

Sensitivity to Factors Underlying the Hiatus

Kate Marvel, Gavin A. Schmidt,
Kostas Tsigaridis, Ben Cook

NASA GISS

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

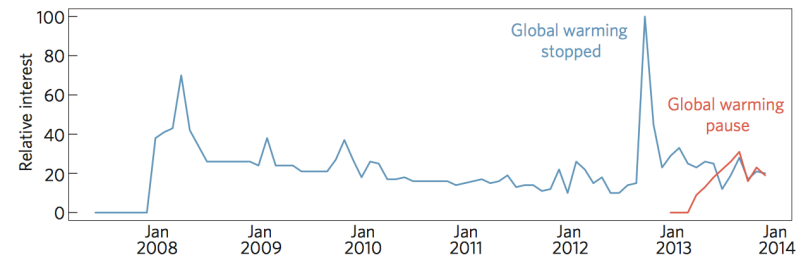


Figure 2 | Global internet search trends. Quantity of Google searches³⁴ for the terms 'global warming stopped' (blue) and 'global warming pause' (red) over the period from January 2007 to December 2013, expressed as 'relative interest' with the highest monthly total given an index of 100. Note that the Google data was accessed on 23 January 2014 and is subject to change.

David MacKay FRS and 3 others favorited

Mar 30

.@NatureClimate has — gasp! — a paper on the hiatus!!!! Seriously, why don't they just start journal "Nature Hiatus" nature.com/nclimate/journ...

← ↻ 3 ★ 8 ...

