

## ARIES // EO Africa

African Framework for Research  
Innovation, Communities and Applications



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**Open-source hyperspectral and thermal  
EO algorithms: Informing irrigated  
agriculture in Africa**

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<sup>2</sup>**VITO** Vlaamse Instelling voor  
Technologisch Onderzoek

<sup>3</sup>**LIST** Luxembourg Institute of  
Science and Technology

<sup>4</sup>**AKTC** Zambian Agricultural  
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Center

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# ARIES // EO Africa Explorer



## R&D Platform

**Goals:** Develop **experimental EO analysis techniques**. Use experiences to inform **future missions**. Make plant water and drought indicator **products available** on online **platform**.



[eoafrica-aries.org](http://eoafrica-aries.org)  
[eo4society.esa.int/eo-africa/](http://eo4society.esa.int/eo-africa/)

Test sites in Senegal, Mali, Niger and Zambia

## Data



**High-resolution hyperspectral & thermal data** combined with in-situ data **for drought monitoring**



## Partnership



## Impact



**Knowledge sharing, capacity development and policy relevance**

Contribute to **Food Security**

**Main focus = impact of drought/water stress on crop and forage productivity at high spatial resolution and temporal frequency.**



(Irrigated) cropland monitoring

Near-real time and sub-field scale!

Need for data fusion and augmentation techniques

Rangeland monitoring

Both spatial and temporal requirements are lower compared to the cropland case.

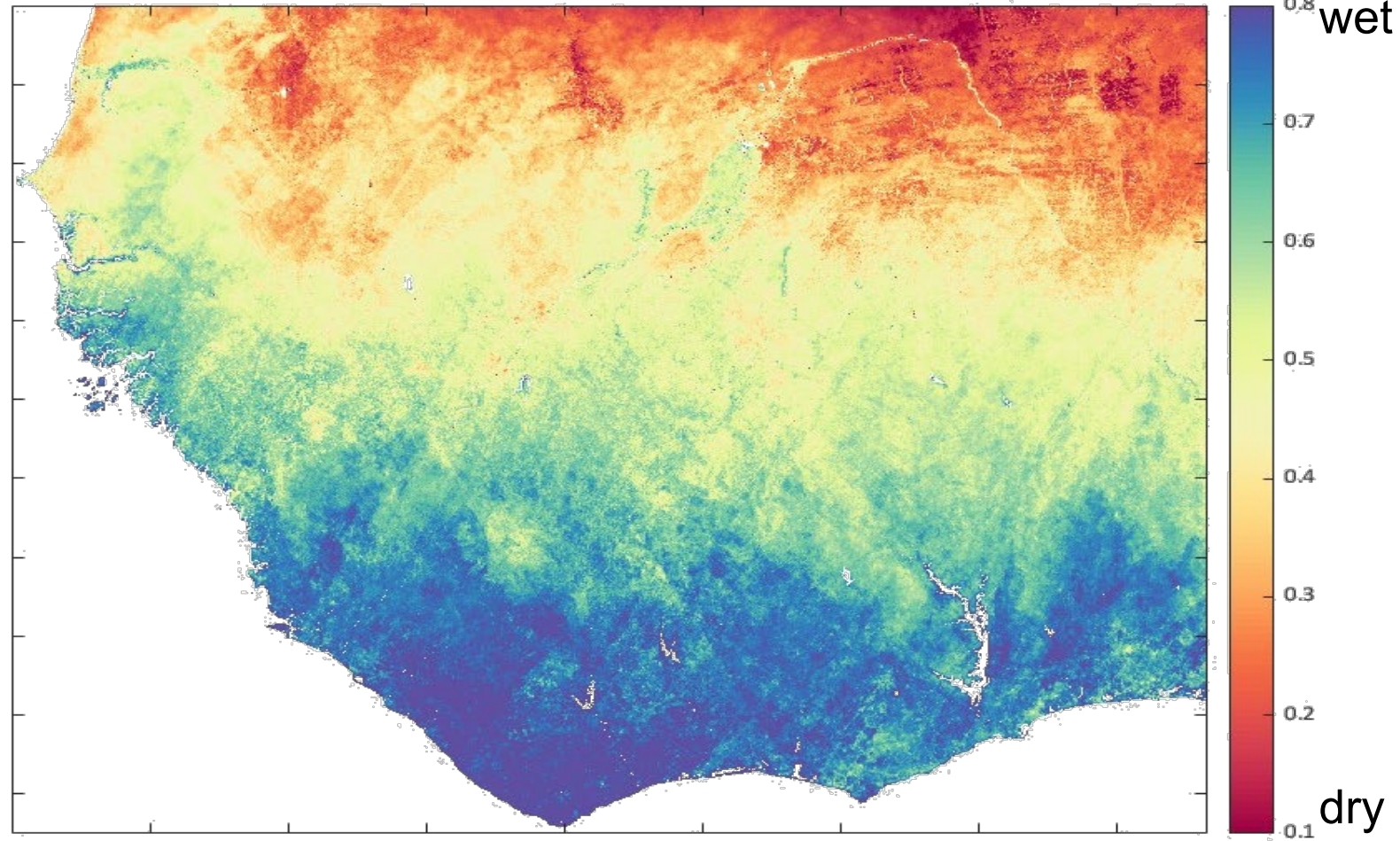
**Main challenge: translating crop water stress and productivity indicators to information on drought onset, duration and impact as well as for irrigation advice**

# ARIES // EO Africa – Indicator development

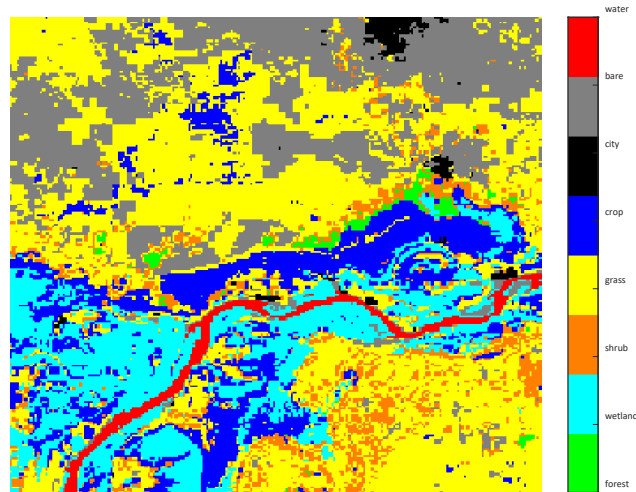
Thermal Data

General humidity mapping using ECOSTRESS Evaporative Stress Index (ESI) (multiple years' mean)

