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Responses of Global Atmospheric Circulation to Climate Indices Based on APCC Hindcast Data

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1. Introduction

From 14 centers in 10 countries, the Asia-Pacific Economic Cooperation (APEC) Climate Center (APCC) collects global climate prediction data every month and issues monthly-rolling Multi-Model Ensemble (MME) predictions for the upcoming six-month seasons, which are disseminated through the website (www.apcc21.org). In cooperation with KMA (Korea Meteorological Administration), the APCC also produces climate predictions of temperature and precipitation over South Korea every month. The climate indices e.g. Niño3.4 from reanalysis data have been taken into account for the predictions of the temperature and precipitation over South Korea even though the MME prediction data is also essential. The responses of atmospheric circulation to the climate indices and correlation between temperature and precipitation over South Korea and the indices are studied by using both reanalysis and hindcast data, which are finally provided as a guidance so that the APCC forecasters can produce more reliable predictions.

2. Data and methodology

APCC currently monitors 20 atmospheric and oceanic indices and predicts 9 indices out of them. The criteria for selecting indices for this study are as follows: 1) be predicted by APCC; 2) have high correlations with observed indices; and 3) have high correlations with temperature and rainfall over South Korea.

The data sets used in this study is described in Table 1. The station data of mean temperature and precipitation over South Korea are obtained from ASOS. With these data sets, four of global atmospheric variables of reanalysis and hindcast data are analyzed: geopotential height at 500 hPa, sea level pressure, temperature at 2m, and wind at 850 hPa.

Table 1 Descriptions of the data sets used in this study. The common data period of the above data is 1983-2005.

Data	Description	Variables
Automated Synoptic Observing system (ASOS; data.kma.go.kr)	61 stations over South Korea	- Mean temperature - Precipitation
CAMS OPI (Janowiak and Xie, 1999)		- Precipitation
NCEP-DOE Reanalysis (Kanamitsu et al., 2002)		- Geopotential height at 500 hPa - Sea level pressure - Temperature at 2m - Wind at 850 hPa
MME hindcast data of APCC	Simple Composite Method (SCM)	
Hindcast data of individual models	JMA NASA APCC NCEP CMCC PNU CWB POAMA MSC	

The variables are regressed onto the selected climate indices for the months when the correlation between indices from reanalysis data and those from MME hindcast data is high. The regressed patterns of MME hindcast data are displayed as colored shadings, whereas those of individual model data spread are displayed as dots when standard deviations being less than average ones of regression coefficients of individual models.

3. Results and conclusions

The Niño3.4 and AO (Arictic Oscillation) out of 20 indices are selected based on the correlations between indices from reanalysis and MME hindcast data (Fig. 1). The Niño3.4 shows high prediction skill all year round.

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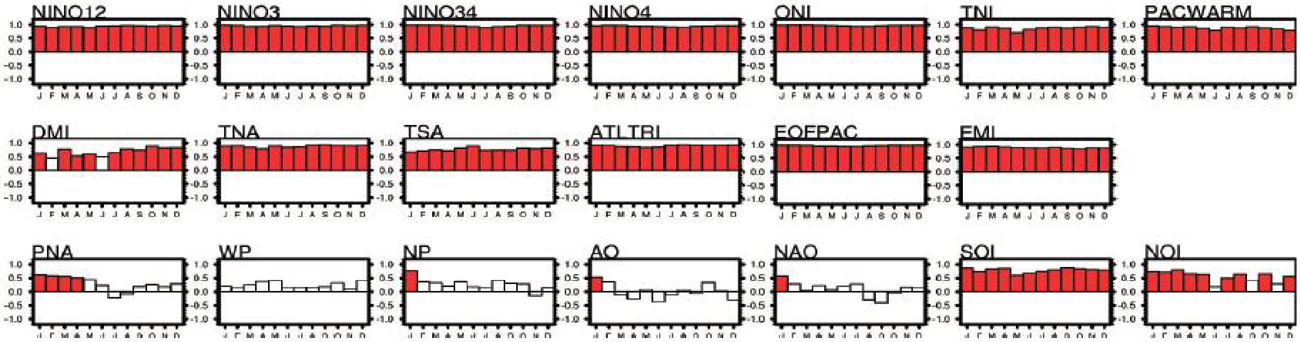

Fig. 1 Temporal correlations between observed and predicted indices. Red bars denote correlations which are significant at 95% level.

