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Tutorial Session: June 4-6 Scientific Workshop: June 8-10

RPN

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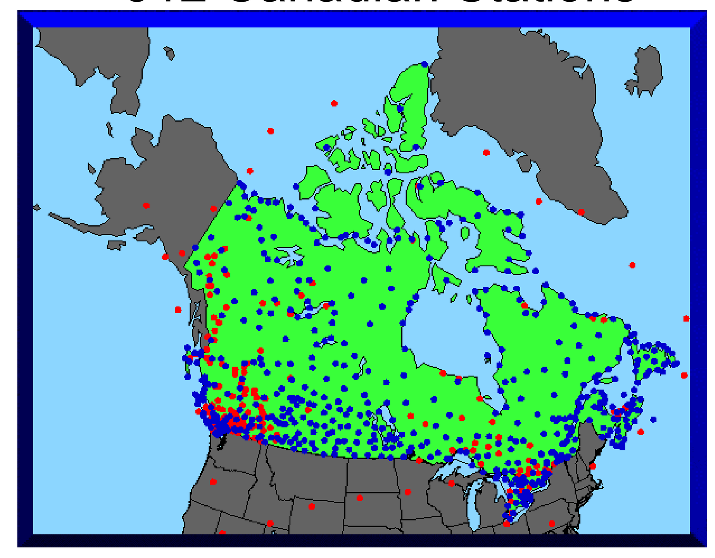
A block bootstrapping method for verification of the Canadian NWP model

Justification:

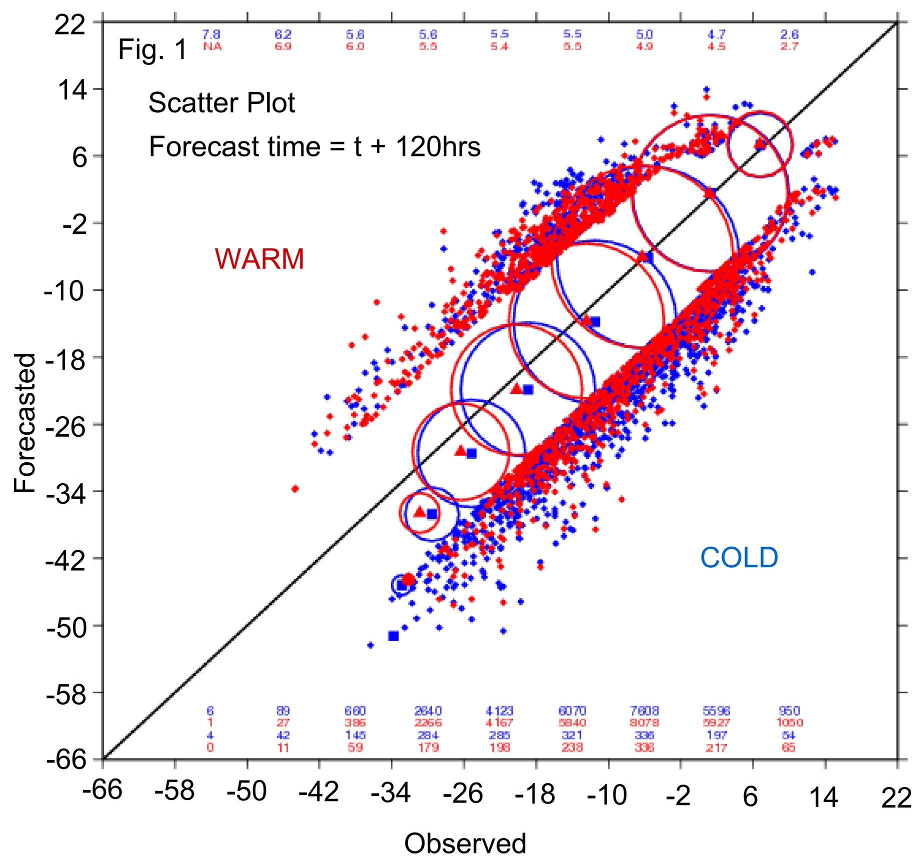
Meteorological data are correlated both in space and time. To deal with these correlations, data is treated in blocks. Blocks consist of the entire estimate population over a given number of days. The bootstrap methods will randomly sample over the blocks.

