AUSTRALIAN NATIONAL FACILITY FOR OCEAN GLIDERS (ANFOG)

Data Management

USER's MANUAL
Version 3.1
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Version	Date	Comments	Author
0.9	28/12/2007	Creation of document	Mun Woo
1.0	16/07/2008	Changed fill values from 99999 to NaN	Mun Woo
1.1	11/09/2008	Changed units of DOXY to mg/L Corrected POSITION_QC dimensions to NSURF	Mun Woo
1.2	8/10/2008	Added 6 QC tests Changed oxygen probe temperature range = 0 to 40 ^{o}C Changed pitch range = -90 to 90 deg	Mun Woo
1.3	31/10/2008	Added data transfer flow diagrams (figures 1 & 2). Included Appendix showing uncertainties for values taken from sensors. Amended Spike test & Gradient test to include considerations for data deeper than 500 db. Added sawtooth profile figure (Fig. 3).	Mun Woo
1.4	07/01/2009	Added sensor list for Seaglider (Ref Table 3.5)	Mun Woo
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2.2	21/05/2009	Changes made to conform to IMOS NETCDF USER'S MANUAL Version 1.2, and IMOS FILE NAMING CONVENTION Version 1.3.	Mun Woo
2.3	07/08/2009	Addition of DOXY time-lag correction, and corresponding parameter DOXYraw to store original uncorrected values.	Mun Woo
3.0	12/04/2010	Inclusion of additional parameters HEAD, UCUR & VCUR derived from engineering parameters. Processed file names now include 'E' and 'V' to reflect inclusion of engineering parameter & seawater current velocities.	Mun Woo
3.01	01/08/2012	Minor modifications in the QC process Addition of Irradiance parameters (OCR: Ocean Colour Radiometer)	Claire Gourcuff
3.1	01/10/2012	New processing code for interpolation of raw engineering	Claire Gourcuff

		data. Addition of parameter PRES. Additional QC on OCR parameters data. DOXY unit correction. Table 1 updated. New values for QC range tests (CDOM, DOXY, DEPTH, TEMP). Spike test on FLU2, CDOM and VBSC removed. Flag FLU2, CDOM, VBSC and OCR data < 0.5 m depth. Flag descending OCR profiles. Format change to the document: previous section 3. expanded and now split into sections 3. and 4.	and Christine Hanson

1. Introduction

This document is the Australian National Facility for Ocean Gliders (ANFOG) data user's manual. ANFOG is a facility under Australia's Integrated Marine Observing System (IMOS). The document contains the description of the formats and files produced by ANFOG.

1.1 ANFOG program

The underwater ocean glider represents a technological revolution for oceanography. Autonomous ocean gliders can be built relatively cheaply, are controlled remotely and reusable allowing them to make repeated subsurface ocean observations at a fraction of the cost of conventional methods. ANFOG, with IMOS/NCRIS/EIF funding, currently deploys a fleet of 15 gliders around Australia. The data retrieved from the glider fleet will contribute to the study of the major boundary current systems surrounding Australia and their links to coastal ecosystem processes.

The ANFOG glider fleet consists of two types: Slocum gliders and Seagliders. Slocum gliders (named for Joshua Slocum the first solo global circumnavigator), manufactured by Teledyne Webb Research Corp, are optimised for shallow coastal waters (< 200m) where high manoeuvrability is needed. ANFOG currently has 7 Slocum gliders for deployment on the continental shelf. Seagliders, originally designed and built at the University of Washington and now supplied by iRobot, are designed to operate most efficiently in the open ocean up to 1000m water depth. ANFOG uses Seagliders to monitor the boundary currents surrounding Australia. The Seagliders are used to conduct repeated glider surveys across the boundary currents and continental shelves, which is valuable for gathering long-term environmental records of physical, chemical and biological data not widely measured to date. Whilst the Slocum gliders, due to their low cost and operational flexibility, will be of great use in intensive coastal monitoring, both types of gliders weigh only 52kg, enabling them to be launched from small boats. They have a suite of sensors able to record temperature, salinity, dissolved oxygen, turbidity, dissolved organic matter and chlorophyll against position and depth. Currently, all Slocum gliders are instrumented with a Seabird-CTD, WETLabs FLBBCD 3 parameter optical sensor (measuring Chlorophyll-a, CDOM & 700nm Backscatter), an Aanderaa Oxygen optode and Satlantic 4-channel OCR (Ocean Colour Radiometer) downwelling irradiance sensor. The Seagliders are equipped with a Seabird-CTD, WETLabs BBFL2VMT 3 parameter optical sensor (measuring Chlorophyll-a, CDOM & 700nm Backscatter) and a Seabird Oxygen sensor.

The ANFOG data formats are based on NetCDF because:

- It is a widely accepted data format by the user community,
- It is a self-describing format for which tools are widely available,
- It is a reliable and efficient format for data exchange.

Data from Slocum and Seagliders are processed according to the schematics in Figures 1 and 2, respectively. Information pertaining to the uncertainty inherent in the data values is listed in the Appendix of this document.

