The Fate of Man-made Radionuclides in a Semi-Enclosed Basin

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Introduction

In a global scale, water reservoirs are used to dump material from power plants and industries, where the biggest impact occur in areas with low circulation and water exchange with open ocean. In the context of nuclear power plants, 96% are installed closest to water bodies, using this waters in the cooling system. In Brazil, there is two nuclear power plants in operation, located in the Almirante Alvaro Alberto Central Nuclear (AAACN), that captures and discharge water in the Ilha Grande Bay (Figure 1), region with great touristic and social ambiental importance.

Understand the circulation patterns in this region is important to avaliate how the nuclear material will disperse supporting the stakeholders, in the case of a nuclear leakage, such as occurred in Fukushima, in 2011.

This study aims to investigate how wind and tide force the dispersion of these radioactive material in the estuary system and where they will affect with greater impact.

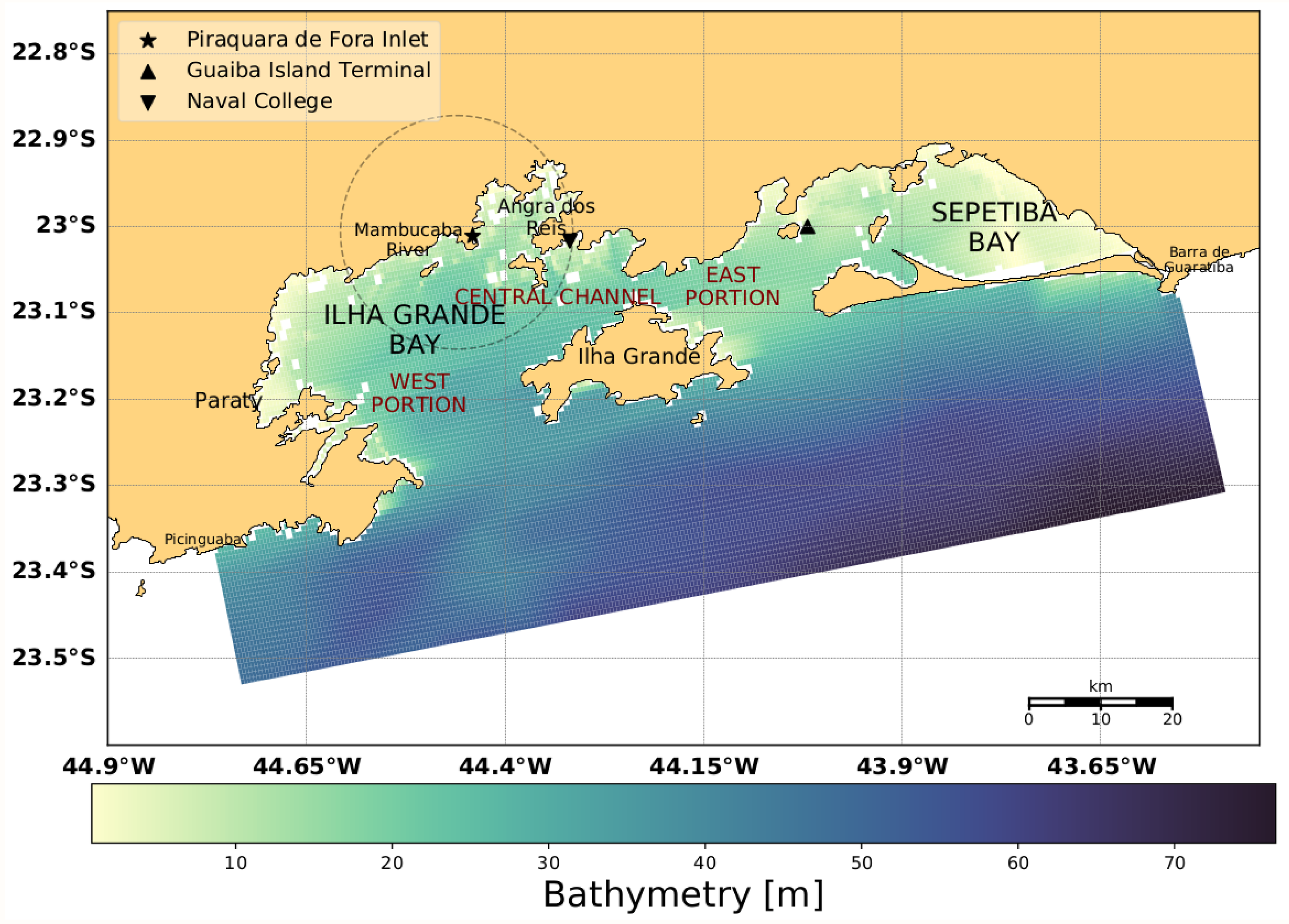

Figura 1 : The Ilha Grande and Sepetiba Bay domain used for ECOM model runs, showing bathymetry in meters. Several sites that are discussed in the paper are shown.

Methods

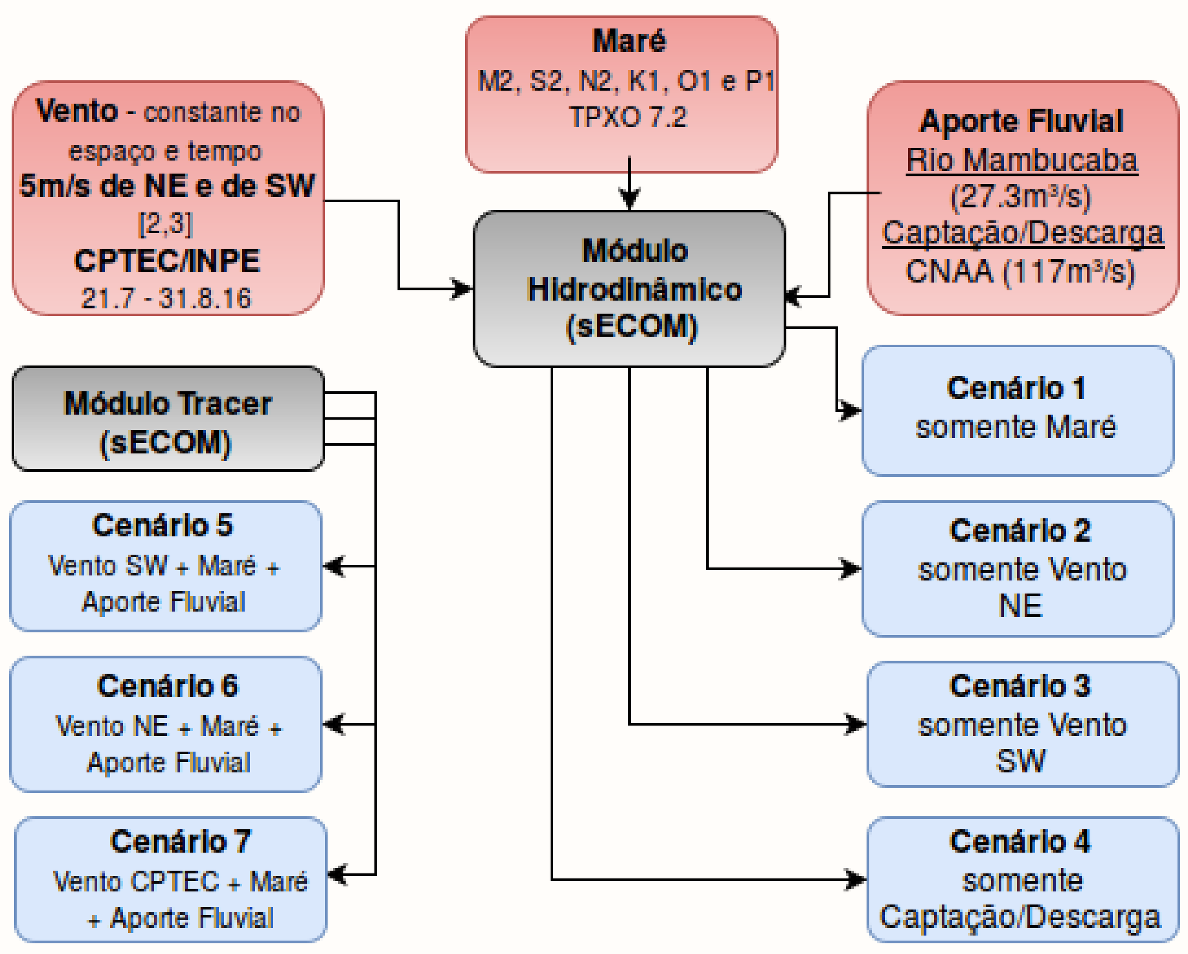

Figura 2 : Scheme of the method applied in this work, where the read boxes represent input data, black boxes the modules from ECOM and the blue boxes represent the experiments performed in this work.

