Western Region Technical Attachment
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A COMPARISON OF SPRING 1992 ANTICYCLONE FORECASTS FOR THE AVN, NGM, AND ETA MODELS

In several previous Technical Attachments (TAs), (WRTAs 91-27 and 92-16), the latest performance statistics of the NMC models have been reviewed. This TA summarizes the spring 1992 (hereafter, referred to as SP92) NMC model verification statistics for anticyclone forecasts compiled by Jamie Kousky and Richard Grumm of NMC. The three NMC models examined are the Nested Grid Model (NGM), Aviation run of the Global Spectral Model (AVN), and the new Eta model (ETA).

Since the new version of the Global Spectral Model (T126-wave resolution) in March 1991, two full spring seasons of statistics (1 March through 31 May) have been collected. WRTA 91-27 reviews the spring 1991 model verification errors (cyclones and anticyclones) for both the NGM and AVN. In SP92, the ETA model (80 km resolution) was fully operational, therefore, providing a third product for statistical verification for anticyclone forecasts. The data discussed in this TA refers to SP92 and should not be considered representative of an individual model's performance in general, but rather for spring seasons under a similar large-scale pattern such as 1992.

Geographical Distribution of Errors

The 48-hour forecast is used to compare the spacial error distributions for the AVN, ETA, and NGM for SP92. Although the errors are of greater magnitude for the 48-hour model forecasts (when compared to the 24-hour forecasts), the geographical distribution of the errors is very similar. Therefore, only the 48-hour model forecast errors for surface pressure, 1000-500 mb thickness, and distance are discussed in this review.

Figures 1a-c depict anticyclone surface pressure errors for the ETA, NGM, and AVN, respectively. Spatially, the models were similar in their location of both over and underestimates in surface pressure forecasts; however, they did differ on the magnitude of the error. The underestimates in surface pressure generally occurred over eastern North America with the ETA model forecast errors being the largest (greater than -2 mb region over James Bay).

The overestimates in surface pressure forecasts occurred over western North America, with the NGM and AVN errors spatially very similar (Figs. 1b,c). A positive anomaly couplet (i.e., overestimated surface pressures) occurred over the northwest U.S., with one maximum off the west coast of British Columbia and the other in the lee of the northern Rockies. Off the coast of British Columbia, the AVN and NGM error magnitudes corresponded well (greater than +3 mb). The AVN's overestimate of surface pressure was greater than that of the NGM in the lee of the Rockies (by approximately 1 mb), and extended slightly northwest into Alberta.

Overall, the ETA model overpredicted surface pressure for SP92 anticyclones in the same region, west of British Columbia, however the magnitude was less (by approximately 2 mb). The ETA model also produced a positive error anomaly in the northern High Plains, east of the AVN and NGM model errors. This may be the result of the topographical resolution incorporated in the ETA model. The magnitude of the surface pressure error (mean) was less due to the ETA model's inconsistency (i.e., having surface pressure errors of both signs reduces the mean).

In SP92, a center of positive 500 mb height anomalies (and the corresponding 500 mb ridge) was located over western North America. This created a preferred anticyclone track in the same region where the surface pressures were overpredicted (Fig. 2). The previously discussed overpredicted surface anticyclone pressure region in western North America is a result of the model's inability to forecast the decay and re-intensification of these systems as they propagate over the Rockies.

The 1000-500 mb thickness errors for the ETA, NGM, and AVN model forecasts are depicted in Figures 3a-c. The 1000-500 mb negative thickness errors correspond conversely to the surface pressure errors. In other words, the couplet of overpredicted surface pressures over western North America was a result of the model's overall cold bias in that same region. Thus, lower 1000-500 mb thickness values were generally found in the region of high surface pressure errors.

