Effects of Climate Change on Water Availability

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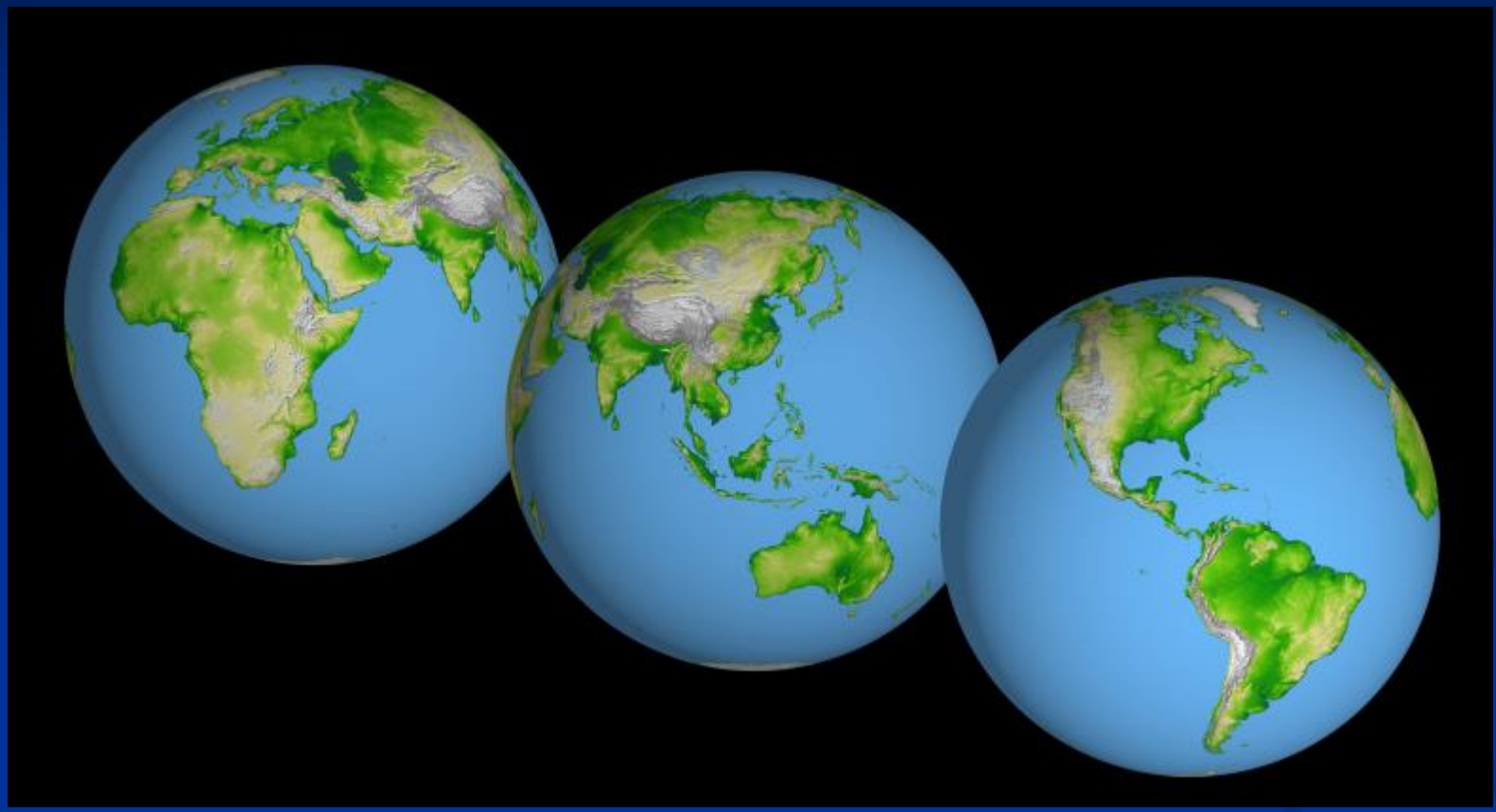
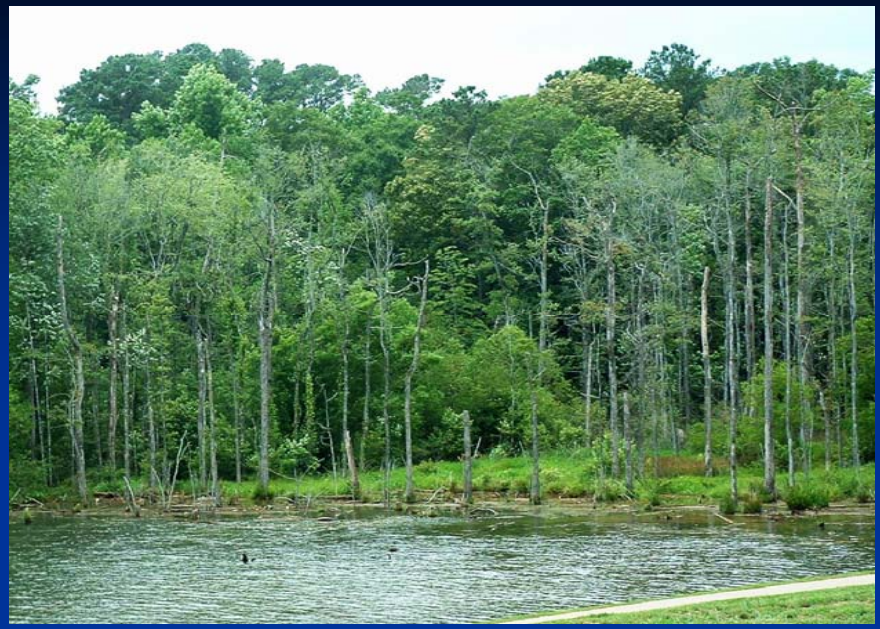
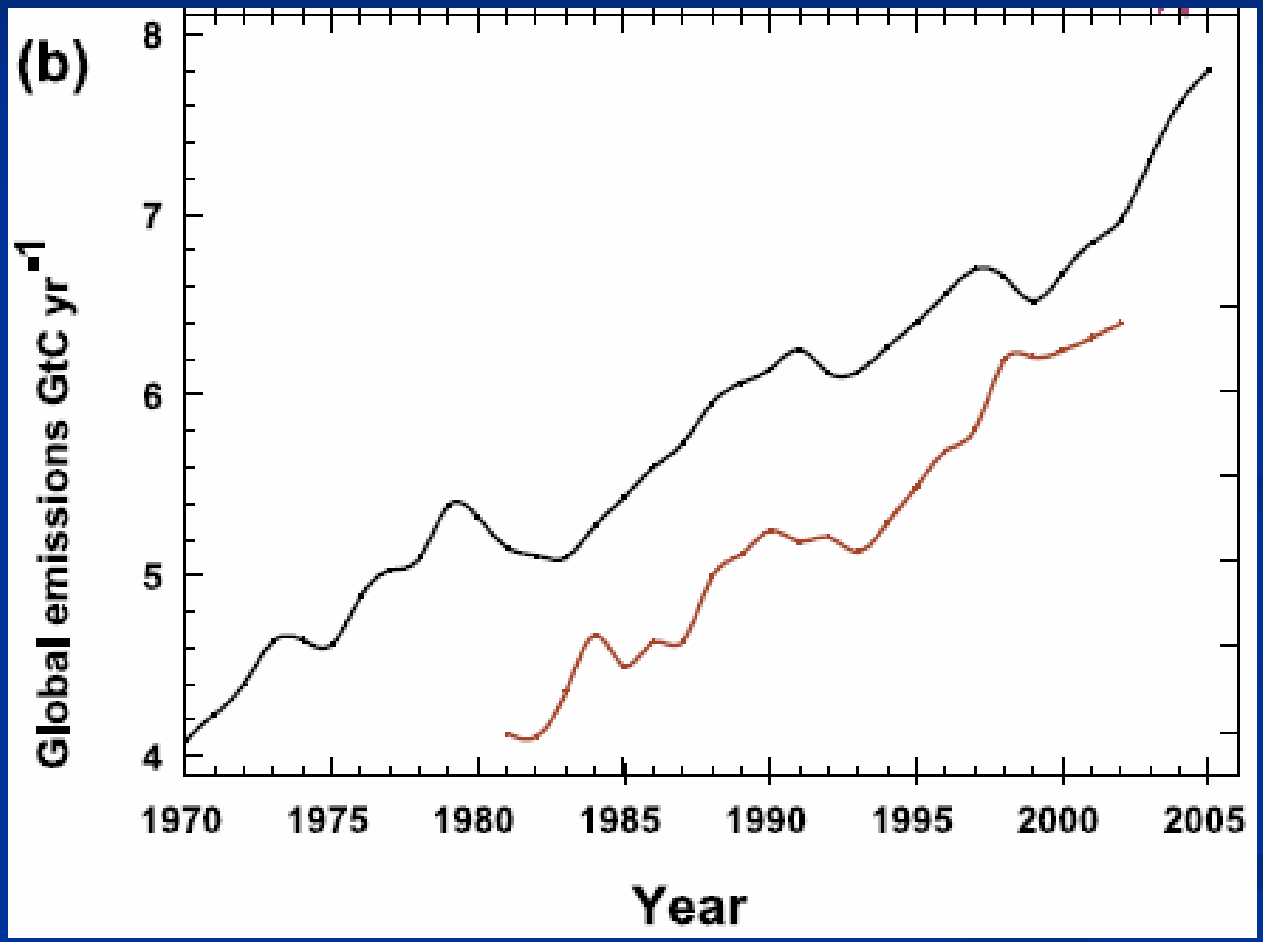


