Sensitivity to Factors Underlying the Hiatus

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Defining “hiatus”

- 1998-2012 trend in global-mean, annual-mean surface temperature T
- Trend is lower than CMIP5 model predictions (by some measures)
- Endpoints are judiciously chosen to include (warm) 1998, exclude (warm) 2014

Why the interest?

Scientific community

- Interested in internal variability
- Model-obs mismatch always interesting
- “High-impact” research

Popular media

- Hawkins et al 2014

Figure 2 | Global internet search trends. Quantity of Google searches[34] for the terms ‘global warming stopped’ (blue) and ‘global warming pause’ (red) over the period from January 2007 to December 2013, expressed as ‘relative interest’ with the highest monthly total given an index of 100. Note that the Google data was accessed on 23 January 2014 and is subject to change.

The big question

- Does the hiatus (so defined) tell us anything about climate sensitivity?

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- Probably not.

Plausible explanations

- Observational bias
- Uncertain, short trend
- Internal variability (compatible with models)
- Internal variability (underestimated by models)
- Model sensitivities too high
- Externally forced changes to internal variability
- Forcing errors

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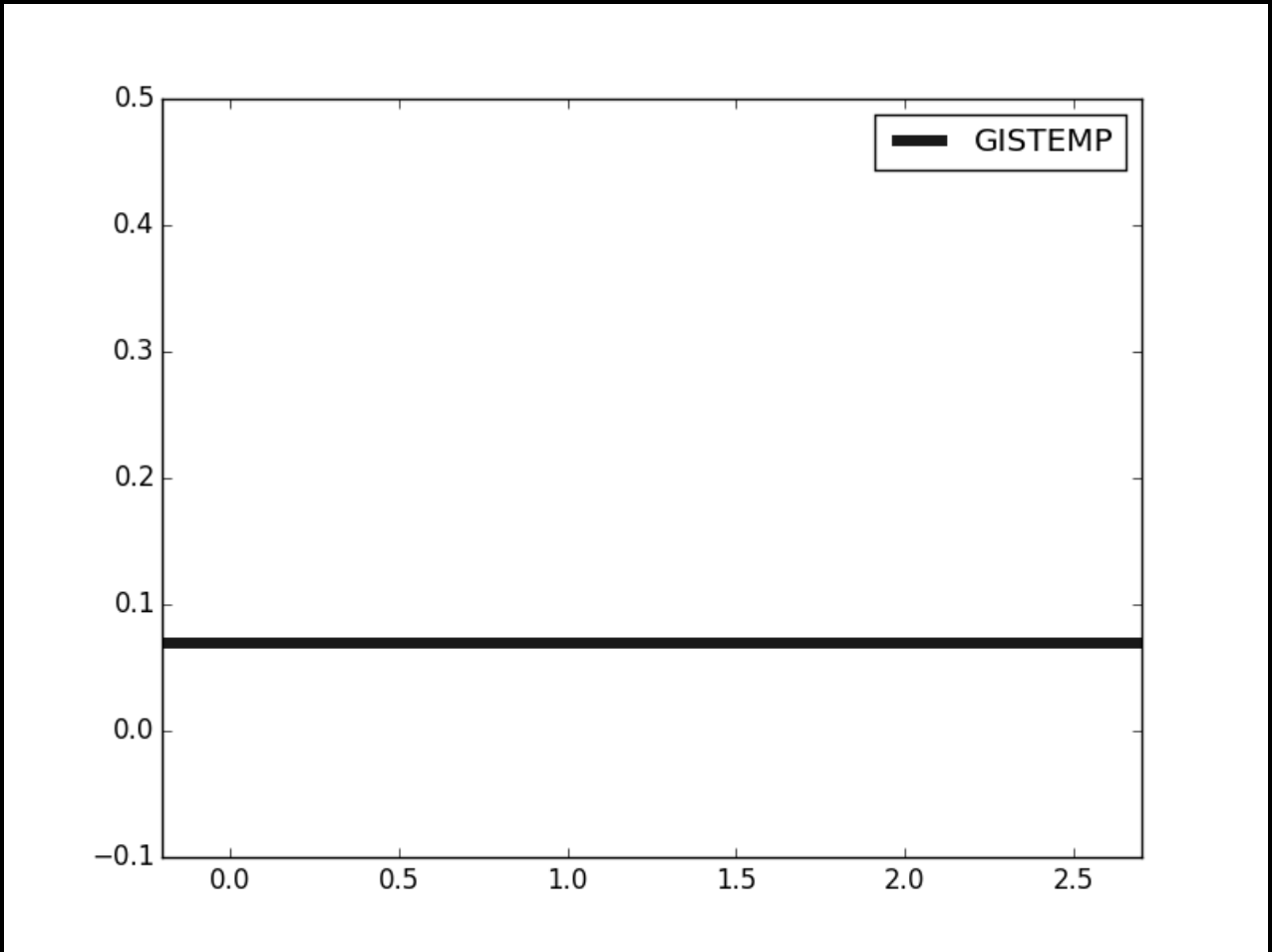
Observational uncertainty

- Four different observational datasets
- Different coverages, corrections applied for bias

