RÉPUBLIQUE FRANÇAISE
*Liberté*
*Égalité*
*Fraternité*

cirad
AGRICULTURAL RESEARCH FOR DEVELOPMENT

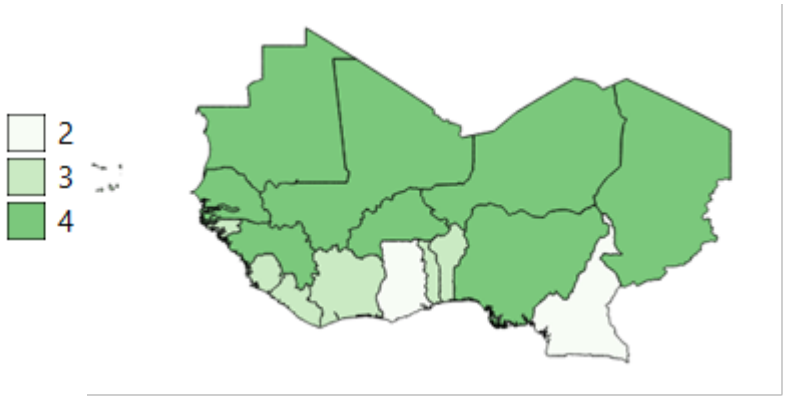
# Comparison of the vegetation anomalies products used in the crop monitoring systems

## West Africa study case

**Agnès Bégué**, L. Lemettais, S. Madec, L. Leroux, R. Interdonato

# 40 years of Earth Observation for crop monitoring in countries at risk …

- More than 5 Crop Monitoring Systems for food security in West Africa




*Number of operational Crop Monitoring systems in West Africa*
(FEWS -NET, GIEWS, ASAP, VAM, AGRHYMET, CROPWATCH)

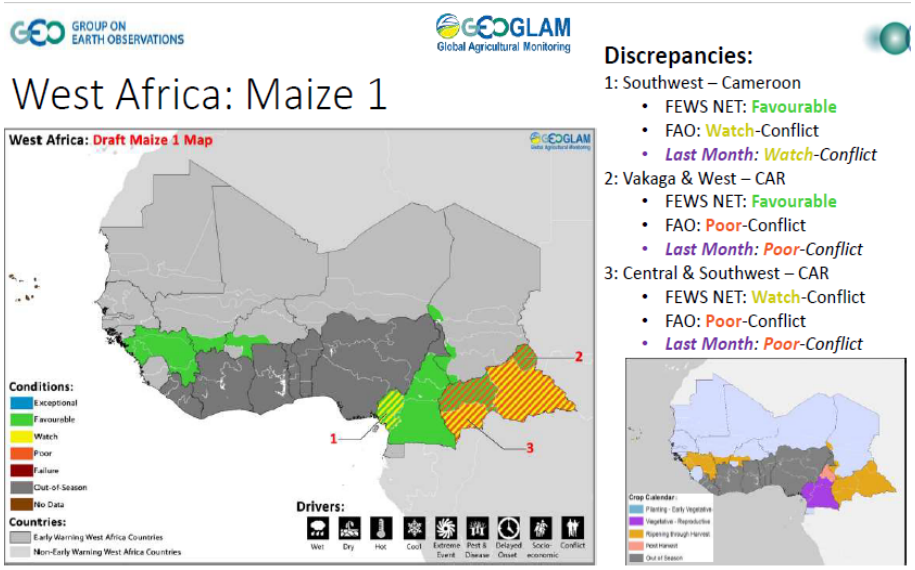

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

cirad

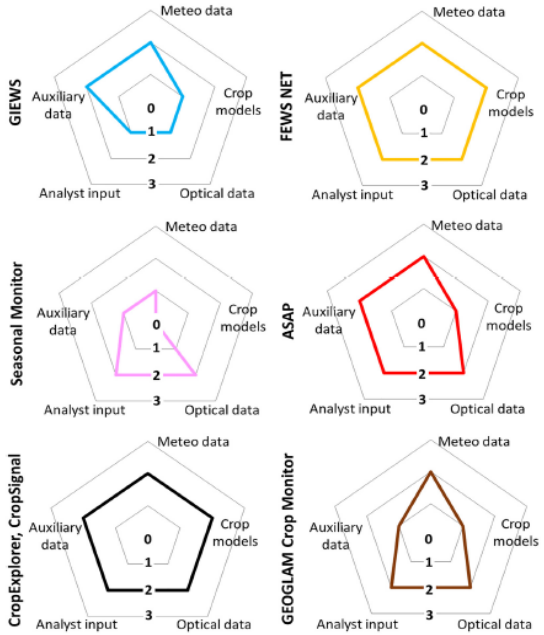
cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

tetis
TERRITOIRE ENVIRONNEMENT TÉLÉDÉTECTION INFORMATION SPATIALE

# … and still some discrepancies in crop condition assessment




Example of discrepancy map on the maize crop conditions in West Africa, as reported by FEWS NET and GIEWS.
*Source: Courtesy of GEOGLAM Crop Monitor*
*Becker-Reshef et al., 2020*



