



Assessment of temperature and salinity data obtained from in-situ platforms in the Mediterranean Sea

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1. INTRODUCTION

MyOcean is the implementation project of the GMES Marine Core Service, aiming at deploying the first concerted and integrated pan-European capacity for Ocean Monitoring and Forecasting (<http://www.myocean.eu.org>). The project objective is to analyze, forecast and observe the oceans at global and regional (European Seas) scales in order to provide a monitoring service for marine environment and security.

The MyOcean Service aims to provide the best data available on the global ocean and regional seas related to temperature, salinity, currents, ice extent, sea level and biogeochemical properties. There are several fields of applications related to marine safety, marine resources, climate and seasonal forecasting as well as marine and coastal environment.

As part of Work Package (WP) 15, the scientific and technical validation of In Situ-TAC (Technical Assembly Centres) products in delayed mode (DM) is periodically scheduled in order to assure an excellent quality of data. This scientific document describes the method developed at the Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS) in order to perform the DM quality assessment of the physical variables (temperature and salinity) in the Mediterranean Sea, collected with moorings, profiling floats, gliders and vessels. The procedure follows the specifications contained in the Validation Plan (2010) and is also based on the validation procedure described in Von Schuckmann (2010).

The DM validation procedure is part of the fundamental functions (summarized in Figure 1) implemented by the In-Situ TAC component within the MyOcean project - WP 15.

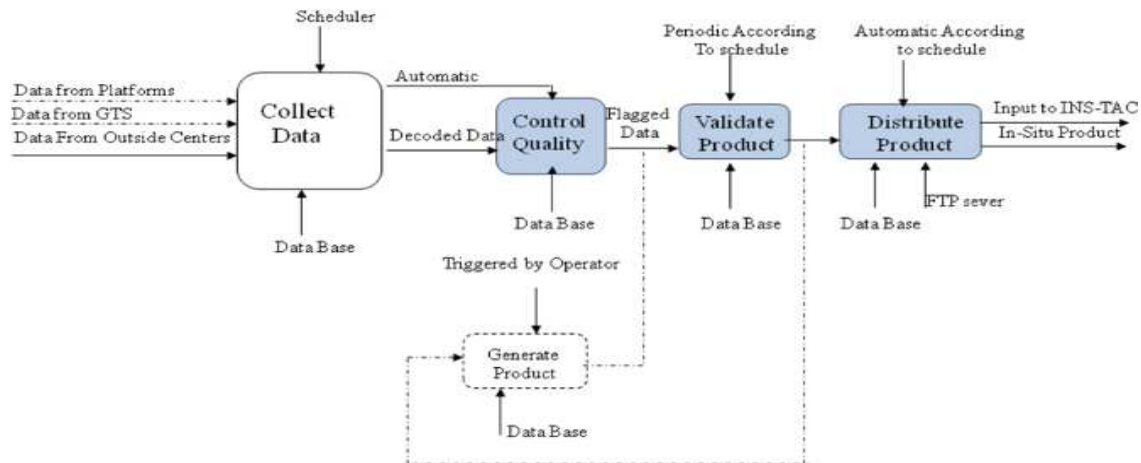


Figure 1. Functions implemented by the In-Situ Tac component.

2. METHODOLOGY

OGS is in charge of the DM validation of the physical variables (temperature and salinity) in the Mediterranean Sea collected with in-situ platforms belonging to several European research institutes. In Figure 2 a schematic view of the entire process of the validation is shown. The NetCDF real-time (RT) monthly files stored in the Mediterranean server at HCMR are the input of the assessment procedure. The total amount of data is quite large: as an example, Figure 3 shows that, between January 2010 and March 2011, the amount of measurements is about 135000. The Mediterranean coverage is quite good: the data are well spatially distributed with some exceptions in the southern Ionian and in the Levantine sub-basins.

