Visualization of an Atmospheric Dataset
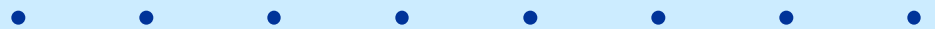
Adria H. Liszka

GCEP/SURE

Brookhaven National Laboratory

24 August 1999

Due to an almost unmanageable size, atmospheric datasets necessitate the use a clear and logical analysis tool: visualization. With this tool, scientists can study complex data in the form of images, and develop hypotheses based on the patterns of data. This project concentrates on taking the first step towards a comprehensive and automated atmospheric visualization program. The data parameters within the sets, such as those from the European Center for Medium-Range Weather Forecasts (ECMWF), fall into one of four categories: two-dimensional scalars, three-dimensional scalars, two-dimensional vectors, and three-dimensional vectors. Since the two-dimensional scalar visualization task has already been tackled, the project focuses on adding data representation capability in the other categories. This goal is accomplished through the programs `tempanim.net` (three-dimensional scalar data temperature), `surfacewindanim.net` (two-dimensional vector data surface wind) and `windanim.net` (three-dimensional vector data wind) in IBM's Data Explorer. These simplified programs render only one type of data because the overall goal of complete generalization is too complicated to achieve immediately. This paper focuses on the accomplishments of the three programs and discusses the next steps towards the ideal, complete data visualization program of the future.

BACKGROUND

- ## The Science

  -- general dataset from the European Center for Medium-Range Weather Forecasts (ECMWF)

  -- particular coverage 0-360 latitude, 0-81 S longitude, 0-100 hPa height, starting on 1 November 1995, 06:00.

- ## The Programming

  -- SGI Onyx Reality Station

  -- programming environment IBM's Data Explorer

- ## The Merging of the Two

  -- the project

METHOD

- ## Model 2D Scalar Data
  -- completed before my arrival

- ## Model 3D Scalar Data
  -- completed 19 July 1999

- ## Model 2D Vector Data
  -- completed 3 August 1999

- ## Model 3D Vector Data
  -- completed 12 August 1999

Three-Dimensional Scalar Data

Example: Temperature
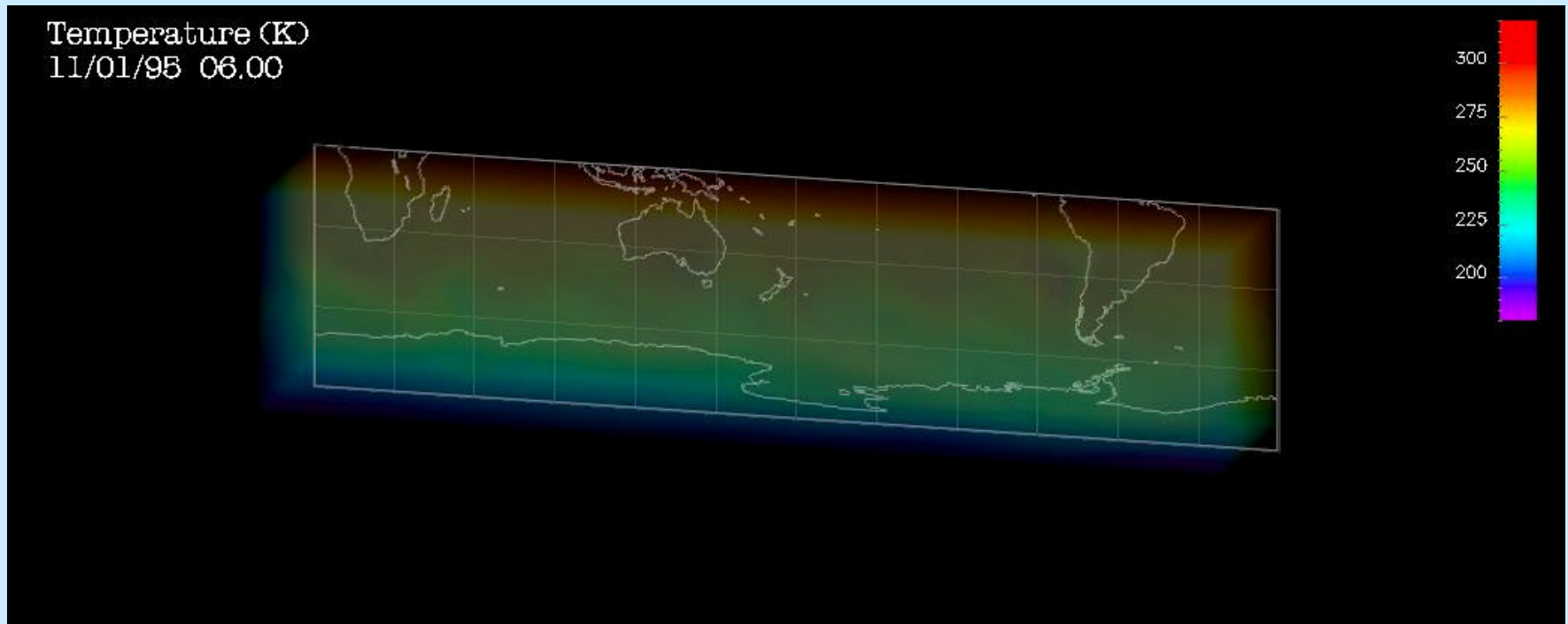
(parameter 130)