GISTEMP



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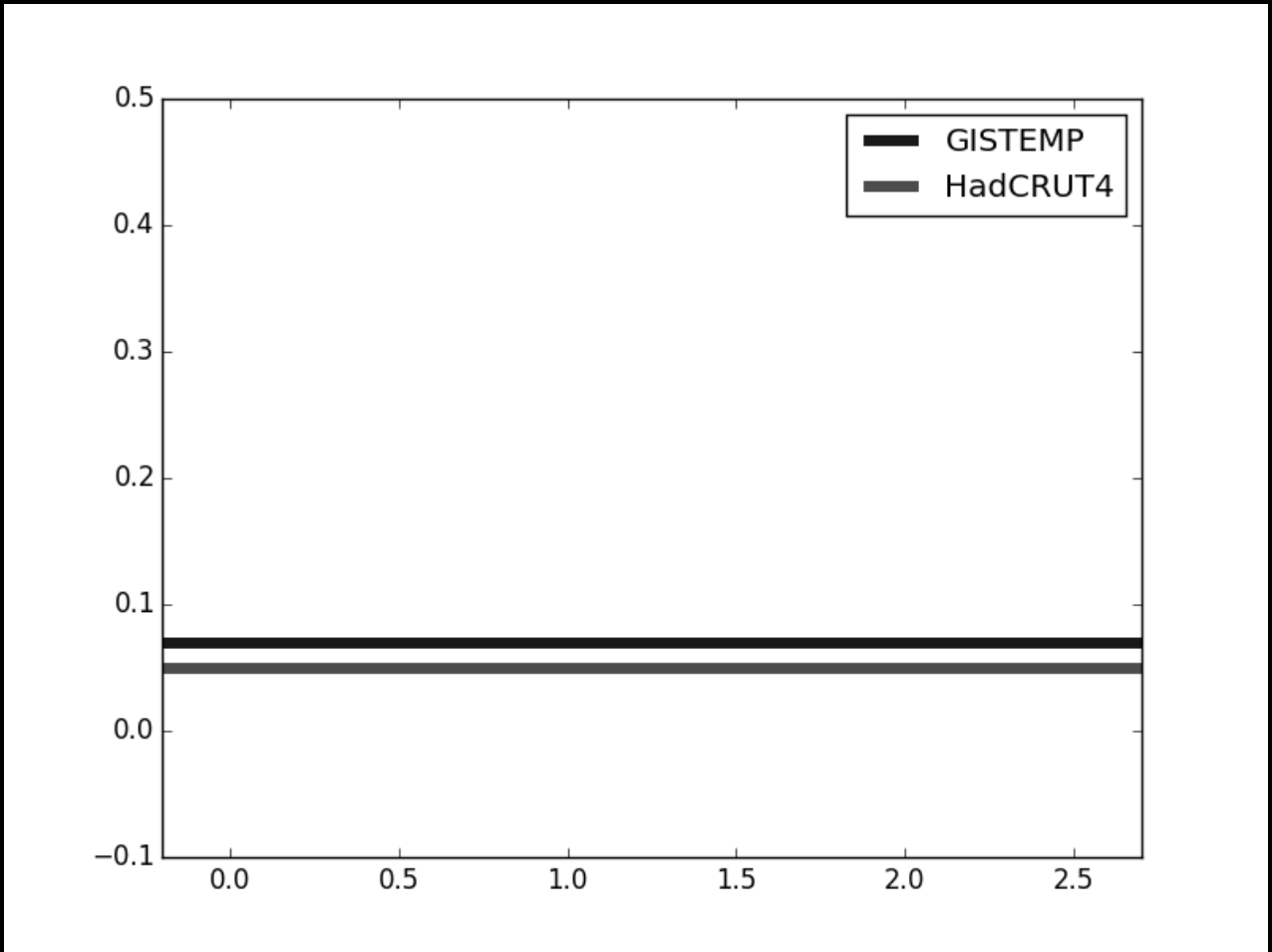
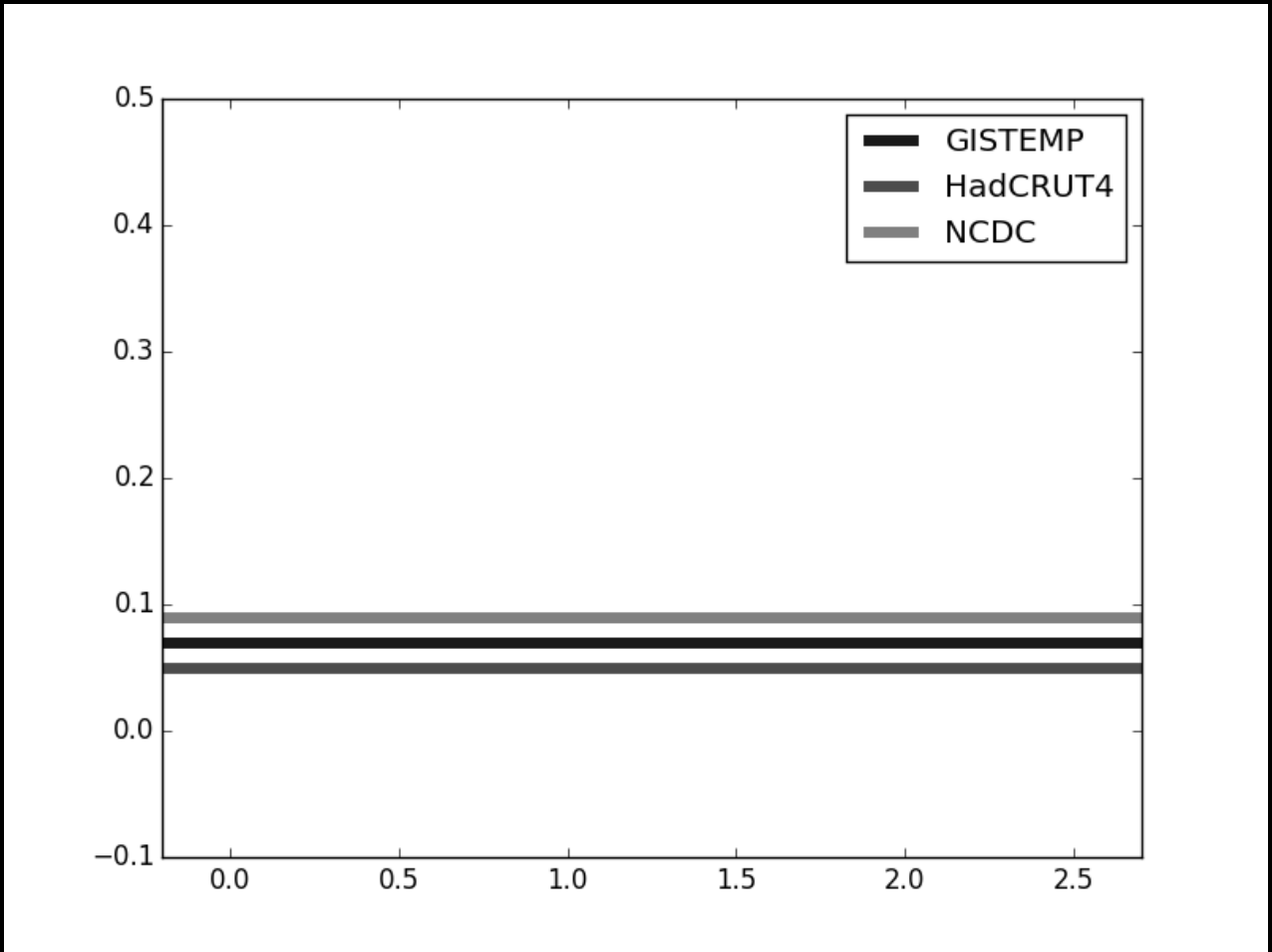
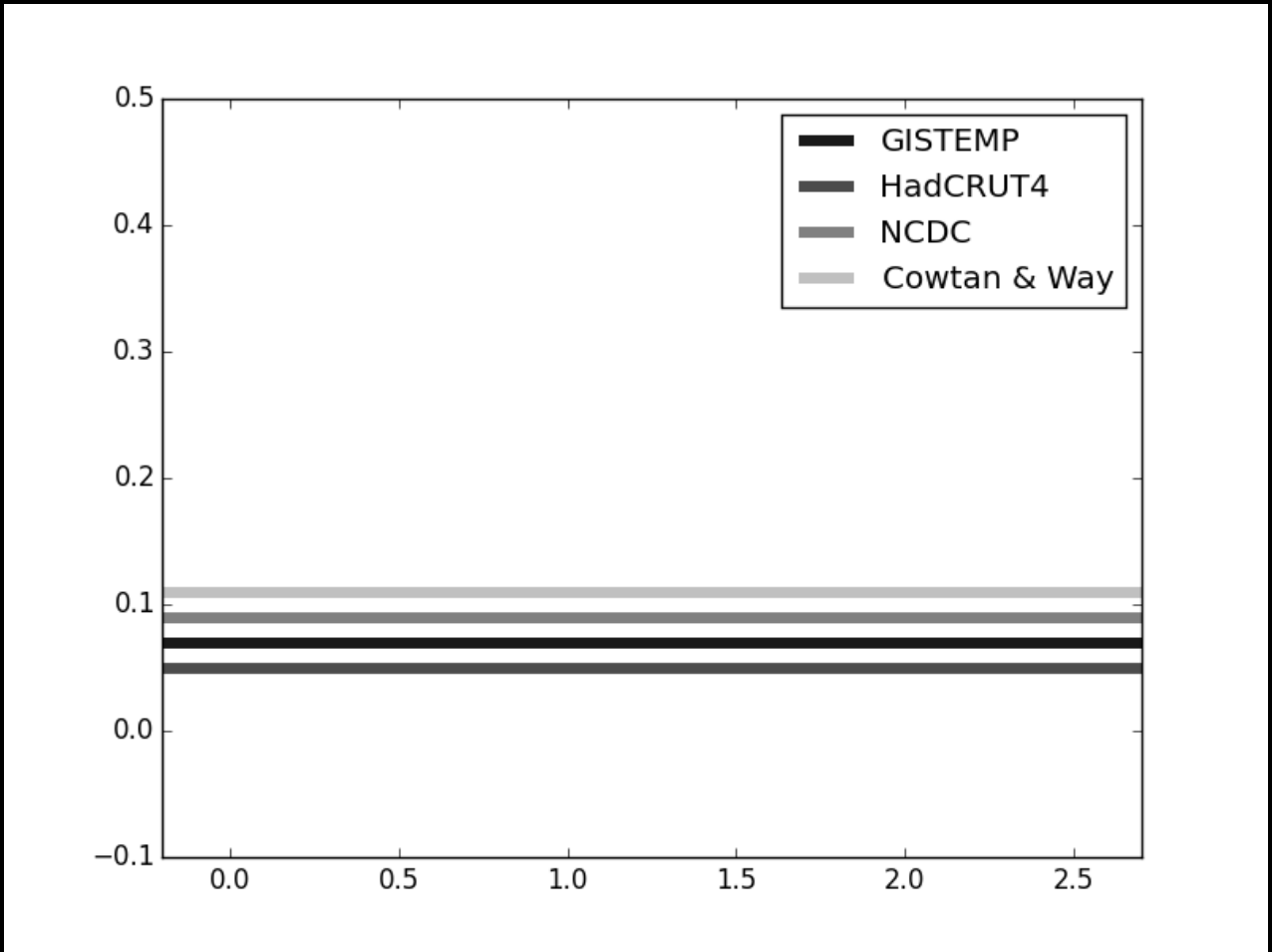


