

Daily to interannual variations of velocity and vertical shear in the tropical North Atlantic

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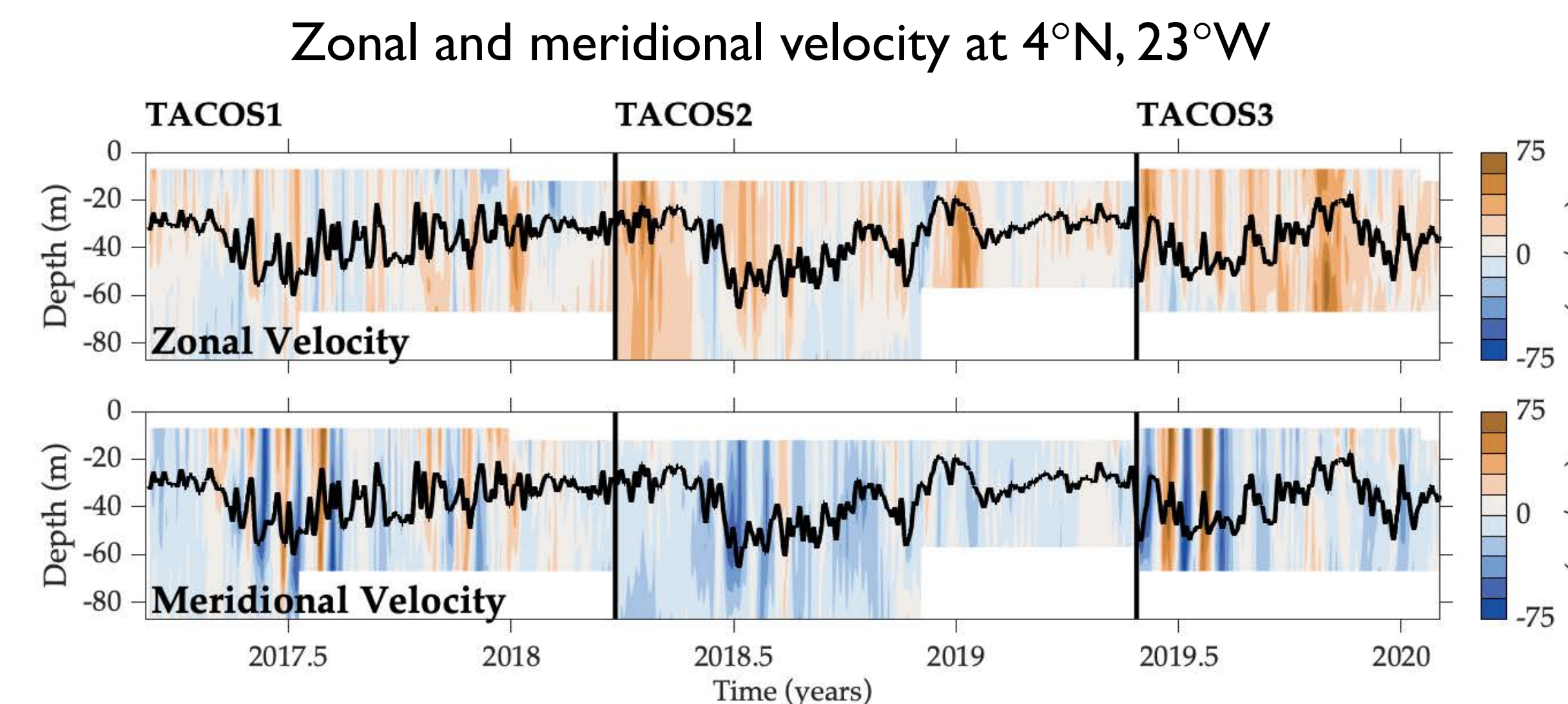


Acknowledgments:

Thank you to the scientists, engineers, research vessel crews, and NOAA and international agencies who support PIRATA. NOAA/AOML's Physical Oceanography Division provided support for TACOS. PIRATA mooring data can be found here: www.pmel.noaa.gov/pirata/

