Enhancement of the Late Boreal Winter Lead Time Predictability over the Extratropical Region

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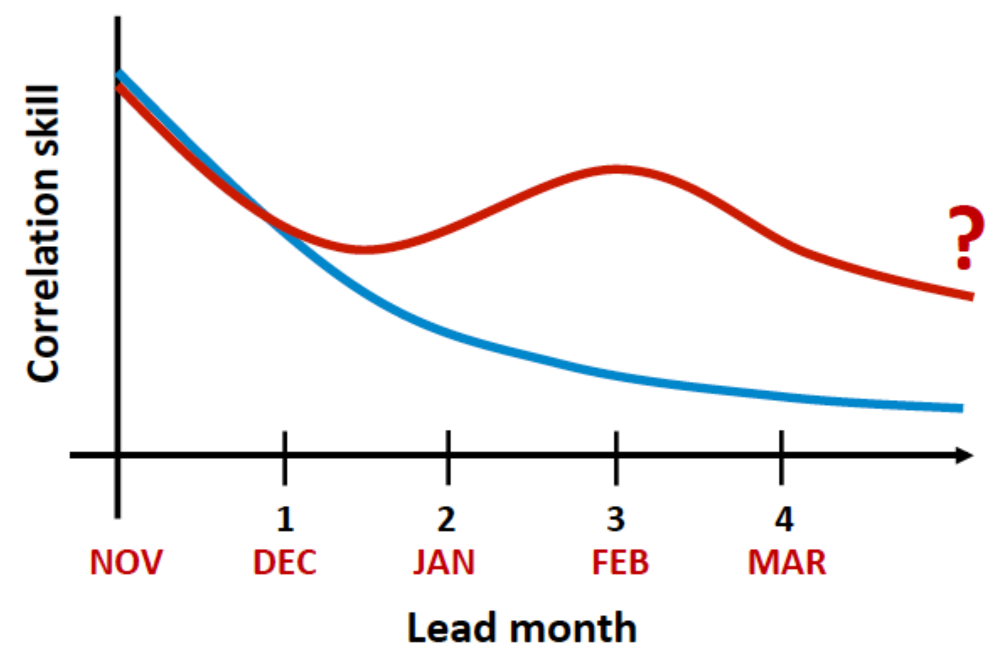
Summary

Sub-seasonal to Seasonal predictability over the extratropical region during the boreal winter season is a challenging issue. Generally, the predictability decreases with the lead-time, this is because it losses memory based on the initialization. However, the internal atmospheric dynamics such as the coupling of the lower stratosphere with troposphere may provide signal, which tends to influences the prediction skill. To understand this perspective, we analyzed the new hindcast dataset available from the European Centre for Medium-Range Weather forecasts (ECMWF) namely as SYSTEM5 (SYS5) based on November Initial Condition.



- We found the prediction skill over the extratropical region in particular over the Pacific and North American (PNA) region initialized in November drops with lead time but it again picks up during lead-3 month (i.e. February). The prediction skill increases to 0.4-0.5, which is statistically significant at 95% level. This increase in the Prediction signal is also noted in the upper troposphere in the tropical region.
- The pick up of the late winter predictability in the extratropical region in particular over PNA is contradictory to the tropics, where prediction skill degrades with lead-time.
- We noted that the extratropical internal atmospheric memory, where lower stratosphere plays an important role in the enhancement of the prediction skill over the PNA and the adjoining region. The downward propagation of the stratosphere signal is responsible of the increase in the prediction skill during the late winter.
- Further, the prediction skill in the ENSO years is higher than non-ENSO years over the PNA at lead-3.

Datasets and Methodology

- Hindcast dataset from the European Centre for Medium-Range Weather Forecasts (ECMWF) SYSTEM 5 for the period 1981-2015 . Each Year the reforecast is initialized in November and the forecast made for next 7 months. The model atmospheric resolution is T319 with 91-vertical levels, where a model top is at 0.01hPa. Total 25 ensemble members are available on the resolution of 1 x 1 degree (*ECMWF Seas5 user Guide*).
- The Era Interim reanalysis dataset is used as an observation to analyze the prediction skill simulated by the model (*Dee et al. 2011*).
- Hadley Centre (HadISST) Sea Surface Temperature (SST) dataset (*Rayner et al. 2003*).
- Polar vortex is defined based on the 30-hPa zonal mean of the zonal wind anomalies at 60 °N.

