CleanAtlantic

Tackling marine litter in the Atlantic Area

Marine litter in local environments from mussel aquiculture activities: modelling and validation

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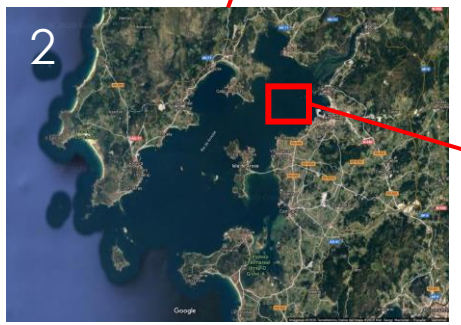
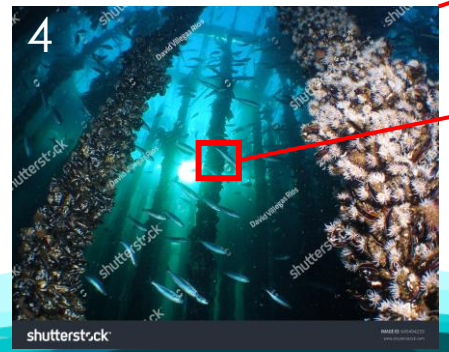
Introduction

- The initial conditions of marine litter transport models continue to be one of the big handicaps to produce accurate results. The amount and the type of marine debris emitted by the different sources are the large the main uncertainty on modelling marine litter accumulation [Critchell, 2015, 2016].
- In marine local environments under industrial activity, the sources are confined in space and time and some industrial activities introduce debris objects. This allows us to reduce the uncertainties mentioned above in the marine litter modelling problem.
- One of these activities is the mussel aquiculture. In Galicia (NW Spain) (Figs. 1 and 2), the mussel farms (Fig.3) are based in floating rafts inside the rias(estuaries), with vertical ropes submerged where the mussels are attached to grow up (Fig.4). To avoid the mussel detachment, plastic sticks called mussel pegs or stoppers with a length of 17cm and a width of 2 cm on average are used (Fig.5).
- These mussel pegs can be lost when the mussel extracting activity takes place (Fig. 6). There are estimations of lost around **3 million units per year due to this activity.**
- This marine litter activity produces a very well-defined object with well defined initial conditions in space and time inside the Rias reducing these uncertainties to perform modelling and data validation on marine litter accumulations with lagrangian models.
- Here, we will focus on the floating mussel pegs lost by mussel farm activity in Ría de Arousa, in the region of Galicia (northwest of Spain).





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Main goals

1. Analysis of the met-ocean conditions in the beaching and coastal accumulation.

We use the met-ocean operational model data from MeteoGalicia to perform Lagrangian simulations with MOHID-Lagrangian model to obtain concentrations of mussel pegs and the probability maps on surrounding areas inside the Ría de Arousa for different periods between 2018 to 2020. Also, we analyze the impact of the different met-ocean conditions in the beaching and coastal accumulation.

2. Near future: results validation with beach surveys.

We will validate the modelling results with real data obtained from clean beaches surveys inside the estuary for different periods between 2018 to 2020 with high aquiculture activity.

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Methodology – Modelling Setup

1. Analysis of the met-ocean conditions in the beaching and coastal accumulation.

1. **Hydrodinamic model:**
   - 3D Hydrodynamic MOHID (34 levels, horizontal step ~ 300 m) (Fig .1)
   - MeteoGalicia Operational Model for Ria de Arousa. http://mandeo.meteogalicia.es/thredds/catalog.html
   - Runs everyday with a 2 day of forecast prediction.
   - Wind forcing and river discharges included

2. Lagrangian model

- MOHID-Lagrangian
- Mussel pegs as floating particles (2D) with diffusion.
  - **On going work**: waves and wind drift influence
- Beaching based on real coastline
- No refloating
- Daily run (here we focus on 2018 Oct to 2019 Feb)
- Particles release covers the entire area.
  - **On going work** : Release from real working areas.
- Pilled up particles after 2 days per buffer section.

