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Transport of Microplastics in a choked coastal lagoon in South Brazil

Ítele E. dos Santos[1,4], Elisa H. L. Fernandes[1,4], Isabel Jalón-Rojas[2,5], Pablo D. da Silva[1,4], Grasiela L. L. Pinho[3,4]

[1] Laboratório de Oceanografia Costeira e Estuarina (LOCOSTE)
[2] UMR CNRS 5805 EPOC
[3] Laboratório de Microcontaminantes Orgânicos e Ecotoxicologia Aquática (CONECO)
[4] Universidade Federal do Rio Grande, , Av. Itália Km 8, 96.201-900 Rio Grande, RS, Brazil
[5] Université de Bordeaux, B18, allée Geoffroy Saint-Hilaire, CS 50023, 33615 Pessac Cedex, France

iteleed@gmail.com

Introduction

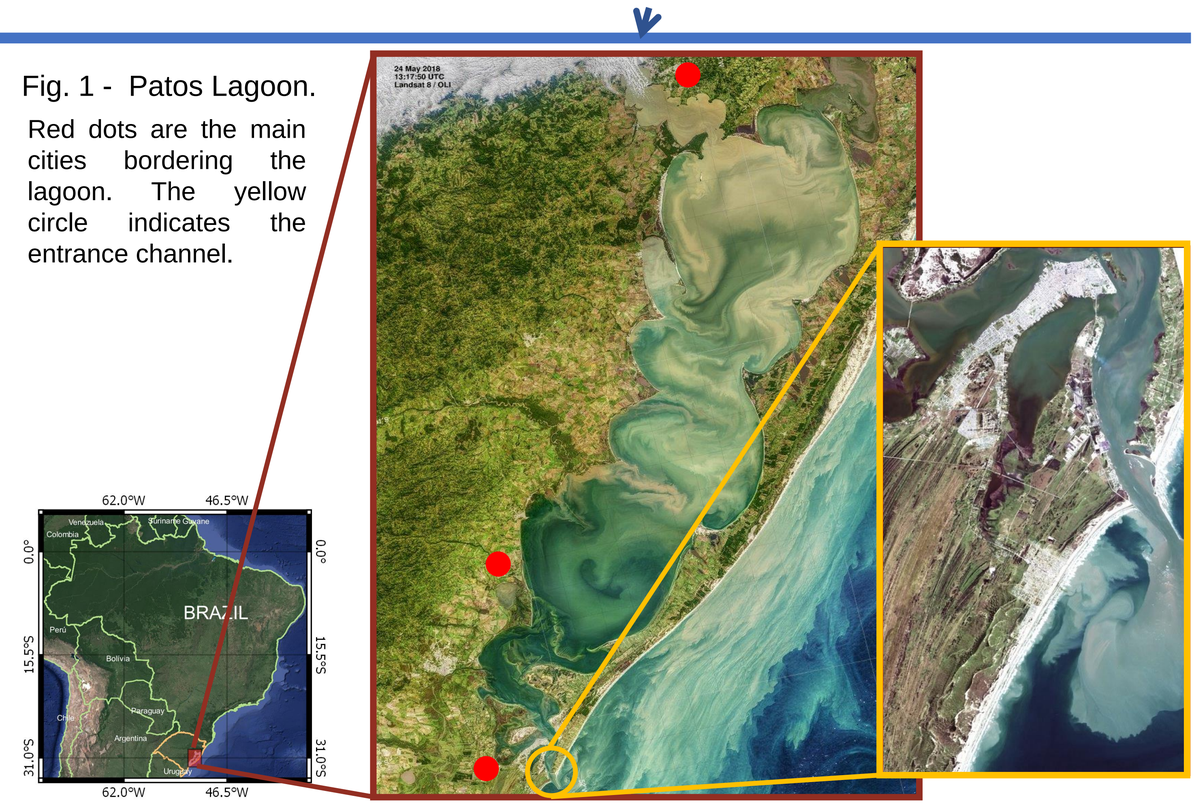
Microplastics (MPs) are known to have impacts on marine life, ecosystems, and ultimately to human life. Research studies have addressed this problem in different terrestrial and marine environments. In transitional aquatic systems, such as coastal lagoons, however, they are still understudied. These areas are of high importance as they could be serving as a buffer zone for the accumulation and redistribution of plastic particles from continental sources to the marine environment.

