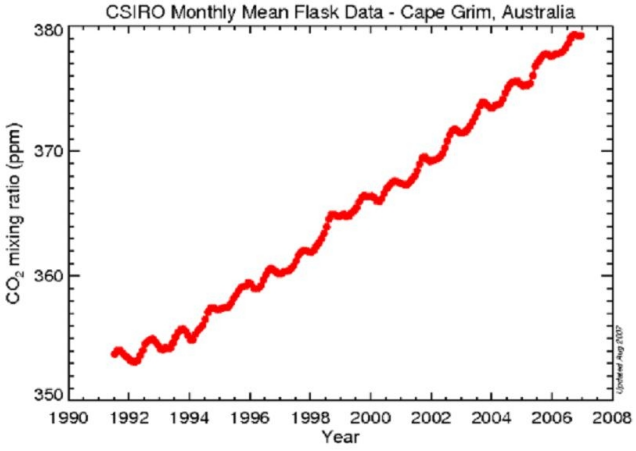
Climate Change:
How do we know what we know?

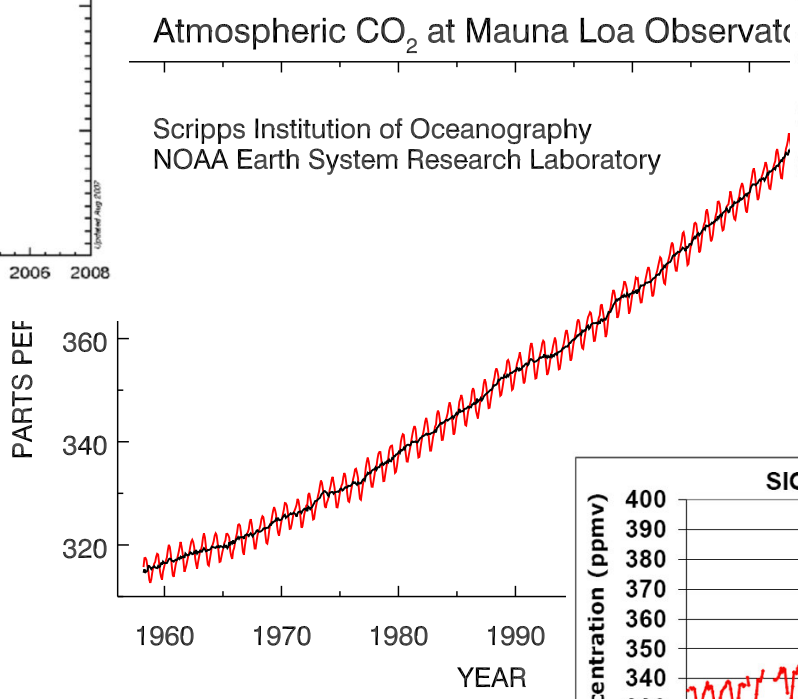
Nadir Jeevanjee

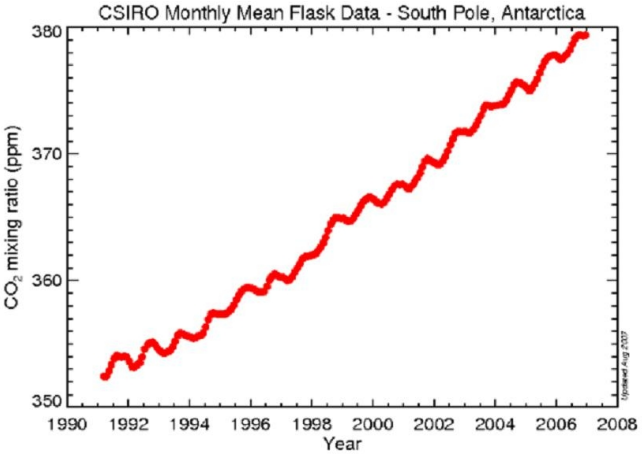
Hess Fellow

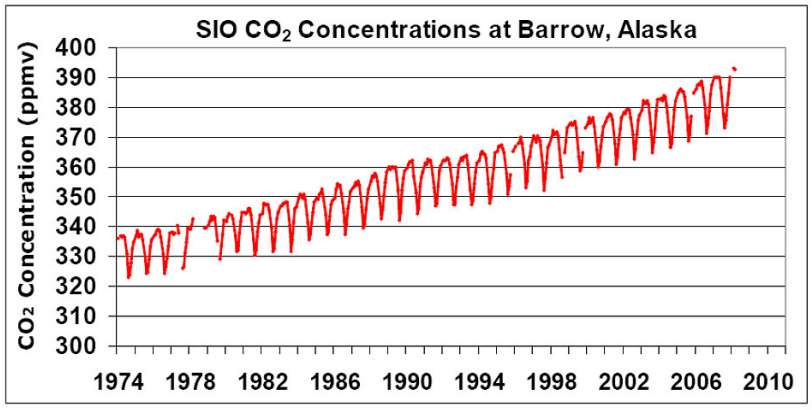
Dept. of Geosciences, Princeton University

