Delayed Mode Quality Control of Argo float WMO 6903236

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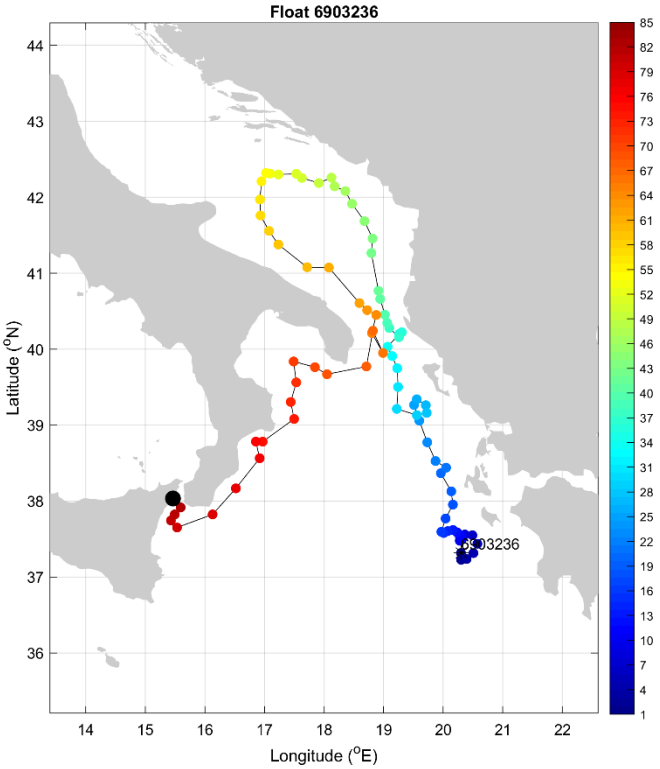

Contents

1 Introduction

This report includes the delayed mode analysis performed for float 6903236. It was deployed in Mediterranean Sea (Ionian sub-basins) in March 2018 and after performed 86 cycles died. During its life, the float passed different water mass. Before the analysis, real-time QC flags were visually inspected. The list of flags applied is QC=1 for cycles. 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 6903236 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:
1-86 PSAL QC=1

2.2 Satellite Altimeter Report

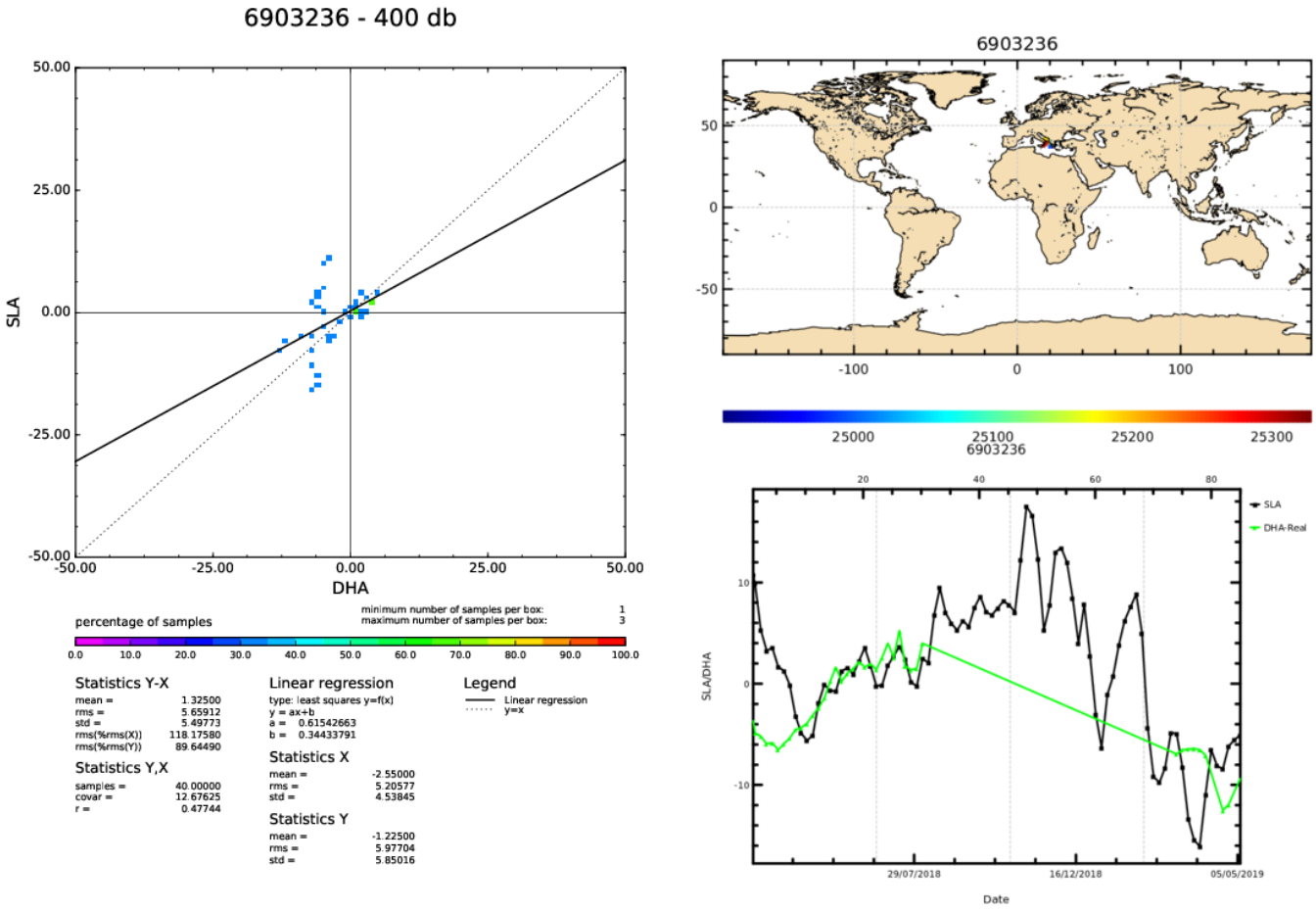

Figure 1: Float 6903236. The comparison between the sea surface height (SSH) from the satellite altimetry and dynamic height anomaly (DHA) extracted from the Argo float temperature and salinity. The figure is created by the CLS/Coriolis and distributed by Ifremer (ftp://ftp.ifremer.fr/ifremer/argo/etc/argo-ast9-item13-AltimeterComparison/figures/).

2.3 Time Series of Argo Float Temperature and Salinity

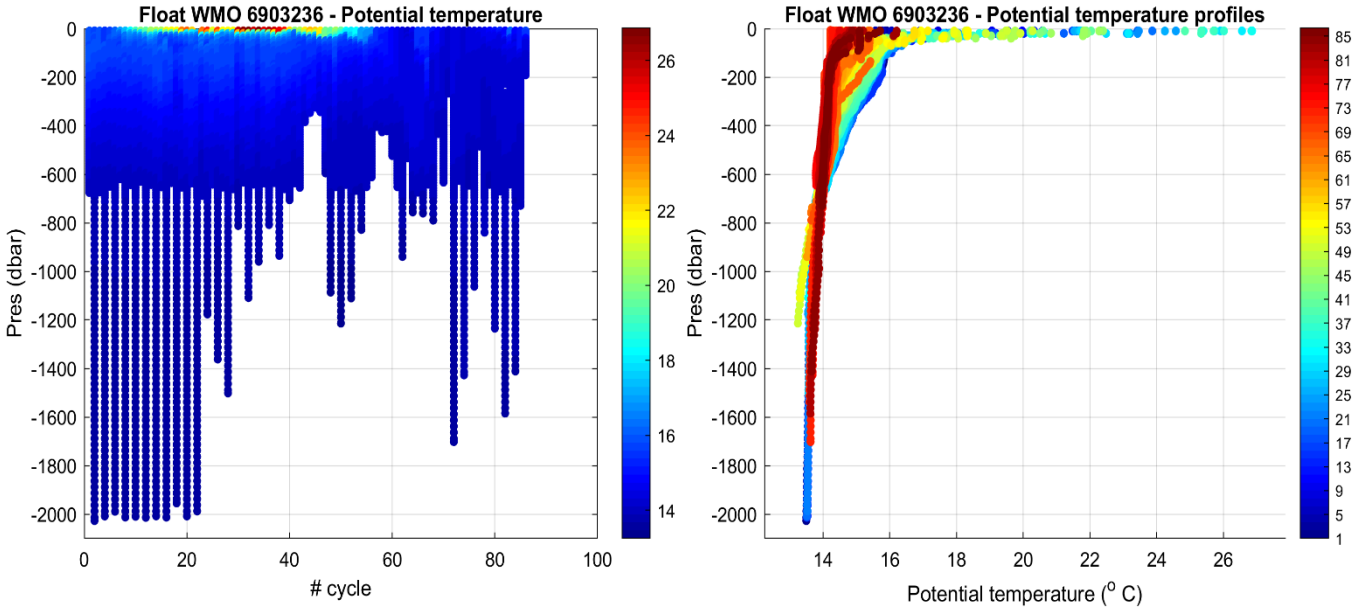

Figure 2: Float 6903236. Time series of Argo float potential temperature (°C) on the left, and potential temperature profiles color-coded per cycle number on the right.

