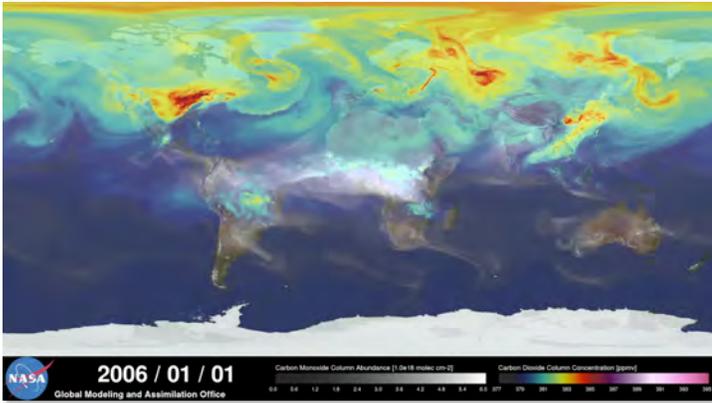


Atmospheric CO₂

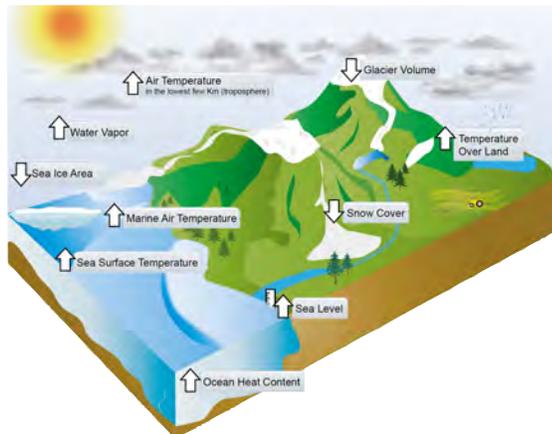


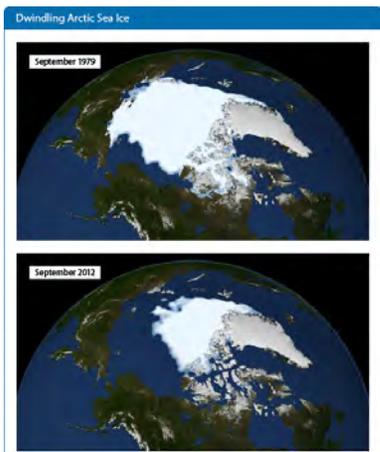
“Warming of the climate system is unequivocal, since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased.”

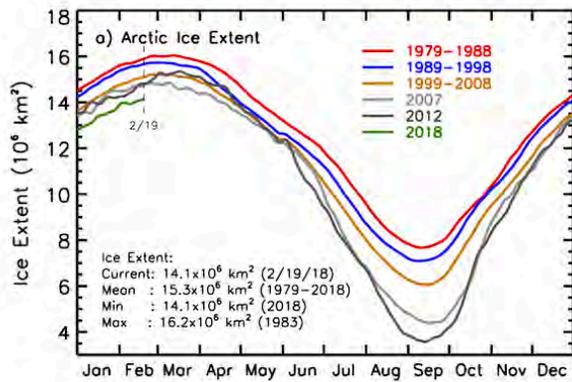


Intergovernmental Panel on Climate Change (IPCC)
5th Assessment report, 2013

Independent lines of evidence







Why the Arctic?

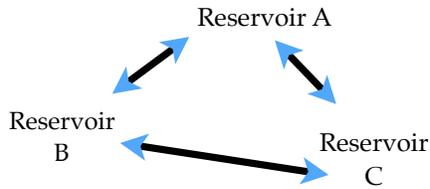


- * Water vapor is a greenhouse gas.
- * In the humid tropics, small addition of CO_2 or water vapor has little effect.
- * In cold, dry regions like the poles or upper atmosphere the effect is greater.



Cycles & Reservoirs

- * Material is transferred between reservoirs as part of a cycle.
- * Elements on Earth are from when the Earth was accreted (~4.5 billion years ago).
- * Cycles interconnect.





Carbon reservoirs

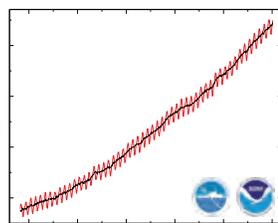
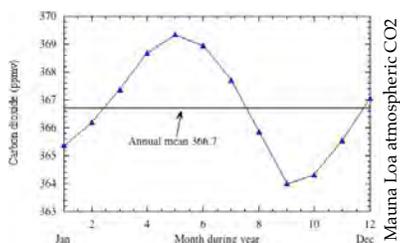
Reservoir	Amount
Carbonate Sediments	150,000
Soils (dissolved carbon)	25,000
Oceans and Freshwater (dissolved CO ₂)	140
Biomass (living material)	30
Fossil fuels (plus organic carbon in sediments)	27
Atmospheric CO ₂	2

Amounts are in units of 10¹² tons of CO₂ equivalent.



