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# The Rapid Arctic Warming of January 2016: Impacts, Processes, and Predictability

S.-Y. Simon Wang[1,2], Yen-Heng Lin[1] and Ming-Ying Lee[3]

[1]*Department of Plants, Soils and Climate, Utah State University, Logan, UT, USA*
[2]*Utah Climate Center, Utah State University, Logan, UT, USA*
[3]*Central Weather Bureau, Taipei, Taiwan*

## ABSTRACT

In early January 2016, the Arctic troposphere underwent a substantial warming accompanying a rapid transition in the Arctic Oscillation (AO) into the negative phase (Fig. 1a). The tropospheric polar vortex broke down quickly causing a massive blocking in Siberia with a prolonged accumulation of cold airmass. The supercharged Siberian high then collapsed causing a record cold surge throughout East Asia, e.g. unprecedented snowfall in Taiwan, severe snowstorms in Korea, and even hyperthermia deaths in northern Thailand. The subseasonal property of this rapid AO transition was investigated and compared against the more widely known sudden stratospheric warming (SSW) events, one of which occurred in March 2016 with only mild consequences (Fig. 1b). Diagnostic analysis from the similar tropospheric and stratospheric warming cases indicates that Arctic warming is distinct from the SSW in that tropical sources of teleconnection are discernible (Fig. 2), associated with traceable poleward propagations of EP-flux in the upper troposphere (Figs 3,4). Results indicate a recent and accelerated increase in the tropospheric warming type versus a flat trend in stratospheric warming type (Fig. 5). Moreover, An ECHAM5 model was run to attribute the event and the result suggests that low Arctic sea ice in the 2015-16 winter did enhance the Arctic warming (not shown). Given that the AO transition associated with the tropospheric warming type occurs much more quickly than that with the stratospheric warming type, the noted increase in the former implies intensification in the boreal-winter midlatitude weather extremes.

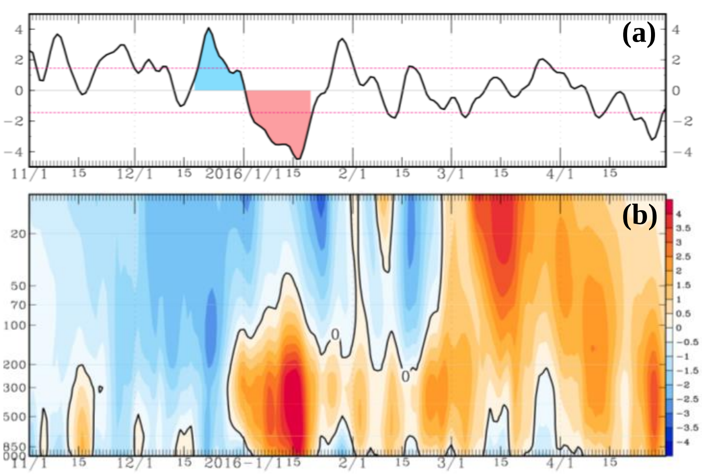


**Fig. 1** Time series form November 2015 to April 2016 of (a) Arctic Oscillation index. (b) Standardized geopotential height anomaly over Arctic regions (65°N~90°N).

## References

Cohen, J., J.A. Screen, J.C. Furtado, M. Barlow, D. Whittleston, D. Coumou, J. Francis, K. Dethloff, D. Entekhabi, J. Overland, and J. Jones, 2014: Recent Arctic amplification and extreme mid-latitude weather. *Nat. Geosci.*, **7**, 627–637.

L'Heureux, M. L., and R. W. Higgins, 2008: Boreal winter links between the Madden–Julian oscillation and the Arctic Oscillation. *J. Climate*, **21**, 3040–3050.

Riddle, E. E., M. B. Stoner, N. C. Johnson, M. L. L'Heureux, D. C. Collins, and S. B. Feldstein, 2013: The impact of the MJO on clusters of wintertime circulation anomalies over the North American region. *Clim. Dyn.*, **40**, 1749–1766, doi:10.1007/ s00382-012-1493-y.