Description

- imports a scalar dataset

- renders data as a volume or isosurface

- orients user with base map

- other options

  scales data along the z-axis to spread out the levels

  writes image or sequence to file

Example

Temperature (K)
11/01/95 06.00

300
275
250
225
200

This is the temperature data volume rendered for the first data time, 1 November 1995 at 6 am. The warm temperatures are on the surface near the equator, and the cooler temperatures are higher in the atmosphere and near Antarctica. The view on this image is off front, with a scaling of three on the height axis.

Two-Dimensional Vector Data

Example: Surface Wind

(parameters 131, 132)

Description

- imports a vector dataset

- renders data as arrow glyph, text glyph, streamline, ribbon or contour map
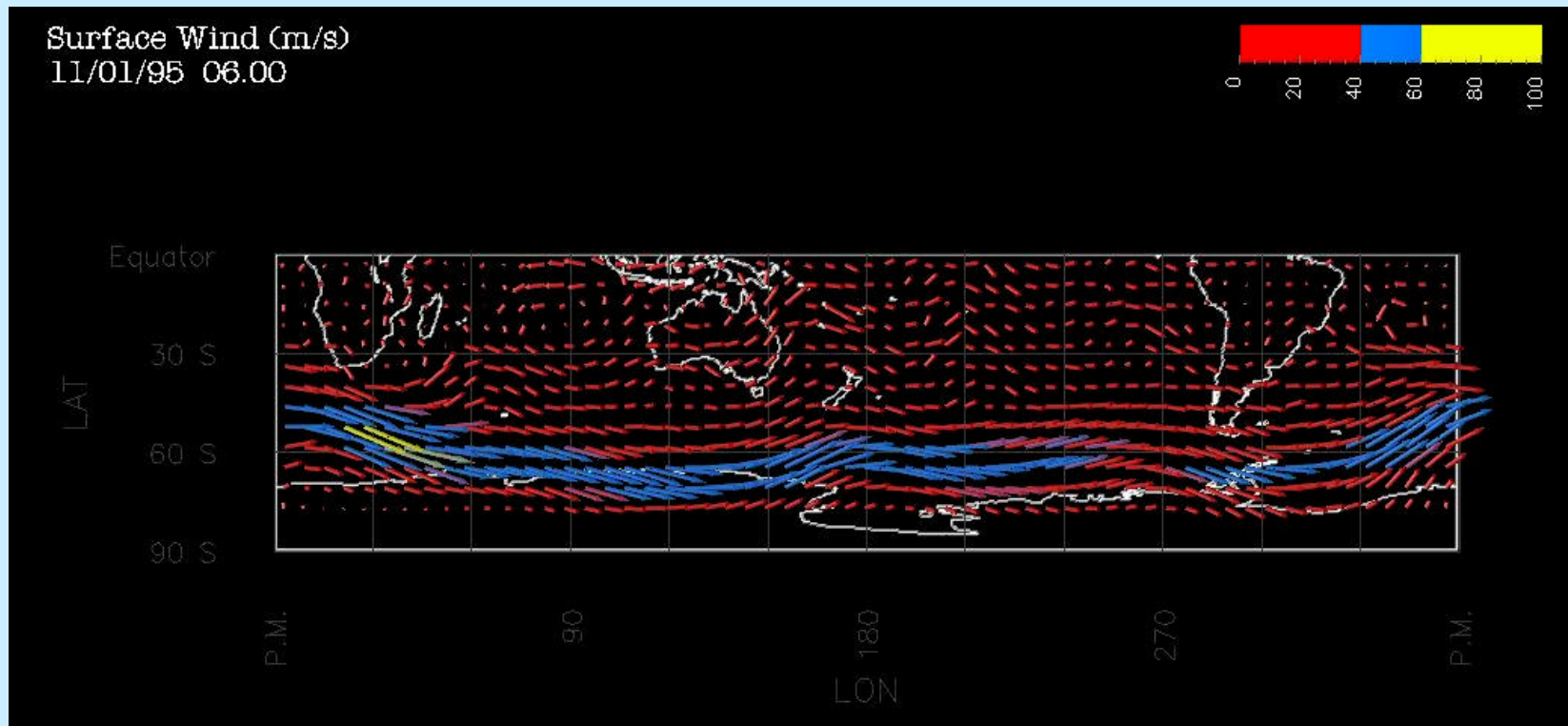
- orients user with x and y axes

