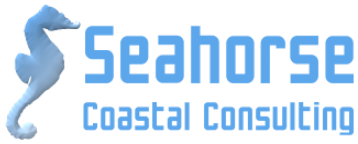
# ADCIRC Results Visualization with Paraview

| REVISION HISTORY | | | |
|---|---|---|---|
| NUMBER | DATE | DESCRIPTION | NAME |
| 1.0 | May 2013, Seahorse Coastal Consulting | | JF |

# Contents




# 1 Executive Summary

The use of the NetCDF4 output format allows ADCIRC and ADCIRC+SWAN users to use the powerful open source 3D visualization system Paraview to visualize their results. Seahorse Coastal Consulting has developed several small utility programs that write small XML file to accompany the NetCDF4 output files from ADCIRC or ADCIRC+SWAN. These XML files implement the XDMF (extensible data and model format, a US Army Research standard) format, that Paraview can read directly. This document describes the compilation and use of these utilities, as well as the process of loading the data into Paraview and setting up a visualization.

# 2 Software Requirements

The following software packages are required:

- Paraview (obtained from http://www.paraview.org)
- NetCDF4 (obtained from http://www.unidata.ucar.edu/software/netcdf), version 4.1 or higher is recommended
- adcmesh.f90: a utility package for manipulating ADCIRC mesh files
- adcirc2netcdf.f90: converts ascii ADCIRC files to NetCDF4
- generateCPP.f90: calculates CPP projection for a given mesh in a NetCDF4 ADCIRC output file and adds the coordinates to the file
- generateXDMF.f90: creates an XML file to accompany an existing ADCIRC NetCDF4 file, thereby implementing the XDMF format
- A Fortran compiler

The Fortran90 files list above are open source software and are a part of the ADCIRC Surge Guidance System (ASGS) package.

# 3 Software Compilation

The utilities described above are relatively simple and are intended to be standards compliant and therefore widely portable among different Fortran compilers. As a result of this simplicity, a makefile is not required for building these executables. Rather, the source code for each utility has sample commands in comments at the top to provide examples for compiling with different compilers.

For example, the command you use to build generateXDMF.f90 with the gfortran compiler might look like the following:

```
gfortran -o generateXDMF.x -ffree-form -ffree-line-length-none -I/usr/include
 generateXDMF.f90 -lnetcdf -lnetcdff -lz
```

You may or may not need to adjust the "-I" option to reflect the installation location of NetCDF4 on your platform. And although the adcmesh.f90 file does not appear in the compilation command above, it is referenced in an *include* directive in the source code, so it must be present in the same directory where the above command was issued.

Once you've compiled all the Fortran utilities above (although adcirc2netcdf.f90 is only needed if you'll be starting with ascii ADCIRC output), you're ready to run the programs to generate XDMF output.

# 4 Creating XDMF Output

XDMF actually consists of two separate but related files: a binary file that holds model data and an XML file that describes the type of coordinate system, the names of the variables, the time stamps on time varying data, etc. This section of this document describes the process of creating XDMF files from ADCIRC output, using the Shinnecock Inlet test case (which is available from adcirc.org).

## 4.1 Starting from an ASCII ADCIRC File

XDMF uses HDF5 to store large datasets; NetCDF4 uses HDF5 as the underlying file format, so ADCIRC's native NetCDF4 output files fulfill this requirement. If you're starting with ascii ADCIRC files, they must first be converted from ASCII to NetCDF4 format. The utility program *adcirc2netcdf.f90* was developed for this purpose.

Complete details on the command line options for this utility are provided in the manual page `adcirc2netcdf(1)` which is also available in the *doc* subdirectory of the ASGS repository. One detail that may not be obvious from the manual page is that a metadata file is also required for the adcirc2netcdf utility to work; this metadata file (called an attributes file) must contain at least a specifically formatted line containing the calendar time that corresponds to the ADCIRC cold start time. Any other metadata attributes are optional.

