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Offshore and Internal Boundary Layers

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LONG-TERM GOAL

Our main goal is to separate the influences of stability, wave state, and internal boundary-layer development on air-sea surface exchange. This requires re-examination of the basic structures of internal boundary layers in offshore flow and the physics of their development.

OBJECTIVES

Our objective is to replace the present concept of the internal boundary layer with a more complete picture and eliminate the basic idealizations in the "textbook" internal boundary layer. We will then modify the standard bulk aerodynamic formulations to include the effects of internal boundary layers and wave state.

APPROACH

We are analyzing an expanded data set collected during the Risoe Air Sea Experiment. This field program includes a heavily instrumented tower 2 km off the Danish coast which provides detailed profiles of fluxes, wind, and temperature. We are also analyzing an early data set collected by a series of towers on a beach of a Frisian Island off the coast of The Netherlands. This data set, which has not been previously analyzed in any detail, interogates a heated internal boundary layer as cool air flows from the oceanic surface over the warm beach. We will also assess the utility of several other data sets.

WORK COMPLETED

Only one graduate student, Cheryl Klipp, has been hired to date and she has concentrated on processing the data over the heated beach. At the writing of this report, she has completed the very initial stages of the data analysis.

RESULTS

The initial analysis indicates that the internal boundary layer, as observed at a fixed location, can be intermittent due to variations in its depth. The flow over the beach provides the best opportunity for identifying the textbook internal boundary layer because the surface discontinuity is well-defined and the advected turbulence from the marine boundary layer over the new internal boundary layer is relatively weak and should not interfere substantially with the development of the internal boundary layer. We

will not be able to directly evaluate the bulk aerodynamic formulation with this data and will move on to additional data sets in the near future.

IMPACT/APPLICATION

Even under near-perfect conditions, the classical concept of an internal boundary layer requires modification, and coastal zone meteorology must be generalized accordingly.

RELATED PROJECTS

Analysis of offshore tower eddy correlation data is being carried out under grant N00014-98-0282 from the Office of Naval Research. This data set allows analysis of detailed vertical structure in the lowest 40 m whereas the above work concentrates on horizontal structure in the coastal zone.

Work on an ONR grant entitled "Spatial Variations of the Wave, Stress and Wind Fields in the Shoaling Zone" (N00014-97-1-0279) will conduct a field program at Duck, North Carolina in March of 1999. This program will concentrate on spatial variations in the coastal zone with offshore flow of warm air over cool water using the LongEZ aircraft.