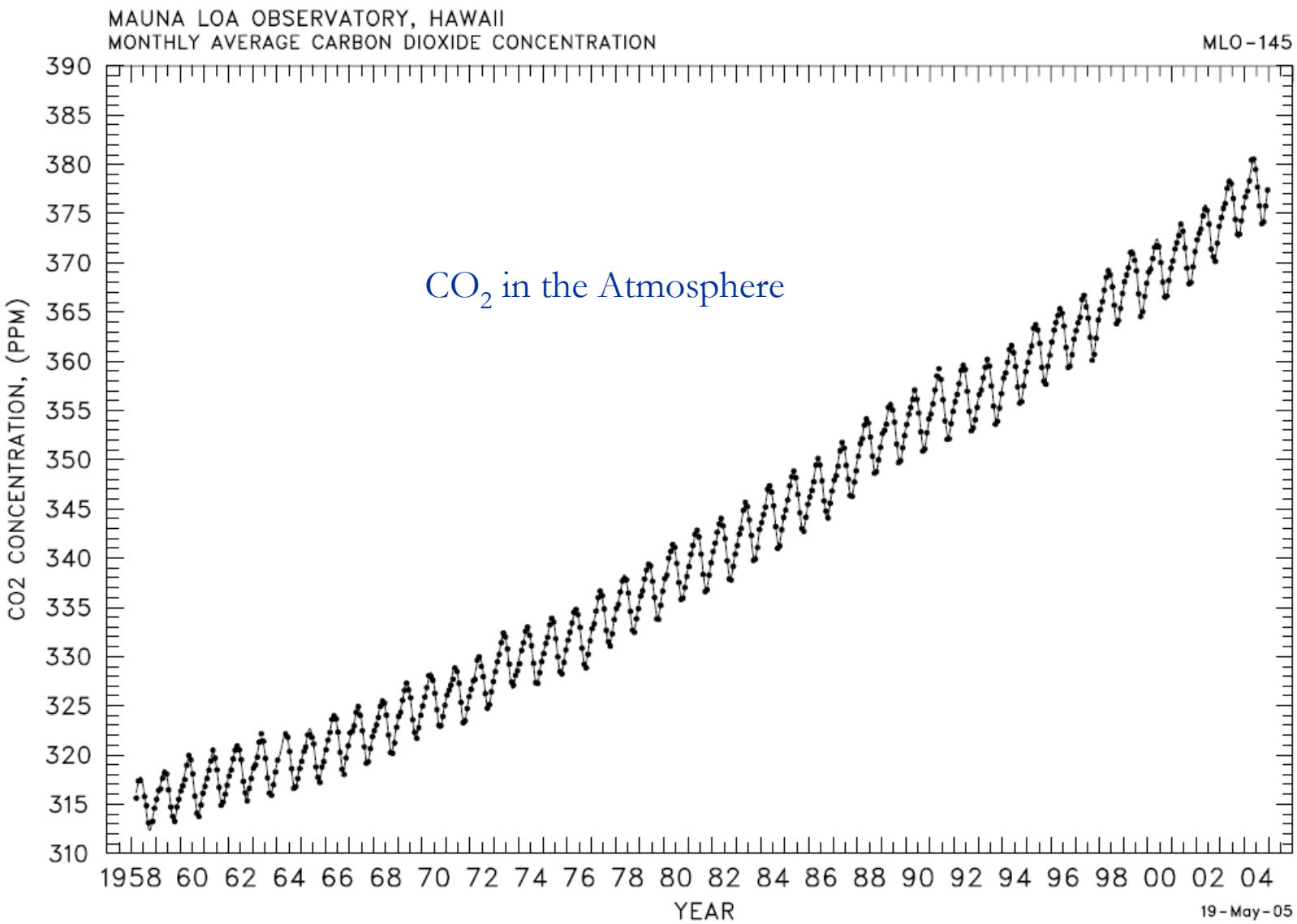
NASA



Annual CO_2 Emission from fossil fuel burning and cement production



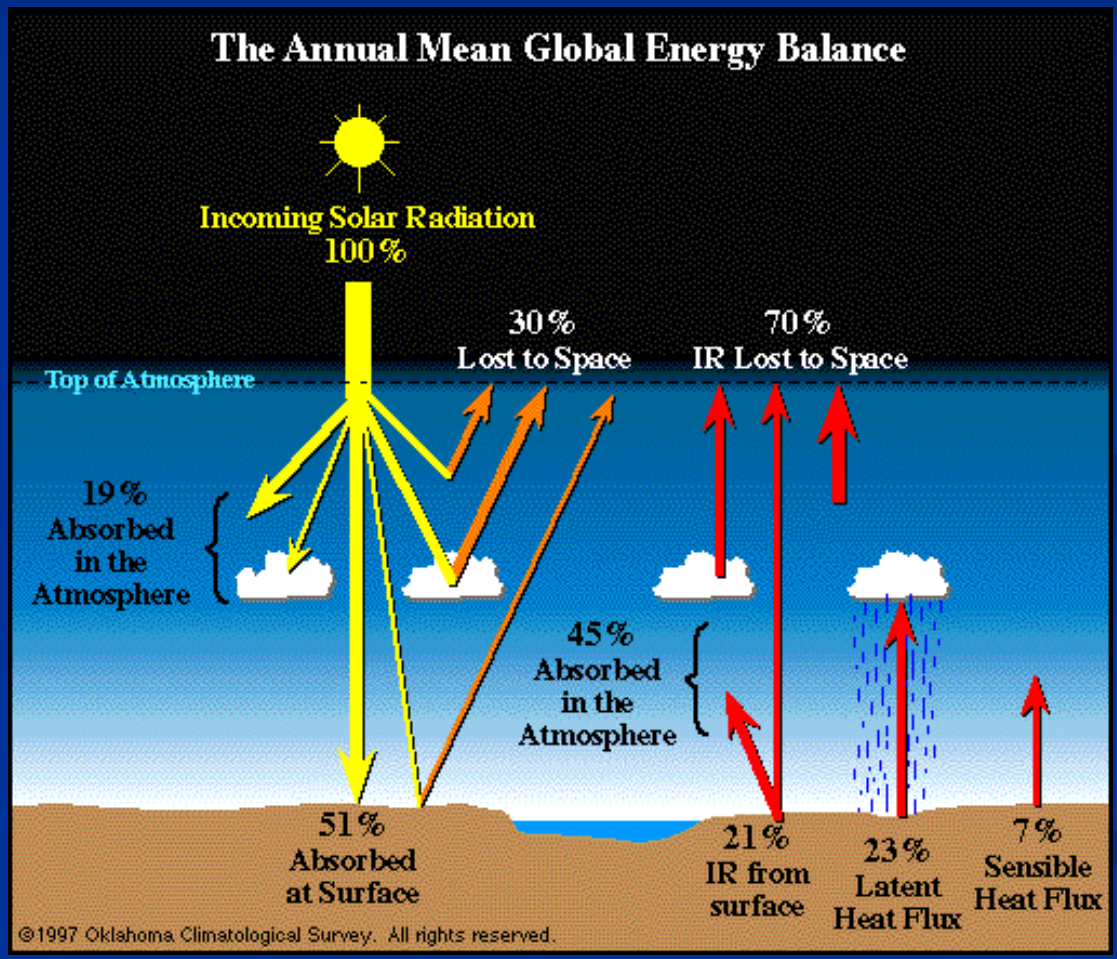
(Forster et al., 2007)



