J5.2 # APPLYING D3D IN AN OPERATIONAL ENVIRONMENT

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1. INTRODUCTION

The Forecast System Laboratory (FSL) Display 3-Dimensions workstation application (D3D) allows forecasters to view model data in a multi-dimensional interactive display. D3D, based on the University of Wisconsin's Vis5D software, supplements Advanced Weather Interactive Processing System (AWIPS) 2-D display capabilities available to forecasters. Large volumes of data can be rapidly assimilated with an increased temporal and multi-dimensional understanding of how meteorological processes interact.

During Spring 2001, the NWS forecast office in Gray, ME worked in cooperation with the NWS Eastern Region Headquarters and FSL as a D3D workstation test site. The goal of this project is to determine operational strengths and limitations of the workstation through input from the hydrometeorological staff.

2. INTRODUCING D3D INTO OPERATIONS

There were several aspects to consider introducing D3D into forecast operations. The hardware needed to be procured, access to a real-time data feed needed to be obtained, and the staff needed to be trained, both in software interface knobology and techniques application.

2.1 *Obtaining the Hardware*

As part of the test, the Scientific Services Division (SSD) of ERH obtained a PC for the forecast office in Gray on which to run the D3D workstation. The Dell® PC contains dual Pentium III processors. While the D3D workstation software does not explicitly use two processors, the Linux operating system will attempt to use the second processor, allowing D3D use utilize the first processor almost exclusively, thereby increasing performance.

Due to the significant amount of software rendering required by the D3D program, a 3D accelerated video card with 32 MB of RAM was also included. Thus, the workstation as delivered contains considerably more computing power than an typical AWIPS workstation.

2.2 *Obtaining Access to Real-Time Data*

The D3D software, as delivered by FSL, was configured to display case study data. A case study was included in the original software package distribution. Since the test was intended to gauge the utility of the D3D workstation in an operational setting, access to the D2D data tree in AWIPS was necessary. It is important to note that D2D is not required to run D3D.

Access to real-time data necessitated adding the D3D workstation to the AWIPS Local Area Network (LAN). Other options, such as moving data to the workstation via the Local Data Acquisition and Dissemination computer (LDAD), were dismissed as too taxing on the AWIPS LAN. After receiving permission from the AWIPS Security Office, the D3D workstation was added to the AWIPS LAN.

2.3 Training the Staff

Initially, the D3D workstation was located away from the forecast floor. This was done to facilitate staff training. Training began with one-on-one sessions, performed by a forecaster who attended the WFO-Advanced RT99 exercise (Szoke et al. 2001) in November, 1999. During the training session, each element of the software was reviewed in detail, and possible real-time applications were discussed.

After the one-on-one training, each forecaster was asked to complete a series of job sheets, each focusing on a specific aspect of the software. The job sheets, based on those used in the RT99 exercise, helped reinforce the points brought out in the one-on-one training.

Once the staff was trained on D3D, the workstation was relocated to the operations area, where the staff began using the software in a real-time setting.

3. DETERMINING THE ROLE OF D3D IN OPERATIONS

As is the case with any new software package or forecast technique, it is important to determine whether it adds to or detracts from the forecast process. In this case, it is difficult to objectively determine the impact of the software.

To subjectively assess the impact of D3D in operations, forecasters were asked to complete an end-of-shift questionnaire. Modeled after the questionnaires administered during the RT99 exercise, forecasters were asked about the relevance of each element of the D3D software, and how it could be used if included in future AWIPS builds. In addition, due to the beta status of the software, questions concerning software performance were included. The results of the questionnaires can then be used as input to the D3D developers at FSL.

4. USE OF D3D: EXAMPLES

Perhaps the best way to demonstrate the utility of D3D is to present two examples where the capability of D3D, as a more thorough diagnostic tool than D2D alone, is demonstrated.

4.1 *Using Isosurfaces*

Examination of the 0000 UTC 03 October 2001 AVN model forecast cycle in D2D showed strengthening warm air advection over eastern Ontario and western Quebec, in advance of a shortwave moving eastward across western Ontario. Precipitation associated with this feature was forecast to develop across central and southern Quebec between 1800 UTC 03 October and 0000 UTC 04 October 2001, affecting mainly southeast Quebec and northern Maine.

Further examination of the processes involved in creating the precipitation was performed using D3D. This examination allowed forecasters at WFO Gray, Maine, to get a much better idea of where and when the maximum precipitation could be expected.

Employing an isosurface of vorticity (associated with the approaching short wave) and isosurfaces of temperature (5 and 10 degrees Celsius) allowed the forecaster to get a better appreciation for the **depth** of the approaching shortwave and associated warm advection.

Finally, isosurfaces of vertical velocity were added. Looping through the model output showed a maximum in depth of vertical velocity isosurface at the intersection of the maximum depth of vorticity and temperature isosurfaces. Not surprisingly, the forecast maximum precipitation amounts and timing coincided with the occurrence of the **maximum depth** of vertical velocity.

The benefit of the D3D data interrogation in this case enabled forecasters to identify the feature with the most vertical depth. This feature would be responsible for a majority of the resultant precipitation over the Gray, Maine forecast area. Other similar features were observed, but none possessed the same magnitude of depth. This is important because the "traditional" model forecast interrogation (D2D) usually involves an examination of data on single pressure or potential temperature fields or at single data points. While multiple, seemingly identical, features may be observed on a surface, such as vorticity on the 500-mb surface, one would have trouble reconciling which of the vorticity maximums will likely have the most effect on the sensible weather at the surface. As documented in this case, the vorticity advection, coupled with the temperature advection, produced numerous areas of upward vertical velocity. The three-dimensional area with the largest atmospheric depth had the most effect on the sensible weather at the surface.

4.2 *Using Trajectories*

Use of trajectories in forecast operations has been limited to plotting single points on a two-dimensional surface. The third dimension was simulated by changing the values of predetermined fields for each point.

Forecast trajectories in D3D explicitly show the three-dimensional aspects of trajectories, and allow the forecaster to determine which fields to display.

The 0000 UTC 27 September 2001 Eta model was forecasting upper-level ridging to build southeast across Quebec and northern New England. Rapid clearing was observed to be occurring in conjunction with the building ridge. Forecasters at Gray, Maine, were interested to know if the rapid clearing would continue into their forecast area, as well as the origin of the drier air.

Trajectories were constructed with starting points over central Quebec . The trajectories had starting points ranging between 300 mb and 850 mb. Colored by relative humidity, the trajectories clearly showed the drying that occurred as the air parcels descended from the upper levels towards the surface.

Looping through the model forecasts using multiple isosurfaces of relative humidity and the trajectories also showed the approaching airmass drying with time, as the trajectories reached further into southern New England. Thus forecasters were able to determine that the arriving airmass would provide rapid clearing, as well as contain air parcels that originated in the upper troposphere.

5. REFERENCES

Szoke, E.J., U.H. Grote, P.C. Kucera, P.T McCaslin, P.A. McDonald, and W.F. Roberts, 2001: D3D: A Potential 3D Visualization Tool for the National Weather Service. *Preprints, International Conference on Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography and Hydrology*, Albuquerque, NM, Amer. Meteor. Soc. http://d3d.fsl.noaa.gov/ams01/paper/D3D_for_the_NWS.html