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AN INVESTIGATION OF LOW CLOUD FORECASTING USING THE NGM GRIDPOINT DATA FOR RALEIGH AND CHARLOTTE, NC DURING THE SPRING OF 1991

Michael P. Rusnak
National Weather Service Forecast Office
Raleigh, North Carolina

Editor's Note: The NGM gridpoint data analyzed in this study is not available at the majority of NWS offices.

1. INTRODUCTION

Accurate forecasting of low cloud cover and its associated weather depends on the proper evaluation of many variables. The prediction of low clouds is a major concern for aviation weather forecasting. With the emphasis today on the use of new technology, the demand for more timely and accurate forecasts of adverse weather conditions is expanding.

During the past 5 years, there have been several changes in the National Meteorological Center (NMC) forecast models. A number of advanced diagnostic and forecast techniques have also been developed by researchers and forecasters at NMC. One technique makes use of hourly gridded data from the Nested Grid Model (NGM), which is not possible to do with the conventional operational numerical guidance. Starting in January 1991, experimental NGM numerical guidance output (NGM Gridpoint Data) was introduced to a few select forecast offices including WSFO Raleigh-Durham (RDU), to be used on a trial basis.

The purpose of this study was to evaluate the performance of the NGM gridpoint data for the Spring months of April, May, and June of 1991 at WSFO Raleigh-Durham and WSO Charlotte (CLT), both located in North Carolina. This paper will investigate the reliability of the NGM gridpoint forecasts of low clouds by comparing the model forecasts to the observed atmospheric conditions.

2. NGM GRIDPOINT DATA

The NGM was first used as a research model in late 1974. It was later implemented as an operational prediction model in 1985 (Phillips 1979). Recently, the archived hourly output from the NMC dynamical models has provided the basis for advanced graphic diagnostic and forecast tools. NMC has established two primary archive systems. These are the Regional Profile Archive (RPA) and the Global Profile Archive. This paper will focus on the use of the RPA.

The RPA system archives the NGM model output, including the initialized raw data and forecast diagnostic quantities at selected stations across North America. Currently, the RPA archives this information for more than 200 North American stations for each individual hour of the 48-hr model forecast (Fig. 1). Every 12 hours, the forecasts are interpolated to a selected station from the nearest four model grid points. These data are then saved and used for verification studies (Plummer 1989).

NGM gridpoint data can be accessed via the National Advanced Systems (NAS) 9000 computer at NMC. An example of the raw NGM gridpoint model data are shown in Figure 2. These gridpoint data supply the forecaster with more detail on the structure of the model vertical profile. Although there is an abundance of information in this product, one must remember, as with any form of numerical guidance, the forecasts might be extremely inaccurate for some events. An example of each column of the guidance, starting from the left to right, is as follows:

P - Model projection hour (0 to 48).

GMT - UTC time of day.

HR PRCP - Hourly precipitation in thousandths of an inch.

TOT PRCP - Total precipitation in hundredths of an inch.

TEMPERATURE - in the 1st (BL), 4th (L4), 6th (L6), 9th (L9) and 12th (L12) model layers.

RELATIVE HUMIDITY - (First digit of nearest 10% for each model layer. * means > 95%).

LAYER...APPROXIMATE CENTER OF THE LAYER ABOVE MSL

- 1 600 feet (Boundary layer)
- 2 2000 feet
- 3 3500 feet
- 4 5000 feet (~ 850 mb layer)
- 5 7000 feet
- 6 9000 feet (~ 700 mb layer)
- 7 12000 feet
- 8 15000 feet
- 9 18000 feet (~ 500 mb layer)
- A 21000 feet
- B 26000 feet
- C 32000 feet (~ 300 mb layer)
- D 37000 feet
- E 43000 feet
- F 50000+ feet

AV - Average relative humidity; surface to 500 mb (layers 1-9).

SFC PRES - Model surface pressure in millibars.

K* - K stability index; * denotes use of nearest layer temperature and dew point to compute values.

85-70 DDSS - Mean wind direction and speed; 850 to 700 mb (layers 4,5,6).

