

THE UK METEOROLOGICAL OFFICE MESOSCALE INTERACTIVE GRAPHICS FACILITY

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1. INTRODUCTION

The Mesoscale Graphics Facility (MGF), Golding (1990A), has been developed over many years; it has evolved from a series of small independent programs, which were created to display Mesoscale Model forecasts (Golding 1990B), into a single large program, which provides real time tools for interaction with all of the data which is referenced by the *Mesoscale Directory*. As far as is practicable, it is written in standard Fortran and GKS (approximately 50,000 lines of code). The adoption of a modular design makes the program flexible and allows the code to be easily updated. The system is menu-driven, but the form in which the answers are provided depends on the mode in which the program is running.

The MGF has four top-level access routes: the general access route, which provides a highly flexible approach to the interactive manipulation and display of data, is used as a research tool; the Standard Forecast Products, which provides more directed interactive access to a more restricted set of observation and model products, is used operationally by the forecasters in the Central Forecast Office (CFO); batch access, which allows predetermined hardcopy output to be produced in the background, is used to produce operational forecast charts from the Mesoscale Model; the Interactive Mesoscale Initialisation (IMI), Wright and Golding (1990), which allows the interactive generation of the initial conditions from which the Mesoscale Model is run, is used operationally by a forecaster in CFO.

2. THE DISPLAY STRUCTURE

The MGF can be run on a variety of different graphics terminals which are linked to the mainframe at Bracknell (an HDS EX100), with the exact form of interaction and the display structure varying accordingly. Here, only the structure of the display on the IBM 5080 graphics terminal, the 'flagship' machine for the MGF, will be described in detail; menu selection on the 5080 terminal is carried out using a mouse and tablet.

The *Display* for the 5080 terminal, shown in fig. 1, consists of a number of *Pictures* (maximum of 19) and the *Main* and *Marginal Menus*; only one picture is shown in fig. 1

