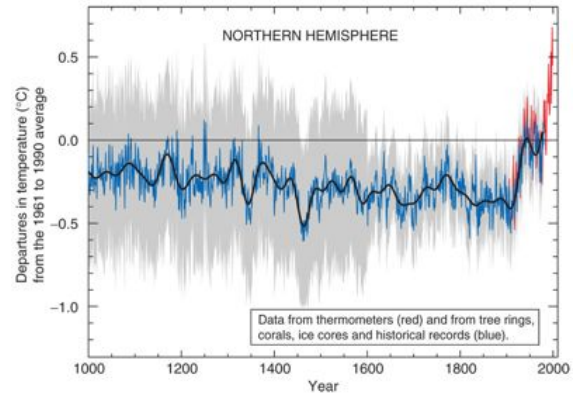


1 See something.
 2 Think of a reason why.
 3 Figure out a way to check your reason.
 4 And?
 5 Now, everyone gets to dump on you.
 6 Repeat until consensus formed.



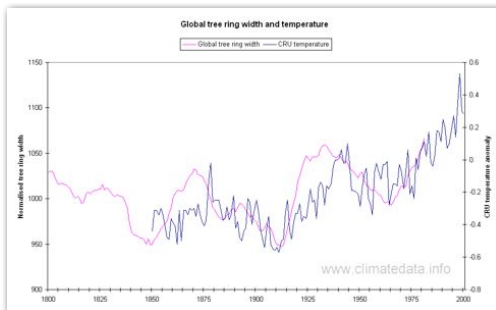
- Weather is the set of all extant phenomena in a given atmosphere at a given time.
- Climate is the average and variations of weather in a region over long periods of time.

FACT:
The Earth is getting warmer.



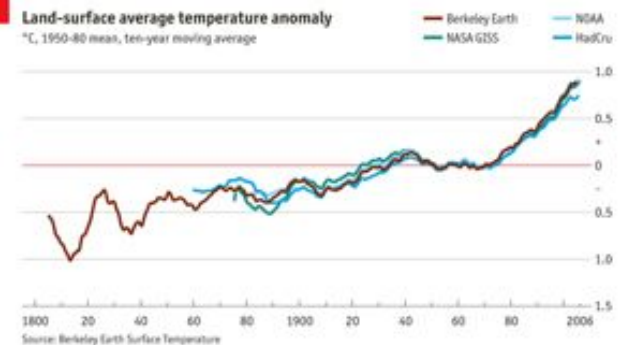
Instrumental records: 1st example (1659) Quasi-global (~1850s)
 International Meteorological Organization (1873)
 World Meteorological Organization (1950)

Pre: 1800s rely on PROXY DATA



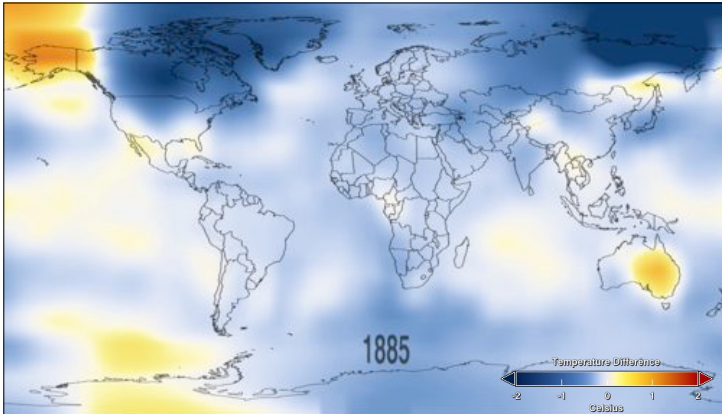
Tree Rings as example of Proxy Data

http://www.climatedata.info/Proxy/Proxy/treerings_introduction.html



Berkeley Earth Surface Temperature, 2011 still in progress
 (lead scientist: Richard Muller)

