Delayed Mode Quality Control of Argo float WMO 3901957

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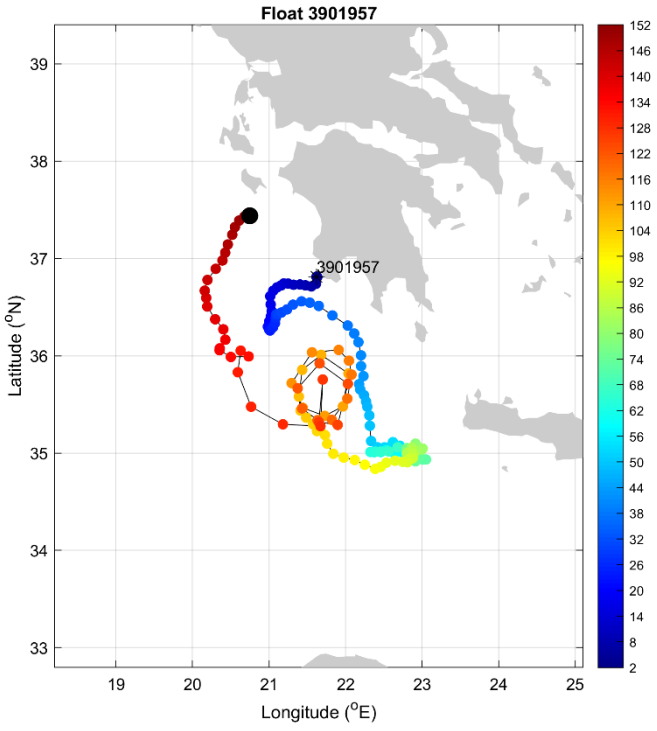

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1 Introduction

This report includes the delayed mode quality control analysis (DMQC) performed for Argo float WMO 3901957. It was deployed in the Mediterranean Sea (Ionian sub basin) in May 2018 and performed 154 cycles before becoming inactive. This float was not DMQC-ed before. Before the analysis, real-time QC flags were visually inspected. The list of flags applied is QC=1 to cycles 2 to 128, QC=3 from 129 to 142, QC=4 from 143 to 154. In addition, the satellite altimetry 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 temperature, salinity and density profiles plotted against the nearby historical CTD were generated. This visual analysis helps 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_PHYBGCWAV_DISCRETE_MYNRT_013_035
- Coriolis: CTD_for_DMQC_2024V01
- Historical CTD profiles from various research institutes

Argo:

- ARGO_for_DMQC_2022V03

Argo float WMO 3901957 is an Arvor float where the pressure values are auto corrected on board and no adjustment is required. The OWC was run to estimate any salinity offset and/or 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 automatically applied to the float in real-time mode by the Coriolis DAC is the following:

Cycle number 2-128 → PSAL QC=1

Cycle number 129-142 → PSAL QC=3

Cycle number 143-154 → PSAL QC=4

2.2 Satellite Altimeter Report

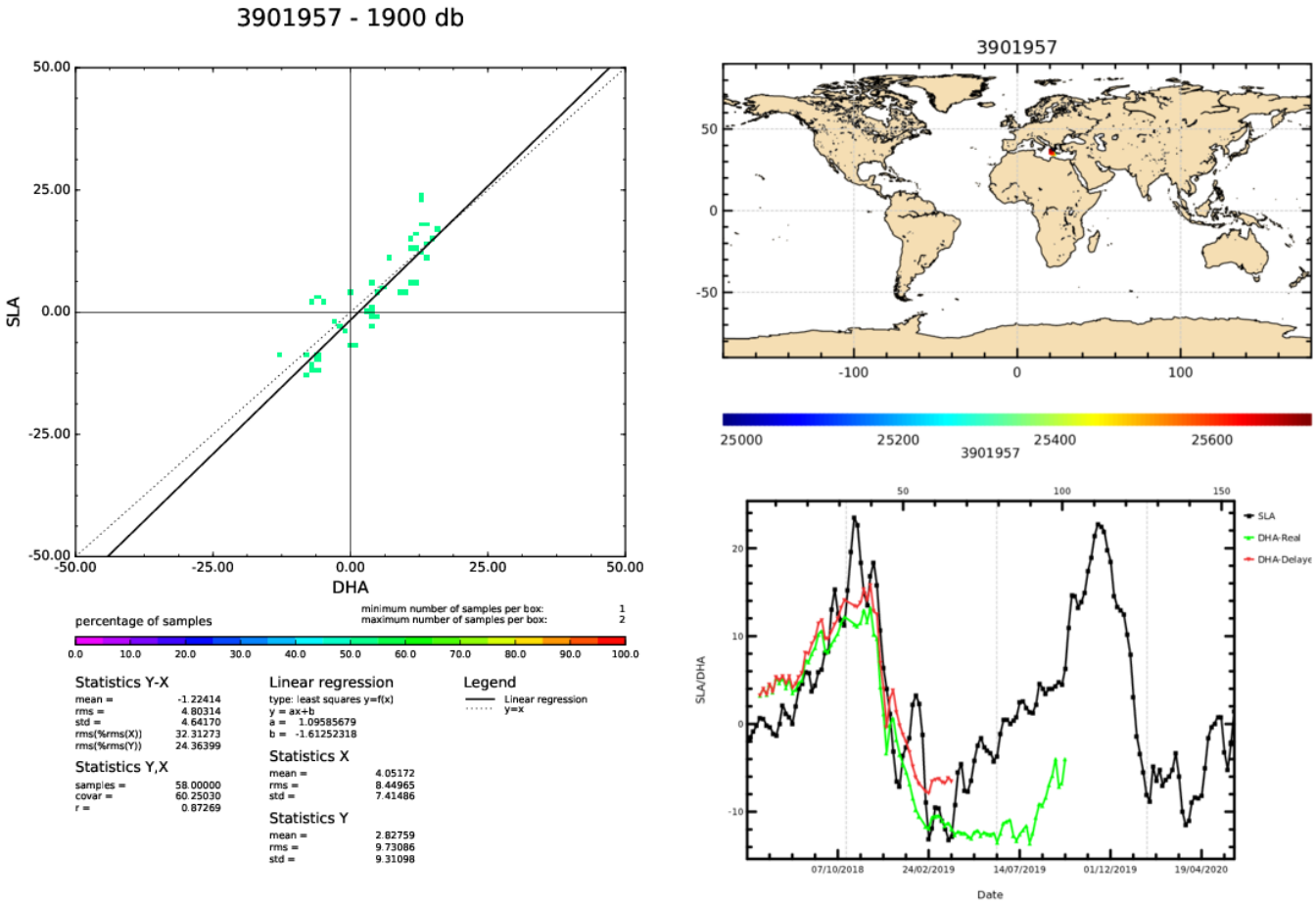

Figure 1: Float 3901957. The comparison between the sea surface height (SSH) from the satellite altimetry and dynamic height anomaly (DHA) extracted from the Argo float temperature and salinity. The figure is created by the CLS/Coriolis and distributed by Ifremer (ftp://ftp.ifremer.fr/ifremer/argo/etc/argo-ast9-item13-AltimeterComparison/figures/).

