Western Region Technical Attachment
No. 90-18
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GLOBAL MODEL FORECASTS OF THE GREAT BRITAIN STORM OF 25 JANUARY 1990

[Editor's Note: Much of this Technical Attachment was taken from NMC Office Note 366 by Bradley A. Ballish, "Global Model Forecasts of the Great Britain Storm of 25 January 1990". Most Western Region forecasters will find this particular storm to be of only casual academic interest due to where it occurred. However, the study illustrates some interesting operationally significant model characteristics.]

On 25 January 1990, a severe storm hit Great Britain, causing over one billion dollars in damage and dozens of deaths. In 24 hours, the storm deepened more than 30 mb and, thus, can be considered a bomb (Sanders and Gyakum, 1980). Fig. 1 shows the NMC final analysis at 1000 mb and 500 mb for 1200 UTC 25 January 1990. The 1000 mb map shows a very deep low with a very strong height gradient over southern England. At 500 mb, there is a modest depression embedded in a strong westerly flow. During the 24 hours leading up to this time, the system moved halfway across the Atlantic Ocean and deepened 330 meters at 1000 mb!

The 5-day forecast from the European Centre for Medium Range Weather Forecasts (ECMWF) verifying at 1200 UTC 25 January is shown in Fig. 2. For the unusual storm, the ECMWF 5-day 1000 mb forecast was quite successful. The model forecast a deep 1000 mb low in approximately the correct location, but not quite deep enough. The 500 mb trough was forecast a little too far west of the observed position.

The ECMWF 4-day 1000 mb forecast (not shown) looked more like a trough with strong westerly winds moving around the Icelandic low. Thus, the 4-day forecast was not as good as the 5-day product. The 3-day and 2-day forecasts were similar to the 4-day product. The 1-day forecast was much better, but not quite deep enough.

The NMC MRF model in use during this event had 18 levels in the vertical, with T80 spectral horizontal resolution. The 5 1/2-day (132 hour) forecast is shown in Fig. 3, and gives no indication of a storm over England. NMC's first skillful forecast of the storm occurred 3 1/2 days (84 hours) in advance as shown in Fig. 4. Comparison with Fig. 1 indicates the 1000 mb low was not forecast quite deep enough. The forecast did indicate the tight gradient over southern England, but lacked the cyclonic curvature shown in the verifying analysis.

Unlike the ECMWF, the MRF produced excellent forecasts each model run after it locked onto the storm at 84 hours. Due to technical problems, NMC only received two British Meteorology Office forecasts valid at 1200 UTC 25 January. The UKMET 48-hour forecast placed the 1000 mb low in about the right location, but 150 meters too weak (not shown). The 24-hour forecast (also not shown) was still 90 meters too weak, i.e., better than the ECMWF but not nearly as good as the MRF.

The intriguing questions that arise from the performance of the models are: 1) why did the ECMWF forecasts deteriorate after its 5-day forecast, and 2) why were the MRF 5-day and 4-day forecasts so poor, followed by excellent forecasts from the 3-day forecast onward? Some possible answers can be found by looking at where the storm was prior to its explosive and destructive deepening over the eastern Atlantic Ocean, e.g., the initial model conditions for the forecast runs.

Five days prior to the devastating storm striking Great Britain, the system was a cut-off low aloft over the central United States as shown in Fig. 5. After 1200 UTC on 20 January, the upper low filled and lifted northeastward across the northeast United States as an open wave in the westerlies. By 72 hours prior to the Great Britain storm, the wave was over the western Atlantic Ocean. While the system was over the data-rich North American continent the NMC analyses consistently threw out observational data and analyzed the low with too little depth and insufficient cyclonic curvature. This is due to a buddy check system which is univariate. Thus, nearby wind and height residuals with a circular or cyclonic pattern appear to differ too much from each other and, hence, are not used in the analysis.

By three days prior to the storm, the 500 mb wave was over the Atlantic Ocean and the most important data for input to the initial analyses was ship data and satellite temperature soundings. NMC's surface database has two special features. First, NMC enters a large number of surface "Bogus" observations. These are values of mean sea level pressure produced by human analysts. The second special feature is that the Ocean Products Center (OPC) does extensive quality control of ship observations. The OPC can keep the Optimum Interpolation data preprocessor from ever seeing a report, or force the use of a report. The European Centre does not use human quality control on ships, nor does the Centre use surface bogus data.

