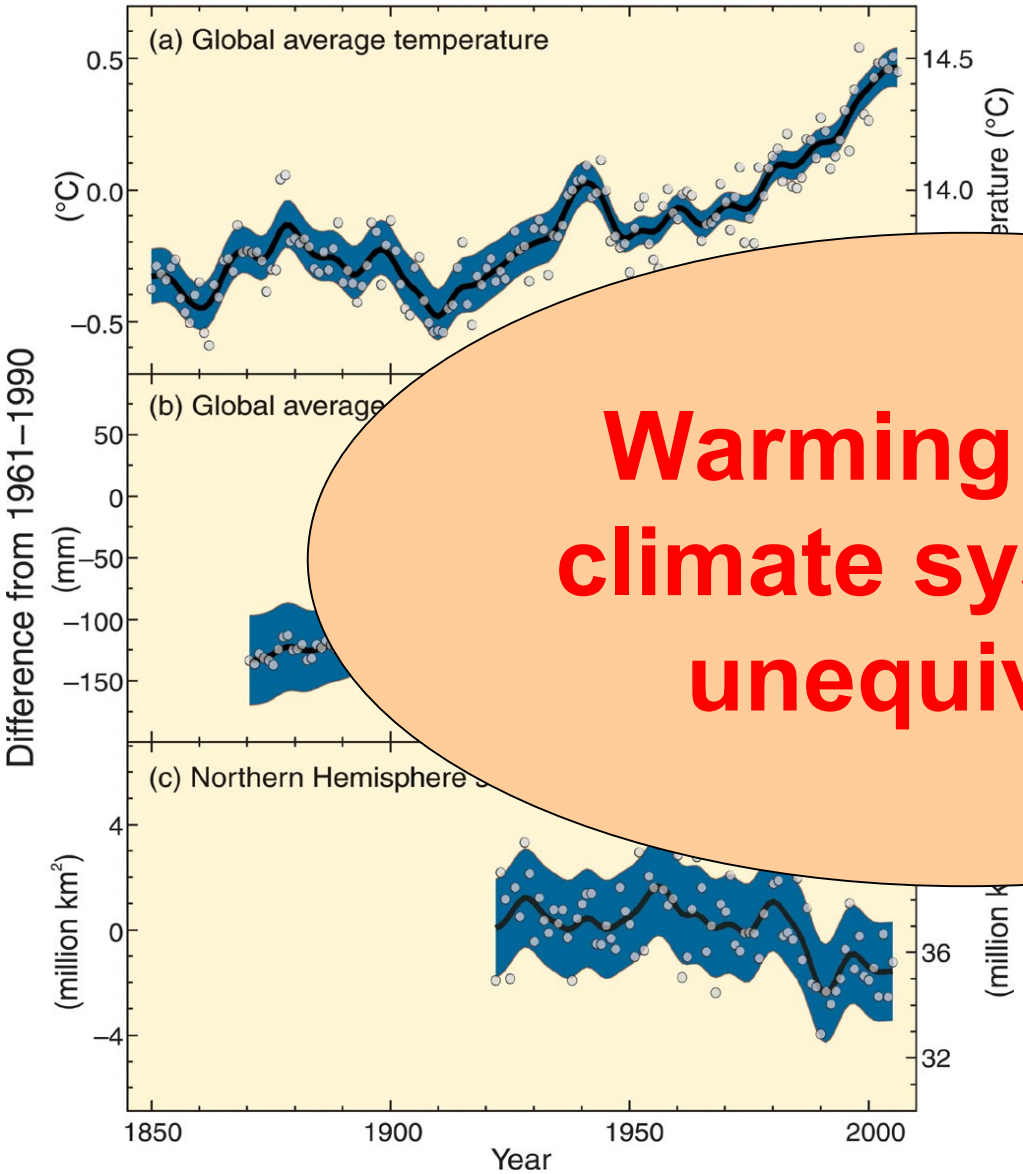
IPCC Fourth Assessment Report

Synthesis Report

Topic 1: Observed changes in climate and their effects

Topic 2: Causes of change

1. Observed climate change



100-yr warming trend (1906-2005) of 0.74°C.

reased since TAR.

Warming of the climate system is unequivocal

nm per yr

mm per yr

Decreasing:

- snow and ice extent
- Arctic sea ice extent
- Mountain glaciers

Observed change at continental, regional and ocean basin scales

Over 1900 – 2005:

- Precipitation increased significantly in: eastern parts of North and South America + Northern Europe + Northern and Central Asia.
- Precipitation decreased in: Sahel + Mediterranean + Southern Africa + parts of Southern Asia.

Since 1970 or earlier:

- Area affected by drought increased
- Cold extremes less frequent
- Heat waves more frequent (most land areas)
- Heavy precipitation events more frequent (most areas)
- Intense tropical cyclone activity increased in N Atlantic

Many Natural Systems are Affected

Changes in snow, ice and frozen ground

- Increased number and size of glacial lakes
- Ground instability in mountain & permafrost regions
- Changes in some Arctic and Antarctic ecosystems

Hydrological system changes

- Increased runoff
- Earlier spring peak discharge (glacier & snow-fed rivers)
- Altered thermal structure and water quality (rivers & lakes)

Many Natural Systems are Affected (2)