For the Shinnecock Inlet test case, a metadata attributes file might look like the following:

```
3
seconds since 2005-07-26 00:00:00 +00:00
'Purpose' 'Example to illustrate the use of adcirc2netcdf'
'Author' 'ADCIRC Modeler at MyCompany'
'Contact' 'adcircrulez@mycompany.com'
```

If we save the lines above to the file as `shinnecock_atts.txt` in the same directory as the output files from the Shinnecock Inlet test case, we can then create a new NetCDF4 data file containing the data from our ascii-formatted maximum water surface elevation file (which is like a high water marks file) maxele.63 with the following command:

```
adcirc2netcdf.x --netcdf4 --meshfile fort.14 --attfile shinnecock_atts.txt
 --datafile maxele.63
```

If your netcdf2adcirc.x executable file is not in the same directory as your output files, and is not in your PATH environmental variable, you'll have to supply the full path to the executable on the command line, rather than just the name of the executable. You can verify that the metadata that you provided in the `shinnecock_atts.txt` file were actually incorporated in the NetCDF4 file by executing

```
ncdump -h maxele.63.nc > header.txt
```

and looking at the `header.txt` file in a text editor.

## 4.2 Once You Have a NetCDF4 File

Whether you've generated a NetCDF4 file from ADCIRC natively (by using format type 5 for NOUTGE, NOUTGW, etc) or by creating a NetCDF4 file with *adcirc2netcdf*, its now possible to generate a small XML file to accompany the ADCIRC data and to describe the coordinate system, the number of time steps in the file, etc.

Because these data are to be used in visualization, the first step in the process involves the computation of the cpp projection if the vertex locations from the geographic projection provided in the NetCDF4 file. This step is a convenience, and is not strictly required, but it will save you from the need to scale the results in the vertical in Paraview; the distortion caused by using latitude and longitude in the horizontal direction and meters in the vertical direction can be extreme. The CPP projection creates a Cartesian coordinate system using meters in all three physical dimensions.

To compute the CPP projection of the x and y vertex coordinates, execute the *generateCPP* as follows:

```
generateCPP.x --datafile maxele.63.nc
```

Have a look inside the file with `ncdump -h maxele.63.nc > header.txt` to confirm that the original *x* and *y* coordinates are still there and that a new set of coordinates labeled *x_cpp* and *y_cpp* have been added.

Next, we generate a small XML text file to accompany and describe our data using the *generateXDMF* utility as follows:

```
generateXDMF.x --use-cpp --datafile maxele.63.nc
```

where the `--use-cpp` option will cause the resulting XML file to refer to the CPP projected coordinates from the NetCDF4 file. Have a look at the XML file `maxele.63.nc.xmf` with a text editor, and note that the NodeLocations refer to *x_cpp* and *y_cpp*. If you ever wanted the file to refer to the vertex coordinates in geographic projection, simply edit these lines to refer to *x* and *y* instead if *x_cpp* and *y_cpp*.

