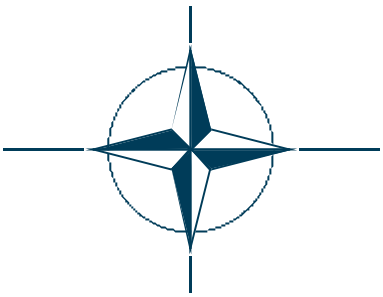
NORTH ATLANTIC TREATY ORGANISATION



(NATO)

ANNEX C

to

ADDITIONAL MILITARY LAYERS

INTEGRATED WATER COLUMN

PRODUCT SPECIFICATION

Version 2.1, 30th June 2006

Produced and issued by the United Kingdom Hydrographic Office under the direction of the geospatial Maritime Working Group of the NATO Geographic Conference.

ANNEX C

NETWORK COMMON DATA FORM (NET CDF) IMPLEMENTATION OF INTEGRATED WATER COLUMN PRODUCT SPECIFICATION

Document Control

ISSUE

Date	Author	Issue	Summary of Changes
4th July 2005	B Parish, J Gardiner	1.0	First issue
9 Nov 2005	B Parish, J Gardiner	2.0	Revised by GMWG & MILOC meetings
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APPROVALS

Approver and Title	Signature	Date
Chairman GMWG		21/10/05
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VERSION CONTROL

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Correspondence and hard copy	HA/351/002/008	N/A

CONTENTS

C.1 AML IWC Net CDF Format and Structure

C.1.1 References

This document requires reference to the following documents;

1. STANAG 7170 Additional Military Layers
2. Additional Military Layers, Integrated Water Column, Product Specification
3. NetCDF version 3.6.0-p1 dated 18 February 2005
4. The COARDS convention
5. NetCDF best Practice
6. The Network Common Data Form standard and a number of netCDF libraries and documentation are available for download at the following address; http://www.unicar.ucar.edu/packages/netcdf/
7. The COARDS convention is accessible at the following address ftp://ftp.unidata.ucar.edu/pub/netcdf/Conventions/COARDS

C.1.2 Document Structure

This document defines the implementation of Additional Military Layer (AML), Integrated Water Column (IWC) in conformance with the Network Common Data Form (NetCDF) standard. The document has been constructed in conformance with the COARDS convention and follows what is currently defined as best practice within the NetCDF community.

This document is structured to support the modular nature of the datasets comprising IWC and the variable resolutions at which data may appropriately be delivered in support of a given task. Consequently this document has three main components which are described separately below.

1. Component 1 describes the water column physical properties
2. Component 2 describes the marine mammal information
3. Component 3 describes the ocean currents

AML IWC data files may be accompanied by an optional ASCII file containing general information, this file will be called “readme.txt”

C.1.3 Global attributes common to each component

The data file contains a series of global attributes that satisfy the requirements of IWC AML and COARDS.

C1.3.1 AML IWC mandatory metadata

production_agency = "text string"
dataset_name = "text string"
edition_number = "text string"

release_date = "coded string CCYYMMDD”
product_specification_description = "enumerated"
product_specification_version = "text string"
spatial_scale_band = "enumerated"
temporal_scale_band = "enumerated"
completeness = "text string"
coverage = "text string"
ido_status = "enumerated"
protective_marking = "enumerated"
owner_authority = "enumerated (NATO country code)"
caveat = "text string"
copyright = "text string"
grid_type = “text string”

For Example

production_agency = "United Kingdom Hydrographic Office"
dataset_name = "Gridded Physical Properties DataBase"
edition_number = "JMC 1.0"
release_date = "20050617"
product_specification_description = "IWC"
product_specification_version = "1.0"
spatial_scale_band = "4"
temporal_scale_band = "C"
completeness = "Complete"
coverage = "JMC Exercise region"
ido_status = "NATO"
protective_marking = "UNCLASSIFIED"
owner_authority = "GBR"
caveat = "N/A "
copyright = "© British Crown Copyright 2004. All rights reserved"
grid_type = “lattice”