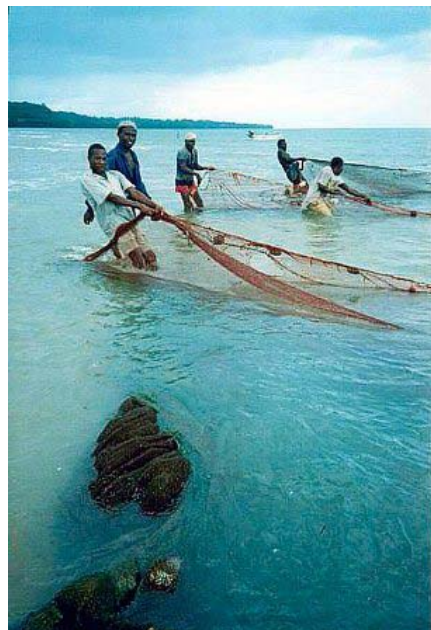
Recent warming in terrestrial ecosystems

- Spring events occur earlier in year
- Plant and animal ranges shift poleward or upward

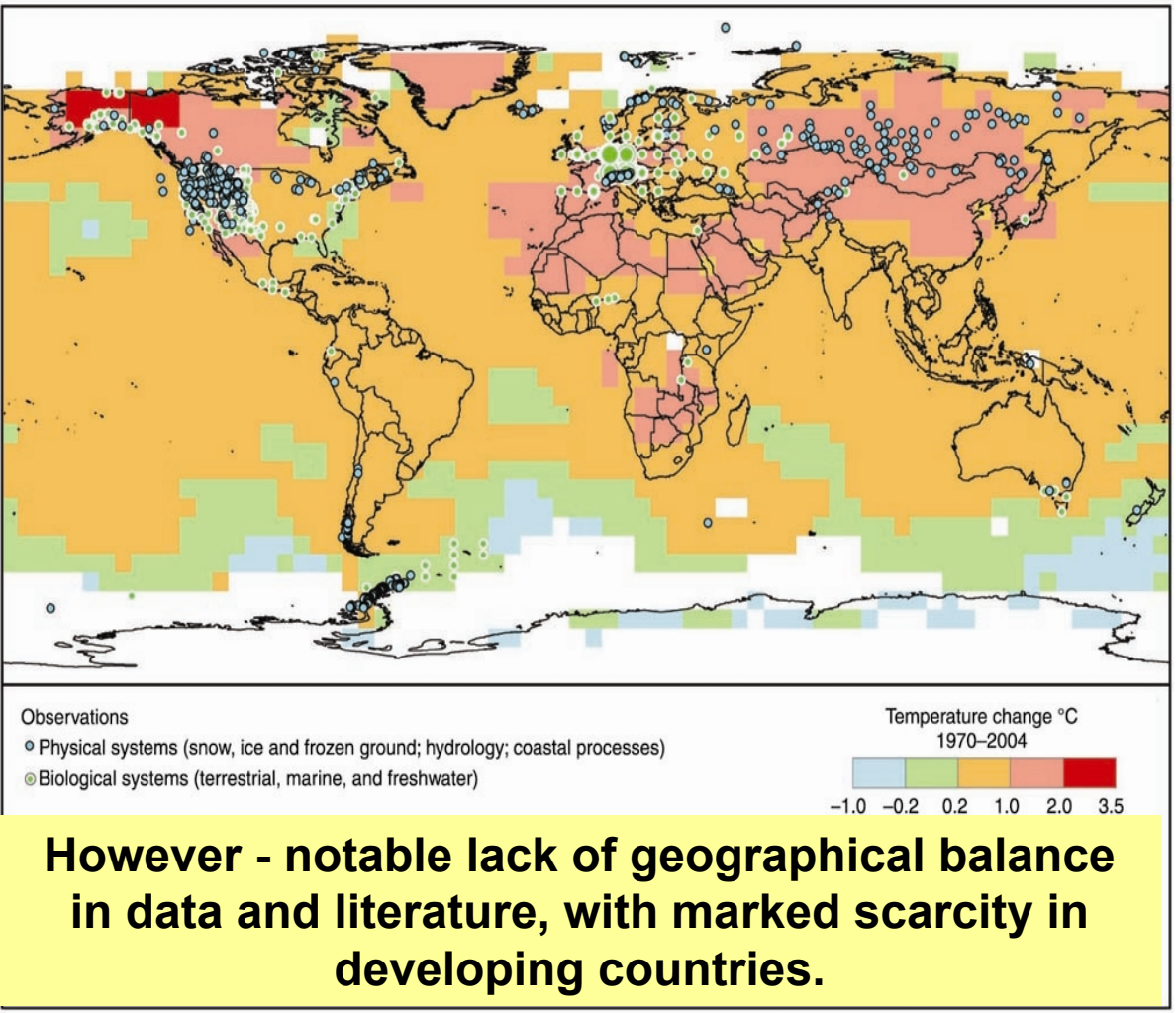
Rising water temperatures

Changes in ice cover, salinity, oxygen, circulation

- Shifts in ranges and other changes in algal, plankton and fish abundance



Observed changes in Physical and Biological systems



However - notable lack of geographical balance in data and literature, with marked scarcity in developing countries.

