Earth Observation Tools to Manage Africa's Food Systems by Joint Knowledge of Crop Production and Irrigation Digitisation

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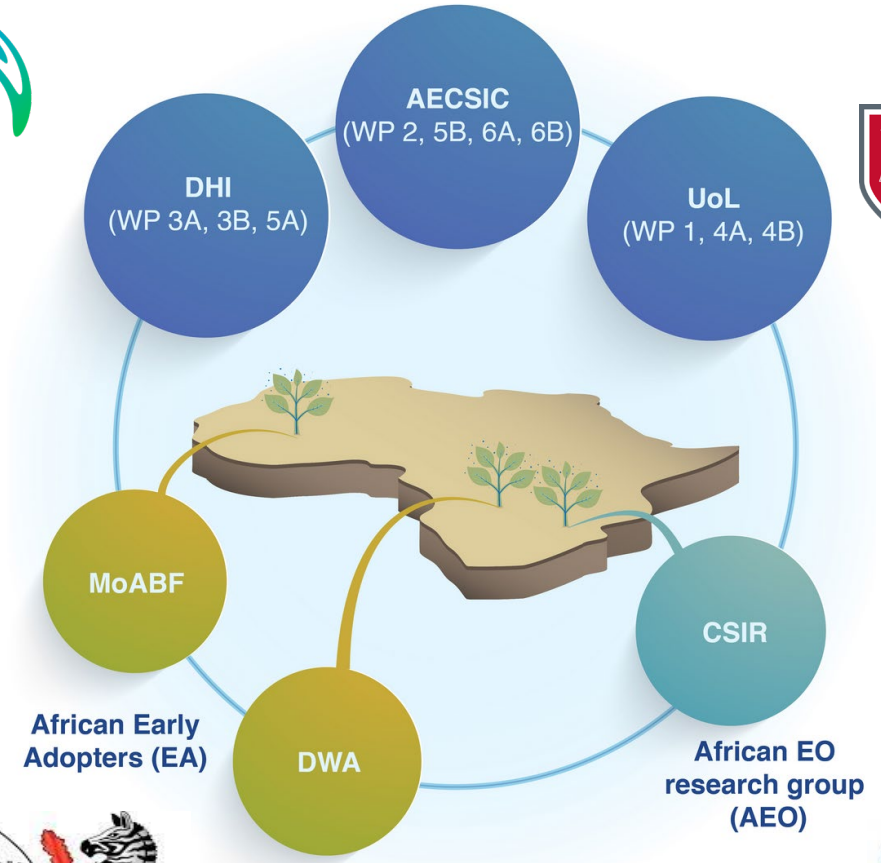
UNIVERSITY OF LEICESTER

EO4Africa Symposium 24.09.2024

The consortium

CSIC
Consejo Superior de Investigaciones Científicas

DHI



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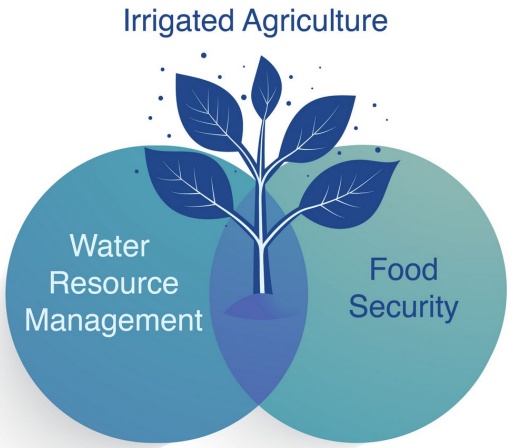
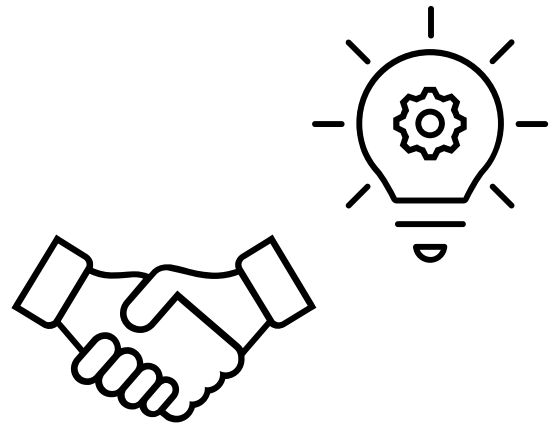
CSIR
Touching lives through innovation

Earth **O**bservation tools to **M**anage **A**frica's food systems by **J**oint-knowledge of crop production and **I**rrigation digitization **EO-MAJI**





