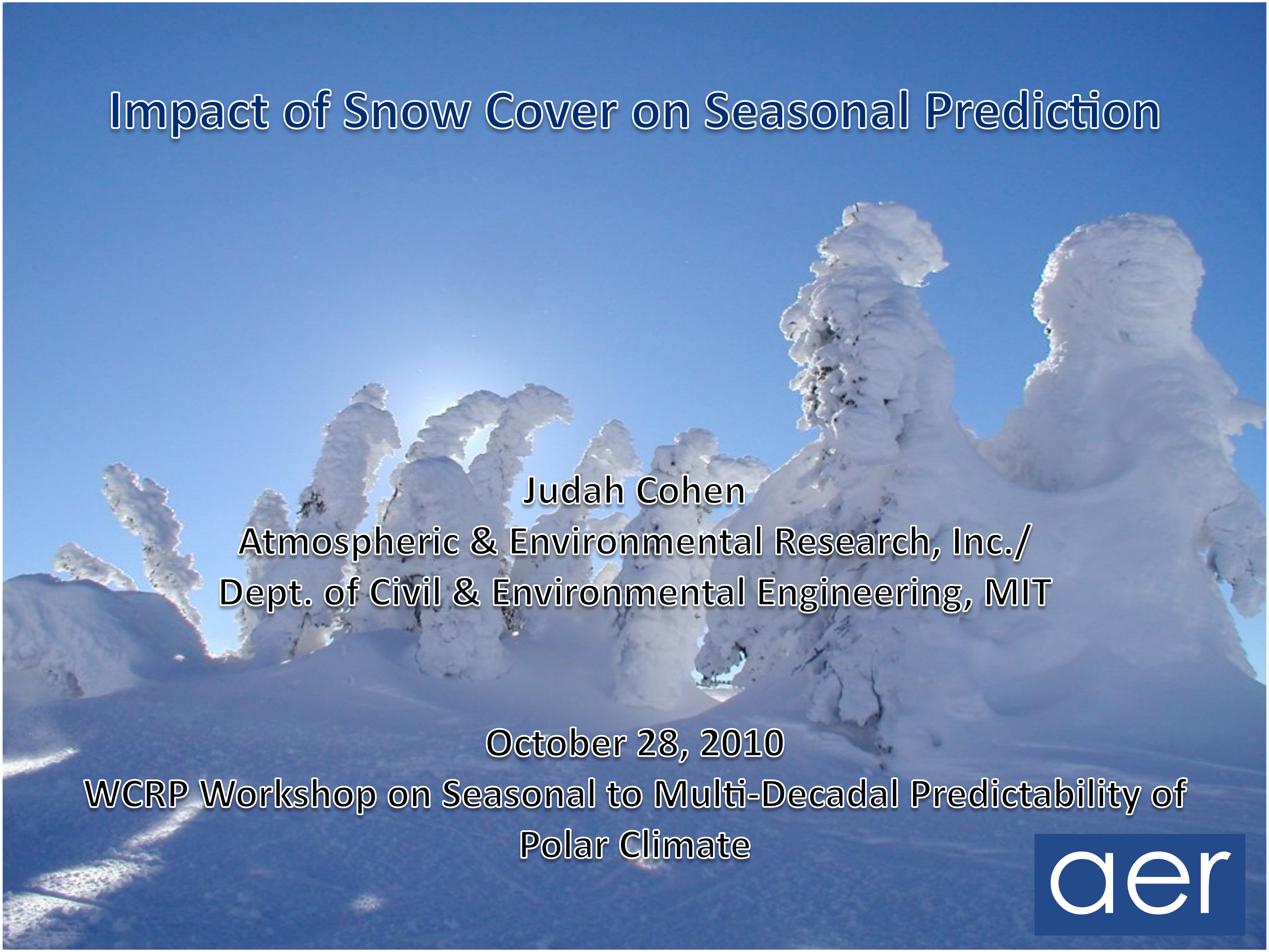

Impact of Snow Cover on Seasonal Prediction

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October 28, 2010
WCRP Workshop on Seasonal to Multi-Decadal Predictability of Polar Climate

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Outline

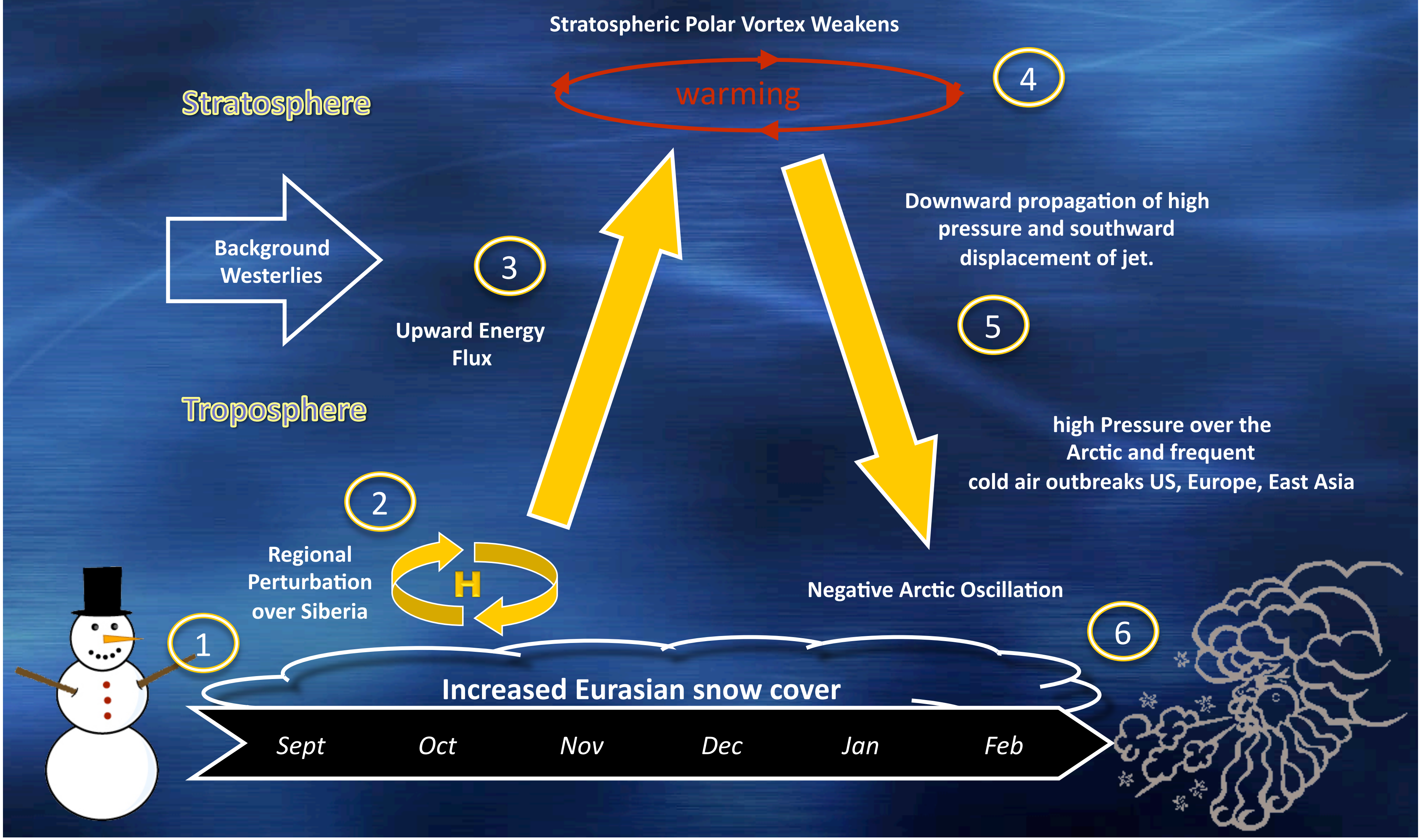
• Review of dynamical pathway how Eurasian fall snow cover extent leads/forces the leading mode of winter climate variability in the troposphere and the stratosphere (AO/NAM).

• Diagnose the evolution of last winter's extreme AO as a paradigm for how autumn snow influences the hemispheric winter climate.