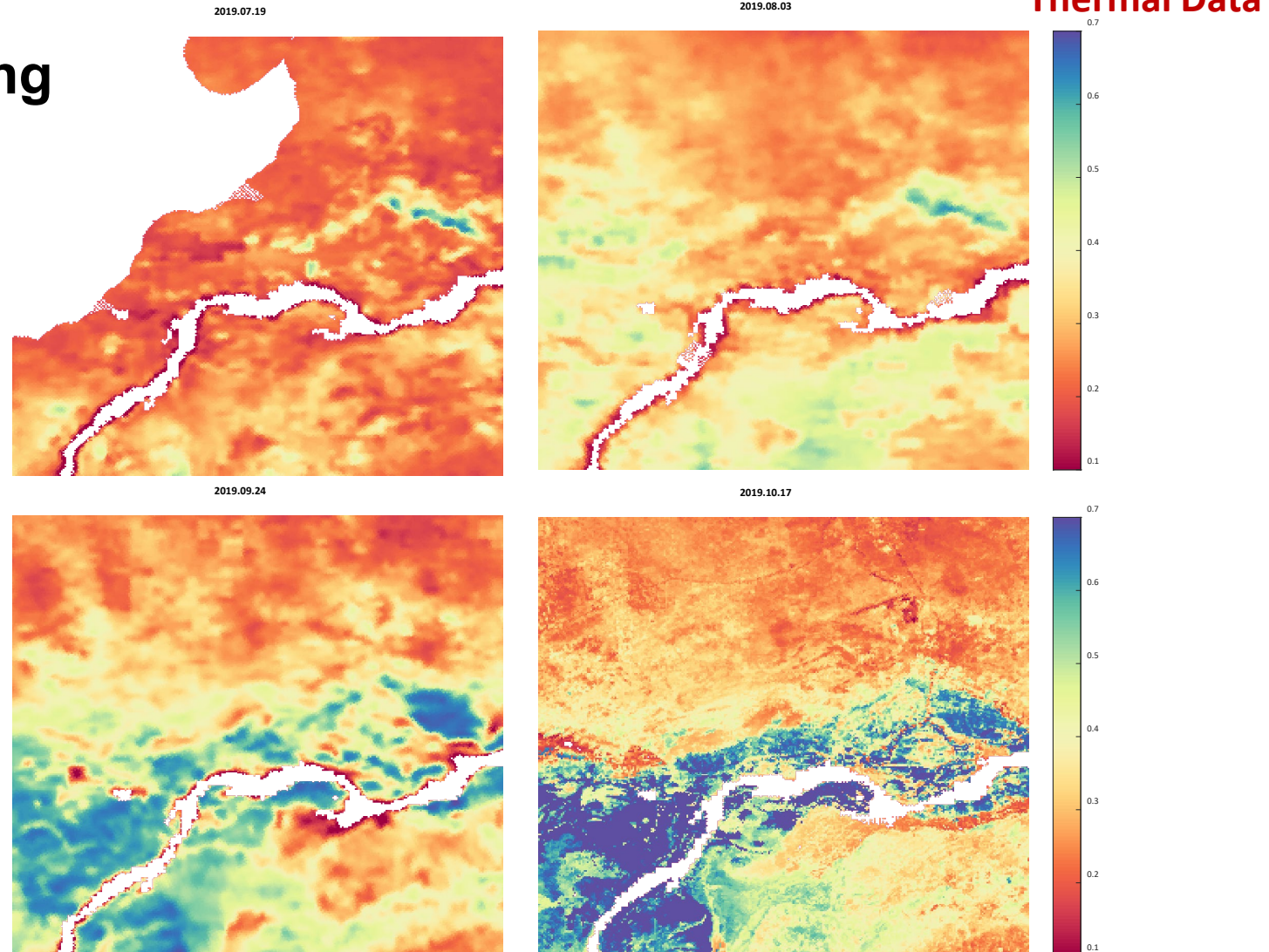
$$ESI = \frac{ActualET}{PotentialET}$$



- ECOSTRESS ESI Local Mapping



Land cover at the Mali site (Lat: 16.6730 °, Long: -3.0448 °)

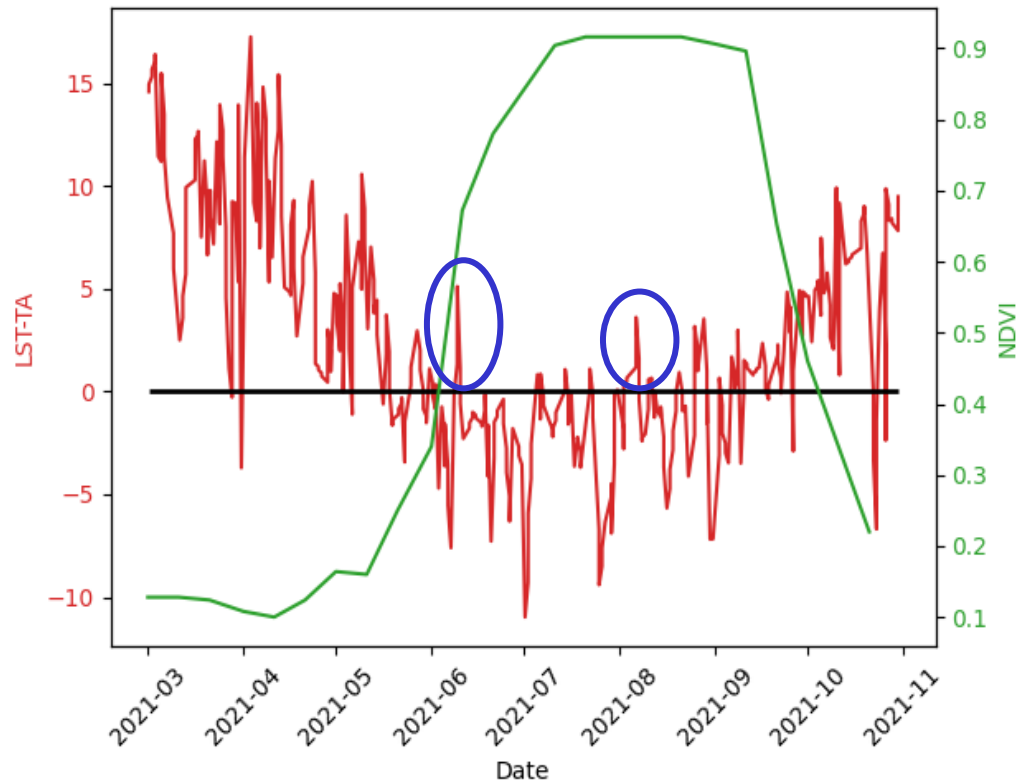


# ARIES // EO Africa – Indicator development

Thermal Data

## High resolution crop water stress (VITO)

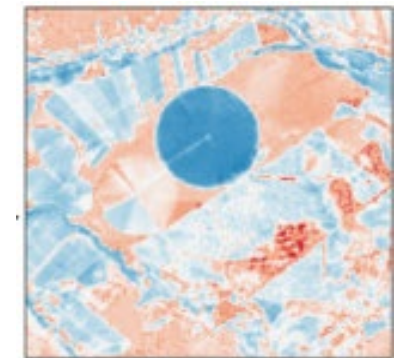
Land surface temperature – air temperature → provides relative indication of crop water stress



Field monitoring requires daily, high-resolution LST estimates!