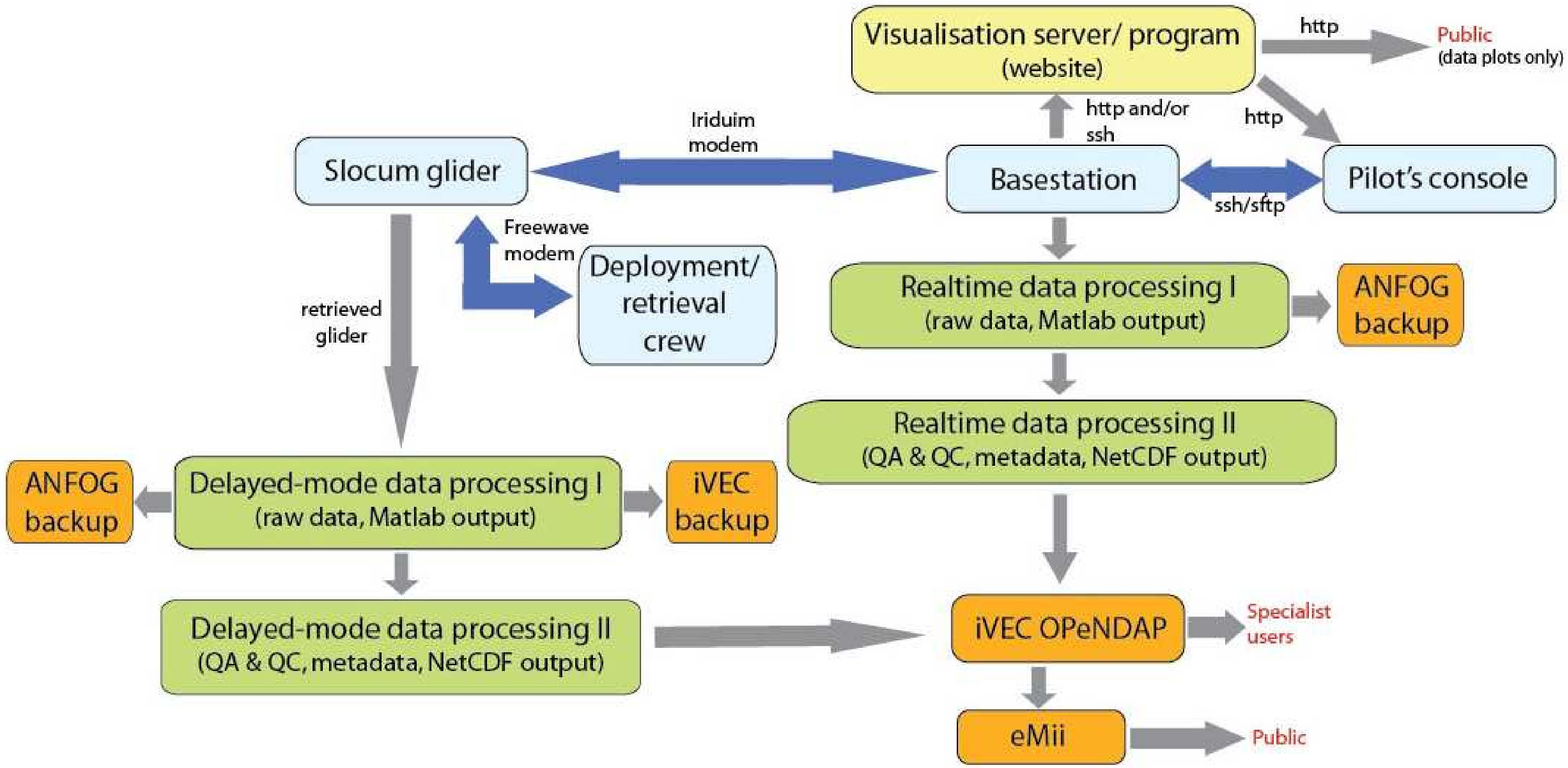

Figure 1: Slocum glider data transfer system.

