

Improving estimates of population status and trend with superensemble models

<https://github.com/datalimited>

Sean C. Anderson, Andrew B. Cooper, Olaf P. Jensen, Cóilín Minto, James T. Thorson, Jessica C. Walsh, Jamie Afflerbach, Mark Dickey-Collas, Kristin M. Kleisner, Catherine Longo, Giacomo Chato Osio, Daniel Ovando, Iago Mosqueira, Andrew A. Rosenberg, Elizabeth R. Selig

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WFC, May 2016



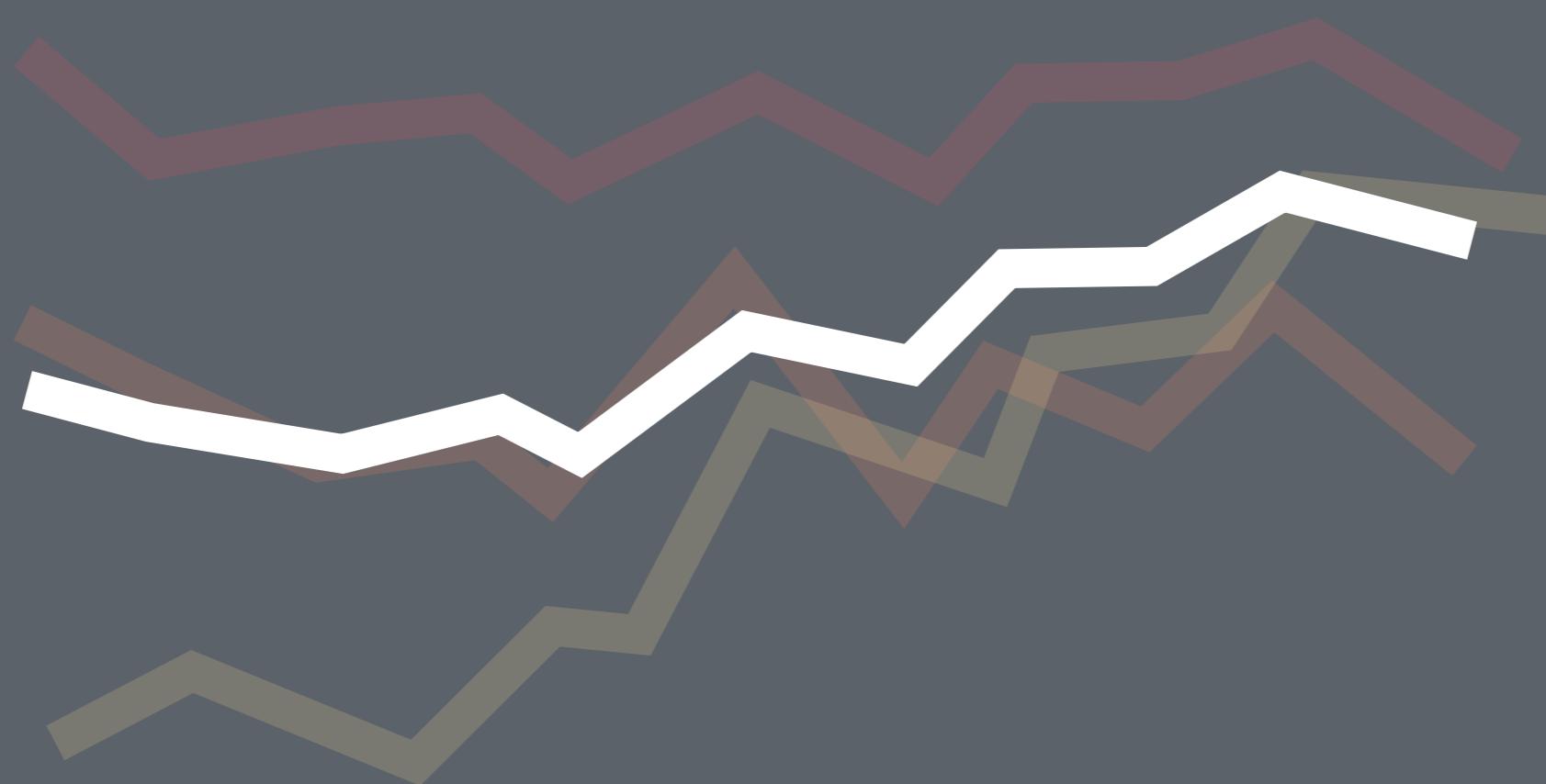
Status

Trend

Conflicting status and trend predictions?



Ensemble average



Superensembles



Superensembles

Krishnamurti et al. 1999. Science.
Improved Weather and Seasonal
Climate Forecasts from Multimodel
Superensemble.



Superensembles:

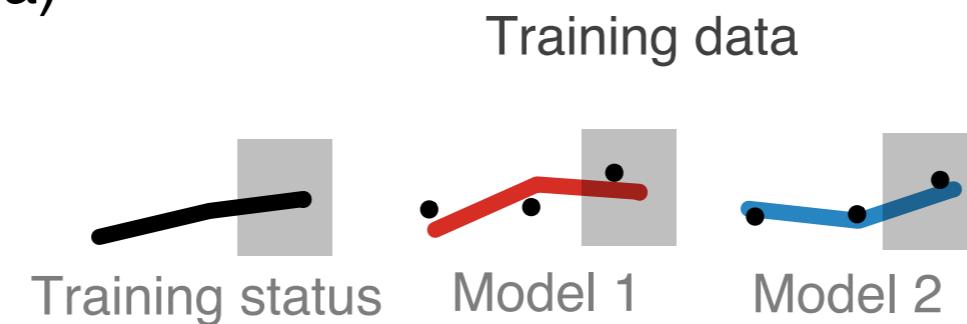
**Use model predictions as data
in a new statistical model
fit to “known” values.**

Superensembles:

**Use model predictions as data
in a new statistical model
fit to “known” values.**

Building a superensemble

(a)

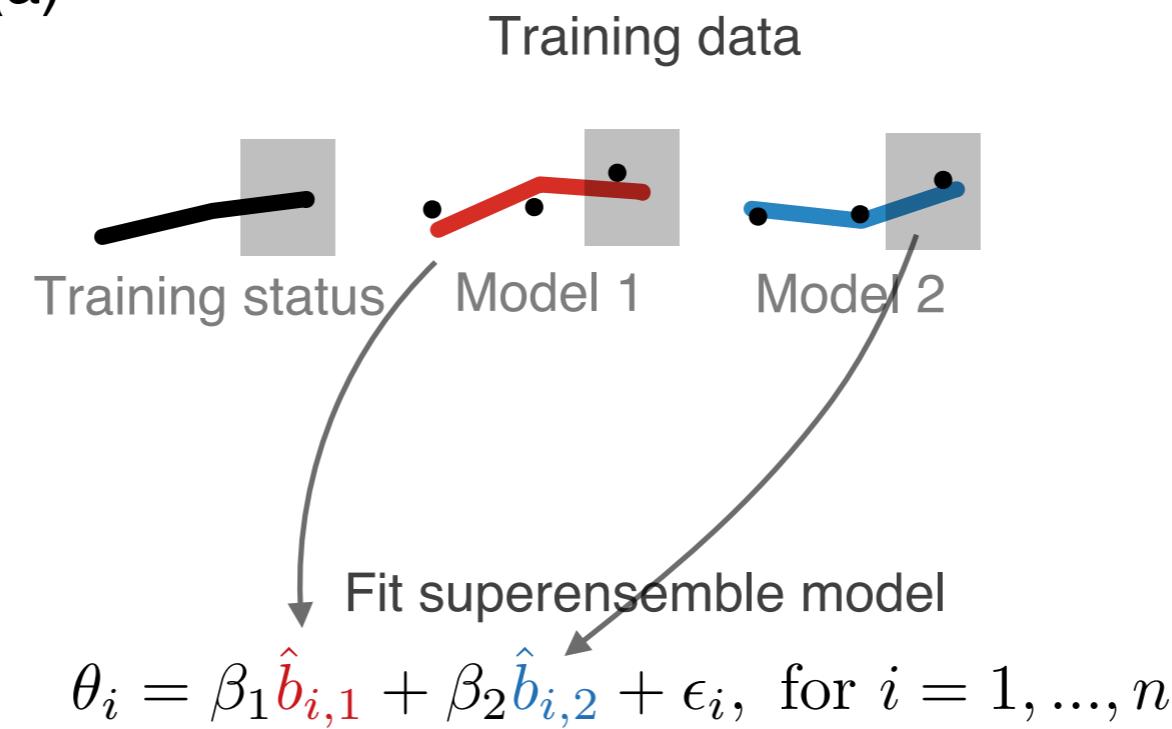


Fit superensemble model

$$\theta_i = \beta_1 \hat{b}_{i,1} + \beta_2 \hat{b}_{i,2} + \epsilon_i, \text{ for } i = 1, \dots, n$$

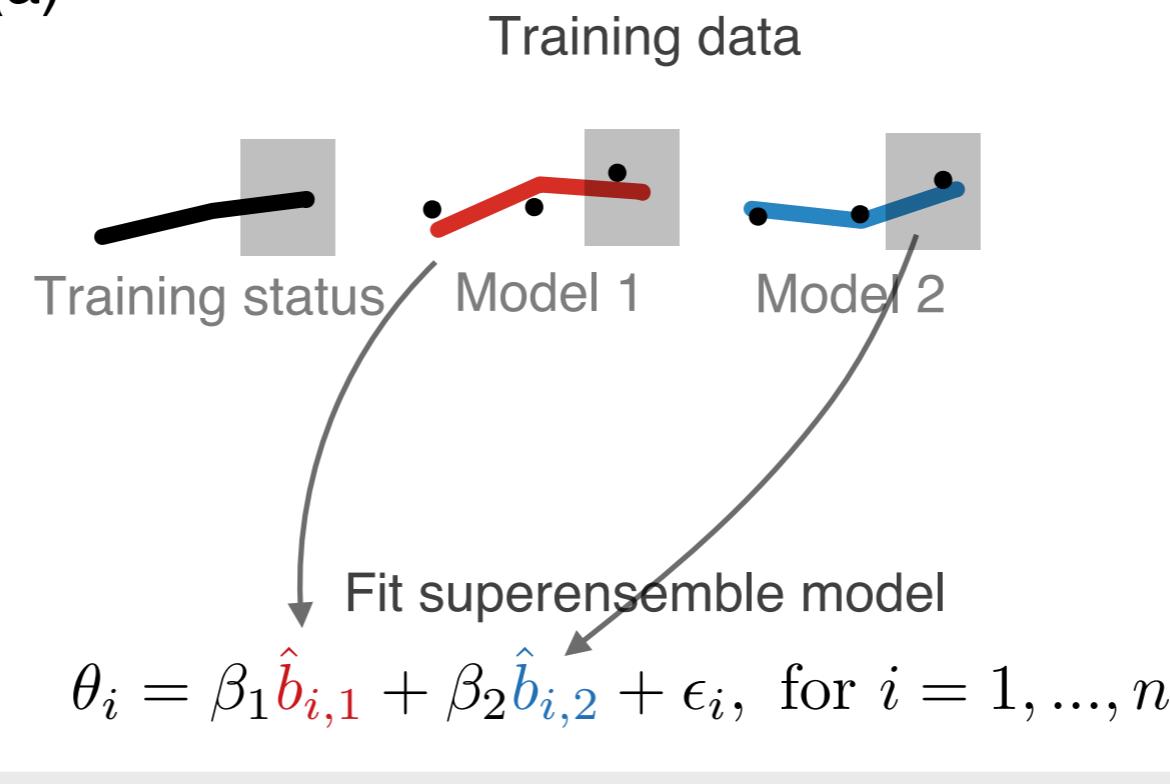
Building a superensemble

(a)



