AMIGAS II, AN ADVANCED METEOROLOGICAL IMAGE AND GRAPHICS ANALYSIS SYSTEM

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I. Introduction

AMIGAS II is an integrated hardware and software system which acquires, processes, and displays meteorological data for the operational weather forecaster. AMIGAS II is designed around easy to use interfaces between the meteorologist and the underlying software and hardware components, thus allowing a meteorologist to use the system without having any knowledge of the computer hardware and its operating system. To create meteorological products, AMIGAS II utilizes a distributed and expandable architecture that is based on a CYBER mainframe computer for data ingest, product generation, and product management; a meteorological workstation for display of products and forecaster interaction with them; and a request interface which enables the user to define a set of permanent products. These hardware components are all connected by an Ethernet Local Area Network (LAN). Figure 1 illustrates a typical AMIGAS II hardware configuration.

Real-time communication processors ingest satellite, radar, and observational data and transfer the information to the mainframe for storage on system data bases. Meteorological applications analyze and process this information into graphical products. The products are transmitted and stored locally on the workstations where they are transformed into viewable graphics for display. The forecaster interacts with the products at the workstation via an easy to use windowed interface. The forecaster does not have to know where and how the processing is done. The system is designed to run the needed tasks on the appropriate set of hardware and software, shielding the meteorologist from the system level command interfaces and allowing him or her to concentrate on forecasting duties.

II. The Product Paradigm

The basic building block of an AMIGAS II product is a "component" (Figure 2). Examples of components include a map background, an image, a skew-T diagram, or a horizontal analysis. Table I gives a complete list of the meteorological products currently supported by AMIGAS II. Components are defined by the user in terms of their content (e.g. date/time, type of product, parameters, grid-length, and the units in which to display meteorological parameters). For those components which use upper air data, AMIGAS II allows the forecaster to choose the vertical coordinate in which the data are to be displayed. Pressure, log pressure, pressure to the kappa, sigma, height AGL, height MSL, and potential temperature are all supported vertical coordinates in the AMIGAS II system.

Upper Air Horizontal Analyses
Surface Horizontal Analyses
Upper Air Plot Data
Surface Plot Data
Satellite Imagery
Remapped Satellite Imagery
Conventional Radar Imagery
Doppler Radar Imagery
Radar Mosaics
Distance Cross Sections
Time Cross Sections
Upper Air Data List
Surface Data List
Skew-T Diagrams
Stuve Diagrams
Vertical-Parameter Diagrams
Parameter-Time Diagrams
Fine, Medium, and Coarse Map Backgrounds

