3D Visualization of Global Ocean Circulation

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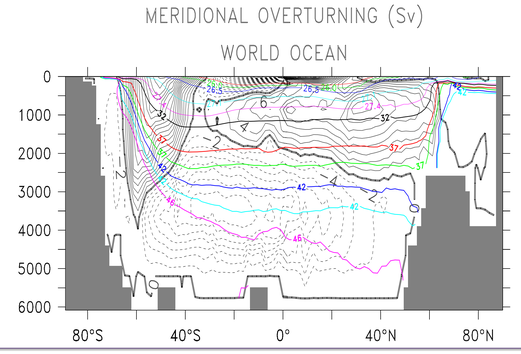
Abstract

Advanced 3D visualization techniques are seldom used to explore the dynamic behavior of ocean circulation. Streamlines are an effective method for visualization of flow, and they can be designed to clearly show the dynamic behavior of a fluidic system. We employ vector field editing and extraction software to examine the topology of velocity vector fields generated by a 3D global circulation model coupled to a one-layer atmosphere model simulating preindustrial and last glacial maximum (LGM) conditions. This results in a streamline-based visualization along multiple density isosurfaces on which we visualize points of vertical exchange and the distribution of properties such as temperature and biogeochemical tracers. Little work has been done to create 3D visualizations of ocean circulation even though there are many models that have been developed to generate 3D data. Previous work involving this model examined the change in the energetics driving overturning circulation and mixing between simulations of LGM and preindustrial conditions. This visualization elucidates the relationship between locations of vertical exchange and mixing, as well as demonstrates the effects of circulation and mixing on the distribution of tracers such as carbon isotopes.

3D Ocean Model

- UVic 2.9 Climate Model
- Resolution: 1.8x3.6, 19 levels
- 3D general ocean circulation model
- Coupled to a single-layer energy-moisture balance atmospheric model
- Describes circulation on timescale of hundreds of years
- PD and LGM simulations

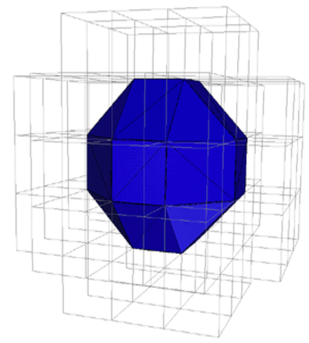


Methods

- Processed data from model

Marching Cubes

- Used VTK Marching Cubes algorithm to extract density isosurfaces
- Interpolation of data on surface

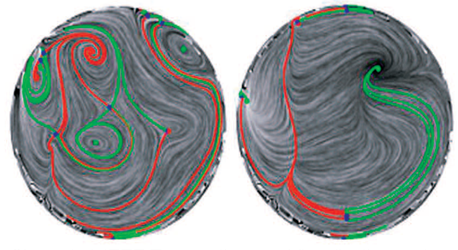


Bourke, P. (1994).

- Used streamlines to represent velocity vector field

Vector Field Editing software

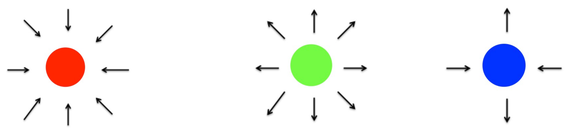
- Extracts qualitative features of vector field



Chen et al. IEEE Transactions on Visualization and Computer Graphics (2007).

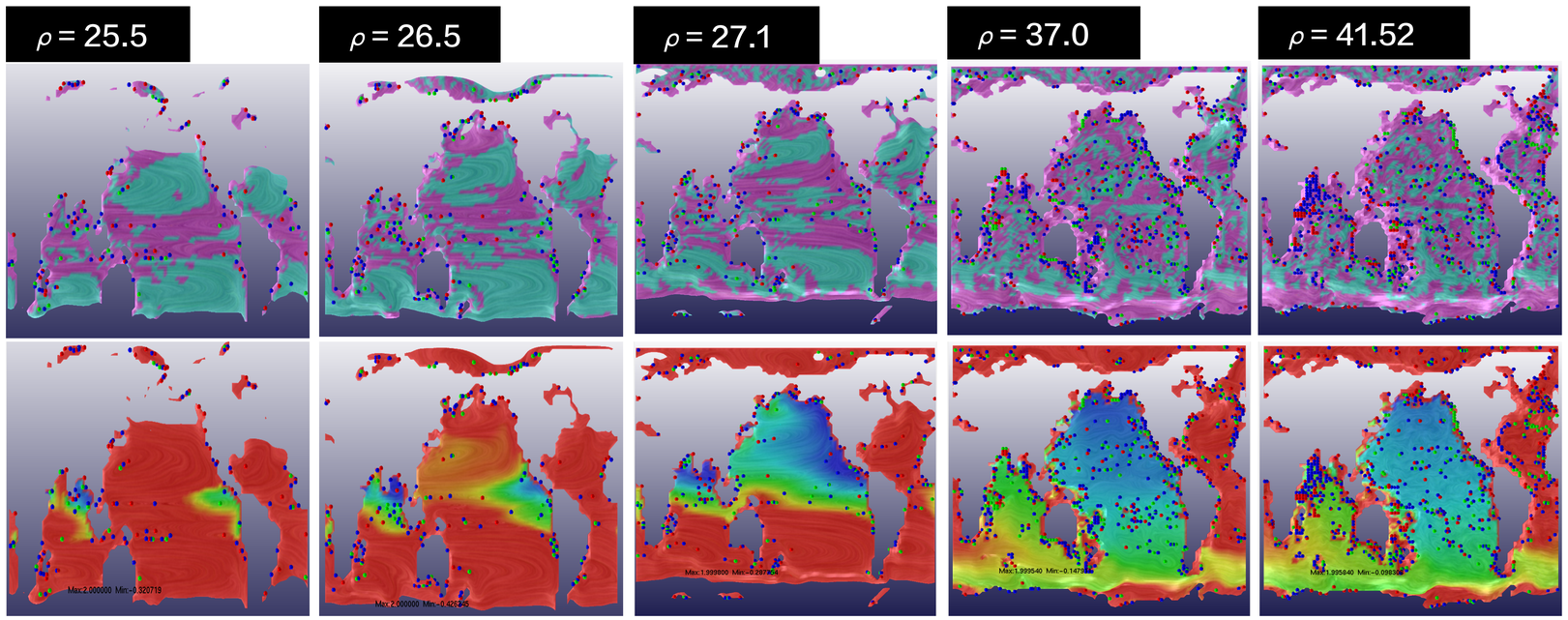
Symbology

- Source
- Sink
- Saddle



PD Upwelling and Downwelling

PD $\delta^{13}C$



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