River freshwater fluxes and mesoscale dynamics in the South East Asia region

Christophe Maes[1], Delphine Dobler[1],
Tonia Capuano[2], Marine Herrmann[2], and Ariane Koch-Larrouy[2]

(1) Laboratoire d'Océanographie Physique et Spatiale, www.umr-lops.fr
(2) Laboratoire d'Etudes en Géophysique et Océanographie Spatiales (LEGOS)

Air-sea freshwater fluxes affect the ocean salinity and the resulting upper layers stratification that critically contributes to the density-driven global ocean circulation and to the climate variability. Regionally, river runoffs or plumes play also a key role for the local stratification, by interacting with the local ocean dynamics and eddies at meso- and submeso-scales. Recently, the impact of such river discharges has been revived by considering their crucial role on the dispersion of oceanic plastic debris that originates from land sources. Dynamics of the floating materials entering the oceans is rather complex and it remains important to understand the impact of the river freshwater fluxes on their dispersion. The aim of this study is to investigate such a role in the South East Asia region by analyzing the net effect of cutting off the river freshwater fluxes on the dynamics reproduced by different eddy resolving ocean general circulation models. Several river discharge products will be considered from classical climatology to time series issued from climatic data centers. If a strong impact on the sea surface salinity field is expected, emphasis will be set on the induced effect on the eddy features and variability, as well as on the consequences for lateral stirring and Lagrangian dispersion occurring at the ocean surface. Applications for the marine litter dispersion resulting from the river discharges in Indonesia will be presented and discussed.

⊙ CONTEXT & OCEAN MODEL

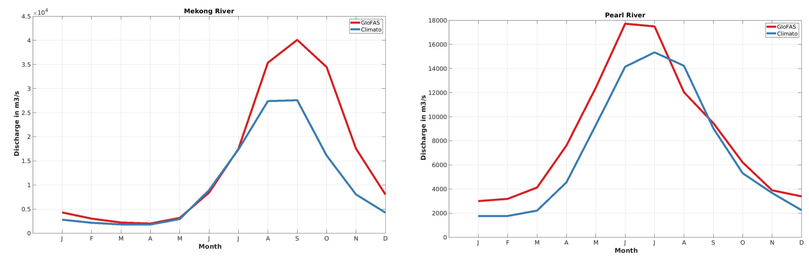
The original project aims, first, at strengthening Indonesian institutions awareness and knowledge about marine pollution by plastics, under the auspices of AFD and IRD.

Secondly, the project aims to implement appropriate prevention and recommendation, through support to the monitoring and modelling of marine debris.

Based on the holistic approach by combining sources (21 major rivers of Indonesia), dispersion through ocean currents and Lagrangian analysis, Dobler *et al.* (2021) establish an atlas of floating and stranded particles (marine debris) along the coasts of Indonesia and regional countries.

Next step is to consider and develop a model configuration that will allow to test the physics of dispersion.

Full Atlas by Dobler *et al.* (2021) available here : https://www.researchgate.net/profile/Christophe-Maes

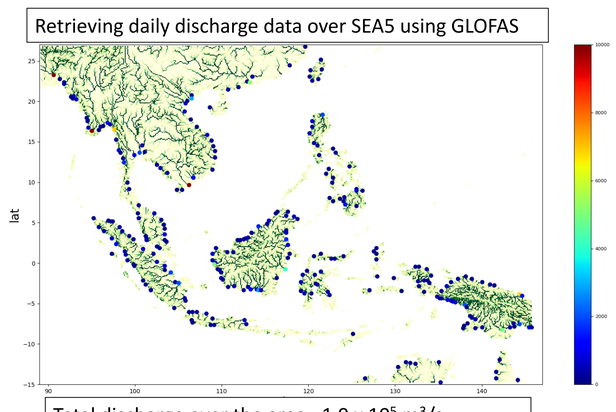


- Regional configuration, SEA5:

3D ocean circulation SYMPHONIE model
5 km, 60 vertical levels, 1197 x 902 points
Period of simulation : 2009-2018
Lateral forcing : COPERNICUS daily 1/12°
Atmosphere forcing : ECMWF hourly 1/8°
Rivers forcing : GLOFAS 5 days (~300 rivers)
Tidal forcing : FES2014, 9 components

