

CF Conventions for netCDF

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Abstract

The CF (Climate and Forecast) Conventions are a community-developed metadata standard for storing and describing Earth system science data in the netCDF binary data format. Numerous existing FOSS (Free and Open Source Software) and commercial software tools can explore, analyze, and visualize data that is encoded using the CF Conventions. The CF community holds annual workshops to develop, refine, and review enhancements to the CF Conventions and to manage the CF governance and processes. The EarthCube netCDF-CF project worked with the CF community on the development of extensions to netCDF-CF. Several of these have been accepted into the CF Conventions. Work on these extensions involved broad participation by members of the existing netCDF-CF community as well as members of science domains not traditionally represented in the netCDF-CF community. This presentation will provide an update of recent work and an overview of CF plans and future activities.

CF Conventions for netCDF

CF Conventions for netCDF
 Ethan Davis, UCAR Unidata
 Daniel Lee, EUMETSAT
 Kevin O'Brien, Univ. of Washington/JISAO and NOAA/PMEL

CF is a community-developed convention for storing and describing earth system science data in the netCDF data format

CF Web Page:

- <http://cfconventions.org/>

OPEN

Earth System Science Data Types Supported by CF

Ready to use:

- Gridded data
- Timeseries, soundings, aircraft tracks
- Unstructured grids (e.g., triangular mesh)
- CF-Radial: Radial data for radar and lidar
- Timeseries for a polyline or polygon (aka Geometries)
- Groups (hierarchical structure)

Proposed, with prototype software:

- Satellite swath data
- Linked Data with netCDF

OPEN

Start Using and Contributing to CF

All who are interested in CF are encouraged to take part in the CF community development process.

Changes and enhancements to the CF Conventions document are suggested and discussed in [GitHub issues](#) on the CF Conventions repository. The verbatim changes to the text of the document is developed in [GitHub Pull Requests](#) on the CF

OPEN

Tools to work with netCDF-CF data

NetCDF-CF is widely used and has numerous existing FOSS (Free and Open Source Software) and commercial software tools which can explore, analyze, and visualize data that is stored and described as netCDF-CF data.

Interactive Applications

- IDL, MIDAS-V, Borealis
- Farm and Live Access Server (LAS)
- Arctic, MATLAB, IDL, NCL

Command-line Tools

OPEN

NetCDF-CF: Gridded Data

OPEN

CF Standard Names

A standard name identifies the geophysical quantity in a data variable and helps users of data from different sources to decide which quantities can be compared.

The current CF Standard Names Table ([version T2](#), released March 2020) contains 4418 standard names.

- New CF Standard Names are proposed in [GitHub issues](#) on the CF Discuss repository.

OPEN

Ethan Davis, UCAR Unidata

Daniel Lee, EUMETSAT

Kevin O'Brien, Univ. of Washington/JISAO and NOAA/PMEL

ENTER NAMES OF AFFILIATED INSTITUTIONS

PRESENTED AT:

2020 EarthCube Annual Meeting

Virtual – June 18, 2020

CF IS A COMMUNITY-DEVELOPED CONVENTION FOR STORING AND DESCRIBING EARTH SYSTEM SCIENCE DATA IN THE NETCDF DATA FORMAT

CF Web Page:

- <http://cfconventions.org/> (<http://cfconventions.org/>)

CF Discussion:

For questions, general discussion, and for proposing new CF Standard Names.

- Use GitHub Issues on the CF Discuss repo
 - <https://github.com/cf-convention/discuss/issues> (<https://github.com/cf-convention/discuss/issues>)

CF Conventions Document:

To make specific proposals for changing or extending the CF conventions

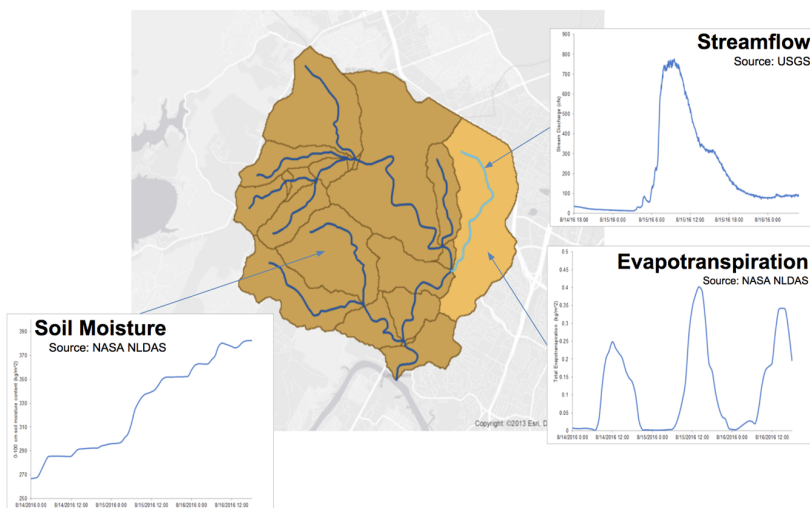
- Use GitHub Issues on the CF Conventions repo
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CF Website:

To contribute fixes or improvements to the CF Website

- Use GitHub Issues on the CF Website repo
 - <https://github.com/cf-convention/cf-convention.github.io/issues> (<https://github.com/cf-convention/cf-convention.github.io/issues>)

NetCDF-CF: Geometries (Polylines & Polygons)



Compatible With

- Well-Known Text geometry primitives
- OGC Simple Features
- GeoJSON
- Shapefile
- Various geospatial databases

TOOLS TO WORK WITH NETCDF-CF DATA

NetCDF-CF is widely used and has numerous existing FOSS (Free and Open Source Software) and commercial software tools which can explore, analyze, and visualize data that is stored and described as netCDF-CF data.

Interactive Applications

- IDV (<https://www.unidata.ucar.edu/software/idv/>), McIDAS-V (<https://www.ssec.wisc.edu/mcidas/software/v/>), Panoply (<https://www.giss.nasa.gov/tools/panoply/>)
- Ferret (<https://ferret.pmel.noaa.gov/Ferret/>) and Live Access Server (LAS)
- ArcGIS (<https://desktop.arcgis.com/en/>), MATLAB (<https://www.mathworks.com/products/matlab.html>), IDL (<https://www.harrisgeospatial.com/Software-Technology/IDL>), NCL (<https://www.ncl.ucar.edu/>)

Command-line Tools

- NetCDF Operators (<http://nco.sourceforge.net/>) (NCO)
- Climate Data Operators (<https://code.mpimet.mpg.de/projects/cdo/>) (CDO)

Data Servers

- THREDDS Data Server (<https://www.unidata.ucar.edu/software/tds/>) (TDS)
- Hyrax Data Server (<https://www.opendap.org/software/hyrax-data-server>)
- ERDDAP (<https://coastwatch.pfeg.noaa.gov/erddap/index.html>)
- ncWMS (<https://reading-escience-centre.github.io/ncwms/>) and ncSOS (<https://github.com/asascience-open/ncSOS/wiki>)

Libraries

- netCDF-C (<https://www.unidata.ucar.edu/software/netcdf/>) and wrappers
- netCDF-Java (<https://www.unidata.ucar.edu/software/netcdf-java/>)
- GDAL (<https://gdal.org/>)
- LROSE (<https://www.eol.ucar.edu/content/lidar-radar-open-software-environment>)

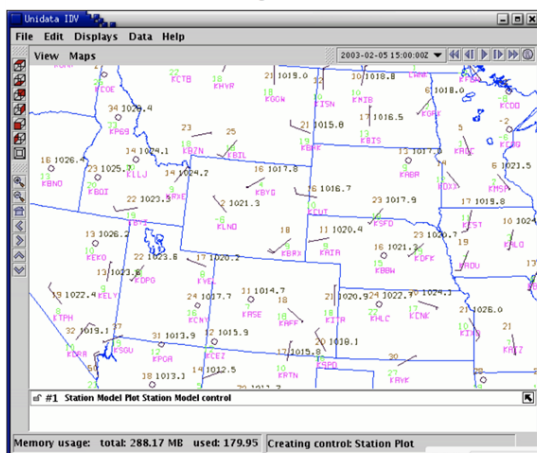
Python Libraries

- Data access:
 - netcdf4-python (<https://unidata.github.io/netcdf4-python/netCDF4/index.html>), xarray (<http://xarray.pydata.org/en/stable/>), siphon (<https://www.unidata.ucar.edu/software/siphon/>), cfmdm (<https://ncas-cms.github.io/cfmdm>)
- Plots and Maps: matplotlib (<https://matplotlib.org/>), cartopy (<https://scitools.org.uk/cartopy/docs/latest/>), cf-plot (<http://ajheaps.github.io/cf-plot/>)

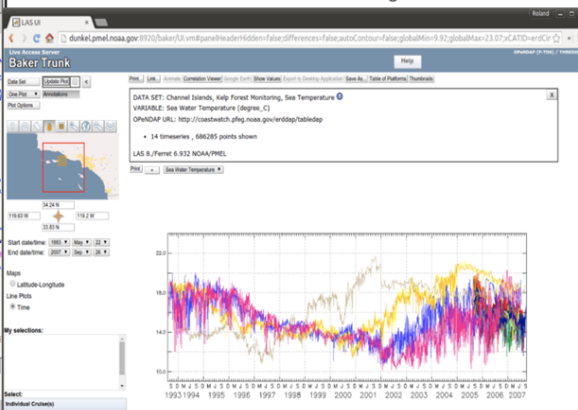
- Analysis and visualization:
 - Iris (<https://scitools.org.uk/iris/docs/latest/>), MetPy (<https://www.unidata.ucar.edu/software/metpy/>), pyART (<https://arm-doe.github.io/pyart/>), cf-python (<https://ncas-cms.github.io/cf-python/>)

