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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service

Mean Diurnal and Monthly Height Changes in the Troposphere Over North America and Vicinity

AUGUST F. KORTE AND DEVER COLSON

Systems
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August F. Korte and DeVer Colson

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August F. Korte and DeVer Colson
Techniques Development Laboratory

ABSTRACT. Maps of mean diurnal (12-hourly) and median (midway between 0000 and 1200 GMT) monthly height changes at the 850-, 700-, and 500-mb levels over North America and vicinity from January through December are presented, using grid-point data from an earlier study. The height changes were objectively derived and analyzed by computer. The use of these charts as an aid to weather forecasting is briefly described.

INTRODUCTION

The Techniques Development Laboratory (TDL) of the National Weather Service (NWS) recently completed charts (Korte 1971) for use in obtaining mean monthly heights at the 850-, 700-, 500-, and 300-mb levels over the Intermountain West for any desired month of the year. These mean maps are useful in obtaining an intensity classification of upper lows according to their height departures from normal. These classified lows can be applied as described in earlier investigations about the synoptic climatology of precipitation for the Intermountain West during winter (Jorgensen et al. 1967a; 1967b; Klein et al. 1968; and Korte et al. 1969).

To obtain upper level data in a convenient form and at a reasonable cost, upper air historical fields of pressures, temperatures, and humidities at 1000, 850, 700, 500, and 300 mb were extracted from the files of the Fleet Numerical Weather Central (FNWC) at Monterey, Calif. (Stevenson and Woodworth 1968 and Woodworth 1969), for the period from November 1961 through January 1969. These data were used by TDL to develop mean height maps centered on the midmonth for each of the 12 months of the year at both the 0000 and 1200 Greenwich Mean Time (GMT) observations. The resulting mean maps were obtained by computer and are presented separately for each month for both 0000 and 1200 GMT at each of four levels--850, 700, 500, and 300 mb (Korte 1971).

Since these maps were prepared, additional and more detailed hemispheric mean maps were published (Crutcher and Meserve 1970) applicable at 0000 GMT only. Earlier, 700-mb mean height charts were printed (O'Connor 1961) for a 12-year period. Recent mean surface maps produced by FNWC (Hesse and Stevenson 1968) refer to a similar unpublished study of diurnal-height differences at 500 mb.

Recent papers (Colton 1970; Morrissey and Brousaides 1970; and Teweles 1970) show that the humidity measurements obtained with U.S. radiosondes since about 1960 have been, in general, too low. The magnitude of this effect has not yet been determined, but it will tend to lower heights in daylight by amounts up to an order of 10 meters.

This Technical Memorandum shows examples of mean height-difference maps indicating diurnal intervals (1200 minus 0000 GMT) in figures 1 through 12 as well as monthly intervals (the following month minus the preceding month) in figures 13 through 24. The monthly height change is obtained using the median height midway between the 1200 and 0000 GMT mean height to represent the following and preceding months of the interval.

Only the three lower levels of the four considered earlier (Korte 1971) were used in this Technical Memorandum because they are more closely related to precipitation forecasting (Klein et al. 1968).

DISCUSSION OF RESULTS

The diurnal charts show that the larger height changes generally occur over Arizona, New Mexico, and adjacent northern Mexico at 850 mb. Large changes in both temperature and lower level height often occur in such arid regions. The largest of the 850-mb height changes (e.g., figs. 4 and 5) occur in April and May. The locations of maxima for the 700- and 500-mb levels vary between April and August within an area over the Western States (e.g., figs. 4 through 8). The maximum normal diurnal height changes over the Northwestern States at 500 mb are in good agreement with those found in an earlier study (Teweles 1954). Our changes are generally slightly larger and are located to the south when compared to Teweles' results during the months April through August.

The height changes at 700 mb are slightly larger, but the locations of the maxima over the western states and along the Pacific coast are in good agreement with earlier studies (Teweles 1949). The greatest difference is that Teweles found large maximum (+) changes in the Gulf coast region throughout the year except for an eastward displacement from September to December. Our charts do not show any such (+) changes in the Southeast. It should be realized that our data period was considerably longer and a different smoothing technique was used.

It is interesting to notice that the values of the monthly height change rise near the State of Washington, but fall in the Northeast at all levels from January to February (see fig. 13). The reverse situation is evident for the monthly height differences from February to March (see fig. 14).

USE OF THE MEAN MAPS

The height-change charts in the appendix are presented for each month of the year. They may be used with the charts and interpolation table found in the cited Memorandum by Korte (1971) to obtain a more accurate mean height if desired. By examining the values in the area of interest on the chart, one can decide if the height change in the time interval under consideration is sufficient to require interpolation. If interpolation is considered necessary, then one may use the following procedure:

Step 1. With masking tape, fasten a transparent sheet over the applicable map found in the cited Memorandum by Korte (1971) and trace small portions of each of the four corners of the map as alinement marks. Mark the position of the location of interest with a small "x." Alinement marks may also be indicated using any convenient set of latitude-longitude intersections if greater accuracy is desired.

Step 2. Transfer the overlay from step 1 to the applicable median monthly height-change chart and read the desired change in height for use with the interpolation table in step 3 of the cited Memorandum by Korte (1971). The median height-change charts (figs. 13 through 24) are presented for the interpolation indicated. Samples of this type of chart have been used as forecast aids in the Western United States (Anon. 1970a and 1970b).

The diurnal charts (figs. 1 through 12) are useful in estimating the portion of the deepening or filling that occurs in either a high or low resulting from diurnal changes. However, it may be possible that the weather system under consideration may not be actually deepening or filling to the extent one may extrapolate when these transitory diurnal effects are considered. Examples of this effect are shown in a recent paper of the NWS (Anon. 1970a).

It should be noted in using these charts that the ± height changes in figures 1 through 12 may be algebraically added to the 0000 GMT synoptic chart to estimate the diurnal change and that the sign should be reversed if applied to the following 1200 GMT synoptic chart. Similarly, for more accurate mean height estimates, figures 13 through 24 can be used with either the corresponding 0000 or 1200 GMT mean monthly height chart because a median mean monthly height change is shown. The interpolated ± mean monthly median height change may be algebraically added to this initial mean monthly height to obtain the mean monthly height for a date between the 16th of one month and the 15th of the following month. Thus, the sign depends on whether one is extrapolating forward (using the sign as shown) or backward (reversing the sign) from any given chart indicated in the appendix. In addition, height trends can be qualitatively judged where quantitative values are not desired.

ACKNOWLEDGMENTS

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APPENDIX

MEAN MONTHLY HEIGHT-CHANGE CHARTS FOR DIURNAL (12-HOUR) AND MONTHLY (30-DAY) INTERVALS

The following charts show the mean height changes in geopotential meters at 850, 700, and 500 mb for the months of January through December. These height changes are shown for each of these months by figures 1 through 12 for 1200 minus 0000 GMT and by figures 13 through 24 for the monthly median height changes. Only the trend in height from 0000 to 1200 GMT (i.e., 1200 minus 0000 GMT) is shown in each case for figures 1 through 12. Only the change in median height (i.e., midway between 0000 and 1200 GMT) and between adjacent months (following month minus previous month) is shown in each case for figures 13 through 24. To reverse the trend of the period interval, simply reverse the corresponding sign of the change in height. Each change of height represents an arithmetic average of objectively analyzed grid-point data for every month in the period of record (November 1961 through January 1969). All charts are shown on NOAA, National Weather Service, NWS Form Map 1608, 4-65, scale 1:30,000,000, Polar Stereographic Projection, true at latitude 60°N.

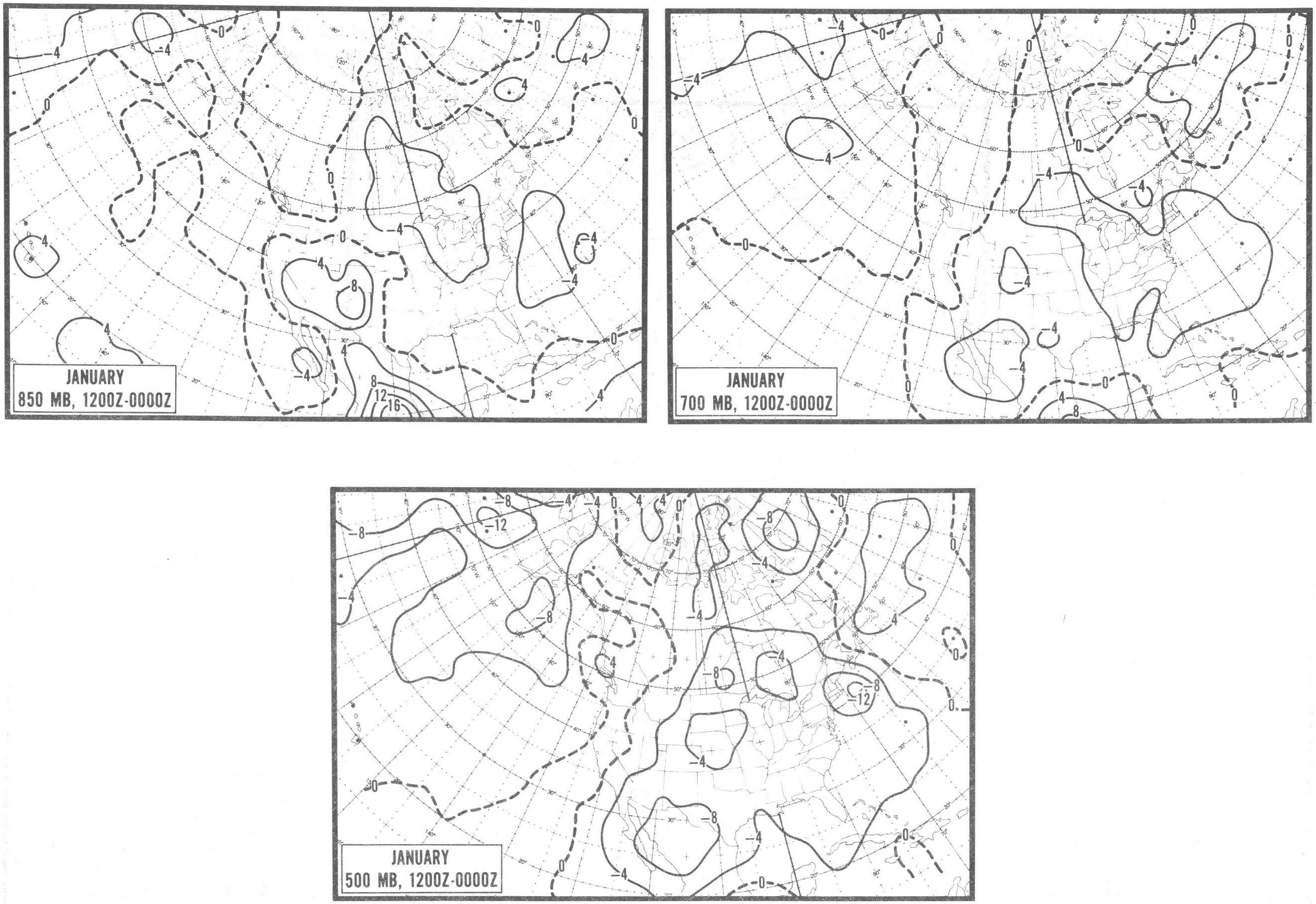


Figure 1. --Mean diurnal height-change at 850, 700, and 500mb, 1200Z-0000Z, January. Units in geopotential meters.

