

BRIX-2: Second Biomass Retrieval Inter-comparison eXercise

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What is BRIX-2?



- BRIX-2 represents a joint effort between ESA and NASA to **intercompare algorithms** specifically **for biomass mapping** using current and future spaceborne missions.
- These objectives shall be achieved by making available **standardised test cases** (based on airborne campaign and spaceborne simulated data), inviting the scientific community to **develop and apply retrieval algorithms** based on this test case, and finally **compare and evaluate the performance** of submitted results.
- For the purpose of an objective algorithm evaluation, the exercise will be base on the **ESA-NASA joint-Mission Algorithm and Analysis Platform (MAAP)**.

The objectives of BRIX-2 are:



1. Provide an **objective, standardized comparison and assessment** of biomass retrieval algorithms developed for the **Biomass, NISAR and GEDI** missions, and fusion of these mission datasets.
2. Establish a forum to **involve scientists** in the development of retrievals that **have so far not been part of the biomass** community.
3. The **adoption of vetted validation standards and methods** to compare biomass estimates to reference datasets (e.g. field plots or airborne lidar biomass maps).
4. **Collect inputs** from the biomass user and scientific community on data formats and characteristics towards the generation of Analysis Ready Data.

What BRIX-2 is not!



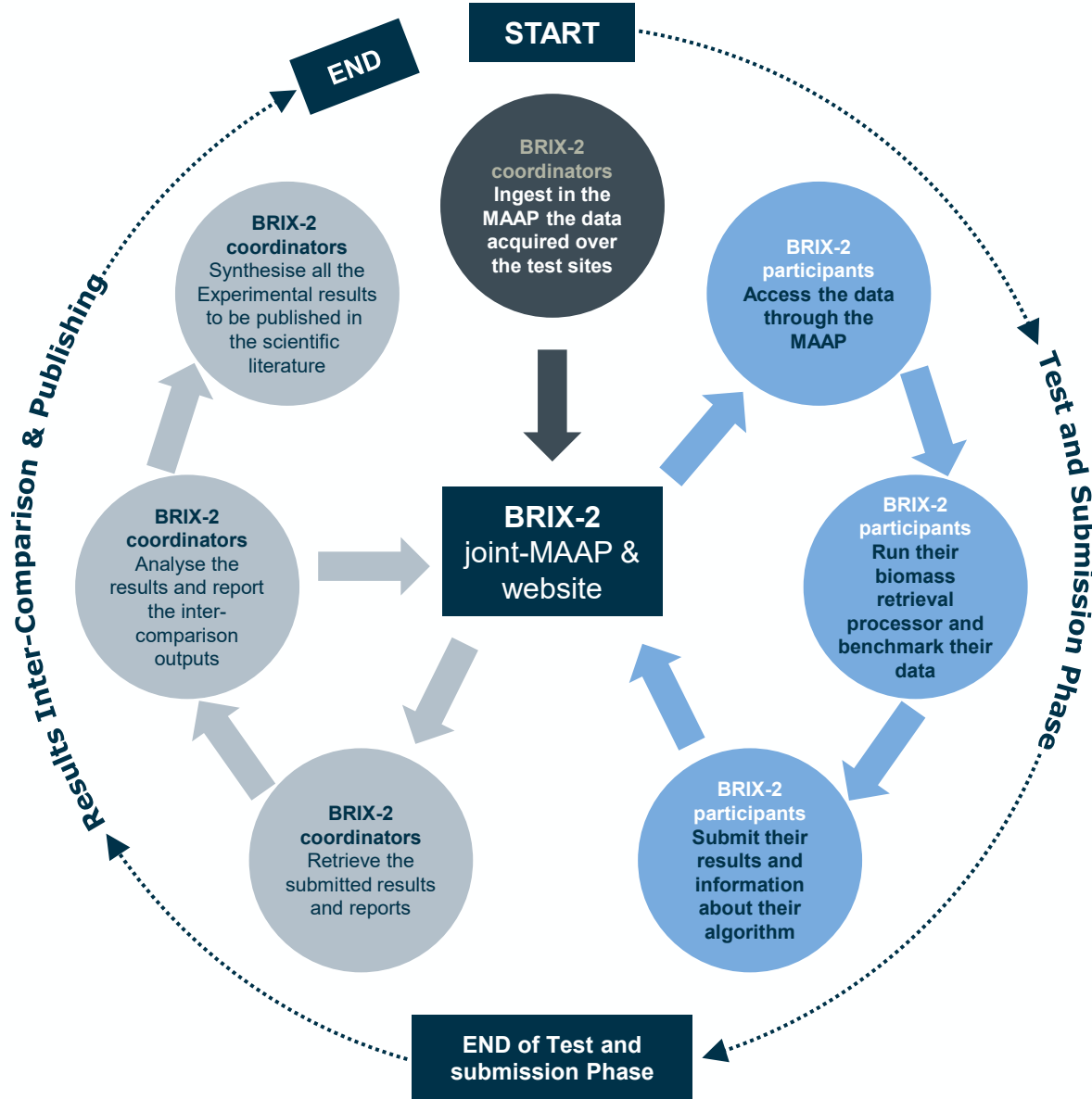
- BRIX-2 should **not** be a **competition** where the best performing algorithm wins. The exercise should be a **scientific experiment** with a focus on the **inter-comparison of algorithms** by validating derived biomass maps against in-situ reference measurements.
- BRIX-2 allows an increased understanding of **strengths** of the next generation of active remote sensing datasets, with a focus toward **algorithm fusion**. This is not intended as an algorithm competition, but **how we can combine lesson learned from the strengths of a range of algorithms**.