<http://berkeleyearth.org/>

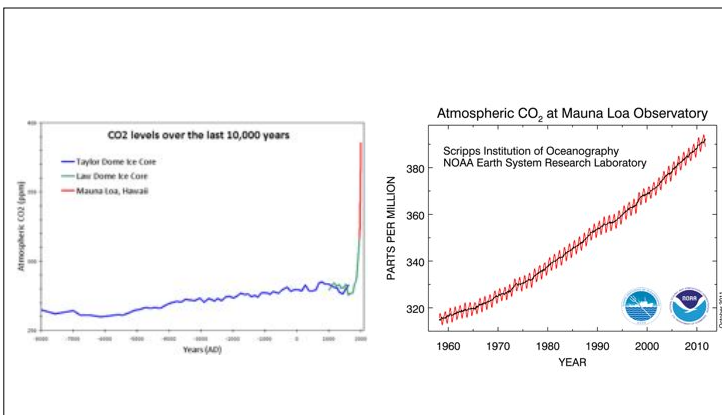


NASA Goddard Institute for Space Studies analysis of global temperature data.

<http://svs.gsfc.nasa.gov/vis/a000000/a003600/a003674/index.html>

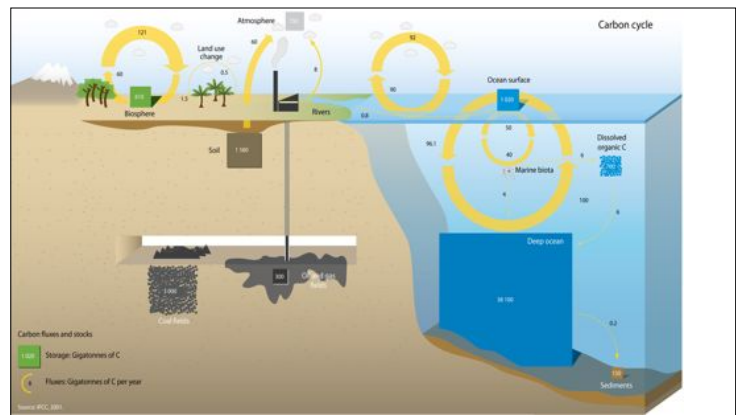
FACT:
The Earth is getting warmer.

FACT:
There is more CO₂ in the Earth's atmosphere. Much of this is due to human activity.



CO₂ historical trends

Ice Cores as example of Proxy Data
<http://www.climatedata.info/Proxy/Proxy/icecores.html>



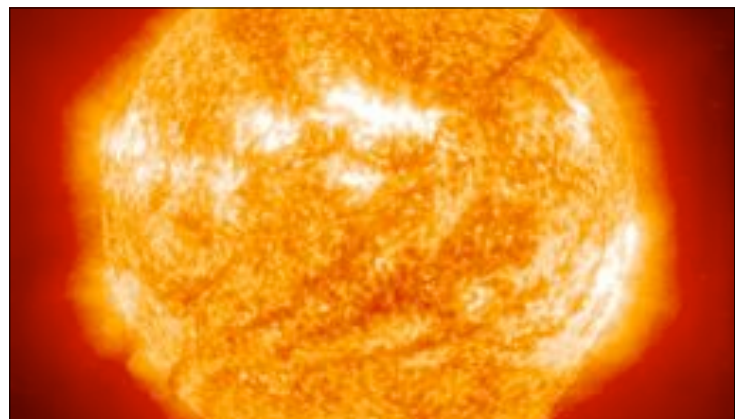
Carbon Cycle logistics.

Can track C from fossil fuel burning to see how much (or how quick) the cycle operates.

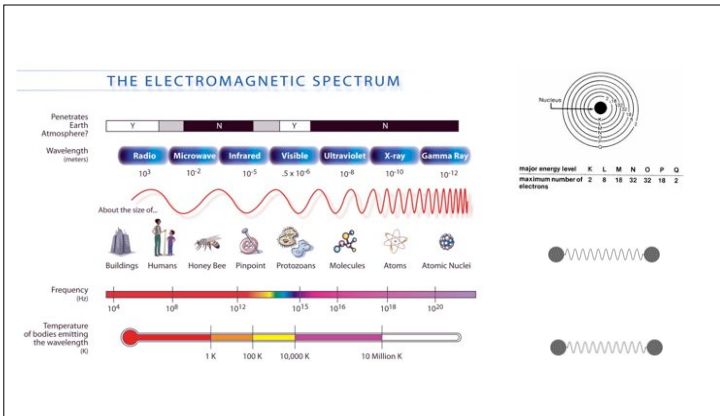
FACT:
The Earth is getting warmer.

