ESA OSIP Marlisat Final Presentation

Marc Lucas & Team (CLS- Pixalytics)

29/09/2022

Agenda

- ✓ Overview
- ✓ Satelite Detection
- ✓ Tag Development
- ✓ Surface Currents
- ✓ Discussion
- ✓ AOB
- ✓ Close

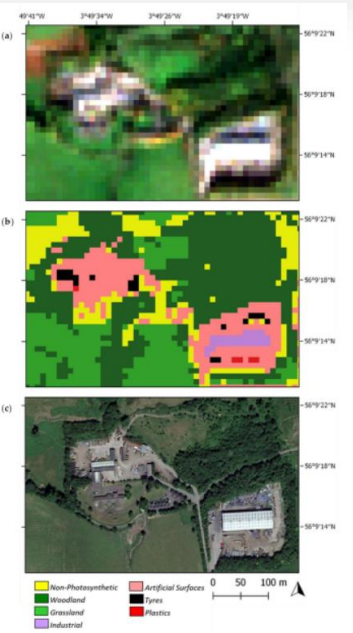
Contract Reference

- ESA Contract No. 4000131481/20/NL/GLC = OSIP Remote Sensing for Marine Litter-Early Technology Development Scheme
- Project Title: A full-range plastic marine litter monitoring service to support cleaning and littering reduction actions by mapping hotspots, pathways and littering sources

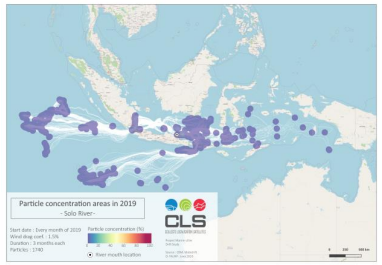
- Project Duration: 18 months
  - Proof of Concept: 6 months
  - Demonstration: 12 months

Objectives

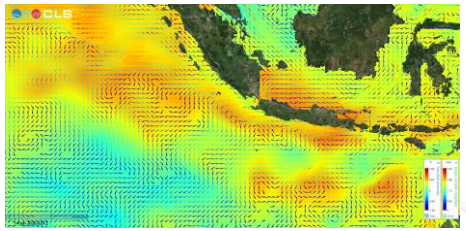
- Detect: plastic source through EO means



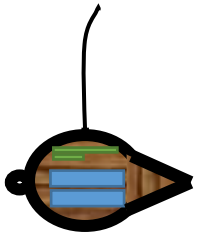
- Track: the behavior of marine plastic litter



- Forecast: marine litter movement and accumulation areas



MARLISAT Initial Concept



Tag Trajectories

Forcing Coefficient

WP 2200 & 3200

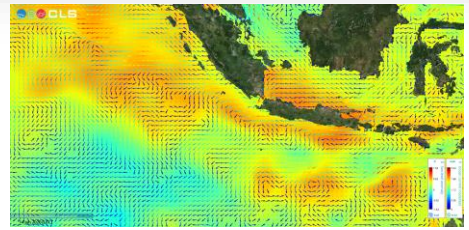
Satellite Image

Initial Locations

WP 2100 & 3100

Wind Field

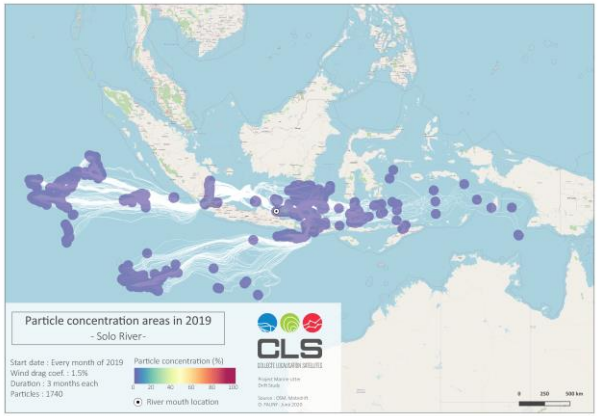
Drift model



Upper Ocean Current Field

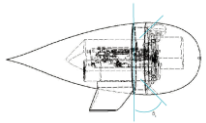
WP 2300 & 3300

Accumulation Areas



MARLISAT Final Concept

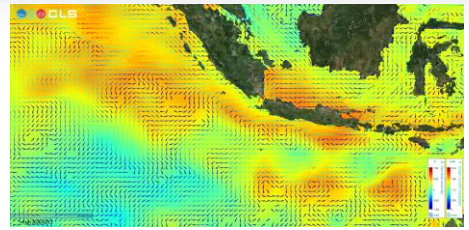
Tag Trajectories



Forcing Coefficient

WP 2200 & 3200

Wind Field



Upper Ocean Current Field

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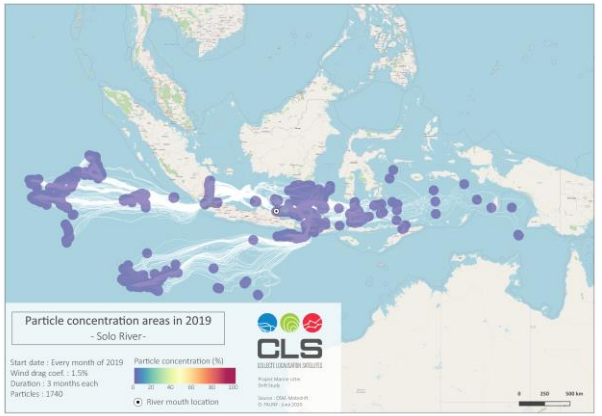
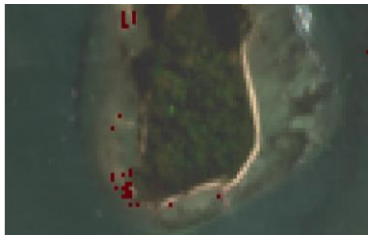


Satellite Image



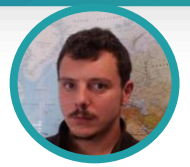
Plastic Detection

WP 2100 & 3100

Plastic detection overlaid on Sentinel-2 RGB

The Team

Project Lead : Marc Lucas



Satellite detection :

- Samantha Lavender

Current and Drift Study:

- Helene Etienne

- Solène Jousset

- Olivia Fauny

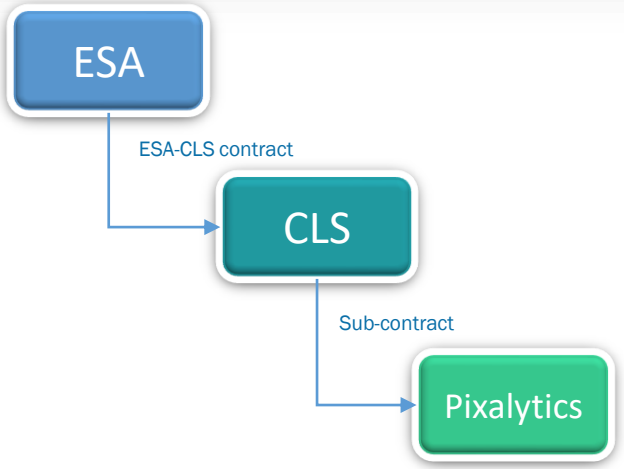
Tag development :

- Phillipe de Saint Leger

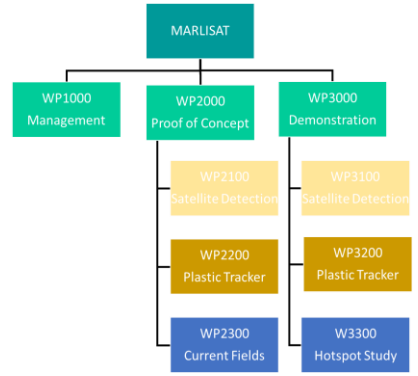
Organization

- Project Duration: 24 months
  - Proof of Concept: 6 months
  - Demonstration: 18 months

- Lead: CLS
- Satellite Detection: Pixalytics
- Tracker: CLS
- Satellite Currents: CLS

