How do subsurface Tropical Instability Waves in the Atlantic Ocean influence vertical mixing?

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Subsurface Tropical Instability Waves (subTIWs) can cause a vertical two-layer structure above the thermocline with periodically increasing and decreasing shear, which may impact vertical mixing.

Analysis of subTIWs using high-resolution output from the global and comprehensive model ICON-O (Korn, 2017)

ICON-O ➡

- Ocean only setup
- Global and comprehensive
- 10 km horizontal resolution
- 128 vertical levels
- Forced with hourly ERA5 data from 2000 to 2018
- Analysis of daily mean values

Identifying subTIW periods and depth dependence using Power Spectral Density (PSD)

Surface TIW periods:	15 – 60 days
subTIW periods:	15 – 40 days
Average depth of strongest subTIW energy:	64 m

Period of strongest subTIW energy at

23°W/0°N :	20 – 24 days
23°W/2°N :	26 – 34 days
23°W/2°S :	26 – 34 days

I. Difference in forcing of surface TIWs and subTIWs leads to different spatial patterns

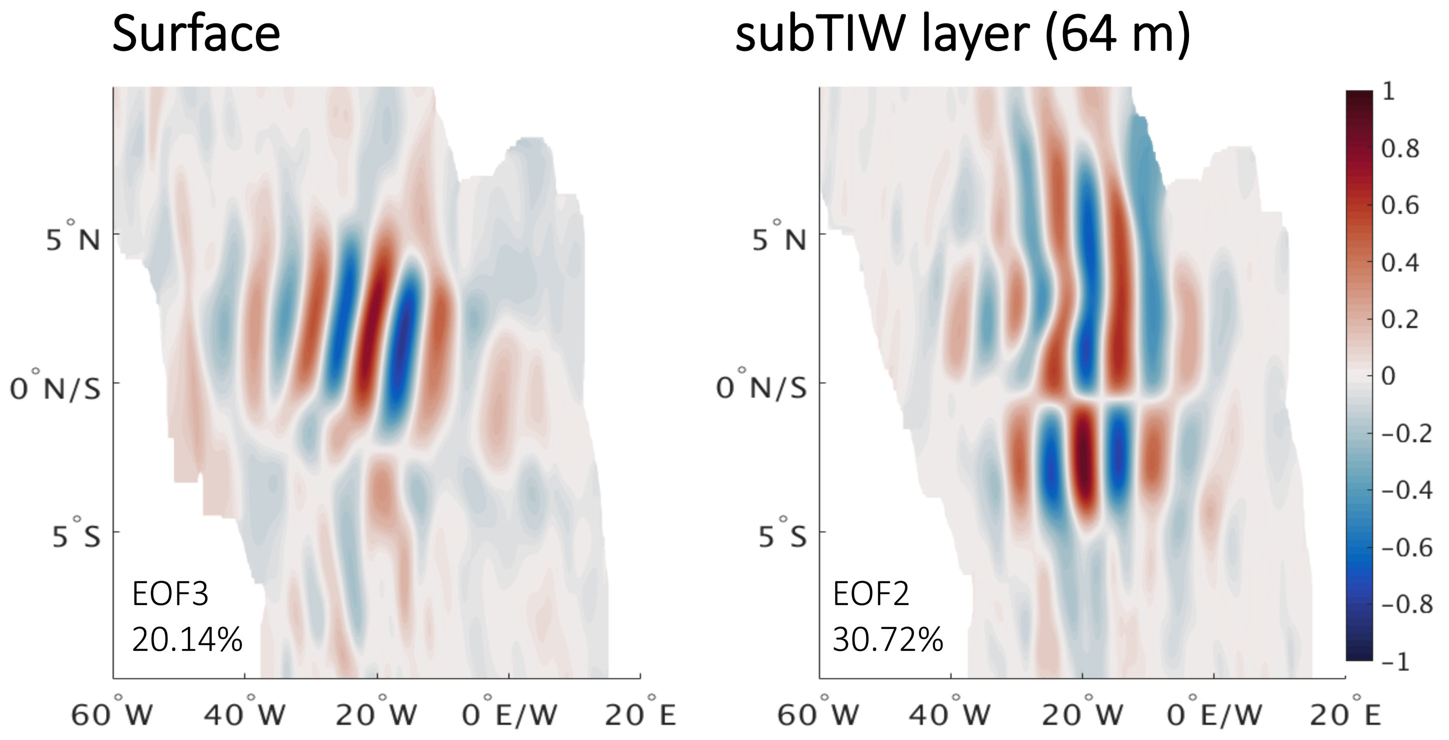

Fig. 1: EOF modes of bandpass filtered (15 – 60 days) temperature at the surface (left) and in subTIW layer (right). Values are normalized and non-dimensional.

