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The only reliable measurements of ocean temperatures show a statistically not significant warming over the decade since they started

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ABSTRACT

The Argo Programme is aimed to assess the warming of our oceans through measurements of temperatures through a global-array of 3,000 free-drifting profiling floats sampling the upper 2000 m of the ocean. The programme is returning after a decade of operation a negligible warming of the lower layer 700m to 2000m. This small warming is rated at about 0.0012 °C/year well below the 0.0070 °C/year of the climate model predictions and well below the actual accuracy of the combined computational and experimental procedure, certainly much larger than the claimed ± 0.0050 °C.

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KEYWORDS

Sea level global change;
Sea level oceanography;
Global changes in Oceans.

INTRODUCTION

Sea levels around the world are rising. Tide gauge based reconstructions of global mean sea levels (GMSL) show a rise of 195 mm between 1870 and 2004^[1]. Other reconstructions^[2] based on tide gauge results as well as satellite radar altimetry show a rate of rise of sea level of 1.7 mm/year from 1950 to 2009, and about 3.3 mm/year from 1993 to 2009. The two main factors that have been claimed to contribute to that sea level rise are the thermal expansion and the contribution of land-based ice due to increased melting^[3].

It has been shown in recent papers^[4-7] that however all the long term tide gauges of the world recording the monthly sea levels since the 1800s or the beginning of the 1900s consistently show periodic oscillations about an almost perfectly linear trend over the last century. The longer of these oscillations have a quasi-

60 year periodicity, and it has been suggested that what has been claimed as present sea level acceleration and presently higher than before rates of rise of sea levels is only the result of the selective focusing on the latest valley to peak movement of a multi decadal oscillation.

The quasi-60 year oscillations of the climate parameters and of sea levels have been identified by many other authors^[8,9], but there has been not too much discussion on the consequently misleading rates of rise of sea levels computed with selected short time windows in selected locations.

The thermal expansion factor assumes that the ocean temperatures having been warming significantly^[10,11]. According to models global warming is increasing the ocean heat content considerably at a rate of $0.7 \cdot 10^{22}$ Joules/year roughly equivalent to 0.0070 °C/year by considering an increment of 1022 Joules in the heat content of the 0-700m layer translates in a 0.0105 °C increase in the average temperature of this layer.

Current Research Paper

Before the start of the ARGO project in 2003 [www.argo.ucsd.edu], there were only few scattered, poor quality measurements and what is assumed as measured ocean temperature over the layer 0-700m and below for the past is more the results of theories and models rather than of actual measurements of engineering accuracy. The ARGO measurements are basically the first measurements of engineering accuracy of the ocean heat content^[18].

Argo is a global-array of more than 3,000 free-drifting profiling floats that measures the temperature and salinity of the upper 2000 m of the ocean.

This project permits for the first time continuous monitoring of the temperature, salinity, and velocity of the upper ocean, with all data being relayed and made publicly available within hours after collection. The Argo Program is part of the Global Ocean Observing System, and the aim is to assess the global warming.

The pre-ARGO data is very poor quality and is not considered here. The ARGO data is much better, but short. It is claimed that it is not yet possible to use Argo data to detect global change signals, as the dataset is not yet long enough to observe global change signals (www.argo.ucsd.edu). However, if 10 years of tide gauge results (www.bom.gov.au/pacificsealevel/index.shtml; www.bom.gov.au/oceanography/projects/abslmp/abslmp.shtml) were used to infer unbelievably high rates of rise of sea levels in the Australian and Pacific sea levels monitoring projects even if it is very well known that sea levels have multi-decadal oscillations of quasi-60 years, it does not seem too wrong to comment on the ARGO results collected over a decade.

While the most part of the ARGO literature has been focused on regional or short term implications, it has already been argued that the rate of global mean warming has been lower over the past decade than previously^[13] and this observation might require a downwards revision of estimates of equilibrium climate sensitivity^[17].

