Building a climatology at Maria Island for QC purpose in the IMOS-Toolbox

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Material

For this study, data gathered by Jeff Dunn in the area of Maria Island have been considered (I believe it involves the historical water samples data collected from 1944 to 2006 + any data set used to build CARS at this location). The NRSMAI_1944_2006.xls data set can be found in Excel format through the IMOS portal (http://imos.aodn.org.au/webportal/) looking at "ANMN National Reference Station – Delayed", "NRSMAI", and then "Historical data" (https://df.arcs.org.au/ARCS/projects/IMOS/public/ANMN/NRS/NRSMAI/HISTORICAL). The dataset provided on request by Jeff Dunn consist in 3 NetCDF files for Temperature, Salinity and Dissolved Oxygen (maria_t.nc, maria_s.nc, maria_o2.nc).

Tools

Matlab R2010b has been used to read, plot, and process the data into a NetCDF climatology file via two scripts : readJeffSampling.m and plotSampling.m.

Study (/QC?)

Geographical study

Data samples have been collected over a large geographical area.

At first sight, it is not obvious that some samples should be rejected because of their location in a very distinct area (river mouth area against offshore area, areas separated by bathymetry or coastline, etc...) than the nominal location of the National Reference Station Maria Island 90m. What can be worrying is the important distance between the nominal NRSMAI site location and some of the samples, and the important depth (even not too far from the nominal location) of some CTD casts (up to 1000m against 90m in a 10km radius).

So an impossible location test and an impossible depth test have been performed in order to take into account only the stations which were collected within a certain radius from the nominal position of the NRSMAI site (Lat = -42.59667; Lon = 148.2333) and a certain maximum depth (nominal depth = 90m).

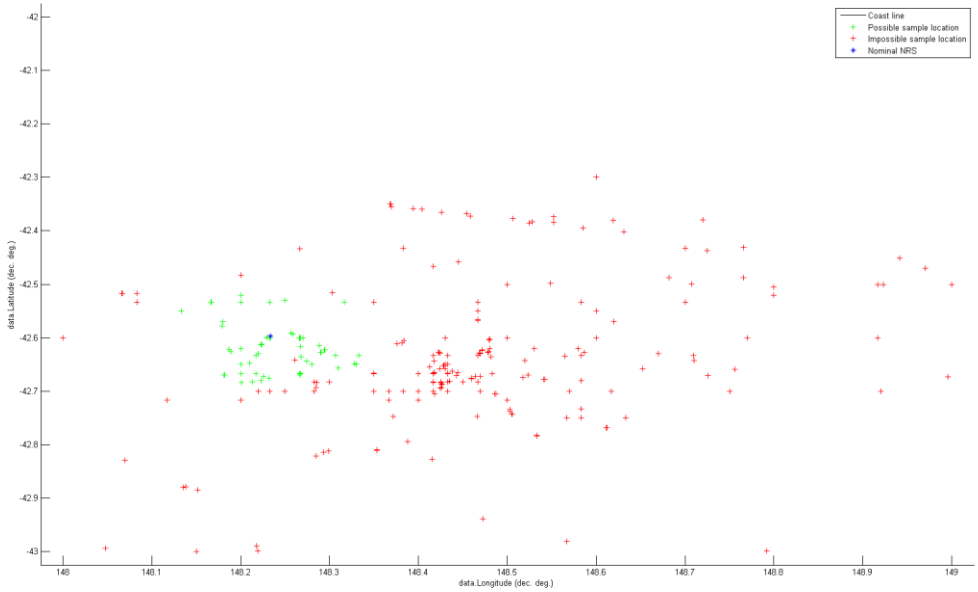


Figure 1 : Samples location

A 10km radius and 200m maximum depth give good results as it keeps only the profiles that occurred in a water column of ~=90m depth, consistent with the nominal NRSMAI site depth. Including more data on a wider radius is taking the risk of introducing inconsistencies due to spatial differences.

