Geophysical Research Abstracts
Vol. 12, EGU2010-14627, 2010
EGU General Assembly 2010

Predictable Modes of Summertime Upper-Tropospheric Circulation in the Northern Hemisphere: Linkage with Global Monsoon and ENSO

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The first two leading empirical orthogonal function (EOF) modes of summertime upper-tropospheric circulation in the Northern Hemisphere (NH) are identified as predictable modes using National Centers for Environmental Prediction (NCEP)/department of Energy (DOE) reanalysis II in concert with three coupled models' hindcast data from NCEP, Geophysical Fluid Dynamic Lab (GFDL), and Bureau of Meteorology Research Center (BMRC) for 25 years of 1981-2005. The analysis reveals that prediction skills of individual coupled models and their multi-model ensemble (MME) prediction for JJA 200-hPa geopotential height (GPH) in the NH basically come from the coupled models' capability in predicting the two predictable modes of interannual variability. In observation (the one-month lead MME prediction), the first two EOF modes altogether account for 84 % (90.1%) and 35.4 % (70.5%) of the total variance over the Tropics and the Extratropics, respectively, in the NH, indicating that the MME highly overestimates fractional variance of the predictable modes especially over the Extratropics. The residual higher modes cannot be captured by the current coupled models and their MME prediction.
The long-lead predictability of the first EOF mode comes mainly from El Niño-Southern Oscillation (ENSO) since it tends to occur summers after mature phase of ENSO. The MME well predicts both temporal and spatial characteristics of the first mode even at 5-month lead (January initial condition) with a temporal correlation coefficient (TCC) skill for principal component (PC) of 0.62 and a pattern correlation coefficient (PCC) skill for eigenvector of 0.96. The second EOF mode is related to not only developing ENSO on interannual time scale but also SST variability over the North Pacific and Atlantic Ocean on interdecadal time scale. The MME is also capable to capture the second mode even at 5-month lead with a TCC skill of 0.67 and a PCC skill of 0.87. While the MME well predicts the zonally symmetric part of the second eigenvector, it has difficulty in capturing the prominent wavelike structure of it, so call circumglobal teleconnection (CGT) pattern. Each coupled model has a significantly different CGT pattern from each other as well as from the observed counterpart. In both observation and the MME prediction, the first two leading modes are accompanied by significant rainfall and surface air temperature anomalies in the continental region of the Extratropics. The MME's success in predicting the first (second) EOF mode likely leads to better prediction of JJA precipitation anomalies over East Asia (Central and Southern Europe) one-month ahead.