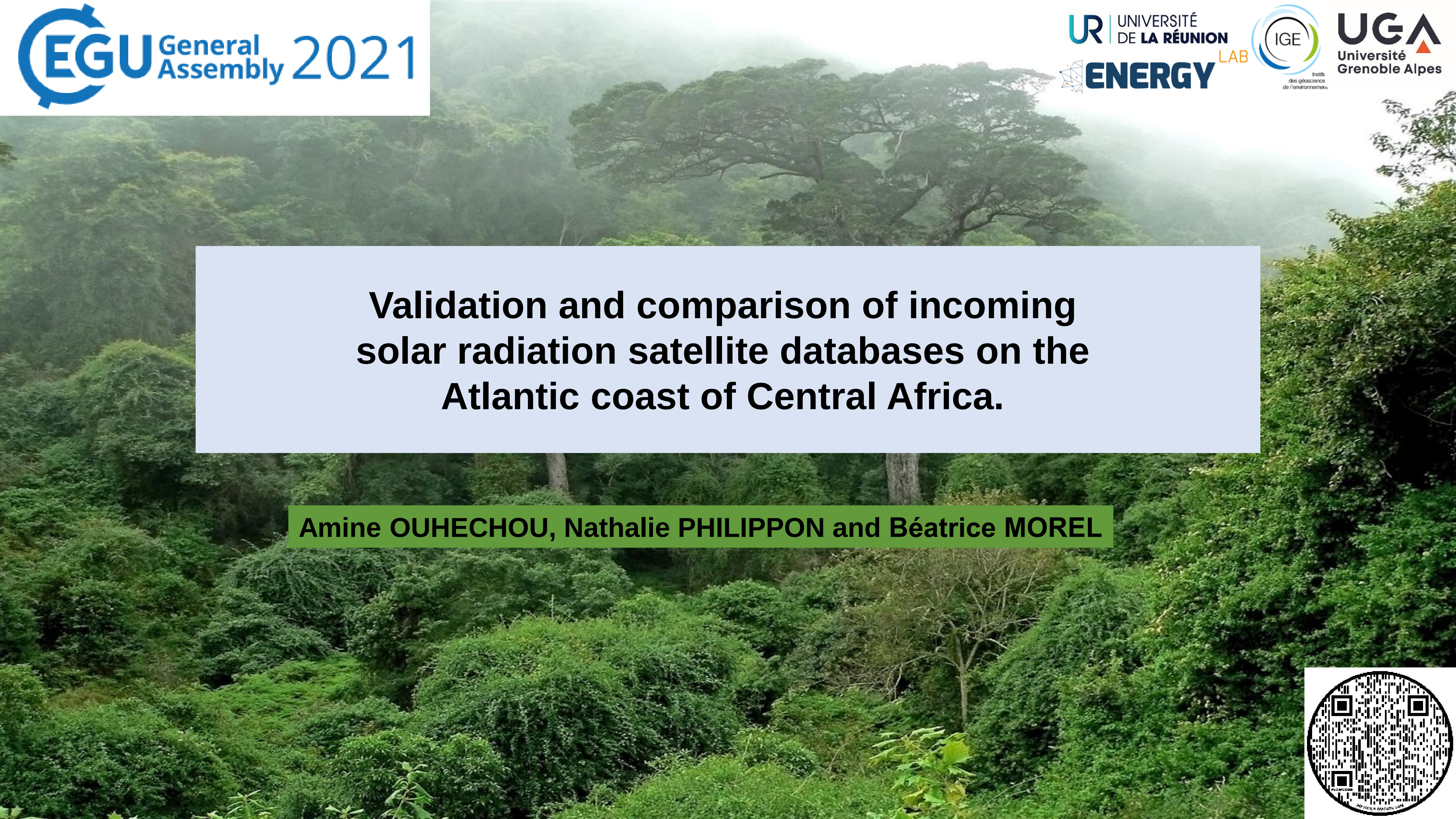
Validation and comparison of incoming solar radiation satellite databases on the Atlantic coast of Central Africa

Amine Ouhechou, Nathalie Philippon, Béatrice Morel

EGU General Assembly 2021



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Amine OUHECHOU, Nathalie PHILIPPON and Béatrice MOREL

UNIVERSITÉ DE LA RÉUNION
ENERGY LAB
IGE Institut des géoscience de l'environnement
UGA Université Grenoble Alpes