BL DDSS - Mean wind direction and speed; boundary layer (layer 1).

After analyzing the data, you will notice that discrepancies occasionally exist between the grid point data and the NGM FRH and associated graphics. According to Mostek (1993, personal communication) at NMC's Techniques Development Unit, some of the reasons for the discrepancies include:

- Different values of precipitation output, due to the gridpoint values being "true" values computed by the NGM while the values on AFOS products result from a "smoother/desmoother" process.

- The pressure column is sea level pressure in the NGM FRH, while the pressure column in the gridpoint data uses the model elevation which represents the surface in the NGM.

There are many ways to analyze the NGM gridpoint data. One of the quickest and easiest ways to view the forecasted vertical distribution of moisture and potential cloud layers, is to take a copy of the raw gridpoint data, rotate it 90° to the left and read the relative humidity output with time being projected from left to right and altitude increasing upward. To stress model layers that are at or near saturation, the forecaster should contour the layers that have relative humidities of 80% (8 on printout) or higher. An example of an analyzed gridpoint data model run is illustrated in Figure 3.

Analyzing other NGM gridpoint data variables has forecasting advantages as well. The BL, L4 and T3 (from the NGM FRH) temperatures can aid in the forecasting of precipitation type. Forecasters at WSFO Washington, D.C. have developed a software package (Nierow and Kane 1993) that uses the NGM gridpoint data to produce NGM forecast soundings available for analysis using the SHARP program (Hart and Korotky 1991). These soundings can be useful for determining thermodynamic and dynamic indices for a specific forecast period.

3. METHODOLOGY

For purposes of this study, model data was only examined if low clouds were predicted. During the 3 month period of this study, a total of 40 NGM model runs were analyzed. Twenty cases were taken from 1200 UTC, and 20 were from 0000 UTC. Sixteen cases came from April, 14 were from May, and 10 were from June. After obtaining the data and observations for each case, the following method was used to determine the low cloud layers lists as follows:

- Low clouds were defined as layers 1 through 4 on the NGM gridpoint data, the lowest 5,000 feet of the model atmosphere.

- Forecasted relative humidities in the model lower layers had to be 80% or higher in order for a cloud layer to be indicated. A layer prediction verified if it was either broken (6/10 to 9/10), or overcast (10/10) in coverage. A layer did not verify if the observation indicated scattered (5/10 coverage or less) or if less than 80% relative humidity was forecasted.

4. RESULTS

Tables 1 and 2 summarize the monthly cloud verification results in 12-hr periods for RDU and CLT. Table 3 combines the 3 months of data into a seasonal value for the Spring of 1991. The predicted NGM model gridpoint cloud layers (relative humidity greater than 80%), indicated a relatively high percentage of correct forecasts when the model indicated low clouds. The overall verification statistics for the observed low cloud layers, with respect to the model forecast low clouds, are listed in Table 4.

A closer examination of the combined 48-hr forecast results for both cities revealed that:

- 74% of all model forecasted low cloud layers verified.

- 1% of model low cloud layers that were not forecasted occurred.

- 14% of model low cloud layers that were forecasted did not occur.

- 11% of model low cloud layers that were not forecasted did not occur.

5. CONCLUSION

Overall, the NGM gridpoint data provided useful low cloud forecasting guidance for the Spring of 1991. However, it should be noted that this study only used 3 months of data with model runs that only forecasted cloud layers 5,000 feet or lower. With this is mind the following observations can be made:

- The forecast verified more than 70% of the time when a low cloud layer was predicted by the model.

- The percentage of low clouds forecasted and verified by the NGM gridpoint data, either increased or varied slightly as the projection increased to 48-hrs.

If this study is an indication of the reliability of the NGM gridpoint data in predicting the occurrence of low cloud layers, this type of information could become a valuable aviation and public forecasting tool.

The difficulty of forecasting low cloud cover can be reduced by applying objective forecast techniques that relate important weather processes to observed surface conditions. Some of these techniques include:

- NGM gridpoint data.

- Satellite imagery interpretation.

- Numerical guidance from different forecast models.

