METEOROLOGICAL APPLICATIONS GRAPHICS INTEGRATED COLOUR SYSTEM (MAGICS/GKS)

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Summary: This paper describes the graphics software package MAGICS by showing examples of the graphical output from the package. There are only a few of the examples given with this paper, mainly due to the fact that the original colour examples cannot be portrayed properly in black and white.

1. INTRODUCTION

The Meteorological Applications Graphics Integrated Colour System (MAGICS), developed at the European Centre for Medium-Range Weather Forecasts (ECMWF), is a software system that performs a major portion of the general meteorological graphics applications at the Centre.

It was designed to conform to and use new meteorological and graphics standards, e.g. GKS, GRIB, BUFR. It makes use of modern contouring methods (CONICON) and enables users to take advantage of colour graphics and device independence. The object of this talk is to describe the main features of MAGICS in terms of plotted output. The features described are: DATA INPUT, MAPPING, CONTOURING, SHADING, WIND PLOTTING, TEXT FACILITIES, LEGEND PLOTTING, OBSERVATIONS and SPECIFICATION GROUPS.

1.1 Data input

Data to be plotted can be presented in a number of ways, depending on its type: contour fields, wind fields or observations.

A contour field can be presented as either a rectangular array of grid point values or in GRIB code format. GRIB code can be presented as either an external file or as a one dimensional data array.

A wind field can be presented as either a pair of rectangular arrays of grid point values or in GRIB code format. The pair of rectangular arrays can contain either U or V velocity components, or speed and direction components, of the wind. GRIB code can be presented as either an external file or as a pair of one dimensional data arrays.

Observation fields can be presented as either an input file or an array. The array can only contain a single observation. Data for observation plotting must be in the ECMWF Reports Data Base (RDB) format. A future release of MAGICS will permit data to be presented as WMO standard BUFR code.

1.2 Mapping

Mapping is the placing or projecting of coastlines, grids and data onto the user's plotting area. Two types of projections are catered for in MAGICS, cylindrical and polar stereographic. It is not necessary for users to extract the required area before passing data as MAGICS can perform this function and the conversion to polar stereographic, if required.

It is also possible to pass the precise data for the requested area in the projection required.

1.3 Contouring

MAGICS contouring is based on CONICON, which is designed to draw the contours of continuously differentiable fields. The contours themselves consist of pieces of conic sections (ellipses, parabolas, hyperbolas) joined as continuously differentiable functions. Thus smoothing is never needed.

The contours are calculated in the user's input field and then projected onto the required area, for both cylindrical and polar stereographic. This ensures that no further interpolations are required.

