Small-scale variability of air-sea momentum and heat fluxes in the tropical Atlantic trade wind region

Oregon State University College of Earth, Ocean, and Atmospheric Sciences

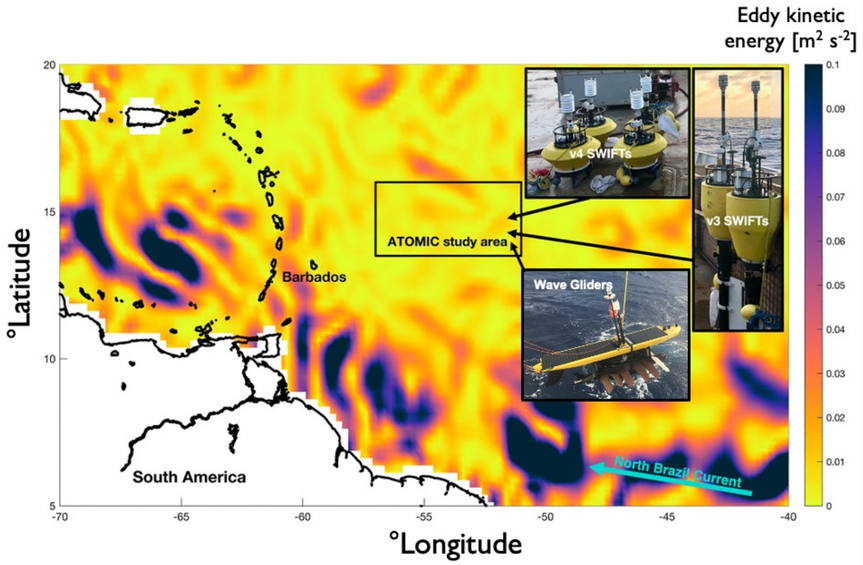
Suneil Iyer[1,*], Kyla Drushka[1], Jim Thomson[1], Elizabeth Thompson[2]

[1]Applied Physics Laboratory, University of Washington; [2]NOAA Physical Sciences Laboratory

[*]Now at College of Earth, Ocean, and Atmospheric Sciences, Oregon State University

The ATOMIC Field Campaign:

- January-February 2020
- Observations made in the NW tropical Atlantic trade wind region north of the coastal area with coherent mesoscale activity



Observations from 6 SWIFT drifters and 2 Wave Gliders:

Air : T, humidity, wind, P, clouds

Fluxes: heat, vapor, buoyancy, momentum

Ocean: T, S, currents, wave parameters, wave spectra, TKE dissipation rate

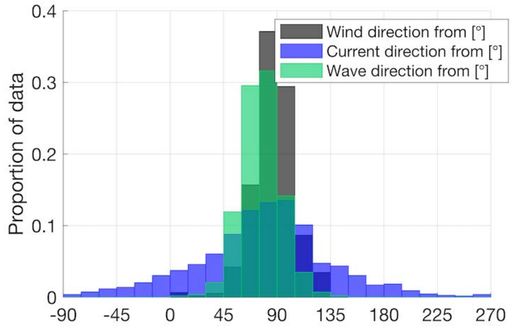
*SWIFTs (WGs) deployed for 21 (30 and 34) days

Research Questions:

1) ***Do variations in the surface current direction and magnitude influence waves and momentum flux?***

2) ***Do sea surface temperature (SST) variations influence air-sea heat and buoyancy flux?***

Air-sea momentum flux is modified by the wave-relative current

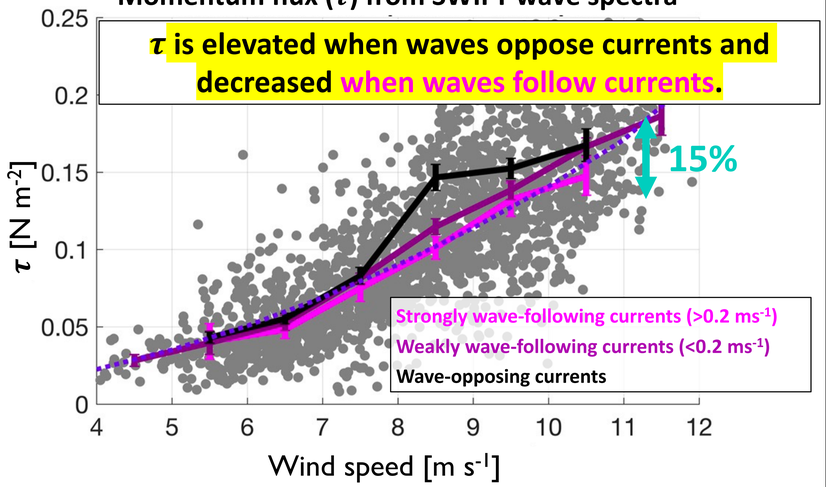


Wind and waves are consistently from the east (trade winds), but surface ocean currents are more variable and sometimes opposed the wind and wave directions.

