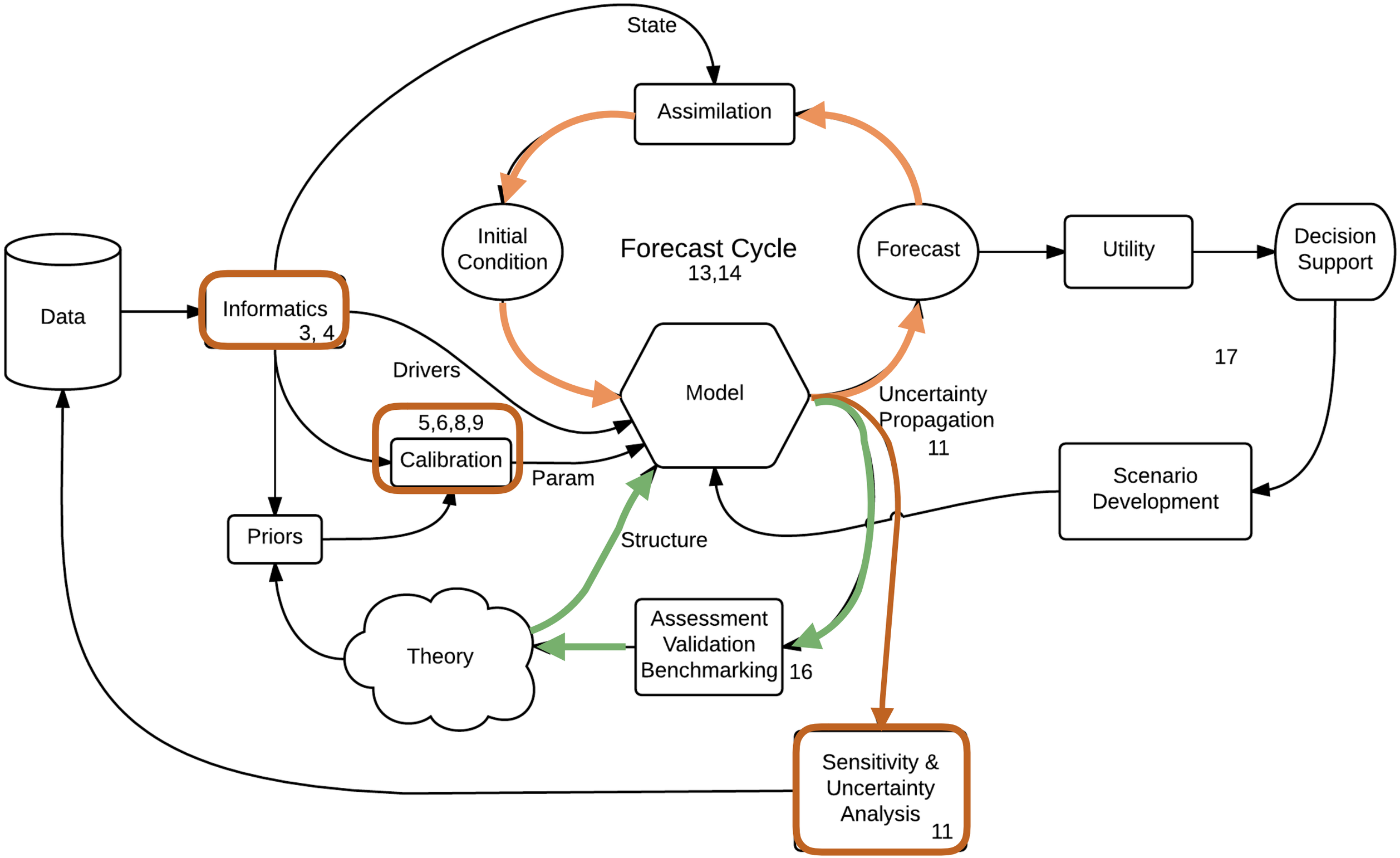
Assessing Model Performance

Lesson 11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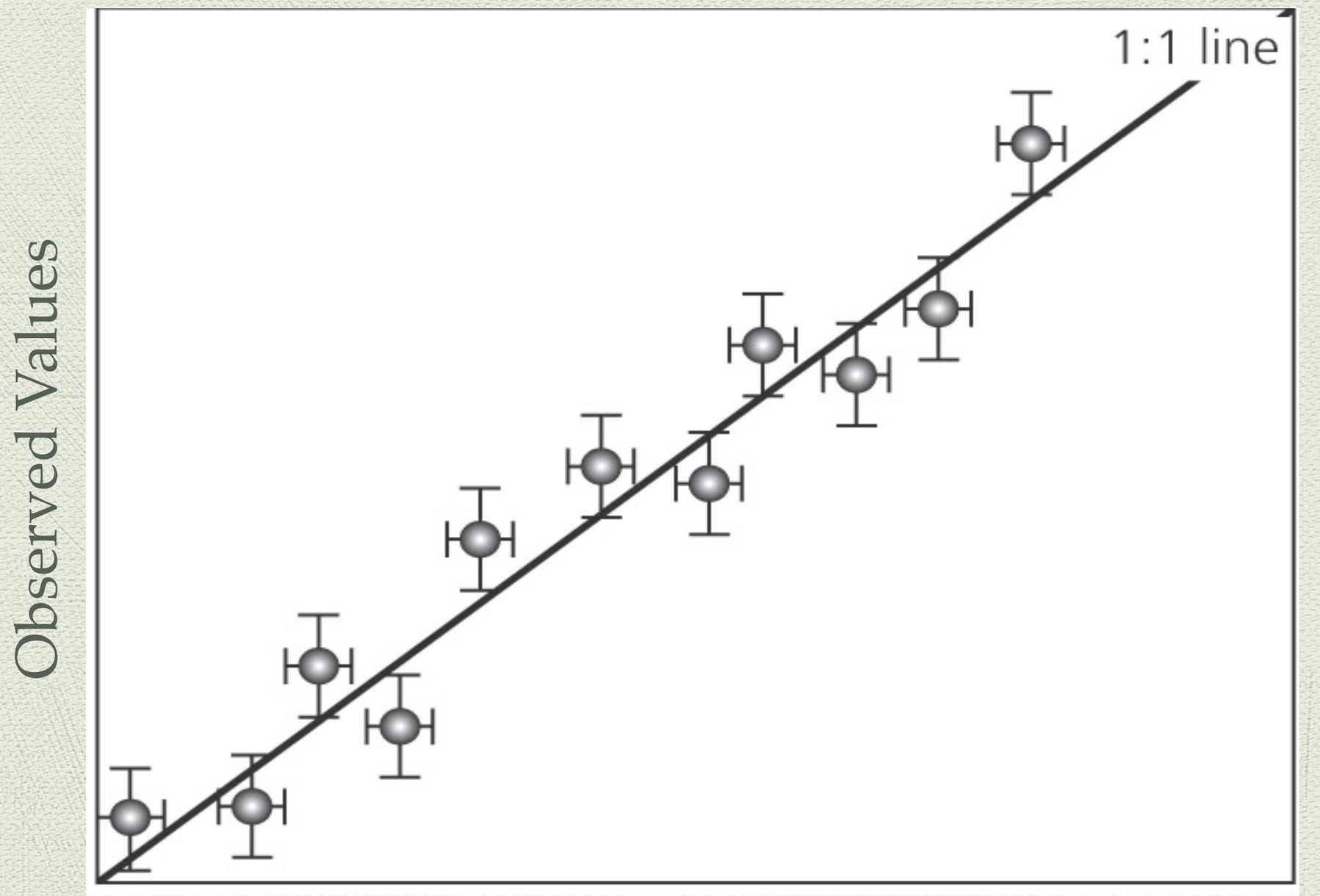
- Range of values
- Units
- General pattern in time & space

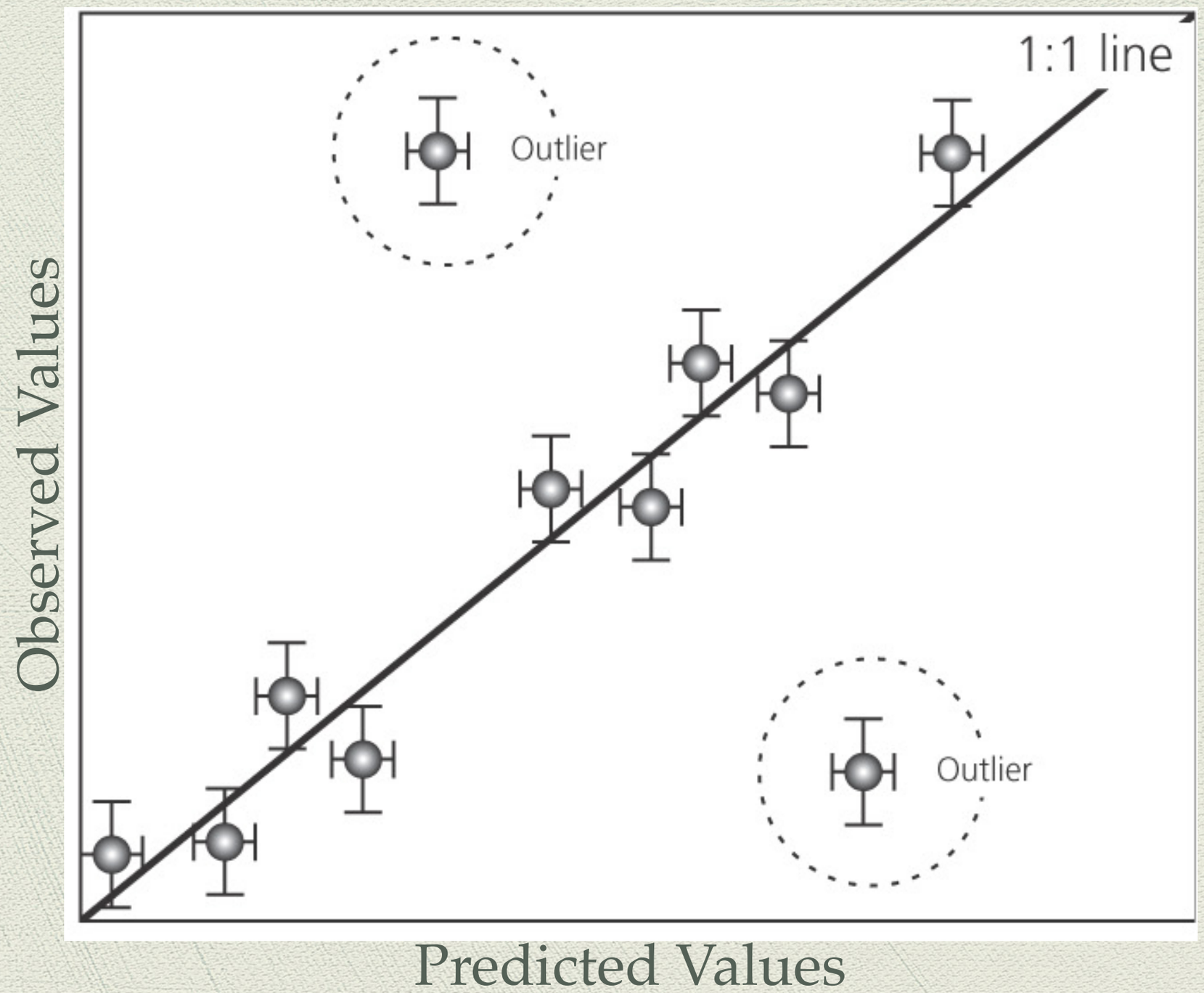
Step 1: Is the model output reasonable?

