Utility of Teleconnection Based Neural Network Forecast Tools for Temperature and Precipitation Outlooks

46th Annual Climate Diagnostics and Prediction Workshop

Lightning Talk

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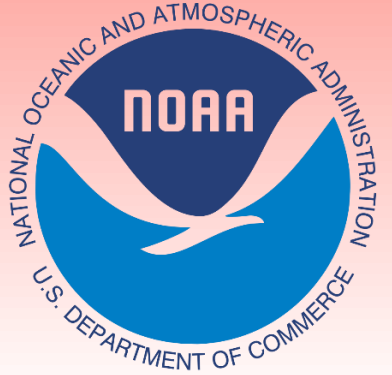
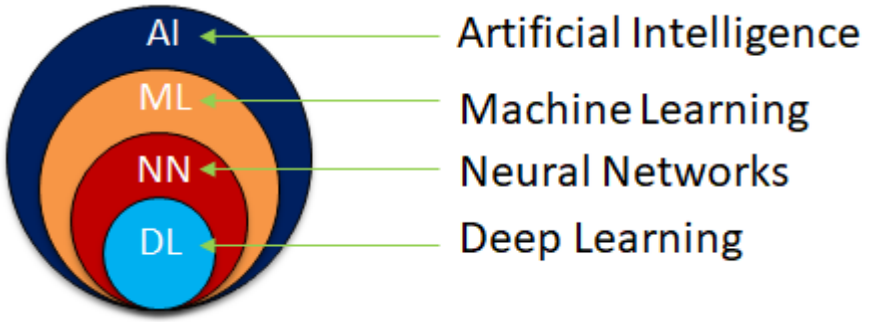


Review of Basic Machine Learning Principals

- Machine Learning (ML) in the Atmospheric Sciences aims to synthesize complex relationships (i.e. non-linear) between fields into a useable model.

- This is achieved by finding the optimal weighting of the inputs of a model to maximize its accuracy in predicting the output (target).



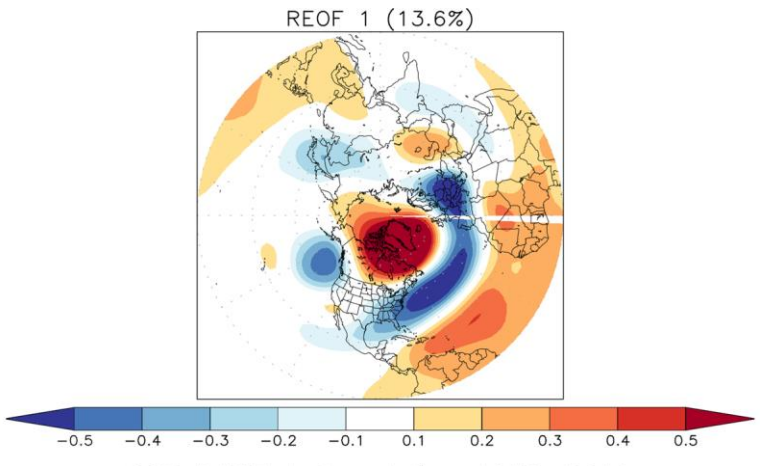
Project Framework

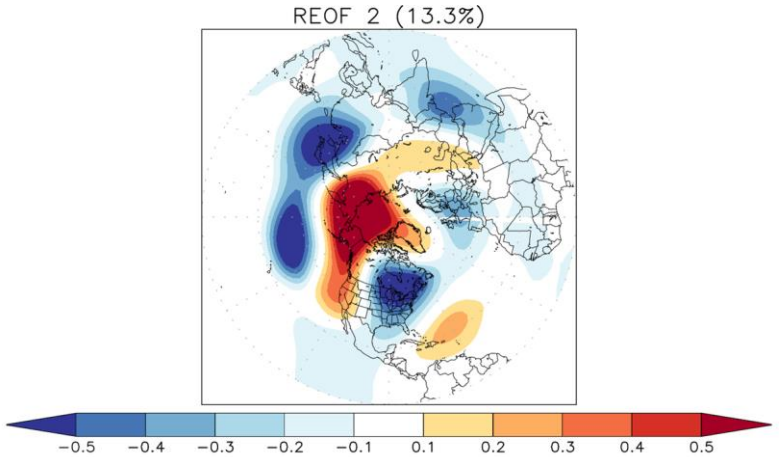
Co-collaborators:
Kyle MacRitchie and
Matt Rosencrans

