by far the most terrifying film you will ever see.

an inconvenient truth
A GLOBAL WARNING

now playing in select theaters
SPECIAL REPORT GLOBAL WARMING

BE WORRIED. BE VERY WORRIED.
Climate change isn't some vague future problem—it's already damaging the planet at an alarming pace. Here's how it affects you, your kids and their kids as well.

EARTH AT THE TIPPING POINT
HOW IT THREATENS YOUR HEALTH
HOW CHINA & INDIA CAN HELP
SAVE THE WORLD—OR DESTROY IT
THE CLIMATE CRUSADERS
INDIA
ALASKA
RETREAT OF MID-LATITUDE GLACIERS
South Cascade Glacier, Washington

1928

2000

About 2 km shorter.
Terminus replaced by artificial lake.
Decrease in length about 15 meters per year.
In 2003, decrease was 30 m in length and 6.5 m in thickness.

http://www.worldviewofglobalwarming.org/pages/glaciers.html
GRINNELL GLACIER
GLACIER NATIONAL PARK 1911 - 2000

http://www.worldviewofglobalwarming.org/pages/glaciers.html
GLACIER AX010, NEPAL, 1978-2004

http://snowman.ihas.nagoya-u.ac.jp/download/photo/AX010.html
Muir Glacier - Muir Inlet
Glacier Bay National Park, Alaska
1941 vs. 2004

Muir Glacier, William O. Field on 13 August 1941 and by Bruce F. Molnia on 31 August 2004
Glacial retreat is 2.5 km.
Base is 450 meters higher.

http://www.worldviewofglobalwarming.org/pages/glaciers.html
The Greenhouse Effect

Some solar radiation is reflected by the Earth and the atmosphere.

Solar radiation passes through the clear atmosphere

Most radiation is absorbed by the Earth's surface and warms it.

Some of the infrared radiation passes through the atmosphere, and some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower atmosphere.

Infrared radiation is emitted from the Earth's surface.
THE GREENHOUSE EFFECT

THE EARTH’S ENERGY BUDGET: A DELICATE BALANCE

• Sunlight heats the Earth.
• The warm Earth radiates energy (in the form of infrared radiation, or heat) back out to space.
• Some of this infrared radiation is trapped in the atmosphere, giving Earth its temperate climate.

This is the greenhouse effect. Without it, the Earth’s climate would be like the moon’s, harsh and severe.
GLOBAL ENERGY BALANCE
Global and annual average energy fluxes in watts per square meter

Global and annual average energy fluxes in watts per square meter

\[
\frac{1}{4} S_0 = 343 \text{ W m}^{-2}
\]

\[
\alpha = 31\% 
\]

\[
1/4 S_0 (1 - \alpha) = \sigma T^4
\]

\[
\approx 254K = -2°F
\]

\[
69\% = 1 - \alpha
\]

\[
\approx 288K = 59°F
\]

\[
\text{H}_2\text{O, CO}_2, \text{CH}_4...
\]

\[
\text{Atmosphere}
\]

\[
\text{Schwartz, 1996, modified from Ramanathan, 1987}
\]
ATMOSPHERIC RADIATION

Energy per area per time

Power per area

Unit: Watt per square meter
W m\(^{-2}\)
ATMOSPHERIC CARBON DIOXIDE IS INCREASING

Global carbon dioxide concentration and infrared radiative forcing over the last thousand years.
GREENHOUSE GASES AND TEMPERATURE OVER 450,000 YEARS

Vostok core, Antarctica

Modified from Petit et al., Nature, 1999
Looking to the Future . . .
Prediction is difficult, especially about the future.

– Niels Bohr
PROJECTIONS OF FUTURE CO2 EMISSIONS

![Graph showing CO2 emissions projections for different scenarios.]

- Scenarios: A1B, A1T, A1FI, A2, B1, B2, IS92a
- Y-axis: CO2 emissions (Gt C/yr)
- X-axis: Year (2000 to 2100)
PROJECTIONS OF FUTURE TEMPERATURE CHANGE

- A1FI
- A1B
- A1T
- A2
- B1
- B2
- IS92a (TAR method)

Several models
all SRES envelope

Model ensemble
all SRES envelope

Bars show the range in 2100 produced by several models

BNL Research
THE BIG PROBLEM FOR LONG ISLAND . . .

