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Analysis of seasonal variations of internal tides in the Luzon Strait by multi-satellite altimetry data

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Abstract

Internal tide is one important factor of driving the vertical transport of ocean nutrients and influencing ocean structure and ocean circulation. In this study, six satellite altimeters data from 1993-2021 are used to retrieve the seasonal variations of M_2 and K_1 internal tides in the Luzon Strait by plane-wave fitting. Then the effects of ocean current and ocean stratification on internal tides are analyzed. The results show that the internal tides of M_2 and K_1 in the Luzon Strait have strong seasonal variations. The geostrophic current affects the M_2 and K_1 internal tide, but ocean stratification do not have a linear relation with the internal tide generation.

Data and Study area

Data: Envisat(2002-2010), Geosat Follow-On(2000-2008), TOPEX/Poseidon (1993-2002), Jason-1(2002-2008), Jason-2(2008-2016), Jason-3(2016-2021)

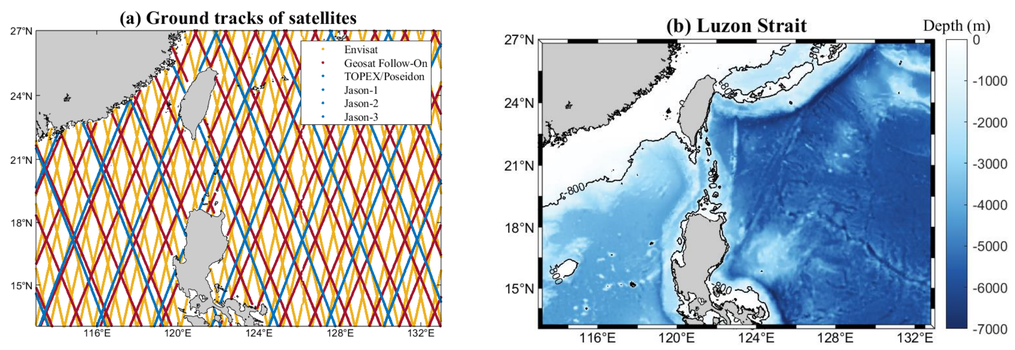

Fig.1. (a) ground tracks of altimeter satellite and (b) the study area

Method

Plane wave fitting: $SSH = \Sigma_{m=1}^{3} A_m \cos(kx\cos\theta_m + ky\sin\theta_m - \omega t - \phi_m)$

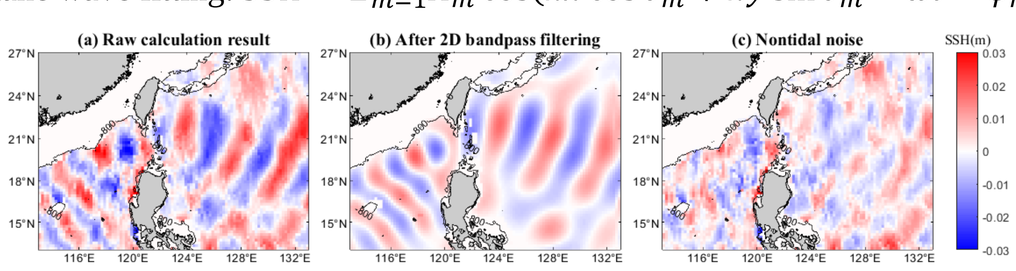

Fig.2. (a)The K_1 internal tide by plane wave fitting.(b) The K_1 internal tide after 2-D band-pass filtering.(c) the difference between (a) and (c)

