

## This past weekend in Cape Town



**Clockwise from left:**

- Michael Walker, Cape Times
- Michael Walker, Cape Times
- Sam Clark, Independent Newspapers
- Jeffrey Abrahams, Independent Newspapers



Is this climate change?

## Tropical cyclones



**Left:**

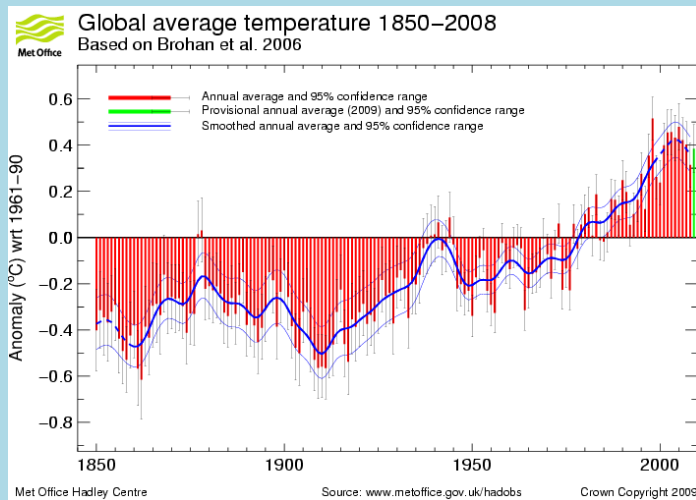
Zambezi Valley, Mozambique, after Cyclone Favio (François Goemans)

**Right:**

New Orleans, US, after Hurricane Katrina (US Navy)



