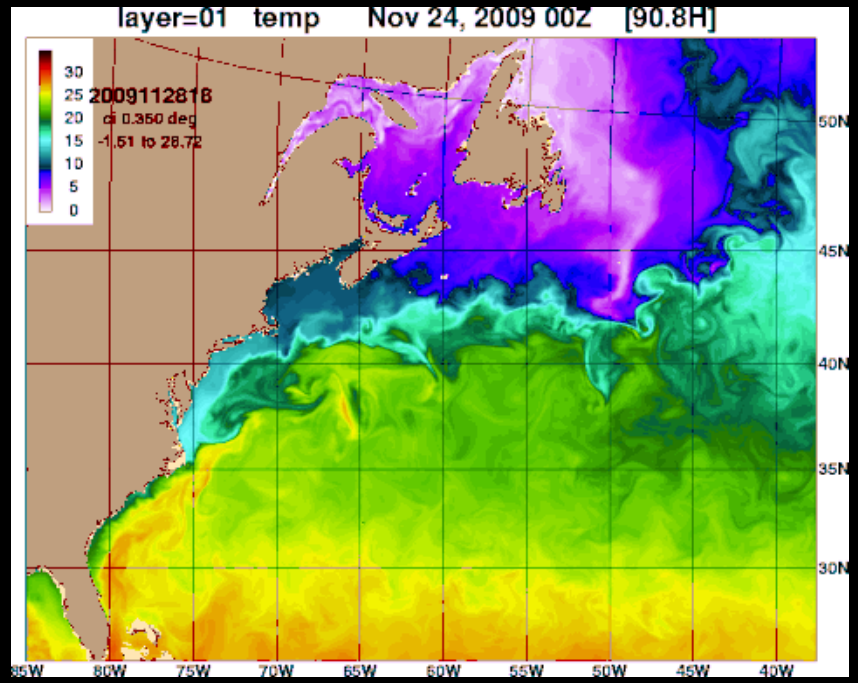
Evaluating the utility of the Gulf Stream Index for predicting recruitment of Southern New England yellowtail flounder



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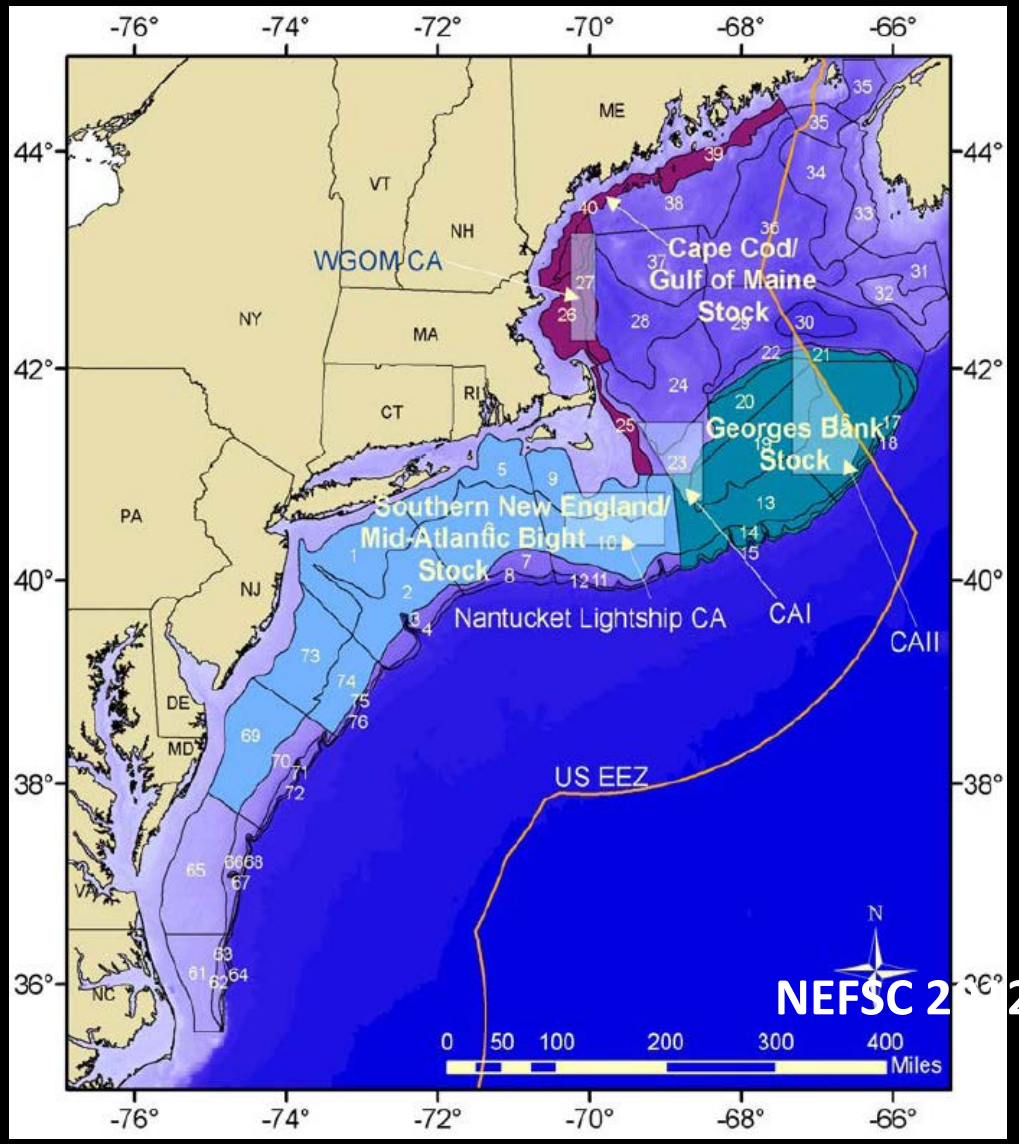
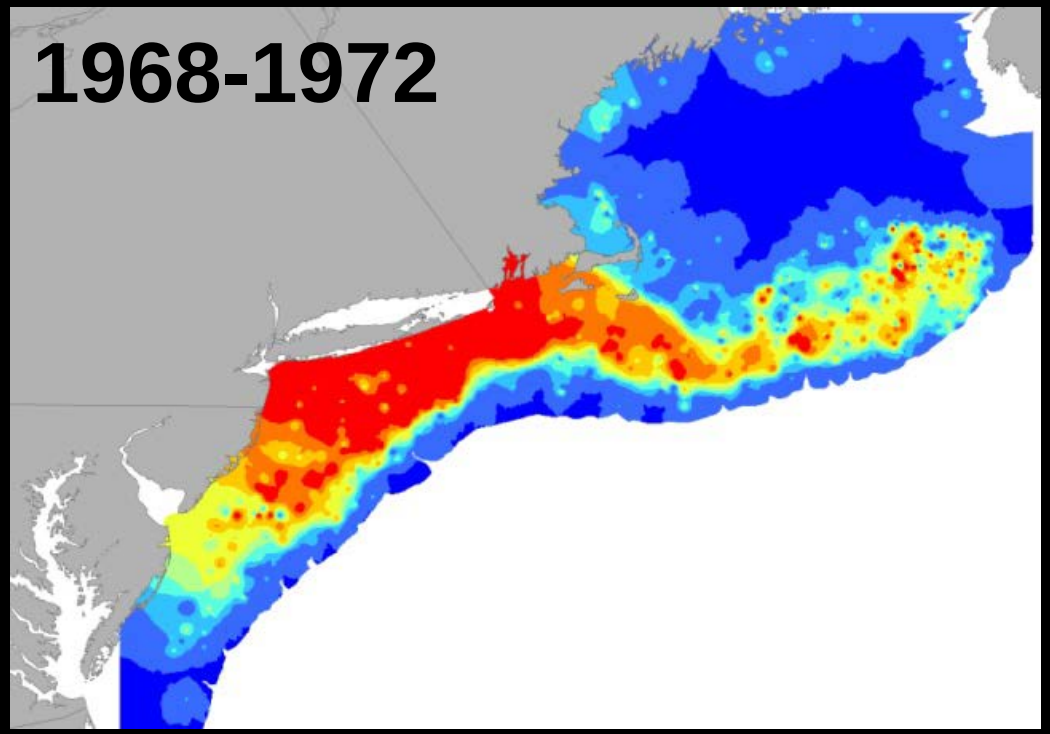
4th Climate Change Symposium

