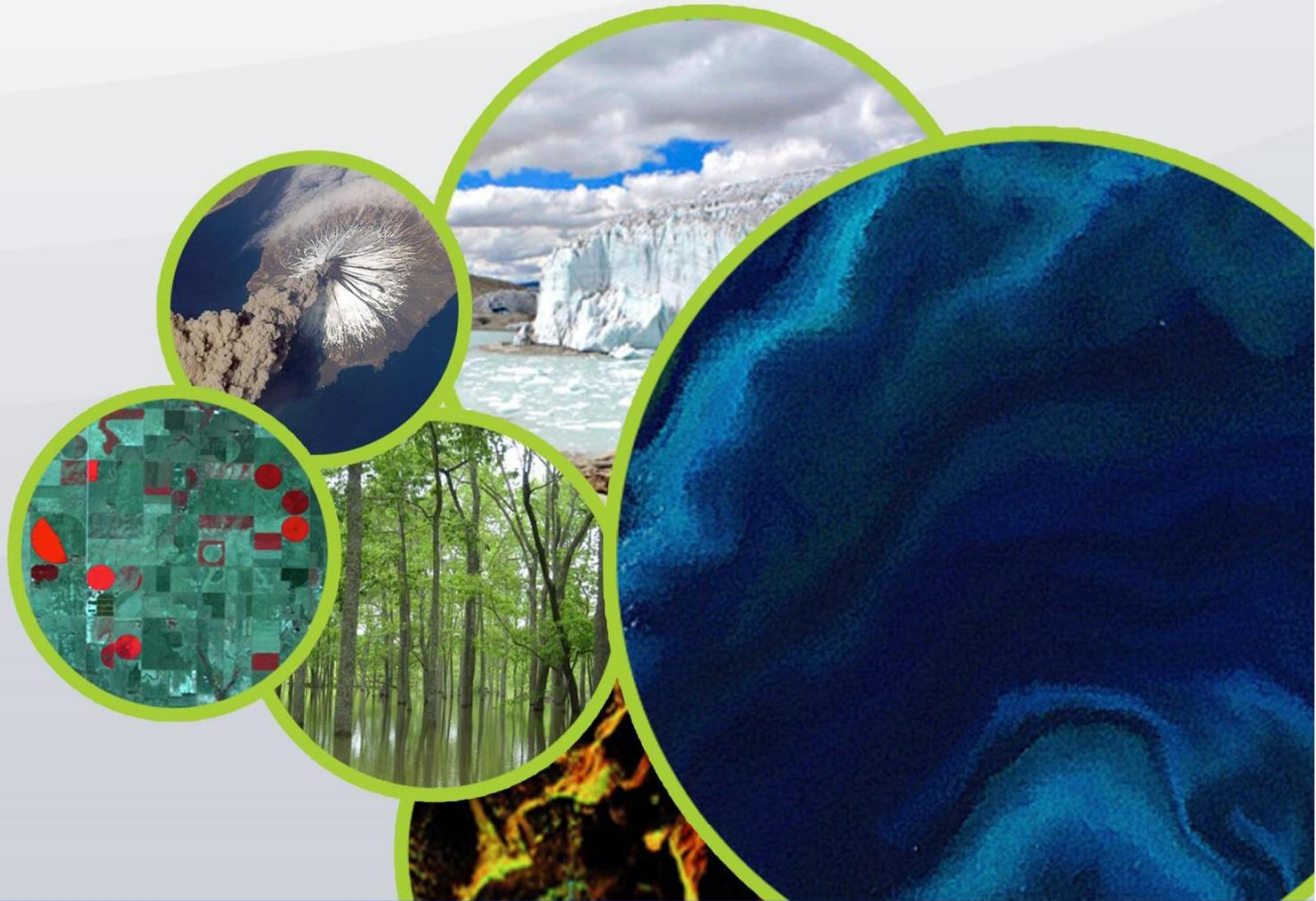




Committee on Earth Observation Satellites



## CEOS WGCapD EO Training Workshop

22-25 June 2018, AGEOS, Libreville, Gabon

Training workshop report

## Use of Earth Observations for Environmental Monitoring in Africa

22-25 June 2018  
*3<sup>rd</sup> AfrigeOSS Symposium*  
Libreville, Gabon



**Figure 1:** Participants and instructors on the final day of the training workshop (*credit: G. Moussavou*).

revised October 2018

## CONTENTS

1. Summary
  2. Objectives
  3. Profile of participants
  4. Instructors
  5. Workshop proceedings
  6. Annex: Workshop agenda
- 

