NOTES AND CORRESPONDENCE

Evidence for a Quasi-Biennial Variation in Eccentricity of the North Polar Vortex

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ABSTRACT

The centroid of the north polar vortex has been determined from 300 mb mean-monthly maps for the 10-year period 1963–72. There is a significant correlation of 0.79 between the 12-month running average distance of the centroid from the North Pole and the 50 mb zonal wind at Balboa, Canal Zone; i.e., the eccentricity appears to be greater at the time of quasi-biennial east wind minimum.

The centroid, or center of circulation, of the north polar vortex has been estimated at 300 mb for each month of the 10-year period 1963–72 using the mean-monthly maps prepared by the Institut für Meteorologie der Freien Universität Berlin (1963–72). The calculation involved determination, at 30° longitude intervals, of the distance from the North Pole to the middle contour of those contours encircling the Pole, and then evaluation of the centroid in the customary manner. Inasmuch as in temperate latitudes the contours on mean-monthly maps tend to be concentric, the error introduced by estimation of the centroid from only one contour should be small.

Fig. 1 presents a comparison of the 12-month running average 50 mb zonal wind at Balboa, Canal Zone (9N), and the 12-month running average value of polar vortex eccentricity at 300 mb, expressed as the distance in degrees latitude from the North Pole to the vortex center which, as it turns out, is located generally along the 180th meridian. The eccentricity of the polar vortex is indicated to be about $\frac{1}{2}°$ latitude greater near the time of the quasi-biennial east wind minimum than the east wind maximum in the low tropical stratosphere, although the two curves are not exactly in phase; and in 1966 there is a hump in the eccentricity trace which is not reflected in the zonal wind trace. Because of the reduction in amplitude resulting from the application of a 12-month running filter to an essentially 24-month oscillation, the difference in eccentricity at times of east wind maxima and minima is actually closer to 1° latitude. Based on the 10 years of data, the correlation between the two traces is 0.79, significant at the 1% level according to Fisher's Z test (Brooks and Carruthers, 1953), even after division of the data sample by 8 because of the use of 12-month running means (Mitchell, 1966).

While one hesitates to generalize from such a short period of record, it is apparent that the possibility of a relation between eccentricity of the north polar vortex and the tropical quasi-biennial zonal wind oscillation must at least be considered. The relationship is not a strong one since the average annual centroid displacement is an order of magnitude larger than the indicated quasi-biennial displacement, but if it exists it is certainly of interest from a theoretical point of view and may also be of interest from a practical point of view because subtle changes in meteorological elements might be associated with even very small displacements in a feature as basic as the polar vortex. Thus, the systematic tendency for the tropopause at Canadian stations to be relatively high at the time of quasi-biennial east wind minimum in the tropics (Angell and Korshover, 1974a) may reflect the effect of increased polar-vortex eccentricity, as may the observation that over the contiguous United States between 1951 and 1972 sunshine duration was about 1% less at the same time (Angell and Korshover, 1974b), the latter implying that at the time of greatest eccentricity the cloudiness over the United States is slightly above average, perhaps because of a very slight increase in the southerly component of flow (see also La Seur, 1954).

Inasmuch as the centroid of the north polar vortex is always displaced toward the Pacific Ocean, support for the above relation between eccentricity of the polar vortex and the quasi-biennial zonal wind oscillation in the tropics comes from the significant tendency, based

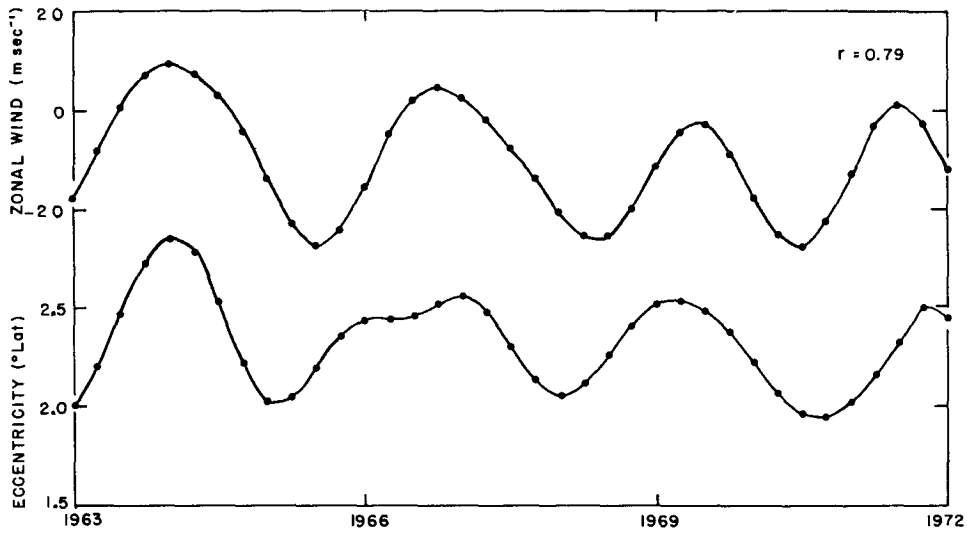

FIG. 1. Comparison between the 12-month running average 50 mb zonal wind at Balboa, Canal Zone (top), and the 12-month running average distance (degrees latitude) of the 300 mb polar vortex center from the North Pole (bottom). The data are plotted at 3-month intervals.

on data from 1951 to 1967, for the Pacific high to be closer to the equator at the time of quasi-biennial east wind minimum (Angell and Korshover, 1974c) or, from the above, at the time of greatest displacement of the polar vortex toward the equator (greatest eccentricity).

The 100 mb Berlin maps have been examined from the same point of view, and while they indicate some tendency for the eccentricity to be greatest at the time of the quasi-biennial east wind minimum in the low tropical stratosphere, the relation is far from a significant one. However, because of the greater density and quality of the data at 300 than at 100 mb, one would tend to place more reliance on the results obtained at 300 mb; consequently, the lack of a significant relation at 100 mb, while somewhat disconcerting, certainly does not invalidate the hypothesis.

Since the zonal wind oscillations in the tropical stratosphere are well documented back to 1950, it would be useful for anyone having access to what they consider representative hemispheric upper air maps for the 1950's to see if the above relation between polar vortex eccentricity and the tropical wind regime holds also during that earlier period.

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