Multiple models used in weather forecasting and climate impact assessments

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Workshop on Multiple Models for Management in the Chesapeake Bay (M3.2)

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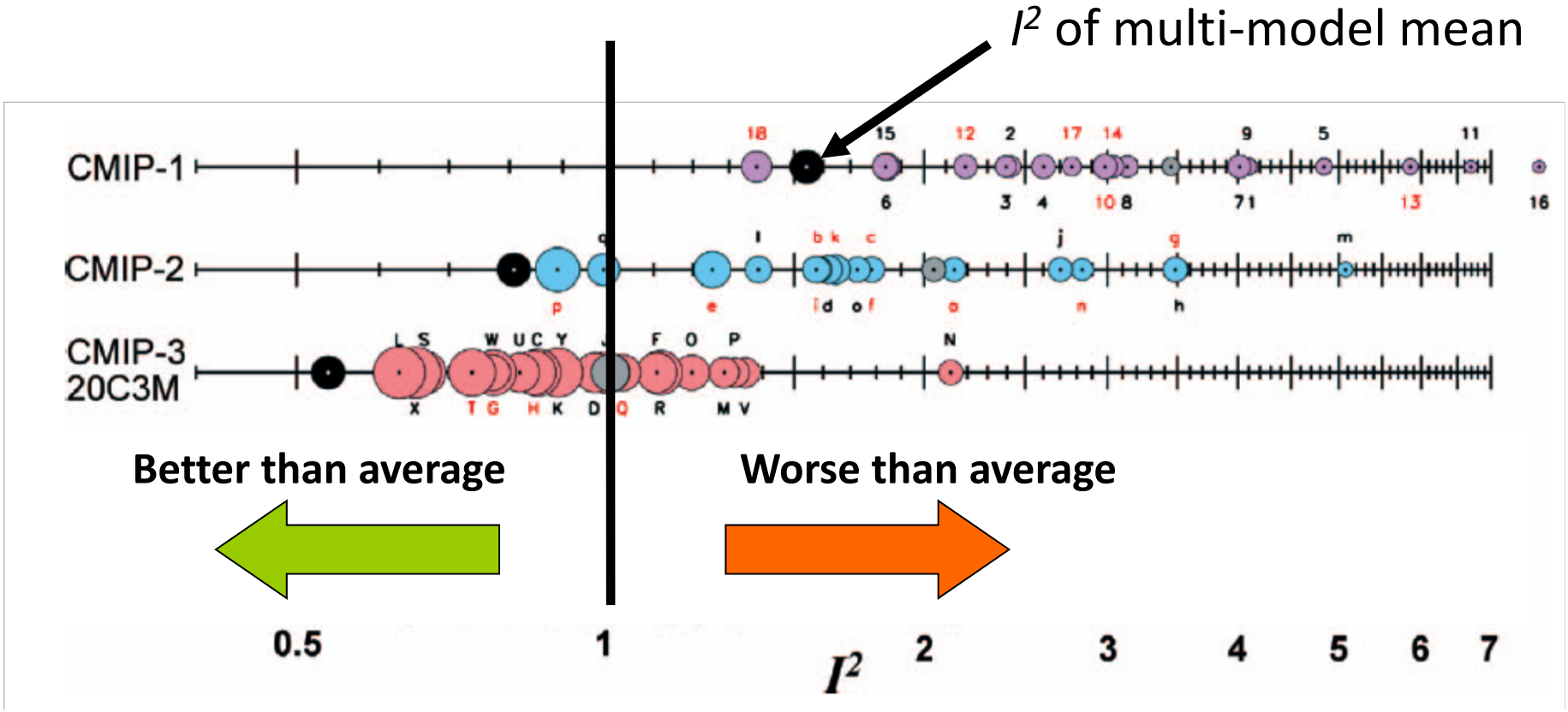
Climate impact assessments

- Multiple GCMs routine for 20 years
- Output from IPCC, DOE
- 3 completed “CMIPs”: dozens of GCMs, about 10 nations
- RCMs now available