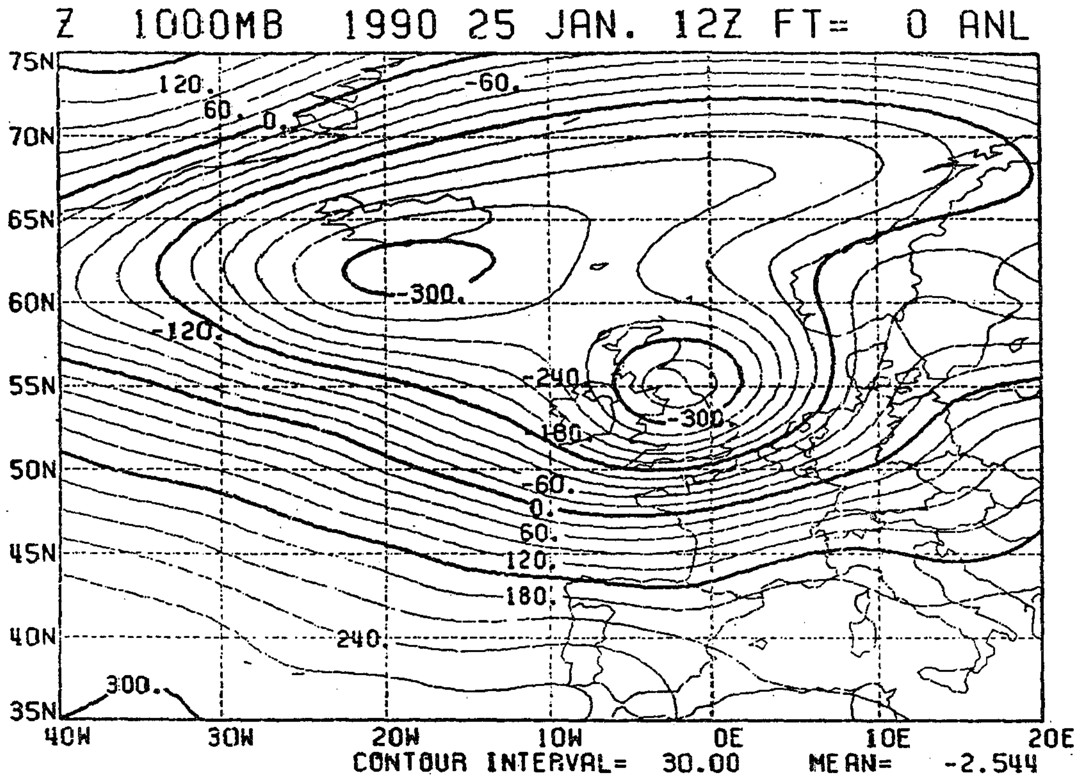
In summary, when the 500 mb low that was important for this storm was over the U.S., the NMC analyses had both heights not as low and cyclonic wind circulations not as strong as the observations indicated. This was clearly due, at least in part, to a univariate buddy check that removes some wind and height observations even when they appear to have some geostrophic consistency. Analysis of other cases indicates that even with no buddy check problems, NMC still can underdraw for geostrophic data residuals. This may be a theoretical error in the analysis scheme. Conversely, the European model made excellent forecasts from their initial analyses five and four days prior to the storm. When models were later initialized while the incipient storm was over the Atlantic Ocean, the tables were turned. The extensive human bogusing and ship observation quality control efforts for the NMC analyses led to much better forecasts than those of the ECMWF, whose analysis scheme does not include such features.

Care must be exercised in drawing conclusions from a single case. However, this example suggests that forecasters should look closely at initial analyses when the MRF and ECMWF differ significantly on forecasting "bombs". If the bomb originates from a strongly curved feature over a data-rich area, then the ECMWF may have a better handle on developments. If the storm develops from an incipient system over oceanic areas, then the MRF may perform better.

