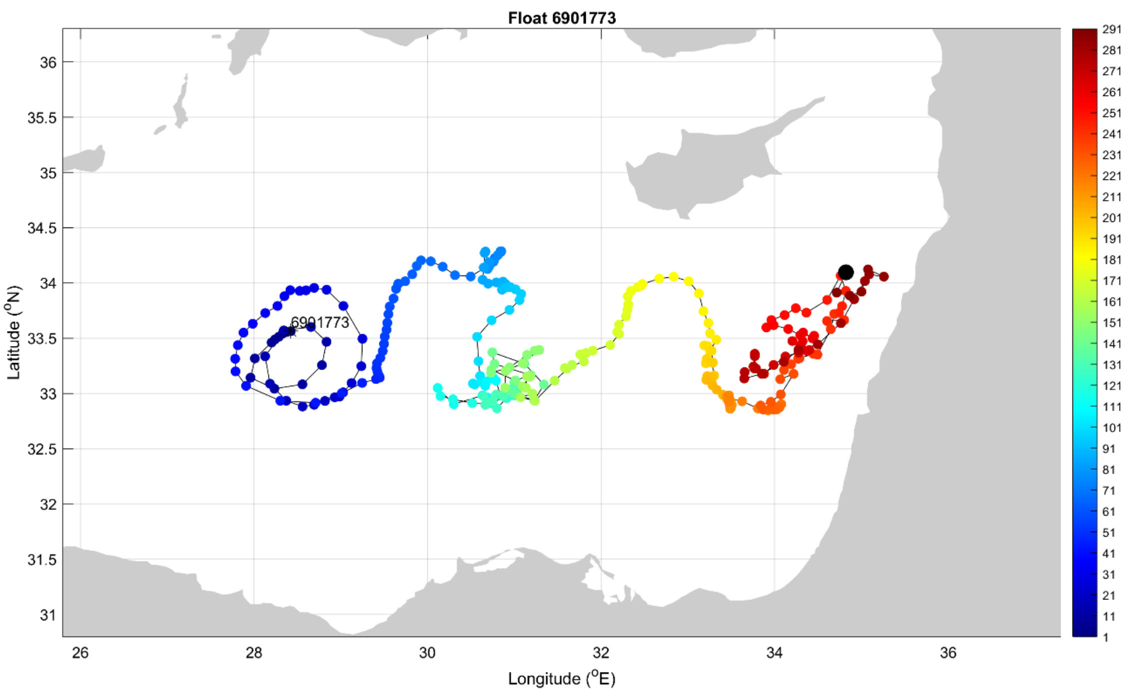
Delayed Mode Quality Control of Argo float WMO 6901773

Antonella Gallo
ORCID ID: 0000-0002-8836-1550

National Institute of Oceanography and Applied Geophysics - OGS
Borgo Grotta Gigante 42/C - 34010 - Sgonico (TS) – Italy
31/03/2021



Contents

1 Introduction

This report includes the delayed mode analysis performed for float 6901773. It was deployed in Mediterranean Sea (Levantine sub basin) in May 2015 and performed 292 cycles. Before the analysis, real-time QC flags were visually inspected. The list of flags applied is QC=1 to cycles from 1 to 266 and QC=3 to cycles from 267 to 292. Then, the satellite altimeter comparison plot between the sea surface height and dynamic height anomaly, constructed for this float by Ifremer, was analyzed. Plots of temperature and salinity time series and plots of temperature, salinity and density plotted against the nearby historical CTD profiles was generated. This visual analysis can help in detecting sensor salinity anomalies and spikes.
The reference dataset used is composed of the following CTD and Argo historical datasets:

CTD:

- CMEMS: INSITU_MED_TS_REP_OBSERVATIONS_013_041
- Coriolis: CTD_for_DMQC_2018V01
- Historical CTD profiles provided through personal contact

Argo:

- ARGO_for_DMQC_2018V01

Float 6901773 is the Provor III float where the pressure sensor is auto corrected and no adjustment is required. The OWC was run to estimate a salinity offset and a salinity drift (Cabanes et al., 2016).

2 Quality Check of Argo Float Data

2.1 Verification of Real-time Mode QC flags

The list of flags applied to the float in real-time mode is as follows.

Cycle number:
1-266 PSAL QC=1

267-292 PSAL QC=3

2.2 Satellite Altimeter Report

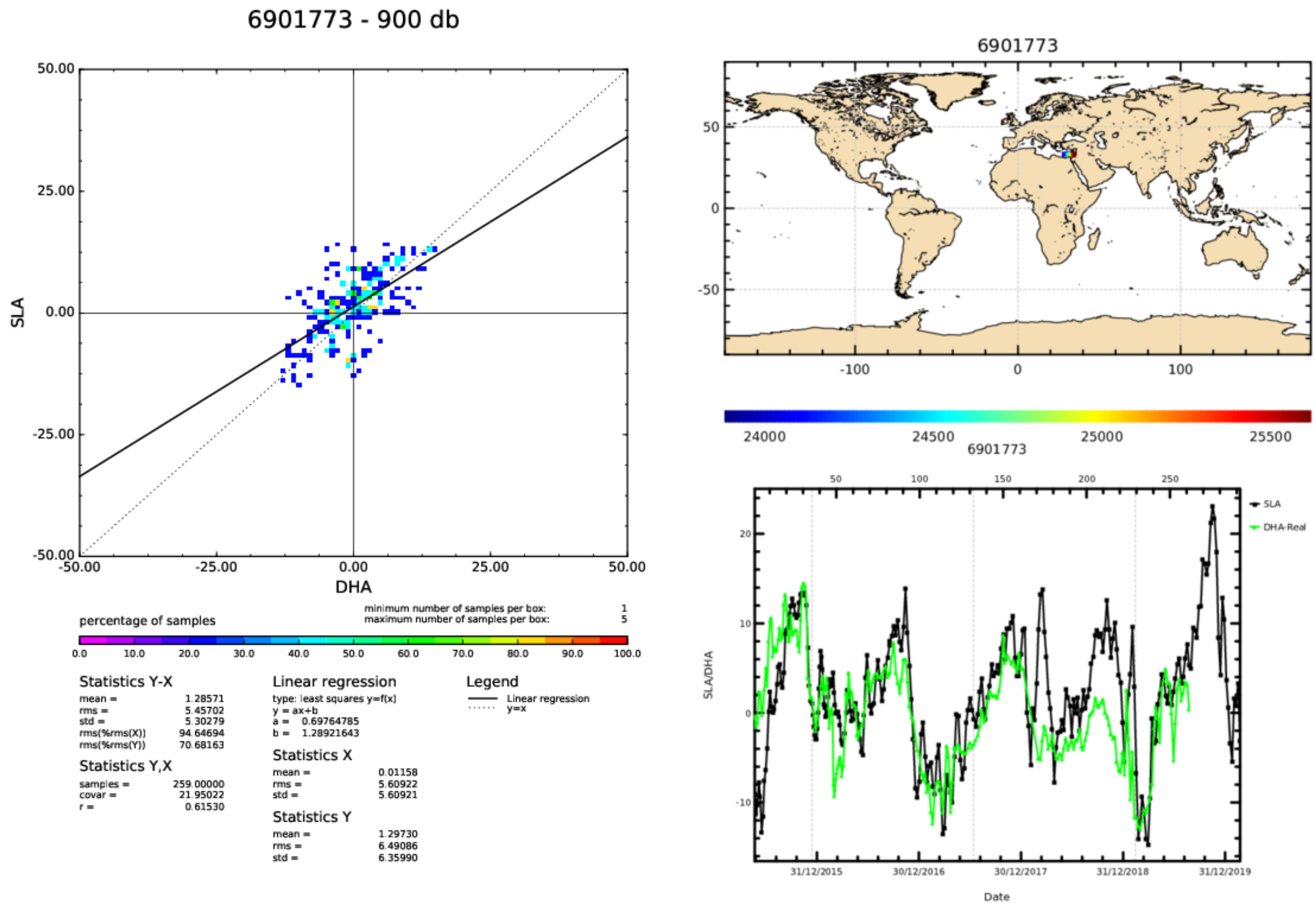


Figure 1: Float 6901773. The comparison between the sea surface height (SSH) from the satellite altimetry and dynamic height anomaly (DHA) extracted from the Argo float temperature and salinity. The figure is created by the CLS/Coriolis and distributed by Ifremer (ftp://ftp.ifremer.fr/ifremer/argo/etc/argo-ast9-item13-AltimeterComparison/figures/).

