Southern Hemisphere Blocking Climatology

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1. INTRODUCTION

Different methods, as well as indices, have emerged to simplify the interpretation of the atmospheric state on which the kinematic properties of the flow fulfill blocking conditions. These indices have been more often calculated for the Northern Hemisphere than for the Southern Hemisphere due to the lack of observations over the extensive southern oceans.

A measure of the zonal index is usually defined to represent two middle latitude atmospheric states--a high index, associated with highly zonal flow, which is characterized by strong westerlies, and a low index, which represents the breakdown of the westerlies and the predominance of meridional flow. Indices similar to the zonal index have been defined in several previous blocking studies (e.g., van Loon, 1956; Lejenas and Okland, 1983; Lejenas, 1984). Lejenas and Okland (1983) and Lejenas (1984) defined blocking indices for the Northern Hemisphere and Southern Hemisphere, respectively, as the 500 mb geopotential height difference between two latitudes--one situated in the lower midlatitudes and the other at the higher midlatitudes.

In the present study, two different blocking indices are computed for the Southern Hemisphere for the period 1979-1985. Advantages and disadvantages of these indices are discussed. Both indices are similar to the zonal index--one is based on sea level pressure (SLP) and the other on upper tropospheric zonal wind.

2. DATA AND METHODOLOGY

The upper tropospheric (250 mb) zonal wind was extracted from the Climate Analysis Center's pentad circulation archive. Daily SLP data were obtained from the National Center for Atmospheric Research. Both data sets are derived from the National Meteorological Center final analysis and have global distribution, with latitude-longitude resolution of 2.5 degrees. To make the data sets compatible, pentad averages of SLP were computed for the seven-year period under study.

The SLP index used here is defined as follows:

$$IP = SLP(35S) - SLP(55S)$$

The 250 mb zonal wind index used in our study is the same as that used by the Australian Bureau of Meteorology, which is defined as:

$$IU = 0.5(u(25S) + u(30S) + u(55S) + u(60S) - u(40S) - u(50S) - 2u(45S))$$

The above indices were first computed for 1985 and compared to periods of blocking, which were subjectively determined from the pentad SLP analyses. $IP<10$ mb and $IU>35$ ms^{-1} were found to be the best criteria for blocking occurrences. A region is considered blocked when there are at least three subsequent longitudes satisfying these criteria. Blocking episodes are determined using each index independently.

The blocking frequency (in percentage) at a certain longitude is defined as:

$$f = (np / nt) 100$$

where np and nt are the number of blocked pentads in that longitude and the total number of pentads for that period of time.

3. RESULTS AND DISCUSSION

Figures 1a and 1b show the blocking frequency for the total period considered (1979-1985), using the SLP index and 250 mb index, respectively. A preferred region of blocking is evident over eastern Australia, and the neighboring western Pacific is clearly indicated in both figures. This is consistent with earlier works (van Loon, 1956; Mo, 1983; Trenberth and Swanson, 1983; Lejenas, 1984). The remarkable difference between these two figures is the prominent secondary maximum for the SLP index, which appears in Fig. 1a. This feature is probably due more to the influence of the Andes on the SLP distribution than to blocking. The much weaker maximum which appears in the 250 mb index does, however, suggest that blocking is slightly more frequent over South America than it is over the immediately adjacent oceanic regions. Results from previous works (van Loon, 1956; Lejenas, 1984) show a more extensive region of blocking from 70°W eastward to the Greenwich meridian.

A weak maximum in the SLP index over Africa, not evident in the 250 mb index, is probably related to topographic effects in that region and not to blocking events. The predominance of the Pacific in frequency of blocking events (Fig. 1) agrees well with previous works (van Loon, 1956; Mo, 1983; Trenberth and Swanson, 1983; Lejenas, 1984).

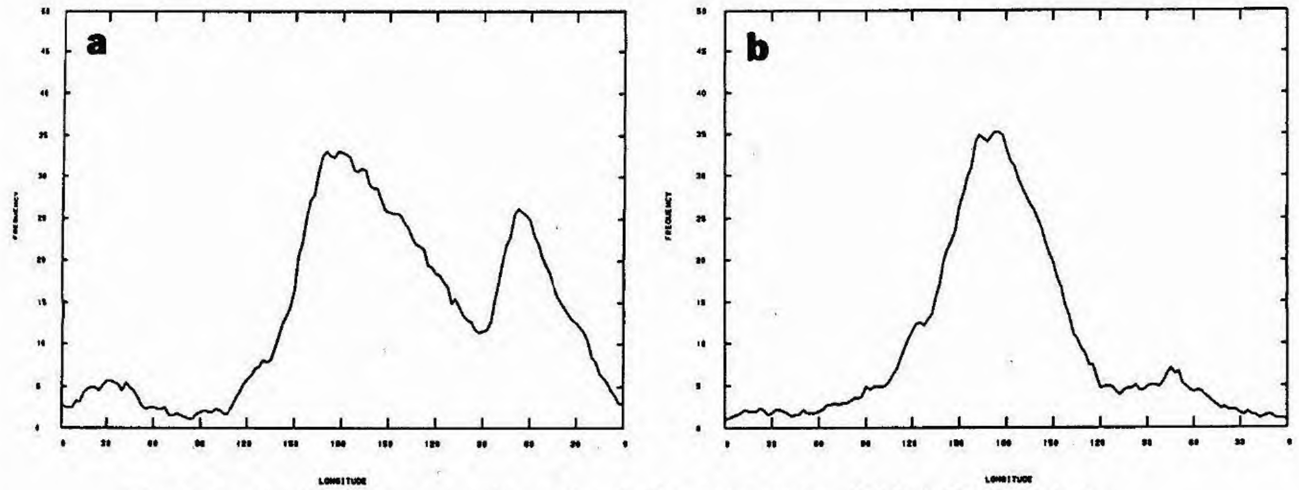

Figure 1 Blocking frequency (percentage) for seven years (1979 - 1985): (a) for sea level pressure index and (b) for 250 mb zonal wind index.

Excluding the regions affected by orography, both indices give similar results. However, there are some differences that can be summarized. Among 556 episodes identified using SLP, 308 are common to both indices.

Regarding the seasonal variations of blocking occurrence, the frequencies obtained by using the SLP index do not show a remarkable variation between seasons in the western Pacific and Australian region, although the blocking frequency is somewhat less during the Southern Hemisphere spring. In the eastern Pacific there is a clearer indication of seasonal variation with maximum blocking activity occurring in the fall and winter months. Lejenas (1984) shows high blocking frequency during the period from June through September and quite low frequency during October and November for this region, which is consistent with our results.

However, blocking frequencies calculated using the 250 mb zonal wind index present very strong seasonal dependence, with a pronounced maximum during the winter and a minimum during the summer. This is due to the fact that this index depends only on the upper level zonal winds, which are stronger during the winter.

Although the climatological results for the SLP and 250 mb zonal wind indices are quite similar, a comparison between individual seasons and years shows large differences.

4. SUMMARY AND CONCLUSIONS

Results based on the SLP index falsely identify blocking events east of the Andes and over Africa, due to orographic influences. Thus, this index seems to be more appropriate over oceanic areas than over land. The 250 mb zonal wind index is not affected by orography but does exaggerate seasonal variations which do not appear to be real. Therefore, both indices have limitations that must be considered when attempting to identify blocking episodes.

It is interesting to note that although around 60% of the events are identified by both indices, the Southern Hemisphere blocking climatology presents very similar results--mainly concerning the region of maximum occurrence over eastern Australia and the western Pacific. In this case the results are in agreement with those of previous works performed using different indices and techniques.

5. REFERENCES

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