

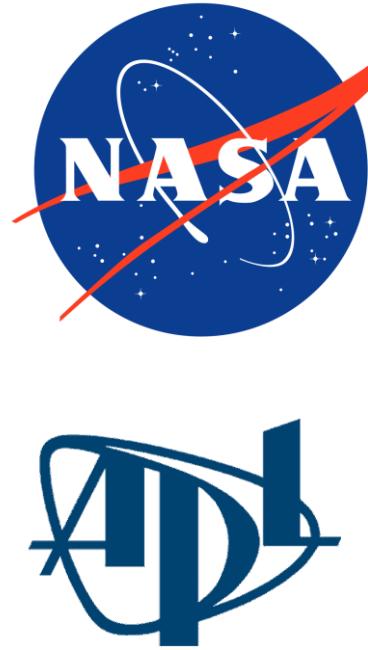
Multi-Scale Ocean Variability in the Central California Current System

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One-Sentence Summary

Bridging the gap between basin-scale weather and turbulence mixing, this research uses 15 years of autonomous glider data and satellite images to reveal how atmospheric rivers and mesoscale strain drive the submesoscale fronts that dissipate the ocean's energy.



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Applied Physics Laboratory

$O(1000)\text{km}$

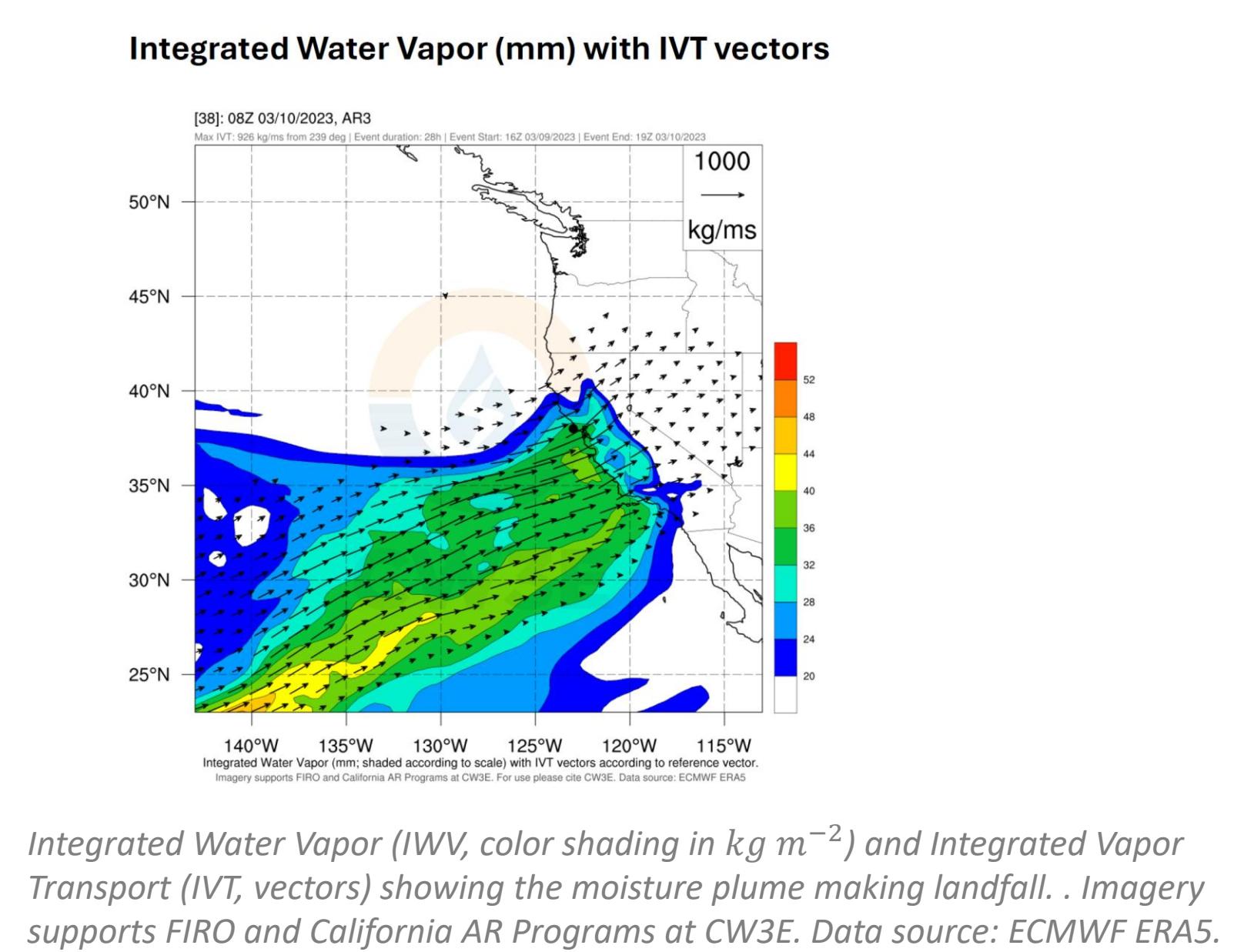
Macroscale

The Engine

Forcing from Above:

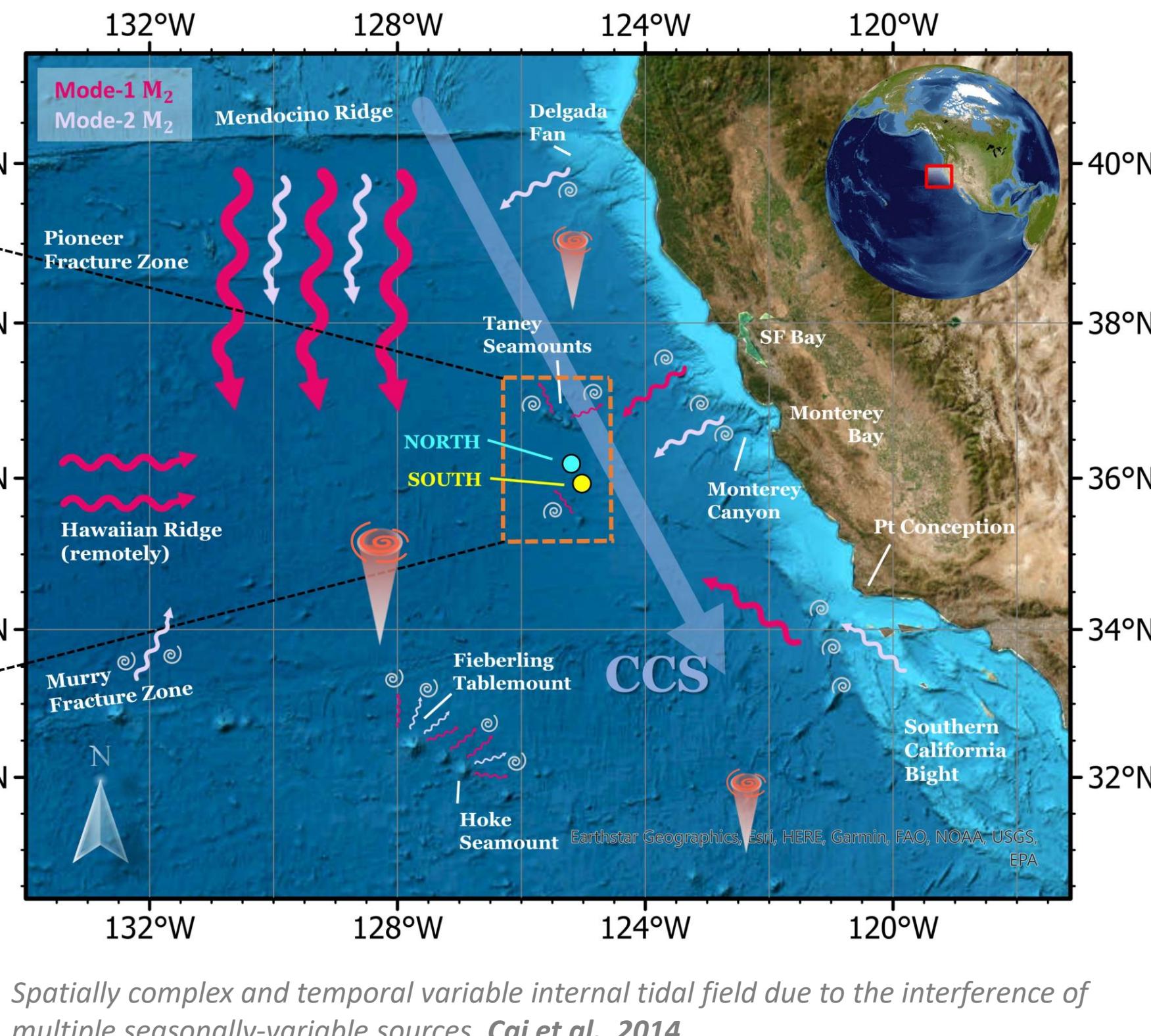
Atmospheric Rivers inject massive pulses of freshwater buoyancy