ARGO TEMPERATURE RESULTS

The ARGO system permits to measure within a reasonable accuracy the temperature up to 2,000m. The measurements are performed by more than 3,000 buoys. The temperatures in the Argo profiles are claimed

to be accurate to ± 0.0050 °C and depths are claimed to be accurate to ± 5 m (wo.jcommops.org/cgi-bin/WebObjects/Argo.woa/wa/faq?id=246).

This error estimate is overly optimistic, as certainly optimistic is the expectation that the global ocean temperature 0-2000 m is predicted within an accuracy of ± 0.0050 °C considering the number of independent measurements collected in space, deep and time needed to derive the global temperature through averaging.

Measurements are repeated in space, deep and time with many buoys. Like all Conductivity-Temperature-Depth (CTD) instruments, the CTDs on Argo floats all have sensor response errors that must be corrected as best as possible and the Sea-Bird Electronics model SBE-41 and SBE-41CP CTDs that are widely used on profiling floats are no exception (floats.pmel.noaa.gov/dmqc/sensor_response_ex.html). The SBE 41/41CP uses the MicroCAT Temperature, Conductivity, and Pressure sensors. The CTD is shipped fully calibrated, and has demonstrated excellent long-term stability, eliminating the need for post-deployment tampering of the calibration to force agreement with the local TS. The temperature sensor with calibration standard ITS-90 has an initial accuracy of 0.002 °C and stability of 0.0002 °C/year (www.seabird.com/products/spec_sheets/41data.htm).

The ARGO marine atlas (www.argo.ucsd.edu) is used to create the temperature plots January 2004 to December 2012. This Atlas uses gridded Argo data to create a variety of plots. Figure 1 presents the ARGO temperatures. The pictures show the temperature map average January–December 2004, temperature map average January–December 2012 and the average temperature time history January 2004 to December 2012 over the layer 0-100, 100-700 and 700-2000 decabar pressure (0-100m, 100m-700m and 700m-2000m deep).

The layer 0-100 decabar does not warm at all over the 9 years. The average temperature actually decreases at a rate of -0.0088 °C/year.

The layer 100-700 decabar is warming marginally over the 9 years. The average temperature increases at a rate of 0.0031 °C/year.

The layer 700-2000 decabar is warming marginally over the 9 years. The average temperature increases