SEN-ET \*



1 km

20 m

\* Sentinel-3, Sentinel-2, DEM

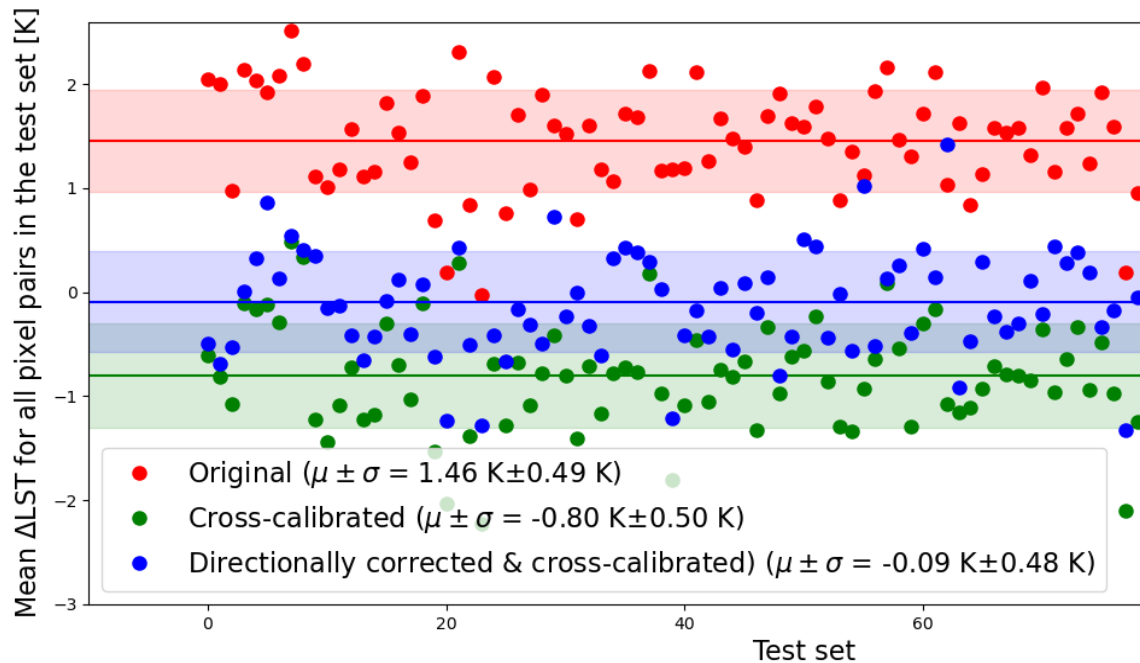
# ARIES // EO Africa – Indicator development

## High resolution crop water stress (VITO)

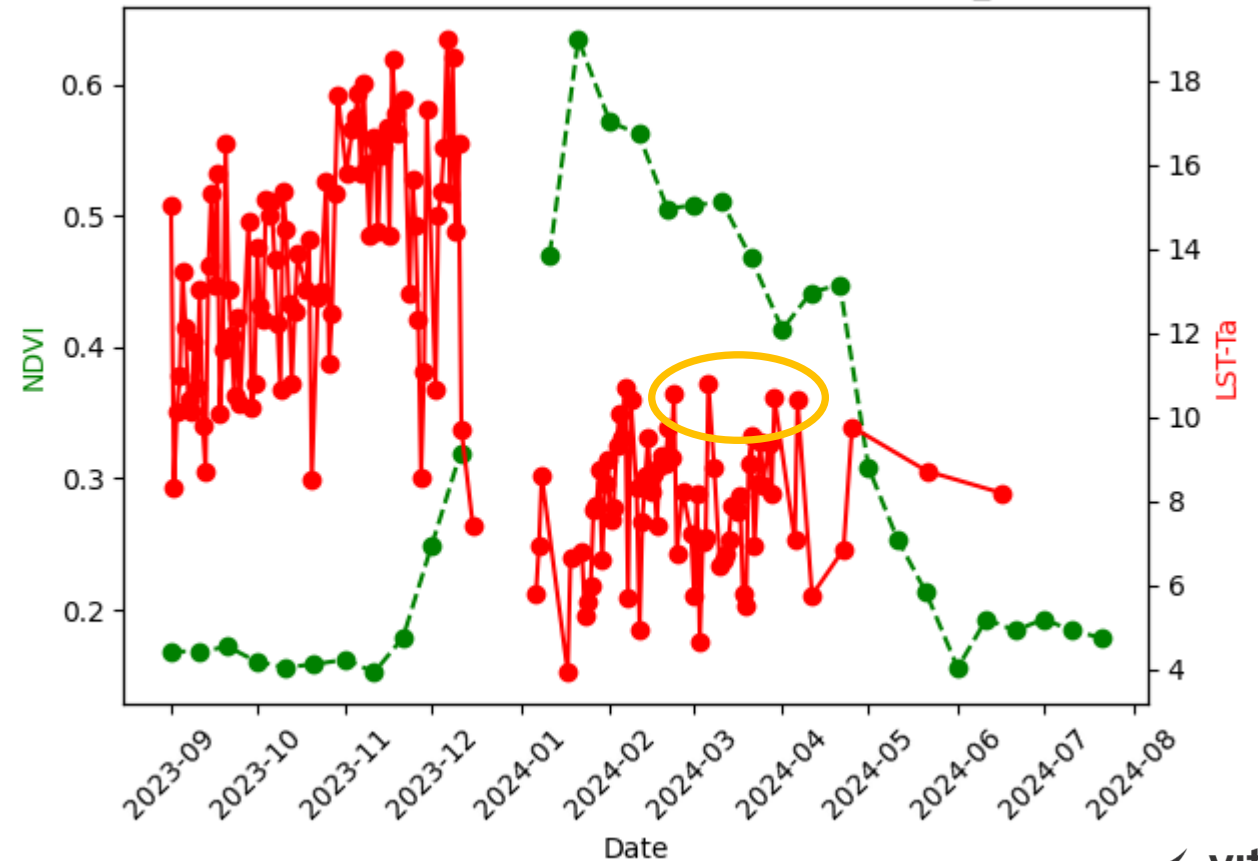
Thermal Data

### Sharpened LST vs 70 m ECOSTRESS

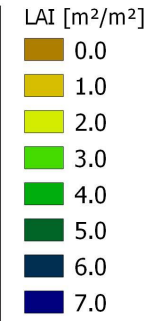
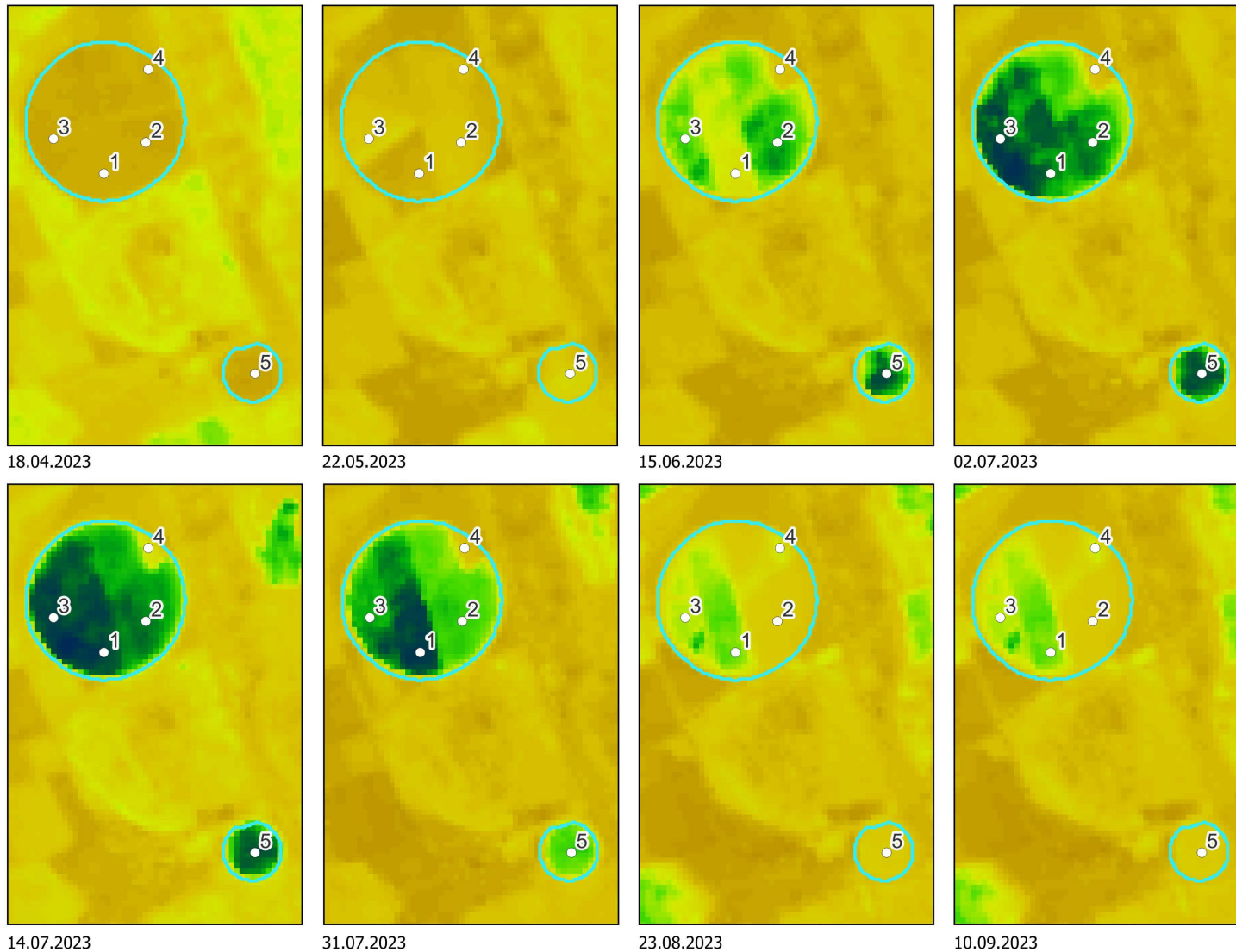
→ Bias correction + correction of directionality effect