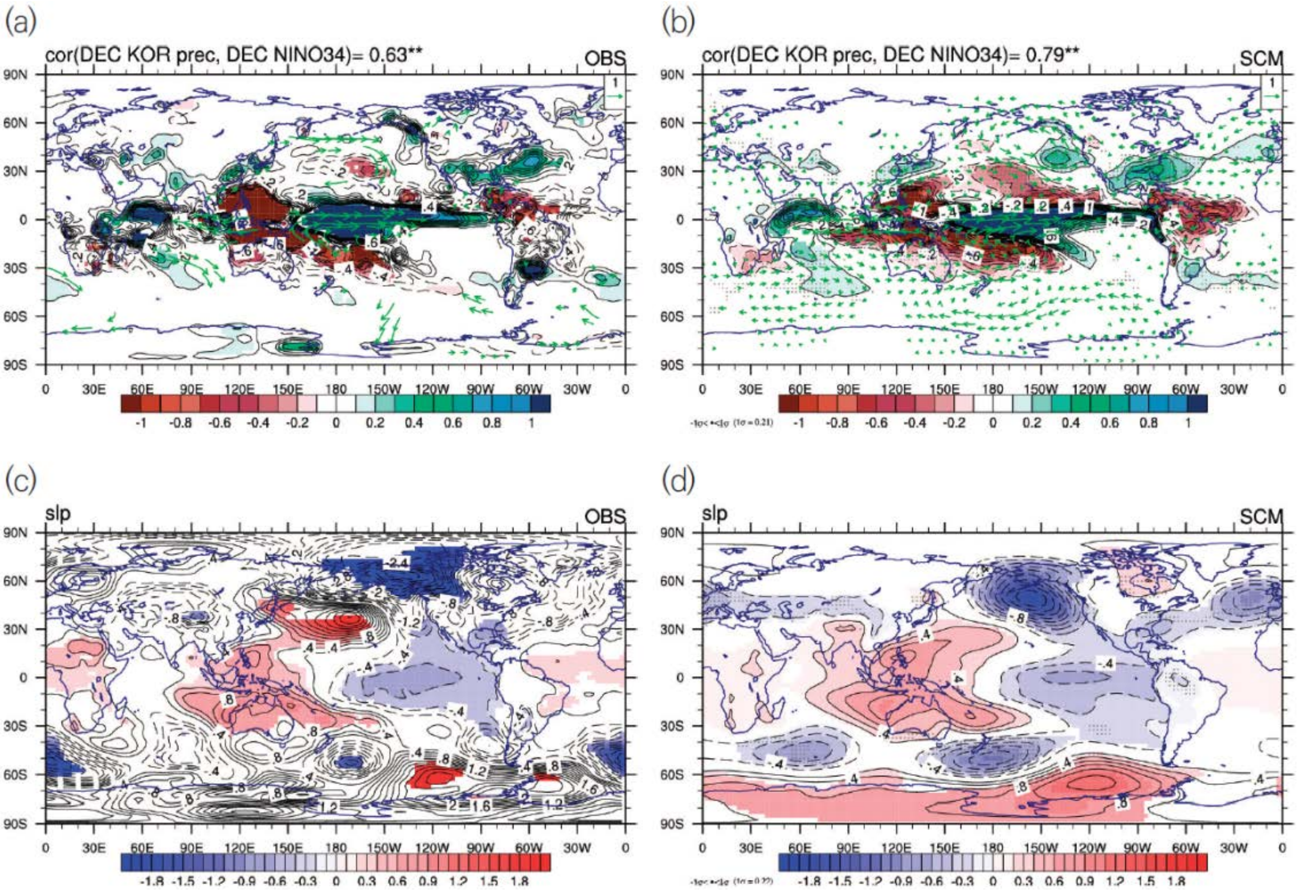

Fig. 2 Regressed precipitation (top) and sea level pressure (bottom) anomalies onto Niño 3.4 SST for December from reanalysis (left) and SCM hindcast (right) data.

The AO has significant prediction skill for January, which is taken into account for the prediction of winter temperature over South Korea.

The correlation coefficients between rainfall over South Korea and Niño3.4 for December are 0.63 in OBS and 0.79 in SCM, respectively (Fig. 2(a) and (b)). The wet condition and the southwesterly over South Korea are well simulated by SCM. The consistent responses of MME participating models on Niño3.4 are also shown. The anticyclonic circulation over the western Pacific and the cyclonic one over the eastern Pacific is predicted by SCM (Fig. 2(c) and (d)). Based on these results, not only the observed Niño3.4 but also the predicted one should be considered for the prediction of precipitation over South Korea for December.