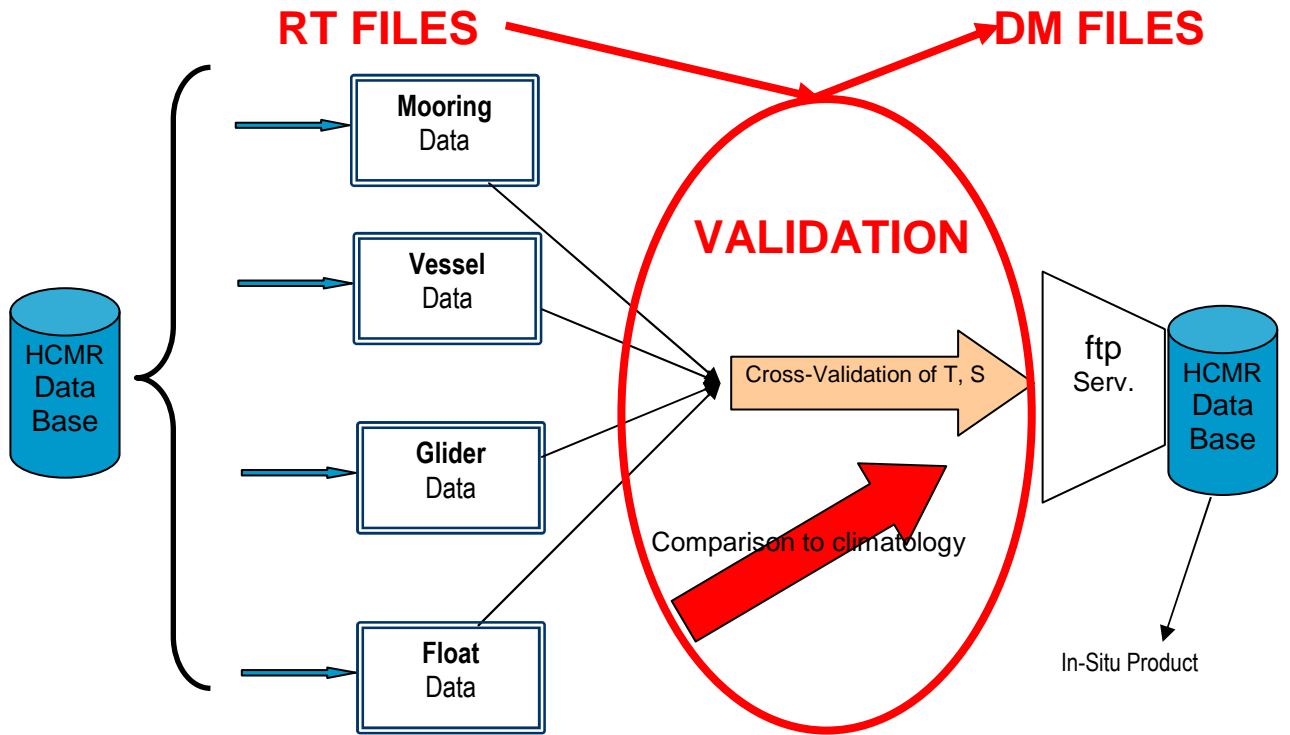


Figure 2. schematic view of the validation process.

