GRAPHICAL FACILITIES AT THE IRISH METEOROLOGICAL SERVICE

by

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1. Introduction

The Irish Meteorological Service has been using pen plotters, for the plotting of charts and the contouring of numerically produced forecasts, for the past 18 months. The plotters were purchased two years ago and, after an exhaustive investigation of the various possibilities open to the Service, two Calcomp 960 offline pen-plotters were chosen.

Pen plotters, rather than electrostatic plotters, were chosen because one of the main requirements in the specifications was for a plotter that could plot SYNOP reports on pre-printed stationary. Electrostatic plotters were investigated but were considered unsuitable because (a) the resolution was not good enough, (b) pre-printed stationary could not be used (nor could a background be drawn in a different colour to the main plot), and (c) the special paper used in an electrostatic plotter was incompatible with the use of a pencil and eraser by the Forecaster (in particular pencil lines, once drawn on the paper, could not be removed without destroying the plot).

The decision to go for an offline system was prompted by the requirement that it should be possible to run the plotters (for the plotting of SYNOP and upper air reports) off a PDP-11/40 without putting too large a strain on the PDP. The Calcomp 925 tapedrive/controller, which was chosen, contains a microprocessor which can be pre-programmed to draw the Meteorological Symbols. This programming has since been carried out with the aid of Calcomp.

The Computer system consists of a DEC-2050 mainframe with 256k words of memory front ended by two PDP-11/40's processors (See Fig.1). The mainframe is used for Numerical Weather Prediction while the PDP-11's handle communications (including the link to ECMWF). There are two PDP-11's to provide backup. At present all the graphical programmes are run on the mainframe but a graphics system on the PDP's is under development.

2. Software

The software has been written to be as portable as possible since the graphics system is still under development and it is intended to add further hardware devices in the future. All routines (except the SYNOP plotting routines which use the special features of the Calcomp 925 controller) are written in terms of a standard graphical interface consisting of just three routines via. SETPLT, ENDPLT and MOVE. SETPLT initialises the plotting, ENDPLT terminates the plotting, and MOVE draws lines. All characters are defined by software (using calls to MOVE) and at present the text plotting routine (called PLTTXT) contains upper and lower case Roman letters, Irish letters, and Greek letters, as well as the usual punctuation marks, numerals and a selection of mathematical symbols. One great advantage of this software approach is that it enables the user to clip individual letters using a standard set of clipping and windowing routines.

The following packages have been written (or converted) to use this interface:

PCONTR :The main contouring library. This package allows the user to contour data specified on a regular rectangular mesh. There are also routines for gridding data which is not specified on such a mesh and finally there are routines for producing pseudo-three-dimensional plots with or without hidden line elimination.

PLTMAP :Routines for drawing polar-stereographic background maps of any portion of the globe. These routines are a modified version of the mapping routines in the ECMWF Contouring package.

GRAFIX :Routines for the production of annotated graphs. The user can plot using a variety of line-styles (solid, dashed etc.) and the graphs can be annotated using any of the character sets defined in PLTTXT.

IRLMAP :Routines for drawing high resolution maps of Ireland and/or Britain. These routines were provided by Mr.J.Davis of the Dublin Institute of Advanced Studies.

PAPER :Routines for outputting text on A4 paper.

In addition there are a number of packages which interface to the Calcomp routines directly. The following is a list:

PSYNOP :Routines for plotting SYNOP reports. This package will also plot upper-air reports. The symbols are defined on the Calcomp 925 tape-drive/controller.

PTEFIG :Routines for plotting tephigrams. These routines are a modified version of the tephigram routines in the ECMWF contouring package.

ECGRFX :The ECMWF Graphics package consisting of a Contouring package, mapping routines and tephigram routines.

It is intended to implement PSYNOP, PTEFIG and a subset of the contouring and mapping routines (viz. PCONTR and PLTMAP respectively) on the PDP-11's in the near future.

Output from the routines which use the SETPLT, ENDPLT and MOVE interface can be routed to either the Calcomp plotters or the lineprinter. The resolution of the lineprinter routines is quite crude but they are useful for development work because of the faster turn around compared with using the offline plotters.