• Objectives

- ❖ Analyze the mean spatial and temporal variations of solar radiation (light availability for tree photosynthesis

- ❖ Document the specificity of the Atlantic coast

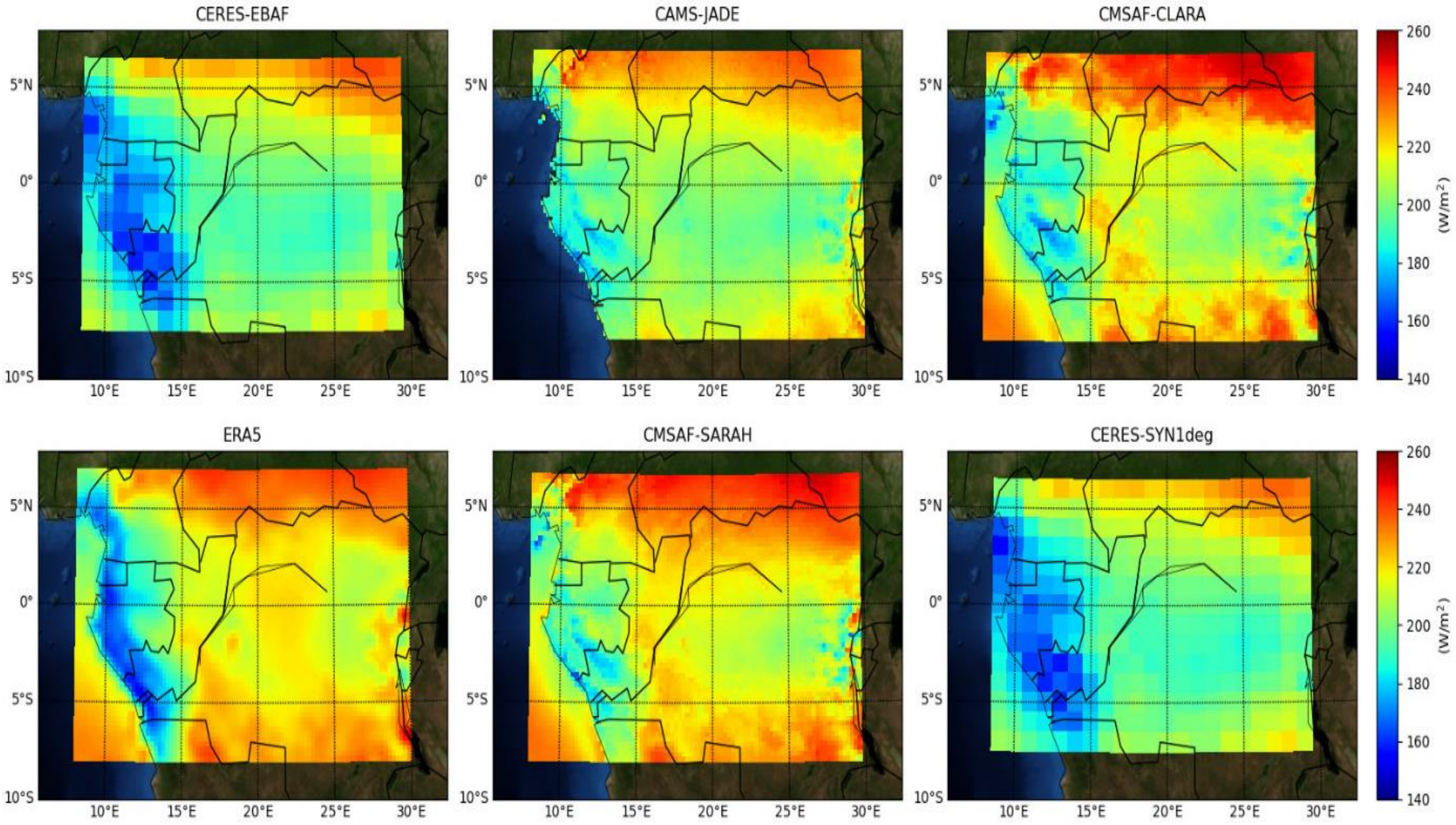
- ❖ Determine which satellite estimate(s) (in the absence of sufficient in-situ measurements) is the most suitable for the study of solar radiation on the Atlantic coast.