NetCDF-CF: Station and Timeseries Data

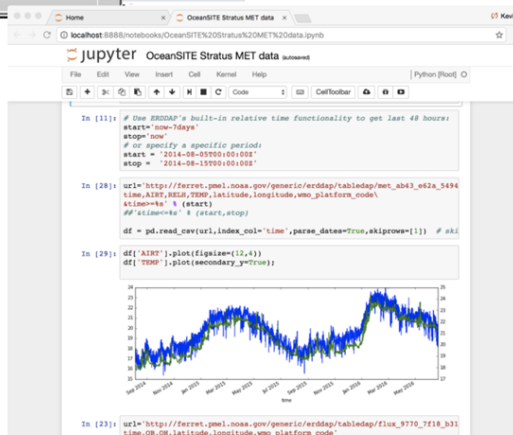
Plots of meteorological station data using the IDV



Plots of ocean timeseries data using Ferret and LAS



Timeseries plot in a Jupyter Notebook



(Also see CF Website page listing CF-enabled software (<http://cfconventions.org/software.html>))

EARTH SYSTEM SCIENCE DATA TYPES SUPPORTED BY CF

Ready to use:

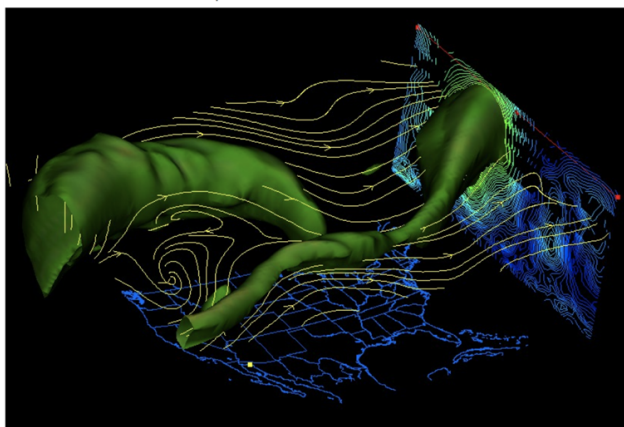
- Gridded data
- Timeseries, soundings, aircraft tracks
- Unstructured grids (e.g., triangular mesh)
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- Groups (hierarchical structure)

Proposed, with prototype software:

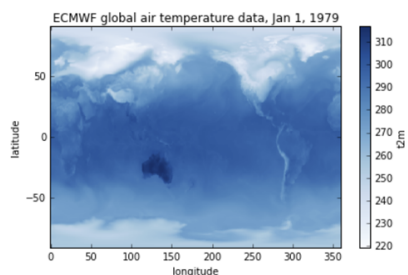
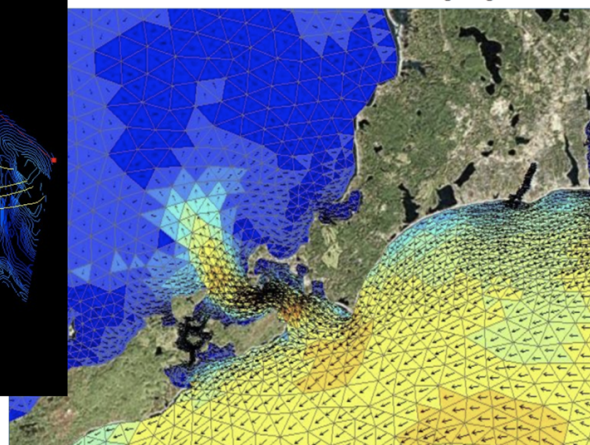
- Satellite swath data
- Linked Data with netCDF

NetCDF-CF: Gridded Data

Visualization of wind using the IDV:
streamlines and speed isosurface



Visualization of
triangular grid data



Visualization using python:
xarray and matplotlib

Under development or planned:

- Quantification of uncertainty
- Climate indices and derived statistics
- Corridor (aircraft track with volume)