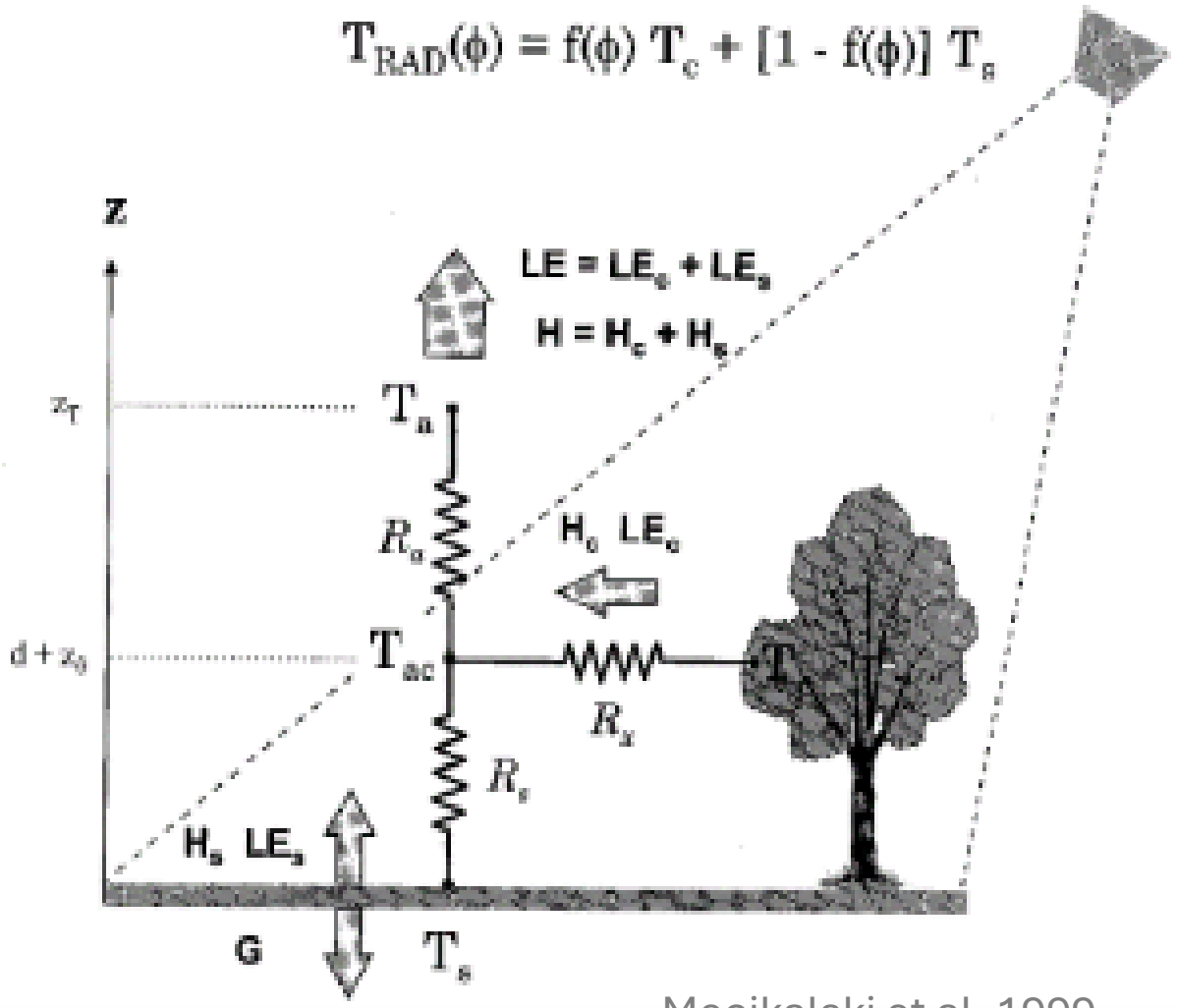
Impact
Novel methods for improved regional water management

Outcome
Irrigated agriculture information products from ECOSTRESS and PRISMA

Collaboration
Consortium –
EO Research Groups –
African Early Adopters

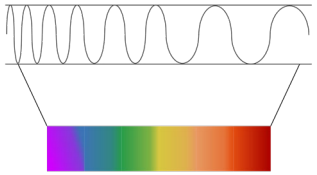
Evapotranspiration model: Two Source Energy Balance

- Physical model
- Models instantaneous land-surface energy fluxes (W/m^2)
- Partitions Evaporation and Transpiration with resistances in series
- Robust in many environments
- Continually developed
- Extrapolation to daily ET (mm/day)



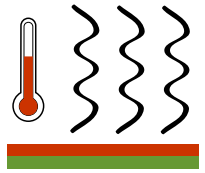
Mecikalski et al. 1999

Two Source Energy Balance: Input data



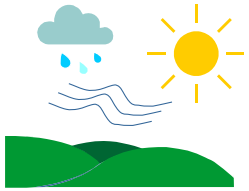
Shortwave optical

biophysical properties of the surface (leaf area index, albedo)



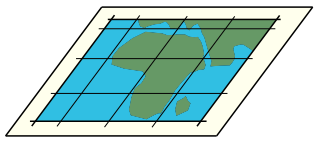
Thermal infrared

lower boundary condition for surface-air energy exchange



Meteorological data

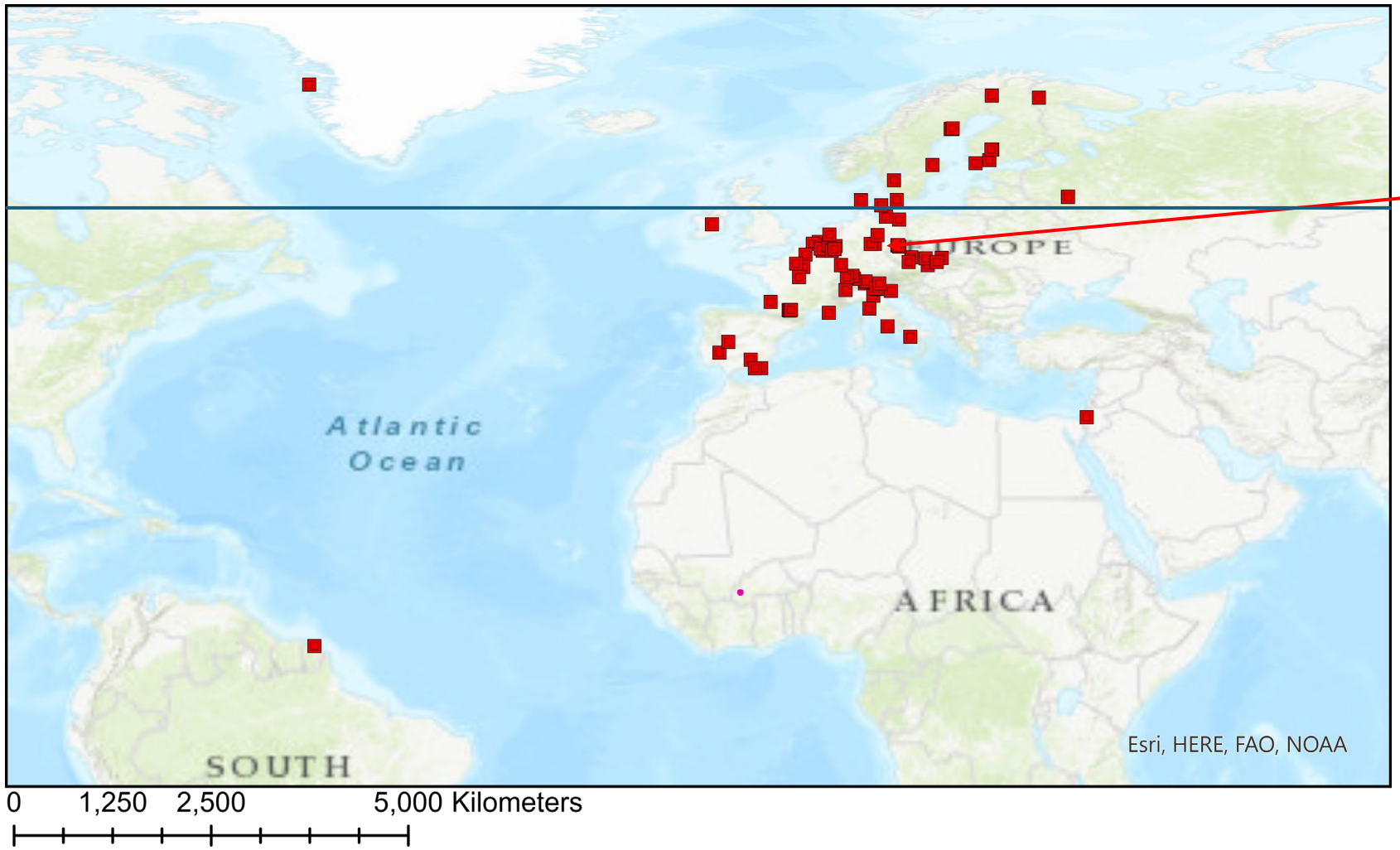
drives and modulates energy exchange between surface and air