How do we know atmospheric CO_2 is increasing?



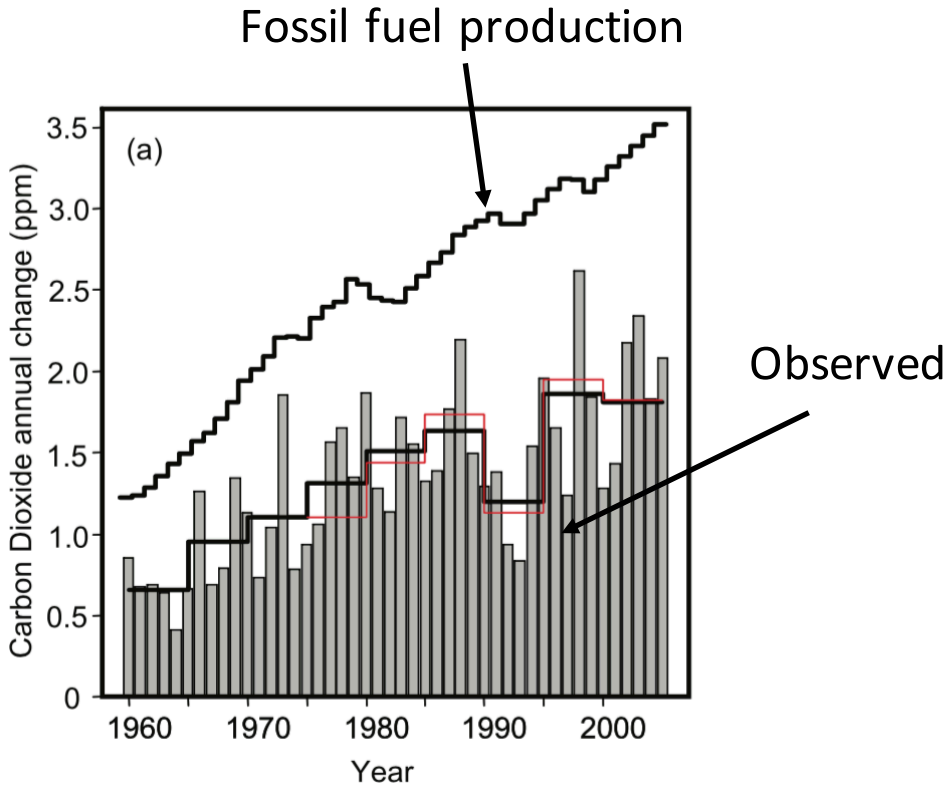


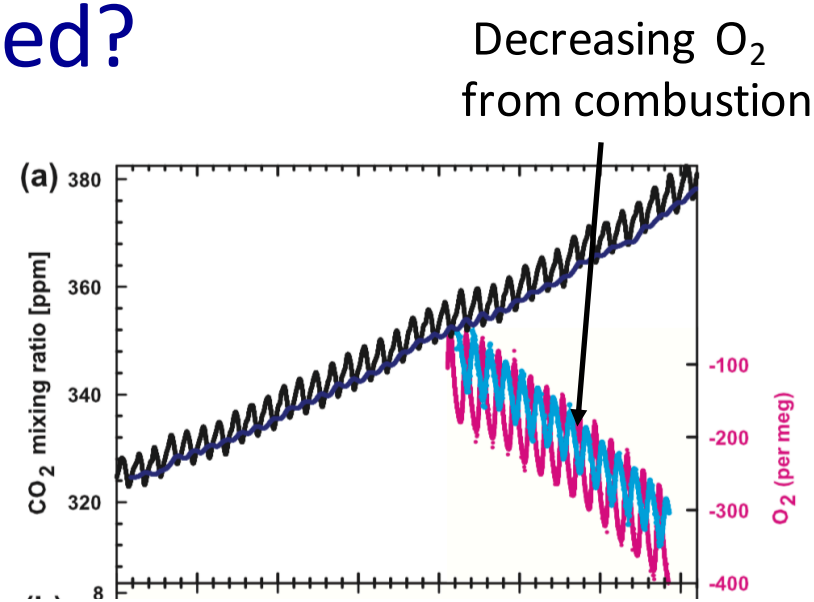




Source: http://cdiac.ess-dive.lbl.gov/trends/co2/csiro/

How do we know these CO_2 increases are human-caused?