CO_2 in the Atmosphere


O
C
O

CO_2


The Annual Mean Global Energy Balance
Incoming Solar Radiation
100 %
30 %
Lost to Space
70 %
IR Lost to Space
Top of Atmosphere
19 %
Absorbed
in the
Atmosphere
45 %
Absorbed
in the
Atmosphere
51 %
Absorbed
at Surface
21 %
IR from
surface
23 %
Latent
Heat Flux
7 %
Sensible
Heat Flux
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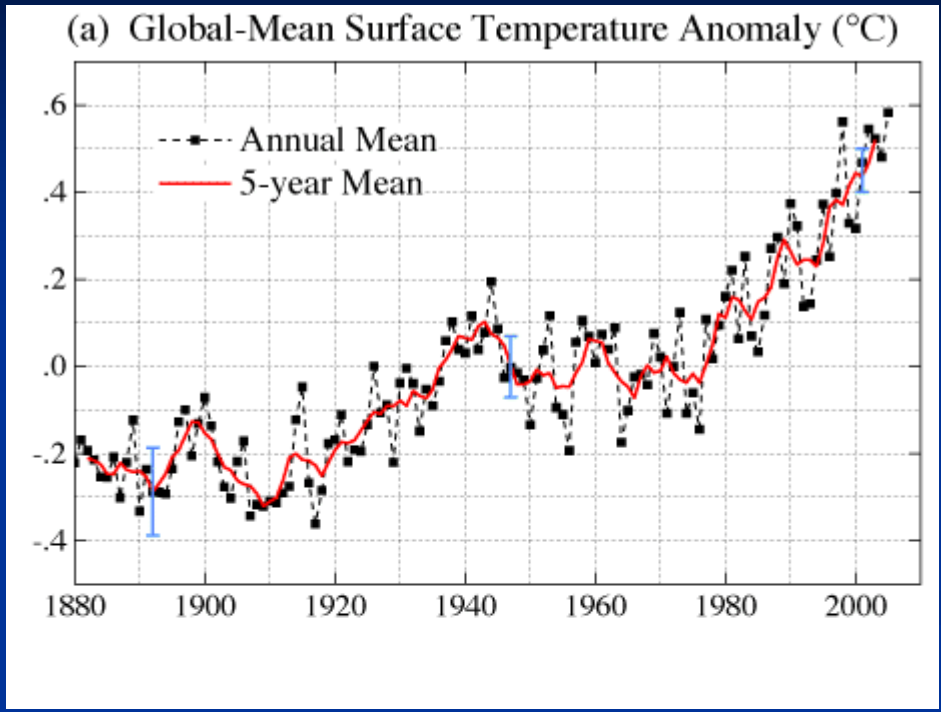
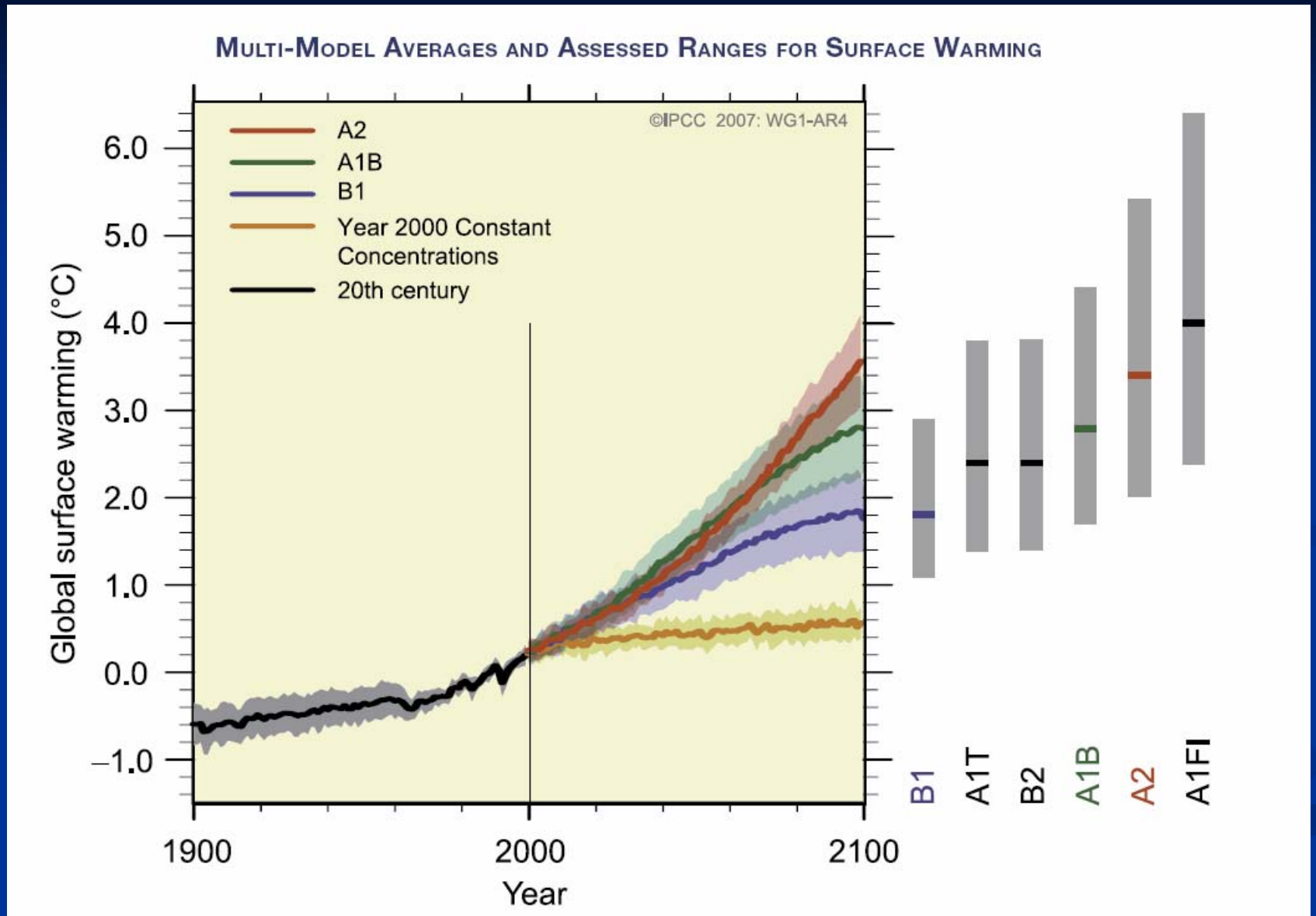

(a) Global-Mean Surface Temperature Anomaly (°C)
Annual Mean
5-year Mean
.6
.4
.2
.0
-.2
-.4
1880
1900
1920
1940
1960
1980
2000

(NASA GISS)

IPCC 2007 Executive Summary:

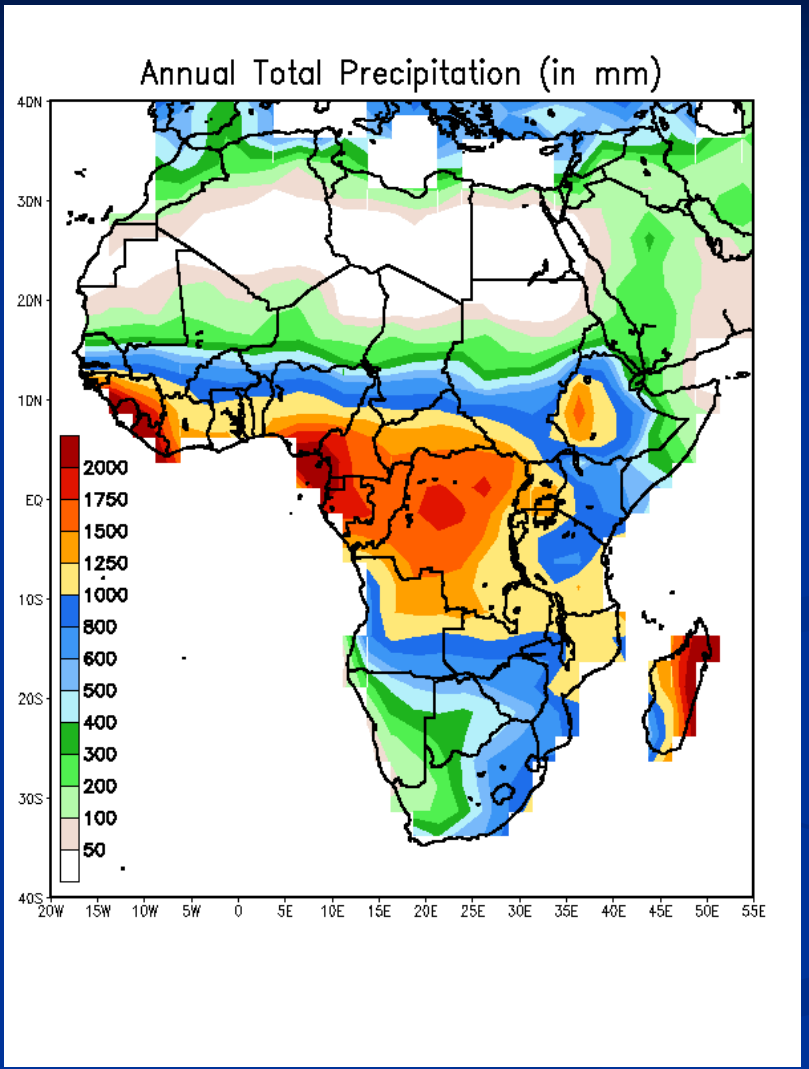
Most of the observed increase in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic greenhouse gas concentrations.