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Correspondence to: Yen-Heng Lin, Department of Plants, Soils and Climate, Utah State University, Logan, UT, USA; E-mail: yheng@pie.com.tw

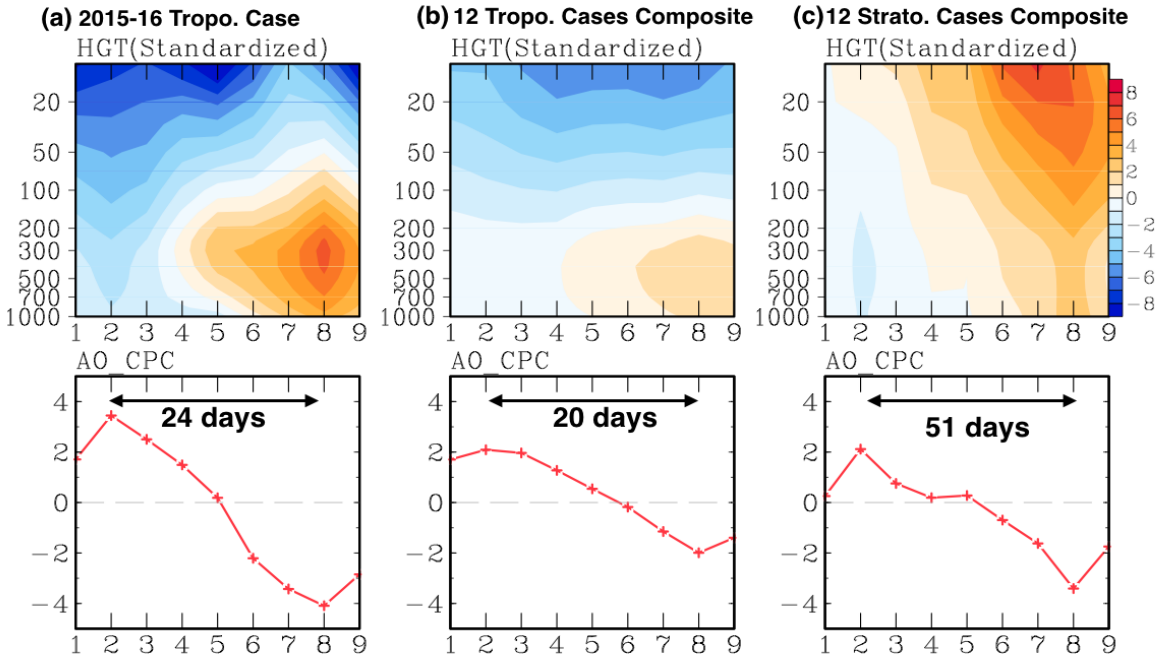


**Fig. 2** Nine phases of Standarized Geopotential height over 65°N~90°N and AO index for (a) January 2016 case, (b) 12 AO phase change cases with tropospheric warming, and (c) 12 AO phase change cases with stratospheric warming. The selected composite cases are depended on the AO index with phase change from +1.2 to -1.2 standard deviation.

