

My pilgrimage in Data Analysis

我在數據分析的天路歷程

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我的生平

– 1937/12/13 生於武漢（南京大屠殺那天）

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- Enter Taida to study Civil Engineering

My Mindset

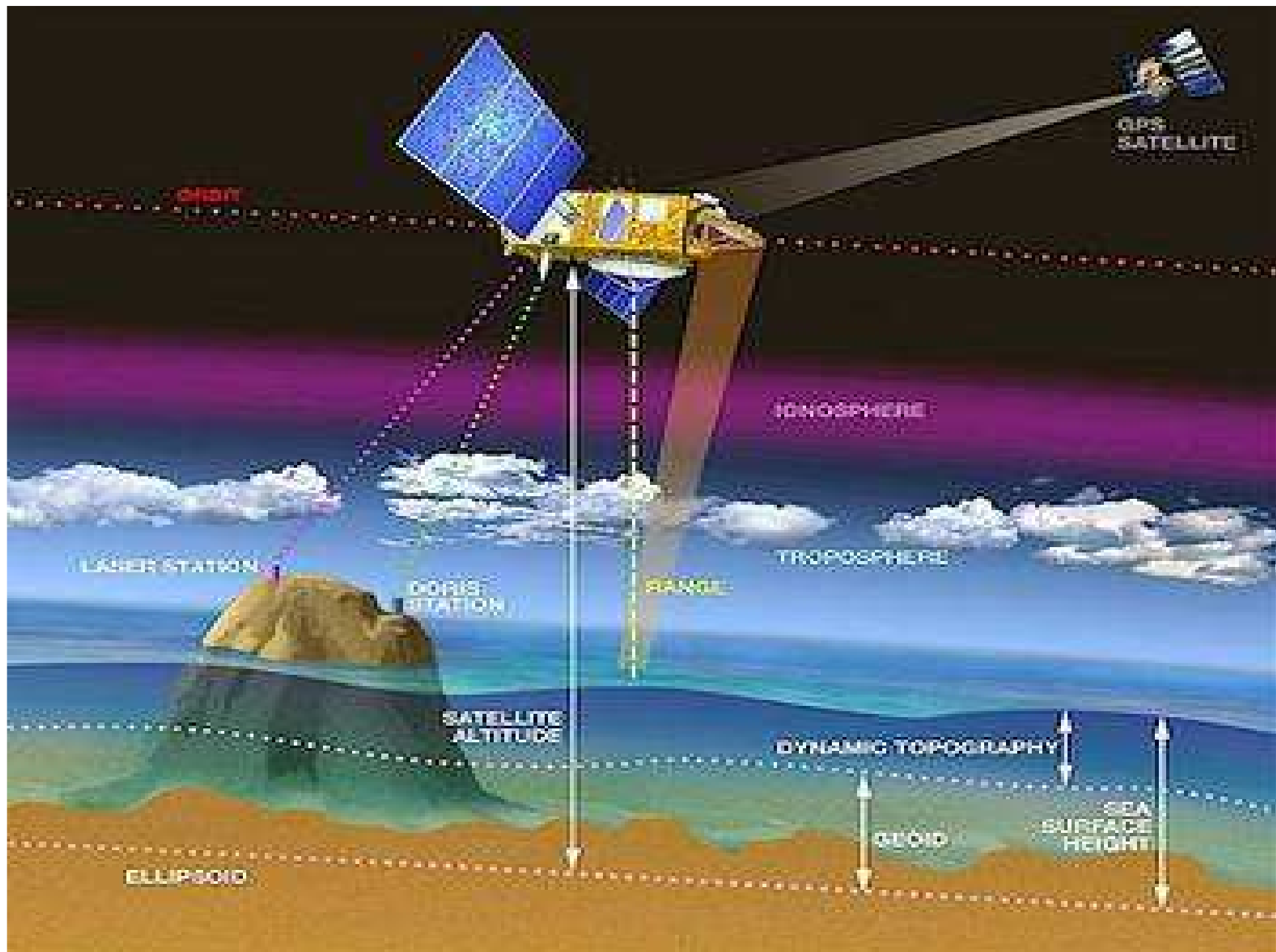
- Yes, I was very happy then, for that was my cherished life time goal (up till then): be a civil engineer to build railroad all over China and make my country rich.
- But my career follows a tortuous road.

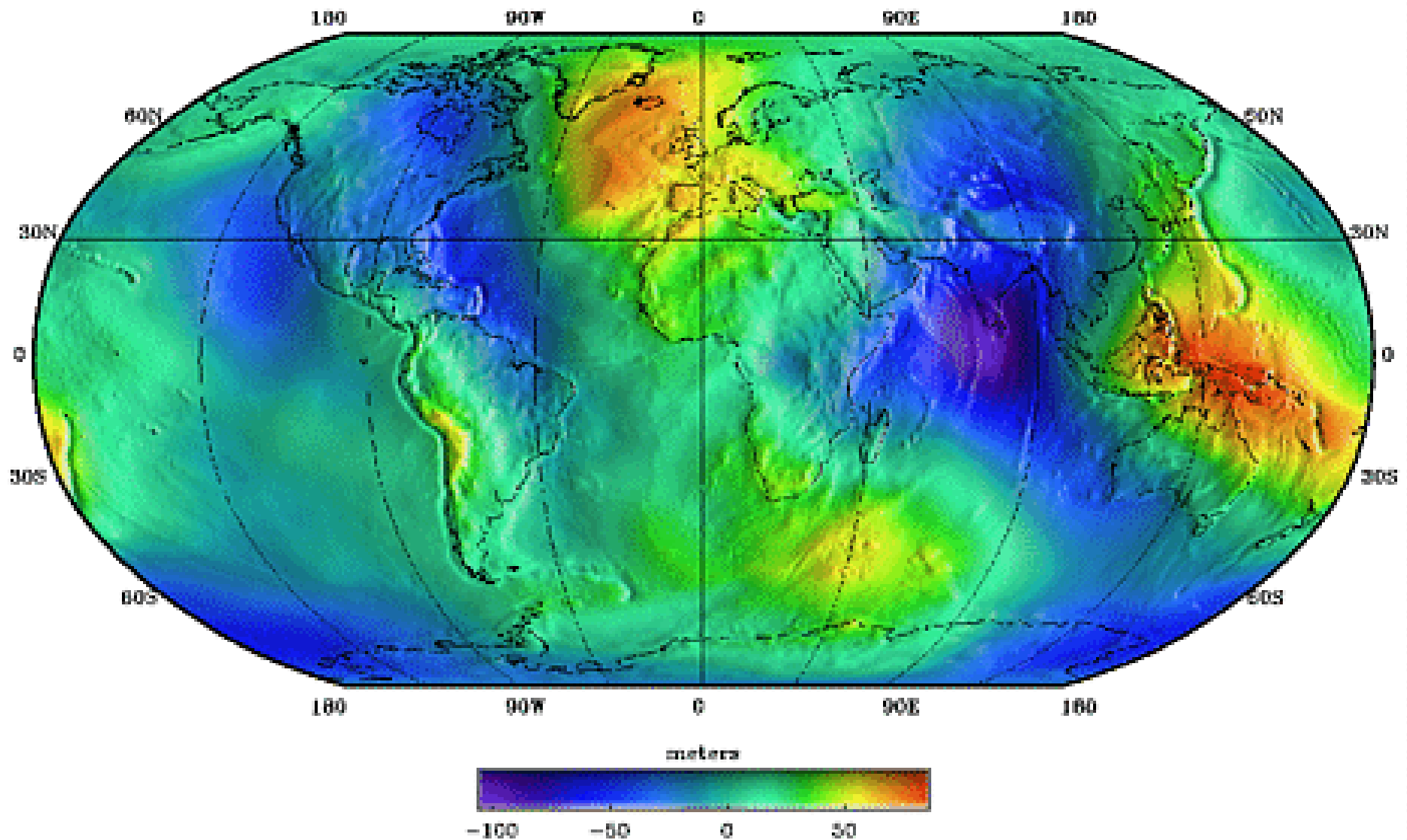
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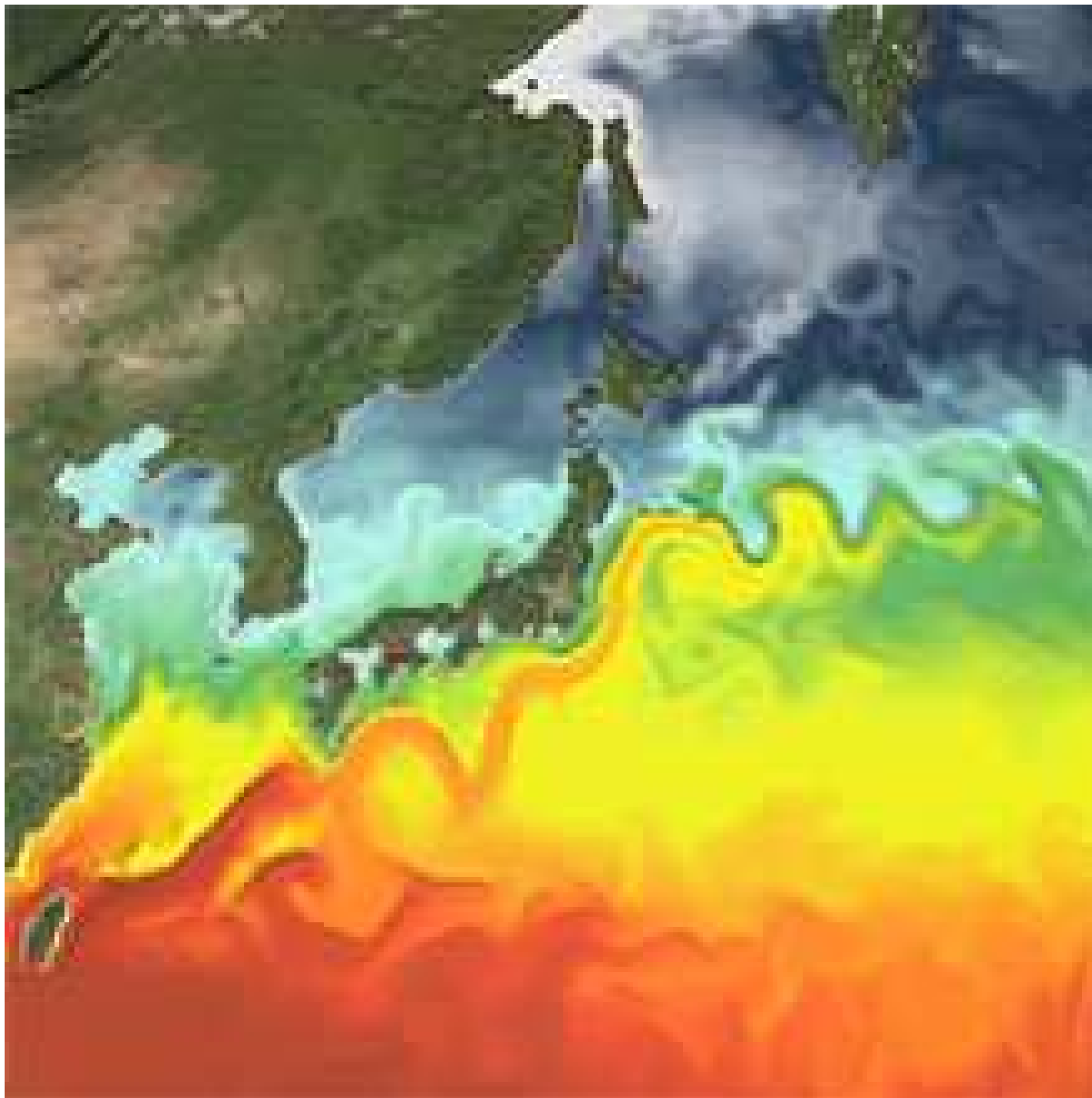
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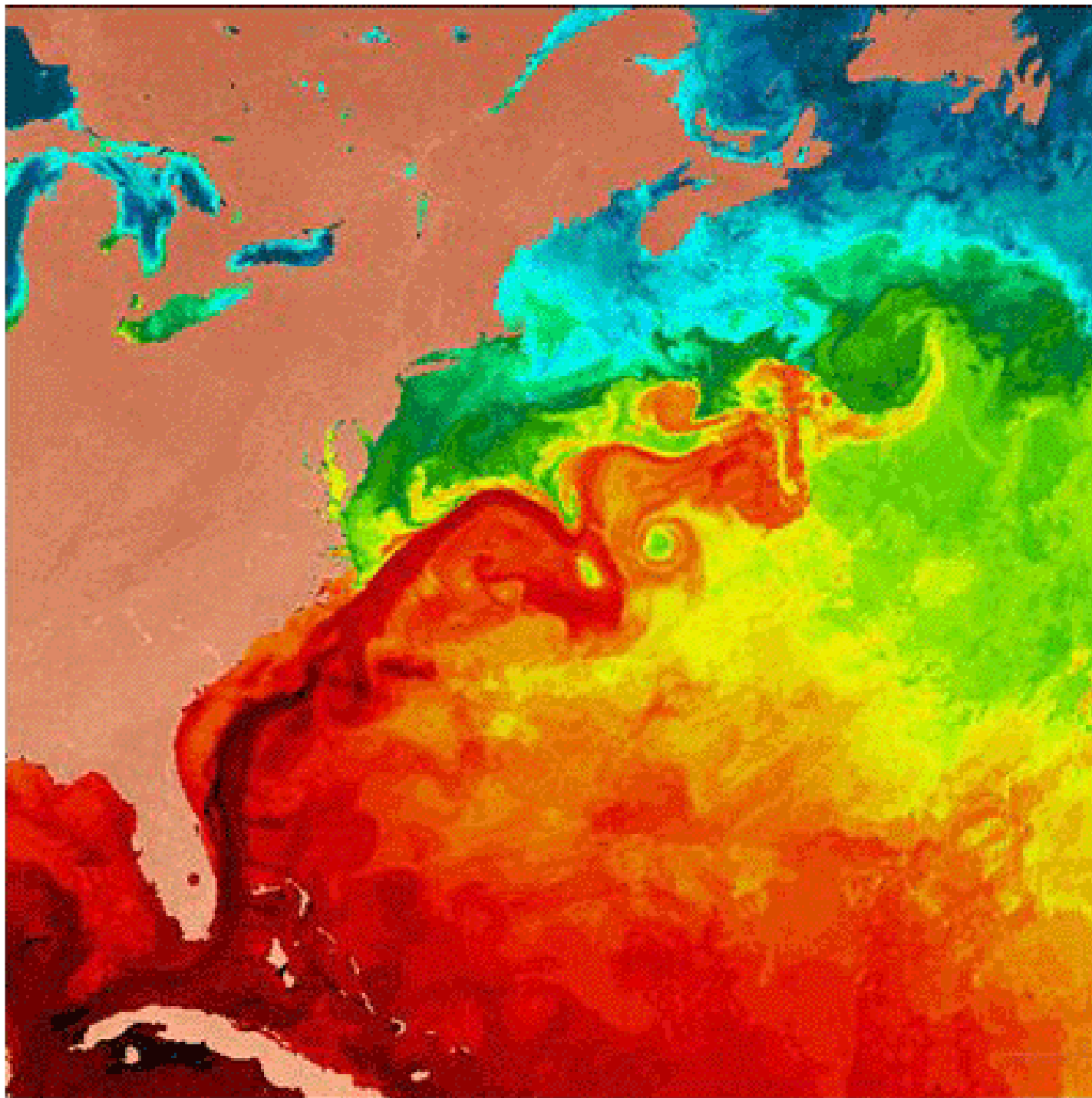


