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NcCut: A NetCDF Viewer and Transecting Tool

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Statement of Need

NcCut is a simple yet flexible NetCDF4 file and image viewer that is designed to require no programming or GIS experience to use. In addition to being a GUI for generating "quick" visualizations of NetCDF4 data, NcCut allows a user to view and produce plots of transects of NetCDF4 data along various dimensions. This is a commonly performed task in oceanography and atmospheric sciences research used to understand the vertical composition of a section of ocean or atmosphere. For example, Sivkov & Bubnova (n.d.) used such vertical transects to study the vertical distributions of suspended particulate matter across the Atlantic Ocean. In another example, Gutjahr et al. (2022) used vertical transects of modeled climate and ocean data in Greenland to study air-sea interactions during a Katabatic storm.

Such transect selecting tools are a common feature in GIS software (QGIS Contributors (2022), Tornero (2014), GRASS Development Team (2022)) and are present in some more complex viewers that work with unstructured data (Schlitzer, 2023), but these options are all either meant for more complicated data formats or require a user to spend a great amount of time learning how to use the software before they can do any meaningful data analysis. NcCut provides this transecting functionality with a GUI interface, allowing for rapid selection of transects, which is often very useful in initial investigation or feature selection applications. There are many simple NetCDF viewers that already serve this audience (Pierce (2023), NASA Goddard Institute for Space Studies (2023), Cuntz (2021)), but none of these simpler viewers have a way for users to take transects across NetCDF data.

Functionality

NcCut's functions can be divided into two main categories:

Viewer

NcCut allows users to load NetCDF4 files, or images in JPG, JPEG, or PNG formats, and has adjustable graphics for different file sizes. In the case of NetCDF4 files, the user can choose between different variables and dimensions of the data to view. The user can select which dimensions to use as the x, y and z dimensions for the viewer, and once displayed the user can switch between different displays of the x and y dimensions at different z-values. This is intuitive for many NetCDF4 files which contain three-dimensional datasets with data arrays at different vertical heights or depths. The data is displayed as an image mapped to a color map, which can be changed by the user as well as the contrast of the image. Once loaded and configured, users can drag, rotate, flip, and zoom in on the file however they please. The NetCDF4 viewing capabilities and settings are shown in Figure 1, where an ocean temperature dataset from the MIT General Circulation Model LLC4320 simulation is being displayed (accessed via `xmitgcm` https://xmitgcm.readthedocs.io).

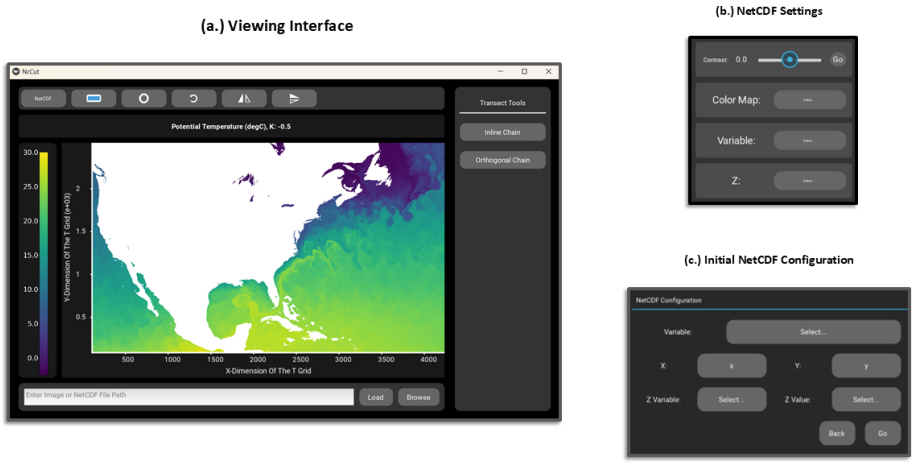

Figure 1: a.) The viewing interface shown with a NetCDF4 file of ocean temperature in the Gulf Stream region. b.) The setting options for NetCDF files. c.) The initial configuration menu for loading NetCDF4 files.

"Cut" Making

Using NcCut, users can mark out transects onto loaded images or NetCDF4 data which can then be plotted and saved for further analysis. There are two tools for marking out transects:

The first is the 'Inline Chain' tool. Users can click on points along a feature and lines will be drawn connecting the points forming a "chain". Transects are then made along the line segments shown (Figure 2a). Multiple chains can be drawn at once, and plotted together in the plotting menu (Figure 3). When plotted, the transect data from each segment is plotted continuously end to end. If the loaded file is an image, the transect data is the mean of the RGB values of each pixel along the transect. The pixels are interpolated using linear interpolation to improve the accuracy of the pixel selection. If the loaded file is a NetCDF4 file, the transect data is taken from the original dataset (also interpolated) at each point along the transect. The second is the 'Orthogonal Chain' tool. Using this tool, users can click points along a feature and transects of a set width will be made orthogonal to the line marked out by the user (Figure 2b). This width can be adjusted at any point in the marking process and multiple such chains can be drawn on the same file and plotted together. For use on large projects worked on over multiple sessions, the transect data saved from the plotting menu (Figure 3) can be reloaded back into NcCut and continued.

