Monthly Mean Forecast Experiments with the GISS Model: Correction[1,2]

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We have recently learned that one of the three monthly mean forecasts computed by Spar *et al.* (1976; hereafter referred to as SAK) with the GISS general circulation model (Somerville *et al.*, 1974) was started from incorrect initial conditions. For the January 1975 prediction cited in that paper, a climatological mean January data set was accidentally substituted for the required 1 January 1975 initial data. The forecast for January 1975 has been recomputed with the proper initial conditions, and the corrected results are presented below.

Table 1 shows the hemispheric and global energetics for January 1975, including the observed (O), the corrected forecast (F) and the erroneous SAK forecast. P_M and P_E represent the mean zonal and eddy available potential energies, and K_M and K_E are the mean zonal and eddy kinetic energies, all in units of 10^5 J m^{-2}. (The "observed" values shown in Table 1 differ slightly from those in SAK because only 30 days were used in the latter while 31 days were used in the corrected computation.)

From Table 1 it is apparent that the use of correct initial conditions has improved the gross forecast mean energetics. Both mean zonal and eddy energies are now closer to the observed than in SAK. In particular, the anomalously low K_E forecast in SAK, which first drew our attention to the error in the initial conditions, and which resulted from the use of a smooth climatological initial state, no longer appears in the corrected monthly mean forecast. Furthermore, as an apparent consequence of the increased eddy energy in the corrected forecast, the mean meridional temperature gradient has been reduced, and the excessive mean zonal energies found in the SAK forecast do not appear in the corrected forecast.

The meridional profiles of vertically and zonally averaged mean zonal wind speed shown in Fig. 1 of SAK indicated a serious failure in the model forecast for January 1975. In Fig. 1 of the present note, both the observed and SAK forecast wind profiles are reproduced together with the corrected forecast wind profile. Although the corrected forecast is still far from satisfactory, the use of correct initial conditions has reduced somewhat the large forecast errors in the regions of the wind maxima, and shifted the latitude of the maximum wind in the Northern Hemisphere poleward, as observed. This modest improvement is also illustrated in Fig. 2, showing the observed and the two forecast vertical profiles of mean zonal wind speed at the latitude of the observed Northern Hemisphere jet stream (34°N) for January 1975. Again, even in the corrected forecast, the jet stream velocity is too strong, but the error is now smaller than in SAK. (The corrected forecast also provides a slightly better simulation of the decrease in jet velocity from January 1974 to 1975 than did the SAK forecast.)

In SAK, the monthly mean forecasts were evaluated over various areas of the earth in terms of root-mean-square (rms) errors and S-1 skill scores (Teweles and Wobus, 1954), which were also computed for no-skill "forecasts" of climatology (M) and first day persistence (P). These results for January 1975 are reproduced in Table 2 together with the scores for the corrected forecast. Comparing the 1975 F (corrected) and SAK forecasts, one finds that, of the 29 scores, 18 were

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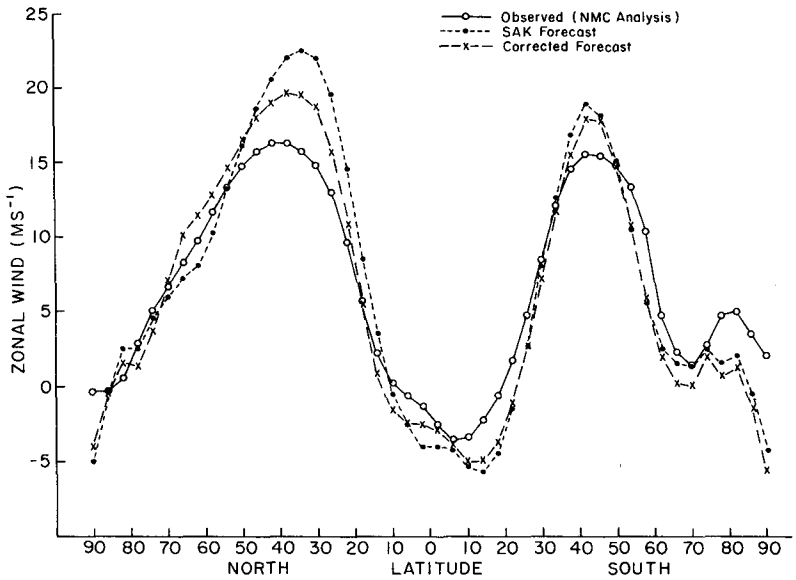

FIG. 1. Vertically and zonally averaged monthly mean zonal wind profiles for January 1975: solid curve, observed; dotted curve, SAK forecast; dashed curve, corrected forecast.

improved, 9 were made worse and 2 were unchanged by the use of correct initial conditions. Counting the number of forecast scores better than climatology and persistence, we find 16 F forecasts compared with 15 SAK forecasts. Over the Northern Hemisphere, the F forecast is superior to SAK at sea level and about equal in skill at 500 mb. However, over North America, the 500 mb F forecast is actually worse than the SAK forecast, while the sea-level pressure forecast is slightly better.

