Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

AAS002-04 Room: 301B Time: May 28 14:30-14:45

Reproducibility and Future Projection of Summertime Storm-Track Activity over The Arctic in CMIP3 Climate Models

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Cyclones over the Arctic region are of climatic importance as they bring heat and moisture into the region from lower latitudes. Many of the cyclones moving into the region in summer develop along the polar frontal zone that forms in association with meridional temperature gradient between the Arctic Ocean and the eastern Eurasian continent. The aim of this study is to examine the reproducibility of the summertime storm-track activity over the Arctic in the present climate, as an ensemble signature of synoptic-scale cyclones, in the CMIP3 climate models. Future projection of the activity based on the SRES-A1B experiment is also examined. The storm-track activity is measured as lower-tropospheric poleward heat flux associated with subweekly disturbances. Meridional gradient of the climatological-mean surface air temperature is used as a measure of local baroclinicity. The observed climatological summertime storm-track activity is maximized off the Siberian coast and over the Beaufort Sea. The distribution of the storm-track activity is well reproduced in most of the climate models, but the reproducibility is relatively poor in intensity. The reproducibility is also low for the westerly jet along the Siberian coast, reflecting the effect of storms to transport westerly momentum downward. In fact, positive correlation among the models is found between the intensity of eddy heat flux along the eastern Siberian coast and the lower-tropospheric westerly wind speed and associated baroclinicity. The future projection of the summertime storm-storm track activity over the Arctic region is strongly model-dependent, indicating relatively low reliability of the projection. Those models with greater warming projected over Siberia tend to simulate greater enhancement in the storm-track activity. This tendency suggests that the model representations of physical and biological processes that influence surface (air) temperature over Siberia are key for reliable future projection in the Arctic storm-track activity.

Keywords: storm track, CMIP3 climate model, future projection, cyclone