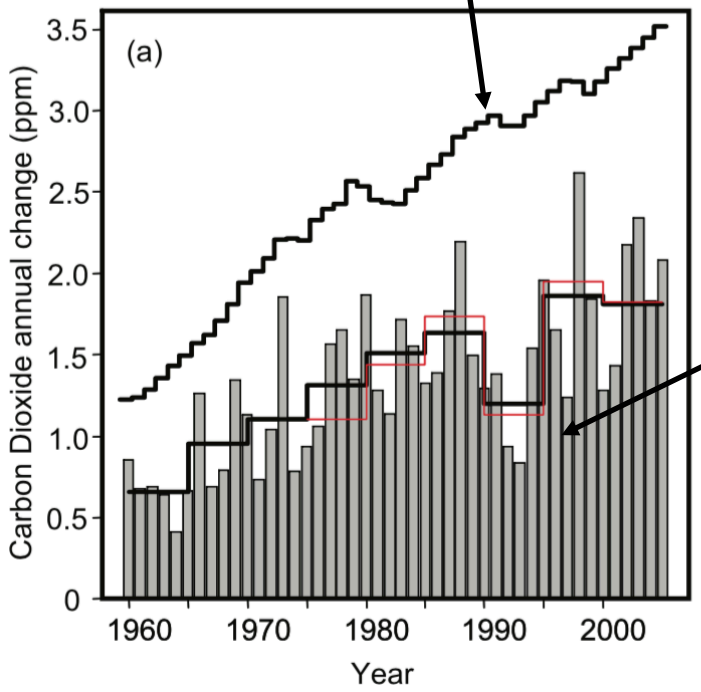


Source: Denman et al. (2007) (IPCC AR4 WG1 Ch.7)
Forster et al. (2007) (IPCC AR4 WG1 Ch.2)

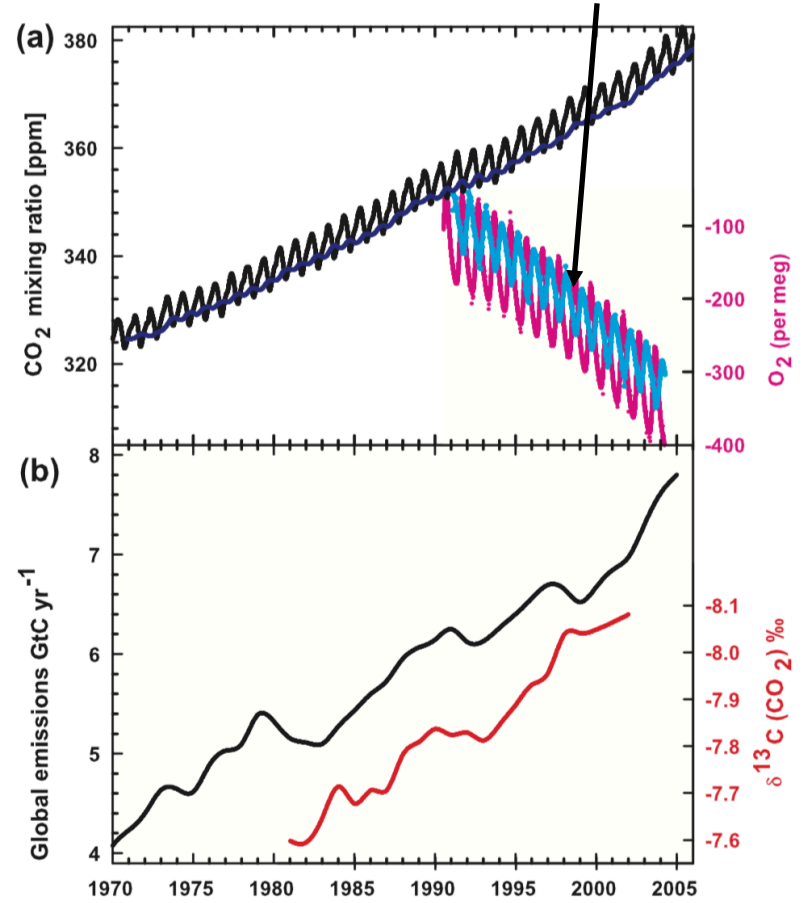
How do we know these CO_2 increases are human-caused?