Statistical Errors

Tables 1-3 show the statistical errors for surface pressure, 1000-500 mb thickness, 850 mb temperature, and distance, at all forecast periods, for the AVN, NGM and ETA, respectively. Overall, the AVN and NGM both overpredicted, while the ETA model underpredicted surface pressure for anticyclones in SP92. The AVN had the lowest root mean square (RMS) errors for surface pressure. The ETA model was inconsistent in the sign of the errors (which lowered the mean errors), and produced the largest RMS errors (indicating larger overall forecast errors in surface pressure).

The AVN also had the smallest RMS errors for 1000-500 mb thickness forecasts with a mean cold bias at all forecast periods. The NGM and ETA models experienced both warm and cold mean biases, depending on the forecast period, and larger RMS errors than the AVN. This is an indication of the NGM and ETA model's greater inconsistency when forecasting thickness.

As for the distance errors, the AVN had both the smallest RMS and mean errors for the SP92 period, followed by the NGM and ETA models, respectively. The mean AVN distance error (from the center of the anticyclone) at 48 hours was 21 km less than the NGM and 125 km less than the ETA model.

Summary

It should be emphasized again that the above review of anticyclone verification errors is based on only one season of one year. However, it can have applications in future spring seasons (1 March-31 May) with 500 mb positive height anomalies over western North America. In these situations, the AVN and NGM seem to consistently overforecast anticyclones, especially in the lee of the northern Rockies and off the coast of British Columbia. These two models can also be expected to have a cold bias (lower than observed

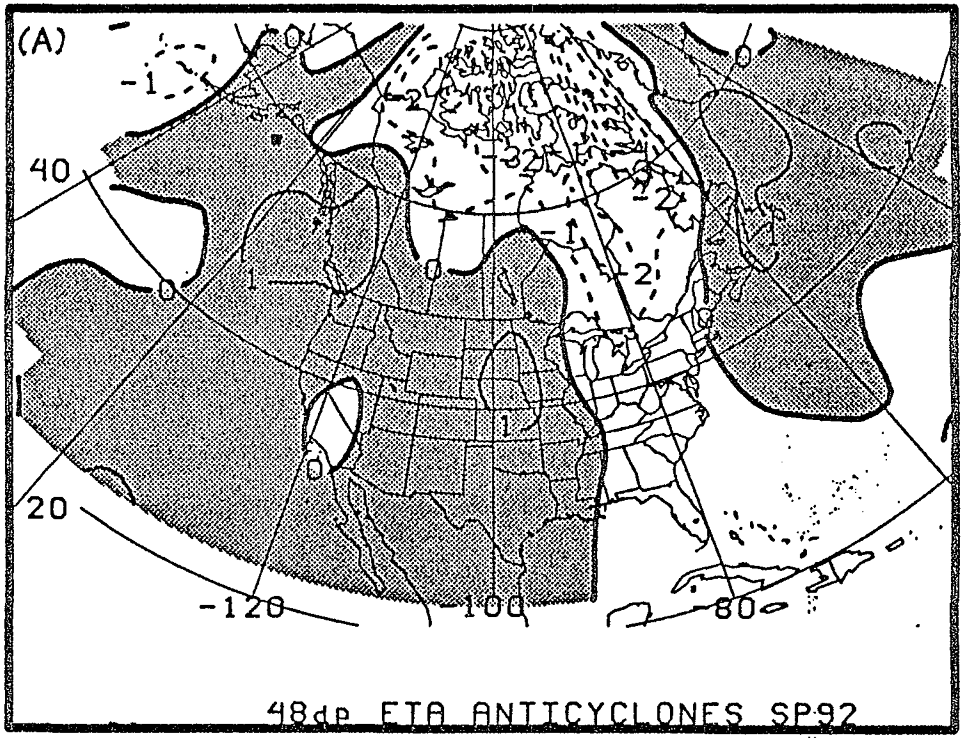
1000-500 mb thickness values) over the northwest U.S., at least during spring seasons. Despite its biases, the AVN was the most accurate in forecasting surface pressure, 1000-500 mb thickness, and the distance from the observed anticyclone centers.
The ETA model was the most inconsistent and, therefore, had the highest RMS errors. The ETA model is expected to perform better as a quantitative precipitation forecast (QPF) model, especially in the western U.S.

