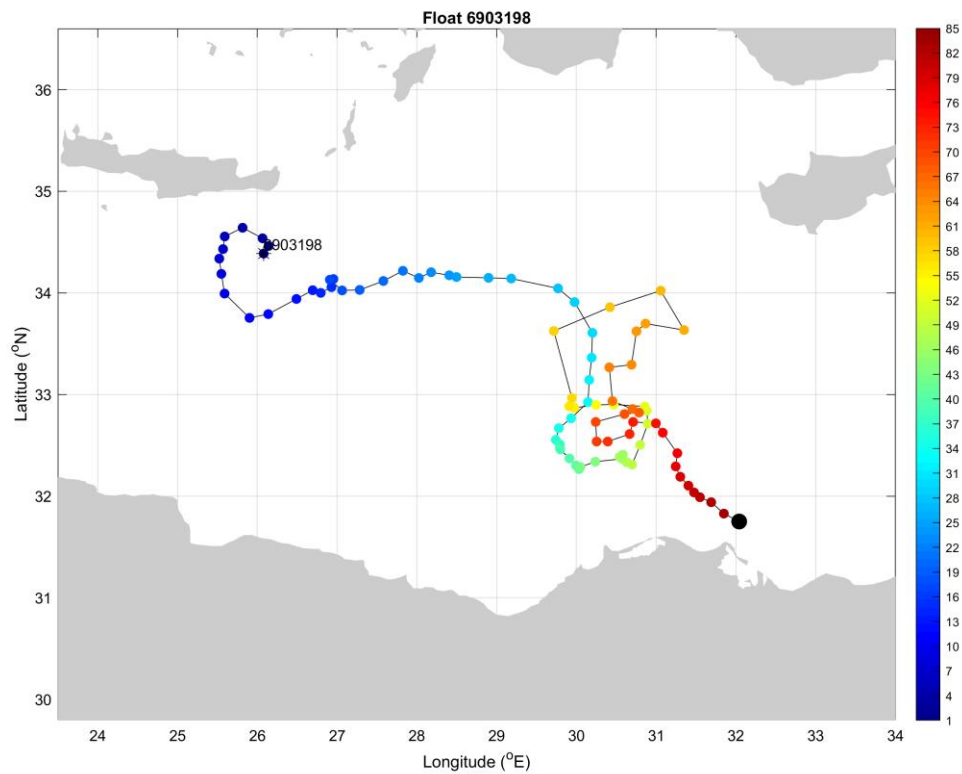# Delayed Mode Quality Control of Argo float
WMO 6903198

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Float 6903198

Contents

1 Introduction

This report includes the delayed mode analysis performed for float 6903198. It was deployed in Mediterranean Sea (Cretan sub-basin) in June 2016 and after performed 87 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 73 and QC=4 to cycle from 74 to 87. 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 6903198 is the Apex float, where the pressure sensor is not auto-corrected to zero while at the sea surface. For this sensor the pressure data in will be corrected during processing in delayed mode if necessary. The procedures of correction sea surface pressure are described in Argo Quality Control Manual for CTD and Trajectory Data (Wong et al., 2020).

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:
1-73 PSAL QC=1

74-87 PSAL QC=4
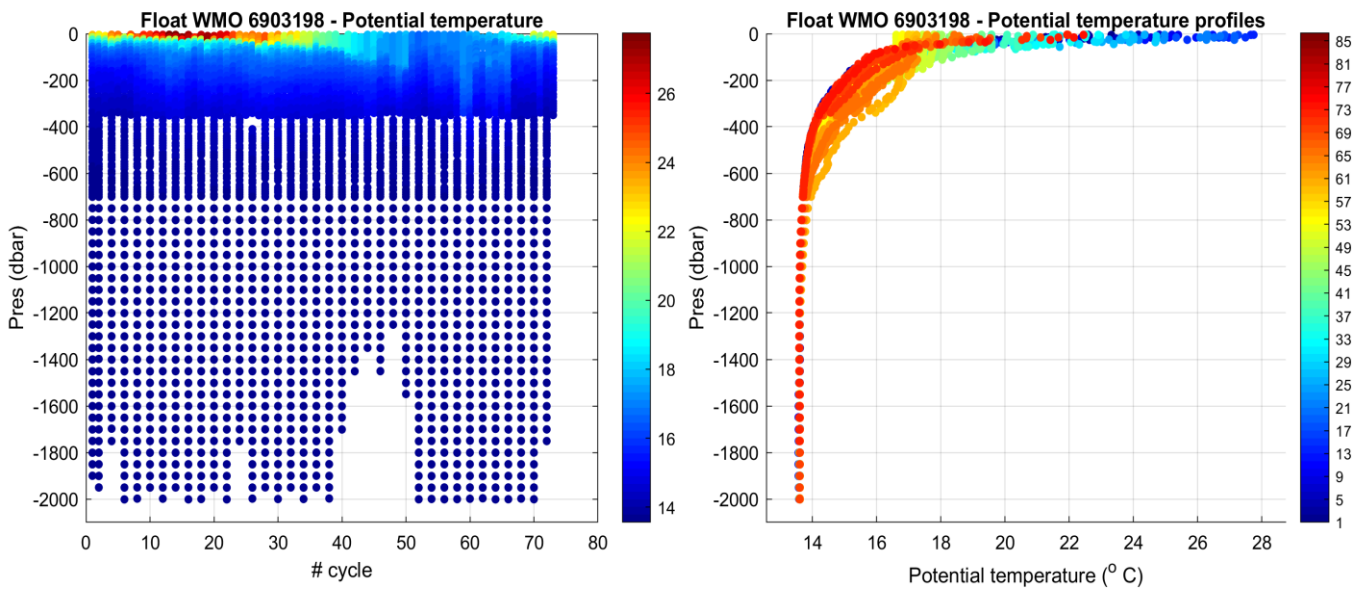
2.2 Time Series of Argo Float Temperature and Salinity

Figure 1: Float 6903198. Time series of Argo float potential temperature (°C) on the left, and potential temperature profiles color-coded per cycle number on the right.
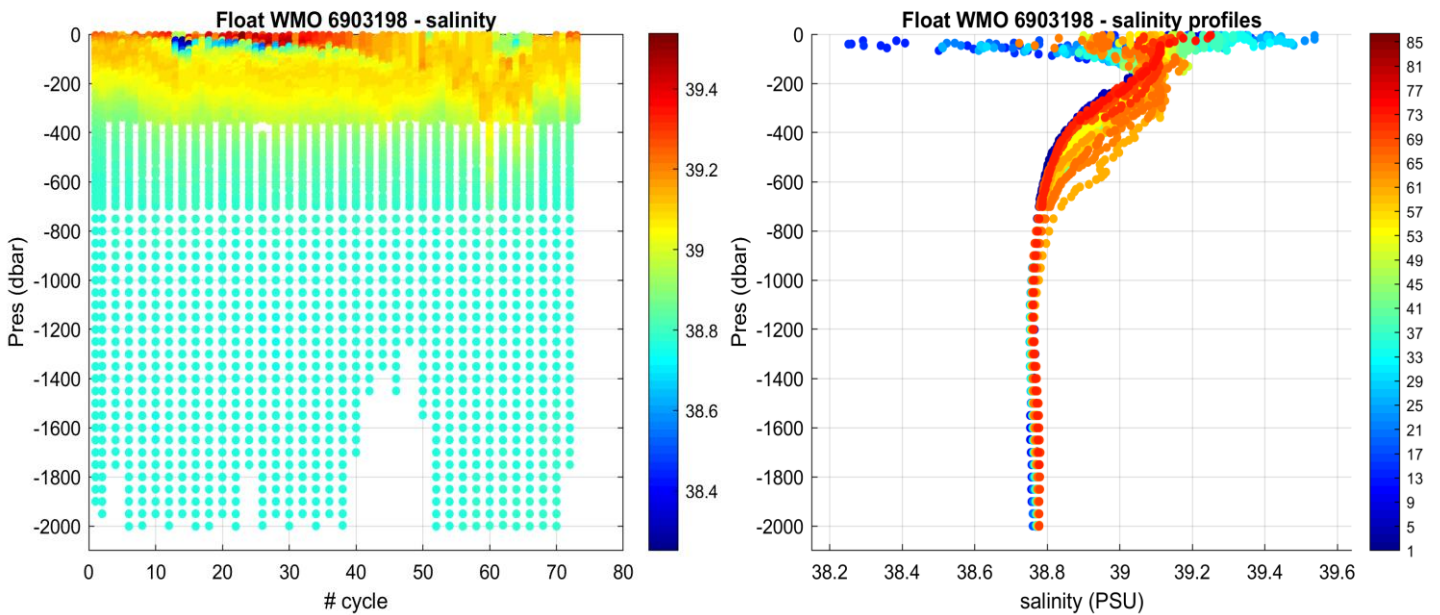

Figure 2: Float 6903198. Time series of Argo float potential salinity (PSS-78) on the left, and salinity profiles color-coded per cycle number on the right.

