



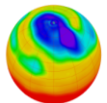
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# CF Conventions

Ocean Data Dojo  
December 2022

Alison Pamment



**Centre for Environmental  
Data Analysis**

SCIENCE AND TECHNOLOGY FACILITIES COUNCIL  
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INFRASTRUCTURE FOR THE EUROPEAN NETWORK  
FOR EARTH SYSTEM MODELLING





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# CF overview

# The CF (Climate - Forecast) metadata conventions

<http://cfconventions.org/>

- Originated in 2000 for sharing of climate model data
- Define wide-ranging rules for describing geoscientific data in netCDF files
- Provide a description of the data in each variable, including spatiotemporal and other dimensional properties
- Enable users to identify comparable data held in different files
- Facilitate the development of software to extract, process, regrid, analyse and display data

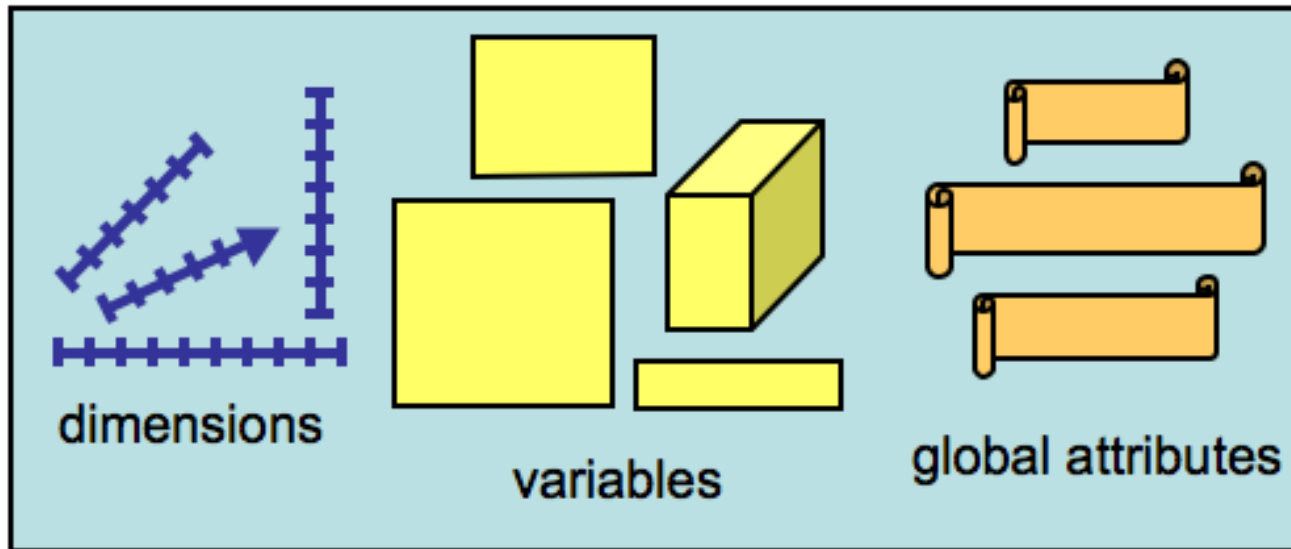
# The CF (Climate and Forecast) metadata conventions

<http://cfconventions.org/>

- Adopted by many international modelling projects, such as CMIP (Coupled Model Intercomparison Project)  
<https://www.wcrp-climate.org/wgcm-cmip>
- Increasingly being used for observational data, e.g. SeaDataNet oceanographic data and GOES series satellite products
- WMO (World Meteorological Organisation) is developing experimental CF profiles for radar data, marine and atmospheric trajectories:  
<https://community.wmo.int/activity-areas/wis/wmo-cf-extensions>

# What's in a NetCDF file?

NetCDF files are containers for Dimensions, Variables, and Global Attributes.



A netCDF file has a **.nc** file extension and contains some **dimensions**, **variables**, **global** (file-level) **attributes**, and **data values** associated with the variables.