3. Postprocessing

- PostGIS Data Base
- Coastline segmentation in 500 m and 1000 mm (Fig. 3).
- Each polygon generated from segmentation - **Buffer**
- Focus on Arousa Island (yellow rectangle, 7.5 x 4.5 km^2) figure below.
  - **On going work:** the whole Ria Area

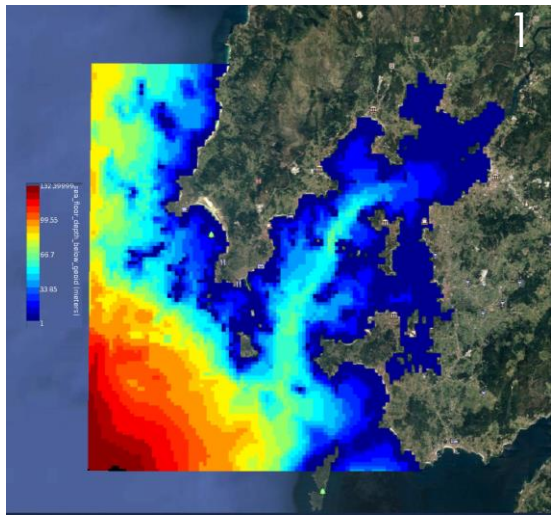

Fig. 1 Model bathymetry of Ria de Arousa

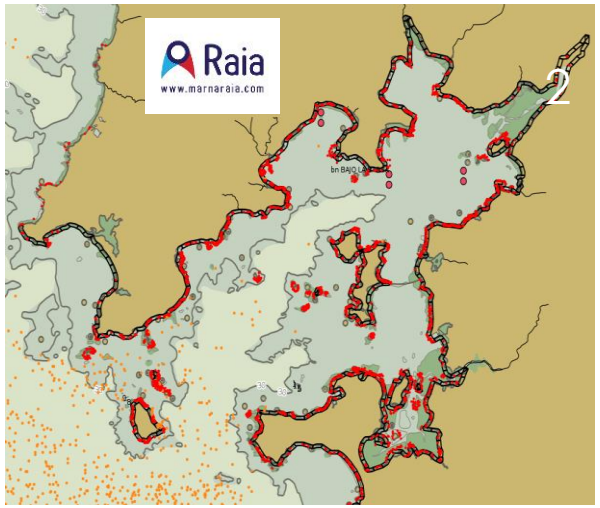

Fig 2. Example of Lagrangian particle simulation.

Fig 3. Coastline segmentation to create buffers. Yellow rectangle: focusing area.

meteogalicia

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Methodology – Marine Litter Surveys

2. Near future: results validation with beach surveys.

- **Survey 1. Citizen science: High School "IES da Illa de Arousa".**

Specific monitoring survey form was designed:

- 49 students monitoring 39 beaches weekly
- Marine litter distribution along the coastline
- Hotspot characterization (size, composition)
- **Count of mussel pegs (used as tracers)**
  - **7500 mussel pegs collected**
  - 650 monitoring survey covered
  - 600 pictures

Fig. 1 Different situations of beach litter accumulation.

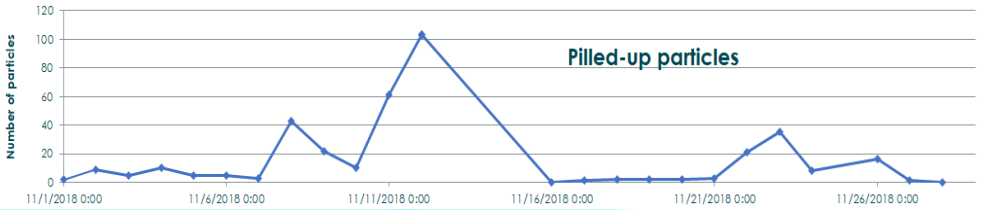
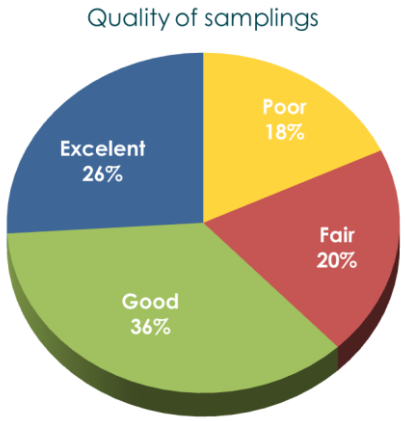