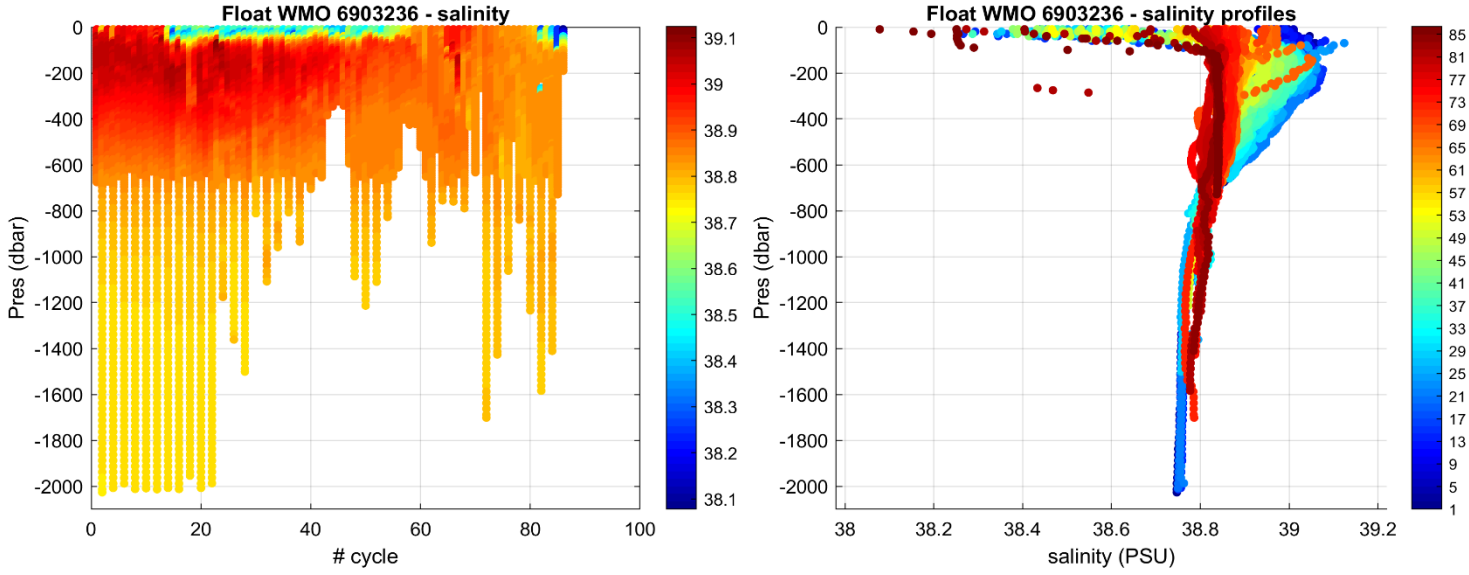

Figure 3: Float 6903236. Time series of Argo float potential salinity (PSS-78) on the left, and salinity profiles color-coded per cycle number on the right.

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). No potential salinity offset is observed. Figures 4 and 5 highlight the different water masses that the float sampled.

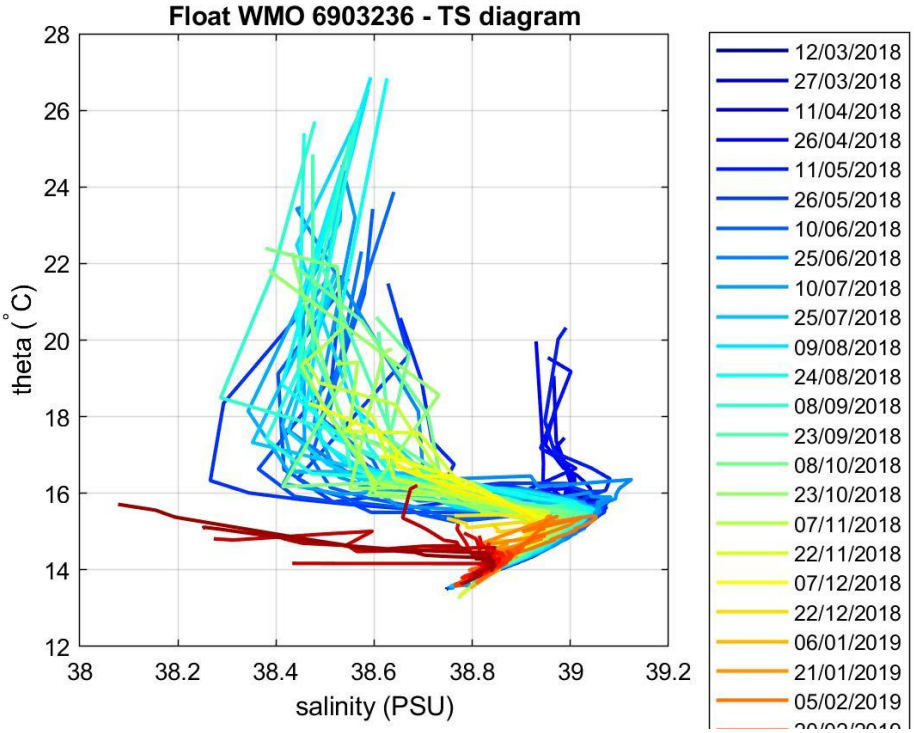

Figure 4: Float 6903236. θ-S diagram color-coded per cycle number.

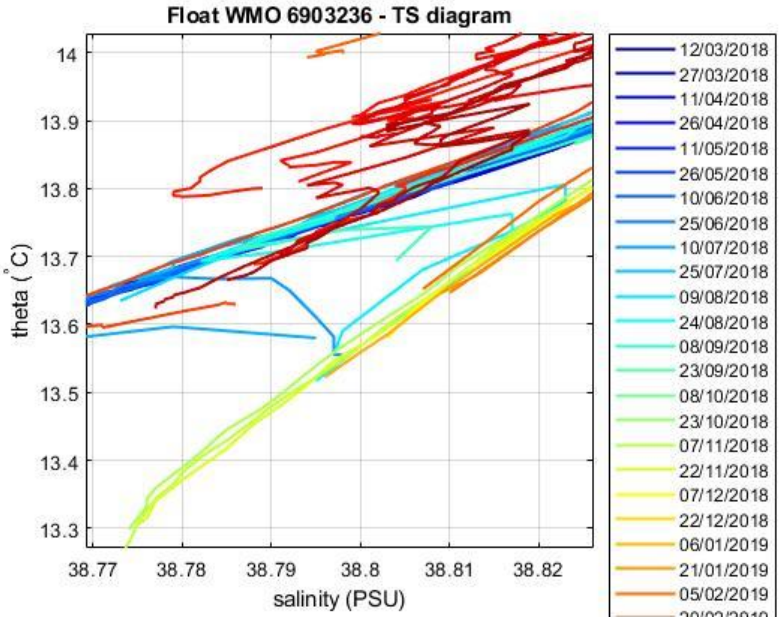

Figure 5: Float 6903236. Area of the θ-S diagram (color-coded per cycle number) where the θ-S relationship is more uniform.

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 9 years). A time difference between 3 and 6, 6 and 9 and larger than 9 years is depicted in green, cyan and blue, respectively.

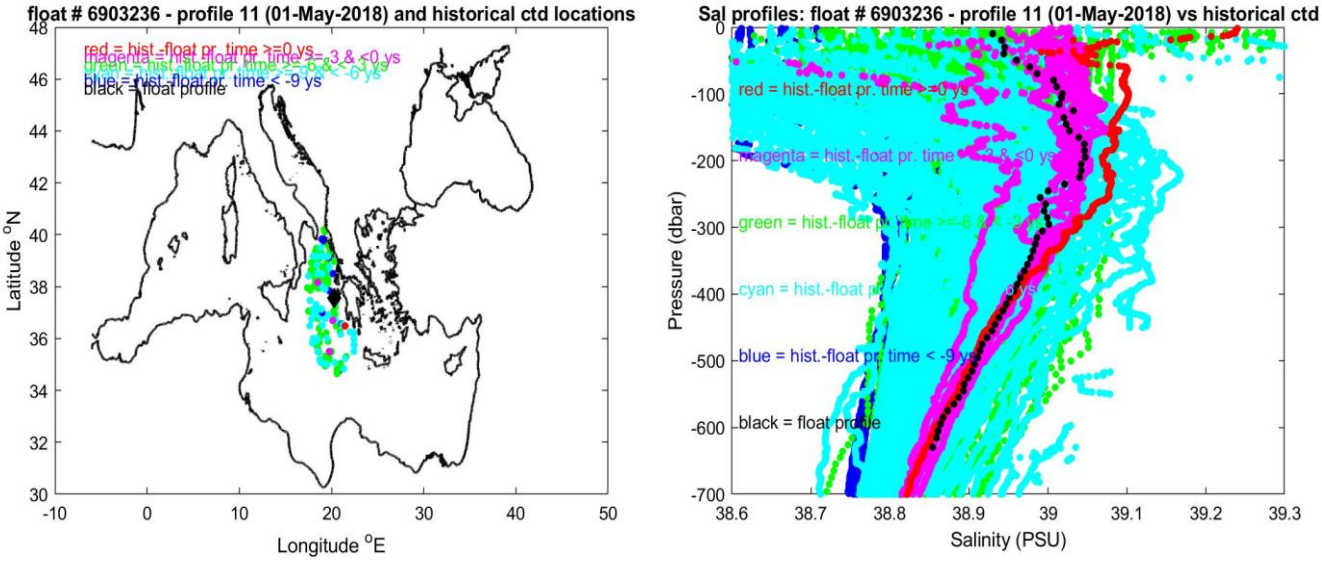

Figure 6: Float 6903236. Locations of the salinity float profile number 11 and historical CTD data (right panel) and the respective salinity profiles (left panel).

