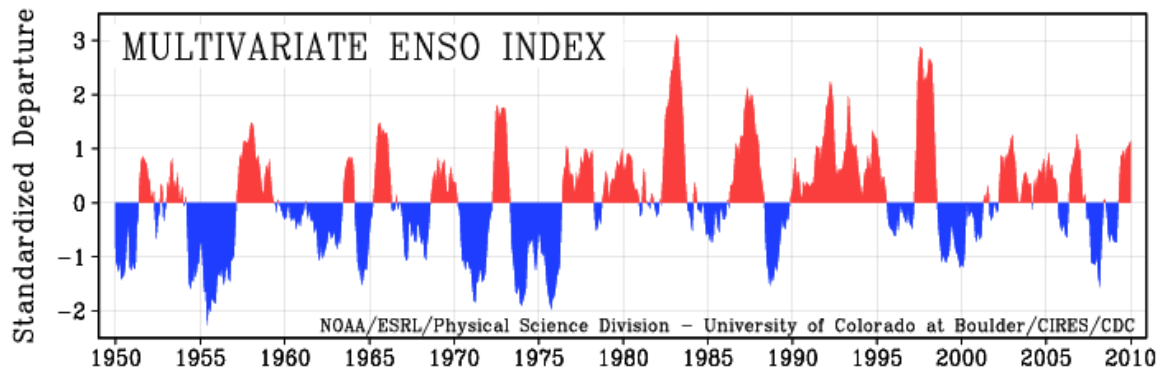
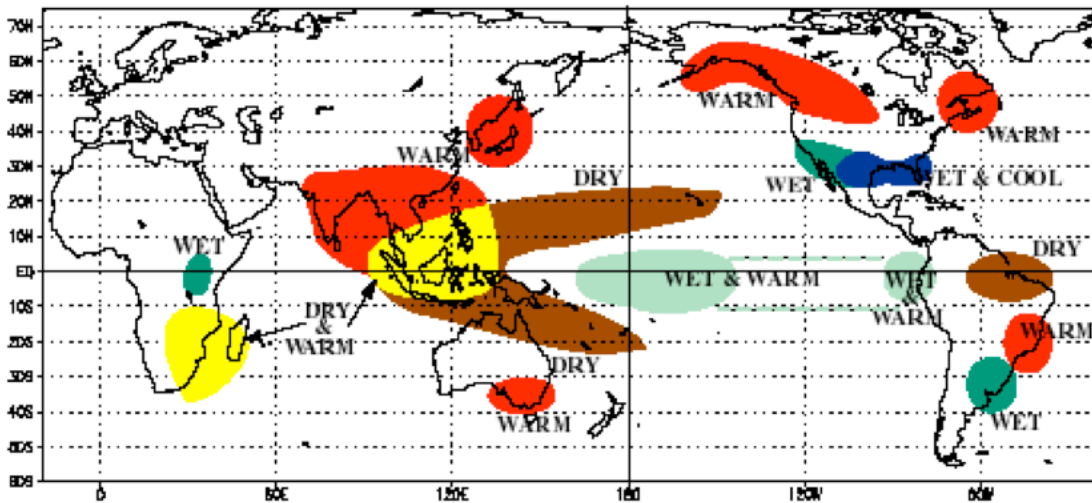


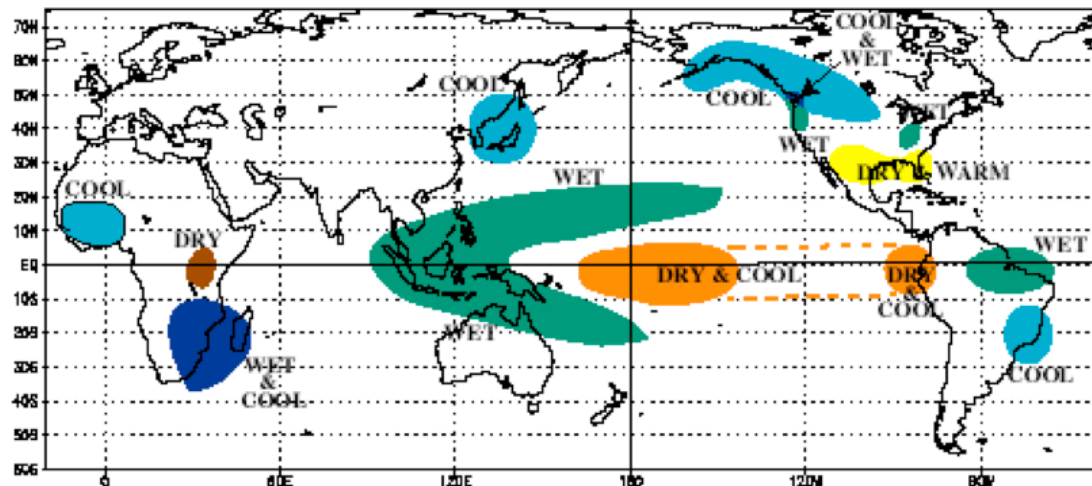
The **El Niño Southern Oscillation (ENSO)**, is a phenomena in the ocean and atmosphere of the Pacific that has global climatic impact. ENSO is described as having a cool or negative phase (La Niña), when warm water gathers in the West Pacific Warm Pool, and a warm or positive phase (El Niño), when that water moves East, “sloshes back” over the Pacific.