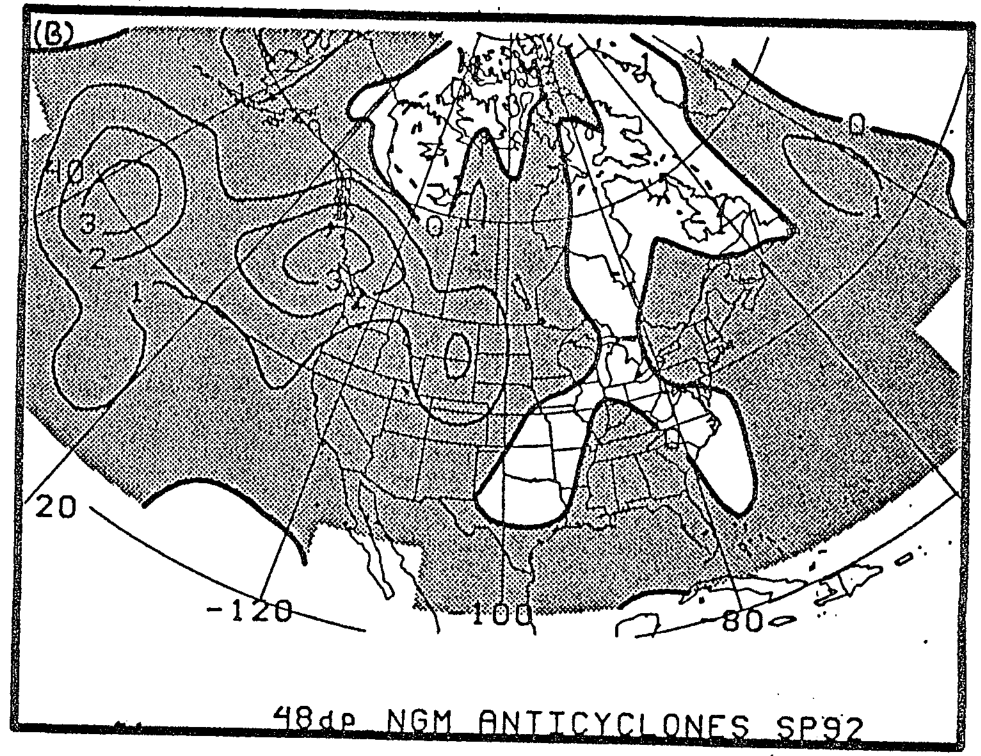
References

Western Region Technical Attachment, No. 91-15, April 23, 1991. March 1991 Surface Cyclone Performance of the Aviation and Nested Grid Models.

Western Region Technical Attachment, No. 91-27, July 9, 1991. AVN/NGM model comparison.

Western Region Technical Attachment, No. 92-16, April 28, 1992. Verification of the Aviation/NGM Models-Winter of 91-92.