Table I: Meteorological applications in AMIGAS II

A combination or overlay of one or more components is a "slide." A slide is the simplest form of an AMIGAS II product. The distinguishing characteristic of a slide is that all components which make up a slide must have the same image or map projection. Table II shows those map projections currently supported by AMIGAS II. An image, either radar or satellite can be remapped into any of these map projections. In addition, multiple images can be remapped into the same projection to produce a radar or satellite mosaic.
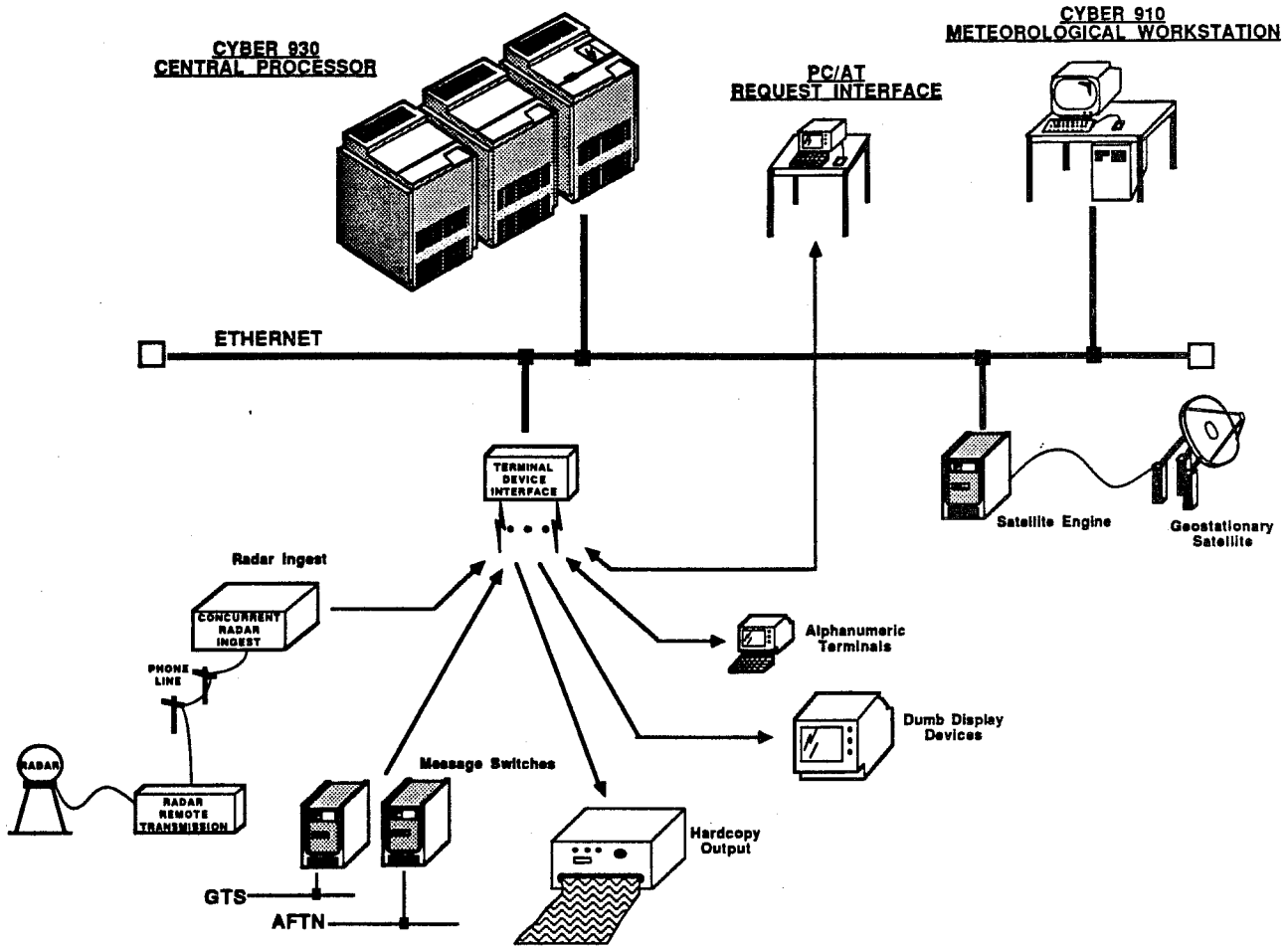
Figure 1. A typical AMIGAS II hardware configuration. Ethernet links the central processor with the Request Interface and the meteorological workstation, as well as with data sources and various auxiliary output devices.

Mercator
Spherical
Polar Stereographic
Tangent Lambert-Conformal
Secant Lambert-Conformal

Table II: Map projections supported by AMIGAS II

A slide may also contain a single diagram, e.g. skew-T or a cross section (time or distance) analysis or a list of meteorological data. These types of slides are always single component slides.

When viewing a slide at the meteorological workstation, the forecaster can turn individual components on or off to produce different pictures. For instance, one may define a slide to contain all pertinent analyses at 500mb along with the station plot and the map background. When viewing this product the forecaster can then easily select any combination of components which he or she desires to view, thereby creating many different perspectives on the mid-tropospheric situation.

AMIGAS II also provides the meteorologist with the capability to change certain aspects of a component, such as its color, the parameter being plotted, or the amount of information being included in the map background. All of these functions are performed by the forecaster at the workstation; there is no need to reprocess the data each time a different view of the picture is desired. Finally, the user has the means to change the overall appearance of the slide, e.g. to change the background color of the slide or to turn the legend information on or off.

The second type of AMIGAS II product is the "carousel." A carousel is a user-defined collection of slides. The slides which make up a carousel may be viewed individually, manually advanced for the purpose of doing a weather briefing, or automatically looped for the purpose of animation. There are no restrictions on the types of slides which can be combined to form a carousel. The carousel should be some logical grouping of slides and may contain slides with many different horizontal or vertical projections. When viewing a carousel, one can go directly to any slide in it and perform the same manipulations on that slide as were described above.