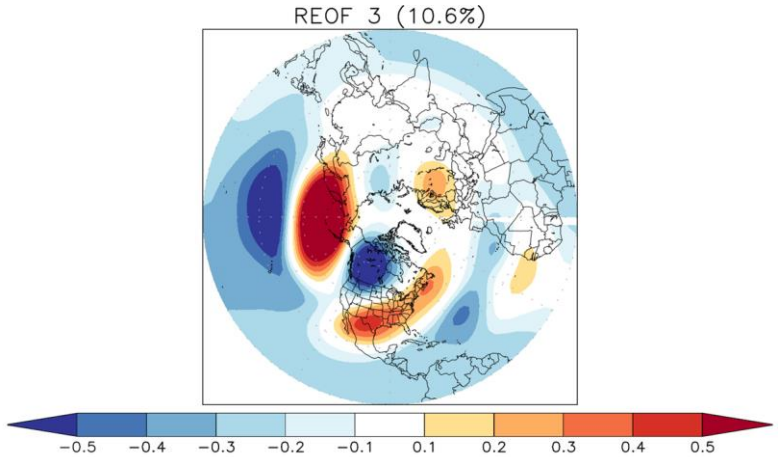
Theory to Test: Machine learning (ML) algorithms can be used to relate large scale teleconnection patterns to surface temperature and precipitation. Current numerical models have better skill predicting geopotential heights than surface variable, thus there is skill to be gained.

Experiment Design: Use an artificial neural network (ANN) that optimizes the skill of Week 3/4 temperature and precipitation forecasts.

- **Inputs:** Principal component (PC) forecasts of the leading teleconnection patterns (based on Baxter's rotated EOFs)
- **Targets:** Week 3/4 Temperature and Precipitation Observations







Project Flowchart

GEFS z200 Ensemble Week 3/4 Mean Anomaly Forecast

ECWMF z200 Ensemble Week 3/4 Mean Anomaly Forecast

GEFS/ECMWF z200 Week 3/4 Anomaly Forecast

Pre-set NDJ leading EOFs (~75% variance explained)

PC 1 Value

PC 2 Value

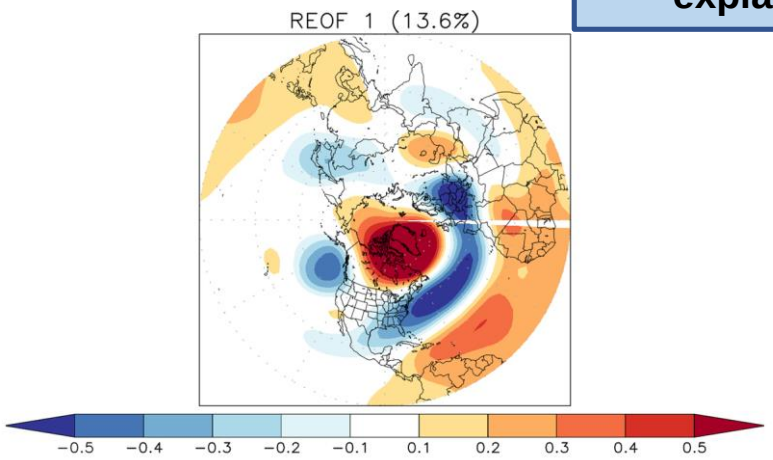
. . .

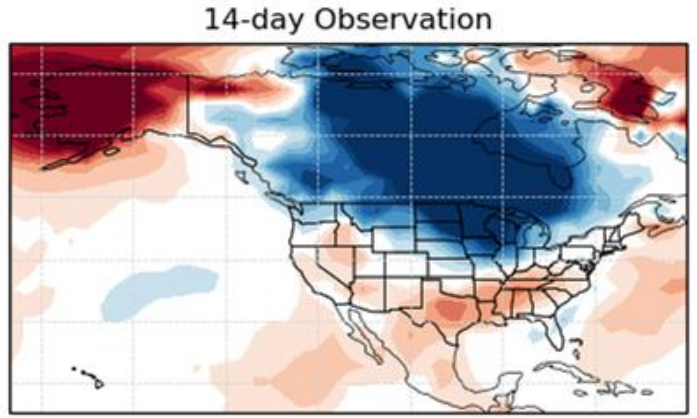
PC 8 Value

Hidden Layer

. . .

Target: Observed Week 3/4 Temperature/ Precipitation grid points





General Goal: Experimentally develop a model for Week 3-4 temperature/precipitation consolidation that uses ensemble forecasts from the ECMWF and GEFSv12 as predictors. Conduct evaluations and comparison with CPC's existing model consolidations.