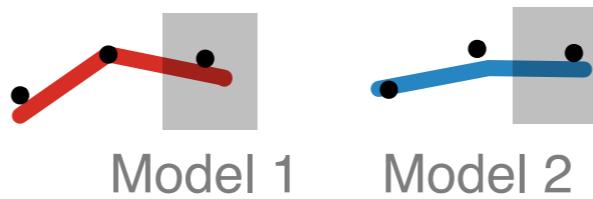
Building a superensemble

(a)



(b)

Data of interest



Predict using superensemble model

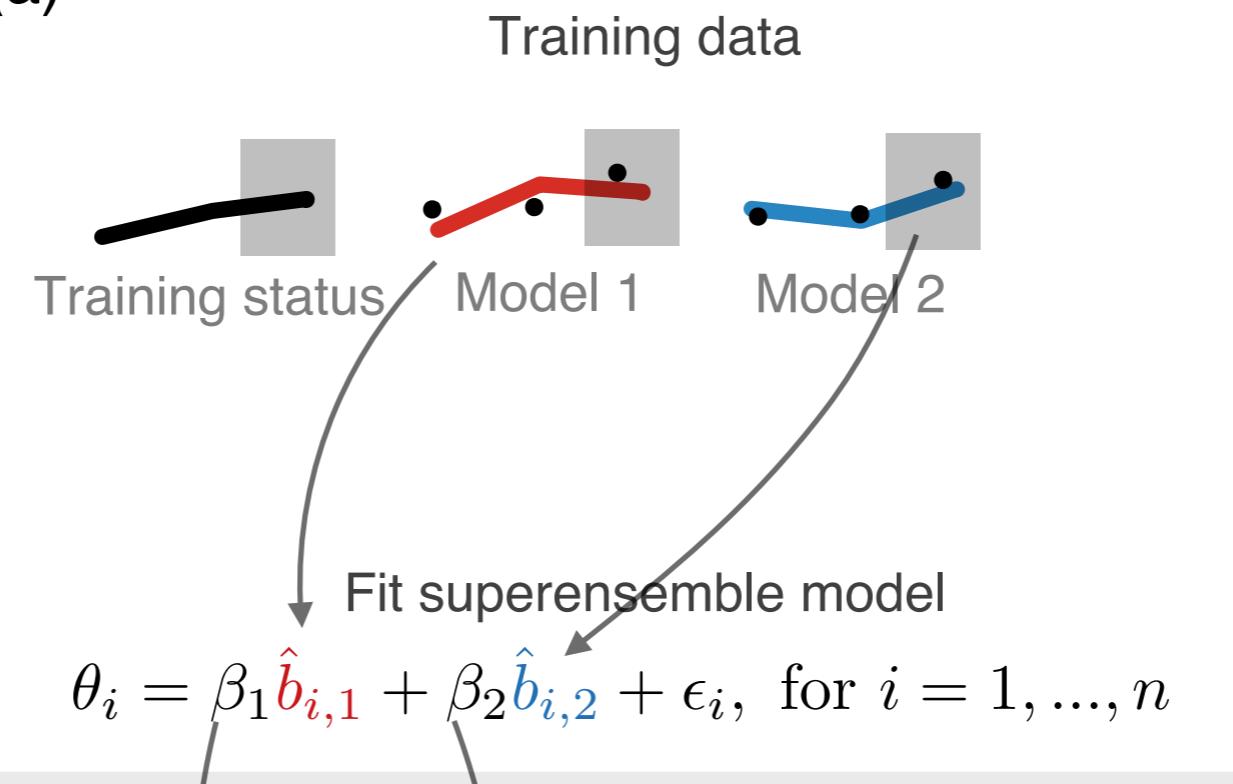
$$\hat{\theta}_j = \hat{\beta}_1 \hat{b}_{j,1} + \hat{\beta}_2 \hat{b}_{j,2}, \text{ for } j = 1, \dots, m$$

.. - - -

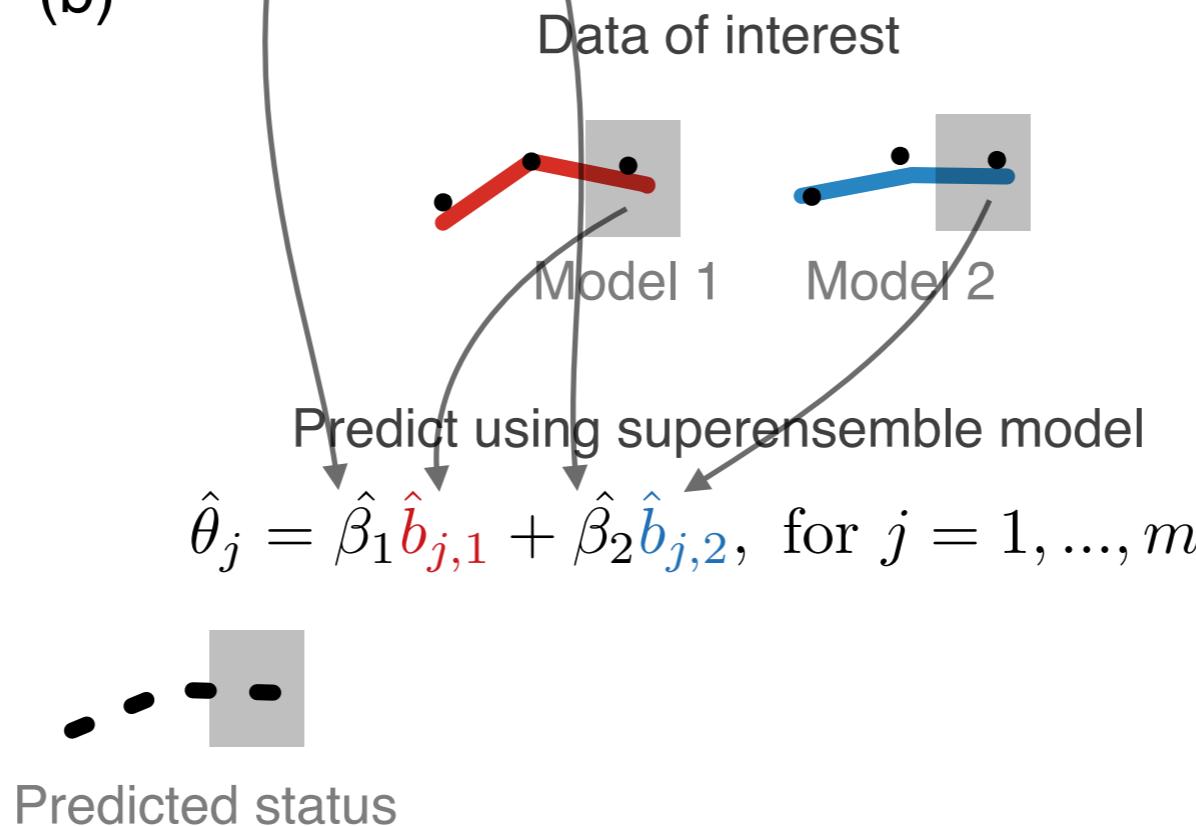
Predicted status

Building a superensemble

(a)



(b)



FAO Fisheries and Aquaculture Circular. No. 1086



Developing new approaches to global stock status assessment and fishery production potential of the seas

Rosenberg, A A, Fogarty, M J, Cooper, A B, Dickey-Collas, M, Fulton, E A, Gutierrez, N L, Hyde, K J W, Kleisner, K M, Longo, C, Minte-Vera, C V, Minto, C, Mosqueira, I, Osio, G C, Ovando, D, Selig, E R, Thorson, J T, and Ye, Y. 2014.

Simulated stocks

3 life histories: small pelagic, large pelagic, demersal

3 levels of initial biomass depletion

4 harvest dynamics

2 levels of process noise

2 levels of process noise autocorrelation

...

Total: 5760 fisheries

<https://github.com/iagomosqueira/stockStatusFAO>

4 models for data-limited stocks

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COM-SIR

CMSY

SSCOM

4 models for data-limited stocks

COM-SIR

Catch-only model, sampling
importance resampling

Vasconcellos & Cochrane 2005

CMSY

SSCOM

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State-space catch-only
model

Thorson et al. 2013 CFJAS

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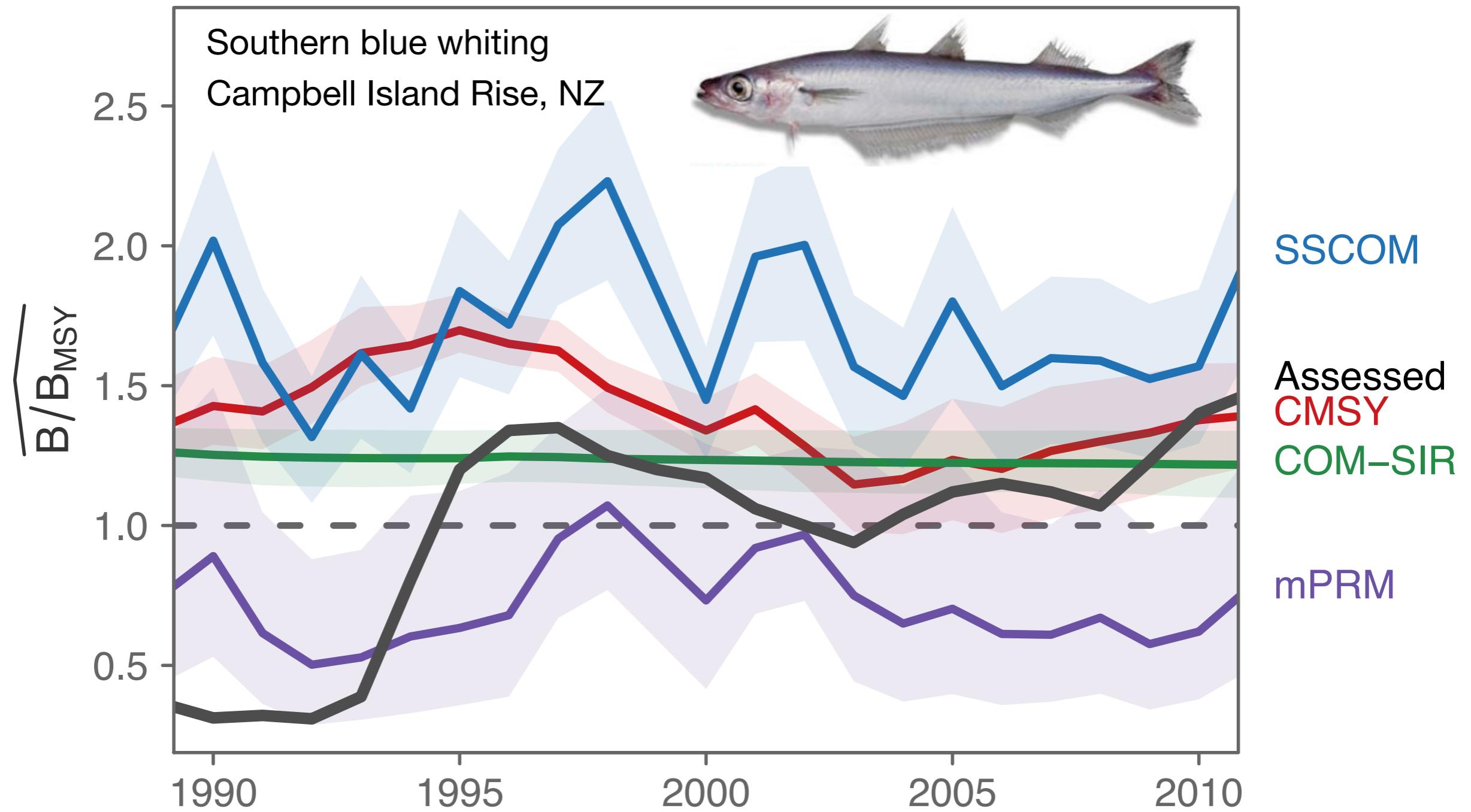
Thorson et al. 2013 CFJAS