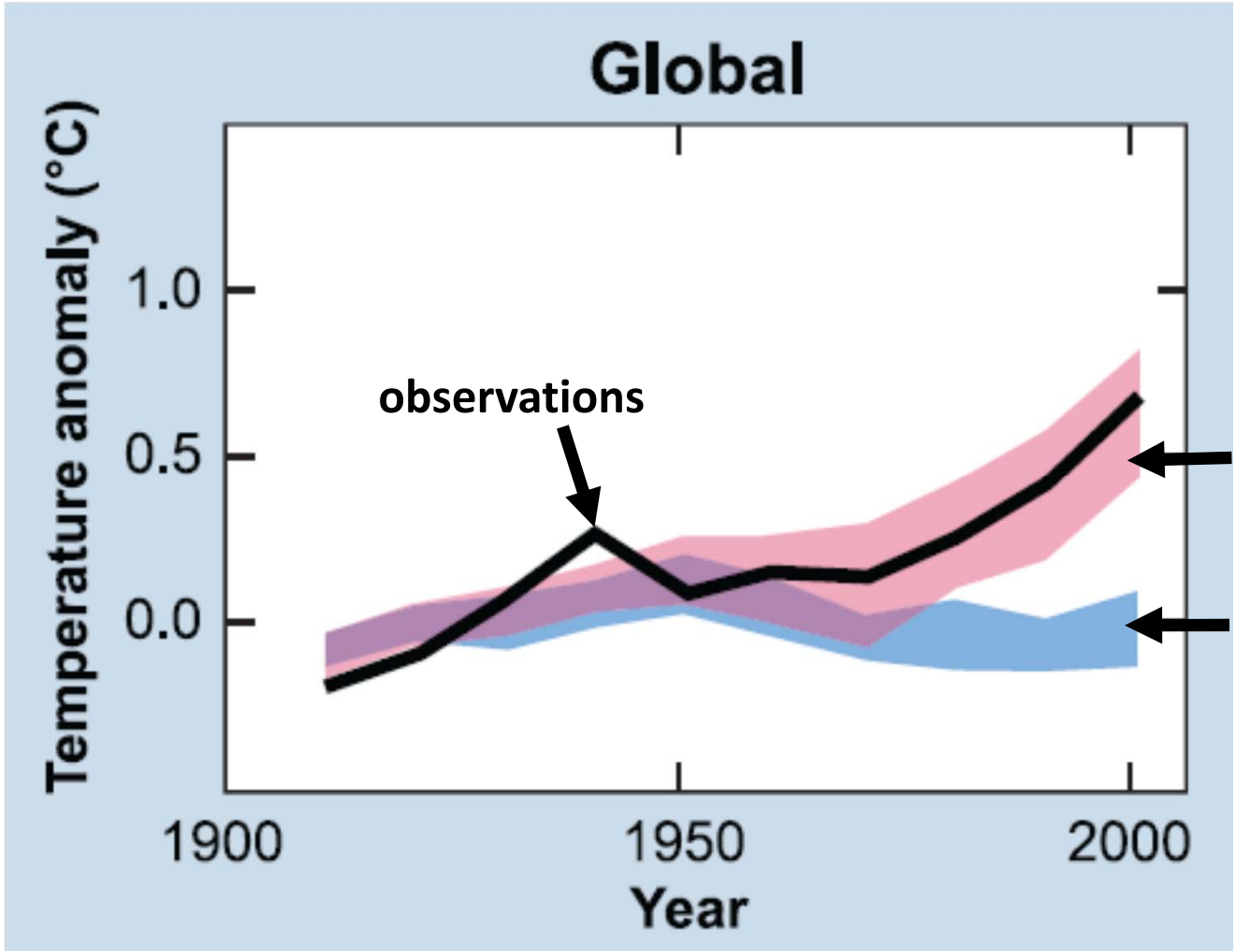
The multi-model mean is best

Error index (I^2) based on mean pattern of 14 climate variables (1979-1999)



Source: Reichler and Kim (2008)

