Geophysical Research Abstracts
Vol. 16, EGU2014-4624-1, 2014
EGU General Assembly 2014

Effect of sea surface temperature variability in the East/Japan Sea on the North Pacific atmospheric circulation in a regional climate model

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The East/Japan Sea (EJS) is a semi-enclosed marginal sea in the upstream of the North Pacific storm track. The leading modes of wintertime interannual variability in the EJS sea surface temperature (SST) are characterized by the basin-wide warming-cooling and the northeast-southwest dipole. Processes leading to local and remote atmospheric responses to these SST anomalies are investigated using the hemispheric-scale Weather Research and Forecast (WRF) model with multi-nesting. The atmosphere in direct contact with anomalous diabatic forcing in the EJS exhibits a linear response with respect to the sign SST anomalies, producing increased (decreased) wind speed and precipitation response over warm (cold) SSTs. This local response is due to modulation of both the vertical stability of the marine atmospheric boundary layer and the adjustment of sea-level pressure. The linearity in the local response suggests the importance of fine-scale EJS SSTs to predictability of the regional weather and climate variability. The remote circulation response, in contrast, is strongly nonlinear. An intraseasonal equivalent barotropic ridge emerges in the Gulf of Alaska as a common remote response independent of the EJS SST anomalies. This downstream blocking response is reinforced by the enhanced storm track variability east of Japan via transient eddy vorticity flux convergence. Strong nonlinearity in remote response implies that detailed EJS SST patterns may not be critical to this downstream ridge response. Overall, results demonstrate a remarkably far-reaching impact of the EJS SSTs on the atmospheric circulation.