CERP NetCDF Metadata Conventions

Version 1.2, August 13, 2014

Abstract

This document describes the Comprehensive Everglades Restoration Plan (CERP) metadata conventions for NetCDF. These conventions are designed to be used for data associated with the Florida Everglades region, and will facilitate data sharing between organizations involved in Everglades science.

The CERP metadata conventions are heavily based on the Climate and Forecast (CF) Metadata Conventions (Version 1.4). Files that comply with the CERP conventions will also be compliant with the CF conventions. The CERP conventions add optional and mandatory attributes to further describe the NetCDF file, and further specifies some optional CF attributes as mandatory. This assures that NetCDF files conforming to the CERP conventions will also conform to the CF conventions.

All CERP NetCDF compliant files should also be compliant with the NetCDF Climate and Forecast (CF) Metadata Conventions (version 1.4).

This document does not attempt to define an entirely new standard; it lists the changes made from the CF 1.4 conventions along with best practices. Therefore the CERP NetCDF conventions are formally described as the CF 1.4 conventions together with the changes below, which take precedence over the CF 1.4 conventions when in conflict.

1. All Coordinate and Data Variables

a. The **long_name** attribute is mandatory for all coordinate and data variables. The **long_name** attribute will give a concise description of the variable, and is used as the primary means of displaying the data type in the viewing applications such as data plots and legends. Example:

```
float depth(time, y, x) ;
      depth:long_name = "water depth" ;
```

b. The **units** attribute is mandatory for all coordinate and data variables. The NetCDF library uses the UDUNITS package for units parsing. When possible, the **units** attribute for variables should use a unit recognized by this package. A list of units recognized by the UDUNITS package can be found at: http://www.unidata.ucar.edu/software/udunits/udunits-1/udunits.txt.

```
double y(y) ;
      y:units = "km" ;

double lon(y, x) ;
      lon:units = "degrees_east" ;
```

```
double Temperature(time, cells) ;
      Temperature:units = "K" ;
```

i. This list may not cover everything, such as dimensionless units. In the case of dimensionless units, use a numerical representation of the units when possible, i.e. "1/10e6" for "parts per million".

2. Coordinate Variables

a. The **standard_name** attribute is mandatory for all coordinate variables. The **standard_name** attribute is used to determine the specific axis of the variable as it pertains to the coordinate system. The standard names for Cartesian projected coordinate systems are "projected_x_coordinate" and "projected_y_coordinate". The standard names for geographic coordinate systems are "latitude" and "longitude". The standard names for the rotated pole projection are "grid_latitude" and "grid_longitude".

```
double y(y) ;
      y:standard_name = "projection_y_coordinate" ;

double lon(y,x) ;
      lon:standard_name = "longitude" ;
```

b. Time is regarded in these conventions as an optional coordinate variable. The rules of attribution for coordinate variables will apply to all time coordinate variables that are present in a NetCDF file. See: CF 1.4 Section 4.4 - Time Coordinate.

3. Data Variables

a. The **standard_name** attribute is recommended for data variables. The **standard_name** attribute is used to determine if datasets are of a comparable quantity. A list of common standard names can be found at http://cf-pcmdi.llnl.gov/documents/cf-standard-names/. If an acceptable standard name cannot be found in this list, then the **standard_name** attribute should not be used. A standard name suitable to the data type may be created following the *Guidelines for Construction of CF Standard Names* document found at the above link and submitted to the CF mailing list for inclusion in the standard names list, however the new standard name will not be considered valid for use until it is accepted and included in the official list of standard names. The mailing list address is linked to in the *Guidelines for Construction of CF Standard Names* document.

