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PERSISTENT COOLING OF THE POLAR STRATOSPHERE IN 2011 WINTER AND SPRING

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A recent[1] study pointed out that Arctic sea ice reduction of the Barents and Kara Seas in early winter leads to warming of the polar stratosphere in subsequent mid-winter. Atmospheric response to the sea ice reduction in the troposphere enhances upward propagation of the planetary waves into the stratosphere, which causes warming of the polar stratosphere. Less sea ice in 21 century than before may explain frequent occurrence of major stratospheric sudden warming and subsequent negative phase of the Arctic Oscillation in winters of this century. In spite of less-than-usual sea ice in preceding autumn in 2010, persistent cooling of the polar stratosphere from January to March was observed, which led significant ozone depletion in spring of 2011[2]. A study attributed this cooling to positive sea surface temperature (SST) anomalies in the North Pacific[3], inducing tropospheric circulation anomalies similar to the Pacific North American pattern or Western Pacific (WP) pattern. The latter has been shown to suppress upward planetary waves into the stratosphere, thereby lowering polar stratospheric temperatures[4,5].

Our analysis reveals that cooling of the polar stratosphere followed the WP pattern events in January 2011. However, the cooling of the stratosphere was not accompanied by WP pattern events in February and March. The stratospheric cooling in February was associated with downward planetary wave propagation in the stratosphere, which might be caused by instability in the upper stratospheric jet after a short pulse of upward planetary wave propagation[6]. The reason for the persistent cooling through March has, however, not been uncovered yet. We will discuss whether the persistent stratospheric cooling in 2011 was related to the recent climate change by analyzing similar events observed in the past by using a long-term reanalysis data set.

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