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Evaluating the performance of a global ensemble prediction system over tropics using two different model physics perturbation schemes

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Introduction

An increase in computational resources in NCMRWF had allowed to run the its global Ensemble Prediction System (NEPS-G) at high resolution (~12km ; Mamgain et al. 2020). Still many important physical processes are not resolved. This study is to understand the role of model physics perturbations on the spread of important atmospheric variables during the South Asian summer monsoon period. We started some experiments to quantify the uncertainty due to two available model physics perturbation options (1) Random parameters (RP; Bowler et. al. 2008) and (2) stochastic perturbation physics tendencies (SPT; Sanchez et. al. 2016). Some of the preliminary results are shown here.

NEPS-G and Experimental Setup

In NEPS-G, initial condition perturbations are generated by Ensemble Transform Kalman Filter (ETKF) method. The model uncertainties are taken care by the Stochastic Kinetic Energy Backscatter (SKEB) and RP/SPT schemes. In operational NEPS-G, RP scheme was replaced with SPT scheme in year 2020. Long forecast provided by NEPS-G at 00 UTC is the combination of 11 members from 00 UTC cycle and lagged 11 members from 12 UTC cycle. So total 22 perturbed members forecast at 12 km resolution are considered. The results shown here are only based on the role of model physics perturbation. Therefore, we used same initial condition to all the perturbed ensemble members.

Results

Sample Size: Day 1 to Day 7 Forecast valid for 1st June to 6th June 2021 with 22 perturbed members
Variables : Temperature at 850 hPa (T_850) , Zonal wind at 850 and 200 hPa (U_850 and U _200), meridional wind at 200hPa (V_200)
Area of study: Tropics (23.5°S to 23.5°N), Mid-Latitudes (23.5°N to 60°N)

Spread-RMSE

Tropics

T_850 U_850 U_200 V_200

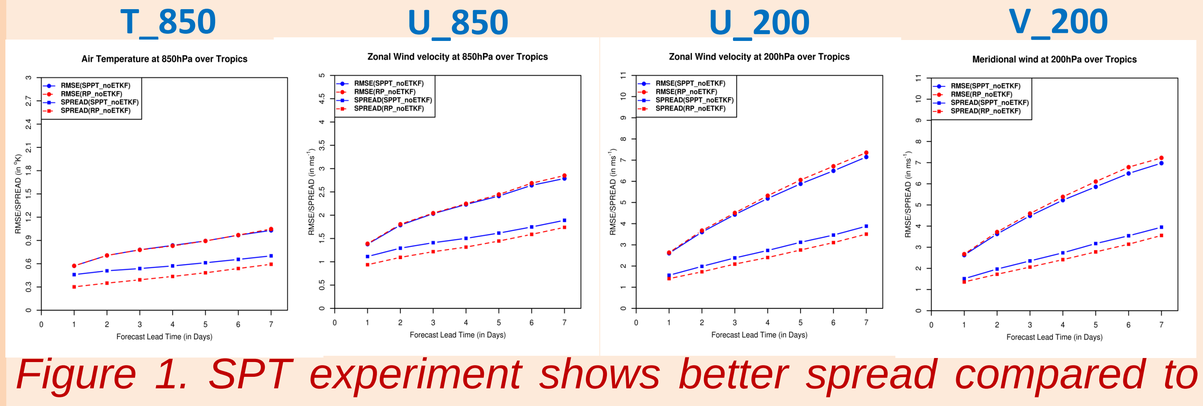

Figure 1. SPT experiment shows better spread compared to RP in all the selected variables. Small improvement in RMSE of 200hPa wind components with SPT experiment is noticed .

Mid-latitudes (Northern)

T_850 U_850 U_200 V_200

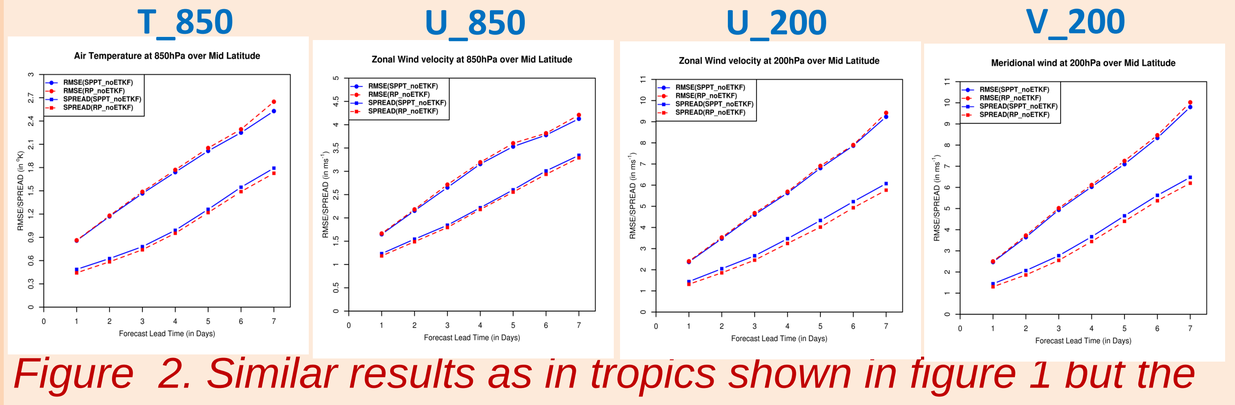

Figure 2. Similar results as in tropics shown in figure 1 but the improvement in SPT experiment is comparatively less in mid-latitudes.

