EVALUATING THE SUBSEASONAL PREDICTABILITY OF QUASI-STATIONARY WAVES IN DYNAMICAL WEATHER FORECAST MODELS

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INTRODUCTION

Quasi-stationary Rossby waves (QSWs) modulate long-lasting (one week or longer) atmospheric ridges and troughs, and thus are related to blocking weather and temperature extremes[1] in the midlatitudes.

QSWs provide a unique opportunity to improve subseasonal forecast of extreme events because of their long lasting behavior

In this study, we evaluate the subseasonal forecast skill of QSWs in dynamical weather forecast model in Winter season.

By analysing the forecast skill of QSWs, we aimed to identify the presence of potential information in weather models that can inform extreme event forecast in the midlatitudes.

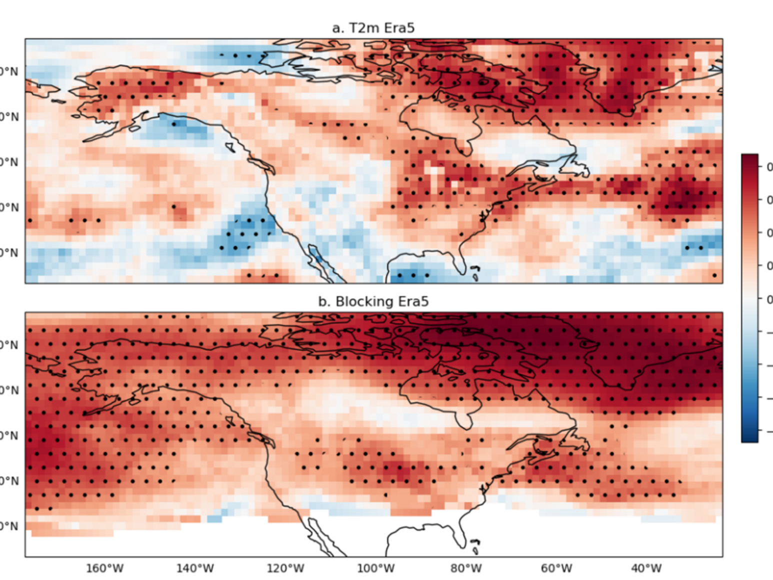

Fig 1. Correlation between spatially smoothed QSWs and (a) 2meter temperature and (b) tblocking weather in the North America region in ERA5. Black dots indicate grid points significant at p=10% level.

METHODOLOGY

The evaluation is performed on the ECMWF operational weather forecast acquired from the subseasonal to seasonal (S2S) project. For skill evaluation, three more models were anaysed to identify the inter-model relationship in skill. The models are CMA, HMCR and Meteo-France.

QSWs are identified using the 15 day low-pass filtered anomalies in meridional wind at 300HPa. The method uses the hilbert transform to identify wave envelopes [2].

Model evaluation was performed using the anomally correlation coefficient (ACC):

$$ACC = \frac{\sum_{i=1}^{N}(f_i - \bar{f})(o_i - \bar{o})}{\sqrt{\sum_{i=1}^{N}(f_i - \bar{f})^2}\sqrt{\sum_{i=1}^{N}(o_i - \bar{o})^2}}$$

MIDLATITUDE SKILL

Improved subseasonal skill is seen in the north Pacific region consistent across four dynamical models. There is hardly any skill remaining in other regions at these lead times.