WARM EPISODE RELATIONSHIPS DECEMBER - FEBRUARY



COLD EPISODE RELATIONSHIPS DECEMBER - FEBRUARY



Q. Focusing on the West Pacific Warm pool, what happens in the atmosphere during an El Niño? During a La Niña?

Estimates of **global temperature** depend on surface measurements as well as satellite observations. These data are combined in models, a process called “reanalysis”, to estimate the state of the atmosphere.

Both types of measurement have their advantages and limitations.

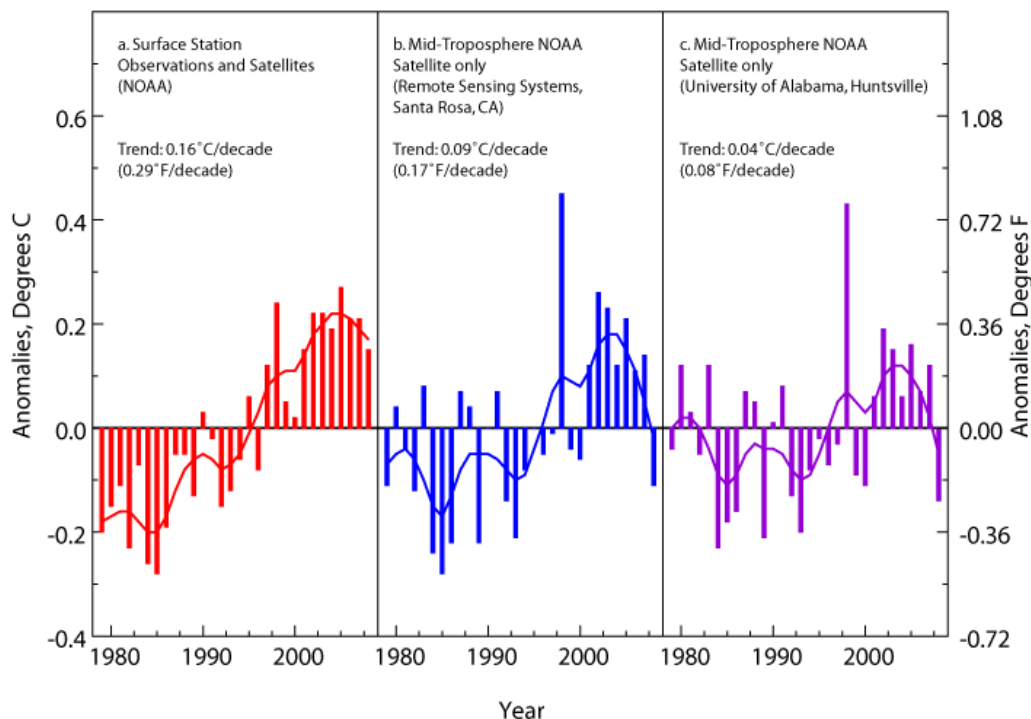
Satellites often measure temperature at the tops of clouds, which can be quite high and cold; this also means that their measurements are not always made at the same height. Satellites also cannot see the entire world at once, so their measurements are not simultaneous.

Surface measurements use many different instruments, which may not all be calibrated identically. Surface measurements are also be subject to highly localized processes.

People work hard to account for and correct these problems, but the biases of each are one reason they are generally used as model drivers in the reanalysis process rather than considered directly.