NCDC



Cowtan and Way



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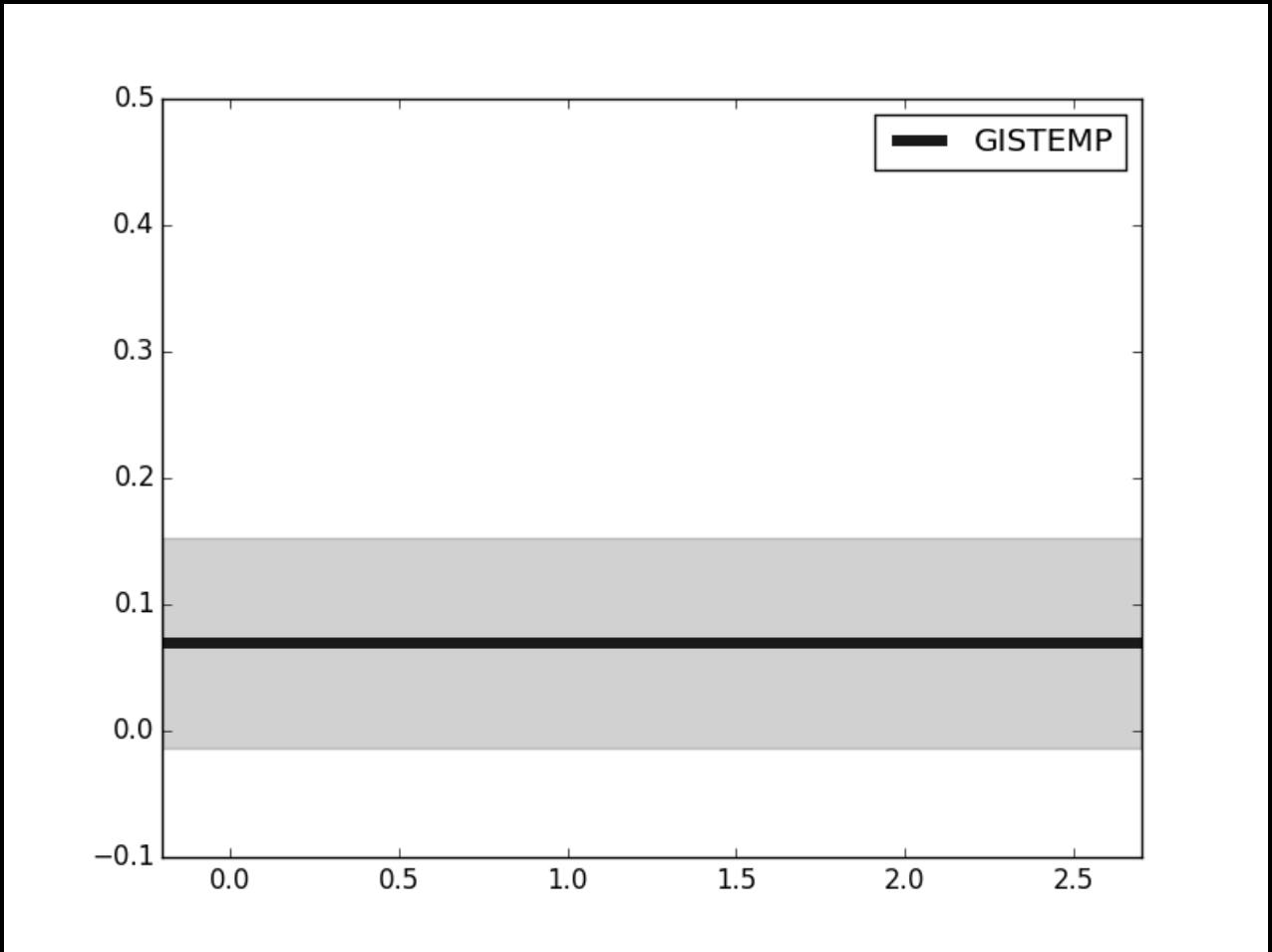
15 year trends

- For each observational dataset, we calculate 5-95% confidence interval on the linear regression slope
- Assume no adjustment for autocorrelation in the residuals

GISTEMP



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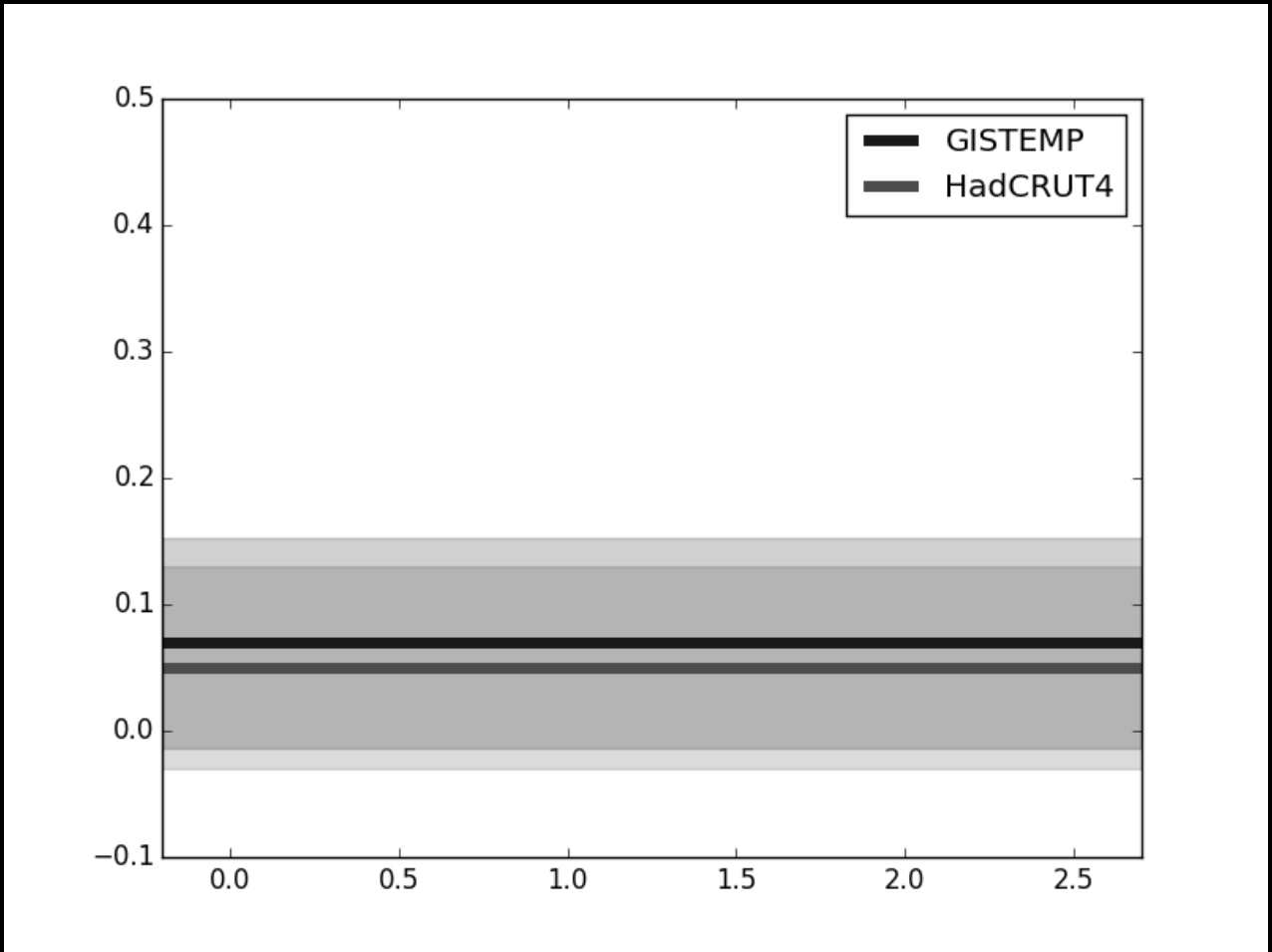

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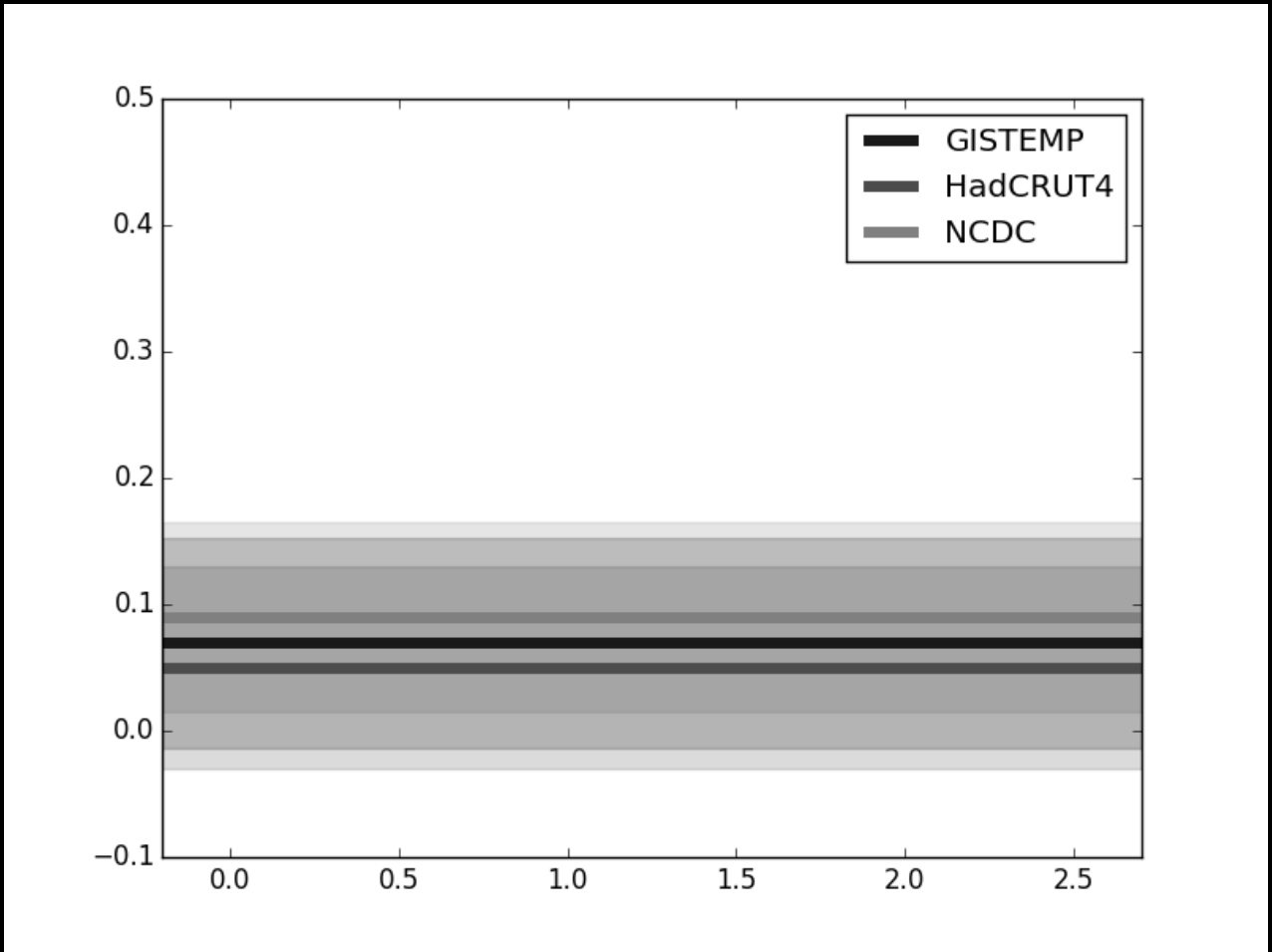

