Radar Remote Sensing for Agricultural Applications

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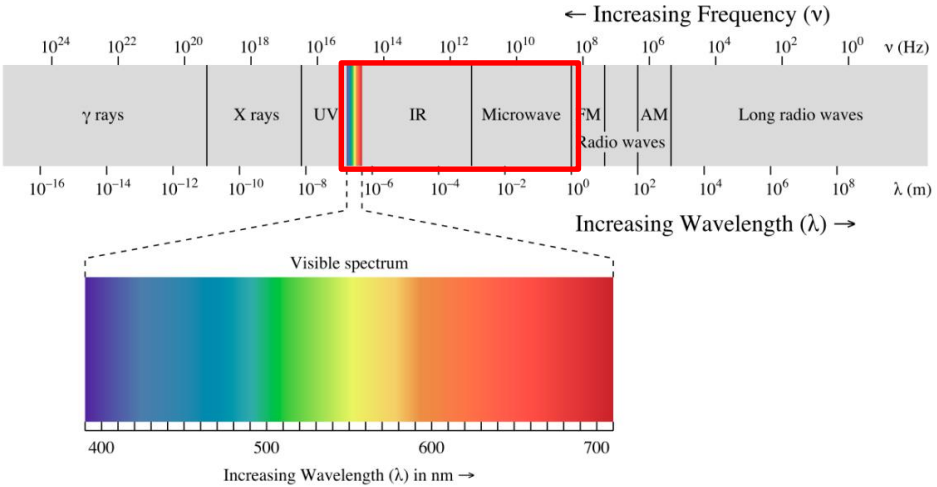
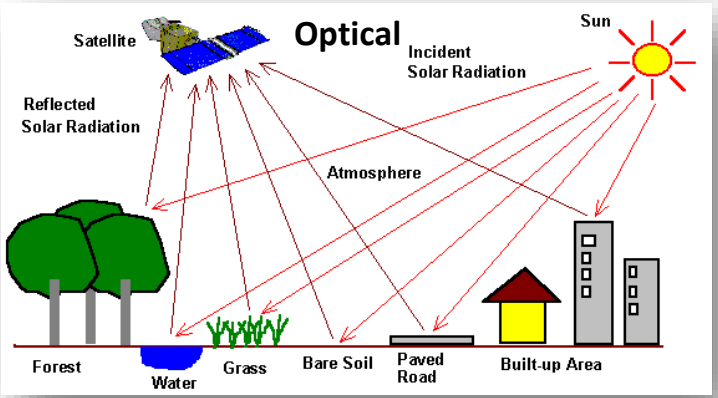
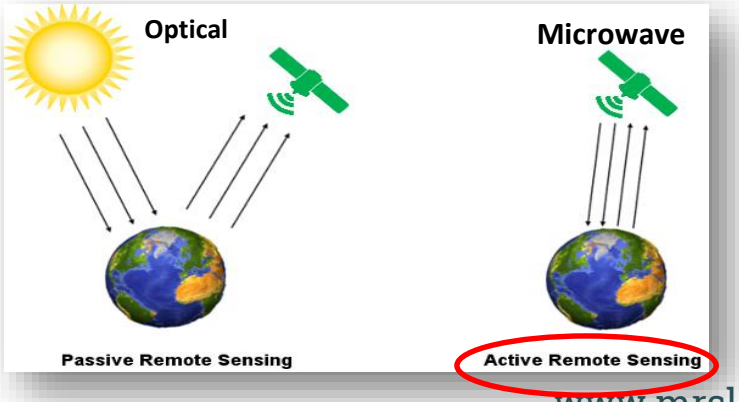
Satellite Remote Sensing

Electromagnetic Wave Spectrum







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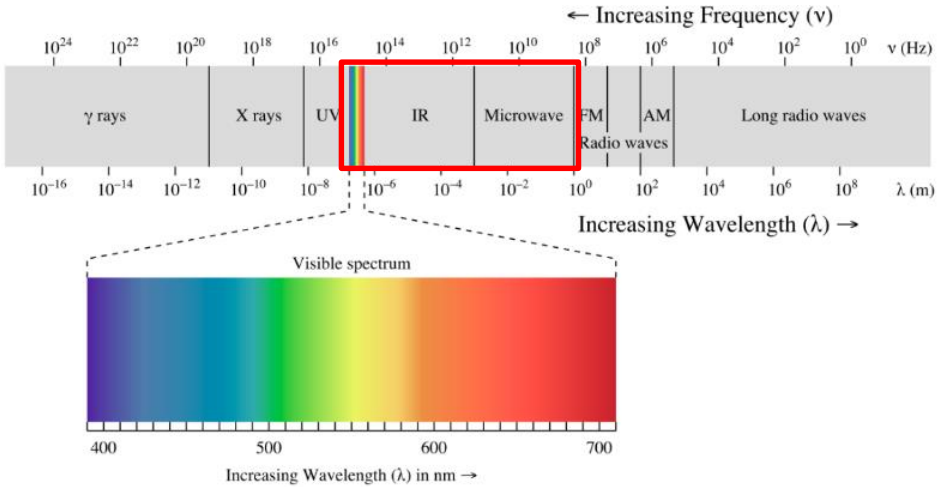
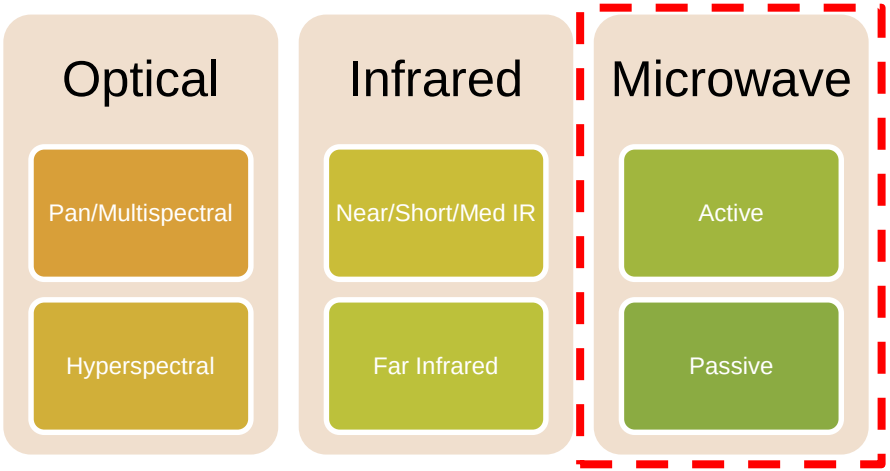
Satellite Data Selection

Major Applications

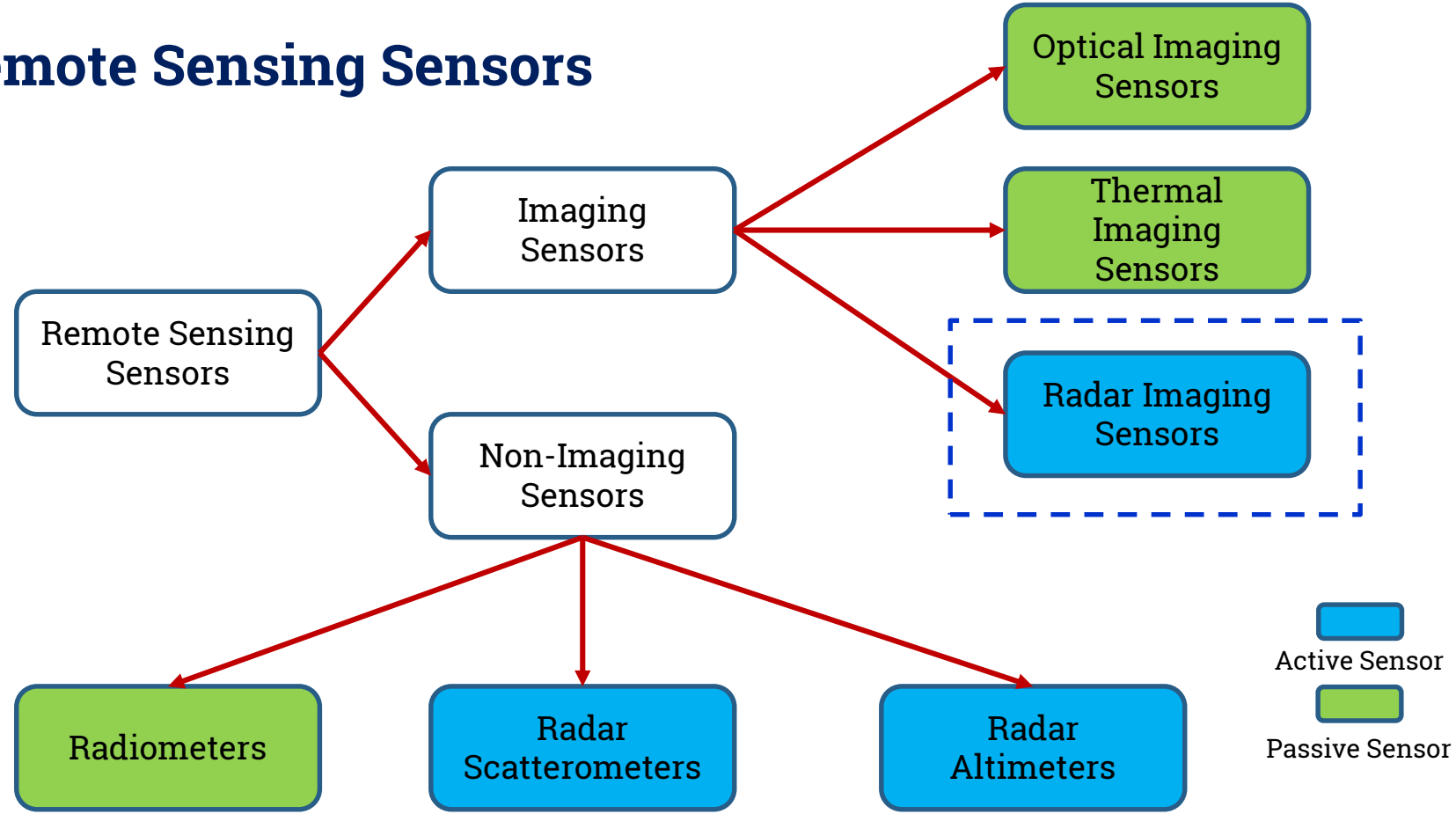
1. **Agriculture and Soil**
2. Forestry
3. Land Use and Land Cover
4. Geosciences
5. Urban and Infrastructure
6. Ocean, Atmosphere and Climate Science
7. Disaster Management Support



