Study on internal waves at Dongsha Atoll

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Abstract

The refraction and reconnection of internal solitary waves (ISWs) around the Dongsha Atoll (DSA) in the northern South China Sea (SCS) are investigated based on SAR observations and numerical simulations. In general, a long ISW front refracts and splits into northern and southern branches when it passes the DSA. In this study, the statistics of Envisat ASAR images show that the two wave branches can reconnect behind the DSA (Figure 1), but the reconnection location varies. Based on the first realistic simulation whose results agree well with the consecutive TerraSAR-X (TSX) images captured within 12 h of each other, eight sensitivity simulations are conducted and show that ocean stratification, background currents, and initial wave amplitudes all affect the phase speeds of wave branches and therefore shift their reconnection locations while shapes and locations of incoming wave branches upstream of the DSA profoundly influence the subsequent propagation paths.

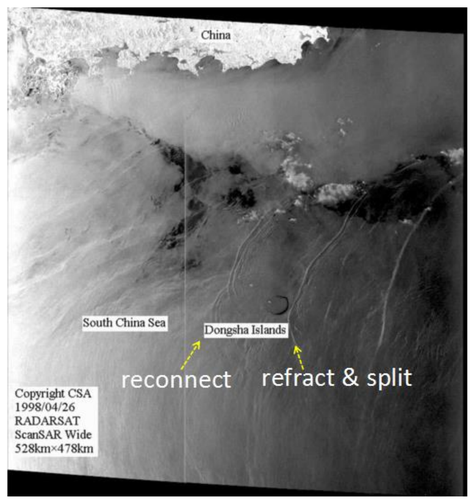
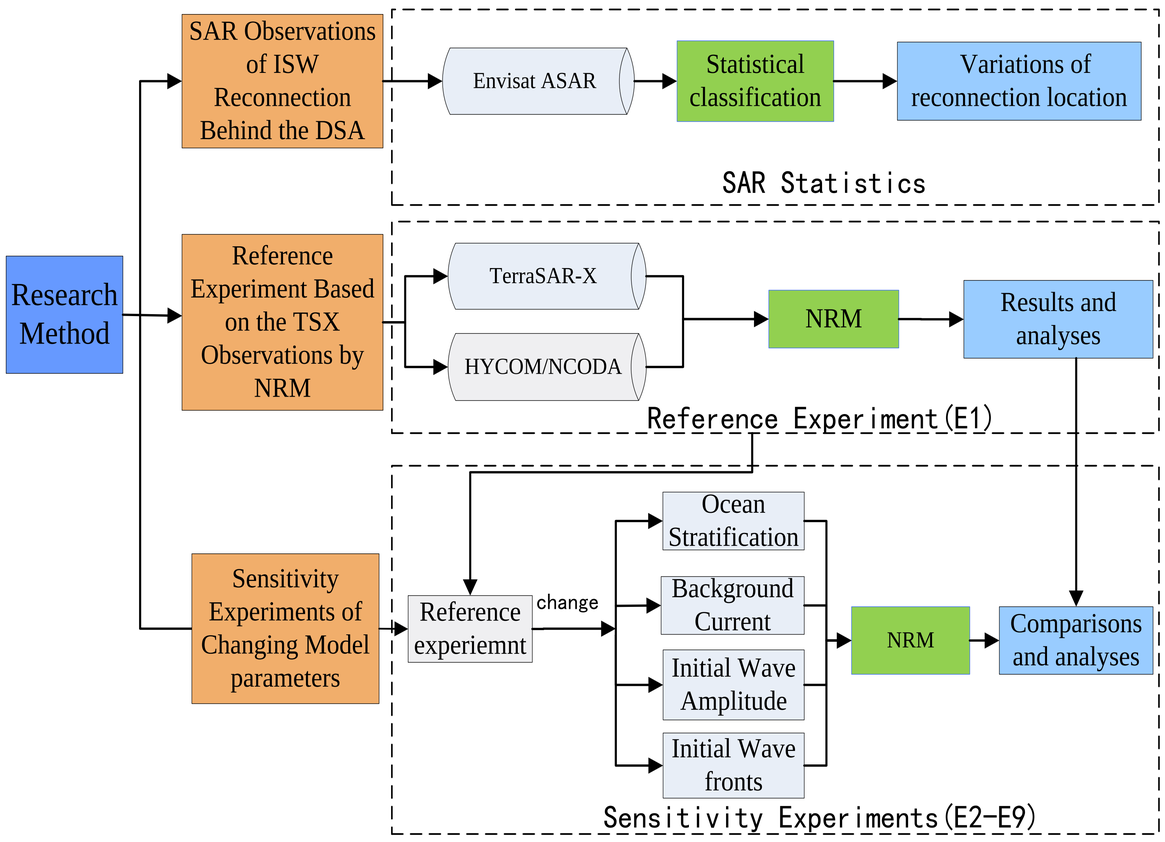


