This study examines the extratropical prediction skill of the subseasonal-to-seasonal (S2S) prediction models. A total of ten models that have participated in the S2S project are evaluated by computing mean squared skill score (MSSS) of extratropical geopotential height for the common reforecast period of 1999-2010. It is found that multi-model mean skill and inter-model skill spread are 9.99 ± 8.85 days at 500 hPa but 12.37 ± 8.85 days in the Northern Hemisphere. Quantitatively similar results are also found in the Southern Hemisphere with 9.83 ± 7.75 days at 500 hPa and 12.91 ± 6.62 days at 50 hPa.

A higher prediction skill in the stratosphere is partly due to a well-predicted polar vortex in winter. In summer, the stratospheric prediction skill becomes comparable to or even lower than the tropospheric prediction skill. This is not physically meaningful but caused by weak stratospheric variability that is taken into account in computing MSSS. Except in the summer stratosphere, the model prediction skills are largely controlled by eddy errors rather than zonal-mean errors. Specifically, eddy phase errors play a crucial role in setting the prediction limit with a relatively minor contribution of eddy amplitude errors. This result suggests that S2S prediction skill could be improved by better representing wave propagation. A linear correlation between the stratospheric and tropospheric prediction skills further suggests that the tropospheric prediction skill could be improved by better constraining stratospheric circulation in the models.

Detailed analysis: (example) ECMWF model

MSSS skill is the lead time [day] when MSSS crosses 0 line, which defines the magnitude of mean squared error (MSE) of the models is the same as the magnitude of observational variance.

When the sum of planetary scale waves and the sum of the extratropical phase error is zero, then the prediction skill is the same as the inter-model variance. When the sum of the extratropical phase error is zero, the prediction skill is the same as the multi-model variance.

Decomposition of prediction errors

MSSS (Mean Squared Skill Score)