In the following paragraphs we will discuss the station plotting routines, the tephigram routines, the contouring routines, the mapping routines and the graph plotting routines.

3. The station plotting routines

Synoptic reports decoded by the Service's A.D.E. (Automatic Data Extraction) programmes are plotted on pre-printed stationery in two colours using the pen plotters. Each station plot is rotated to lie along the meridian passing through the station. The elements of the station plot are displaced, as necessary, to allow the plotting of the wind arrow without overlap. Ships are plotted in the margin when there is insufficient room on the chart to plot them, in position, without overlap with previously plotted land or sea stations. Fig.2 shows an example of a SYNOP plot.

Upper air reports are also plotted using the pen-plotters. In this case there is no need to check for overlap between the land and sea stations.

4. The tephigram routines

The tephigram routines are a modifed version of those used at ECMWF. They have been converted to run on the Calcomp plotters. Fig. 3 shows a typical plot.

5. The contouring routines

The contour package has been specifically designed for a pen plotter. Every contour line (either open or closed) is drawn as a continuous succession of pen movements starting with a pen up movement, at the beginning of the line, and continuing with a series of pen down movements. The whole of each contour is accumulated as a list of points in the computer memory before output. This method of contouring allows the use of a global smoothing procedure, where all the points are used simultaneously, and it also simplifies the labelling routine.

The contouring routine steps through a list of contour heights (which can be defined as either a table of values or by means of a central value and an increment) and it scans the mesh for each contour value. There are two scans for each contour height. In the first scan the programme steps through the matrix being contoured, cell by cell from left to right along each row, and row by row from bottom to top. As it scans it sets up lists of linked points (i.e. points on the same portion of a contour). At the end of this initial scan it scans through its lists of points and

produces a table of linked segments. As soon as it has located all the segments belonging to one contour the grid intersections are passed to the drawing routines where the lines are smoothed and labels inserted. Normally the second scan does not begin until the whole matrix has been searched. However, if the routines run out of space during the first scan, a special call is made to the second scan routines,thus releasing space.

The grid intersections are determined by linear interpolation between adjacent end points on the cell boundaries. Only the two end points are used in the interpolation process. In cases where a cell contains four intersections (i.e. a saddle point or a col) the points are joined in the manner which gives the shortest total line length. In cases where both methods of joining would lead to the same total line length the points are joined in a cross.

The contours are smoothed using cubic splines. The spline coefficients are calculated globally, rather than piecewise, and the spline coefficients generated by the smoothing procedure are then used for drawing the curve with a resolution determined by the local curvature of the curve.

The labelling routine is based on a test of straightness similar to that used in the ECMWF contouring package. If the smoothing option has been invoked then the spline coefficients are used to curve the contour labels following the curve.

The contour package is used operationally to contour the ECMWF forecast charts and to produce output from the Service's Numerical Weather Prediction (NWP) Model. This NWP model is based on the Yugoslav LAPEM model and it runs on a transformed latitude-longitude grid (with the projected pole in the Pacific Ocean). The output of the model is contoured on the transformed grid and the pen positions are then converted to points on a polar stereographic projection and output on a pre-printed chart called the F-chart (i.e. forecast chart). The transformed grid is much larger than the F-chart and consequently the output is clipped to lie within the limits of the chart. This method of contouring is faster, overall, than interpolating the forecast from a transformed latitude-longitude grid to a polar-stereographic grid and then contouring on the interpolated grid. Fig.4 and Fig.5 show samples of the type of output produced by this package. Note the use of Irish lettering in Fig.4.

6. The mapping routines

The mapping routines are the same as those used at ECMWF. They have been converted to work in terms of our standard graphical interface. (See Fig.4 for an example of the type of output produced using these routines).

7. The graph plotting routines

These are used, mainly by the Research section, for displaying simple annotated graphs of Y versus X. Verification scores for the forecasts are displayed using these routines. Fig.6 shows a sample output obtained using this package.