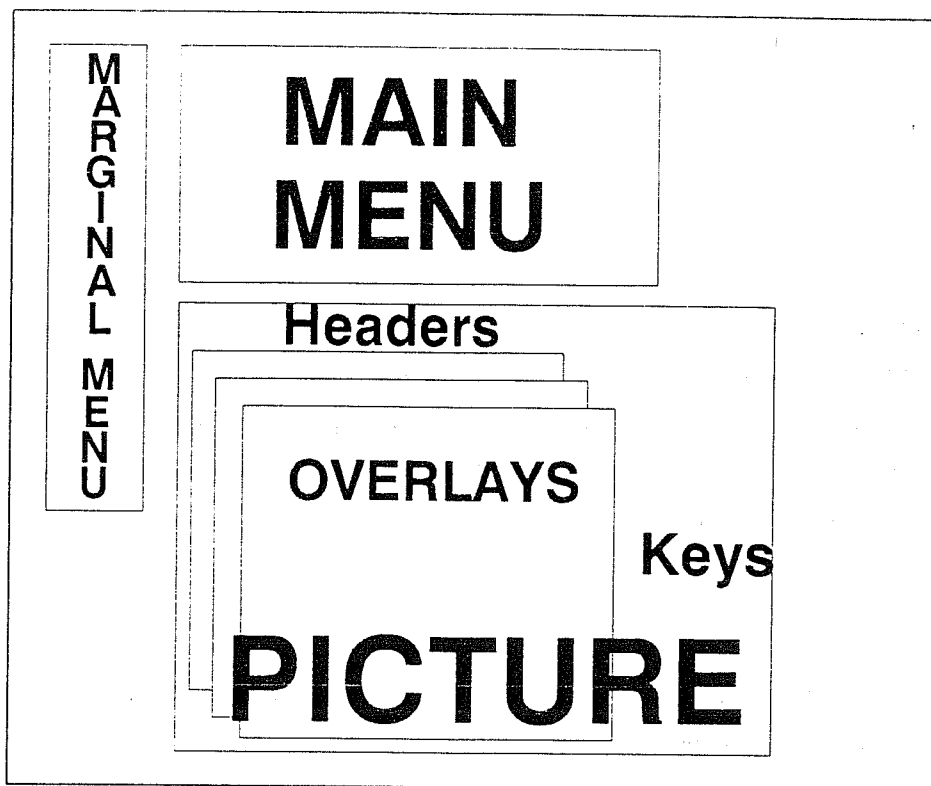


Fig. 1 The Display structure on an IBM 5080 graphics terminal

for simplicity. In turn, Each Picture consists of a number of *Overlays*, and each Overlay contains a single *Element* (eg screen temperature, total cloud cover) and has an associated *Header* and *Key*; the Element will be derived from one or more *Fields* of data. The Main Menu consists of a list of the current options, and will depend on the operation which is currently being performed. The Marginal Menu consists of a fixed list of options which allow general interaction with the current Display.

Most of the other types of graphics terminals on which the MGF can be used do not allow the simultaneous display of Pictures and the Menus; this means that the Marginal Menu is not available, and the scope for interaction is reduced.

3. DATA VISUALISATION

Since the general access route is the most flexible way of using the MGF, it is this approach which will be described here, although many of the aspects discussed apply equally well to the other access routes.

3.1 Accessing the data

The datasets containing the data to be visualised are allocated and subsequently accessed using the information held in the Mesoscale Directory, a data dictionary which contains a limited amount of information on up to 200 datasets. These

datasets are currently divided into six types:

1. Observations
2. Fields
3. Images
4. Ascents
5. Graphics
6. Compressed fields

The data available for display includes surface observations (type 1), radiosonde ascents (4), Sferics data (3), radar imagery (3) (FRONTIERS and COST-73) and Meteosat satellite imagery (3) (infrared and visible), model data (2 or 6) from both the Mesoscale Model and the Met Office Regional Model and a series of map overlays (5).

3.2 Display options

The display format for the initial, and subsequently any additional or new pictures is selected from six possibilities:

1. Map format charts (x-y)
2. Time Series (t)
3. Cross-sections (x-z)
4. Vertical profiles (z)
5. Time-height sections (t-z)
6. Traverses (x)

Depending on the display format and the data type (see section 3.3), a default display type will be assigned to each Element, but a different display type may be selected from the following list if required (note that not all display types are appropriate to all data types and display formats):

1. Spot values
2. Contours
3. Colour slicing
4. Symbols
5. Vectors
6. Differences
7. Vertical axis graph
8. Horizontal axis graph
9. Tephigram
10. Station plot
11. Hand drawn

It is also possible to change other display attributes such as colour, contour

spacing, shading, character size etc.

3.3 Retrieving the data

After selecting the display format, it is necessary to specify the location; this may be done on screen with reference to a map or by specifying coordinates. The selection of location is very flexible; for example, a cross-section can be any length and orientation, and its depth between any two heights.

To retrieve the data, it is necessary to uniquely define the data required. This is done by selecting the dataset description, dataset time, variable, level and time from a series of menus; not all of these selections will be appropriate to any particular Element, but menus are presented as required. The requested Element need not be one which is present in the dataset; if it is not present, the required Fields will be read into memory and the Element derived; a large number of diagnostics can be calculated on a variety of different surfaces (eg Model levels, pressure, potential temperature).

