Remote Sensing of Vertical Velocity

Eric D'Asaro, Ernesto Rodriguez, Luc Lenain, Andrey Shcherbina, Tom Farrar
APL/UW JPL SIO APL/UW WHOI

Measurement of Vertical Velocity

from

Divergence of surface horizontal velocity – Aircraft

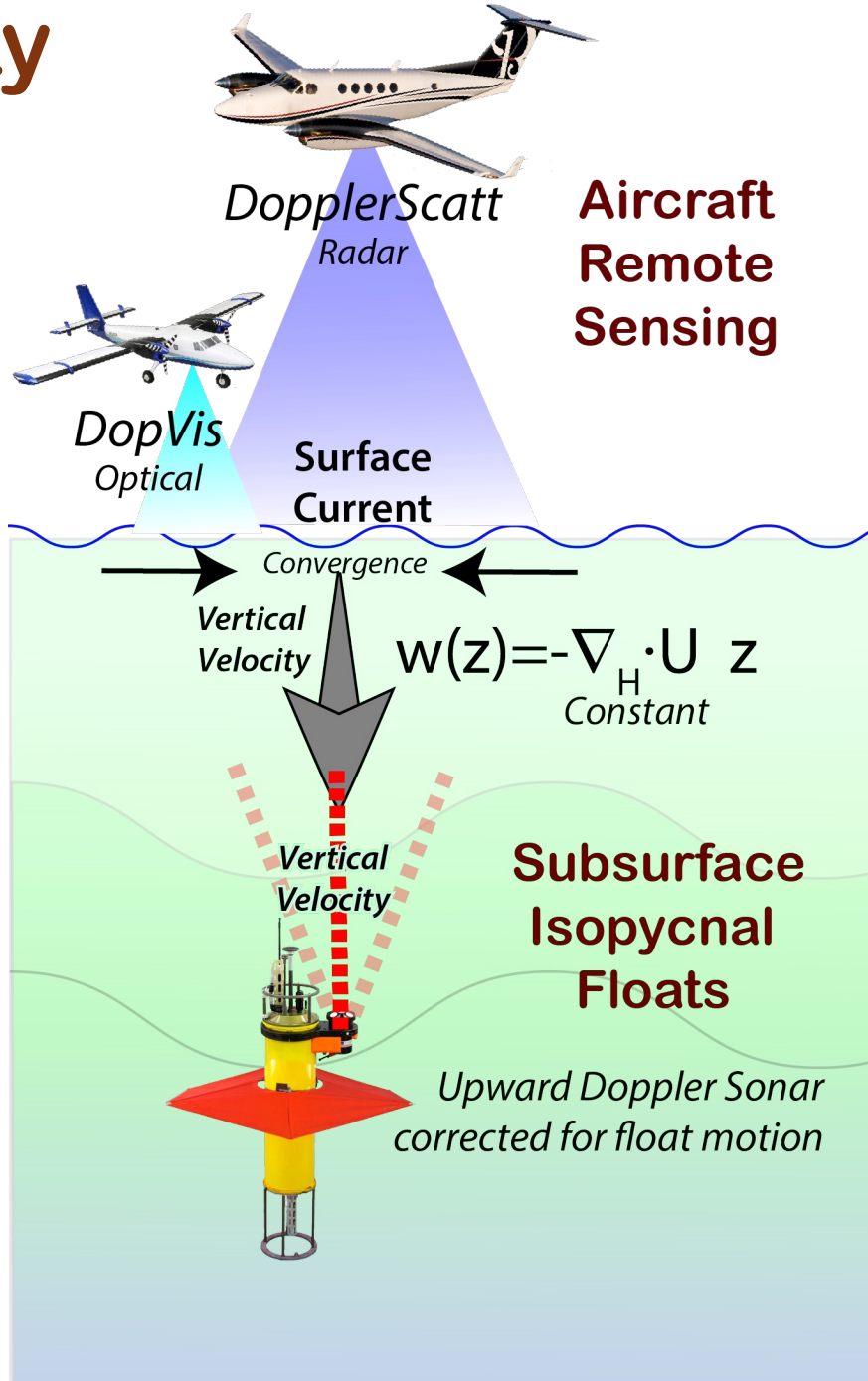
Subsurface vertical velocity - Subsurface floats