Fossil fuel production

Observed



Decreasing O_2 from combustion



Source: Denman et al. (2007) (IPCC AR4 WG1 Ch.7)
Forster et al. (2007) (IPCC AR4 WG1 Ch.2)

How do we know these CO_2 increases are behind the observed warming?

Different temperature reconstructions from land-based thermometer records are consistent

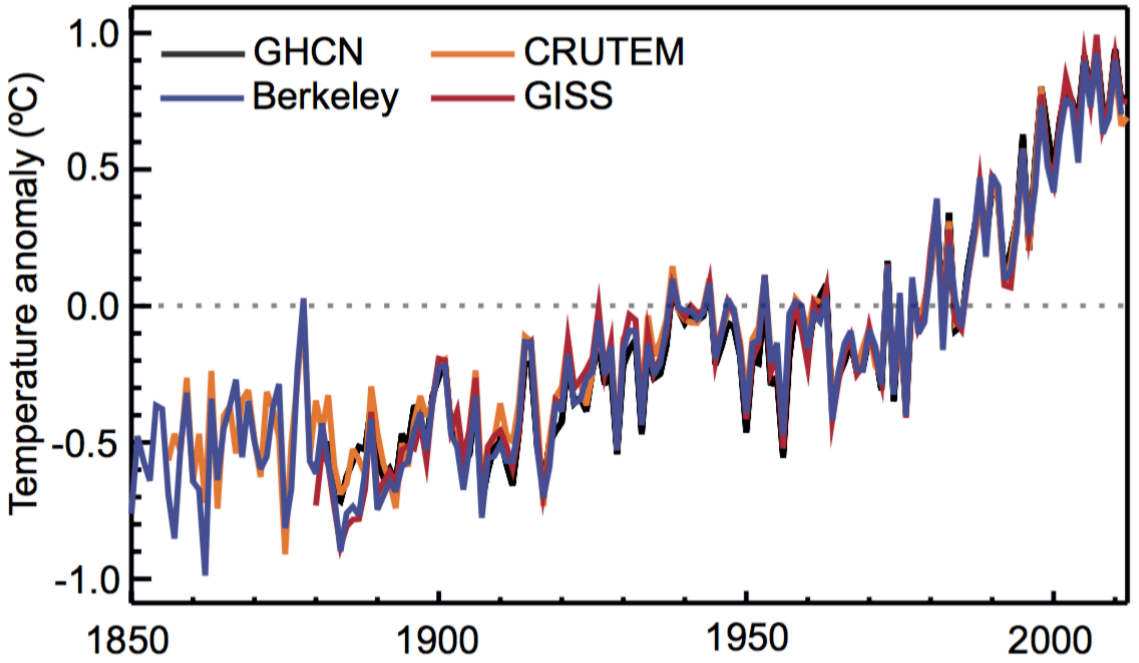
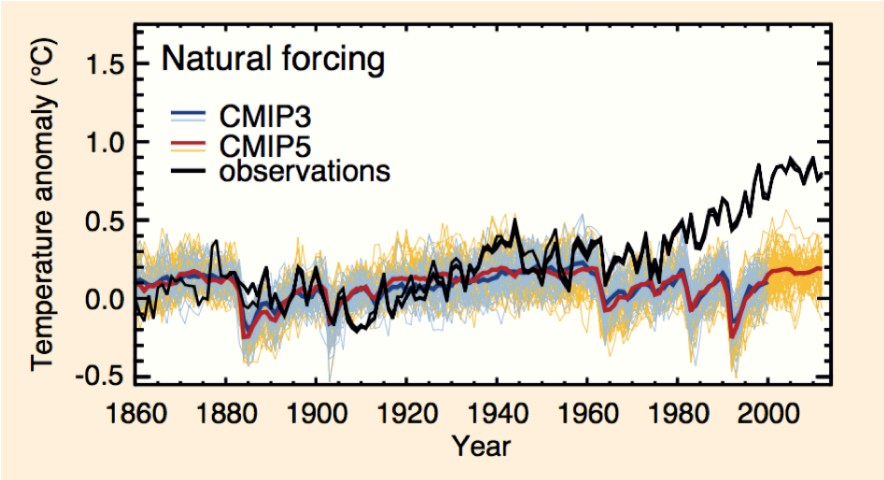


Figure 2.14 | Global annual average land-surface air temperature (LSAT) anomalies relative to a 1961–1990 climatology from the latest versions of four different data sets (Berkeley, CRUTEM, GHCN and GISS).

