Amazon campaign: current plans

Clement Albergel, Dirk Schuettemeyer, Malcolm Davidson, ESA

13th Climate Change Initiative colocation & CMUG Integration meetings
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Scoping an Amazon experiment

CEOS Strategy Paper
(https://ceos.org/observations/documents/GST_Strategy_Paper_V3.1.pdf)

There are focal areas on the globe where there is greater modelling uncertainty about current and projected emissions of GHG, the Amazon is one of them.

Large-scale field experiment has the potential to bring together a complete suite of observations and models in specific critical zones currently regarded as tipping points of terrestrial emissions.

Theme (II) a. Supporting national & international obligations under UNFCCC

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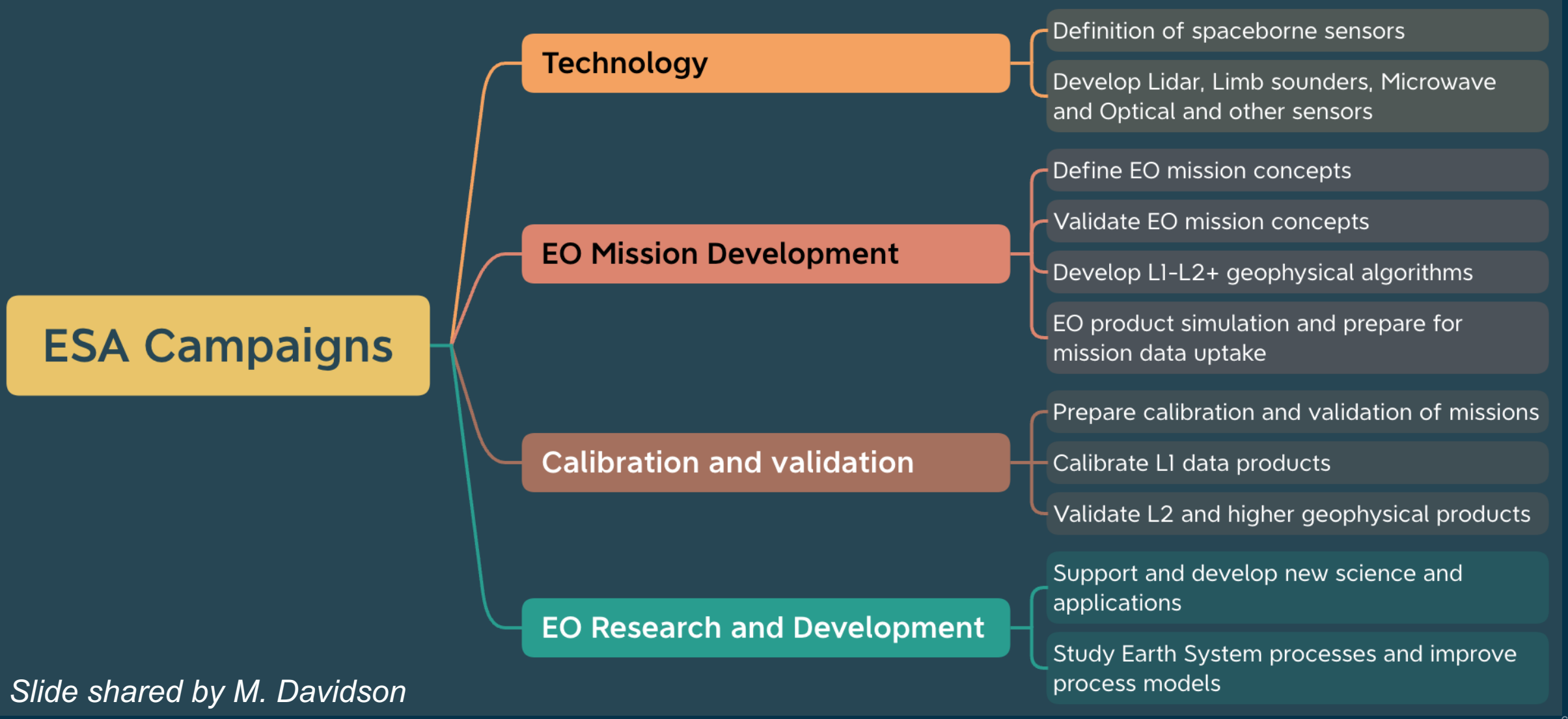
➔**Recommendation 4**: CEOS should consider, in conjunction with modelers, setting up one or more focused observational campaigns in the areas suggested above, or others, as a major contribution to the understanding of the trends of GHG emissions from natural sources in key areas.

Role of ESA Earth Observation campaigns



Slide shared by M. Davidson

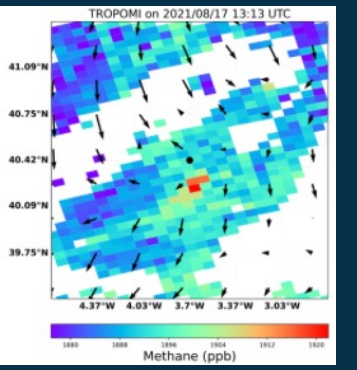
Scope and relevance of ESA campaign activities

ESA campaign activities started in 1981

- 225 campaigns as of June 2023
- 10-15 campaigns/year with increasing trend
- Cross-cutting EO missions, mission phases and EO programmes (e.g. from missions to data uptake and use)
- Built on ESA transnational access to ground and airborne facilities in member states
- Leverage long-standing partnerships with national and international organisations and science institutes

Relevance for Climate Space programmes

- Provide reference data for Climate Space product performance and validation including independent estimates of uncertainties
- Bridge spatial scales between field plots to satellite products to resolve and support process understanding and parametrisation



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Scoping an Amazon experiment

The main objective:

To better understand the spatio-temporal variation in carbon stocks and fluxes (CO_2, CH_4) associated with different land cover types to:

1. inform the calibration of growth and recovery timescales in the parameterization of forest types in models (e.g., secondary forests vs primary forests) and
2. improve the representation of degradation fires and extreme fires in models.
3. confirm emission factors associated with deforestation vs land management fires, and forest degradation,
4. bridge the scales – using ground-based measurements to validate space-borne derived estimates and prepare for future mission (e.g. FLEX, BIOMASS) for the different forest types

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Mechanism:

- Set up a field experiment to measure relevant parameters by means of combined ground-based (proximal sensing + in-situ) and airborne systems (remote sensing + in-situ).
- The focus will be on covering local to regional scales with long-term ground-based observation in combination with dedicated airborne activities.
- The activity will be performed in very close cooperation with Brazilian partners, NASA and selected Partners from Europe

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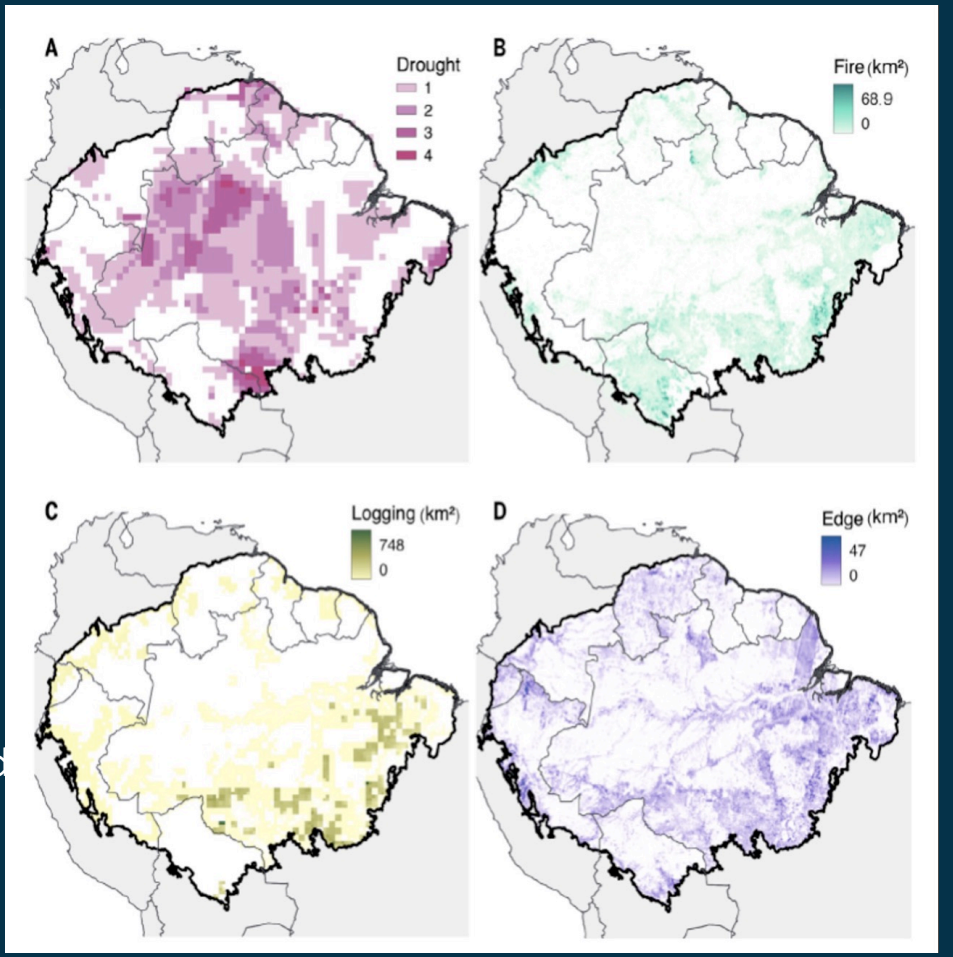
Scoping an Amazon experiment

- Vast area: 23 x size of UK, >EU
- 25% global land biomass & land carbon sink
- Brazil largest gross land fluxes in Global C Budget
- 15% global freshwater flux to oceans
- 15% global biodiversity
- Home to millions, ethnic diversity
- Passing tipping point in forest loss >$250billion

- 20% Deforestation of Brazilian Amazon
- 38% of remaining forests are degraded
- Increasing pressure with future warming, drying and disturbance
- Different factors will be probably modulated by El Niño during 2023-24



Who:
The activity will be performed in very close
cooperation with Brazilian partners

Key Partners from Europe:
- Kings College London
- British Antarctic Survey, UK
- Wageningen University, NL
- University of Exeter, UK
- BIRA, Belgium
- LSCE, France
- Max Planck Institute Jena, Germany
- University Milano, Italy

Potential partners from NASA:
- Ben Poulter (NASA Goddard)
- Simon Hook (JPL)
- Simon Yueh (JPL)

Fawcett et al., GCB, Amazon biomass in decline due to deforestation and degradation (esa.int)