## Can this man blame global warming?



Met Office Hadley Centre



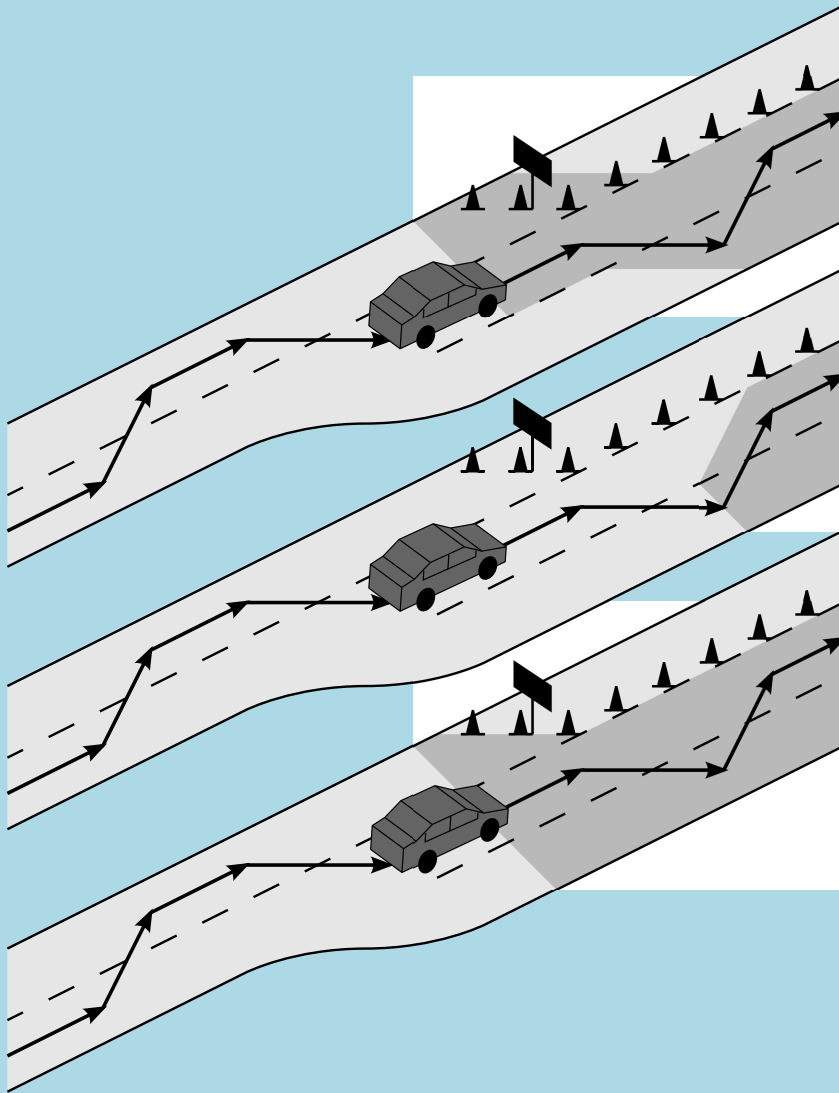
Michael Walker, Cape Times

- Of course not.
- He was not affected by anything global.
- He was not affected by temperature.

## Can he blame climate change?

- What is *climate*?
- There are many different definitions currently in use.

## A useful definition



- Climate is the set of all possible weather given certain external boundary conditions (e.g. solar brightness, greenhouse gas emissions, colour of the tarmac).
- “Climate is what you expect, weather is what you get.”  
- Edward Lorenz

- If that is climate, then why does he care about climate change per se?
- He may be more interested in what caused that climate change.
  - He would need to understand the cause in order to determine how (and if) climate is changing.
  - He may be able to sue a cause.

Is this climate change?

## Can he blame greenhouse gas emitters?



Province of Ontario



Michael Walker, Cape Times

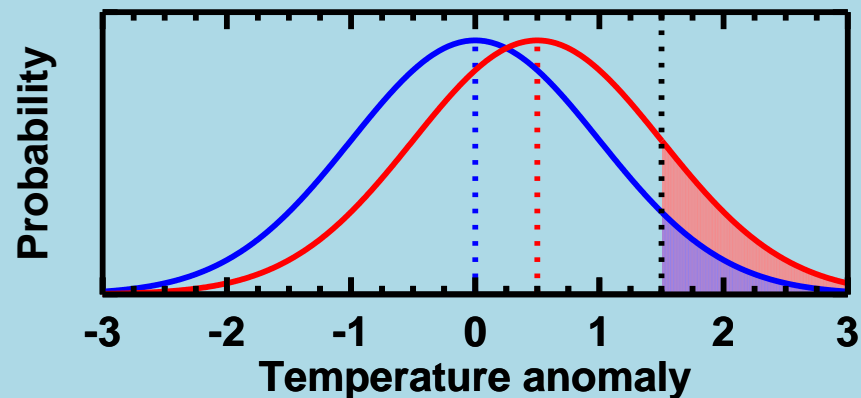
## What your television weatherman will say

*“While this is the sort of weather event that we expect to be more (or less) common under climate change caused by human emissions, we cannot say whether this one event was caused by those emissions.”*

- This understanding of “cause” differs from that used in environmental law and in epidemiology.

## What the weatherman should be able to say

*“Yes (no), the risk of this event has increased (decreased) by X times because of human emissions.”*



