Quantifying Soil Moisture from Space-based Synthetic Aperture Radar (SAR) and Ground-based Geophysical and Hydrological Measurements

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Problems & proposed solution

1. Soil moisture (SM) plays an essential role in agriculture activities

2. Africa is facing the most significant challenges of water stress because food production and security depend on those water resources DUE to Climate Change & global warming

3. Thus, monitoring SM at high resolution is of vital importance for irrigation activities, estimation of crop yields, and food security

4. SMOS and SMAP provide a global mapping of surface SM, However, the SM retrieved from these instruments has a low spatial resolution NOT suitable for agriculture applications

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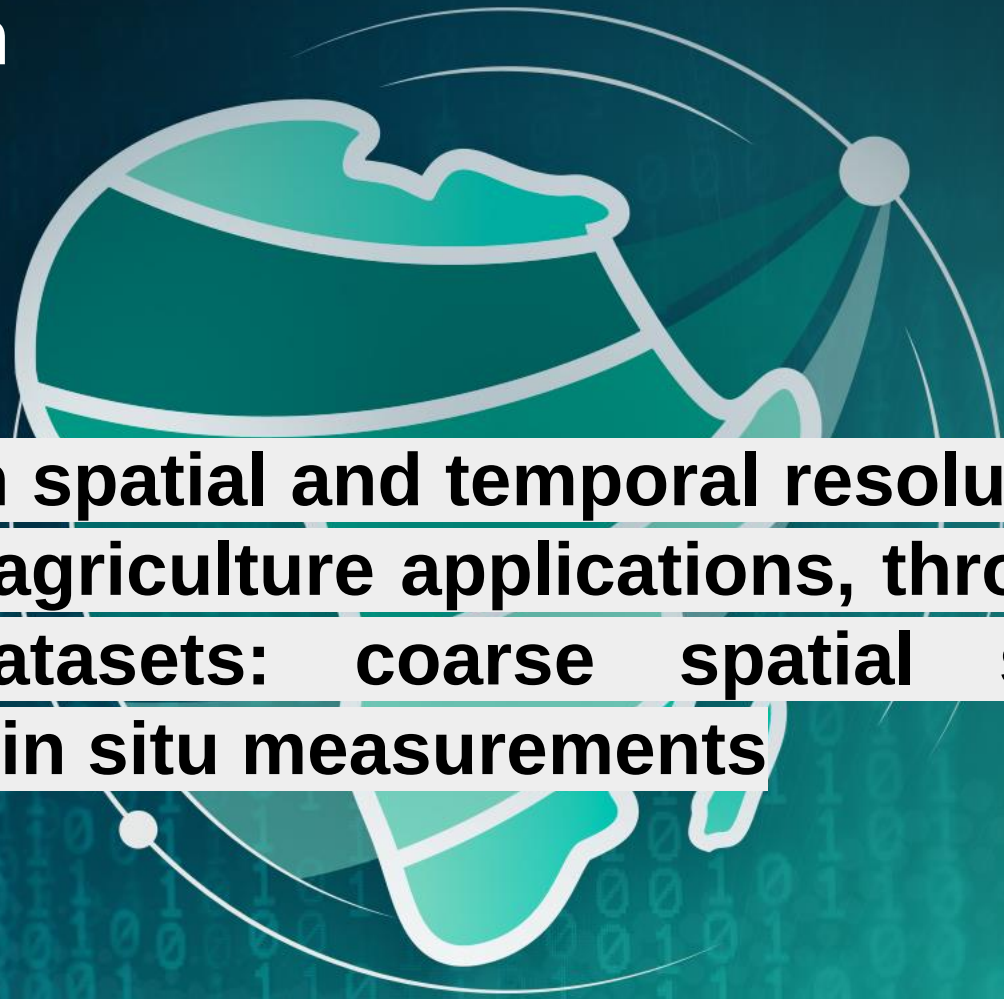
Problems & proposed solution



The operational retrieval of high spatial and temporal resolution SM products under vegetation, for agriculture applications, through an algorithm that combines datasets: coarse spatial satellite observation and fine resolution in situ measurements