2.3 Time Series of Argo Float Temperature and Salinity

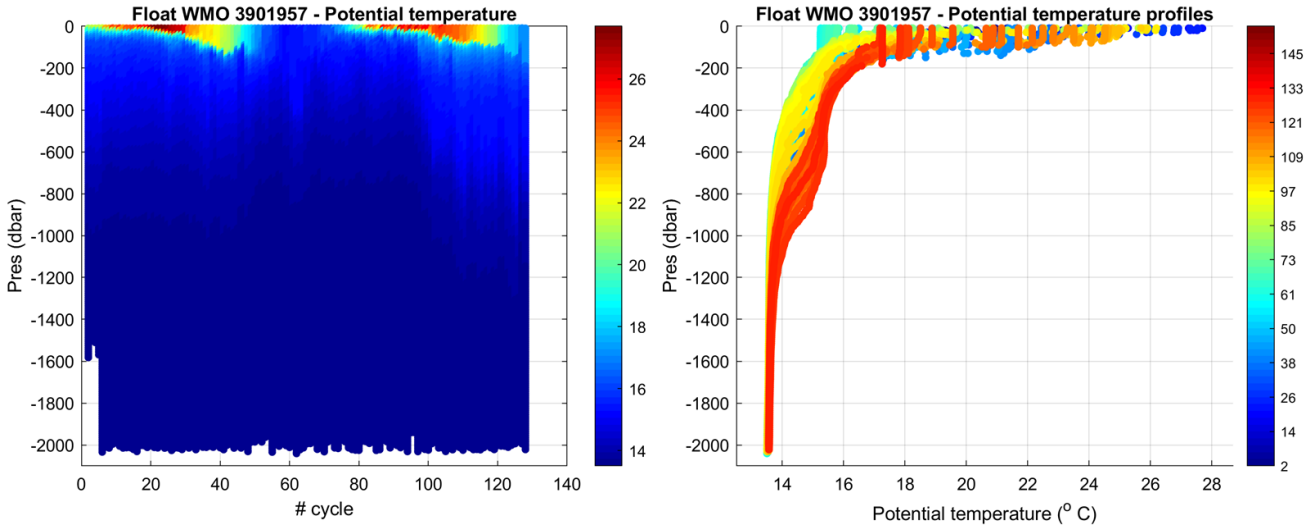

Figure 2: Argo float WMO 3901957. Time series of Argo float potential temperature (°C) on the left, and potential temperature profiles color-coded per cycle number on the right.

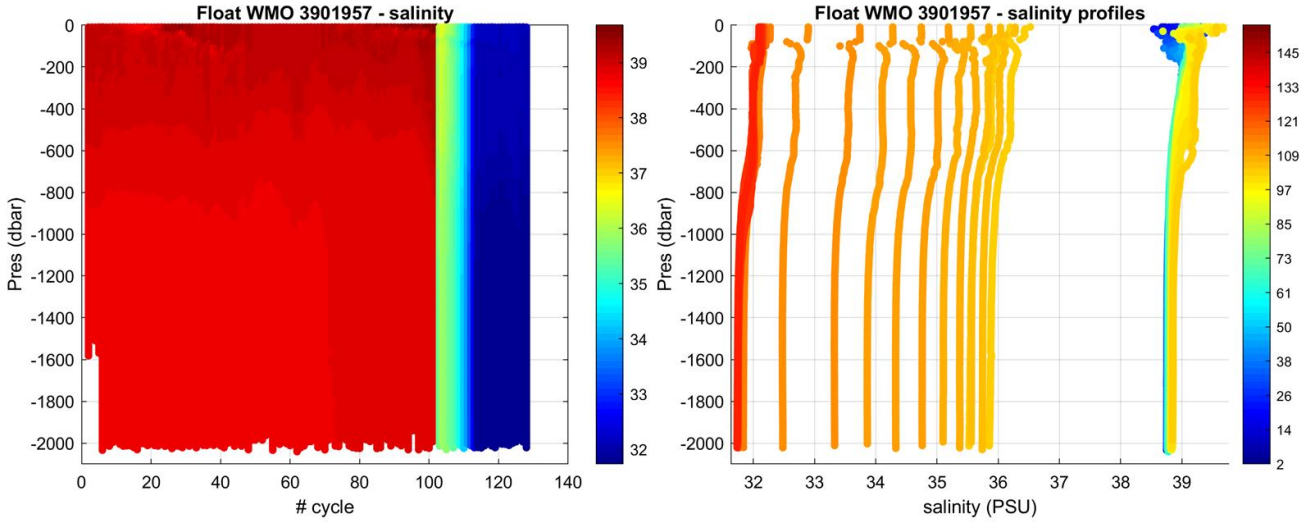

Figure 3: Argo float WMO 3901957. Time series of Argo float potential salinity (PSS-78) on the left, and salinity profiles color-coded per cycle number on the right.

Before running the Owens, Wong and Cabanes method, referred to as OWC 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.

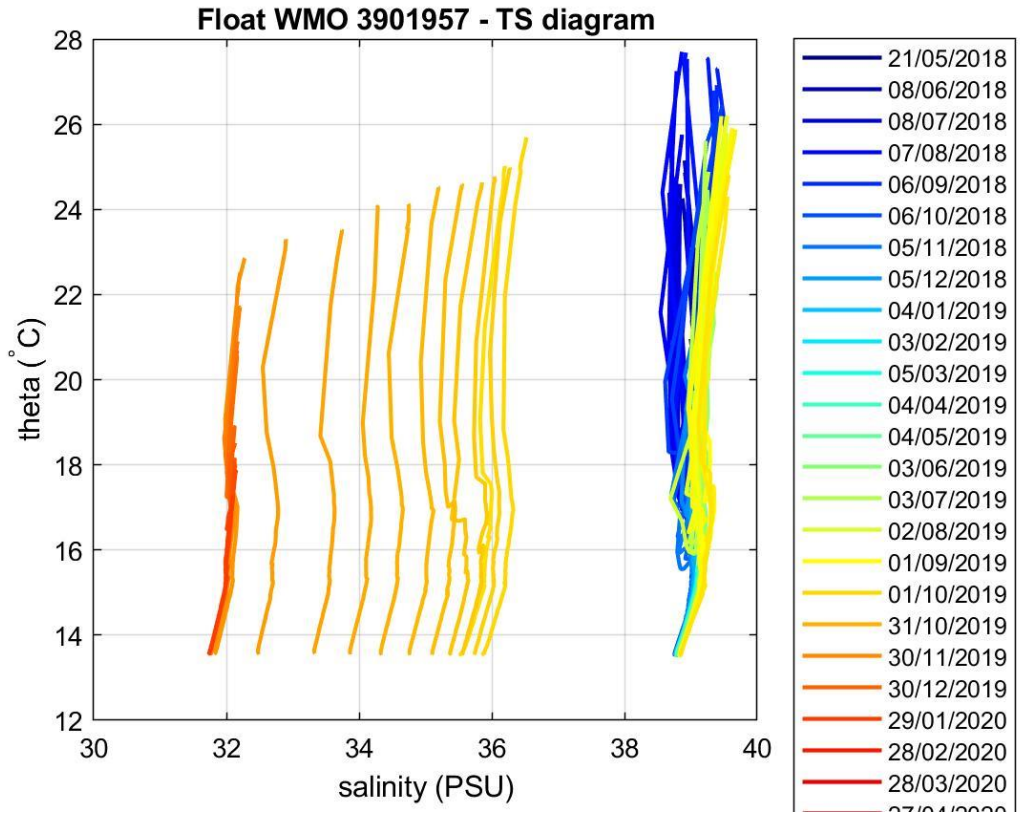

Figure 4: Argo float WMO 3901957. θ-S diagram color-coded per cycle number.