8. Future plans

In the short term it is planned to complete the installation of the PSYNOP and PTEFIG routines on the PDP-11/40's. In the longer term the service hopes to purchase a graphics VDU and an online electrostatic plotter. Plotters may be installed at the airports, also.

9. Acknowledgements

The author acknowledges the assistance of Mr. H. Watkins and Mr. A. Lemaire at the European Centre for Medium Range Weather Forecasts in implementing the ECMWF contouring package.

He wishes to thank ECMWF for providing their contouring package, Mr. J. Davis of the Dublin Institute for Advanced Studies for the IRLMAP mapping routines and Mr. P. Lynch (Irish Meteorological Service) for help in designing the Greek character set.

IRISH METEOROLOGICAL SERVICE COMPUTER COMPLEX

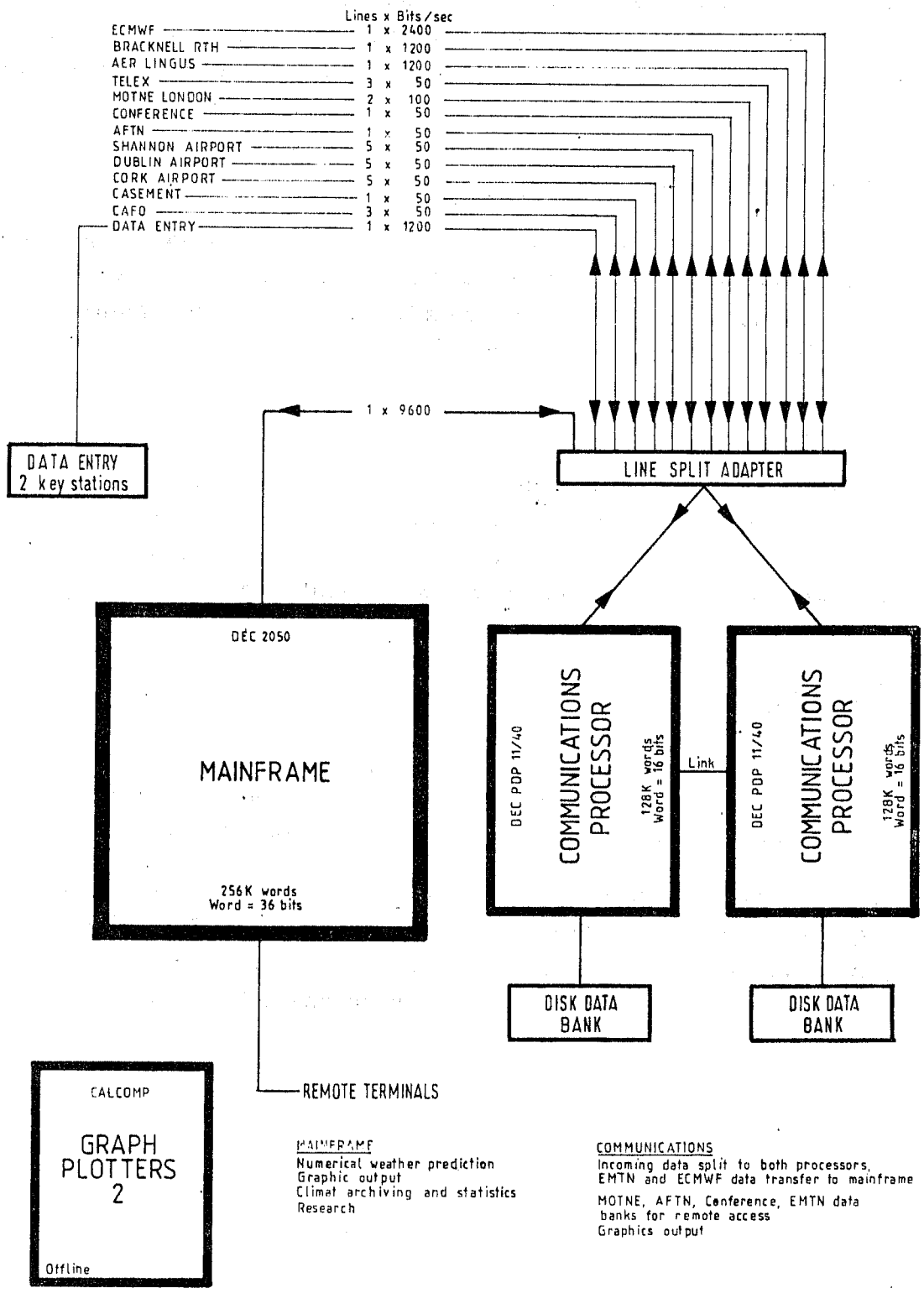

Figure 1 : The Computer System at the Irish Meteorological Service.