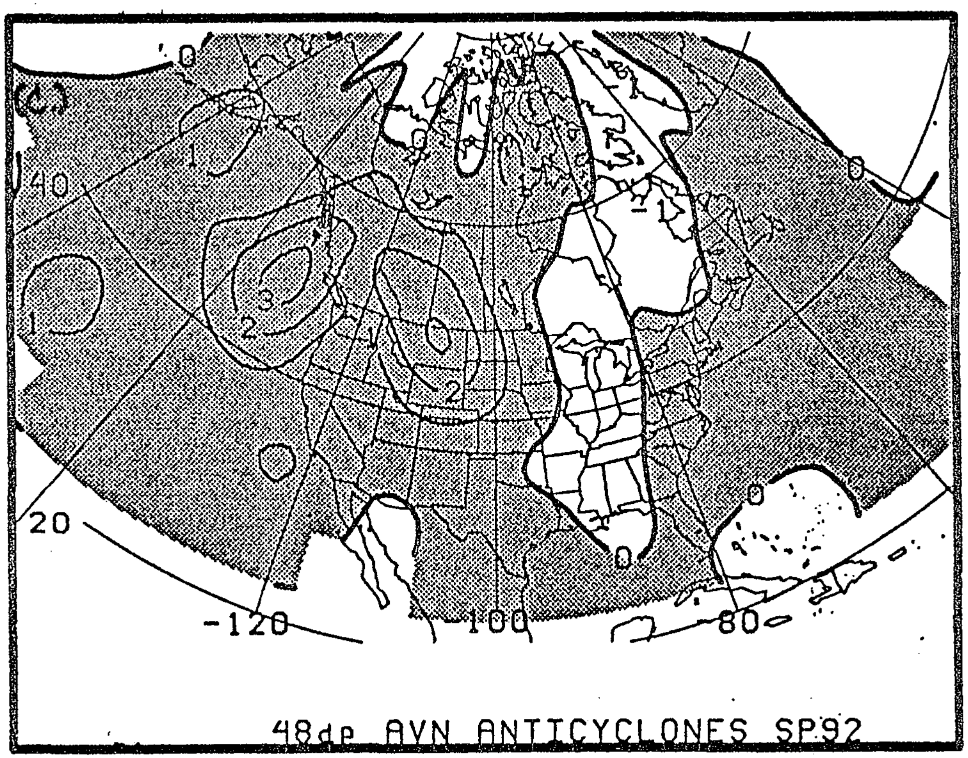
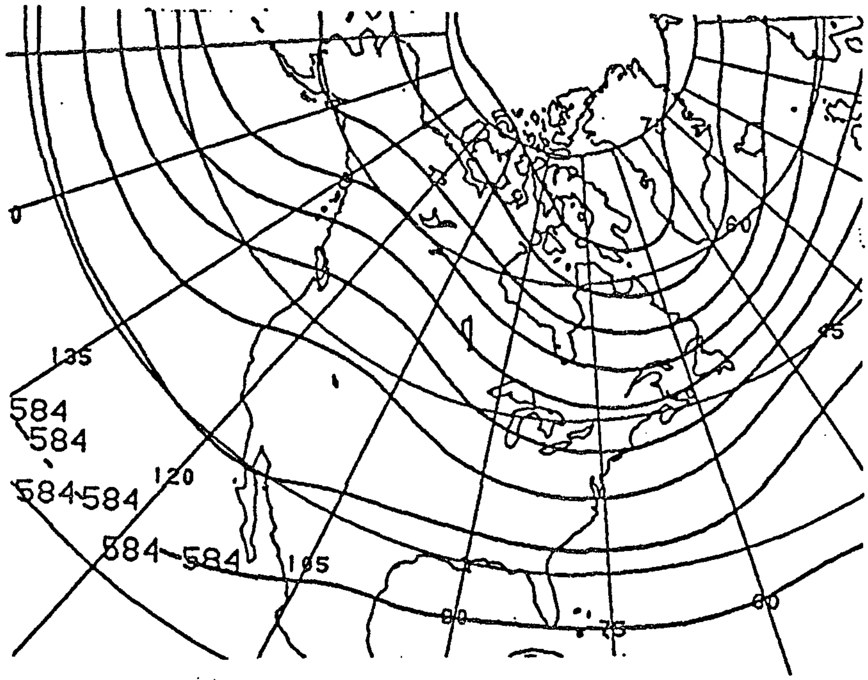