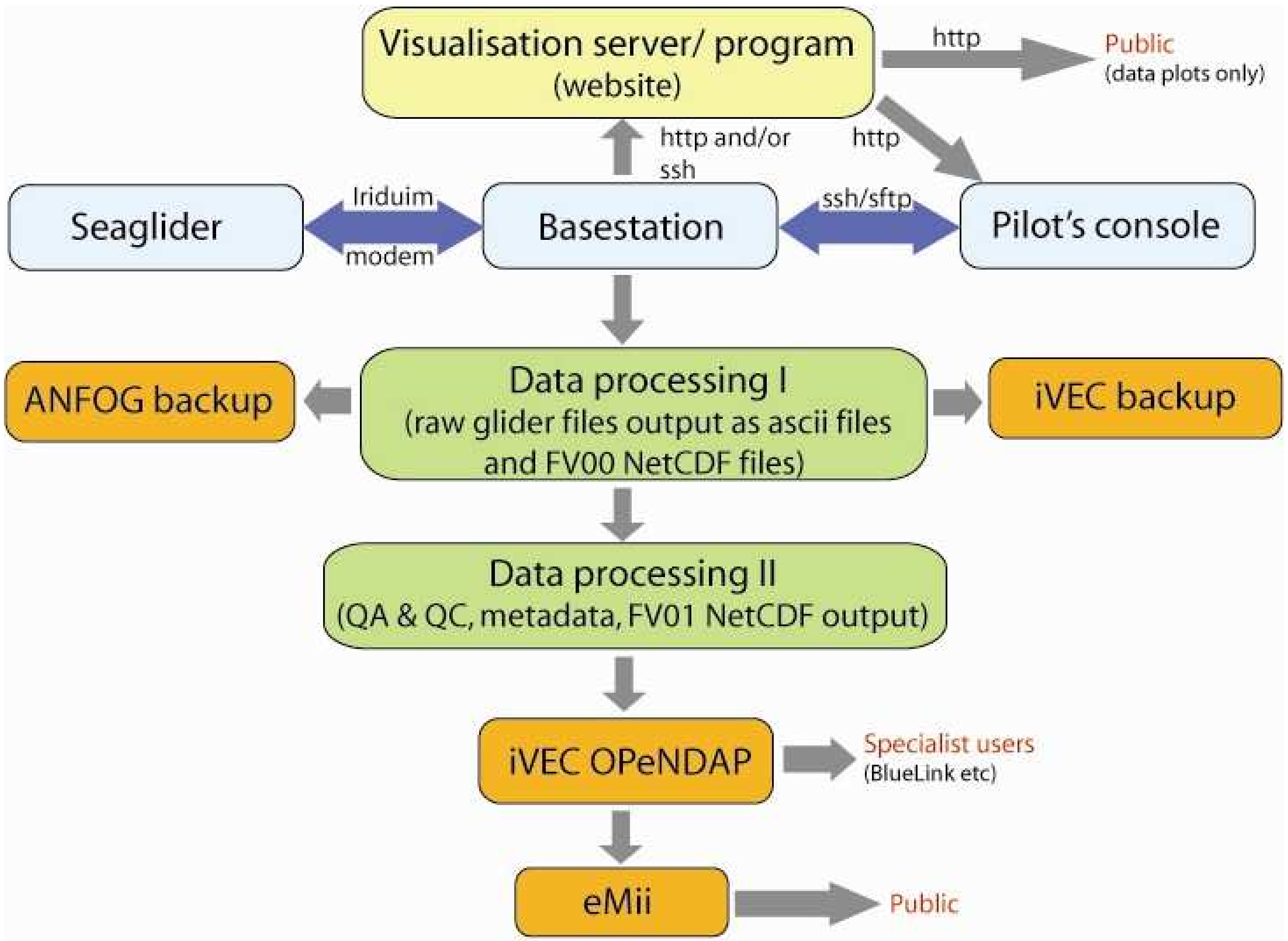

Figure 2: Seaglider data transfer system.

1.2 Slocum glider data

Slocum gliders have an endurance of ~30 days and range of 1,500 km. Typically, the Slocum glider first records its position and the time stamp at the surface and then performs multiple dive-ascent cycles continuously in a saw-tooth pattern through the water column (Fig. 3). After that, it surfaces again to transmit data, receive new instructions from the base station (if any), and finally it records its position and time stamp before diving into the next segment of saw-tooth sampling.

1.3 Seaglider data

Seagliders have an endurance of 1-6 months and range of 6,000 km. Typically, the Seaglider surfaces after every dive-ascent cycle, takes GPS fixes and uploads data. On some occasions, pilots may set the seaglider to surface after a pre-determined number of dives have been completed in order to navigate through strong surface currents.

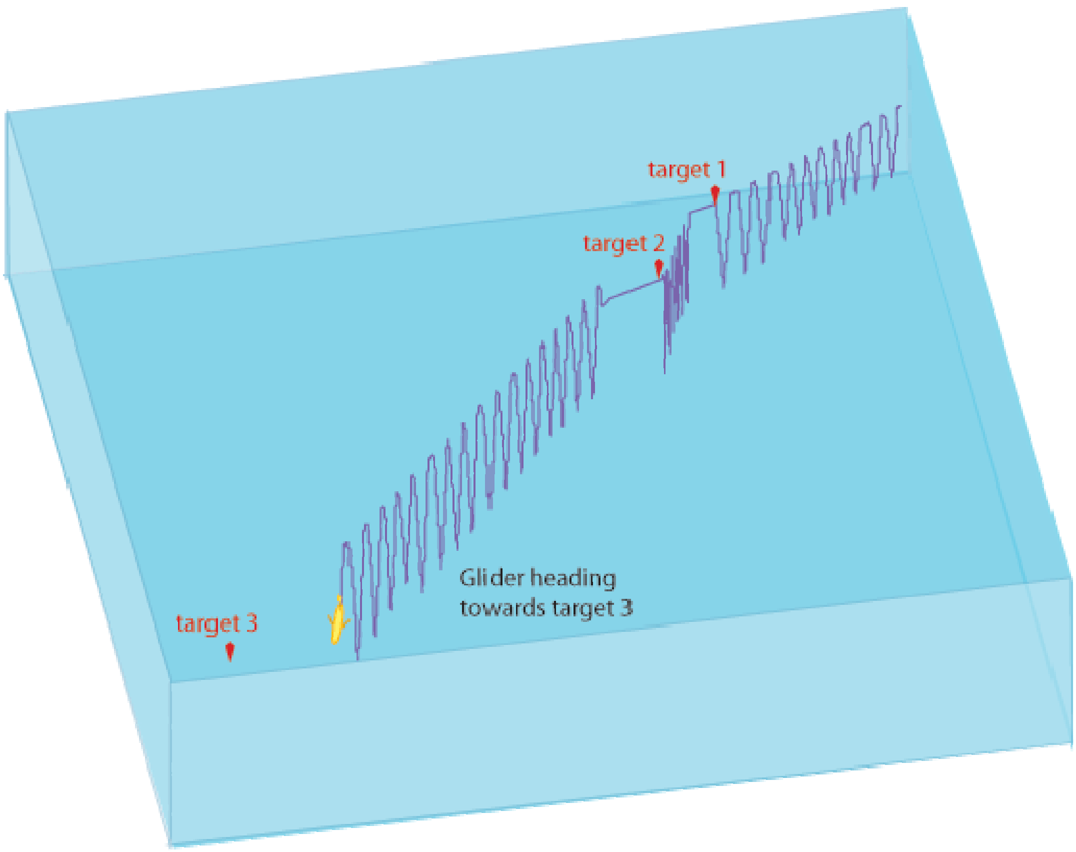

Figure 3: A Slocum glider performing 3 segments of saw-tooth lines. It surfaces at target points. This is different from a Seaglider, which usually surfaces after every descent-ascent cycle.