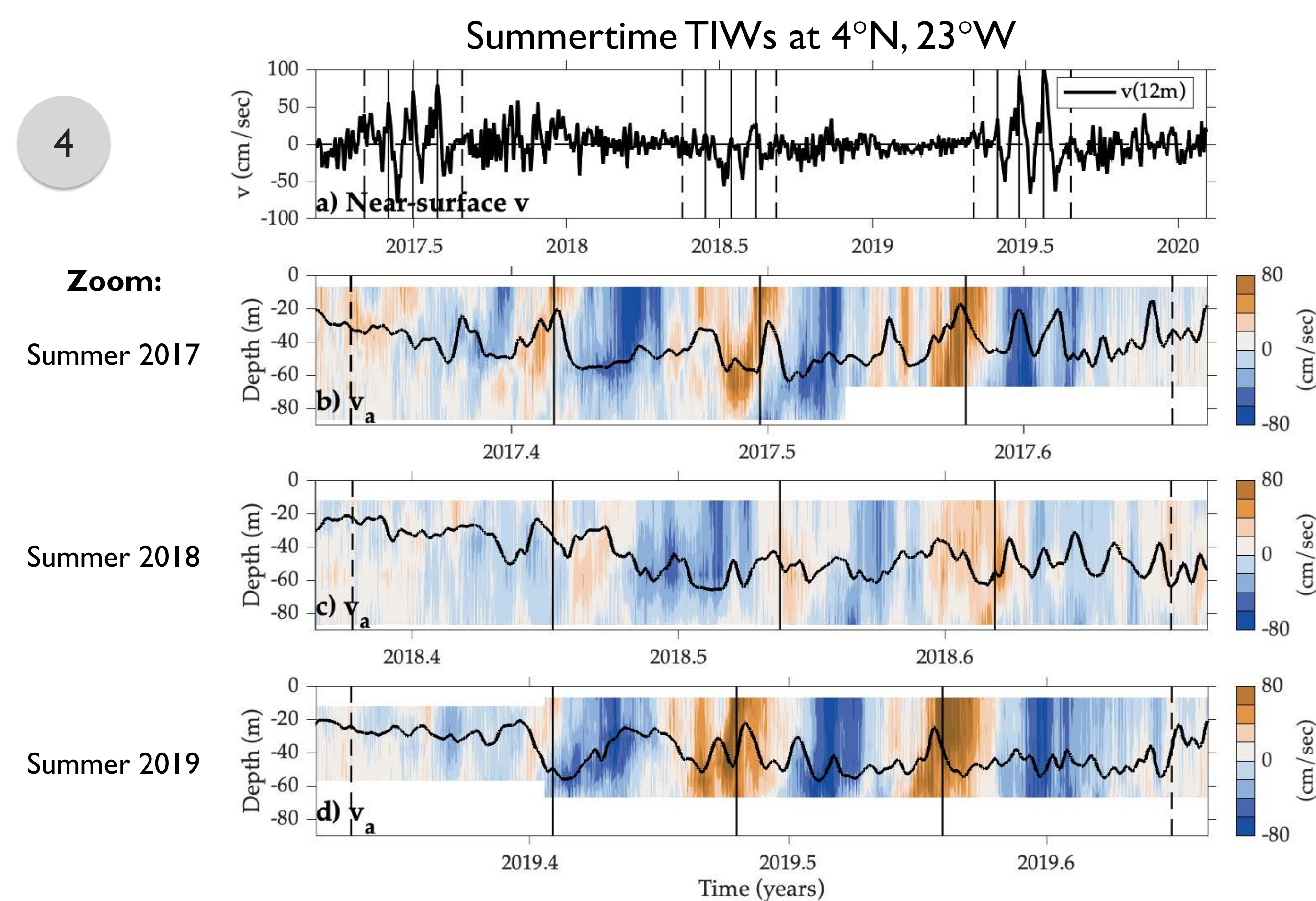
Changes in upper ocean currents influence temperature, salinity, and air-sea fluxes in the tropical North Atlantic, which in turn affect the weather, climate, and fisheries of the surrounding continents. The Prediction and Research Moored Array in the Tropical Atlantic (PIRATA) consists of eighteen moorings that have been used for climate research, numerical weather prediction, and ocean forecasting for over two decades. The Tropical Atlantic Current Observations Study (TACOS) measured upper ocean currents and vertical shear from March 2017 to January 2020 at the 4°N, 23°W PIRATA mooring near the boundary between the South Equatorial Current northern branch (SECN) and North Equatorial Counter Current (NECC).

