CLIMATOLOGY OF BLOCKING IN THE GLAS CLIMATE MODEL

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1. INTRODUCTION

During the past several years, the GLAS climate model has been integrated with a variety of initial and boundary conditions. Results of winter and summer simulation by the GLAS climate model have been discussed by Halem et al., (1979) and Straus and Shukla, (1981). The model has shown remarkable success in simulating the storm tracks. The purpose of this note is to examine the model's ability to simulate the occurrence of persistent anomalies to be referred to as blocking.

2. DATA

We have used 17 winter and 7 summer simulations with the GLAS climate model (Halem et al., 1979; Shukla and Bangaru, 1980). The time series at each grid point for each run was fitted to a parabola to define the seasonal cycle, ϕ_s,

$$\phi_s(t) = a + bt + ct^2$$

The mean values of coefficients $\overline{a}$, $\overline{b}$, and $\overline{c}$ were determined by averaging the coefficients over all runs in a set and seasonal cycle was defined as:

$$\overline{\phi}_s(t) = \overline{a} + \overline{b}t + \overline{c}t^2$$

at each grid point. Anomaly ϕ' at each grid point was defined as:

$$\phi'(t) = \phi(t) - \overline{\phi}_s(t)$$

If, at any grid point, an anomaly of +100 gpm or more persists for 7 days or more, we count it as a blocking event. We have calculated the frequency of blocking events at each grid point for winter and summer simulations separately and presented the results in the next section.

3. RESULTS

Figures 1a, 1b, 1c, and 1d show the standard deviations of daily values of geopotential height for winter and summer, respectively. Model standard deviations look more like observed band-pass variances rather than observed total variances. This suggests that the model does not simulate the low frequency components realistically (Straus and Shukla, 1981).

Figures 2a and 2b show the map of number of events for which anomaly ϕ' of +100 gpm or more persisted for 7 days or more. Figure 2a shows only the Northern Hemisphere, and Figure 2b also shows the Southern Hemisphere. In the Northern Hemisphere, the centers of maxima are located near 50°N, 180°W (Pacific), 75°N, 30°W (Greenland), 60°N, 40°E (USSR), and 70°N, 135°W. An analysis of 15 years of observations (Shukla and Mo, 1981) showed only three centers of maxima; moreover, the locations of the maxima are not correctly simulated. The Pacific and

the Russian maxima are shifted southwestwards, and the Atlantic maxima is shifted northwestwards with respect to the observations. It is not appropriate to compare the magnitude of the frequency because model runs have very similar initial conditions. Shukla and Bangaru (1979) found that a large SST anomaly in the Pacific produced a persistent anomaly in the atmospheric circulation over North America. This situation is being further analysed by Chen and Shukla and it is found that SST anomaly run produced persistent low wave numbers.

Figure 2b shows that during northern winter the Southern Hemisphere has relatively lower frequency of blocking. The maxima in blocking occur between 70°-80°S. We do not have corresponding observations to compare the Southern Hemisphere results.

Figure 2c shows the frequency of blocking for summer simulations. There is almost no blocking event in the Northern Hemisphere (the maxima over Greenland is not a realistic one), and surprisingly, there is no blocking activity in the Southern Hemisphere either.

We have also examined the number of events for winter simulations for anomalies of -100 gpm or less persisting for 7 days or more. In agreement with the observations, maximum frequency maps for simulated positive and negative anomalies occur in the same region.

The model's day-to-day fluctuations are dominated by synoptic scale disturbances which give maximum variance in storm track regions, whereas, in the observations, the maxima of daily standard deviations are related with large persistent positive and negative anomalies associated with blocking.

We have calculated the characteristic time T_0 for winter model runs and 15 observed winters, respectively.

$$T_0 = 2 \int_0^T (1 - \frac{\tau}{T}) R(\tau) \, d\tau$$

where $R(\tau)$ is lagged autocorrelation at lag τ, and $T = 30$ days. We find that the model underestimates the value of T_0, indicating the model's inability to simulate persistent patterns and low frequency components.

