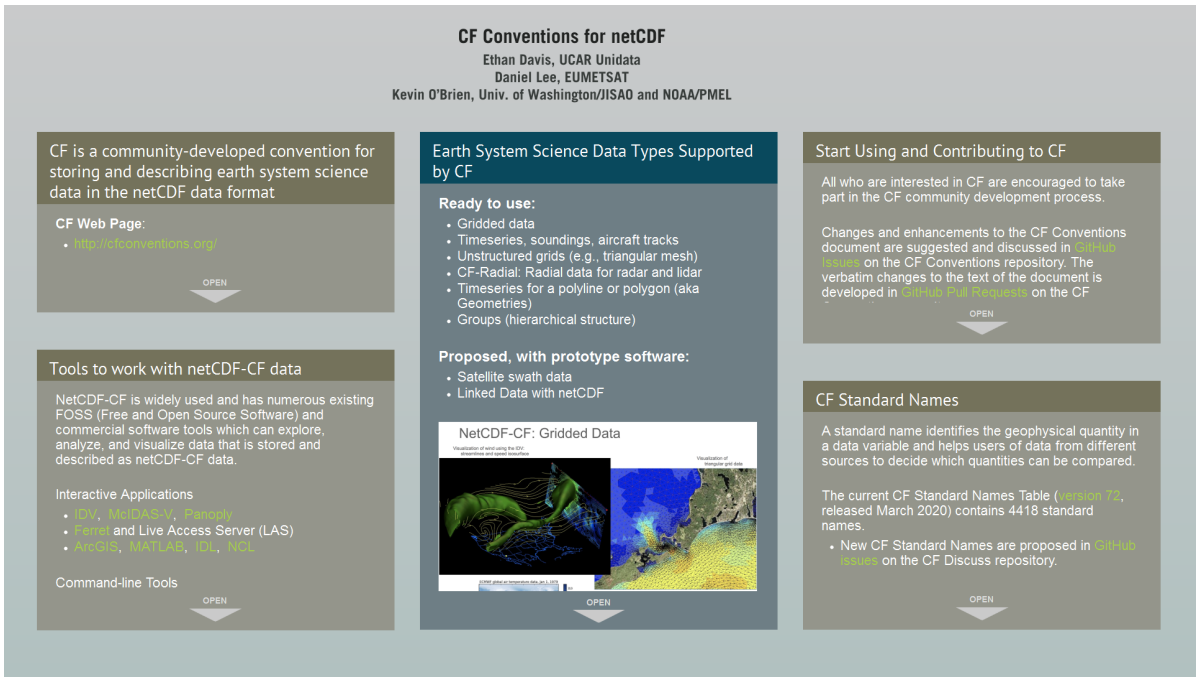
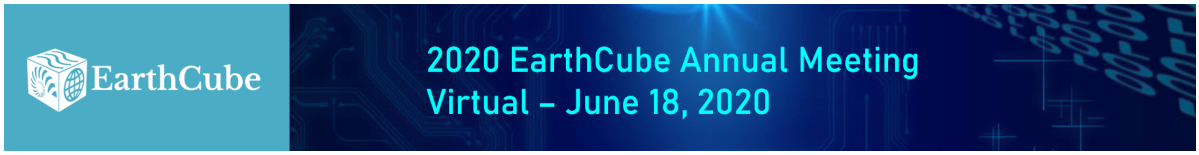
CF Conventions for netCDF



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

ENTER NAMES OF AFFILIATED INSTITUTIONS

PRESENTED AT:



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:

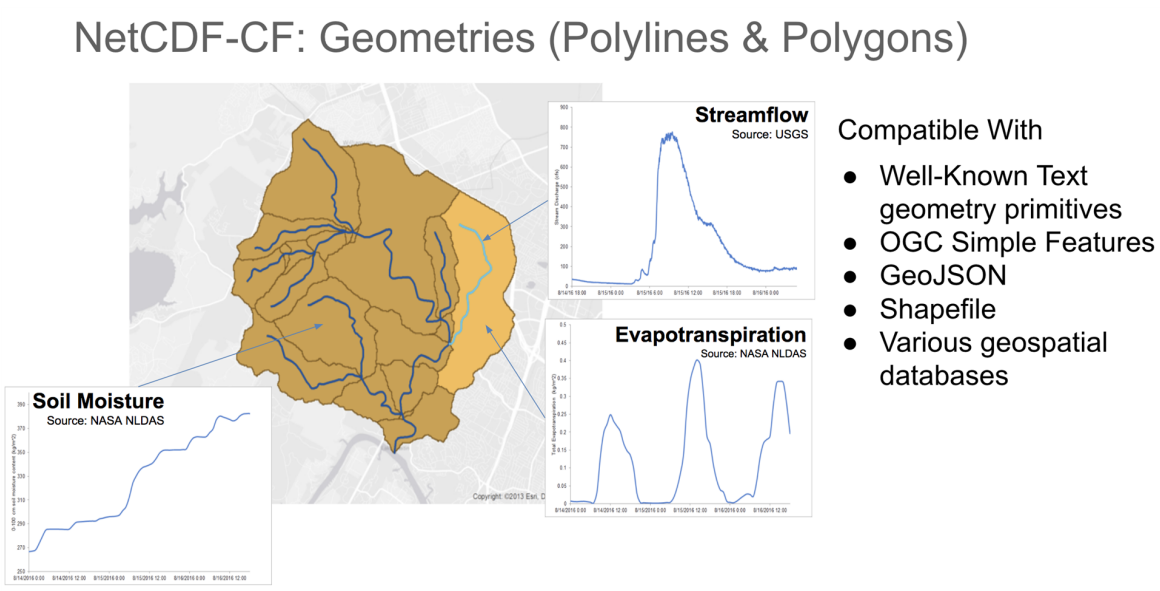
To make specific proposals for changing or extending the CF conventions