mPRM

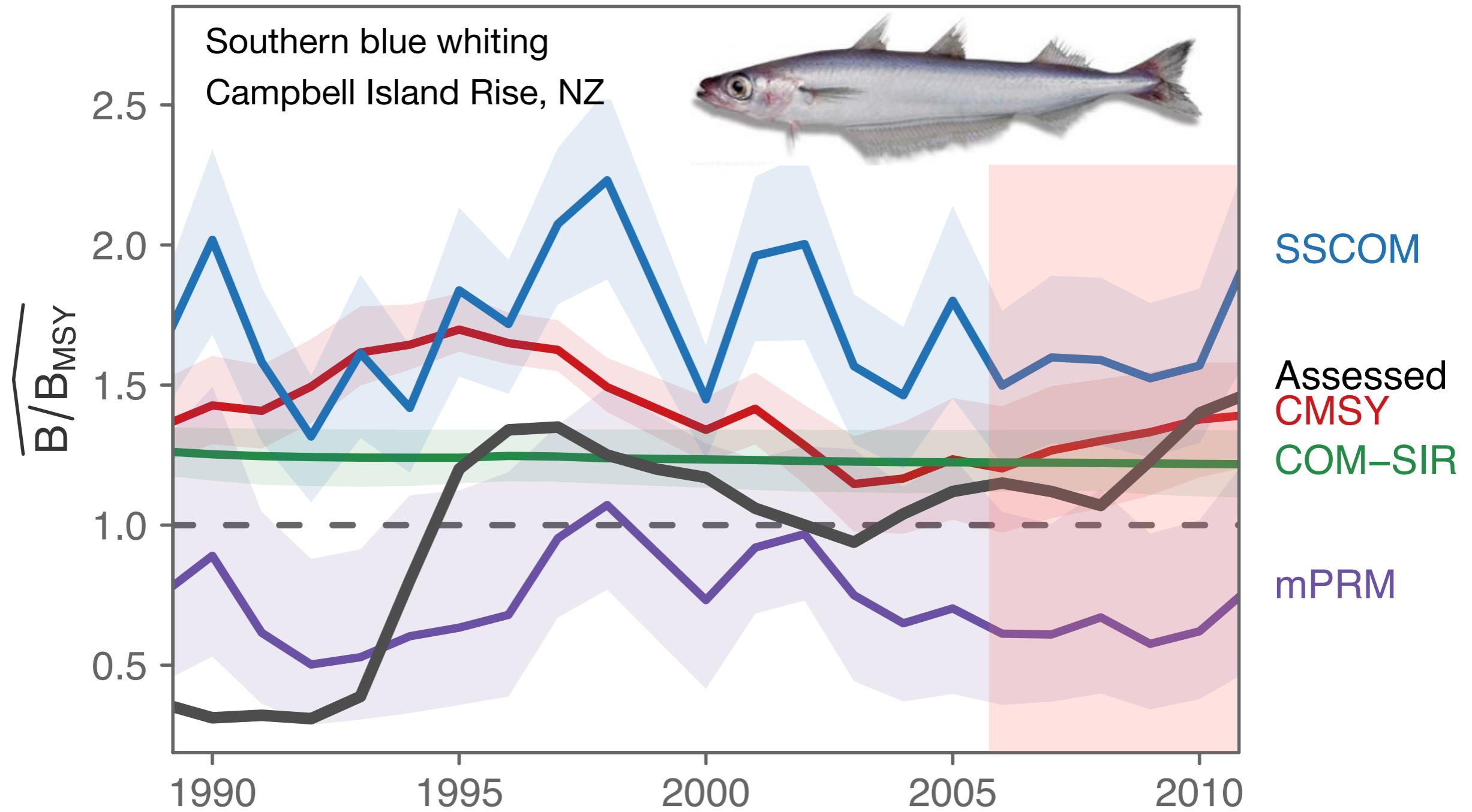
Modified panel regression
model

Costello et al. 2012 Science

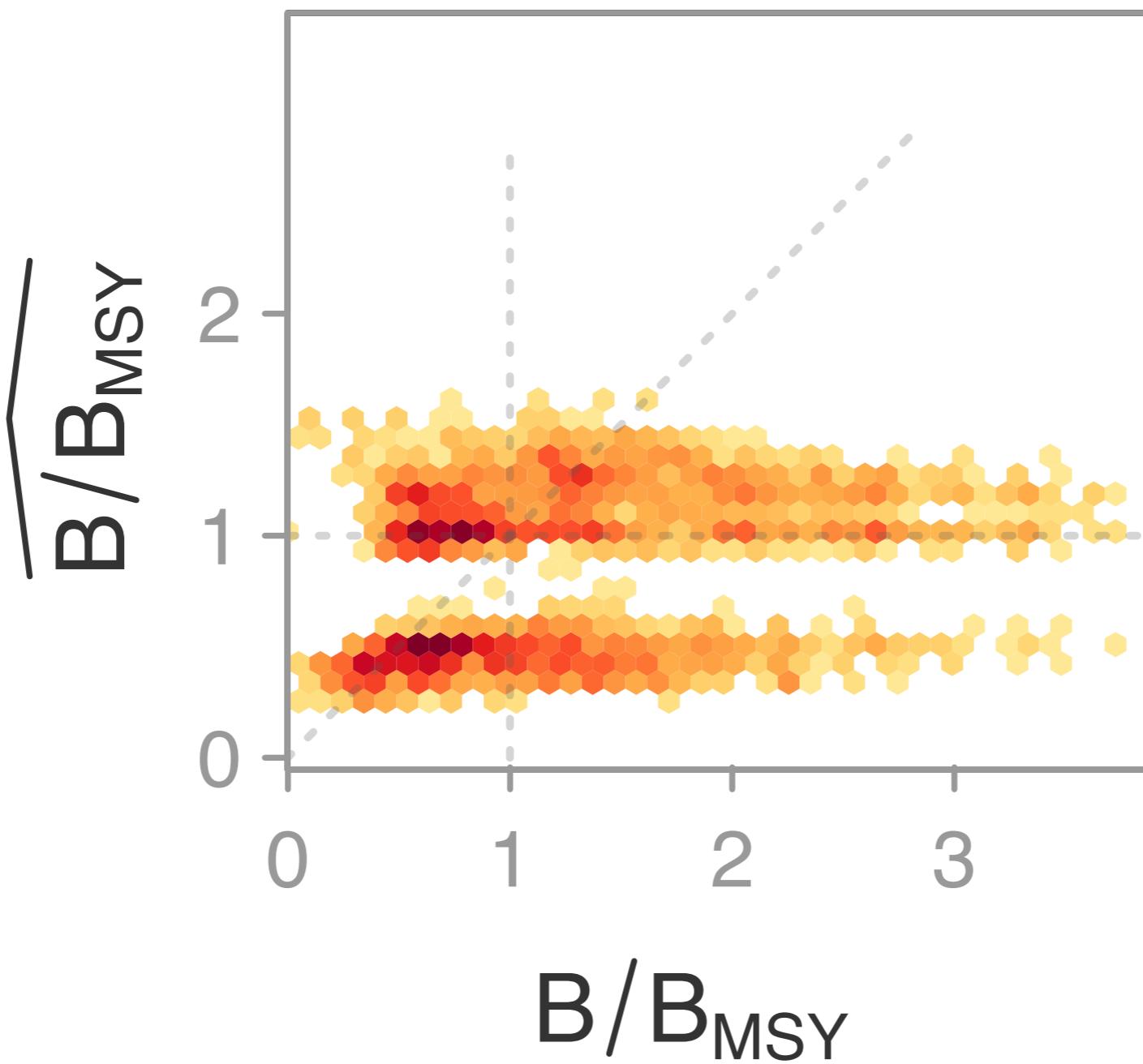
4 data-limited models



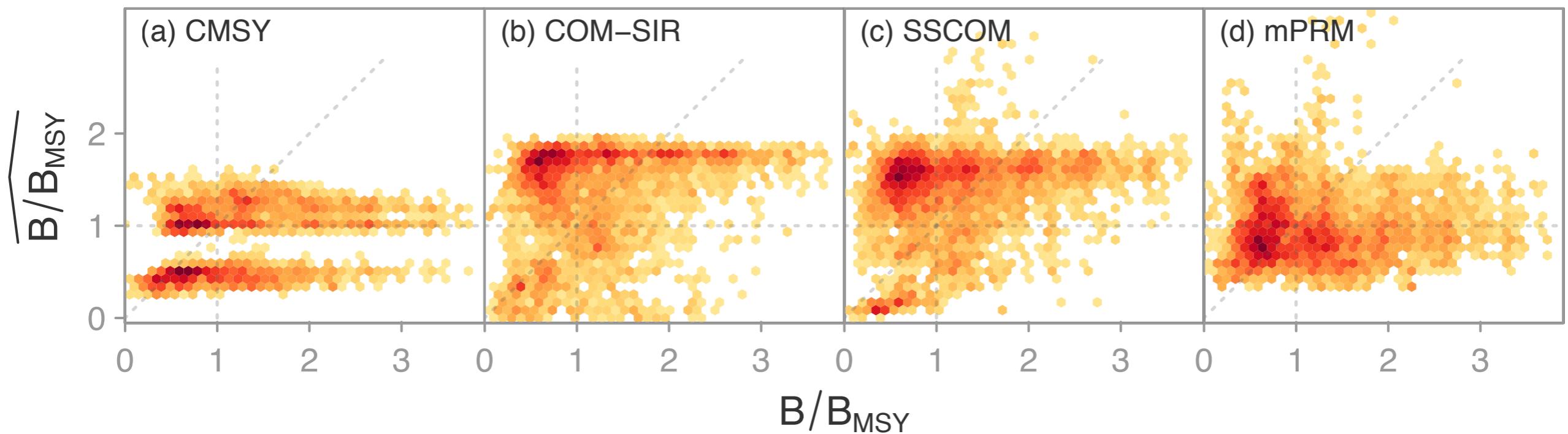
4 data-limited models



Catch-MSY fit to simulated stocks



4 models fit to simulated stocks