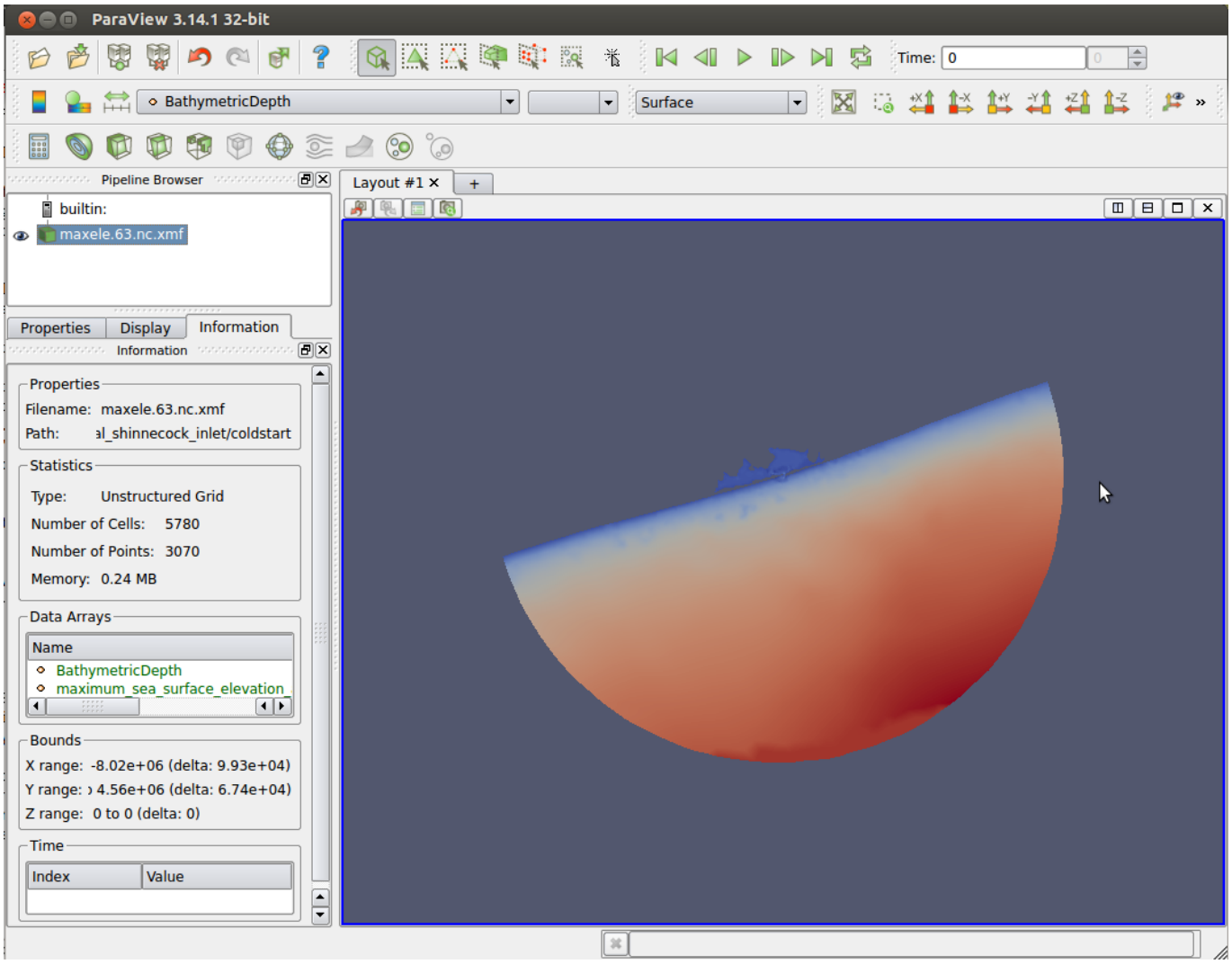
If each of the steps outline in this section were successful, you are now ready load the file into Paraview for visualization.

## 5 Visualization with Paraview

Start up Paraview, then

1. Click *File→Open*.
2. Select the `maxele.63.nc.xmf` file.
3. Click on the *Properties* tab.
4. Click the green *Apply* button.

At this point you should see something like the following screenshot, a filled contour plot of the mesh bathymetry using Paraview's default color scale, autoscaled to the range of depths in the Shinnecock Inlet mesh.




Instead of the bathymetric contours, we'd like to look at the contours of maximum water surface elevation. To do this, go to the dropdown box at the top of the application window that currently identifies `BathymetricDepth` as the dataset that the visible dataset. Click on this dropdown box and select `maximum_sea_surface_elevation_above_datum`, which is ADCIRC's name for the maximum water surface elevation data.

