

A low-poly, geometric illustration of an iceberg floating in a blue sea. The iceberg is composed of many triangular facets in various shades of blue and white. Only the tip of the iceberg is visible above the water line, while the much larger, submerged part is visible below the surface. The background is a solid light blue sky.

Data structure/formatting

Øystein Godøy and Markus Fiebig

Outline

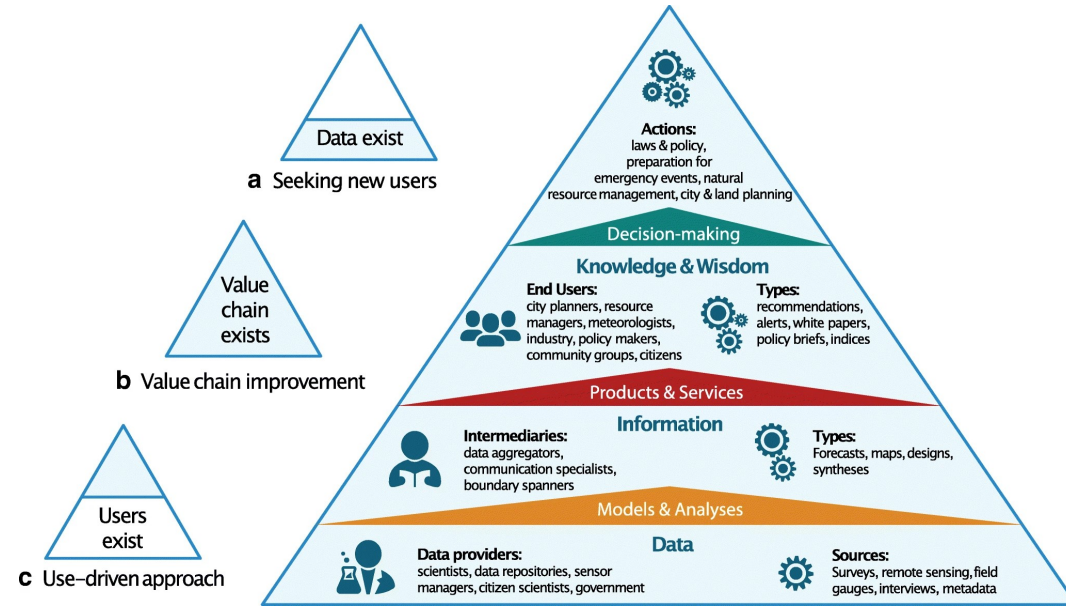
- Standard names, vocabularies
- NetCDF/CF grid, trajectory, profile, timeseries
- Granularity requirements

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

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



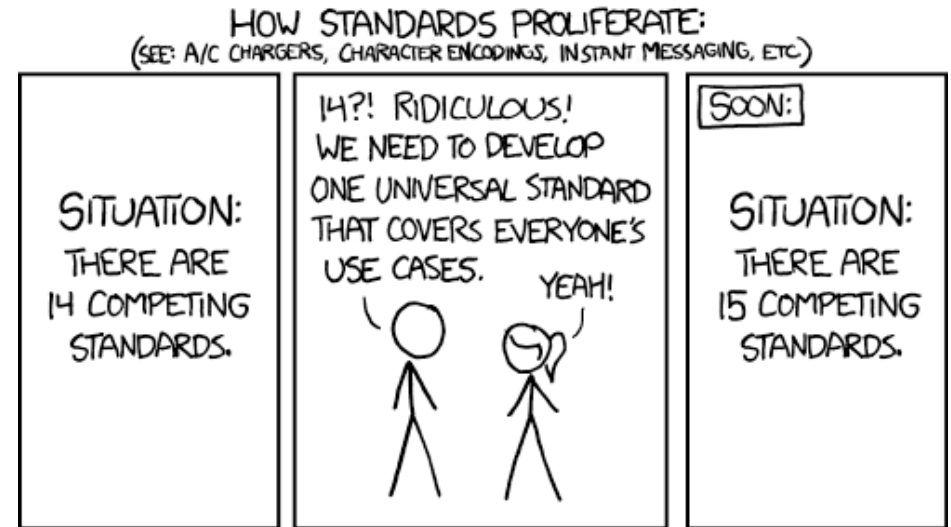
Virapongse, A., Pearlman, F., Pearlman, J. et al. Ten rules to increase the societal value of earth observations. *Earth Sci Inform* 13, 233–247 (2020). <https://doi.org/10.1007/s12145-020-00453-w>

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.