C1.3.2 AML IWC non-mandatory metadata

data_source = "text string"
orig_auth = "text string"
data_type = "text string"
image_file = "hyperlink"
text_file = "hyperlink"
reference = "text string"
supporting_info = "text string"

For example

data_source = "MEDS"
orig_auth = "MEIC"
data_type = "Oceanographic Observations"
image_file = "N/A"
text_file = "N/A"
reference = "N/A"

supporting_info = “N/A”

C1.3.3 Additional Attributes required by NetCDF implementation

description = "text string"
convention = "text string"
positive = “text string"

For example;
description = "GPPDB AML example"
convention = "COARDS"
positive = “down"

Component 2 Specific attributes

mm_parameter_order = “comma separated list defining the order of the mm_parameter components”
mm_parameter_description = “description of mm_parameter components in a semi colon separated list”

For example;

mm_parameter_order = “RES, RES quality (RAG), Activity, Activity quality (RAG), Probability of occurrence, Probability of occurrence quality (RAG), Predicted density, Predicted density quality (RAG)”
mm_parameter_description = “The suitability of the environment to support a given species; Red, Amber, Green where green is good and red is poor; The type of activity a species can be exhibiting; Red, Amber, Green where green is good and red is poor; The likelihood of encountering a given species; Red, Amber, Green where green is good and red is poor; The number of animals of a given species predicted to be present; Red, Amber, Green where green is good and red is poor”

Coordinate value ordering:
The coordinate values of a coordinate variable must be either monotonically increasing or monotonically decreasing. However, the coordinate values need not be evenly spaced. Missing values are not permitted in coordinate variables.

Coordinate Variable Attributes:
If a coordinate variable contains longitude, latitude, depth, elevation, date, or time values then the units attribute is mandatory; it is used to determine the orientation of the coordinate variable. Since coordinate variables may not contain missing values the attributes “_FillValue ” and “missing_value” may not be used with coordinate variables. “scale_factor” & “add_offset” will not be used with coordinate variables.

Time or date dimension:
Coordinate variables representing time must always explicitly include the units attribute; there is no default value. A time coordinate variable will be identifiable by its units, alone

Climatological time:
Coordinate variables representing climatological time (an axis of 12 months, 4 seasons,

etc. that is located in no particular year) should be encoded like other time axes but with the added restriction that they be encoded to begin in the year 0000.

Vertical (height or depth) dimension:
Coordinate variables representing height or depth must always explicitly include the units attribute; there is no default value for the units attribute. The units attribute will be of character type.

The direction of positive, whether up or down, cannot in all cases be inferred from the units. The direction of positive is useful for applications displaying the data. For this reason the new attribute *positive* is defined. The *positive* attribute may have the value "up" or "down".

NB: there are also specific attributes mandated by COARDS which are included with the data they describe

C.1.4 Component 1 specific attributes

C1.4.1 Dimensions

This section describes the encoding of the Physical Properties component of AML IWC The Physical Properties dataset is five dimensional, as follows:

Dim No.	Dimension name	Unit of Measure
1	n_profiles	no units (this is a count)
2	time	climatological time CCYYMMDDHHMMSS expressed 00000616120000 for noon on 16th June **every** year i.e the midpoint of the climatological time period. For Example, when describing a monthly climatology: January: 00000116120000 February: 00000216120000 March: 00000316120000 Etc.
3	depth	metres
4	latitude	decimal degrees
5	longitude	decimal degrees

Each dimension is also a co-ordinate variable, which implies some restrictions over normal variables, as described in section C1.3.3, from the COARDS convention.

N-Profile

The n_profile dimension provides the facility to encode cluster climatologies. Cluster climatologies allow for more than one climatological profile for a particular geographical and temporal location and there is probability of occurrence associated with each profile. The maximum number of profiles at a location is in the order of (but not constrained to)10 and the associated probabilities must total 100%.

The associated probabilities are stored in a variable called n-profile probability which is four dimensional (n_profile, time, latitude, longitude)

If the source data does not contain cluster profiles then n_profile will be a singleton dimension and the probability of occurrence, at all locations, will be 100%.

