Standard Deviations of 24-Hour 10-Mb Height and Temperature Changes in the Northern Hemisphere

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ABSTRACT

This note deals with the standard deviations of 24-hr changes in 10-mb temperatures and heights. The standard deviations are differently distributed in disturbed and in quiet winter months. In the disturbed months their largest values form a coherent area at high latitudes; in the quiet months they surround the polar region as a ring with its center on the Atlantic side.

1. Introduction

The following is a short description of the day-to-day changes of 10-mb temperature and height in winter north of 10N. We use the standard deviation of the 24-hr differences (abbreviated to SD)

$$\sigma_{\Delta 24\text{ hr}}=\sqrt{\frac{\Sigma(x'-\bar{x})^2}{n}},$$

where $\bar{x}$ is the single-month mean of the 24-hr differences, and x' is the individual 24-hr difference. A standard deviation of the daily height or temperature difference from its monthly mean would be a less fit measure of the interdiurnal variability: if, for example, the daily values during the first half of a month are much below the mean of the month, and those during the second half are much above, there would be only one big interdiurnal change (when the shift from negative to positive deviations takes place); yet the standard deviation of the daily values would be large.

The SD below have been calculated from daily 10-mb maps prepared at the Freie Universität in Berlin.

2. Description

Fig. 1 contains the zonally averaged SD of 10-mb height and temperature for the month of January in single years and the 6-year mean for July. The year-to-year variation of the SD in July is small and the values for the single months of July, which are not shown, lie well below the lowest values of January. Large interannual differences of height SD are characteristic of the region north of 40N, whereas the years are much alike in the tropics and subtropics. The picture of the temperature SD is similar, although the largest differences

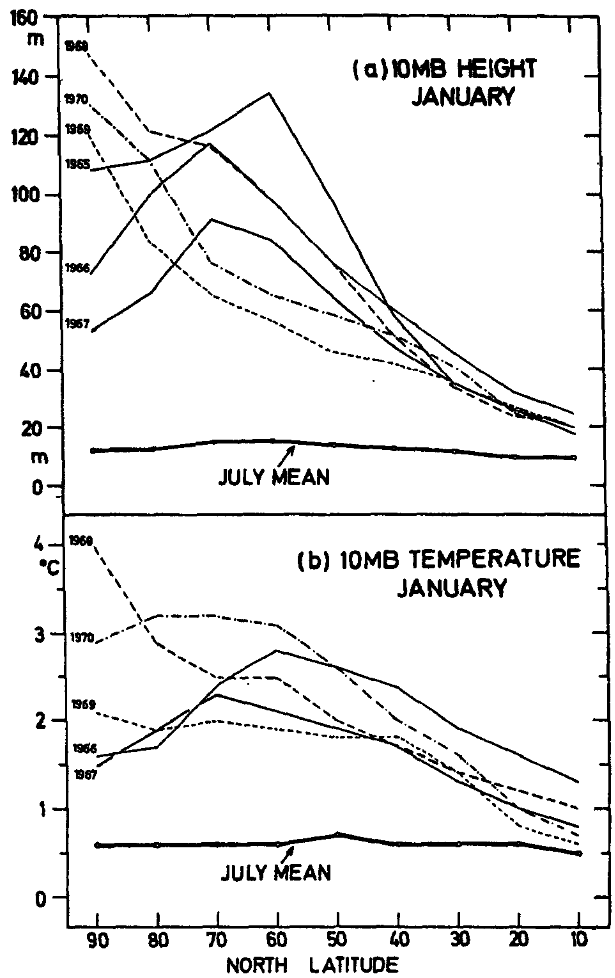

FIG. 1. Meridional profiles of zonally averaged standard deviations of the 24-hr changes in a) 10-mb height, and b) 10-mb temperature. Single years in January; mean of the same years in July. The daily values of the temperatures in January 1965 had not been punched at the time we computed the 10-mb SD.

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between the individual years are confined to the polar region.

The curves in Fig. 1a fall into two groups: one in which the SD increases to the pole and another where the peak is reached near the edge of the polar area. In the former group are two years with a protracted circulation breakdown and polar warming in January (1968, 1970), and in the latter group three years when the polar vortex remained comparatively undisturbed and cold (1965, 1966, 1967); January 1969 did not belong in either extreme.