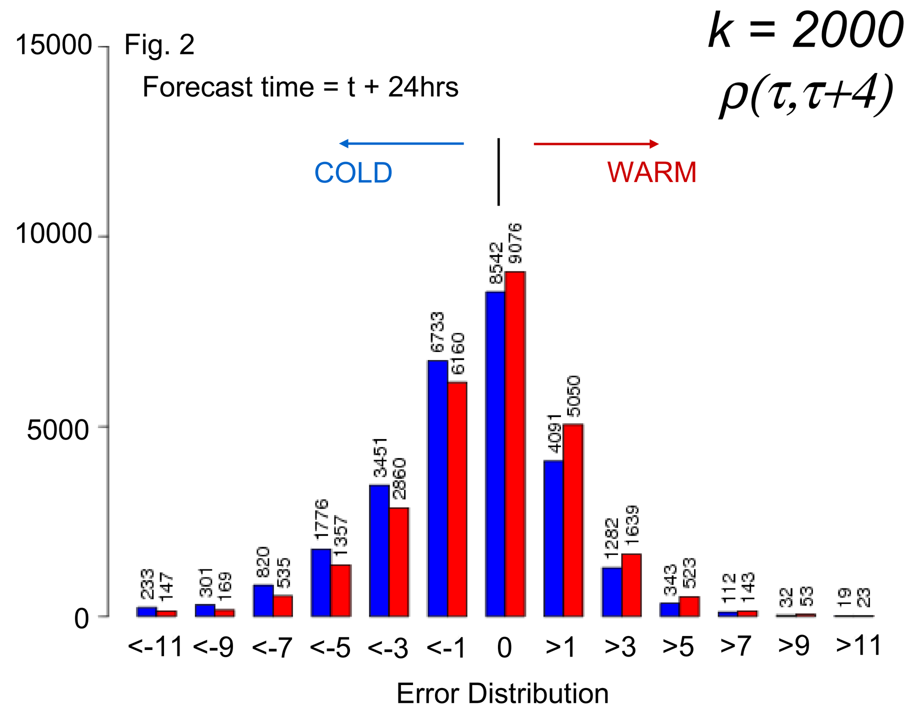
512 Canadian Stations



Verification Period	00 GMT model run
20 December 2006 to 28 February 2007	Proposed model (red); Operational model (blue)

Surface Temperature (2 m)





- $\hat{F}$ = estimate of the probability distribution F, from the data set $(x_1, x_2, x_3, ..., x_n)$

$\hat{F}^1 \rightarrow (x_1^1, x_2^1, x_3^1, ..., x_n^1)$ x_i^1 = set 1 of n members, some members randomly appearing zero, once, twice, etc

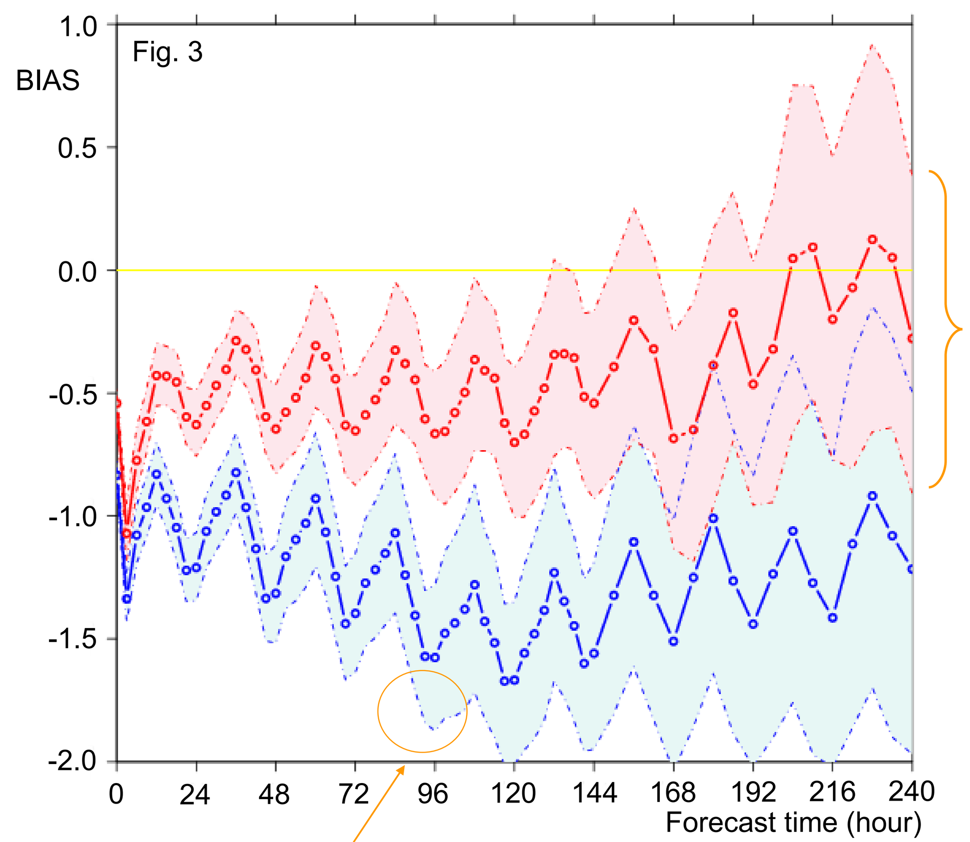
$\hat{F}^2 \rightarrow (x_1^2, x_2^2, x_3^2, ..., x_n^2)$ x_i^2 = set 2 of n members, some members randomly appearing zero, once, twice, etc