2. Glider data and meta-data format

Glider format files contain meta-data and data for one deployment of one glider. The observation data is stored as a data timeseries in NetCDF format. Data are transmitted from the gliders, passed through processing and quality control procedures immediately after the glider begins reporting at the surface. For Slocum gliders, while the glider is in the water, a subset of the dataset is transmitted, while the full dataset will only be available for processing upon vehicle retrieval.

2.1 Dimension and definition

ANFOG Glider data are collected as time-series, where three-dimensional coordinates of latitude, longitude and depth coordinates are recorded, along with various measured parameters. Measured parameters thus share the same dimension. The length of the time-series data varies according to the duration spent underwater and frequency of sampling, with deeper dives typically producing longer data time-series.

Name	Value	Definition
TIME	TIME = unlimited	Number of time steps over which data was sampled.

2.2 Global attributes

This section contains general information about the file itself.

Name	Example	Definition
project	char('Integrated Marine Observing System');	The scientific project that produced the data
conventions	char('IMOS version 1.2');	Format convention used by the dataset
title	char(['Seaglider data from Hobart20090213']);	Short description of the dataset indicating whether data has come from a Seaglider or Slocum, and the corresponding name of the mission.
institution	char('ANFOG');	Name of the institute or facility where the original data was produced.
date_created	char(‘2008-12-10T09:35:36Z’);	Date and time at which the data was created. Format: yyyy-mm-ddTHH:MM:SSZ'

		Example: 2008-12-10T09:35:36Z : December 10th 2008 9:35:36AM
abstract	char(' Seaglider data from the oceans around Australia have been collected by ANGOG since February 2009 and are ongoing. The data are obtained from an onboard suite of instruments which include Seabird-SBE41 CTD (Conductivity, Temperature, Depth), WETLabs BBFL2VMT 3 parameter optical sensor (measuring Chlorophyll-a, CDOM and 660nm Backscatter) and a Seabird-SBE43 dissolved oxygen sensor. This NetCDF file was created by ANFOG using the IMOS filenaming convention version 1.3 and the IMOS netCDF user's manual version 1.2.');	A paragraph describing the dataset: type of data contained, how it was created, who collected it, what instruments were used, what data formatting convention was used, etc.
comment	char(' This file contains data from Dive No. 1, a single dive, i.e. a descent and ascent cycle. Onboard instruments: Seabird CTD SBE 41 SN 085 cal 24-Feb-08, Seabird dissolved oxygen sensor SBE 43f SN 124 cal 20-Jul-07, WETLabs sensor BBFL2-VMT SN 403 cal 27-Feb-08.');	Additional information about the data, methods used to produce it, and instruments used (model, serial number and calibration date).
history	char('2008-12-10T09:35:36Z Written by MATLAB script seagliderFV.m v1.2');	An audit trail for modifications to the original data. First line contains timestamp, name and version of script that produce original netCDF file. Every subsequent line contains a time stamp, modification name and modified arguments.

source	char(' Seaglider mission');	Method of production of the original data.
keywords	char(' Turbidity, Chlorophyll, Organic Matter, Oxygen, Fluorescence, Scattering, Water Temperature, Conductivity, Salinity');	A comma separated list of key words and phrases.
references	char(' http://www.imos.org.au');	Published or web-based references describing the data or methods used to produce it.
quality_control_set	double(1)	Definition of the quality control set used for the data, if the same for all variables. (See Table 2.)
platform_code	char('sg155');	ANFOG glider unit number (as listed in Table 1). These are platform codes unique within the IMOS project.
naming_authority	char('IMOS');	Naming authority will always be IMOS.
cdm_data_type	char('Trajectory')	Unidata Common Data Model data type used by THREDDS. More information on http://www.unidata.ucar.edu/projects/THREDDS/CDM/CDMTDS.htm
geospatial_lat_min	double(-32.0892);	Southernmost latitude (positive north) from which dataset was obtained; a value between -90 and 90 degrees.
geospatial_lat_max	double(-32.0828);	Northernmost latitude (positive north) from which dataset was obtained; a value between -90 and 90 degrees.
geospatial_lon_min	double(115.1759);	Westernmost longitude (positive east) from which dataset was obtained; a value between -180 and 180 degrees.
geospatial_lon_max	double(115.1781);	Easternmost longitude (positive east) from which dataset was obtained; a value between -180 and 180 degrees.
geospatial_vertical_min	double(23.0);	Minimum depth of measurements, in metres.