• Data used

Data set	Spatial resolution	Temporal resolution	Temporal range	Satellite	orbit type
CERES-EBAF	1° × 1°	Monthly	2000-03 / 2019-11	Terra + Aqua	**Heliosynchronous orbit**
CERES-SYN1deg	1° × 1°	Hourly	2000-03 / 2019-11	Terra + Aqua	**Heliosynchronous orbit**
Ré-analyses ERA5	0.25° × 0.25°	Monthly	1979-01 / 2020-12	---	---
CM SAF-CLARA-A2	0.25° × 0.25°	Monthly	1982-01 / 2015-12	**AVHRR sensors on series of NOAA satellites and the METOP satellite.**	**polar orbit**
CAMS-JADE	0.2° × 0.2°	15 minutes	2005-01 / 2018-12	**MVIRI/SEVIRI on METEOSAT MSG**	**geostationary orbit**
CM SAF-SARAH 2	0.05° × 0.05°	Hourly	1983-01 / 2020-12	**MVIRI/SEVIRI on METEOSAT MSG**	**geostationary orbit**
FAO stations	**N/A(station)**	Monthly means	---	---	---
Original meteorological stations	**N/A(station)**	15min to daily	---	---	---

• Results and Discussion

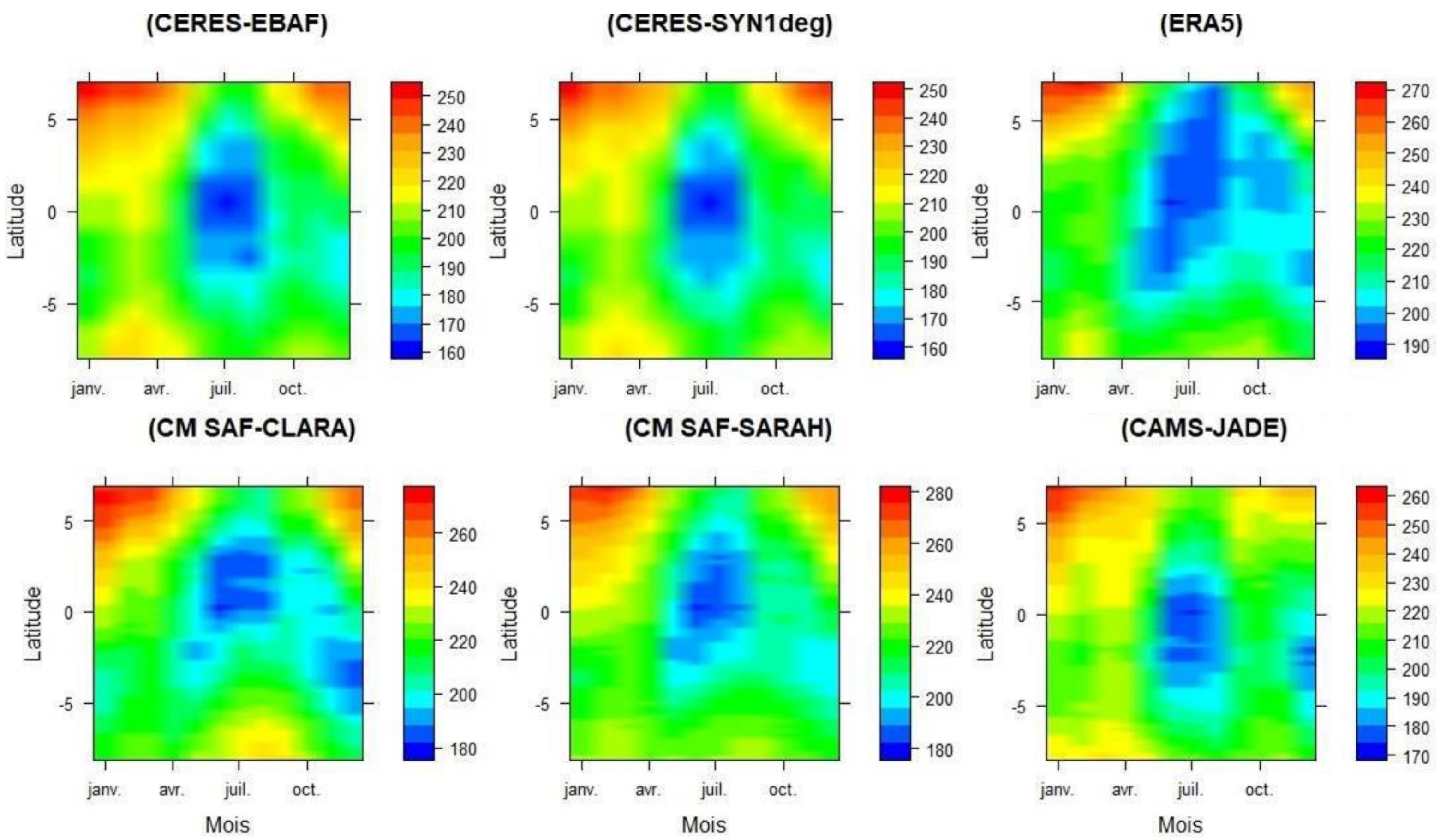
Spatial distribution of the annual mean of incoming solar radiation



