Bio Argo data processing in Australia
ADMT 16

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Ann Gronell Thresher
CSIRO Oceans and Atmosphere Flagship

Cast of thousands:

RT processing:

- Ann Thresher, Dirk Slawinski

DM processing:

- Hugh Doyle*, Luke Wagner, Esmee van Wijk, Dirk Slawinski, Catriona Johnson

PIs:

- Tom Trull, Nick Hardman-Mountford, (Bronte Tilbrook)

Bio floats and sensors deployed to date:

- Aanderaa optode 3830 (DOXY)
- Seabird 63 optode (DOXY)
- Seabird 43F IDO (DOXY)
- CROVER transmissometer (CP650)
- FLBB_AP2 (CHLA, BBP700 and BBP532)
- FLTNU (CHLA, CDOM, BBP700)
- Eco Triplet ((BBP470, BBP532, BBP700)
- SUNA (NITRATE)
- Satlantic OCR-I (UP_RADIANCE412, 443, 490 and 555)
- Satlantic OCR-R (DOWN_IRRADIANCE412, 443, 490 and 555)

Newest float combinations:

- Seabird 63 Optode, FLBB_AP2
- Seabird 63 Optode, FLBB_AP2, SUNA
- Seabird 63 Optode, FLTNU, Eco Triplet, CROVER, OCR-R, OCR-I

There is a significant cost to processing this data, particularly initially

Current status:

- All Bio floats now processed in Real Time
- Bio-Data, including both raw and derived parameters, is delivered to GDACs in format version 3.1 BR files
- Estimate it took at least 1 month of full time effort to decode the data and derive the final parameters
- This does not include the time required to prepare and deploy the floats

Data QC:

- DOXY data and TEMP_DOXY data goes through RT QC procedures but is not calibrated in RT
  - Note that our oxygen data is largely from sensors that have been calibrated at our local calibration unit – all cal coeffs are provided by them, along with a notation of which T sensor was used to do the calibration. This is then used when DOXY is calculated from the raw values.
- Other Bio data is not QCd but final parameters are derived from the raw variables in RT.

DM software development

- A huge effort has been put into this to cope with upgrade to format version 3.1 as well as the increasingly complex Bio data streams.
- This has been done in parallel with development of our DMQC software for PSAL.
- Primary Bio effort initially has been on DOXY DMQC

- Software is based on our Core DM software
- It has been extended to assess DOXY data using the procedure proposed by *Takeshita et al., (2013)*
- We have implemented and evaluated this approach by comparison of the CSIRO Argo oxygen data set to the climatology CARS 2009.

