A Probabilistic Load Forecast System Based on the Analog Ensemble Method

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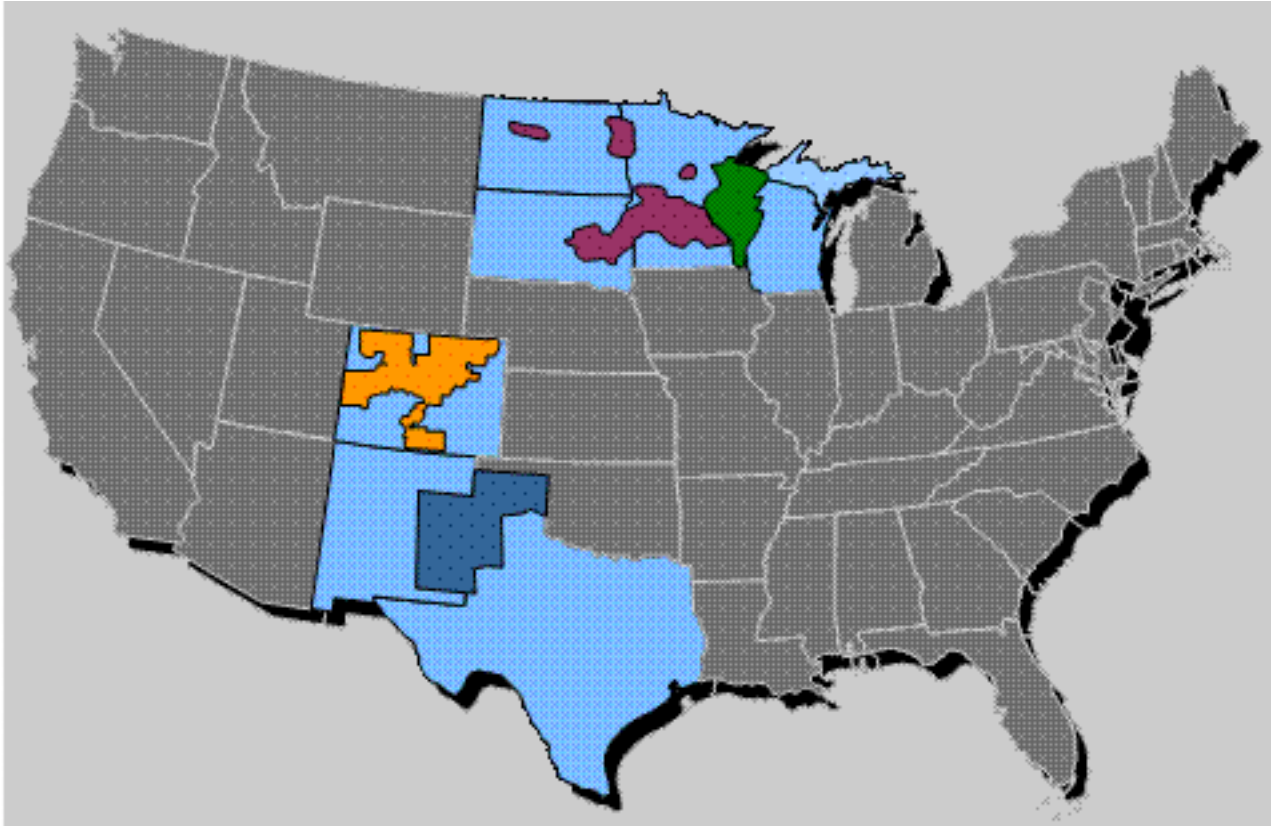
Introduction

- The prediction of electrical demand (load) is essential for daily operation and planning activities of electrical utilities (grid stability, energy market etc.)
- The Analog Ensemble (AnEn) model will be tested together with a Neural Network (NN) model to generate load probabilistic forecast (short term,1-3 days ahead)
- The tests have been carried out on a 6-month period for the Public Service Company of Colorado (PSCO), service area in Colorado
- Some scores for assessing the quality of NN+AnEn forecast will be shown