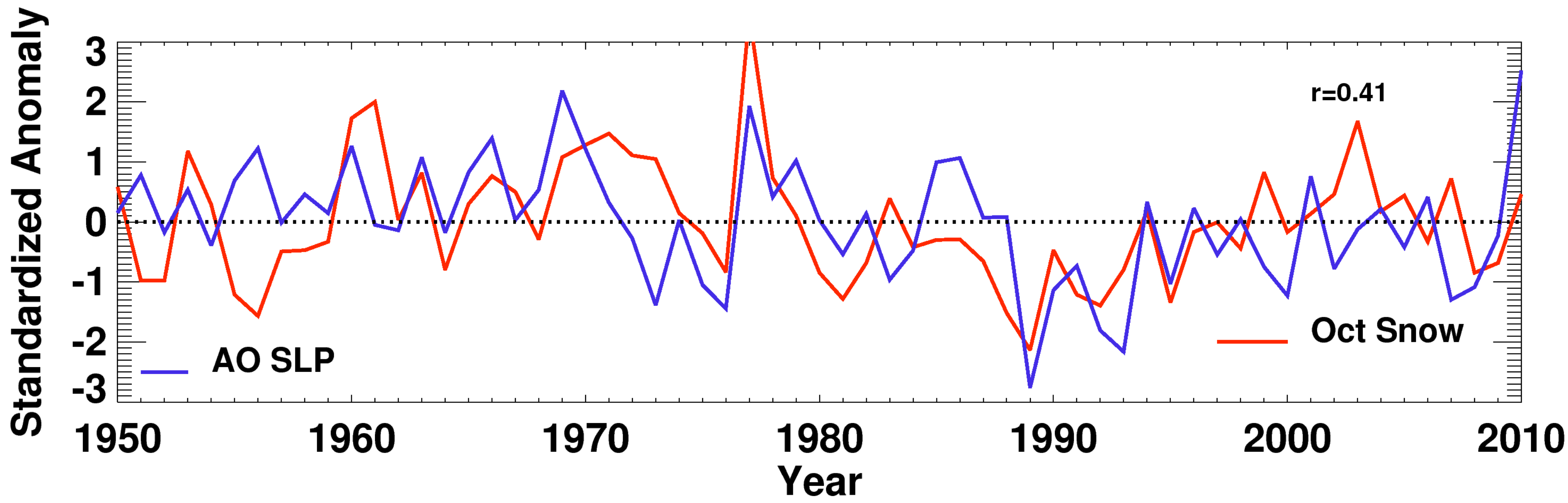
• Same processes associated with snow variability have also influenced recent decadal trends.

• Present a prediction of the upcoming winter.

Snow Forced Cold Signal (Cohen et al. 2007)

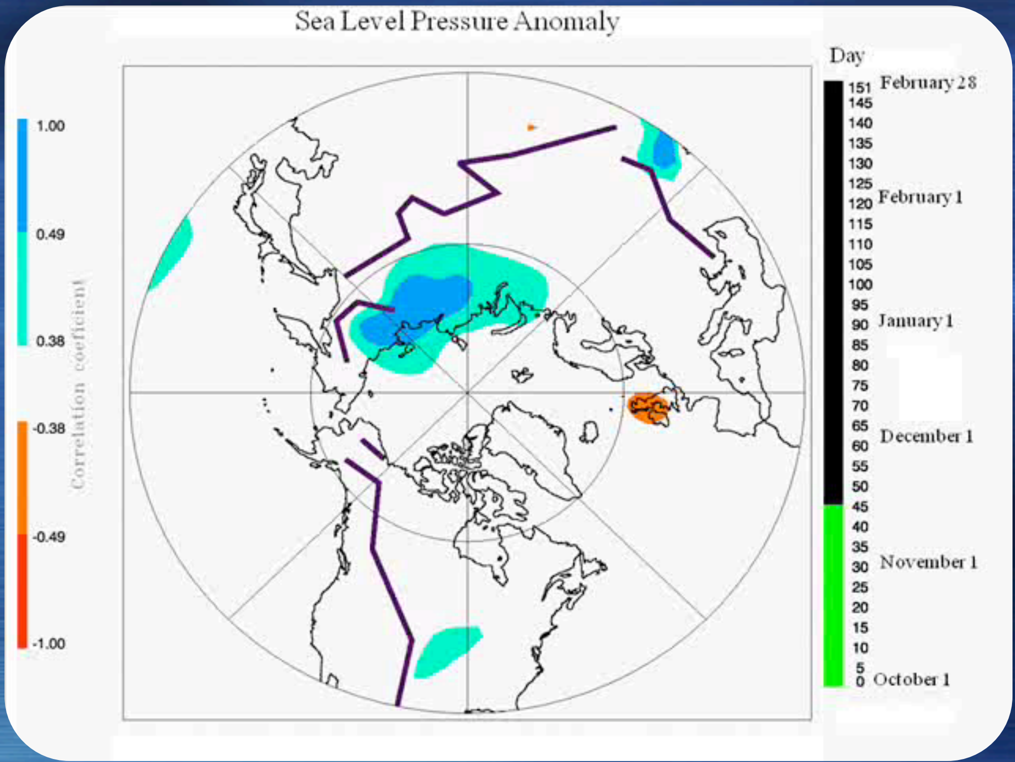


October Snow and Winter AO



- ✓Statistically significant relationship
- ✓Very similar decadal trends especially from 1977-1988 and from 1989-present

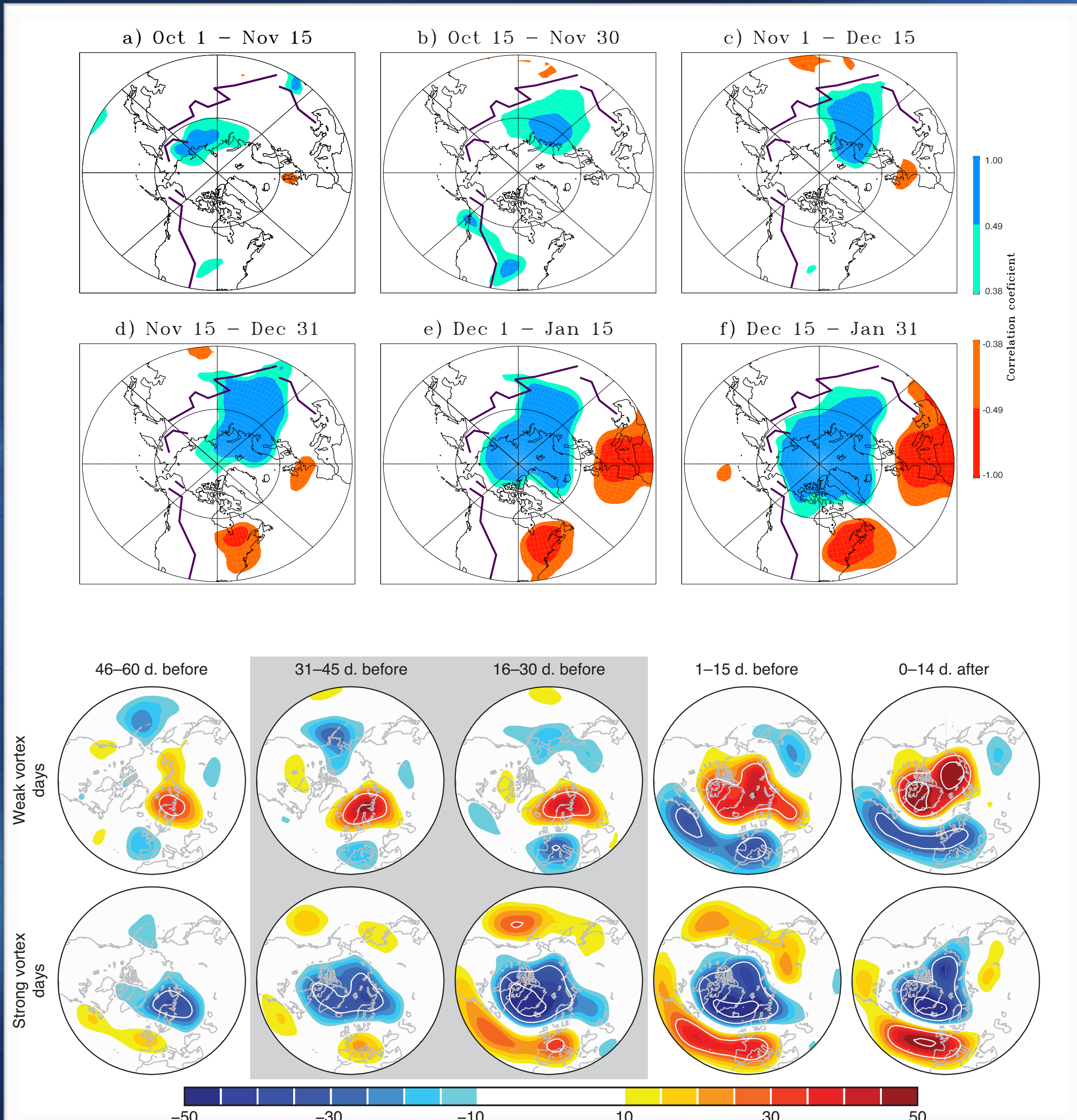
Progression of Siberian High - from Regional to Hemispheric



Winter AO events are preceded by same signed regional precursors related to the development of the Siberian High.