Agree surprisingly well in upper 50m

This may be a viable method for ODYSEA

Vertical velocity is a complex sum of processes

Be careful with simple methods to extract it from SWOT



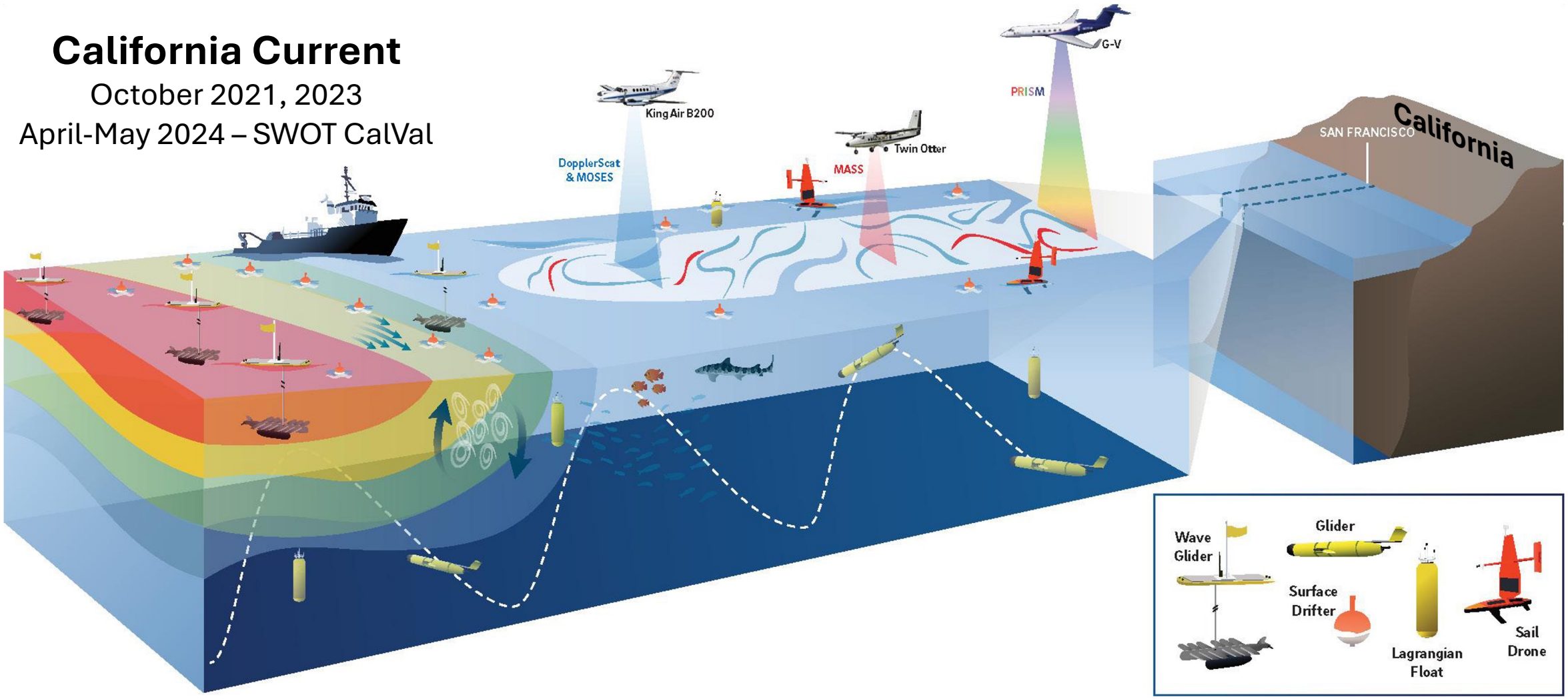
S-MODE Earth Venture Suborbital Investigation (EVS-3)

