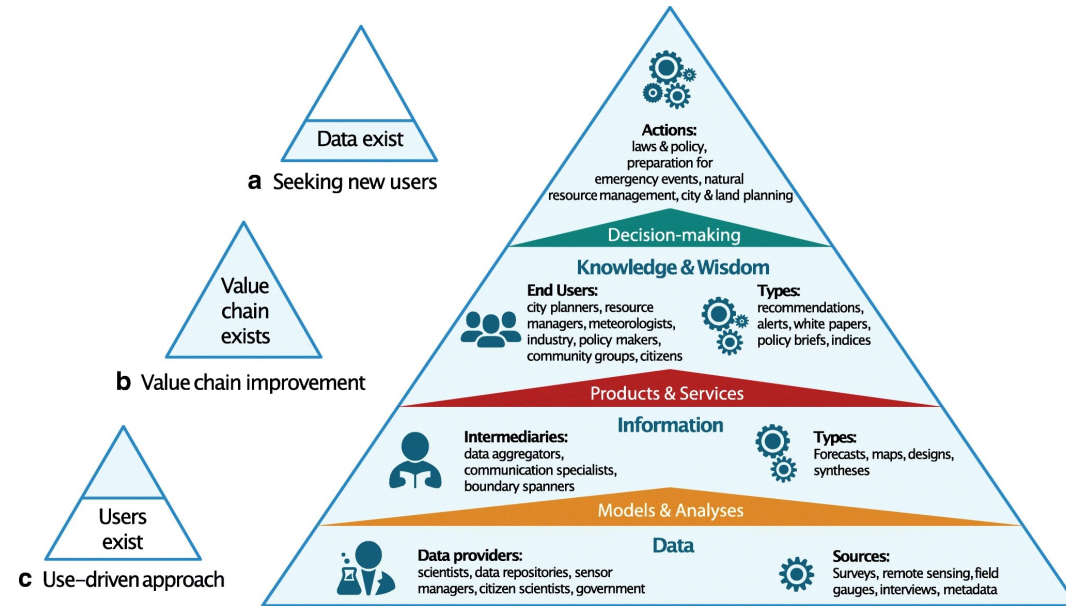# Outline

- Standard names, vocabularies

- NetCDF/CF grid, trajectory, profile, timeseries

- Granularity requirements

Benefits of standardised documentation

- Why not use the "Google" approach?
- Science is based on a shared terminology
  - There will never be only one proper way of documenting
  - There will always be a need for brokering
- Data and metadata must be connected
  - To find data
  - To use data

- Standardised documentation and formatting
  - enables the possibility to filter datasets
  - enables the possibility to link datasets
  - enables standardised applications to analyse data
  - enables users to use the data
- Need to be pragmatic…
  - And let computers do the boring part
  - But humans need to instruct computers

NorDataNet
Norwegian Scientific Data Network

Standardised documentation criteria

- Self contained information
  - Structural representation of data
  - Semantic annotation of data and structures
  - Avoid using "containers"
  - Slicing of data during analysis
  - Sustainability of format specification, tools and APIs

a Seeking new users — Data exist

b Value chain improvement — Value chain exists

c Use–driven approach — Users exist

Actions: laws & policy, preparation for emergency events, natural resource management, city & land planning

Decision-making

Knowledge & Wisdom

End Users: city planners, resource managers, meteorologists, industry, policy makers, community groups, citizens

Types: recommendations, alerts, white papers, policy briefs, indices

Products & Services

Information

Intermediaries: data aggregators, communication specialists, boundary spanners

Types: Forecasts, maps, designs, syntheses

Models & Analyses

Data

Data providers: scientists, data repositories, sensor managers, citizen scientists, government

**Sources:** Surveys, remote sensing, field gauges, interviews, metadata

Virapongse, A., Pearlman, F., Pearlman, J. et al. Ten rules to increase the societal value of earth observations. Earth Sci Inform 13, 233–247 (2020). https://doi.org/10.1007/s12145-020-00453-w

Data Formats: Choosing and Adopting Community Accepted Standards

- Most projects (rightly so) focus on the content of their data files, you need to consider the format as well.

- Since you captured or created the data, and stored them in your own files, you know
    - how the data are organized,
    - how to read them,
    - how to use them,
    - characteristics of the data that could constrain their use.

- **The goal of a good data format is to make it easier for others to read the data too.**

- Many hours have gone into developing standards for formats – try to learn from them.

Curt Tilmes, NASA, 2013 ESIP Material

Why use community standards

- If you try to develop your data format from scratch, you will forget something.

- Build on the experience and improvements built into the community standards over years of use.

- Tools and analysis software natively support reading community standard data.

- Reduce development effort and support reuse.

- Positive feedback – they are more likely to be adopted by others.

http://xkcd.com/927/

Curt Tilmes, NASA, 2013 ESIP Material
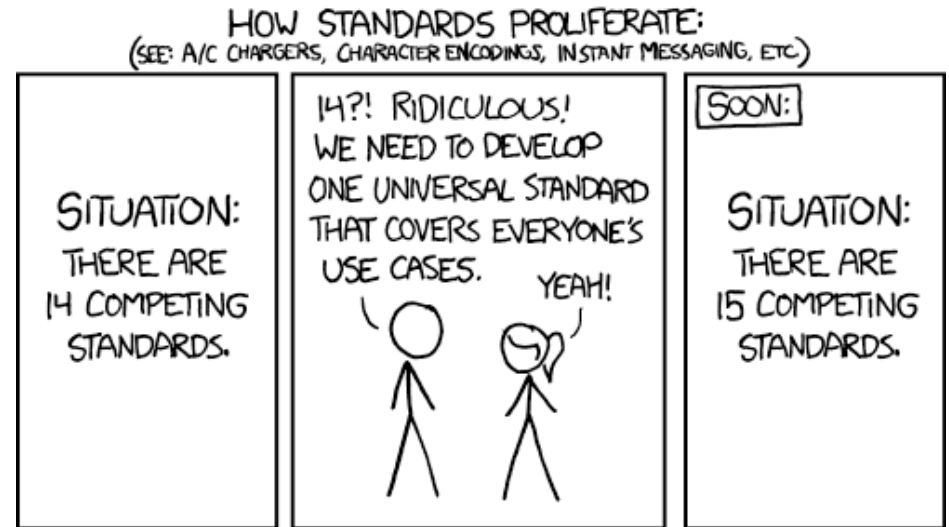
There is nothing like a perfect standard...

NorDataNet
Norwegian Scientific Data Network

Use self describing data formats

- Self-describing data formats have become a well accepted way of archiving and disseminating scientific data.

- Before self-describing data formats became widely used, each project often invented their own data formats, often raw binary or even ASCII.