FACT:
There is more CO₂ in the Earth's atmosphere. Much of this is due to human activity.

FACT:
CO₂ is a greenhouse gas.

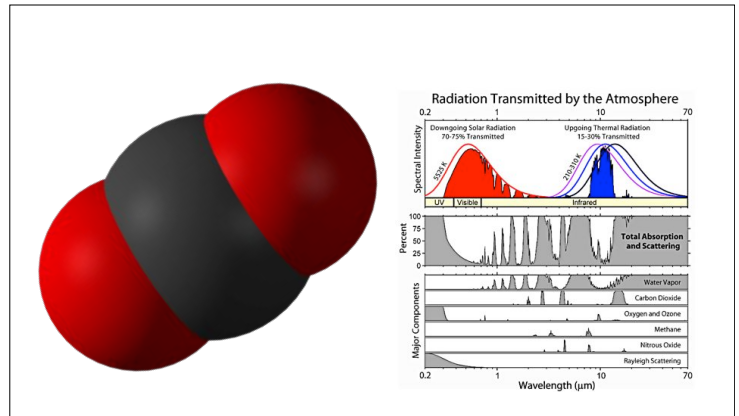


It all starts with the Sun



Electromagnetic radiation basics. With a little quantum stuff thrown in.

Key thing is that energy can be absorbed and re-emitted

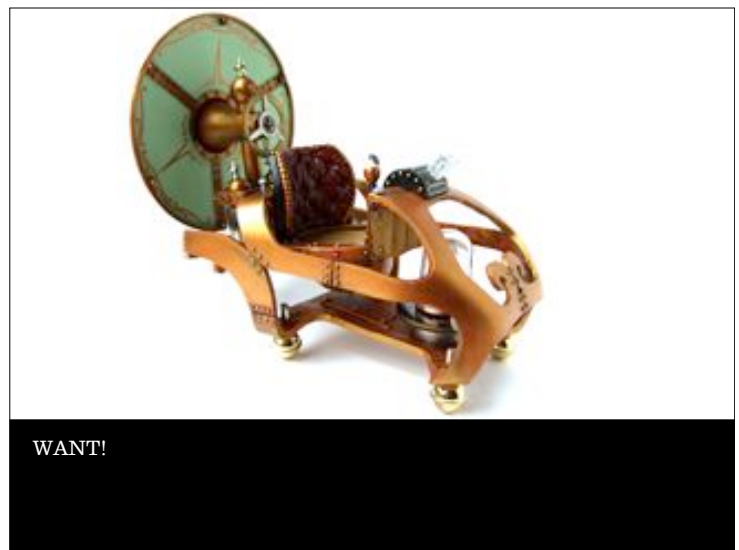


Carbon Dioxide is a Greenhouse Gas. This simply means that it can absorb energy at thermal radiation frequency.

FACT:
The Earth is getting warmer.

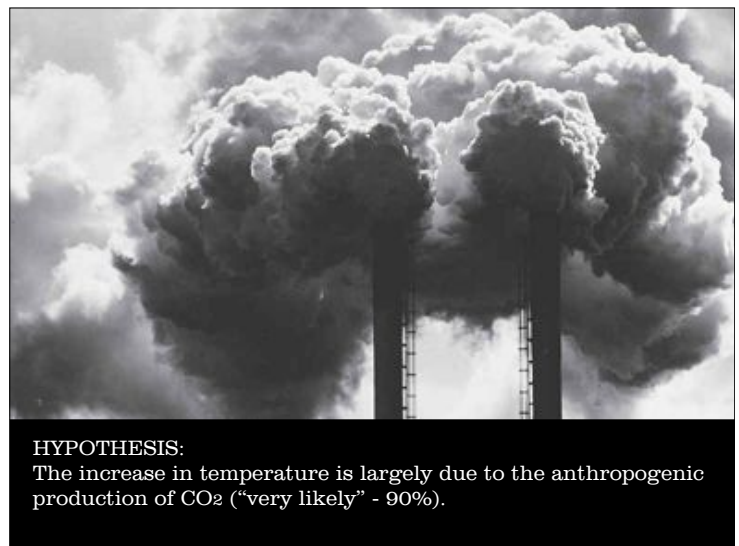
FACT:
There is more CO₂ in the Earth's atmosphere. Much of this is due to human activity.

