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AFRI4CAst
Supporting Food Security & Food Safety in Africa

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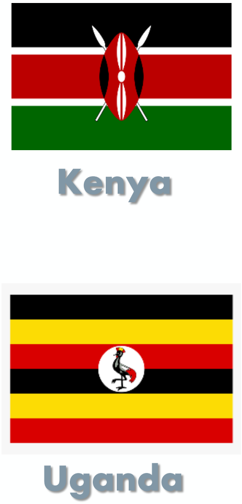
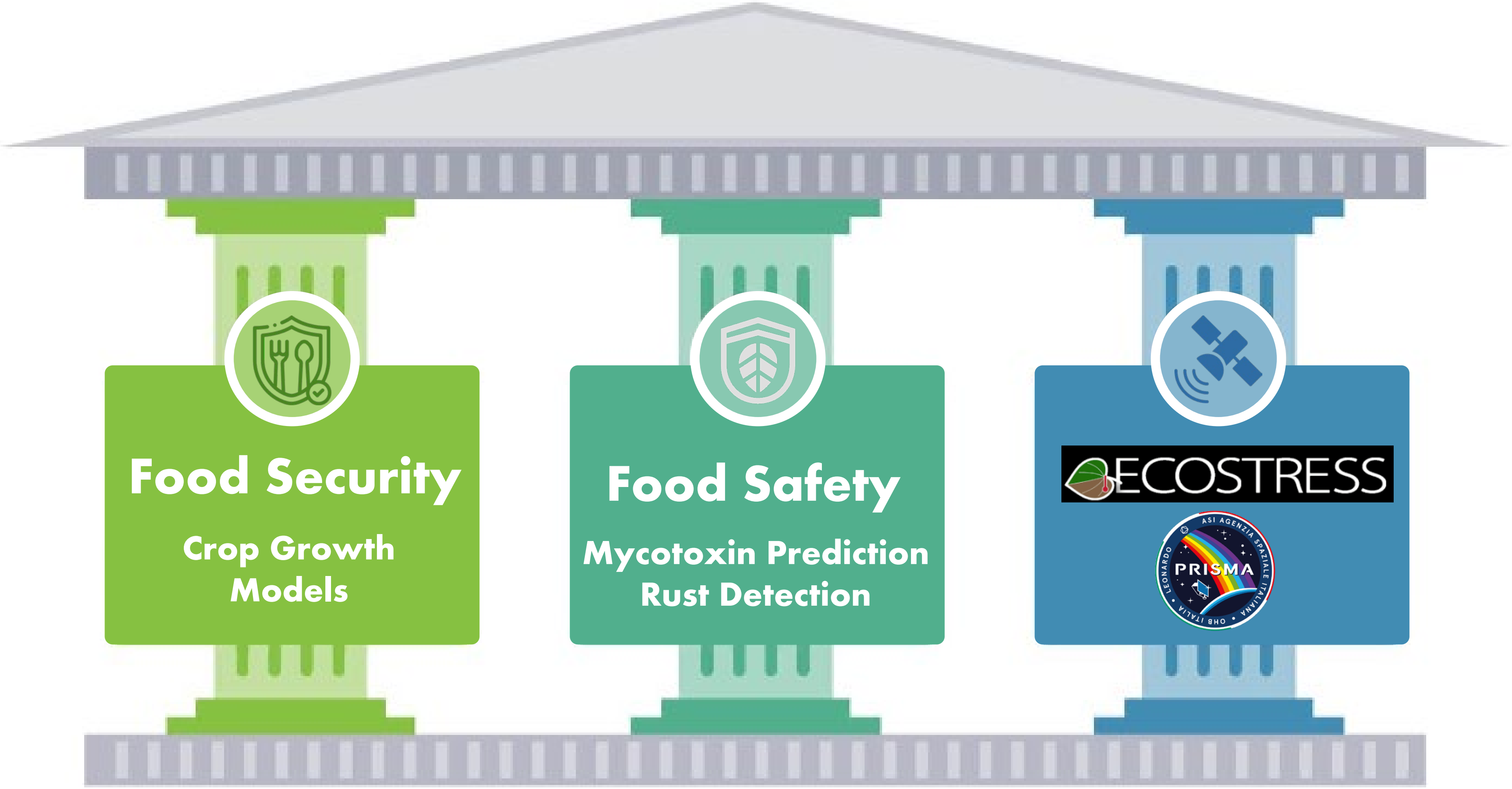
In a nutshell