- These approaches had a number of problems:
  - Machine dependent byte ordering or floating point organizations
  - Required a 'key' to be able to open the file and read the right data.
  - A new custom reader is needed for each different data organization. Working in a new language could be very difficult since you have to redevelop the reader anew.
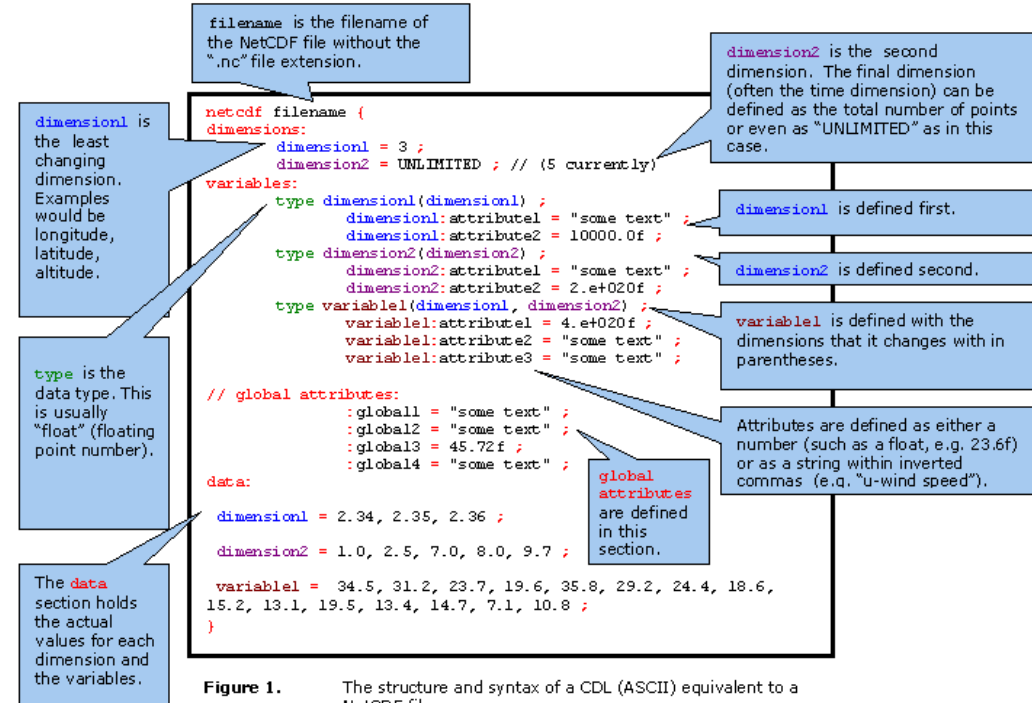
Figure 1. The structure and syntax of a CDL (ASCII) equivalent to a NetCDF file.

Curt Tilmes, NASA, 2013 ESIP Material

NetCDF Climate and Forecast (CF) Metadata Conventions

Brian Eaton · Jonathan Gregory · Bob Drach · Karl Taylor · Steve Hankin · Jon Blower · John Caron · Rich Signell · Phil Bentley · Greg Rappa · Heinke Höck · Alison Pamment · Martin Juckes · Martin Raspaud – Version 1.7

Table of Contents

featureType	Description of a single feature with this discrete sampling geometry		Link
	Form of a data variable containing values defined on a collection of these features	**Mandatory space-time coordinates for a collection of these features**	
point	a single data point (having no implied coordinate relationship to other points)		
	data(i)	x(i) y(i) t(i)	Section H.1, "Point Data"
timeSeries	a series of data points at the same spatial location with monotonically increasing times		
	data(i,o)	x(i) y(i) t(i,o)	Section H.2, "Time Series Data"
trajectory	a series of data points along a path through space with monotonically increasing times		
	data(i,o)	x(i,o) y(i,o) t(i,o)	Section H.4, "Trajectory Data"
profile	an ordered set of data points along a vertical line at a fixed horizontal position and fixed time		
	data(i,o)	x(i) y(i) z(i,o) t(i)	Section H.3, "Profile Data"
timeSeriesProfile	a series of profile features at the same horizontal position with monotonically increasing times		
	data(i,p,o)	x(i) y(i) z(i,p,o) t(i,p)	Section H.5, "Time Series of Profiles"
trajectoryProfile	a series of profile features located at points ordered along a trajectory		
	data(i,p,o)	x(i,p) y(i,p) z(i,p,o) t(i,p)	Section H.6, "Trajectory of Profiles"