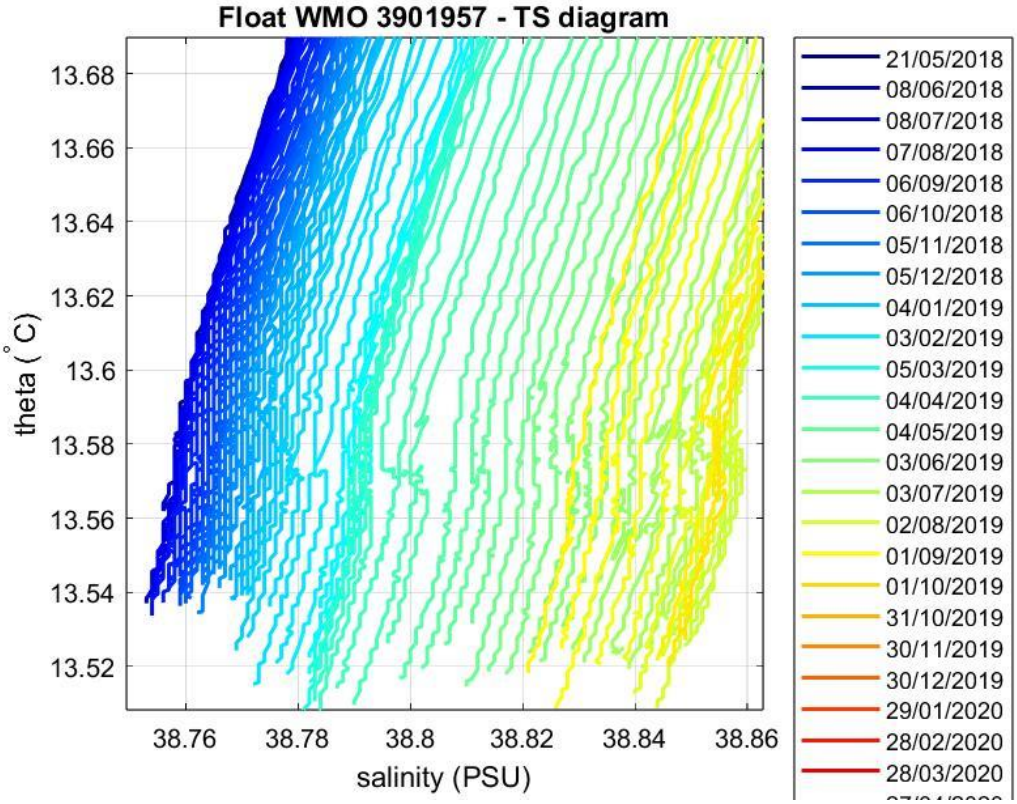

Figure 5: Argo float WMO 3901957 Area of the θ-S diagram (color-coded per cycle number) where the θ-S relationship is more uniform.

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 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 5 years).

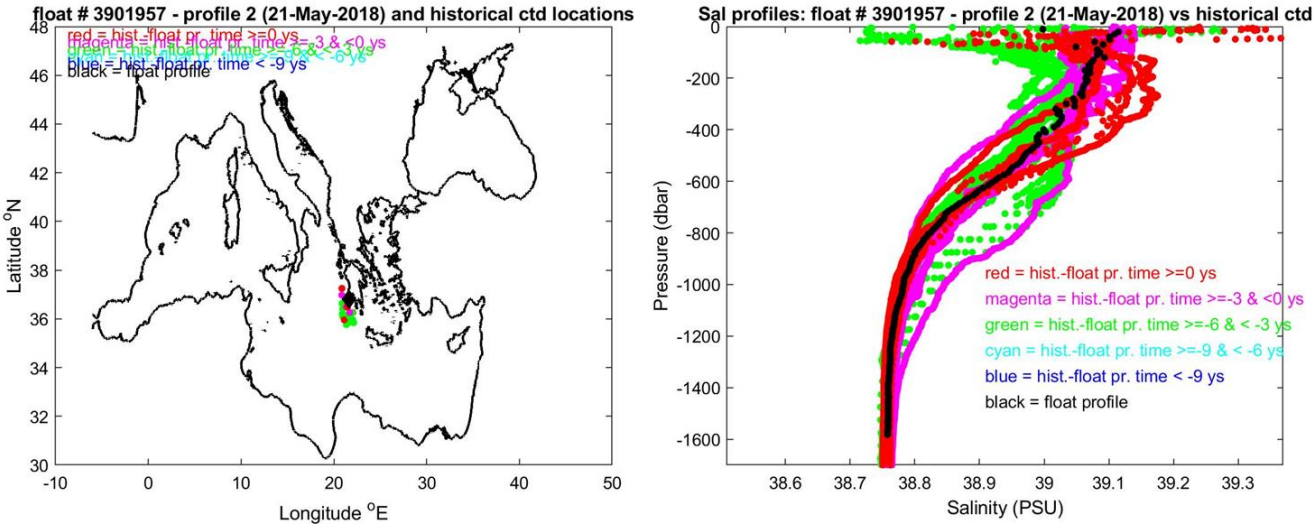

Figure 6: Argo float WMO 3901957. Locations of the salinity float profile number 2 and historical CTD data (right panel) and the respective salinity profiles (left panel).

