Warm hole in Pacific Arctic sea ice cover forced mid-latitude Northern Hemisphere cooling during winter 2017-18, *Scientific Reports*, 2019,

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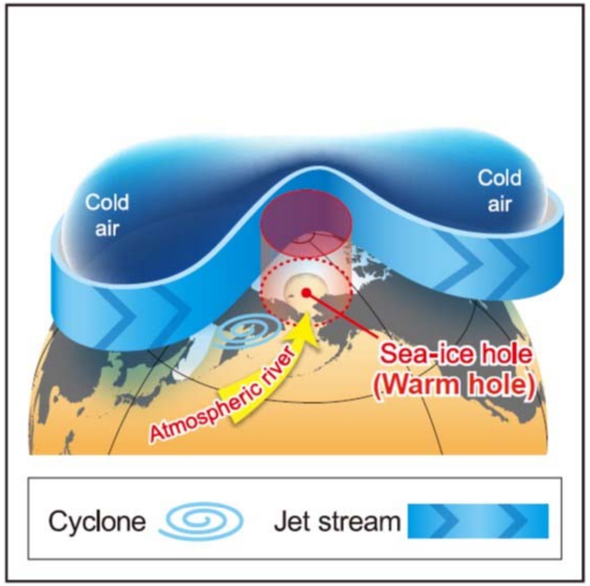
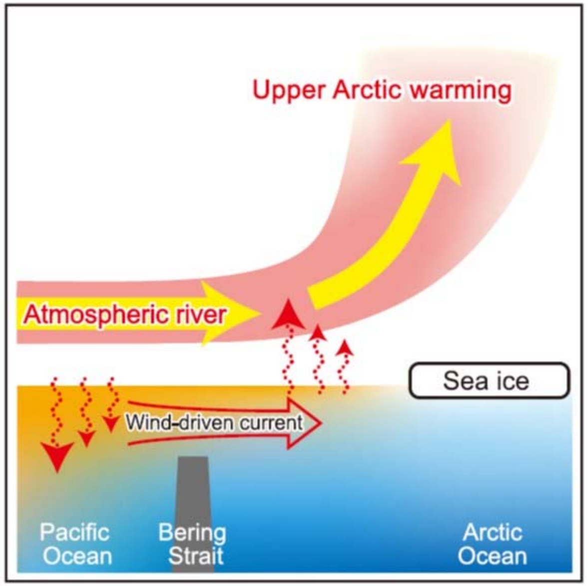
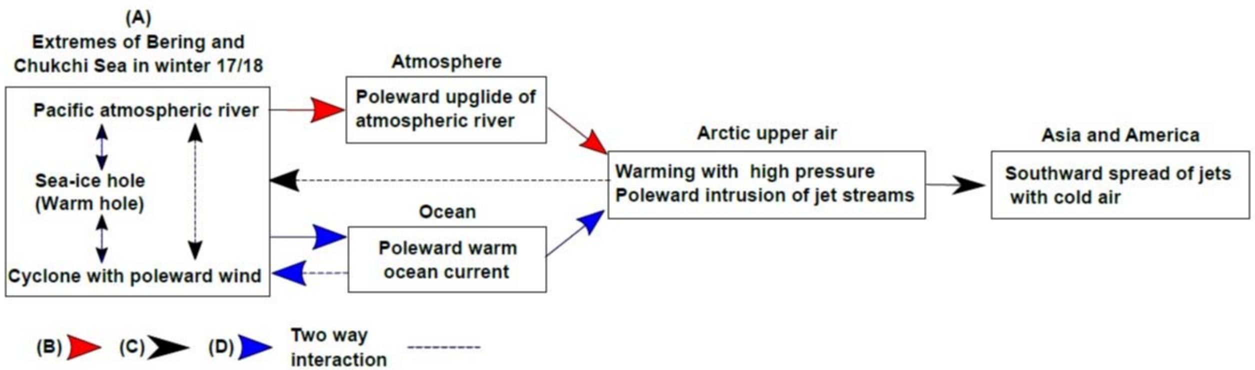
V.A Alexeev, L. Cai (IARC, University of Alaska)

Conclusive illustration







Warm hole in Pacific Arctic sea ice cover forces mid-latitude Northern Hemisphere cooling during winter

Y. Tachibana, K.K Komatsu, U. Ando, K. Ota (Mie University, Japan),
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The winter of 2017–18 was abnormally cold over Eastern Canada and East Asia. Likewise, both Korea and Japan also experienced record-breaking winter cold. The seasonal mean temperature in western Japan was the lowest recorded since 1985–86.

Related Paper:

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Background

Why the winter of 2017–18 was abnormally cold although the Earth is warming?

A persistent southward meandering of the jet stream covered East Eurasia and North America, allowing cold Arctic air to spread into these regions, where it rarely does.

Direct explanations for this severe winter remain unclear

La Niña alone does not explain the cold weather of 2017–1817-18, because La Niña occurs approximately every four years, and because La Niña was weak in this particular season. The reduction in sea ice extent off the northern coast of Norway (the Barents Sea ice) tends to make Eurasia cold (e.g., Honda et al., 2009, GRL). Barents Sea ice was not exceptionally low in the 2017–18 winter compared with recent years. The downward influence of the was not predominant in the 2017–18. Stratospheric sudden warming had not occurred until late winter.