3-fold cross-validation

Data

3-fold cross-validation

Build Test
superensemble performance



3-fold cross-validation

Build Test
superensemble performance

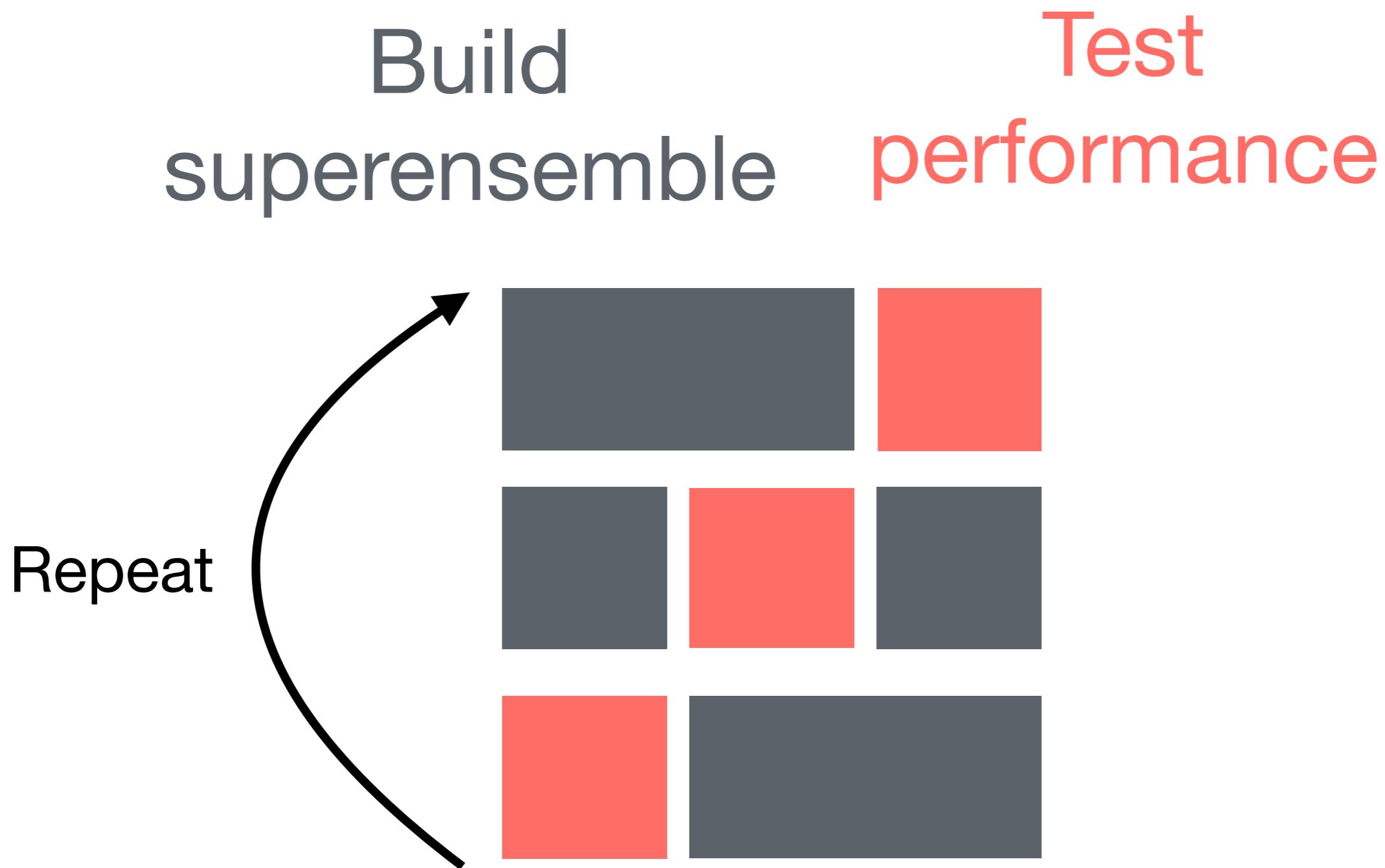


3-fold cross-validation

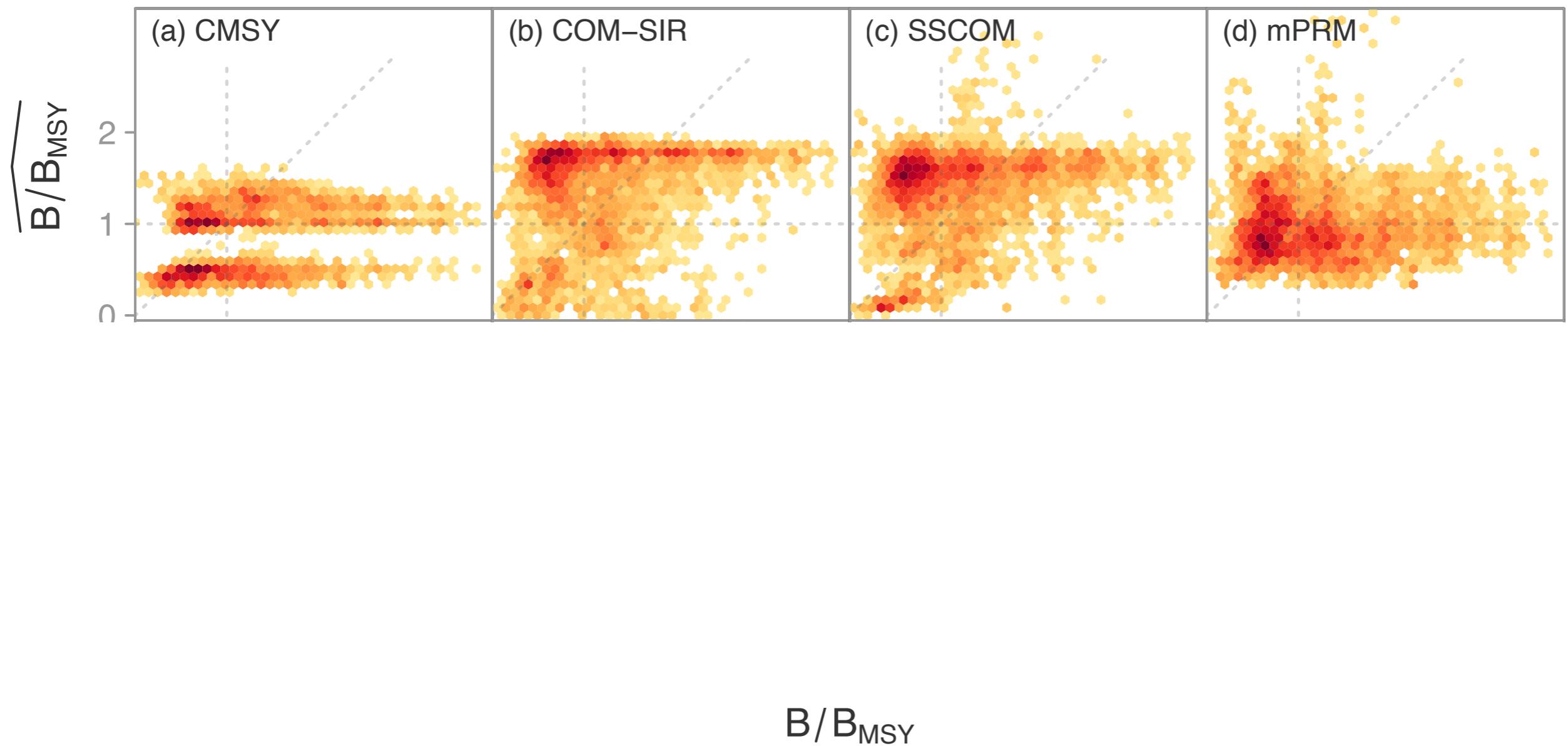
Build Test
superensemble performance



