Future changes in Northern Hemisphere wintertime storm activity as a consequence of global warming are investigated using MRI-AGCM with horizontal grid sizes of 60 and 20 km. A future (2075-2099) climate experiment, in which the change in sea surface temperature (SST) derived from the CMIP3 multi-model ensemble mean is added to observed SST, is compared with a present-day (1979-2003) climate experiment. Results of three-member initial-value ensemble simulations using the 60-km model are presented. Similar results are obtained in the 20-km model.

In the future climate experiment, the frequency of strong cyclones (sea-level pressure below 980 hPa) shows a significant increase whereas the frequency of total cyclones shows a significant decrease, similar to the results obtained from the CMIP3 models themselves. The increase in strong cyclones is seen on the polar side and downstream side of Atlantic and Pacific storm tracks. The growth rate of the cyclones increases in areas upstream of these regions.

For the regions with the increasing growth rate, a strong correlation is seen between the cyclone growth rate and upper troposphere zonal wind at a monthly-mean timescale. The enhanced zonal wind in these regions, in the future experiments, corresponds to an enhanced rate of cyclone growth. This relationship can be explained by changes in wave-breaking pattern, that is, a decrease in wave breakings in the cyclonic shear (LC1) and an increase in wave breakings in the anticyclonic shear (LC2). Associated with these changes, rapid cyclone developments are more commonly seen, and weak, long-lived cyclones become less frequent.