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III. Product Definition

All AMIGAS II products are defined as either a "slide" or a "carousel". The forecaster or site administrator uses the Request Interface to create a set of product definitions. The Request Interface is a PC based, windowed interface which allows the user to create product definitions without having to learn a complicated computer command language. This interface employs various mouse-driven facilities to present application parameter values and options (e.g. pull-down menus, push buttons, list boxes, and dialog boxes). Figure 3 shows an example of the windowed interface used by the Request Interface. Keyboard input is avoided wherever possible, thus reducing the chance of the user making an error. By selecting and specifying parameter values, the user creates product definitions, which are then saved in a data base on the mainframe computer. Figure 4 depicts the Request Interface screen for defining an upper air analysis component. These product definitions are stored indefinitely, so that once a set of products is defined, the user does not have to continually redefine them.

IV. Creating Instances of Products

Actual instances of these products are created either on a scheduled or an ad-hoc basis. When a specific instance of a product is created, it is automatically routed to a set of user-specified destinations for display. These instances of AMIGAS II products become a part of the site's product database and can be retained for a user-defined length of time for later display.

The primary mode for operating the system is to build products via the AMIGAS II scheduler. The scheduler allows the predefined products which are part of the product database to be created at a user-specified time interval. The AMIGAS II administrator uses a full screen interface to define what products are to be scheduled, the starting and stopping time for each individual product, and the time interval at which each product is to be created. When building products via the scheduler, the meteorologist can view the products as they arrive at the meteorological workstation without having to make specific requests for them.

Images

ONE OR MORE COMPONENTS ARE COMBINED TO MAKE EACH SLIDE

Alphanumerics

Low Temperature
Record -30 F
International Falls

THE USER SELECTS SLIDES AND CAROUSELS FROM A LIST OF COMPLETED PRODUCTS AND INDICATES IN WHICH WINDOW EACH SHOULD BE DISPLAYED