Neural Network Testing:

- The NN uses the 8 NDJ PC values calculated from the GEFSv12/ECMWF Week 3-4 ensemble mean as predictors for the associated Temperature/Precipitation fields.
- Training (200 samples): Wednesdays between 10/15/2000 and 10/21/2015.
- Testing (51 samples): Wednesdays between 10/28/2015 and 1/9/2019.
- Observations: CPC Observation data set
- Domain: CONUS/AK.
- Try both deterministic and probabilistic output

Example Output Example

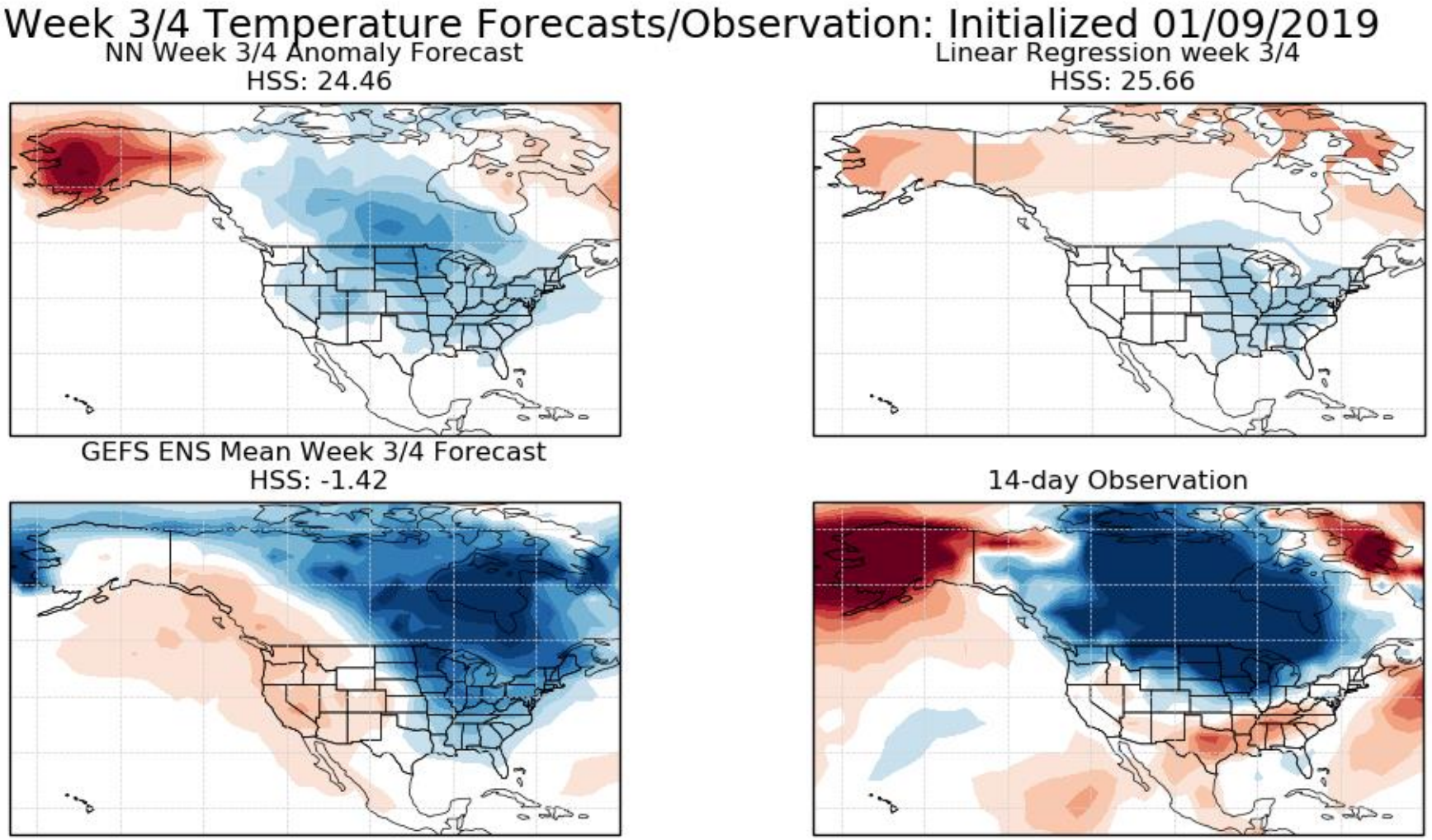


Figure 2. Example for a deterministic temperature forecast/observation sample. Scoring over the CONUS and Alaska (Last example, just happened to be a good one)

Skill Results for the testing dataset

2-category HSS for 51 testing samples:

	Temperature	Precipitation
Deterministic NN	19	6.0
Probabilistic NN	18	2.0
Linear Regression	19.2	7.5
GEFS/ECMWF Blend	24.2	8.3

Simple 50/50 blend of the ensemble mean of each model

Summary/ Ongoing Investigation

- Summary:
  - This investigation demonstrates the utility of ML in S2S forecasting and teleconnections as predictive features, but this simple model does not provide additional skill to traditional methods.
  - Much knowledge gained about ML and how to structure and run experiments in Python.
- Do PCs offer additional information to GEFS/ECMWF temperature forecasts?
- Any Utility on the Seasonal?