

# Why **EVERYONE** is talking about **CLIMATE CHANGE**

K. Guruswamy

National Chemical Laboratory

**BUT FIRST...**

# National Science Day – 28 February



Sir CV Raman  
1930 Nobel Prize in Physics

"for his work on the scattering of light and for the discovery of the effect named after him"

## A New Type of Secondary Radiation.

If we assume that the X-ray scattering of the 'unmodified' type observed by Prof. Compton corresponds to the normal or average state of the atoms and molecules, while the 'modified' scattering of altered wave-length corresponds to their fluctuations from that state, it would follow that we should expect also in the case of ordinary light two types of scattering, one determined by the normal optical properties of the atoms or molecules, and another representing the effect of their fluctuations from their normal state. It accordingly becomes necessary to test whether this is actually the case. The experiments we have made have confirmed this anticipation, and

case of gases and vapours, owing to the excessive feebleness of the effect. Nevertheless, when the vapour is of sufficient density, for example with ether or amylene, the modified scattering is readily demonstrable.

C. V. RAMAN.  
K. S. KRISHNAN.

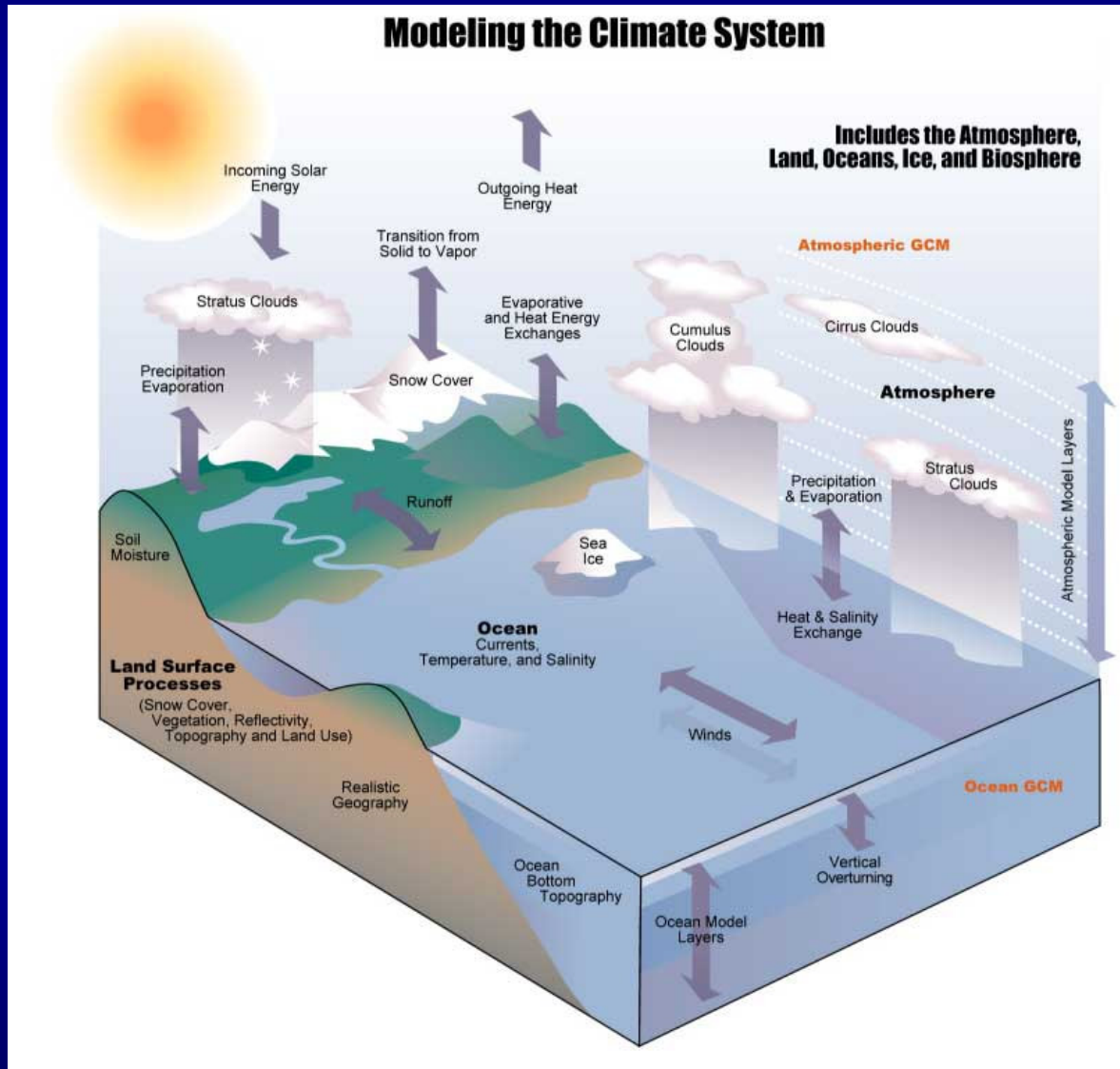
210 Bowbazar Street,  
Calcutta, India,  
Feb. 16.