Major Remote Sensing Satellite data types



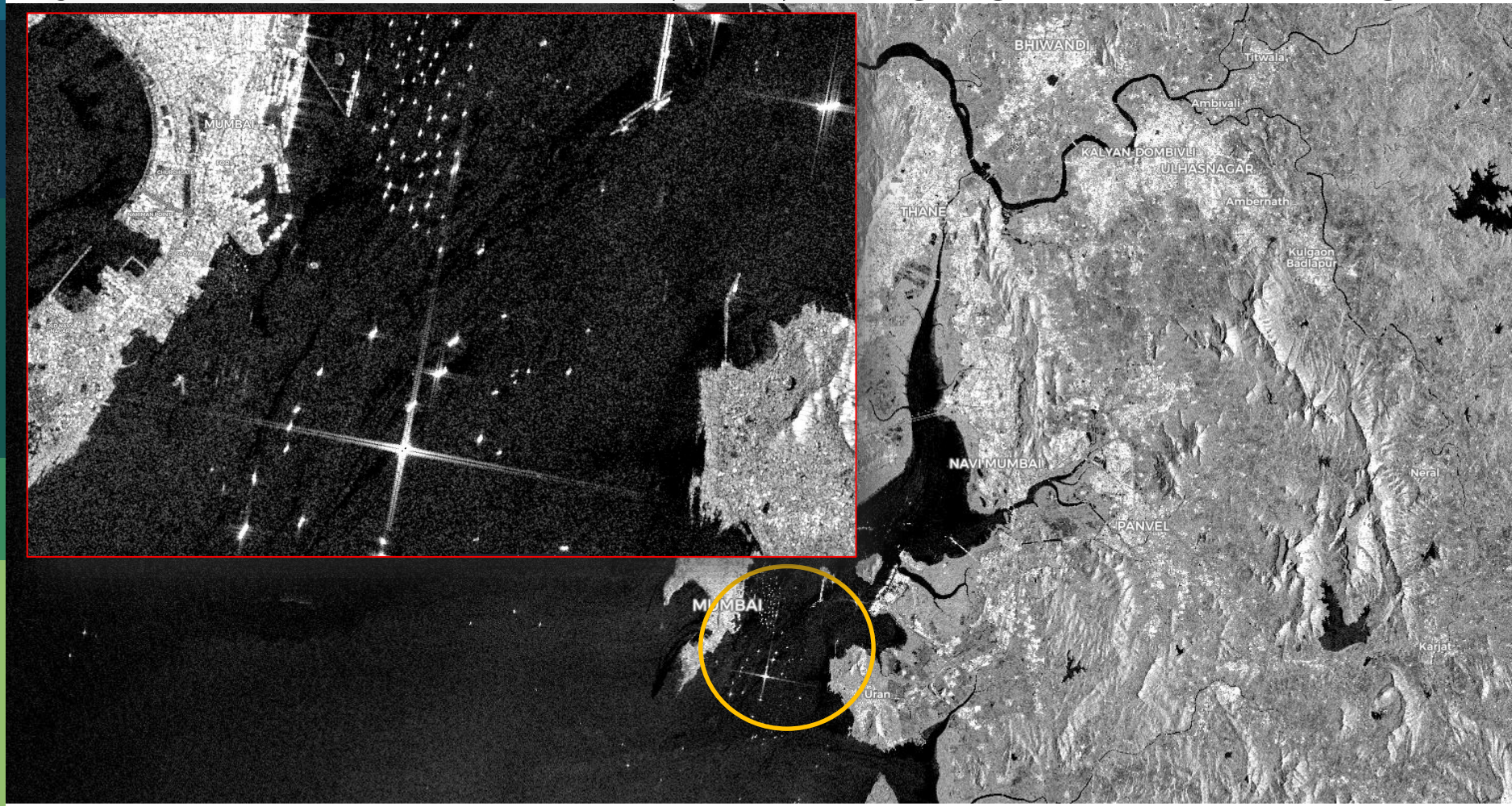
Remote Sensing Sensors



Synthetic Aperture Radar (SAR) Imaging Satellites

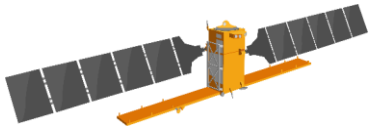
Courtesy: European Space Agency - ESA

Synthetic Aperture Radar (SAR) Imaging Satellites: Images

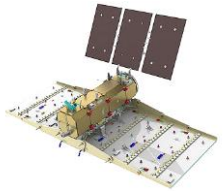


Why Radar Remote Sensing ? Gaining attention/Challenges

- Rapid expansion of constellations of SAR satellites



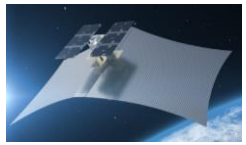
Sentinel-1A/1B



SAOCOM 1A/B

RADARSAT Constellation

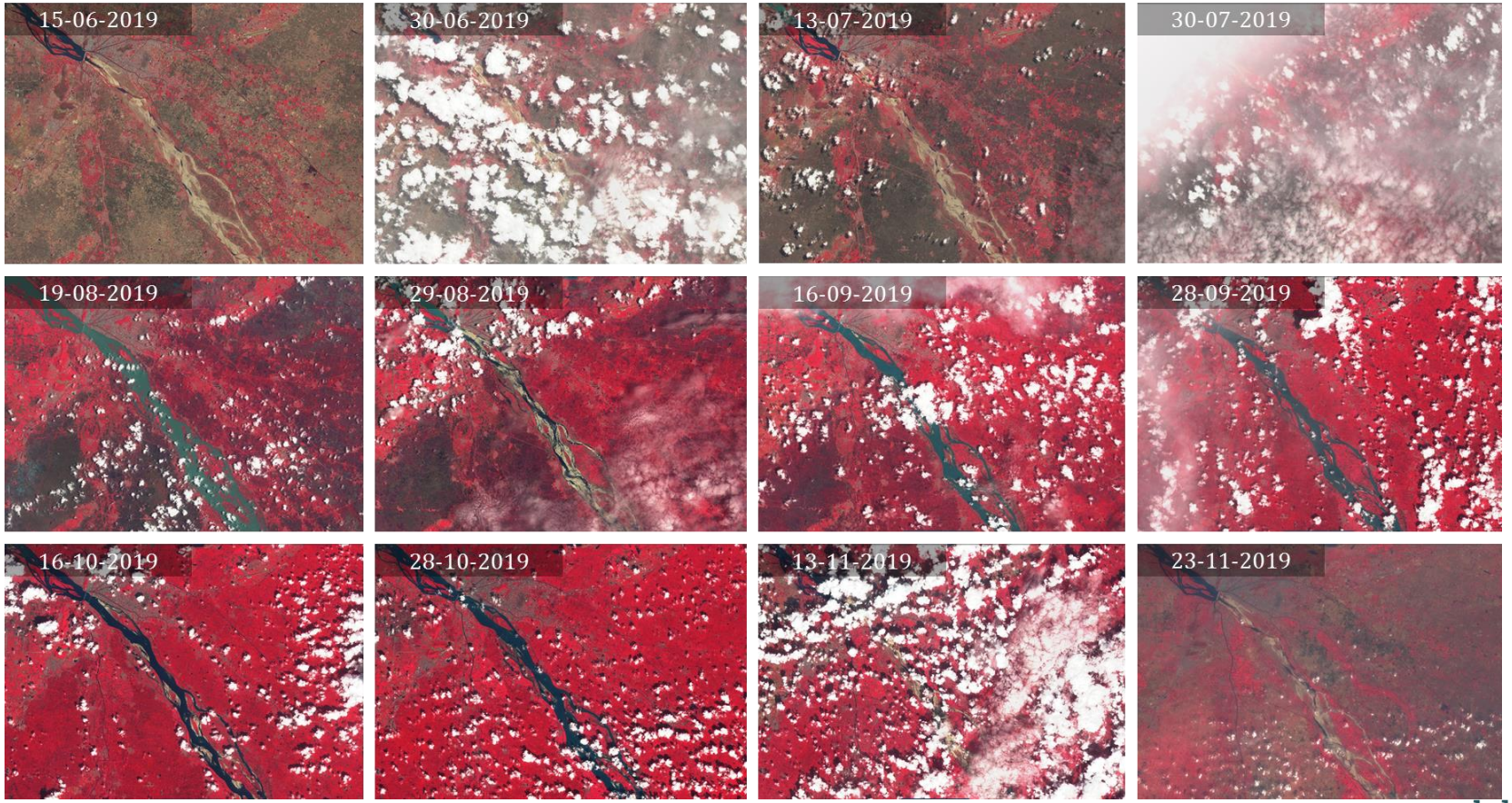
NISAR
NASA - ISRO SAR Mission



Capella X-SAR

- Provide **wide-swath coverage and all-weather monitoring**
- There is an increased need to explore the potential for quantitative estimation of **bio/geo-biophysical parameters** using SAR data
- No proven **single best inversion approaches** for the estimation of biophysical parameters from vegetation models using full and dual polarimetric SAR data
- Due to the **large data volume** of new dual-pol SAR systems, exploration of processing chains for crop inventory map generation at a larger scale is limited.
- **New generation dual and compact-pol SAR** systems provide an opportunity to develop improved algorithms for parameter estimation

