Signatures of Fronts and Waves in Divergence-Vorticity-Strain Joint Probability Density Functions

(Created using surface velocities from a high-resolution ocean model)

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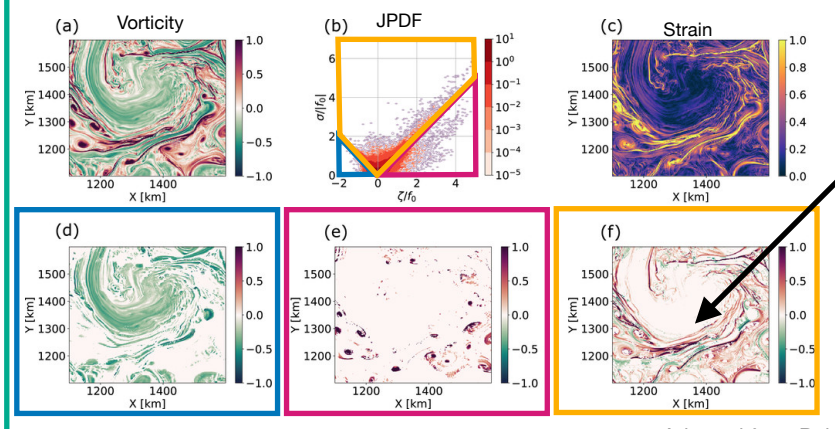
1. JPDFs are useful for identifying flow features

In idealized models, joint probability density functions (JPDFs) of vorticity, $\zeta = v_x - u_y$, and strain, $\sigma = \sqrt{(u_x - v_y)^2 + (v_x + u_y)^2}$, are useful for identifying different components of the flow.