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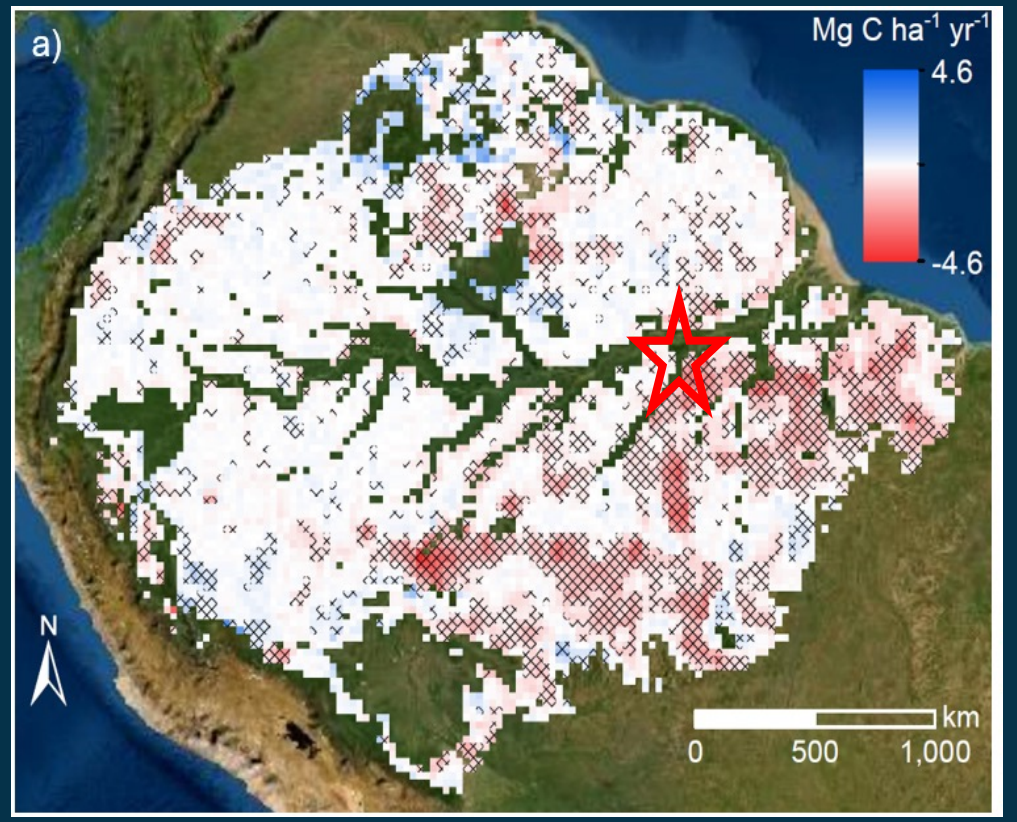
Scoping an Amazon experiment



AGC trends (2011–2019) over the Amazon biome.

Location: Tapajos (Para state)

Land cover

Here you have the full range of land cover types (degraded, agriculture, secondary and intact forests)

Climate Risk

This area was massively impacted by the last El Nino in 2015/16 leading to increased burning.

Challenges

- Fire modelling; response of intact forest to detrimental climate;
- lack of representation of secondary and degraded forests in models (disturbance and recovery dynamics; new PFTs for secondary forests);
- mosaic and edge effects (i.e. landscape heterogeneity);
- representation of agriculture.

Fawcett et al., GCB, Amazon biomass in decline due to deforestation and degradation (esa.int)

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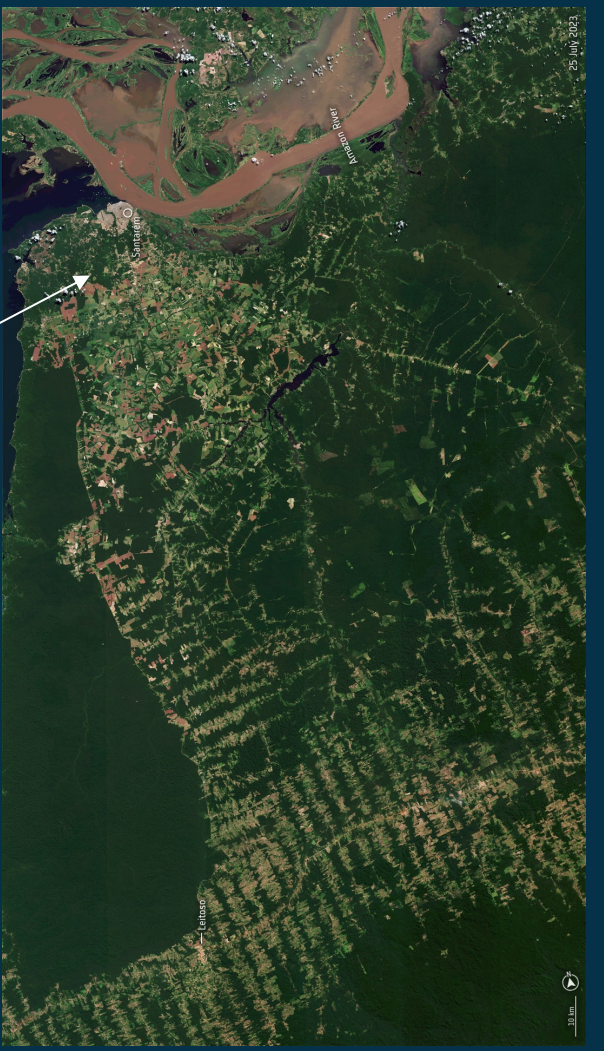
Santarem area

The experiment in the Amazon is foreseen to cover around 100 x 100 km and includes a range of different types of land cover such as degraded land, agriculture, secondary and intact forests.



Difference in forest cover between 1989 (top) from Landsat and 2023 (bottom) from Copernicus Sentinel-2.

The bottom image also shows the road to the flux tower that will be used during the campaign.

The Large-Scale Biosphere-Atmosphere (LBA) experiment : the largest cooperative international scientific project ever to study the interaction between the Amazon forest and both the regional and global atmospheres.

(credits: Top: USGS/Landsat, processed by ESA; Bottom: contains modified Copernicus Sentinel data (2022), processed by ESA. Area of interest has to be rotated to fit into a 16to9 image)

