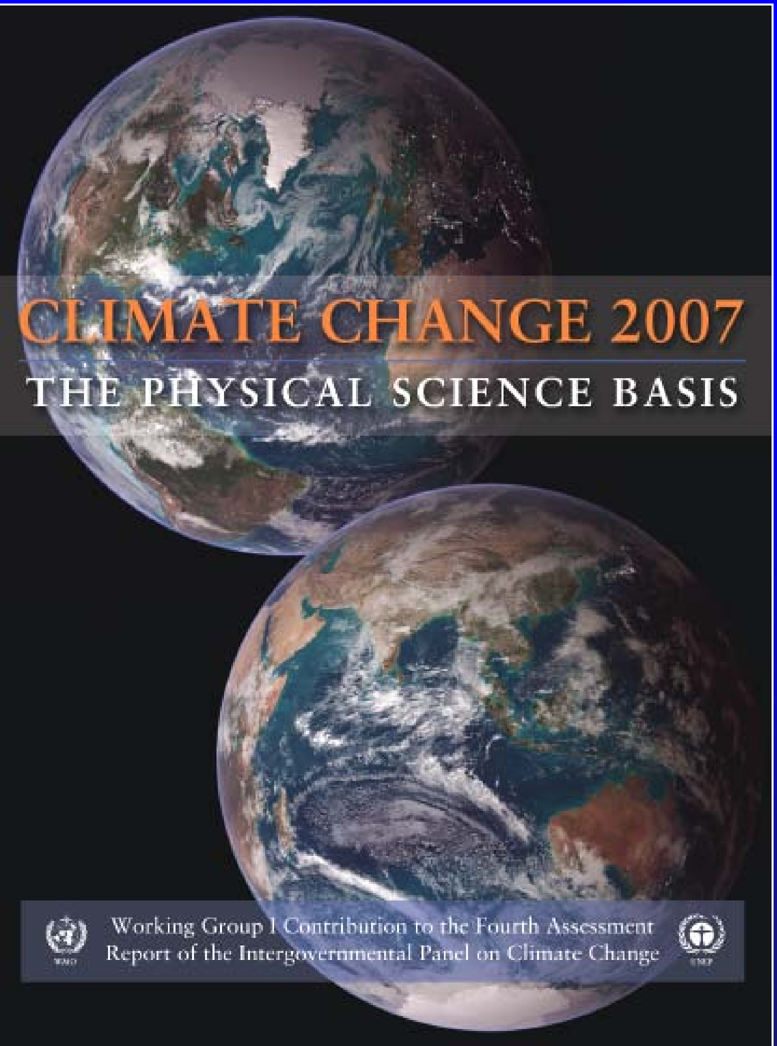
Climate change and the IPCC



Kevin Trenberth

NCAR

AR4: WG I
996 pp

NCAR

IPCC

2007:

The Nobel Peace Prize goes to the **Intergovernmental Panel on Climate Change (IPCC)** and **Albert Arnold (Al) Gore Jr.** "for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change".

1988 - The establishment of the IPCC

Role of the IPCC:

The role of the IPCC is to **assess** on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation.
Review by experts and governments is an essential part of the IPCC process.

1988 - The establishment of the IPCC
WMO, UNEP

1990 - **First IPCC Assessment Report**

1992 - IPCC Supplementary Reports

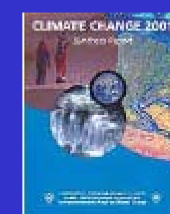
> 1992- Adoption of the UNFCCC
> 1994- Entry into force of the UNFCCC
> Ratified by 189 countries

1994 - IPCC Special Report

1995 - **Second IPCC Assessment Report**

1996 - COP-2, 1997 - COP-3

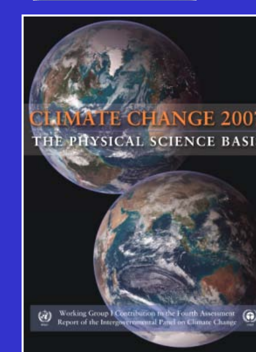
> 1997- Adoption of Kyoto Protocol at COP-3
> 2005 Feb 16- Kyoto Protocol ratified by 164 countries
> (But not by USA or Australia)