Reference:

Sanders, F. and J.R. Gyakum, 1980: Synoptic-Dynamic Climatology of the "Bomb". *Mon. Wea. Rev.*, **108:** 1589-1606.

(a)



(b)

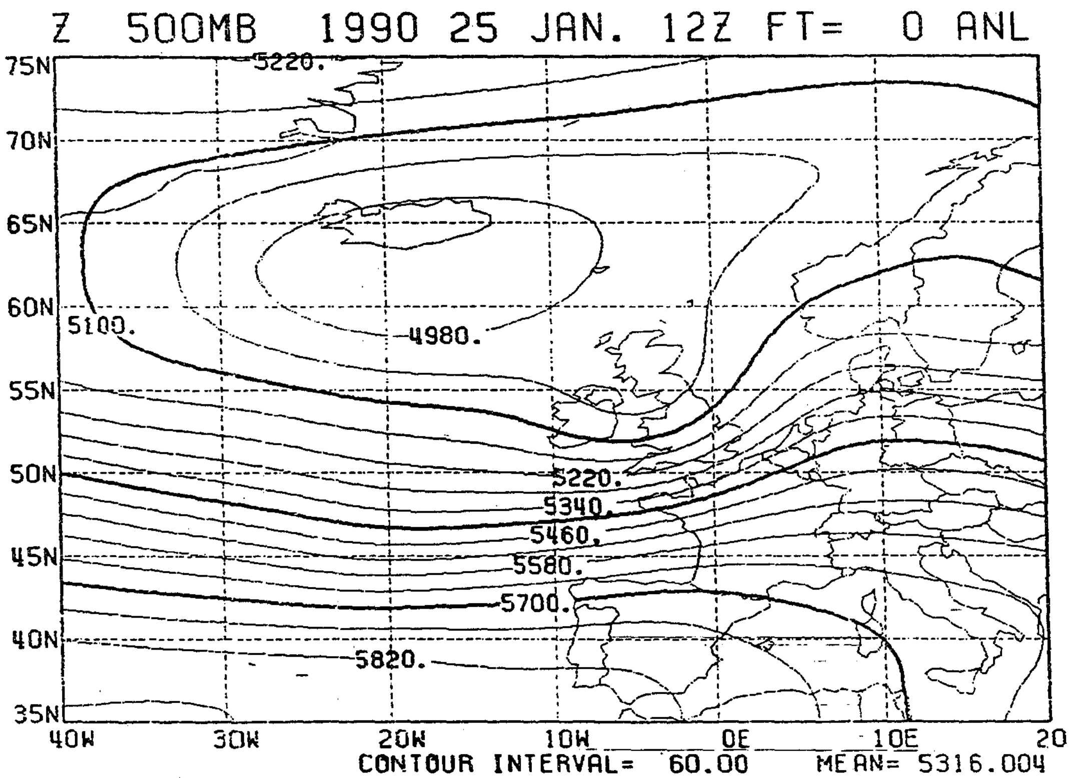
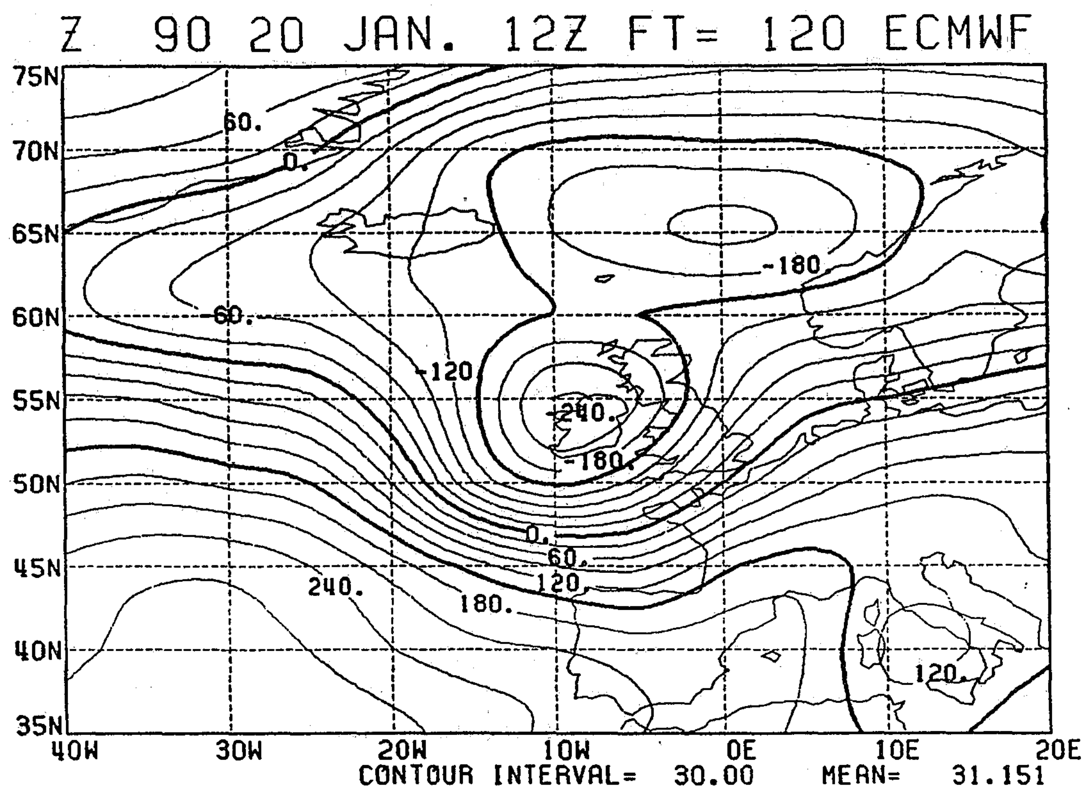