Source: Hartmann et al. 2013 (IPCC AR5 WG1 Ch.2)

How do we know these CO_2 increases are behind the observed warming?

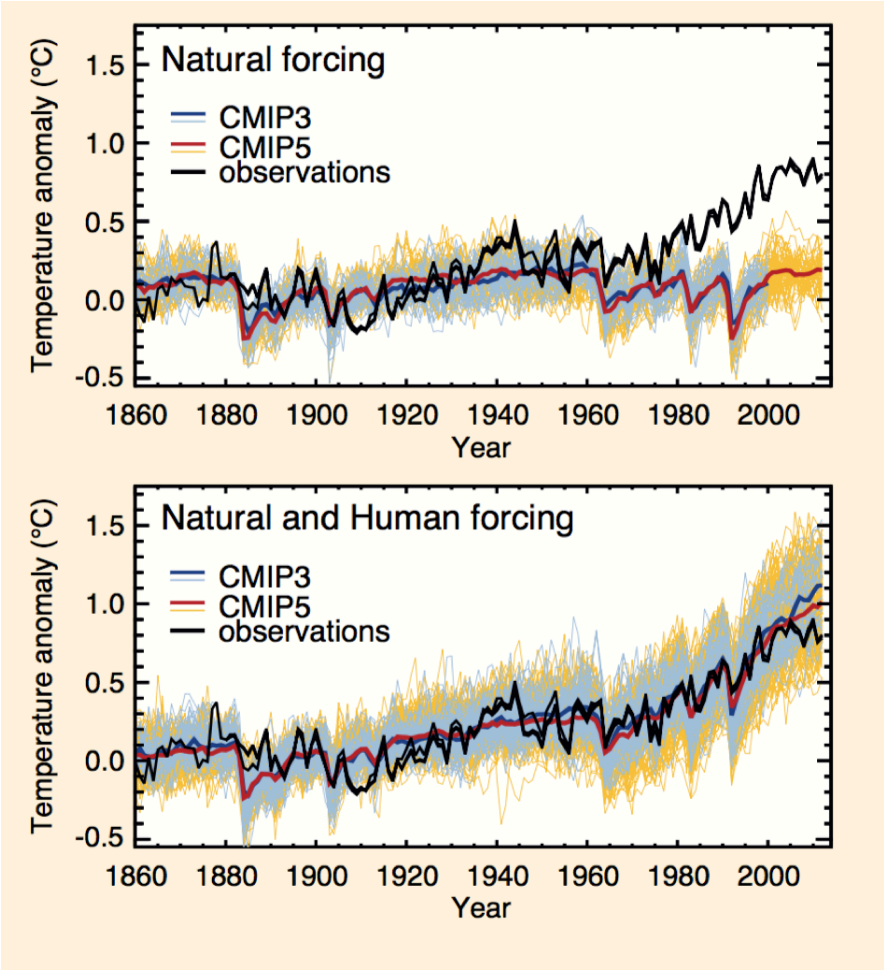
CMIP = International ensemble of global climate models



Source: Bindoff et al. 2013 (IPCC AR5 WG1 Ch.10)