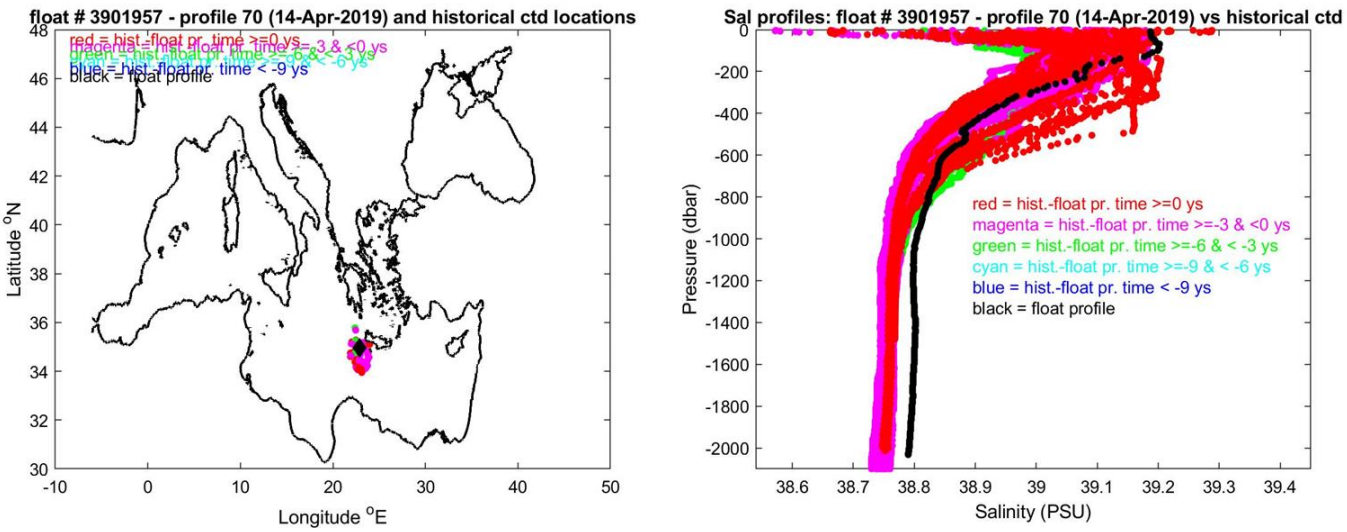

Figure 7: Argo float WMO 3901957. Locations of the salinity float profile number 70 and historical CTD data (right panel) and the respective salinity profiles (left panel).

The comparison of these 2 selected salinity float profiles with the closest (in space and time) salinity reference profile in shown in Figures 8 and 9. The agreement between the selected float salinity profiles and the historical salinity profiles is not very good in the intermediate and deep layers for cycle 70: this is an indication that a significant drift of the conductivity sensor is going on.

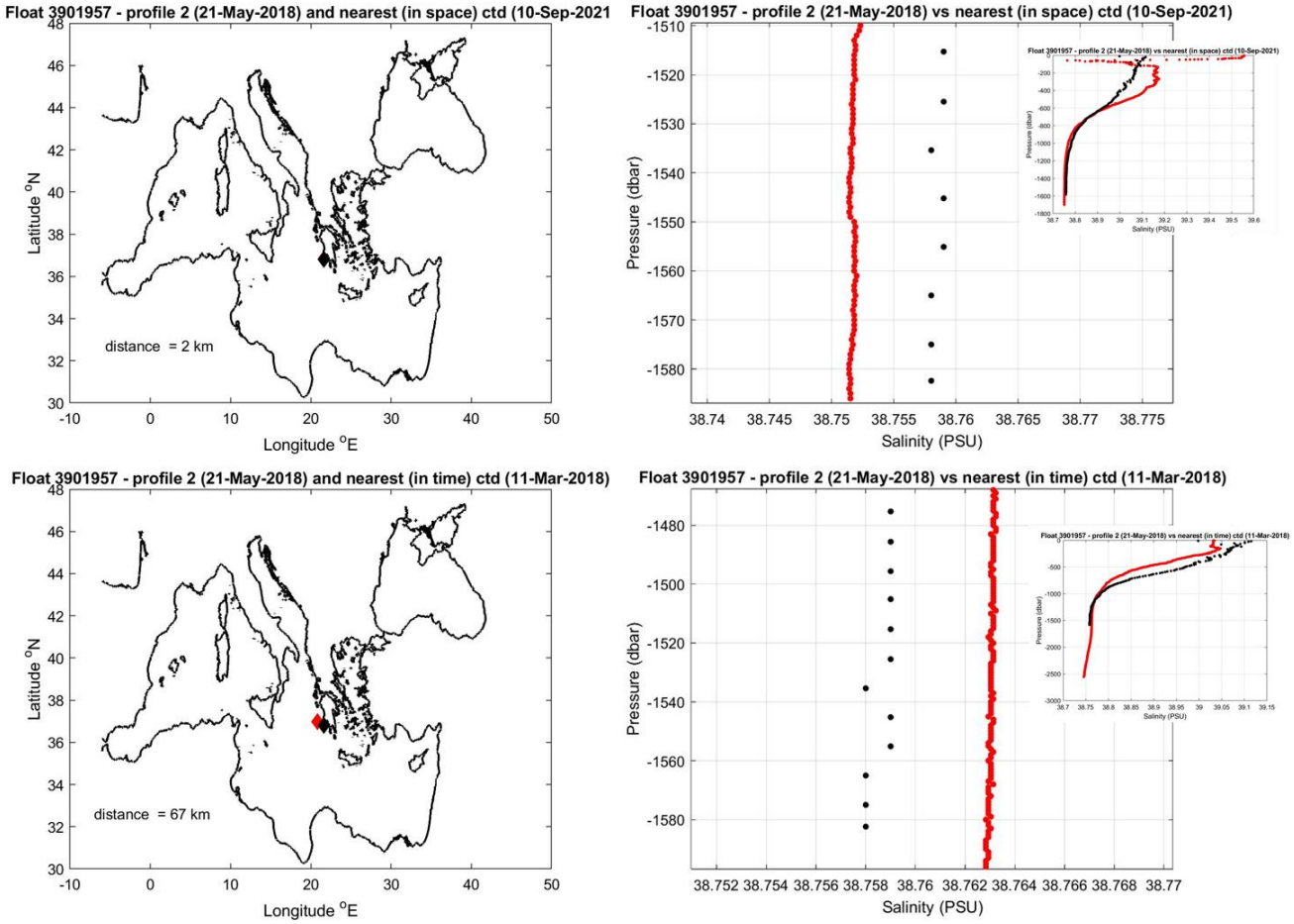

Figure 8: Float 3901957. The salinity float profile number 2 (black dots) are compared to the nearest in space (top) and in time (bottom) reference profile (red dots). The locations of the two profiles and their distance is presented in the left panel.