Fig. 1. NMC final analysis heights, 1200 GMT 25 January, 1990: (a) 1000 mb, (b) 500 mb.

(a)



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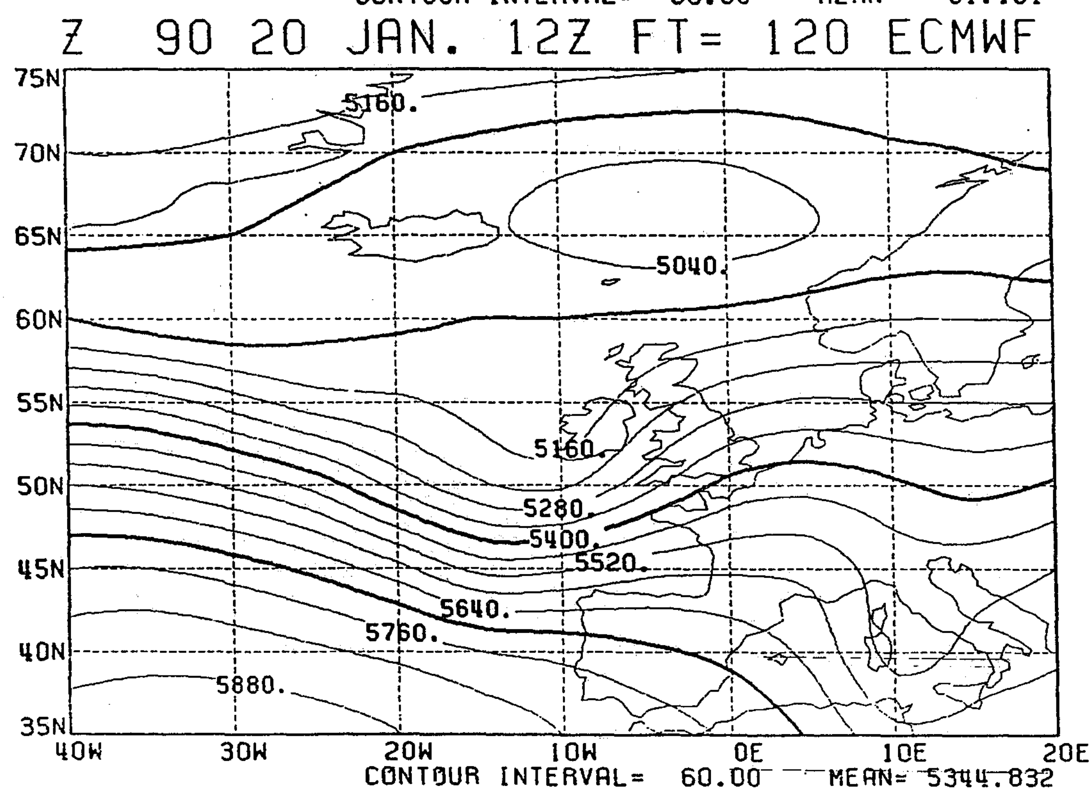
