문서번호 APCC-출장-16-0051(2016-01-25)

결재	선임연구원	팀장	부서장	원장
	01/20 Vladimir Kryjov	01/22 유진호	01/25 김형진	01/25 정진승
협조				

TRAVEL REPORT FORM
출장보고서

I. **Reporter** 보고자

Department 소속	Position 직위(직급)	Name 성명	Travel Date 날짜	Note 비고
Climate Prediction Team	Research Fellow	Vladimir Kryjov	2016.01.09.~16	

II. **Major Activities** 주요업무 수행내용

1. Main Contents and Activities 주요내용 및 활동

- Poster presentation on the prediction of the wintertime Arctic Oscillation (AO)
- Discussions with AMS meeting participants

2. Relevance to APEC Climate Center's Activities 결론 및 소감

Wintertime AO affects temperature in East Asia, which prediction is Kryjov's research task. Kryjov's results on the prediction of the wintertime AO are on the highest world level of nowadays.

III. **References** 참고사항

(with attachment of any information or report in case of attendance of conferences, workshops and meetings) 학술대회, 워크숍, 회의 등 참석 시 관련 정보 및 문서 첨부

1. Presented and Collected Materials 주요 수집자료

2. Suggestions and Remarks 건의사항

Predictability of the Wintertime Arctic Oscillation Based on Autumn Circulation: Assessment on Independent Data

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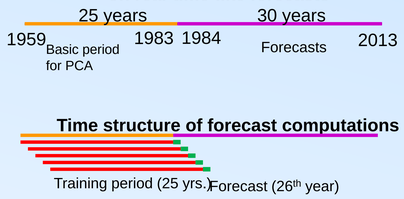
Abstract

A statistical method for a one month lead prediction of the wintertime seasonal mean Arctic Oscillation (AO) index is discussed. Predictors, independently constructed for each forecast based on October geopotential height of the 500 hPa surface, indicate that the strongest impact of October circulation on the wintertime AO originates from a circulation anomaly over the Taymyr Peninsula. Winters of the positive (negative) AO polarity tend to be preceded by an October cyclonic (anticyclonic) Taymyr circulation anomaly causing an advection of the cold (warm) air to the central Arctic leading to enhancement (weakening) of the circumpolar vortex, and advection of the warm (cold) air to the East Asia with corresponding weakening (enhancement) of the East Asia trough associated with the planetary wave-1 and wave-2. Independent verification assessments based on series of 30 forecasts of the December-February (DJF) AO index (AOI) reveal a high skill of the developed method, with correlation coefficients between the predicted and observed DJF AOI being 0.61-0.66 and mean squared error skill scores being 0.37-0.43.

Data and Method

Z1000, Z500 – NCEP/NCAR Reanalysis-I, 2.5x2.5
Series size is 55 years (winters 1958/59-2012/13)

Data time structure for prediction assessment on real-time-like forecasts



Time structure of forecast computations

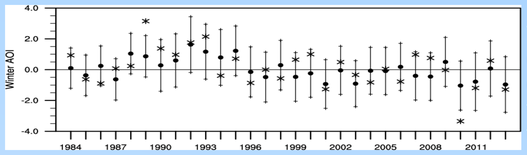
Total: 30 forecasts with a yearly increment

Each year prediction procedure consists of five steps:

1. Computation of a correlation map between October Z500 and the DJF AOI using the data from the training period (25 years);
2. Construction of a 25-year series of predictor computed as a projection of October Z500 anomaly fields on the correlation map;
3. Derivation of a regression equation linking the DJF AOI with the constructed predictor based on the 25-year training period;
4. Estimation of the 26th year predictor by projecting of the October Z500 field from the 26th year onto the correlation map;
5. Estimation of the forecast value of the DJF AOI using the 26th year value of the predictor.

The whole prediction procedure from construction of a correlation map through forecast estimation is performed independently upon prediction procedures of other years

Prediction Skill

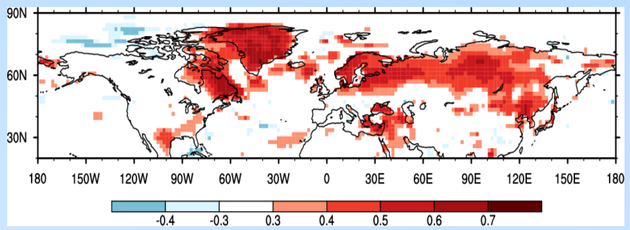


Time series of the DJF observed (snowflakes) and predicted (circles) AOI. Crosses denote the 95% confidence intervals of the predicted AOI

The TCC and MSSS between the observed and predicted DJF AOI (1984-2013) regarding to the basic period of the AO

AO basic period(s)	TCC	MSSS
1958 – 1983	0.66	0.43
25-yr sliding training periods*	0.61	0.37
1979-2000 (CPC AO)	0.60	0.35

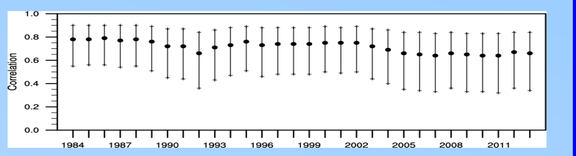
*Illustrations correspond to this option

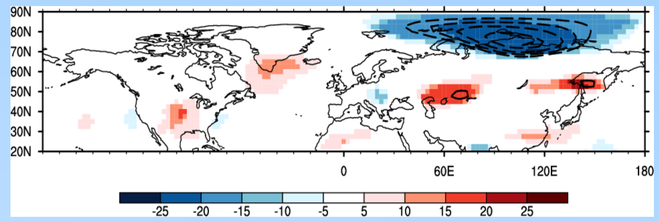


The TCC between the observed and predicted DJF temperature anomalies for the winters 1984-2013

What underlies?