- ❑ **The Atlantic coast receives the least quantity of solar radiation**
- ❑ **Satellite products from MSG are the brightest**

• Results and Discussion

Hovmöller diagram



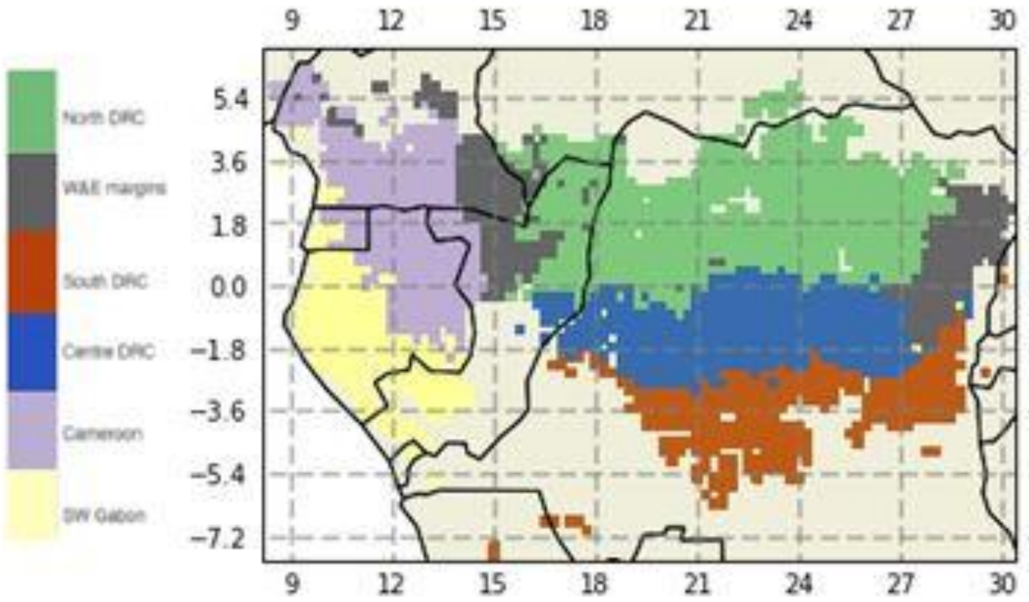
- ❑ **The longitudinal extent is 8° - 30°E**

- ❑ **The minimum of solar radiation is observed in June-August**
- ❑ **CLARA and ERA5 have a second minimum during the October-November rainy season**