Results and Discussions

Wind v. Tide: Surface Circulation

Was observed an intense eastward current in central channel in the Experiment I, with northeasterly winds, associated to South America Subtropical High, reaching velocities closest to 0.25 $m.s^{-1}$, while in the Experiment II, with winds associated to Frontal Systems passage, such current reach a maximum of 0.23 $m.s^{-1}$, with a westward direction. The difference between those two experiments, considering the same wind's intensity, may be cause by the open area available for southwesterly wind. Finally, in the Experimet III, only with tides from TPXO 7.2, present the highest velocities, concentrated in the eastern region of modelled domain, with maximum of 0.6 $m.s^{-1}$ during flood spring tide.

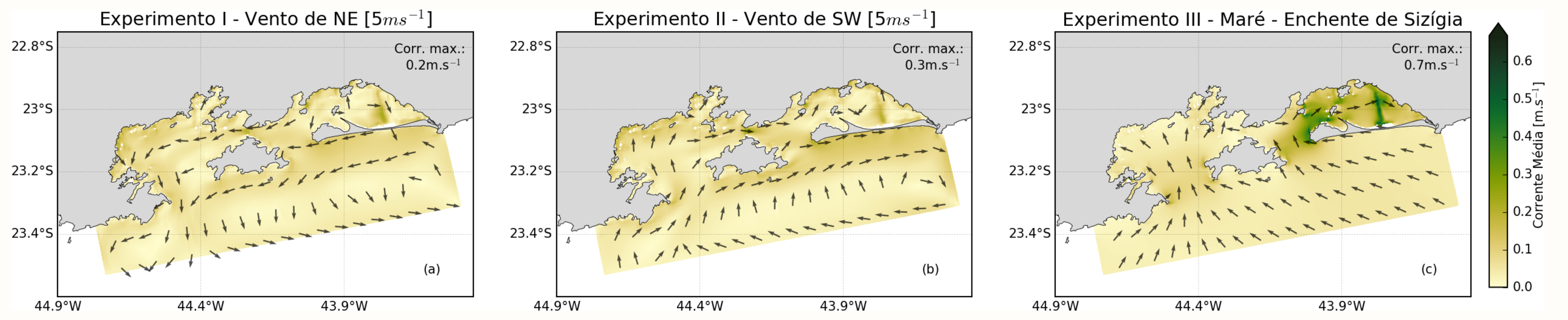

Figura 3 : Corrente média nos cenários 1,2 e 3. Os painéis (a) e (b) representam o último instante modelado e (c), o instante da segunda maré enchente de sizígia do período modelado.

In Experiments V and VI, all variables are used (tide, wind and fluvial discharge), with variable winds based on typical values, like in the Experiments I and II, respectively. In these scenarios, we identify that southwesterly winds induce the strongest surface currents, with mean values of 0.43 $m.s^{-1}$ (Figure 4.a and 4.b). Despite the influence of the tide in more intense currents, the surface current direction will be controlled by the direction of the wind (Figure 4.c and 4.d), consequenty, controlling the direction of the radioactive material direction. The tide, in this case, will be the main mechanism acting on advection of radioactive material.

