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LETTER

Enhanced mid-to-late winter predictability of the storm track variability in the North Pacific as a contrast with the North Atlantic

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Abstract
The storm tracks are a major driver of regional extreme weather events. Using the daily output of reanalysis and a latest generation ensemble seasonal forecasting system, this study examines the interannual variability and predictability of the boreal winter storm tracks in the North Pacific and North Atlantic. In both basins, the leading mode of storm track variability describes a latitudinal shifting of the climatological storm tracks. The shifting mode is closely connected with the extratropical large-scale teleconnection patterns (i.e. Pacific-North America teleconnection and North Atlantic Oscillation).

The main predictability source for the shifting mode of the North Pacific storm tracks are the ENSO-related sea surface temperature anomalies. Assessment of the seasonal prediction skill further shows that the shifting mode of the North Pacific storm tracks is in general better predicted than that of the North Atlantic storm tracks likely due to stronger ENSO effects.

Our analyses also find that, through the modulations of ENSO and the subtropical jet, the shifting mode of the North Pacific storm tracks exhibit a mid-to-late winter predictability enhancement. During El Niño phases, the North Pacific subtropical jet shifts equatorward and becomes strongest in mid-to-late winter, which dominates the upper-level flow and guides the storm track most equatorward. We argue that the intensification and equatorward shift of the North Pacific subtropical jet in mid-to-late winter of El Niño years provide the main reason for the increased mid-to-late winter predictability for the storm tracks. The results imply that good representation of the background subtropical jet in models is important for winter climate prediction of storm tracks.

1. Introduction

The extratropical storm tracks, which feature frequent passage of synoptic weather systems, are a major driver of regional and global climate variability due to their strong redistribution of momentum, heat and moisture (Chang *et al* 2002, Hoskins and Hodges 2002). On the interannual time scale, the extratropical storm tracks exhibit strong variation in both position and strength (Lau 1988, Wettstein and Wallace 2009, Chang *et al* 2013). The dominant modes of storm track variability, which are often defined by the leading empirical orthogonal functions (EOF) of high-pass variance in meridional wind or geopotential height (Lau 1988), describe 'latitudinal shifting' and 'pulsing' of the climatological mean storm tracks (Strong and Davis 2008). In the winter months, changes in storm tracks can strongly affect the extreme weather in midlatitude regions, including strong winds, extreme precipitation, heavy snow and coastal storm surge (Chang and Yau 2016, Ma and Chang 2017). Given these wide-spread impacts on surface climate, skillful seasonal prediction of storm track activities is of huge societal and scientific interest.

The interannual variability of the extratropical storm tracks is considered to be closely connected with the dominant teleconnection patterns in the Northern Hemisphere, such as the Pacific North America (PNA), the Western Pacific (WP) and North Atlantic Oscillation/Arctic Oscillation (NAO/AO) (Lau and Nath 1991, Wettstein and Wallace 2009, Ma and Zhang 2018). Some previous studies have suggested that a portion of the interannual variability of the teleconnection patterns is driven by external forcing (e.g. sea surface temperature (SST) anomalies, stratospheric forcings), permitting some predictability of these teleconnection patterns on longer time scales (Deser *et al* 2007, Riddle *et al* 2013, Kang *et al* 2014, Scaife *et al* 2014, Kidston *et al* 2015). This implies that the storm track variability also has some predictability on the seasonal time scale.

Dynamical seasonal forecasting systems have demonstrated extensively the prediction skill of large-scale circulations. The skill for the storm tracks, which exhibit strong synoptic variance, has been less explored. Using high-frequency (6-hourly) data, storm track activities predicted by models can be derived. Using an average predictability time (APT) method, Yang *et al* (2015) examined the seasonal predictability of extratropical storm track in the Geophysical Fluid Dynamics Laboratory's (GFDL) high-resolution climate model. They found that the leading predictable components of extratropical storm tracks are the ENSO-related spatial pattern, and the second predictable components are mostly due to changes in external radiative forcing and multidecadal oceanic variability. Feng *et al* (2018) used an EOF analysis and supported the results of Yang *et al* (2015) by showing that the first predictable mode of extratropical storm tracks in the ECMWF Integrated Forecast System is generated by the ENSO-induced wave train. He further suggested that the second predictable mode is generated by the North Pacific Mode. As a whole, these previous studies on storm track predictability mainly focused on a hemispheric scale. However, as suggested by Wettstein and Wallace (2009), the storm track variabilities are more sectorally restricted, and the spatial patterns of the storm track variability are most clearly defined when EOF analysis is performed on sectors encompassing individual climatological storm tracks (e.g. the North Pacific and North Atlantic). Using a latest generation Met Office Seasonal Prediction System, this study explicitly examines the winter predictability of extratropical storm track variability in both the North Pacific and North Atlantic. Here, we show that ENSO-related SST anomalies provide dominant predictability sources to the winter storm track shift. Moreover, we will show that the North Pacific storm track variability exhibits a mid-to-late winter predictability enhancement, likely due to the subtropical jet control on the ENSO-storm track relation.