geospatial_vertical_max	double(980.0);	Maximum depth of measurements, in metres.
time_coverage_start	char('2008-12-10T09:35:36Z’)	Start date and time in UTC, for which data in the dataset was collected. Format: yyyy-mm-ddTHH:MM:SSZ' Example: 2008-12-10T09:35:36Z : December 10th 2008 9:35:36AM
time_coverage_end	char('2008-12-10T09:35:36Z’)	End date and time in UTC, for which data in the dataset was collected. Format: yyyy-mm-ddTHH:MM:SSZ' Example: 2008-12-10T09:35:36Z : December 10th 2008 9:35:36AM
local_time_zone	double(10)	Local time zone.
data_center	char('eMII eMarine Information Infrastructure')	Data center in charge of management and distribution of the data resource.
data_centre_email	char(‘info@emii.org.au’)	Data centre contact email address.
author_email	char(‘claire.gourcuff@uwa.edu.au’)	NetCDF file author contact email address.
author	char(‘Dr Claire Gourcuff’)	Name of person responsible for the creation of the dataset.
principal_investigator	char(‘Prof Charitha Pattiaratchi’)	Name of principal investigator in charge of the glider unit.
principal_investigator_email	char(‘chari.pattiaratchi@uwa.edu.au’)	Principal investigator’s email address.
institution_references	char('http://imos.org.au/emii.html')	Reference to the data provider.
citation	char(‘'Citation to be used in publications should follow the format: "IMOS.[year-of-data-download],[Title],[Data access URL],accessed [date-of access]’)	Citation used for usage of this data.

acknowledgement	char('IMOS is an initiative of the Australian Government being conducted as part of the National Collaborative Reserach Infrastructure Strategy. Assistance with logistical and technical support for this project has been provided by ANFOG - Australian National Facility for Ocean Gliders.')	Any users (including re-packers) of IMOS data are required to acknowledge the source of the data in this format.
distribution_statement	char('ANFOG data may be re-used, provided that related metadata explaining the data has been reviewed by the user, and the data is appropriately acknowledged. Data, products and services from IMOS are provided "as is" without any warranty as to fitness for a particular purpose.')	Statement describing data distribution policy.

2.3 Measurements

This section contains information about the various types of data recorded during data sampling. Please refer to IMOS NETCDF USER'S MANUAL version 1.2 for further details.

2.3.1 Format of data and attributes in NetCDF datafile

Name	**Definition**	**Comment**
TIME	double TIME (TIME); TIME.standard_name = 'time'; TIME.long_name = 'time'; TIME.units = 'days since 1950-01-01T00:00:00Z'; TIME.axis = 'T'; TIME.valid_min = 0; TIME.valid_max = 90000.0; TIME._FillValue = -99999.0; TIME.quality_control_set = 1;	Time at which <PARAM> measurements were made. Values are recorded as days since 12am of 1st January 1950. The quality_control_set

	TIME.quality_control_indicator [1]= 1; TIME.comment = [ ]; TIME.ancillary_variables='TIME_quality_control'; TIME.uncertainty = 0.003; TIME.local_time_zone = 8;	is as listed in table 2. The quality_control_indicator values are as listed in table 3.
LATITUDE	float LATITUDE(TIME); LATITUDE.standard_name = 'latitude'; LATITUDE.long_name = 'latitude'; LATITUDE.units = 'degrees_north'; LATITUDE.axis = 'Y'; LATITUDE.valid_min = -90; LATITUDE.valid_max = 90; LATITUDE._FillValue = 99999.0; LATITUDE.comment = 'First and last values were obtained from GPS fixes; all others were derived by interpolation.'; LATITUDE.ancillary_variables = *'LATITUDE_quality_control';* LATITUDE.quality_control_set = 1; LATITUDE.quality_control_indicator[1] = 1; LATITUDE.uncertainty = 1E-06; LATITUDE.reference_datum = 'geographical coordinates, WGS84 projection';	Estimates of latitudinal position based on the position at the surface. The quality_control_set is as listed in table 2. The quality_control_indicator values are as listed in table 3.
LONGITUDE	float LONGITUDE(TIME); LONGITUDE.standard_name = 'longitude'; LONGITUDE.long_name = 'longitude'; LONGITUDE.units = 'degrees_east'; LONGITUDE.axis = 'X'; LONGITUDE.valid_min = -180; LONGITUDE.valid_max = 180; LONGITUDE._FillValue = 99999.0; LONGITUDE.comments = 'First and last values were obtained from GPS fixes; all others were derived by interpolation.'; LONGITUDE.ancillary_variables = *'LATITUDE_quality_control';* LONGITUDE.quality_control_set = 1; LONGITUDE.quality_control_indicator[1] = 1; LONGITUDE.uncertainty = 1E-05; LONGITUDE.reference = 'geographical coordinates, WGS84 projection';	Estimates of longitudinal position based on the position at the surface. The quality_control_set is as listed in table 2. The quality_control_indicator values are as listed in table 3.
DEPTH	float DEPTH(TIME); DEPTH.standard_name = 'depth';	Depth values are measured as metres

[1] <PARAM>.quality_control_indicator is only used when all the quality control flags for the parameter data are constant.

	DEPTH.long_name = 'depth below sea-surface'; DEPTH.units = 'metres'; DEPTH.axis = 'Z'; DEPTH.positive = 'down'; DEPTH.valid_min = 0; DEPTH.valid_max = 1200; DEPTH._FillValue = 99999.0; DEPTH.QC_set = 1; DEPTH.QC_indicator[1] = 1; DEPTH.uncertainty = 0.01; DEPTH.reference = 'sea-surface';	downward from the sea surface. The quality_control_set is as listed in table 2. The quality_control_indicator values are as listed in table 3.
<PARAM>	float <PARAM>(TIME); <PARAM>.standard_name [2]= '<X>'; <PARAM>.long_name = '<X>'; <PARAM>.units = '<X>'; <PARAM>.valid_min = <X>; <PARAM>.valid_max = <X>; <PARAM>._FillValue = 99999.0; <PARAM>.quality_control_set = 1; <PARAM>.quality_control_indicator[1] = 1; <PARAM>.uncertainty[3] = <X>; <PARAM>.comment = ' '; <PARAM>.ancillary_variables = '<X>';	<PARAM> contains the values of a parameter listed in reference table 4. <X> : this field is specified in the reference table 4. The quality_control_set is as listed in table 2. The quality_control_indicator values are as listed in table 3.
<PARAM_quality_control>	double <PARAM_quality_control> (TIME); <PARAM_quality_control> .long_name = 'quality flag for <PARAM>.standard_name[4]'; <PARAM_quality_control> .standard_name = ' <PARAM>.standard_name status_flag'; <PARAM_quality_control>.quality_control_set = 1; <PARAM_quality_control>.quality_control_conventions = 'IMOS standard set using IODE flags.'; <PARAM_quality_control>._FillValue = 9999; <PARAM_quality_control>.valid_min = 0; <PARAM_quality_control>.valid_max = 9; <PARAM_quality_control>.flag_values = [0,1,2,3,4,5,6,7,8,9]; <PARAM_quality_control>.flag_meanings =	Quality flag applied on the <PARAM> values. Information on flag meanings is found in table 3.