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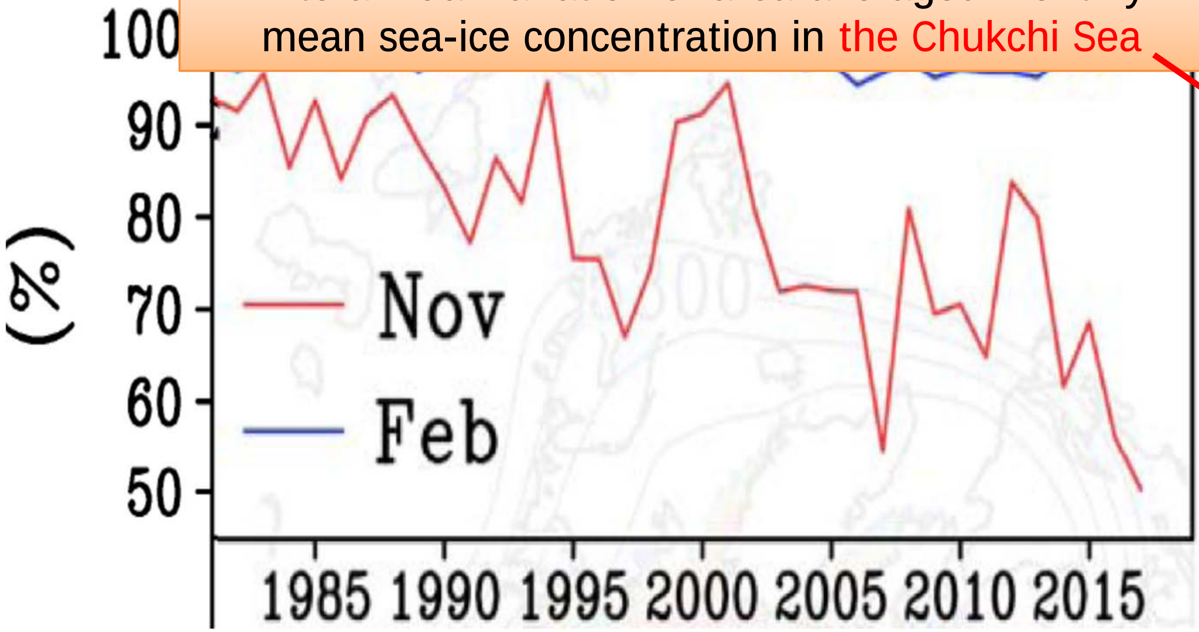
Interannual variation of area-averaged monthly mean sea-ice concentration in the Chukchi Sea



Bering Sea ice was also smallest in 2017-18

Sea ice distribution in late November 2017
Warm hole
Japan Meteorological Agency

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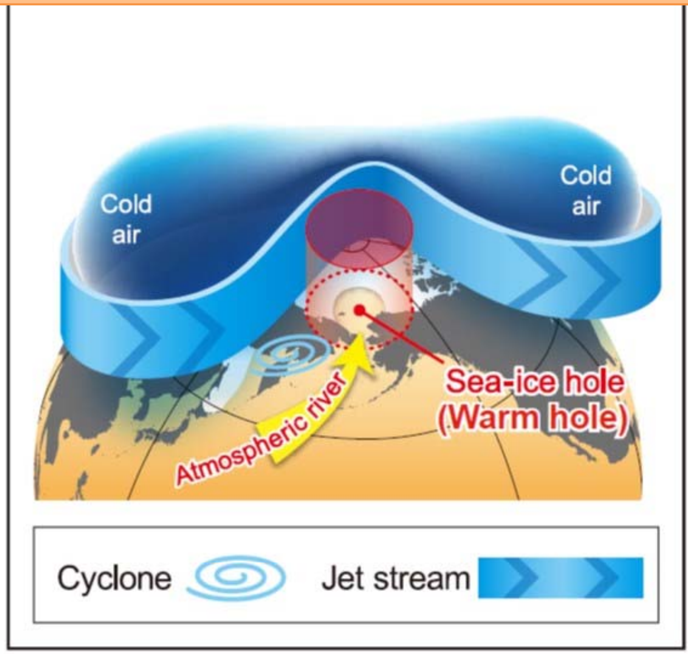