Shading represents sea level pressure anomalies averaged for 45 day periods

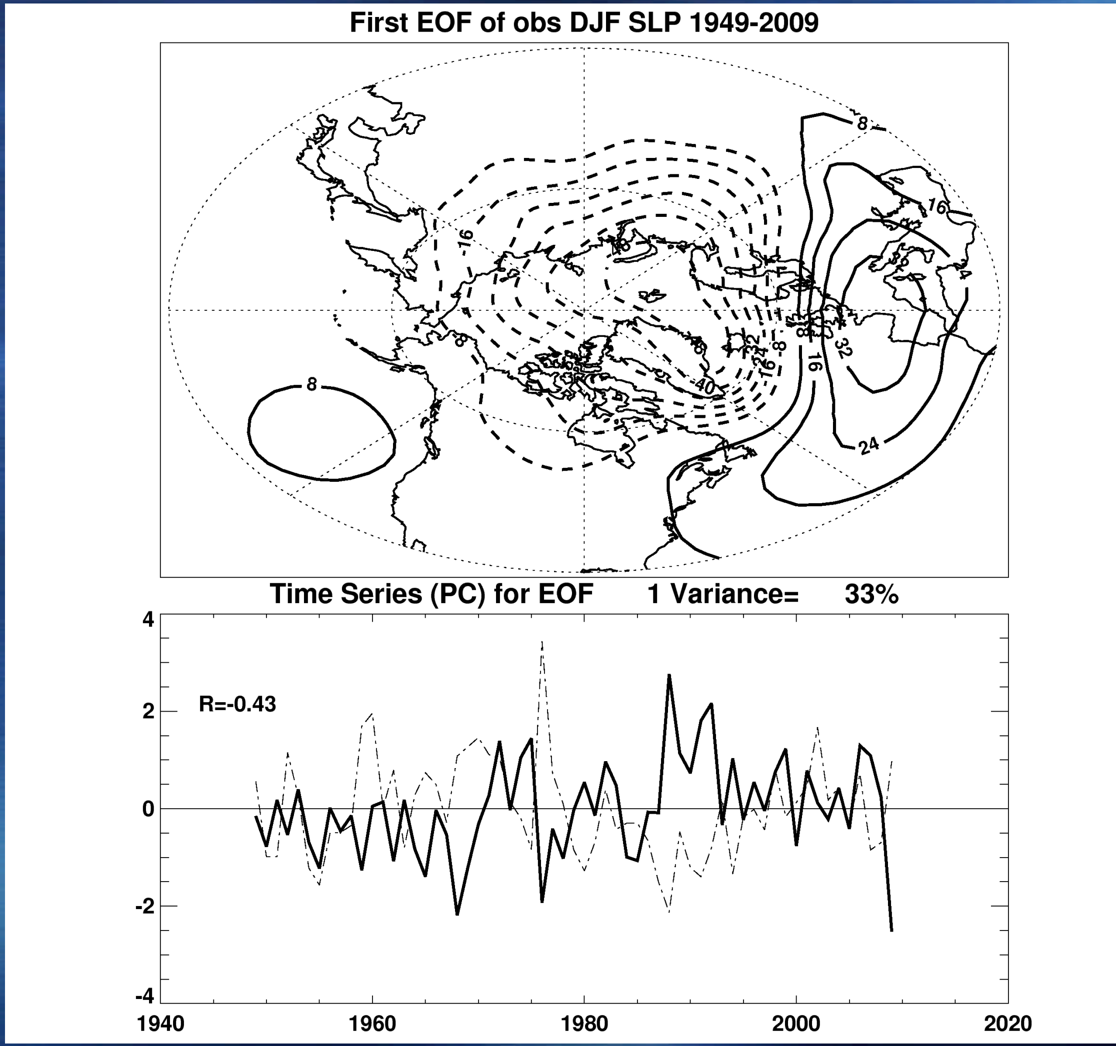
Tropospheric Precursors



Cohen et al. 2001

Kolstad and Charlton-Perez in press

DJF Arctic Oscillation

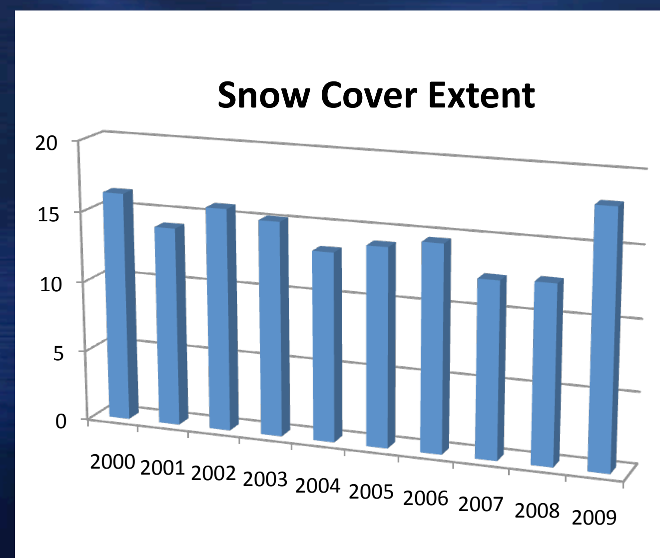


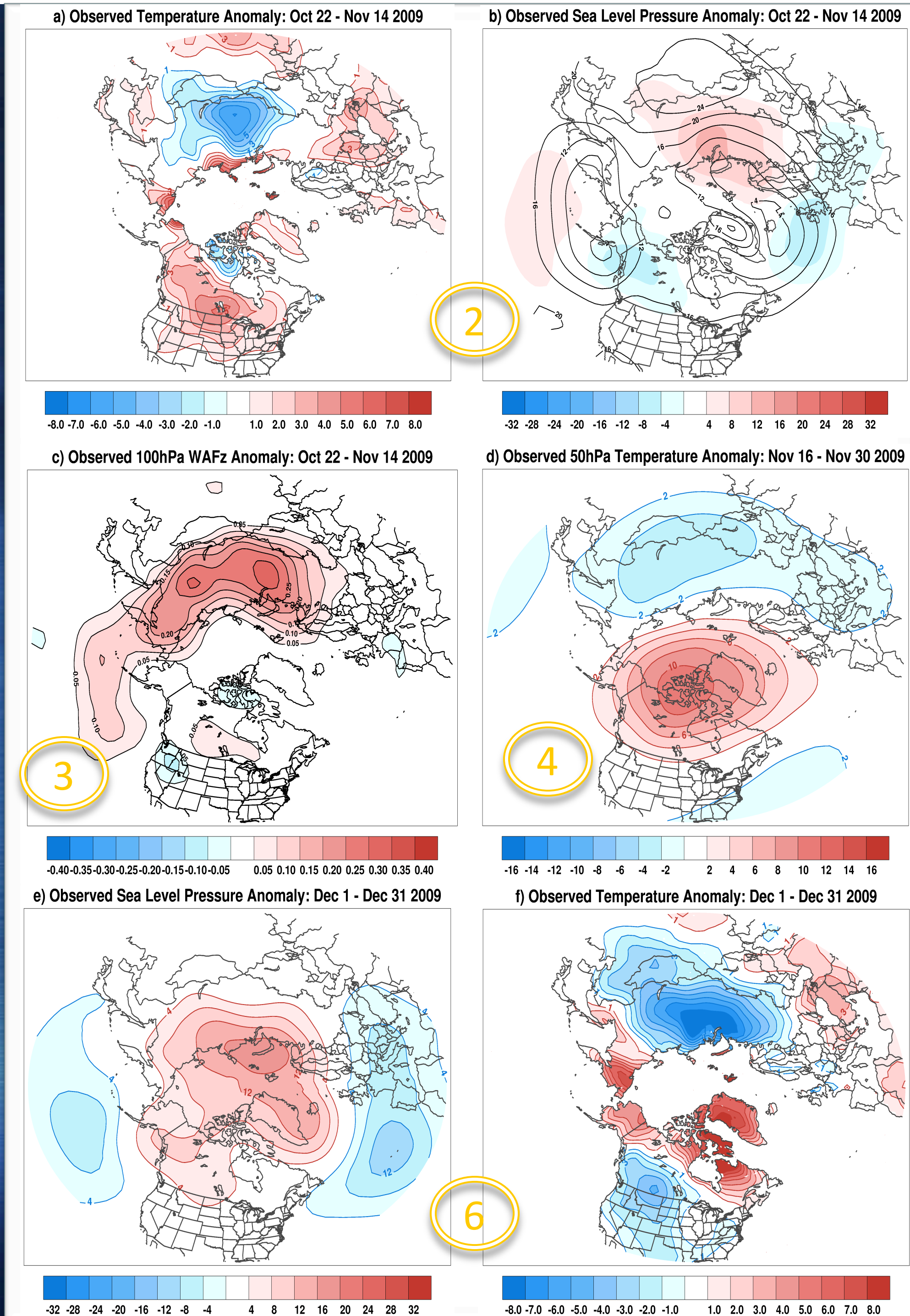
Cohen et al. 2010

October Siberian Snow Cover

A rapid advance occurred in the last three weeks

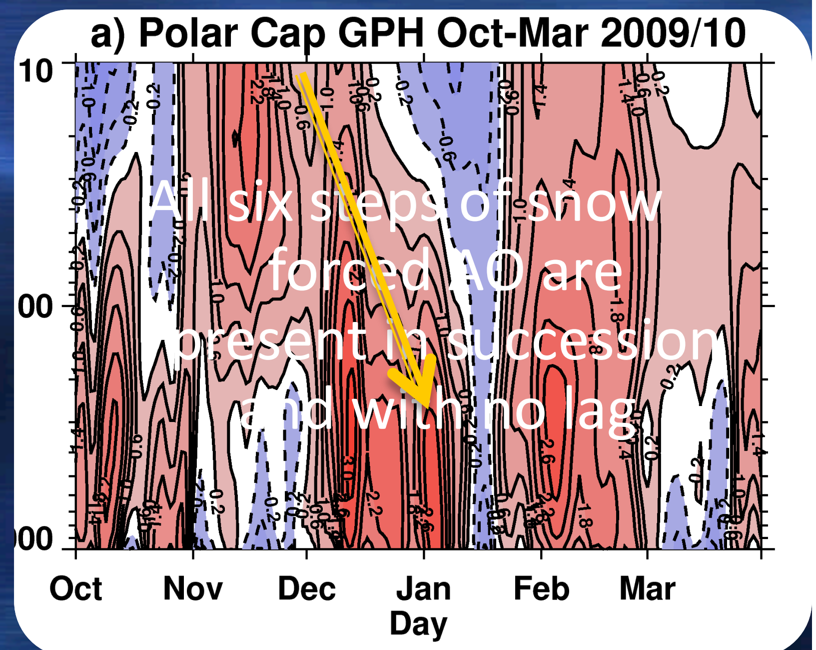
Equivalent to the SCE advance across North America from September through January