The big question

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

The big question

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

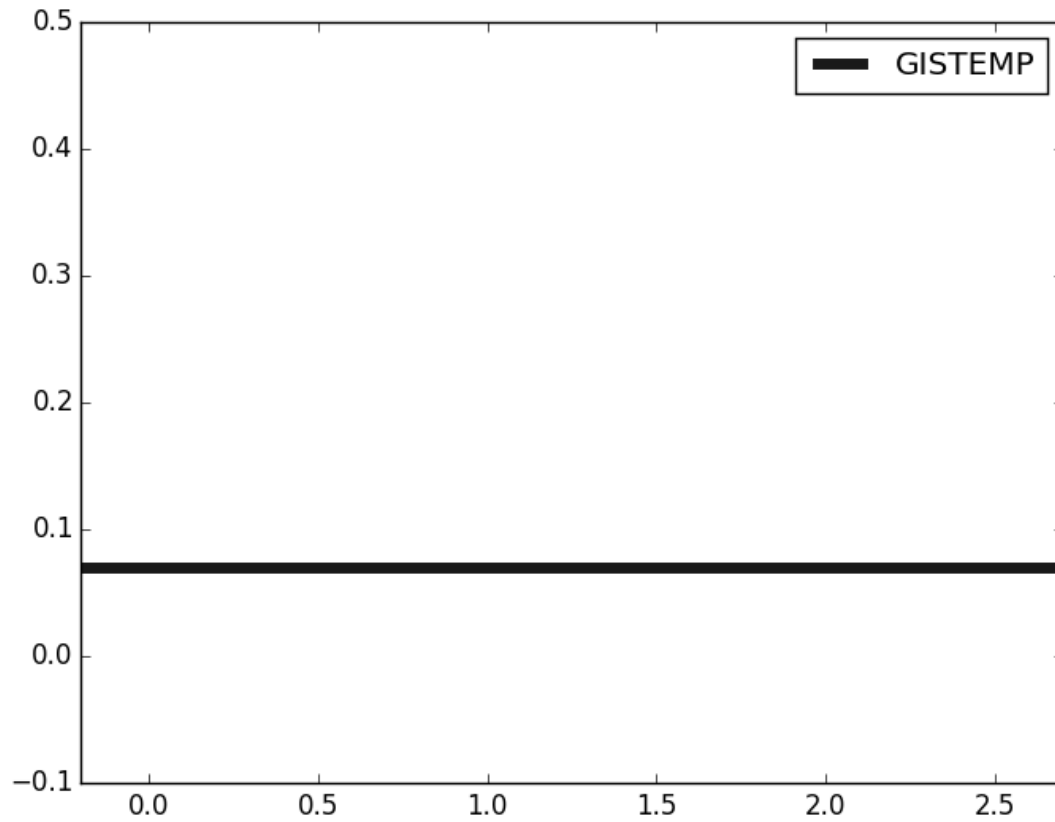
Plausible explanations

- **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

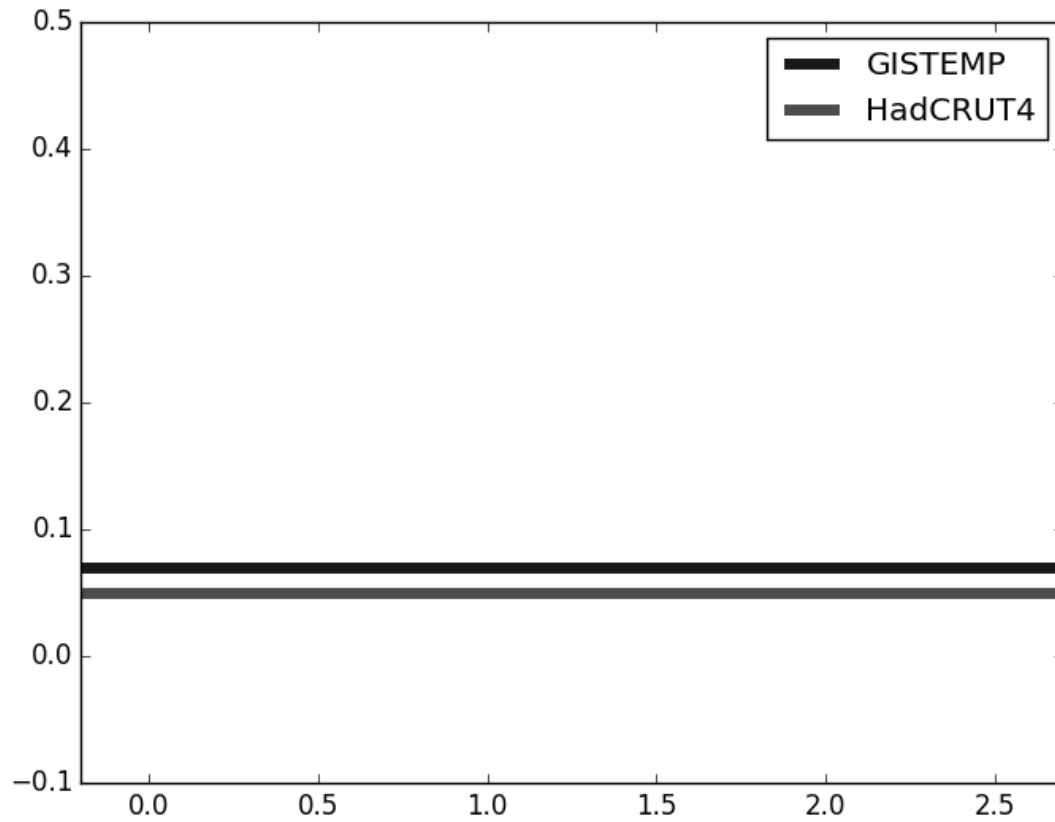
Observational uncertainty

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

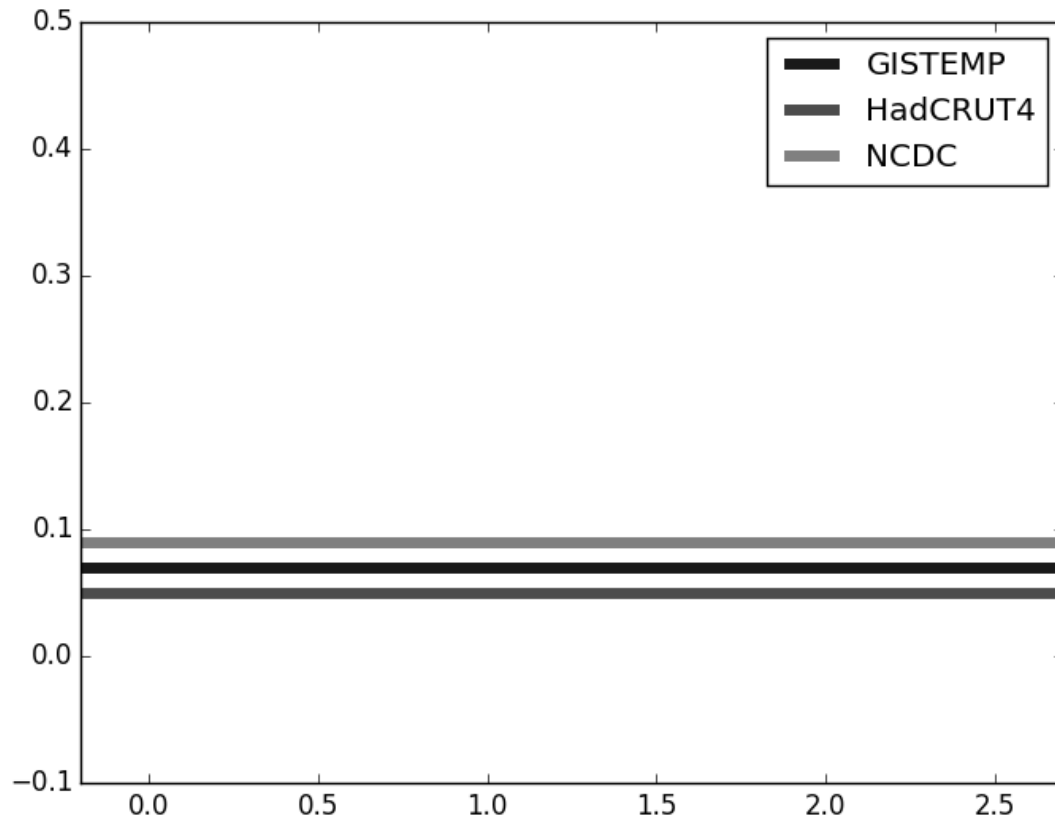
GISTEMP



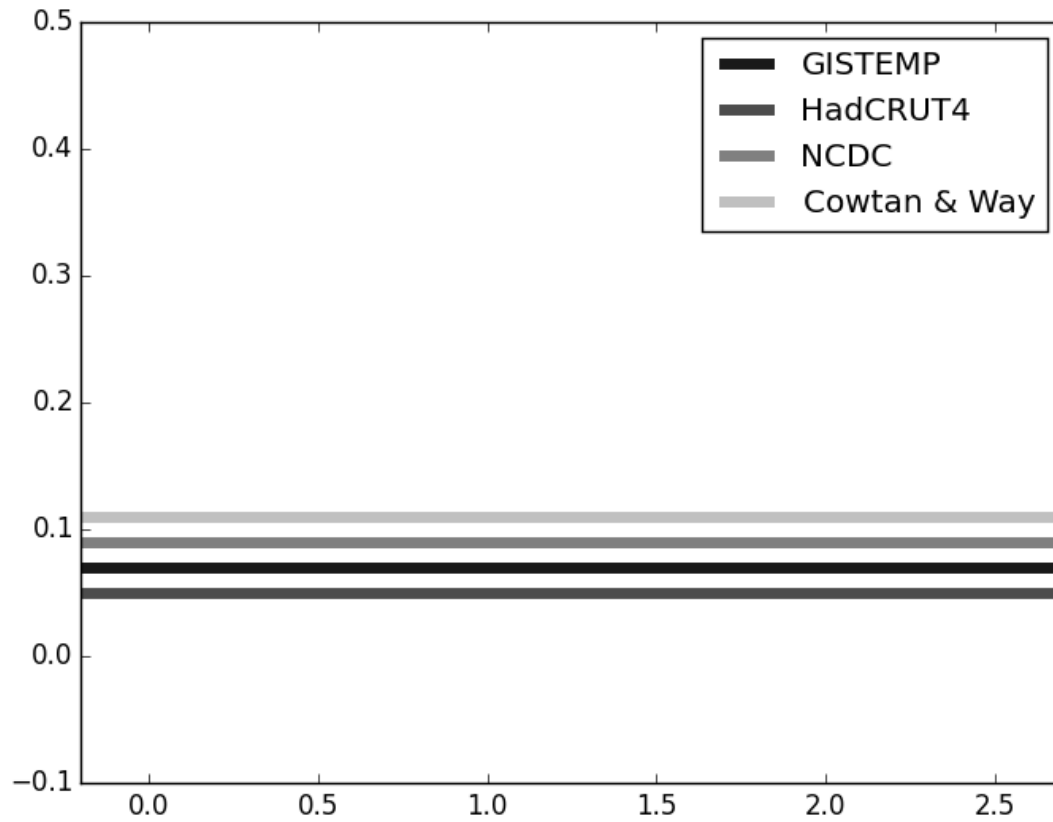
HADCRUT4



NCDC



Cowtan and Way