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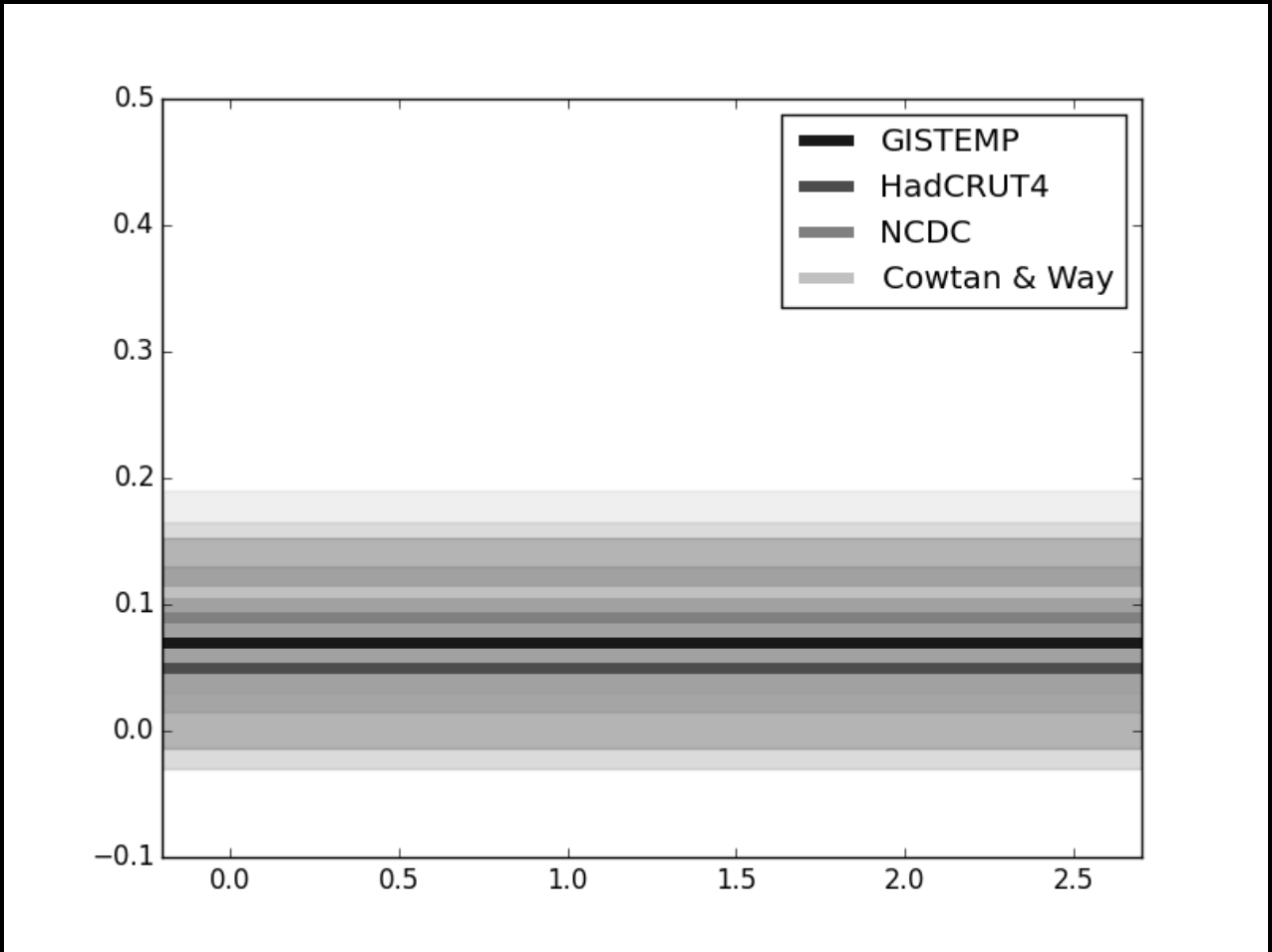
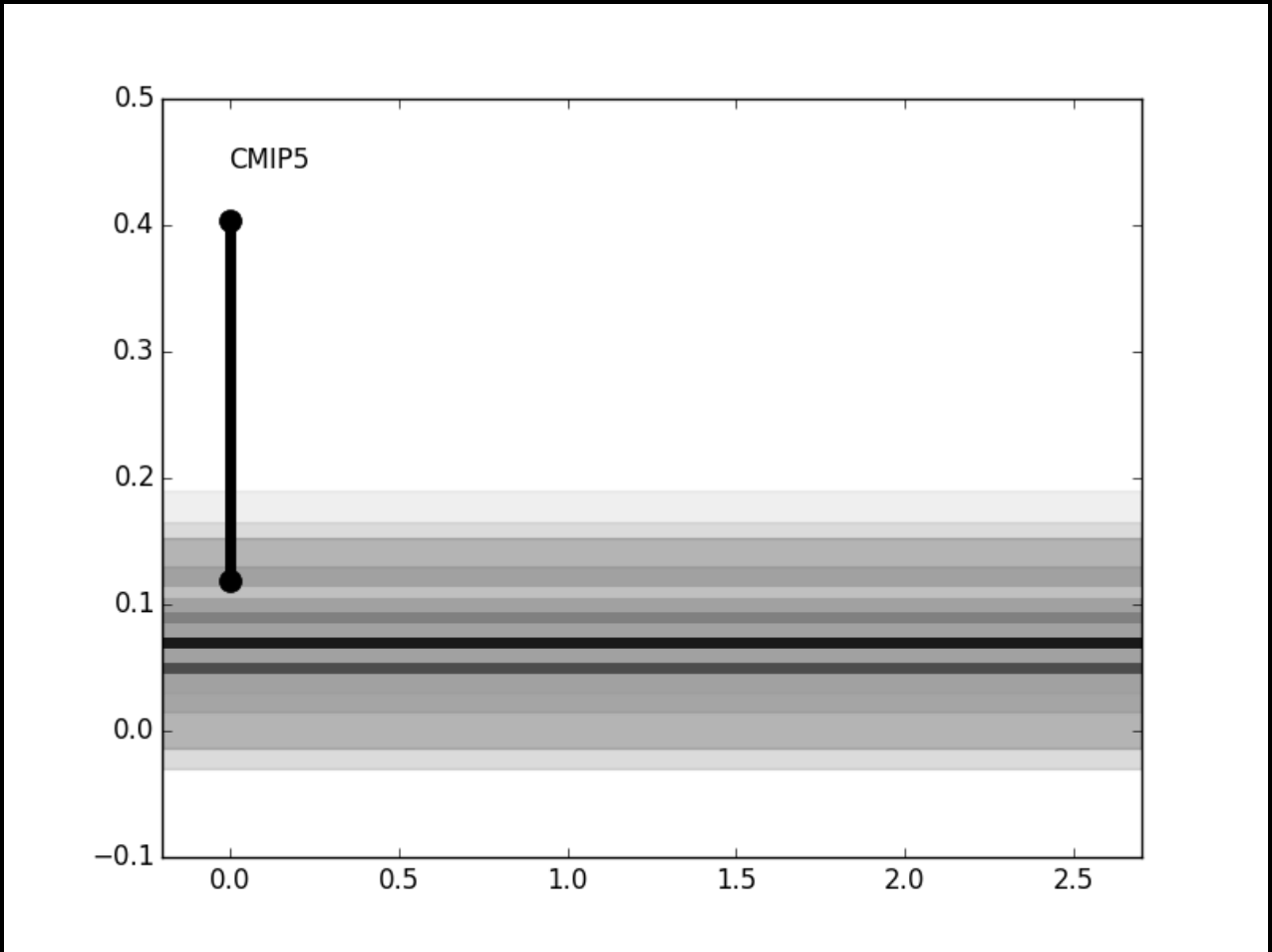