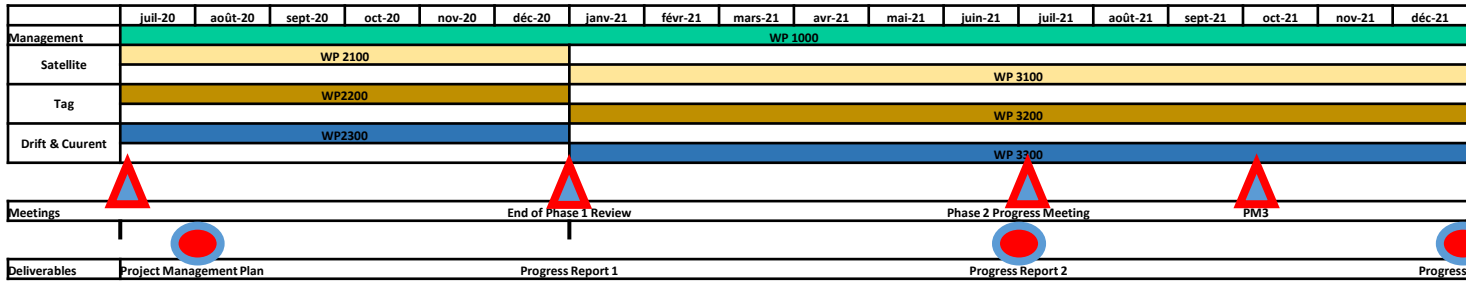


Project Organization



WBS of the Project

Planning & Deliverables



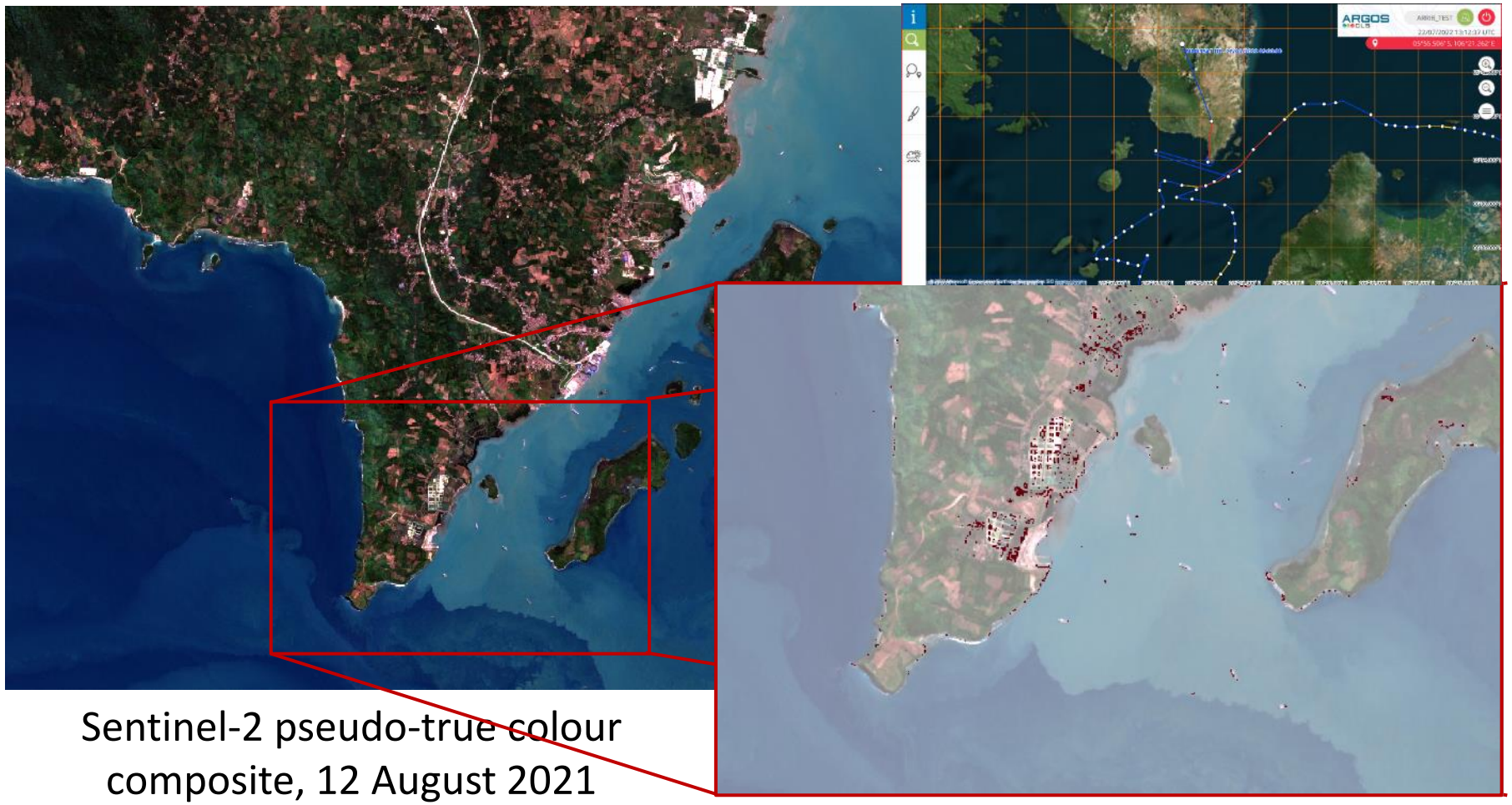
WP3100
Satellite Detection

Samantha Lavender
25/09/2022

Task 3.1: Satellite Detection Prototype

- The plastics classification code has been run in parallel with the drifter and modelling activities.
- Journal paper on classification approach submitted to Remote Sensing of Plastic Pollution Special Issue of Remote Sensing, which has been accepted and published: https://doi.org/10.3390/rs14194772. Also, details of the training dataset has been uploaded to Ocean Scan: https://www.oceanscan.org/dataset/a8375686-76c5-42d4-936b-2ad8bd59118e
- Integration of Very High Resolution commercial imagery to improve spatial resolution of the Sentinel data (image sharpening) is an on-going activity, as since the last meeting the focus was the previous two activities.

Plastic detection for drifter beaching location

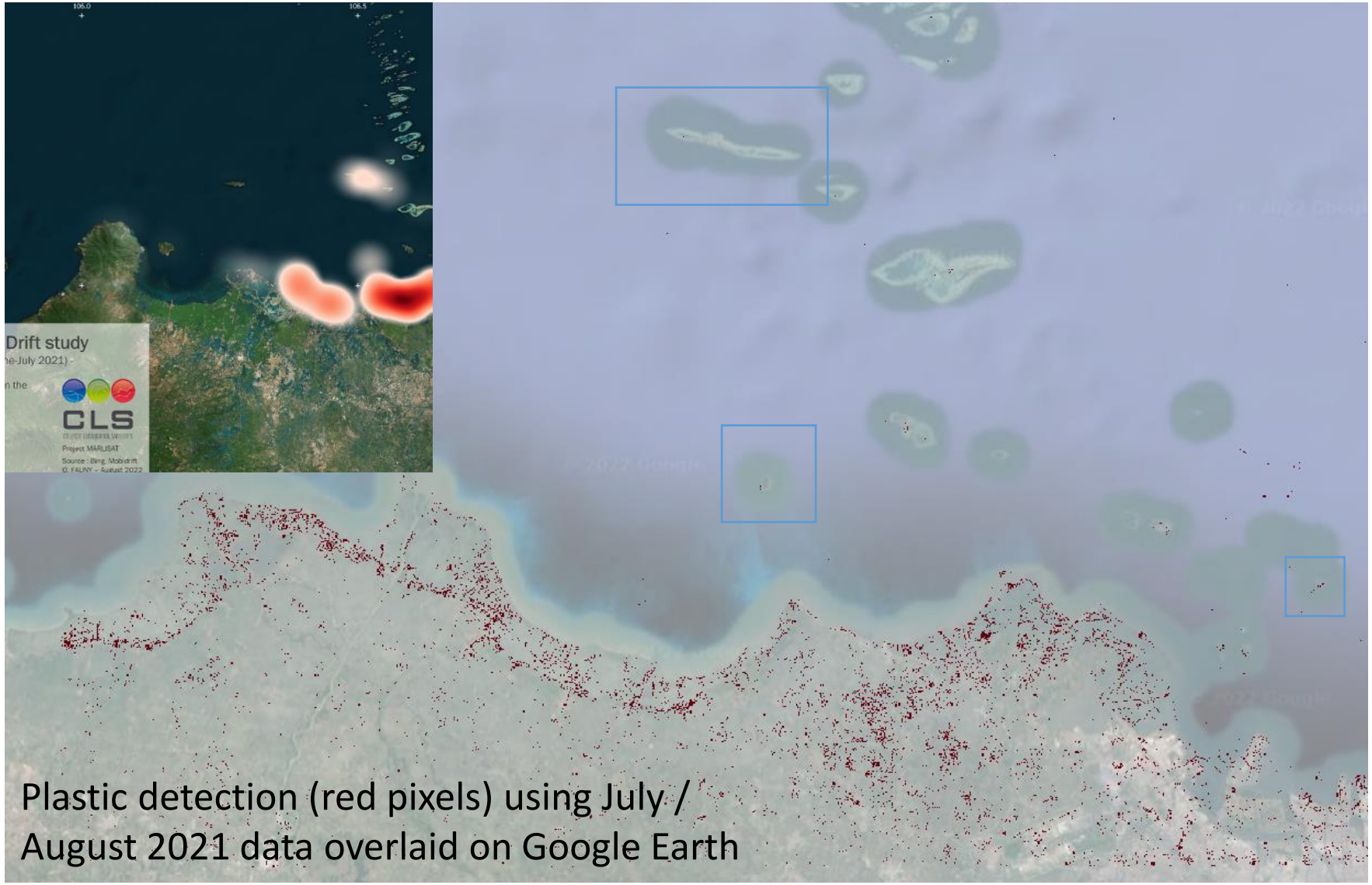


Sentinel-2 pseudo-true colour composite, 12 August 2021

Plastic detection (red pixels) using July / August 2021 data

The location of the drifter beaching is showing plastic along the coast and there is plastic inland due to aquaculture ponds.

