IMPLEMENTATION OF PROPOSED IODE QUALITY FLAG SCHEME FOR QUALITY CONTROL OF CTD OCEAN PROFILE DATA AT RAN HYDROGRAPHY AND METOC BRANCH

Greg Reed, Deputy Director, Ocean Data Services, RAN Hydrography and Metoc Branch

1  INTRODUCTION

The quality control flagging scheme described follows the 2-level QC flag scheme proposed by IODE (IODE, 2012). In this scheme the Level 1 flag is the primary level QC flag. Level 2 flags are secondary level indicating results of specified QC tests. The example given here of the Level 2 flags use numerical code i.e. 0 (passed), 1 (failed) or 2 (unknown) to indicate test status of a specified test.

A netCDF file has been generated that contains a set of global attributes sufficient to generate a metadata record in ISO-19115/19139-MCP format. For this purpose attribute names recommended by the NetCDF Attribute Convention for Dataset Discovery (NACDD) (Unidata, 2012) are used.

Global attributes specific to the CTD instrument have been used and technical data such as data parameters, cruise number, serial no, scan rate, cast direction, etc. The data parameter names used come from the CF standard names list (NetCDF Climate and Forecast Metadata Convention, 2012a).

2  HS DEPLOYABLE CTD

The CTD temperature sensor is calibrated on the ITS-90 temperature scale against a master CTD using a controlled temperature bath. The pressure sensor is calibrated using a Druck Pressure Calibrator. The conductivity sensor is calibrated in a temperature controlled bath against seawater samples of known conductivity.

The deployable CTD is fitted within an inductive type conductivity cell, a platinum thermometer and silicon pressure sensor. It is lowered and raised by a hand winch sampling at a rate of 1.83 Hz. Data files are recorded in the downcast and upcast direction but most data is from downcasts due to higher quality. The raw CTD data contains a non-monotonic sequence of pressures due to up/down motion of ship/winch. A sequence of unique monotonic pressures up to the maximum value is extracted and then linearly interpolated to 1 decibar pressure levels with the corresponding interpolated temperature and salinity. Data is then flagged with quality control flags after visual inspection and comparison to average climatology and historical CTD casts.

3  QUALITY CONTROL

Quality control involves viewing location of the data on a chart, visual inspection of each profile of temperature and salinity and comparison with nearest neighbours and climatology. Quality flags are applied according to the proposed primary level quality flag codes (good, not
evaluated, suspect, bad). Quality flags may apply at the whole profile level or individual pressure levels.

CTD cast positions and times undergo a land and ship speed check. Casts with position on land or unrealistic speed between casts are flagged as failed position or time. Temperature and salinity profiles are then compared against a 3 standard deviation envelope from the CSIRO-Atlas of Regional Seas (CSIRO, 2009). Profiles or segments of profiles with data outside the envelope are flagged as questionable or failed. Profiles are also checked for consistency or doubtful features by comparing with previous/next casts (buddies) and also by comparison with historical CTD casts taken in the same area and season. The raw data file is converted to netCDF before quality control.

A sample processed netCDF CTD data file is listed in Annex 1.