1) Lead Time Monthly Prediction

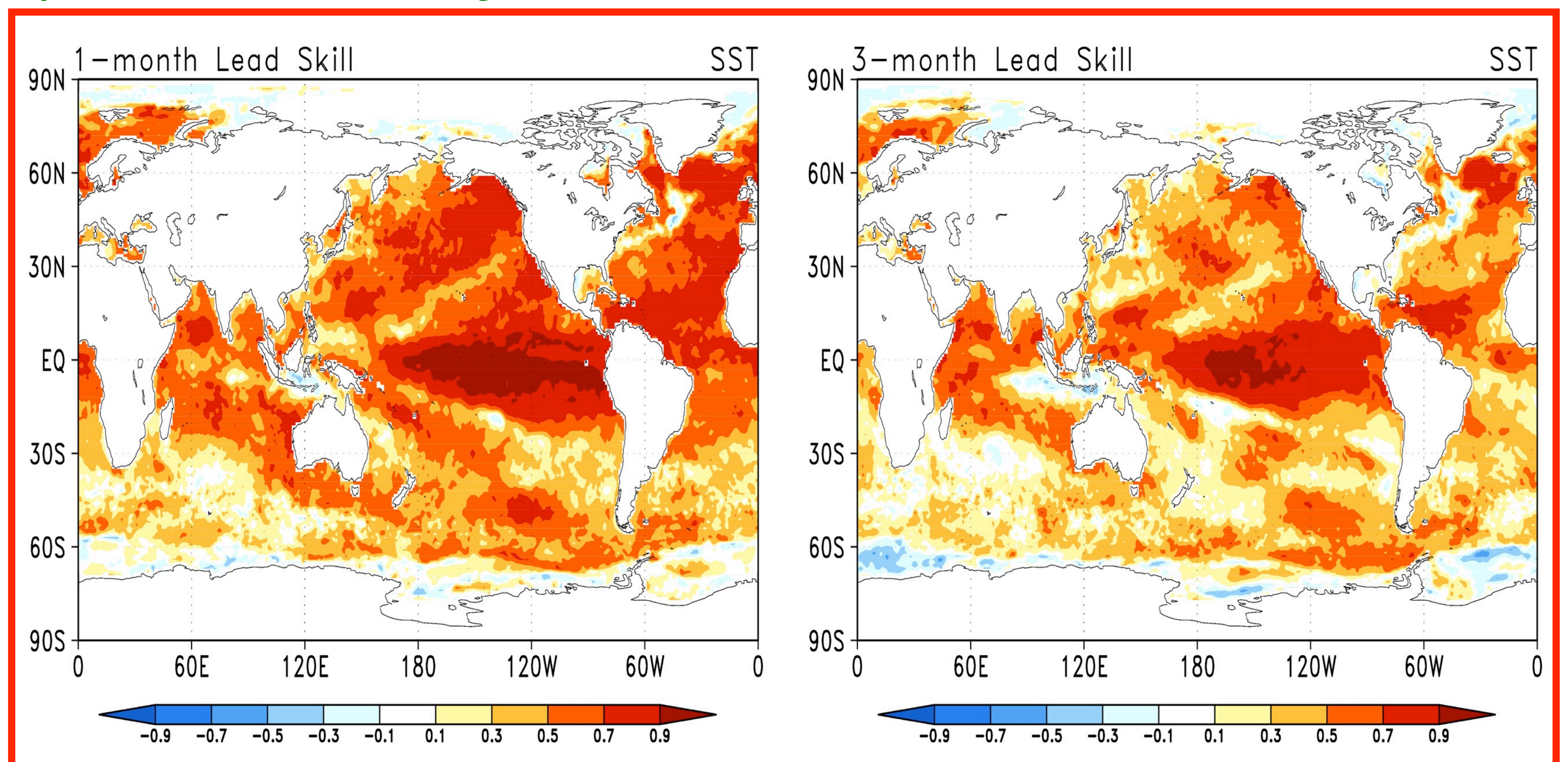


Figure 1: Lead time monthly Prediction Skill of the Sea Surface Temperature (SST) anomalies for the month of December (Lead-1) and February (lead-3) for the period 1981-2015.