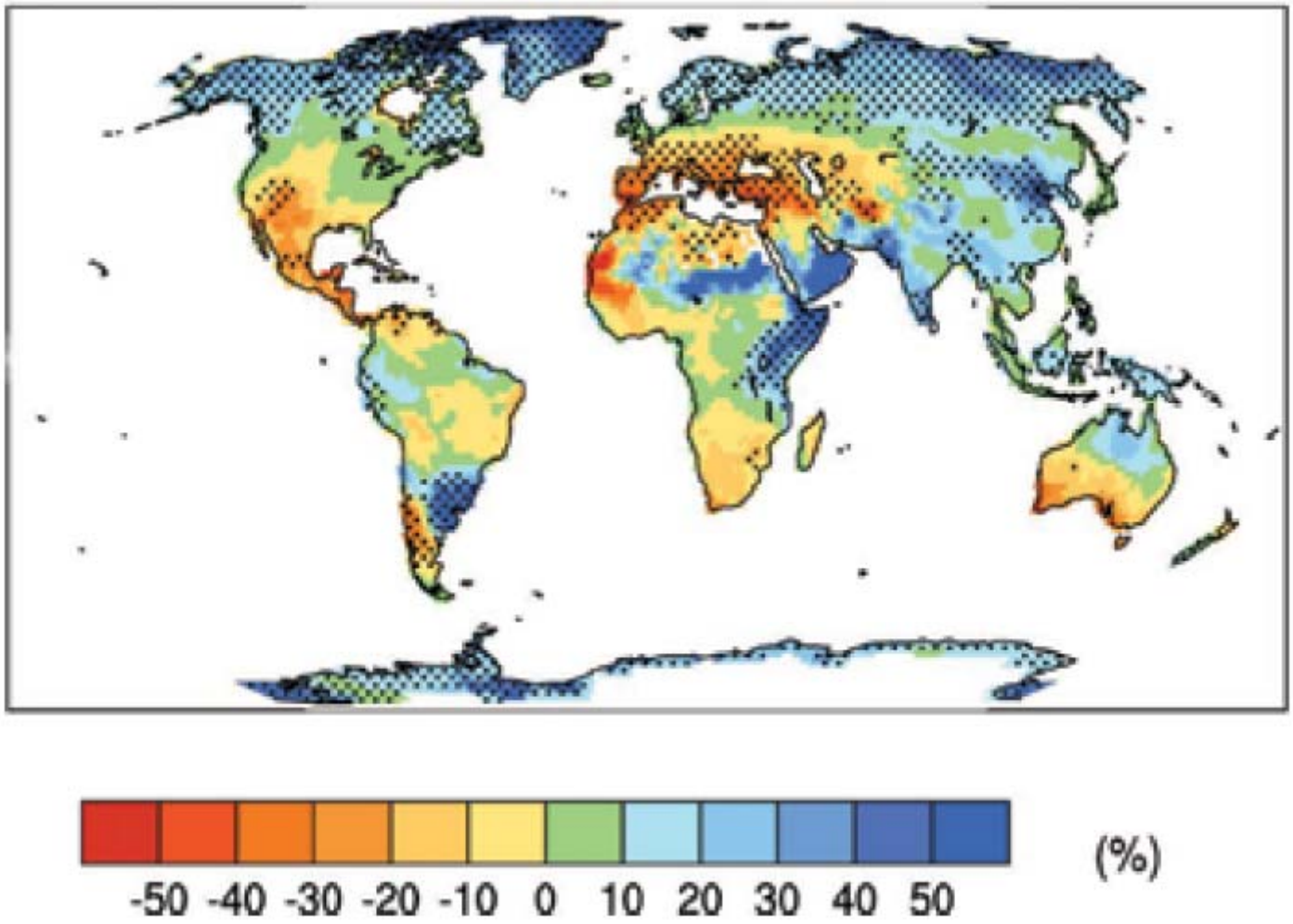
Observed and simulated global temperature change



Shading indicates 5-95% range of models

Source: Hegerl et al. (2007)

Projected surface runoff changes (A1B, 2080-2099 minus 1980-1999)