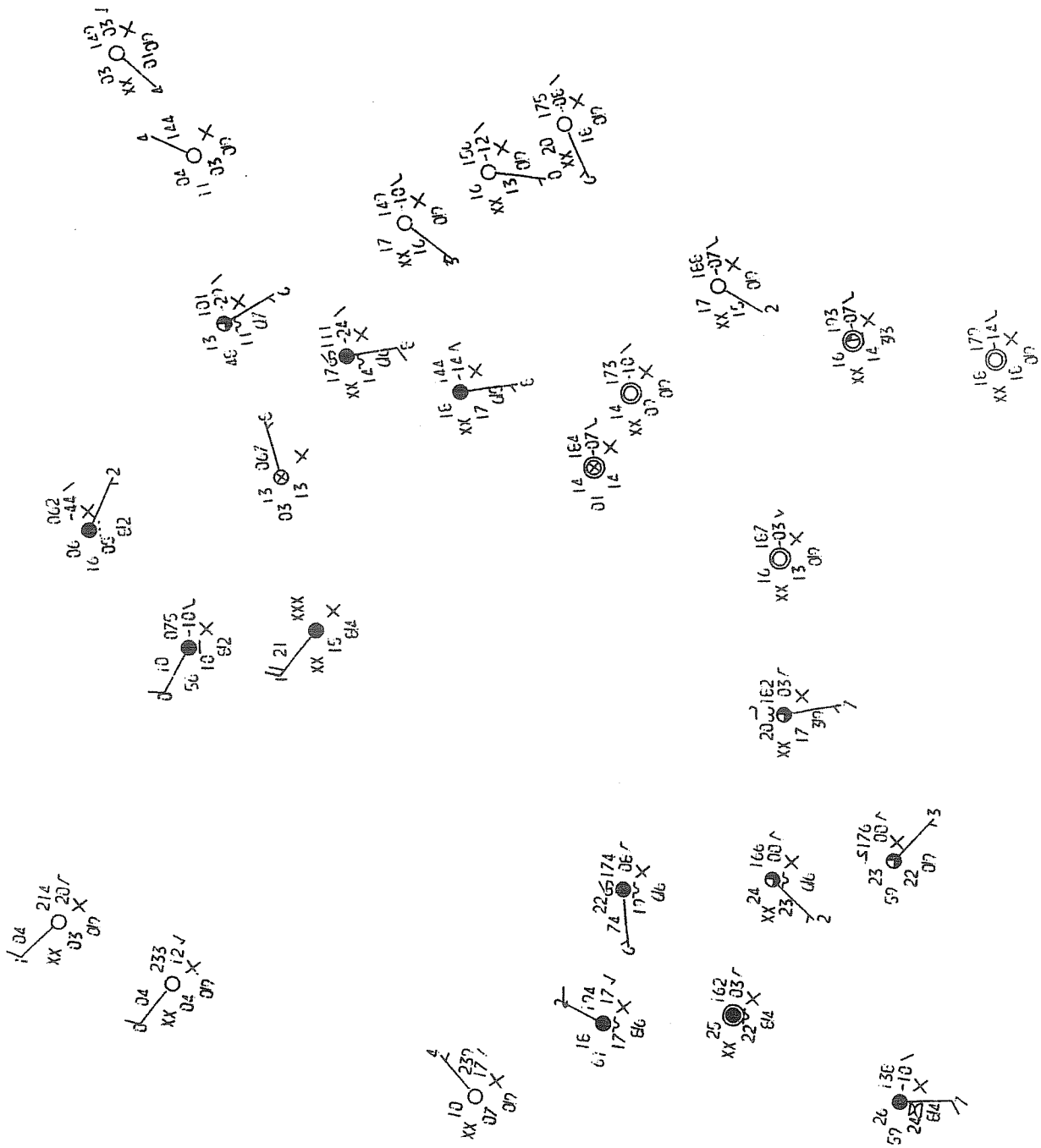

Figure 2 : Example of SYNOP plotting. This data is normally plotted on a pre-printed background