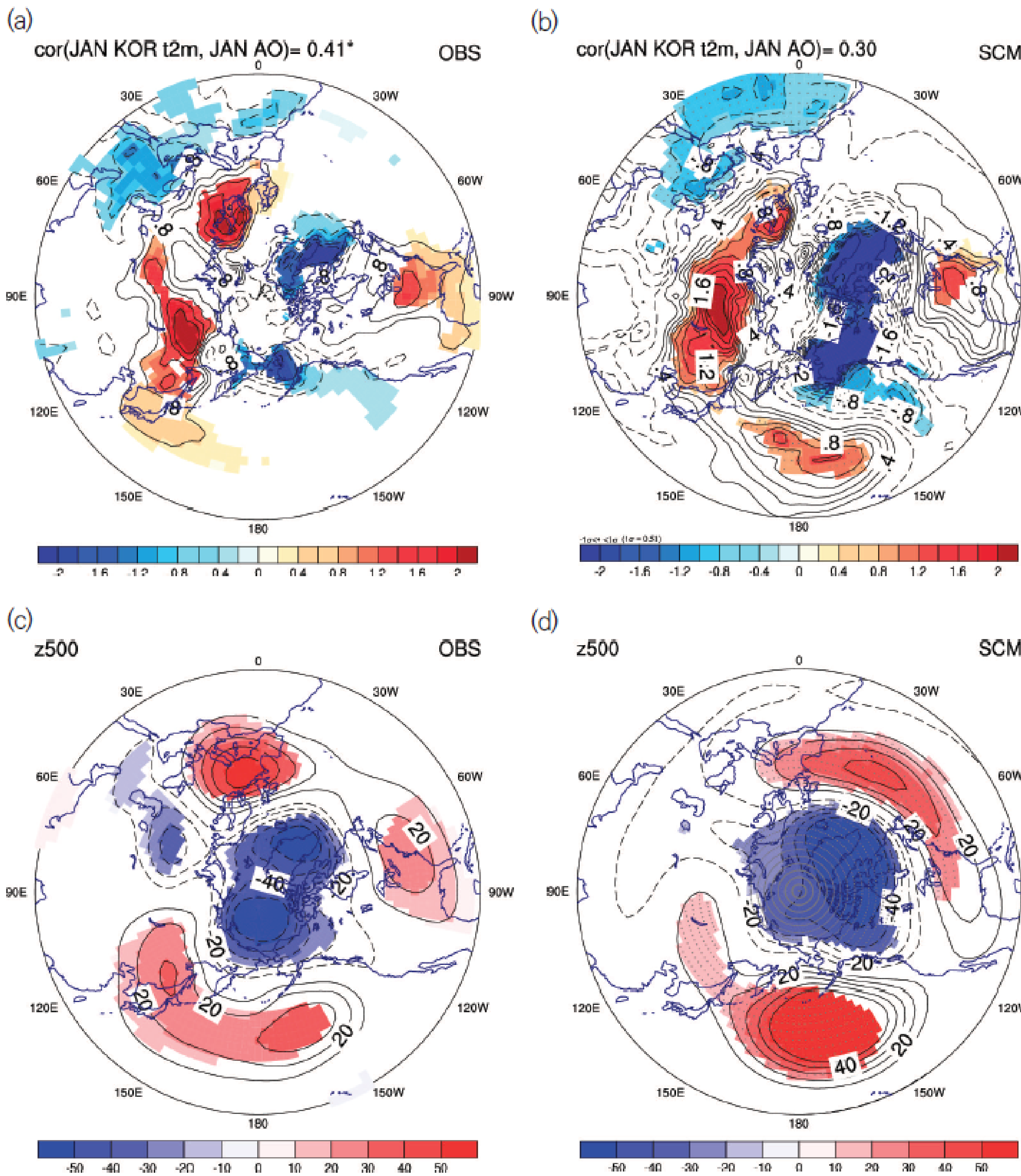

Fig. 3 Regressed temperature at 2m (top) and geopotential height at 500 hPa (bottom) anomalies onto AO index for January from reanalysis (left) and SCM hindcast (right) data.

On the other hand, no significant correlation between the temperature over South Korea and AO from SCM for January is shown. The regressed patterns of SCM are similar to that of OBS though (Fig. 3 (a) and (b)). The positive temperature anomalies over Northeast Asia, Siberia, and eastern USA and negative ones over Canada, Middle East, and North Africa from SCM are similar to the ones from OBS. The positive anomalies over South Korea in OBS don't cover it in SCM though. The AO-related pattern of geopotential height at 500 hPa - negative anomalies over the Arctic and positive ones over the northern North Pacific and Atlantic is predicted by SCM and the consistency among the responses of the individual models is shown (Fig. 3 (c) and (d)).

This study covers the prediction skill of hindcast data. The predictability for the indices and related atmospheric circulation patterns with the real-time forecast data of APCC will be further studied.

References

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