Seasonal Variation of the Kuroshio Intrusion into the South China Sea from Satellite Geostrophic Streamlines

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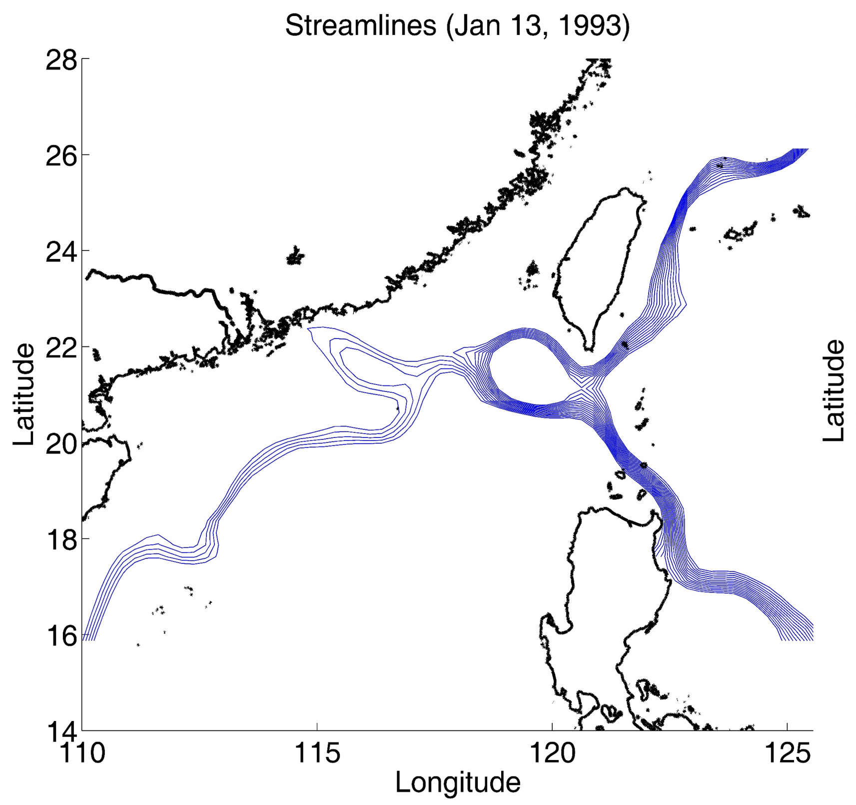
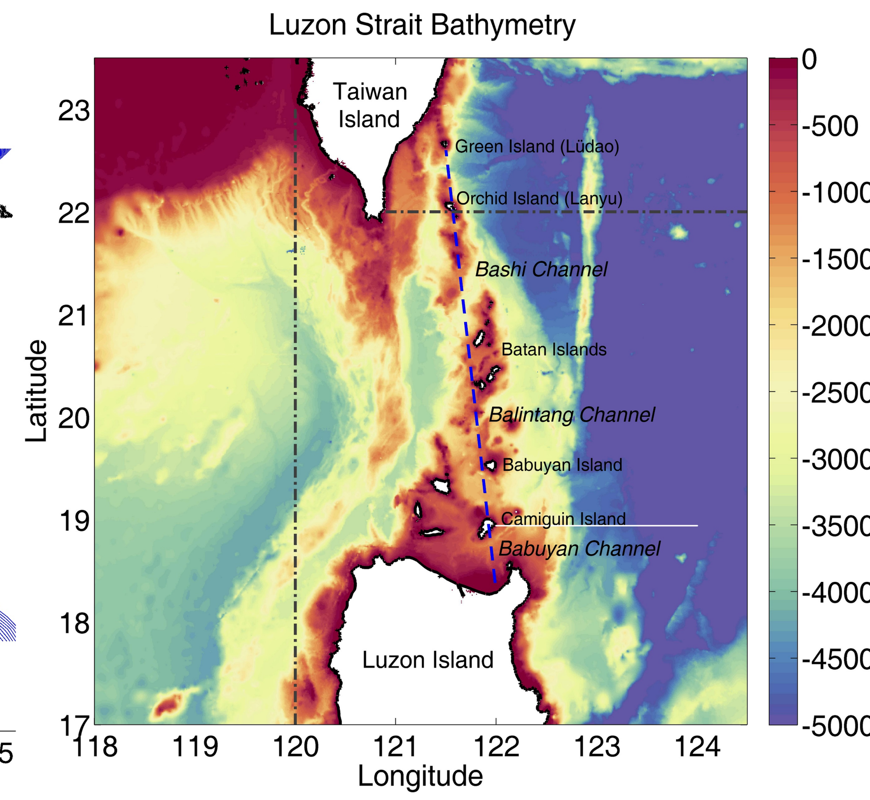
1. Background and Problem

