Can we believe the surface temperature record?

better phrasing (for science):
"How accurate is the surface temperature record?"

Quantifying Uncertainty
- key aspect of scientific method, knowledge
- often very difficult

One (partial) approach:
independent groups analyzing the same data set

Global Annual Average Temperature

- The global annual averaged surface temperature has risen about 0.85°C (1.5°F) in the past 100 years
- The past decade is the warmest in the instrumental record

IPCC Fig SPM3
Does the surface temperature record show warming?
Yes: trend analysis reveals accelerating warming

Is the warming "Global"
Yes, although enhanced over land at poles (as expected)
Warming extends above the surface

FIGURE TS.6: Patterns of linear warming trends over the period 1979-2005 for the surface (right, from thermometers) and lower atmosphere (left, from satellite).

Northern Hemisphere annual average surface temperature
Decreasing Cold Nights

Global Annual Cold Nights

Trends (days per decade)

Black lines significant at 95% level

Increasing Warm Days

Global Annual Warm Days

Trends (days per decade)

IPCC WG1 2009; FAQ 3.3, Figure 1.
Trends in Annual Land Precipitation

Areas in grey have insufficient data to produce reliable trends. Trends significant at the 5% level are indicated by black + marks.

IPCC WG1 2007 Figure 3.13.

Changes in Glacier Length 1500-2000

Most glaciers around the world are receding
Northern Hemisphere Snow Cover

Snow cover has decreased by 7.5% since 1922.

Shaded areas show 95% uncertainty levels.
Zero represents the 1961-1990 average.

IPCC Fig SPM3

Atmospheric Water Vapor

a) Column Water Vapour, Ocean only: Trend, 1988-2004

b) Global ocean mean (%) 1.2% per decade

IPCC Fig TS.8
Global Ocean Heat Content (0-700m)

- Solid lines are three independent estimates (95% confidence interval in grey)

IPCC Fig TS.16

Change in upper ocean temperature (1955-2003)

Trends in ocean temperature (averaged east-west) from 1955-2003

warming > 0.125C  cooling < 0.125C

IPCC 2007 Fig 5.3
At least half of the rise since 1960 is due to thermal expansion
The remaining is due to melting glaciers and ice caps

Other signs of (global) warming

- melting mountain glaciers
- decrease in winter snow cover
- increasing atmospheric water vapor
- warming of global oceans
- rising sea level (due to warming and ice-melt)
- timing of seasonal events
e.g. earlier thaws, later frosts
- thinning and disappearing Arctic sea ice
- species range shifts (poleward and upward)

Every one of these data sets can be questioned.
Taken together, the totality of evidence of global warming is quite convincing.
Trends in 20th Century Climate

- Material taken from the most recent IPCC report
  - What is the IPCC?
- Global Trends
- Regional Trends
- Pacific Northwest
- Summary

- Warming seen over all land and ocean regions
  - More in higher latitudes than in tropics; more over land than water
Change in Permafrost Temperatures in Alaska