AR event around IOPII: 9-10 March 2023, AR3



The stage is noisy:

Eddies and internal tides modulate the background environment

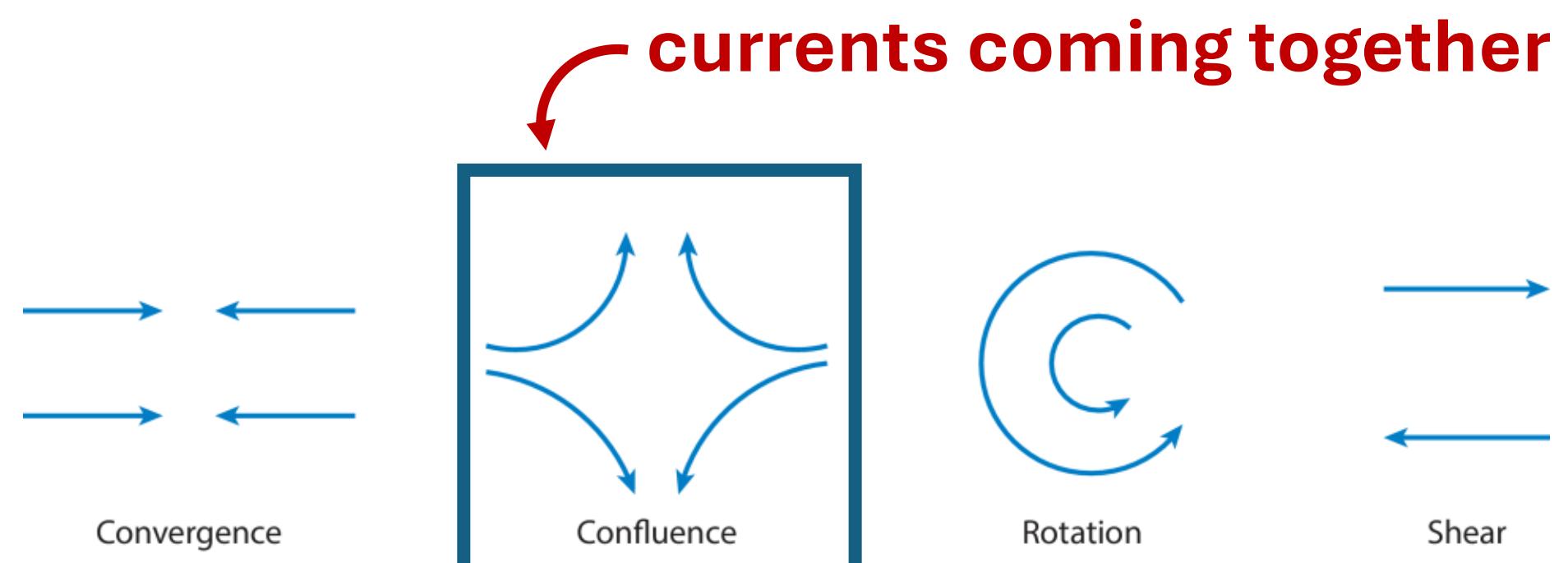


$O(100)\text{km}$

Mesoscale

The Squeeze

The 2D Deformation Field

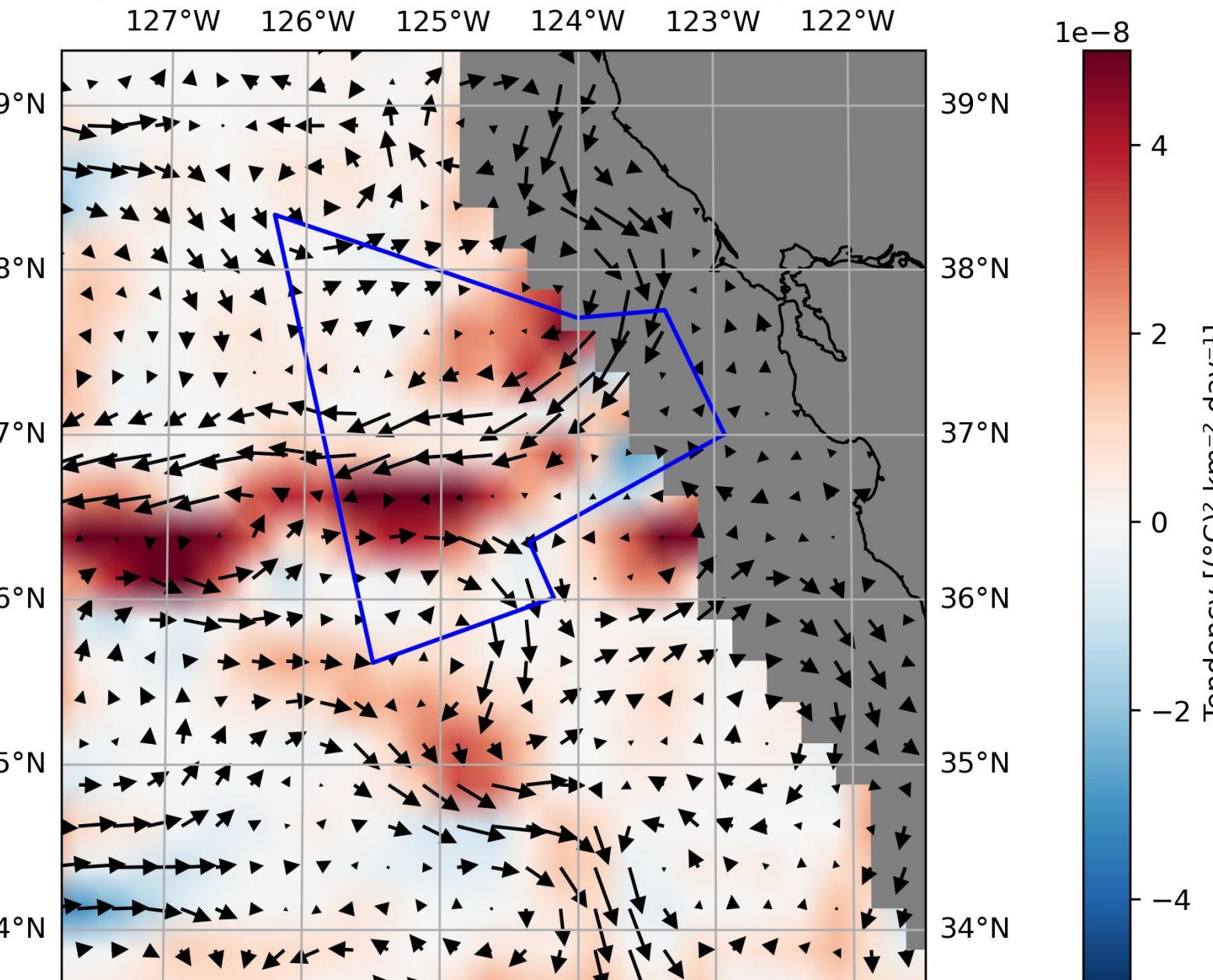


Frontogenesis (Mechanism)

$$\mathcal{F} = Q \cdot \nabla_h b$$

The Q-Vector measures the 'squeeze'. Mesoscale eddies strain broad gradients into sharp filaments, forcing energy down to smaller scales

Frontogenesis tendency (hori. deformation) calculated with RSS Microwave SST and Geostrophic Currents (time-averaged from 20 March to 15 May 2023)



- Strong offshore band of frontogenesis (36–37.5°N)
- Confluent geostrophic flow strains and sharpens thermal gradients