With correct 1975 initial conditions, the number of "successful" forecast scores (i.e., better than climatology and persistence) is now 16 (41%) for sea-level pressure, 6 (67%) for 850 mb temperature, and 32 (82%) for the three Januaries of 1973–74–75, compared with 13 (33%), 6 (67%) and 34 (87%), as reported in SAK. The average rms error of the three January 500 mb height forecasts over the Northern Hemisphere is now 71 m (compared with 72 m in SAK) and the average S-1 skill score at 500 mb for the same set of forecasts is again 47. Thus, the use of corrected initial conditions for the January 1975 forecast has not significantly changed the forecast error statistics reported in SAK for the three Januaries.

The corrected prognostic maps of sea-level pressure and 500 mb height for January 1975, which are shown here in Figs. 3 and 4 together with the observed monthly mean fields, may be compared with those

TABLE 1. Observed (O), corrected forecast (F) and SAK forecast energetics for January 1975. P_M and P_E are mean zonal and eddy available potential energies and K_M and K_E are mean zonal and eddy kinetic energies, all in units of 10^5 J m^{-2}.

	Northern Hemisphere			Globe		
	O	F	SAK	O	F	SAK
P_M	55.5	60.4	67.5	41.4	41.7	47.3
P_E	7.2	7.5	6.8	5.5	6.1	4.9
K_M	7.8	8.9	10.7	6.3	6.7	8.0
K_E	6.3	5.9	4.7	4.9	5.1	3.8

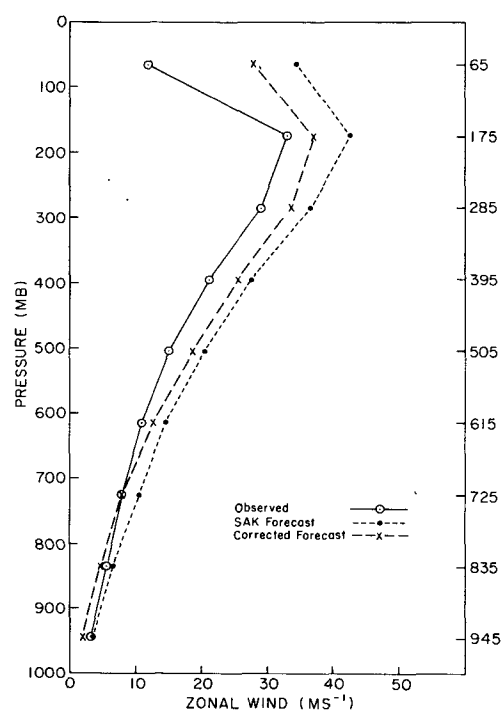

FIG. 2. Vertical profiles of zonally averaged monthly mean zonal wind for January 1975 at latitude 34°N: solid curve, observed; dotted curve, SAK forecast; dashed curve, corrected forecast.