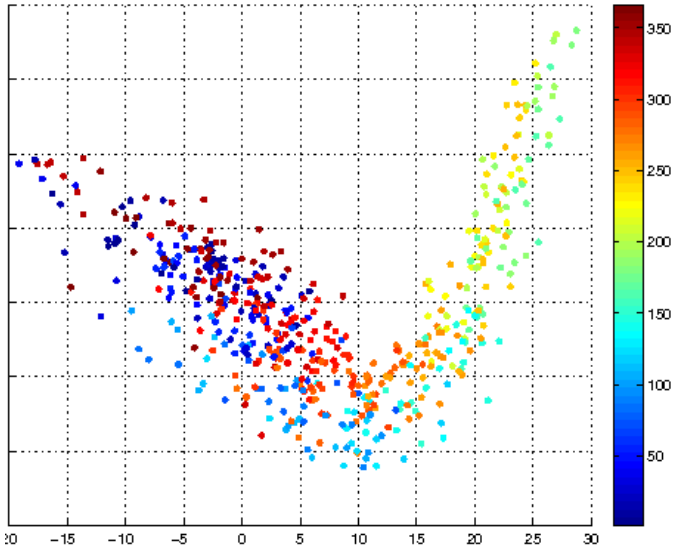
PSCO service area



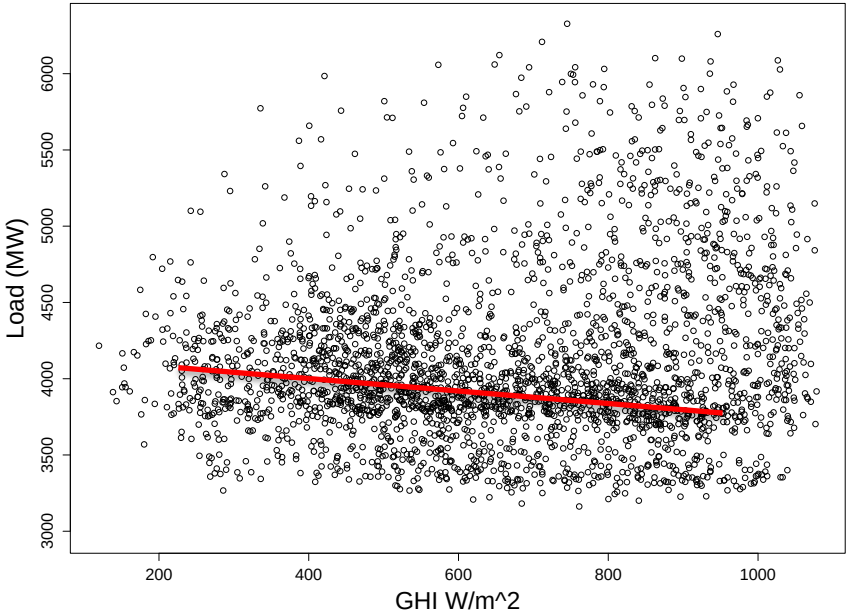
- Load hourly data from Xcel for the period 20120901-20140930 of PSCO service area (orange shaded)