2.3 Time Series of Argo Float Temperature and Salinity

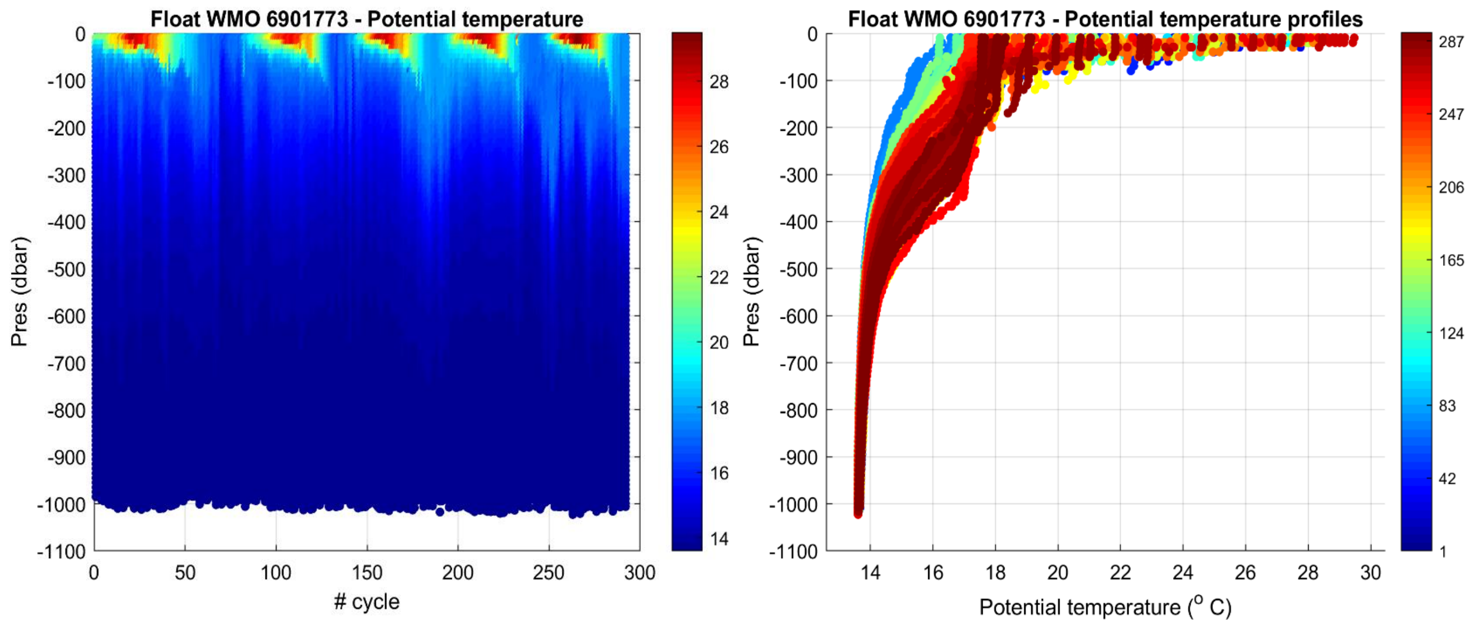


Figure 2: Float 6901773. Time series of Argo float potential temperature (°C) on the left, and potential temperature profiles color-coded per cycle number on the right.

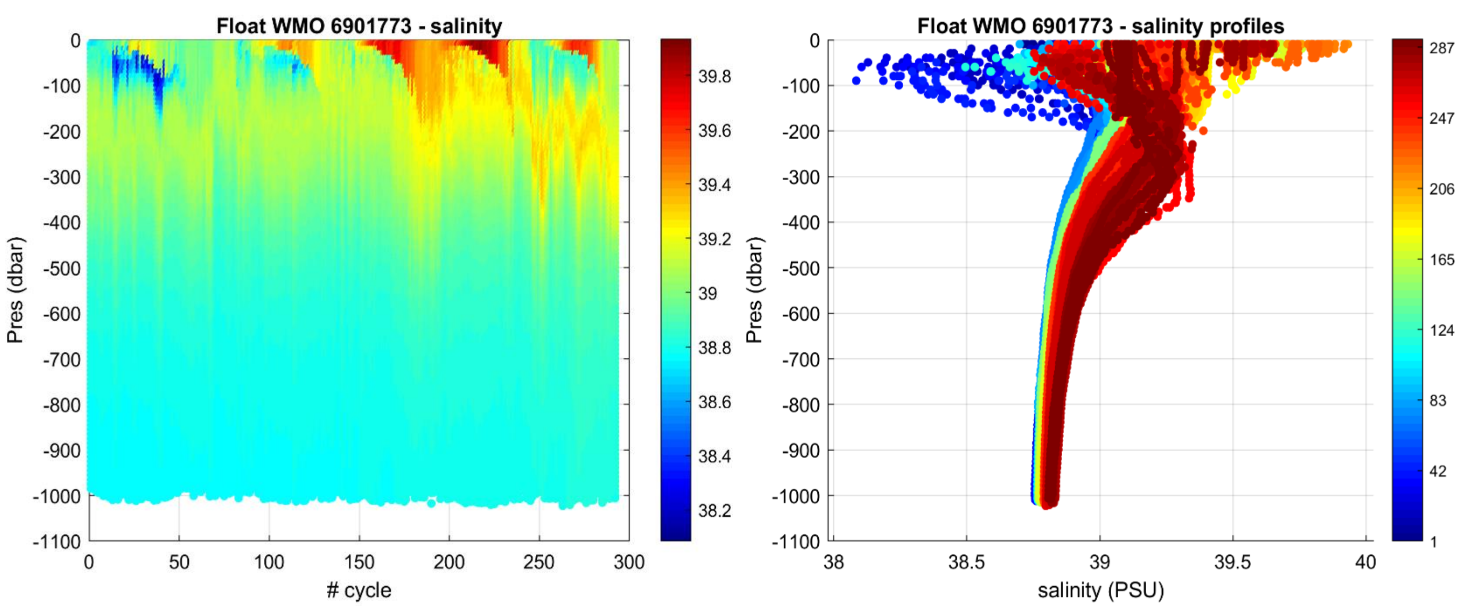


Figure 3: Float 6901773. Time series of Argo float potential salinity (PSS-78) on the left, and salinity profiles color-coded per cycle number on the right.

Before running the Owens and Wong method, referred to as OW hereafter, the theta-salinity (θ-S) diagram of the float is analyzed (Figure 4) and in particular the area where the θ-S relationship is the tightest (Figure 5). A significant salinity drift is observed.

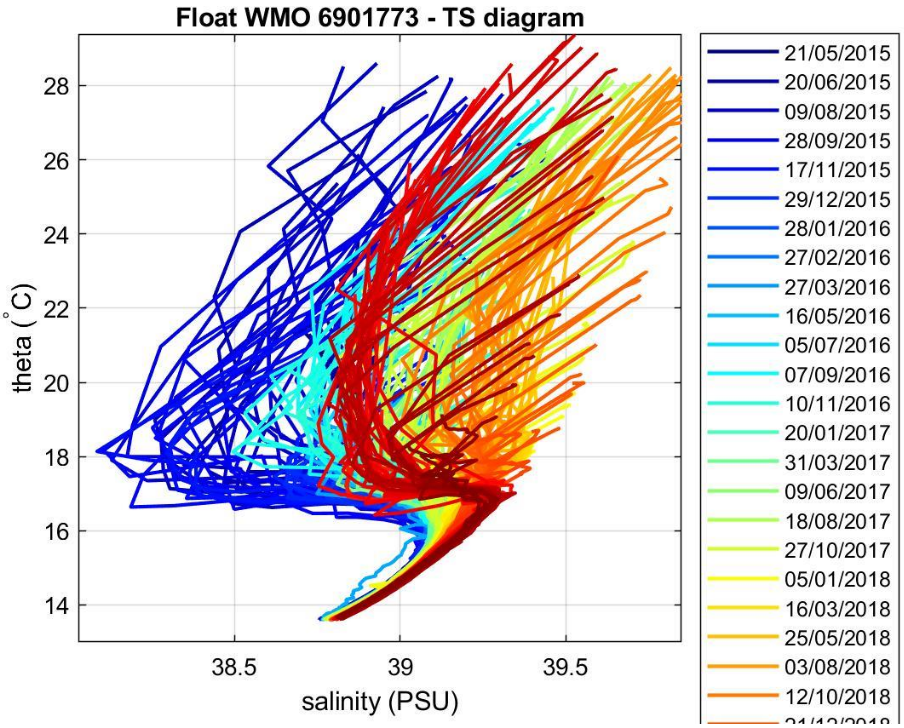


Figure 4: Float 6901773. θ-S diagram color-coded per cycle number.

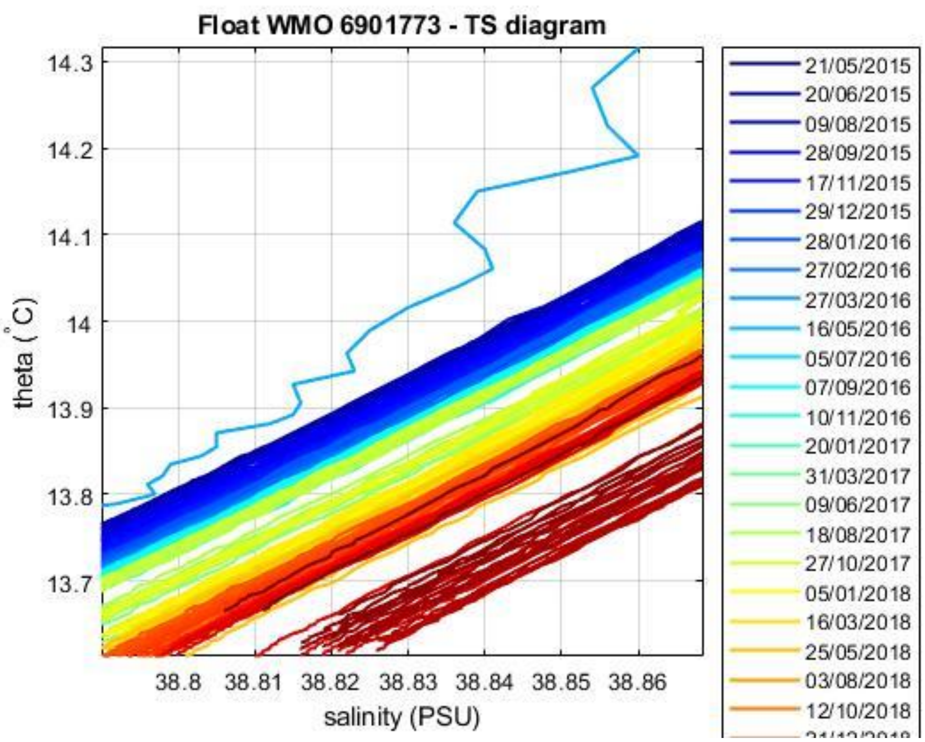


Figure 5: Float 6901773. Area of the θ-S diagram (color-coded per cycle number) where the θ-S relationship is more uniform.