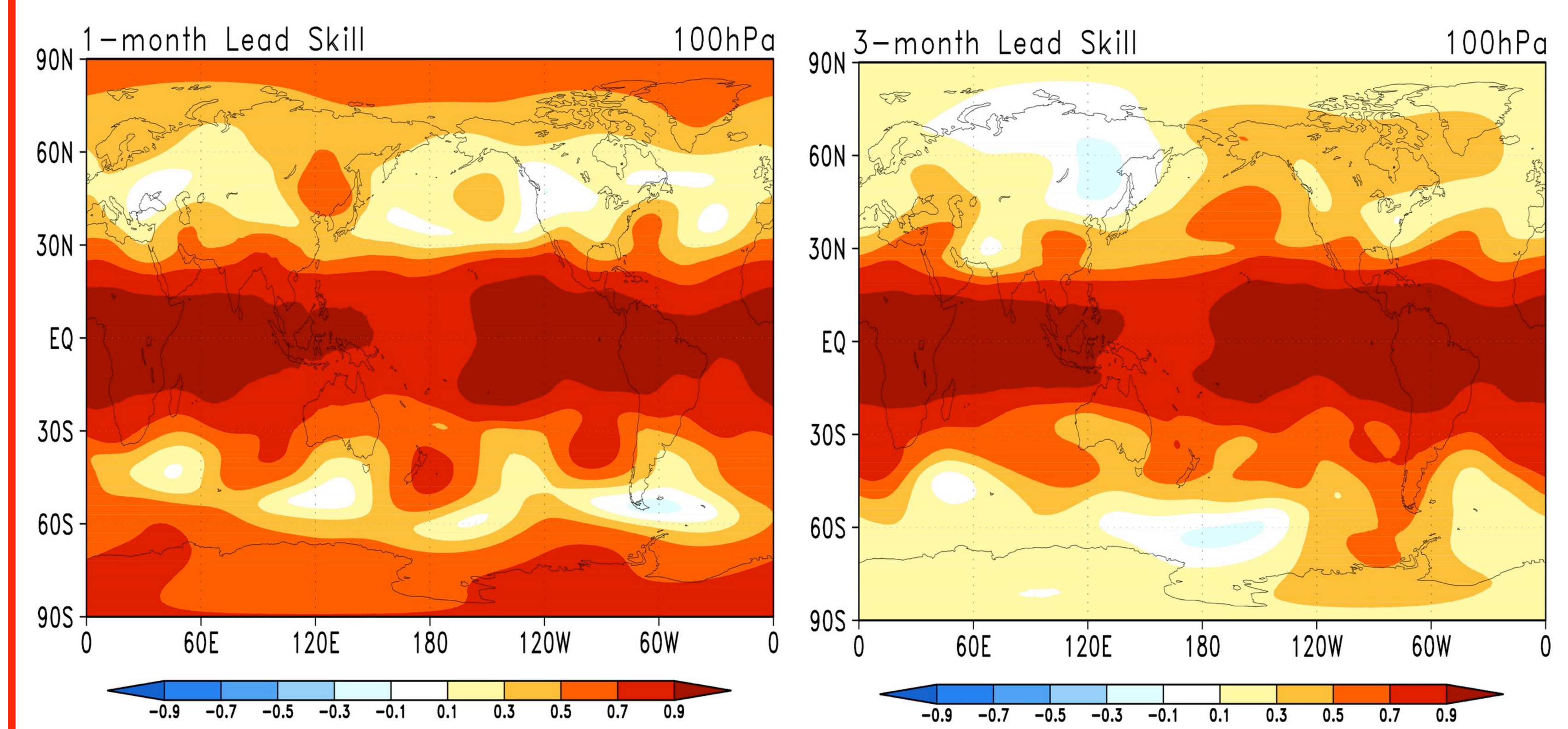


Figure 2: Lead time Prediction Skill of the 100-hPa geopotential height anomalies for the month of December (Lead-1) and February (lead-3) for the period 1981-2015.