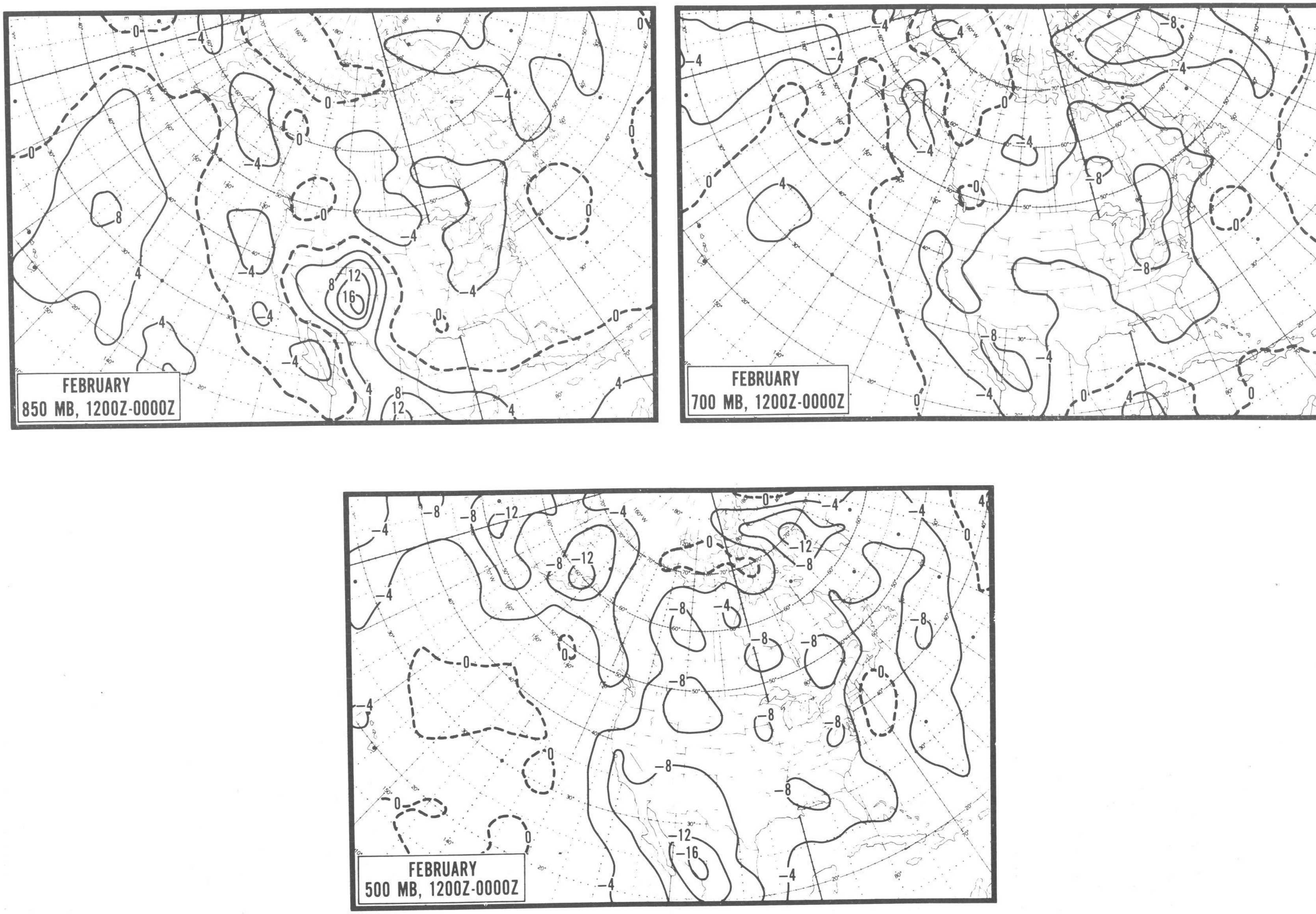


Figure 2.--Mean diurnal height-change at 850, 700, and 500mb, 1200Z-0000Z, February. Units in geopotential meters.

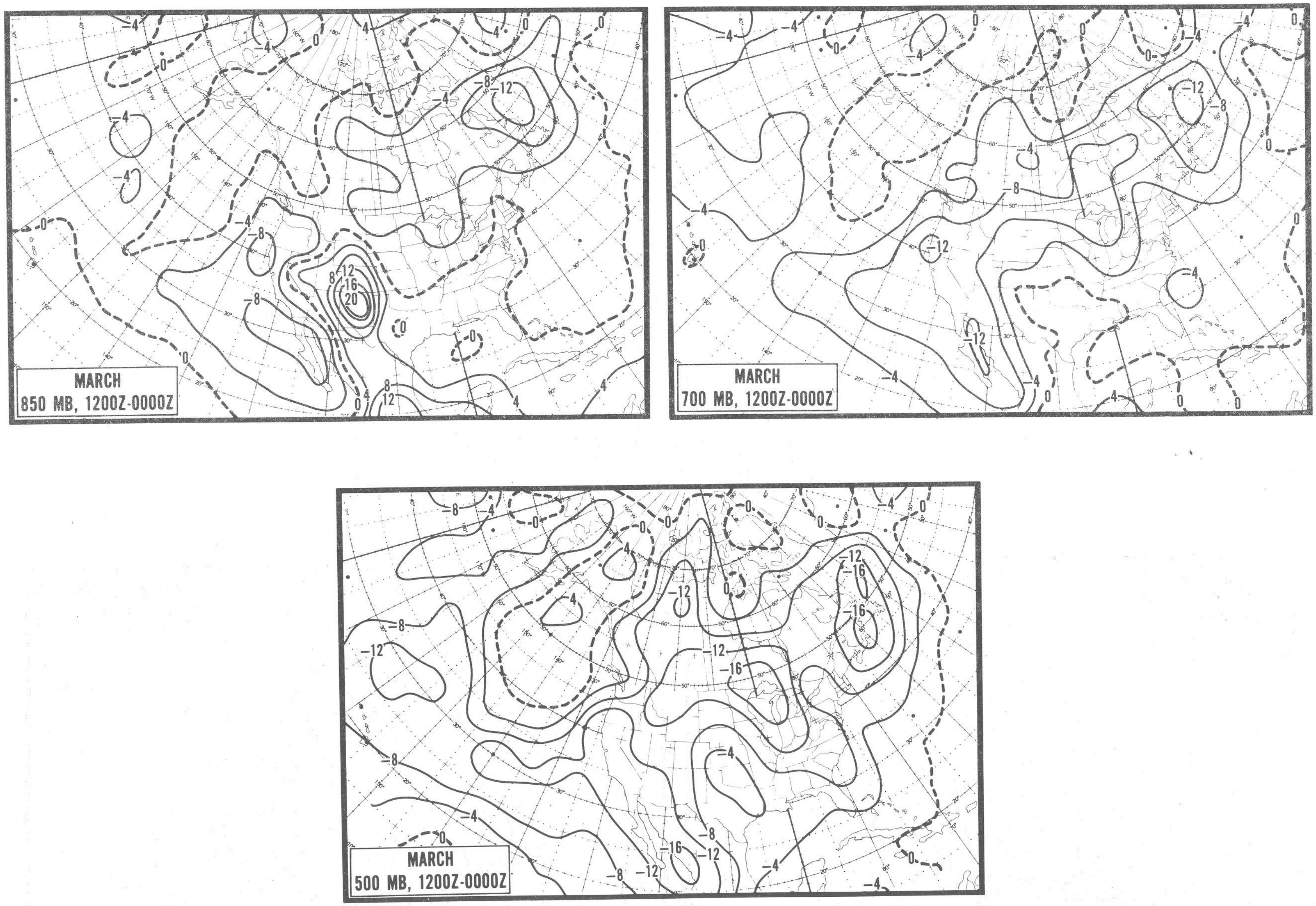


Figure 3.-- Mean diurnal height-change at 850, 700, and 500mb, 1200Z-0000Z, March. Units in geopotential meters.

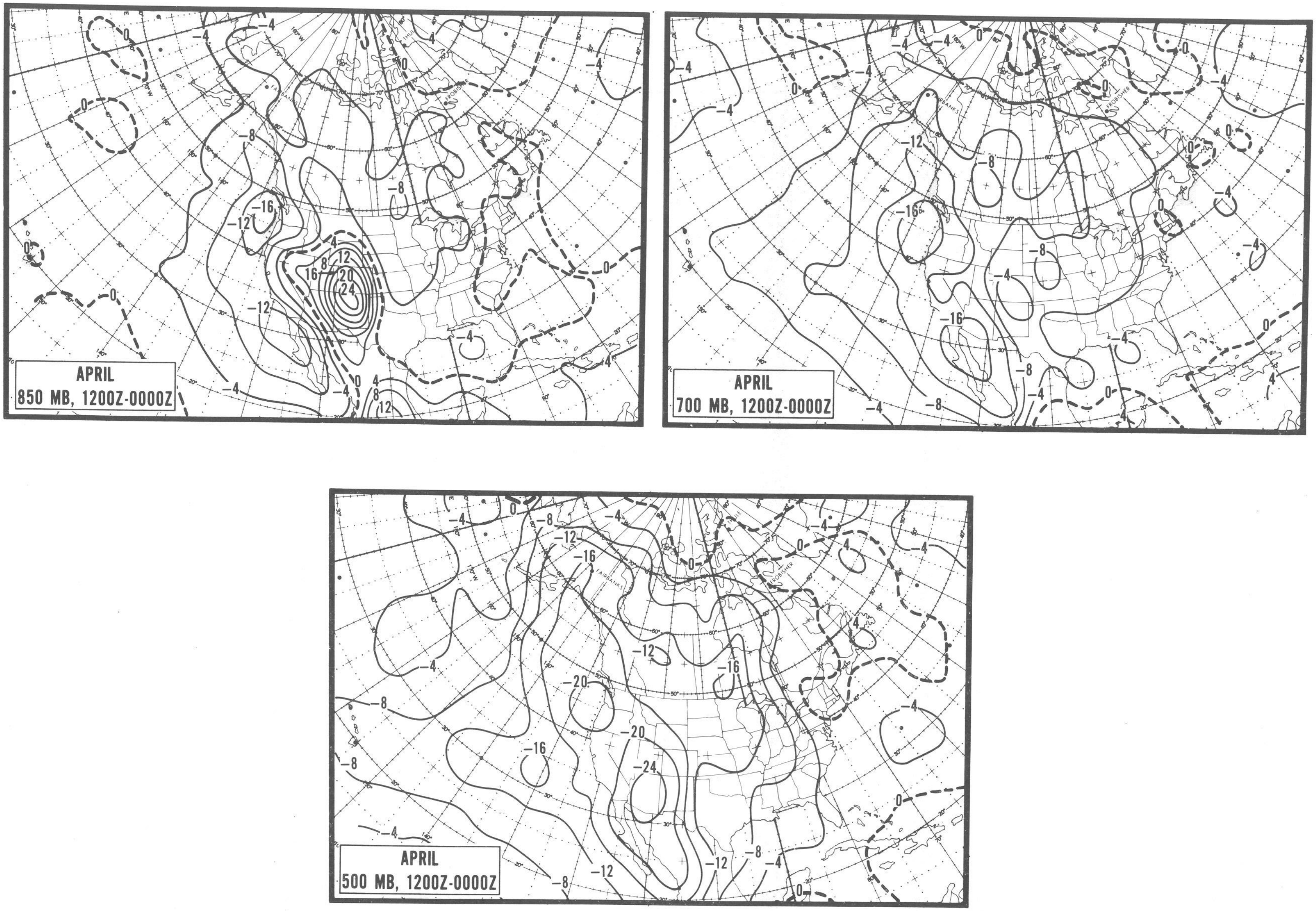


Figure 4.--Mean diurnal height-change at 850, 700, and 500mb, 1200Z-0000Z, April. Units in geopotential meters.