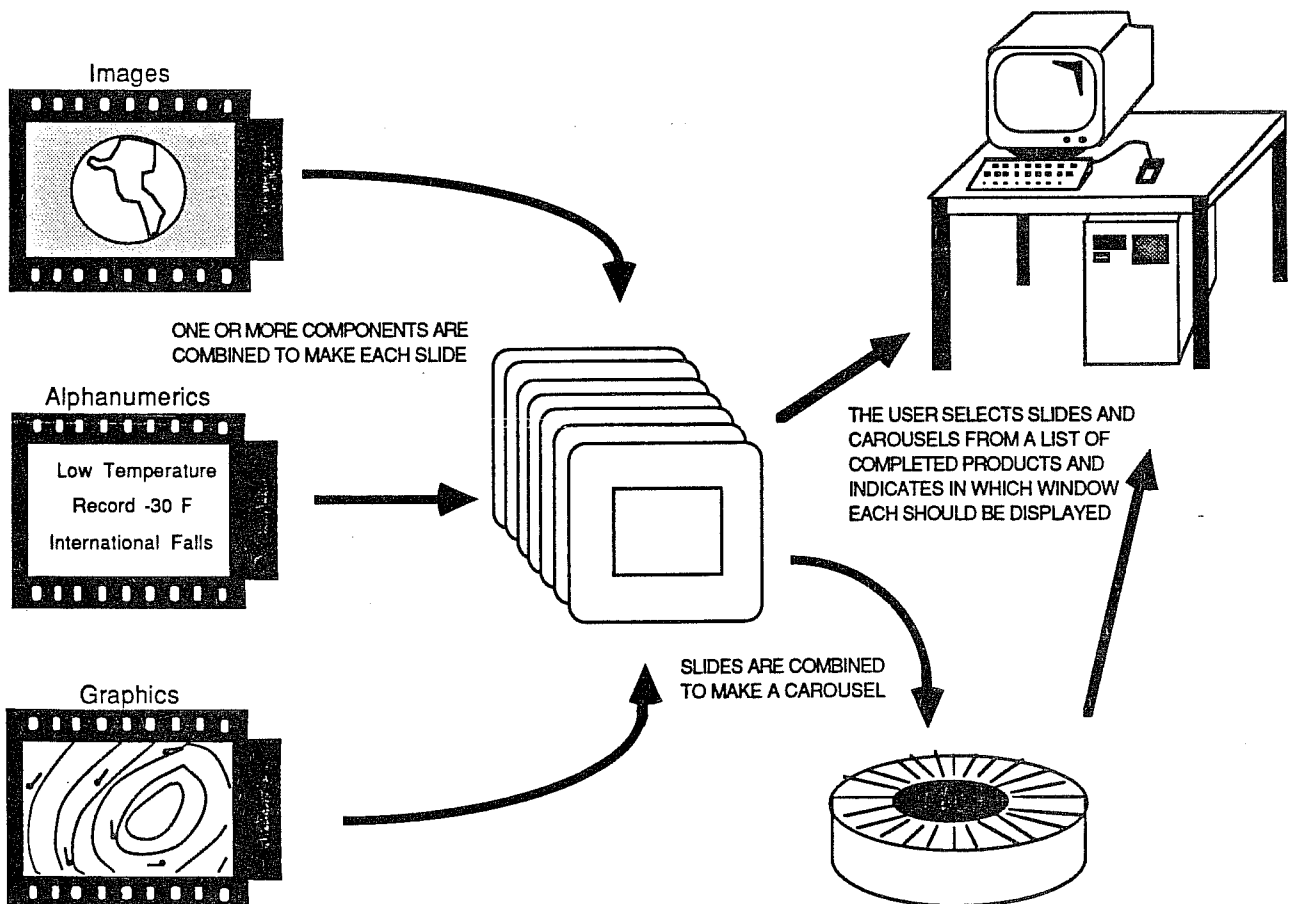SLIDES ARE COMBINED TO MAKE A CAROUSEL

Graphics

Figure 2: The Amigas II Product Paradigm. Components are combined with a projection to make a slide. Slides may be created directly or optionally combined into a carousel. Products are viewed at the meteorological workstation.
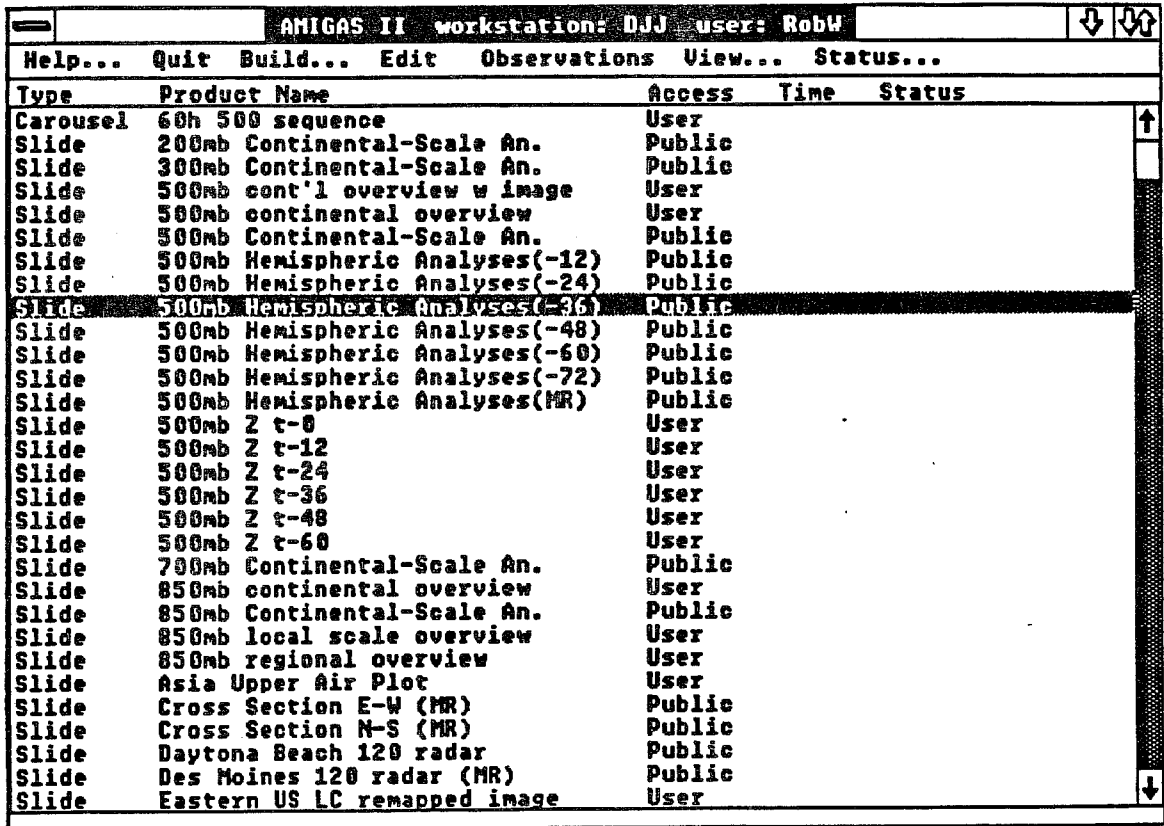
```
┌──┬─────────────────────────────────────────────────────────────┬──┬──┐
│━━│         AMIGAS II workstation: DJJ user: RobW               │⇩ │⇩⇩│
├──┴─────────────────────────────────────────────────────────────┴──┴──┤
│ Help...  Quit  Build...  Edit   Observations  View...  Status...     │
├───────────────────────────────────────────────────────────────────┬─┤
│ Type      Product Name                    Access  Time  Status     │↑│
│ Carousel  60h 500 sequence                User                     ├─┤
│ Slide     200mb Continental-Scale An.     Public                   │ │
│ Slide     300mb Continental-Scale An.     Public                   │ │
│ Slide     500mb cont'l overview w image   User                     │ │
│ Slide     500mb continental overview      User                     │ │
│ Slide     500mb Continental-Scale An.     Public                   │ │
│ Slide     500mb Hemispheric Analyses(-12) Public                   │ │
│ Slide     500mb Hemispheric Analyses(-24) Public                   │ │
│ Slide     500mb Hemispheric Analyses(-36) Public                   │ │
│ Slide     500mb Hemispheric Analyses(-48) Public                   │ │
│ Slide     500mb Hemispheric Analyses(-60) Public                   │ │
│ Slide     500mb Hemispheric Analyses(-72) Public                   │ │
│ Slide     500mb Hemispheric Analyses(MR)  Public                   │ │
│ Slide     500mb Z t-0                     User                     │ │
│ Slide     500mb Z t-12                    User                     │ │
│ Slide     500mb Z t-24                    User                     │ │