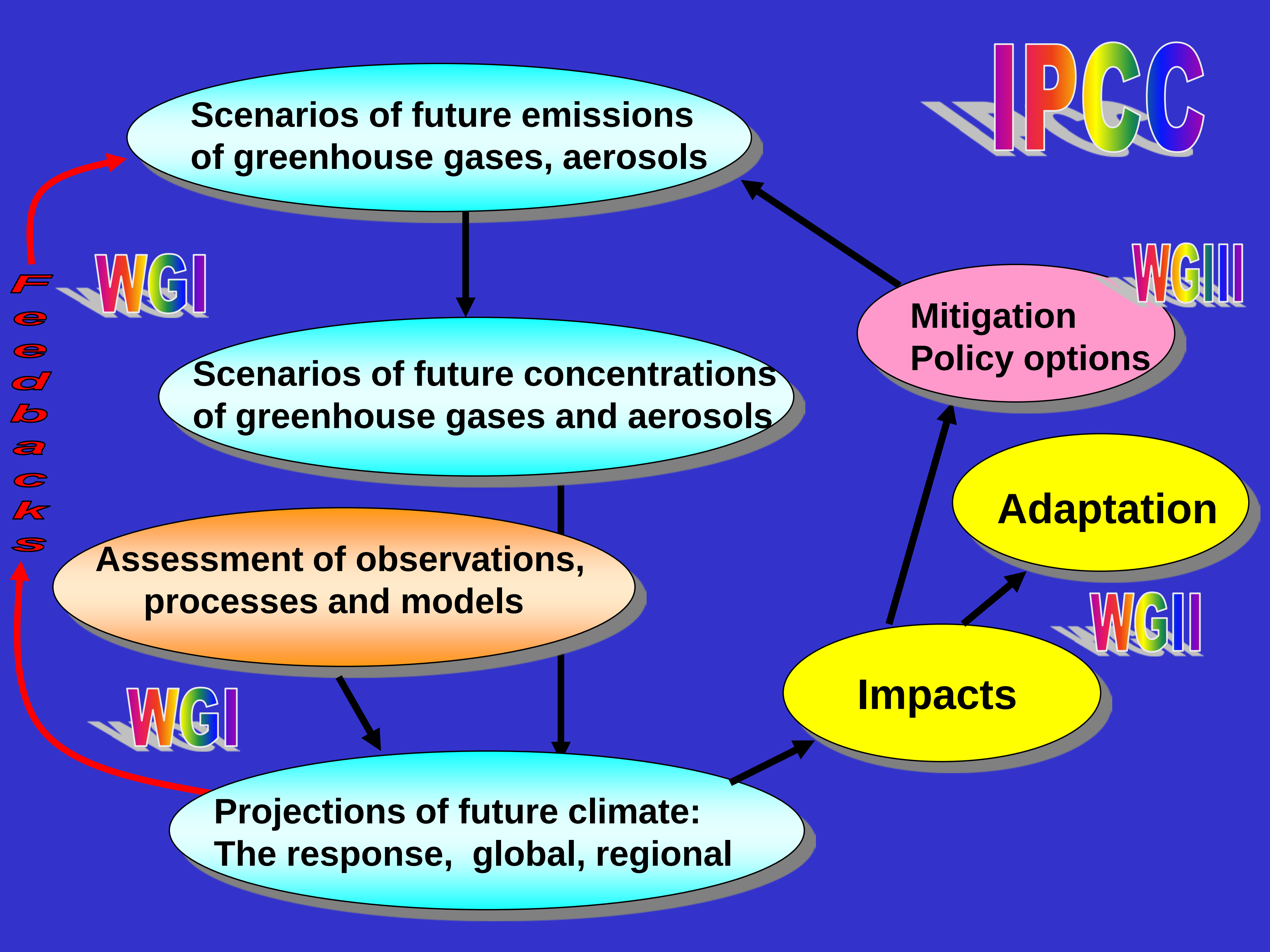
2001 - **Third IPCC Assessment Report**

2002 - COP-8, 2003 - COP-9

2007 - **Fourth IPCC Assessment Report**



2009/12 - COP-15 Copenhagen


IPCC
Scenarios of future emissions of greenhouse gases, aerosols
WGI
Feedbacks
Scenarios of future concentrations of greenhouse gases and aerosols
Assessment of observations, processes and models
WGI
Projections of future climate: The response, global, regional
WGIII
Mitigation Policy options
Adaptation
WGII
Impacts

IPCC Scientific Assessment 2007

AR4
WG I: 11 Chapters
996 pages (vs TAR 882)

140 lead authors
Hundreds contributors (66 Chapter 3)
2 or 3 Review editors for each chapter (26)
Over 700 reviewers.

Chapter 3: 2 CLAs, 10 LAs, 66 CAs
47 figures (126 panels), 8 Tables, 863 references,
102 pp. plus supplementary material
2231/ 1270 comments in scientific/governmental review
3501 total comments: all responded to in xls spread sheet (available publically)

NCAR

IPCC 2000
EMISSIONS REPORT 99
CLIMATE 2050
IPCC 1992
CLIMATE 2030
KYOTO

NCAR

Copenhagen December 2010

Representatives of 192 nations gathered in Copenhagen to seek a consensus on an international strategy for fighting global warming, in a series of meetings between Dec. 7 and Dec. 18, 2009.

Leaders concluded a climate change deal which fell short of even the modest expectations for the summit.

The **accord** drops what had been the expected goal of concluding a binding international treaty by the end of 2010, which leaves the implementation of its provisions uncertain. It is likely to undergo many months, perhaps years, of additional negotiation before it emerges in any internationally enforceable form.

In late 2009:

- Many emails were stolen from the University of East Anglia server involving Phil Jones.
- Phil Jones and I were Coordinating Lead Authors on Chapter 3 of IPCC and so over 100 of the emails involved me.
- Now known as "**climategate**" but really more like "**swiftboating**", these emails have been used to damn the IPCC and many of us. There were several things in the emails that were obviously not for public consumption and violations of the freedom of information act were revealed.
- None of mine were embarrassing to me at all, but one was highly misused and went viral.
- Several enquiries have failed to reveal any issues with the science, and have exonerated Jones.

In late 2009 (coinciding with Copenhagen) to 2010, malicious attacks have occurred on many who participated in the IPCC report, and the IPCC did not handle them well by defending its processes.

The report itself has been scrutinized along with all of the comments and responses to the comments.

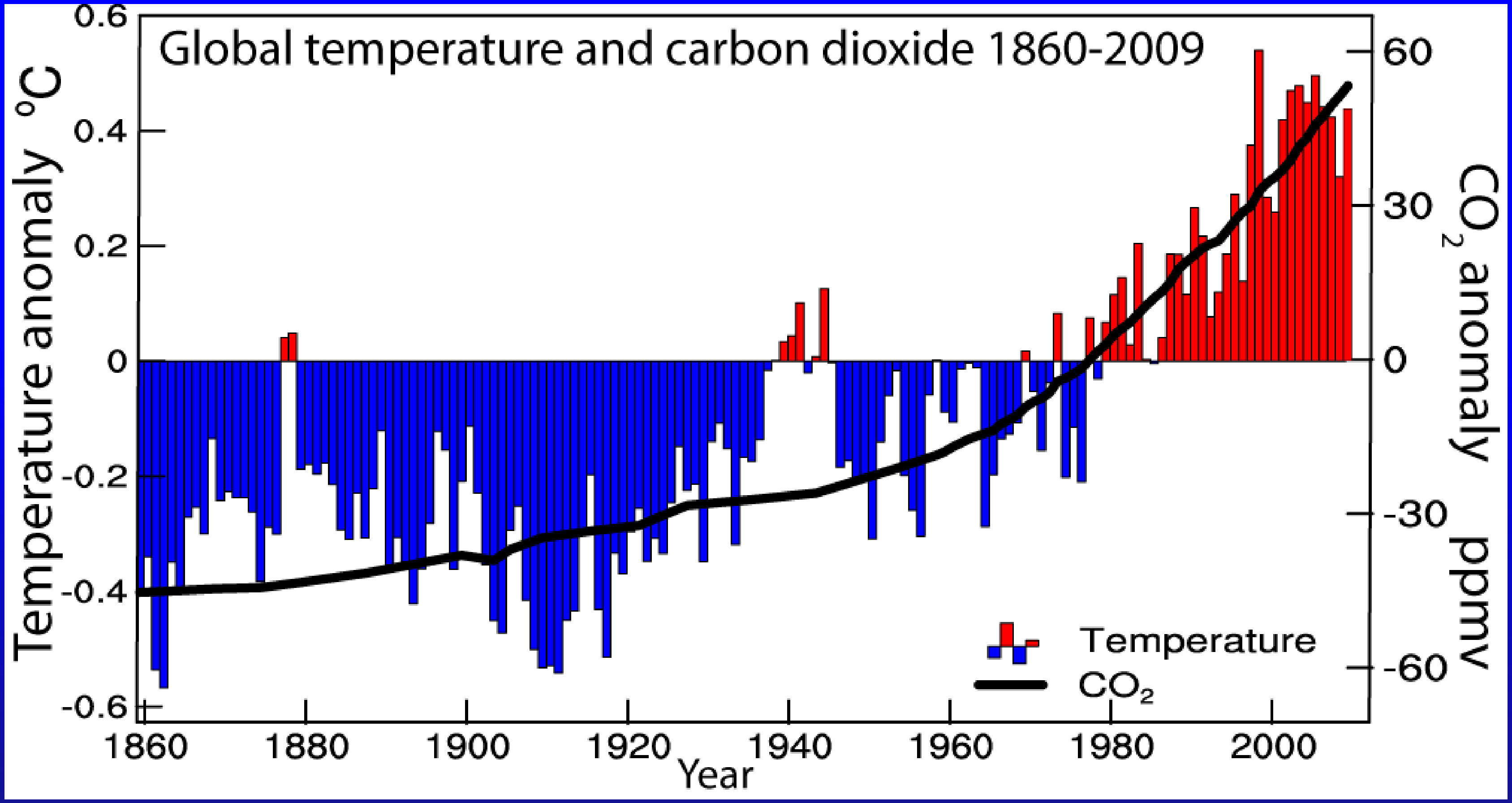
Two minor errors have been found: both in WG II, none in WG I.
-Himalayan glaciers melt (correct in WG I)
-Area of Netherlands below sea level

None of all the attacks have in any way changed the science or the conclusions with regard to the climate change threats.