BRIX-2 has following challenges:



1. How to **optimally use** the available **P-band SAR, L-band SAR and LIDAR** data in the retrieval?
2. Retrieval will be tested on a **limited geographic** area but the algorithm has to be **applicable globally...**
3. How to use **datasets**, including time-series, from **future BIOMASS, NISAR and GEDI** missions?
4. How to **make retrieval consistent globally** and in agreement with each mission requirements?

Different steps and corresponding schedule



Milestones:

- **First Workshop**
(29-30 April 2021)
- **Results Submission Deadline**
(May 2022)
- **Results Evaluation Report**
(July 2022)
- **Second workshop**
(September-October 2022)



Evaluation of Results & Publication



- The evaluation will be done by ESA/NASA, following standards from the CEOS LPV protocol. This should guarantee a **fair evaluation**. ESA/NASA will release a **report to the participants summarising the evaluation results**.
- After the experiment has been closed we will make the **evaluation scripts available on the ESA-NASA MAAP**. This allows people to **repeat the experiment** and **compare their results** against the published ones.
- ESA/NASA **commit not to distribute the outcome** of the exercise **without prior consent** of the participants.
- The results should easily be adapted for publication as a **peer reviewed article co-authored by all participants** who wish to publish the outcomes of the activity.

Approach and datasets

- Participants shall generate a biomass map and an uncertainty map within a given geographic bounding box using a pre-determined BRIX-2 dataset that includes radar, lidar and field data.
- Participants are not requested to use all datasets.
- Data that has been acquired during the ESA-NASA AfriSAR campaign in Gabon.
- Additional relevant data can be considered.



Validation data:

- In-situ measurements for Lopé, Mabounie, Rabi and Mondah sites:
Pre-processed 1 ha forest plots (including subplots) data at Lopé, Mabounie, Rabi and Mondah with estimated AGB (ton/ha) and forest height (m).
- Airborne lidar maps derived from field data and LVIS at Lope, Mabounie, Rabi and Mondah (https://daac.ornl.gov/cgi-bin/dsvviewer.pl?ds_id=1775)

Evaluation approach:

- Notebooks for conducting the validation will be developed in collaboration with the full BRIX-2 team, and implemented on the MAAP with a transparent visualization of outputs and summary statistics for each candidate algorithm.