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Food Security & Safety In-situ Data

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Kenya

UNIVERSITY OF NAIROBI

Collected data

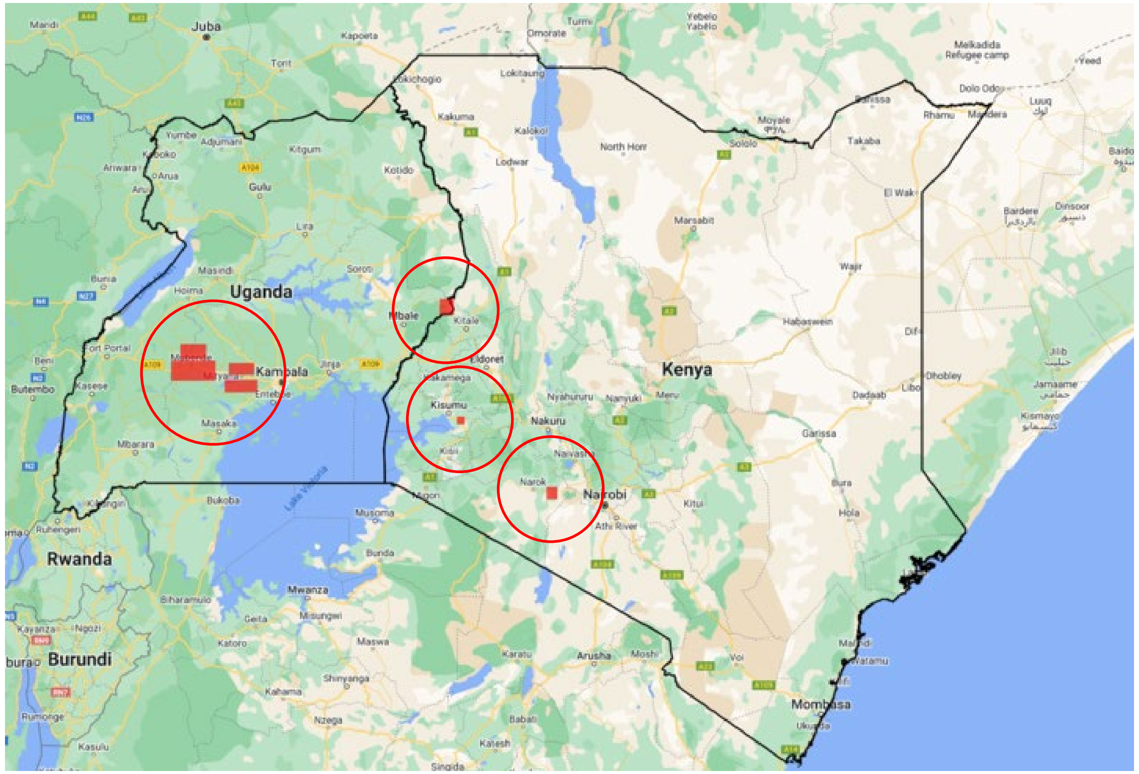
- Agronomic & yield data
- LAI field measurements
- Mycotoxin production
- Rust disease severity
- LAI & chlorophyll