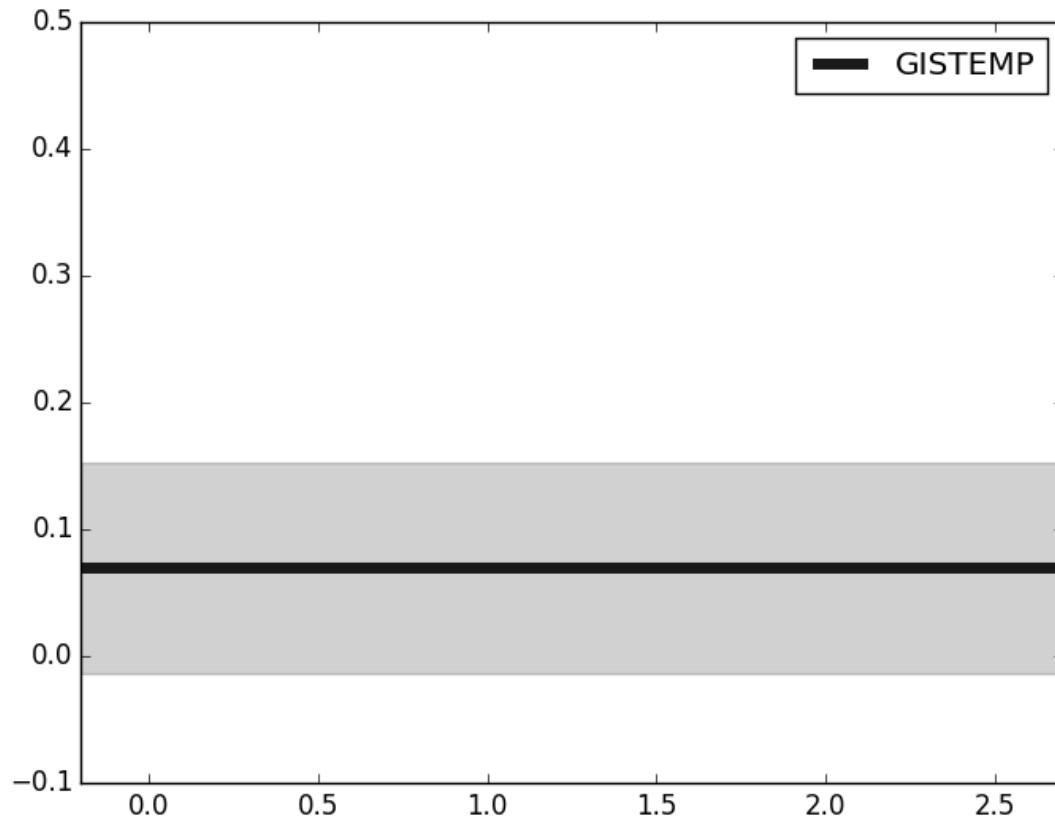
Plausible explanations

- 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

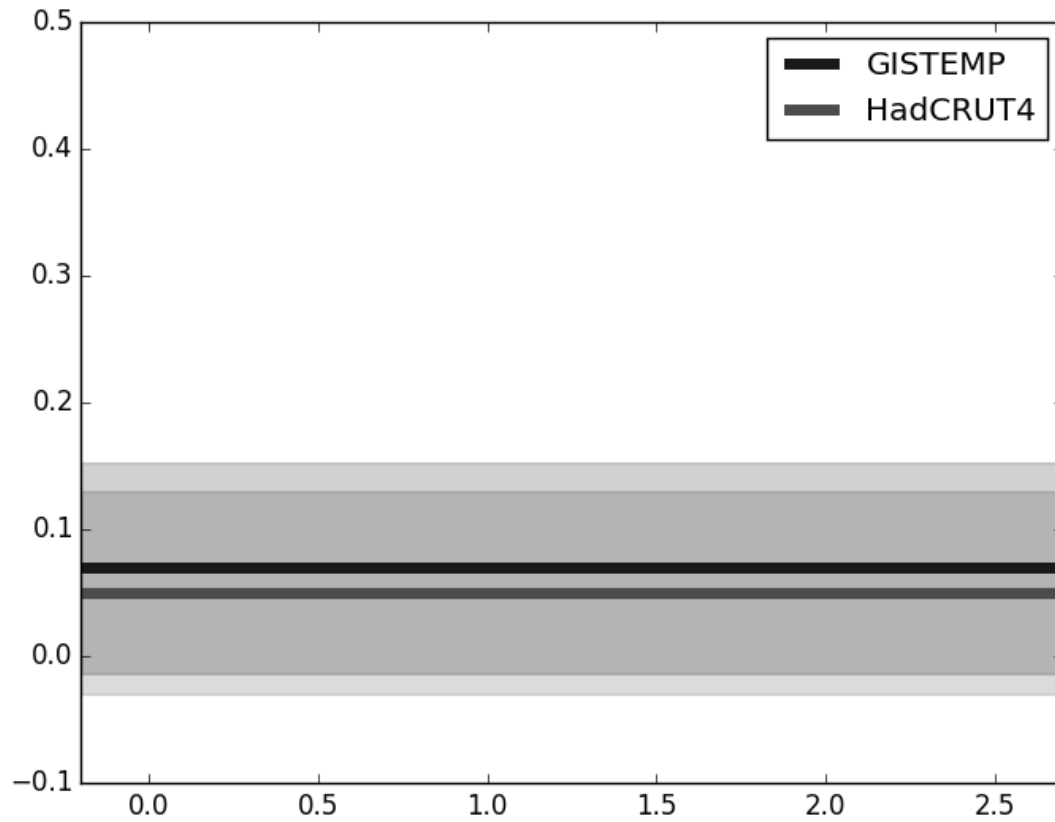
15 year trends

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

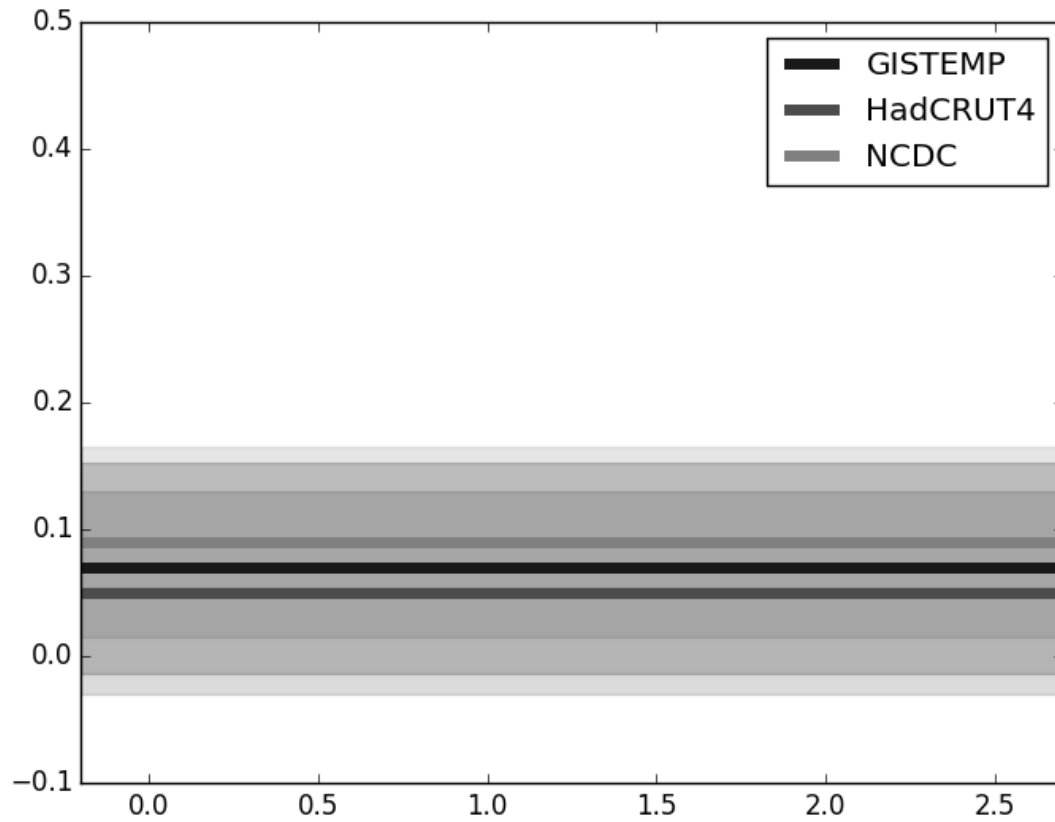
GISTEMP



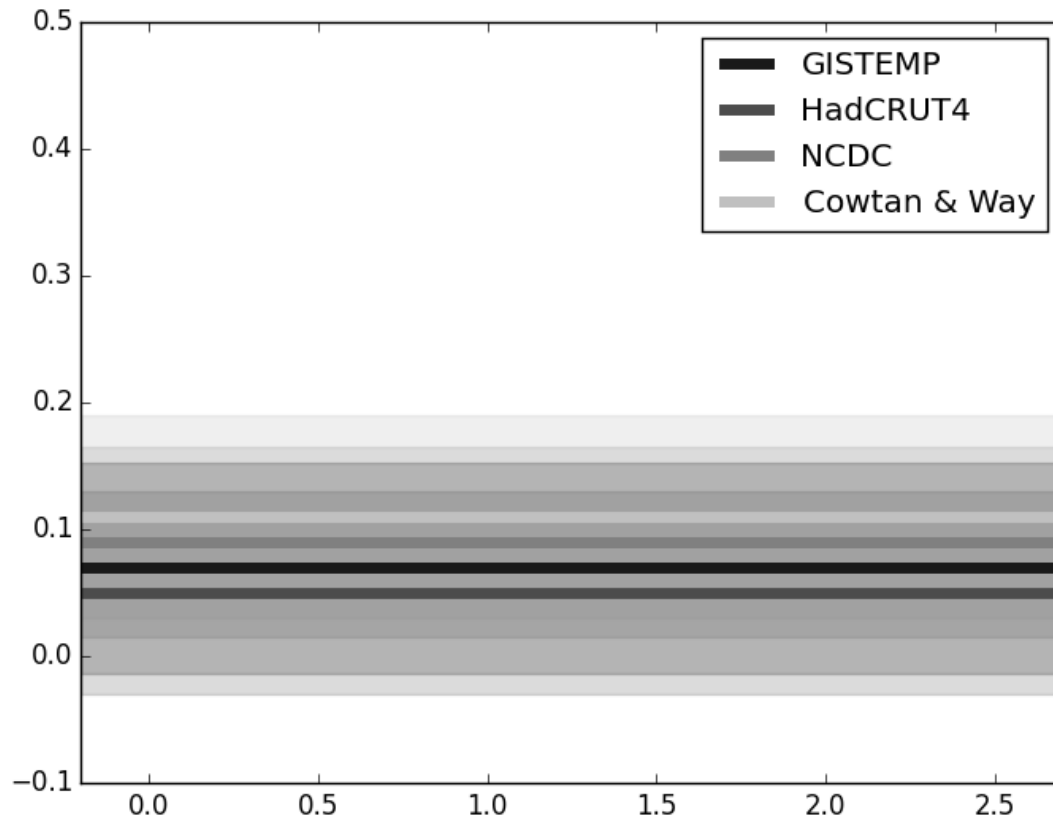
HADCRUT4



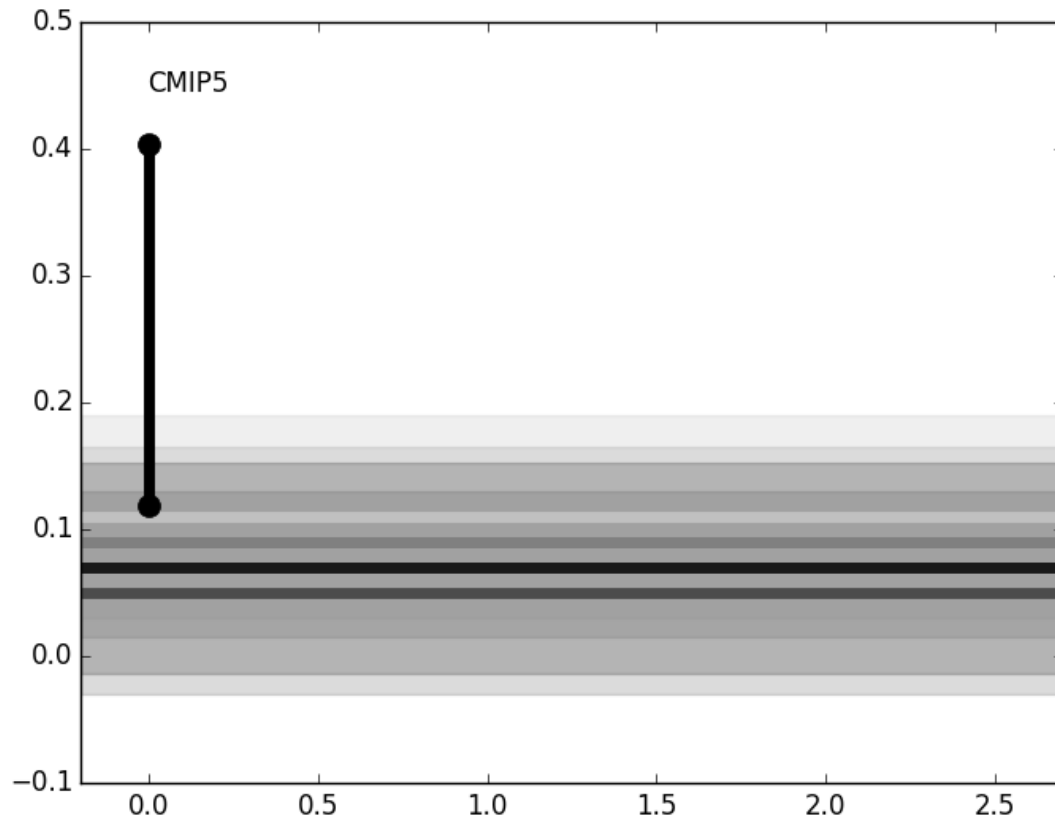
NCDC



Cowtan and Way



CMIP5 models 5-95% range



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

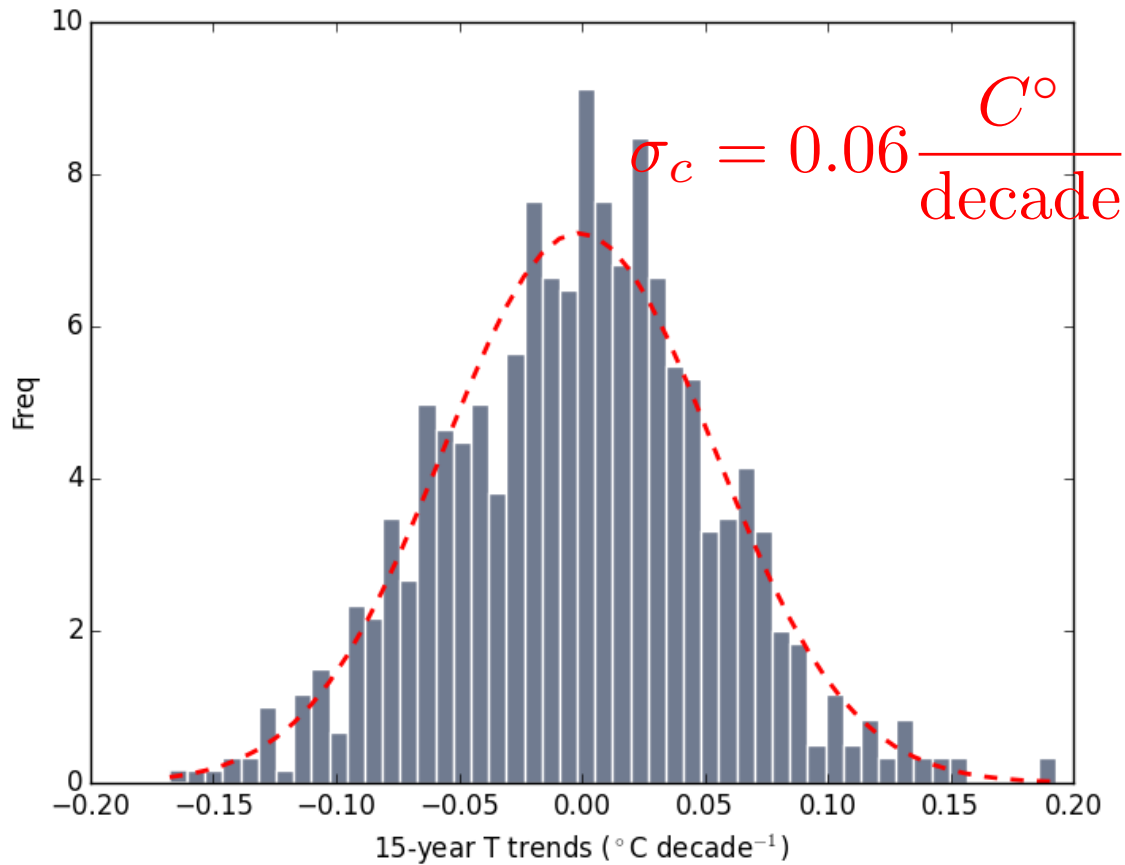
Simple statistical model