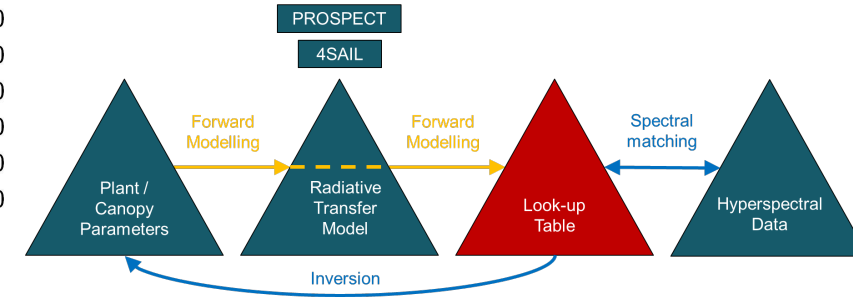
Time series of LST-Ta and NDVI for plot field\_W



# ARIES // EO Africa – Indicator Development



## Hyperspectral Data



## Leaf Area Index Derivation from RTM inversion

Combination of EnMap and PRISMA to increase revisit rate

**2023**

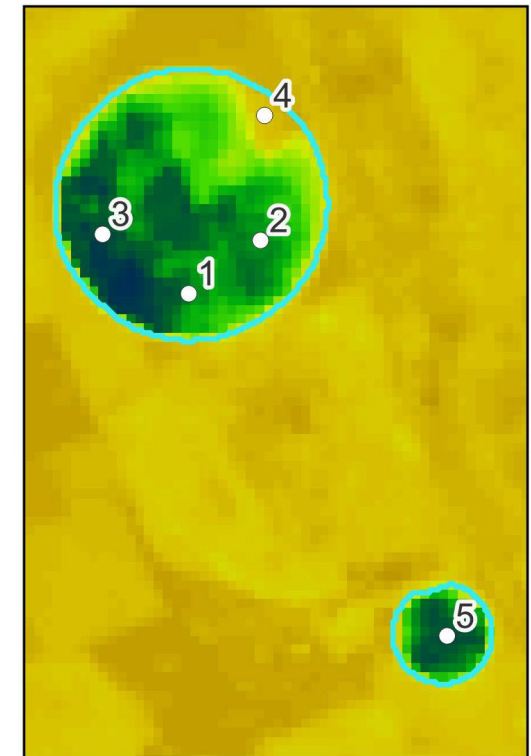
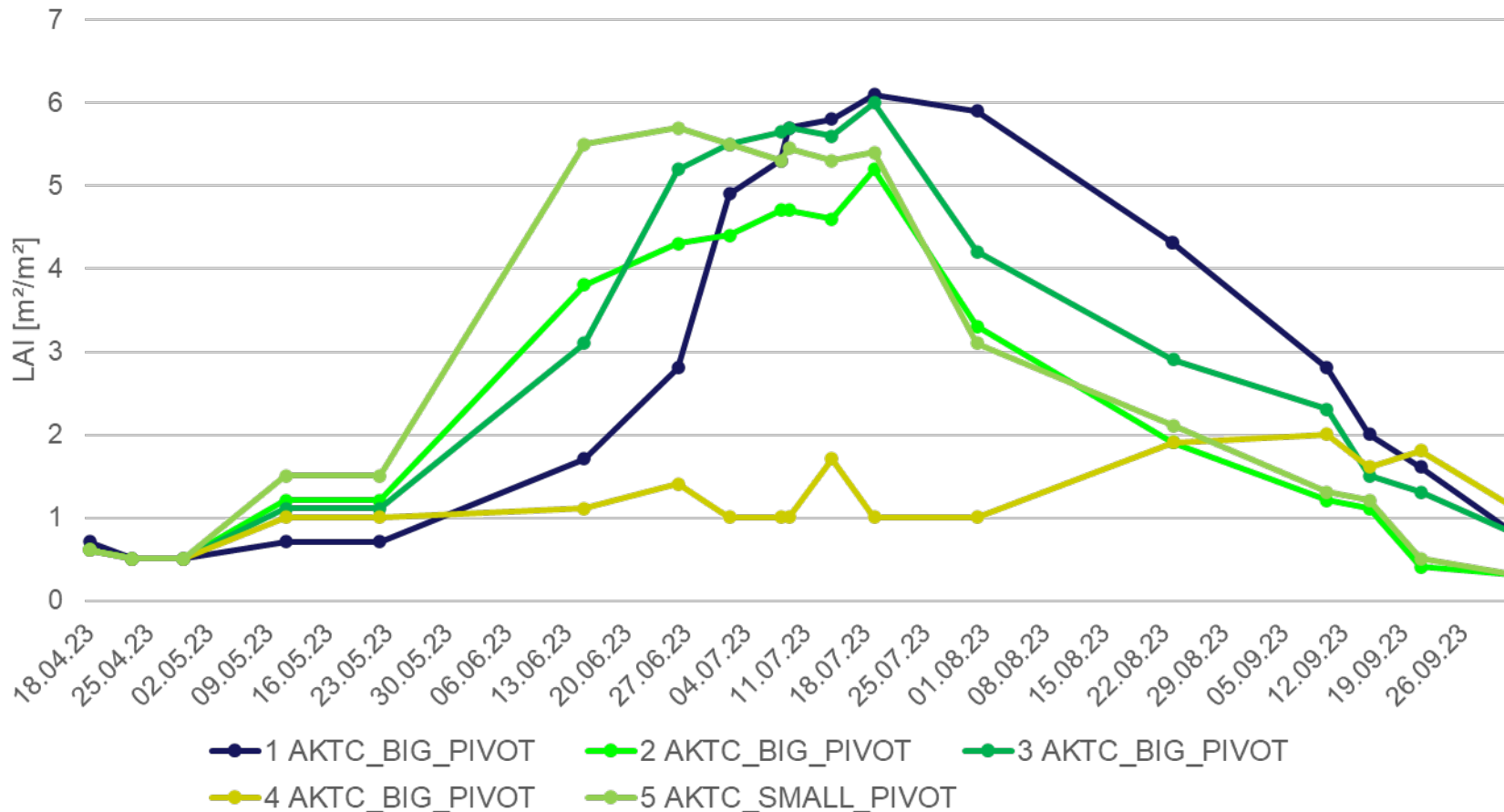