# Why **EVERYONE** is talking about **CLIMATE CHANGE**

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# Let us understand climate



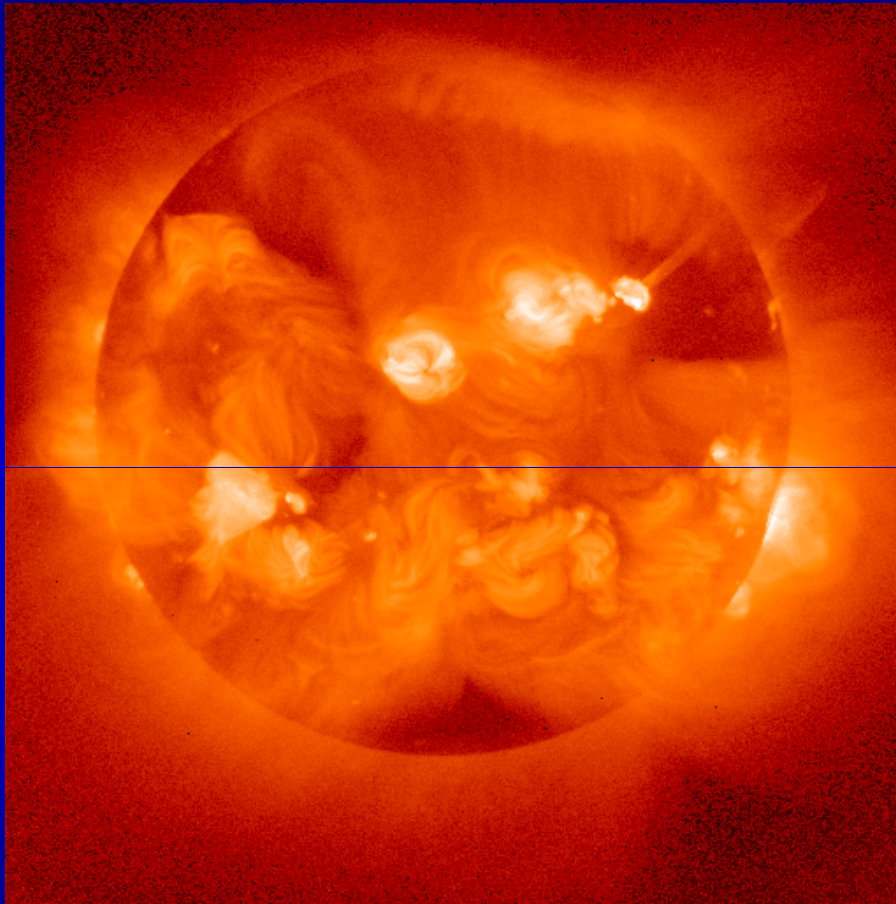
“Climate is what you expect, weather is what you get”

Climate patterns: snow melting, wind & ocean currents, ocean evaporation – energy input for all these from the SUN

Climate – *incredibly* complicated due to the number of processes. “The Butterfly effect” Study of weather laid the foundation of chaos theory.