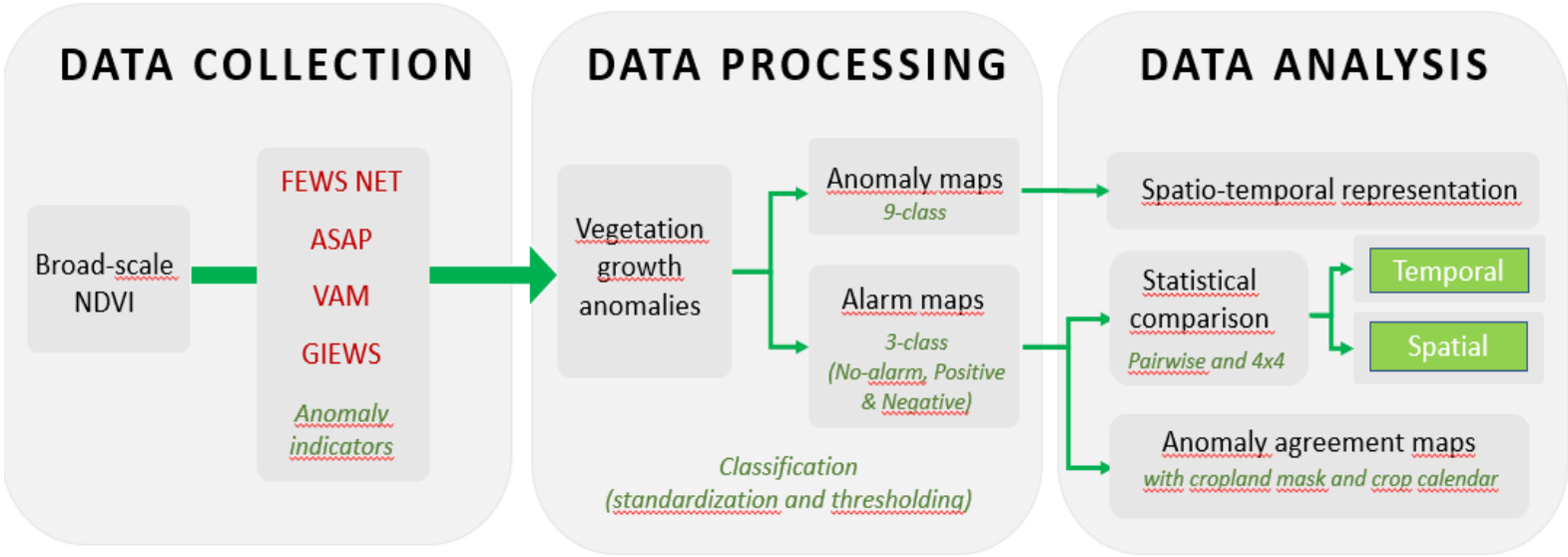

A comparison of global agricultural monitoring systems (sources of input data) and current gaps. *Fritz et al., 2019*

# What can explain these discrepancies?

A comparative experiment of **growth vegetation anomalies** produced by the main Crop Monitoring Systems in West Africa for the 2010-2020 period

- Are there temporal or spatial patterns of discrepancies?
- What consequences for the Early Warning Systems for food security?
- How to compare different vegetation anomalies both in time and space?

# The approach




A set of four NDVI-based growth anomaly indicators was selected, harmonized, classified and compared in time and space

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

cirad

cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

tetis

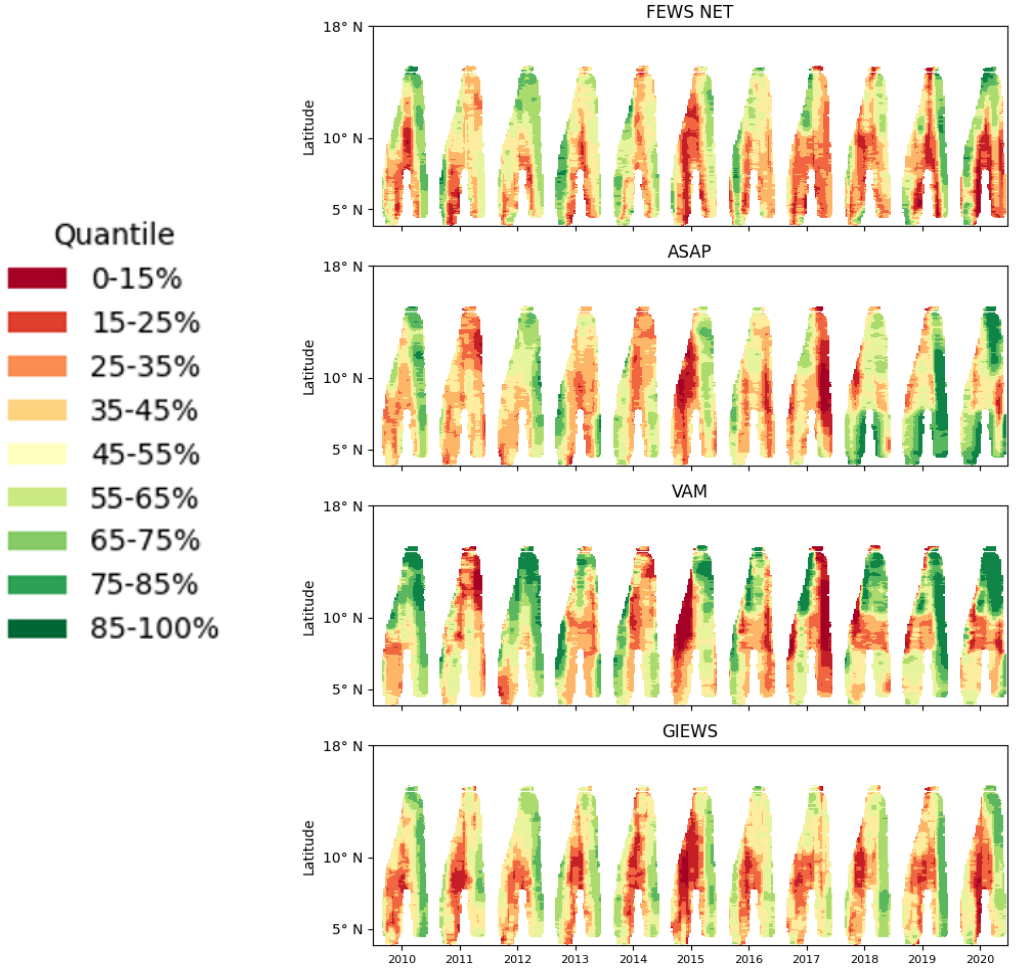
# Data collection

- Selection of 4 NDVI-based anomaly indicators from 4 operational crop monitoring systems

| | FEWS NET | VAM | ASAP | GIEWS* |
|---|---|---|---|---|
| Satellite product | eMODIS Level-1B Collection 6 (MODIS Terra & Aqua) | MYD13C1-MOD13C1 (MODIS Terra & Aqua) | MOD13A2-MYD13A2 V006 (MODIS Terra & Aqua) | NOAA-AVHRR & METOP (since 2007) |
| Pre-processing | Weighted least-squares linear regression smoothing | Whittaker filter | Whittaker filter | Weighted least-squares linear regression smoothing |
| NDVI-based Anomaly indicator | % median: NDVI | % mean: NDVI | z-score: NDVI | % mean: NDVI |
| Spatial resolution | 250 m | 5.6 km | 1 km | 1 km (since 2007) |
| Frequency | 10 days | 8 days | 10 days | 10 days |
| Time reference | 2003-2017 | 2002-2013 | 10/2001 to 12/2020 | 1984-2014 |
| Web application | Early Warning eXplorer (EWX) https://earlywarning.usgs.gov/fews/search | Hunger Analytics Hub https://dataviz.vam.wfp.org/Hunger-Analytics-Hub | ASAP Warning Explorer https://mars.jrc.ec.europa.eu/asap/wexplorer/ | ASIS Global indicators https://www.fao.org/giews/earthobservation/asis/index_2.jsp?lang=en |