List of Tables

Data consumers

Data consumer
Services

Common Data Model

Data provider
services

Data providers

NorDataNet
Norwegian Scientific Data Network

Storage format 1

Storage format 2

Storage format 3

Storage format 4

Storage format 5

Adapter

Common Data Model

OPeNDAP

Dataset
description
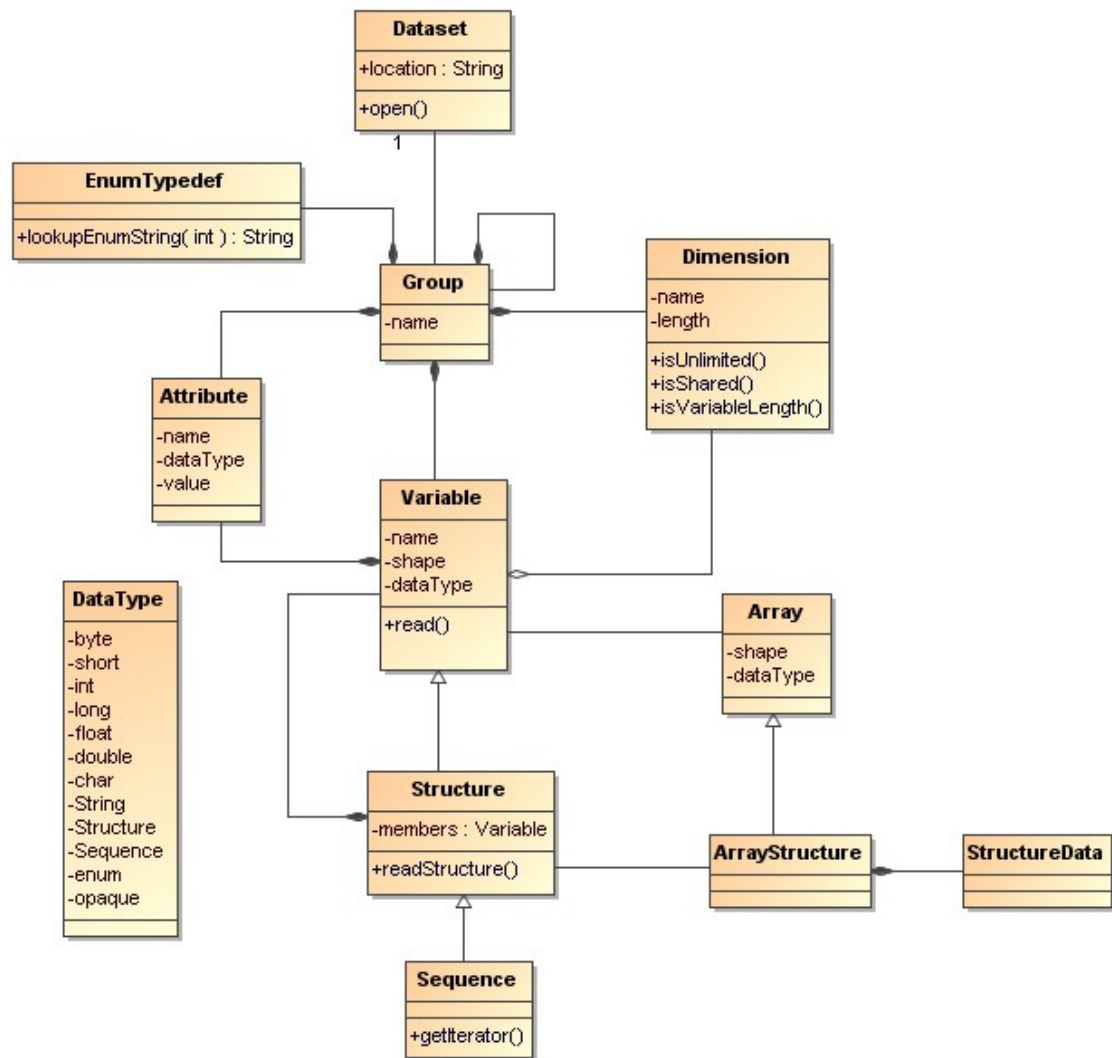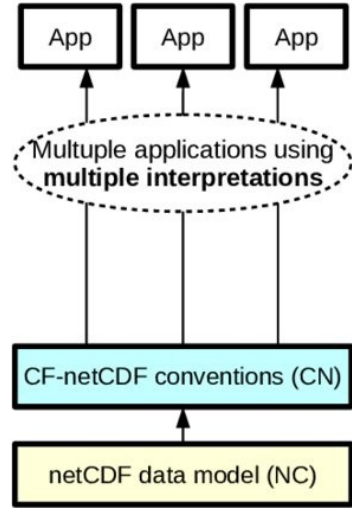
Data
(Binary/ASCII)
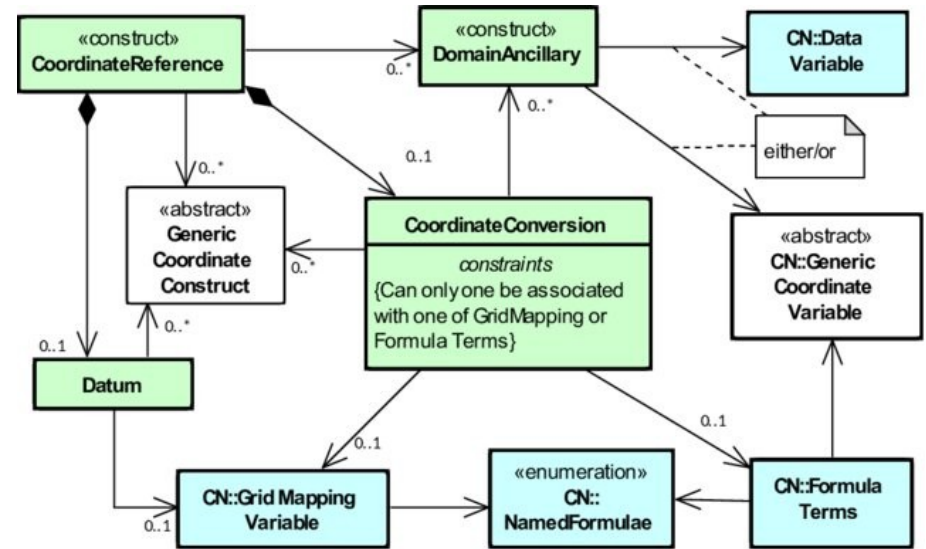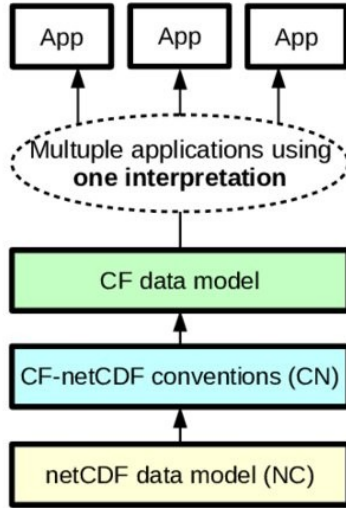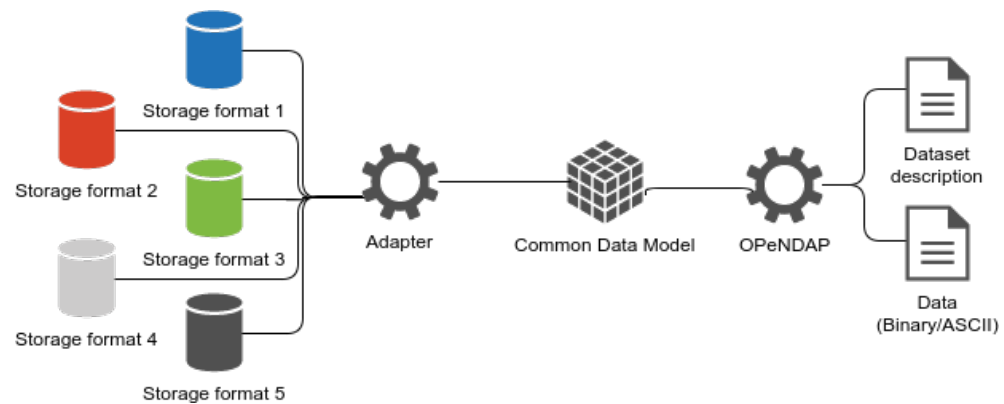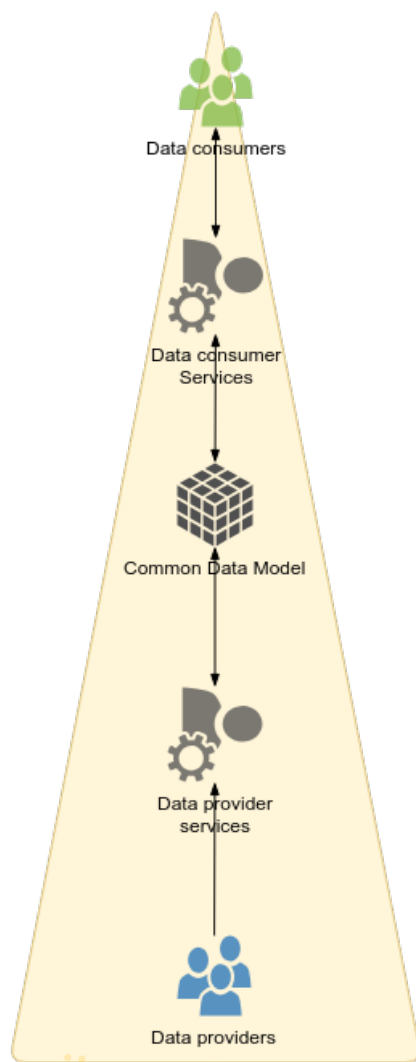
CF Standard Name Table

Version 66, 15 May 2019

Refer to the [Guidelines for Construction of CF Standard Names](#) for information on how the names are constructed and interpreted, and how new names could be derived.

A note about units
The canonical units associated with each standard name are usually the SI units for the quantity. [Section 3.3 of the CF conventions](#) states: "Unless it is dimensionless, a variable with a standard_name attribute must have units which are physically equivalent (not necessarily identical) to the canonical units, possibly modified by an operation specified by either the standard name modifier … or by the cell_methods attribute." Furthermore, [Section 1.3 of the CF conventions](#) states: "The values of the units attributes are character strings that are recognized by UNIDATA's Udunits package [UDUNITS], (with exceptions allowed as discussed in Section 3.1, "Units")." For example, a variable with the standard name of "air_temperature" may have a units attribute of "degree_Celsius" because Celsius can be converted to Kelvin by Udunits. For the full range of supported units, refer to the [Udunits documentation](#). Refer to the [CF conventions](#) for full details of the units attribute.

Search

temperature		
	Search Standard Names	Show All Standard Names

○ AND ● OR (separate search terms with spaces)
☐ Also search help text
Found 132 standard names matching query: temperature

View by Category

[Atmospheric Chemistry](#)	[Atmosphere Dynamics](#)	[Carbon Cycle](#)	[Cloud](#)	[Hydrology](#)
[Ocean Dynamics](#)	[Radiation](#)	[Sea Ice](#)	[Surface](#)	