### 1. Summary

In the context of the 3<sup>rd</sup> AfriGEOSS Symposium / AfriGEOSS week 2018, a training workshop on the ***Use of Earth Observations for Environmental Monitoring in Africa*** was held at the offices of the Agence Gabonaise d'Etudes et d'Observations Spatiales (AGEOS), in Libreville, Gabon, from 22-25 June 2018. The workshop was organized by the Working Group on Capacity Building and Data Democracy (WGCapD) of the Committee on Earth Observation Satellites (CEOS). The workshop featured the participation of instructors from CEOS WGCapD members, including the European Space Agency, the United Kingdom's National Centre for Earth Observation (NCEO) and the Centre for Landscape and Climate Research (CLCR), on behalf of the United Kingdom's Group on Earth Observations (UK GEO), and the United States of America's National Aeronautics and Space Administration (NASA). Additionally, trainers from the Kenya-based Regional Centre for Mapping of Resources for Development (RCMRD), and the Niger-based Agrometeorology, Hydrology, and Meteorology regional center (AGRHYMET) also participated on behalf of the respective SERVIR Eastern & Southern Africa and SERVIR West Africa programs those centers are implementing jointly with NASA and USAID. The training benefited a total of some twenty (20) participants who participated across the workshop's three sessions. At the end of the training, participants were familiarized with a range of topics related to the use of Earth Observation (EO) data for environmental monitoring, including:

- the fundamentals of microwave remote sensing,
- the fundamentals of optical remote sensing,
- portals for acquiring synthetic aperture radar (SAR) data,
- applications of SAR for flood and pollution mapping,
- applications of SAR for forest monitoring,
- applications of multispectral data for image classification and time series analysis,
- use of desktop-based platforms like the Sentinel Application Platform (SNAP),
- online resources such as the [Copernicus Research and User Support \(RUS\)](#) service portal, and
- use of cloud-based data processing resources such as [Google Earth Engine \(GEE\)](#) and the Food & Agriculture Organization (FAO)'s [System for Earth observations, data access, Processing & Analysis for Land monitoring \(SEPAL\)](#).

Three months ahead of the meeting, via email, colleagues who had offered to contribute training sessions via the CEOS WGCapD wrote to the AfriGEOSS coordinating contacts to seek guidance on their preferred training focus for training workshops at the 3<sup>rd</sup> AfriGEOSS Symposium. Those contacts responded requesting a draft plan for the three days. The proposed trainers put together a draft plan, taking note that the 2<sup>nd</sup> AfriGEOSS Symposium had stated priorities, including EO for Sustainable Forest management in Africa, and climate services. A few days before the workshop, the SAR training focus was modified, on

the basis that AGEOS had hosted a SAR workshop in 2017, but no alternative focus was suggested. Ideally, for future symposia, more precise training requirements should be clarified early enough to plan the sessions and specialists' travel arrangements accordingly. The workshop's final agenda is included as an **Annex** to this report.

## 2. Objectives

The main objective of the workshop was to familiarize participants with the range of applications of EO data for environmental monitoring in Africa. Per the workshop's three related sessions, the specific objectives included:

- Reviewing the fundamentals of optical and microwave remote sensing
- Demonstrating portals for accessing SAR and multispectral data
- Visualizing SAR and multispectral imagery
- Reviewing applications of optical and microwave remote sensing for environmental monitoring
- Reviewing applications of optical and microwave remote sensing for monitoring pollution and flooding
- Reviewing online resources like Copernicus RUS
- Reviewing data analysis and processing using desktop applications like SNAP, and Python packages, and online, cloud-based platforms like GEE and SEPAL

## 3. Profile of participants

The 20 participants who participated in the training workshop hailed mainly from the government and academic sectors. While the majority of participants were from **Gabon**, there were also participants from **Ghana** and **South Africa**, and also **Kenya** and **Niger**, when including co-instructors who also sat in on other sessions. Virtually all participants had experience with geographic information systems (GIS), as well as varying levels of expertise in optical as well as microwave remote sensing.