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/>

There is nothing like a perfect standard...

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.

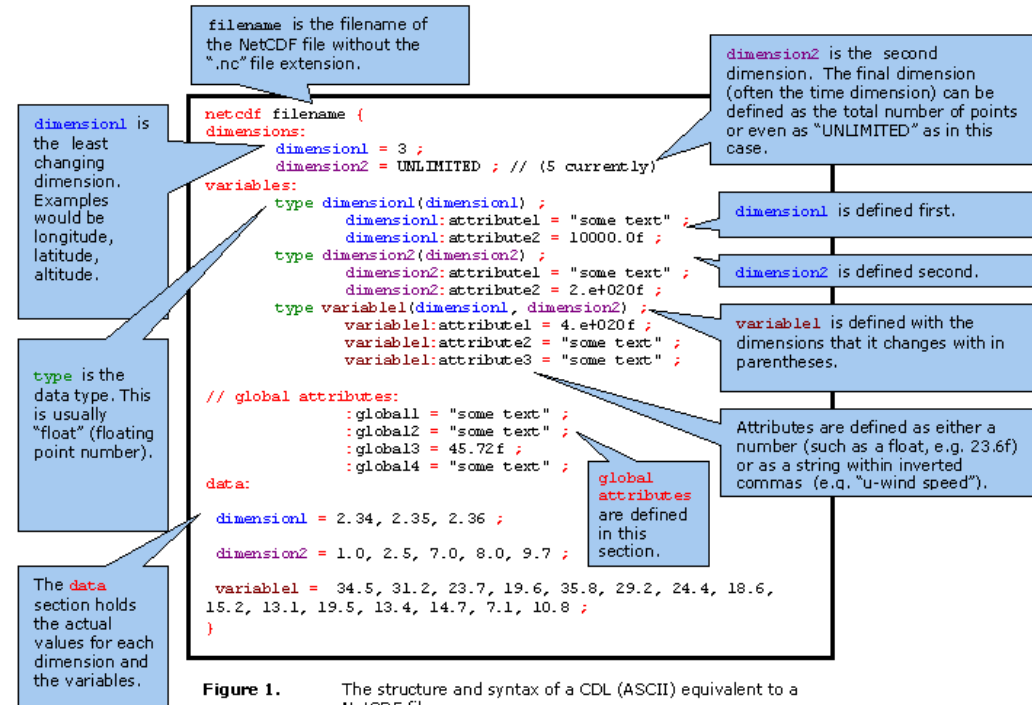


Figure 1. The structure and syntax of a CDL (ASCII) equivalent to a NetCDF file.

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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

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 - Atmosphere sigma coordinate

cell_method ^ v Highlight All Match Case Whole Words 4 of 55 matches

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"