│ Slide     500mb Z t-36                    User                     │ │
│ Slide     500mb Z t-48                    User                     │ │
│ Slide     500mb Z t-60                    User                     │ │
│ Slide     700mb Continental-Scale An.     Public                   │ │
│ Slide     850mb continental overview      User                     │ │
│ Slide     850mb Continental-Scale An.     Public                   │ │
│ Slide     850mb local scale overview      User                     │ │
│ Slide     850mb regional overview         User                     │ │
│ Slide     Asia Upper Air Plot             User                     │ │
│ Slide     Cross Section E-W (MR)          Public                   │ │
│ Slide     Cross Section N-S (MR)          Public                   │ │
│ Slide     Daytona Beach 120 radar         Public                   │ │
│ Slide     Des Moines 120 radar (MR)       Public                   ├─┤
│ Slide     Eastern US LC remapped image    User                     │↓│
└────────────────────────────────────────────────────────────────────┴─┘
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Figure 3. AMIGAS II Request Interface Main Mode Window

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┌──┬────────────────────────────────────────────────────────────┬──┬──┐
│━━│        AMIGAS II workstation: DJJ user: RobW               │⇩ │⇩⇩│
├──┴───┬─────────────────────────────────┬────────────────────┬─┴──┴──┤
│ H    │   Editing Slide: New Slide      │    Status...       │       │
├─┬────┴──┬────────────────────────────────────────┬──────────┴──┬──┬─┤
│T│ H     │       Analysis Upper Air Data          │             │  │↑│
│C├─┬─────┴────────────────────────────────────────┴─────────────┤  ├─┤
│S│ │R  Help...  Finish  Time...  Vertical Coordinate  Levels... │  │ │
│S│ │                                                            │  │ │