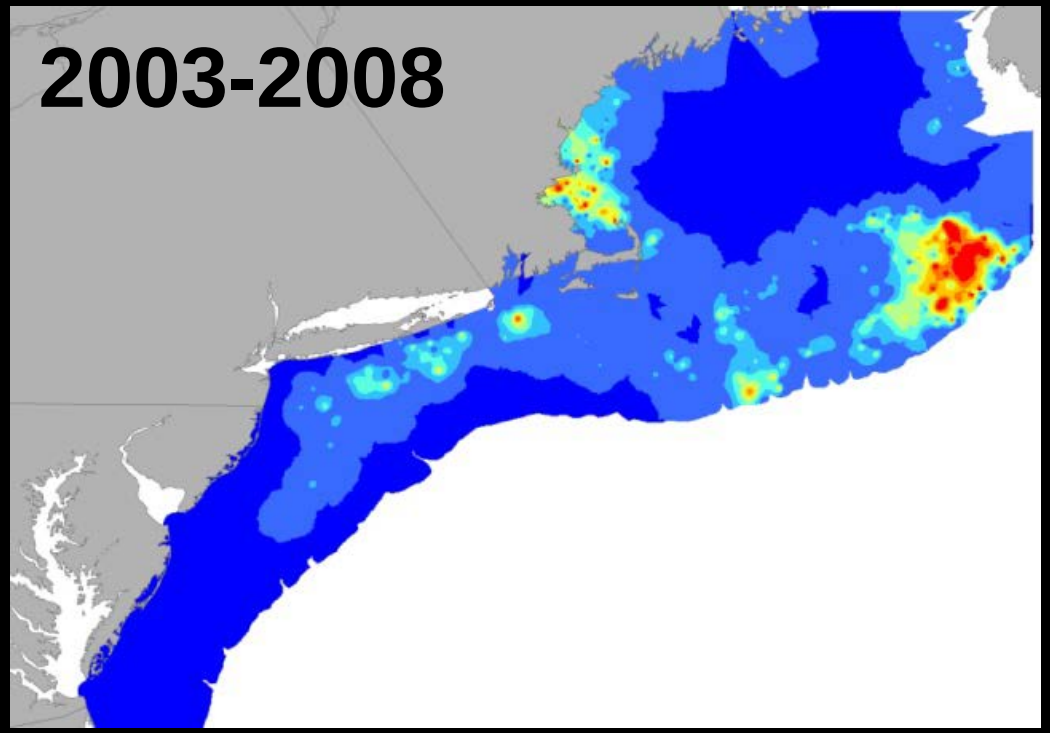
Yellowtail flounder (*Limanda ferruginea*)