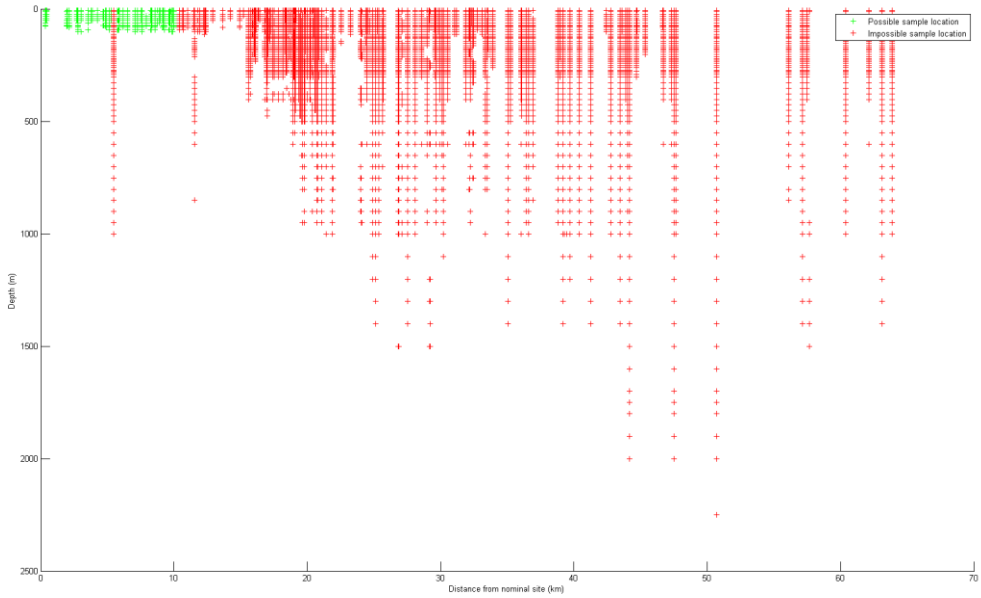


Figure 2 : Samples depth in distance from nominal NRSMAI location

Temporal study

The geographical filtering of samples previously performed still seems to be relevant from the temporal point of view.

Total, 7137 on 12886 samples have been removed (55%). Most of the samples are presents in a radius of 1 to 5km from the nominal NRSMAI site location.

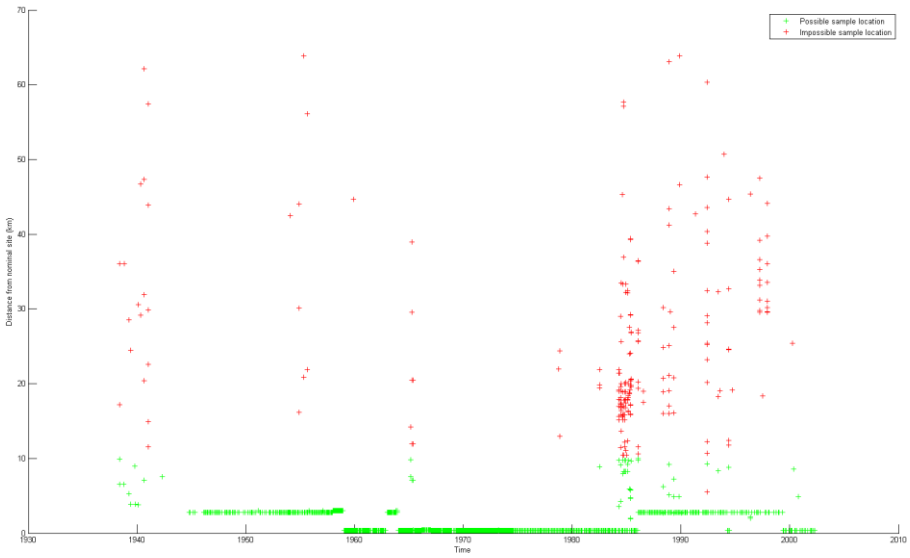


Figure 3 : Samples distance from nominal NRSMAI location in time

Again, considering samples depth in time, we can see that only samples belonging to profiles which occurred in water column depth consistent with the nominal NRSMAI site depth have been kept.

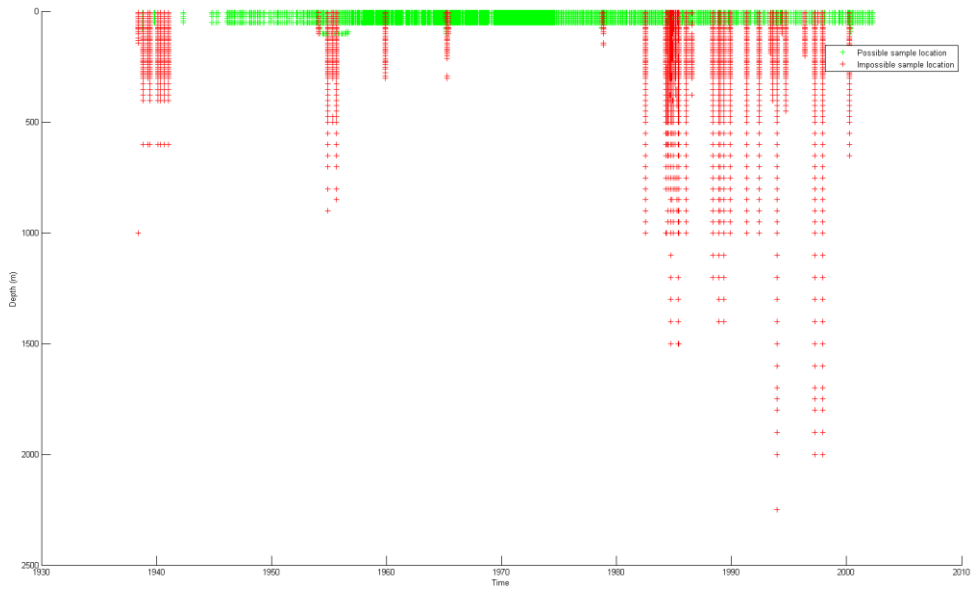


Figure 4 : Samples depth in time

Maria Island National Reference Station has the privilege of having been Temperature and Salinity sampled over 62 years. This would make a perfect candidate to build a climatology from its entire data set, and for Quality Control purpose, if it hasn't been too much affected by climate change.