4. CONCLUSIONS

Although the GLAS climate model simulates the storm tracks (band-pass variance) quite realistically, the model is not successful in simulating the occurrence of persistent anomalies. Examination of model simulated synoptic maps shows that the blocking type of configurations appear frequently, but they do not persist.

REFERENCES

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Shukla, J., and K. C. Mo, 1981: Seasonal variations of blocking. Submitted to Mon. Wea. Rev.

Shukla, J., and B. Bangaru, 1979: Effect of a Pacific SST anomaly on the circulation over North America: A numerical experiment with the GLAS model. GARP Publication Series, 22, 501-518.

Straus, D., and J. Shukla, 1981: Space-time spectral structure of a GLAS general circulation model and a comparison with observatins. J. Atmos. Sci., 38, 902-917.
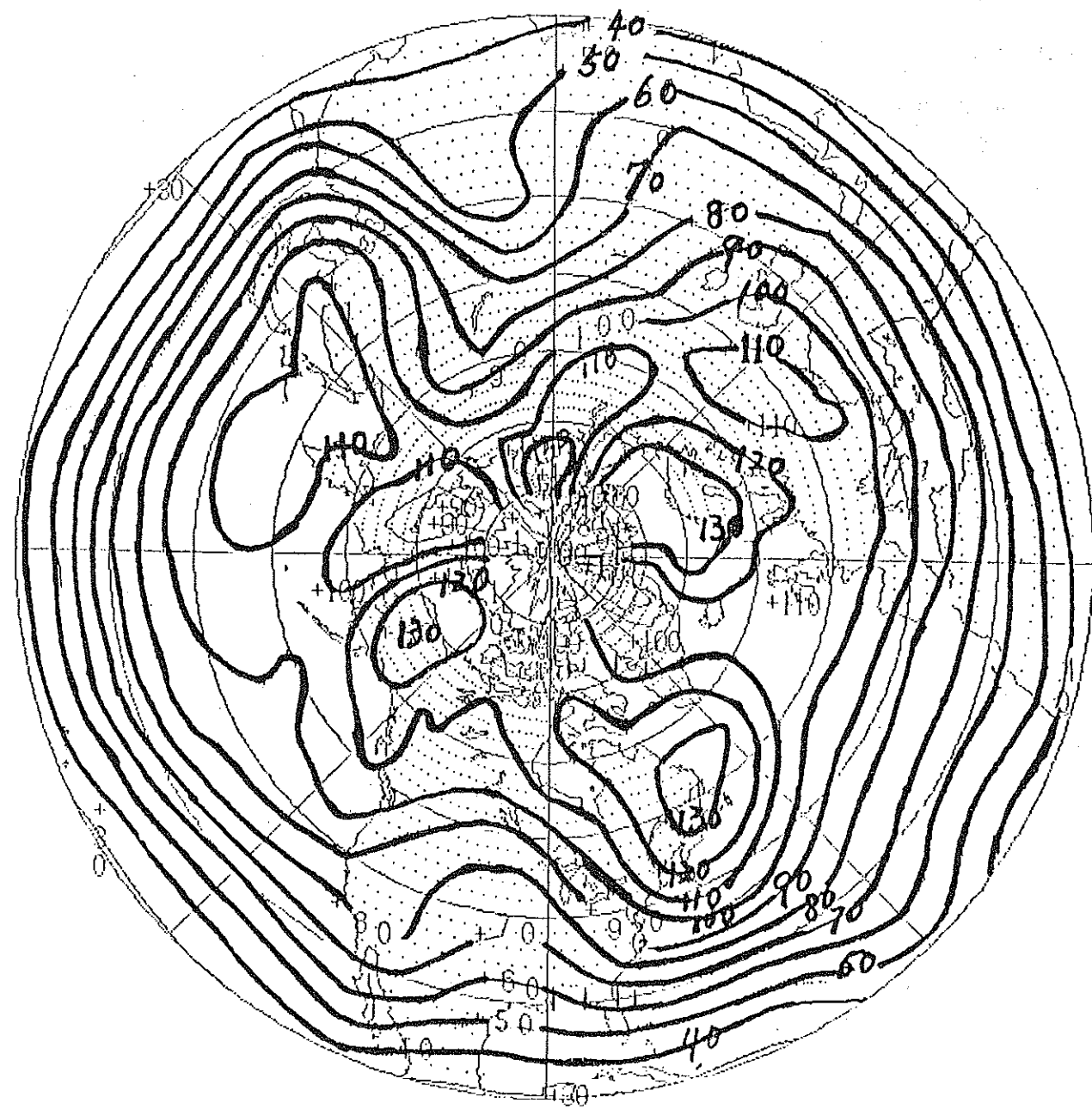
Figure 1a. The standard deviation of daily values for winter simulations.
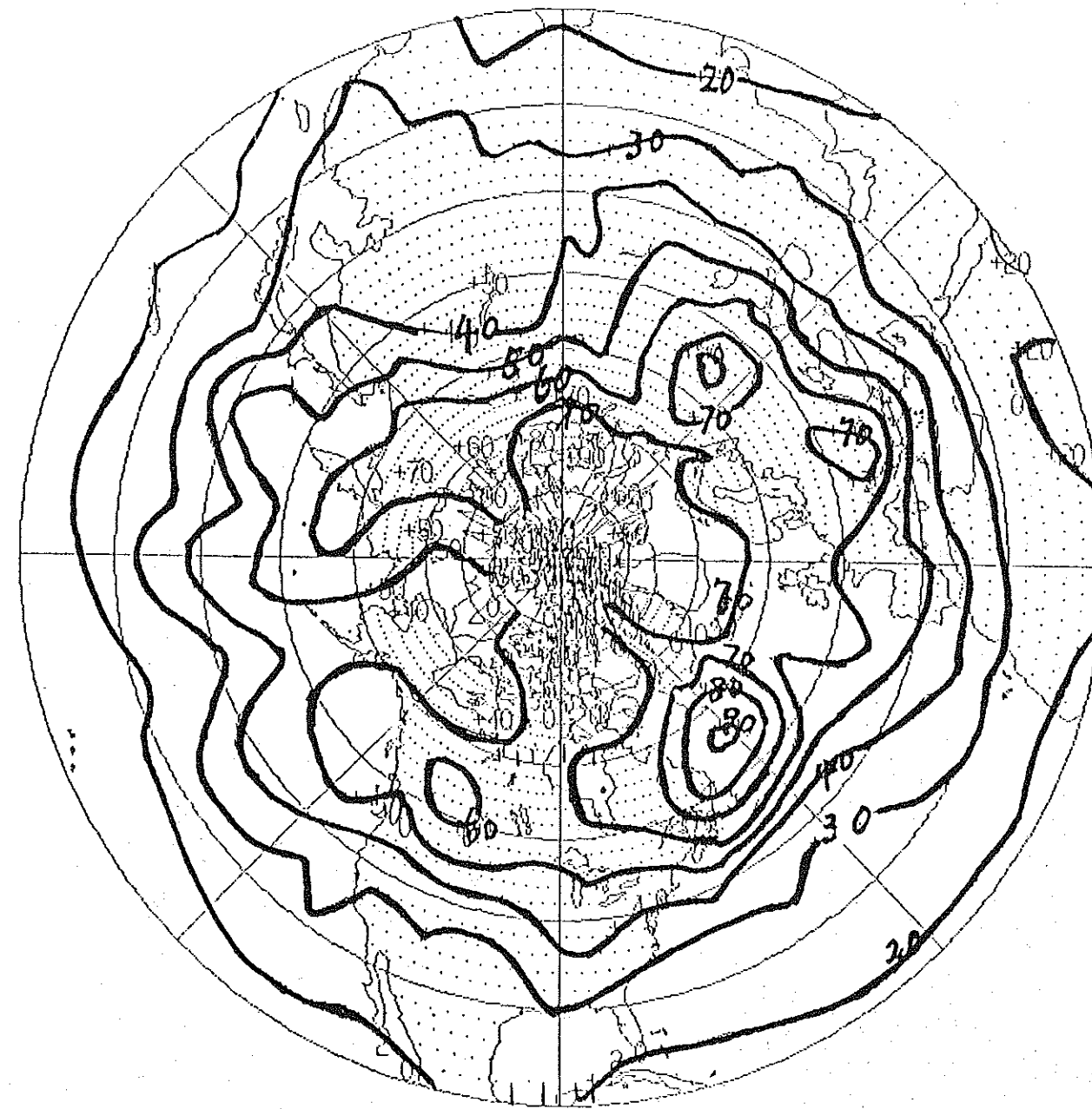
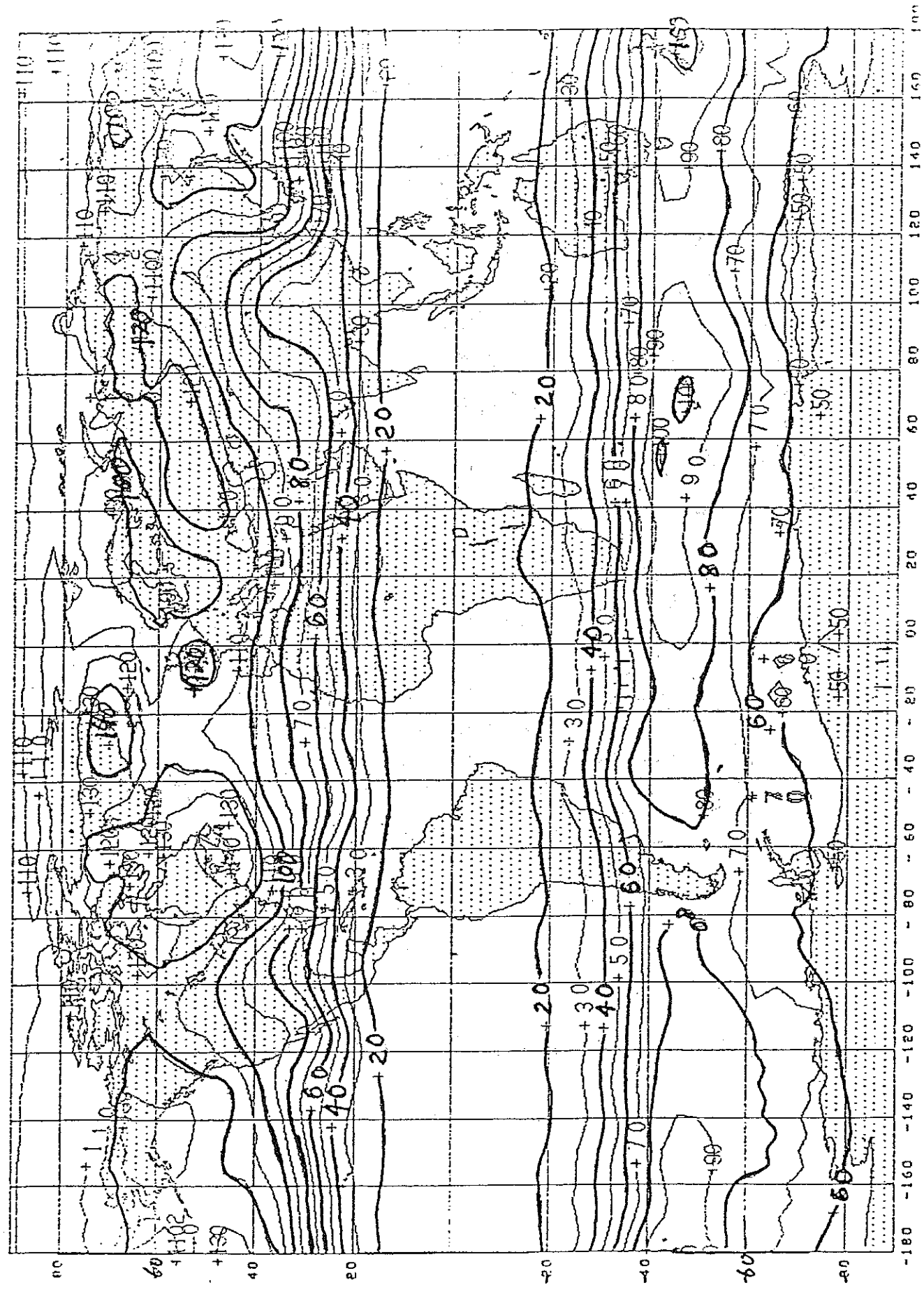Fig. 1b. The standard deviation of daily values for summer simulations.

