

## Recommendations to Improve CF and UGRID Compliance of ADCIRC Output (July 2022)

### Background

Currently, ADCIRC output files generated in the CF/UGRID format are not fully compliant with the CF standard, and have some discrepancies in style with the UGRID standard. This document presents recommended changes to improve compliance, which could help make post-processing and visualization of ADCIRC output easier in the future by making metadata more human-readable and easier to interpret.

As a basis for the recommended changes, ADCIRC output files generated by ASGS from the last advisory of Hurricane Ida (2021) will be used. You can access these files on the LSU CCT THREDDS server at the following links: [maxele.63.nc](https://maxele.63.nc), [fort.63.nc](https://fort.63.nc). To justify the recommended changes, results from CF and UGRID compliance checking software and references to the CF and UGRID standard documentation will be used. The changes apply to maxele and fort.63 files, but should be easily generalizable to other types of output.

The first section, [“Required changes for CF compliance”](#), lists changes that are necessary to avoid compliance errors and should be implemented as soon as possible. The next two sections, [“Recommended changes related to CF compliance”](#) and [“Recommended changes for UGRID compliance and style”](#), list changes that are recommended, but are not as urgent and are open to interpretation.

### Required changes for CF compliance

#### (1) Remove or fix invalid standard names

- Remove the `standard_name` attribute for `zeta_max` and `time_of_zeta_max` variables in maxele files

Original:

```
double zeta_max(node) ;
    zeta_max:long_name = "maximum water surface elevationabove geoid" ;
    zeta_max:standard_name = "maximum_sea_surface_height_above_geoid" ;
    zeta_max:coordinates = "y x" ;
    zeta_max:location = "node" ;
    zeta_max:mesh = "adcirc_mesh" ;
    zeta_max:units = "m" ;
    zeta_max:_FillValue = -99999. ;
```

Marcos Botto Tornielli  
Contact Email: mbottot@mit.edu

```
double time_of_zeta_max(node) ;  
    time_of_zeta_max:long_name = "time of maximum water surface elevationabove geoid" ;  
    time_of_zeta_max:standard_name = "time_of_maximum_sea_surface_height_above_geoid" ;  
    time_of_zeta_max:coordinates = "y x" ;  
    time_of_zeta_max:location = "node" ;  
    time_of_zeta_max:mesh = "adcirc_mesh" ;  
    time_of_zeta_max:units = "sec" ;  
    time_of_zeta_max:_FillValue = -99999. ;
```

#### Updated:

```
double zeta_max(node) ;  
    zeta_max:long_name = "maximum water surface elevationabove geoid" ;  
    zeta_max:coordinates = "y x" ;  
    zeta_max:location = "node" ;  
    zeta_max:mesh = "adcirc_mesh" ;  
    zeta_max:units = "m" ;  
    zeta_max:_FillValue = -99999. ;  
  
double time_of_zeta_max(node) ;  
    time_of_zeta_max:long_name = "time of maximum water surface elevationabove geoid" ;  
    time_of_zeta_max:coordinates = "y x" ;  
    time_of_zeta_max:location = "node" ;  
    time_of_zeta_max:mesh = "adcirc_mesh" ;  
    time_of_zeta_max:units = "sec" ;  
    time_of_zeta_max:_FillValue = -99999. ;
```

- Add underscores to the standard\_name attribute of the depth variable in all files (“depth\_below\_geoid” instead of “depth below geoid”)

#### Original:

```
double depth(node) ;  
    depth:long_name = "distance below geoid" ;  
    depth:standard_name = "depth below geoid" ;  
    depth:coordinates = "time y x" ;  
    depth:location = "node" ;  
    depth:mesh = "adcirc_mesh" ;  
    depth:units = "m" ;
```

#### Updated:

```
double depth(node) ;  
    depth:long_name = "distance below geoid" ;  
    depth:standard_name = "depth_below_geoid" ;  
    depth:coordinates = "time y x" ;  
    depth:location = "node" ;  
    depth:mesh = "adcirc_mesh" ;  
    depth:units = "m" ;
```

### Justification

CF standard names are defined in a [standard name table](#). If there isn't a standard name in the table that corresponds to the variable you're defining, it's better not to use a standard name, since using an invalid one leads to compliance errors. For example, the standard name used for zeta in fort.63 files, "sea\_surface\_height\_above\_geoid", is defined in the table, but the standard name used for zeta\_max in maxele.63 files, "maximum\_sea\_surface\_height\_above\_geoid" is not. In order to use a standard name, you would need to verify that it's defined in the table, and adding modifiers such as "maximum\_" to a valid standard name may not work.