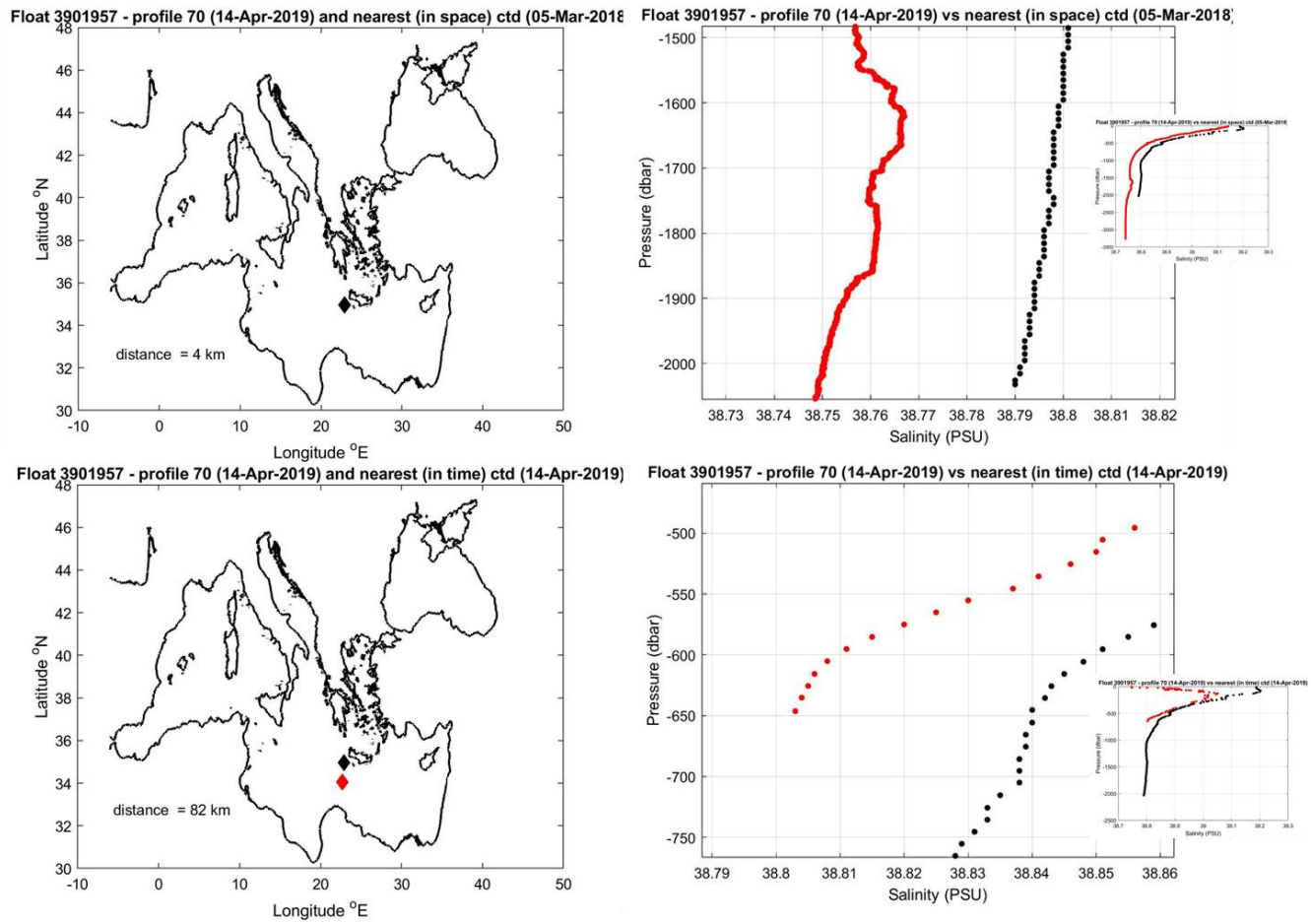

Figure 9: Argo float WMO 3901957. The salinity float profile number 70 (black dots) are compared to the nearest in space (top) and in time (bottom) reference profile (red dots). The locations of the two profiles and their distance is presented in the left panel.

3 Correction of Salinity Data

3.1 Comparison between Argo Float and CTD Climatology

3.1.1 Configurations used in the OWC method

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

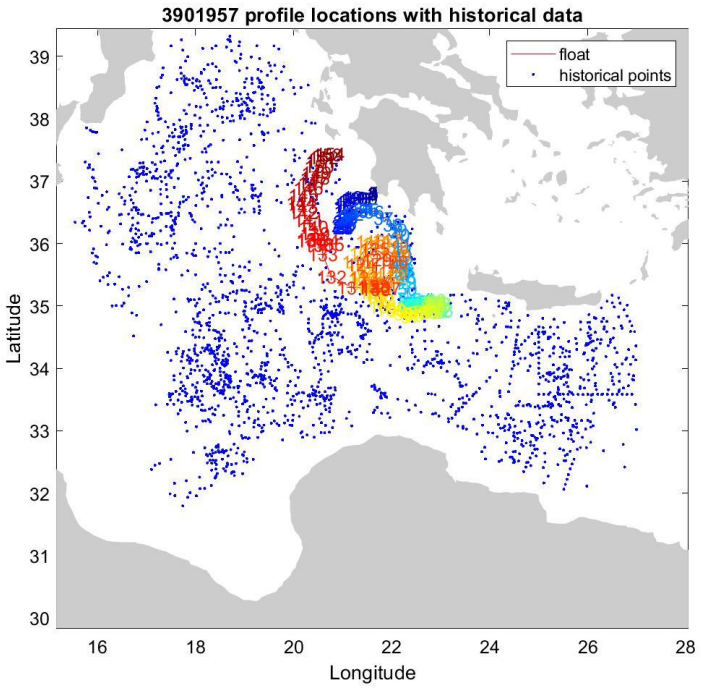

Figure 10: Argo float WMO 3901957. Location of the float profiles (red line with colored numbers) and the reference data selected for mapping (blue dots).

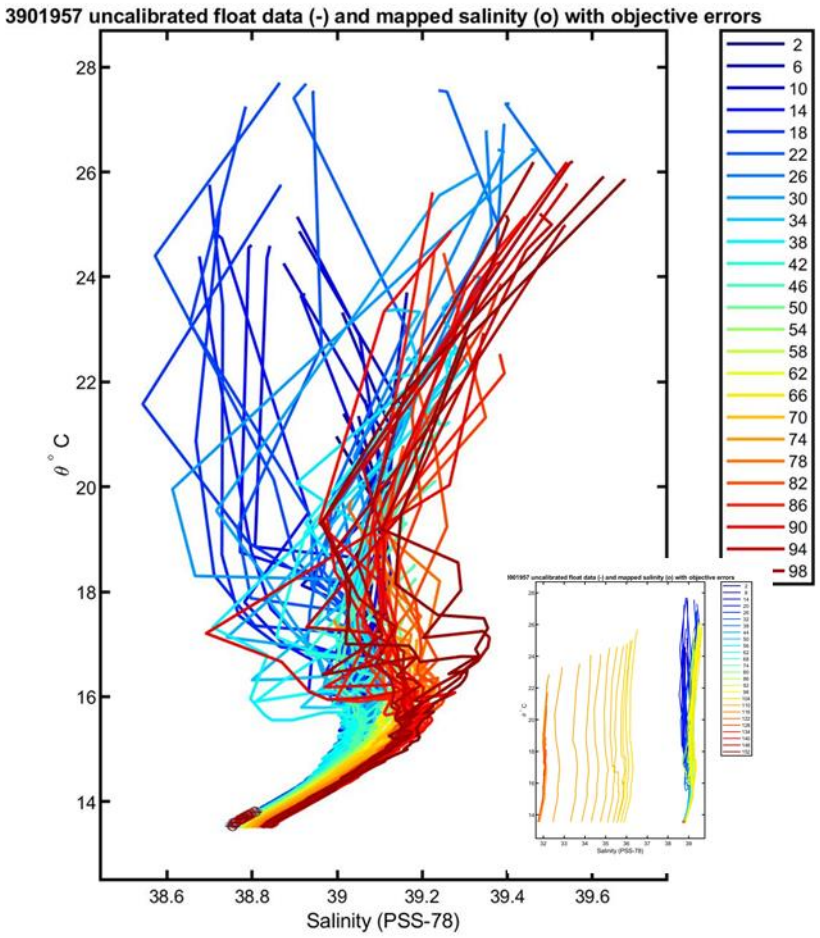

Figure 11: Argo float WMO 3901957. Plot the original float salinity and the objectively estimated reference salinity at the 10 float theta levels that are used in calibration considering profiles from 2 to 100. The small figure shows all cycles.