- Use GitHub Issues on the CF Conventions repo
  - https://github.com/cf-convention/cf-conventions/issues (https://github.com/cf-convention/cf-conventions/issues)

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)



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)

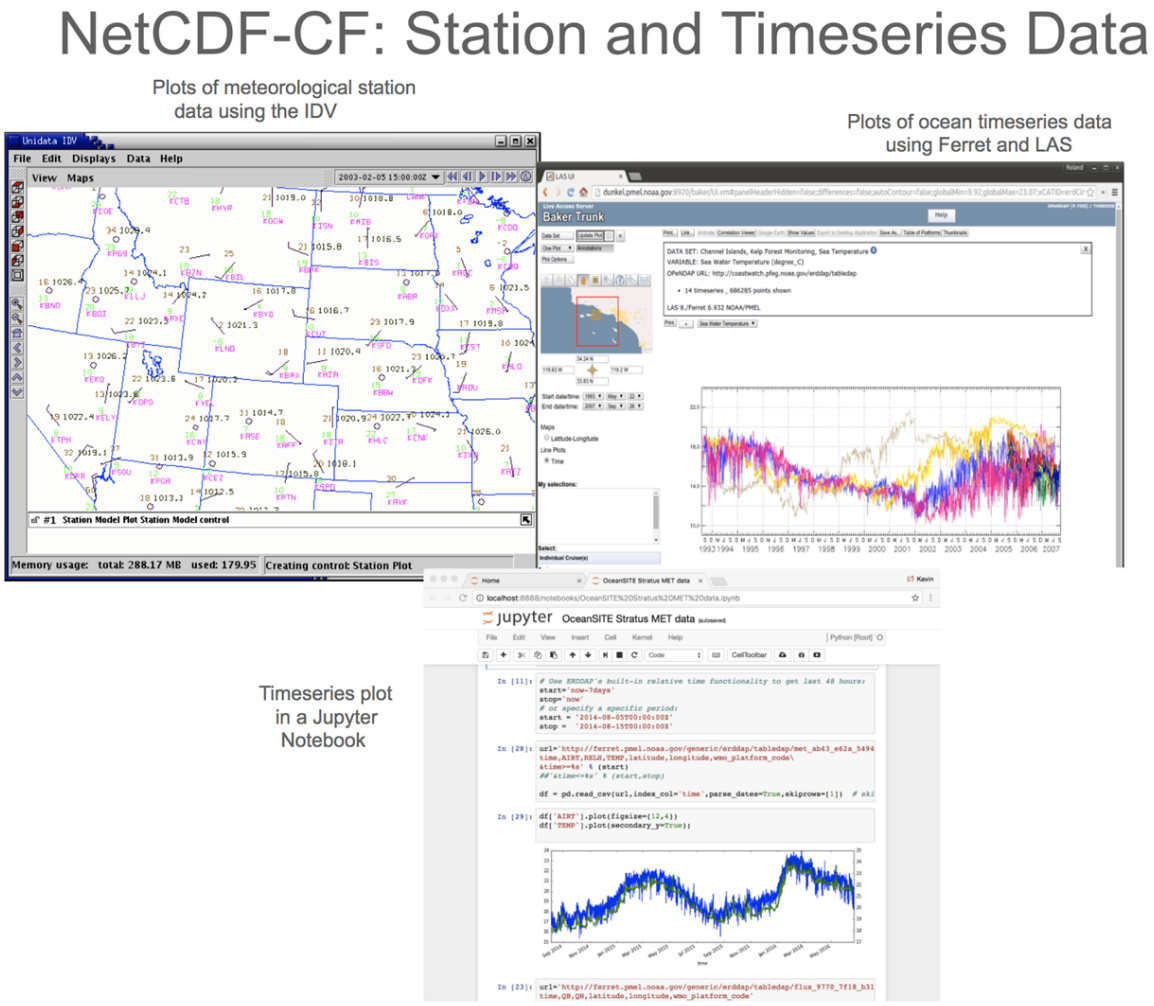
Libraries

- 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/), cfdm (https://ncas-cms.github.io/cfdm)
- 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/)