Running a fever:
Seeing the doctor

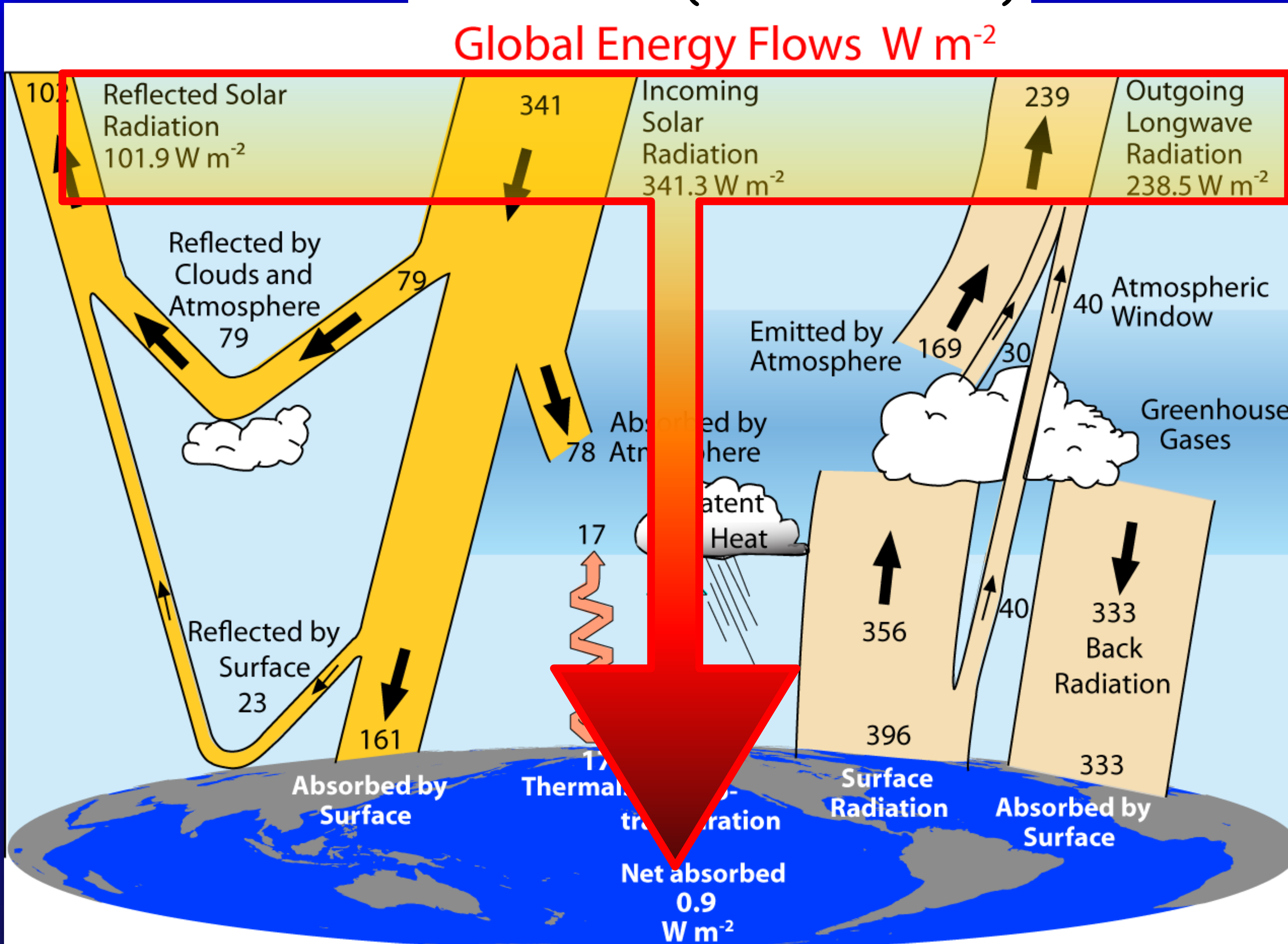
- **Symptoms**: the planet's temperature and carbon dioxide are increasing
- **Diagnosis**: human activities are causal
- **Prognosis**: the outlook is for more warming at rates that can be disruptive and will cause strife
- **Treatment**: mitigation (reduce emissions) and adaptation (plan for consequences)

Global temperatures and carbon dioxide through 2009



Base period 1961-90

2000-2005 (CERES Period)