# Energy inputs to the earth: The SUN

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The BIG guy in the solar system

99.86% of all the mass in the solar system; about 100x earth diameter

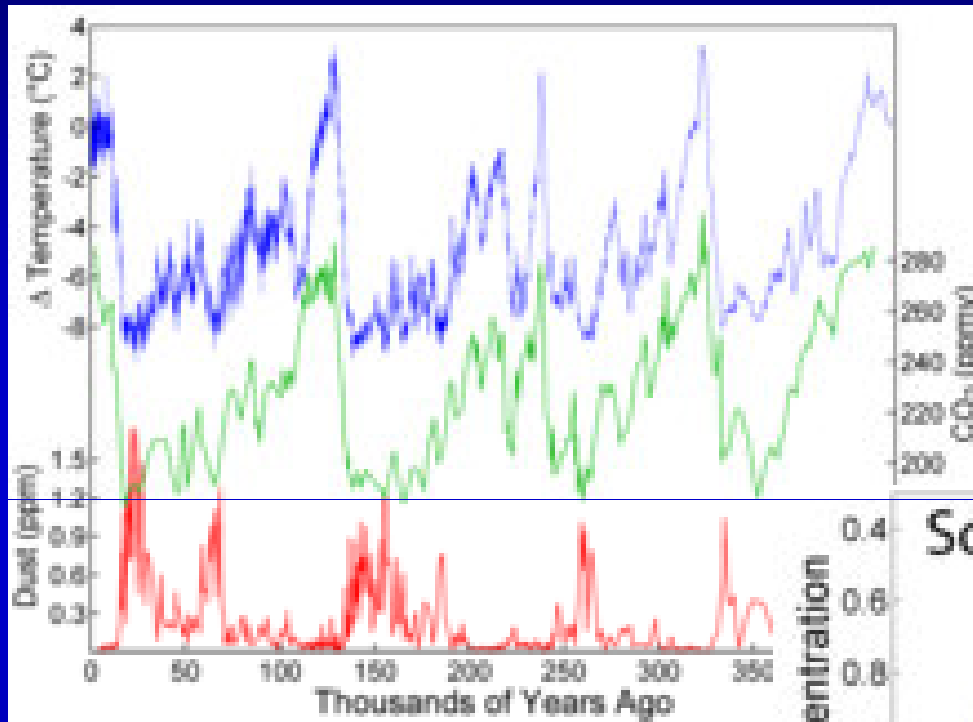
Chemical reactions in stars release energy. Light from the sun delivers energy to the earth. This energy decides the climate/weather.

Changes in the sun, for example, sun spots, have a huge impact on our climate.

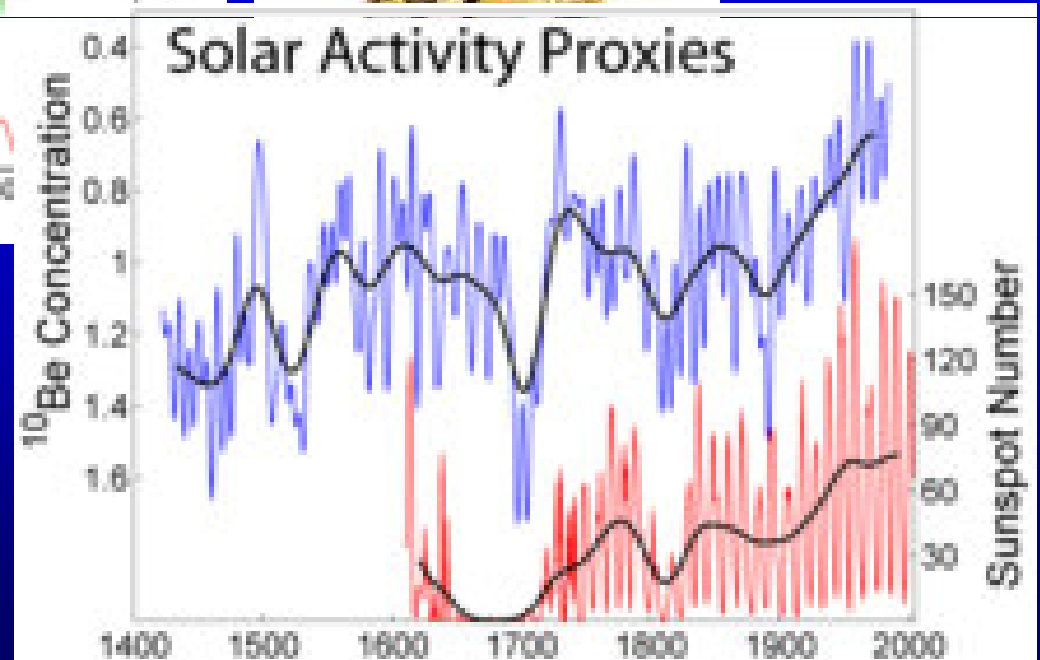
Solar energy: about 100 million billion watts