2. Data and methodology

2.1. Reanalysis and hindcast data

In this study, we analyze the storm track variability derived from both reanalysis data and ensemble hindcast. Specifically, we use daily (1200UTC) meridional velocity, monthly zonal velocity and sea level pressure ($1.5° \times 1.5°$) over the period 1979-2018 from the European Centre for Medium-Range Weather Forecasts (ECMWF) interim reanalysis (ERA-Interim; Dee *et al* 2011), and monthly sea surface temperature data ($1° \times 1°$) from Met Office Hadley Centre (HadISST; Rayner *et al* 2003). The ensemble hindcasts are taken from the Met Office Global Seasonal Forecast System 5 (GloSea5; MacLachlan *et al* 2014). The climate model at the core of this forecast system is Hadley Center Global Environmental Model version 3 (HadGEM3), which has atmospheric resolution of $0.83° \times 0.55°$ and 85 quasi-horizontal vertical levels. The oceanic resolution is $0.25° \times 0.25°$ with 75 quasi-horizontal levels. A 24-member ensemble of forecasts is run for each winter in the period 1993–2012 initialized from three start dates centered on 1 November. We use the daily (1200UTC) meridional velocity to represent the storm track statistics and use monthly surface temperature to identify the predictability source in the model.

2.2. Methodology

Seasonal standard deviation of the 24-hour difference filtered daily 200-hPa meridional velocity is used to indicate the seasonal storm track activity (Wallace *et al* 1988, Chang *et al* 2002). Specifically,

$$\overline{v'^2} = \sqrt{\frac{1}{N}\sum_{t=1}^{N}[v(t+24\,\mathrm{h})-v(t)]^2}, \qquad (1)$$

where N is the sample size of winter season, and v' denotes the synoptic anomaly of the meridional wind at 200 hPa. The monthly storm track activities are similarly derived from equation (1), with N denoting the sample size of the corresponding month. As discussed in previous studies (Chang *et al* 2002, Chang and Yau 2016), the 24-hour difference filter highlights the synoptic variability with time scales between 1.2 and 6 days.

In the reanalysis, the leading mode of the interannual variability of the storm tracks is represented by performing the EOF analysis on seasonal mean (December-February (DJF)), area-weighted $\overline{v'^2}$ anomalies north of $20°N$ in both the North Pacific and North Atlantic. The seasonal-mean storm track indices are defined as the leading normalized principal component (PC1) time series by their standard deviations.

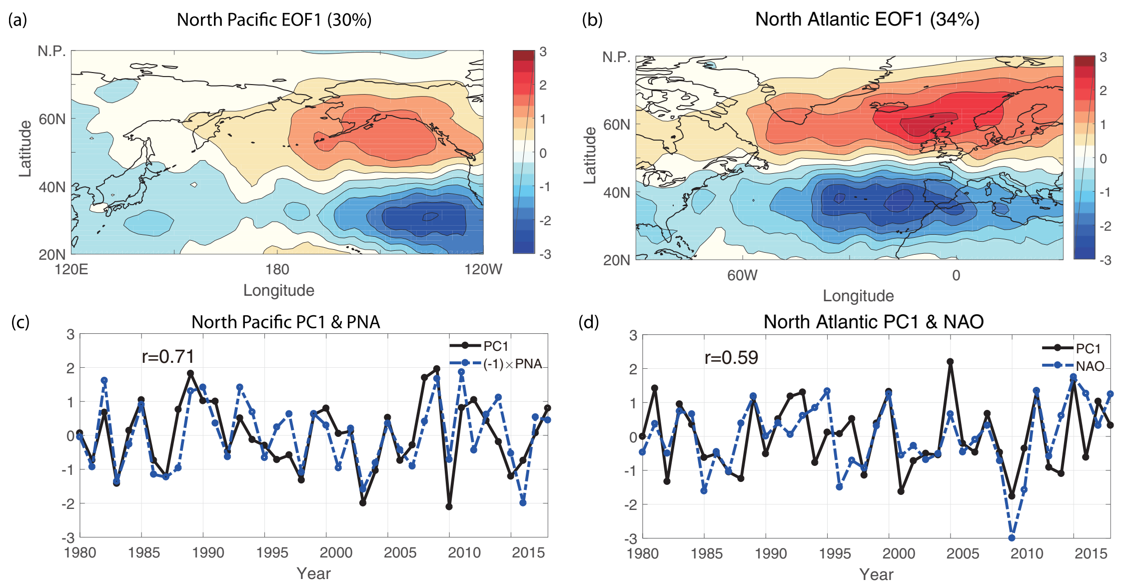

Figure 1. Spatial patterns of the observed leading EOF mode (contour interval: 0.5 ms^{-1}) of DJF-mean storm tracks in the (a) North Pacific and (b) North Atlantic. (c) The standardized PC1 (shifting index) of the DJF-mean North Pacific storm tracks (solid line) and the PNA index (dashed line). Here the PC1 denotes the shifting index of storm tracks. For ease of comparison, the PNA index is multiplied by −1. (d) as in (c) but for the shifting index of North Atlantic storm tracks and the NAO index.

