Delayed Mode Quality Control of Argo float WMO 6901836

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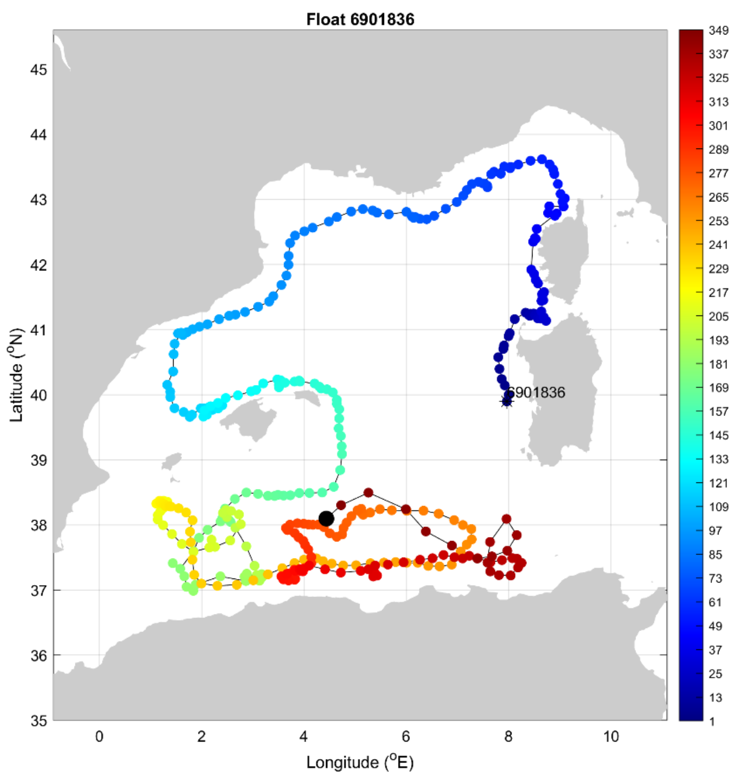

Contents

1 Introduction

This report includes the delayed mode analysis performed for float 6901836. It was deployed in Mediterranean Sea (Algerian sub-basin) in June 2014 and after performed 359 cycles died. Before the analysis, real-time QC flags were visually inspected. The list of flags applied is QC=1 to cycles from 1 to 314 and QC=3 from 315 to 359. 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 6901836 is the Arvor 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:
1-314 PSAL QC=1

315-359 PSAL QC=3 (added to greylist)

2.2 Satellite Altimeter Report

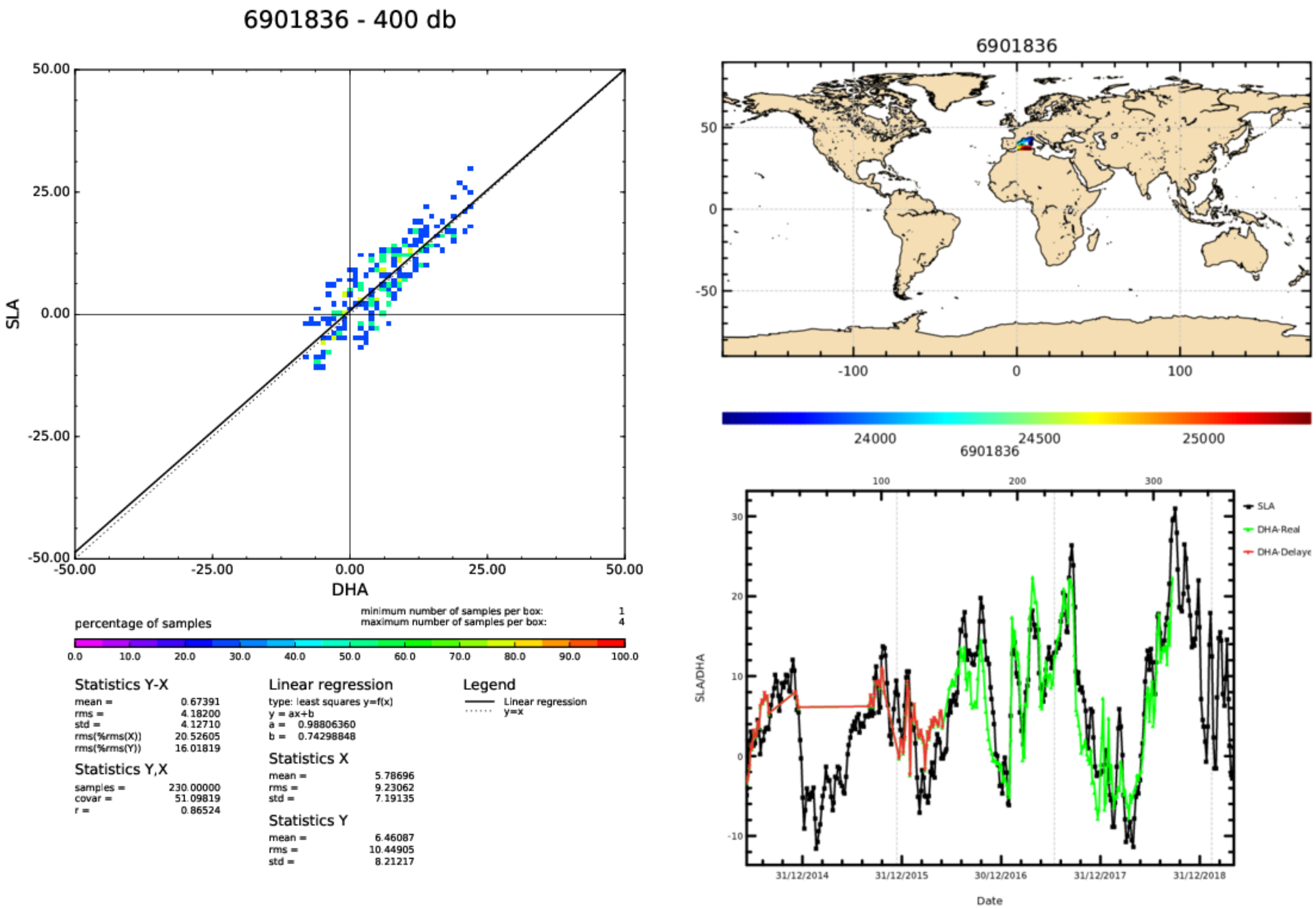

Figure 1: Float 6901836. The comparison between the sea surface height (SSH) from the satellite altimetry and dynamic height anomaly (DHA) extracted from the Argo float temperature and salinity. The figure is created by the CLS/Coriolis and distributed by Ifremer (ftp://ftp.ifremer.fr/ifremer/argo/etc/argo-ast9-item13-AltimeterComparison/figures/).

2.3 Time Series of Argo Float Temperature and Salinity

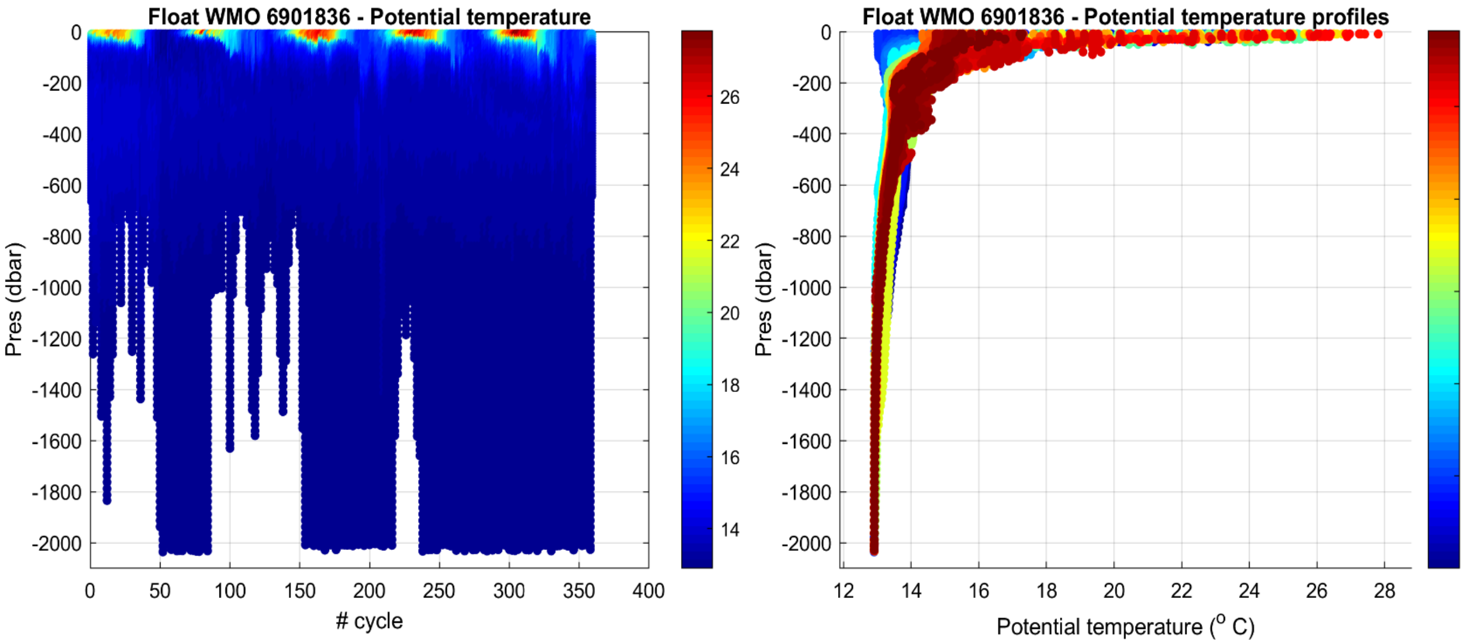

Figure 1: Float 6901836. Time series of Argo float potential temperature (°C) on the left, and potential temperature profiles color-coded per cycle number on the right.