Before running the Owens and Wong method, referred to as OW hereafter, the theta-salinity (θ-S) diagram of the float is analyzed (Figure 3) and in particular the area where the θ-S relationship is the tightest (Figure 4). A significant salinity drift/offset is observed.
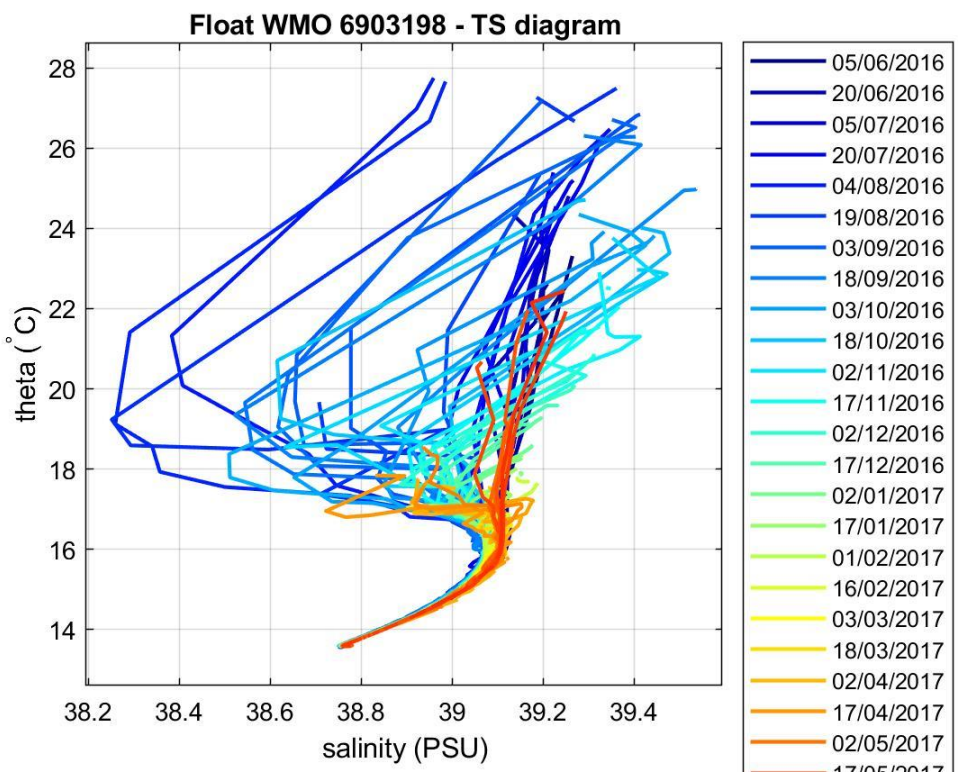

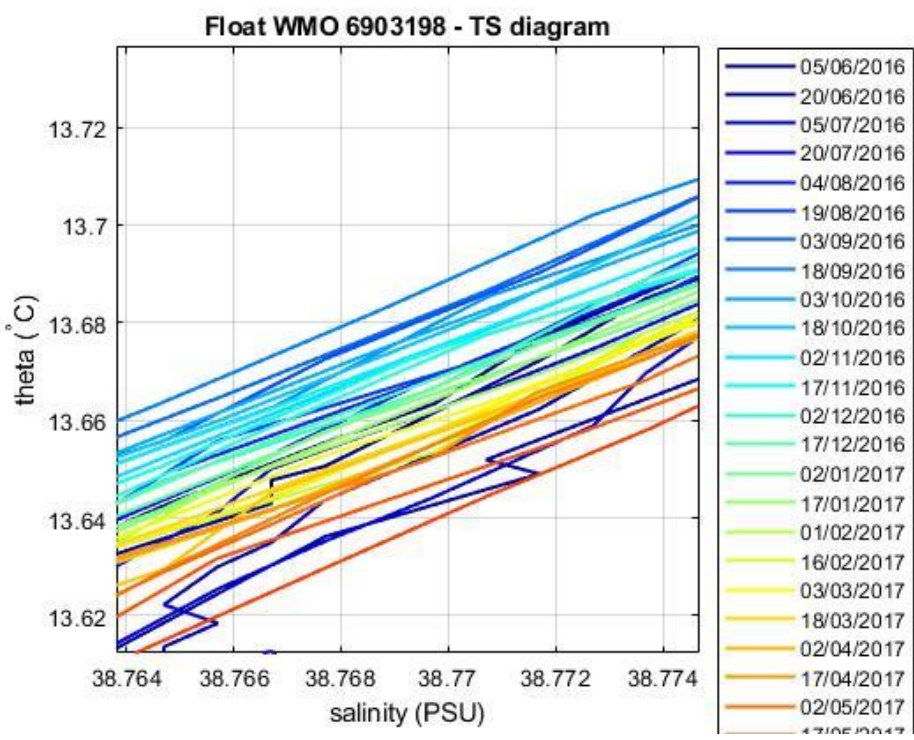**Figure 3:** Float 6903198. θ-S diagram color-coded per cycle number.

Figure 4: Float 6903198. Area of the θ-S diagram (color-coded per cycle number) where the θ-S relationship is more uniform.

2.3   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 5, 6 and 7 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.
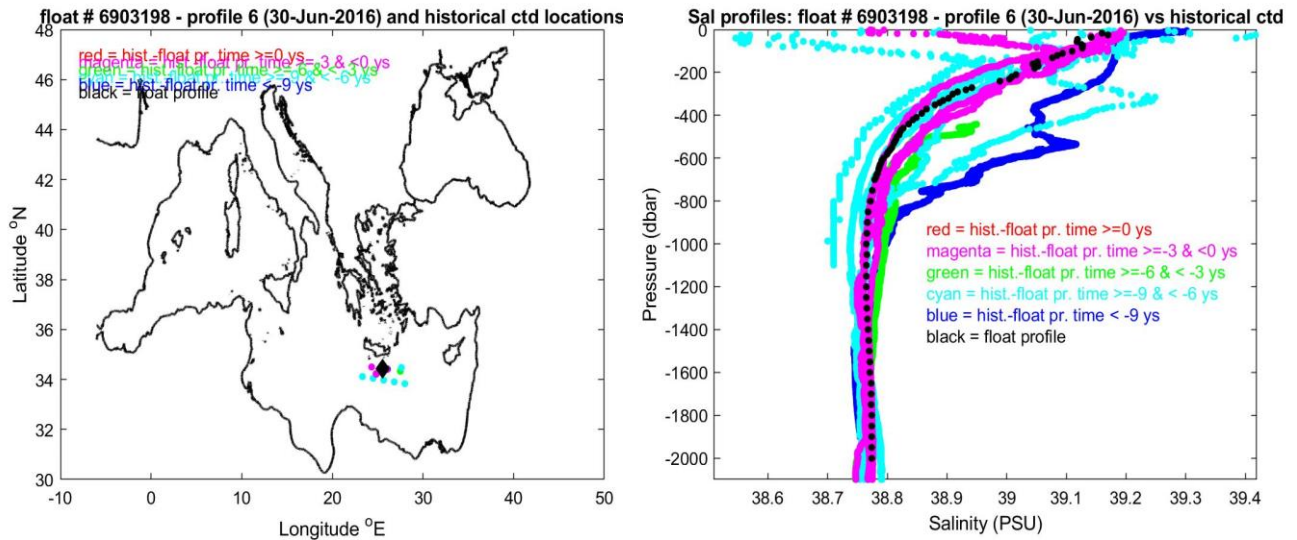