Submesoscale vertical transport in the upper ocean

California Current

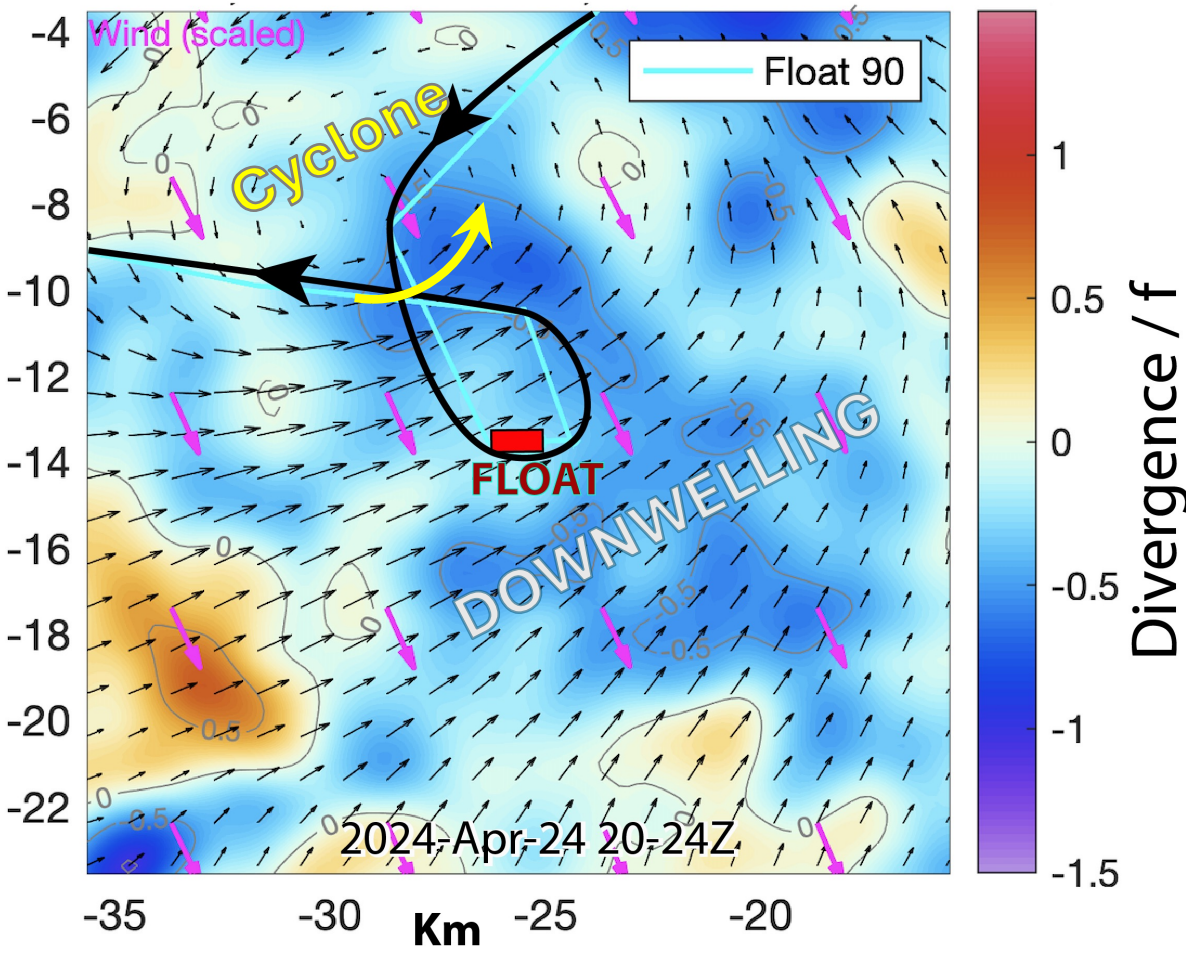
October 2021, 2023

April-May 2024 – SWOT CalVal