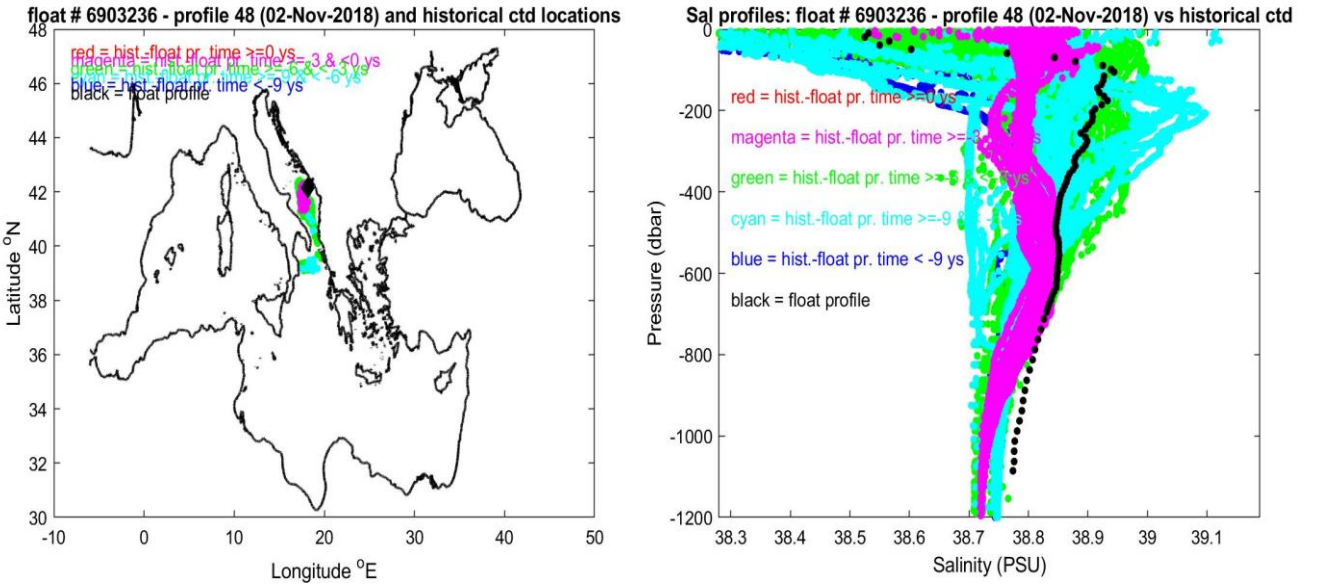

Figure 7: Float 6903236. Locations of the salinity float profile number 48 and historical CTD data (right panel) and the respective salinity profiles (left panel).

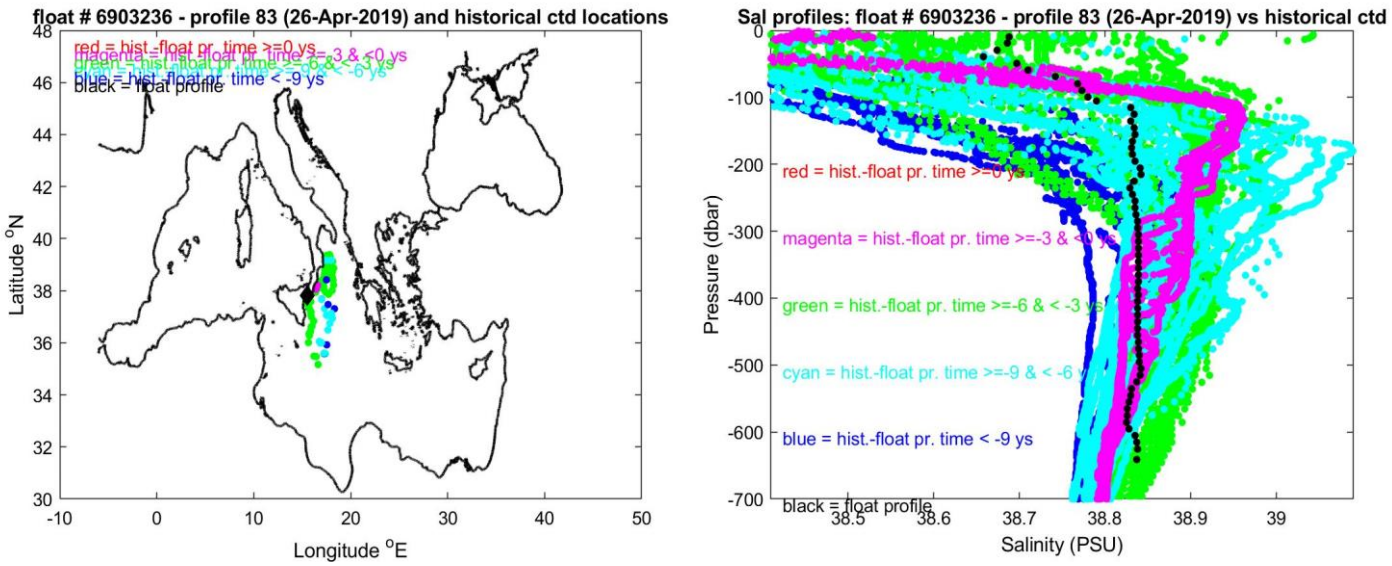

Figure 8: Float 6903236. Locations of the salinity float profile number 83 and historical CTD data (right panel) and the respective salinity profiles (left panel).

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 for profile 11. Figure 10 shows a potential drift. Recent studies confirm that the salinity in the Adriatic subbasin is increased so that we consider correct the salinity of profile 48. The reference profile being old, will be reviewed. For the profile 83, the depth reached by the float is not enough and the comparison is not reliable.

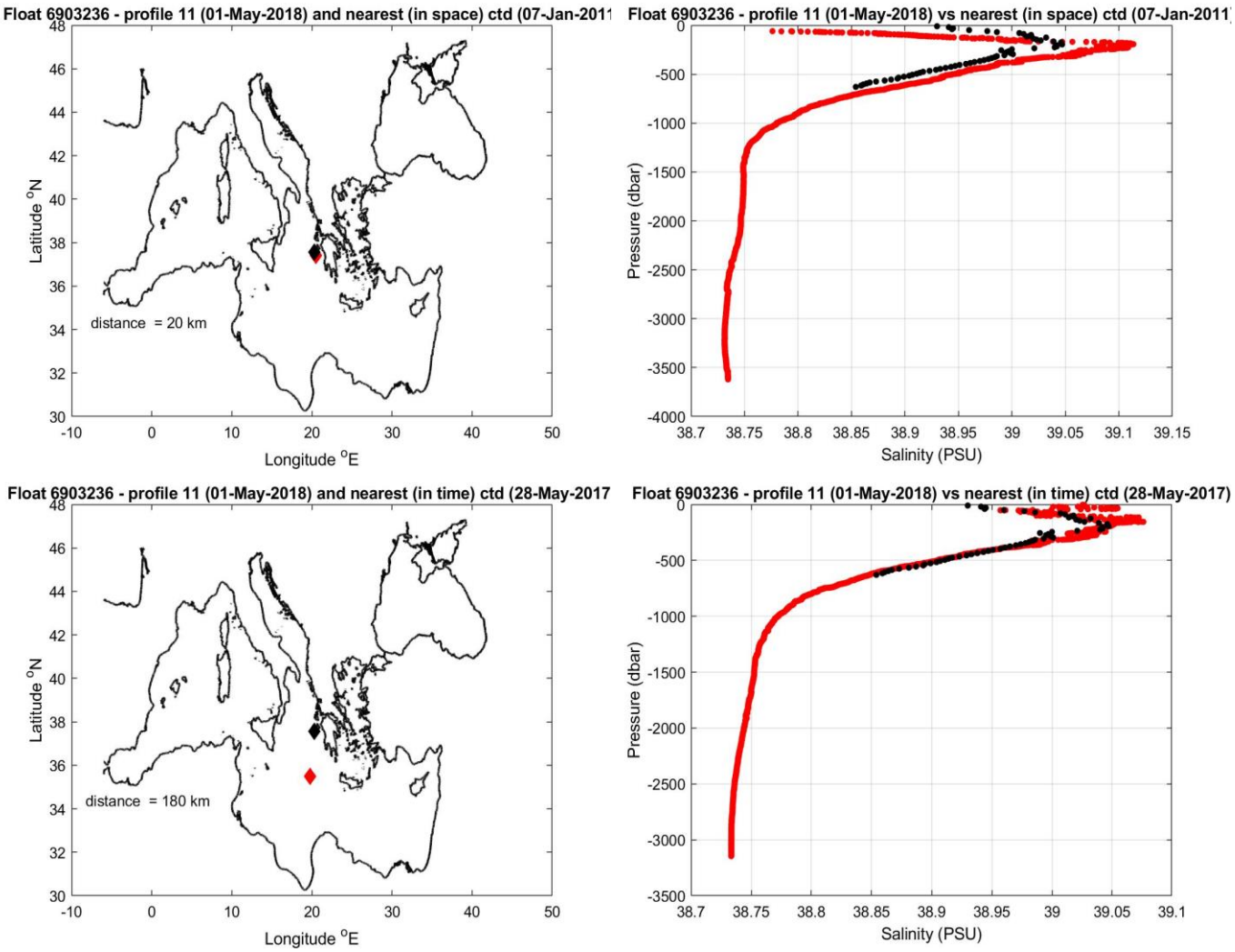

Figure 9: Float 6903236. The salinity float profile number 11 (black dots) are compared to the nearest in space (top) and in time (bottom) reference profile (red dots). The locations of the two profiles and their distance is given in the left panel.