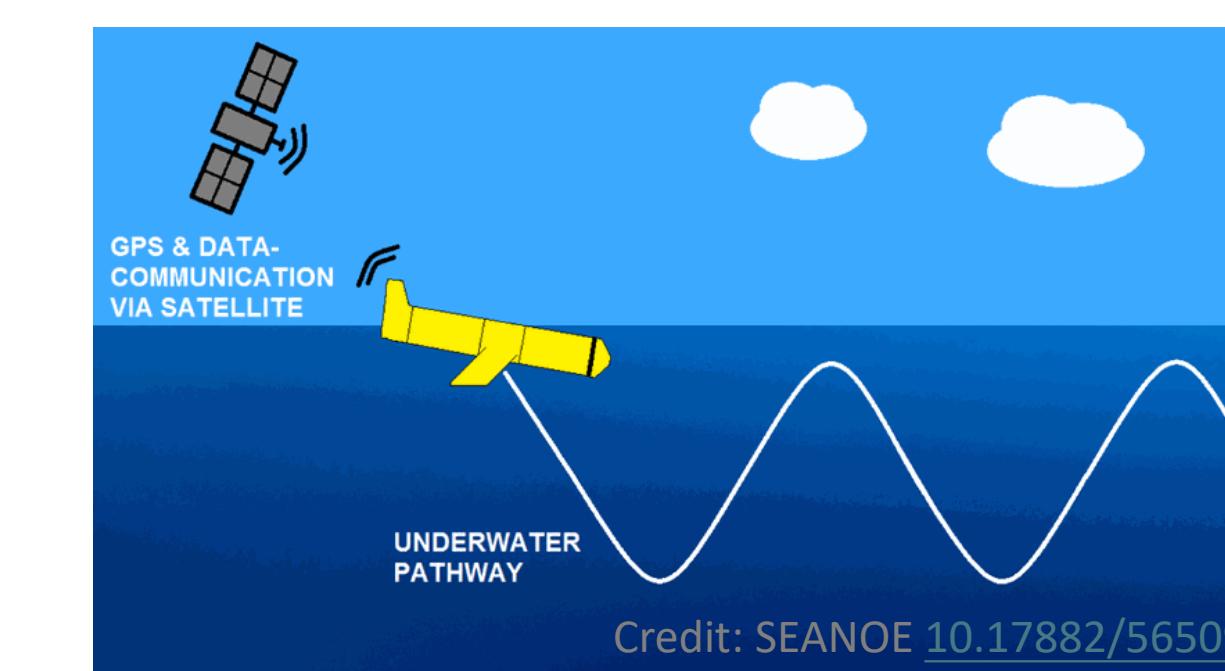
$O(10)\text{km}$

Submesoscale

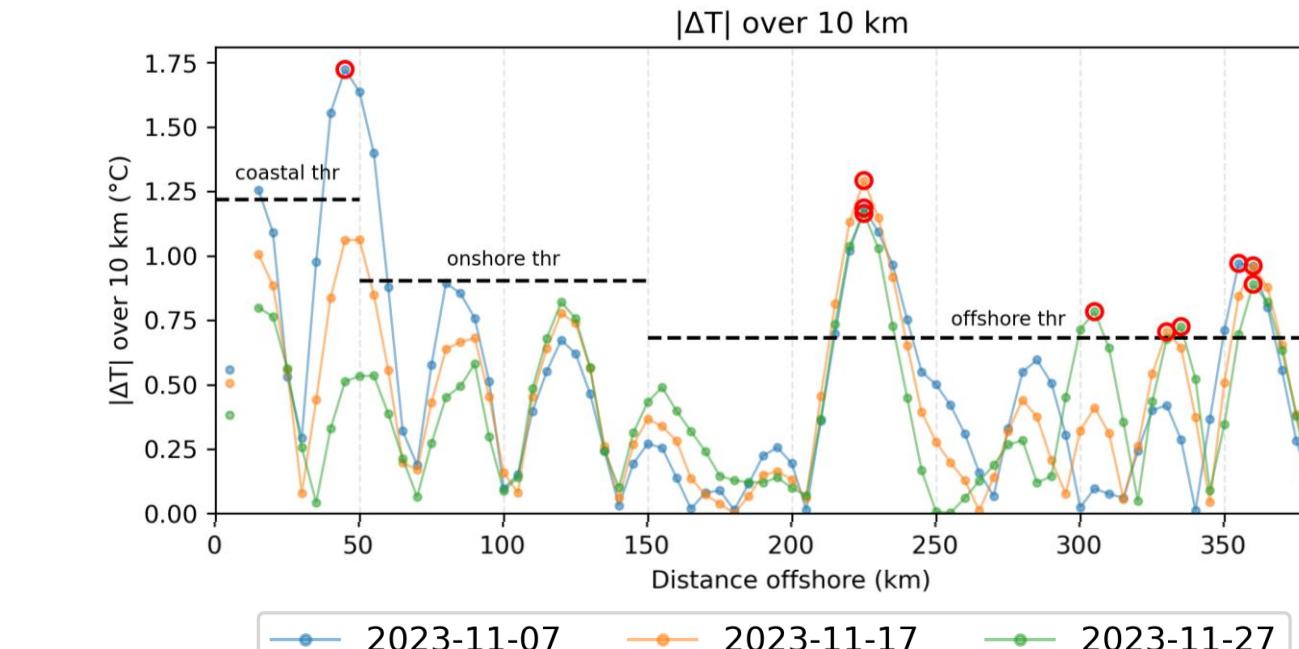
The Leak

CUGN glider (2006-2024)