Step 2: Graphical comparisons to data

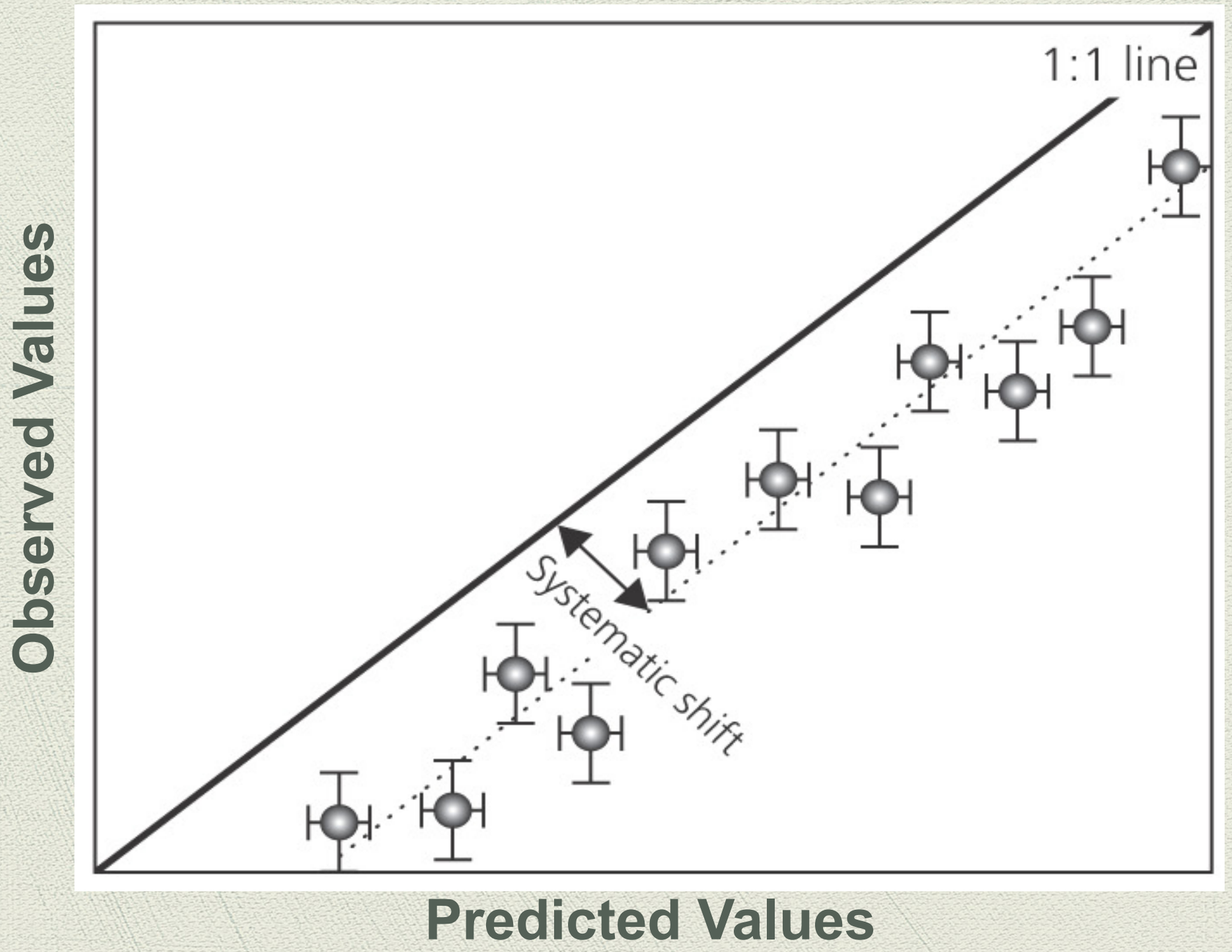
Accuracy of Prediction



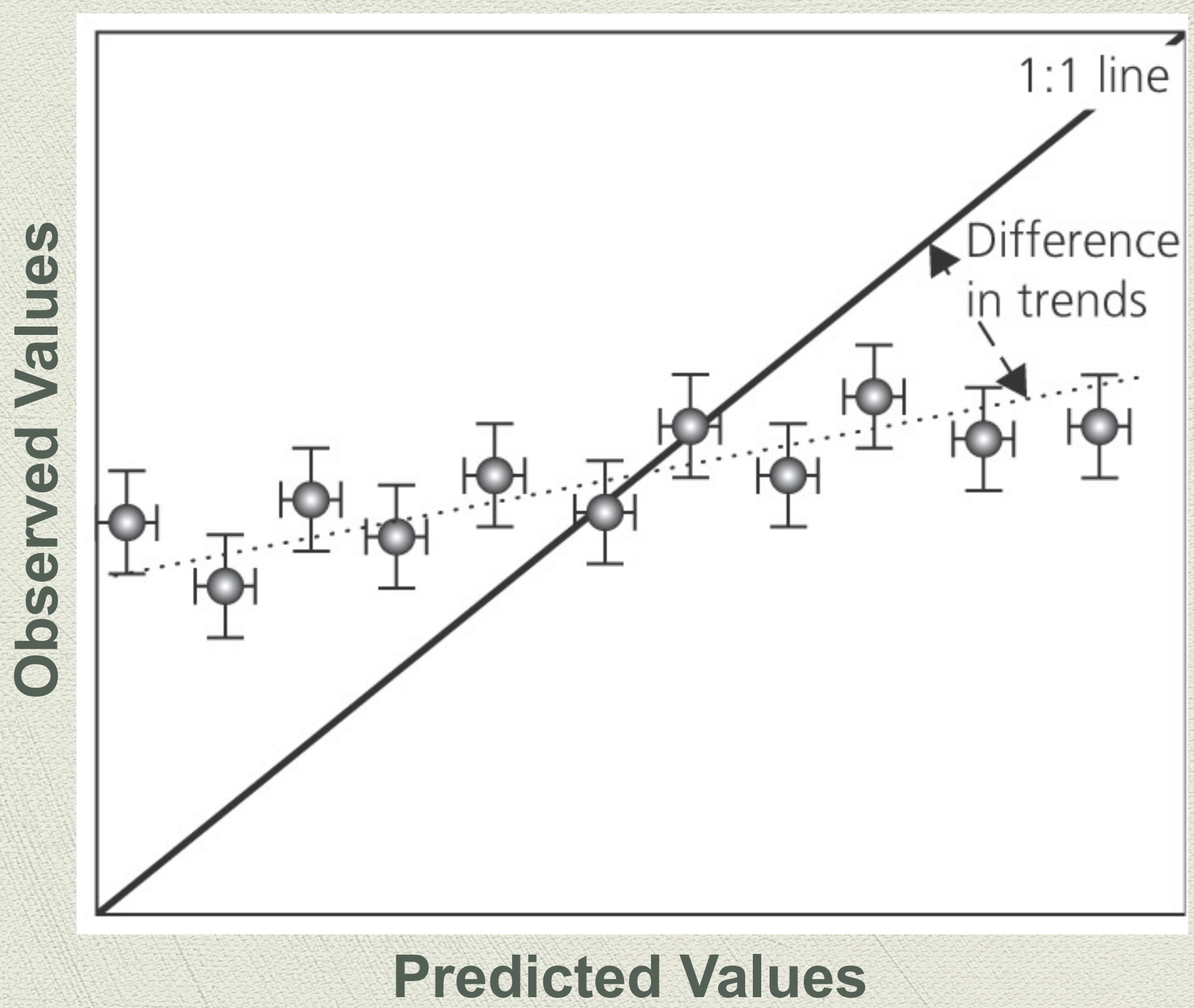
Identify Outliers



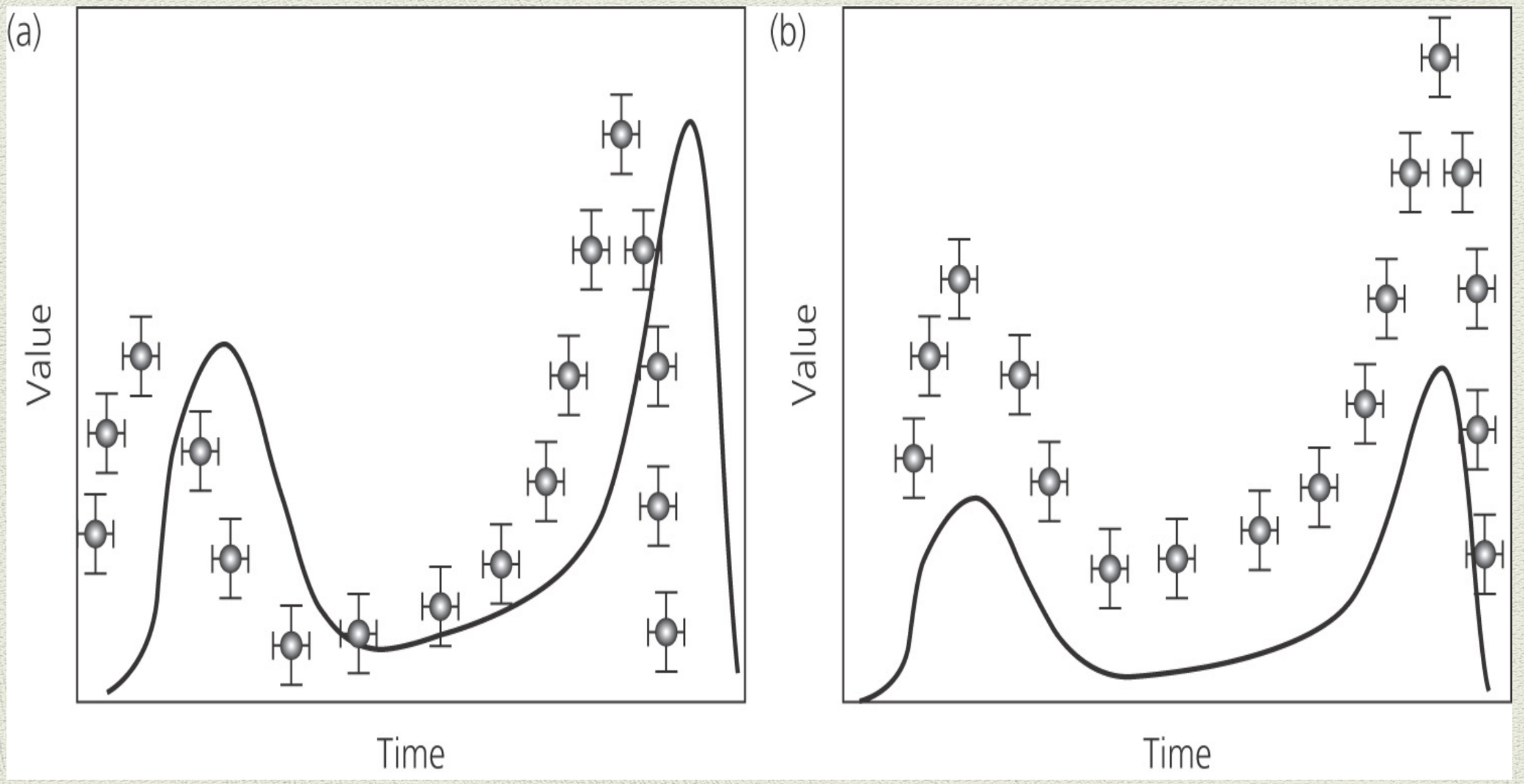
Assess Biases