Figure 5: Float 6903198. Locations of the salinity float profile number 6 and historical CTD data (right panel) and the respective salinity profiles (left panel).
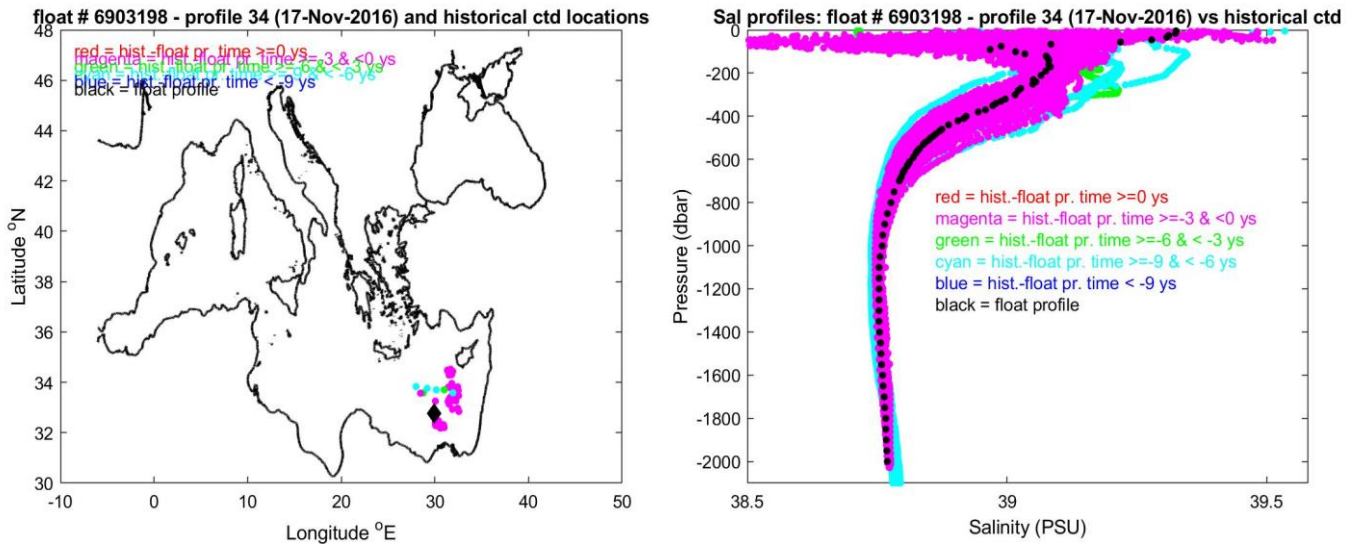

Figure 6: Float 6903198. Locations of the salinity float profile number 34 and historical CTD data (right panel) and the respective salinity profiles (left panel).
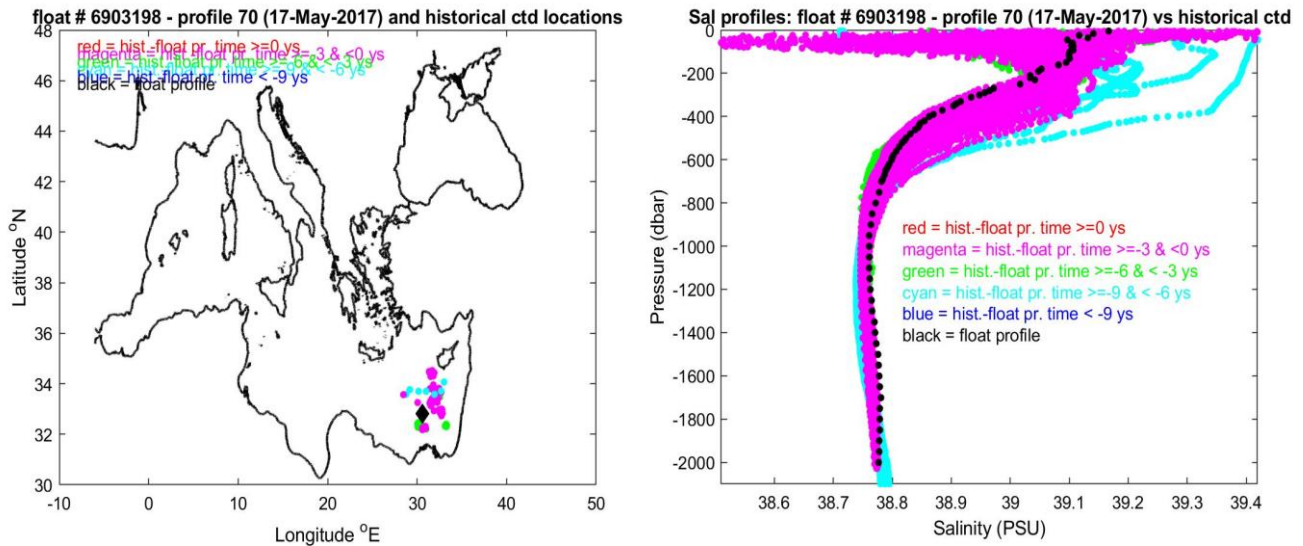
Figure 7: Float 6903198. Locations of the salinity float profile number 70 and historical CTD data (right panel) and the respective salinity profiles (left panel).

The comparison of these 3 selected salinity float profiles with the closest (in space and time) salinity reference profile in shown in Figures from 8 to 10. 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.
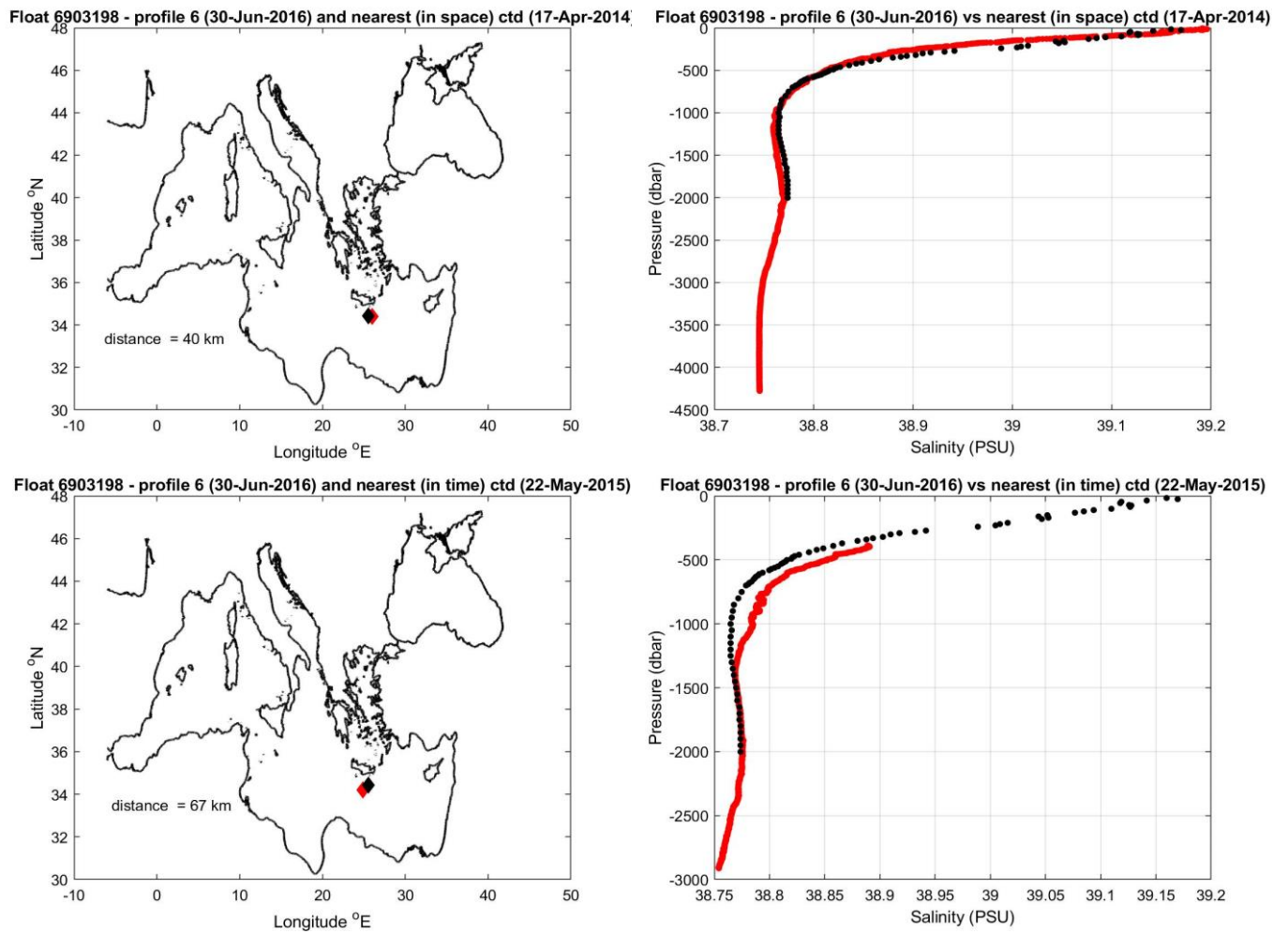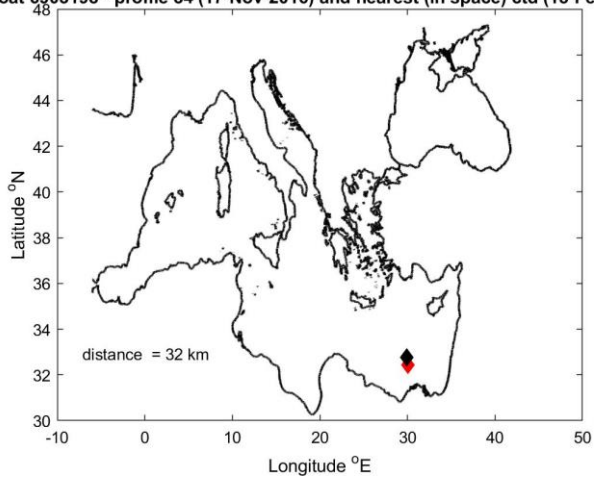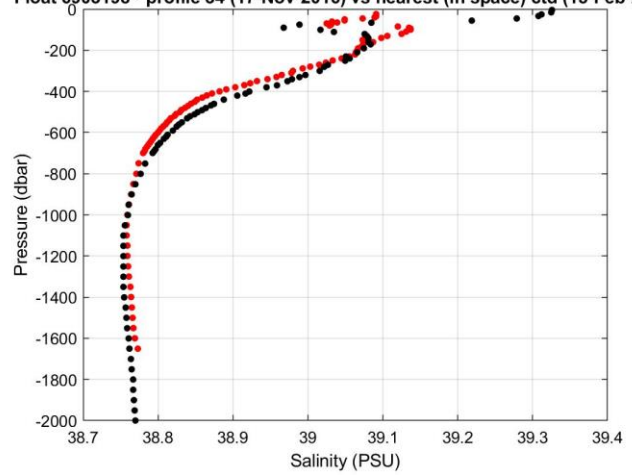
Figure 8: Float 6903198. The salinity float profile number 6 (black dots) are compared to the nearest in space (top) and in time (bottom) reference profile (red dots). The locations of the two profiles and their distance is given in the left panel.