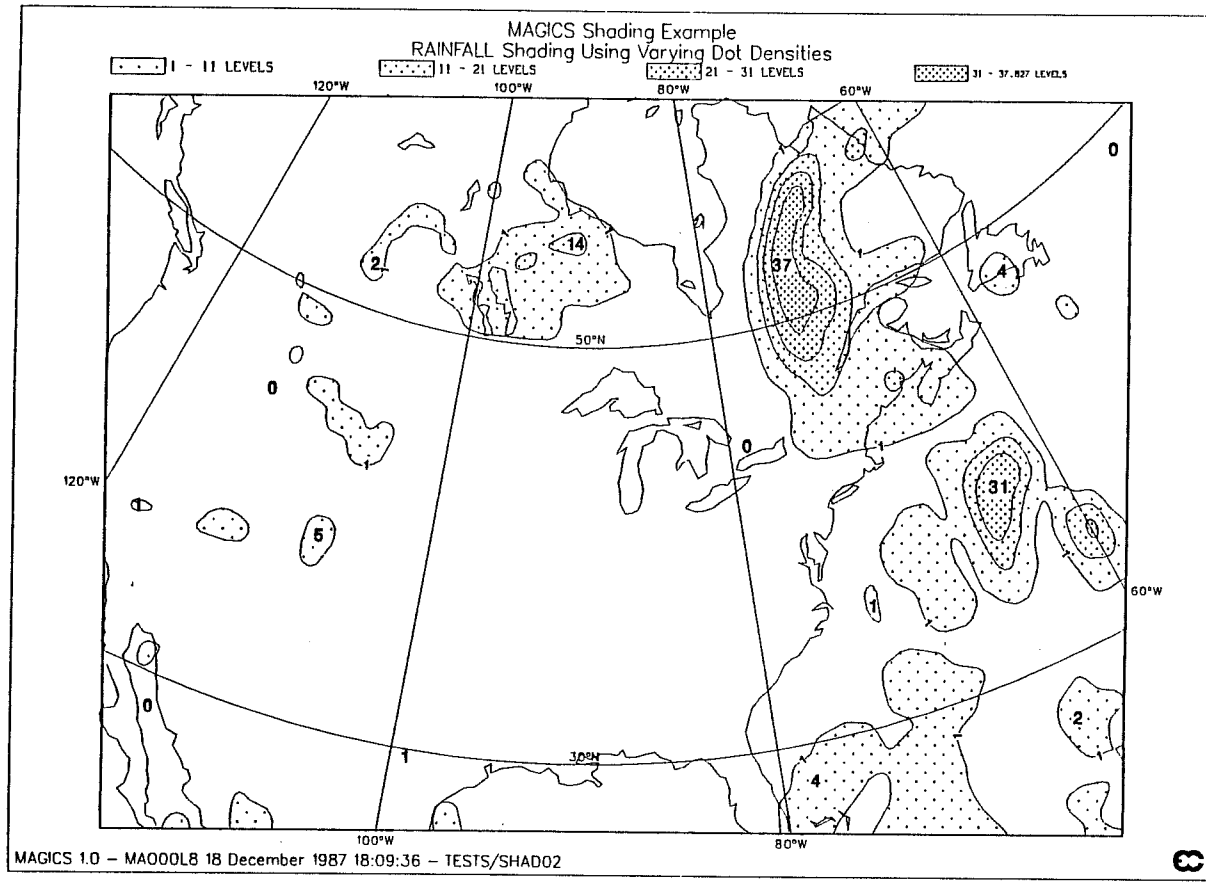

Figure 2: Shaded Contours of Rainfall

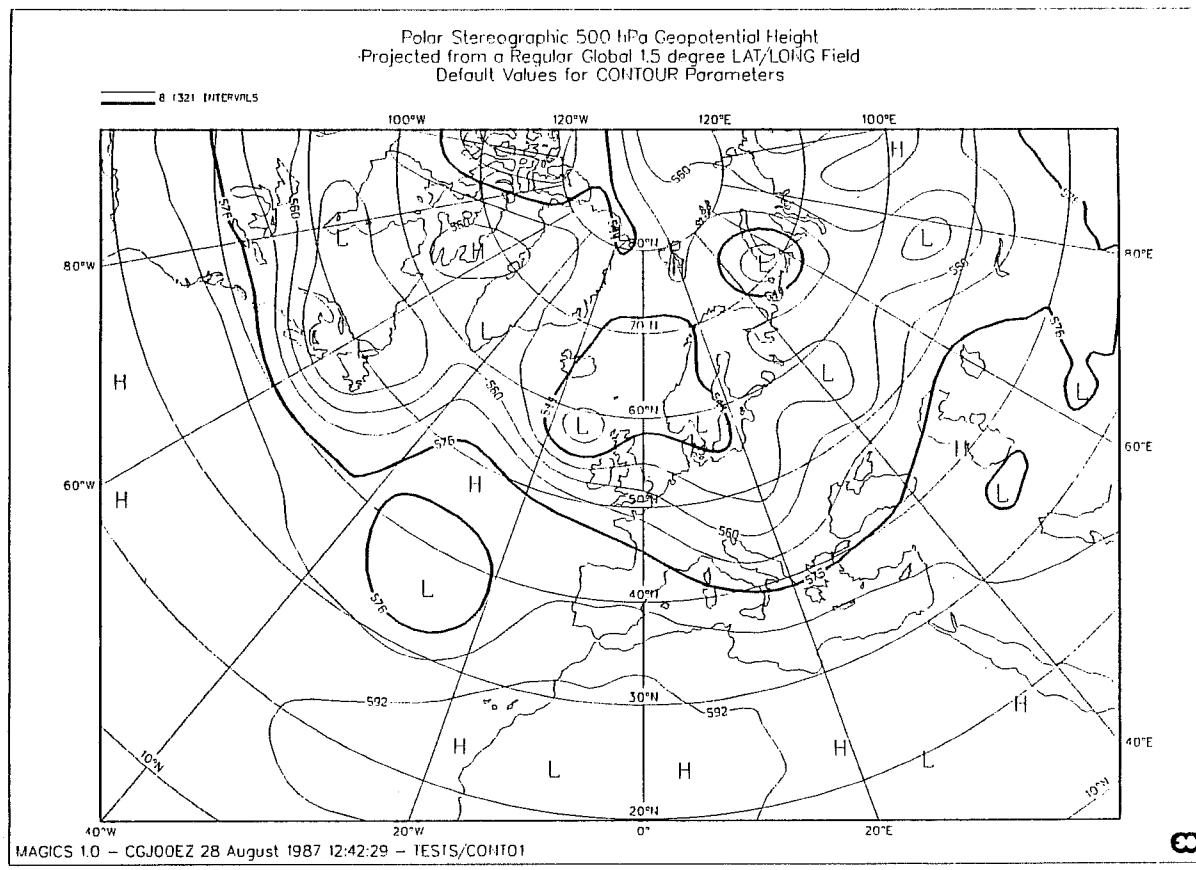

Figure 1: 500 hPa Geopotential height countours

For the user interface, emphasis has been placed on simplicity, making it easy for the user to define the contour levels required and the attributes to draw them with. Users have full control over plotting of labels, highs and lows as well as the thickness and colour of contour lines. Another feature of MAGICS contouring allows users to plot the grid point values on their exact location, either on their own or overlaid on contour lines. See Fig. 1 for contouring example.

1.4 Contour shading

Contour shading allows users to shade the areas between contour levels with varying intensities, patterns and colours. MAGICS parameters exist to control all the features and options in shading and their default values should ensure that, for most plots, a reasonable shaded plot can be achieved without having to set most of the shading parameters. Shading may be requested with or without contour lines.

Shading enables more information to be plotted on a map without causing confusion. It is useful for highlighting specific details, e.g. negative temperatures, rainfall above 20 millimetres etc. Shading can make a map more easily understood, particularly when used with MAGICS legend facilities. Fig. 2 shows an example of MAGICS shading.

1.5 Wind field plotting

Wind fields may be presented to MAGICS as U and V velocity components, as speed and direction components or as GRIB code data. They may be plotted in one of four ways:

1. Wind arrows; where the wind is represented by a vector whose length is proportional to the speed of the wind.

2. WMO standard wind flags; where a wind flag is represented by barbs and solid pennants.

3. Streamlines; these are lines that are everywhere tangential to the instantaneous wind vectors.

4. Isotachs; which are contour lines of equal wind speed.

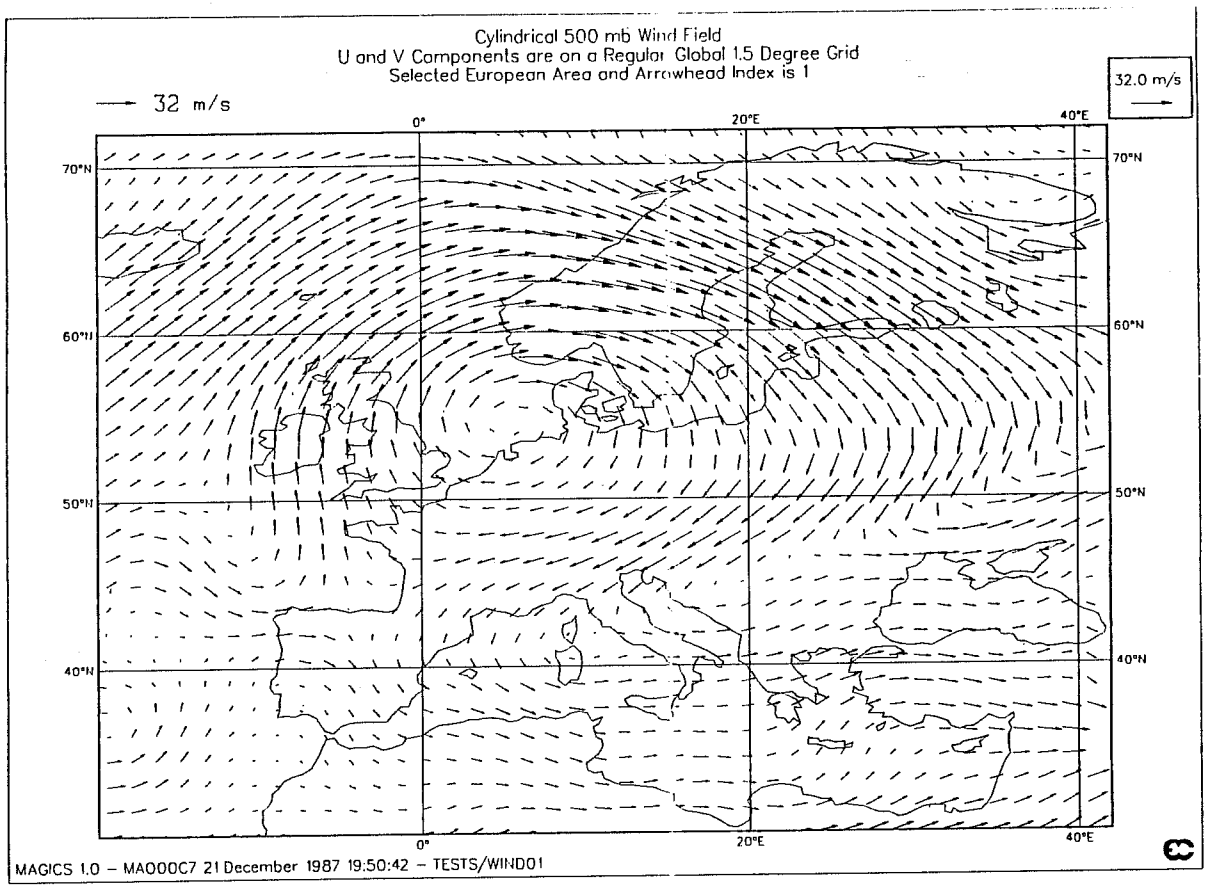

Figure 4: 500 hPa Wind Arrows

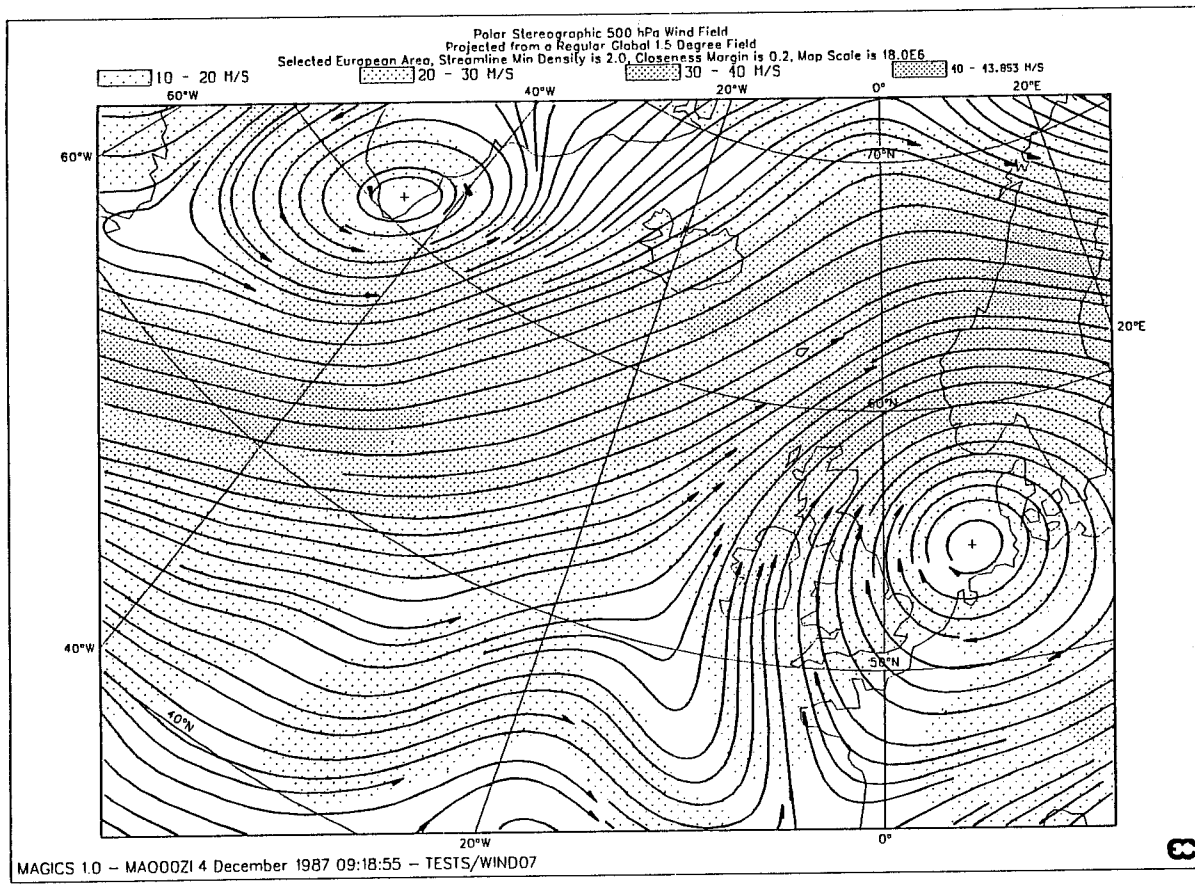

Figure 3: 500 hPa Streamlines and Isotachs

Wind related parameters, which are generated from differential properties of the wind field, may be plotted using normal contouring facilities, e.g. Divergence, Vorticity, Stream Functions and Velocity Potential. The use of colour enables the plotting of coloured wind arrows where the colour of the arrow can represent the relevant temperature, humidity etc. See Figs. 3 and 4 for wind plotting examples.

1.6 Text facilities

MAGICS allows users to plot a block of text anywhere within the user's page. A text block consists of a number of text lines, up to a maximum of ten lines, and may be positioned automatically by MAGICS or specifically by the user.

Facilities exist for plotting integer, real and character values, the necessary type conversion being done by MAGICS. It is possible to plot the values of any MAGICS parameters in a text line.

Users have full control, via MAGICS parameters, over all aspects of text plotting, such as colour and style, as well as the height of text lines and the spacing between lines.

1.7 Legend plotting

MAGICS legend facilities enable users to annotate their plots. For contouring, attributes like style, colour, and thickness are associated with a text, describing the relevant contour interval used in the plot. Shading legend entries consist of a sample of each shading pattern used in the plot. The angle of the shading dots and the dot sizes, colours and distance apart are exactly as they are plotted on the main chart.

For wind plotting, the shape and length of arrows are associated with a text which can describe the wind speed. Also, wind arrow colours may be associated with a text to describe the significance of the colours. Wind flags, plotted each time in the legend with a full barb, are associated with a text which describes the wind strength.