ECGM96 Geoid (30'x30'): the equi-potential surface

IR Image



IR Image



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– 從流力到海洋

– 從海洋到數據分析

Observations

- On average, people change jobs every 5 years in the United States, mostly not on the subjects of their choices.
- Any one should be prepared to face something new: **life time learning**.
- Thus, it is crucial to be **an educated person**.

An educated person (Harvard)

- An **educated person** should have a deep understanding of themselves and how they fit into the world, and have “soft skills” – **complex problem-solving, creativity, entrepreneurship, the ability to manage themselves, and the ability to be lifelong learners.**

(An educated person should be knowledgeable, wise, creative, empathetic, engaged.)

Data Analysis

Data are the our only connection
to the reality.

We are **drowning in data**,
But **still thirsty of knowledge**.

Henri Poincaré

Science is built up of facts*,
as a house is built of stones;
but an accumulation of facts is no more a science
than a heap of stones is a house.

* **Unexamined facts (data) are useless!**

Data Processing and Data Analysis

- **Processing** [proces < L. Processus < pp of Procedere = Proceed: *pro-* forward + *cedere*, to go] : A particular method of doing something.
- **Data Processing >>>> Mathematically meaningful parameters**
- **Analysis** [Gr. *ana*, up, throughout + *lysis*, a loosing] : A separating of any whole into its parts, especially with an examination of the parts to find out their nature, proportion, function, interrelationship etc.
- **Data Analysis >>>> Physical understandings**

My contribution in data analysis is meager.

I only asked some simple questions:

What is frequency?

What is trend?

And find the answer through **EMD**.

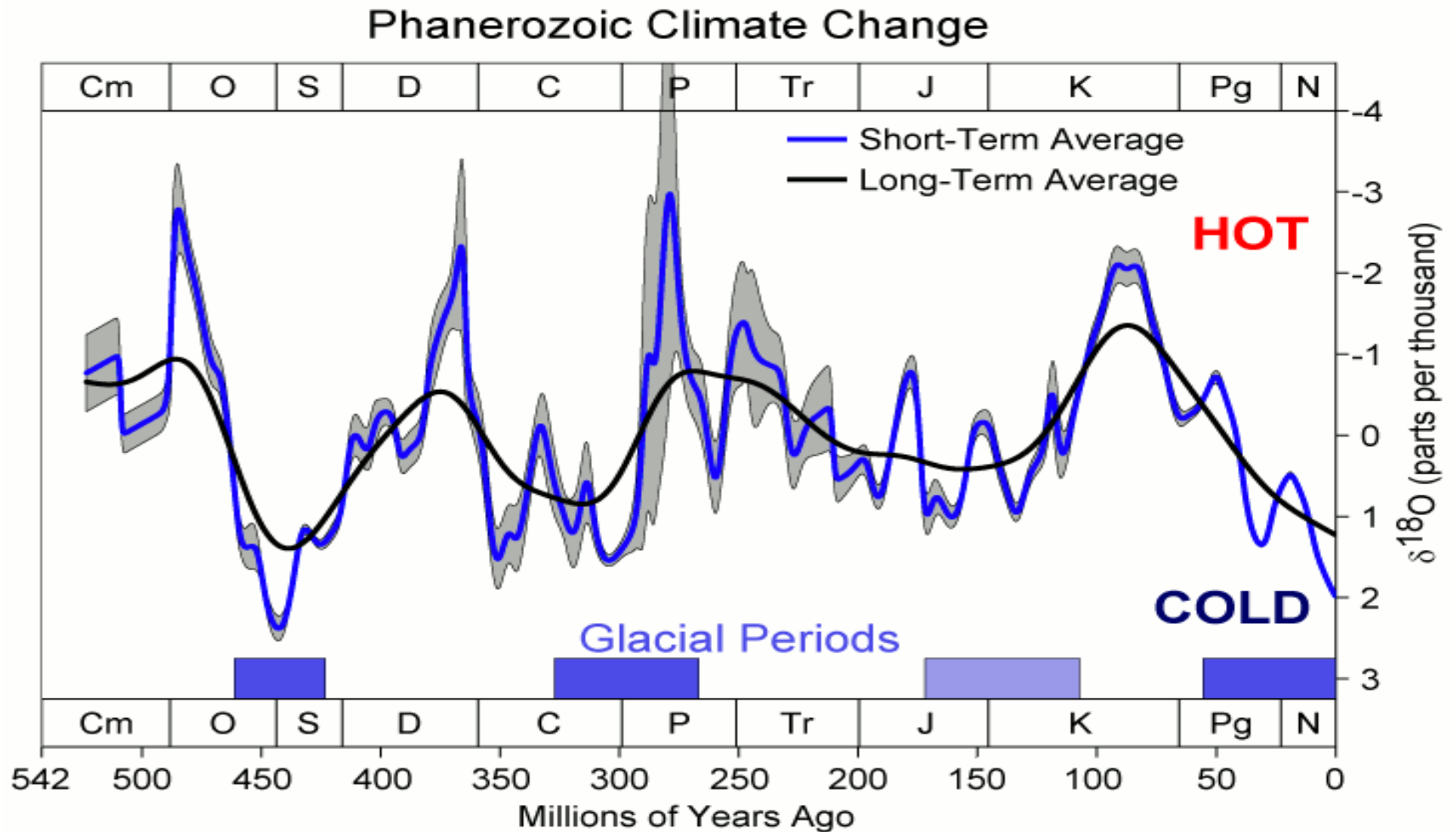
Let us examine the climate problem

Global Warming

I am not a climatologist;
let us use existing **data** to examine
Climate Change and let data tell their
own story.

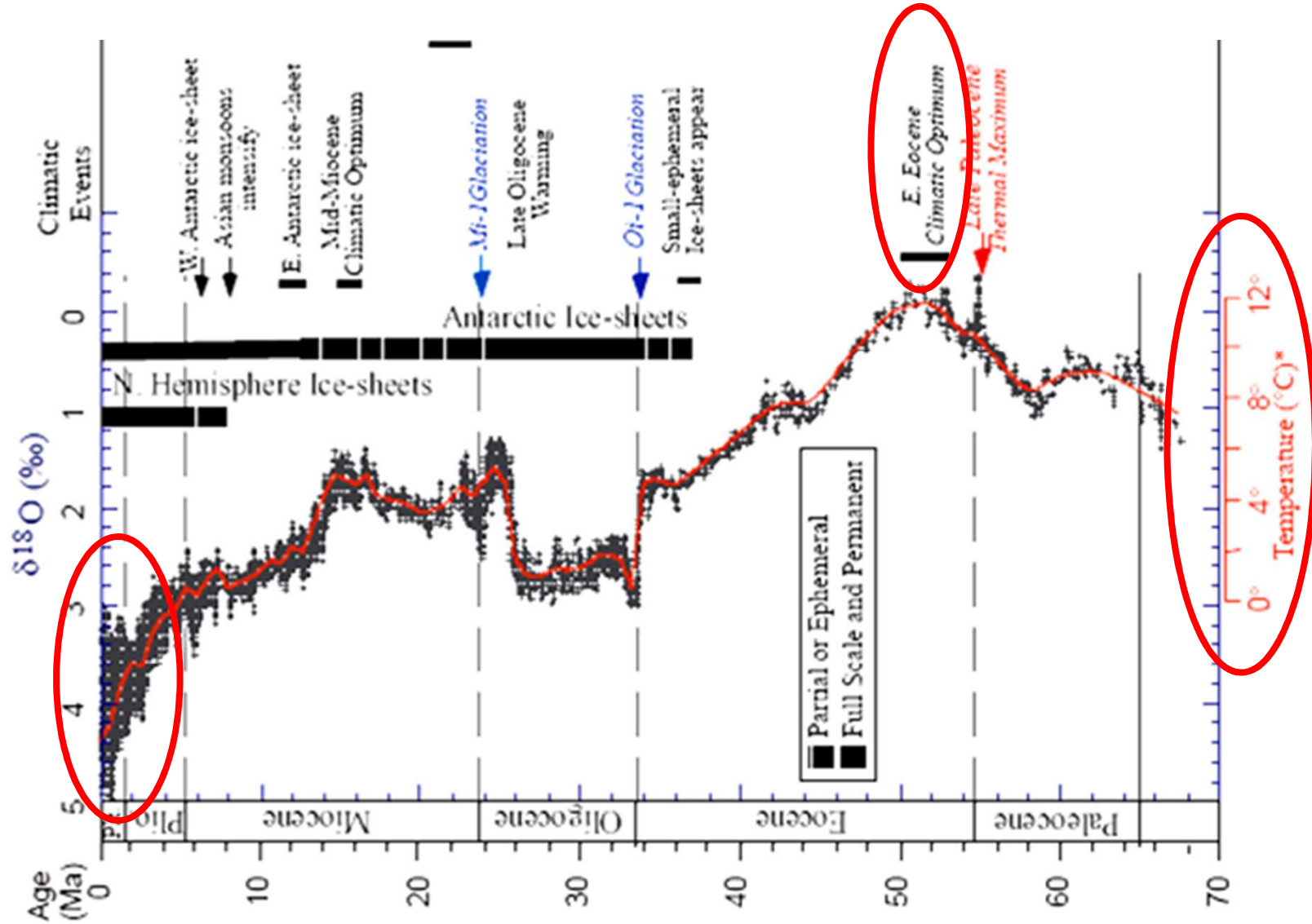
$\pm 2^{\circ} \text{C}$

The Longest Temperature Proxy



Oxygen and Carbon records

Deep sea foraminifera isotope records : [Zachos et al., 2001](#) , [Science](#)