LBA scientific challenges

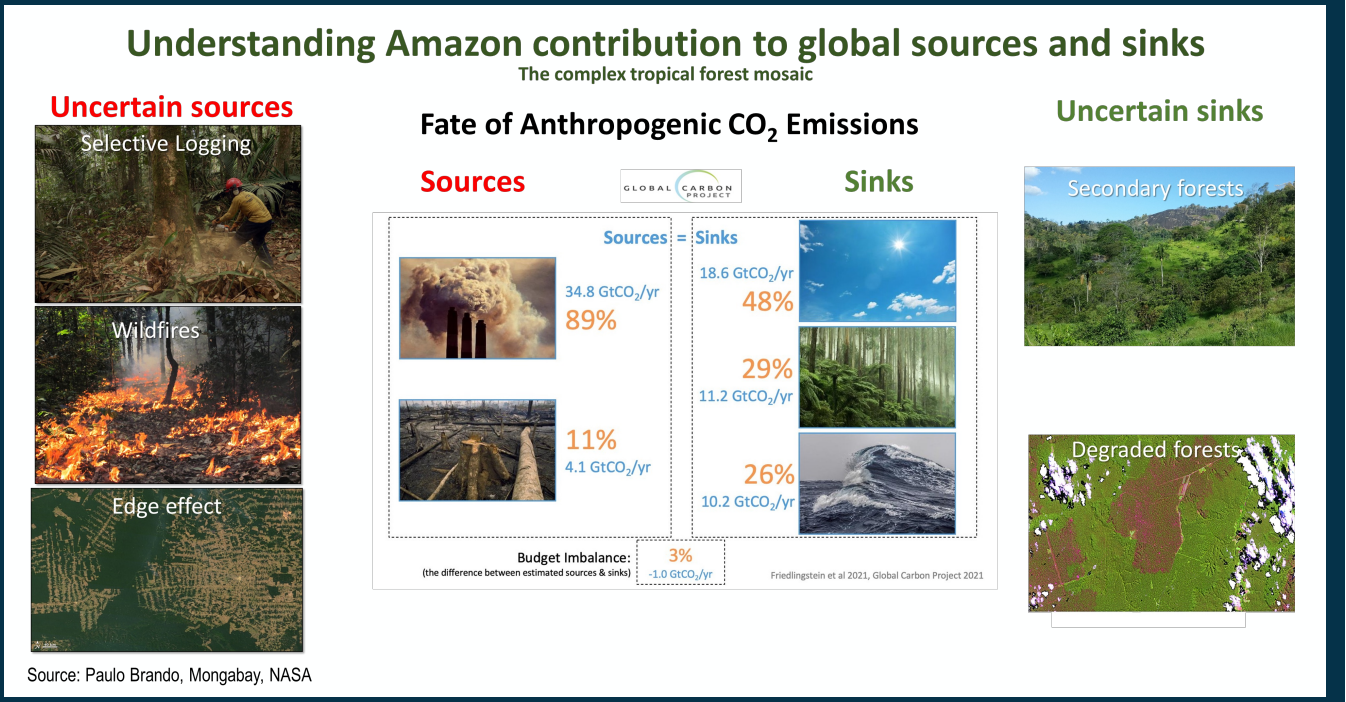
1) What is the contribution of the Amazon to the global carbon budget in terms of sources and sinks?

2) How do changes in Amazonia surface structure and processes modify climate?

3) How do changes in climate impact Amazon functioning?

4) How functioning and resilience of Amazon are modified in a landscape dominated by human-modified ecosystems?

5) How can we manage the system to minimize negative impacts and optimize generation of ecosystem services ?



Slide shared by L. Aragao
LBA President of Scientific Committee

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- The LBA KM67 site already has a solid research infrastructure in place, including flux towers allowing canopy access for eddy covariance measurements, and a basecamp.
- Opportunity for ESA to engage with LBA scientist & New opportunities for LBA to expand and go beyond standard ecological measurements to include novel remote-sensing.
- The field experiment will include taking greenhouse gas measurements with instruments carried on aircraft and from towers and from the ground.

LBA basecamp

LBA KM67

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- The site in secondary forest already is equipped with basic meteorology and ground-based remote sensing equipment including a CIMEL, short and longwave radiation measurements
- Opportunity to extend and deploy additional Eddy-Covariance system and proximal sensing for vegetation and GHG utilizing the existing infrastructure
- Opportunity to collaborate with local Universities

Container & Platform with remote sensing equipment at the secondary forest site.

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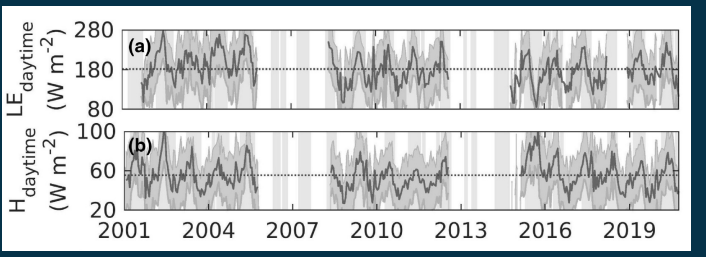
Schematic representation of the planned observing strategy

Sentinel5p, Sentinel2, Sentinel3, SMOS, OCO-2 …

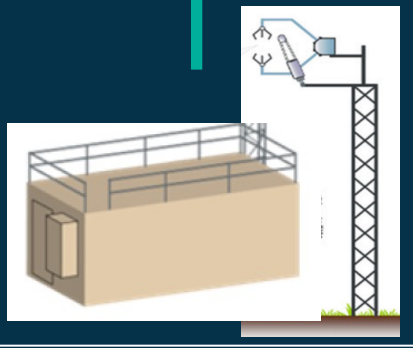
RS and in-situ Aircraft observations e.g. BAS Twin Otter

I. **GHG concentrations Quantification and Verification**
II. **Satellite Validation and Interpretation**
III. **Fire Impact**
IV. **Model Evaluation**

