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

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Figure 2 | Global internet search trends. Quantity of Google searches\(^3\) 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
Plausible explanations

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Observational uncertainty

• Four different observational datasets
• Different coverages, corrections applied for bias
Cowtan and Way

![Graph showing temperature data from various sources. The graph compares datasets such as GISTEMP, HadCRUT4, NCDC, and Cowtan & Way. The data is represented on a horizontal axis and a vertical axis, with the y-axis indicating temperature values and the x-axis representing time.]
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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
HADCRUT4
NCDC
Cowtan and Way
CMIP5 models 5-95% range
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Simple statistical model

\[ T = \frac{F}{\lambda} + N(\mu, \sigma) \]
Internal variability

- $F = \text{estimated using GISS time series} = 0.37 \text{ W/m}^2 \text{ decade}$
- $\Lambda = \text{CMIP5 median value} = 1.8$
- Internal variability centered around 0
- Get width of internal variability from concatenated control runs
- Non-overlapping 15-year trends
Noise estimate

\[ \sigma_c = 0.06 \, ^{\circ}\text{C decade}^{-1} \]
Simple statistical model

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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

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Expanding internal variability width

Increase noise amplitude
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\[ T = \frac{F}{\lambda} + \mathcal{N}(\mu, \sigma) \]

\[ \lambda = \lambda_{CMIP5} \]

\[ \sigma_c \]
Uncertainty in response
Response uncertainty
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Simple statistical model

\[ T = \frac{F}{\lambda} + N(\mu, \sigma) + N(0, \sigma_c) \]
Forcing Uncertainty
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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

(c): Forcing correction

Year

Forcing (W m$^{-2}$)

historical+RCP8.5 forcing
Forcing in hiatus
Modified Forcing
Simple statistical model

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

= \text{modified}
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.