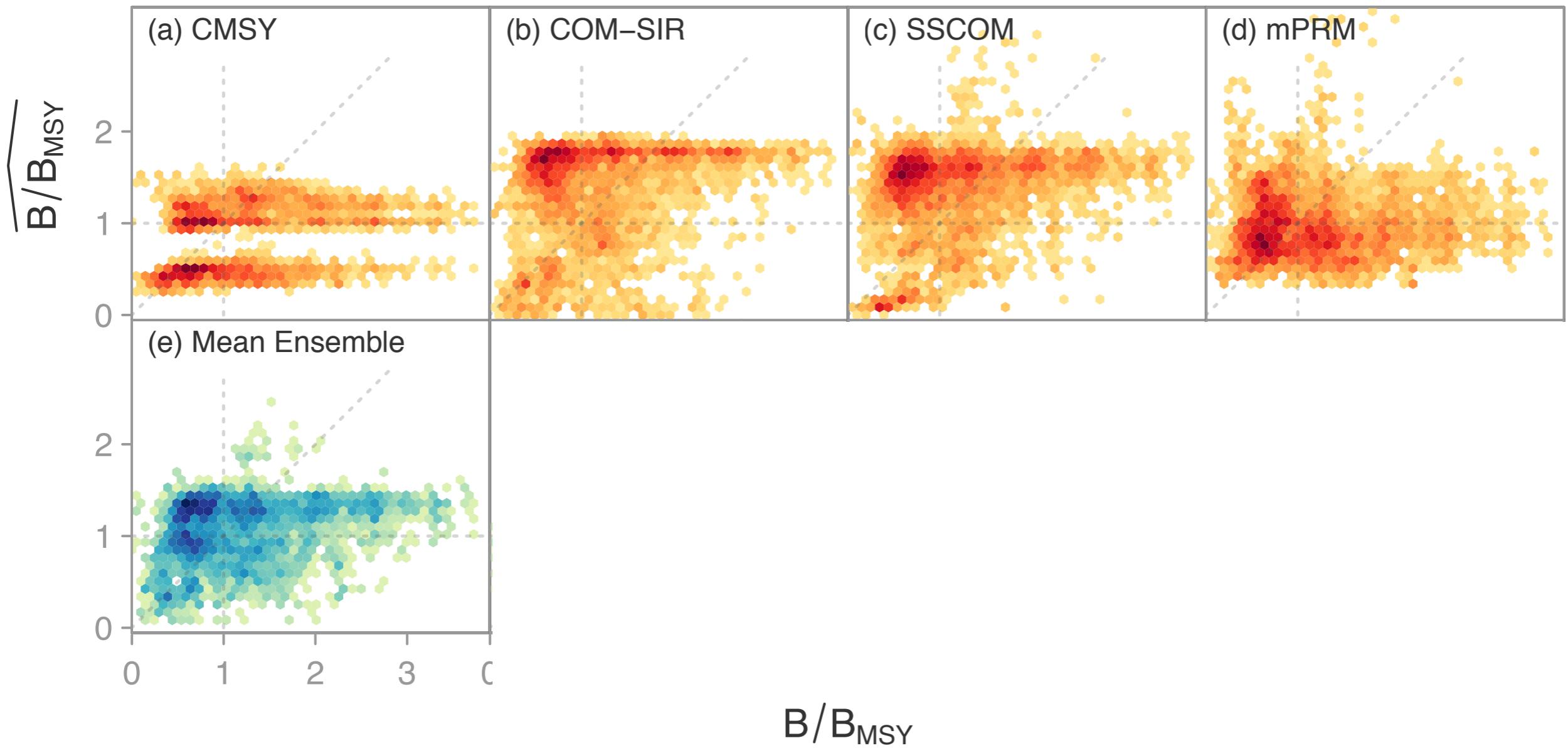
3-fold cross-validation



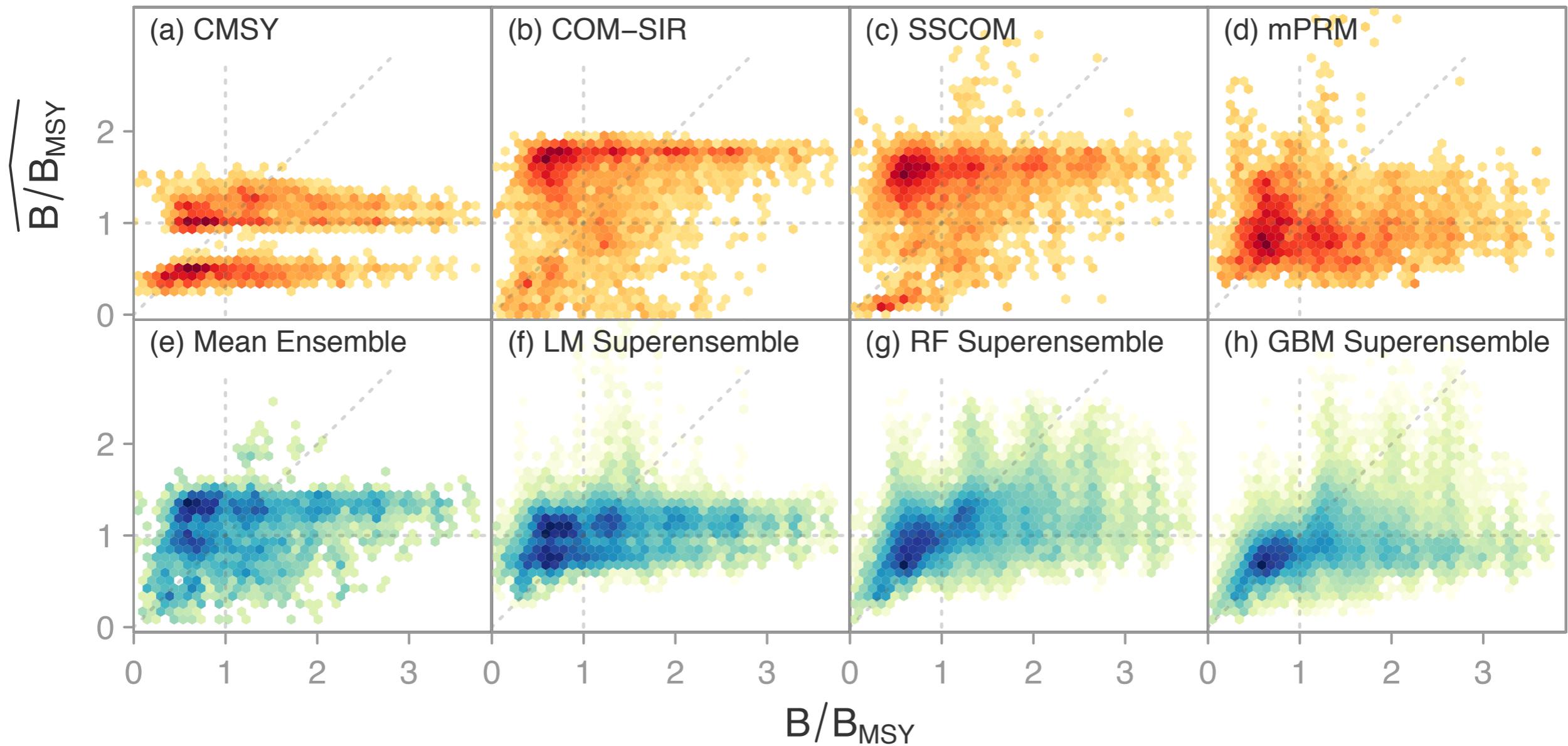
4 models fit to simulated stocks



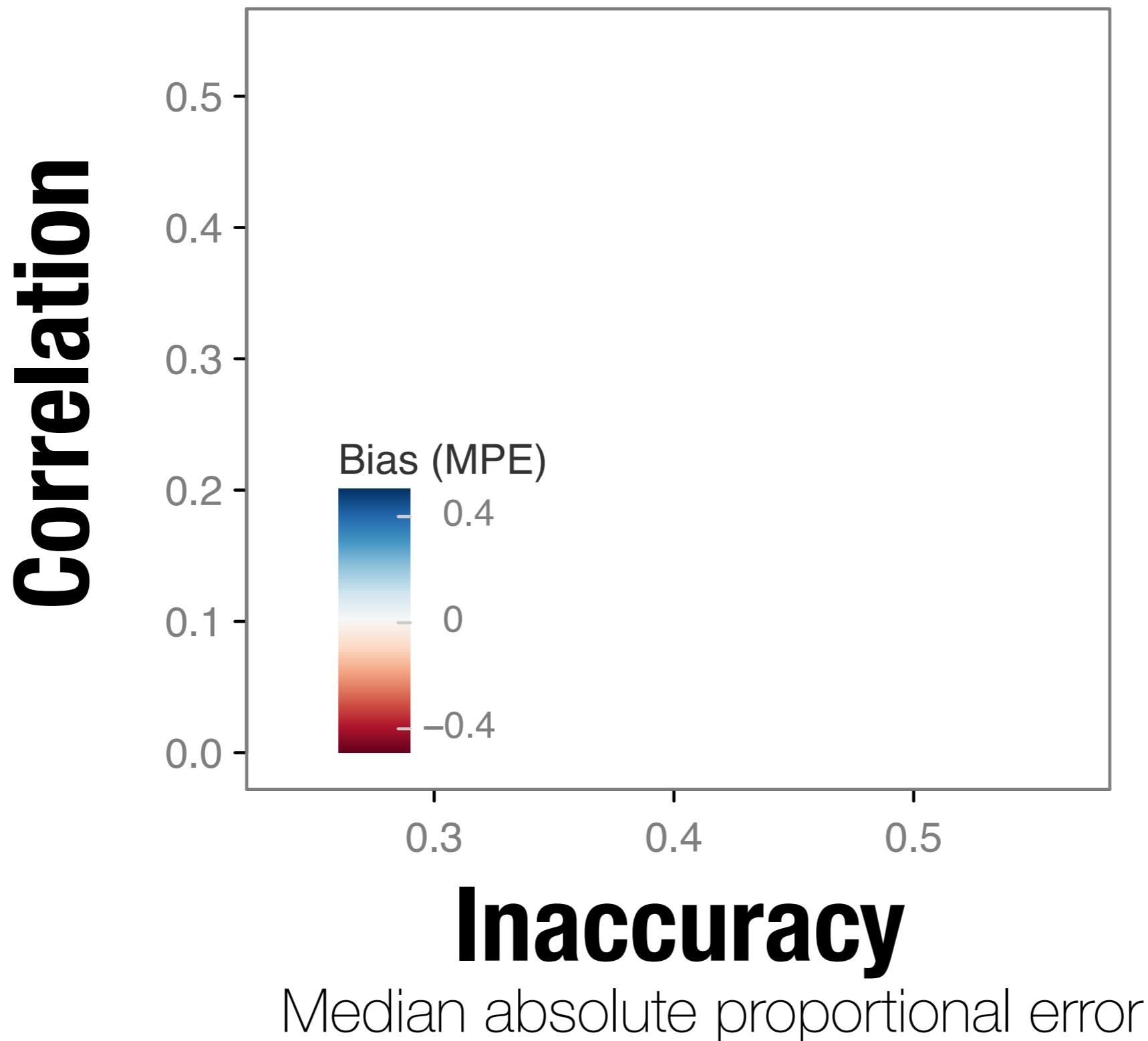
4 models fit to simulated stocks + ensembles



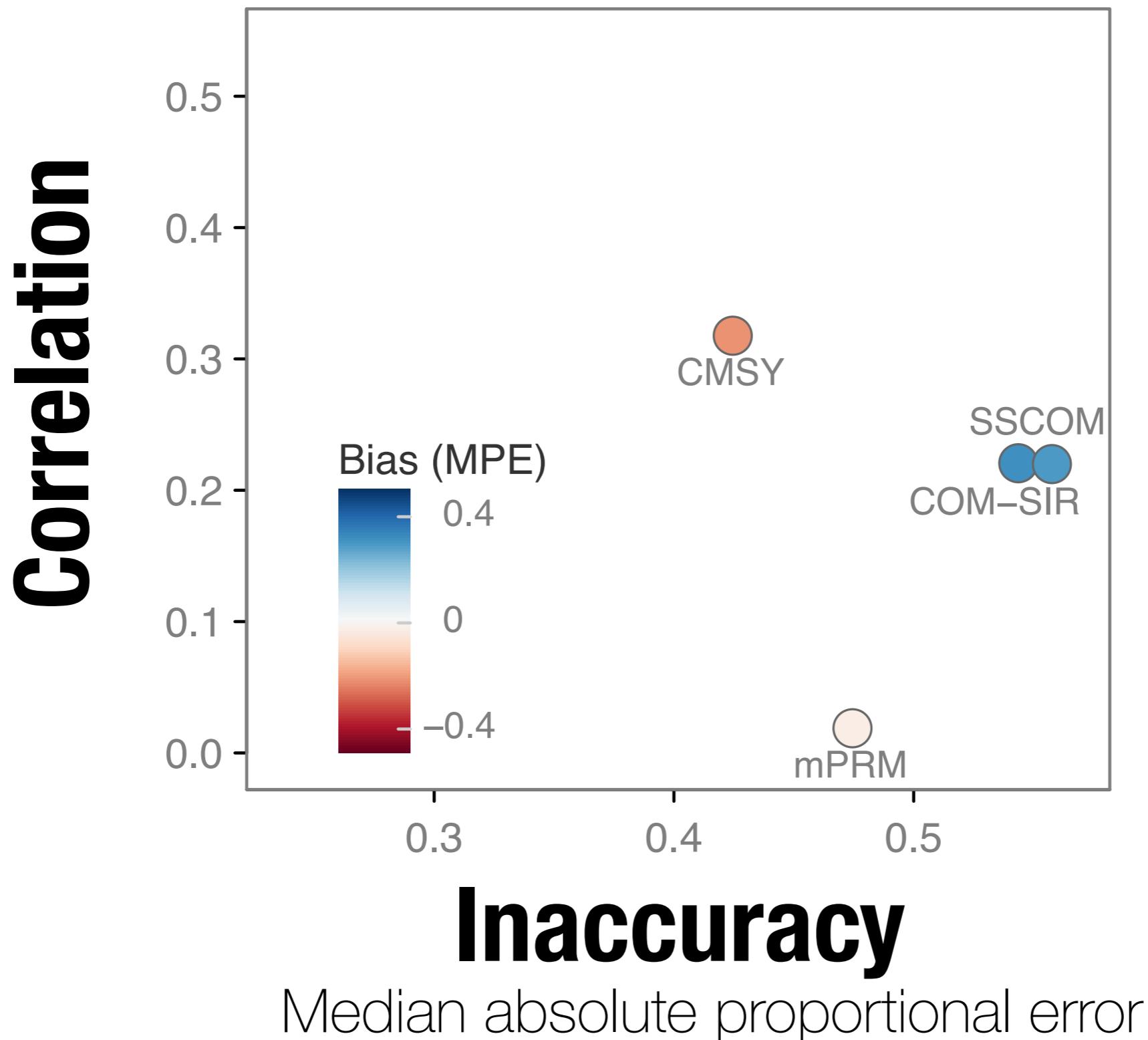
4 models fit to simulated stocks + ensembles