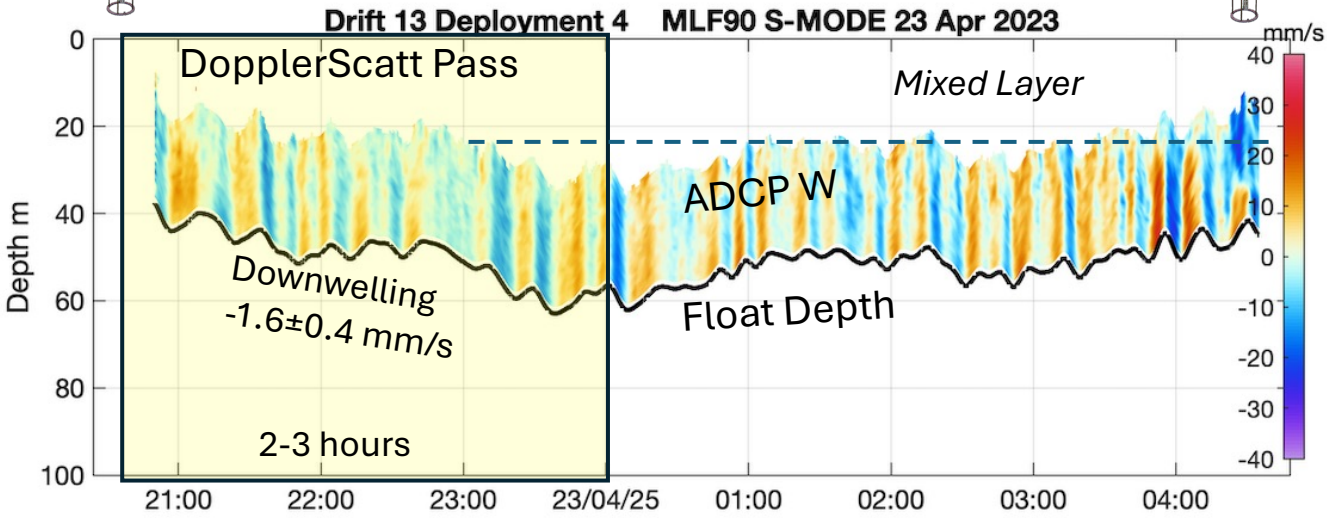


DopplerScatt Divergence

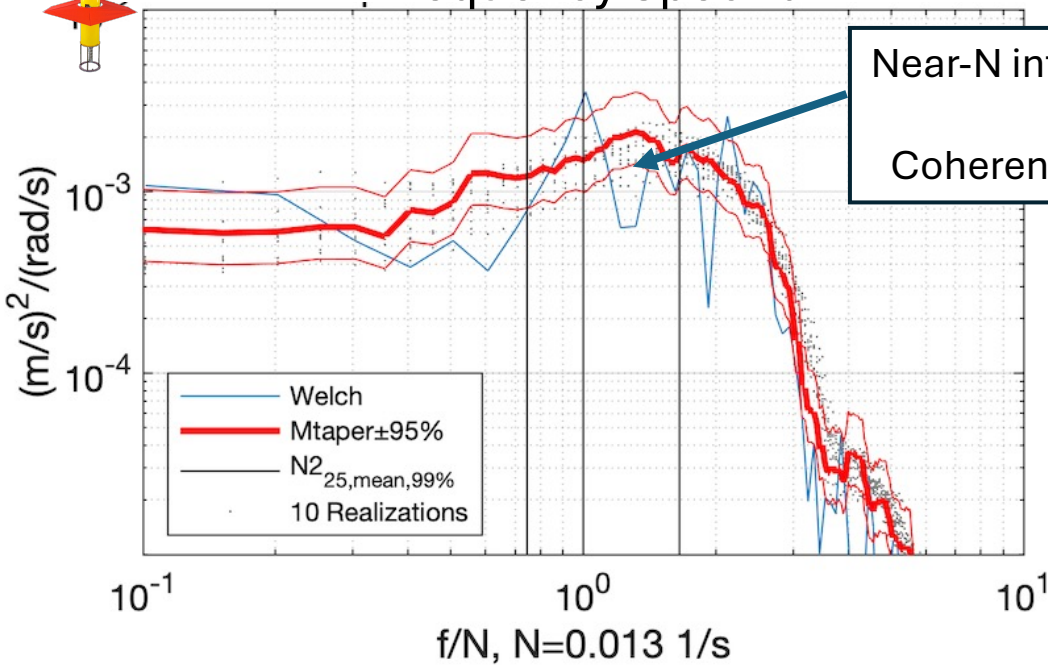
Averaged over multiple passes
2-3 hours, 2 km smoothing