Efforts have been put on the comparison between the river discharges provided by GLOFAS (Harrigan *et al.* 2020) and usual climatology (Dai&Trenberth, see figures above), and the retrieval of river mouths in the SEA5 domain (right figure)

Retrieving daily discharge data over SEA5 using GLOFAS

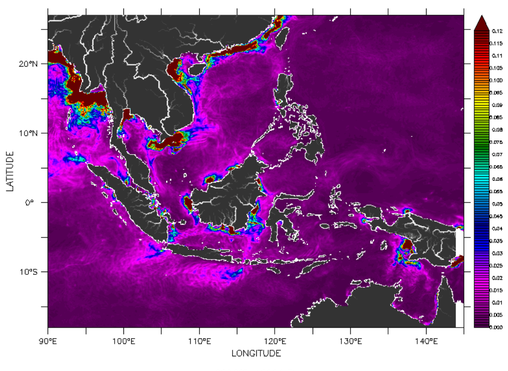


Total discharge over the area : 1.9 x 10^5 m^3/s
→ 308 rivers in our configuration

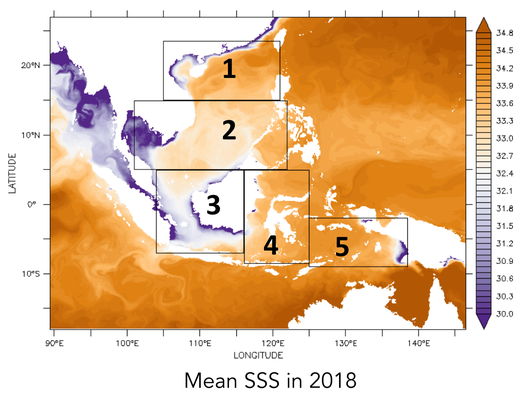
⊙⊙ THE SSS SIGNAL AND THE IMPACT OF RIVER DISCHARGES

Mean state and RMS in SSS exhibits, as expected, strong changes in the region, meaning that a solid validation procedure is required.

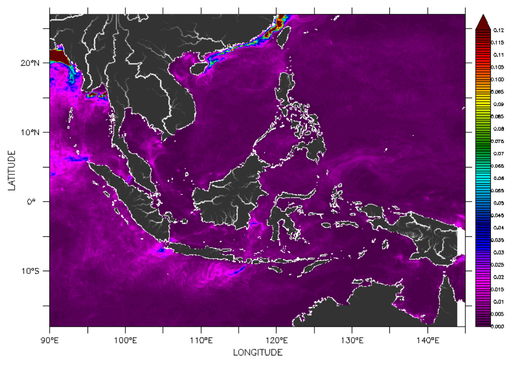
Validation of the seasonal variations of SSS for 2018 across the region considers another ocean model with assimilation (Hycom, gofs31), a satellite product (SMAP, JPLv5) and a combination of in situ and satellite products (OI-SSS, apdrc). The annual mean for each product is removed.