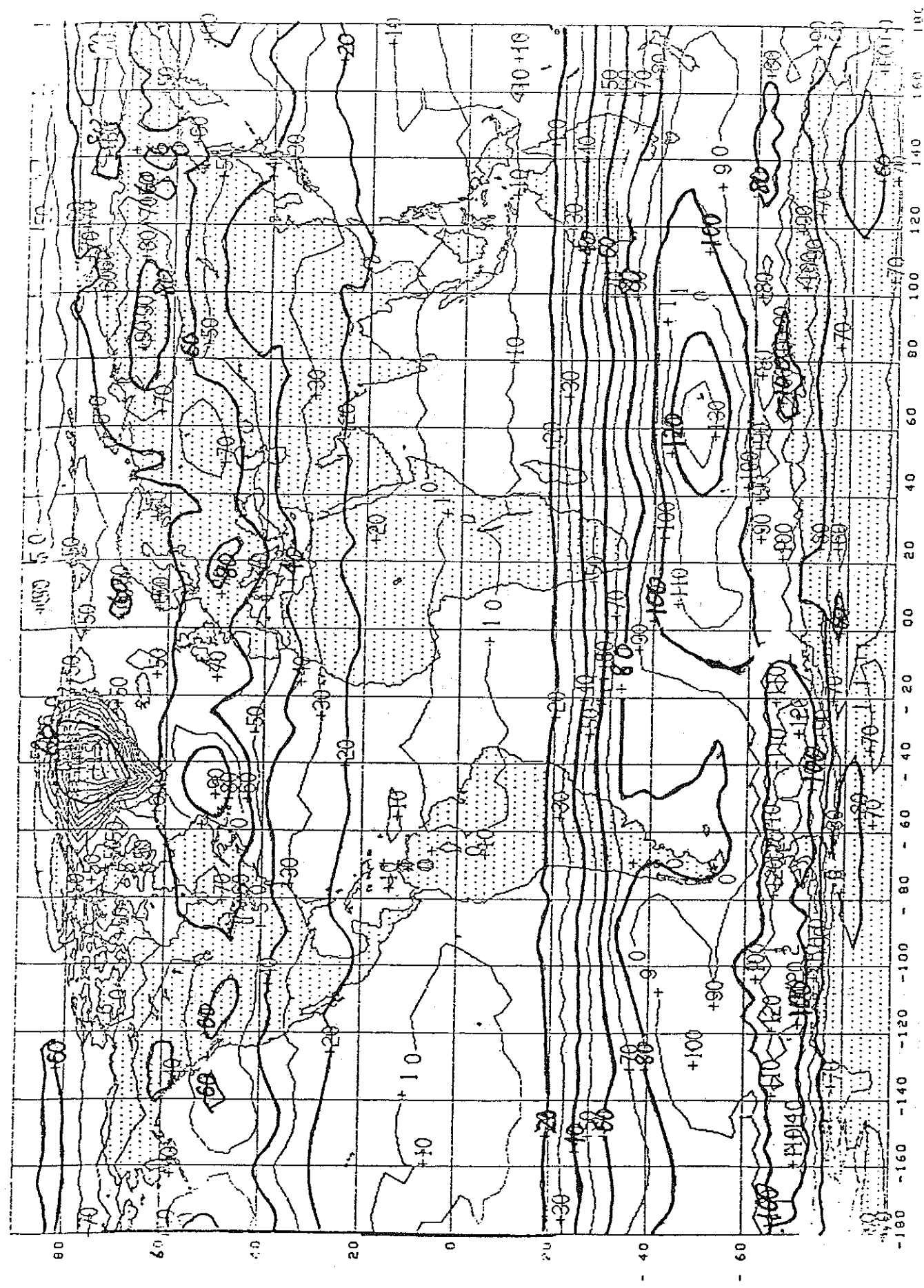Fig. 1c. Global standard deviations for winter simulations.