Fig. 2 Time series with the number of mussel pegs collected for the beach on Fig.1



- **Pros**
  - Very intensive sampling
  - Weekly recollection of mussel pegs
- **Cons**
  - Difficulties to explain Hotspot vs. ML items
  - We can not choose the time and day of sampling
  - Beach cleaning activities
  - Some mussel producers are collecting the pegs

- **Survey 2. 2019 - 2020 stopped by COVID19. Data is still under processing**

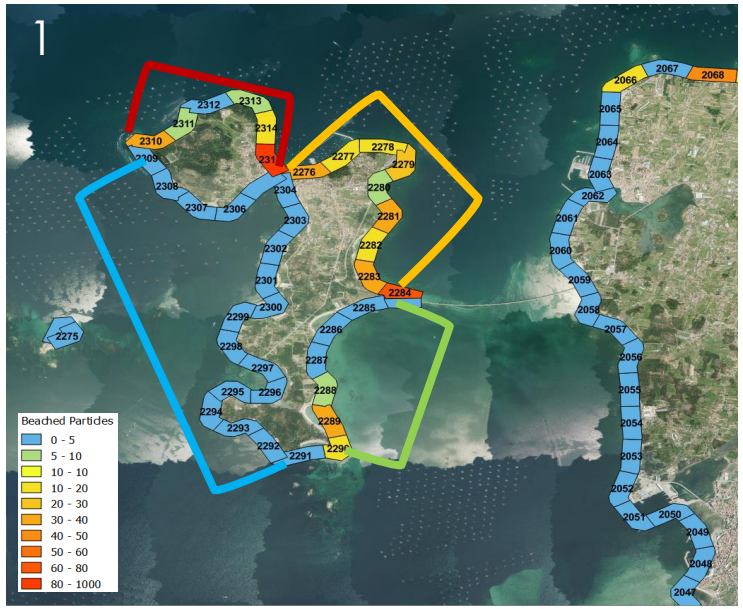
Preeliminary results – Buffer counts

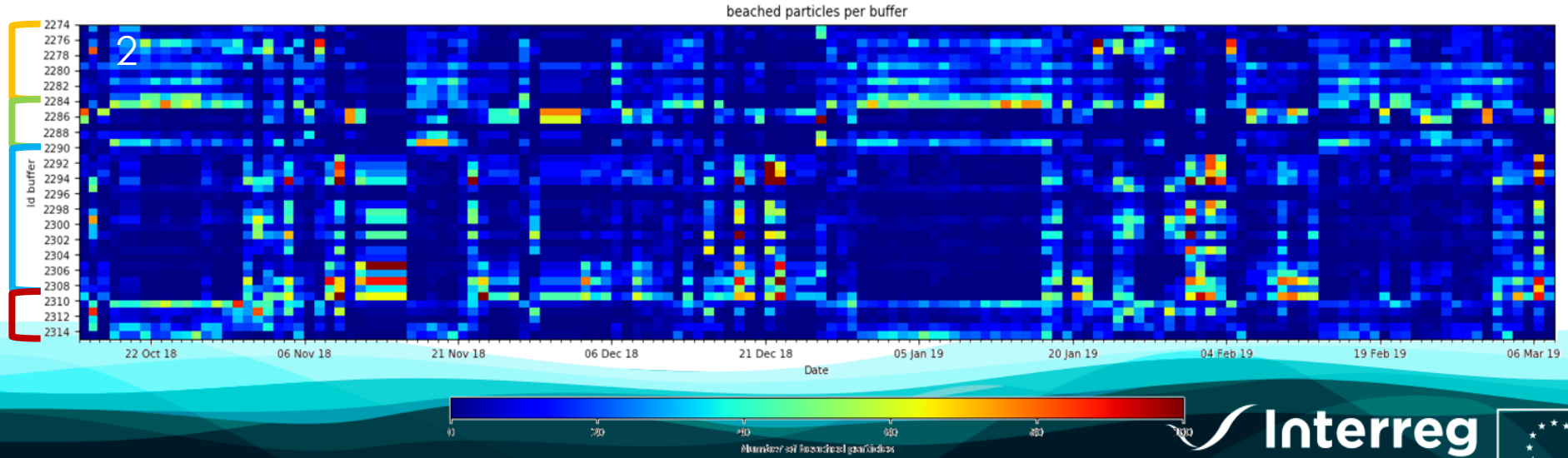
1. Analysis of the met-ocean conditions in the beaching and coastal accumulation.