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Data access

Coordinate systems

Data types

Point

Trajectory

Station

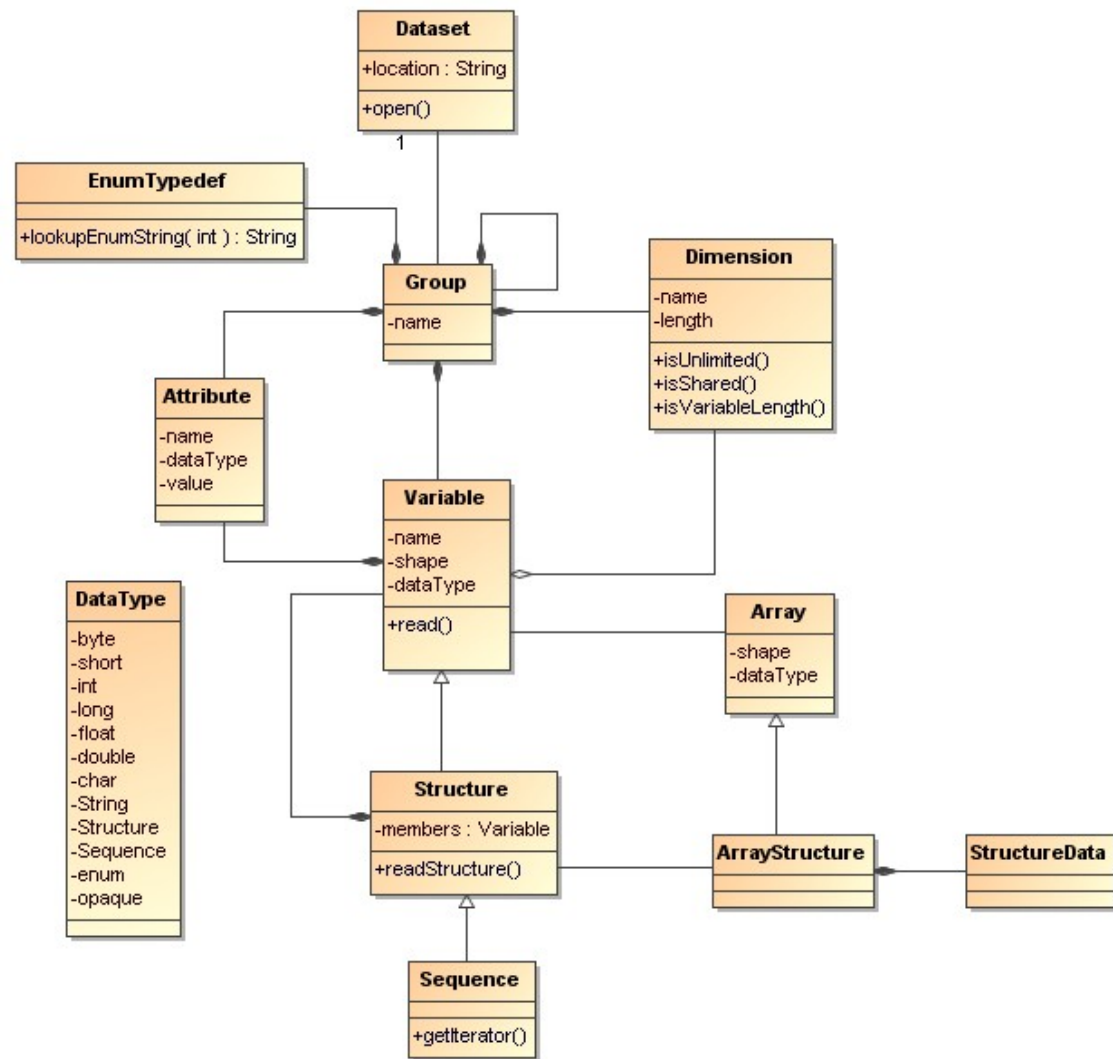
Profile

Grid

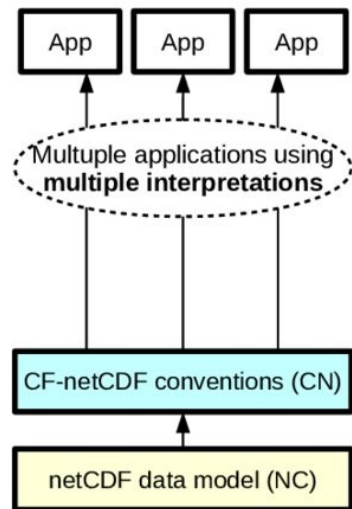
Swath

Radial

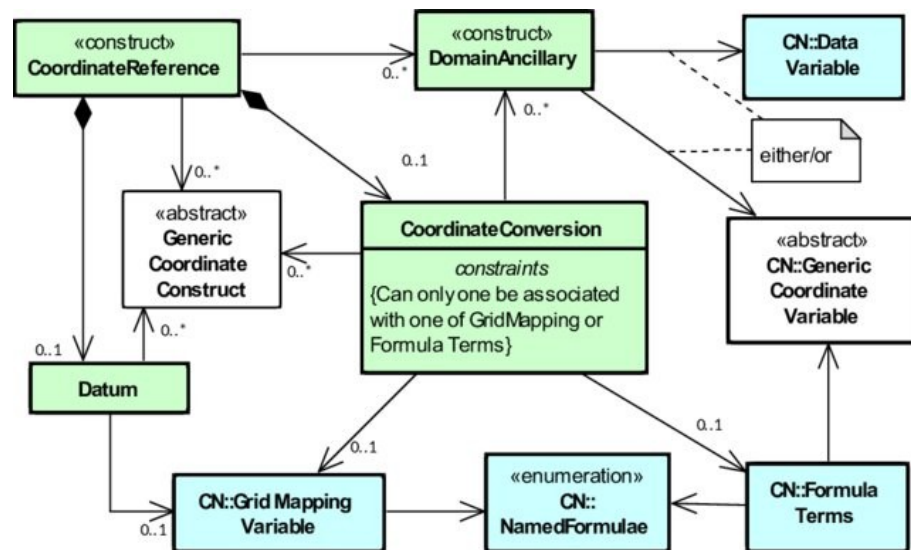
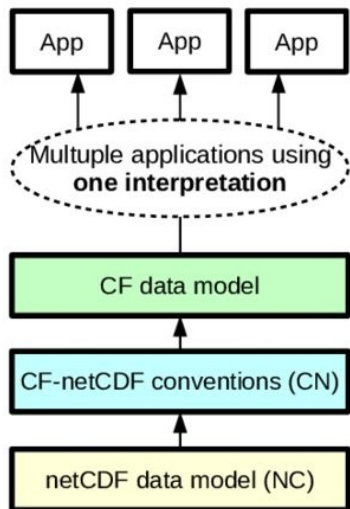
Geometry

