Time Variability of Lake Ontario Winter Precipitation Patterns

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An eigenvector analysis of December, January, February and total winter precipitation values for twelve stations for the period 1947 to 1982 (36 years) was completed. Subsets of seven stations for 80 years and three stations for 125 years were also analyzed. The stations along the southern and eastern shores of Lake Ontario were: Buffalo, Albion, Batavia, Brockport, Rochester, Sodus, Geneva, Syracuse, Oswego, Camden, Lowville, and Watertown. Table 1 shows the percent variability accounted for by each of the first four linearly independent eigenvector patterns of the twelve station (36 year) set for each of the months and the winter season.

Table 1. Variability (%)

Pattern	Dec	Jan	Feb	Winter
1	59	66	63	59
2	12	9	10	11
3	8	6	7	8
4	6	5	5	5

Figures 1, 2 and 3 show the first four eigenvector patterns for December, February and winter, respectively, for the 36-year period. Isopleths show stippled areas of above normal precipitation departures in units of standard deviations.

Because the December and January patterns were similar, only the December pattern is shown. Pattern 1 is consistent in all months and, thus, for the winter season in showing that overall, precipitation has been uniformly below the mean in most years. This is, no doubt, a result of the skewed distribution of precipitation values where the mean is abnormally affected by years of much above average precipitation.

Pattern 2 shows a similar area of above normal precipitation to the southern shore of Lake Ontario in December, January and, thus, the winter season. This pattern reverses in February. One suggested explanation for these patterns is the lake-effect snow phenomenon. The December-January, early winter period, may have large snow accumulations to the east of the lake, but lake-effect snow is of low water-equivalent, as much as 20:1. The lake-effect dominance in this pattern may produce negative (water equivalent) precipitation departures. On the other hand, the February pattern, usually the coldest month, may denote above normal precipitation values from the persistence of the lake-effect snows while normal synoptic precipitation events are less dominant. Certainly, Lake Erie often becomes insignificant as a lake-effect source by this time of the winter.

Pattern 3 seems reasonably consistent in showing positive departures to the south of the lake in all periods with an extended area near the eastern shore in January. It is suggested that these patterns may indicate a relation to coastal storms which may circulate precipitation from a northeasterly direction back into New York. This would be consistent with the negative departures through the higher elevations to the east of the lake where a northeasterly flow would exhibit downsloping with less precipitation. The negative departures to the far western corner of New York are often seen as these circulations frequently do not extend the precipitation amounts that far west.

Pattern 4 also appears to have a lake-effect connection, particularly in the strong

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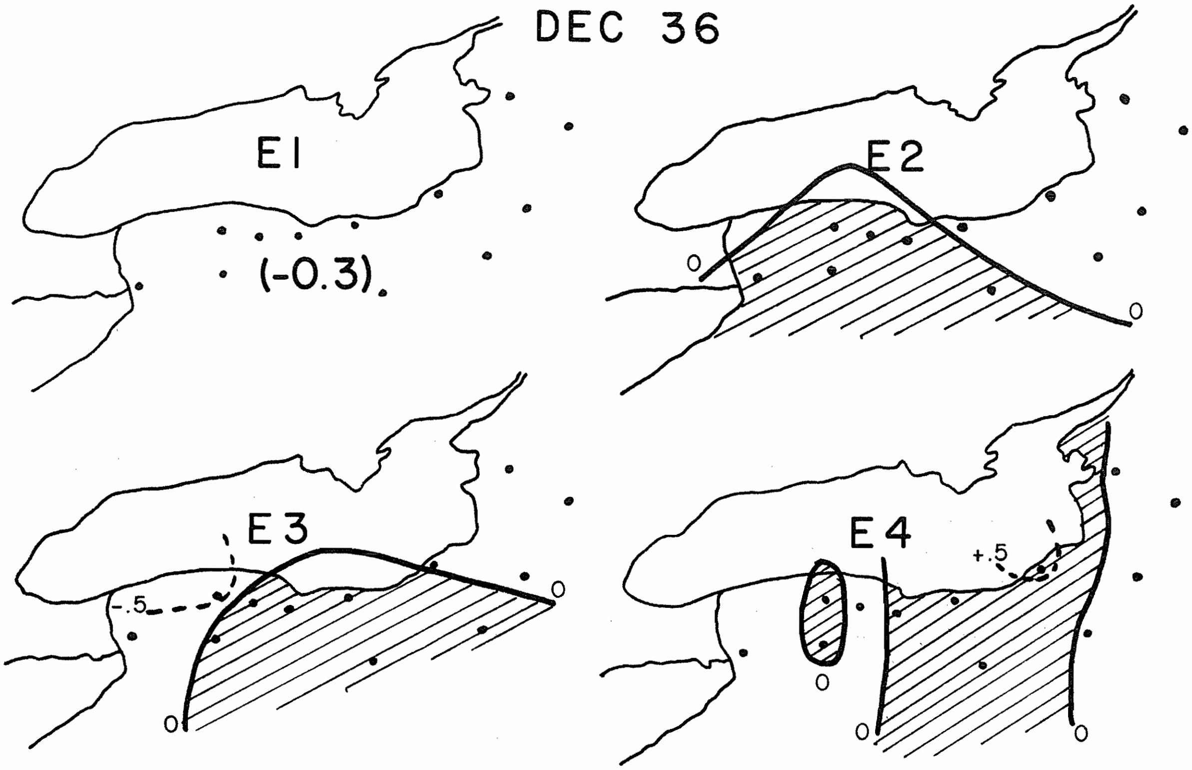