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Hyperspectral Data

2023

LAI Values (Wheat) at different Pixels within AKTC's Irrigation Pivots during the 2023 dry season

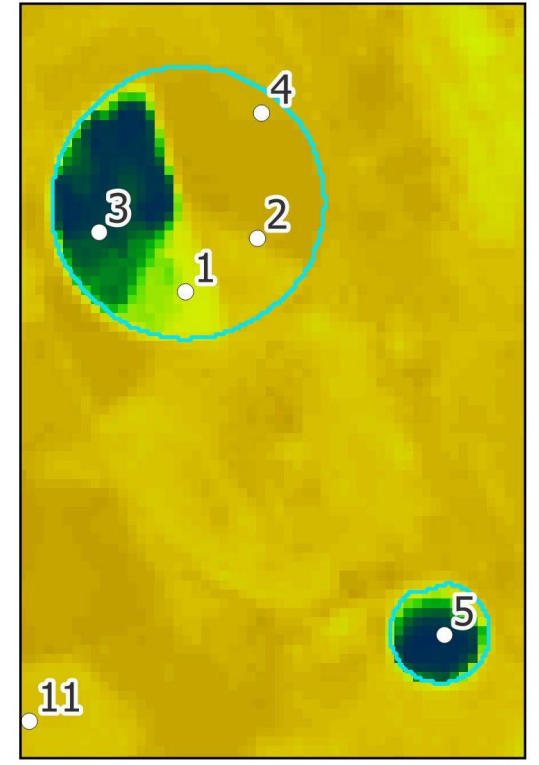
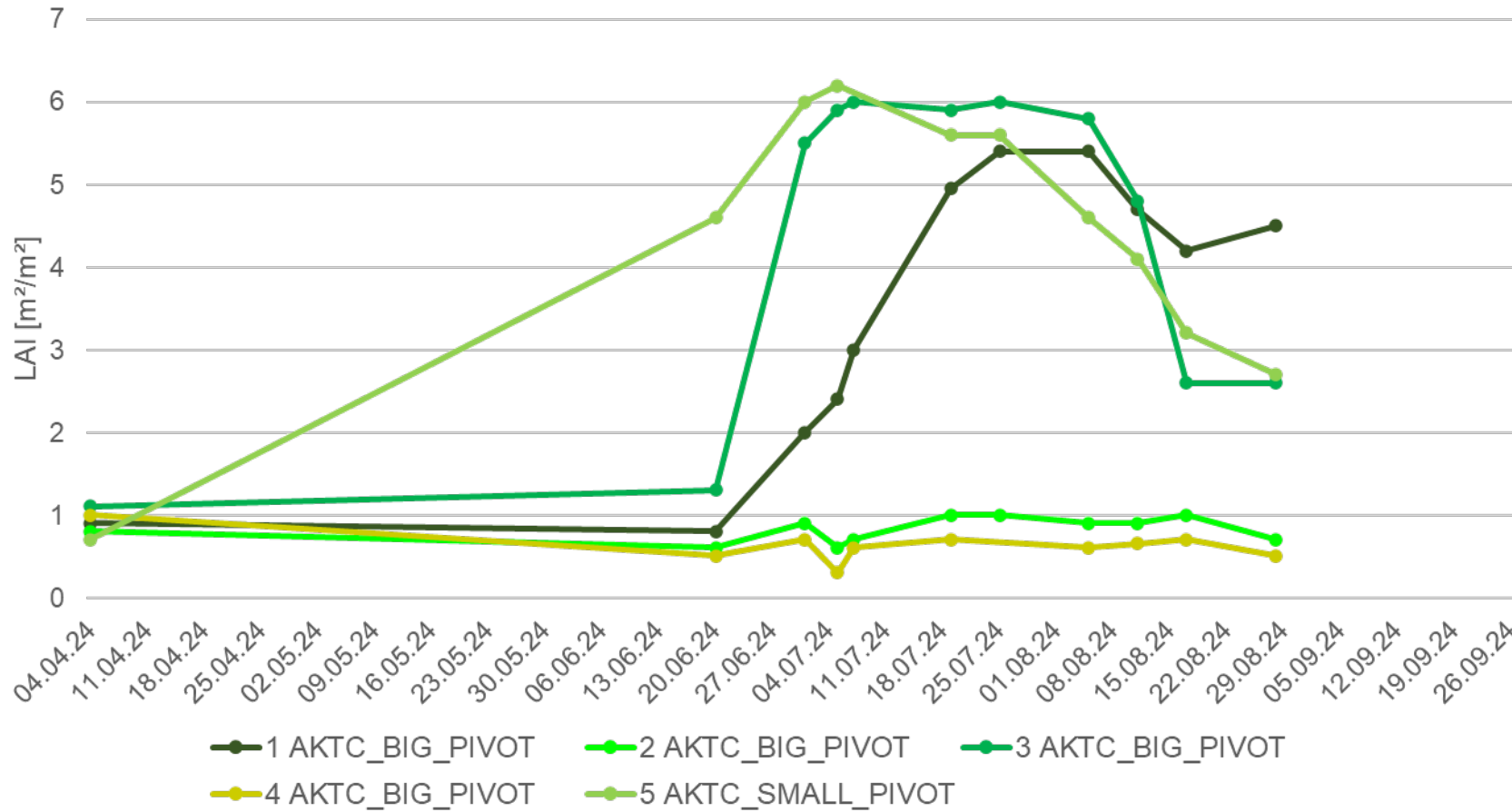