Figure 9: Float 6903198. The salinity float profile number 34 (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.
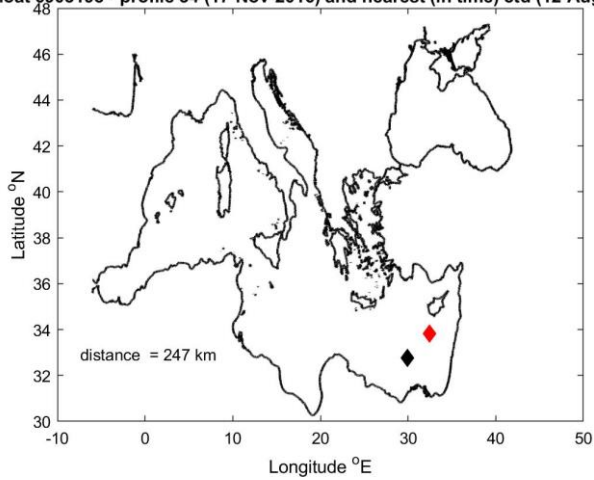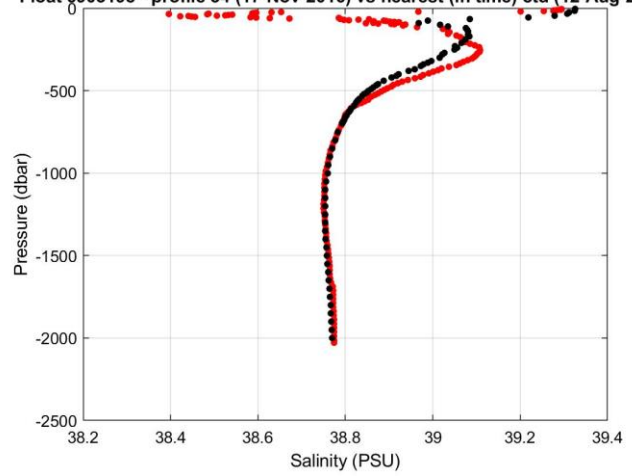
Figure 10: Float 6903198. The salinity float profile number 70 (black dots) are compared to the nearest in space (top) and in time (botton) reference profile (red dots). The locations of the two profiles and their distance is given in the left panel.
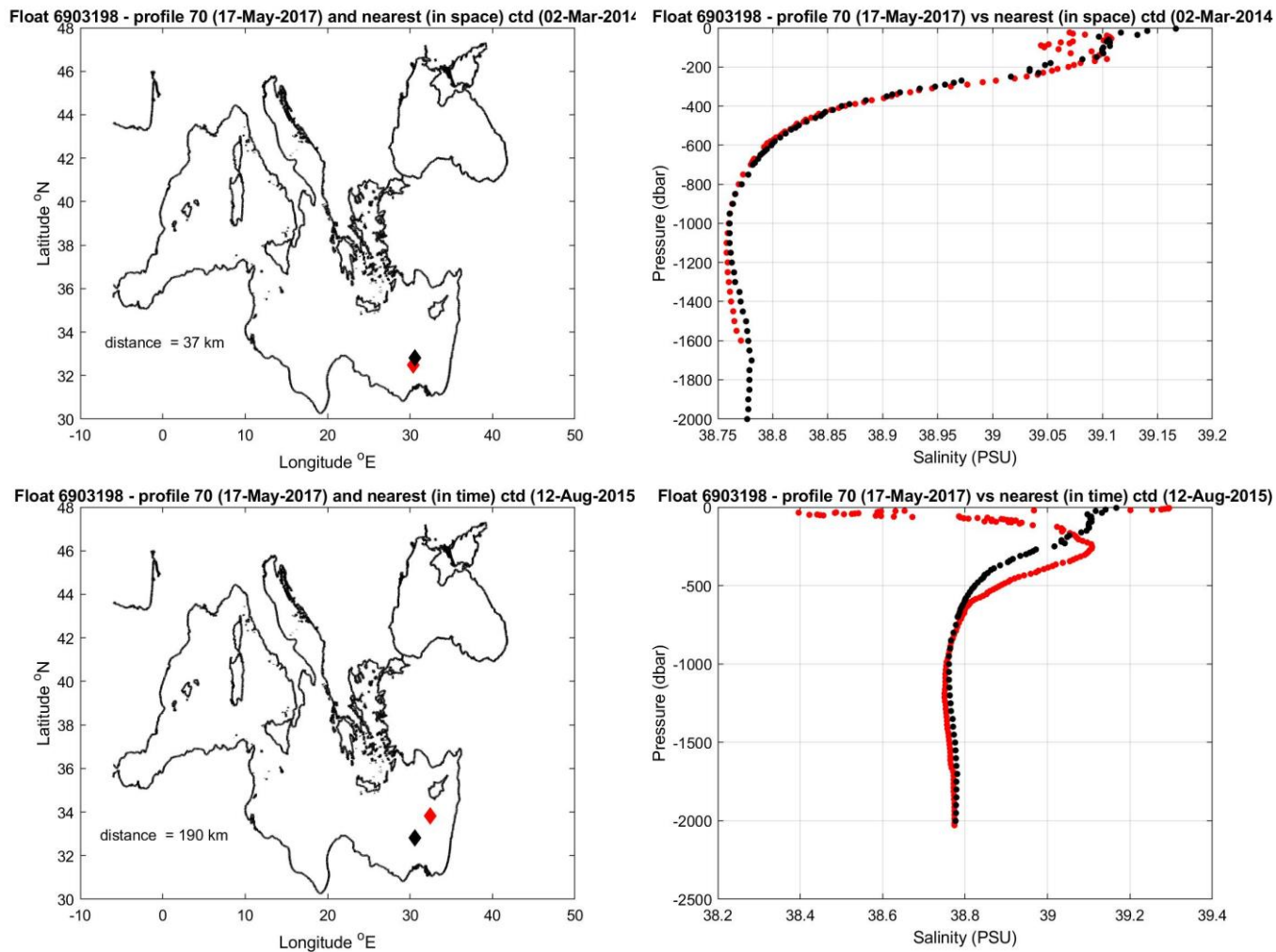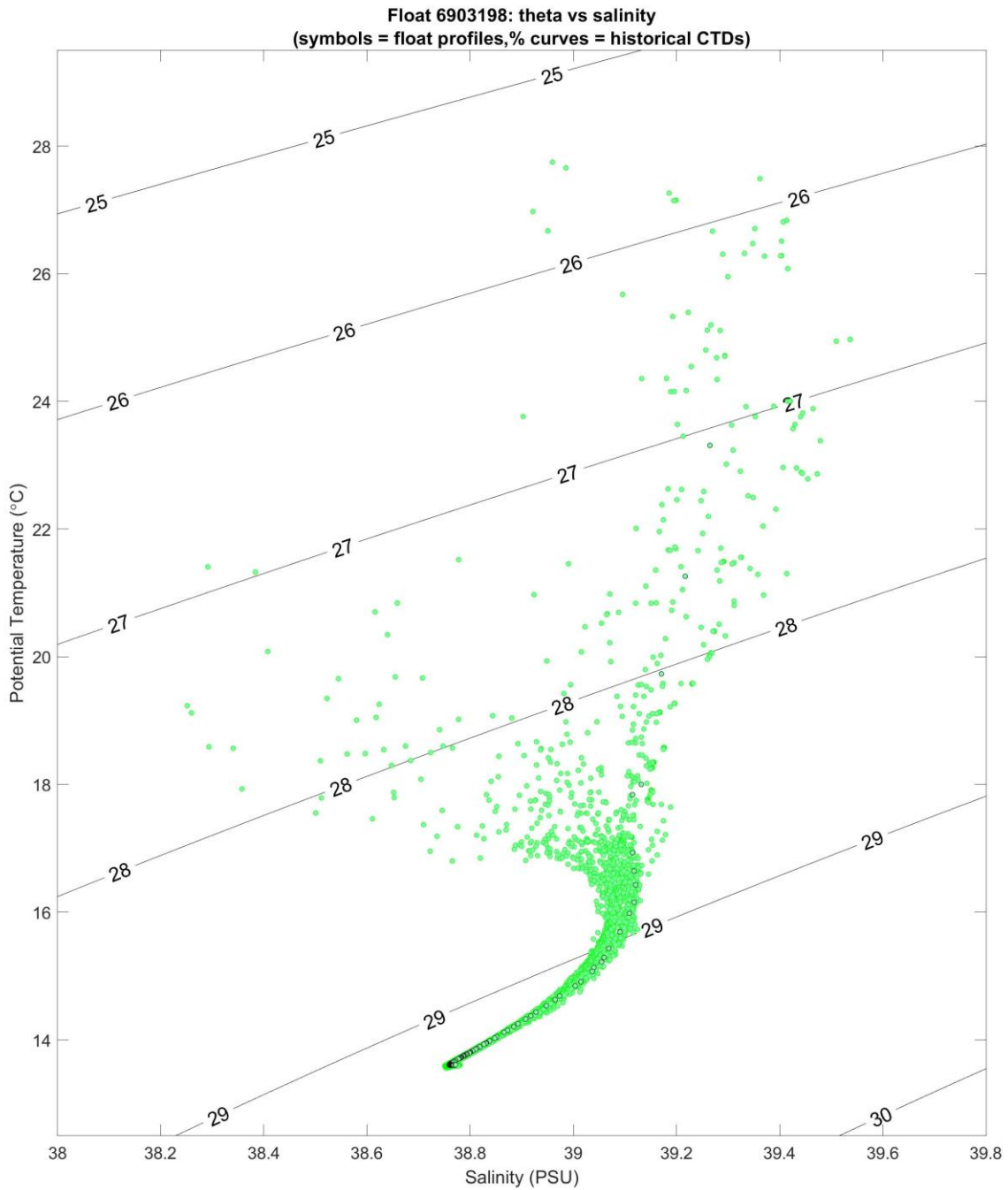
Figure 11: Float 6903198. T/S diagram plotted with and data from WMO boxes of CTD reference data +/- 10°of latitude and longitude. The black and blue cycles indicate the first and the last Argo profile, respectively. Green symbols represent other Argo profiles from this float. The thin colours lines indicate the reference data.