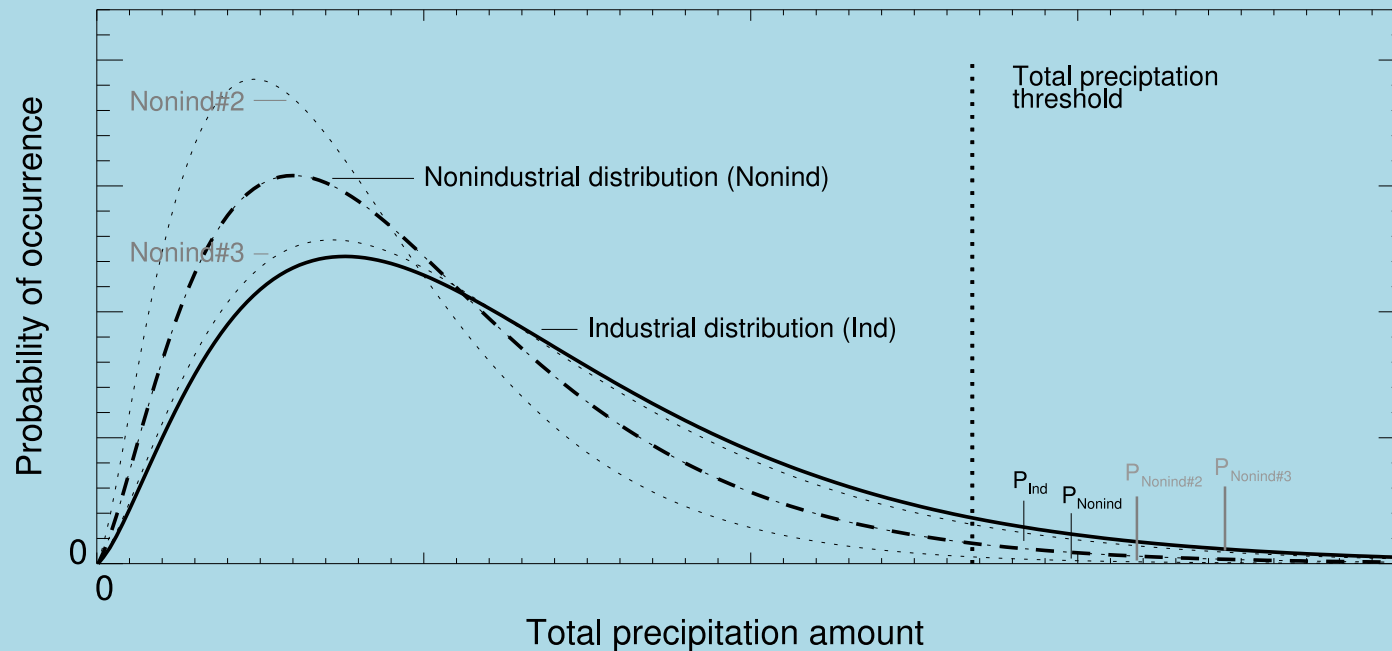
- Occurrence (a case) is weather, but risk (probability) is climate.
- Weather is random (chaotic), but climate is deterministic.

## How can he figure this out?

The Autumn 2000 flooding in Britain (work by Pardeep Pall)