│S│ │   Date:[Most Recent]  Time Difference:   [000000 ]         │  │ │
│S│ │   Time:[-00000]       Vertical Coordinate:[Pressure    ]   │  │ │
│S│ │  ┌Grid Algorithm┐ ┌Met Parameters──────────────────────┐   │  │ │
│S│ │  │              │ │ Parameter         Interval  Units  │   │  │ │
│S│ │  │ Scan Radii:  │ │ Height MSL         60        m   ↑ │   │  │ │
│S│ │  │              │ │ Temperature        5         C     │   │  │ │
│S│ │  │ 1: [15]      │ │ Dewpoint           5         C     │   │  │ │
│S│ │  │              │ │ Dewpnt Depression  5         C     │   │  │ │
│S│ │  │ 2: [10]      │ │ 12 Hr Hght Change  5         m     │   │  │ │
│S│ │  │              │ │ Wind Speed         2         m/s   │   │  │ │
│S│ │  │ 3: [5]       │ │ Streamlines        5           ↓   │   │  │ │
│S│ │  │              │ └────────────────────────────────────┘   │  │ │
│S│ │  │ 4: [ ]       │ □ Dewpoint          [5]    ( C )          │  │ │
│S│R│  │              │                                           │  │ │
│S│ │  │ 5: [ ]       │ □ Advection       (Set Interval)          │  │ │
│Sli  │  └──────────────┘                                          │  │ │
│Sli  │  ┌Grid──────────────────────┐                             │  │ │
│Sli  │  │ Gridlength (km): [190.5]  │      ┌Levels┐               │  │ │
│Sli  │  │ True At Latitude: [60]    │      │  500 │               │  │ │
│Sli  │  └──────────────────────────┘      │      │               │  │ │
│Sli  │                                    │      │               │  │ │
│Sli  │  Name:  [New Component     ]       │      │               │  │ │
│Sli  │                                    └──────┘               ├─ │ │
│Sli  │  Legend: [                  ]                             │↓ │ │
└─┴───┴────────────────────────────────────────────────────────────┴──┘
```
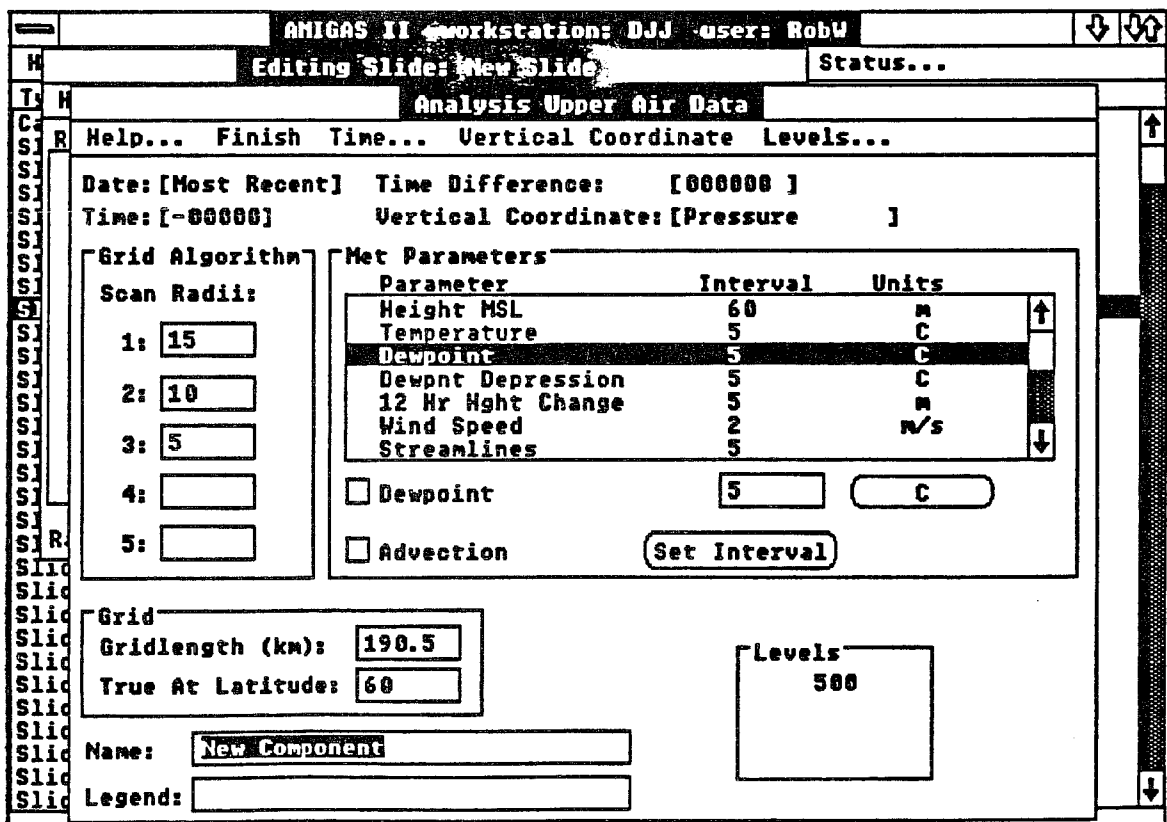
Figure 4. AMIGAS II Request Interface Analysis Upper Air Data Editor