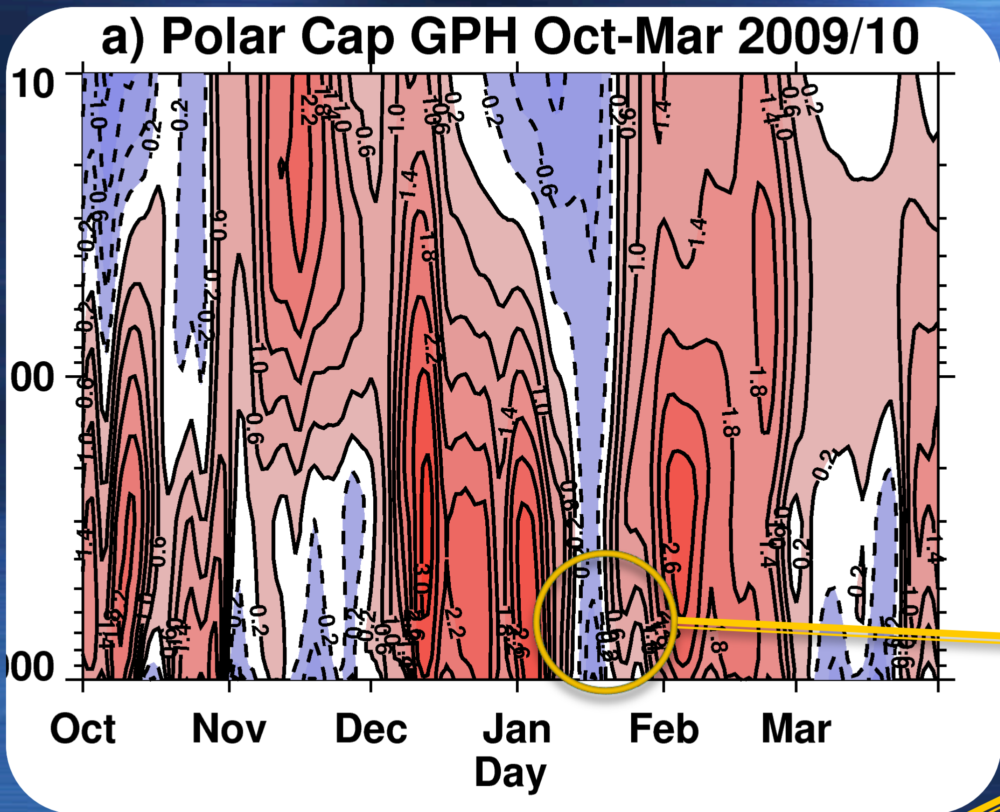


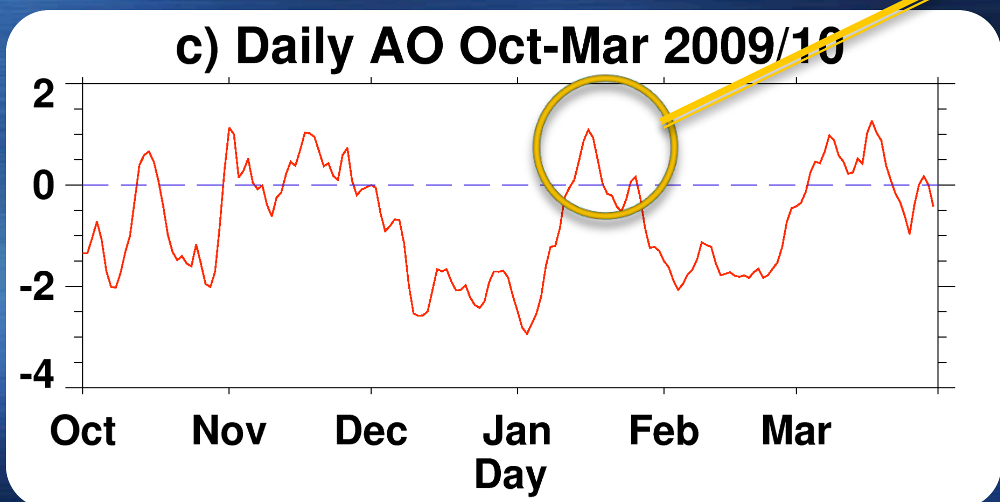


1 Rapid snow cover advance after October 7.

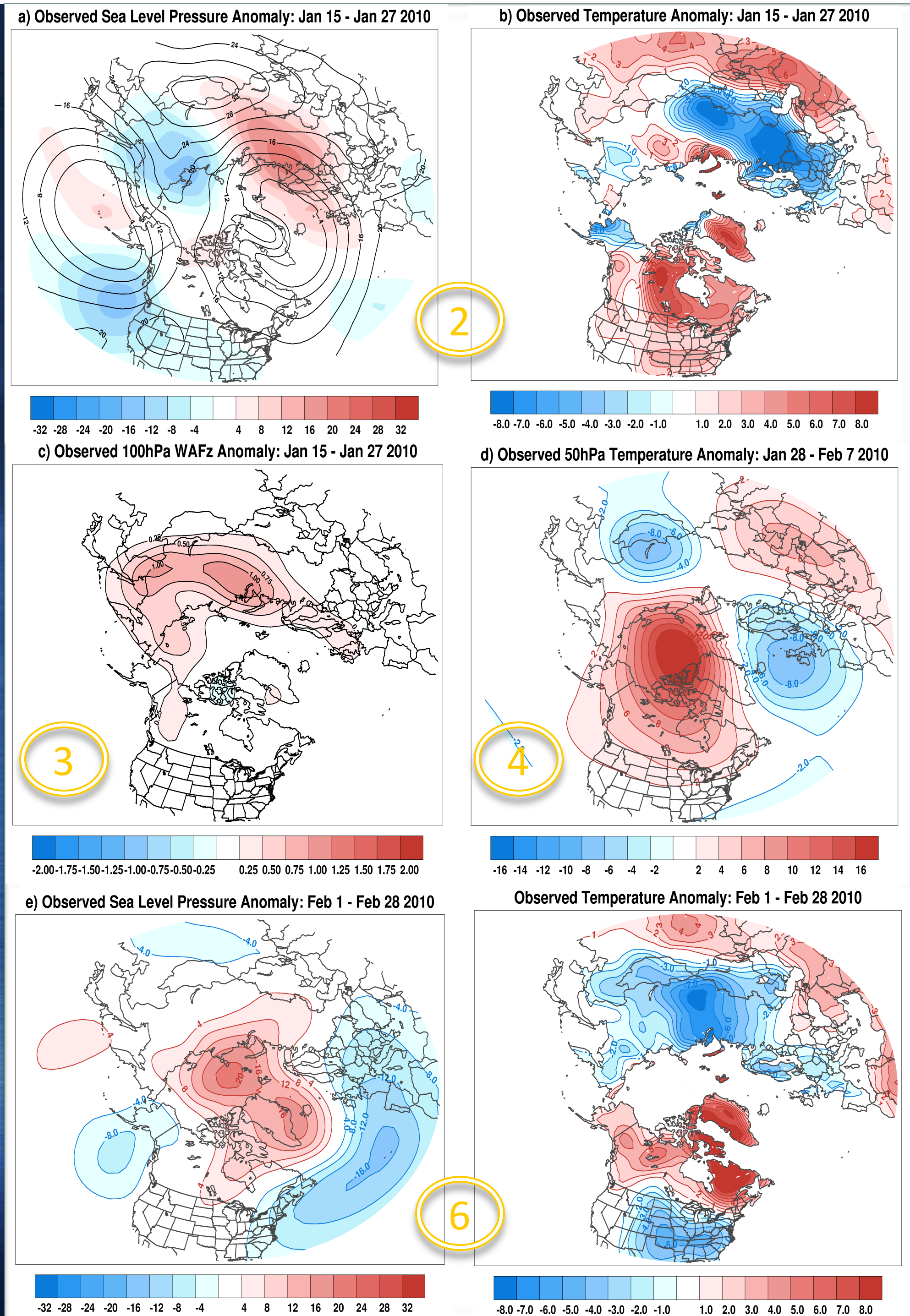
5 Downward propagation mid Nov-Dec 1 as seen on polar cap plot.







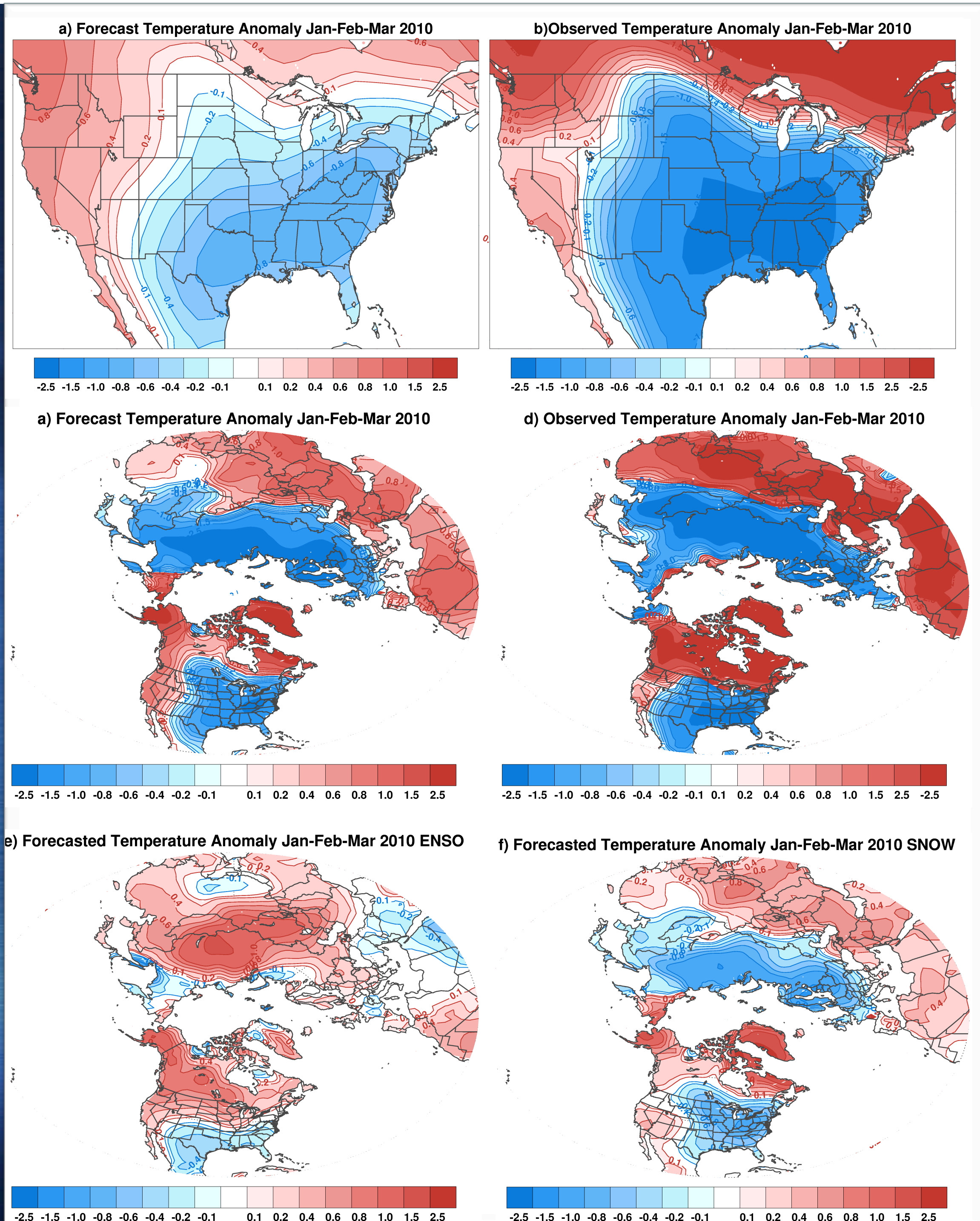
The AO event which peaks in mid-December clearly comes to an end by mid-January



1. Rapid snow cover advance in October and persistently high Eurasian SCE (second greatest winter Eurasian SCE on record).

5. Downward propagation late Jan-Feb 1 as seen on polar cap plot.

All six steps of snow forced AO are present in succession with no lag and is identical of what occurred in the fall.



Forecast posted to the NSF website in real-time:

http://www.nsf.gov/news/special_reports/autumnwinter/predicts.jsp

Based on the skillful forecast of the model, much of the large-scale temperature variability is due to the snow and positive SLP forcing which is a proxy for the AO. ENSO only seems to have influenced North American temperatures.

A model result after the event is not the same as a model result prior to the event!

