

ANALYSIS OF MARINE BOUNDARY LAYER PHASE II DATA

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LONG-TERM GOALS

The long-term goals are to understand and parameterize the basic physics of the wind, waves and associated temperature and humidity structure in the boundary layer over the ocean. This is done via direct measurements from the Research Platform FLIP of the wind profile, turbulence, waves and associated variables. Data from other experiments (coastal up-welling, tropical ocean (TOGA COARE), and over land) are used for comparison and extension to different regimes.

OBJECTIVES

The objective is to determine the applicability of similarity theories, which have been based on over-land measurements, to the surface layer over the ocean. New parameterizations will be developed for application over the ocean. We also are doing basic research on wind-wave physics.

APPROACH

A high-quality data set was obtained in April-May 1995 from R/P FLIP as a part of the Marine Boundary Layers ARI. A view of the instrumentation, which consisted of a vertical array of sonic anemometers for turbulence, 12 cup and vane anemometers for wind speed and direction, and associated measurements of wave height (courtesy of SIO) and fluctuating pressure (courtesy of NOAA ATD), is shown in Fig. 1. The 7 gb of data are analyzed with spectral, statistical and new techniques developed at UCI.

WORK COMPLETED

Detailed corrections have been made for the effects of the slight motion of FLIP and its boom on the measured velocities. These are important for some of the higher-order turbulent statistics. The work was done in conjunction with Dr. Jim Edson of WHOI.

The problem of the difference between the surface layer (i.e., about 10 m height) wind and stress directions was examined from the FLIP data set and, for reference, a data set

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from over land. For the FLIP conditions where winds and waves were steady, there appears to be alignment of the wind and stress vectors, which agrees with the over-land results and Ekman-layer theory. There are transient cases where there can be misalignment.

The Hilbert transform technique to examine phase differences between a turbulent signal and the wave height signal was developed further.

RESULTS

The results of the FLIP motion correction have shown that, while the motion of the wind velocity sensors is generally small, it is important for some statistics and low-wind conditions. Fig. 2 shows co-spectra before and after motion correction in a high wind case, where motion is not a factor, and in a low wind case where there are large corrections at the wave swell frequency.

The wind-stress angle difference for the period of the MBL II cruise is shown in Fig. 3, where the angle difference is shown as a Box Plot, which summarizes the spread of the data. For the main period of JD 123-128, the difference is near zero. In periods of wind speed transitions, the difference is large and of either sign.

The Hilbert transform technique has provided in-sight into the physics of wind-wave interaction. At small wave ages the phase is positive indicating pressure forcing of wave growth, while for large wave age (waves out-running the wind) the pressure force is near zero, and perhaps slowing the waves.

IMPACT

The results to date of the MBL II wind-wave analysis have clearly shown the effects of gravity waves on the overlying wind flow and their interactions.

TRANSITIONS

As a result of the MBL II analysis, I participated in two Workshops convened by the Naval Research Laboratory, Monterey, CA, and presented papers on wind-wave interaction.

RELATED PROJECTS

The analysis of the MBL II data has contributed to interpretation of results from other experimental data sets obtained over the ocean, in particular, TOGA COARE and the coastal up-welling experiments CODE and SMILE.

REFERENCES

The Web page is <http://wave.eng.uci.edu>

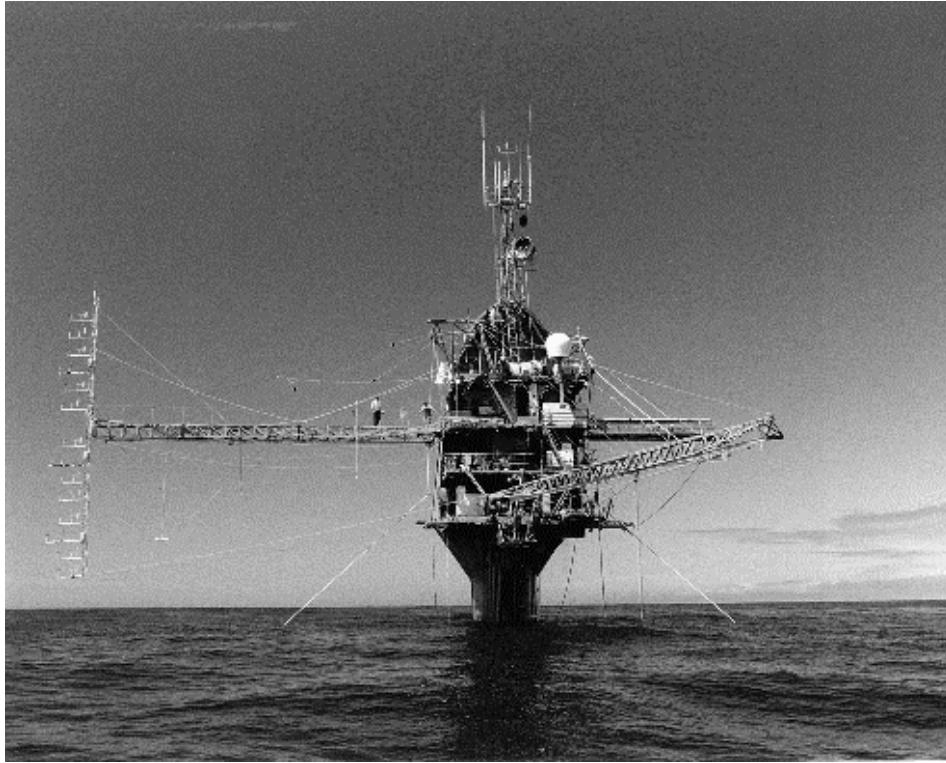


Figure 1. Photo of R/P FLIP deployed in the Marine Boundary Layers II experiment. The meteorological mast is on the left boom.