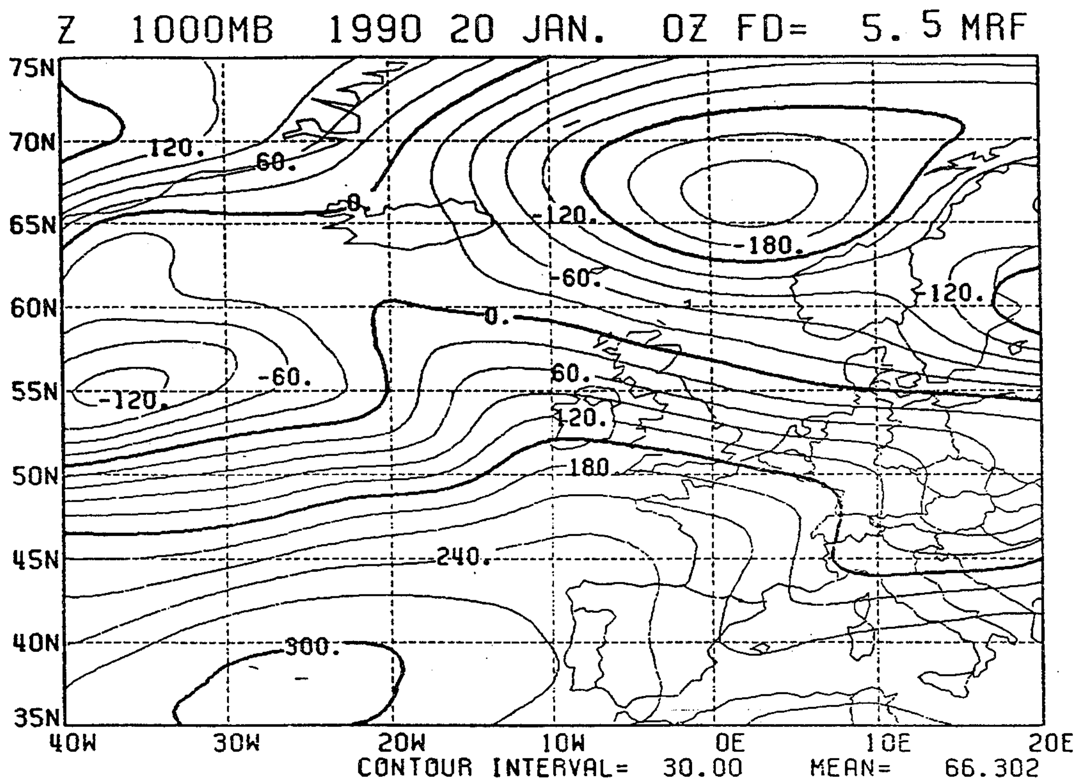


Fig. 2. ECMWF 5 day height forecasts, valid 1200 GMT 25 January, 1990: (a) 1000 mb, (b) 500 mb.

(a)