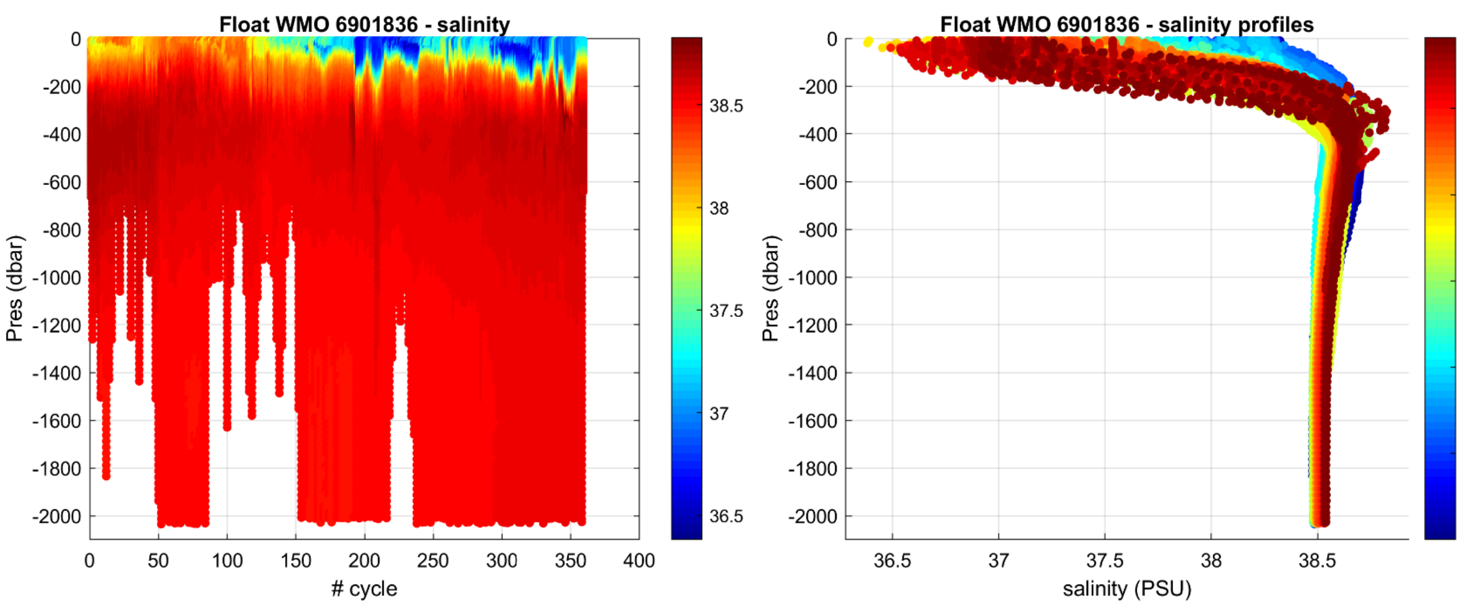

Figure 2: Float 6901836. Time series of Argo float potential salinity (PSS-78) on the left, and salinity profiles color-coded per cycle number on the right.

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.

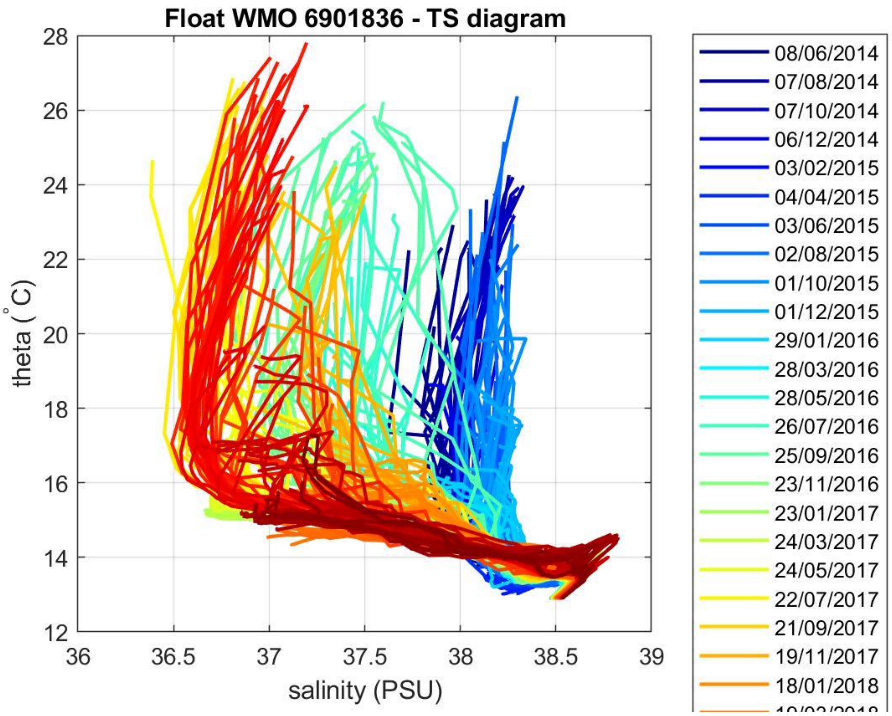

Figure 3: Float 6901836. θ-S diagram color-coded per cycle number.

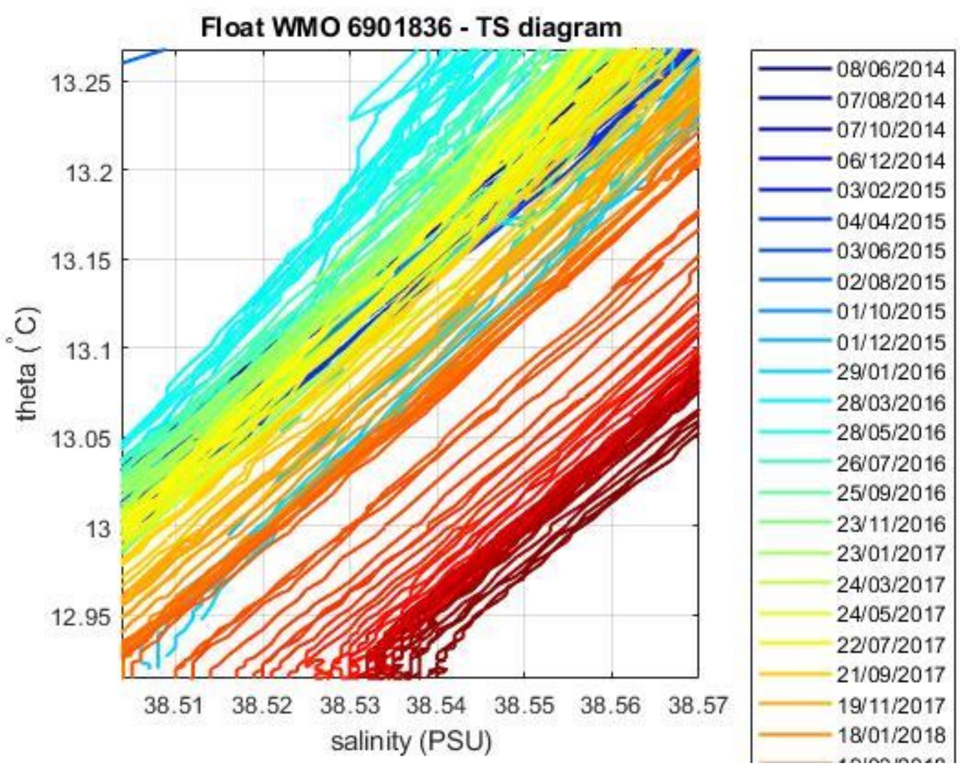

Figure 4: Float 6901836. Area of the θ-S diagram (color-coded per cycle number) where the θ-S relationship is more uniform.

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.

