P 7.7 AWIPS RADAR AND WARNING STRATEGIES USING MULTIPLE WORKSPACES

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1. Introduction

During 2003-2004, the National Weather Service (NWS) upgraded the Advanced Weather Interactive Processing System (AWIPS) workstation hardware from relatively slow processing Hewlett Packard (HP) workstations with CRT monitors to much faster LINUX based CPUs with high resolution Liquid Crystal Displays (LCDs). In the HP environment, multiple monitors were used to display data, but only one Display 2-Dimensional (D2D) could be open on each monitor. The D2D component of the AWIPS workstation is the primary user interface; it allows forecasters to display and manipulate graphic and image products, work with gridded model data, and run interactive hydrometeorological applications. Strategies were developed to optimize D2D data display capabilities under HP, but the process was cumbersome, and required constant manipulation of numerous products.

The new LINUX based workstations have faster processors and improved graphics cards, permitting multiple virtual workspaces (i.e., desktops) to be open simultaneously on each LCD. Multiple D2D sessions can be open on a single LCD, each in a unique workspace. New data display strategies allow the workstations to be set up to easily monitor multiple severe weather hazards. Multiple workspace strategies significantly reduce product manipulation, resulting in greater situational awareness (SA; Ensley 1988) and more effective warning operations.

This paper presents AWIPS radar detection and warning strategies using multiple workspaces. Operational Templates are introduced to demonstrate how individual workspaces can be set up to monitor 1) radar signatures of severe weather and flash floods, 2) radar evidence of imminent tornadoes and damaging wind, 3) satellite imagery, observations, and mesoscale analysis/forecast graphics, and 4) software for graphically generating warnings (WarnGen) and creating or disseminating products (Watch Warning Advisory; WWA).

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Multiple workspaces allow considerably more data to be displayed, a method to organize the data, and much less data display manipulation (i.e., swapping of D2D panes and loading new data into D2D panes).

In addition to multiple workspaces, this paper will demonstrate how to effectively manage numerous D2D tasks (e.g., Procedure Bundles, Tables, radar One Time Requests, etc.) unique to each workspace. This eliminates the need to search for windows that disappear behind the main D2D window. A combination of multiple workspaces and efficient task management allows more time to concentrate on severe weather detection and warning operations.

2. General Strategy

Effective warning environments require a strategy for visualizing, organizing, and using large volumes of data (e.g., radar, observations, satellite imagery, mesoscale models). Multiple workspaces can be set up to display information for a variety of severe weather hazards simultaneously, including separate displays for WarnGen and WWA. High SA requires the ability to 1) display all relevant information simultaneously, from the storm scale to regional scales, 2) screen and prioritize relative threats and storms, 3) manage numerous tasks easily (e.g., Radar Product Generator [RPG], Volume Coverage Pattern [VCP], AWIPS Procedures [radar, satellite, ground-level observations, model, etc], and 4) issue/disseminate warnings and other products. The following sections propose a multiple workspace strategy for maintaining high SA and an effective warning environment.

3. Specific Strategies

3.1 Workspace 1 - General Severe

Workspace 1 (Fig. 1) is set up to maintain high SA for a variety of severe weather hazards. In this example, the left D2D (A) is configured with a three-pane layout. The main pane is used to monitor the flash flood threat with the Flash Flood monitoring Program (FFMP). FFMP is an application that displays basin specific information, including basin average rainfall rates, basin average rainfall accumulations, Flash Flood Guidance (FFG), and explicit basin average rainfall relative to FFG. The Procedure used to display FFMP also displays the Composite Reflectivity (CZ) product, which toggles to basin-specific information. Linking actual radar Products (CZ) to basin-specific estimates of rainfall and FFG allow warning forecasters to look immediately upstream in their evaluation of the flash flood threat, thus adding a predictive element to the application. The left panes are used for Reflectivity (Z) cross section analysis of storms to reveal physical structures.