02.07.2023

# ARIES // EO Africa – Indicator Development

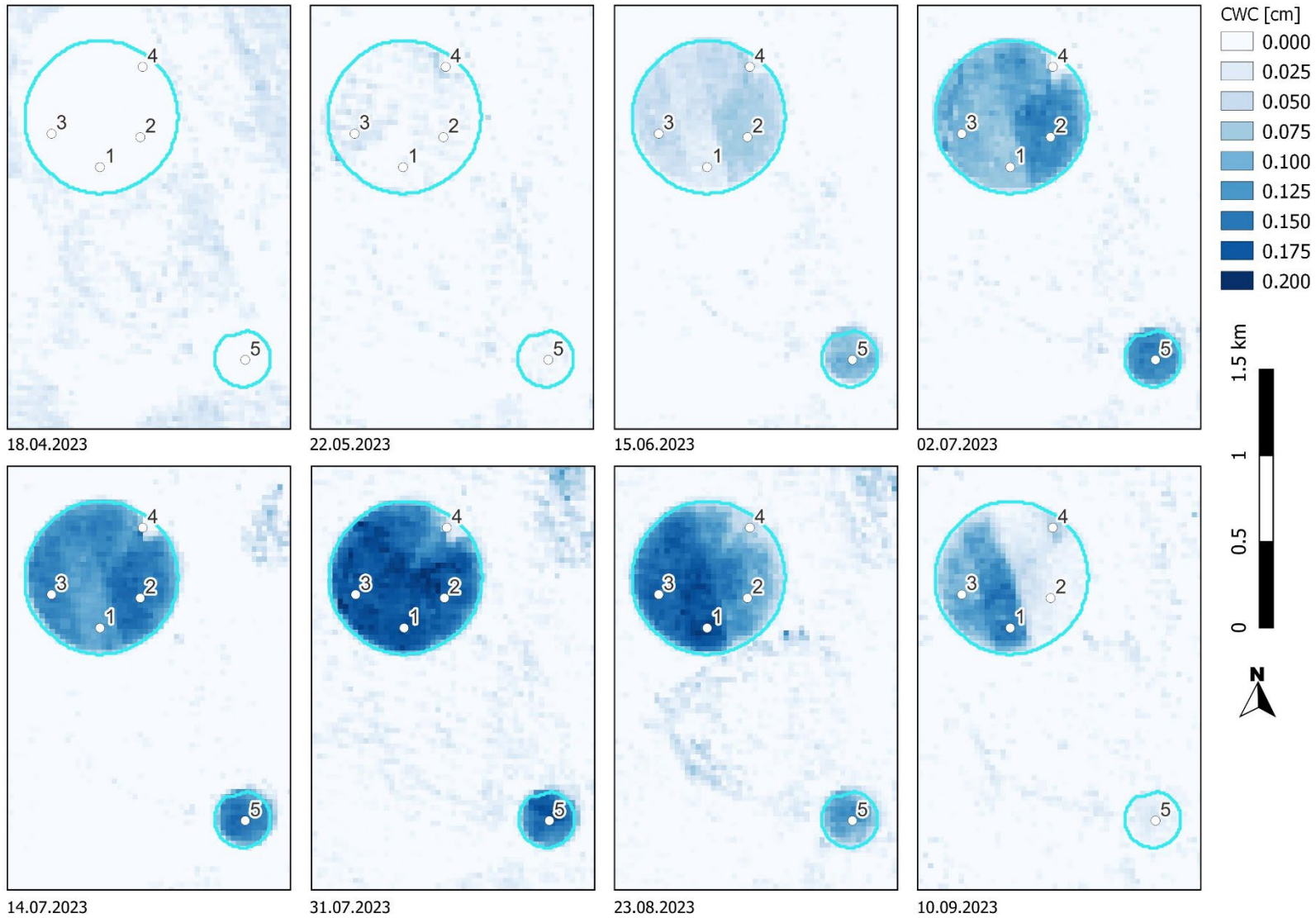
Hyperspectral Data  
**2024**

LAI Values (Wheat) at different Pixels within AKTC's Irrigation Pivots during the 2024 dry season

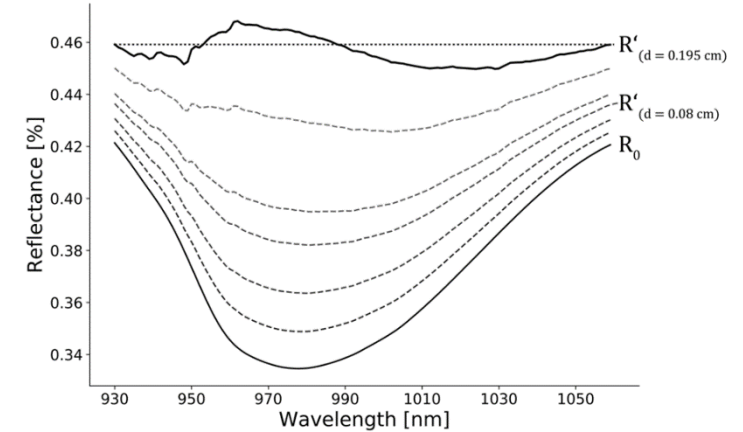


01.07.2024

# ARIES // EO Africa – Indicator Development



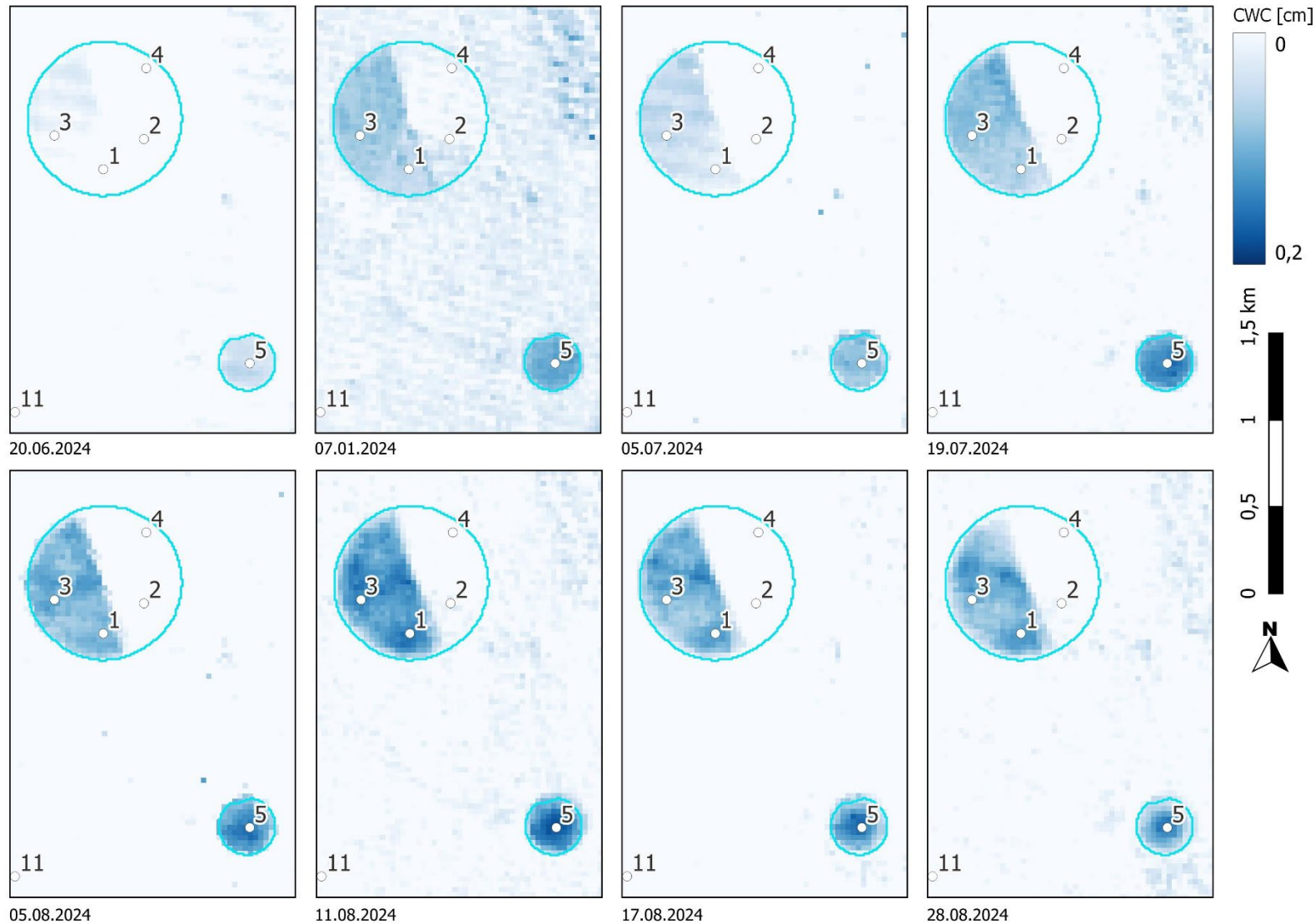
## Hyperspectral Data 2023



Canopy Water  
Content Values  
(Wheat) for AKTC's  
Irrigation Pivots  
during the 2023 dry  
season