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If there is a need for the meteorologist to create a non-scheduled product, he can do this by using the Request Interface to make an ad-hoc build request. Normally the definition for the product would have been created at a previous time, and all the meteorologist would have to do is request the product's creation. This allows a forecaster to create products which may not be of interest to all users on the AMIGAS II system.

Within the AMIGAS II system there are two types of products: public and user products. A public product is defined by the AMIGAS II administrator and would be available to all users on the AMIGAS II system. Only public products can be scheduled. User products are associated with a given AMIGAS II user. When a forecaster logs onto the system, both public products and individual user products can be viewed. This allows a user to tailor a set of products to his or her own special interests.

V. Displaying AMIGAS II Products

The primary display device for an AMIGAS II product is the meteorological workstation. The workstation provides the user with the means to view products and interact with the products for the purpose of enhancing and highlighting features of interest.

The Display Interface, which is the display software that resides on the meteorological workstation, is an operationally-oriented, multiple window environment. Figure 5 illustrates how the windowed environment of the Display Interface can be used to view multiple meteorological products on the same screen. The Display Interface gives the meteorologist the capability for displaying slides and carousels which contain various combinations of image, graphics and alphanumeric data. The meteorologist may select any number of windows and position them any place on the display screen. Interactive functions are controlled through mouse-driven facilities which include icons, pull-down menus, and dialog boxes. All interaction with the Display Interface is done with a mouse and is very easy to learn; the meteorologist needs no knowledge of the underlying operating system to operate the Display Interface.

Currently the types of interaction which can be done by the user from the Display Interface include animation, pan, zoom, resize, change display colors, and selection of the product, components and (in some cases) the parameter or attribute to be viewed. The Display Interface also allows multiple product viewing via the multiple window environment. Currently under development is a graphical editor which will allow the meteorologist to add
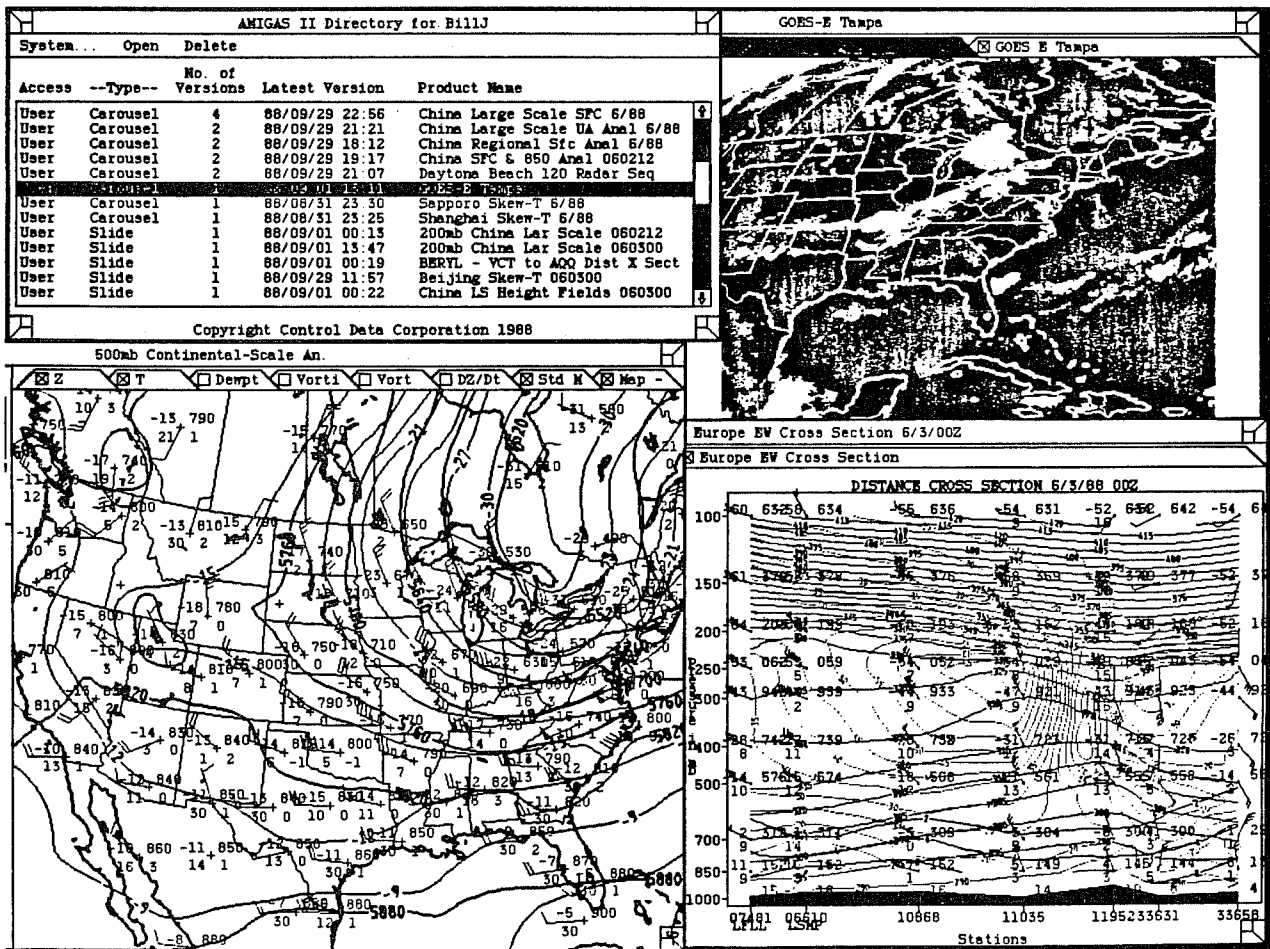