b. To facilitate compatibility with the ESRI ArcGIS software package as well as other open source GIS software packages, all data variables must include an attribute describing the coordinate system in a form known as a Well Known Text string (WKT). The WKT string must be stored in the **esri_pe_string** attribute as shown in the example below:

```
depth:esri_pe_string =
      "PROJCS[\"NAD_1983_UTM_Zone_17N\",GEOGCS[\"GCS_North_American
      _1983\",DATUM[\"D_North_American_1983\",SPHEROID[\"GRS_1980\"
      ,6378137.0,298.257222101]],PRIMEM[\"Greenwich\",0.0],UNIT[\"D
```

```
egree\",0.0174532925199433]],PROJECTION[\"Transverse_Mercator
\"],PARAMETER[\"False_Easting\",500000.0],PARAMETER[\"False_N
orthing\",0.0],PARAMETER[\"Central_Meridian\",-81.0],PARAMETE
R[\"Scale_Factor\",0.9996],PARAMETER[\"Latitude_Of_Origin\",0
.0],UNIT[\"Meter\",1.0]]" ;
```

i. For more information on WKT strings, see: http://www.geoapi.org/2.0/javadoc/org/opengis/referencing/doc-files/WKT.html

c. To further describe the characteristics of the data, the **cell_methods** attribute can be used. This attribute can describe the statistical nature of the data, such as mean, maximum, instantaneous (point), etc. The value of the **cell_methods** attribute must be selected from the list of cell methods in the CF conventions document. See: CF 1.4 Appendix E. Cell Methods.

```
float pressure(time, stations) ;
      pressure:long_name = "pressure" ;
      pressure:units = "kPa" ;
      pressure:cell_methods = "time: point" ;

float maxtemp(time, stations) ;
      maxtemp:long_name = "temperature" ;
      maxtemp:units = "K" ;
      maxtemp:cell_methods = "time: maximum" ;

float ppn(time, stations) ;
      ppn:long_name = "depth of water-equivalent precipitation" ;
      ppn:units = "mm" ;
      ppn:cell_methods = "time: sum" ;
```

d. The **_FillValue** attribute must be used to specify missing data values in a data variable. The value of this attribute should be the same as the missing data representation in the variable's actual data. See: CF 1.4 Section 2.5.1 - Missing Data.

e. To facilitate data visualization in spatial contexts, the inclusion of **min** and **max** attributes is suggested for each data variable. The values of these attributes should correspond to the minimum and maximum values contained in the data, respectively.

4. Grid Mapping (Projection) Variables

a. All data variables must be accompanied by a grid mapping variable matching the **grid_mapping** attribute in the data variable. This is necessary to be able to view data in the correct spatial context. See: CF 1.4 Appendix F. Grid Mappings.

b. All grid mapping variables must have attributes describing the ellipsoid used for the mapping. There are two possible combinations of attributes that can completely describe an ellipsoid:

i. **semi_major_axis** and **inverse_flattening**

```
int crs ;
      crs:grid_mapping_name = "latitude_longitude" ;
      crs:longitude_of_prime_meridian = 0.0 ;
```

```
        crs:semi_major_axis = 6378137.0 ;
        crs:inverse_flattening = 298.257223563 ;
```

ii. **semi_major_axis** and **semi_minor_axis**

```
int transverse_mercator ;
        transverse_mercator:grid_mapping_name = "transverse_mercator"
        ;
        transverse_mercator:longitude_of_central_meridian = -93. ;

        transverse_mercator:latitude_of_projection_origin = 0. ;

        transverse_mercator:scale_factor_at_central_meridian = 0.9996
        ;
        transverse_mercator:false_easting = 500000. ;
        transverse_mercator:false_northing = 0. ;
        transverse_mercator:semi_major_axis = 6378137. ;
        transverse_mercator:semi_minor_axis = 6356752.31424518 ;

        transverse_mercator:_CoordinateAxisTypes = "GeoY GeoX" ;
```

iii. Note: For Java development, the above attributes are only supported in version of the NetCDF Java libraries 4.2.20100726.1909 and higher.