The center D2D (B) is configured with a three-pane layout, and displays two 4-panels and one single pane. The 4-panel in the main frame shows the County Warning Area (CWA) scale; displays include a mid- Layer Reflectivity Maximum (LRM) in the top left pane, a high- layer LRM in the bottom left pane, a 0.5^{o} reflectivity (Z) in the top right pane, and a Vertically Integrated Liquid (VIL) in the bottom right pane. The 4-panel in the bottom left pane is similarly configured, but is zoomed in to a storm or group of storms of interest. The top left pane displays regional satellite imagery and lightning data. This configuration promotes SA because information is presented on all relevant scales. The 4-panels allow relatively easy screening and ranking of storms where updraft strength is an important (or primary) consideration for severe weather detection. Although these 4-panel Procedures offer limited value when assessing the severe potential of low-topped storms, low-topped line structures (bowing segments), or potentially tornadic supercells, other workspaces are set up to display other physical and flow structures.

The right D2D (C) is configured with three panes. The main pane includes the System for Convective Analysis (SCAN), an application that helps warning forecasters screen and rank storms for relative threats. The SCAN graphic toggles between 8-bit Z and 8-bit Velocity (V), providing the highest resolution for storms and line segments with heightened potential for damaging winds. Depending on the specific threat, the upper- and lower-left panes display relevant radar products from adjacent radars. This allows easy comparisons between dedicated and adjacent radars for specific threats.

Real-time radar products and satellite images corresponding to A, B, and C are displayed in Fig. 1 as A' (left D2D), B' (center D2D), and C' (right D2D).

3.2 Workspace 2 - Tornado and Wind

Workspace 2 (Fig.2, (A)) is set up to convey information necessary for assessing the potential for tornadoes and damaging winds. The left D2D is configured with a 4-panel for evaluating Mid-Altitude Radial Convergence (MARC, Schmocker et. al, 1996) signatures. The upper-left panel displays the 8-bit 0.5^{0} Z/V toggle, and the remaining panels show successively higher (through the storm's mid-level) slices of Z and Storm-Relative Velocity Map (SRM). MARC signatures are often associated with line structures (bowing line segments) producing damaging winds at the surface.

The center D2D (B) is configured with a three-pane layout. The main pane displays the All Tilts of Z and SRM. All Tilts are very useful when assessing physical and flow structures because all elevation angles are displayed, one on top of another. This allows radar operators to animate or step vertically through storms, one elevation slice at a time. The two left panes are used to generate and display velocity cross sections, which can show descending rear inflow jets and tornadic shears.

The right D2D (C) displays a 4-panel of the lowest 4 elevation angles of Z/SRM, useful for quickly assessing mesocyclones, shear, and TVSs.

Workspace 2 is especially useful when spotters, law enforcement, emergency managers, and the public phone in reports of wall clouds, rotation, and tornadoes. The radar operator can quickly switch to workspace 2 and assess the relevant potential, then switch to workspace 4, if necessary, to issue a warning (see 3.4, below).

3.3 Workspace 3 - Mesoscale Analysis

Workspace 3 (Fig.2, (B)) is reserved for applications, products, and images that support mesoscale analysis, including the Rapid Update Cycle (RUC), Local Analysis and Prediction System (LAPS), other mesoscale models (e.g., locally run MM5, etc.), satellite images, lightning, radar products from adjacent radars, and ground-based observations (METARs and mesonets). Composite charts of hourly surface analyses are constructed from model output to highlight the physical processes supporting severe storm development, convective organization, and storm mode (Korotky, 2002). To uncover relevant information quickly, these charts are designed to illustrate 1) measures of instability and vertical wind shear, 2) three-dimensional moisture availability, content, and distribution and, 3) synoptic and mesoscale forcing mechanisms. Continual analysis of the near-storm environment is critical for understanding the evolution of storms and projecting their future impacts. It is difficult to maintain SA without understanding why things are happening as they are.

3.4 Workspace 4 - Warngen and WWA

Workspace 4 (Fig.2 (C)) is set up primarily for generating, issuing, and disseminating warnings and other time critical products. The left D2D contains a Z/SRM with lower reflectivity values filtered out for graphically generating warnings with WarnGen. Cities are added for a quick sanity check. The right D2D is reserved for generating and disseminating products with WWA. The Center D2D is configured with models (e.g., the Eta and GFS) for large scale briefing purposes.