To explore the connection between the storm track variability and large-scale circulation patterns, two teleconnection circulation indices from the Climate Prediction Center (CPC) are employed in this study: the PNA index and the NAO index, which can be downloaded from https://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/teleconnections.shtml. The two CPC indices are defined based on rotated EOF analysis of the geopotential height. Due to the limitation of data availability of model output, we apply sea level pressure instead to calculate the corresponding PNA and NAO indices in the prediction skill analyses. The 39-yr correlation between the two methods in the reanalysis is 0.84 for the PNA index and 0.91 for the NAO index. The Nino3.4 index is calculated as the regional averaged SST over $(5°N-5°S, 170°W-120°W)$. The North Pacific subtropical jet latitude (LAT_{STJ}) is obtained by estimating the location of maximum 200-hPa westerly averaged over $120°E-120°W$. The zonal wind speed at the subtropical jet latitude is denoted as the North Pacific subtropical jet speed (U_{STJ}).

To assess the prediction skill of the storm track variability using the hindcast dataset, the predicted winter $\overline{v'^2}$ anomalies are projected onto the leading mode of storm track variability in the reanalysis of the same period. The predicted storm track indices are defined as the standardized resulting ensemble-averaged and individual ensemble time series by the standard deviation of the model. The prediction skill is then represented by the Temporal Correlation Coefficients (TCC) between the ensemble averaged storm track indices of 24 forecast members per winter and the observed storm track indices. The Root Mean Square Error (RMSE) is also used to validate the prediction skill results.

3. Results

3.1. Observed interannual variability of the winter storm tracks in the North Pacific and North Atlantic

Figure 1 reviews the observed interannual variability of the winter storm tracks in the Northern Hemisphere. The leading mode of storm track variability is investigated via EOF analyses performed on ERA-Interim DJF-mean $\overline{v'^2}$. Since the storm tracks peak in the North Pacific and North Atlantic, the EOF analysis is performed on the two sectors respectively. Figure 1(a) displays the leading EOF pattern of the DJF-mean storm tracks in the North Pacific. It shows a north-south dipole in the eastern basin, suggesting a 'latitudinal shifting' of the climatological mean North Pacific storm tracks (30% explained variance). The dominant pattern of storm track variability in the North Atlantic is shown in figure 1(b). The first EOF mode also features a meridional shifting (34% explained variance) of the mean North Atlantic storm tracks. The above results are consistent with the spatial patterns using 500-hPa geopotential height (Lau 1988) and 300-hPa meridional velocity (Wettstein and Wallace 2009).

Previous studies have demonstrated that the interannual variability of the storm tracks is closely connected with the dominant teleconnection patterns of climate variability. We next investigate the relationship between the storm track variability and these teleconnection pattern indices using latest reanalysis data. Since the first EOF mode denotes meridional