An example

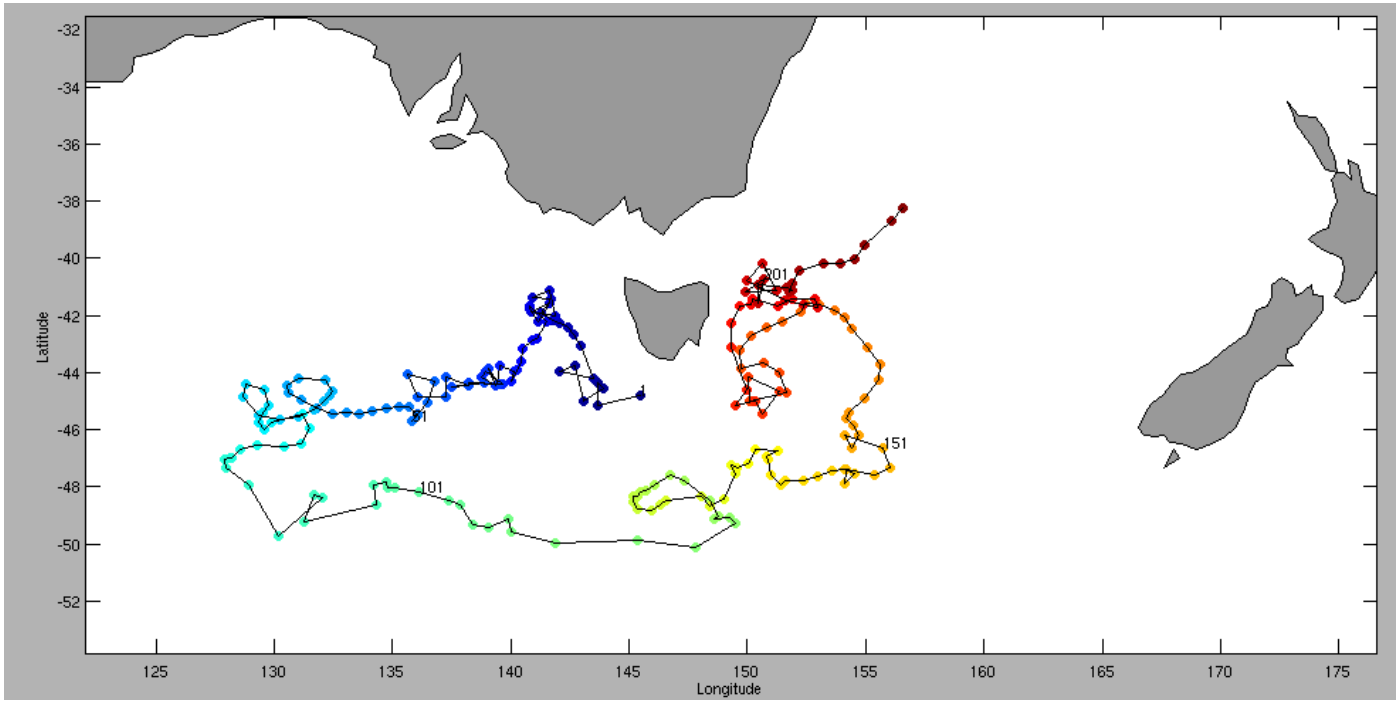


Figure shows cycle positions of the float 5901644. The colour scale represents the age of the float. The first profile is in dark blue while the last profile is in dark red.