- other options

  samples data along the x- and y-axis to reduce size of field

  writes image or sequence to file

  adds base map

Example

This is the surface wind data rendered in arrows for the first data time, 1 November 1995 at 6 am. There is a high pressure system between Africa and Australia, and the air near Antarctica travel in a wave motion. The sampling on this image is every sixth point in both the x (longitudinal) and y (latitudinal) directions.

Three-Dimensional Vector Data

Example: Wind

(parameters 131, 132, 500)

Description

- imports a vector dataset

- renders data as arrow glyph, streamline, ribbon or volume contour map

- orients user with x, y, and z axes

- other options

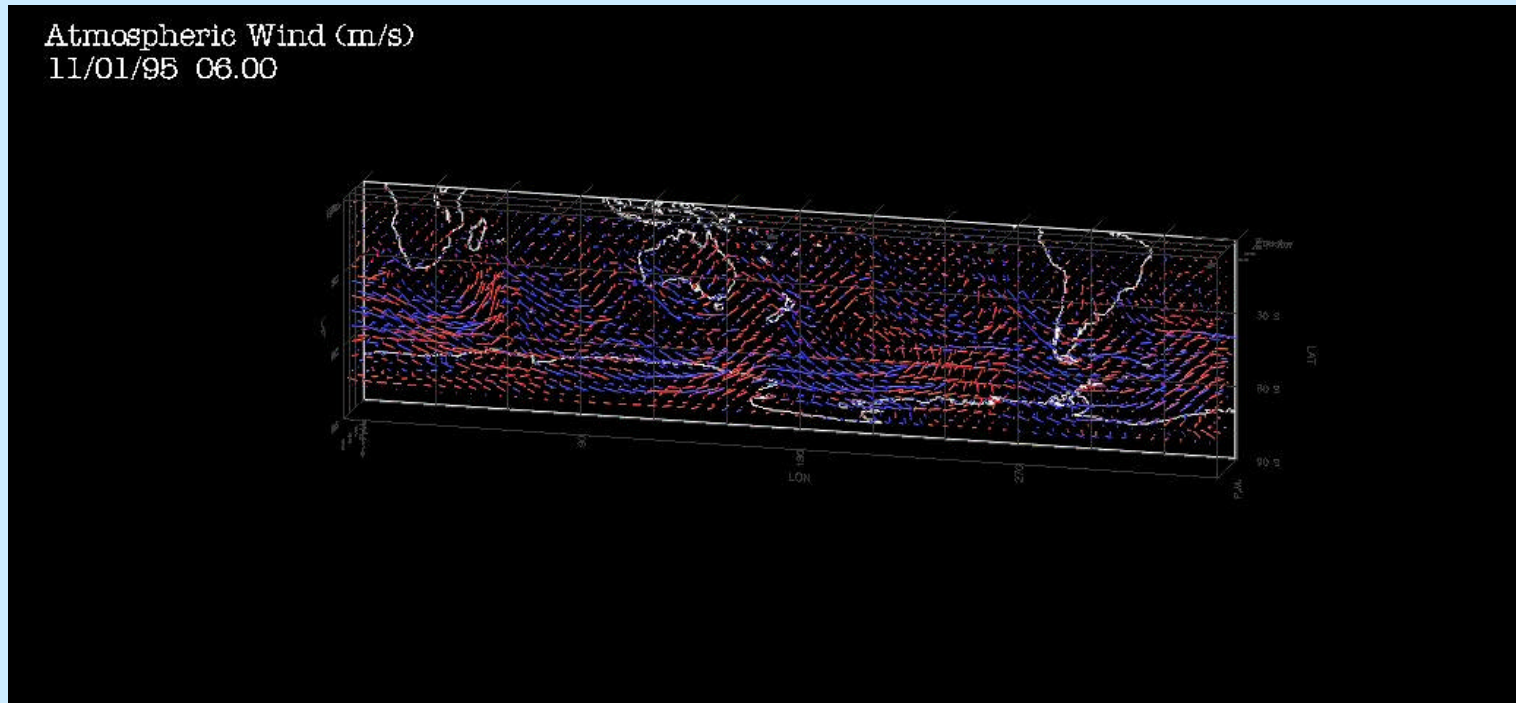 *samples data along the x, y, and z-axis to reduce size of field*

  writes image or sequence to file

  adds base map

  chooses either meteorology (ECMWF) or model (GChM-O) data

Example

Atmospheric Wind (m/s)
11/01/95 06.00

This is the wind data rendered in arrows for the first data time, 1 November 1995 at 6 am. The data in red is pointing 'up' (w-wind is positive) and the data in blue is pointing 'down' (w-wind negative). The sampling on this image is every sixth point in both the x (longitudinal) and y (latitudinal) directions, and every ninth in the z direction.