Detection of plastic linked to modelling outputs



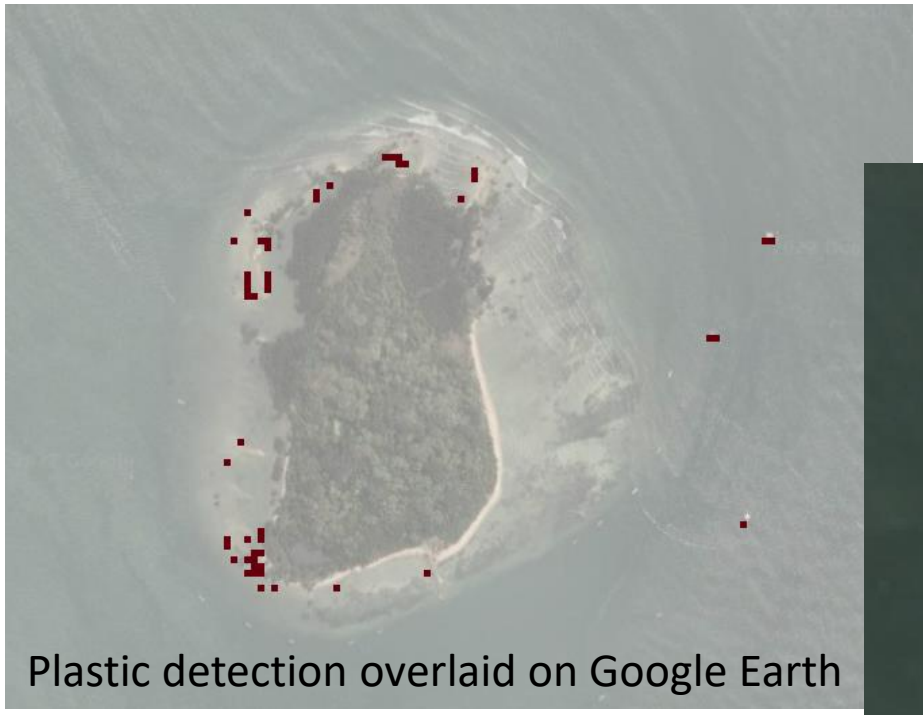
Plastic detection (red pixels) using July / August 2021 data overlaid on Google Earth

Detection of plastic accumulation around Tidung Barat island

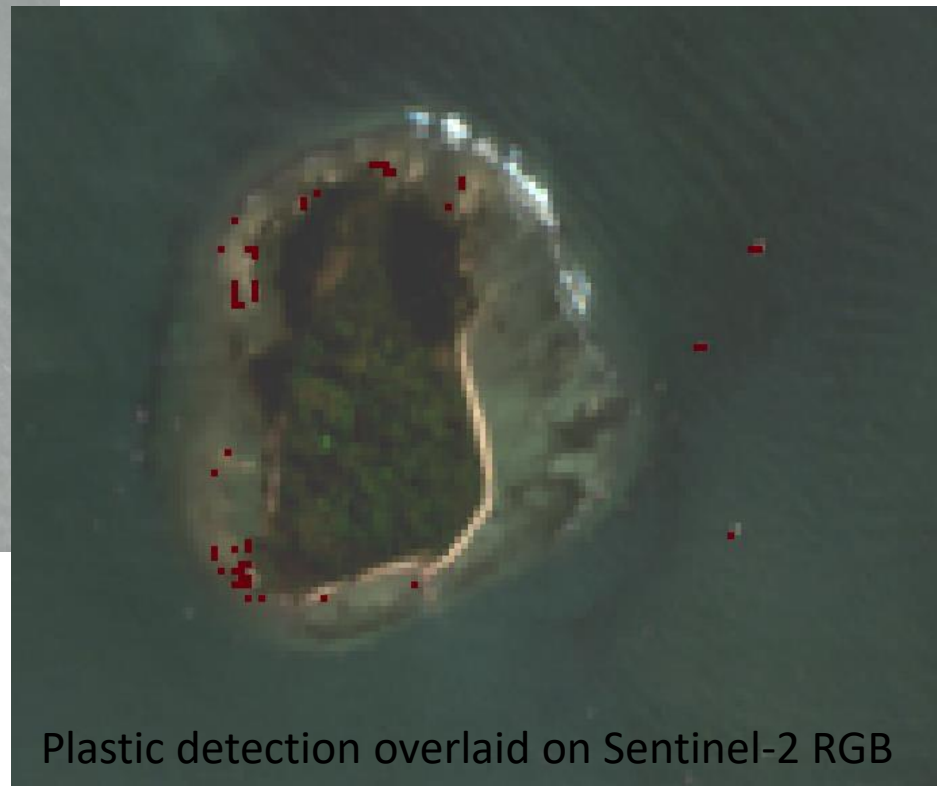
Plastic detection overlaid on Google Earth

Plastic is being detected around Tidung Barat that is the centre of one of the large patches in the model – plastic is primarily detected on the shore rather than floating in the sea. The small number of detections in the sea are primarily from vessels.

Detection of plastic accumulation around Pulau Laki island



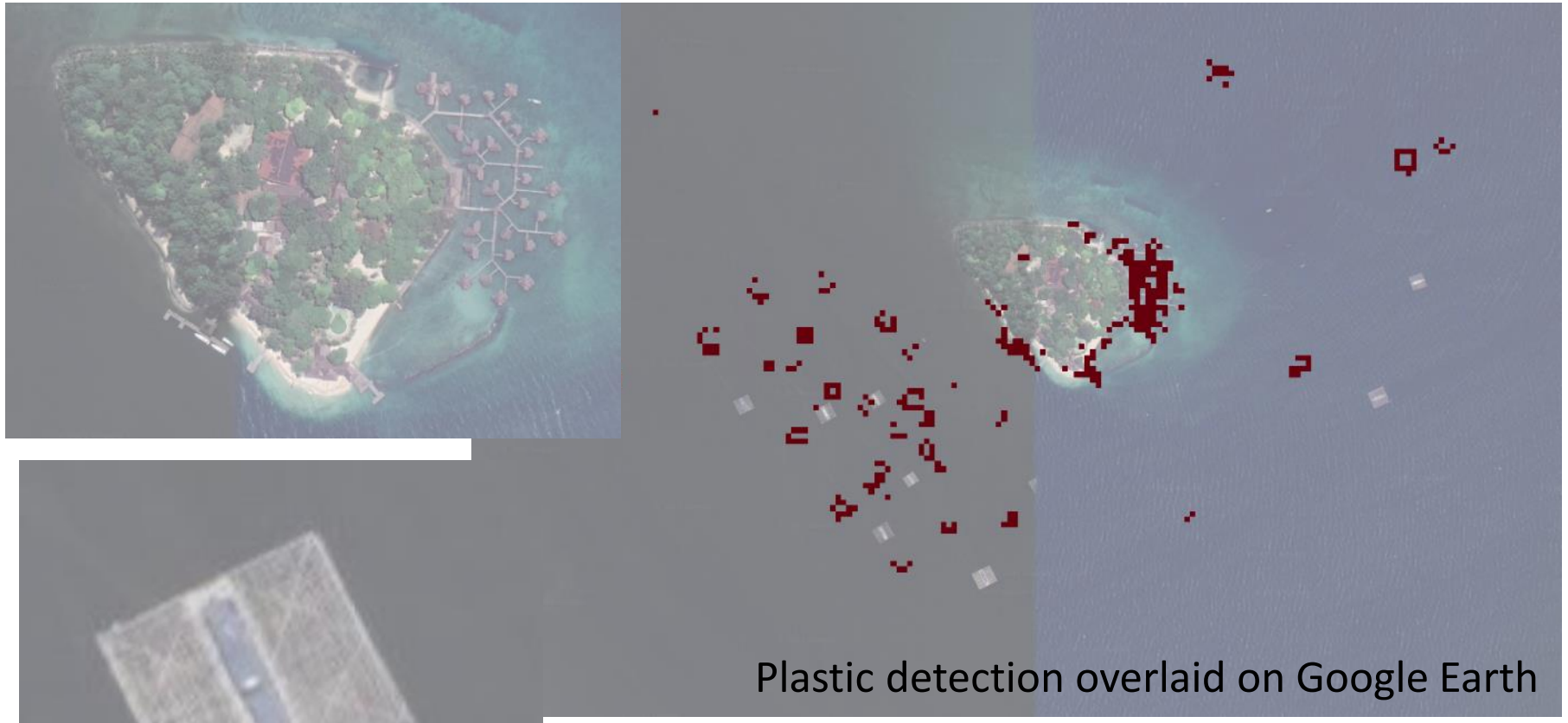
Plastic detection overlaid on Google Earth



Plastic detection overlaid on Sentinel-2 RGB

Plastic is being detected around Pulau Laki that is the centre of a smaller patch in the model, and for small fishing vessels.

Detection of aquaculture activities



Plastic detection overlaid on Google Earth

There are multiple detections off Pulau Opak Besar Timur that appear to be aquaculture cages, with the strong detection on the right of the island being an eco-tourism resort.

Ongoing and Next Steps

- Continuing to work with the Lawyer/NGO in Spain to detect plastic waste associated with the greenhouses. This has been difficult as the patches they are interested in are small (not visible in Sentinel-2) and have varying colours. This might benefit from Reinforced Learning where the training model is further trained to create a “site specific” version that is more accurate than the generic model when applied to that site.
- Continue work on using the very high resolution optical and SAR data, obtained through an ESA TPM request, to take advantage of a combination of high spatial and spectral resolution data.
- Work on optimising the code so that the AWS cloud-computing costs to run the code continually over an area is reduced.

