Faculty of Science

# UCS#4: Downscaling of SMOS soil moisture over Africa

**T. Tagesson,** S. Horion, V. Zaldo, H. Nieto,
G. Mendiguren & R. Fensholt

# Introduction

The **Soil Moisture and Ocean Salinity mission (SMOS) launched by ESA** provides surface (0-~5 cm depth) soil moisture retrievals at global scale (revisit time 1-3 days).

Being based on passive microwave remote sensing, it has a rather low spatial resolution (average 40 km).

This large discrepancy between the observation scale and the scale in situ measurements are problematic.

- The main aim with this user case study is to validate a downscaling methodology to facilitate calibration and validation of SMOS data using localized in-situ measurements in Africa.

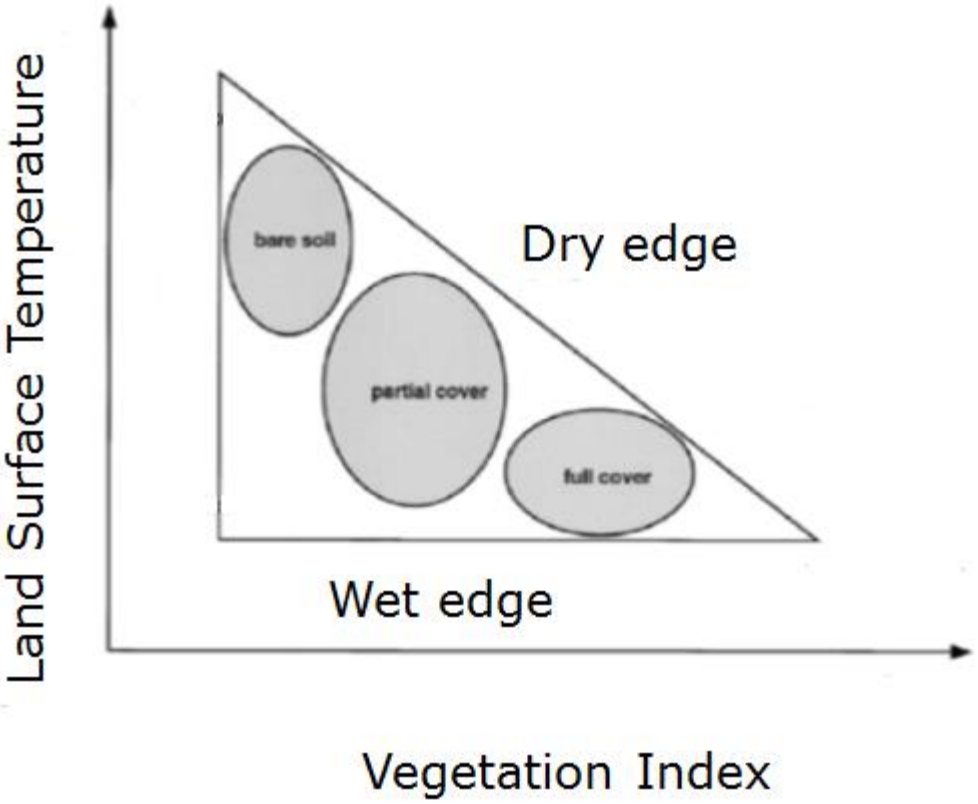
# Objectives

Objective 1: Produce a continental-scale time series of the Temperature and Vegetation Dryness Index (TVDI) using GlobTemperature datasets from SEVIRI (~4km spatial resolution).

Objective 2: Downscale soil moisture retrievals from SMOS to the spatial resolution of SEVIRI using the produced TVDI, and validate against in-situ measurements.

Objective 3: Analysis of intra-annual variability of soil moisture, and assessment of droughts 2010-2015.

