BRACKNELL METEOROLOGICAL OFFICE

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Introduction

This presentation will be more of a "view" than an "overview" and will basically cover the Bracknell Model, the products, and the services provided by the Bracknell Meteorological Office. First of all, Bracknell is situated approximately 40 miles west of London (quite close to Windsor Castle).

Last year Bracknell became one of the world centers for civil aviation; it is also a regional center. As far as things in the United States (U.S.) go, that change may not have made very much difference, but for Europe, it was quite a significant change. There are two Numerical Forecast Centers very close in the United Kingdom (UK). One, of course, is the Bracknell Meteorological Office; the other is the European Center for Medium Range Weather Forecasting, which is a consortium of about 25 European countries that have set up a center purely for numerical modeling. The latter provides no forecast services; it is purely for numerical model guidance aimed particularly at the medium-range period (4–10 days). Their model is run once a day and has a late cutoff time ($\sim$ T+11); the products are very good, but aimed very much toward the medium-range. The Meteorological Office at Bracknell is the National Weather Service for the UK. It runs a global model twice a day with a much earlier cutoff and with much more forecasting for shorter periods ahead (up to 36 hours and up to 6 days). As far as civil aviation goes, it is Bracknell which is providing the products.

World Center and Regional Centers Products

As mentioned above, the global model is run twice a day. Taking into account the standard range of observations in our analysis, we provide the following data: surface and radiosonde; aircraft reports (these are particularly important in the data-sparse areas); satellite soundings and wind; followed by the intervention from a human forecaster. The human forecaster has the opportunity to look at those observations, input interactive quality control graphics, and make sure the analysis from which the forecast starts is as good as it can be. The analysis is every six hours with temperatures and winds.

The forecast model is a global model run on a 150 km grid with 15 levels (a good resolution for a global model). Therefore, there are about 1/3 million grid points in that model; yet, reproducing in that forecast model, a 24-hour forecast takes four minutes. That is the power of the Cyber-205.

Backup is very important as far as running models is concerned. The most important thing is that the backup is transparent to the user; i.e., the user of the products sees those products exactly the same as whether they are the real thing or whether they have been coupled together with our backup arrangements. Our backup arrangements are that every time we produce a forecast run (perhaps to 12 or 18 hours for aviation), we extend that forecast to produce identical products for 12 hours later. Therefore, we always have a forecast from the previous run to fall back on if we have problems with the next run. If necessary, we go back 24 hours, but before doing that, we would tend to use the products from the other World Center in Washington. Again, the products from Washington would probably be 12 hours in arrears.

The standard output from the global products are wind, temperature, height (standard levels), tropopause, and maximum wind (available $\sim$ T + 0430). We run the model with a cutoff of $\sim$ T + 0320, and the products output at 0430, twice per day. These products go out electronically to the airlines. organizations such as SETA, and they also go out to the regional area forecast centers. The regional centers are responsible for turning those products into charts. Figure 1 is a forecast chart from the Bracknell Model on 6 March 1985 covering Europe, Africa and South America showing a marked trough in the wind flow. Besides providing products for civil aviation, products are also provided for military aviation. Figure 2 is an example of a series of forecast charts at different flight levels which go to the military center at Strike Command at High Wickingham. Unlike in the U.S., the services in the UK are provided from one center; therefore, the Meteorological Office at Bracknell provides the products for the Royal Air Force as well as the products for civil aviation.

Another task of the regional centers is to provide significant weather charts. In the U.S. there is one center in Washington, DC; thus, you may not see a difference between the World Center and the Regional Centers. In Europe there are three Regional Centers: one each in Bracknell, Paris and Frankfurt. These weather charts are produced every six hours by forecasters. We exchange products with the U.S. and the other European centers, so we have a good idea of what is going on. Figure 3 shows the areas for which the UK is responsible, for west-bound flights across the Atlantic. Much of our information for the U.S. is taken from products exchanged with Washington.