Uganda

Collected data

- Agronomic & yield data
- Rust disease severity

Environmental Surveys
INFORMATION, PLANNING AND POLICY SYSTEMS



Food Security
Crop growth model – AQUACROP

Objectives

- Evaluate the accuracy of AquaCrop to predict wheat, maize, rice yield
- Determine ready-to-use crop files based on satellite derived phenology
- Provide a simple, less data-intensive methodology for future yield prediction

Work Plan

- Locate wheat, maize and rice parcels
- Collect agronomic & yield data
- Use databases on soil & meteorological data
- Acquire satellite images
- Characterize growth based on NDVI evolution
- Classify growth patterns
- Run AquaCrop
- Evaluate the accuracy of yield prediction

Food Security
Crop growth model – AQUACROP

In-situ data

Country	Crop	Location	Parcels	Crop density	Irrigation	Variety	Sowing Harvest	Yield
Kenya		Narok county	36	✓		✓	✓	✓
Kenya		Narok county	74	✓		✓	✓	✓
Kenya		Ahero county	252	✓	✓	✓	✓	✓
Uganda		Bukwo District	149	✓		✓	✓	✓
Uganda		Mubende District	147	✓		✓	✓	✓

EO data

Sentinel - 2

Growing Season

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

$$LAI = 5.7 \cdot GreenWDRVI^2 + 1.7 \cdot GreenWDRVI - 0.08$$

$$GreenWDRVI = \frac{a \cdot NIR - Green}{\alpha \cdot NIR + Green} + \frac{1 - \alpha}{1 + a}$$

$$CC_{RS}(\%) = 94 \cdot [1 - \exp(-0.43 \cdot LAI)]^{0.52}$$

Food Security
Leaf Area Index model – PROSAIL

In-situ data

Country	Crop	Location	Parcels	Chlorophyll	LAI
Kenya		Narok county	50	✓	✓
Kenya		Narok county	50	✓	✓

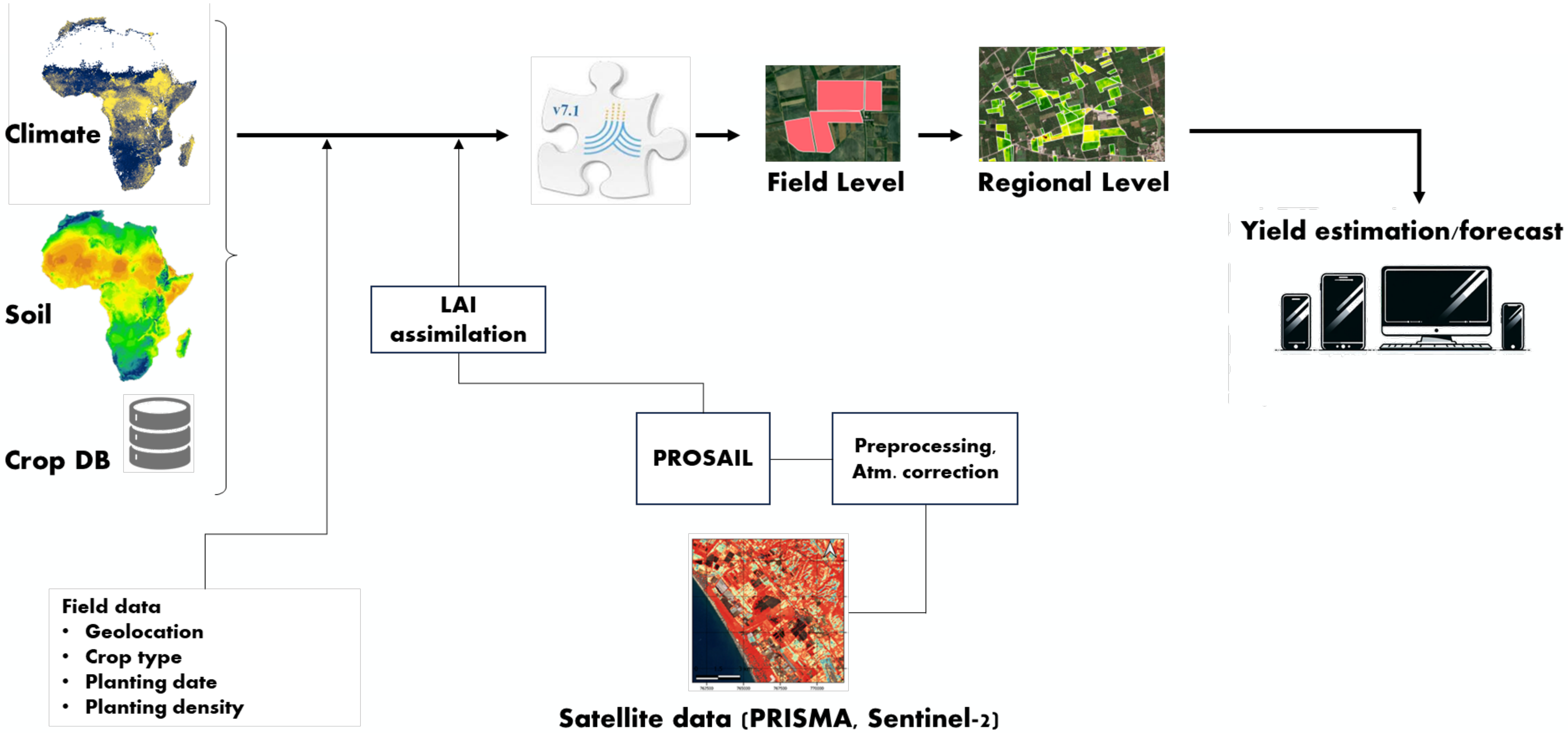
A coupling scheme of PROSAIL with a machine learning regression algorithm to directly extract LAI