Considering samples' values at fixed depth (for each profile, the collected data has been vertically interpolated every 10m) and for each variable in time, one might be interested in the linear regression trend.

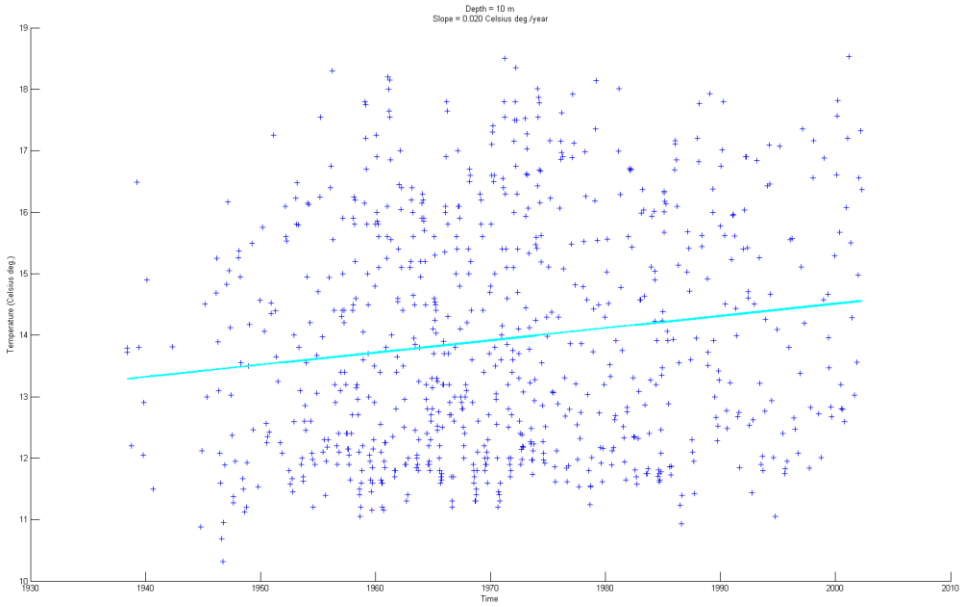


Figure 5 : Samples temperature in time at 10m (profiles' measurements are vertically interpolated)

Depth (m)	Slope (Celsius deg./year)
0	0.021
10	0.020
20	0.020
30	0.018
40	0.016
50	0.016
60	0.028
70	0.026
80	0.027
90	0.036

Table 1 : Temperature trend in time over data set per depth

The warming trend is more important in surface but still lower than the maximums ocean warming trends of +/-0.05 Celsius degrees/year over the past 50 years heralded by ***The Copenhagen Diagnosis***, *2009: Updating the World on the Latest Climate Science.* I. Allison, N.L. Bindoff, R.A. Bindschadler, P.M. Cox, N. de Noblet, M.H. England, J.E. Francis, N. Gruber, A.M. Haywood, D.J. Karoly, G. Kaser, C. Le Quéré, T.M. Lenton, M.E. Mann, B.I. McNeil, A.J. Pitman, S. Rahmstorf, E. Rignot, H.J. Schellnhuber, S.H. Schneider, S.C. Sherwood, R.C.J. Somerville, K. Steffen, E.J. Steig, M. Visbeck, A.J. Weaver. The University of New South Wales Climate Change Research Centre (CCRC), Sydney, Australia, 60pp.

Increasing trends from 60 to 90m is not reliable and certainly due to a lack of data at these depths. Indeed, further in the process of building a climatology for these depths, the output statistics are likely to be non representative of the real distribution.

At this stage no conclusion has been taken as to reduce the data set time period which should be used in building the climatology in order to tamper the effect of climate change on this climatology.

Seasonal study

Considering samples values at all depths and for each variable from a seasonal point of view, one may highlight doubtful samples which need to be removed.

On the overall, the samples show an important seasonal trend while summer/stratified and winter/mixed periods are well rendered.

