ECMWF Model Output on Video

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1 INTRODUCTION

The ECMWF forecast model, which produces a 10 day forecast, generates over 5 gigabytes of data on a daily basis. Such a large volume of data can only be fully analysed using modern graphical and visualisation techniques.

Traditionally, meteorologists analyse forecast data using black and white hard copy maps. At ECMWF a major investment has been made in the Meteorological Applications Graphics Integrated Colour System (MAGICS) [1]. MAGICS has provided the Centre's meteorologists with a simple method of producing colour maps, which has lead directly to new presentation methods for meteorological data [2]. By adding colour to a black and white map, many more meteorological fields can be represented. For example, a simple black arrow drawn on a map can represent the wind speed and direction at a number of fixed points on the globe, or in the atmosphere. By colouring the arrows according to the temperature of the wind at these points, frontal systems stand out even to the untrained eye, and experienced meteorologists can spot interesting effects that they have not seen before in such detail.

The next step, after the introduction of colour, is to introduce a time factor by producing animated sequences of weather maps. Such sequences clearly depict the development and interaction of forecast weather systems.

2 The ECMWF Video System, Hardware Configuration and Operation

The heart of the ECMWF video system is a single board display frame buffer, supplied by Dowty Computer Graphics, which sits in the UNIBUS of one of the Centre's VAX (see Fig. 1).

Animated sequences are produced on the Centre's X-MP/48 using the MAGICS package. Image files, in device dependent form, are then moved from Cray disk to VAX disk over the Centre's network. A simple program on the VAX then reads these image files and sends them along the UNIBUS to the frame buffer.

The frame buffer has a resolution of 768 by 574 pixels (i.e. normal PAL television resolution), 4 bit planes and a look up table of 4096 colours. Colours are selected by setting each of three guns (red, green and blue) to an intensity between 0 and 15 inclusive.

As output, the frame buffer produces a Red Green Blue (RGB) signal which is connected to an Abekas Cox PAL encoder. The encoder produces a standard PAL video signal, which can be recorded on any domestic PAL VHS video recorder, or more professional equipment. In

order to produce good quality tapes, the video system uses a Sony U-MATIC 5850P recorder, which has the ability to record to single frame accuracy.

As the complexity of pictures does not permit their production in real time, it is necessary to record just a few frames of each picture at a time. When the picture has been recorded, the frame buffer can be erased and a new picture drawn, which can then, in turn, be recorded. It is therefore necessary to carefully synchronize the drawing of pictures on the frame buffer and their recording on the U-MATIC. This is achieved by connecting an animation control unit, from EOS Electronics A.V., to the U-MATIC. The VAX can communicate with the control unit along a standard RS232 interface. It can therefore instruct the U-MATIC to record a certain number of frames at the appropriate time, and can determine when the recording has been completed.