Total energy consumption on earth: about 15 million million watts (viz.  $1/10000^{\text{th}}$  the solar energy)

# Climate change: Natural causes



100,000 year periodicity corresponding to the Milankovitch cycles (variations in earth's orbit)



11 year cycle for sun spots



People are talking about *man-made climate change*

# PRESS TRUST OF INDIA

## Climate change clear and present danger: Ban

Share Print E-mail Comment



### The ultimate supergroup

Andy Gill tells the extraordinary story of The Traveling Wilburys INEXTRA

EXCLUSIVE  
BY STEVE CONNOR, SCIENCE EDITOR

The Earth today stands in imminent peril and nothing short of a planetary rescue will save it from the environmental cataclysm of dangerous climate change. Those are not the words



# THE HINDU

News » National

Published: February 25, 2010  
Updated: February 25, 2010 12:46 IST

**Per capita CO2 emissions to rise 3-fold by 2030**

PTI



# Man-made Global Warming – Is it real?

Will our Himalayan glaciers disappear by 2035???

**TIMESONLINE**

From The Times

February 4, 2010

## IPCC chief Rajendra Pachauri under pressure to go over glacier error



[guardian.co.uk](http://guardian.co.uk)

### Climate wars damage the scientists but we all stand to lose in the battle

It is open season on climate scientists, but such hand-wringing has allowed the creeping rehabilitation of climate scepticism



David Adam  
[guardian.co.uk](http://guardian.co.uk), Tuesday 23 February 2010 08.00 GMT

[A larger](#) | [smaller](#)

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### Rajendra Pachauri to defend handling of IPCC after climate change science row

Rajendra Pachauri, the embattled Chairman of the Intergovernmental Panel on Climate Change (IPCC), is to fly into this idyllic Indonesian island today in an attempt to end the crisis that has beset his organisation - and himself - over the past two months.

By Geoffrey Lean, in Bali  
Published: 3:52PM GMT 24 Feb 2010

He will try to regain the confidence of his ultimate bosses - the world's governments - after repeated calls for his resignation in the wake of the discovery of errors in its latest report.



eland in 2007. Climate change. Environment. Global warming.  
onnico/AP

# IPCC: What is this? How does it work?

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Rachel Pike's TED Talk  
[www.ted.com](http://www.ted.com)

# OK, so is man-made global warming real?

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Al Gore's 2008 TED Talk  
[www.ted.com](http://www.ted.com)  
(start at 5.05 min; end at 9 min)

James Balog's TED talk  
[www.ted.com](http://www.ted.com)  
(start at 3.53 min; end at 17.48 min)

Appear to be reasonably believable evidence that the current warming that we are seeing is caused, at least in part, by humans

How can we cool down the earth?