3 Sea surface pressure calibrations

The adjusted surface pressure is plotted in Figure 12. Surface pressure is extracted from the Argo technical file: the variable name is "PRES_SurfaceOffsetCorrectedNotResetNegative_1cBar Resolution_dbar". No adjustment of the CTD pressure profiles is required because the correction is less than the accuracy of the sensor (2.4 dbar).
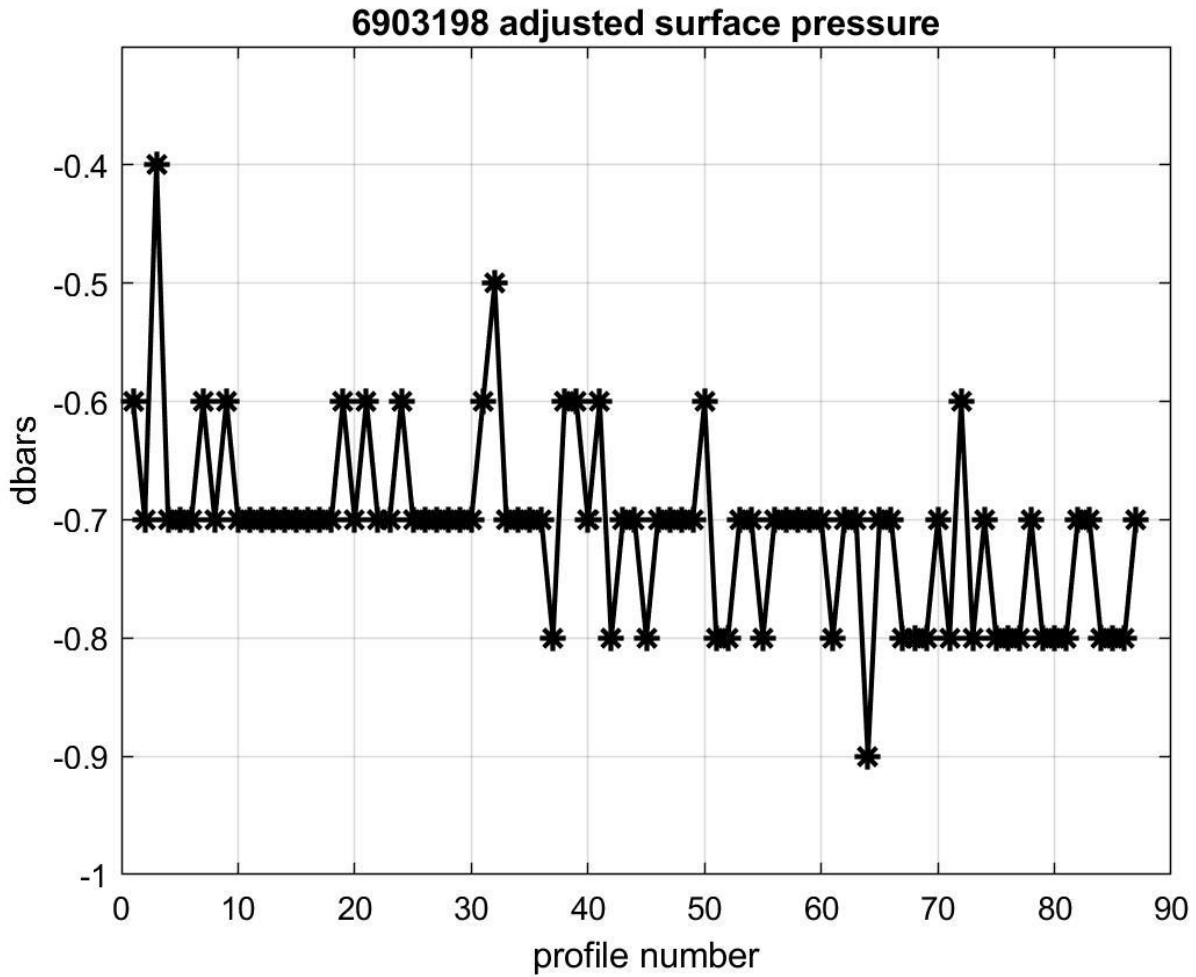

Figure 12: Float 6903198. Adjusted surface pressure values versus profile number.