## 4. Instructors

- **ESA / Université Paris-Est Marne-la-Vallé:** Jean-Paul Rudant
- **University of Leicester:** Sophie Hebden (NCEO), Maryam Pourshamsi (CLCR)
- **NASA SERVIR Science Coordination Office:** Emily Adams, Emil Cherrington
- **RCMRD / SERVIR Eastern & Southern Africa:** Allan Maungu Oware
- **AGRHYMET / SERVIR West Africa:** Mamane Bako

## 5. Workshop proceedings

The workshop was held over a period of three days, between Friday 22 June and Monday 25 June 2018. Sunday 24 June 2018 was a free day. Each day essentially featured a different session, with instruction offered by representatives from different institutions, but nonetheless inter-related with the other sessions. Due to the linguistic mix of the participants, English and French were also used interchangeably for workshop instruction. The training took place both at AGEOS' main offices in Nkok, outside of Libreville, as well as at project offices of AGEOS, within Libreville proper.

**Day 1: Friday 22 June 2018**

- The first day of the workshop was instructed by Professor Jean-Paul Rudant of the [Université Paris-Est Marne-la-Vallée](#), in representation of [ESA](#). Professor Rudant delivered presentations on the theory of microwave remote sensing, as well as optical [multispectral] remote sensing, and showed examples comparing both types of data.



**Figure 2:** ESA representative Professor Jean-Paul Rudant (2<sup>nd</sup> from right), along with some of the participants and other instructors, outside of AGEOS' main offices in Nkok, Gabon (*credit: S. Hebden*).

- Those presentations were complemented by practical exercises using [ESA's SNAP software](#), with participants being introduced to the [Copernicus Open Access Hub](#) as a source of accessing SAR (Sentinel-1) and multispectral (e.g. Sentinel-2) imagery. Ship detection and flood mapping were among the exercises that were covered in this first session.