FUTURE DIRECTIONS

- Generalize the programs
- Expand analysis capability
- Add color, rotation, and vector legends
- Combine parameters
- Increase rendering speed

CONCLUSIONS

- The three programs introduced here are useful, but impractical as they only handle four of the dataset's 76 parameters.

- Each program introduces at least one new concept and several possible directions for improvement.
  -- new concept for 3D Scalar: base map in `gif` format
  -- new concept for 2D Vector: stationary axes
  -- new concept for 3D Vector: *Switch*/*Slab* sampling

- In working towards the overall goal of a comprehensive data visualization tool, the ideas on future directions is as important as these three programs.

ACKNOWLEDGEMENTS

Deepest thanks to:

- **Dr. Carmen Benkovitz** *of the Environmental Chemistry Division, Brookhaven National Laboratory.*

- **Dr. Mike McGuigan** *of the Information Technology Division, Brookhaven National Laboratory.*

- **Mr. Altaf Mubaraki**, **Mr. Ernie Lewis**, **Dr. Fred Brechtel**, **Dr. Gordon Smith** *and* **Mr. Ron Oglesby** *of Brookhaven National Laboratory.*

- **Dr. Jeffrey Gaffney** *of Argonne National Laboratory,* **Dr. Milton Constantine** *from Oak Ridge National Laboratory, and* **Ms. Mary Kinney** *from Oak Ridge National Laboratory.*