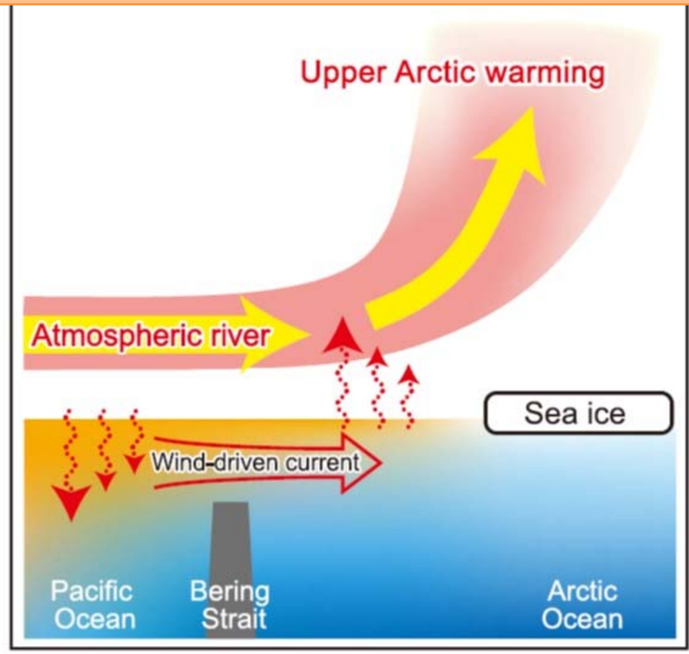

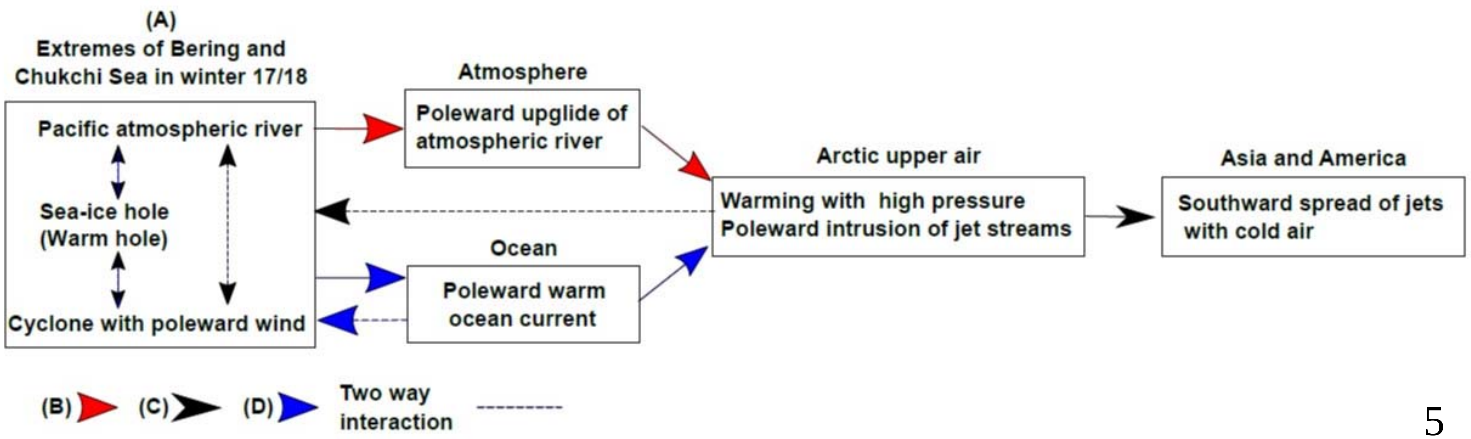

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