



This is the print version of the [Skeptical Science](http://sks.to/lindzenchoi) article '[Lindzen and Choi find low climate sensitivity](http://sks.to/lindzenchoi)', which can be found at <http://sks.to/lindzenchoi>.

Working out climate sensitivity from satellite measurements

What The Science Says:

Lindzen's analysis has several flaws, such as only looking at data in the tropics. A number of independent studies using near-global satellite data find positive feedback and high climate sensitivity.

Climate Myth: Lindzen and Choi find low climate sensitivity

Climate feedbacks are estimated from fluctuations in the outgoing radiation budget from the latest version of Earth Radiation Budget Experiment (ERBE) nonscanner data. It appears, for the entire tropics, the observed outgoing radiation fluxes increase with the increase in sea surface temperatures (SSTs). The observed behavior of radiation fluxes implies negative feedback processes associated with relatively low climate sensitivity. This is the opposite of the behavior of 11 atmospheric models forced by the same SSTs. ([Lindzen 2009](#))

Climate sensitivity is a measure of how much our climate responds to an energy imbalance. The most common definition is the change in global temperature if the amount of atmospheric CO₂ was doubled. If there were no feedbacks, climate sensitivity would be around 1°C. But we know there are a number of feedbacks, both positive and negative. So how do we determine the net feedback? An empirical solution is to observe how our climate responds to temperature change. We have satellite measurements of the radiation budget and surface measurements of temperature. Putting the two together should give us an indication of net feedback.

One paper that attempts to do this is [On the determination of climate feedbacks from ERBE data \(Lindzen et al 2009\)](#). It looks at sea surface temperature in the tropics (20° South to 20° North) from 1986 to 2000. Specifically, it looked at periods where the change in temperature was greater than 0.2°C, marked by red and blue colors (Figure 1).

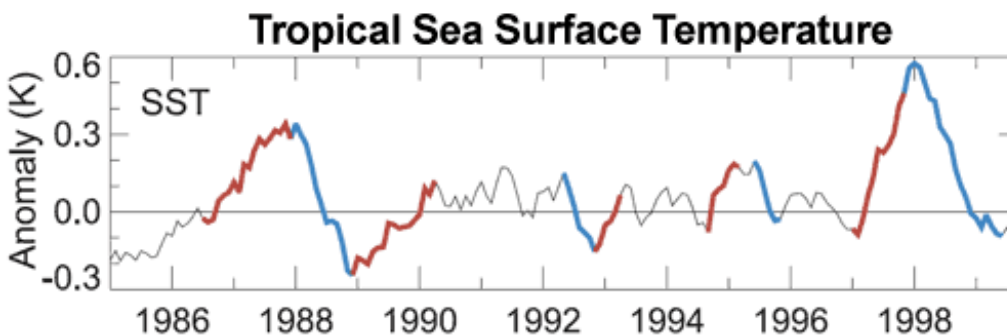


Figure 1: Monthly sea surface temperature for 20° South to 20° North. Periods of temperature change greater than 0.2°C marked by red and blue ([Lindzen et al 2009](#)).

Lindzen et al also analysed satellite measurements of outgoing radiation over these periods. As short-term tropical sea surface temperatures are largely driven by the El Nino Southern Oscillation, the change in outward radiation offers an insight into how climate responds to changing temperature. Their analysis found that when it gets warmer, there was more outgoing radiation escaping to space. They concluded that net feedback is negative and our planet has a low climate sensitivity of about 0.5°C.

Debunked by Trenberth

However, a response to this paper, [Relationships between tropical sea surface temperature and top-of-atmosphere radiation \(Trenberth et al 2010\)](#) revealed a number of flaws in Lindzen's analysis. It turns out the low climate sensitivity result is heavily dependent on the choice of start and end points in the periods they analyse. Small changes in their choice of dates entirely change the result. Essentially, one could tweak the start and end points to obtain any feedback one wishes.

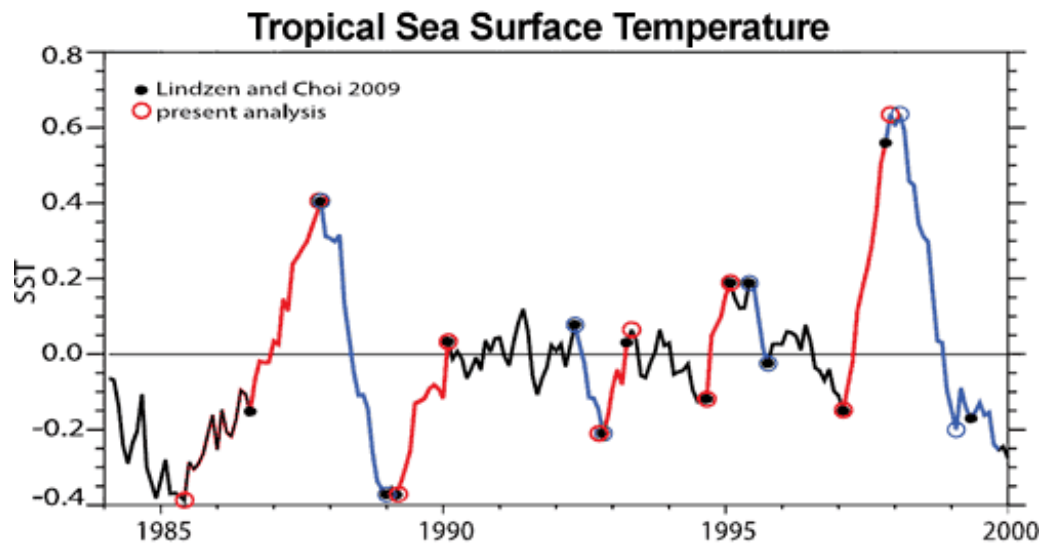


Figure 2: Warming (red) and cooling (blue) intervals of tropical SST (20°N - 20°S) used by [Lindzen et al 2009](#) (solid circles) and an alternative selection proposed derived from an objective approach (open circles) ([Trenberth et al 2010](#)).