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

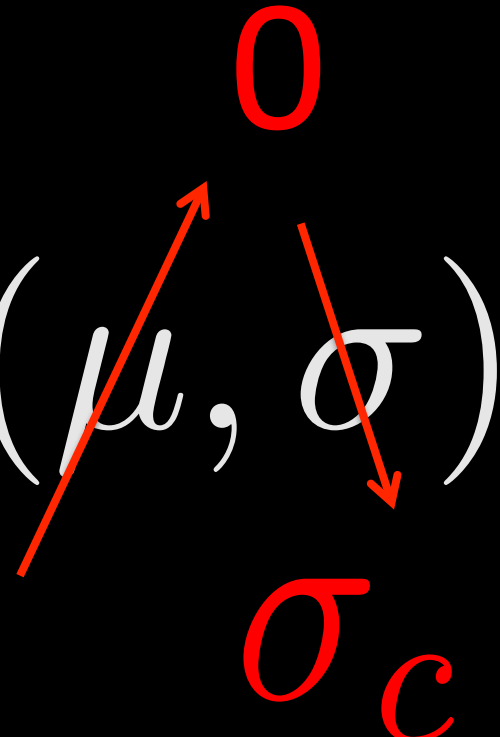
Internal variability

- F = estimated using GISS time series (=0.37 W/m² decade)
- λ = 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

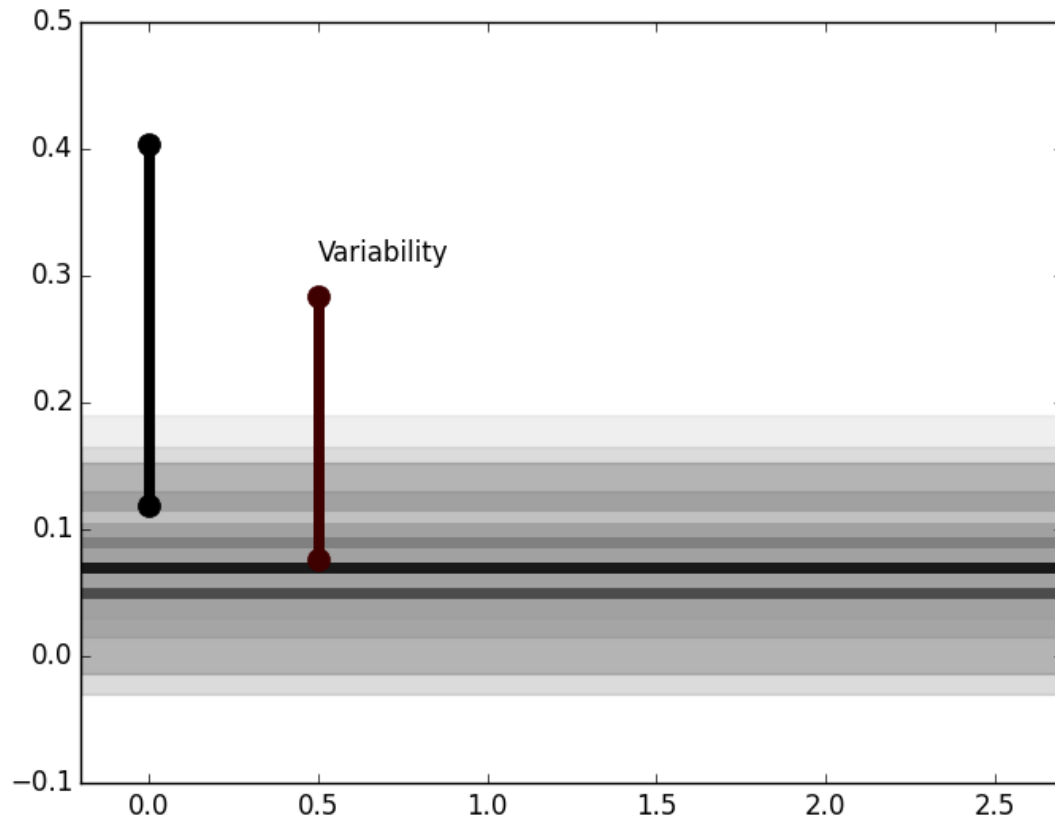


Simple statistical model

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


The diagram illustrates a simple statistical model. The equation is $T = \frac{F}{\lambda} + N(\mu, \sigma)$. The variables F and λ are underlined in red. The normal distribution