CMIP5 models 5-95% range



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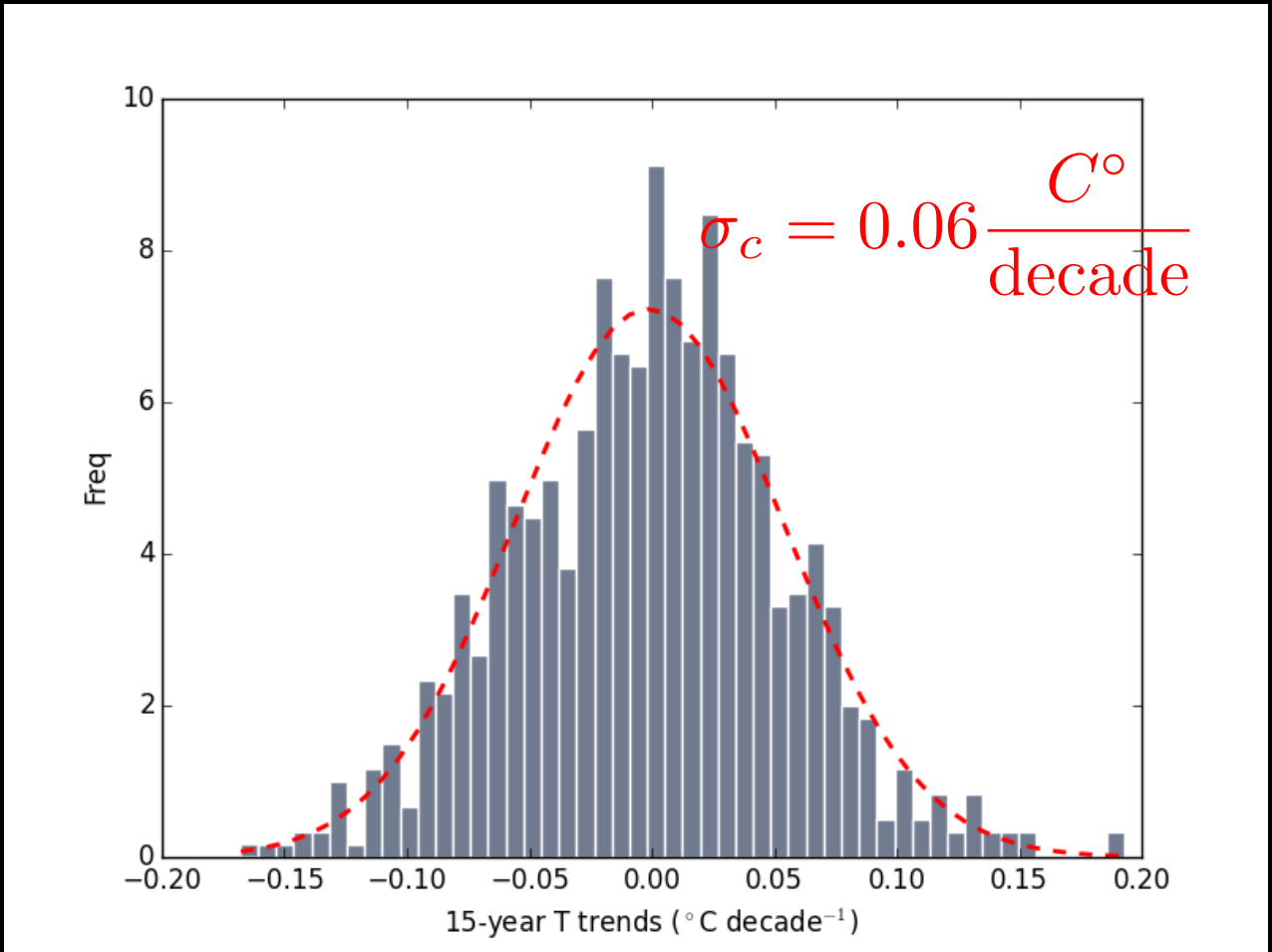
Simple statistical model

$$T = \frac{F}{\lambda} + N(\mu, \sigma)$$

Internal variability

- F = estimated using GISS time series (=0.37 W/m2 decade)
- Lambda = CMIP5 median value = 1.8
- Internal variability centered around 0
- Get width of internal variability from concatenated control runs
- Non-overlapping 15-year trends

Noise estimate



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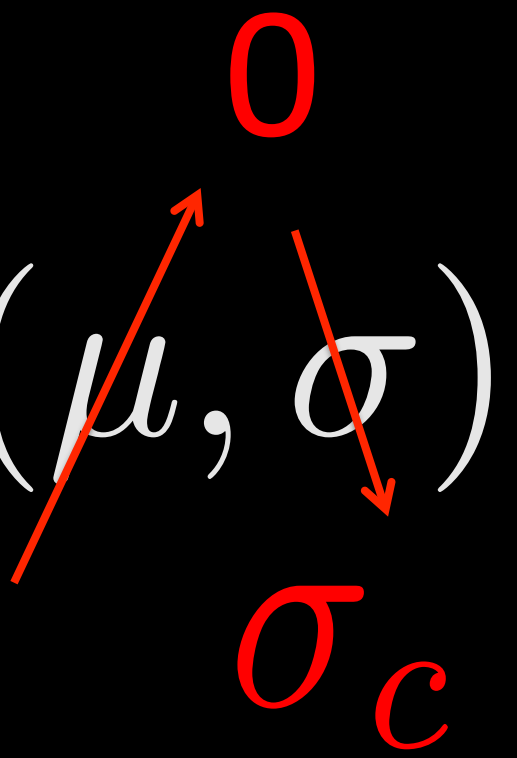
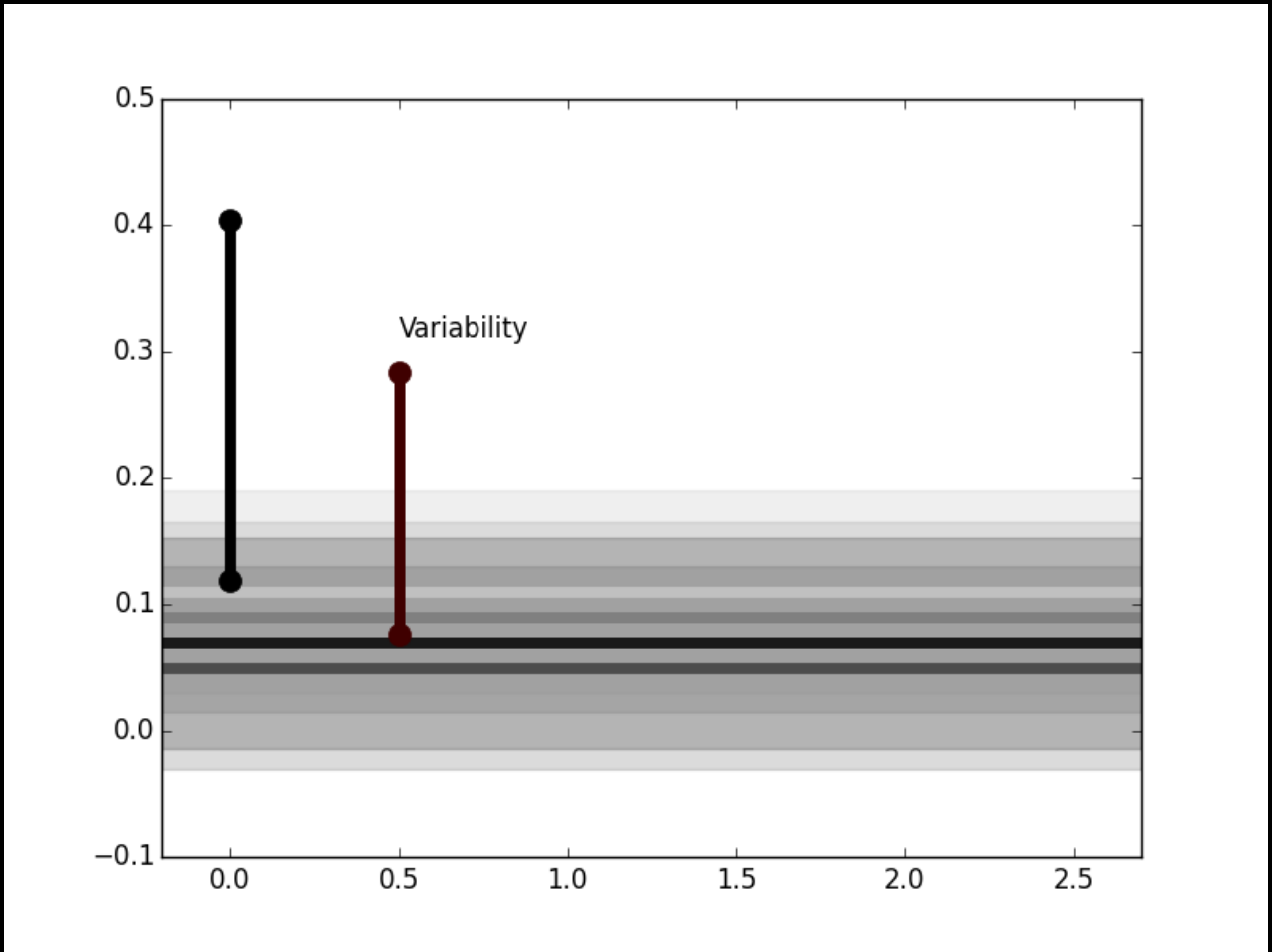