Standard Name	Canonical Units	AMIP	GRIB
▶ air_potential_temperature	K	theta	13
▼ air_temperature	K	ta	11 E130
Air temperature is the bulk temperature of the air, not the surface (skin) temperature.			
▶ air_temperature_anomaly	K		25
▶ air_temperature_at_cloud_top	K		
▶ air_temperature_at_effective_cloud_top_defined_by_infrared_radiation	K		
▶ air_temperature_lapse_rate	K m-1		19
▶ air_temperature_threshold	K		
▶ brightness_temperature	K		118
▶ brightness_temperature_anomaly	K		
▶ brightness_temperature_at_cloud_top	K		
▶ canopy_temperature	K		

```
netcdf radflux_bjornoya {
dimensions:
        time = UNLIMITED ; // (3847970 currently)
        strlen25 = 25 ;
variables:
        double time(time) ;
                time:long_name = "time of the observation" ;
                time:short_name = "time" ;
                time:standard_name = "time" ;
                time:units = "seconds since 1970-01-01 00:00:00 UTC" ;
                time:axis = "T" ;
        char stationid(strlen25) ;
                stationid:long_name = "name and/or stationnumber used as identif
ier" ;
        float latitude ;
                latitude:long_name = "latitude" ;
                latitude:short_name = "latitude" ;
                latitude:standard_name = "latitude" ;
                latitude:units = "degree_north" ;
                latitude:valid_min = -90.f ;
                latitude:valid_max = 90.f ;
        float longitude ;
                longitude:long_name = "longitude" ;
                longitude:short_name = "longitude" ;
                longitude:standard_name = "longitude" ;
                longitude:units = "degree_east" ;
                longitude:valid_min = -180.f ;
                longitude:valid_max = 180.f ;
        float ssi(time) ;
                ssi:long_name = "shortwave irradiation at the surface" ;
                ssi:short_name = "ssi" ;
                ssi:standard_name = "surface_downwelling_shortwave_flux" ;
                ssi:_FillValue = -999.f ;
                ssi:units = "watts/meter2" ;
                ssi:cell_method = "time: mean (last minute)" ;
        float ssisenstemp(time) ;
                ssisenstemp:long_name = "temperature of the surface shortwave ir
radiation sensor" ;
                ssisenstemp:short_name = "ssisenstemp" ;
                ssisenstemp:_FillValue = -999.f ;
                ssisenstemp:units = "degC" ;
                ssisenstemp:cell_method = "time: mean (last minute)" ;
        float dli(time) ;
                dli:long_name = "difference between downward atmospheric longwav
e irradiation and emitted CGR4 irradiance" ;
                dli:short_name = "dli" ;
                dli:standard_name = "surface_net_downward_longwave_flux" ;
                dli:_FillValue = -999.f ;
                dli:units = "watts/meter2" ;
                dli:cell_method = "time: mean (last minute)" ;
        float dlisenstemp(time) ;
                dlisenstemp:long_name = "temperature of the surface longwave irr
adiation sensor" ;
                dlisenstemp:short_name = "dlisenstemp" ;
                dlisenstemp:_FillValue = -999.f ;
                dlisenstemp:units = "degC" ;
                dlisenstemp:cell_method = "time: mean (last minute)" ;
        float battery(time) ;
                battery:long_name = "minimum battery voltage" ;
                battery:short_name = "battery" ;
                battery:_FillValue = -999.f ;
                battery:units = "V" ;
                battery:cell_method = "time: min (last minute)" ;
```

```
// global attributes:
                :Conventions = "CF-1.0" ;
                :history = "2008-10-23 creation\n",
                        "2016-01-01 revision" ;
                :title = "Downwelling surface radiative fluxes at Bear Island" ;
                :abstract = "Downwelling surface radiative fluxes observed at th
e meteorological station at Bear Island in the Barents Sea. Measurements are mad
e using Kipp and Zonen CMP21 and CGR4 pyranometers and pyrgeometers. Daily maint
enance is performed by the meteorological personnel at the station. Data are ave
raged over the last minute and the time is set to UTC. This data set has been co
llected with support from the Norwegian Research Council. The quality control fo
cus on the radiative parameters, thus sensor temperatures may contain errors." ;
                :topiccategory = "ClimatologyMeteorologyAtmosphere" ;
                :keywords = "Radiative Flux" ;
                :gcmd_keywords = "Atmosphere > Atmospheric Radiation > Shortwave
 Radiation\n",
                        "Atmosphere > Atmospheric Radiation > Longwave Radiation
" ;
                :area = "Barents Sea" ;
                :activity_type = "Land station" ;
                :PI_name = "<D8>ystein God<F8>y" ;
                :contact = "o.godoy@met.no" ;
                :institution = "Norwegian Meteorological Institute" ;
                :url = "http://www.met.no/" ;
                :product_name = "radiative fluxes" ;
                :Platform_name = "Bj<F8>rn<F8>ya" ;
                :project_name = "iAOOS-Norway/IPY-THORPEX" ;
                :start_date = "2008-04-01 13:14 UTC" ;
                :stop_date = "2015-12-16 12:50 UTC" ;
                :distribution_statement = "Restricted to iAOOS-Norway" ;
                :southernmost_latitude = 74.5166667 ;
                :northernmost_latitude = 74.5166667 ;
                :westernmost_longitude = 19.01666667 ;
                :easternmost_longitude = 19.01666667 ;
                :quality_statement = "Quality controlled" ;
                :nco_openmp_thread_number = 1 ;
data:

 time = 1207055640, 1207055700, 1207055760, 1207055820, 1207055880,
    1207055940, 1207056000, 1207056060, 1207056120, 1207056180, 1207056240,
    1207056300, 1207056360, 1207056420, 1207056480, 1207056540, 1207056600,
    1207056660, 1207056720, 1207056780, 1207056840, 1207056900, 1207056960,
    1207057020, 1207057080, 1207057140, 1207057200, 1207057260, 1207057320,
    1207057380, 1207057440, 1207057500, 1207057560, 1207057620, 1207057680,
    1207057740, 1207057800, 1207057860, 1207057920, 1207057980, 1207058040,
    1207058100, 1207058160, 1207058220, 1207058280, 1207058340, 1207058400,
    1207058460, 1207058520, 1207058580, 1207058640, 1207058700, 1207058760,
    1207058820, 1207058880, 1207058940, 1207059000, 1207059060, 1207059120,
    1207059180, 1207059240, 1207059300, 1207059360, 1207059420, 1207059480,
    1207059540, 1207059600, 1207059660, 1207059720, 1207059780, 1207059840,
    1207059900, 1207059960, 1207060020, 1207060080, 1207060140, 1207060200,
    1207060260, 1207060320, 1207060380, 1207060440, 1207060500, 1207060560,
    1207060620, 1207060680, 1207060740, 1207060800, 1207060860, 1207060920,
    1207060980, 1207061040, 1207061100, 1207061160, 1207061220, 1207061280,
    1207061340, 1207061400, 1207061460, 1207061520, 1207061580, 1207061640,
    1207061700, 1207061760, 1207061880, 1207061940, 1207062000,
    1207062060, 1207062120, 1207062180, 1207062240, 1207062300, 1207062360,
    1207062420, 1207062480, 1207062540, 1207062600, 1207062660, 1207062720,
    1207062780, 1207062840, 1207062900, 1207062960, 1207063020, 1207063080,
    1207063140, 1207063200, 1207063260, 1207063320, 1207063380, 1207063440,
    1207063500, 1207063560, 1207063620, 1207063680, 1207063740, 1207063800,
    1207063860, 1207063920, 1207063980, 1207064040, 1207064100, 1207064160,
    1207064220, 1207064280, 1207064340, 1207064400, 1207064460, 1207064520,
```

