Acquisition of an Underway CTD System for the Flow Encountering Abrupt Topography DRI

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LONG-TERM GOALS

Strong westward flow in the North Equatorial Current (NEC) encounters tall, steep, submarine topography and islands. During the Flow Encountering Abrupt Topography (FLEAT) DRI, investigators will determine:

- Whether appreciable energy/momentum is lost from the large-scale NEC flow to smaller scales and through which processes?
- What limits numerical models/state estimates from making accurate statistical/deterministic predictions at $<$10 km resolution around submarine topography and islands? How can we improve them?

OBJECTIVES

In cooperation with other FLEAT investigators, observations and model results will be examined up- and downstream of topography to address two overarching hypotheses:

- Energy and momentum are lost in appreciable amounts due to encounters between low-frequency flows and topographic features that are not well/explicitly resolved in regional models. This would happen through a combination of (i) quasi-linear processes (e.g. form drag, lee waves, eddy generation) over small-scale topographic features and (ii) fundamentally nonlinear processes (turbulent island wakes).
- Downscaling model fidelity may be considerably improved by combination of focused numerical process studies, inclusion/assimilation of new in situ data densely spaced around topography, and better dynamical understanding of the key physical processes.

APPROACH

An underway conductivity-temperature-depth (UCTD) instrument will be deployed regularly to make spatial surveys of eddies and wakes generated at points (Rudnick and Klinke, 2007). This work is a component of FLEAT and will take place on CRRF's coastal research vessel, *Kemedukl* in 2016-17. The *Kemedukl* is a fast (20 knots) and highly manoeuvrable vessel, which can be repositioned and stopped quickly. The UCTD drops straight down as line spoold freely from the tailspool and from the compact winch on deck (Figure 1). The UCTD can reach at least 1000 m every $<$30 minutes from a stationary vessel (and possibly in $\sim$20 minutes if consistent 4 m s^{-1} drop rates can be achieved from a free-spooling winch without spooling the tail). An existing 300 kHz acoustic Doppler current profiler can be used to obtain currents to about 100 m when on station.

Sampling plans will be coordinated with Jonathan Nash (OSU) and Eric Terrill (SIO), who have a remotely-operated surface sampler (ROSS) and coastal measurement array. The extent of these surveys will be $<$50 miles from shore and focus on submesoscale eddies and wakes.

As another contribution to FLEAT, a proposal has been sent to the Schmidt Ocean Institute to use the UCTD on a 21-day cruise on R/V *Falkor* in conjunction with other cruises on R/V *Revelle* in 2017.

