Observations of Air-Sea Interactions over the Tropical Oceans

James B. Edson
Woods Hole Oceanographic Institution

Marine physicists have made significant progress in recent decades in our ability to directly measure surface fluxes from research vessels and specialized platforms such as the Air-Sea Interaction SPAR (ASIS) and the R/P FLIP. These platforms utilize Direct Covariance Flux Systems (DCFS) to remove platform motion from the measured wind speeds to measure the flux directly. Over the past decade or so, researchers have begun to collect long time series, O(year), of momentum and buoyancy fluxes from surface moorings. The instrumentation on these moorings experience less flow distortion and measure a wider variety of conditions given their longer deployments than typical for oceanographic air-sea field campaigns on research vessels.

The latest generation of DCFS have been deployed in the Tropics in field campaigns such as the multi-agency DYNAMO program and the recently completed NASA SPURS field program. A significant achievement was reached during SPURS with the inclusion of LI-COR infrared gas analyzers to make fast-response humidity measurements on a surface mooring. This represented the first extended measurement of direct covariance measurements of latent heat fluxes from buoy. Direct measurement of the latent heat flux allow researcher to isolate the sensible heat flux from the buoyancy flux measurements to study their behavior independently. This was accomplished by increasing the power available on the buoy using a deep well and additional batteries. Effects are currently underway to reduce the power requirements for fast-response humidity measurements for use on low-power platforms.

Advances in our ability to make direct covariance flux measurements from surface mooring are finding their way onto operational buoy arrays. For example, a joint effort between WHOI, NOAA-PMEL and NOAA-ESRL is being funded by the NOAA TPOS project has developed a DCFS that computes research quality fluxes in near realtime and telemeters them to shore. This capability allows research to be conducted during deployment and minimizes data loss due to system failure and vandalism. The DCFS is expected to be deployed on a subset of the next generation surface moorings as part of TPOS, which will include radiative fluxes, wave statistics and ocean currents along with more standard measurements of mean pressure, temperature, humidity, salinity and rainfall. The instrumentation developed for these platforms are now being deployed on more mobile platforms that include autonomous sailing drones and boats, wave-riders and expendable drifting buoys and spars.

These measurements are required to investigate the exchange of momentum, heat and mass across the coupled boundary layers with a key application being improvement of bulk turbulent flux parameterizations under all wind, sea-state and stability conditions. These bulk models find wide use in numerical modeling, in field process studies that rely on bulk fluxes from more readily available means, and in their use in global gridded air-sea flux products that combine model and satellite data. The lack of long-term, high-quality turbulent flux time series near the air-sea boundary during high wind and sea states is a long-standing and serious impediment to improved understanding of air-sea exchange. This talk will describe some of these advances in measurement technology used to measure air-sea fluxes over the tropical oceans, and provide examples of how this data is being used to improve our understanding of air-sea interaction under a wide-variety of conditions.