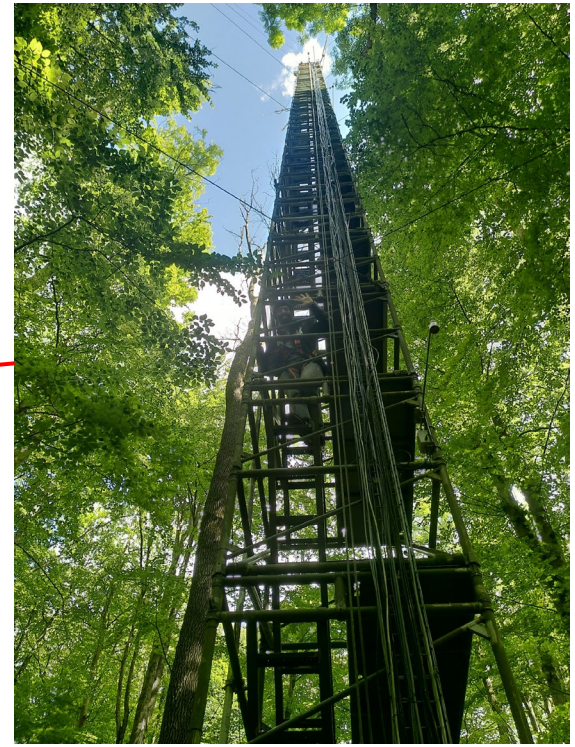


Ancillary data

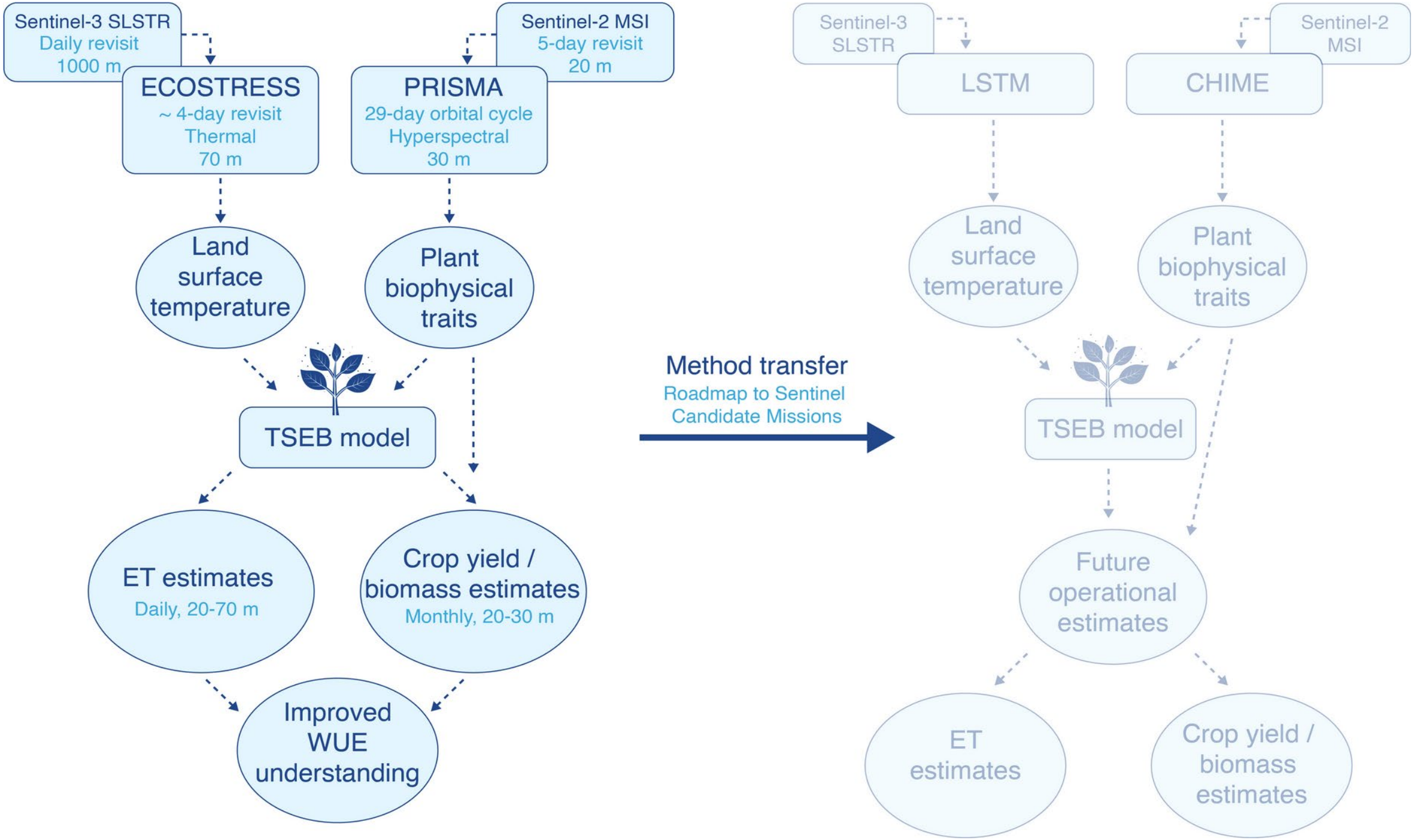
vegetation / obstacle height, other biophysical properties