parameters μ and σ are also underlined in red. A red '0' is positioned above the normal distribution parameters, with a red arrow pointing from the '0' to μ and another red arrow pointing from the '0' to σ . A red σ_c is positioned below the normal distribution parameters.

Internal variability



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

Underestimated amplitude of internal variability

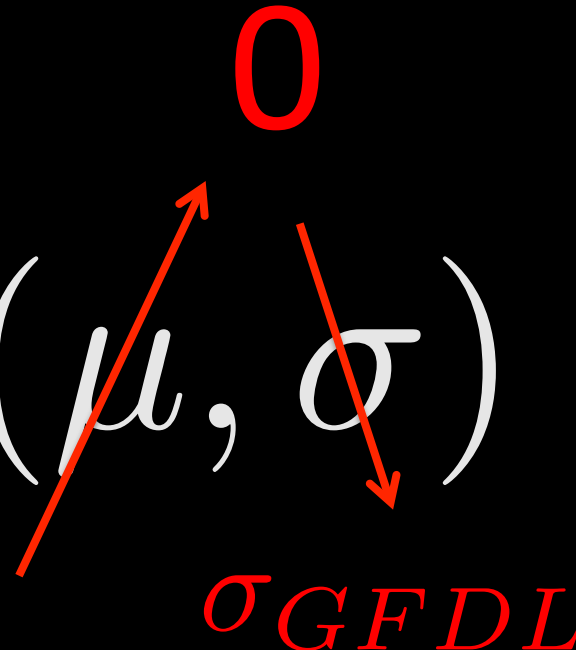
- GFDL model has largest internal variability width (0.14 C/decade)
- Replace width with GFDL width