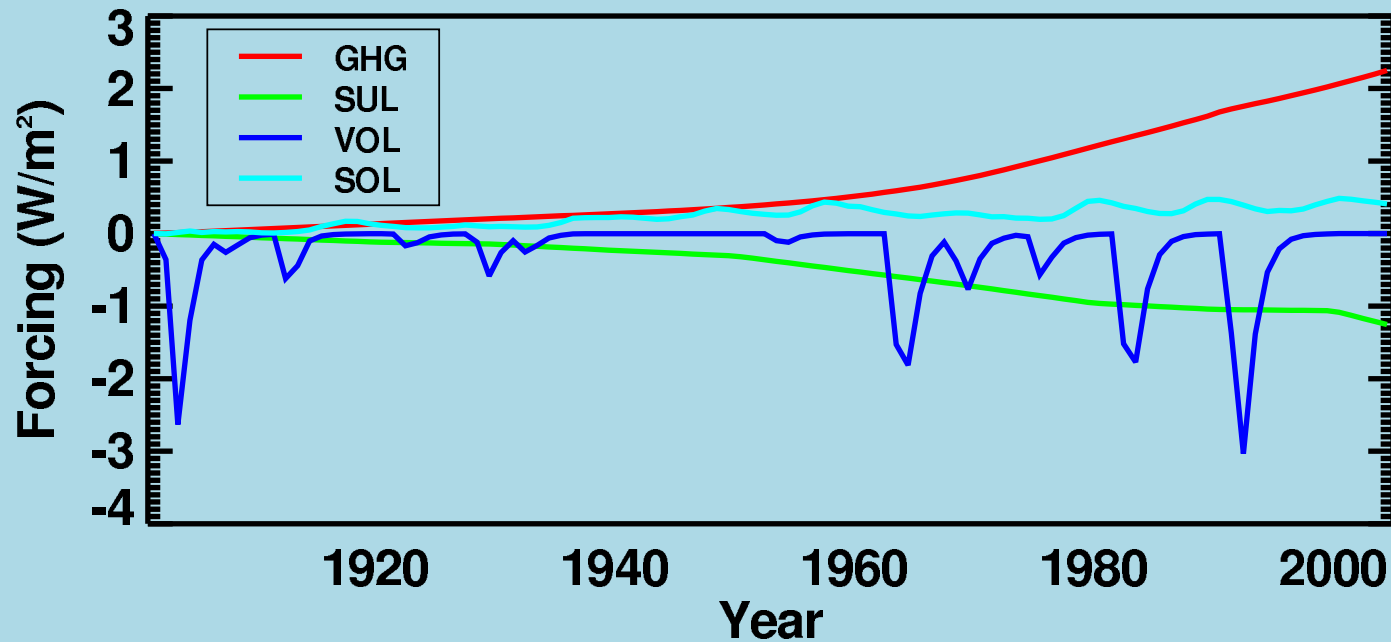


## The idea



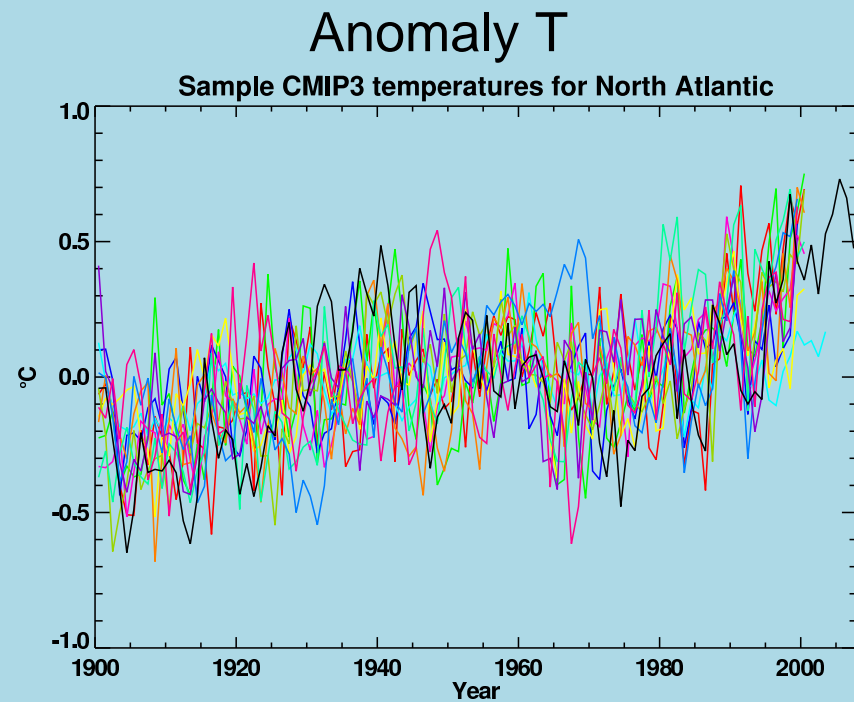
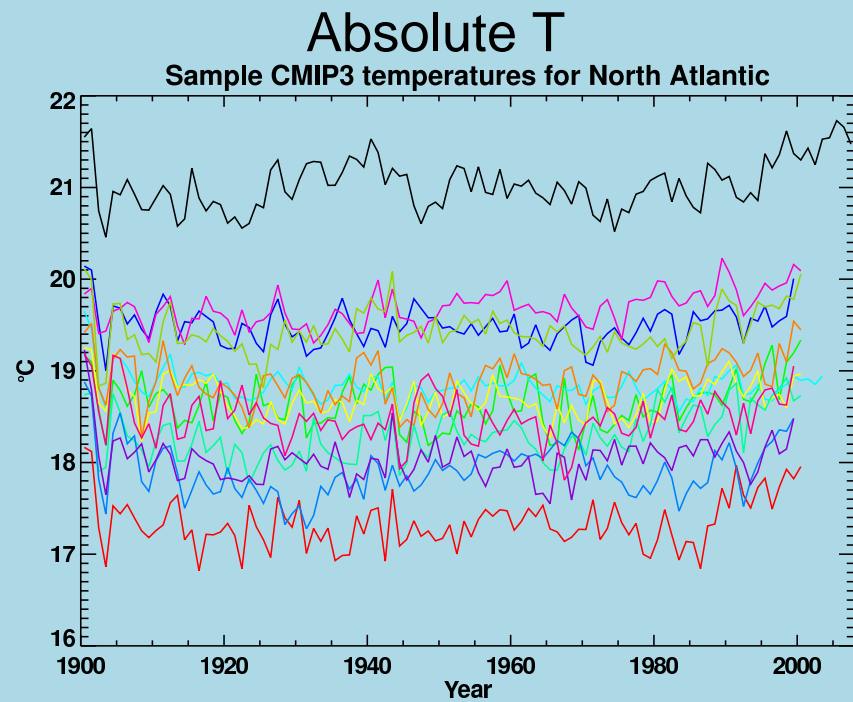
- Estimate the risk of the event now.
- Estimate the risk if we had never been emitting.
- Compare.