WP3200
Tag Deployment

Philippe de St Leger

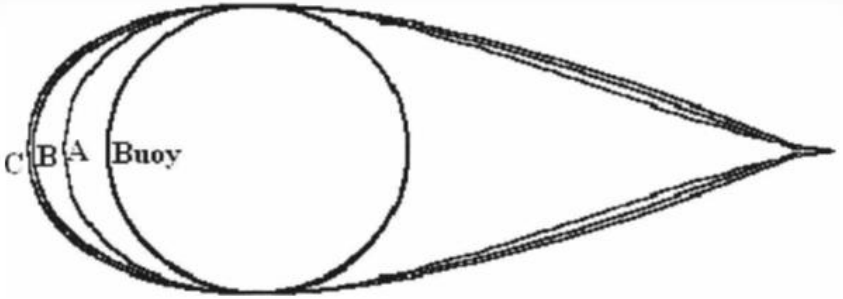
05/09/2022

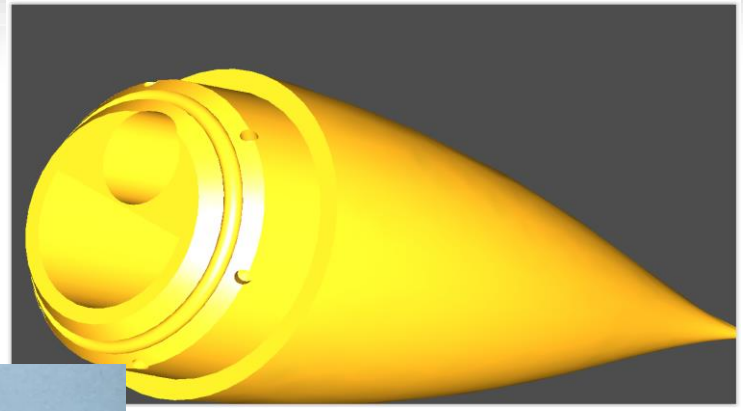
Work achieved

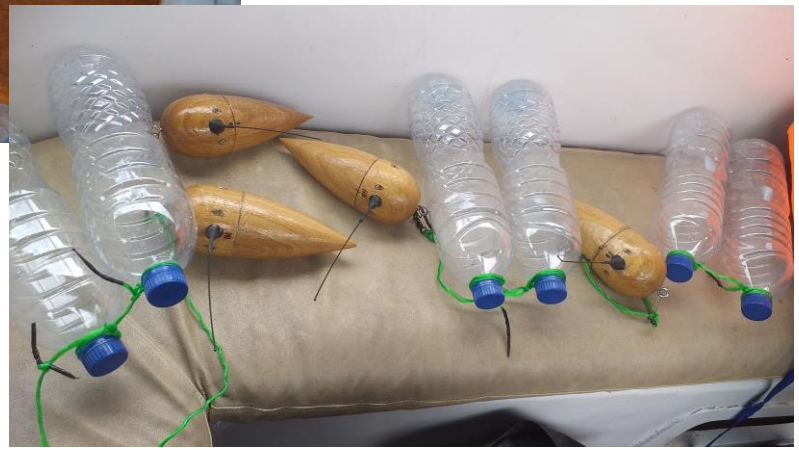
Design

Procurement

Tests/Validation

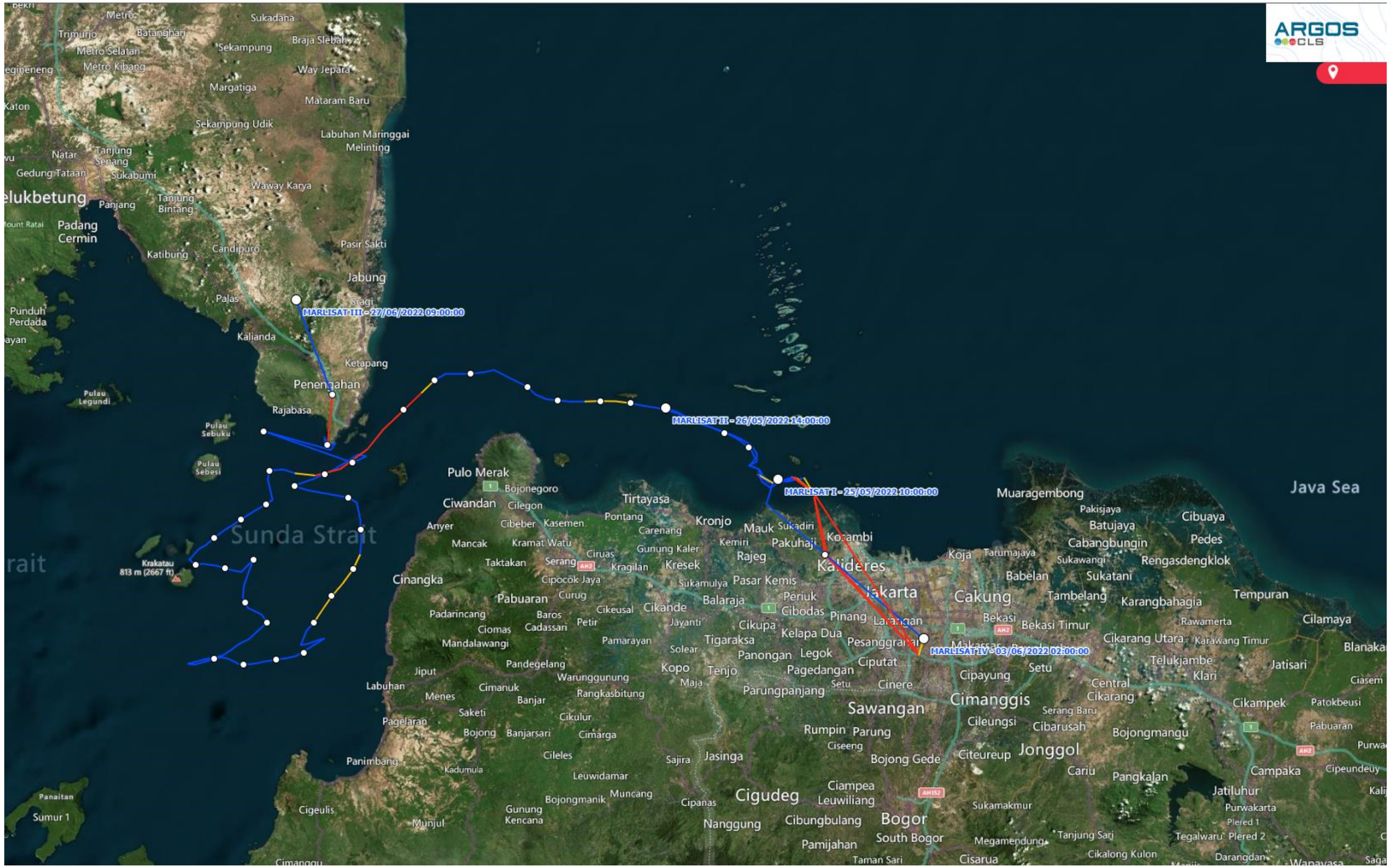






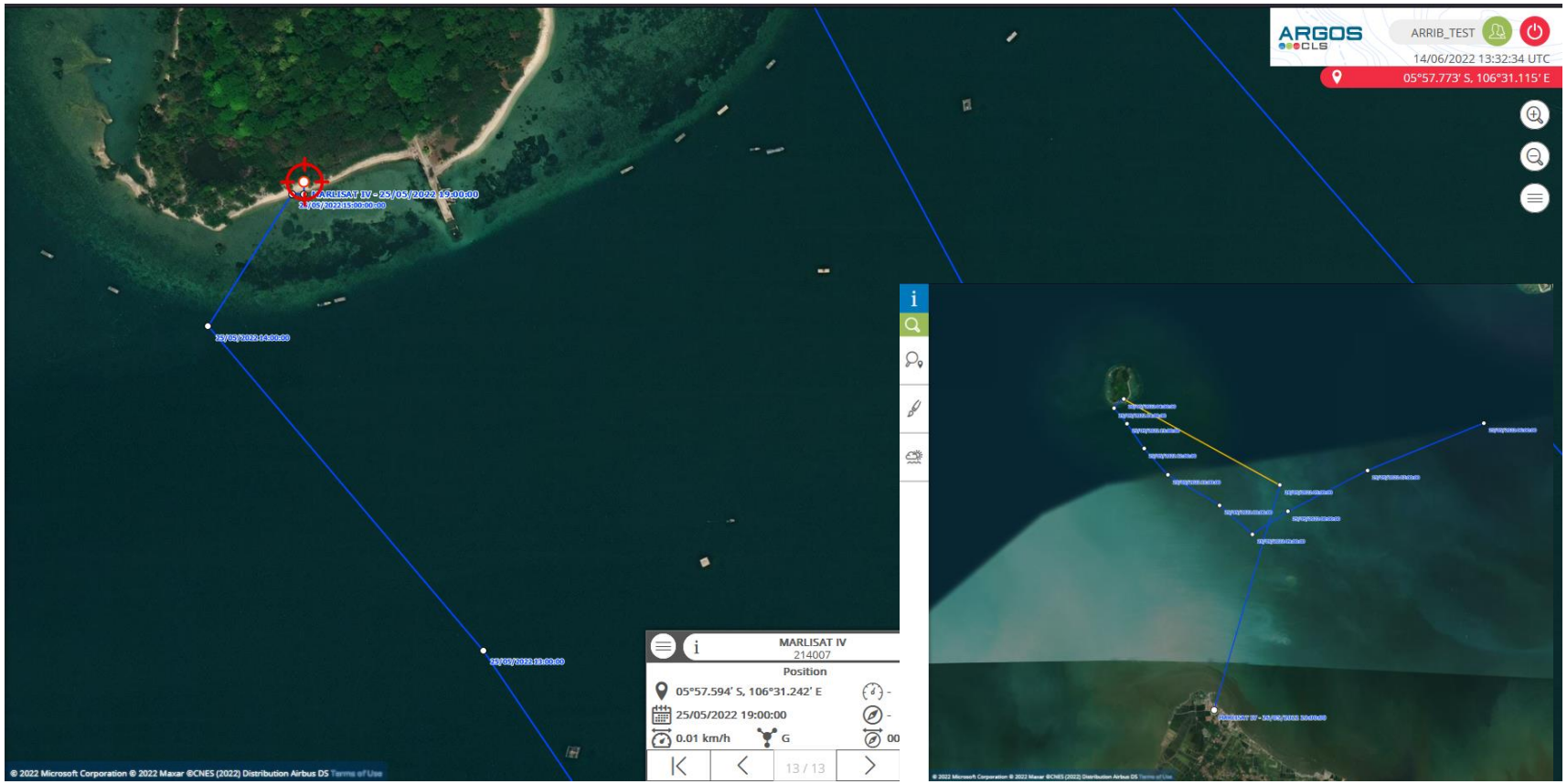
4 final units prepared / tested / shipped / deployed →