RÉPUBLIQUE FRANÇAISE Liberté Égalité Fraternité cirad cnes CENTRE NATIONAL D'ÉTUDES SPATIALES tetis TERRITOIRE ENVIRONNEMENT TÉLÉDÉTECTION INFORMATION SPATIALE

# Vegetation anomalies Hovmöller plots 2010-2020 for West Africa




Cropland mask
GLC-SHARE
*(Latham et al., 2014)*

+

Growing season mask
ASAP Phenological indices
(*Rembold et al., 2019*)

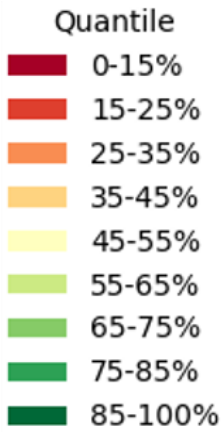
RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

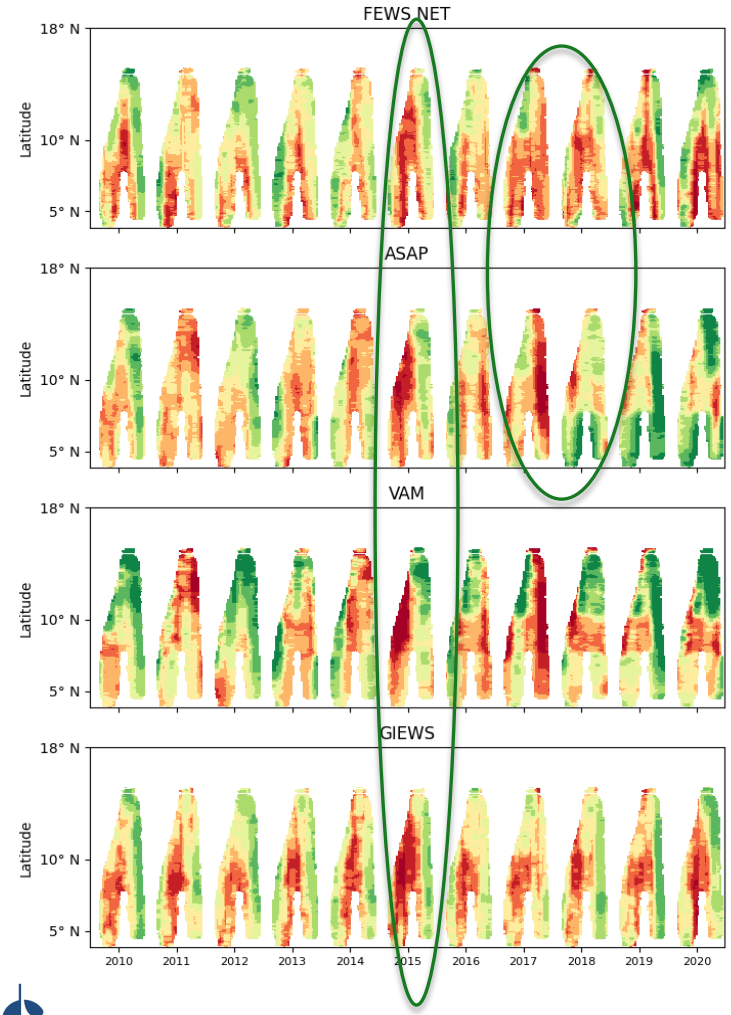
cirad

cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

tetis
TERRITOIRE ENVIRONNEMENT TÉLÉDÉTECTION INFORMATION SPATIALE

# Vegetation anomalies Hovmöller plots 2010-2020 for West Africa




Cropland mask
GLC-SHARE
*(Latham et al., 2014)*

+

Growing season mask
ASAP Phenological indices
(*Rembold et al., 2019*)

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

cirad

cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

tetis
TERRITOIRE ENVIRONNEMENT TÉLÉDÉTECTION INFORMATION SPATIALE

# From vegetation anomalies maps to alarm maps

To simplify the spatial analysis, the extreme classes corresponding to <15% and >85% of the rank percentile values over the 2010-2020 period were respectively labelled as “negative alarm” and “positive alarm” classes.

The **alarm maps** of the 4 systems together, and pairwise were then compared.

*Mean of the annual similarities of the 3-class alarm maps of the 4 systems*

| All pixels → | Cropland pixels → | Cropped pixels |
|---|---|---|
| 27,6% | 33,3% | 30,7% |

| | |
|---|---|
| 1,2% | (-) alarm |
| 2,1% | (+) alarm |
| 27,3% | (0) alarm |

# From vegetation anomalies maps to alarm maps

- To simplify the spatial analysis, the extreme classes corresponding to <15% and >85% of the rank percentile values over the 2010-2020 period were respectively labelled as “negative alarm” and “positive alarm” classes.

- The alarm maps of the 4 systems together, and pairwise were then compared.

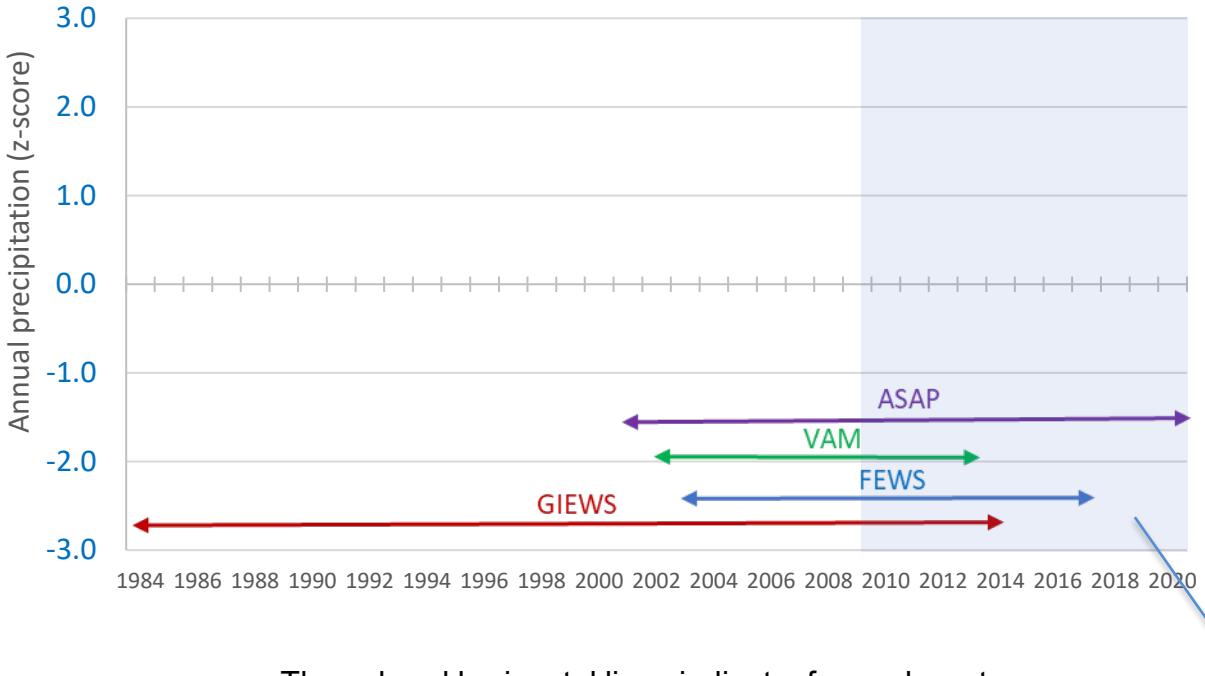
*Pairwise Spearman rank correlation between the 4 systems*