Short-Period Forecasting

When discussing short-period forecasting for particular air fields or routes over small areas, the man-machine mix becomes very important. The aforementioned

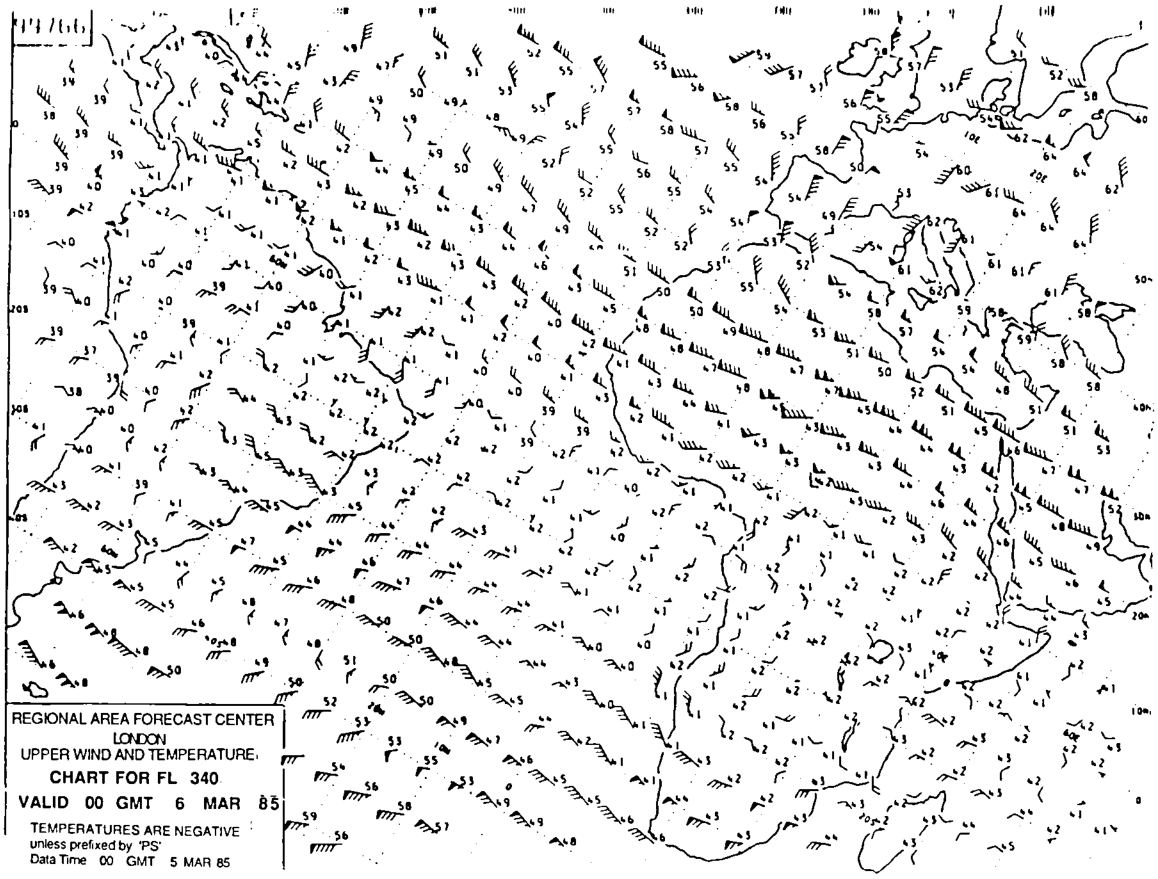

Figure 1. Forecast chart from the Bracknell model on 6 March 1985.