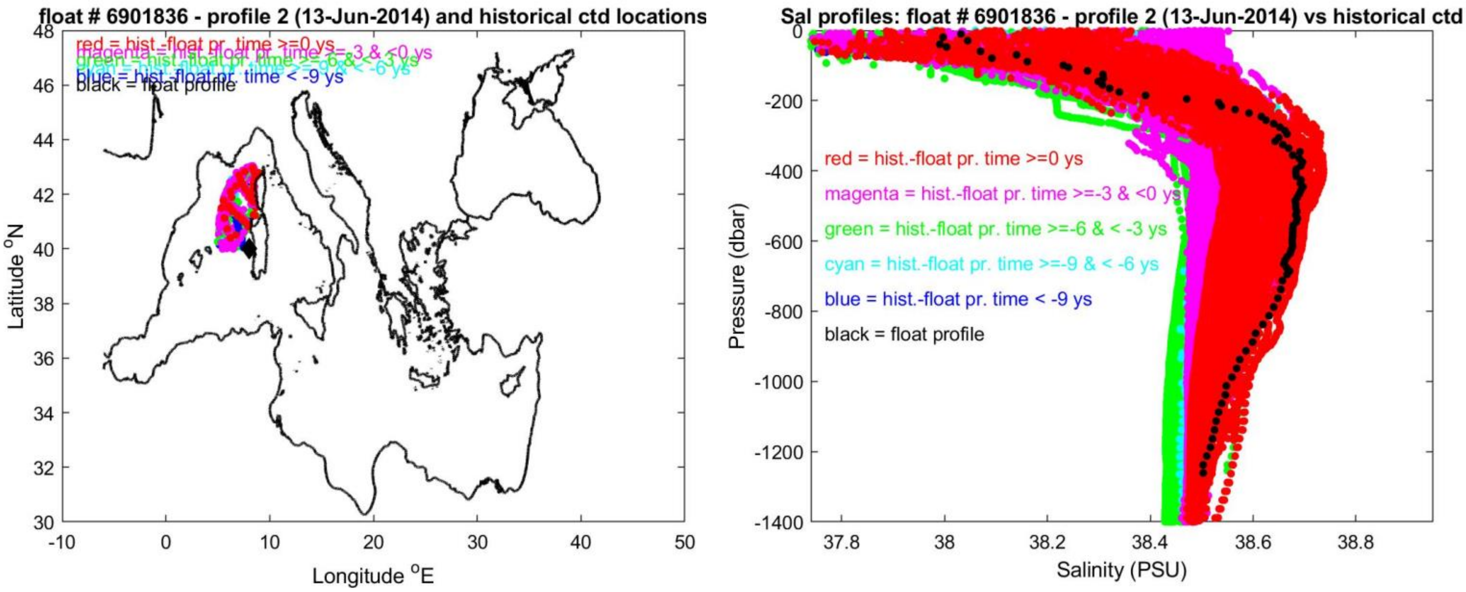

Figure 5: Float 6901836. Locations of the salinity float profile number 2 and historical CTD data (right panel) and the respective salinity profiles (left panel).

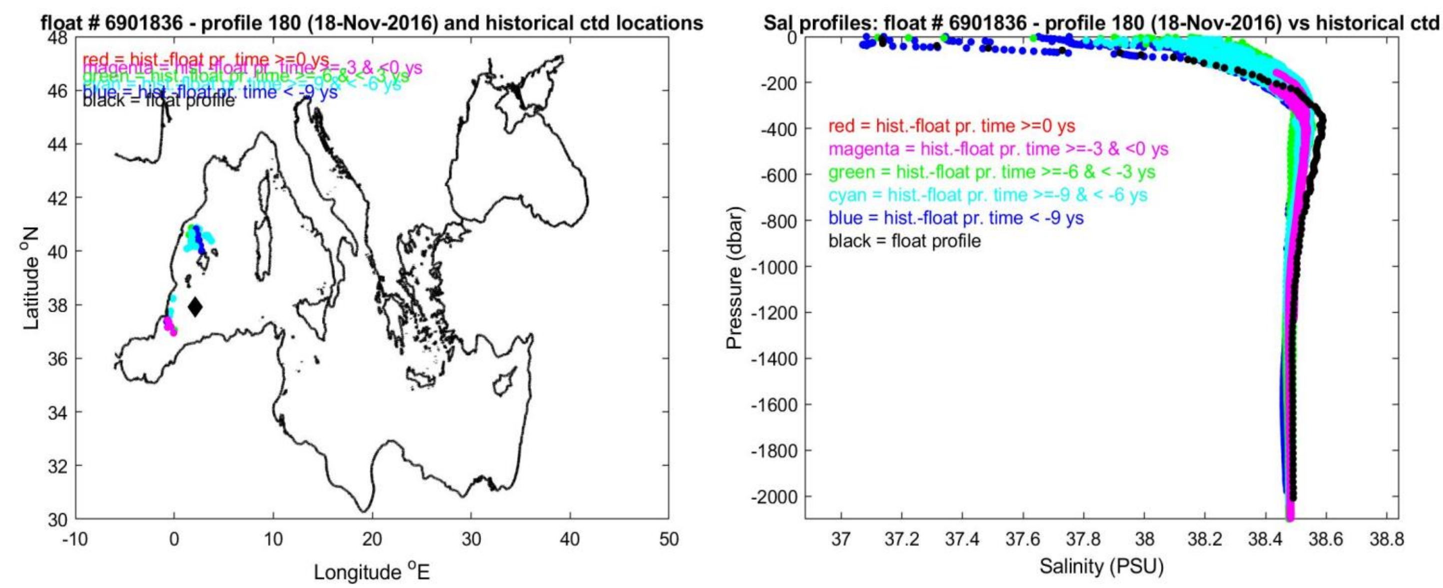

Figure 6: Float 6901836. Locations of the salinity float profile number 180 and historical CTD data (right panel) and the respective salinity profiles (left panel).

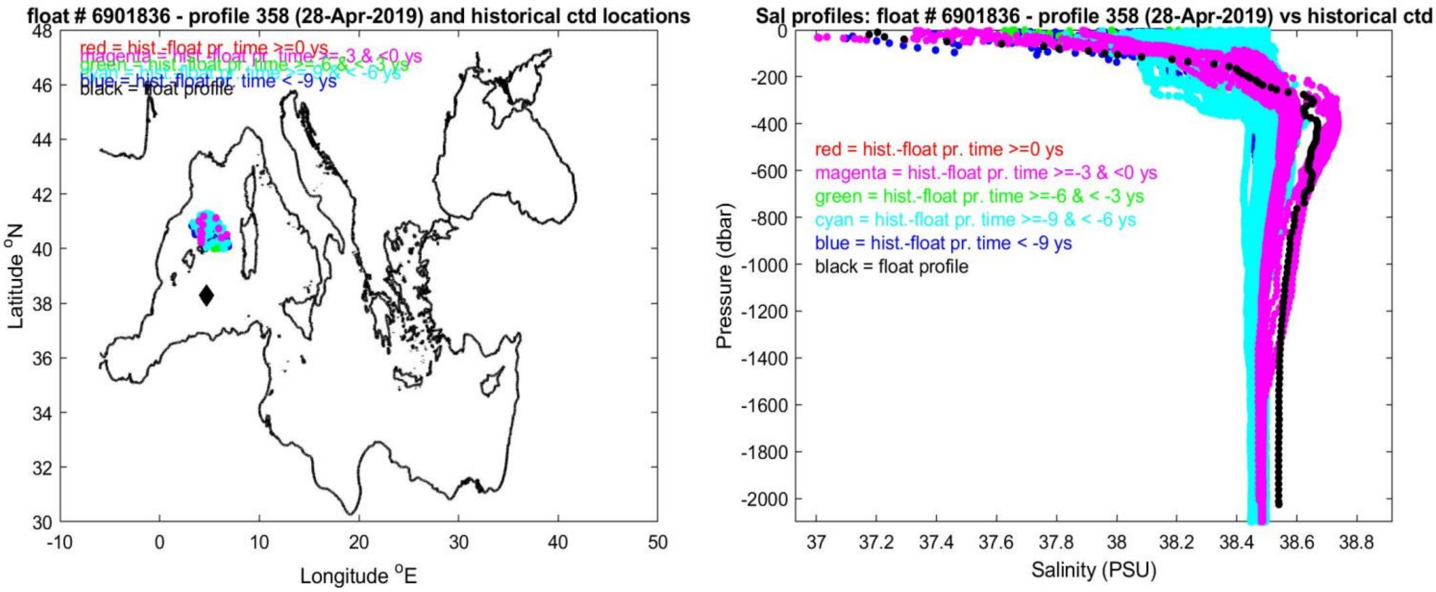

Figure 7: Float 6901836. Locations of the salinity float profile number 358 and historical CTD data (right panel) and the respective salinity profiles (left panel).