File   Edit   View   Bookmarks   Settings   Help

Bjørnøya : ncdump

NorDataNet
Norwegian Scientific Data Network

Bjørnøya : ncview — Konsole

File   Edit   View   Bookmarks   Settings   Help

```
-rw-rw-r-- 1 steingod steingod 2,6M mai    1  2015 radflux_bjornoya-201504.dat
-rw-rw-r-- 1 steingod steingod 1,2M mai    1  2015 radflux_bjornoya-201504.nc
-rw-rw-r-- 1 steingod steingod 2,6M juni   1  2015 radflux_bjornoya-201505.dat
-rw-rw-r-- 1 steingod steingod 1,2M juni   1  2015 radflux_bjornoya-201505.nc
-rw-rw-r-- 1 steingod steingod 2,4M juli   1  2015 radflux_bjornoya-201506.dat
-rw-rw-r-- 1 steingod steingod 1,1M juli   1  2015 radflux_bjornoya-201506.nc
-rw-rw-r-- 1 steingod steingod 2,4M aug.   1  2015 radflux_bjornoya-201507.dat
-rw-rw-r-- 1 steingod steingod 1,1M aug.   1  2015 radflux_bjornoya-201507.nc
-rw-rw-r-- 1 steingod steingod 2,5M sep.   1  2015 radflux_bjornoya-201508.dat
-rw-rw-r-- 1 steingod steingod 1,2M sep.   1  2015 radflux_bjornoya-201508.nc
-rw-rw-r-- 1 steingod steingod 2,4M okt.   1  2015 radflux_bjornoya-201509.dat
-rw-rw-r-- 1 steingod steingod 2,2M nov.   1  2015 radflux_bjornoya-201510.dat
-rw-rw-r-- 1 steingod steingod 2,6M des.   1  2015 radflux_bjornoya-201511.dat
-rw-rw-r-- 1 steingod steingod 1,2M des.   1  2015 radflux_bjornoya-201511.nc
-rw-rw-r-- 1 steingod steingod 1,4M jan.   1  2016 radflux_bjornoya-201512.dat
-rw-rw-r-- 1 steingod steingod 616K jan.   1  2016 radflux_bjornoya-201512.nc
-rw-rw-r-- 1 steingod steingod  15M aug.  16  2016 radflux_bjornoya-2016.cdl
-rw-rw-r-- 1 steingod steingod  21M aug.  16  2016 radflux_bjornoya-2016.dat
-rw-rw-r-- 1 steingod steingod 9,4M aug.  16  2016 radflux_bjornoya-2016.nc
-rw-rw-r-- 1 steingod steingod 103M okt.  14  2016 radflux_bjornoya.nc
-rw-rw-r-- 1 steingod steingod  73M aug.  29  2013 radflux_Bjørnøya.nc
-rw-rw-r-- 1 steingod steingod  32M aug.  29  2013 radflux_Bjørnøya.tgz
-rwxr-xr-x 1 steingod steingod  322 juni   6  2008 radobs_collection_status.txt*
drwxr-xr-x 2 steingod steingod 4,0K juni  25  2013 tmp/
drwxr-xr-x 2 steingod steingod 4,0K juni  25  2013 tmp2/
steingod@tuba:/disk1/data/radflux/Bjørnøya$ ncdump radflux_bjornoya.nc | m
steingod@tuba:/disk1/data/radflux/Bjørnøya$ ncview radflux_bjornoya.nc
Ncview 2.1.6 David W. Pierce  29 Oct 2015
http://meteora.ucsd.edu:80/~pierce/ncview_home_page.html
Copyright (C) 1993 through 2015, David W. Pierce
Ncview comes with ABSOLUTELY NO WARRANTY; for details type `ncview -w'.
This is free software licensed under the Gnu General Public License version 3; t
ype `ncview -c' for redistribution details.

Warning: Cannot convert string "-*-helvetica-*-r-*-*-14-*-*-*-*-*-*-*" to type F
ontStruct
Note: 43208 missing values were eliminated along axis "time"; index= 1 2 3 4 5
6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 4294967298..
```

Bjørnøya : ncview

Ncview 2.1.6

no variable selected

Ncview 2.1.6 David W. Pierce 29 Oct 2015

*** SELECT A VARIABLE TO START ***

Current: x=20-May-2008 10:10:08, y=904.478

Quit   ->1   ⏪   ◀   ⏸   ▶   ⏩   Edit   ?   Delay: Opts

3gauss   Inv P   Inv C   Mag X1   Linear   Axes   Range   Bi-lin   Print

Var: stationid

dlisenstemp

Dim: Name: Min:

strlen25   Min:

---

shortwave irradiation at the surface from D…ing surface radiative fluxes at Bear Island

Close   Print   Dump   Locked

shortwave irradiation at the surface from Downwelling surface radiative fluxes at Bear Island

X Axis: time   Use Log: X   Y   X Range   Y Range

NorDataNet
Norwegian Scientific Data Network

Window 1 (left):
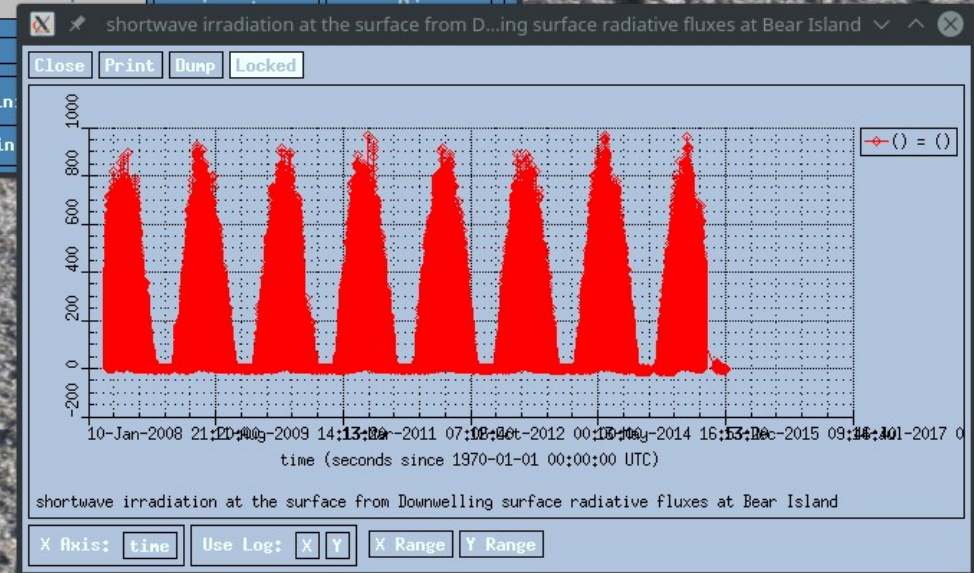
```
netcdf obs-temp_01028 {
dimensions:
        obs = UNLIMITED ; // (299 currently)
        profile = 30000 ;
        name_strlen = 5 ;
variables:
        float lon ;
                lon:long_name = "station longit
                lon:standard_name = "longitude"
                lon:units = "degrees_east" ;
        float lat ;
                lat:long_name = "station latitu
                lat:standard_name = "latitude"
                lat:units = "degrees_north" ;
        float alt ;
                alt:long_name = "station altitu
                alt:standard_name = "height" ;
                alt:units = "m" ;
        char station_wmonr(name_strlen) ;
                station_wmonr:long_name = "WMO
        double time(profile) ;
                time:standard_name = "time" ;
                time:long_name = "time_of_radio
                time:units = "seconds since 197
                time:axis = "T" ;
                time:cf_role = "profile_id" ;
        int row_size(profile) ;
                row_size:long_name = "number of
                row_size:sample_dimension = "ob
        float PP(obs) ;
                PP:long_name = "pressure level"
                PP:standard_name = "air_pressur
                PP:units = "hPa" ;
                PP:axis = "Z" ;
        int vss(obs) ;
                vss:long_name = "Vertical sound
                vss:flag_masks = 131072, 65536,
1024, 512, 256, 128, 64, 32, 16, 8, 2 ;
:
```