In general, standard names are much more restrictive than long names (long names can contain anything). Since standard names aren't required, [you can just use a long name](#) when there isn't an appropriate standard name in the table. This is the recommendation for maxele files, which use invalid standard names for some variables. In those cases, the standard name attribute can be removed, leaving just the long name to describe the variables.

You can see examples of compliance errors due to invalid standard names in compliance checks [1](#) and [2](#) for the maxele file.

### **(2) Remove the positive attribute for x and y**

- Remove the positive attribute from coordinate variables x and y in all files

#### Original:

```
double x(node) ;
    x:long_name = "longitude" ;
    x:standard_name = "longitude" ;
    x:units = "degrees_east" ;
    x:positive = "east" ;
double y(node) ;
    y:long_name = "latitude" ;
    y:standard_name = "latitude" ;
    y:units = "degrees_north" ;
    y:positive = "north" ;
```

#### Updated:

```
double x(node) ;
    x:long_name = "longitude" ;
    x:standard_name = "longitude" ;
    x:units = "degrees_east" ;
double y(node) ;
    y:long_name = "latitude" ;
    y:standard_name = "latitude" ;
    y:units = "degrees_north" ;
```

Justification:

Maxele [compliance check 1](#) shows an error from the positive attributes of x and y. The positive attribute is for [vertical coordinates only](#) and its values can only be “up” or “down”. Therefore, this attribute does not apply to the x and y coordinate variables and should be removed from both. The units for y (degrees\_north) and x (degrees\_east) are [sufficient to indicate the positive direction](#) according to CF, making a positive attribute unnecessary.

**(3) Remove units attributes with “nondimensional” value**

- Remove the units attribute from variables for which its value is “nondimensional”
  - These variables are element, neta, nvdll, ibtypee, nbdv, nvel, nvell, ibtype, and nbvv

Original:

```
int element(nele, nvertex) ;  
    element:long_name = "element" ;  
    element:cf_role = "face_node_connectivity" ;  
    element:start_index = 1 ;  
    element:units = "nondimensional" ;
```

Updated:

```
int element(nele, nvertex) ;  
    element:long_name = "element" ;  
    element:cf_role = "face_node_connectivity" ;  
    element:start_index = 1 ;
```

(Just shown for element variable, but this change should be applied to all variables mentioned above)

Justification:

As seen in maxele CF compliance checks [1](#) and [2](#), “nondimensional” is not a valid value for the units attribute. [Units are not necessary](#) if a variable is nondimensional, so in this case the attribute should be removed. Similarly to standard names, acceptable units are defined in a table by the CF conventions and “nondimensional” is not included in this table.

**(4) Rename global attributes that have invalid names and consolidate Conventions attribute**

- Two global attributes that have invalid names (\_FillValue and fort.15) should be renamed
- The Conventions attribute should be consolidated to include both CF and UGRID and the convention attribute should be removed

Marcos Botto Tornielli  
Contact Email: mbottot@mit.edu

Original:

```
:_FillValue = -99999. ;  
:model = "ADCIRC" ;  
:version = "v53.05-modified" ;  
:grid_type = "Triangular" ;  
:description = "ASGS cs:20210728000000 cy:IDA19 ASGS" ;  
:agrid = "LA_v20a-WithUpperAtch_chk.grd" ;  
:runes = "ASGS cs:20210728000000 cy:IDA19 ASGS" ;  
:runid = "nhcConsensus" ;  
:title = "LA ASGS v19k" ;  
:institution = "Seahorse" ;  
:source = "LONI" ;  
:history = "ASGS Nowcast/Forecast" ;  
:references = "http://www.seahorsecoastal.com" ;  
:comments = "Model time is relative to UTC." ;  
:host = "queenbee.loni.org" ;  
:convention = "CF" ;  
:Conventions = "UGRID-0.9.0" ;  
:contact = "jason.fleming@seahorsecoastal.com" ;  
:creation_date = "2021-08-30 15:55:53 -05:00" ;  
:modification_date = "2021-08-30 15:55:53 -05:00" ;  
:fort.15 = "==== Input File Parameters (below) =====" ;
```