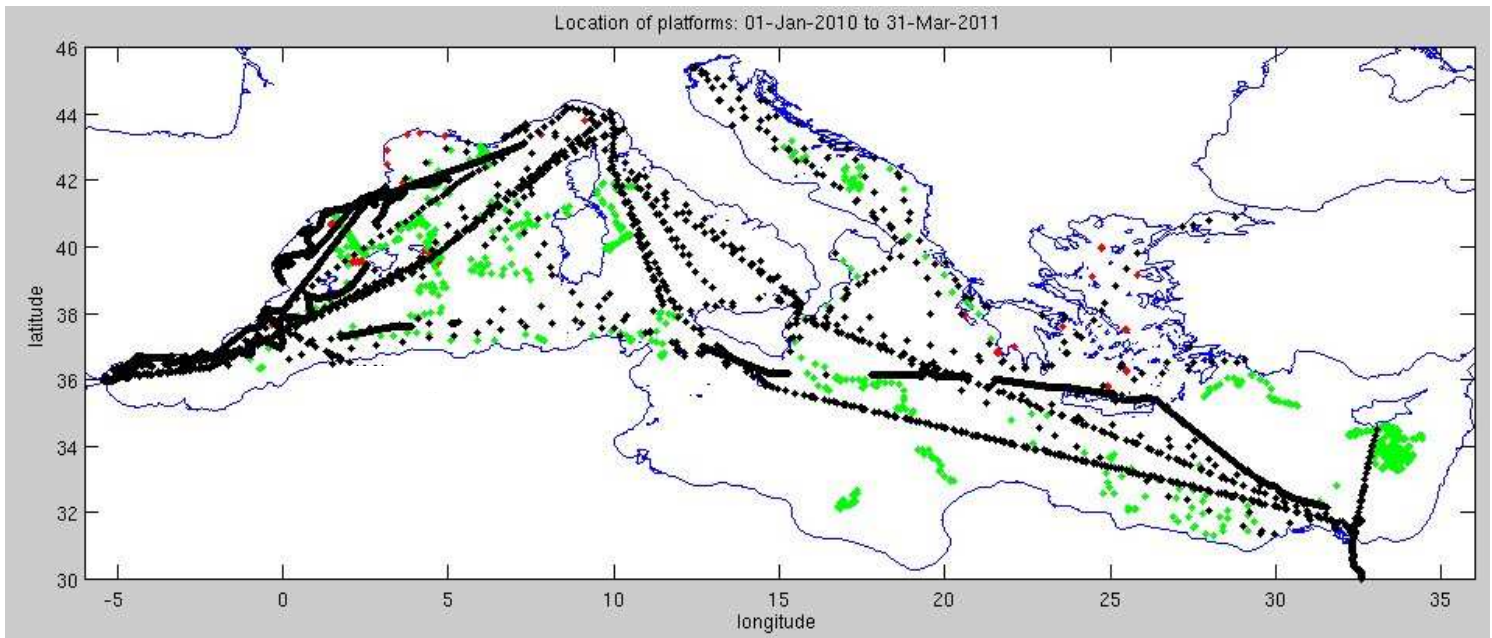


Figure 3. Platform locations in the Mediterranean Sea. Red points refer to moorings, black to vessel data and float locations are depicted in green.

In particular, we implemented a method that combines a comparison to a climatology and among the nearest platforms (cross-validation).

The target is to analyze the differences as a function of the spatial and temporal distances between the measurements: for this purpose, spatial and temporal windows have been set and the consistency check of the measurements is performed within these windows. The comparison is performed in a 2X2 degrees square, between -6° to 36° longitude East and 30° to 46° latitude North. The depth ranges and the vertical resolution adopted are presented in Table 1. The resolution decreases while increasing depth (like the thermohaline variability). The choice of these windows is a compromise: they have to be set large enough to contain a fair amount of reference data; on the contrary, the dimension has to take in account the correlation scales of temperature and salinity.

Depth ranges	Vertical resolution
0-100 m	10 m
100-800 m	25 m
800-2000 m	100 m
2000-4000 m	200 m

Table 1. Depth ranges (left) and the vertical resolution (right) adopted.

The comparison is therefore done in a portion (volume) of the water column and all the RT good data (hence data with the quality control (QC) flag equal to 1, 2, 5, 8) pass through the validation procedure. In the framework of the WP 15, it was decided to perform the validation even if the QC for the pressure data is not done: so, all the pressure data (whatever is the name of the pressure variable) inferred by moorings and vessels and the PRES_ADJUSTED data with QC flag equal to 0 (it means that QC has not been done) are accepted by the validation method.

The cross-validation technique allows to compare data provided by different platforms in a small time window (60 days \rightarrow month to be validated ± 30 days). In this way a reliable consistency check is performed. The limit of this technique could be the scarcity of data and hence the condition to be applied is to have at least 2 different platforms and at least 5 data points.

