



Global ocean heat content as viewed in nine ocean reanalyses

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This paper examines nine analyses of global 0/700m temperature and heat content during the 43-year period 1960-2002. Among the analyses are two that are independent of any numerical model, six that rely on sequential data assimilation including an ocean general circulation model, and one that uses 4Dvar including an ocean general circulation model and its adjoint. Most analyses show gradual warming of the global ocean with an estimated trend of $0.77 \times 10^8 \text{ Jm}^{-2}/10\text{yr}$ as the result of rapid warming in the early 1970s and again beginning around 1990, with a decade of global cooling in-between. However, the geographic distribution of anomalous heat varies among even the analyses with similar global averages. In the second part of this paper we examine these geographic variations and their link to natural and anthropogenic climate fluctuations.

The subtropical North Atlantic is subject to warming at twice the global average per unit area with pronounced warming in the 1960s and again in the late 1980s through 2002 with weak cooling in the 1970s and early 1980s. However, the vertical structure of this warming does vary significantly among analyses. The Barents Sea region of the Arctic Ocean generally warms in the 1990s, while the western subpolar North Atlantic has been cooling in most analyses.

Heat content variability in the North Pacific shows spatial and temporal patterns consistent with the Pacific Decadal Oscillation. The central subtropical gyre cools in the late-1970s, while the tropics and eastern ocean warms. By the 1990s the western tropics have cooled, while the eastern tropics have warmed, reducing the average east-west

slope of the equatorial thermocline during this decade.

The largest disagreements among analyses occur in the Southern Hemisphere where data sampling is limited and meteorological estimates are less accurate. Nevertheless, the analyses reveal a number of consistent features such as warming of the South Atlantic, which bear further exploration.