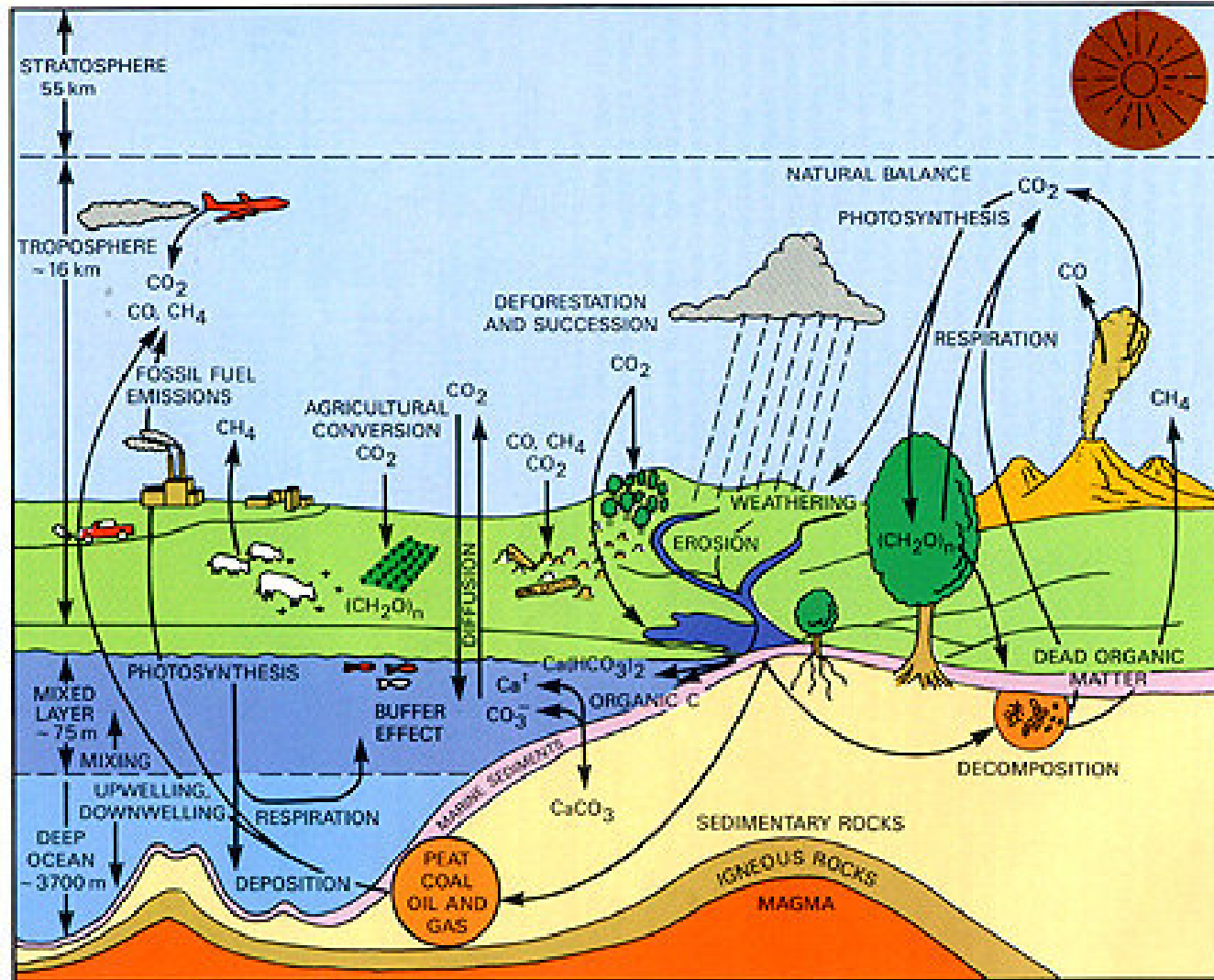
A Radical Idea – “Geoengineering”

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David Keith's TED Talk  
[www.ted.com](http://www.ted.com)

# The Carbon problem

rst.gsfc.nasa.gov/Sect16/Sect16\_4.html  
[http://en.wikipedia.org/wiki/Carbon\\_cycle](http://en.wikipedia.org/wiki/Carbon_cycle)