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 deeper layers, where the water column is more stable, for profiles 2 and 180. The comparison shows a drift for profile 358.

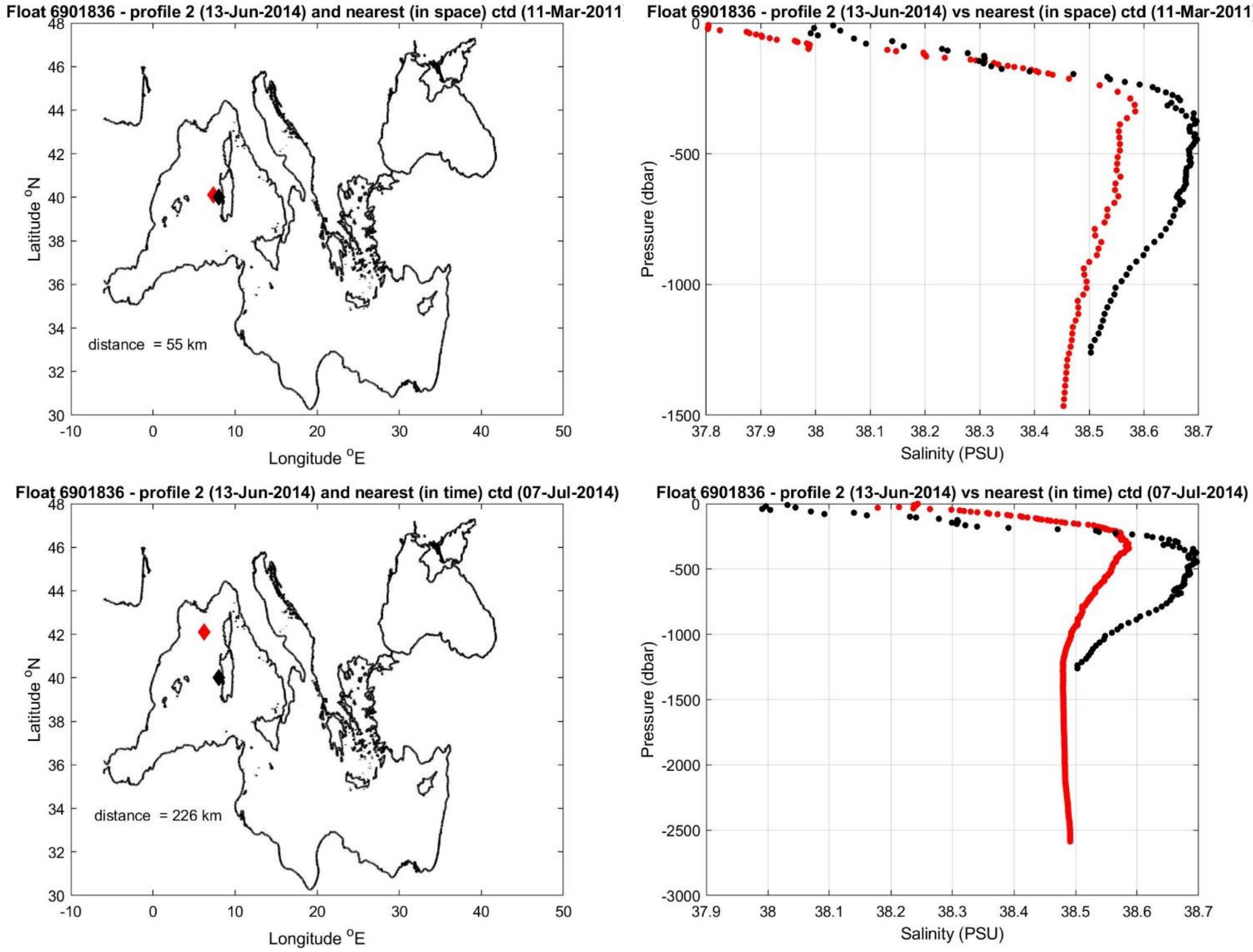

Figure 8: Float 6901836. The salinity float profile number 2 (black dots) are compared to the nearest in space (top) and in time (bottom) reference profile (red dots). The locations of the two profiles and their distance is given in the left panel.

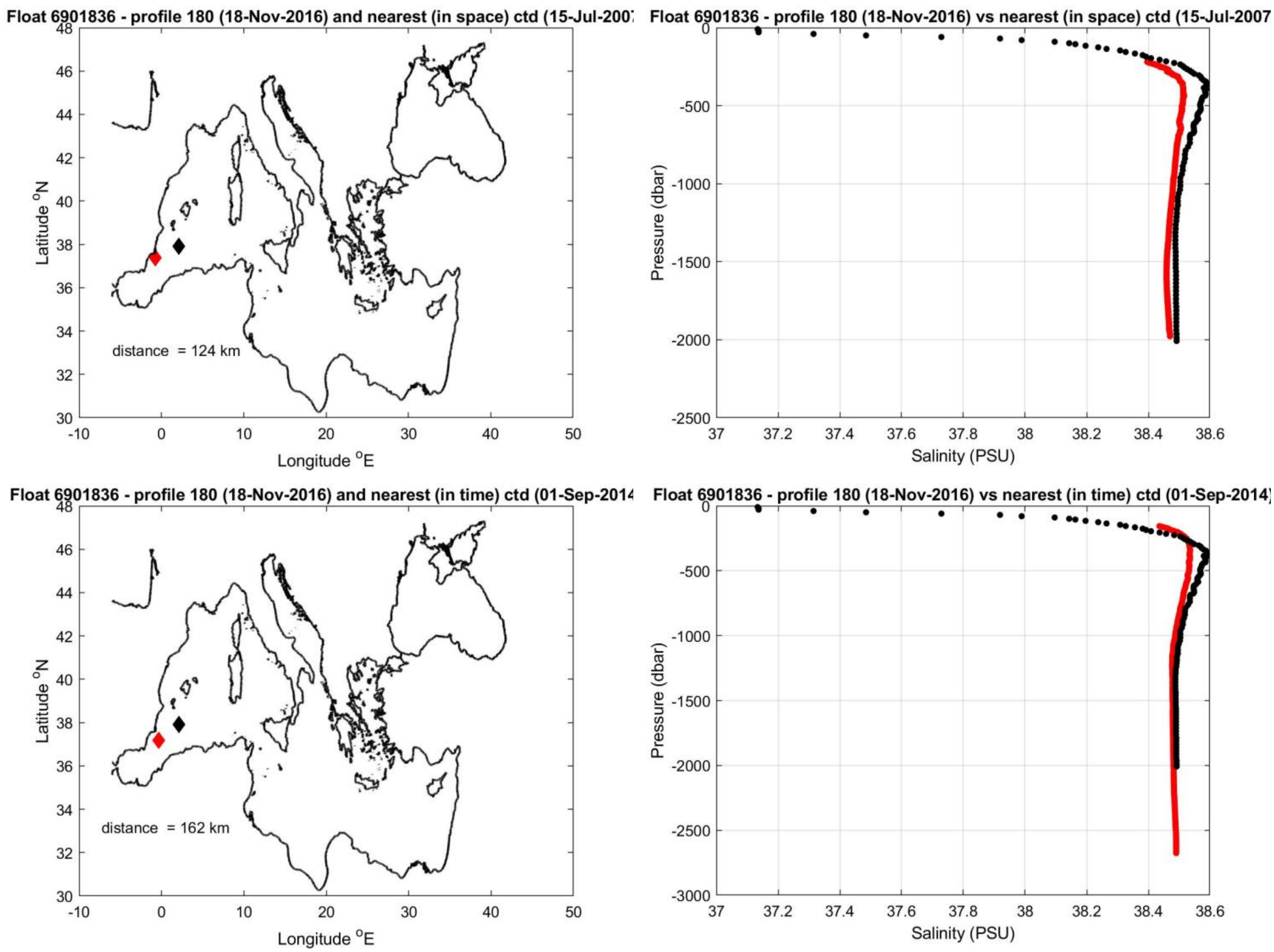

Figure 9: Float 6901836. The salinity float profile number 180 (black dots) are compared to the nearest in space (top) and in time (bottom) reference profile (red dots). The locations of the two profiles and their distance is given in the left panel.

