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AGRICULTURAL RESEARCH FOR DEVELOPMENT

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

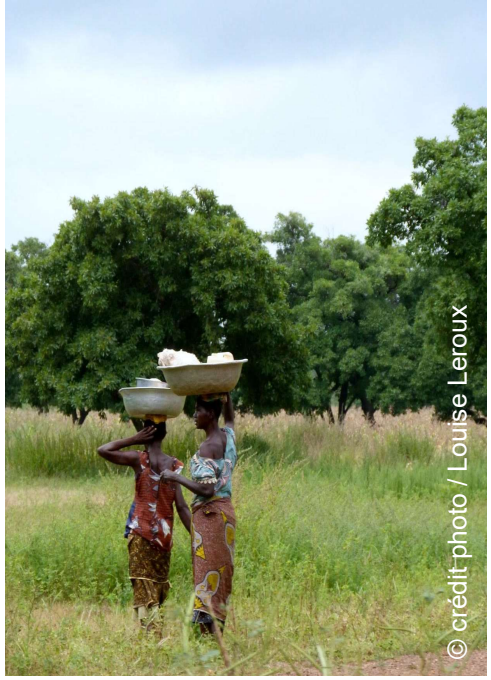
West Africa study case

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)



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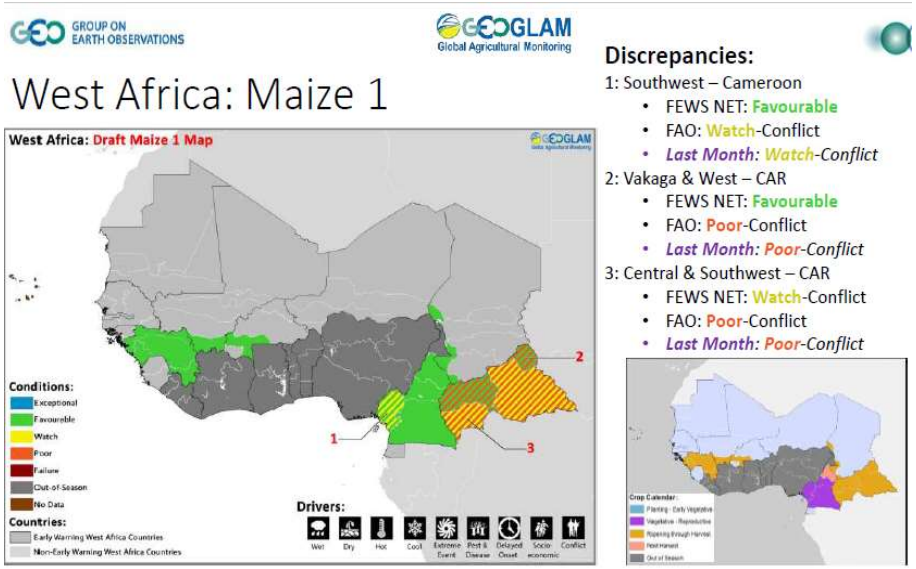
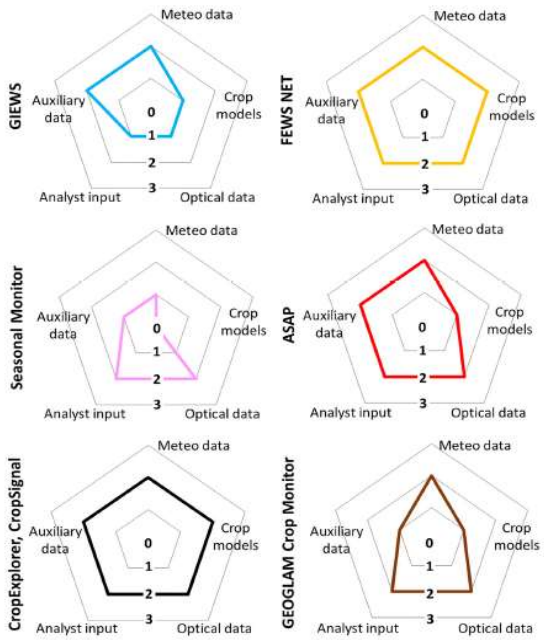
… and still some discrepancies in crop condition assessment



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*

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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?