## Difficulty: many possible causes



- Also an issue for our flooded neighbour:  
does he care about the blame of all anthropogenic causes or just the greenhouse gases?

## What are the actual values?



## What about cyclones?

- There is no real theory of cyclone genesis.
- There is no real theory of cyclone frequency.
- Cyclone intensity should be related to ocean temperature.

## Changes in cyclone intensity

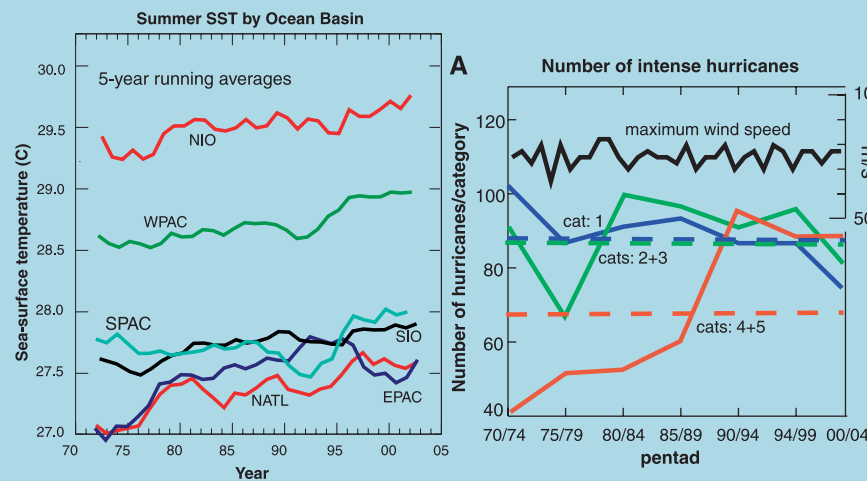


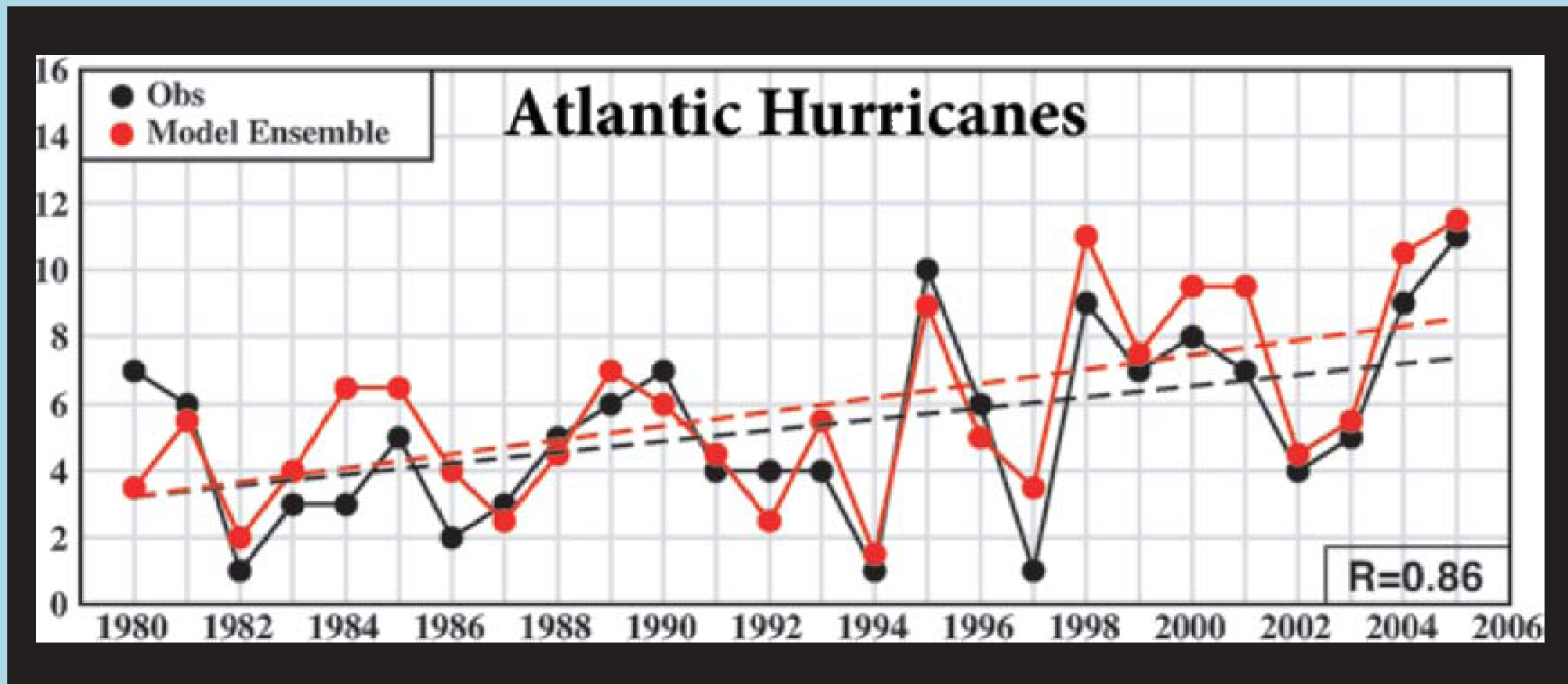
Table 1. Change in the number and percentage of hurricanes in categories 4 and 5 for the 15-year periods 1975–1989 and 1990–2004 for the different ocean basins.

| Basin                | Period    |            |           |            |
|----------------------|-----------|------------|-----------|------------|
|                      | 1975–1989 |            | 1990–2004 |            |
|                      | Number    | Percentage | Number    | Percentage |
| East Pacific Ocean   | 36        | 25         | 49        | 35         |
| West Pacific Ocean   | 85        | 25         | 116       | 41         |
| North Atlantic       | 16        | 20         | 25        | 25         |
| Southwestern Pacific | 10        | 12         | 22        | 28         |
| North Indian         | 1         | 8          | 7         | 25         |
| South Indian         | 23        | 18         | 50        | 34         |

Webster et alii, 2005

- Follows theory, but with catches.