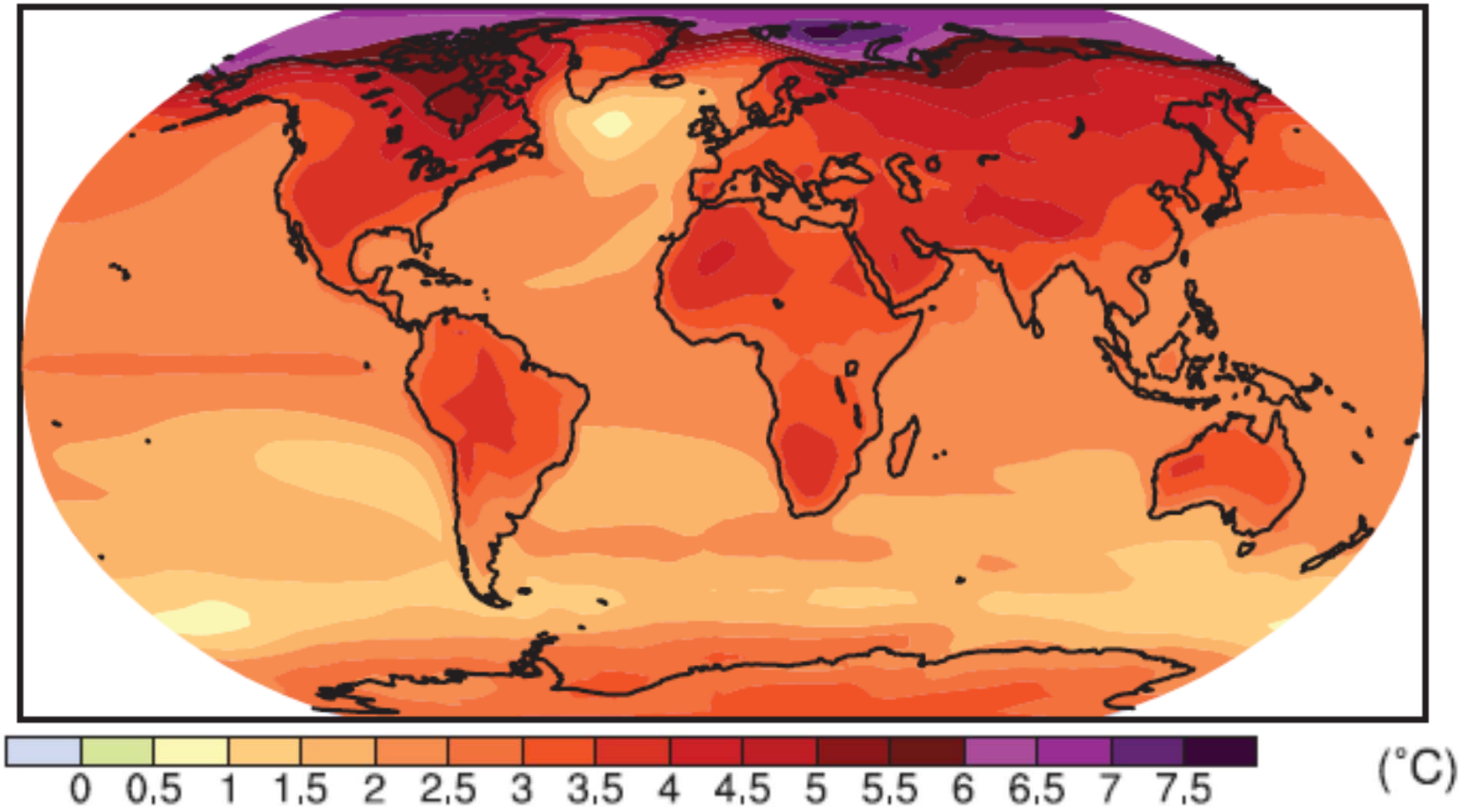


Meehl et al. (2007)

15-model mean. Stippling: >80% of models agree on sign of change.