START USING AND CONTRIBUTING TO CF

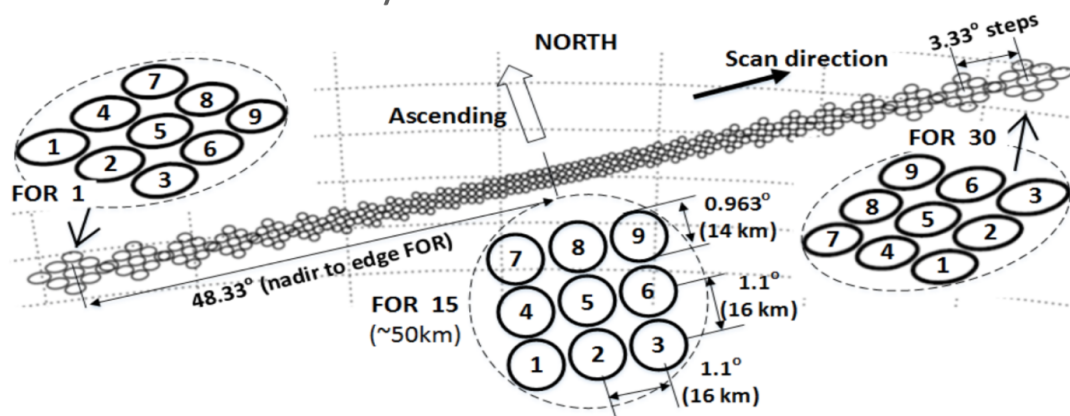
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The CF community holds annual workshops (<http://cfconventions.org/Meetings/>) to develop, refine, and review enhancements to the CF convention and to manage the CF governance and processes.

NetCDF-CF: Satellite Swath Data

Data collected by instruments on satellites, airplanes, and unmanned aerial systems



CF STANDARD NAMES

A standard name identifies the geophysical quantity in a data variable and helps users of data from different sources to decide which quantities can be compared.

The current CF Standard Names Table (version 72 (<http://cfconventions.org/Data/cf-standard-names/72/build/cf-standard-name-table.html>), released March 2020) contains 4418 standard names.

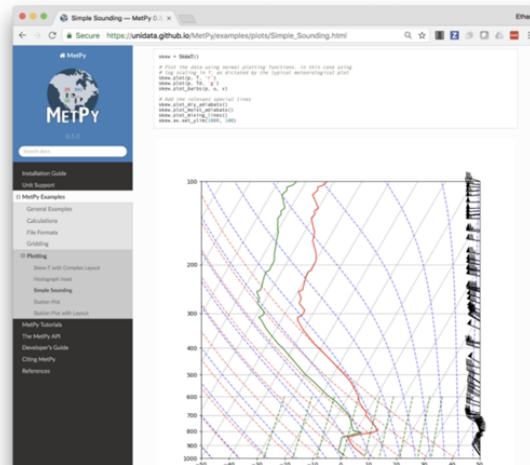
- New CF Standard Names are proposed in GitHub issues (<https://github.com/cf-convention/discuss/issues>) on the CF Discuss repository.
- Proposals should follow the guidelines (<http://cfconventions.org/Data/cf-standard-names/docs/guidelines.html>) for constructing CF standard names.
- Along with the name, a description and the canonical units for the standard name must be agreed.

NetCDF-CF: Profile and Track Data

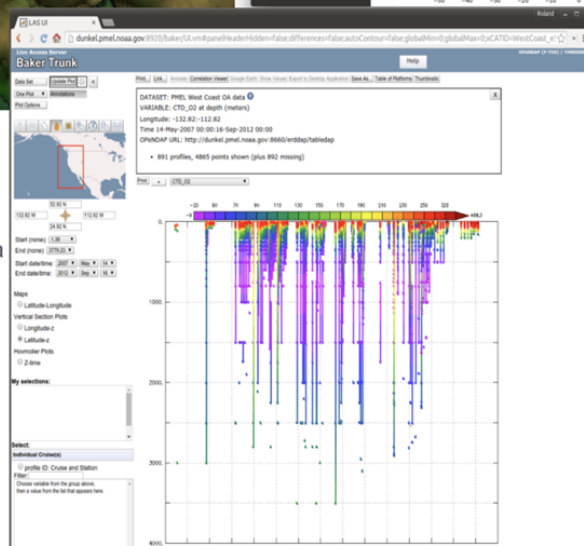
Visualization of aircraft track and
dropsondes data using the IDV



Plot of atmospheric sounding
using the MetPy python library

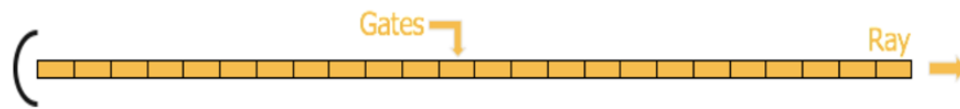


Plots of ocean sounding data
using Ferret and LAS



CF-Radial

Represent data from pulsed instruments – RADARs and LIDARs – in their native polar coordinates



A collection of **GATES** forms a **RAY**.
A collection of **RAYS** forms a **SWEEP**.
A collection of **SWEEPS** forms a **VOLUME**.

