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Correction factors for bathythermograph temperature in the Western Mediterranean. Detection of differences between bottle and CTD temperature

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The evolution of ocean temperature is presumed known from the beginning of the 20th century. The methodology to obtain temperature data has been changing in time, starting with reversible thermometers, followed by bathythermograph until the introduction of CTDs and the continuously sampling ARGO floats.
It is well known that the historical data measured by bathythermograph (hereafter BT) are of low accuracy in T and with large and variable uncertainty in the determination of the depth of the measurement. However BT measurements are cheaper and easier to perform than CTD measurements and historically constitute an important part of the measurements. The volume of BT data has been changing in time and so has their importance in determining water mass characteristics. Therefore, using this kind of data without any correction in the study of long term temperature variability may be the source of biases. Various correction factors to eliminate the temperature biases caused by the BT have been proposed, all of them were based on the comparison of BT temperature with bottle and CTD temperature taking into account data from all around the world.
Our main purpose is to detect the BT temperature biases in the Western Mediterranean and to obtain BT temperature correction factor in different regions of the Western Mediterranean.
We started by comparing CTD and bottle data usually considered as the reference against which BT data are corrected. Bottle data provide the reference before the development of the CTDs in the early 1970s. We find temperature biases between CTD and bottle data as being larger than previously reported. These biases are up to 1ºC in the first 100 meters of the water column, 0.4ºC in the intermediate water and 0.05ºC in water deeper than 600 meters. Therefore, when temperature measured by different instruments are used in the study of long term temperature variability, uncertainty exists and this is caused by both, temperature BT and temperature bottle errors. In the present work the BT correction factors have been estimated considering only CTD data.
The BT errors come from systematic problems in the instrument and from errors in the fall rate equation. Both problems are not constant in time, so, the correction factors reported in previous work were time and depth dependent. As the problems come partially from the fall rate equation, it will also depend on the stratification of the water column, which changes seasonally. Therefore, in the present work the time and depth dependence as well as the seasonality have been taken into account in determining appropriate correction factors.
When temperature trends are estimated with BT and CTD data separately in the various regions of the Western Mediterranean, contradictory results are obtained. This imposes a basic problem: BT data are more abundant but of low accuracy and restricted in the upper 400 m. CTD data are more accurate but really sparse in space and time. We adopt an approach by which we correct the BT data so that they are in agreement with the CTD data where they both measure. On the basic of this correction which is based on very few measurements we readjust the BT data. The resulting trends of the corrected BT measurements are in better agreement with the CTD trends.
The identification of so large differences in the bottle and CTD data and contradictory trends in the BT and CTD data pose, despite the available methods of correction, a fundamental question on whether prior to ARGO floats there is sufficient information to describe the T evolution of the Mediterranean Sea. The situation for salinity is even worse as only bottle and CTD data exist.