Extraordinary features of the planetary wave propagation during the boreal winter 2013/2014 and the zonal wavenumber two predominance

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The boreal winter 2013/2014 can be characterized by frequent upward propagation of planetary wave packets from the troposphere to the stratosphere and continuous strong activity of planetary waves of zonal wavenumber 2 (wave 2) almost throughout the season, in spite of no major stratospheric sudden warming (SSW) occurrence.

The purpose of this study is to compare features of the planetary wave propagation in boreal winters and clarify causation mechanisms of the predominance of wave 2 in the winter 2013/2014 using three reanalysis data (JRA-55, MERRA and ERA-Interim) along with satellite data retrieved from the Aura-MLS observations.

We first investigate inter-annual change of the vertical component of Eliassen-Palm (EP) flux averaged over 30–90°N at 100 hPa during boreal 56 winters since 1958/1959. As a result, we find that the upward EP flux of wave 2 during the winter of 2013/14 is almost equal to the highest value during the winter 2008/2009. In addition, the ratio of the wave 2 contribution to the sum of wave 1 and wave 2 largely surpass 0.75 in only these two winters. Note that no major SSWs occurred in the winter 2013/14 while a remarkable major SSW occurred in the winter 2008/09.

Furthermore, on the basis of wave activity flux analyses, it is found that the upward propagation of planetary wave packets over Western Russia (around 60°E) of the winter 2013/14 is the strongest in recent 34 winters since 1980/1981 winter. It is also revealed that the downward propagation from the stratosphere to the upper stratosphere over Northern Canada (around 120°W) is the strongest in this winter. This strong downward propagation seems to be highly related to the extremely cold winter in Canada and the USA in this winter.

Key words: stratosphere, planetary wave propagation, zonal wavenumber two, reanalysis