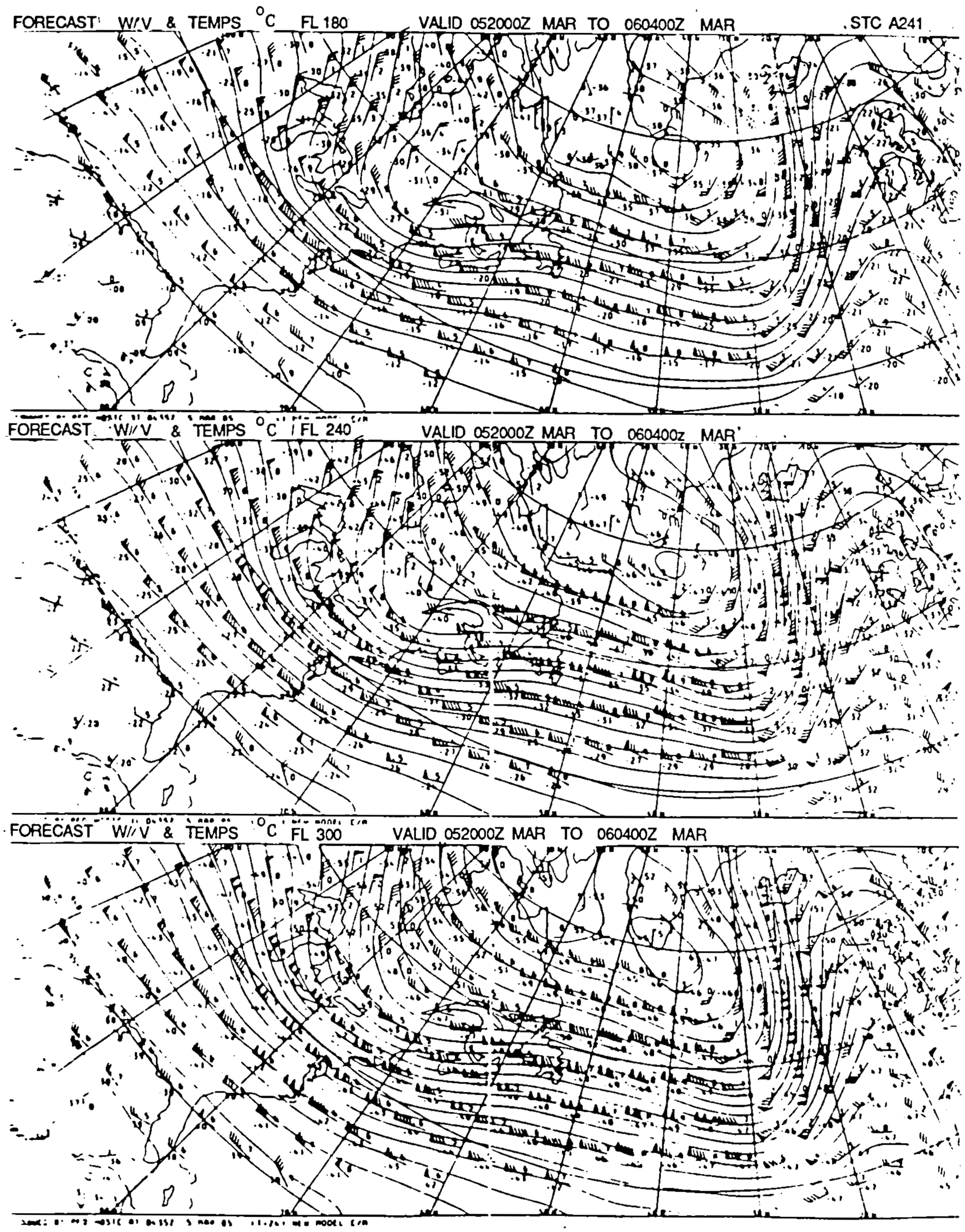

Figure 2. Example of a series of forecast charts at different flight levels.