Forecasting electricity Load: relationship with meteorology

- Dependency on temperature and solar radiation



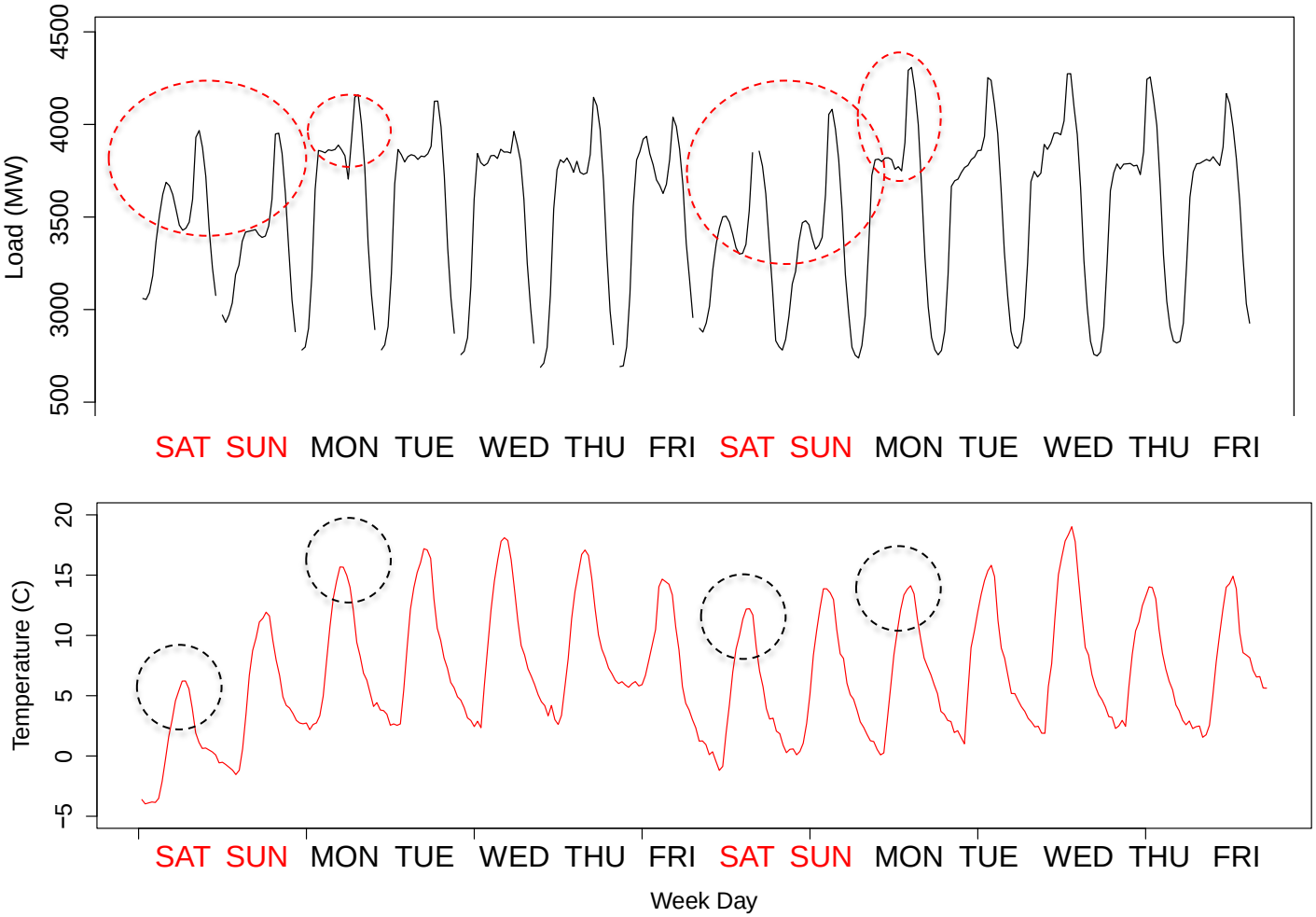
Net load vs. temperature at 8 Pm , colored by Julian Day