# Objective 1: Continental-scale TVDI time series

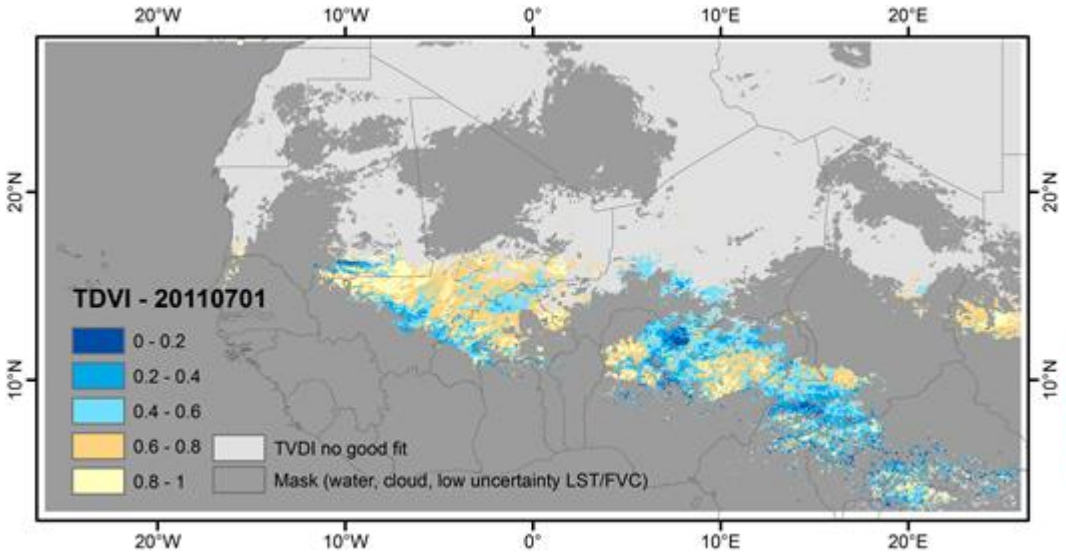



- TVDI is related to soil moisture
- Must be parameterized within a window large enough to define the triangular shape.
- Still requires similar atmospheric forcing and similar vegetation roughness

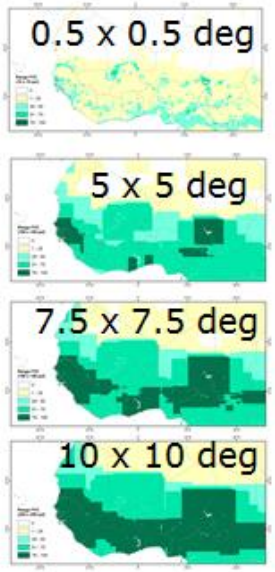
→ **constraints for continental scale processing**

$$TVDI = \frac{LST - LST_{min}}{a + b \times VI - LST_{min}}$$

# Objective 1: Results








FVC range

**Trade-off between**:

Similar vegetation and atmospheric conditions

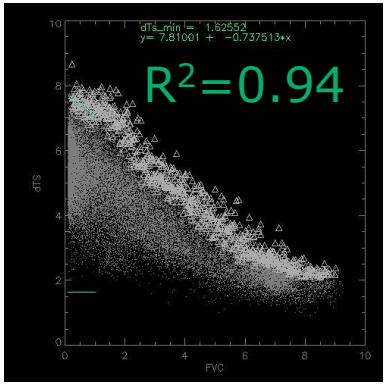
Good FVC range

**Criteria for the selection of good fit:**

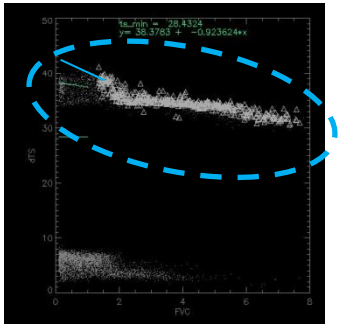
- $R^2$ - dry edge,
- number of points
- FVC range

**High sensitivity of TVDI to**:

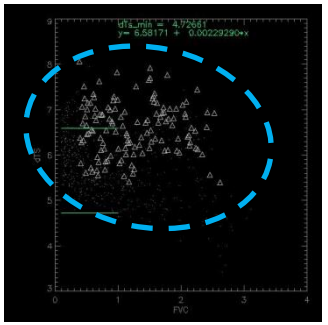
- Remaining clouds
- Window size




Example of good fit



Wrong LST due to remaining cloud cover



Low FVC range (l0-30%)