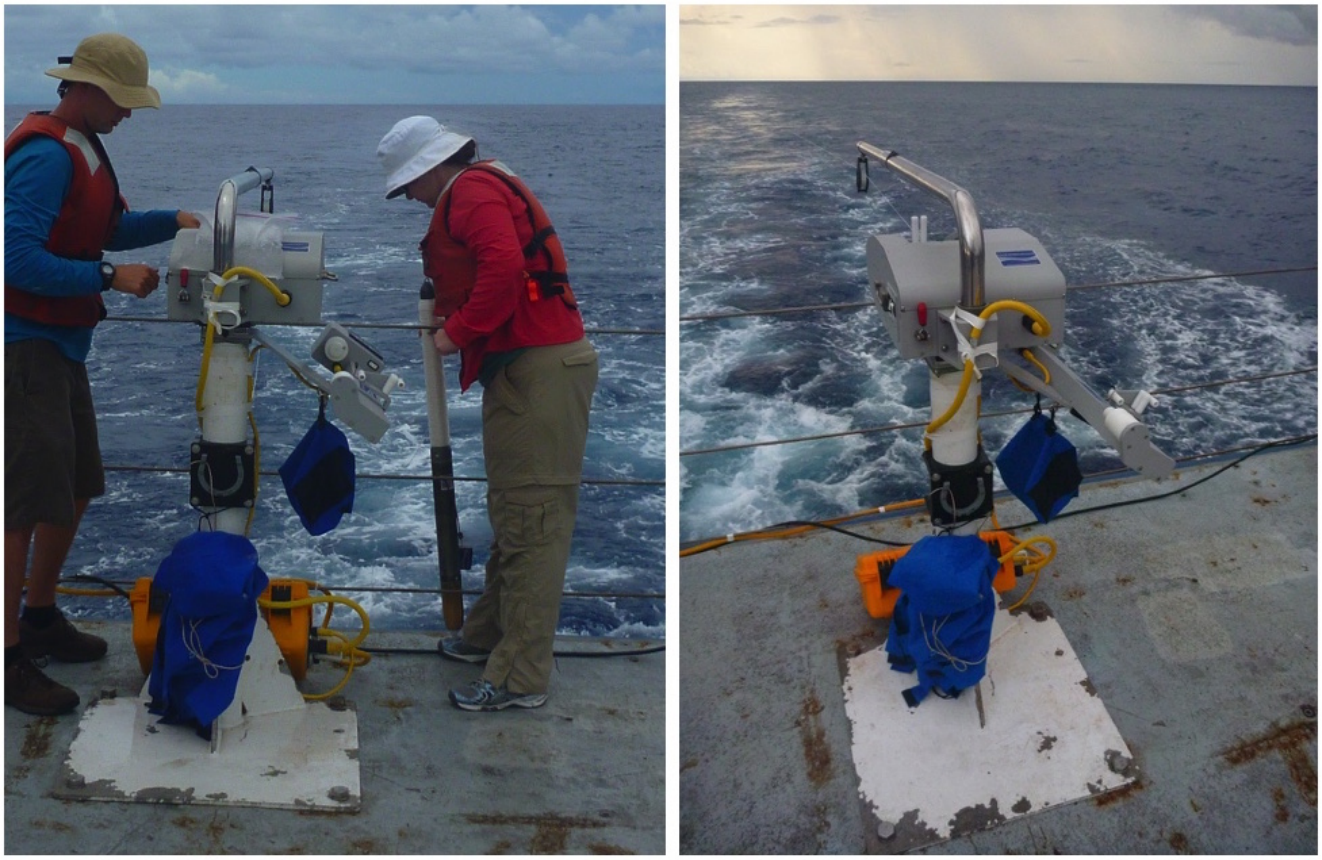

Figure 1: **Left:** ***During a cruise in 2013 on R/V Revelle, the UCTD probe is ready to deploy with line spooled on the tail of the probe.*** **Right:** ***Line spools freely from the winch and the probe, as the ship steams at 10 knots. With free spooling line the UCTD drops straight down and is isolated from ship motion.***

WORK COMPLETED

A science meeting of FLEAT investigators has helped refine the experimental plan for UCTD use and foster collaborative work on eddies and wakes from points and submarine ridges.

Since this DURIP award was received only recently for a UCTD system, the vendor has been notified but nothing has yet been acquired.

RESULTS

None yet because this award was received in September 2015.

IMPACT/APPLICATIONS

An island wake with low Richardson number and large horizontal gradients (of order 10 times the Coriolis frequency) was observed near Merir Island on a cruise on R/V *Revelle* in 2014. Thus, it is likely the wake is turbulent and is removing energy from the incident flow. The downstream extent and overall importance of such wakes will be investigated during FLEAT. Similar results are seen in an island wake in the Kuroshio (Chang et al., 2013), which suggests such features should be common as strong flows encounter steep topography in the western Pacific.

RELATED PROJECTS

There are a number of related projects:

- Previous UCTD and SeaSoar cruises in 2013 and 2014 on *Revelle* and an upcoming 2015 cruise are funded under grants from the core Physical Ocenaography program and from FLEAT. The focus of all these cruises is on boundary currents, arrested lee waves, and island wakes.
- State estimates of the tropical Pacific are being made by Bruce Cornuelle (SIO) and Brian Powell (UH) with results in time for the 2015 cruise and other investigators for future cruises.
- Coastal measurement arrays around Palau have been deployed by Eric Terrill (SIO).
- Gliders have repeated cross-shore sections around Palau (Dan Rudnick, SIO).

REFERENCES

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