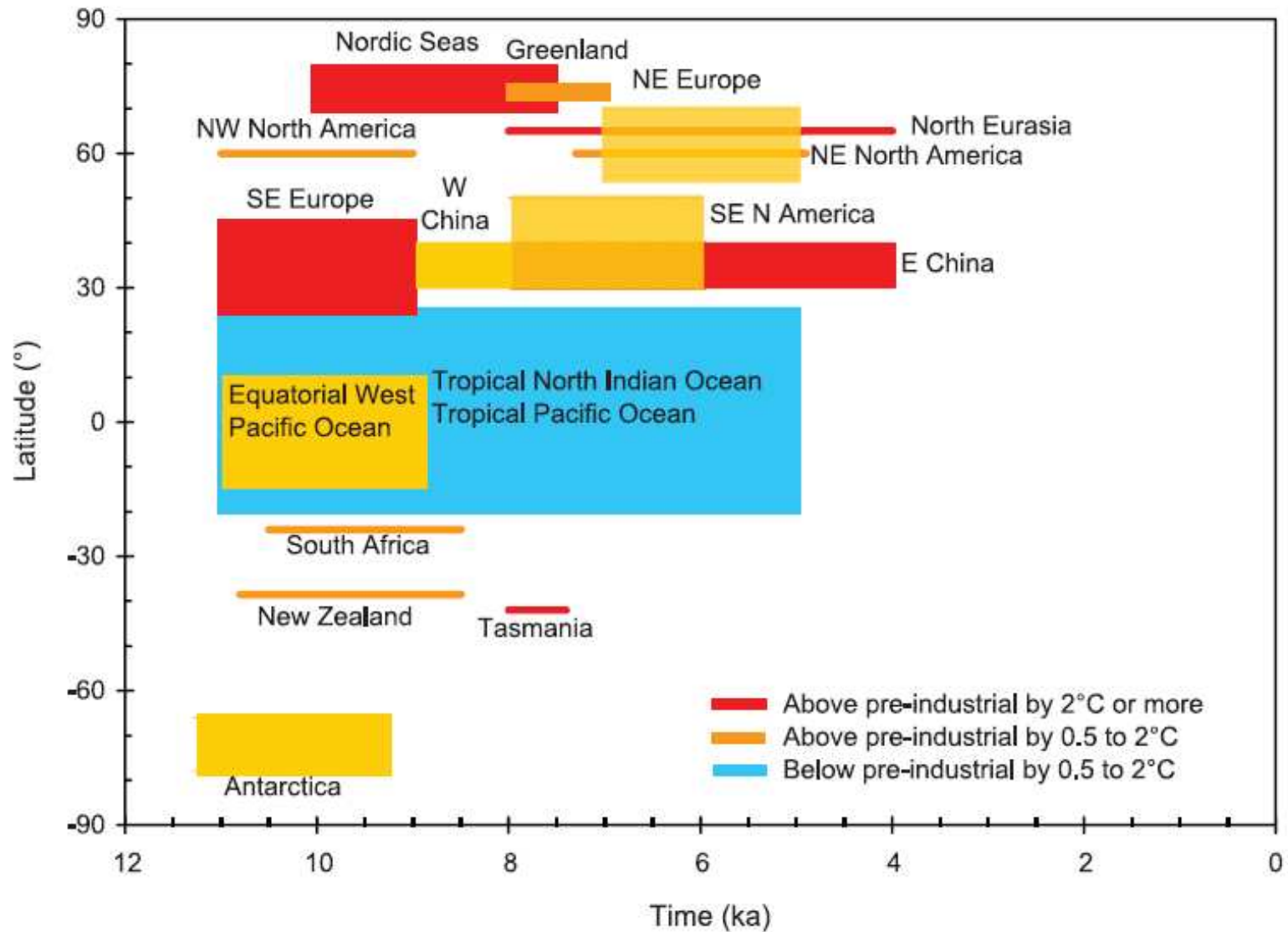


10³ Years

Written history time scale

No instrument, but there are documented evidence.

AR4 : Regional Temperature Changes



Oracle Bone Carvings : 1384-1112 BC

象

象

以象侑祀乙

獲象

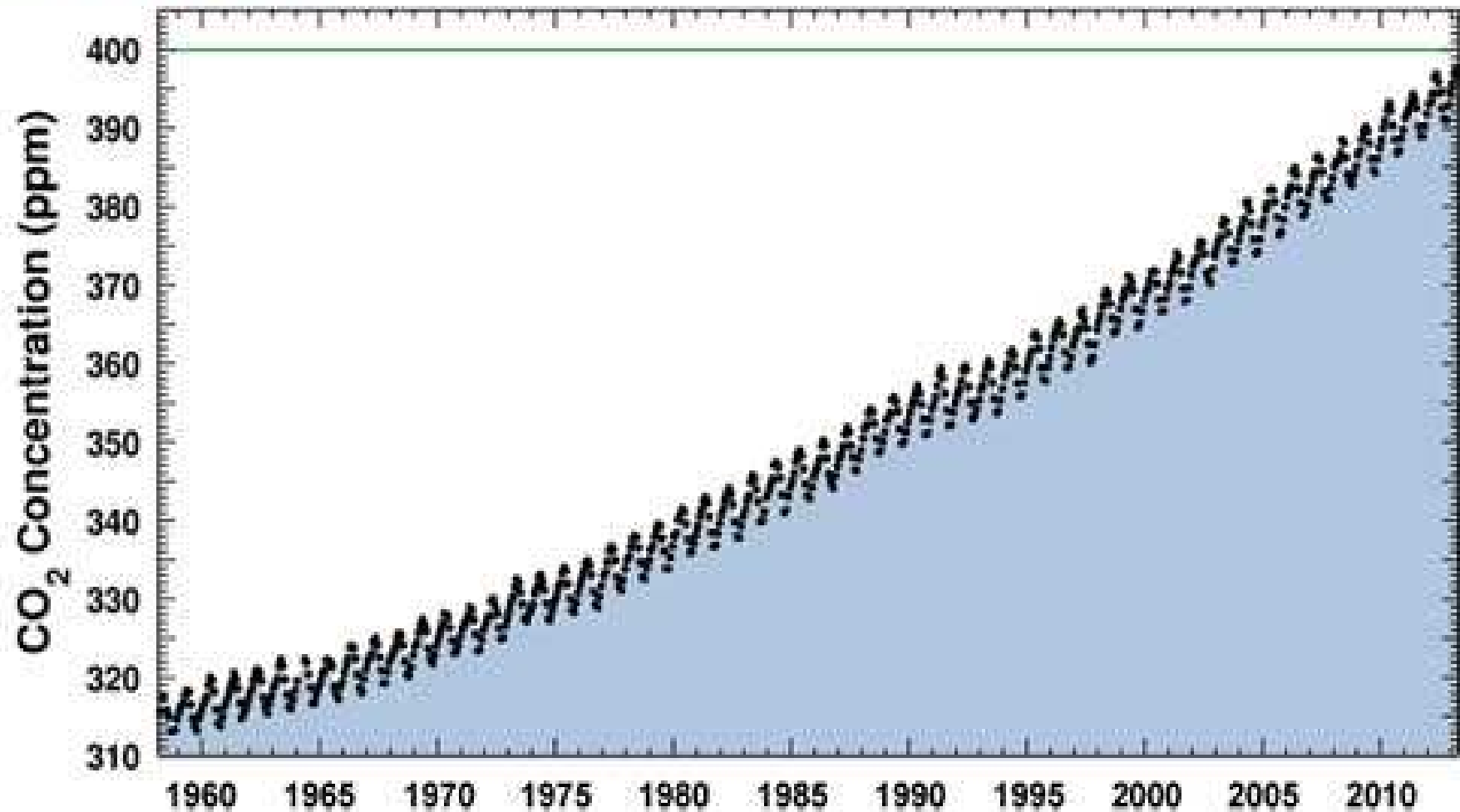
10² Years

Our life time scale

Instrument measured data,
The base of IPCC AAR4 report

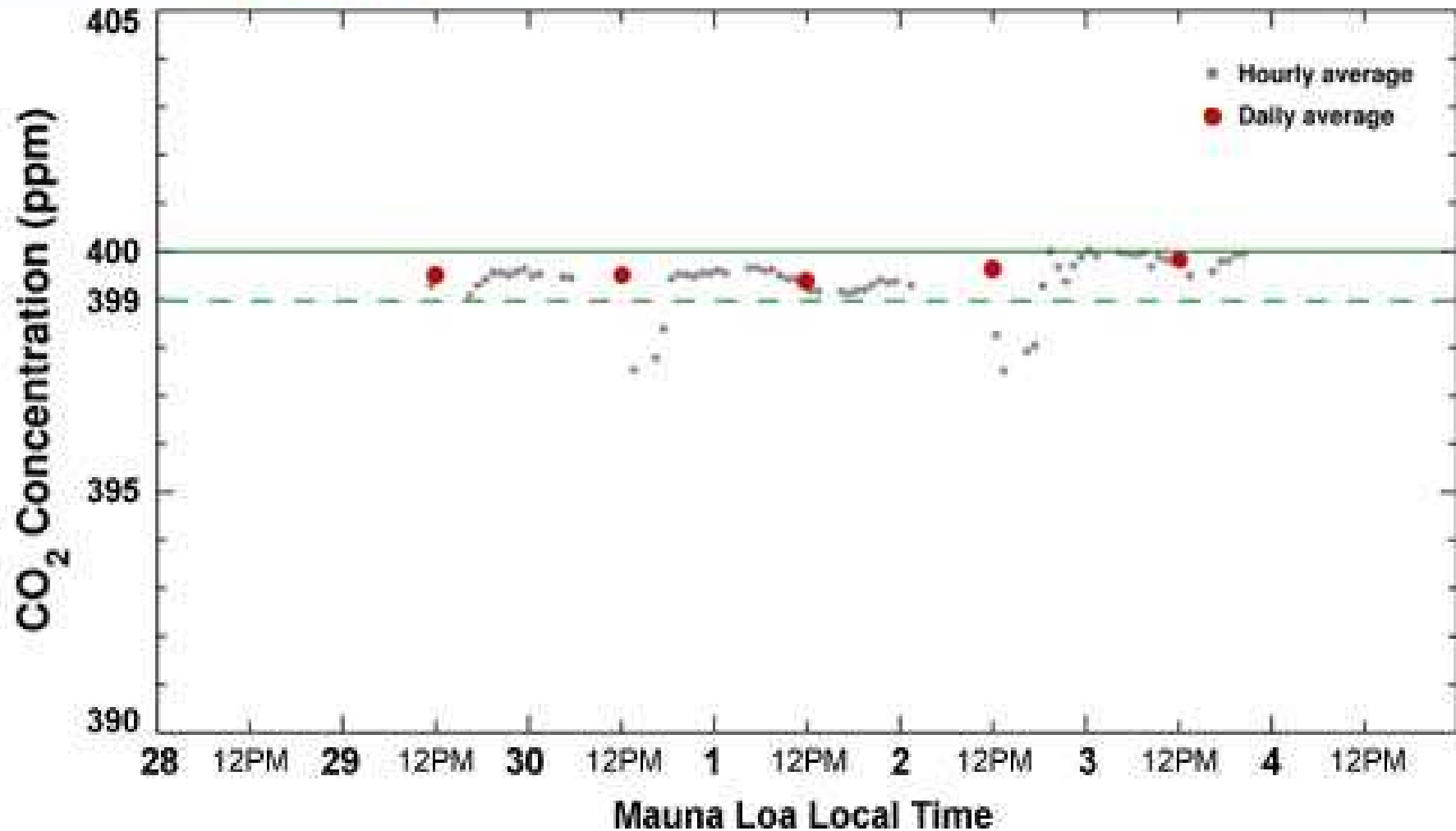
The Keeling Curve

Atmospheric CO₂ Concentration: Mauna Loa Observatory
1958 to Present



Big News

Atmospheric CO₂ Concentration: Mauna Loa Observatory
Week Ending May 4, 2013



Non-News!