4. Task Management

An effective warning environment requires management of numerous software packages displaying simultaneously on each workspace, including the D2D, D2D Procedures, FFMP, SCAN, radar One Time Requests, etc. Unfortunately, warning forecasters are constantly looking for tasks that disappear behind the D2D. This practice is time consuming and leads to diminished SA. Fig. 3 illustrates a floating Task Bar that sits permanently along the top of the D2D in a position where it does not obstruct D2D operations. All running tasks are listed and easily readable in the Task Bar, eliminating the need to move the D2D to search for Procedures and other tasks. Merely clicking on the needed task brings it to the front; clicking again minimizes the task back to the Task Bar. In this manner, FFMP and SCAN tables can be minimized to examine radar images and maximized when needed. Task management is absolutely necessary for maintaining order in a potentially chaotic severe weather operations environment.

5. Discussion

Science, technology, and human factors must act together to produce an effective warning environment (WDTB presentation, Learning from History). Science allows us to understand the environmental potential, threats, and ongoing storm evolutions. Technology provides the tools (AWIPS workstations, software, and applications; WSR-88D, etc.) for visualizing the science, and human factors determine whether or not warning decisions are timely, informed, and correct.

SA is the most significant human factor in a warning environment, and depends largely on perception, comprehension, and projection (Endsley 1988). To make informed warning decisions, forecasters must 1) see the relevant information (perception), understand the significance of what they see (comprehension), and 3) visualize probable outcomes (projection) such as severe vs. non severe; tornado vs. damaging wind.

This paper demonstrated a strategy for using multiple workspaces to display information for a variety of severe weather hazards simultaneously, including separate displays for Warngen and WWA. The strategy allows warning forecasters to maintain high SA because 1) all relevant information on all relevant scales are displayed concurrently, 2) a scientific approach is used to screen and prioritize relative threats and storms, 3) each workspace is organized to solve specific operational problems, 4) numerous tasks and applications can be managed without difficulty, and 5) warnings and other products can be issued/disseminated without disturbing other critical data displays.

The referenced workspace strategy was used by NWS forecasters at Pittsburgh during several significant severe weather events throughout the 2004 convective season. Initial fears of repetitive workstation hangs and AWIPS notification server overloading were not realized; there were no significant operational problems associated with using multiple workspaces. Still, it is recommended that interested NWS Offices test the utility of multiple workspaces slowly (one workstation at a time) to assess operational impacts.

Although the strategy referenced here works well at NWS Pittsburgh, several equally valid strategies are possible; others may find a different approach better suited to solving their particular problems.

6. References

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Schmocker, G. K., R. W. Przybylinski, and Y. J. Lin, 1996: Forecasting the initial onset of damaging downburst winds associated with a Mesoscale Convective System (MCS) using the Mid-Altitude Radial Convergence (MARC) signature. Preprints, 15th Conf. On Weather Analysis and Forecasting, Norfolk VA, Amer. Meteor. Soc., 306-311

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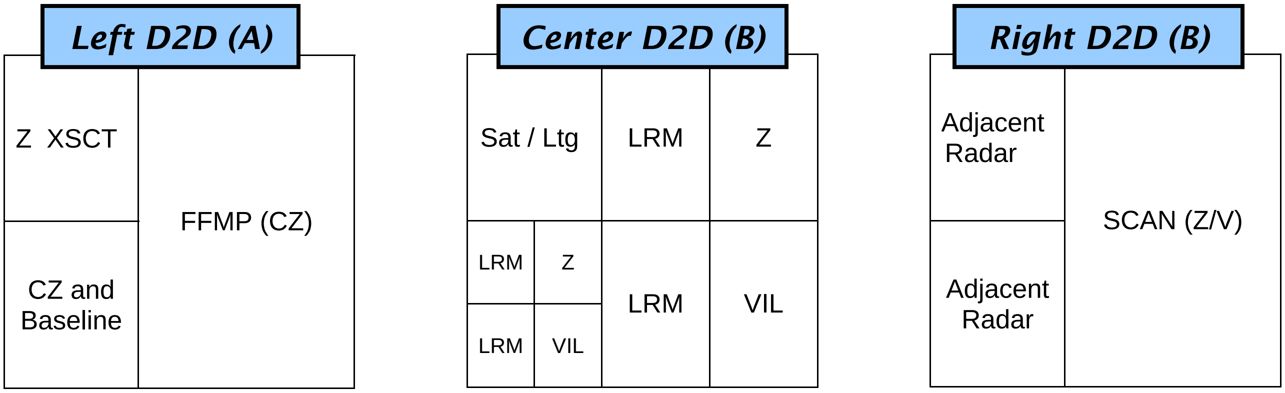