Debunked by Murphy

Another major flaw in Lindzen's analysis is that they attempt to calculate *global* climate sensitivity from *tropical* data. The tropics are not a closed system - a great deal of energy is exchanged between the tropics and subtropics. To properly calculate global climate sensitivity, global observations are required.

This is confirmed by another paper published in early May ([Murphy 2010](#)). This paper finds that small changes in the heat transport between the tropics and subtropics can swamp the tropical signal. They conclude that climate sensitivity must be calculated from global data.

Debunked by Chung

In addition, another paper reproduced the analysis from [Lindzen et al 2009](#) and compared it to results using near-global data ([Chung et al 2010](#)). The near-global data find net positive feedback and the authors conclude that the tropical ocean is not an adequate region for determining global climate sensitivity.

Debunked by Dessler

[Dessler \(2011\)](#) found a number of errors in [Lindzen and Choi \(2009\)](#) (slightly revised as [Lindzen & Choi \[2011\]](#)). First, Lindzen and Choi's mathematical formula to calculate the Earth's energy budget may violate the laws of thermodynamics - allowing for the impossible situation where ocean warming is able to cause ocean warming. Secondly, Dessler finds that the heating of the climate system through ocean heat transport is approximately **20 times larger** than the change in top of the atmosphere (TOA) energy flux due to cloud cover changes. Lindzen and Choi assumed the ratio was close to 2 - an order of magnitude too small.

Thirdly, Lindzen and Choi plot a time regression of change in TOA energy flux due to cloud cover changes vs. sea surface temperature changes. They find larger negative slopes in their regression when cloud changes happen before surface temperature changes, vs. positive slopes when temperature changes happen first, and thus conclude that clouds must be

causing global warming.

However, Dessler also plots climate model results and finds that they also simulate negative time regression slopes when cloud changes lead temperature changes. Crucially, sea surface temperatures are specified by the models. This means that in these models, clouds respond to sea surface temperature changes, but not vice-versa. This suggests that the lagged result first found by Lindzen and Choi is actually a result of variations in atmospheric circulation driven by changes in sea surface temperature, and contrary to Lindzen's claims, **is not evidence that clouds are causing climate change**, because in the models which successfully replicate the cloud-temperature lag, temperatures cannot be driven by cloud changes.

2011 Repeat

Lindzen and Choi tried to address some of the criticisms of their 2009 paper in [a new version which they submitted in 2011](#) (LC11), after [Lindzen himself went as far as to admit](#) that their 2009 paper contained "*some stupid mistakes...It was just embarrassing.*" However, LC11 did not address most of the main comments and contradictory results from their 2009 paper.

Lindzen and Choi first submitted LC11 to the Proceedings of the National Academy of Sciences (PNAS) after adding some data from the Clouds and the Earth's Radiant Energy System (CERES).

PNAS editors sent LC11 out to four reviewers, who provided [comments available here](#). Two of the reviewers were selected by Lindzen, and two others by the PNAS Board. All four reviewers were unanimous that while the subject matter of the paper was of sufficient general interest to warrant publication in PNAS, the paper was not of suitable quality, and its conclusions were not justified. Only one of the four reviewers felt that the procedures in the paper were adequately described.

As PNAS Reviewer 1 commented,

"The paper is based on...basic untested and fundamentally flawed assumptions about global climate sensitivity"

[These remaining flaws in LC11 included:](#)

- Assuming that that correlations observed in the tropics reflect global climate feedbacks.
- Focusing on short-term local tropical changes which might not be representative of equilibrium climate sensitivity, because for example the albedo feedback from melting ice at the poles is obviously not reflected in the tropics.
- Inadequately explaining methodology in the paper in sufficient detail to reproduce their analysis and results.
- Failing to explain the many contradictory results using the same or similar data (Trenberth, Chung, Murphy, and Dessler).
- Treating clouds as an internal initiator of climate change, as opposed to treating cloud changes solely as a climate feedback (as most climate scientists do) without any real justification for doing so.

As a result of these fundamental problems, PNAS rejected the paper, which Lindzen and Choi subsequently got published [in a rather obscure Korean journal](#), the Asia-Pacific Journal of Atmospheric Science.

Wholly Debunked

A full understanding of climate requires we take into account the full body of evidence. In the case of climate sensitivity and satellite data, it requires a global dataset, not just the tropics. Stepping back to take a broader view, a single paper must also be seen in the context of the full body of peer-reviewed research. A [multitude of papers looking at different periods in Earth's history](#) independently and empirically converge on a consistent answer - climate sensitivity is around 3°C implying net positive feedback.



Skeptical Science explains the science of global warming and examines climate misinformation through the lens of peer-reviewed research. The website won the Australian Museum 2011 Eureka Prize for the Advancement of Climate Change Knowledge. Members of the Skeptical Science team have authored peer-reviewed papers, a [college textbook on climate change](#) and the book [Climate Change Denial: Heads in the Sand](#). Skeptical Science content has been used in university courses, textbooks, government reports on climate change, television documentaries and numerous books.



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