Result

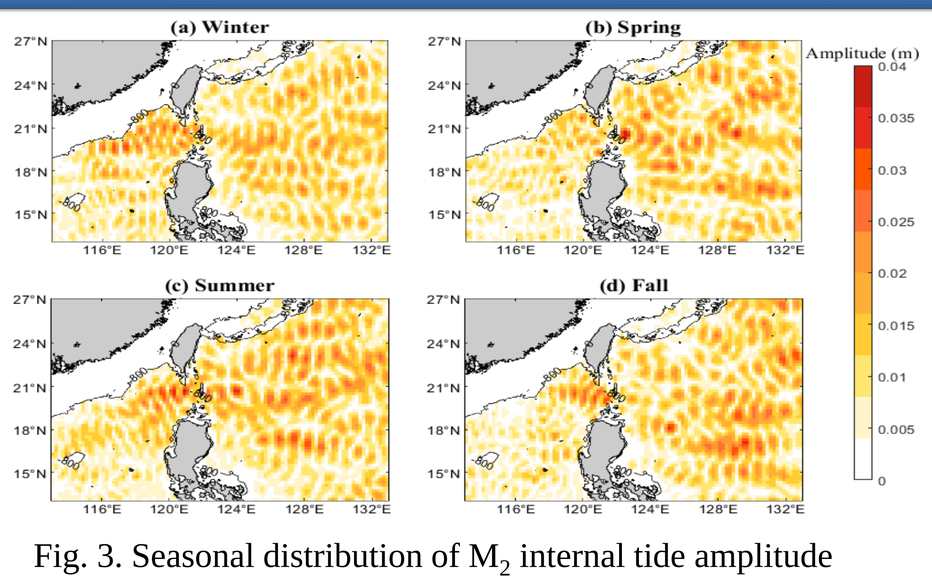

Fig. 3. Seasonal distribution of M_2 internal tide amplitude

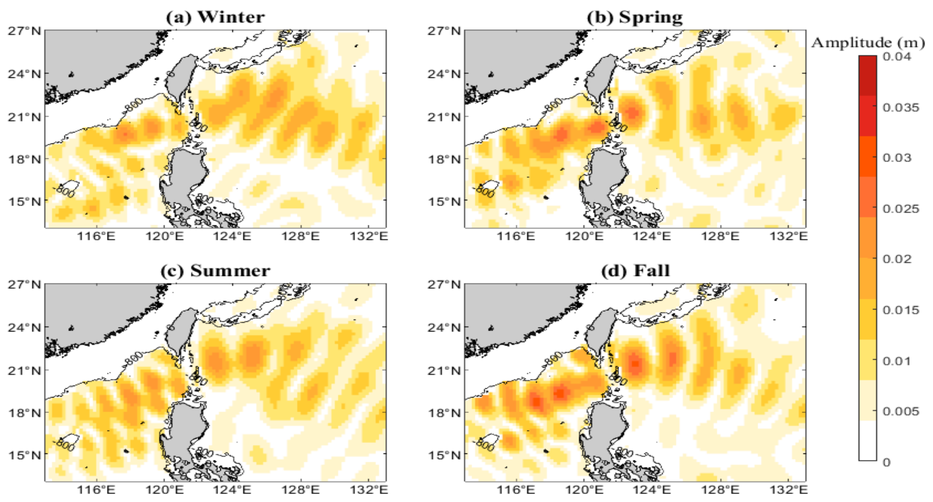

Fig. 4. Seasonal distribution of K_1 internal tide amplitude

Discussion

- **Impact of geostrophic current on internal tide**

The difference in the mean M_2 and K_1 amplitude (west minus east) between two sides of the Luzon Strait (blue box in Fig.5a) shows good agreement with the northward geostrophic current anomaly.

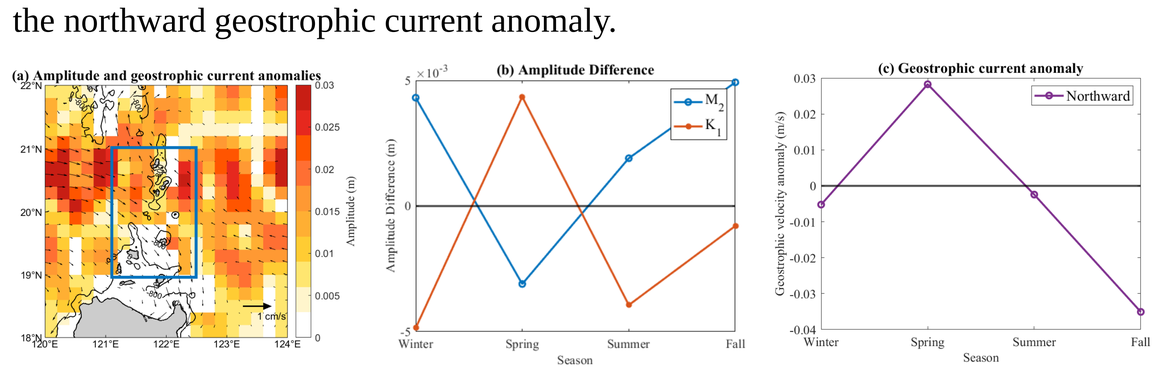

Fig.5. Seasonal variations of M_2 internal tide and geostrophic current anomaly. (a) M_2 internal tide amplitude and geostrophic current anomaly. (b) Seasonal variation of the amplitude difference two sides. (c) Geostrophic current anomaly

- **Impact of ocean stratification on internal tide**

There is no clear linear relationship between ocean stratification and seasonal variation of internal tides.

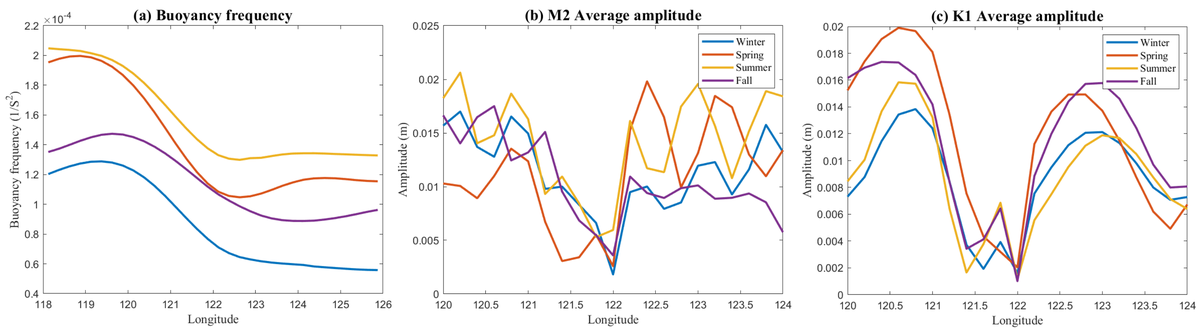

Fig. 6. Ocean stratification and internal tide amplitude. (a) Seasonal depth-averaged buoyancy frequency along 20°N. (b)-(c) averaged amplitude of M_2 and K_1 internal tide in region 18°-21°N, 116°-120.5°E

Conclusions

- In the South China Sea, the mean amplitude of the M_2 internal tide is the largest in summer, and the mean amplitude of the K_1 internal tide is the largest in spring; in the West Pacific, the mean amplitude of the M_2 internal tide is the largest in spring, and the mean amplitude of the K_1 internal tide is the largest in fall.
- Variation of M_2 and K_1 internal tide amplitude in the east and west sides of the Luzon Strait is associated with the northward geostrophic current anomaly in the Luzon Strait.
- The internal tide generation and ocean stratification do not have a linear relation.

Acknowledgments

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Major references

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