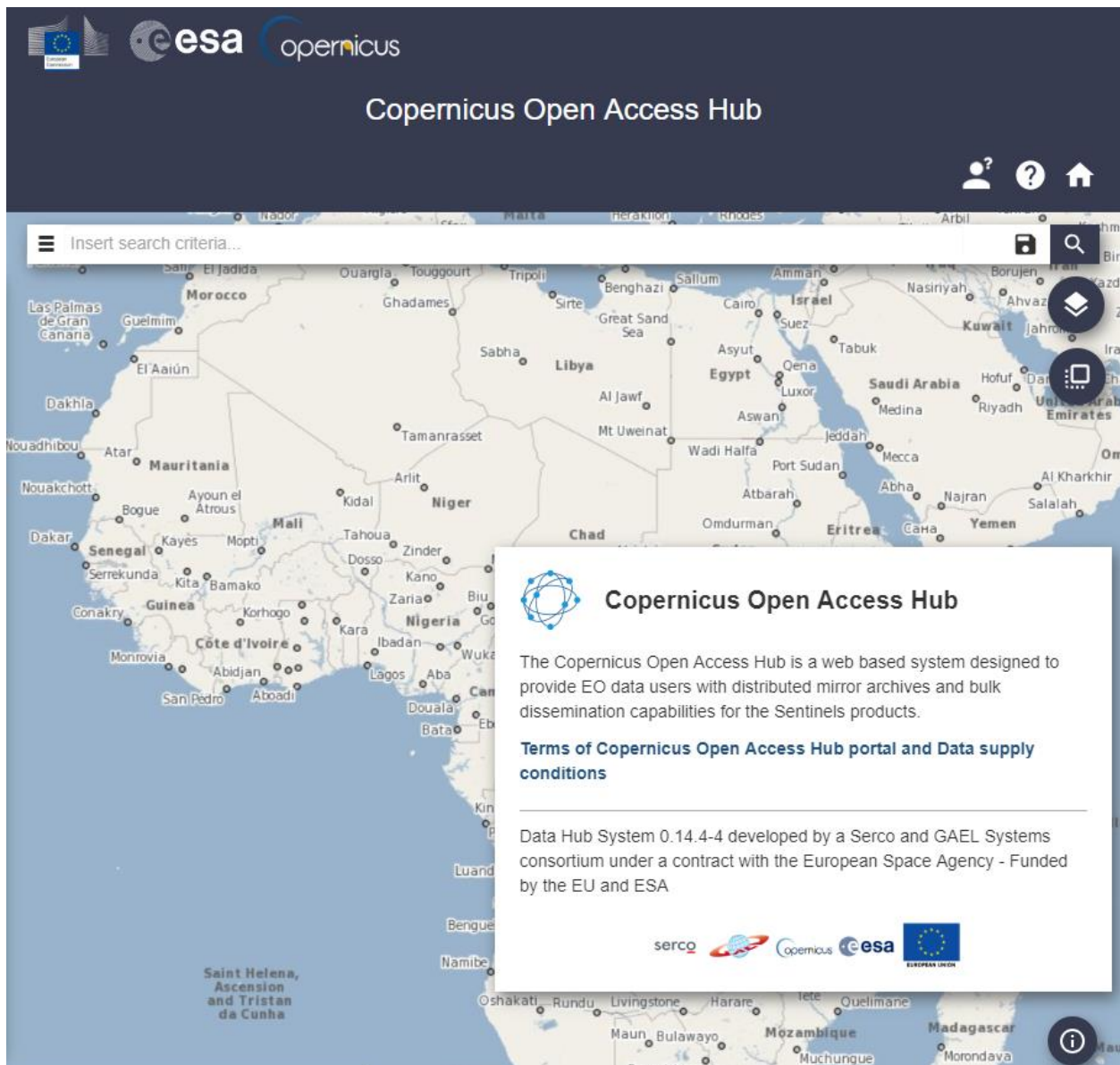


Figure 3: The [Copernicus Open Access Hub](#) was one of the data portals participants were introduced to.

**Day 2: Saturday 23 June 2018**

- The second day's session was co-instructed by Dr. Sophie Hebden of the [NCEO](#) and [Ph.D. candidate] Ms. Maryam Pourshamsi of the [CLCR](#). (The venue for the second day of the workshop was AGEOS' main offices in Nkok.)
- The session built off of the strong foundation laid by Professor Rudant, and presented participants with additional applications regarding the uses of SAR and multispectral data for environmental monitoring.



**Figure 4:** Dr. Sophie Hebden (NCEO) giving a lecture on the use of scripting for analyzing optical data (credit: M. Pourshamsi).

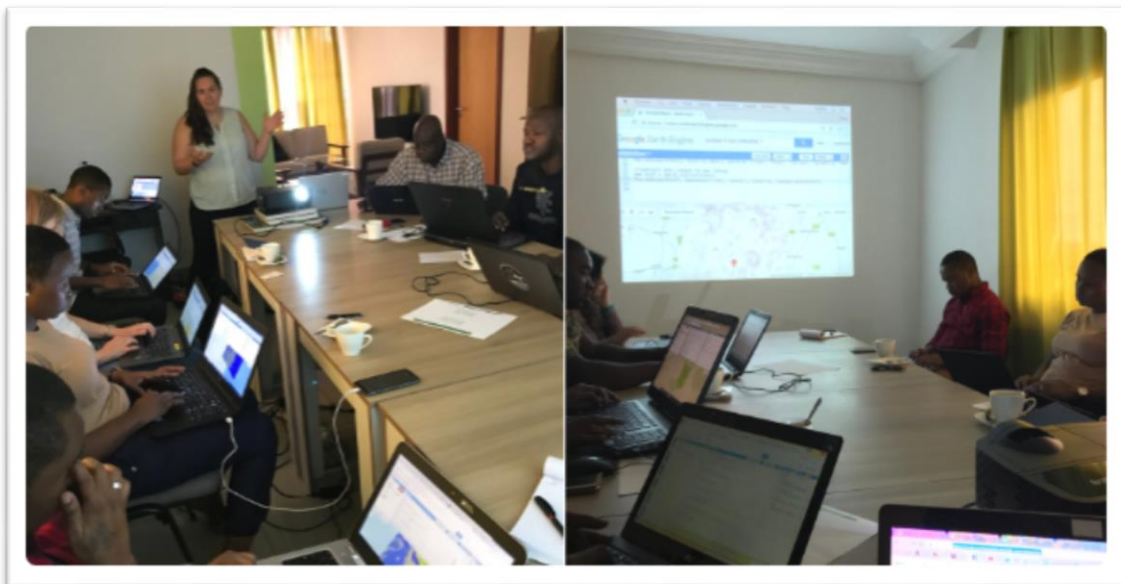
- Where the previous day's exercises had focused on the use of SNAP, Dr. Hebden and Ms. Pourshamsi also introduced participants to Python-based tools for processing data, and participants were also introduced to Landsat and MODIS data from NASA, in addition to the ESA / Copernicus Sentinel-1 and Sentinel-2 data they had used the day before. Among other things, they were also introduced to data from the 2016 joint ESA / NASA [AfriSAR campaign](#) over Gabon, including [LiDAR data from NASA's LVIS](#) sensor, and SAR data from DLR's F-SAR instrument.
- The scripting with Python was then used as a launching pad to explore the JavaScript-based [Google Earth Engine \(GEE\)](#) platform, which was introduced to them as a platform not requiring software installation or data download, and where a great quantity of NASA and ESA data already reside. For the majority of the participants, it was the first time they had been exposed to a platform such as GEE.
- The main focus of the afternoon using GEE was looking at climate datasets, including sea surface temperature, precipitation and NDVI. Participants were also shown the new ECMWF climate data store (with toolbox): [Cds.climate.Copernicus.eu](http://Cds.climate.Copernicus.eu).