We analyse the interannual variability of skill in the North Pacific (boxed region in fig 2a)

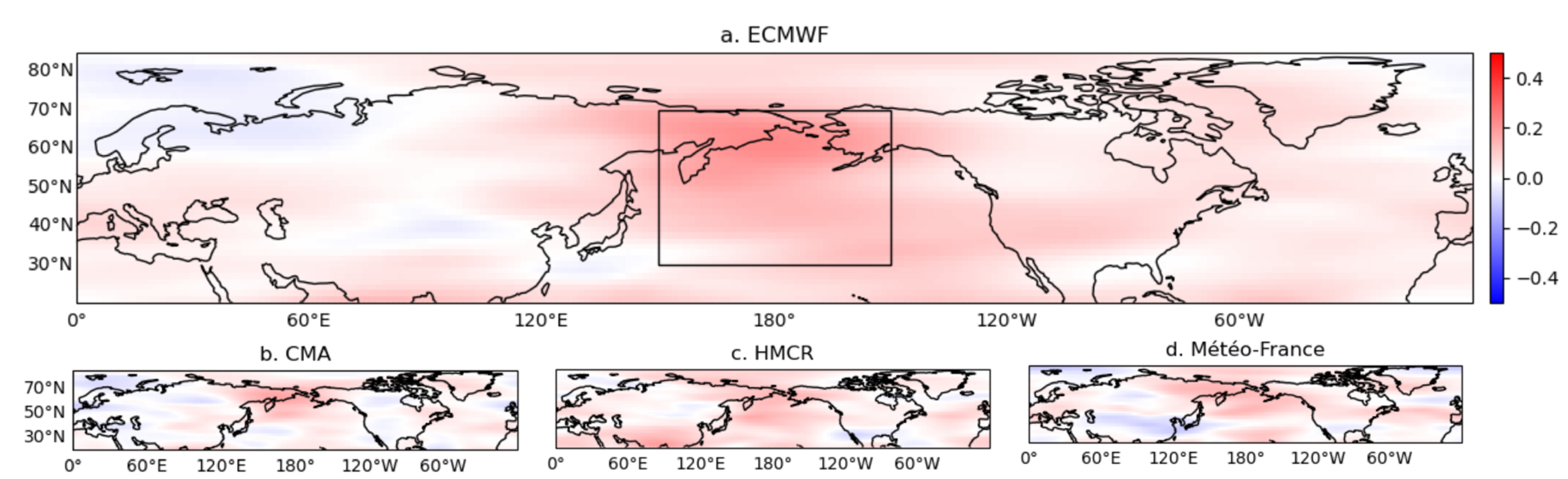

Fig 2. QSW skill in the midlatitude winter averaged over14-28days lead time in (a) ECMWF, (b) CMA and (c) MeteoFrance. Black box in (a) shows the area with relatively high skill and analyzed further.