- Evaluation of low level wind fields.

In the time since this study was completed, additional computer programs have been developed by forecasters at WSFO Buffalo, which display the hourly gridpoint data on a personal computer. Some of the software produces:

- A time vs. height color display of relative humidity and precipitation profiles, wind speed and direction profiles, and a freezing level profile.

- The NGM time series of temperature vs. height can be displayed by use of either a linear or logarithmic scale. This is quite helpful in the forecasting of freezing and/or frozen precipitation.

Most of the NGM gridpoint data graphics are displayed with time advancing to the left, which assists with the visualization of west-to-east moving weather systems. By using the combination of the NGM gridpoint numerical guidance and the new PC based graphics, the NGM gridpoint guidance could become an extremely useful tool in forecasting the occurrence of low cloud layers.

ACKNOWLEDGEMENTS

Special thanks to Tony Mostek (Techniques Developmental Unit, NMC) whose guidance in finding references for the NGM Gridpoint Data was invaluable. Other individuals (at WSFO RDU) to be acknowledged are: Joe Pelissier (DMIC) and Rod Gonski (WPM) for their informative staff memos; and Glenn Field (Lead Forecaster/Mentor) and Kermit Keeter (Lead Forecaster) who helped in proofreading and editing this paper.

REFERENCES

Hart, J.A., and W. Korotky, 1991: The SHARP Workstation V1.50. A Skew T-Hodograph analysis and research program for the IBM and compatible PC. NOAA/NWS, Charleston, WV, 30 pp.

Nierow, A., and R. Kane, 1993: An evaluation of NGM forecast soundings in predicting potential for significant weather situations. *13th Conference on Weather Analysis and Forecasting,* Vienna, VA, American Meteorological Society, 143-149.

Phillips, N.A., 1979: The Nested Grid Model. *NOAA Technical Report, NWS*, 22, Department of Commerce, 80 pp.

Plummer, D.W., 1989: Diagnostic and forecast graphics products at NMC using High Frequency Model Outputs, *Weather and Forecasting,* 4, 83-89.

Siebers, A.L., A.J. Mostek, R.H. Grumm, D.W. Plummer, and J.J. Tuccillo, 1988: Numerical Model Display on the VAS Data Utilization Center. *Fourth Conference and Interactive Information and Processing Systems for Meteorology, Oceanography and Hydrology,* Anaheim, American Meteorological Society, 49-52.