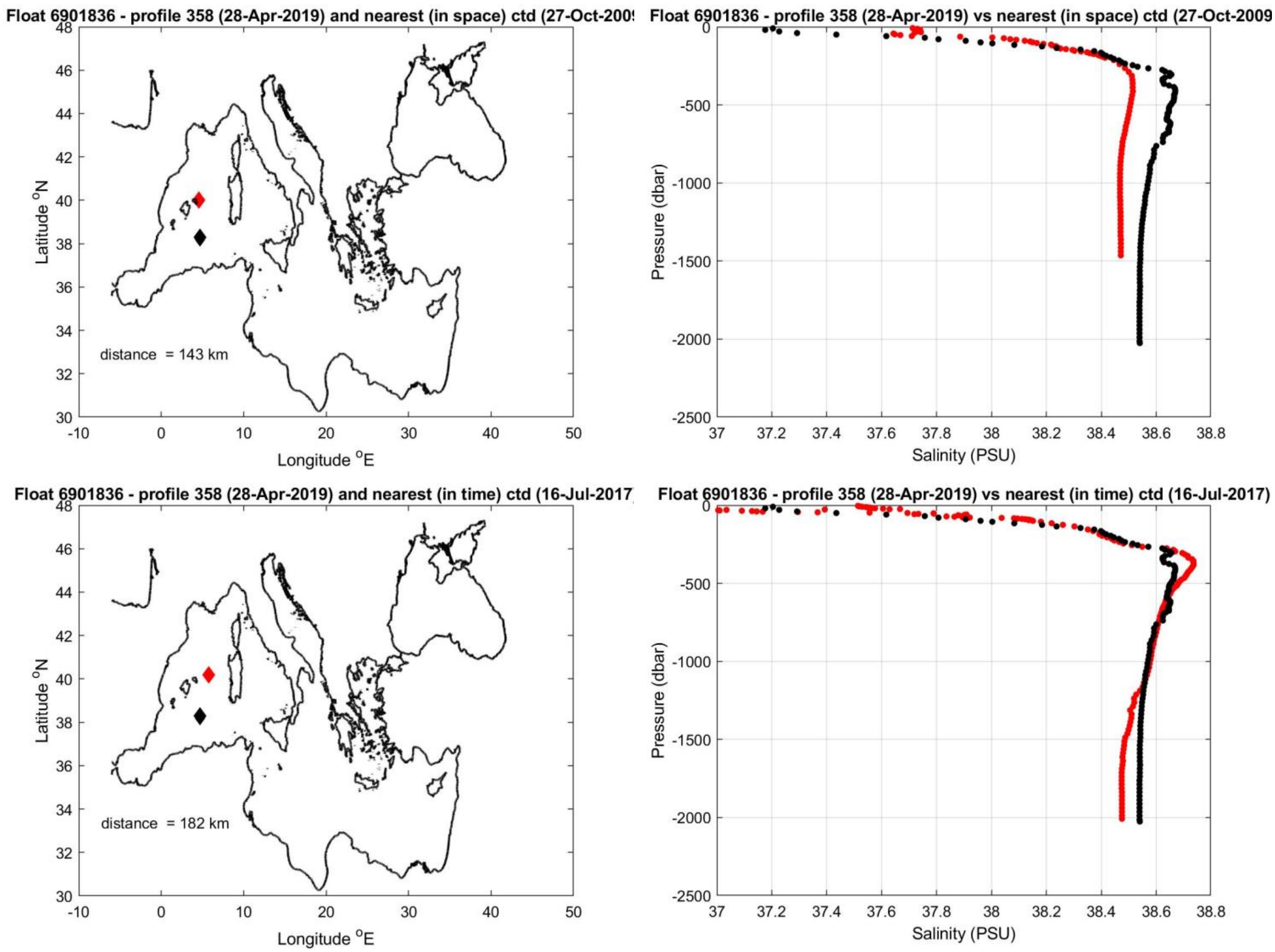

Figure 10: Float 6901836. The salinity float profile number 358 (black dots) are compared to the nearest in space (top) and in time (botton) reference profile (red dots). The locations of the two profiles and their distance is given in the left panel.

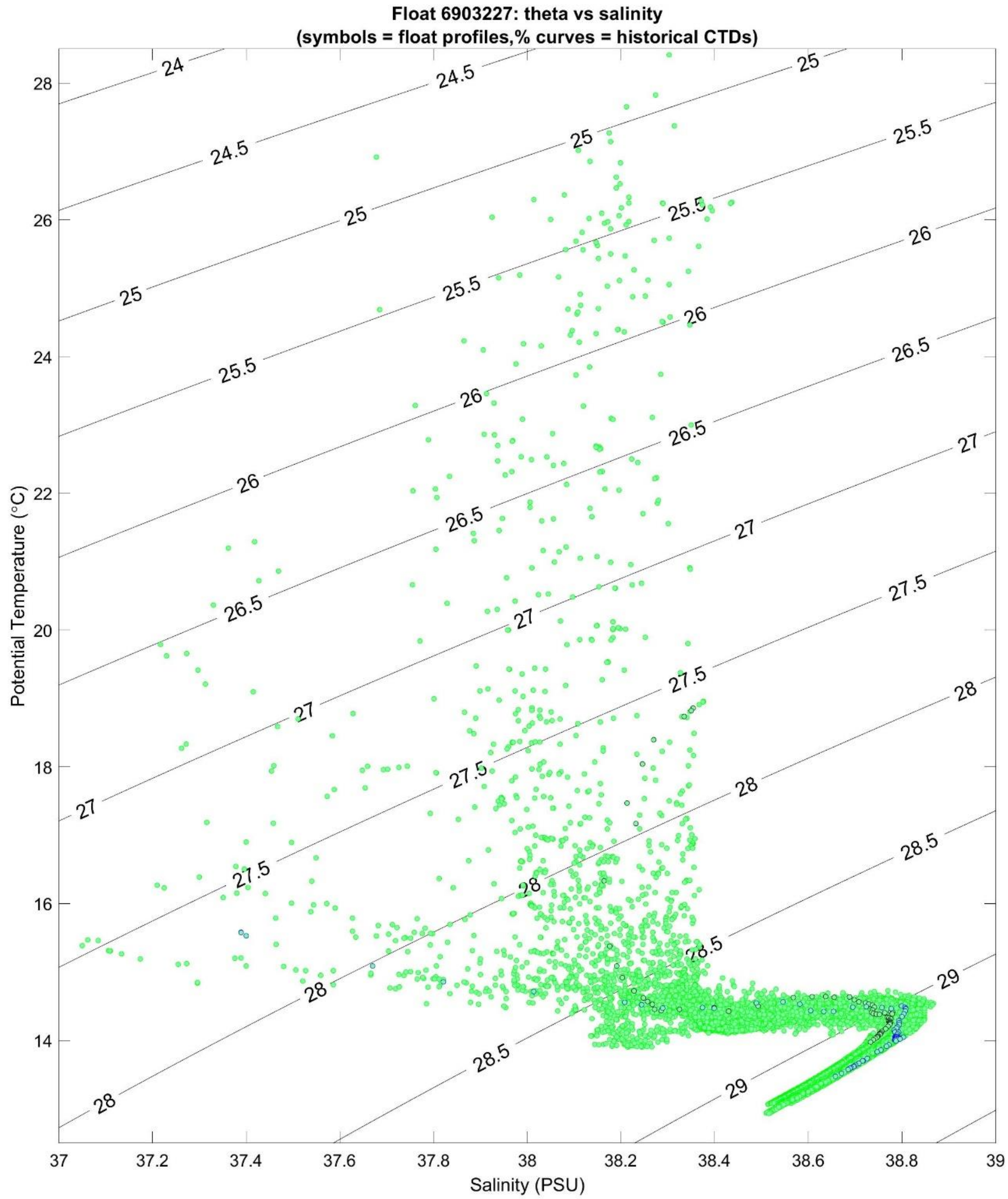

Figure 11: Float 6901836. T/S diagram plotted with and data from WMO boxes of CTD reference data +/- 10°of latitude and longitude. The black and blue cycles indicate the first and the last Argo profile, respectively. Green symbols represent other Argo profiles from this float. The thin colours lines 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