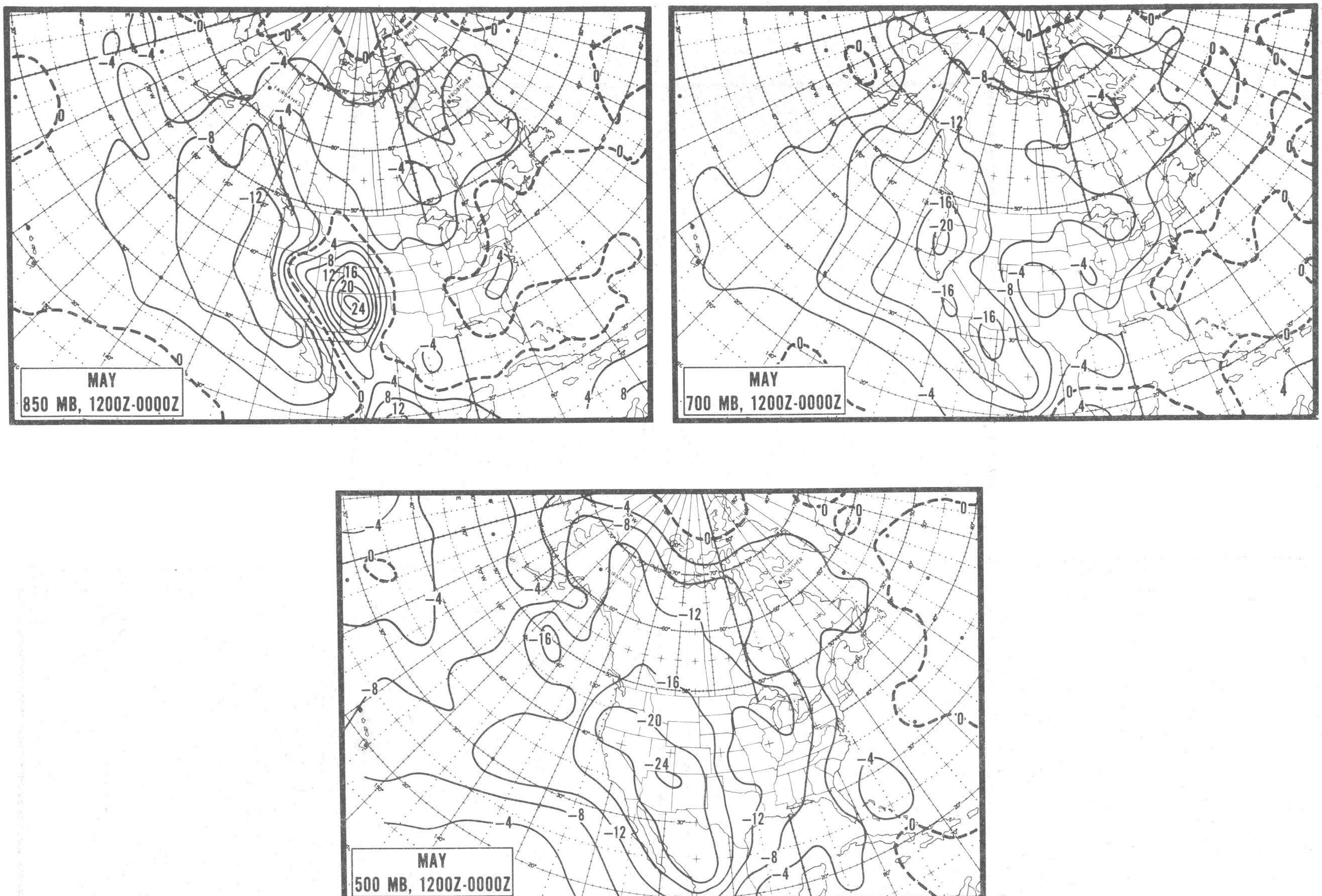
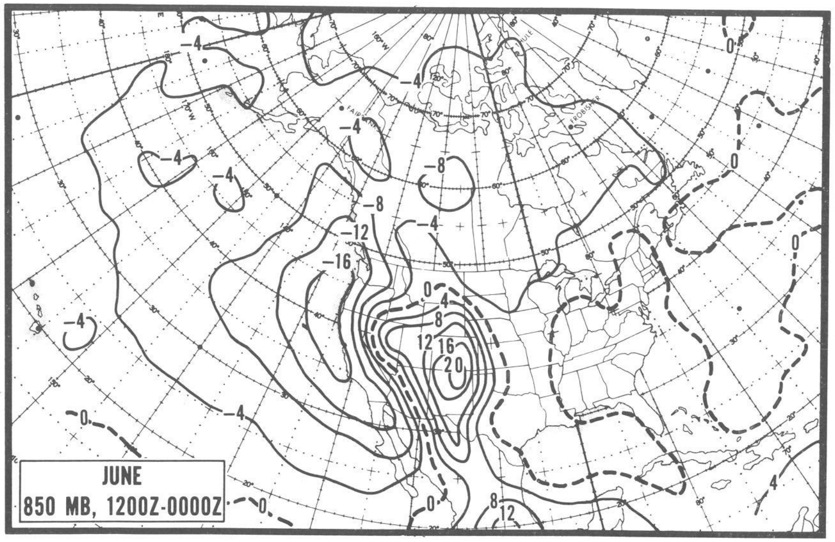
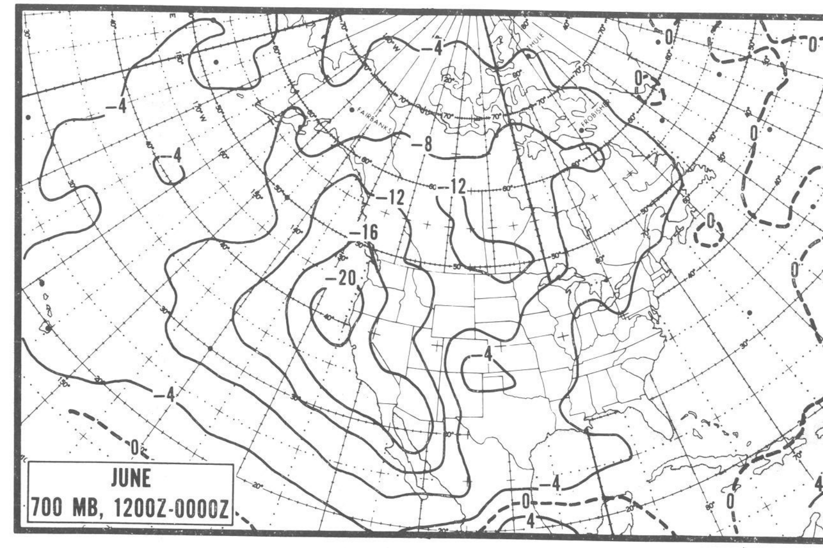


Figure 5.--Mean diurnal height-change at 850, 700, and 500mb, 1200Z-0000Z, May. Units in geopotential meters.





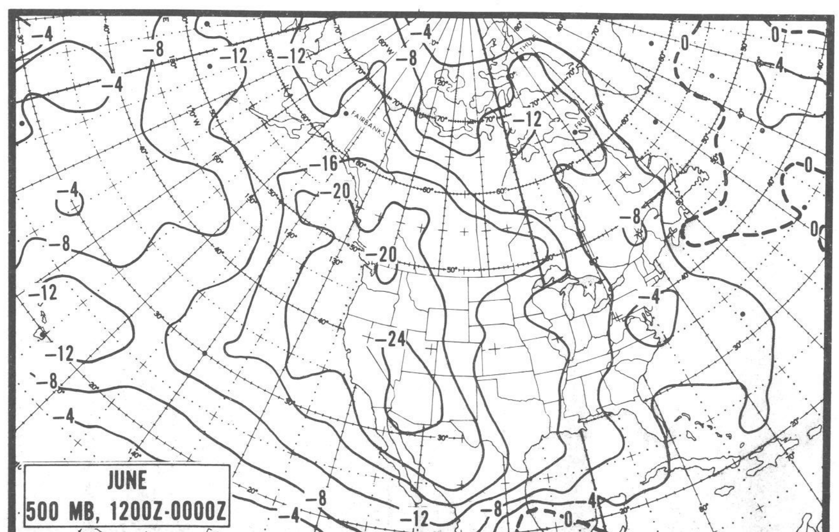
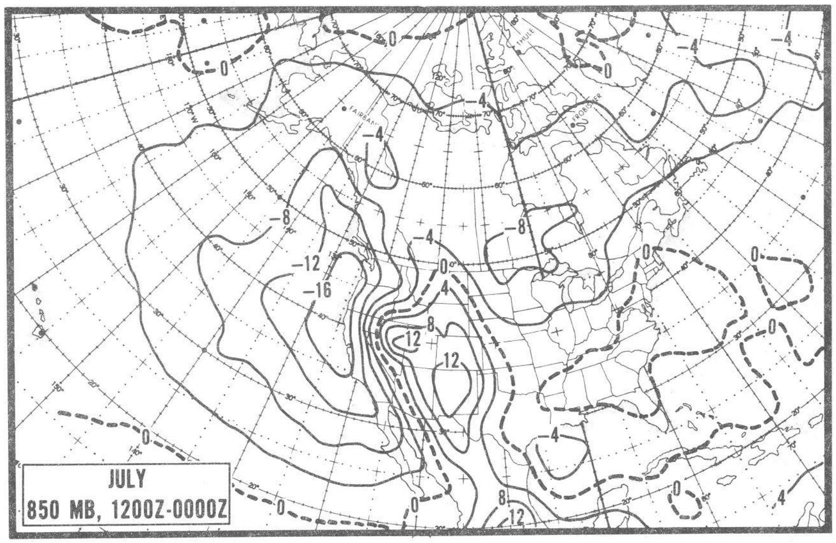
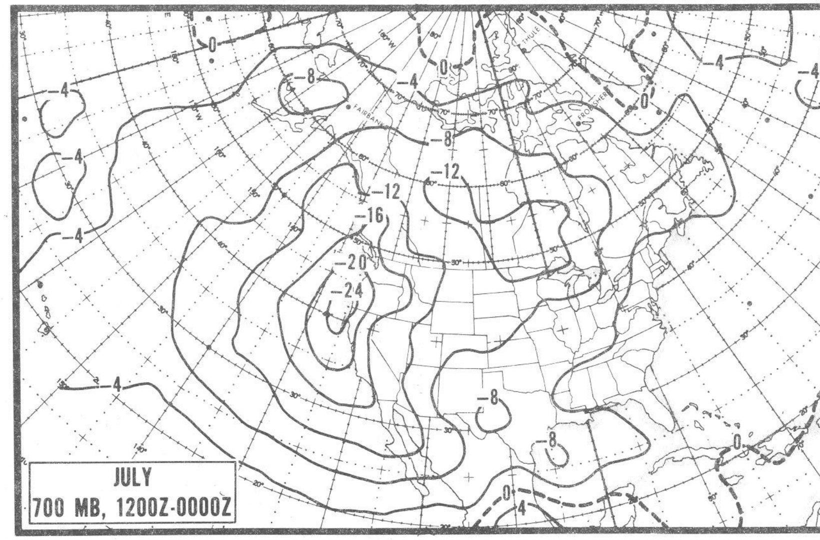


Figure 6.--Mean diurnal height-change at 850, 700, and 500mb, 1200Z-0000Z, June. Units in geopotential meters.