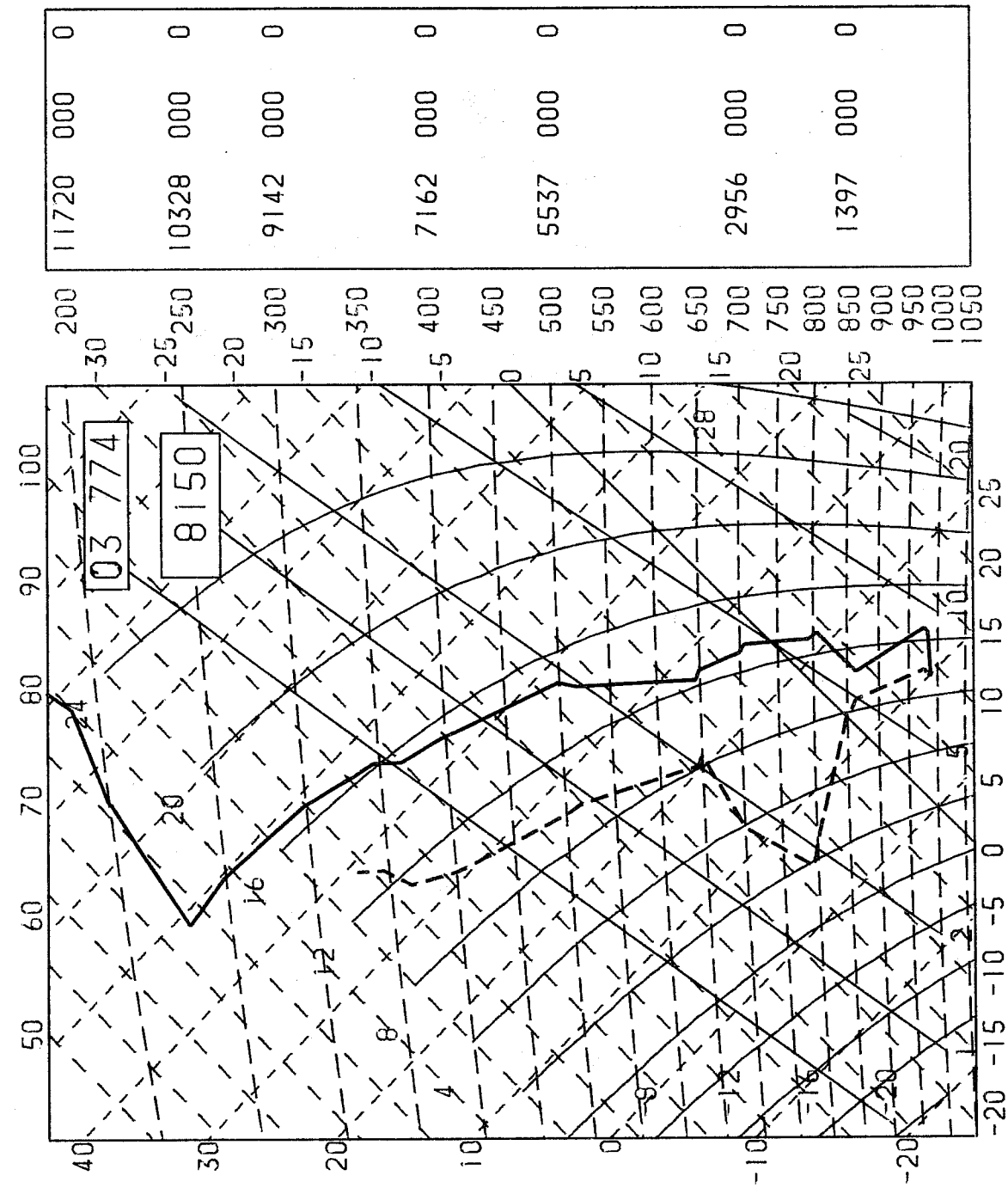

Figure 3

Example of a Tephigram plot using a modified version of the E.C.M.W.F. plotting package