# Examples of CF global attributes

| Attribute   | Meaning                                     |
|-------------|---------------------------------------------|
| conventions | CF version, e.g.<br>Conventions = "CF-1.10" |
| 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                   |

# Examples of variable attributes

| Attribute                                | Meaning                                  |
|------------------------------------------|------------------------------------------|
| <b>standard_name</b>                     | Taken from <b>standard name table</b>    |
| <b>units</b>                             | Mandatory unless dimensionless quantity  |
| <b>long_name</b>                         | Not standardised                         |
| <b>cell_methods</b>                      | Variation within a cell e.g. max, mean   |
| <b>cell_measures</b>                     | Area or volume of a cell                 |
| <b>valid_max, valid_min, valid_range</b> | "Acceptable" data values                 |
| <b>_FillValue</b>                        | Value to use for missing data            |
| <b>flag_values, flag_meanings</b>        | to make "flag" variables self-describing |

# Coordinate Variables in CF

Coordinate variables have the same name as their dimension:

```
dimensions: longitude = 36;
```

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





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# CF standard names

# What is a CF standard name?

A standard name identifies the geophysical quantity in a data variable, e.g. air\_temperature.

Attach the standard name to a data variable using the CF **standard\_name** attribute:

```
float ps1(lat,lon) ;  
  ps1:units = "hPa" ;  
  ps1:standard_name = "pressure_at_mean_sea_level" ;
```

Standard names facilitate data exchange by providing unambiguous identification of variables.

# Why use a standard name?

The names of data variables are **not** standardized in netCDF files.

For example:

- alison1, alison2, xyz345blah
- Temperature, temp, T

Standard names facilitate data exchange by providing unambiguous identification of variables.

We can tell whether variables from different data sources can be compared.

# CF standard name table

<http://cfconventions.org/Data/cf-standard-names/current/build/cf-standard-name-table.html>

| Standard Name                                                                                                                                                                                                                                                                                                 | Canonical Units |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| <b>air_temperature_anomaly</b><br>"Anomaly" means difference from climatology. Air temperature is the bulk temperature of the air, not the surface (skin) temperature.                                                                                                                                        | <b>K</b>        |
| <b>surface_upward_latent_heat_flux</b><br>The surface latent heat flux is the exchange of heat between the surface and the air on account of evaporation (including sublimation). In accordance with common usage in geophysical disciplines, "flux" implies per unit area, called "flux density" in physics. | <b>W m-2</b>    |

# CF standard names: basic rules

- Any variable labelled with the **standard\_name** attribute **must** use a value from the published standard name table
- Standard names consist of letters, digits and underscores, no whitespace.
- English language with US spellings
- Case sensitive
  - Mixed case used for chemical element symbols, e.g.  
**integral\_wrt\_time\_of\_radioactivity\_concentration\_of\_112Ag\_in\_air**
- (Almost) all standard names have an accompanying description
- Names are never removed once they have been added to the table
  - Name can be modified using an 'alias'

**The units attribute used in a data file must be physically consistent with the canonical unit...**

**... but it doesn't have to be identical!**

This is because software implementations of the CF conventions can utilise the UniData UDUnits2 package to convert between equivalent units.

# What **isn't** described in the standard name

- Vertical level and geolocation, e.g. 2m air temperature
  - Use coordinate variables or region labels
- Statistical processing, e.g. mean, maximum, etc.
  - Use cell\_methods attribute
- Portions of grid cell, e.g. mean surface albedo over snow area
  - Use cell\_methods attribute plus area\_type coordinate variable
- Units
  - Use units attribute



# Standard names for marine environment

| Property                                       | Number of names |
|------------------------------------------------|-----------------|
| Ocean / sea_water<br>physics/chemistry/biology | 579             |
| Sea surface waves                              | 80              |
| Sea surface height / tidal                     | 31              |
| Mean sea level change                          | 19              |
| Sea ice                                        | 90              |
| <b>Total</b>                                   | <b>799</b>      |