2) Role of Stratosphere

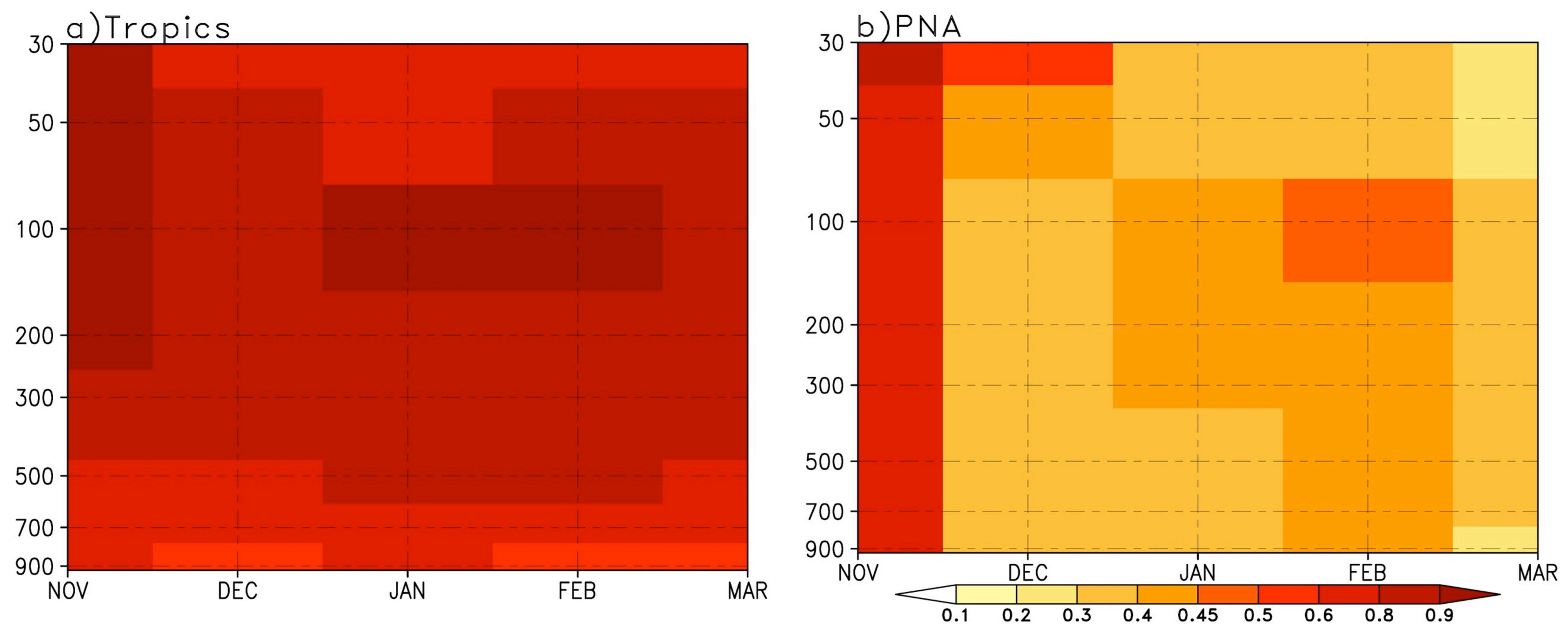


Figure 3: Lead Time Predictability of the geopotential height anomalies over a) tropics [0:360°E; 20°S: 20°N] and b) PNA [150:300°E; 20:70°N] region for the period 1981-2015.