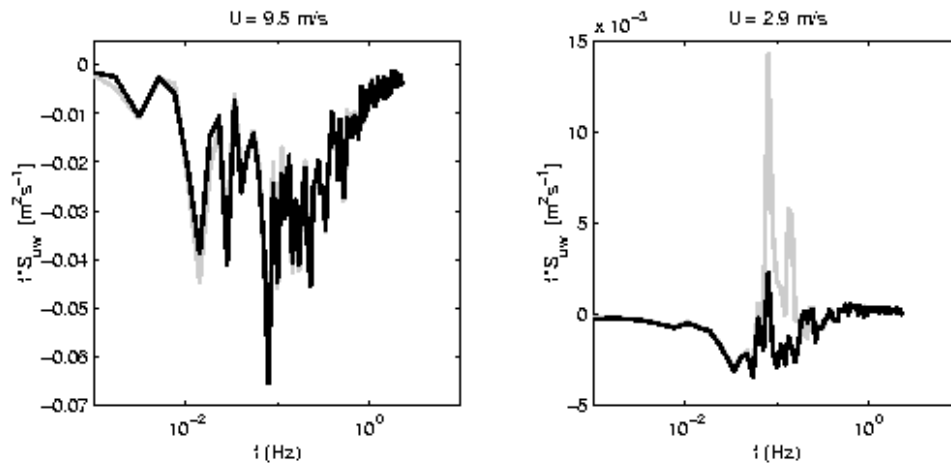


Figure 2. Wind stress co-spectra in high winds (left) and low winds (right) before (grey line) and after (dark line) motion correction. Motion correction is important in low winds and high waves.

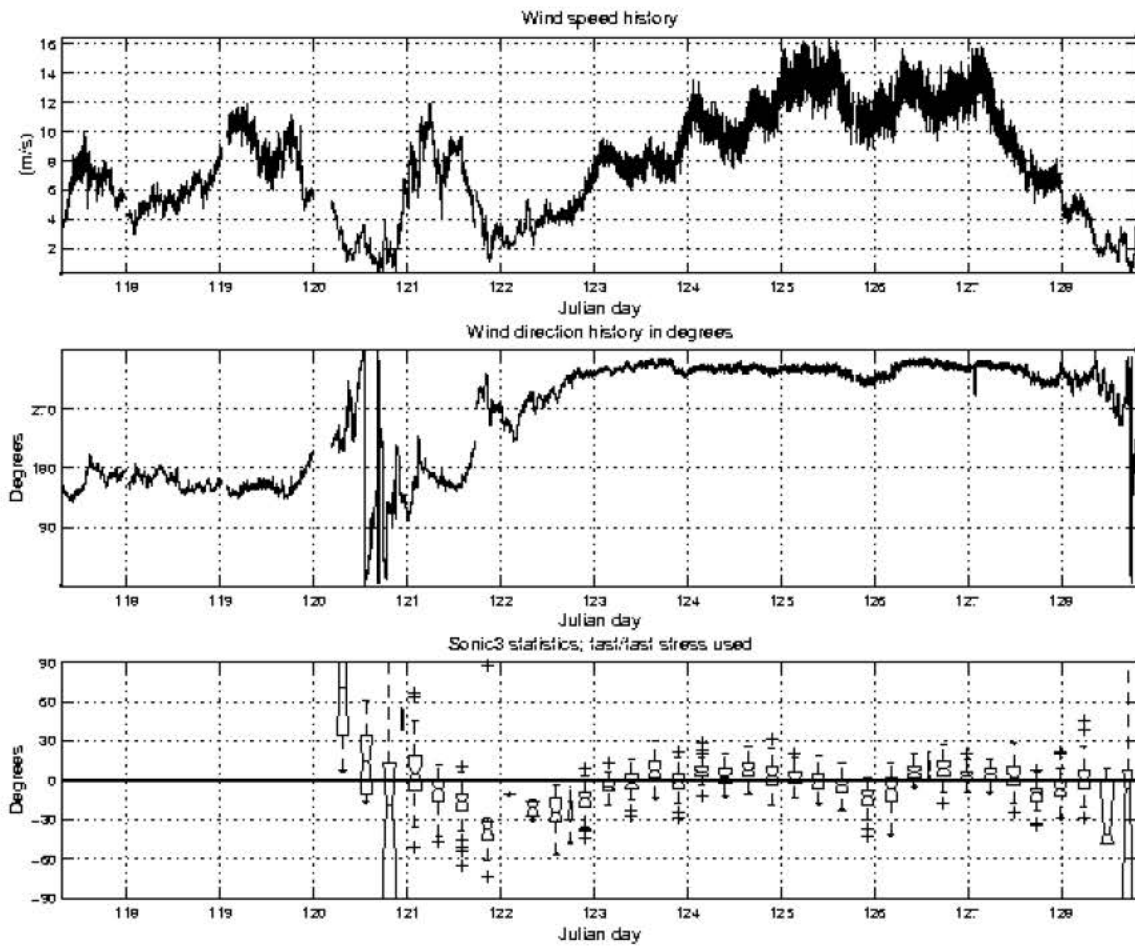


Figure 3. Time series of wind speed (top), wind direction (middle) and difference between wind and stress angles (bottom). The angle differences are shown as Box Plots, where the line throughout the center of the box is the mean, the ends of the box the upper and lower 25% quartile ranges and outliers are shown by the whiskers and points (+).