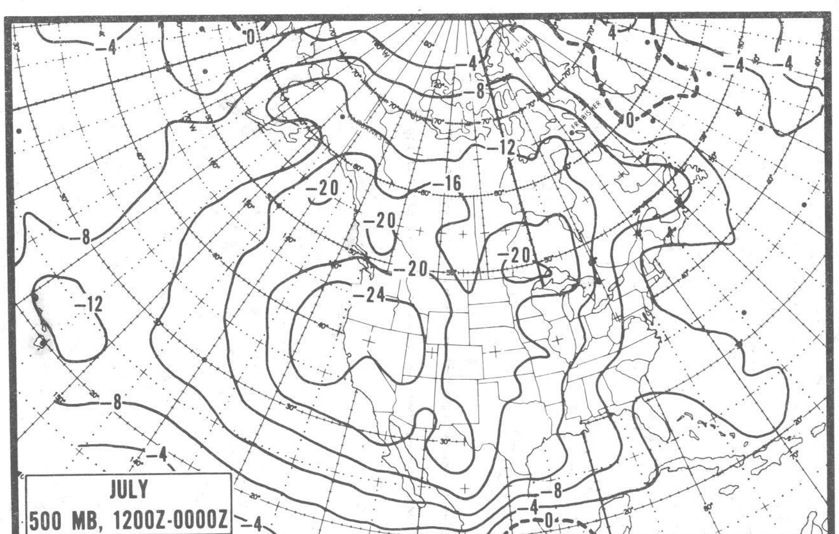
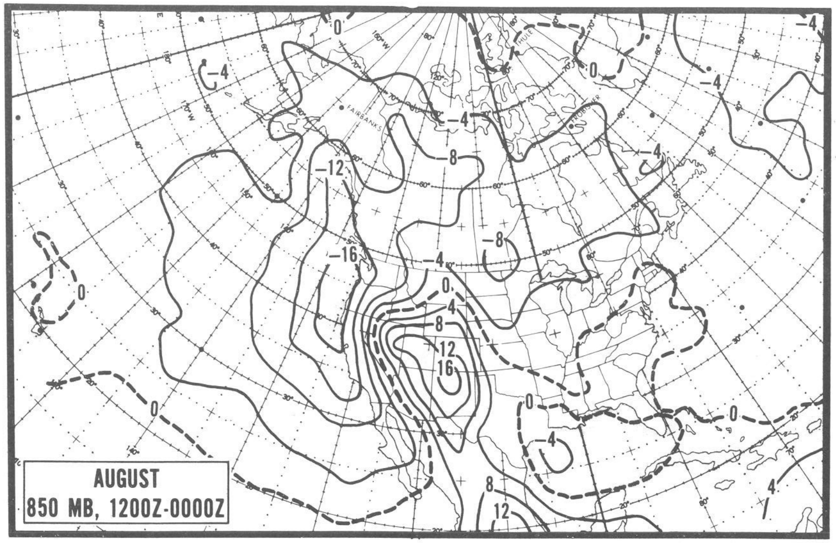
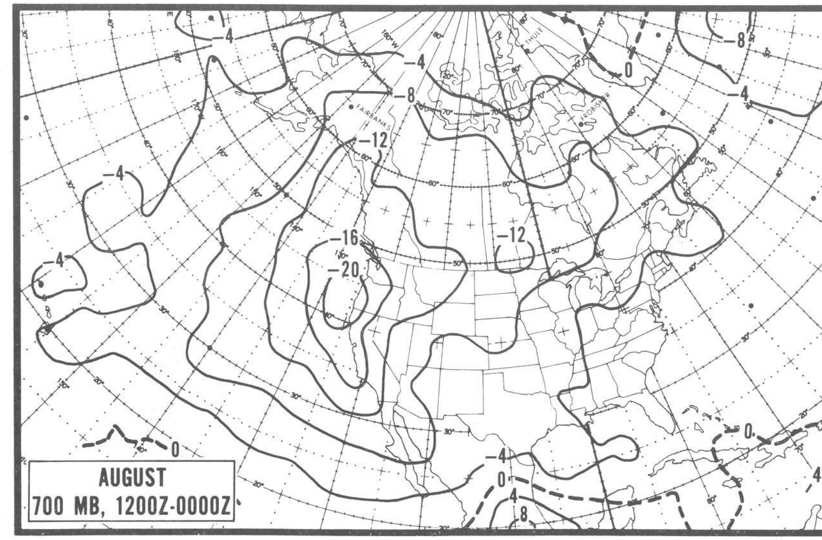


Figure 7.--Mean diurnal height-change at 850, 700, and 500mb, 1200Z-0000Z, July. Units in geopotential meters.





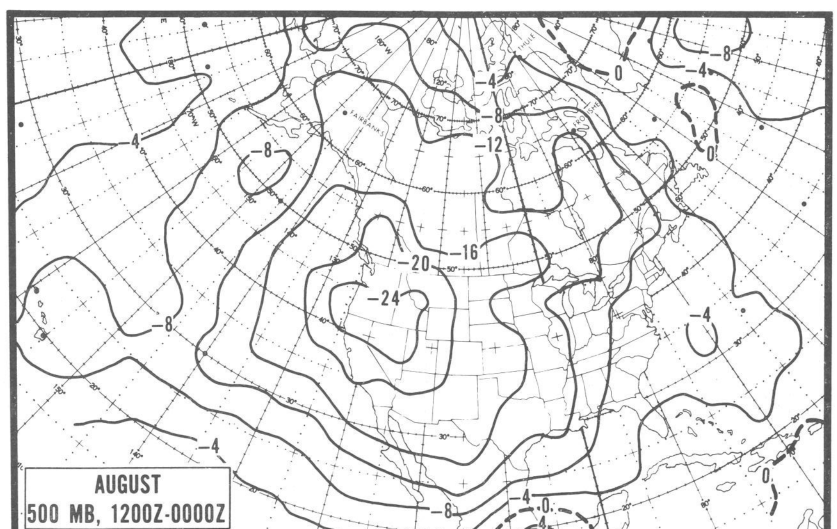


Figure 8.-- Mean diurnal height-change at 850, 700, and 500mb, 1200Z-0000Z, August. Units in geopotential meters.

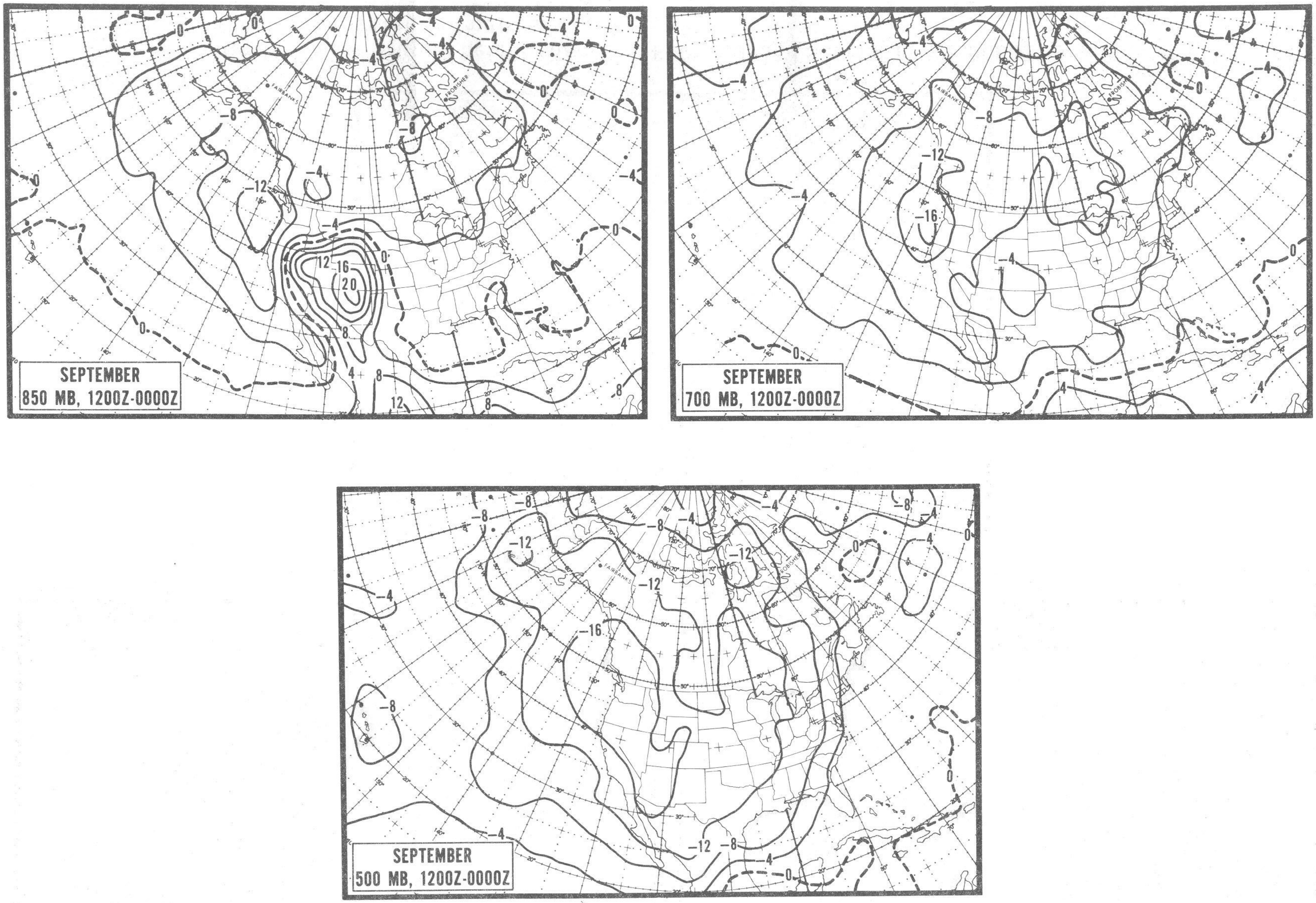


Figure 9.-- Mean diurnal height-change at 850, 700, and 500mb, 1200Z-0000Z, September. Units in geopotential meters.

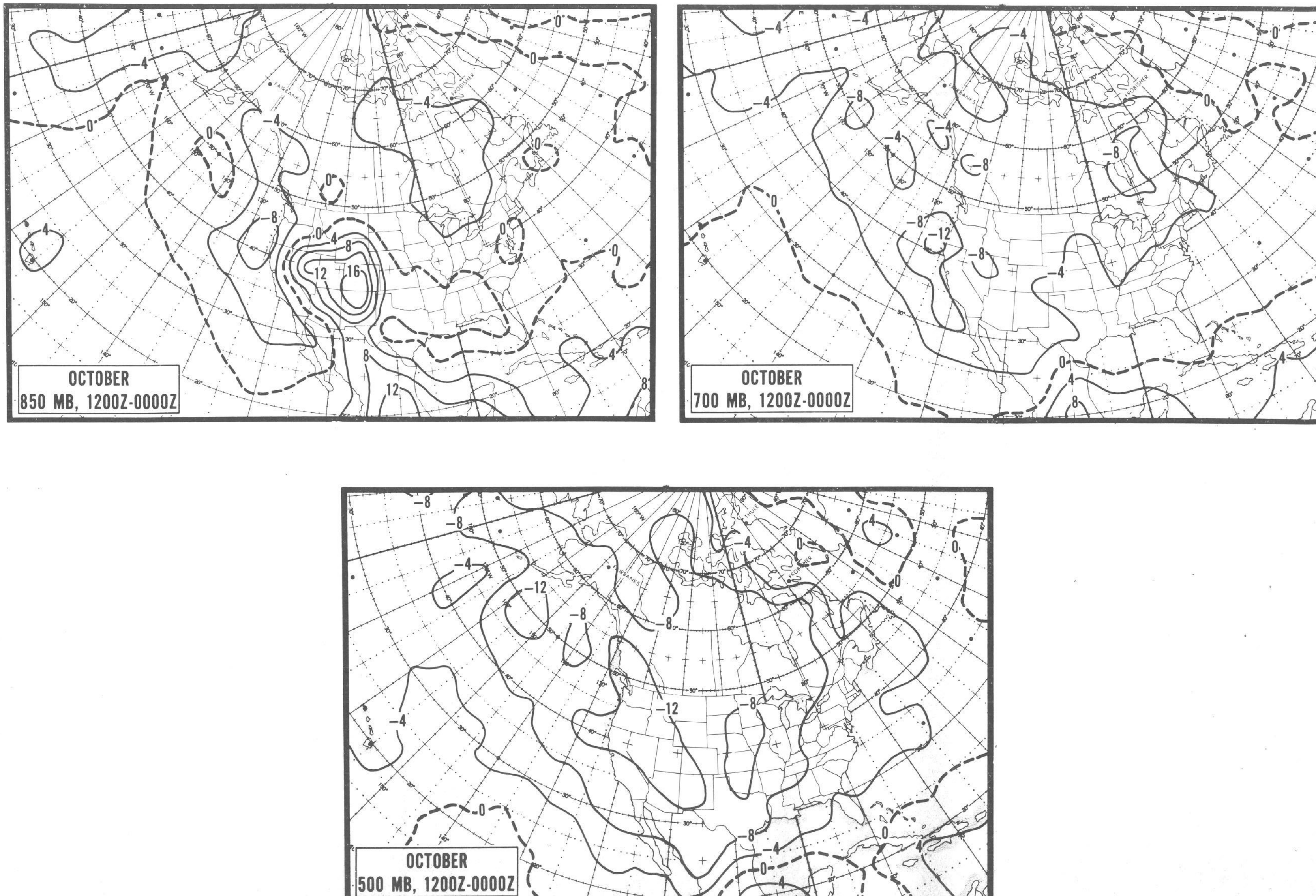


Figure 10.--Mean diurnal height-change at 850, 700, and 500mb, 1200Z-0000Z, October. Units in geopotential meters.