Figure 5. Example of the Display Interface Windowing Capability

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graphics to a slide, e.g. to annotate or to draw fronts, highs, lows, and weather symbols.

In addition, AMIGAS II allows the user to create the product in Computer Graphics Metafile (CGM) format. Once in CGM format, the product can be transferred to any device which is capable of translating a CGM into a displayable format. AMIGAS II incorporates a CGM translator which allows instances of AMIGAS II products to be displayed on many standard output devices including non-interactive terminals and hardcopy plotting devices.

VI. Data Aquisition

An important requirement of an operational meteorological system is the capability to ingest data from multiple data sources with multiple data formats. The AMIGAS II Data Aquisition Subsystem has been designed to accommodate this diversity and to be customized for the requirements of different sites.

Each data source has associated with it a communication method and a formatting application. The communication method is dependent on the type of device that is responsible for receiving the data. Device communication can occur over many types of communication media such as serial communication lines, an Ethernet Local Area Network (LAN), or a higher speed channel connection. The ingest software decodes the information being received and places it into the AMIGAS II database. Because of the open design of this ingest software, new data sources can be easily added to the Data Aquisition Subsystem. Currently AMIGAS II supports the ingest of GOES data along with both Doppler and conventional weather radar.

VII. Future Enhancements

The AMIGAS II system is designed

to be readily expandable to include new applications. Future features will include the ability to input and display gridded data such as model output, textual forecast generation aids, interactive skew-T and Stuve diagrams, and new data sources such as a lightning network. Because of the distributed design of the system, future system configurations would readily support a supercomputer for doing numerical weather prediction.

The AMIGAS II system will allow the user to expand on the basic set of applications by designing an extended set of applications to be integrated into the AMIGAS II system. Currently AMIGAS II provides all the underlying data services needed by the application writer. These data services include access to the observation and image data bases, access to the map string data bases, a set of mapping transformations, a library of graphics routines, and a suite of utilities needed by an application writer to successfully design and implement a new application to run within AMIGAS II. In the future a Generic Request Interface will be provided so that a new application written by a user can be integrated into the AMIGAS II product suite.

VIII. Conclusion

AMIGAS II is a platform of meteorological data processing capabilities which can ingest multiple types of data, analyze these data, and create products in response to the meteorologists' needs. Utilizing state-of-the-art user interfaces and distributed processing, AMIGAS II provides forecasters with the tools they need to interface to the vast amounts of meteorological data necessary for making operational forecasts. The system serves as a baseline capability which can be expanded and adapted to specific needs of a user. Because of its modular architecture and platform design, AMIGAS II is capable of keeping pace with technological advances in today's meteorological community.