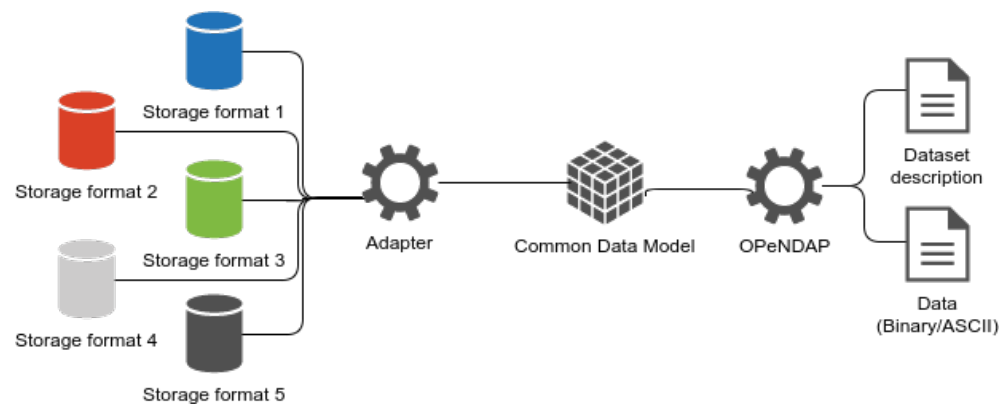
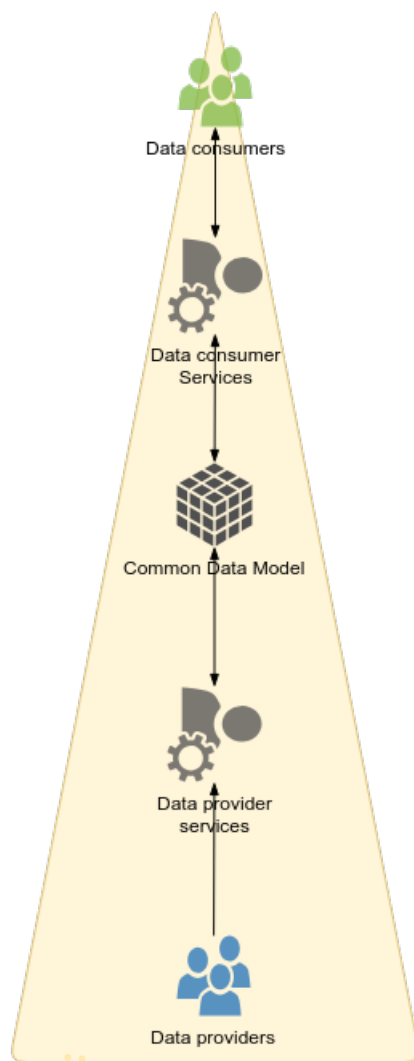


Without a data model:



With a data model:





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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
<div> <div> air_temperature </div> <div> Air temperature is the bulk temperature of the air, not the surface (skin) temperature. </div> </div>	K	ta	11 E130
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		

NorDataNet
Norwegian Scientific Data Network

```
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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 identifier" ;
    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 ssiensamp(time) ;
        ssiensamp:long_name = "temperature of the surface shortwave irradiation sensor" ;
        ssiensamp:short_name = "ssiensamp" ;
        ssiensamp:FillValue = -999.f ;
        ssiensamp:units = "degC" ;
        ssiensamp:cell_method = "time: mean (last minute)" ;
    float dli(time) ;
        dli:long_name = "difference between downward atmospheric longwave 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 dliensamp(time) ;
        dliensamp:long_name = "temperature of the surface longwave irradiation sensor" ;
        dliensamp:short_name = "dliensamp" ;
        dliensamp:FillValue = -999.f ;
        dliensamp:units = "degC" ;
        dliensamp: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)" ;
}
```

