# xcharts : An X-Application for Displaying Meteorological Fields

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## 1. INTRODUCTION

**xcharts** is a workstation application [written directly in X and Motif] which is used at Met Eireann - the Irish Meteorological Service - to display the output of a number of NWP models including the local version of Hirlam, and the models of ECMWF, UKMO and DWD. The user can display but cannot modify the output. A selection of observations can also be shown. Features of the program include a user-friendly graphical interface, an intelligent zoom option, an animation feature, cross-sections and a scripting option. Model data is stored in standard GRIB code but observational data is stored in a non-standard ASCII code. [It is planned to replace this by BUFR code]. Facilities for displaying Meteosat PDUS satellite images are in the process of being introduced and should become operational before the end of 1997.

xcharts grew out of an earlier command processor system [called CHARTS – see Hamilton 1984] and it retains the command language and many of the features of the latter – in particular it has extensive and powerful scripting facilities.

Recent descriptions of **xcharts** are given by Nishimura [1995] and by Hamilton [1995 and 1997].

## 2. MAIN FEATURES AND MENUS

Until recently, CHARTS [Hamilton, 1984] was the main forecaster interface to NWP output. This is a command driven interactive system which allows the display of charts on a DEC VT-340 terminal. It uses a command language which has been designed to be as easy to use as possible. Commands can be abbreviated; there is an on-line HELP system, a hardcopy option, a script option [viz. the so-called 'obey' files], and ambigious or incorrect commands produce meaningful error messages. The system remembers the parameters entered with previous commands and these become the defaults for subsequent commands – this reduces typing to a minimum.

Using CHARTS the forecaster can access NWP output from the Hirlam model as well as the models of ECMWF, DWD and UKMO. Wave-model output is also available [from the local WAM model and the wave models of ECMWF and UKMO]. Finally, observation plots are available both at standard levels and as tephigrams.

The forecasters are very familiar with the old system and so the new system was designed to be as compatible as possible with the old. The new system is called **xcharts** and it includes extra options such as cross-sections, animation and the display of satellite images [PDUS data from Meteosat].

The user interface in **xcharts** combines a command line with menu buttons and icons. This allows for continuity between the old and new systems; it also allows the use of the current set of script [i.e. 'obey' files]. Ideally, all features should be available with either the command interface or the menu interface but, in fact, some of the more obscure features are only available through the command line. However, in practice, the users almost always use the menu buttons.

Pressing a menu button or icon generates a text string [i.e. a command] which is then sent to the command processor for parsing.