Internal variability



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Underestimated amplitude of internal variability

- GFDL model has largest internal variability width (0.14 C/decade)
- Replace width with GFDL width

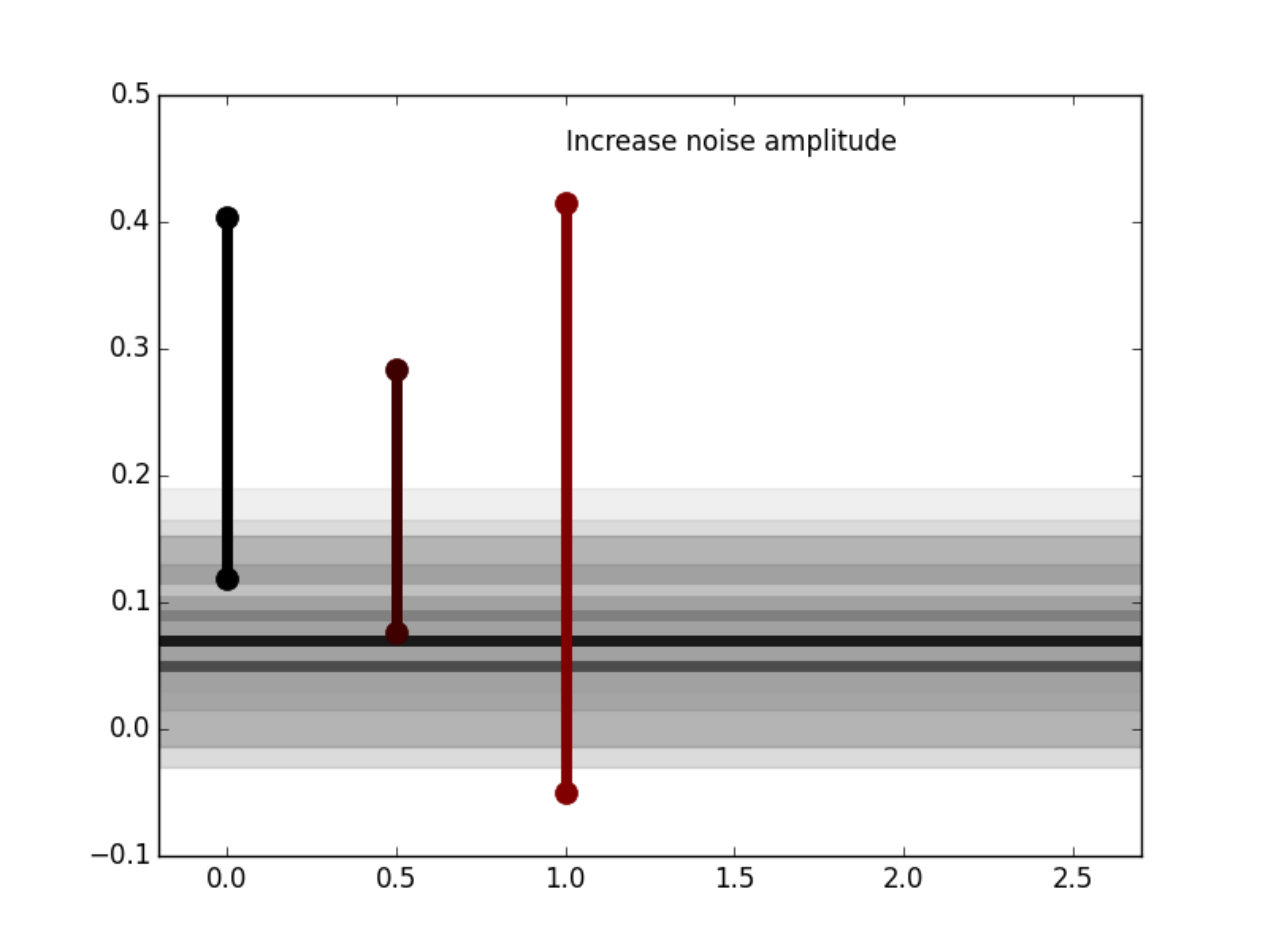
Simple statistical model

$$T = \frac{\overline{F}}{\lambda} + N(\mu, \sigma)$$

0

σ_{GFDL}

Expanding internal variability width



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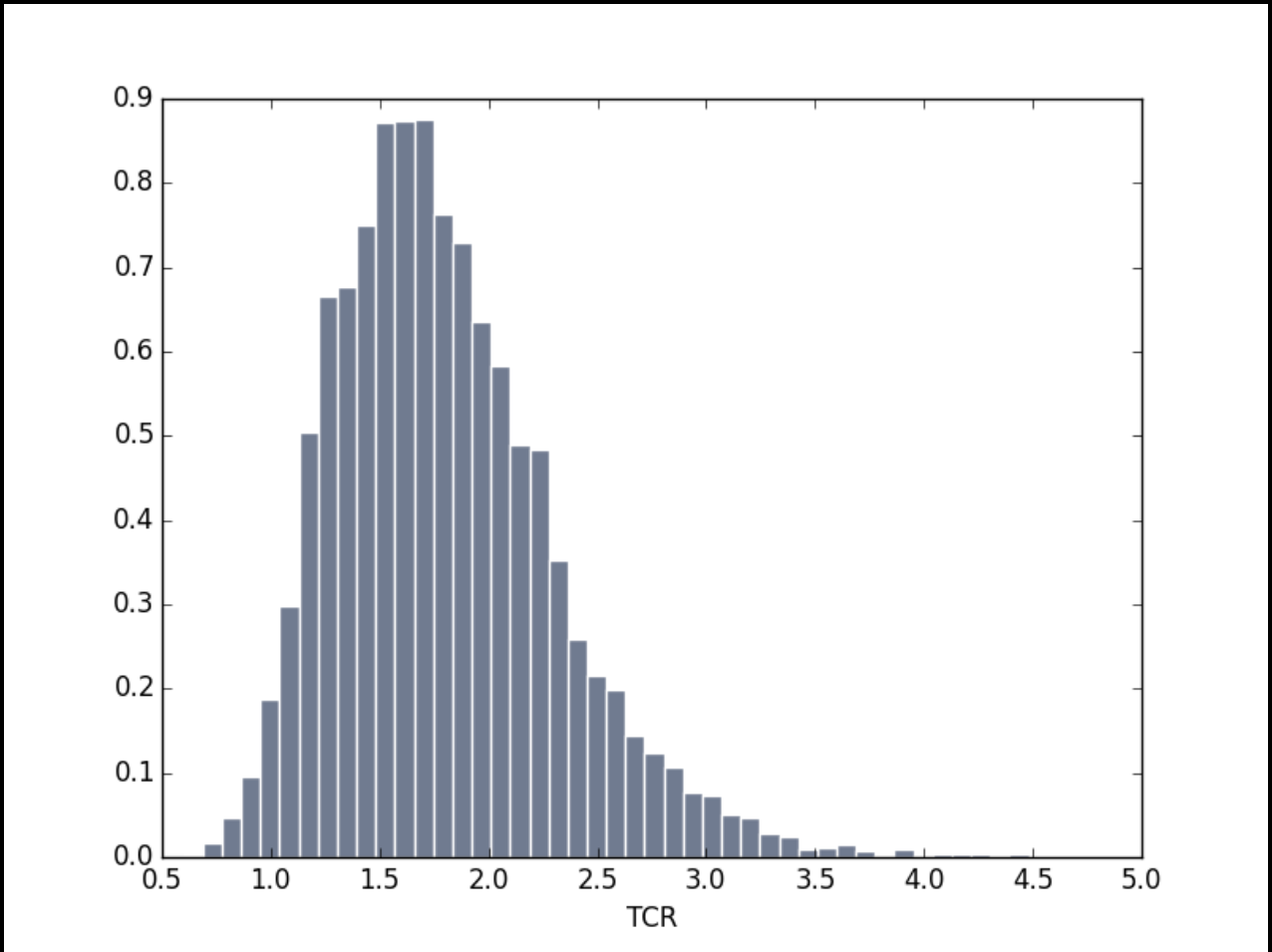
$$= \lambda_{CMIP5}$$

