A characterization of the Equatorial Undercurrent upon its approach to the Galápagos Archipelago

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PROJECT SUMMARY:

The objective of this proposed project plan is to characterize the flow of the Equatorial Undercurrent (EUC) upon its approach and subsequent bifurcation around the Archipiélago de Colón (Galápagos Islands). The three methods of data acquisition that will be employed are as follows. A combination of transects to the north, west, and south of Isabela Island will gather water flow data using a 75 MHz hull-mounted Acoustic Doppler Current Profiler (ADCP) on the R/V Thomas G. Thompson. Various Conductivity, Temperature, and Depth (CTD) casts, mounted with additional sensors, will profile stations along ADCP transects and elsewhere in Isabela's vicinity to profile the local water mass properties, namely, salinity, temperature, and dissolved oxygen. Finally, ARGOS and Iridium Drifters will be deployed in each bifurcated core of the EUC (one Drifter on the north side of Isablea, the other Drifter on the south side of Isabela) in attempt to identify the paths of the bifurcated EUC core flows. The importance of identifying the location, magnitude, and subsequent distribution of the EUC lies not only in improved parameterization, but also for the availability of data for comparison to other seasonal and interannual phenomena.

INTRODUCTION:

Though some meridional fluctuations are evident, once formed, the eastward propagation of the EUC west of the Galápagos is constricted to within two degrees latitude of the equator (Steger 1997) and exists at depths between 50 and 275 meters (Steger 1997). Roughly speaking, the EUC is a subsurface current about 200 meters thick and typically has maximum eastward velocities at a depth of 75 meters (Feldman 1984). The presence of the South Equatorial Current, which is about 15 meters thick and found above the EUC and is thickest north and south of the EUC (Felman 1984) complicates local circulation. Upon approaching the Galápagos, the core of the EUC (highest flow velocities and deepest subsurface extent) is centered approximately 0.5 degrees south of the equator (Lukas 1986, Steger 1997). Since the Galápagos Archipelago extends roughly from 1°N to 1.5°S, it represents an obstacle to the eastward propagation of the EUC. The collision of the EUC's flow against the Galápagos Archipelago results in a combination of three subsequent flows: 1) some of the EUC is upwelled along the steep western bathymetry of Isabela and Fernandina Islands, 2) some of the EUC is deflected to around the northern perimeter of Isabela Island, and 3) some of the EUC is deflected to around the southern perimeter of Isabela Island.

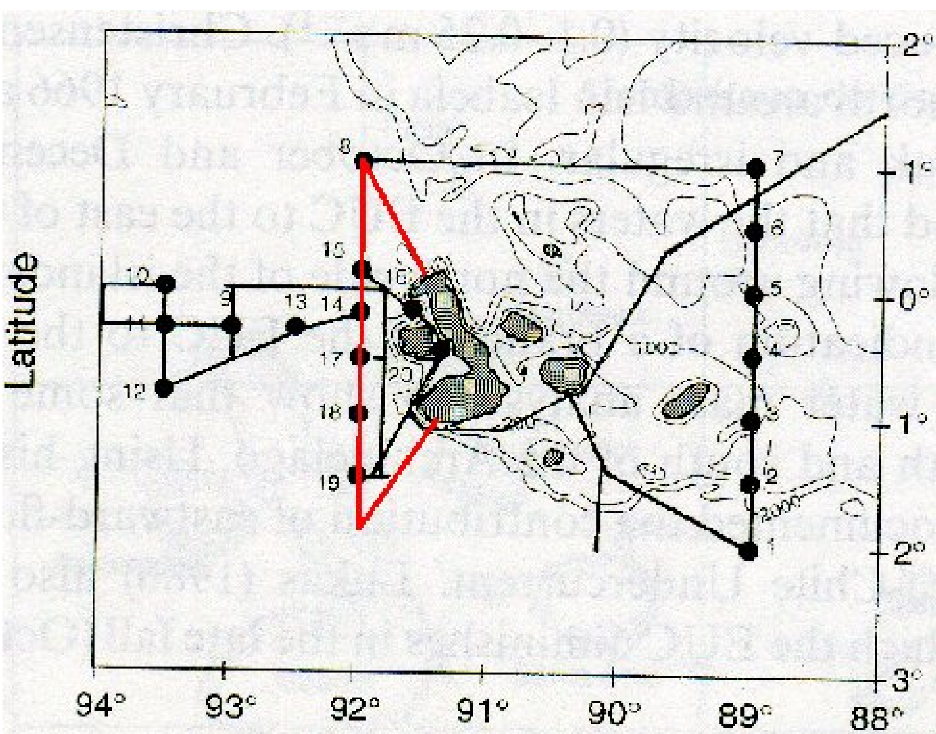
Though the vast majority of the EUC remains subsurface along the western margins of the Galápagos Archipelago, the significance of the presence of nutrient-rich upwelled EUC waters is of tremendous biological importance (Feldman 1984). Among the determinants of the nature of the location and magnitude of the EUC are seasonal and interannual variations in wind stress, strength of neighboring or adjacent currents, and geostrophic forcings (Cane 1979, Enfield 1981).