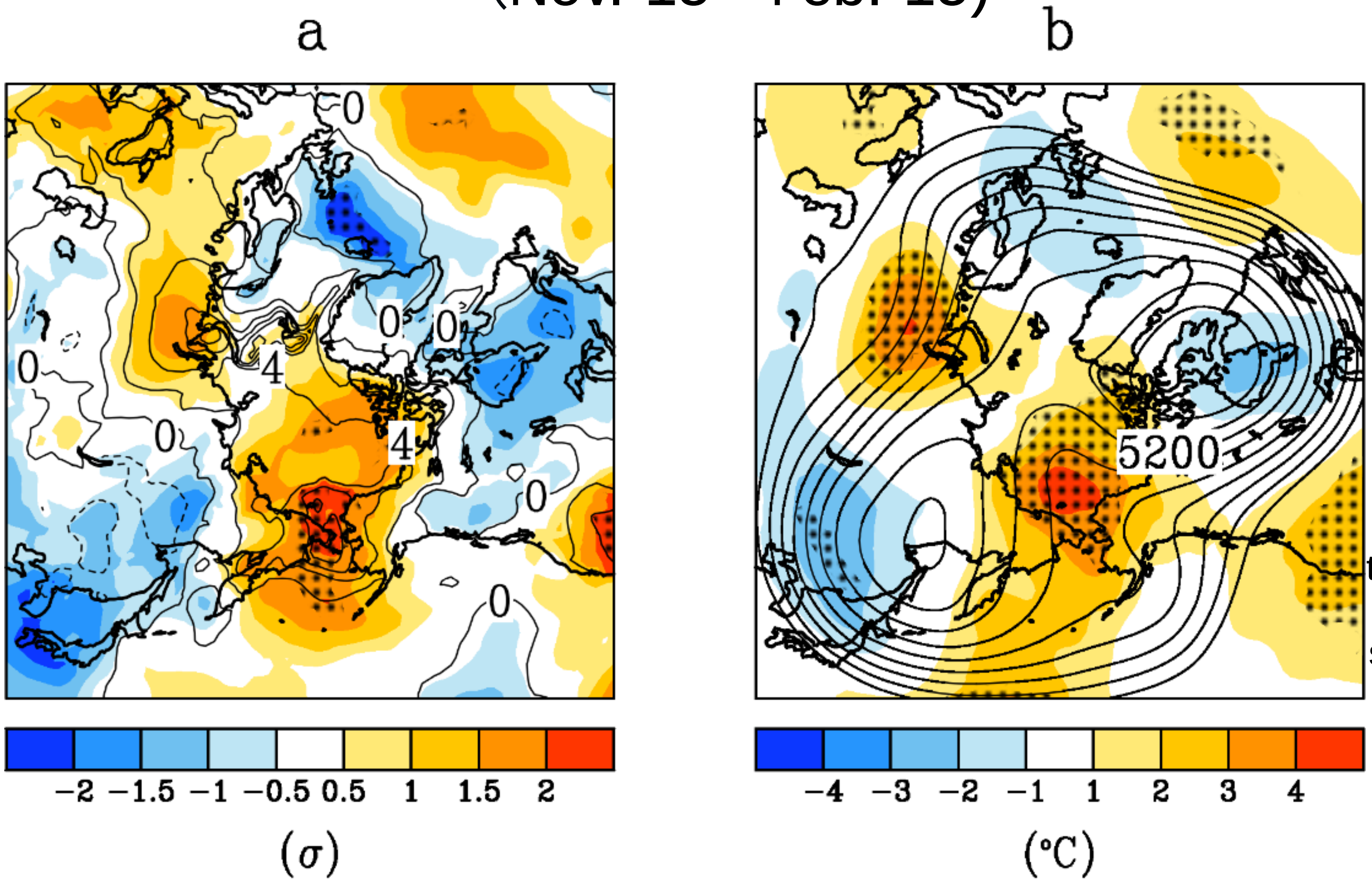
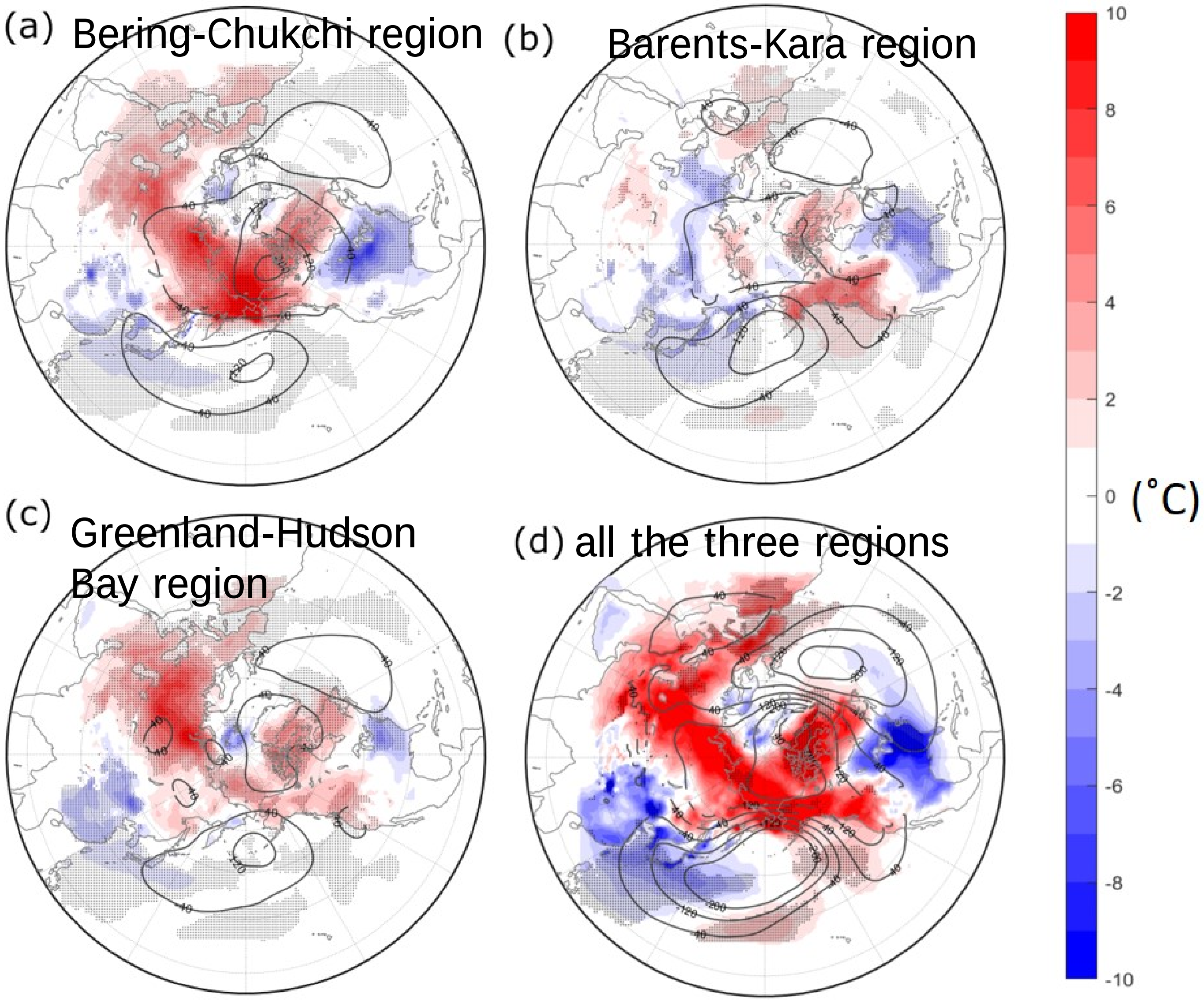
Atmospheric fields 2017−18
(Nov. 15 - Feb. 15)

