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Summertime blocking and Rossby wave breaking over Siberia in a high-resolution GCM

Masato Mori (1), Masahide Kimoto (2), and Masahiro Watanabe (3)
(1) Japan (masato@aori.u-tokyo.ac.jp), (2) Japan (kimoto@aori.u-tokyo.ac.jp), (3) Japan (hiro@aori.u-tokyo.ac.jp)

The Okhotsk high, which is quasi-stationary anticyclone observed over the sea of Okhotsk in summer, have a great influence on summertime climate over the Eastern Asia, and it is known that the Okhotsk high is accompanied by blocking anticyclone at upper troposphere over northeastern Siberia and the sea of Okhotsk. In this study, the blocking anticyclone associated with the Okhotsk high is examined using the ERA40 dataset and a new high-resolution atmosphere-ocean coupled general circulation model (GCM) named MIROC4. The horizontal resolution of the atmospheric model component is T213 (about 60km mesh). To investigate model horizontal resolution dependence, the previous high- and medium-resolution versions of model, MIROC3h (T106) and MIROC3m (T42), are also used. In order to detect blocking anticyclone, we evaluate Rossby wave breaking (RWB) on the dynamical tropopause (the 2PVU surface) following the procedures in Berrisford et al. (2007) and Woollings et al. (2008). It is found that the blocking frequency and duration tend to be well represented as the model resolution becomes high.

The importance of Rossby wave packets propagation along with polar frontal jet stream over the Eurasia Continent to the formation of blocking over the northeastern Siberia has been pointed out in some previous studies (e.g., Nakamura and Fukamachi 2004), and so the reproducibility of waveguide defined by meridional gradient of the climatological absolute vorticity is investigated. The lower-resolution models (MIROC3h and 3m) are found to underestimate the maxima over the Eurasia Continent in summertime, whereas the highest-resolution model (MIROC4) well represents the maxima. These results imply that the reproducibility of waveguide associated with polar frontal jet is one factor which controls the frequency of blocking over the northeastern Siberia. It is considered that the high horizontal resolution of model affects to sharpen the polar frontal jet stream. Furthermore, in the high-resolution model, the horizontal gradient of potential vorticity (PV) is tight, so that a cut-off low-PV air parcel associated with RWB is not easily mixed with surrounding high-PV air. Probability density function of PV gradient for each model indicates that the effect also help to well represent blocking frequency in high-resolution model.