| | FEWS NET | VAM | GIEWS | ASAP |
|---|---|---|---|---|
| FEWS NET | 1 | | | |
| VAM | 0.08 | 1 | | |
| GIEWS | -0.01 | 0.11 | 1 | |
| ASAP | 0.11 | 0.25 | 0.06 | 1 |

# The potential sources of discrepancies

- Satellite data (sensor, spatial resolution …)
- Satellite time series pre-processing
- Vegetation anomaly indices : % mean, % median, z-Score
- Period of reference

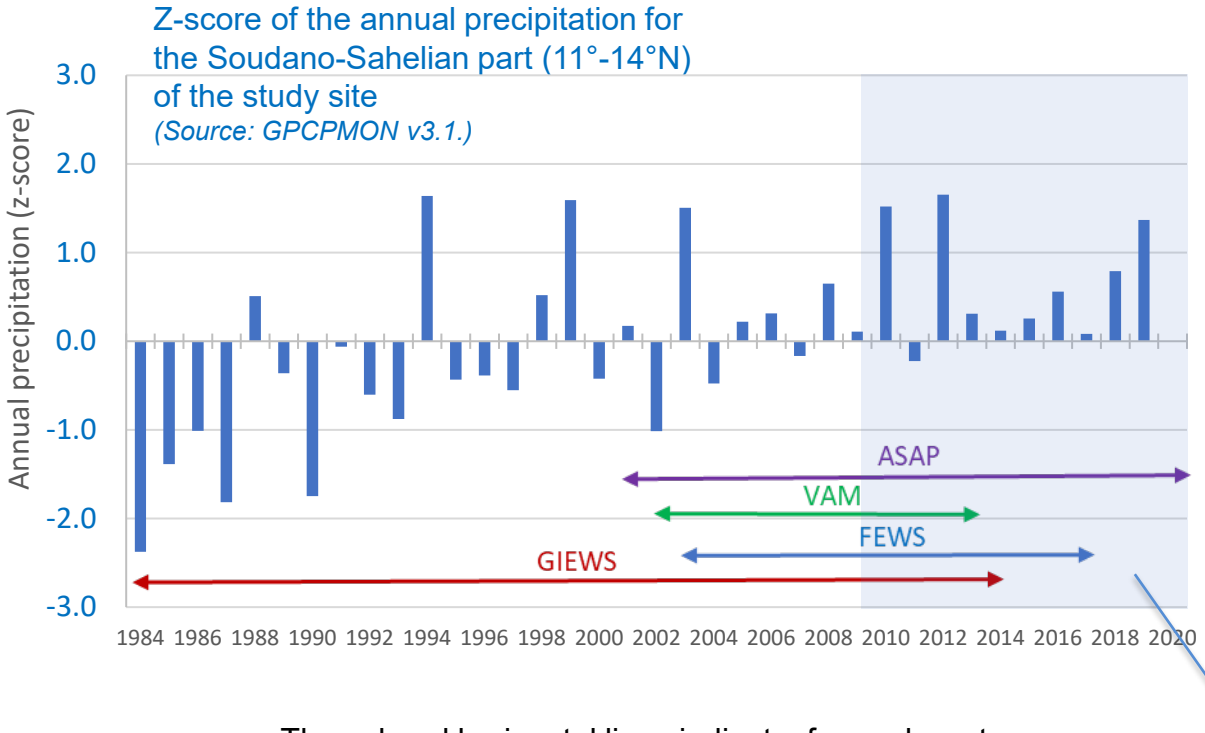
# The potential sources of discrepancies




The colored horizontal lines indicate, for each system, the period of reference used to calculate the vegetation anomalies

The studied period (2010-2020).

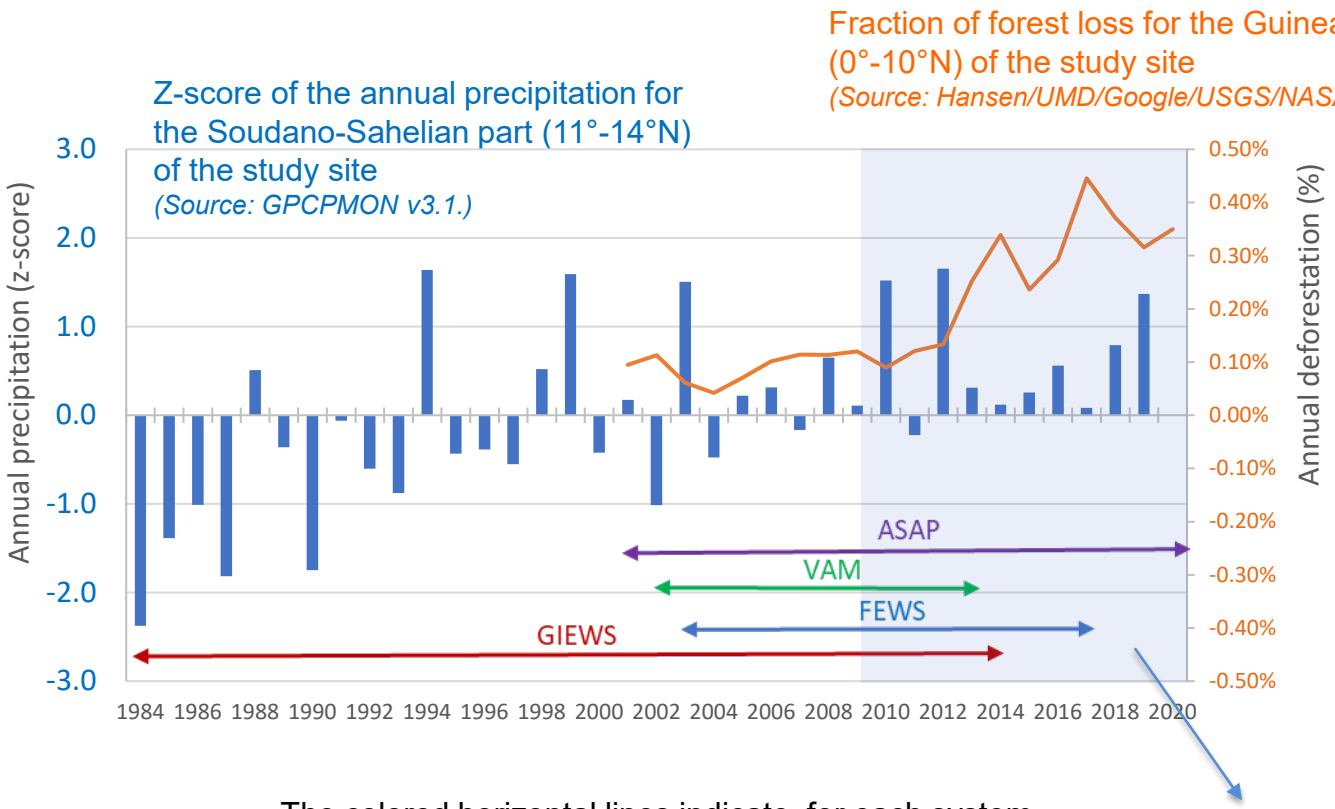
# The potential sources of discrepancies




