SHORTER CONTRIBUTION

CHARACTERISTICS OF THE LOW-LEVEL JET STREAM

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The upper right-hand corner of fig. 1 may serve as a qualitative indication of temperature curves at a southern (s) and a northern (n) Japanese station according to actual radiosonde ascents. These normal temperature curves intersect at about 200 mb. This well-defined isopycnic level corresponds to the beginning of a general reversal of the meridional temperature gradient. Over Japan, a rather definite isopycnic-isobaric level in the middle stratosphere is present in all seasons [1; 2]. The westerly geostrophic wind below the 200-mb level, where the temperature gradient is directed northward, increases with height to a maximum speed at the isopycnic level. With reversal of the temperature gradient above the 200-mb level, the thermal wind acts to reduce the maximum wind.

A common occurrence in wind reports is for the last level to show the strongest reported wind. The computed wind velocity at the last level is often erroneous; and even if it is correct, the actual maximum wind may be at a higher level. In cases of high speeds in the upper atmosphere, the balloon is likely to be carried out of range and lost. Therefore, reference will be made to the remarkable series of "relay" observations at Tateno, Japan.

During the winter seasons since 1951, the Tateno rawinsondes have been regularly released from Honjo, situated about 88 km west-northwest of Tateno. The balloon is followed by theodolites and radio direction-finders at both stations. Since the wind is generally westerly, Tateno is downstream from Honjo. The balloon can thus be successfully tracked at Tateno after the elevation angle at Honjo has become too small. For example, for the 16 soundings listed in [3] for the first half of February 1953, the mean maximum altitude attained was 19.4 km, with the exception of a sounding that was terminated at 7.8 km. Each sounding indicated winds over 60 m/sec at some level. Fig. 2, produced in a fashion similar to that used in [4], is a scatter diagram of wind speed against height for Tateno, based on all relay observations from 1 to 15 February 1953. It is seen that there was very little dispersion about the mean speed, which begins to exceed 50 m/sec near 7 km, and then drops below 50 m/sec above 16 km. The maximum speeds occurred at some level a little higher than 11 km (about 200 mb), which corresponds fairly well with the well-defined isopycnic level as shown in fig. 1. It is indicated that all the winds between 9 and 13 km exceeded 50 m/sec. It should be noted that these observations were specifically designed to increase the capability for measuring such strong winds as these; hence it is not surprising that strong winds should be observed at Tateno.

The lower part of fig. 1 illustrates an idealized front with a temperature inversion across the transitional zone. It is seen that the frontal slope produces triple crossings of the temperature-pressure curves at the two stations. These curves may be considered for the purpose of illustrating the geostrophic wind flow. The westerly wind below the lowest isopycnic level, where the temperature gradient is directed northward, increases upward to a maximum speed at the first isopycnic level. This maximum speed should be taken as the *low-level jet stream*, which is normally associated with bad weather, possibly rain or snow. With the reversal of the temperature gradient at about the first isopycnic level, the thermal wind sub-

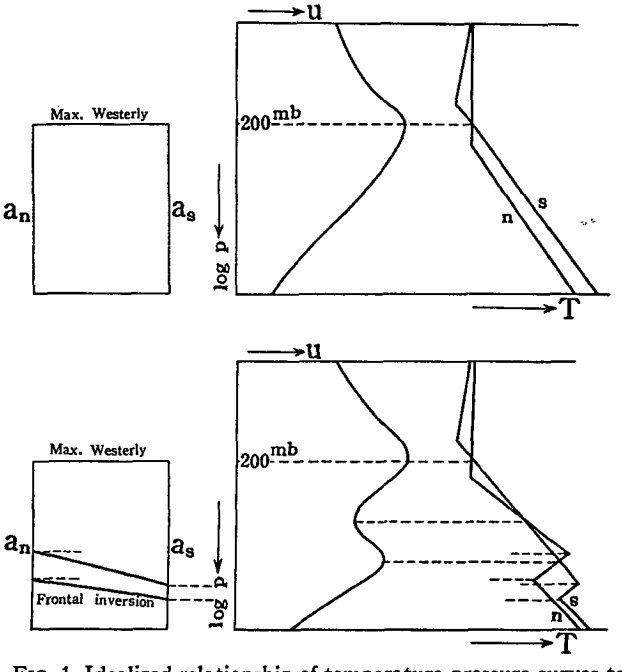

FIG. 1. Idealized relationship of temperature-pressure curves to wind-speed distribution. Top: normal type; bottom: abnormal type associated with low-level jet stream.

