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Coherent changes in large-scale thermal structure and baroclinic life cycle of synoptic eddies in the Northern Hemisphere under global warming

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There is a growing concern that human-induced climate change has been affecting weather systems. However, robust observational evidences that confirm the links between global warming and synoptic phenomena at the global scale are lacking. Here we reveal robust covarying signals between poleward temperature gradient and baroclinic life cycle of synoptic (1-10 days) eddies under global warming. We note that the changes in temperature structure in Northern Hemisphere winter and summer in the past decades are different. In boreal winter, the tropospheric warming has been larger in tropical upper troposphere and around 30°N than for the midlatitude (30-60°N). This inhomogeneous warming resulted in the enhancement of poleward temperature gradient in the subtropical upper troposphere and in the lower midlatitude (30-45°N). We observed correlated increasing trends in the entire baroclinic life cycle of synoptic eddies — including eddy fluxes of heat and momentum, and zonal mean jet — associated with steepened poleward temperature gradients in these regions in the winter Northern Hemisphere over the past four decades. By contrast, in the summer Northern Hemisphere, the overall tropospheric warming over the mid- to high-latitude land areas has been accompanied by weakly reduced synoptic eddy activities and zonal mean flow. Our findings suggest that if greenhouse gas–induced warming continue to change the atmospheric thermal structure as projected in a warming climate, extratropical synoptic disturbances and large-scale circulations may change accordingly.