Field results



Indonesian deployment results

2 units lost at sea after few days
2 units on shore after 1day (recovered) and 11 days



Results and possible improvments

1GPS position per hour and Argos transmission Validated

Hourly GPS collection rate 73%

Autonomy estimation – approx 3months – Real Test in progress

Go to shore exposure → site selection + increase number of trackers

Tracker robustness → to be optimized with better closing system

Tracker Assembly workload -> to be optimized with better closing system

Tracker Wood casing cost -> can be optimized with simpler design

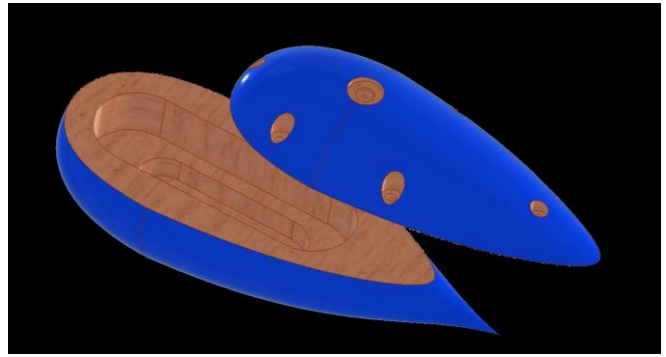
upScaling production :

Low drag design = increasing cost

WoodCasing = increasing cost

No market = no Industrial Manufacture

Msg Date	MARLISAT III	%age
25-May	21	88%
26-May	23	96%
27-May	17	71%
28-May	18	75%
29-May	15	63%
30-May	18	75%
31-May	13	54%
1-Jun	22	92%
2-Jun	15	63%
3-Jun	14	58%
4-Jun	17	71%



ESA OSIP Marlisat

WP 3300: Ocean current

Solène JOUSSET – Hélène ETIENNE - Olivia FAUNY

29/09/2022

MARLISAT Concept

Tag Trajectories

Forcing Coefficient

WP 2200 & 3200

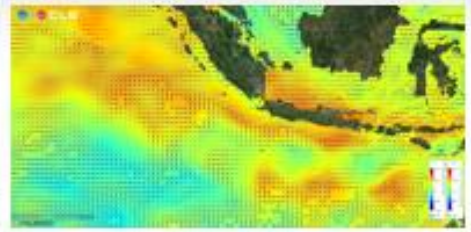
Satellite Image

Initial Locations

WP 2100 & 3100

Wind Field

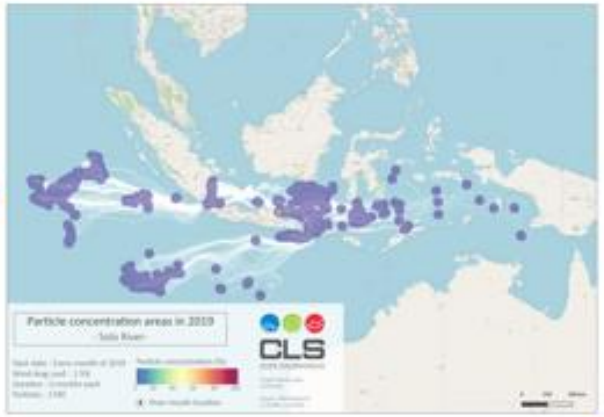
Drift model



Upper Ocean Current Field

WP 2300 & 3300

Accumulation Areas



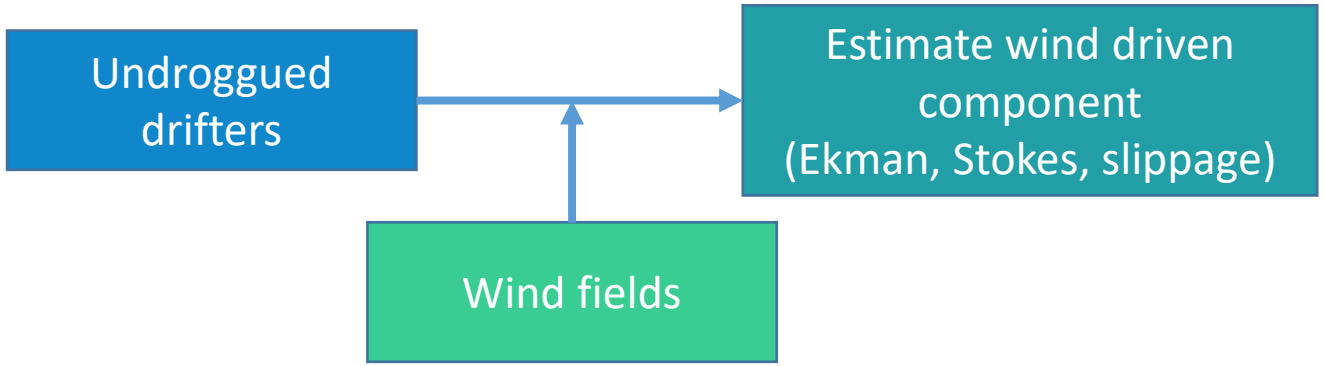
CLS

Objectives

New approach for surface current estimation dedicatd to drift purpose:

We will extract the relevent components to fit an empirical model of wind driven motion from undrogued drifters:

- Use of undrogued drifters to estimate wind driven component (Ekman + stokes)
- Use of combined in-situ and altimetry derived geostrophy (CNESCLS18 Mean Dynamic Topography)
- Use of observed wind (6-hourly blended wind fields estimated mainly from scatterometer) and modeled ERA5 wind fields