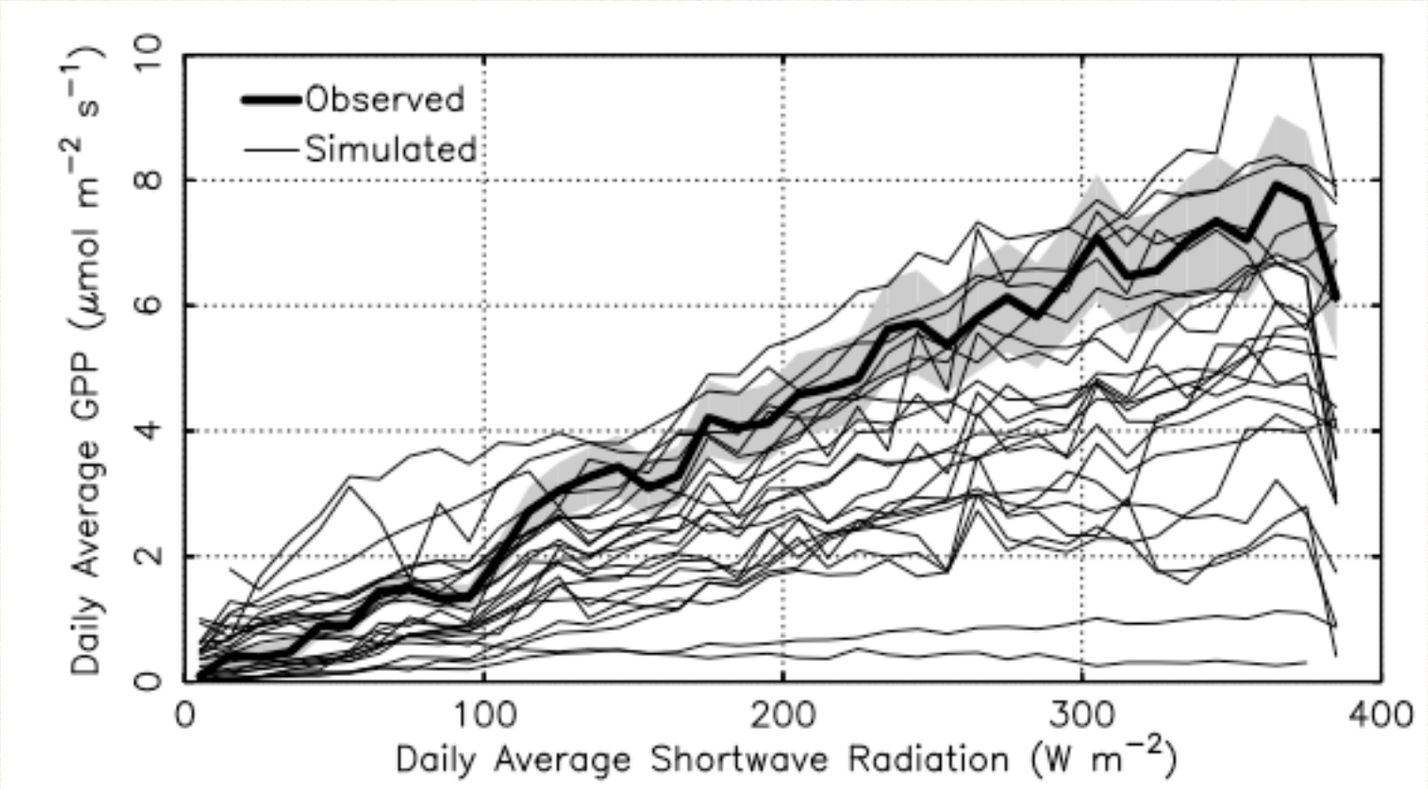


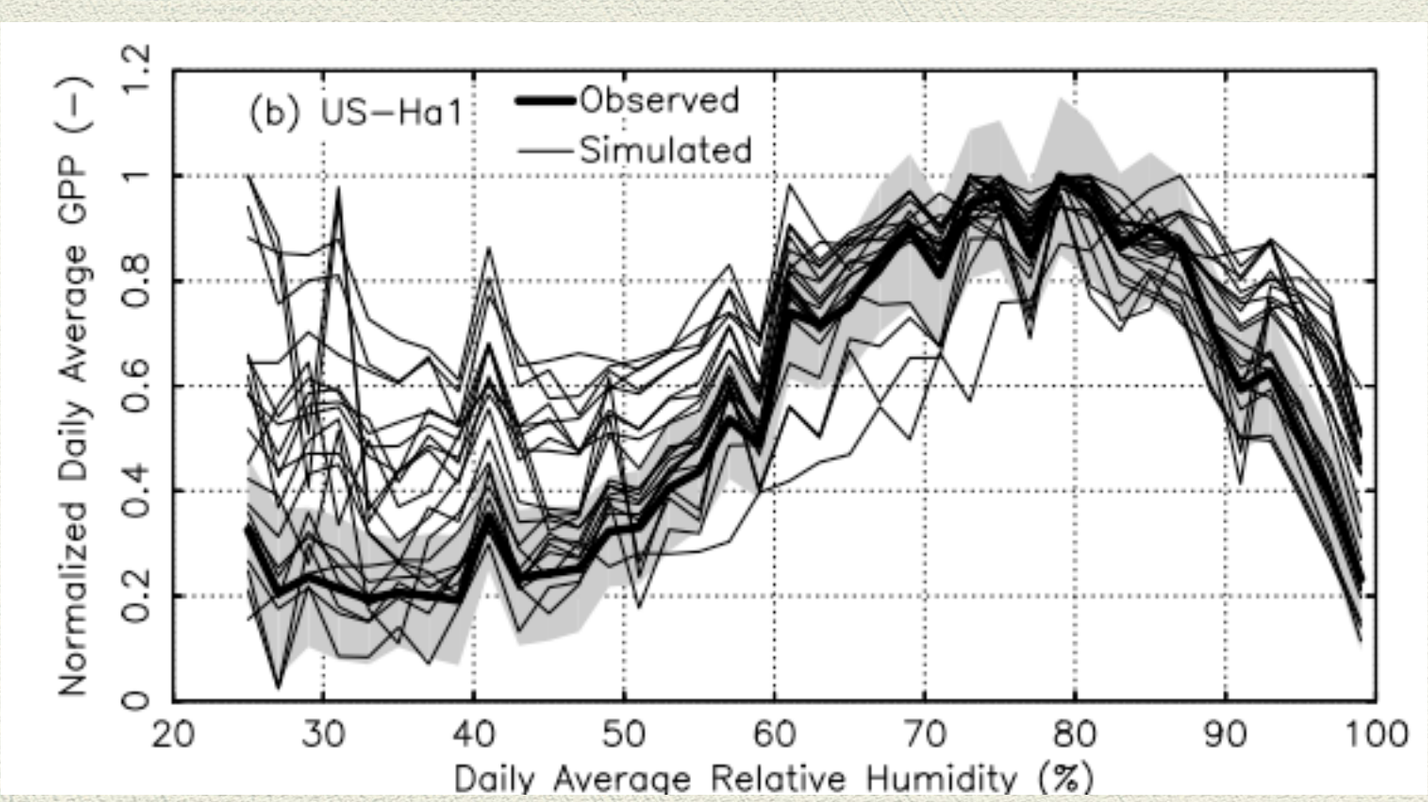
Miscalibration



Dynamics & Drivers



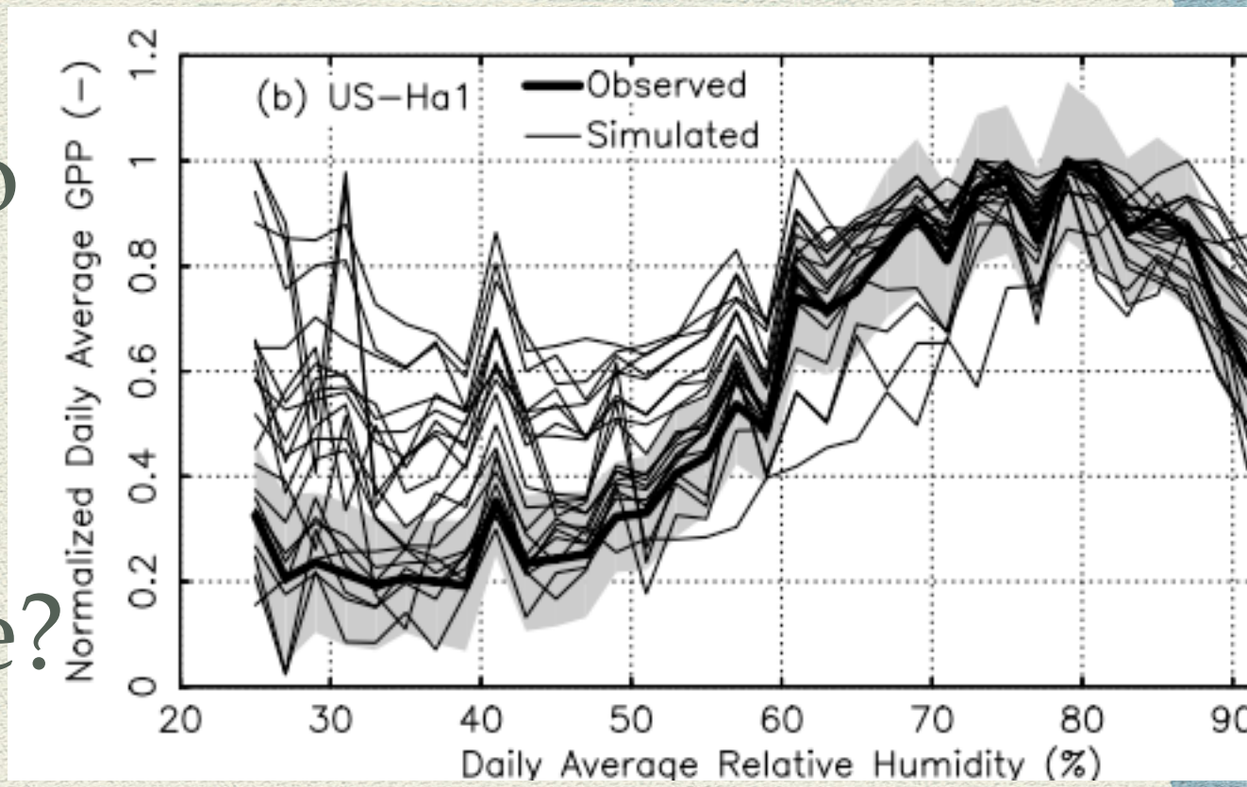




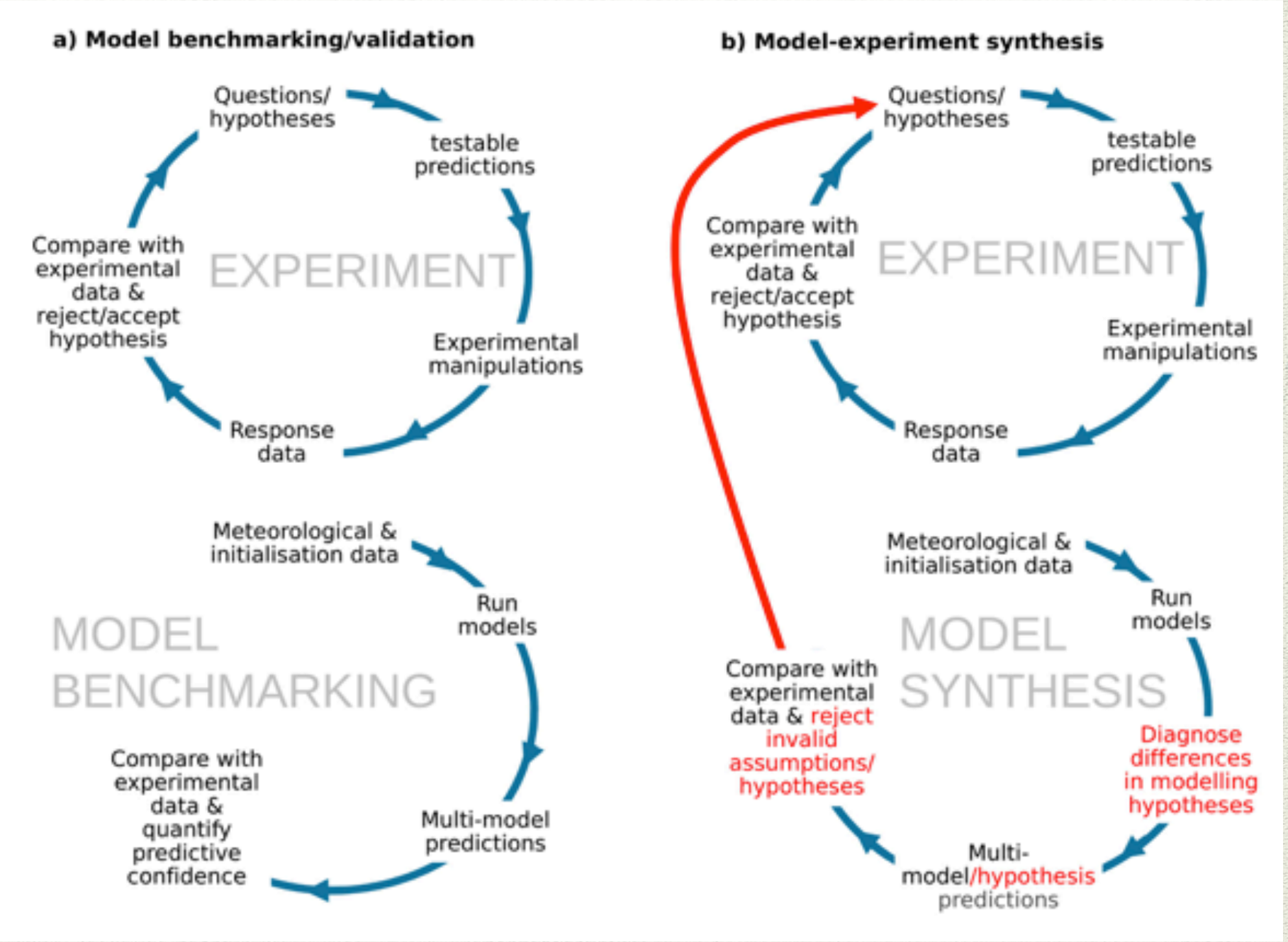
Schaefer et al. 2012 JGR-B