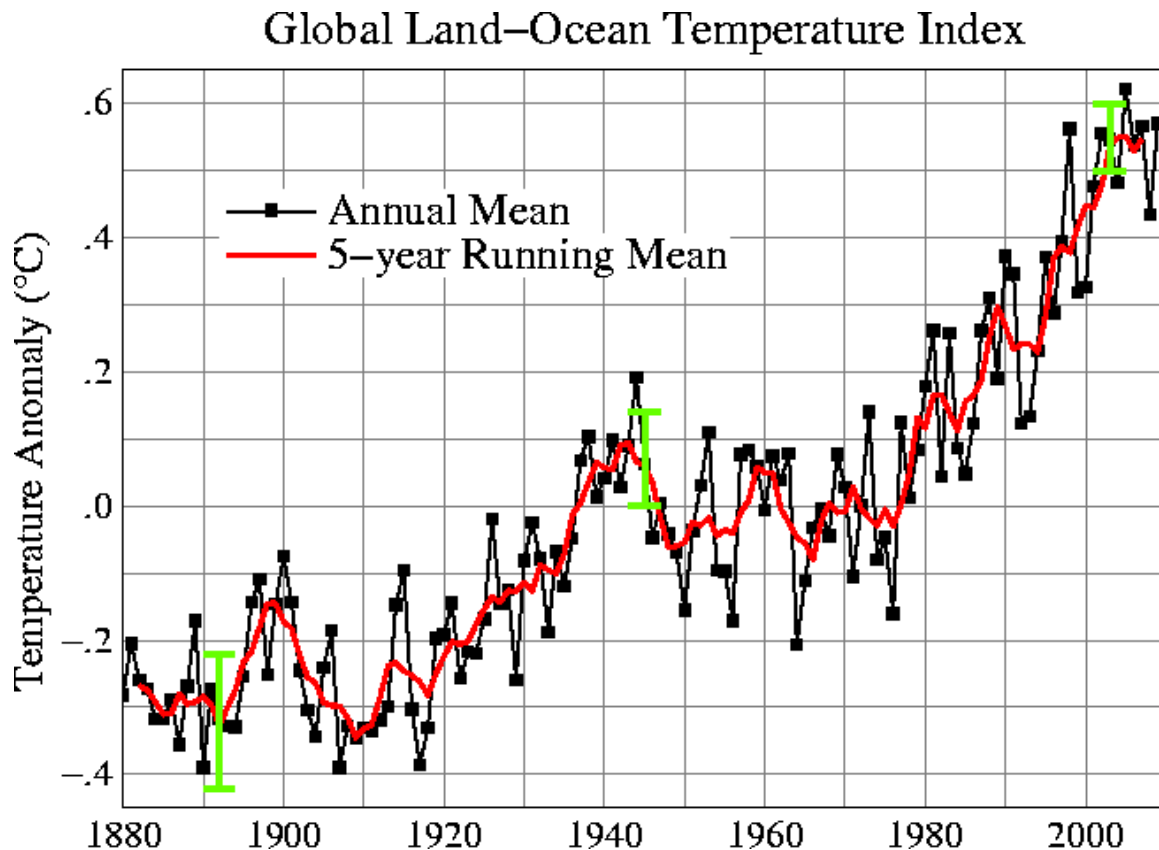
Q. What advantages might the surface record have over satellites? What are satellites better at?

Annual Temperature Anomalies: Middle Troposphere and Surface



Q. Can what we know about ENSO be used to explain some of the differences between the satellite and surface observations? Look at 1998, a strong El Niño year; and 2008 (the last year of temperature anomalies shown) a significant La Niña year. Why might ENSO have a stronger impact on satellite observations than surface measurements?

Once estimates of global temperature have been made, analyzed and reanalyzed; **global warming** may be considered.