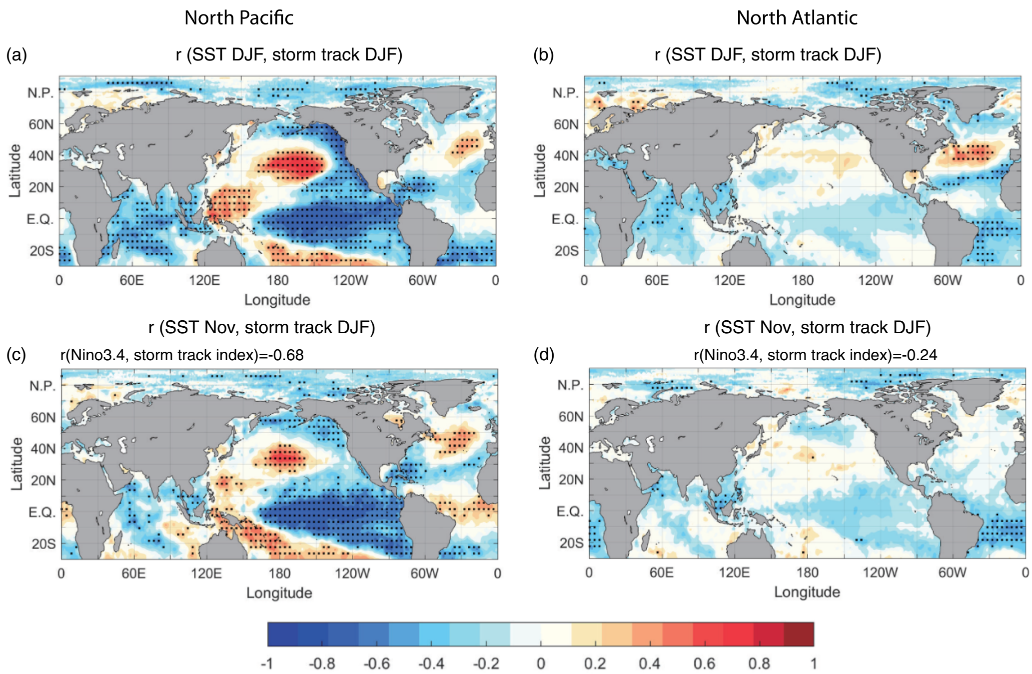

Figure 2. Observed correlation between the DJF-mean SST anomalies and the DJF-mean shifting index of the (a) North Pacific and (b) North Atlantic storm tracks. (c), (d) as in (a), (b) but for the correlation between the November-mean SST anomalies and DJF-mean shifting indices of storm tracks. Values significant at $\alpha = 0.05$ confidence level are highlighted with black dots.

shifting of storm tracks, we refer the PC1 of storm tracks as the shifting index of storm tracks hereafter. Figures 1(c) and (d) display the shifting indices of the storm track variability in both basins and the PNA, NAO indices. The 39-yr (1980–2018) correlation between the shifting index of North Pacific storm tracks and the PNA index is −0.71, and the correlation between the shifting index of North Atlantic storm tracks and the NAO index is 0.59, which are significant at $\alpha = 0.05$ level by Student's t-test and consistent with the results in Wettstein and Wallace (2009) and Ma and Zhang (2018).

3.2. Modulation of ENSO on the North Pacific storm track variability

The above connection between the storm track variability and teleconnection patterns implies that the possible predictability source may arise from the underlying SST anomalies. Figures 2(a) and (b) examine the observed correlation between the DJF-mean SST anomalies and shifting indices of storm tracks. As shown in figure 2(a), the poleward shift of the North Pacific storm tracks is significantly correlated with La Niña-like SST anomalies. This is consistent with previous studies that the meridional displacement of the Pacific storm tracks is related to the ENSO cycle (e.g. Straus and Shukla 1997, Chang *et al* 2002, Chang 2006, Seager *et al* 2010). The storm track pattern shifts southward (northward) and extends eastward (westward) during an El Niño (La Niña) winter. The EOF1 of North Atlantic storm tracks, as shown in figure 2(b), is connected with cold SST anomalies over the tropical North Atlantic and warm anomalies over extratropics. Figures 2(c) and (d) further displays the correlation between the November-mean SST anomalies and the DJF-mean shifting indices of storm tracks. In the North Pacific, the poleward shift of winter storm track is significantly connected with the November La Niña-like SST anomalies. The correlation between the November Nino3.4 index and the North Pacific storm track shifting index is −0.68, which is significant at $\alpha = 0.05$ level by Student's t-test. Note, the North Pacific storm track shift also moderately correlates with November North Atlantic SST triple, implying that the North Atlantic SST triple may provide an additional source to the winter North Pacific storm track shift. By contrast, in the North Atlantic, the winter storm track shift has no significant connection with the preceding North Atlantic SST anomalies, suggesting that the North Atlantic SST anomalies may not provide predictability source to the winter North Atlantic storm track variability. This is consistent with previous studies that the extratropical winter air-sea interaction in the North Atlantic is dominated by the atmospheric driving the ocean (e.g. Visbeck *et al* 2013). However, there is a connection with equatorial SST, suggesting the storm track moves north when SST is colder at, and south, of the equator. The equatorial SST-induced heating may affect the North Atlantic storm track by triggering the Rossby wave train through the modulation of local Hadley cell (Gill 1980, Hoskins *et al* 1977, Sardeshmukh and Hoskins 1988).