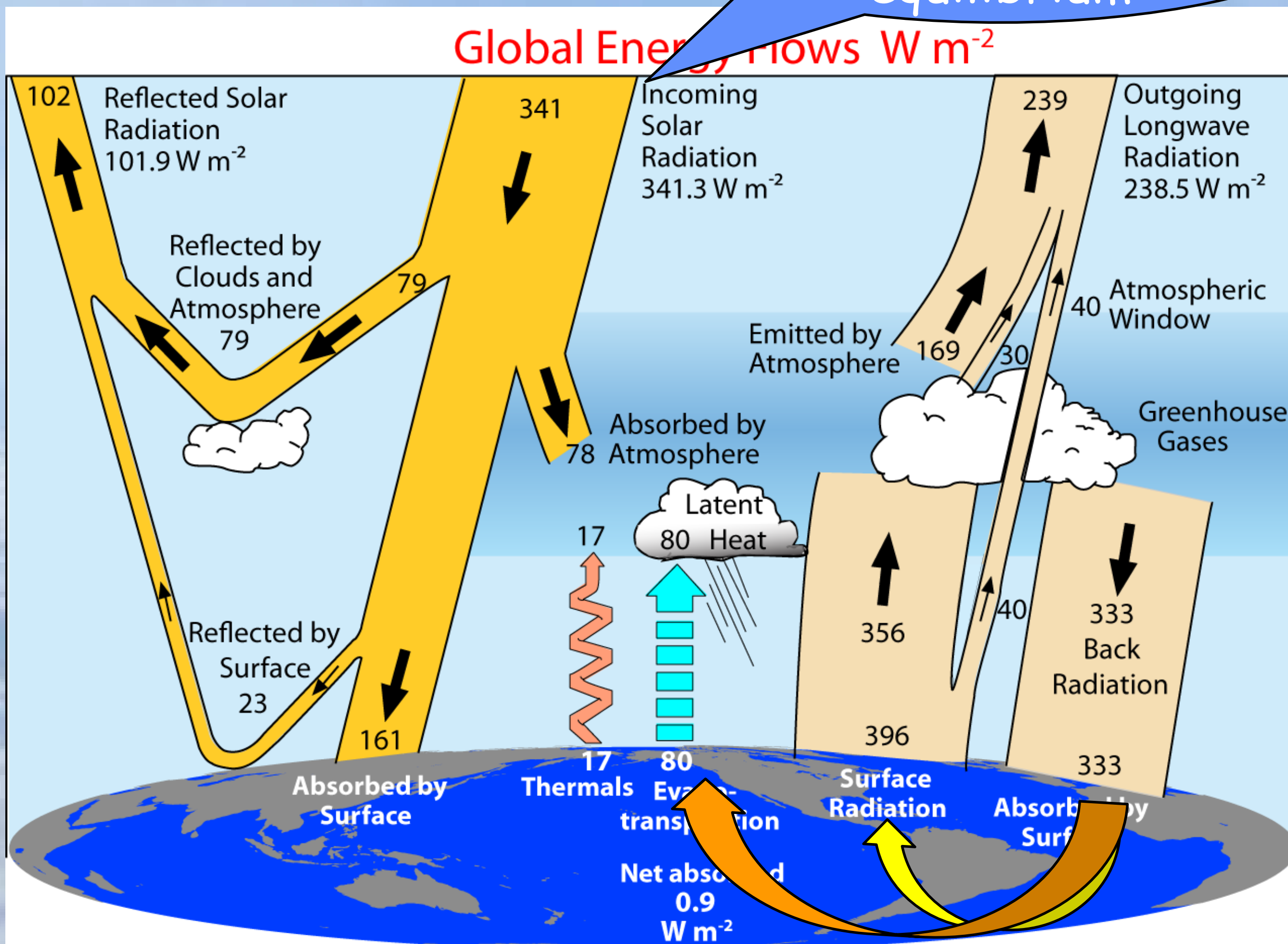


Trenberth et al 200

NCAR

Controls on t … ecipitation

TOA radiation does not change (much) in equilibrium



If the only change in climate is from increased GHGs: then SW does not change (until ice melts and if clouds change), and so OLR must end up the same.

But downwelling and net LW↓ increases and so other terms must change: mainly evaporative cooling.

Transient response may differ from equilibrium (see Andrews et al. 09)
Land responds faster. Radiative properties partly control rate of increase of precipitation.: Stephens and Ellis 2008

2000-2005 Trenberth et al 2009

Climate change and extreme weather events

Changes in extremes matter most for society and human health

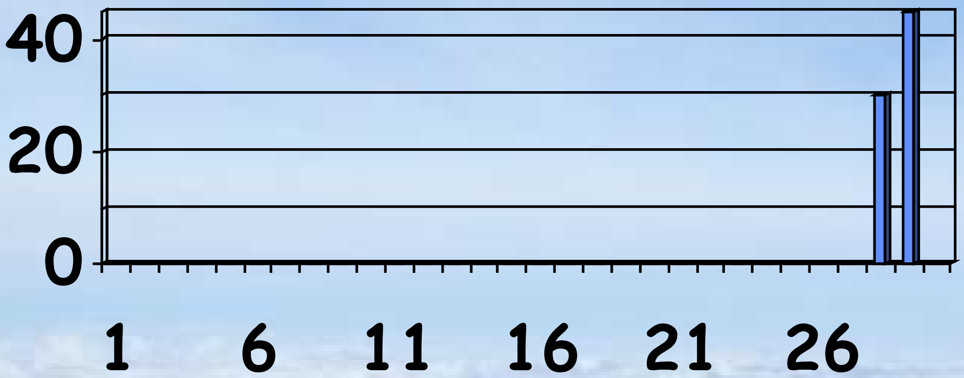
With a warming climate:

- More high temperatures, heat waves
- Wild fires and other consequences
- Fewer cold extremes.

- More extremes in hydrological cycle:
  - Drought
  - Heavy rains, floods
  - Intense storms, hurricanes, tornadoes

Daily Precipitation at 2 stations

A



drought
wilting plants

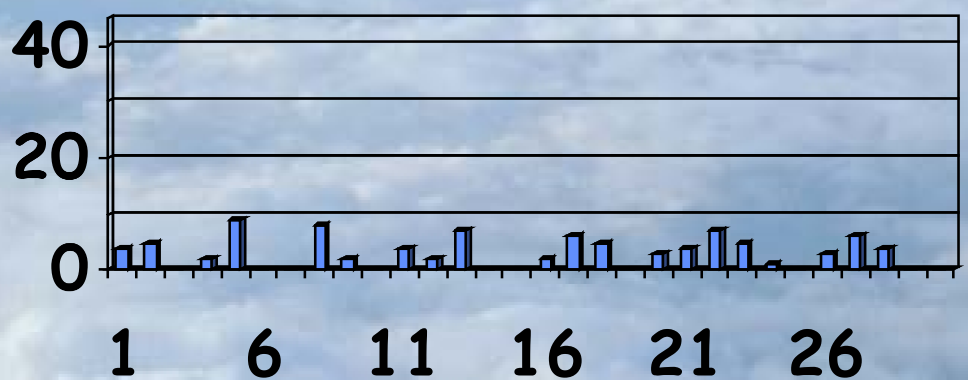
wild fires

local
floods

Monthly
Amount 75 mm

Frequency 6.7%
Intensity 37.5 mm

B



soil moisture replenished
virtually no runoff

Amount 75 mm

Frequency 67%
Intensity 3.75 mm

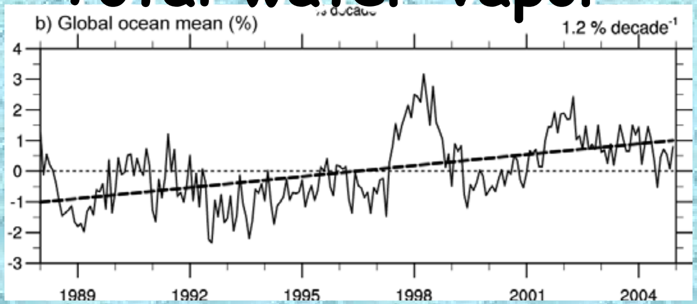
Air holds more water vapor at higher temperatures

A basic physical law tells us that the water holding capacity of the atmosphere goes up at about 7% per degree Celsius increase in temperature. (4% per °F)

Observations show that this is happening at the surface and in lower atmosphere: 0.55°C since 1970 over global oceans and 4% more water vapor.

This means more moisture available for storms and an enhanced greenhouse effect.

Total water vapor



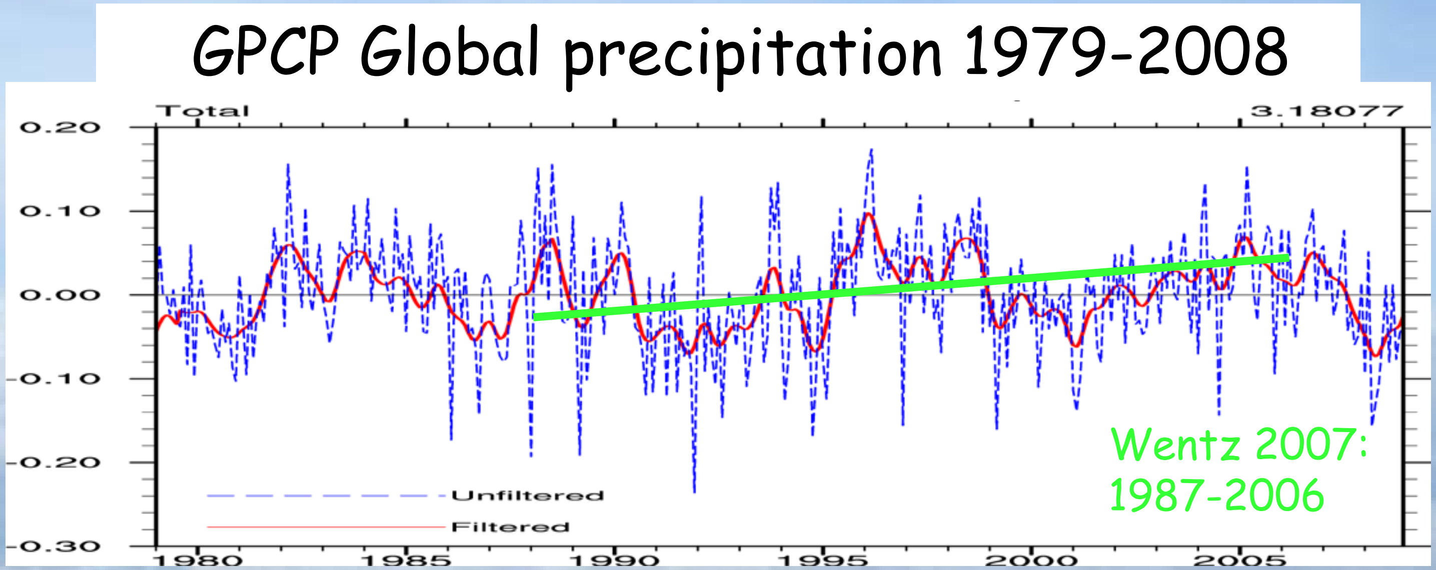
How should precipitation P change as the climate changes?