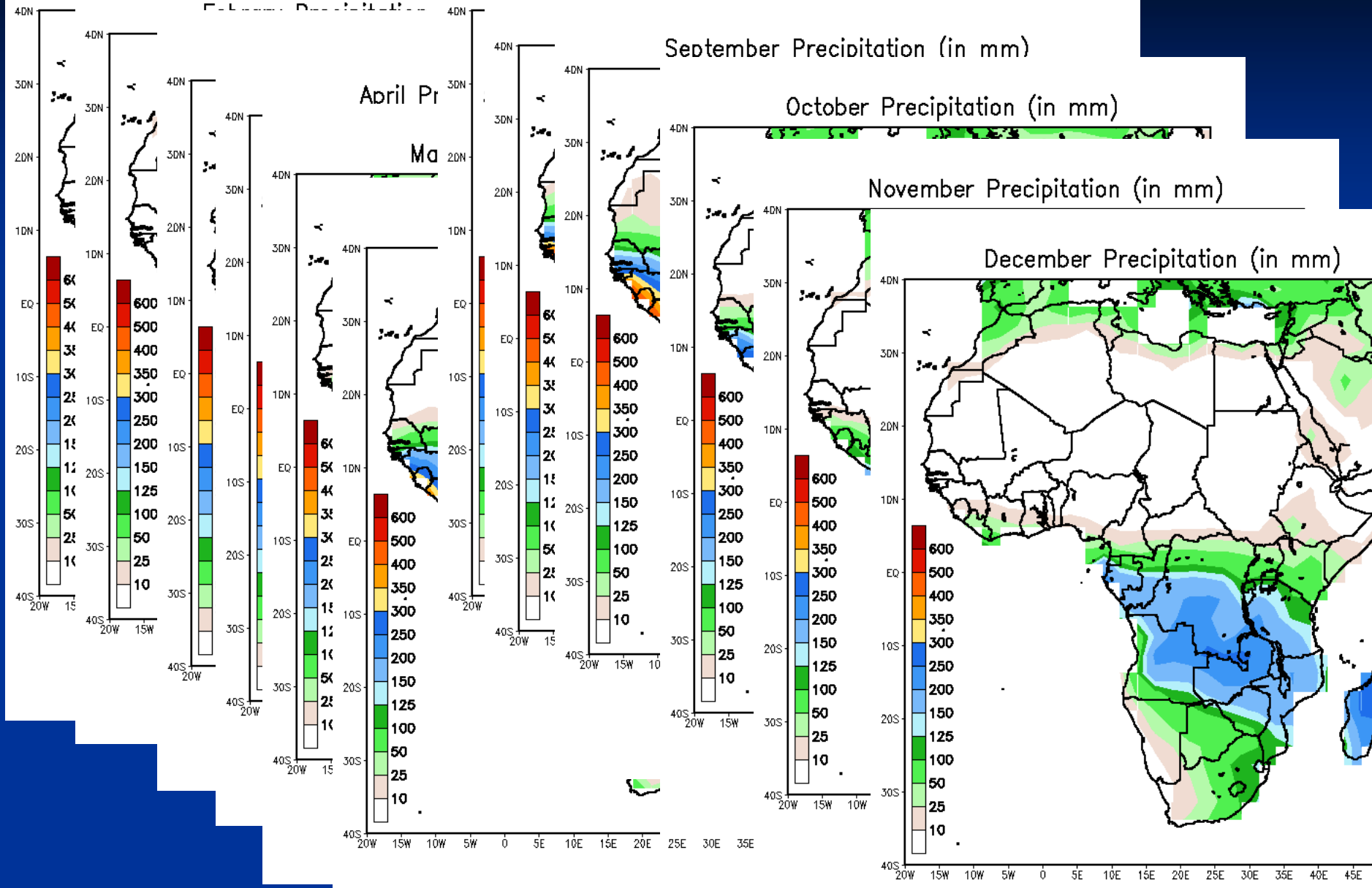

MULTI-MODEL AVERAGES AND ASSESSED RANGES FOR SURFACE WARMING
©IPCC 2007: WG1-AR4
A2
A1B
B1
Year 2000 Constant Concentrations
20th century