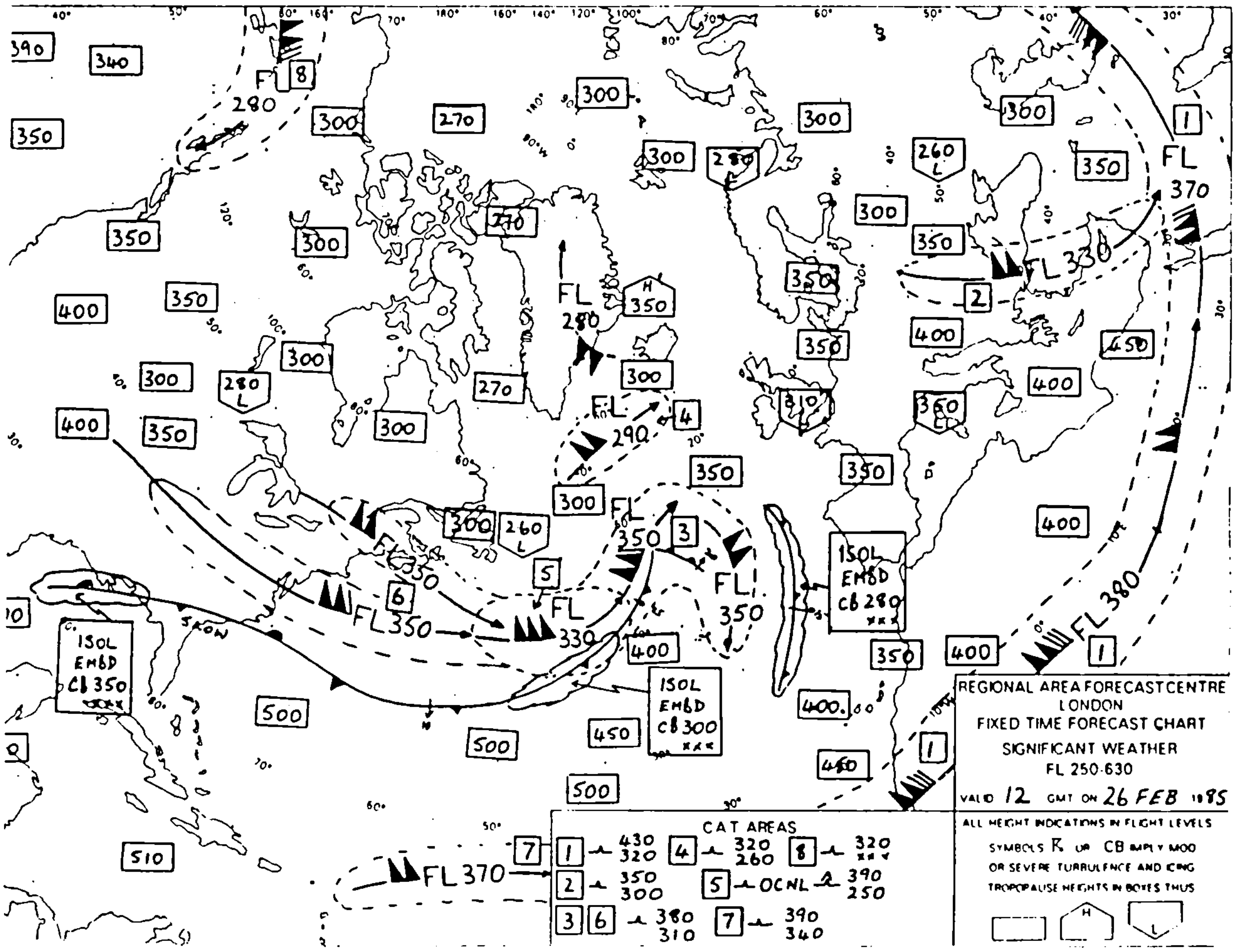

Figure 3. Areas for which the United Kingdom provides forecast services.

method of forecasting has been very much numerical-model dominated. Various experiments have been conducted to see if forecasters could improve on the upper-wind forecasts (e.g., across the Atlantic). The results were that it is very difficult to beat the numerical model, even giving the numerical model guidance to the forecasters. However, once into short-period forecasting, the man becomes much more important. The machine is still very important; thus, we have the man-machine mix using graphic devices which are clearly going to extend over the years to come. We can also think of interaction analysis and extrapolation techniques which have been explored quite significantly in the U.S. We would hope to learn more about these techniques which are very dependent upon good data for the covered areas. However, there is a question as to how far ahead these short-period extrapolations or forecasts can be produced, because the data are being entered only at particular levels and is not particularly helpful for a numerical model, which finds it quite difficult to adjust to data going in at, for instance, only the main flight levels. What is happening to the model at a level like 15,000–20,000 feet when many aircraft are flying much higher? Definite applications are needed, particularly for general aviation and for locations over the U.S., but they are not so essential for going across the Atlantic. There is still the question as to how far they can go. Six hours is promising, but I believe 12 hours is pushing it.

Small-scale models are being run in both the U.S. and the UK. We have a fine-mesh model which covers Europe, the Atlantic, and just into the U.S. We are also developing a mesoscale model which has a 15 km grid and covers quite a small area. It is 1/10 of the resolution of the global model, and it is producing rather interesting results. Figure 4 shows a forecast from that model for Brize Norton. The F/C indicates the forecast observations from the mesoscale model; the ACT indicates the actual observations for different hours. The first section in Figure 4 shows the forecast until midnight. More interesting is what happened after midnight, as is noted in the second section in Figure 4, showing the forecast to 06Z. Brize Norton went into fog at 0300 (with a visibility of about 200 yards), came out of fog a few hours later, then it began to rain about an hour later. This is illustrative not of what we can do now, but of what we may be able to do in the future with the mesoscale model.