Figure 1. The propagation of ISWs near the DSA (Hsu and Liu,2000)

Objective

With the help of SAR data and a nonlinear refraction model (NRM) which is developed by Xie et al. (2016), this study aims to clarify the variation in reconnection locations of ISWs downstream of the DSA and reveals the mechanisms governing the reconnection process of ISWs near the DSA.

Methods



Results

The results of this study are shown in Figure 2 and Figure 4. Figure 3 presents the SAR images used in E1.

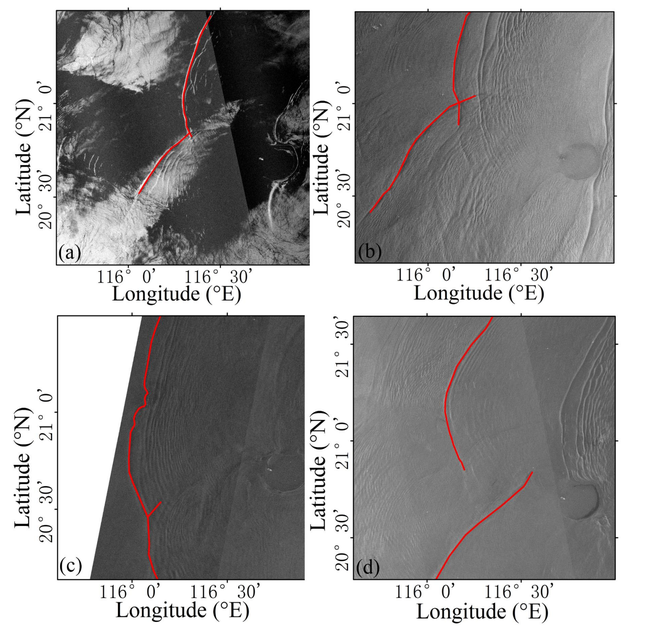


Figure 2. The spatial variations of reconnection or separation of ISWs behind the DSA