Bjørnøya : ncdump

```
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// 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 the meteorological station at Bear Island in the Barents Sea. Measurements are made using Kipp and Zonen CMP21 and CGR4 pyranometers and pyrgeometers. Daily maintenance is performed by the meteorological personnel at the station. Data are averaged over the last minute and the time is set to UTC. This data set has been collected with support from the Norwegian Research Council. The quality control focuses 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 = "Kåre Øystein Godoy" ;
:contact = "o.godoy@met.no" ;
:institution = "Norwegian Meteorological Institute" ;
:url = "http://www.met.no/" ;
:product_name = "radiative fluxes" ;
:Platform_name = "Bjornoya" ;
:project_name = "iA00S-Norway/IPY-THORPEX" ;
:start_date = "2008-04-01 13:14 UTC" ;
:stop_date = "2015-12-16 12:50 UTC" ;
:distribution_statement = "Restricted to iA00S-Norway" ;
:southernmost_latitude = 74.5166667 ;
:northernmost_latitude = 74.5166667 ;
:westernmost_longitude = 19.0166667 ;
:easternmost_longitude = 19.0166667 ;
: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,
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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, 1207061820, 1207061880, 1207061940, 1207062000,
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1207063860, 1207063920, 1207063980, 1207064040, 1207064100, 1207064160,
1207064220, 1207064280, 1207064340, 1207064400, 1207064460, 1207064520,
```

Bjørnøya : ncdump

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Bjørnøya : ncview — Konsole
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-rw-rw-r-- 1 steingod steingod 2,6M mai 1 2015 radflux_bjornoya-201504.dat
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-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
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-rw-rw-r-- 1 steingod steingod 73M aug. 29 2013 radflux_Bjornøya.nc
-rw-rw-r-- 1 steingod steingod 32M aug. 29 2013 radflux_Bjornøya.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/Bjornøya$ ncdump radflux_bjornoya.nc | m
steingod@tuba: /disk1/data/radflux/Bjornøya$ 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..
```

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: 0pts

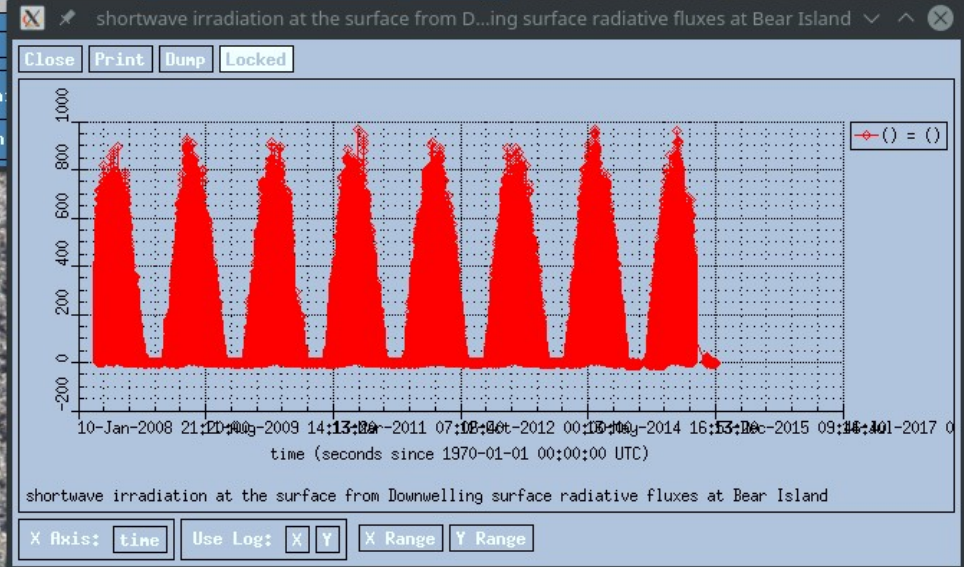
3gauss Inv P Inv C Mag X1 Linear Axes Range Bi-lin Print

Var: stationid

dlisenstep

Din: Name: Min

strlen25 Min



File Edit View Bookmarks Settings Help