NEFSC 2 2

Shifts in distribution

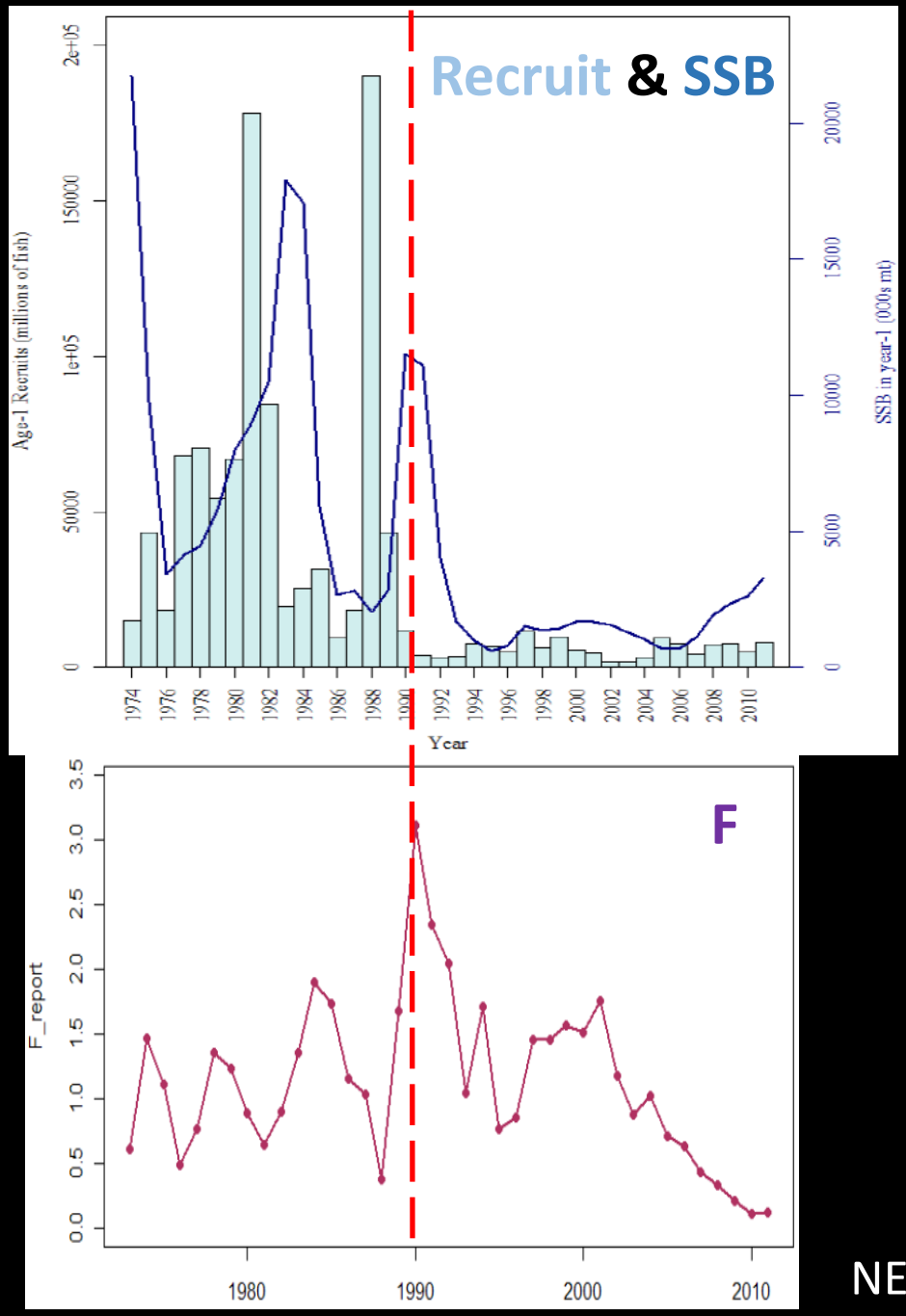




Benchmark assessment

- SNE yellowtail flounder was recently assessed using Age-Structured Assessment Program (ASAP) in 2012

- *"Determining the cause of recent low recruitment was the largest source of uncertainty in this assessment."* – NEFSC 2012



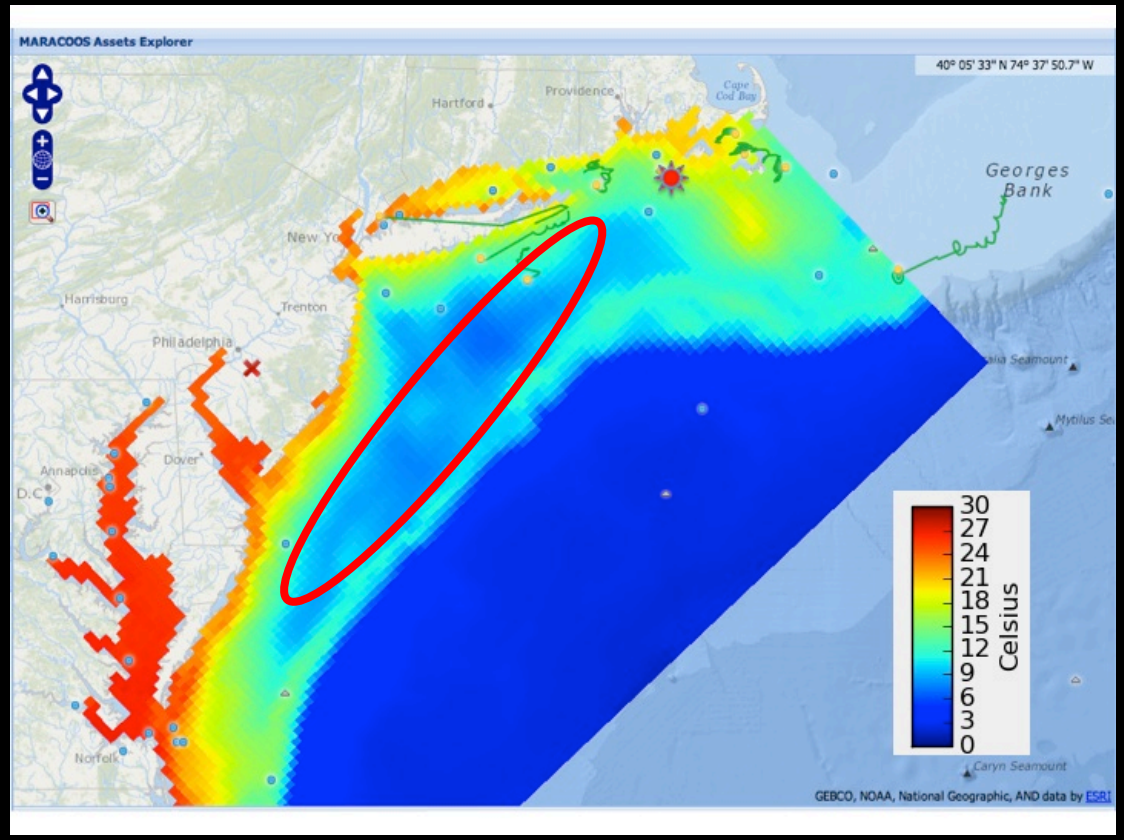
NEFSC 2012

Previous work: Mid-Atlantic cold pool affects recruitment

- Field: Colder cold pool -> higher recruitment level (Sullivan et al. 2000, 2005).

- Modelling: The state-space model that incorporates the Cold Pool Index (CPI) into the SR function has a smaller AIC and retrospective biases (Miller et al. 2016).

Summer BT

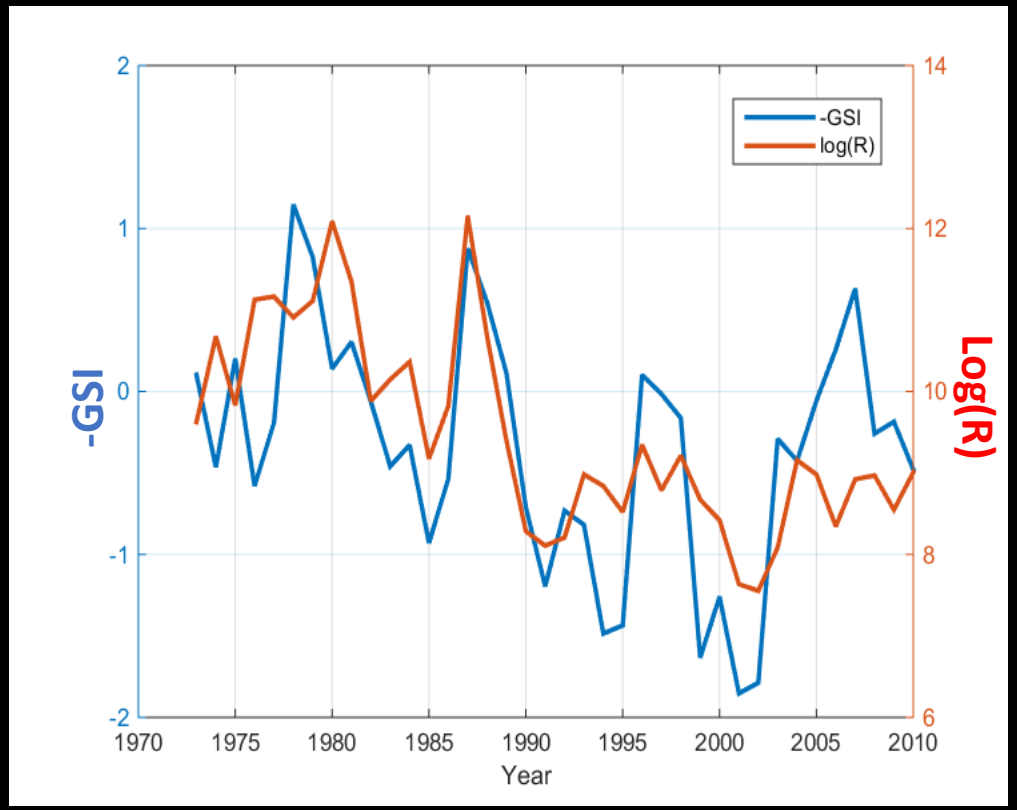


http://maracoos.org/blogs/main/?p=461

1. The best environmentally-explicit stock-recruit function

Environmental index	Lag 1	Lag 2	Lag 3
IL pressure	0.38		
IL longitude			
IL latitude			
AH pressure			
AH longitude			–0.36
AH latitude			–0.38
NAO		–0.37	–0.38
GSI	**–0.52**		
GSNW	–0.41		
CPI	–0.39		