2.4 Comparison Between Argo Float and Climatology

Three salinity float profiles are selected to perform a comparison (in time and space) with the historical data. In figure 6, 7 and 8 each selected profile is compared with all reference data used in this analysis. The salinity float profile is depicted in black while other colors represent the salinity reference profiles. The red color means that the historical data are more recent with respect to the float ones, while magenta states that the float data are more recent than the historical ones (the maximal difference is 6 years). A time difference between 3 and 6, 6 and 9 and larger than 9 years is depicted in green, cyan and blue, respectively.

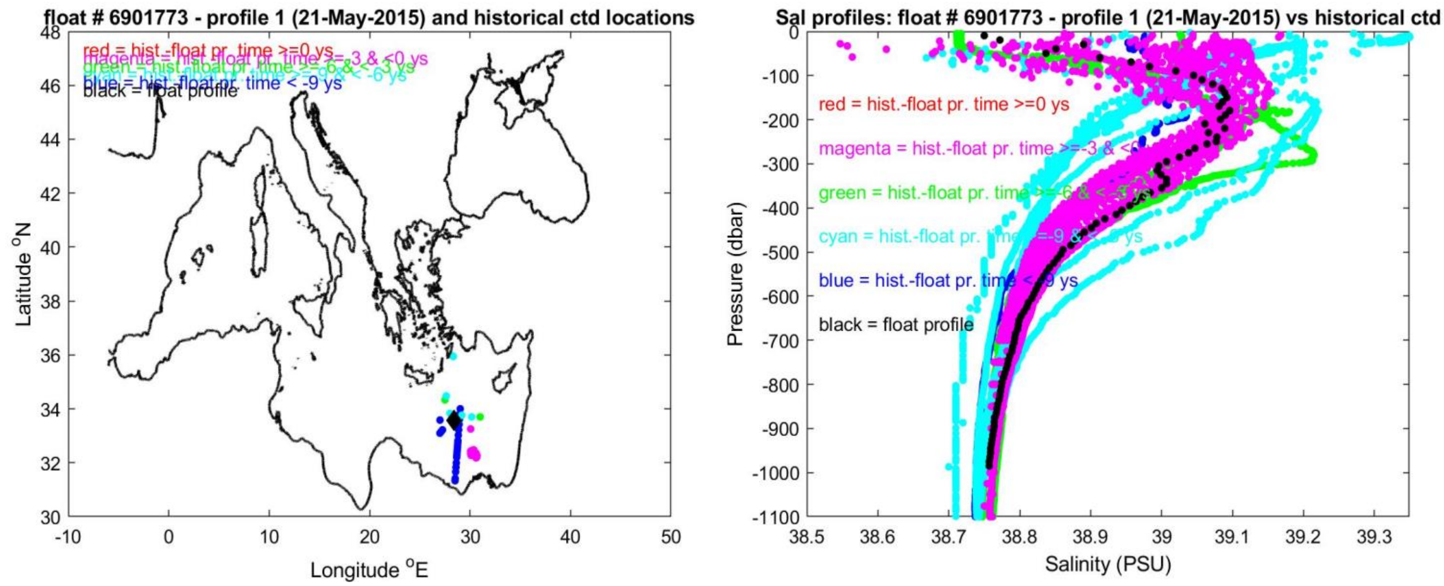


Figure 6: Float 6901773. Locations of the salinity float profile number 1 and historical CTD data (right panel) and the respective salinity profiles (left panel).

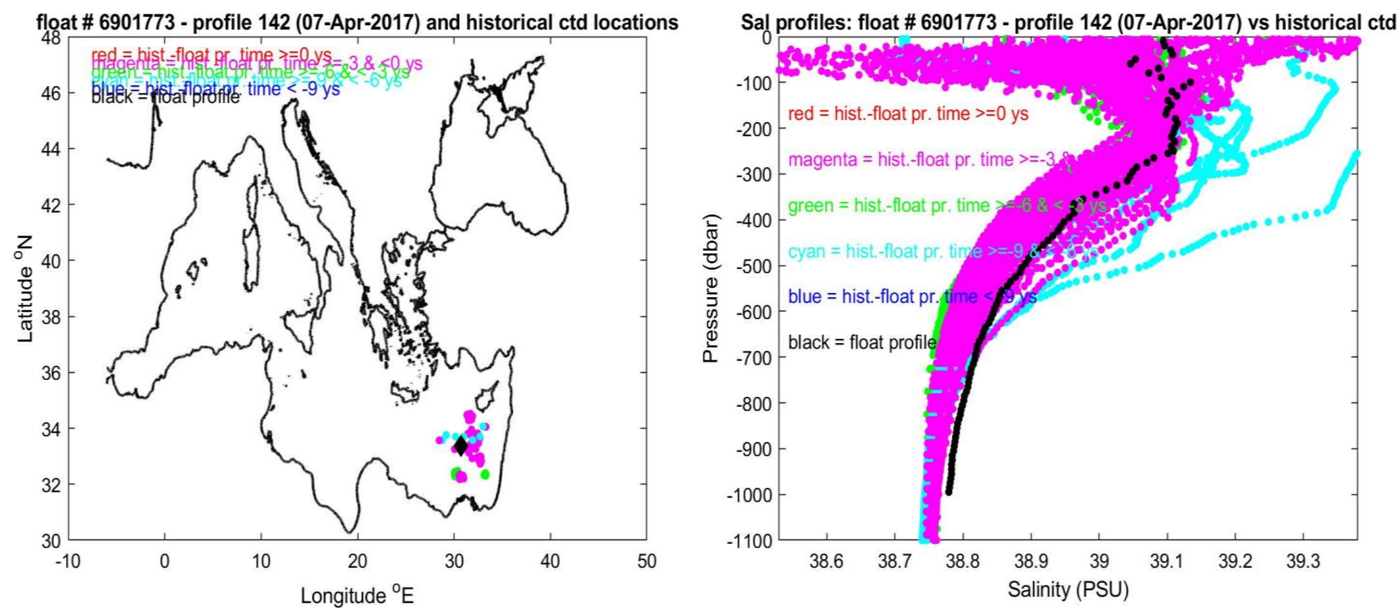


Figure 7: Float 6901773. Locations of the salinity float profile number 142 and historical CTD data (right panel) and the respective salinity profiles (left panel).

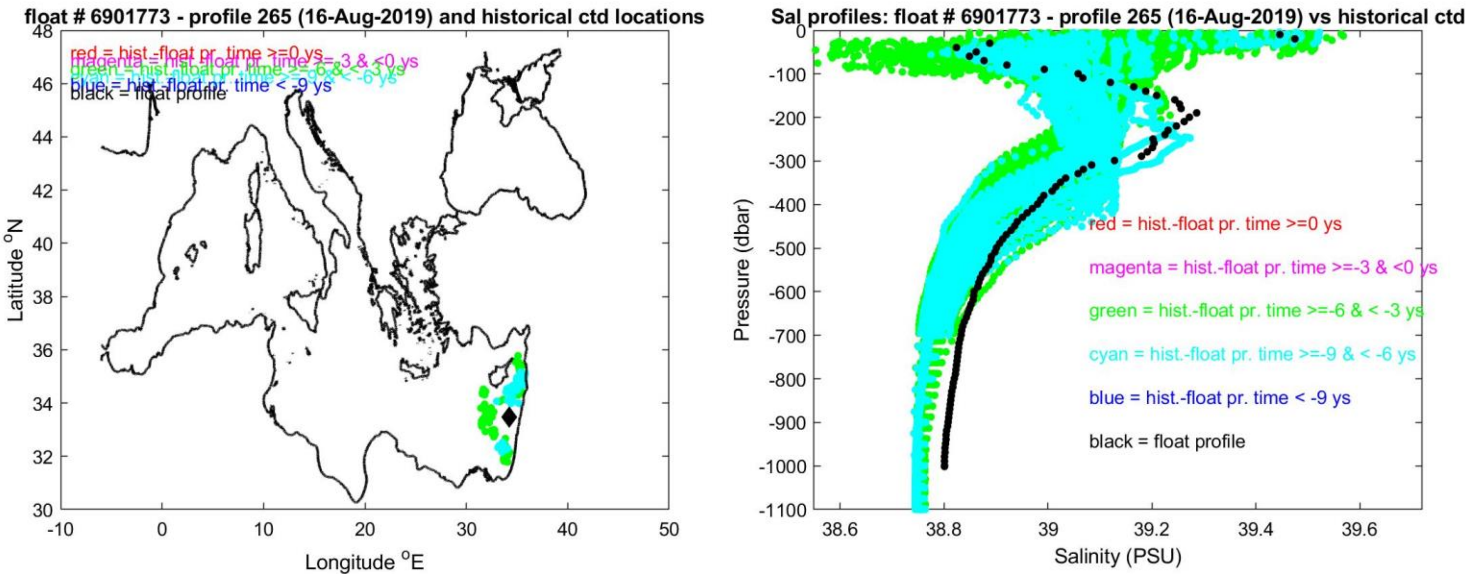


Figure 8: Float 6901773. Locations of the salinity float profile number 265 and historical CTD data (right panel) and the respective salinity profiles (left panel).