ICOS sites





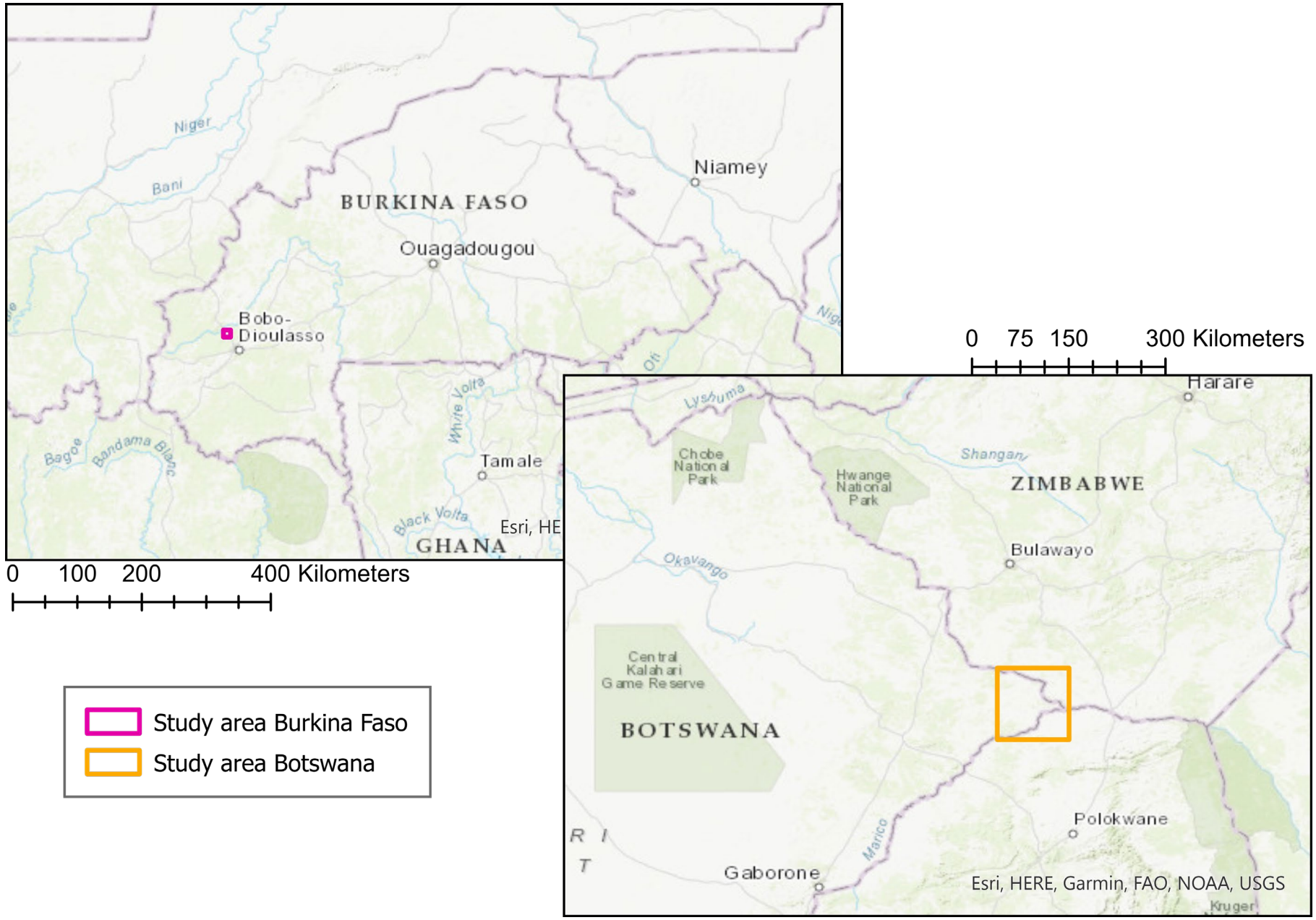
ICOS towers observe greenhouse gases, as well as living and non-living components and **drivers responsible for the exchange of greenhouse gases, water and energy** between ecosystems and the atmosphere


Sentinel-3 SLSTR
Daily revisit
1000 m
ECOSTRESS
~ 4-day revisit
Thermal
70 m
Sentinel-2 MSI
5-day revisit
20 m
PRISMA
29-day orbital cycle
Hyperspectral
30 m
Land surface temperature
Plant biophysical traits
TSEB model
ET estimates
Daily, 20-70 m
Crop yield / biomass estimates
Monthly, 20-30 m
Improved WUE understanding
Method transfer
Roadmap to Sentinel Candidate Missions
Sentinel-3 SLSTR
Sentinel-2 MSI
LSTM
CHIME
Land surface temperature
Plant biophysical traits
TSEB model
Future operational estimates
ET estimates
Crop yield / biomass estimates

African study areas

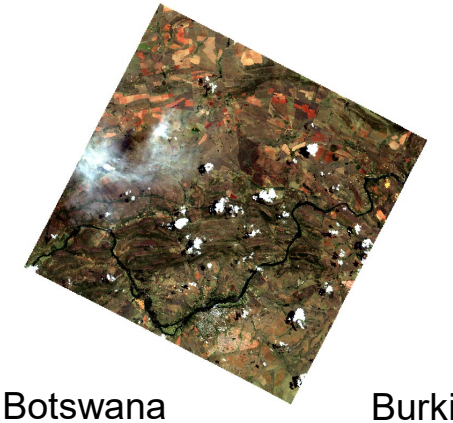
Study area in Burkina Faso
Approximately 120 km^2
Mostly focused on rice

