EXAMINING SST-WIND STRESS COUPLING IN THE VICINITY OF OCEAN FRONTS USING SHIP-BASED DATA

What causes faster winds over warmer waters?
Taking a closer look with high-resolution research vessel data

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This study uses 1-minute averaged ship-based data to perform cross-front momentum budget analysis, with the hope to observe smaller scale air-sea interactions. ERA5 data is used to determine the orientation of SST fronts and for qualitative analysis of the regime based on previous studies.

DATA ACQUISITION

Research vessel cruises that cross strong SST fronts were identified. Transits of the Gulf Stream and the Antarctic Circumpolar Current (ACC) were chosen to capture a variety of regimes (strong/weak cross-front wind, high/mid latitudes).

The SST gradient direction at the point that the ship crossed the front was calculated from reanalysis data. This served as a vector to calculate "cross-front" and "along-front" axes, shown on the plots in orange and cyan, respectively.

The ship's track is shown in red. The region along the track encapsulated in red contains a plot of ship-measured sea temperature. All other plotted variables are time mean ERA5 data.

The polar plots show the ship-measured wind speed and direction. The cross/along-front axes are included here to show the wind direction relative to the SST front.

DIAGNOSTICS

Pressure Adjustment (PA) Mechanism

When a sharp SST front strongly modifies the overlying air temperature, hydrostatic pressure anomalies form across the front, which can be seen in the MSLP Laplacian. The good correspondence between the MSLP Laplacian and the sign-reversed SST Laplacian in the Gulf Stream plots indicate that these pressure anomalies are caused by surface heat fluxes (Takatama et al., 2015), while this not the case for the ACC plots. This suggests that the PA mechanism is significantly more important for the SST-wind stress coupling in the Gulf Stream crossings.

Downward Momentum Mixing (DMM) Mechanism

The curl of the DMM mechanism momentum input is strongly correlated to the sign-reversed crosswind SST gradient, and the convergence of this momentum input is strongly correlated to the sign-reversed downwind SST gradient (Takatama et al., 2015). This is to say that the orientation of the background wind relative to the front is important for how this mechanism influences the SST-wind stress coupling.

Coriolis Mechanism

This mechanism was examined with modeling experiments in Spall 2007. The criteria for this mechanism to be significant are high latitudes and strong cross-front wind. We were able to find a crossing of the ACC with consistent wind speed and direction and isobars perpendicular to the front. These conditions result in the distance over which the Coriolis term adjusts to its new balance being much larger than the width of the front itself. As was shown by Spall, under the right conditions, the momentum input from mechanism can be dominant in the SST-wind stress coupling.

RV Ronald H Brown		RV Laurence M Gould	
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