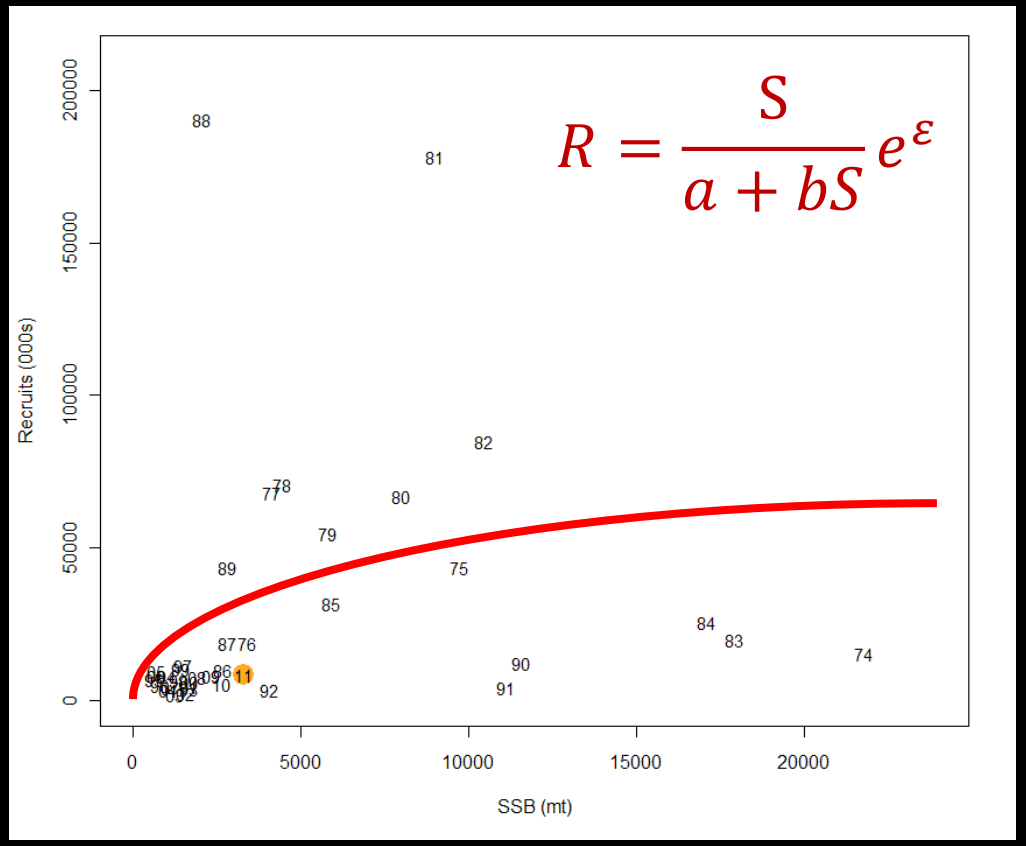
-GSI and log(R)