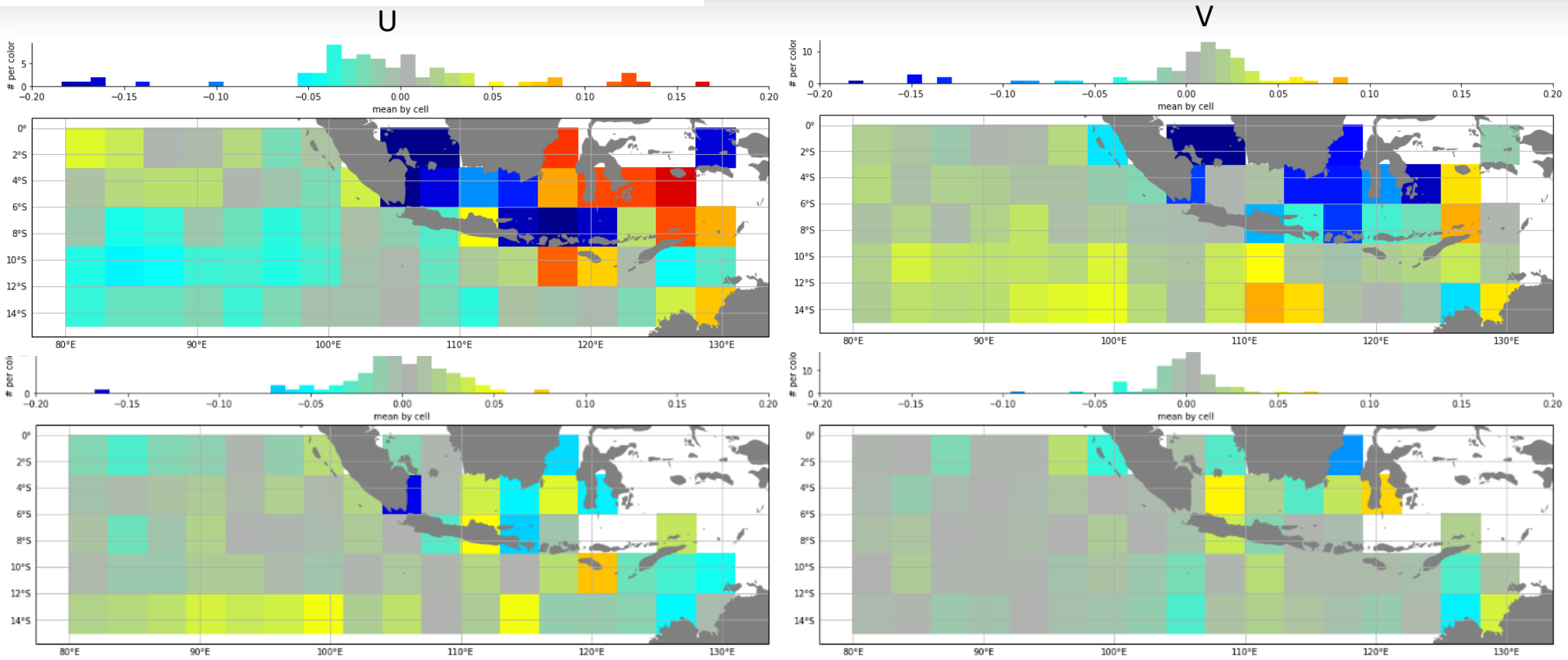


Summary of the work done

- 2 methods tested: the methods of Poulain et al (2009) and the CLS method.
  - The **CLS method** showed better results for the estimation of these wind-driven currents.
- Some numerical issues prevent us from using CERSAT wind stress (observed wind fields).
  - **ERA5 wind fields** will be chosen for the final surface product.
- **Large-scale bias reduction method** based on a linear regression presents an improvement of the results in terms of bias and squared error
- **Choice of method**:
  - Estimation of Ekman currents with the CLS method and ERA5 wind fields,
  - No Stokes drift,
  - Large scale bias correction.
- Validation with undrogued drifters and drift experiments

Validation with undrogued drifters

Global Bias: reconstructed current - total drifter current



CLS method

MARLISAT currents (CLS method + bias correction)

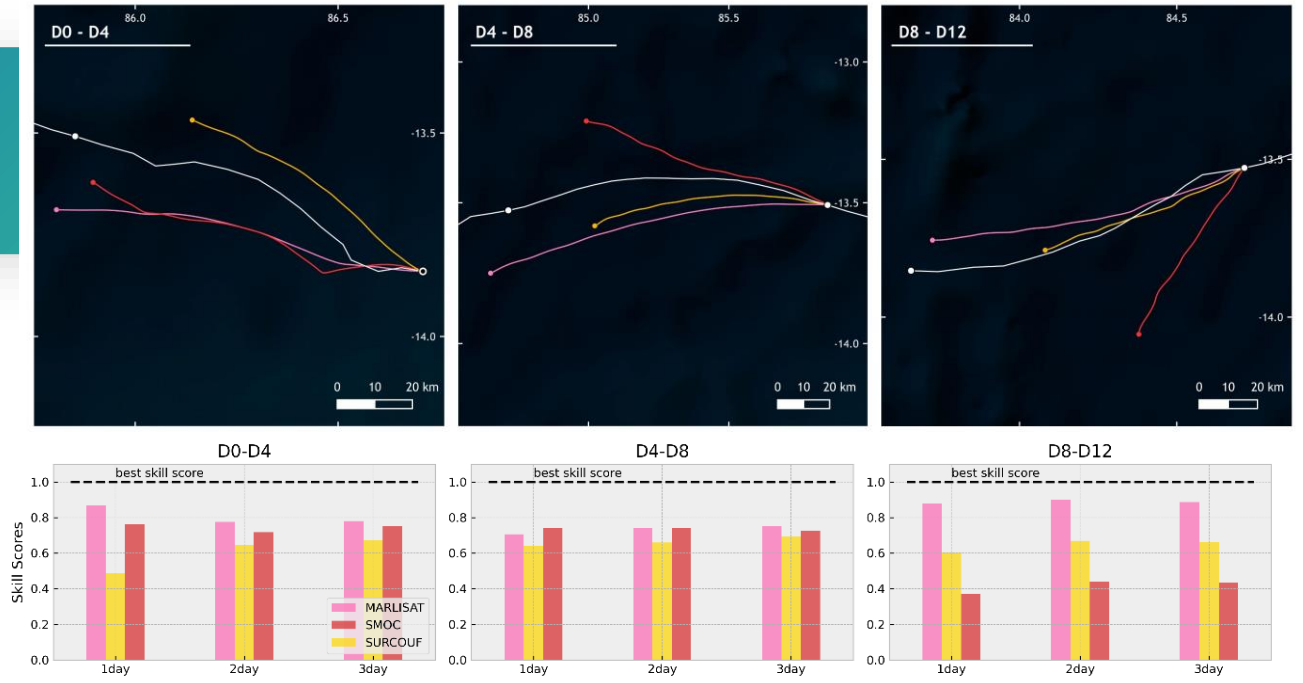
Model	RMS U [m/s]	Coef. Corr. U	RMS V [m/s]	Coef. Corr. V
CLS method	0.209	0.80	0.185	0.59
MARLISAT currents	0.187	0.84	0.166	0.67

Validation with drift experiments

Skill score (Liu and Weisberg 2011)
Generally included between 0 and 1
SS ≈ 1 → Similar trajectories
SS ≤ 0 → Diverging trajectories

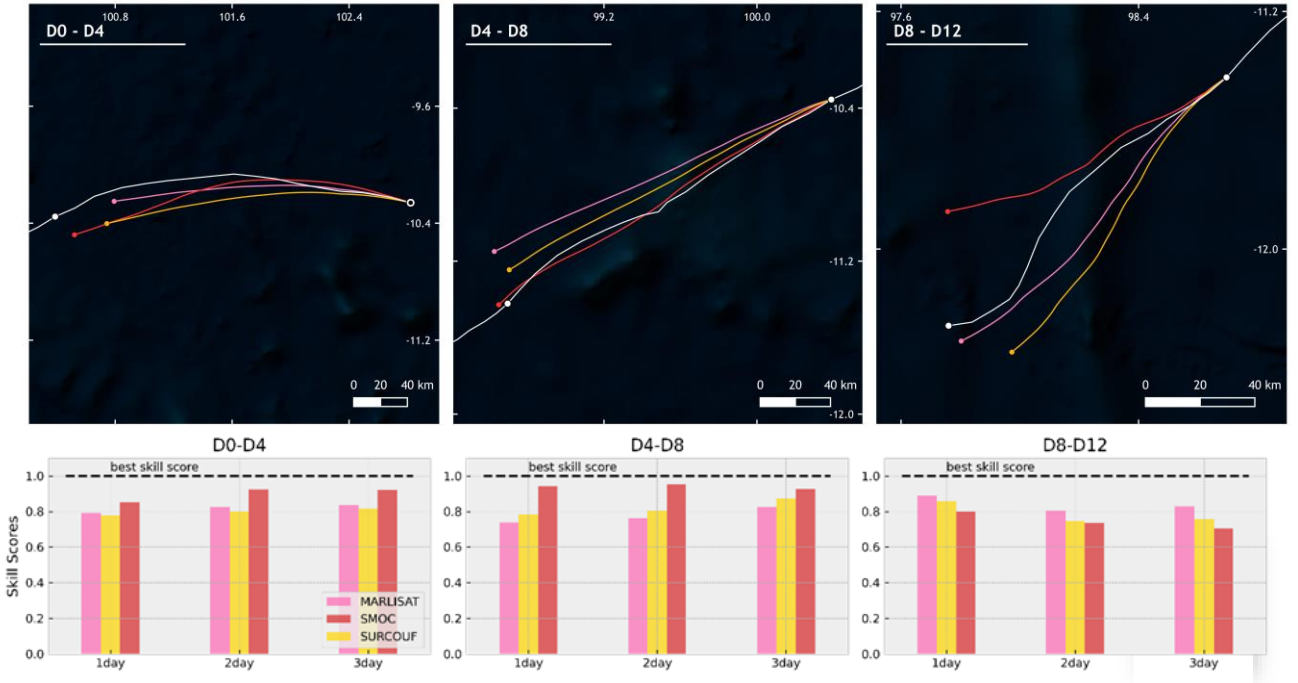
Buoy 65805030

5th - 16th December 2019



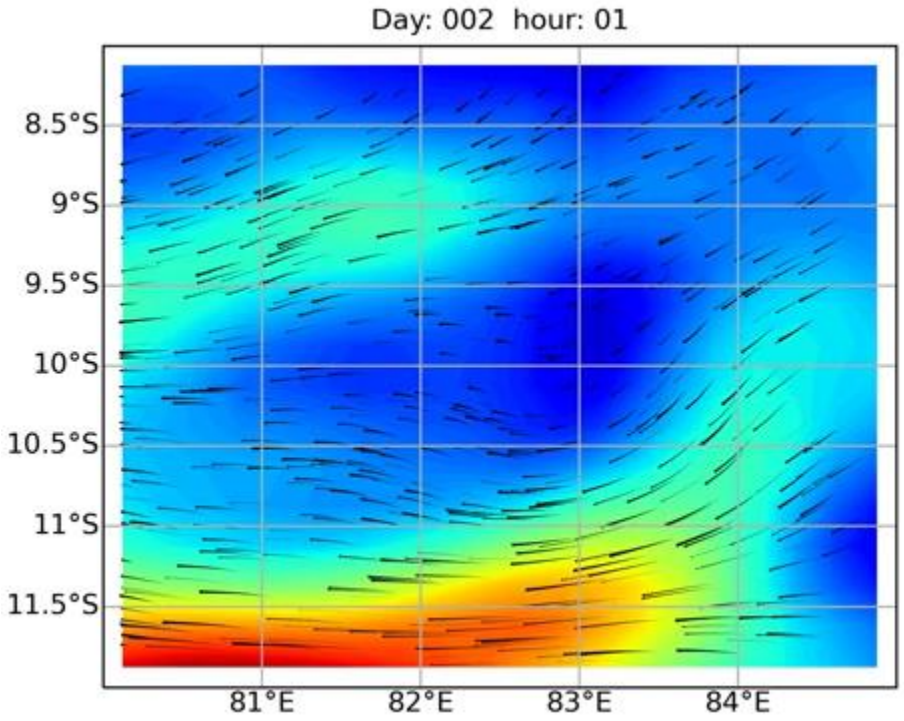
Buoy 65332540

1st - 12th September 2019



Current production

Example of the MARLISAT currents in the open sea



- MARLISAT currents contain:
  - geostrophic currents,
  - wind driven currents (CLS method),
  - a large-scale correction (detailed in the MARLISAT Phase 2 final report section 1.3).

