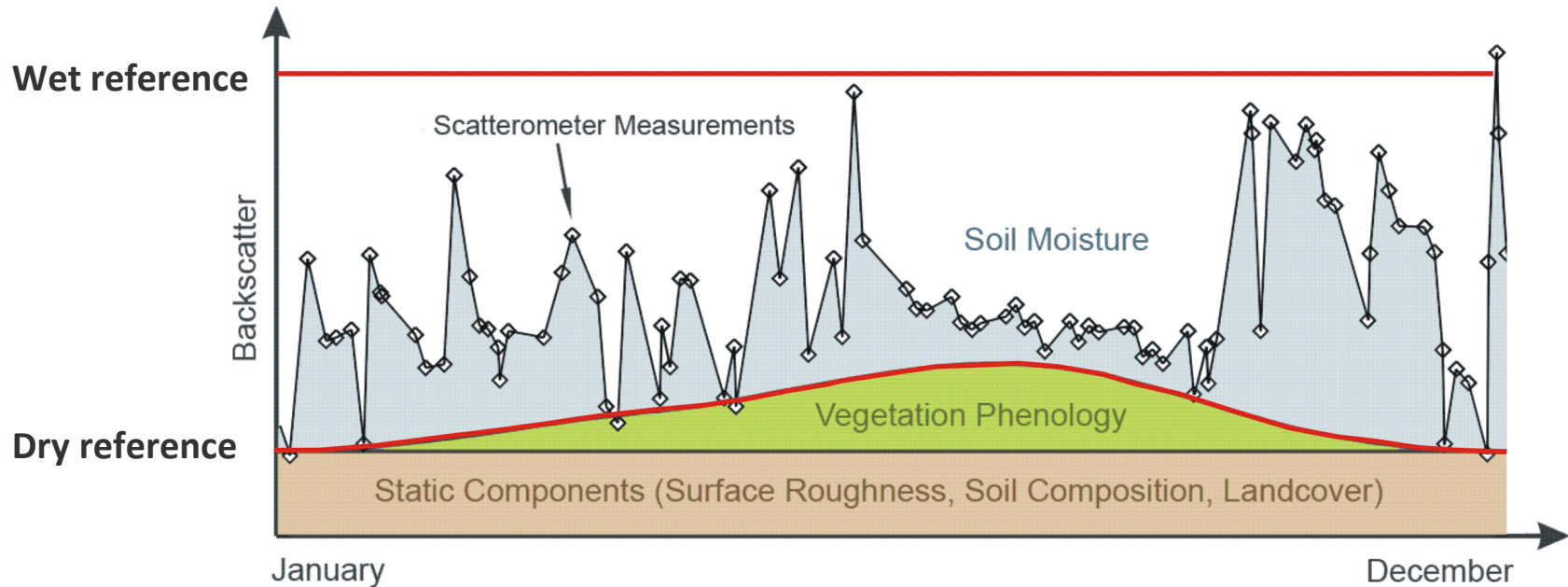
New parameter database



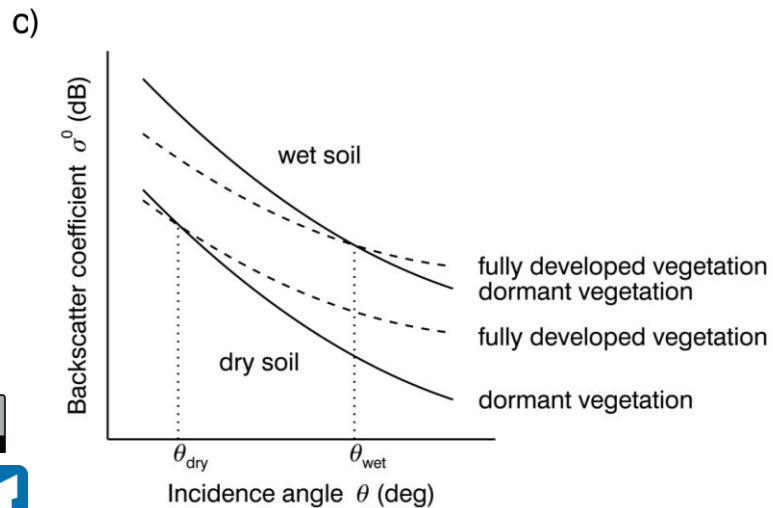
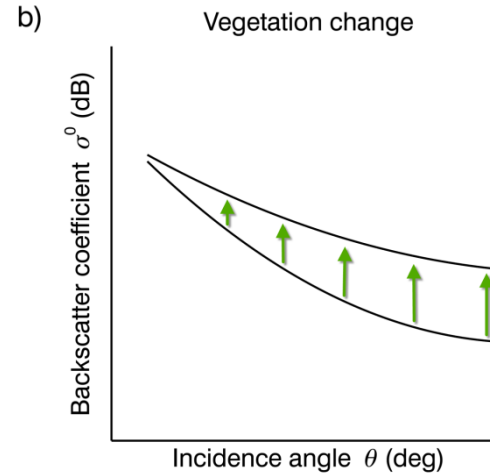
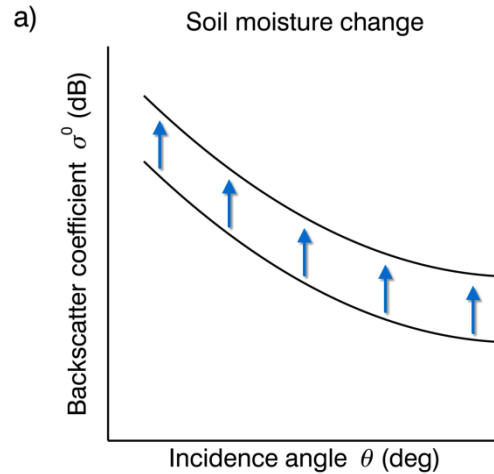
Surface soil moisture (%)