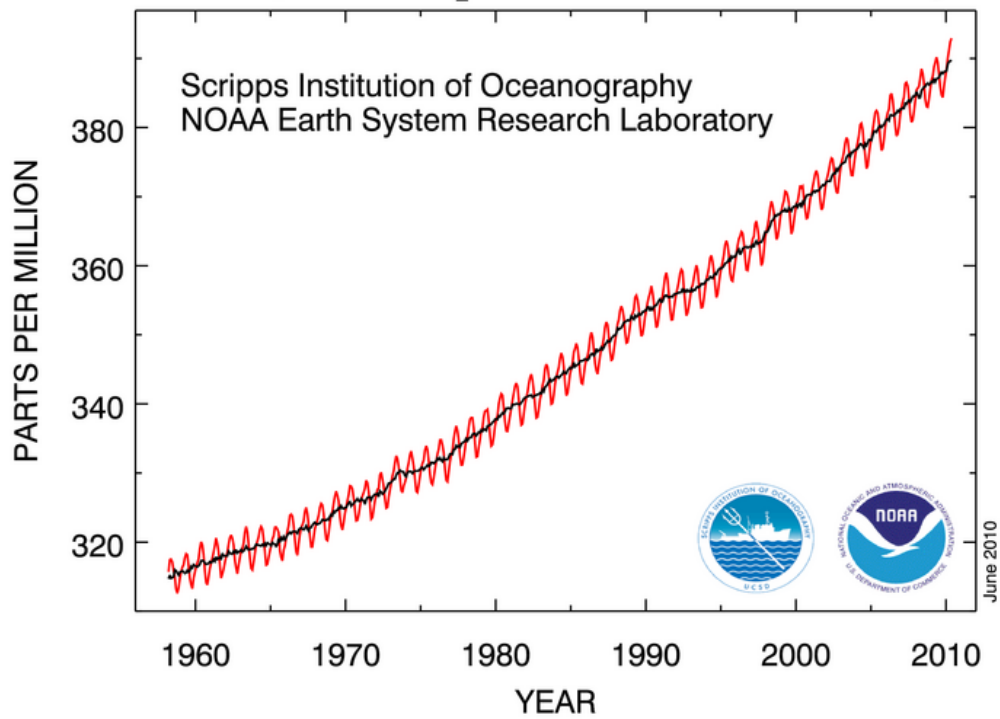


Q. In the previous temperature graph 1980 had a negative anomaly, in this graph its anomaly is positive, why?

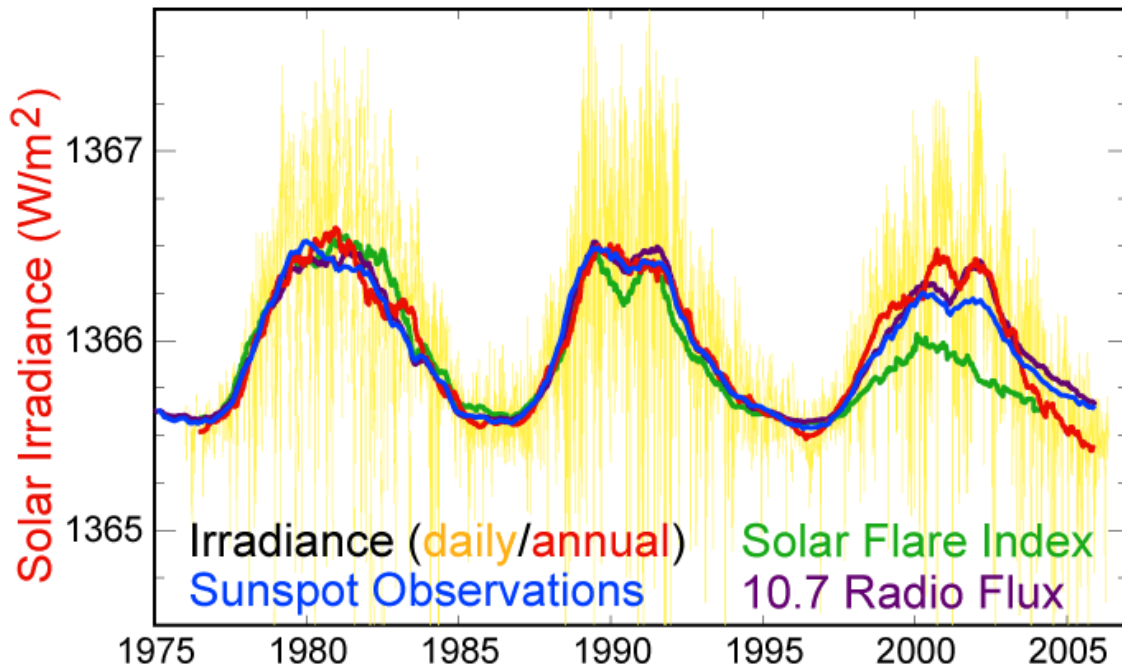
Q. Is the temperature trend linear, or are there “kinks”? What might be responsible for the decreased rate of warming from about 1950-1975?

There are many **forcings** of global temperatures. Some change over very long timescales like the arrangement of the continents or the Earth’s orbital characteristics. Most of these forcings are beyond our control, like aerosols from volcanic eruptions or solar variability. A few factors, like carbon dioxide emissions and land use change, are the direct result of human activities.

Atmospheric CO₂ at Mauna Loa Observatory



Solar Cycle Variations



Q. Are these trends consistent with the temperature record?