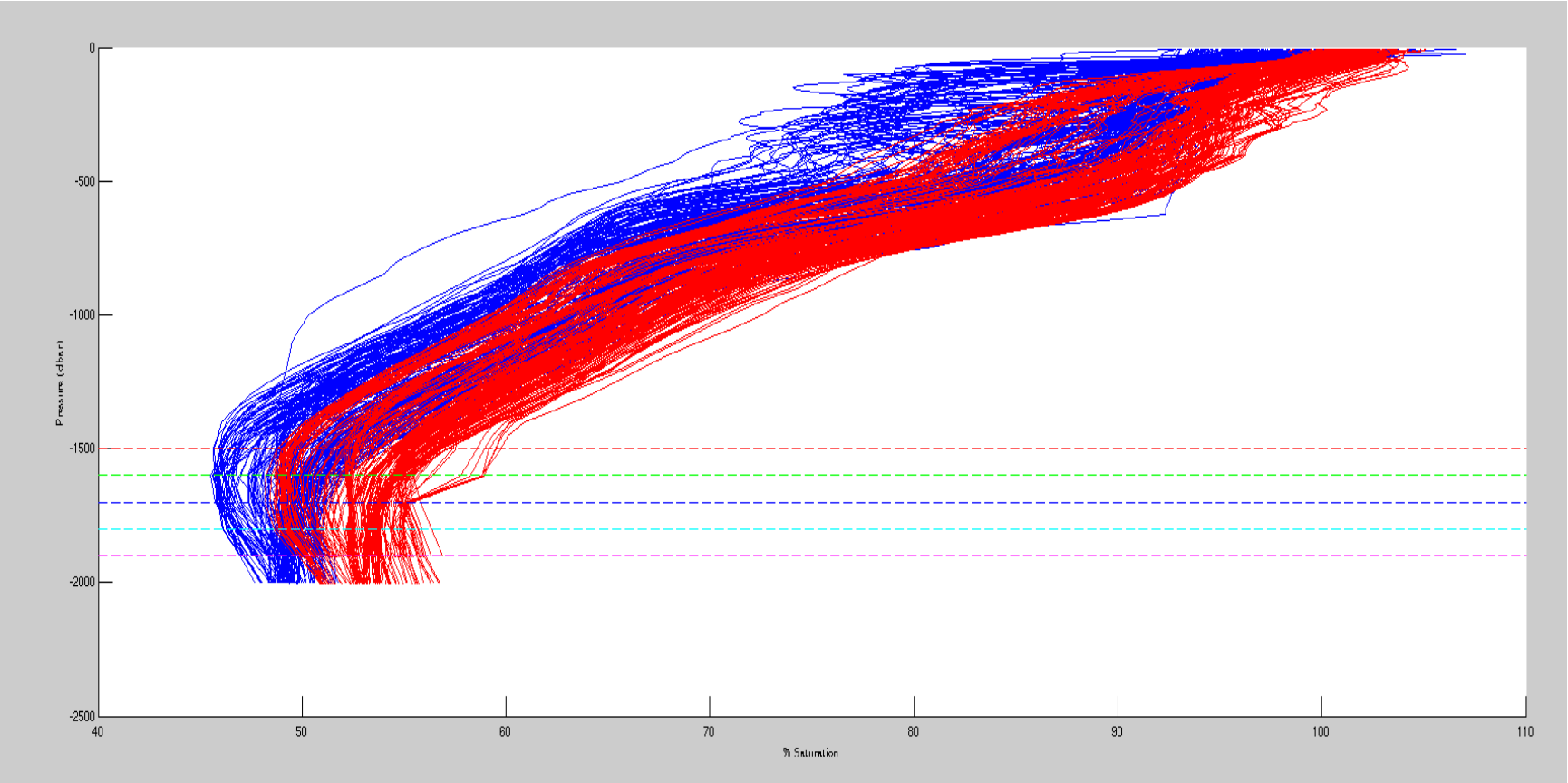


Figure shows oxygen profiles (%Sat) from float in blue compared to CARS 2009 data in red. The vertical structures seem to match relatively well throughout the water column. However, the float data is systematically lower than the climatology.