- With increased GHGs: increased **surface** heating evaporation E⇑ and P⇑
- With increased aerosols, E⇓ and P⇓
- **Net global effect is small and complex**

- Warming and T⇑ means water vapor ⇑ as observed
- Because precipitation comes from storms gathering up available moisture, **rain and snow intensity** ⇑ : **widely observed**
- But this must reduce lifetime and frequency of storms
- Longer dry spells

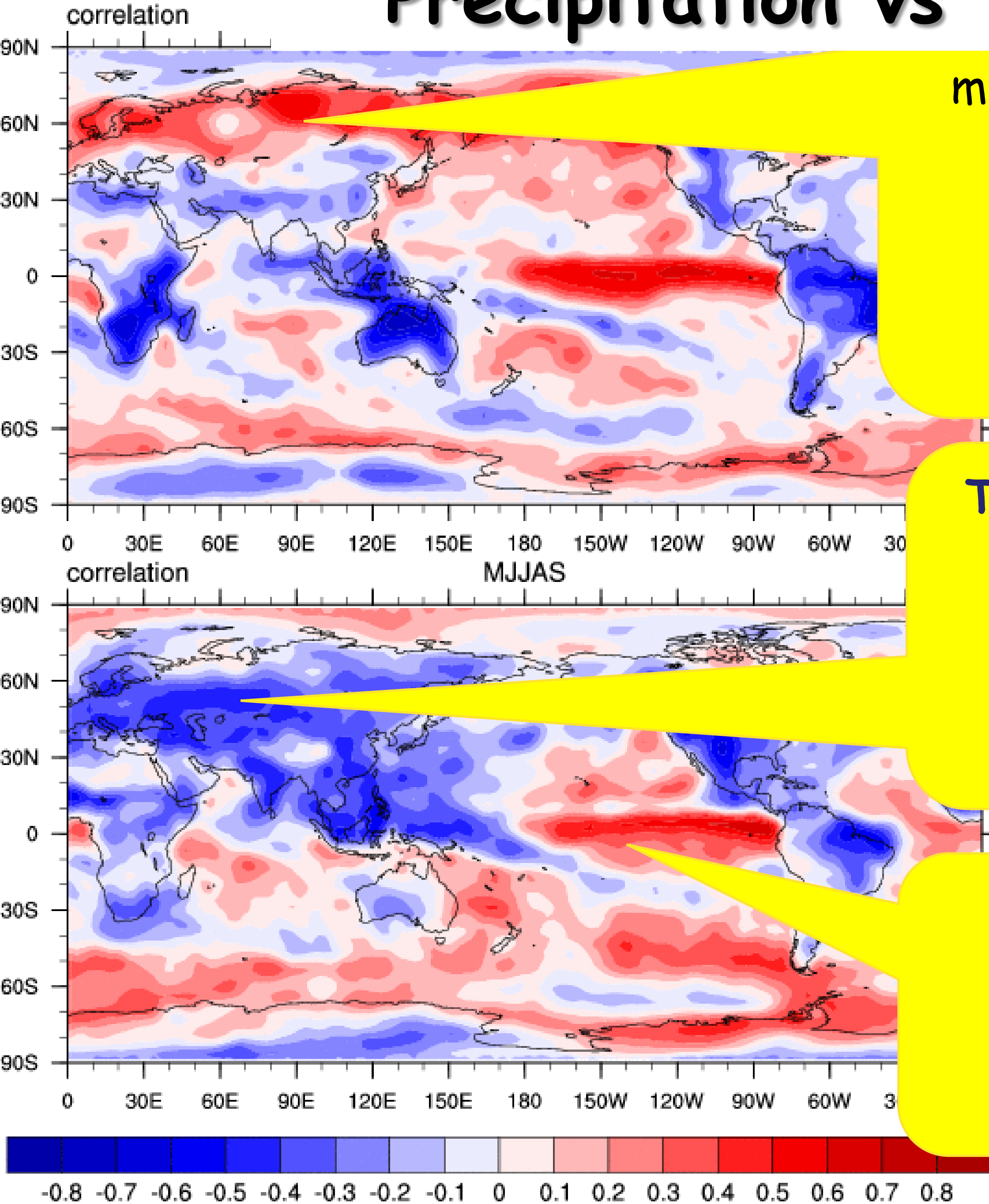
Trenberth et al 2003

There is no trend in global precipitation amounts



Biggest changes in absolute terms are in the tropics, and there is a strong El Niño signal.

Precipitation vs Temperature



old
moisture in cold; storms: warm and moist southerlies.
Clausius-Clapeyron effect
T⇒P

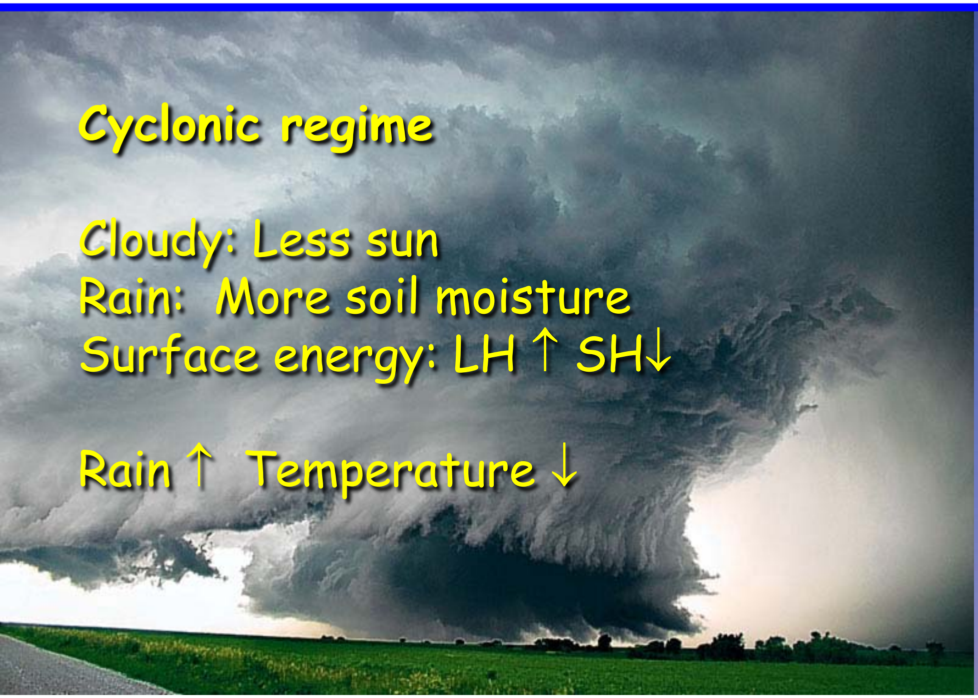
Tropics/summer land: **hot and dry** or **cool and wet**
Rain and cloud cool and **air condition** the planet!
P⇒T

wet.