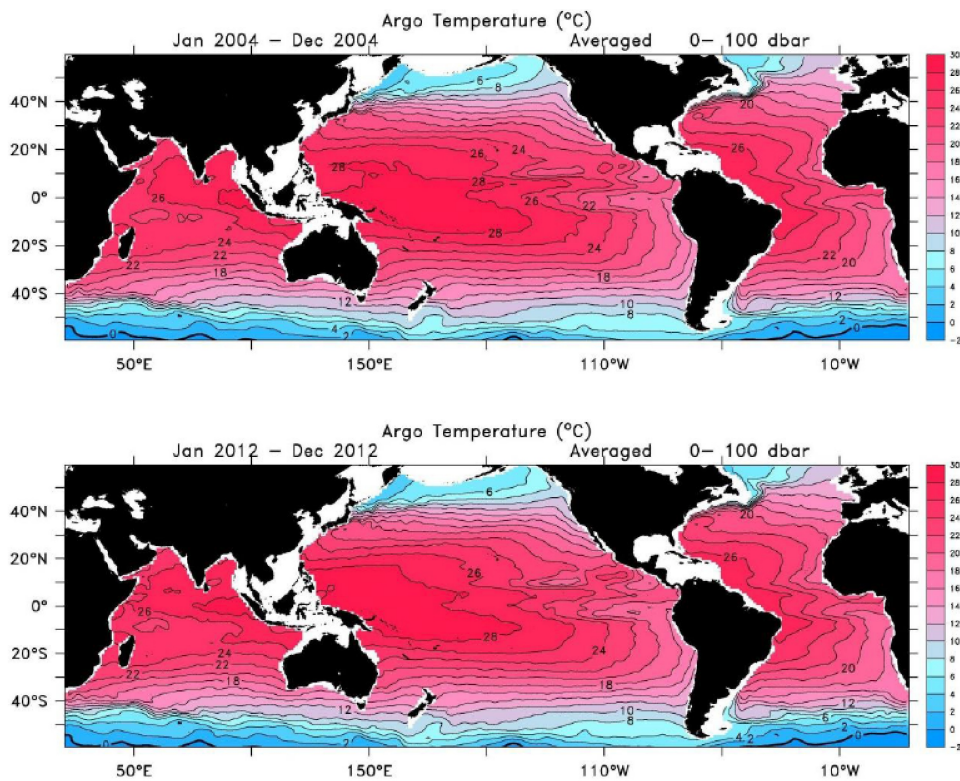


Figure 1a : Temperature map average January –December 2004, temperature map average January –December 2012 over the layer 0-100 deca bar pressure (0m-100m deep).

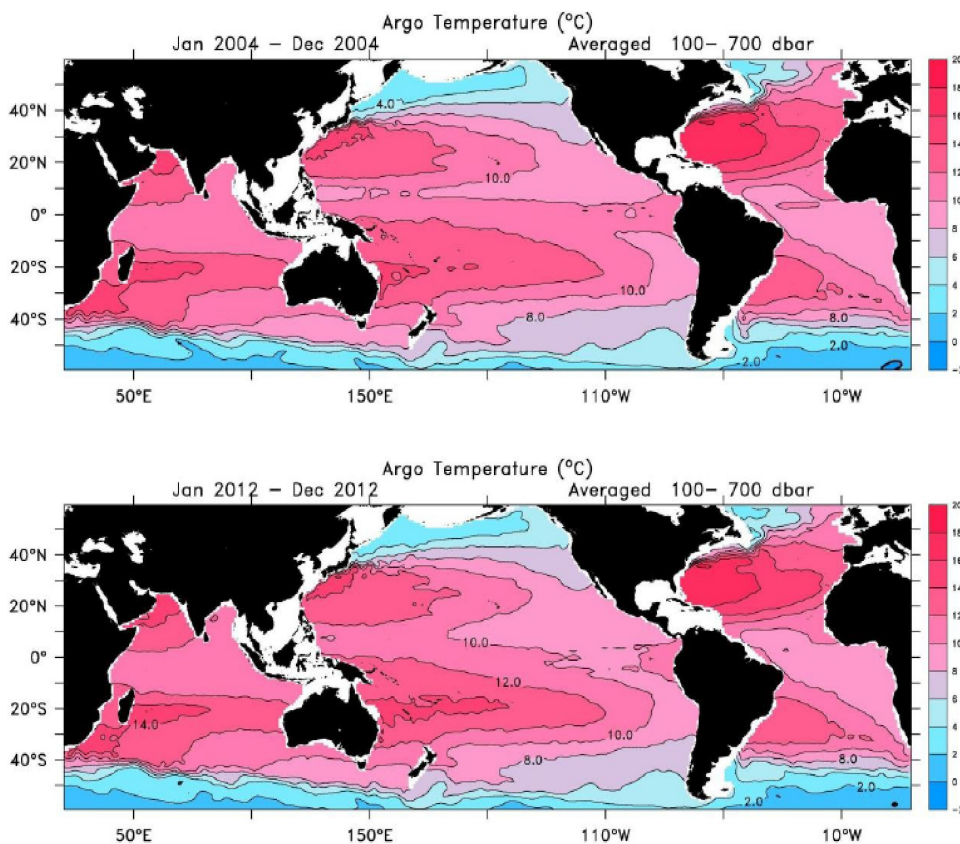


Figure 1b : Temperature map average January –December 2004, temperature map average January –December 2012 over the layer 100-700 deca bar pressure (100m-700m deep).