# Objective 2: Downscaling of SMOS soil moisture

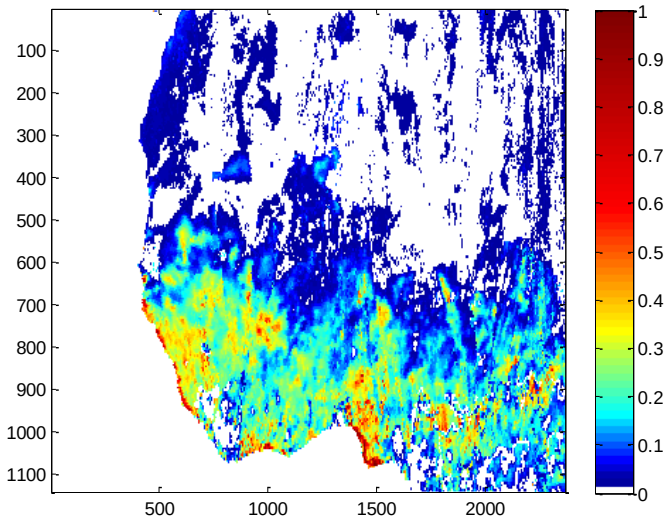
$$\mathbf{SM}_{SEVIRI} = \mathbf{SM}_{SMOS} + \partial\mathbf{SM}/\partial\mathbf{TVDI} \times (\mathbf{TVDI}_{SEVIRI} - \mathbf{TVDI}_{AVG\_SMOS})$$

$\mathbf{SM}_{SEVIRI}$ is downscaled soil moisture
$\mathbf{SM}_{SMOS}$ is SMOS based soil moisture
$\partial\mathbf{SM}/\partial\mathbf{TVDI}$ is change in soil moisture changes per change in TVDI
$\mathbf{TVDI}_{SEVIRI}$ is TDVI for the SEVIRI pixel where SMOS soil moisture is to be downscaled to
$\mathbf{TVDI}_{AVG\_SMOS}$ is average TVDI for the SMOS pixel.

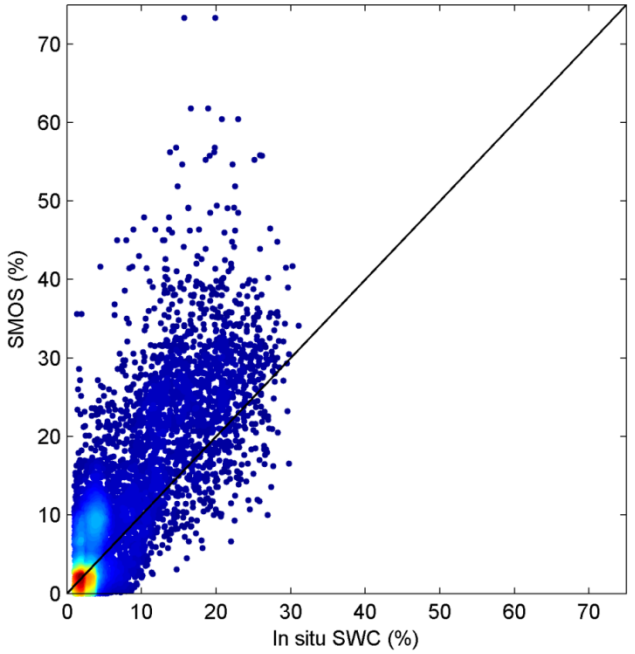

Our test study area is West Africa (3° N 26° W; 28° N 26° E).
We have 7 sites with in situ soil moisture located in three different regions

# Objective 2: Results

## SMOS soil moisture 1-3 July 2011




## Comparison between SMOS soil moisture and in situ based soil moisture




## Analysis to be done:

1: The actual downscaling of SMOS using the produced TVDI.

2:Validation of the produced downscaled SMOS soil moisture against in situ soil moisture.

# Objective 3: Analysis of inter-annual variability in soil moisture

**Analysis to be done:**

1: Comparison with different drought indices to investigate the potential for drought monitoring?

2:Relationship to remote sensing based metrics of vegetation productivity, to investigate influence of soil moisture in vegetation productivity.

3: Investigate applicability for monitoring of intra-annual variability: change in the timing of drought

# Next steps and concluding remarks

**Next steps:**

1: Processing the full time series of TVDI

2:The actual down-scaling of SMOS soil moisture

3: Analysis of the outputs (Objective 3)

**Conclusions:**

1: The case study will provide a soil moisture product at an adequate spatial (4kilometres) and temporal (3 days) resolution.

2:Useful input for forecasting regional weather as well as drought and flood hazards, but also for hydrological and crop production models.

3: Time series analysis of soil moisture will help in getting a better understanding of vegetation response to stress conditions, including phenological changes.