TIWs and subTIWs are both generated mainly through **barotropic instabilities**

Generation	Surface	Subsurface
Increased shear	Of the mean surface circulation north of the Equator	At both flanks of the Equatorial Undercurrent (EUC)
Forcing:	Intensification of southeasterly trade winds	Intensification of EUC in boreal summer

- ➢ TIWs and subTIWs are generated independently of each other
- ➢ Due to the temporally coinciding forcing, both wave types occur at similar times

II. subTIWs can cause a vertical two-layer structure

Two-layer structure with periodically increasing and decreasing vertical shear | **Velocity amplitudes**: 2 m/s | **Onset**: May/June | **Maximum**: August/September

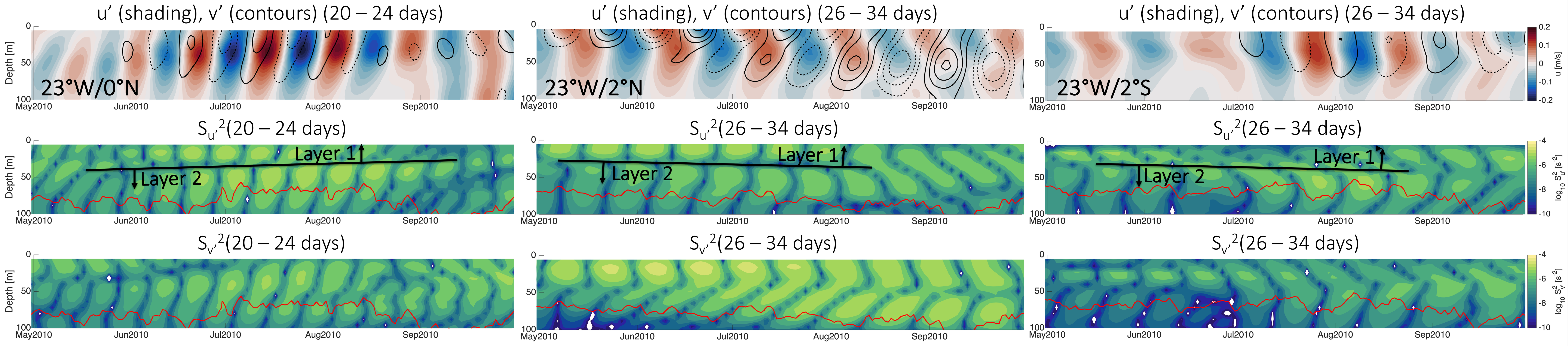

Fig. 2: Bandpass filtered velocity u', v' (top), vertical shear of filtered zonal velocity (middle) and vertical shear of filtered meridional velocity (bottom) during TIW season 2010 at 23° W/0° N (left) , 23° W/2° N (middle) and 23° W/2° S (right) . Red line in the lower panels indicates the thermocline (20 ° C isotherm). Vertical two-layer shear structure is indicated in the middle panel.

III. Differences in subTIW characteristics off and on the Equator

Characteristic	23°W/0°N	23°W/2°N	23°W/2°S
• subTIWs expressed by oscillation of	Zonal velocity	Meridional velocity	Zonal velocity
• ~ 60 % of TIW induced shear related to	Zonal velocity	Meridional velocity	Zonal velocity
• Contribution of shear in lower layer relative to vertically averaged TIW induced shear above the thermocline	~ 1/3	~ 2/3	~ 2/3

Open questions

- How do surface intensified TIWs and subTIWs interact?
- How to quantify the impact of subTIWs on vertical mixing relative to the impact of TIWs?
- How do the model results compare to observations in the tropical Atlantic?

References

Korn, Peter. "*Formulation of an unstructured grid model for global ocean dynamics.*" Journal of Computational Physics 339 (2017): 525-552.

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