Ocean Dynamics: Dynamo

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LONG-TERM GOALS

To gain a more complete understanding of ocean dynamical processes, particularly at fine-scale, through comparison of high, mid- and low-latitude observations, near the sea surface, in the main thermocline, and near the sea floor.

OBJECTIVES

To identify the phenomena involved in the cascade of energy from meso-scales to turbulent scales. In particular, we wish to quantify the relationship between fine-scale background conditions and the occurrence of microscale breaking.

APPROACH

Progress is achieved through a steady-state cycle of instrument development, field observation and data analysis. The primary instruments employed include Doppler sonar and rapidly-profiling CTD's. Our instruments produce information that is quasi-continuous in space and time, typically spanning two decades in the wavenumber domain. This broad band space-time coverage enables the investigation of multi-scale interactions.

WORK COMPLETED

Our major accomplishment has been the execution of the Dynamo Leg IV Experiment in December 2011. Our objective was to document the development of the diurnal surface layer and its relationship to the deeper salinity barrier layer and the internal wavefield on the thermocline below. The approach was to deploy a 3.5 km horizontal “Snake array” (Fig.1), consisting of 5 “Macro “ Wirewalker profiling floats (Fig 2) that cycled to 200 m, and 5 “mini” Wirewalkers that profiled to 20 m.

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WIRE WALKER ARRAY

DYNAMO 2011/12

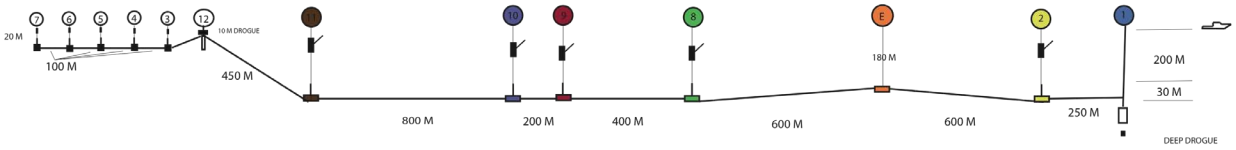

Figure 1. The Snake Array as deployed. The Mini Wirewalkers (WWs) are on the 5 shallow moorings at the left of the picture. These are equipped with Temperature-Pressure recorders. The Macro-Wirewalkers each have a CTD. The WW on buoy 11 also carries an Aquadopp current meter.

Figure 2. A Macro WW going over the side for a ballasting test. The triangular weights on the bottom of the deployment wire proved too small to keep the wire vertical in the strong equatorial shears. The Macro WWs on the Snake array began to profile well on Dec 24, when the deployment weights were augmented by lengths of chain.