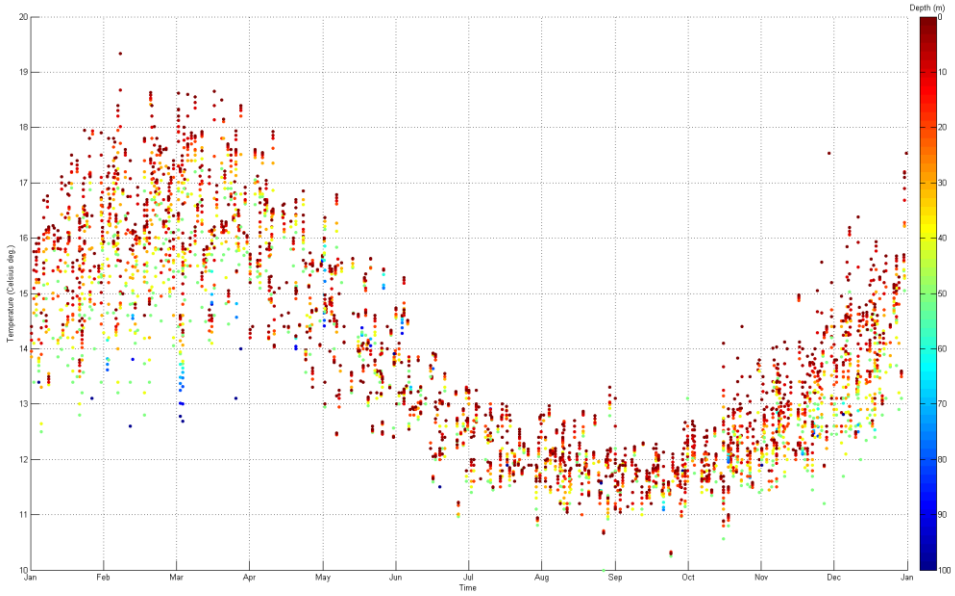


Figure 6: Samples seasonal Temperature with depth as color

Same Quality Control could be performed from seasonal plots depth by depth, or considering the sample distance from the nominal site location instead of its depth. On this latter option, we can see that the profile previously underlined is part of the furthest profiles that have been kept. On the other hand, most of the other as far profiles fit well in the seasonal range.

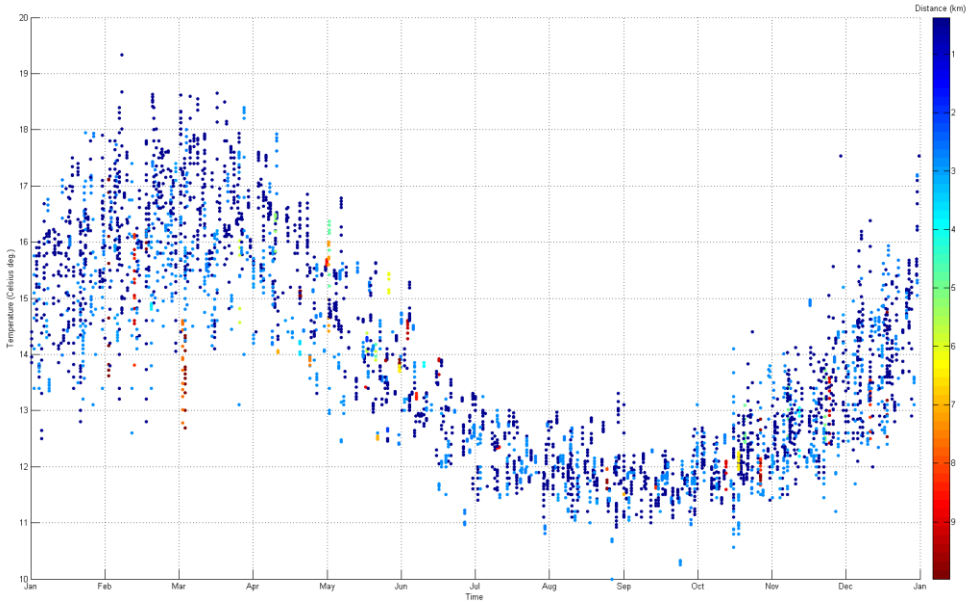


Figure 7 : Samples seasonal Temperature with distance from nominal location as color

At this stage no conclusion has been taken as to withdraw any doubtful sample from the climatology.

TS / TO plots

Temperature against Salinity and Temperature against Dissolved Oxygen plots could help in identifying very distinct water masses that could have been sampled. In the case few identified distinct samples are found then they would be likely to be excluded from the climatology.