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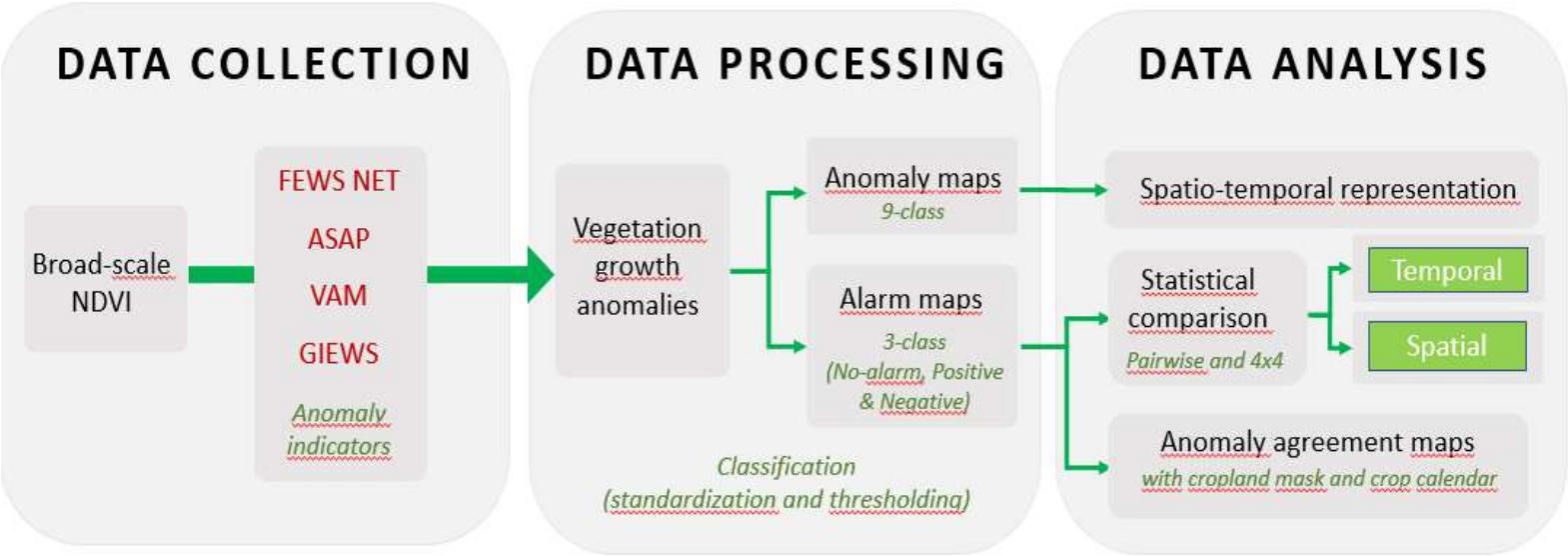
The approach



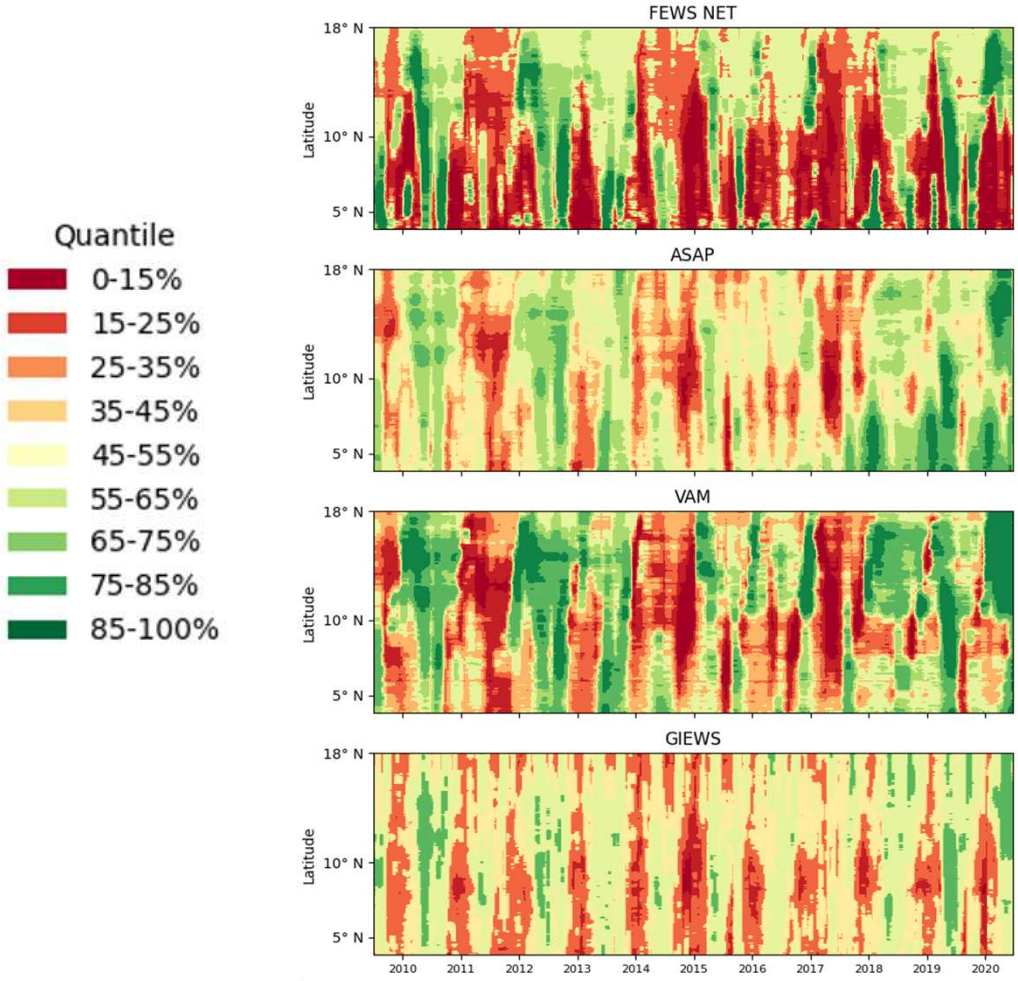
A set of four NDVI-based growth anomaly indicators was selected, harmonized, classified and compared in time and space