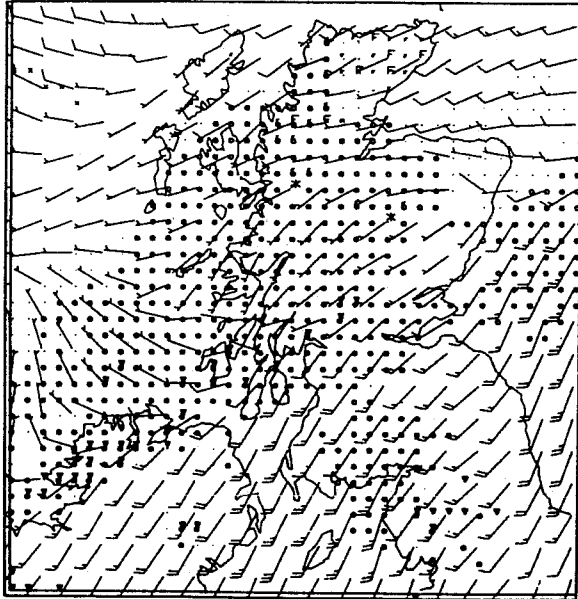
3.4 The display menus

The Main Display Menu, the top-level menu for display purposes, provides the following range of options to change the data and the display, either directly or through other menus:

1. Display picture
2. Animate pictures
3. Obtain hardcopy
4. Add new overlay
5. Start new picture
6. Modify picture
7. Change overlay characteristics
8. Obtain diagnostics
9. Modify data
10. Inspect/modify dataset characteristics

It is worth describing briefly what these different options do. Having specified the display format and retrieved the data, option 1 initiates the drawing of the Picture(s). If more than one Picture has been set up in the same place, then option 2 allows these Pictures to be displayed in sequence to provide animation. Option 3 allows the Pictures on the screen to be copied to either Calcomp, a monochrome vector display on 35 mm film, which can in turn be printed to paper (fig. 2 shows an example), or to a 4-colour printer. New Overlays can be added using option 4, and new Pictures started using option 5. Option 6 allows the Picture characteristics,

DT 06Z 07/01/1992 VT 12Z MSFC.PR WV AT 10.00M AG
 DT 06Z 07/01/1992 VT 12Z MSFC.PR PR CONVECTIVE
 DT 06Z 07/01/1992 VT 12Z MSFC.PR DDDF AT 10.00M AG
 DT 06Z 07/01/1992 VT 12Z MSFC.PR PR GRID-SCALE



DT 06Z 07/01/1992 VT 12Z MSFC.PR C
 DT 06Z 07/01/1992 VT 12Z MSFC.PR M
 DT 06Z 07/01/1992 VT 12Z MSFC.PR RH
 DT 06Z 07/01/1992 VT 12Z MSFC.PR PG.T

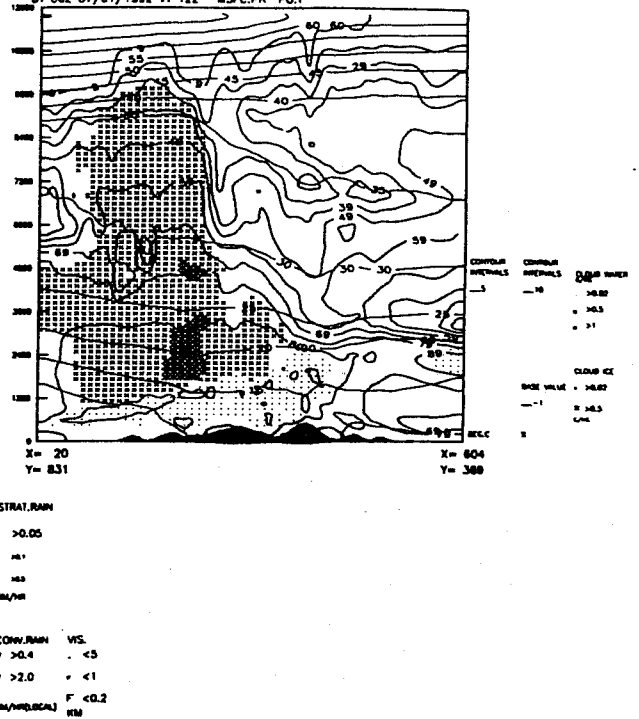


Fig. 2 An example of hardcopy produced from Calcomp; a plan and cross-sectional view of a front (in the cross-section, the symbols represent cloud water/ice)

such as the domain of the Picture, to be changed. Option 7 allows changes to the source dataset, variable, level, time, display type, colours, contour spacing etc. Virtually any change to the Overlays can be achieved using this option; it is often the quickest way to retrieve new data. Option 8 provides the mean, maximum and minimum values for an overlay within an area selected on the screen. Option 9, which allows the modification of the data Fields, is described in section 4. Option 10 allows changes to be made to the datasets which have been allocated through the Mesoscale Directory; it also allows fresh or additional datasets to be allocated.

