Past and Future Measurements of Air-sea Interaction, Upper-ocean Mixing, and Ventilation Pathways from High-endurance Autonomous Platforms

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Abstract: Autonomous platform capabilities now allow a wide range of long-term oceanographic experiments to be conducted with little user interference. Gliding and drifting subsurface profilers can reach a substantial fraction of the ocean depth, and autonomous surface craft can provide sustained measurements of atmospheric forcing, with the result that ships need hardly be involved (or, at least, can be freed up for more specialized uses)! Results are described from recent projects using an autonomous Lagrangian approach (horizontally drifting but vertically profiling EM-APEX floats [Stanford et al 2005] carrying CTD and velocity sensors, in addition to other options, including chlorophyll, turbidity, oxygen, microstructure, and acoustic positioning) to study vertical mixing, wind generation of internal waves, and lateral property fluxes.

Past

Wind Forcing and Near-Inertial Internal Wave Generation

Upper-Ocean Mixing

Density-based “Mixed Layer”

Implications for the seasonal cycle of mixed-layer depth and fraction of time in contact with the atmosphere

Subsurface Pathways from Isopycnal Drifts and Velocity Profile Measurements

(3) Surface velocity estimates from altimetry are an extremely valuable resource but may deviate substantially from subsurface drift paths—particularly, for critical diagnostics like eddy residence time and cross-frontal exchange.

Future

Some directions for new...
(A) vehicles and sensors
(B) autonomous sampling strategies
(C) long-duration overturning/ventilation targets

Cross-frontal shear and watermass ventilation—requires eddy structure, statistics, seasonal cycle.

(1) The role of high-frequency wind components in forcing both surface-layer mixing and near-inertial internal waves emphasizes the continued need for in-situ surface measurement platforms (Kilbourne and Girton 2015).

(2) Layers of active mixing diagnosed from high-resolution density profiles show that, frequently, only a small portion of the “mixed layer” is directly in contact with the surface—a fraction which varies with wind forcing events which may be shorter than the air-sea equilibration time (Kilbourne and Girton 2015a).

An autonomous array for simultaneous spatial and temporal sampling of surface forcing and subsurface response. Tuned for a particular dynamical process (at a particular scale).

Atlantic Meridional Overturning

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