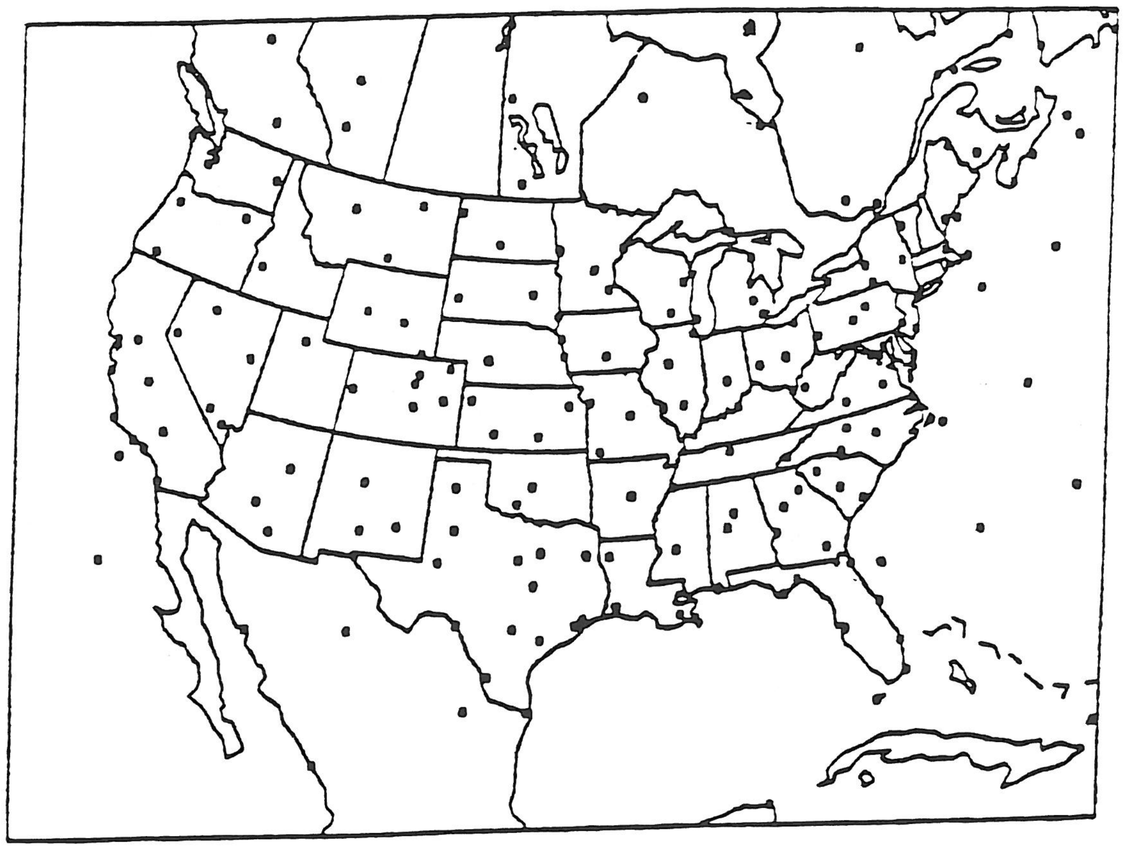

Figure 1. Regional Profile Archive station availability over North America from Siebers et al. (1988).

'USR.WN??.RDU.HRLY.RDU'

91012312 RDU RALEIGH-DURHAM, NC

P	GMT	HR PRCP	TOT PRCP	-------TEMPERATURE------ BL	L4	L6	L9	L12	-RELATIVE HUMIDITY- 123456789ABCDEFG	AV	SFC PRES	K*	85-70 DDSS	BL DDSS
0	12	.000	0.00	-2.3	-7.7	-8.2	-22.5	-44.0	6555432231132210	42	1015	-16	2626	2011
1	13	.000	0.00	-2.2	-7.1	-8.1	-23.1	-43.3	6554442231222210	43	1015	-15	2627	2112
2	14	.000	0.00	-2.1	-6.3	-7.5	-23.3	-41.8	6553442220121210	40	1013	-16	2528	2112
3	15	.000	0.00	-0.1	-5.3	-7.1	-23.0	-41.3	6652442110222310	38	1013	-18	2530	22 8
4	16	.000	0.00	1.9	-4.5	-6.9	-22.4	-41.6	5651442111223310	37	1013	-22	2534	23 9
5	17	.000	0.00	3.3	-3.8	-6.5	-21.3	-42.4	4571431111145410	36	1012	-24	2635	23 9
6	18	.000	0.00	4.5	-3.4	-6.6	-21.1	-42.5	4561432111156310	37	1012	-22	2637	2310
7	19	.000	0.00	5.5	-2.8	-6.4	-20.1	-43.3	4562442111357310	38	1011	-19	2637	2210
8	20	.000	0.00	6.2	-2.4	-6.4	-19.1	-44.1	4562542111355310	39	1010	-16	2636	2211
9	21	.000	0.00	6.7	-1.9	-6.5	-18.6	-44.6	4562652112576410	42	1010	-12	2636	2213
10	22	.000	0.00	6.8	-1.5	-6.6	-18.0	-45.0	4563653113686510	44	1010	-9	2736	2317
11	23	.000	0.00	6.8	-1.2	-6.7	-17.5	-45.2	4563763124687510	46	1010	-6	2736	2419
12	0	.000	0.00	6.6	-0.9	-6.7	-17.4	-45.2	4453363123797610	47	1011	-4	2735	2420
13	1	.000	0.00	6.3	-0.7	-6.5	-17.6	-44.3	44548621349*8610	48	1011	-1	2734	2521
14	2	.000	0.00	6.0	-0.5	-6.0	-17.4	-43.5	4455852237***510	47	1010	-2	2731	2519
15	3	.000	0.00	5.8	-0.5	-5.7	-17.7	-43.2	4455842348***610	48	1011	-2	2730	2619
16	4	.000	0.00	5.4	-0.7	-5.6	-18.2	-43.2	4456832463997510	50	1011	-4	2730	2619
17	5	.000	0.00	5.0	-0.8	-5.3	-18.3	-43.0	4456723689*85410	53	1011	-6	2729	2718
18	6	.000	0.00	4.8	-0.8	-4.9	-18.2	-42.1	44566248***65210	57	1011	-10	2728	2717
19	7	.000	0.00	4.6	-0.9	-4.8	-18.7	-42.3	54576169***56210	60	1012	-12	2729	2816
20	8	.000	0.00	4.3	-0.9	-4.5	-19.7	-43.3	54575189***66310	62	1011	-10	2729	2815
21	9	.000	0.00	4.1	-0.8	-4.2	-19.7	-44.2	54564288***97310	62	1010	-5	2628	2811
22	10	.000	0.00	4.0	-0.8	-4.7	-18.6	-44.7	54564489****7310	64	1010	-1	2627	2710
23	11	.000	0.00	4.0	-0.9	-6.3	-16.9	-45.1	5457469*****8210	70	1011	4	2628	2613
24	12	.000	0.00	4.0	-1.4	-7.3	-15.5	-45.1	546879******9210	79	1011	8	2628	2715
25	13	.000	0.00	3.8	-1.7	-6.7	-14.9	-44.7	55789*******8310	88	1011	9	2625	2714
26	14	.000	0.00	3.0	-1.9	-6.1	-14.8	-44.4	77899*******8310	94	1010	10	2623	2811
27	15	.009	0.01	2.9	-2.0	-6.0	-14.8	-44.8	8999********8310	**	1011	10	2621	28 6
28	16	.036	0.05	3.0	-2.3	-6.2	-14.8	-45.2	9***********9310	**	1010	10	2620	29 5
29	17	.050	0.10	3.8	-2.4	-6.2	-14.6	-45.2	*************310	**	1010	9	2619	32 4
30	18	.046	0.14	4.1	-2.4	-6.1	-14.6	-44.9	*************310	**	1010	9	2519	34 3
31	19	.047	0.19	4.5	-2.4	-6.4	-14.6	-44.7	**9**********310	**	1009	9	2419	0 2
32	20	.055	0.24	5.0	-2.4	-6.8	-14.4	-44.6	*************310	**	1009	9	2418	3 2
33	21	.060	0.30	5.3	-2.4	-7.3	-14.2	-44.4	9************410	**	1008	9	2417	3 2
34	22	.056	0.36	5.3	-2.3	-7.6	-14.0	-44.3	9************410	**	1007	9	2416	4 2
35	23	.047	0.41	5.3	-2.3	-7.6	-13.7	-44.2	999**********410	**	1006	8	2415	4 4
36	0	.033	0.45	5.4	-2.3	-7.3	-13.8	-43.9	999**********510	**	1006	8	2514	3 6
37	1	.033	0.48	5.4	-2.5	-6.7	-14.2	-43.7	999**********510	**	1006	9	2613	3 7
38	2	.027	0.50	5.3	-2.7	-6.1	-14.8	-43.7	999**********510	**	1006	9	2712	3 9
39	3	.013	0.52	5.3	-2.9	-5.3	-15.4	-43.8	99999****9***510	**	1006	8	2812	310
40	4	.003	0.52	5.2	-3.0	-4.8	-16.2	-43.9	999999*98899*510	97	1006	8	2812	312
41	5	.000	0.52	5.0	-3.4	-4.9	-17.0	-43.9	99999**866799410	94	1006	8	2912	213
42	6	.000	0.52	4.6	-4.1	-5.4	-17.6	-44.0	99999**645679410	90	1007	8	3013	115
43	7	.001	0.52	4.2	-4.6	-5.6	-17.8	-44.0	899999*423468310	84	1007	6	3014	116
44	8	.000	0.52	3.6	-4.7	-5.5	-18.0	-44.0	7998889212347310	76	1007	4	2915	117
45	9	.000	0.52	2.7	-4.7	-5.5	-18.5	-43.7	7898778101236310	67	1007	1	2917	117
46	10	.000	0.52	1.7	-4.6	-5.8	-19.2	-43.3	6897666001226310	59	1008	-1	2918	117
47	11	.000	0.52	0.5	-4.5	-6.1	-19.8	-42.8	6786554010115310	52	1009	-4	2919	118
48	12	.000	0.52	-0.8	-4.4	-6.3	-20.2	-42.3	6775433010114300	44	1010	-9	3020	118

