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Characterizing the Effects of Non-stationarity on the Marine Atmospheric Surface Layer during CASPER-West

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5.4: Characterizing the Effects of Non-stationarity on the Marine Atmospheric Surface Layer during CASPER-West

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Renaissance Oklahoma City Convention Center Hotel - Meeting Room 19-20

The Monin-Obukhov similarity theory (MOST) proposed that: given a logarithmic boundary layer, the gradients of the mean wind velocity, temperature, and water vapor within the surface layer are self-similar and universal functions of stability, respectively. While MOST is empirically supported, under certain conditions it has been demonstrated that the complex dynamics at the air-sea interface can erode the validity of the theory's fundamental assumptions of homogeneity, stationarity, and no flux divergence. These limitations present a significant challenge to developing a general understanding of the MASL and therefore, further investigation is needed to address this critical gap. As part of this effort, the large-scale and field-based project, Coupled Air-Sea Processes and Electromagnetic ducting Research (CASPER), was specifically under-taken to provide new insights into the dynamics within the MASL combining the state-of-the-art measurement abilities of research vessels, platforms, and autonomous vehicles.

This presentation will focus on the atmospheric and wave measurements made from an air-sea interaction mast mounted on the R/P FLIP during the second CASPER field campaign, which took place offshore of Southern CA during September and October of 2017. FLIP is an ideal platform for making undisturbed near-surface observations and reduces the operational challenges associated with making detailed measurements at sea from conventional research vessels. The platform was moored at 33° 41'20.40" N, 118° 59'24.00" W, which is 58 km southwest of Santa Monica and east of the Pt. Mugu Naval Sea Range, and was oriented into the seasonally-adjusted wind direction (~290°). The mast was installed on the port-side and comprised of 17 measurement levels representing overlapping bulk and flux profiles spanning from 3 m to 16 m above mean sea level. The 10 bulk-levels included two-dimensional wind and temperature/humidity probes. Six of the flux levels simultaneously measured the turbulent wind, temperature, and water vapor content, while the lowest level was only outfitted with a three-dimensional sonic anemometer. This recent FLIP data set represents one of the few extensive measurements of the near-surface water vapor gradient within the marine environment.

The objective of this study is to investigate the effect non-stationarity and local heterogeneity has on the air-sea fluxes and mean profiles of wind velocity, temperature, and humidity. Preliminary examination of the data revealed 17 non-stationary cases, which were visually identified as strong, coherent deviations from the nominal condition. These events were found to be transient, but long-lived enough (typically 1-3 hours) to justify not classifying them as spurious measurements. Additionally, a review of the imagery acquired from a high-resolution camera mounted on FLIP's face boom, showed the occasional presence of distinct short-wave anomalies (i.e. rough and smooth patches) advecting passed FLIP. During the campaign, some evidence indicated that these may be internal wave-driven surface expressions. The effects these surface discontinuities have on the fluxes and/or profiles within the MASL will be evaluated. The implications these non-stationary and locally heterogenic features have on the general dynamics and thermodynamics within the MASL will be discussed.

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