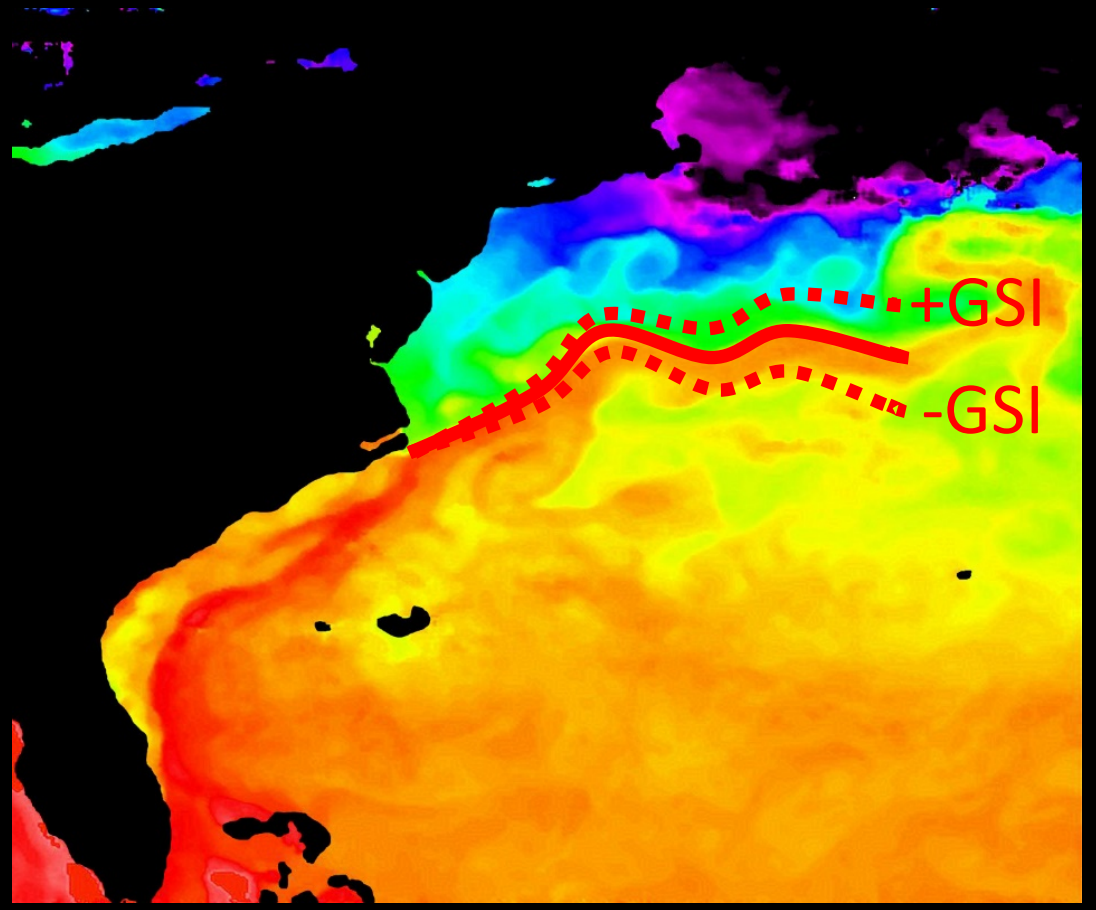


Xu et al. 2018

1. The best environmentally-explicit stock-recruit function

the best environmental covariate + the best way to incorporate this covariate



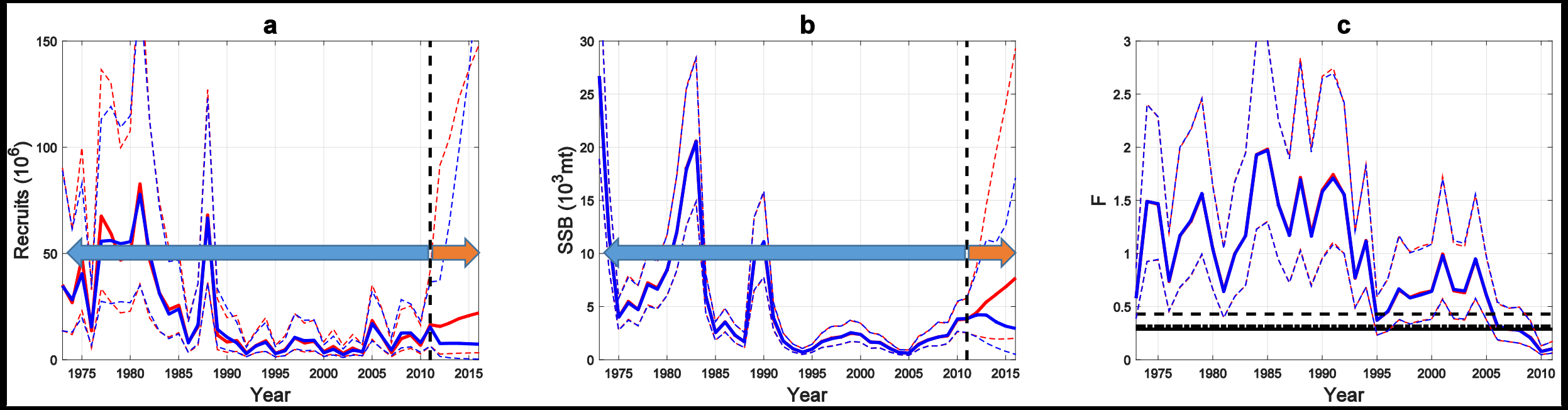


http://podaac.jpl.nasa.gov/AnimationsImages/Images/GulfStream

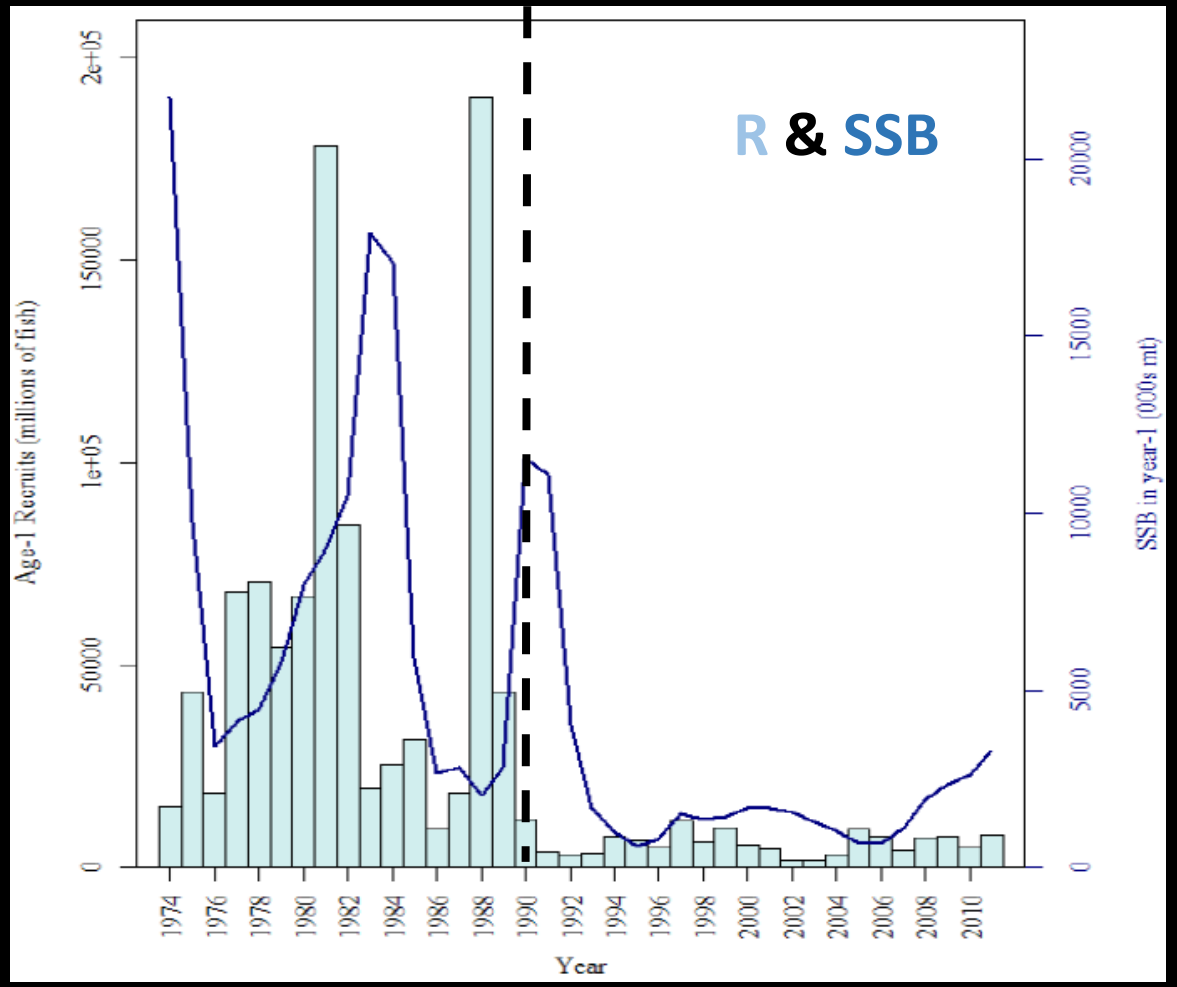
the best covariate + the best way to incorporate the covariate