- **Upper figure**. Buffers (500m) in the coastline and their classification by groups based on their orientation to the prevalent winds. The buffers colour scale corresponds to beached particles pilled up two days after emission.

- **Lower figure**: Hovmoller diagram.
  - Y-axis: Id buffer identifications as it is shown on the upper figure.
  - X-axis: time-series with the number of counts for each buffer.

- Observe the square patterns in the diagram in **the blue buffers group.**

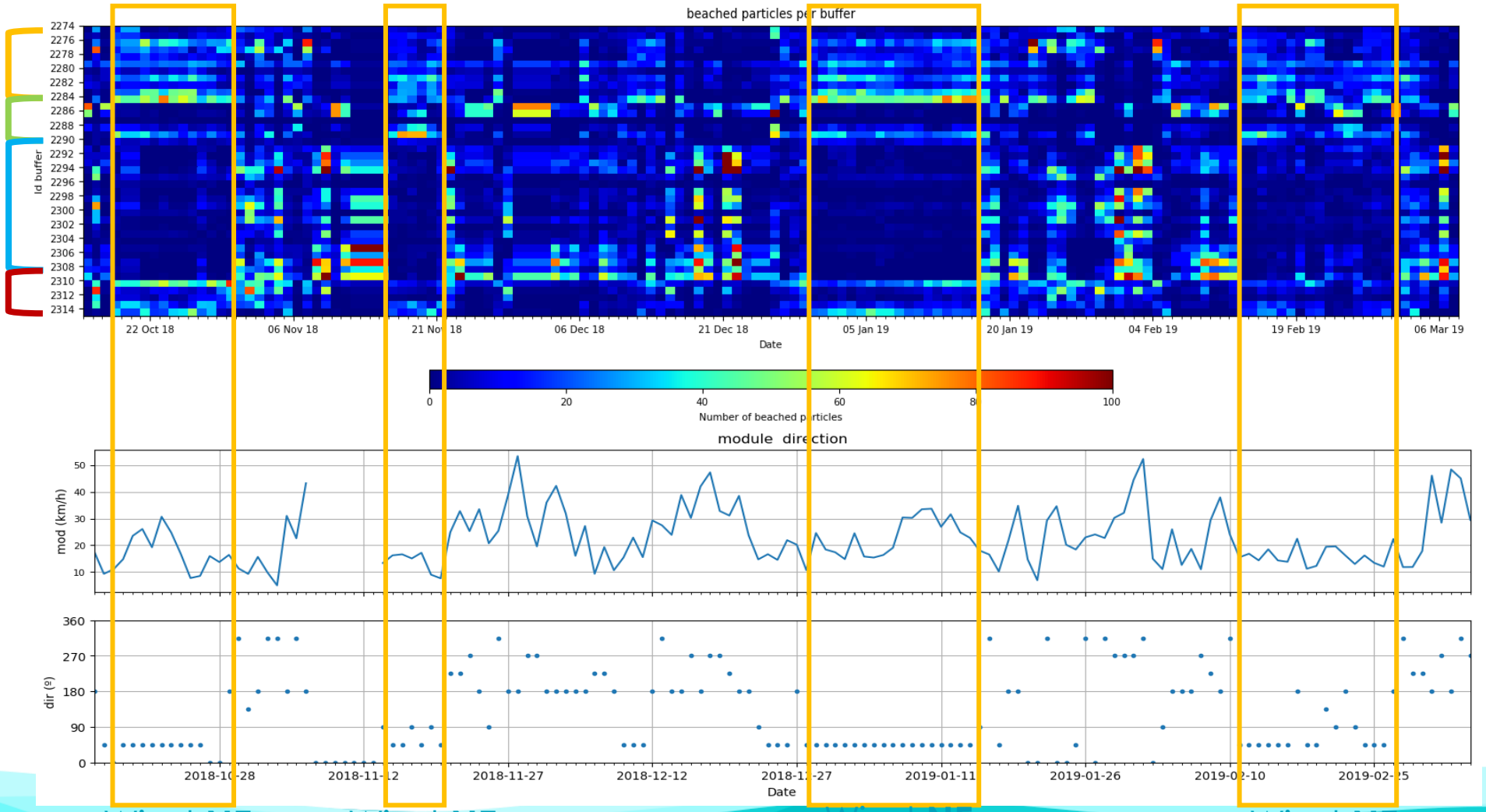




Preeliminary results – wind influence

1. Analysis of the met-ocean conditions in the beaching and coastal accumulation.

- **Upper figure**: Hovmoller diagram.
  - Y-axis: Id buffer.
  - X-axis: timeseries and number of counts for each buffer.