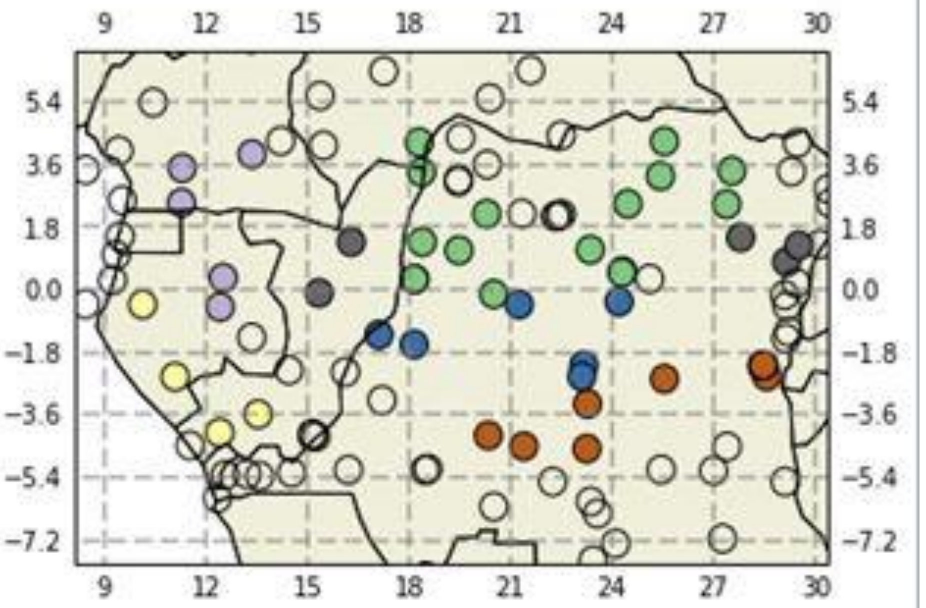
• Results and Discussion

Evaluation of products on sub-regions using FAO's in situ measurements

Climate regionalization of Central Africa



Location of the FAO stations



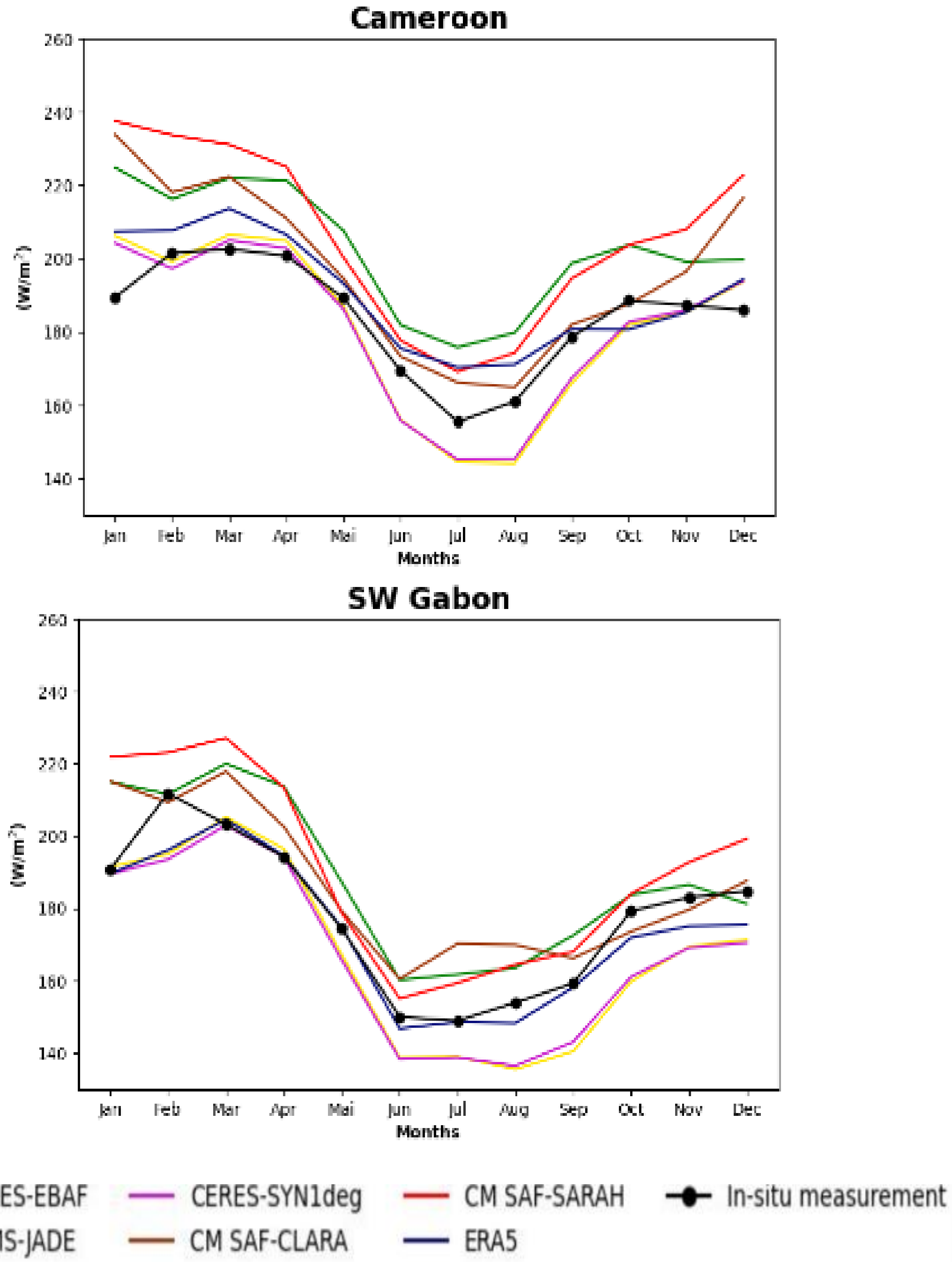
Philippon,N et al. (2018). CYCLES DIURNES DE RAYONNEMENT SOLAIRE ET FORETS EN AFRIQUE CENTRALE.