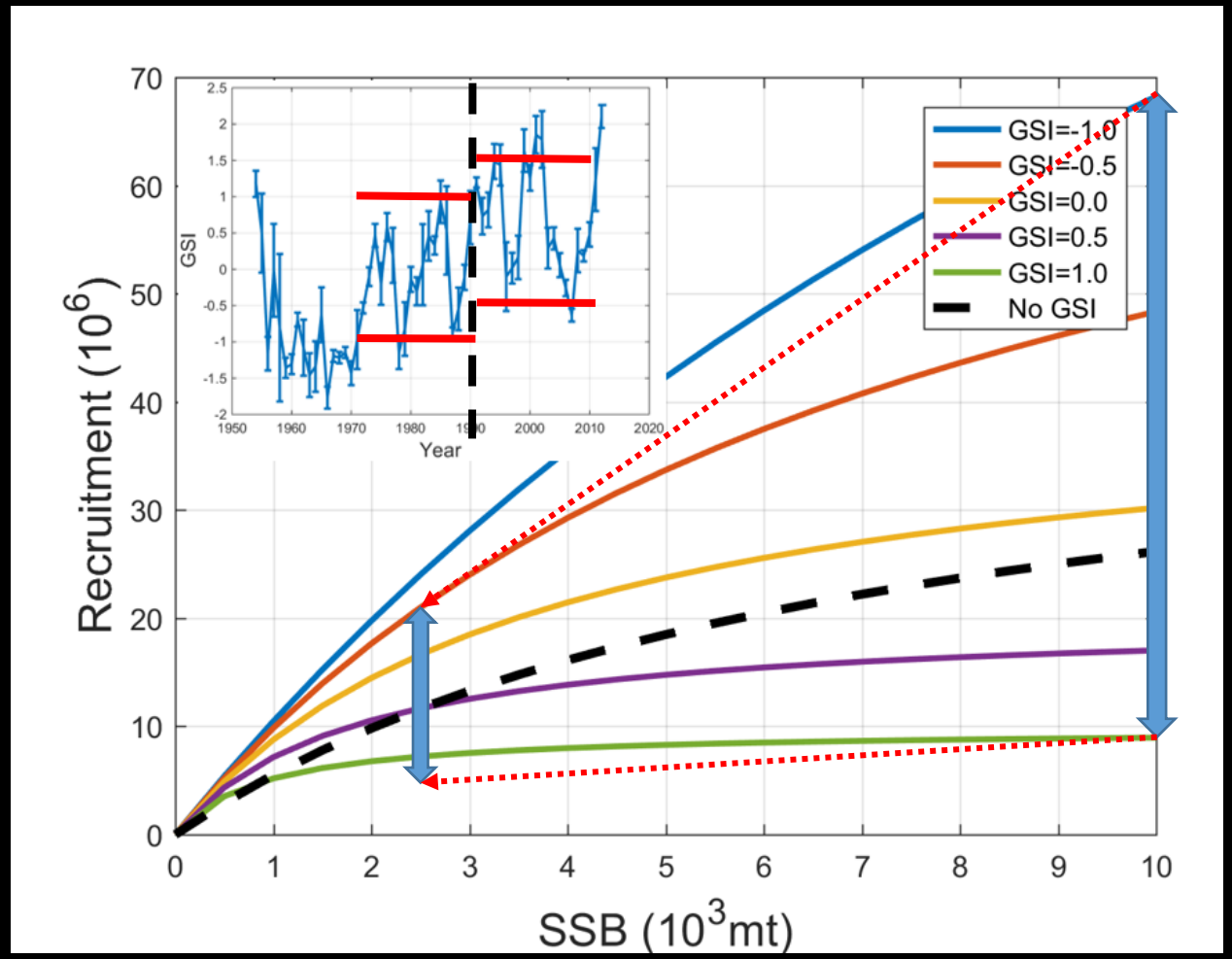
Model	Stock-Recruit function	AIC	(AIC)
R (SSB)		13.890	0.001
R ($CPI_{limiting}$, SSB)		5.396	0.037
R ($CPI_{masking}$, SSB)		4.532	0.057
R ($CPI_{controlling}$, SSB)		3.934	0.076
R ($GSI_{limiting}$, SSB)		**0.000**	**0.547**
R ($GSI_{masking}$, SSB)		4.940	0.046
R ($GSI_{controlling}$, SSB)		1.674	0.237