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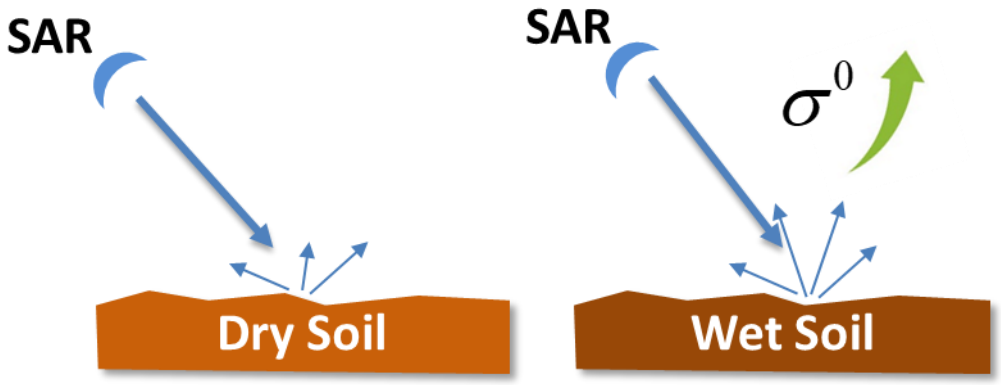
Scientific Background and Objectives

SAR backscatter

Dielectric constant

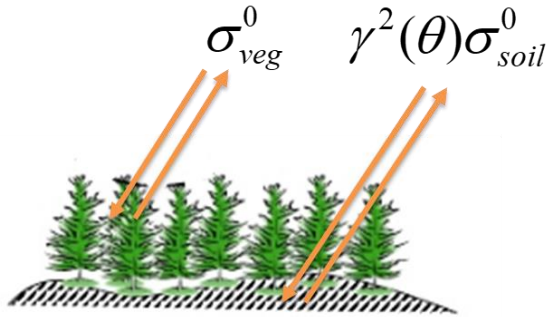
$\varepsilon_{water} \approx 80$

$\varepsilon_{dry_soil} < 5$



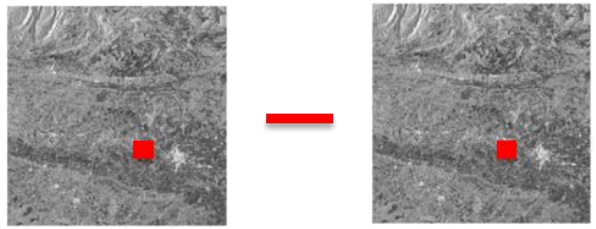
- Change Detection method (CD) between consecutive dates
  to minimize the effects of soil roughness and vegetation change

- The radar signals backscattered by the surface
  - = radar signals scattered by the bare soil with attenuation by vegetation
  - + signals scattered by the vegetation cover