4 Correction of Salinity Data

4.1 Comparison between Argo Float and CTD Climatology

4.1.1 Configurations

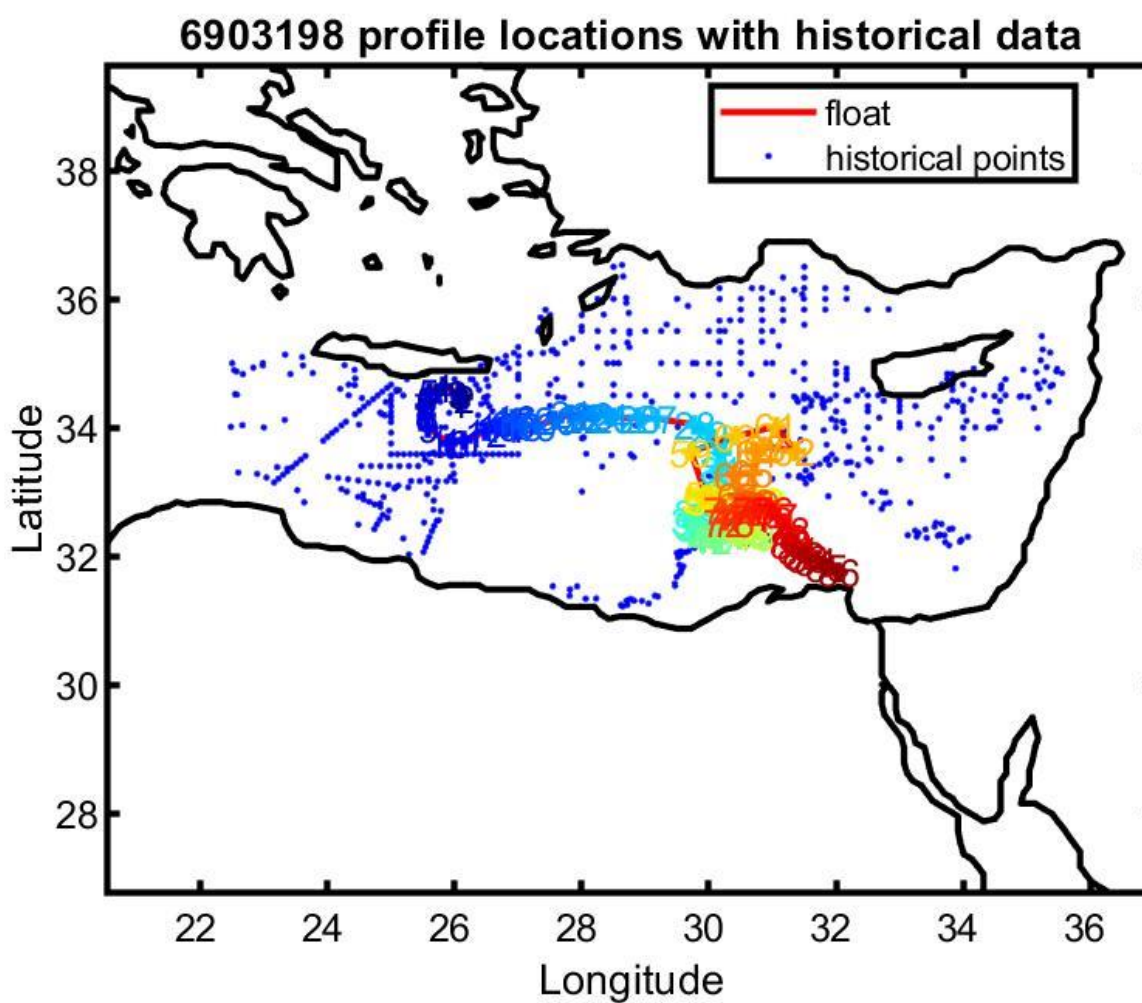| Parameters	Value
CONFIG_MAX_CASTS	300
MAP_USE_PV	1
MAP_USE_SAF	0
MAPSCALE_LONGITUDE_LARGE	4
MAPSCALE_LONGITUDE_SMALL	1.33
MAPSCALE_LATITUDE_LARGE	4
MAPSCALE_LATITUDE_SMALL	1.33
MAPSCALE_PHI_LARGE	0.5
MAPSCALE_PHI_SMALL	0.1
MAPSCALE_AGE	10
MAP_P_EXCLUDE	700
MAP_P_DELTA	250

Figure 13: Float 6903198. Location of the float profiles (red line with colored numbers) and the reference data selected for mapping (blue dots).

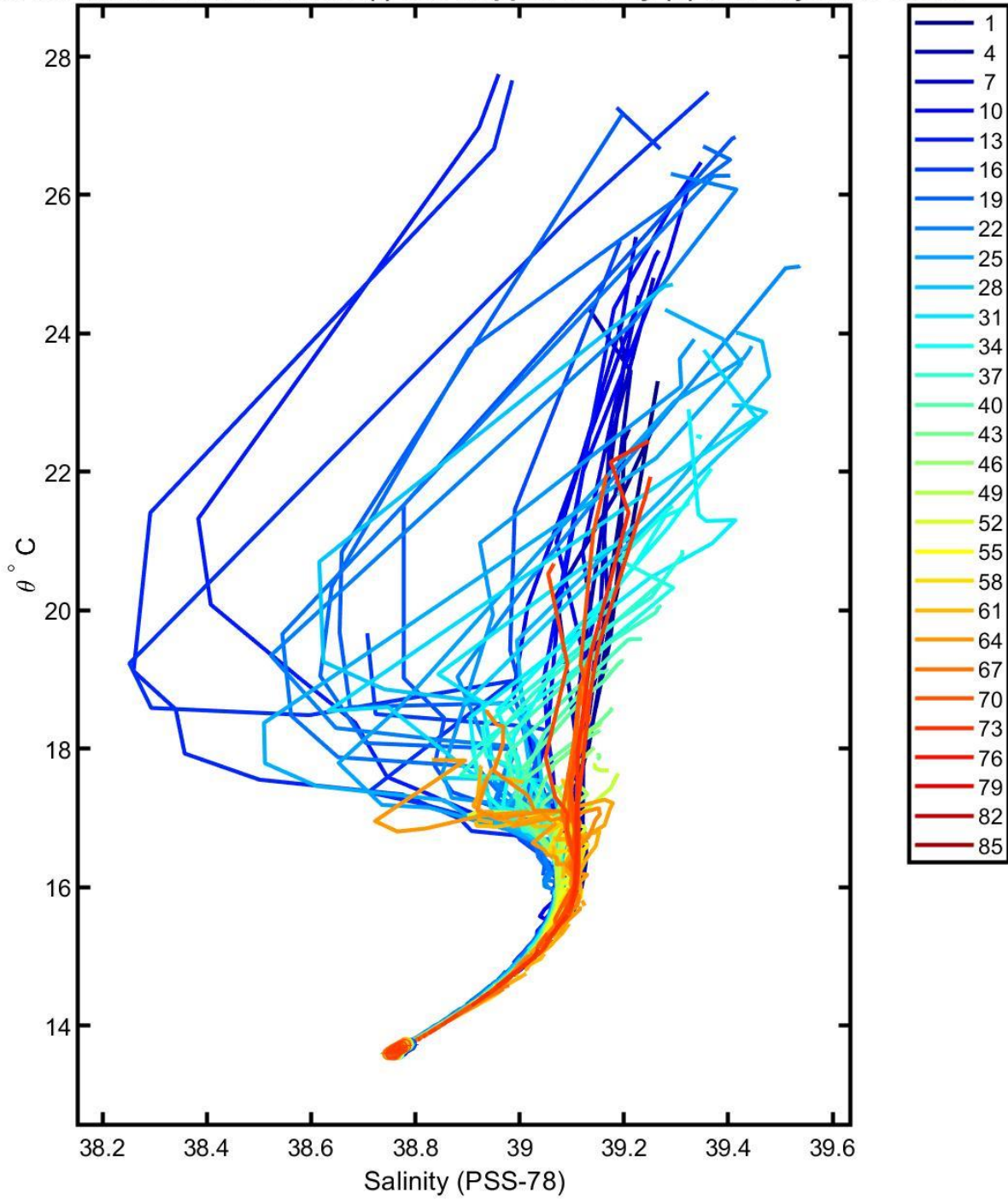**6903198 uncalibrated float data (-) and mapped salinity (o) with objective errors**