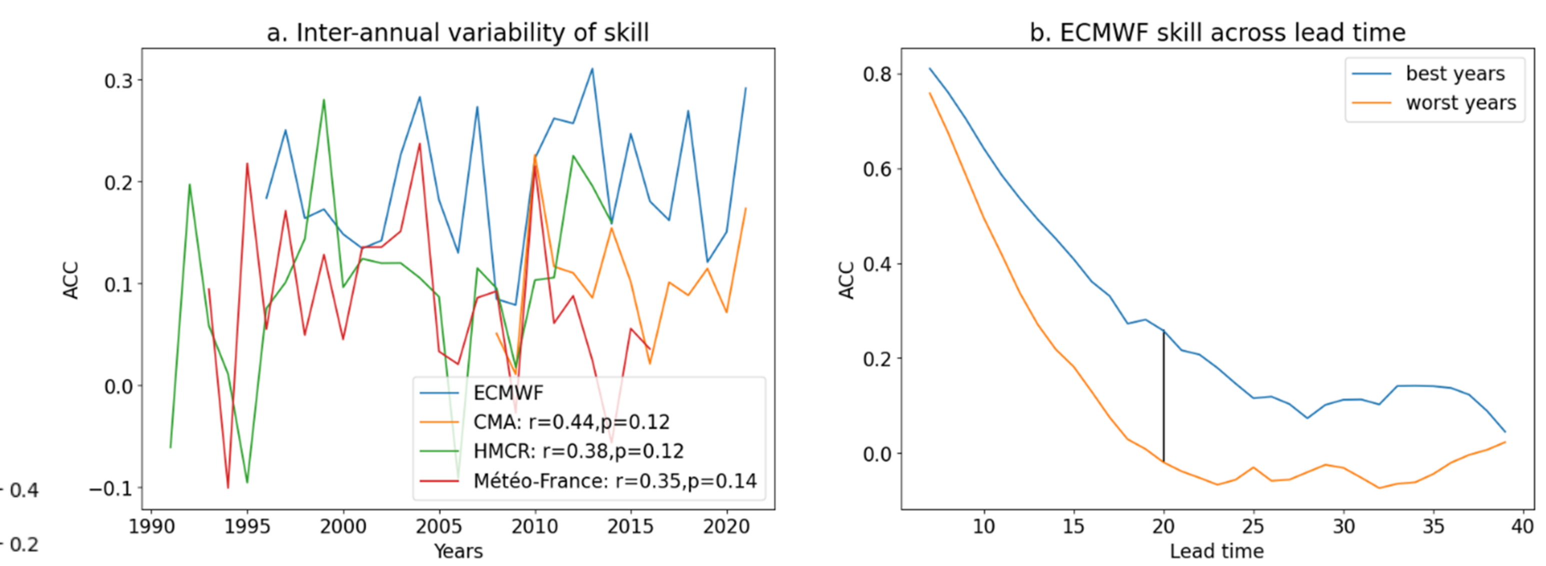

Fig 3. (a) Inter-annual variability of skill in the North Pacific region in four dynamical models and (b) QSW skill in the North pacific in best vs. worst skill years in the ECMWF model. The values in the legend of (a) indicate correlation between ECMWF and the remaining models. Black line in (b) indicates the largest difference between best and worst skill years.

The pacific region has large inter-annual variability that shows some consistency across models. ECMWF shows a pearson's correlation coefficient of 0.4 (p=~0.1) with all three models.

The largest difference between best skill years versus worst years is seen at the subseasonal timescale (around 21 days lead)

CONNECTION WITH SOURCES AND EXTREMES

The skill of QSWs show some relationship with SST patterns and slow zonal wind speed. The influence of SST is dominated by the pattern with little contribution from SST bias. MJO also influences the skill (r=0.3, p= ~0.1) where high amplitude events promote improved skill to a limited extent.

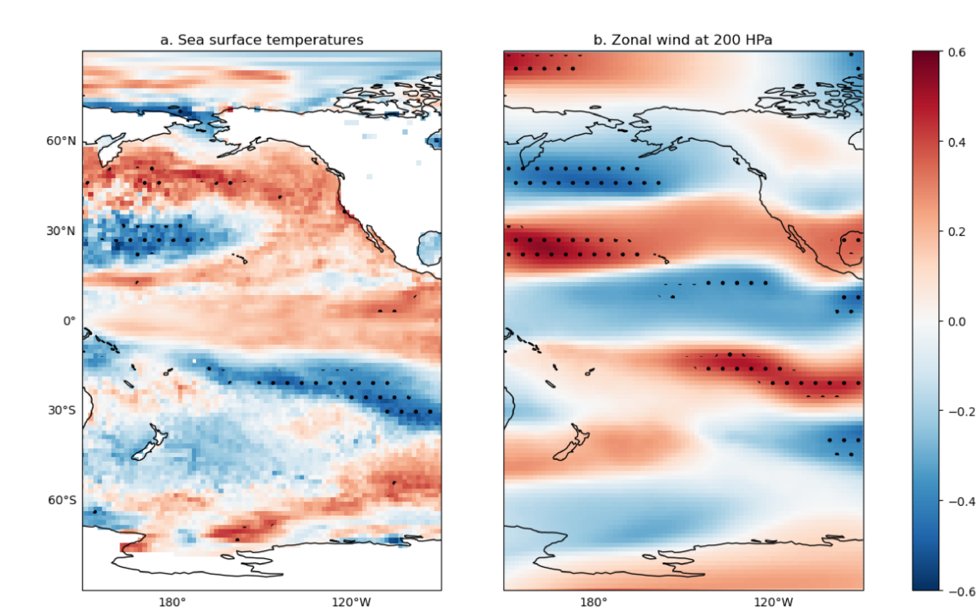

Fig 4. Correlation between North Pacific QSW skill and a. sea surface temperature and (b) zonal wind at 200HPa. Black dots indicate grid points significant at p=10% level.