Sentinel-2 FCC (843) – Vijayawada, India



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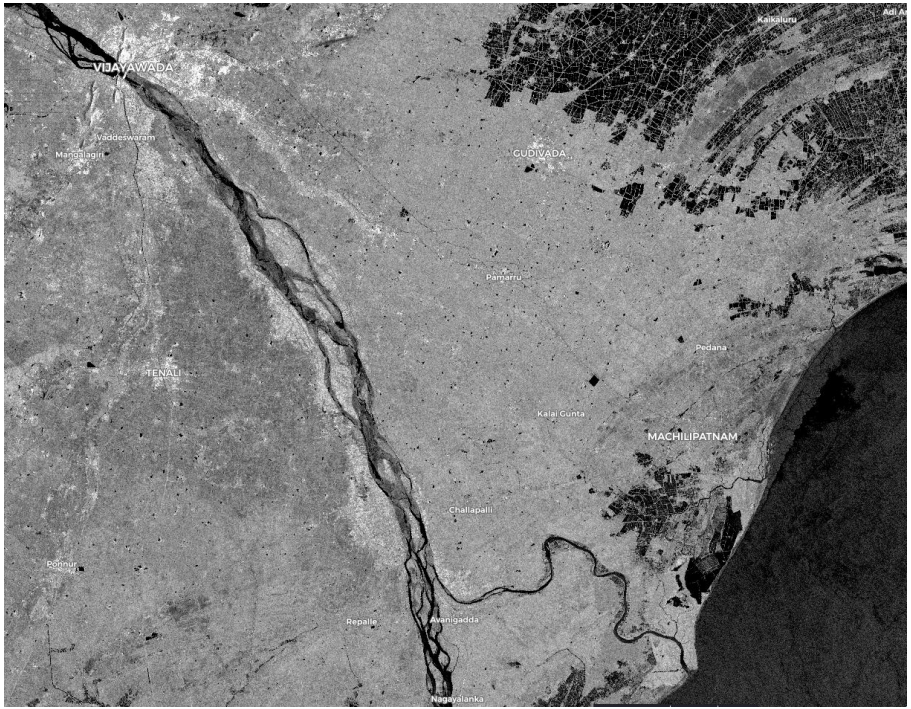
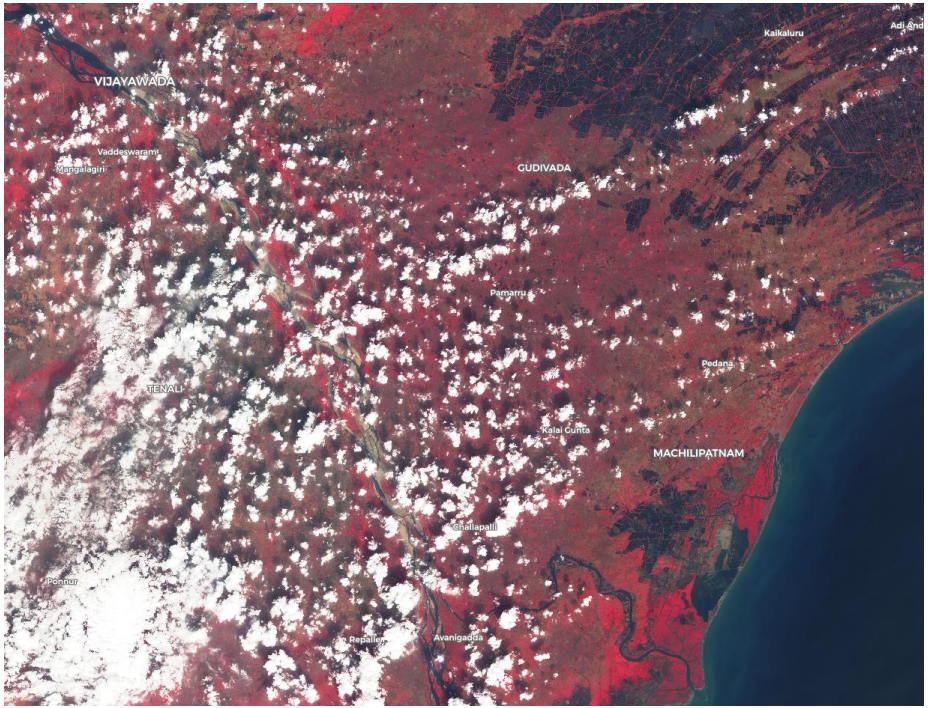
Monitoring **Kharif** season (June – October) crops !



Sentinel-1 SAR image (VV Polarization)

Sentinel-2 Optical Image (FCC)



Advent of the south-west monsoon season

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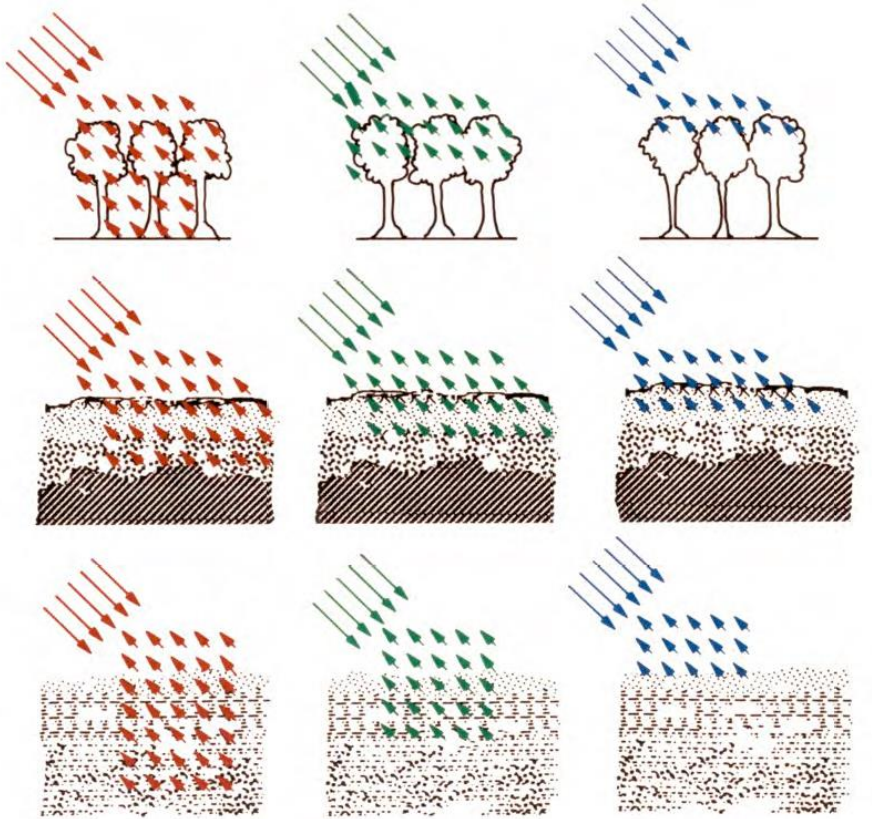
Generic Scattering Properties

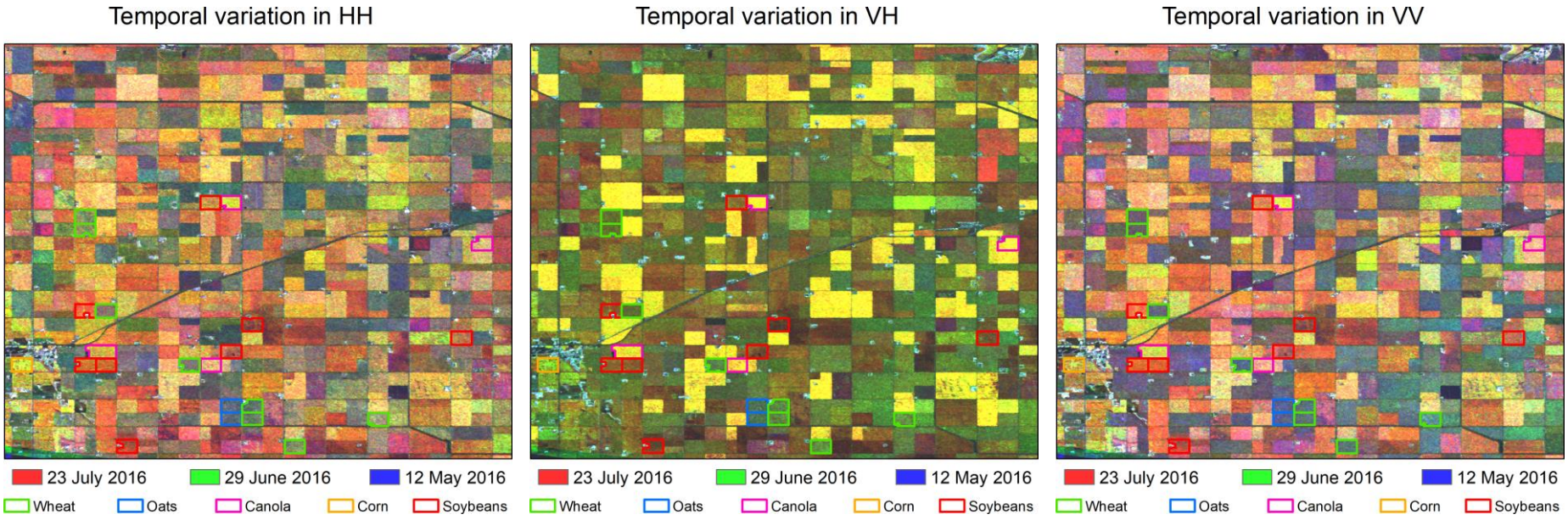
Forest: Leaves interacts with **X-band**, **C-band** can penetrate through the foliage, and **L-band** can possibly see the ground-trunk.

Dry Soil: Surface looks rough with **X-band**, moderate to less rough with **C-band** and **L-band** respectively.

Snow/Ice: Depending on the wetness, the three wavelengths can penetrate to a certain extend in the snow pack. Surface and layering looks rough with **X-band**, moderate to less rough with **C-band** and **L-band** respectively.