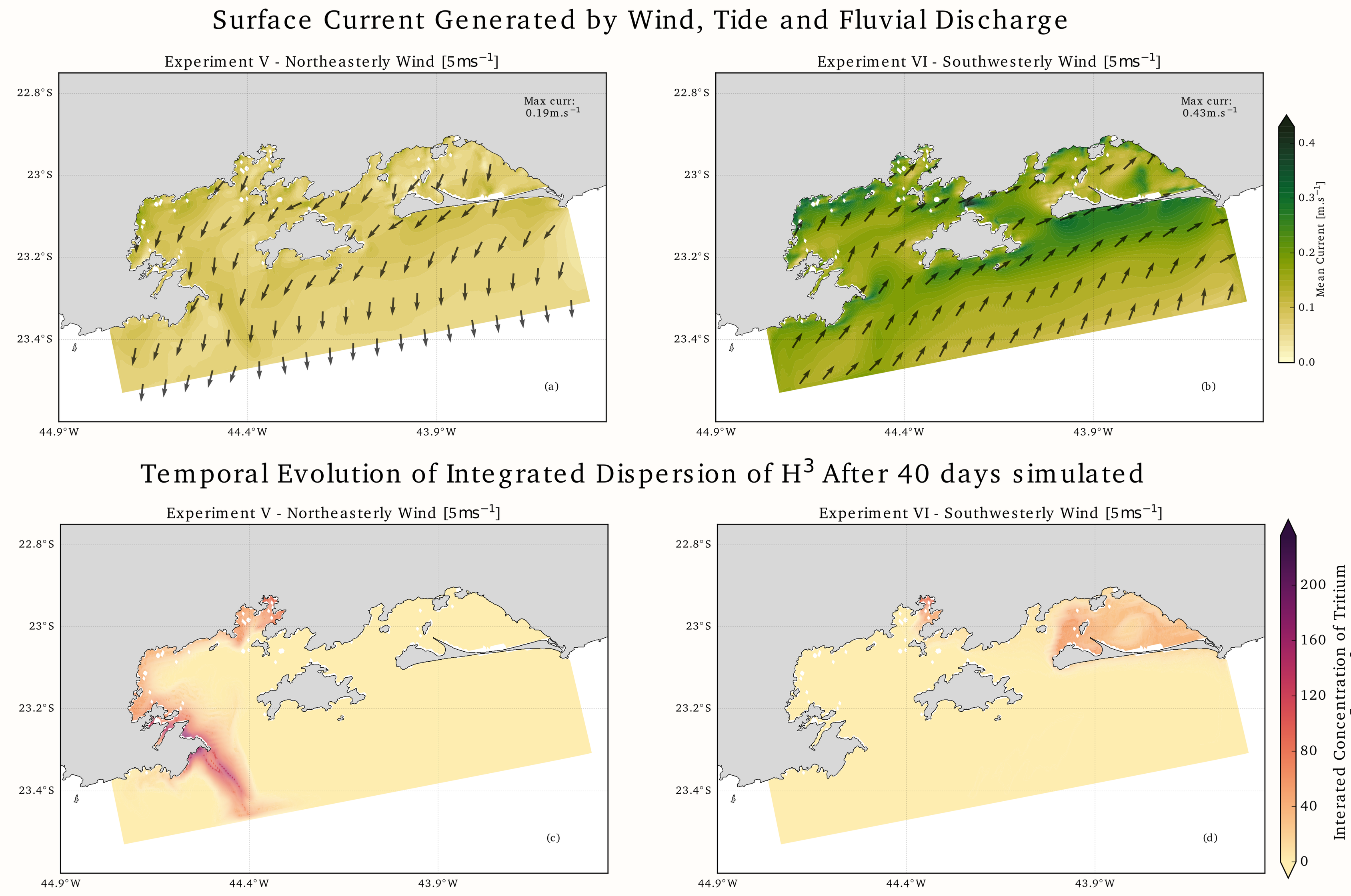

Figura 4 : Mean surface current on the upper panels and integrated dispersion on the inferior panels.

Dispersion in a Scenario Under Nearest to Real Conditions

In condition closest to real, we identify that the radioactive material will evolve to the east, reaching areas with more intense currents and, consequently, with greater mixing of the pollutant. Locally, the material will stay in the northwest of Angra dos Reis, region where [3] identified the higher concentrations in the surface sediment, corroborating with the informations obtained through the hydrodynamics modelling.