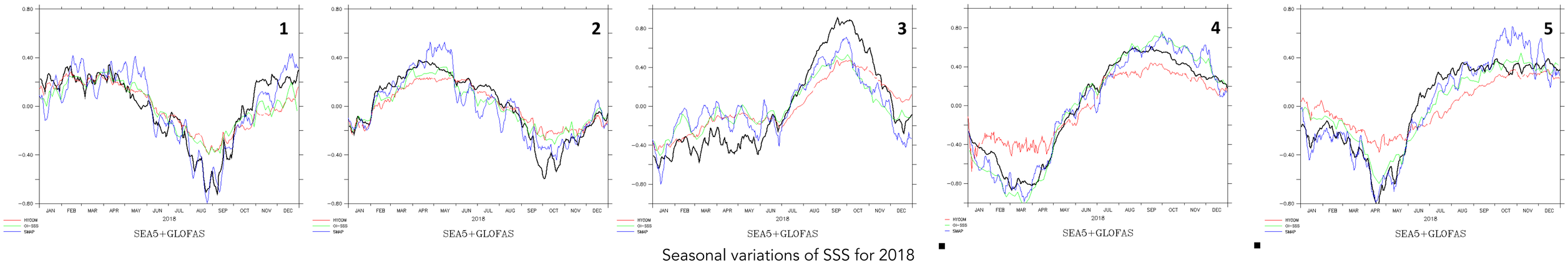
RMS SEA5



Mean SSS in 2018



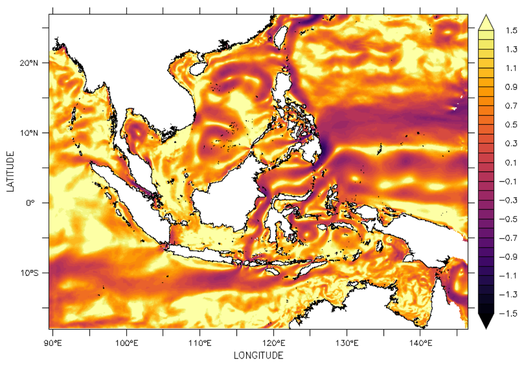
RMS SEA5 noRivers



Seasonal variations of SSS for 2018

Impact of the river discharges is then evaluated in terms of ocean dynamics, as represented in the ratio between EKE and MKE (following the methodology by Sudre *et al.* 2013).

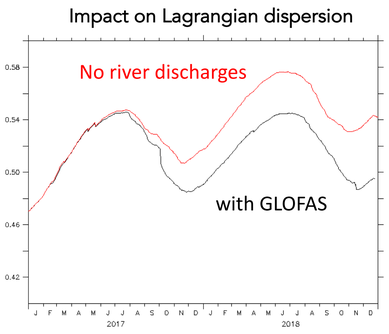
Such diagnostic confirms that the most important effect on mesoscale dynamics is experienced across the South China Sea (see figures aside)



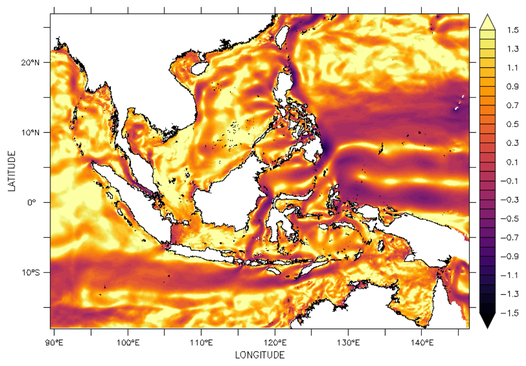
LOG(RATIO)

<= with full river discharges VS. no river discharges =>
RATIO = (EKE / MKE)

Impact on Lagrangian dispersion



Timeseries of particle concentration per grid cell in the SEA5 domain



LOG(RATIO)

<= Consideration of the river discharges on the modelled ocean dynamics also impacts the Lagrangian dispersion at sea and the stranding along the coasts (following the Atlas approach by Dobler *et al.*, 2021); preliminary results show that more particles are still detected at sea, reducing the stranding along coastlines.

⊙⊙⊙ SOME PERSPECTIVES

⇒ Evaluate the precise role of eddies and small-scale dynamics on the dispersion of floating particles and ocean surface circulation,

⇒ Confront this role as compared to the ones of other physical processes such as Stokes drift and/or windage,

⇒ Address the problem with plastic wastes in the South-East Asian region.

Contact: Christophe.Maes@ird.fr

REFERENCES

Dobler D., Martinez E., Rahmania R., Gautama B.G., Farhan A.R., Maes C. 2021. Floating marine debris along Indonesian coasts. An atlas of strandings based on Lagrangian modelling. "Monitoring and modelling the circulation of marine debris in Indonesia" project funded by AFD. Jakarta: IRD, 92 p.

Harrigan, S.; Zsoter, E.; Alfieri, L.; Prudhomme, C.; Salamon, P.; Wetterhall, F.; Barnard, C.; Cloke, H.; Pappenberger, F., GloFAS-ERA5 operational global river discharge reanalysis 1979-present. Earth Syst. Sci. Data 2020, 12, 2043–2060

Sudre, J., C. Maes, and V. Garcon, 2013. On the global estimates of geostrophic and Ekman surface currents, LOFE, 3, 1–20, doi:10.1215/21573689-2071927.