FACT:
CO₂ is a greenhouse gas.



Climate Change 2007: Synthesis Report
Summary for Policymakers

Likelihood Terminology	Likelihood of the occurrence/ outcome
Virtually certain	> 99% probability
Extremely likely	> 95% probability
Very likely	> 90% probability
Likely	> 66% probability
More likely than not	> 50% probability
About as likely as not	33 to 66% probability
Unlikely	< 33% probability
Very unlikely	< 10% probability
Extremely unlikely	< 5% probability
Exceptionally unlikely	< 1% probability



THERMODYNAMICS

A theory is the more impressive the greater the simplicity of its premises, the more different kinds of things it relates, and the more extended its area of applicability. Therefore the deep impression that classical thermodynamics made upon me. It is the only physical theory of universal content which I am convinced will never be overthrown, within the framework of applicability of its basic concepts.

-A. Einstein.

Lisa, get in here. In this house we obey the laws of thermodynamics!
-Homer Simpson.

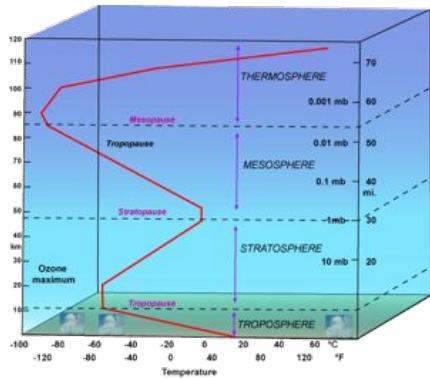
The laws of thermodynamics are to science what Shakespeare is to literature.

FIRST LAW OF THERMODYNAMICS

FTW!

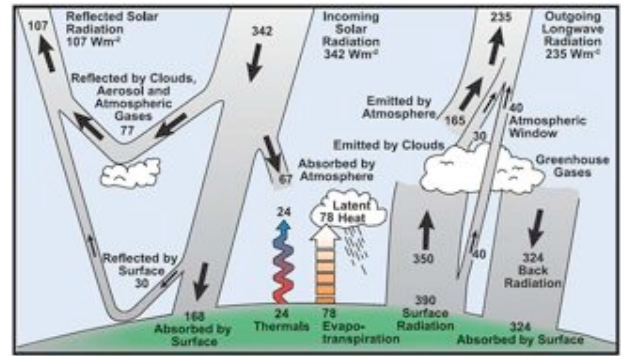
Also colloquially referred to as the "conservation of energy" rule.

It's about *book keeping*



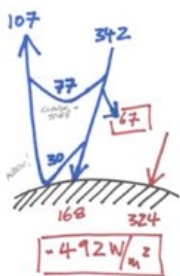
What is the troposphere? In a nutshell, the troposphere is the lowest portion of Earth's atmosphere comprising about 75% of the total mass of the atmosphere. It's here that almost all of its water vapor and aerosols are present.

TROPOPAUSE: This represents the place, where the temperature gradients do flip flop from the surface of the Earth (the top part of the troposphere)

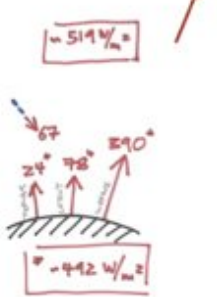


The flowchart...

Incoming + immediately outgoing



Outgoing from surface. (+ the incoming to the atmosphere)



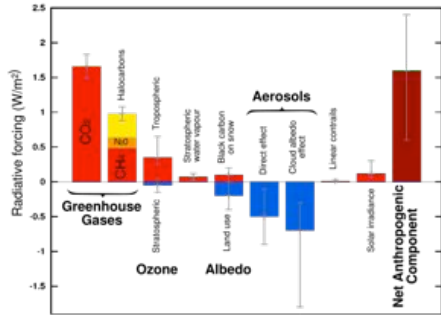
That which is absorbed by the "atmosphere" and re-emitted.



Breakdown of the flowchart...