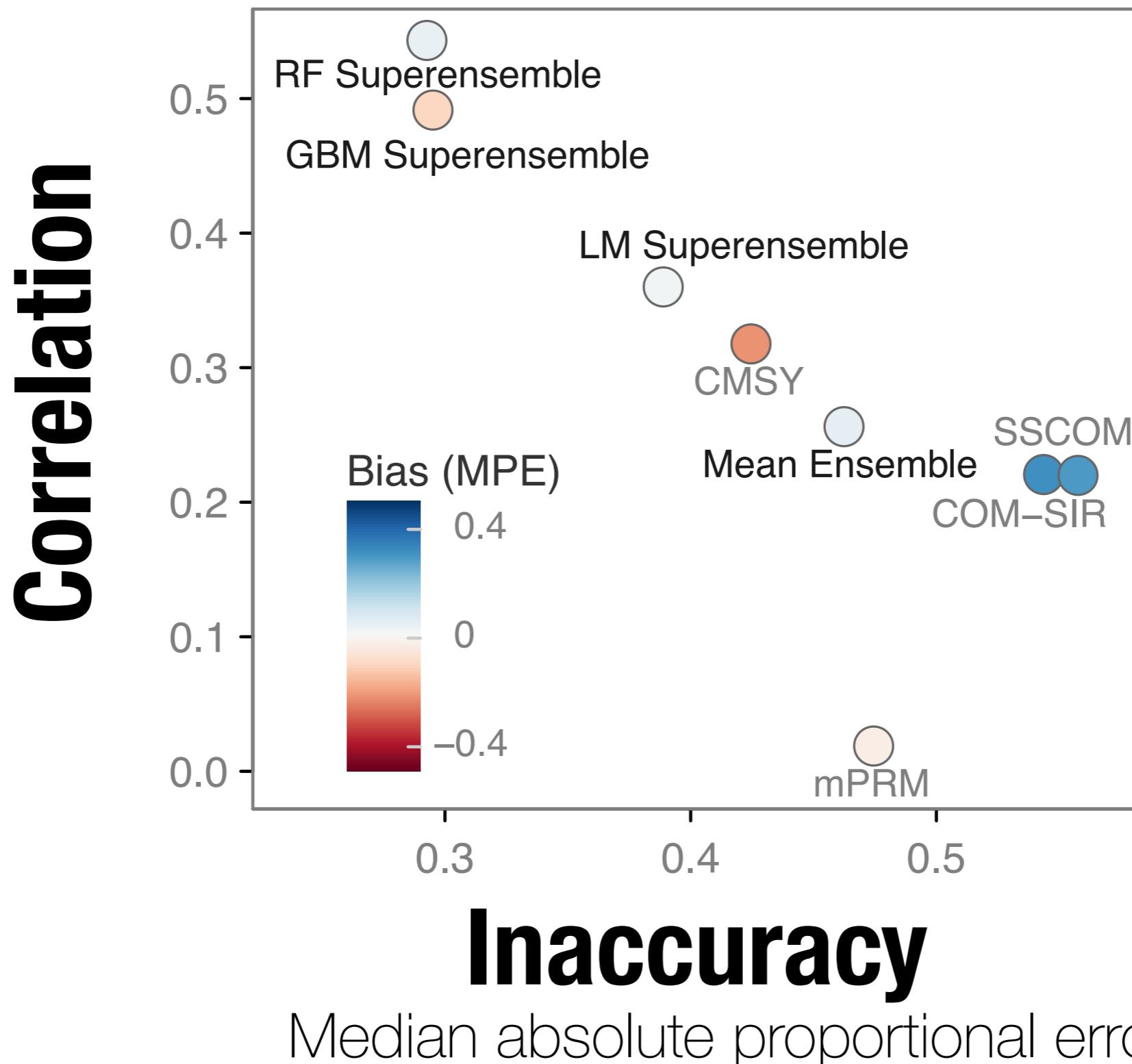
Ensembles: ↑ correlation, ↑ accuracy, ↓ bias



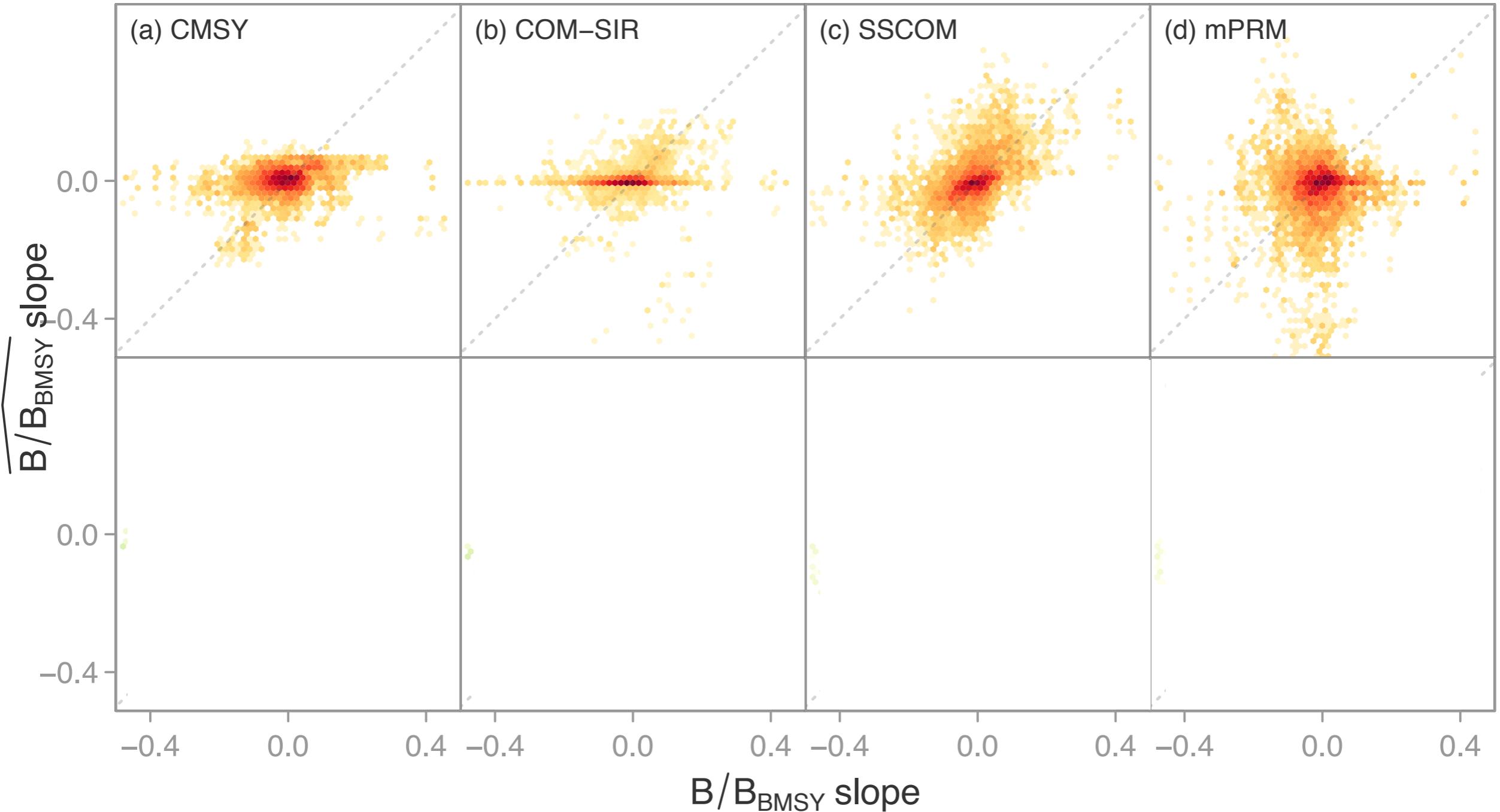
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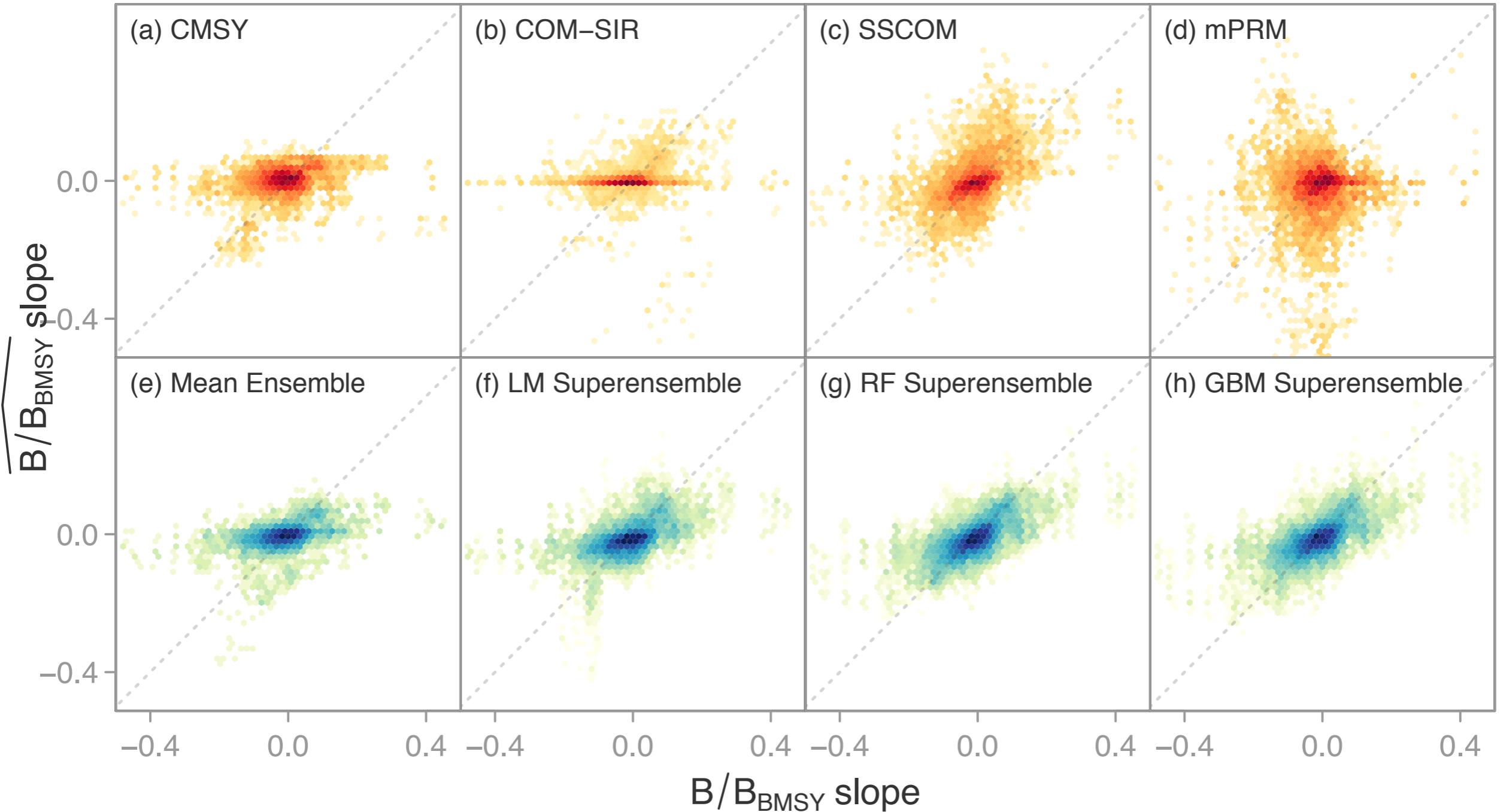
Ensembles: ↑ correlation, ↑ accuracy, ↓ bias