# Ocean physics / chemistry / biology names

| Property                        | Number of names |
|---------------------------------|-----------------|
| Ocean dynamics and transport    | 104             |
| Ocean thermodynamics / salinity | 111             |
| Radiation / surface fluxes      | 93              |
| Ocean model parameters          | 40              |
| Ocean chemistry / biology       | 231             |
| <b>Total</b>                    | <b>579</b>      |

# Examples – physics and chemistry

tendency\_of\_sea\_water\_temperature (K s<sup>-1</sup>)

northward\_ocean\_salt\_transport\_due\_to\_diffusion (kg s<sup>-1</sup>)

mole\_concentration\_of\_ammonium\_in\_sea\_water (mol m<sup>-3</sup>)

mole\_concentration\_of\_calcite\_expressed\_as\_carbon\_in\_sea\_water  
(mol m<sup>-3</sup>)

mole\_concentration\_of\_cfc11\_in\_sea\_water (mol m<sup>-3</sup>)

# Biological taxa

Use a generic standard name for the data variable, e.g.  
mass\_concentration\_of\_**biological\_taxon**\_expressed\_as\_carbon\_in\_  
sea\_water (kg m<sup>-3</sup>)

To specify the taxon, attach a *coordinate* variable to the data variable:

biological\_taxon\_name, e.g. "Calanus finmarchicus"

Optionally, provide a Life Science Identifier

biological\_taxon\_lsid, e.g. "urn:lsid:marinespecies.org:taxname:104464"

CF recommends World Register of Marine Species (WoRMS) for oceanographic data and Integrated Taxonomic Information System (ITIS) for freshwater and terrestrial data.



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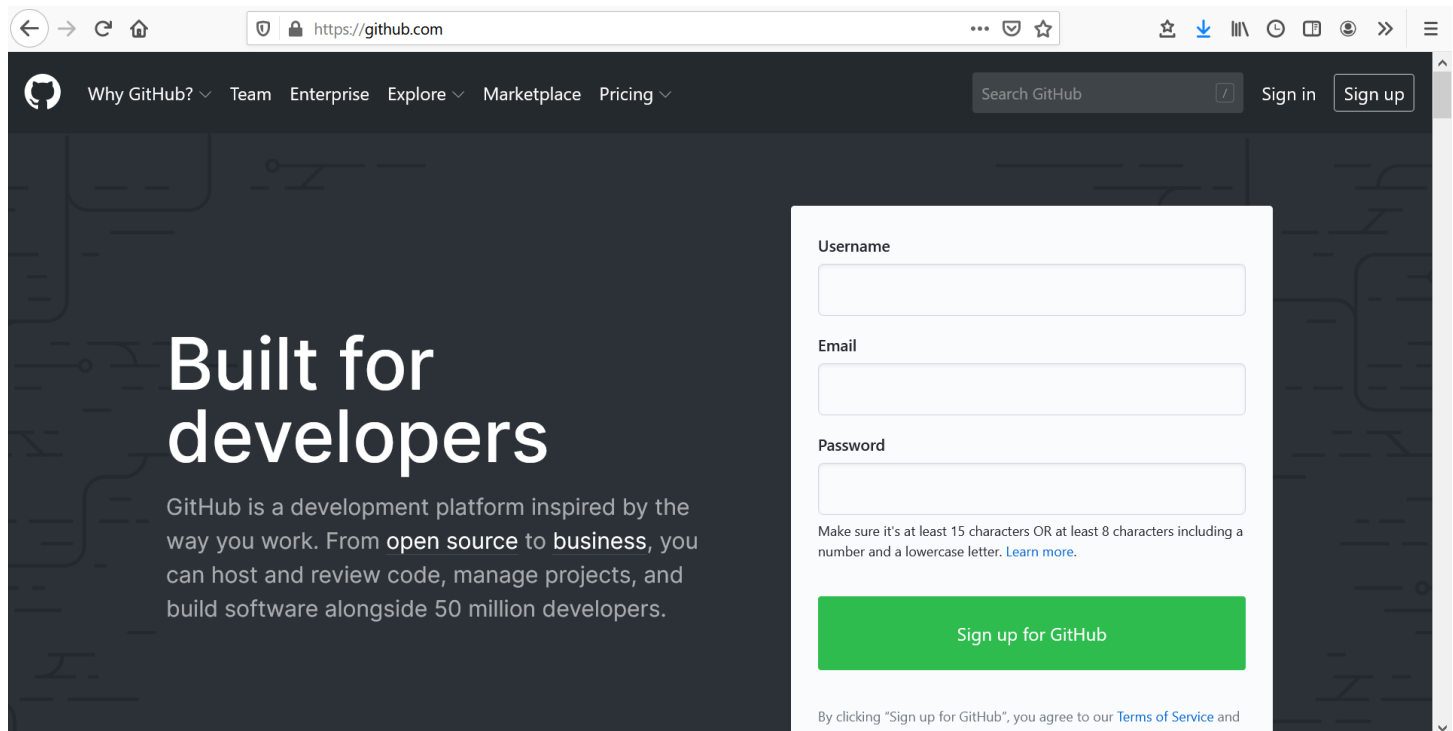
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# Standard names process