Diagnosing a model is Hypothesis Testing

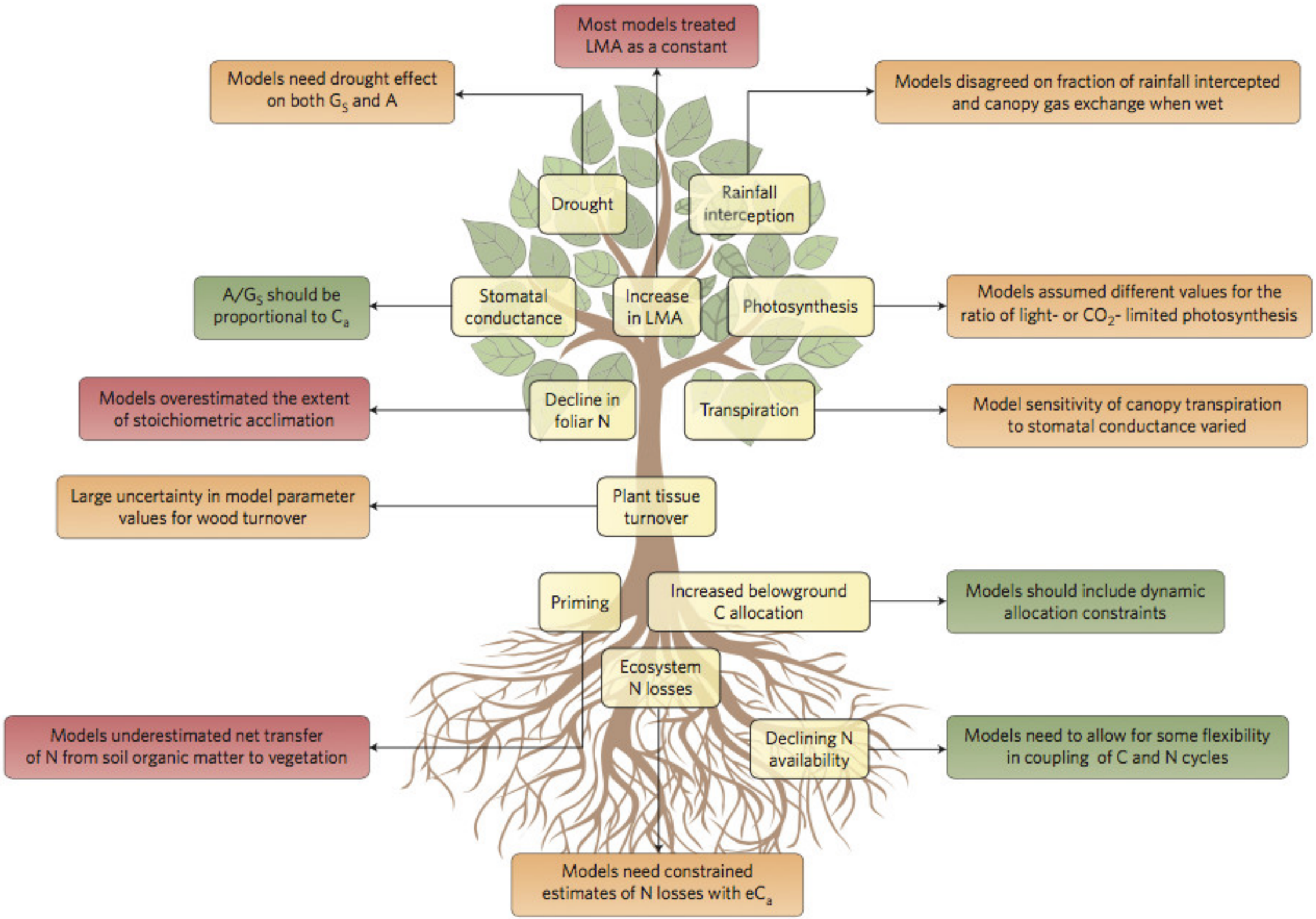
- Why would a model fail at low humidity?
- Stomatal sensitivity too low?
- Too much soil moisture?
- What experiments would I run in the model to test this?