The continuous ranked probability score (CRPS)

Tropics

T_850 U_850 U_200 V_200

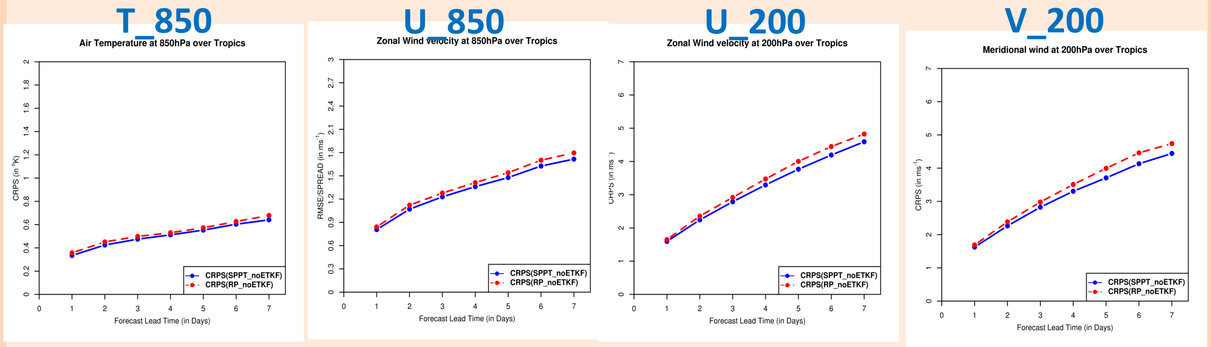

Figure 3. CRPS is better in SPT experiment particularly for 200hPa wind as compared to the surface level

Mid-latitudes (Northern)

T_850 U_850 U_200 V_200

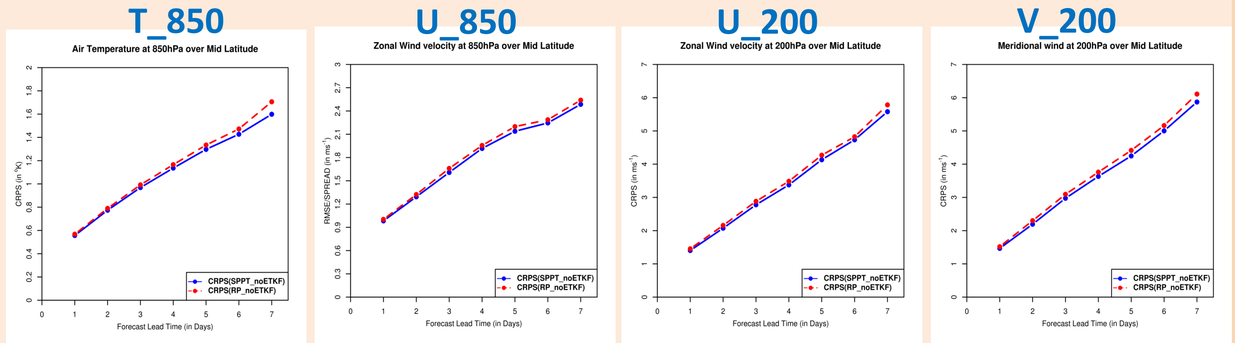

Figure 4. SPT experiment related CRPS shows a smaller improvement in midlatitudes as compared to the tropics

DAY 1 Forecast of Spread ratio (SPPT/RP)

T_850 U_850 U_200 V_200

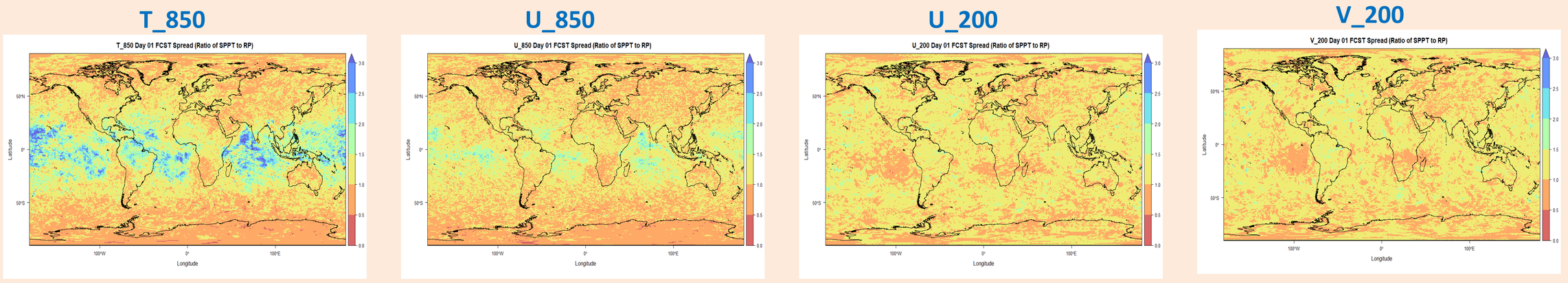

Figure 5. Spread ratio is higher for the tropics as compared to the rest of the regions at 850hPa in Day 1 forecast.

Conclusion

Better performance of SPT over RP simulations in the spread of T850, U850, U200 and V200 has been noticed over the tropics as compared to the extra tropics. CRPS is also improved in case of the SPT experiment. We have planned for more set of sensitivity experiments for a larger set of sample size and model evaluation using both the initial condition and model physics perturbations in future.

References

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