# How do I ask for a new standard name?

STEP 1

Sign up for an account on GitHub  
<https://github.com/>



The screenshot shows the GitHub website's sign-up page. The browser's address bar displays "https://github.com". The page features a dark header with navigation links: "Why GitHub?", "Team", "Enterprise", "Explore", "Marketplace", and "Pricing". A search bar and "Sign in" / "Sign up" buttons are also present. The main content area has a dark background with the text "Built for developers" and a description of GitHub as a development platform. On the right, a white sign-up form is overlaid, containing fields for "Username", "Email", and "Password". Below the password field, there is a note: "Make sure it's at least 15 characters OR at least 8 characters including a number and a lowercase letter. [Learn more.](#)". A prominent green button labeled "Sign up for GitHub" is at the bottom of the form. At the very bottom of the page, a small line of text reads: "By clicking 'Sign up for GitHub', you agree to our [Terms of Service](#) and [Privacy Policy](#)."

# How do I ask for a new standard name?

STEP 2

Navigate to the CF “discuss” repository (repo)  
<https://github.com/cf-convention/discuss>

cf-convention / discuss

Unwatch 56 Star 13 Fork 0

Code Issues 29 Pull requests 0 Actions Projects 0 Wiki Security 0 Insights Settings

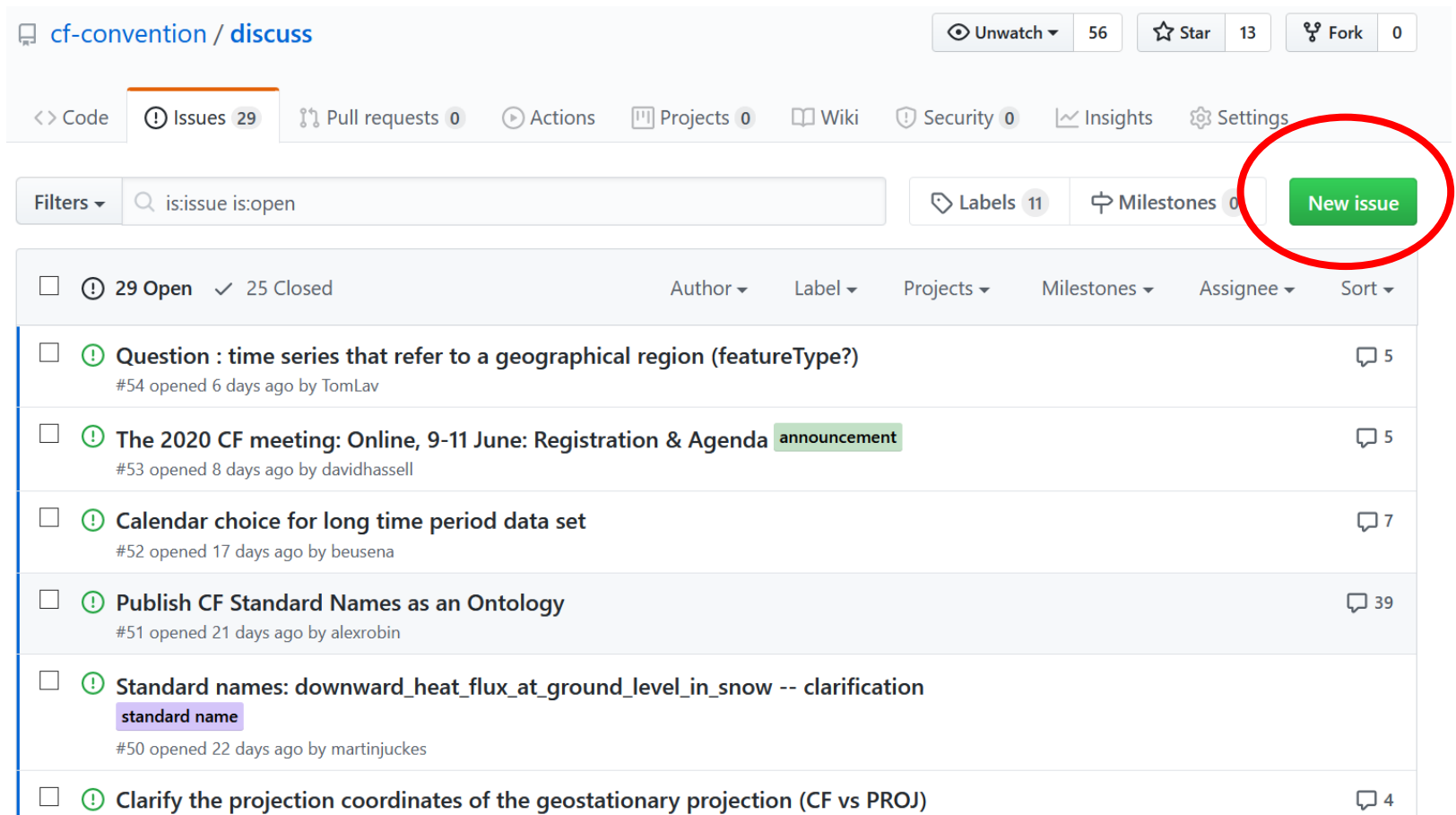
Filters is:issue is:open Labels 11 Milestones 0 New issue

| <input type="checkbox"/> | 29 Open                                                                         | 25 Closed | Author | Label        | Projects | Milestones | Assignee | Sort |
|--------------------------|---------------------------------------------------------------------------------|-----------|--------|--------------|----------|------------|----------|------|
| <input type="checkbox"/> | Question : time series that refer to a geographical region (featureType?)       |           |        |              |          |            |          | 5    |
| <input type="checkbox"/> | The 2020 CF meeting: Online, 9-11 June: Registration & Agenda                   |           |        | announcement |          |            |          | 5    |
| <input type="checkbox"/> | Calendar choice for long time period data set                                   |           |        |              |          |            |          | 7    |
| <input type="checkbox"/> | Publish CF Standard Names as an Ontology                                        |           |        |              |          |            |          | 39   |
| <input type="checkbox"/> | Standard names: downward_heat_flux_at_ground_level_in_snow -- clarification     |           |        |              |          |            |          |      |
| <input type="checkbox"/> | Clarify the projection coordinates of the geostationary projection (CF vs PROJ) |           |        |              |          |            |          | 4    |

# How do I ask for a new standard name?

STEP 3

Open a new issue



cf-convention / discuss

Unwatch 56 Star 13 Fork 0

Code Issues 29 Pull requests 0 Actions Projects 0 Wiki Security 0 Insights Settings