Here, we are studying the transport of MPs in the Patos Lagoon, ***the world's largest chocked coastal lagoon***, located in South Brazil and this poster shows the very early stages of the modelling effort to try to understand the dynamics of MPs in this environment.

Patos Lagoon has 10,360 km² and a drainage basin of 140,000 km², with big cities bordering its margins. It is connected to the South Atlantic Ocean by a long and narrow entrance channel, located in its southernmost part, a nursery ground area where port activities take place.

Fig. 1 - Patos Lagoon.

Red dots are the main cities bordering the lagoon. The yellow circle indicates the entrance channel.



Methods

The transport of MPs in Patos Lagoon will be studied based on the coupling between TELEMAC-3D hydrodynamic model results and the plastic debris transport model TrackMPD. The latest was specifically designed for modelling plastic debris, taking into consideration a wide range of physical properties and transport processes associated with these particles (Jalón-Rojas, 2019).

Simulations will be carried out for 2013, which is considered an El Niño Southern Oscillation (ENSO)-neutral year, fact of relevance since Patos Lagoon is known to be affected by ENSO cycles. This study will serve as a baseline for other future scenarios.

To keep the discretization of important features in Patos Lagoon the domain for TrackMPD had to be divided (due to computational constrains) into two regions with different resolutions: The Main Body (MB) using a mesh of 500x500 and the Estuary Region (ER) with a mesh of 1000x1000.

Scenarios of robust MPs releases and behaviors are still being developed. This poster presents a preliminary example of the TrackMPD application considering the 2D trajectory of 300 floating particles randomically placed over the MB of the Lagoon for 2013.

Preliminary Application of Track MPD in Patos Lagoon

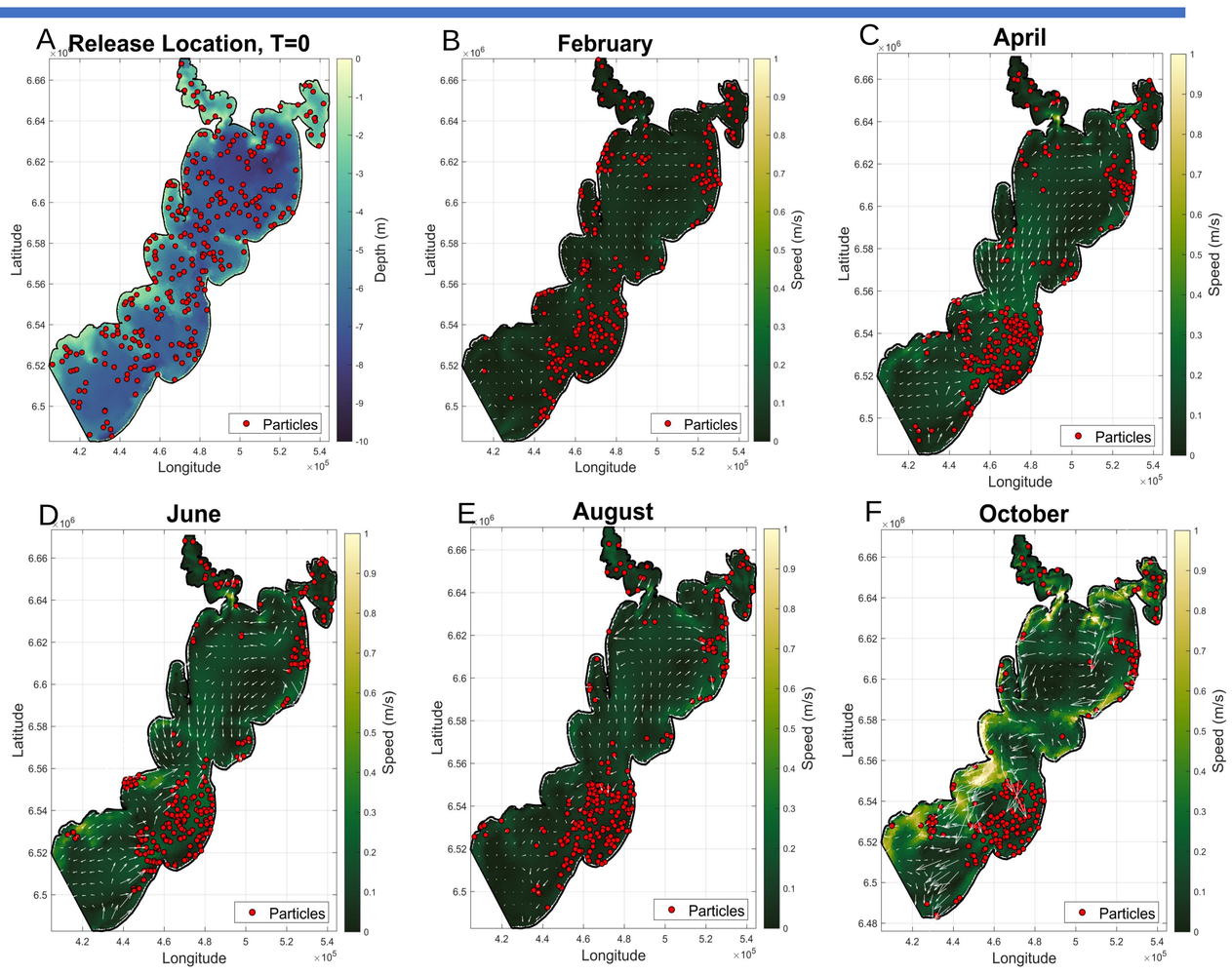
TELEMAC-3D hydrodynamic results showed that current velocities inside the lagoon presented spatial variability, with overall weaker current velocities (0.35 m.s^{-1}) in the MB of the Lagoon.