2. Compare the estimates (1973-2011) and predictions (2012-2016) from **R(SSB)** and **R(SSB, GSI$_{limiting}$)**

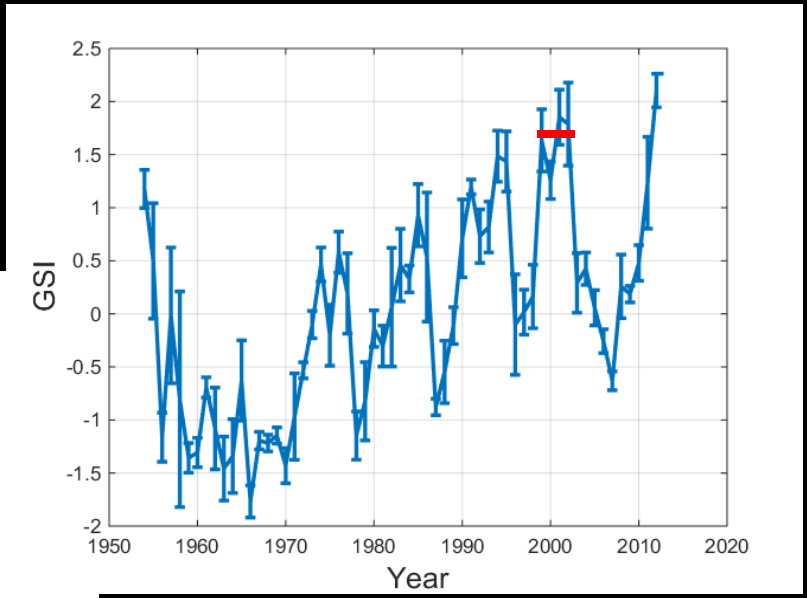


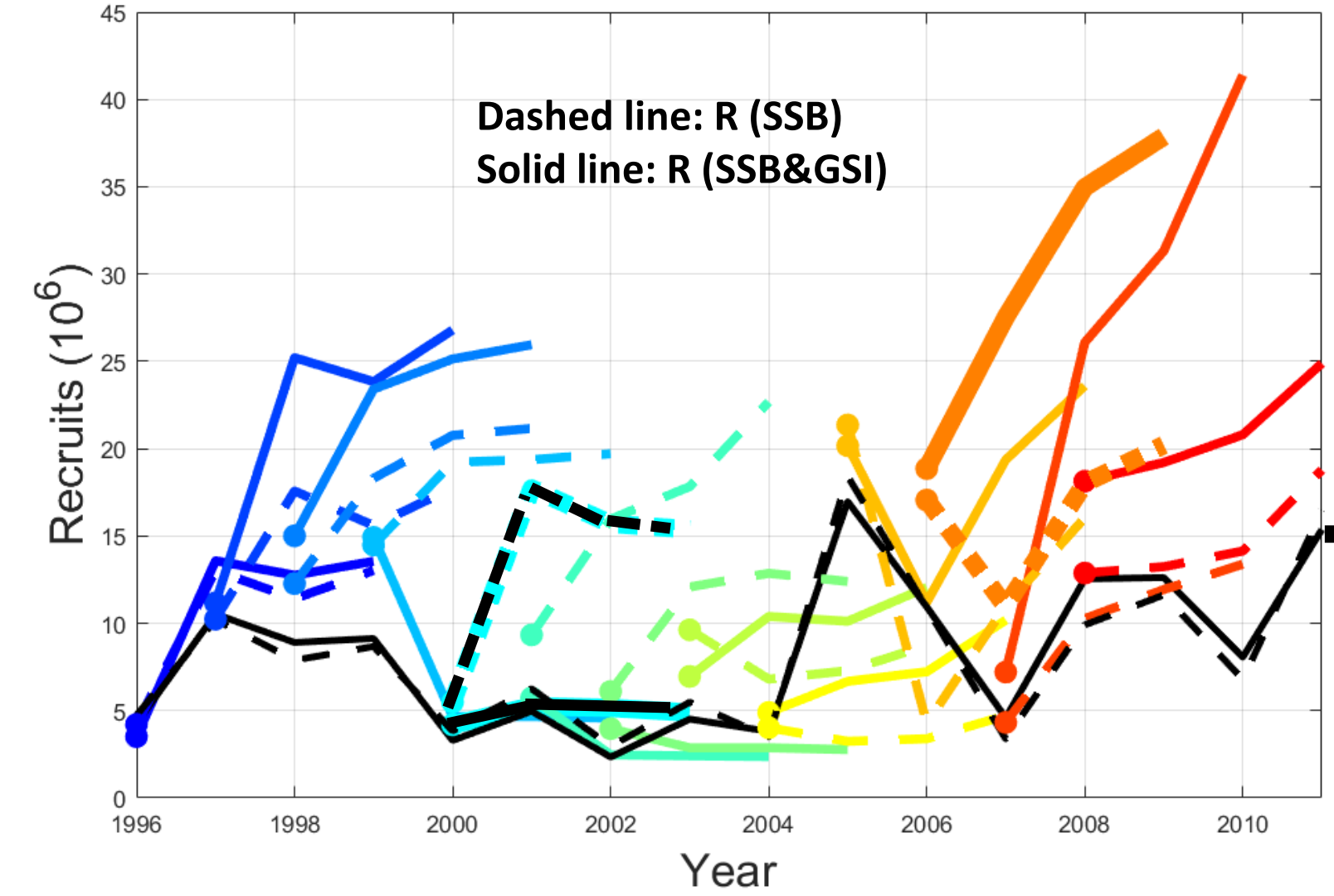
The best fitting stock-recruit function: $R = \frac{SSB}{b+aSSBe^{cGSI}}$





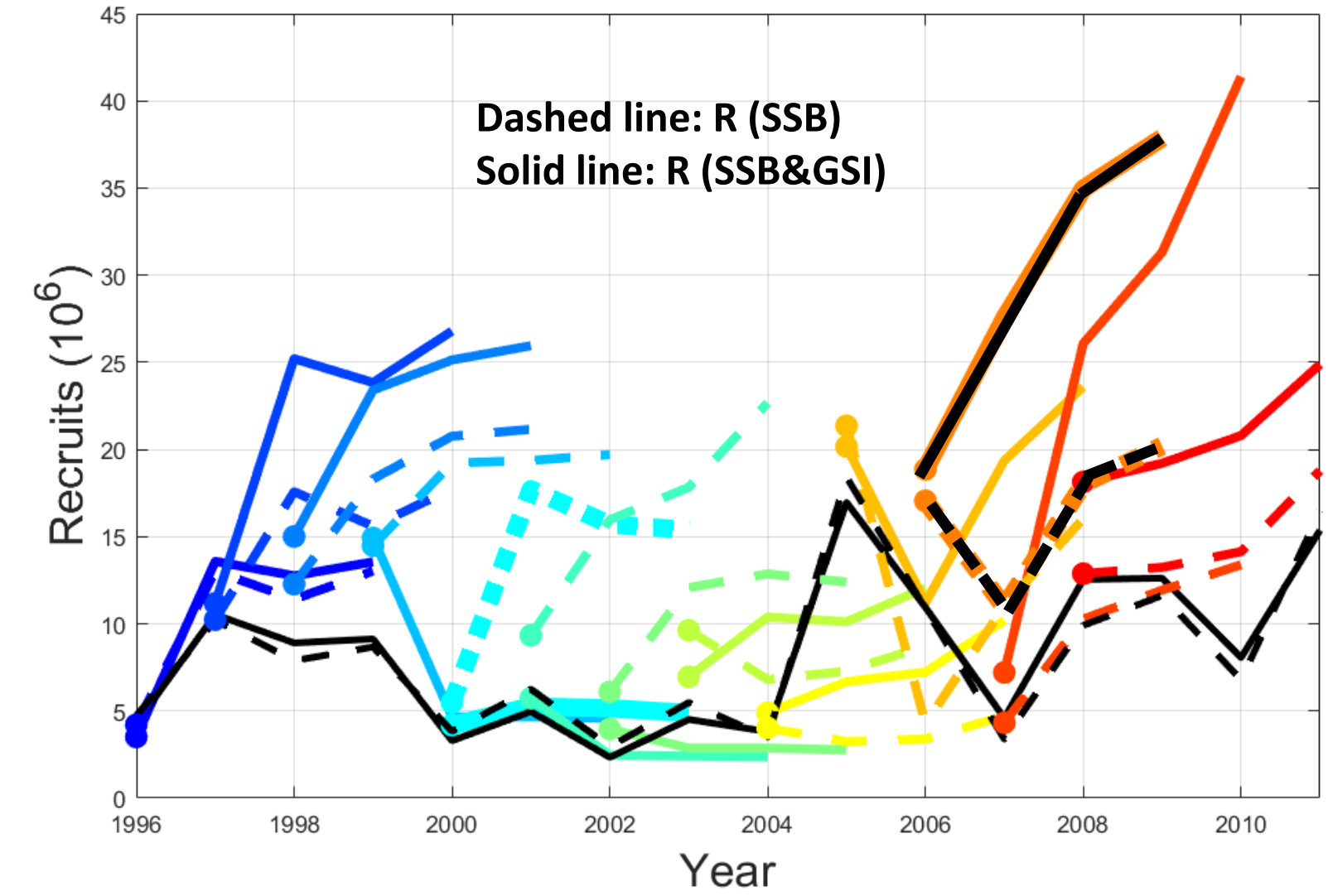
3. Retrospective recruitment predictions