Figure 1. December eigenvector patterns of the 36-year station set.

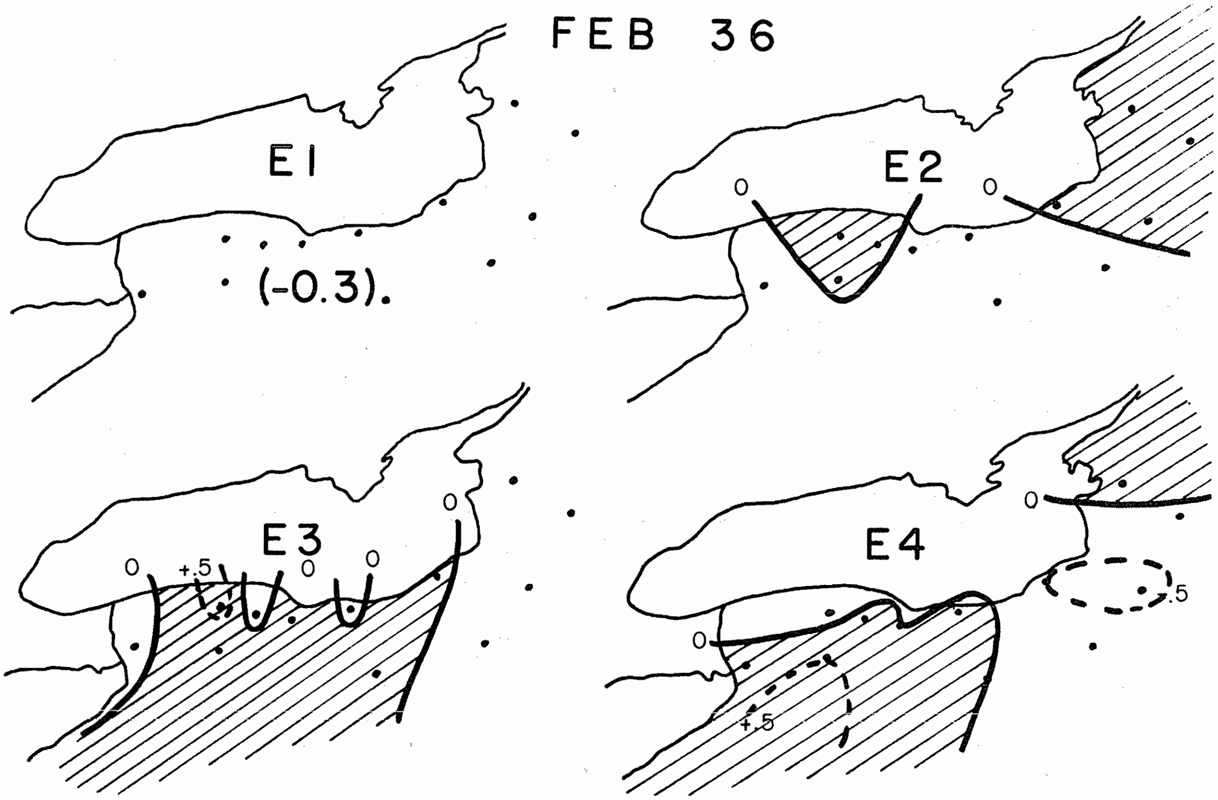

Figure 2. February eigenvector patterns.