The Kuroshio intrusion into the South China Sea through Luzon Strait has a strong seasonal cycle with more intrusion in winter and less in summer. The intrusion mechanism is mostly attributed to the seasonality of current inertia and/or Ekman transport, which are mainly derived from lab or numerical experiments, owing to the lack of long term *in-situ* measurements. Currently only satellite data can provide such an eligible tool to evaluate the variability of surface, albeit only geostrophic, transports of Kuroshio intrusion at various time scales. **The geostrophic current accounts for the major component of Kuroshio and is independent of the effects of direct Ekman transport and nonlinear dynamics. However, its seasonality of intrusion and other characteristics cannot be explained by previous theories.**



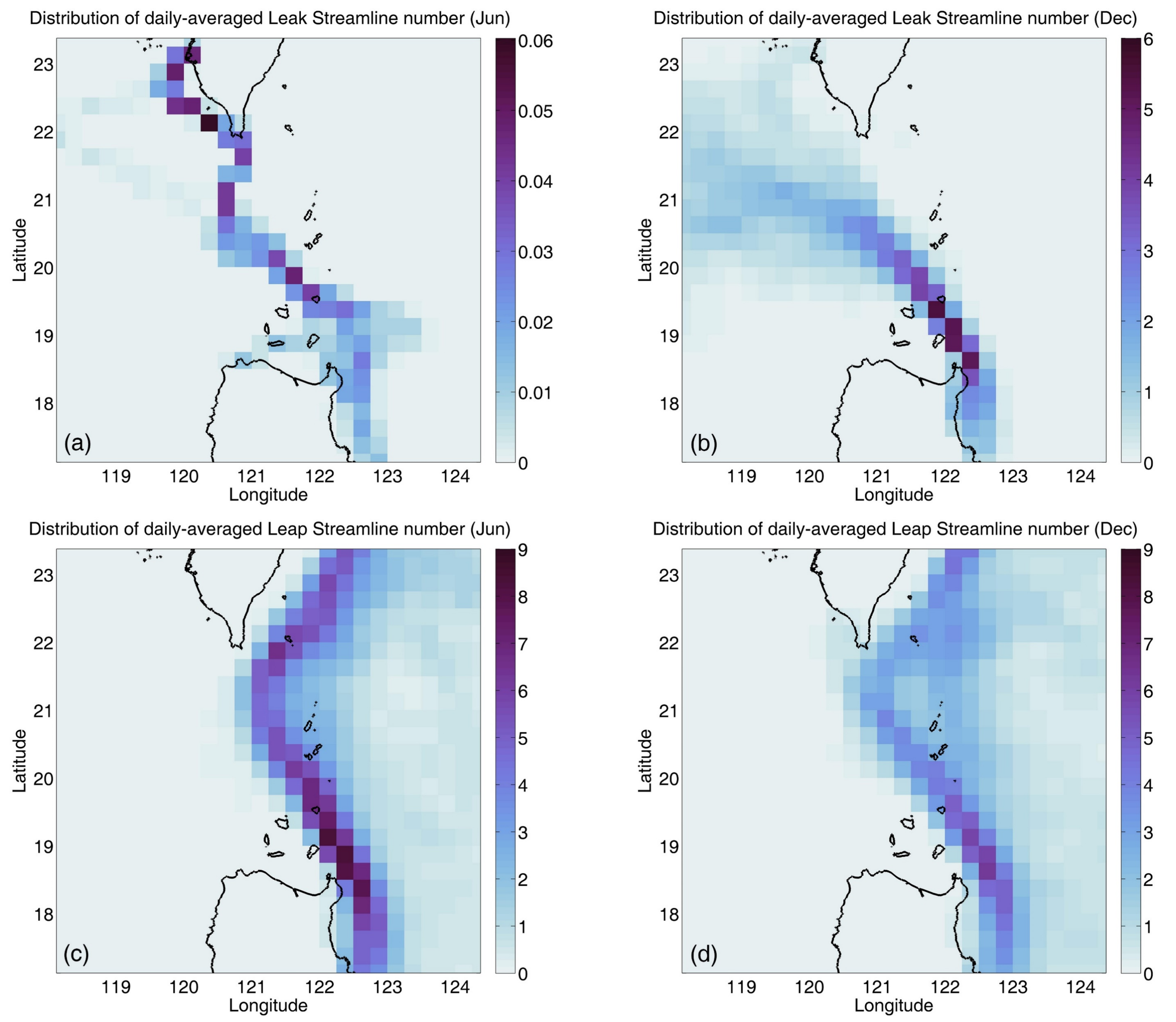


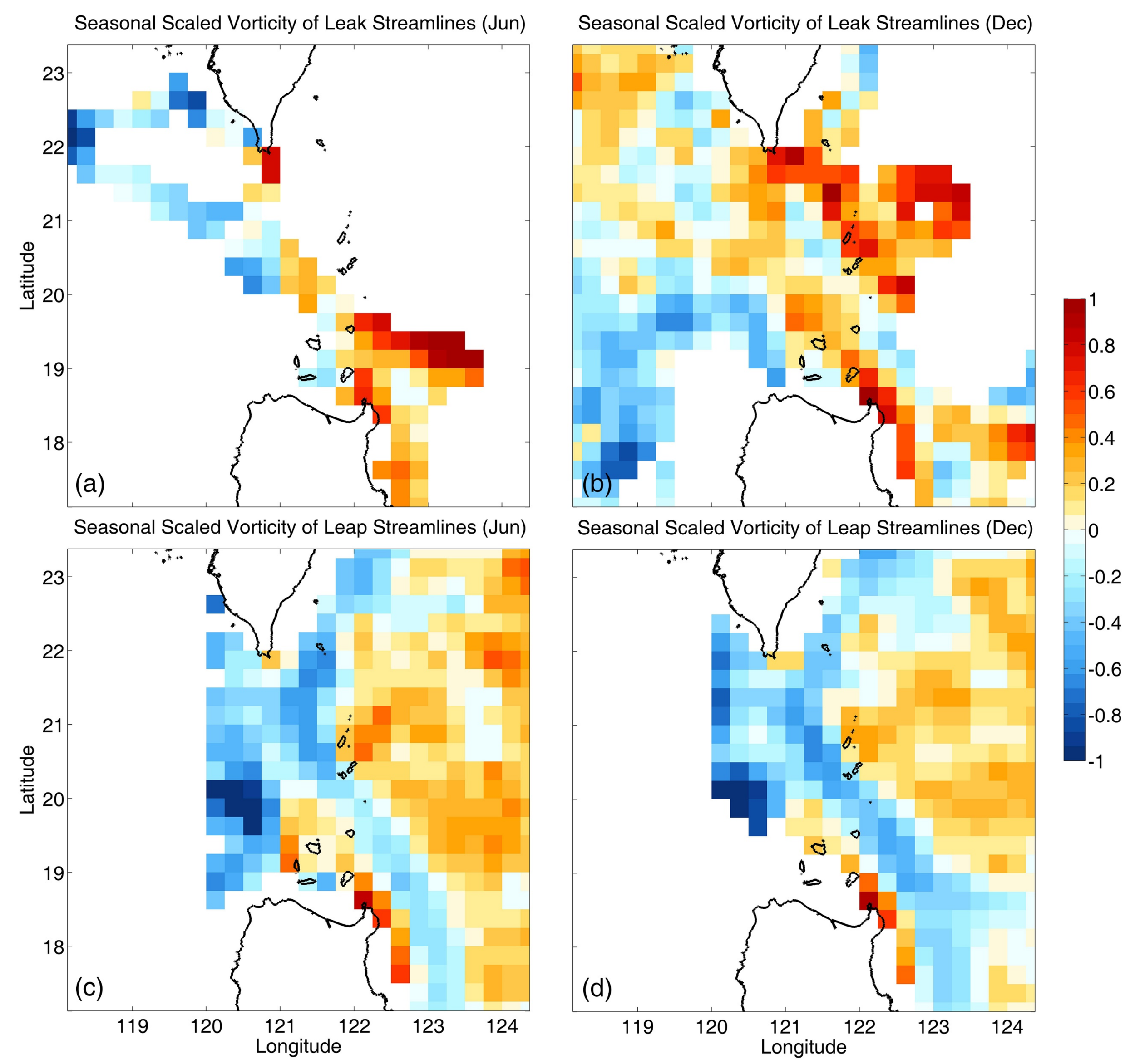
2. Streamline Intrusion

The satellite altimeter as a proxy of geostrophic streamlines is used to track the Kuroshio intrusion. Leak, Leap and Loop are used to define the streamline behaviors based on geometric criteria. Using streamlines allows to evaluate