Provide high-resolution temperature, salinity, velocity data ($\sim 3\text{km}$)



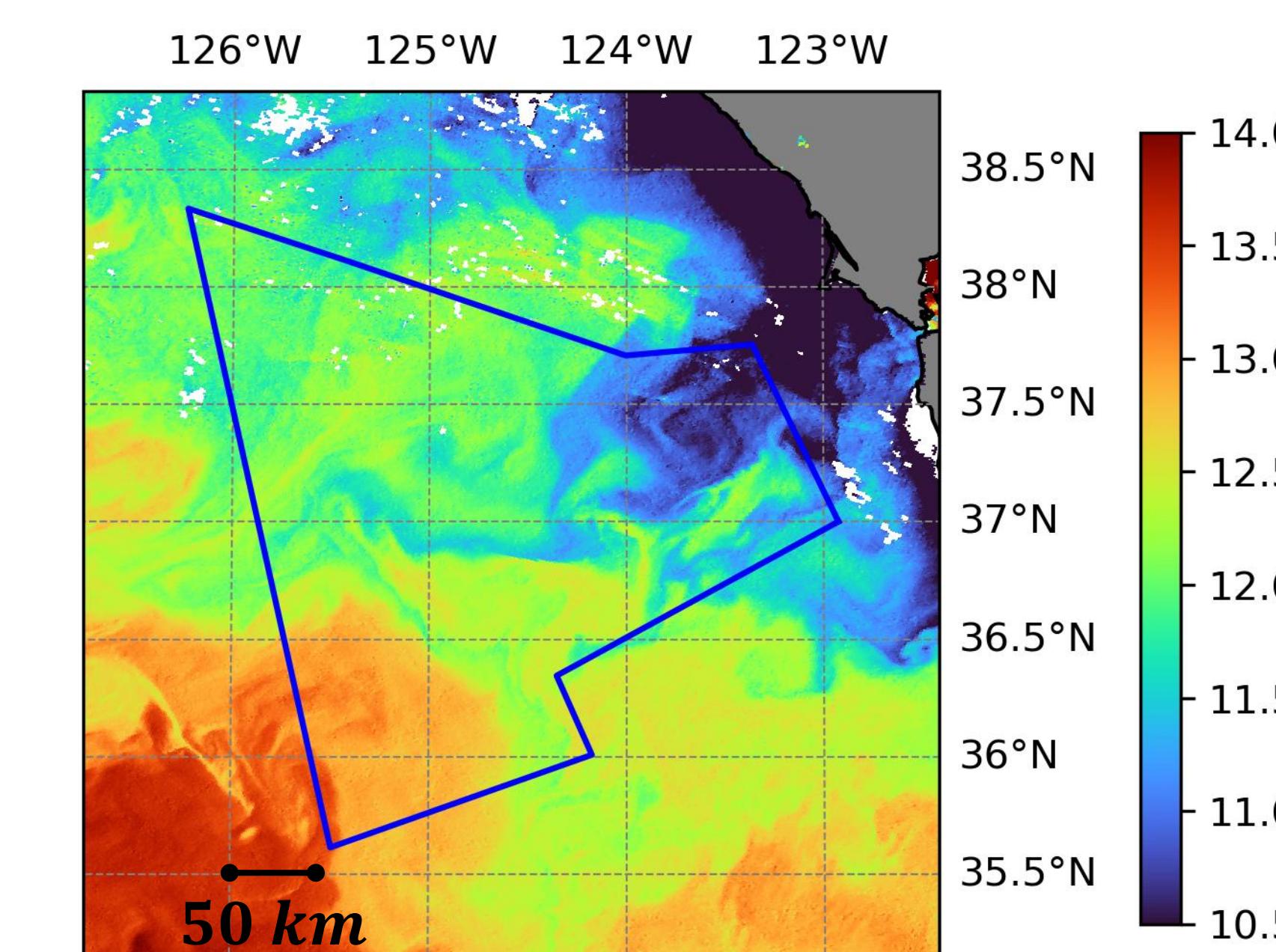
Identify submesoscale features along distance offshore for spatial variation