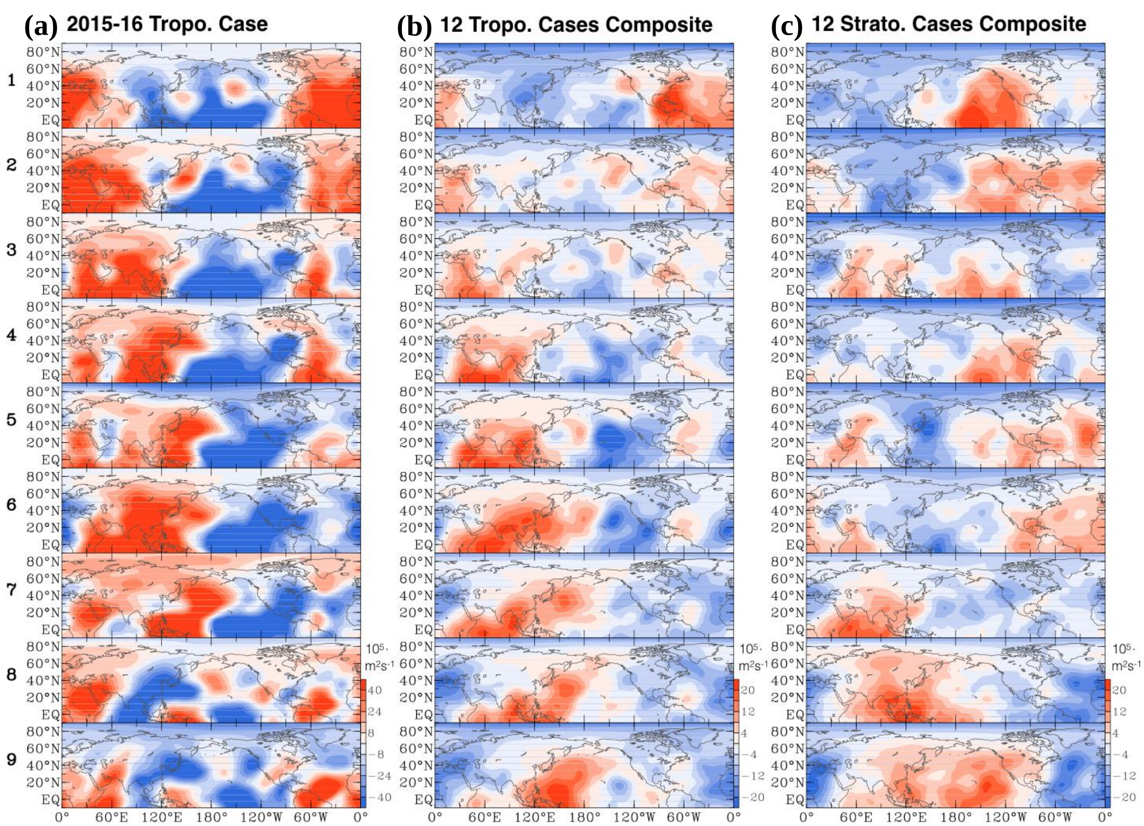


**Fig. 3** Nine phases of 250mb velocity potential (VP) for (a) January 2016 case, (b) 12 AO phase change cases with tropospheric warming, and (c) 12 AO phase change cases with stratospheric warming.

