THE METEOROLOGICAL SYSTEM METIS

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1. INTRODUCTION

The METIS system has been developed for the Royal Netherlands Airforce (RNLAF) as a computer aided meteorological system to support the work of the meteorologists in the provision of reliable short duration weather forecasts to aid in all aspects of mission flight planning. When completed in 1989, the system will consist of a number of networked computer systems distributed throughout the Netherlands. The pilot system is currently undergoing evaluation prior to the installation of the operational systems at the airbases from early 1988 on.

The system represents a novel design developed by Sigmex with the aid of the RNLAF meteorologists, and currently consists of over 12 man years of special computer software. The hardware is based on DEC MicroVAX computers and Sigmex high performance graphics equipment, although the design is such that it can be adapted and implemented on a wide range of computer equipment.

This paper provides an overview of the METIS system facilities and functions, with significant features associated with it's operational use highlighted with descriptions of the display presentations.

2. SYSTEM OVERVIEW

The concept of METIS is to provide computer assisted procedures in support of the meteorologist in providing short range weather forecasts for all aspects of mission planning. The system operates 24 hours a day, 7 days a week, carrying out assigned tasks either on an automatic basis, or manually under the control of an operating meteorologist. All of the relevant incoming weather data is collected in specially designed databases for inspection and analysis. When fully implemented, METIS will consist of a number of computer systems distributed throughout the Netherlands on a network, enabling any available meteorological data to be used throughout the RNLAF.

The meteorological organisation of the RNLAF receives alphanumeric, facsimile, and satellite data via three separate networks. The current Automatic Message Switching System (AMSS), which is linked by fixed telex connections to various meteorological centres in Western Europe, provides information to a Meteorological Autonomous Plot System (MAPS) which then produces graphical representation of the data in the form of hardcopy weather charts, upper atmosphere charts, and diagrams.

This existing system was considered outdated, and the RNLAF embarked on a long term plan to update and enhance the collection, processing and presentation of weather information. The new METIS system was proposed as both a replacements for MAPS and a computer aided analysis system for meteorologists. The first phase is now installed, with extensions to METIS in the areas of radar and satellite information processing, and upgrading of the front-end AMSS system, now being implemented.

Through the AMSS interface, the system receives weather information from over 6000 sources in the Northern hemisphere. Typical examples of this data are :

- Landstation and shipstation synoptic weather reports
- Military aviation weather reports (routine and special)
- Upper level pressure, temperature, humidity and wind reports
- Grid point values (Bracknell, ECMWF)
- Local condition reports
- Trajectory bulletins (air flow)
- Instability indices (Boyden, Rackliff, MOD.Jefferson)

All of the incoming data is stored both in it's original (ASCII) format, and, after verification, as coded elements in the central Point database. This data is held on-line for a time period of up to 48 hours for analysis, plotting, and querying. Information updates or corrections are stored in their original format in addition to updating the relevants items in the database.

In addition to the Point data, a background reference is provided by a graphic database containing digital map data. This consists of 220 degrees of the northern hemisphere digitised as latitude/longitude coordinates at approximately 1 km resolution. Split into individual layers, features such as height contours, rivers, lakes, and national frontiers are represented as backgound information. The features can be individually switched on and off, and a variety of data overlays are possible.

Two further databases exist within the system associated with the process of forecasting. An analytical database provides 2D contours of specified variables, while user work areas contain 'Products' providing the meteorologists partial or finished analysis of any situation.

A METIS Product defines a window into the database. The associated data is extracted and presented in terms of a plot model which can be dynamically changed e.g. surface data can be replaced by upper air data or grid data for the specified time window. Any analysis can be included for the Product time and stored as a separate display layer.

The Products are presented for editing, hardcopy and combining/comparing on the presentation screens. Data manipulation functions are available for controlling the extraction and presentation of data, while annotation functions exist for adding significant information to the basic data. In addition, windowing operations on the background map enable specific or global areas of interest to be shown.

A feature of the system is the use of high performance intelligent graphics generators closely coupled to the local database central processor. By combining multiple screen output (graphics and text), with single tablet and keyboard input, the meteorologist has been provided with an optimised man/machine interface ideally suited to the analytical nature of weather forecasting. The system is command driven with a choice of input methods and levels for users of different experience. On-line help and prompting is available, with immediate response to operator requests. Complete flexibility is available to the meteorologist to define any representation in a Product from the available data.

The manual mode of operation at the workstation is supported by the automatic scheduled production of maps and associated weather charts, with alerts, warnings and alarms produced on the exceeding of some user defined thresholds. In the latter case, the system can be programmed to highlight and/or pan to station in times of particular interest.

3. HARDWARE COMPONENTS

As has already been stated, the complete METIS system consists of a network of individual computer systems distributed throughout the Netherlands. Although there are slight variations in the hardware components, each computer system provides the same facilities and is equipped to carry out all available functions. (The principle difference is the number of meteorological workstations supported.)

A typical system is configured as follows :

- central computer of DEC MicroVax II type with 16 Mbytes of memory, 456 MByte Winchester disc (for local files storage), and 95 MByte cartridge tape (for software installation and archive)

- communications interfaces via serial asynchronous Multiplexers (for local peripherals), and 16 bit parallel interfaces (for the graphics controllers)

- local peripherals of system console, A4 monochrome laser printer (for listings, charts, diagrams, etc.), and A0 pen plotter (for colour hardcopy of large charts, etc.)