Simple statistical model

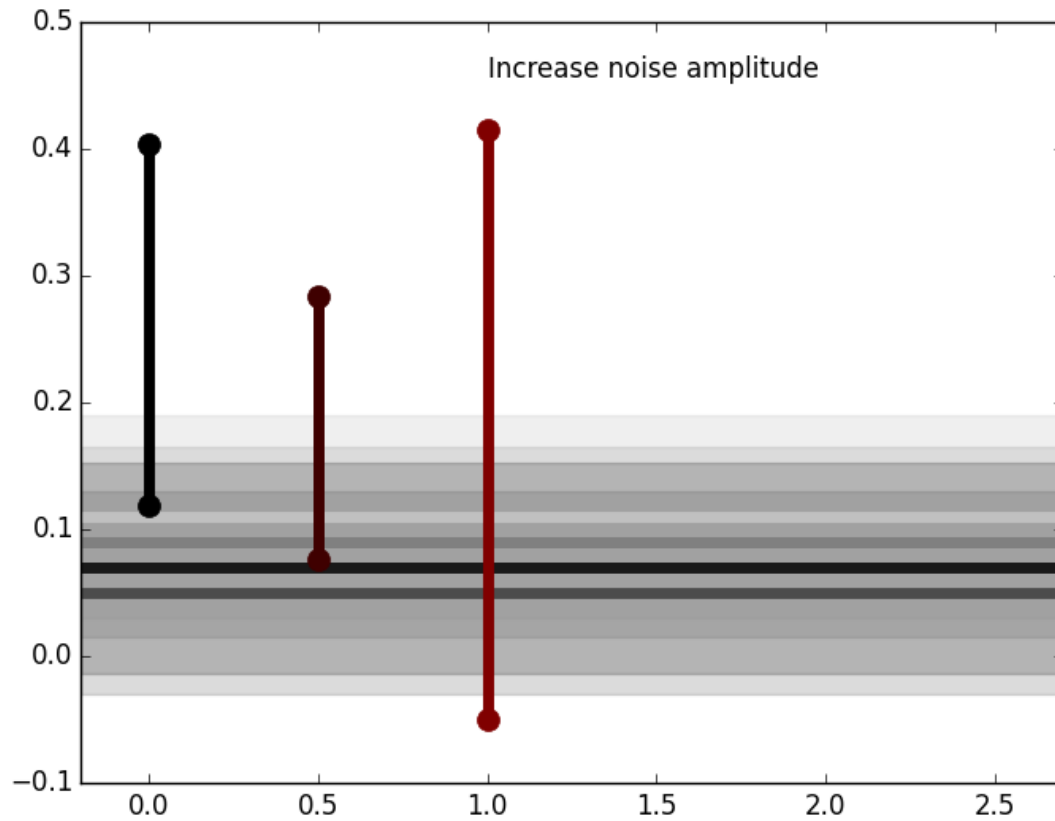
$$T = \frac{\overline{F}}{\lambda} + N(\mu, \sigma)$$

0

σ_{GFDL}

A diagram illustrating a normal distribution. A red '0' is positioned above the distribution. A red arrow points from the '0' down to the symbol sigma in the normal distribution notation N(mu, sigma). Below the sigma symbol, the text sigma_GFDL is written in red, indicating that sigma represents the standard deviation of the GFDL model.