Temporal Variation in SAR Backscatter Intensity



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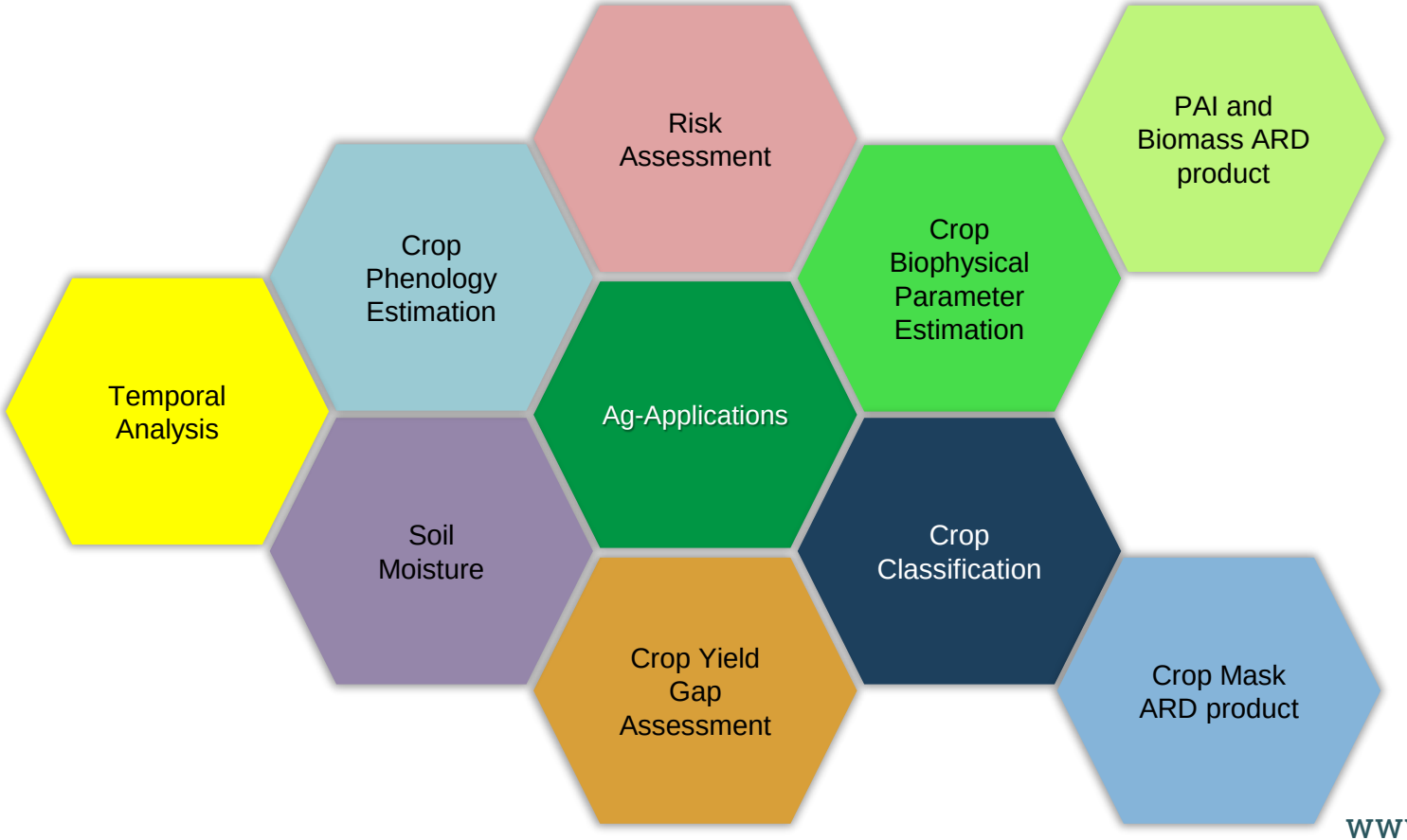
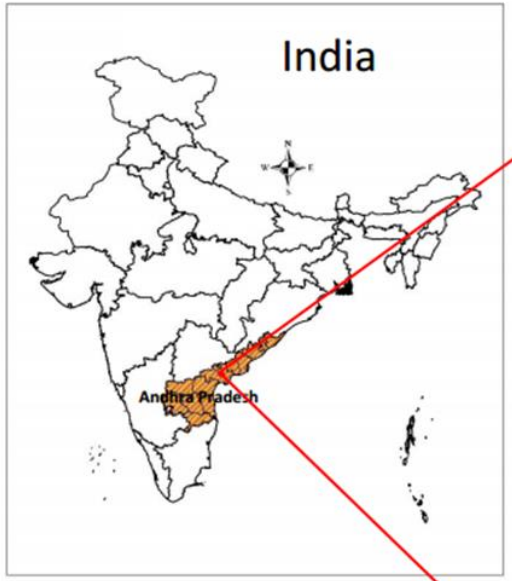
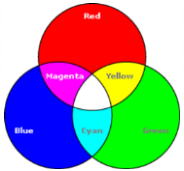
Research Components in SAR Agriculture