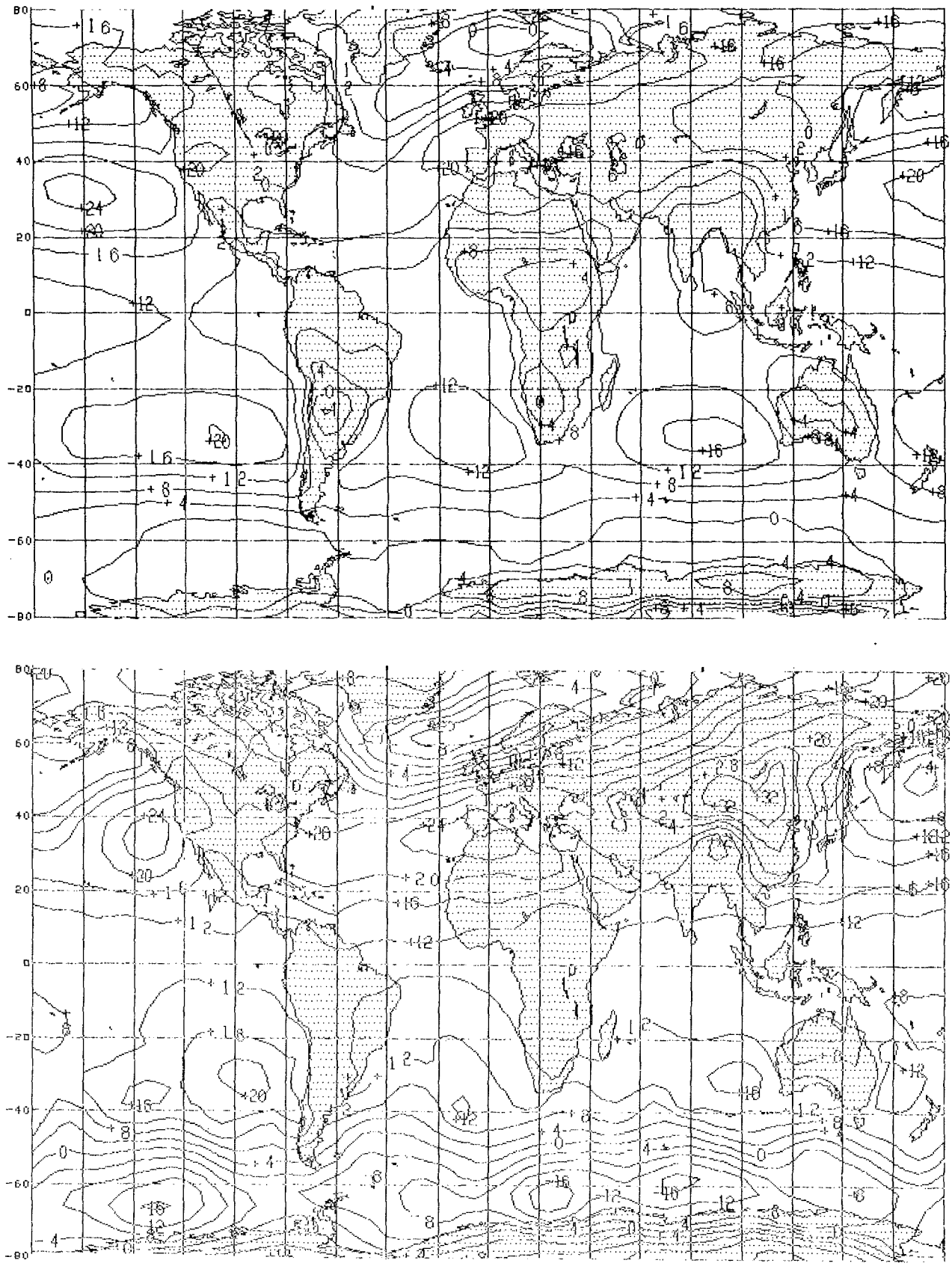

FIG. 3. Forecast (top) and observed (bottom) monthly mean sea-level pressure fields (4 mb isobars) for January 1975.