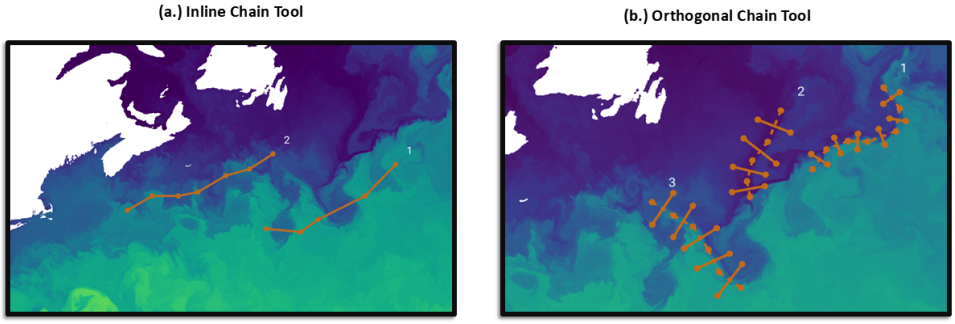

Figure 2: a.) The 'Inline Chain' tool used over features in a loaded NetCDF file. b.) The 'Orthogonal Chain' tool used to take multiple transects orthogonal to various linear features.

In the plotting menu, users can select which chains/transects to plot, and if the file is a NetCDF file the user can additionally plot multiple variables (Figure 3b) and values along the chosen z dimension (Figure 3a). Additionally, users can plot an interactive vertical cross-section of the data values along the chain/transect for all z values (Figure 4). The y-axis of the image is taken from and scaled by the coordinate values of the chosen z-dimension. From this menu users can choose to save the data to a JSON file as well as save the plot to either a PNG or PDF format. The JSON file groups the transect data and their corresponding coordinates together and labels them by the transect number shown in the viewing interface. The transects are then further grouped by the chain they belong to. This labeled and organized data structure aims to be easily loaded and understood using minimal programming experience in a language such as Python or R (there is a tutorial available here on how to work with the output data using Python).

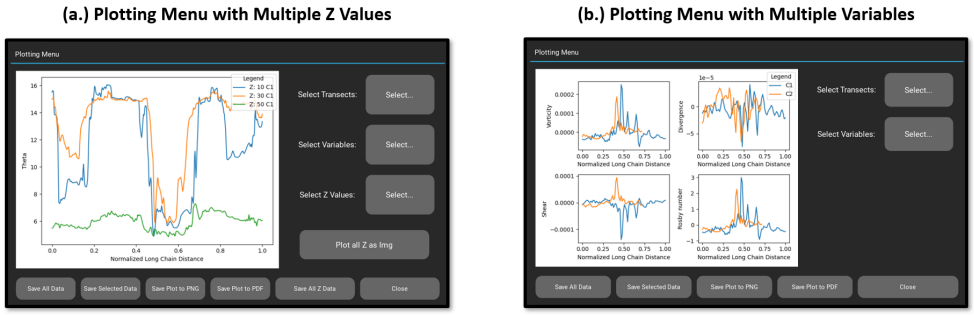

Figure 3: a.) A plot of a single 'Inline Chain' drawn over a feature plotted at multiple values along the z dimension. b.) A plot of two 'Inline Chains' taken over various variables in the NetCDF4 file.

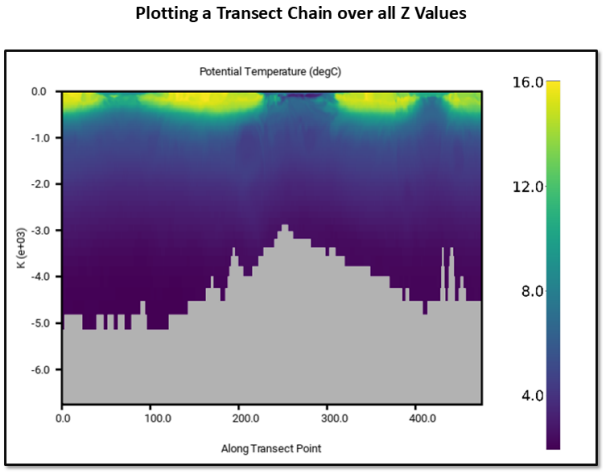

Figure 4: a.) A vertical cross-section of the data along an inline transect chain. In this case, the selected Z dimension was "K", and the variable was ocean potential temperature.

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