Literature survey criteria

At least 20 years of data, ending in 1990 or later

Finds:

~75 studies

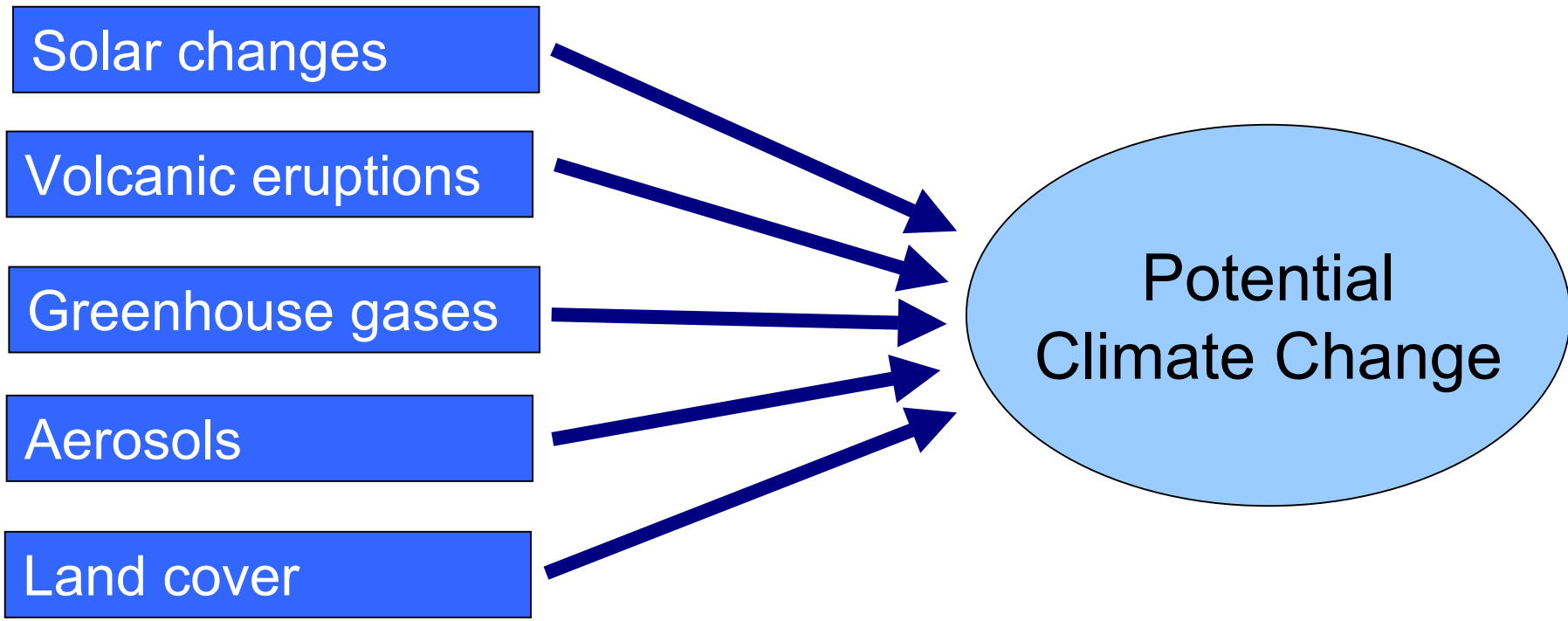
~765 data series of **physical** processes

>28,000 data series of **biological** species

Result:

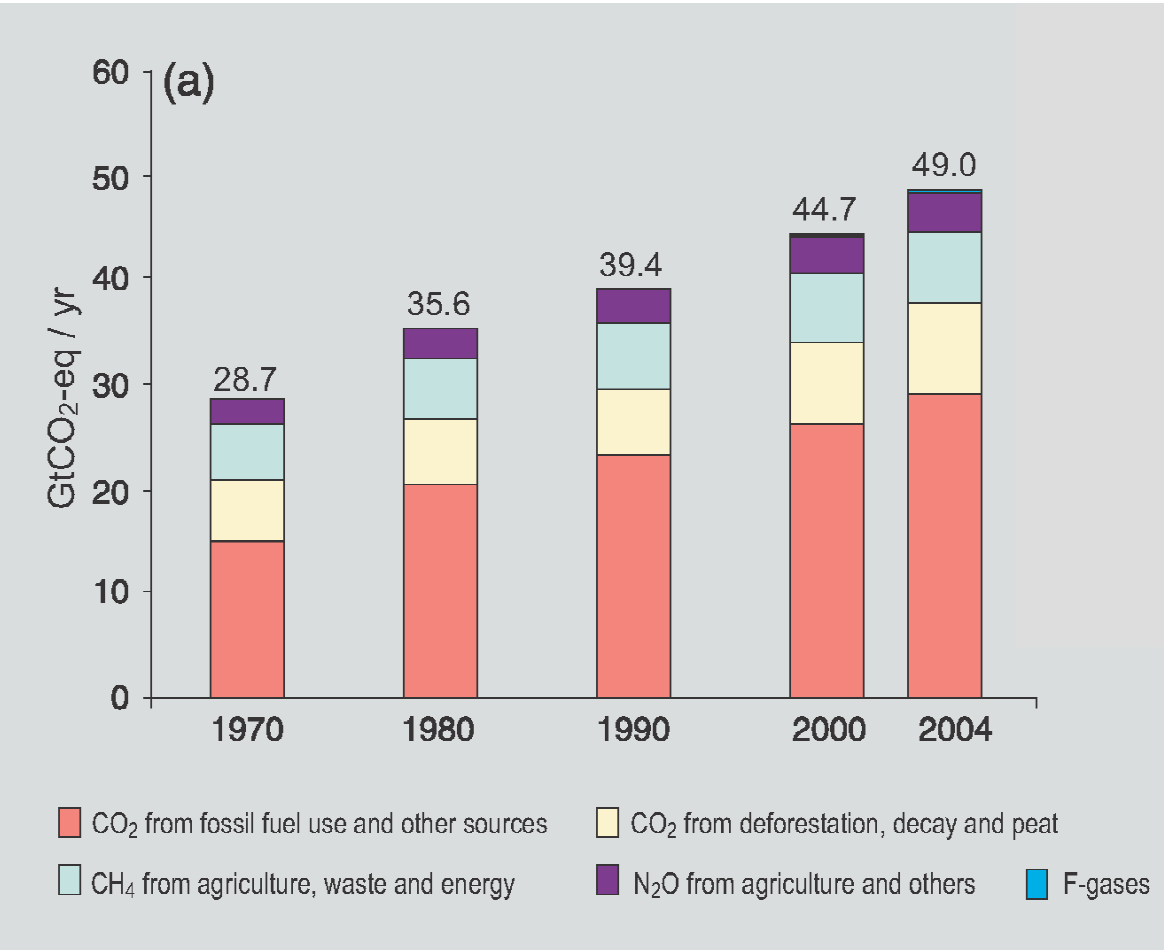
>89% consistent with warming

2. Causes of Change



There are both natural and anthropogenic drivers of climate change

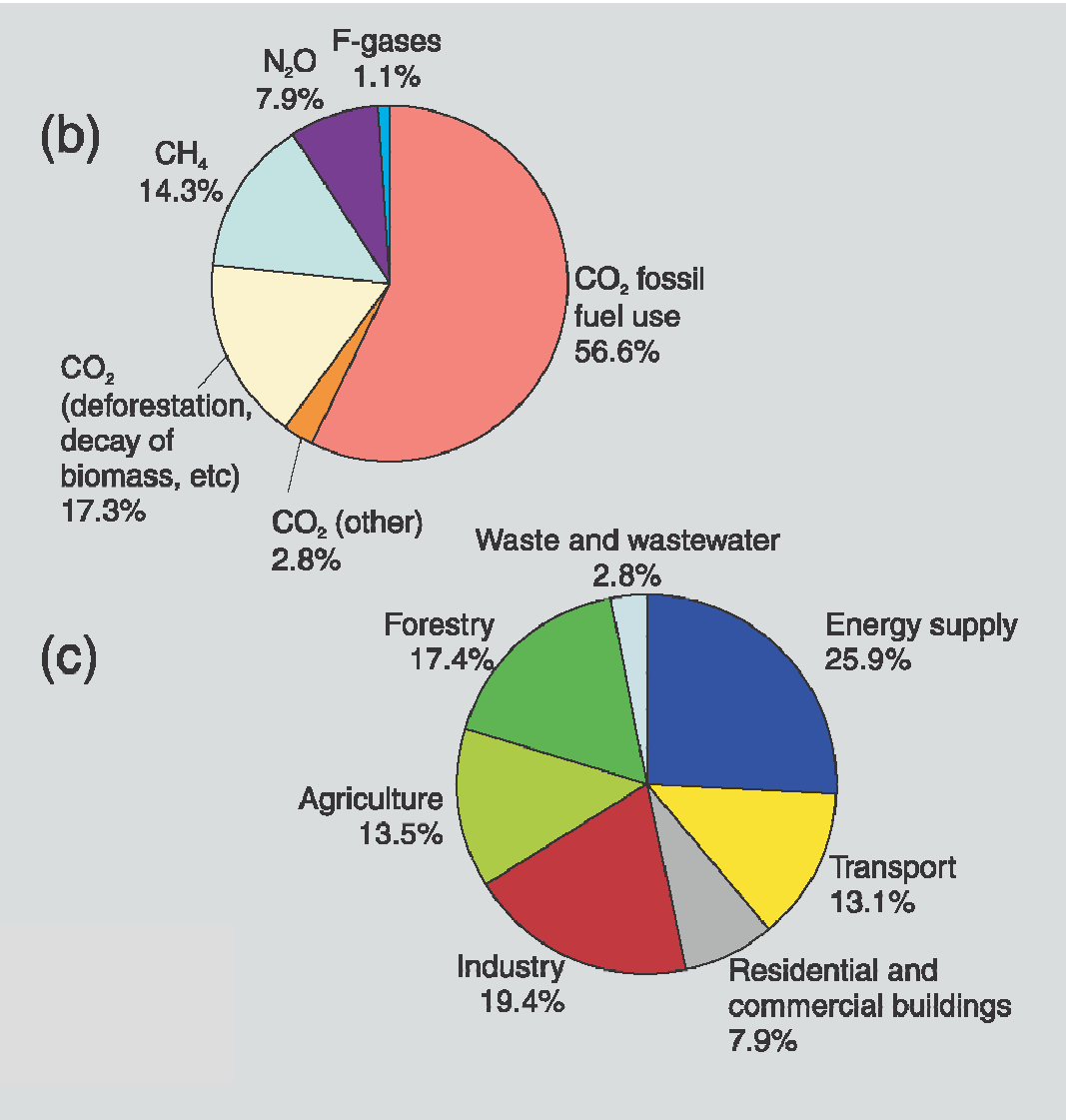
Growth in greenhouse gas (GHG) emissions



Anthropogenic GHG emissions grew by 70% between 1970 and 2004, from 28.7 to 49 $GtCO_2$-eq