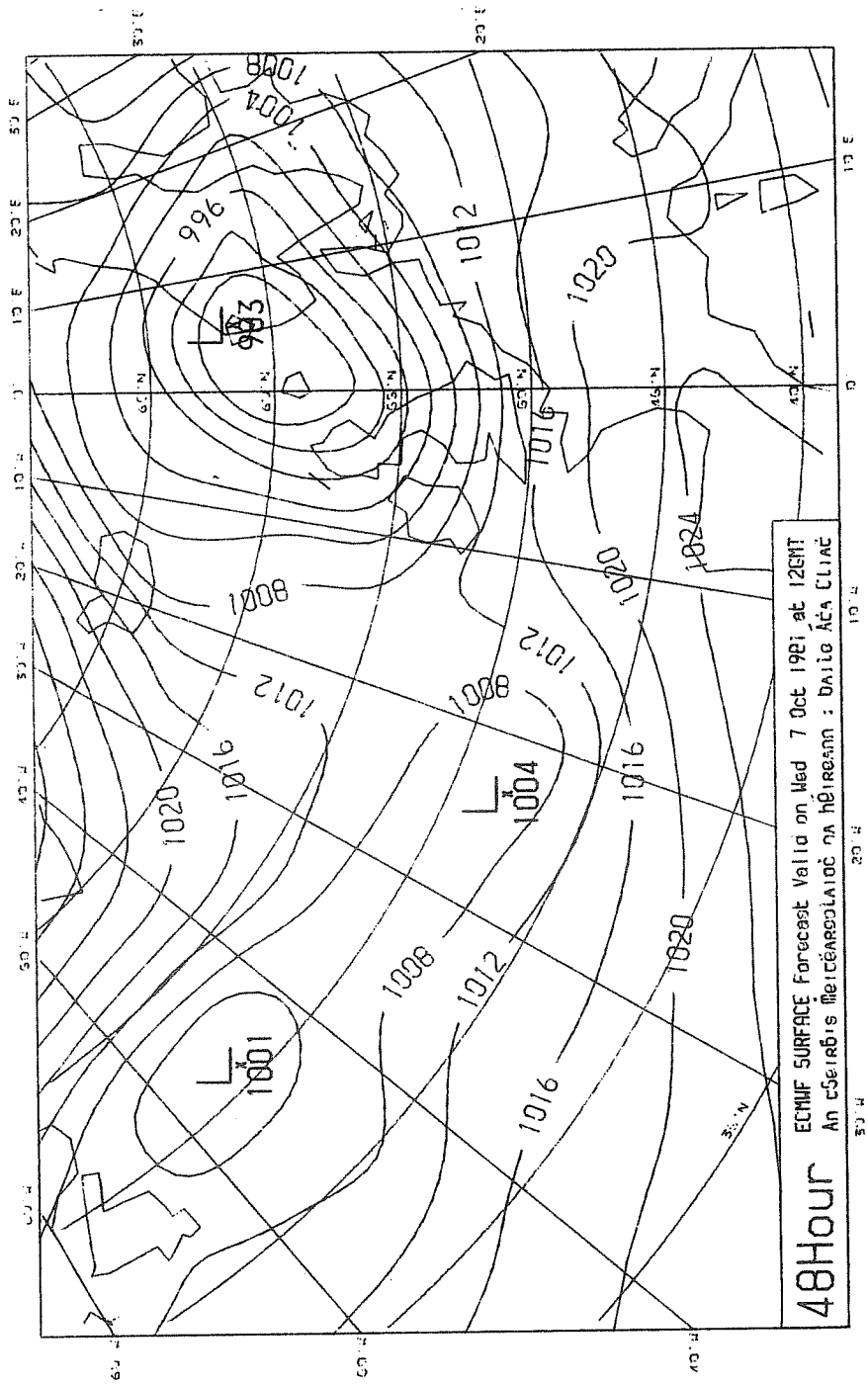

Figure 4 . Example of a contour plot of an E.C.M.W.F. surface forecast. Note the Irish lettering and the use of the E.C.M.W.F. mapping routines