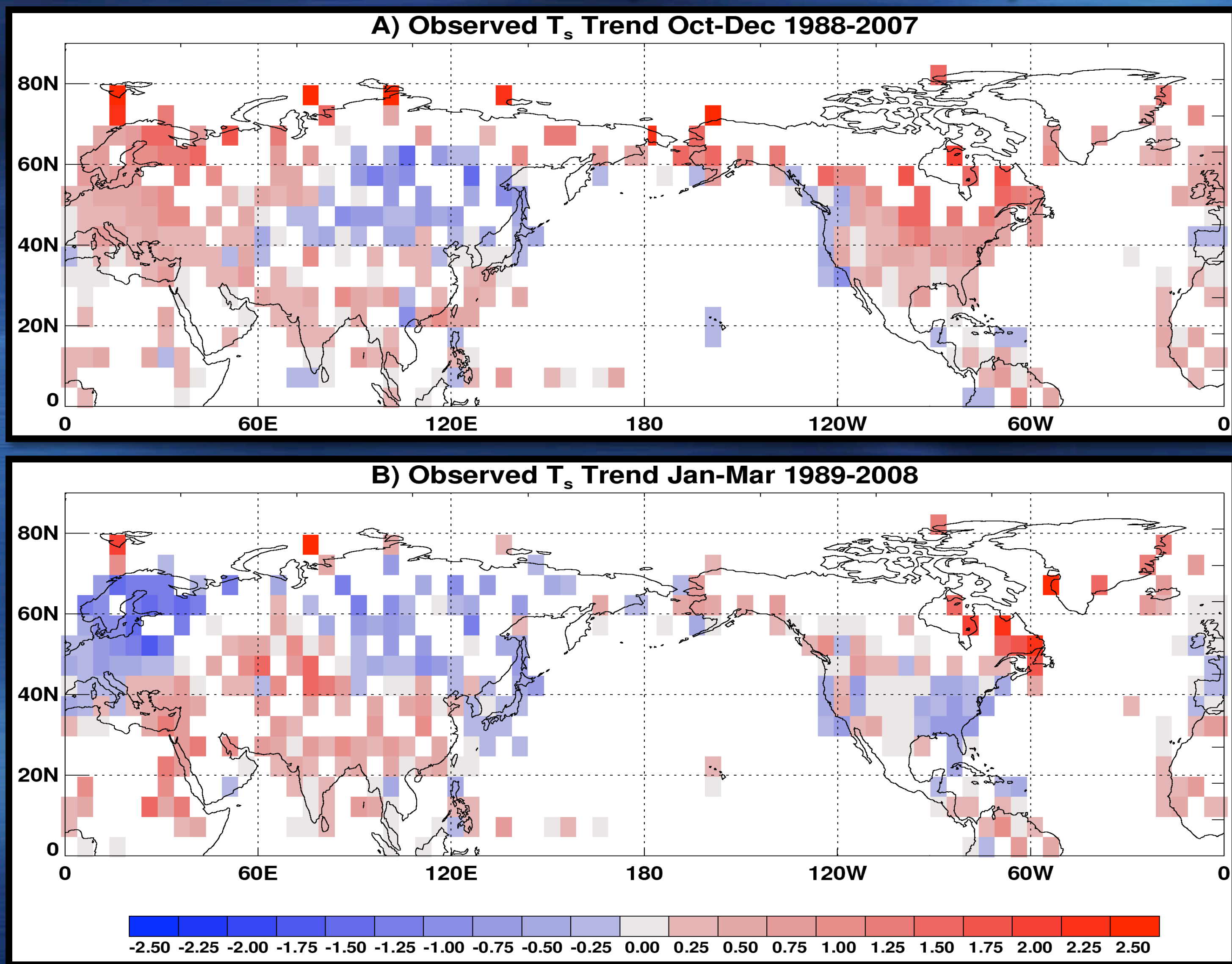
Northern Hemisphere Temperature Trends 1969-2008

	OND		JFM		AMJ		JAS	
40 year trend	**0.68**	0.04	**0.70**	0.05	**0.82**	0.03	**0.77**	0.03
30 year trend	**0.60**	0.04	**0.48**	0.05	**0.85**	0.04	**0.80**	0.04
20 year trend	**0.66**	0.06	0.13	0.02	**0.73**	0.04	**0.78**	0.04
10 year trend	*0.68***	0.09	-0.09	-0.01	*0.56**	0.03	0.42	0.02

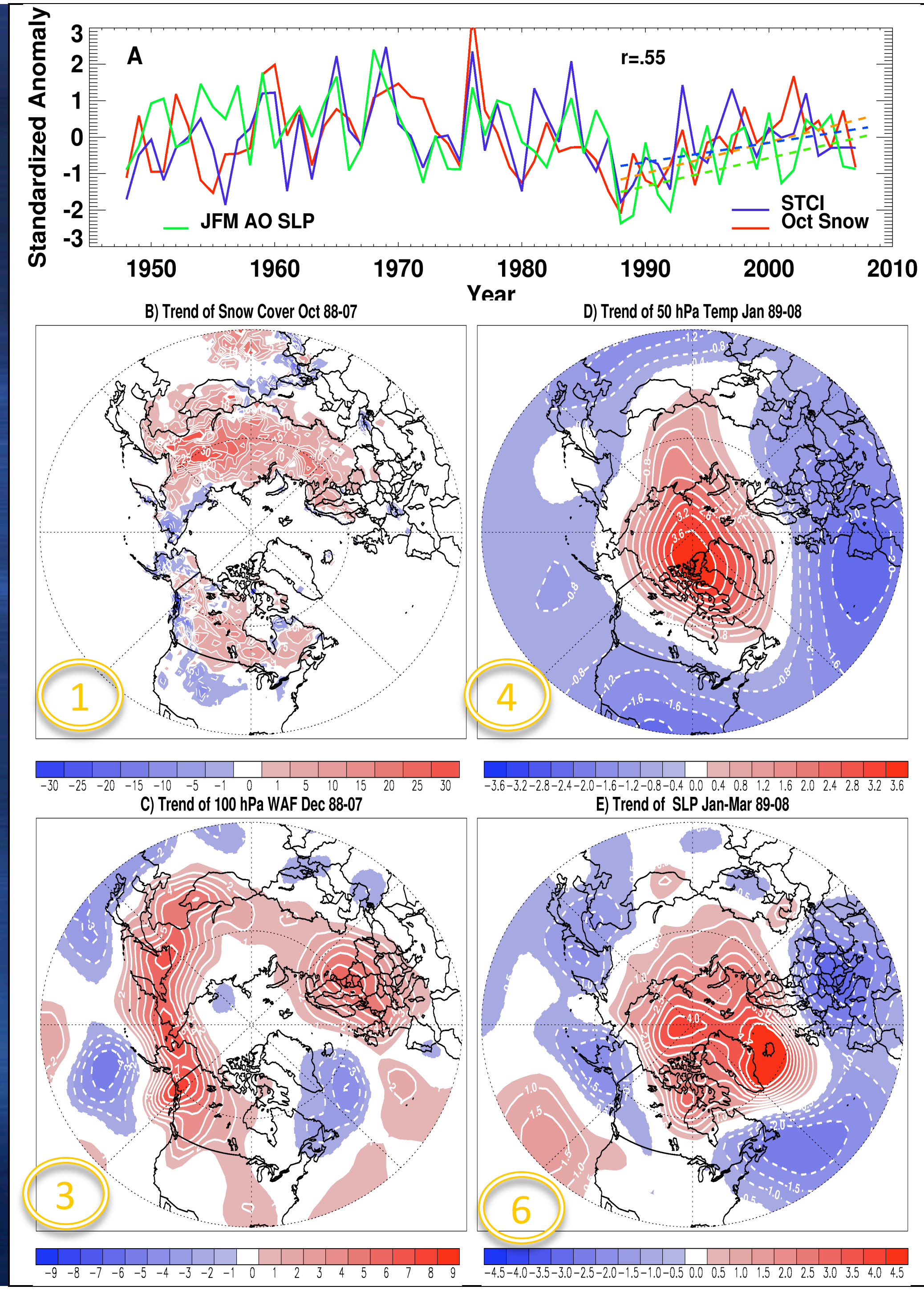
In the most recent two decades warming has continued in all seasons except for winter (JFM) where the warming trend has broken down or even has reversed.