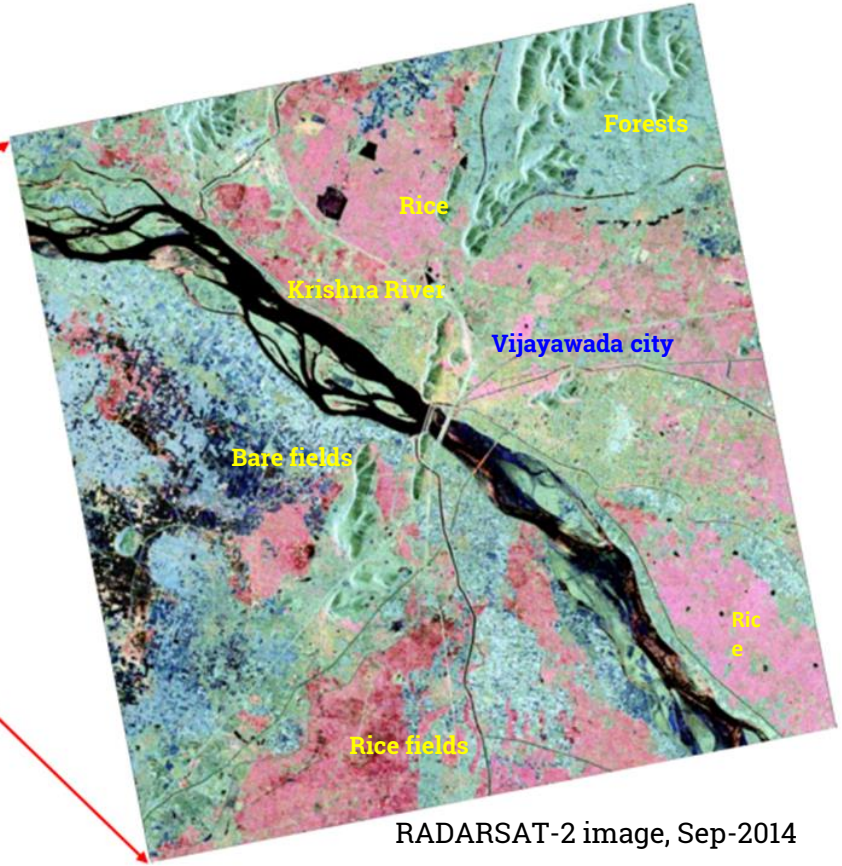


Vijayawada, India: SAR Image Visualization



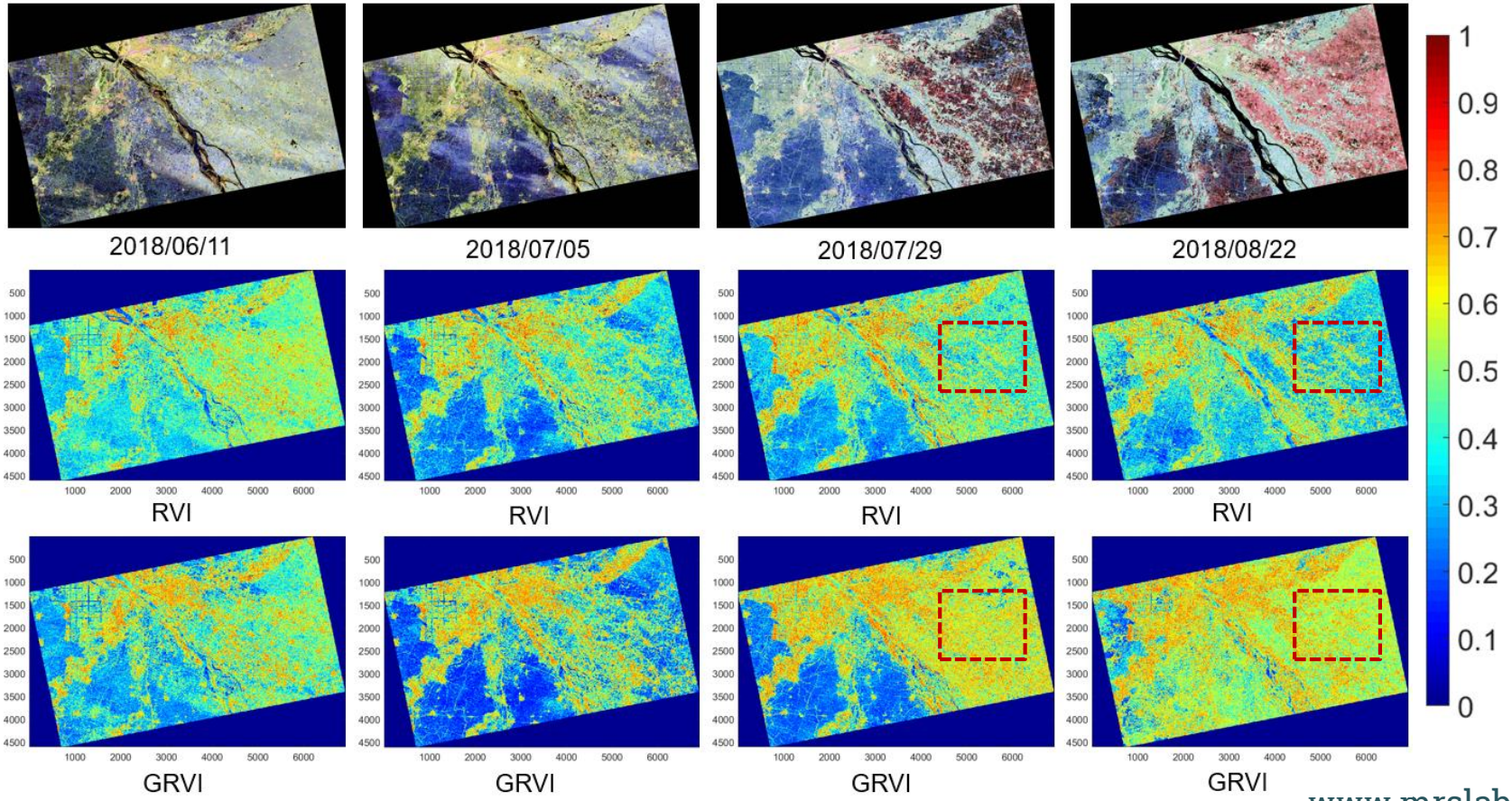


$|HH+VV|$ $|HV|$ $|HH-VV|$



RADARSAT-2 image, Sep-2014

GRVI, Vijayawada, India



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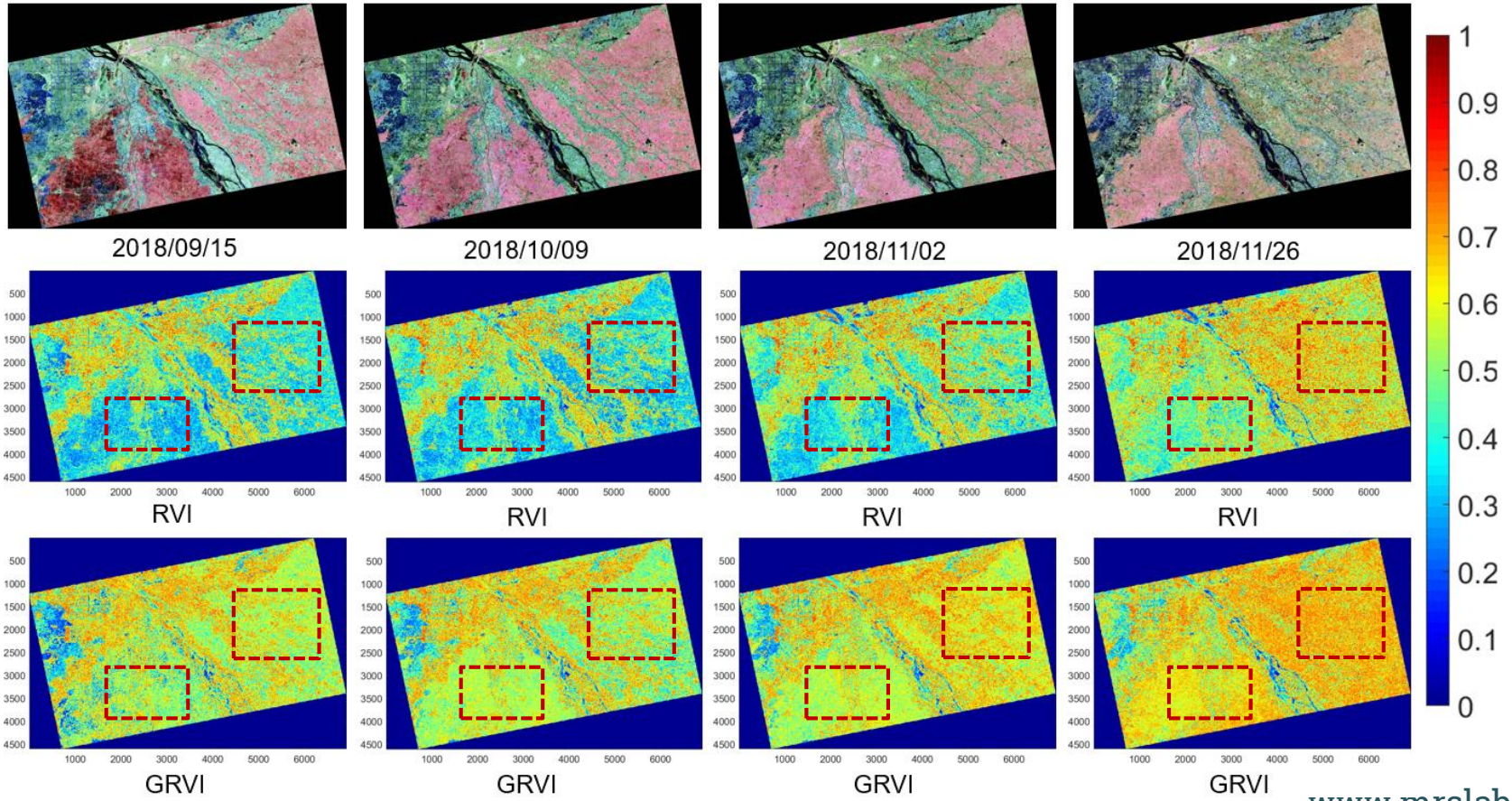
GRVI, Vijayawada, India



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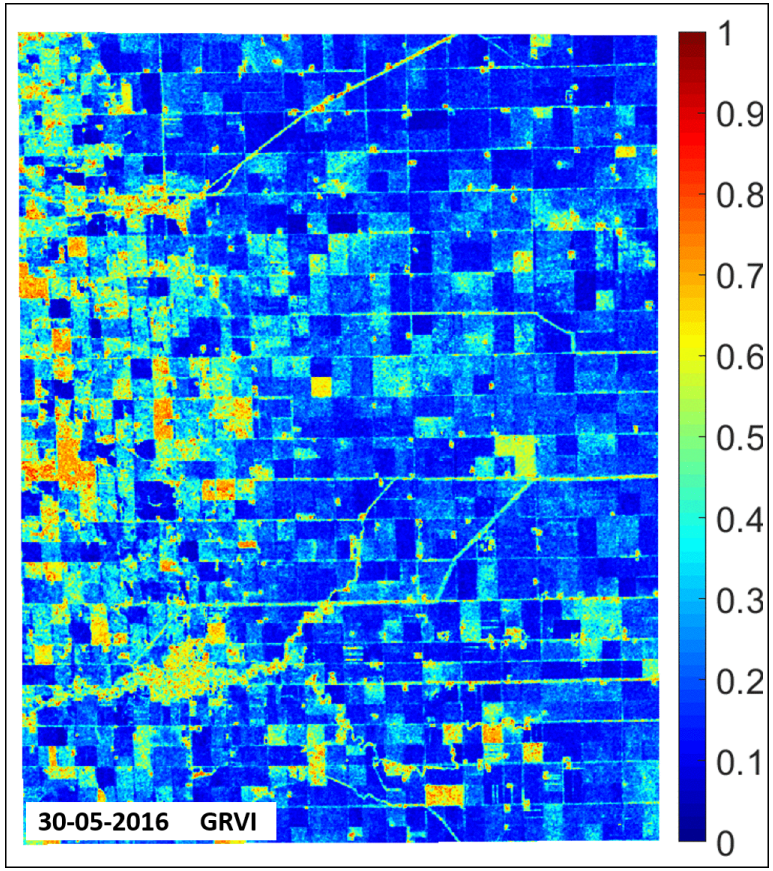

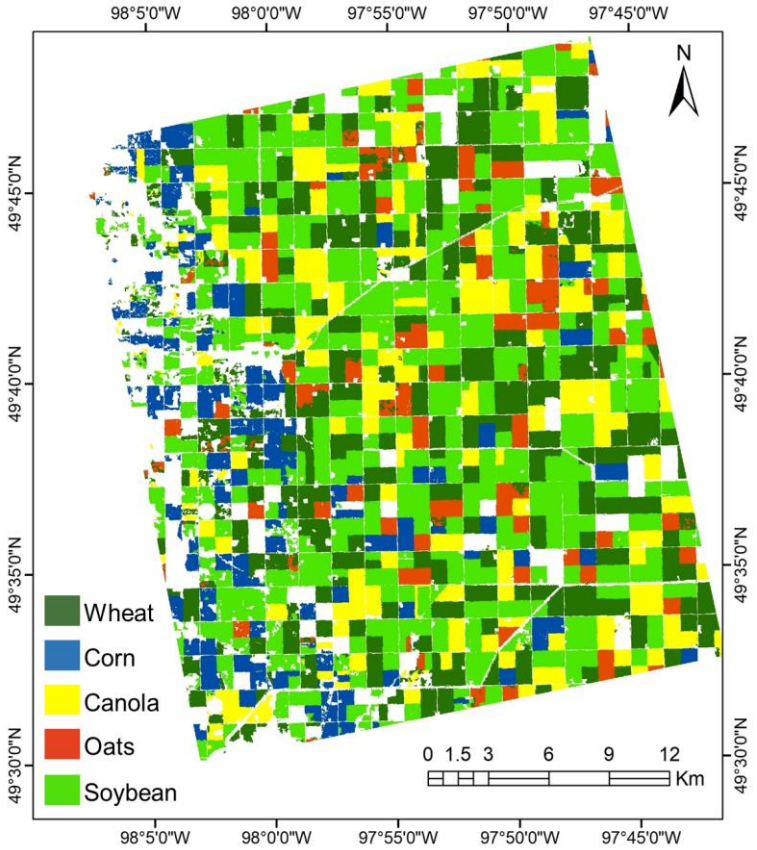

A Generalized Volume Scattering Model Based Vegetation Index from Polarimetric SAR Data,
D. Ratha, D. Mandal, V. Kumar, H. McNairn, A. Bhattacharya and A. C. Frery, ***IEEE Geoscience and Remote Sensing Letters***, 2019