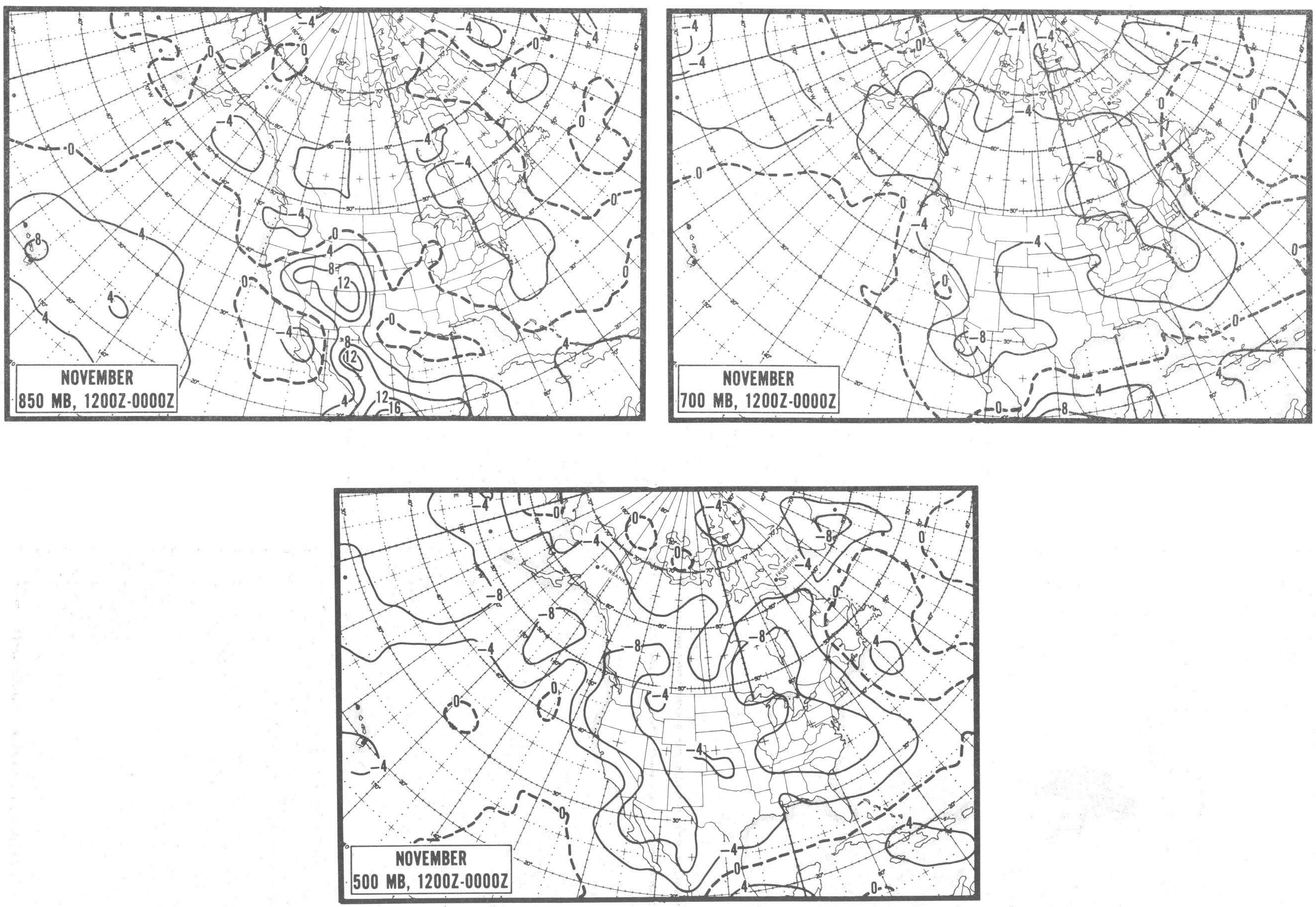


Figure 11.--Mean diurnal height-change at 850, 700, and 500mb, 1200Z-0000Z, November. Units in geopotential meters.

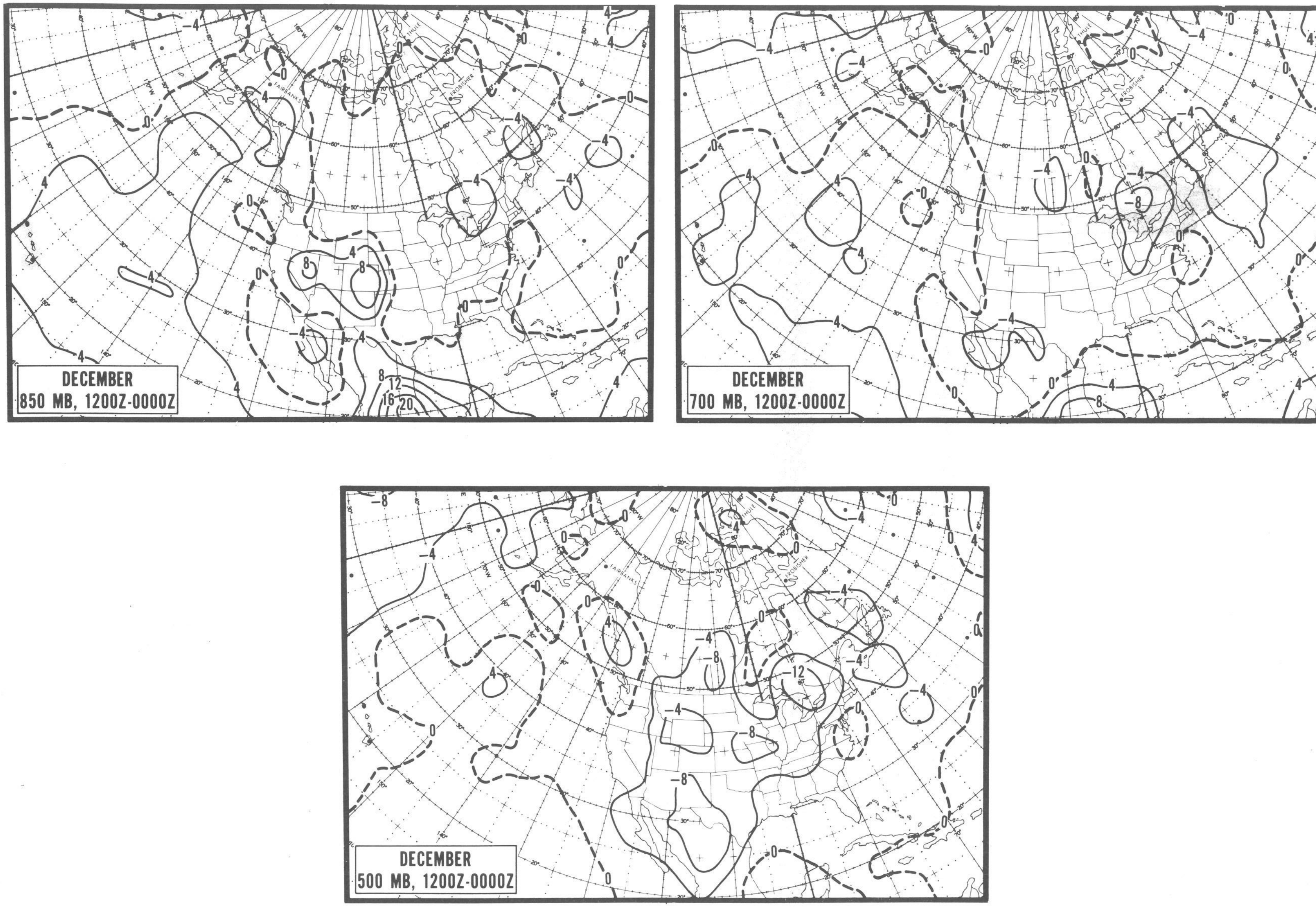


Figure 12.-- Mean diurnal height-change at 850, 700, and 500mb, 1200Z-0000Z, December. Units in geopotential meters.

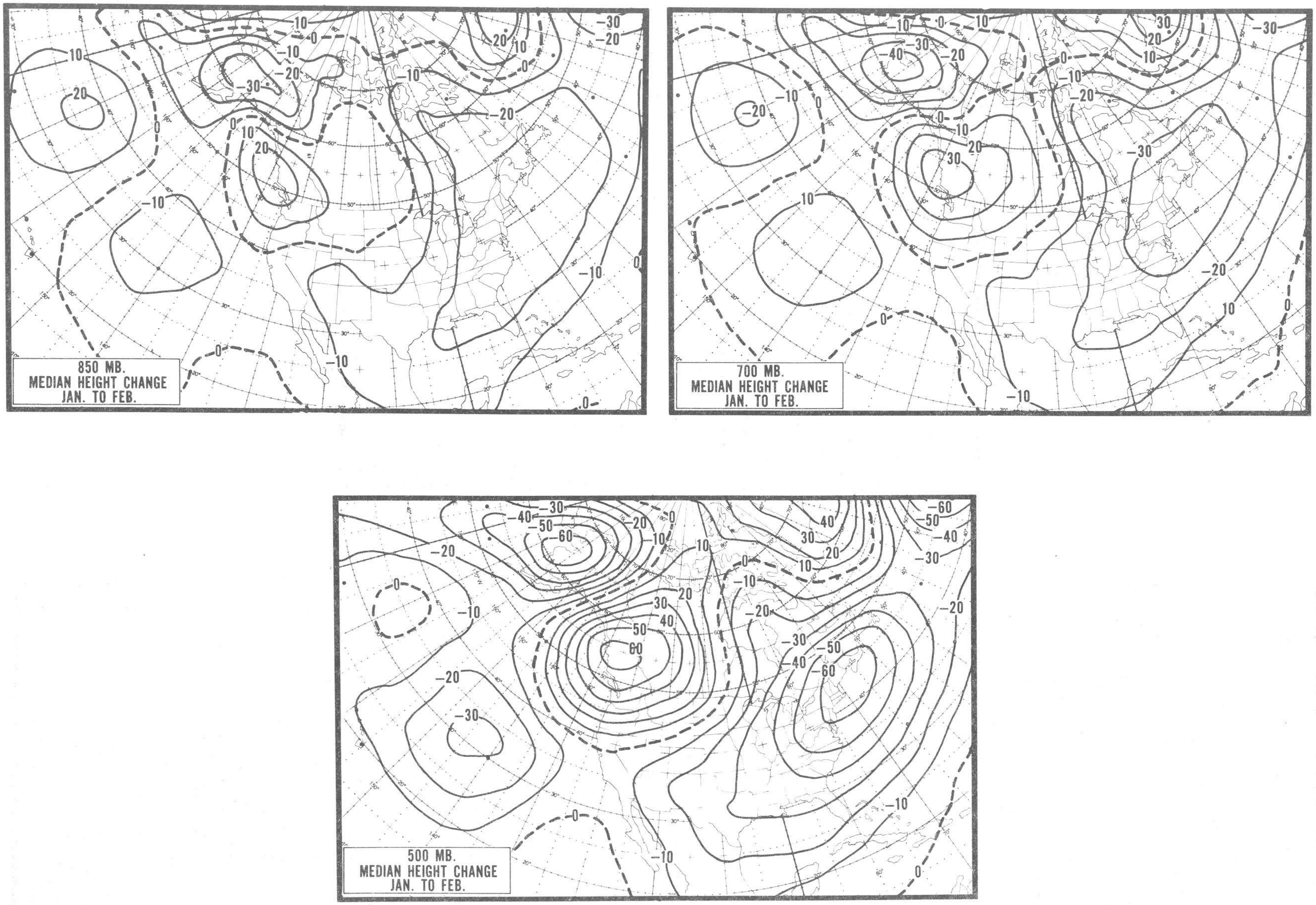


Figure 13.--Median (mean of heights at 1200 and 0000Z) monthly height-change from January 16 through February 15 (February minus January heights). Units in geopotential meters.