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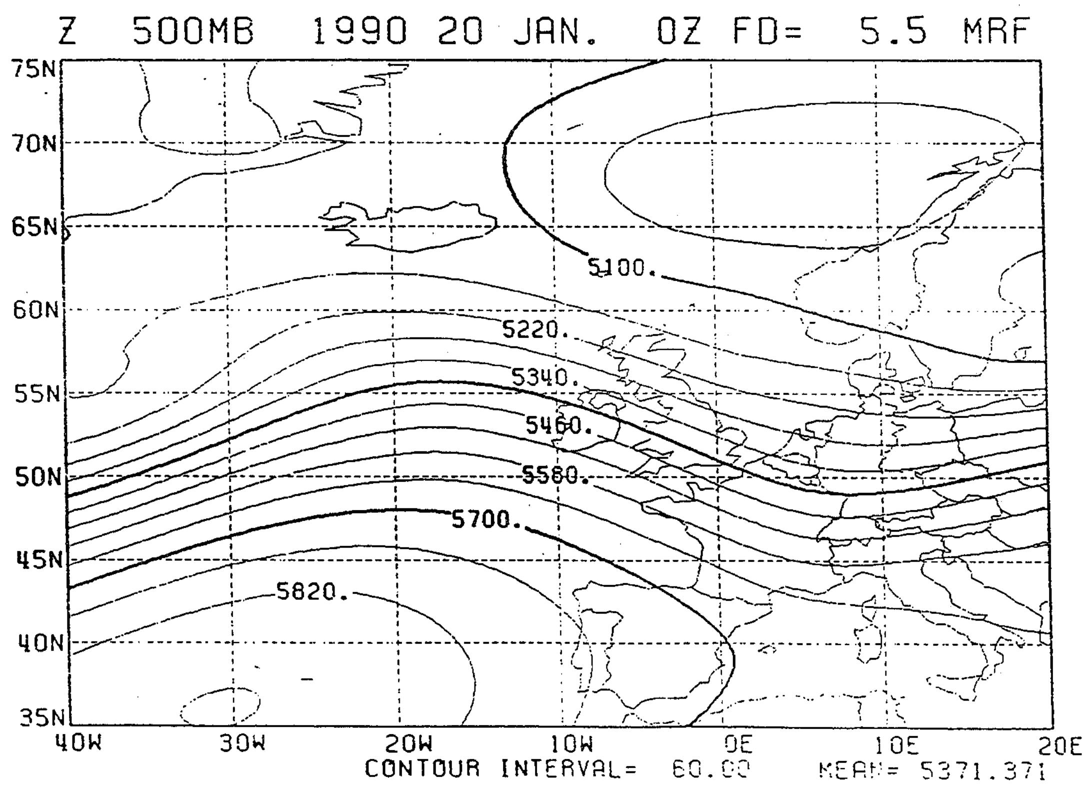
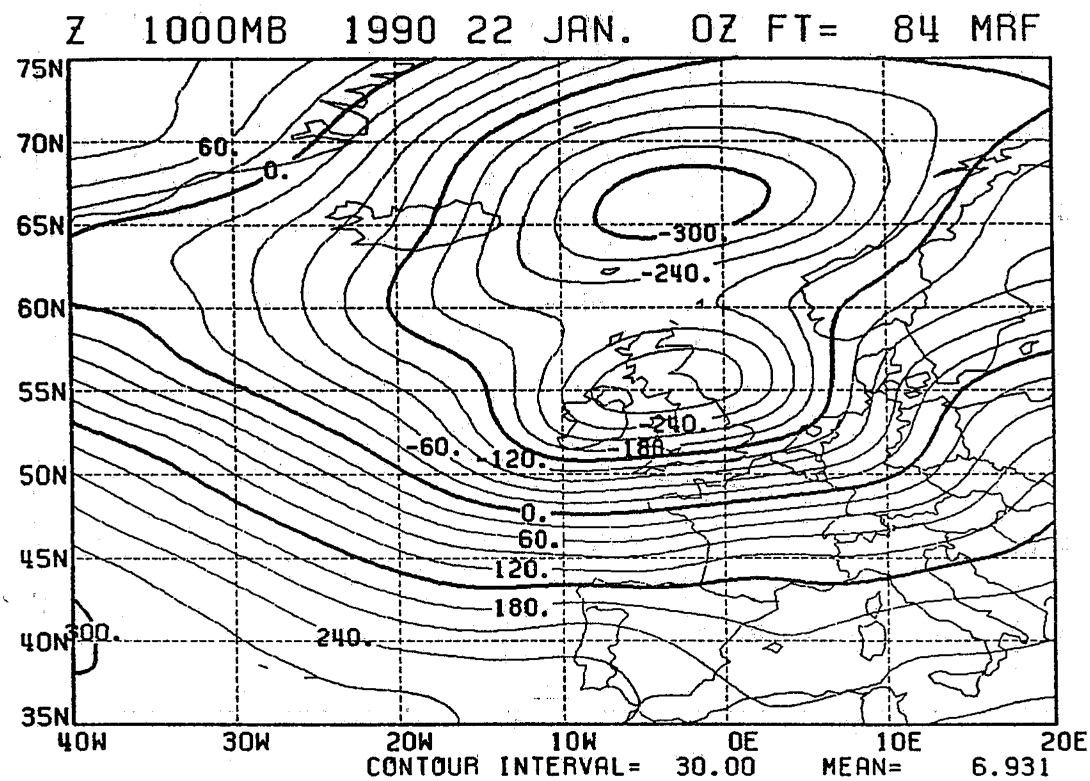