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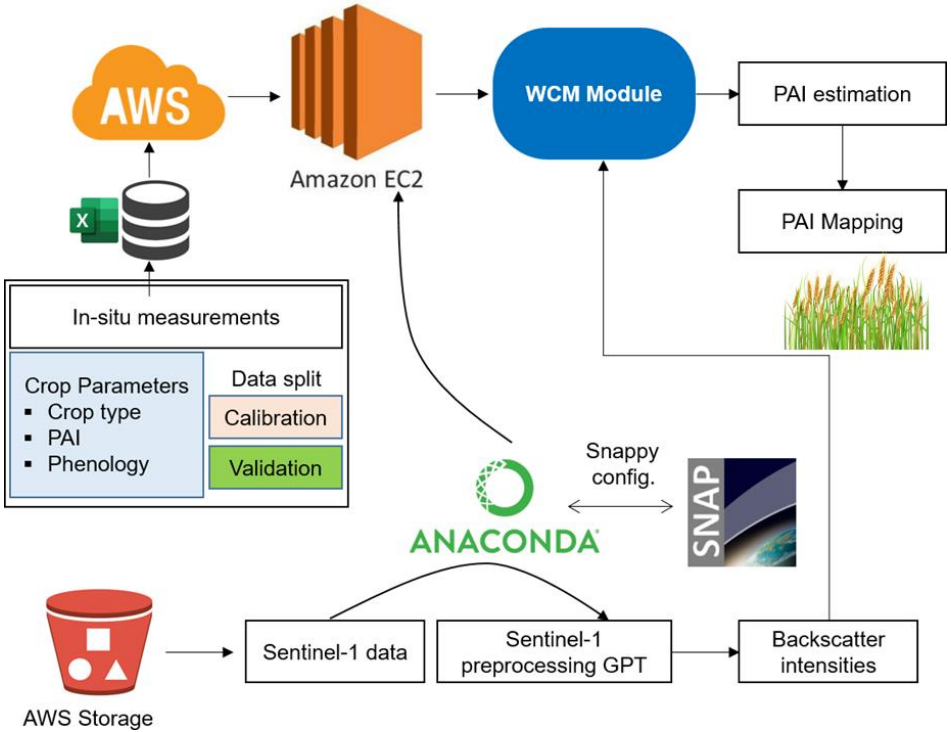
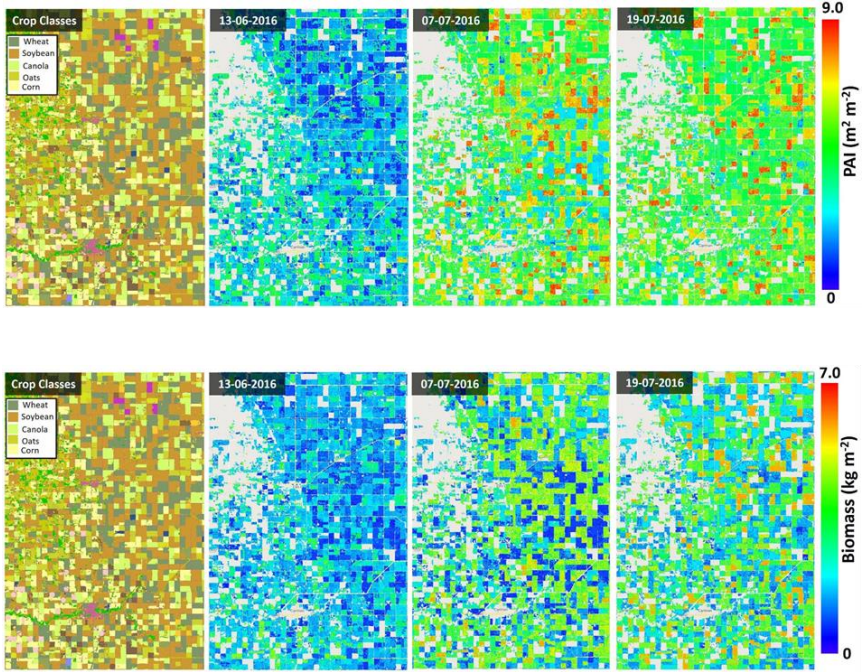
Analysis Ready Data (ARD): PAI and Biomass maps





Sample workflow to generate crop biophysical parameters from **Sentinel-1** data on **AWS cloud platform**

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Codes & Software Availability

PolSAR tools

The codes are available through this link:

https://github.com/Subho07?tab=repositories

The offline version of the code is available from **PolSARTools** QGIS based plugin

https://plugins.qgis.org/plugins/polsar_tools/

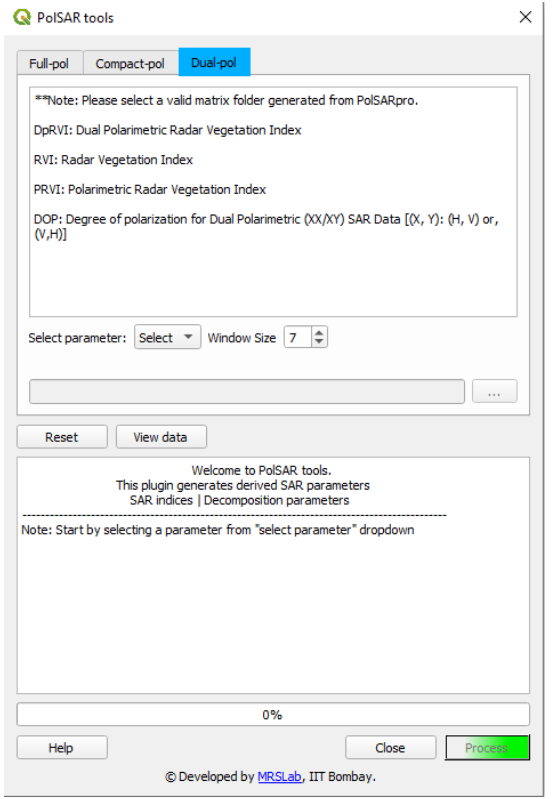
ESA **SNAP** functionalities

- Vegetation Indices :
  - Generalized Radar Vegetation Index (GRVI)
  - Dual-pol Radar Vegetation Index (DpRVI)
  - Compact-pol Radar Vegetation Index (CpRVI)
- Model-free (MF#Components) Decomposition Techniques :
  - MF3CF, MF4CF for full-pol SAR data
  - MF3CC for compact-pol SAR data

PyPI packages

MF3CF: https://pypi.org/project/mf3cf/

MF3CC: https://pypi.org/project/mf3cc/



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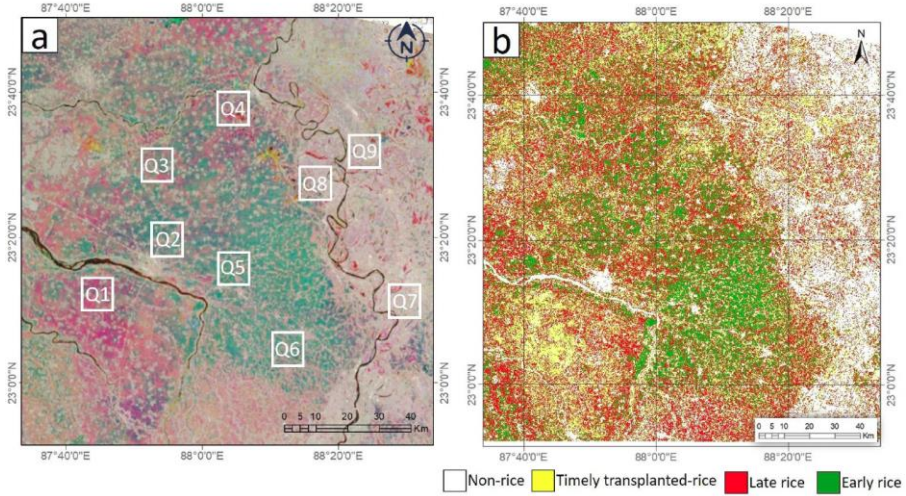
Sen4Rice: Google Earth Engine

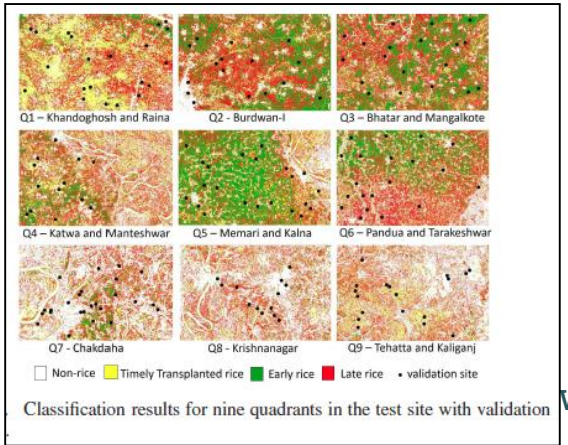


Google Earth Engine

IEEE GEOSCIENCE AND REMOTE SENSING LETTERS 1

Sen4Rice: A Processing Chain for Differentiating Early and Late Transplanted Rice Using Time-Series Sentinel-1 SAR Data With Google Earth Engine

Dipankar Mandal, *Student Member, IEEE*, Vineet Kumar, *Student Member, IEEE*, Avik Bhattacharya, *Senior Member, IEEE*, Yalamanchili Subrahmanyeswara Rao, Paul Siqueira, *Member, IEEE*, and Soumen Bera



Classification results for nine quadrants in the test site with validation

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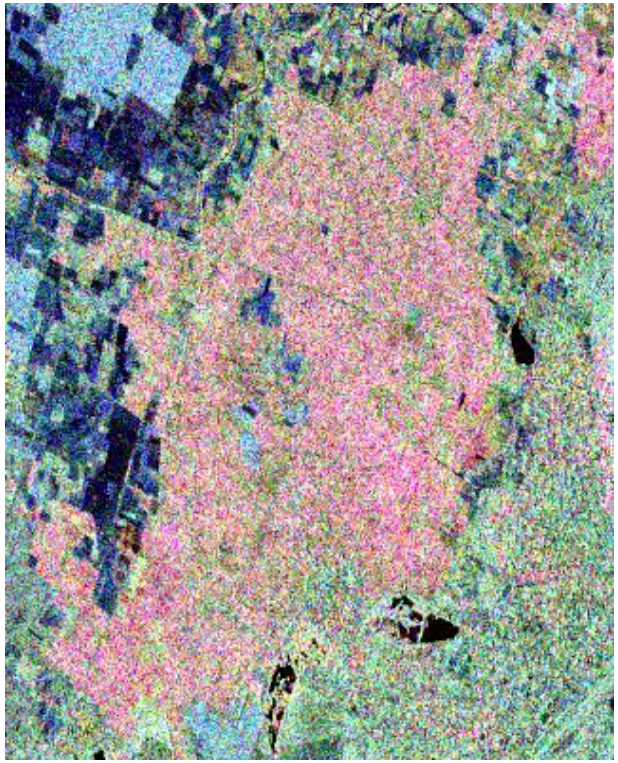
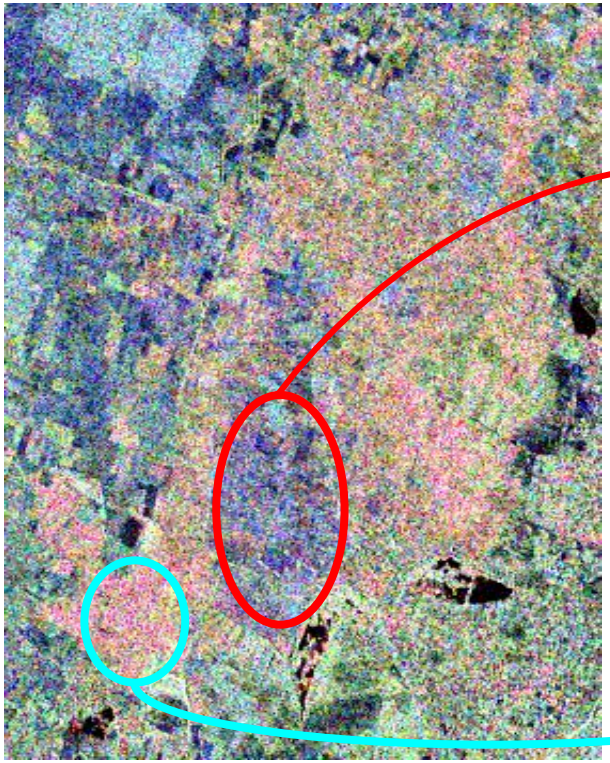
Harvested & Non-Harvested Rice areas Vijayawada, India