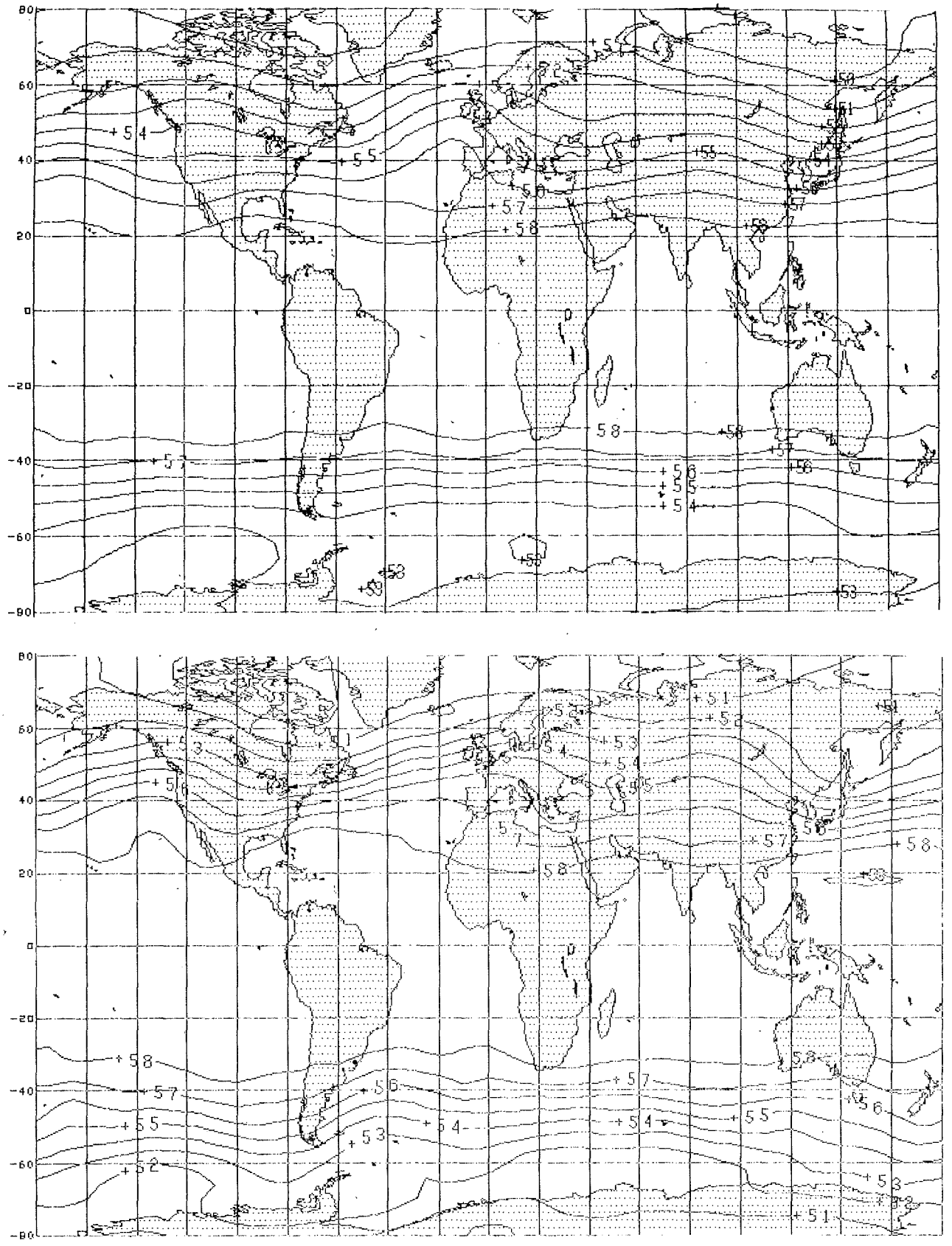

FIG. 4. Forecast (top) and observed (bottom) monthly mean 500 mb height fields (100 m contours) for January 1975.

TABLE 2. RMS errors and S-1 skill scores for January 1975, including corrected forecast (F), SAK forecast and climatology (M) and persistence (P) "forecasts".

A. Sea-level pressure

Region	rms error (mb) F	SAK	M	P	S-1 score F	SAK	M	P
Globe	5.1	6.0	5.9	5.5	67	74	72	62
Northern Hemisphere	5.3	6.1	6.6	7.2	64	72	73	69
Tropics	3.4	3.1	3.0	1.6	62	71	67	50
E. Pacific-U. S.	5.0	5.8	6.8	7.1				
North America	4.2	7.2	10.0	12.4	86	92	97	91
United States	3.5	5.6	7.1	8.2	85	95	103	85
Europe	5.6	7.7	4.1	7.3	63	77	55	76

B. 500 mb height

Region	rms error (m) F	SAK	M	P	S-1 score F	SAK	M	P
Globe	60	64	68	56	42	43	49	47
Northern Hemisphere	62	63	82	73	42	42	52	53
Tropics	30	19	34	23	65	67	71	58
E. Pacific-U. S.	87	84	123	90				
N. America	60	48	130	117	38	34	50	54
United States	58	49	117	108	41	32	40	50
Europe	103	113	38	92	47	53	36	68

C. 850 mb temperature

Region	rms error (°C) F	SAK	M	P
Northern Hemisphere	4.1	4.1	4.5	3.6
E. Pacific-U. S.	4.2	4.9	6.9	5.1
United States	3.7	3.5	7.5	5.2

in Figs. 7 and 10 of SAK. One of the major defects in the SAK sea-level pressure prognosis for January 1975 was found in the Icelandic region, where the low was predicted to lie south of Greenland rather than east of Iceland as observed. This error is significantly reduced in Fig. 3, where the predicted orientation of the Icelandic low is now in rather good agreement with the observed pattern. At 500 mb, however, the principal synoptic error in the SAK forecast for January 1975, which was the failure to predict the correct position of the North American trough, is again repeated in the corrected prognostic map (Fig. 4).

In general, the use of correct initial conditions has resulted in a modest improvement in the monthly mean forecast for January 1975, but has not altered any of the conclusions stated in SAK. (Supplementary note: It should also be noted that the captions on Figs. 12 and 13 in SAK should be reversed.)

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