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[2] *<PARAM>.standard_ name* and *<PARAM_uncertainty>.standard_name* are not used if the parameter does not have a CF standard name.
[3] *<PARAM>.uncertainty* is only used when uncertainty is constant.
[4] *<PARAM>.long_name and <PARAM_uncertainty>.long_*name are used where *<PARAM>.standard.name* is unavailable.

	'no_qc_performed good_data probably_good_data bad_data_that_are_potentially_correctable bad_data value_changed not_used not_used interpolated_value missing_value';	
<PARAM_uncertainty>	float <PARAM_uncertainty>(TIME); <PARAM_uncertainty>.long_name = 'uncertainty for *<PARAM>.long_name'*; <PARAM_uncertainty>.standard_name[1] = '*<PARAM>.standard_name* standard error'; <PARAM_uncertainty>.units = *<PARAM>.units*; <PARAM_uncertainty>._FillValue = 9999;	Uncertainties attributed to each <PARAM> value.
<PARAM_raw>	float <PARAM>(TIME); <PARAM>.long_name= "uncorrected <PARAM>'; <PARAM>.units = '<X>'; <PARAM>.valid_min = <X>; <PARAM>.valid_max = <X>; <PARAM>._FillValue = 99999.0; <PARAM>.comment = ' ';	Raw <PARAM> values which have not been corrected for known issues, e.g. significant time lags for DOXY.

2.3.2 ANFOG platform codes

Listed in Table 1 are codes by which each glider is identified. Each glider unit's name is unique within the IMOS project, and used as its platform code. ANFOG's Seaglider codes begin with 'SG', while the Slocum codes begin with 'SL'.

Table 1: ANFOG glider units as of October 2012.

Glider type	Platform code	Platform type
Seagliders	SG152	Seaglider UW
	SG153	Seaglider UW
	SG154	Seaglider UW
	SG155	Seaglider UW
	SG514	Seaglider 1kA (iRobot)
	SG516	Seaglider 1kA (iRobot)
	SG521	Seaglider 1kA (iRobot)
	SG540	Seaglider 1kA (iRobot)
Slocum	SL209	Slocum G2
	SL210	Slocum G2
	SL239	Slocum G2
	SL248	Slocum G2
	SL281	Slocum G2
	SL286	Slocum G2
	SL287	Slocum G2

2.3.3 Quality control set and indicator

The attribute QC_set enables users to define the type of quality control flagging used for the dataset. Table 2 defines the set numbers as declared in the IMOS NetCDF User's Manual v1.2. When all flags in <PARAM>_QC are constant, the value is indicated using the attribute QC_indicator.

Table 2: List of QC procedure flags used in the IMOS project

Set Number	Description
1	IMOS standard set using the IODE flags
2	ARGO quality control procedure
3	BOM (SST and Air-Sea flux) quality control procedure

The following shows the meanings of the flags used in ANFOG quality control.

Table 3: QC set number 1: IMOS standard set using the IODE flags

Flag value	Meaning	Description
0	No QC performed	The level at which all data enter the working archive. They have not yet been quality controlled.
1	Good data	Top quality data in which no malfunctions have been identified and all real features have been verified during the quality control process.
2	Probably good data	Good data in which some features (probably real) are present but these are unconfirmed. Code 2 data are also data in which minor malfunctions may be present but these errors are small and/or can be successfully corrected without seriously affecting the overall quality of the data.
3	Bad data that are potentially correctable	Suspect data in which unusual, and probably erroneous features are observed.

4	Bad data	Obviously erroneous values are observed.
5	Value changed	Altered by a QC centre, with original values (before the change) preserved in the history record of the profile.
6	Not used	Reserved for future use.
7	Not used	Reserved for future use.
8	Interpolated value	Indicates that data values are interpolated.
9	Missing Value	Indicates that the element is missing.

2.3.4 Parameters

The following table describes the parameter codes used for ANFOG data management.

