**Changes in Ocean Heat, Carbon Content and Ventilation: A review of the first decade of GO-SHIP global repeat hydrography**

***B.M. Sloyan1, L.T. Talley2, R. A. Feely3, R. Wanninkhof4***

**1***Commonwealth Scientific and Industrial Research Organisation (CSIRO), Hobart, Tasmania 7001, Australia*

*2Scripps Institution of Oceanography, University of California, San Diego, La Jolla, California 92093*

*3* *Pacific Marine Environmental Laboratory, National Oceanic and Atmospheric Administration, Seattle, Washington 98115*

**4***Atlantic Oceanographic and Meteorological Laboratory, National Oceanic and Atmospheric Administration, Miami, Florida 33149*

**Text :**

Global ship-based programs, with highly accurate, full water-column physical and biogeochemical observations repeated decadally since the 1970s, provide a crucial resource for documenting ocean change. The ocean, a central component of Earth’s climate system, is taking up most of Earth’s excess anthropogenic heat, with about 19% of this excess in the abyssal ocean beneath 2,000 m, dominated by Southern Ocean warming. The ocean also has taken up about 27% of anthropogenic carbon, resulting in acidification of the upper ocean. Increased stratification has resulted in a decline in oxygen and increase in nutrients in the Northern Hemisphere thermocline and an expansion of tropical oxygen minimum zones. Southern Hemisphere thermocline oxygen increased in the 2000s owing to stronger wind forcing and ventilation.

The most recent decade of global hydrography has mapped dissolved organic carbon, a large, bioactive reservoir, for the first time and quantified its contribution to export production (~20%) and deep-ocean oxygen utilization. Ship-based measurements also show that vertical diffusivity increases from a minimum in the thermocline to a maximum within the bottom 1,500 m, shifting our physical paradigm of the ocean’s overturning circulation.