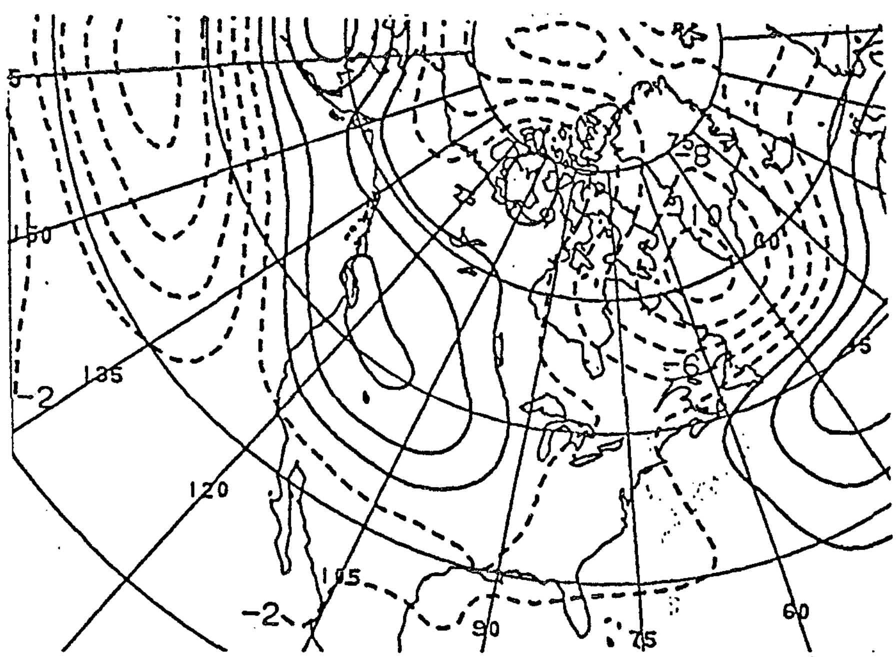