Cohen et al. 2009

OND and JFM Observed Temperature Trends 1988/89-2008/09



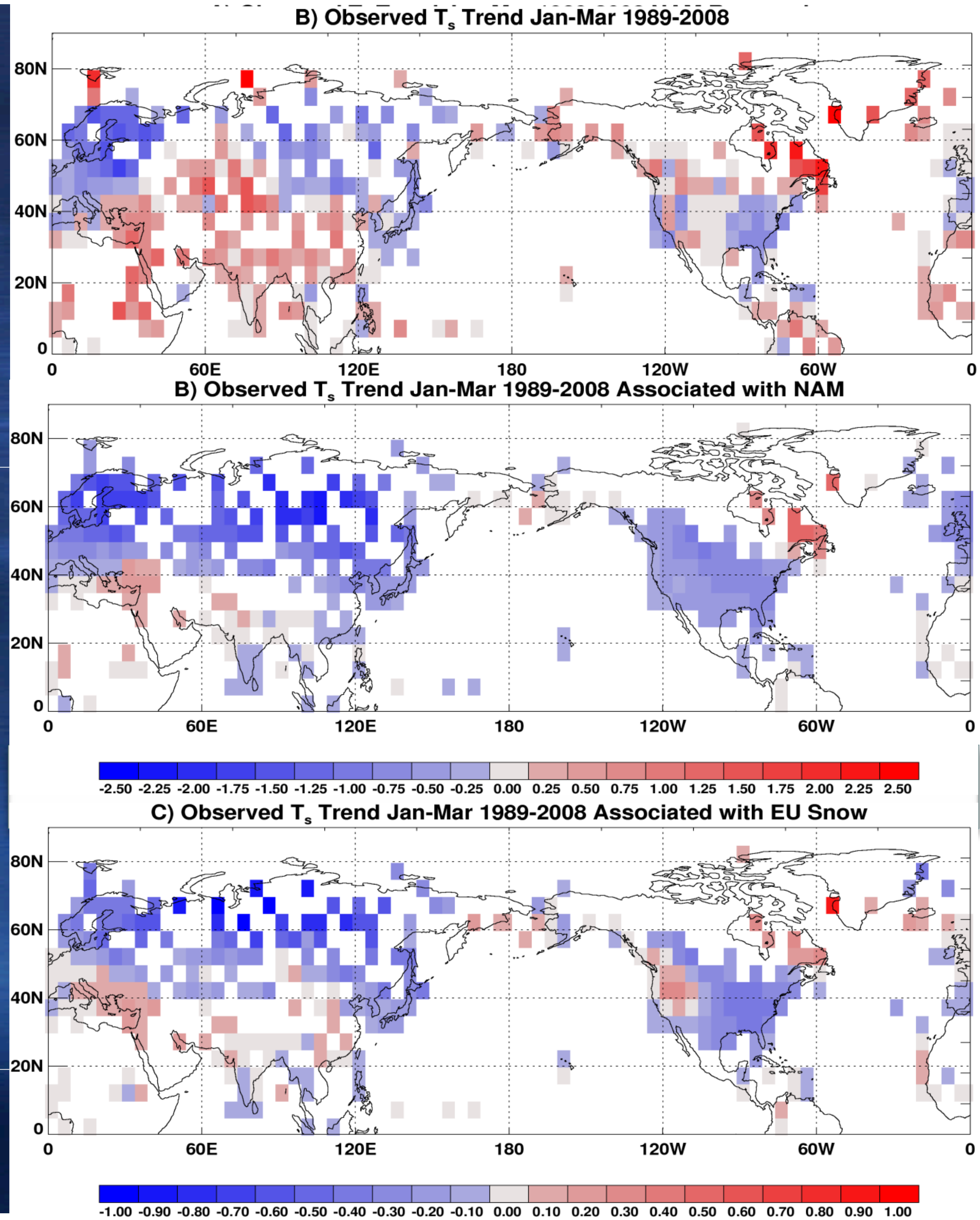
Increased coupling between troposphere and stratosphere in December-January time frame is at least partially responsible for trend reversal between OND and JFM over the past twenty years.



Temperature trend with AO regressed out

Regression of AO with surface temperatures

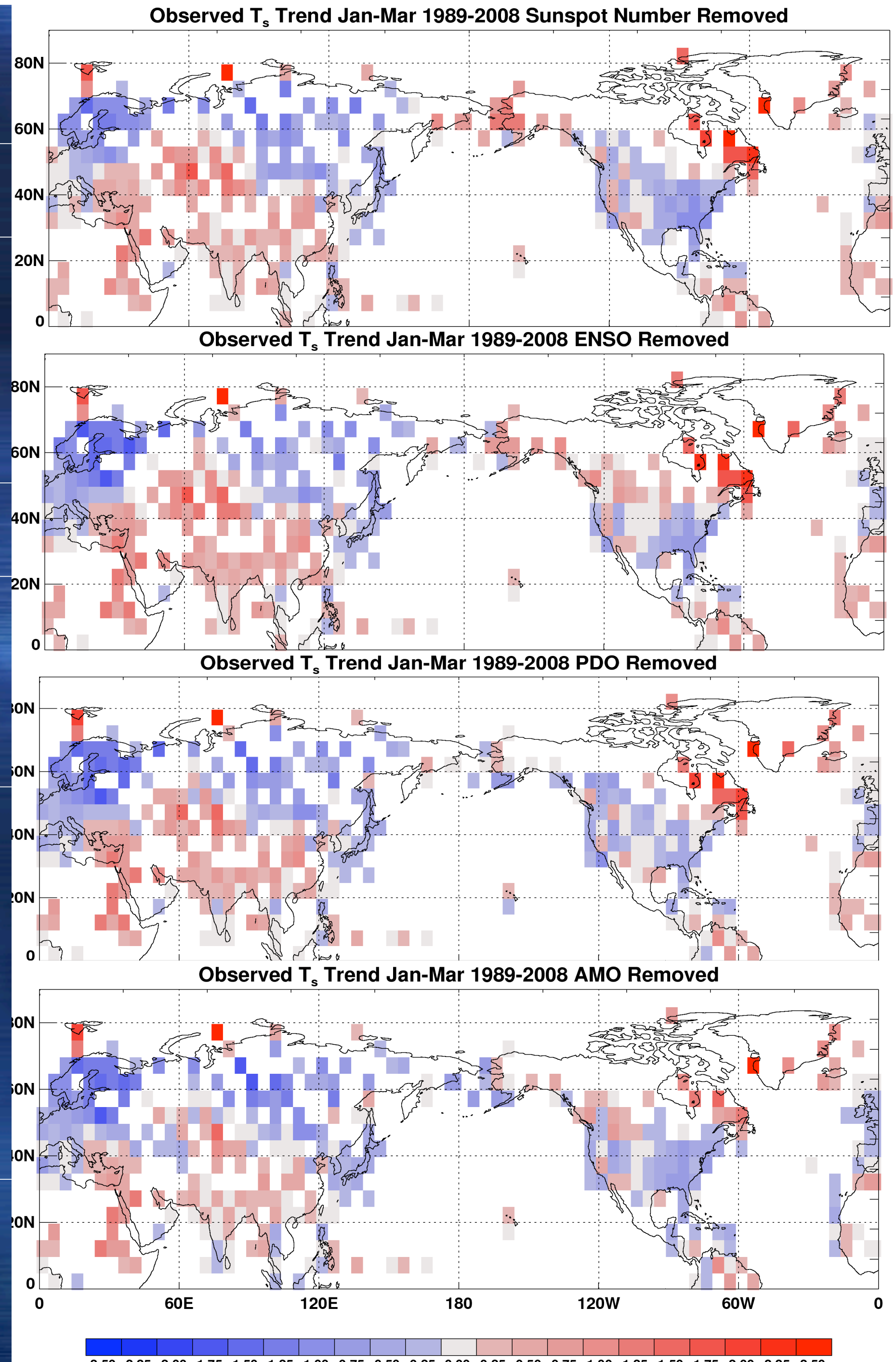
Regression of snow cover With surface temperatures