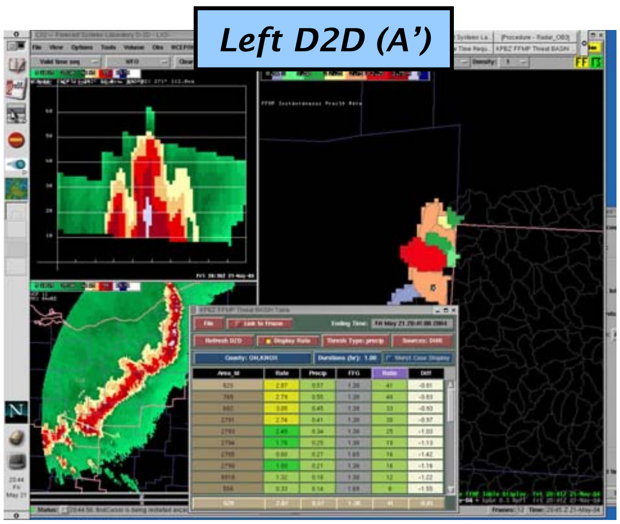

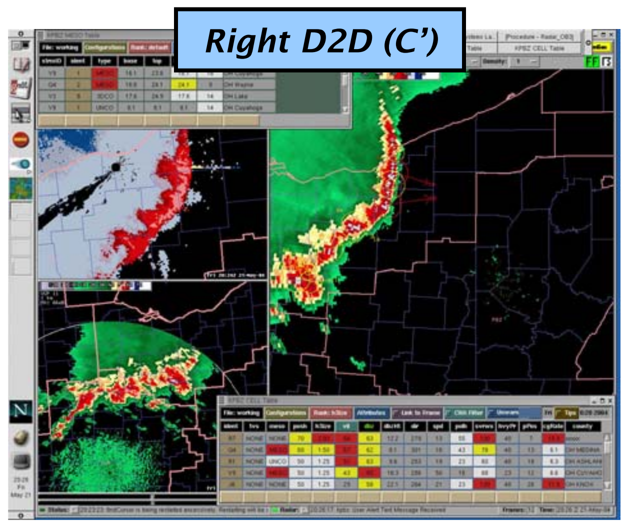

Table 1.

XSCT	Cross section
Sat	Satellite
Ltg	Lightning
LRM	Layer Reflectivity Max
VIL	Vertically Integrated Liquid
Z	Reflectivity
CZ	Composite reflectivity
V	Velocity
SRM	Storm Relative Velocity

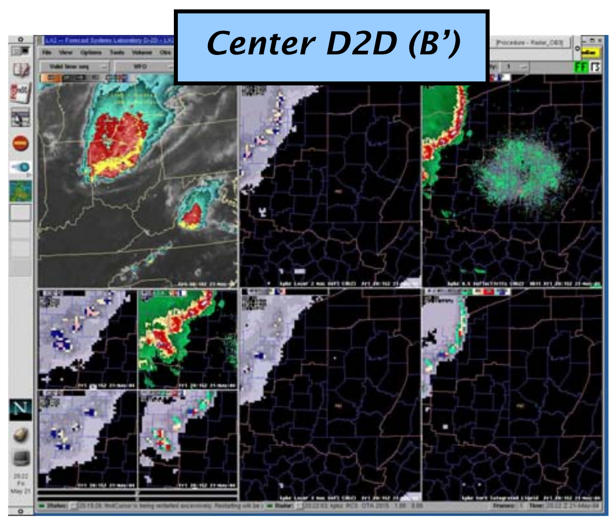

Fig. 1. Workspace 1 Template (A, B, C) and corresponding Radar Products (A', B', C'). Explanation in text. Abbreviations defined in Table 1.

