ITP Program Level III Quality-Control

3 April 2026

1. Quality-control flags

As of 1 January, 2026, final level III data products for the Ice-Tethered Profiler program include data quality-control flags. Quality-control flags are included for both the timeseries and pressure-gridded versions of the level III data (*itpNNN_final_ts.nc* and *itpNNN_final_g.nc*). Level III data in Matlab format (*itpNNNfinal.mat* and *corXXXX.mat*) were created prior to the implementation of quality-control flags and do not contain quality-control flags.

Quality control flags are included for GPS location and for each CTD sensor. The CTD sensors that have quality control flags are: pressure, temperature, conductivity, and salinity, as well as dissolved oxygen if applicable. For each sensor, there is a single quality control flag for each data record (e.g., profile) that applies to all points within that data record. The purpose of this flag is to inform end-users of data that may contain questionable values based on criteria that are described in this document. If necessary, these criteria may be updated in the future. It is up to the user to decide if any or all questionable data are suitable for their purposes.

Five quality-control flag values are used:

flag value	meaning	comment
0	No quality-control is performed	Data presented “as-is”
1	Good data	Passed all quality-control tests
2	Questionable data	May not have fully passed a quality-control test, or other unusual conditions may be present
4	Bad data	Bad or unrealistic data
8	Estimated data	Estimated value; used only for latitude and longitude

The quality-control flag values of 0, 1, 4, and 8 are similar to those used for the Argo program (Wong et al., 2025).

2. GPS location quality-control

A single quality-control flag is used that is applicable to both latitude and longitude. Flags are applied to the full GPS location record, and to GPS locations interpolated to each CTD data record (e.g., profile) using the largest value of the quality-control flag when interpolating.

2.1 Questionable data (flag value 2)

Data are flagged as questionable if 1) the number of satellites (*nsat*) is less than 3 or 2) the horizonal dilution of precision (*hdop*) is greater than 10.

2.2 Estimated data (flag value 8)

Occasionally, the surface package can be pushed beneath the sea ice during an ice ridging event, and it is unable to obtain a GPS location for several months until the sea ice typically melts the following summer. For level III data, we estimate a latitude and longitude in these instances, and a GPS position quality-control flag value of 8 is used.

The metadata may contain further information regarding how the estimate was made. Metadata are included on the ITP program website for each system (as individual text and plots or within a metadata file), and with the metadata documentation for each system archived through NCEI.

3. CTD sensor quality-control

3.1 No quality control performed (flag value 0)

For example, this flag value may be used for oxygen data if no additional quality control is applied.

3.2 Bad data (flag value 4)

A quality-control flag value of four indicates that the entire data record was bad.

For each sensor, a single point or some portion of a data record (e.g., profile) may be bad. In these cases, those bad points are manually removed from a data record and replaced with NaNs; the remaining points within the data record will be subsequently classified and have a sensor quality-control flag of 1 or 2 (good or questionable). Portions of a data record can be bad due to isolated sections of spurious values, or single-point outliers, typically in conductivity or temperature. Any derived variables (e.g. salinity) that are affected by bad values are also converted to NaNs.

3.3 Questionable data (flag value 2)

Level III sensor values are flagged as questionable based on 1) data processing parameter values, 2) a stuck profiler, 3) CTD pump failure, or 4) manual classification. In all cases, salinity is flagged as questionable if either temperature or conductivity values are flagged as questionable.

1. Data processing parameter values:
There are three primary factors affecting the quality of the final temperature and salinity estimates for which four processing parameters are estimated (Johnson et al. 2007): thermistor thermal inertia (*tlag*), conductivity cell - thermistor misalignment (*cshift*), and the cell thermal inertia (*alpha* and *tau*). Biofouling or other unknown conditions are

expected to cause one or more of these parameters to deviate slightly from their nominal value. However, the automated routines can sometimes produce parameter values that are unrealistic or well outside the expected values. Temperature, conductivity, and salinity are flagged as questionable based on whether the relevant processing parameters for that record exceeded plus or minus two standard deviations from their median value over the entire deployment. Temperature is flagged based on outliers in *tlag*, conductivity based on *cshift*, and salinity based on all four (*tlag*, *cshift*, *alpha* and *tau)*. For the level III timeseries data that includes both corrected and adjusted temperature, the temperature quality-control flag is applicable to corrected temperature. The adjusted temperature depends on (*tlag*, *cshift*, *alpha* and *tau)*, which is identical to the quality-control flag for salinity.

For the four processing parameters (*tlag*, *cshift*, *alpha* and *tau*), points outside of plus or minus two standard deviations from the median value over the entire deployment are highlighted in the metadata for each system. Metadata are included on the ITP program website for each system (as individual text and plots or within a metadata file), and with the metadata documentation for each system archived through NCEI.

2. Stuck Profiler:
The profiler can occasionally become stuck on the wire and unable to profile; data records in these cases consist of samples at some constant depth. When this occurs, the parameters used in level III processing may not be possible to calculate, or may have unrealistic values. The sensor data for these data records are reverted to their original (raw) values, and the data record flagged as questionable.

3. CTD pump failure:
If a SBE CTD pump failed, only upward profiles are included in level III data, and all upward profiles are flagged as questionable. Such profiles are retained as they may be suitable for investigating some features such as large-scale properties of the Arctic Ocean. Such profiles would NOT be appropriate for investigating other features, such as fine-scale vertical gradients or the precise depth of the mixed layer base.

4. Manual classification:
Occasionally, additional records can be manually flagged as questionable. This includes cases where the profiler battery is nearing the end of its lifetime and battery voltage has been reduced.

References

Johnson, GC, JM Toole, and NG Larson (2007). Sensor corrections for Sea-Bird SBE-41CP and SBE-41 CTDs, J. Atmos. Oceanic Tech., 24, 1117-1130.

Wong, A., Keeley, R., Carval, T., Argo data management team (2025). Argo Quality Control Manual for CTD and trajectory data. Ifremer. https://doi.org/10.13155/33951