The Diurnal Cycle of Near-Surface Stratified Shear Flow at 0°N, 23°W

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The EMP spans the two seasonal regimes. **Normal Trades**: From Oct. – Dec., the diurnal SST amplitude is low, wind stress is high, and shear on the upper flank of the equatorial undercurrent (EUC) leads to increased $\text{SH}_{\text{mix}}$ above 50 m. **Warm Period**: From Jan. – May, diurnal SST amplitudes increase, along with increased climatological climatological SWR, upwelling, and near-surface shear. This mixed layer is shallow, and vertical advection of the EUC creates a thin layer of near-surface $\text{SH}_{\text{mix}}$ directly below the MLD. This thin shear region modulates the diurnal SST response through mixing, allowing basin scale ocean dynamics to interact with the locally forced response.

Mixed Layer Dynamics

**Normal Trades**: Solar heating of the near-surface layer increases stratification, leading to a shallow mixed layer aligned with the wind stress (Fig. 4, left). Minimum near-surface $\text{SH}_{\text{mix}}$ and near-surface anomalies are found at 14:00 local. Diurnal heating is spread through the near-surface layer, limiting diurnal SST anomalies in most cases. Non-shear sources reach as high as 23 cm $^2$ s$^{-2}$ relative to 20 m in currents, increasing late afternoon values of $\text{SH}_{\text{mix}}$ (4, below). The diurnal cycle of radiation is evident in both $\text{SH}_{\text{mix}}$ and near-surface eddy viscosity (A), (Fig. 4, bottom).

During nighttime hours, the surface heat flux changes sign, and the mixed layer deepens and cools rapidly due to convective overwarming.

**Warm Period**: Maximum diurnal $\text{SH}_{\text{mix}}$ amplitudes are found in January-May, reaching approximately 0.15°C. During this period solar heating is reduced, however wind stress leads to reduced mixing. Accordingly, the mixed layer is shallower, with diurnal temperature anomalies isolated in the upper few meters, returning near maximum values until shortly after the surface heat flux changes sign at 17:00 local. Near-surface $A_{\text{sh}}$ shows little diurnal variability, and is an order of magnitude smaller than during trade wind conditions.

Vertical advection of the EUC results in a near-surface layer that is highly sheared throughout the diurnal cycle. High stratification leads to a stable surface layer (Fig. 7), below, with isopleths of $\text{SH}_{\text{mix}}$ oriented horizontally. The increased shear in this regime results from both basin scale ocean dynamics, rather than local forcing, and has been shown to modulate the local diurnal SST response.

**Fig. 4**: Comparative skew plots of wind stress squared (red), shear squared (black), and mixed layer depth. (a) Ensemble averaged shear skew, and (b) shear skew normalized to individual shear depth and local $\text{SH}_{\text{mix}}$ values. (c) Water column skewed shear averaged over the phase-averaged period. (d) Mean shear skew for the phase-averaged period. (e) Mean shear skew for the warm phase.

**Fig. 5**: Comparative skew plots of wind stress squared (red), shear squared (black), and mixed layer depth. (a) Ensemble averaged shear skew, and (b) shear skew normalized to individual shear depth and local $\text{SH}_{\text{mix}}$ values. (c) Water column skewed shear averaged over the phase-averaged period. (d) Mean shear skew for the phase-averaged period. (e) Mean shear skew for the warm phase.