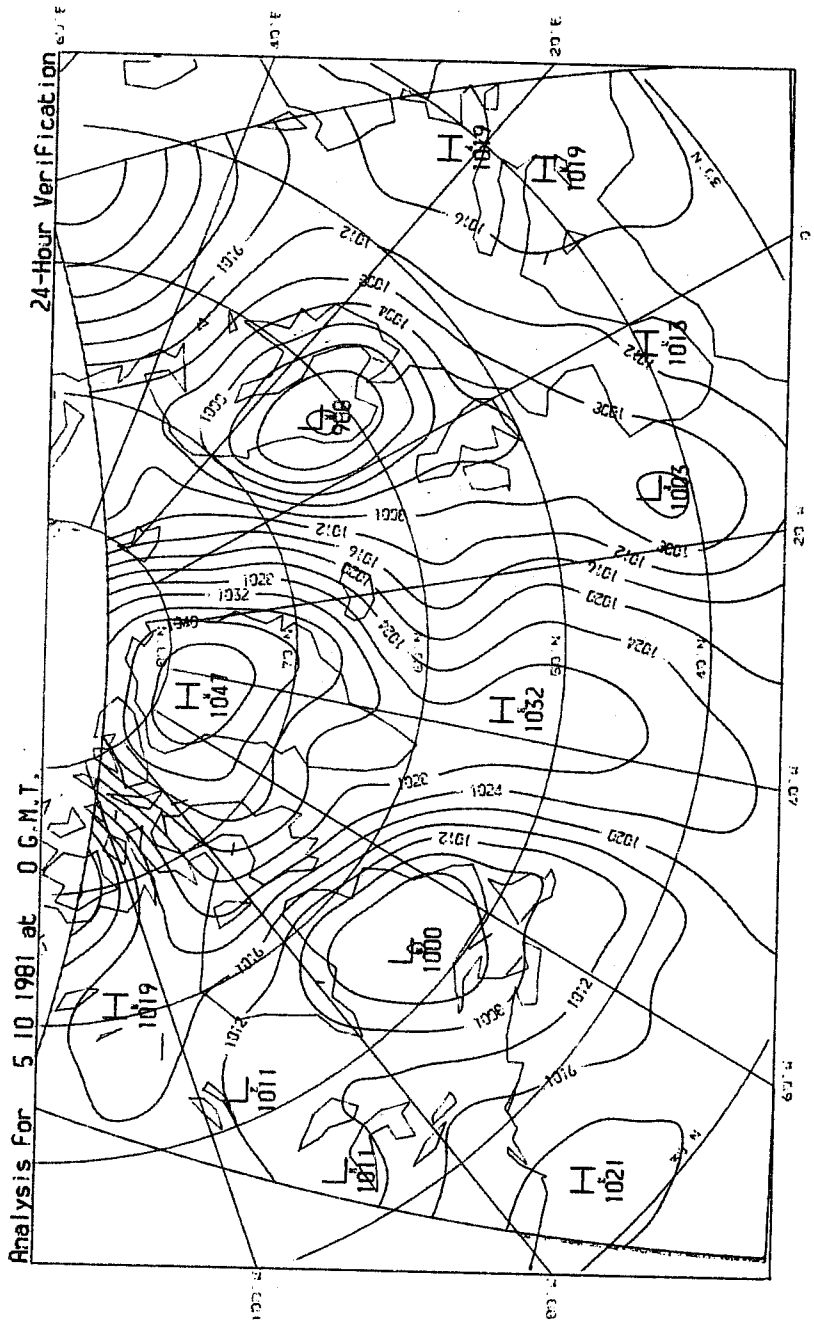

Figure 5 . Example of a numerical analysis contoured on a transformed lattitude-longitude grid. Note that the boundaries of the area are curved and that they have been clipped at the edges of the rectangular box containing the plot.

