SIO High Resolution XBT Transects

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Project Summary

As part of the global ocean observing system for climate, the unique role of the High Resolution Expendable Bathythermograph (HR-XBT) Program is in providing boundary-to-boundary repeating transects that resolve both the oceanic boundary currents and the corresponding interior circulations of the global oceans. Boundary current mass and heat transport are critical elements in the global circulation and heat budget, playing as large a role as the entire interior ocean circulation.

The Scripps HR-XBT Network includes ocean-spanning lines in the Pacific and Indian Oceans, and is implemented in collaboration with U.S. and international partners making complementary measurements in all oceans. Multi-decadal HR-XBT datasets are used by climate researchers and ocean data assimilation modelers to understand the role of upper ocean circulation and variability in the mean and time-varying mass and heat balances. HR-XBT data are freely available in both near real-time and delayed-mode forms.

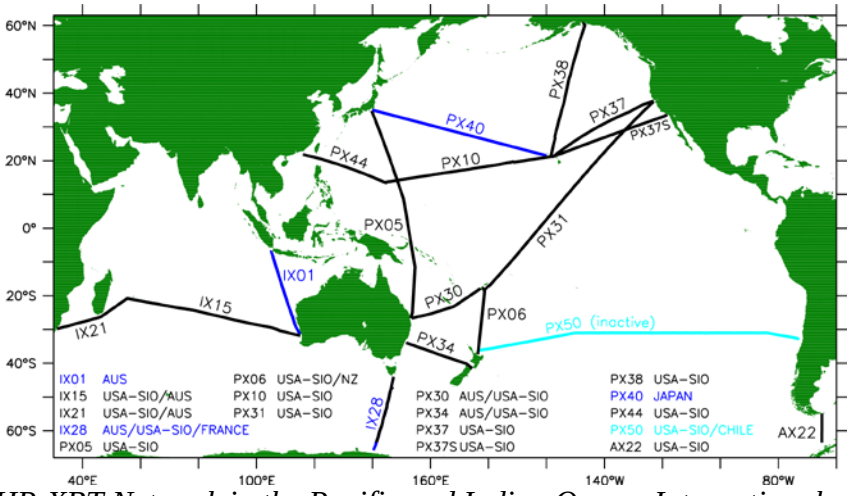

Figure 1: The HR-XBT Network in the Pacific and Indian Ocean. International partnerships are indicated in the notes at the bottom of the figure, the first-listed having primary responsibility.

The HR-XBT Program was initiated in 1986 along a commercial shipping route between New Zealand and Fiji (PX06, Figs 1,2). It was subsequently expanded during the 1990's to include basin-spanning temperature transects in all of the oceans. Major partners in the HR-XBT network include Scripps (Pacific and Indian Ocean), NOAA/AOML (Atlantic), CSIRO (SW Pacific, Indian), and Tohoku University (NW Pacific). The goal of the program is to document gyre-scale variations in ocean circulation and transport on seasonal and longer timescales. Each transect is repeated nominally on a quarterly basis. A technician is on board in order to carry out sampling, with XBT probe spacing at 50 km or less in the ocean interior and as fine as 10 km in

boundary currents. The ship rider also provides technical support for ancillary programs including Argo float and surface drifter deployments. Fig 1 shows the present transects sampled by the Scripps HR-XBT Program and its partners in the Indian and Pacific Oceans. A typical temperature section is shown in Fig 2.