RIISING SEA LEVEL
1 meter
4 meters
5 meters
"Gentlemen, it’s time we gave some serious thought to the effects of global warming."
WHAT CAN WE DO ABOUT IT?
Cities are energy efficient.
CARBON DIOXIDE EMISSIONS BY SECTOR
Comparison of New York City vs. United States Average
Pounds of carbon per person per day

Pounds Carbon per day

NYC  US

Residential  Industrial

New York City, EPA
WHERE IS ALL THIS \( \text{CO}_2 \) COMING FROM?

WHO IS RESPONSIBLE?
PER CAPITA FOSSIL FUEL CO₂ EMISSIONS

By country, year 2000.

Data: G. Marland, Oak Ridge National Laboratory
By country, year 2000.

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By country, year 2000.

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PER CAPITA FOSSIL FUEL CO₂ EMISSIONS

By country, year 2000.

Data: G. Marland, Oak Ridge National Laboratory
PER CAPITA FOSSIL FUEL CO₂ EMISSIONS

By country, year 2000.

Data: G. Marland, Oak Ridge National Laboratory
PER CAPITA FOSSIL FUEL CO$_2$ EMISSIONS

By country, year 2000.

Data: G. Marland, Oak Ridge National Laboratory
PER CAPITA FOSSIL FUEL CO\textsubscript{2} EMISSIONS

By country, year 2000.

Data: G. Marland, Oak Ridge National Laboratory
PER CAPITA FOSSIL FUEL CO₂ EMISSIONS

By country, year 2000.

Data: G. Marland, Oak Ridge National Laboratory
PER CAPITA FOSSIL FUEL CO₂ EMISSIONS

By country, year 2000.

Data: G. Marland, Oak Ridge National Laboratory
By country, year 2000.

Data: G. Marland, Oak Ridge National Laboratory
WHERE IS ALL THIS CO₂ COMING FROM?

WHO IS RESPONSIBLE?
HOW MUCH CARBON IS IN A GALLON OF GASOLINE?

1 lb?  
2 lbs?  
3 lbs!?  
5 lbs!?!

All of this carbon goes into the atmosphere as carbon dioxide when you burn the gasoline in your car.
THE MOST EFFECTIVE WAY TO DOUBLE THE FUEL ECONOMY OF A CAR . . . IS TO PUT TWO PEOPLE IN IT!
CARPOOLSING CAN SAVE MORE THAN GAS
WHERE DOES YOUR ELECTRIC ENERGY COME FROM?

SOURCES OF ELECTRIC ENERGY IN THE UNITED STATES

Annual Total 3.71 Trillion KWH

On Long Island most electric energy derives from combustion of oil.
A typical household using 1000 kilowatt hours of electricity per month is responsible for emission of 3 tons of carbon a year in the form of carbon dioxide. How much does your household contribute?
YOUR CONTRIBUTION TO THE GREENHOUSE EFFECT

At half a pound of carbon per KWH, the average household is responsible for emission of 500 pounds of carbon a month.
WHO IS RESPONSIBLE?

IT’S ALL OF US!

AH, POGO, THE BEAUTY OF THE FOREST PRIMEVAL GETS ME IN THE HEART.

IT GETS ME IN THE FEET, PORKYPINE.

IT IS HARD WALKIN’ ON THIS STUFF.

YEP, SON, WE HAVE MET THE ENEMY AND HE IS US.
WHERE IS THIS CARBON DIOXIDE COMING FROM?
WE ARE ALL RESPONSIBLE.

Burning a gallon of gasoline in your car puts 5 pounds of carbon in the atmosphere as carbon dioxide (CO₂), and it will stay there for decades — maybe a century!

Other sources are home heating and electric power production.
Global Atmosphere, Global Warming

QUESTIONS ABOUT GLOBAL WARMING

- IS IT REAL?
- IS IT IMPORTANT?
- WHAT IS IT DUE TO?
- HOW MUCH MORE CAN WE EXPECT?
- ARE WE SEEING JUST THE TIP OF THE ICEBERG?

RESEARCH IS HELPING TO ANSWER THESE QUESTIONS.

www.ecd.bnl.gov/steve