Global surface warming (°C)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
−1.0
1900
2000
2100
Year
B1
A1T
B2
A1B
A2
A1FI

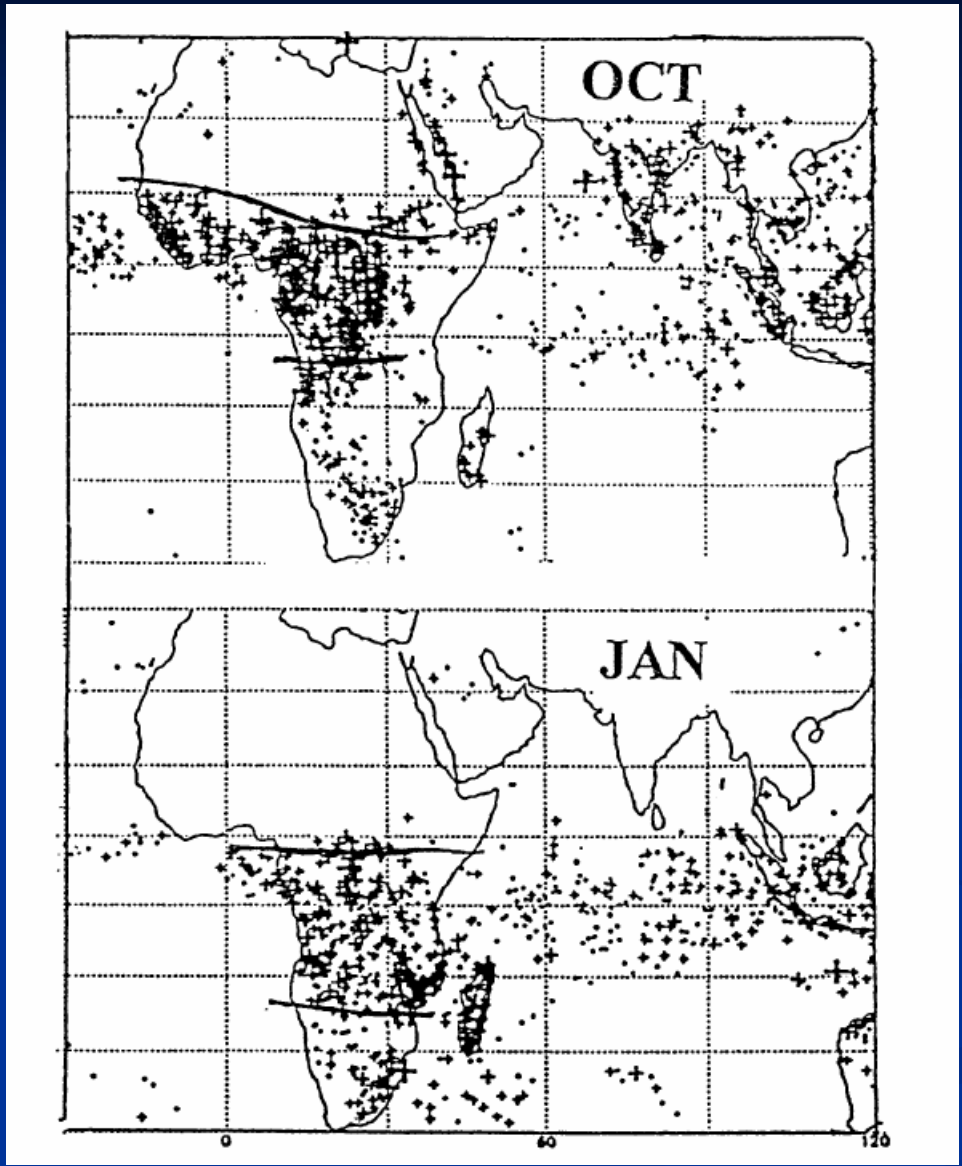
(IPCC 2007)