Expanding internal variability width



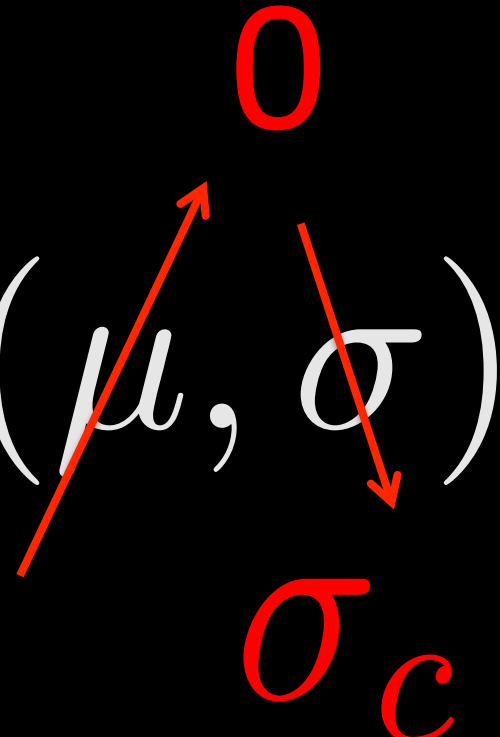
Plausible explanations

- 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

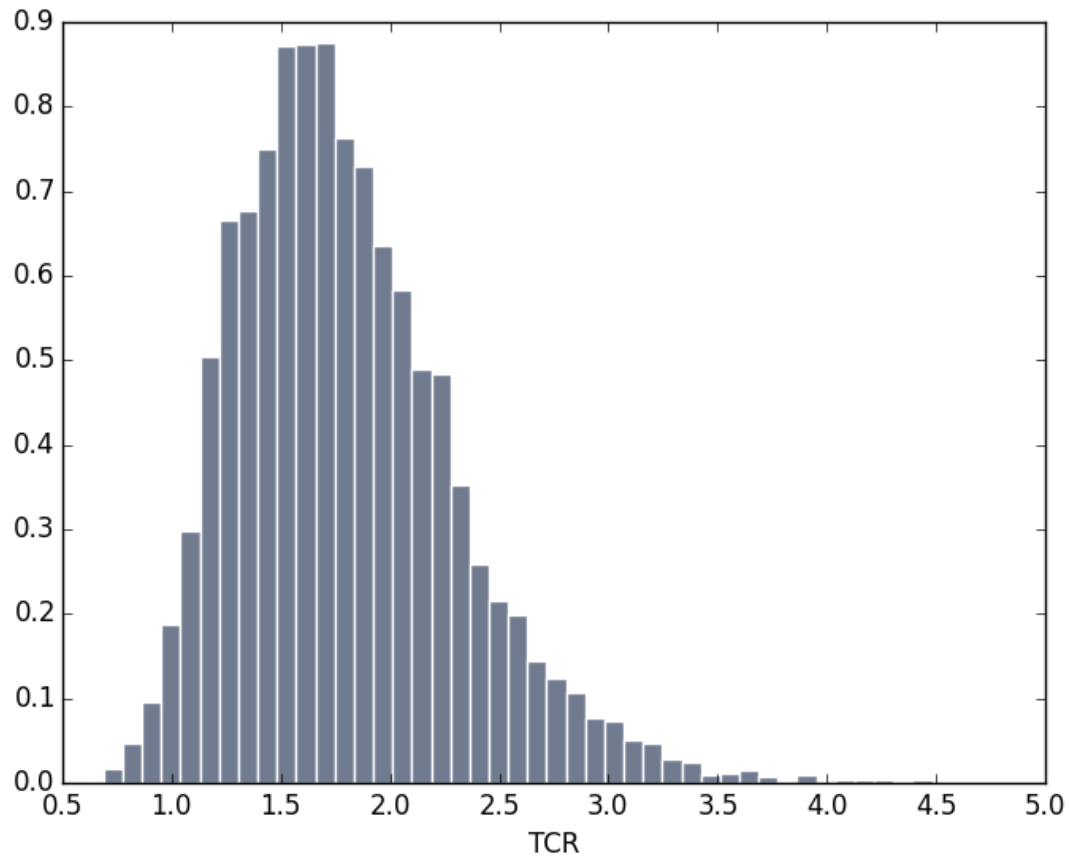
Simple statistical model

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

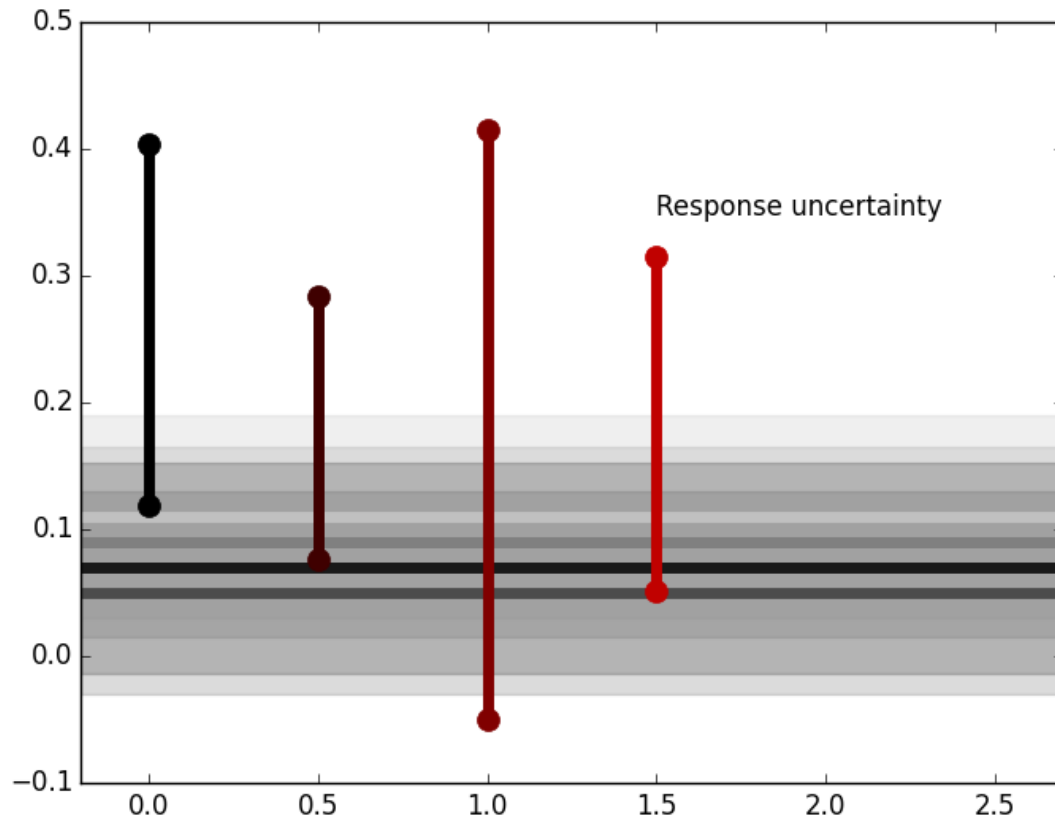
λ_{CMIP5} 0 σ_c



Uncertainty in response



Response uncertainty



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

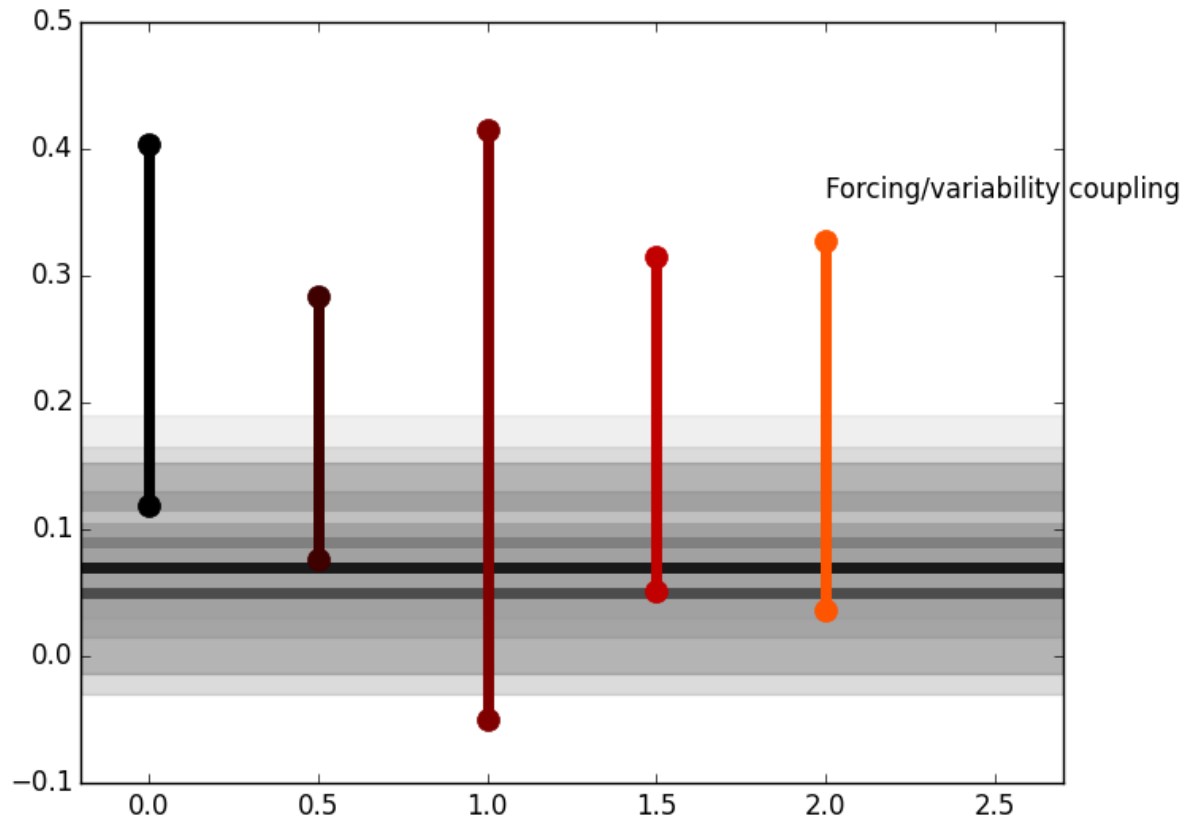
Simple statistical model

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

$N(0, \sigma_c)$

σ_c

Forcing Uncertainty



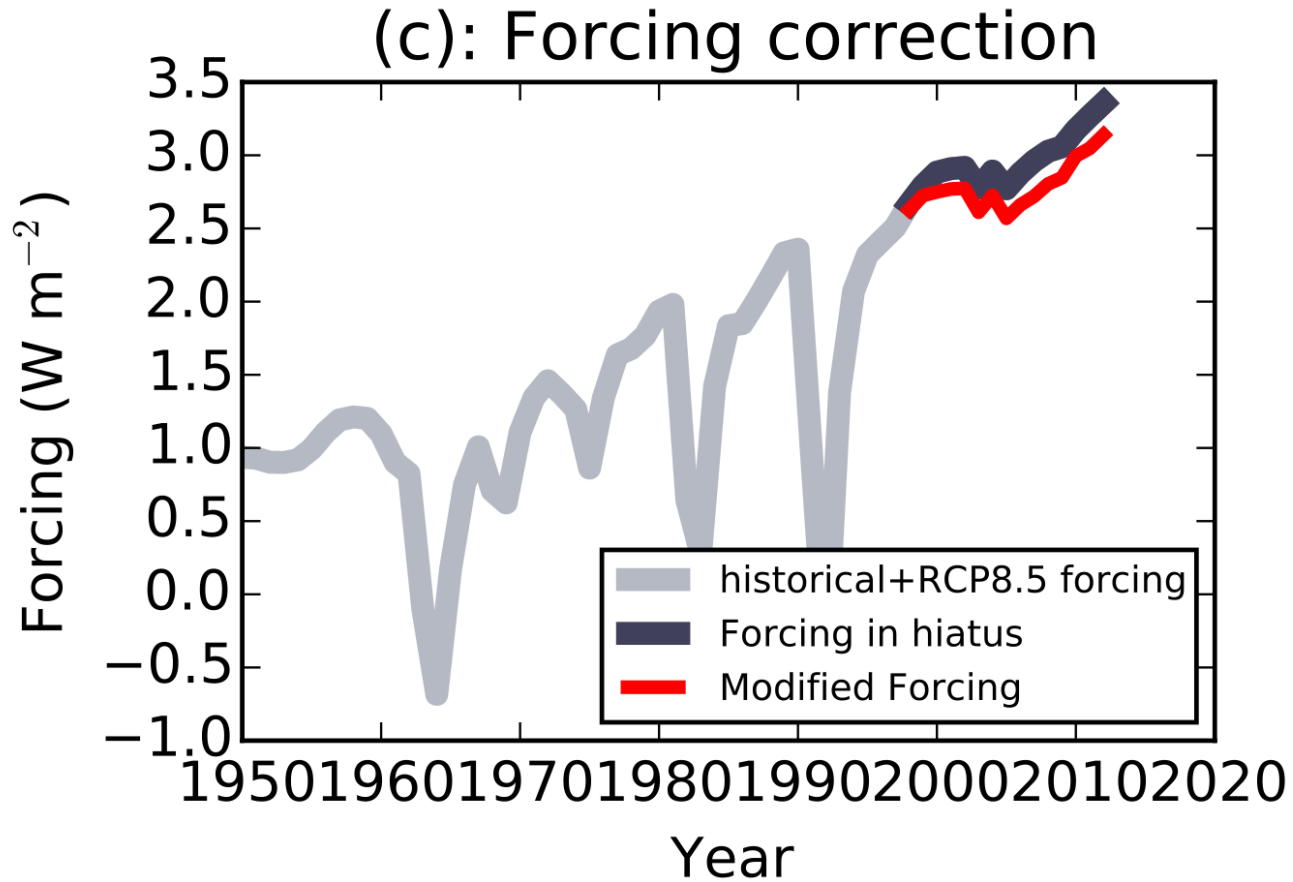
Plausible explanations

- 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

Forcing errors

