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Incidence and trend of blocking action situations on the temperature and precipitation in Argentina

ADELIA P. ALESSANDRO
Departamento de Ciencias de la Atmósfera y los Océanos, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Intendente Güiraldes 2160, Ciudad Universitaria, C1428EGA Buenos Aires, Argentina
Corresponding author; e-mail: perlaalessandro@yahoo.com.ar

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RESUMEN

Se determinan las frecuencias y tendencias de situaciones de acción bloqueante (Bs, por sus siglas en inglés) en el sur de Sudamérica durante el periodo 1960-2011, calculadas en 100 (B100), 70 (B70) y 40º (B40) de longitud oeste. Se estudia además el efecto que estas situaciones ejercen sobre la temperatura y la precipitación. La distribución de la frecuencia de B100, B70 y B40 presenta un máximo en primavera y un mínimo en verano; las tendencias son positivas en verano y otoño y negativas en invierno y primavera. A excepción del verano, las precipitaciones son mayores a las normales cuando los Bs se producen en ambas longitudes. Al norte de aproximadamente 38º S, B70 determina anomalías de temperatura (ΔT) negativas sobre todo el país durante las cuatro estaciones del año y B40 lo hace en primavera y verano. Al sur de aproximadamente 38º S, B100 produce ΔT negativas. Las frecuencias y cantidades de precipitación son mayores en primavera. En otoño (verano) la zona afectada por mayores precipitaciones se reduce a la zona superior norte (inferior sur). De acuerdo con los signos de las tendencias de Bs y de los valores asociados de temperatura y precipitación, se puede inferir que estas situaciones podrían haber contribuido a la variación de ambas variables durante el periodo 1960-2011

ABSTRACT

In southern South America and for the period 1960-2011, frequencies and trends of seasonal blocking situations (Bs) determined at 100, 70 and 40º W (B100, B70 and B40), respectively are estimated. The effect of such situations on temperature and precipitation is also analyzed. The distribution of occurrences of B100, B70 and B40 peaks in spring and has minimum values in summer; trends are positive in summer and fall and negative in winter and spring. To the north of approximately 38º S, B70 determines negative temperature anomalies (ΔT) over the entire country during the four seasons and B40 in spring and summer. Except for summer, rainfall is greater than normal when Bs occur at both longitudes. To the south of approximately 38º S, B100 give place to negative ΔT. The frequencies and amounts of precipitation are greater in spring. This area is limited to the northernmost northern (southernmost southern) area in fall (summer). According to the signs of the trends of the Bs and to the associated values of temperature and precipitation, the way in which they may have contributed to the change in both variables during 1960-2011 is inferred.

Keywords: Indices, circulation change, temperature, precipitation.

1. Introduction

A blocking pattern exists when systems do not progress within the latitude belt of the baroclinic westerlies. The zonal movement of short waves is effectively halted, as the zonal current vanishes, and hence vorticity advection, the major mechanism by which upper level systems move, becomes negligible. Blocking situations pose a major threat for many people, especially those living near upper-level cyclones or near upper-level anticyclone, since the persistent circulation around these systems influence cloudiness, precipitation and temperature.

Blocking situations in the southern hemisphere (SH) were statistically studied first by van Loon (1956) and Taljaard (1972). Subsequently, during the 1980s several authors such as Trenberth and Swanson (1983), Trenberth and Mo (1985), and Trenberth (1986), among others, shed light on the statistical and dynamical knowledge of blocking events occurrence. Noar (1983) applied a numerical forecast to analyze the start and end of a blocking event in Australia during winter 1983 that produced a severe drought and economic damages. Mo (1983) studied the relationship between blocking events and Rossby long waves as well as their amplitudes in the SH.

Some authors, like Mo (1983) and Trenberth (1986) found that the duration of blocking events or large anomalies are less persistent and of lower amplitude in the SH than in the NH. Trenberth attributed this to the presence of the generally stronger westerlies throughout the troposphere at middle to high latitudes of the SH.

Though Tibaldi *et al*. (1994) found that the number of blockings near 70º W is low, other authors point out that the SW of South America is a region with an important presence of these systems. Moreover, in this work 70º W was selected because the blocking situations at that latitude are the best correlated with temperature and precipitation over Argentina in an extended territory, as shown by Alessandro (2003 b).

Results from Trenberth and Mo (1985) showed that a blocking frequency maximum is found in the 45-60º S band over southeastern New Zealand followed by a second frequency peak in the southeast of South America and a minor peak over the Indian Ocean. Some years later, Sinclair (1996) and Mo and Higgins (1997), confirmed the same maxima found and obtained a new area in the southern Pacific, west of South America. Most studies mentioned, found that persistent anomalies are located southeast of New Zealand. This is a region where the climatological split in the jets favors the formation of blocks (Kiladis and Mo, 1998).

Some authors have considered different numbers of consecutive days to define a blocking situation. Much of the pioneering observational work on blocking was done by Rex (1950). For the Northern Hemisphere, he considered as a blocking case that in which the high-pressure system remains almost stationary for at least 10 days. Other authors like Mo (1983) considered seven or more consecutive days, and Trenberth (1986) used five or more days.

Some researchers analyzed the relationship between blocking events and temperature and precipitation for brief periods. Berbery and Lozano (1991) defined a blocking event as those situations where a positive anomaly larger than 150 hPa at 200 hPa persists at least for five days, in both the southern Pacific and southern Atlantic oceans. They also related these events to minimum temperature and precipitation in Argentina from April to June between 1980 and 1986. Positive persistent anomalies in the Atlantic were associated with positive precipitation anomalies to the south of 30º S, negative and more irregularly distributed precipitation anomalies to the north of that latitude, positive minimum temperature anomalies in central Argentina, and negative minimum temperature anomalies over northeastern Argentina. A blocking in the Pacific was associated with negative minimum temperature anomalies and positive precipitation anomalies in Patagonia and negative precipitation anomalies over central and northern Argentina. The Argentinean Patagonia is the region that extends from the Andes mountain range to the Atlantic Ocean and from the Mendoza state of Malargue (35º 17' S) to the Colorado River (approximately 38º 30' S) on the north and to the waters that are located to the south of Cape Horn in the Drake Passage to the south.

In particular, Marques and Rao (1999) analyzed the influence on precipitation of a blocking event occurred from 29 July to 14 August 1986 in South America. They found that precipitation increased to the north of the blocking high but decreased to the south of it. The increment was associated to the northward deflection of migratory lows to the north of the blocking area whereas the decrease was associated to the subsidence effect produced by the blocking high. To the west of South America Rutllant and Fuenzalida (1991) studied the frequency of blocking events and its relationship with the increased precipitation in central Chile.

For the 1979-1995 period, Kayano (1999) found that positive pressure anomalies between 130 and 120º W in the South Pacific, with a persistence of more than seven days, produced negative temperature anomalies south of 46º S in Argentina during the austral winter and south of 35º S during the austral summer.