If the source data does contain cluster profiles then the highest probability profile for a geographical and temporal location would go in position 1 of n_profile. The next most probable profile would go at position 2 and so on.

C1.4.2 Variables

The Physical Properties dataset has five coordinate variables (each dimension is also a coordinate variable and mandatory). It also has up to twenty data variables (only 6 of which are mandatory).

Coordinate Variables	**Dimensions**
n_profile	n_profile
time	Time
depth	Depth
latitude	Latitude
longitude	Longitude

Mandatory Data Variables

Data Variables	**"units"**	**Dimensions**
temperature	degC	n_profiles, time, depth, latitude, longitude
bottom_temperature	degC	n_profiles, time, latitude, longitude
salinity	psu	n_profiles, time, depth, latitude, longitude
bottom_salinity	psu	n_profiles, time, latitude, longitude
n_profile_probability	%	n_profiles, time, latitude, longitude
bottom_depths	metres	latitude, longitude

Non-mandatory Data Variables

Data Variables	**(units)**	**Dimensions**
temperature_sd	(degC)	(n_profiles, time, depth, latitude, longitude)
bottom_temperature_sd	(degC)	(n_profiles, time, latitude, longitude)
salinity_sd	(degC)	(n_profiles, time, depth, latitude, longitude)
bottom_salinity_sd	(degC)	(n_profiles, time, latitude, longitude)
soundspeed	(m/s)	(n_profiles, time, depth, latitude, longitude)
bottom_soundspeed	(m/s)	(n_profiles, time, latitude, longitude)
soundspeed_sd	(degC)	(n_profiles, time, depth, latitude, longitude)
bottom_soundspeed_sd	(degC)	(n_profiles, time, latitude, longitude)
density	(kg/m3)	(n_profiles, time, depth, latitude, longitude)

bottom_density	(kg/m3)	(n_profiles, time, latitude, longitude)
density_sd	(degC)	(n_profiles, time, depth, latitude, longitude)
bottom_density_sd	(degC)	(n_profiles, time, latitude, longitude)
data_quality	(N/A)	(n_profiles, time, latitude, longitude)
data_quantity	(N/A)	(n_profiles, time, latitude, longitude)

Some of the variables are paired, ie. if density is included then bottom_density must also be included. If density_sd is included then bottom_density_sd must be included.

The series of variables to hold bottom information is included to allow data from a variety of sources to be used in the re-construction of full profiles using all available information.

Attribute Variables

The following attributes apply to all physical properties variables

long_name = “text string”
units = “text string”
scale_factor = “floating point”
add_offset = “floating point”
missing_value = “integer”
_FillValue = “integer”

For example

long_name = “Ocean temperature”
units = “degC”
scale_factor = “0.0010”
add_offset = “15”
missing_value = “-32000”
_FillValue = “-31999”

The “long_name” attribute allows for a more informative description of the variable than can be conveyed using the variable name. “long_name” will always be a text string.

The “units” attribute describes the units of the ‘unscaled’ data (i.e before “scale_factor” and “add_offset” have been applied or after the data has been unpacked and these storage constraints have been removed.) The “units” attribute is a text string and should conform to the COARDS conventions.

“scale_factor” and “add_offset” allow the data to be scaled from floating point to integer values to optimise storage. The “scale_factor” value will vary depending on the precision quoted in the data. Values quoted using 3 decimal places will require a scale factor of 0.0010 to be held as integers without losing information. Attributes are held as strings and therefore not scaled hence the offset only applies to data held in variable arrays.

The variables “missing_value” and “_FillValue ” hold the values which indicate that data should be present but is not available and that data should not be present, as follows;

No Data maps to “missing_value” (in IWC always -32000)
Not Applicable maps to “_FillValue” (in IWC always -31999)

Empty fields are not permitted in NetCDF.