The comparison of these 3 selected salinity float profiles with the closest (in space and time) salinity reference profile in shown in Figures from 9 to 11. The agreement between the selected float salinity profiles and the historical salinity profiles is quite good in the intermediate and deep layers for profile 1. The comparison indicates a drift for profile 142 and 265.

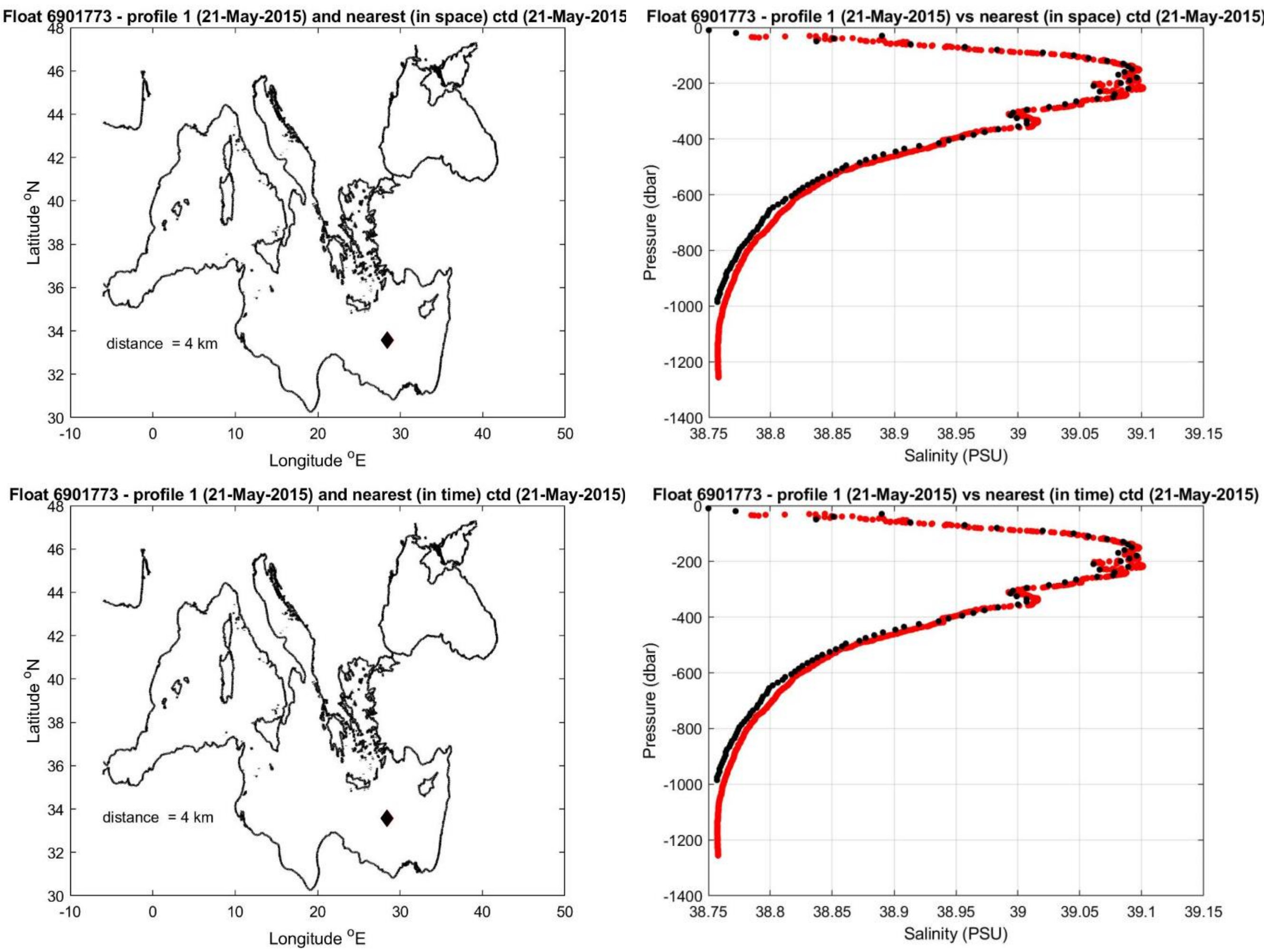


Figure 9: Float 6901773. The salinity float profile number 1 (black dots) are compared to the nearest in space (top) and in time (bottom) reference profile (red dots). The locations of the two profiles and their distance is given in the left panel.

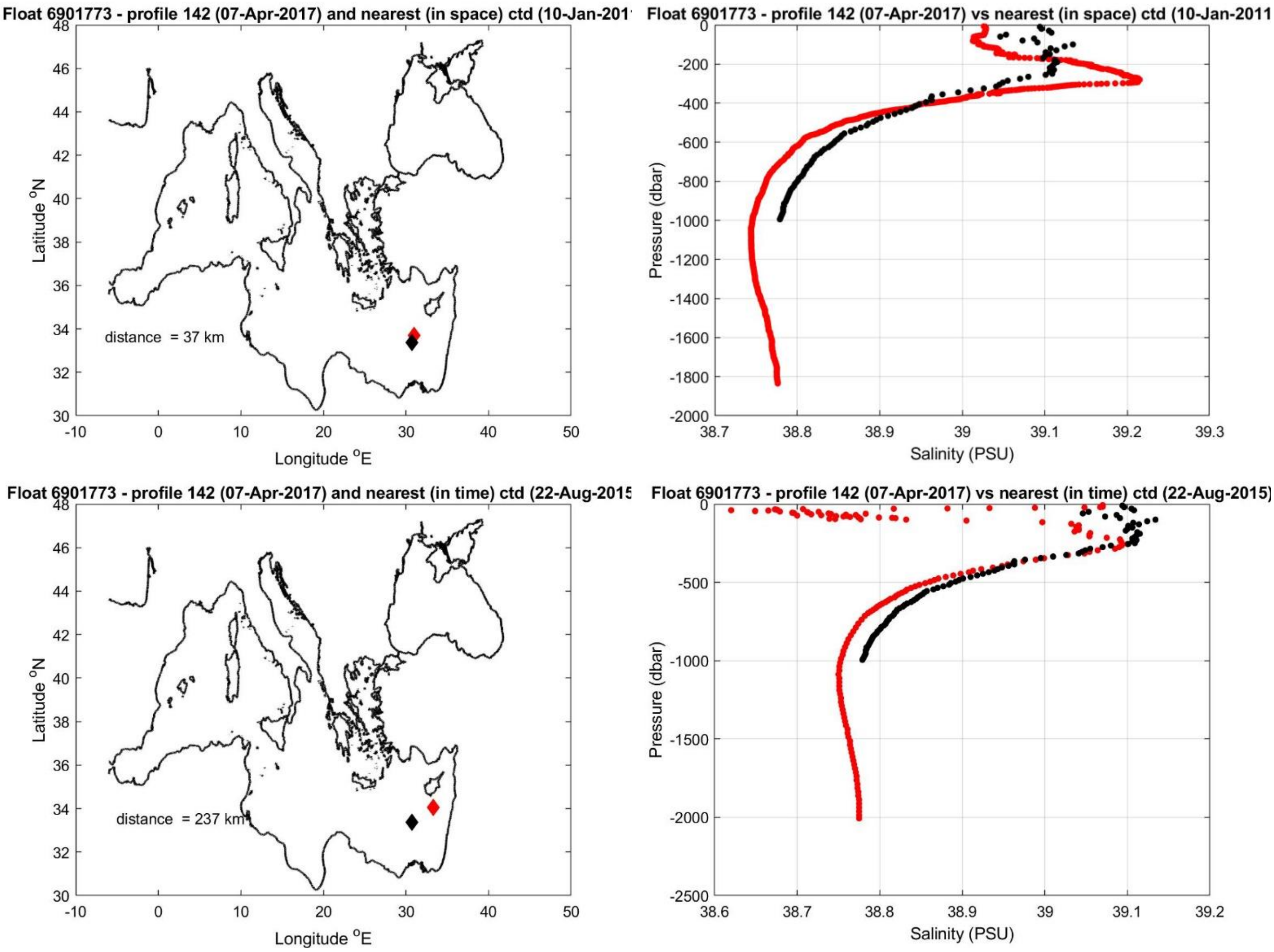


Figure 10: Float 6901773. The salinity float profile number 142 (black dots) are compared to the nearest in space (top) and in time (bottom) reference profile (red dots). The locations of the two profiles and their distance is given in the left panel.