Annual emissions of CO_2 grew by about 80% between 1970 and 2004

CO_2 is the dominant anthropogenic GHG

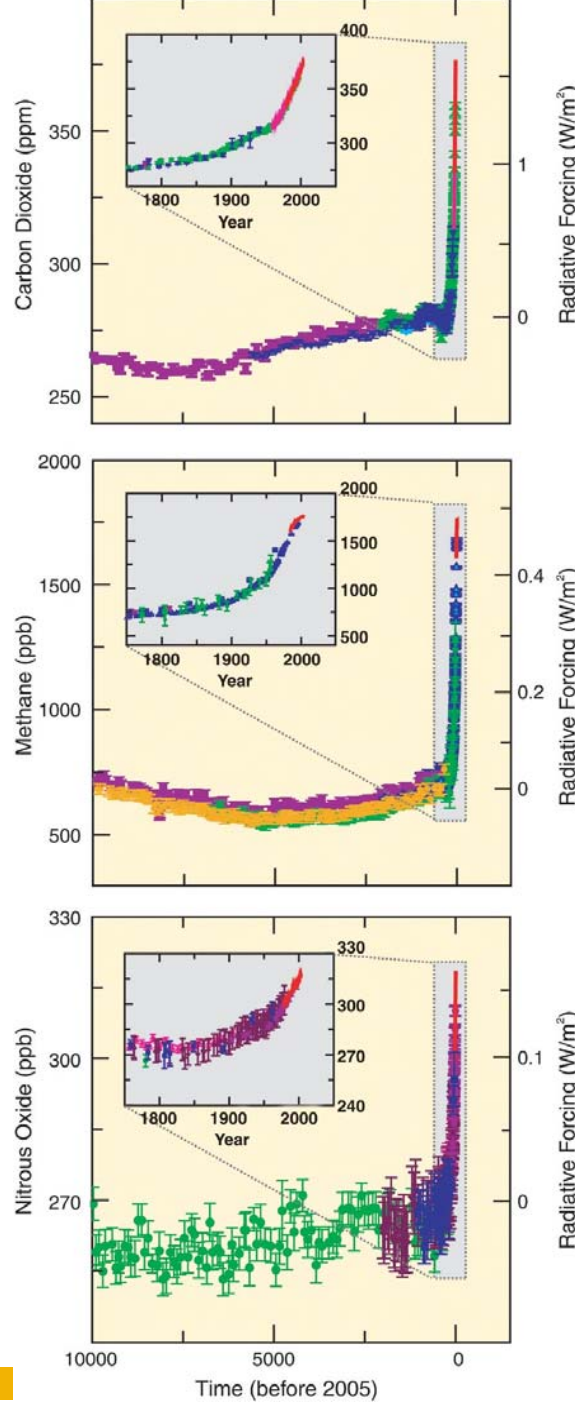


In 2004, CO_2 emissions were about 77% of GWP-weighted emissions of GHGs

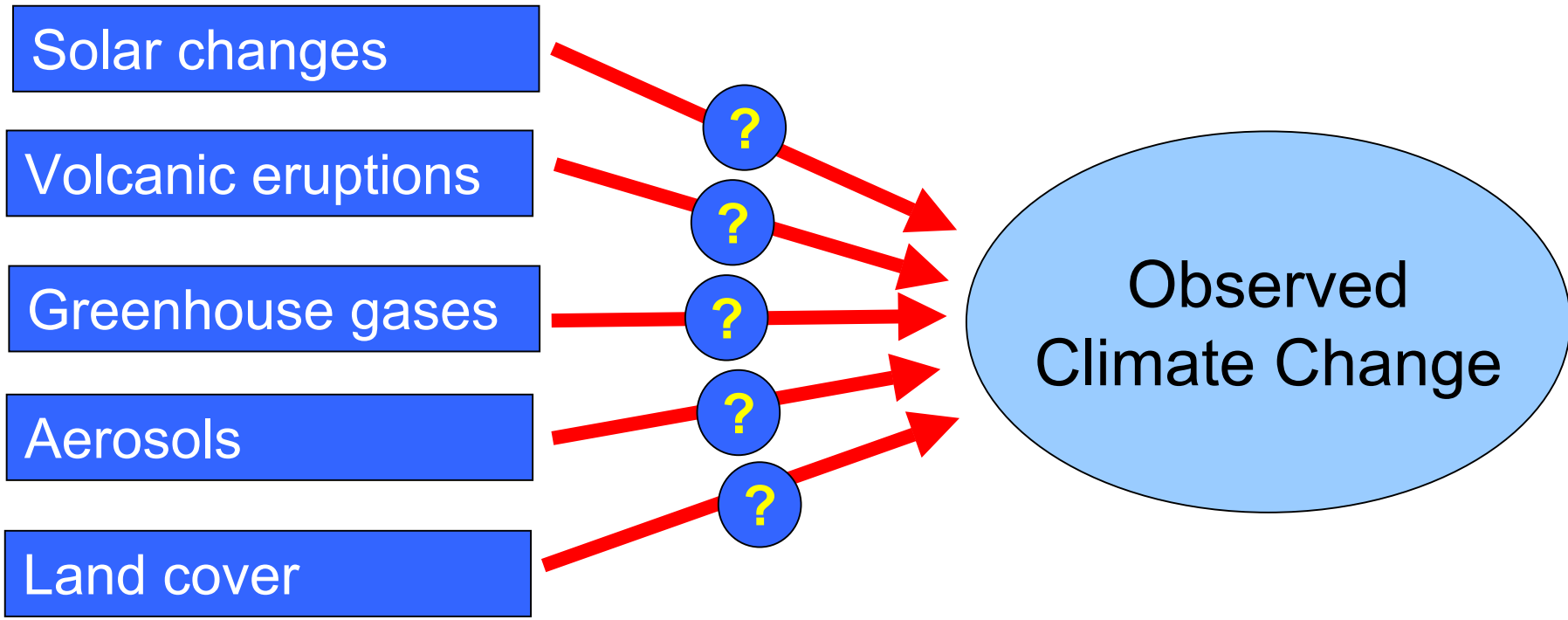
Many sectors contribute. (Forestry includes deforestation)