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The mean currents are weak relative to strong high-frequency fluctuations associated with ~30 day tropical instability waves (TIWs), as well as near-inertial waves, internal waves, and tides. Despite the Atlantic zonal mode being anomalously warm, very energetic TIWs form in boreal summer 2017 and 2019 with up to 100 cm/sec meridional velocity perturbations.

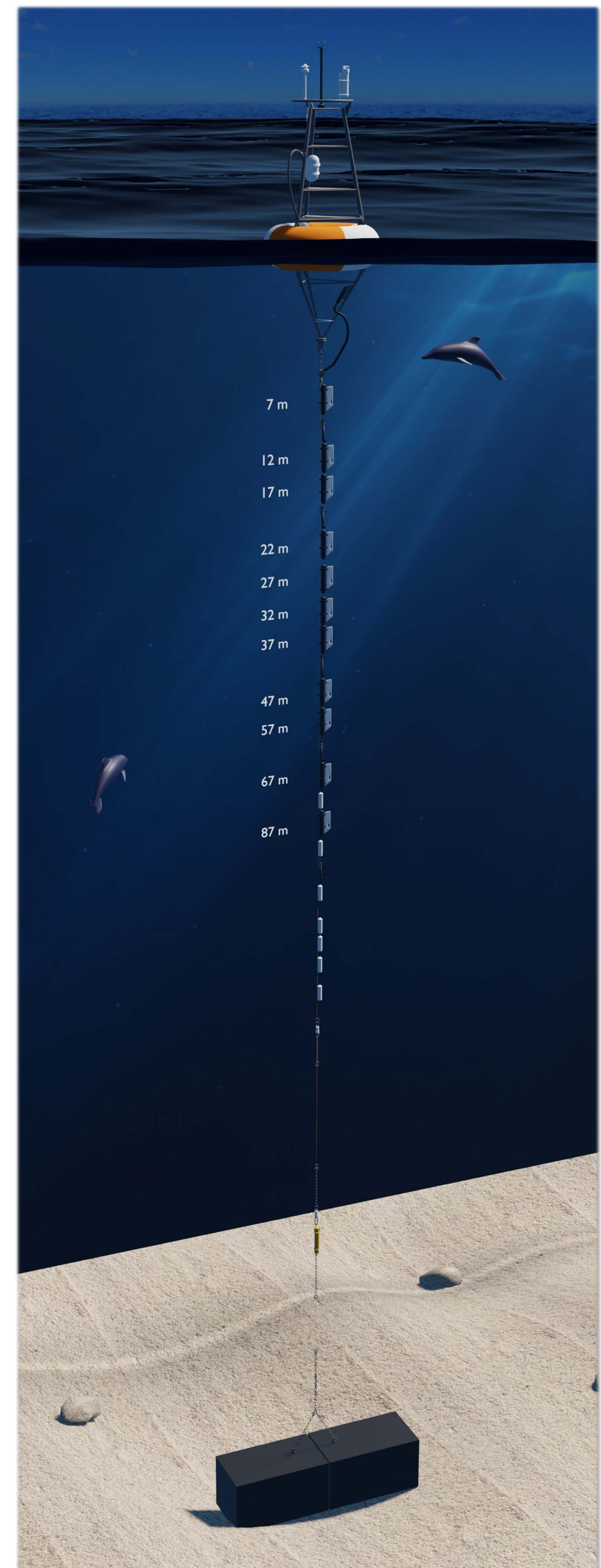
