Recent decrease in upper ocean thermosteric sea level

Introduction

Recently updated estimates based on in situ profile data show a decrease in globally averaged, 0/750 m thermosteric sea level between 2003 and 2005 of approximately 7 mm. The decrease in thermosteric sea level is due to a loss of approximately $3.2 \times 10^{22}$ J of heat from the upper-ocean during this period (Lyman et al., 2006). Despite this decrease in thermosteric sea level, total sea level as measured by altimeters and tide gauges continued to rise at nearly the same rate during this period. If the altimeter measurements are correct, this implies that either deep warming occurred which significantly compensates the upper ocean cooling, or the rate of the freshwater input has dramatically increased.

Errors

Random error in the estimate of thermosteric sea level was estimated in a subsampling experiment using altimeter data in the manner described by Lyman et al. (2006). Error based on the historical in situ sampling patterns were also made in this way to illustrate the large increase in error prior to 1970 and the recent decline in error due to the spin up of the Argo array. For the difference curve shown in Figure 2, it was important to attempt to quantify potential systematic errors as well. Errors on the 6 year trends include random error, but have also been increased by 0.4 mm/yr to account for the potential systematic drift in the altimeter data discussed by Leuliette et al. (2004). In addition, these error estimates were increased by 0.1 mm/yr to reflect potential changes in temperature below 700 m. This is the value of the residual between the 0/700 m and 0/3000 m 40-year trends estimated by Antonov et al. (2005).

The Cooling Signal

The spatial pattern of the 2003 to 2005 cooling signal is complex and mainly reflects changes in circulation as shown in Figure 4. The zonal integral does suggest, however, that much of the cooling occurred at low latitudes.

The Sea Level Budget

The estimate of 0/750 m thermosteric sea level is computed using a wide variety of in situ temperature profile data in the manner described by Willis et al. (2004). Between 2003 and 2005, the upper-ocean thermosteric sea level decreased by $6.7 \pm 1.4$ mm. This was preceded by an $16.5 \pm 1.6$ mm increase between 1993 and 2003. The total sea level curve shown in Figure 1 is from http://sealevel.colorado.edu/. The error bars shown reflect random error only. Potential systematic errors are discussed in the panel on errors.

References


Lyman, J., J. K. Willis, and G. Johnson. 2008. Recent update estimates based on in situ profile data show a decrease in thermosteric sea level of approximately 3.2 x 10^22 J of heat from the upper-ocean during this period. Despite this decrease in thermosteric sea level, total sea level as measured by altimeters and tide gauges continued to rise at nearly the same rate during this period. If the altimeter measurements are correct, this implies that either deep warming occurred which significantly compensates the upper ocean cooling, or the rate of the freshwater input has dramatically increased.

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