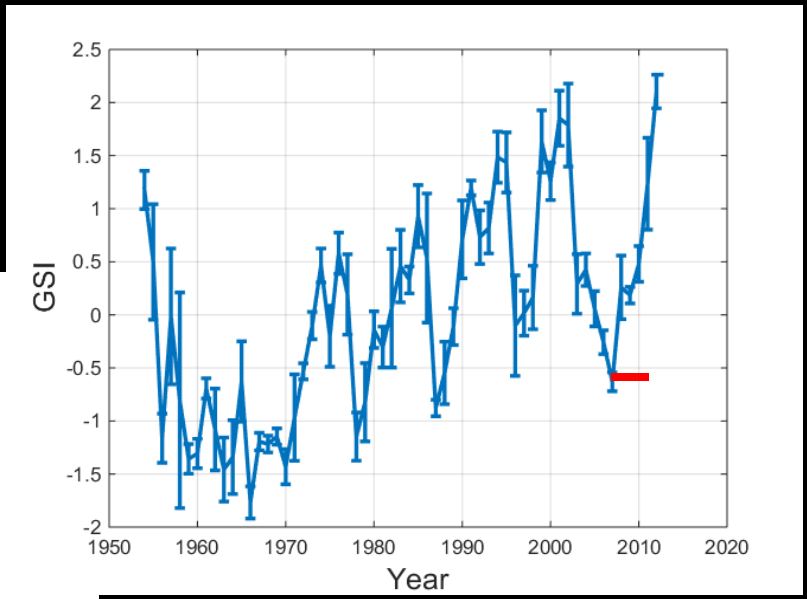




Estimated recruitment from the full data set

3. Retrospective recruitment predictions



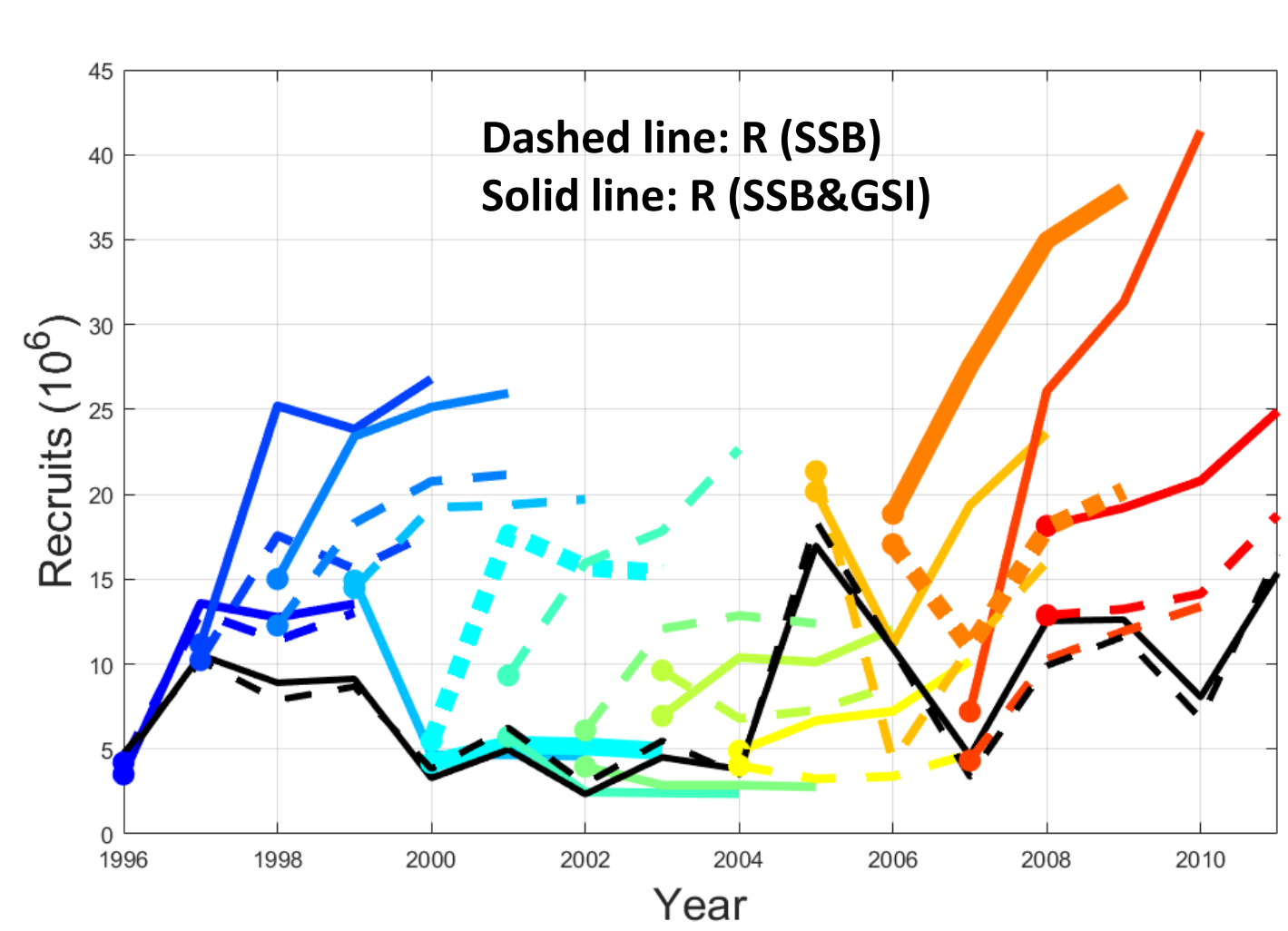


Prediction skill comparison based on

Mean Relative Difference & Mean Absolute Relative Difference

$$\mathrm{MRD_t} = \frac{1}{13}\sum_{i=1996}^{2008}\frac{\theta_{i,t} - \Theta_{i+t}}{\Theta_{i+t}}$$

$$\mathrm{MARD_t} = \frac{1}{13}\sum_{i=1996}^{2008}\frac{|\theta_{i,t} - \Theta_{i+t}|}{\Theta_{i+t}}$$



Prediction lead time	1 year	2 years	3 years
MRD: R(SSB)	1.23	1.53	1.68
MRD: R(SSB&GSI)	0.89	1.26	1.59
MARD: R(SSB)	1.45	1.73	1.76
MARD: R(SSB&GSI)	1.04	1.50	1.77

Why the large-scale GSI performs better than the local-scale CPI in explaining recruitment deviations?

Hypothesis: The large-scale GSI holds information on several local processes that affect the recruitment, and these effects are **additive** in general.

1. Shelf SST (Gawarkiewicz et al. 2012): early pelagic phase
2. Shelf current and eddy (Hare and Cowen 1996): larval transport
3. Shelf primary production (Saba et al. 2015): food availability

Limiting factor: carrying capacity of the ecosystem for pre-recruits

Take-home messages

- The recent low recruitment can be explained by the GS being in a more northerly position and the shelf being warmer
- Including the GSI effect on recruitment improves the near-term prediction skill
- But the accuracy of the prediction is largely determined by the accuracy of the corresponding GSI prediction

Acknowledgement

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Thank you for your attention!
Any questions?