Fig. 3. NMC 5 1/2 day (132 hr) height forecasts, valid 1200 GMT 25 January, 1990: (a) 1000 mb, (b) 500 mb.

(a)



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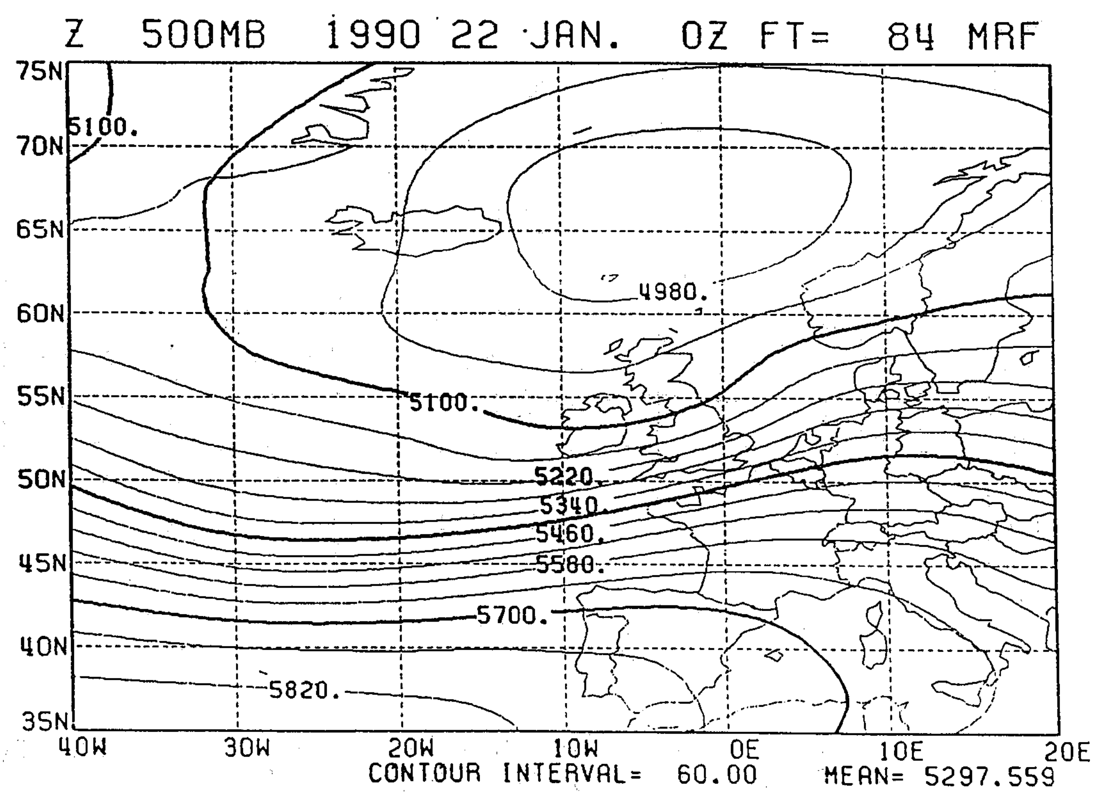

Fig. 4. NMC 3 1/2 day (84 hr) height forecasts, valid 1200 GMT 25 January, 1990: (a) 1000 mb, (b) 500 mb.