15 years of current production :

- From 2006 to 2020
- at a 3-hourly frequency
- computed on a 0.25°x 0.25° spatial grid

Conclusions and perspectives

- Encouraging results of MARLISAT currents
- Difficulties remains in weak currents area.
- The Indonesian area is a particularly difficult area for current estimation:
  - Geostrophy assumption is no valid near the equator, resulting in larger errors on currents
  - Few drifting buoy data especially in Java Sea, wind-driven currents are estimated from these data is more complex and it is possible that some signals are poorly reproduced in the currents

- Perspectives
  - Test the method in an area with more data and not at the equator: the Mediterranean Sea
  - Use bias-corrected wind fields or even observed winds
  - Fit the Ekman model by physical area: classification with Machine Learning

Drift study process

1

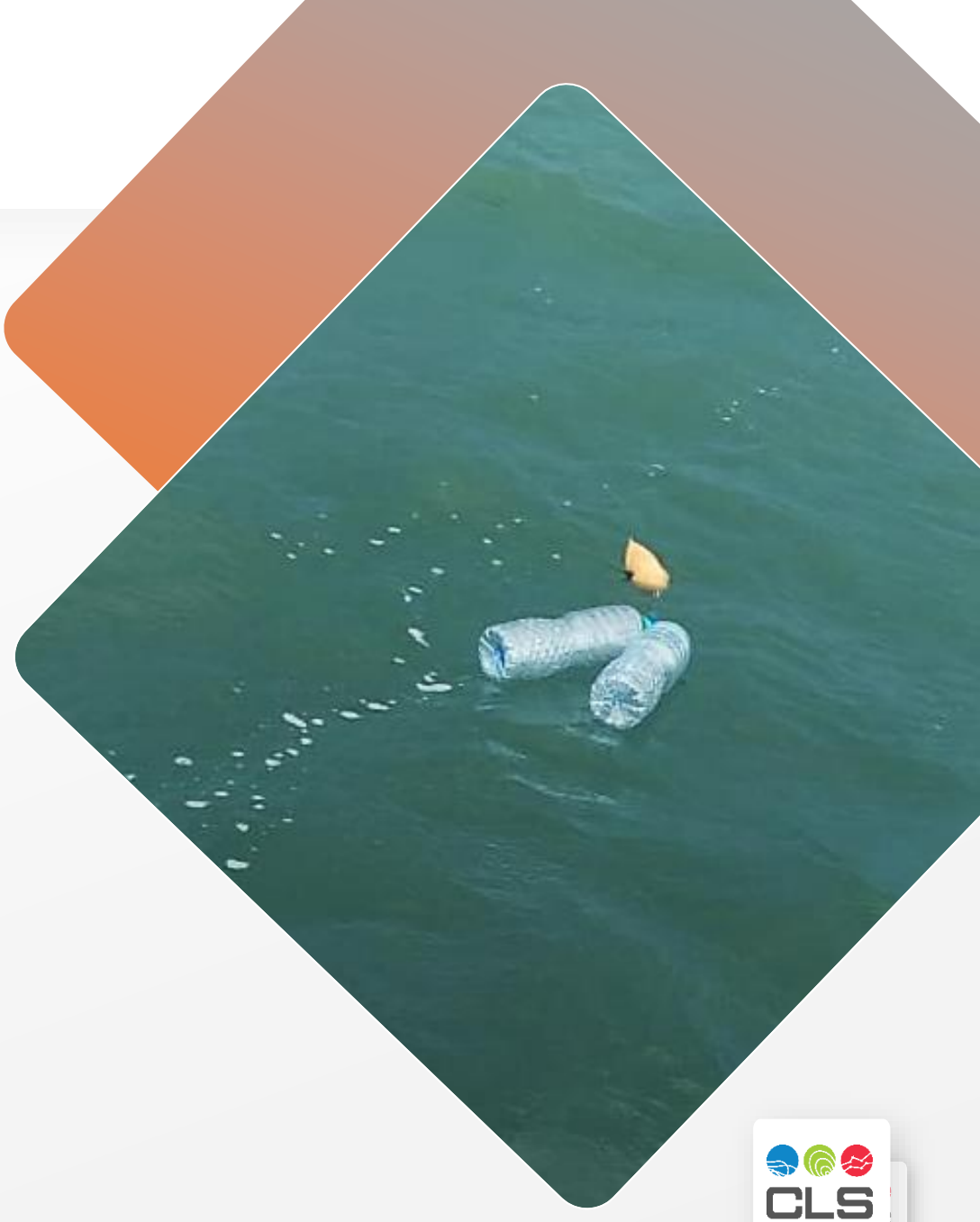
- **Calibration**
- Determine the parameters that simulates the closest trajectory from MARLISAT buoy

2

- **Simulations**
- Perform a drift study for a given period and area

3

- **Identification**
- Identify the simulated main areas of particles accumulation



Calibration

Compute the closest simulation from the trajectory of the MARLISAT buoy

Fixed parameters

Current model : CMEMS hourly

Wind model : NCEP

Tide model : Fes 2014

Vary some parameters in
to find the best combina

Wind coefficient (%)		Tide coefficient (%)	
1.5	10	0	80
2	12	25	100
3	15	50	150
4	18	75	200
6	20		
8	00		

Surface current coefficient (%)	
0	80
10	100
50	150
75	

Start date
25/05 05h (UTC)
26/05 00H (UTC)
26/05 15h (UTC)

Calibration

Best combination

75% current (CMEMS hourly)

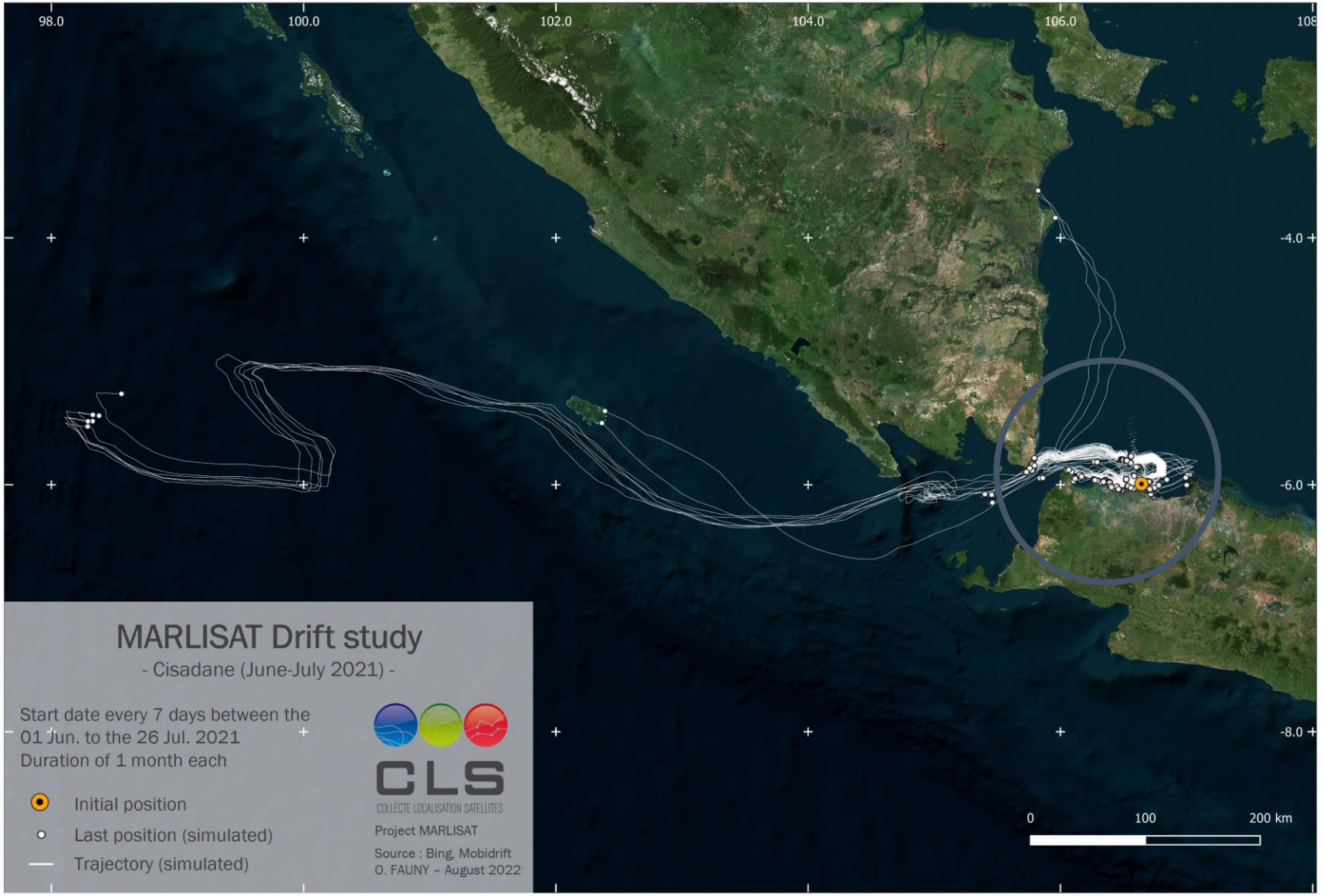
75% tide (Fes14)