The strong impact of November ENSO on the winter North Pacific storm track variability implies that ENSO may provide a seasonal predictability

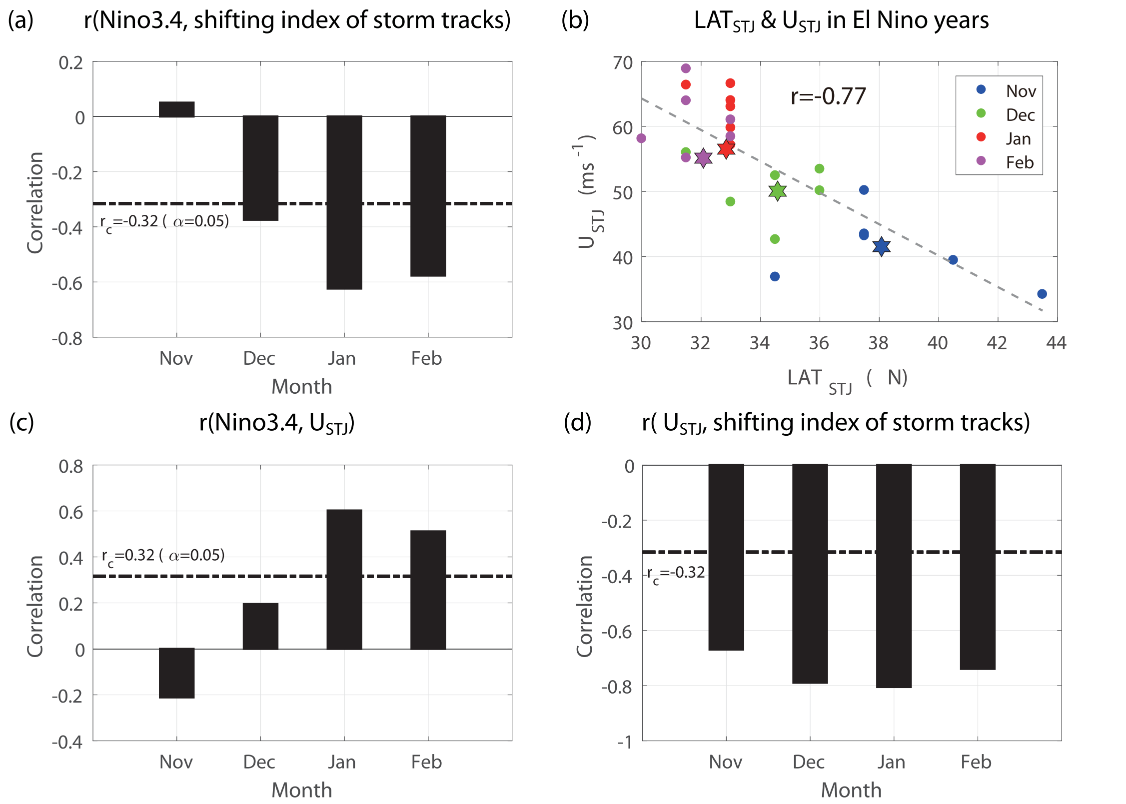

Figure 3. (a) Correlation between the monthly Nino3.4 index and the shifting index of North Pacific storm tracks from November to February. (b) Scatter plot of the monthly North Pacific subtropical jet speed versus subtropical jet latitude during El Niño years. The hexagram denotes the climatology of all years. (c) as in (a) but for the correlation between the Nino3.4 index and the North Pacific subtropical jet speed. (d) as in (a) but for the correlation between the subtropical jet speed and the shifting index of North Pacific storm tracks. The black dashed lines in (a), (c) and (d) denote the critical correlations that are significant at $\alpha = 0.05$ level.

source to the winter storm track variability. We next examine the detailed monthly relation between ENSO and storm track variability in the North Pacific. Figure 3(a) shows the monthly correlation between the Nino3.4 index and the shifting index of the North Pacific storm tracks from November to February. Here the monthly shifting index of storm tracks is obtained by projecting the monthly storm track statistics onto the leading EOF mode of the DJF-mean storm track variability in the North Pacific. It shows that the strongest negative correlation between the Nino3.4 index and the shifting index of storm tracks occurs in January and February.

Why does the North Pacific storm track move most equatorward in mid-to-late winter during El Niño events? As is well documented, the North Pacific storm tracks display strong seasonal cycle, with the storm tracks shifting most equatorward and exhibiting an intensity suppression in January (see Chang *et al* (2002), Yuval *et al* (2018), Novak *et al* (2020) and references therein). Here we further hypothesized that the subtropical jet may play a role in exaggerating such equatorward shift during El Niño events. Previous studies have suggested that the sutbropical jet strengthens on its equatorward flank during an El Niño event. The resultant changes in zonal wind then alter the linear wave refraction and give rise to the latitudinal shift of North Pacific storm track (Seager *et al* 2003, Seager *et al* 2010, Harnik *et al* 2010, Graff and LaCasce 2011). Figure 3(b) displays the North Pacific subtropical jet latitude versus subtropical jet speed from November to February during El Niño phases. The DJF subtropical jet in El Niño years is on average stronger and located slightly equatorward than the climatology of all years. Moreover, a clearly linear relationship is found between the jet latitude and jet speed, with the equatorward-shifted subtropical jet exhibiting stronger jet speed in general. On average, the subtropical jet moves equatorward from November to February and the strongest wind speed is found in January, which is consistent with Novak *et al* (2020). To further test the role of the subtropical jet in modulating the ENSO-storm track relation, figures 3(b) and (c) display the monthly correlation coefficients between the Nino3.4 index and subtropical jet speed, and between subtropical jet speed and the shifting index of storm tracks, respectively. Interestingly, the Nino3.4 index shows a higher correlation with the subtropical jet speed in January and February, while the subtropical jet speed and the storm track shifting index correlates at almost the same level throughout the whole winter. Therefore, we conclude that the subtropical jet may play a critical role in the strongest ENSO modulation on