Study area in Botswana
Approximately 11 500 km^2
Area belongs to three different countries: Botswana, Zimbabwe and South Africa
Various crops, mainly fruit and potatoes

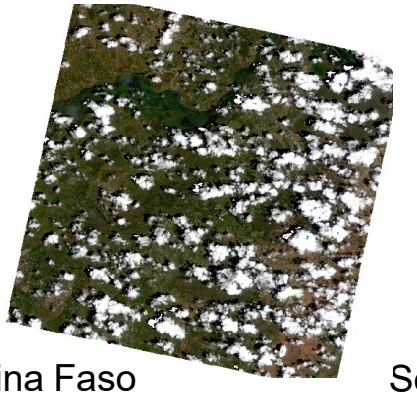


PRISMA data

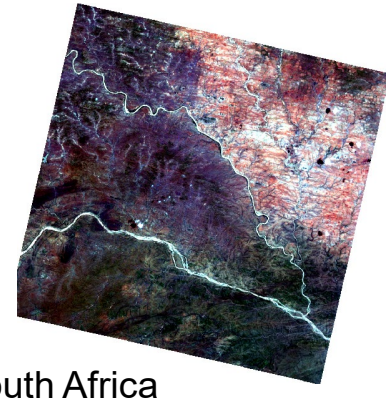
	Botswana	Burkina Faso	South Africa	Majadas	Barrax
First image	12/22/2019	6/29/2022	3/24/2020	4/10/2020	11/16/2021
# images in catalogue	36	4	46	34	15
Max Cloud %	28.9	100	99.9	99.9	6.4
Mean Cloud %	3.2	42.7	14.3	15.8	0.5