• Results and Discussion

Products	Correlation	Bias	Spatial resolut°
CERES-EBAF	0,85	-2,32 W/m^2	1° x 1°
CERES-SYN1deg	0,85	-3,51 W/m^2	1° x 1°
ERA5	0,81	13 W/m^2	0,25° x 0,25°
CMSAF-CLARA	0,76	11 W/m^2	0,25° x 0,25°
CMSAF-SARAH	0,77	15 W/m^2	0,05° x 0,05°
CAMS-JADE	0,75	8 W/m^2	0,2° x 0,2°

- ❑ The cycle is well reproduced by all the products (R>0,75)
- ❑ CERES underestimates and the other products overestimate
- ❑ The maximum in February-March and the minimum in July-August

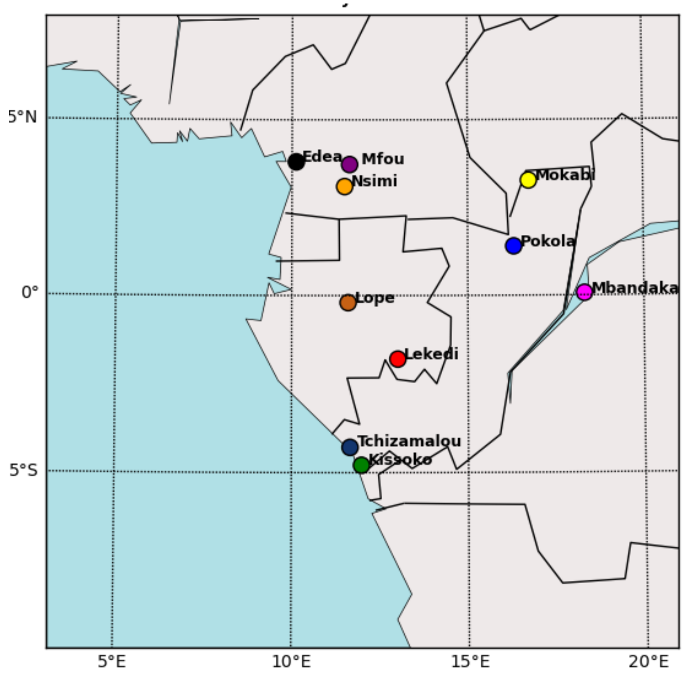
Mean annual cycle of incoming solar radiation