16-Nov-2014



10-Dec-2014

Harvested Rice

Non-Harvested Rice

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PolSAR tools

A plugin to generate polarimetric descriptors is now available for QGIS

Developer: MRSLab, IIT Bombay

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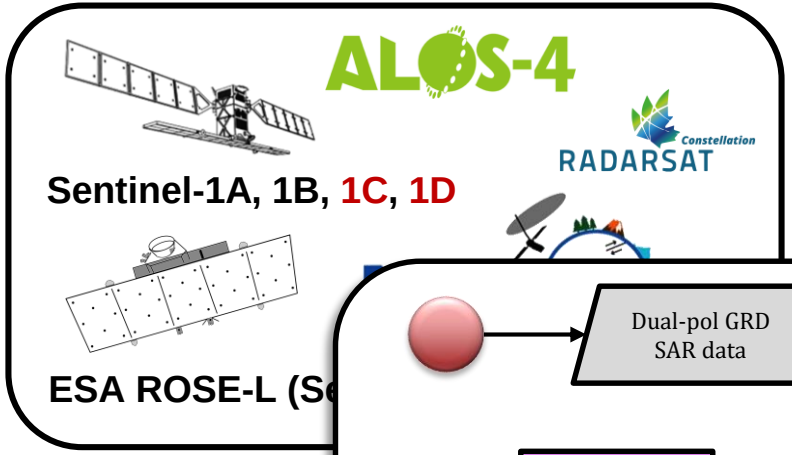

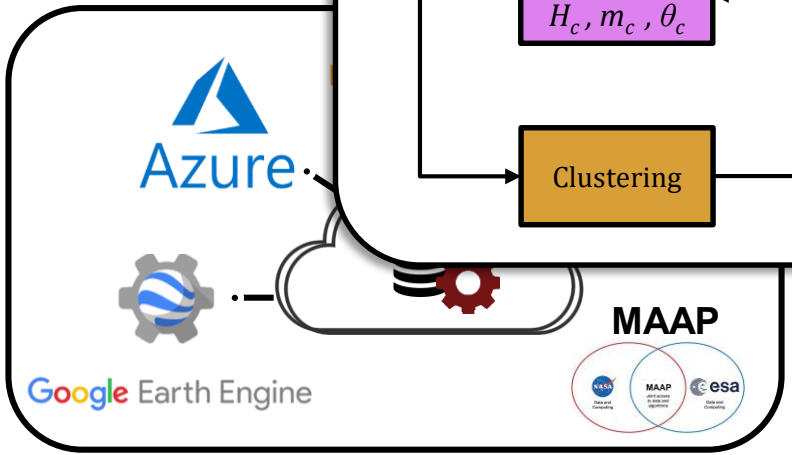

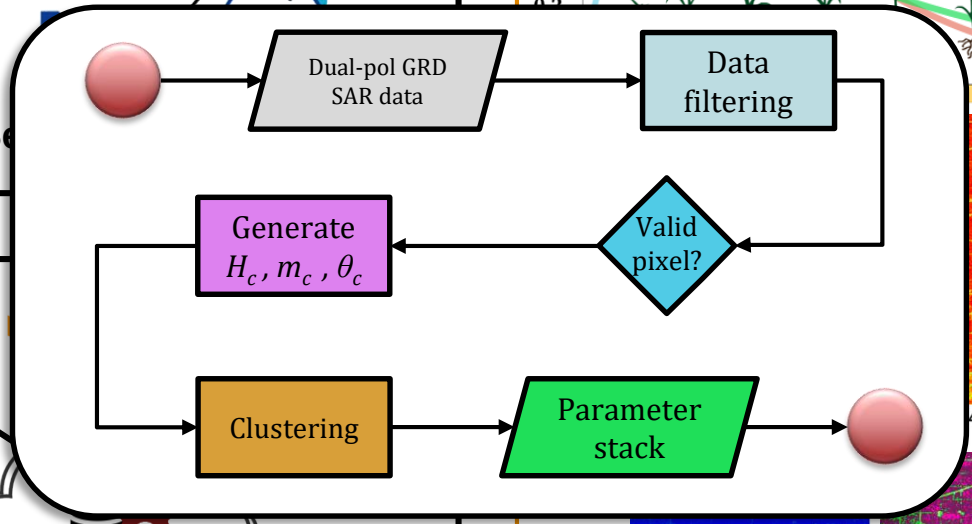

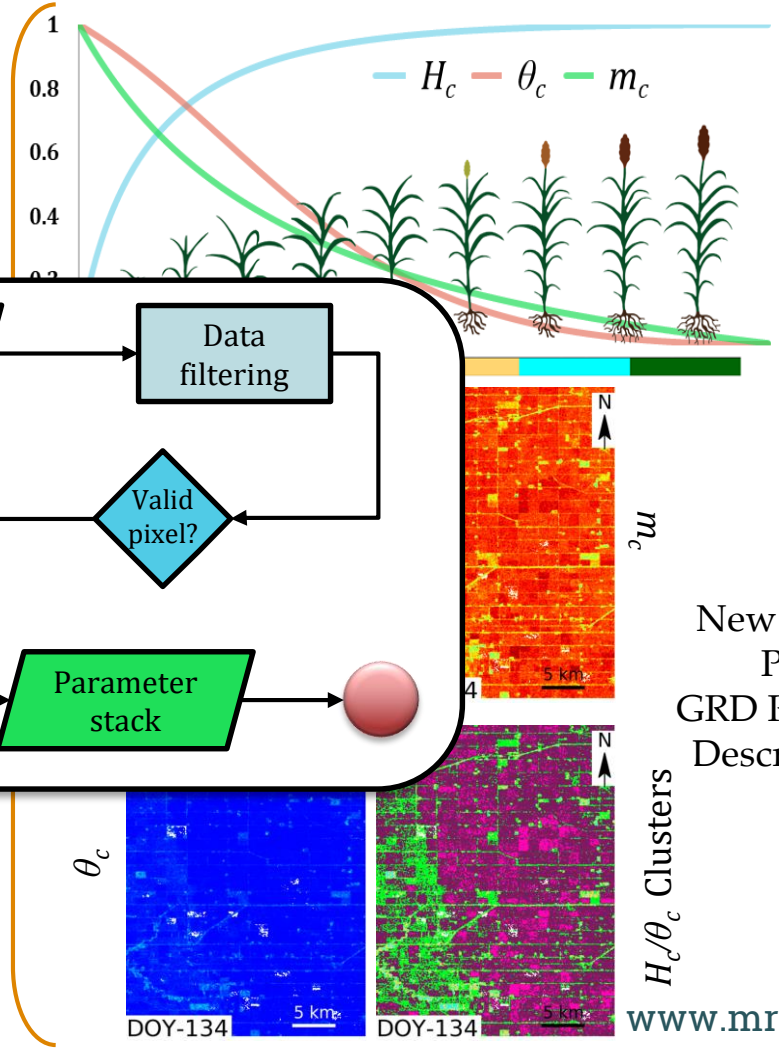

New Dual-Pol GRD Product Descriptors

Google Earth Engine App @ MRSLab
URL: https://bnarayanarao.users.earthengine.app/view/dpgrd