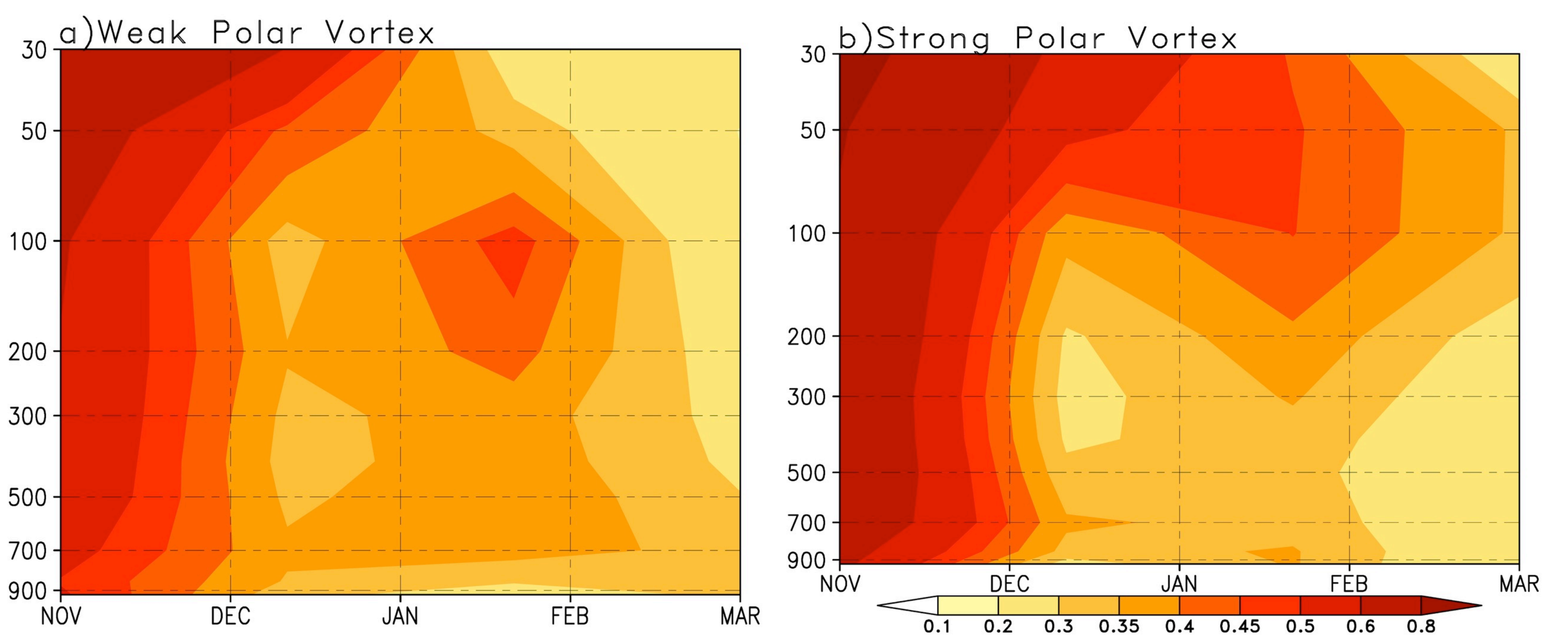


Figure 4: Prediction Skill of the geopotential height anomalies over the [90:270°E; 20:90°N] for a) Weaker Polar vortex b) Stronger Polar vortex years.