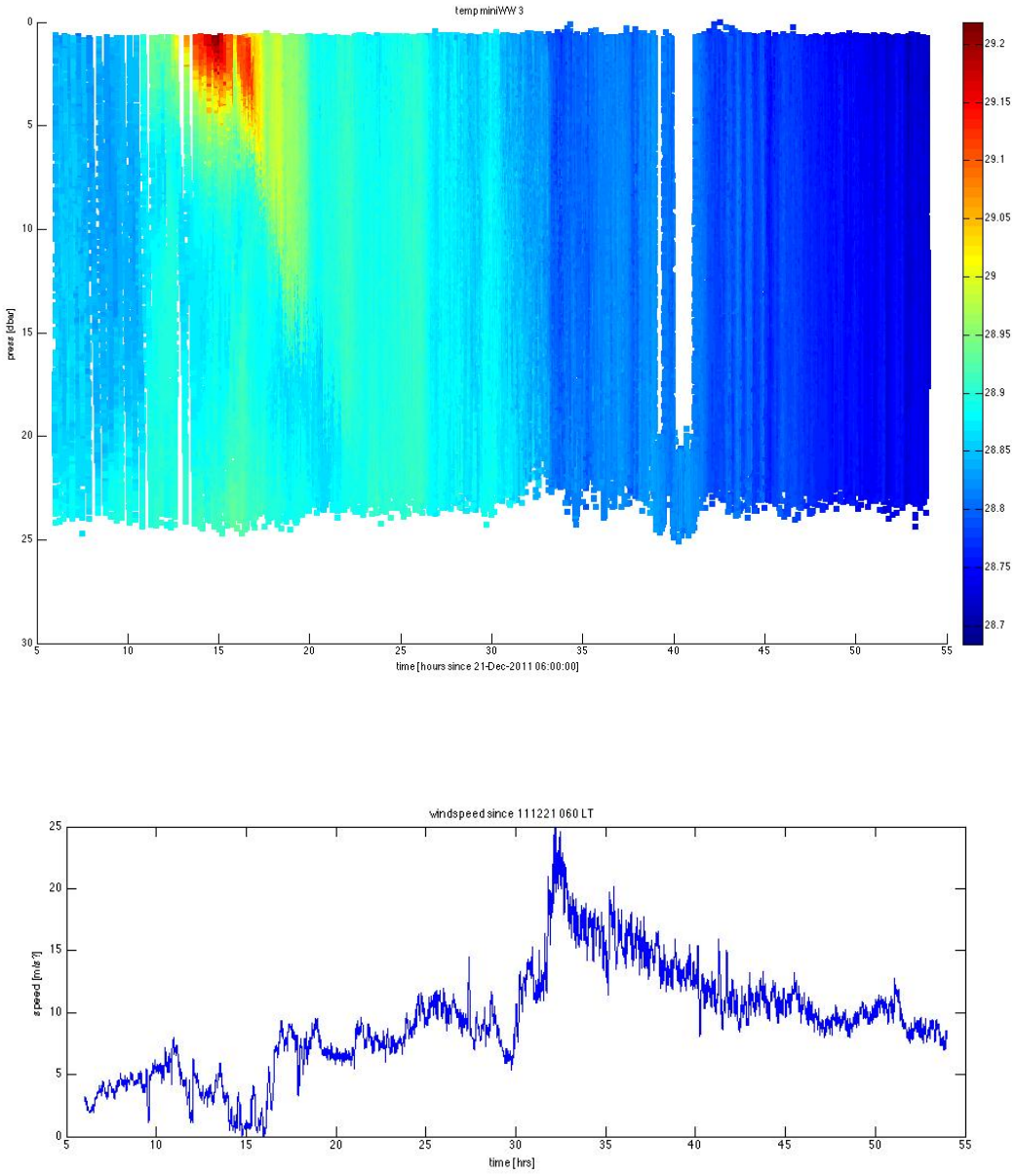

Figure 3. Upper Ocean Temperature vs Depth from a Mini-WW (top). Wednesday, Dec 21, featured moderate winds and a DSL that was eventually mixed into the upper ocean. The following day featured rough weather, with peak winds exceeding 25 m/s on the more believable Revelle anemometer, lower. The upper ocean cooled significantly, from both above & below. (Tycho Huussen)

RESULTS

Surprisingly strong winds, including an MJO event on Dec 22, typically prevented the formation of a clear Diurnal Surface Layer (Fig3). None-the less, several clear examples were captured experimentally. Independent of the DSL, strong signals of nocturnal convection were seen every night. Our focus is on the lateral variability in these signals. The goal is to get the spatial scale of the

turbulence associated with DSL formation, nocturnal convection, as well as the scales of the internal waves on the thermocline. Graduate student San Nguyen is working on these data.

IMPACT/APPLICATIONS

Dynamo illustrates that sub-kilometer scale *horizontal* variability measurements are feasible in the mixed-layer and upper-ocean. An array or free-drifting cluster of Wirewalkers is a powerful tool for quantifying this variability. Additional experience with the analysis and interpretation of the 4-dimentional (***X***-*Z*-time) data is needed.

TRANSITIONS

As an aspect of Dynamo, our group has been developing the "macro" and "mini" Wirewalkers, as well as the "Livewire" wave-powered electrical generator. A number of these devices are planned for use in the coming ONR Vietnam and Sri-Lanka DRIs. The technology has been transitioned.
The first commercial Wirewalker vehicles are now being produced and sold by Brooke Ocean Technology, US.

RELATED PROJECTS

To investigate deep nonlinear phenomena, it is necessary to provide even greater depth-time coverage than the Wirewalker or conventional shipboard systems can provide. In IWISE 2011, we used an improvement of our Fast CTD to work at depths between 500-1900 m in Luzon Strait. With a 3-5 m/s profiling speed, a range of non-linear motions was detectable for the first time,

PUBLICATIONS

Pinkel, R., M. A. Goldin, J. A. Smith, O. Sun, A. Aja, M. N. Bui, T. Hughen. The Wirewalker, a vertically profiling instrument package powered by ocean waves. J Atmospheric and Oceanic Tech., 2010.

Smith, J.A., R.Pinkel, M.Goldin, O.Sun. S, Nguyen, T.Hughen, M. Bui, and T.Aja. Wirewalker Dynamics. J Atmospheric and Oceanic Tech., 2011.

HONORS/AWARDS/PRIZES

AMS Stommel Award
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