**Hypothesis**: an informal idea that has not been thoroughly tested by the scientific community. Most are discarded.

**Theory**: A hypothesis becomes a theory when it can explain and predict observations and it also has been thoroughly tested by the scientific community. Even theories, over time, can be disproved and discarded.

**Law**: If a theory stands the test of time (years and decades) it may be called a law or unifying theory and is the closest approximation to "the truth" possible. Keep in mind that it is impossible to prove that a theory is true, only that it is untrue.

**Forcing**: Factors that cause change.

**Feedback**: A process that alters climate changes already underway. *Positive* means increasing change while *negative* means decreasing change.

**Weather**: Short term, random event within the atmosphere.

**Climate**: Long term trend or statistical probability of changes in the atmosphere.
Since the last major glacial period about 12,000 years ago, climate has been fairly stable.

Humanity has adapted to this climate and our existence is based on this stable climate.

Since the Industrial Revolution, global T has increased by 1°C (1.8°F).
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- IPCC models predict more heat waves and fewer cold snaps with higher emissions of heat trapping gases
- Precisely what is happening in the US (and also globally)
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25 Years of the IPCC
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Video: [Climate Change & Extremes](#)

![Graph showing probability of occurrence vs temperature](image-url)
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Web Alert:

Determining Past Climate
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![Ice cores](image)

The ice from the bottom of that core is over 20,000 years old.

Video: [Ice Core Data](#)
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Mann, et al. (2008)

Marcott, et al. (2013)
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Video: The Hockey Stick & Climate Wars
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Kitchen (2013)
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- Sun’s radiant energy has been fairly constant in the previous millions of years

- Radiative forcing is the difference between incoming vs. outgoing radiation

- Humans are causing an increased radiative forcing mostly due to increased greenhouse gases (GHG)
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Figure 10.5 | Assessed likely ranges (whiskers) and their mid-points (bars) for attributable warming trends over the 1951–2010 period due to well-mixed greenhouse gases, other anthropogenic forcings (OA), natural forcings (NAT), combined anthropogenic forcings (ANT) and internal variability. The Hadley Centre/Climatic Research Unit grid-ded surface temperature data set 4 (HadCRUT4) observations are shown in black with the 5 to 95% uncertainty range due to observational uncertainty in this record (Morice et al., 2012).
• Sun’s radiant energy has been fairly constant in the previous millions of years

• **Radiative forcing** is the difference between incoming vs. outgoing radiation

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Text Book Animation: Global Warming, Climate Change (CH.3)

Web Alert:

**Impact of Greenhouse Gases**

NASA (2010)
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- Climate change from these cycles are **millions** of years

**Web Alert:**

Ruddiman (2008)

**Climate Change: Natural Causes**
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Video: Plate Tectonics
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Web Alert:

**Climate Change: Natural Causes**

- Climate change from these cycles range between 41,000 to 100,000 years
Ocean conveyor moves heat around and causes climate changes on time scales of decades to centuries.

Volcanoes and El Niños change climate on 1-5 year intervals.
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Kitchen (2013)
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- Climate models are based upon well-established laws of physics and use a wealth of actual observations

- These models are able to simulate the current climate

- These models are able to simulate past climate

**Web Alert:**

[Climate Models & Accuracy](#)
Chapter 1

• Various emission scenarios result in different levels of global warming

• **A1F1 is the warmest world** and that is the path we are on now
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IPCC (2013) now uses **Representative Concentration Pathways (RCPs)** instead of previous A & B carbon emission scenarios. There are four pathways: RCP8.5, RCP6, RCP4.5 and RCP2.6 - the last is also referred to as RCP3-PD.

We are currently tracking along RCP8.5
Society quickly becomes vulnerable at global T increases above 2°C
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Web Alert: Modern Day Climate Change

How do we know the world is warming?

Click any label for information

Arctic Sea Ice

Air Temperature over Ocean

Humidity

Snow

Glaciers

Temperature of the Lower Atmosphere

Ocean Heat Content

Sea Surface Temperature

Global Sea Level

Air Temperature over Land

What can we do?

USGCRP Climate Literacy Guide, 2009

NCDC (2010)
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Heat storage in upper 2000 meters of ocean during 2003-2008 based on ARGO data. Knowledge of Earth’s energy imbalance is improving rapidly as ARGO data lengthens. Data must be averaged over a decade because of El Nino/La Nina and solar variability. Energy imbalance is smoking gun for human-made increasing greenhouse effect.

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Skeptical Science (2013)

Web Alert:

Global Cooling?
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IPCC (2013)
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• Climate change is caused by natural and human forcing

• Before 1975, natural and human forcing appear to have shared responsibility for the post-IR global warming

• Since 1975, most of the global warming is due to human activities, primarily emissions of GHGs