4 REFERENCES


5 ANNEX 1. SAMPLE CTD DATA FILE

The following is a proposed CDL for a netCDF file describing a quality controlled vertical profile of pressure, temperature and salinity collected by a CTD instrument. The proposed IODE quality control flagging scheme has been used. The CDL follows the netCDF CF conventions version 1.6 (NetCDF Climate and Forecast Metadata Convention, 2012b). The CTD data is classed as featureType profile as described in Chapter 9.

```
netcdf 20110818T001140Z_M_HI504BEN {
  dimensions:
    time = 1 ;
    pressure = UNLIMITED ; // (9 currently)
    latitude = 1 ;
    longitude = 1 ;
  variables:
    double time(time) ;
    time:standard_name = "time" ;
    time:units = "days since 1950-01-01 00:00:00Z" ;
    time:axis = "T" ;
    time:valid_min = 0 ;
    time:valid_max = 999999 ;
    byte time_qc_flag ;
    time_qc_flag:long_name = "quality control flag for time (primary Level 1 flag)" ;
    time_qc_flag:quality_control_convention = "Proposed IODE qc scheme March 2012" ;
    time_qc_flag:valid_min = 1 ;
    time_qc_flag:valid_max = 9 ;
    time_qc_flag:flag_values = 1b, 2b, 3b, 4b, 9b ;
    time_qc_flag:flag_meanings = "good not_evaluated_or_unknown suspect bad missing" ;
    double latitude(latitude) ;
    latitude:standard_name = "latitude" ;
    latitude:units = "degrees_north" ;
    latitude:axis = "Y" ;
    latitude:valid_min = -90 ;
    latitude:valid_max = 90 ;
    double longitude(longitude) ;
    longitude:standard_name = "longitude" ;
    longitude:units = "degrees_east" ;
    longitude:axis = "X" ;
    longitude:valid_min = -180 ;
    longitude:valid_max = 180 ;
    byte position_qc_flag ;
    position_qc_flag:long_name = "quality control flag for position (primary Level 1 flag)" ;
    position_qc_flag:quality_control_convention = "Proposed IODE qc scheme March 2012" ;
    position_qc_flag:valid_min = 1 ;
    position_qc_flag:valid_max = 9 ;
    position_qc_flag:flag_values = 1b, 2b, 3b, 4b, 9b ;
    position_qc_flag:flag_meanings = "good not_evaluated_or_unknown suspect bad missing" ;
    double pressure(pressure) ;
    pressure:standard_name = "sea_water_pressure" ;
    pressure:units = "decibars" ;
    pressure:axis = "Z" ;
    pressure:valid_min = 0 ;
    pressure:valid_max = 12000 ;
    pressure:positive = "down" ;
    double temperature(pressure) ;
    temperature:_FillValue = -99.99 ;
    temperature:standard_name = "sea_water_temperature" ;
    temperature:units = "degrees_C" ;
    temperature:valid_min = -2 ;
    temperature:valid_max = 40 ;
    temperature:coordinates = "time latitude longitude pressure" ;
    temperature:ancillary_variables = "temperature_whole_profile_flag temperature_whole_profile_flag qcf" ;
    temperature_sd_test ;
    byte temperature_whole_profile_flag ;
    temperature_whole_profile_flag:long_name = "qc flag for whole temperature profile (primary Level 1 flag)" ;
    temperature_whole_profile_flag:quality_control_convention = "Proposed IODE qc scheme March 2012" ;
  }
```
temperature_whole_profile_flag:valid_min = 1 ;
temperature_whole_profile_flag:valid_max = 9 ;
temperature_whole_profile_flag:flag_values = 1b, 2b, 3b, 4b, 9b ;
temperature_whole_profile_flag:flag_meanings = "good not_evaluated_or_unknown suspect bad missing" ;
byte temperature_qc_flag(pressure) ;
temperature_qc_flag:long_name = "quality control flag for temperature (primary Level 1 flag)" ;
temperature_qc_flag:standard_name = "sea_water_temperature status_flag" ;
temperature_qc_flag:quality_control_convention = "Proposed IODE qc scheme March 2012" ;
temperature_qc_flag:valid_min = 1 ;
temperature_qc_flag:valid_max = 9 ;
temperature_qc_flag:flag_values = 1b, 2b, 3b, 4b, 9b ;
temperature_qc_flag:flag_meanings = "good not_evaluated_or_unknown suspect bad missing" ;
temperature_qc_flag:coordinates = "time latitude longitude pressure" ;
byte temperature_sd_test(pressure) ;
temperature_sd_test:long_name = "qc flag for monthly temperature 3 standard deviation test (secondary Level 2 flag)" ;
temperature_sd_test:quality_control_convention = "Proposed IODE qc scheme March 2012" ;
temperature_sd_test:valid_min = 0 ;
temperature_sd_test:valid_max = 2 ;
temperature_sd_test:flag_values = 0b, 1b, 2b ;
temperature_sd_test:flag_meanings = "passed failed unknown" ;
temperature_sd_test:coordinates = "time latitude longitude pressure" ;
double salinity(pressure) ;
salinity:_FillValue = -99.99 ;
salinity:standard_name = "sea_water_salinity" ;
salinity:units = "psu" ;
salinity:valid_min = 0 ;
salinity:valid_max = 45 ;
salinity:ancillary_variables = "salinity_whole_profile_flag salinity_qc_flag salinity_sd_test" ;
salinity:coordinates = "time latitude longitude pressure" ;
byte salinity_whole_profile_flag ;
salinity_whole_profile_flag:long_name = "qc flag for whole salinity profile (primary Level 1 flag)" ;
salinity_whole_profile_flag:quality_control_convention = "Proposed IODE qc scheme March 2012" ;
salinity_whole_profile_flag:valid_min = 1 ;
salinity_whole_profile_flag:valid_max = 9 ;
salinity_whole_profile_flag:flag_values = 1b, 2b, 3b, 4b, 9b ;
salinity_whole_profile_flag:flag_meanings = "good not_evaluated_or_unknown suspect bad missing" ;
salinity_whole_profile_flag:coordinates = "time latitude longitude pressure" ;
byte salinity_qc_flag(pressure) ;
salinity_qc_flag:long_name = "quality control flag for salinity (primary Level 1 flag)" ;
salinity_qc_flag:standard_name = "sea_water_salinity status_flag" ;
salinity_qc_flag:quality_control_convention = "Proposed IODE qc scheme March 2012" ;
salinity_qc_flag:valid_min = 1 ;
salinity_qc_flag:valid_max = 9 ;
salinity_qc_flag:flag_values = 1b, 2b, 3b, 4b, 9b ;
salinity_qc_flag:flag_meanings = "good not_evaluated_or_unknown suspect bad missing" ;
salinity_qc_flag:coordinates = "time latitude longitude pressure" ;
byte salinity_sd_test(pressure) ;
salinity_sd_test:long_name = "qc flag for monthly salinity 3 standard deviation test (secondary Level 2 flag)" ;
salinity_sd_test:quality_control_convention = "Proposed IODE qc scheme March 2012" ;
salinity_sd_test:valid_min = 0 ;
salinity_sd_test:valid_max = 2 ;
salinity_sd_test:flag_values = 0b, 1b, 2b ;
salinity_sd_test:flag_meanings = "passed failed unknown" ;
salinity_sd_test:coordinates = "time latitude longitude pressure" ;
int profile ;
profile:long_name = "profile identifier" ;
profile:cf_role = "profile_id" ;

// global attributes:
:conventions = "CF-1.6" ;
:featureType = "profile" ;
:cdm_data_type = "Profile" ;

data:

time = 22509.0081018517 ;
time_qc_flag = 1 ;
latitude = -10.5688 ;
longitude = 142.11713 ;
position_qc_flag = 1 ;
pressure = 4, 5, 6, 7, 8, 9, 10, 11, 12 ;
temperature_whole_profile_flag = 1 ;
temperature_qc_flag = 1, 1, 1, 1, 1, 1, 1, 1 ;
temperature_sd_test = 0, 0, 0, 0, 0, 0, 0, 0 ;
salinity_whole_profile_flag = 1 ;
salinity_qc_flag = 1, 1, 1, 1, 1, 1, 1, 1 ;
salinity_sd_test = 0, 0, 0, 0, 0, 0, 0, 0 ;
profile = 123456 ;
}