Water mass properties such as a high salinity core (34.95-35.00 PSU) and a thermostad of 13°C demark waters typical of the EUC (Lukas 1986), and thus CTD casts taken at regular intervals in addition to strategic locations, such as the center of the EUC core and the interfaces between the EUC and the neighboring water masses and currents would be valuable. Some seasonal fluctuations of the EUC include strong and shallow current speeds between March and September, and weaker deeper maximum current velocities between November and January (Lukas 1986, Sakai 1972, Fernander and Miller 1981). During the boreal spring a surfacing of the EUC is noted in Jones 1969, and might be attributed to "first baroclinic mode Kelvin waves having an eastward current maximum at the surface (Hayes and Halpern 1984). This process actually displaces the EUC downward with the thermocline (Lukas 1986). During mid November of 1993 the EUC along 92°W was observed to have peak velocities of 60 centimeters per second at a depth of 70 meters and was transporting water at a rate of 6.6 Sverdrups (Steger 1997).

PROPOSED RESEARCH:

<<<< ***NOTE: An updated chart indicating ADCP transect and CTD cast locations will be provided on Tuesday November 29, 2005 due to continuing refinements in cruise planning by affiliated professors and students.***>>>>

The three adjacent line segments drawn in red in the chart below indicate the original proposed transects along which ADCP and CTD would have been gathered. This plan, henceforth referred to as Plan A, is an unreasonable proposition because even when excluding the CTD time requirements, at the ADCP-limited seven knot maximum velocity, these three adjacent transects would require approximately 44.7 hours, which is more time than an undergraduate principle investigator has the right to consume.



Plan A: Traveling three segments at the ADCP-limited 7 knot speed I propose to voyage from the northwest portion of Isabela (anywhere between Punta Vincente Roca on the west and Punta Albemarle on the east) to 1°N and 92°W which would take about 9.5 hours, then travel 3° latitude southward to 2°S and 92°W, which would require about 26.7 hours, and finally, complete a transect towards the southwestern portion of Isabela (anywhere between Punta Essex on the west and Puerto Villamil on the east) requiring an additional 9.5 hours. Total time required for ADCP alone is 44.7 hours (9+26.7+9).

Some version of Plan A is in the process of being contorted to the time available for such experimentation. As soon as I am provided with the facet of the EUC that will be made measurable by ship-time constraints, I will submit an appropriate and detailed purpose and procedure for this feasible data set.

REFERENCES:

Since this the extent and location of the data-acquiring procedures for this proposal are not yet known due to present uncertainties in cruise plans, the following list of references encompasses all possible variations of the original (aforementioned Plan A) project plan. Not all of the following references will be used for any one possible experimental plan, but rather, any of various possible experimental plans will use a combination of the following references.

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