the relative strength of current intrusion type, and better reveal their intrinsic difference of dynamic features

3. Streamline Intrusion Features

No seasonality in streamline paths, current axis, width and intensity but negative vorticity associated with Leap while positive with Leak





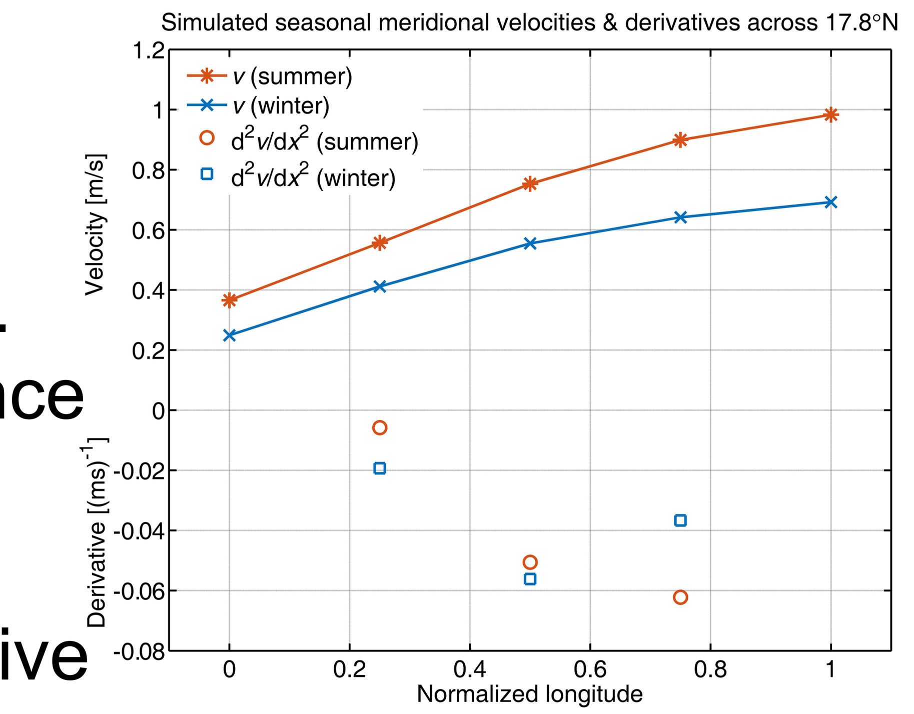
4. Possible Mechanism

4.1 Role of wind

The wind stress curl contribution is small but the uplift and depress of sea surface near the coast due to seasonally-reversing monsoon is the only way to balance the seasonal basin-wide wind stress curl.