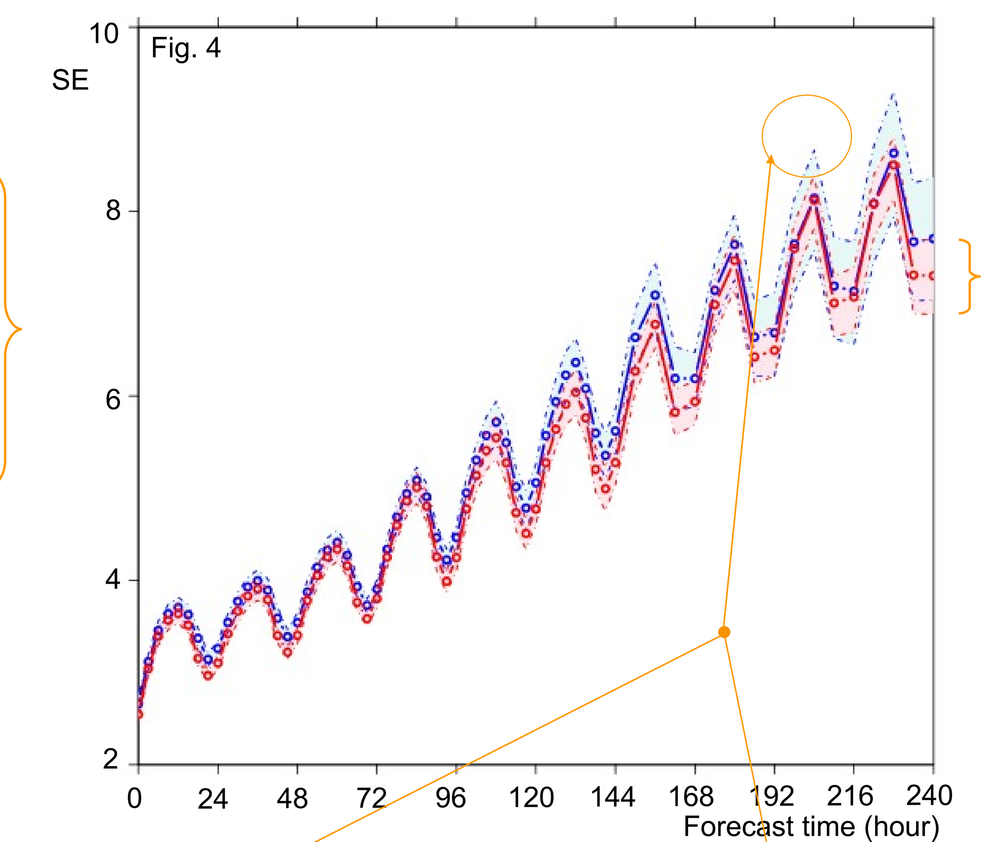
$\hat{F}^3 \rightarrow (x_1^3, x_2^3, x_3^3, ..., x_n^3)$ x_i^3 = set 3 of n members, some members randomly appearing zero, once, twice, etc