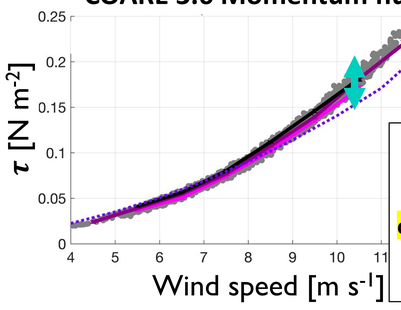
In theory, waves should steepen and momentum flux should be elevated when currents oppose the wind and waves due to changes in relative wind and a Doppler shift caused by wave-current interactions.

Momentum flux (τ) from SWIFT wave spectra

τ is elevated when waves oppose currents and decreased when waves follow currents.

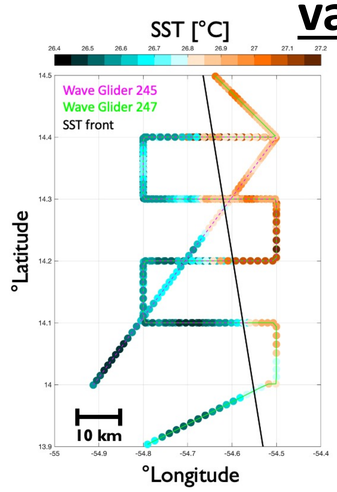


COARE 3.6 Momentum flux (τ)



The spread in observed τ is greater than COARE-calculated τ. This suggests that both the current-relative wind and wave-current interactions (not parameterized by COARE) create significant small-scale variability in τ.

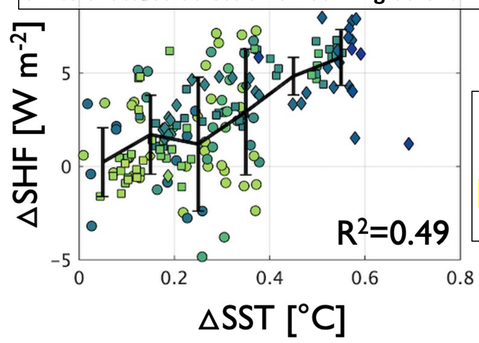
Air-sea heat flux is modified by SST variability



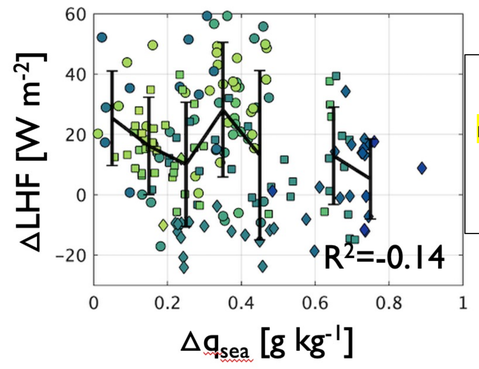
Significant variability in SST was observed, with variations of up to 0.8°C across scales of tens of kilometers such as in the example on the left.

SST changes would theoretically influence air-sea sensible heat fluxes (by modifying the air-sea temperature difference) and latent heat fluxes (by modifying the sea surface saturation specific humidity and air-sea humidity difference).

Δ = Difference between observations from SWIFT drifters located across a 10-100 km gradient



SST gradients are correlated with sensible heat flux gradients → ocean (SST) variability significantly modulates the spatial variability of sensible heat flux.



Sea surface saturation specific humidity ($q_{sea} \propto$ SST) gradients are not correlated with latent heat flux gradients → the atmosphere primarily modulates the spatial variability of latent heat flux.

E-mail: iyersu@oregonstate.edu

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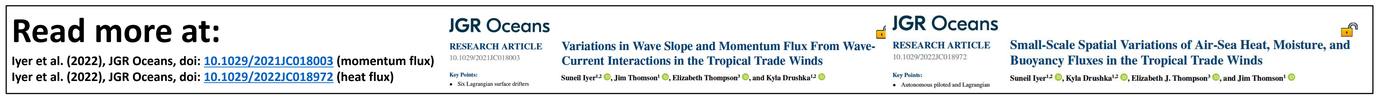
Read more at:

Iyer et al. (2022), JGR Oceans, doi: 10.1029/2021JC018003 (momentum flux)
Iyer et al. (2022), JGR Oceans, doi: 10.1029/2022JC018972 (heat flux)



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