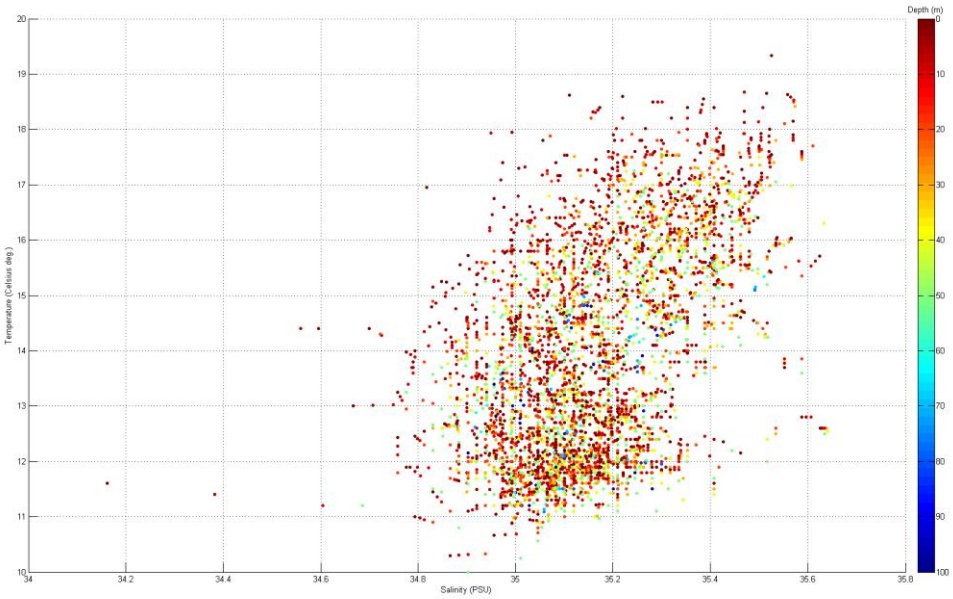


Figure 8 : Samples Temperature / Salinity plot with depth as color

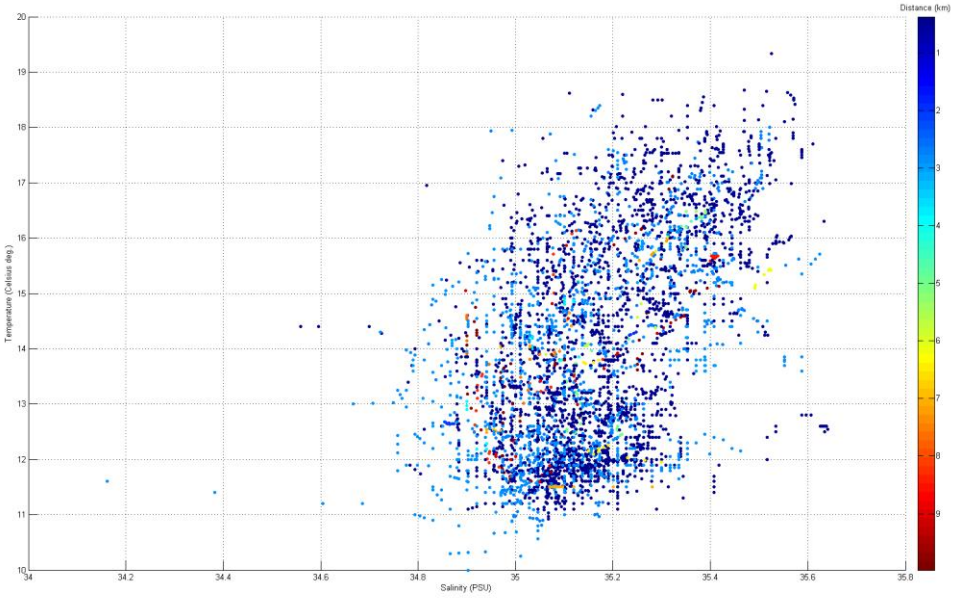


Figure 9 : Samples Temperature / Salinity plot with distance form nominal location as color