⋮

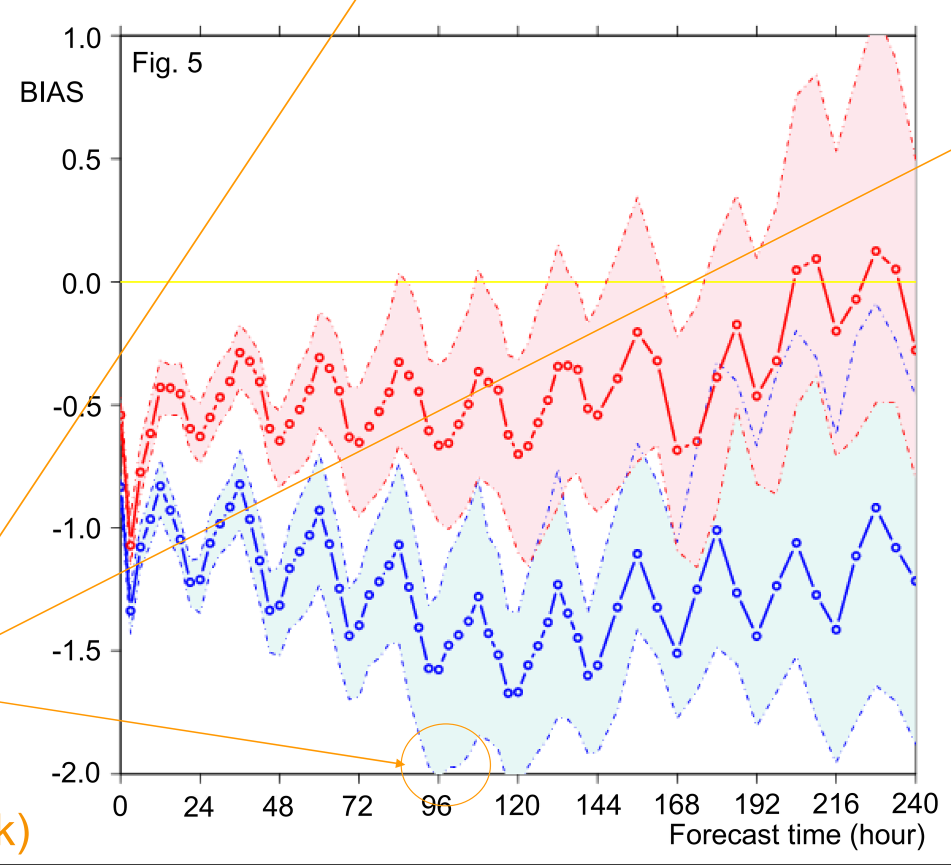
$\hat{F}^k \rightarrow (x_1^k, x_2^k, x_3^k, ..., x_n^k)$ x_i^k = set k of n members, some members randomly appearing zero, once, twice, etc