The MEDAR-MEDATLAS climatology is used to perform the comparison with the in-situ data whenever the cross-validation technique cannot be adopted due to scarcity of data. In this case, a larger time window (years \rightarrow month to be validated minus several years) is adopted. The use of climatology has been introduced in order to check as many files as possible: the comparison with the Medar-Medatlas climatology to perform the validation is maybe not as reliable as the cross-validation method due to the high variability of the Mediterranean thermohaline properties and the scarcity of recent data. Hence, only major spikes and data inconsistencies are detected. But, this part of the validation procedure could be improved using the upcoming and more recent SeaDataNet climatology. The spatial and temporal distribution of the climatological profiles is presented in Figure 4 and 5.

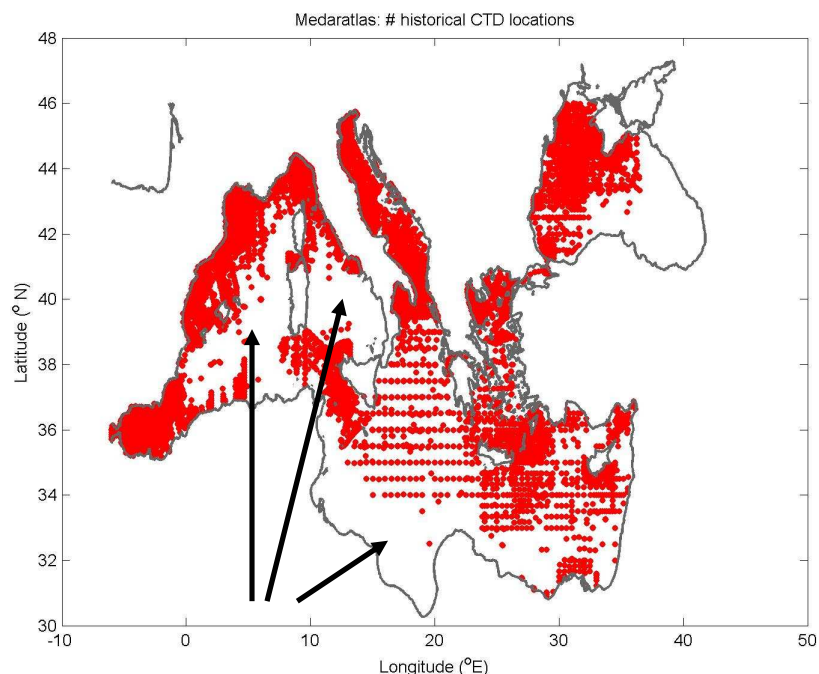


Figure 4. Spatial distribution of the climatological profiles. Black arrows indicate areas with scarcity of data.