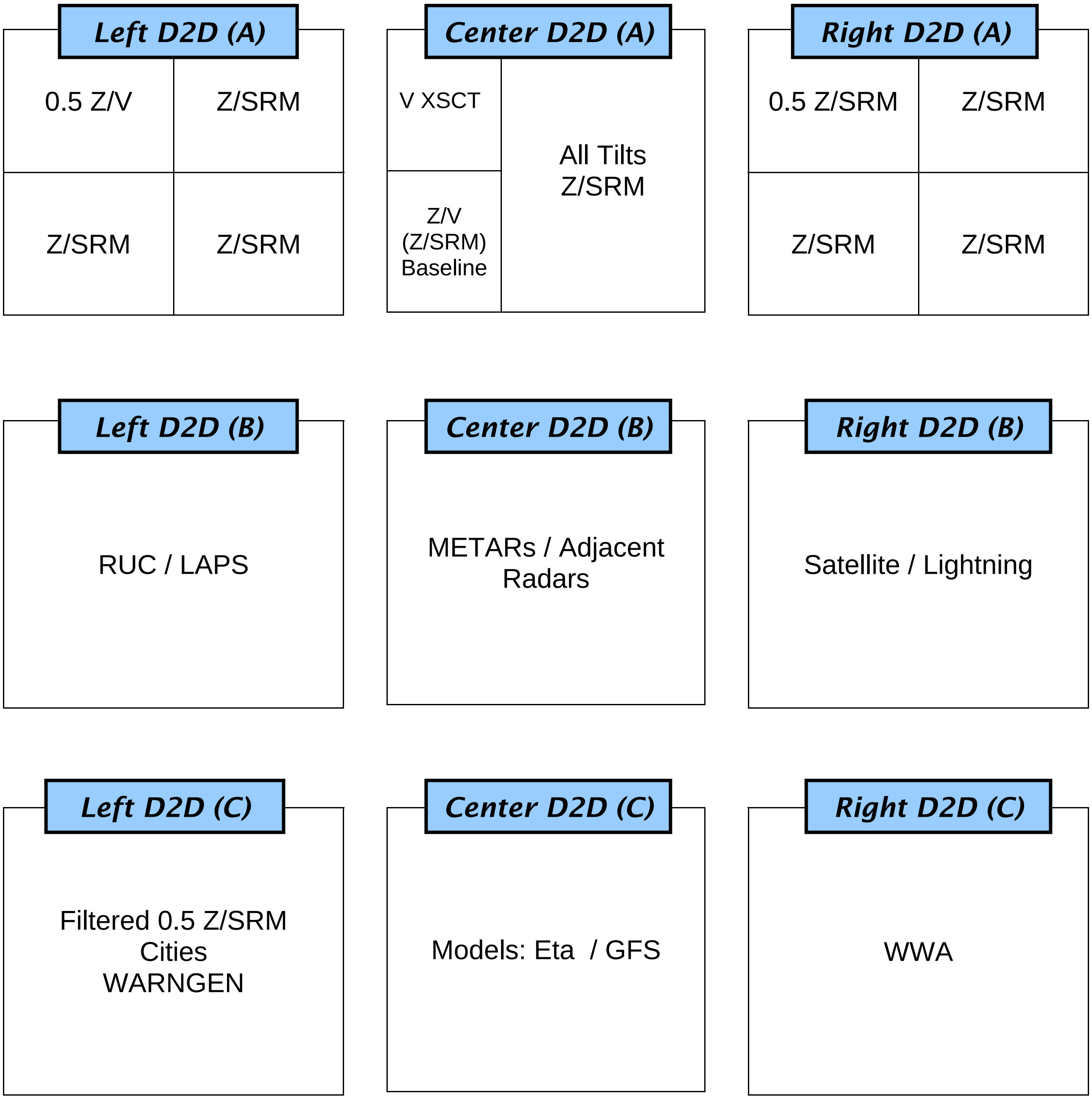

Fig. 2. Workspace 2 (A), Workspace 3 (B), and Workspace 4 (C) Templates. Explanation in text. See Table 1. for explanation of abbreviations