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

Vegetation anomalies Hovmöller plots 2010-2020 for West Africa



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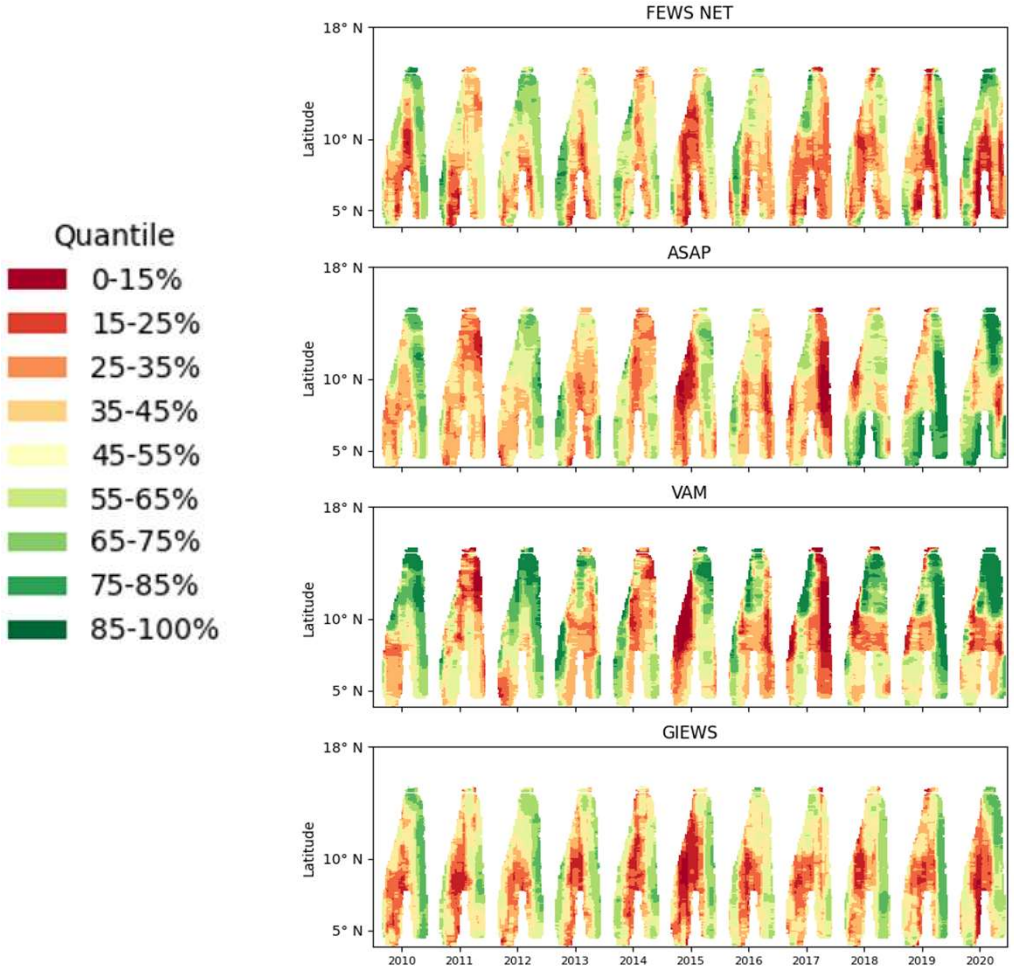

Cropland mask
GLC-SHARE
(Latham et al., 2014)