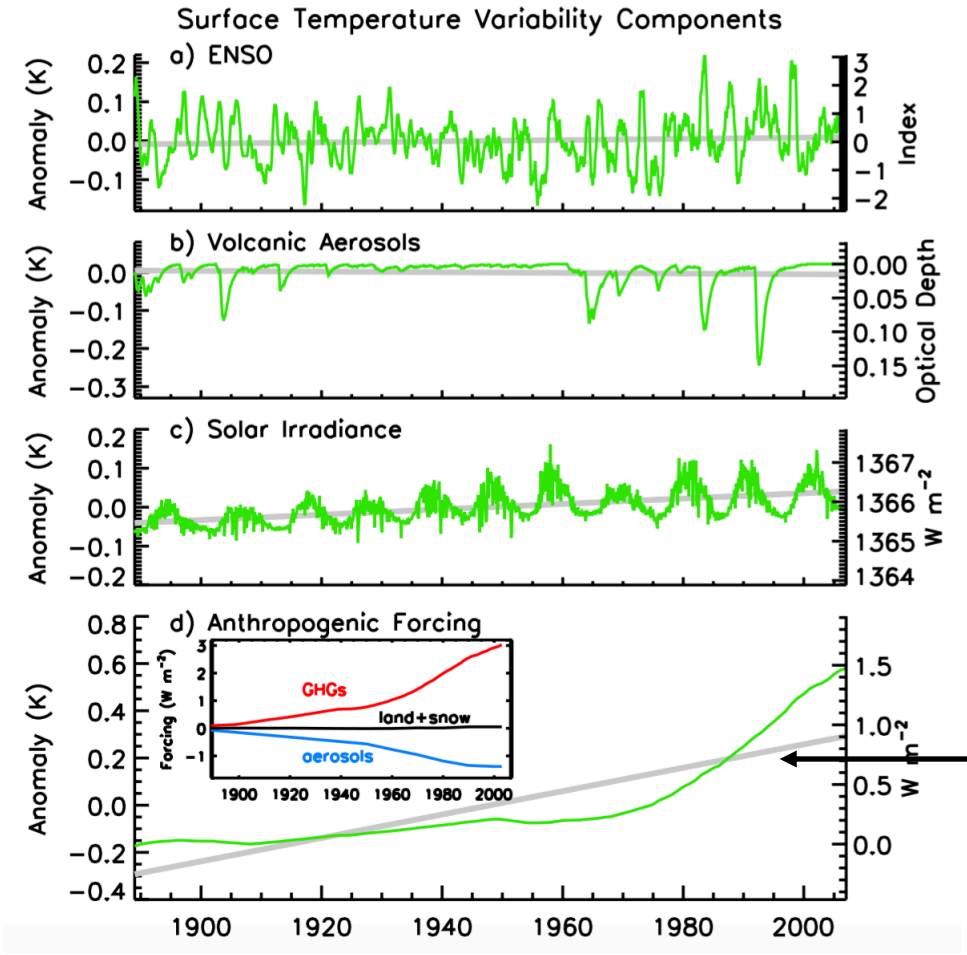
How do we know these CO_2 increases are behind the observed warming?

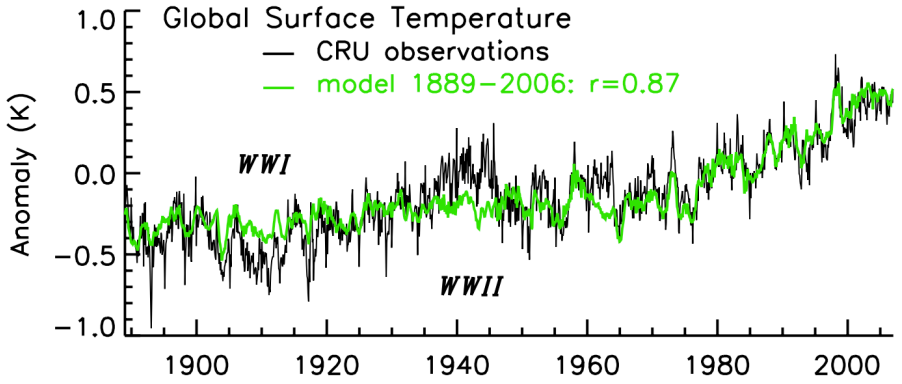
CMIP = International ensemble of global climate models



Source: Bindoff et al. 2013 (IPCC AR5 WG1 Ch.10)

How do we know these CO_2 increases are behind the observed warming?