Float Vertical Velocity

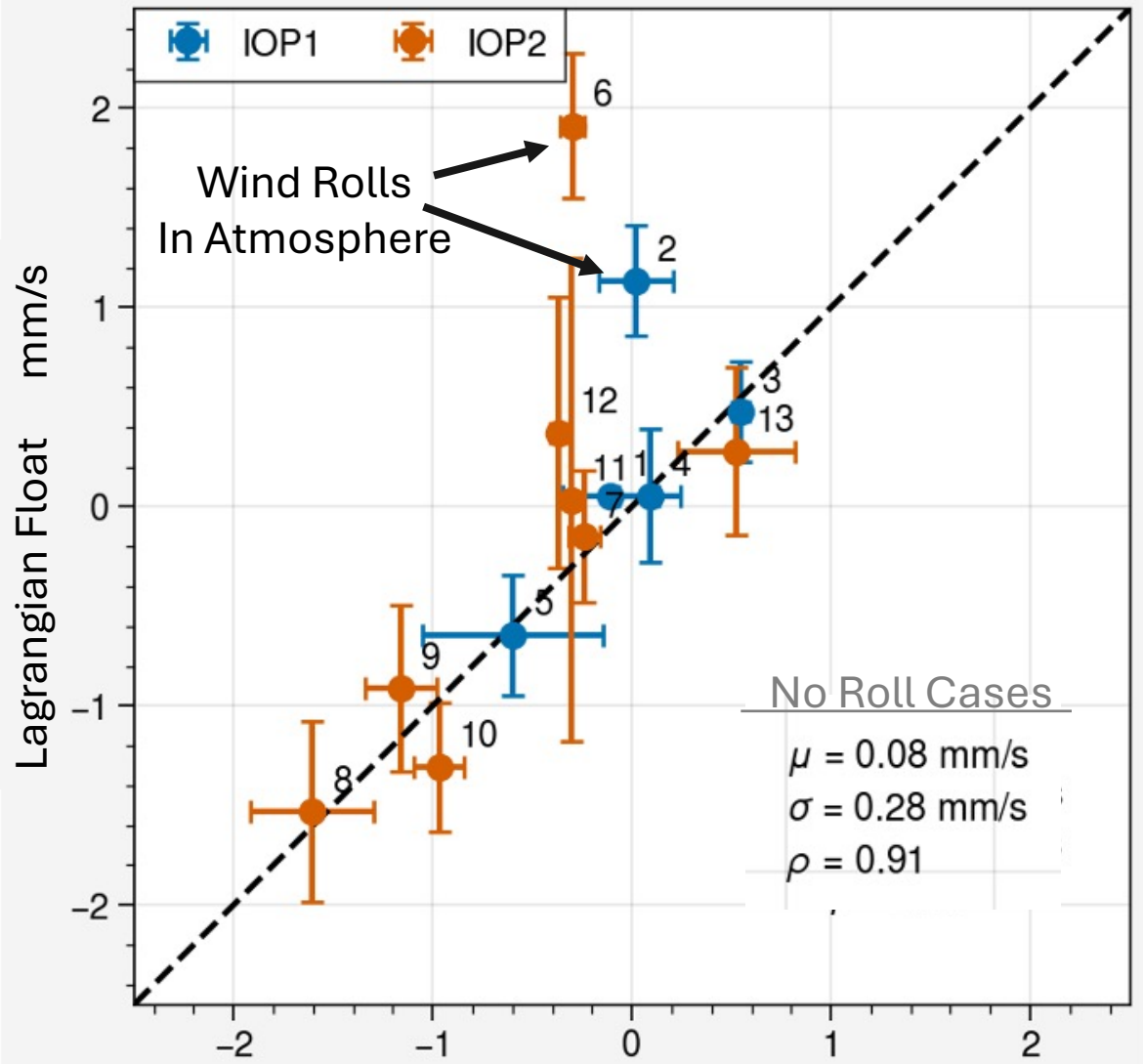


Frequency Spectra



Vertical Velocity

Averaging 2 km, 2-3 hours



DopplerScatt and Floats can measure vertical velocity to an accuracy of ±0.3 mm/s

Can we validate SWOT W using these?