Three-month mean T2m anomaly. Hatching areas recorded the highest or lowest since 1981 (Trend is removed)

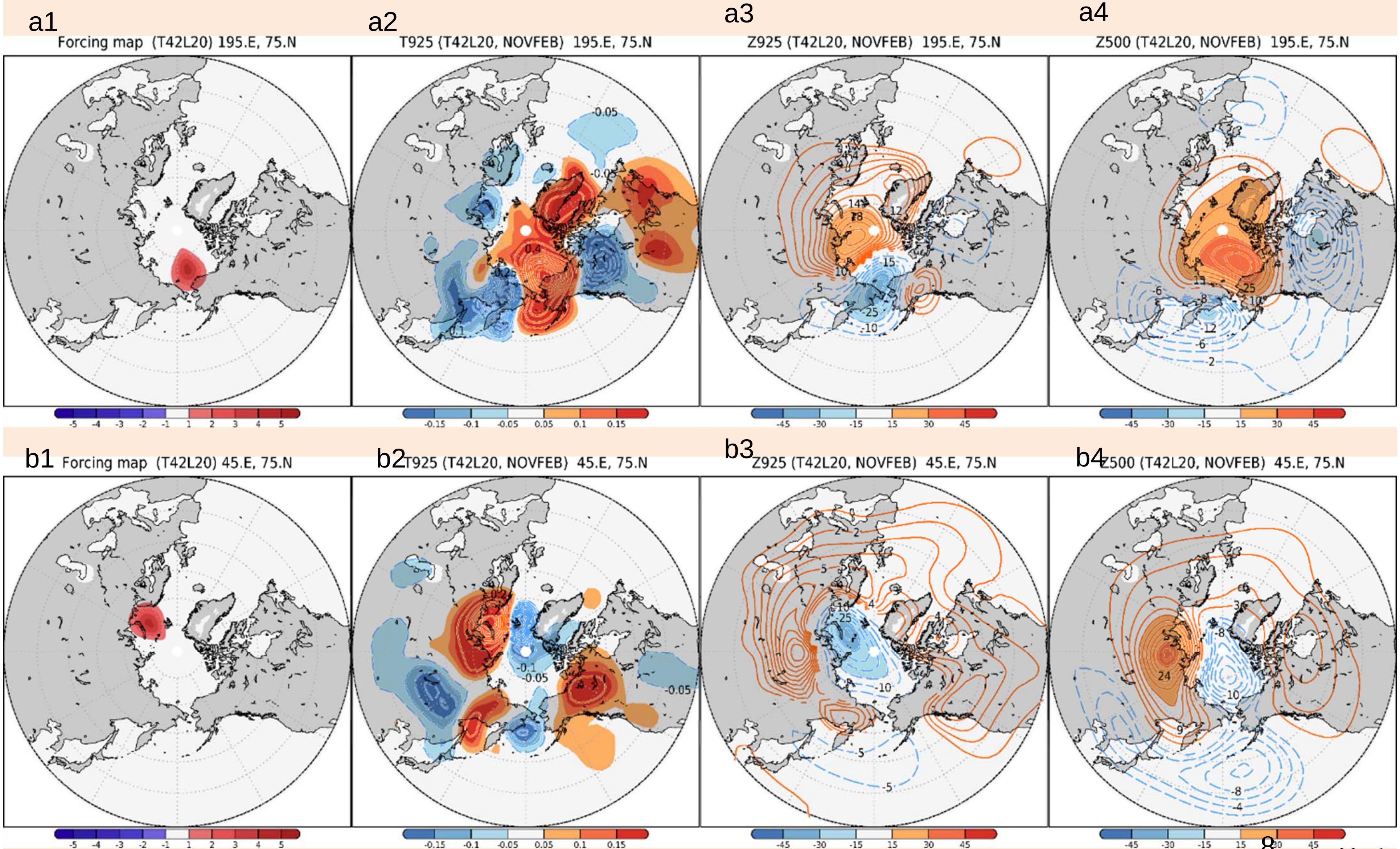


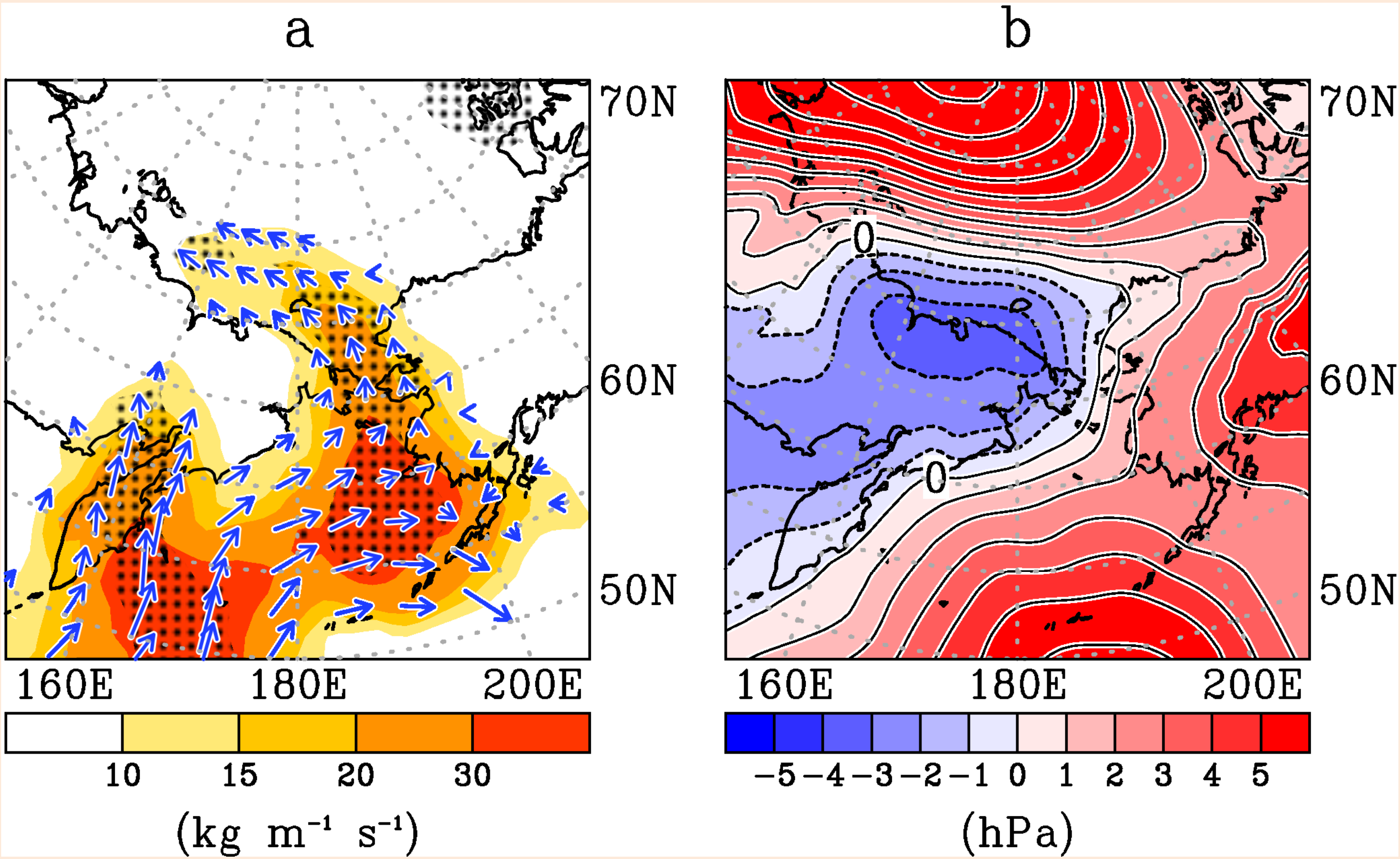
Three-month mean Z500(contour) and T500 anomaly(shaded). Hatching areas recorded the highest or lowest since 1981 (Trend is removed)



Atmospheric response under the 2017-18 sea-ice boundary condition by a numerical simulation in the lower troposphere. Z850 (contour) and T2m(shaded). Atmospheric deviation fields in February when sea-ice boundary condition over a specific region is set in 2017-18 from those of 1983-84.