Economist March 30, 2013

Falling off the scale

1

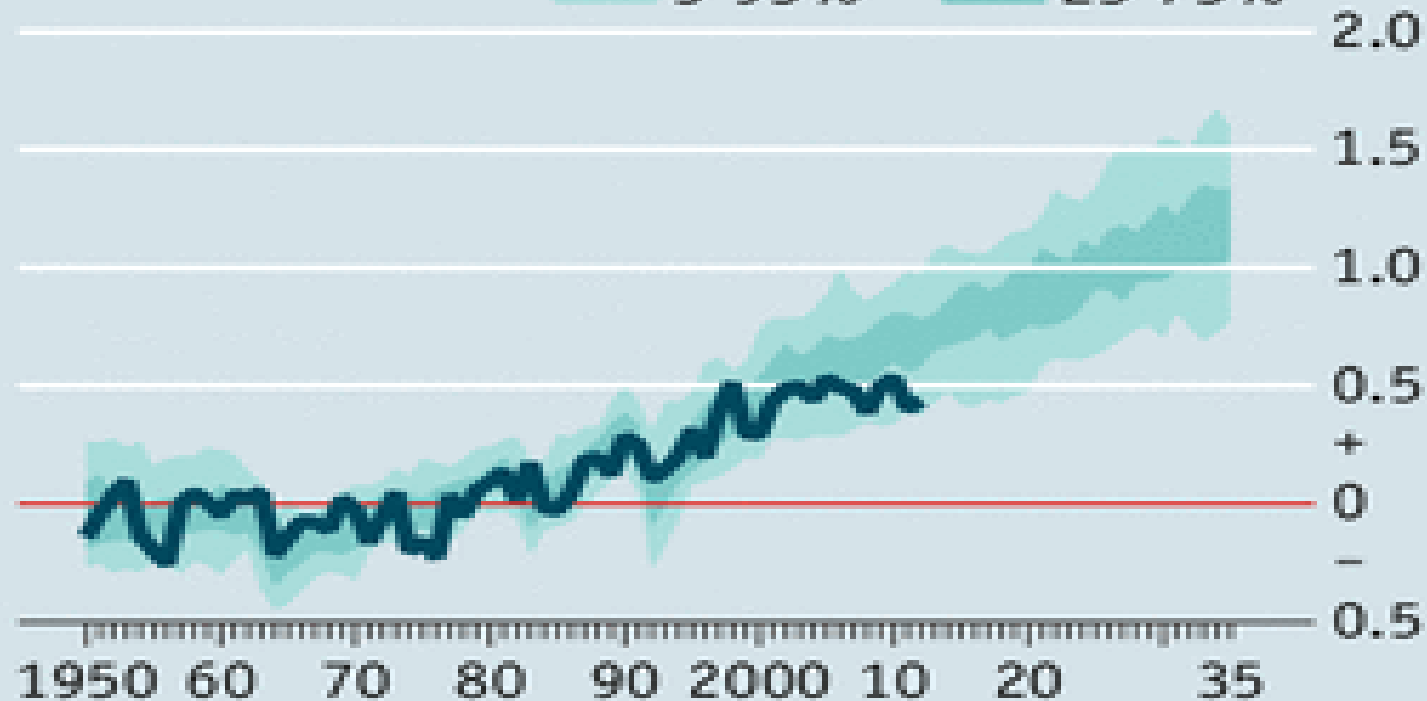
Change in global mean temperature, °C

— Actual

Computer models

5-95%*

25-75%*

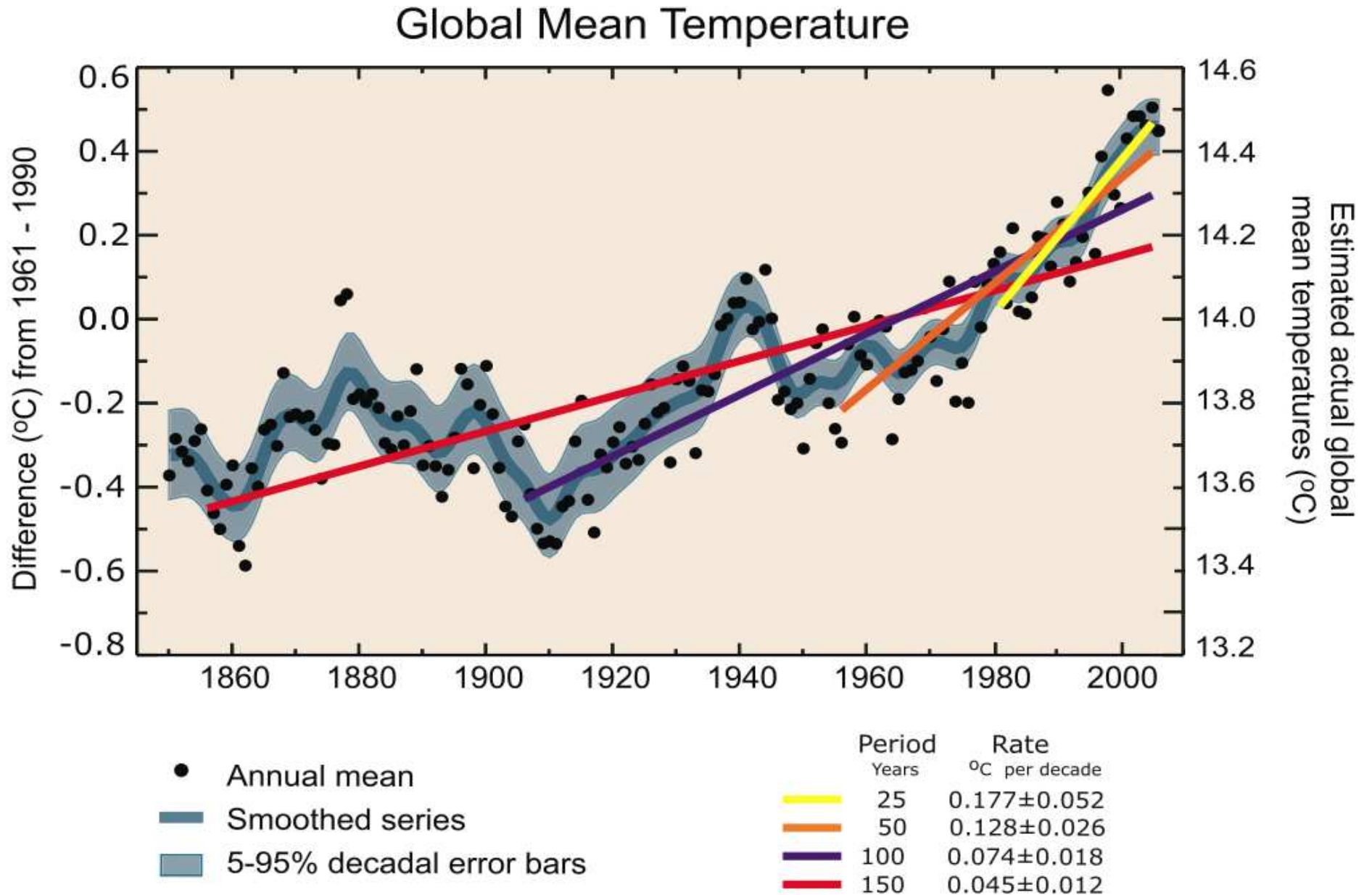


Source: Ed Hawkins, University of Reading; CMIP5 model dataset

*Confidence interval

The mainstream scientific truth

IPCC Global Mean Temperature Trend



*“Note that for shorter recent periods,
the slope is greater, indicating
accelerated warming.”*

IPCC 4th Assessment Report 2007

What will the Data tell us?

Not impose our subjective view!

What is a trend? How to define it?

How to define a trend?

The State-of-the arts: **Trend**

“One economist’s trend is another economist’s cycle”

Engle, R. F. and Granger, C. W. J. 1991 *Long-run Economic Relationships*.
Cambridge University Press.

Philosophical Problem Anticipated

名不正則言不順

言不順則事不成

——孔夫子

Definition of the Trend

Huang et al, *Proc. Roy. Soc. Lond.*, 1998

Wu et al, *PNAS*, 2007

Within the given data span, the trend is an intrinsically fitted monotonic function, or a function in which there can be at most one extremum.

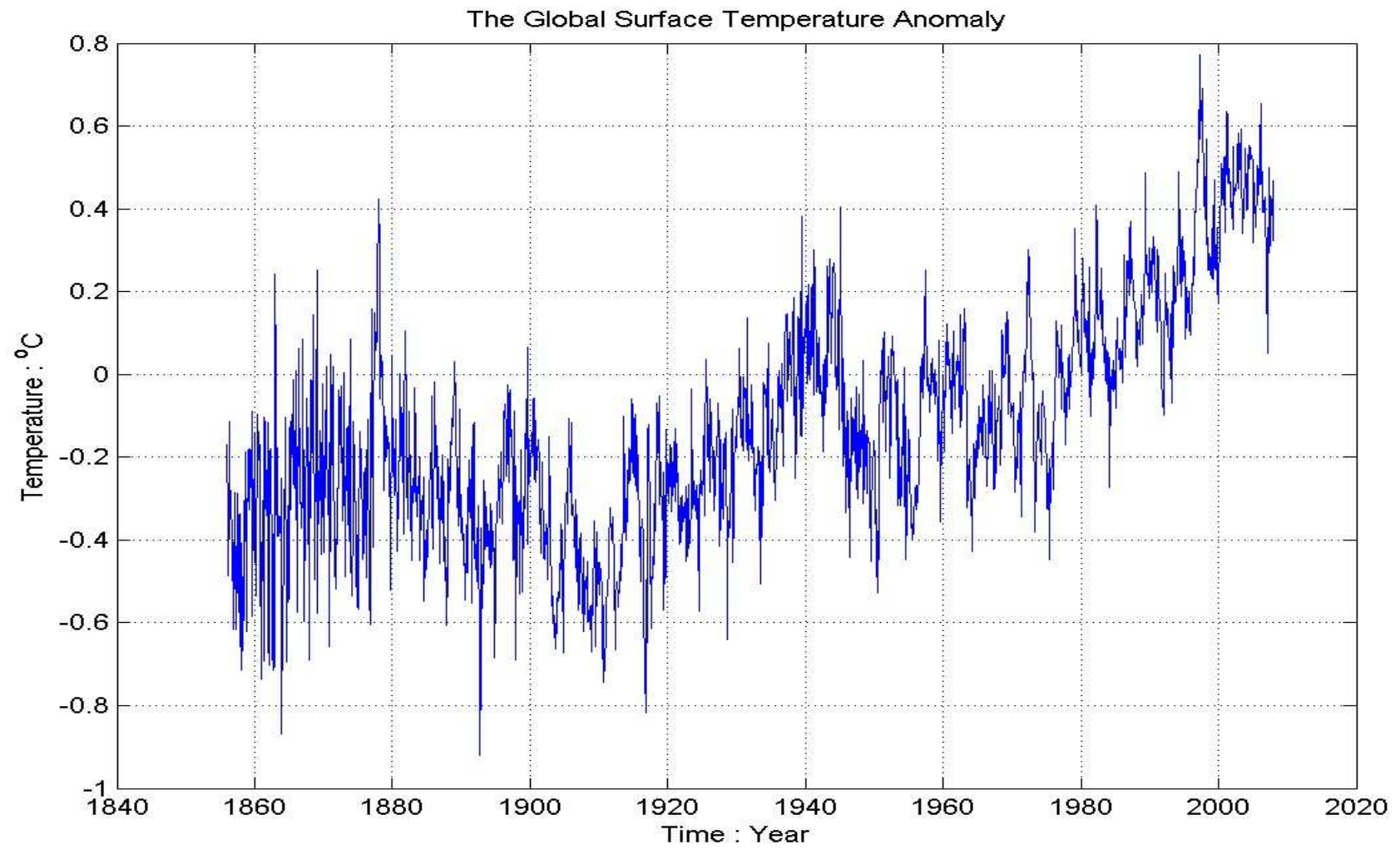
The trend should be an **intrinsic** and **local** property of the data; it is determined by the same mechanisms that generate the data.