Oceans: El Nino high SSTs produce rain, ocean forces atmosphere
SST⇒P

Trenberth and Shea 2005

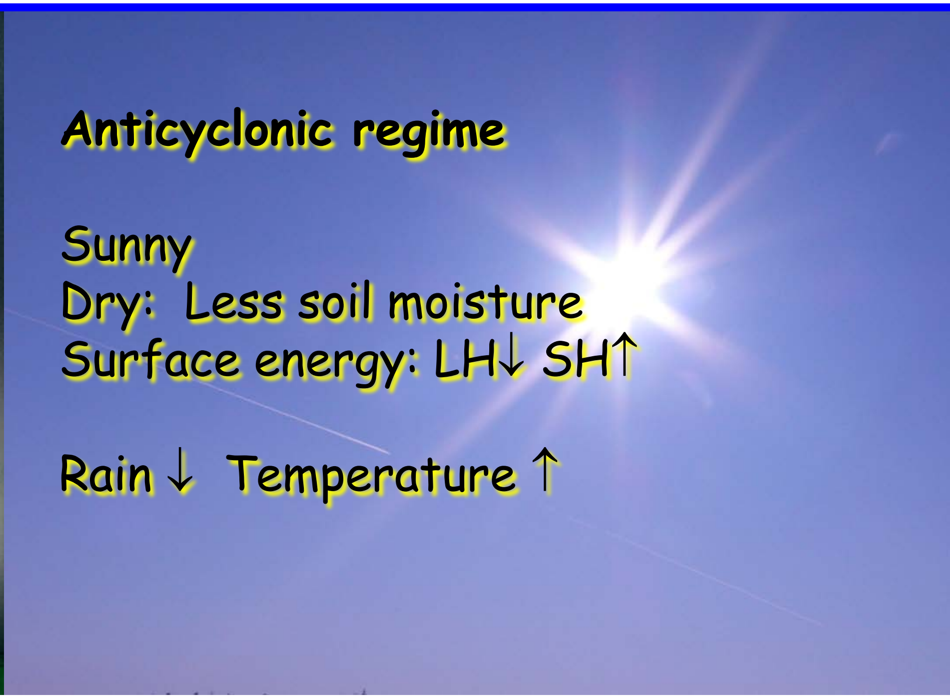
Temperature vs Precipitation



Cyclonic regime

Cloudy: Less sun
Rain: More soil moisture
Surface energy: LH ↑ SH↓

Rain ↑ Temperature ↓



Anticyclonic regime

Sunny
Dry: Less soil moisture
Surface energy: LH↓ SH↑

Rain ↓ Temperature ↑

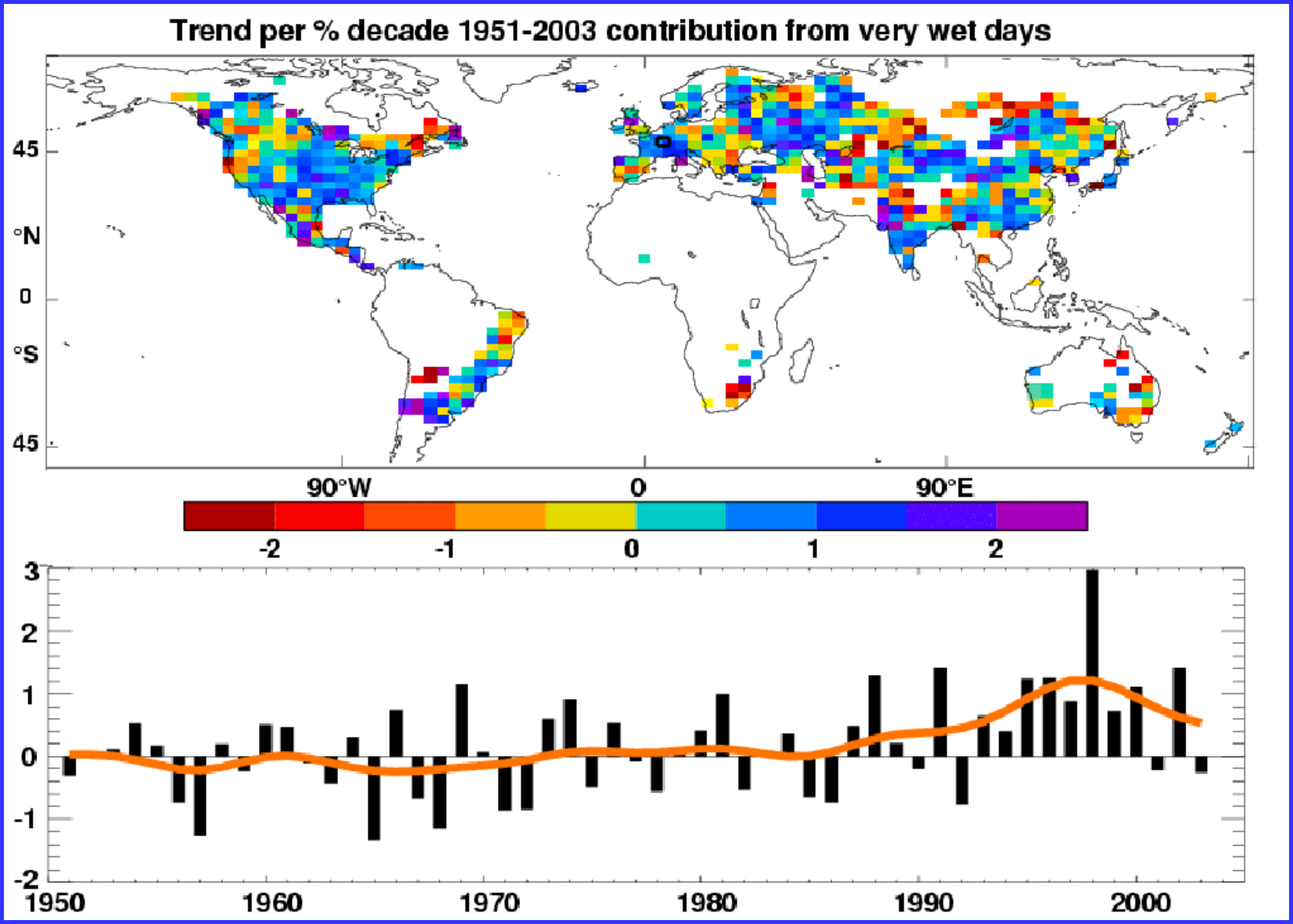
Summer: Land

Strong negative correlations

Does **not** apply to oceans

Supply of moisture over land is critical

- Over **land in summer** and over **tropical continents**, the strong negative correlations between temperature and precipitation suggest factors other than C-C are critical: the **supply of moisture**.
- There is a strong diurnal cycle (that is not well simulated by most models).
- In these regimes, convection plays a dominant role
- Recycling is more important in summer and advection of moisture from afar is less likely to occur.
- Monsoons play a key role where active.
- Given the right synoptic situation and diurnal cycle, severe convection and **intense rains** can occur.