In 1982, we made a transition from our 10-level model using the IBM 36195 to a 15-level model using the Cyber-205. The NMC is now going through the same phase. During that period, many tests were run between the old and new models, and Figure 5 shows these results. This was an 18-hour forecast produced in the summer of 1982 just prior to introducing the new model. The diagram on the left is the maximum wind forecast made by the 10-level model, and the diagram on the right is the forecast made by the 15-level model. The thick lines indicate the 100 kn isotach. The big difference can be noted by the 10-level model producing a complete envelope right around the ridge, and the 15-level model forecasting winds of up to

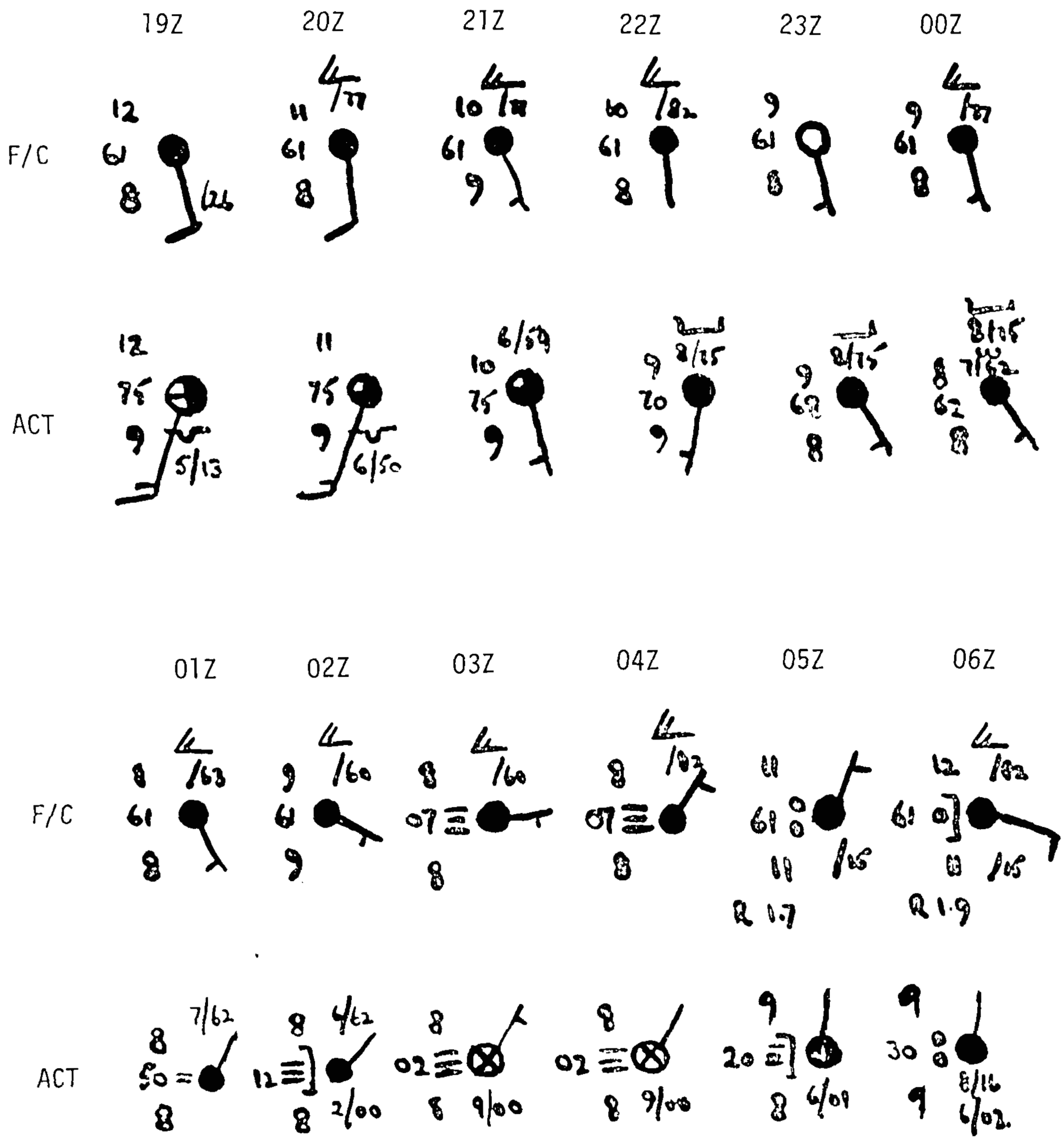

Figure 4. A forecast from the mesoscale model for Brize Norton.