Being local, it has to associate with a **local length scale**, and be valid only within that length span, and be part of a full wave length.

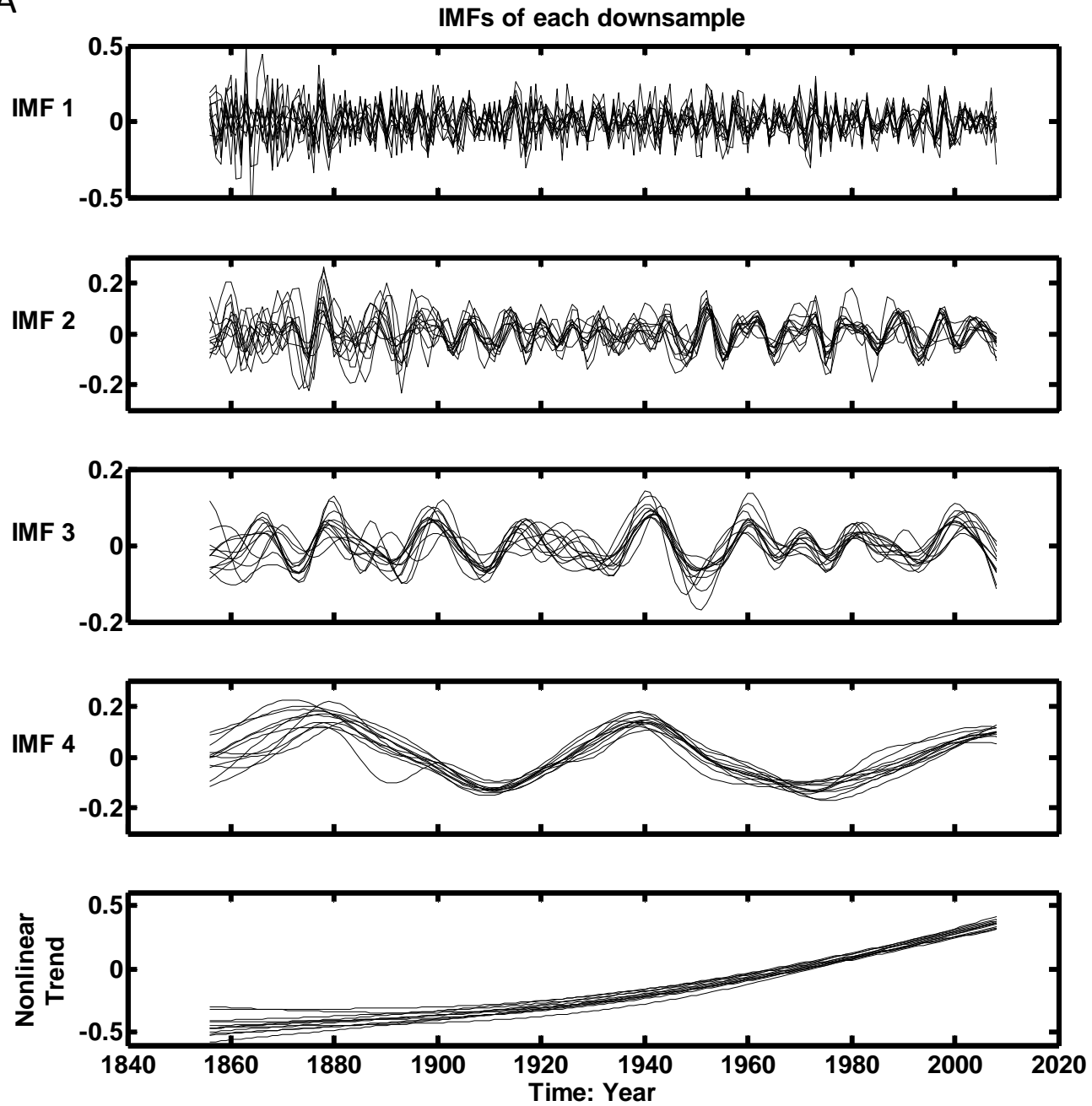
The method determining the trend should be **intrinsic**. Being intrinsic, the method for defining the trend has to be **adaptive**.

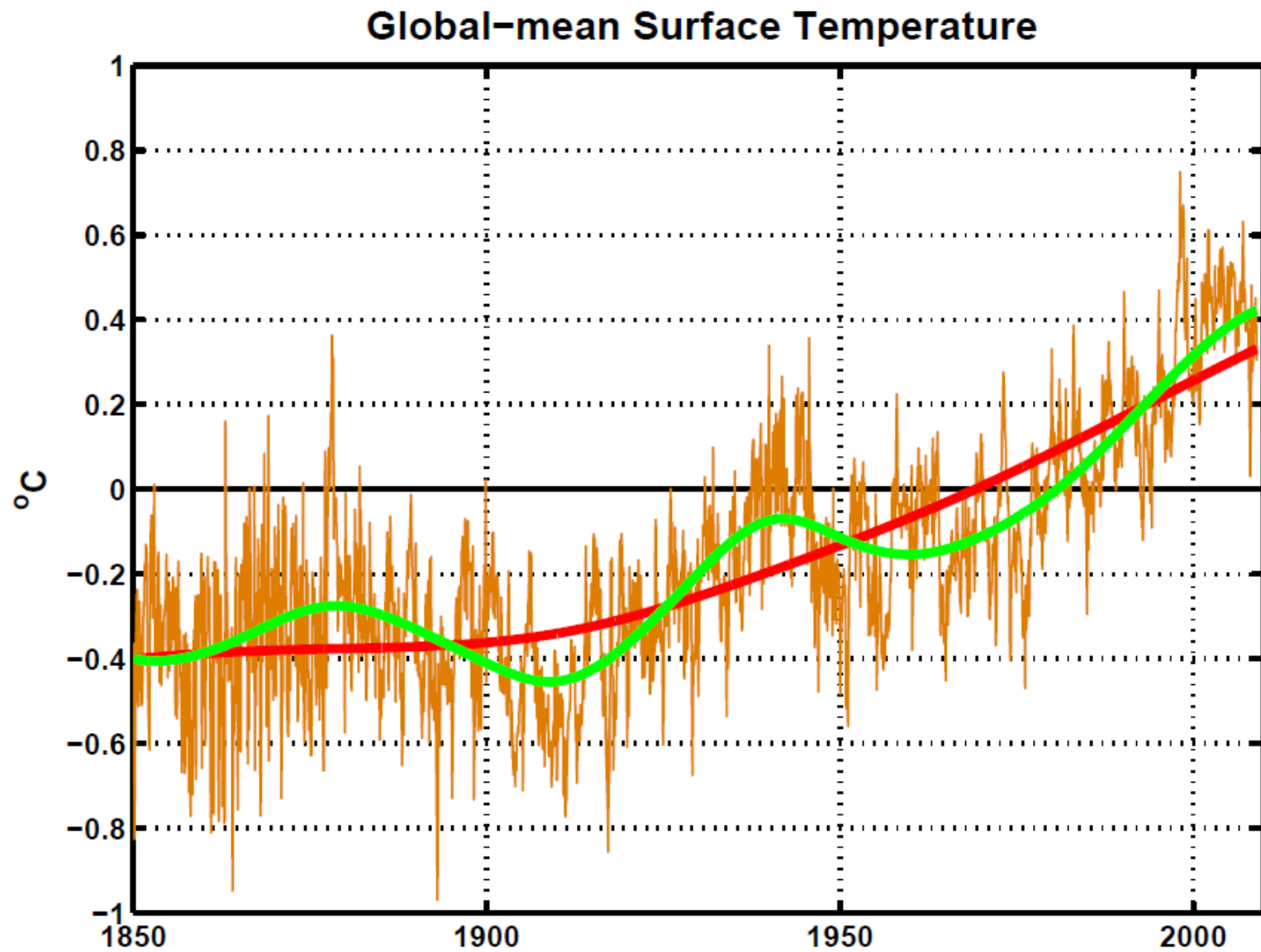
All traditional trend determination methods are **extrinsic**.