Current Research Paper

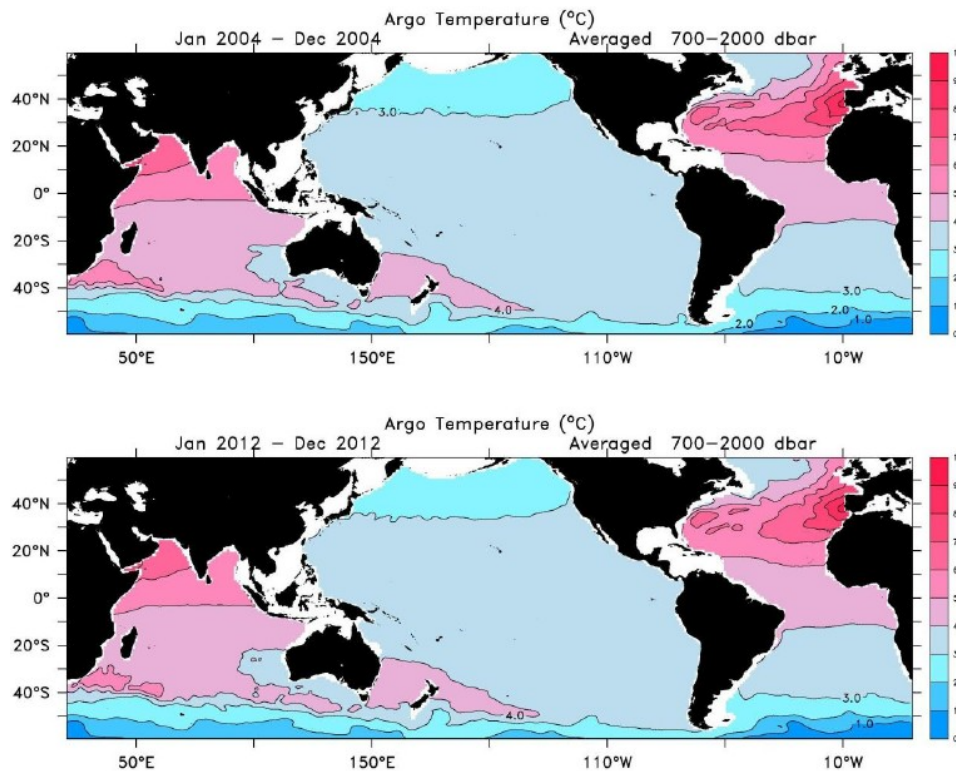


Figure 1c : Temperature map average January –December 2004, temperature map average January –December 2012 over the layer 700-2000 deca bar pressure (700m-2000m deep). 2004 and 2012 are the first and last full year of the ARGO record.

at a rate of 0.0012 °C/year.

Globally, the layer 0-2000 deca bar pressure (0-2000m deep) experienced an average temperature increase of 0.0012 °C/year.

Even considering the very optimistic accuracy of ± 0.0050 °C for the temperature profiles, no error for depths, and no additional error for the procedure determining the average ocean temperature from a large number of independent measurements in space, deep and time, this warming is everything but statistically significant.

DISCUSSION

The “robust warming of the global upper ocean” of^[11] is the result of using for the past very scattered measurements of very poor quality to determine through models and reconstructions what is being measured by ARGO only since 2003.

The novelty of the present approach is to consider only reliable experimental results and do not mix up present reliable experimental data with past unreliable results that are more theoretical or computational than

truly experimental.

The ARGO result was immediately far from the expected with a small, still statistically insignificant cooling^[24]. During 2006, the Argo Network was thought to have shown a declining trend in ocean temperatures. “Ocean measurements suggest the world’s seas have cooled substantially during some of the warmest years in recent history. If real, the dip is likely to reflect a short-term fluctuation in an ocean that is warming overall, say climate scientists.”