Focus on key assumptions



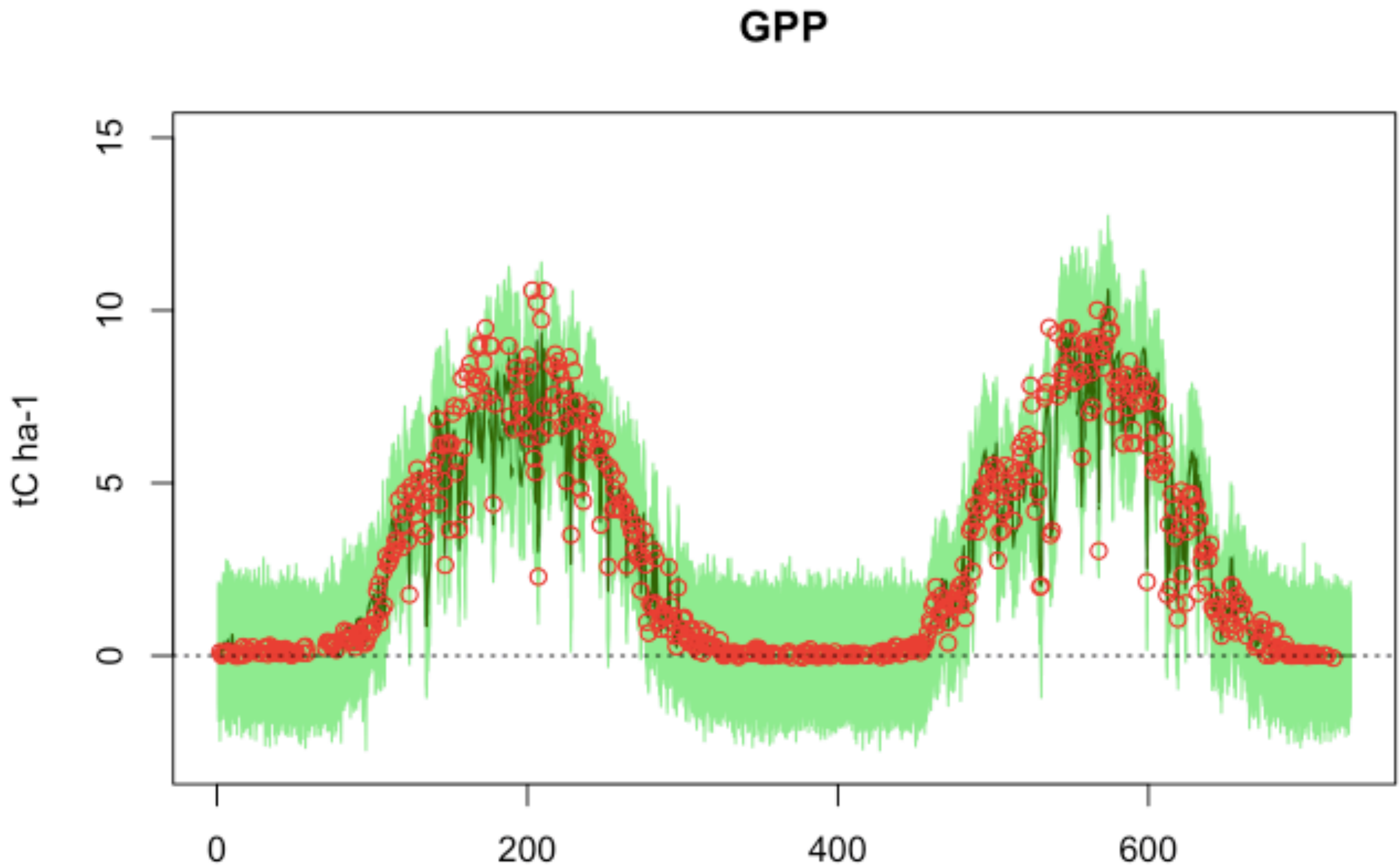
Walker et al 2014



Medlyn et al NCC 2015

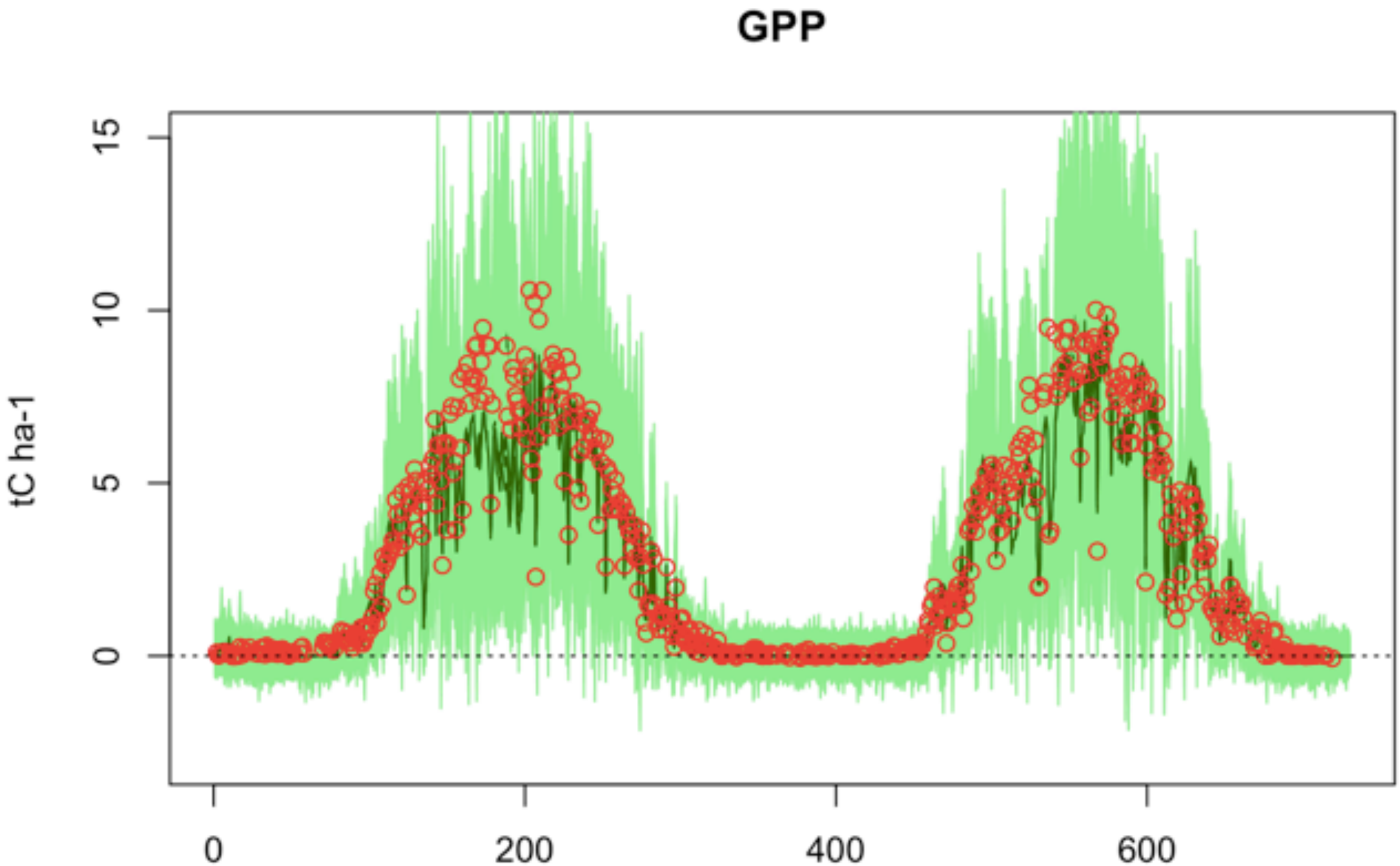
“data simulated under a model should look similar to data gathered in the real world.”
Conn et al 2018

IN THE FITTING, WE ASSUMED IID NORMAL ERRORS



Does that seem like an adequate description of the data?

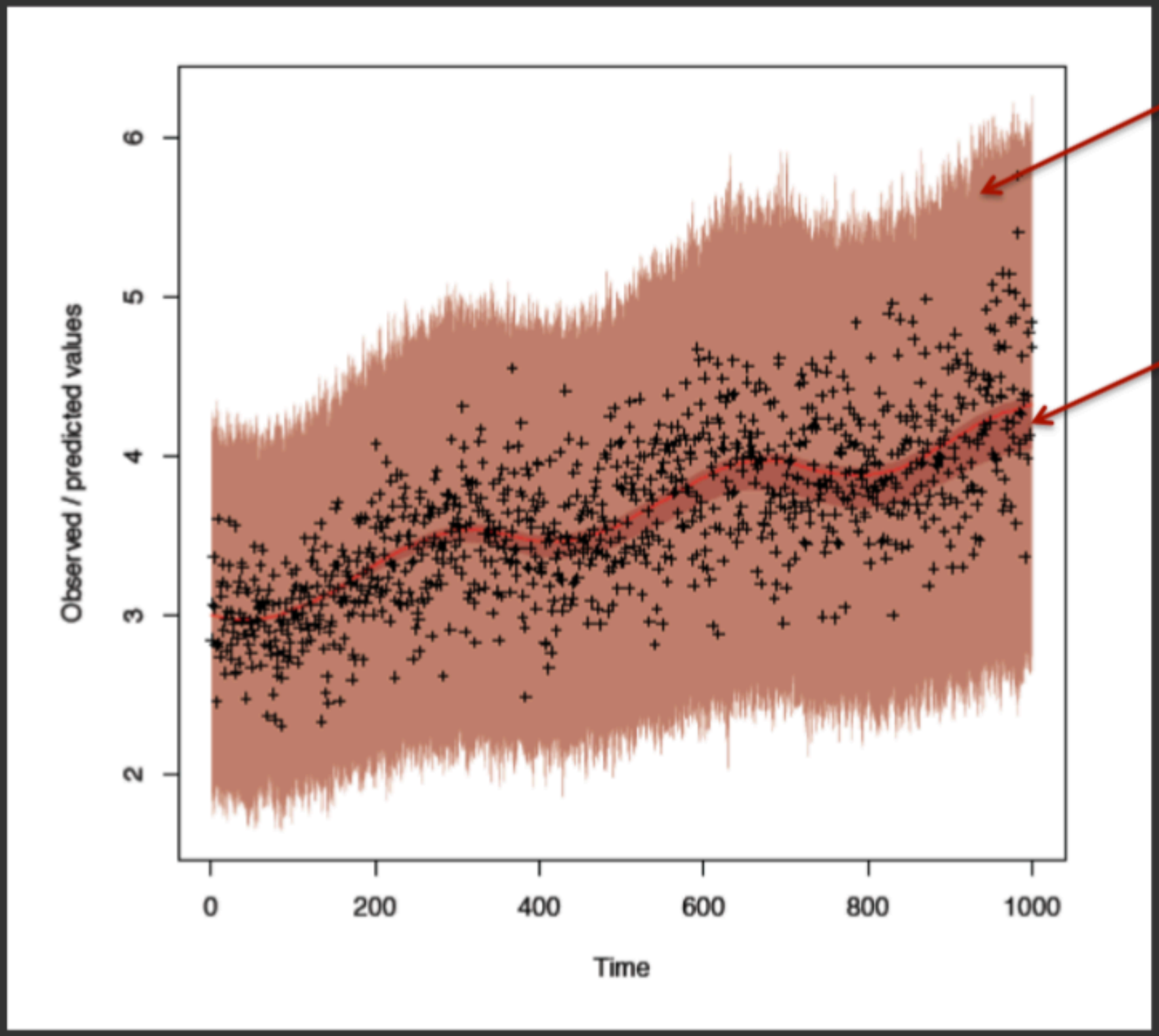
IN THIS FITTING, WE ASSUMED EXPONENTIAL ERRORS WITH NON-CONSTANT VARIANCE



Does that seem like an adequate description of the data?

Bayesian p-value / prediction interval

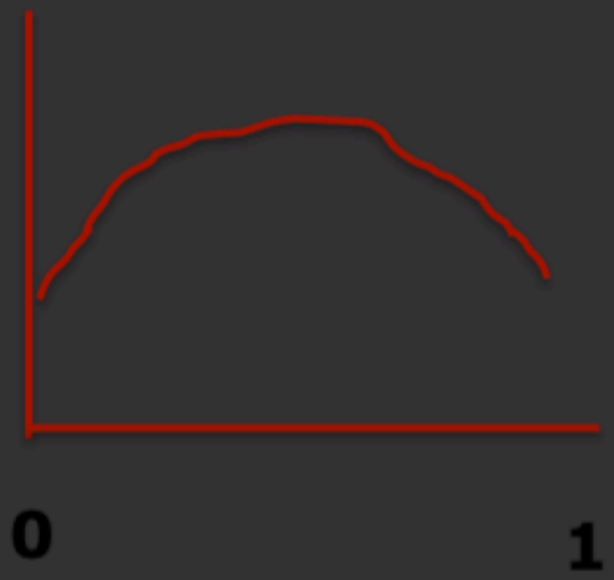
- Posterior predictive distribution is the uncertainty of the „true“ value
- **Prediction interval** is the expected variance of the observed values = PPD + error
  - Shows us what distribution we would expect for the data
- Bayesian p-value is when we use PPD + error to calculate the value of the cdf of the observed data
  - Distribution should be flat (uniform)
  - „Bayesian residuals“