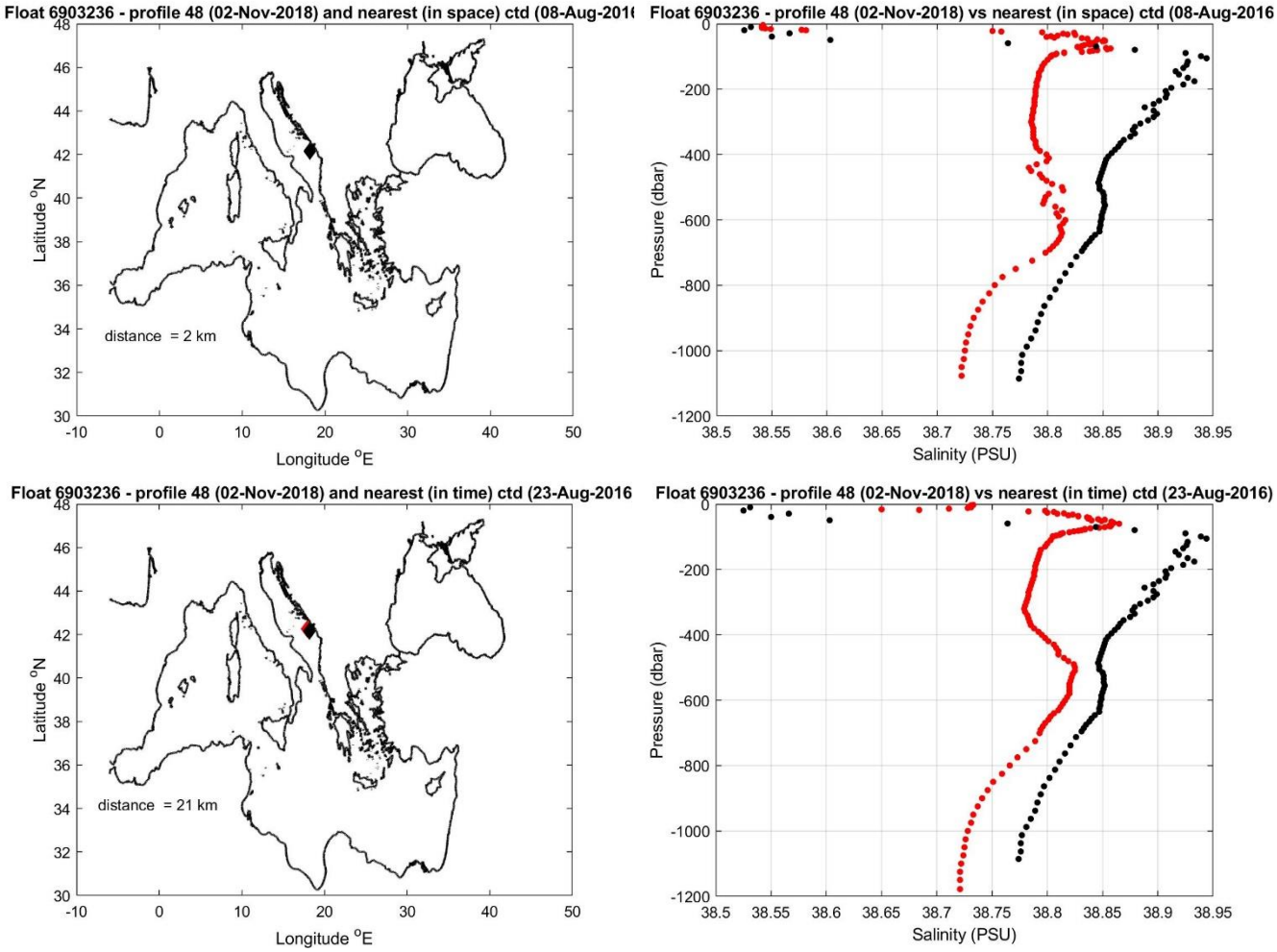

Figure 10: Float 6903236. The salinity float profile number 48 (black dots) are compared to the nearest in space (top) and in time (bottom) reference profile (red dots). The locations of the two profiles and their distance is given in the left panel.

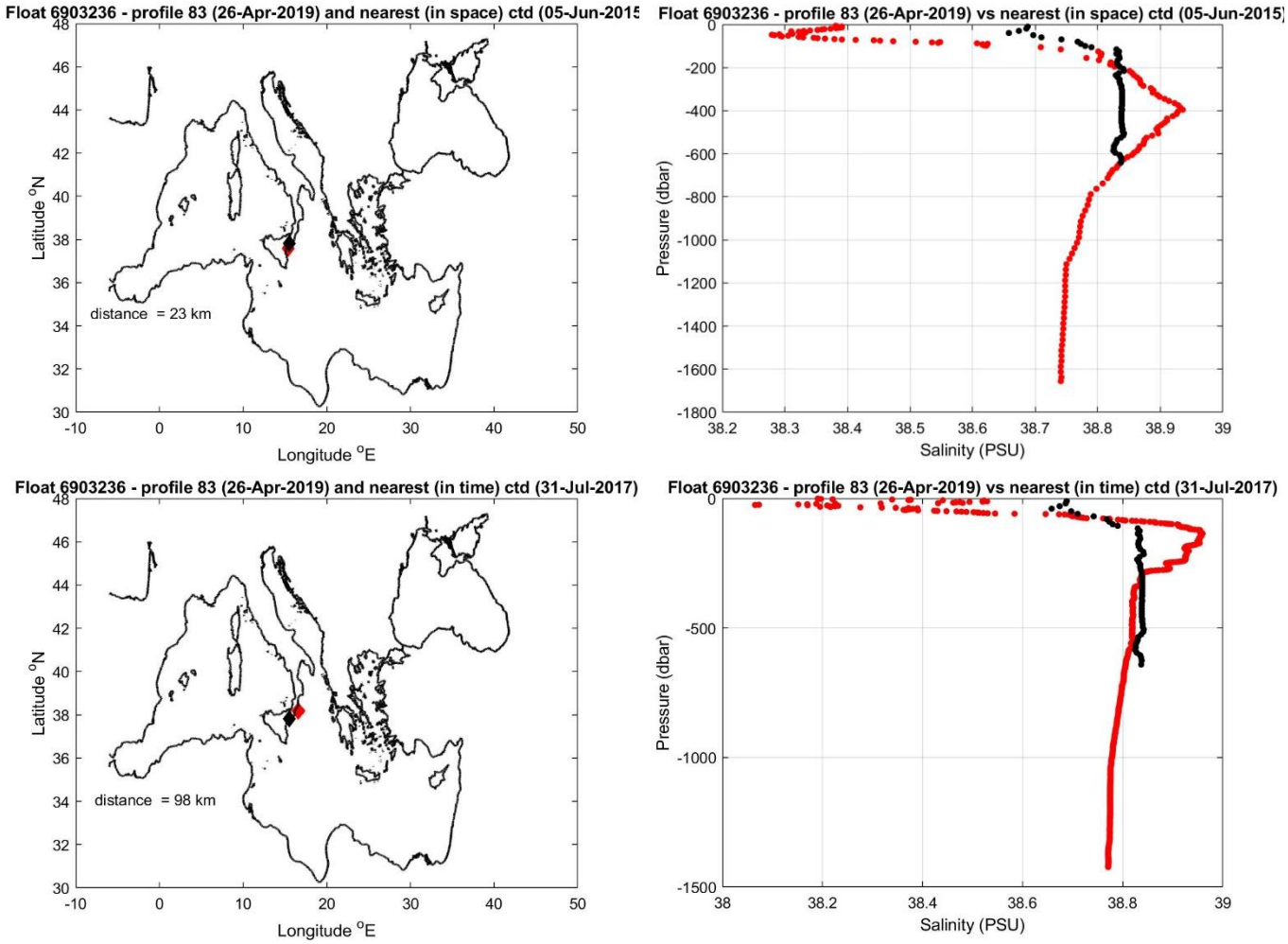

Figure 11: Float 6903236. The salinity float profile number 83 (black dots) are compared to the nearest in space (top) and in time (botton) reference profile (red dots). The locations of the two profiles and their distance is given in the left panel.

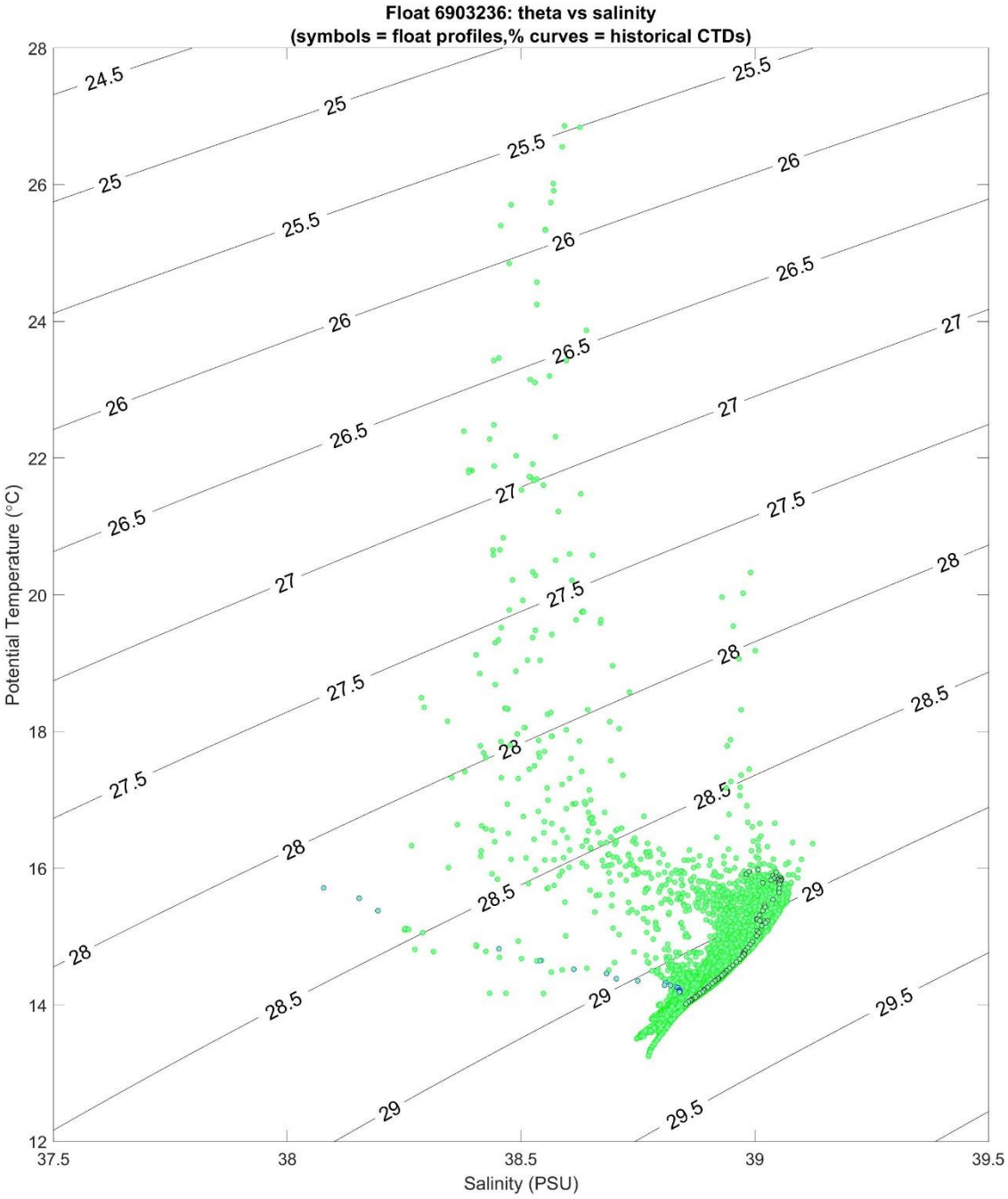

Figure 12: Float 6903236. T/S diagram plotted with and data from WMO boxes of CTD reference data +/- 10°of latitude and longitude. The black and blue cycles indicate the first and the last Argo profile, respectively. Green symbols represent other Argo profiles from this float. The thin colours lines 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