The following figure shows the menu interface and a typical plot.
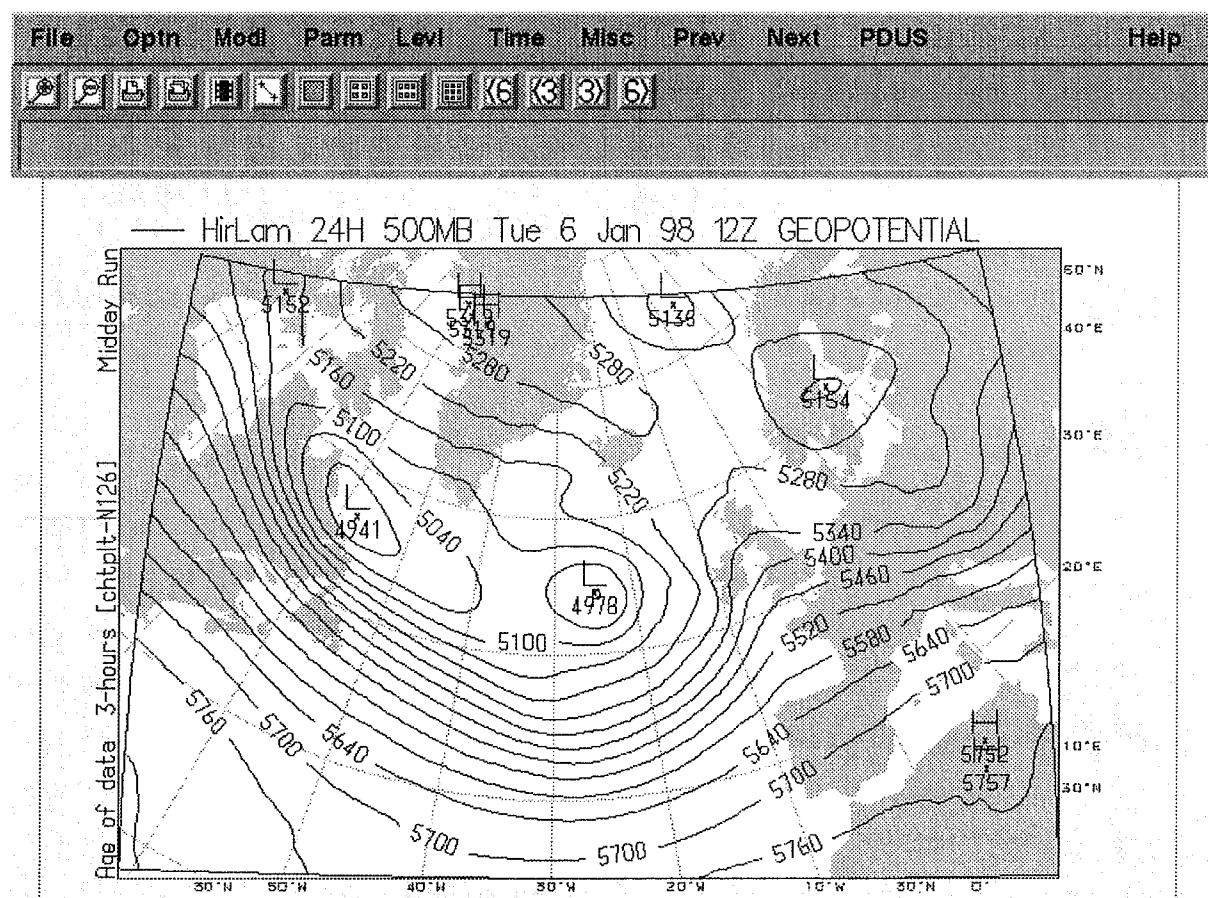


The menu buttons are used to specify script ['obey'] files [File]; various display options [Optn]; choice of model, parameter, level and forecast length [Modl/Parm/Levl/Time]; miscellaneous options [Misc]; previous and next forecast chart [Prev/Next]; satellite

image data [PDUS] and Help [Help]. The icons specify zooming and un-zooming, single and multiple hardcopy, animation, cross-sections, various page-layouts and the selection of the next and the previous plot. [See Nishimura [1995] for a discussion of the icons].

The main 'Plot' button is available as a pop-up menu when the user presses the right-hand mouse button in the drawing area. It produces the main menu of which the following is a [greatly-simplified] version :

| HIRLAM | Pressure | Surface | Analysis |
|--------|----------|---------|----------|
| ECMWF | Geopotential | 1000mb | 12hour |
| UKMO | Temperature | 925mb | 24hour |
| DWD | Rainfall | 850mb | 36hour |
| | WindArrows | 700mb | 48hour |
| | Isotachs | 500mb | 60hour |
| | CloudCover | 400mb | 72hour |
| | etc | etc | etc |

| Plot | | Overplot | |
|------|--|----------|--|

The procedure is for the user to specify a model, parameter, level in the atmosphere and length of forecast. Then, clicking on the 'plot' button will produce a new plot; clicking on the 'overplot' button will superimpose the chart on the previous plot. The system remembers previous values [which are highlighted] and it is unnecessary to specify any value which has not changed. Difference charts and thickness charts are specified by means of sub-menus [not shown].

The 'Optn' [option] and 'Misc' [miscellaneous] buttons on the main menubar allow the user to specify various options, such as the colour of the plot, which are of secondary importance.