$$\sigma^0_{cover} = \sigma^0_{veg} + \gamma^2(\theta)\sigma^0_{soil}$$

Mv Rou



consecutive dates

$$\sigma^0_{cover} = \sigma^0_{veg} + \gamma^2(\theta)\sigma^0_{soil}$$

Mv Rou

$$\Delta\sigma^0_{cover} = H(NDVI, Mv)$$

Scientific Background and Objectives

sentinel-1

A: April 03, 2014
~~B: April 22, 2016~~
C-SAR
12 days, 10 m

sentinel-2

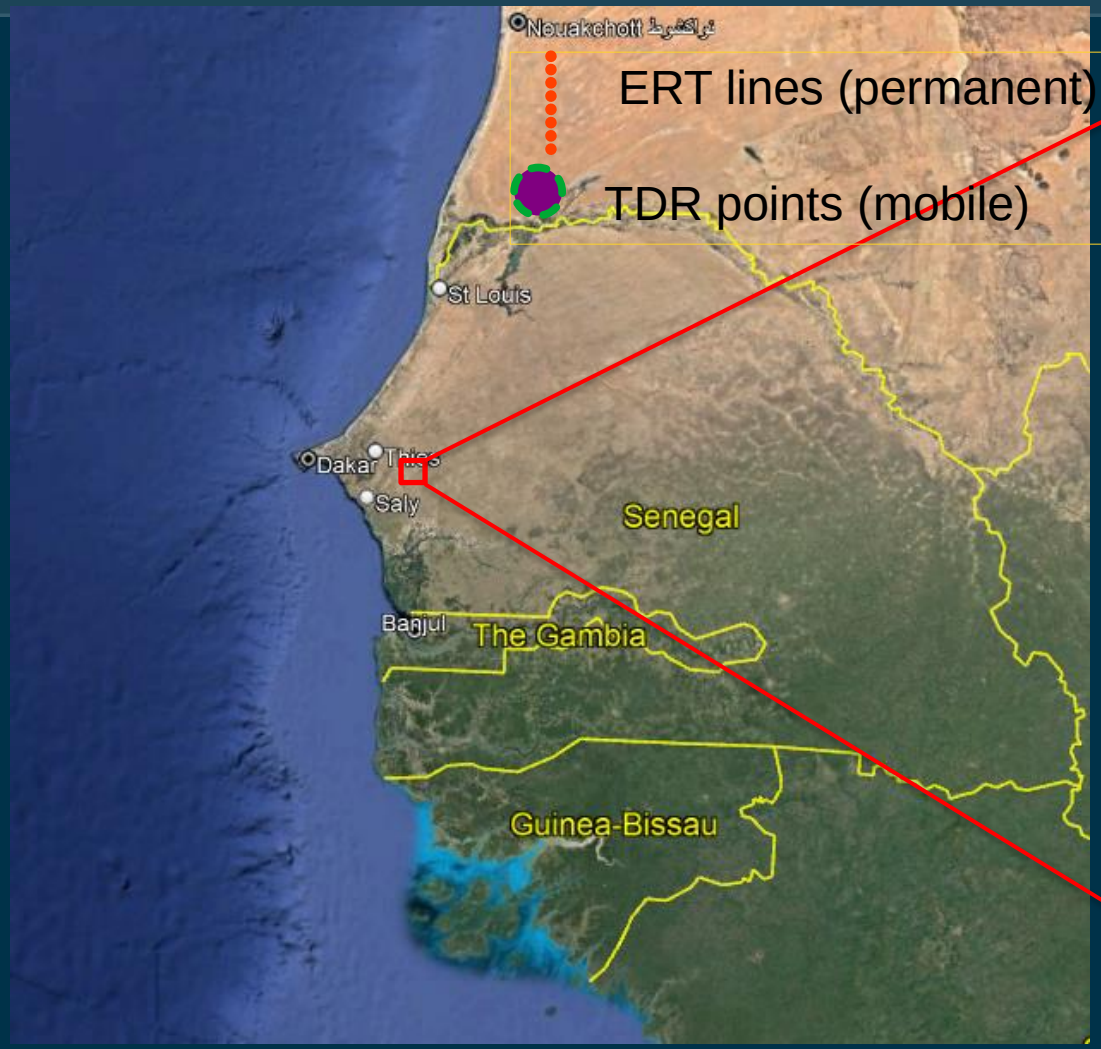
A: June 23, 2015
B: March 7, 2017
Multi Spectral Instrument
10 days, 10 m