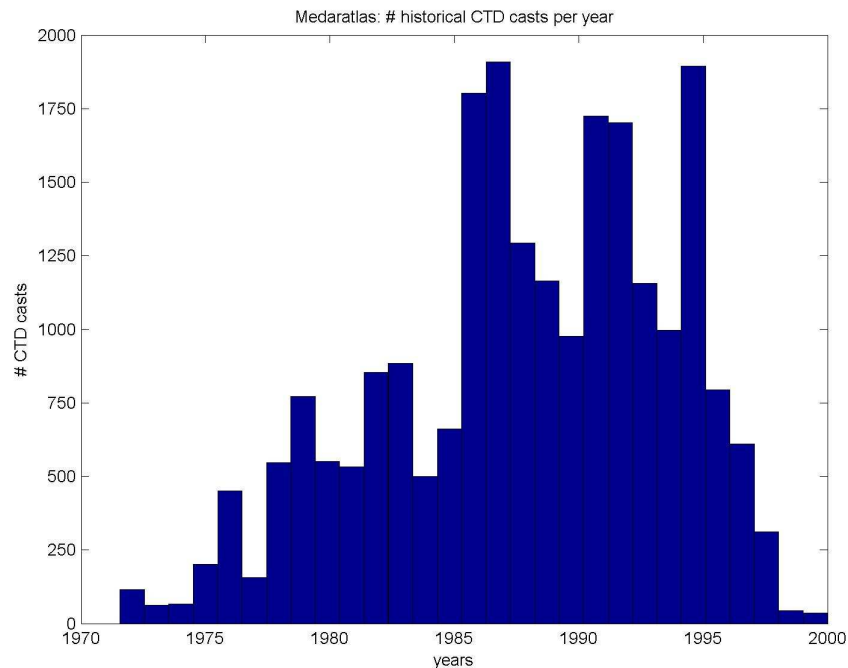


Figure 5. Temporal distribution of the climatological profiles.

The temporal data coverage exhibits two peaks in the years 1987 and 1995 with about 2000 CTD casts per year; the sampling is generally good within this period but before 1986 and after 1995 the number of CTD casts decreases drastically. The spatial coverage is quite good, but the southern Ionian, Tyrrhenian and Algerian seas have not been completely sampled. For this reason we prefer not to interpolate the data in these areas but to use the nearest data of the nearest 2X2 boxes to do the comparison.

The reference data and the data to be assessed are searched into a specific geographical area, time window and water volume. The mean value and standard deviation are computed in each water column portion. Anomalous values are those which are out of the predefined statistical thresholds listed in Table 2.

Depth interval	Range
Surface – 400 meters	5 x standard deviation
400 – 800 meters	4 x standard deviation
800 meters - bottom	3 x standard deviation

Table 2. Depth intervals (left) and respective accepted ranges (right).

A visual QC is performed on all the presumed erroneous data points, which are pointed out by the application of the assessment procedure, before changing the QC flags. Figure 6 is an example that shows an anomalous salinity point detection at 10 m depth.

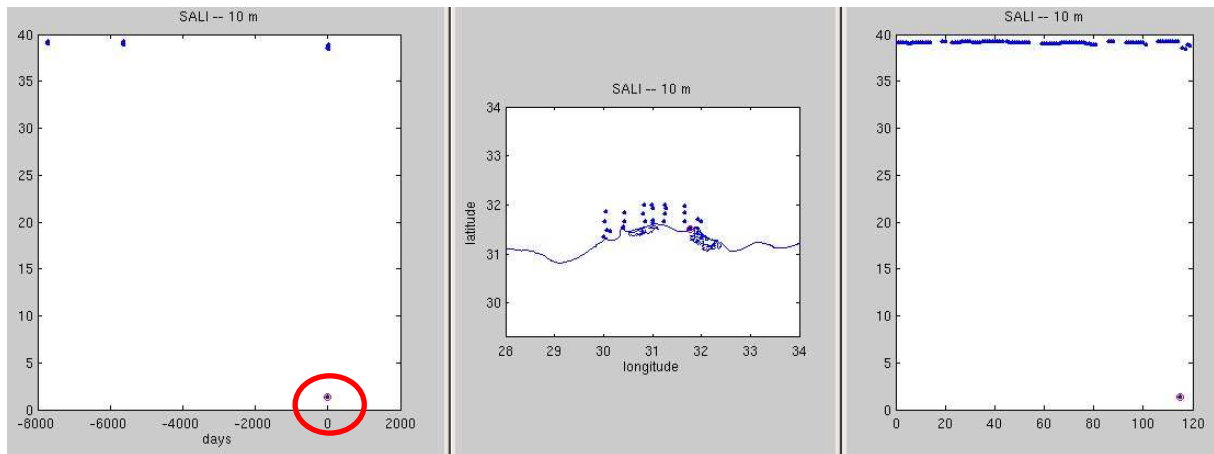


Figure 6. Example of the validation procedure output: salinity data versus time (left panel), geographical locations (central panel) and number of measurements (right panel). Blue points with a red circle refer to presumed erroneous data points.

The salinity data versus time are plotted in the left panel; the geographical locations in the central panel and the number of measurements on the right. The blue point with a red circle (highlighted by a larger red circle) probably refers to the Nile river output and it is flagged out (the QC flag changes from 1 to 4).