Figure 14: Float 6903198. Plot the original float salinity and the objectively estimated reference salinity at the 10 float theta levels that are used in calibration.
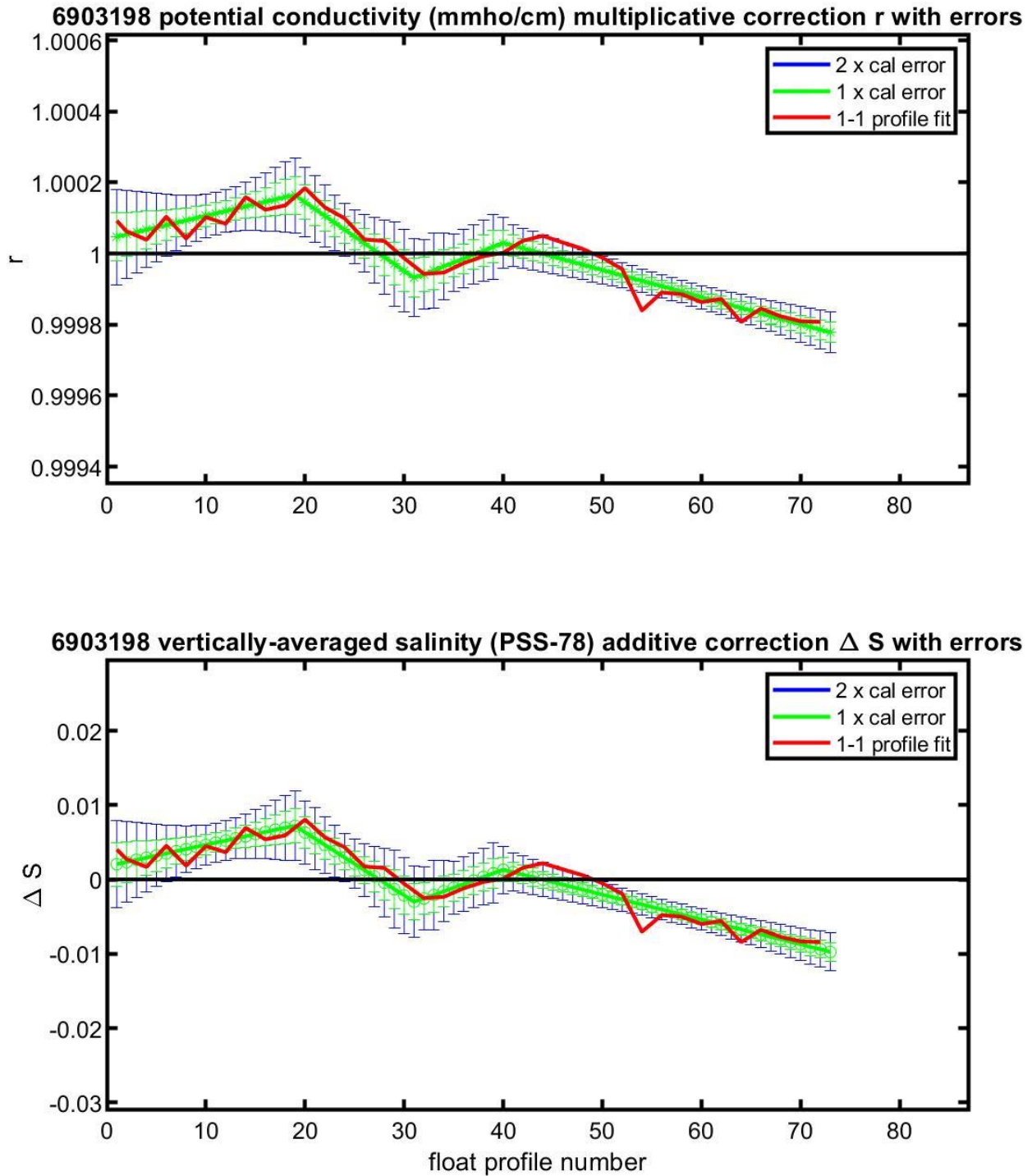
Figure 15: Float 6903198. Evolution of the suggested adjustment with time. The top panel plots the potential conductivity multiplicative adjustment. The bottom panel plots the equivalent salinity additive adjustment. The red line denotes one-to-one profile fit that uses the vertically weighted mean of each profile. The red line can be used to check for anomalous profiles relative to the optimal fit.
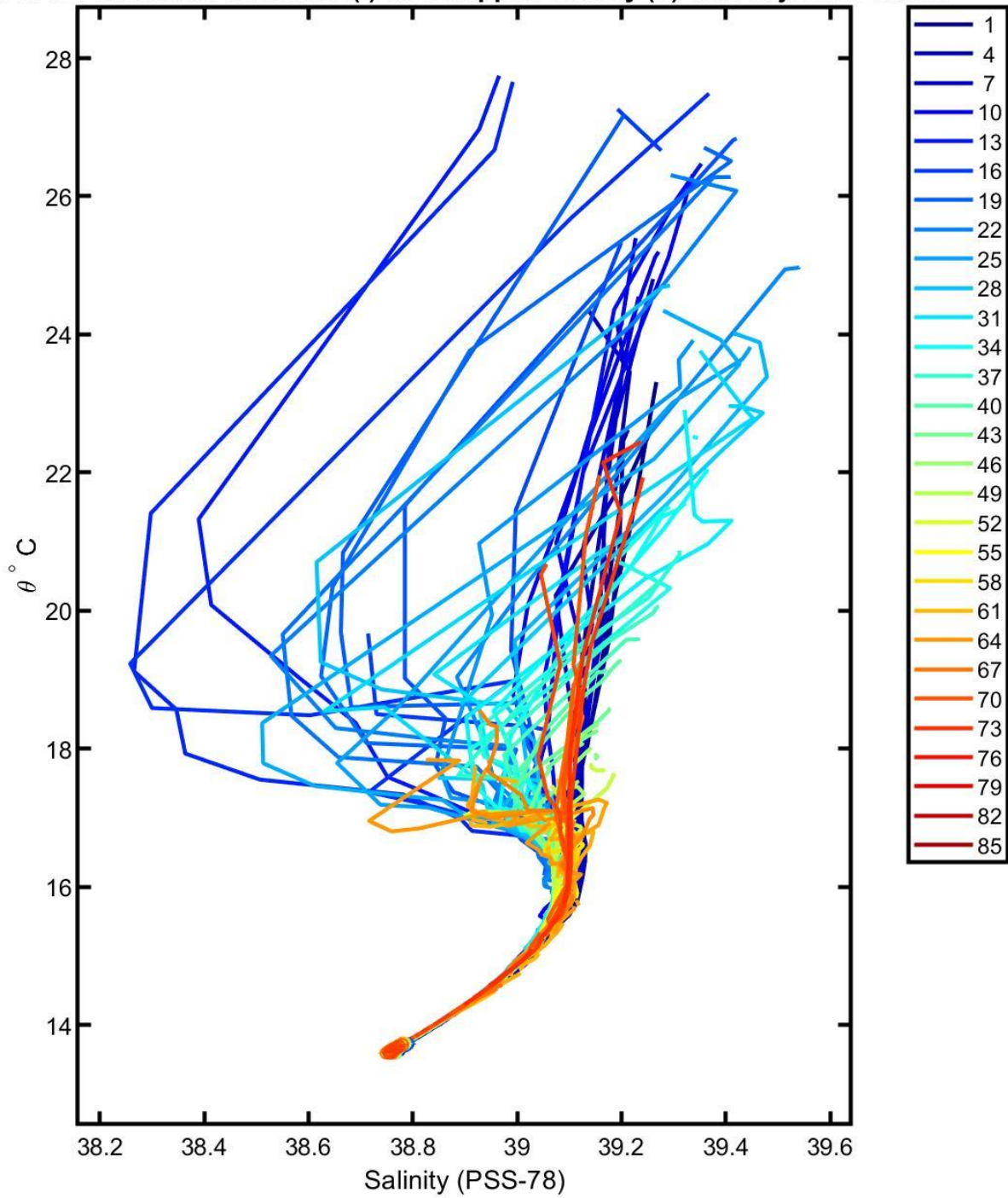
Figure 16: Float 6903198. The plot of calibrated float salinity and the objectively estimated reference salinity at the 10 float theta levels that are used in calibration.