**Figure 5:** Ph.D. candidate Maryam Pourshamsi (CLCR) presenting on the use of SAR data for forestry applications (credit: S. Hebden).

### Day 3: Monday 25 June 2018

- On the final day of the training workshop, which occurred the day prior to the official start of the 3<sup>rd</sup> AfriGEOSS Symposium, the venue was one of the project offices of AGEOS, within Libreville proper. The final day's session was instructed by Ms. Emily Adams and Dr. Emil Cherrington of the [SERVIR Science Coordination Office \(SCO\)](#) of the NASA Marshall Space Flight Center (NASA MSFC), with important contributions from Mr. Allan Oware of [RCMRD / SERVIR Eastern & Southern Africa](#), and Mr. Mamane Bako of [AGRHYMET / SERVIR West Africa](#).
- The third day built on the previous two days of training, and focused largely on the use of Google Earth Engine (GEE) as a platform for rapid processing of 'big data,' but it also included review of other portals and tools such as the [FAO's SEPAL](#).
- For the purpose of sharing the GEE scripts with the users attending the training, a code repository in was developed and shared with the workshop participants: <https://goo.gl/MpwhCm>.<sup>1</sup> (This complemented the [code repository](#) developed for the training delivered the previous year at the [2017 AfriGEOSS Symposium](#).)

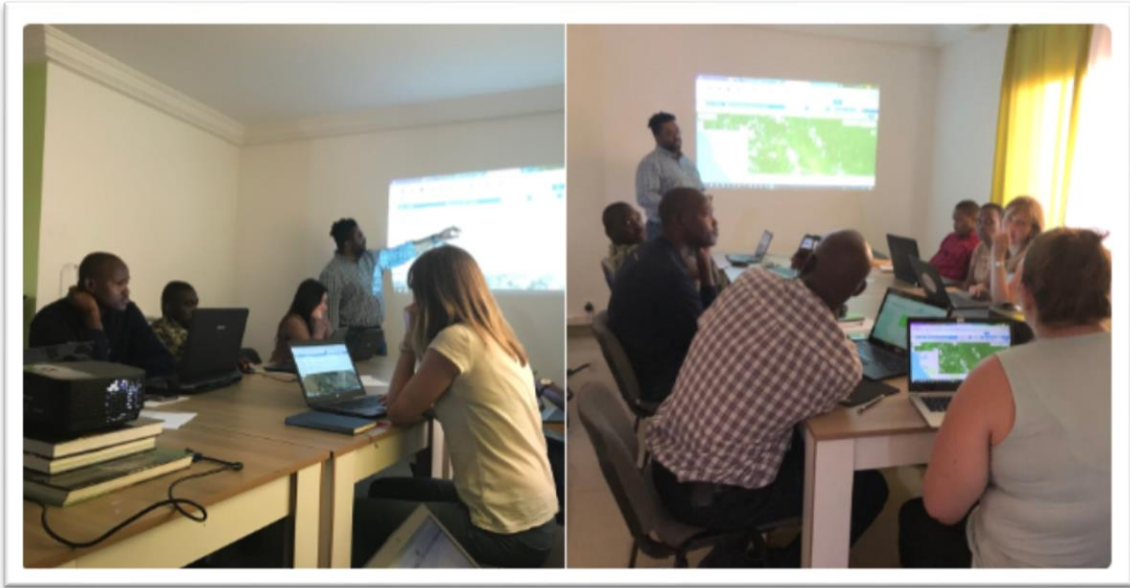


**Figure 6:** Emily Adams (NASA SERVIR SCO) showing how Landsat-based change detection techniques can be implemented in the cloud.