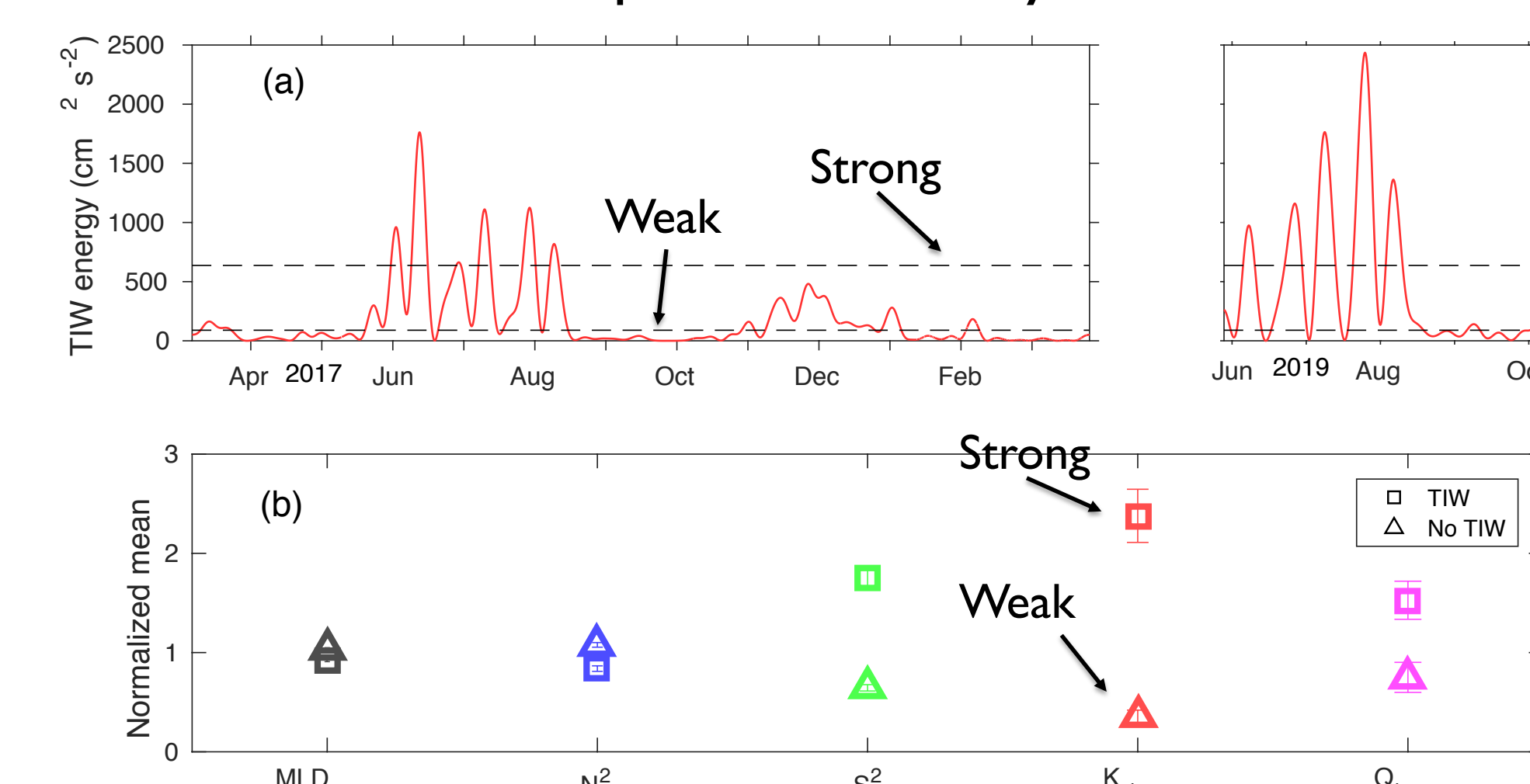
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TIWs are important because they are associated with elevated vertical shear. This enhanced vertical shear exists on fine vertical scales (< 10 m) and a reduced array with coarser vertical sampling would underestimate the shear. Shear from TIWs generates mixing and monthly mean cooling of 15-30 W m⁻² during summer 2017 and 2019 (Foltz et al., submitted to JGR).