```
netcdf obs-temp_01028 {
dimensions:
    obs = UNLIMITED ; // (299 currently)
    profile = 30000 ;
    name_strlen = 5 ;
variables:
    float lon ;
        lon:long_name = "station longitude" ;
        lon:standard_name = "longitude" ;
        lon:units = "degrees_east" ;
    float lat ;
        lat:long_name = "station latitude" ;
        lat:standard_name = "latitude" ;
        lat:units = "degrees_north" ;
    float alt ;
        alt:long_name = "station altitude" ;
        alt:standard_name = "height" ;
        alt:units = "m" ;
    char station_wmonr(name_strlen) ;
        station_wmonr:long_name = "WMO station identifier" ;
    double time(profile) ;
        time:standard_name = "time" ;
        time:long_name = "time of radiosonde observation" ;
        time:units = "seconds since 1970-01-01 00:00:00 UTC" ;
        time:axis = "T" ;
        time:cf_role = "profile_id" ;
    int row_size(profile) ;
        row_size:long_name = "number of observations per profile" ;
        row_size:sample_dimension = "obs" ;
    float PP(obs) ;
        PP:long_name = "pressure level" ;
        PP:standard_name = "air_pressure" ;
        PP:units = "hPa" ;
        PP:axis = "Z" ;
    int vss(obs) ;
        vss:long_name = "Vertical sound speed" ;
        vss:flag_masks = 131072, 65536, 1024, 512, 256, 128, 64, 32, 16, 8, 2 ;
}
```

nc_to_mmd : bash gcw : less applicat

File Edit View Bookmarks Settings Help

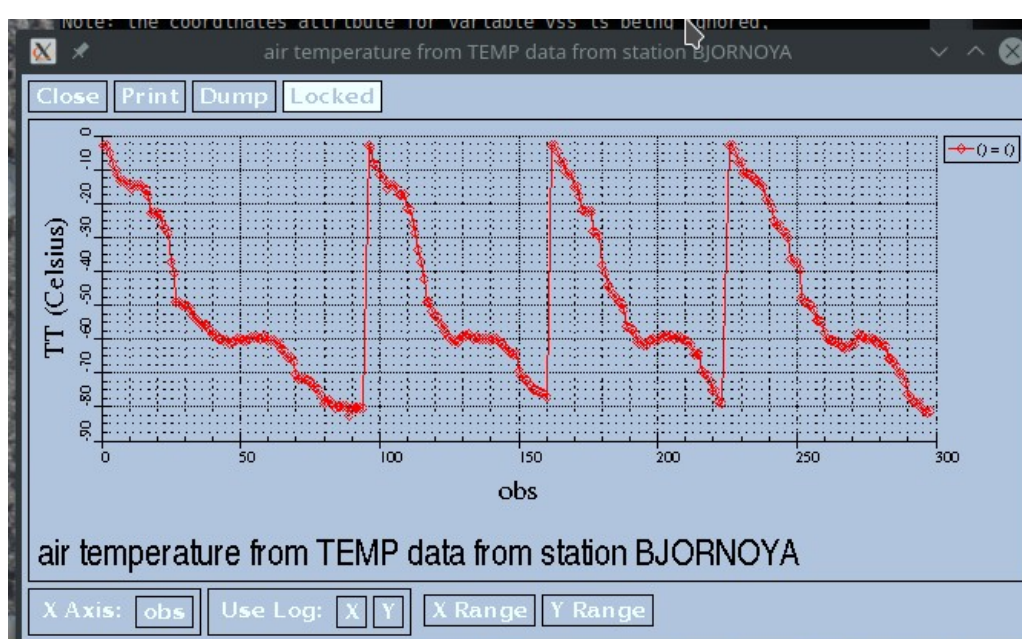
```
PP:units = "hPa" ;
PP:axis = "Z" ;
int vss(obs) ;
    vss:long_name = "Vertical sound speed" ;
    vss:flag_masks = 131072, 65536, 1024, 512, 256, 128, 64, 32, 16, 8, 2 ;
    vss:flag_meanings = "surface_level maximum_wind_level significant_level temperature_data beginning_of_missing_humidity_data beginning_of_missing_wind_data end_of_missing_wind_data determined_by_regional_decision_pressure_level_1 the_vertical_coordinate" ;
    vss:valid_range = 0, 262142 ;
    vss:FillValue = 262143 ;
    vss:coordinates = "time PP" ;
float gh(obs) ;
    gh:long_name = "geopotential height" ;
    gh:standard_name = "geopotential_height" ;
    gh:units = "m" ;
    gh:FillValue = -999.f ;
    gh:coordinates = "time PP" ;
float TT(obs) ;
    TT:long_name = "air temperature" ;
    TT:standard_name = "air_temperature" ;
    TT:units = "Celsius" ;
    TT:FillValue = -999.f ;
    TT:coordinates = "time PP" ;
float TD(obs) ;
    TD:long_name = "dew point temperature" ;
    TD:standard_name = "dew_point_temperature" ;
    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 applicat (END)

