Four years of velocity and vertical shear observations in the tropical North Atlantic

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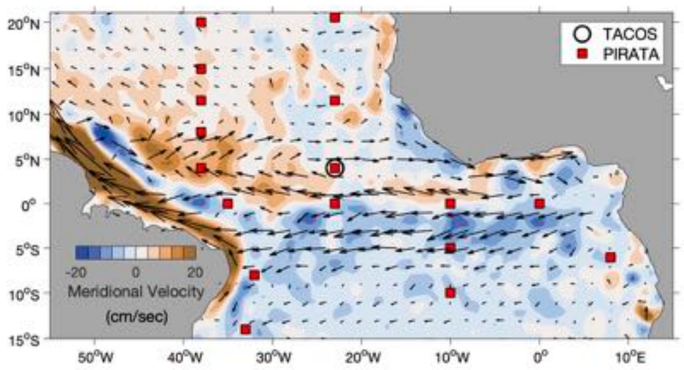
PIRATA mooring data can be found here: www.pmel.noaa.gov/pirata/

The Prediction and Research Moored Array in the Tropical Atlantic (PIRATA) consists of eighteen moorings in the tropical Atlantic that have been used for climate research, numerical weather prediction, and ocean forecasting for over two decades. The Tropical Atlantic Current Observations Study (TACOS) resolved for the first time the upper ocean currents and shear at the 4°N, 23°W PIRATA mooring from March 2017 to November 2020 (Perez et al., 2019; Foltz et al. 2020; Perez et al., in prep.).

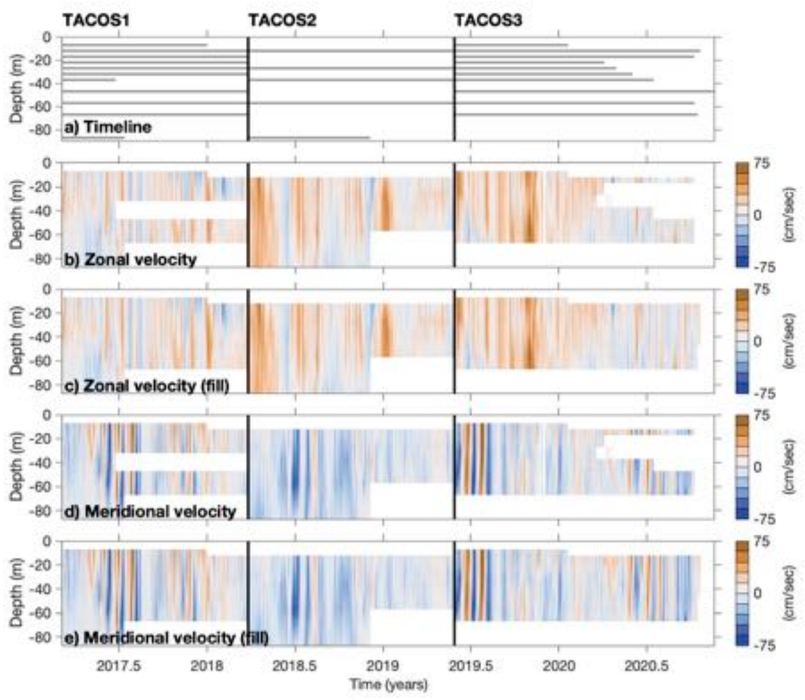
1

Mean currents from surface drifter climatology



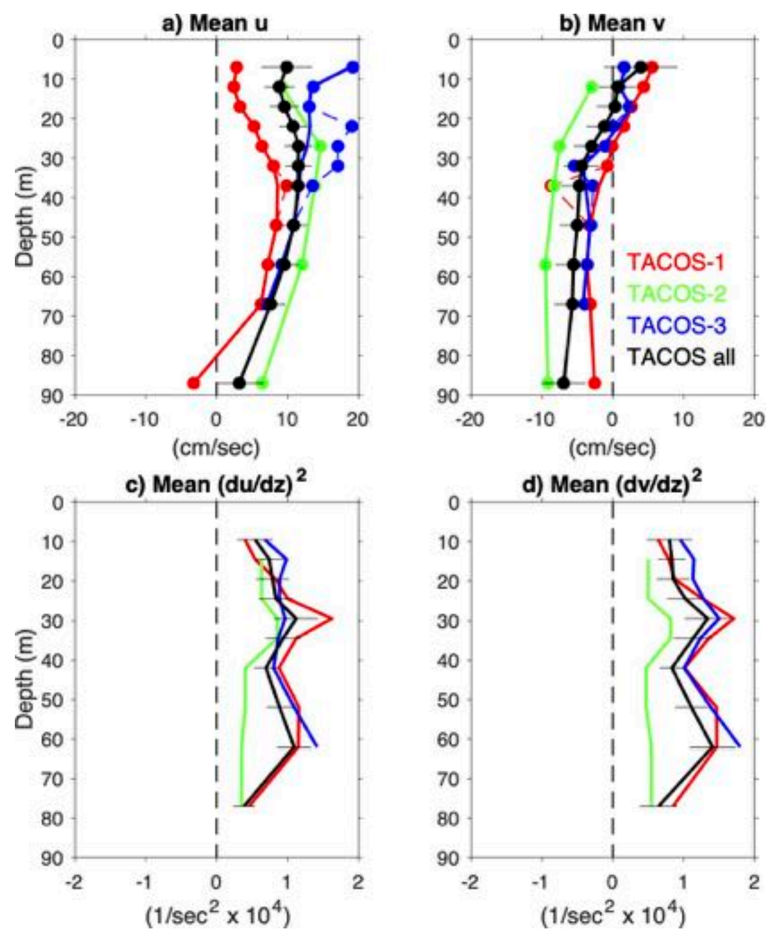
Time series of zonal and meridional velocity data collected during TACOS at 4°N, 23°W, and the gap-filling applied. A 5-day low-pass has been applied.