+

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

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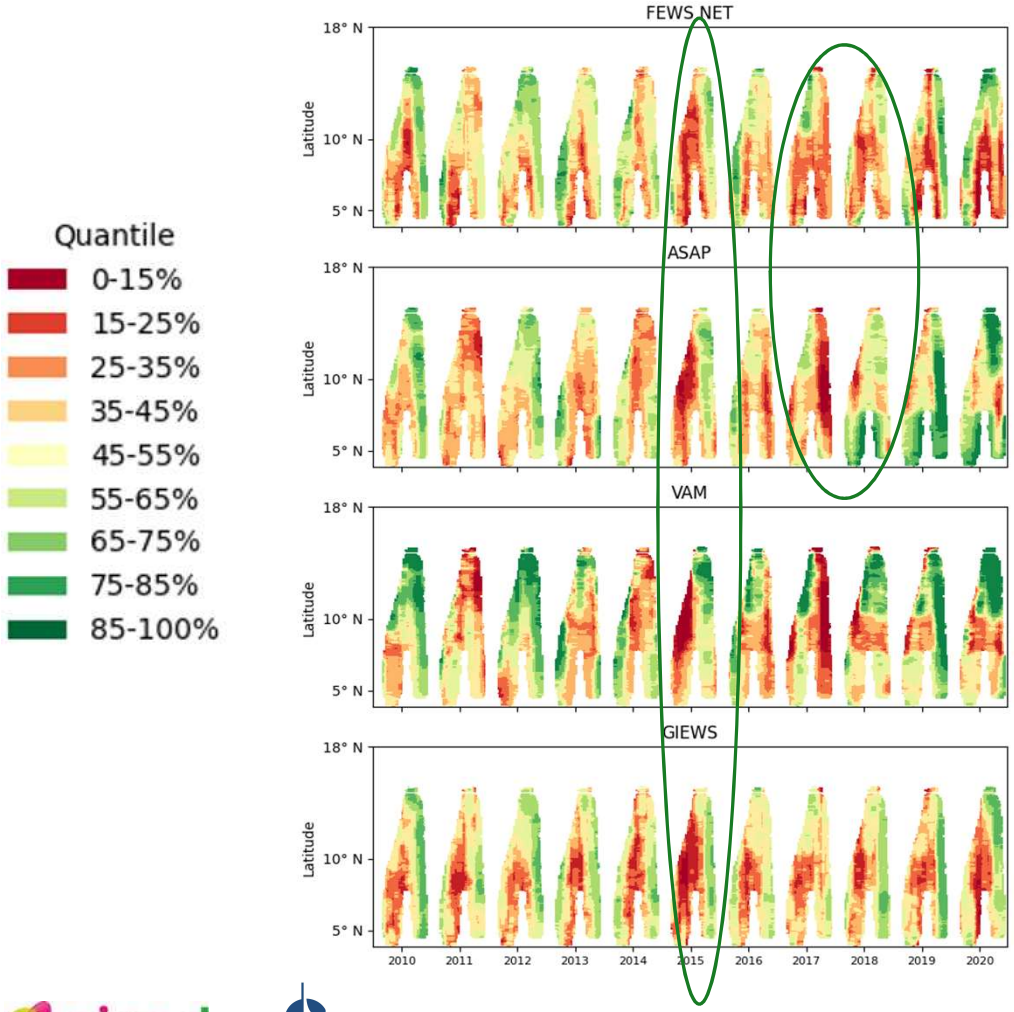

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From vegetation anomalies maps to alarm maps

- 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

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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

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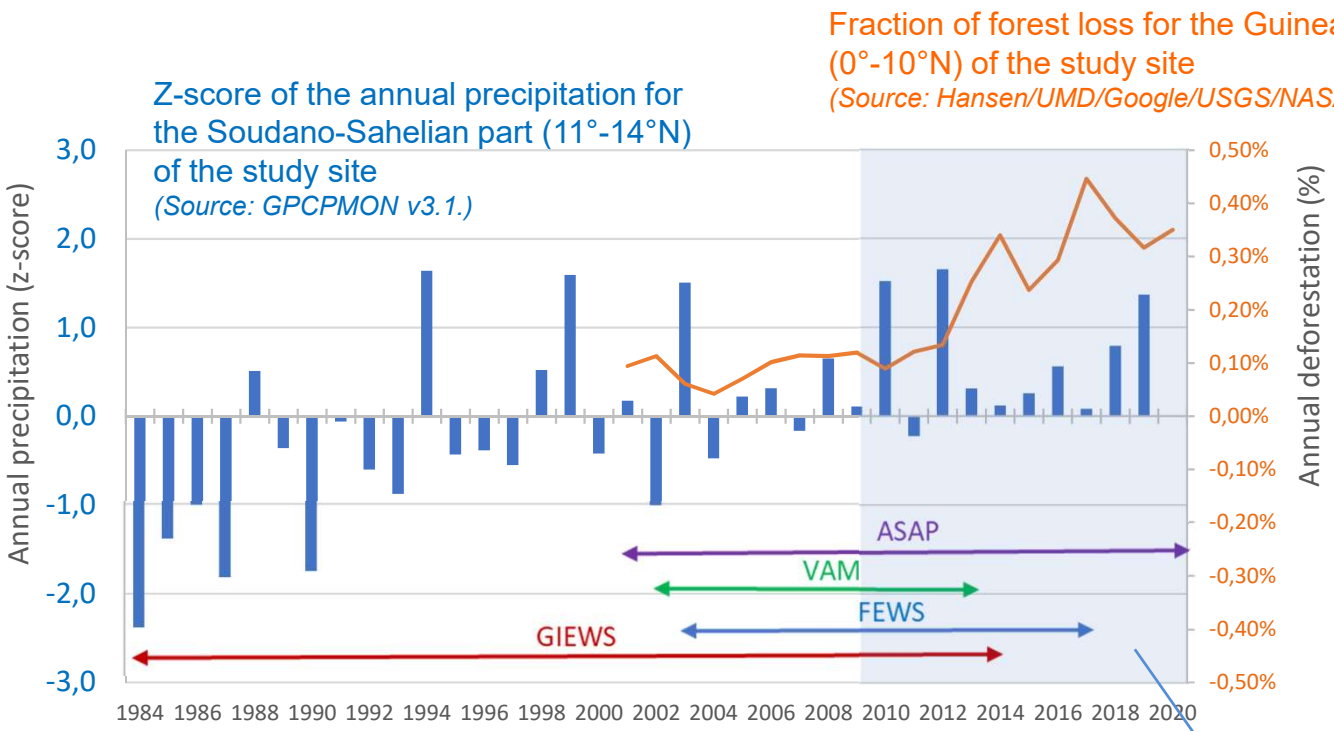
The potential sources of discrepancies

- 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).