C.1.5 Component 2 specific attributes

C1.5.1 Dimensions

This section describes the encoding of the Marine Mammals component of AML IWC The Marine Mammals dataset is four dimensional, as follows:

Dim No.	Dimension name	Unit of Measure
1	mm_parameter	**1**: floating point value between 0 and 1 expressed to 2 decimal places, **2**: enumerated list, **3**: enumerated list, **4**: enumerated list, **5**: percentage, **6**: enumerated list, **7**: decimal count, **8**: enumerated list
2	time	climatological time CCYYMMDDHHMMSS expressed 00000616120000 for noon on 16th June **every** year i.e the midpoint of the climatological time period. For Example, when describing a monthly climatology: January: 00000116120000 February: 00000216120000 March: 00000316120000 Etc.
3	latitude	decimal degrees
4	longitude	decimal degrees

C1.5.2 Variables

Each species is considered a variable (each dimension is also a coordinate variable and mandatory) named using a code for each species. As many species as are required can be encoded as variables. The code is defined by the first two letters of the genus and the first three letters of the species. For example the Humpback Whale (genus = "Megaptera", species = "novaeangliae") is referred to as menov. There is one exception to this rule where a duplication of species code occurred. Mediterranean Monk Seal is species code momoa. A full list of species codes is provided in Appendix A of the Product Specification.

The number of variables in a file will depend on the number of animal species for which information is encoded. The minimum number of variables will be five, the four co-ordinate variables “mm_parameter”, “time”, “latitude”, “longitude” with one species variable.

species_code (mm_parameter, time, latitude, longitude)

To extract the data it is necessary to address the correct position in the “mm-parameter” array. For example to extract the RES data for Humpback Whales it would be necessary to address position 1 in the “mm-parameter” array of the “menov” variable. To extract the Activity data it would be necessary to address position 3. To extract Probability of occurrence data it would be necessary to address position 5 etc. Quality statements expressed as Red, Amber or Green are paired with the parameters they describe in the mm_parameter dimension. Further parameters that may be added in later phases of IWC development would be added after these.

Variable Attributes

"scale_factor" and "add_offset" allow the data to be scaled from floating point to integer values to optimise storage. The "scale_factor" value will vary depending on the precision quoted in the data. Values quoted using 3 decimal places will require a scale factor of 0.0010 to be held as integers without losing information. Attributes are held as strings and therefore not scaled hence the offset only applies to data held in variable arrays.

The variables "missing_value" and "_FillValue " hold the values which indicate that data should be present but is not available and that data should not be present, as follows;

No Data maps to "missing_value" (in IWC always -32000)
Not Applicable maps to "_FillValue" (in IWC always -31999)

Empty fields are not permitted in NetCDF.

Each species variable has the following attributes:

long_name = "text string"
units = "text string"
scale_factor = "floating point"
add_offset = "floating point"
missing_value = "integer"
_FillValue = "integer"
common_name = "text string"
species_code = "text string"
family = "text string "
genus = "text string "
species = "text string "
max_group_size = "text string"
min_group_size = "text string"
quality_max_group_size = "text string"
quality_min_group_size = "text string"
conservation_status = "text string"
habitat = "text string"
quality_habitat = "text string"
habitat_min_depth = "text string"
habitat_max_depth = "text string"
quality_habitat_depth = "text_string"
max_dive_depth = "text string"
min_dive_depth = "text_string"
max_dive_duration = "text string"
min_dive_duration = "text string"
max_surface_duration = "text string"
min_surface_duration = "text string"
quality_max_dive_depth = "text string"
quality_min_dive_depth = "text string"
quality_max_dive_duration = "text string"
quality_min_dive_duration = "text string"

quality_max_surface_duration = “text string”
quality_min_surface_duration = “text string”
danger = “text string”
quality_danger = “text string”
max_voice_freq = “text string”
min_voice_freq = “text string”
quality_voice_freq = “text string”
min_voice_source_level = “text string”
max_voice_source_level = “text string”
quality_voice_source_level = “text string”
max_adult_length = “text string”
min_adult_length = “text string”
quality_max_adult_length = “text string”
quality_min_adult_length = “text string”
max_swim_speed = “text string”
min_swim_speed = “text string”
quality_max_swim_speed = “text string”
quality_min_swim_speed = “text string”
sensitivity_group = “integer”
quality_sensitivity = “text string”

res_value = “floating point”
res_quality = “floating point”
activ_value = “floating point”
activ_quality = “floating point”
prob_value = “floating point”
prob_quality = “floating point”
density_value = “floating point”
density_quality = “floating point”

Activity start and end dates may be inferred from the activity grids, at the temporal resolution of the dataset.