PPD + Error

Posterior Predictive Distribution

Distribution of ecdf values for residuals

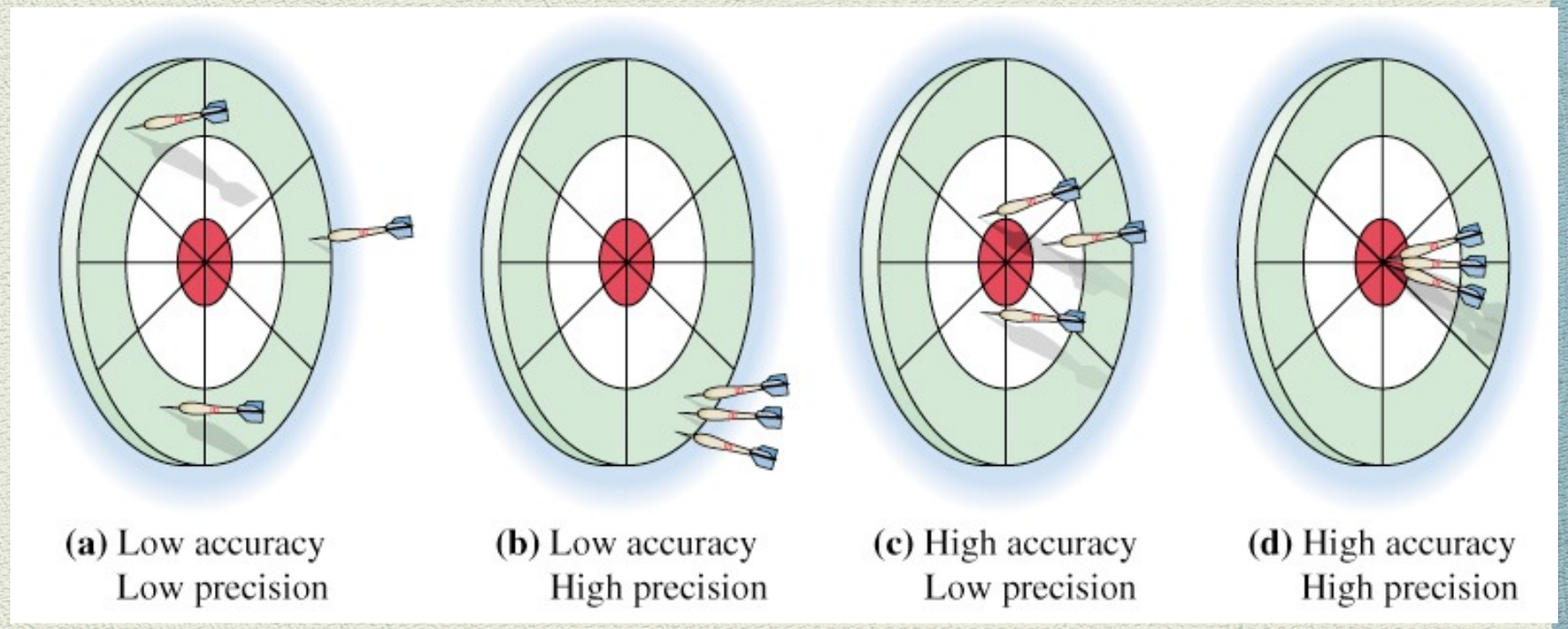


Step 3: Quantitative Skill Assessment

Error Statistics

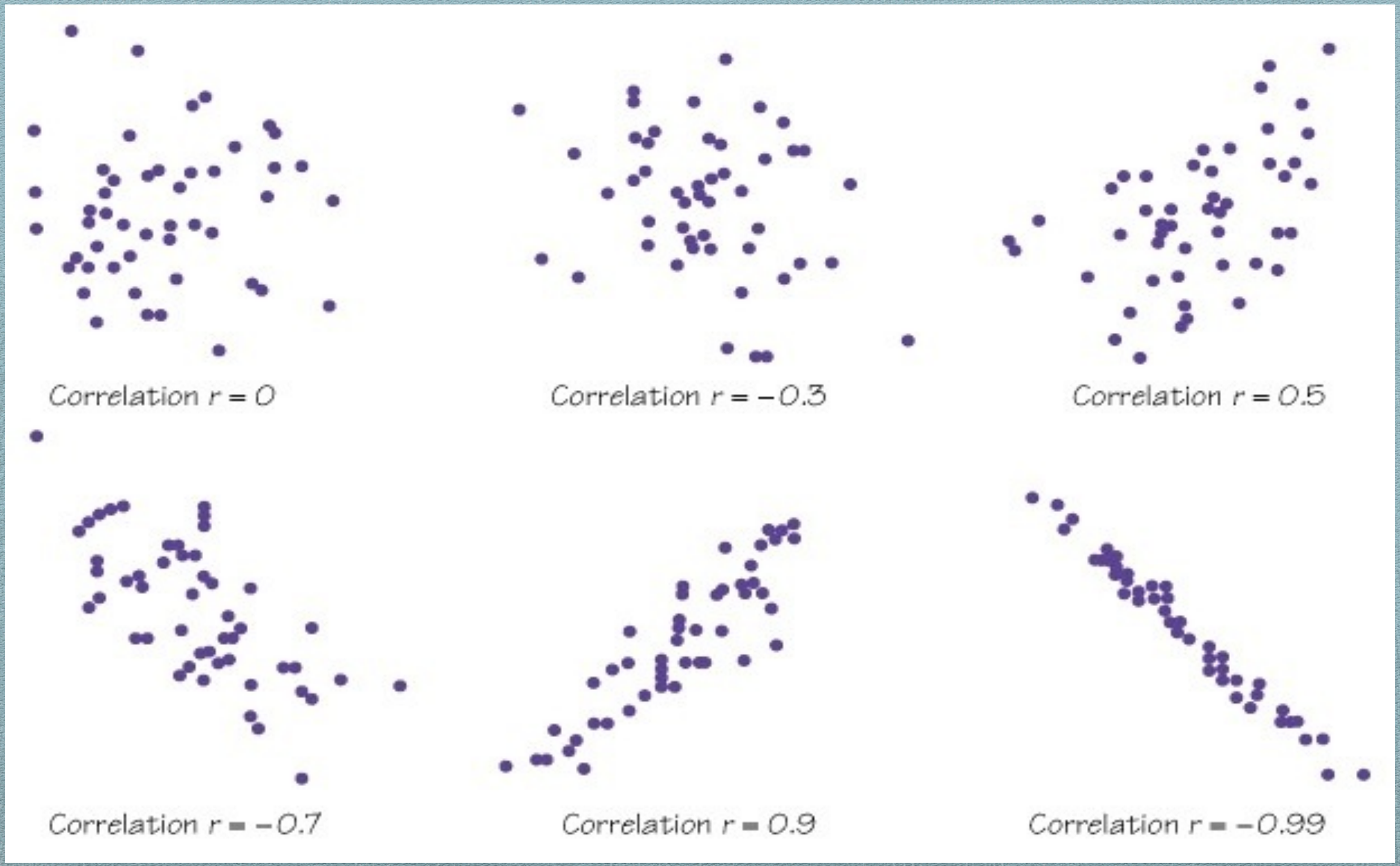
- Root Mean Square Error (RMSE)
- Bias
- Correlation (r)
- R^2
- Regression slope

$$\mathrm{RMSE} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(y_i - x_i)^2}$$

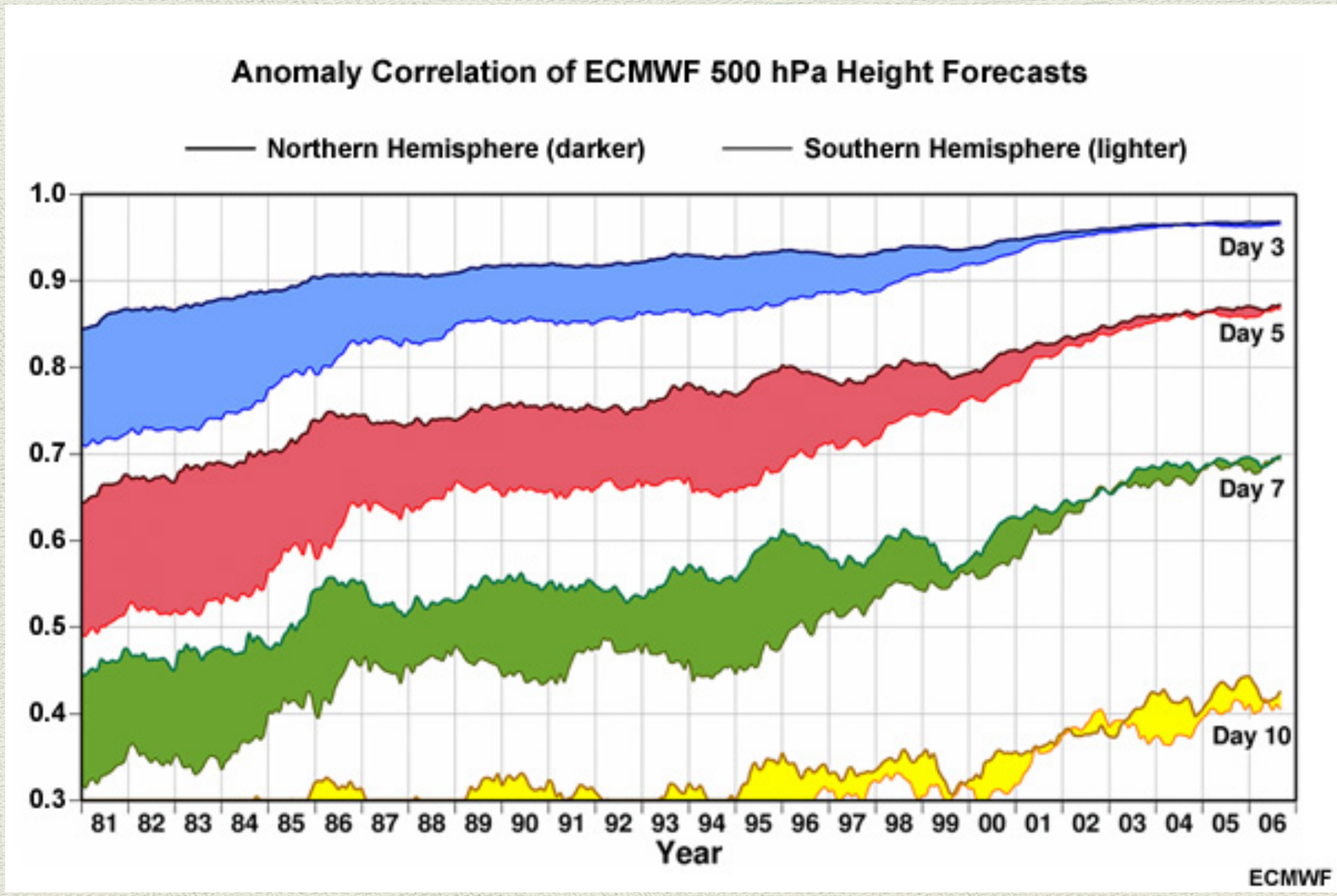


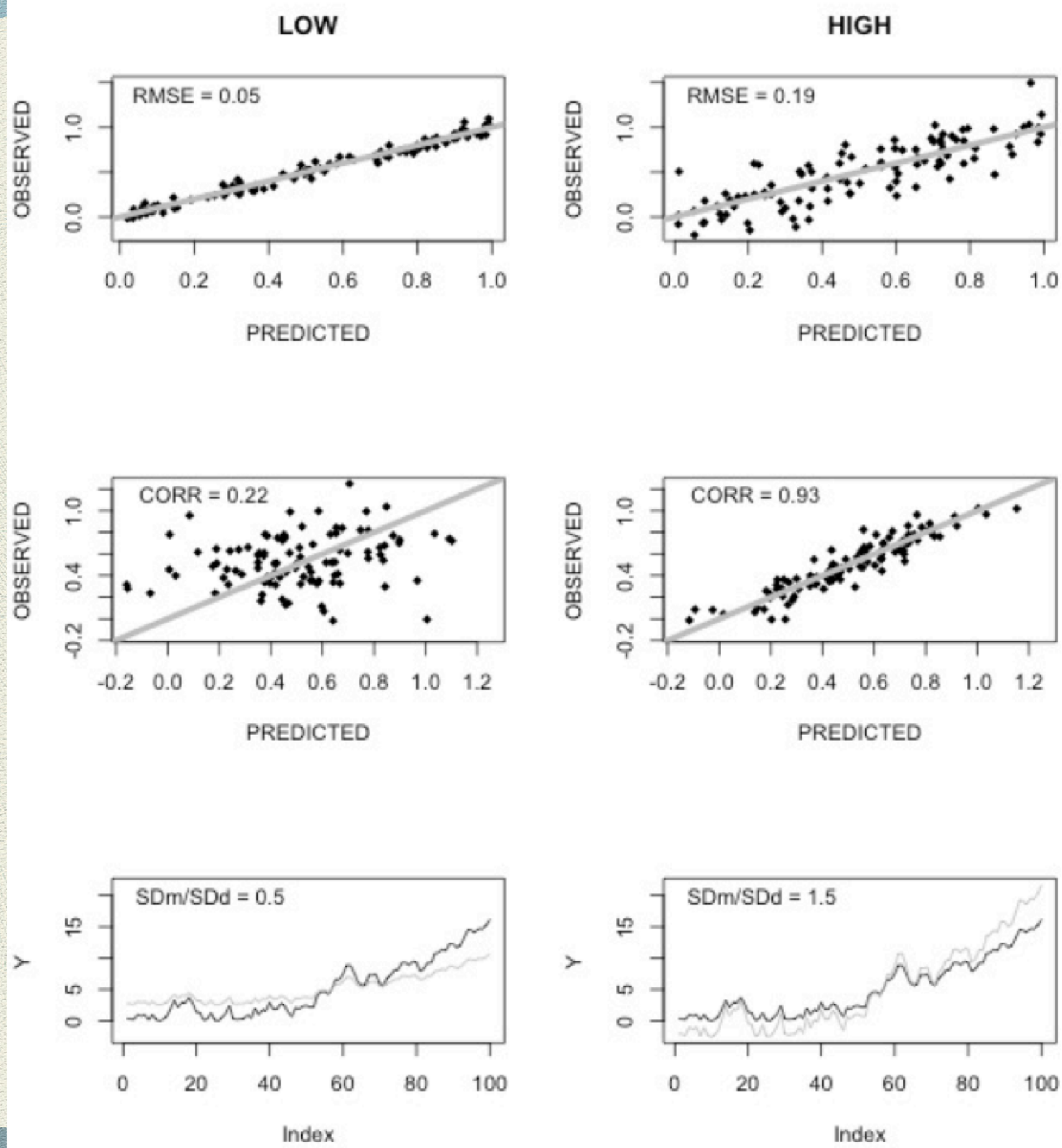
Proper: based on the metric used for calibration
Local: depends on data that could actually be collected