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)

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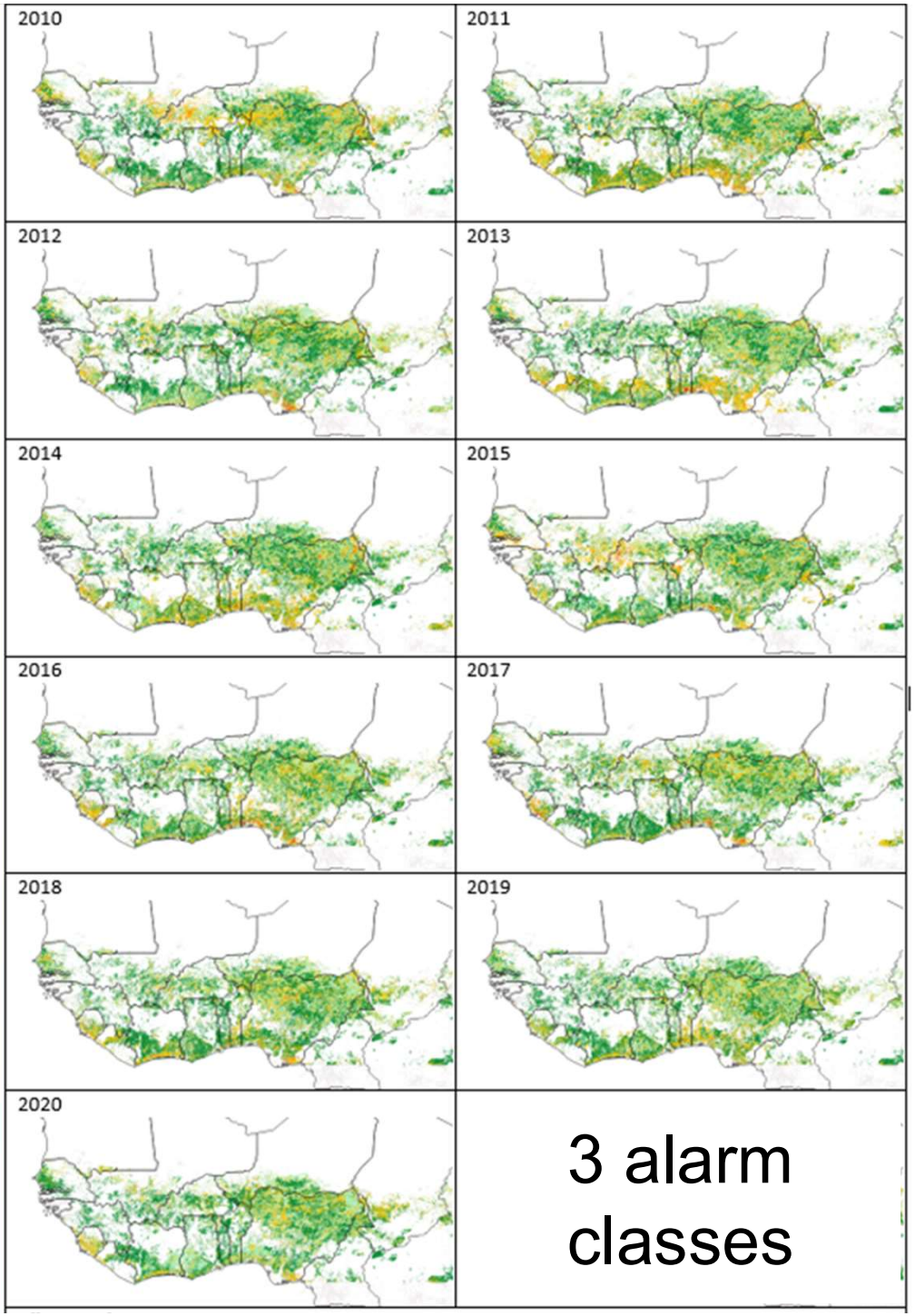
The alarm agreement maps



- 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)