GSTA



IMFs of GSTA



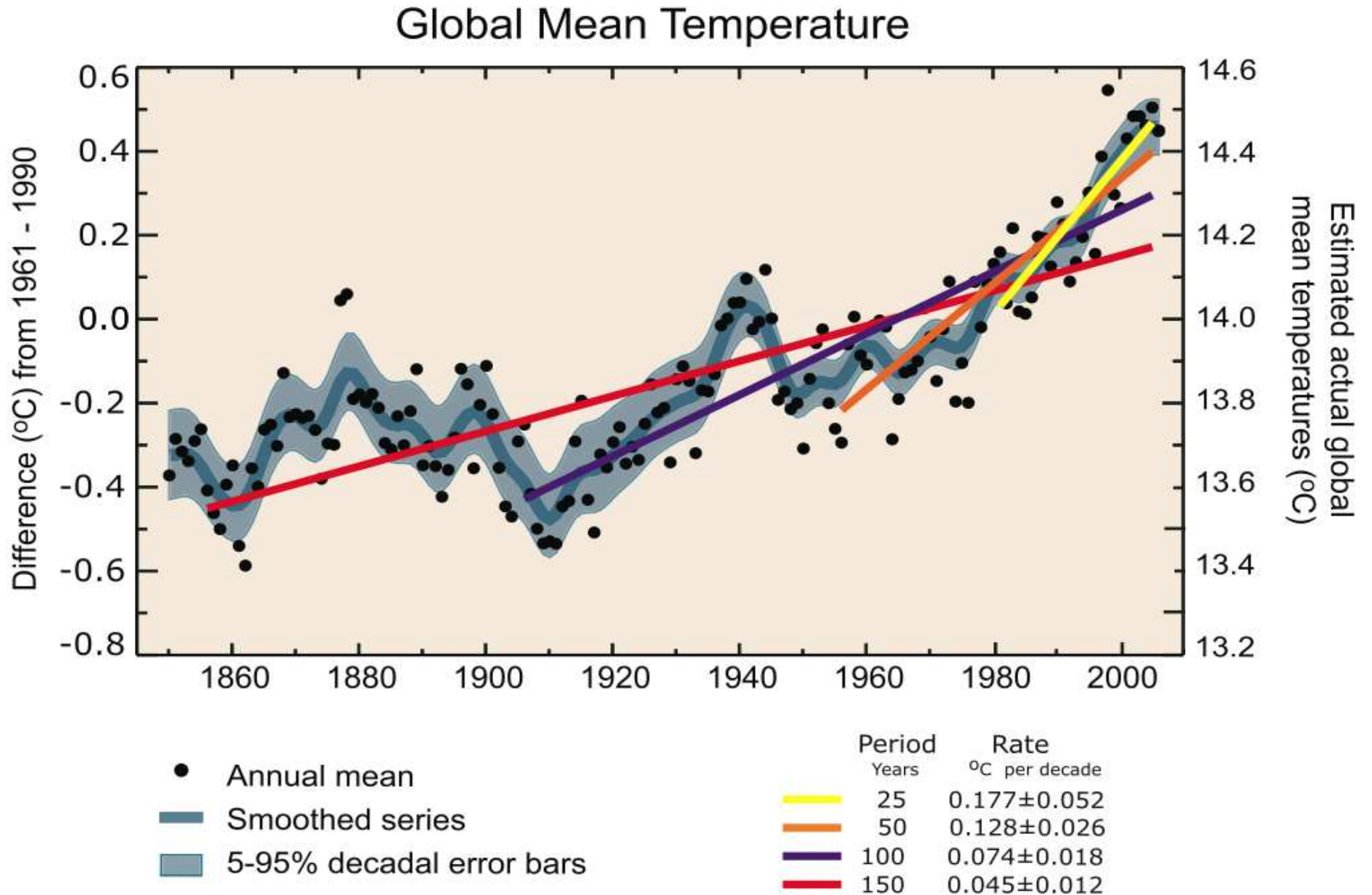


Wu, Huang, Wallace, Smoliak and Chen (2011): Trend + 65-year AMO mode

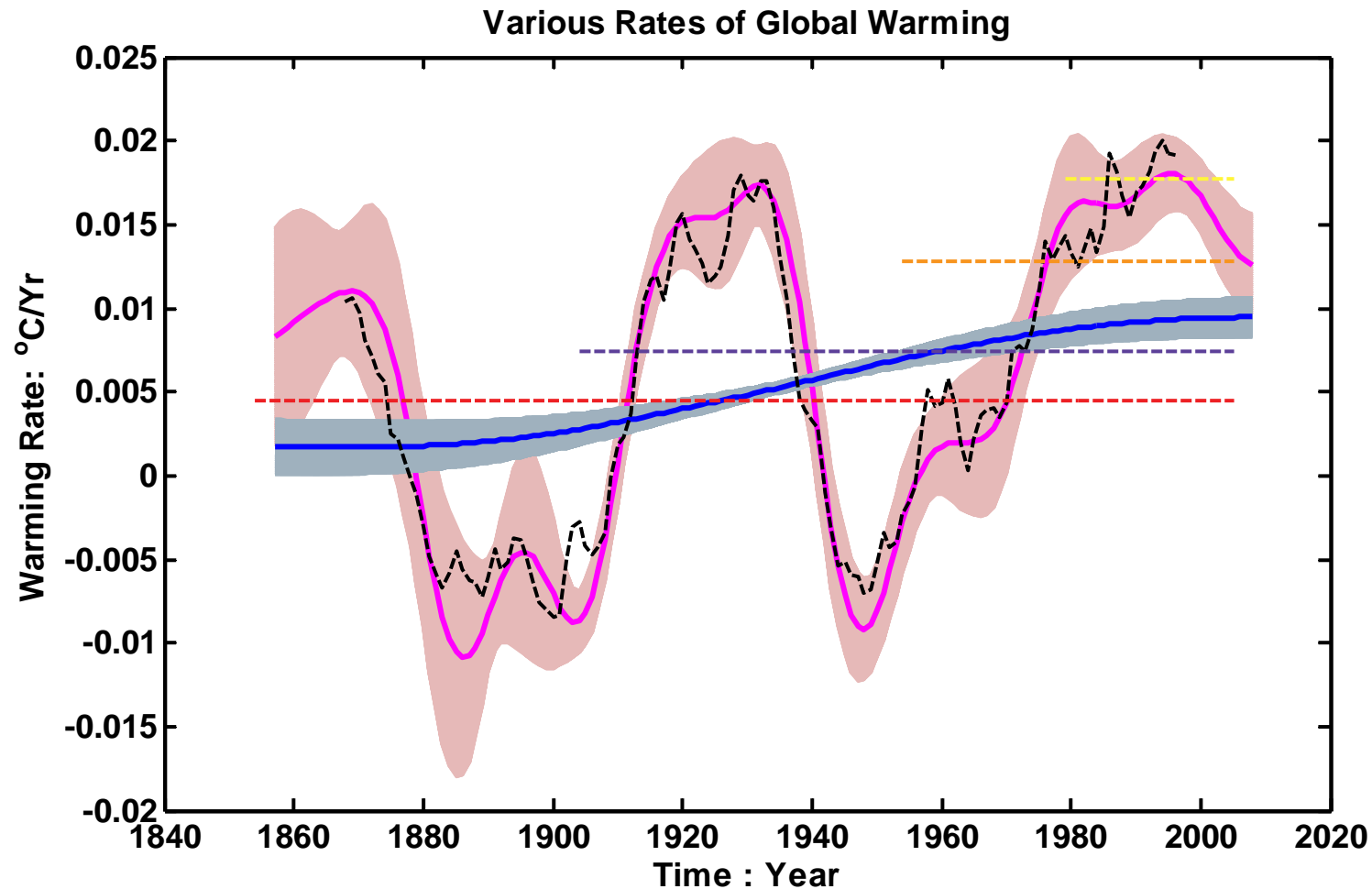
The Warming Trend

The true trend with all the cycles removed

IPCC Global Mean Temperature Trend



Comparison between non-linear rate with multi-rate of IPCC



Blue shadow and blue line are the warming rate of non-linear trend.

Magenta shadow and magenta line are the rate of combination of non-linear trend and AMO-like components.

Dashed lines are IPCC rates.

The rate of warming ($^{\circ}\text{C}/\text{decade}$) over different temporal span.

	Last 150 years	Last 100 years	Last 50 years	Last 25 years
AR4	0.04	0.07	0.13	0.18
ST and MDV	0.05	0.09	0.12	0.15
ST	0.05	0.07	0.08	0.08

So far, we can conclude the following:

The Earth has experienced high natural temperature.
The Earth is warming relentlessly, though not as fast.

‘Climate change’ will create hazards, of course;
Should the hazards become disasters?

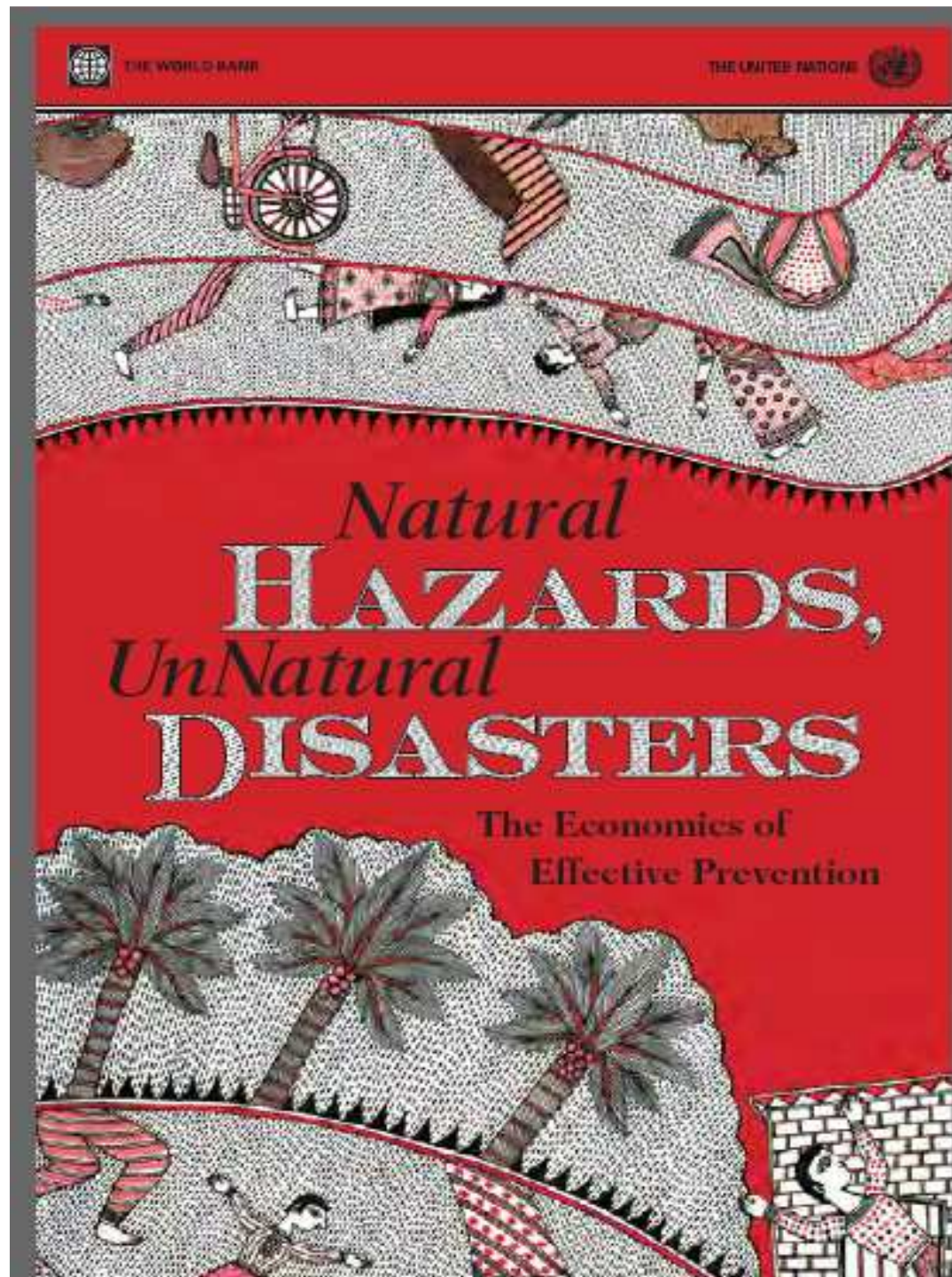
Let us look at the future.

The Future

How to face the consequences
and avoid the unNatural disasters

Our Choices

- Reduction of carbon consumption
- Geoengineering and
- Sustainable Development coupled with prevention, mitigation relief and adaptation.



United Nations
& World Bank
2010

Recommended by 6
Nobel Economics
Laureates.

“Earthquakes, droughts, floods, and storms are *natural hazards*, but the *unnatural disasters* are deaths and damages that result from human acts of omission or commission.”

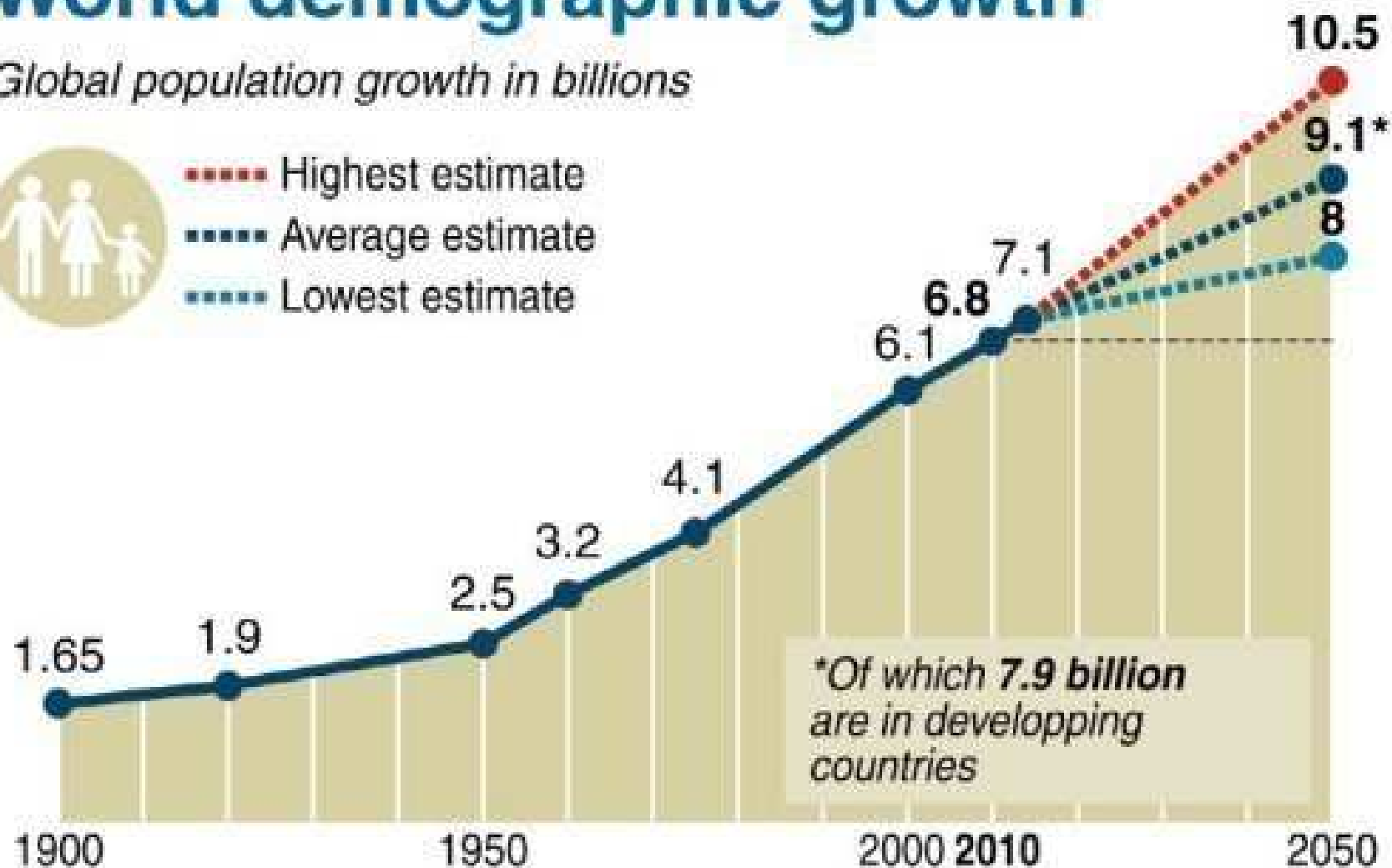
Natural hazards and un-Natural Disasters