Figure 1. Pressure (mb) errors for SP92 in the (a) ETA (b) NGM and (c) AVN models.

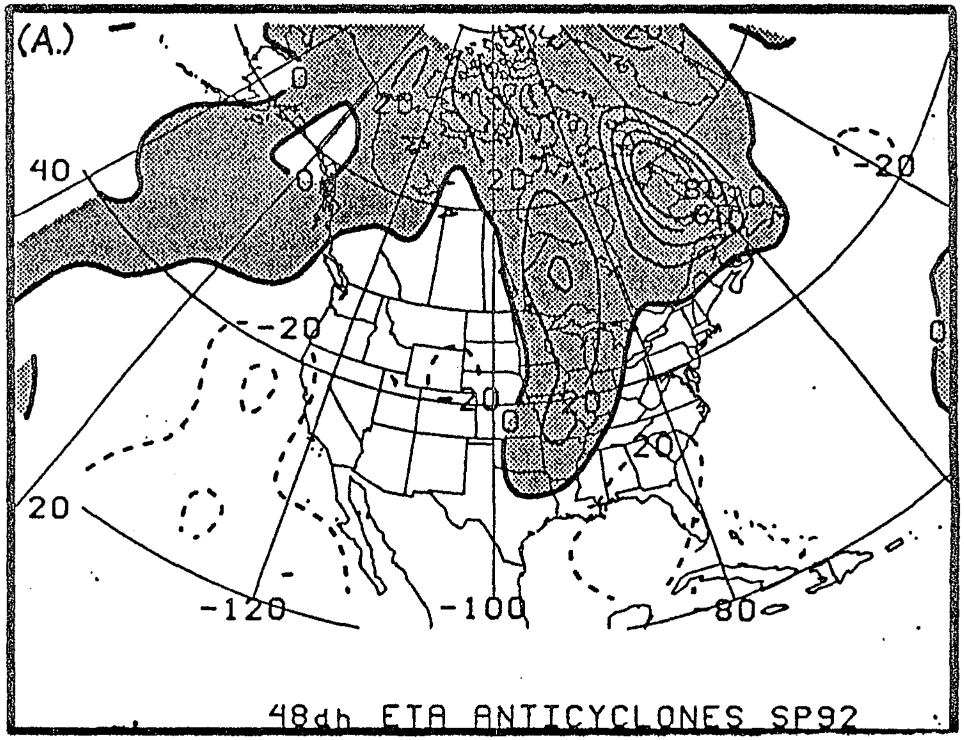


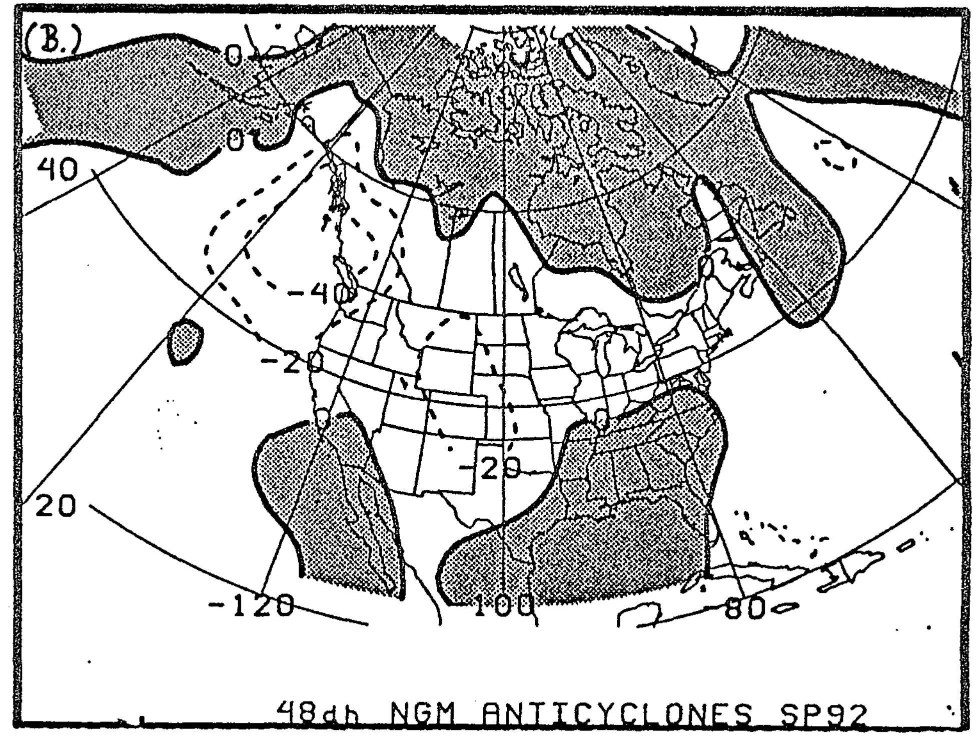
a. 500 mb Mean Heights (dm) S92



b. 500 mb Height Anomalies (dm) SP92

Figure 2. 500 mb (a) mean heights and (b) height anomalies for SP92 in dm.