Atmospheric Concentrations

- Global atmospheric concentrations of CO_2, CH_4 and N_2O have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values
- Atmospheric concentrations of CO_2 and CH_4 in 2005 exceed by far the natural range over the last 650,000 years
- There is *very high confidence* that the net effect of human activities since 1750 has been warming

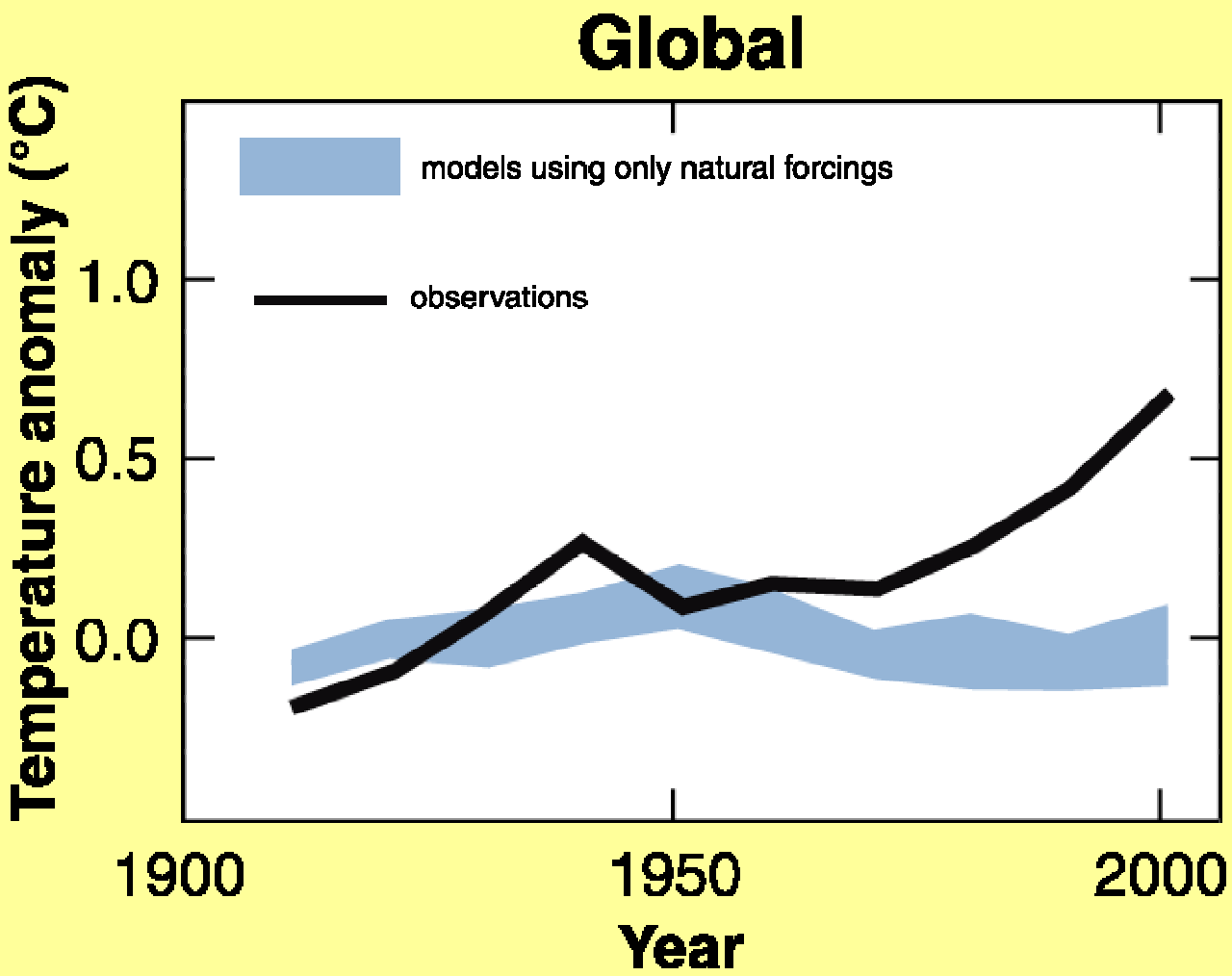


Attribution of observed climate change



Evaluates whether observed changes are quantitatively consistent with the expected response to external forcings - and inconsistent with alternative physically plausible explanations.