World demographic growth

Global population growth in billions



- Highest estimate
- Average estimate
- Lowest estimate

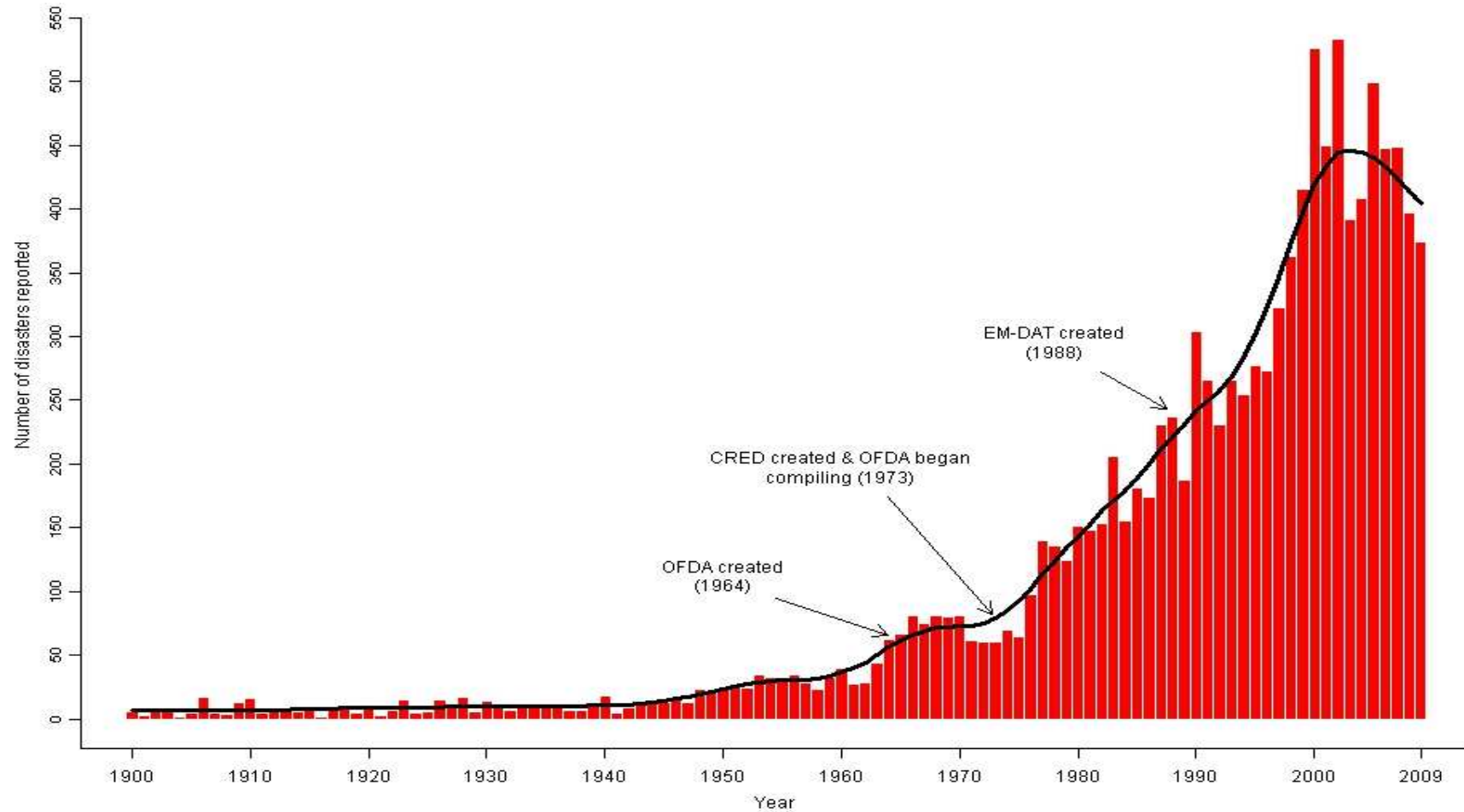


Source : UN - Department of Economic and Social Affairs (2009)