(the rest of the global variables are left out here for the sake of brevity)

Updated:

```
:FillValue = -99999. ;  
:model = "ADCIRC" ;  
:version = "v53.05-modified" ;  
:grid_type = "Triangular" ;  
:description = "ASGS cs:20210728000000 cy:IDA19 ASGS" ;  
:agrid = "LA_v20a-WithUpperAtch_chk.grd" ;  
:runes = "ASGS cs:20210728000000 cy:IDA19 ASGS" ;  
:runid = "nhcConsensus" ;  
:title = "LA ASGS v19k" ;  
:institution = "Seahorse" ;  
:source = "LONI" ;  
:history = "ASGS Nowcast/Forecast" ;  
:references = "http://www.seahorsecoastal.com" ;  
:comments = "Model time is relative to UTC." ;  
:host = "queenbee.loni.org" ;  
:Conventions = "CF-1.8 UGRID-1.0" ;  
:contact = "jason.fleming@seahorsecoastal.com" ;  
:creation_date = "2021-08-30 15:55:53 -05:00" ;  
:modification_date = "2021-08-30 15:55:53 -05:00" ;  
:fort_15 = "==== Input File Parameters (below) =====" ;
```

Note: FillValue and fort\_15 are just suggestions for the naming of these global attributes; they could be renamed differently, as long as the new names comply with the CF standard.

### Justification:

Global attributes should begin with a letter and only contain letters, numbers, and underscores (see errors in maxele CF compliance checks [1](#) and [2](#)), so `_FillValue` and `fort.15` need to be renamed. The `_FillValue` global attribute could also be removed rather than renamed, since it's not needed as a global attribute and CF compliance check [1](#) shows that the CF standard doesn't expect it to be defined there. However, if it's important for the value to be listed there, it should be renamed.

The CF standard [expects the CF version to be listed in the Conventions global attribute](#), which isn't currently the case in ADCIRC output. Therefore, the unnecessary convention attribute should be removed and the Conventions attribute should be changed to indicate both the CF and UGRID versions as shown above. This will allow compliance checkers to identify which version of CF should be checked against.

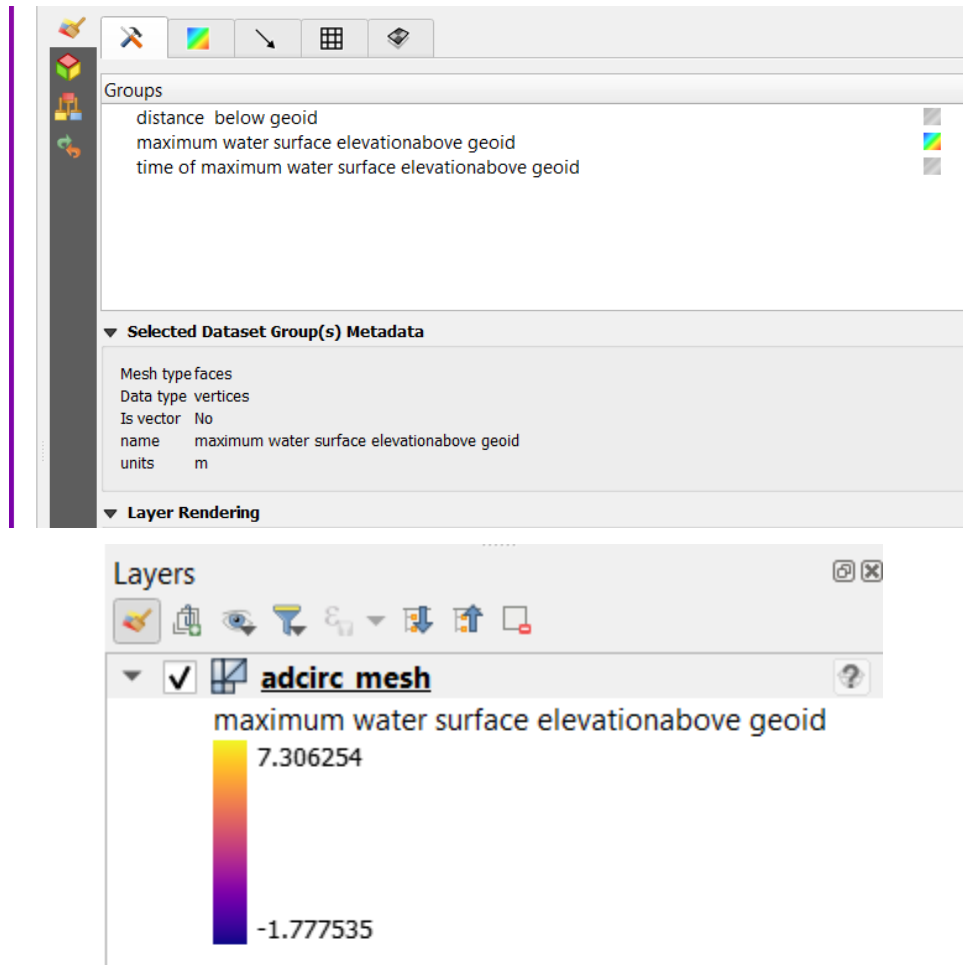
## **Recommended changes related to CF compliance**