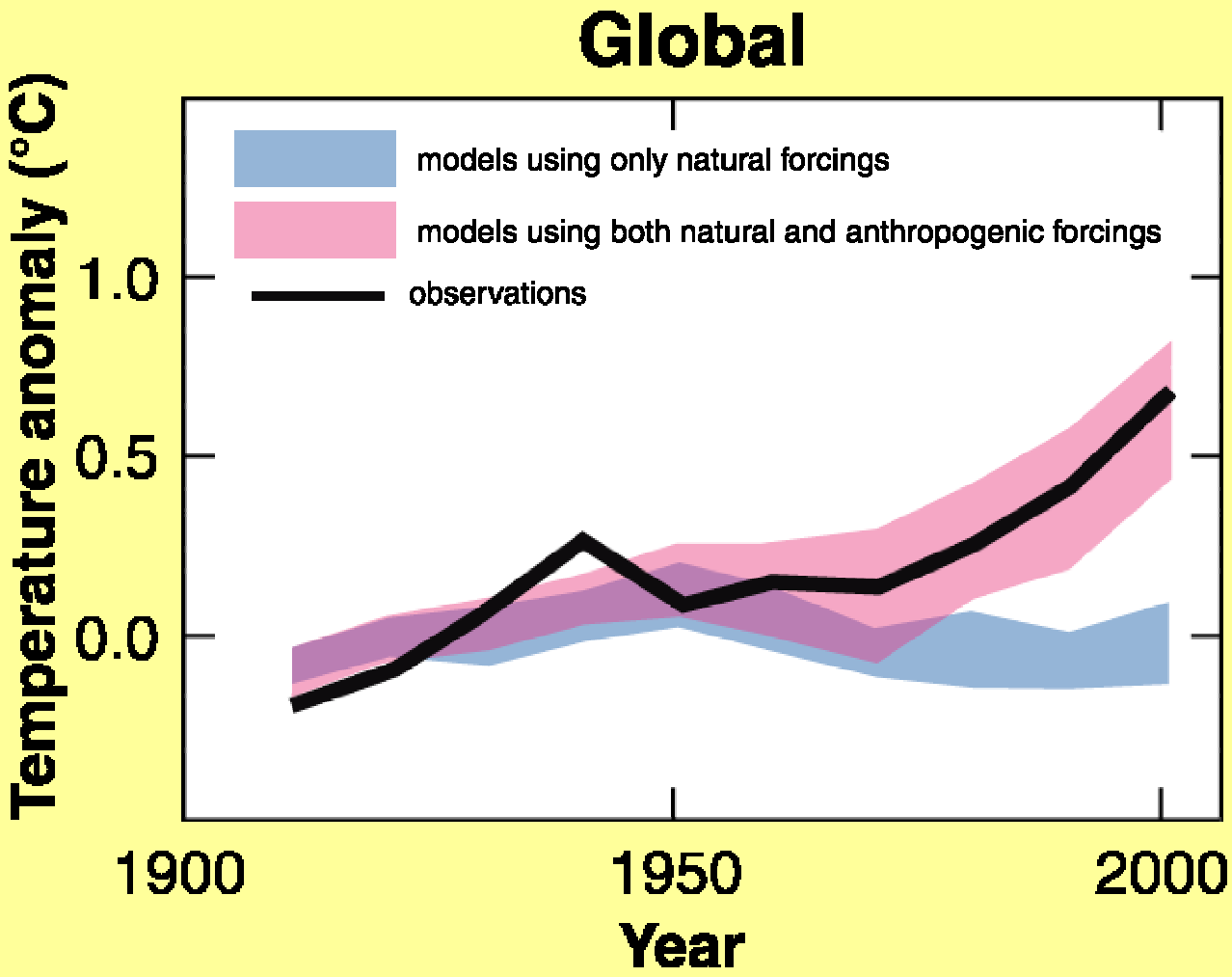
Natural forcings would have led to cooling since 1950



Decadal averages of observed and simulated global average surface temperature

Shaded band shows 5 – 95% range from climate model simulations

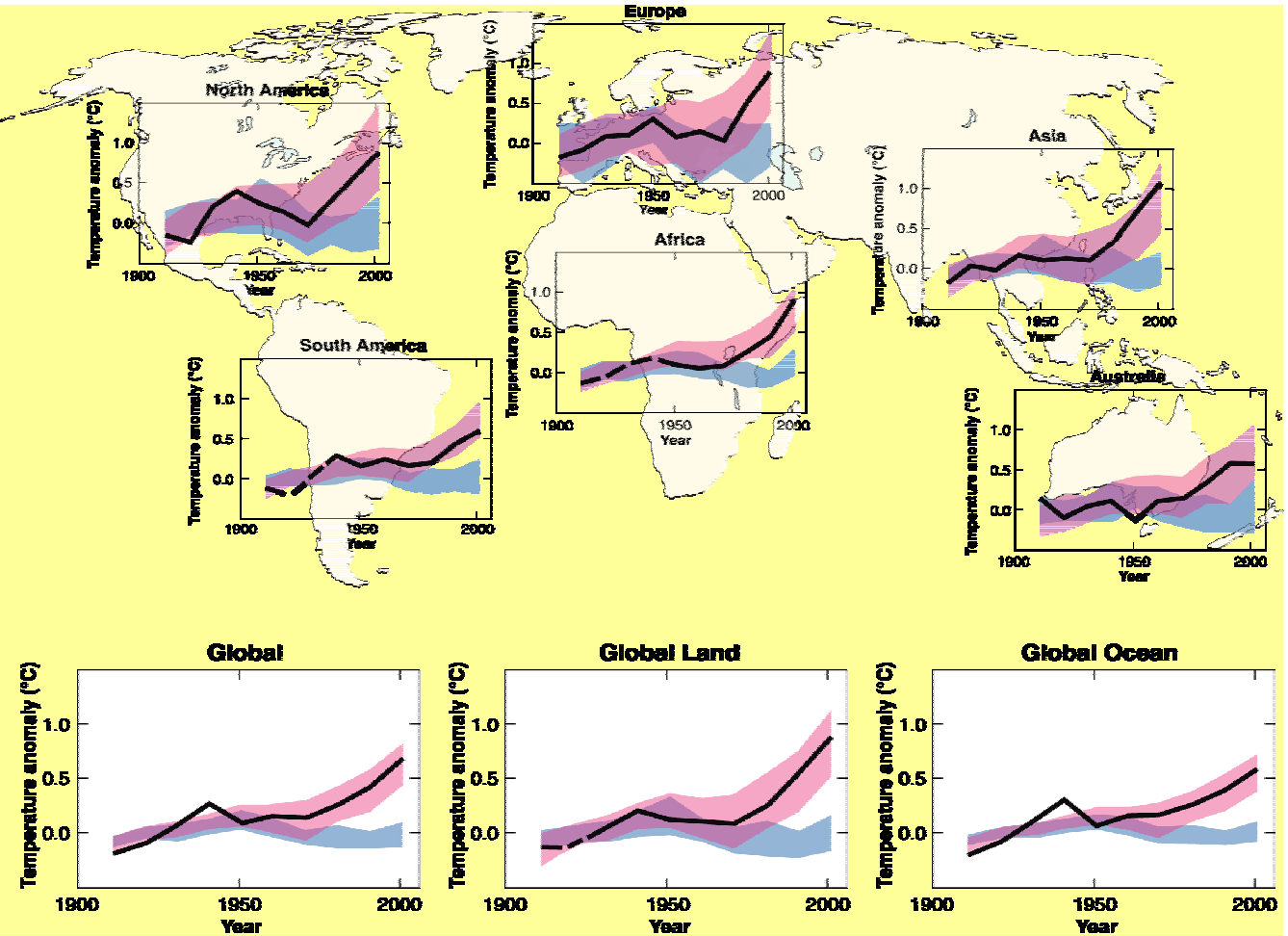
Observed warming simulated only by models that include anthropogenic forcings