Typical vertical velocities averaged over 2 km and 2-3 hours are ~1 mm/s *(100 m/day)*

Surface divergence and vertical velocity at 15-50 m are correlated. **Why so deep?**

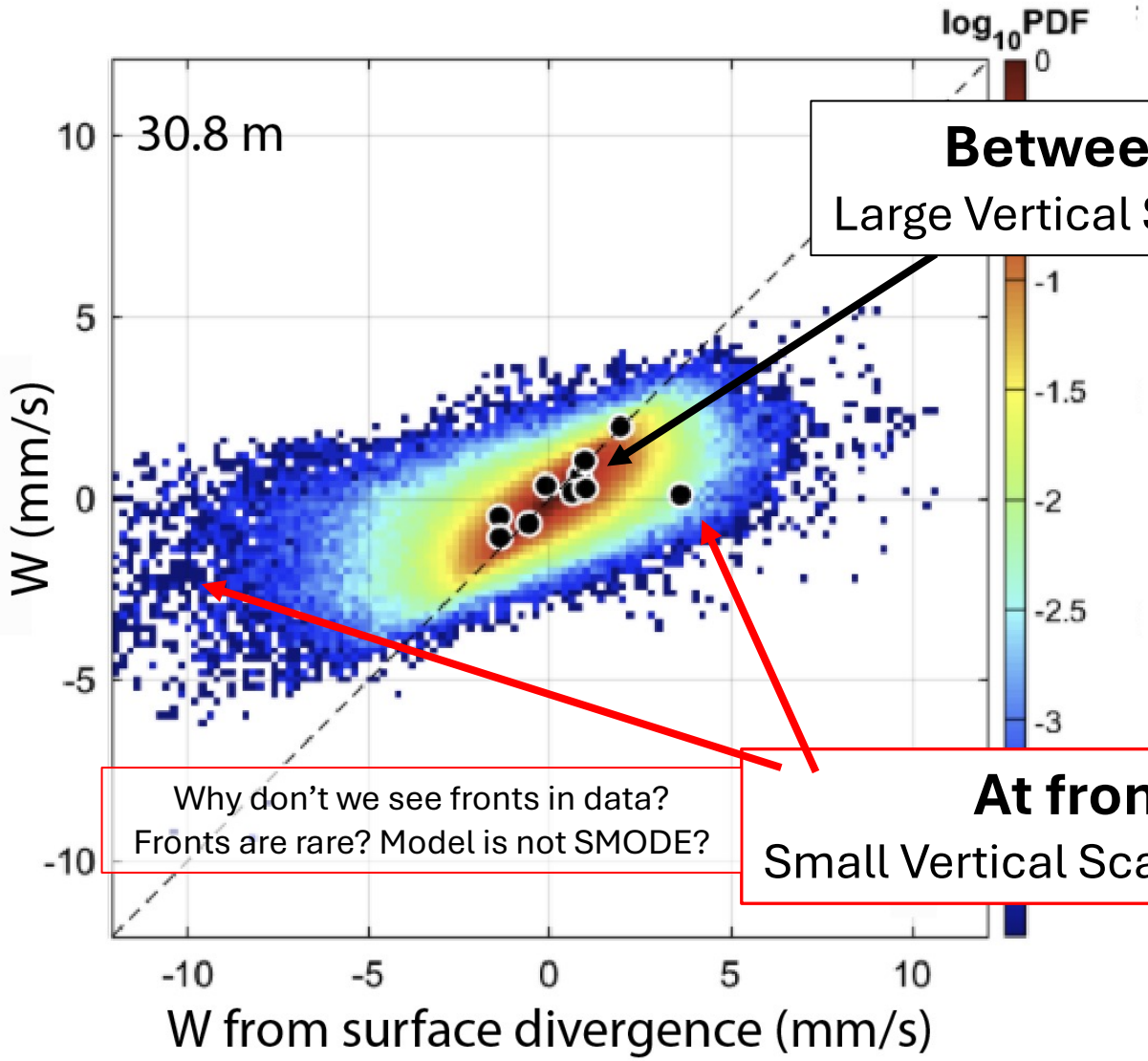
Some outliers occur during presence of small-scale atmospheric boundary layer rolls. **Submesoscale dynamics should include atmospheric forcing.**

DopplerScatt: Multi-Pass spanning 2-3 hours;GFMv3 Float:2-3 hour ADCP average.Depth 15-50; Errors from internal wave model

