

Read and Write Data

The CF Metadata Conventions (for NetCDF)

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CF Conventions and Metadata

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NetCDF CF Metadata Conventions

The conventions for CF (Climate and Forecast) metadata are designed to promote the processing and sharing of files created with the [NetCDF API](#). The CF conventions are increasingly gaining acceptance and have been adopted by a number of projects and groups as a primary standard. The conventions define metadata that provide a description of what the data in each variable represents, and the spatial and temporal properties of the data. This enables users of data from different sources to ensure that quantities are comparable, and facilitates building applications with powerful extraction, regridding, and display capabilities.

The CF conventions generalize and extend the [COARDS conventions](#).

Here are the slides for a talk that provides an [overview of CF](#). An expository version of this talk is in this [article](#).

Discussion about CF Metadata takes place in two formats:

CF Metadata Trac, and cf-metadata mailing list. For further explanation of each of these, take a look at the [Discussion page](#).



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Metadata Conventions

- Just as we have standard file formats to facilitate data exchange we can also standardize the way we provide metadata.
- In the earth system sciences the **CF (Climate and Forecast)** metadata conventions are an important aid to data sharing and usability.

What do the CF metadata conventions allow us to do?

- By setting the data in context CF enhances the ability to interpret the data inside netCDF files while still allowing the use of all the standard netCDF tools
- Standard software can be used to read and write the metadata

What do the CF metadata conventions allow us to do?

CF metadata can be used to:

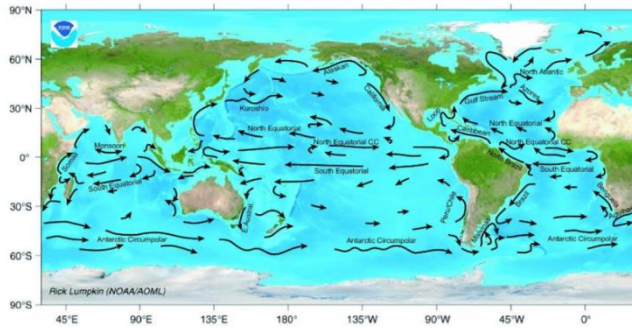
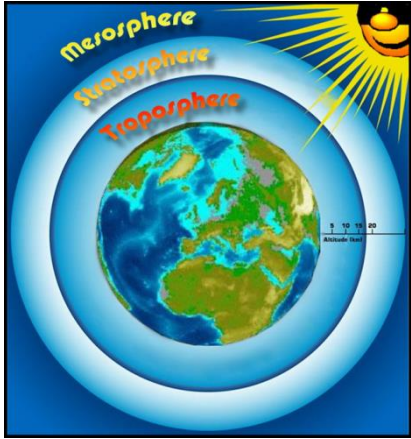
- find data in an archive ('**Discovery**' metadata).
- provide information necessary to interpreting the data ('**Usage**' metadata).
- control standard data manipulation tools, e.g, for performing mathematical operations or producing visual plots.

Goals of CF

(as stated by lead author: Jonathan Gregory)

- Locate data in space–time and as a function of other independent variables, to facilitate processing and graphics.
- Identify data sufficiently to enable users of data from different sources to decide what is comparable, and to distinguish variables in archives.
- Framed as a netCDF standard, but most CF ideas relate to metadata design in general, hence can be contained in other formats such as XML.

All types of data





Basis of design

- Data should be self-describing
- Readable by humans and machines
- Minimise redundancy
- Represented in CDL

The main CF global attributes

conventions	E.g.: <code>Conventions = "CF-1.6"</code>
title	What's in the file
institution	Where it was produced
source	E.g. Name of model, instrument
history	Audit trail of processing
references	Publications, web pages
comment	Miscellaneous information

Variable attributes

standard_name	from standard name table
units	mandatory unless dimensionless quantity
long_name	not standardised
cell_methods	variation within a cell e.g. max, mean
cell_measures	area or volume of a cell
valid_max, valid_min, valid_range	for numeric variables
_FillValue, missing_value	CF deprecates <code>missing_value</code> in favour of <code>_FillValue</code>
flag_values, flag_meanings	to make "flag" variables self describing

Coordinate Variables in CF

E.g.:

```
longitude(longitude)
  :units = "degrees_east";
  :axis = "X";
  :standard_name = "longitude";
```

Time

Time (year, month, day, hour, second) is recorded as:

time_unit **since** reference_time

e.g. days **since** 1990-1-1

seconds **since** 2013-12-31 00:00

2000-2-29 15:00:00 = 36583.625 days since 1900-1-1

Time

- To make matters still more complicated, the way the time units are interpreted can also depend on the value of the `calendar` attribute.
- Second and minute are easy to use because the SI system defines the length of the second, and a minute 60 seconds, so choice of calendar doesn't affect those units.
- However, sometimes a much larger time unit, such as day or month, is the only sensible choice for your data.

Time (using calendars)

E.g. days **since** 1990-1-1

In the standard 365-day calendar:

2000-2-29 15:00:00 = 36583.625 days since 1900-1-1

In the 360-day calendar used by some climate models:

2000-2-29 15:00:00 = 35058.625 days since 1900-1-1

Beware year and month units!

year = 365.242 days

month = year/12.0

Calendars

- The calendar is indicated by the **calendar** attribute of the **time coordinate** variable
- Default is to use the "standard" calendar, but it is good practice to always specify a value.
- Possible values are:

gregorian *or* standard (default)

noleap *or* 365_day

360_day

proleptic_gregorian

all_leap *or* 366_day

julian

CF Standard Name Table

- Currently 2500+ names in the table – and growing!
- Updated monthly
- Version numbers and date stamp introduced in 2006
- Once names are added they are not removed

CF Standard Name Table: examples

Standard Name	Canonical Units	AMIP
air_density	kg m ⁻³	
air_potential_temperature	K	theta
air_pressure	Pa	plev
air_pressure_anomaly	Pa	
air_pressure_at_cloud_base	Pa	

Canonical units (and standard names)

- Canonical_units are agreed at same time as standard name – they go hand in hand, e.g.
- mass_concentration → units = "kg m⁻³"
- mole_concentration → units = "mol m⁻³"
- String valued
- Must be supported by the Unidata UDUNITS package which converts between recognized units.

CF compliance checker

- A python program to check that the metadata in a netCDF-3 file complies with CF metadata conventions
- Available via the web at:
<http://puma.nerc.ac.uk/cgi-bin/cf-checker.pl>
- Select version of conventions to check against
- Checks the metadata, NOT the data!
- Command line version for batch processing

CF - How to get involved

- **Q:** Who are the CF community?
- **A:** Anyone who wants to be!

CF website

- <http://cfconventions.org/>

CF mailing list

- <http://mailman.cgd.ucar.edu/mailman/listinfo/cf-metadata>
- For general CF discussion and new standard names

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