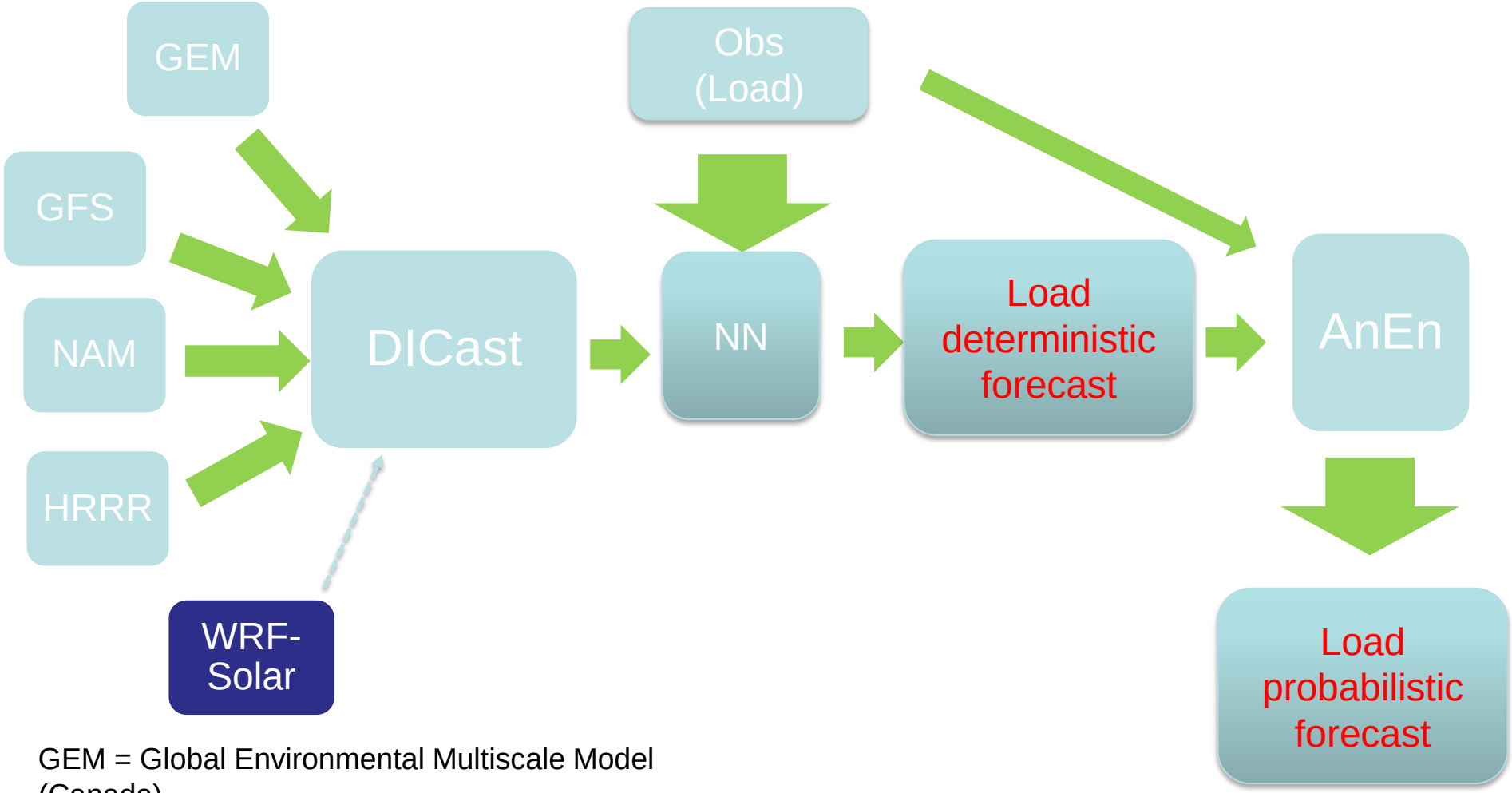
Net load vs. radiation (GHI) at 760 days, 2-5 PM

