Last updated: 8 Jun, 2001

- 28 Mar, changed lower limit of temperature in Med to 10.0
- 8 Jun: Modified spike and gradient tests according to advice from Yasushi and added inversion test

Argo Real-time Quality Control Test Procedures

Introduction

Because of the requirement for delivering data to users within 24 hours of the float reaching the surface, the quality control procedures on the real-time data are limited and automatic. The test limits are briefly described here. More detail on the tests can be found in IOC Manuals and Guides #22 or at
http://www.meds-sdmm.dfo-mpo.gc.ca/ALPHAPRO/gtspp/qcmans/MG22/guide22_e.htm
Note that some of the test limits used here and the resulting flags are different from what is described in Manuals and Guides #22.

If data from a float fail these tests, certain of the data will not be distributed on the GTS. However, all of the data, including those having failed the tests, should be converted to the appropriate netCDF format are forwarded to the Global Argo Servers.

Presently, the TESAC code form is used to send the float data on the GTS (see http://www.meds-sdmm.dfo-mpo.gc.ca/meds/Prog_Int/J-COMM/J-COMM_e.htm). This code form only handles profile data and reports observations as a function of depth not pressure. It is recommended that the UNESCO routines be used to convert pressure to depth (Algorithms for computation of fundamental properties of seawater, N.P. Fofonoff and R.C. Millard Jr., UNESCO Technical Papers in Marine Science #44, 1983) If the position of a profile is deemed wrong, or the date is deemed wrong, or the platform identification is in error then none of the data should be sent on the GTS. For other failures, only the offending values need be removed from the TESAC message. The appropriate actions to take are noted with each test.

Tests

1. Platform Identification

Every centre handling float data and posting them to the GTS will need to prepare a metadata file for each float and in this is the WMO number that corresponds to each float ptt. There is no reason why, except because of a mistake, that an unknown float ID should appear on the GTS.

Action: If the correspondence between the float ptt cannot be matched to the correct WMO number, none of the data from the profile should be distributed on the GTS.

2. Impossible Date Test

The test requires that the observation date and time from the float be sensible.

Year greater than 1997
Month in range 1 to 12
Day in range expected for month
Hour in range 0 to 23
Minute in range 0 to 59

Action: If any one of the conditions is failed, the date should be flagged as wrong and none of the data from the profile should be distributed on the GTS.

3. Impossible Location Test

The test requires that the observation latitude and longitude from the float be sensible.

Action: If either latitude or longitude fails, the position should be flagged as wrong and none of the data from the float should go out on the GTS.

Latitude in range -90 to 90
Longitude in range -180 to 180

4. Position on Land Test

The test requires that the observation latitude and longitude from the float be located in an ocean. Use can be made of any file that allows an automatic test to see if data are located on land. We suggest use of at least the 5-minute bathymetry file that is generally available. This is commonly called ETOPO5 / TerrainBase and can be downloaded from
http://www.ngdc.noaa.gov/mgg/global/global.html

Action: If the data are cannot be located in an ocean, the position should be flagged as wrong and they should not be distributed on the GTS.

5. Impossible Speed Test

Drift speeds for floats can be generated given the positions and times of the floats when they are at the surface and between profiles. In all cases we would not expect the drift speed to exceed 3 m/s. If it does, it means either a position or time is wrong, or a float is mislabeled. Using the multiple positions that are normally available for a float while at the surface, it is often possible to isolate the one position or time that is in error.

Action: If an acceptable position and time can be used from the available suite, then the data can be sent to the GTS. Otherwise, flag the position, the time, or both as wrong and no data should be sent.

6. Global Range Test

This test applies a gross filter on observed values for temperature and salinity. It needs to accommodate all of the expected extremes encountered in the oceans.

Temperature in range -2.5 to 40.0 degrees C
Salinity in range 0.0 to 41.0 PSU

Action: If a value fails, it should be flagged as wrong and only that value need be removed from distribution on the GTS. If temperature and salinity values at the same depth both fail, both values should be flagged as wrong and values for depth, temperature and salinity should be removed from the TESAC being distributed on the GTS.

7. Regional Global Parameter Test

This test applies to only certain regions of the world where conditions can be further qualified. In this case, specific ranges for observations from the Mediterranean and Red Seas further restrict what are considered sensible values. The Red Sea is defined by the region 10N,40E; 20N,50E; 30N,30E; 10N,40E and the Mediterranean Sea by the region 30N,6W; 30N,40E; 40N,35E; 42N,20E; 50N,15E; 40N,5E; 30N,6W.

Action: Individual values that fail these ranges should be flagged as wrong and removed from the TESAC being distributed on the GTS. If both temperature and salinity values at the same depth both fail, then values for depth, temperature and salinity should be removed from the TESAC being distributed on the GTS.