Projected surface temperature changes (A1B, 2080-2099 minus 1980-1999)

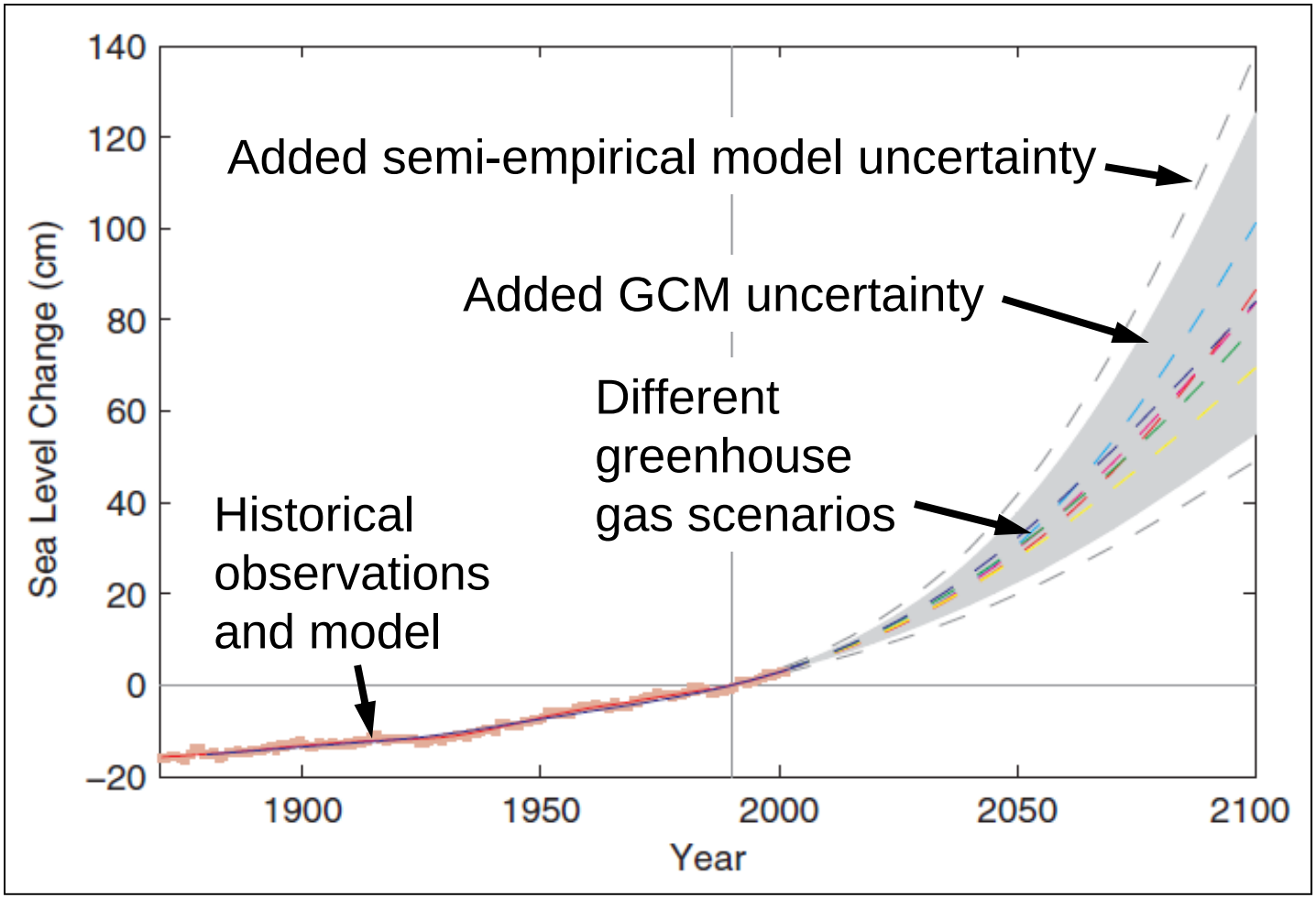
Multi-model ensemble mean



Meehl et al. (2007)