- **Lower figure:** Windspeed and direction (wind rose – 8 directions) from Sálvora meteorological station from Meteogalicia:
  - https://www.meteogalicia.gal/observacion/estacions/estacions.action?request_locale=es#
- The yellow rectangles remark those patterns with lower beached particles belong to NE prevailing winds situations.

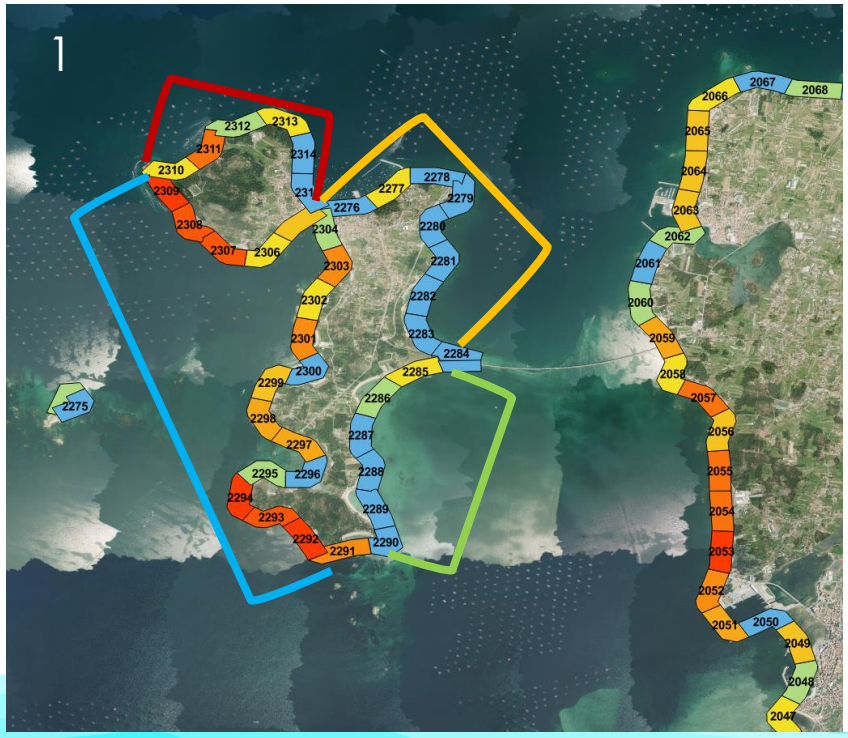


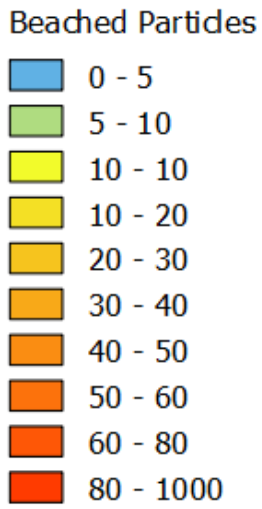
Preeliminary results – wind influence

1. Analysis of the met-ocean conditions conditions in the beaching and coastal accumulation.

- Under **south wind** conditions those buffers in **the blue group** are more exposed to this wind direction accumulate a higher number of beached particles, while those in the others side of the island show a lower number of beached particles.