Fronts tend to have

High strain

High vorticity

High convergence

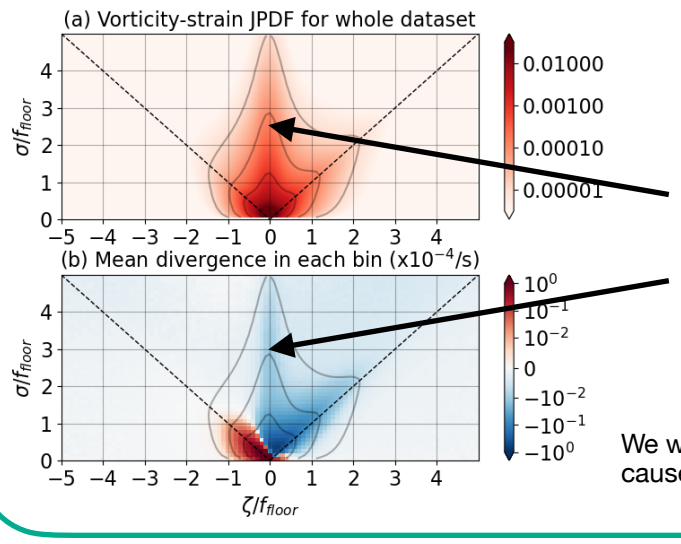
Adapted from Balwada et al. 2021

We plan to use JPDFs as a tool for evaluating our success at

i) inferring surface velocities from SWOT observations, and

ii) Separating wave and balanced parts of the flow

2. JPDFs of LLC4320 surface velocity have features that we haven't seen before



JPDFs in previous work did not show this feature. It has

High strain

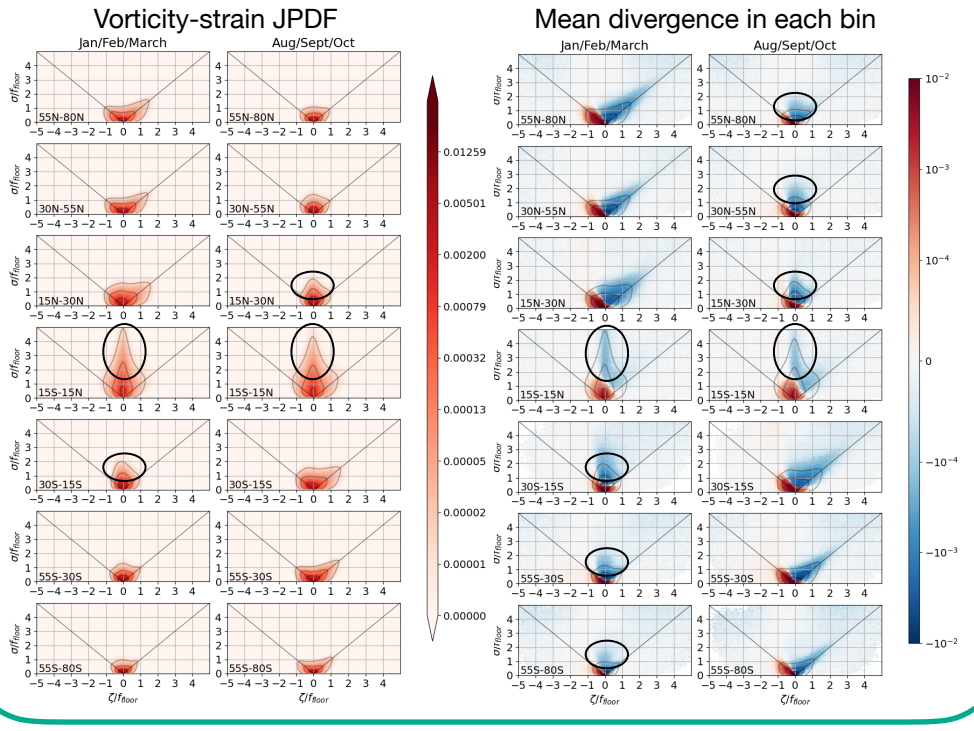
Low vorticity

High convergence

We want to understand what causes this feature

3. This new feature mostly occurs near the equator and in the summer hemisphere

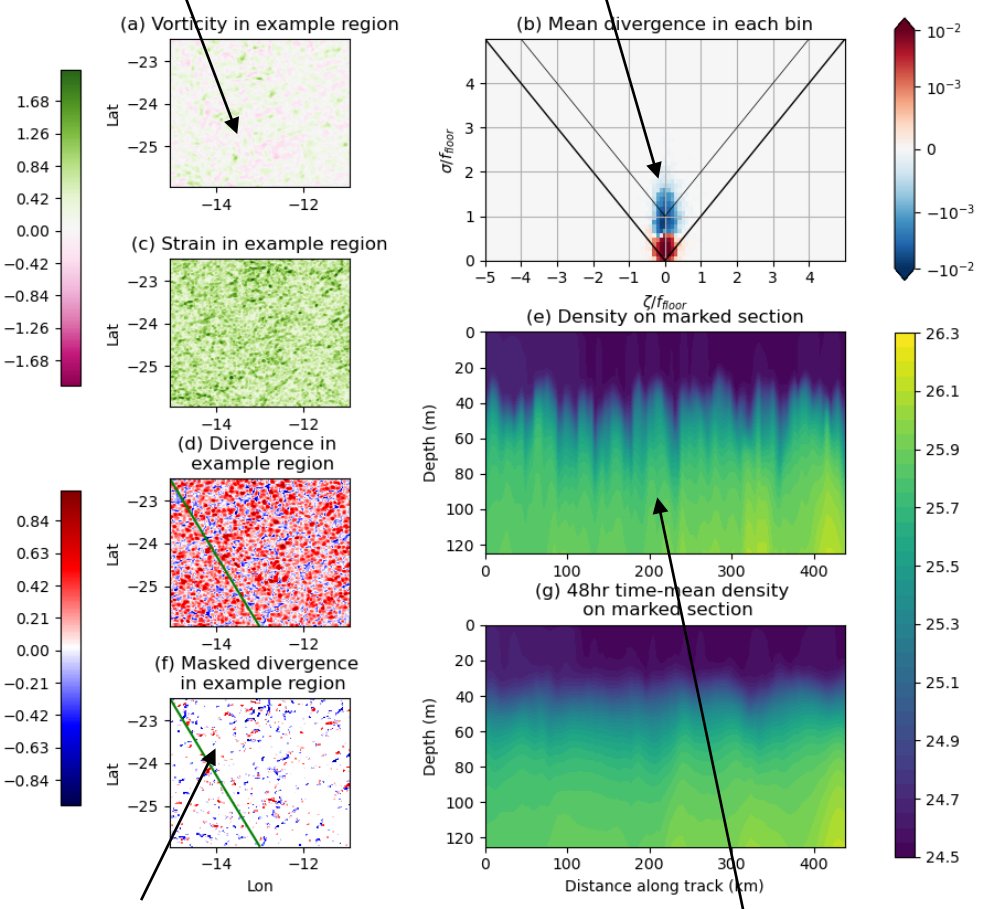
We calculated the JPDFs in each latitude band and season



4. Case study suggests the feature at high strain and low vorticity is caused by internal waves

This is a wave dominated region

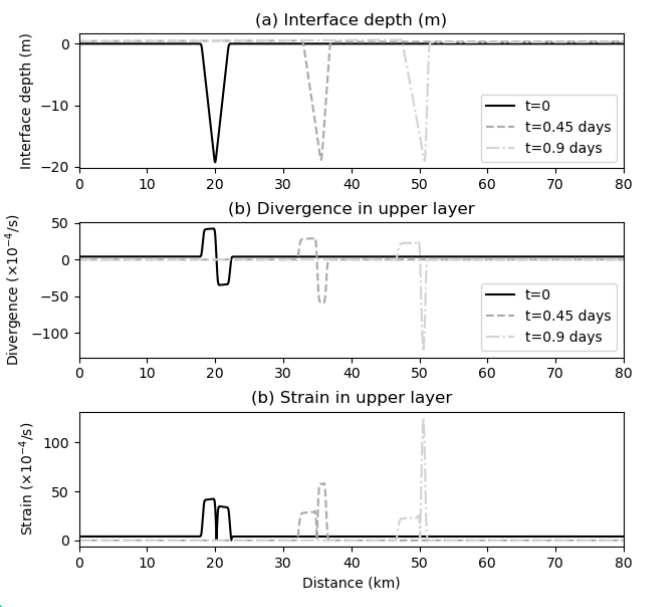
Convergence is present at high strain & low vorticity



Waves tend to have narrow regions with strong convergence and wide regions with strong divergence

Waves can be seen traveling along mixed layer base

5. This seems to be related to wave steepening



This steepening causes large strain and large convergence to occur at the same location

6. Conclusions

JPDFs are a useful tool for evaluating the prevalence of fronts in surface flows

Here we identified a new signal that appears to be caused by internal waves, which "tip forwards" due to Earth's rotation

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