5. Global attributes

a. Global attributes are used to describe the contents of an entire NetCDF file. A CERP compliant NetCDF file *should* include the following global attributes:
   i. **title** - a concise description of the file.
   ii. **author** - the name of the author or originator of the file.
   iii. **institution** - the name of the institution or organization that created the file.
   iv. **Conventions** - the CF version that the file complies with (currently "1.4").
   v. **source** - a description of the software that created the file, including the name, version number, and any configuration information that is needed to recreate the file if possible. If the file contains empirical data, then the method of collection and any other pertinent information should be listed here.
   vi. **history** - a history of all modifications performed to the file. Entries should include a date stamp followed by a description of the modification. The first entry in this attribute should ALWAYS be the initial file creation date stamp and a description stating that it was the initial creation of the file.
   vii. **cerp_version** - the CERP version that the file complies with (currently "1.2").
   viii. **comment** - a roughly 1 to 3 sentence explanation of what this file contains.
   ix. **qaqc** - a value describing the quality control/quality assurance status of the file. If the originator's institution has standard qaqc terms, then the appropriate term should be used here.

b. Optionally, the author, institution, source, qaqc, and comment attributes can be added to individual data variables.

Appendix A. Example NetCDF header for a file containing temporal data.

```
dimensions:
      time = UNLIMITED ; // (10 currently)
      y = 400 ;
      x = 300 ;
variables:
      int time(time) ;
            time:long_name = "time step" ;
            time:_CoordinateAxisType = "Time" ;
            time:units = "years since 2014-08-14T00:00:00 +0000" ;
      double y(y) ;
            y:long_name = "y coordinate of projection" ;
            y:standard_name = "projection_y_coordinate" ;
            y:_CoordinateAxisType = "GeoY" ;
            y:units = "Meter" ;
      double x(x) ;
            x:long_name = "x coordinate of projection" ;
            x:standard_name = "projection_x_coordinate" ;
            x:_CoordinateAxisType = "GeoX" ;
            x:units = "Meter" ;
      int transverse_mercator ;
            transverse_mercator:grid_mapping_name = "transverse_mercator" ;
            transverse_mercator:longitude_of_central_meridian = -81. ;
            transverse_mercator:latitude_of_projection_origin = 0. ;
            transverse_mercator:scale_factor_at_central_meridian = 0.9996 ;
            transverse_mercator:earth_radius = 6371229. ;
            transverse_mercator:false_easting = 500000. ;
            transverse_mercator:false_northing = 0. ;
            transverse_mercator:semi_major_axis = 6378137. ;
            transverse_mercator:semi_minor_axis = 6356752.31414036 ;
            transverse_mercator:_CoordinateAxisTypes = "GeoY GeoX" ;
      float example(time, y, x) ;
            example:long_name = "example data variable" ;
            example:coordinates = "time y x" ;
            example:units = "n/a" ;
            example:_FillValue = 1.#QNAN0f ;
            example:esri_pe_string = "PROJCS[\"NAD83 / UTM zone 17N\",
            GEOGCS[\"NAD83\",     DATUM[\"North American Datum 1983\",
            SPHEROID[\"GRS 1980\", 6378137.0, 298.257222101, AUTHORITY
            [\"EPSG\",\"7019\"]],       TOWGS84[0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
            0.0],       AUTHORITY[\"EPSG\",\"6269\"]],
            PRIMEM[\"Greenwich\", 0.0, AUTHORITY[\"EPSG\",\"8901\"]],
            UNIT[\"degree\", 0.017453
            292519943295],     AXIS[\"Geodetic longitude\", EAST],
            AXIS[\"Geodetic latitude\", NORTH],
            AUTHORITY[\"EPSG\",\"4269\"]],
            PROJECTION[\"Transverse_Mercator\", AUTHORITY[\"EPSG\",\"9807\"]],
            PARAMETER[\"central_meridian\", -81.0],
            PARAMETER[\"latitude_of_origin\", 0.0],
            PARAMETER[\"scale_factor\", 0.9996],   PARAMETER[\"false_easting\",
            500000.0],   PARAMETER[\"false_northing\", 0.0]
            ,   UNIT[\"m\", 1.0],   AXIS[\"Easting\", EAST],
            AXIS[\"Northing\", NORTH],   AUTHORITY[\"EPSG\",\"26917\"]]" ;
```

```
            example:grid_mapping = "transverse_mercator" ;
            example:min = 0.f ;
            example:max = 13.60787f ;

// global attributes:
            :Conventions = "1.4" ;
            :cerp_version = "1.2" ;
            :history = "Created Thu Aug 14 09:31:46 EDT 2014" ;
            :source = "CERP NetCDF Library" ;
            :comment = "CERP NetCDF Library" ;
            :institution = "JEM" ;
            :author = "mckelvym on IGS-McKelvy" ;
```