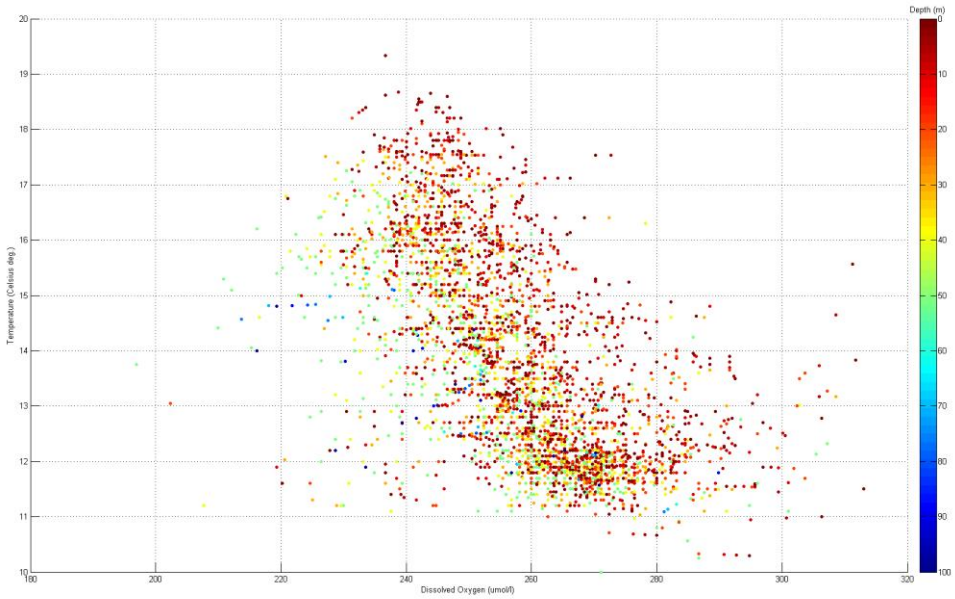


Figure 10 : Samples Temperature / Dissolved Oxygen plot with depth as color

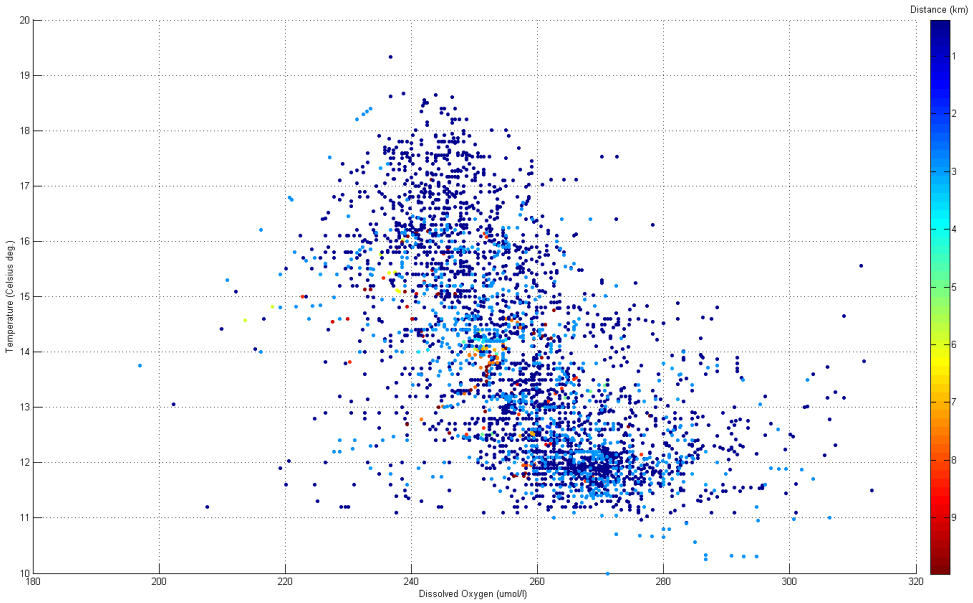


Figure 11 : Samples Temperature / Dissolved Oxygen plot with distance from nominal location as color

At this stage no conclusion has been taken as to withdraw any doubtful sample from the climatology.

Climatology building methodology

Processing the data

For each profile, all measured parameters have been vertically interpolated between 0 and 90m every 10m to have data on a regular vertical grid. Linear interpolation has been used and NaN introduced on outer boundaries when necessary.

Date time information is converted in days of year (values are integers belonging to [0; 365[ ) so that we have seasonal time information.

Then, from a seasonal point of view and for each depth, data has been binned on a bi-weekly basis (bin size = 365/26 ~= 14.04 days) and then mean, median, standard deviation, min, max and n number of samples per bin has been computed.

Given time represents the location in time of the centre of a bin. It has been decided that the first centre of a bin is 1st of January at 00:00am (equivalent seasonal time value = 0).

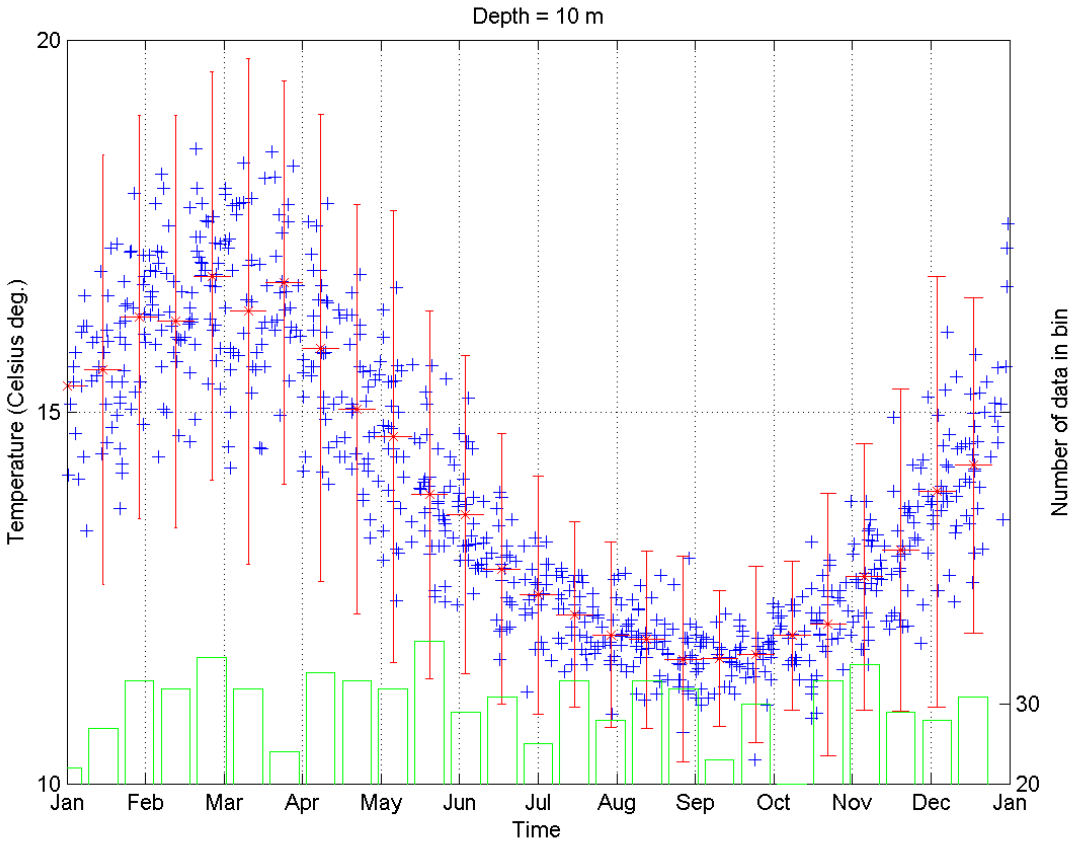


Figure 12 : Temperature binning at depth = 10m

From depth 0m to 50m, we manage to collect between 30 and 20 points per bin which is good enough to properly render the signal.