Figure 2. Example of raw NGM gridpoint data for Raleigh-Durham, NC. (1200 UTC cycle, January 23, 1991).

'USR.+N99.RDU.HRLY.RDU'

91012312 RDU RALEIGH-DURHAM, NC

P	GMT	HR PRCP	TOT PRCP	TEMPERATURE BL	L4	L6	L9	L12	RELATIVE HUMIDITY 123456789ABCDEFG	AV	SFC PRES	K*	85-70 DDSS	BL DDSS
0	12	.000	0.00	-2.3	-7.7	-8.2	-22.5	-44.0	6555432231132210	42	1015	-16	2626	2011
1	13	.000	0.00	-2.2	-7.1	-8.1	-23.1	-43.3	6554442231222210	43	1015	-15	2627	2112
2	14	.000	0.00	-2.1	-6.3	-7.5	-23.3	-41.8	6553442220121210	40	1013	-16	2528	2112
3	15	.000	0.00	-0.1	-5.3	-7.1	-23.0	-41.3	6652442110222310	38	1013	-18	2530	22 8
4	16	.000	0.00	1.9	-4.5	-6.9	-22.4	-41.6	5651442111223310	37	1013	-22	2534	23 9
5	17	.000	0.00	3.3	-3.8	-6.5	-21.3	-42.4	4571431111145410	36	1012	-24	2635	23 9
6	18	.000	0.00	4.5	-3.4	-6.6	-21.1	-42.5	4561432111156310	37	1012	-22	2637	2310
7	19	.000	0.00	5.5	-2.8	-6.4	-20.1	-43.3	4562442111357310	38	1011	-19	2637	2210
8	20	.000	0.00	6.2	-2.4	-6.4	-19.1	-44.1	4562542111355310	39	1010	-16	2636	2211
9	21	.000	0.00	6.7	-1.9	-6.5	-18.6	-44.6	4562652112576410	42	1010	-12	2636	2213
10	22	.000	0.00	6.8	-1.5	-6.6	-18.0	-45.0	4563653113686510	44	1010	-9	2736	2317
11	23	.000	0.00	6.8	-1.2	-6.7	-17.5	-45.2	4563763124687510	46	1010	-6	2736	2419
12	0	.000	0.00	6.6	-0.9	-6.7	-17.4	-45.2	4453863123797610	47	1011	-4	2735	2420
13	1	.000	0.00	6.3	-0.7	-6.5	-17.6	-44.3	44548621347*8610	48	1011	-1	2734	2521
14	2	.000	0.00	6.0	-0.5	-6.0	-17.4	-43.5	4455852237***510	47	1010	-2	2731	2519
15	3	.000	0.00	5.8	-0.5	-5.7	-17.7	-43.2	4455842348***610	48	1011	-2	2730	2619
16	4	.000	0.00	5.4	-0.7	-5.6	-18.2	-43.2	4456832468997510	50	1011	-4	2730	2619
17	5	.000	0.00	5.0	-0.8	-5.3	-18.3	-43.0	4456723689*85410	53	1011	-6	2729	2718
18	6	.000	0.00	4.8	-0.8	-4.9	-18.2	-42.1	44566248***65210	57	1011	-10	2728	2717
19	7	.000	0.00	4.6	-0.9	-4.8	-18.7	-42.3	54576169***56210	60	1012	-12	2729	2816
20	8	.000	0.00	4.3	-0.9	-4.5	-19.7	-43.3	54575189***66310	62	1011	-10	2729	2815
21	9	.000	0.00	4.1	-0.8	-4.2	-19.7	-44.2	54564288***97310	62	1010	-5	2628	2811
22	10	.000	0.00	4.0	-0.8	-4.7	-18.6	-44.7	54564489****7310	64	1010	-1	2627	2710