Atmospheric response to given forcing. Red color of a1 and b1 indicates forcing area. (a2,b2) Response of 925 hPa temperature from (a1) and (b1) forcing, respectively. (a3,b3) As in (a2,b2) but for 925 hPa height. (a4,b4) As in (a2,b2), but for 500 hPa height. (simple linear baroclinic model (LBM). Watanabe and Kimoto, 2000)





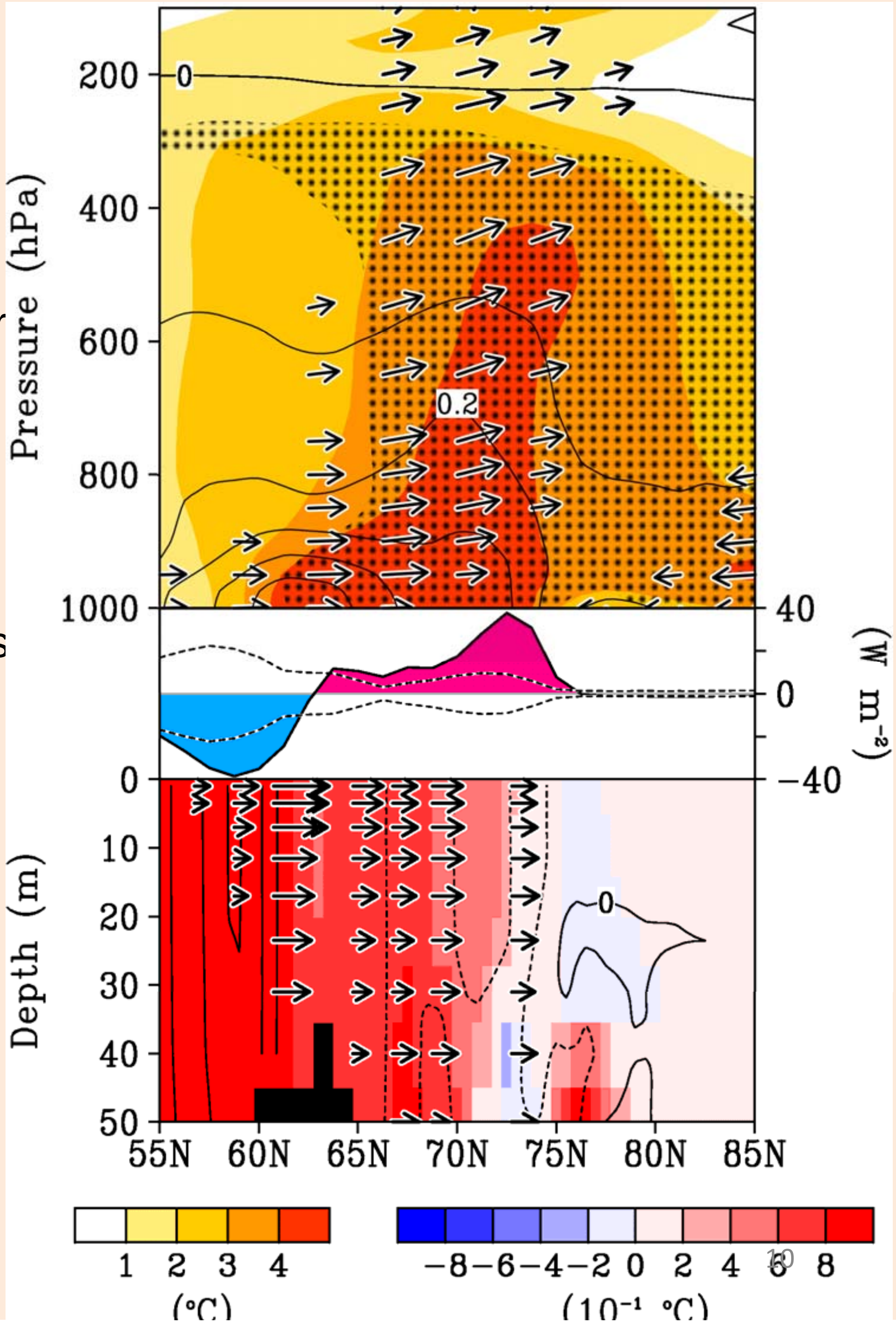
Anomalous poleward moisture flux and sea level pressure over the Pacific side of the Arctic Ocean and the Bering Sea in winter 2017–18.
(a) the three-month mean vertically integrated moisture flux in winter 2017–18.
(b) three-month mean sea level pressure (SLP) anomaly

Vertical-meridional section showing longitudinally averaged atmospheric and oceanic fields covering Bering-Chukchi region in winter 2017–18

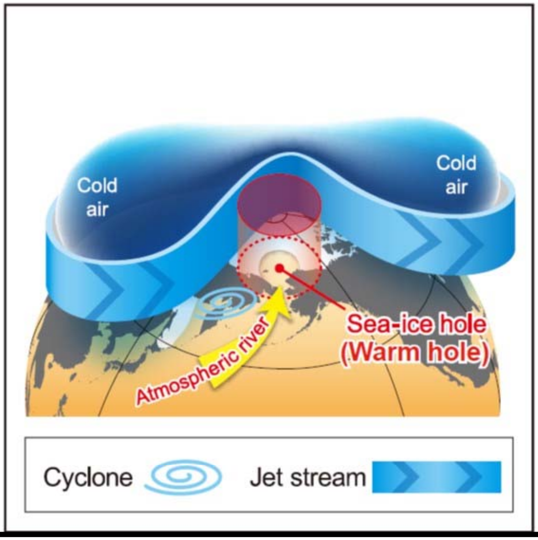
(Upper) Atmospheric fields Color: warm air temperature anomaly; Arrow: northward and upward wind anomaly; Contour: positive specific humidity anomaly.