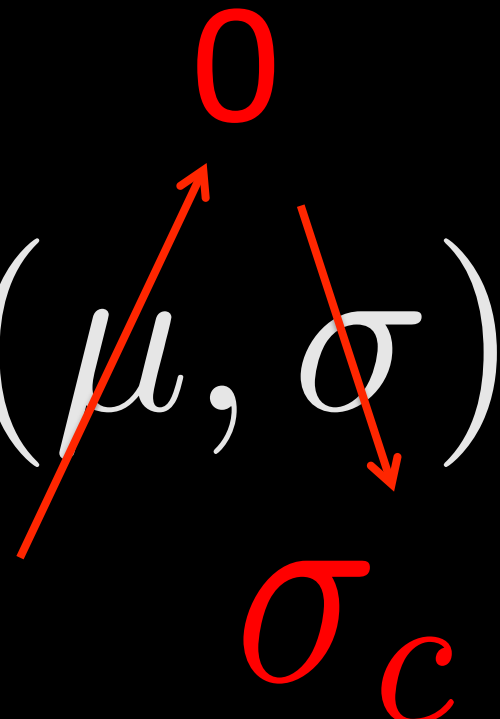
- CMIP5 model “historical” forcings stop in 2005
- Evidence for substantial VI, SI, AA forcings 2005-2012
- Use updated forcings from Schmidt et al Nat Geosci

Updated forcing



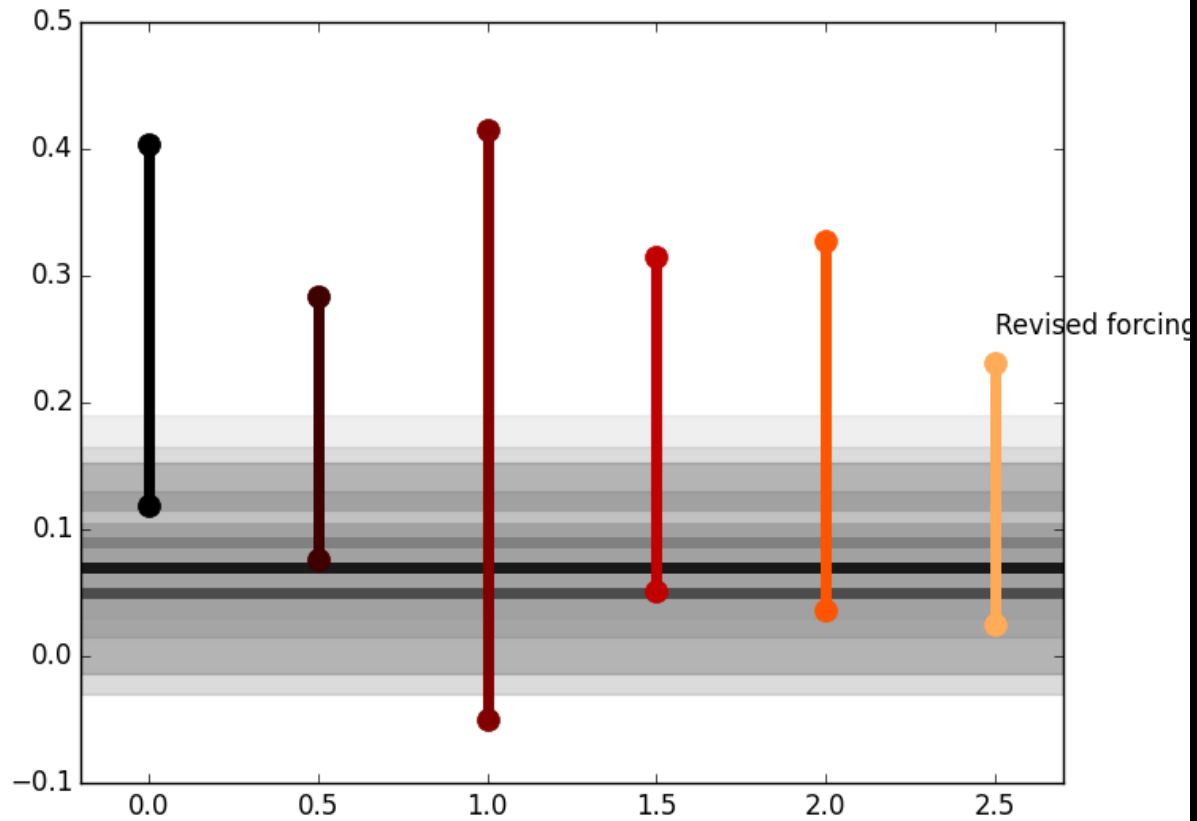
Simple statistical model

$$= F_{\text{modified}}$$

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


The diagram illustrates the relationship between the parameters of the normal distribution and the variables in the equation. A red arrow points from the Greek letter μ to the number 0, indicating that the mean is zero. Another red arrow points from the Greek letter σ to the symbol σ_c , indicating that the standard deviation is σ_c .

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.