Evaluation metrics



- Bias

$$\mu = \frac{1}{n} \sum (B_x - B_y)$$

- Covariance

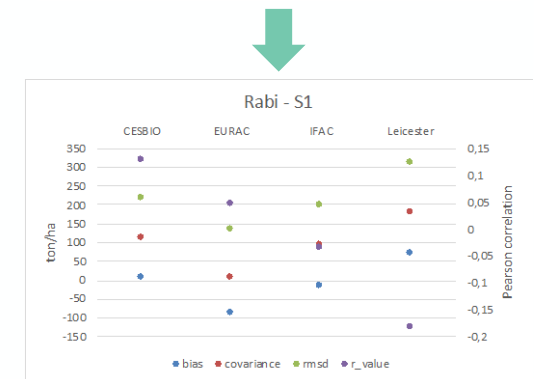
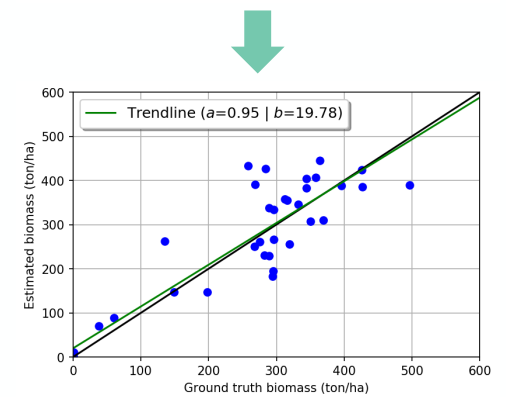
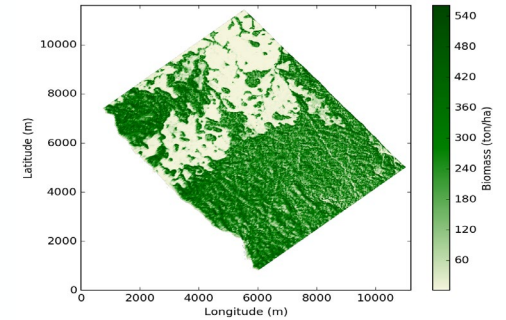
$$\sigma = \frac{1}{n-1} \sum (B_x - \bar{B}_x)(B_y - \bar{B}_y)$$

- RSMD

$$RMSD = \sqrt{\frac{1}{n} \sum (B_x - B_y)^2}$$

- Pearson Correlation

$$r = \frac{n \sum B_x B_y - \sum B_x \sum B_y}{\sqrt{n \sum B_x^2 - (\sum B_x)^2} \sqrt{n \sum B_y^2 - (\sum B_y)^2}}$$



Original list of BRIX-2 participants



- Qian Song [DLR, DE]
- Sean Healey [US Forest Service national forest inventory, US]
- Zheng-Shu Zhou [CSIRO - Australian Resources Research Centre, AU]
- Polyanna da Conceição Bispo [University of Manchester, GB]
- Pedro Rodriguez-Veiga [University of Leicester, GB]
- Rubén Valbuena [Bangor University, GB]
- Emanuele Santi [CNR-IFAC, IT]
- Helen Baldwin Parache [NASA - University of Alabama Huntsville, US]
- Juan Guerra-Hernandez [Universidade de Lisboa, PT]
- Harry Carstairs [University of Edinburgh, GB]
- Ana Maria Pacheco Pascagaza [University of Leicester / Manchester, GB]
- James R. Kellner [Brown University / GEDI Mission Science Team, US]
- Adrian Pascual [ASU, US]
- Iain McNicol [University of Edinburgh, GB]
- Michael Schlund [University of Twente, NL]
- Christiane Schmullius [Friedrich-Schiller-University Jena, DE]
- Mikhail Urbazaev [Friedrich-Schiller-University Jena, DE]
- Richard Lucas [Aberystwyth University, GB]
- Wangfei Zhang [Southwest Forestry University, CN]
- Pierre-Antoine Bou [CESBIO, FR]
- Chiara Aquino [University of Edinburgh, GB]
- Joao Carreiras [University of Sheffield, GB]
- Thomas Chen [Academy for Mathematics, Science, and Engineering, US]
- Maryam Pourshamsi [Airbus, GB]
- Karimon Nesha [Wageningen University, NL]



BRIX-1 summary

ESA only



- ESA lead and based on the « precursor of the MAAP ».
- **Intercompare a biomass retrieval models** based on the data that has been acquired during the AfriSAR campaign for the La Lopé super site.
- The retrieval was evaluated over the three independent test sites Mondah, Rabi and Mabounie with existing forest plot data and lidar estimates of biomass.
- 4 teams took part to the experiment with their model:
 - Leicester/JPL → Modelling
 - CESBIO → Semi-Empirical/Likelihood
 - IFAC → Machine Learning
 - EURAC → Machine Learning



BRIX-1 summary

ESA only



Analysis

- **Similar behaviour** observed for the 4 models, while they are based on different methods.
- **Very good results on Lopé** (where the training ROIs were provided). **Worse results on the other sites** (where the training ROIs were not provided).
- A first conclusion is that using the same ROIs for training and validation will introduce **strong bias** in the estimation of the retrieval.

Observations:

- The **standard file format** and **georeferencing** helped a lot the analysis.
- The algorithms were **well documented** (paper, user manual for algorithm...)

If you are interested in more information on...



BRIX-1:



<https://earth.esa.int/web/sppa/meetings-workshops/hosted-and-co-sponsored-meetings/brix>

BRIX-2:



<http://polinsar-biomass2021.esa.int/brix-2/>

Thank you!