3.1.2 Results

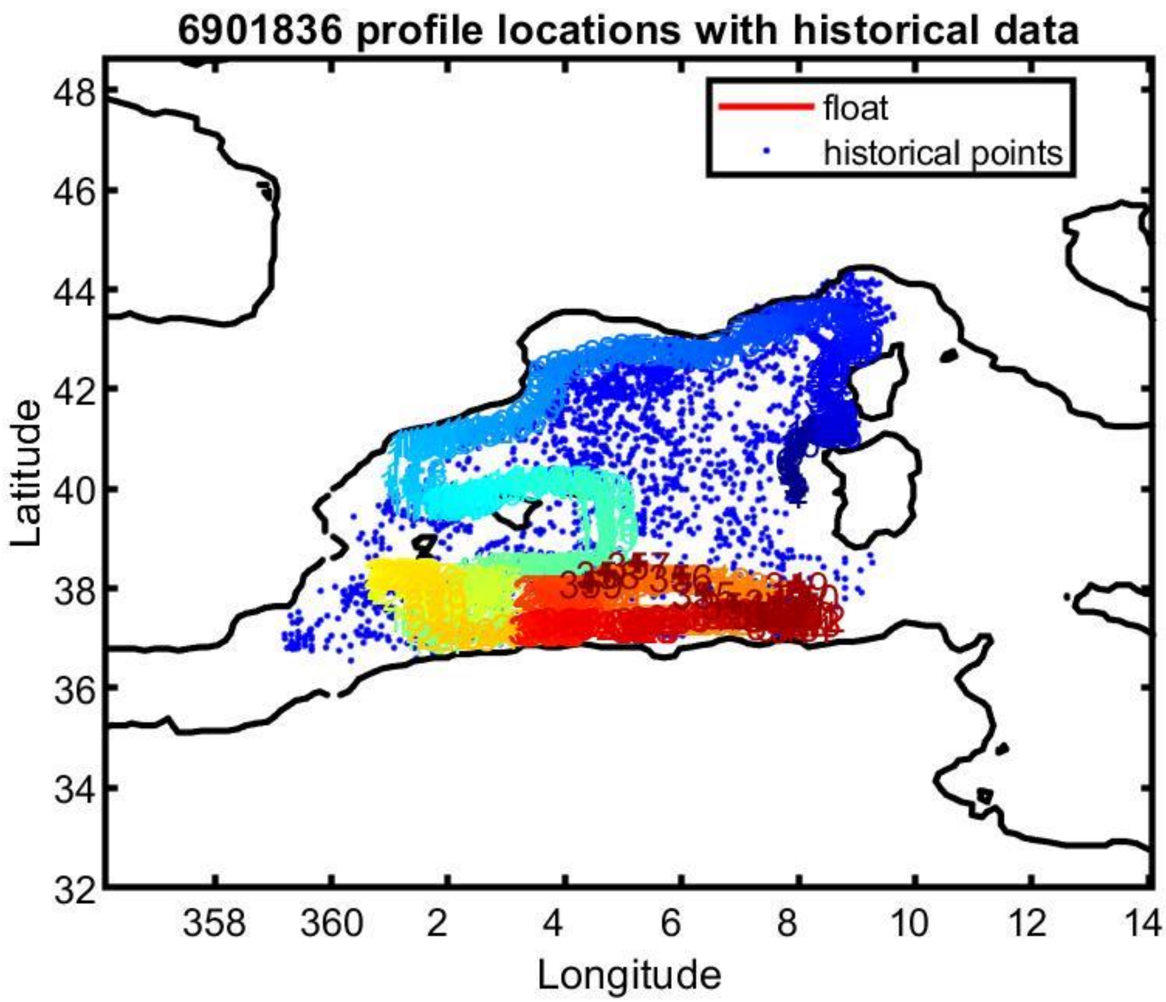

Figure 12: Float 6901836. Location of the float profiles (red line with colored numbers) and the reference data selected for mapping (blue dots).

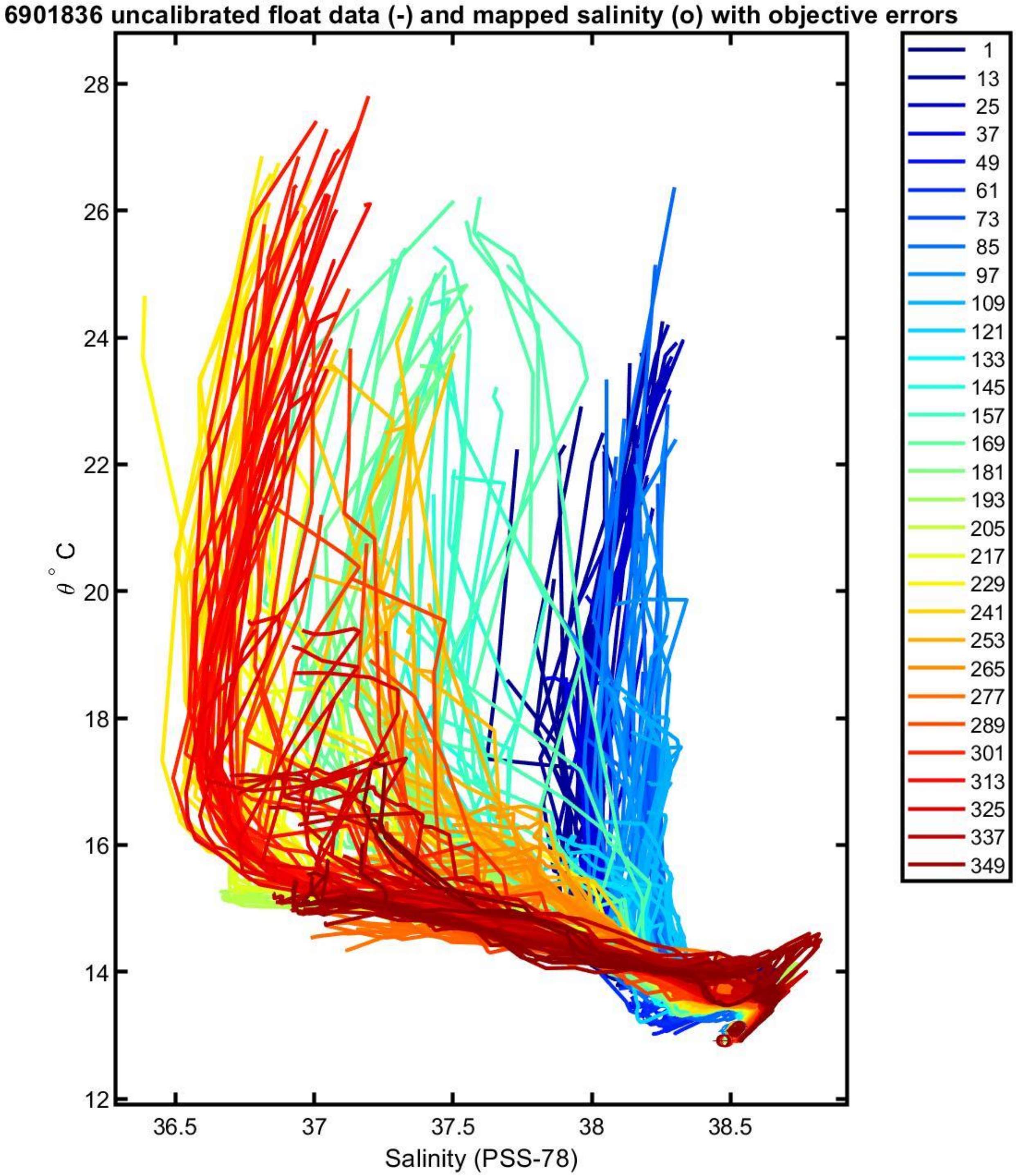

Figure 13: Float 6901836. Plot the original float salinity and the objectively estimated reference salinity at the 10 float theta levels that are used in calibration.