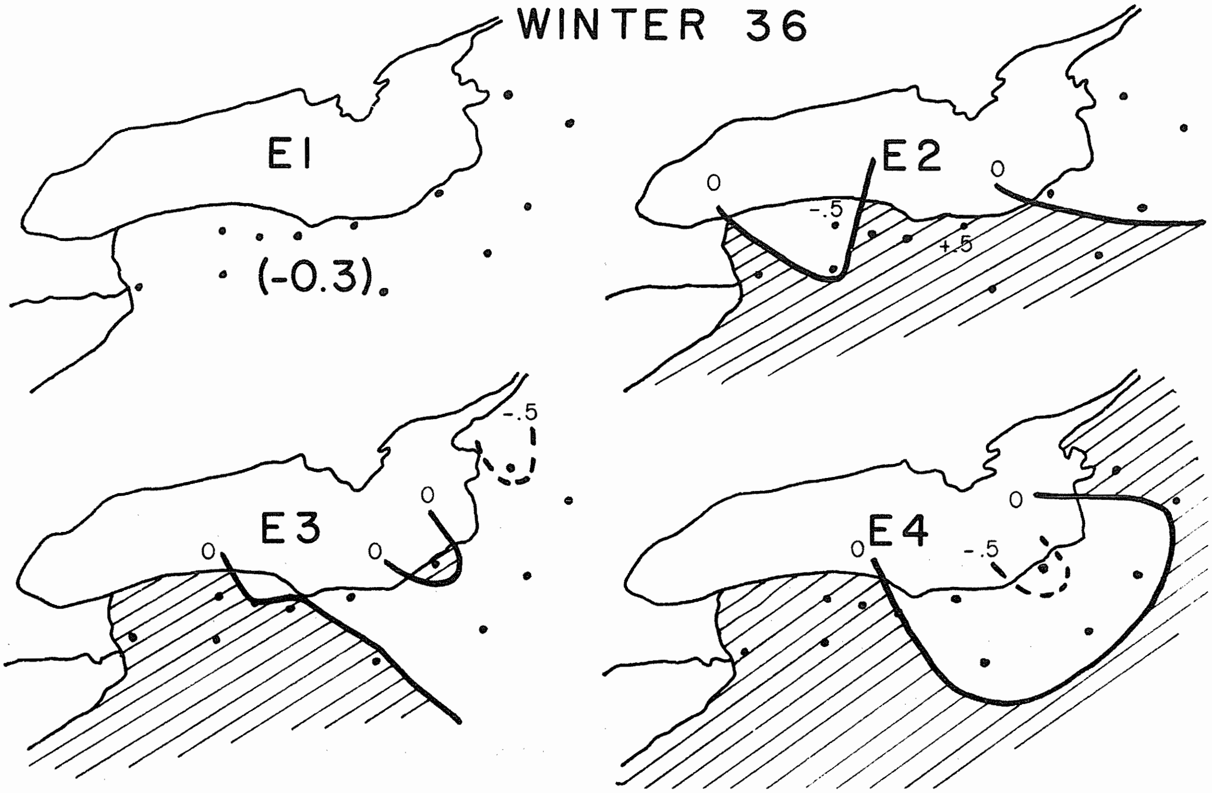

Figure 3. Winter eigenvector patterns.

negative departures around Oswego in the February and winter patterns. The reversal of the second pattern may show the lake effect persistence or low water equivalence as mentioned previously.

These patterns were basically consistent with the longer, 125-year period. The 80-year period generally shows pattern reversals from the December, January and winter patterns above. The February patterns are consistent, however. It is hypothesized that the reversals are associated with the climatic warm period from 1903 through 1947.

CONCLUSIONS

Winter season precipitation distribution patterns as derived from empirical orthogonal function analysis seem to indicate components due to lake-effect snowfall influences and coastal cyclonic storms as well as uniform synoptic scale precipitation events.

These patterns have been remarkably stable over long periods of time. However, pattern reversals have occurred that appear to be linked to large-scale climatic changes.

These patterns, however, are not sufficiently detailed to resemble individual yearly distributions. This analysis method apparently yields descriptive patterns which require additional refinement to elucidate physical mechanisms of precipitation variation.