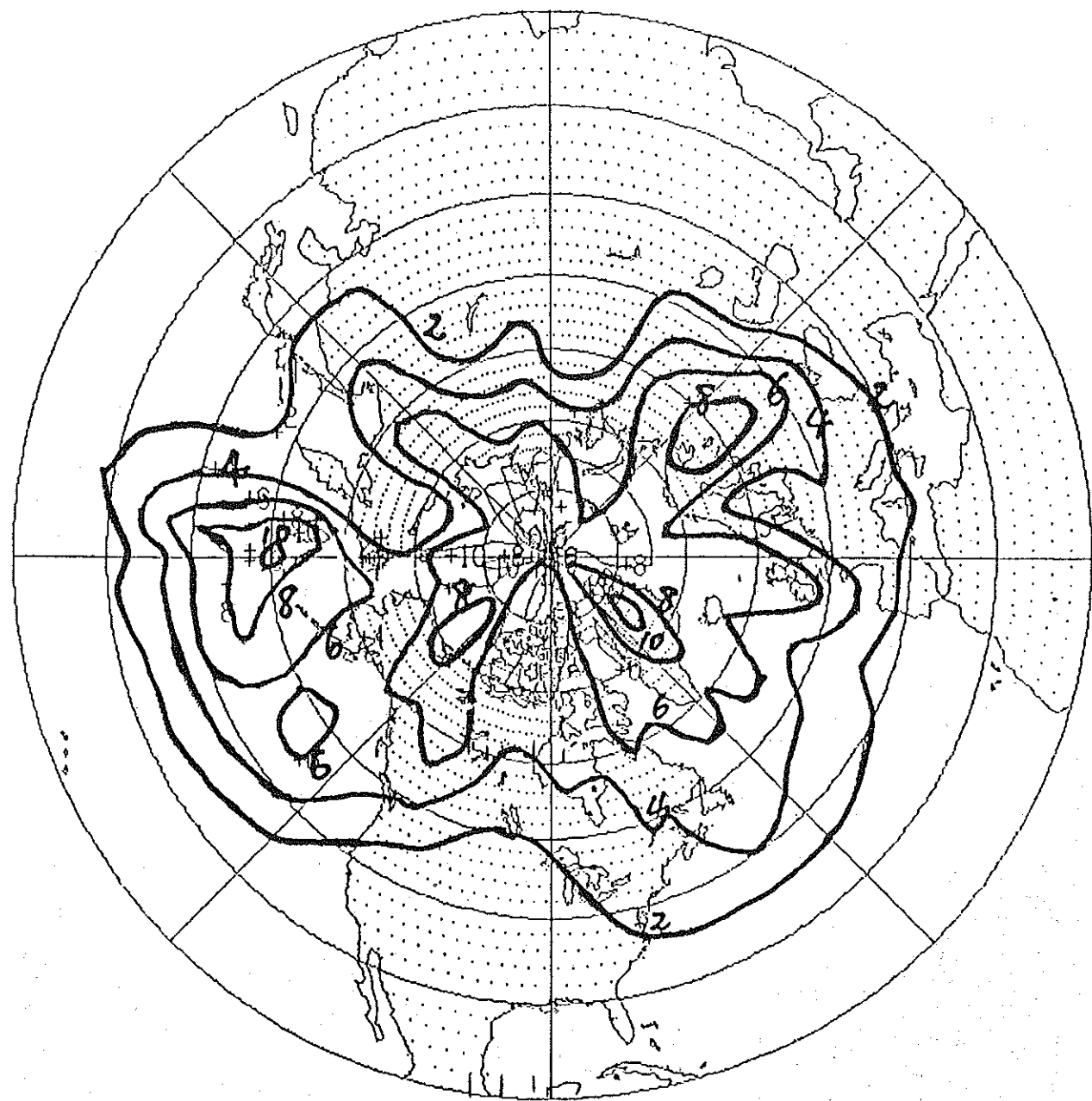Fig. 1d. Global standard deviations for summer simulations.