In Figure 7, another example shows that the validation procedure detected 4 anomalous salinity data at 200 m depth in the Sicily Channel; these data are compared to climatological profiles older more than 15 years and the operator has to decide whether these points have to be flagged out or not.

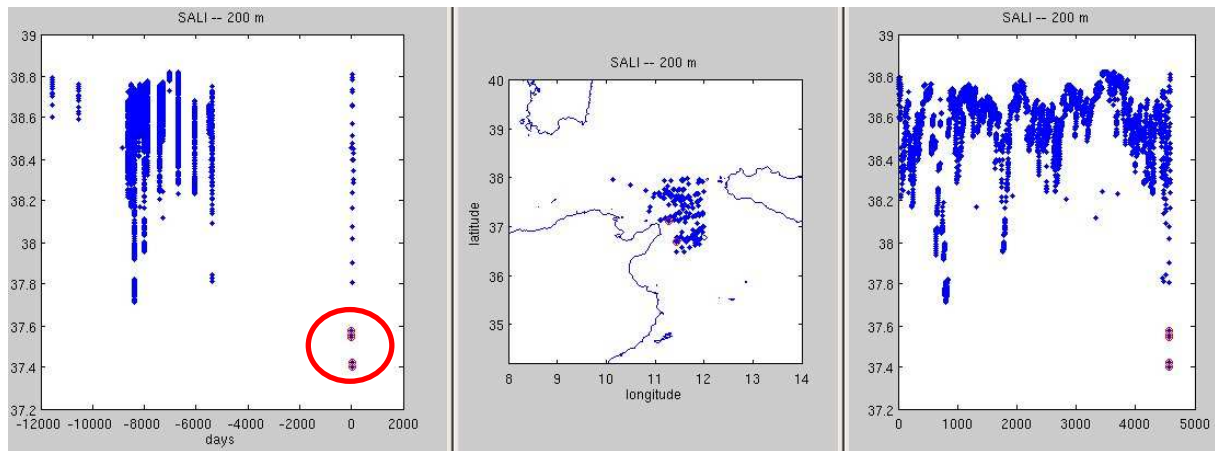


Figure 7. Same as Figure 6.

The final output of the validation procedure is the production of delayed-mode (DM) files. Within the DM files, the QC flags are, in case, changed; the variable data mode is changed to “D”; the variable data mode attribute is changed to “M” or “D”; the global attribute data mode is changed to “M” or “D”. Finally, the DM files overwrite the RT files stored in the HCMR server.

4. SOFTWARE

A briefly description of the software that was developed for the validation purpose is useful to understand the architecture of the validation procedure. The first step consists in downloading (automatically and, in case, manually) the data from the HCMR server: a *perl* script was written in order to make a copy of the remote files (via FTP protocol) on the local server. A *matlab* script named “Validation” is the main function that lists the monthly files to be processed, sets some parameters and starts the validation procedure that calls about 40 *matlab* functions. The NetCDF files are red and only the parts of files that are really needed for the validation are extracted and used: files (or part of them) with bad QC flags and in general not useful for the validation purpose are rejected. The files to be assessed follow the procedure described in this technical report and specific functions are called to perform the “cross-validation” or the comparison to

the climatology. The NetCDF files on the local server are then overwritten including the information about the validation that was performed. Several *ascii* files are produced to list the validation results, the reasons for rejecting the files and the anomalies encountered. The last step consists of uploading the validated files on the HCMR server: another *perl* script copies the NetCDF files from the OGS local server to the remote server (via FTP protocol) in a specific folder named “validation”. The files are then put in the respective platform folders and the HCMR personnel takes care of moving (overwriting) the files in the main directory (/pub/monthly).

REFERENCES

Karina von Schuckmann and Cécile Cabanés (2010): Validation methods of temperature and salinity measurements: Application on global measurements performed at the Coriolis data center.

Scientific Calibration (ScCp) and Validation Plan (ScVP). Calibration report for WP15 InSitu TAC V1 (2010). Technical note.