### **(1) Improve long names and optionally add comment attributes**

- Long names that aren't descriptive enough could be updated
  - For example, the long name of the `adcirc_mesh` variable, which is currently just "mesh\_topology", could be changed to something like "Topology data of 2D unstructured mesh" (as seen in [this example](#) in the UGRID conventions documentation).
- Long names which have issues such as missing or extra spaces should be fixed
- If extra information is needed that would clutter the long name, a comment attribute can be added to the variable

### Justification:

Long names can include any content in any format, so they should ideally be as descriptive as possible so that variables can be easily understood through a quick read of the netCDF header. There are also specific uses for long names. A practical example of why the formatting of long names matters is when visualizing ADCIRC output files with QGIS. QGIS uses a variable's long name to label it in the GUI, and the long name is also automatically assigned as a color bar label. In this case, it's helpful for the long name to be descriptive, and possibly include some extra information such as units but without being too long or cluttered.



(Examples of how long names are used by QGIS)

As an example, the long name of `zeta_max` in maxele files could be changed from "maximum water surface elevationabove geoid" to "Maximum Water Surface Elevation (m)", and a comment attribute could be added that indicates "Water surface elevation is measured above the geoid".

```
double zeta_max(node) ;  
    zeta_max:long_name = "Maximum Water Surface Elevation (m)" ;  
    zeta_max:comment = "Water surface elevation is measured above the geoid." ;  
    zeta_max:coordinates = "x y" ;  
    zeta_max:location = "node" ;  
    zeta_max:mesh = "adcirc_mesh" ;  
    zeta_max:units = "m" ;  
    zeta_max:_FillValue = -99999. ;
```

(Example of how long name and comment attributes could be implemented)

This way, the long name is formatted in a way that would look intuitive and descriptive when labeling something like a color bar, and the comment attribute is used for any extra information that might be useful.

## (2) Add long names to variables that don't have one

- Variables that don't have long name (max\_nvdl and max\_nvell) should have one added

### Justification:

Although variables are not required to have a standard name or long name, it's still recommended to at least have one of the two (as seen by the warning for max\_nvdl and max\_nvell in CF compliance check [1](#)). Since long names are less restrictive, the easiest approach would be to add a long name in cases where neither attribute is present.

## (3) Add a calendar attribute to the time variable

- Add a calendar attribute to the time variable in all files (see [this section](#) of the CF documentation for possible values)
  - Easiest change would be to use the value standard

### Justification:

Although it's not required, the CF conventions [recommend including a calendar attribute](#) with the time variable. If there's no calendar attribute, CF considers the default to be the standard calendar as defined [here](#). Therefore, the simplest way to implement this change would be to add a calendar attribute with the value standard (time: calendar = "standard").

## Recommended changes for UGRID compliance and style

### (1) Update coordinates attribute of mesh variables

- For maxele: change value of the coordinates attribute of depth, zeta\_max, and time\_of\_zeta\_max to "x y"
- For fort.63: change the value of the coordinates attribute of depth and zeta to "x y"

Original (for fort.63):

```
double depth(node) ;  
    depth:long_name = "distance below geoid" ;  
    depth:standard_name = "depth below geoid" ;  
    depth:coordinates = "time y x" ;  
    depth:location = "node" ;  
    depth:mesh = "adcirc_mesh" ;  
    depth:units = "m" ;
```