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

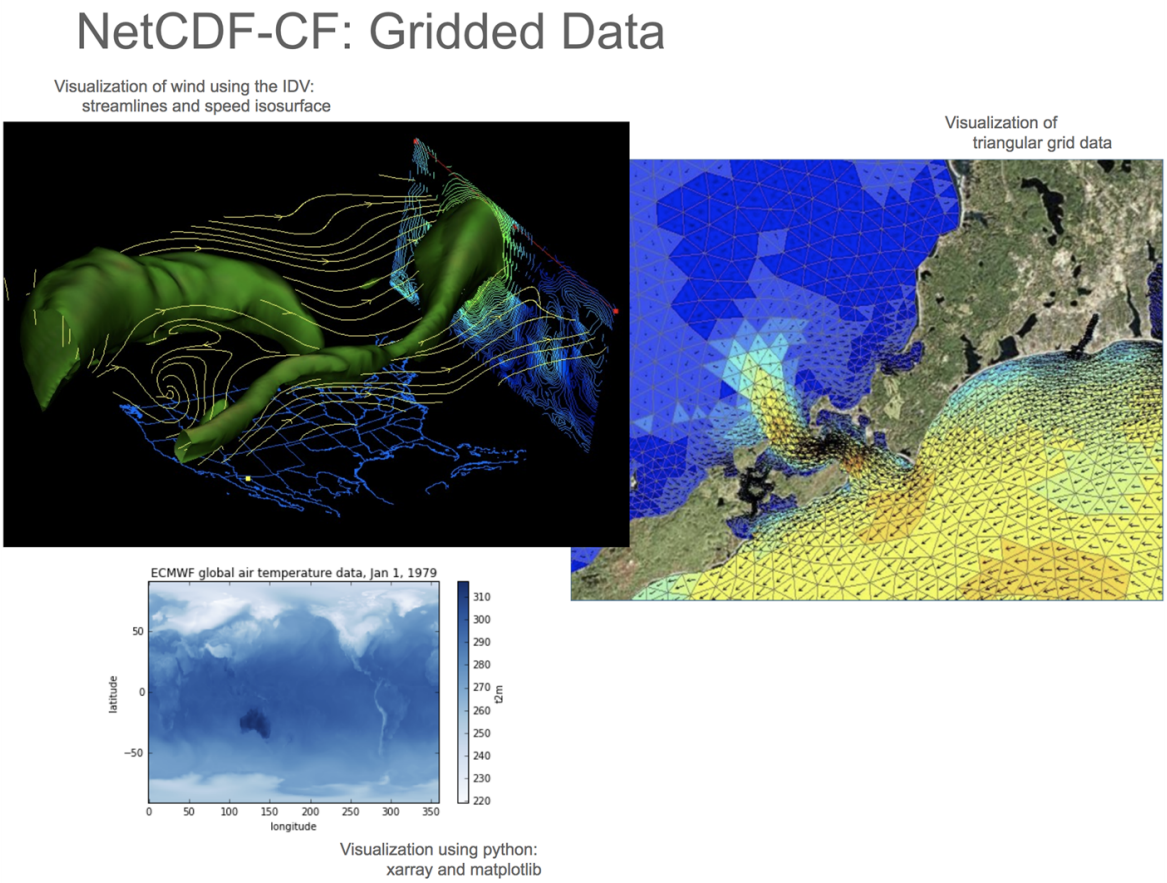
EARTH SYSTEM SCIENCE DATA TYPES SUPPORTED BY CF

Ready to use:

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



Under development or planned:

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

START USING AND CONTRIBUTING TO CF

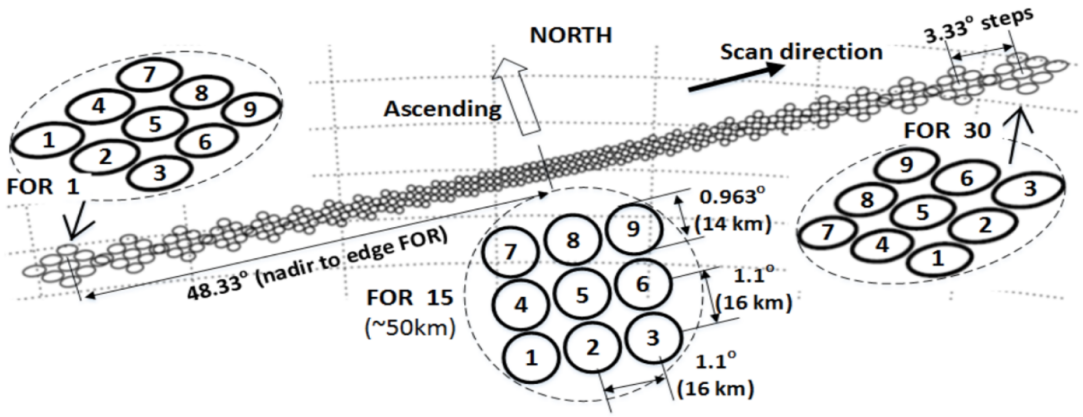
All who are interested in CF are encouraged to take part in the CF community development process.