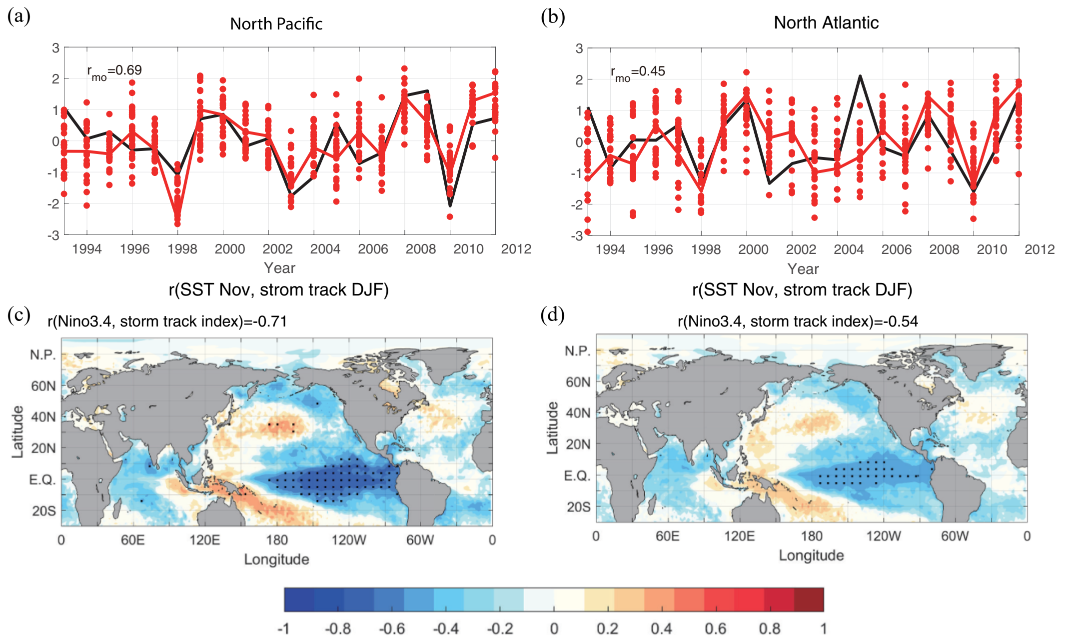

Figure 4. The DJF-mean shifting indices of the (a) North Pacific and (b) North Atlantic storm tracks in observations (black solid line), ensemble mean forecasts (red solid line), and individual ensemble member hindcasts. Average of the correlations between the November-mean surface temperature anomalies and the predicted DJF-mean storm track shifting indices of individual ensemble hindcasts in the (c) North Pacific and (d) North Atlantic. Values significant at $\alpha = 0.05$ confidence level are highlighted with black dots.

the storm track shift during mid-to-late winter. During El Niño phases, the North Pacific subtropical jet shifts equatorward and becomes strongest in mid-to-late winter, which dominates the upper-level flow and guides the storm track most equatorward. Since the ENSO provides a seasonal predictability to the North Pacific storm track shift, the closer ENSO-storm track connection in mid-to-late winter implies that the predictability of storm track variability is also enhanced in mid-to-late winter, which will be discussed in the next subsection.

3.3. Prediction skill of storm track variability in ensemble seasonal forecasting system

Before analyzing the monthly prediction skill of storm track variability, we first assess the seasonal predictability of the storm track variability for the ensemble seasonal forecasting system. The predicted winter-mean storm track shifting index is obtained by projecting the ensemble-mean DJF-mean storm track statistics onto the observed leading mode of the DJF-mean storm track variability. Figures 4(a) and (b) show the normalized storm track shifting indices in both ensemble hindcast and reanalysis. In the North Pacific, the predicted and observed storm track shifting indices are highly correlated at 0.69 (significant at $\alpha = 0.05$ level by Student's t-test), suggesting that the model has a good skill in predicting the north-south shifting of the North Pacific storm tracks (figure 4(a)). In the North Atlantic, the correlation between the predicted and observed storm track shifting indices is 0.45 (significant at $\alpha = 0.1$ level by Student's t-test), also showing a relatively good prediction skill for the latitudinal shift of the storm tracks (figure 4(b)).