Marcos Botto Tornielli  
Contact Email: mbottot@mit.edu

```
double zeta(time, node) ;  
    zeta:long_name = "water surface elevation above geoid" ;  
    zeta:standard_name = "sea_surface_height_above_geoid" ;  
    zeta:coordinates = "time y x" ;  
    zeta:location = "node" ;  
    zeta:mesh = "adcirc_mesh" ;  
    zeta:units = "m" ;  
    zeta:_FillValue = -99999. ;
```

#### Updated:

```
double depth(node) ;  
    depth:long_name = "distance below geoid" ;  
    depth:standard_name = "depth below geoid" ;  
    depth:coordinates = "x y" ;  
    depth:location = "node" ;  
    depth:mesh = "adcirc_mesh" ;  
    depth:units = "m" ;  
double zeta(time, node) ;  
    zeta:long_name = "water surface elevation above geoid" ;  
    zeta:standard_name = "sea_surface_height_above_geoid" ;  
    zeta:coordinates = "x y" ;  
    zeta:location = "node" ;  
    zeta:mesh = "adcirc_mesh" ;  
    zeta:units = "m" ;  
    zeta:_FillValue = -99999. ;
```

#### Justification:

[According to the UGRID conventions](#), the `coordinates` attribute should only reference spatial coordinates, even if a variable is time-varying. Although time being referenced by `coordinates` doesn't cause any errors in the UGRID compliance check (see [here](#) for maxele and [here](#) for fort.63), it's not consistent with the style shown in the UGRID documentation. In [this example](#), you can see how UGRID suggests defining a water surface elevation variable similar to ADCIRC's `zeta`. Even though the variable is time-varying, time doesn't show up in the `coordinates` attribute, and the order of the spatial coordinates is `x` first, then `y`. Therefore, the changes recommended in this section would make ADCIRC output files more consistent with the UGRID standard.

#### **(2) Remove the unnecessary dimension from the `adcirc_mesh` variable**

- The `adcirc_mesh` variable currently has a dimension of 1; it would be more consistent with UGRID style to define `adcirc_mesh` without dimensions

#### Justification:

The results of UGRID compliance checks (see [here](#) for maxele and [here](#) for fort.63) recommend that the mesh variable should be defined without dimensions, and the UGRID documentation defines it that way [in examples](#).

### (3) Make variables names more consistent with UGRID style

- The mesh variable `element` and coordinate variables `x` and `y` could be renamed to `adcirc_mesh_face_nodes`, `adcirc_mesh_node_x`, and `adcirc_mesh_node_y` to clarify their association with the mesh

#### Justification:

In the [2D triangular mesh topology example](#) in the UGRID documentation, all mesh-related variables start with the name of the mesh, showing a clear association with the original mesh variable. Also, connectivity variables are named based on the two components of the mesh that they connect, such as `face_nodes` for the `element` variable in ADCIRC output. Although this style is not a requirement (and variable names can be anything), it could help to make the netCDF header more readable. Also, other people who generate UGRID output already use a style similar to the one shown in the UGRID documentation, so using this style would also help to make ADCIRC output more consistent with the wider usage of UGRID.

However, this change has no impact on compliance, so if it's important for the current variable names to stay the same, the recommendations may not be relevant.

### Conflict between CF and UGRID

Currently, UGRID isn't formally recognized by the CF convention, so some UGRID-specific attributes show up as errors in CF compliance checks. In ADCIRC output files, these attributes are the `cf_role` for the `element` and `adcirc_mesh` variables, as well as the `node_coordinates` attribute of `adcirc_mesh`. These errors are currently unavoidable, but once UGRID is formally incorporated into CF and CF compliance checkers are updated, the errors should disappear.

You can follow the progress of UGRID being formally recognized by CF through [this GitHub discussion](#).

## Results from compliance checking software

This section shows results from different compliance checks on the Hurricane Ida output files described in the [Background](#) section. If you would like to reproduce these results, there are links to the GitHub pages of the compliance checking software in each subsection where you can find installation instructions. Installation for these tests was done through conda.