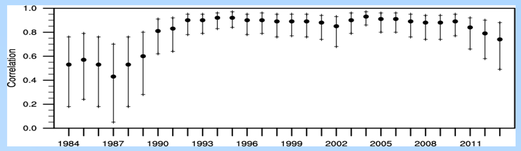
High and stable correlation between the DJF AOI and the constructed October predictors





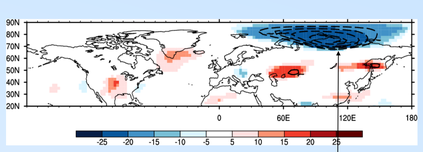
Stable correlation maps with the main contributors to the constructed predictors resembling inverted October Taymyr Circulation Anomaly (TCA) of Kryjov (2015)

The mean correlation map between the DJF AOI and October Z500 (contours), contour interval is 0.05, negative values are dashed; contours between -0.4 and 0.4 are omitted.
The number of forecasts (out of 30) with an absolute value of the correlation coefficient between the DJF AOI and October Z500 exceeding 0.4 (shading),
Positive (negative) values correspond to positive (negative) correlation coefficients



Correlations between the constructed predictors and the inverted October TCI (Z700 anomalies averaged over the trapezoid [80ºN-70ºN, 100ºE-120ºE])

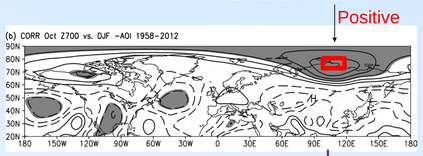
Mechanisms

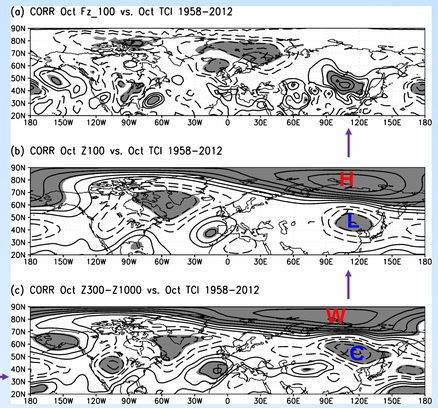


Negative

October TCA

Positive





Propagation of the long planetary waves from the troposphere to stratosphere, their interaction with the zonal mean zonal flow, and downward propagation of the resulting geopotential anomalies to the troposphere, which are reflected in the AO polarity, were explained theoretically (Charney and Drazin, 1961; Haynes *et al.*, 1991) and supported in both empirical studies (e.g. Baldwin and Dunkerton, 1999; Limpasuvan *et al.*, 2005a; Cohen *et al.*, 2010) and modelling studies (e.g. Shindell *et al.*, 2001; Fletcher and Kushner, 2011).

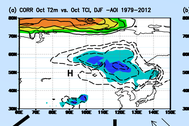
In the BW figs from Kryjov (2015) the AOI is inverted

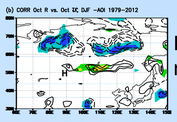
General Scheme

(vice versa when polarity is opposite)

October Taymyr Circulation Anomaly and the TCI is **positive**
(Constructed October Predictors of the AOI are **negative**)

Temperature response





Precipitation response

- increases geopotential heights in the Arctic
- enhances EA trough (Wave-1, -2)
- increases rate of snow extent increase, r(TCI,SAI)=0.68*
- enhances Siberian High

DJF AO is **negative**

*TCI – Taymyr Circulation Index (Kryjov, 2015)
*SAI – Snow Advance Index (Cohen&Jones,2011)

Conclusion

- This study provides significant support to the strong relationships between the DJF AO and October circulation, with the October Z500-based predictor pattern closely resembling the TCA and predictor series strongly correlating with the TCI of Kryjov (2015).
- A regression method for prediction of the DJF AO based on October circulation with flexible construction of the predictors tested on independent data has shown its efficiency. Verification assessments performed on the series of 30 forecasts of the DJF AOI reveal the TCC between the predicted and observed DJF AOI being above 0.60 and MSSS being above 0.35.
- This skill is comparable with the skill of the most successful numerical model forecasts (GloSea5 (MacLachlan et al., 2014) and PNU (Sun&Ahn, 2015)). It implies that the method may be applied for prediction of the wintertime AO both solely and in combination with numerical seasonal models of similar skill. The second option is preferable because of the difference in sources of predictability, particularly, our statistical forecasts are based on the October extratropical circulation anomalies while seasonal model predictions are mainly governed by tropical SST anomalies.

Associated papers:

Kryjov, V.N., 2015: October circulation precursors of the wintertime Arctic Oscillation. *International Journal of Climatology*, 35, 161-171, DOI: 10.1002/joc.3968

Kryjov, V.N., Y.-M. Min, 2016: Predictability of the Wintertime Arctic Oscillation Based on Autumn Circulation. *International Journal of Climatology*, Wiley online library, DOI: 10.1002/joc.4616

Acknowledgement

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