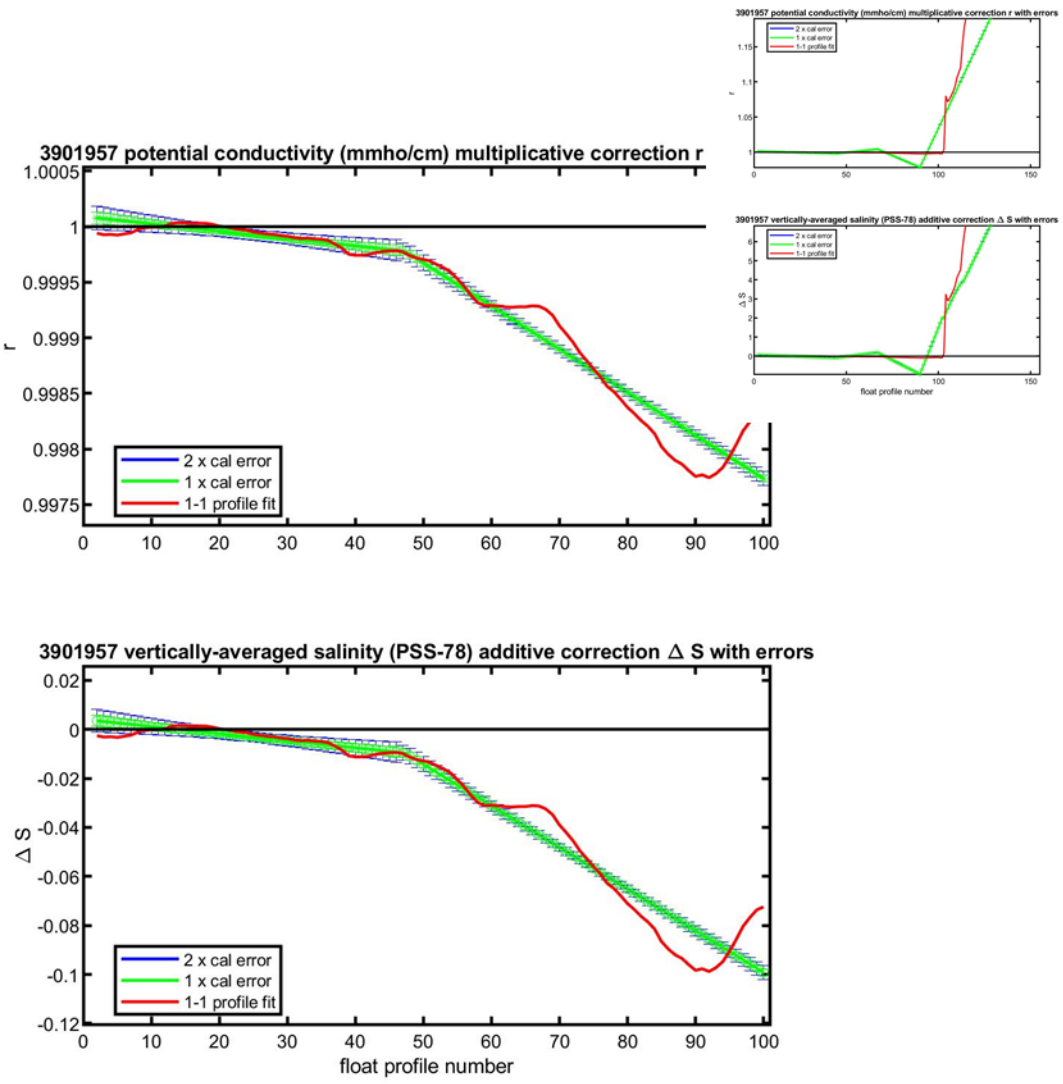

Figure 12: Argo float WMO 3901957. Evolution of the suggested adjustment with time considering profiles from 2 to 100. The small figure shows all cycles. The top panel plots the potential conductivity multiplicative adjustment. The bottom panel plots the equivalent salinity additive adjustment. The red 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.

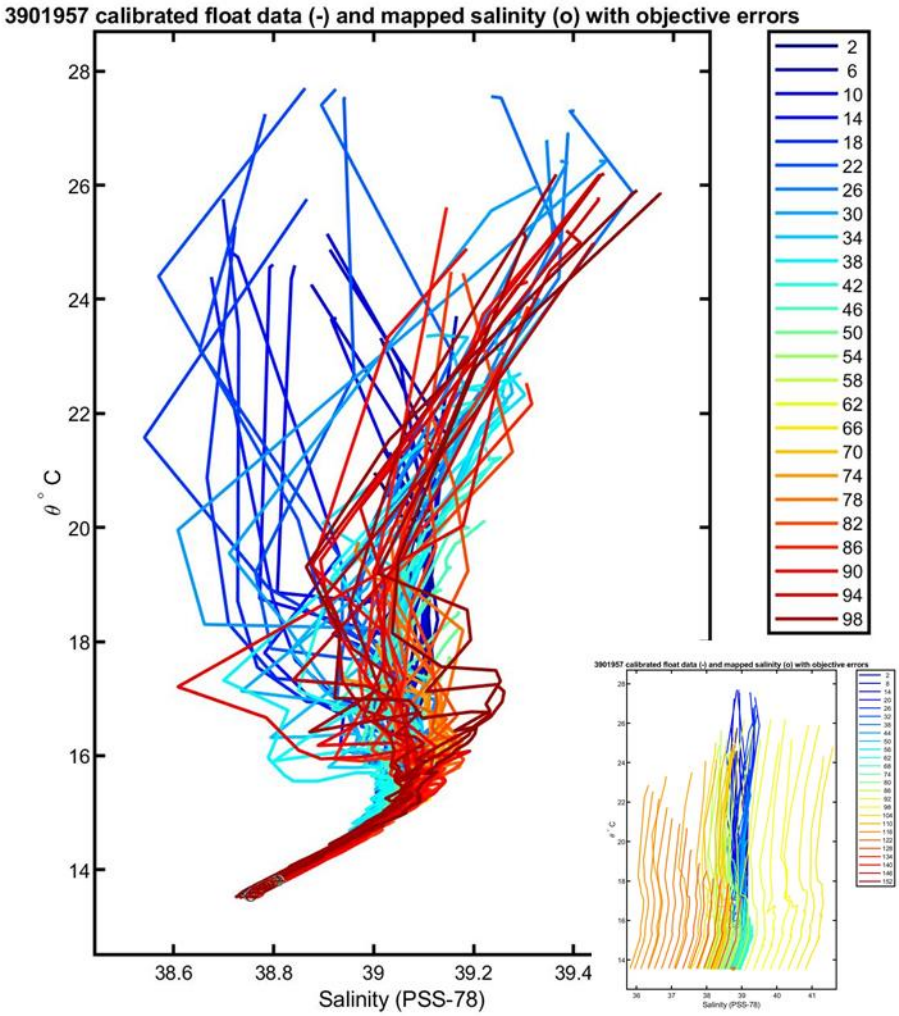

Figure 13: Argo float WMO 3901957. The plot of calibrated float salinity and the objectively estimated reference salinity at the 10 float theta levels that are used in calibration considering profiles from 2 to 100. The small figure shows all cycles.