# Thank you!

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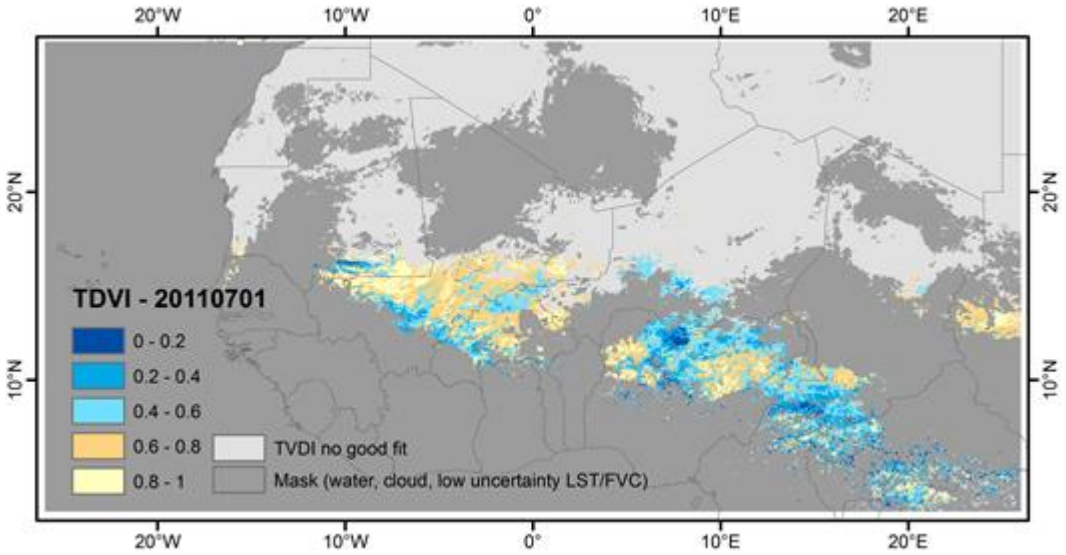
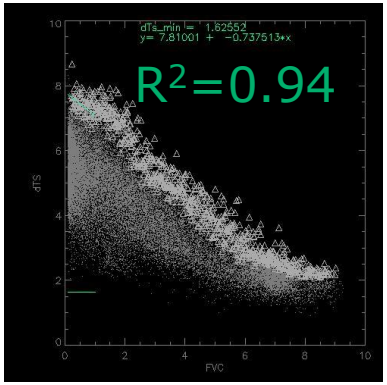
**torbern.tagesson@ign.ku.dk**

# Objective 1: Results

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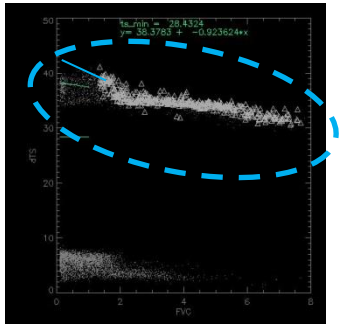

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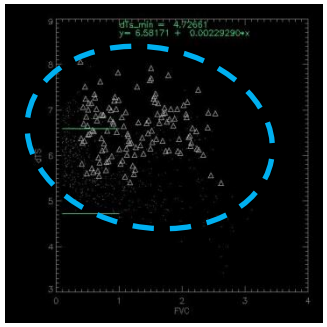

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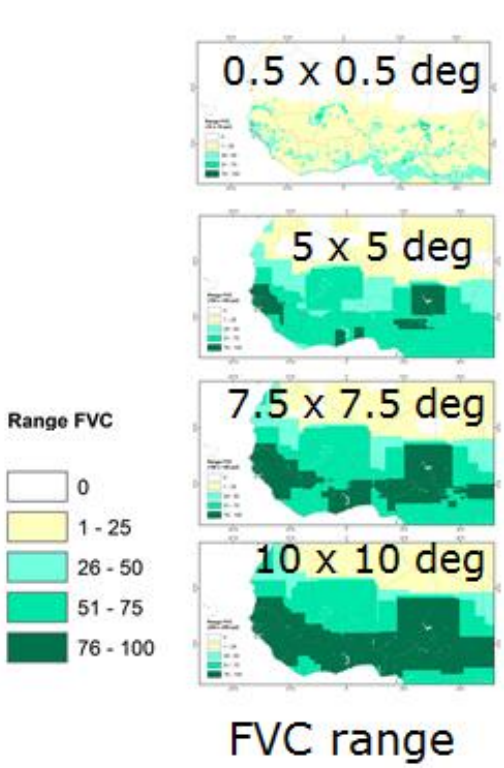


**Trade-off between:**

Similar vegetation and atmospheric conditions

Good FVC range

**Analysis to be done:**

1: Test different window sizes to see the influence on the produced TVDI.

2:Change the code so that desert areas are included, but given a flag value.

3: Test different filtering criteria, to make sure that the produced TVDI is reasonable.