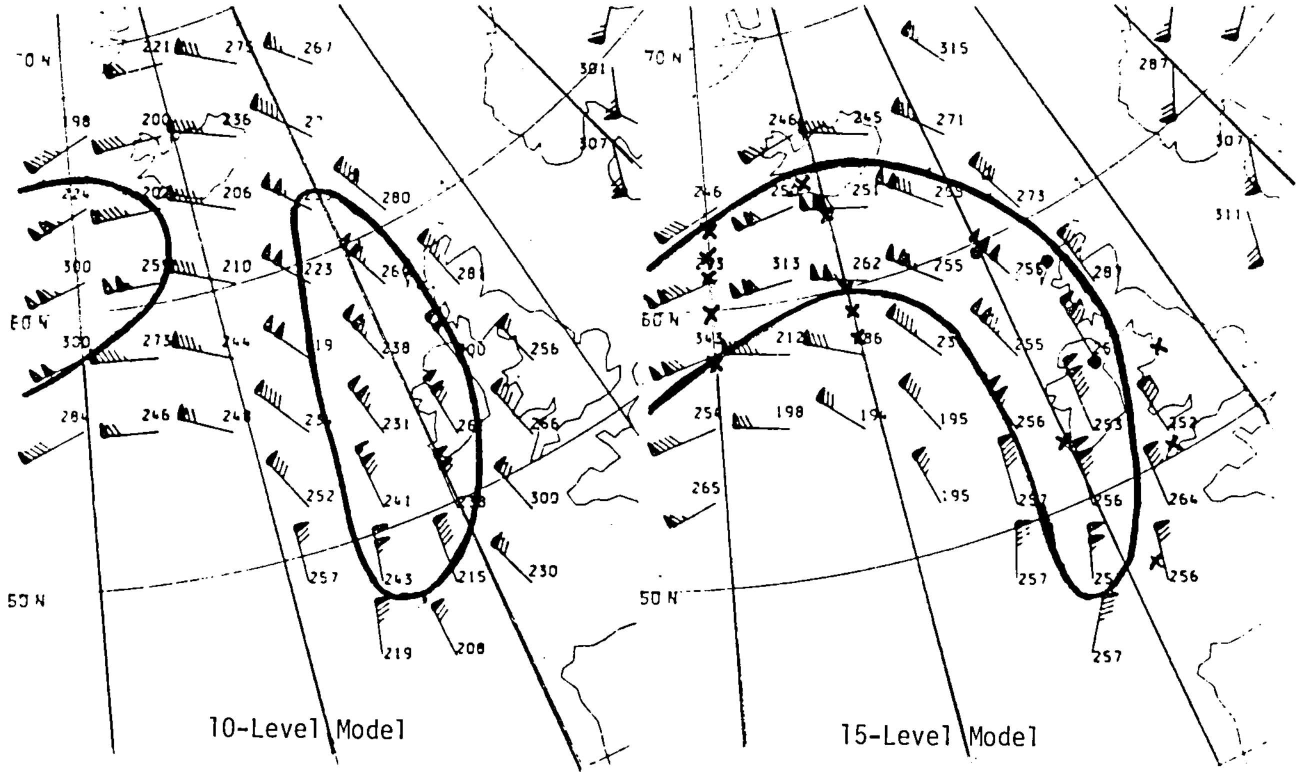

Figure 5. 18-hour forecasts from 00Z 30 August 1982.

150 kn compared with a maximum of about 120 kn. For verifying analysis, the x's indicate aircraft reports of 100 kn or greater; so it is fairly clear that the 100 kn did indeed extend around the ridge. The •'s indicate the radiosonde observations or aircraft reports of 150 kn. So, in the middle of that core, there were certainly winds of 150 kn. That is the type of improvement we have been noticing fairly typically since we transferred to our new model.

A great deal of verification work is done to see how good the models are. Figure 6 shows the 48-hour forecast of 500 mb height; regardless of the parameter, you can see the big drop in forecast errors over the period between 1966 to 1983. One axis shows the error in the model, and the other axis shows the period from 1966/67 (when the early models were introduced) to 1982/83, with the last one being in 1983/84. During the period of our 10-level model, forecast errors decreased gradually toward the large drop, shown by the circles, which indicates use of the 15-level model introduced in 1982. It is also interesting to note that the models improve during their life as improvements are gradually input to the system. The black circles to the right of the diagram on Figure 6 indicate the 72-hour forecast errors from the current 15-level model. They are about as good as the 10-level model forecasts were about five or six years ago.