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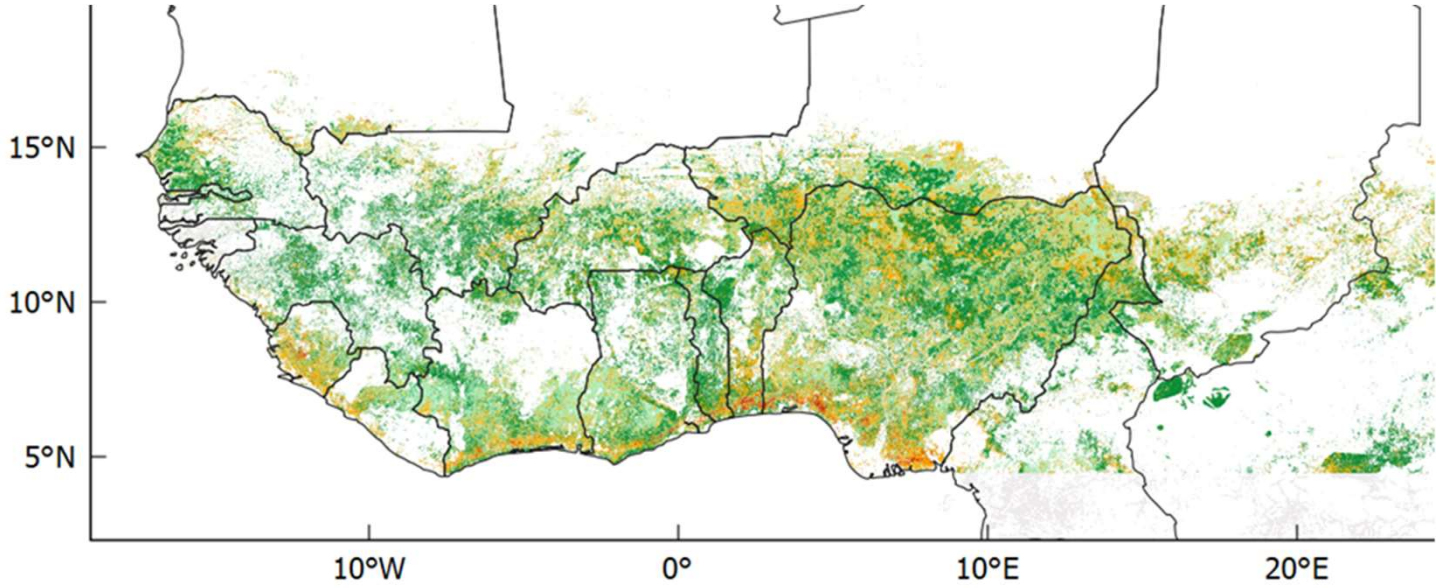
The alarm agreement maps

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



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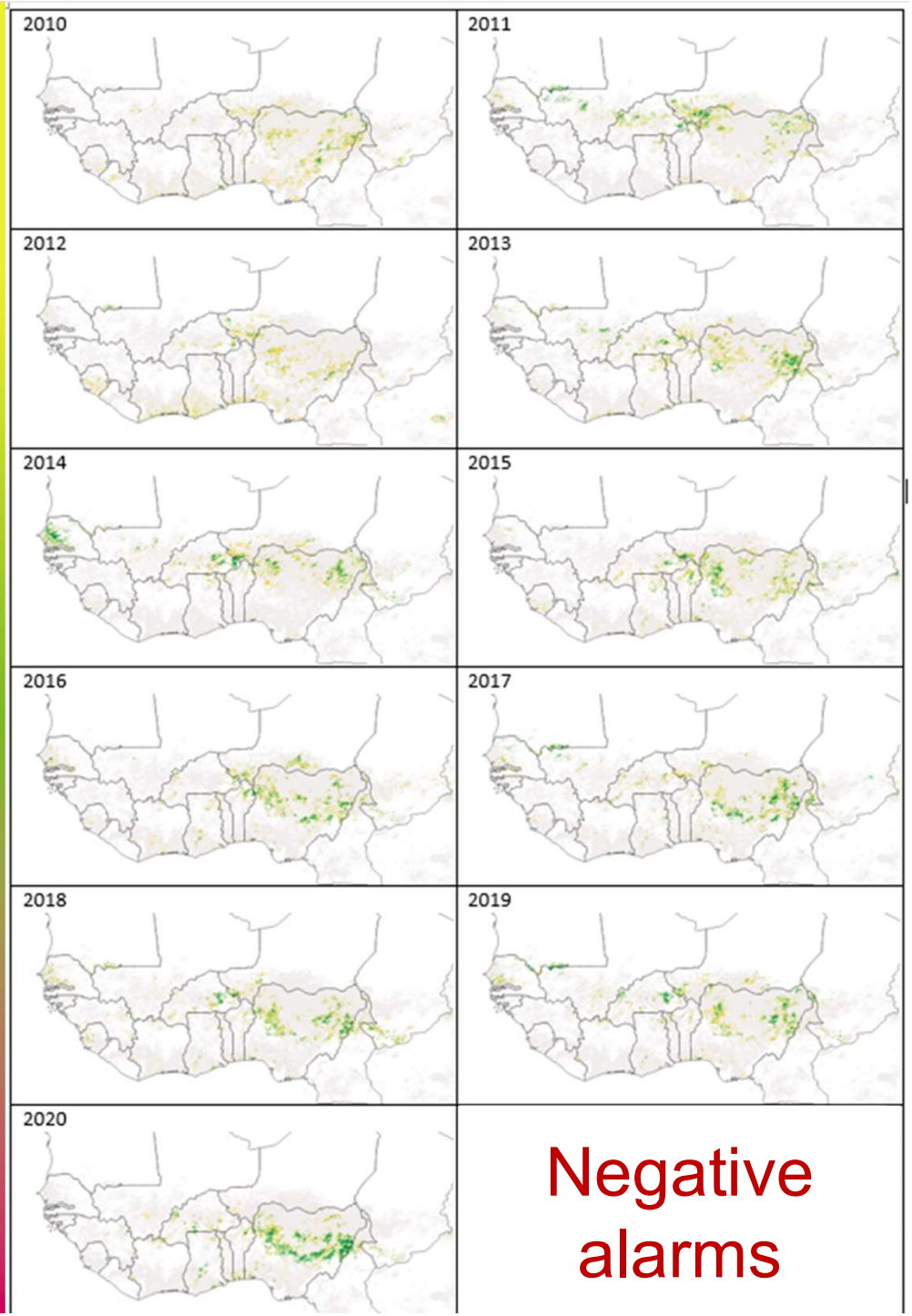