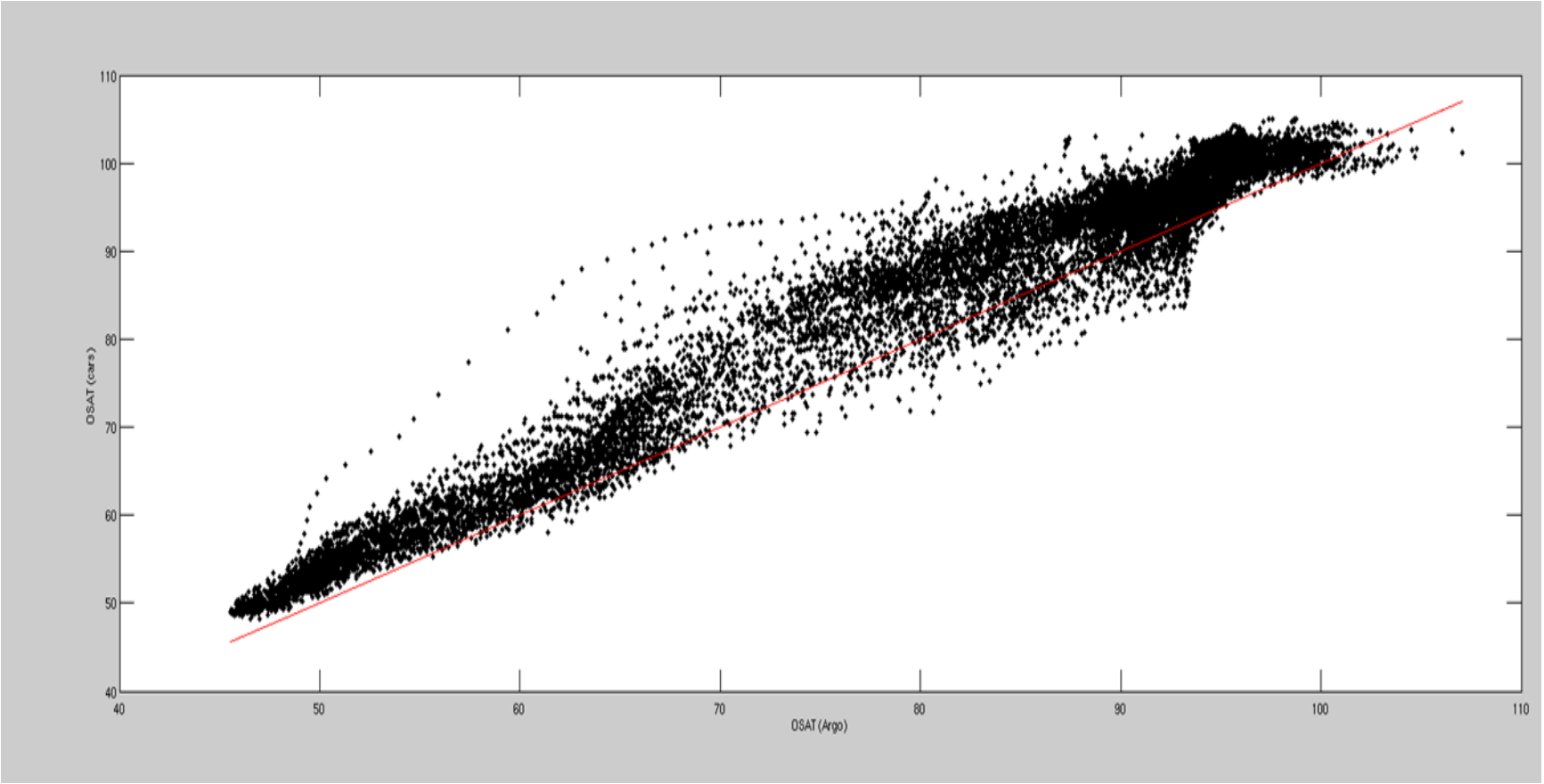
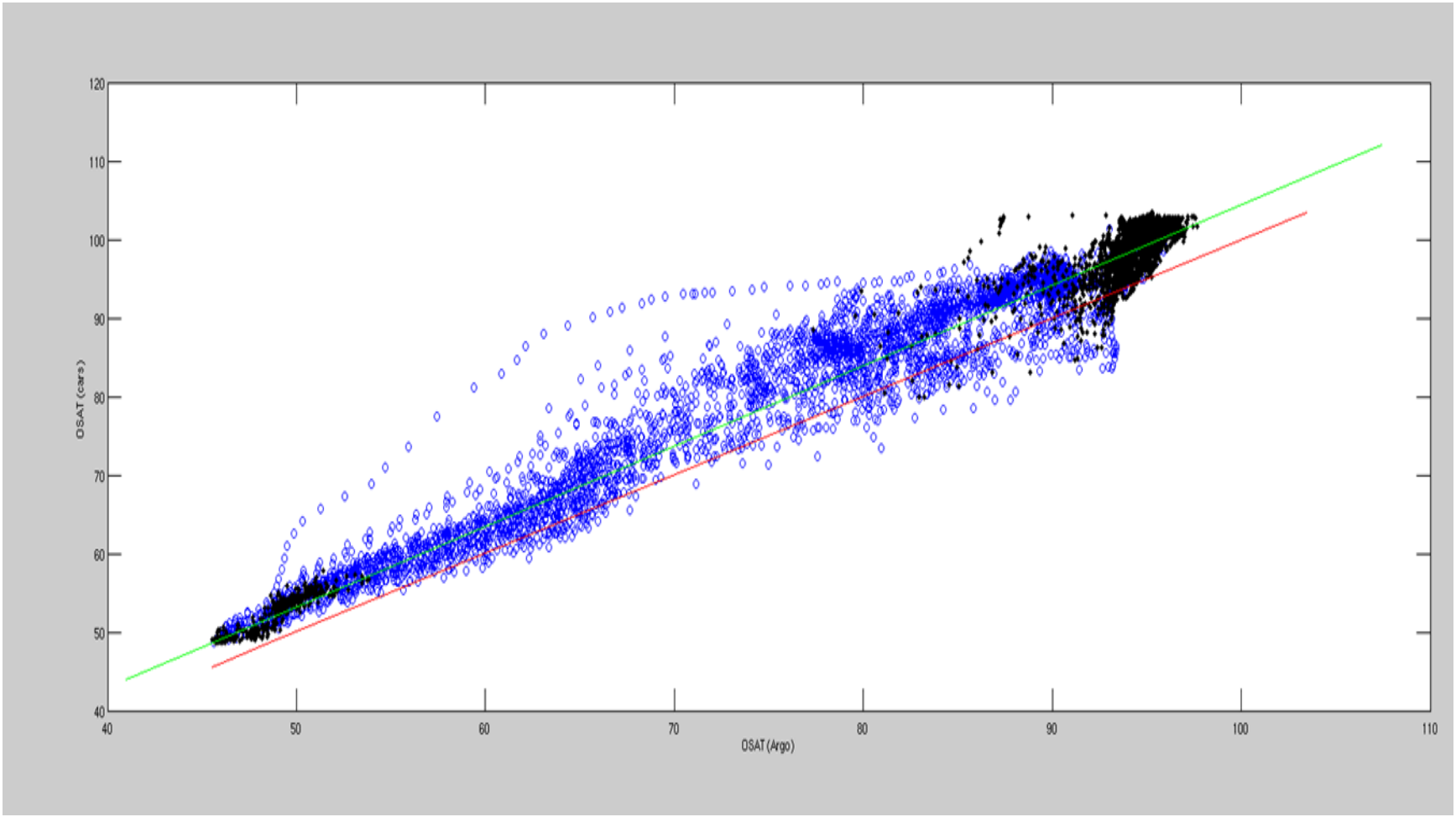