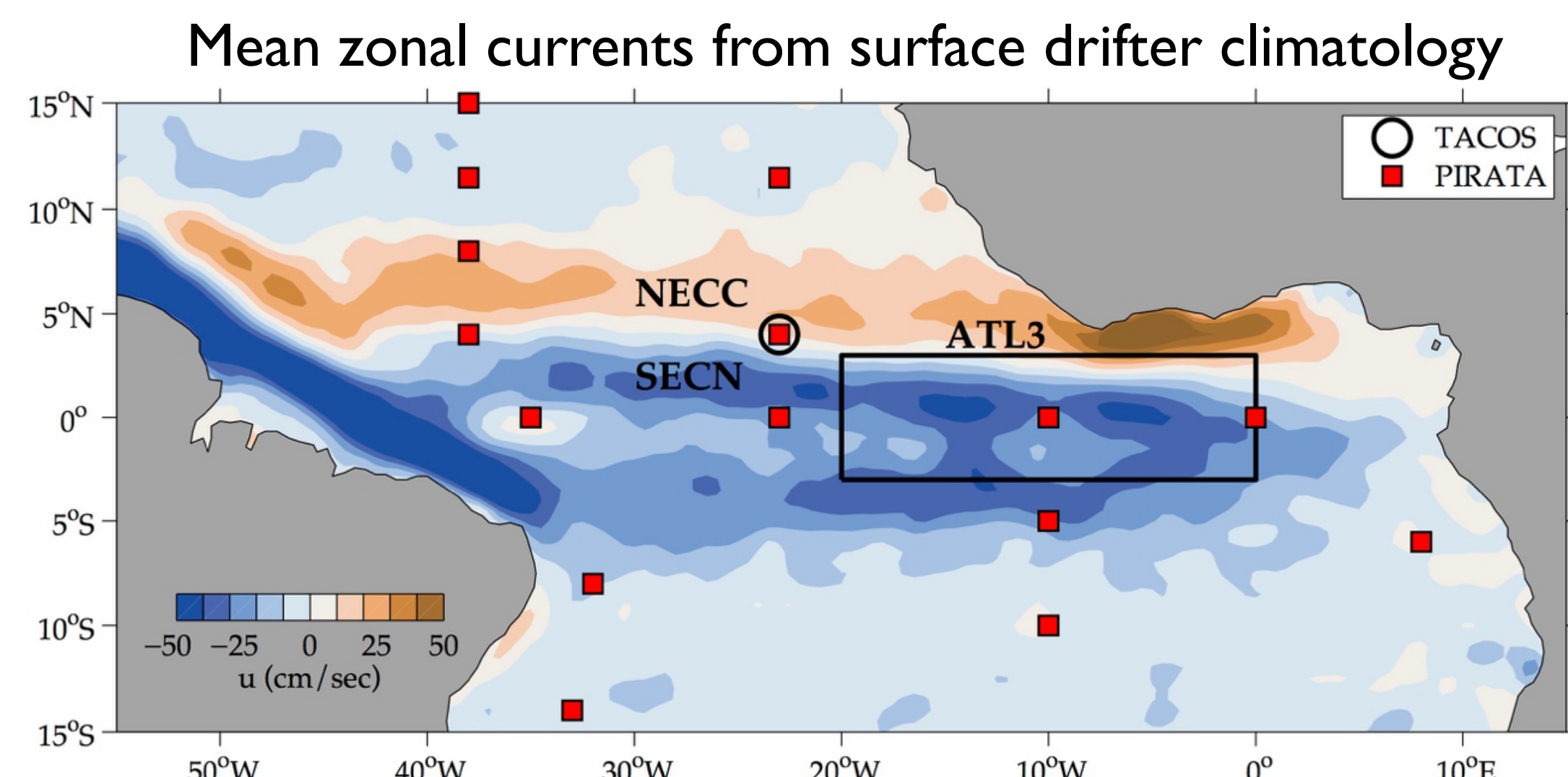
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TIW kinetic energy and composites of mixed layer depth, stratification, shear squared, diffusivity, and turbulent heat flux