tracts from the west-wind speed up to the second isopycnic level, where the curves cross again. Depending upon the magnitude of the maximum wind at the lowest isopycnic level and the magnitude of the intervening gradient, it is possible to go through a level where no geostrophic wind exists. Thus, at the point of second crossing of the temperature-pressure curves, the minimum westerly or maximum easterly wind will occur. From here to the third crossing, the isopycnic level at about 200 mb, the thermal wind will again act to increase the westerly speed to another maximum.

The curves in the lower part of fig. 1 represent the vertical structure only schematically. Comparison may be made with the low-level jet stream observed over Tateno at 1005 JMT 2 February 1952, as shown in fig. 3. Also shown in that figure are the temperature curves two hours later at Shionomisaki (33°27′N, 135°46′E) and Tateno (36°3′N, 140°8′E). The corresponding wind profile at Shionomisaki is, of course,

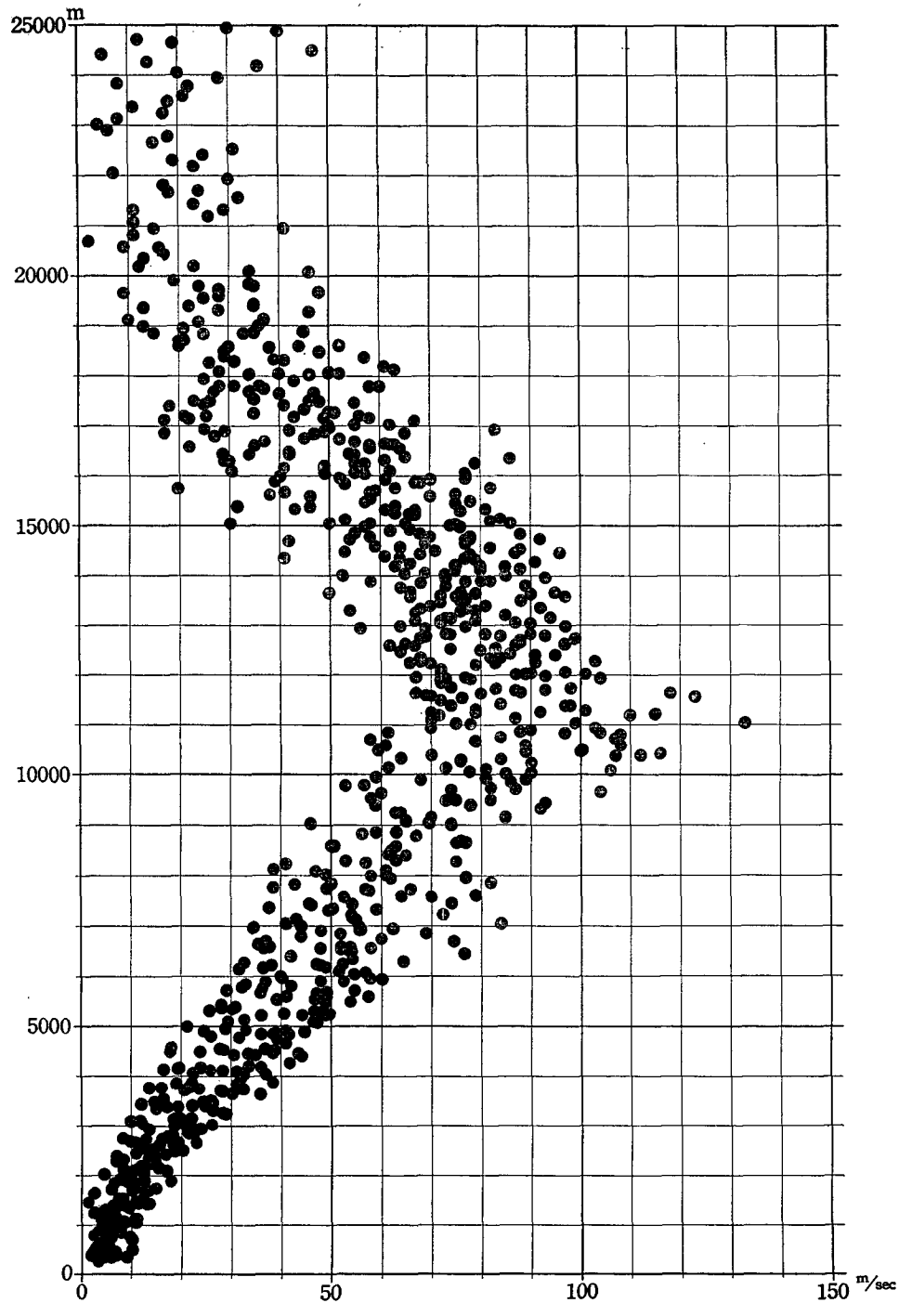

FIG. 2. Wind speed against height at Tateno, 1 to 15 February 1953. (Based on data of [3] and fig. 7 of [4].)

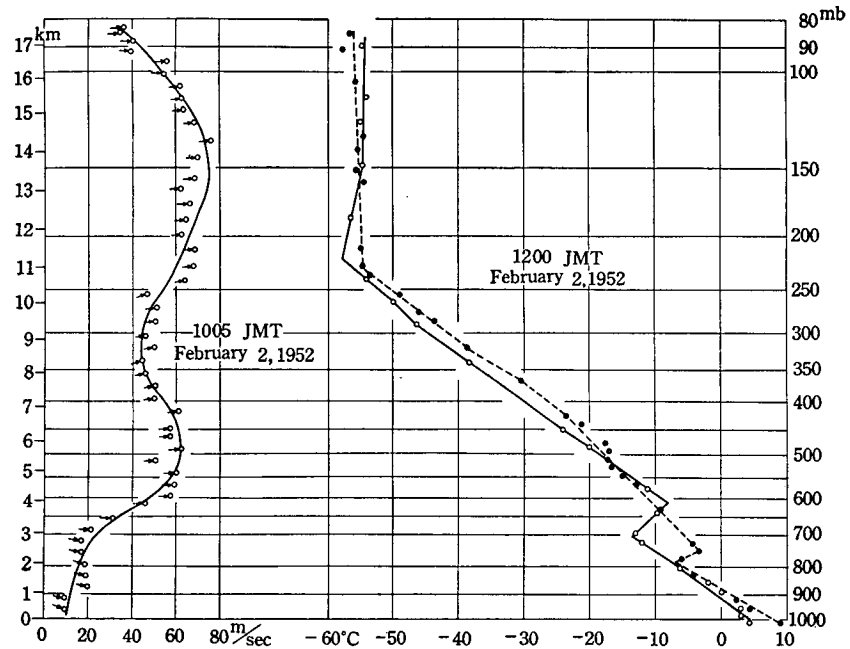

FIG. 3. Soundings for 2 February 1952. Wind sounding at Tateno at 1005 JMT; arrows fly with wind. Temperature soundings at Tateno (solid) and Shionomisaki (dashed) at 1200 JMT.

not available to such great heights. The vertical variation of west-wind speed shows the general features described above. However, there is considerable disagreement between these data and the hypothetical case of fig. 1 in the region of the two lower isopycnic levels. The wind and temperature soundings are two hours apart and were taken at the time of passage of an active cold front, presumably accompanied by frequent and rapid variations of wind direction and speed as well as temperature field.

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