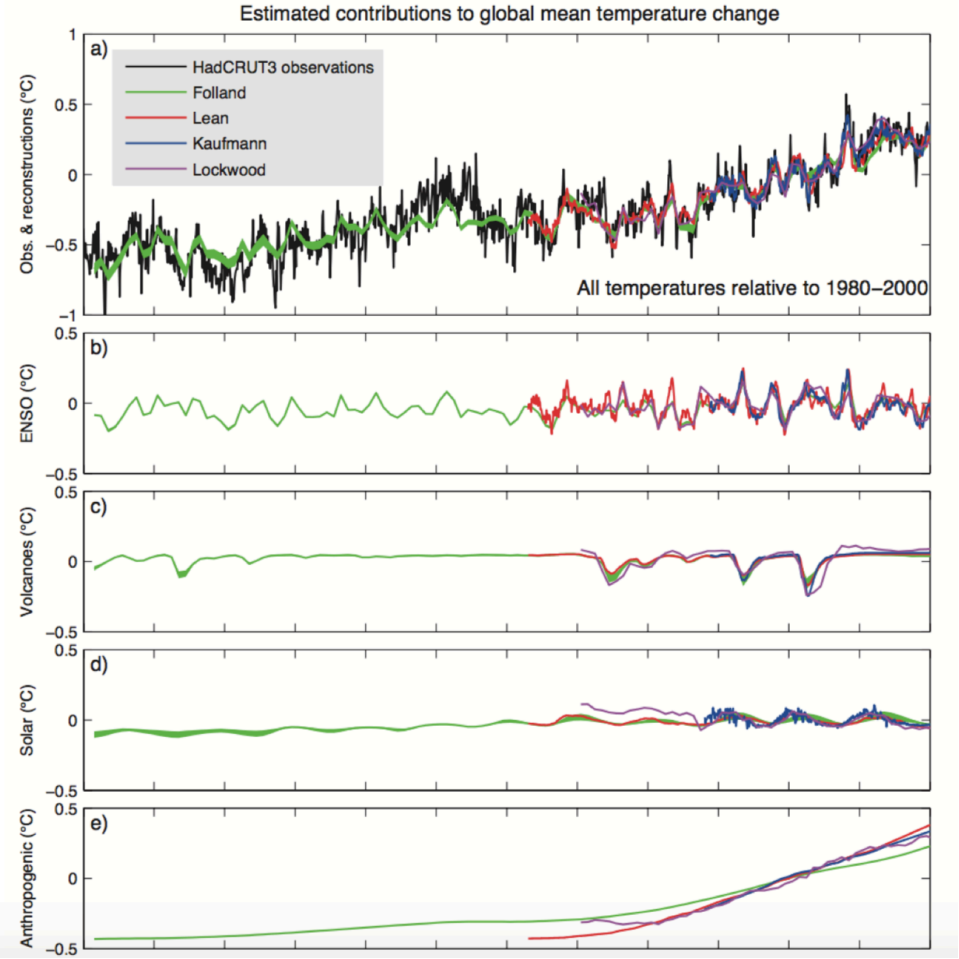




Linear regression suggests that most of the warming trend comes from GHGs

Source: Lean 2008, GRL

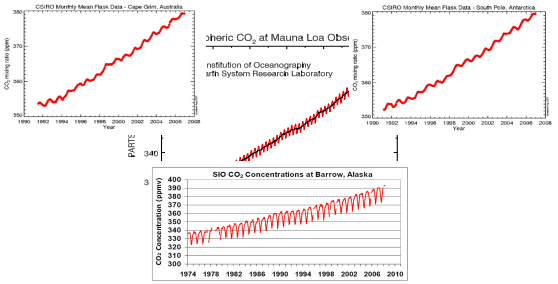
How do we know these CO_2 increases are behind the observed warming?

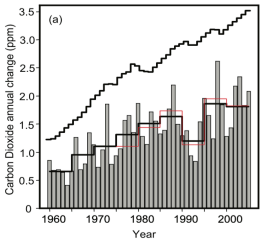


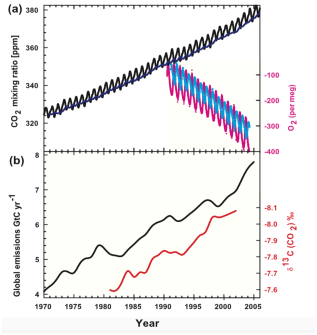
Source: [Bindoff et al. 2013](#) (IPCC AR5 WG1 Ch.10)

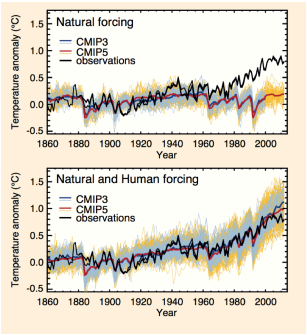
Different regression models agree on this conclusion