Negative alarms

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

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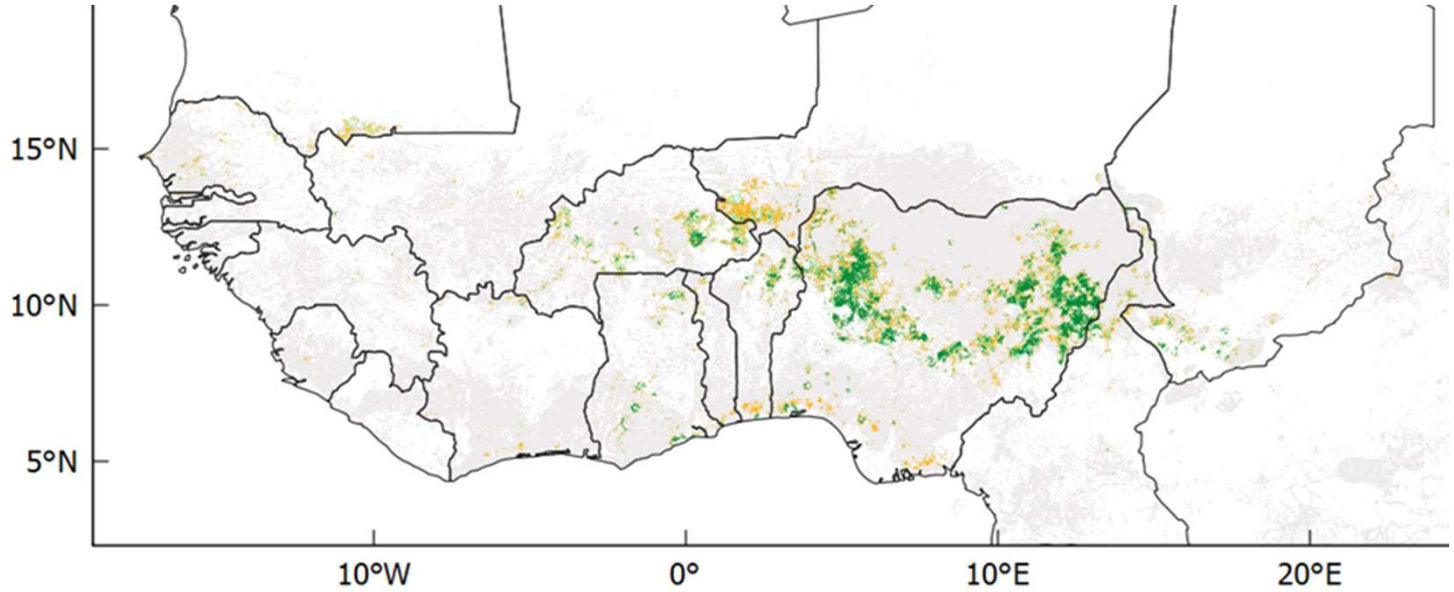
The alarm agreement maps

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



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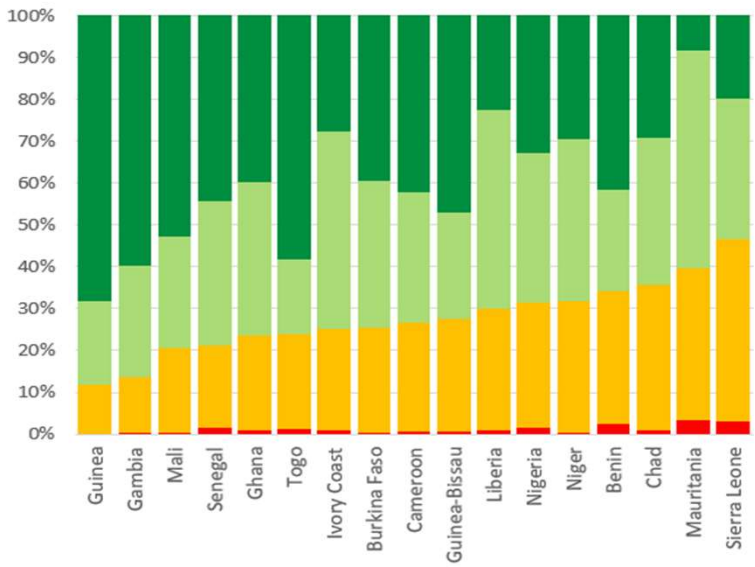
Geographic analysis