# ARIES // EO Africa – Indicator Development

Hyperspectral Data  
2024



Canopy Water  
Content Values  
(Wheat) for AKTC's  
Irrigation Pivots  
during the 2024 dry  
season

# ARIES // EO Africa – Platform Integration

## ECOSTRESS data discovery

foodsecurity explorer DaMa

Map layers: + Add layers

No dataset selected

**Data discovery**

CATALOGUE FS-X Events My storage External WMS

ECOSTRESS Dataset  
ECOSTRESS dataset Catalogue

COLLECTION  
ECOSTRESS

PROCESSING LEVEL  
L1B\_GEO

PRODUCT DATE  
Start date: End date:

AOI  
No area specified

IDENTIFIER

Search

ECOSTRESS\_L1B\_GEO\_19779\_012\_20211231T220718\_0601\_01.h5

ISS ECOSTRESS  
2021-12-31 23:07:18  
0.0 %

Center on map Bookmark

ECOSTRESS\_L1B\_RAD\_19779\_012\_20211231T220718\_0601\_01.h5

ISS ECOSTRESS  
2021-12-31 23:07:18  
0.0 %

Center on map Bookmark

ECOSTRESS\_L1B\_GEO\_19779\_011\_20211231T220626\_0601\_01.h5

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Center on map Bookmark

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ISS ECOSTRESS  
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Center on map Bookmark

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ISS ECOSTRESS  
2021-12-31 23:05:34  
0.0 %

Center on map Bookmark

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ISS ECOSTRESS  
2021-12-31 23:05:34  
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Center on map Bookmark

354951 items 1 2 3 4 5 ... 17748 20 / page

## EnMAP-Box

Creation of Look-up-table

Sensor Type: EnMap\_207 (207 bands)

Select Leaf Model: Prospect D

Select Canopy Model: 4SAIL

Select Background: Use default soil spectrum

Settings: Size of statistical drawings: 10000

Leaf Model Parameters (PROSPECT):

- Structure Parameter (N) [-]: 1.5
- Chlorophyll A + B (Cab) [µg/c]: 0.0
- Water Content (Cw) [cm]: 0.01
- Dry Matter Content (Cm) [g/c]: 0.005
- Carotenoids (Ccx) [µg/cm²]: 15.0
- Brown Pigments (Cbrown) [-]: 0.0
- Anthocyanins (Canth) [µg/cm]: 2.0
- Proteins (Cp) [g/cm²]: 0.0

Plant Water Retrieval Tool

Input Image: [Field]

Output Image: [Field]

NDVI threshold: 0.00

Image No Data: NA

Output No Data: [Field]

Divide Input by: 1

How to use this tool

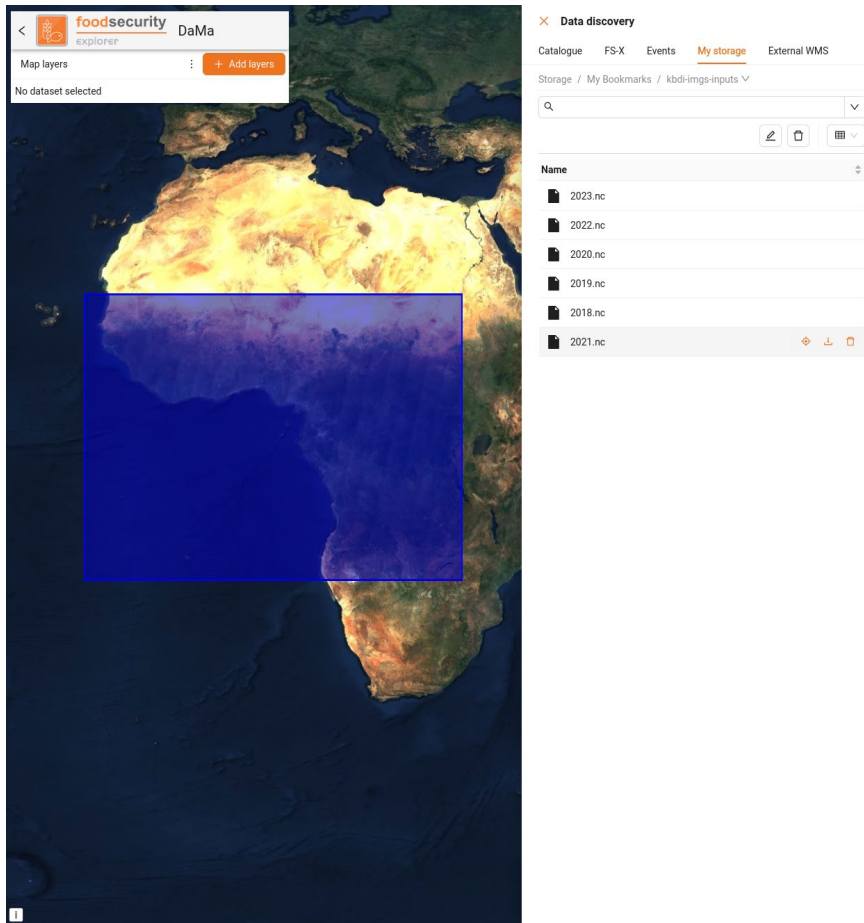
Creation and Inversion of LUT (PROSAIL)

Calculation of CWC using the Plant Water Retrieval Tool

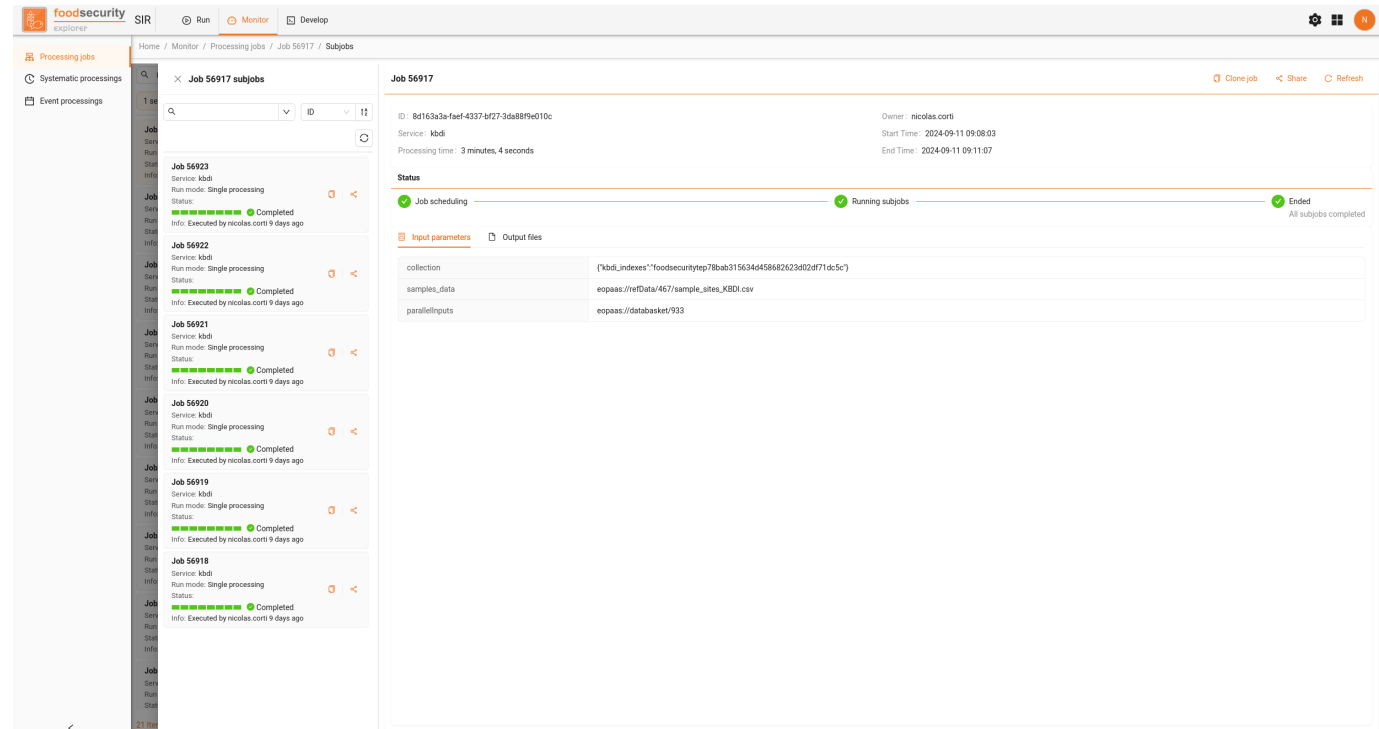
More information → <https://foodsecurity-explorer.com>

