SCIENTIFIC EVALUATION OF THE GLOBAL UPPER OCEAN THERMAL NETWORK

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ABSTRACT *– Details are presented on a quantitative assessment of the global upper ocean thermal network, with a focus on the eXpendable BathyThermograph Ship-Of-Opportunity Programme (XBT SOOP). Sampling characteristics were determined from data in the global archives (World Ocean Database 1998), with information being extracted along designated SOOP lines. These lines were assessed against the science goals of the network using a number of weighted criteria. The resulting information is used to help determine priorities for the maintenance and future direction of the network, taking into account other existing and planned networks such as TAO, satellite altimetry and profiling floats. General recommendations are made concerning data management structures.*

1 – INTRODUCTION

The eXpendable BathyThermograph (XBTs) Ship-of-Opportunity Programme (XBT SOOP) has for many years been the prime source of upper ocean thermal data. It has supported research programmes such as the Tropical Ocean Global Atmosphere (TOGA) and the World Ocean Circulation Experiment (WOCE), and is now a major component of the Global Ocean Observing System (GOOS). In recent times, however, there have been a number of developments in the upper-ocean thermal network which warrant review of the design of the XBT SOOP. These include the Tropical Atmosphere-Ocean array (TAO), the Topex/Poseidon altimeter, and the planned future global array of profiling floats (Argo). These capabilities, plus the development of skillful model and data assimilation systems, have forever changed the way we gather and interpret information. With such information available it does not make sense to design and evaluate networks in isolation. Networks must be considered as a contribution to a larger, integrated in situ and remote system, with consequences for sampling and design.

In response, the GCOS/GOOS/WCRP Ocean Observations Panel for Climate (OOPC), the Ship-of-Opportunity Program of the IOC/WMO Integrated Global Ocean Services System (IGOSS SOOP), and the CLIVAR Upper Ocean Panel (UOP) convened a study to review the upper ocean network (see conference paper by Smith et al.). Support for the study, as well as an international workshop, was provided by NOAA and the Australian Bureau of Meteorology. This paper provides details of a background study evaluating the existing XBT SOOP.

2 – EVALUATION METHODOLOGY

Upper ocean thermal data (mainly XBT data, but also including MBT, CTD, mooring and hydrology data) were sourced from the World Ocean Database (1998) and the WOCE CD ROM Data Set. Other sources of information included NODC's Inventory of Physical Oceanographic Profiles, WOCE Data Information Unit summaries, and the annual SOOP operator summaries.

Sampling as a function of space and time, extending back to at least the early 1900's, was determined from data sets filtered along traditional shipping lines/regions (as defined in TOGA/WOCE) (see Fig.1 for an example). Using this information and the other historical program information mentioned above, each line was rated against a number of criteria: phenomenological relevance, spatial extent, ship-track variation, record length, record completeness, temporal resolution, spatial resolution, data quality, timeliness of data delivery, sampling depth, complimentarity/uniqueness, logistics. These criteria were then assigned a weighting for each of the science goals for the network, with the weighted sum for each line giving a measure of the importance of a line for a particular goal. The scientific goals were defined as: 1) practical and experimental seasonal-to-interannual ENSO prediction; 2) understanding tropical ocean variability and predictability; 3) mid- and high-latitude ocean variability (intraseasonal-to-interannual); 4) global and regional heat storage; 5) ocean transport and circulation; 6) climatologies and climate change; 7) ocean state estimation and short-range ocean forecasting. All forms of sampling (broadcast, high-density, frequently-repeated, ad hoc, etc.) were included in the analysis. Consolidated "maps" of information level/content, based on the dominant scales of climate signals, were produced for the major basins to determine the effective contributions from the different observing systems.

3 –RESULTS AND RECOMMENDATIONS

Although some of the criteria can only be measured subjectively, in general the method gives a good quantitative evaluation of the lines against the scientific goals. The XBT SOOP is shown to provide a number of valuable and unique attributes. These include, amongst others, the provision along certain lines of long time-series of upper ocean heat content and in-situ resolution of ocean transport, which ideally compliment other observing systems in a truly integrated observing system. However, due to a number of logistical problems and changes in shipping routes, areas of poor recent coverage by XBT SOOP include the Southern Ocean, southeastern Pacific Ocean, southern Atlantic Ocean, and southern Indian Ocean. A comparison of available data sets indicates the need for even greater coordination of international efforts to assemble and quality control the "definitive", high quality global archive of upper ocean thermal measurements. Subtle, but important inconsistencies exist between data sources in both information and metadata content.

Fig. 1 Fremantle-Sunda Strait XBT line sampling statistics (line IX-1)