In a quiet month (Fig. 2) the biggest 24-hourly changes lie as a belt along the border of the polar region, the belt being off center with respect to the pole. The largest amount of daily changes is in the zone of strong westerlies surrounding the mean monthly polar low which in this month was centered near Spitzbergen. In a disturbed month (Fig. 3) the largest SD form a co-

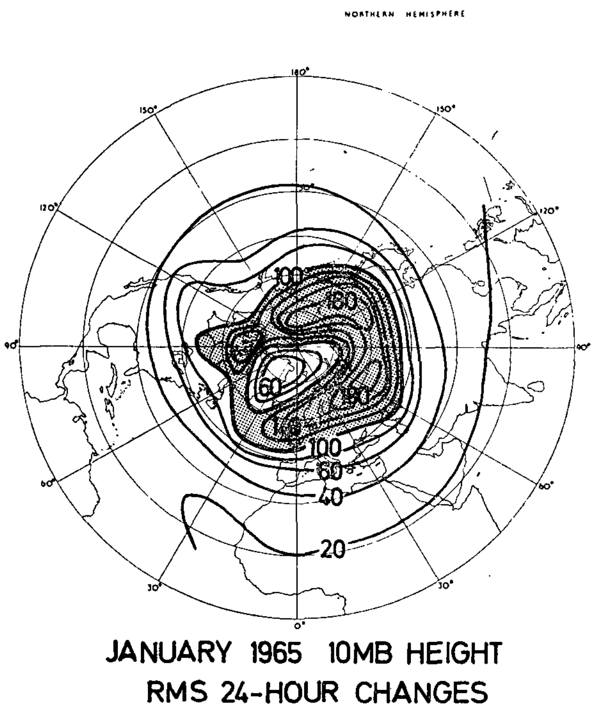

Fig. 2. Standard deviation of the 24-hr changes in 10-mb height in January 1965.

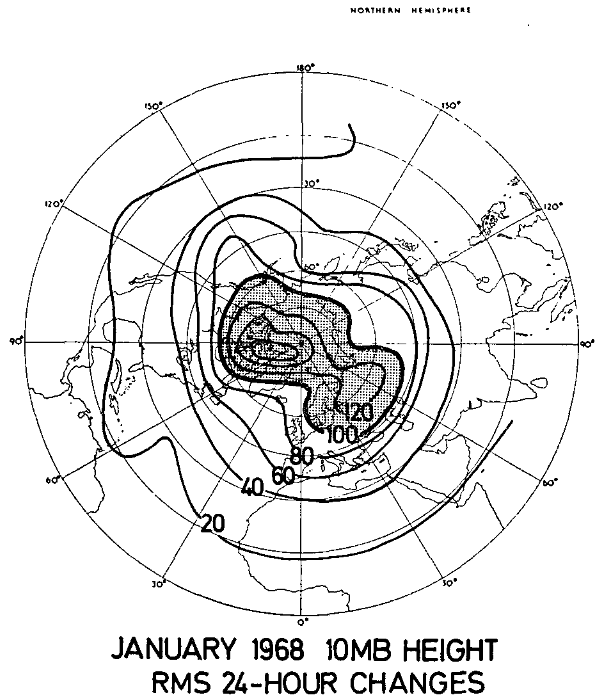

Fig. 3. Same as Fig. 2, but for January 1968.

herent area at high latitudes. It is the areal distribution of the daily changes rather than their size that distinguishes the quiet from the disturbed winter month.

An examination of the daily maps shows that the large interdiurnal changes do not arise from regularly moving waves such as in the troposphere. In the disturbed January of 1968, for instance, the peak resulted from the slow motion of 3–5 large highs and lows north of 45N. Each high or low includes a belt of steep gradients and since small day-to-day displacements of steep gradients show as large SD, the movement of the pressure cells will distribute the large SD over the area where they move. In the undisturbed January of 1965, the vortex center stayed within the very confined region between Peary Land and Novaya Semlya, where the SD in Fig. 2 is small, and the ring-shaped peak of SD is a result of small daily displacements of the steep gradients surrounding the low center.