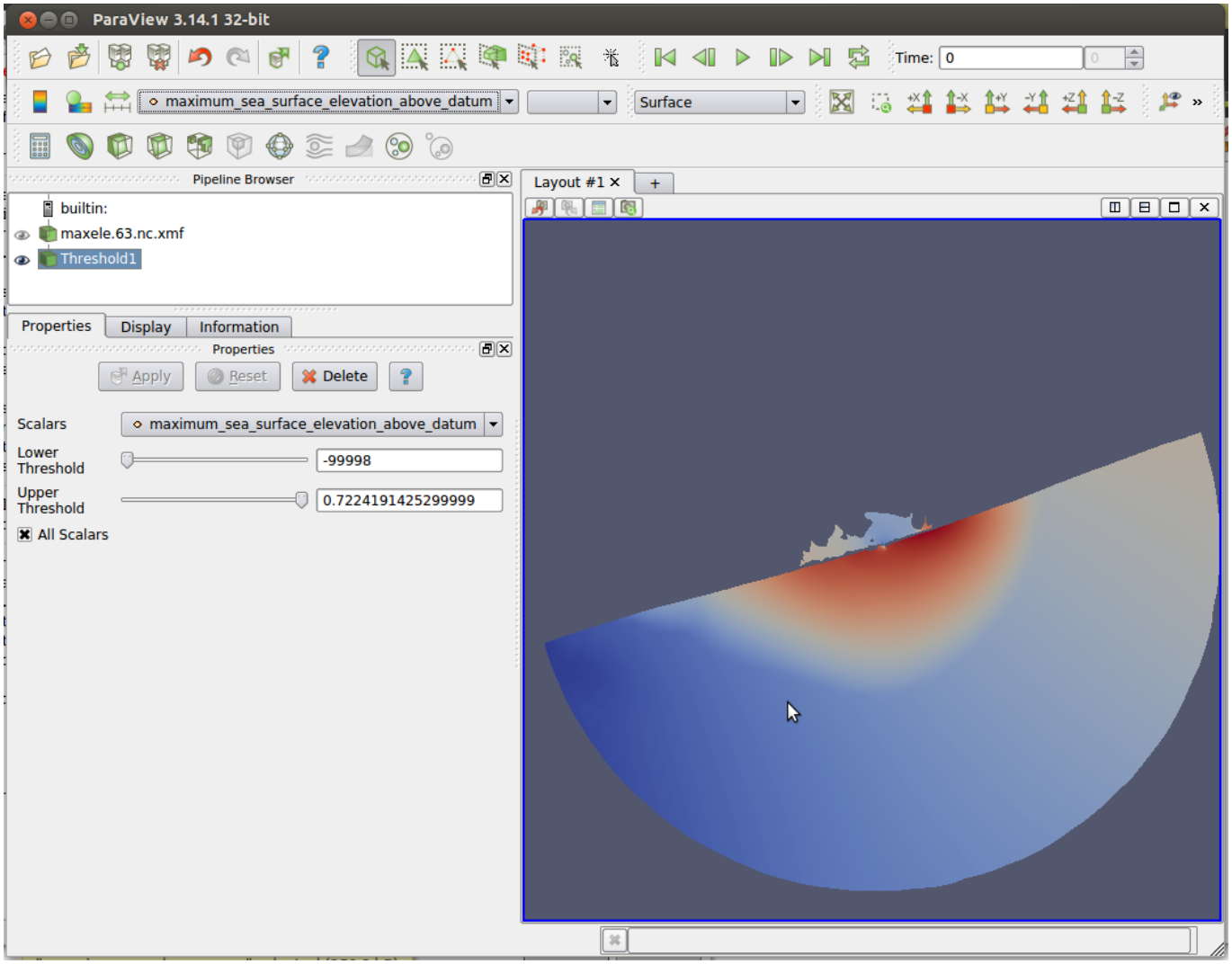
Once the visible dataset has changed, you'll find that the contour plot is now all red, with a few tiny specks of blue near the barrier island. This is because Paraview is autoscaling the data, and ADCIRC always labels dry nodes with an elevation value of -99999.0 meters. As a result, Paraview thinks that the bottom of the water surface elevation range is -99999.0 meters.

To fix this color scale issue caused by missing values, we must filter out the missing values with Paraview's Threshold filter:

1. Click *Filters→Threshold* or the Threshold filter button.
2. Paraview created a *Threshold* filter and added it to the visualization pipeline.
3. Click on the *Properties* tab.
4. Click on the *Scalars* dropdown box that is currently labeled `BathymetricDepth`, and then click on `maximum_sea_surface` because those are the scalars we want to filter.
5. In the *Lower Threshold* text box, change the value to -99998 so that the dry node values will no longer be part of the dataset.
6. Click the green *Apply* button.

7. You may have to repeat the step where you click the dropdown box near the top of the window, if it has reverted to `BathymetricDepth`; select the `maximum_sea_surface_elevation_above_datum` again in this dropdown box if needed.
8. Rescale the colors to the data range of the Thresholded data set using color rescale button (the button icon looks like a ruler with a green double headed arrow above it).

The Paraview window should look like the following:




If so, then congratulations, you are now using Paraview to visualize ADCIRC results!

## A This Document

This document was prepared from the text file ADCIRCParaview.txt using software called asciidoc (http://www.methods.co.nz/-asciidoc/). The document can be formatted as an html page with the command

```
asciidoc --backend html5 -a toc2 ADCIRCParaview.txt
```

or formatted as a pdf with the command

```
a2x --format=pdf -a toc2 ADCIRCParaview.txt
```