Fig. 2a. Number of events at each grid point N.H. for which positive anomaly of 100 gpm or more persists for 7 days or more for winter simulations.
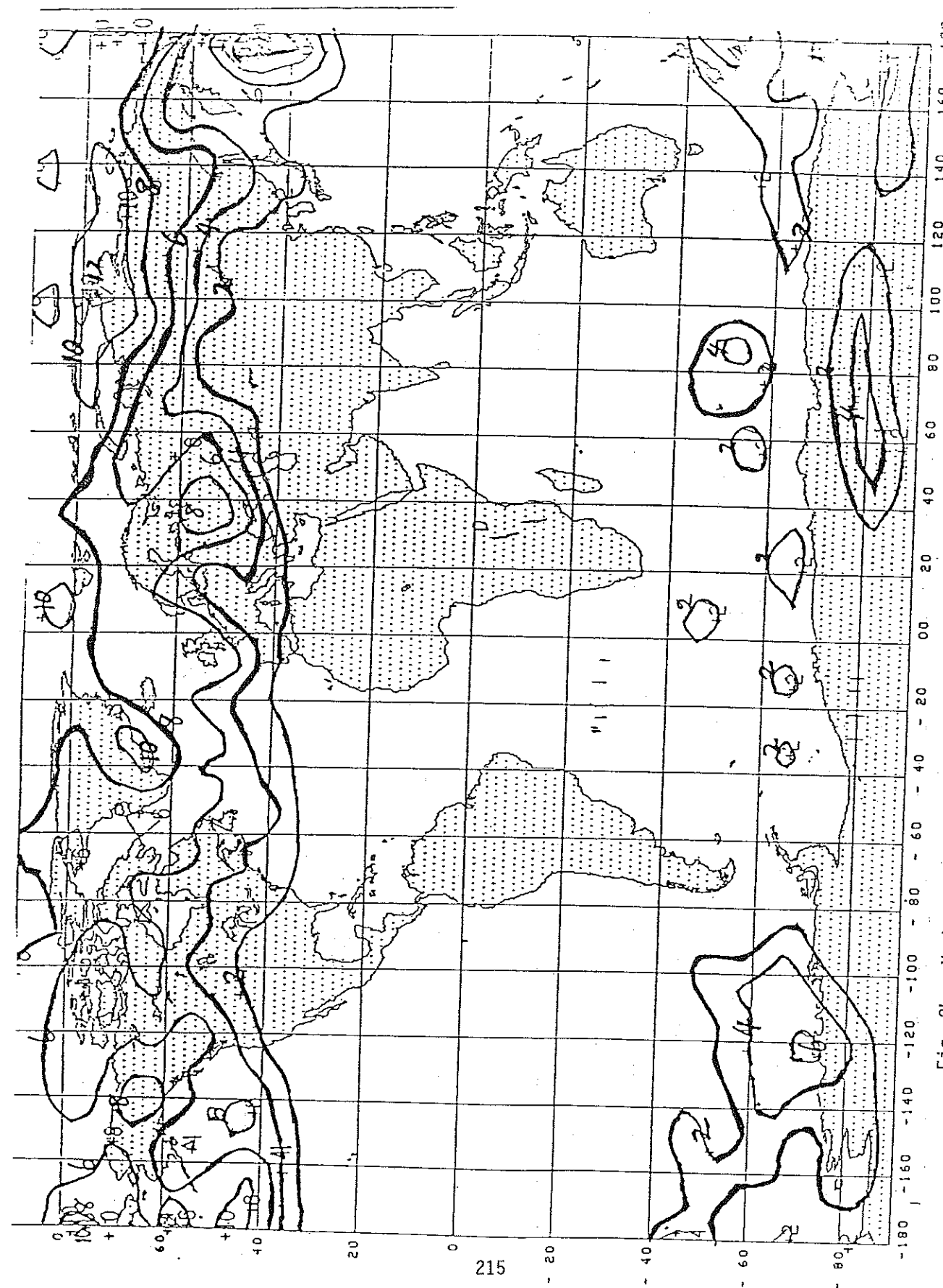