The 'Modl', 'Parm', 'Levl', and 'Time' buttons are 'short-cut' buttons which are designed to reduce the amount of typing required. Thus, the 'Modl' button is used to change the model [e.g. from Hirlam to ECMWF] and plot immediately. So, for example, if a 24-hour Hirlam forecast of surface pressure is displayed and the user clicks on the 'ECMWF' option in the 'Modl' menu then a similar ECMWF chart will be displayed, without the need to click on anything else.

The 'Prev' and 'Next' buttons are used to retard or advance the time of the plot.

Thus, if the plot consists of a number of superimposed charts, these buttons will retard/advance all the charts. The 'Prev' button has the options '-3hours', '-6hours', '-12hours', '-18hours' and '-24hours' with similar options for 'Next'. In addition there are arrow icons corresponding to 'Prev-6', 'Prev-3', 'Next+3' and 'Next+6', respectively.

The 'Zoom' icon implements a zoom where the zoom cursor is defined as a latitude/longitude intersection i.e. as a circle of latitude and a straight line of longitude. The new area is defined by the lower-left and upper-right corners in latitude/longitude. All charts are recontoured after the zoom; if observations are being displayed a 'declutter' algorithm is applied.

The 'UnZm' icon cancels a zoom [i.e. it displays the entire chart]; the 'Hard' icon produces a hardcopy and the 'Help' button displays a help menu with some simplified help on various options.

The 'Animate' icon allows the user to animate the display. This option was developed by E. Nishimura [1995]. The 'Cross-section' button is used to select two points to define a track and the cross section along the track is then displayed in another window.

The user can divide the screen into sections and plot four, six or nine charts.

Finally, the user can display tephigrams by first selecting a plot of the data available and then pointing at the required station.

## 3. DESIGN CONSIDERATIONS IN XCHARTS

The program is based on the earlier command driven CHARTS program. Consequently, it still allows users to use a command line. In fact, clicking buttons actually generates command strings which are sent to the original CHARTS command interpreter.

The 'obey' file option has been retained and users can write scripts to display charts. The following file will display a set of Hirlam forecasts [with the screen divided into quarters] :

Underplot Quarter=1 Hirlam surface press 6Hour

Underplot Quarter=2 12Hour

Underplot Quarter=3 18Hour

Underplot Quarter=4 24Hour

Display

The 'Underplot' command stores a chart for later plotting. Thus the first four commands define the 6-hour, 12-hour, 18-hour and 24-hour Hirlam forecasts of surface pressure in the four quarters of the screen. The 'Display' command then displays the plot.

The user can use the main 'Plot' menu [or the command line] to select non-existent products [e.g. Hirlam 3-day forecasts are not available]. In such a case the system prints a warning message.

Versions of **xcharts** has been installed in the general forecast office [viz. CAFO] in Dublin and in the aviation forecast office [viz. CAO] in Shannon Airport. The latter is approx. 200 Km from Dublin.

The raw field data, used by **xcharts** in CAFO, is stored as a set of GRIB fields on a server machine. The data disks are nfs mounted on the workstation. Tests with routers and/or bridges and with 64-kilobit/128-kilobit lines have shown that this approach is too slow for Shannon. So, in this case, as soon as the GRIB products become available [either from a run of Hirlam or from one of the sets of model output we receive over the GTS] they are copied to Shannon where they are stored locally on the workstation. This makes the response time much faster. It also makes the system more resilient to line outages, server breakdowns etc.

## 4. EXPERIENCE WITH FASTEX

The experimental phase of FASTEX [i.e. the Fronts and Atlantic Storm Track Experiment, FASTEX 1997a and FASTEX 1997b] was run from Shannon Airport and a team of forecasters from Met Eireann, in conjunction with other teams from France, Britain, Canada and the USA, were involved with forecasting frontal development, deepening of lows, flight planning etc.