- alphanumeric VT220 terminals (for database information query and update)

- fully integrated meteorological workstation consisting of dual screen 1448x1024 resolution Sigmex 6264 graphic subsystems, VT220 alphanumeric terminal, and A1 size data tablet

Most systems are equipped with two meteorological workstations, although both one and three workstation versions are being installed. The use of the intelligence and local processing capability of the Sigmex graphics units allows the generation of the complex displays to be off-loaded from the MicroVAX, thereby enabling a flexible cost effective configuration to be based on the same central processor.

4. SYSTEM FUNCTIONALITY

As has already been stated, the METIS system collects weather data on a 24 hour, 7 days a week basis for use by the meteorologists. Access to the available data has been made particularly flexible, with a variety of screen presentations available in alphanumeric or graphic form, and paper hardcopy in a range of sizes. The heart of the system is this presentation functionality, and this will be described in this section.

The alphanumeric terminals are used to display and manipulate the weather data in both it's raw (incoming) format, and the internal Point data format which already contains some interpretation. Data can be viewed and corrected if appropriate, and database information relating to particular stations or conditions can be queried and displayed.

The graphics presentation is the most comprehensive, enabling a combination of Products (user definable views of tha data) to be displayed on one or both of the screens. The split screen facility allows division of either screen for display of up to 4 different Products, while Products can be combined for comparitive evaluation in the same display.

The Product displays are built from user defined layers, typically presented against a background map and latitude/longitude grid. This map data (itself consisting of layered features), is a stereographic projection of the Northern Hemisphere held locally in the graphics generator. Windows of any size and rotation may be defined on the total map area. Within the system, 16 standard areas are defined, although it is possible to dynamically window in or out to change the scale of the background map. The operator can pan in any of 8 directions, or to any point, or to any specified weather station.

Overlaying the map data is the weather data selected for a particular time window, and displayed according to a 'plot model'. This plot model defined by the meteorologist determines what is extracted from the database and how it is displayed. The plots remain a constant size and stay upright during window operations. The number of plots displayed is dependent on the background scale (i.e. number of plots in the geographic area), and the size of plot. The system will ensure that the plots displayed do not overlap. The number of plots decluttered is notified to the operator, and these may be made visible by scaling in or including fewer data elements to give smaller plots.

The form and content of the station plots is dynamically selectable using screen pop-up menus. The plots are then redrawn from the database taking into account the plot size and background scaling. The meteorologist can force certain stations to be displayed, and the system will rearrange the display accordingly. Plot models can be stored and edited to create new forms. International symbols for weather type , cloud type, cloud cover, wind speed, etc. are used for the station display, and stations generating warnings may be highlighted.

The four basic presentations that are available are Surface plots, Upper Air plots, Grid overlays, and User defined plots (using the plot model). As examples, in addition to individual station plots, data may be plotted simultaneously from more than one level (e.g. temperature at all standard levels), or plots from up to four different times can be drawn against each station.

Synoptic data may be passed to the system as a 2-D grid of points and values, (eg. public domain data from Bracknell, ECMWF). This data can be displayed as a separate presentation layer in it's raw state or contoured in a user specified manner. Interpolation of irregular grids for contouring (such as weather station data) can also be accomplished and displayed as an overlay with automatic smoothing and annotation.

Annotation is built up from standard graphical primitives, symbols, and text strings, and incorporated in another layer of the presentation. This facility is provided by a sophisticated interactive graphics editor allowing control over the display attributes (line type and thickness, colour, fill area pattern, etc.). Editing functions are also provided to manipulate the presentation (eg. giving control over feature visiblity).

Additional facilities enable the provision of various graphs associated with the stored data. One example is the plotting of a vertical slice of the atmosphere at a given station as temperature against pressure. Adiabatic and isothermal lines are presented and the meteorologist can interrogate the available information. Climatology displays are provided as histograms showing such items as maximum/minimum temperature, humidity variation, average precipitation, over various time periods for a given station. Polar diagrams for wind strength and direction for a given month and station are also provided.

The METIS system was also designed to support the traditional plotting of Products, either directly specified from the meteorological workstation, or as part of the automatic functioning of the system. Using the device independence of the GKS software, any graphical presentation can be plotted on the A4 or A0 plotters. Maps or charts can be scheduled for production at any specified time, and plotting of Products can be triggered by incoming data type or content.

5. SUMMARY

The system as described is the result of many years study and planning by the RNLAF to define the requirements of a meteorological workstation. Although in use for a comparatively short period of time, the benefits are already apparent, but principally can be stated as :

- information is collected and stored in one central database enabling faster and more versatile access to the available data

- computer assisted warnings and alerts can be programmed with immediate visual feedback

- flexible generation of displays and hardcopy for briefings, reports, etc.

The METIS programme was designed as a phased approach to the practical problems associated with the replacement of out of date equipment, while providing operational meteorologists with state of the art computer assistance in their task of forecasting and briefing for flight planning. With the basic functionality established and installed, the system is now being optimised and extended to include the processing and integration of radar, facsimile and satellite data for use within the METIS database. Eventual integration into a total Command and Control System will enable weather information to be made available for all aspects of logistics planning.