Red Sea
Temperature in range 21.7 to 40.0
Salinity in range 0.0 to 41.0
Mediterranean Sea
Temperature in range 10.0 to 40
Salinity in range 0.0 to 40.0

8. Pressure Increasing Test
This test requires that the profile has pressures that are monotonically increasing (assuming the pressures are ordered from smallest to largest).

Action: If there is a region of constant pressure, all but the first of a consecutive set of constant pressures should be flagged as wrong. If there is a region where pressure reverses, all of the pressures in the reversed part of the profile should be flagged as wrong. All pressures flagged as wrong and all of the associated temperatures and salinities are removed from the TESAC distributed on the GTS.

9. Spike Test
Differences between sequential measurements, where one measurement is quite different than adjacent ones, is a spike in both size and gradient. The test does not consider the differences in depth, but assumes a sampling that adequately reproduces the temperature and salinity changes with depth. The algorithm is used on both the temperature and salinity profiles.

Test value = $| V2 - (V3 + V1)/2 | - | (V3 - V1) / 2 |$
where V2 is the measurement being tested as a spike, and V1 and V3 are the values above and below.
Temperature: The V2 value is flagged when
the test value exceeds 6.0 degree C. for pressures less than 500 db or
the test value exceeds 2.0 degree C. for pressures greater than or equal to 500 db
Salinity: The V2 value is flagged when
the test value exceeds 0.9 PSU for pressures less than 500 db or
the test value exceeds 0.3 PSU for pressures greater than or equal to 500 db

Action: Values that fail the spike test should be flagged as wrong and are removed from the TESAC distributed on the GTS. If temperature and salinity values at the same depth both fail, they should be flagged as wrong and the values for depth, temperature and salinity should be removed from the TESAC being distributed on the GTS.

10. Top and Bottom Spike Test

This is a special version of the Spike test, which compares the measurements at each end of the profile, to the adjacent measurement. Temperature at the top or bottom should not be different form the adjacent measurement, by more than 1 degrees C. Salinity at the top or bottom should not be different from the adjacent measurement, by more than 0.5 PSU.

Action: Values that fail the test should be flagged as wrong and are removed from the TESAC distributed on the GTS. If temperature and salinity values at the same depth both fail, both values are flagged as wrong and then the values for depth, temperature and salinity should be removed from the TESAC being distributed on the GTS.

11. Gradient Test

This test is failed when the difference between vertically adjacent measurements is too steep. The test does not consider the differences in depth, but assumes a sampling that adequately reproduces the temperature and salinity changes with depth The algorithm is used on both of the temperature and salinity profiles.

Test value = | V2 - (V3 + V1)/2 |
where V2 is the measurement being tested as a spike, and V1 and V3 are the values above and below.
Temperature: The V2 value is flagged when
the test value exceeds 9.0 degree C. for pressures less than 500 db or
the test value exceeds 3.0 degree C. for pressures greater than or equal to 500 db
Salinity: The V2 value is flagged when
the test value exceeds 1.5 PSU for pressures less than 500 db or
the test value exceeds 0.5 PSU for pressures greater than or equal to 500 db

Action: Values that fail the test (i.e. value V2) should be flagged as wrong and are removed from the TESAC distributed on the GTS. If temperature and salinity values at the same depth both fail, both should be flagged as wrong and then values for depth, temperature and salinity should be removed from the TESAC being distributed on the GTS.

12. Digit Rollover Test
Only so many bits are allowed to store temperature and salinity values in a profiling float. This range is not always large enough to accommodate conditions that are encountered in the ocean. When the range is exceeded, stored values rollover to the lower end of the range. This rollover should be detected and compensated for when profiles are constructed from the data stream from the float. This test is used to be sure the rollover was properly detected.

Temperature difference between adjacent depths > 10 degrees C
Salinity difference between adjacent depths > 5 PSU

Action: Values that fail the test should be flagged as wrong and are removed from the TESAC distributed on the GTS. If temperature and salinity values at the same depth both fail, both values should be flagged as wrong and then values for depth, temperature and salinity should be removed from the TESAC distributed on the GTS.

13. Stuck Value Test
This test looks for all measurements of temperature or salinity in a profile being identical.

Action: If this occurs, all of the values of the affected variable should be flagged as wrong and are removed from the TESAC distributed on the GTS. If temperature and salinity are affected, all observed values are flagged as wrong and no report from this float should be sent to the GTS.

14. Density Inversion
This test uses values for temperature and salinity at the same pressure level and computes the density. The algorithm published in UNESCO Technical Papers in Marine Science #44, 1983 (referred to earlier) should be used. Densities are compared at consecutive levels in a profile.

Action: If the density calculated at the greater pressure is less than that calculated at the lesser pressure, both the temperature and salinity values should be flagged as wrong. Consequently, the values for depth, temperature and salinity at this pressure level should be removed from the TESAC distributed on the GTS.