### Maxele CF compliance check 1

The following results are from running the CF compliance checker [developed by the UK Centre for Environmental Data Analysis \(CEDA\)](#):

```
CHECKING NetCDF FILE: maxele.63.nc
=====
Using CF Checker Version 4.1.0
Checking against CF Version CF-1.8
Using Standard Name Table Version 79 (2022-03-19T15:25:54Z)
Using Area Type Table Version 10 (23 June 2020)
Using Standardized Region Name Table Version 4 (18 December 2018)

WARN: (2.3): Global attribute _FillValue: Attribute names should begin with a letter and be
composed of letters, digits and underscores
INFO: Attribute _FillValue is being used in a non-standard way; as a global attribute. (See
Appendix A)
WARN: (2.3): Global attribute fort.15: Attribute names should begin with a letter and be
composed of letters, digits and underscores
ERROR: (2.6.1): This netCDF file does not appear to contain CF Convention data.

-----
Checking variable: time
-----
WARN: (4.4.1): Use of the calendar and/or month_lengths attributes is recommended for time
coordinate variables

-----
Checking variable: x
-----
ERROR: (4.3): Invalid value for positive attribute

-----
Checking variable: y
-----
ERROR: (4.3): Invalid value for positive attribute

-----
Checking variable: element
-----
INFO: attribute cf_role is being used in a non-standard way
```

Marcos Botto Tornielli  
Contact Email: mbottot@mit.edu

ERROR: (3.1): Invalid units: nondimensional  
ERROR: (9.5): Invalid value for cf\_role attribute

-----

Checking variable: adcirc\_mesh

-----

INFO: attribute cf\_role is being used in a non-standard way  
INFO: attribute node\_coordinates is being used in a non-standard way  
INFO: (3.1): No units attribute set. Please consider adding a units attribute for completeness.  
ERROR: (9.5): Invalid value for cf\_role attribute

-----

Checking variable: neta

-----

ERROR: (3.1): Invalid units: nondimensional

-----

Checking variable: nvdll

-----

ERROR: (3.1): Invalid units: nondimensional

-----

Checking variable: max\_nvdll

-----

WARN: (3): No standard\_name or long\_name attribute specified

-----

Checking variable: ibtypee

-----

ERROR: (3.1): Invalid units: nondimensional

-----

Checking variable: nbdv

-----

ERROR: (3.1): Invalid units: nondimensional

-----

Checking variable: nvel

-----

ERROR: (3.1): Invalid units: nondimensional

-----

Checking variable: nvell

-----

ERROR: (3.1): Invalid units: nondimensional

-----

Checking variable: max\_nvell

-----

WARN: (3): No standard\_name or long\_name attribute specified

-----

Marcos Botto Tornielli  
Contact Email: mbottot@mit.edu

Checking variable: ibtype

-----

ERROR: (3.1): Invalid units: nondimensional

-----

Checking variable: nbvv

-----

ERROR: (3.1): Invalid units: nondimensional

-----

Checking variable: depth

-----

ERROR: (3.3): Invalid syntax for 'standard\_name' attribute: 'depth below geoid'

-----

Checking variable: zeta\_max

-----

ERROR: (3.3): Invalid standard\_name: maximum\_sea\_surface\_height\_above\_geoid

-----

Checking variable: time\_of\_zeta\_max

-----

ERROR: (3.3): Invalid standard\_name: time\_of\_maximum\_sea\_surface\_height\_above\_geoid

ERRORS detected: 17

WARNINGS given: 5

INFORMATION messages: 5

## Maxele CF compliance check 2

The following results are from running the CF compliance checker [developed by NOAA](#):

-----  
IOOS Compliance Checker Report  
Version 5.0.2  
Report generated 2022-06-24T17:20:07Z  
cf:1.8  
<http://cfconventions.org/Data/cf-conventions/cf-conventions-1.8/cf-conventions.html>  
-----

Corrective Actions  
maxele.63.nc has 6 potential issues

### Errors

#### \$3.1 Units

- \* units for nvel, "nondimensional" are not recognized by UDUNITS
- \* units for nvdll, "nondimensional" are not recognized by UDUNITS
- \* units for ibtype, "nondimensional" are not recognized by UDUNITS
- \* units for nvell, "nondimensional" are not recognized by UDUNITS
- \* units for nbvv, "nondimensional" are not recognized by UDUNITS
- \* units for ibtypee, "nondimensional" are not recognized by UDUNITS

Marcos Botto Tornielli  
Contact Email: mbottot@mit.edu

\* units for nbdv, "nondimensional" are not recognized by UDUNITS  
\* units for neta, "nondimensional" are not recognized by UDUNITS