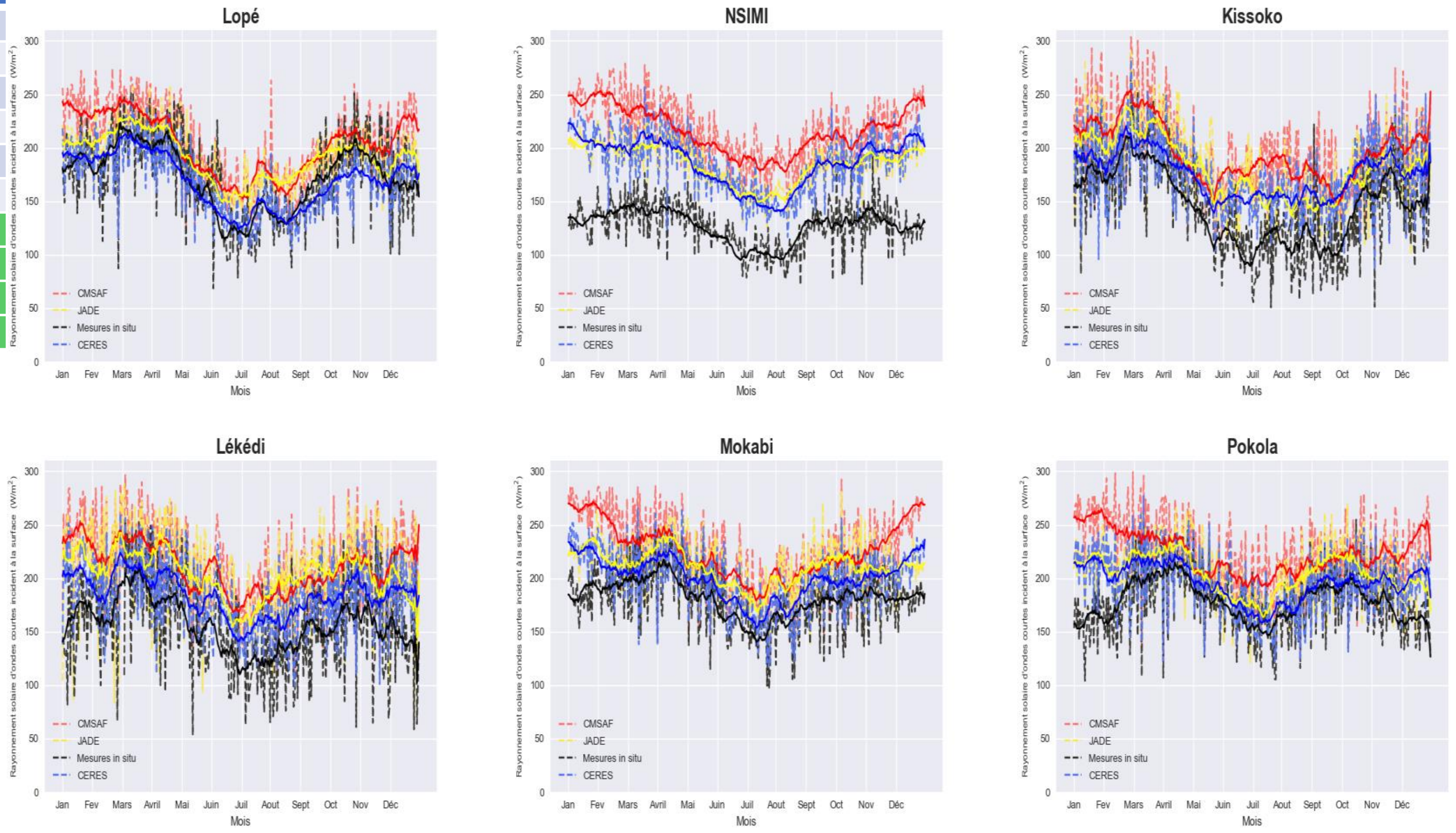


• Results and Discussion

Validation and inter-comparison of (CERES-SYN1deg , CMSAF-SARAH and CAMS-JADE) on a daily scale with original meteorological data.