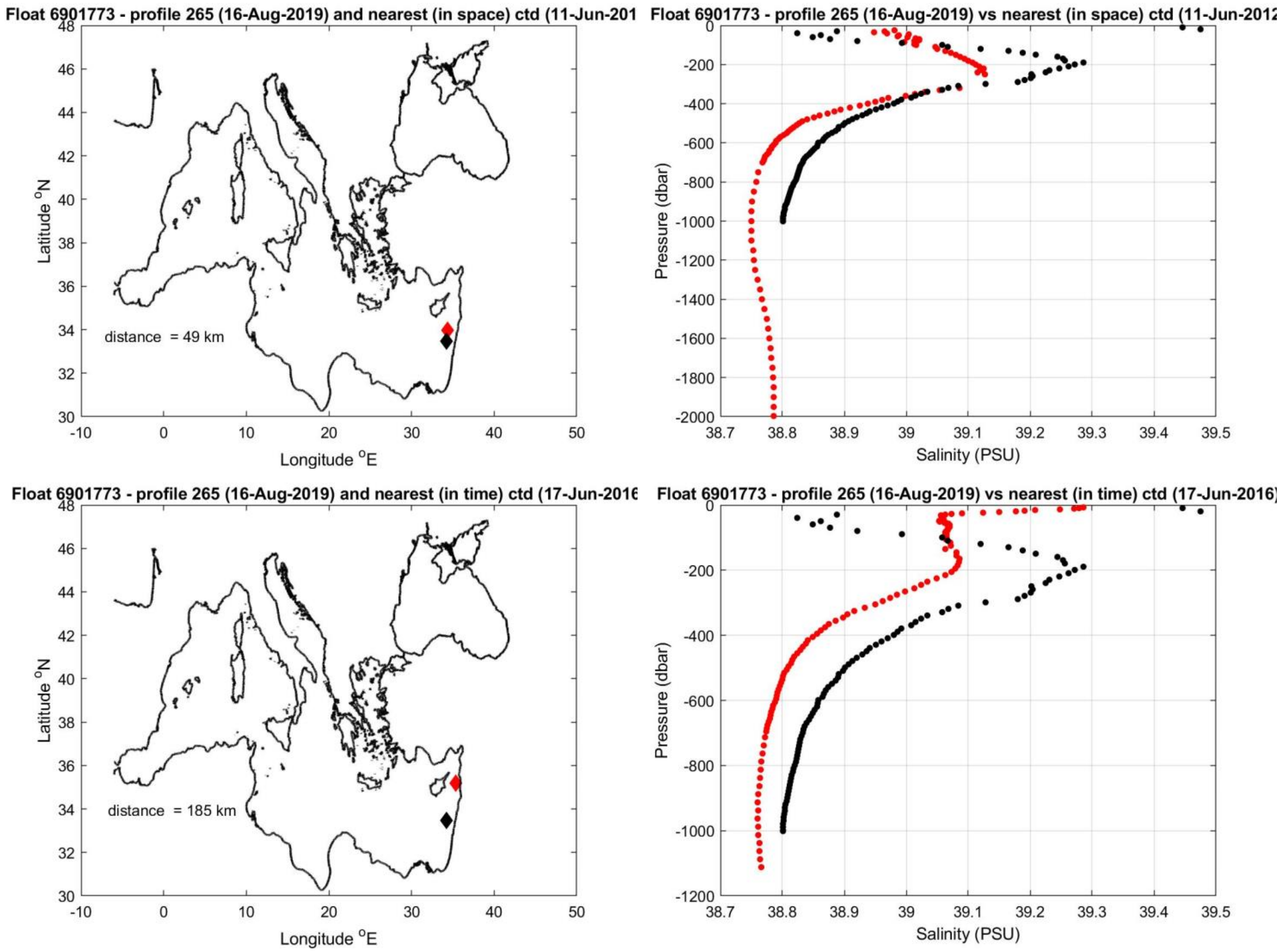


Figure 11: Float 6901773. The salinity float profile number 265 (black dots) are compared to the nearest in space (top) and in time (botton) reference profile (red dots). The locations of the two profiles and their distance is given in the left panel.

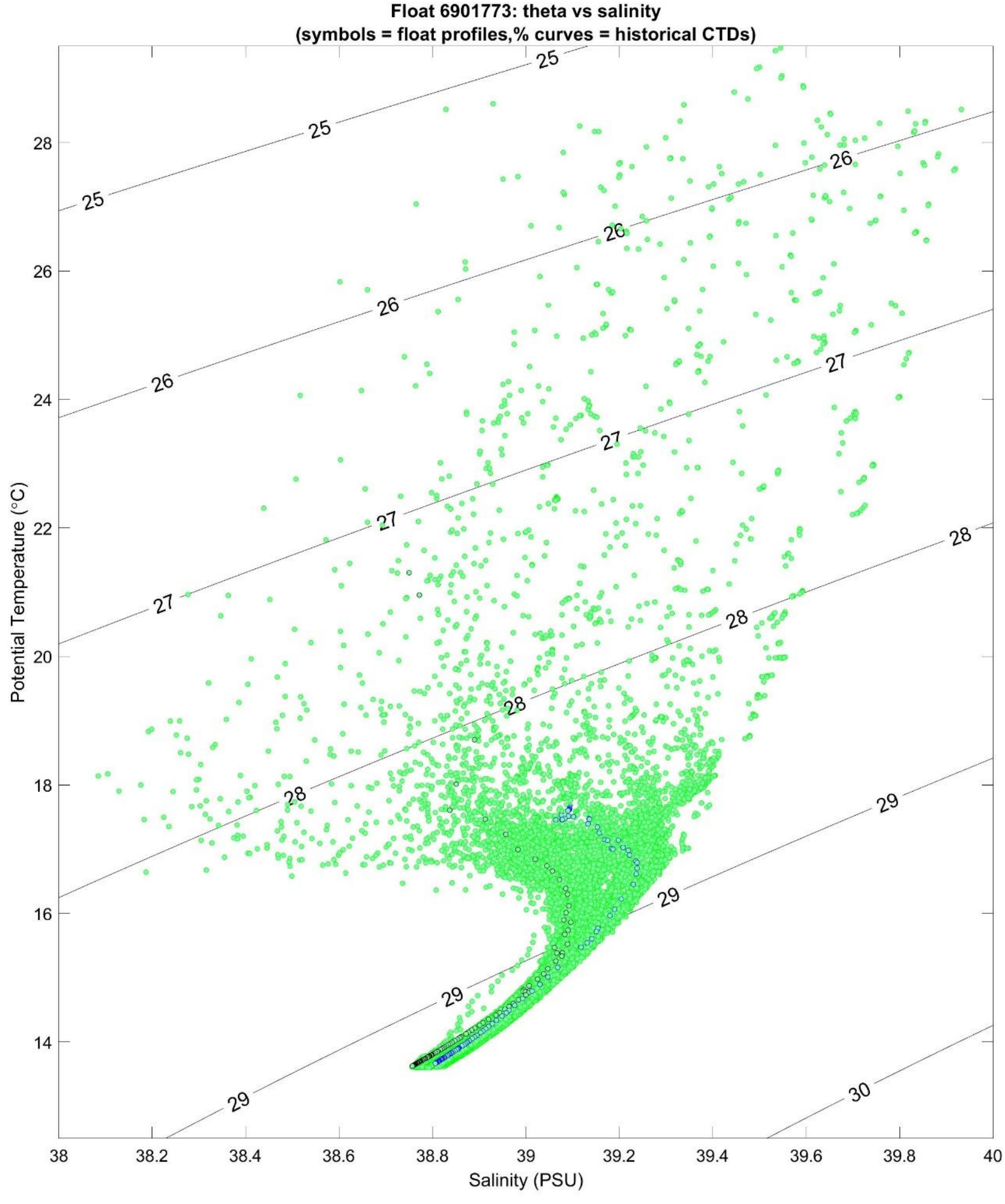


Figure 12: Float 6901773. T/S diagram plotted with and data from WMO boxes of CTD reference data +/- 10°of latitude and longitude. The black and blue cycles indicate the first and the last Argo profile, respectively. Green symbols represent other Argo profiles from this float. The thin colours lines indicate the reference data.