Changes and enhancements to the CF Conventions document are suggested and discussed in GitHub Issues (https://github.com/cf-convention/cf-conventions/issues) on the CF Conventions repository. The verbatim changes to the text of the document is developed in GitHub Pull Requests (https://github.com/cf-convention/cf-conventions/pulls) on the CF Conventions repository.

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.

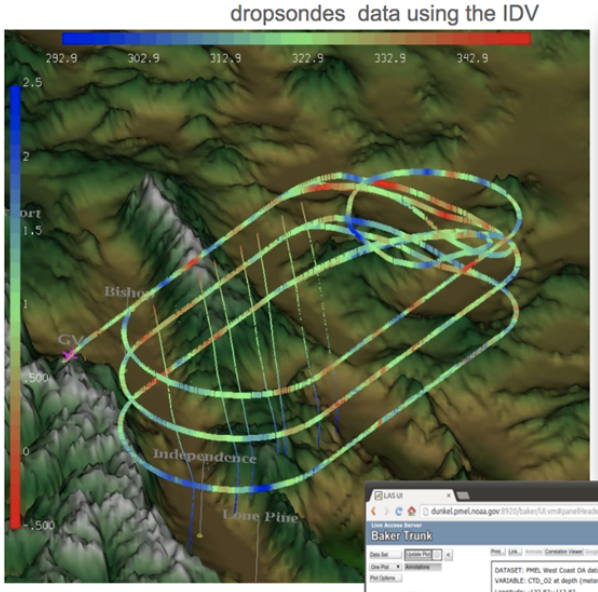
- New CF Standard Names are proposed in GitHub issues (https://github.com/cf-convention/discuss/issues) on the CF Discuss repository.

- Proposals should follow the guidelines (http://cfconventions.org/Data/cf-standard-names/docs/guidelines.html) for constructing CF standard names.

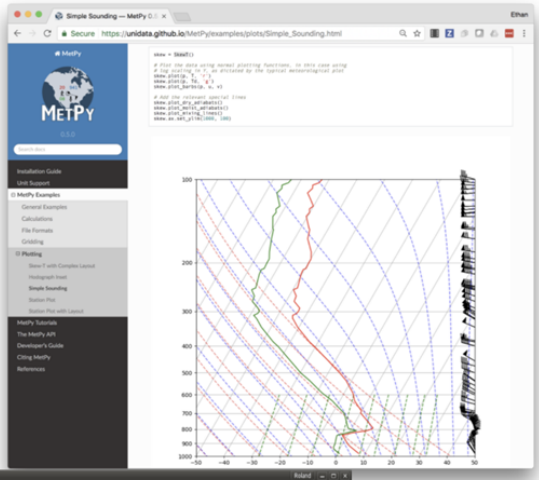
- Along with the name, a description and the canonical units for the standard name must be agreed.

NetCDF-CF: Profile and Track Data

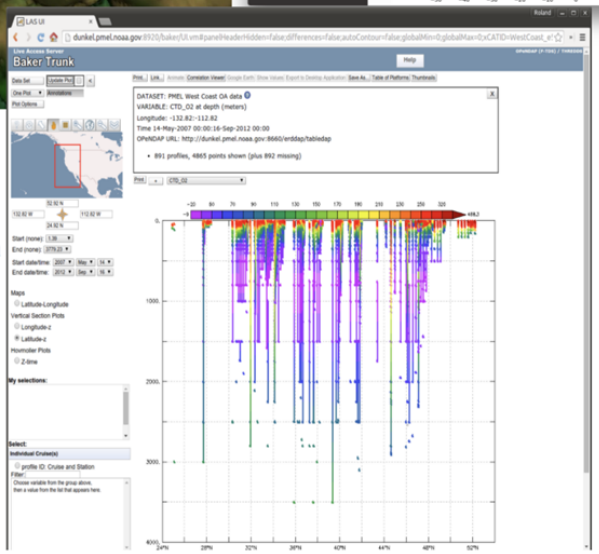
Visualization of aircraft track and dropsondes data using the IDV



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.