# Influence of Siberian autumn snow cover on the following winter atmospheric dynamics using modeling data and observations


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## INTRODUCTION

*The most extensive snow cover is formed in Siberia and, according to NOAA satellite observations, this cover is generally formed in October (Gong G. et al., 2003). In 2007 Cohen J. and co-authors suggested a possible mechanism of influence of autumn Eurasian snow cover anomalies on atmospheric conditions in a following winter in Northern Hemisphere (Cohen J. et al., 2007). The area of snow cover rapidly increases exceeding normal values in Siberia during last decades. Emerged diabatic cooling in the region of under study results in pressure increase over and temperature decrease under the corresponding normal values. Thus, in troposphere upward energy flux increases, and then it is absorbed in stratosphere. Strong convergence of wave activity flux causes the geopotential heights increase, polar vortex slowdown and stratospheric temperature increase. Emerged geopotential and wind anomalies extend from stratosphere to troposphere up to surface. As a result, strong negative AO mode appears near the surface.*

## GOAL:

**to assess the effect of positive snow cover anomalies, formed in October in Siberia, on the atmospheric conditions of this territory in the following winter.**

## REGION and DATA

**Region:** Siberia (Western Siberia): 50N-70N 60E-90E

**Observations** (1975-2014):

snow cover – RIHMI-WDC (http://meteo.ru/it/178-aisori)

2 m temperature – NOAA (ftp://ftp.cdc.noaa.gov/pub/data/gsod/)

**Arctictic Oscillation Index:** NOAA

**Modeling data:**

INMCM4 (1975-2005), INMCM5 (1979-2008)

(Volodin E.M. et al., 2010; Volodin E.M., 2014)

## RESULTS

An interannual behavior of October Siberian snow cover area, winter mean (DJF) AO Index (left scale) and surface air temperature (right scale) and loading pattern of the AO were considered.

Considered data show similar interannual behavior. But observations have higher variation then modeling data (Figure 1).

The first EOF mode explains 19% of atmospheric variability for observational data, 20 % for INMCM4 and 23% for INMCM5.