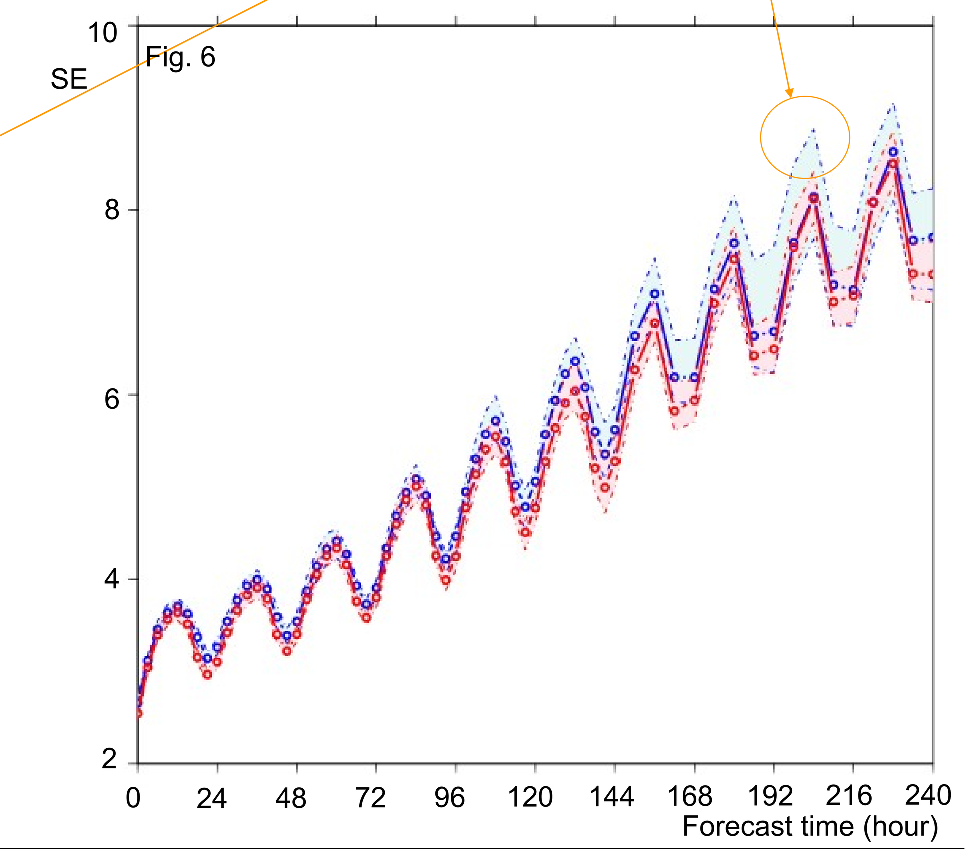
$k = 2000$ $\rho(\tau,\tau+4)$





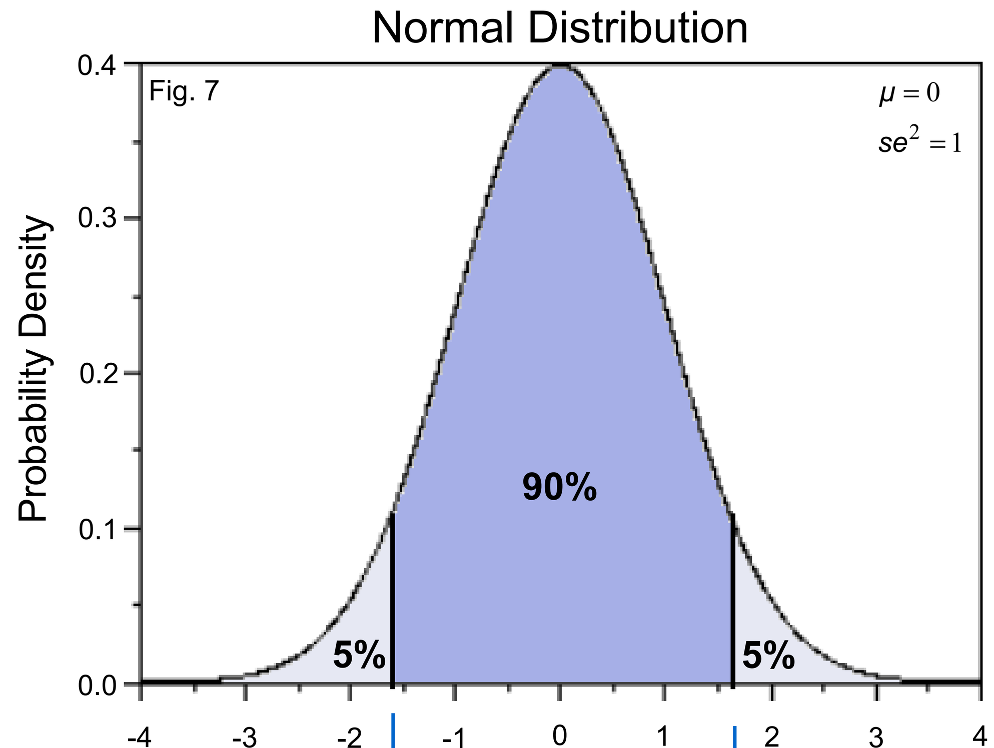
$k = 20$ $\rho(\tau,\tau+4)$

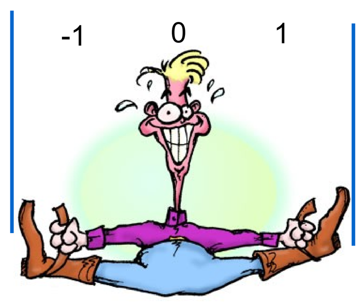




Effect with a small number of bootstrap (k)