Restrepo-Coupe et al. 2023

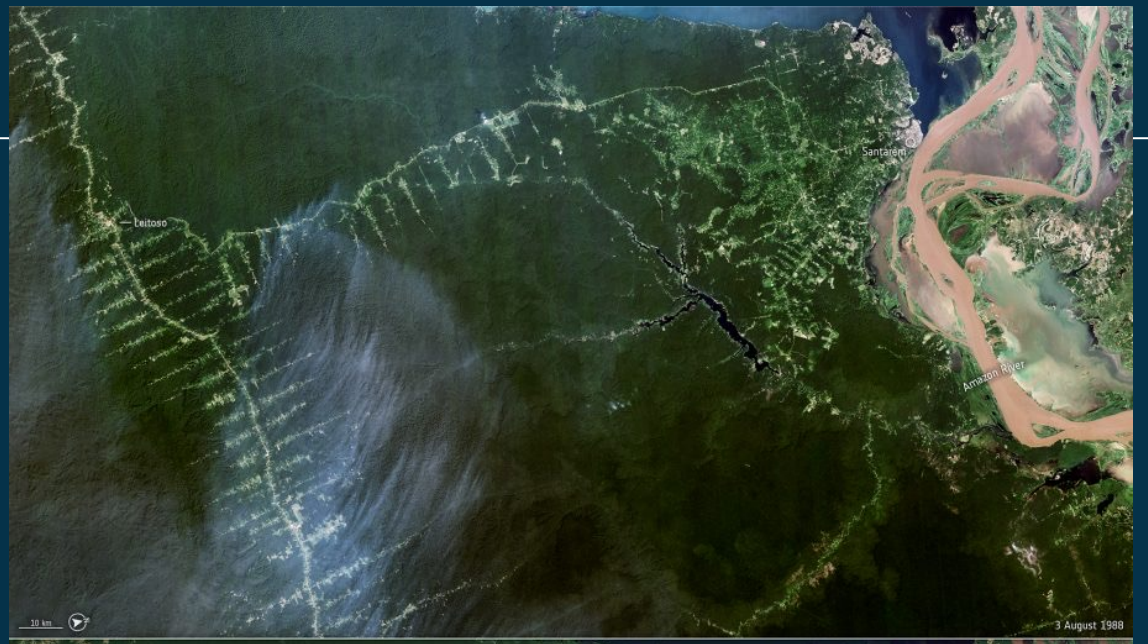


Carbon and land-surface modelling including long-term components



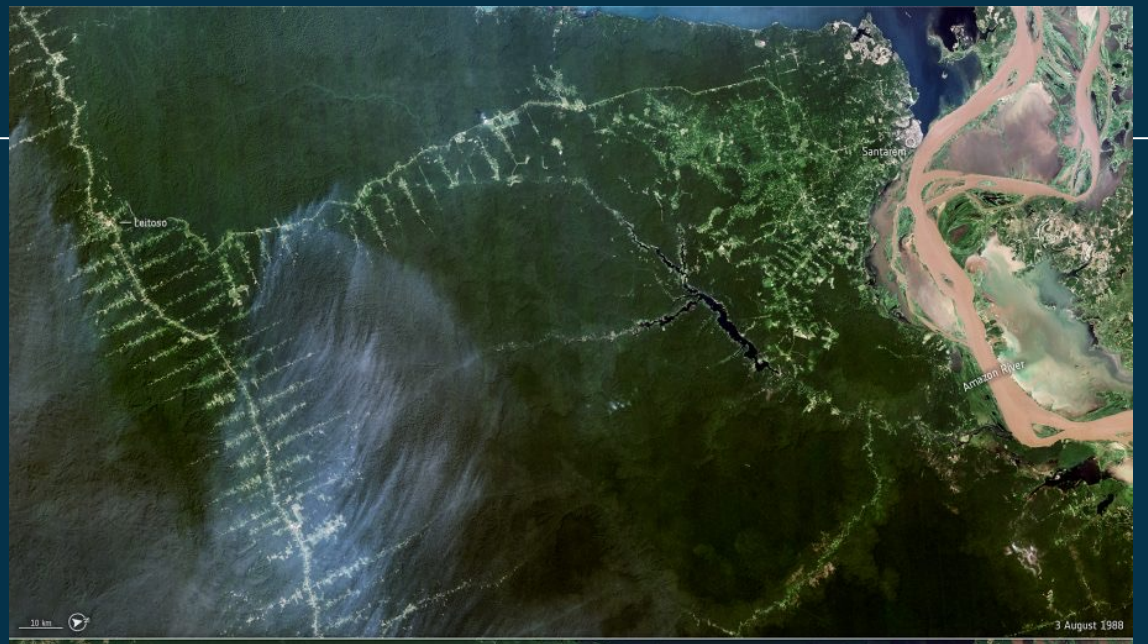
Tower-based GHG measurements including:

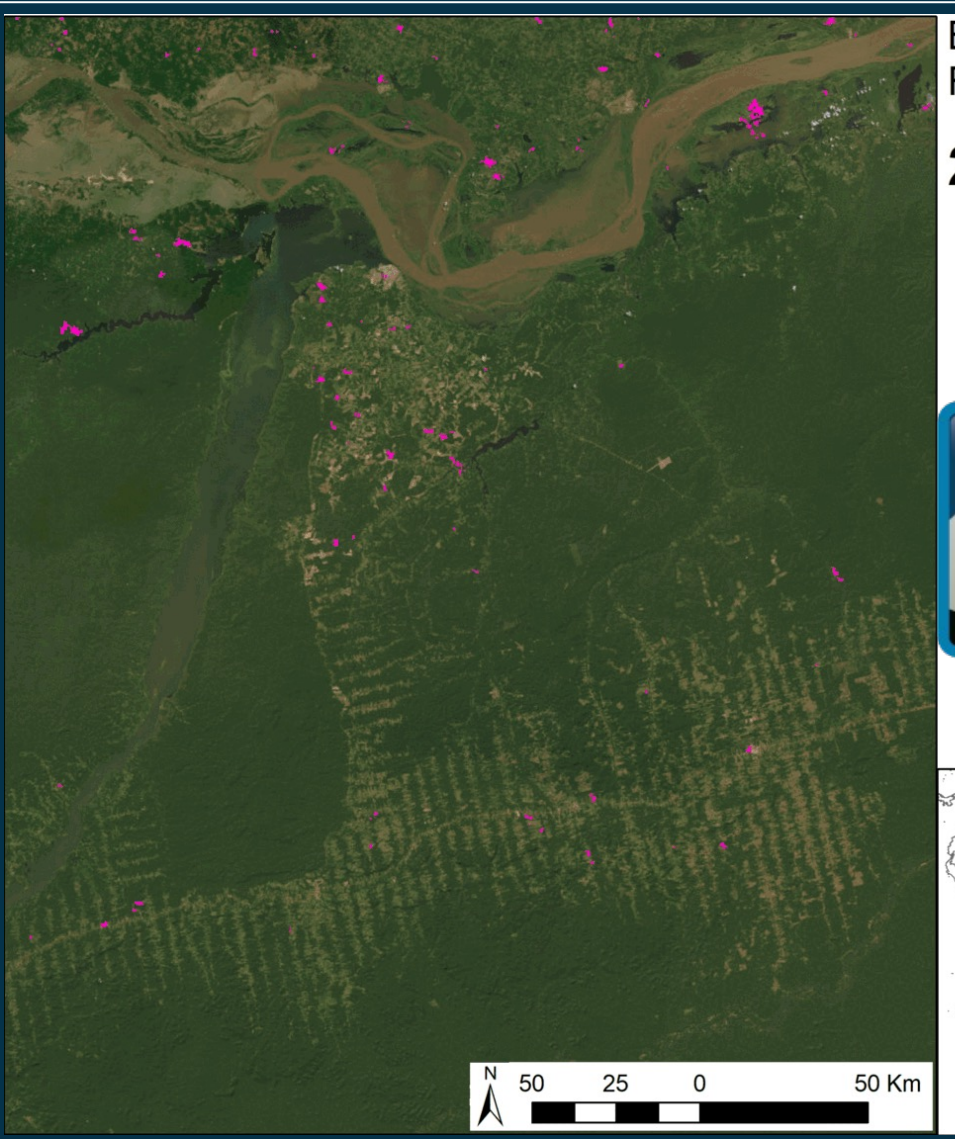
- Ecosystem scale fluxes:
- Soil sensors:
- Radiation sensors:
- Water Fluxes
- Tree growth and biometric measurement