3 Correction of Salinity Data

3.1 Comparison between Argo Float and CTD Climatology

3.1.1 Configurations

Parameters	Value
CONFIG_MAX_CASTS	300
MAP_USE_PV	1
MAP_USE_SAF	0
MAPSCALE_LONGITUDE_LARGE	4
MAPSCALE_LONGITUDE_SMALL	1.33
MAPSCALE_LATITUDE_LARGE	4
MAPSCALE_LATITUDE_SMALL	1.33
MAPSCALE_PHI_LARGE	0.5
MAPSCALE_PHI_SMALL	0.1
MAPSCALE_AGE	10
MAP_P_EXCLUDE	700
MAP_P_DELTA	250
MAX BREAKS	1

3.1.2 Results

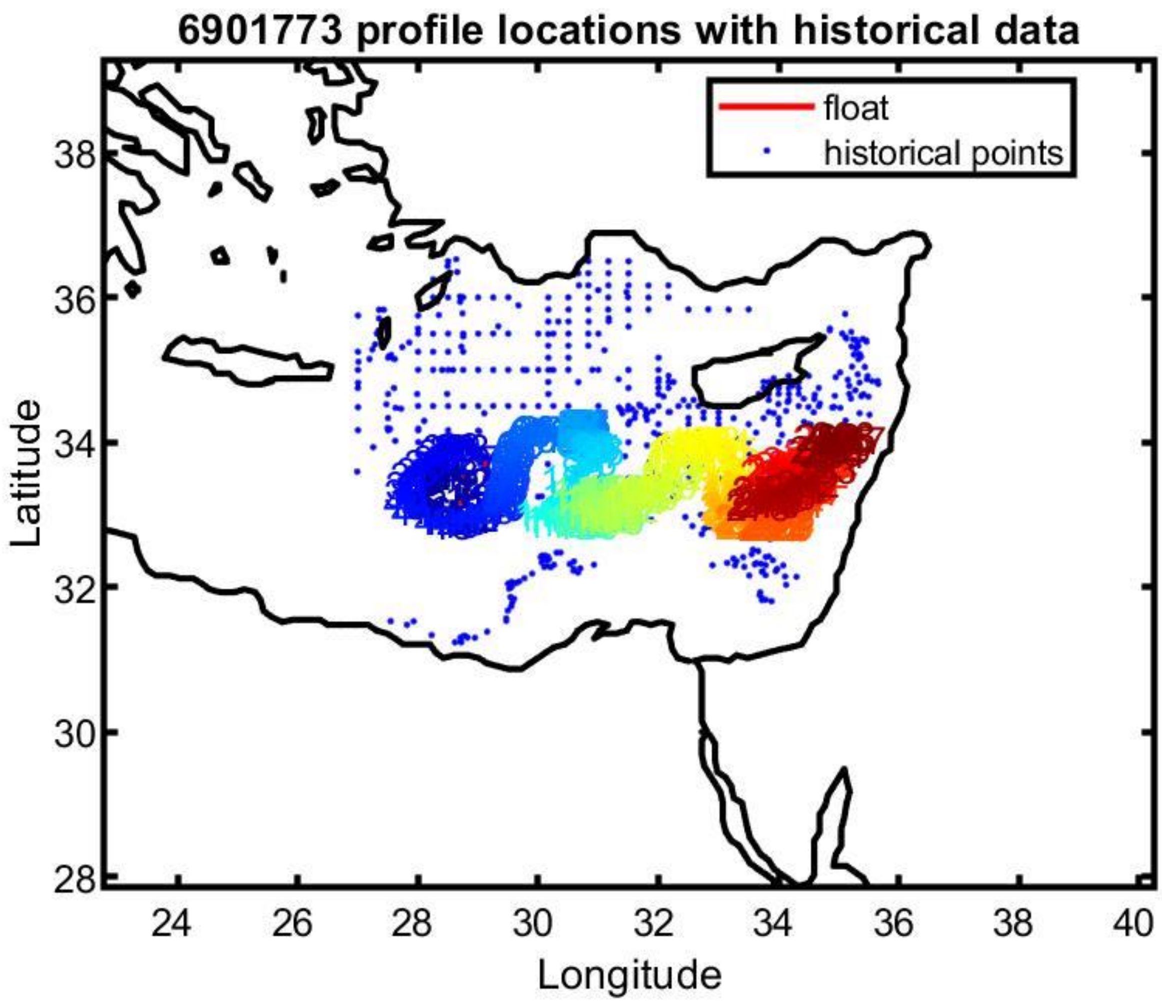


Figure 13: Float 6901773. Location of the float profiles (red line with colored numbers) and the reference data selected for mapping (blue dots).

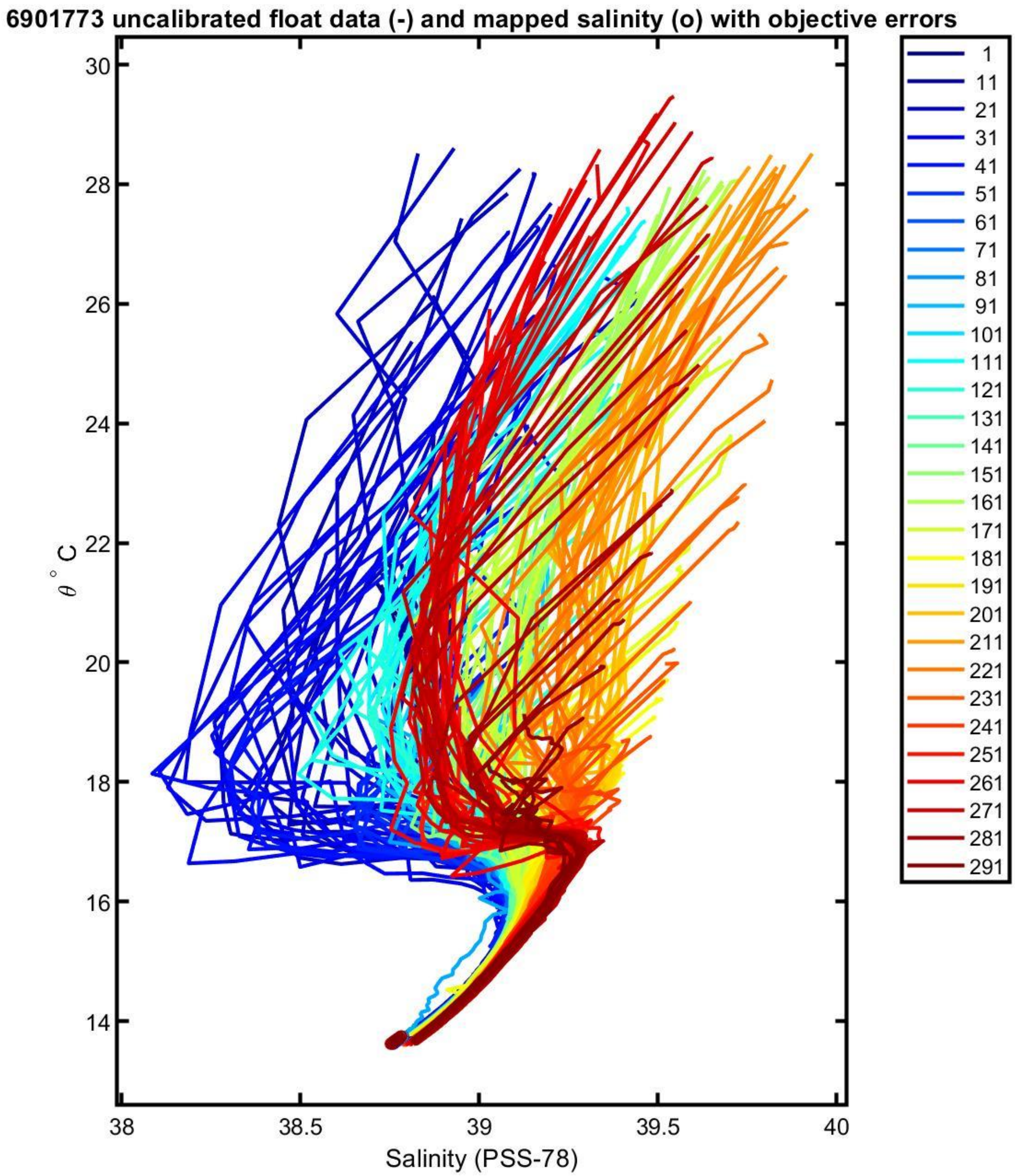


Figure 14: Float 6901773. Plot the original float salinity and the objectively estimated reference salinity at the 10 float theta levels that are used in calibration.