Radiative Forcing Components



The radiative forcing of the surface-troposphere* system due to the perturbation in or the introduction of an agent (say, a change in greenhouse gas concentrations) is the change in net irradiance (solar plus long-wave; in Wm^{-2}) at the tropopause AFTER allowing for stratospheric temperatures to readjust to radiative equilibrium, but with surface and tropospheric temperatures and state held fixed at the unperturbed values.

Anthropogenic and natural warming inferred from changes in Earth's energy balance

Markus Huber and Reto Knutti*

The Earth's energy balance is key to understanding climate and climate variations that are caused by natural and anthropogenic changes in the atmospheric composition. Despite abundant observational evidence for changes in the energy balance over the past decades^{1,2}, the formal detection of climate warming and its attribution to human influence has so far relied mostly on the difference between spatio-temporal warming patterns of natural and anthropogenic origin^{3,4}. Here we present an alternative attribution method that relies on the principle of conservation of energy, without assumptions about spatial warming patterns. Based on a massive ensemble of simulations with an intermediate-complexity climate model we demonstrate that known changes in the global energy balance and in radiative forcing tightly constrain the magnitude of anthropogenic warming. We find that since the mid-twentieth century, greenhouse gases contributed 0.85 °C of warming (5–9% uncertainty) (0.6–1.1 °C), about half of which was offset by the cooling effects of aerosols, with a total observed change in global temperature of about 0.56 °C. The observed trends are extremely unlikely (<5%) to be caused by internal variability, even if current models were found to strongly underestimate it. Our method is complementary to optimal fingerprinting attribution and produces fully consistent results, thus suggesting an even higher confidence that human-induced causes dominate the observed warming.

Owing to its large heat capacity, the ocean accounts for more than 85% of the energy content change Q in the climate system⁵. A robust ocean warming trend is evident despite sparse data and uncertainties and biases in ocean observations^{6,7}. The feedback parameter λ is inversely related to climate sensitivity⁸. We use a massive ensemble of the Bern2.53 climate model of intermediate complexity^{9,10}, driven by bottom-up estimates of historic radiative forcing F_r and constrained by a set of observations of the surface warming T since 1950 and heat uptake Q since the 1950s (see Methods). The Special Report on Emissions Scenarios (SRES) A2 (ref. 14) emission scenario is used as one illustration of a non-intervention scenario. The radiative forcing time series^{11,12} are shown in Fig. 1 along with the probabilistic model output based on the constrained model parameters¹³. The energy balance model has no natural interannual variability but is able to reproduce the observed global trend of past temperature and ocean heat uptake. Uncertainties in surface warming, ocean heat uptake and in all individual radiative forcing components are considered (see Methods). Figure 2a shows the contribution of different forcing species to the accumulated forcing since the year 1950. The partitioning of the net cumulative forcing into ocean heat uptake and outgoing longwave radiation is illustrated in Fig. 2b. Between 1850 and 2010, the climate system accumulated a total net forcing energy of 140×10^{21} J with a 5–95% uncertainty range of $95\text{--}197 \times 10^{21}$ J, corresponding to an average net radiative forcing of roughly 0.54 ($0.36\text{--}0.76$) Wm^{-2} . The additional energy input is balanced in

It would appear that most recent calculations suggest that at least 74% of the climate change we see is due to human activity.

<http://www.nature.com/news/at-least-three-quarters-of-climate-change-is-man-made-1.9538>



WANT!

$$DU = DQ - DW$$

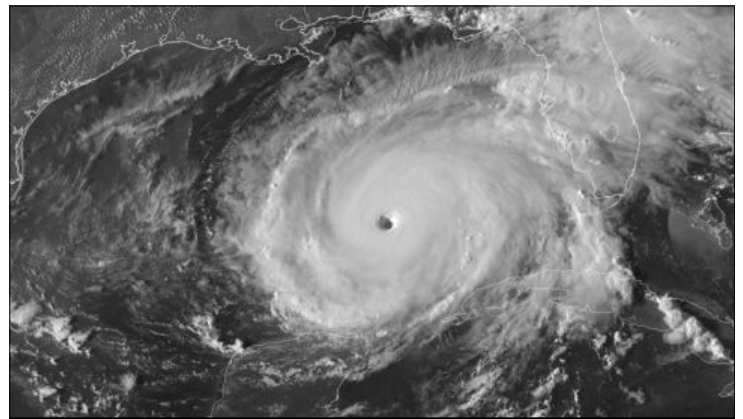
HYPOTHESIS:

These greenhouse gas amounts and increases in temperature will lead to predictable (and bad) effects to the planet and its inhabitants.