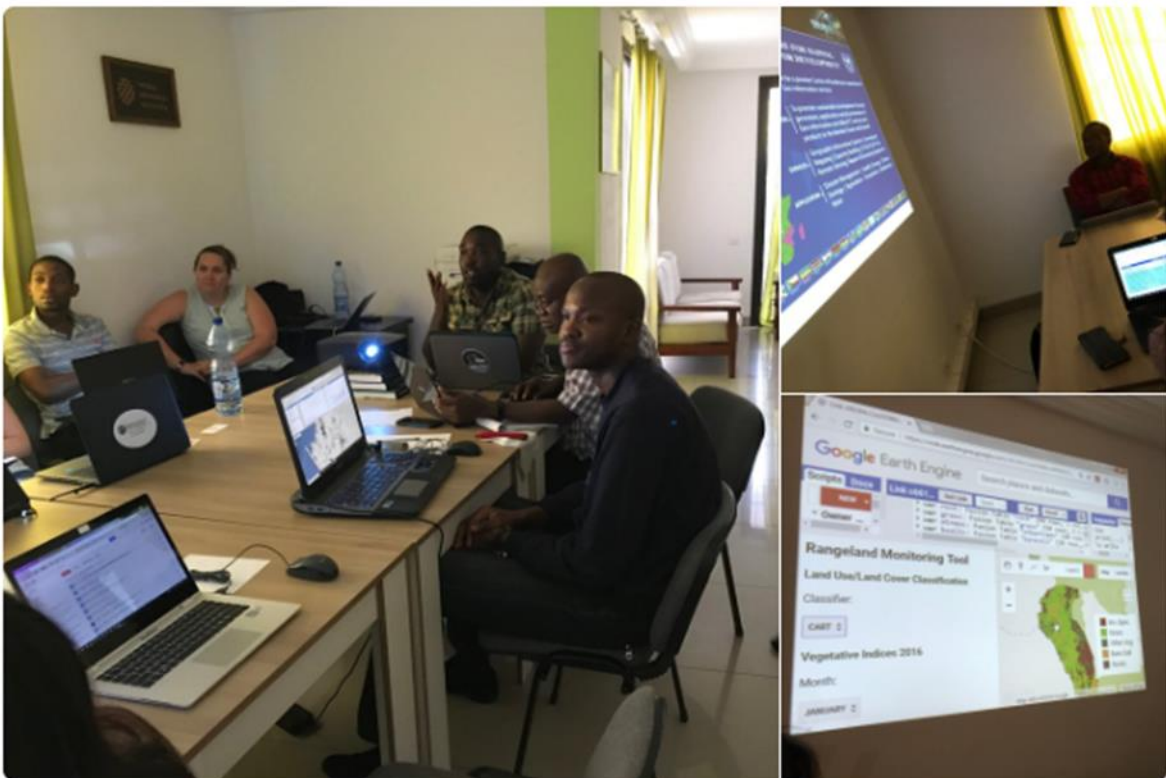
- Participants were shown how to query, visualize, process, and extract imagery using the platform, as well as how to generate vegetation indices, perform image classifications, spectral mixture analysis, and time series analysis of image derivatives.
- The representatives from RCMRD and AGRHYMET also illustrated how their institutions are using the cloud for implementing services in the context of SERVIR (**Figures 8-9**).
- As shown in **Figure 10**, participants were shown how to leverage the cloud to generate cloud-free mosaics of even perpetually cloudy countries like Gabon. As shown in **Figure 11**, they were instructed in how to apply processing routines to large areas, such as a basic forest cover classification at the scale of the entire continent of Africa.

<sup>1</sup> Other resources from day 3 of the training are also available at: <https://goo.gl/URhEuX>.