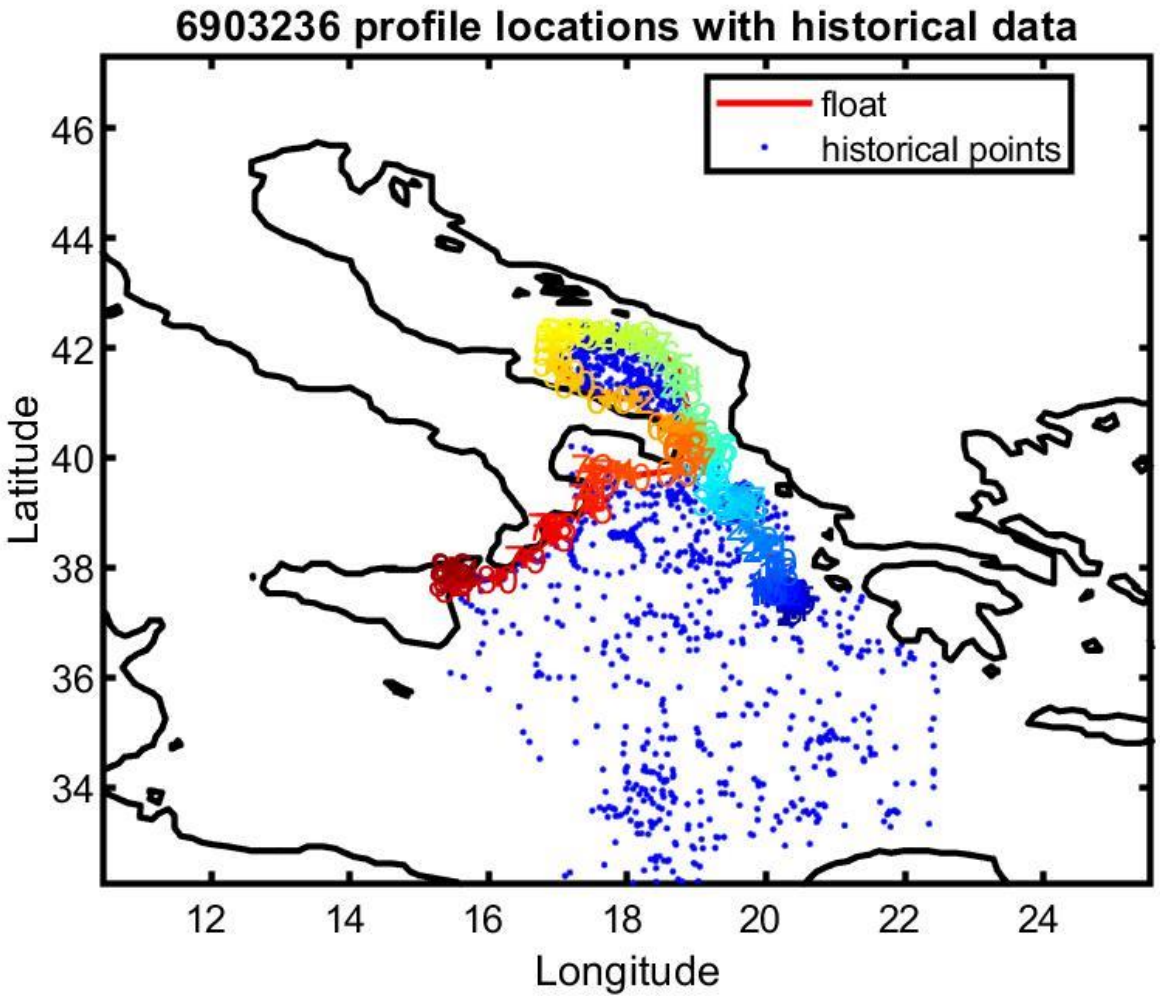

Figure 13: Float 6903236. Location of the float profiles (red line with colored numbers) and the reference data selected for mapping (blue dots).

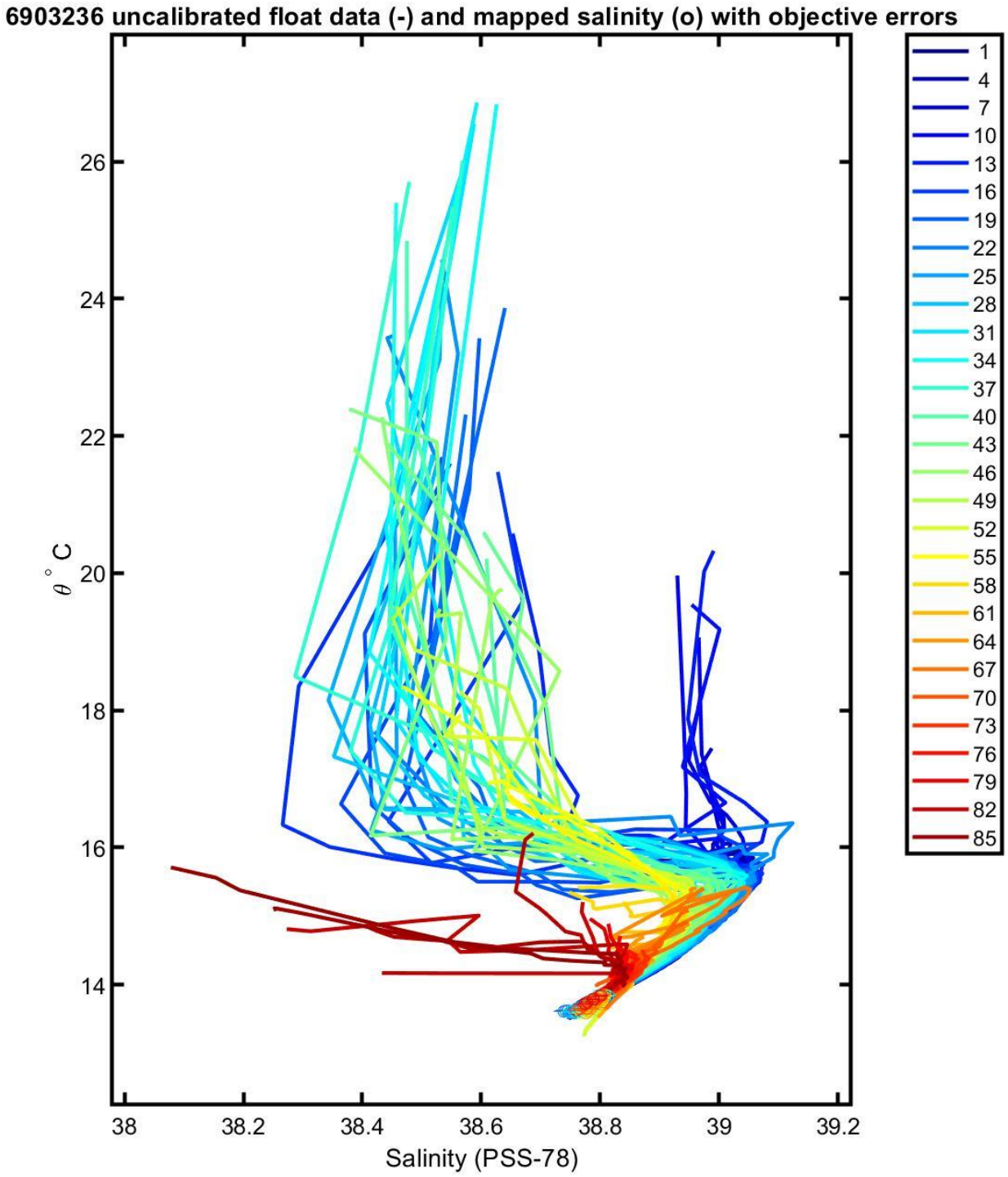

Figure 14: Float 6903236. Plot the original float salinity and the objectively estimated reference salinity at the 10 float theta levels that are used in calibration.