3) Prediction Skill of the ENSO Years

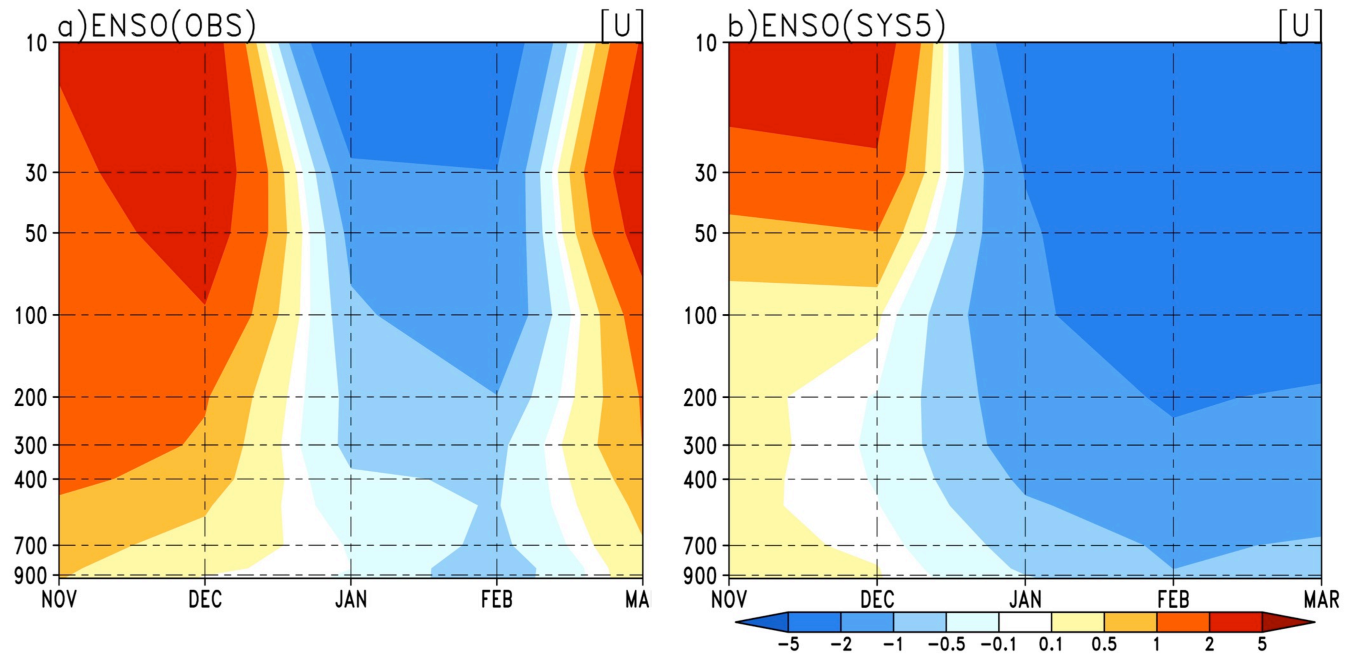


Figure 5: ENSO zonal mean of the zonal wind anomalies at 60 °N for a) Observation (OBS) and b) ECMWF-SYS5. Units are m/s.

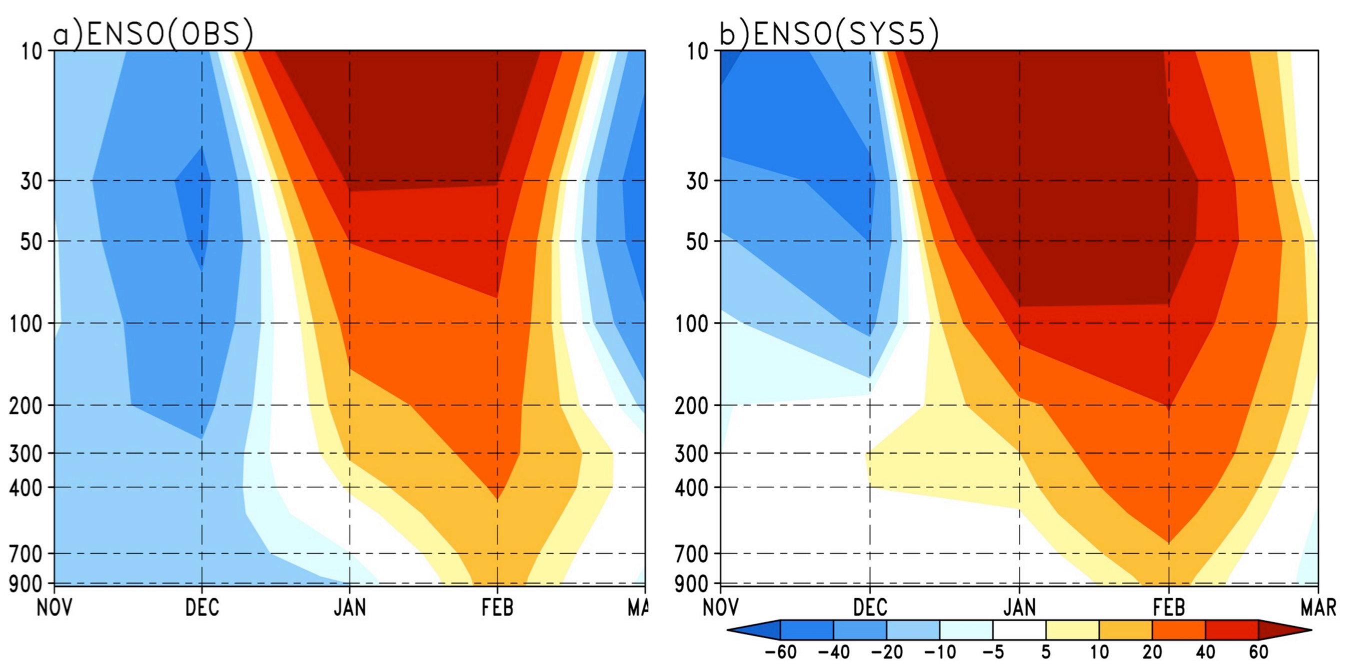


Figure 6: ENSO geopotential height anomalies for a) Observation and b) ECMWF-SYS5 prediction averaged over domain [55:65 °N and 90:270 °E]. Units are m.