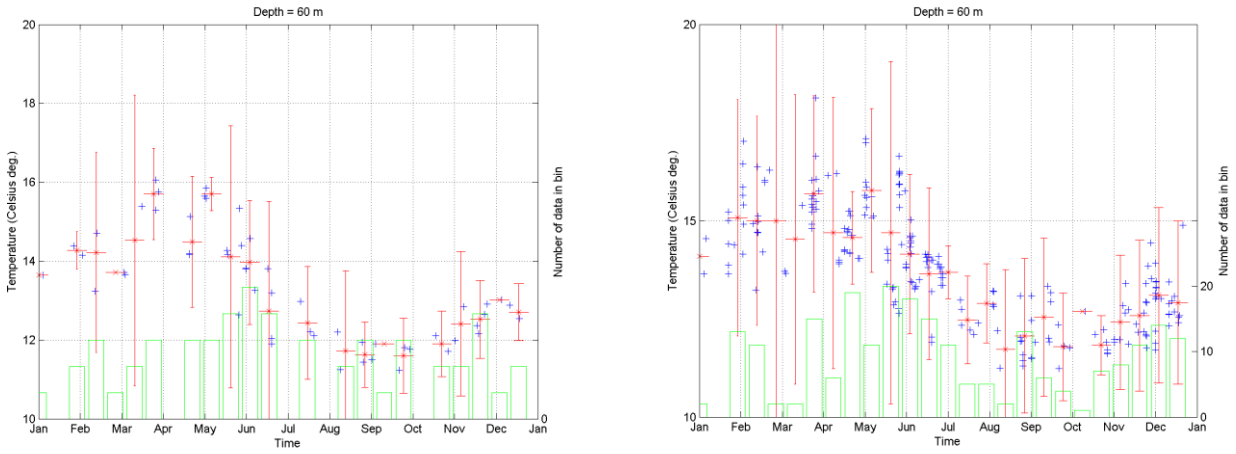
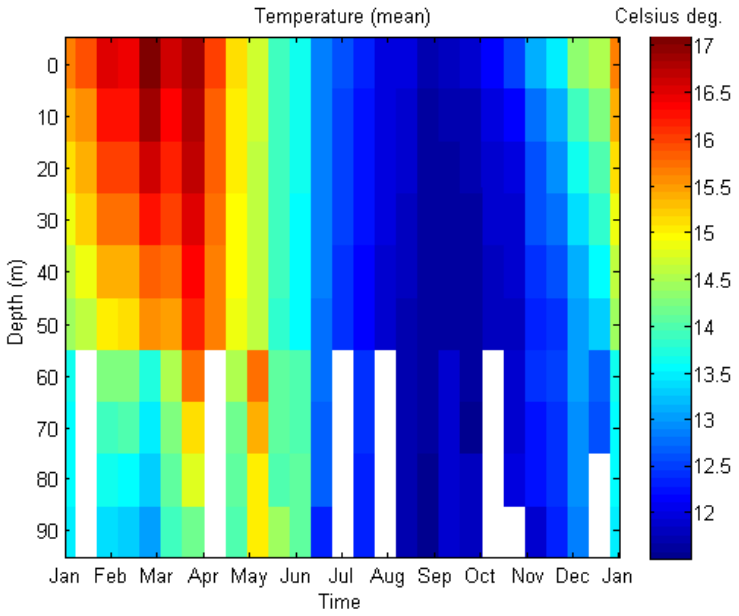


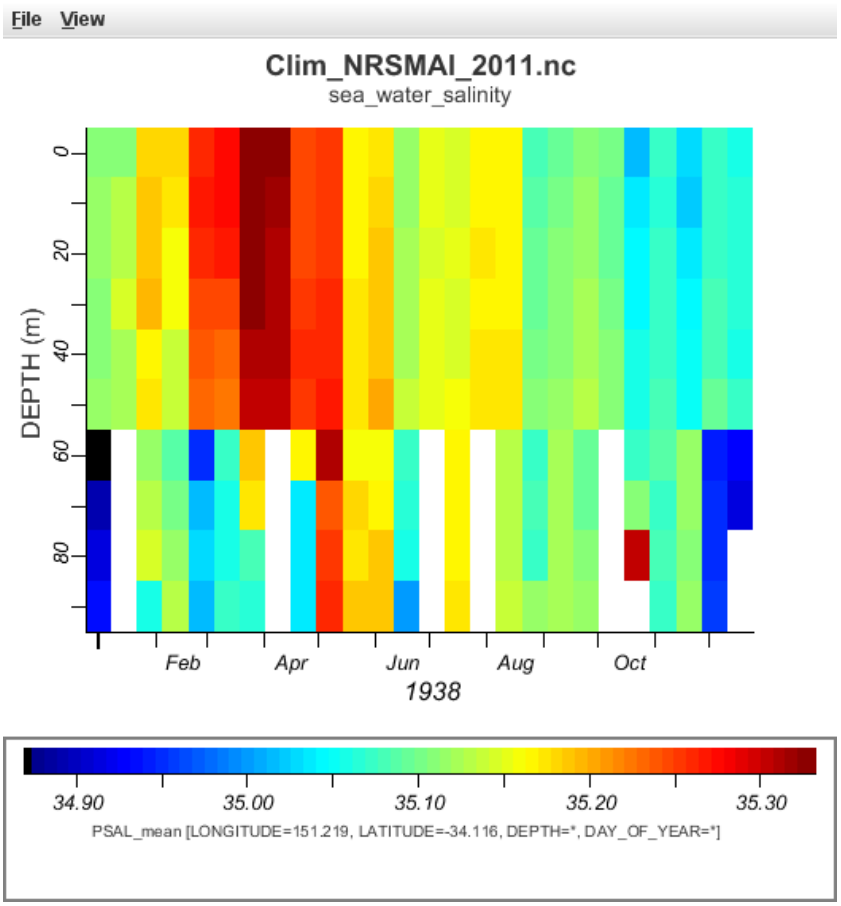
Figure 13 : Temperature binning at depth = 60m; with and without filtering