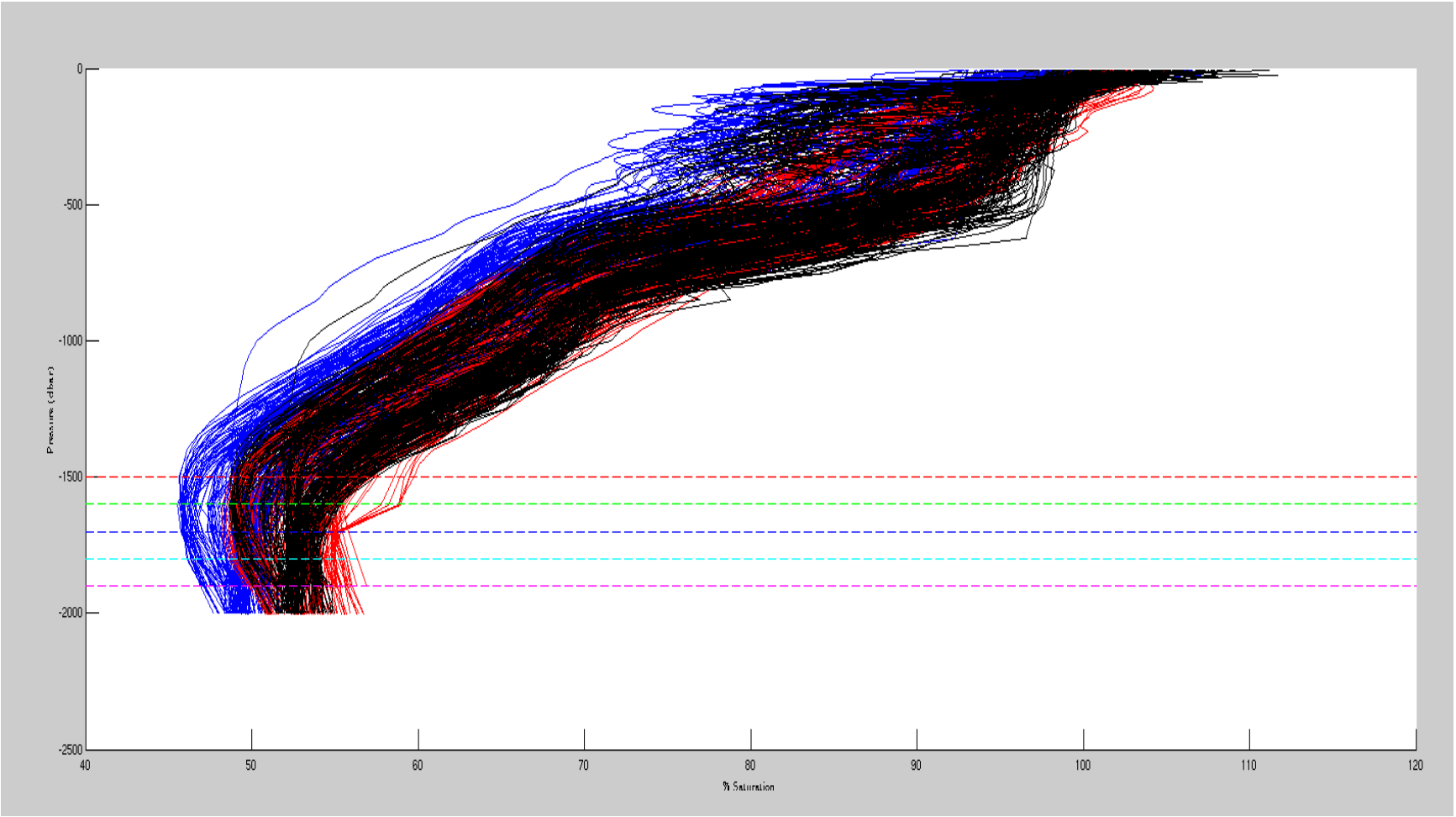
Figure shows CARS 2009 oxygen data plotted as a function of the corresponding float data. This plot is used to calculate C_1 (gain) and/or C_0 (offset) for a float. The red line is the 1:1 line.