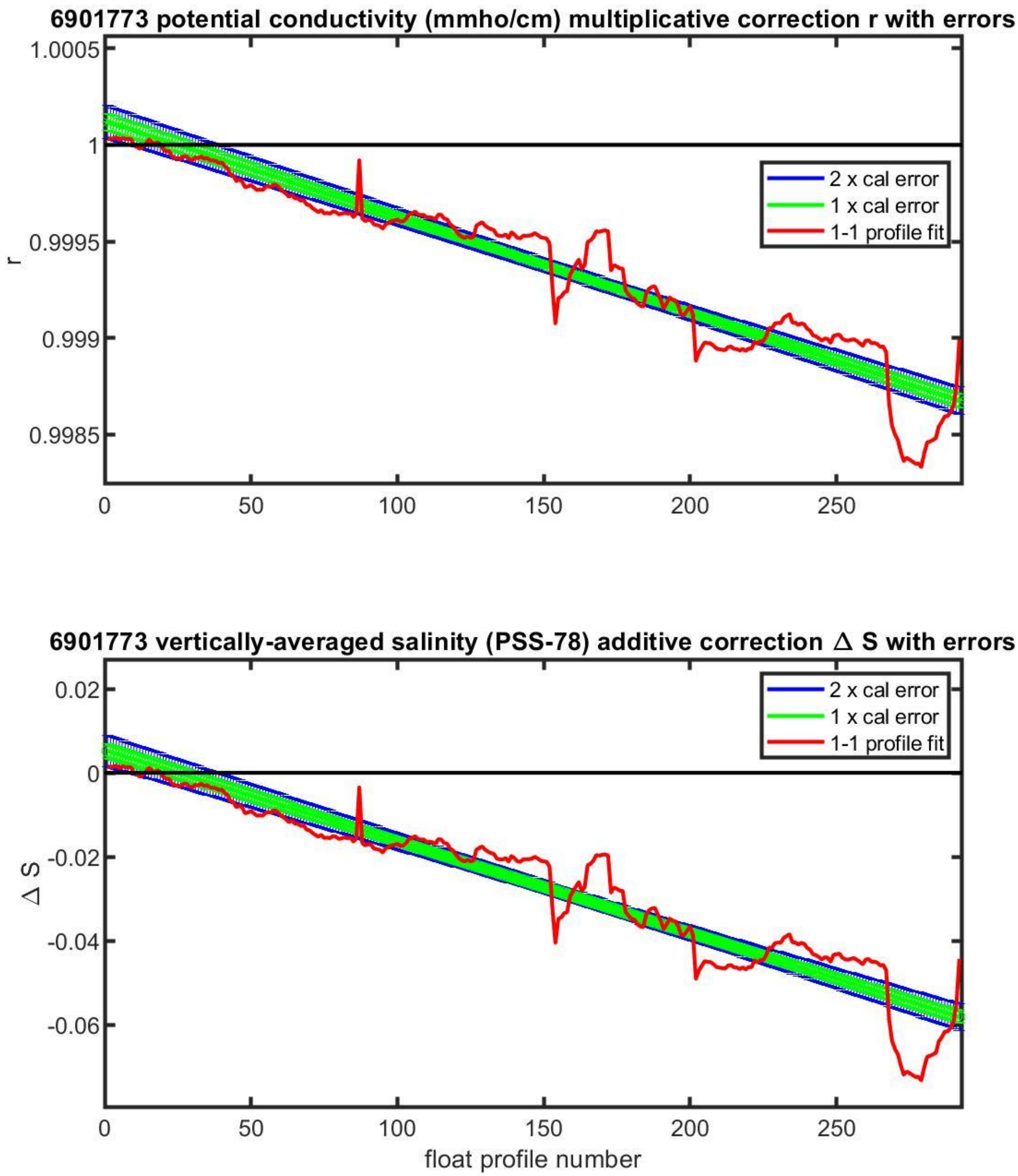


Figure 15: Float 6901773. Evolution of the suggested adjustment with time. The top panel plots the potential conductivity multiplicative adjustment. The bottom panel plots the equivalent salinity additive adjustment. The red line denotes one-to-one profile fit that uses the vertically weighted mean of each profile. The red line can be used to check for anomalous profiles relative to the optimal fit.

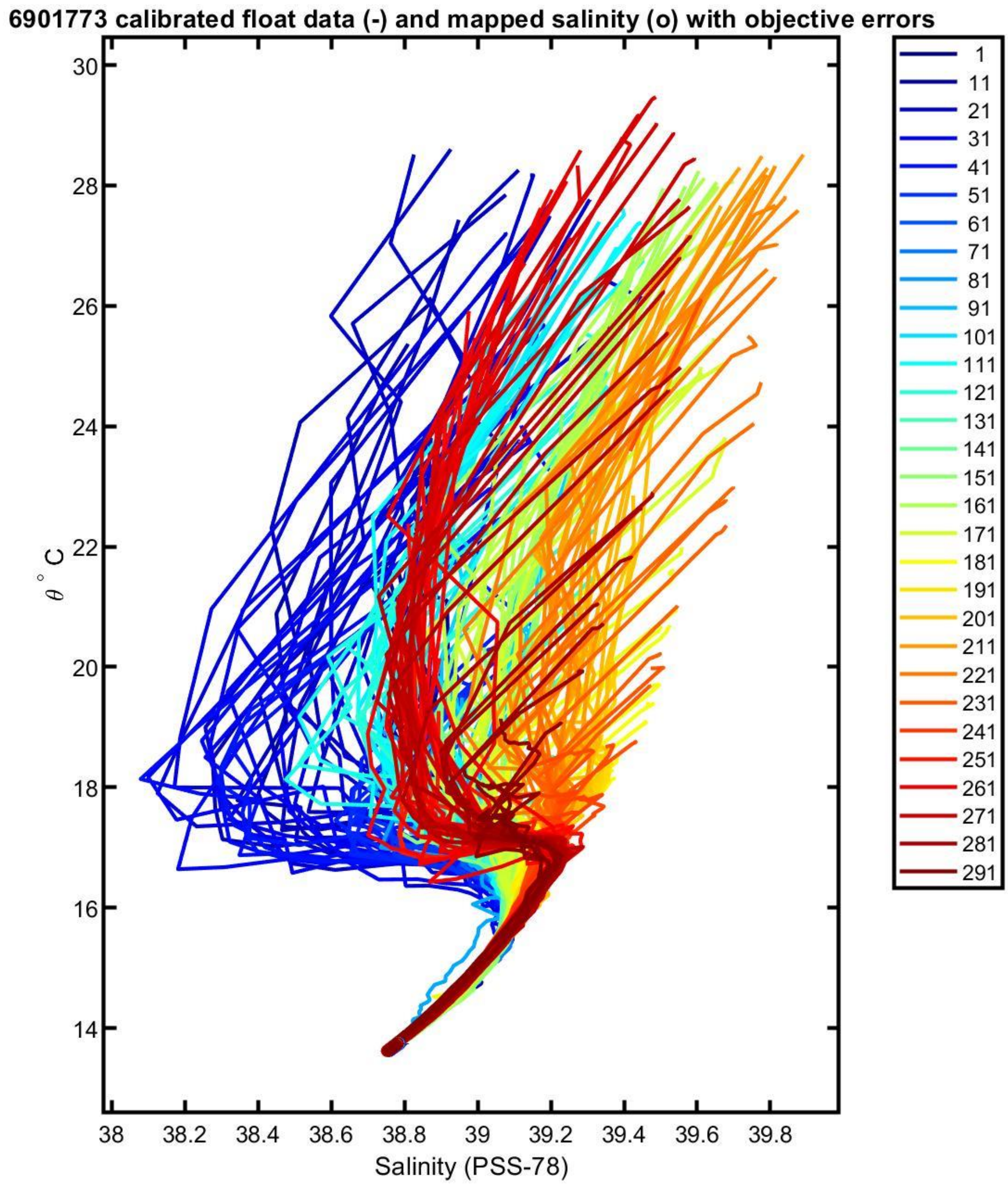


Figure 16: Float 6901773. The plot of calibrated float salinity and the objectively estimated reference salinity at the 10 float theta levels that are used in calibration.

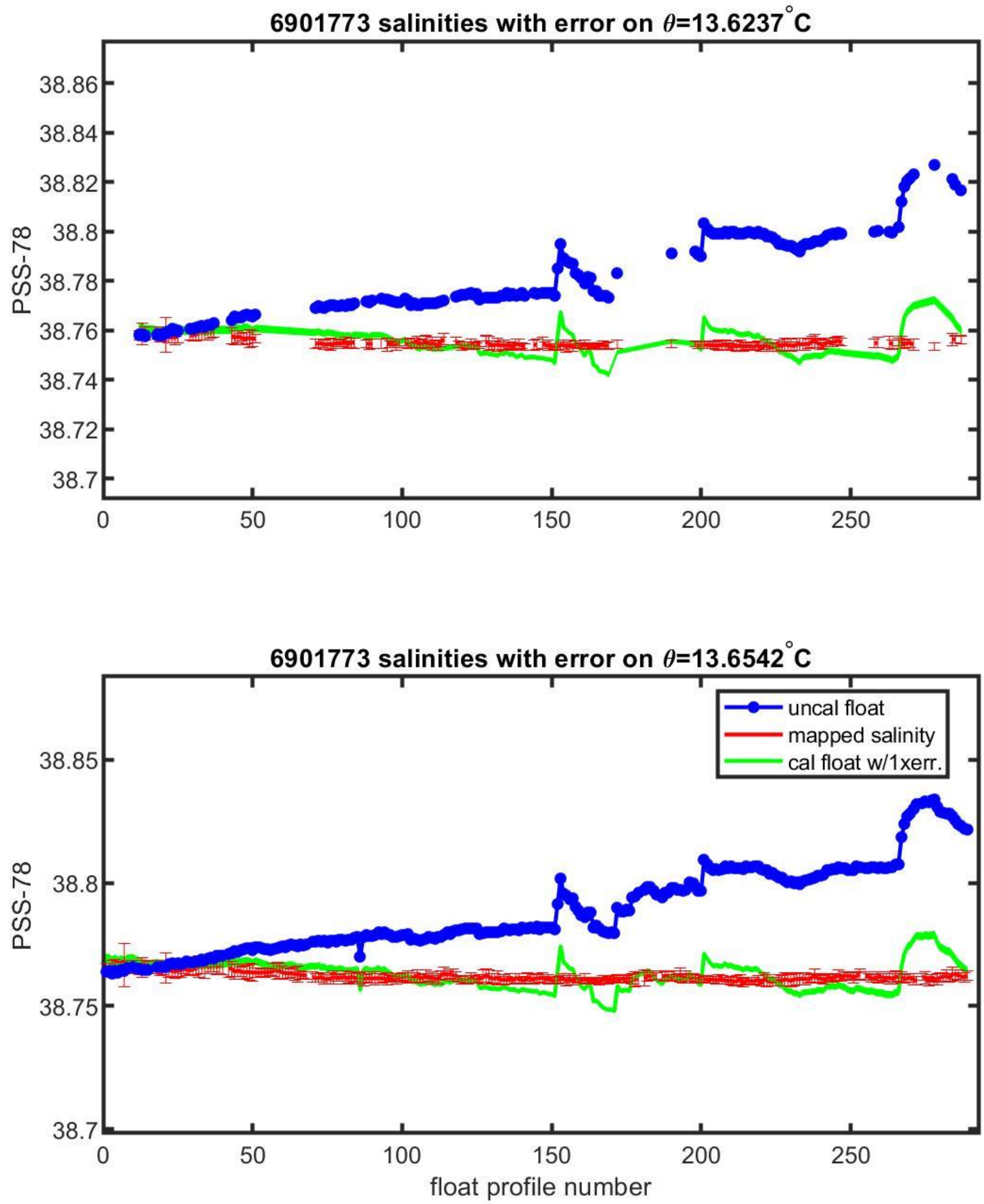


Figure 17: Float 6901773. Plots of the evolution of salinity with time along with selected theta levels with minimum salinity variance.