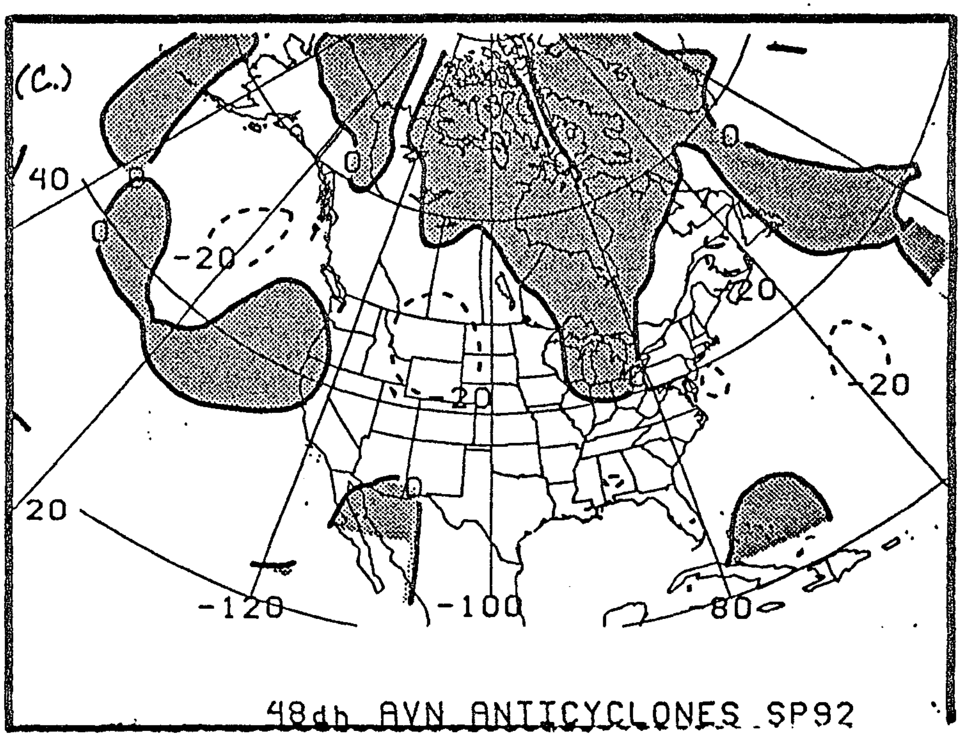


Figure 3. 1000-500 mb thickness error (dm) for the (a) ETA (b) NGM and (c) AVN models.

Anticyclones : SP92

Model	Fcst	Number	Pressure (mb)		Temp 850 (K)		Thickness (m)		Distance (km)	
			mean	RMS	mean	RMS	mean	RMS	mean	RMS
AVN	12	469	0.30	1.08	0.01	1.39	-0.76	25.08	147	191
AVN	24	419	0.68	1.61	-0.03	1.81	-1.40	33.39	203	265
AVN	36	399	0.76	2.12	-0.03	2.27	-2.12	40.05	258	342
AVN	48	381	0.87	2.66	-0.18	2.36	-3.97	43.36	322	418
AVN	60	356	0.94	3.06	-0.24	2.87	-6.23	53.27	408	527
AVN	72	296	0.93	3.36	-0.41	3.59	-7.41	67.22	468	601

Table 1. Mean pressure, 850 mb temperature, 1000 to 500 mb thickness and distance errors and RMS of the errors in the AVN by forecast of surface anticyclones during SP92.

Model	Fcst	Number	Pressure (mb)		Temp 850 (K)		Thickness (m)		Distance (km)	
			mean	RMS	mean	RMS	mean	RMS	mean	RMS
NGM	12	581	0.52	1.43	-0.07	1.95	-0.95	31.68	193	239
NGM	24	520	0.91	2.22	0.02	2.43	-1.83	40.79	242	295
NGM	36	495	1.15	3.01	0.01	2.69	0.72	44.96	301	377
NGM	48	438	1.16	3.59	-0.07	2.83	-3.07	46.53	343	432

Table 2. As in Table. 1 except for NGM anticyclones during SP92.

Model	Fcst	Number	Pressure (mb)		Temp 850 (K)		Thickness (m)		Distance (km)	
			mean	RMS	mean	RMS	mean	RMS	mean	RMS
ETA	12	466	-0.30	1.71	-0.01	2.33	-1.48	39.91	233	285
ETA	24	432	-0.12	2.33	0.14	2.64	0.11	46.90	286	349
ETA	36	418	-0.11	2.90	-0.02	3.20	-1.92	57.32	366	456
ETA	48	389	-0.02	3.27	-0.01	3.62	-0.10	69.53	447	564

Table 3. As in Table. 1 except for ETA anticyclones during SP92.

Tables 1-3. Statistical errors for the AVN, NGM, and ETA models for SP92.