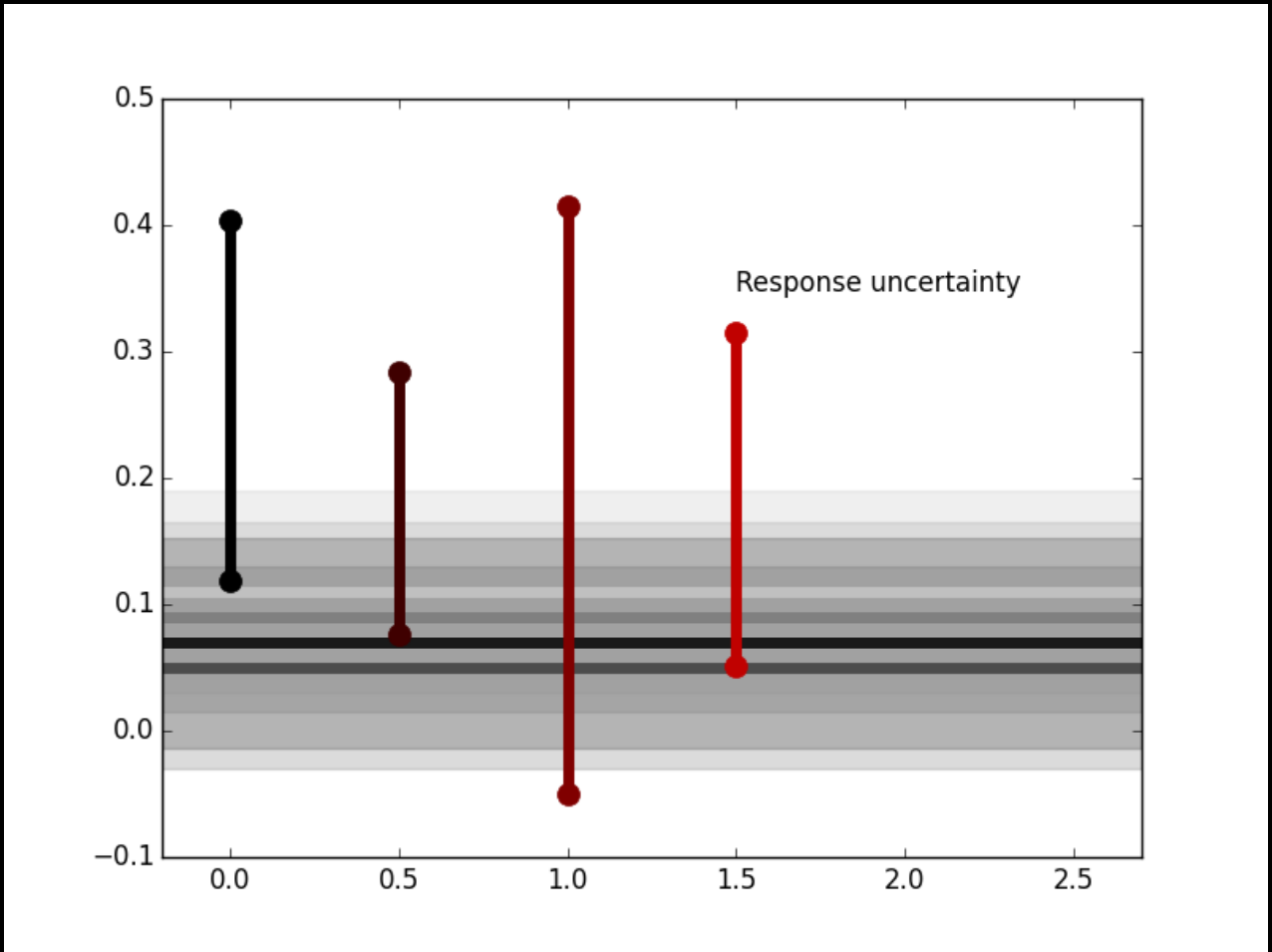
0

σ_c

Uncertainty in response



Response uncertainty



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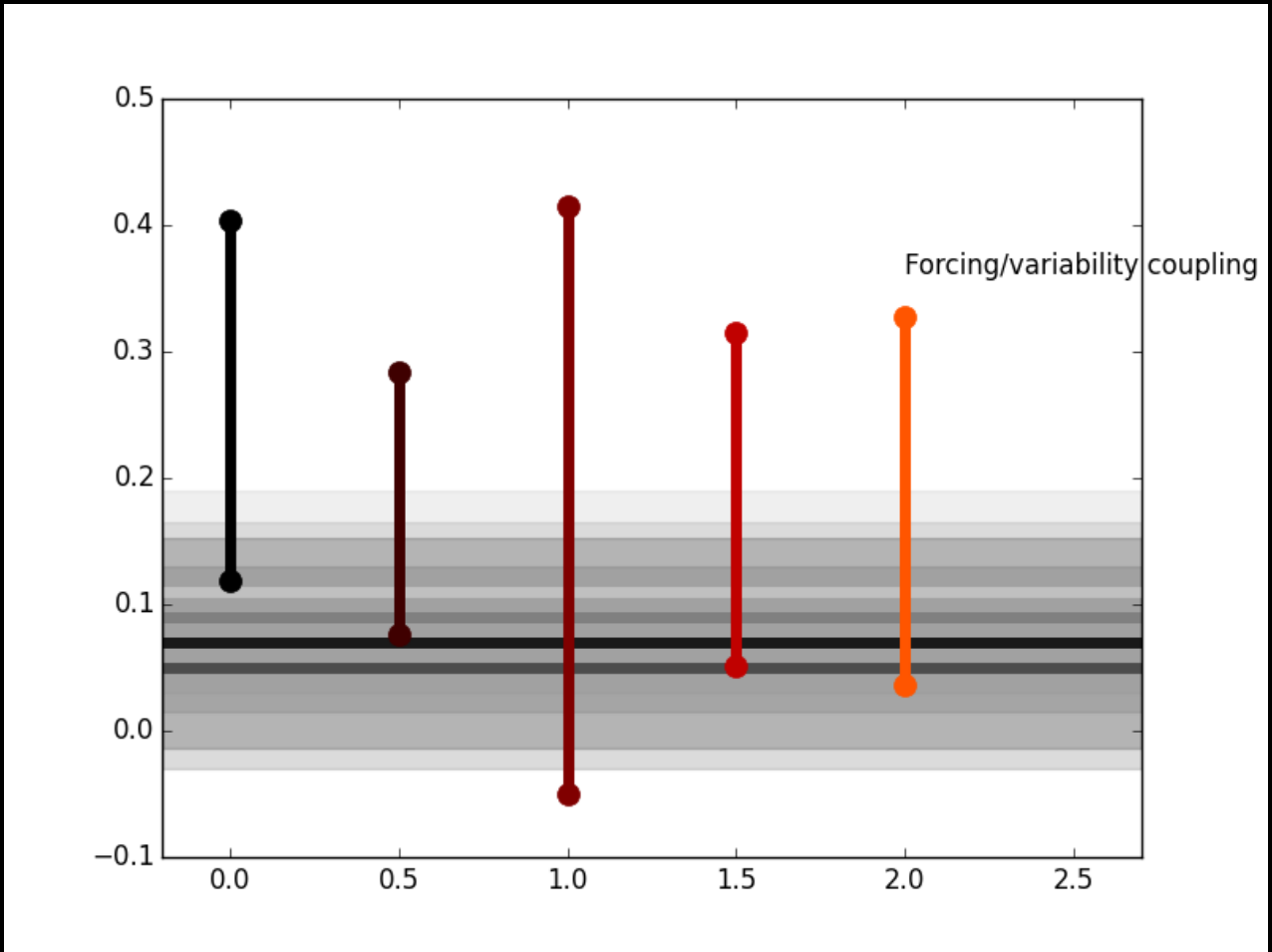
$$T = \frac{\overline{F}}{\lambda} + N(\mu, \sigma)$$