The colored horizontal lines indicate, for each system, the period of reference used to calculate the vegetation anomalies

The studied period (2010-2020).

# The potential sources of discrepancies




The colored horizontal lines indicate, for each system, the period of reference used to calculate the vegetation anomalies

The studied period (2010-2020).

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

cirad

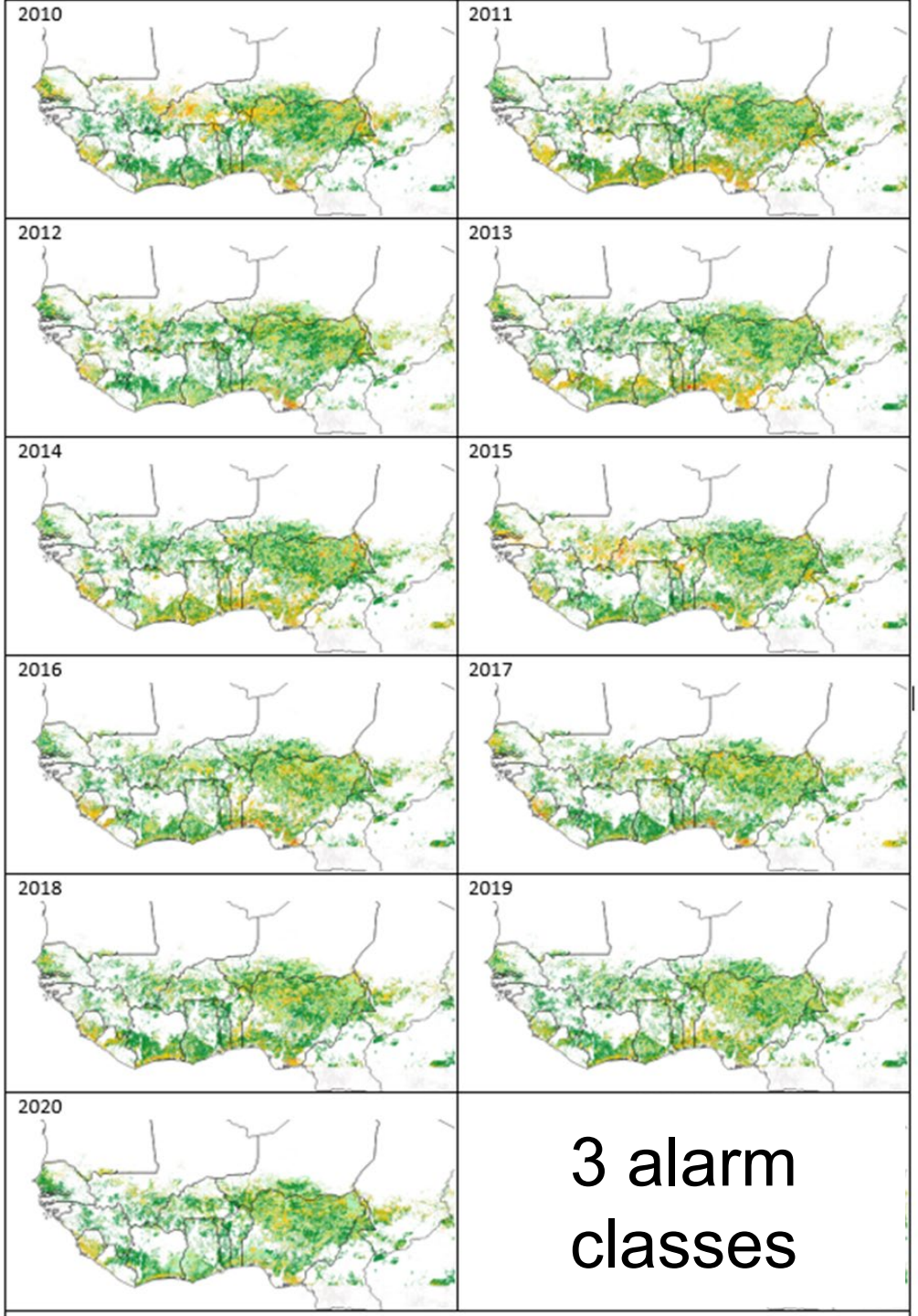
cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

tetis
TERRITOIRE ENVIRONNEMENT TÉLÉDÉTECTION INFORMATION SPATIALE

# What's next ?

- Statistical comparison of the anomaly products
  - Unexpected discrepancies between the systems
  - Identification of potential sources of discrepancies

- The spatio-temporal analysis -> alarm agreement maps (3 classes)