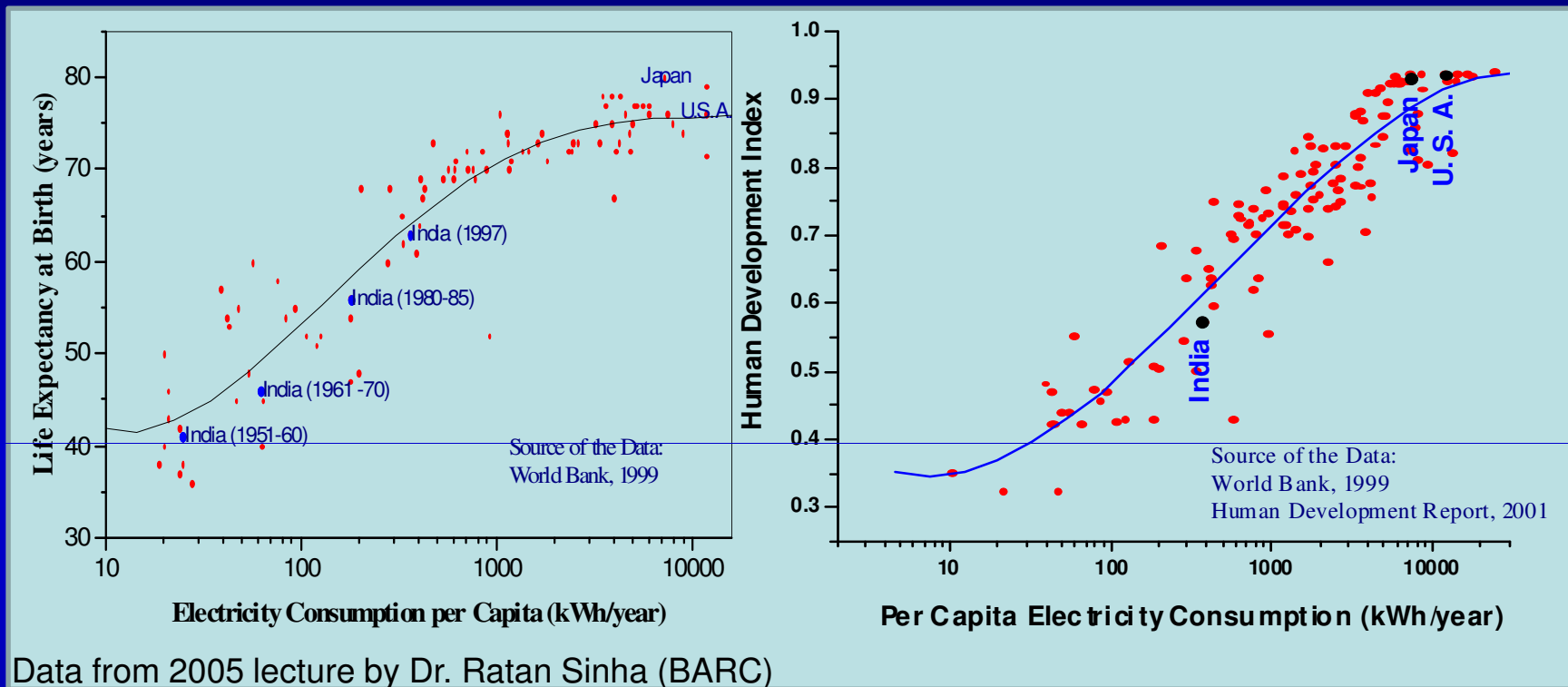
# The Carbon problem

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Al Gore's 2009 TED Talk  
[www.ted.com](http://www.ted.com)



# Energy and the Carbon problem



Data from 2005 lecture by Dr. Ratan Sinha (BARC)

With the economy growing, energy consumption WILL go up (a lot !)

Where will this come from?

Mix of coal, nuclear, and NON CONVENTIONAL (Renewable budget increased by 61% to 1000 crores; National Action Plan on Climate Change)


NCL – Large program on solar energy

# What is your Carbon Footprint? <http://calculator.carbonfootprint.com>

## Carbon Footprint Calculator

Language: English (United States) Why create an account?

Welcome **House** Flights Car Motorbike Bus & Rail Secondary Results



### Household carbon footprint calculator

Enter your consumption of each type of energy, and press the Calculate button

Your individual footprint is calculated by dividing the amount of energy by the number of people in your household.

To calculate your full household footprint, select "1".

How many people are in your household? 1

Electricity:  kWh

Natural gas:  kWh

Heating oil:  litres

Coal:  metric tons

LPG:  litres

Propane:  litres

Wooden pellets:  metric tons


**Calculate Household Footprint**

**Total House Footprint = 0.26 metric tons of CO<sub>2</sub>** **Offset Now**

**Carbon Footprint Calculator**

Language: English (United States) [Why create an account?](#)

Welcome House **Flights** Car Motorbike Bus & Rail Secondary Results

 **Flight carbon footprint calculator**  
You can enter details for up to 3 flight itineraries

Return trip  One-way flight

From: BOM: Mumbai Chhatrapati Shivaji, India

To: DEL: Delhi Indira Gandhi Intl, India

Via (optional):

Class: Economy class

Trips: 1

Click to include radiative forcing [what's this?](#)

**Calculate & Add To Footprint**

**Total Flights Footprint = 0.24 metric tons of CO<sub>2</sub>** [Offset Now](#)

0.24 metric tons: Economy class direct return flight from BOM to DEL [\[remove\]](#)


One return flight between Mumbai and Delhi

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  - Business Calculator
  - Home Calculator
  - Integration Tools
- CO<sub>2</sub> Reduction
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## Carbon Footprint Calculator

Language: English (United States) ▾ [Why create an account](#)