Forecasting electricity Load: daily cycle, weekly cycle

- Dependency on temperature, daily cycle and weekly cycle overlapped

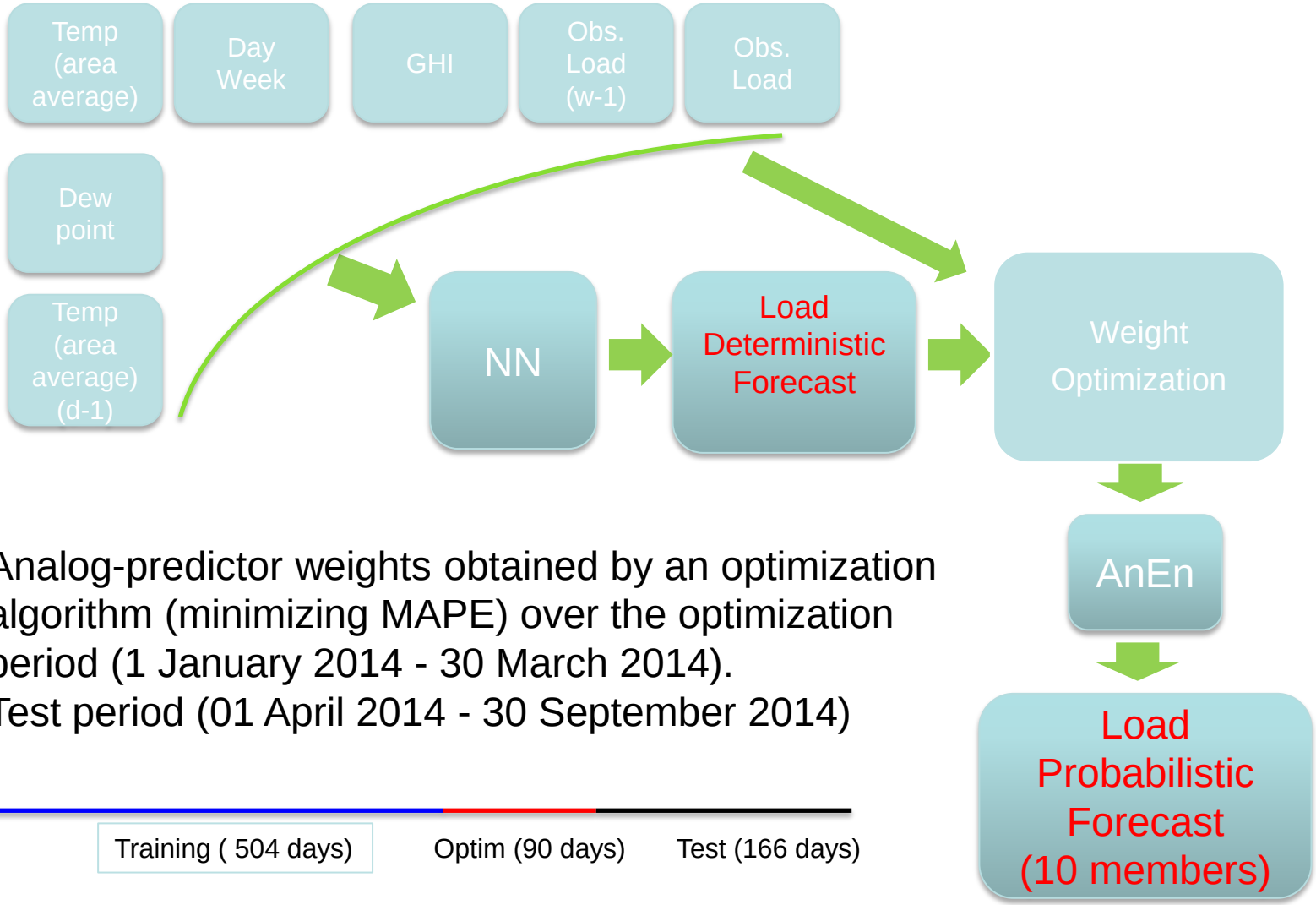


Modeling System



GEM = Global Environmental Multiscale Model (Canada)
GFS = Global Forecast System (US NWS)
NAM = North American Model (US NWS)
HRRR = High Resolution Rapid Refresh (ESRL)

