What you should know about global climate change and why it is important

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What is meant mean by *Climate Change*?

*Climate change* is a change in the distribution of weather patterns over periods ranging from decades to millions of years. Climate is NOT the same as weather, which usually is measured in hours, days or weeks.
• How is climate change characterized?

• Climate change is characterized by measuring things such as, average global temperature, sea level rise, extent of glaciers, sea and land ice, and heat content and acidity of the ocean.
• The climate has been changing throughout earth’s history. What is different now?

• Human civilization is only about 10,000 years old. During that period the climate has been relatively constant.

• However, in the past 150 years the climate has been changing faster than at any other time during in human history.
• We now have evidence that for the first time in earth’s history, human activities are effecting the state of the climate.

• Also, now there are 7 thousand million people on earth. By 2050, there will likely be 9 thousand million people. Modern civilization is highly interconnected and dependent on vulnerable infrastructure. Agriculture is a global enterprise. All this means that climate effects everyone on the planet.
How to think about the climate and evidence that the climate is changing.
FAQ 1.2, Figure 1. Schematic view of the components of the climate system, their processes and interactions.
Ten indicators of a warming world

- Air Temperature Near Surface (Troposphere)
- Humidity
- Temperature Over Oceans
- Sea Surface Temperature
- Sea Ice
- Sea Level
- Ocean Heat Content
- Temperature Over Land
- Glaciers
- Snow Cover
Multiple indicators of a changing global climate

Source: IPCC AR5
Global temperatures are higher now than they have been for 75% of the 11,300 years since the end of the last glacial period, according to a report in Science. Temperature variations and projections indicated are relative to the average global temperature from 1961 to 1990.

Change in global temperatures (in degrees Fahrenheit):

- Rise 1° over 1,800 years
- Plateau for 4,000 years
- Drop 1.3° over 5,400 years
- Rise 1.3° in last 100 years

Source: Science

BRADY MACDONALD Los Angeles Times
Indications of climate change: snow cover and sea ice extent

(a) Northern Hemisphere spring snow cover

(b) Arctic summer sea ice extent

Source: IPCC AR5 2013
Indications of climate change:
ocean heat content, sea level rise and acidity

(c) Change in global average upper ocean heat content

(d) Global average sea level change

(b) Surface Ocean CO₂ and pH

Source: IPCC AR5 2013
What are causes of climate change?

There are *natural* causes and *human* causes.

Most important natural cause would be a change in energy output from the sun.

Human-induced causes come mostly from the emissions of greenhouse gases, such as carbon dioxide, methane, nitrous oxides, ozone and CFC's.
Evidence now shows that human activity is the main cause of climate change, mostly through the release of greenhouse gases to the atmosphere.
Simple Greenhouse Effect

The Greenhouse Effect
Some of the infrared radiation passes through the atmosphere but most is absorbed and re-emitted in all directions by greenhouse gas molecules and clouds. The effect of this is to warm the Earth’s surface and the lower atmosphere.

Solar radiation powers the climate system.

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

About half the solar radiation is absorbed by the Earth’s surface and warms it.

Infrared radiation is emitted from the Earth’s surface.

FAQ 1.3, Figure 1. An idealised model of the natural greenhouse effect. See text for explanation.
Carbon dioxide is the most important GHG

Mauna Loa Observatory, Hawaii
Monthly Average Carbon Dioxide Concentration

Data from Scripps CO\textsubscript{2} Program   Last updated May 2013

Year

Northern Hemisphere
CO2 levels highest in over 800,000 years
Lawrence Livermore Laboratory Climate Simulation

http://climate.llnl.gov/media/climate002.html
Attributing Climate Change

Source
IPCC
AR5
A. Global Climate Forcings

- All Greenhouse Gases
- Black Carbon (BC)
- Solar Irradiance
- Snow Albedo (BC effect)
- Stratospheric Aerosols
- Reflective Tropospheric Aerosols
- Aerosol Indirect Effect
- Land Use

B. Temperature Change

- Run 1
- Run 2
- Run 3
- Run 4
- Run 5
- 5 Run Mean
- Observations
Models and attributing climate change: need to include anthropogenic contributions to get agreement with observations.
Temperature and Mosquito Vectors

Mosquito Life Cycle

Time required for parasite development

PNAS (2010) 107: 15135-15139
Effect of Temperature on Malaria

Distribution of the primary Malaria agent

- **Current distribution**
- **Possible extended distribution by 2050** (suitable climate)

Current distribution, represents maximum extent of the distribution of the *falciparum* Malaria parasite. For 2050, areas within the current maximum extent has been excluded from the map.

The scenario is based on the high scenario from the HadCM2 experiment.

Vibrio parahaemolyticus in Alaska

Cannot grow below 15°C
Recent outbreak 1000 Km further north than any previous outbreak
Impact of Altered Precipitation

- Both drought and flooding affect fresh water supplies, increasing transmission of pathogens like Salmonella and Rotovirus.
- Increased rainfall provides more breeding grounds for mosquitoes, promoting transmission of diseases such as Malaria, Dengue, Yellow fever.
- Periodic drought followed by heavy rain often increases rodent populations.
Four Corners Disease (1993)

Drought → Heavy spring rains → Mouse overpopulation → Hantavirus (Sin nombre)

http://www.cdc.gov/ncidod/diseases/hanta/hps/noframes/outbreak.htm
- Increased average terrestrial and ocean surface temperature
  - Changes in precipitation
  - Storms, floods, drought

- Contamination of water by pathogens
- Increase in number / activity of vectors
- Changes in populations of animal carriers

- Diarrheal diseases
- Diseases transmitted by ticks, mosquitos, and other insects
- Diseases transmitted from animals
Summary

• Climate change effects almost every aspect of earth’s ecosystems.

• Basic physics and chemistry of climate change well understood.

• Atmospheric concentrations of CO$_2$ have increased steadily since the 19$^{th}$ century. Current level is 400 ppm.

• Global temperatures have increased over same period and are roughly correlated with increased levels of CO$_2$.

• Climate models can reasonably describe past climate trends.

• Human activities are a main driver of global warming.
What can be done?

• Reduce significantly the amount of GHC emitted to the atmosphere, mostly carbon dioxide.

• This means reducing to a minimum the use of carbon-based fuels (coal, oil, natural gas).
What can be done?

- Prepare for effects of climate change, such as sea level rise, more frequent extreme weather events, too much and too little water and spread of disease.
Why is all this important?

• Human kind is engaged in a great, global, uncontrolled experiment that directly effects the very atmosphere we all depend on for existence.

• No one yet knows the result of this experiment. Should we wait to find out or act NOW.??
It’s in our hands