Example encoding for Humpback whale;

long_name = “Humpback whale”
units = “N/A”
scale_factor = "0.0010"
add_offset = "0.0"
missing_value = "-32000"
_FillValue = "-31999"
common_name = "Humpback whale"
species_code = "180530"
family = "Balaenopteridae"
genus = "Megaptera"
species = "novaeangliae"
max_group_size = “15"
min_group_size = “2”
quality_max_group_size = “Red”
quality_min_group_size = “Red”

conservation_status = "VU A1ad"
habitat = "004, mainly coastal - continental slope (down to very deep waters)"
quality_habitat = “Red”
habitat_min_depth = “10”
habitat_max_depth = “1000”
quality_habitat_depth = “Red”
max_dive_depth = “100”
min_dive_depth = “30”
max_dive_duration = “45”
min_dive_duration = “10”
max_surface_duration = “20”
min_surface_duration = “5”
quality_max_dive_depth = “Amber”
quality_min_dive_depth = “Amber”
quality_max_dive_duration = “Amber”
quality_min_dive_duration = “Amber”
quality_max_surface_duration = “Amber”
quality_min_surface_duration = “Amber”
danger = “002, medium risk”
quality_danger = “Red”
max_voice_freq = “25”
min_voice_freq = “10”
quality_voice_freq = “Red”
min_voice_source_level = “2”
max_voice_source_level = “6”
quality_voice_source_level = "Green"
max_adult_length = “20”
min_adult_length = “10”
quality_max_adult_length = “Red”
quality_min_adult_length = “Red”
max_swim_speed = “6”
min_swim_speed = “2”
quality_max_swim_speed = "Green"
quality_min_swim_speed = “Amber”
sensitivity_group = “1”
quality_sensitivity = "Green"

res_value = “0.25”
res_quality = "-1"
activ_value = “4”
activ_quality = "-5"
prob_value = “35”
prob_quality = "-3"
density_value = “15.25”
density_quality = “-1”

C.1.6 Component 3 specific attributes

C1.6.1 Dimensions

This section describes the encoding of the Ocean Currents component of AML IWC
The Ocean Currents dataset is four dimensional, as follows:

Dim No.	Dimension name	Unit of Measure
1	time	climatological time CCYYMMDDHHMMSS expressed 00000616120000 for noon on 16th June **every** year i.e the midpoint of the climatological time period. For Example, when describing a monthly climatology: January: 00000116120000 February: 00000216120000 March: 00000316120000 Etc.
2	depth	metres
3	latitude	decimal degrees
4	longitude	decimal degrees

Each dimension is also a co-ordinate variable, which implies some restrictions over normal variables, as described in section C1.3.3, from the COARDS convention.

C1.6.2 Variables

The Ocean Currents dataset has four dimensions which are also co-ordinate variables and mandatory. It also has up to ten variables (only five of which are mandatory).

Coordinate Variables	Dimensions
time	Time
depth	Depth
latitude	Latitude
longitude	Longitude

Mandatory Data Variables

Data Variables	"units"	Dimensions
ocean_current_rate	cm/s	time, depth, latitude, longitude
ocean_current_direction	degrees	time, depth, latitude, longitude
bottom_current_rate	cm/s	time, latitude, longitude
bottom_current_direction	degrees	time, latitude, longitude
Bottom_depths	m	latitude, longitude