Table 4: Parameters measured as timeseries by sensors on ANFOG gliders.

code	**standard_name / long_name (for non-CF)**	**_FillValue**	**valid_min**	**valid_max**	**units**
CNDC	sea_water_electrical_conductivity	99999	0	60	S m^{-1}
DOXY	mass_concentration_of_oxygen_in_sea_water	99999	0	16	mL L^{-1}
FLU2	fluorescence	99999	0	50	mg m^{-3}
DEPTH	depth	99999	0	1000 (Seaglider) 200 (Slocum)	m
PSAL	sea_water_salinity	99999	2	41	PSU
TEMP	sea_water_temperature	99999	-2.5	40	Celsius
╪CDOM	concentration_of_coloured_dissolved_organic_matter	99999	0	386	ppb
╪VBSC	volumetric_backscatter_coefficient	99999	0	0.0148	m^{-1} sr^{-1}

╪HEAD	vehicle_heading	99999	-360	360	Degrees
UCUR*	eastward_sea_water_velocity	99999	0	1000	$m\ s^{-1}$
VCUV*	northward_sea_water_velocity	99999	0	1000	$m\ s^{-1}$
PRES	sea_water_pressure	99999	-5	1100 (Seaglider) 220 (Slocum)	dbar
OCR**	downwelling_spectral_irradiance_in_seawater	99999	0	1000	$uW\ cm^{-2}\ nm^{-1}$

╪ indicates a non-CF parameter. These parameters do not have associated standard names. Instead, *long_name* is listed.
* users should note that UCUR and VCUR are depth-mean velocities of the seawater over all the water that the glider travels through between surfacing. The values are approximate estimates derived from engineering parameters.
** the codes are wave length dependant, depending on each sensor. For instance for platform SL210, the four irradiance codes are: OCR443_9, OCR489_7, OCR554_2 and OCR670_2

2.4 File naming convention

NetCDF files from ANFOG follows the following convention:

IMOS_ANFOG_<data-code>_<start-date> _ <platform-code> _FV <file-version> _<product-type>_END-<end-date>.nc

Examples:

IMOS_ANFOG_BCEOSTUV_20090210T044813Z_SG155_FV01_timeseries_END-20090210T050626Z.nc

IMOS_ANFOG_ER_20090210T044813Z_SG155_FV00_timeseries_END-20090210T050626Z.nc

Table 5: Elements of file-naming convention.

Part of filename	**Description**
data-code	B: biology (plankton, fluorescence, nutrients, dissolved organic matter) C: conductivity O: oxygen concentration S: salinity of sea water T: temperature of sea water U:turbudity of sea water (including backscatter) V:velocity of sea water

	E: Engineering or technical parameters. R: Raw data.
start-time	Start date and time of the measurements in UTC. Date format is: yyyymmddTHHMMSSZ where T is the delimiter between date and time, and Z indicates that time is in UTC. Example: 20090211T114713Z is 11th February 2009, 11:47:13 AM
platform-code	The glider unit's name. See table 1.
file-version	Value representing the version of the file. This value is preceded by two characters: 'FV'. 00 : Level 0 – raw data. Raw data is defined as unprocessed data and data products that have not undergone quality control. The data may be in engineering units or physical units. Time and location details can be in relative units and values can be pre-calibration measurements. Level 0 data is unsuitable for public access. 01 : Level 1 – quality controlled data. Quality controlled data have passed quality assurance procedures such as routine estimation of timing and sensor calibration or visual inspection and removal of obvious errors. The data are in physical units using standard SI metric units, with calibration and other routine pre-processing applied. All time and location values are in absolute coordinates to agreed standards and datum. Metadata exists for the data . This is the standard data level that is made available to eMII and to the IMOS community.
product-type	(optional) This code gives information about the product included in the dataset. Example: timeseries
end-date	End date and time of the measurements in UTC. The code is preceded by four characters: 'END-'. Date format is: yyyymmddTHHMMSSZ where T is the delimiter between date and time, and Z indicates that time is in UTC. Example: 20090211T114713Z is 11th February 2009, 11:47:13 AM
creation-date	(optional) Creation date and time of the file. The data format is the same as the start and end date. The code is preceded by the two characters C-. In the case of ANFOG datasets, files that include a creation date have been re-processed with an updated version of the processing software. Example: C-20081112T231255Z

3. Quality Control

3.1 Automatic tests

The following are quality control tests applied to ANFOG glider data:

1. Impossible date test

This test checks if time values are within a timeframe possible for the ANFOG fleet.

The test requires that the observation date and time from the glider fall between 2007 (when the glider program began) and present time at processing.

2. Impossible location test

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

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

If either latitude or longitude fails, the position is flagged as bad data.

3. Range test

This test applies a gross filter on observed values for the measured scientific parameters. It needs to accommodate all of the expected extremes encountered in the oceans around Australia. Valid maxima and minima as listed in Table 4 are tested, except for the engineering parameters HEAD, UCUR and VCUR for which no QC is performed.

4. Deepest pressure test

This test requires that the profile has pressures that are not higher than vehicle safe depth range plus 10%.

- Pressure in range -5 to 220 and Depth in range 0 to 200 m (for SLOCUM)
- Pressure in range -5 to 1100 and Depth in range 0 to 1000 m (for Seaglider)

If there is a region of incorrect depth, the depths and corresponding measurements are flagged as bad data.

5. Spike test

This test is based on Argo Data Management (2012) for temperature and salinity. A difference 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

Dissolved Oxygen:
The V2 value is flagged when

- the test value exceeds 4 kg $m^{-3}$for pressures less than 500 db or
- the test value exceeds 5.5 kg $m^{-3}$for pressures greater than or equal to 500 db

6. Gradient test

This test is based on Argo Data Management (2012). It 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 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

7. Surface data
Bio-optical parameters (CDOM, FLU2 and VBSC) and OCR data are consistently flagged as bad (quality_control = 4) above 0.5m depth.

8. Ascending CTD profiles

PSAL, TEMP and CNDC ascending values are flag to 3 (potentially correctable bad data).

9. Descending OCR profiles

As the radiometer is angled at -20° to the horizontal plane, it is only level when the glider is ascending through the water column. All descending OCR data are flagged 4 (bad data).