In 1978, we began to verify against observations in lieu of against analyses for greater accuracy. Figure 7 shows the RMS temperature errors for an area covering Europe, the Atlantic, and eastern America from 1978 to 1984. The open circles are the 10-level model, and the full circles are the 15-level model, with 1982 being the transition year. Similarly for winds, Figure 8 shows the 24-hour RMS vector wind errors, 200 mb, down to about 14 kn, over the same area as in Figure 7. As a new model comes in, the figures get better; but equally, improvements are introduced during the course of the model. A big change was introduced into our model in December, which added a new parameterization. In fact, for January, which is normally one of our worst months because the jets are strong, the figure was 14 kn, which is the same as the whole of the average for 1984. The figure for February was 13 kn. The year 1985 appeared to be a good year, also.

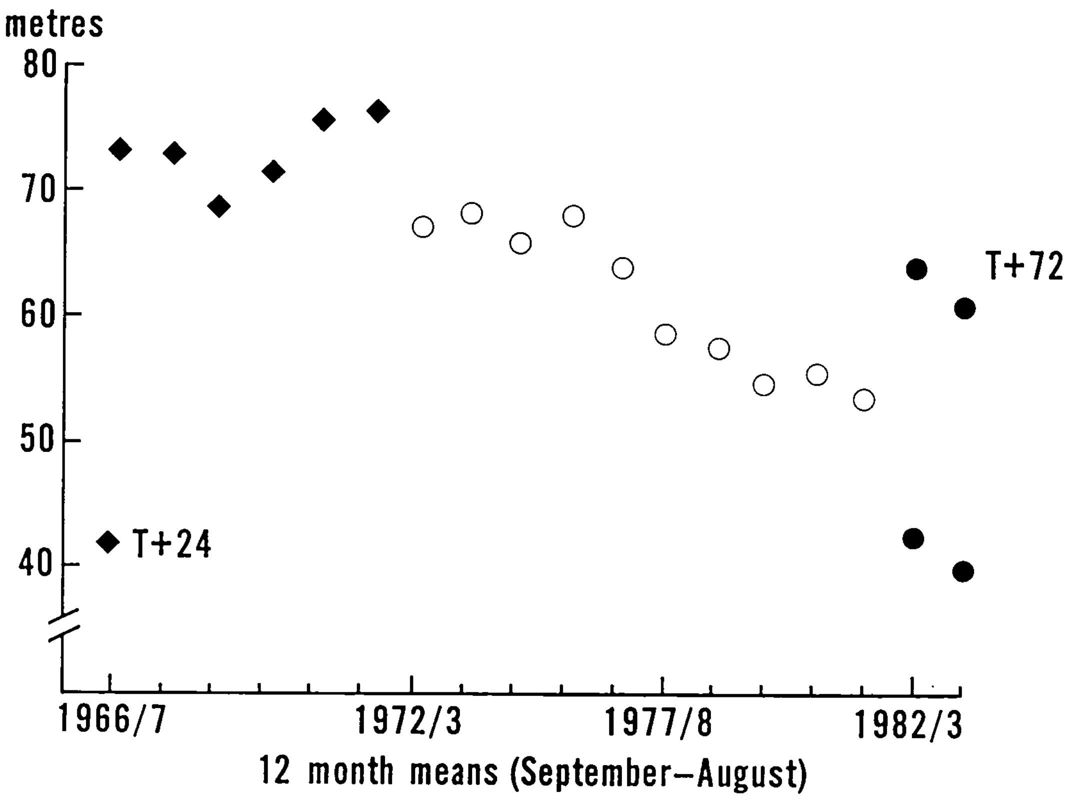

Figure 6. The 500 mb RMS height errors compared with model forecasts at T + 48.