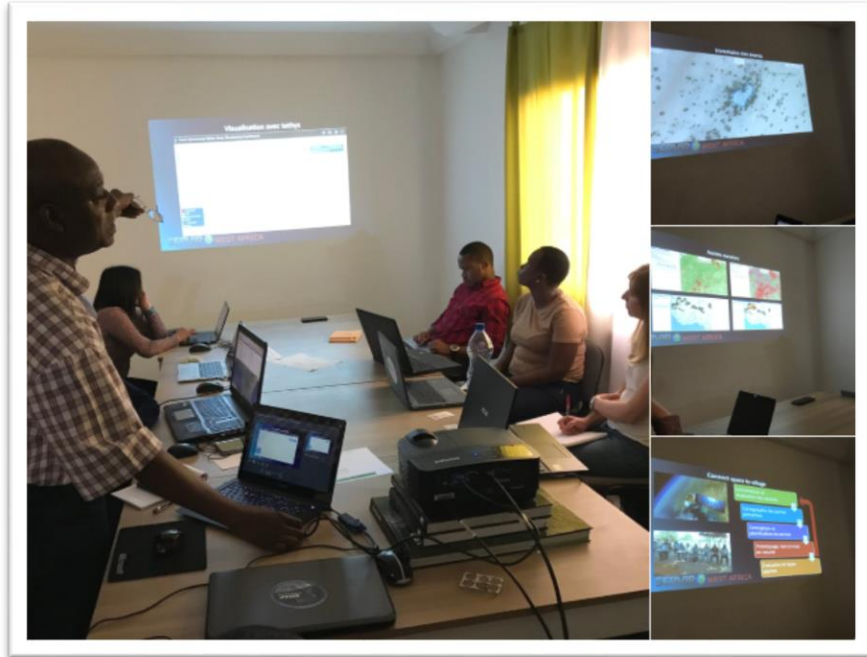




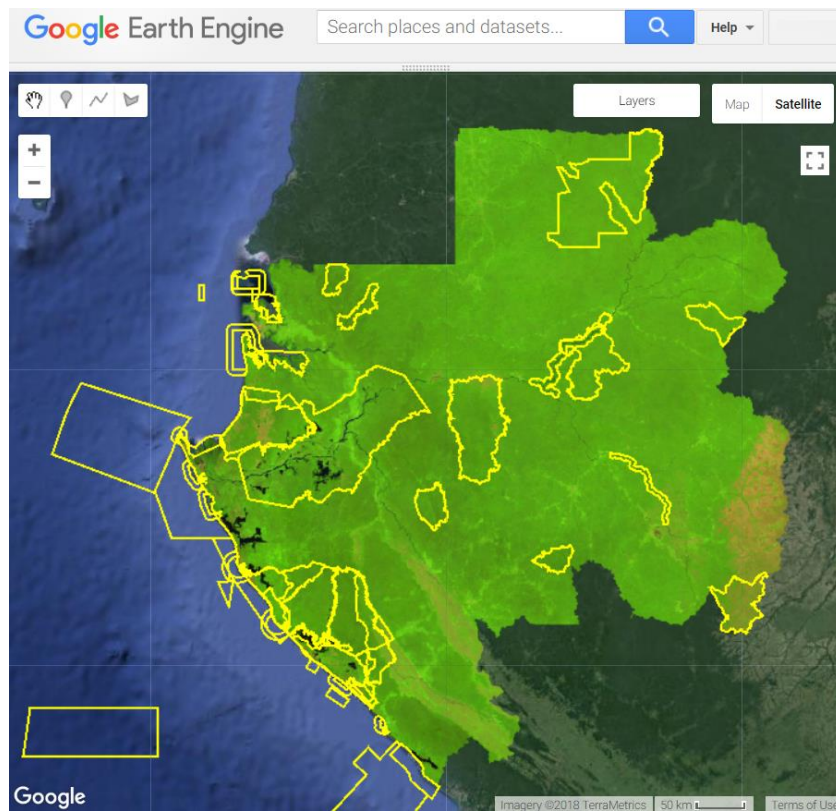
**Figure 7:** Dr. Emil Cherrington (NASA SERVIR SCO) showing how cloud-based processing was used to generate cloud-free MODIS mosaics of Gabon, and derived products.