File Edit View Bookmarks Settings Help

```
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 Pressure Wind Radiosonde TEMP" ;
    :gcmd_keywords = "Atmosphere > Atmospheric Pressure > Surface Pressure\n",
        "Atmosphere > Atmospheric Temperature > Surface Air Temperature\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" ;
}
```

nc_to_mmd : bash gcw : less applicat



I am not set up to handle cases with code n 0 or 2 effective dims
Note: 5 missing values were eliminated

6

> nc_to_mmd : bash > gcw : less

Quit >1 << < || > >> Edit ? Delay: Opts

3gaus Inv P Inv C Mag X Linear Axes Range Bi-lin Print

Var: station_wmon time row_size PP

vss gh TT TD

FF DD

Dim:	Name:	Min:	Current:	Max:	Units:
	name_strler	Min:	Current:	Max:	Units:

```
time:long_name =  
time:calendar = "stan  
time:units = "seconds  
time:axis = "T" ;  
double latitude ;  
latitude:standard_nam  
latitude:long_name =  
latitude:units = "deg  
double longitude ;  
longitude:standard_na  
longitude:long_name =  
longitude:units = "de  
float air_pressure_at_sea_le  
air_pressure_at_sea_l  
air_pressure_at_sea_l
```

```

File Edit View Bookmarks Settings Help
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" ;
}

```

```
> steingod : bash
```

```

File Edit View Bookmarks Settings Help
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" ;
}

```

```
> steingod : bash
```

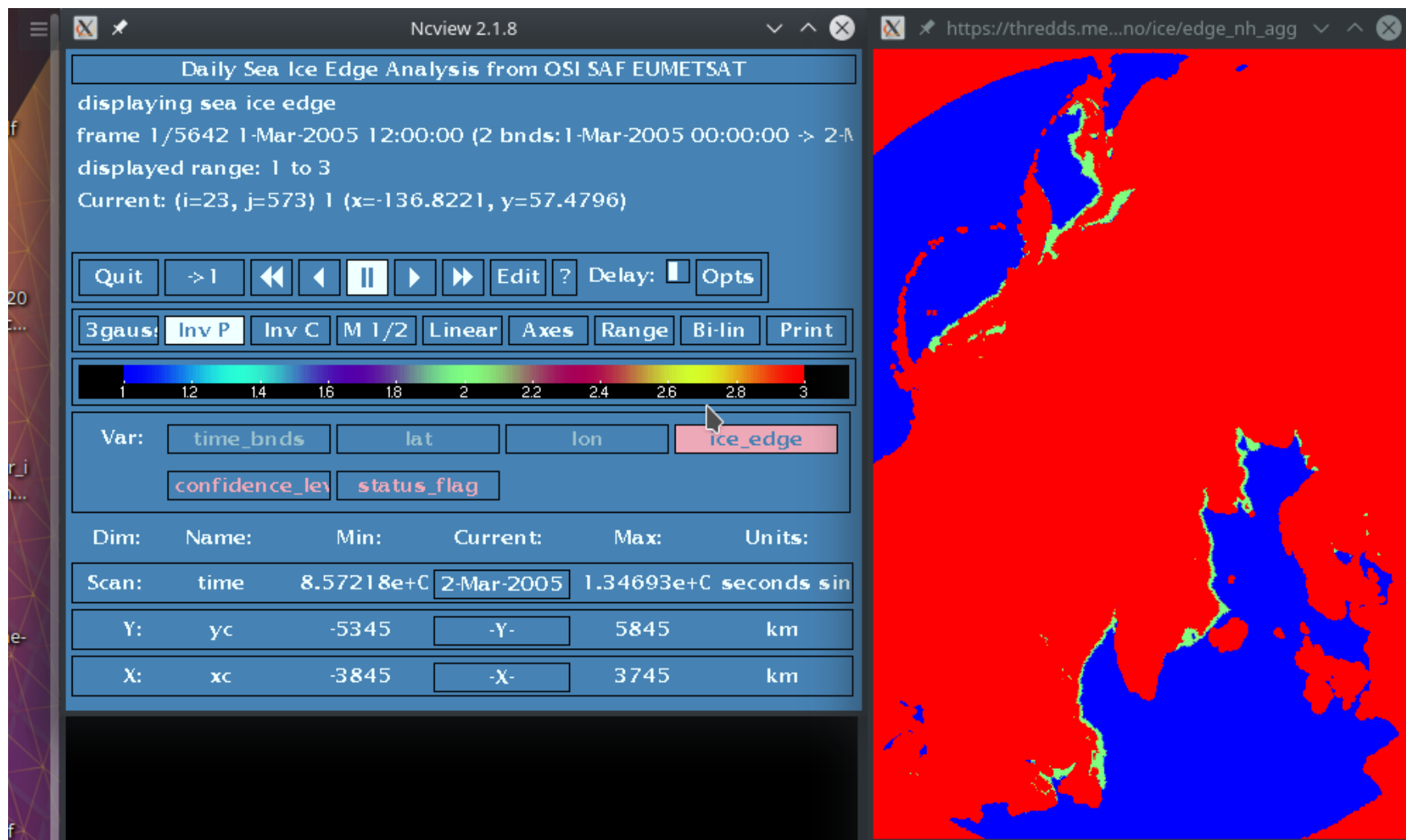
```

File Edit View Bookmarks Settings Help
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.
It is\n",
    "based on atmospherically corrected signal and a Ba
yesian\n",
    "merging approach 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)

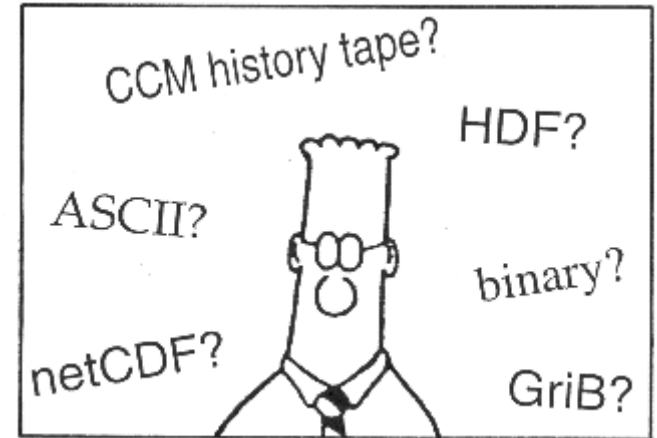
```

```
> steingod : bash
```