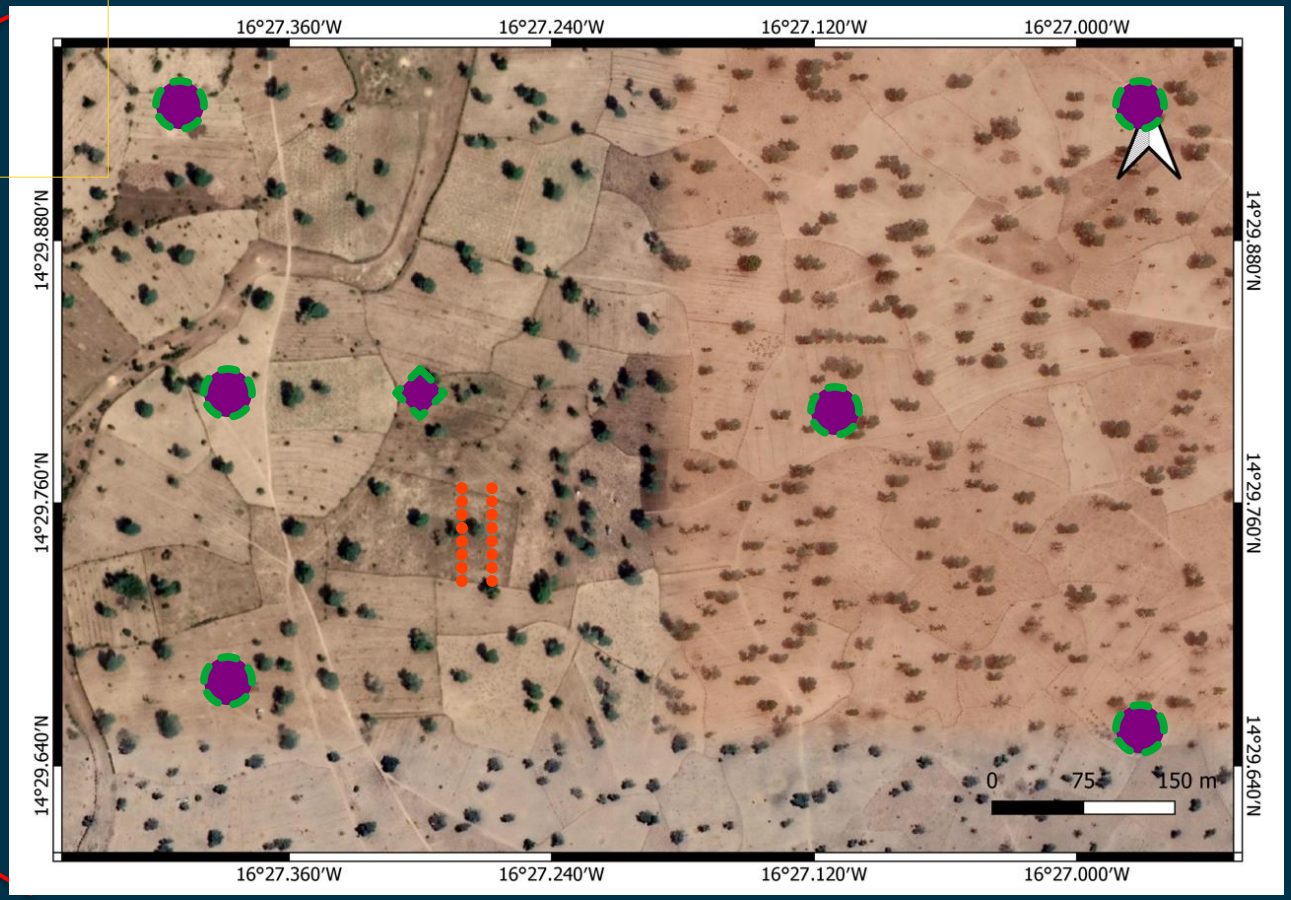
Ground-based Geophysical and Hydrological Measurements:

multispectral camera embarked on a drone, electrical resistivity tomography (ERT), time domain reflectometry (TDR)

High Resolution Soil Moisture

Study Area, “Faidherbia-Flux”, (groundnut basin in Niakhar, Senegal)





Study Area, “Faidherbia-Flux”: instrumentations

Electrical Resistivity Tomography (ERT)	Permanent (Four parallels line of 32 electrodes with 25 cm electrode spacing and 0.5 m interline) Non-invasive,	5 times per day for 5 months
Time Domain Reflectometry (TDR): CS 659	Manual	Every 12 days across an area 3 times larger than the expected downscale resolution i.e 300 m X 300 m
Multispectral drone	Get centimeter accuracy of plants growth and estimation of soil roughness	Every 24 days for 5 months

Research Outline

GB Measurements implementation plan:

sentinel-1

A: April 03, 2014
C-SAR
12 days, 10 m

sentinel-2

A: June 23, 2015
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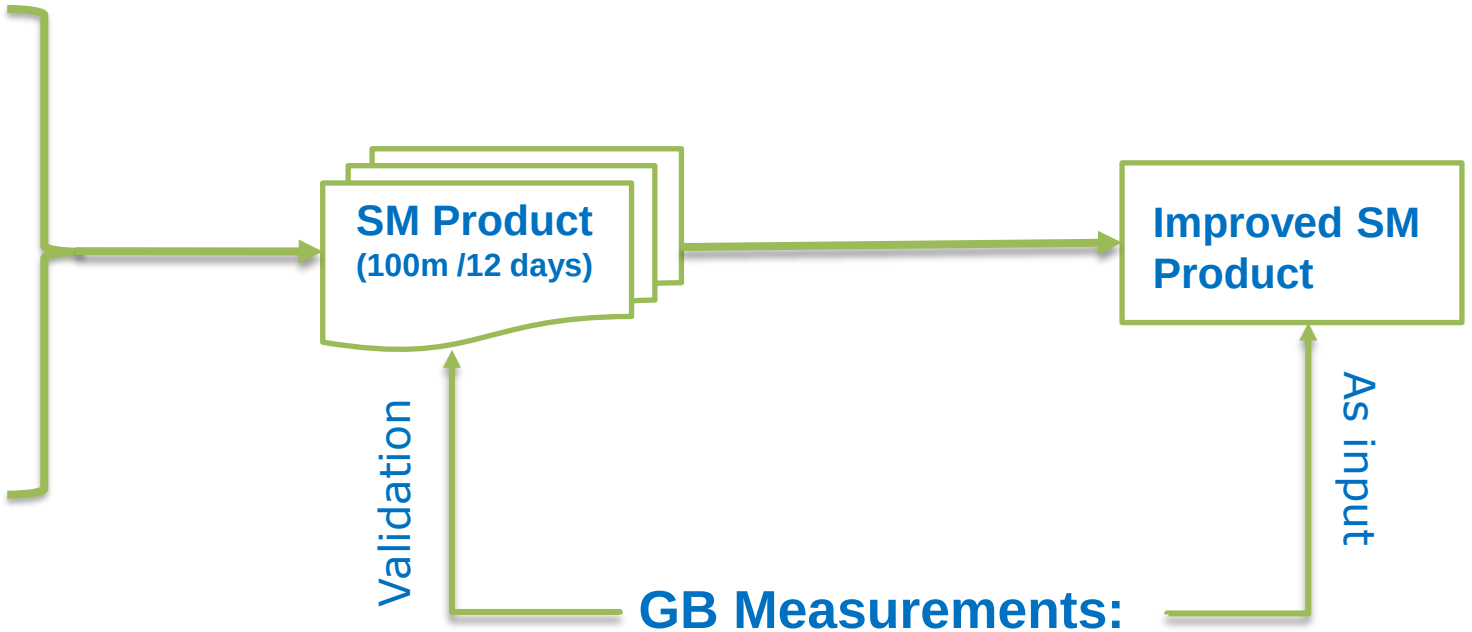
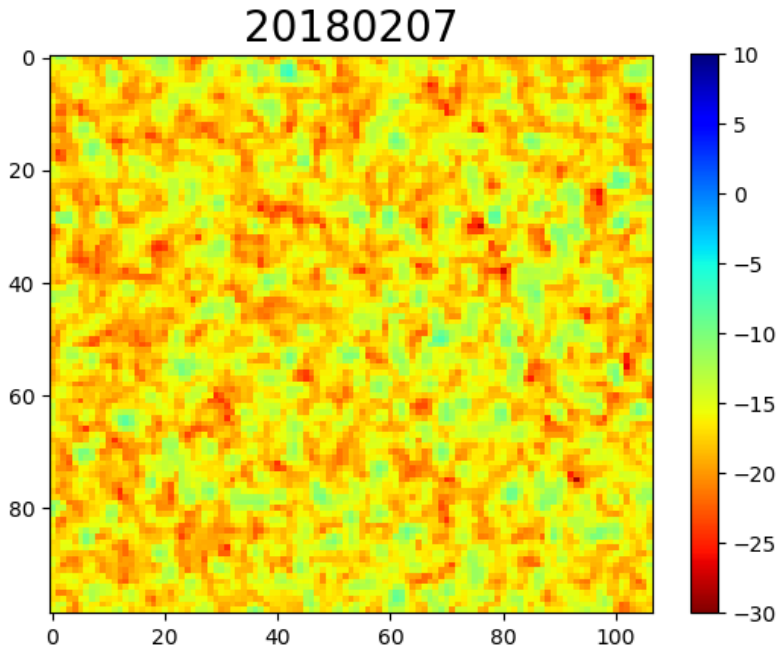
Multi Spectral Instrument
10 days, 10 m