Ensembles also help with trend



Ensembles also help with trend



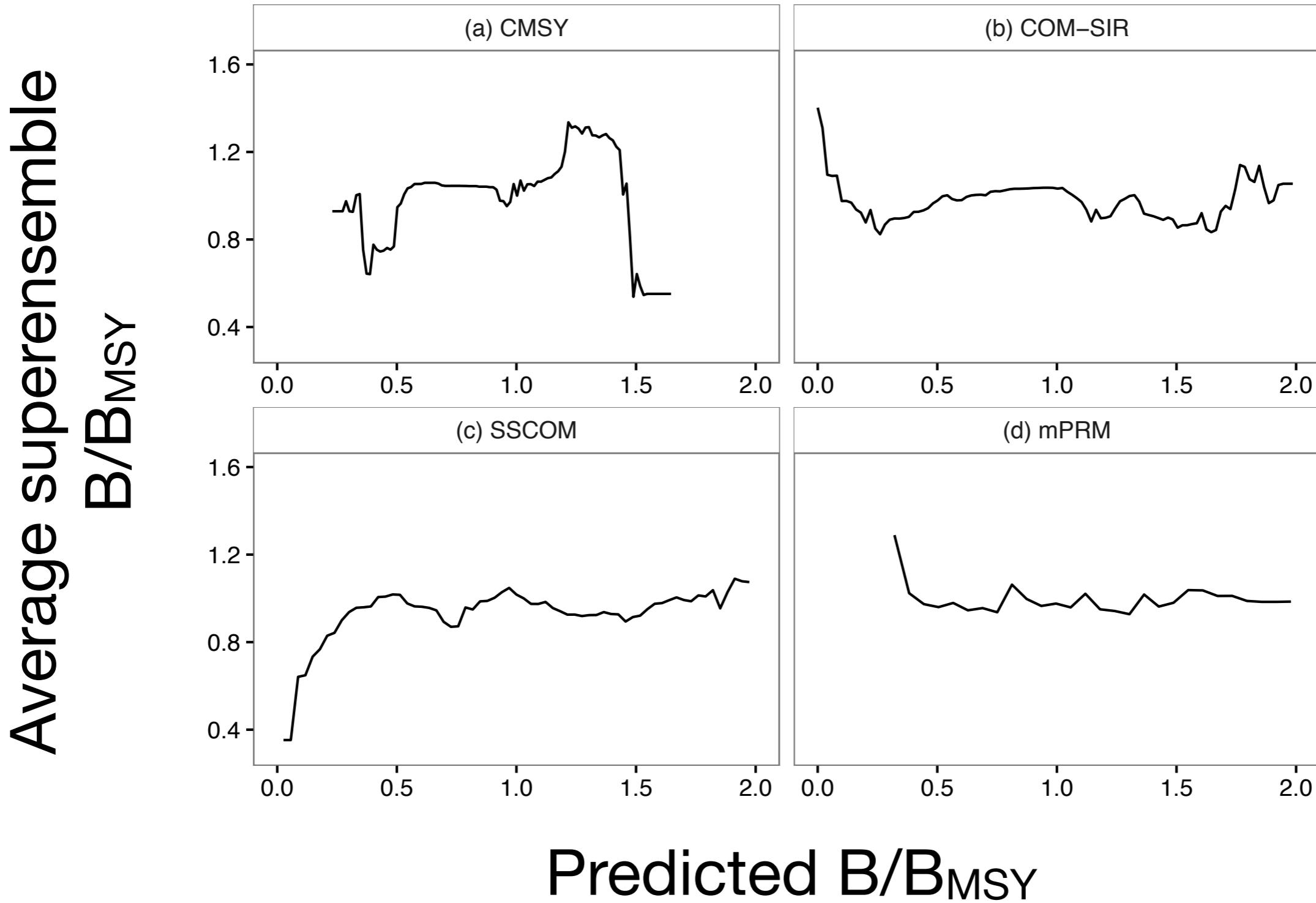
All models are wrong but some are useful.

-George Box 1978 Robustness in Statistics

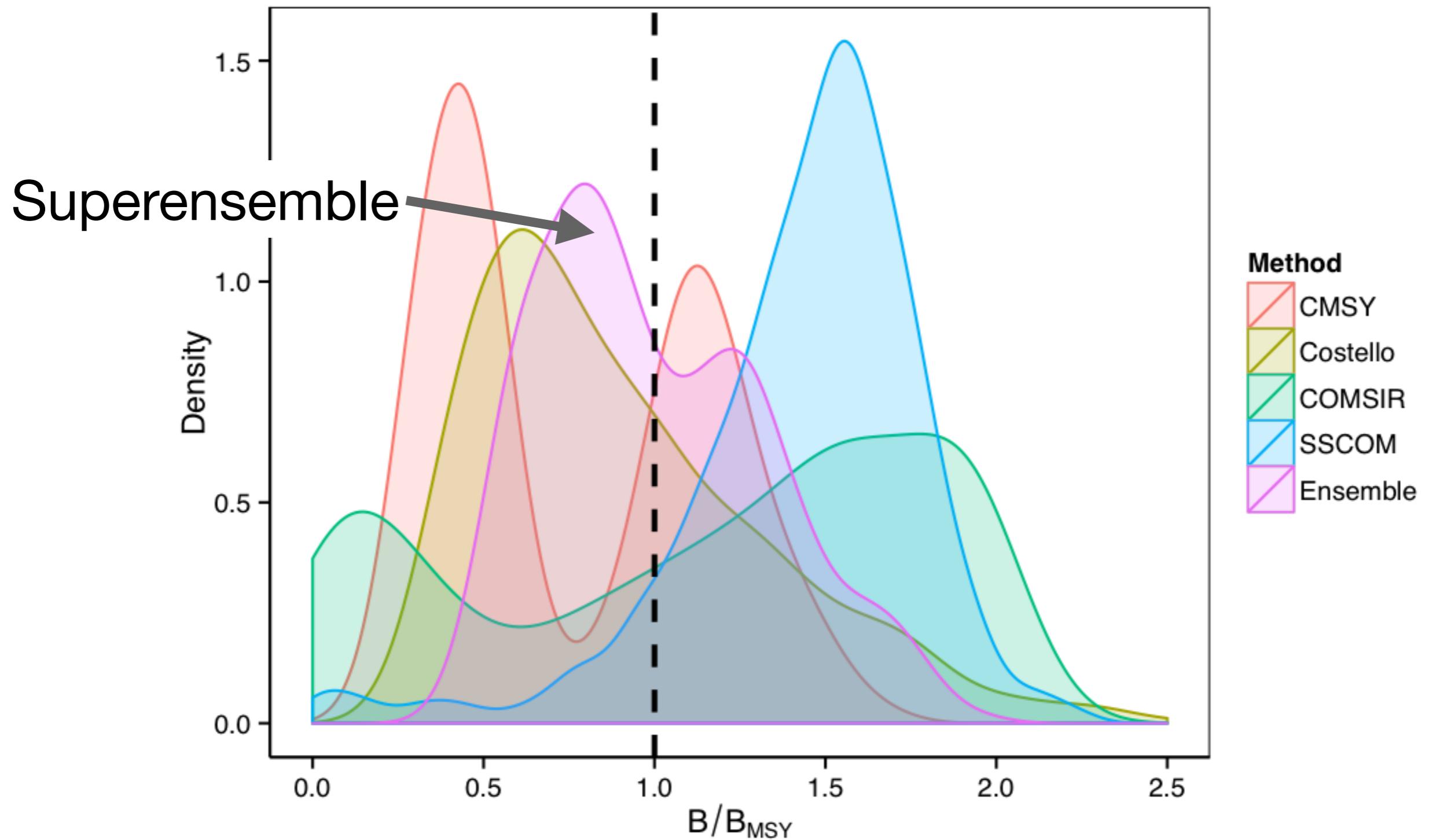
All models are wrong but some are more useful in some contexts than others...

