Natural Causes (cont)

1. Solar output has showed little or no upward trend since 1978, when satellites began measurement, only periodic variation of less than 0.1% in 11 yr. cycles. Earlier records of sunspot activity (related to solar output) suggest an increase in solar radiation dating back ~two centuries, but not recently. IPCC Scientists believe that at most 20% of warming of past decades can be attributed to increased solar output.
2. Earth system internal variability, such as the El Nino-Southern Oscillation (warming), can have large effects on temperatures. However, between 1000 and 1800, the overall *proxy record* shows nothing similar to the rate of warming seen since the late 19th century. The 1990s & 2000s appear to be the warmest decades in 1000 yrs.
3. Therefore, there is no compelling evidence that forcing mechanisms (#1-4), or internal variability (#5), or a combination thereof can account for the rate of warming of the past century.

***If natural causes and variability do not appear to have caused most of recent warming, are human activities sufficient to have caused it?***

Human activities have increased the concentrations of CO2 (30%) and other greenhouse gasses over past few centuries. Basic physics provide support for the warming role of greenhouse gasses, as do climate models that are based on physics, and empirical observations.

The Intergovernmental Panel on Climate Change has concluded that “…most of the observed warming over (the years 1950-2012) is likely to have been due to the increase in greenhouse gas concentrations.”

**Remember the process in which greenhouse gasses help warm the atmosphere…**

Some of the shortwave radiation from the sun penetrates the atmosphere, and is absorbed by the earth’s surface. Then, the earth emits longwave radiation, some of which is absorbed by the greenhouse gasses in the troposphere. Thus, solar radiation warms the earth’s surface, and then earth radiation warms the troposphere. (Note: surface air is also warmed through turbulent heat transfer from the heated earth.)

**What are likely impacts of global warming ?**