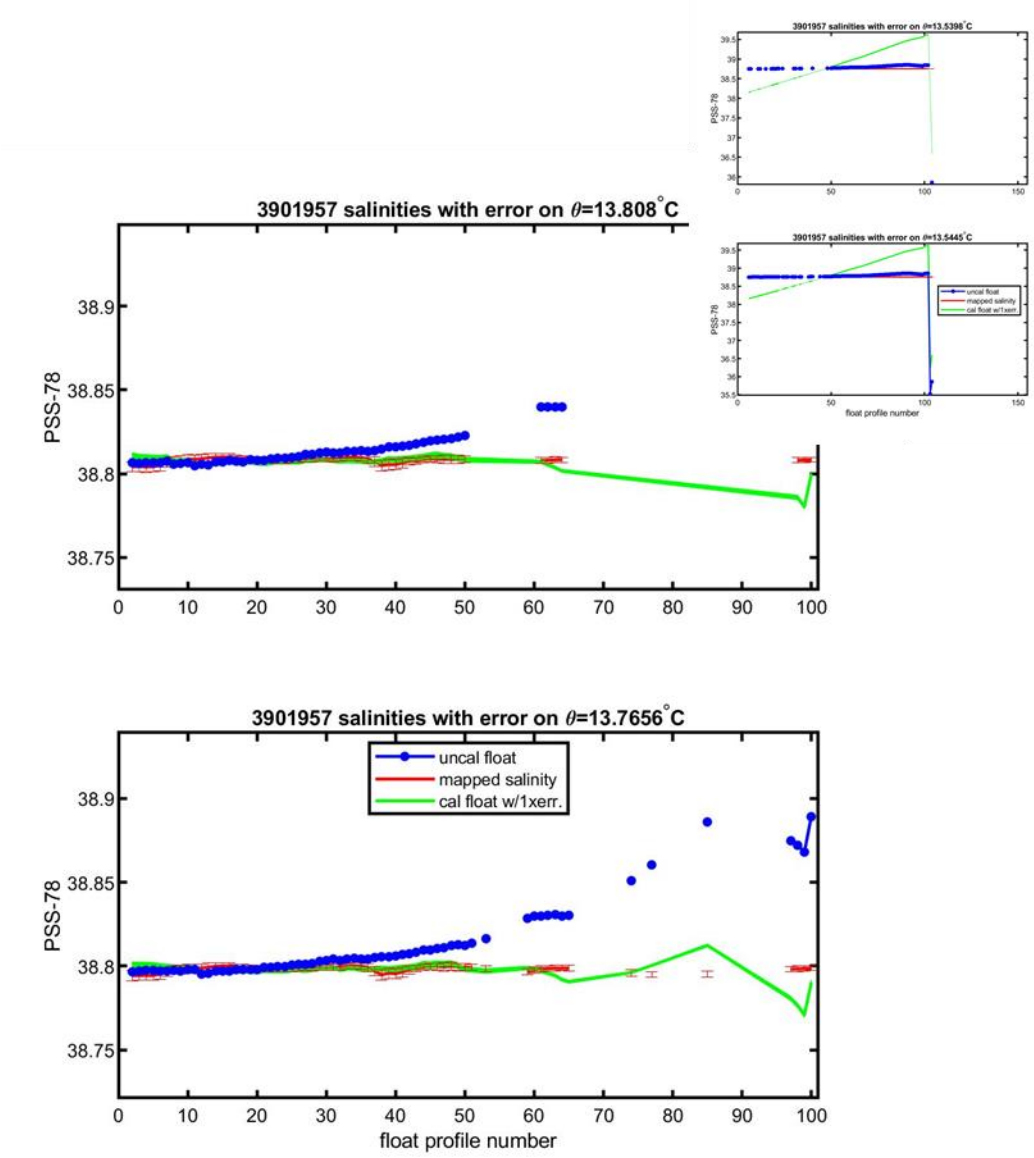

Figure 14: Argo float WMO 3901957. Plots of the evolution of salinity with time along with selected theta levels with minimum salinity variance considering profiles from 2 to 100. The small figure shows all cycles.