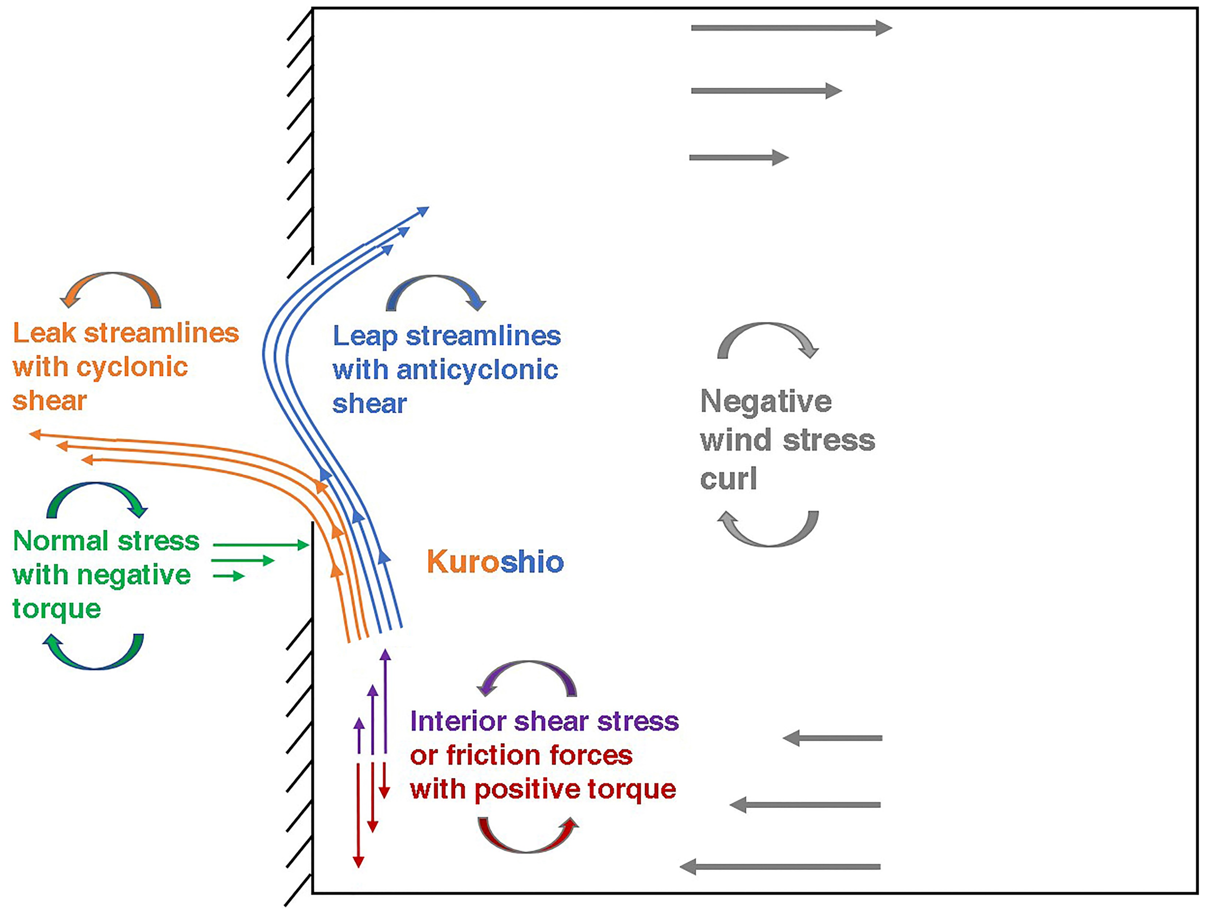
4.2 Second derivative of velocity

$\partial^2 v/\partial x^2$ measures both frictional force and diffusive flux of vorticity from the boundary with different sign. In winter, it is larger to balance the basin-wide stress curl, which also implies the large frictional force or large positive force torque.



4.3 Global and Local Views

- Globally vorticity (torque work) balance. The anticyclonic shear is a natural response to negative wind curl. Locally positive friction torque balanced by normal stress torque from the wall



- Loss of balance due to the gap drives the intrusion
- The monsoon changes the intensity of the positive friction torque, larger in winter and thus more intrusion