3.2 Manual QC

3.2.1. Visual QC
Subjective visual inspection of data values by an operator. To avoid delays, this is not mandatory before real-time distribution.

The parameters that are visually checked and manually flagged are: PSAL, TEMP, DOXY, FLU2, CDOM and VBSC. The consistency with CNDC is also checked knowing that PSAL is calculated from CNDC and TEMP.

Examples of conditions where additional QC is applied:

- glider out of the water
- glider sitting in the seabed
- noise experienced due to bio-fouling or other reasons

3.2.2. Oxygen Time-lag correction

Significant time-lags are found in the original dissolved oxygen measurements logged by Slocum gliders. These lags are removed per cast by re-sampling to 2-metre depth bins and finding the lag correction which minimises the separation between the dissolved oxygen values of each downcast and subsequent. Original uncorrected values are retained in the parameter *DOXY_raw*.

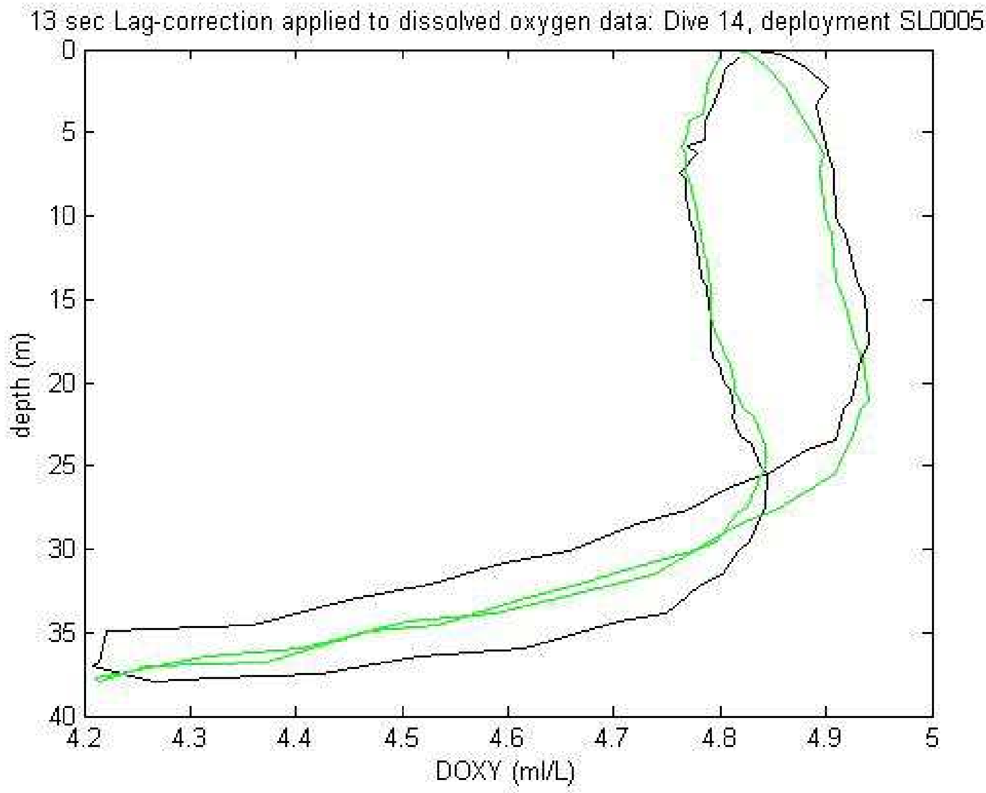

Figure 4: Time-lag correction is made to measurements of dissolved oxygen. (Green line: corrected data. Black line: raw data.)

References:

Argo Data Management (3 January 2012): Argo Quality Control Manual, v2.7

Mancini, S., K. Tattersall and R. Proctor (30 April 2009): IMOS NETCDF USER'S MANUAL, v1.2

Appendix:

Uncertainty Values

The CTD data is derived in both cases from a Seabird Inc. CTD. The CTD will be calibrated on an annual schedule.

Seaglider (SBE41 + SBE43 dissolved oxygen sensor + BBFL2-VMT optical)

Temperature: ± 0.002 + 0.002°C (95% c.i.)
Pressure: ± 1 dBar (0.1% 0f 1000m range = 1 dBar)
Conductivity: ± 0.0003 S/m + 0.004 S/m per annum (95% c.i.)
Dissolved Ox ± 2% + 2% per 1000 hours
Fluorescence: ± 1.5% over the first year
CDOM: ± 1.5% over the first year
Turbidity: ± 1.5% over the first year
Surface Location: Uc < 10m radius (95%) (GPS)

Slocum (SBE41 + Aanderaa optode dissolved oxygen sensor + BBFL2-SLO optical)

Temperature: ± 0.002 °C + 0.002 °C (95% c.i.)
Pressure: ± 0.5 dBar (0.1% 0f 350m range = 0.4 dBar)
Conductivity: ± 0.0003 S/m + 0.004 S/m per annum (95% c.i.)
Dissolved Ox ± 8uM/kg or 5% whichever greater
Fluorescence: ± 1.5% over the first year
CDOM: ± 1.5% over the first year
Turbidity: ± 1.5% over the first year
Surface Location: Uc < 10m radius (95%) (GPS)

The sensors on the gliders will be calibrated on an annual cycle. The Seaglider sensors will be serviced and recalibrated during the mandated re-batterying process at the manufacturer's premises. Recalibration of the Slocum sensors will be carried out either at Seabird or at an independent facility.