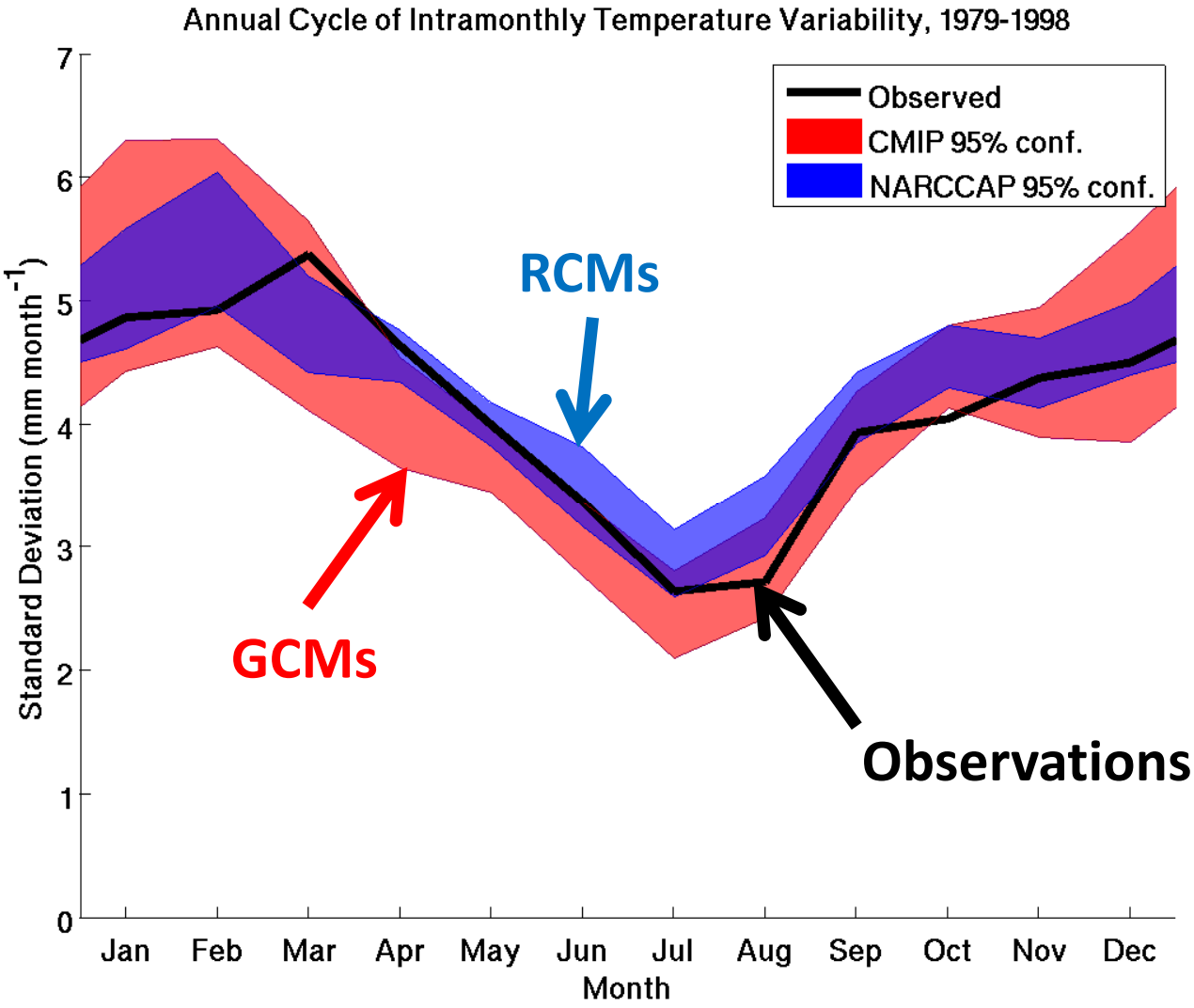
Global sea-level change

Semi-empirical model of global-mean sea level based on global-mean surface air temperature