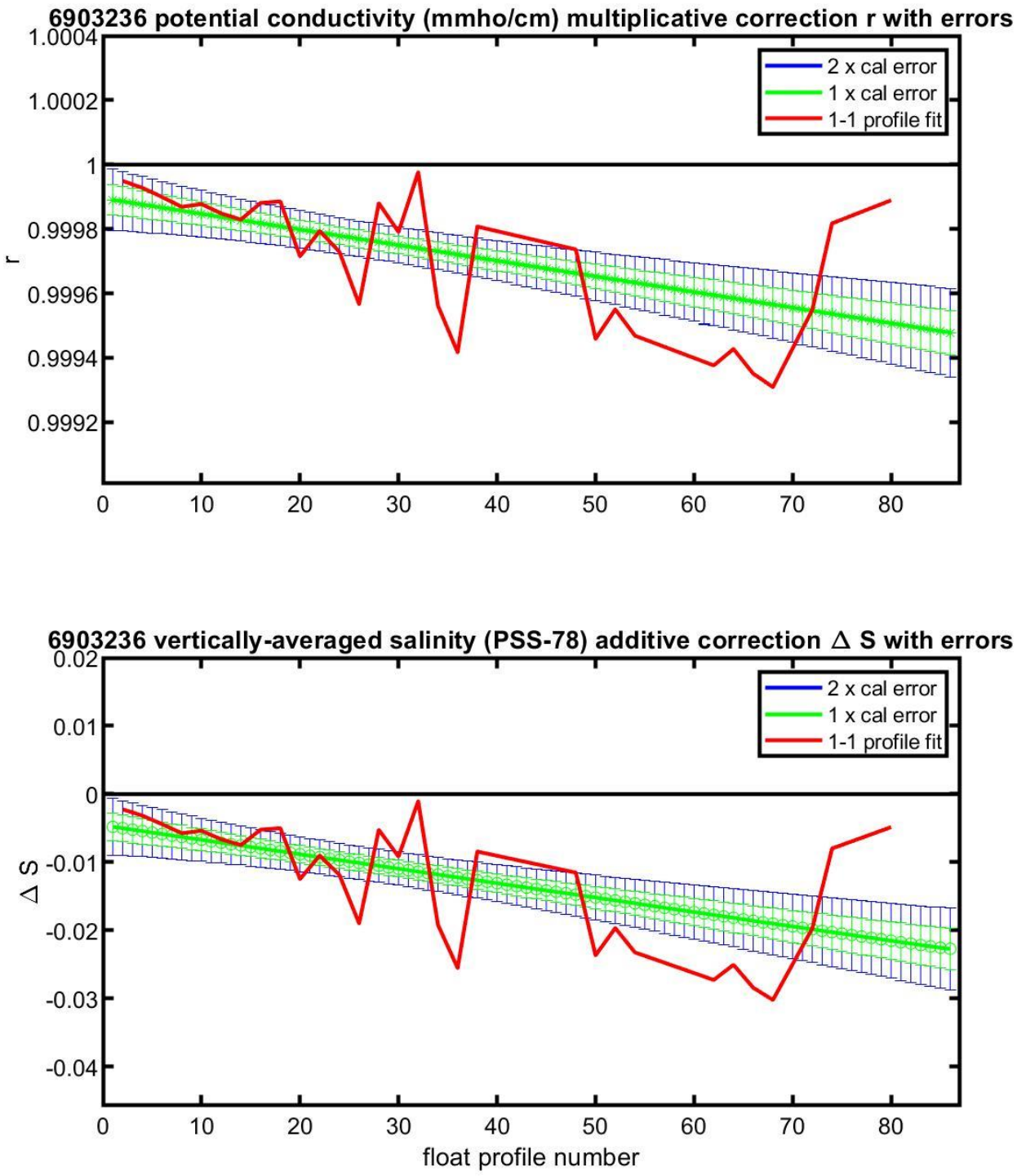

Figure 15: Float 6903236. Evolution of the suggested adjustment with time. The top panel plots the potential conductivity multiplicative adjustment. The bottom panel plots the equivalent salinity additive adjustment. The red line denotes one-to-one profile fit that uses the vertically weighted mean of each profile. The red line can be used to check for anomalous profiles relative to the optimal fit.

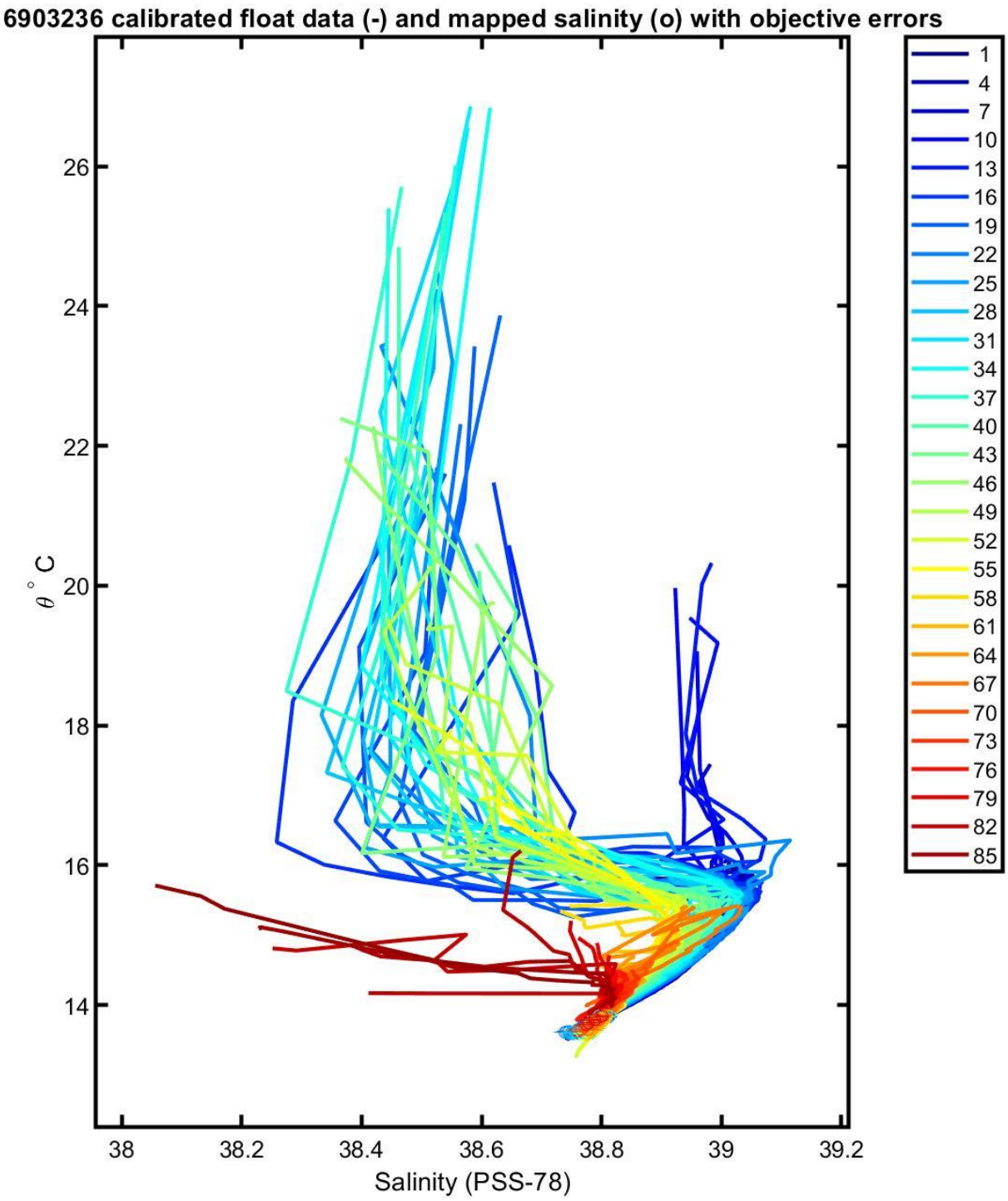

Figure 16: Float 6903236. The plot of calibrated float salinity and the objectively estimated reference salinity at the 10 float theta levels that are used in calibration.

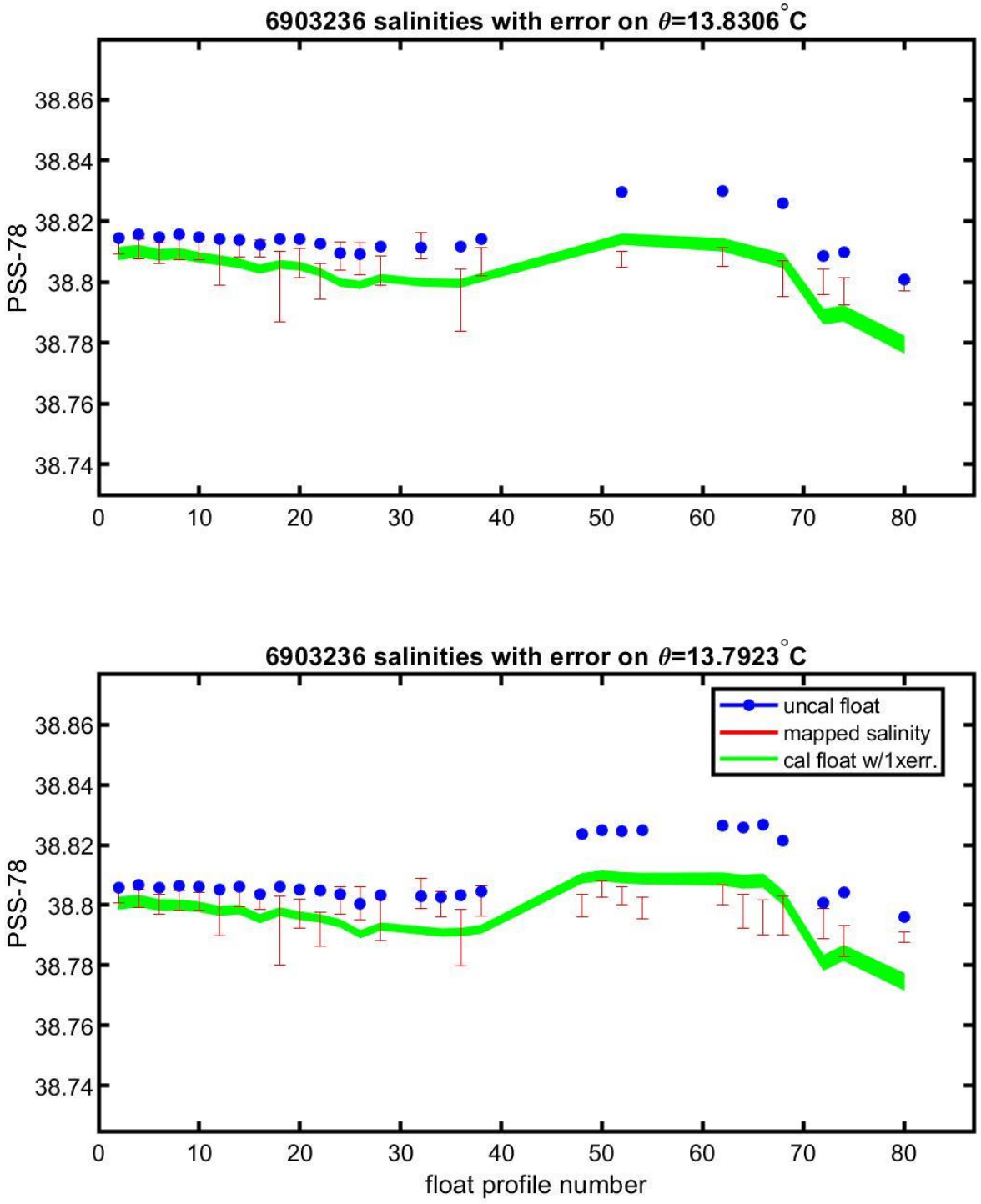

Figure 17: Float 6903236. Plots of the evolution of salinity with time along with selected theta levels with minimum salinity variance.