To assess the model ability to capture the impact of November SST anomalies on the winter storm track variability, figures 4(c) and (d) show the average of correlations between the November surface temperature anomalies and the predicted DJF-mean storm track shifting indices of all ensemble hindcasts. For the shifting index of North Pacific storm tracks, as shown in figure 4(c), it negatively correlates with the November surface temperature anomalies over eastern tropical Pacific, which is consistent with the observed correlation pattern shown in figure 2(c). The average of correlations between the November Nino3.4 index and predicted DJF-mean storm track shifting indices of all ensemble hindcasts is −0.71, which is comparable with the observed correlation value (−0.68). This suggests that the mechanism that the autumn ENSO anomalies affecting the winter storm track shift in the North Pacific operates well in the model hindcast. This also explains why the model has high skill in predicting the shifting mode of the North Pacific storm track. Figure 4(d) displays the correlation between the November surface temperature anomalies and the shifting index of North Atlantic storm tracks. The correlation coefficients show weak but still significant negative values in the tropical eastern Pacific as well, exhibiting a La Niña-like pattern, suggesting that ENSO also provides a predictability source to the remote North Atlantic storm track shift in the hindcast, which is consistent with Scaife *et al*

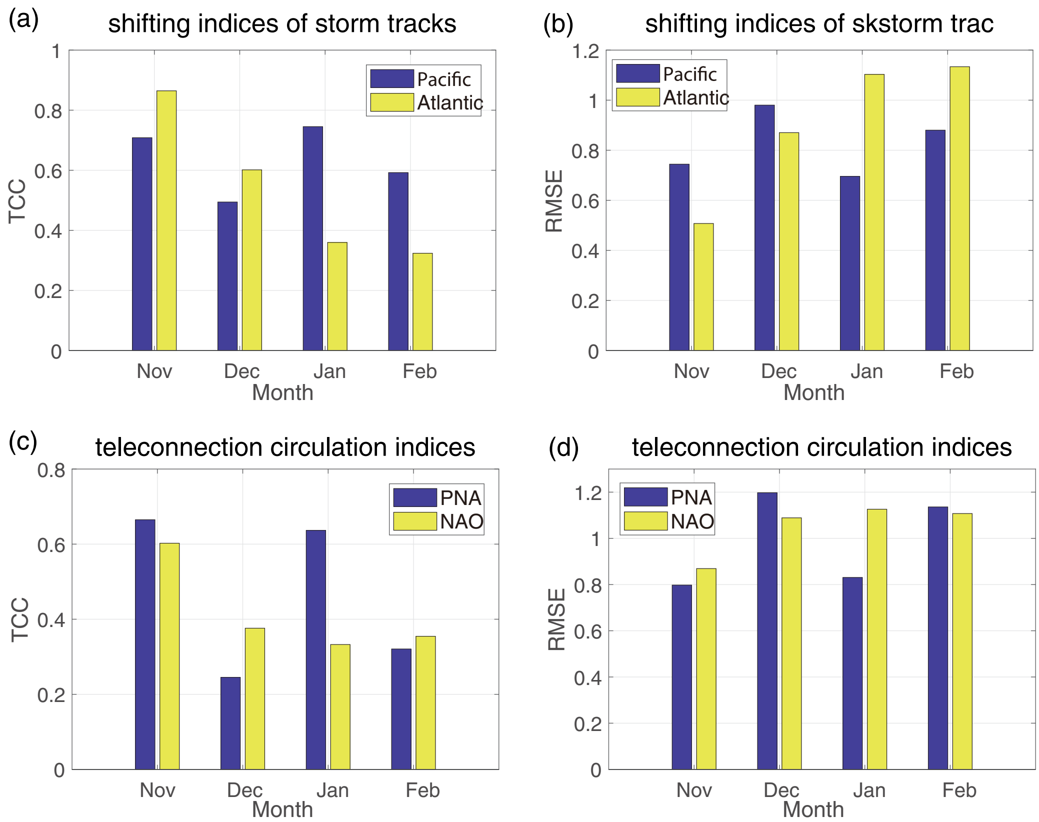

Figure 5. The skill of predicting the monthly mean shifting indices of the North Pacific (blue bars) and North Atlantic (yellow bars) storm tracks measured by (a) the temporal correlation coefficient and (b) the root mean square error. (c), (d) as in (a), (b) but for the PNA (blue bars) and NAO (yellow bars) indices.

(2014). The stronger-than-observed ENSO-North Atlantic storm track relationship also suggests the model overly responds to ENSO. The average of correlations between the November Nino3.4 index and predicted DJF-mean storm track shifting indices of all ensemble hindcasts is −0.71 in the North Pacific and −0.54 in the North Atlantic, indicating that the better prediction skill of the storm track shifting index in the North Pacific than the North Atlantic may be related to the stronger model predictability source from ENSO.