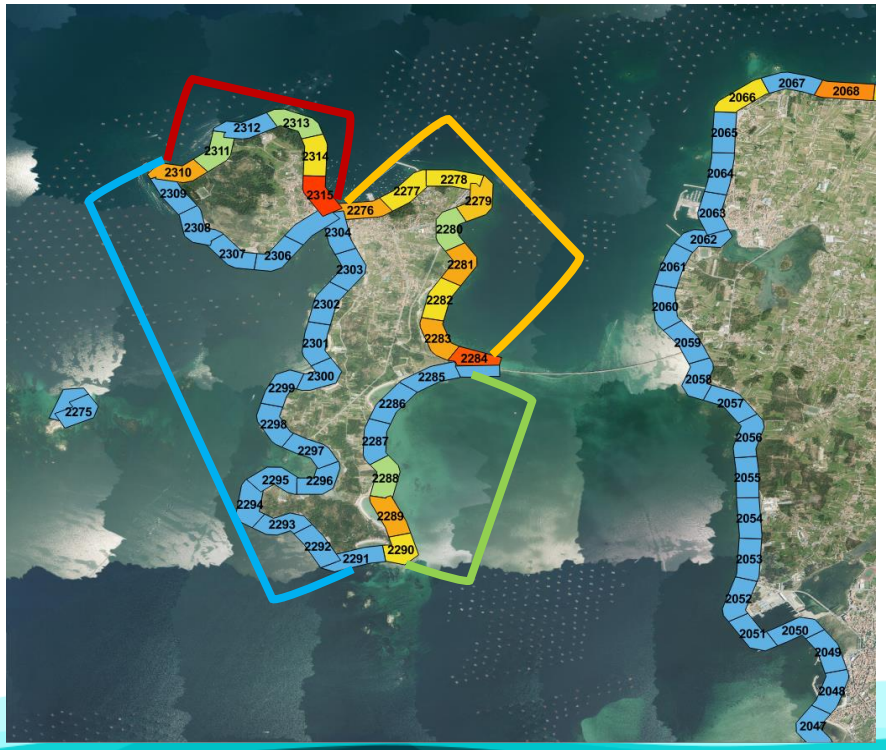
2018-11-09 Wind **S**





- Under **north-east wind** conditions those buffers in the blue group, are less exposed to the prevailing wind direction. **Red and yellow** groups accumulate a higher number of beached particles, while those in the others side of the island (**blue group**) show a lower number of beached particles.

2019-01-15 Wind **NE**



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Summary and future work

- On this short presentation we show preliminary results for the modelling and validation of marine litter in the region of Ría the Arousa (NW Spain). At this moment we are currently focusing on the analysis met-ocean conditions play on marine litter accumulation, showing the strong role of the prevalent winds.
- On the upcoming months, once the beach litter data surveys becomes available, we will use this data to validate the obtained results.
- Future work:
  - Several implementations are currently being tested:
    - Realistic release frequency
    - Spin up period for lagrangian releases.
    - Realistic lagrangian initial boxes
    - Influence of wind and waves
  - Future reviews:
    - Coastline
    - Buffers: size and position
    - Beaching probability: coastline properties

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Main references

Critchell, K., & Lambrechts, J. (2016). Modelling accumulation of marine plastics in the coastal zone; what are the dominant physical processes? *Estuarine, Coastal and Shelf Science*, *171*, 111–122. https://doi.org/10.1016/j.ecss.2016.01.036

Critchell, K., Grech, A., Schlaefer, J., Andutta, F. P., Lambrechts, J., Wolanski, E., & Hamann, M. (2015). Modelling the fate of marine debris along a complex shoreline: Lessons from the Great Barrier Reef. *Estuarine, Coastal and Shelf Science*, *167*, 414–426, https://doi.org/10.1016/j.ecss.2015.10.018

Thank you.
Questions are welcome!

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