Fig. 2b. Number of events at each grid point (global) for which positive anomaly of 100 gpm or more persisted for 7 days or more for winter.
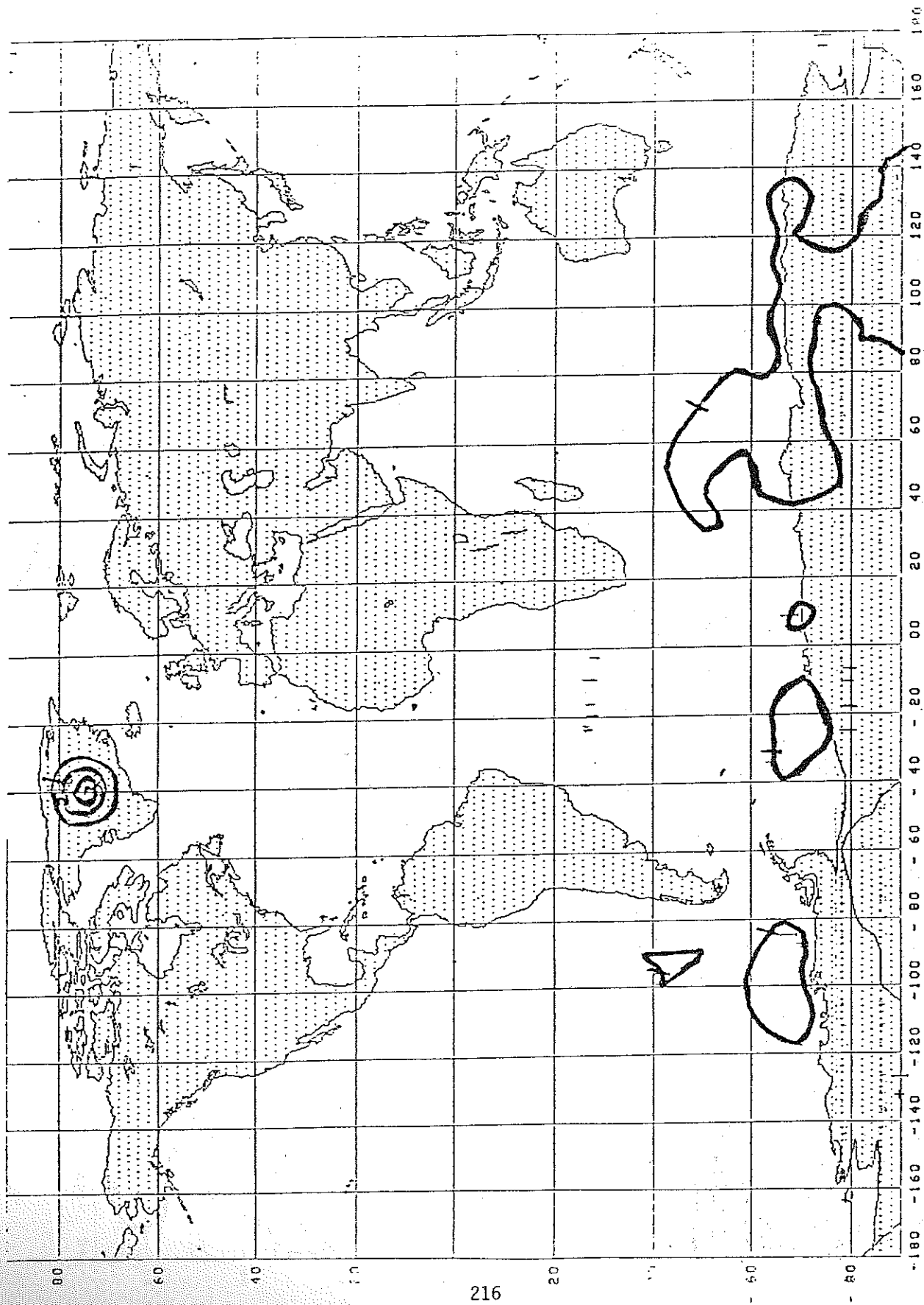
Fig. 2c. Number of events at each grid point (global) for which positive anomaly of 100 gpm or more persisted for 7 days or more for summer.