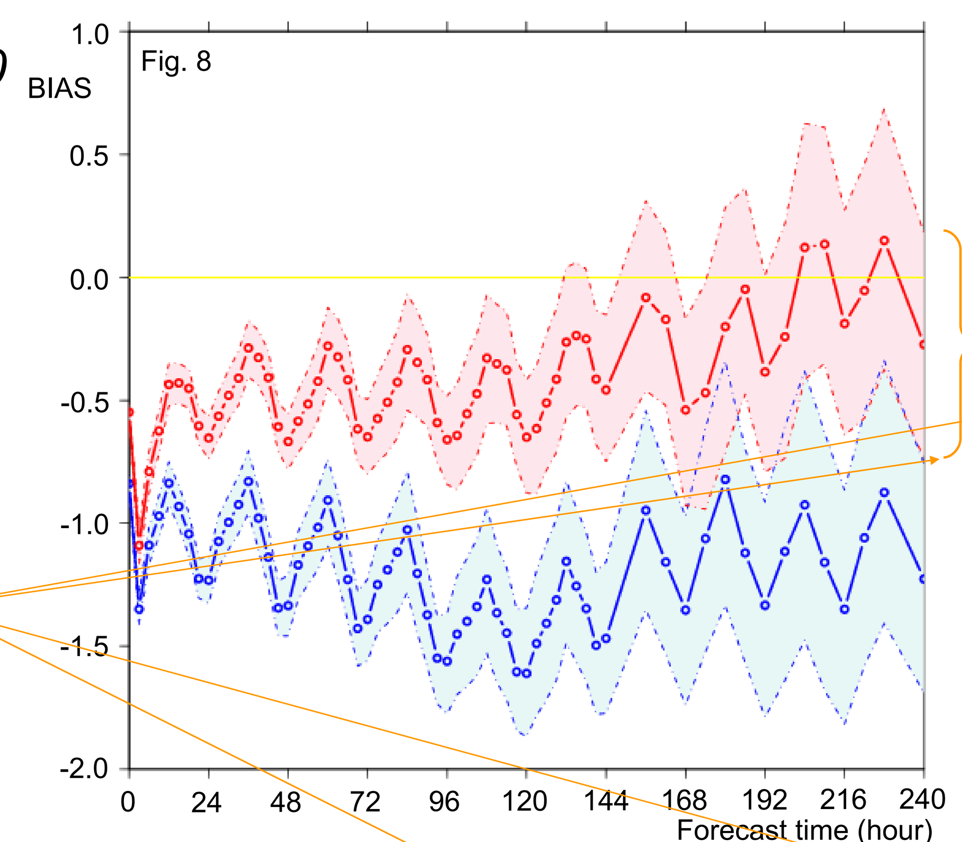
Normal Distribution

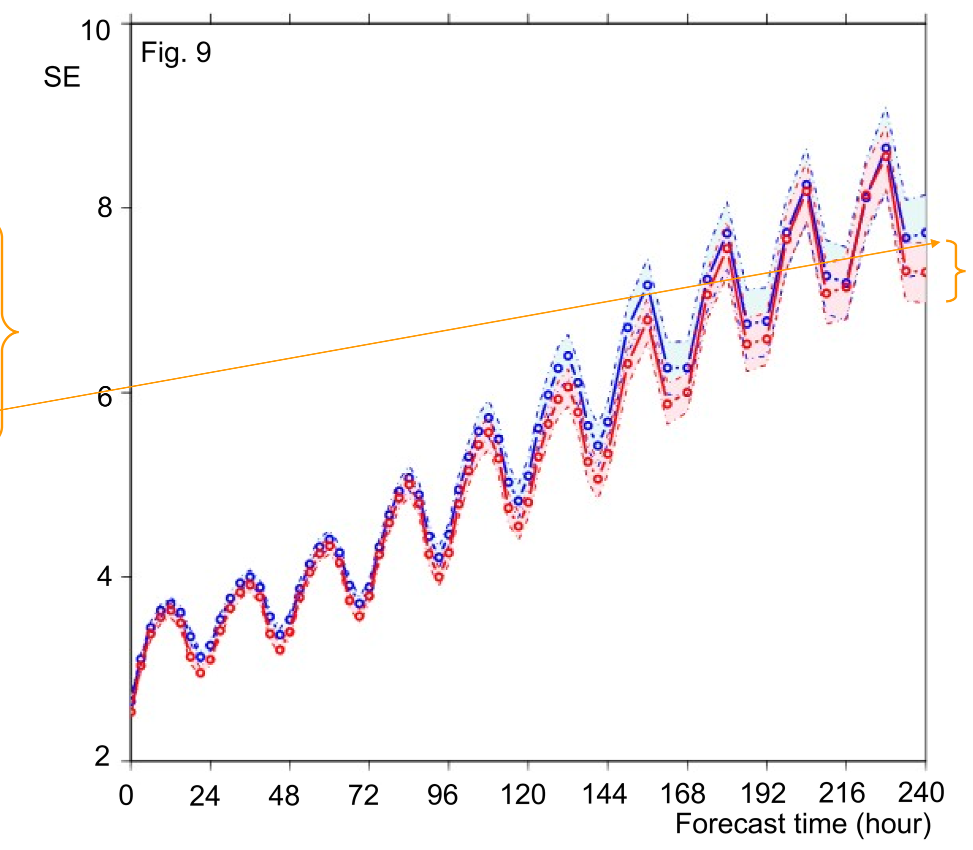




Confidence interval

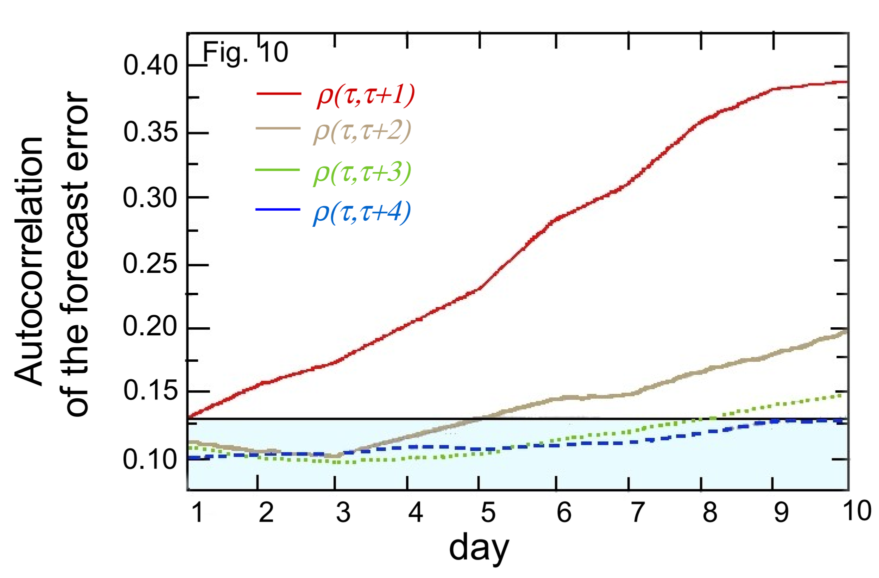