2



Mean zonal and meridional currents and shear squared at 4°N, 23°W during the three TACOS deployments.

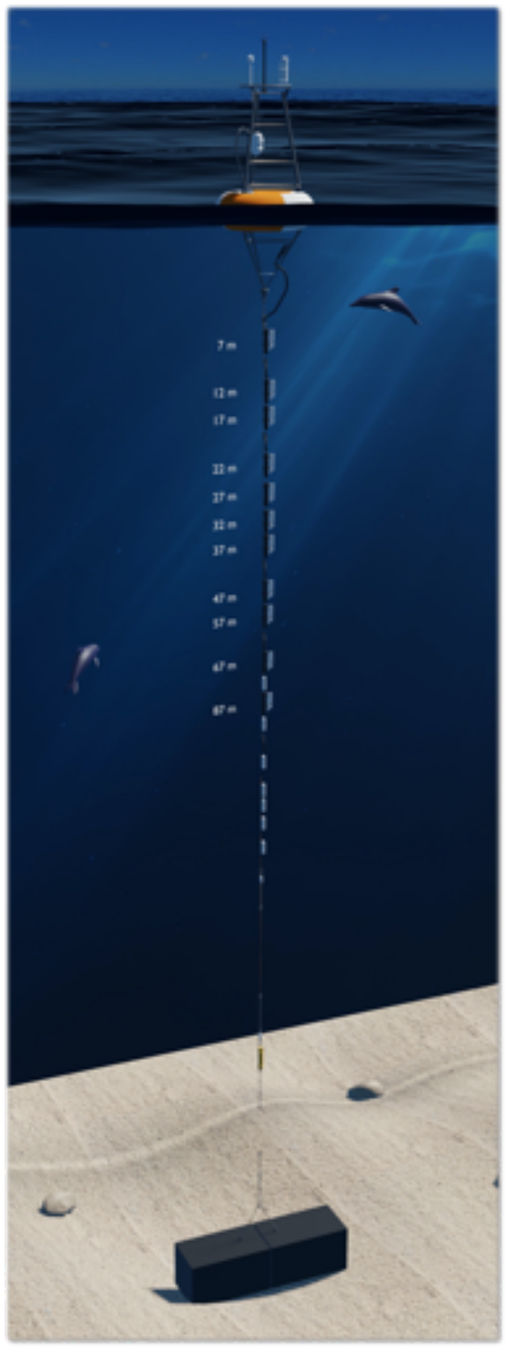
3



The mean zonal currents are eastward with maximum of ~12 cm/sec between 27 and 37 m. Maximum vertical shear squared is found near 30 m depth on average, just below the base of the mixed layer in winter and spring, and at 62 m associated with the summertime deepening of the mixed layer. At 4°N, zonal and meridional velocity contribute roughly equally to the shear squared.

Analysis of the second and third TACOS deployments confirms the significant interannual variability of zonal and meridional velocity in this region, with stronger eastward flow near the surface and stronger southward subsurface flow during those deployments compared to the first deployment. If we degrade the number of sensors from 11 to 5, the vertical shear squared during TACOS1 and TACOS3 decrease and nearly overlay on top of the TACOS2 vertical shear squared curve.

TACOS deployment at 4°N, 23°W.
Image credit: Bertrand Dano.



Aquadopps prior to first deployment in March 2017

TACOS Publications

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. *Journal of Geophysical Research Oceans, 124, 4133-4151,* doi: 10.1029/2019JC015064.

Foltz, G. R., R. Hummels, M. Dengler, R. C. Perez, and M. Araujo, 2020: Vertical turbulent cooling of the mixed layer in the Atlantic ITCZ and trade wind regions. *Journal of Geophysical Research Oceans*, 125, doi:10.1029/2019JC015529.

See Dr. Jonathan Christophersen's poster for more about TACOS diurnal variability!

