

# Geostrophic balance: so useful it became a blind spot

A scalar surface encodes dynamics it was never supposed to reveal.

## LARGE SCALES

### Balance

The ocean is approximately geostrophic—an extraordinarily powerful approximation.

## TENS OF KILOMETERS & BELOW

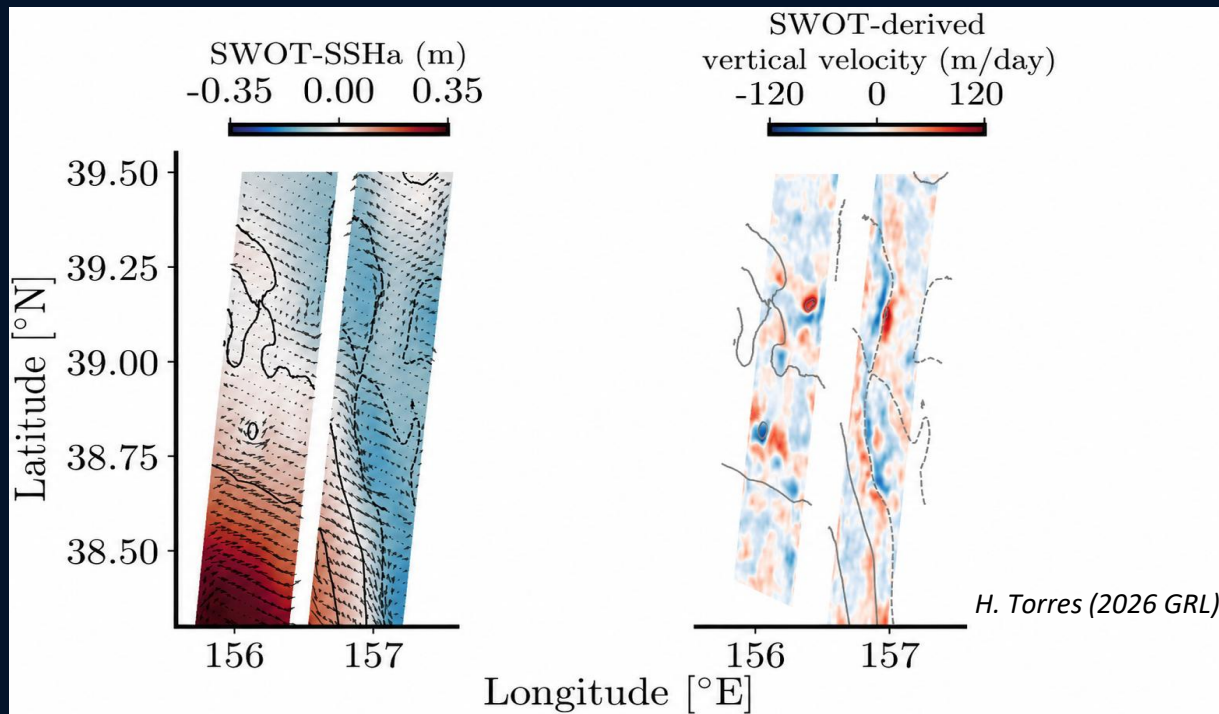
### Imbalance

Fronts, convergence, divergence and vertical velocities emerge—with outsized effects on energy and tracers.

## RECENTLY LEARNED

### Hidden information

Physics-aware ML extracts divergent and vertical motion from SSHa – where geostrophic balance predicts zero.



**SWOT observations demand more complete dynamics.**

**Together they reveal what geostrophy alone could not.**

*H. Torres (2026 GRL)*