# ARIES // EO Africa – Platform Integration

KBDI Parallel processing for years 2018, 2019, 2020, 2021, 2022, 2023

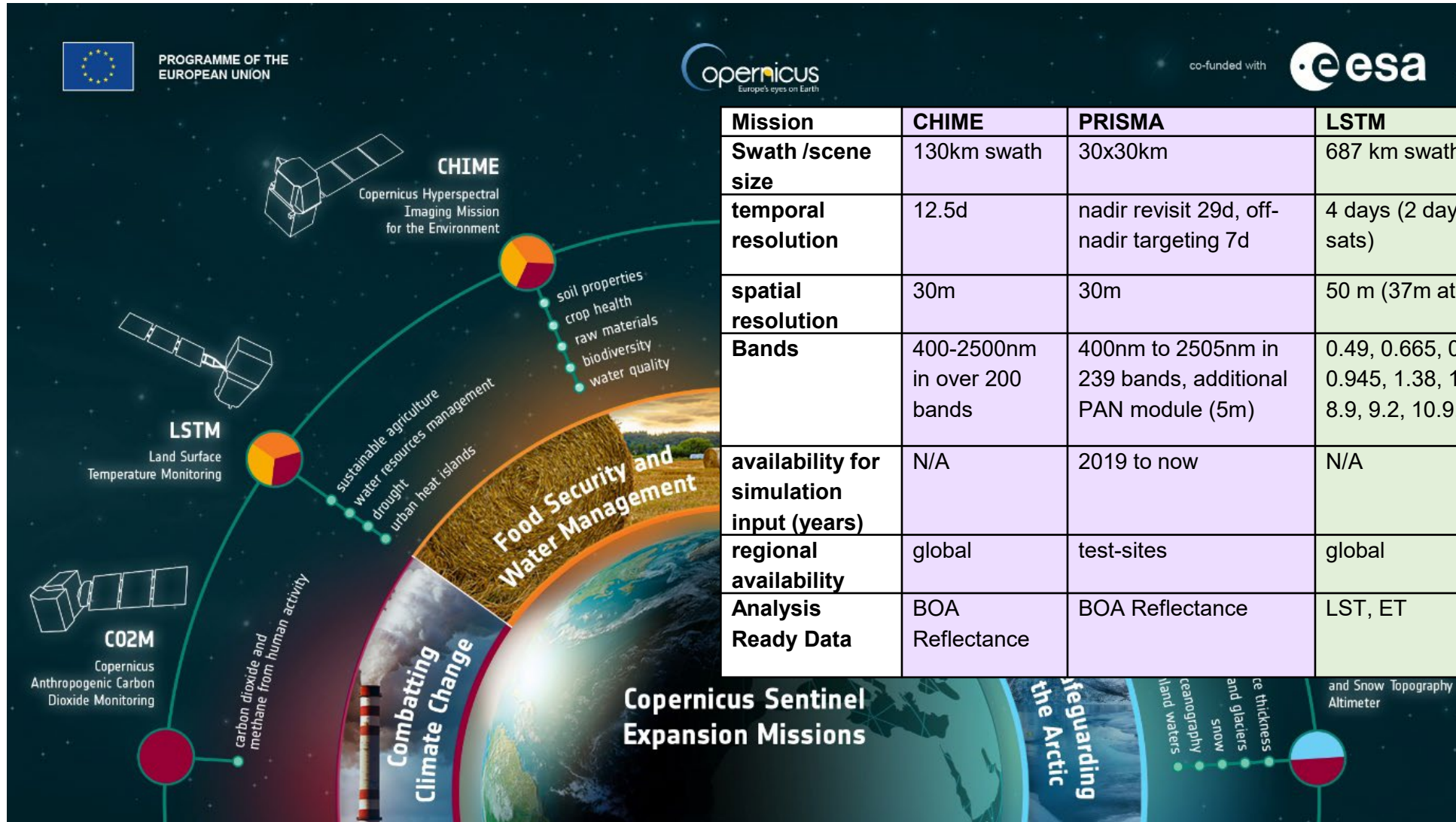


Processing time: 3 minutes 4 seconds



More information → <https://foodsecurity-explorer.com>

# ARIES // EO Africa – Recommendations LSTM & CHIME



**PROGRAMME OF THE EUROPEAN UNION**

**copernicus** Europe's eyes on Earth

co-funded with **esa**

**CHIME**  
Copernicus Hyperspectral Imaging Mission for the Environment

**LSTM**  
Land Surface Temperature Monitoring

**CO2M**  
Copernicus Anthropogenic Carbon Dioxide Monitoring

carbon dioxide and methane from human activity

soil properties  
crop health  
raw materials  
biodiversity  
water quality

sustainable agriculture  
water resources management  
drought  
urban heat islands

**Food Security and Water Management**

**Combating Climate Change**

**Copernicus Sentinel Expansion Missions**

regarding the Arctic

ice thickness and glaciers  
snow  
topography  
land waters

and Snow Topography Altimeter

Mission	CHIME	PRISMA	LSTM	ECOSTRESS
<b>Swath /scene size</b>	130km swath	30x30km	687 km swath	384 km swath
<b>temporal resolution</b>	12.5d	nadir revisit 29d, off-nadir targeting 7d	4 days (2 days for 2 sats)	Irregular (ISS)
<b>spatial resolution</b>	30m	30m	50 m (37m at nadir)	70m
<b>Bands</b>	400-2500nm in over 200 bands	400nm to 2505nm in 239 bands, additional PAN module (5m)	0.49, 0.665, 0.865, 0.945, 1.38, 1.61, 8.6, 8.9, 9.2, 10.9, 12 µm	1.66, 8.29, 8.78, 9.20, 10.49, 12.09 µm
<b>availability for simulation input (years)</b>	N/A	2019 to now	N/A	2019 to now
<b>regional availability</b>	global	test-sites	global	global
<b>Analysis Ready Data</b>	BOA Reflectance	BOA Reflectance	LST, ET	LST, ET

# ARIES // EO Africa – Thank you!

ARIES aims to improve the monitoring of **drought conditions** and the detection of **crop water stress** in support of **food security**.



## Consortium:



## Stakeholders:

