Routine Forecasting with the Barotropic Model

by

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Introduction

Since 1 December 1954 the Royal Swedish Air Force Weather Service has been conducting a series of test forecasts of the 500-mb topography under operational conditions. Forecasts for 24, 48 and 72 hours have been prepared on a routine basis, using the barotropic model and the digital computer BESK. The tests to date have covered the periods 1—16 December 1954, 17 January—25 February 1955 and from 12 April 1955 to the time of writing. It was originally planned to issue 42 sets of three forecasts during the first two periods, but some forecasts failed due to minor breakdowns of the computer (see tables).

The daily schedule for preparing the numerical forecasts has normally proceeded according to the following plan: The analysis of the 0300 GMT 500-mb map is completed at about 1230 GMT (the approximate time of receipt of the last observations). The reading of the data from the grid points and the punching and checking of the input data tape for BESK follows, and is completed about 1530 GMT. The actual computation follows immediately and is normally completed after 65 to 75 minutes.

Methods of verification

The verification of the prognostic charts have been made for the area shown in fig. 1.

Two different methods of verification were applied. In the first place the correlation coefficients and the errors using the observed and computed changes in all grid points within the verification area. Secondly, in order to get a direct estimate of the prognostic value of the charts to the forecaster, a subjective verification was carried out by 6 meteorologists from 4 different weather services (Vedurstofan, Iceland, Det Norske Meteorologiske Institutt, Norway, the Swedish Weather Service (SMHI) and the Royal Swedish Air Force Weather Service). The prognostic value of the charts within the verification area was given in the form of numbers from 1 to 5, number 1 denoting "failing", and 5 "very good". The natural way of getting an estimate of the value of numerical weather prediction in routine forecasting is to compare the results with the corresponding results obtained by conventional methods. In order to obtain a comparison of this kind, the two methods of verification mentioned above were also applied to the corresponding series of 24 and 48 hrs prognostic charts issued by the Swedish Weather Service (SMHI). The results of the forecasts are given in table I, II and III and the averages are also presented in fig. 2.

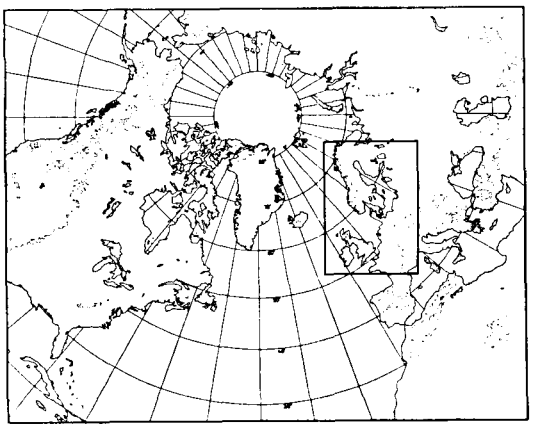

Fig. 1. The forecast area and the verification area.

Table I

24 hrs forecasts							
Date of initial map	Numerical method			Conventional method			
	s	r	ε	s	r	ε	
1 Dec. -54, 03..	5	0.92	50	4	0.61	86	
2 » -54, 03..	5	0.89	102	5	0.90	47	
3 » -54, 03..	4	0.73	93	4	0.66	108	
6 » -54, 03..	5	0.93	18	3	0.63	65	
7 » -54, 03..	3	0.75	68	3	0.79	58	
8 » -54, 03..	5	0.94	49	4	0.71	81	
9 » -54, 03..	5	0.79	69	3	0.00	288	
10 » -54, 03..	5	0.90	62	5	0.83	48	
13 » -54, 03..	5	0.75	51	4	0.06	102	
15 » -54, 03..	4	0.76	71	4	0.83	86	
16 » -54, 03..	5	0.85	56	5	0.85	65	
17 » -54, 03..	5	0.92	60	5	0.91	48	
17 Jan. -55, 03..	4	0.88	52	3	0.76	67	
18 » -55, 03..	4	0.89	46	1	0.51	74	
19 » -55, 03..	3	0.36	74	3	0.84	68	
24 » -55, 03..	3	0.70	51	3	0.56	65	
27 » -55, 03..	5	0.74	38	5	0.90	36	
28 » -55, 03..	5	0.66	41	5	0.36	59	
31 » -55, 03..	5	0.91	24	5	0.69	49	
1 Febr. -55, 03..	5	0.81	47	4	0.66	60	
2 » -55, 03..	3	0.53	53	4	0.78	31	
3 » -55, 03..	5	0.91	26	4	0.68	43	
4 » -55, 03..	4	0.75	34	4	0.43	55	
7 » -55, 03..	4	0.82	46	4	0.65	54	
8 » -55, 03..	3	0.76	39	2	0.31	76	
9 » -55, 03..	5	0.77	48	4	0.80	59	
10 » -55, 03..	4	0.76	51	4	0.63	40	
11 » -55, 03..	3	0.71	78	5	0.81	49	
14 » -55, 03..	2	0.65	79	4	0.85	47	
15 » -55, 03..	2	0.80	55	2	0.72	83	
16 » -55, 03..	4	0.76	81	3	0.39	114	
17 » -55, 03..	4	0.90	78	4	0.91	62	
18 » -55, 03..	5	0.23	118	5	0.65	47	
22 » -55, 03..	4	0.74	59	2	0.20	64	
23 » -55, 03..	4	0.78	40	2	0.35	68	
24 » -55, 03..	5	0.72	51	5	0.22	70	
25 » -55, 03..	5	0.83	39	3	0.92	50	
Mean	4.2	0.77	57	3.8	0.63	70	

Table II

48 hrs forecasts							
Date of initial map	Numerical method			Conventional method			
	s	r	ε	s	r	ε	
1 Dec. -54, 03..	3	0.79	134	5	0.90	113	
2 » -54, 03..	3	0.75	174	3	0.52	109	
3 » -54, 03..	2	0,71	237	1	0.48	187	
6 » -54, 03..	3	0.71	118	4	0.53	157	
7 » -54, 03..	3	0.77	114	2	0.66	110	
8 » -54, 03..	4	0.92	112	3	— 0.24	309	
9 » -54, 03..	3	0.63	200	2	0.59	178	
10 » -54, 03..	4	0.41	245	4	0.78	77	
13 » -54, 03..	2	0.60	142	2	0.53	107	
15 » -54, 03..	3	0.02	169	3	0.02	150	
16 » -54, 03..	4	0.86	100	4	0.61	87	
17 » -54, 03..	5	0.88	113	3	0.66	130	
17 Jan. -55, 03..	3	0.61	99	3	0.62	82	
18 » -55, 03..	—	—	—	—	—	—	
19 » -55, 03..	3	0.65	81	4	0.80	145	
24 » -55, 03..	—	—	—	—	—	—	
27 » -55, 03..	5	0,13	96	4	0.48	65	
28 » -55, 03..	5	0.21	97	5	0.66	53	
31 » -55, 03..	5	0.93	53	3	0.68	69	
1 Febr. -55, 03..	3	0.72	100	4	0.75	60	
2 » -55, 03..	4	0.78	72	4	0.77	63	
3 » -55, 03..	4	0.87	61	1	0.65	23	
4 » -55, 03..	5	0.80	63	2	0.22	91	
7 » -55, 03..	4	0.87	55	4	0.64	91	
8 » -55, 03..	3	0.77	62	4	0.83	100	
9 » -55, 03..	4	0.77	77	2	0.48	114	
10 » -55, 03..	4	0.86	134	2	0.61	64	
11 » -55, 03..	2	0.38	191	3	0.45	84	
14 » -55, 03..	3	0.43	188	4	0.32	127	
15 » -55, 03..	5	0.49	148	4	0.48	143	
16 » -55, 03..	—	—	—	—	—	—	
17 » -55, 03..	5	0.93	136	3	0.76	114	
18 » -55, 03..	4	0.39	119	4	0.53	85	
22 » -55, 03..	3	0.78	69	2	0.34	93	
23 » -55, 03..	3	0.71	67	3	0.02	114	
24 » -55, 03..	5	0.63	104	1	0.14	105	
25 » -55, 03..	4	0.66	89	1	0.77	73	
Mean	3.7	0.66	118	3.0	0.53	108	

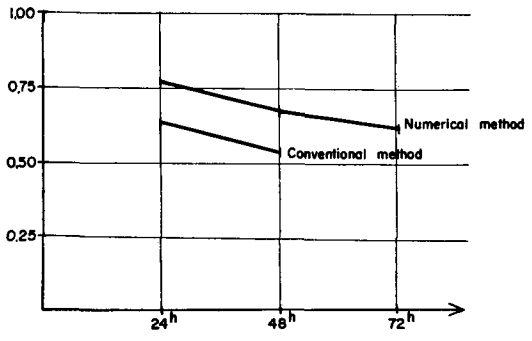

Fig. 2. Graphical representation of the variation of the correlation coefficient.

Practical application in daily weather forecasting

The numerical prognostic charts have been used on a daily routine basis for forecasting the general weather situation for the next 3—5 days. In this connection, the 72-hr forecasts have been of special interest, as prognostic charts for as much as 3 days have not previously been used at the Swedish Air Force Weather Service.

In spite of the systematic errors which occasionally appear in the 72-hr forecasts (BOLIN, 1955) they have in most cases been very useful for the routine weather forecasting.