Each team of forecasters had their own graphics system and it was very useful to be able to compare **xcharts** with other systems and to get ideas for enhancements and improvements.

Various modifications were made to **xcharts** including the definition of a background map covering the areas of interest to FASTEX, the production of extra products including plots of vorticity and Cb-tops, enhancement to the 'Save as postscript' options to produce postscript files suitable for display on the FASTEX web pages and a better version of the cross-section option.

The Irish forecasters identified the main strength of **xcharts** as its ease of use and access to multiple models. They identified its main limitations as its inability to deal with image data [satellite data and/or radar data]; its lack of certain derived fields [such as potential vorticity] and the difficulty of reading charts with many overlays.

Since FASTEX, we have tried to address these limitations and we are working on incorporating various extra derived products, adding satellite data from Meteosat and

introducing a treshold option to make charts more readable. We hope to make the satellite option available to the forecasters before the end of 1997.

## 5. SATELLITE IMAGE DATA

Met Eireann recently acquired a PDUS [Primary Data User Station] receiver for Meteosat data. The system [built by VCS] receives data on the satellite projection but it can make data available on a polar-stereographic projection by performing its own grid transformations. This greatly simplifies the interface between the PDUS system and **xcharts**.

A polar-stereographic map is defined for the image data and visual/infra-red/water-vapour files are prepared by the PDUS and copied to a disk accessible to **xcharts**. A new menu button [called PDUS] was added to **xcharts**. When this is pressed, the program looks at the disk and makes a list of the eight most recent visual, eight most recent infra-red and eight most recent water-vapour images. The dates/times of these 24 images are displayed as the PDUS menu [plus a 25th entry – 'Switch Off PDUS'] and, by clicking on one of these entries, the user resizes the window to the size of the PDUS image [actually 900x700 pixels] and draws the image as an underlay for the current NWP chart. Subsequent NWP products will be displayed on this image until the user either asks for a new image or selects the 'Switch Off PDUS' button.

Hardcopies of the PDUS charts are available [via Postscript files which are generated, on request, by **xcharts**]. However, at present, there is no zoom or animation option for the image data.

## 6. FUTURE PLANS

We hope to continue the development of **xcharts** and include more derived products such as potential vorticity. We are investigating the feasibility of including radar data as well as satellite data. **xcharts** currently plots observations using data from a special set of ASCII files – we want to modify it to read BUFR data.

The command-line version of CHARTS is likely to persist for quite some time since it can be run from an ordinary graphics terminal over a relatively slow line; the X version needs a workstation or X-terminal with at least a 64-kilobit line.

We are looking at the possibility of adding a treshold option. This would make charts more readable since, for example, the user could locate the jet-stream by making a request such as 'Plot Isotachs MinValue=100' [i.e. only plot wind values of at least 100knots].

# REFERENCES

FASTEX [1997a]: see A. Joly et al 'Definition of the Fronts and Atlantic Storm-Track Experiment [FASTEX]' to appear in Bull. Amer. Meteor. Soc. (1997).

FASTEX [1997b]: see the following URL's for information on the FASTEX experiment and sample plots from various graphics systems :

$http://www.cnrm.meteo.fr:8000/dbfastex/joss_catalog/index.html$

$http://www.cnrm.meteo.fr:8000/cnrm/fastex/$

$http://www.atd.ucar.edu/dir_off/projects/FASTEX.html$

Hamilton, J.E.M., [1984]: 'The Design of an Interactive Graphics System for the Display of Meteorological Fields', Software Practice and Experience, Vol. 14, No. 6, p. 587-600 (June 1984).

Hamilton, J.E.M., [1995] 'Graphics Workstations at the Irish Meteorological Service', Fifth Workshop on Meteorological Operational Systems, ECMWF, Reading, Nov 1995.

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Nishimura, E., [1995] 'Recent Developments in X-Charts', Hirlam Progress Report No. 3, Irish Meteorological Service, Dublin 1995.