Welcome House Flights Car Motorbike Bus & Rail Secondary Results



### Public transport carbon footprint calculator

Enter mileage for each type of public transport, and press the Calculate button

Bus:	<input type="text"/>	<input type="text" value="km"/>	<input type="text" value="▾"/>
Coach:	<input type="text"/>	<input type="text" value="km"/>	<input type="text" value="▾"/>
Local or Commuter Train:	<input type="text"/>	<input type="text" value="km"/>	<input type="text" value="▾"/>
Long Distance Train:	<input type="text" value="3000"/>	<input type="text" value="km"/>	<input type="text" value="▾"/>
Tram:	<input type="text"/>	<input type="text" value="km"/>	<input type="text" value="▾"/>
Subway:	<input type="text"/>	<input type="text" value="km"/>	<input type="text" value="▾"/>
Taxi:	<input type="text"/>	<input type="text" value="km"/>	<input type="text" value="▾"/>

**Calculate Bus & Rail Footprint**

**Total Bus & Rail Footprint = 0.05 metric tons of CO<sub>2</sub>**
**Offset Now**

A return journey by train between Pune and Delhi

Carbon Footprint

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## Carbon Footprint Calculator

Language:

[Why create an account?](#)

Welcome

House

Flights

**Car**

Motorbike

Bus & Rail

Secondary

Results



### Car carbon footprint calculator

You can enter details for up to 2 cars

Mileage:

Choose vehicle:

Or enter efficiency:

**Total Car Footprint = 0.20 metric tons of CO<sub>2</sub>**



Carbon Footprint

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## Carbon Footprint Calculator

Language:

[Why create an account?](#)

Welcome

House

Flights

Car

Motorbike

Bus & Rail

Secondary

Results



### Motorbike carbon footprint calculator

You can enter details for up to 2 motorbikes

Mileage:

Or enter efficiency:   [reset](#)

[Calculate & Add To Footprint](#)

**Total Motorbike Footprint = 0.06 metric tons of CO<sub>2</sub>** [Offset Now](#)

0.06 metric tons: 600 km on a small motorbike/moped/scooter up to 125cc [\[remove\]](#)



Secondary carbon footprint comes to 0.42 MT/month

Eating red meat instead of being vegetarian increases the footprint by ~16%

Owning 2 cars instead of 1 increases the footprint by about 16%

Remember: Also need to count cost of manufacture, transport of product to you

The image shows a screenshot of a web-based carbon footprint calculator. It features a list of categories with dropdown menus for selection. The categories and their selected options are:

- Food preferences:** I am a vegetarian
- Organic produce:** I never buy or grow organic food, or don't know what we buy
- In season food:** I try to buy or grow some in season food
- Imported food and goods:** I prefer to buy goods produced closer to home
- Fashion:** I buy new clothes when I need them
- Packaging:** I only buy things which are nicely packaged
- Furniture and electricals:** I mostly buy new but generally keep things for more than 5 years
- Recycling:** Some of my waste is recycled
- Recreation:** I occasionally go out to places like the movies, bars or restaurants
- Car manufacture:** I own one car
- Finance and other services:** I use the standard range of financial services

At the bottom of the form, there is a green button labeled "Estimate Secondary Footprint". Below this, a summary box displays "Total Secondary Footprint = 5.52 metric tons of CO<sub>2</sub>" followed by a green button labeled "Offset Now".

## Carbon Footprints: Some numbers

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**India average: 1.2 MT/year/person**

**China: 3.84 MT/year/person**

**Germany: 9.8 MT/year/person**

**USA: 20.8 MT/year/person**

**Bangladesh: 0.25 MT/year/person**

**Based on our calculation: 8.22 MT/year >> National  
(assuming 3 flights/year) average**

## What we talked about today

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### Climate

Man made climate change, IPCC

Global warming – Geoengineering

The carbon problem and carbon footprints  
and we watched several TED videos

A few of the resources available on the web:

[http://pmindia.nic.in/climate\\_change.htm](http://pmindia.nic.in/climate_change.htm)

<http://www.ipcc.ch>

<http://www.epa.gov/climatechange/>

[http://en.wikipedia.org/wiki/climate\\_change](http://en.wikipedia.org/wiki/climate_change)

<http://www.climatecrisis.net>

“Will Jellyfish rule the world”; Hickman, L.; Puffin, India  
2009

Thank you