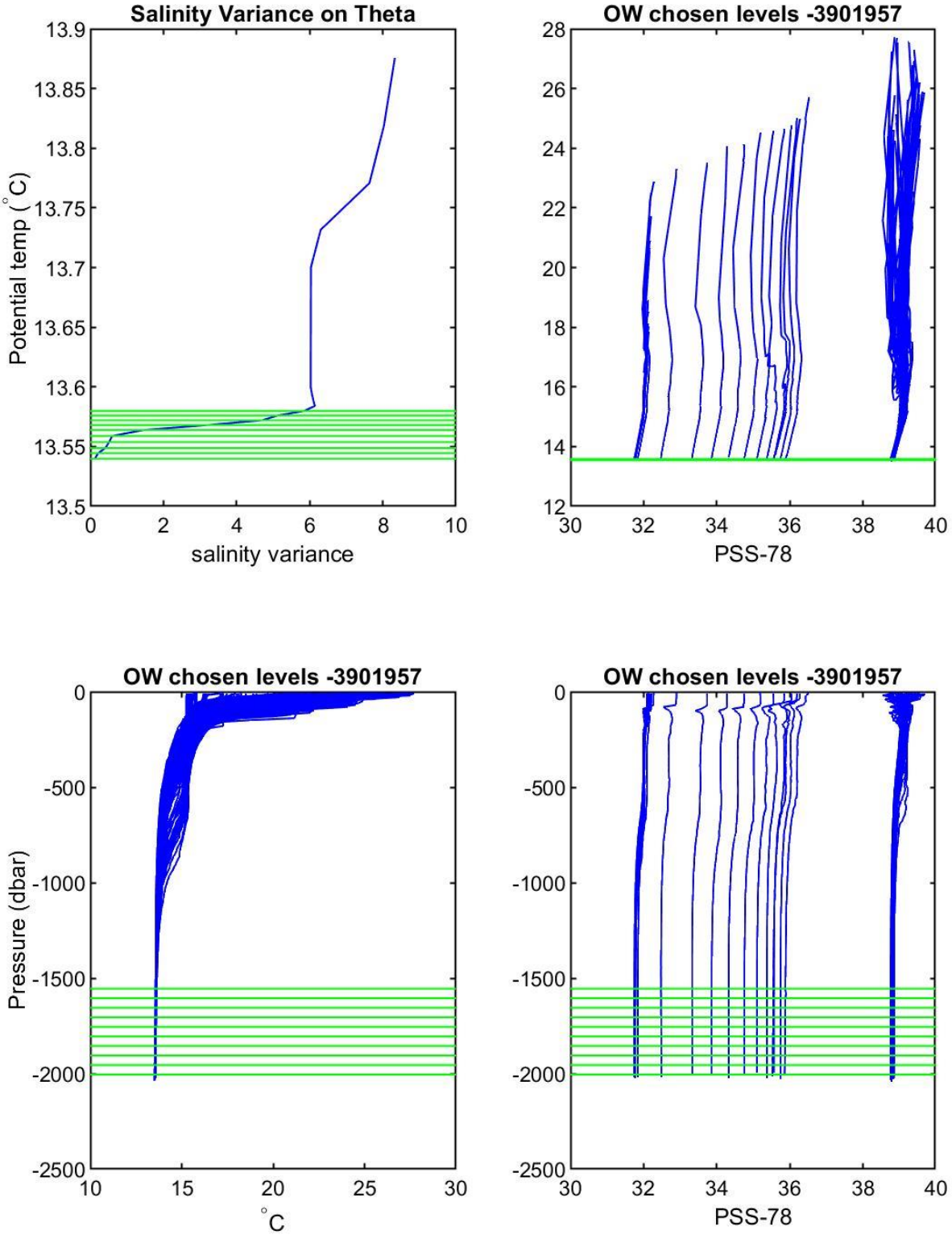

Figure 15: Argo float WMO 3901957. Plots include the theta levels chosen for calibration: Top left: Salinity variance at theta levels. Top right: T/S diagram of all profiles of Argo float. Bottom left: potential temperature plotted against pressure. Bottom right: salinity plotted against pressure.

The analysis of the θ-S diagram of profile segments deeper than 700 dbar (Figure 16) shows that the OW method was run where the θ-S relationship is the tightest.

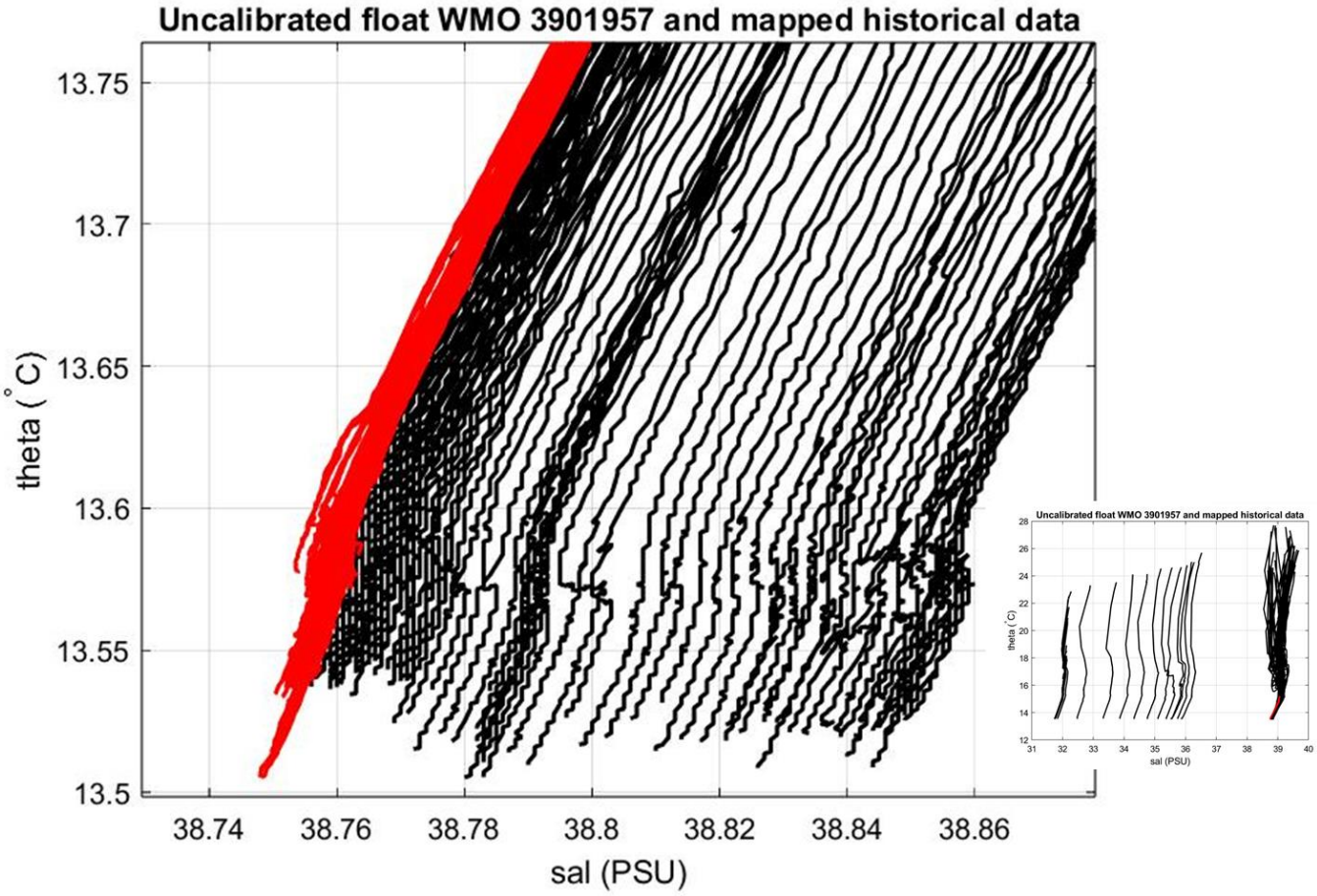

Figure 16: Argo float WMO 3901957. Uncalibrated float salinity profile (black lines) and mapped historical data (red lines) in the most uniform part of the θ-S curve.

4 Summary

Float was deployed in the Ionian sub-basin, in the Mediterranean Sea. The most favorable water masses for DMQC purposes (which exhibits a uniform θ-S relationship and are useful for comparison with climatology) are waters deeper than 700 m. This float was not DMQC-ed before. The visual comparison between Argo float and reference data shows a significant salinity drift.

The OWC analysis shows a significant salinity drift. The figures in this report refer to cycles 2 to 100 to allow for readable graphs. Figure 12 reveals that the least square fit from OWC is quite reliable. The correction proposed by OWC suggests that the sensor started to drift at cycle 2 with a correction a little bit larger than the Argo requested accuracy (0.01) until cycle 50. After cycle 50 the so-called abrupt salinity drift (ASD) began, with accelerated drift rate. Therefore, salinity data from cycles 2 to 50 are adjustable, but are bad and unadjustable from cycle 51 onward. After several analyses, it was decided that the salinity data of float WMO 3901957 need a delayed mode correction for profiles from 1 to 50. QC 1 is applied. No correction is applied for cycles from 51 to 154 with QC=4.

PSAL_ADJUSTED=PSAL+ ΔS from cycle 1 to 50

PSAL_ADJUSTED=PSAL from cycle 51 to 154

The quality flags applied are the following:

PSAL_ADJUSTED_QC='1' from cycle 1 to 50

PSAL_ADJUSTED_QC='4' from cycle 51 to 154

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