Correlation



Correlation




LOW
HIGH
RMSE = 0.05
RMSE = 0.19
CORR = 0.22
CORR = 0.93
SDm/SDd = 0.5
SDm/SDd = 1.5
OBSERVED
PREDICTED
Y
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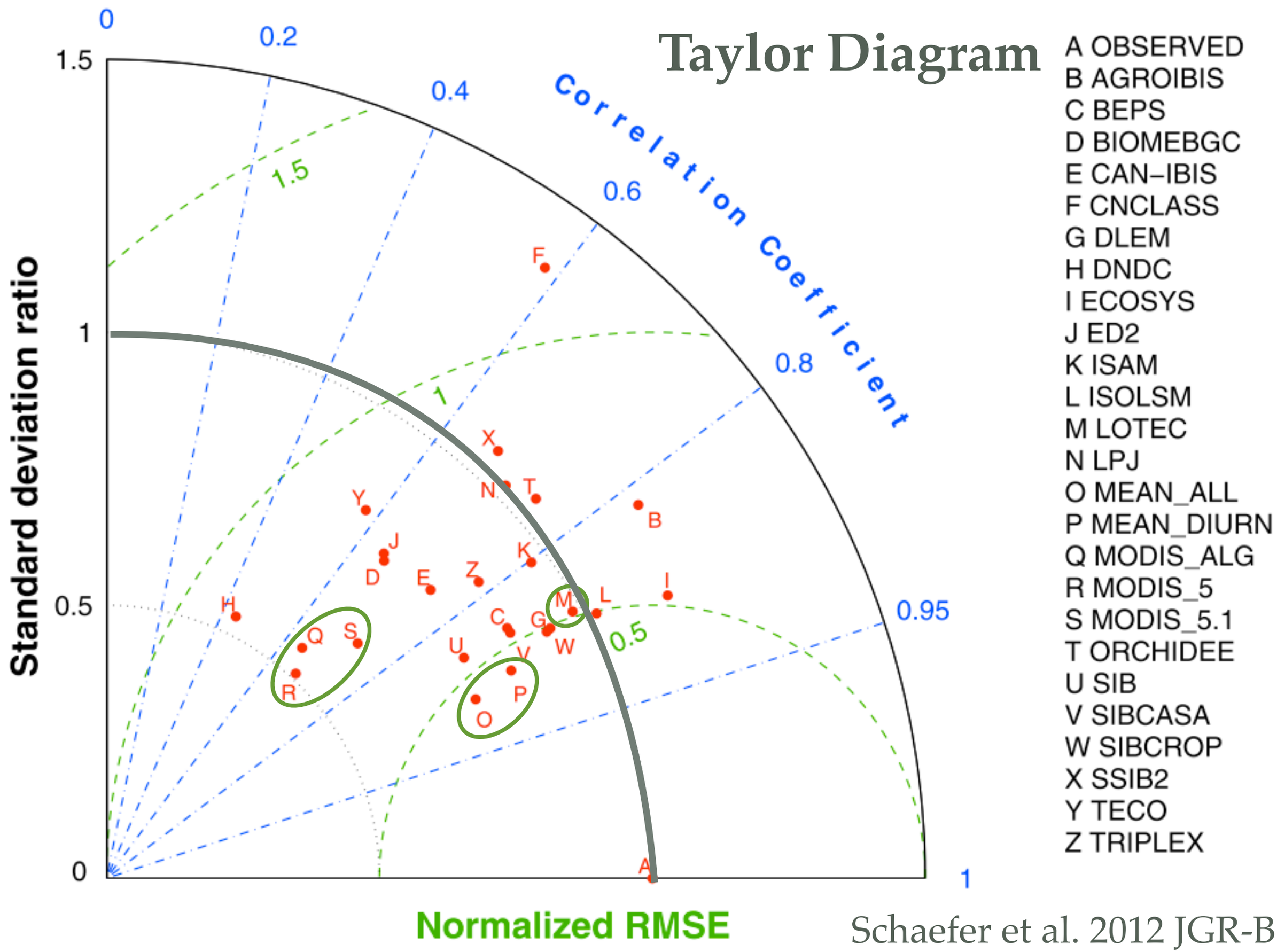
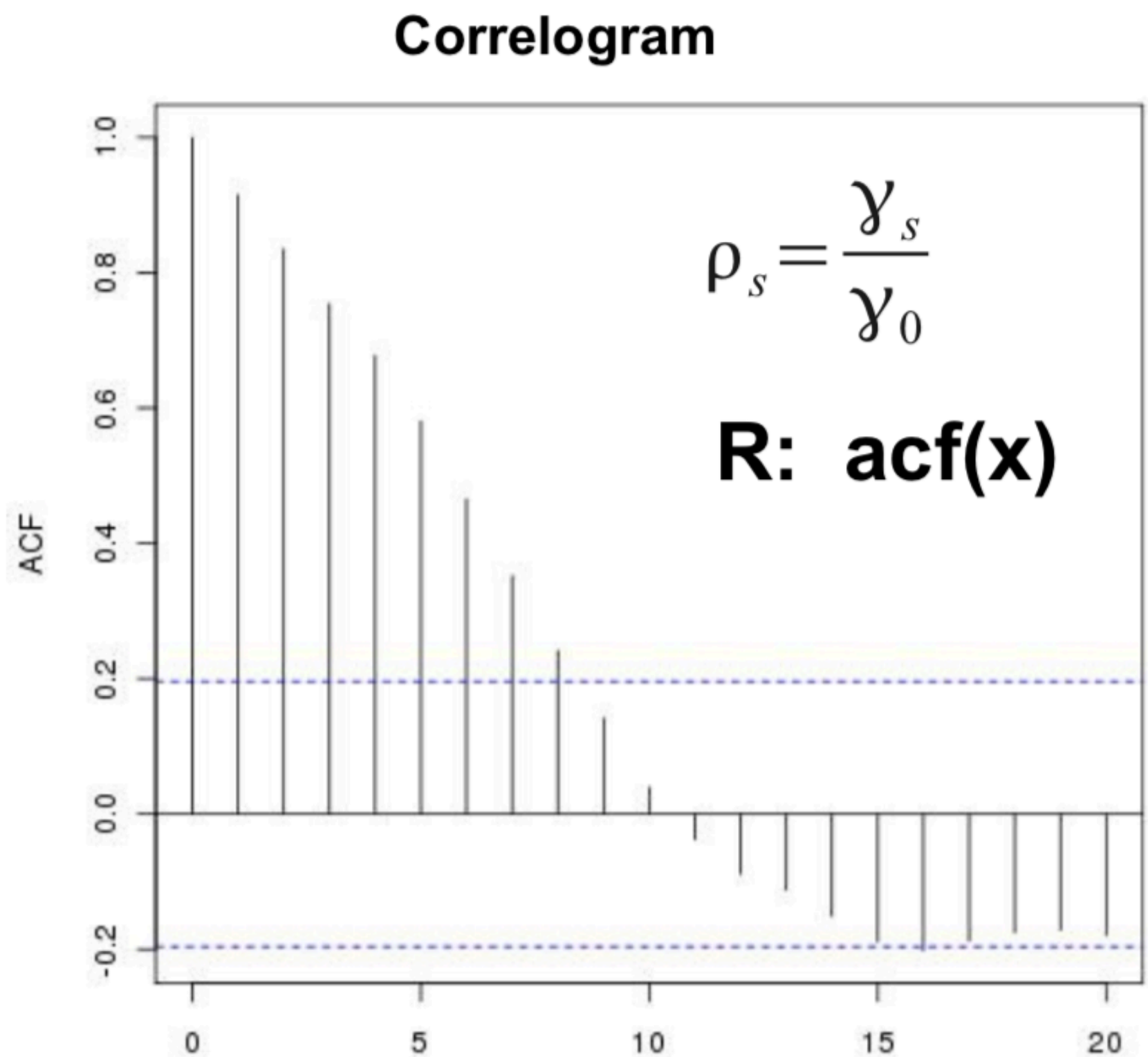
Taylor Diagram



Schaefer et al. 2012 JGR-B

Autocorrelation

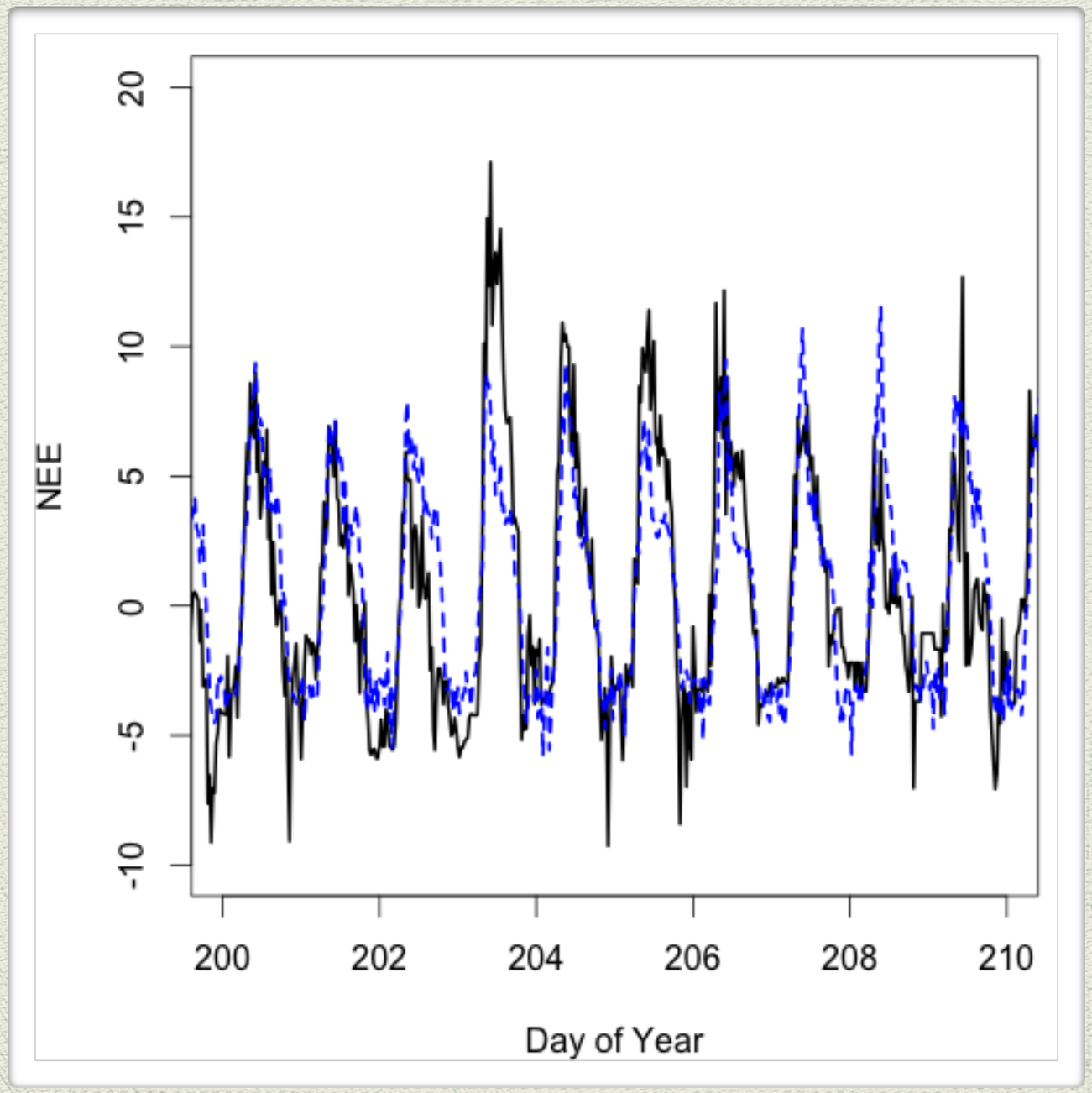


$$\rho_s = \frac{\gamma_s}{\gamma_0}$$

R: acf(x)

"Climatology"