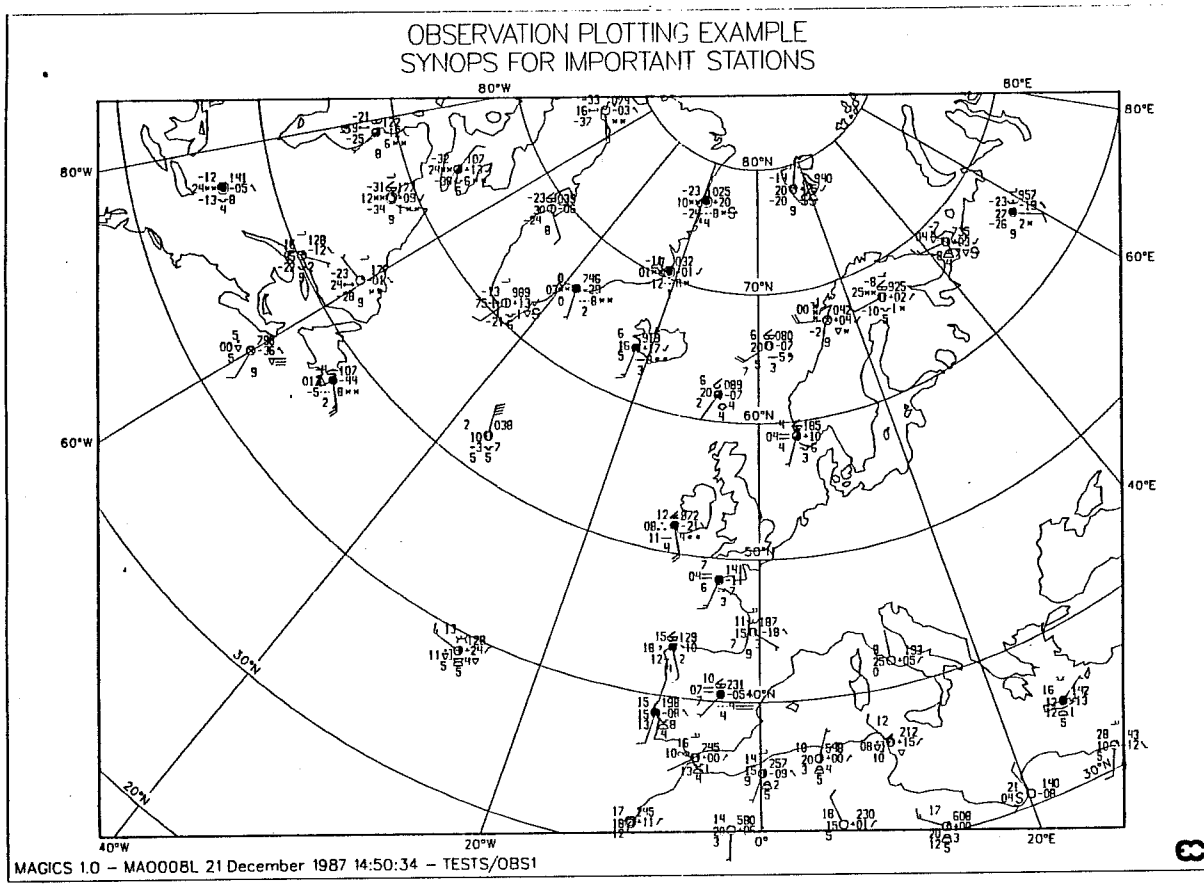

Figure 6: Synoptic Observations

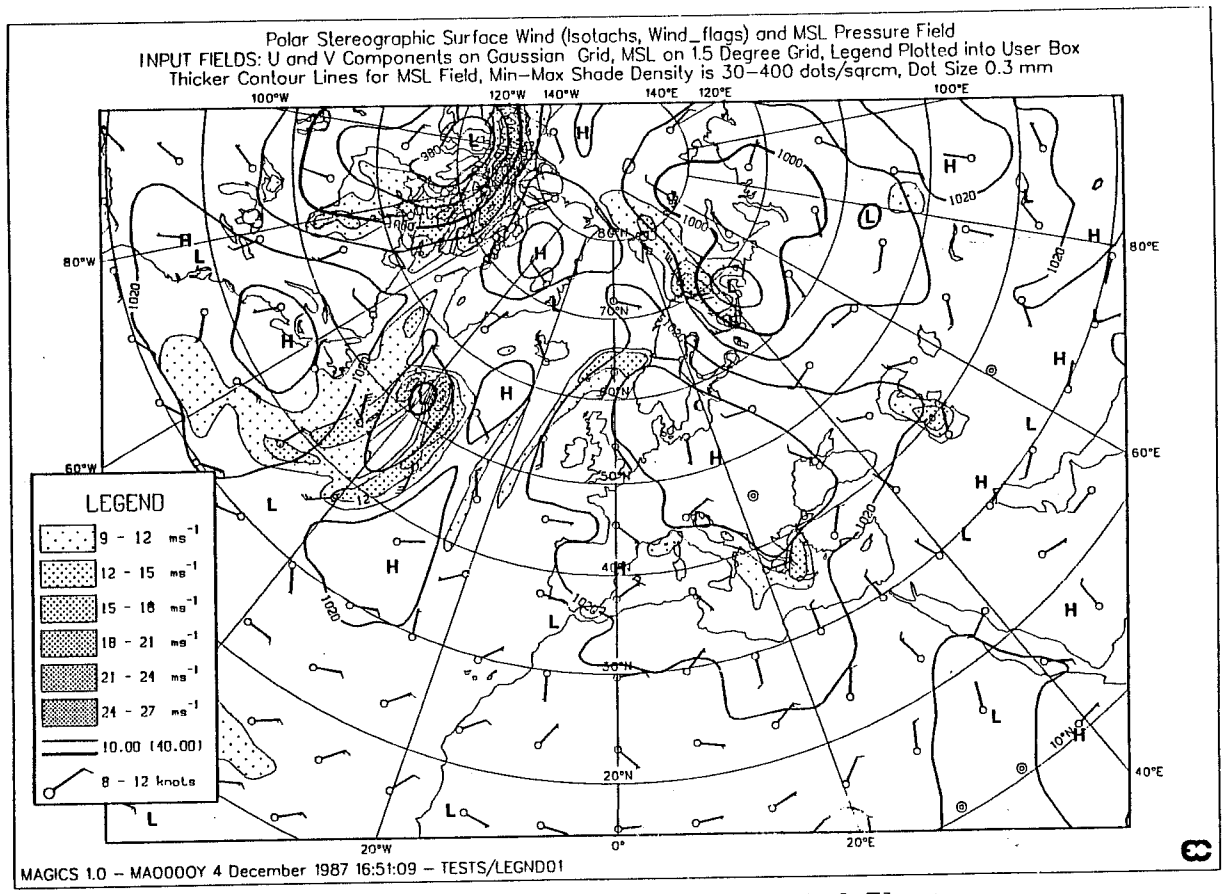

Figure 5: MSL Pressure and 10 metre Wind Flags

The legend entries are plotted into an area known as the legend box, each legend entry consisting of three distinct parts: symbol, automatic text and user text. The user has full control over the positioning of the legend box, the number of legend entries and the way entries are plotted within the box. All figures, except figure 6, have examples of legend plotting.

1.8 Observation plotting

Observation plotting allows for the plotting of all observation types, i.e. SYNOP, AIREP, SATOB, DRIBU, TEMP, PILOT and SATEM. At present, observational data for plotting must be in the ECMWF Reports Data Base (RDB) format and may be presented to MAGICS in the form of an input file or in an array. An array may be used if only one observation is to be plotted. A future release of MAGICS will permit observations to be presented as WMO standard BUFR code.

The user has full control over the type, number and size of the observations to be plotted. It is possible to plot only the positions of observations. The amount of meteorological information plotted may also be controlled by the user. Figure 6 shows observation plotting.

1.9 Specification groups

A MAGICS specification group consists of a set of one or more MAGICS parameter values.