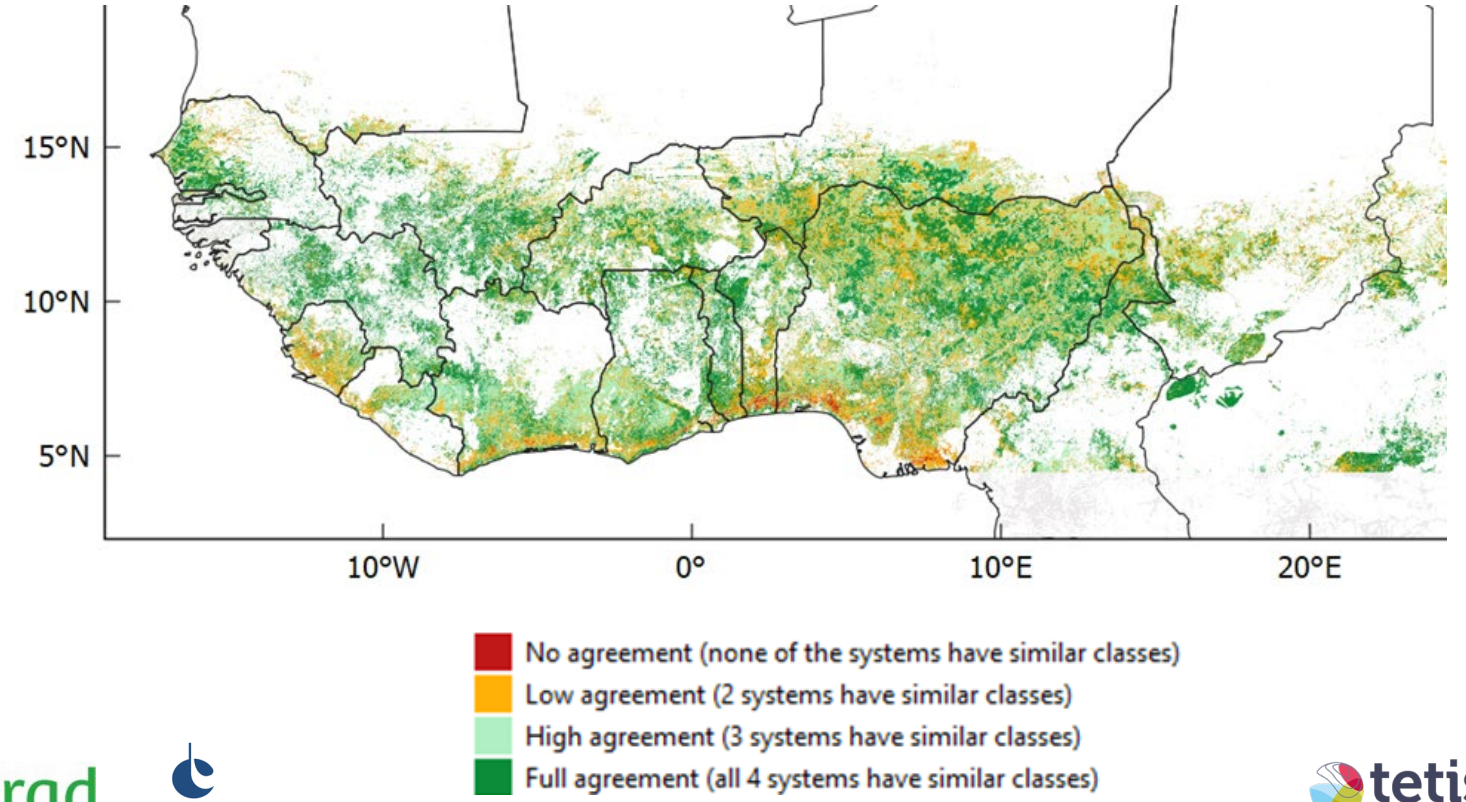

# The alarm agreement maps

- No agreement (none of the systems have similar classes)
- Low agreement (2 systems have similar classes)
- High agreement (3 systems have similar classes)
- Full agreement (all 4 systems have similar classes)

tetis
TERRITOIRE ENVIRONNEMENT TÉLÉDÉTECTION INFORMATION SPATIALE

# The alarm agreement maps

*Agreement map of the **3-alarm classes**, calculated for the cropland and the crop growing season for the 2010-2020 period*