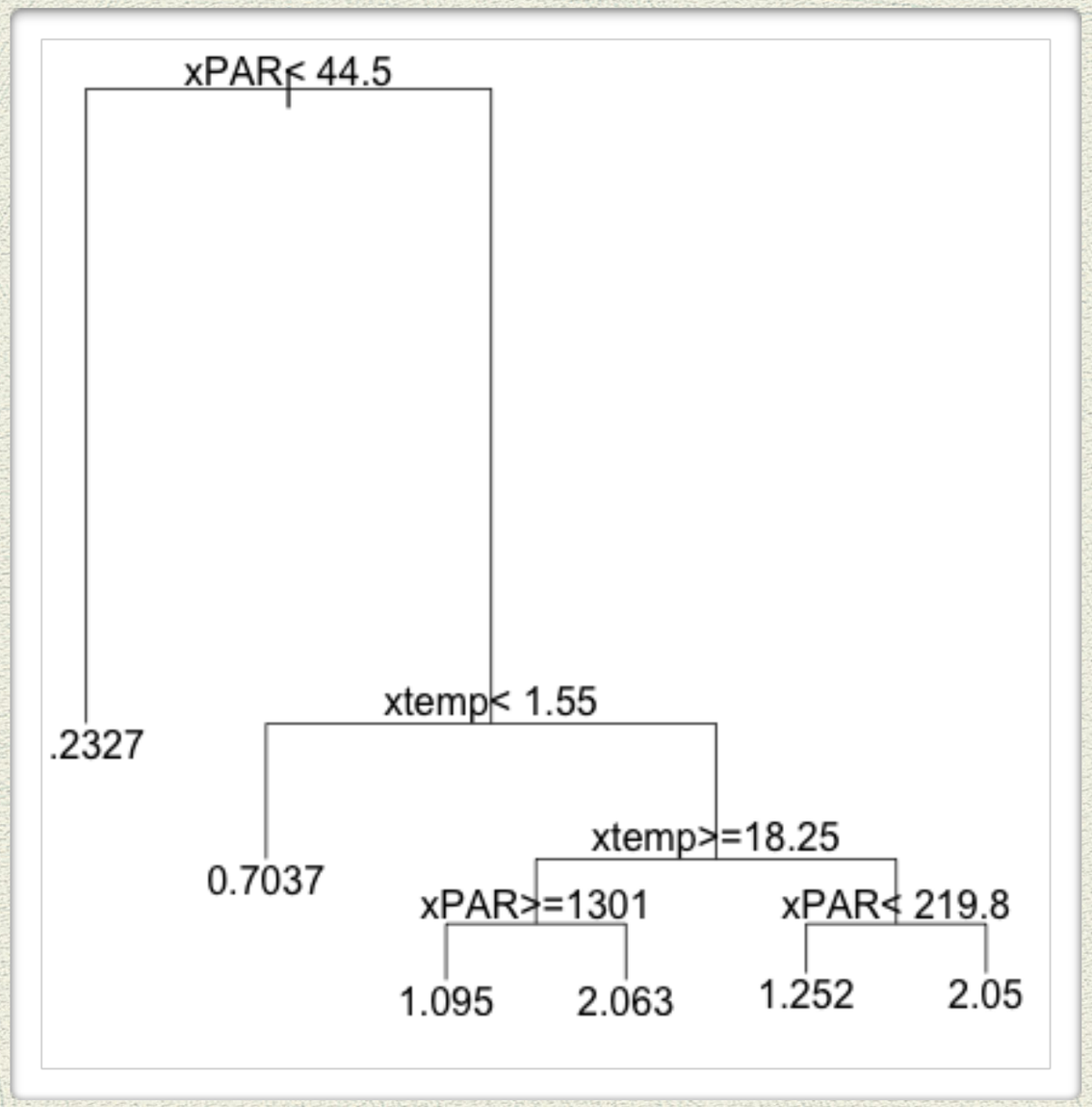
- Comparing process model performance to time-scale appropriate summary statistics



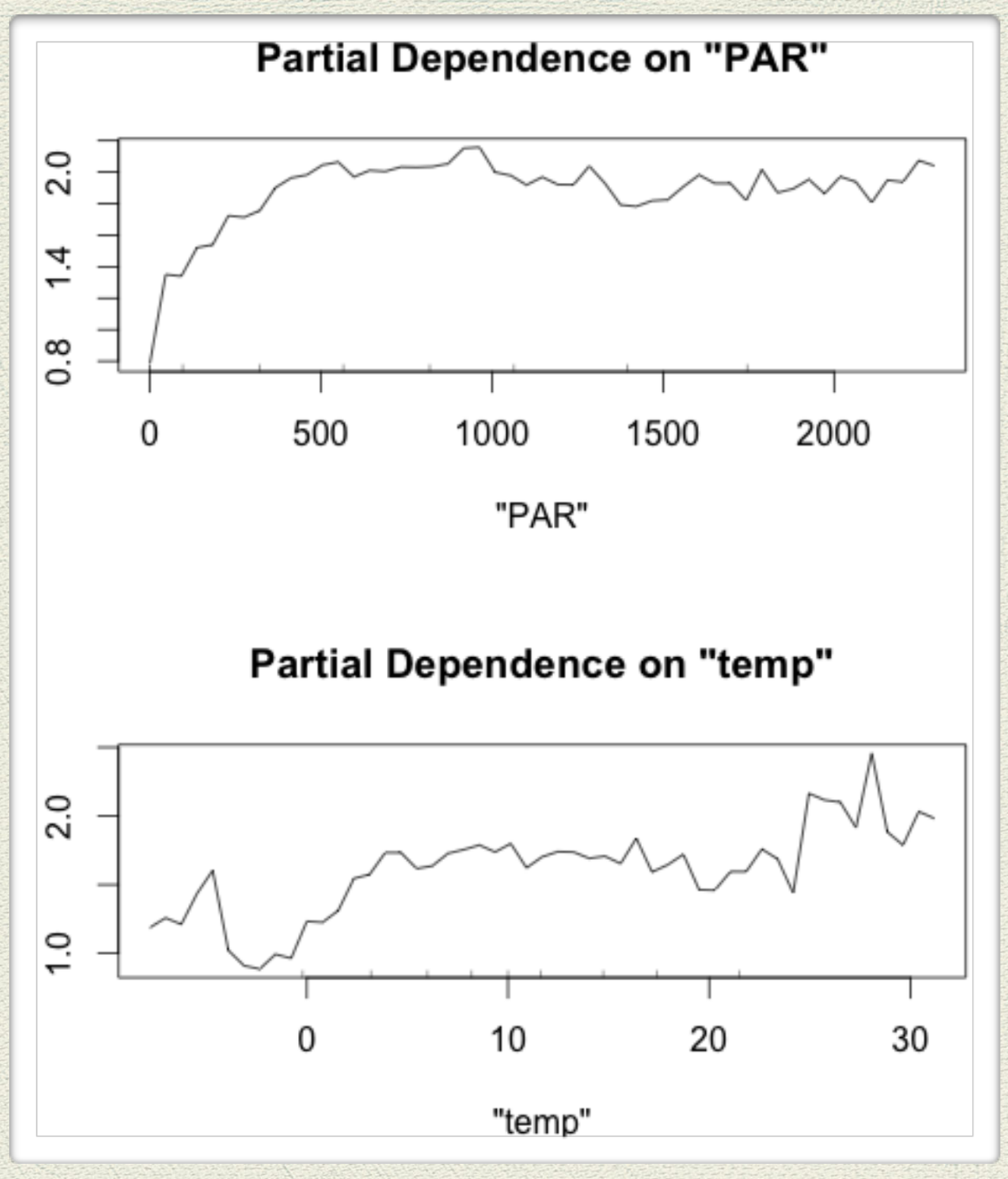
Data mining the residuals

- Wide variety of Data Mining algorithms in use
- Large debate about use in process modeling and forecasting
- Potentially useful for generating hypothesis about when/where model fails
- CART
- GAM
- Random Forests
- Boosted regression trees
- Artificial Neural Network
- Support Vector Machines

CART

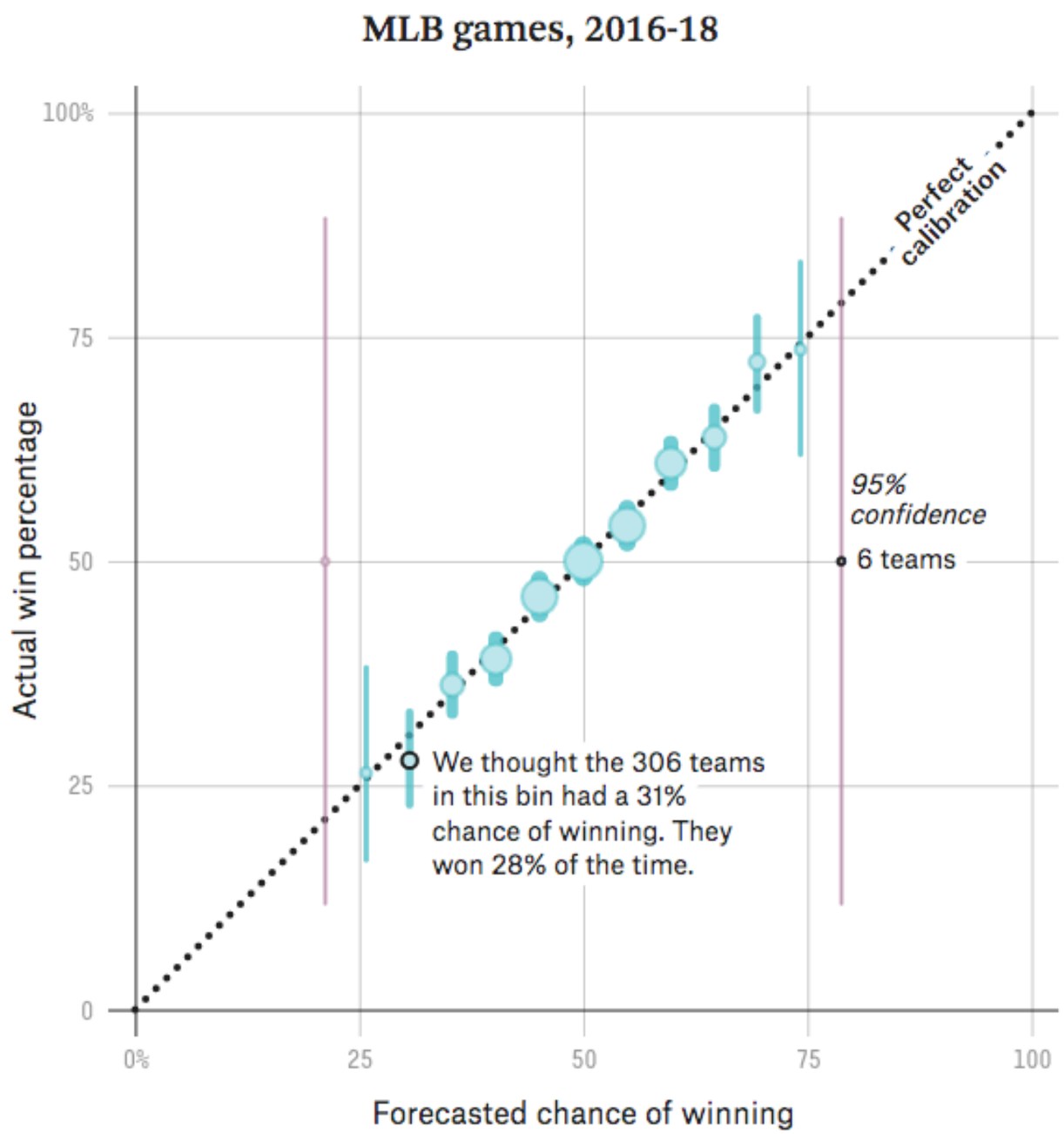


Random Forest



PUBLISHED APR. 4, 2019, AT 7:00 AM

How Good Are FiveThirtyEight Forecasts?



https://projects.fivethirtyeight.com/checking-our-work/