EO data

PRISMA sentinel-2

- **Spectral channels**
- **Solar Zenith Angle**
- **Viewing Zenith Angle**
- **Relative Azimuth Angle**

Food Security
Crop growth model – AQUACROP



Objectives

- Develop or evaluate a model for rust detection
- Use satellite data
- Provide a simple methodology for rust detection

Work Plan

- Locate wheat and maize parcels
- Collect in-situ rust detection data
- Acquire satellite images
- Evaluate the accuracy of rust detection

A linear regression model was developed based on an available cloud-free Landsat-8 image that coincided with the 3rd field visit.

35 LandSat-8 fit indices were tested.

Two approaches:
Separate models for each crop in each country.
One model combining all available datasets.

KENYA			KENYA & UGANDA
Wheat data	Maize data	Wheat & Maize data	Wheat & Maize data
CI	INTENSITY	ALTERATION	WRDVI
WDRVI	WETNESS	WETNESS	BWDRVI
INTENSITY	AFRI1600	AFRI1600	variGREEN
AFRI1600	PVR	FE_2	GARI
SIWSI		WRDVI	

Food Safety
Rust Disease Detection

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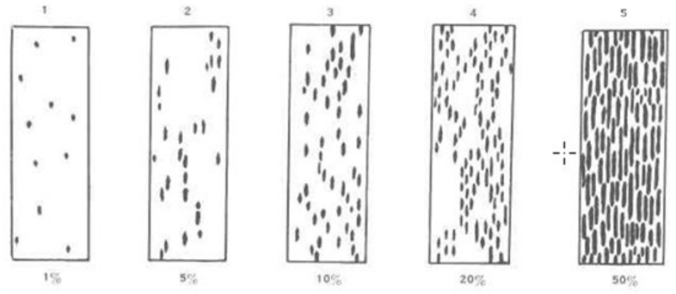
In-situ data

Country	Crop	Location	Parcels	Rust Scoring	Variety	Sowing Harvest
Kenya		Narok county	50	✓	✓	✓
Kenya		Narok county	50	✓	✓	✓
Uganda		Bukwo District	40	✓	✓	✓