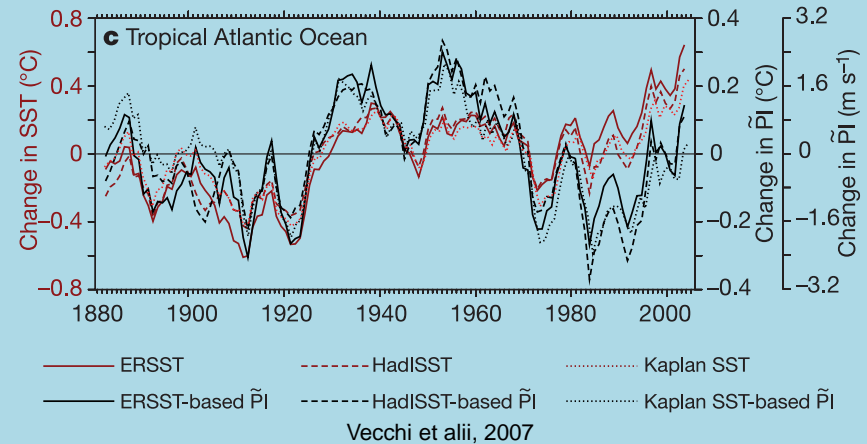
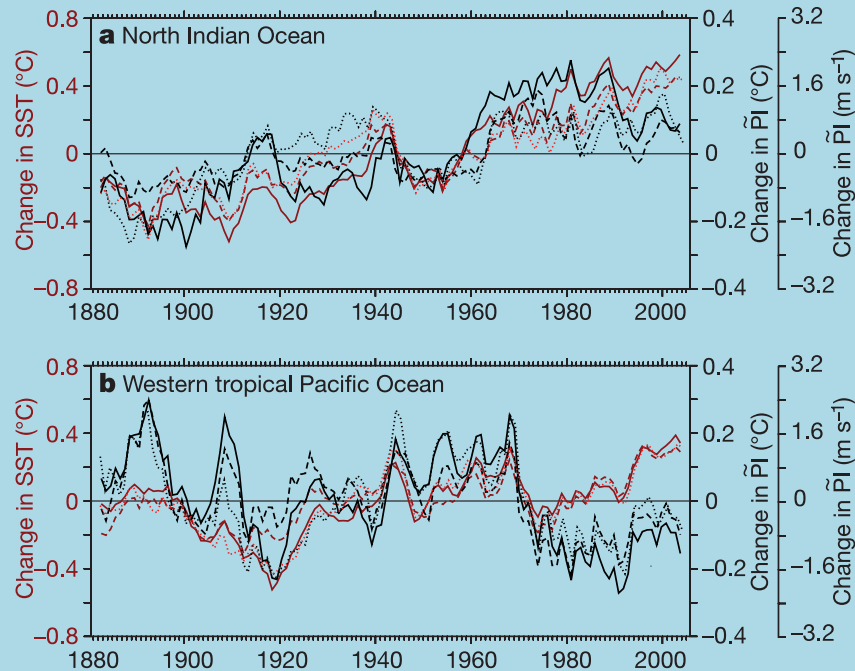
## How do dynamical climate models do?



Knutson et alii, 2007

- Astonishingly well, considering they do not resolve eyewalls.

## But does this mean we understand what is happening?



PI=potential intensity  
(an upper bound on cyclone  
intensity)

- Warmth is not everything – the regional pattern matters.

## So did our emissions cause Hurricane Katrina?

- Of course not, hurricanes happen.
- Our emissions may have caused a change in the risk (probability).
- Evidence is equivocal at the moment, but it seems that our emissions have not changed the risk of Atlantic hurricanes.
- A different story may hold for Indian cyclones though.