All 3 alarms



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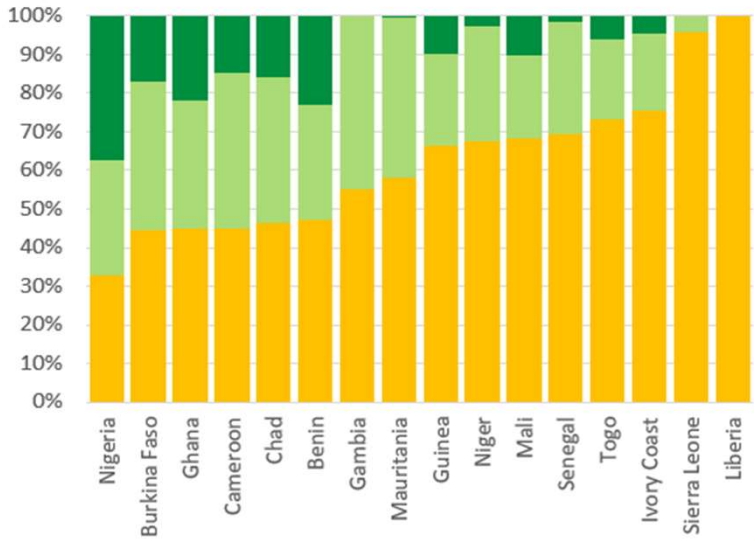
Negative alarms



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

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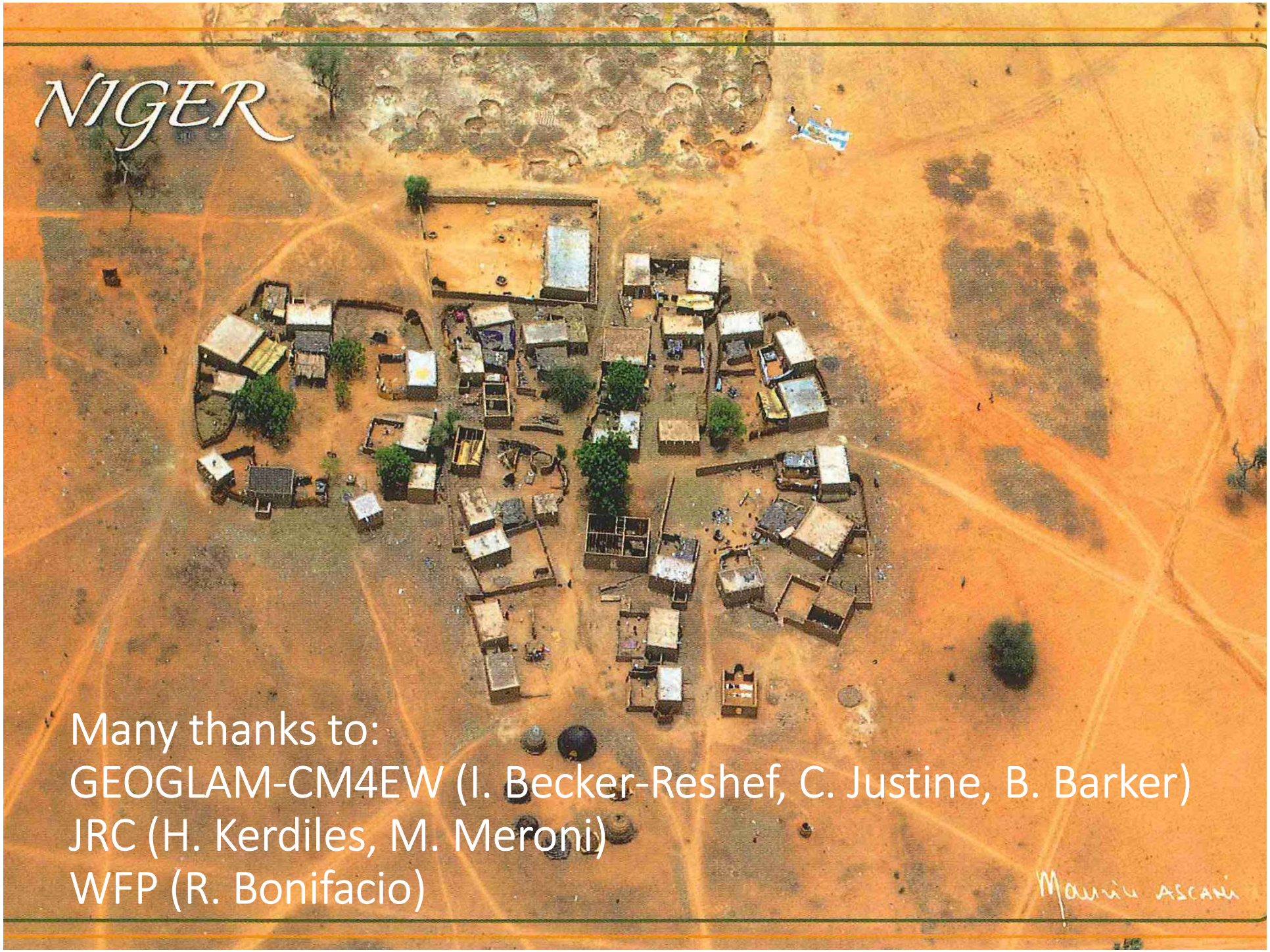

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WFP (R. Bonifacio)