-This talk

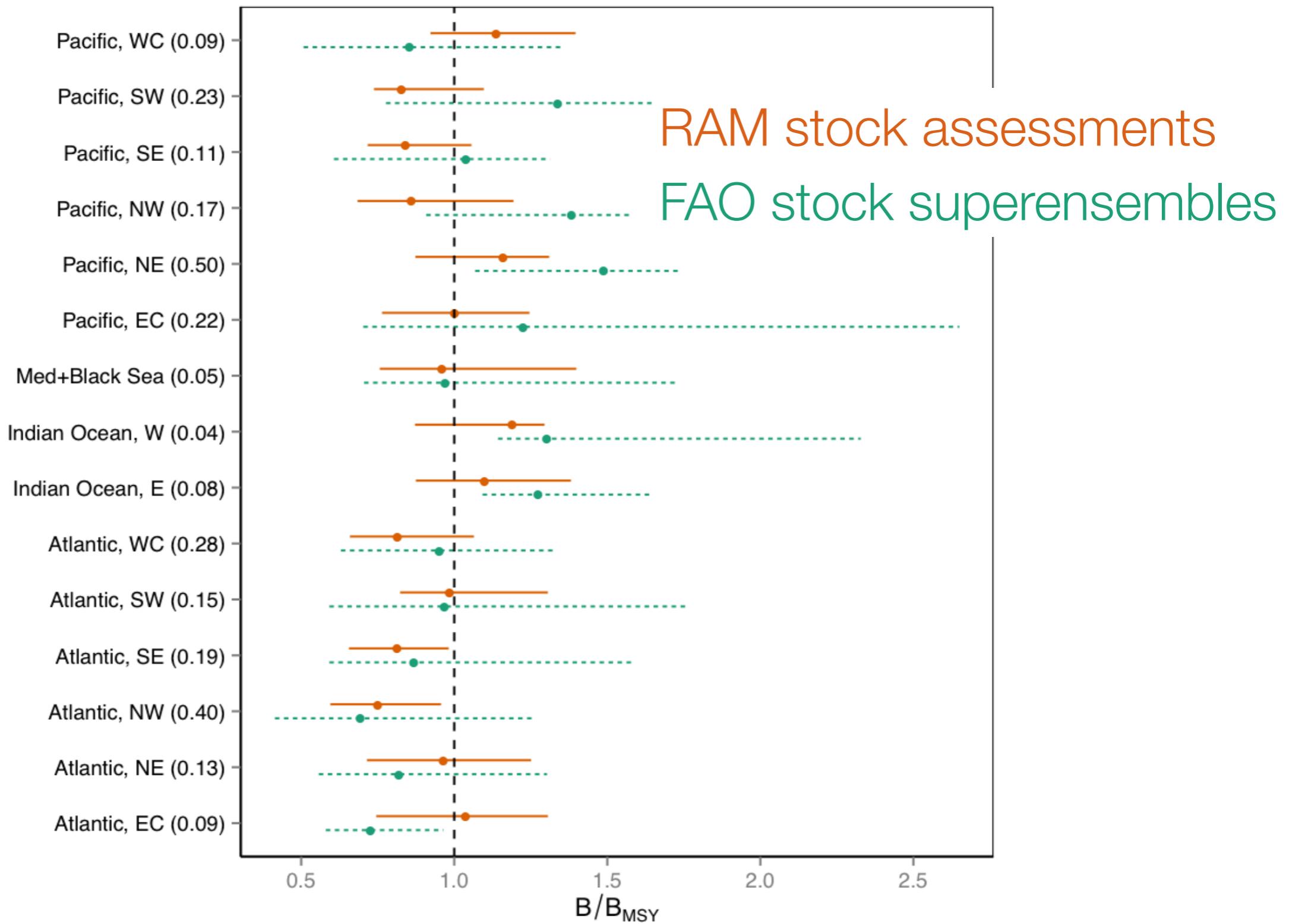
Diagnosing the utility of models



Global (FAO) ensemble B/B_{MSY}



B/B_{MSY} by FAO region





'Known' training dataset



'Known' training dataset Representative dataset



'Known' training dataset Representative dataset Diverse models



Best or among the best



*Best or among the best
Relatively simple*



*Best or among the best
Relatively simple
Added insight*



datalimited R package

github.com/datalimited (soon)

R: COM-SIR method ▾

[Find in Topic](#)

`comsir {datalimited}`

R Documentation

COM-SIR method

Description

Catch-only model with sample importance resampling based on the method described in Vasconcellos and Cochrane (2005).

Arguments

`yr` A time series of years associated with the catch

`ct` A time series of catch

`start_r` A numeric vector of length 2 giving the lower and upper bounds on the population growth rate parameter. This can either be specified manually or by translating resiliency categories via the function [`resilience`](#).

Slides: <https://github.com/datalimited>

Authors: Sean C. Anderson, Andrew B. Cooper, Olaf P. Jensen, Cólín Minto, James T. Thorson, Jessica C. Walsh, Jamie Afflerbach, Mark Dickey-Collas, Kristin M. Kleisner, Catherine Longo, Giacomo Chato Osio, Daniel Ovando, Iago Mosqueira, Andrew A. Rosenberg, Elizabeth R. Selig

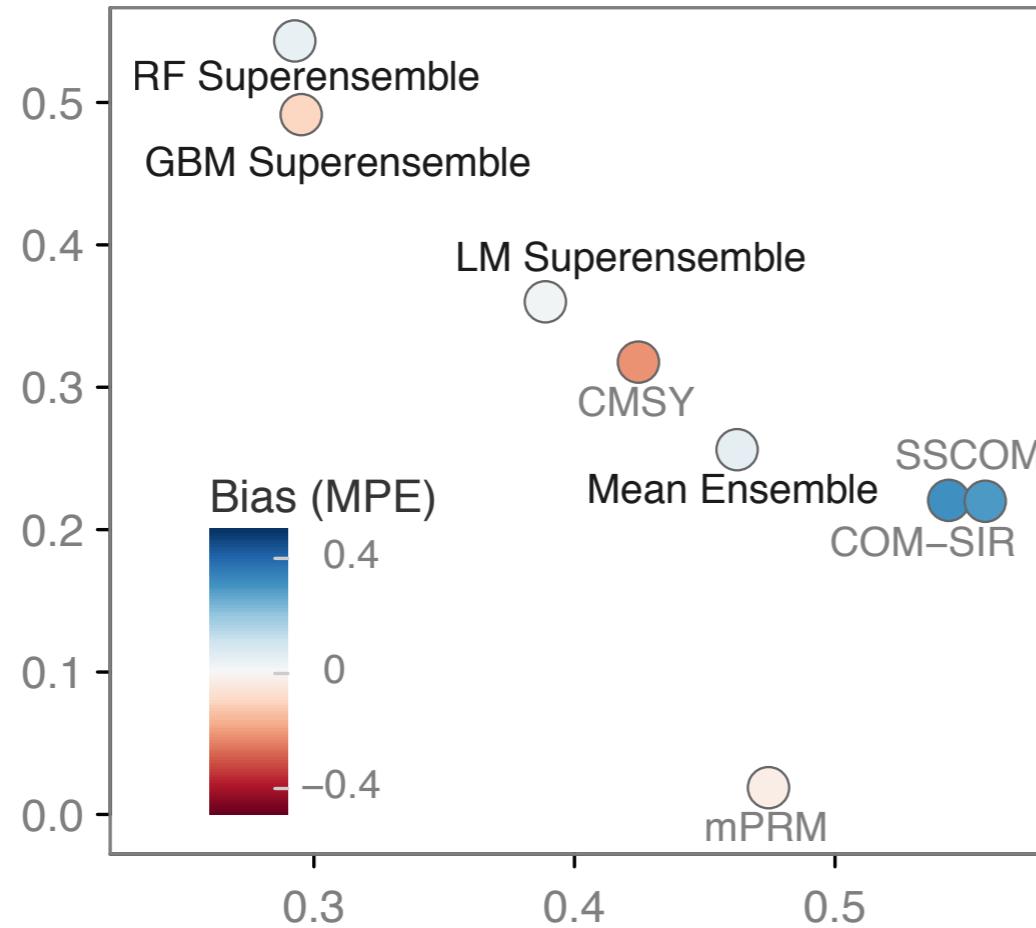


Sean C. Anderson

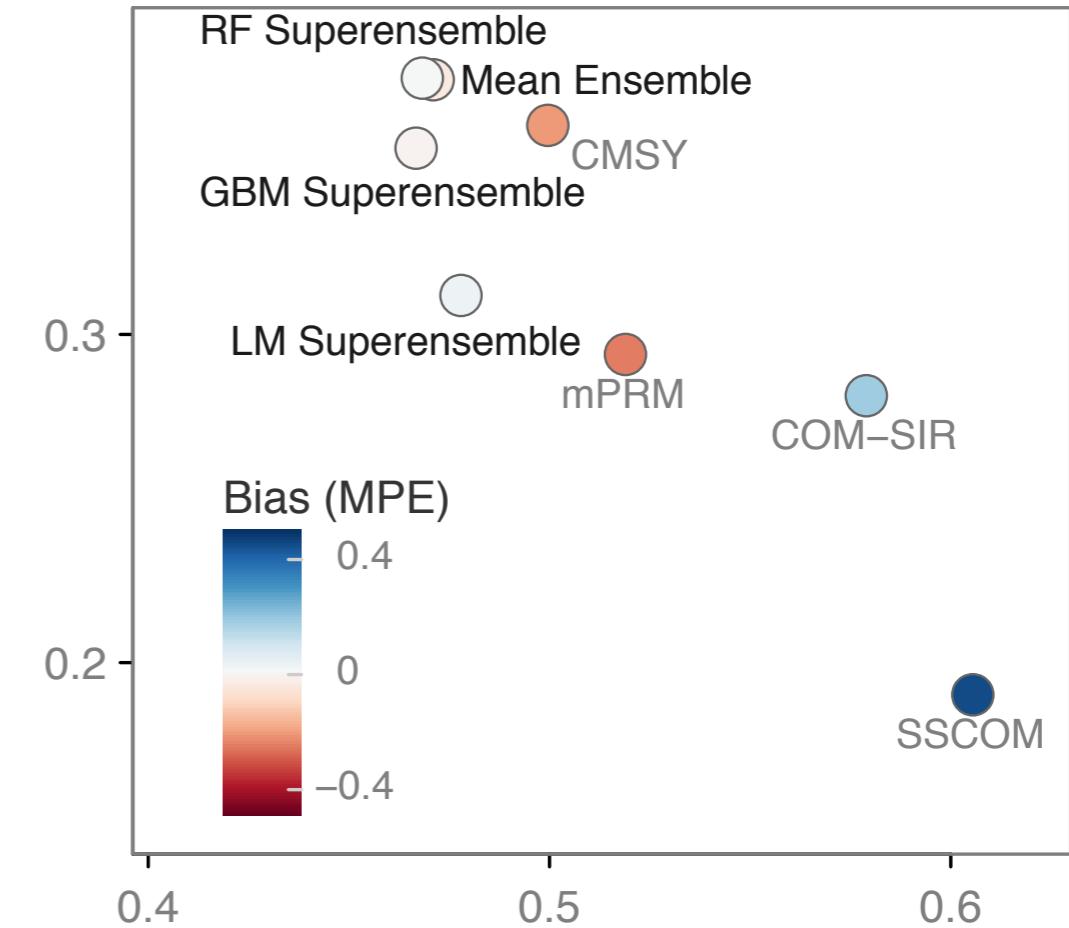
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Smith Fellow, University of Washington, U.S.

Cross-validation

Correlation



RAM stocks



Inaccuracy

Median absolute proportional error

Status: RAM Legacy database