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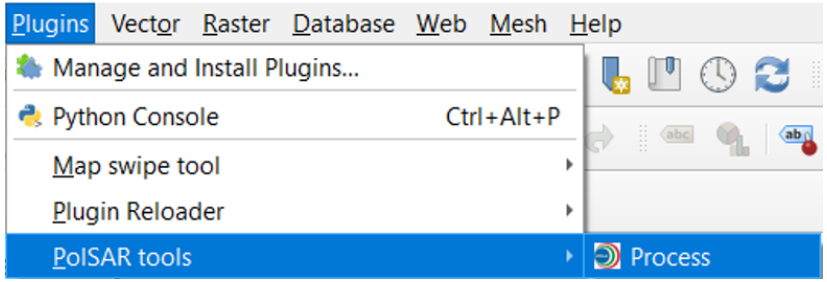
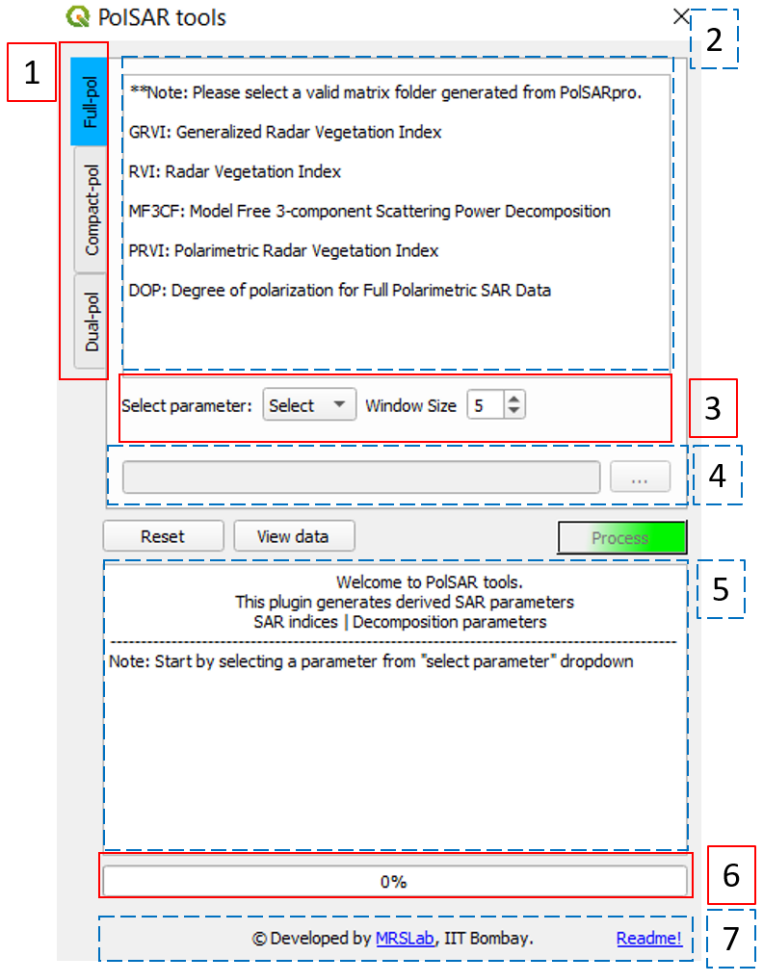
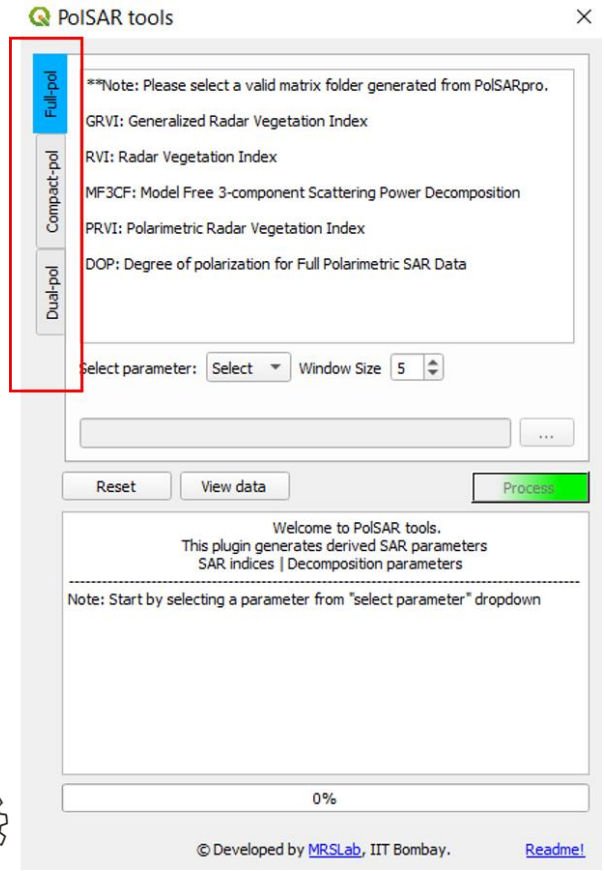
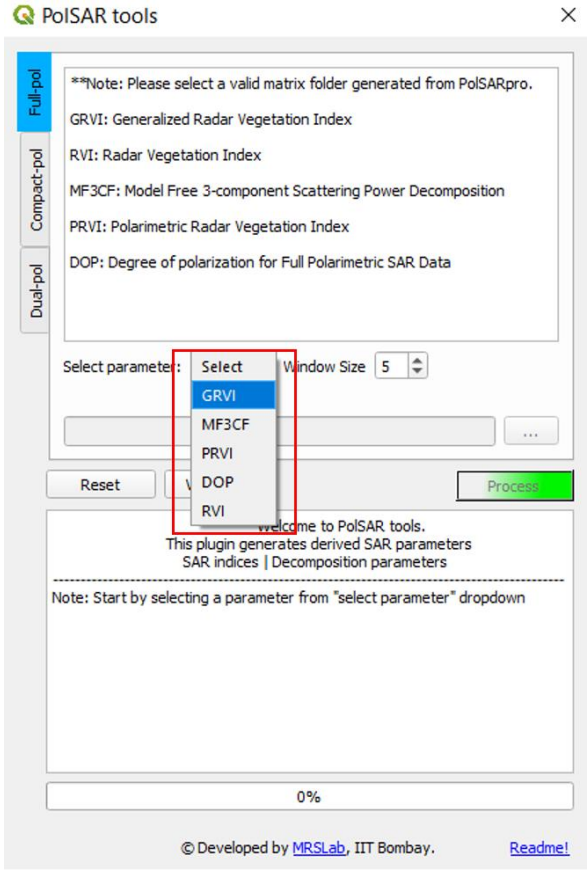
Contributions using QGIS

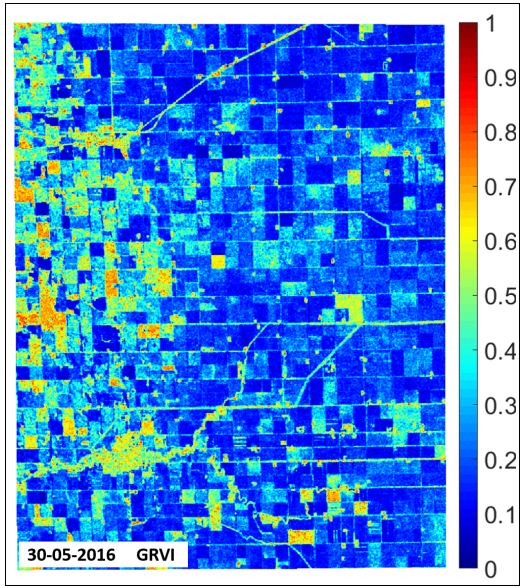




Contributions using QGIS







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The Present & Future of EO

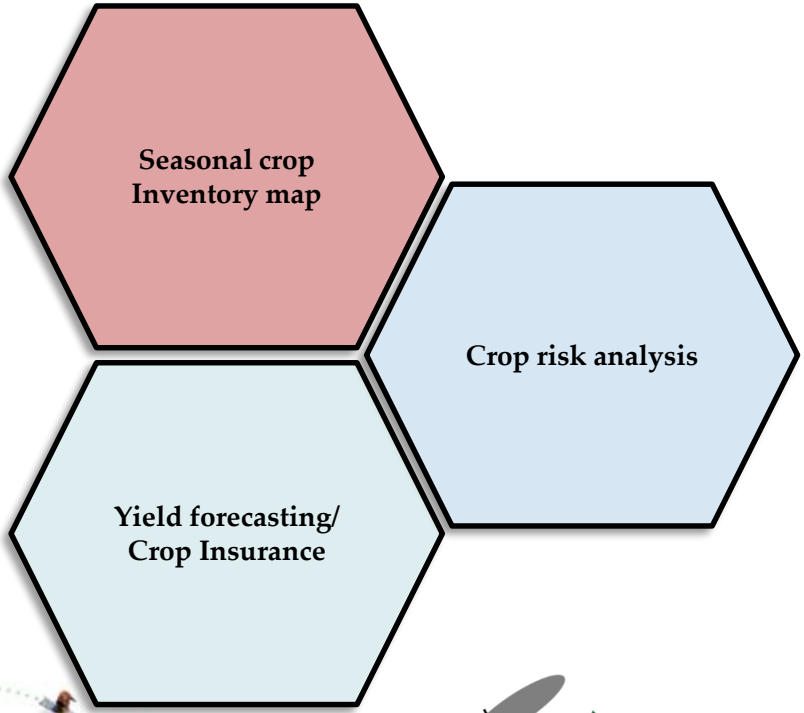
sentinel-1

sentinel-2

LANDSAT

LDCM

Data Continuity Mission



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RISAT-1A

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CONAE

Constellation

RADARSAT

NISAR

NASA - ISRO SAR Mission

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Europe's eyes on Earth

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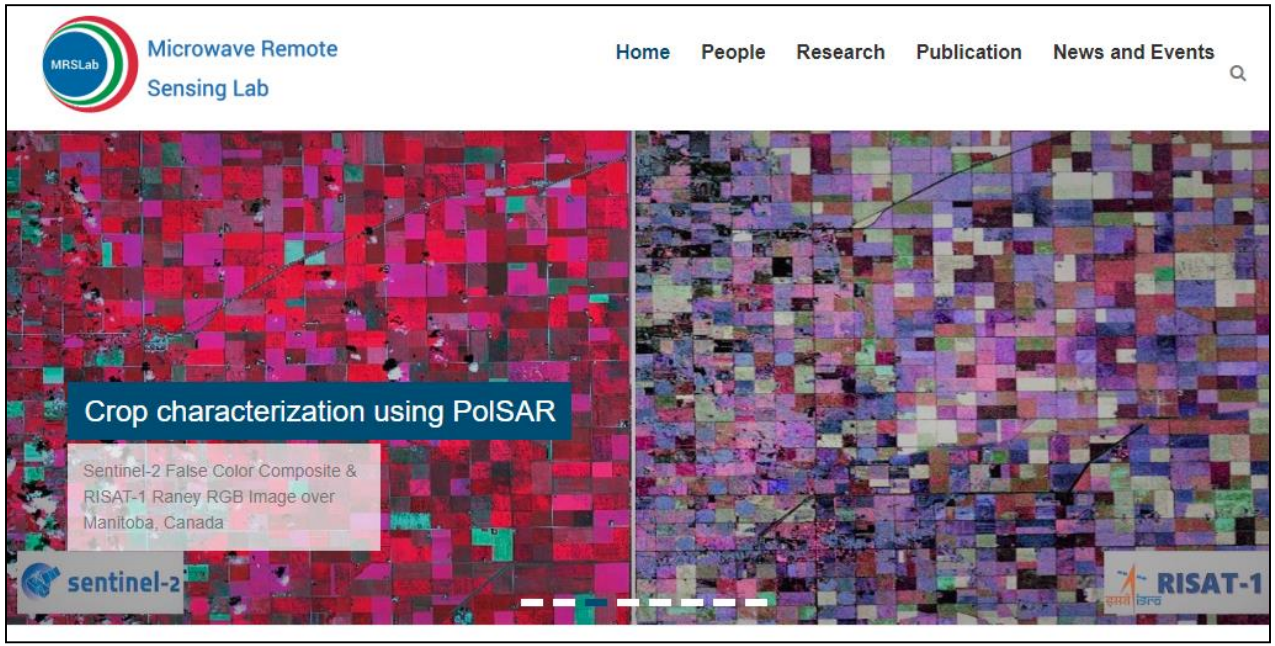
Strengthen Global Agricultural Monitoring



Thank You