Botswana
10/25/2022



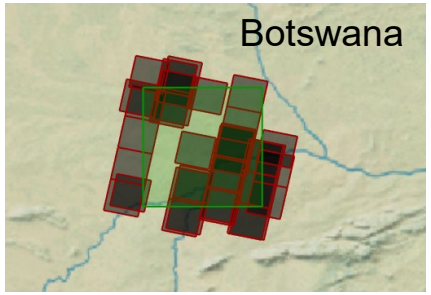
Burkina Faso
09/24/2022

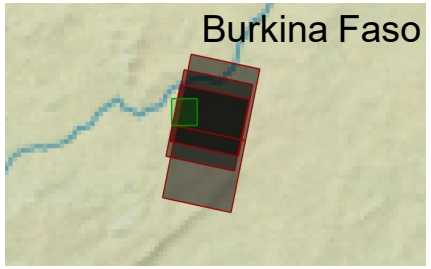


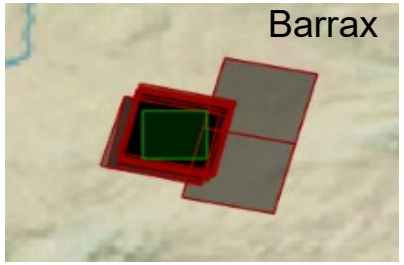
South Africa
11/23/2022

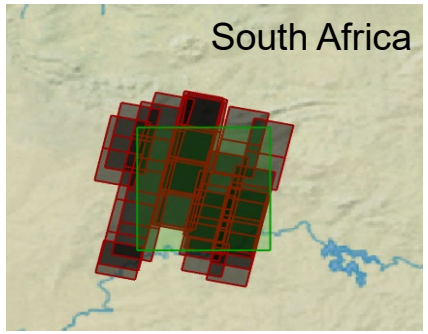
African Sites

Spanish Sites



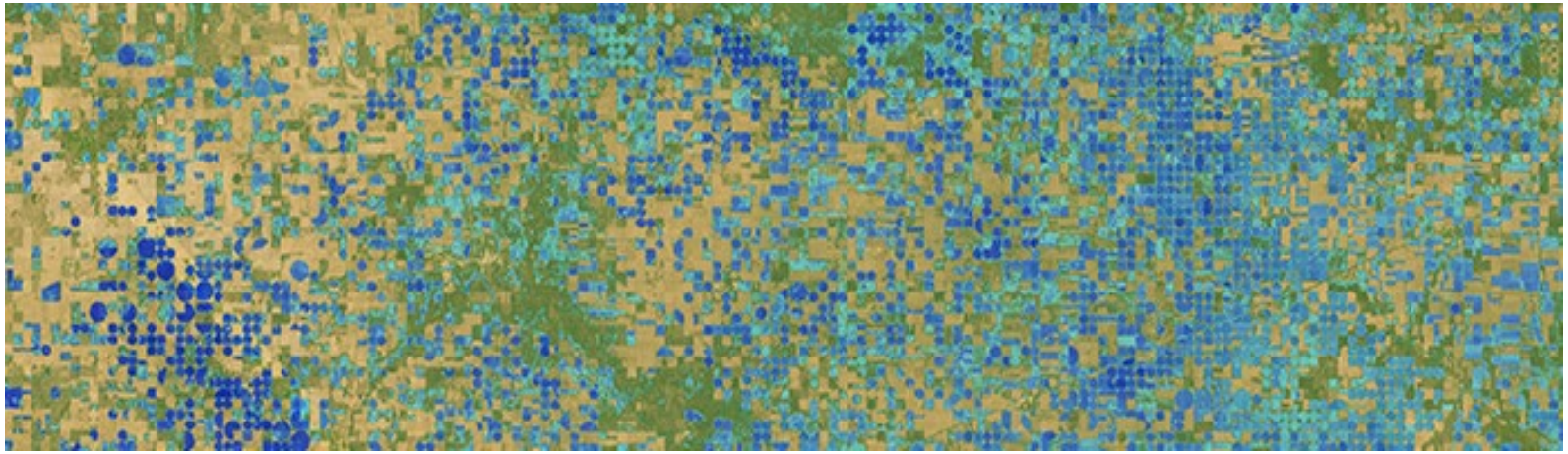






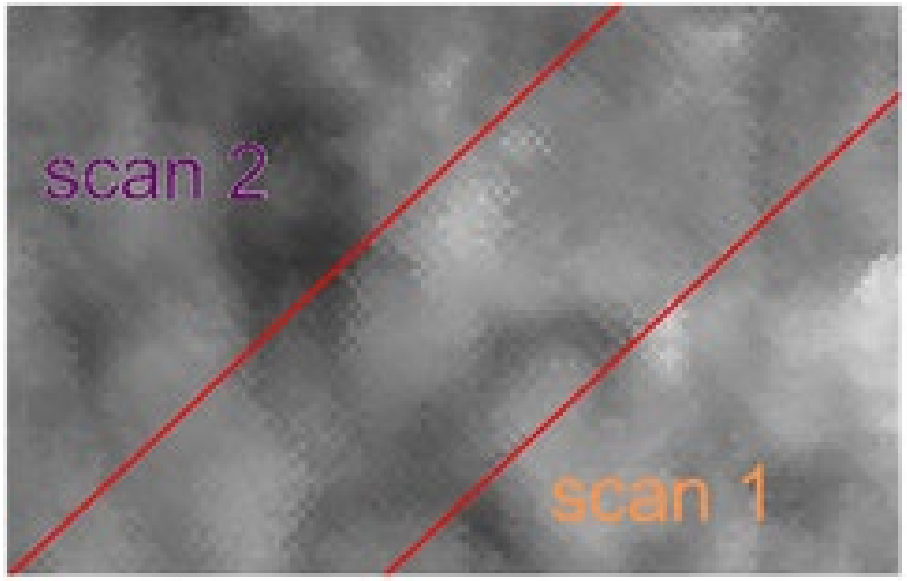
ECOSTRESS data

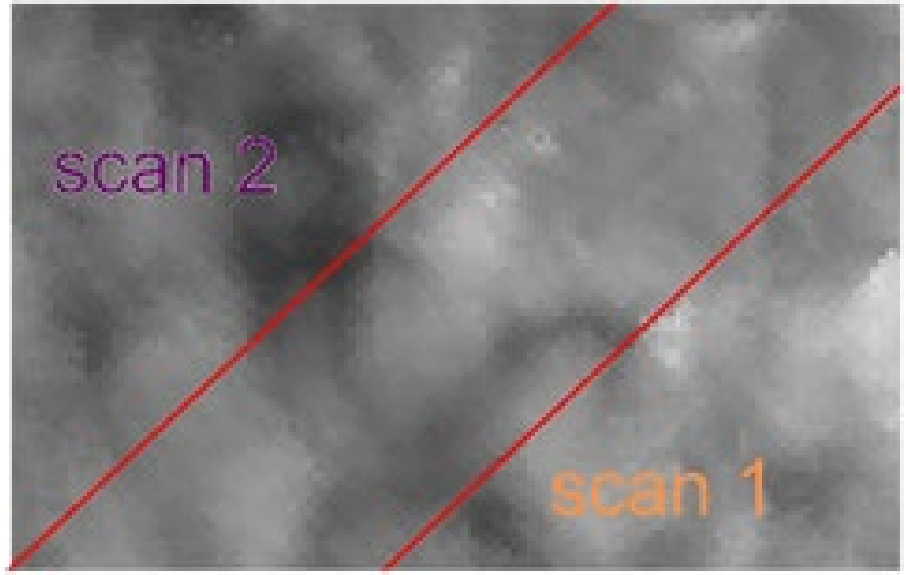
- 5 TIR bands at 70 m spatial resolution
- Precessing orbit of the ISS – varying acquisition time
- L2 LSTE product, derived using TES algorithm
- 400 km scene footprint
- Image quality issues:
  checkerboard pattern and georeferencing inaccuracy



ECOSTRESS geometry: checkerboard pattern

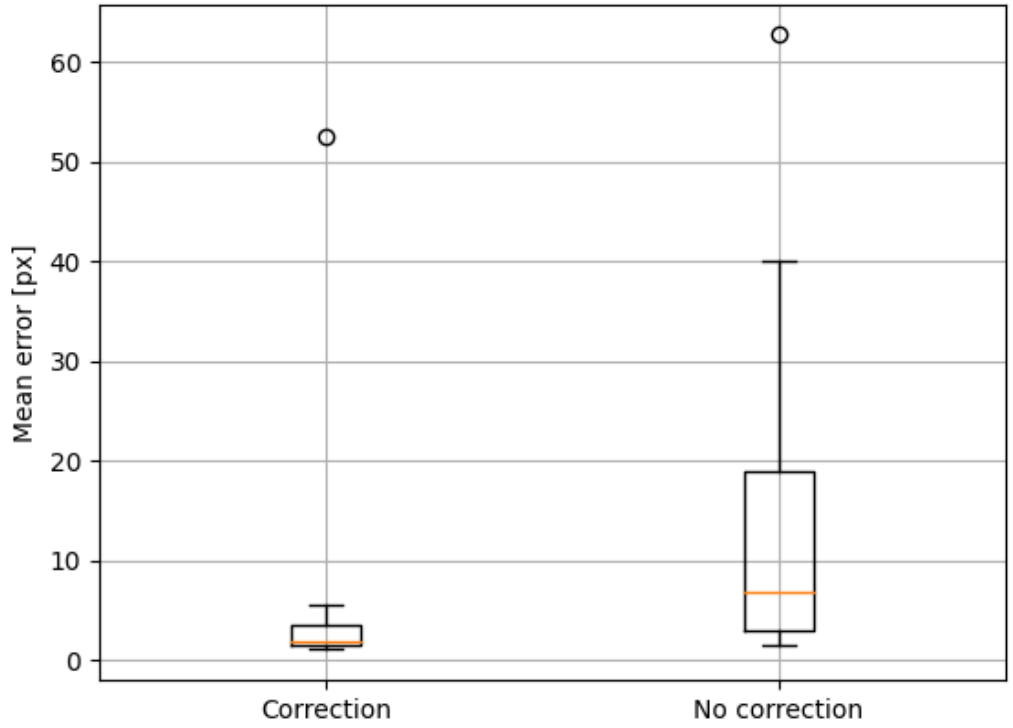
- Result of two separate issues: radiometric and geometric
- The two sides of the scanning mirror are not parallel
- A static problem requiring photogrammetric correction parameters