The data used are shown in black and data omitted are shown in open blue circles. The green line is the model II linear regression.

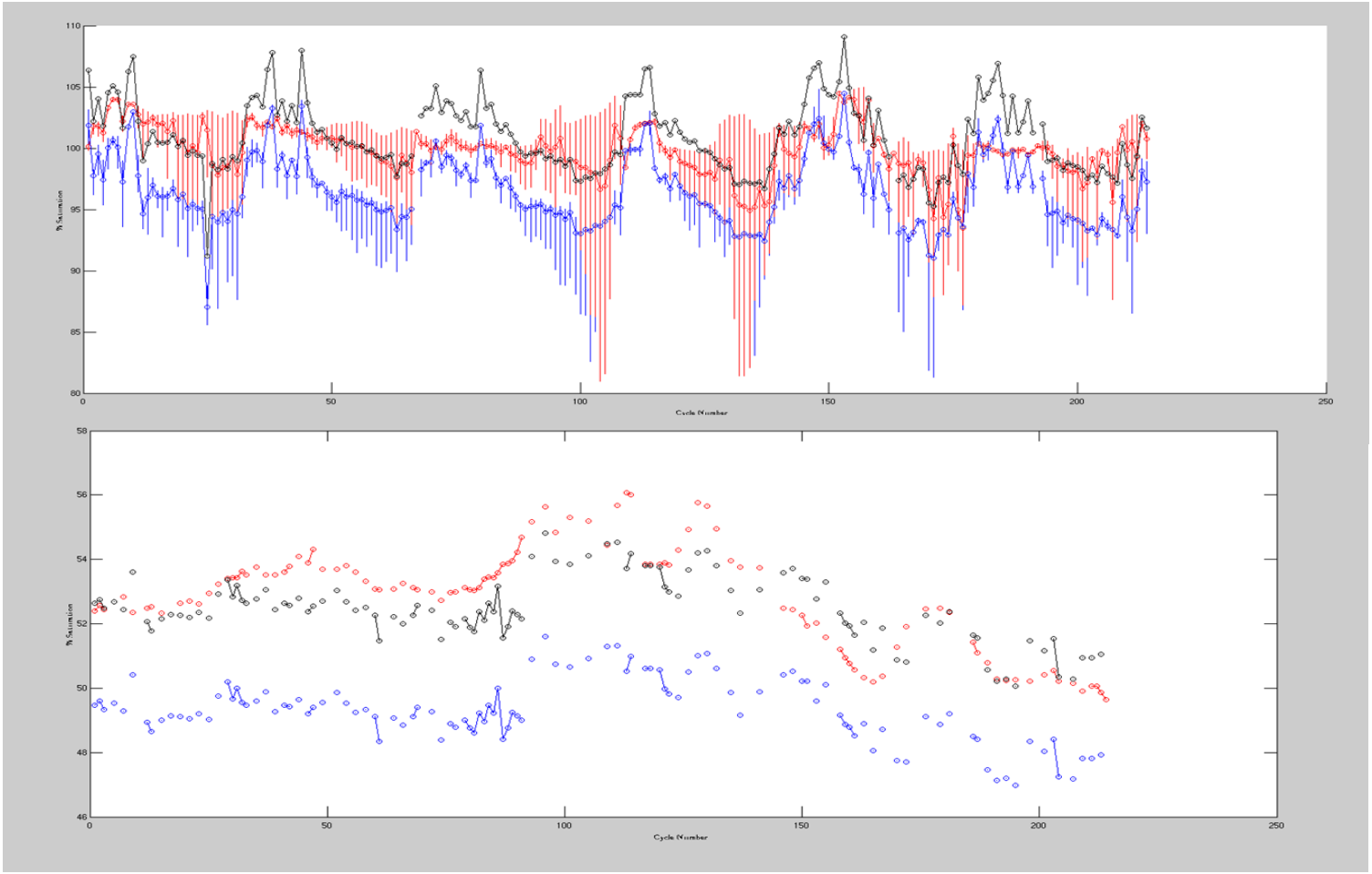
Data is omitted for several reasons:

- Measurements in strong vertical gradients are omitted to minimize errors due, for instance, to slow sensor response times.
- Only data from the mixed layer and below 1500 db is used
- A seasonal filter is applied to the mixed layer data: only float data collected from May through September is used. This approach provides a better comparison to the climatology as the %Sat remains very close to solubility equilibrium over these months.



Calculated correction coefficients are then then used to adjust the raw float data. Figure shows corrected float data in black, raw float data in blue and CARS 2009 data in red.

- Calibration is validated by comparing corrected float data to calibrated oxygen profiles taken on deployment of several floats.
- On average the calibrated profiles and the climatology agree well at the surface (within ~3 %Sat) and in the deep (within ~1 %Sat).
- Before calibration, the average agreement at the surface and in the deep is 8 and 6 %Sat, respectively.



The MATLAB GUI that has been developed allows us to assess the correction in the mixed layer (top panel), and at specified positions in the water column (bottom panel = 1900 db).

Next steps:

- Further development of the GUI and procedures
- Finalizing delivery formats for the Bio data in DM
- Adding data from our new sensors – Nitrates, pH, CHLA, CDOM, CP, etc

- For more details, please contact Hugh Doyle

Hugh.Doyle@csiro.au

Questions?

CARS 2009 Climatology

- Monthly climatology for TEMP, PSAL, $[O_2]$ (µM), and oxygen percent saturation

  - %Sat = $[O_2]$ / $[O_{2Sat}]$ x 100 where $[O_{2Sat}]$ is the oxygen saturation at solubility equilibrium [*Garcia and Gordon, 1992*].

  - All oxygen measurements used to create the climatology were made by Winkler titration.

  - The standard uncertainty of the climatology for the majority of the open ocean is estimated to be ~ 2 %Sat [*Garcia et al., 2010*].

- The DM software is GUI based
- The first step is to derive the model II linear regression relationship between $\%Sat_{float}$ and$\%Sat_{CARS}$ using two different approaches:
  - $\%Sat_{CARS} = C_{0,\%Sat} + C_{1,\%Sat} \times \%Sat_{float}$ (1)
  - $\%Sat_{CARS} = C_{1,\%Sat} \times \%Sat_{float}$ (2)

where C_0 (offset) and C_1 (gain) are the coefficients from the regression.