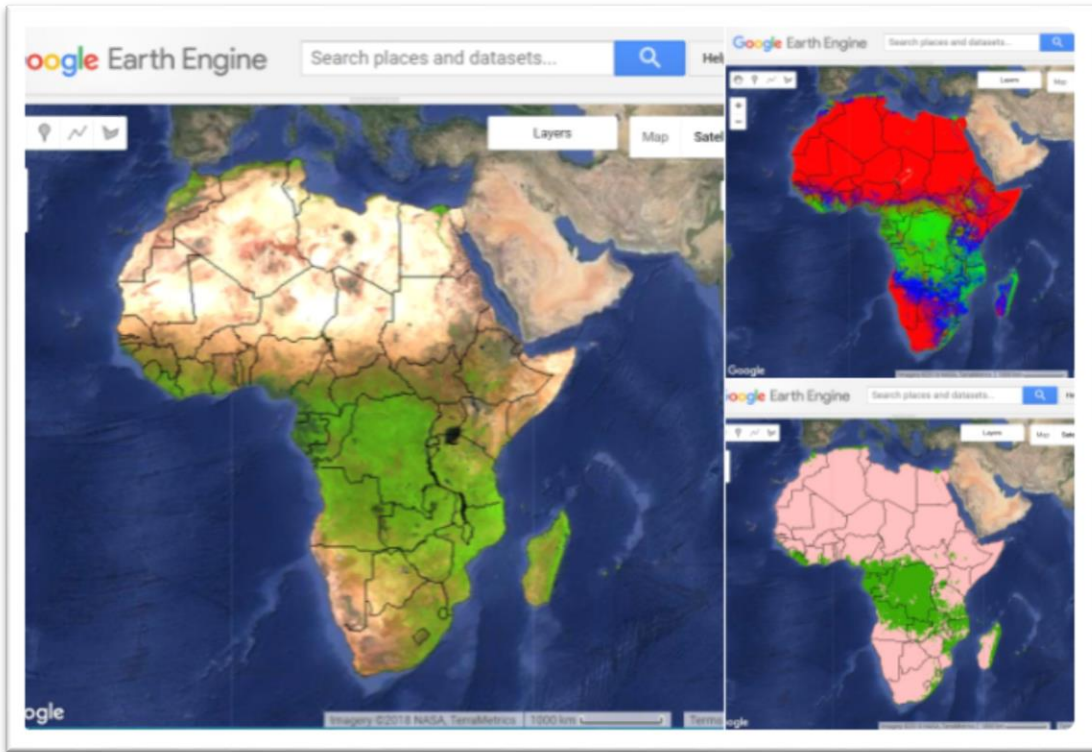
**Figure 8:** Allan Oware of RCMRD illustrating how SERVIR Eastern & Southern Africa services can be developed using cloud-based services.



**Figure 9:** Mamane Bako of AGRHYMET presenting on the use of cloud-based services for monitoring ephemeral water bodies in West Africa.



**Figure 10:** Cloud-free, false color mosaic of Gabon generated using GEE, using 19 years of daily MODIS observations.



**Figure 11:** MODIS false color mosaic of Africa derived from imagery from the 1<sup>st</sup> quarter of 2018 (left), and derived spectral mixture analysis (SMA) output (top right) and forest cover (bottom right).

## 6. Annex I: Workshop agenda

Time	Friday 22 June	Saturday 23 June	Sunday 24 June	Monday 25 June
Trainers	Jean-Paul Rudant	Sophie Hebden, Maryam Pourshamsi	FREE	Emily Adams <sup>1</sup> , Emil Cherrington <sup>1</sup> Allan Maungu Oware <sup>2</sup> Bako Mamane <sup>3</sup>
Representing	European Space Agency (ESA) / Université Paris-Est Marne-la-Vallée	UK National Centre for Earth Observation (NCEO) / UK Group on Earth Observations (UK GEO)		<sup>1</sup> U.S. National Aeronautics and Space Administration (NASA) <sup>2</sup> Regional Centre for Mapping of Resources for Development (RCMRD) <sup>3</sup> Agro-meteorology, Hydrology, Meteorology Regional Center (AGRHYMET)
8:30-12:00	<ul style="list-style-type: none"> <li>Overview of Synthetic Aperture Radar (SAR)</li> <li>Comparison between SAR and optical data</li> </ul>	<ul style="list-style-type: none"> <li>Use of SAR for forestry applications (Python-based)</li> </ul>		<ul style="list-style-type: none"> <li>Introduction to Earth Engine</li> <li>Image visualization</li> <li>Image processing</li> </ul>
12:00-13:00	Lunch break			Lunch break
13:00-17:00	<ul style="list-style-type: none"> <li>Overview of Sentinel-1 imagery</li> <li>Practical exercises: flood mapping, pollution mapping (SNAP-based)</li> </ul>	<ul style="list-style-type: none"> <li>Processing of climate datasets (EE-based)</li> </ul>		<ul style="list-style-type: none"> <li>Image classification</li> <li>Time series analysis</li> <li>Example EE applications in East Africa and in West Africa</li> </ul>