nc_to_mmd : bash   gcw : less   applic

Window 2 (middle):

```
                PP:units = "hPa" ;
                PP:axis = "Z" ;
        int vss(obs)
                vss:long_name = "Vertical soun
                vss:flag_masks = 131072, 65536
1024, 512, 256, 128, 64, 32, 16, 8, 2 ;
                vss:flag_meanings = "surface_le
el maximum_wind_level significant_level_tempera
ignificant_level_wind beginning_of_missing_temp
rature_data beginning_of_missing_humidity_data
nning_of_missing_wind_data end_of_missing_wind_
etermined_by_regional_decision pressure_level_o
the_vertical_coordinate"
                vss:valid_range = 0, 262142 ;
                vss:_FillValue = 262143 ;
                vss:coordinates = "time PP" ;
        float gh(obs) ;
                gh:long_name = "geopotential h
                gh:standard_name = "geopotentia
                gh:units = "m" ;
                gh:_FillValue = -999.f ;
                gh:coordinates = "time PP" ;
        float TT(obs) ;
                TT:long_name = "air temperature
                TT:standard_name = "air_tempera
                TT:units = "Celsius" ;
                TT:_FillValue = -999.f ;
                TT:coordinates = "time PP" ;
        float TD(obs) ;
                TD:long_name = "dew point temp
                TD:standard_name = "dew_point_t
                TD:units = "Celsius" ;
                TD:_FillValue = -999.f ;
                TD:coordinates = "time PP" ;
        float FF(obs) ;
                FF:long_name = "wind speed" ;
                FF:standard_name = "wind_speed
                FF:units = "m s-1" ;
```
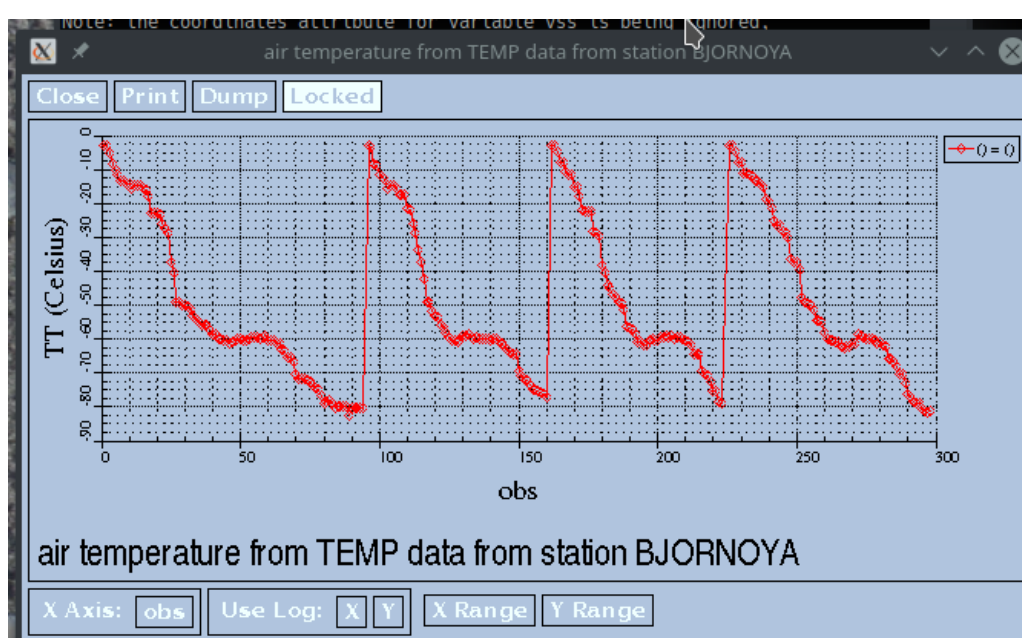
nc_to_mmd : bash   gcw : less   applic

Window 3 (right):

```
                FF:_FillValue = -999.f ;
                FF:coordinates = "time PP" ;
        float DD(obs) ;
                DD:long_name = "wind direction" ;
                DD:standard_name = "wind_from_direction" ;
                DD:units = "degree" ;
                DD:_FillValue = -999.f ;
                DD:coordinates = "time PP" ;

// global attributes:
                :featureType = "timeSeriesProfile" ;
                :title = "TEMP data from station BJORNOYA" ;
                :abstract = "Radiosonde profiles from BJORNOYA" ;
                :institution = "Norwegian Meteorological Institute" ;
                :contact = "o.godoy@met.no" ;
                :PI_name = "Øystein Godøy" ;
                :Conventions = "CF-1.7" ;
                :activity_type = "Land station" ;
                :topiccategory = "ClimatologyMeteorologyAtmosphere" ;
                :keywords = "Atmospheric Observation Temperature Humidity Pressu
re  Wind Radiosonde TEMP" ;
                :gcmd_keywords = "Atmosphere > Atmospheric Pressure > Surface Pr
essure\n",

                        "Atmosphere > Atmospheric Temperature > Surface Air Temp
erature\n",

                        "Atmosphere > Atmospheric Water Vapor > Humidity" ;
                :project_name = "ACCESS" ;
                :area = "Northern Hemisphere" ;
                :product_name = "TEMP" ;
                :distribution_statement = "Free" ;
                :history = "2019-02-14 revision" ;
                :southernmost_latitude = 74.5038f ;
                :northernmost_latitude = 74.5038f ;
                :westernmost_longitude = 19.0012f ;
                :easternmost_longitude = 19.0012f ;
                :start_date = "2018-01-01 00:00:00 UTC" ;
                :stop_date = "2018-01-02 00:00:00 UTC" ;
}
(END)
```

