A FRESH LOOK AT PERSISTENT MID-PACIFIC RIDGING

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Abstract

Persistent ridging in the North Pacific is a major contributing factor to winter weather in Alaska and western Canada. In general, when the axis of a persistent ridge is located near the International Dateline, air temperatures in Alaska are typically cooler than normal. However, if the ridge axis is located in the Gulf of Alaska, temperatures are well above normal. Many of these events also evolve into anticyclones located north of 50°N. This paper analyzes 10 events of persistent mid-Pacific ridging with respect to planetary waves, wind and outgoing longwave radiation (OLR) anomalies, as well as stratospheric temperature anomalies. These 10 events are also described within the climate environment in which they exist by using monthly climate indices such as the Southern Oscillation index and the Arctic Oscillation Index.

Planetary wave analysis indicates that persistent mid-Pacific ridges occur when planetary wave 2 amplifies simultaneous with a reduction in the amplitude of wave 1. Of prime importance is the reduction in the amplitude of the trough produced by wave 1, which is climatologically located near the dateline. Prior to and concurrent with the formation of a persistent mid-Pacific ridge are significant OLR anomalies over the Indian and western Pacific Oceans. This is linked to a retraction of the jet stream over the mid-latitudes of the western Pacific. Additionally, five of the 10 events displayed major stratospheric warmings over Siberia during the weak prior to onset. Height anomalies are also evident in the stratosphere prior to onset, overall the polar vortex appears to be elongated over Siberia. The limited number of short-wave ridges that amplify and develop into a persistent ridge each winter season suggests that simultaneous multiple forcings are a necessity. This paper suggests that these forcings occur in the tropics, mid-latitudes, as well as in the Arctic.

1. Introduction

During the cooler months of the year, persistent ridging may occur in the vicinity of the International Dateline, resulting in a major shift in the position of the polar jet stream and storm track across the North Pacific. These persistent ridging events typically have a duration of 7 to 14 days and may develop into anticyclones that persist for roughly another week before the Aleutian Low is re-established . During these events as cold dry air moves out of the arctic toward the southeast, that the state of Alaska frequently experiences it's coldest temperatures of the season.

The term "persistent ridge"(PR) is used in this paper instead of the commonly used "blocking", because the latter term has a plethora of definitions in terms of duration and amplitude (see Lupo and Smith 1995 for summary). The emphasis is on PRs that reside in the greater Bering Sea region, which lies roughly between 160°E - 160°W and 45°N - 65°N. This paper focuses on the period from October through April, although ridging over the Bering Sea in the warmer months of the year is a common occurrence as well. The purpose of this study is to enhance the generalized work that has already been done with regard to PR in the mid-Pacific (Rex 1950, Austin 1980, Dole 1989). It is hoped that an analysis of 10 persistent mid-Pacific ridges (MPR) will enable meteorologists to better understand and forecast these events as they occur across the region.

In the following section an overview of the literature on PR is given. Section 3 covers data management issues while in section 4 a description of synoptic patterns prior to and during MPR's is reviewed. The link between MPRs and planetary waves is discussed in section 5. The relationship between MPRs and outgoing longwave radiation (OLR) anomalies over the tropical Indian and western Pacific Oceans, as well as upper tropospheric wind anomalies is explored in sections 6 and 7. Section 8 gives a brief analysis of the conversion of persistent ridges into anticyclones, while section 9 discussions the possible correlation between persistent ridging and stratospheric warm events. Section 10 presents a discussion on the evolution of MPRs in relation to commonly monitored indices, such as the Northern and Southern Oscillation Indices (NOI, SOI), as well as mid-Pacific sea-surface temperature anomalies (PDO).

2. Literature Review

Interest in persistent ridging by the meteorological community dates back to around 1950. Since that time numerous papers have been written on subject, most of which can be categorized into two groups: the climatology of PR, and those that have focused on the dynamics. The main result of the climatological studies is that during the Northern Hemisphere winter, there are two main regions where persistent ridging frequently occurs. The first is over the eastern half of the Atlantic and western Europe centered around the Greenwich Meridian. The second is over the eastern Pacific centered near 150°W (Rex 1950a,b, Quiroz 1986, 1987, Dole 1989, Lejenas and Madden 1992, Lupo and Smith 1995, Renwick and Wallace 1996, Wiedenmann *et al* 2002, Pelly and Hoskins 2003). A third weaker response occurs in the vicinity of the Ural Mountains. These studies have also emphasized the coupling of persistent ridging and the development of a deep low/trough upstream of the ridge. A number of authors have suggested or noted the linkage between PR and the strength and position of the polar jet (Rex 1950a, Dole 1989), higher than normal amplitude planetary waves (Austin, Quiroz 1986, Lejenas and Madden 1992), and stratospheric warmings (Austin 1980, Quiroz 1987).