The monthly prediction skill of storm track variability initialized in November is further examined in figure 5. The predicted monthly storm track shifting index is obtained by projecting the ensemble-mean monthly storm track statistics onto the observed leading mode of the DJF-mean storm track variability. Intuitively, the predictability decreases with lead time because of the memory loss of the initialization as seen from November to December. However, over the North Pacific, the TCC of the shifting mode of storm track exhibits an increase in January and February, which confounds this expectation. By contrast, the North Atlantic storm track variability shows a decreased prediction skill with lead time, as one would ordinarily expect. The monthly evolution of prediction skill is also confirmed by the RMSE, as shown in figure 5(b). The increased mid-to-late winter prediction skill of storm track variability over the North Pacific is consistent with the stronger mid-to-late winter ENSO modulation on the North Pacific storm track shift as previously discussed in figure 3.

Figures 5(c) and (d) also assess the monthly prediction skill of the PNA and NAO indices. The predicted PNA and NAO indices are obtained by projecting the monthly ensemble-mean sea level pressure anomalies onto the observed DJF-mean PNA and NAO patterns respectively. Both the TCC and RMSE between the predicted and observed monthly teleconnection indices show that the PNA index exhibits enhanced prediction skill in midwinter, similar to the shifting index of the North Pacific storm tracks. The skill for the NAO index decreases with lead time in a similar way to that of the shifting index of the North Atlantic storm tracks, although some other studies have noted a late winter increase in skill (Jia *et al* 2017, Saito *et al* 2017). This can be understood because there is a strong interaction between the PNA(NAO) pattern and the North Pacific (North Atlantic) storm tracks through the role of synoptic eddy feedback (Ren *et al* 2009, Ren *et al* 2012, Zhou *et al* 2017). Similar monthly evolution of the winter prediction skill of the PNA and NAO indices was also found by Johansson (2007) using multiple forecasting systems but the reason was not explored, and we suggest that the enhanced midwinter PNA predictability may due to the stronger ENSO-PNA relation.

4. Conclusion and discussion

Using the daily output of a reanalysis dataset and a latest generation seasonal forecasting system, the interannual variability and predictability of the North Pacific and North Atlantic extratropical storm tracks in boreal winter are examined. It is shown that the leading mode of interannual variability of storm tracks in both basins describes a latitudinal shifting of the climatological storm tracks. The latitudinal shifting of the extratropical storm tracks in the North Pacific and North Atlantic is associated with the PNA and NAO respectively, which is consistent with the previous results (Wettstein and Wallace 2009, Ma and Zhang 2018). The strong connection between the teleconnection patterns and the storm track variability further implies that the underlying tropical SST anomalies, particularly ENSO, are primary predictability source for the latitudinal shift of storm tracks. Since the North Pacific storm track shift has stronger connection with the ENSO, it shows a higher winter prediction skill than the North Atlantic storm track shift. The important role played by the ENSO in our analysis is also in agreement with the modelling studies by Compo and Sardeshmukh (2004), Yang *et al* (2015) and Feng *et al* (2018).

Sub-seasonal to Seasonal (S2S) predictability over the extratropical region during boreal winter is a challenging issue. Intuitively, the prediction skill is expected to decrease with lead time due to the memory loss based on the initialization. However, our new results suggest that, over the North Pacific, the latitudinal shift of storm track exhibits a prediction skill enhancement during mid-to-late winter, which confounds this expectation. By contrast, the skill for the latitudinal shift of the North Atlantic storm track decreases monotonically with lead time, as one would ordinarily expect. We further propose that it is the subtropical jet control on the relation between ENSO and storm track shift giving rise to such mid-to-late winter predictability enhancement in the North Pacific. During El Niño phases, the North Pacific subtropical jet shifts equatorward and becomes strongest in mid-to-late winter, which dominates the upper-tropospheric flow and guides the storm tracks most equatorward. Since the subtropical jet is important for the winter storm track prediction, improving the simulation of the background subtropical jet and its variability in climate models may further enhance the winter prediction skill over the extratropical regions.

ENSO is the most skillful source for the winter prediction of the North Pacific storm track variability. However, as indicated by previous studies, several other factors may also affect the storm track activities, including the midlatitude SST front (OReilly and Czaja 2015, Joyce *et al* 2019), remote influence of Arctic sea ice and/or Eurasian snow cover(Cohen *et al* 2014, Coumou *et al* 2018), stratospheric forcing (Kidston *et al* 2015, Wang *et al* 2018, Nie *et al* 2019) and radiative forcing (Shaw *et al* 2016). Future work will continue to assess the relative importance of these plausible predictors in the winter storm track variability prediction.

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Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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