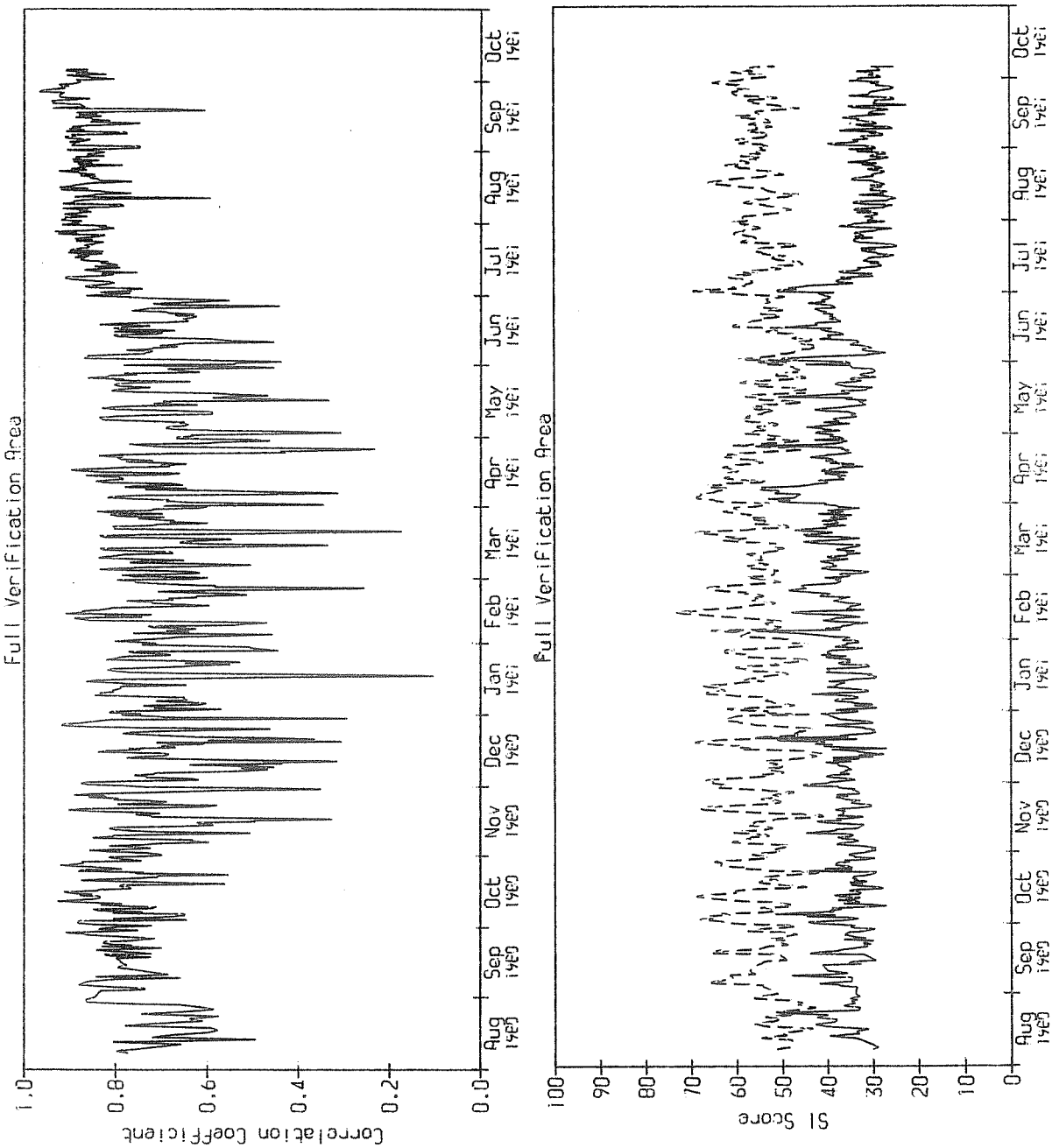

Figure 6 . Example of the type of plot produced by the Research section.