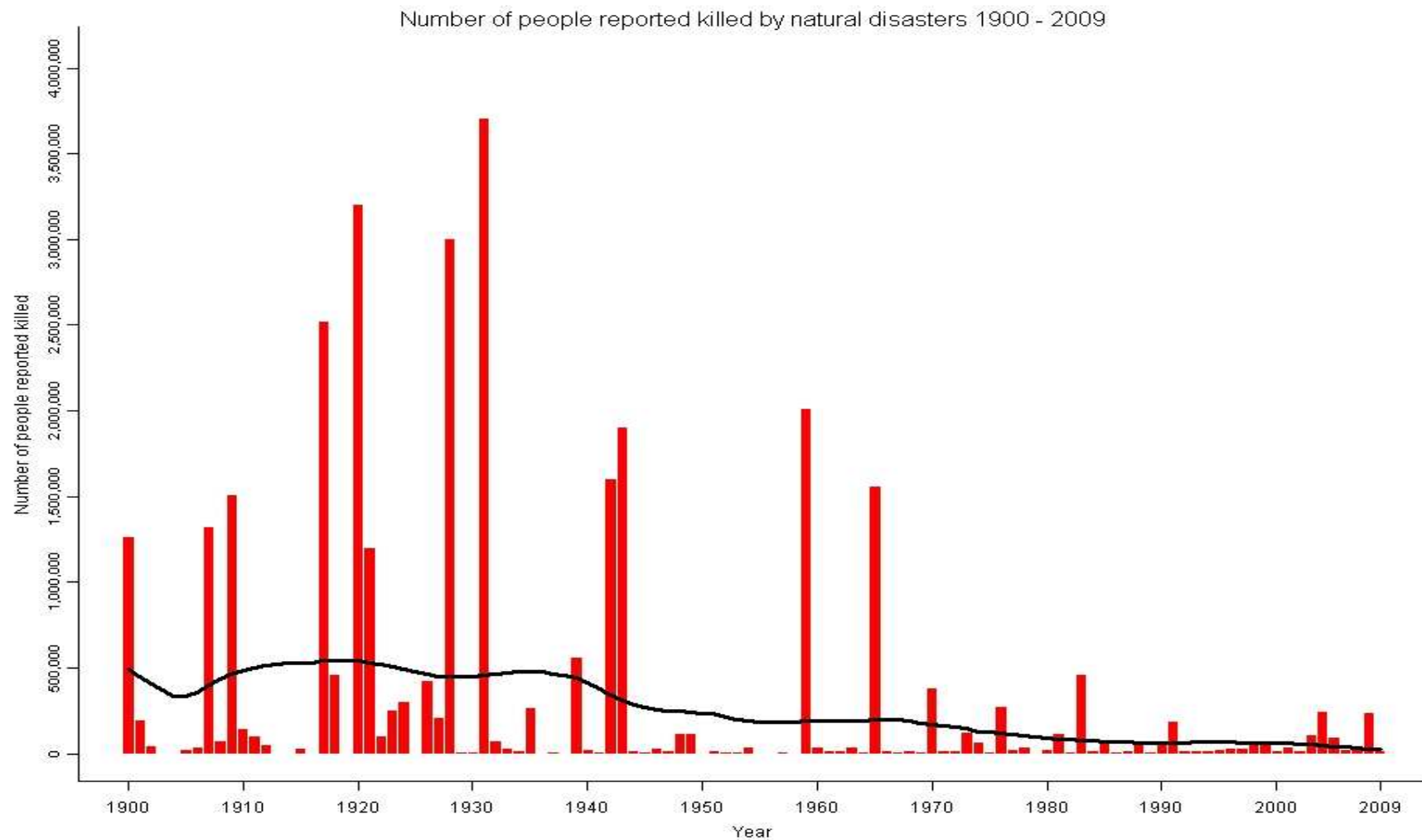
AFP

Number of disasters reported: 1900-2009

Natural disasters reported 1900 - 2009

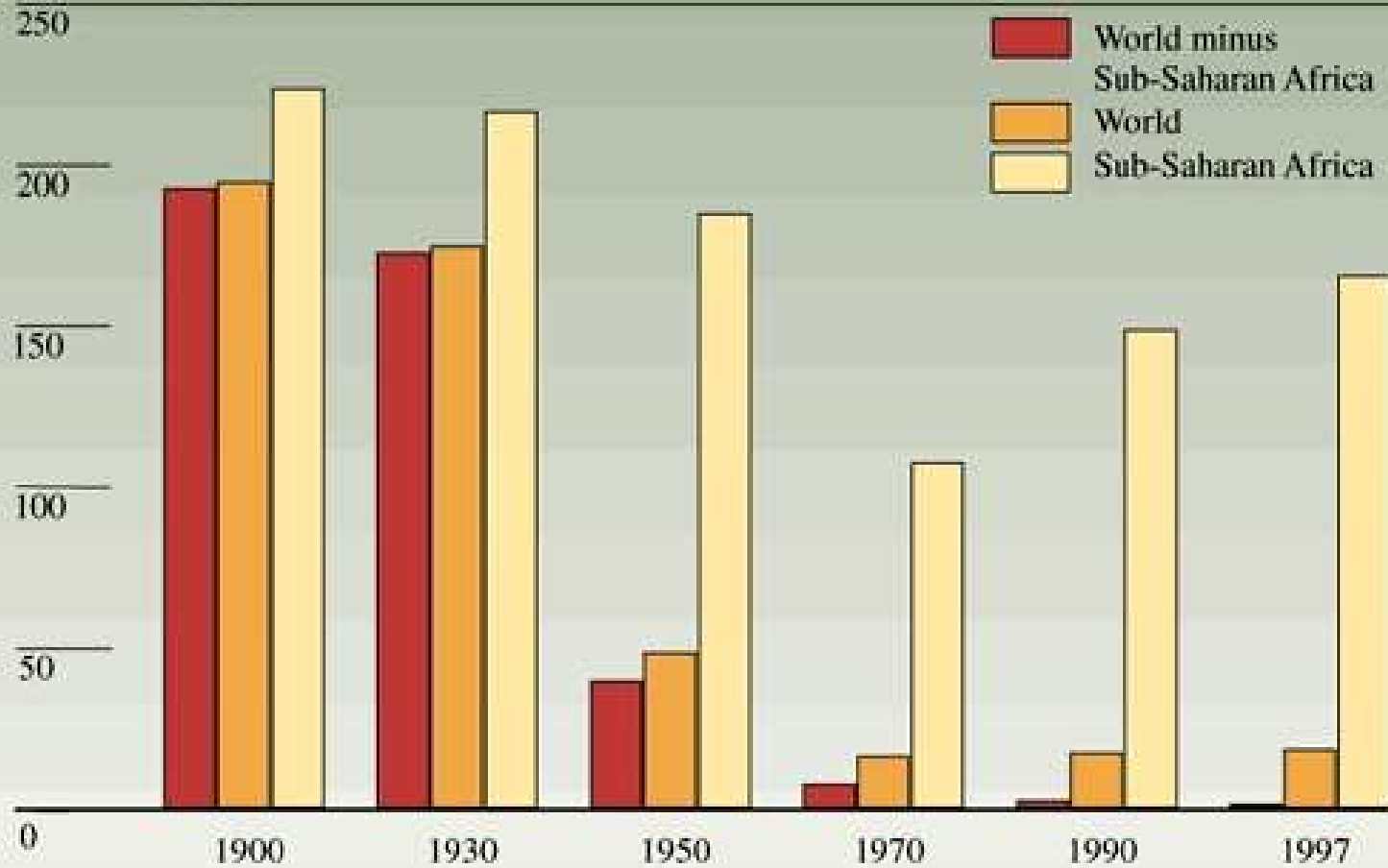


Number of people killed in disasters: 1900-2009

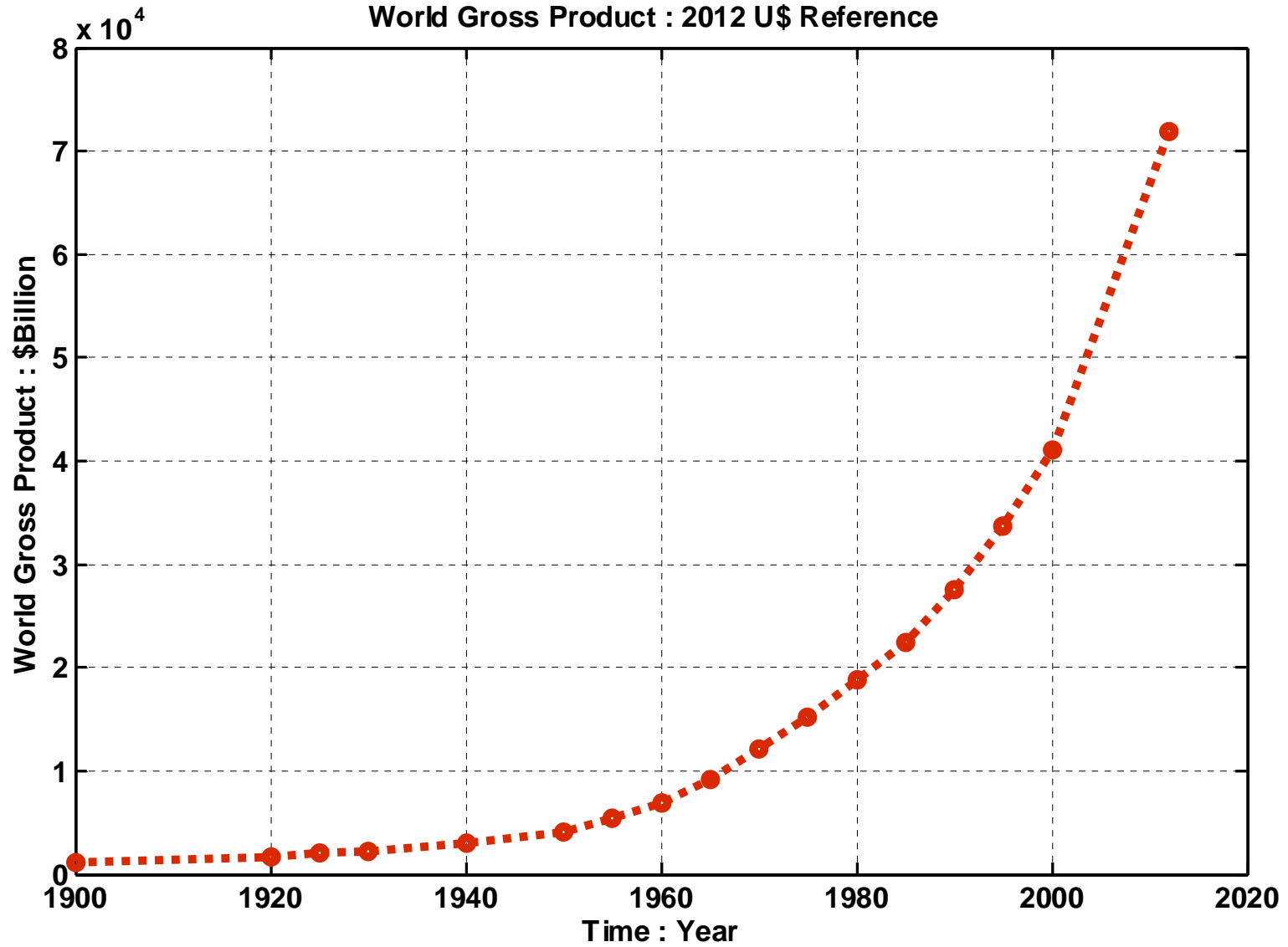


Malaria Mortality Annual Rates Since 1900

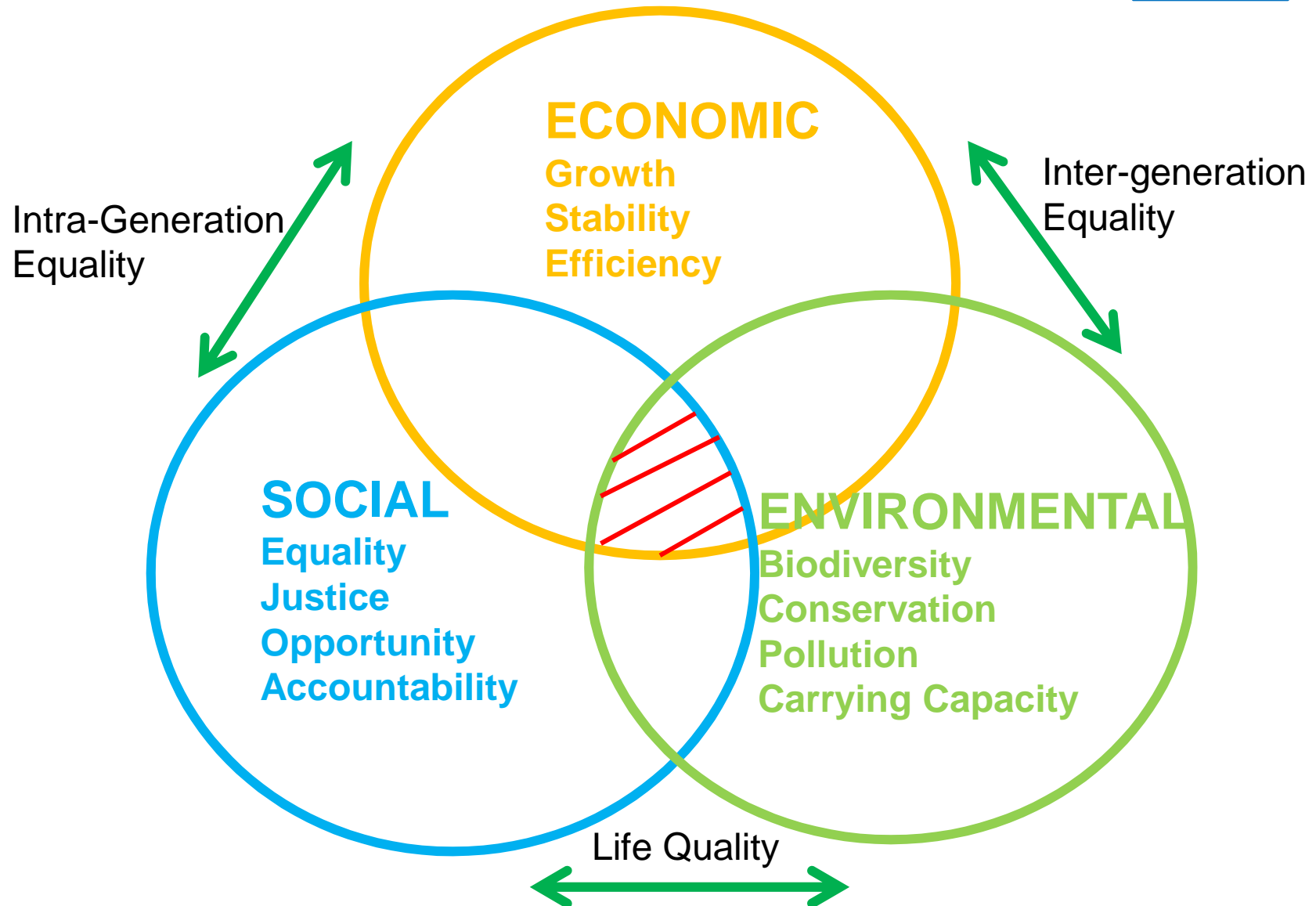
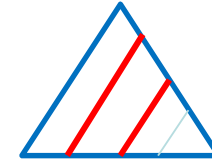
Per 100,000 population

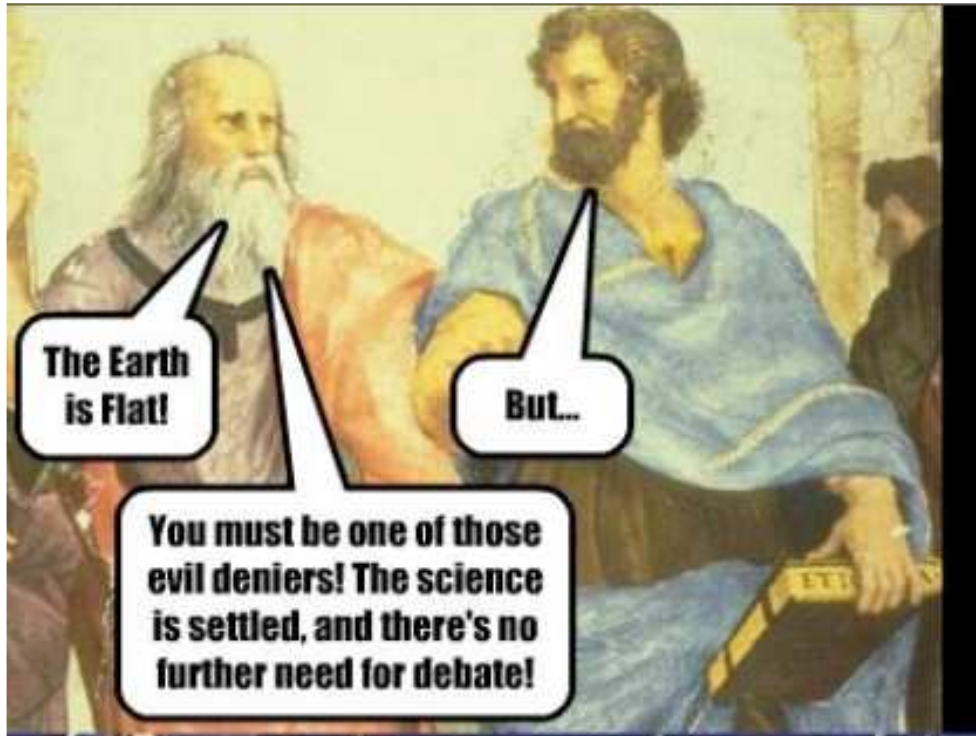


World Gross Product : \$ Billion



Sustainable Development :





Politicians sell certainty;
Scientists live off doubt.

Role reversal now!!

Is science democratic and ruled
by majority, or authority?

Neither!

Veritas!

Veritas vos liberabit!



Current Efforts and Applications

- **Non-destructive Evaluation for Structural Health Monitoring**
 - (DOT, NSWC, DFRC/NASA, KSC/NASA Shuttle, THSR)
- **Vibration, speech, and acoustic signal analyses**
 - (FBI, and DARPA)
- **Earthquake Engineering**
 - (DOT)
- **Bio-medical applications**
 - (Harvard, Johns Hopkins, UCSD, NIH, NTU, VHT, AS)
- **Climate changes**
 - (NASA Goddard, NOAA, CCSP)
- **Cosmological Gravity Wave**
 - (NASA Goddard)
- **Financial market data analysis**
 - (NCU)
- **Theoretical foundations**
 - (Princeton University and Caltech)

The best a scientist can give to the world
is his results, not his philosophy.

C. A. Truesdell

I am going to violate this commandment today

Algorithm for creation

- **Read**, but not believe them all: life time learning.
- **Think**, without box but thoroughly
- **Question**, everything especially the obvious (Calculus vs. *$f=ma$*)
- **Improve**, never satisfy and stop
- **Cultivate**, Smart companions

Oh, Yes!

Luck

I am a great believer in luck.

What is Luck?

- Luck is the convergence of **preparation and opportunity** (Pierre Trudeau).
- I am a great believer in luck, and I find **the harder I work the more I have of it.** (Thomas Jefferson)
- I always find luck waiting for me, in my library, at 2 or 3 o'clock in the morning. (Nietzsche)

And above all, be happy

- Greek philosopher Epictetus had said: "Only the educated are free."
- Hence: **Veritas vos liberabit!**
- Consequently, **智足者常樂!**
- **Like what you do** vs. not do what you like.

Thanks

Good luck to you all!

And be Happy.