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The seasonally varying currents are significantly smaller than velocity fluctuations associated with westward propagating tropical instability waves (TIWs), near inertial waves, and semi-diurnal variations. There is a weak semi-annual (annual) seasonal cycle in the near-surface (subsurface) currents.

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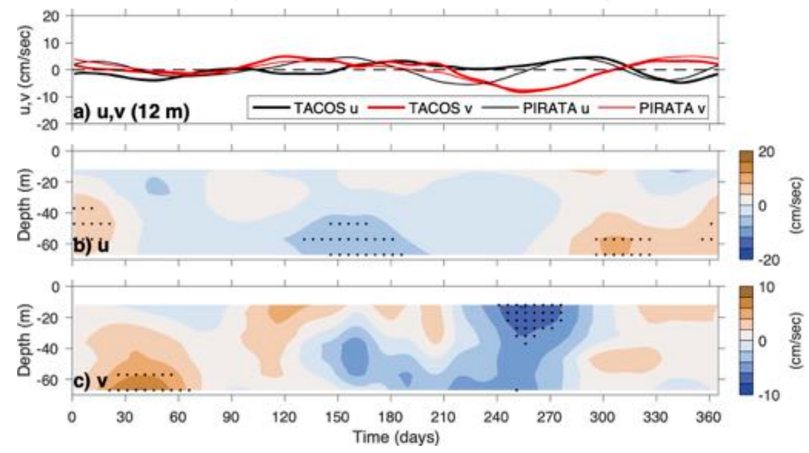
Seasonal Cycle of zonal and meridional velocity



Despite the Atlantic zonal mode being in a positive phase in 2017-2020, energetic summertime TIWs were observed with ±75 to 100 cm/sec meridional velocity fluctuations in 2017 and 2019. These signals can be seen in the first empirical orthogonal function (EOF) mode, which carries 85% of the variance, and strongly affects velocity in the upper 60 m.

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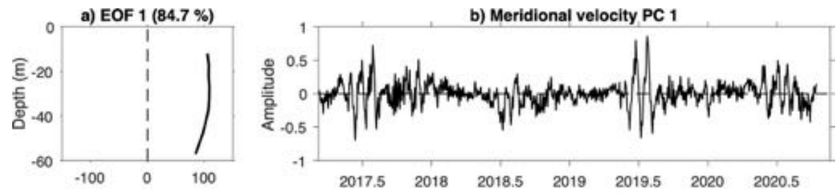

We examine more closely the structure of the summertime TIWs at 4°N, 23°W by forming TIW composites. The TIWs are aligned relative to maximum northward flow at the surface (black vertical lines) and averaged in nondimensionalized time coordinates. The individual TIW periods vary from 22 to 38 days, with a mean period of 28 days.

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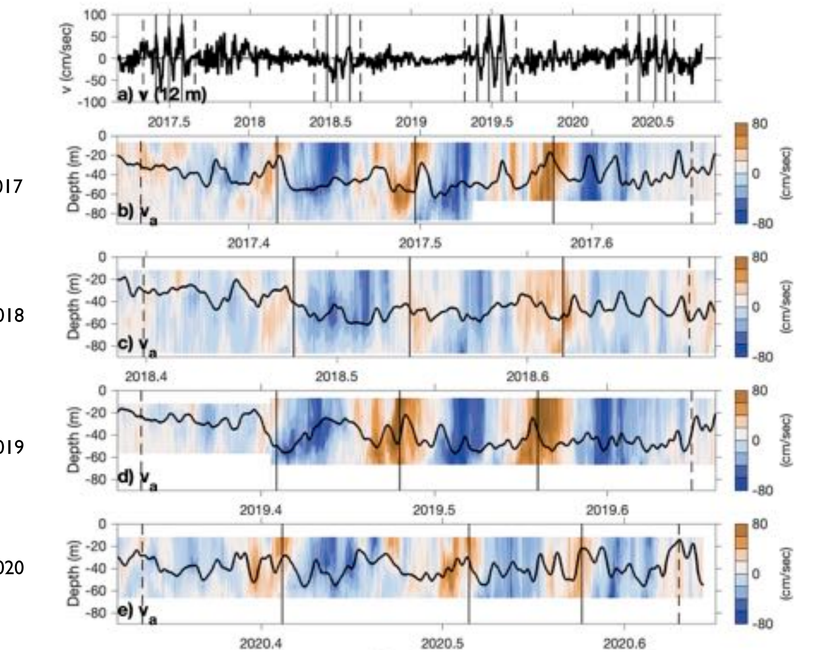

Summertime TIW composites reveal a robust meridional velocity structure in both stronger (2017, 2019) and weaker (2018, 2020) TIW years, although the amplitudes are twice as strong during 2017 & 2019. During strong events, there is enhanced du/dz and dv/dz which leads to elevated shear squared below 40m. This elevated shear squared migrates towards the surface during the northward phase of the composite TIW.

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