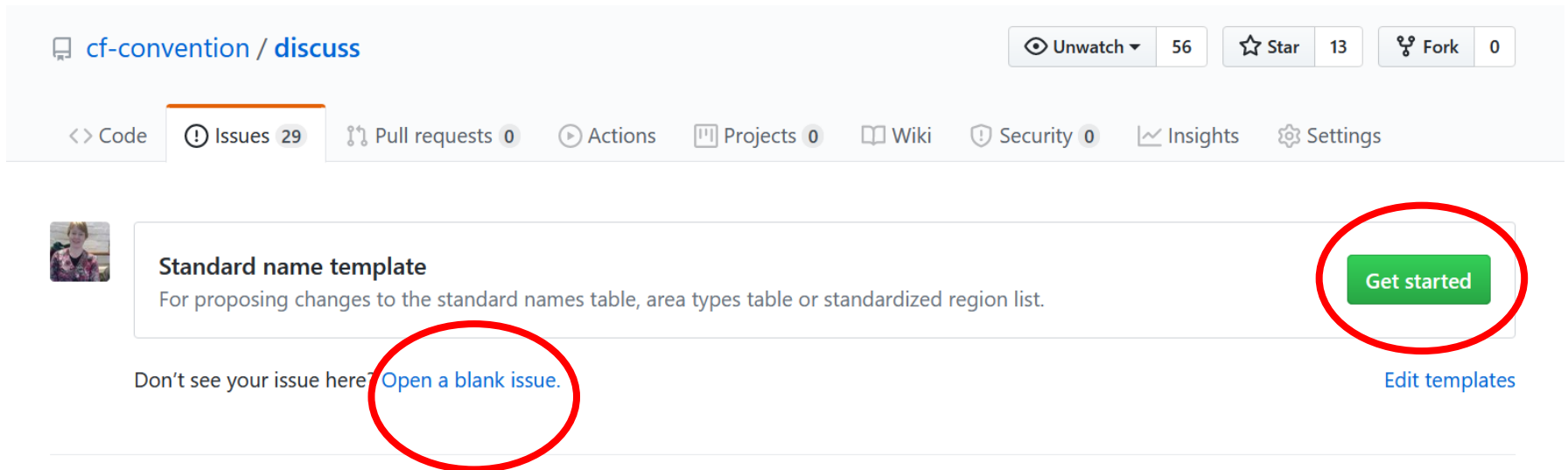
Filters is:issue is:open Labels 11 Milestones 0 **New issue**

| <input type="checkbox"/> | 29 Open ✓ 25 Closed                                                                                                                                  | Author | Label | Projects | Milestones | Assignee | Sort |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-------|----------|------------|----------|------|
| <input type="checkbox"/> | <b>Question : time series that refer to a geographical region (featureType?)</b><br>#54 opened 6 days ago by TomLav                                  |        |       |          |            |          | 5    |
| <input type="checkbox"/> | <b>The 2020 CF meeting: Online, 9-11 June: Registration &amp; Agenda</b> <b>announcement</b><br>#53 opened 8 days ago by davidhassell                |        |       |          |            |          | 5    |
| <input type="checkbox"/> | <b>Calendar choice for long time period data set</b><br>#52 opened 17 days ago by beusena                                                            |        |       |          |            |          | 7    |
| <input type="checkbox"/> | <b>Publish CF Standard Names as an Ontology</b><br>#51 opened 21 days ago by alexrobin                                                               |        |       |          |            |          | 39   |
| <input type="checkbox"/> | <b>Standard names: downward_heat_flux_at_ground_level_in_snow -- clarification</b><br><b>standard name</b><br>#50 opened 22 days ago by martinjuckes |        |       |          |            |          |      |
| <input type="checkbox"/> | <b>Clarify the projection coordinates of the geostationary projection (CF vs PROJ)</b>                                                               |        |       |          |            |          | 4    |

# How do I ask for a new standard name?

STEP 4

Select the standard name template



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Code Issues 29 Pull requests 0 Actions Projects 0 Wiki Security 0 Insights Settings

**Standard name template**  
For proposing changes to the standard names table, area types table or standardized region list.