Why NetCDF and OPeNDAP?

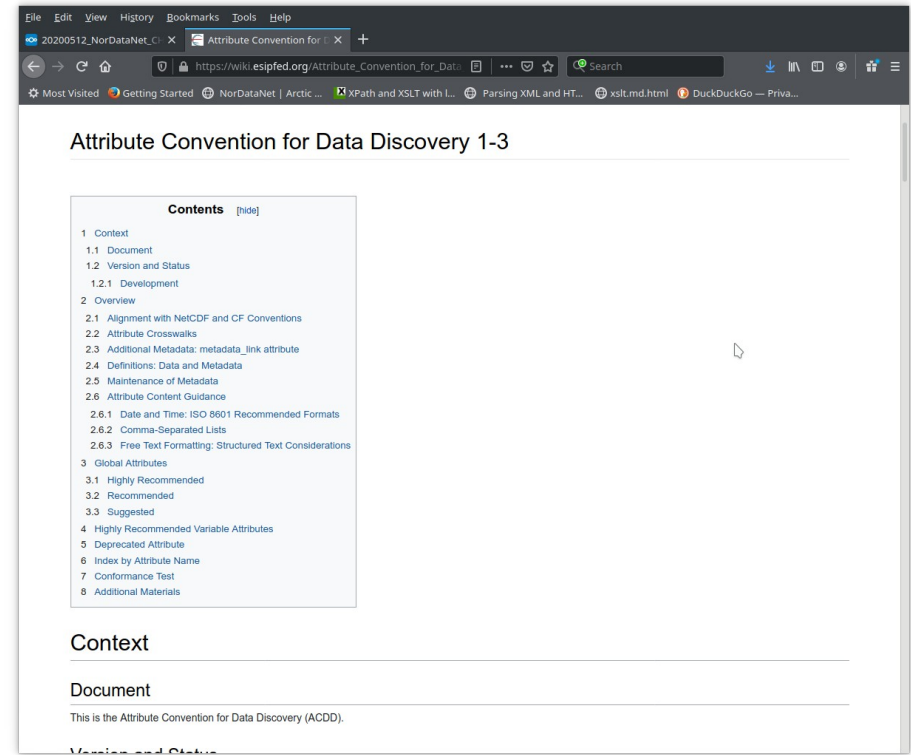
- NetCDF-CF provides a self describing data
 - in a form compatible with semantic web approaches
 - allowing interdisciplinary use
 - suitable for many different types of data
 - widely used by science communities
 - those not using are often not using standardised approaches
 - Widely supported by analysis 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>



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