Users may request MAGICS to save, retrieve or delete specification groups in memory. It is alo possible to save and retrieve specification groups in a user file. If required, the user may alter this file by using normal text editors. MAGICS can read specification groups from a user file, which has been written by MAGICS or by the user.

Specification groups are useful when writing MAGICS application programs that produce, for example, a predetermined sequence of plots. Users can predefine and save specific groups of MAGICS parameters that are used for each picture in the sequence. They simplify programming and make programs more readable.

1.10 Elements of MAGICS design

1. Small number of Fortran callable subroutines.
2. Comprehensive list of keywords called MAGICS parameters, e.g. CONTOUR_LINE_COLOUR, MAP_COASTLINE_RESOLUTION.
3. This method allows a lot of flexibility.
4. The parameters are plain language and, therefore, easy to remember.
5. The parameter list can easily be extended.

1.11 MAGICS subroutines

1. ACTION routines.
2. PSEUDO-ACTION routines.
3. PARAMETER SETTING routines.
4. ENQUIRY routines.

1.12 Joint MAGICS/GKS project

MAGICS is currently being converted to being GKS based. This is a joint project with 12 of the ECMWF Member States. The conversion should be complete early in 1988, when the Member States participating will receive copies of the package. Also in 1988, CRAY and CYBER NOS/VE versions of MAGICS/GKS will be installed at the Centre.

1.13 MAGICS documentation

1. MAGICS REFERENCE MANUAL contains full details of all the concepts.
2. MAGICS USER GUIDE contains a comprehensive set of examples.
3. MAGICS POCKET GUIDE contains a summary of MAGICS, diagramatically illustrated.