Non-mandatory Data Variables

Data Variables	(units)	Dimensions
ocean_current_vector_u	(cm/s)	(time, depth, latitude, longitude)
bottom_current_vector_u	(cm/s)	(time, latitude, longitude)
ocean_current_vector_v	(cm/s)	(time, depth, latitude, longitude)
bottom_current_vector_v	(cm/s)	(time, latitude, longitude)
ocean_current_vector_w	(cm/s)	(time, depth, latitude, longitude)
bottom_current_vector_w	(cm/s)	(time, latitude, longitude)
ocean_current_rate_sd	(cm/s)	(time, depth, latitude, longitude)
bottom_current_rate_sd	(cm/s)	(time, latitude, longitude)
ocean_current_direction_sd	(degrees)	(time, depth, latitude, longitude)
bottom_current_direction_sd	(degrees)	(time, latitude, longitude)
ocean_current_data_quality	(N/A)	(time, depth, latitude, longitude)
ocean_current_data_quantity	(N/A)	(time, depth, latitude, longitude)
ocean_current_data_type	(N/A)	(time, depth, latitude, longitude)

Some of the variables are paired, ie. if ocean_current_rate_sd is included then bottom_current_rate_sd must be included.

The series of variables to hold bottom information is included to allow data from a variety of sources to be used in the re-construction of full profiles using all available information.

Variable Attributes

The “long_name” attribute allows for a more informative description of the variable than can be conveyed using the variable name. “long_name” will always be a text string.

The “units” attribute describes the units of the ‘unscaled’ data (i.e before “scale_factor” and “add_offset” have been applied or after the data has been unpacked and these storage constraints have been removed.) The “units” attribute is a text string and should conform to the COARDS conventions.

“scale_factor” and “add_offset” allow the data to be scaled from floating point to integer values to optimise storage. The “scale_factor” value will vary depending on the precision quoted in the data. Values quoted using 3 decimal places will require a scale factor of 0.0010 to be held as integers without losing information. Attributes are held as strings and therefore not scaled hence the offset only applies to data held in variable arrays.

The variables “missing_value” and “_FillValue ” hold the values which indicate that data should be present but is not available and that data should not be present, as follows;

No Data maps to “missing_value” (in IWC always -32000)
Not Applicable maps to “_FillValue” (in IWC always -31999)

Empty fields are not permitted in NetCDF.

The following attributes apply to all ocean currents variables

long_name = “text string”
units = “text string”
scale_factor = “floating point”
add_offset = “floating point”
missing_value = “integer”
_FillValue = “integer”

For example

long_name = “Ocean current rate standard deviation”
units = “cm/s”
scale_factor = “0.0010”
add_offset = “0.15”
missing_value = “-32000”
_FillValue = “-31999”

C.2 File Naming

AML IWC will follow the file naming convention specified below.

Format

XXXInac123.nc

Where

XXX = the three-letter NATO country code of the producer (NATO STANAG 1059)

I = the first character of the three-letter AML product identifier. As defined, the overall basic AML service would be made up of nine products:

M – MFF (Maritime Foundation and Facilities)
E – ESB (Environment, Seabed and Beach)
R – RAL (Routes Areas and Limits)
L – LBO (Large Bottom Objects)
S – SBO (Small Bottom Objects)
C – CLB (Contour Line Bathymetry)
I – IWC (Integrated Water Column)
N – NMB (Network Model Bathymetry)
A – AMC (Atmospheric & Meteorological Climatology)

n = 'Spatial Scale Band' values are given below.
1 - 20 degrees or coarser
2 - 5 degrees
3 - 1 degree
4 - 30 minutes
5 - 6 minutes
6 - 1 minute
7 - 30 seconds
8 - 6 seconds
9 - 1 second or finer

a = 'Temporal Scale Band' values are given below.
A - Year
B – Quarter Year
C - Month
D – Semi-month
E - Week

F - Day

c = the security classification code:
N – COSMIC TOP SECRET
W – FOCAL TOP SECRET
T – TOP SECRET
S – SECRET
C – CONFIDENTIAL
R – RESTRICTED
U - UNCLASSIFIED

123 = product specific alphanumeric identification. This is dependent upon the geographical partitioning of the product and is at the discretion of the producing authority.