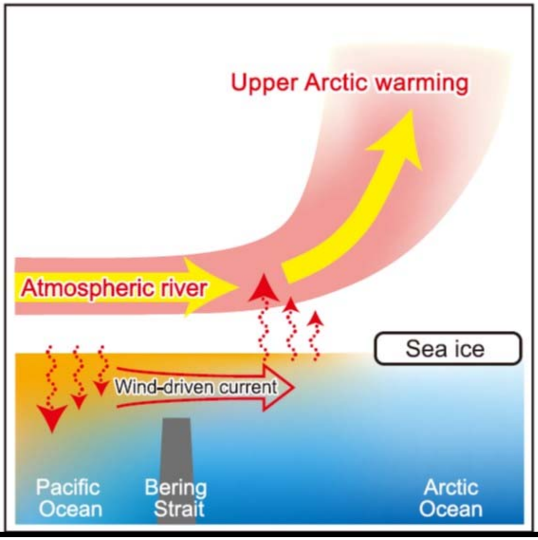
(Middle) The sum of latent and sensible heat flux anomaly, upward direction defines positive (red), and downward is negative (blue)

(Bottom) Oceanic fields
Shade: ocean temperature anomaly.
Arrow: time change of northward ocean current from 12 November to 15 February in 2017–18 winter, minus climatological time change. Contour: time change of temperature from 12 November to 15 February in winter 2017–18, minus climatological time change.



Warm hole in Pacific Arctic sea ice cover forces mid-latitude Northern Hemisphere cooling during winter





The self-sustainable positive feedback mechanism observed during the 2017–18 winter could recur in future years, because the warm hole would be expected to appear again and again. This would provide Eastern Asia and North America with cold winter.

Related Paper:
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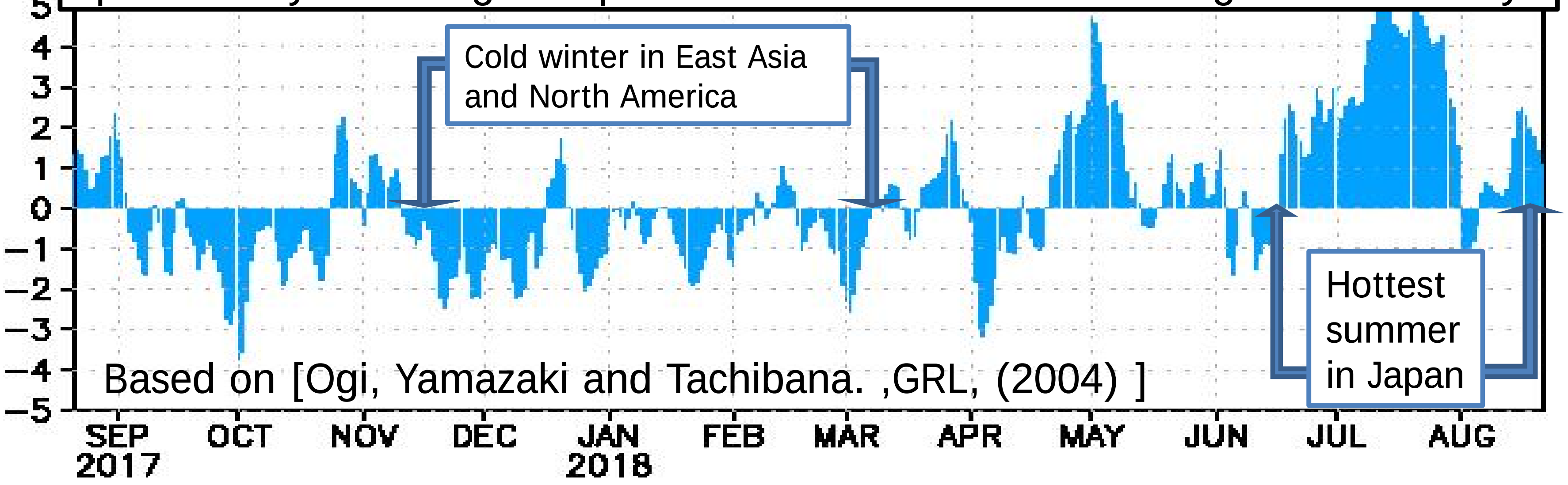
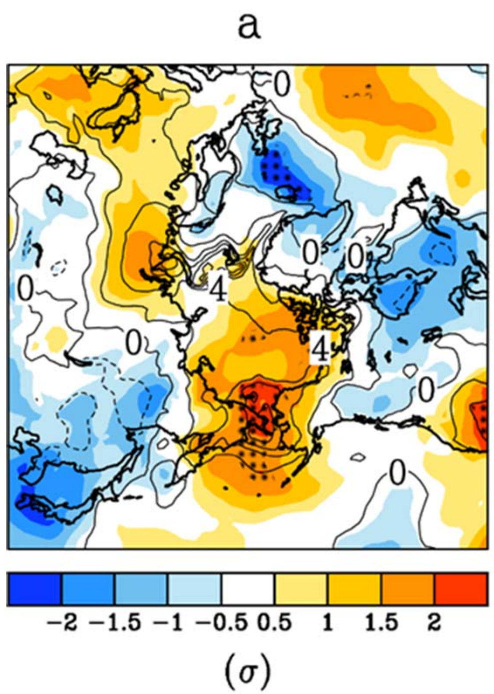
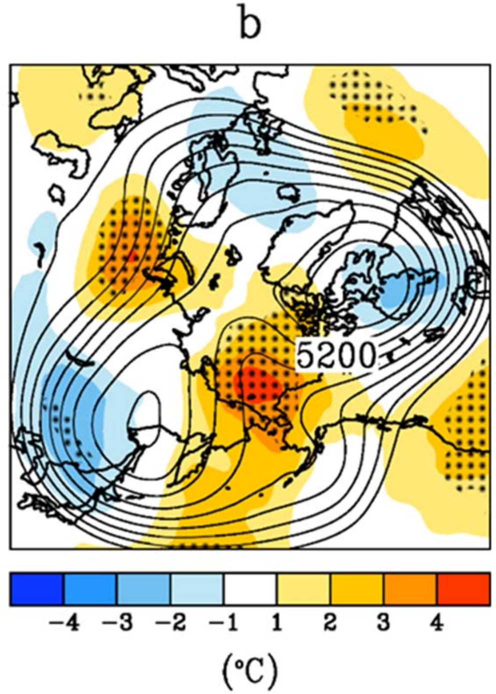
AO index