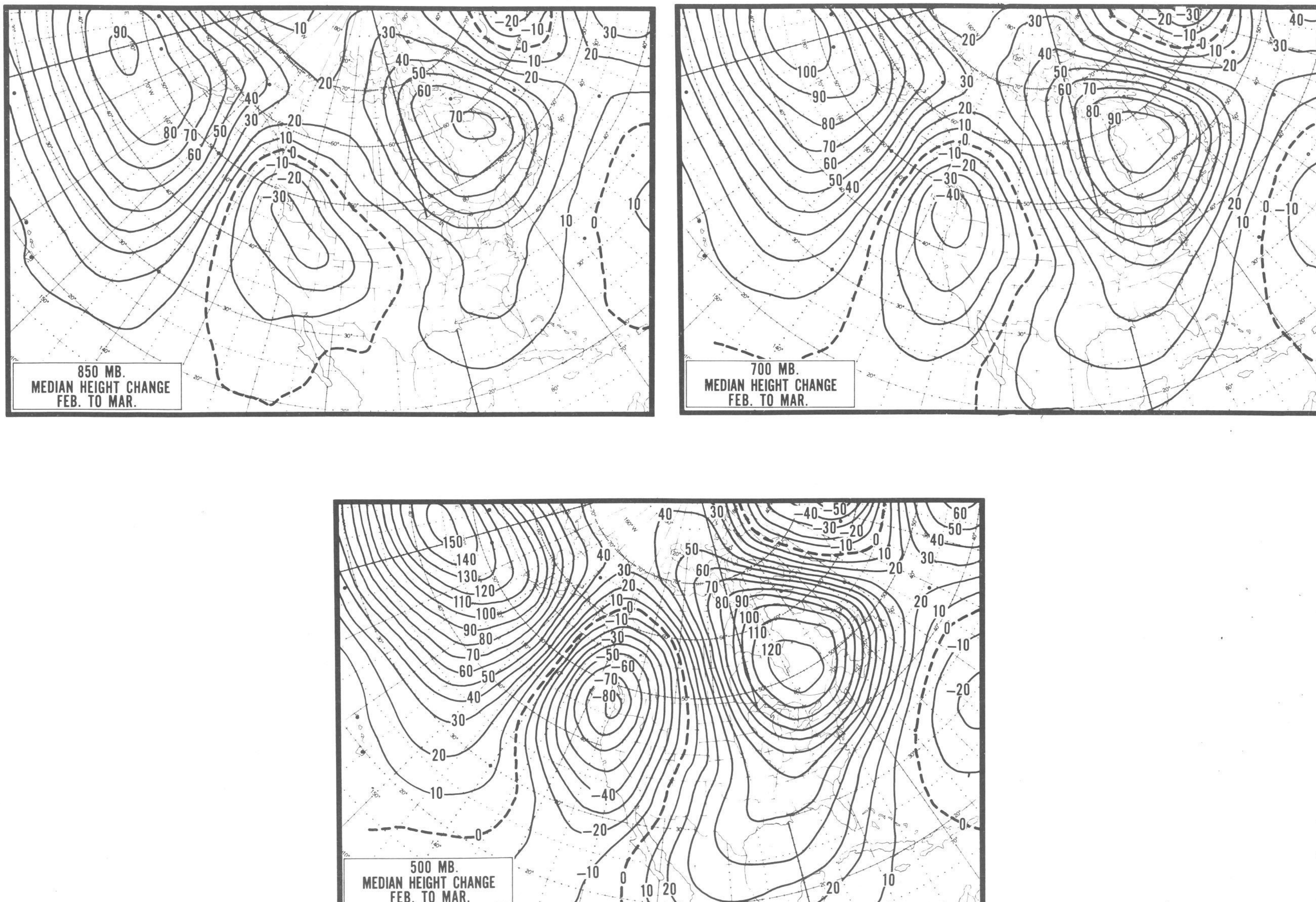


Figure 14.--Median (mean of heights at 1200 and 0000Z) monthly height-change from February 16 through March 15 (March minus February heights). Units in geopotential meters.

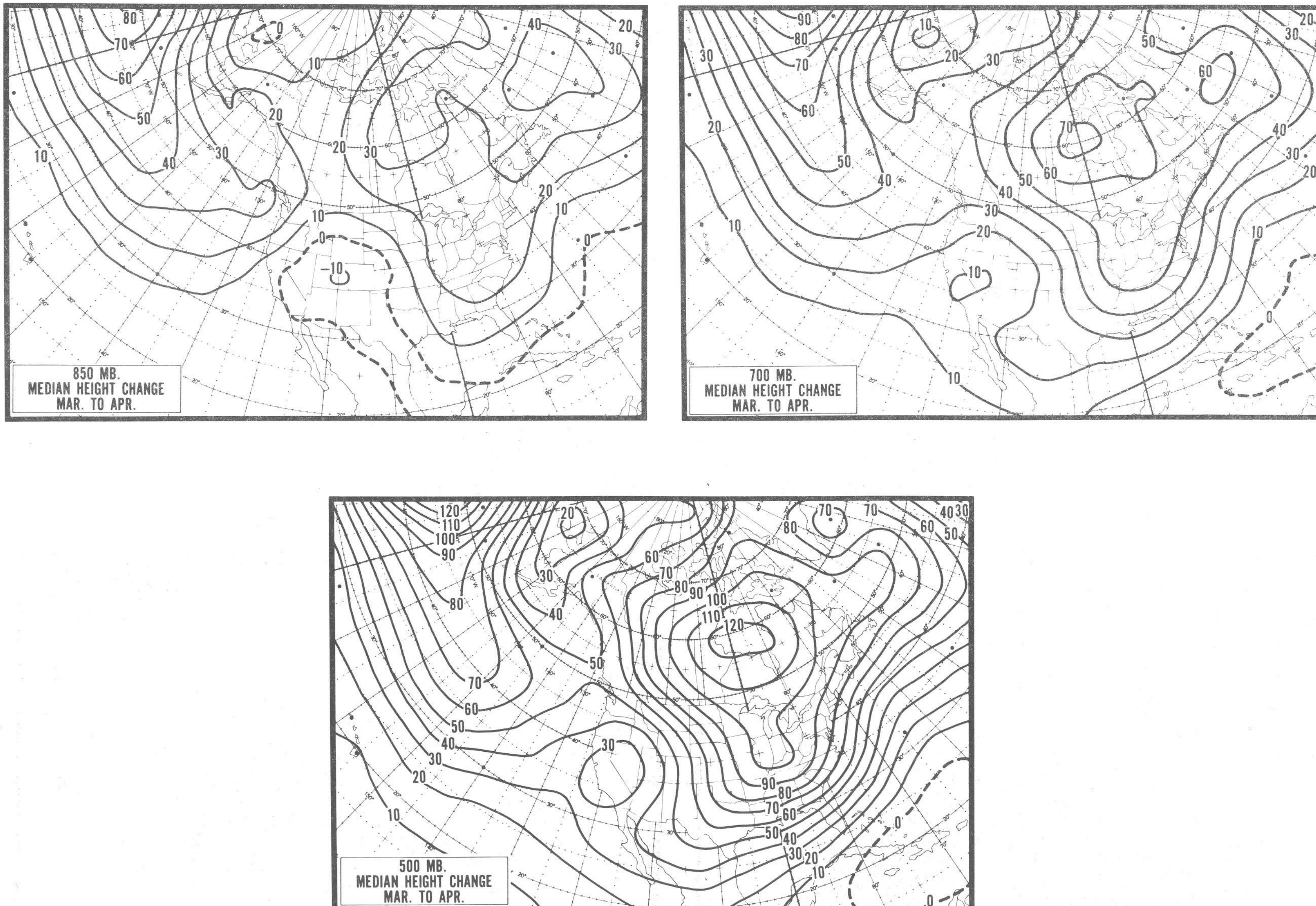


Figure 15.--Median (mean of heights at 1200 and 0000Z) monthly height-change from March 16 through April 15 (April minus March heights). Units in geopotential meters.

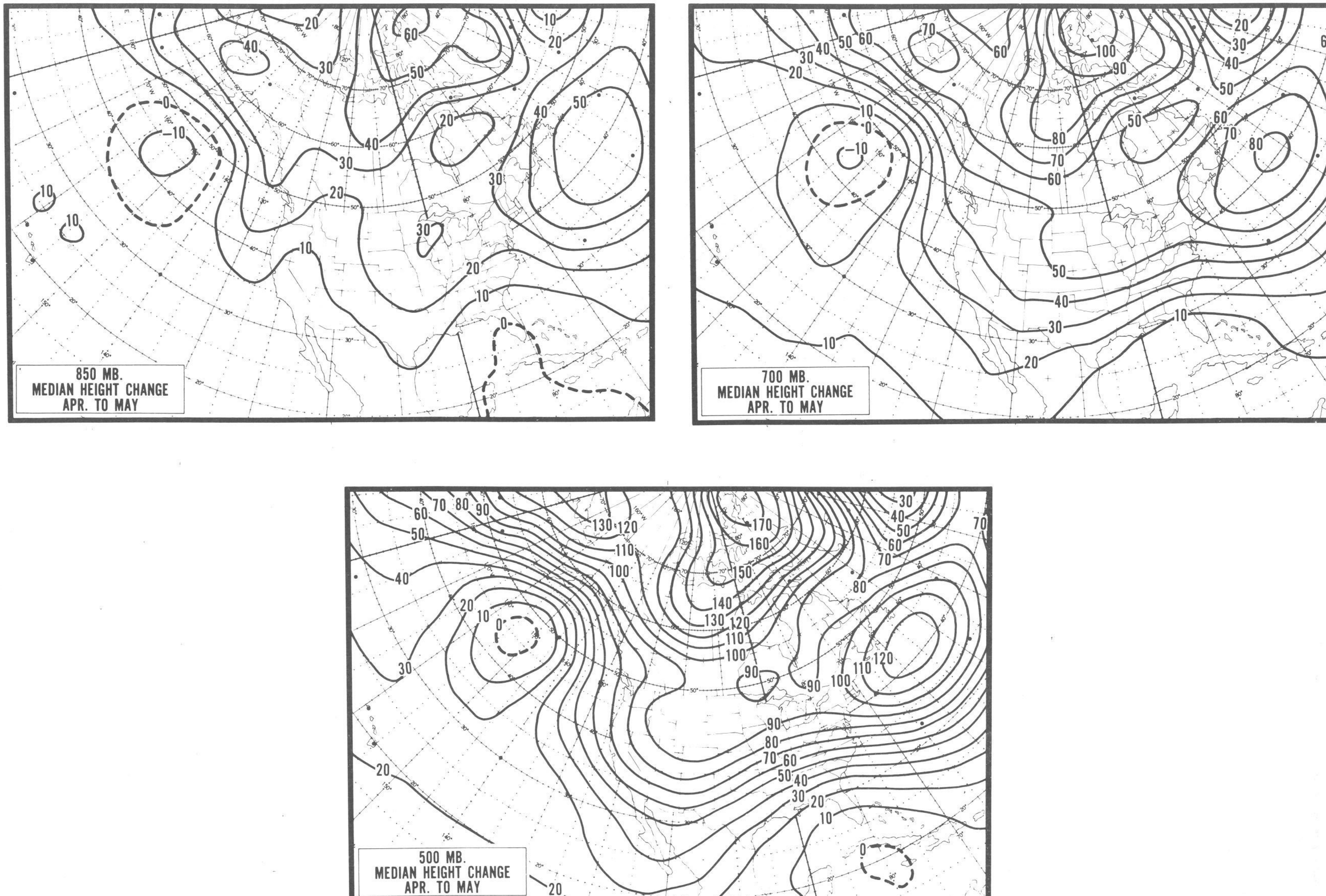
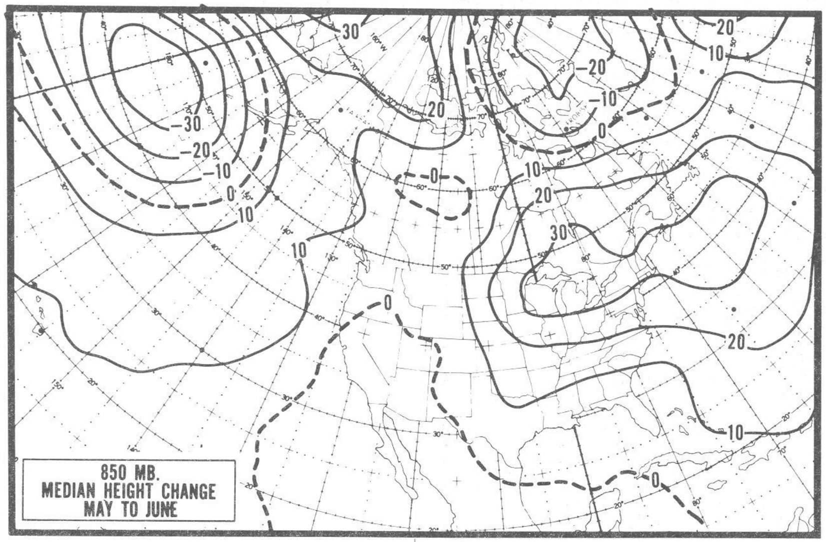
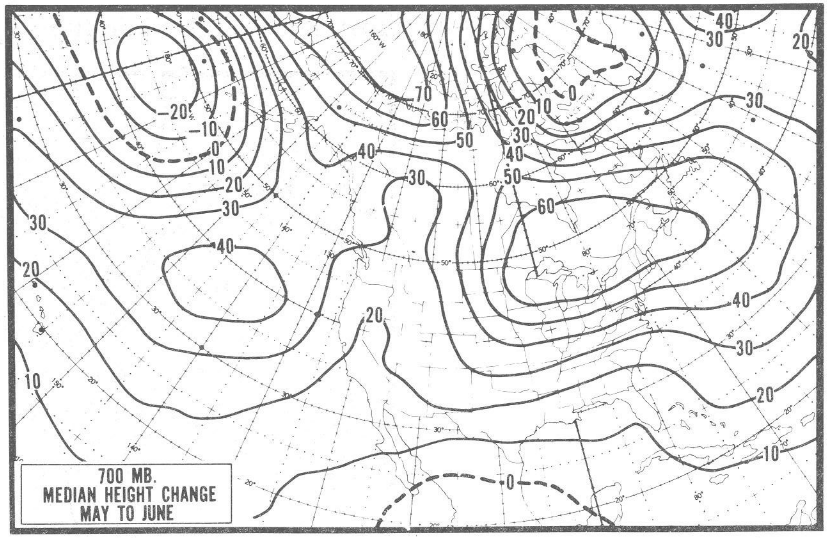


Figure 16.--Median (mean of heights at 1200 and 0000Z) monthly height-change from April 16 through May 15 (May minus April heights). Units in geopotential meters.