Decadal averages of observed and simulated global average surface temperature.

Shaded band shows 5 – 95% range from climate model simulations

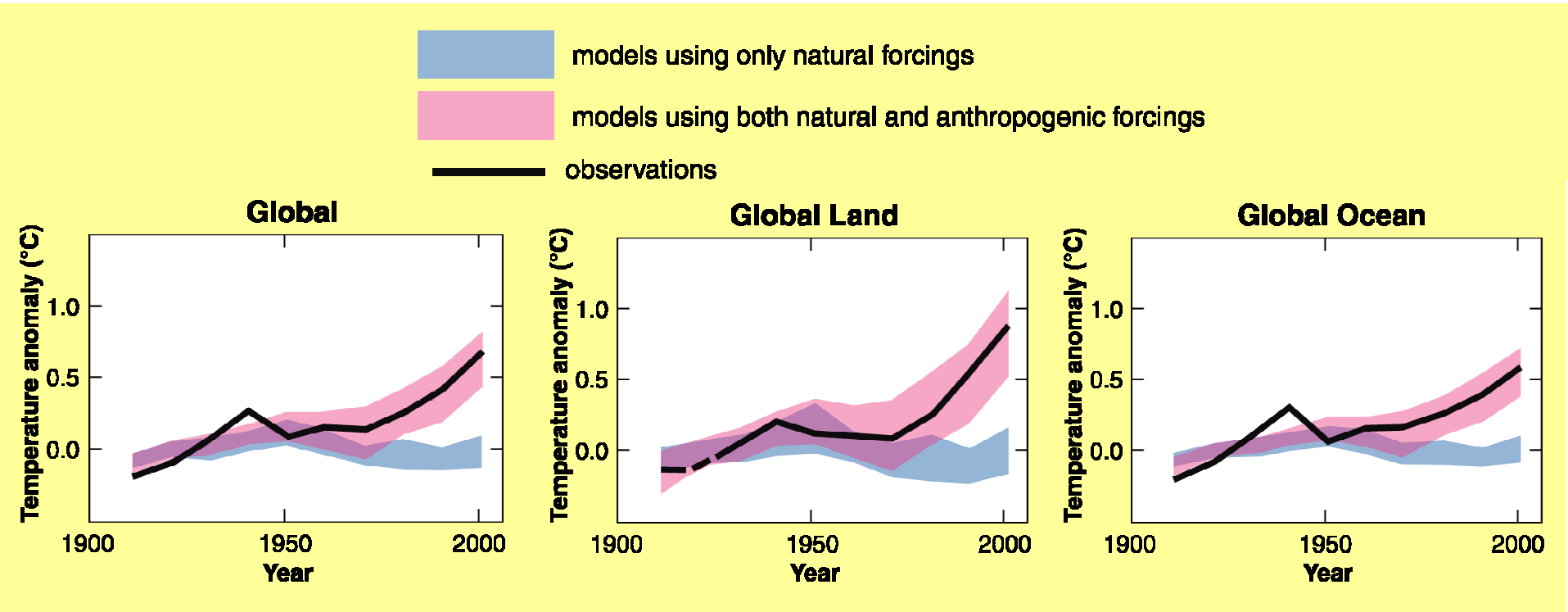
Global and continental temperature change



Note patterns of observed and simulated warming differ by continent and for land vs ocean.

Shaded band shows 5 – 95% range from climate model simulations

Warming due to greenhouse gases explains many observed features – such as the land warming faster than the oceans



Attribution of climate responses and effects

- Most of the observed increase in globally-averaged temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic GHG concentrations

- Advances since the TAR show that discernible human influences extend beyond average temperature to other aspects of climate

- Anthropogenic warming over the last three decades has *likely* had a discernible influence at the global scale, on observed changes in many physical and biological systems