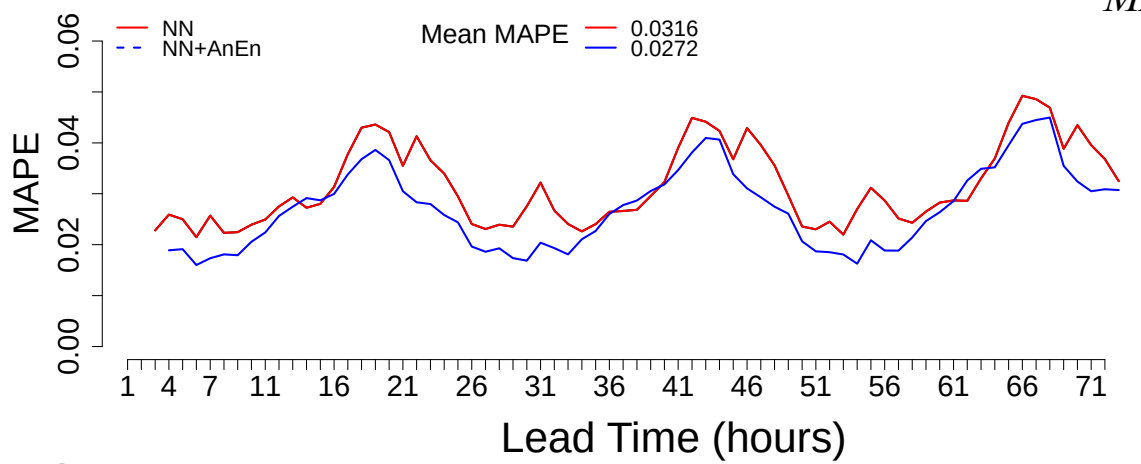
NN and AnEn configurations



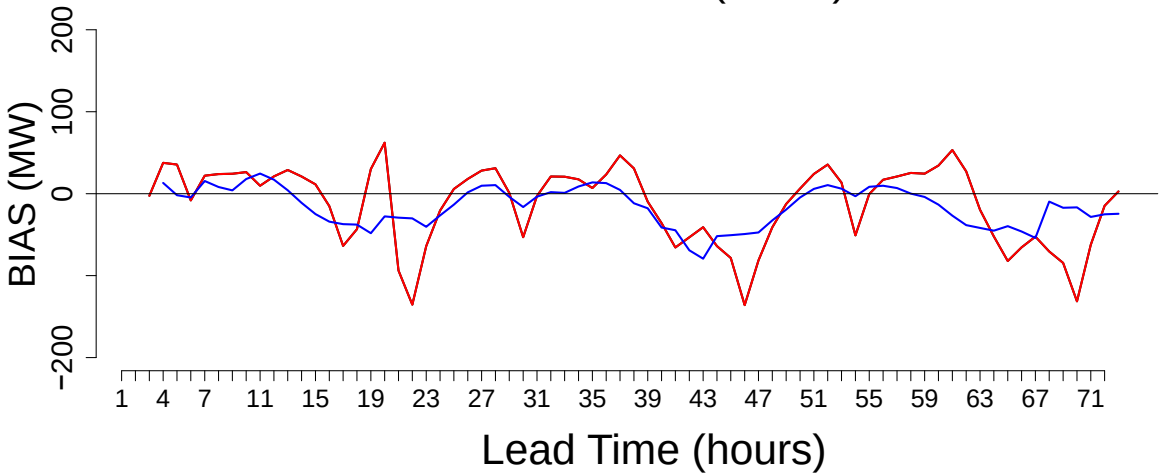
Analog-predictor weights obtained by an optimization algorithm (minimizing MAPE) over the optimization period (1 January 2014 - 30 March 2014).
Test period (01 April 2014 - 30 September 2014)