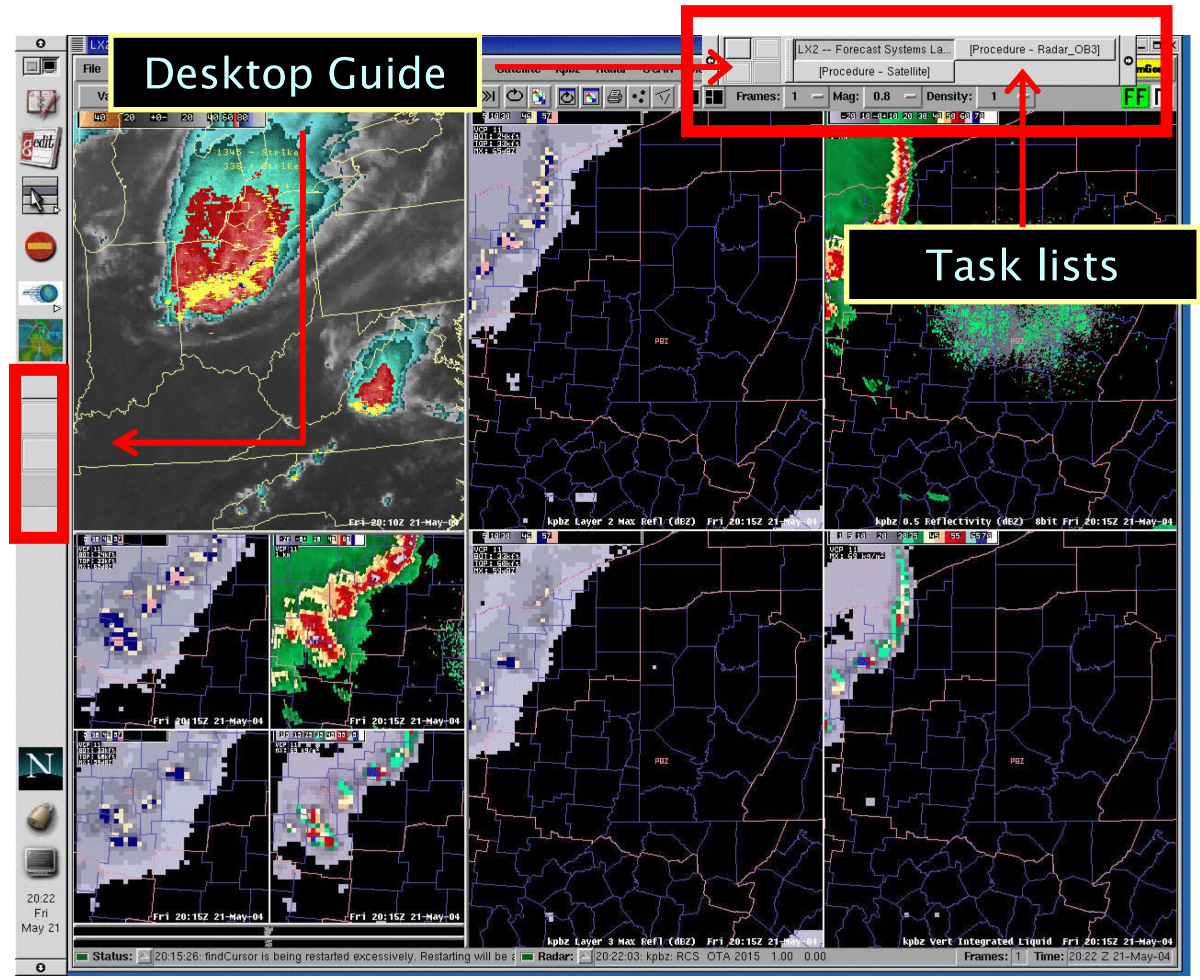

Fig. 3. A Task list for manipulating tasks and a Desk Guide for switching workspaces.