EO data

LandSat-8

Specific dates

Enhanced Vegetation Index 2
Ferric iron, Fe^{2+}
Ferric iron, Fe^{3+}
Global Vegetation Moisture Index
Green atmospherically resistant vegetation index
Green Optimized Soil Adjusted Vegetation Index
Green Soil Adjusted Vegetation Index
Green-Blue NDVI
Green-Red NDVI
Ideal vegetation index
Intensity

Aerosol free vegetation index 1600
Alteration
Ashburn Vegetation Index
Atmospherically Resistant Vegetation Index
Atmospherically Resistant Vegetation Index 2
Blue-wide dynamic range vegetation index
Chlorophyll Index Green
Coloration Index
Green Normalized Difference Vegetation Index
Differenced Vegetation Index MSS
Enhanced Vegetation Index

Mid-infrared vegetation index
Norm G
Norm NIR
Norm R
Normalized Difference Plant pigment ratio
Normalized Difference Photosynthetic vigor ratio
Normalized Difference 860/1640
Specific Leaf Area Vegetation Index
Tasselled Cap – vegetation
Tasselled Cap – wetness
Weighted Difference Vegetation Index
Wide Dynamic Range Vegetation Index

Food Safety
Prediction of Mycotoxins Production

Objectives

- Develop or evaluate a model for aflatoxin B_1 and deoxynivalenol (DON) prediction
- Use agro-meteorological data
- Provide a simple methodology for aflatoxin contamination risk prediction

Work Plan

- Locate maize parcels
- Perform maize kernels sampling & analysis
- Acquire meteorological data
- Evaluate the accuracy of the mechanistic weather-driven models

Risk Levels	Aflatoxin	Deoxynivalenol
no risk	9.6% (n=5)	-
very low risk	-	-
low risk	90.4% (n=47)	78.8% (n=41)
moderate risk	-	7.7% (n=4)
high risk	-	3.8% (n=2)
very high risk	-	9.6% (n=5)

Food Safety
Prediction of Mycotoxins Production

In-situ data

Country	Crop	Location	Parcels	Aflatoxin DON	Aflatoxin AFB_1	Variety	Sowing Harvest
Kenya		Narok county	52	✓	✓	✓	✓

Sampling · Grinding · Extraction · Analysis (detection & quantification)

Meteorological data & tested models

Model Input:

- Temperature (min, max, average)
- Relative Humidity
- Cumulative daily Precipitation