NN and NN+AnEn, MAPE and BIAS

$$MAPE = 100 \times \left\langle \frac{|obs - forecast|}{obs} \right\rangle$$

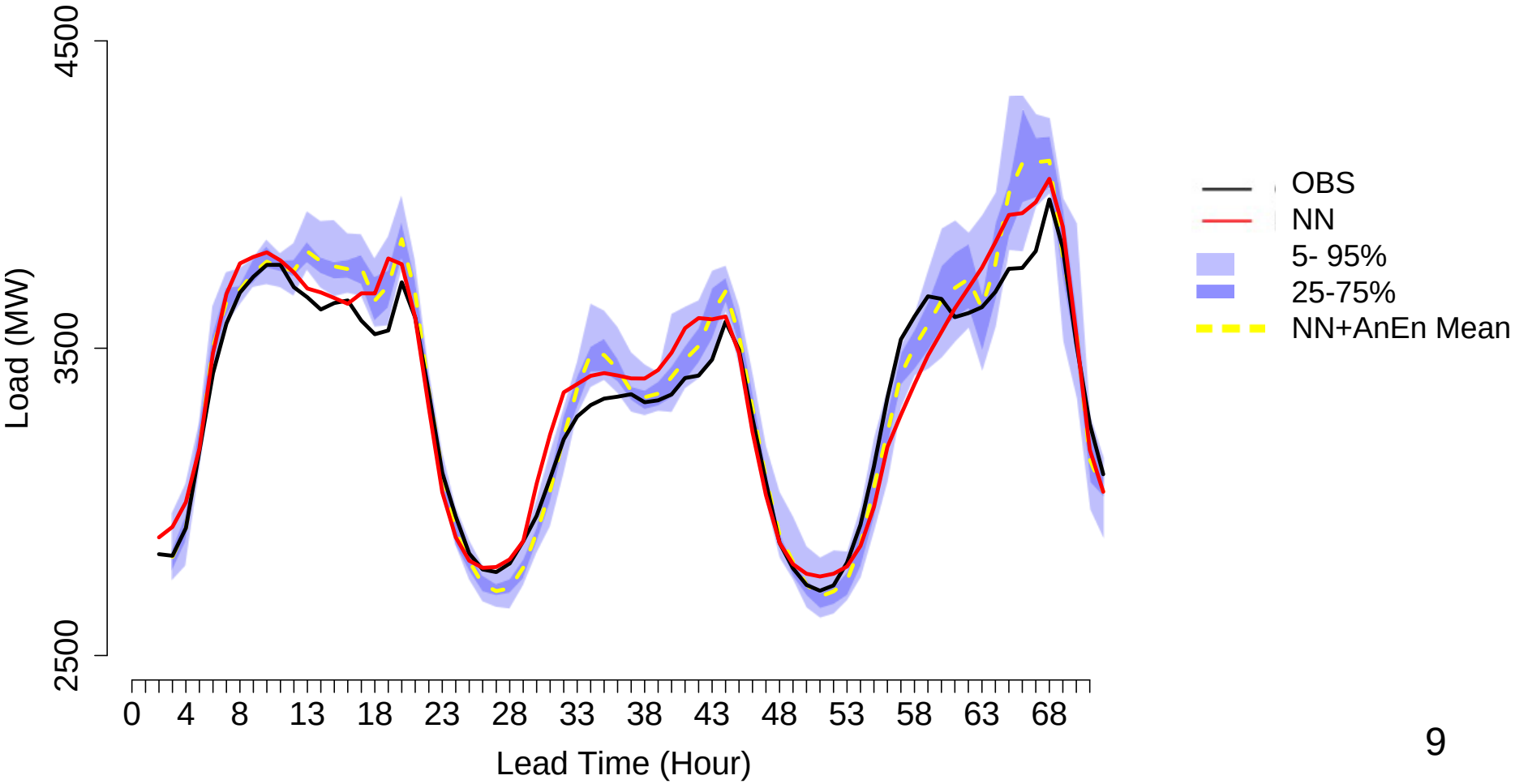


$$BIAS = \langle forec \rangle - \langle obs \rangle$$

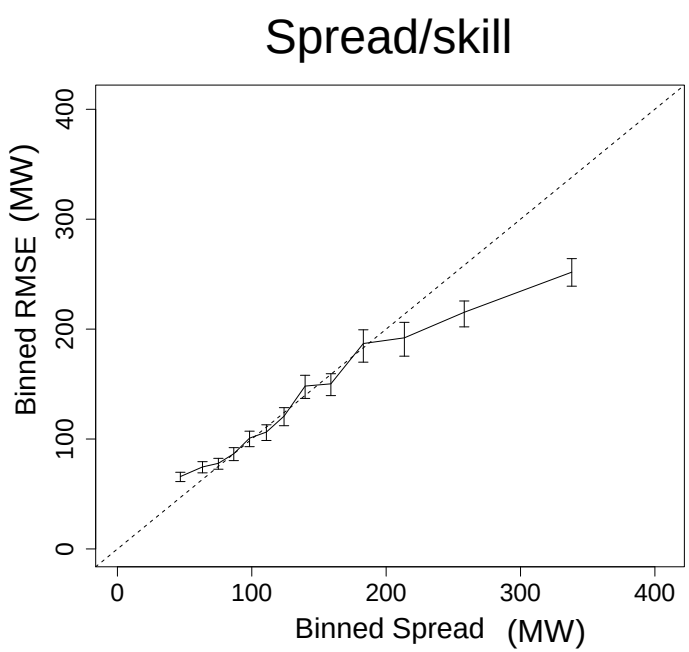


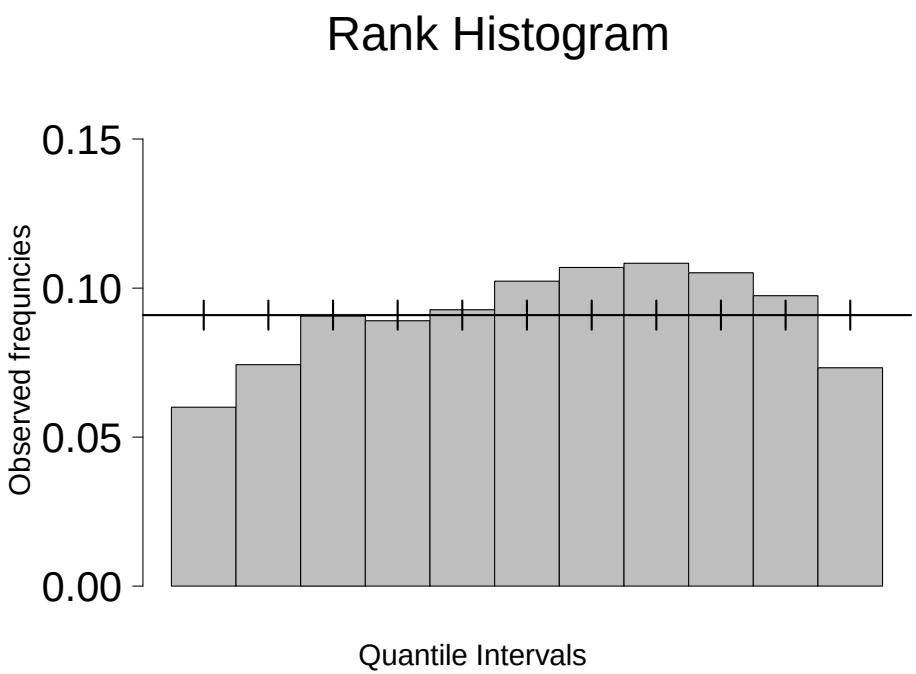
Conclusion: AnEn+NN mean improves NN in terms of MAPE (~ 14%) and BIAS