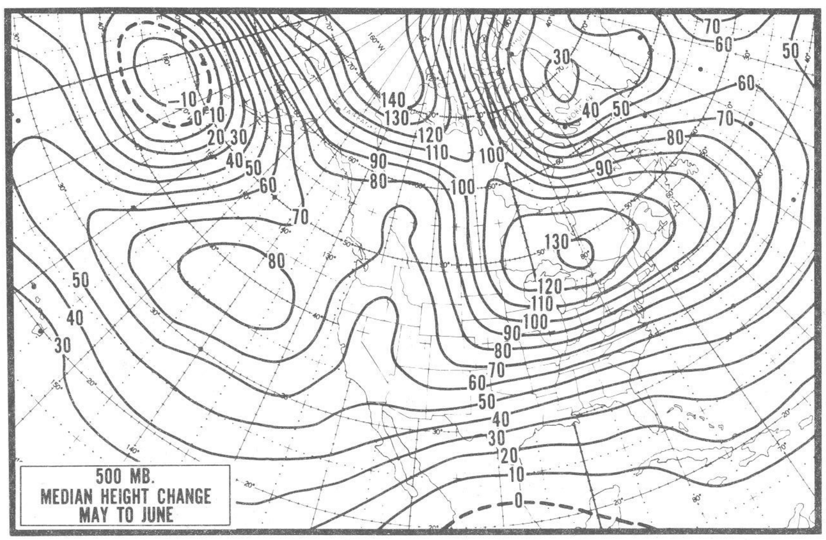


Figure 17.--Median (mean of heights at 1200 and 0000Z) monthly height-change from May 16 through June 15 (June minus May heights). Units in geopotential meters.

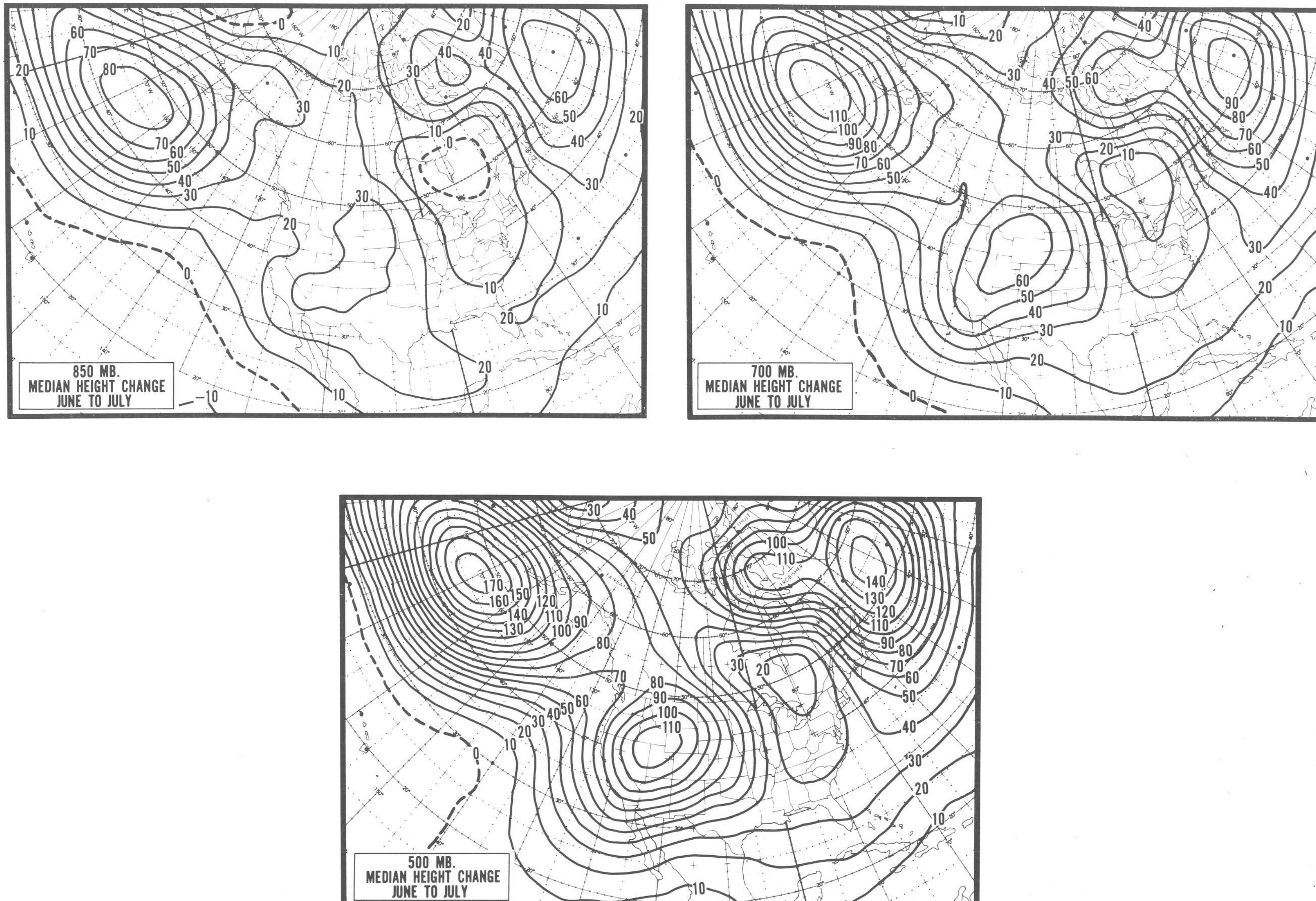
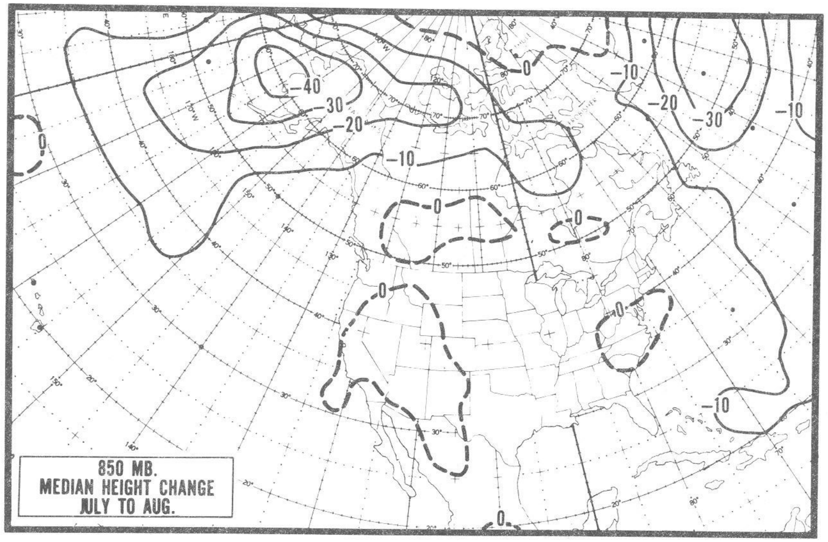
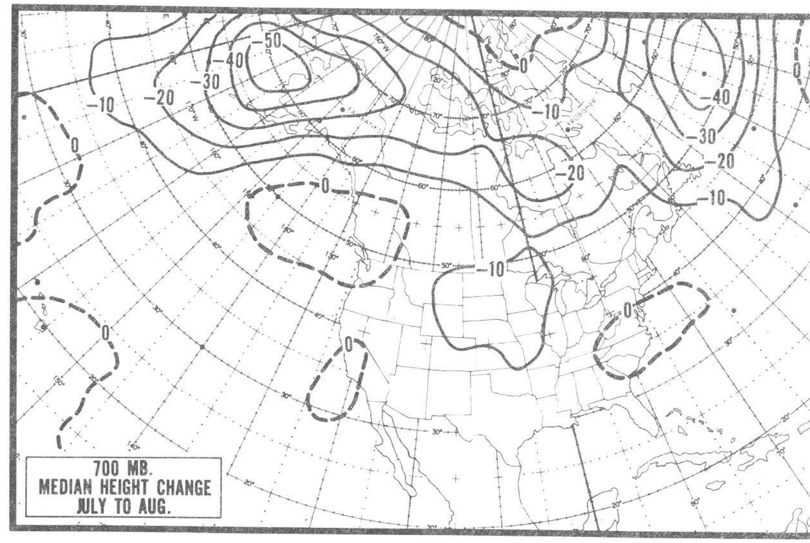


Figure 18.--Median (mean of heights at 1200 and 0000Z) monthly height-change from June 16 through July 15 (July minus June heights). Units in geopotential meters.





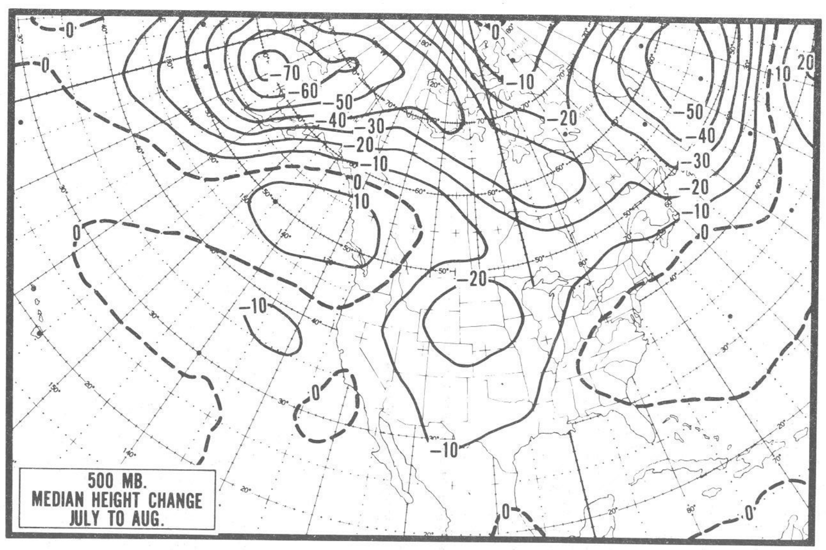


Figure 19.--Median (mean of heights at 1200 and 0000Z) monthly height-change from July 16 through August 15 (August minus July heights). Units in geopotential meters.