23	11	.000	0.00	4.0	-0.9	-6.3	-16.9	-45.1	5457469*****8210	70	1011	4	2628	2613
24	12	.000	0.00	4.0	-1.4	-7.3	-15.5	-45.1	546879******9210	79	1011	8	2628	2715
25	13	.000	0.00	3.8	-1.7	-6.7	-14.9	-44.7	55789*******8810	88	1011	9	2625	2714
26	14	.000	0.00	3.0	-1.9	-6.1	-14.8	-44.4	77899*******8310	94	1010	10	2623	2811
27	15	.009	0.01	2.9	-2.0	-6.0	-14.8	-44.8	8999********8310	**	1011	10	2621	28 6
28	16	.036	0.05	3.0	-2.3	-6.2	-14.8	-45.2	9***********9310	**	1010	10	2620	29 5
29	17	.050	0.10	3.8	-2.4	-6.2	-14.6	-45.2	*************310	**	1010	9	2619	32 4
30	18	.046	0.14	4.1	-2.4	-6.1	-14.6	-44.9	*************310	**	1010	9	2519	34 3
31	19	.047	0.19	4.5	-2.4	-6.4	-14.6	-44.7	**9**********310	**	1009	9	2419	0 2
32	20	.055	0.24	5.0	-2.4	-6.8	-14.4	-44.6	*************310	**	1009	9	2418	3 2
33	21	.060	0.30	5.3	-2.4	-7.3	-14.2	-44.4	9************410	**	1008	9	2417	3 2
34	22	.056	0.36	5.3	-2.3	-7.6	-14.0	-44.3	9************410	**	1007	9	2416	4 2
35	23	.047	0.41	5.3	-2.3	-7.6	-13.7	-44.2	999**********410	**	1006	8	2415	4 4
36	0	.038	0.45	5.4	-2.3	-7.3	-13.8	-43.9	999**********510	**	1006	8	2414	3 5
37	1	.033	0.48	5.4	-2.5	-6.7	-14.2	-43.7	999**********510	**	1006	9	2613	3 7
38	2	.027	0.50	5.3	-2.7	-6.1	-14.8	-43.7	999**********510	**	1006	9	2712	3 9
39	3	.013	0.52	5.3	-2.9	-5.3	-15.4	-43.8	99999****9***510	**	1006	8	2812	310
40	4	.003	0.52	5.2	-3.0	-4.8	-16.2	-43.9	999999*98899*510	97	1006	8	2812	312
41	5	.000	0.52	5.0	-3.4	-4.9	-17.0	-43.9	99999**866799410	94	1006	8	2912	213
42	6	.000	0.52	4.6	-4.1	-5.4	-17.6	-44.0	99999**645679410	90	1007	8	3013	115
43	7	.001	0.52	4.2	-4.6	-5.6	-17.8	-44.0	899999*423468310	84	1007	6	3014	116
44	8	.000	0.52	3.6	-4.7	-5.5	-18.0	-44.0	7998889212347310	76	1007	4	2915	117
45	9	.000	0.52	2.7	-4.7	-5.5	-18.5	-43.7	7898778101236310	67	1007	1	2917	117
46	10	.000	0.52	1.7	-4.6	-5.8	-19.2	-43.3	6897666001226310	59	1008	-1	2918	117
47	11	.000	0.52	0.5	-4.5	-6.1	-19.8	-42.8	6786554010115310	52	1009	-4	2919	118
48	12	.000	0.52	-0.8	-4.4	-6.3	-20.2	-42.3	6775433010114300	44	1010	-9	3020	118

Figure 3. Example of analyzed NGM gridpoint data for Raleigh-Durham, NC. (1200 UTC cycle, January 23, 1991).