To summarize, image files that are dumped onto VAX disk from the CRAY are written to the frame buffer by a small program running on the VAX. When an image is completed, the program instructs the U-MATIC recorder, via the animation control unit, to record a certain number of frames. When the U-MATIC recorder has completed the recording it signals the VAX via the control unit. The program is then able to erase the frame buffer and draw the next image. This process continues until all the images have been recorded.
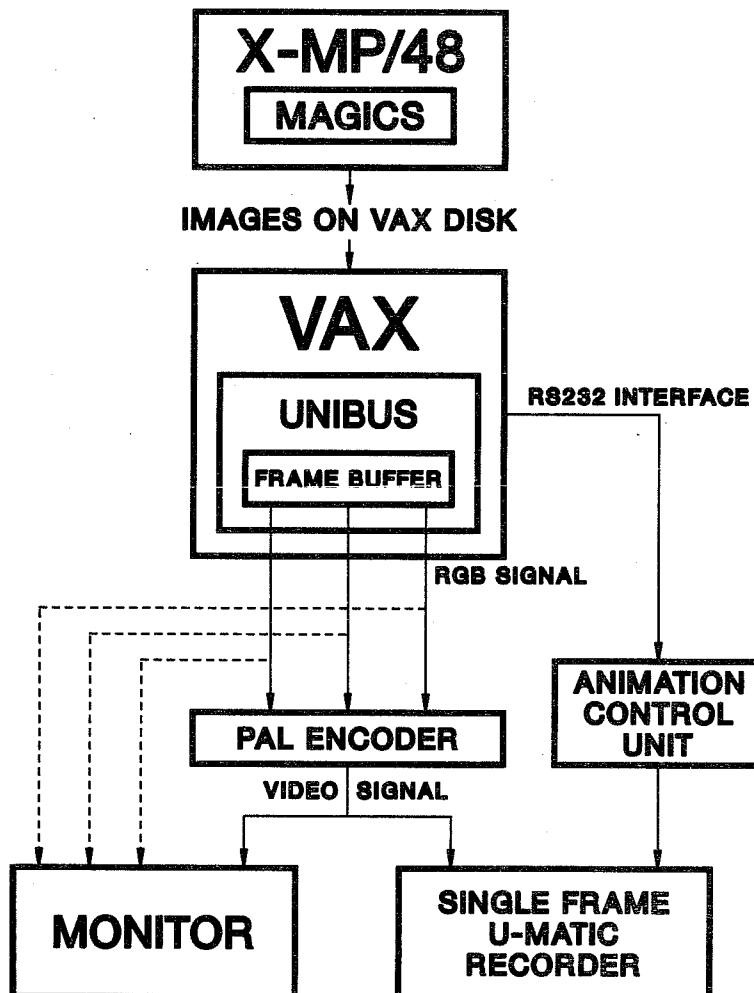

Fig. 1 ECMWF video system

3 PRESENTATION OF VIDEOS

The video recording made at ECMWF shows animated sequences, over varying time ranges, of selected weather parameters. The data used to create the video was taken from a special data set which has been created at ECMWF. This data set consists of the forecast of 4 February 1988 at one hourly time steps for 7 days.

The synoptic case selected for the study comprises the period 7 to 9 February 1988. During this period a disturbance developed ca. 1000 kilometres south of Newfoundland, deepening from 1017 hPa to 943 hPa, according to the analysed fields, with a corresponding deepening from 10121 to 940 in the operational forecast. In view of this explosive deepening, ca. 50 hPa in 24 hours during the most active phase, the skill of the global forecast model in being able to depict this process is quite amazing, in particular as the first indication of the development did not emerge until some 72 hours into the forecast.

The video consists of seven different animated sequences as follows:

1. MSL pressure and 700 hPa humidity (shaded) on an area encompassing the north Atlantic, west and mid Europe. The time range is from 72 to 120 hours in one hour time steps, i.e. 49 frames displayed at a rate of one frame per second and repeated at half speed.

2. 500 hPa height and 850 hPa temperature (shaded). The area, time range and display rate are the same as sequence 1.

3. MSL pressure and one hourly pressures tendencies (shaded) over the central north Atlantic area. The time range is from 72 to 96 hours with one hour time steps, i.e. 25 frames. These are displayed first at a rate of one frame per second and then repeated at a rate of one frame every two seconds and repeated at half speed.

4. MSL pressure and accumulated large scale and convective precipitation (shaded). The area, time range and display rates are the same as sequence 3.

5. MSL pressure, 850 hPa temperatures (shaded) and 30 metre winds. The area, time range and display rates are the same as sequence 3.

6. Cross-section of horizontal wind and potential temperatures (shaded). The cross-section line runs from 56N, 42W to 38N, 28W. The time range and display rates are the same as sequence 3.

7. Cross-section of Vertical velocity (shaded) and potential temperatures. The cross-section line is the same as sequence 6 and the time range and display rates are the same as sequence 3.

References

[1] ECMWF Annual Report 1985
[2] WMO Bulletin, volume 36, number 1, January 1987