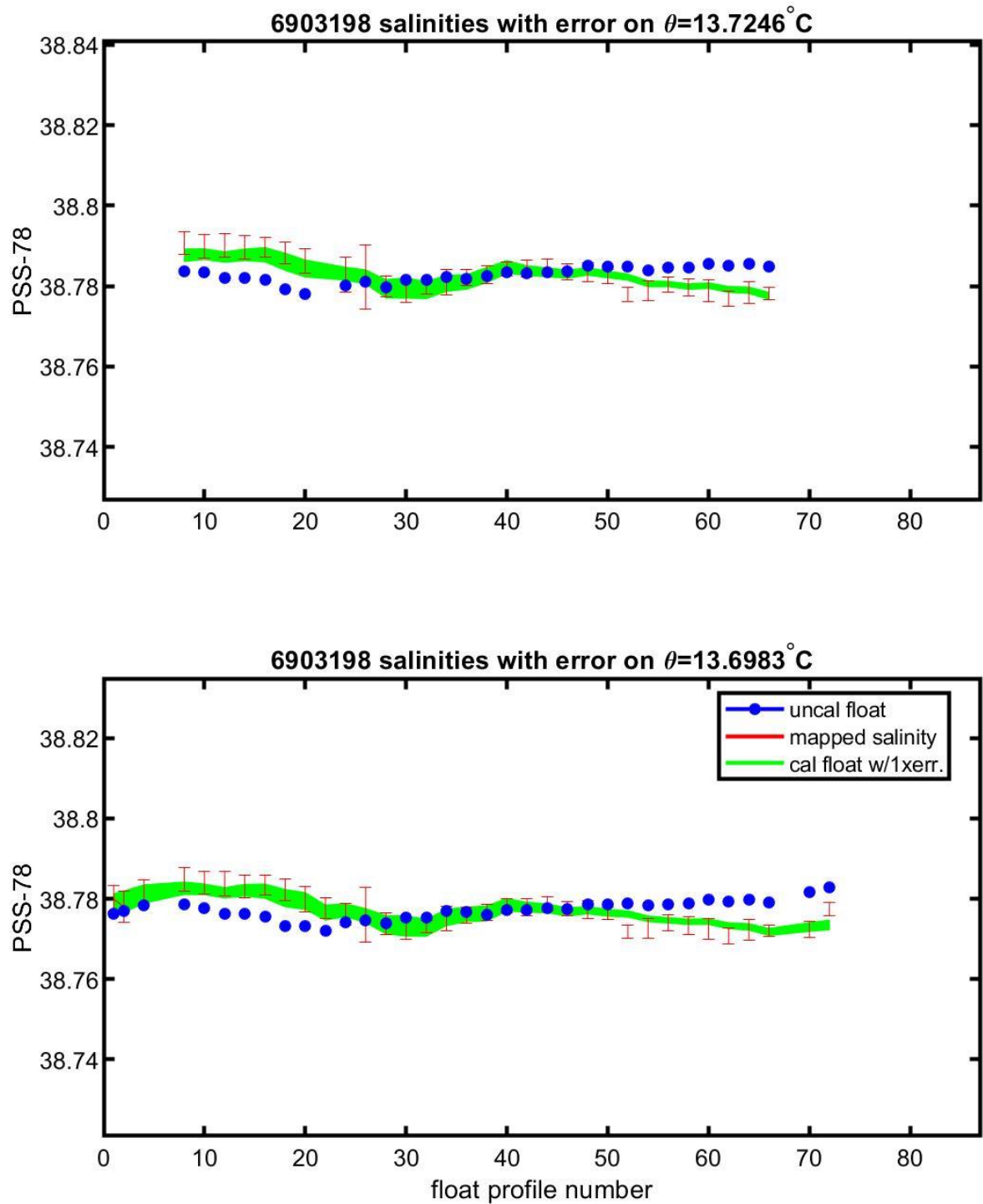**Figure 17:** Float 6903198. Plots of the evolution of salinity with time along with selected theta levels with minimum salinity variance.
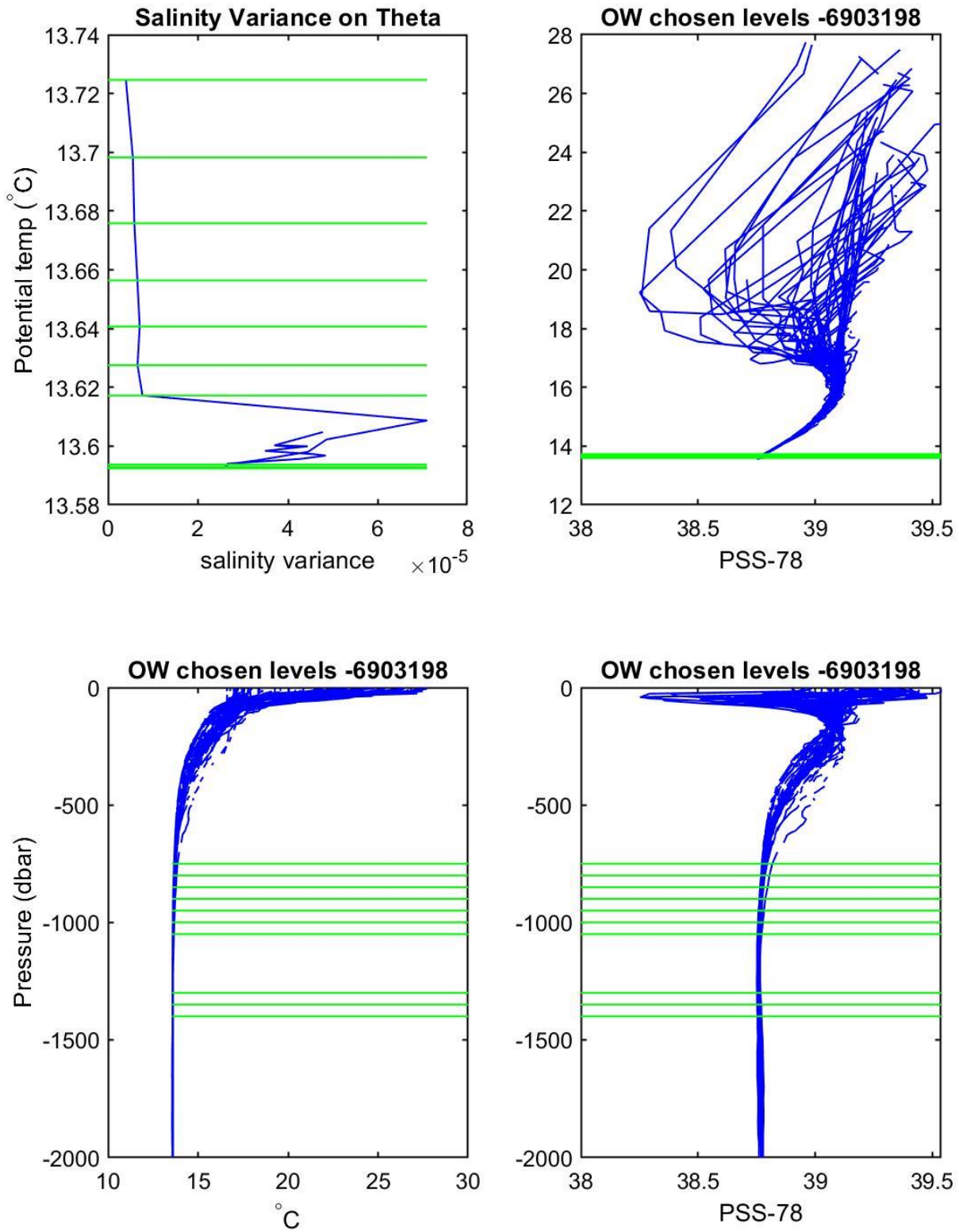
Figure 18: Float 6903198. Plots include the theta levels chosen for calibration: Top left: Salinity variance at theta levels. Top right: T/S diagram of all profiles of Argo float. Bottom left: potential temperature plotted against pressure. Bottom right: salinity plotted against pressure.

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.
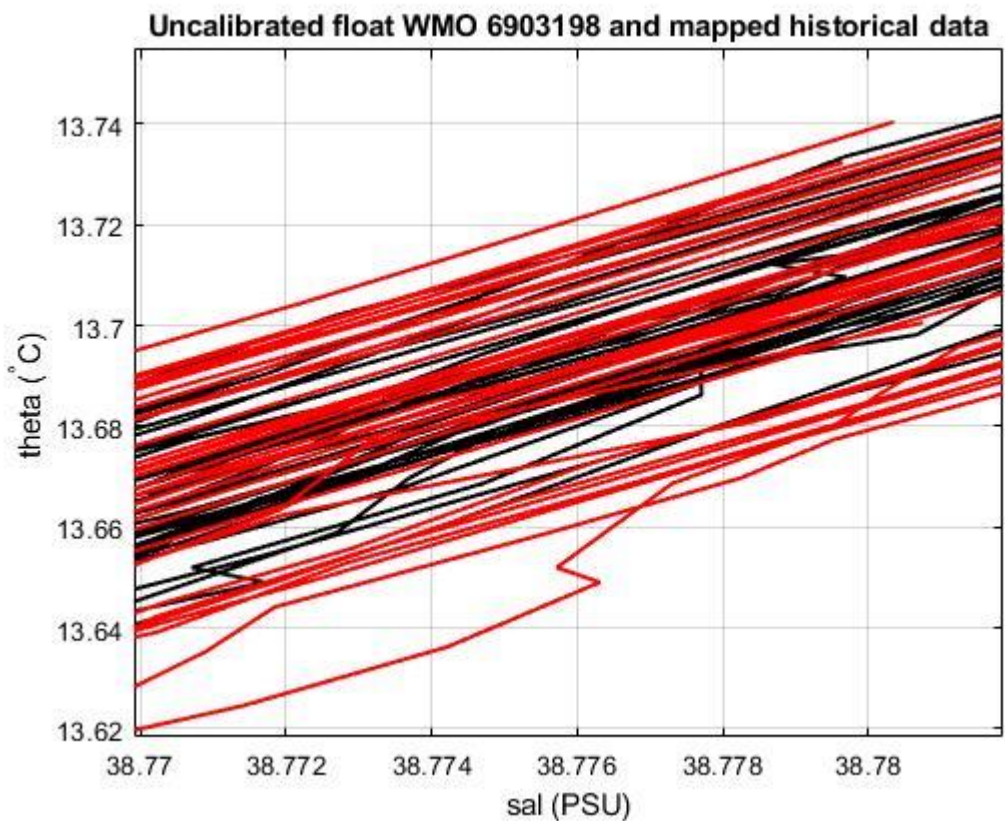

Figure 19: Float 6903198. Uncalibrated float salinity profile (black lines) and mapped historical data (red lines) in the most uniform part of the θ-S curve.

5   Summary

Float was deployed in the Cretan sub-basin, in the Mediterranean Sea. During its life passes in Levantine sub basin where died. 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 no potential salinity offset/drift. This float was DMQC-ed until cycle 73 with PSAL adjusted QC=1.

The OWC analysis showed no significant salinity offset. Figure 15 reveals that the least square fit could have uncertainties. Figure 17 shows that the float salinity is quite constant on selected θ-levels. The correction proposed by OW is below the Argo requested accuracy (0.01). After several analyses, the last decision is that the salinity data of float WMO 6903198 doesn't need a delayed mode correction. QC 1 is applied to cycle from 1 to 73. QC 4 is applied to cycle from 74 to 87.

PSAL_ADJUSTED=PSAL from cycle 1 to 87

The quality flags applied are the following:

PSAL_ADJUSTED_QC='1' from cycle 1 to 73

PSAL_ADJUSTED_QC='4' from cycle 73 to 87

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

Annie Wong, Robert Keeley, Thierry Carval and the Argo Data Management Team (2020). Argo Quality Control Manual for CTD and Trajectory Data. http://dx.doi.org/10.13155/33951