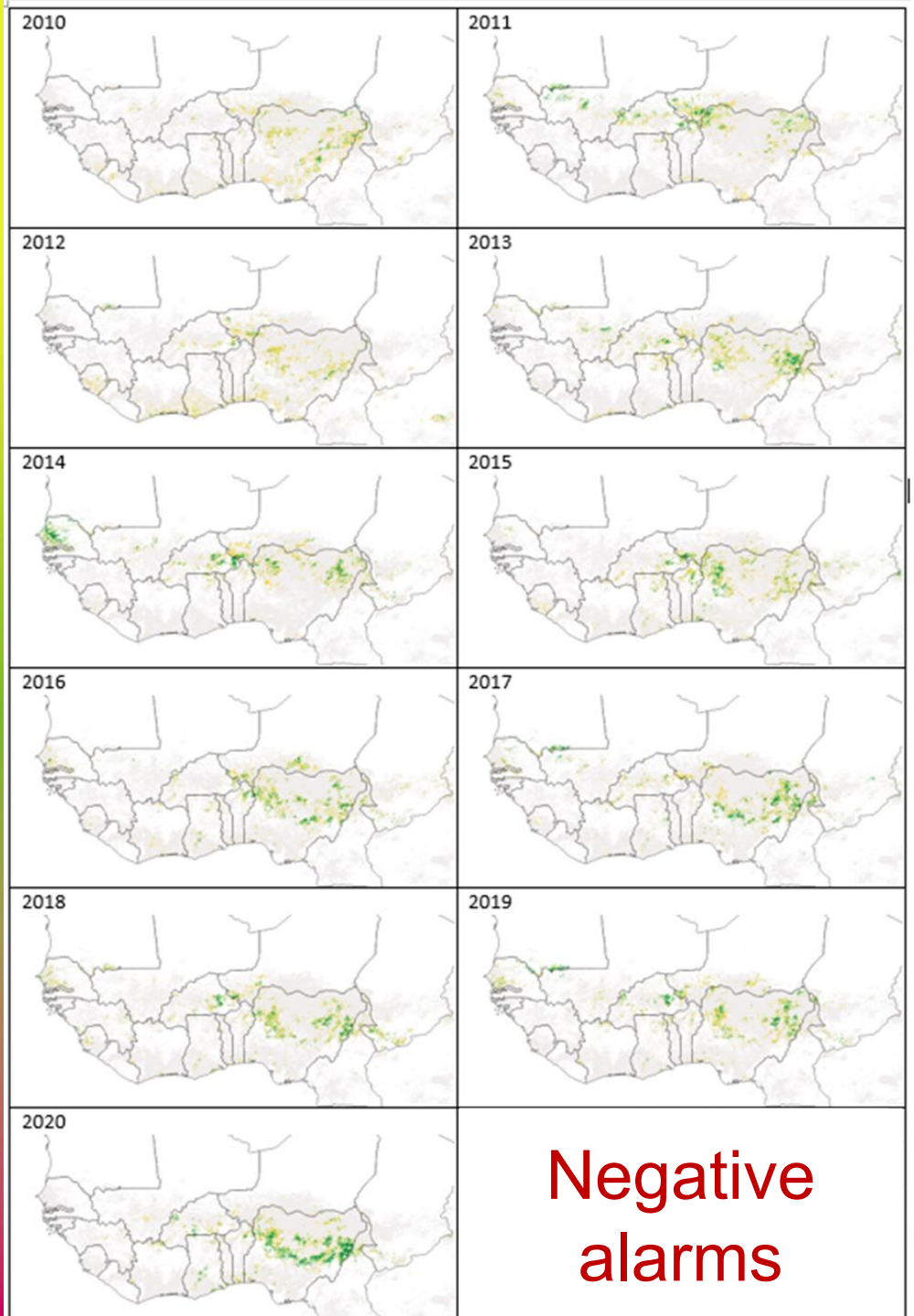



RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

cirad

cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

tetis
TERRITOIRE ENVIRONNEMENT TÉLÉDÉTECTION INFORMATION SPATIALE




# The alarm agreement maps

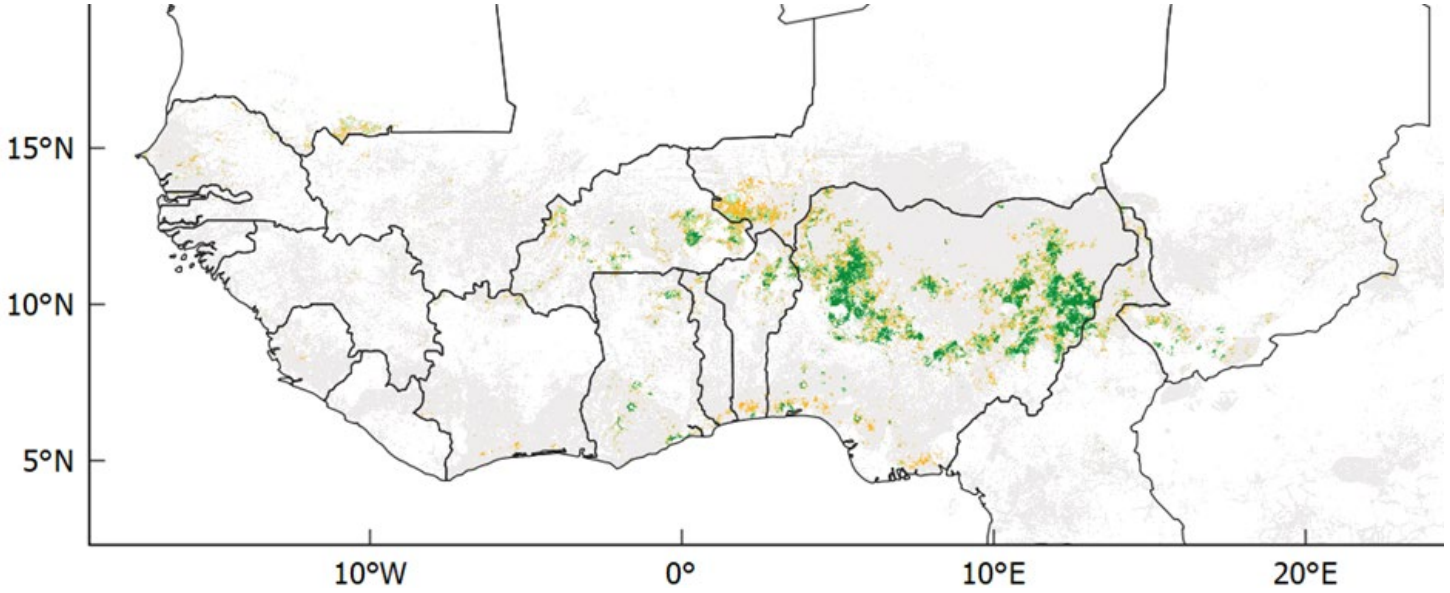
- No agreement (none of the systems have similar classes)
- Low agreement (2 systems have similar classes)
- High agreement (3 systems have similar classes)
- Full agreement (all 4 systems have similar classes)

Negative alarms

tetis
TERRITOIRE ENVIRONNEMENT TÉLÉDÉTECTION INFORMATION SPATIALE

# The alarm agreement maps

*Agreement map of **negative alarm** class, calculated for the cropland and the crop growing season for the 2010-2020 period*




RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

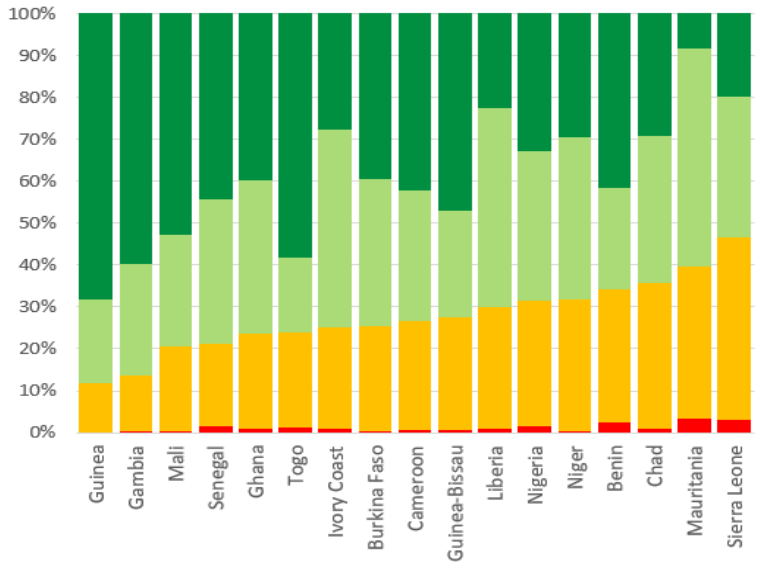
cirad

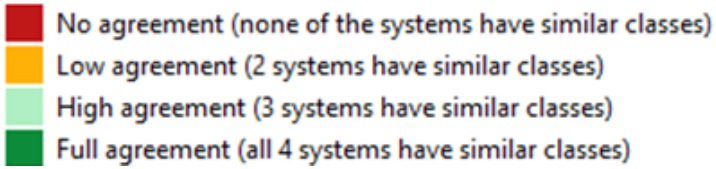
cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