300-m LCC
1992-2021
Credit:
Celine Lamarche

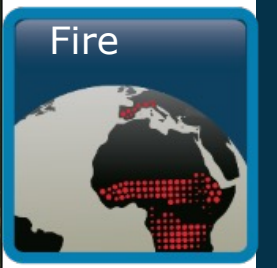
Credit:
Lucrecia Pettinari





Burned Area
FireCCI51

2001



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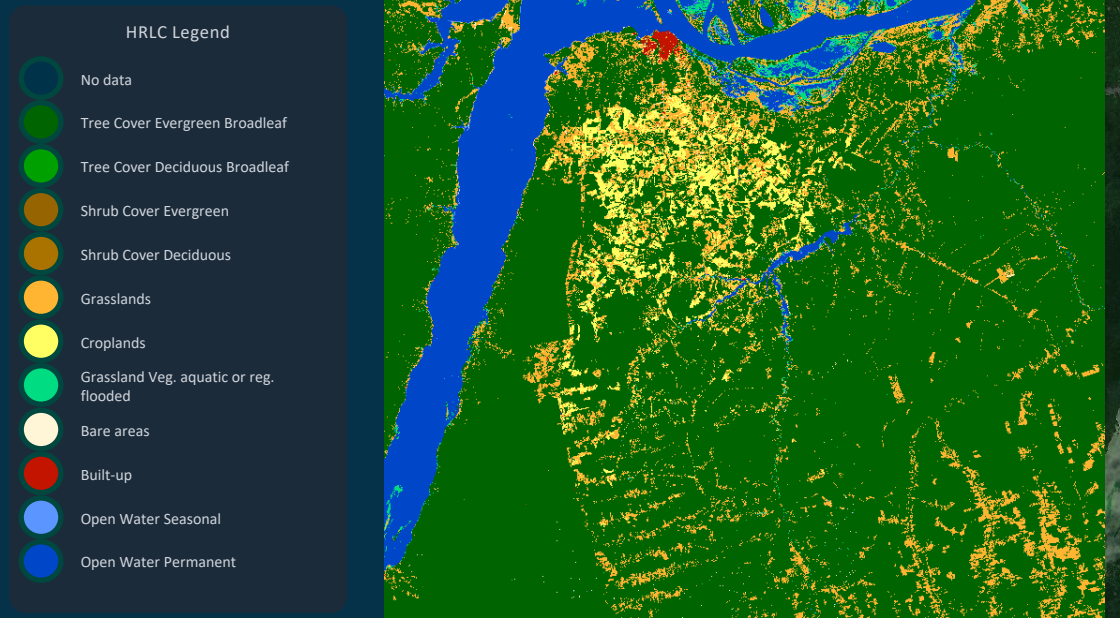
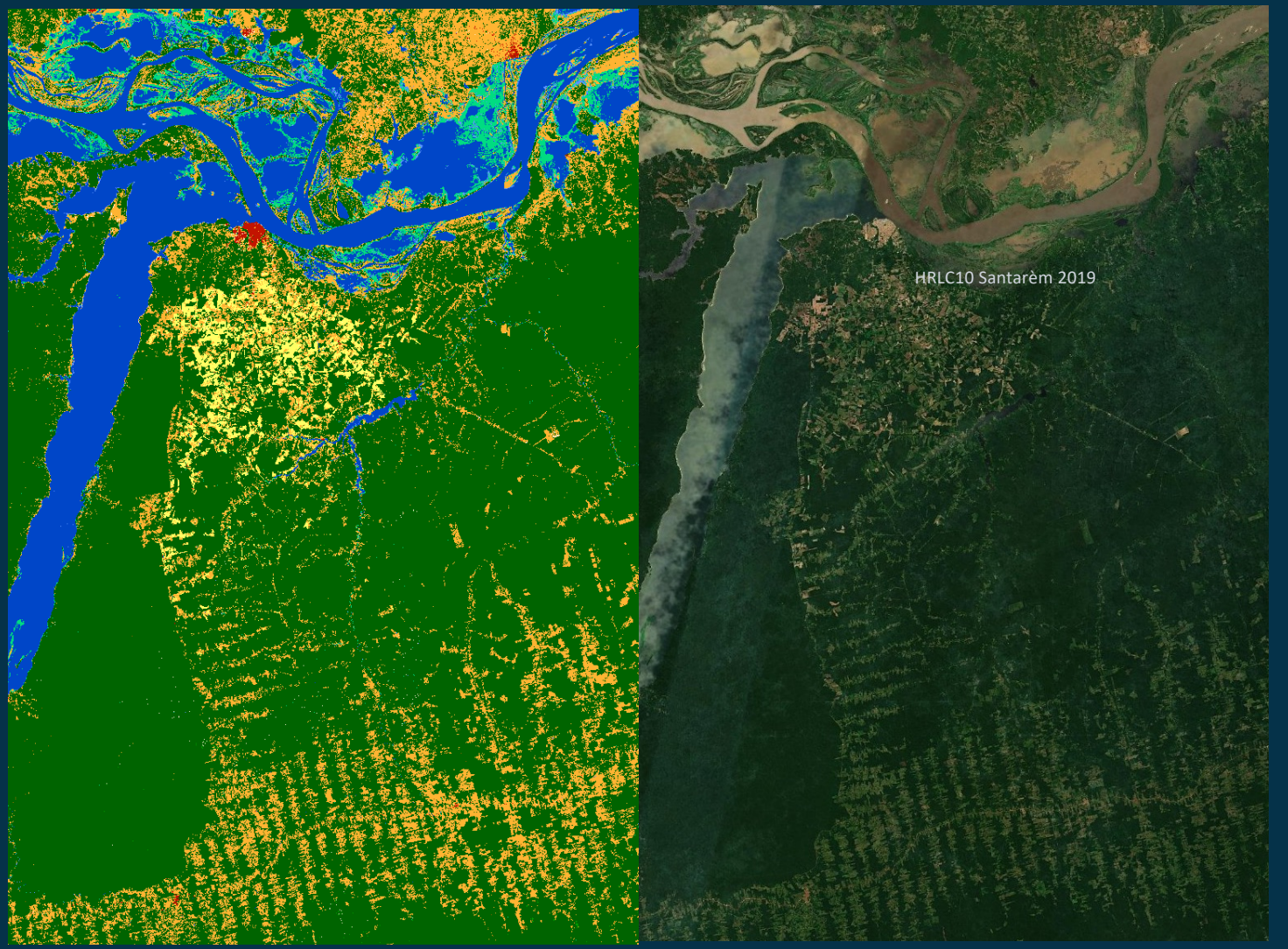
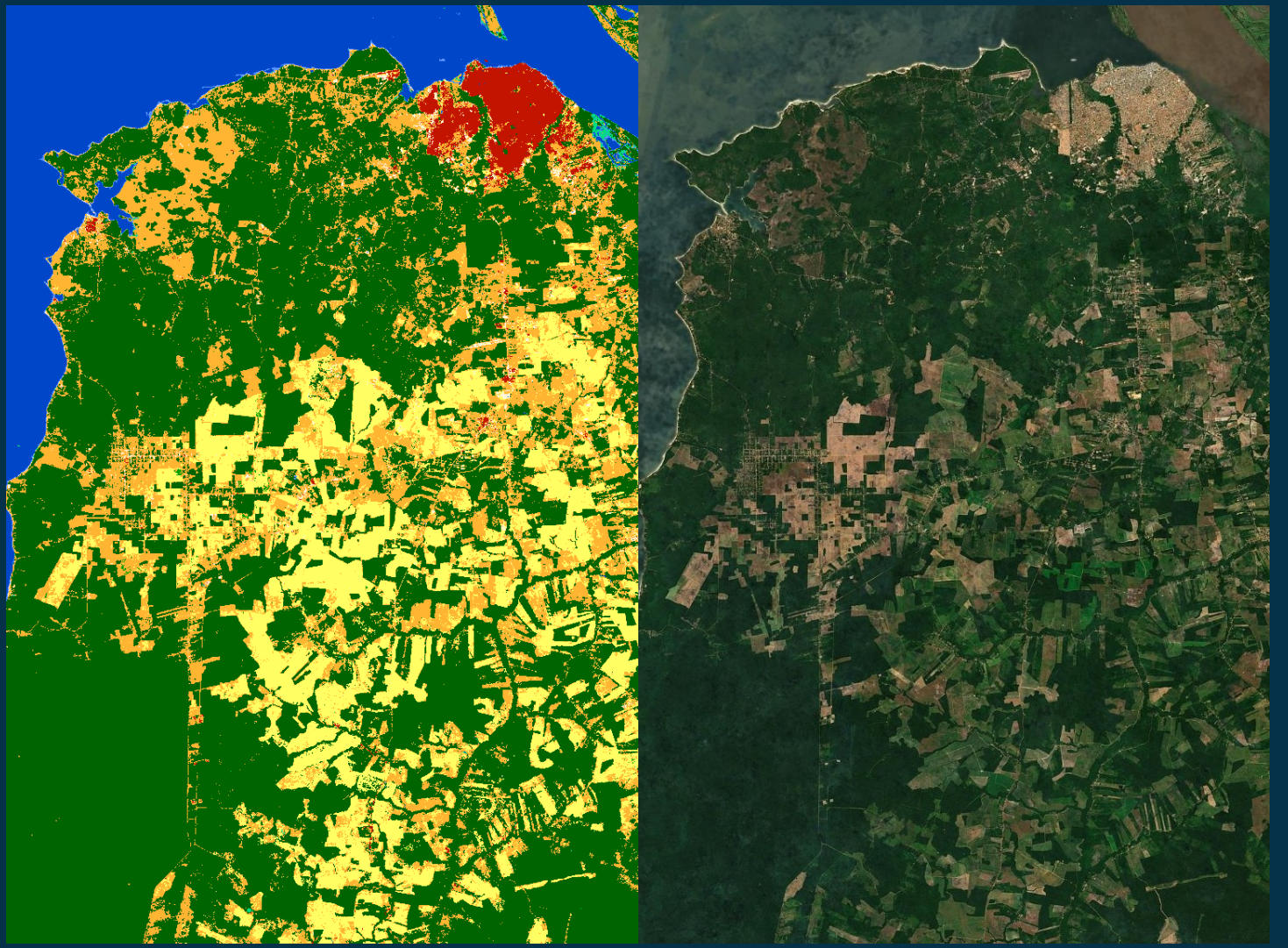




