

# **“Investigation of multi-scale ocean circulation dynamics & variability based on satellite altimetry & modeling simulations”**

**Bo Qiu & Shuiming Chen, Univeristy of Hawaii at Manoa**

## **Project Summary**

By participating in the 2017-2020 OSTST, we have in the past 4 years explored and clarified the nature and causes of the multi-scale upper ocean circulation variability in the following 3 research areas.

**(1) Kuroshio Extension (KE) variability and its role in controlling the dedacal variability of the North Pacific climate system.** Specifically, we identified a delayed negative feedback mechanism that links the KE variability to the basin-scale atmospheric stormtrack changes with a preferred 10-year timescale. We quantified the relative importance of the atmospheric forcing versus the intrinsic oceanic forcing in controlling the decadal KE variability. The results are published in Qiu et al. (2017, 2020).

**(2) Characterization of interannually-modulating mesoscale eddies in the global oceans.** For the South Pacific, we clarified dynamic causes for, and biological impact by, the mesoscale eddy modulations along the subtropical countercurrent bands (Travis and Qiu 2017, 2020). Dynamic causes for the interannual eddy variability in the subtropical South Indian Ocean were also identified (Delman et al. 2018). For the global ocean, we combined altimeter and surface drifter data and quantified mesoscale eddy's roles in upper ocean biological activities and its impact upon the smaller-scale kinetic energy field (Zhang et al. 2019, Zhang and Qiu 2020).

**(3) Exploration of fine-scale SSH signals.** We evaluated dynamic transition scales in the world ocean from balanced geostrophic motions to unbalanced internal tide/internal wave motions based on the ADCP measurements and high-resolution MITgcm simulation (Qiu et al. 2017, 2018). We explored the possibility of reconstructing the 3D upper ocean structures, including vertical velocity fields, based on high-resolution SSH measurements (Qiu et al. 2020).

## **Refereed Publications Supported by 2017–2020 OSTST:**

- Qiu, B., S. Chen, and N. Schneider, 2017:** Dynamical links between the decadal variability of the Oyashio and Kuroshio Extensions. *J. Climate*, 30, 9591-9605.
- Qiu, B., T. Nakano, S. Chen, and P. Klein, 2017:** Submesoscale transition from geostrophic flows to internal waves in the northwestern Pacific upper ocean. *Nature Commun.*, 8, 14055, doi:10.1038/ncomms14055.
- Minobe, S., M. Terada, B. Qiu, and N. Schneider, 2017:** Western boundary sea level: A theory, rule of thumb, and application to climate models. *J. Phys. Oceanogr.*, 47, 957-977.
- Travis, S., and B. Qiu, 2017:** Decadal variability in the South Pacific Subtropical Countercurrent and regional mesoscale eddy variability. *J. Phys. Oceanogr.*, 47, 499-512.
- Qiu, B., S. Chen, P. Klein, J. Wang, H. Torres, L.-L. Fu and D. Menemenlis, 2018:** Seasonality in transition scale from balanced to unbalanced motions in the world ocean. *J. Phys. Oceanogr.*, 48, 591-605.
- Delman, A.S., T. Lee, and B. Qiu, 2018:** Interannual to multidecadal forcing of mesoscale eddy kinetic energy in the subtropical southern Indian Ocean. *J. Geophys. Res.*, 123, <http://doi.org/10.1029/2018JC013945>.
- Qiu, B., S. Chen, B. Powell, P.L. Colin, D.L. Rudnick, and M.C. Schonau, 2019:** Nonlinear short-term upper ocean circulation variability in the tropical western Pacific. *Oceanography*, 32(4), 22-31.
- Zhang, Z., B. Qiu, P. Klein, and S. Travis, 2019:** The influence of geostrophic strain on oceanic ageostrophic motion and surface chlorophyll. *Nature Commun.*, 10, 2838 doi:10.1038/s41467-019-10883-w.
- Klein, P., G. Lapeyre, L. Siegelman, B. Qiu, L.-L. Fu, H. Torres, Z. Su, D. Menemenlis, and S. Le Gentil, 2019:** Ocean-scale interactions from space. *Earth Space Sci.*, 6, 795-817.
- Qiu, B., S. Chen, P. Klein, H. Torres, J. Wang, L.-L. Fu, & D. Menemenlis, 2020:** Reconstructing upper ocean vertical velocity field from sea surface height in the presence of unbalanced motion. *J. Phys. Oceanogr.*, 50, 55-79.
- Travis, S., and B. Qiu, 2020:** Seasonal reversal of the near-surface chlorophyll response to the presence of mesoscale eddies in the South Pacific Subtropical Countercurrent. *J. Geophys. Res.*, 125, e2019JC015752.
- Zhang, Z., and B. Qiu, 2020:** Surface chlorophyll enhancement in mesoscale eddies by submesoscale spiral bands. *Geophys. Res. Lett.*, 47, e2020GL088820. <https://doi.org/10.1029/2020GL088820>.
- Qiu, B., S. Chen, N. Schneider, E. Oka, and S. Sugimoto, 2020:** On reset of the wind-forced decadal Kuroshio Extension variability in late 2017. *J. Climate*, accepted.