ERA-5, ERA-5 Land

Aflatoxin model

Aflatoxin B_1 Index: AFI

AFI < 40 = no risk

40 < AFI ≤ 120 = low risk

120 < AFI ≤ 150 = intermediate risk

150 < AFI ≤ 180 = high risk

Deoxynivalenol model

Five levels of risk for DON

DON ≤ 0.1 indicates very low risk

0.1 < DON ≤ 0.9 low risk

1 < DON ≤ 1.9 intermediate risk

2 < DON ≤ 4,9 high risk

DON > 5 very high risk

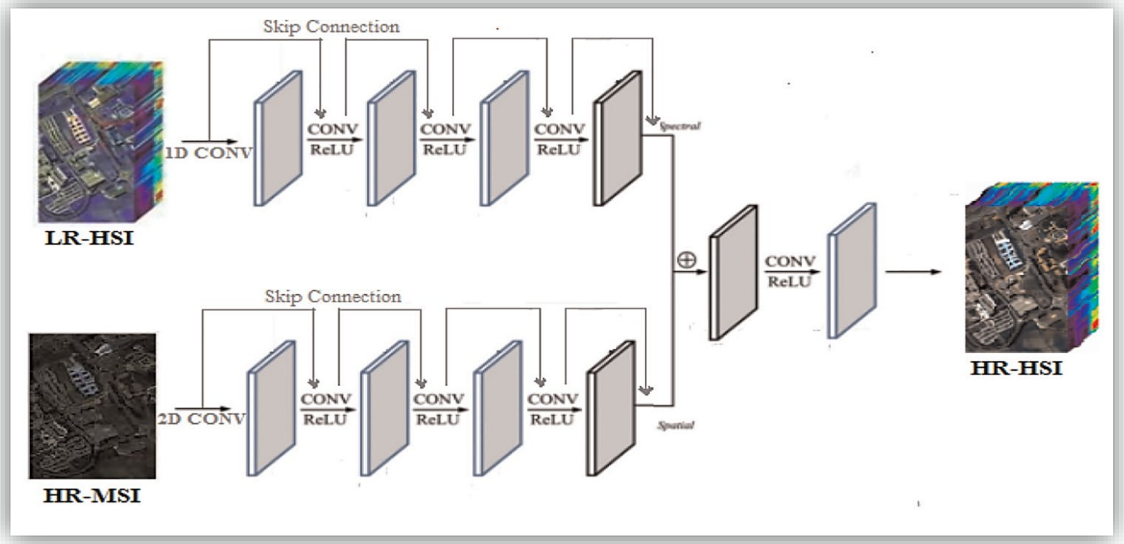
EO Data Products
Hyperspectral Data Fusion

Objectives

- Spatial Enhancement of hyperspectral imagery
- Downscale from 30 m to 10 m spatial resolution
- Apply a Deep Learning model: Guided Deep Decoder (GDD) for unsupervised HS-MS fusion & Zero-Shot Learning

Work Plan

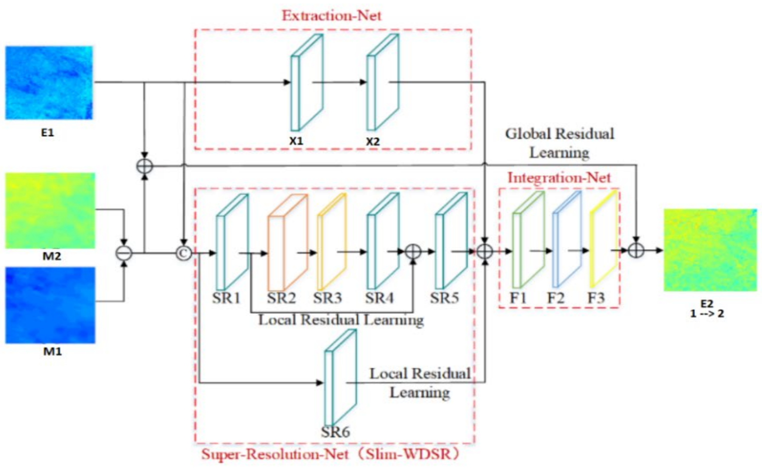
- Locate PRISMA & S2 images depicting the same area
- Acquire the cloud free satellite images
- Evaluate the DL model