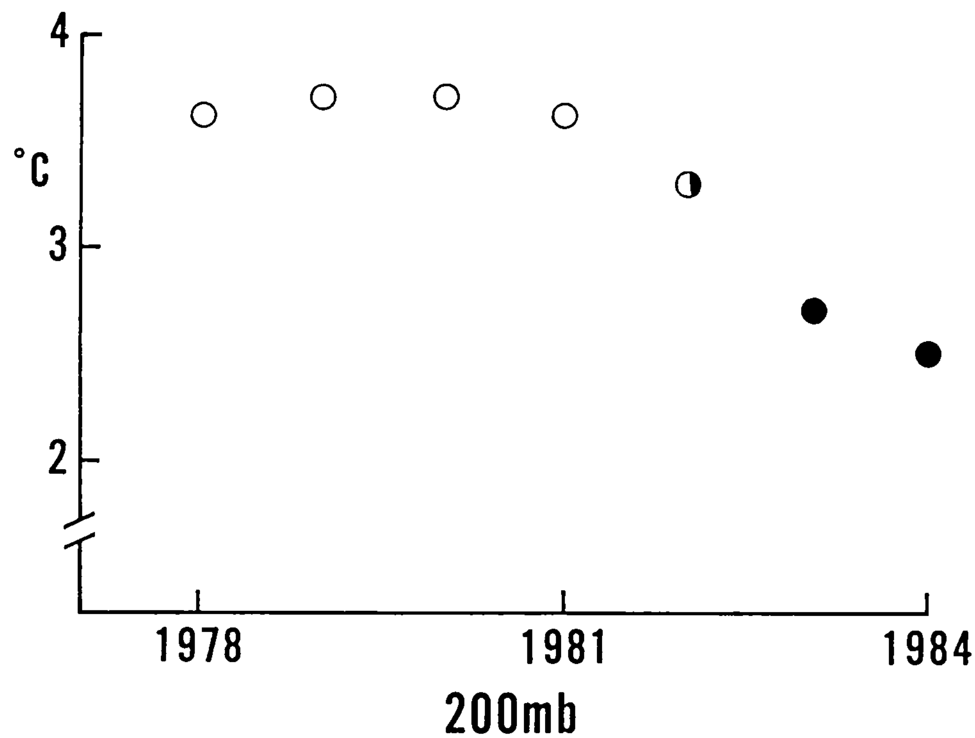

Figure 7. The 1978 to 1984 T + 24 temperature RMS errors for Europe, the Atlantic, and Eastern America.

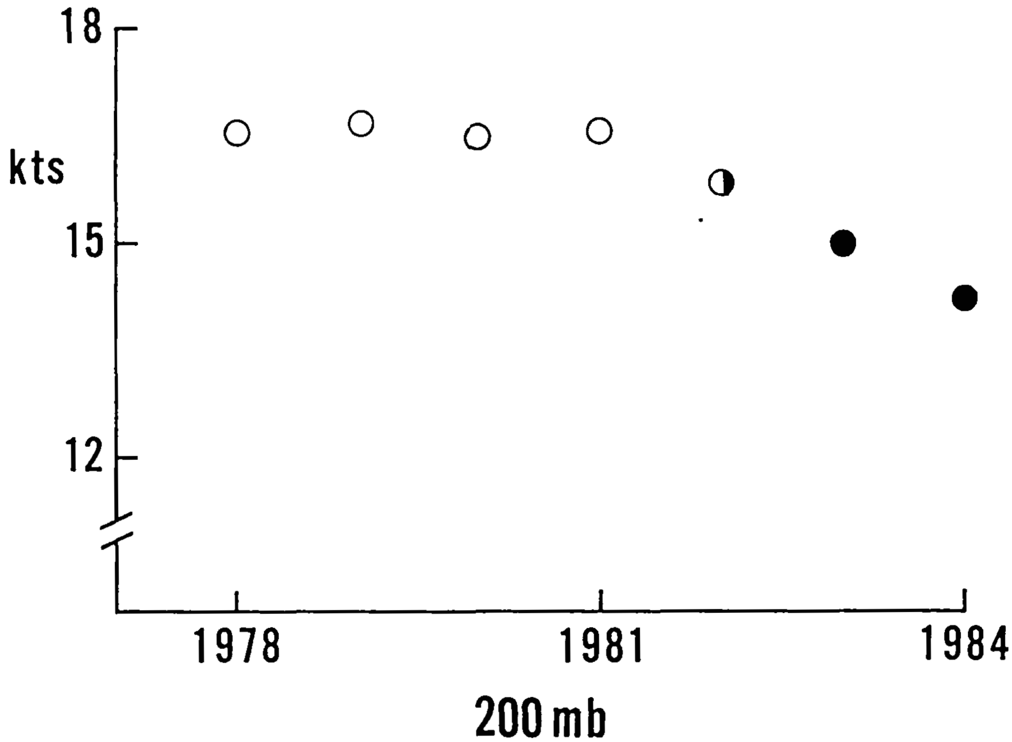

Figure 8. The T + 24 vector wind errors over same area as seen in Figure 7.