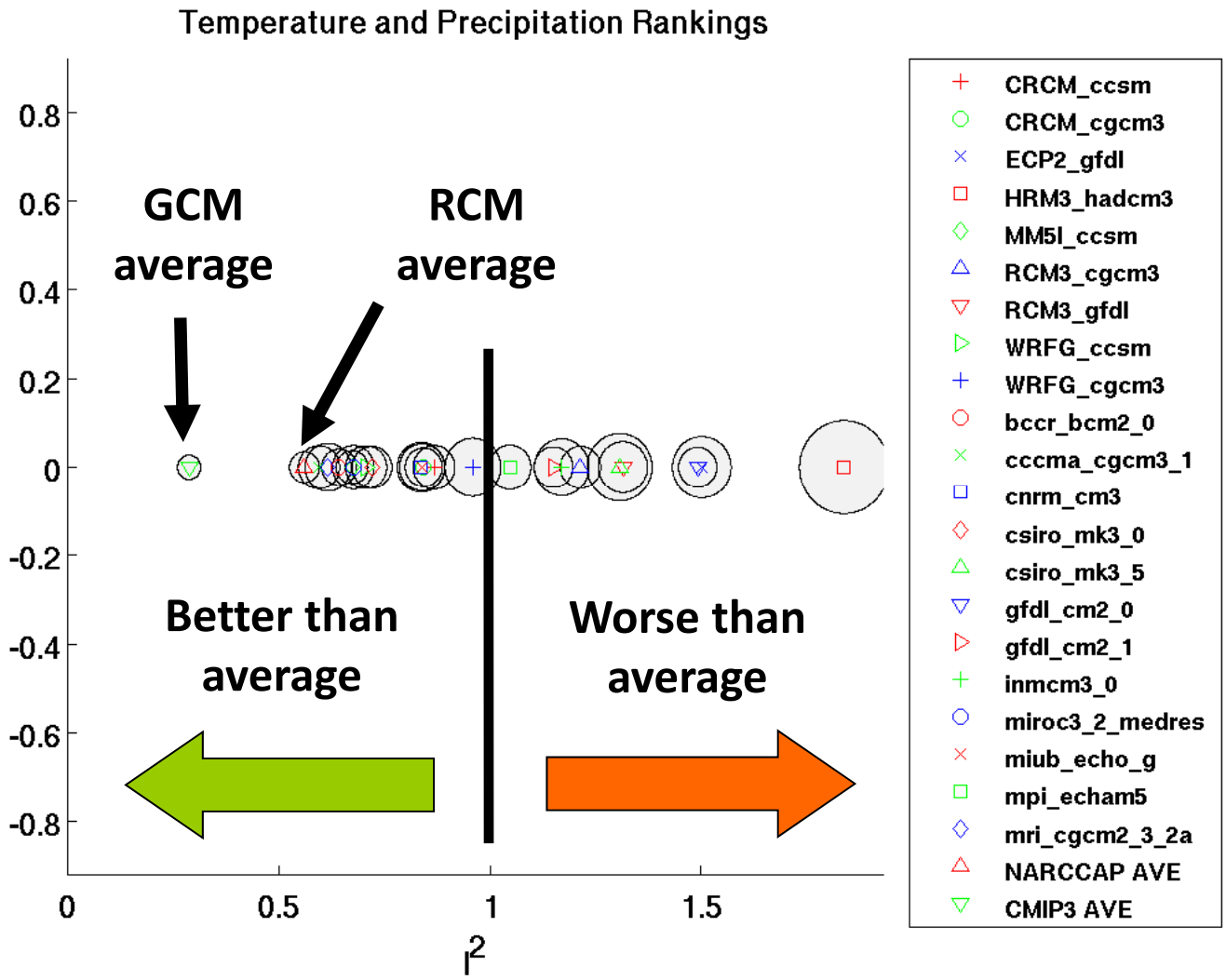
Rahmstorf (2007)