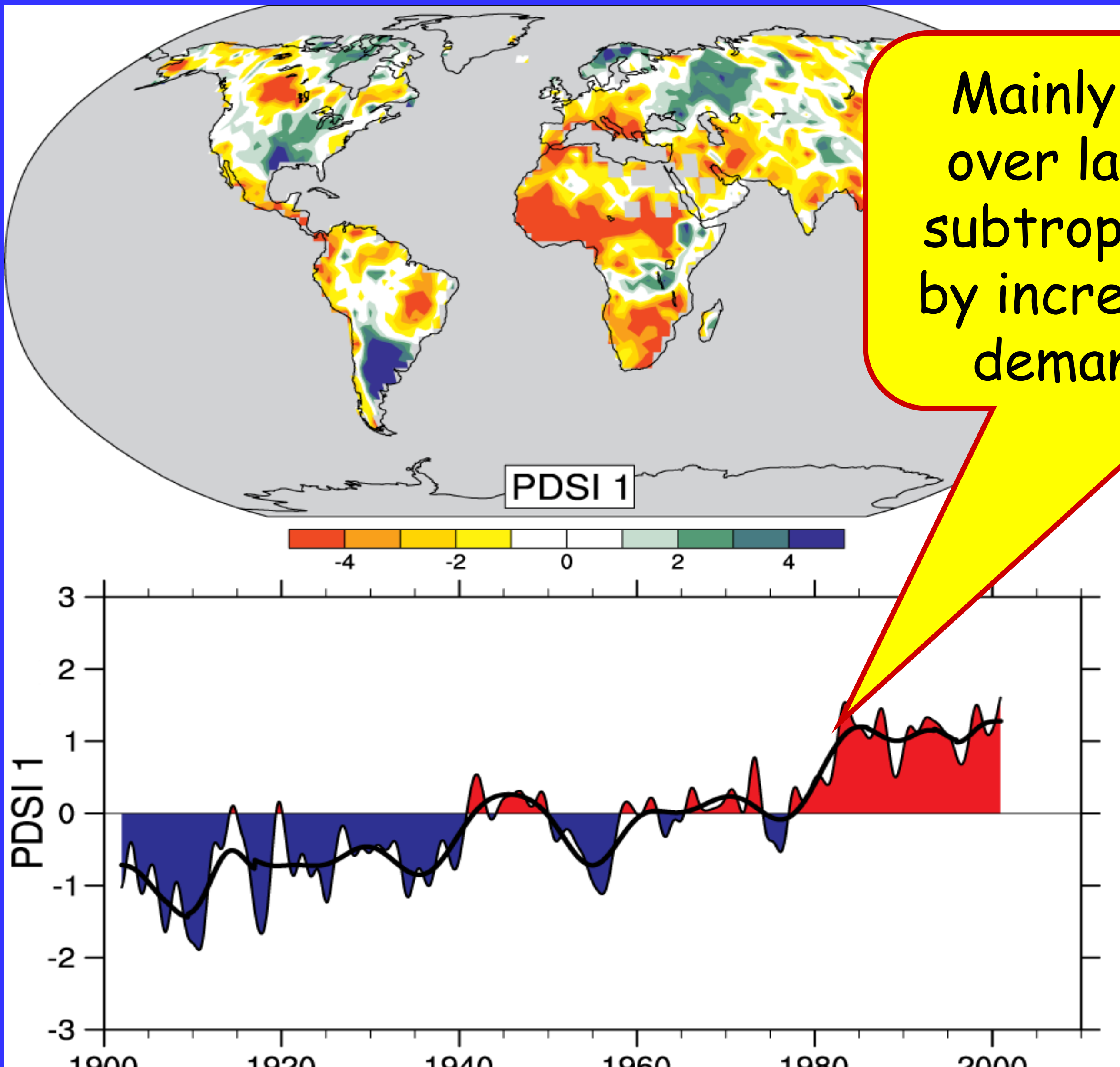
Precipitation

Observed trends (%) per decade for 1951-2003 contribution to total annual from **very wet days** > 95th %ile.

Alexander et al 2006
IPCC AR4

Heavy precipitation days are increasing even in places where precipitation is decreasing.

Drought is increasing most places



Mainly decrease in rain over land in tropics and subtropics, but enhanced by increased atmospheric demand with warming

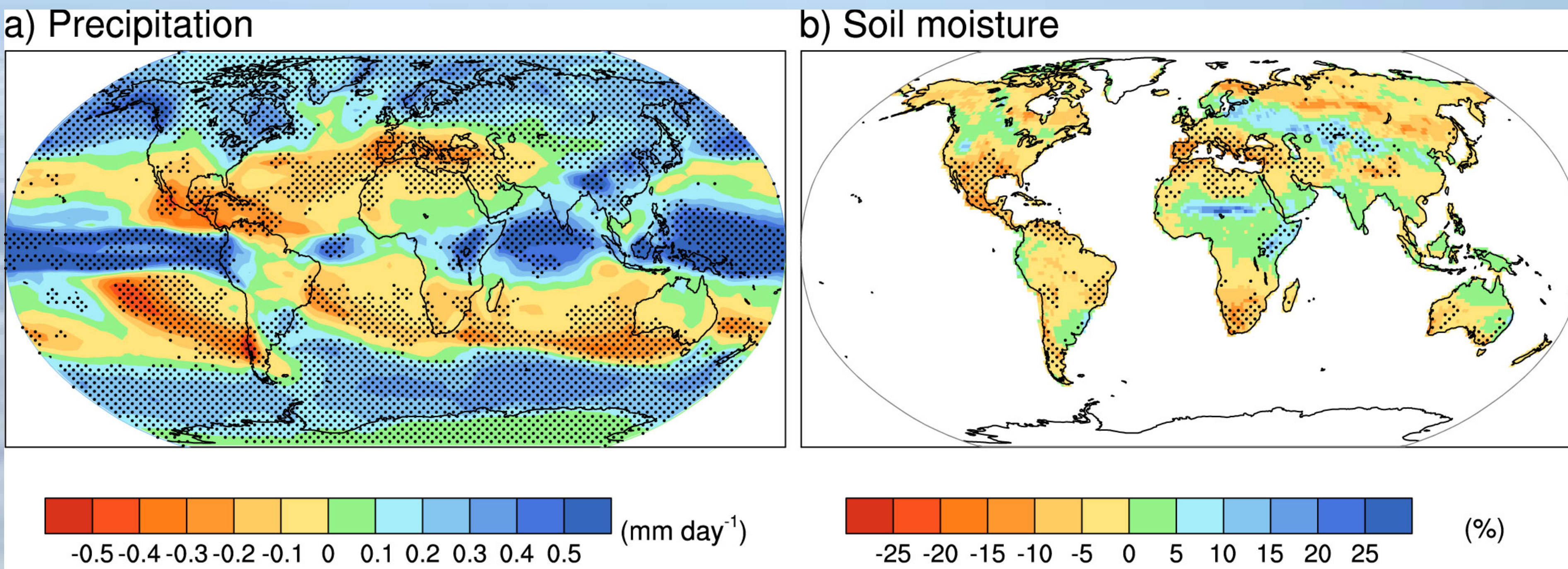
Severity Index (PDSI) for 1900 to 2002.

