# Contents



# 1 Background

This document assumes that the reader is familiar with NetCDF and OPeNDAP. Background reading on these topics can be found in Section 7.

NetCDF-4 files accessible by an OPeNDAP URL can be downloaded using the Data Access Protocol (DAP). For downloading entire files, there may not be many advantages to using DAP for downloads in comparison to other methods such as the `wget` utility. However, DAP becomes more useful if the user wants to download subsets of the data.

This document is primarily intended for users of the ADCIRC Surge Guidance System (ASGS) who want to visualize the results of ASGS which are hosted on THREDDS servers. Time-series data such as a `fort.63.nc` file contain information for 120 time values, but relevant storm surge data generally only involves the first few time values, so downloading the entire file is often not efficient.

# 2 Software Requirements

The commands in this document require the NetCDF Operators (NCO) package. Installation instructions for various types of machines can be found here: http://nco.sourceforge.net/#Executables. If you have access to a package manager such as APT or Homebrew, these are most likely the simplest way to install NCO. For example, on Ubuntu Linux, you can install with `apt install nco`. On a high-performance computing system that uses environment modules, you may have access to an NCO installation with `module load`.

The relevant utility from the NCO package used here is `ncks`. This document assumes that the `ncks` utility is on your path.

# 3 Usage Example: The ncks utility

Suppose you want to download a `fort.63.nc` file output by ADCIRC with the ASGS, but you are only interested in the data for the first 20 time values. The following command is an example of how you can download this data with an OPeNDAP URL:

```
ncks -7 -h -L 5 -d time,0,19 'http://fortytwo.cct.lsu.edu/thredds/dodsC/2020/al13/27/CTXCS2017/
    qbc.loni.org/CTXCS2017_al132020_jgf/nhcConsensus/fort.63.nc'
```

The following bullet points detail the meaning of the various command line options used here with `ncks`:

- `-d time,0,19`: Specifies that the donwloaded file should only contain data for the first 20 time values.
- `-L 5`: Spcifies a compression level of 5, which is used to reduce the file size. If this is not used, the result of a download through DAP will actually be larger in terms of storage than the same file downloaded through something like `wget`
- `-7`: Specifies that the downloaded file should be in "NetCDF-4 classic" format. This is the format that ASGS results are in when downloaded with `wget`, so it is used here for consistency.
- `-h`: This option means that the command used to download the file will not be appended to the "history" attribute of the NetCDF file. By default, NCO utilities do append the command to the "history" attribute.

You can also specify a different name for the downloaded file, with an additional option, `-o`:

```
ncks -7 -h -L 5 -d time,0,19 'http://fortytwo.cct.lsu.edu/thredds/dodsC/2020/al13/27/CTXCS2017/
    qbc.loni.org/CTXCS2017_al132020_jgf/nhcConsensus/fort.63.nc' -o custom_name.nc
```

## 4 The `netcdf_timeslice_dap.sh` utility

The repository mbotto123/paraview-adcirc-vis has a utility which implements basic automation on the command shown in the previous section. This utility is called `netcdf_timeslice_dap.sh` and can be found in the utilities directory.

## 5 Comments on compression

There are two topics which benefit from some additional comments. The first is the compression option when downloading data with DAP. Compression is necessary to reduce the size of the downloaded file when using DAP; if no compression is used, then the file will be larger than an equivalent file downloaded with a tool such as `wget`. The following resources provide some background reading:

- Article on compression by the NetCDF developers at UCAR: https://www.unidata.ucar.edu/blogs/developer/entry/netcdf_compression
- Article on compression tools and guidelines by the Computational Modelling Systems [1] group of the Australian Research Council: http://climate-cms.wikis.unsw.edu.au/NetCDF_Compression_Tools

The second article linked above recommends a compression level of 5 as a general guideline. For the development of the `netcdf_timeslice_dap.sh` utility, this level was tested on a full `maxele.63.nc` file and found to result in a similar file size than when the same file was downloaded with `wget`. However, this was not a rigorous test, and the compression level may have to be adjusted if the user sees unreasonably large file sizes.

Based on similar tests with compression level 5, it should be noted that for the usage example in Section 3, the resulting file should not be expected to be as small as 1/6 the size of the original. However, the difference between the original size and the downloaded size should still be significant enough to justify downloading the smaller subset rather than the entire file.

## 6 Comments on `nccopy`

There is also a utility included in a standard NetCDF installation [2] which allows you to download files using DAP. This utility is `nccopy`. For an entire file, it essentially provides the same functionality as `ncks`. For example, if you want to download a `maxele.63.nc` file with DAP, you could use the following `nccopy` command:

[1] http://climate-cms.wikis.unsw.edu.au/Home
[2] Asssuming that the installation includes DAP support

```
nccopy -d 5 -k 'netCDF-4 classic model' '<OPeNDAP URL>' <name of file>
```

or an equivalent `ncks` command:

```
ncks -7 -L 5 '<OPeNDAP URL>' -o <name of file>
```

which should give similar results. `nccopy` allows you to specify bounds for the variables in the NetCDF file through the OPeNDAP URL. The following URL shows an example of requesting all of the variables from a `fort.63.nc` file, while specifying the bounds of the time variable:

```
http://fortytwo.cct.lsu.edu/thredds/dodsC/2020/al13/27/CTXCS2017/qbc.loni.org/
    CTXCS2017_al132020_jgf/nhcConsensus/fort.63.nc?time[0:19],x,y,element,adcirc_mesh,neta,
    nvdll,max_nvdll,ibtypee,nbdv,nvel,nvell,max_nvell,ibtype,nbvv,depth,zeta'
```

When passed to `nccopy` with a compression level of 5, this seems like it might yield the same results as the example in Section 3. However, testing for this type of `nccopy` usage showed that the file size was actually the same as the original with data for the full 120 time values. Therefore, this approach does not replicate the capabilities of `ncks`.

# 7 Resources

- NetCDF homepage: https://www.unidata.ucar.edu/software/netcdf/
- OPeNDAP homepage: https://www.opendap.org/about
- DAP standard homepage: https://earthdata.nasa.gov/esdis/eso/standards-and-references/data-access-protocol-2

# 8 Where to find the latest version of this document

The latest version of this document can be found at: https://github.com/mbotto123/paraview-adcirc-vis/tree/master/documentation

# 9 Author information

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