PA GCM and RCM evaluation: variability



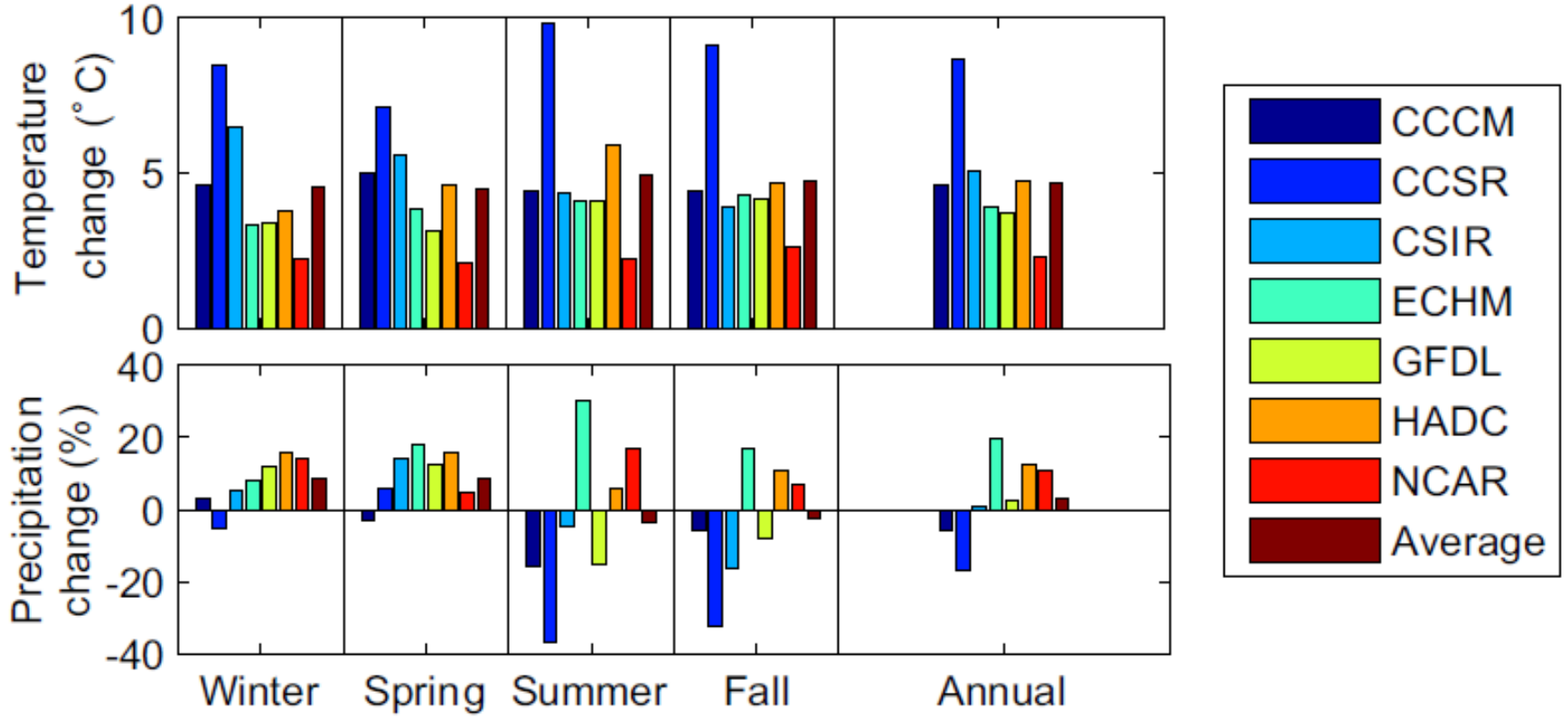
Shortle et al. (2013)

Evaluation of climate models for PA



Shortle et al. (2013)

End-of-21st-Century climate projections for Chesapeake Watershed (A2 scenario)



Najjar et al. (2010)

Weather Forecasters

I would be lost without multiple atmospheric model output—
I use it everyday that I forecast.

Paul Knight

Broadcast meteorologist

Jenni Evans

Tropical meteorologist

Use of ensembles has become the norm for tropical cyclone forecasting.

Ensembles provide the envelope of possibility for the storms, which gives much more information than any single realization.

For severe storms, we use multiple models in large part because they differ in resolution and how far out they go in time.

Yvette Richardson

Severe storms meteorologist

George Young

Without multi-model ensembles it is hard to know how much to trust any one model.

Consensus—a weighted average of forecasts—almost always beats any one model.

Nate Silver's election prediction is essentially the same technique we use in meteorology. By simply taking a poll of polls—an ensemble—his margin of error was much less than the margin of error of any individual poll.

Paul Markowski

Severe storms meteorologist

Correctly predicted every state in 2012 presidential election. Missed one in 2008.

Summary

- Hard to imagine weather and climate prediction without multiple models
- Multi-model mean is often the best
- Model spread gives estimate of uncertainty

References

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