$k = 2000$ $\rho(\tau,\tau+1)$





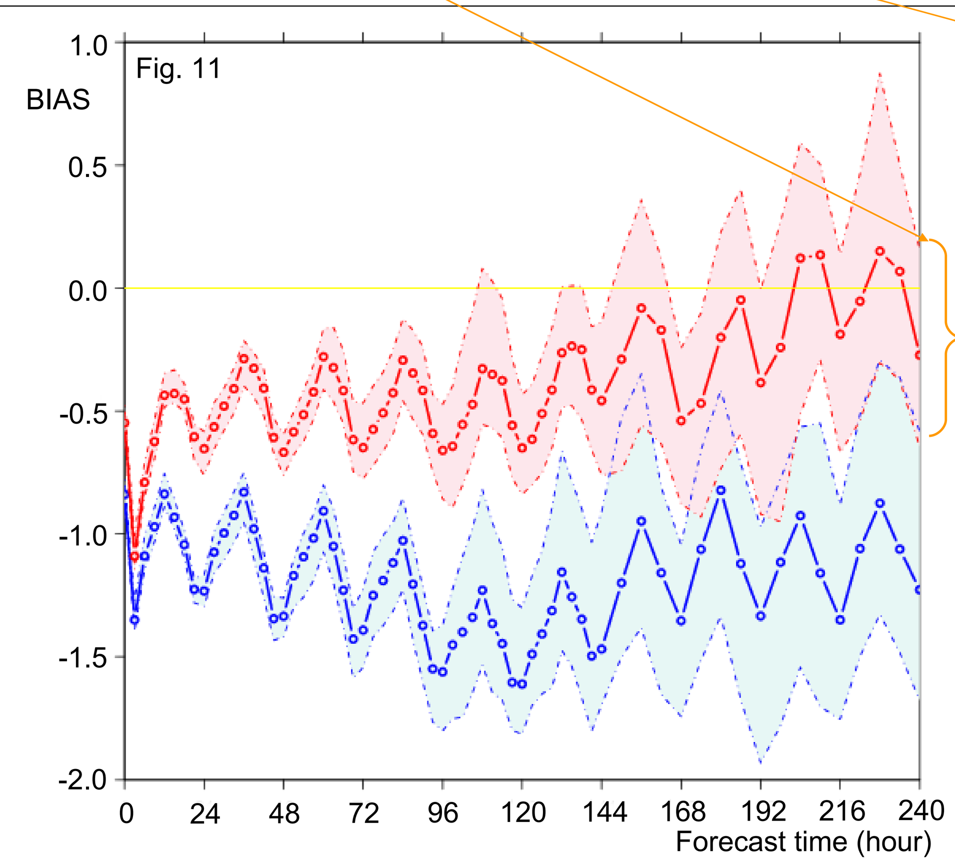
The spread (90% confidence interval) is larger as the forecast time increases