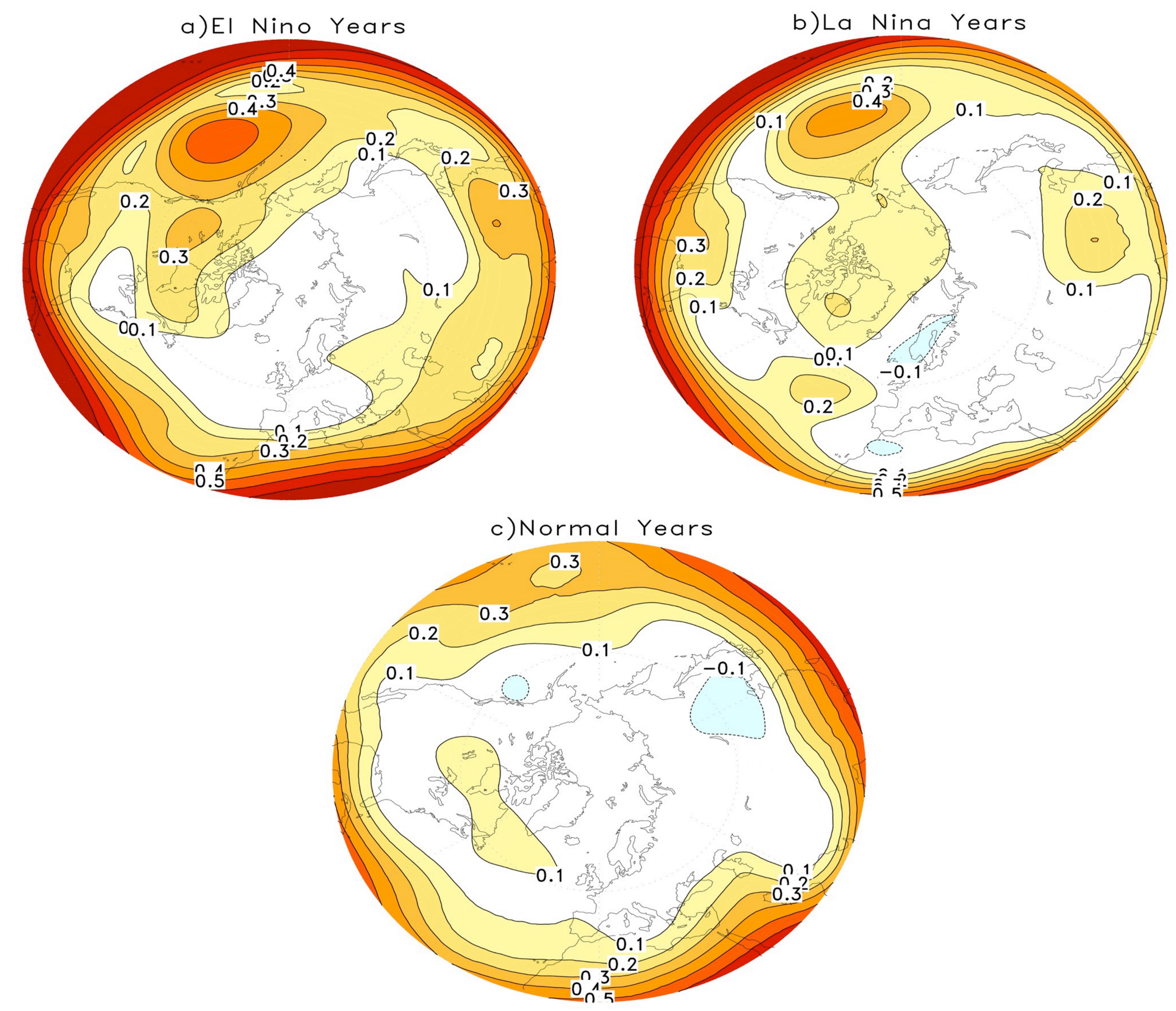


Figure 7: Covariance of the 100-hPa geopotential height anomalies for a) El Niño b) La Niña c) Normal Years.

4) Concluding Remarks

- ECMWF-SYS5 simulated the sub-seasonal prediction skill of the PNA boreal winter anomalies quite well.
- The prediction skill of the polar vortex coincides well with the enhancement of the PNA circulation anomalies prediction skill during the late boreal winter.
- We would like to acknowledge ECMWF and Copernicus (CS3) for the availability of the dataset.