$N(0, \sigma_c)$

σ_c

Forcing Uncertainty



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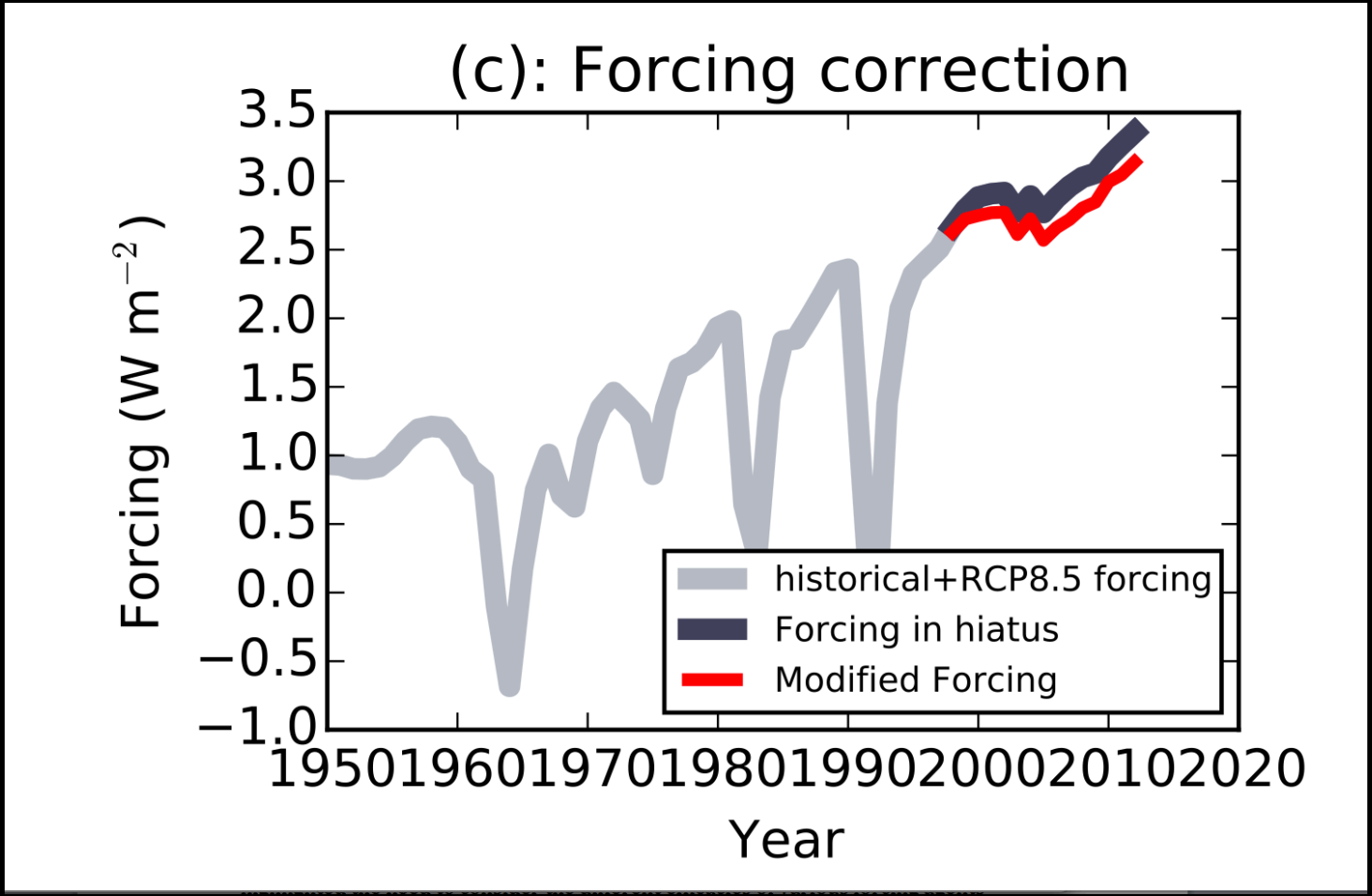
Forcing errors

- CMIP5 model “historical” forcings stop in 2005
- Evidence for substantial Vl, Sl, AA forcings 2005-2012
- Use updated forcings from Schmidt et al Nat Geosci

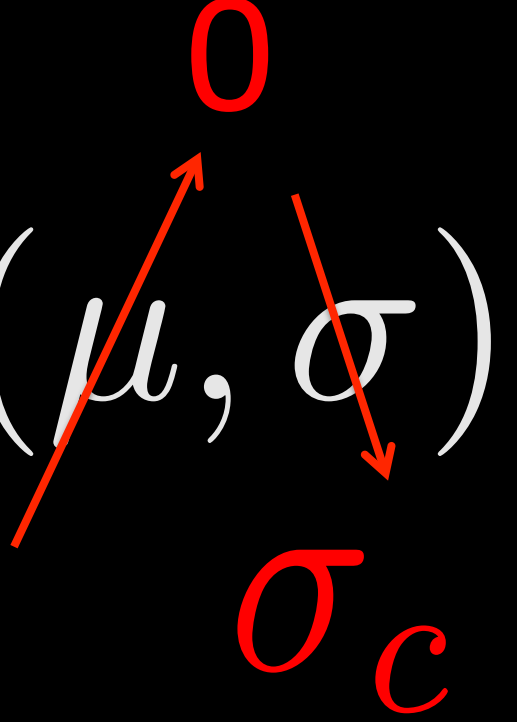
Updated forcing



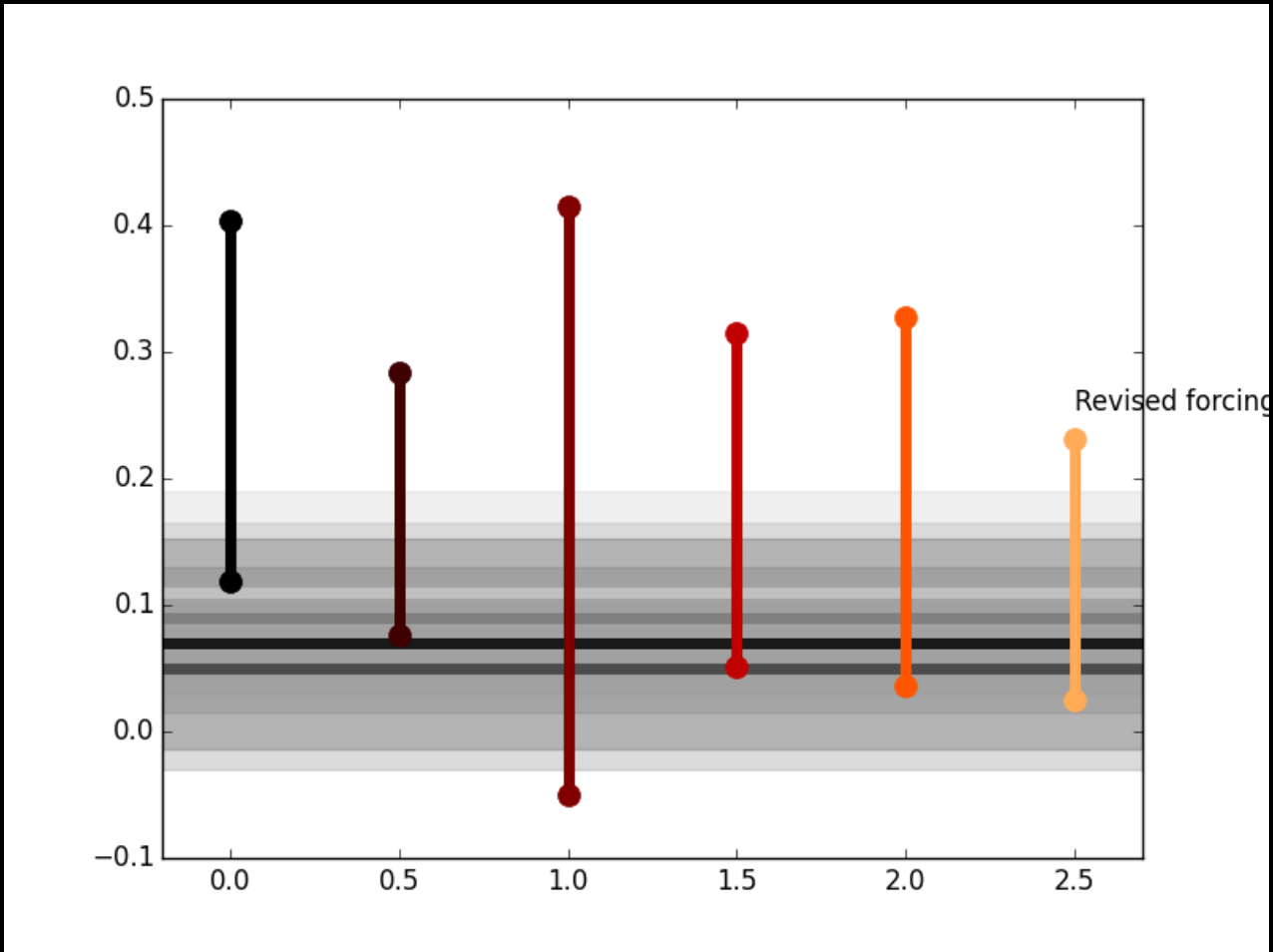
Simple statistical model

$$= F_{modified}$$

$$T = \frac{F}{\lambda} + N(\mu, \sigma)$$



Revised forcing



Conclusions

- If the hiatus is defined solely as a short-term temperature trend, there are many possible ways to reconcile models and observations
- Useful to focus on regional or seasonal characteristics
- Studying the hiatus may not tell us much about future climate trajectories, but if we can move beyond global mean temperature to a more complete understanding of current climate conditions, internal variability, and the physical mechanisms underlying decadal fluctuations in temperature, it will be worth the time spent.