The time series (below) accounts for most of the trend in PDSI.

AR4 IPCC

"Rich get richer, poor get poorer"

Projections: Combined effects of increased precipitation intensity and more dry days contribute to lower soil moisture



2090-2100

IPCC

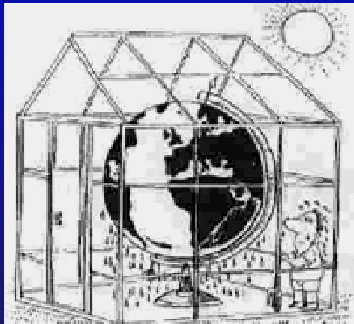
Table SPM.2. *Recent trends, assessment of human influence on the trend and projections for extreme weather events for which there is an observed late-20th century trend. {Tables 3.7, 3.8, 9.4; Sections 3.8, 5.5, 9.7, 11.2–11.9}*

IPCC AR4

Phenomenon[a] and direction of trend	Likelihood that trend occurred in late 20th century (typically post 1960)	Likelihood of a human contribution to observed trend[b]	Likelihood of future trends based on projections for 21st century using SRES scenarios
Warmer and fewer cold days and nights over most land areas	*Very likely*[c]	*Likely*[d]	*Virtually certain*[d]
Warmer and more frequent hot days and nights over most land areas	*Very likely*[e]	*Likely (nights)*[d]	*Virtually certain*[d]
Warm spells/heat waves. Frequency increases over most land areas	*Likely*	*More likely than not*[f]	*Very likely*
Heavy precipitation events. Frequency (or proportion of total rainfall from heavy falls) increases over most areas	*Likely*	*More likely than not*[f]	*Very likely*
Area affected by droughts increases	*Likely* in many regions since 1970s	*More likely than not*	*Likely*
Intense tropical cyclone activity increases	*Likely* in some regions since 1970	*More likely than not*[f]	*Likely*
Increased incidence of extreme high sea level (excludes tsunamis)[g]	*Likely*	*More likely than not*[f,h]	*Likely*[i]

Global warming effects from humans are already identifiable

- Rising sea level: coastal storm surges, salt water intrusions, flooding
- Heavier rains, floods: water contamination, water quality
- Drought: water shortages, agriculture, water quality
- Heat-waves: wildfires
- Stronger storms, hurricanes, tornadoes: damage, loss of life, loss of habitat
- Changes in climate: crops, famine, discontent and strife, more insects (range, seasons), fungal and other disease; vector-borne disease.
- Sea ice loss: habitat loss
- Permafrost melting: infrastructure at risk

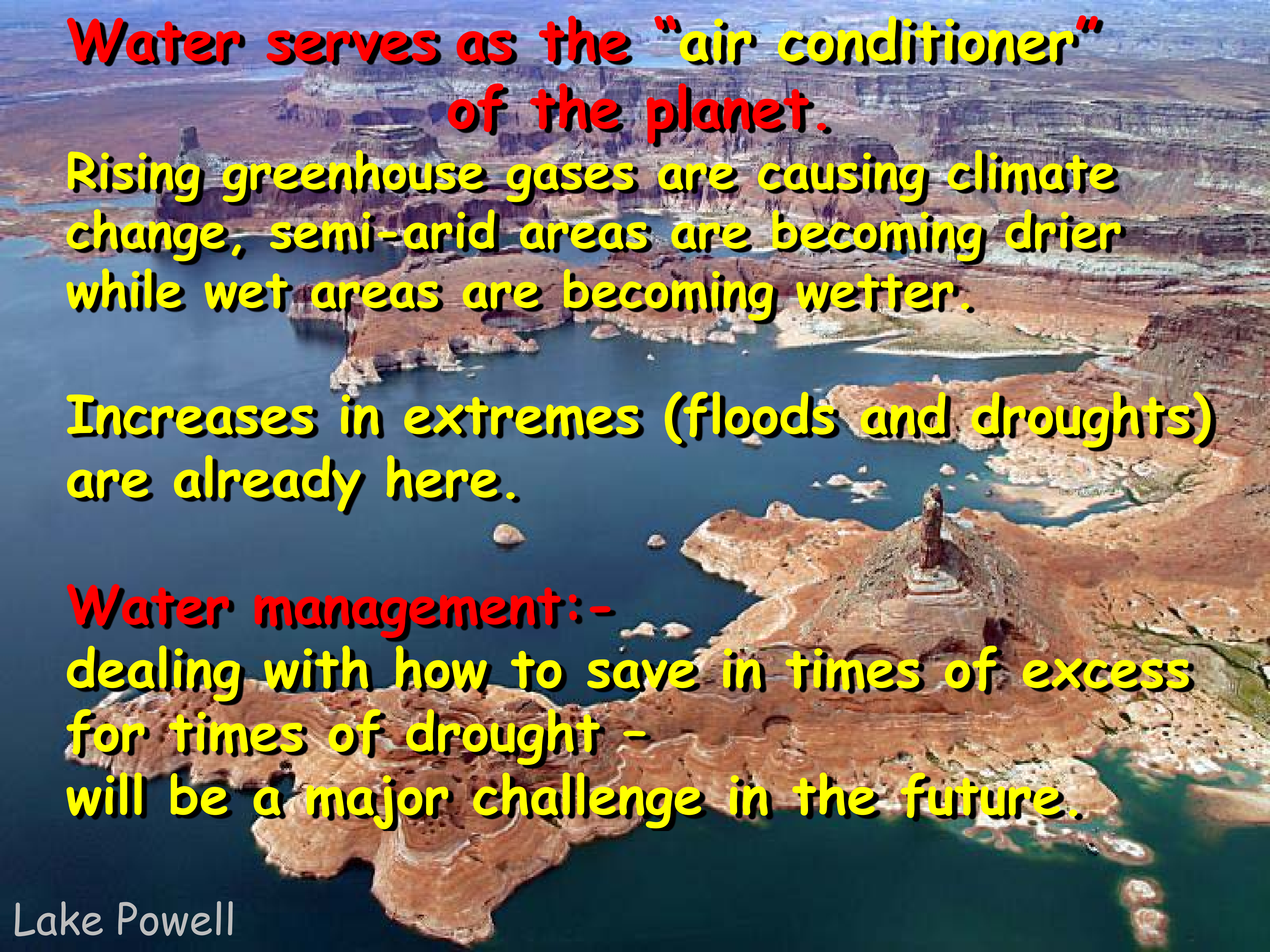


Water serves as the "air conditioner" of the planet.

Rising greenhouse gases are causing climate change, semi-arid areas are becoming drier while wet areas are becoming wetter.

Increases in extremes (floods and droughts) are already here.

Water management:-
dealing with how to save in times of excess for times of drought –
will be a major challenge in the future.



Lake Powell

THE POLITICIAN