Physical motivated change detection algorithm



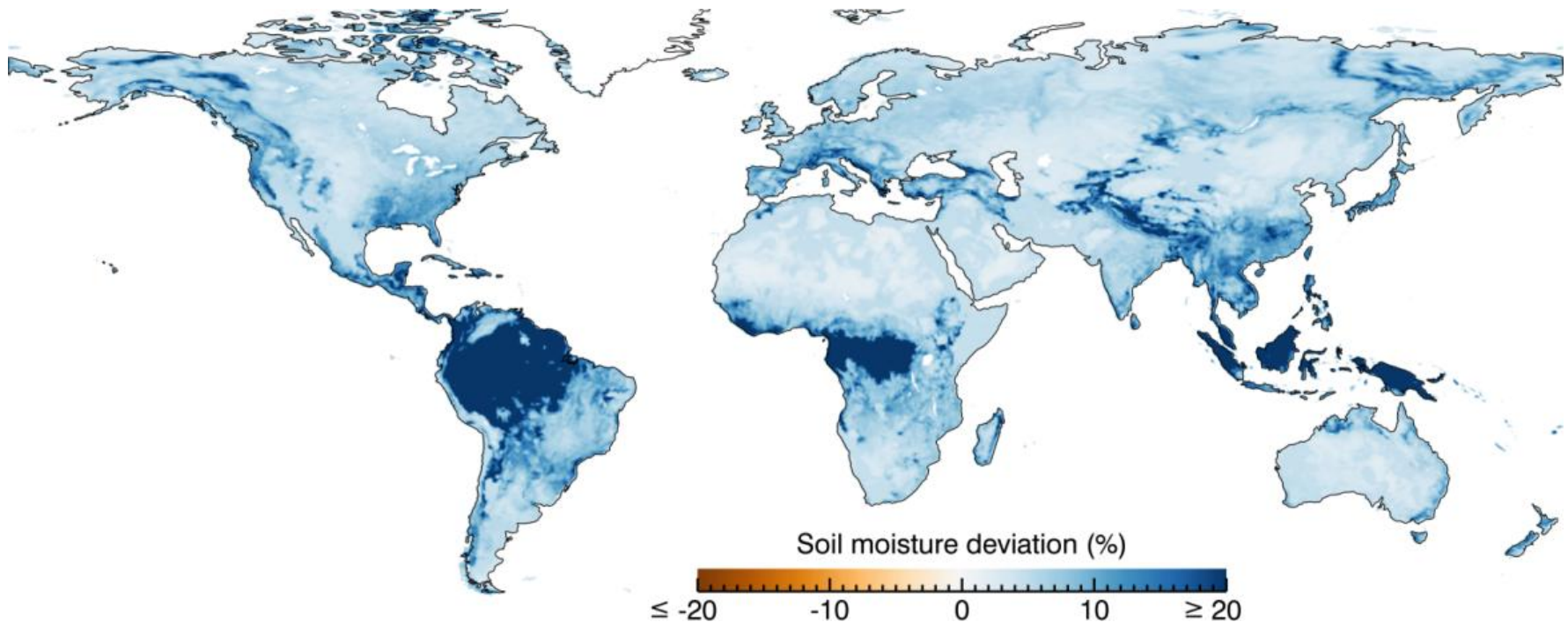
Vegetation correction



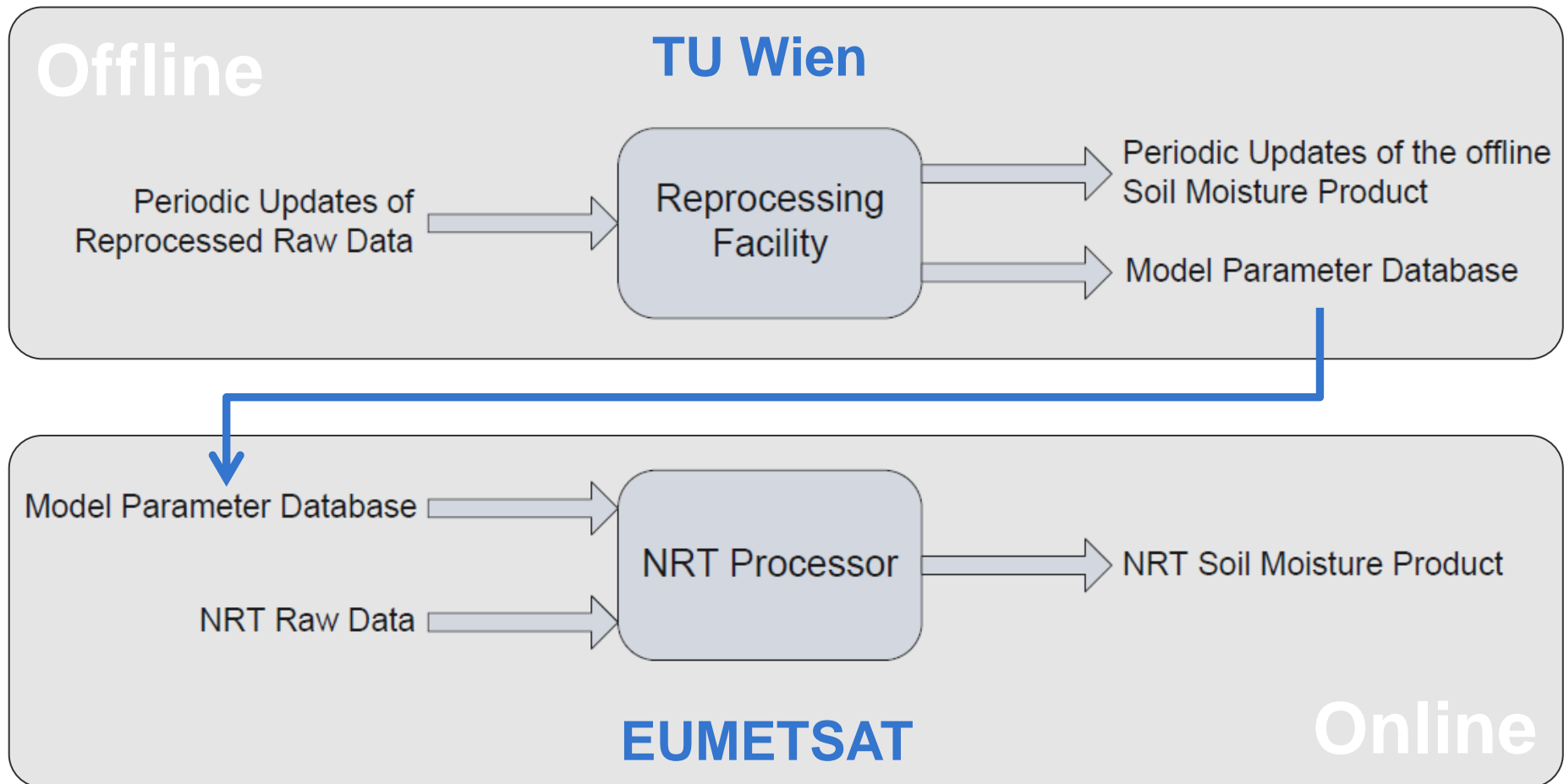
- Backscatter intensity decreases with increasing incidence angle
- Different reaction on soil moisture change and vegetation change

Impact of absolute calibration difference on soil moisture

- Simulated soil moisture deviation due to an absolute calibration difference of the raw measurements of 0.22 dB



Offline and Online Processing Chains of Soil Moisture



The initial ASCAT Soil Moisture Product

25 km

50 km