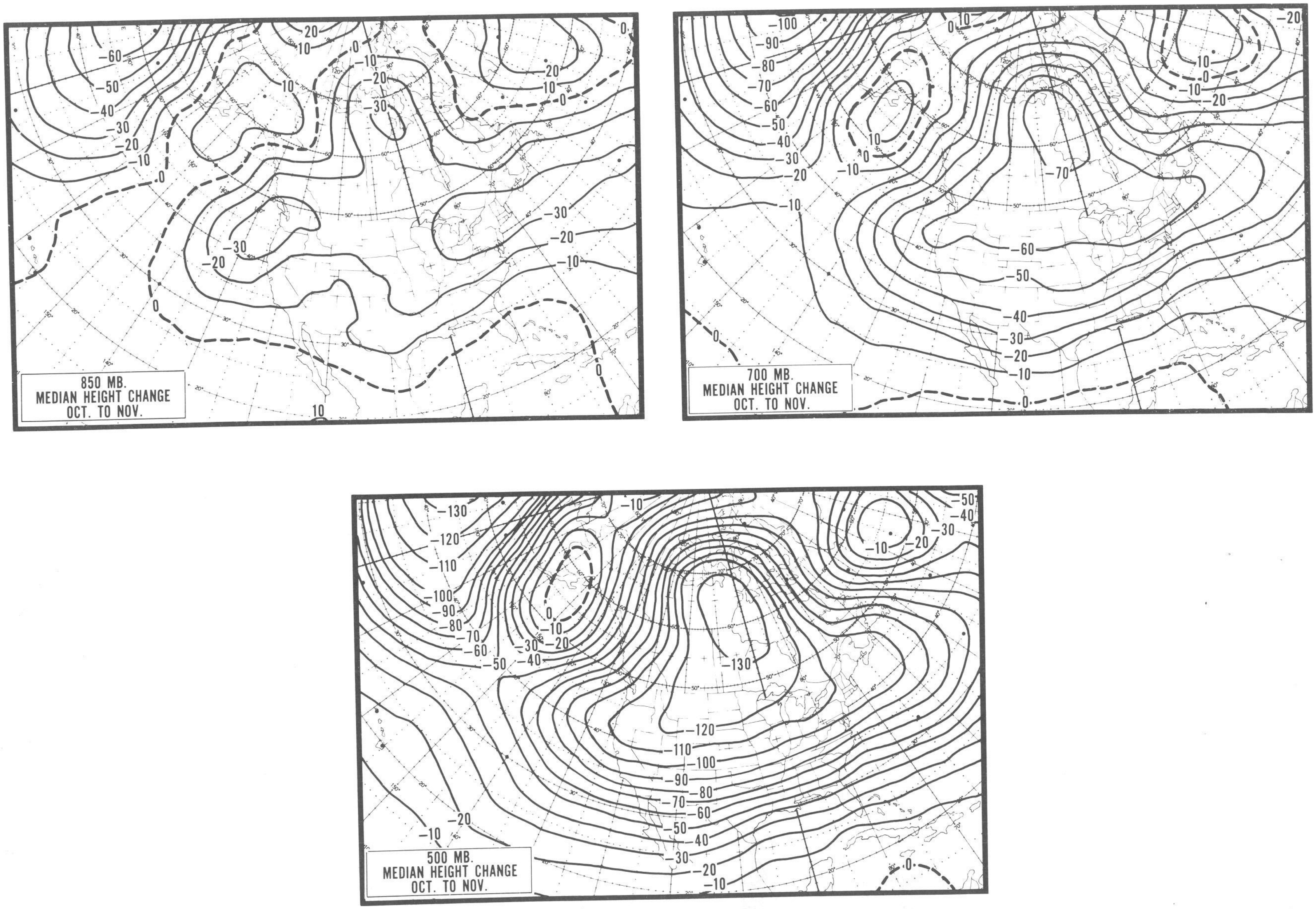


Figure 22.--Median (mean of heights at 1200 and 0000Z) monthly height-change from October 16 through November 15 (November minus October heights). Units in geopotential meters.

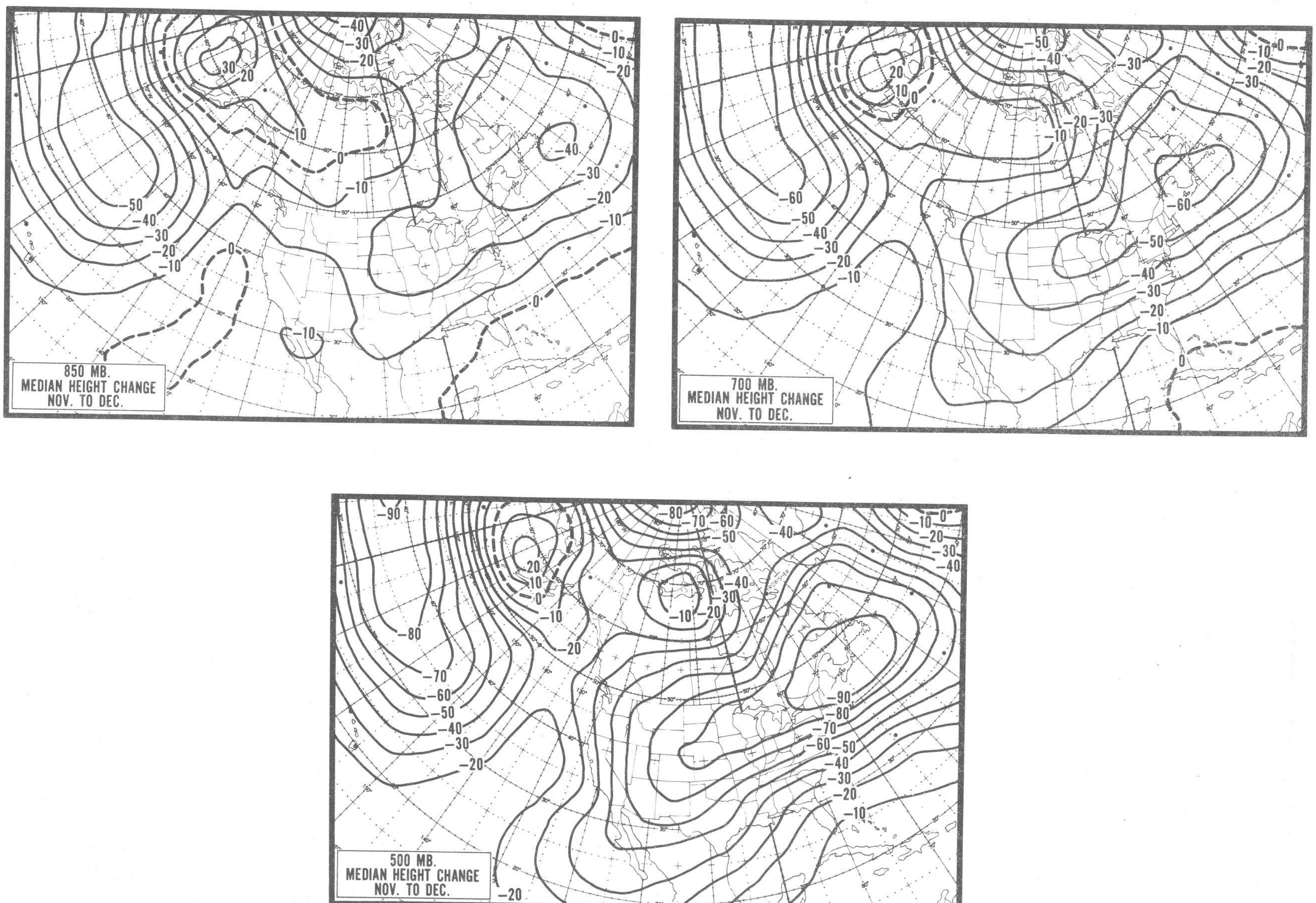


Figure 23.--Median (mean of heights at 1200 and 0000Z) monthly height-change from November 16 through December 15 (December minus November heights). Units in geopotential meters.

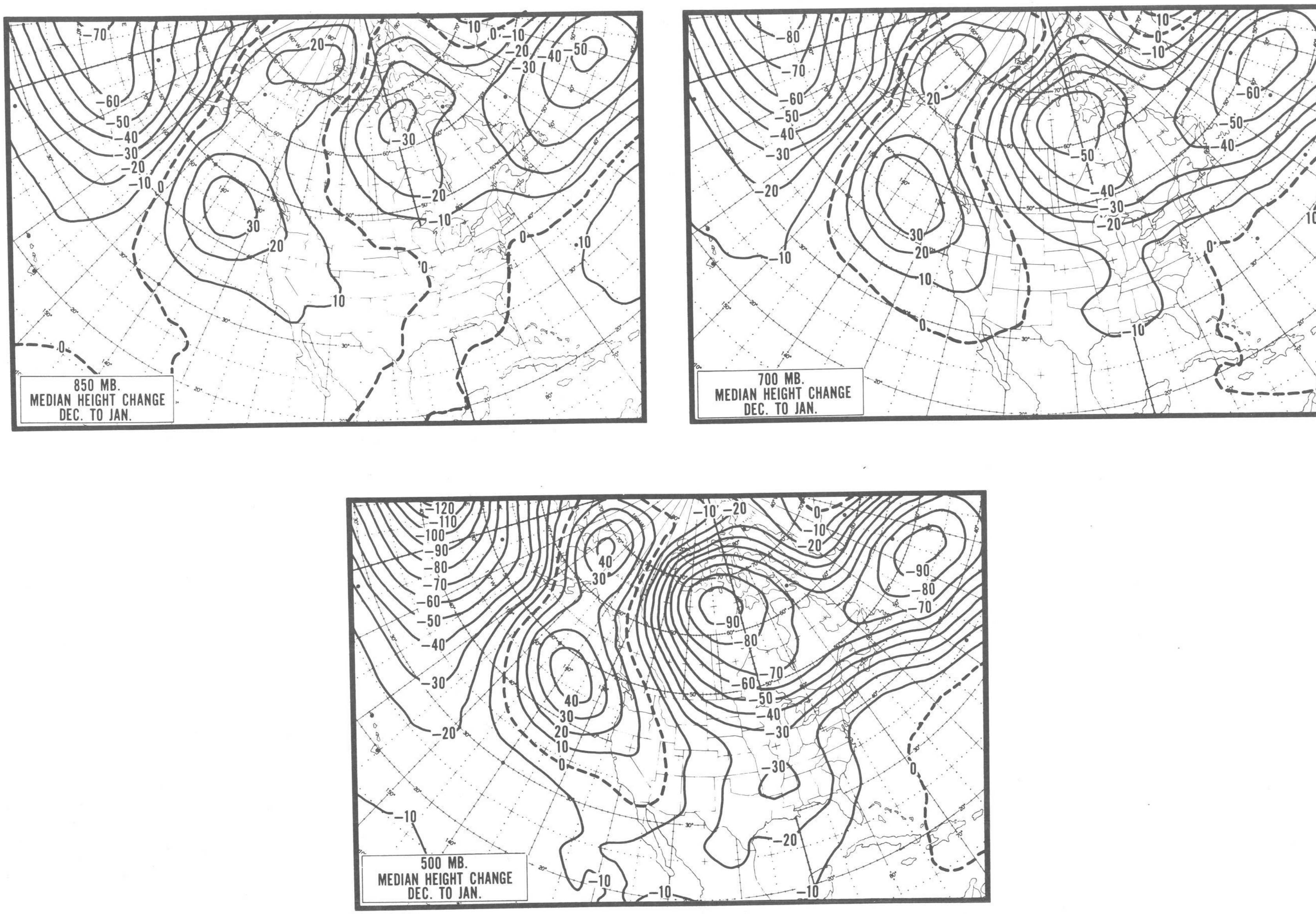


Figure 24.--Median (mean of heights at 1200 and 0000Z) monthly height-change from December 16 through January 15 (January minus December heights). Units in geopotential meters.

(Continued from inside front cover)

WBTM TDL 27 An Operational Method for Objectively Forecasting Probability of Precipitation. Harry R. Glahn and Dale A. Lowry, October 1969. (PB-188 660)

WBTM TDL 28 Techniques for Forecasting Low Water Occurrences at Baltimore and Norfolk. Lt. (jg) James M. McClelland, USESSA, March 1970. (PB-191 744)

WBTM TDL 29 A Method for Predicting Surface Winds. Harry R. Glahn, March 1970. (PB-191 745)

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WBTM TDL 33 Calculation of Precipitable Water. L. P. Harrison, June 1970. (PB-193 600)

WBTM TDL 34 An Objective Method for Forecasting Winds Over Lake Erie and Lake Ontario. Celso S. Barrientos, August 1970. (PB-194 586)

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NWS TDL 46 SPLASH (Special Program to List Amplitudes of Surges From Hurricanes) I. Landfall Storms. Chester P. Jelesnianski, April 1972.