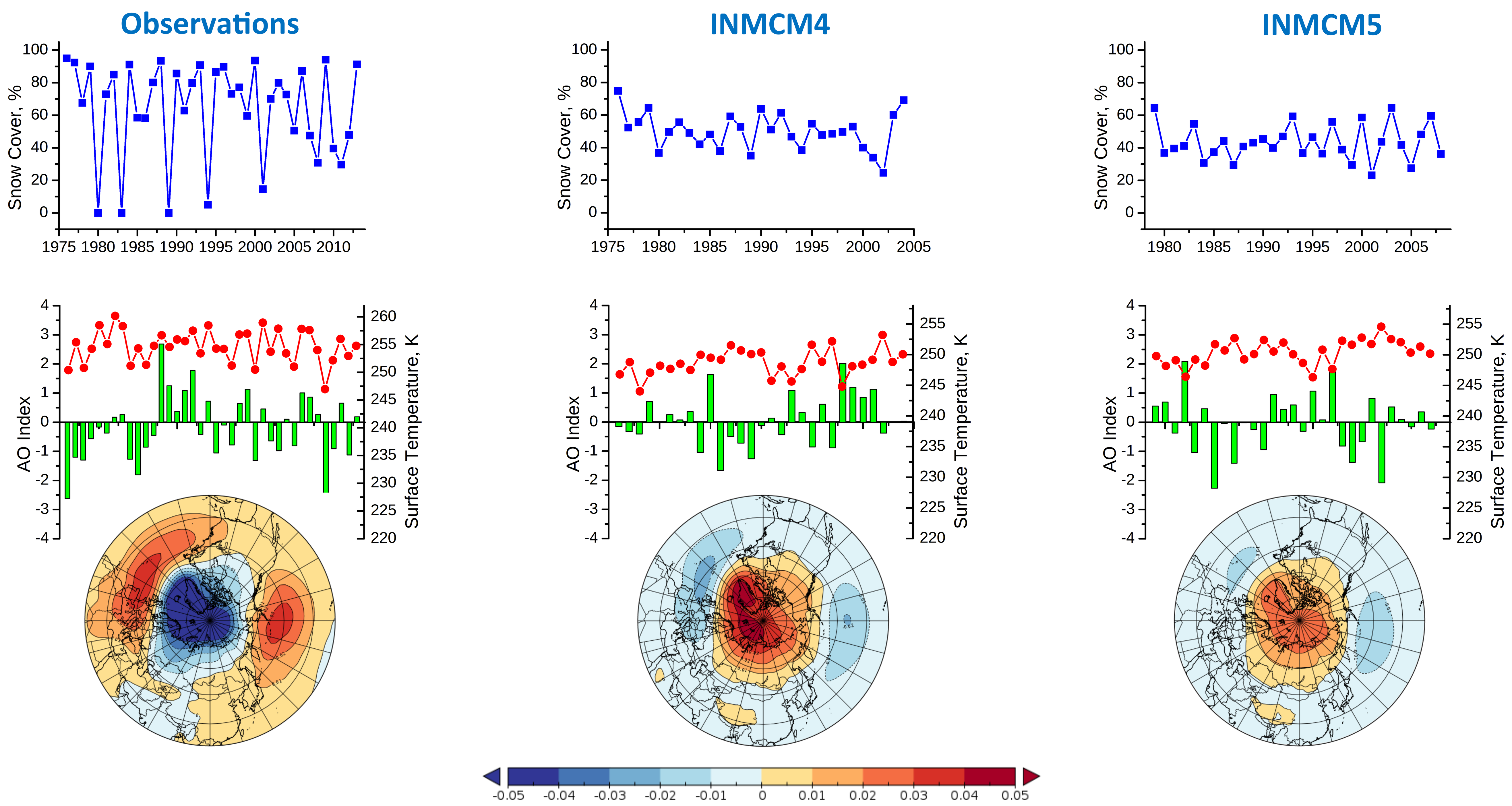


***Figure 1.*** *Interannual behavior of October Siberian snow cover area, winter mean (DJF) AO Index (left scale) and surface air temperature (right scale) and loading pattern of the AO. Left pictures set is observations, middle pictures set is INMCM4, right pictures set is INMCM5.*

***Table 1.*** *Correlation coefficient between October snow area and seasonal mean surface temperature in Siberia and AO Index. Blue color indicates 90 % statistical significance, green color is 95 %.*

| Period (N of years) | $S_{Snow}$ vs AO Original / Detrended | $S_{Snow}$ vs $T_s$ Original / Detrended | AO vs $T_s$ Original / Detrended |
|---|---|---|---|
| **Observations** | | | |
| 1976-2013 (38) | -0,277 / 0.210 | -0,342 / 0,354 | 0,711 / 0,647 |
| 1994-2013 (20) | -0,406 / -0,477 | -0,401 / 0,434 | 0,823 / -0,207 |
| 1976-1994 (19) | -0,231 / 0,040 | -0,384 / 0,346 | 0,623 / 0,338 |
| 1994-2008 (15) | -0,440 / 0,135 | -0,409 / 0,396 | 0,700 / 0,243 |
| **INMCM4** | | | |
| 1976-2004 (29) | 0,032 / -0,010 | -0,217 / -0,159 | -0,475 / -0,186 |
| 1976-1991 (16) | 0,348 / -0,084 | -0,225 / -0,200 | -0,273 / 0,472 |
| 1991-2004 (14) | -0,176 / -0,191 | -0,194 / -0,191 | -0,718 / -0,849 |
| 1984-1997 (14) | 0,155 / 0,201 | 0,187 / -0,008 | -0,507 / 0,658 |
| **INMCM5** | | | |
| 1979-2007 (29) | 0,191 / -0,120 | -0,020 / -0,052 | -0,643 / -0,022 |
| 1979-1994 (16) | 0,186 / 0,155 | 0,027 / 0,050 | -0,629 / 0,188 |
| 1994-2007 (14) | 0,209 / 0,036 | -0,029 / -0,154 | -0,673 / -0,118 |
| 1987-2000 (14) | 0,554 / 0,461 | -0,213 / -0,222 | -0,725 / -0,138 |

Correlation analysis of original and detrended data showed statistically significant linear link between considered parameters just for some periods for observations and INMCM5 data (Table 1).

## CONCLUSION

**This study showed the follow:**

1. **Model INMCM5 reproduce the October Siberian snow cover effect better then INMCM4. INMCM5 has upper location of TOA (at 1 hPa instead of 10 hPa in INMCM4) and higher vertical resolution (128 vertical levels instead of 21 in INMCM4). But commonly models INMCM4 and INMCM5 underestimate the considered link.**
2. **The obtained high sensitivity of results to the period choice may indicate both a nonlinearity of considered influence and the possible dependence its exhibition from the other atmospheric and surface conditions.**

**The presented results are consistent with the results obtained earlier on the basis of a simpler climatic model of intermediate complexity (Martynova Yu.V., Krupchatnikov V.N., 2010), and do not contradict the results obtained by other authors (Furtado J.C. et al., 2015; Popova V.V. et al., 2014).**

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