Sentinel-2 cloudless composite 2019 EOxCloudless©

Credit:
Lorenzo Bruzzone



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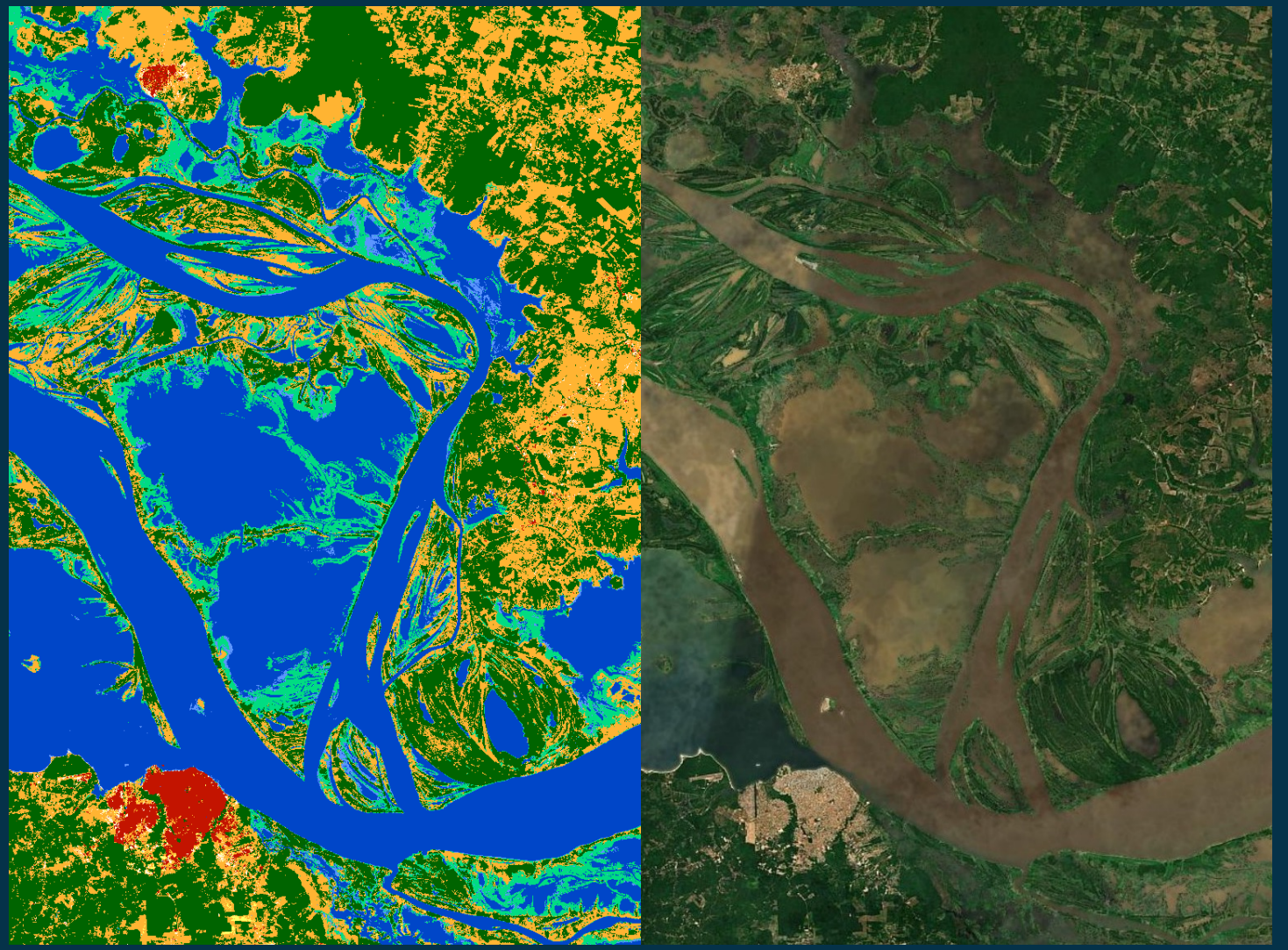

Scoping the Amazon field campaign

Current Schedule:

1. Identification of target sites to match the campaign objectives performed in September 2023
2. Identification of suitable equipment including NASA ongoing
3. Airborne campaign: September – October 2024 planning started (BAS aircraft as baseline)
4. Installation of ground-based equipment: Spring/ Summer 2024
5. Airborne campaign: September – October 2024
6. NASA to join in 2025 for airborne activities due to scheduled activities in 2024
7. CNES is setting up a collaboration with Brazilian partners including a larger campaign in 2026
8. Keen interest from UN-IMEO to join

Summary & Conclusions

1. A large-scale field experiment focusing on the Amazon, has the potential to bring together a complete suite of observations and models in a specific critical zone Planning for a longer-term campaign in the Amazon started
2. Main objective to better understand the spatio-temporal variation in carbon stocks and fluxes (CO_2, CH_4) associated with different land cover types
3. Key region has been identified including existing ground-based infrastructure
4. Discussion with Partners in Brazil, Europe, and US started
5. Tentative schedule discussed with main partners

Thank you!

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[Setting up to take stock of emissions from the Amazon – Campaign Earth (esa.int)]

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