### \$3.3 Standard Name

\* Standard name modifier "below geoid" for variable depth is not a valid modifier according to CF Appendix C  
\* standard\_name time\_of\_maximum\_sea\_surface\_height\_above\_geoid is not defined in Standard Name Table v72. Possible close match(es): ['square\_of\_sea\_surface\_height\_above\_geoid', 'sea\_surface\_height\_above\_geoid', 'tendency\_of\_sea\_surface\_height\_above\_sea\_level']  
\* standard\_name maximum\_sea\_surface\_height\_above\_geoid is not defined in Standard Name Table v72. Possible close match(es): ['sea\_surface\_height\_above\_geoid', 'square\_of\_sea\_surface\_height\_above\_geoid', 'sea\_surface\_height\_above\_geopotential\_datum']

### \$5 Coordinate Systems

\* dimensions for auxiliary coordinate variable time (time) are not a subset of dimensions for variable depth (node)

### \$9.5 Coordinates and metadata

\* face\_node\_connectivity is not a valid cf\_role value. It must be one of timeseries\_id, profile\_id, trajectory\_id  
\* mesh\_topology is not a valid cf\_role value. It must be one of timeseries\_id, profile\_id, trajectory\_id

### Warnings

### \$2.3 Naming Conventions

\* global attribute \_FillValue should begin with a letter and be composed of letters, digits, and underscores  
\* global attribute fort.15 should begin with a letter and be composed of letters, digits, and underscores

### \$2.6 Attributes

\* \$2.6.1 Conventions global attribute does not contain "CF-1.8"

## Maxele UGRID compliance check

The following results are from running the UGRID compliance checker [developed by Patrick Peglar from UK Met Office](#):

### File mesh structure

-----

#### Meshes

```
"adcirc_mesh"
  node("node")
    coordinates : "x", "y"
  face("nele")
    face_node_connectivity : "element"
```

#### Mesh Data Variables

Marcos Botto Tornielli  
Contact Email: mbottot@mit.edu

```
"depth"  
  mesh : "adcirc_mesh"  
  location : "node"  
"zeta_max"  
  mesh : "adcirc_mesh"  
  location : "node"  
"time_of_zeta_max"  
  mesh : "adcirc_mesh"  
  location : "node"
```

UGRID conformance checks complete.

List of checker messages :

... WARN A101 : Mesh variable "adcirc\_mesh" has dimensions.

Total of 1 problems logged :

0 Rxxx requirement failures

1 Axxx advisory recommendation warnings

Done.

## Fort.63 CF compliance check 1

The following results are from running the CF compliance checker [developed by the UK Centre for Environmental Data Analysis \(CEDA\)](#):

CHECKING NetCDF FILE: fort.63.nc

=====

Using CF Checker Version 4.1.0

Checking against CF Version CF-1.8

Using Standard Name Table Version 79 (2022-03-19T15:25:54Z)

Using Area Type Table Version 10 (23 June 2020)

Using Standardized Region Name Table Version 4 (18 December 2018)

WARN: (2.3): Global attribute \_FillValue: Attribute names should begin with a letter and be composed of letters, digits and underscores

INFO: Attribute \_FillValue is being used in a non-standard way; as a global attribute. (See Appendix A)

WARN: (2.3): Global attribute fort.15: Attribute names should begin with a letter and be composed of letters, digits and underscores

ERROR: (2.6.1): This netCDF file does not appear to contain CF Convention data.

-----

Checking variable: time

-----

WARN: (4.4.1): Use of the calendar and/or month\_lengths attributes is recommended for time coordinate variables

-----

Checking variable: x

-----

Marcos Botto Tornielli  
Contact Email: mbottot@mit.edu

ERROR: (4.3): Invalid value for positive attribute

-----  
Checking variable: y  
-----

ERROR: (4.3): Invalid value for positive attribute

-----  
Checking variable: element  
-----

INFO: attribute cf\_role is being used in a non-standard way

ERROR: (3.1): Invalid units: nondimensional

ERROR: (9.5): Invalid value for cf\_role attribute

-----  
Checking variable: adcirc\_mesh  
-----

INFO: attribute cf\_role is being used in a non-standard way

INFO: attribute node\_coordinates is being used in a non-standard way

INFO: (3.1): No units attribute set. Please consider adding a units attribute for completeness.