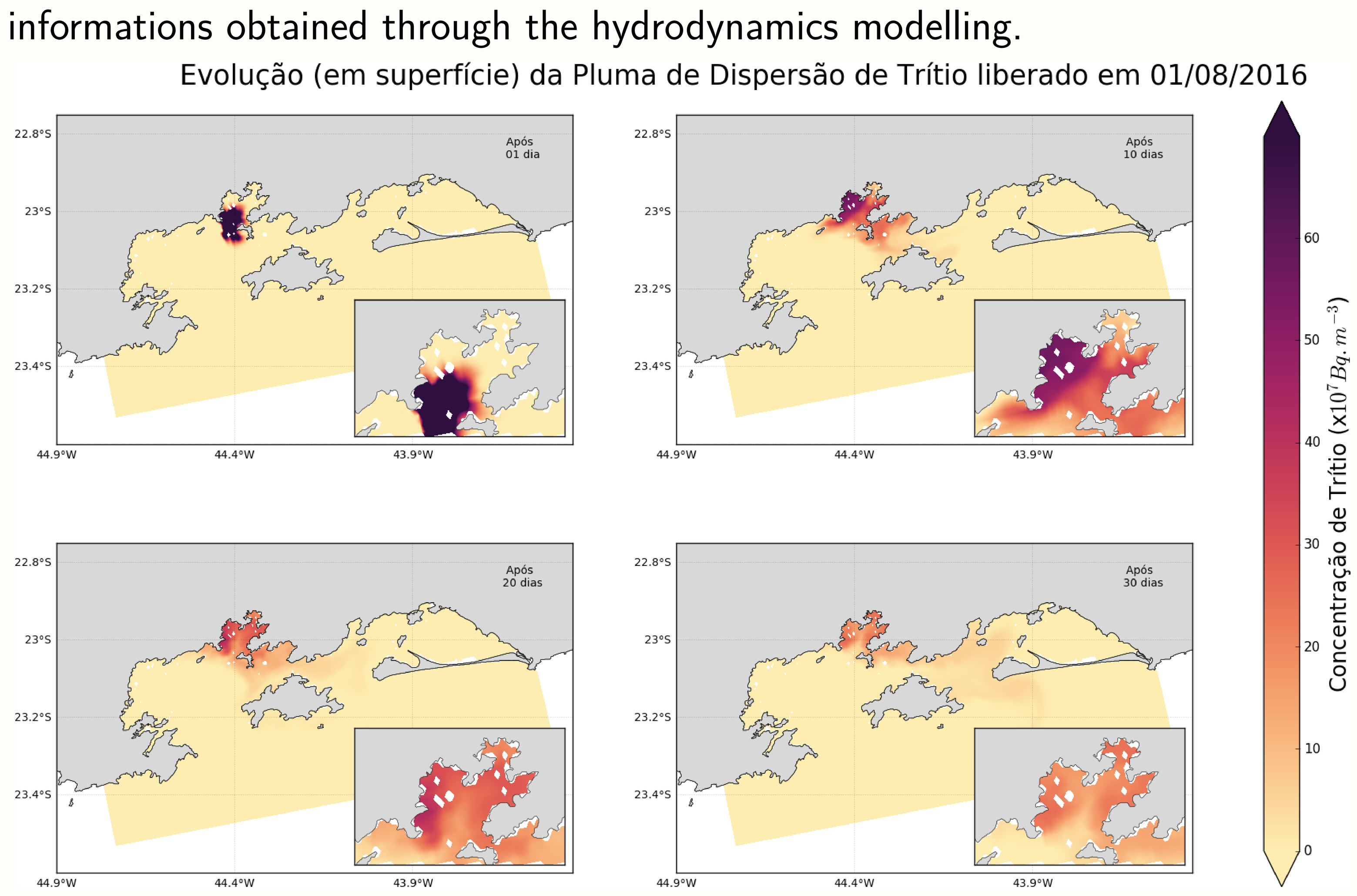

Figura 5 : Temporal evolution of the radioactive material under spatial and temporal wind variations.

Conclusions

- Wind control direction;
- Tide control the mixing;
- In closest to real condition, the plume evolves to regions with more intense currents and
- The most impacted region is Angra dos Reis, followed by Central Channel and Mambucada River and, finally, the East Portion is the main area of mixing.

Referências

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