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Variability of river plume in the Gulf of Tonkin

Duy Tung Nguyen[1,2], Nadia Ayoub[1], Patrick Marsaleix[1], Florence Toublanc[1], Pierre De Mey-Fremaux[1], and Thanh Ngo Duc[2]

[1]LEGOS/University of Toulouse, CNES, CNRS, IRD, UPS, France

[2]Department of Space and Aeronautics, University of Science and Technology of Hanoi (USTH), Vietnam

The quality of estuarine, coastal and marine environment in the Gulf of Tonkin, in the South China Sea, is an essential issue to the ecosystems' health and to the living conditions and economy of the Viet Nam population. The stakes are particularly high since the demographic density in the Red River delta is one of the highest in the world. Understanding the physical processes that drive the ocean circulation and its response to anthropic pressure there is therefore of primarily importance for enlightened resource management, as well as for designing adequate monitoring and forecasting systems.

As a first step toward a better understanding of the physical coastal and marine environment, we present here a study on the Red river plume variability in the Gulf of Tonkin over the period 2011-2016. The study is based on a numerical simulation, under realistic conditions, using the SYMPHONIE coastal model developed at LEGOS (Marsaleix et al., 2008). Compared with various data sources, the model results show good performances. The river plume is then identified and examined at different time scales. In general, the surface coverage of the river plume is strongly correlated with the runoff but with a 1-month lag. However, in some years, a higher peak in runoff does not create a higher peak of the plume area, suggesting that other forcings need to be taken into account to explain the variability of the river plume.

Using K-mean clustering, the main patterns of the plume are identified. The result shows that the plume has a large variability at both seasonal and interannual scales. Each pattern shows the plume under different forcing conditions. Most of the time, the plume is narrow and sticks along the coast due to the downcoast current and northeasterly wind. In the summer, due to monsoon, the wind direction changes to southwesterly and helps the plume to spread offshore. The plume reaches its highest coverage in September after the peak of runoff; then its coverage decreases again when the monsoon reverses.

We also analyze events of offshore export of freshwater at daily time scales and show that they can be associated with recurrent coastal eddies during the summer monsoon. We investigate the respective role of wind and runoff in the eddies formation. Comparison with a run without river allows to identify the main impacts of the plume on the ocean states, for example in the current and sea surface elevation.