Results: Time series example: NN+AnEn, NN



NN+AnEn: Statistical consistency

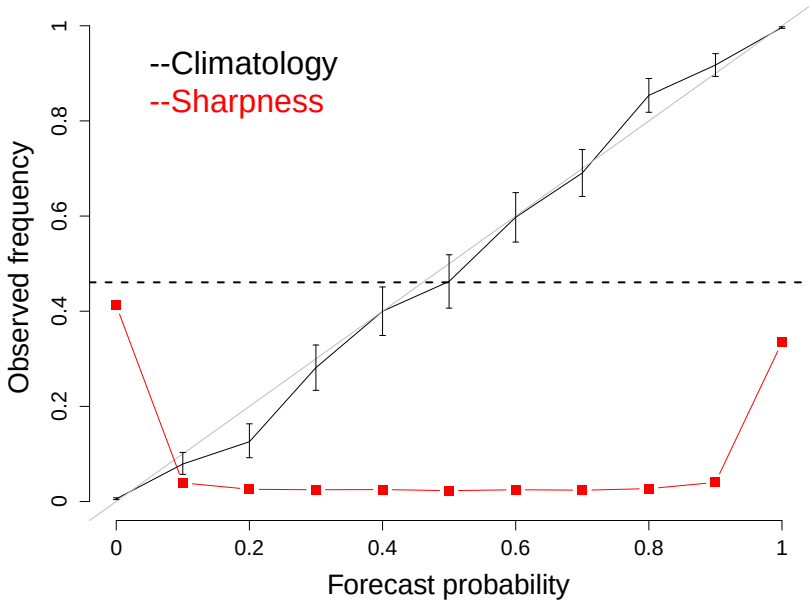




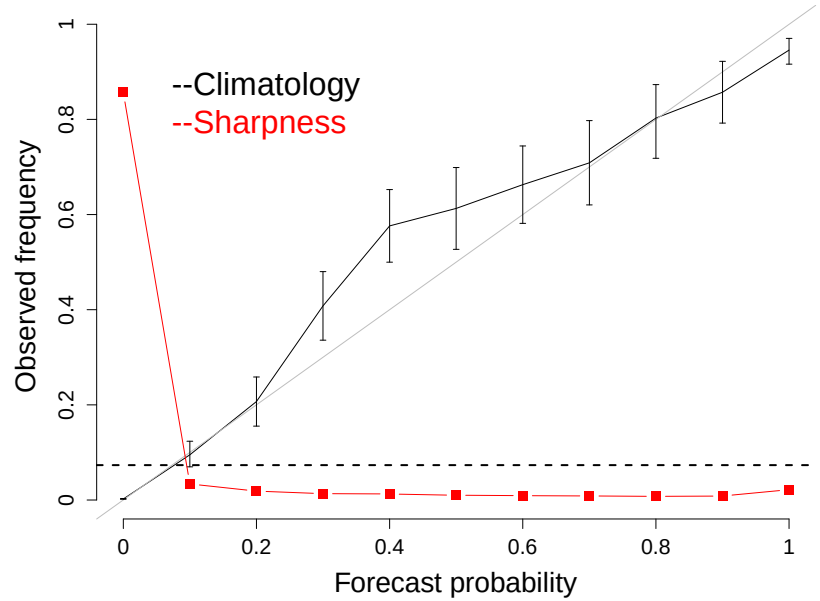
Conclusion: Slightly over dispersive, increasing time window for AnEn search could help

NN+AnEn: Reliability and Sharpness

Event: Load> 3800 MW



Event: Load> 5000 MW



Summary and Future Work

- Preliminary results of NN+AnEn performance were analyzed on a ~594-day long training period and 166-day long verification period over PSCO service area of Colorado (US)

Results:

- NN+AnEn mean performs better than NN on deterministic prediction (lower MAPE)
- NN+AnEn adds probabilistic load predictions to a deterministic systems (NN)

Future work:

- Tests with longer verification periods
- Tests with a higher time window for analog searching. When forecasting variables with a strong daily cycle (as load) this could help in improving quality of probabilistic forecasting