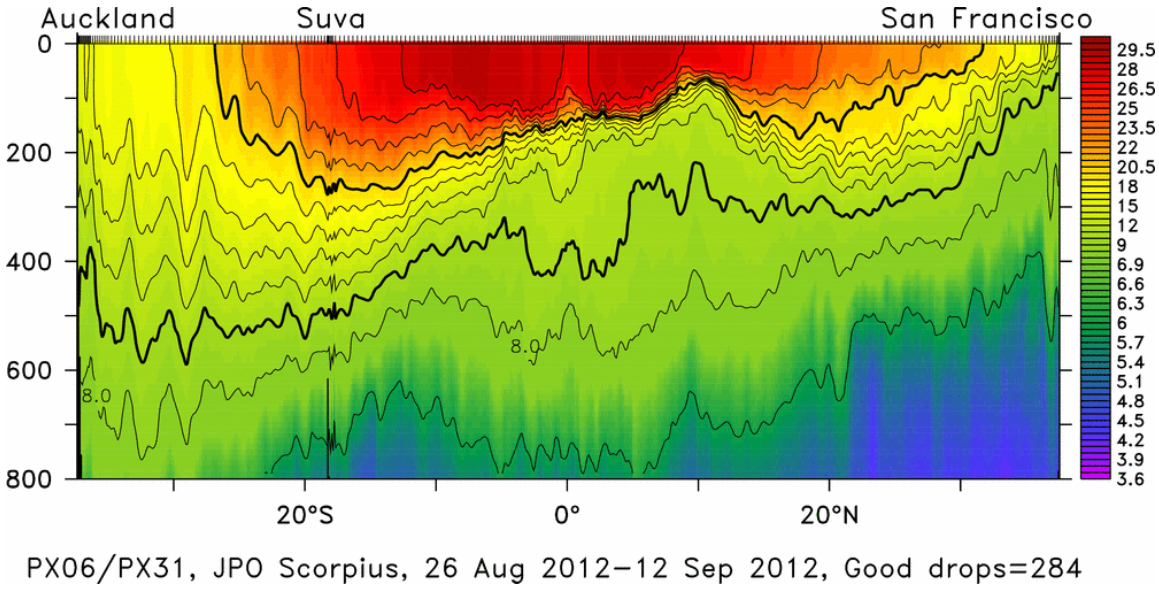

Figure 2. Example of a recent temperature transect (°C) with 284 XBT profiles along PX06/09/37. Sampling has been 4 times per year along PX06 since 1986.

Specific scientific objectives of the HR-XBT program are to:

- Measure the seasonal and interannual fluctuations in the transport of mass, heat, and freshwater across transects which define large enclosed ocean areas (Fig 1).
- Determine the long-term mean, annual cycle and interannual fluctuations of temperature, geostrophic velocity and large-scale ocean circulation in the top 800 m of the ocean.
- Determine the spatial and temporal statistics of variability of the temperature and geostrophic velocity fields.
- Provide appropriate *in situ* data (together with Argo profiling floats, tropical moorings, air-sea flux measurements, sea level etc.) for testing ocean and ocean-atmosphere models.
- Identify permanent boundary currents and fronts, describe their persistence and recurrence and their relation to large-scale transports.
- Estimate the significance of baroclinic eddy heat fluxes.

In the context of NOAA's *Program Plan for Building a Sustained Ocean Observing System for Climate*, the HR-XBT Network is a part of the Ship-of-Opportunity Networks. It directly addresses objective 3 of the Plan: *Document the ocean's storage and global transport of heat and fresh water.* In the global ocean observing system for climate, only the HR-XBT Program provides regular observations of both the ocean's boundary currents and interior circulations. Indeed, all five subtropical western boundary current systems are sampled (including the Atlantic

by our NOAA/AOML partners) as well as the subtropical interiors, eastern boundary currents, the tropical oceans, and the high latitude oceans.

The configuration of the HR-XBT Network is in accordance with the recommendations of the Upper Ocean Thermal Review (Smith *et al*., 2001, The Upper Ocean Thermal Network, *In Observing the Oceans in the 21st Century*, C. Koblinksy and N. Smith eds.) and the OceanObs'09 Community White Paper by Goni *et al.*, 2010. The Scripps HR-XBT network is managed for compatibility with the NOAA/SEAS system, and all XBT casts are distributed (via the Global Telecommunications System) in near real-time for operational users as well as sent to NODC for archiving. The HR-XBT Network is managed in accordance with the Global Climate Observing System (GCOS) Ten Climate Monitoring Principles.

The primary uses of HR-XBT data are in research and education (including 9 PhD theses completed to date), documenting the roles of ocean circulation and variability in the climate system. HR-XBT data are used in both statistical data analyses and data assimilation modeling, to describe seasonal to decadal variability in both ocean circulation and ocean temperature. The real-time data stream is utilized in many operational ocean models. The HR-XBT network is the only element of the global ocean observing system that has the climate-resolving aspects of time series stations while observing basin-wide interior and important boundary current circulations.