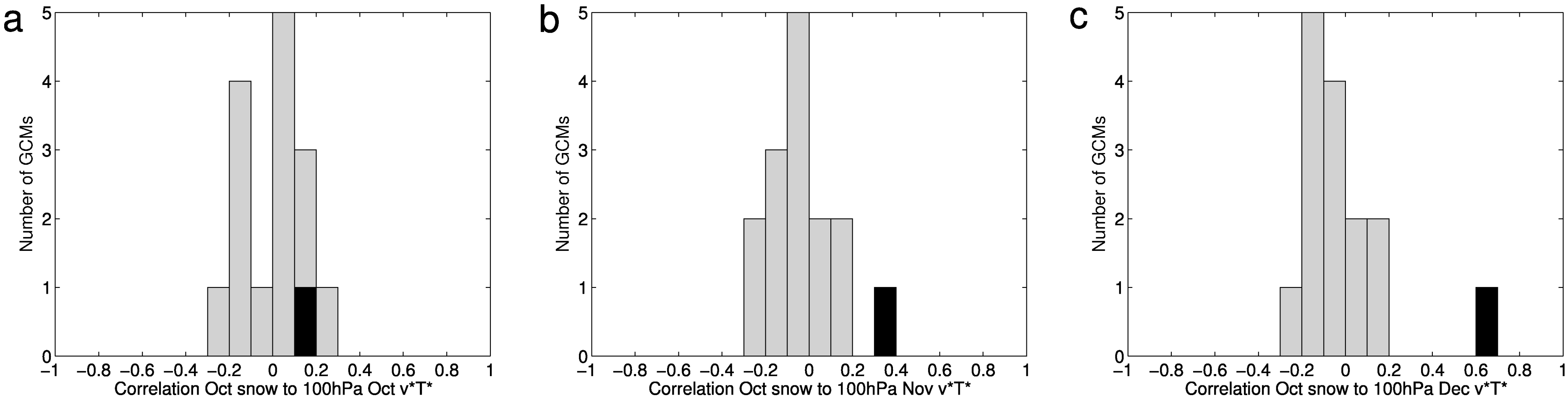
Solar variability regressed out

Nino 3.4 regressed out

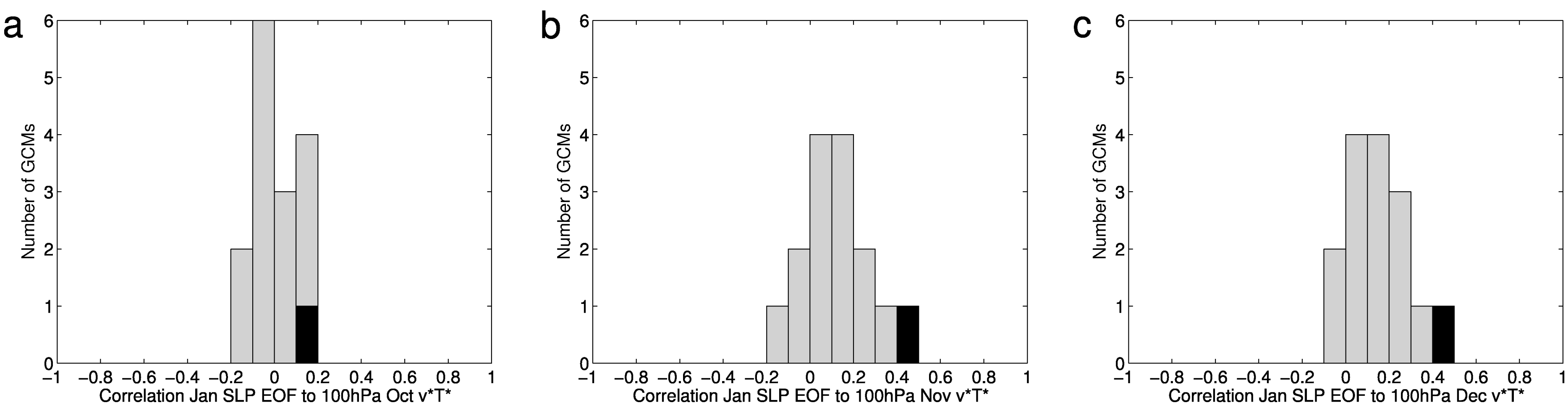
Temperature trend with Pacific and Atlantic decadal indices regressed out



GCMS and snow, Strat/Trop Coupling



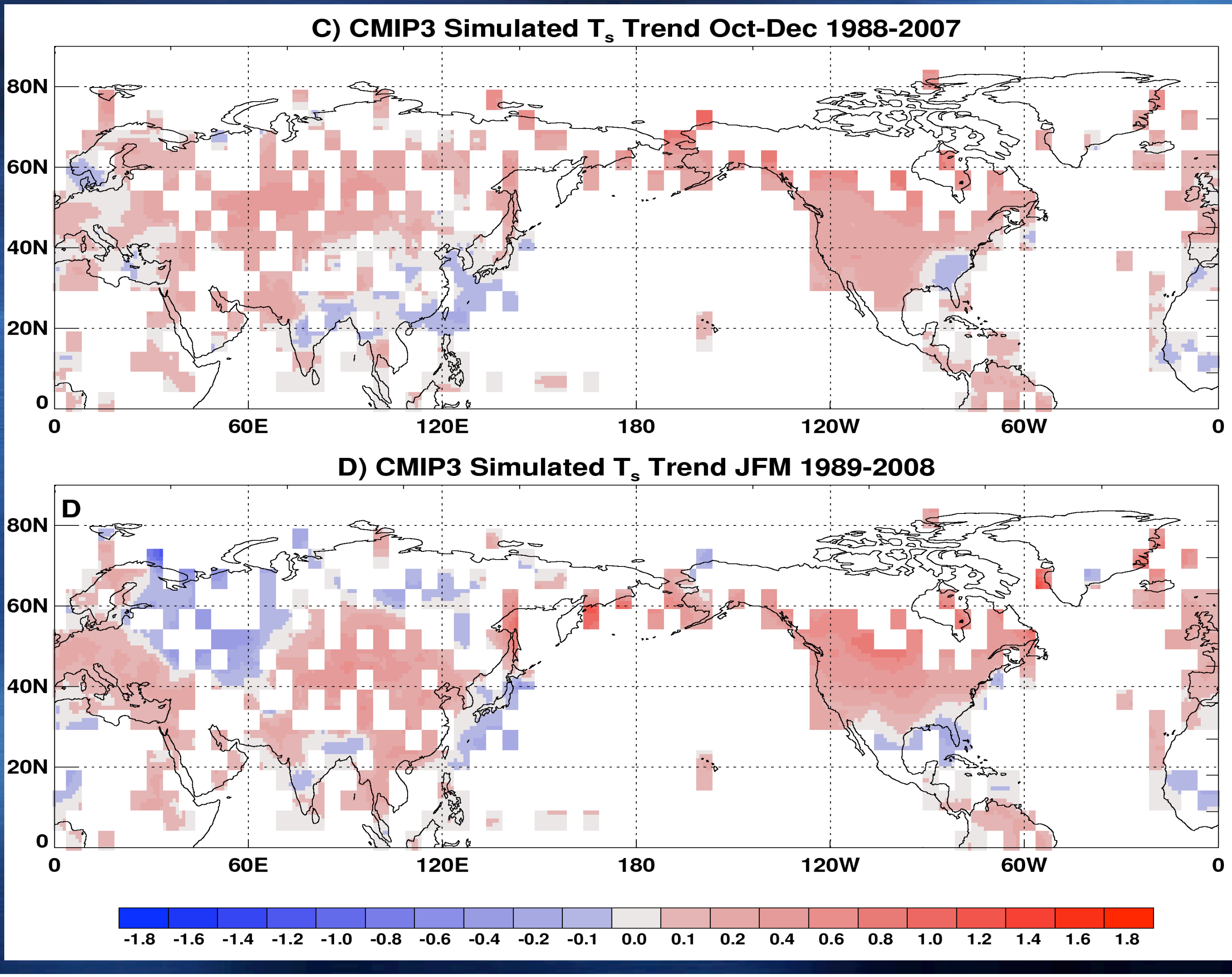
Models completely miss link between snow cover variability and vertical EP flux



Models also poorly simulate link between leading vertical EP flux and lagging surface response

Hardiman et al. JGR 2008

OND and JFM CMIP3 Simulated Trends



Summary

• It has already been demonstrated that high latitude snow cover and tropospheric precursors are skillful predictors for the high and mid – latitudes of the NH.

• The same dynamical pathway that operates on seasonal timescales can potentially improve our understanding and predictions of decadal variability.

•In my opinion, further improvement in forecast skill would be achieved with further observational and modeling studies. In particular advances can be made in improving model simulations with more effort.