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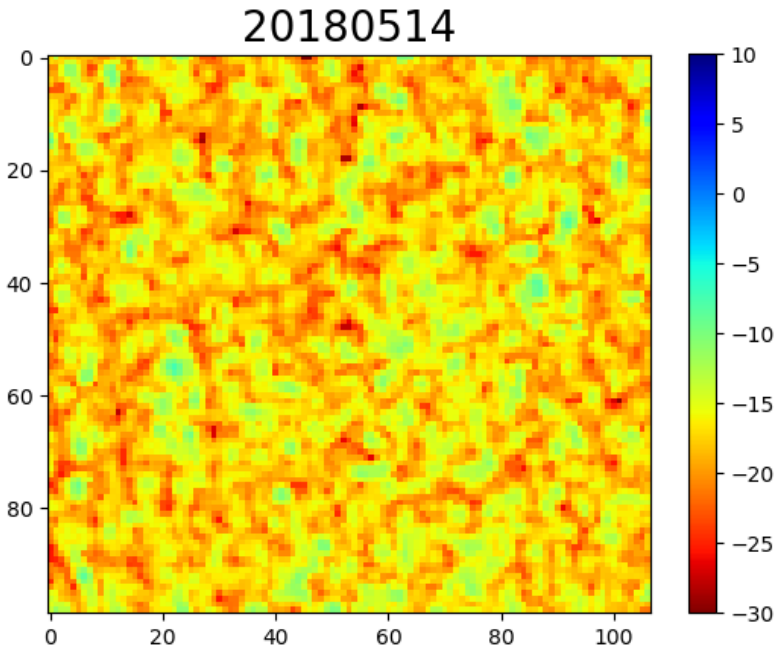
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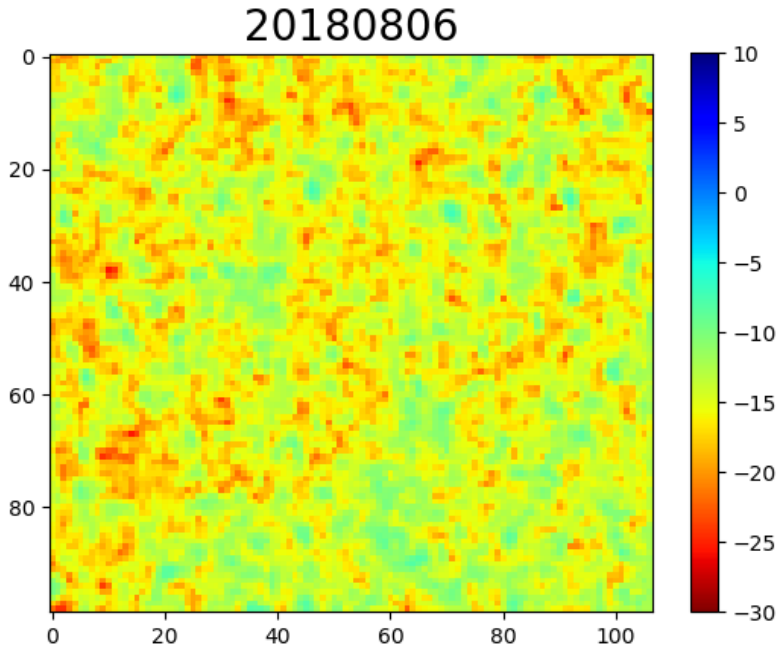
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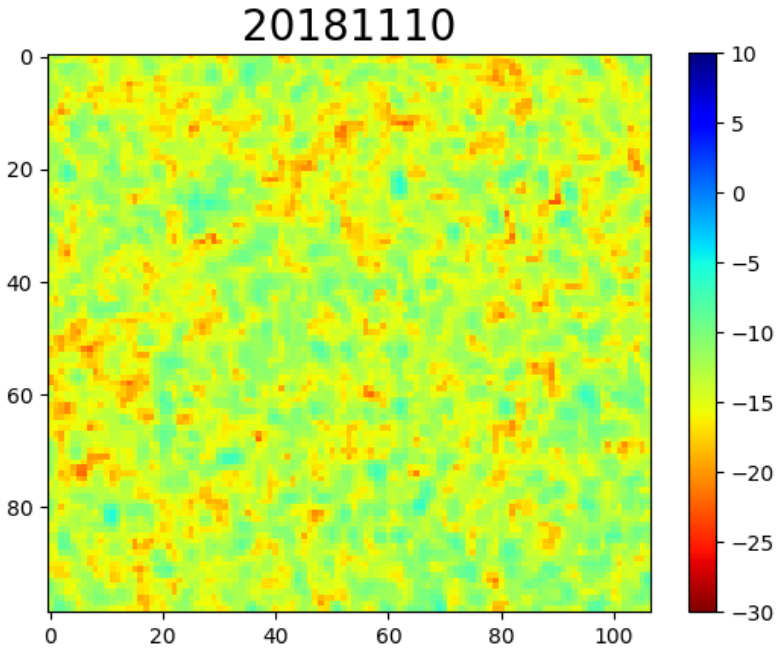
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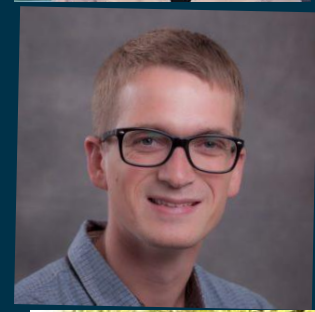

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