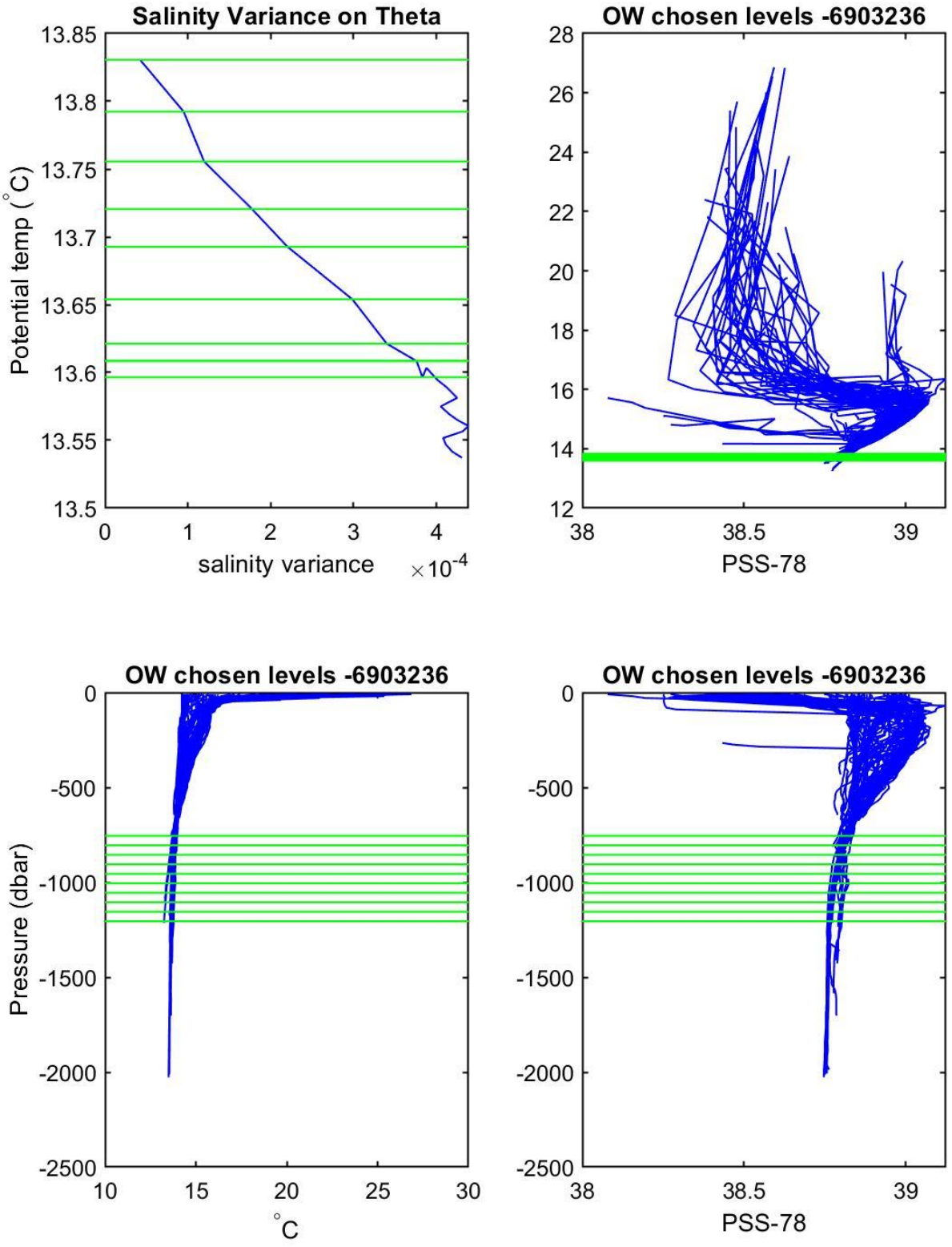

Figure 18: Float 6903236. Plots include the theta levels chosen for calibration: Top left: Salinity variance at theta levels. Top right: T/S diagram of all profiles of Argo float. Bottom left: potential temperature plotted against pressure. Bottom right: salinity plotted against pressure.

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.

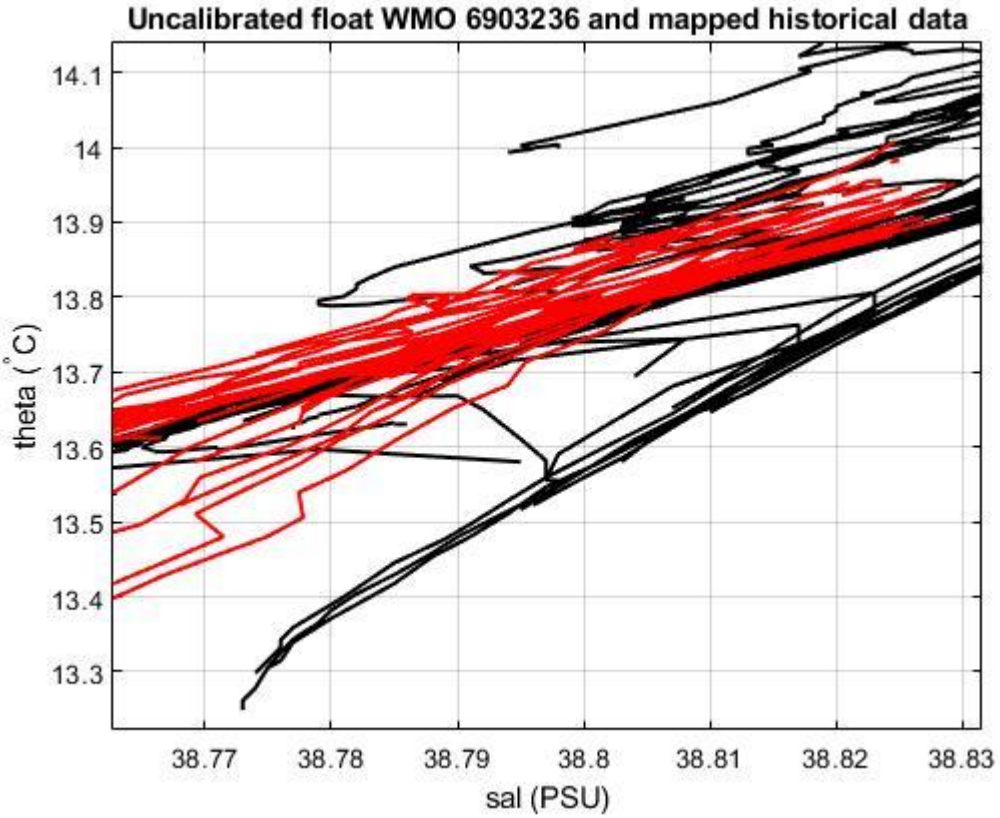

Figure 19: Float 6903236. Uncalibrated float salinity profile (black lines) and mapped historical data (red lines) in the most uniform part of the θ-S curve.

4 Comparison between Argo float under study and other Argo float in the same area

The float was deployed in the Ionian subbasin and after cycle 31 went the Adriatic subbasin. Then returned in the Ionian subbasin, the float continued near the Puglia and Calabria coast. To obtain an additional qualitative analysis, we separate Ionian and Adriatic part and compared them with other floats in the same area. WMO 6901781 and WMO 6902848 (Figure 20) floats are selected to perform a comparison with the float in the Adriatic subbasin. WMO 6901818 and WMO 6901829 (Figure 20) floats are selected to perform a comparison with the float in the Inonian subbasin.

Figure 20: Float 6903236. Trajectory of the floats used for the comparison in the Adriatic subbasin.

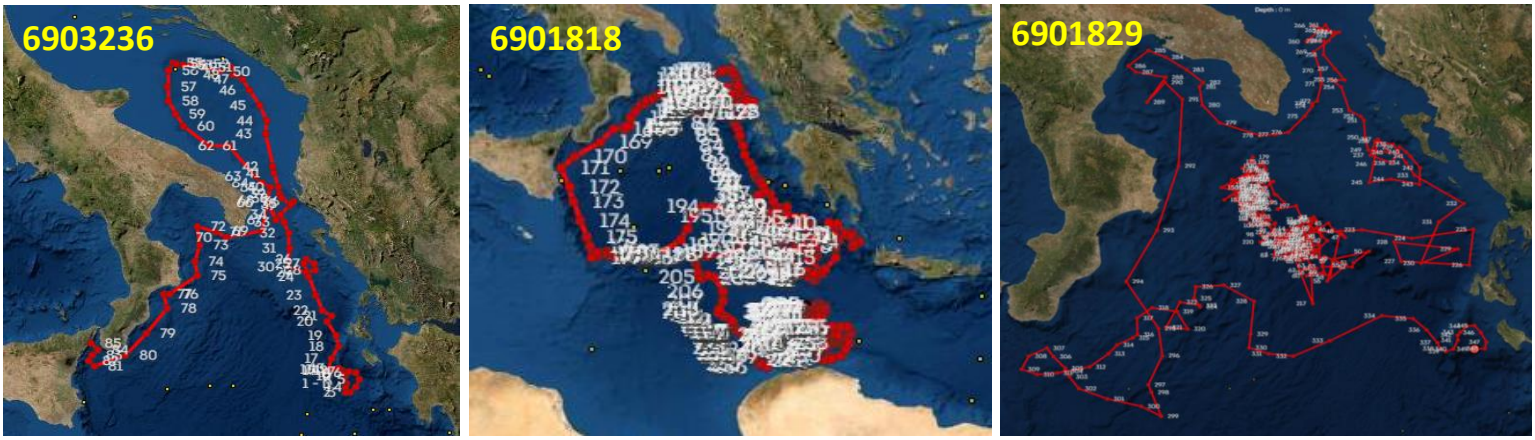

Figure 21: Float 6903236. Trajectory of the floats used for the comparison in the Ionian subbasin.