10% wind (NCEP)

Start **26/05 15h** (UTC)

Simulations

- 1 simulation every week between June and July 2021 (9 in total)
- Parametrization from the calibration phase
- Run with Mobidrift (Lagrangian drift tool)
- Total of 2250 particles simulated (250 part./run)



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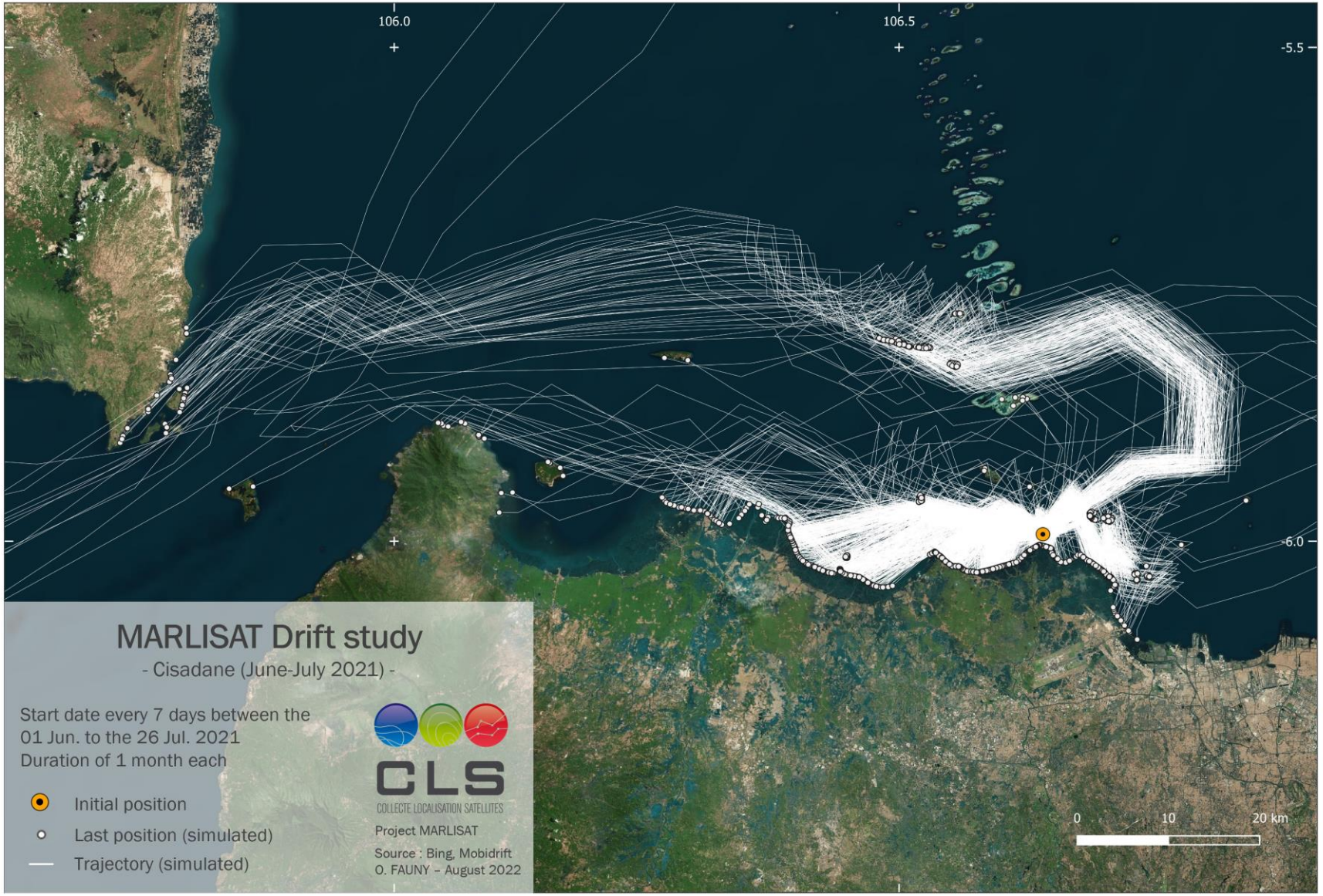

Simulations and identification

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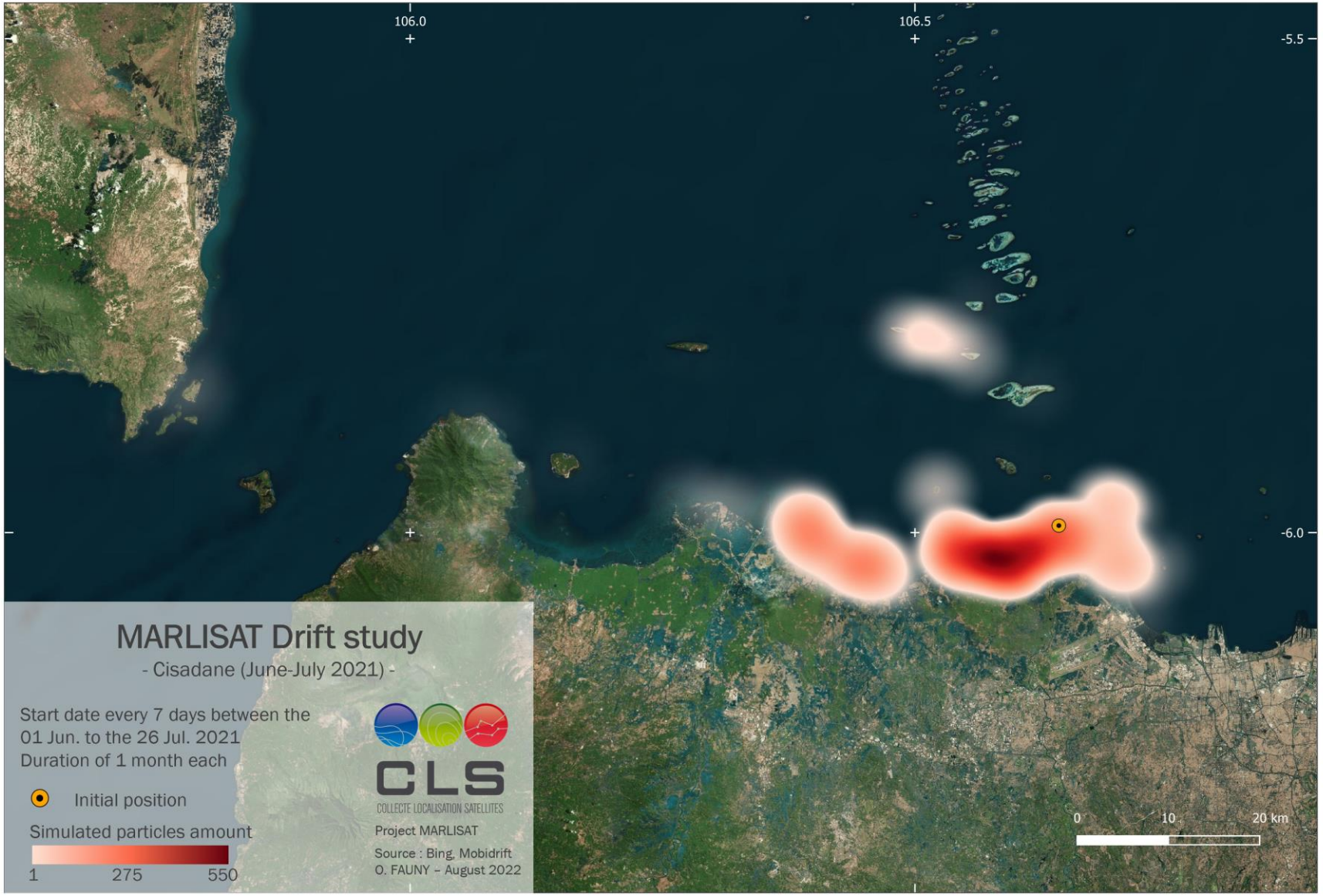

- Thank You!!!!

Contact: mlucas@groupcls.com