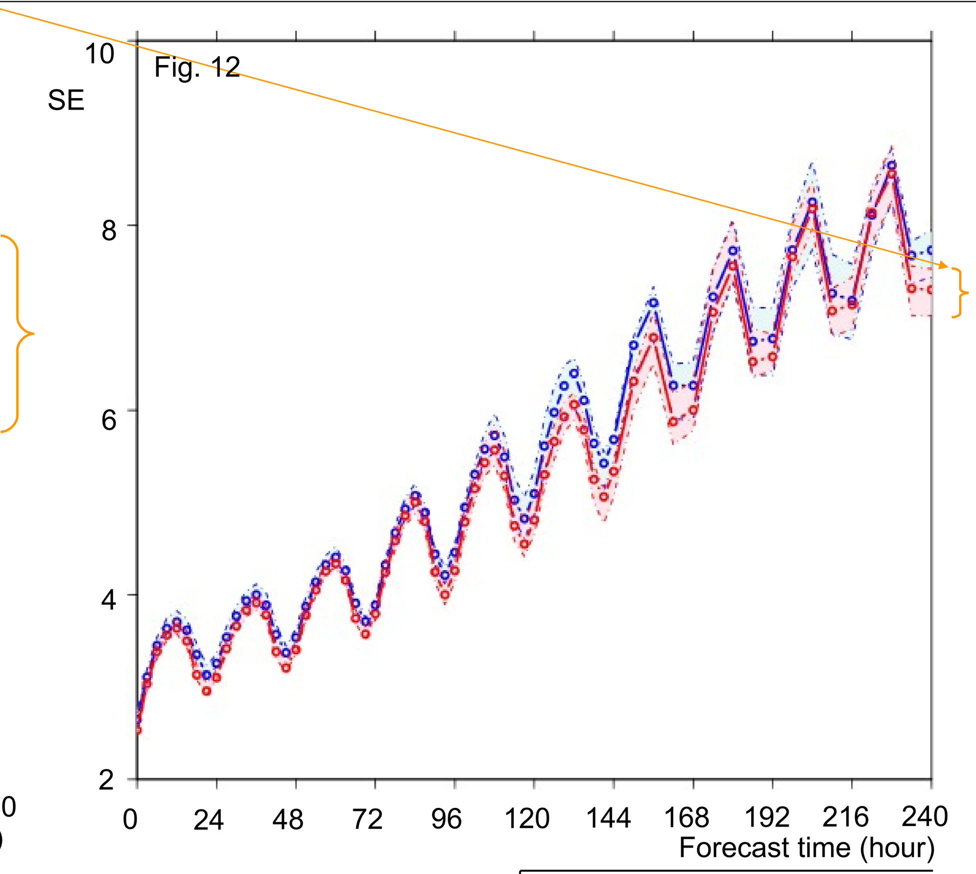
Ensemble mean of EPS vs Temperature radiosonde at 850 hPa, September 10th, 2005



(Candille G. et al: Verification of an Ensemble Prediction System against Observations, Monthly weather review, **135**, 2688-2699)

$k = 20$ $\rho(\tau,\tau+1)$





$$Bias = \frac{1}{n}\sum_{i=1}^{n}(F_i - O_i)$$

$$\text{Standard Error} = SE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(F_i - O_i)^2 - Bias^2}$$

From 0 to 144 hours, scores are every 3 hours, and every 6 hours thereafter. Solid lines represent the score and the dash line represent the 5% confidence interval (lower bound) and the 95% confidence interval (upper bound.)

Conclusion:

- It is always essential to first visualize the data (quality control).
- Verify whether the errors fellow the expected distribution.
- The block bootstrapping is sensitive to the number of bootstrap (spatial correlation) and number of days (temporal correlation). Comparison of Fig. 3 and Fig. 8 shows that it is necessary to use a longer τ for a longer forecast times.