Get started

Don't see your issue here? [Open a blank issue.](#) [Edit templates](#)



# How do I ask for a new standard name?

STEP 5

Use the template to write your proposal

Standard names: \*add your own title here\*

Write Preview H B I @

Before submitting an issue be sure you have read and understood the rules for vocabulary changes:  
[http://cfconventions.org/standard\\_name\\_rules.html](http://cfconventions.org/standard_name_rules.html)

Please note that it is fine to group together a number of proposals in a single GitHub issue (i.e. it is not necessary to open a separate issue for each vocabulary term). Change proposals should include the following information as applicable.

**Proposer's name** This information will be used to add entries to the vocabulary editor:  
<http://cfeditor.ceda.ac.uk/proposals/1>. If you prefer not to add your name, your github id will be used instead.

**Date** Also used in the vocabulary editor.

For each term please try to give the following:

- Term** Proposed term to appear in the vocabulary
- Description** A brief description to explain the meaning of the term
- Units** (If applicable).

Attach files by dragging & dropping, selecting or pasting them.

Styling with Markdown is supported

**Submit new issue**

# CF standard name rules

- Any member of the community may comment on proposals
- Aim of the discussion is to achieve consensus (we now have two moderators!)
- Rules are laid out at [http://cfconventions.org/standard\\_name\\_rules.html](http://cfconventions.org/standard_name_rules.html)
- Provision for “fast tracking” new names that are very similar to existing terms, subject to checking
- CF standard names committee can be asked to vote if consensus cannot be achieved

# Rules for acceptance / rejection of proposals

- A proposal will be **accepted** if one of the following is true:
  - (a) it is similar to existing terms and has been checked for consistency by the moderator;
  - (b) consensus has been reached in favour of the proposal;
  - (c) the moderator's summary indicates that consensus in favour of the proposal has nearly been achieved;
  - (d) a majority of the standard names committee vote to accept the proposal.
- A proposal will be **rejected** if one of the following is true:
  - (a) it duplicates an existing vocabulary term;
  - (b) consensus has been reached against the proposal;
  - (c) the moderator's summary indicates that consensus against the proposal has nearly been achieved;
  - (d) a majority of the standard names committee vote to reject the proposal;
  - (e) the proposer withdraws the proposal.

# CF standard name table

<http://cfconventions.org/Data/cf-standard-names/current/build/cf-standard-name-table.html>

| Standard Name                                                                                                                                                                                                                                                                                                 | Canonical Units |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| <b>air_temperature_anomaly</b><br>"Anomaly" means difference from climatology. Air temperature is the bulk temperature of the air, not the surface (skin) temperature.                                                                                                                                        | <b>K</b>        |
| <b>surface_upward_latent_heat_flux</b><br>The surface latent heat flux is the exchange of heat between the surface and the air on account of evaporation (including sublimation). In accordance with common usage in geophysical disciplines, "flux" implies per unit area, called "flux density" in physics. | <b>W m-2</b>    |

# NERC Vocabulary Server (NVS2)

## Collection (complete vocabulary):

[vocab.nerc.ac.uk/collection/P07/current/](http://vocab.nerc.ac.uk/collection/P07/current/)

(CF standard names)

## Single term:

<http://vocab.nerc.ac.uk/collection/P07/current/CFV16A1/>

(age\_of\_sea\_ice)

OR

## Single term:

[http://vocab.nerc.ac.uk/standard\\_name/age\\_of\\_sea\\_ice/](http://vocab.nerc.ac.uk/standard_name/age_of_sea_ice/)

# CF collections in NVS2

CF standard\_names: P07

CF area\_type list: P29

CF standardized region list: P30

CF cell\_methods list: P15

CF calendars: P37

CF vertical coverages: P38

Access methods: URL, SOAP, SPARQL endpoint

SPARQL: XML, JSON, text, CSV and TSV