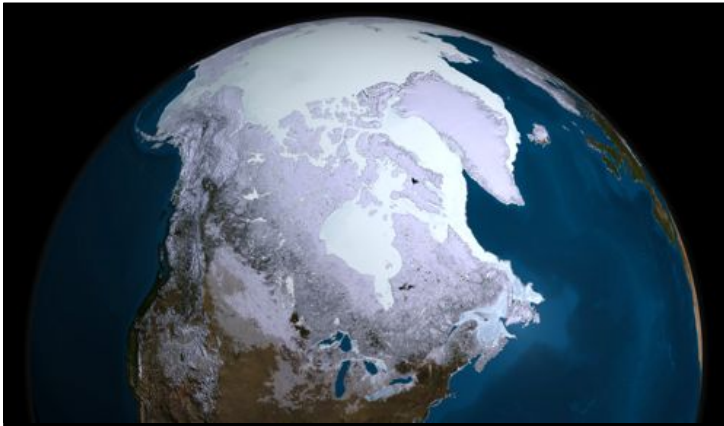
$$DU = DQ - DW$$

In short:

dU = internal energy
 dQ = heat
 dW = work



ADJUSTING LEVELS OF WORK - AIR, WATER, EVEN LAND.



ADJUSTING LEVELS OF INTERNAL ENERGY.
ICE MELTING, SEA LEVELS, TROPIC BANDS
CHANGE IN CHEMICAL REACTIONS

$$PV = NRT$$

demo

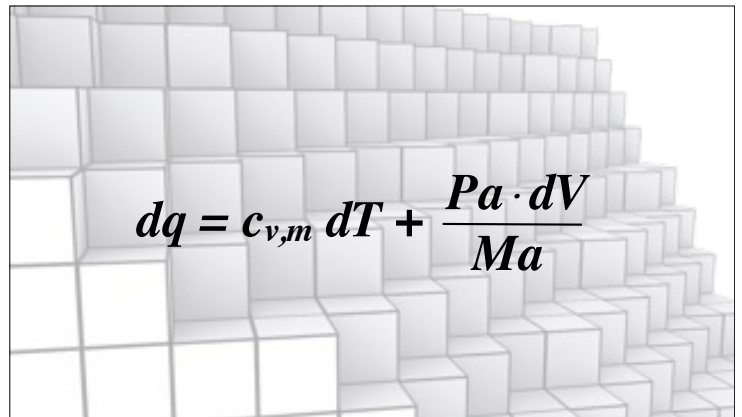
Boyles Law:

P = Pressure, V = Volume, N = number of molecules of gas
R = a constant to tie it all together ($8.314472 \text{ m}^3 \cdot \text{Pa} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$)
T = Temperature



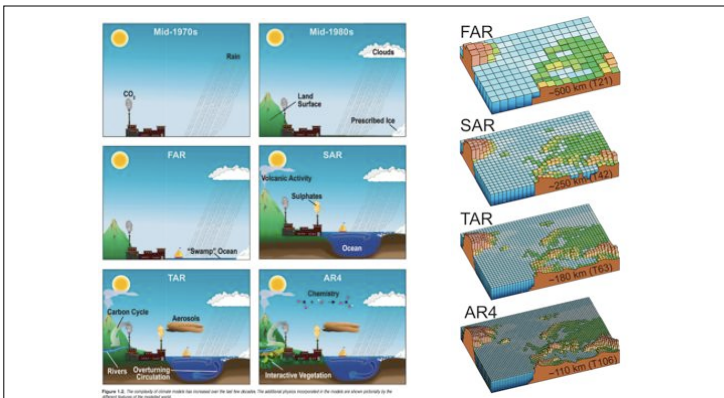
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T = Temperature



$$dq = c_{v,m} dT + \frac{Pa \cdot dV}{Ma}$$

This is what you get when you combine the First Law of Thermodynamics with Boyles Law. This is often referred to as a formal rendition of the the 1st Law for atmospheric considerations.