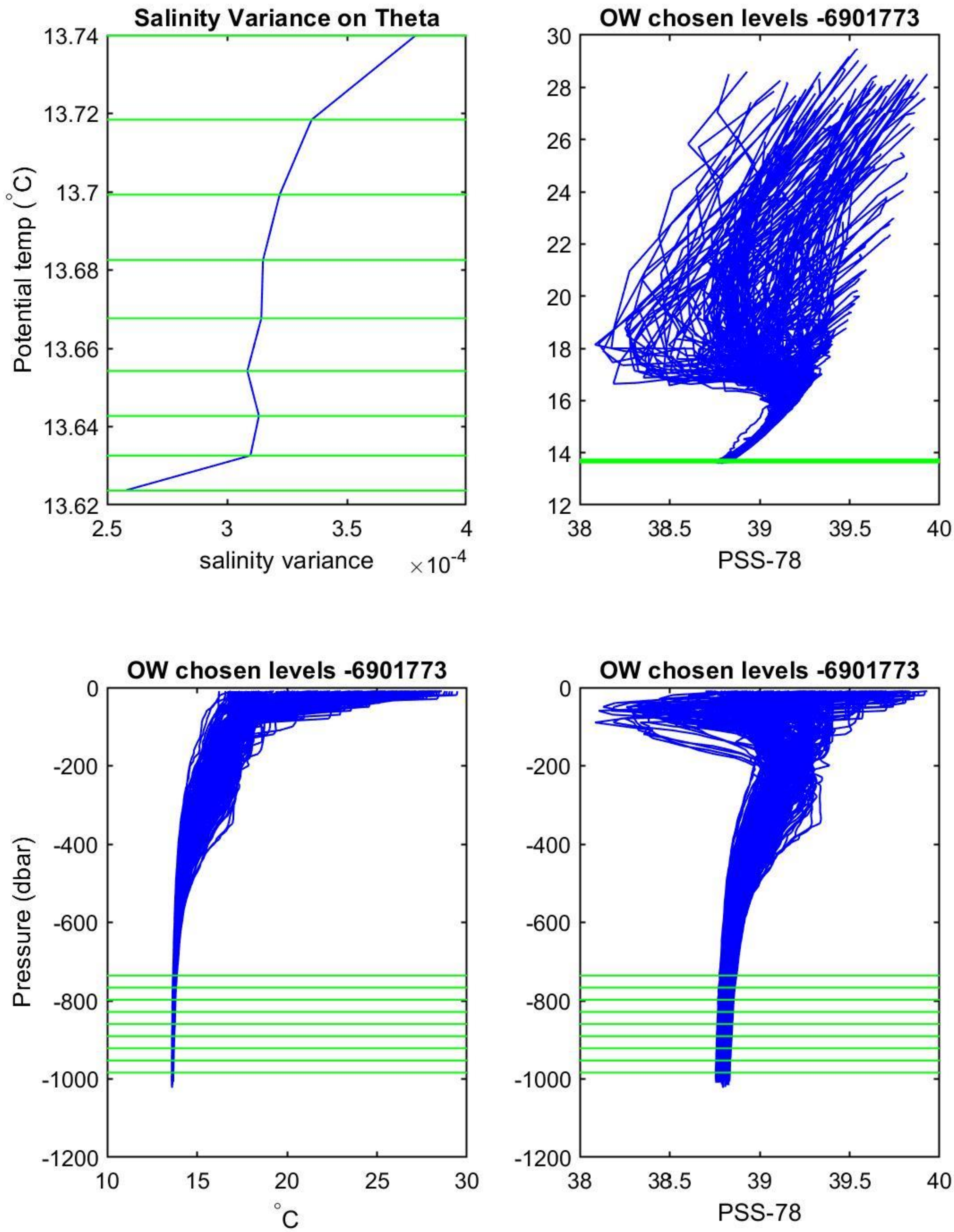


Figure 18: Float 6901773. Plots include the theta levels chosen for calibration: Top left: Salinity variance at theta levels. Top right: T/S diagram of all profiles of Argo float. Bottom left: potential temperature plotted against pressure. Bottom right: salinity plotted against pressure.

The analysis of the θ-S diagram of profile segments deeper than 700 dbar (Figure 19) shows that the OW method was run where the θ-S relationship is the tightest.

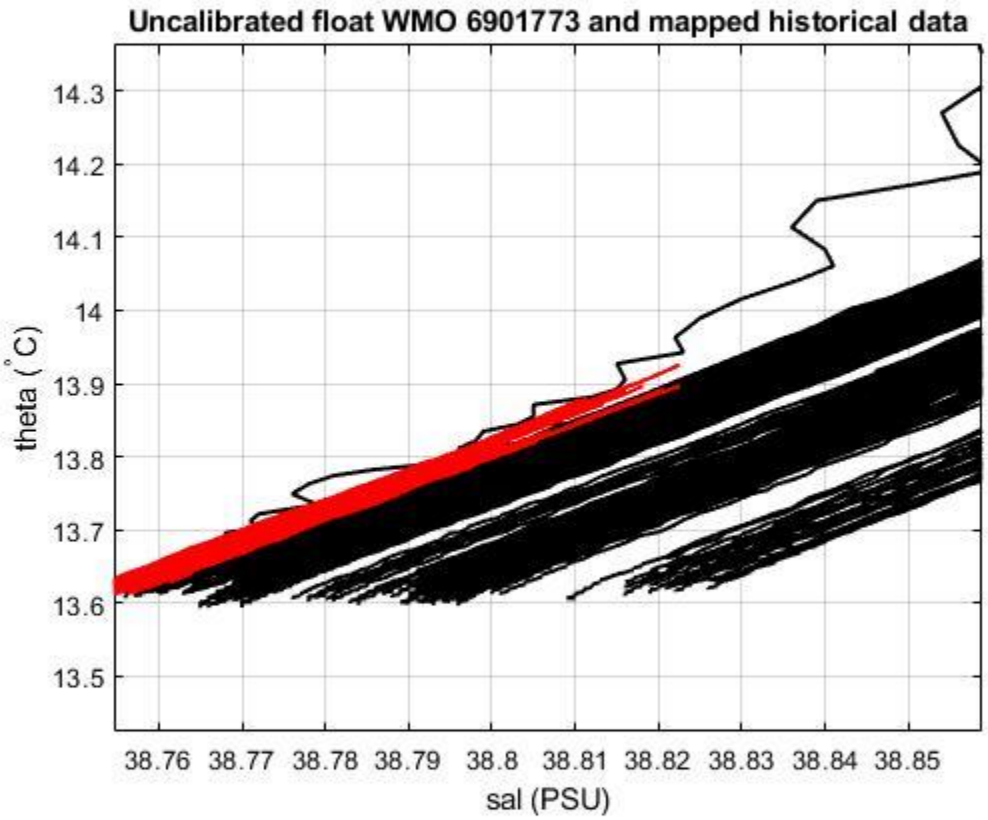


Figure 19: Float 6901773.Uncalibrated float salinity profile (black lines) and mapped historical data (red lines) in the most uniform part of the θ-S curve.

4 Summary

Float was deployed in the Levantine sub-basin, in the Mediterranean Sea. The most favorable water masses, which are useful for comparison with climatology is relatively stable intermediate and deep waters from around 700 m. The initial comparison between Argo float and reference data shows a salinity offset/drift. This float was not DMQC-ed before.
The OWC analysis shows a significant salinity offset/drift. Figure 17 shows that the salinity drift start from cycle 62 and increasing strongly on selected θ-levels. This float has some characteristics of a fast salty drifter: the correction gets larger than 0.01 within 1yr after deployment and reaches 0.05 within 5 years after deployment.
After several analyses, the last decision is that the salinity data of float WMO 6901773 need a delayed mode correction. QC 1 is applied for cycles from 1 to 244 except for the cycle 86 which is the one that detaches itself from the others. QC 4 is applied for cycles from 245 to 292.

PSAL_ADJUSTED=PSAL+ ΔS from cycle 1 to 292

The quality flags applied are the following:

PSAL_ADJUSTED_QC='1' from cycle 1 to 244

PSAL_ADJUSTED_QC='4' for cycle 86

PSAL_ADJUSTED_QC='4' from cycle 245 to 292

The delayed-mode files (Dfiles) have been created accordingly and sent to the Coriolis GDAC.

5 References

Cabanes, C., Thierry, V., & Lagadec, C. (2016). Improvement of bias detection in Argo float conductivity sensors and its application in the North Atlantic. Deep-Sea Research Part I: Oceanographic Research Papers, 114, 128–136. https://doi.org/10.1016/j.dsr.2016.05.007