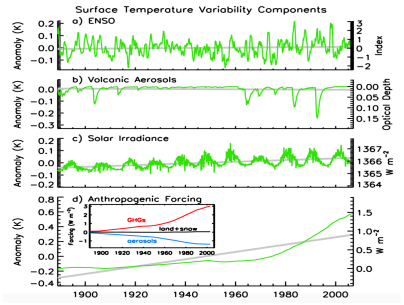
Review

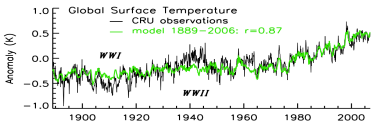






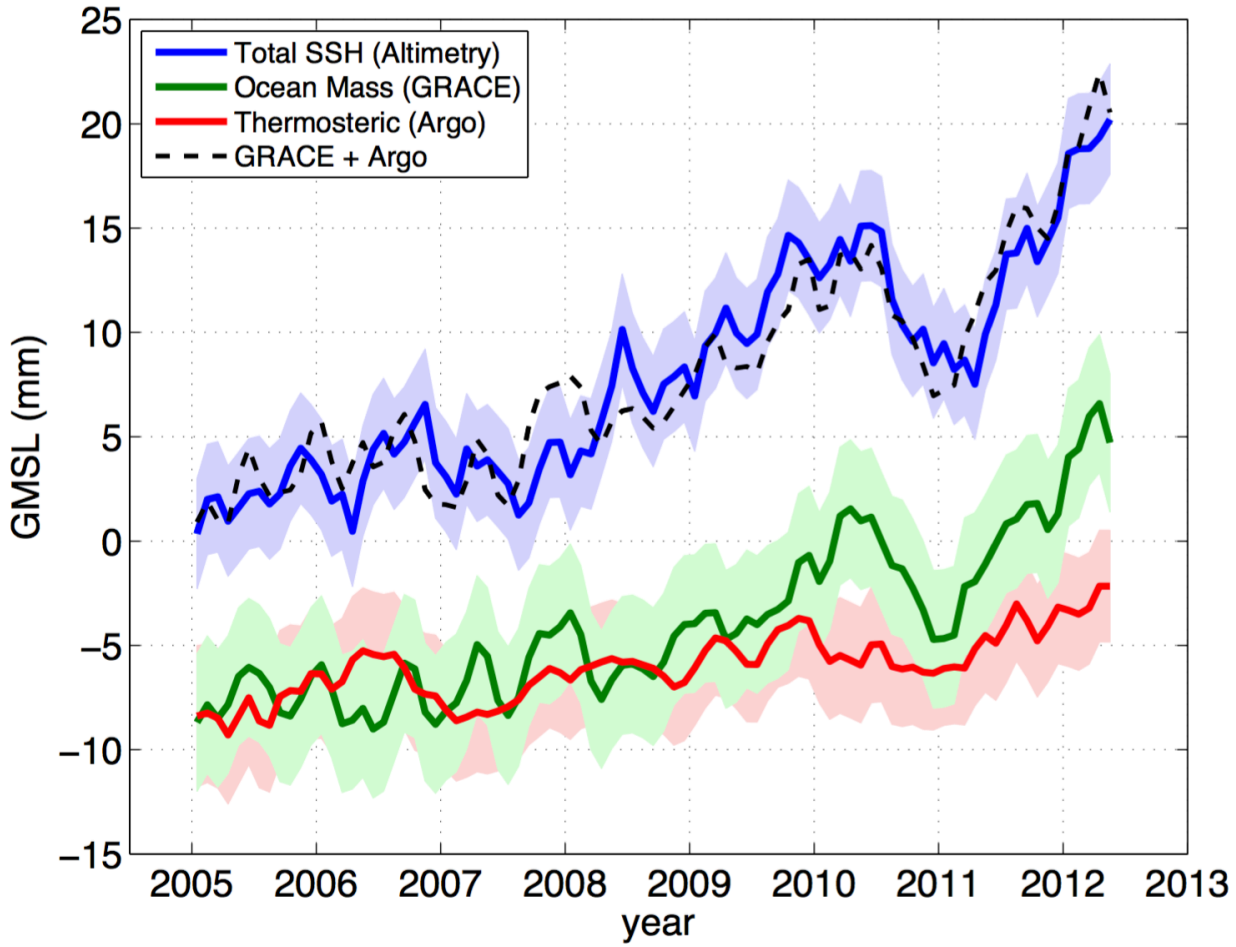






- Atmospheric CO2 is increasing
- This increase is consistent with fossil fuel combustion
- Simple and complex models can only replicate observed warming by including CO2 greenhouse effect

How do we know sea level is rising, and what are the causes?



Source: Church et. al. (2013) (IPCC AR5 WG1 Ch.13)