nc_to_mmd : bash   gcw : less   applicate : bash

NorDataNet
Norwegian Scientific Data Network

```
netcdf edge_nh_agg {
dimensions:
        nv = 2 ;
        time = 5642 ;
        xc = 760 ;
        yc = 1120 ;
variables:
        int Polar_Stereographic_Grid ;
                Polar_Stereographic_Grid:grid_mapping_name = "polar_stereographi
c" ;
                Polar_Stereographic_Grid:straight_vertical_longitude_from_pole =
 -45.f ;
                Polar_Stereographic_Grid:latitude_of_projection_origin = 90.f ;
                Polar_Stereographic_Grid:standard_parallel = 70.f ;
                Polar_Stereographic_Grid:false_easting = 0.f ;
                Polar_Stereographic_Grid:false_northing = 0.f ;
                Polar_Stereographic_Grid:semi_major_axis = 6378273.f ;
                Polar_Stereographic_Grid:semi_minor_axis = 6356890.f ;
                Polar_Stereographic_Grid:proj4_string = "+proj=stere +a=6378273
+b=6356889.44891 +lat_0=90 +lat_ts=70 +lon_0=-45" ;
        double xc(xc) ;
                xc:axis = "X" ;
                xc:units = "km" ;
                xc:long_name = "x coordinate of projection (eastings)" ;
                xc:standard_name = "projection_x_coordinate" ;
        double yc(yc) ;
                yc:axis = "Y" ;
                yc:units = "km" ;
                yc:long_name = "y coordinate of projection (northings)" ;
                yc:standard_name = "projection_y_coordinate" ;
        double time(time) ;
                time:axis = "T" ;
                time:long_name = "reference time of product" ;
                time:standard_name = "time" ;
                time:units = "seconds since 1978-01-01 00:00:00" ;
                time:calendar = "standard" ;
                time:bounds = "time_bnds" ;
        double time_bnds(time, nv) ;
                time_bnds:units = "seconds since 1978-01-01 00:00:00" ;
        float lat(yc, xc) ;
                lat:long_name = "latitude coordinate" ;
                lat:standard_name = "latitude" ;
                lat:units = "degrees_north" ;
        float lon(yc, xc) ;
                lon:long_name = "longitude coordinate" ;
                lon:standard_name = "longitude" ;
                lon:units = "degrees_east" ;
        byte ice_edge(time, yc, xc) ;
                ice_edge:_Unsigned = "false" ;
                ice_edge:long_name = "sea ice edge" ;
                ice_edge:standard_name = "sea_ice_classification" ;
                ice_edge:_FillValue = -1b ;
                ice_edge:valid_min = 1b ;
                ice_edge:valid_max = 3b ;
                ice_edge:grid_mapping = "Polar_Stereographic_Grid" ;
                ice_edge:coordinates = "lat lon" ;
                ice_edge:flag_values = 1b, 2b, 3b ;
                ice_edge:flag_meanings = "open_water open_ice close_ice" ;
                ice_edge:flag_descriptions = "\n",
                        " 1 -> no ice or very open ice\n",
                        " 2 -> open ice cover (4 to 7 tens)\n",
                        " 3 -> close, very close and fast ice" ;
        byte confidence_level(time, yc, xc) ;
                confidence_level:_Unsigned = "false" ;
:
```

```
netcdf edge_nh_agg {
dimensions:
        nv = 2 ;
        time = 5642 ;
        xc = 760 ;
        yc = 1120 ;
variables:
        int Polar_Stereographic_Grid ;
                Polar_Stereographic_Grid:grid_mapping_name = "polar_stereographi
c" ;
                Polar_Stereographic_Grid:straight_vertical_longitude_from_pole =
 -45.f ;
                Polar_Stereographic_Grid:latitude_of_projection_origin = 90.f ;
                Polar_Stereographic_Grid:standard_parallel = 70.f ;
                Polar_Stereographic_Grid:false_easting = 0.f ;
                Polar_Stereographic_Grid:false_northing = 0.f ;
                Polar_Stereographic_Grid:semi_major_axis = 6378273.f ;
                Polar_Stereographic_Grid:semi_minor_axis = 6356890.f ;
                Polar_Stereographic_Grid:proj4_string = "+proj=stere +a=6378273
+b=6356889.44891 +lat_0=90 +lat_ts=70 +lon_0=-45" ;
        double xc(xc) ;
                xc:axis = "X" ;
                xc:units = "km" ;
                xc:long_name = "x coordinate of projection (eastings)" ;
                xc:standard_name = "projection_x_coordinate" ;
        double yc(yc) ;
                yc:axis = "Y" ;
                yc:units = "km" ;
                yc:long_name = "y coordinate of projection (northings)" ;
                yc:standard_name = "projection_y_coordinate" ;
        double time(time) ;
                time:axis = "T" ;
                time:long_name = "reference time of product" ;
                time:standard_name = "time" ;
                time:units = "seconds since 1978-01-01 00:00:00" ;
                time:calendar = "standard" ;
                time:bounds = "time_bnds" ;
        double time_bnds(time, nv) ;
                time_bnds:units = "seconds since 1978-01-01 00:00:00" ;
        float lat(yc, xc) ;
                lat:long_name = "latitude coordinate" ;
                lat:standard_name = "latitude" ;
                lat:units = "degrees_north" ;
        float lon(yc, xc) ;
                lon:long_name = "longitude coordinate" ;
                lon:standard_name = "longitude" ;
                lon:units = "degrees_east" ;
        byte ice_edge(time, yc, xc) ;
                ice_edge:_Unsigned = "false" ;
                ice_edge:long_name = "sea ice edge" ;
                ice_edge:standard_name = "sea_ice_classification" ;
                ice_edge:_FillValue = -1b ;
                ice_edge:valid_min = 1b ;
                ice_edge:valid_max = 3b ;
                ice_edge:grid_mapping = "Polar_Stereographic_Grid" ;
                ice_edge:coordinates = "lat lon" ;
                ice_edge:flag_values = 1b, 2b, 3b ;
                ice_edge:flag_meanings = "open_water open_ice close_ice" ;
                ice_edge:flag_descriptions = "\n",
                        " 1 -> no ice or very open ice\n",
                        " 2 -> open ice cover (4 to 7 tens)\n",
                        " 3 -> close, very close and fast ice" ;
        byte confidence_level(time, yc, xc) ;
                confidence_level:_Unsigned = "false" ;
:
```

```
                status_flag:flag_descriptions = "\n",
                        " 0 -> nominal value from algorithm used\n",
                        " 2 -> sea ice algorithm applied over lake\n",
                        " 10 -> background data was used for setting the value\n
",
                        " 14 -> value set using an ice type mask\n",
                        "100 -> missing value due to over land\n",
                        "101 -> missing value due to missing data\n",
                        "102 -> unclassified pixel" ;

// global attributes:
                :title = "Daily Sea Ice Edge Analysis from OSI SAF EUMETSAT" ;
                :product_id = "OSI-402" ;
                :product_name = "osi_saf_ice_edge" ;
                :product_status = "operational" ;
                :abstract = "The daily analysis of sea ice edges and  extent  is
 obtained\n",
                        "from operation satellite images of the polar regions.
",
                        "based on atmospherically  corrected  signal  and  a Ba
yesian\n",
                        "merging approch to estimate sea ice class probabilities
. This\n",
                        "product is freely available from the EUMETSAT Ocean  an
d  Sea\n",
                        "Ice Satellite Application Facility (OSI SAF)." ;
                :topiccategory = "Oceans ClimatologyMeteorologyAtmosphere" ;
                :keywords = "Sea Ice Edge,Sea Ice,Oceanography,Meteorology,Clima
te,Remote Sensing" ;
                :gcmd_keywords = "Cryosphere > Sea Ice > Ice Edges\n",
                        "Oceans > Sea Ice > Ice Edges\n",
                        "Cryosphere > Sea Ice > Ice Extent\n",
                        "Oceans > Sea Ice > Ice Extent\n",
                        "Geographic Region > Northern Hemisphere\n",
                        "Vertical Location > Sea Surface\n",
                        "EUMETSAT/OSISAF > Satellite Application Facility on Oce
an and Sea Ice, European Organisation for the Exploitation of Meteorological Sat
ellites" ;
                :northernmost_latitude = 90.f ;
                :southernmost_latitude = 31.02939f ;
                :easternmost_longitude = 180.f ;
                :westernmost_longitude = -180.f ;
                :activity_type = "Space borne instrument" ;
                :area = "Northern Hemisphere" ;
                :instrument_type = "Multi-sensor analysis" ;
                :platform_name = "Multi-sensor analysis" ;
                :start_date = "2020-09-05 00:00:00" ;
                :stop_date = "2020-09-06 00:00:00" ;
                :project_name = "EUMETSAT OSI SAF" ;
                :institution = "EUMETSAT OSI SAF" ;
                :PI_name = "Signe Aaboe" ;
                :contact = "osisaf-manager@met.no" ;
                :distribution_statement = "Free" ;
                :copyright_statement = "Copyright 2020 EUMETSAT" ;
                :references = "OSI SAF Sea Ice Edge and Type Product User\'s Man
ual, Aaboe, S., v1.1, 2015\n",
                        "http://osisaf.met.no\n",
                        "http://www.osi-saf.org" ;
                :history = "2020-09-06 creation" ;
                :product_version = "4.0" ;
                :software_version = "5.0" ;
                :netcdf_version = "3.6.3" ;
                :Conventions = "CF-1.4" ;
}
(END)
```
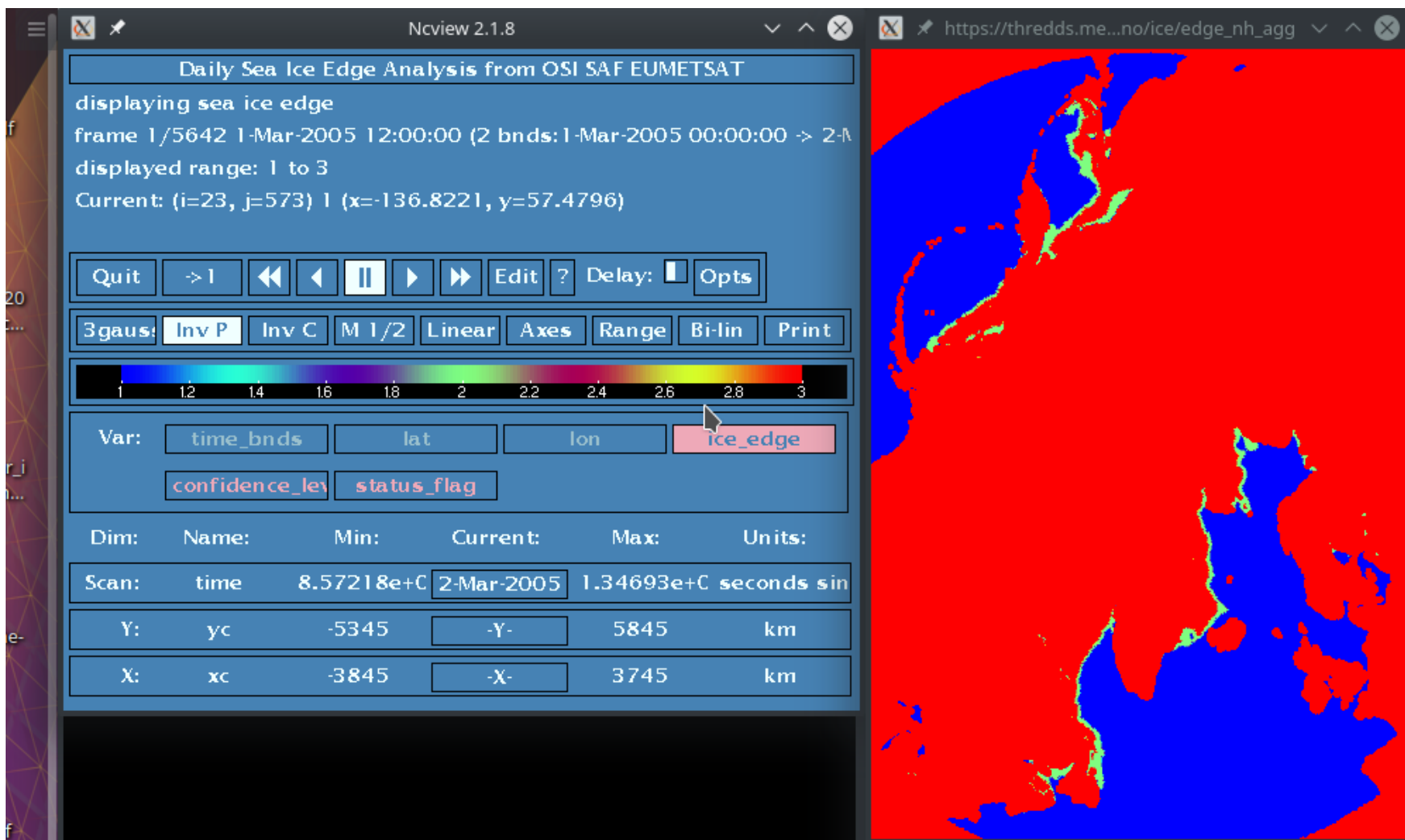
Why NetCDF and OPeNDAP?