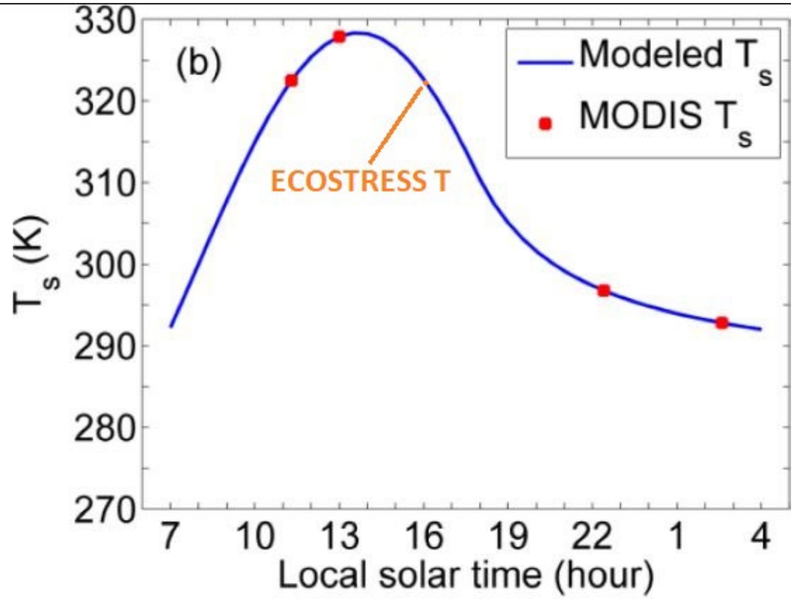


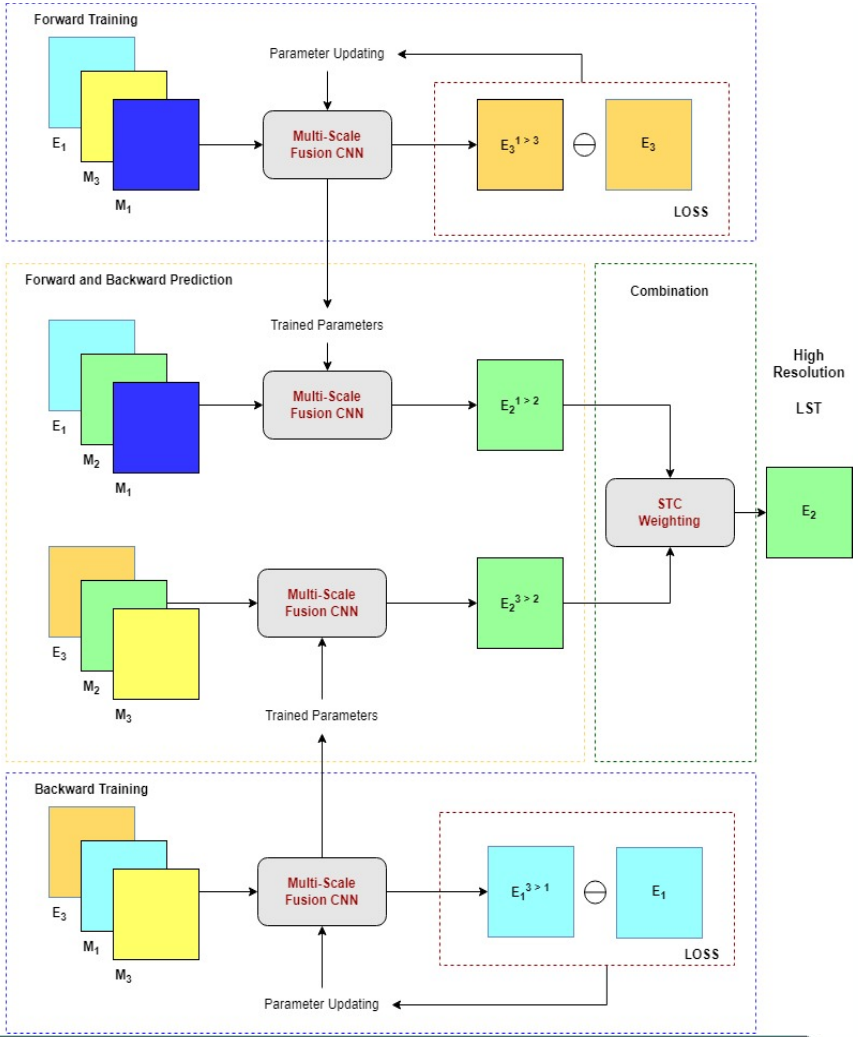
EO Data Products
Spatiotemporal Enhancement of ECOSTRESS imagery

Objectives

- **Diurnal Temperature Cycle (DTC) modeling with MODIS LST data**
- **External validation of DTC with Sentinel-3 LST**
- **Spatiotemporal Fusion Network**







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