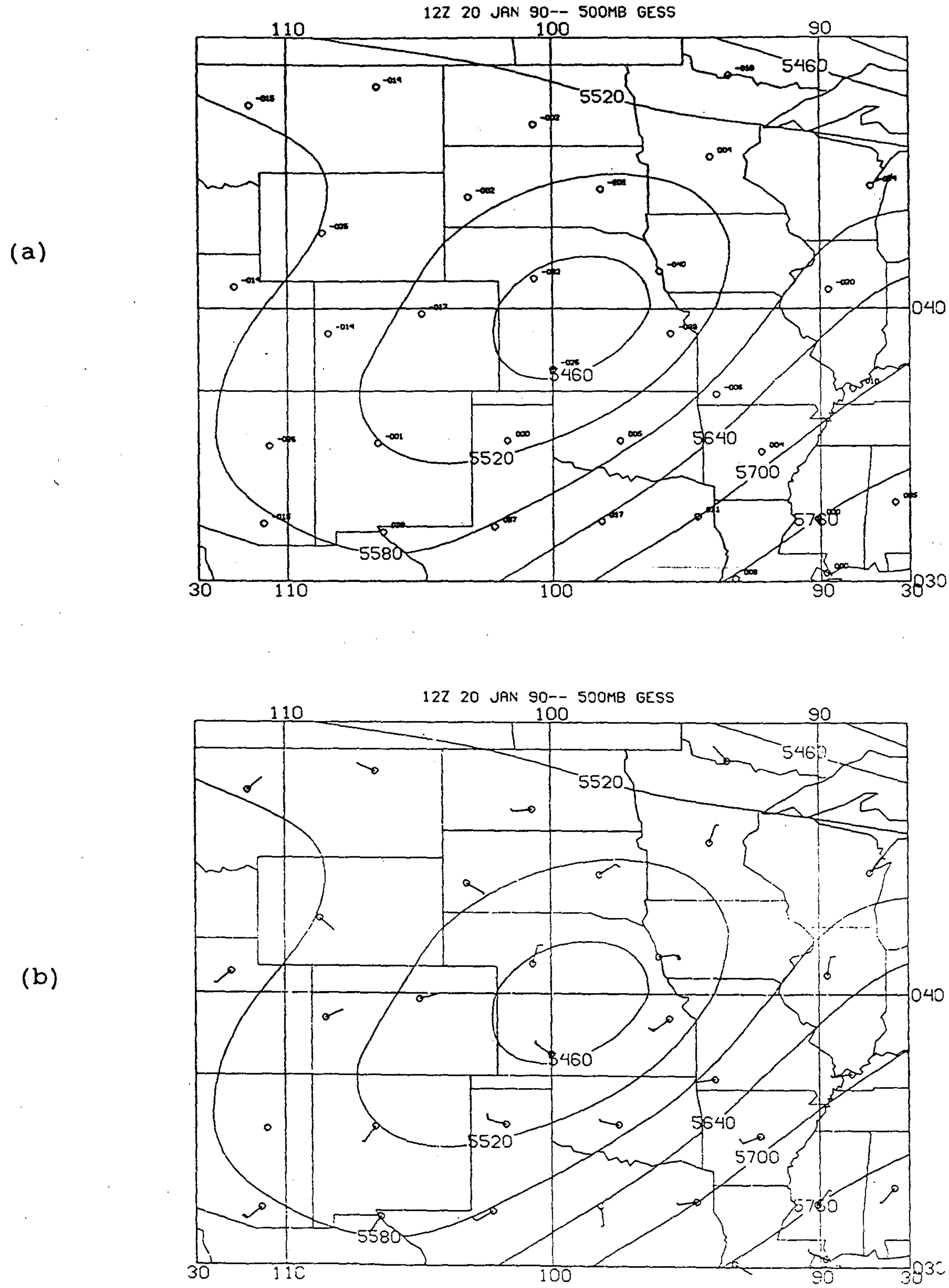

Fig. 5. NMC first-guess 500 mb heights for 1200 GMT 20 January 1990: (a) with height residuals, (b) with wind residuals.