The relationship between QSWs and blocking/temperature extremes have some spatial agreement with observed results. However, the correlation values are relatively underestimated.

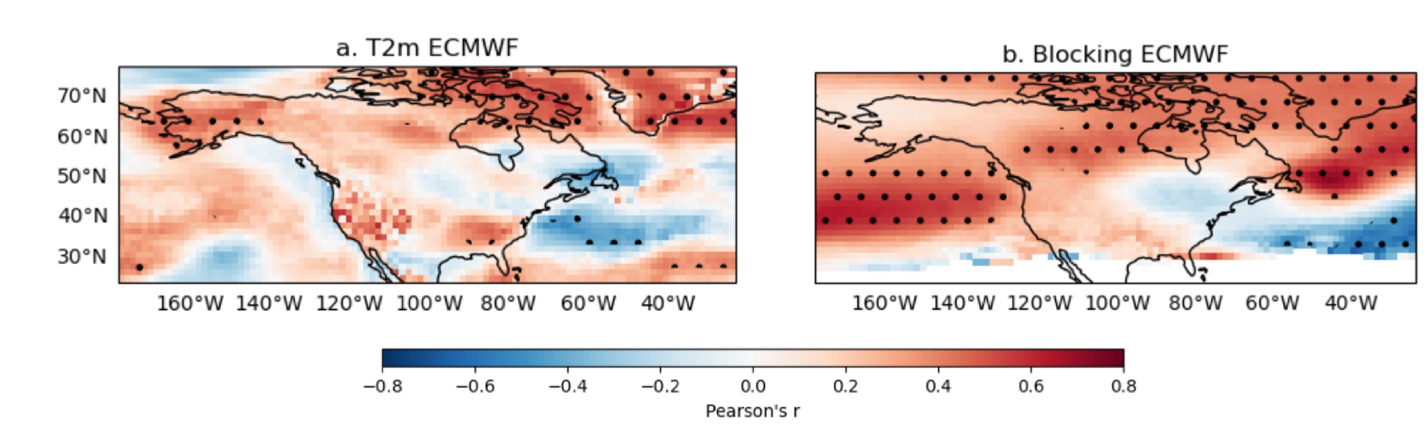

Fig 5. Correlation between spatially smoothed QSWs and (a) 2meter temperature and (b) tblocking weather in the North America region in ECMWF. Black dots indicate grid points significant at p=10% level.

CONCLUSIONS

QSWs show some subseasonal skill in the North Pacific consistent across models. The models mostly replicate QSW relationships with blocking and temperature with some underestimation of the linkage. The skill shows large inter-annual variability that shows some link with SST patterns, zonal wind at 200HPa and MJO indices.

KEY REFERENCES

[1] Wolf, G., Brayshaw, D. J., Klingaman, N. P., & Czaja, A. (2018). Quasi-stationary waves and their impact on European weather and extreme events. Quarterly Journal of the Royal Meteorological Society, 144(717), 2431-2448. https://doi.org/10.1002/qj.3310

[2] Zimin, A. V., Szunyogh, I., Patil, D. J., Hunt, B. R., & Ott, E. (2003). Extracting Envelopes of Rossby Wave Packets. Monthly Weather Review, 131(5), 1011-1017. https://doi.org/10.1175/1520-0493(2003)131<1011:EEORWP>2.0.CO;2