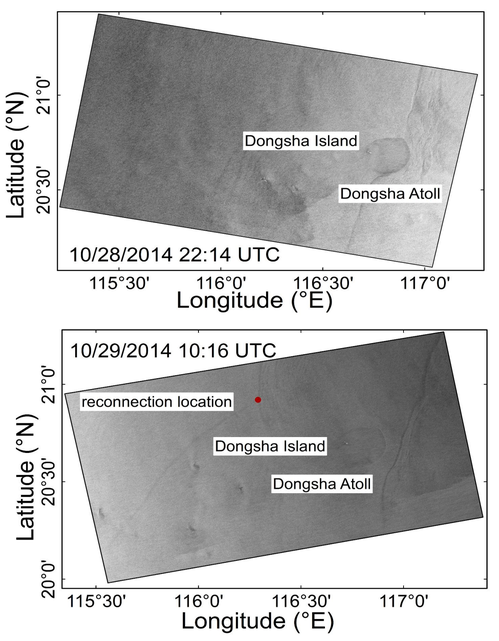


Figure 3. Two consecutive TSX images within 12 h used in E1

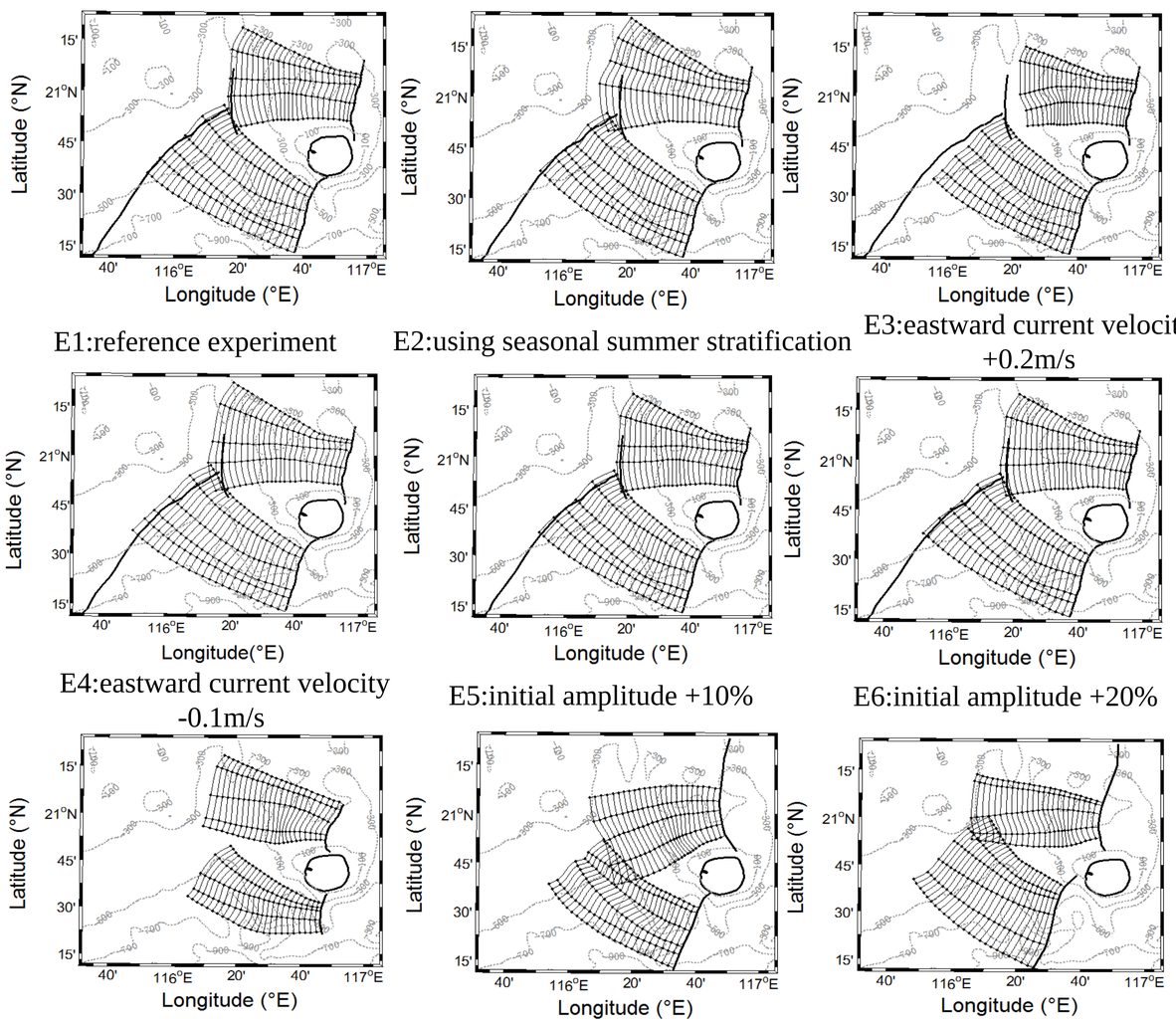


Figure 4. Results of a reference experiment and other eight sensitivity experiments

Conclusions

- Relative to the extension line of Dongsha Island, the reconnection of ISW branches can be categorized into the west (Figure 2a), northwest (Figure 2b), southwest (Figure 2c) of Dongsha Island. Besides, there are other ISWs which still separate from each other behind the DSA (Figure 2d).
- The results of E1 prove the validity of the NRM model around the DSA.
- Experiments E2-E9 show that ocean stratification, background currents, and initial wave amplitude all affect the phase speeds of ISW branches and therefore shift their reconnection locations while initial wave fronts profoundly influence the subsequent propagation paths.

References

Hsu, M. K., & Liu, A. K. (2000). Nonlinear internal waves in the South China Sea. Canadian Journal of Remote Sensing, 26(2), 72–81.

Xie, J., He, Y., L ü, H., Chen, Z., Xu, J., & Cai, S. (2016). Distortion and broadening of internal solitary wavefront in the northeastern South China Sea deep basin. Geophysical Research Letters, 43(14).