persistently in its negative phase from mid-November through mid-February

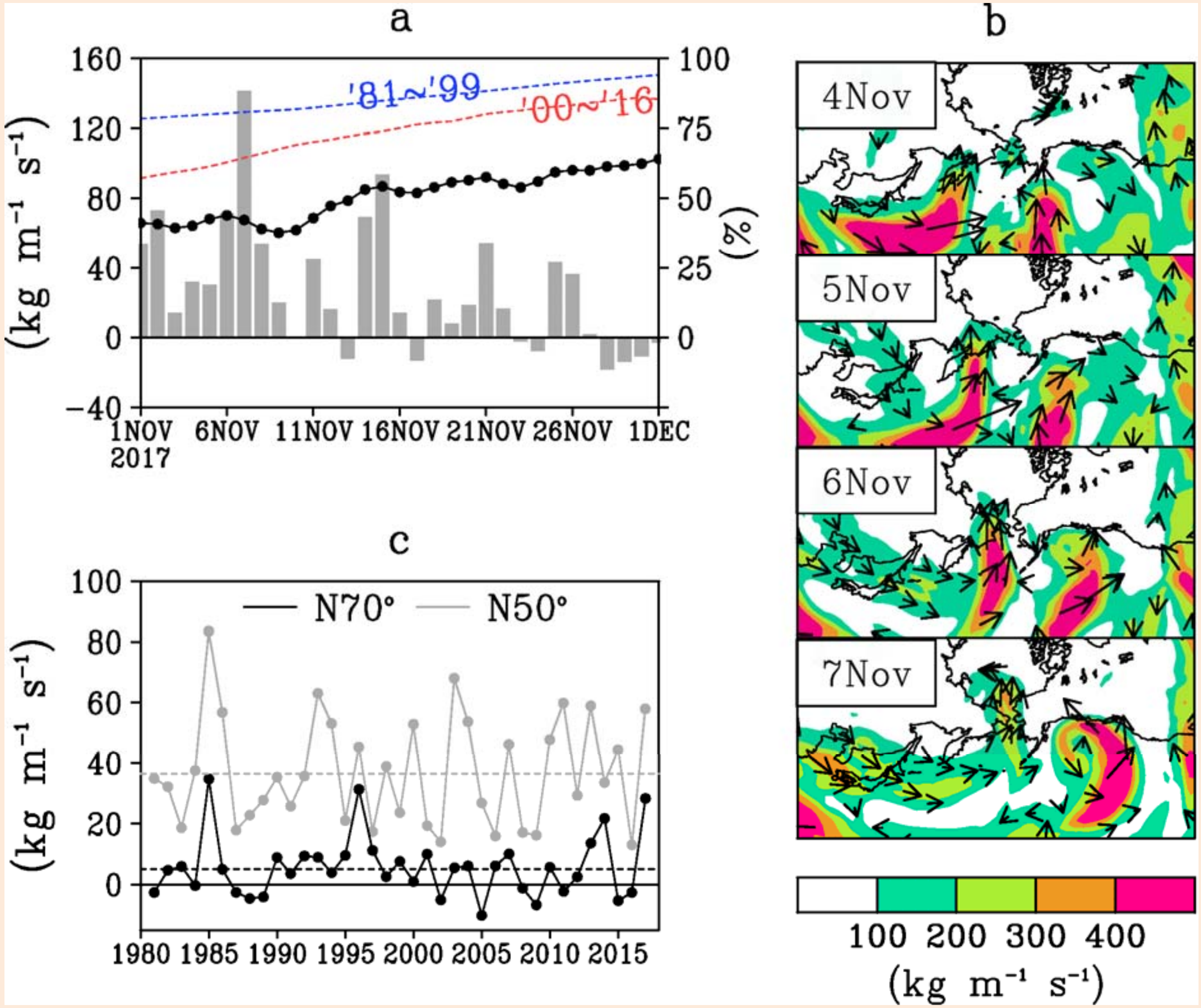


Three-month mean T2m anomaly. Hatching areas recorded the highest or lowest since 1981





Three-month mean Z500(contour) and T500 anomaly(shaded). Hatching areas recorded the highest or lowest since 1981



Pacific Atmospheric rivers and their intrusion across Bering Strait in the beginning of winter of 2017. a) Black curve shows the evolution of sea ice concentration in Pacific side of the Arctic in 2017. The unit is %. Red and blue curves show those of 1981-1999 average, and 2000-2016 average respectively. Bar shows the value of northward moisture flux across 70 degrees north. The unit is $kg\ m^{-1}\ s^{-1}$. (b) An atmospheric river event shown by vertical integrated vapour flux (IVT) from 4 to 7 November 2017. c) interannual variation of northward IVT crossing at 50 and 70 degrees north and their climatological mean values.

(a) Map of monthly mean sea-ice concentrations in November 2017, and interannual variation of area-averaged monthly mean sea-ice concentration within a fan-shaped area in the Chukchi Sea
(b) Ice concentration deviation for winter 2017–18, from those of most recent five-year mean. Average period is from November to February.