Satellite Inferred Image

Cold water come from the coast and get advected offshore

VIIRS NPP L2 SST on 2023-04-21 (750 m)



Impact

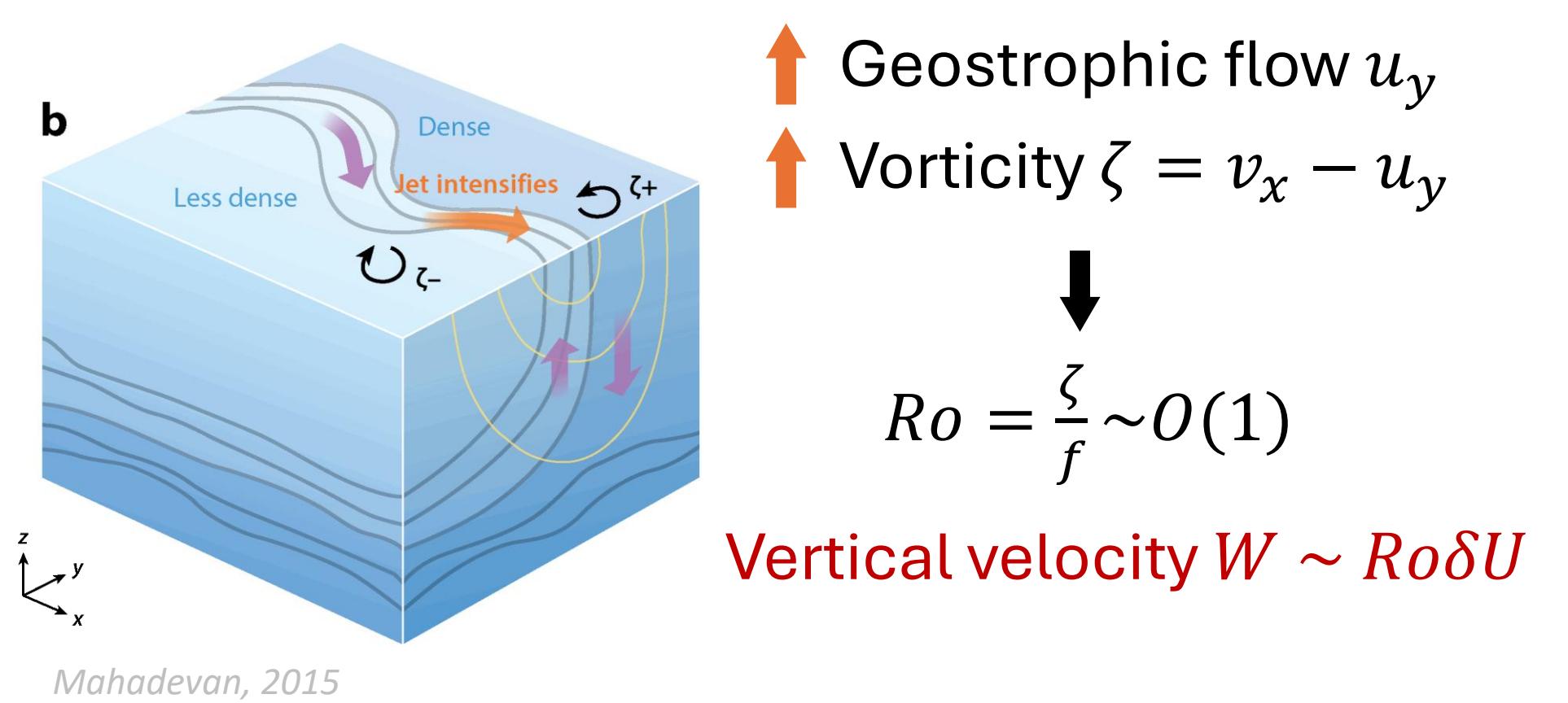
The Reality Check

VS GLORYS12V1 Reanalysis Model

Reanalysis models may miss submesoscale (salinity fronts) because they lack event-based river forcing (ARs)

Why does Submesoscale Matter?

The loss of geostrophic balance and **strong vertical velocity**



Implication to climate via Up-Gradient Vertical Heat Transport; **five times larger** than mesoscale