Table III

72 hrs forecasts				
Date of initial map		Numerical method		
		s	r	ε
1 Dec.	-54, 03	3	0.83	192
2 »	-54, 03	3	0.67	163
3 »	-54, 03	—	0.77	253
6 »	-54, 03	—	—	—
7 »	-54, 03	4	0.76	209
8 »	-54, 03	3	0.68	180
9 »	-54, 03	—	—	—
10 »	-54, 03	3	— 0.09	345
13 »	-54, 03	4	0.85	191
15 »	-54, 03	3	0.71	182
16 »	-54, 03	3	0.61	153
17 »	-54, 03	3	0.90	224
17 Jan.	-55, 03	2	0.31	153
18 »	-55, 03	—	—	—
19 »	-55, 03	—	—	—
24 »	-55, 03	—	—	—
27 »	-55, 03	4	0.44	152
28 »	-55, 03	3	— 0.23	188
31 »	-55, 03	5	0.90	84
1 Febr.	-55, 03	2	0.73	128
2 »	-55, 03	4	0.74	151
3 »	-55, 03	4	0.76	118
4 »	-55, 03	3	0.76	105
7 »	-55, 03	2	0.68	98
8 »	-55, 03	2	0.77	109
9 »	-55, 03	4	0.89	165
10 »	-55, 03	1	0.42	234
11 »	-55, 03	—	—	—
14 »	-55, 03	—	—	—
15 »	-55, 03	3	0.26	281
16 »	-55, 03	—	—	—
17 »	-55, 03	3	0.68	160
18 »	-55, 03	—	—	—
22 »	-55, 03	1	0.53	107
23 »	-55, 03	—	—	—
24 »	-55, 03	3	0.60	196
25 »	-55, 03	3	0.56	222
	Mean	3.0	0.61	176

An example of a successful 72-hr forecast is shown in fig. 2. The weather situation for several days prior to the date when this forecast was made had been characterised by a N to NW flow and cold weather over Scandinavia. During the 3 following days the weather situation changed, resulting in a milder weather-type dominated by a SW flow over southern Scandinavia. This development was very well indicated by the 72-hr forecast.

REFERENCE

BOLIN, B., 1955: Numerical forecasting with the barotropic model. *Tellus* **7**, 27—49.

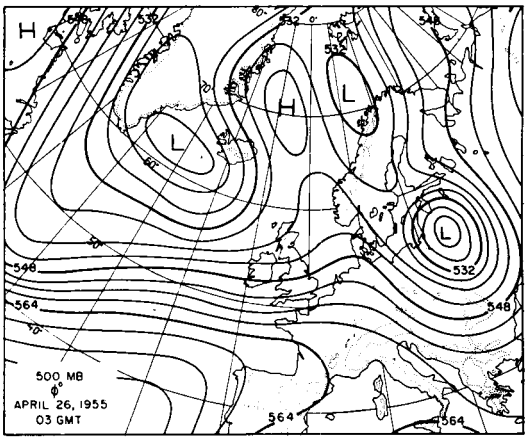

Fig. 3 a. Observed 500 mb contours on April 26, 1955, 0300 GMT. The heights are given in decameter as unit.

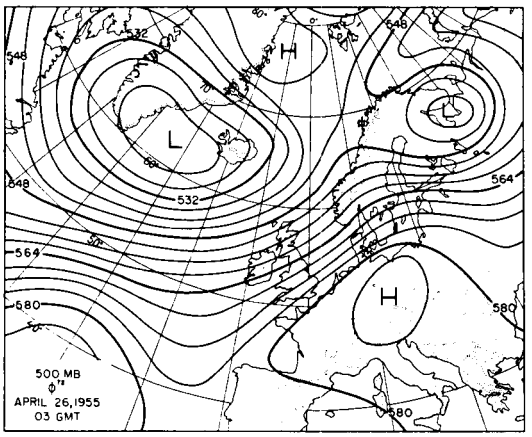

Fig. 3 b. 72-hour forecast of 500 mb from map shown in a.

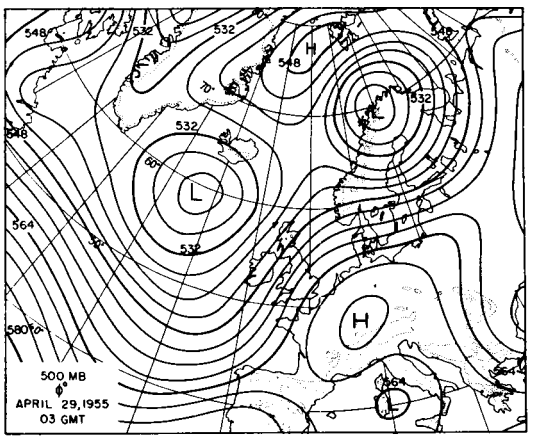

Fig. 3 c. Observed contours on April 29, 1955, 0300 GMT.