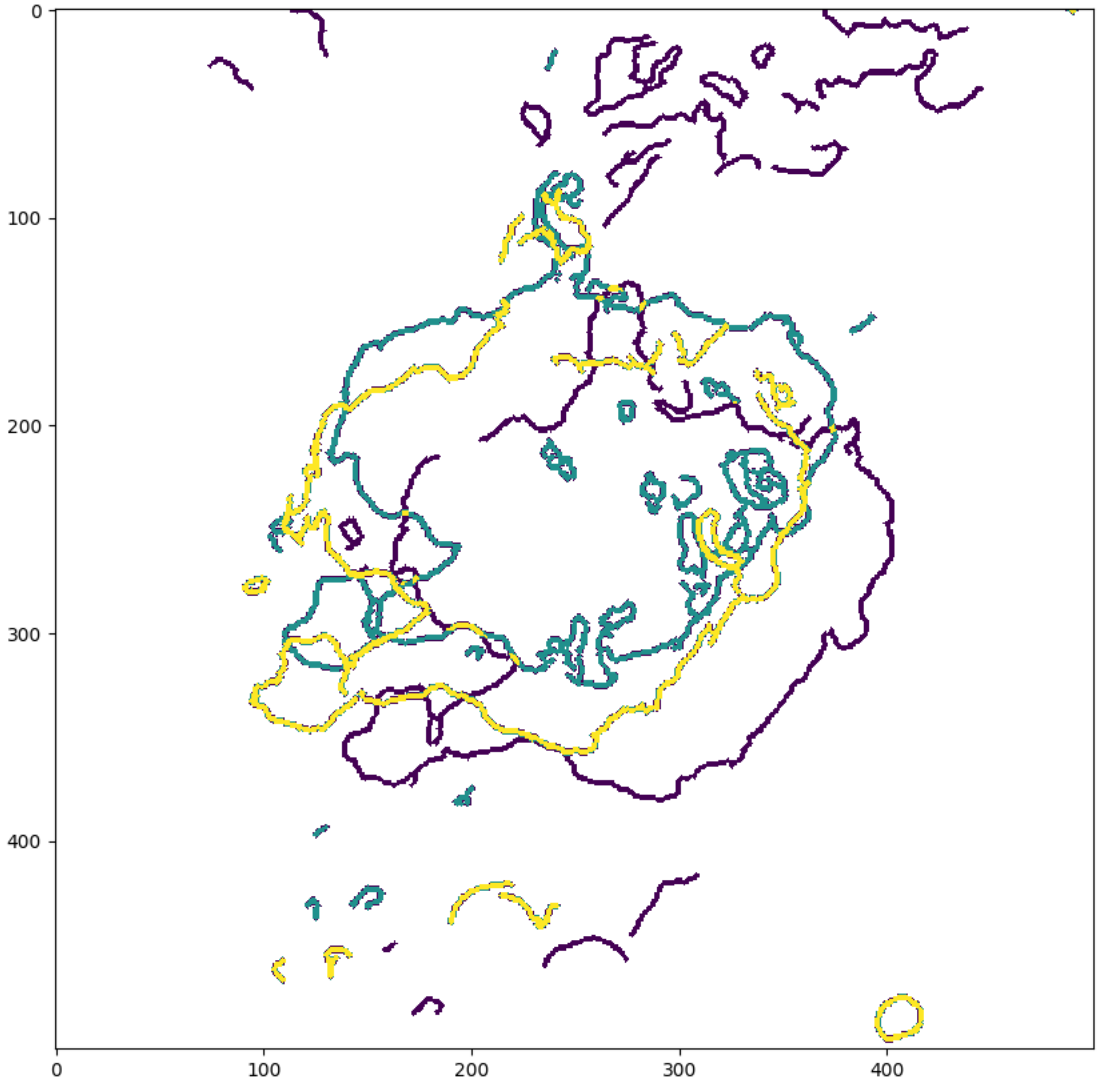




Georeferencing inaccuracy

- Georeferencing procedure is based on a static basemap
- Significant errors can be observed in some study areas e.g. in Africa





Status

- ET model is validated
- Water accounting and crop yield methodology is validated using simulated data
- Once the pre-processing of the satellite data is ready, the model will be applied on the satellite data
- Geometry issues:
  - Statistical analysis of the checkerboard pattern
  - Creation of automated procedure for matching of ECOSTRESS imagery to an up-to-date basemap

Questions?