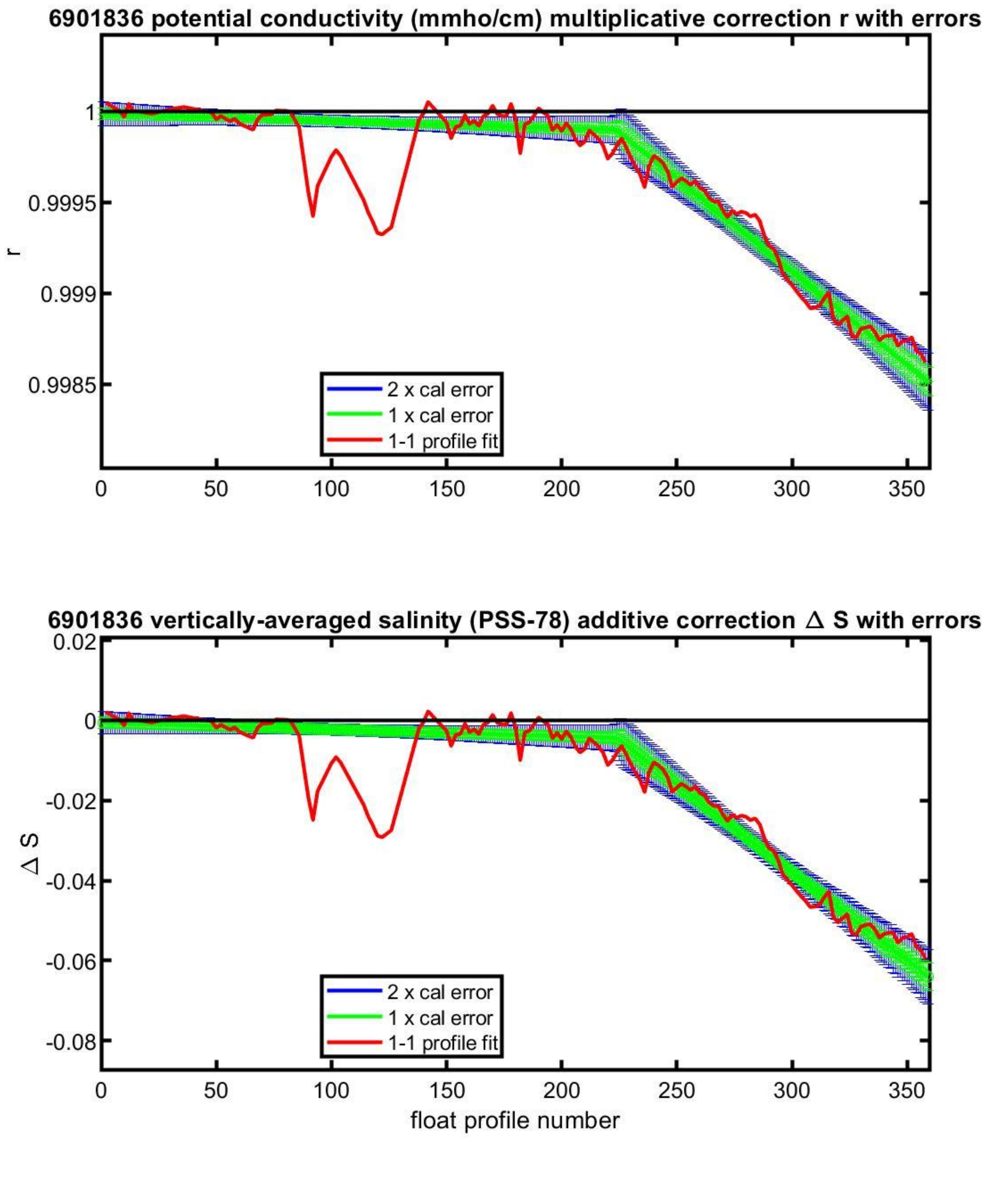

Figure 14: Float 6901836. Evolution of the suggested adjustment with time. The top panel plots the potential conductivity multiplicative adjustment. The bottom panel plots the equivalent salinity additive adjustment. The red line denotes one-to-one profile fit that uses the vertically weighted mean of each profile. The red line can be used to check for anomalous profiles relative to the optimal fit.

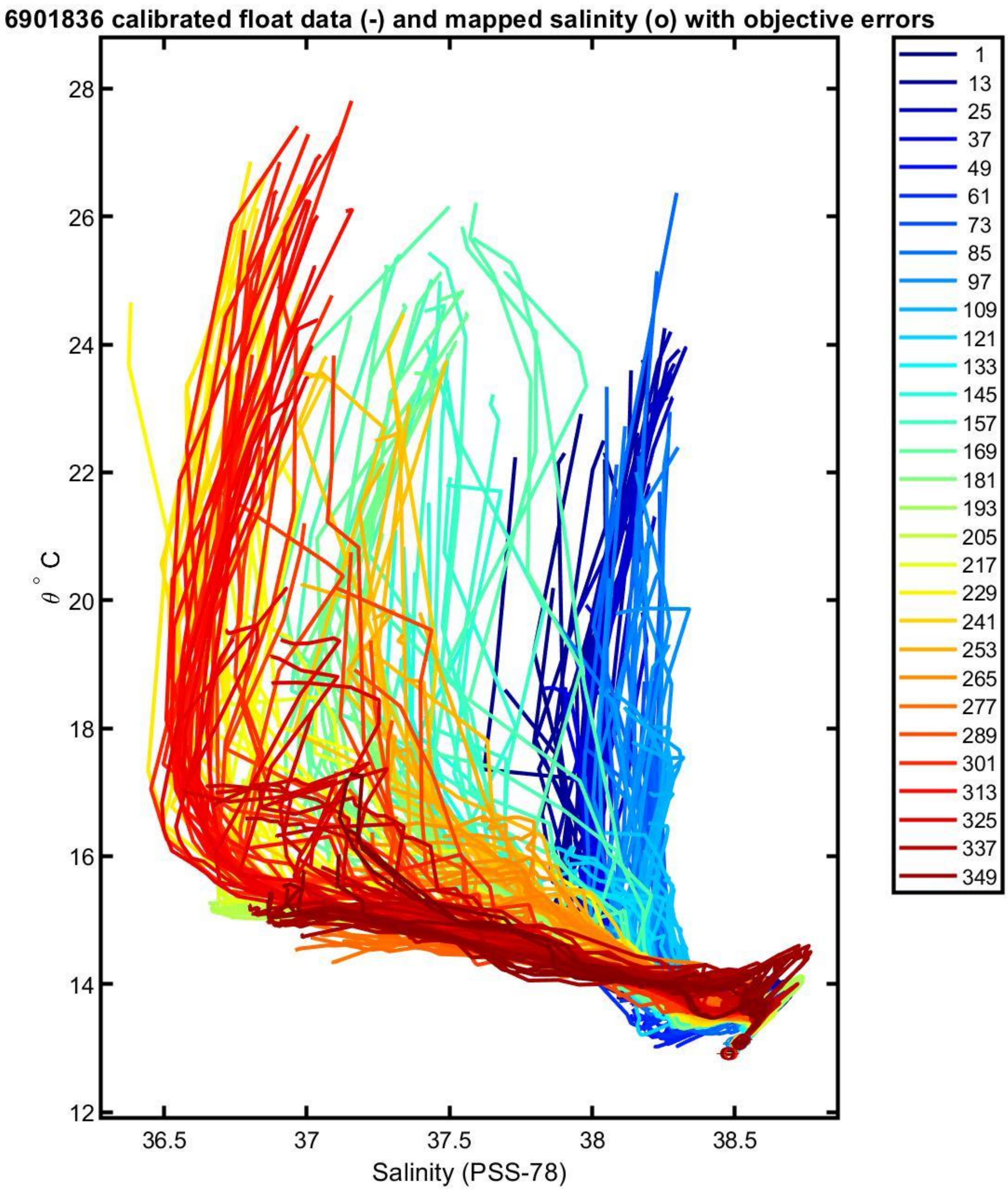

Figure 15: Float 6901836. The plot of calibrated float salinity and the objectively estimated reference salinity at the 10 float theta levels that are used in calibration.

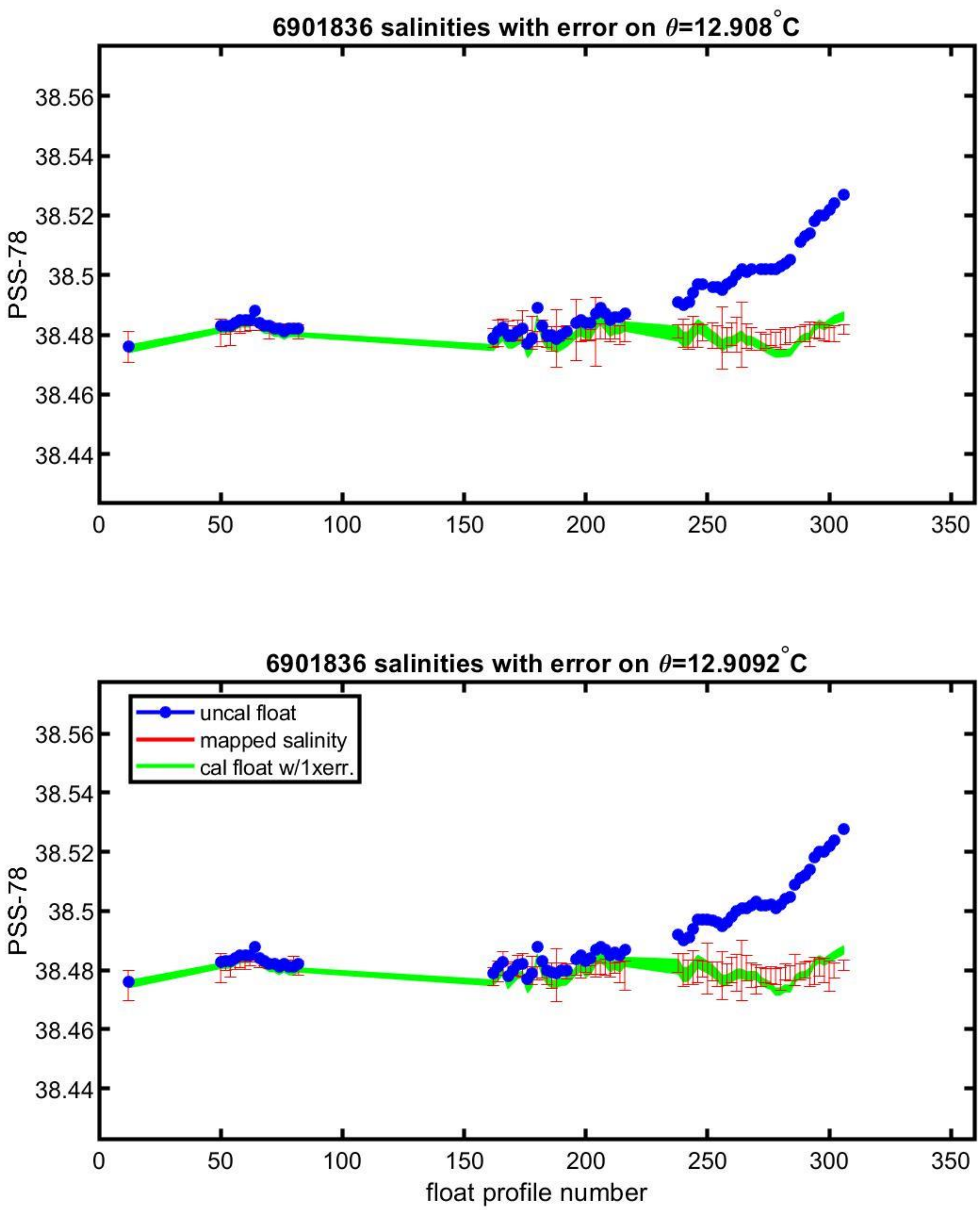

Figure 16: Float 6901836. Plots of the evolution of salinity with time along with selected theta levels with minimum salinity variance.