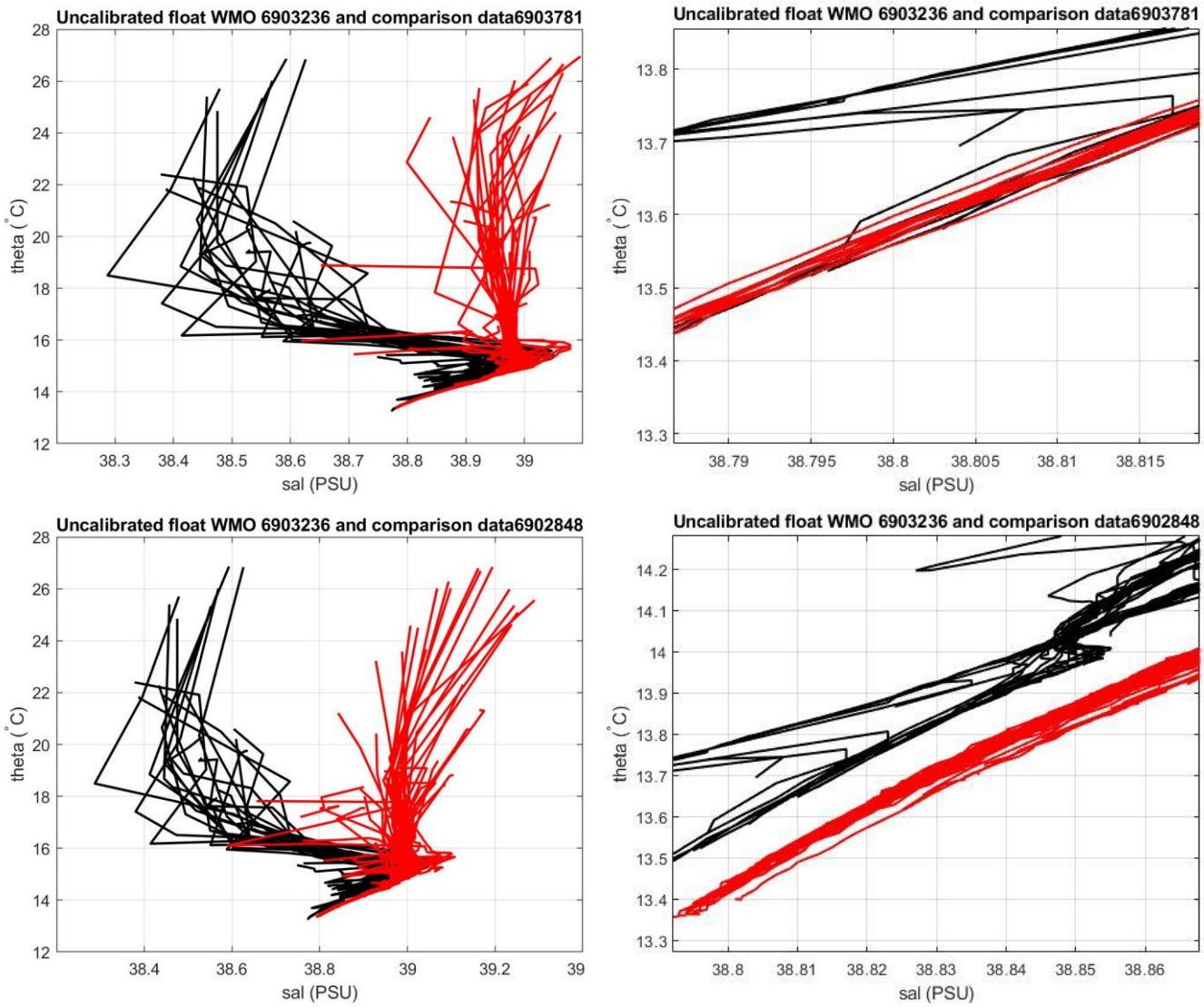

Figure 21: Float 6903236. On the left, comparison between float 6903236 (black line) and float 6903781 (red line, up) and float 6902848 (red line, down). On the right zoom in the most uniform part of the θ-S curve.

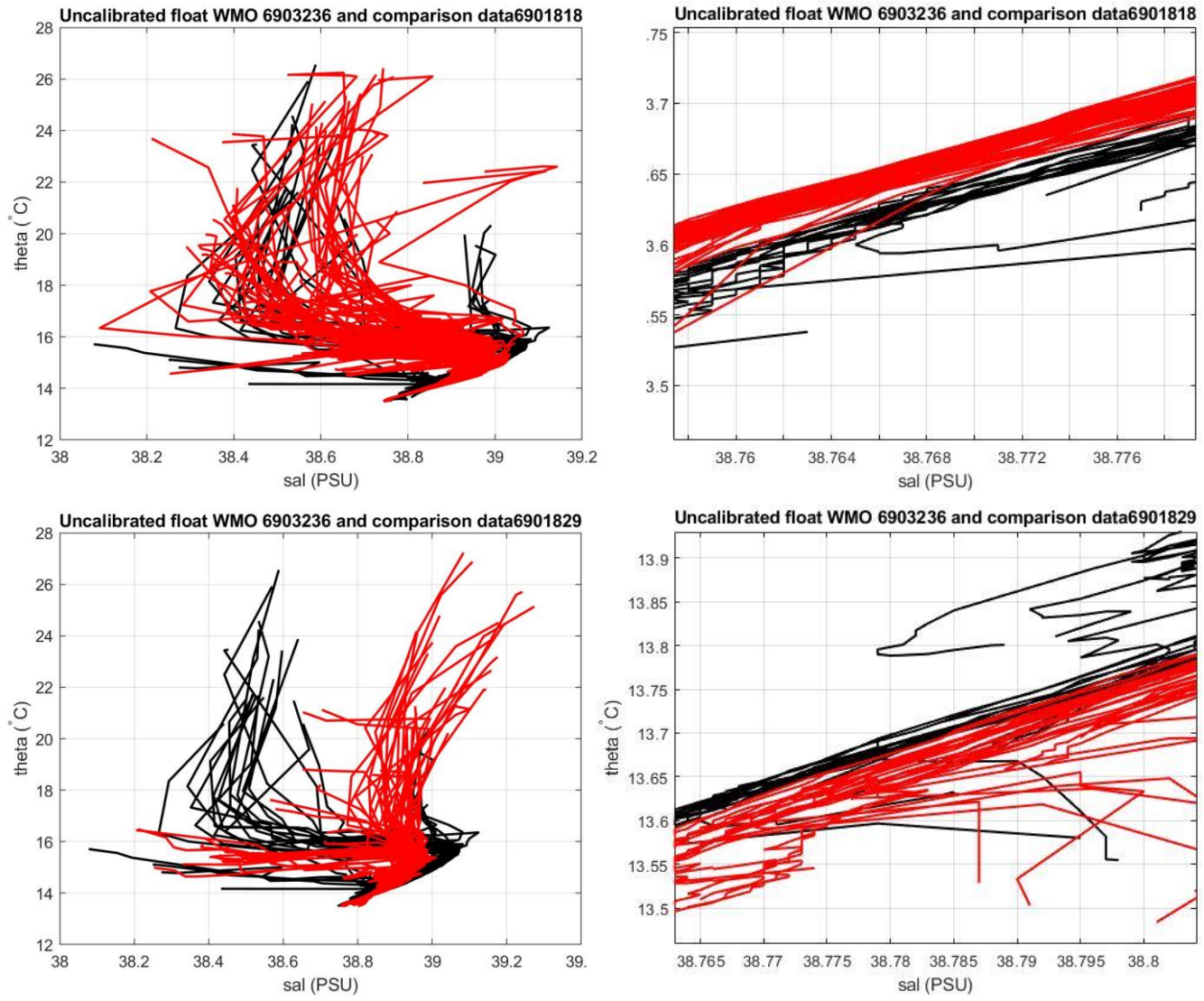

Figure 22: Float 6903236. On the left, comparison between float 6903236 (black line) and float 6901818 (red line, up) and float 6901829 (red line, down). On the right zoom in the most uniform part of the θ-S curve.

5 Summary

Float was deployed in the Ionian sub-basin, in the Mediterranean Sea. During its life it went in the Adriatic subbasin and the returned in Ionian one, near Puglia and Calabria coast. 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 that the float sample shallow depth. The TS diagram highlights the different water masses that the float passed. No significant drift is showed. This float was not DMQC-ed before.

The OWC analysis didn't produce results with a reliable statistic due to the depth reached by the float and the old reference dataset. However, figure 17 shows a possible drift. After a careful analysis we observed that also figure 17 highlights the three different water masses passed by the float. Futhermore, recent studies confirm the salinity in the Adriatic subbasin is increased. A comparison with float in the Adriatic and Ionian area respectively was performed to better delayed mode check data.

After several analyses, the last decision is that the salinity data of float WMO 6903236 seem accurate and don't need a delayed mode correction. QC=2 is applied for different reasons. The float moves in different water masses and also near the coast where the depth is not enough to reached the intermediate layer where water mass is useful for analysis. Furthermore, the reference dataset is old enough to obtain a good mapped reference salinity. The DMQC analysis will be repeated as soon as there will be a new reference.

PSAL_ADJUSTED=PSAL from cycle 1 to 86

The quality flags applied are the following:

PSAL_ADJUSTED_QC='2' from cycle 1 to 86

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

6 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