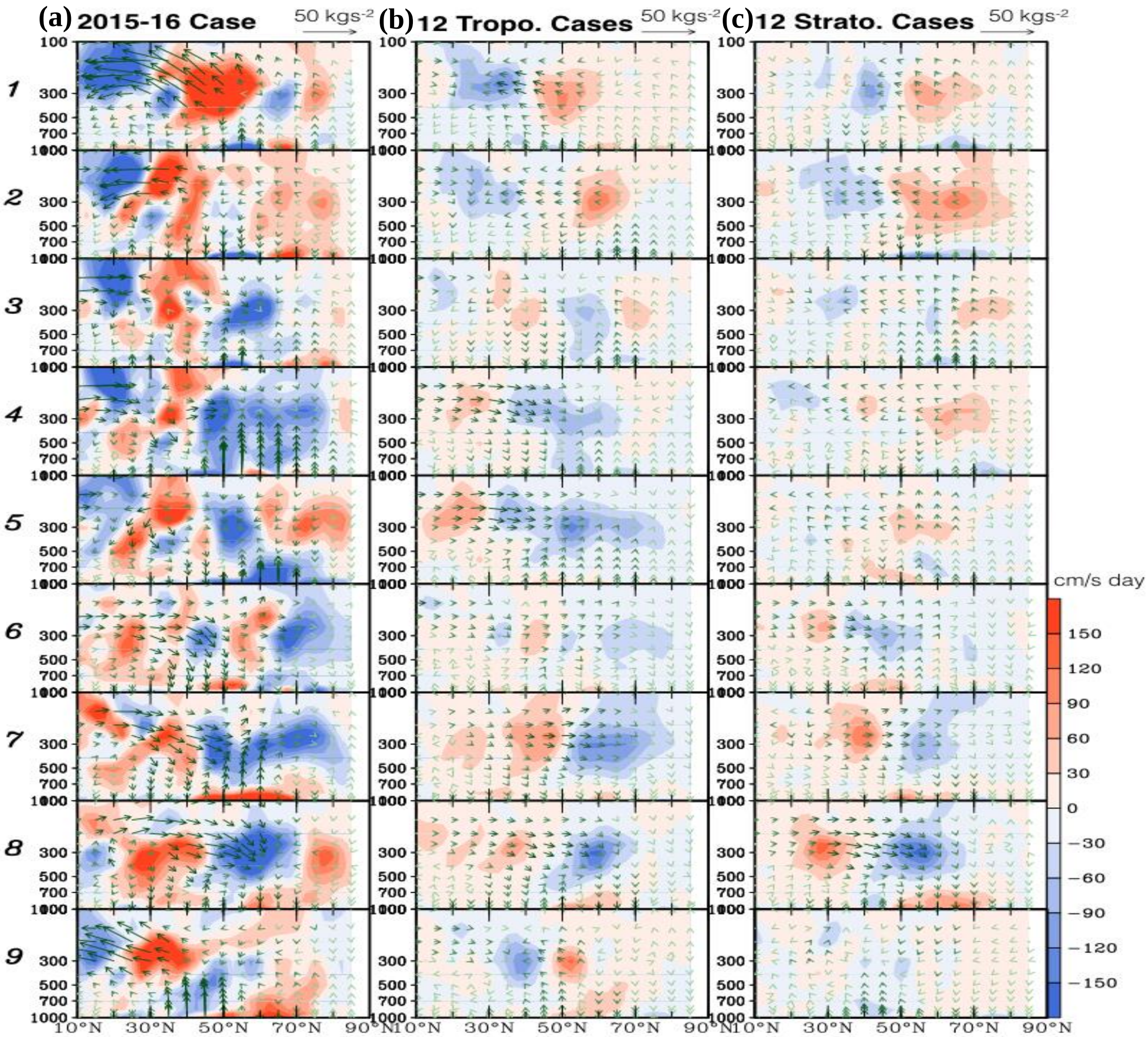


**Fig. 4** The same as Fig.3, but for EP-Flux over troposphere.

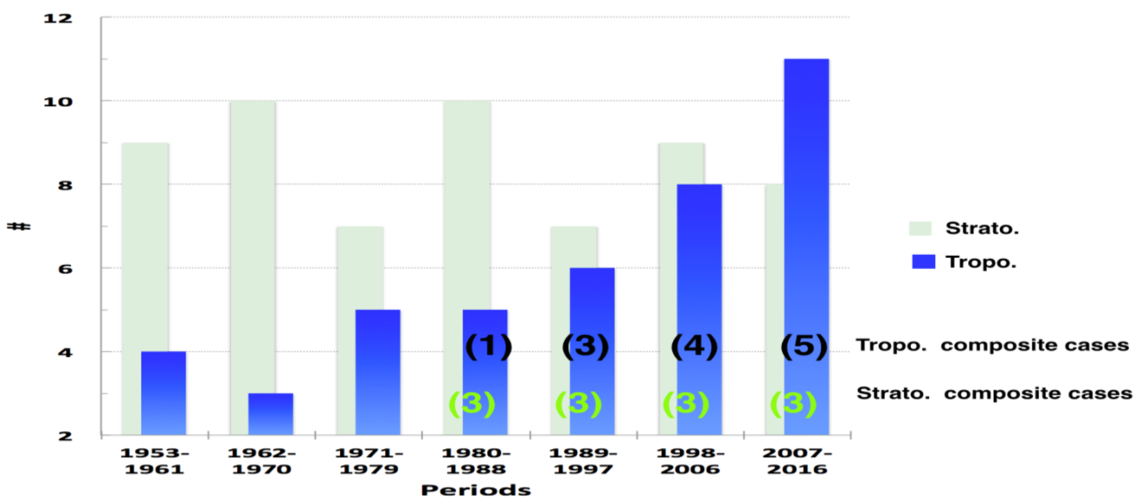


**Fig. 5** The total cases of tropospheric and stratospheric warming with 9-years interval (cases are based on standardized geopotential height anomaly only, and the number shows the cases using in composite analysis).