Models are composed of algorithms (a step by step calculation), which in turn are based on processing mathematical expressions, which in turn may be derived from physical laws, which in turn are derived from the things people see and do and measure everyday and throughout history.

By 2100 the world will have changed in ways that are difficult to imagine – as difficult as it would have been at the end of the 19th century to imagine the changes of the 100 years since. Each storyline assumes a distinctly different direction for future developments, such that the four storylines differ in increasingly irreversible ways. Together they describe divergent futures that encompass a significant portion of the underlying uncertainties in the main driving forces. They cover a wide range of key “factors” characteristics such as demographic change, economic development, and technological change. For this reason, their plausibility or feasibility should not be considered solely on the basis of an extrapolation of current economic, technological, and social trends.

- The A1 storyline and scenario family describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building, and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1 scenario family develops into three groups that describe alternative directions of technological change in the energy system. The three A1 groups are distinguished by their technological emphasis: fossil intensive (A1FI), non-fossil energy sources (A1T), or a balance across all sources (A1B).
- The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing global population. Economic development is primarily regionally oriented and per capita economic growth and technological change are more fragmented and slower than in other storylines.
- The B1 storyline and scenario family describes a convergent world with the same global population that peaks in mid-century and declines thereafter, as in the A1 storyline, but with rapid changes in economic structures toward a service and information economy, with reductions in material intensity, and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social, and environmental sustainability, including improved equity, but without additional climate initiatives.
- The B2 storyline and scenario family describes a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. It is a world with continuously increasing global population at a rate lower than A2, intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 storylines. While the scenario is also oriented toward environmental protection and social equity, it focuses on local and regional levels.

IPCC SCENARIOS.



We like stuff.



We like stuff.

OPEN ACCESS Freely available online 

The Progressive Increase of Food Waste in America and Its Environmental Impact

Kevin D. Hall*, Juen Guo, Michael Dore, Carson C. Chow*

Laboratory of Biological Modelling, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, Maryland, United States of America

Abstract
 Food waste contributes to excess consumption of freshwater and fossil fuels which, along with methane and CO₂ emissions from decomposing food, impacts global climate change. Here, we calculate the energy content of nationwide food waste from the difference between the US food supply and the food consumed by the population. The latter was estimated using a validated mathematical model of metabolism relating body weight to the amount of food eaten. We found that US per capita food waste has progressively increased by ~50% since 1974 reaching more than 1400 kcal per person per day or 150 trillion kcal per year. Food waste now accounts for more than one quarter of the total freshwater consumption and ~300 million barrels of oil per year.

Citation: Hall KD, Guo J, Dore M, Chow CC (2009) The Progressive Increase of Food Waste in America and Its Environmental Impact. PLoS ONE 4(11): e7940. doi:10.1371/journal.pone.007940

Editor: Thoriksdottir I. A. Sorenson, Institute of Preventive Medicine, Denmark

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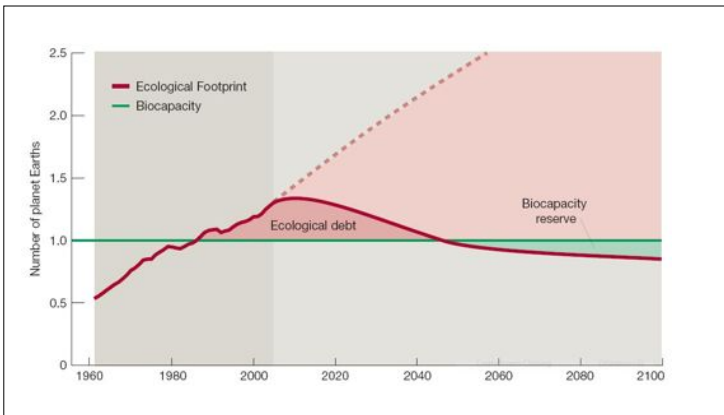
Competing Interests: The authors have declared that no competing interests exist.

* E-mail: kevinhidd@nidd.nih.gov (KDH); carsonchidd@nidd.nih.gov (CCC)

We are very wasteful.



Our ecological footprint is pretty horrendous.



Our ecological footprint is pretty horrendous.

Who will suffer most with the following?

- More dW
- Changes in Landscape
- Changes in Water Supply
- Changes in Biodiversity

Hint: it's not us...