Carbon reservoirs

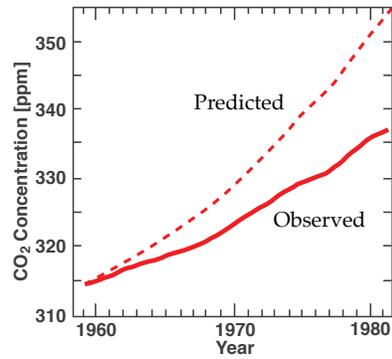
- * The total size of the biomass reservoir probably hasn't changed much over last ~200 years. Increases in human population and agriculture offset by deforestation etc.
- * Annual cycle of plant growth and death moves CO₂ from atmosphere to biomass and back.





Carbon reservoirs

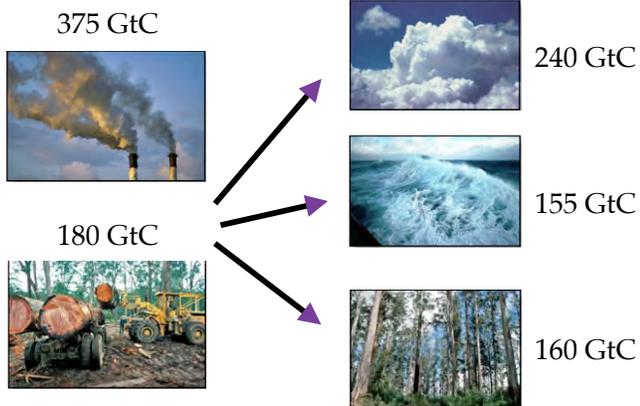
Observed atmospheric CO₂ levels are smaller than predicted from oil, coal production records.



So some CO₂ must be going in to the ocean.



1750 to 2011 GHG totals





Ocean Acidification



THE SCIENTIFIC METHOD

- Observe a phenomenon
- Make an educated guess about what caused the phenomenon
- Test that idea by making predictions and conducting further observations or experiments (what else should happen if this idea is correct?)
- If predictions were correct, make more predictions and test again (and again, and again!)
- If NOT correct, modify the idea or develop new one

Summary of Local Impacts of Climate Change to Hawai'i



The rate of **warming air temperature** in Hawai'i has quadrupled in the last 40 years to over 0.3°F (0.17°C) per decade. This warming could cause thermal stress for plants and animals, and heat-related illnesses in humans as well as expanded ranges for pathogens and invasive species.



A **decrease in the prevailing northeasterly trade winds**, which drive orographic precipitation on windward coasts, has been recorded in Hawai'i over the last 40 years.



Hawai'i has seen an overall **decline in rainfall** in the last 30 years, with widely varying precipitation patterns on each island. It is projected that Hawai'i will see more drought and heavy rains causing more flash flooding, harm to infrastructure, runoff, and sedimentation.



Declining precipitation trends have caused a **decrease in stream base flow** over the last 70 years, and could reduce aquifer recharge and freshwater supplies and influence aquatic and riparian ecosystems and agriculture.



Sea surface temperatures have warmed between 0.13°F and 0.41°F (0.07°C and 0.23°C) per decade in the Pacific for the last 40 years. This trend is projected to accelerate, warming by 2.8°F to 4.9°F (1.5°C to 2.7°C) before the end of the century. This warming can influence ocean circulation and nutrient distribution.



Global **ocean acidity has increased** by 30% due to marine uptake of CO₂, correlating to a pH change of 0.1. Acidification is expected to continue, with additional pH changes between 0.1 and 0.4 by the end of the century. Ocean acidification could trigger a wide range of impacts on marine biota, including inhibiting shell and skeleton growth in corals, shellfish, and plankton.



Sea level has risen over the last century on each island at rates varying from 0.5-1.3 inches (1.5-3.3 centimeters) per decade, which has contributed to shoreline recession. Accelerating rates of sea-level rise have been detected in global sea level data. Rates of rise are projected to continue to accelerate, resulting in a 1-3 foot (approximately 0.3-1 meter) rise, or more, by the end of the century. Sea-level rise will exacerbate coastal inundation, erosion and hazards, leading to the degradation of coastal ecosystems, beach loss, and increasing damage to infrastructure in low-lying areas.



Threats to human health posed by Hawai'i's warming climate may include increased heat-related illness and wider ranges of vector-borne diseases such as dengue fever.



'No regrets' actions





Some key ideas

- * Climate change is a natural process that has happened for millions of years.
- * The climate system includes many cycles linked together.
- * Human activities are increasing the rate of climate change.
- * Climate change is not just warming - its much more complicated.
- * 2012 was a record low for Arctic Sea Ice.
- * Polar regions are most sensitive to climate change.
- * Positive feedback reinforces the cycle.