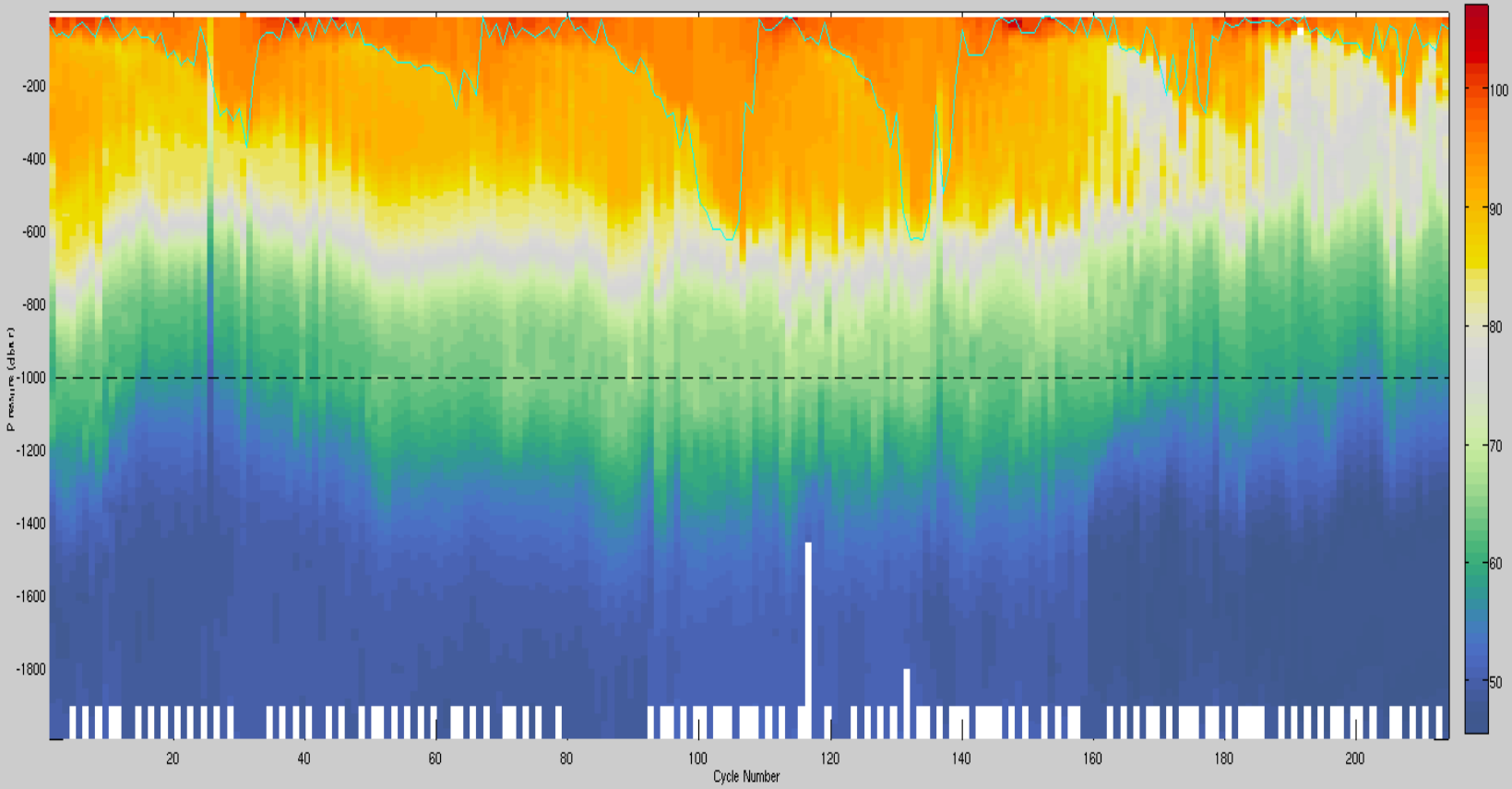
- The second step is to calculate the corrected float oxygen saturation using either

$$\%Sat_{float}^{*} = C_{0,\%Sat} + C_{1,\%Sat} \times \%Sat_{float} \qquad (1)$$

or

$$\%Sat_{float}^{*} = C_{1,\%Sat} \times \%Sat_{float} \qquad (2)$$

The standard deviations (SD) of the coefficients are noted and used as a QC.



Time series plot of dissolved oxygen obtained from the Argo float. The green line shows the mixed layer depth - as calculated using a density criterion of 0.03 kg/m^3 (*Montegut et al., 2004*).