Visualization of Divergence and Vorticity in Three Dimensions

Abstract

Though inherently three-dimensional, atmospheric wind fields are operationally analyzed by viewing many two-dimensional maps on select isosurfaces. Historically, the reason for planar analysis has been the desire in any given volume. The indices \( i \) and \( j \) stand for each grid point iteration in the \( x \) and \( y \) directions, respectively. The offset, \( s \), is the number of grid space widths away from the center point that are used in the calculation.

Grid Spacing: The optimum grid spacing for divergence was calculated using a scatter plot. The inflection point of the curve denoted where the loss of data was balanced by the removal of noise. Grid spacings of 15-20 were used in the calculation.

Visualization Methods: The open-source software Paraview was used to render wind field data and disseminate the results. Vorticity was visualized using the stream tracer, contour, and glyph filters. Divergence is visualized using the glyph and contour filters.

Results

The techniques used to visualize divergence and vorticity were successful. Comparing 2D forecasting techniques to the 3D computations and visualizations of the same events revealed the usefulness of 3D visualization of divergence and vorticity. Amplified areas of upper-level divergence are easiest to view using contours while small values of divergence are unidentifiable. Surface divergence can best be found by coloring isotherms by divergence. The calculations and visualizations indicated positive values of divergence in areas where they are expected. Regarding the visualization of vorticity, wind glyphs colored by vorticity and stream tracers colored by vorticity clearly show vorticity in the correct areas - large positive vorticity in the base of the trough and large negative vorticity at the tops of the ridges.

SUMMARY

Forecasters are no longer constrained by 2D visualization techniques. Three-dimensional visualization of vorticity and divergence can provide for a quicker diagnosis technique. The calculations of divergence and vorticity are computed by finding a finite difference between grid point neighbors of the North American Mesoscale model gridded data. Vorticity and divergence were visualized using the open-source software Paraview. Divergence is visualized using the glyph, stream tracer, and contour filters, and vorticity is visualized using the glyph and contour filters.