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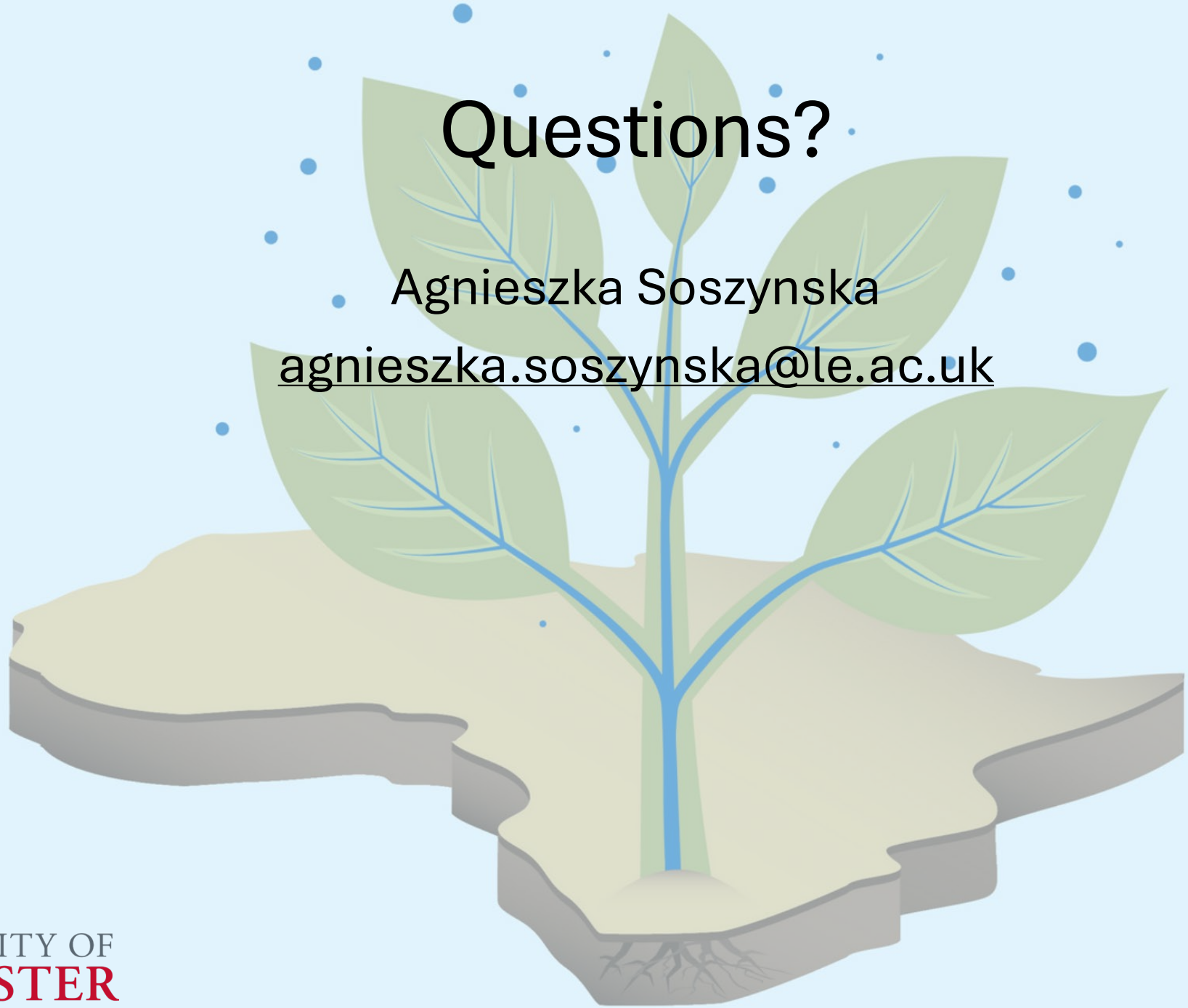

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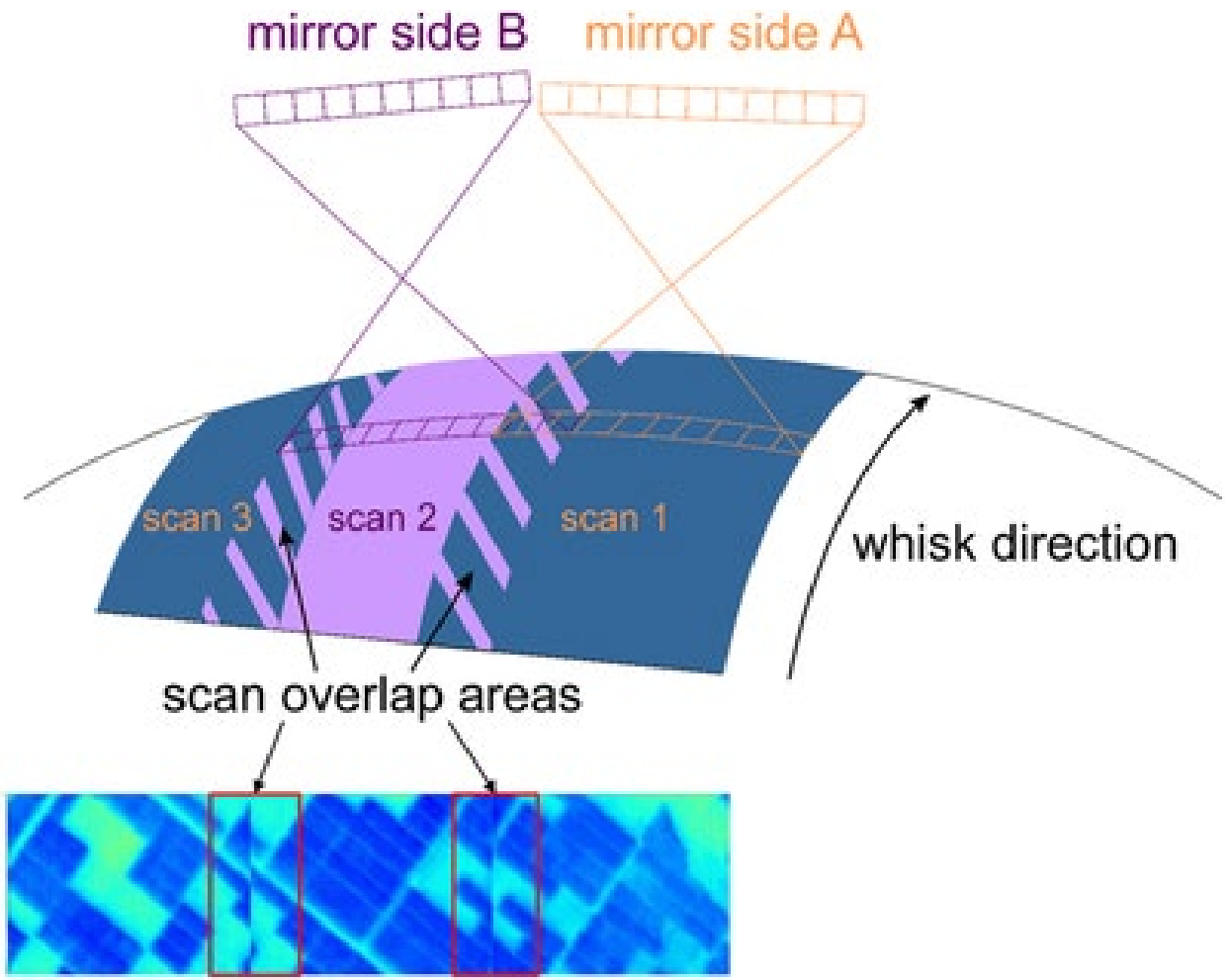
ECOSTRESS scanning principle



PRISMA processing