TACOS full current meter configuration at 4°N, 23°W. During TACOS2 only 12m, 27m, 37m, 57m, and 87m were deployed. Image credit: Bertrand Dano.

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The record mean eastward currents (black line) are strongest (~13 cm/sec) near 37 m. The mean meridional currents are weak (~5 cm/sec) with northward flow near surface and southward flow below 12 m.

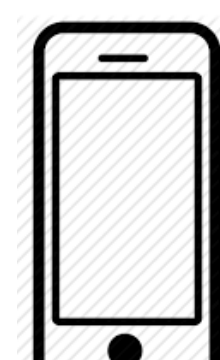
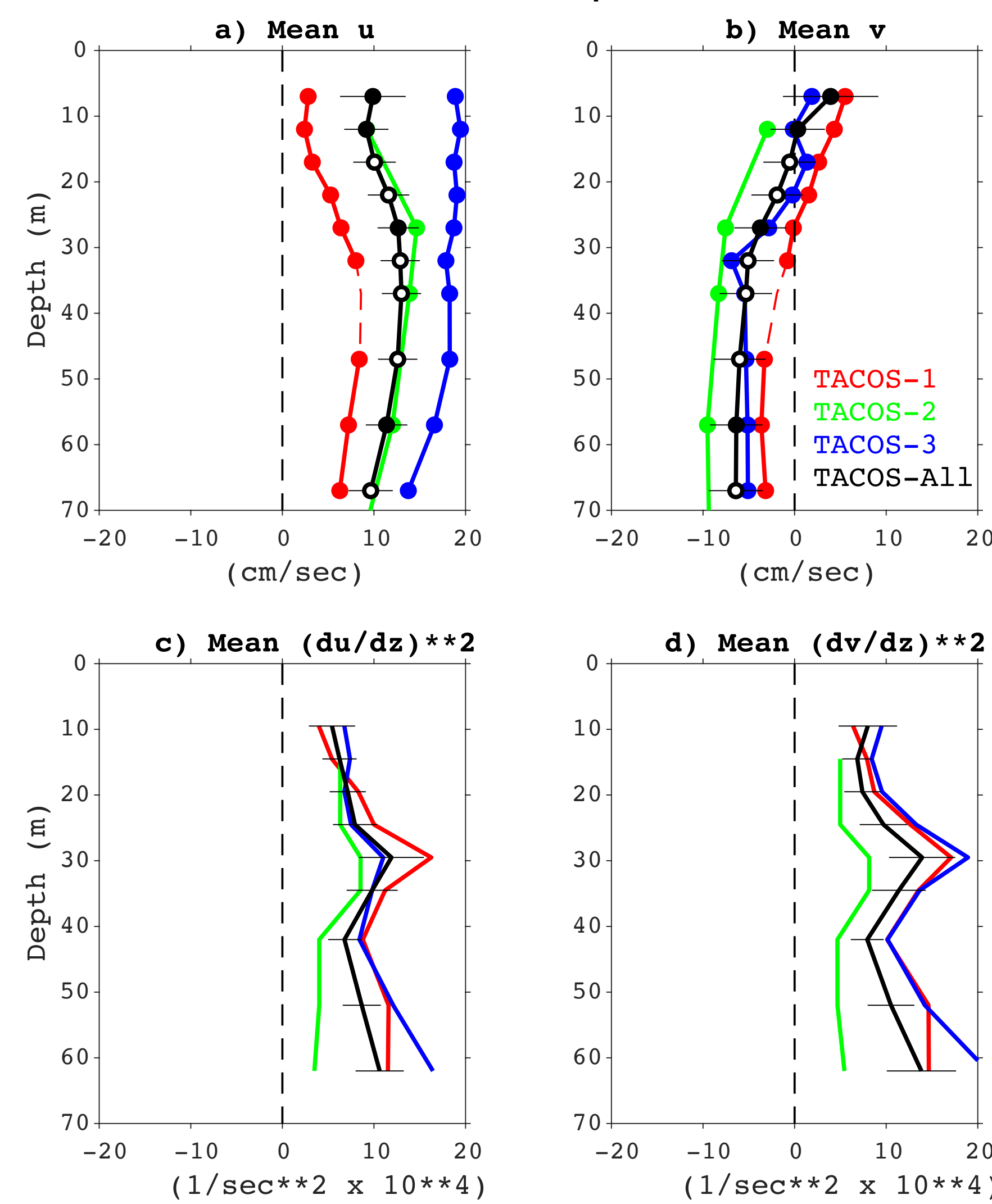
Maximum mean vertical shear is found near 30 m just above base of the mixed layer.

There is significant variability in the record means, with stronger southeastward flow in the last deployment (TACOS3, blue line) compared to the first deployment (TACOS1, red line).

The second deployment underestimates vertical shear (TACOS2, green line).

In this region, year-to-year variability of zonal velocity exceeds that of meridional velocity, is mostly geostrophically driven, and is influenced by SECN, NECC, and Atlantic coupled modes (Perez et al., 2019, JGR).

Mean currents and shear squared at 4°N, 23°W



Take a picture to download the paper using the first year of TACOS data:
Perez, R. C., G. R. Foltz, R. Lumpkin, C. Schmid, 2019: Direct Measurements of Upper Ocean Horizontal Velocity and Vertical Shear in the Tropical North Atlantic at 4°N, 23°W. *J. Geophys. Res.*, 124, 4133-4151, doi: 10.1029/2019JC015064.