From 60m to the bottom, the amount of points per bin drops to 0 to 5 and many fortnight bins cannot be computed. Considering far and deep profiles (without filtering) fills some gaps but the output is still far from being reliable (between 0 and 20 points per bin) and the 0 to 50m layer might be badly affected by this less relevant further/deeper data. Using filtered data is still more relevant to me as the enhancement brought by all the data seems little.

Results in the NetCDF file

The NetCDF file format for this climatology file tries to follow as much as possible the IMOS NetCDF user manual. In addition, because the file contains climatological data, it intends to follow the recommendations described in 7.4. Climatological Statistics of the CF conventions version 1.6.




File View
Clim_NRSMAI_2011.nc
sea_water_salinity
DEPTH (m)
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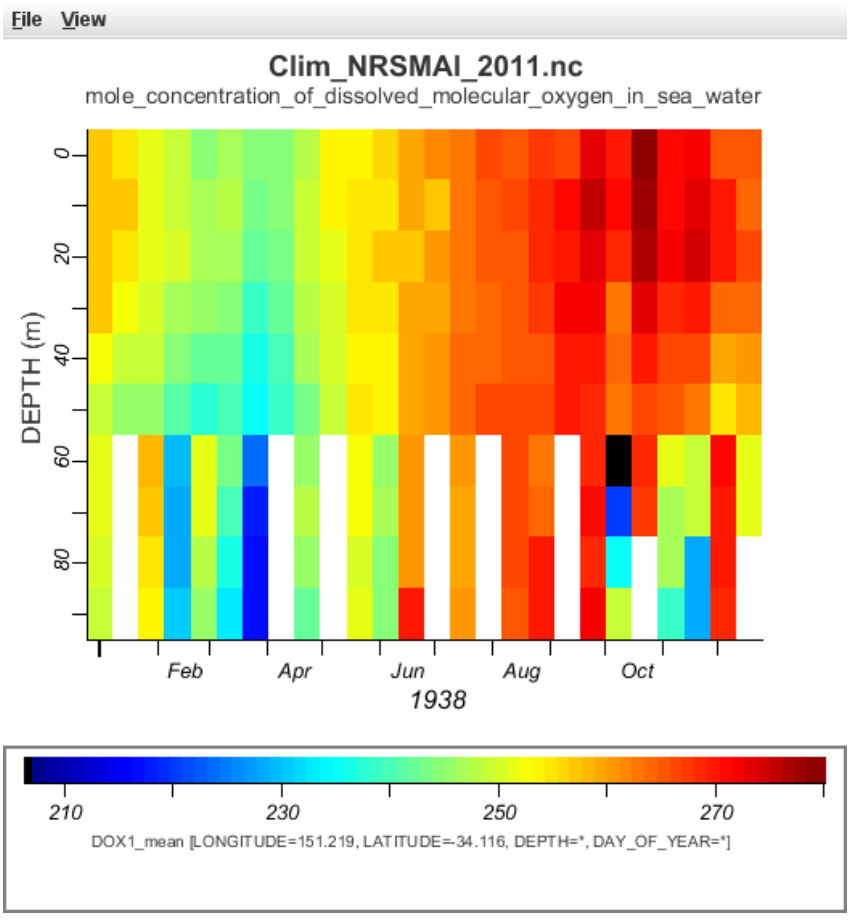
20
40
60
80
Feb
Apr
Jun
Aug
Oct
1938
34.90
35.00
35.10
35.20
35.30
PSAL_mean [LONGITUDE=151.219, LATITUDE=-34.116, DEPTH=*, DAY_OF_YEAR=*]


File View
Clim_NRSMAI_2011.nc
mole_concentration_of_dissolved_molecular_oxygen_in_sea_water
DEPTH (m)
0
20
40
60
80
Feb
Apr
Jun
Aug
Oct
1938
210
230
250
270
DOX1_mean [LONGITUDE=151.219, LATITUDE=-34.116, DEPTH=*, DAY_OF_YEAR=*]