Differences were observed between the margins of Patos Lagoon due to the Lagoon's morphology and predominant wind direction, with current velocities around 0.35 m.s^{-1} on the west margin and 0.20 m.s^{-1} on the east margin.

These hydrodynamical results served as initial guides to check if these variables were having any effect on the particles placed on the MB.

The **TrackMPD** simulation showed that during the simulated period, 22% of the particles ended up being exported out of the modeled domain. The particles that stayed, were rearranged to what it seems four probable regions of higher accumulations. These regions are highlighted in the Figure 2G, which is relative to the last simulated time step.

These particle results when compared to the hydrodynamic results were correspondent to the low-speed profile of the currents inside the MB of the Lagoon, reflected by the low number of particles that left the domain during the simulated period. Also the patterns of accumulation in this scenario corresponded to specific areas of even lower current speeds and recirculation cells.



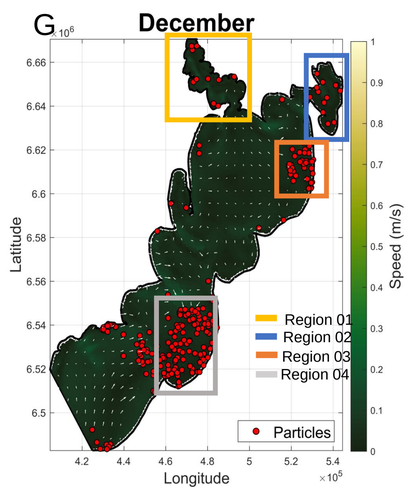


Fig 2 – A) Distribution of the particles released in the MB of the Lagoon and associated bathymetry. B-G) Temporal evolution of the transport of these particles during the simulated year associated with current velocities and directions of currents in the MB. Each image is referent to the last day of the respective month. Colored squares are possible accumulating zones.

To watch the animation of the simulated period access the video using the QR-code or the link below:

https://youtu.be/fe-2dK1OseI

Conclusions

Although there is still a range of variables and different hydrodynamic scenarios to be considered for realistic MPs simulations in Patos Lagoon, this preliminary scenario serves to show a preliminary application of the TrackMPD model in the region.

The accordance between areas of low current speed and accumulation showed by the two models gives the indication that TrackMPD is working as it should when applied to a complex coastal environment.

The objective forward is to make better and more realistic simulations that will serve as the first step towards the management of MPs in Patos Lagoon, helping researchers and policy makers to better address this problem.

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