tetis
TERRITOIRE ENVIRONNEMENT TÉLÉDÉTECTION INFORMATION SPATIALE

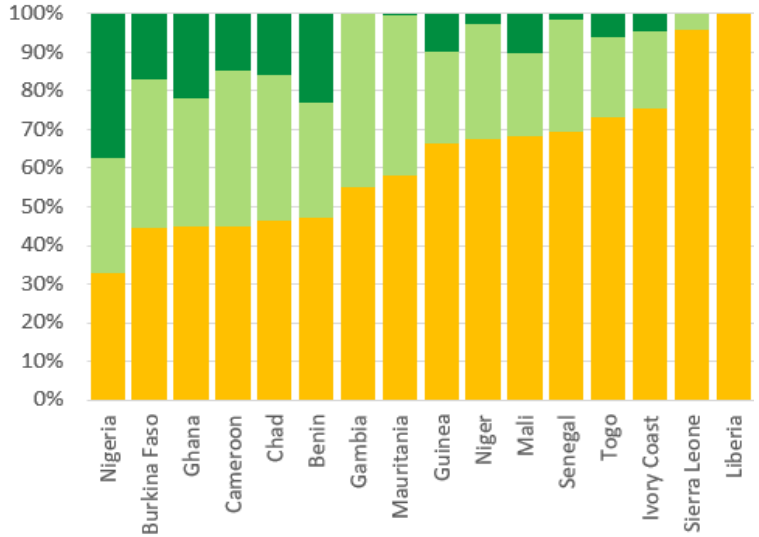
# Geographic analysis

All 3 alarms




Negative alarms




RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

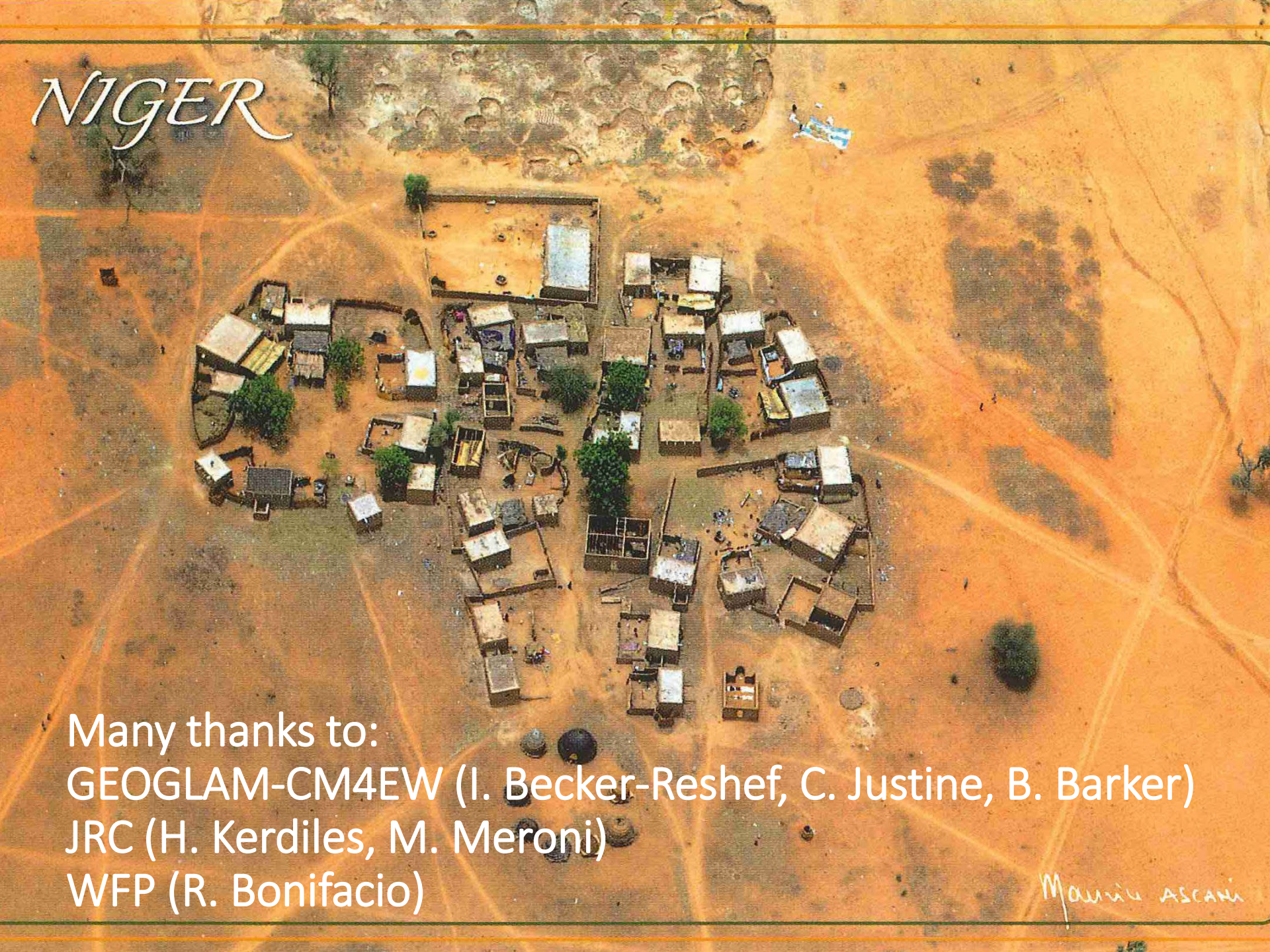
cirad

cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

tetis

# Conclusions

- Study limitations :
  - In terms of datasets:
    - Only the NDVI-based anomaly products were considered (other indices exist)
    - Data used for the study (anomaly classes for GIEWS, anomaly values for other systems).
  - In terms of data processing:
    - Potential bias due to the spatial and temporal resampling of the initial products
    - The arbitrary threshold of 15% of the extreme percentiles to define the alarm classes
    - The use of a unique cropland map and of a unique growing season calendar
- Study results :
  - An approach for spatio-temporal comparison,
    … in the current environment where more and more products are emerging
  - A light on an unexpected source of discrepancies between systems
- Study promises :
  - Which product to use,
    … in an environment where an increasing number of products are available
  - The negative alarm agreement maps could provide information on the confidence level associated with the negative anomaly -> Early warning system


NIGER
Many thanks to:
GEOGLAM-CM4EW (I. Becker-Reshef, C. Justine, B. Barker)
JRC (H. Kerdiles, M. Meroni)
WFP (R. Bonifacio)