Identify Potential to Improve Ensemble Sub-seasonal Precipitation and Temperature Forecasts With Deep Learning

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1. Introduction

Artificial Intelligence / Machine Learning (AI/ML) technology has demonstrated many advantages over traditional statistical methods and has been successfully used to improve weather-climate forecast skill in recent decades. At the NOAA Climate Prediction Center (CPC), AI/ML technology has been used to model the relationships between the dynamical model forecasts and observed climate variables, such as week 3~4 precipitation and temperatures, and explore the potential to improve sub-seasonal forecasts with the NCEP CFSv2, GEFSv12 and ECMWF ensemble dynamical forecasts. As the byproducts of our research, the results here will provide some insights in the two important aspects for the architectures of sub-seasonal to seasonal (S2S) ensemble forecast systems that may potentially impact the sub-seasonal predictability of the ensemble forecast systems: (1) how each individual member be generated and (2) intervals (temporal resolutions) of initialization (e.g. forecasts issued on daily, twice per week or once per week). The analysis and exploration here may be benefit for designing future S2S ensemble forecast systems.

2. Deep Learning System

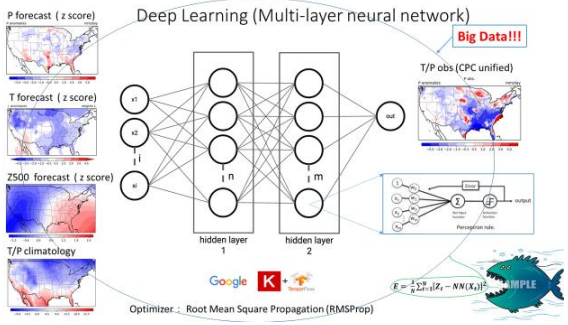

Fig. 1 Flexible and non-linear DL system.

3. Applications

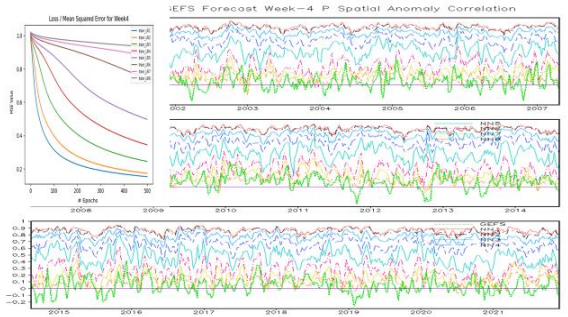

Fig.2 DL system can perform very good fitting.

Fig.3 Independent forecasts show clearly overfitting.

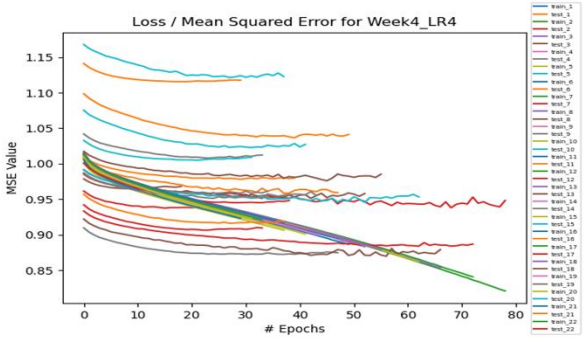

Fig.4 Cross-validation (20+ years) presents large spread in forecast skills.

4. Validation across individual members

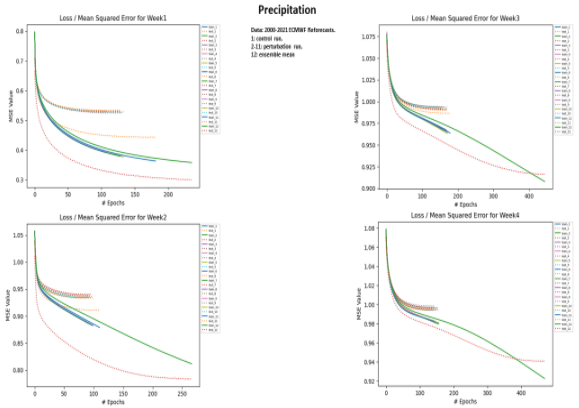

Fig.5 Precipitation: validation across individual members

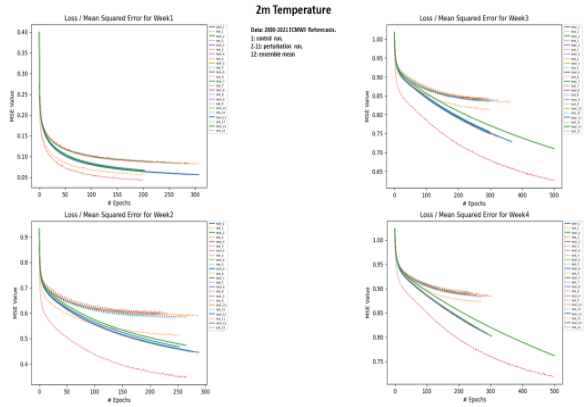

Fig.6 2m Temperatures: validation across individual members

5. Using more initial conditions

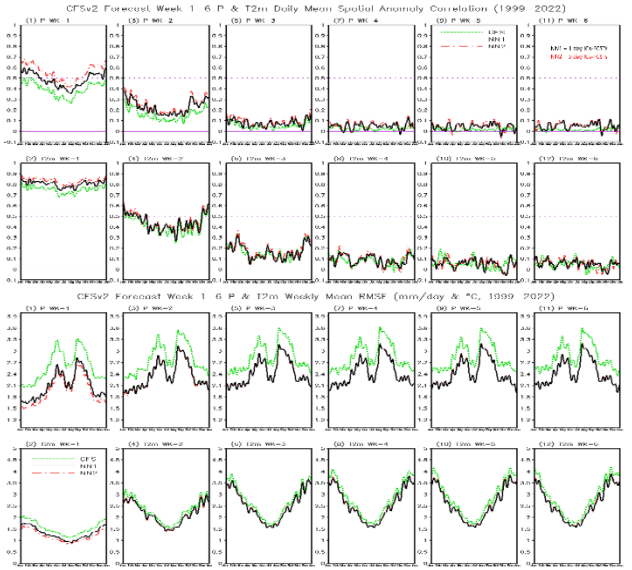

Fig.7 Daily mean Week1-6 P/T2m spatial anomaly correlation & RMSE.

6. Summary

1. DL advantages: Flexible nonlinear tool & Easy to handle BIG DATA
2. Unique & beneficial NN architectures: Non-linear impact, pattern relationship and co-variability
3. DL can perform more sophisticate corrections to improve sub-seasonal P & T2m forecasts
4. ML as a diagnostic tool – identify potential to build better S2S ensemble forecast systems

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