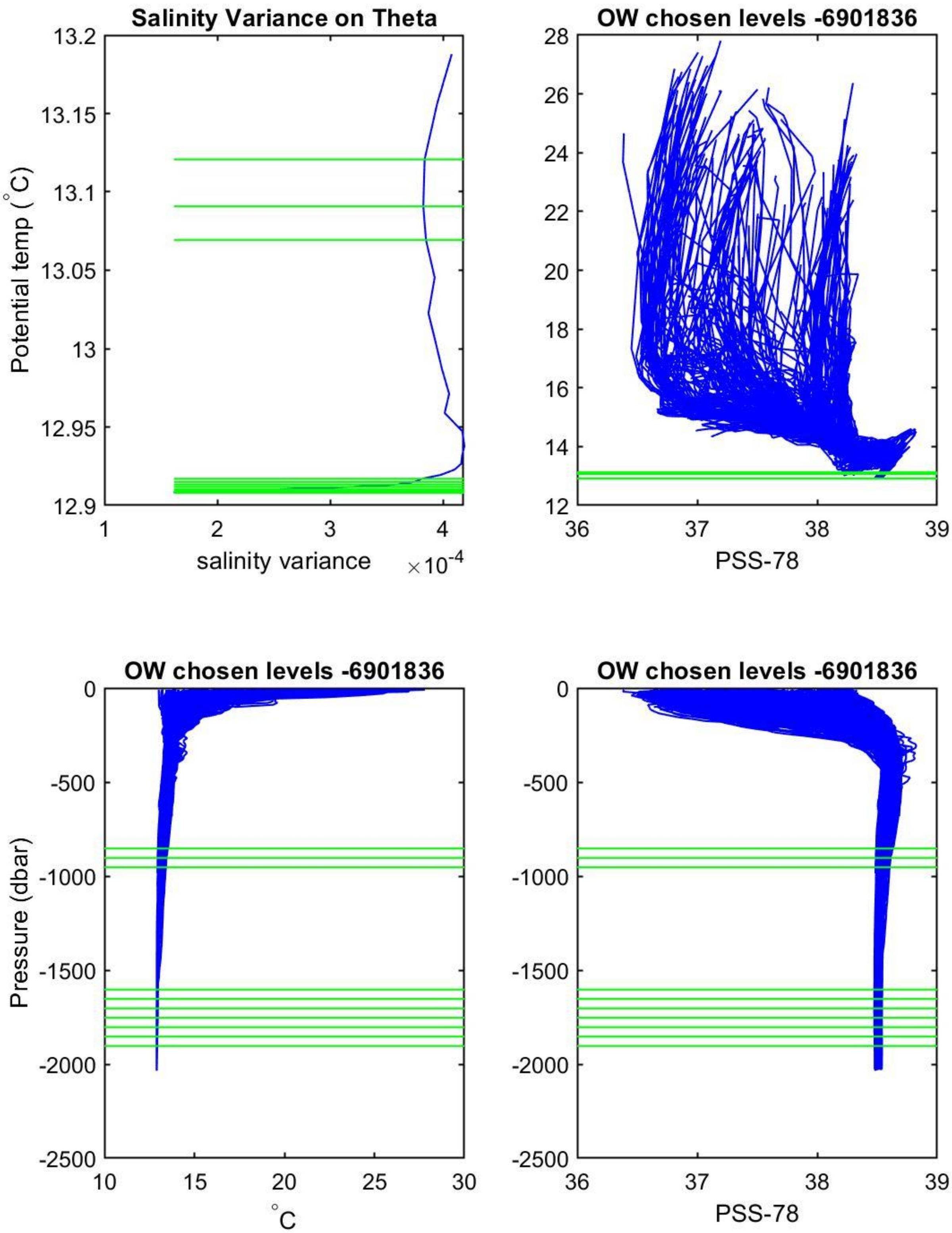

Figure 17: Float 6901836. Plots include the theta levels chosen for calibration: Top left: Salinity variance at theta levels. Top right: T/S diagram of all profiles of Argo float. Bottom left: potential temperature plotted against pressure. Bottom right: salinity plotted against pressure.

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.

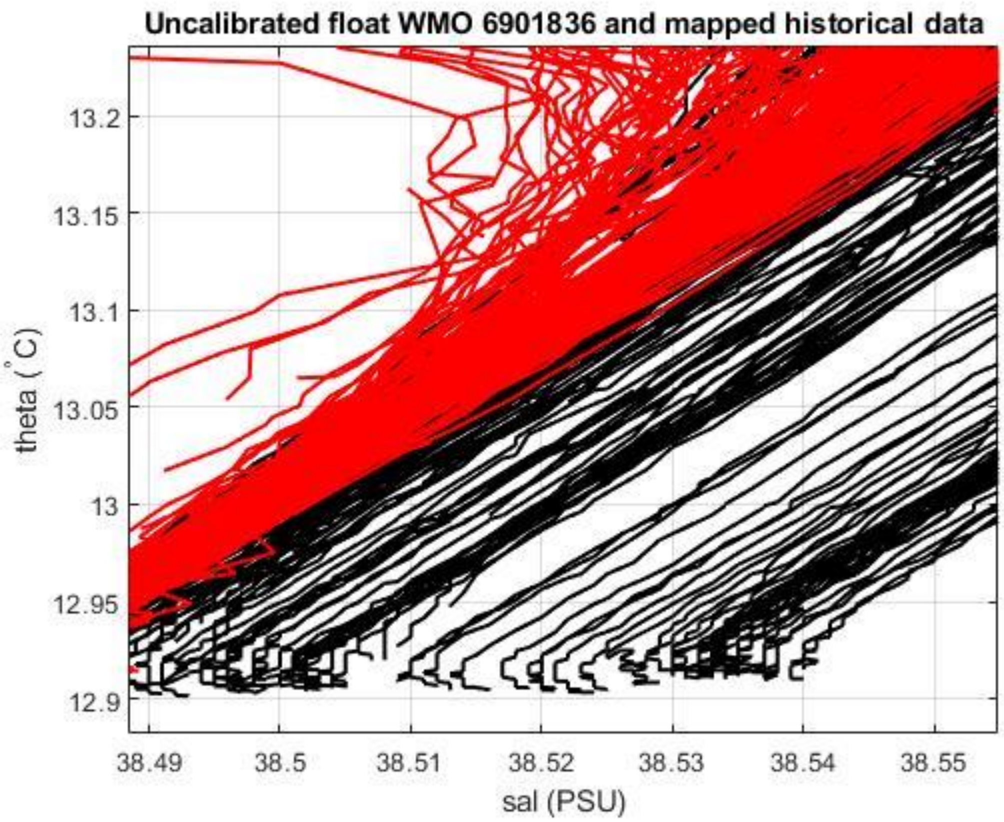

Figure 18: Float 6901836. Uncalibrated float salinity profile (black lines) and mapped historical data (red lines) in the most uniform part of the θ-S curve.

4 Summary

Float was deployed in the Algerian sub-basin, in the Mediterranean Sea. During its life passes in Liguro Provencal and Catalan sub basins. 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 potential salinity offset/drift. This float was DMQC-ed until profile 149 with QC 1. The OWC was applied to all cycles.

The OWC analysis showed a significant salinity drift. Figure 14 reveals that the least square fit has great uncertainties from cycle 221. Figure 16 shows a significant drift from profile 220 on selected θ-levels. The correction proposed by OW is below the Argo requested accuracy (0.01) until cycle 220, then increase and reaches 0.06 for profiles from 315 to 359. After several analyses, the last decision is that the salinity data of float WMO 6901836 needs a delayed mode correction for cycles from 1 to 359. QC 1 is applied for cycles from 1 to 314 and QC 4 for cycles from 315 to 359

PSAL_ADJUSTED=PSAL+ ΔS from cycle 1 to 359

The quality flags applied are the following:

PSAL_ADJUSTED_QC='1' from cycle 1 to 314

PSAL_ADJUSTED_QC='4' from cycle 315 to 359

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