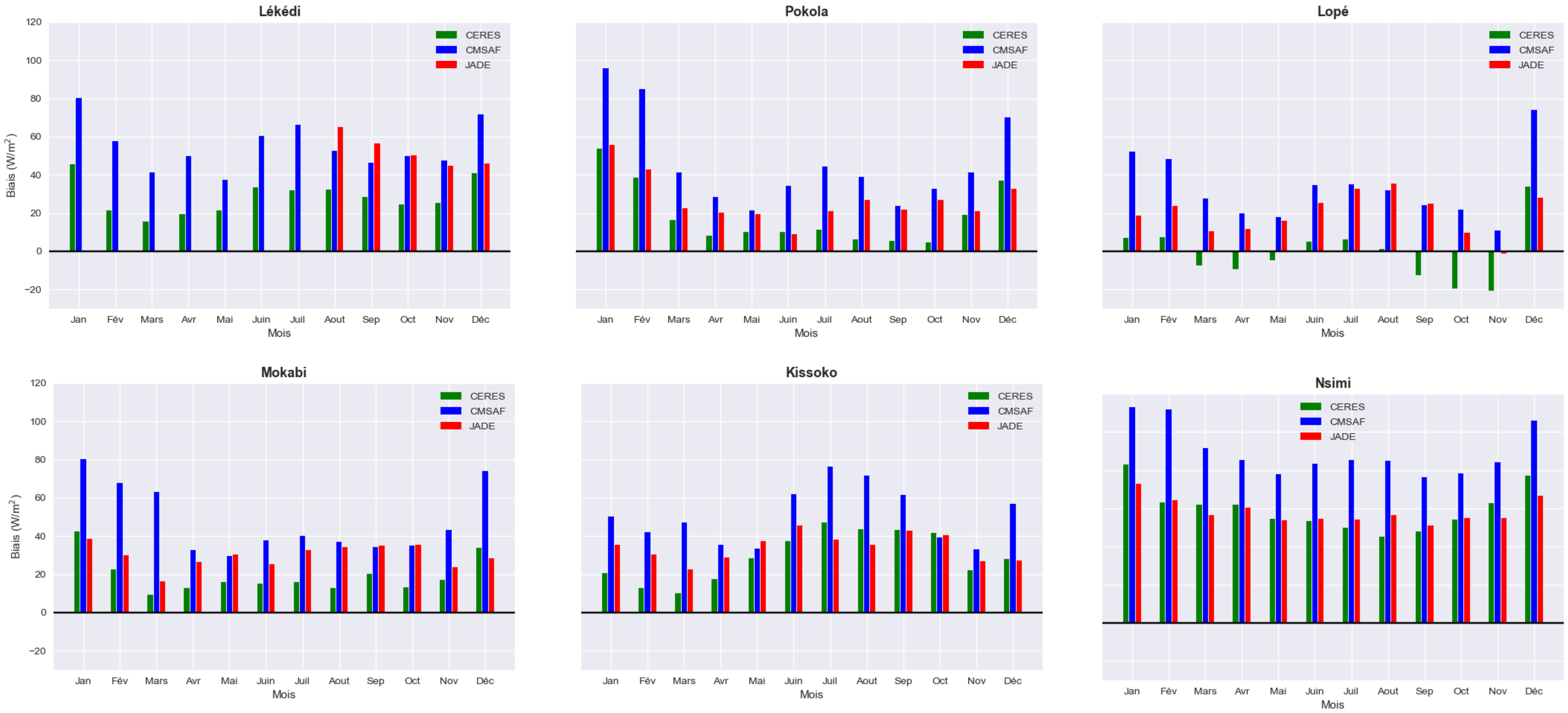
Stations	Country	Temporal resolution	Availability period
Pokola	Congo	15 min	03/2016 – 12/2020
Lopé	Gabon	Daily	01/2012 – 10/2015
Lékédi	Gabon	15/30 min	07/2018 – 07/2019
Mokabi	Congo	15 min	03/2016 – 12/2020
NSIMI	Cameron	Daily	04/2004 – 03/2008
Kissoko	Congo	30 min	04/2004 – 06/2006
Tchizamalou	Congo	15 min	06/2006 – 12/2009
Edea	Cameroun	15 min	01/2020 – 12/2020
Mbandaka	RDC	15 min	11/2018 – 12/2020
Mfou	Cameron	15 min	09/2018 – 12/2020





• Results and Discussion

Monthly variation of bias results.



- ❑ The strongest biases are observed during the 2 dry seasons.
- ❑ Strong biases in January-February when it is in the North of the equator and the opposite when it is in the South.

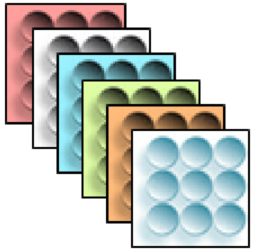
	CERES-SYN1deg	CAMS-JADE	CMSAF-SARAH
Correlation	[0.55 – 0.91]	[0.58 – 0.87]	[0.6 – 0.9]
Bias	[-20 – 51]	[23.8 – 52]	[34.7 – 86]
RMSE	[8.8 – 83]	[19 – 73]	[21 – 113]

• Results and Discussion

❑ **Products see too many bright days and fewer obscure days**

• Conclusion

The incoming solar radiation data from 5 satellite estimates, including CERES-EBAF, CERES-SYN1deg, CMSAF-SARAH, CMSAF-CLARA and CAMS-JADE, as well as the ERA5 reanalyses



The comparison of the six products shows that the Atlantic coast of Central Africa receives the least amount of solar radiation in all products.

Less of Bias for CERES-EBAF and CERES SYN1deg products which underestimate the incident solar radiation while the other satellite products overestimate it. CMSAF-SARAH overestimates the most.

The satellite products represent well the spatial distribution, and reproduce well the mean annual cycle of incident solar radiation