Appendix B. Example NetCDF header for a file containing atemporal data.

```
dimensions:
        y = 400 ;
        x = 300 ;
variables:
      double y(y) ;
            y:long_name = "y coordinate of projection" ;
            y:standard_name = "projection_y_coordinate" ;
            y:_CoordinateAxisType = "GeoY" ;
            y:units = "Meter" ;
      double x(x) ;
            x:long_name = "x coordinate of projection" ;
            x:standard_name = "projection_x_coordinate" ;
            x:_CoordinateAxisType = "GeoX" ;
            x:units = "Meter" ;
      int transverse_mercator ;
            transverse_mercator:grid_mapping_name = "transverse_mercator" ;
            transverse_mercator:longitude_of_central_meridian = -81. ;
            transverse_mercator:latitude_of_projection_origin = 0. ;
            transverse_mercator:scale_factor_at_central_meridian = 0.9996 ;
            transverse_mercator:earth_radius = 6371229. ;
            transverse_mercator:false_easting = 500000. ;
            transverse_mercator:false_northing = 0. ;
            transverse_mercator:semi_major_axis = 6378137. ;
            transverse_mercator:semi_minor_axis = 6356752.31414036 ;
            transverse_mercator:_CoordinateAxisTypes = "GeoY GeoX" ;
      float example(y, x) ;
            example:long_name = "example" ;
            example:coordinates = "y x" ;
            example:units = "n/a" ;
            example:_FillValue = 1.#QNAN0f ;
            example:esri_pe_string = "PROJCS[\"NAD83 / UTM zone 17N\",
GEOGCS[\"NAD83\",     DATUM[\"North American Datum 1983\",       SPHEROID[\"GRS
1980\", 6378137.0, 298.257222101, AUTHORITY
[\"EPSG\",\"7019\"]],       TOWGS84[0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0],
AUTHORITY[\"EPSG\",\"6269\"]],     PRIMEM[\"Greenwich\", 0.0,
AUTHORITY[\"EPSG\",\"8901\"]],     UNIT[\"degree\", 0.017453
292519943295],     AXIS[\"Geodetic longitude\", EAST],     AXIS[\"Geodetic
latitude\", NORTH],     AUTHORITY[\"EPSG\",\"4269\"]],
PROJECTION[\"Transverse_Mercator\", AUTHORITY[\"EPSG\",\"9807\"]],
PARAMETER[\"central_meridian\", -81.0],   PARAMETER[\"latitude_of_origin\",
0.0],   PARAMETER[\"scale_factor\", 0.9996],   PARAMETER[\"false_easting\",
500000.0],   PARAMETER[\"false_northing\", 0.0]
,   UNIT[\"m\", 1.0],   AXIS[\"Easting\", EAST],   AXIS[\"Northing\", NORTH],
AUTHORITY[\"EPSG\",\"26917\"]]" ;
            example:grid_mapping = "transverse_mercator" ;
            example:min = 0.f ;
            example:max = 13.60787f ;

// global attributes:
            :Conventions = "1.4" ;
            :cerp_version = "1.2" ;
            :history = "Created Thu Aug 14 10:40:08 EDT 2014" ;
```

```
:source = "CERP NetCDF Library" ;
:comment = "CERP NetCDF Library" ;
:institution = "JEM" ;
:author = "mckelvym on IGS-McKelvy" ;
```