ERROR: (9.5): Invalid value for cf\_role attribute

-----  
Checking variable: neta  
-----

ERROR: (3.1): Invalid units: nondimensional

-----  
Checking variable: nvdll  
-----

ERROR: (3.1): Invalid units: nondimensional

-----  
Checking variable: max\_nvdll  
-----

WARN: (3): No standard\_name or long\_name attribute specified

-----  
Checking variable: ibtypee  
-----

ERROR: (3.1): Invalid units: nondimensional

-----  
Checking variable: nbdv  
-----

ERROR: (3.1): Invalid units: nondimensional

-----  
Checking variable: nvel  
-----

ERROR: (3.1): Invalid units: nondimensional



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```
-----  
Checking variable: nvel1  
-----  
ERROR: (3.1): Invalid units: nondimensional  
  
-----  
Checking variable: max_nvel1  
-----  
WARN: (3): No standard_name or long_name attribute specified  
  
-----  
Checking variable: ibtype  
-----  
ERROR: (3.1): Invalid units: nondimensional  
  
-----  
Checking variable: nbvv  
-----  
ERROR: (3.1): Invalid units: nondimensional  
  
-----  
Checking variable: depth  
-----  
ERROR: (3.3): Invalid syntax for 'standard_name' attribute: 'depth below geoid'  
  
-----  
Checking variable: zeta  
-----  
  
ERRORS detected: 15  
WARNINGS given: 5  
INFORMATION messages: 5
```

## Fort.63 CF compliance check 2

The following results are from running the CF compliance checker [developed by NOAA](#):

```
-----  
I00S Compliance Checker Report  
Version 5.0.2  
Report generated 2022-06-24T17:25:59Z  
cf:1.8  
http://cfconventions.org/Data/cf-conventions/cf-conventions-1.8/cf-conventions.html  
-----  
Corrective Actions  
fort.63.nc has 6 potential issues  
  
Errors  
-----  
$3.1 Units
```

Marcos Botto Tornielli  
Contact Email: mbottot@mit.edu

```
* units for nbvv, "nondimensional" are not recognized by UDUNITS
* units for nbdv, "nondimensional" are not recognized by UDUNITS
* units for nvel, "nondimensional" are not recognized by UDUNITS
* units for nvell, "nondimensional" are not recognized by UDUNITS
* units for nvdl, "nondimensional" are not recognized by UDUNITS
* units for neta, "nondimensional" are not recognized by UDUNITS
* units for ibtype, "nondimensional" are not recognized by UDUNITS
* units for ibtypee, "nondimensional" are not recognized by UDUNITS
```

### \$3.3 Standard Name

```
* Standard name modifier "below geoid" for variable depth is not a valid modifier according
to CF Appendix C
```

### \$5 Coordinate Systems

```
* dimensions for auxiliary coordinate variable time (time) are not a subset of dimensions for
variable depth (node)
```

### \$9.5 Coordinates and metadata

```
* face_node_connectivity is not a valid cf_role value. It must be one of timeseries_id,
profile_id, trajectory_id
* mesh_topology is not a valid cf_role value. It must be one of timeseries_id, profile_id,
trajectory_id
```

### Warnings

#### \$2.3 Naming Conventions

```
* global attribute _FillValue should begin with a letter and be composed of letters, digits,
and underscores
* global attribute fort.15 should begin with a letter and be composed of letters, digits, and
underscores
```

#### \$2.6 Attributes

```
* $2.6.1 Conventions global attribute does not contain "CF-1.8"
```

## Fort.63 UGRID compliance check

The following results are from running the UGRID compliance checker [developed by Patrick Peglar from UK Met Office](#):

### File mesh structure

-----

#### Meshes

```
"adcirc_mesh"
  node("node")
    coordinates : "x", "y"
  face("nele")
    face_node_connectivity : "element"
```

#### Mesh Data Variables

Marcos Botto Torielli  
Contact Email: mbottot@mit.edu

```
"depth"  
  mesh : "adcirc_mesh"  
  location : "node"  
"zeta"  
  mesh : "adcirc_mesh"  
  location : "node"
```

UGRID conformance checks complete.

List of checker messages :

```
... WARN A101 : Mesh variable "adcirc_mesh" has dimensions.
```

Total of 1 problems logged :

```
0 Rxxx requirement failures  
1 Axxx advisory recommendation warnings
```

Done.