The Marginal Menu, a fixed list of options which is displayed all the time, allows general graphical changes to be made quickly. The options are as follows:

1. Hide/show overlay(s) or picture(s)
2. Delete overlay(s)
3. Zoom/unzoom picture(s)
4. Move overlay(s) or picture
5. Change priority of pictures
6. Sketch

The first two options allow the temporary or permanent removal of Overlays or the temporary removal of pictures, which can be used to clarify the display. Option 3 enables one or more Pictures to be zoomed, to allow the closer inspection of a particular region of interest. Option 4 allows Pictures to be repositioned on the screen, or Overlays to be moved from one Picture to another or moved to start a new Picture. Option 5 can be used to adjust which Picture is 'on top' when two Pictures overlap. Option 6 allows the user to add his or her own annotations to a Picture in the form of a sketch Overlay; a menu provides a selection of meteorological symbols which are positioned on the screen using the mouse.

4. DATA MODIFICATION

In addition to data display, the MGF allows data modification; the data Field used to generate the element in the overlay can be changed, thus changing the displayed overlay. This modified Field may be written back to a dataset, for more permanent retention. This is used extensively in the Interactive Mesoscale Initialisation in a fairly directed way, but a slightly more general set of modification options are available in the general access route, which permits almost unlimited data experimentation. First the set of points to which the modification is to be made is selected, then the type and magnitude of the change.

The method of selection is chosen from the following self-explanatory menu:

1. Single point
2. Line
3. Area
4. Full area
5. Same as for last modification
6. Add to existing area
7. Area covered by values in a range in any stored field
8. Inverse of area last selected

The actual point/line/area/etc is then selected on screen using the mouse; for option 7 the stored Field and the range of values are also selected.

The type of change is chosen from the following menu:

1. Set value
2. Apply correction
3. Multiply by a factor
4. Copy values from another field or image
5. Add values from another field
6. Analyse specified values

7. Smooth data
8. Move data
9. Draw contour

The appropriate values for the modification are entered; for option 1 this is a field value, for option 2 a correction, for option 3 a scaling factor, for option 7 a half-width in gridlengths and for option 8 translation coordinates. Options 4 and 5 require another Field which is already in memory to be selected from a list. Option 6 requires either the selection of the positions and values of some user-specified 'observations' or the selection of an observation dataset. Using a mouse, option 9 allows the user to draw a contour, which is then 'assimilated' into the Field.

There are also a small number of more powerful, directed options which allow changes to be made to more than one Field at a time: the modification of multi-level cloud Fields using precalculated cloud top/base/cover/profile information; the copying of radar rainfall values into a Mesoscale Model precipitation Field; the insertion of a hydrostatically and geostrophically balanced pressure perturbation; the modification of the low level temperature and humidity fields to represent a cold fog; and the identical modification of a number of records in a dataset.

5. CONCLUSIONS

The Mesoscale Graphics Facility provides a highly flexible tool for the visualisation of data associated with the UK Meteorological Office Mesoscale Model. In addition to display, the MGF allows data to be modified in a variety of ways. The general access route provides the most flexible access to the MGF, but other more specialised access routes, such as the Interactive Mesoscale Initialisation and the batch access, have been developed for specific tasks. The modularity and the use of standard Fortran and GKS make the MGF portable, and it has already been implemented on a Sun workstation.

References

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