- NetCDF-CF provides a self describing data
  - in a form compatible with semantic web approaches
  - allowing interdisciplinary use
  - suitable for many different types of data
  - widely used by science communities
  - those not using are often not using standardised approaches
  - Widely supported by analysis tools
  - http://www.cgd.ucar.edu/ccr/bettge/CSM-netCDF/csm_why_netcdf.html
- OPeNDAP provides data to be access over the internet as data streams
  - from programs that weren't originally designed for that purpose,
  - as well as some that were.
  - delivers data, not files
  - Segmenting data in time and space(s)
  - Bridges the message approach of operational data with the long time series approach of climate analysis
  - An OPeNDAP URL might point to an archive containing large volumes of data
  - OPeNDAP provides sophisticated server side sub-sampling capabilities
  - To continue http://docs.opendap.org/index.php/QuickStart

NorDataNet
Norwegian Scientific Data Network
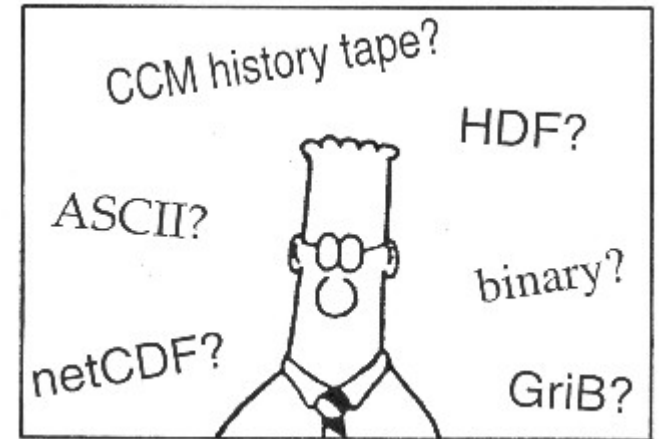
Climate and Forecast Conventions Governance

Discovery metadata embedded with data

- Attribute Convention for Data Discovery

- Current in version 1.3

- Allows discovery metadata to be generated automatically

- https://wiki.esipfed.org/Attribute_Convention_for_Data_Discovery_1-3

- https://www.nordatanet.no/en/node/172

- https://adc.met.no/node/4
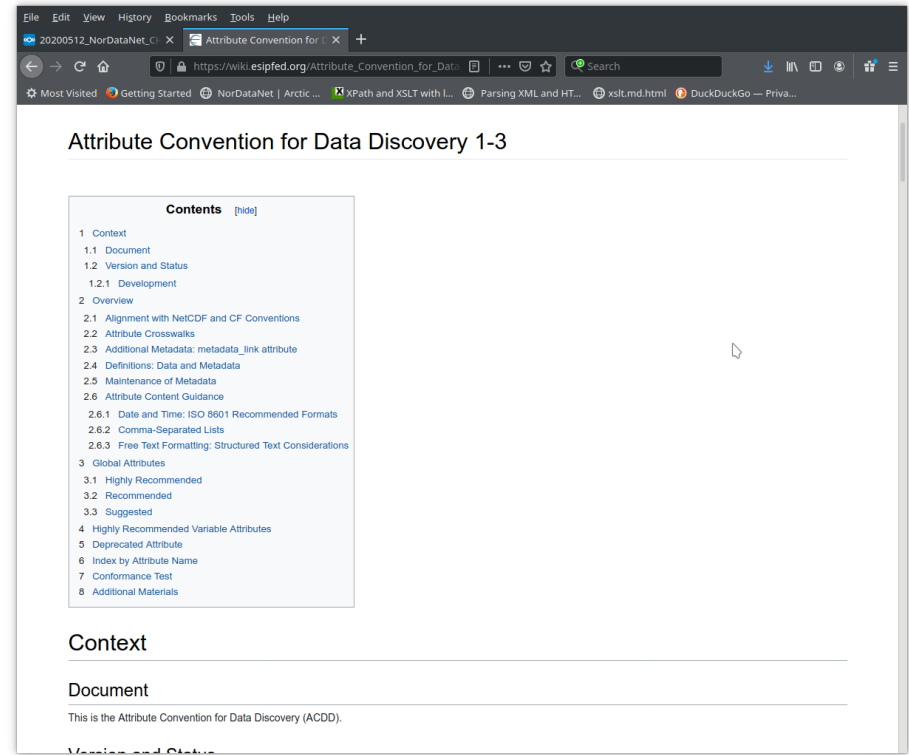
Granularity

- The level of detail considered in a model or decision making process.
  - The greater the granularity, the more detailed information.

- From granule
  - A small compact particle of substance

- Granular data are detailed data
  - The bits and pieces data are divided into

- To decide on granularity when publishing, think on user perspectives
  - Aggregation can be done automatically