As always occur with the measurements of climate data not verifying the model predictions, one of the authors of the cooling report lately discovered that there were problems with the data used for the analysis and confirmed “The oceans are absorbing more than 80 percent of the heat from global warming” and “If you aren’t measuring heat content in the upper ocean, you aren’t measuring global warming” (earthobservatory.nasa.gov/Features/OceanCooling/).

After correcting these errors in the Argo thermometer measurements, results showed that the world’s oceans were absorbing additional energy and were warming, however still far from the expected and, as

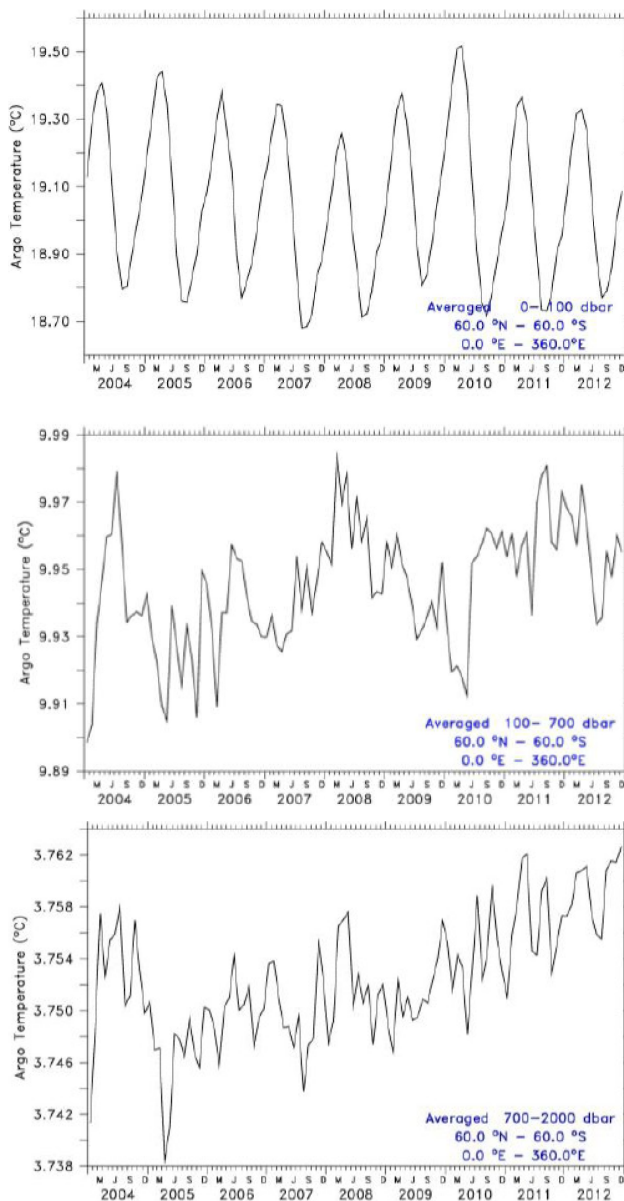


Figure 1d : Average temperature time history January 2004 to December 2012 over the layers 0-100 deca bar pressure (0m-100m deep), 100-700 deca bar pressure (100m-700m deep) and 700-2000 deca bar pressure (700m-2000m deep)

nobody has claimed so far, well below the uncertainty in the temperature measurements.

CONCLUSION

The sea level budget does not close. In 2013, the measured warming after correction is still much less than the warming of the models and below the accuracy of the computational procedure.

During the decade 2003-2013, there has been no significant thermal expansion contribution to the ac-

celerating sea levels. This is in perfect agreement with the lack of any acceleration experienced in the long term tide gauges since the 1900s.

While the authors of [13] prudentially claim “the rate of global mean warming has been lower over the past decade than previously” this statement should be better corrected in “the rate of global warming is negligible over the first decade where measurements of ocean temperatures have been properly collected within the ARGO project”.

It is not the experimental evidence that has to be tuned to theories or computations. Actually, all the theories and simulations should be validated versus reliable experimental data.

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