200m ROMS Simulation: Surface divergence usually predicts 30m W

< 1 mm/s 80%

But not at fronts



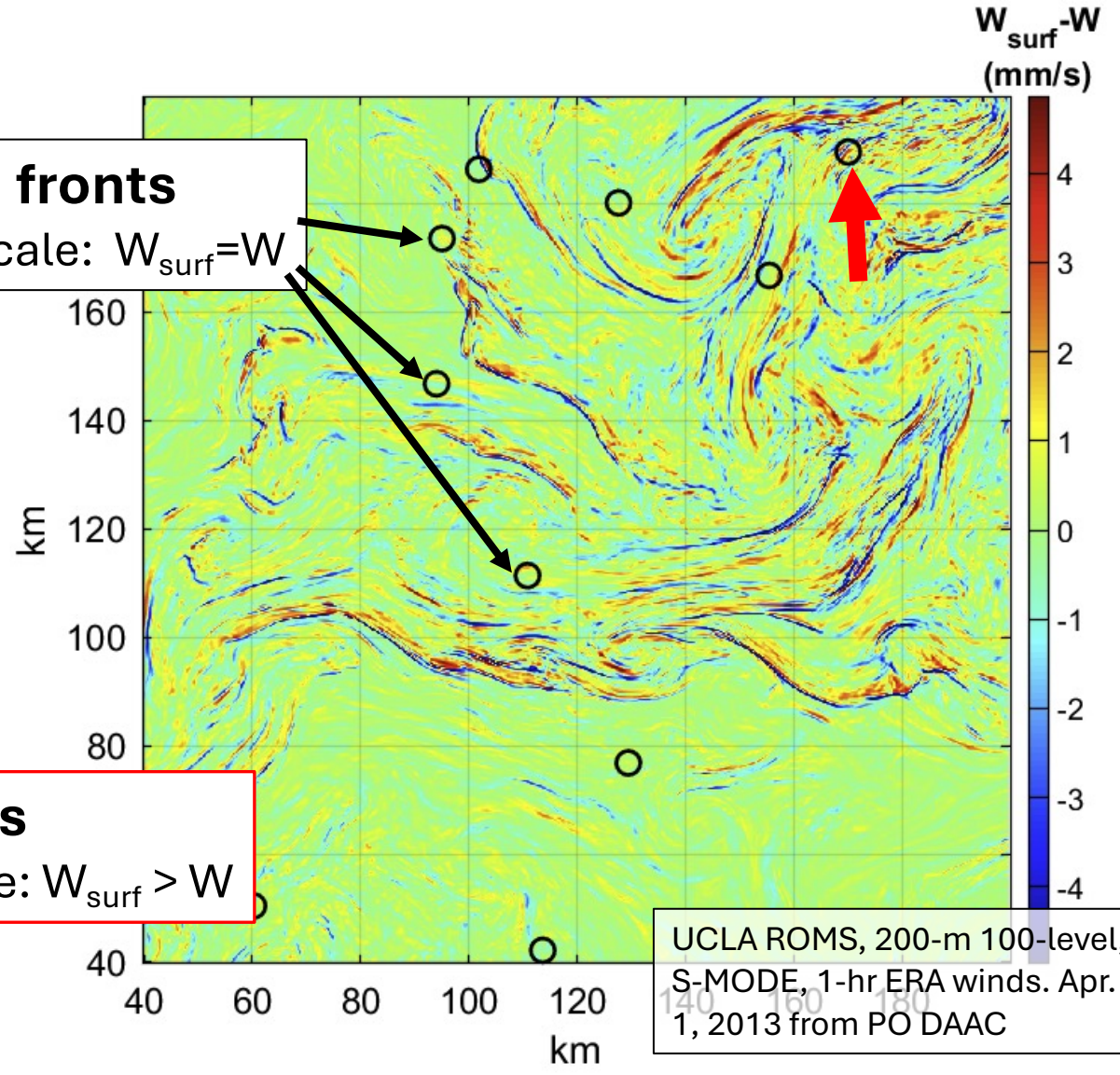
Between fronts

Large Vertical Scale: W_{surf}=W

Why don't we see fronts in data?
Fronts are rare? Model is not SMODE?

At fronts

Small Vertical Scale: W_{surf} > W



UCLA ROMS, 200-m 100-level, S-MODE, 1-hr ERA winds. Apr. 1, 2013 from PO DAAC

Implications for extracting upper ocean W from SWOT

In California current

Measured:

Typical W: 1 cm/s

Average W: 1 mm/s (over 2-3 hours, 2 km)

Near-N internal waves

Vertically coherent to 50m

Model:

Submesoscale frontal circulations

Shallow (20m) & Rare

Not measured by a few deep samples