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2009年中国东北夏季低温及其与前期海气系统变化的联系

An investigation into 2009 summer low temperature in Northeast China and its association with prophase changes of the air-sea system

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中文摘要:

依据中国东北地区拥有百年地面观测记录的长春和哈尔滨测站气温资料、NCEP/NCAR再分析资料和英国哈得来中心海表温度资料, 揭示2009年东北地区发生的迄今已有15年没有出现的夏季低温事件成因。结果表明: 发生东北夏季低温时的水平和垂直环流结构均为低值系统, 东北冷涡异常活动是其最直接的影响因子; 有利的年代际变化背景是, 哈尔滨和长春6—8月平均气温年代际尺度 (≥ 9 a) 的振荡值1999—2008年约 -0.8 $^{\circ}\text{C}/10$ a, 显著低于全球变暖东北区域响应的线性增暖值 0.2 $^{\circ}\text{C}/10$ a (1961—2000年), 与长春和哈尔滨夏季气温呈正相关的前一年冬季太平洋极涡面积指数年代际振荡亦呈显著下降趋势。与1994—2008年东北夏季高温的500 hPa平均环流距平场显著不同, 北极涛动呈强的负位相分布, 东北亚、阿留申和北大西洋上空为显著负距平区; 2009年前一年冬季与明显低温的1972年的前一年冬季北太平洋涛动均呈显著的负位相, 春季仍持续, 且2009年前一年冬季赤道中东太平洋SSTA为拉尼娜位相, 2009年春季明显减弱; 2009年6—7月夏季东北冷涡活动异常强与4—5月500 hPa北太平洋地区超长波扰动转为定常波扰动槽有关; SVD和谐波分析表明, 北太平洋涛动的异常位相不仅是东北夏季气温变化的重要前期信号, 还是大气中除了天气尺度的混沌分量外可提取的一种行星尺度稳定分量。关键词

英文摘要:

Under the background of global warming, a summer (JJA) low temperature event, which has not occurred for about 15 years since 1994, happened in 2009 in the central and northern region of northeast China. By using the NCEP/NCAR reanalysis data, the one hundred year observed temperature data from the stations at Changchun and Harbin, and the Hadley Center sea surface temperature (SST) data, this paper tries to reveal the reason of the northeast China summer low temperature (NESLT) event. Some results were found as follows: The study on both horizontal and vertical circulation structures over northeast China during the period when summer low temperature events occurred, reveals that when it occurred both the horizontal and vertical circulation over northeast China were associated with a low-value system and anomalous activities of the Northeast China cold vortex (NECV) were the most direct influential factor to the low temperature events. The decadal variability (≥ 9 years) of temperature was favorable to the occurrence of summer low temperature in 2009: the decadal oscillation of summer average temperature of Harbin and Changchun in 2009 was still in an obviously downward trend from the late 1990' s to the early 2010' s with its declining change rate from 1999 to 2008 reached 0.8 $^{\circ}\text{C}/10$ years, obviously exceeding the linear rising tendency of 0.2 $^{\circ}\text{C}/10$ years of the regional warming of northeast China from 1961 to 2000. And the previous winter North Pacific polar vortex (NPPV) area index, which was significantly positively related with the observed summer temperatures of Harbin and Changchun, was also in a significantly declining tendency. In addition, in the summer of 2009, the Arctic Oscillation (AO) appeared a negative phase distribution, and the Northeast Asia, the Aleutian Islands and the North Atlantic were significant negative anomaly regions, which are opposite to the pattern of summer average 500 hPa height anomalies over 1994-2008 when the NESLT event was absent. Furthermore, the negative phase of the North Pacific Oscillation (NPO) in the preceding winter of 2009 was obviously strong, just as it once happened in 1972, when a summer low temperature and cool injury event occurred in northeast China. Meanwhile, the SSTA in the eastern central equatorial Pacific Ocean showed a La Nina phase in the preceding winter of 2009 but the strength of La Nina phase weakened obviously in the spring of 2009. The abnormally strong activity of the NECV in the June and July of 2009 was related with the fact that the disturbances of stationary wave replaced the original ones of ultralong wave over the North Pacific region in the April and May of 2009. By employing the method of the singular value decomposition (SVD) and harmonic analyzing, it is found that the phase of NPO was not only an important precursor for summer temperature variations over northeast China, but also a stable component on the planetary scale that we can extract from the atmosphere in addition to the chaos component on the synoptic scale.

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