FCST PRD IN HRS	STATION: RDU MONTH: APRIL NUMBER OF MODEL RUNS: 16				STATION: RDU MONTH: MAY NUMBER OF MODEL RUNS: 14				STATION: RDU MONTH: JUNE NUMBER OF MODEL RUNS: 10			
	% OF LOW CLOUDS				% OF LOW CLOUDS				% OF LOW CLOUDS			
	FCST AND OBS	NOT FCST AND OBS	FCST AND NOT OBS	NOT FCST AND NOT OBS	FCST AND OBS	NOT FCST AND OBS	FCST AND NOT OBS	NOT FCST AND NOT OBS	FCST AND OBS	NOT FCST AND OBS	FCST AND NOT OBS	NOT FCST AND NOT OBS
12	64.7	5.8	17.6	11.7	71.4	0	7.1	21.4	70.0	0	10.0	20.0
24	70.5	0	17.6	11.7	71.4	0	14.3	14.3	90.0	0	10.0	0
36	70.5	0	5.8	23.5	71.4	0	14.3	14.3	80.0	0	20.0	0
48	70.5	5.8	5.8	17.6	100.0	0	0	0	70.0	0	20.0	10.0

Table 1. Monthly NGM gridpoint data verification for Raleigh-Durham, NC.

FCST PRD IN HRS	STATION: CLT MONTH: APRIL NUMBER OF MODEL RUNS: 16				STATION: CLT MONTH: MAY NUMBER OF MODEL RUNS: 14				STATION: CLT MONTH: JUNE NUMBER OF MODEL RUNS: 10			
	% OF LOW CLOUDS				% OF LOW CLOUDS				% OF LOW CLOUDS			
	FCST AND OBS	NOT FCST AND OBS	FCST AND NOT OBS	NOT FCST AND NOT OBS	FCST AND OBS	NOT FCST AND OBS	FCST AND NOT OBS	NOT FCST AND NOT OBS	FCST AND OBS	NOT FCST AND OBS	FCST AND NOT OBS	NOT FCST AND NOT OBS
12	68.8	0	12.5	18.7	78.6	0	7.1	14.3	50.0	0	40.0	10.0
24	75.0	6.3	6.3	12.5	64.3	7.1	14.3	14.3	90.0	0	10.0	0
36	75.0	0	18.7	6.3	78.6	0	7.1	14.3	50.0	0	50.0	0
48	75.0	6.3	6.3	12.5	78.6	0	7.1	14.3	80.0	0	20.0	0

Table 2. Monthly NGM gridpoint data verification for Charlotte, NC.

FCST PRD IN HRS	STATION: RDU TIME: SPRING 1991 NUMBER OF MODEL RUNS: 40				STATION: CLT TIME: SPRING 1991 NUMBER OF MODEL RUNS: 40			
	% OF LOW CLOUDS				% OF LOW CLOUDS			
	FCST AND OBS	NOT FCST AND OBS	FCST AND NOT OBS	NOT FCST AND NOT OBS	FCST AND OBS	NOT FCST AND OBS	FCST AND NOT OBS	NOT FCST AND NOT OBS
12	68.7	1.9	11.6	17.7	65.8	0	19.9	14.3
24	77.3	0	13.9	8.7	76.4	4.5	10.2	8.9
36	73.9	0	13.4	12.6	67.9	0	25.3	6.8
48	80.2	1.9	8.6	9.2	77.9	2.1	11.1	8.9

Table 3. Seasonal NGM gridpoint data verification for Raleigh-Durham and Charlotte, NC.

	% OF LOW CLOUDS AT RDU	% OF LOW CLOUDS AT CLT
FCST AND OBSERVED	75.0	72.0
NOT FCST AND OBSERVED	0.9	1.7
FCST AND NOT OBSERVED	11.9	16.6
NOT FCST AND NOT OBSERVED	12.2	9.7
TOTAL	100.0	100.0

Table 4. Overall verification statistics (low cloud cover) for the combined 48-hr NGM model forecast periods for Raleigh-Durham and Charlotte, NC.