Africa
Europe
Asia
Algiers
Tunis
Casablanca
Tripoli
Alexandria
Cairo
Dakar
Khartoum
Lagos
Addis Ababa
Abidjan
Accra
0°
Equator
Indian
Ocean
Nairobi
Kinshasa
Dar es Salaam
Luanda
Atlantic
Ocean
Harare
Antananarivo
0
800 Miles
0
800 Kilometers
Pretoria
Johannesburg
Maputo
Durban
Cape Town
Tropical wet
Tropical wet and dry
Semiarid
Desert
Subtropical dry summer
Humid subtropical
Humid oceanic
Highland

Rainfall Features


Annual Total Precipitation (in mm)
4DN
3DN
2DN
1DN
EQ
1OS
2OS
3OS
4OS
2000
1750
1500
1250
1000
800
600
500
400
300
200
100
50
20W
15W
10W
5W
0
5E
10E
15E
20E
25E
30E
35E
40E
45E
50E
55E

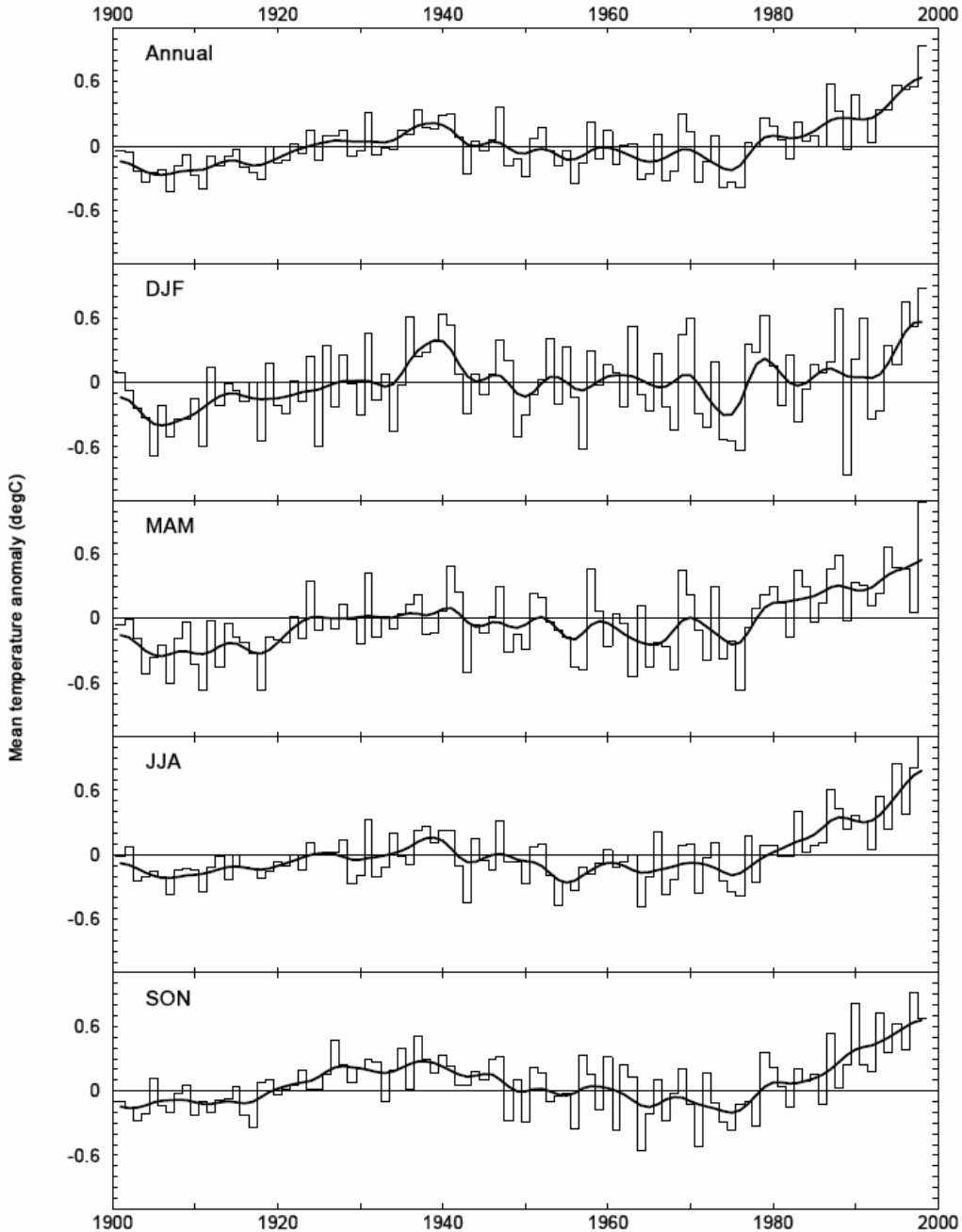

September Precipitation (in mm)
October Precipitation (in mm)
November Precipitation (in mm)
December Precipitation (in mm)
600
500
400
350
300
250
200
150
125
100
50
25
10



(Nicholson and Grist 2003)

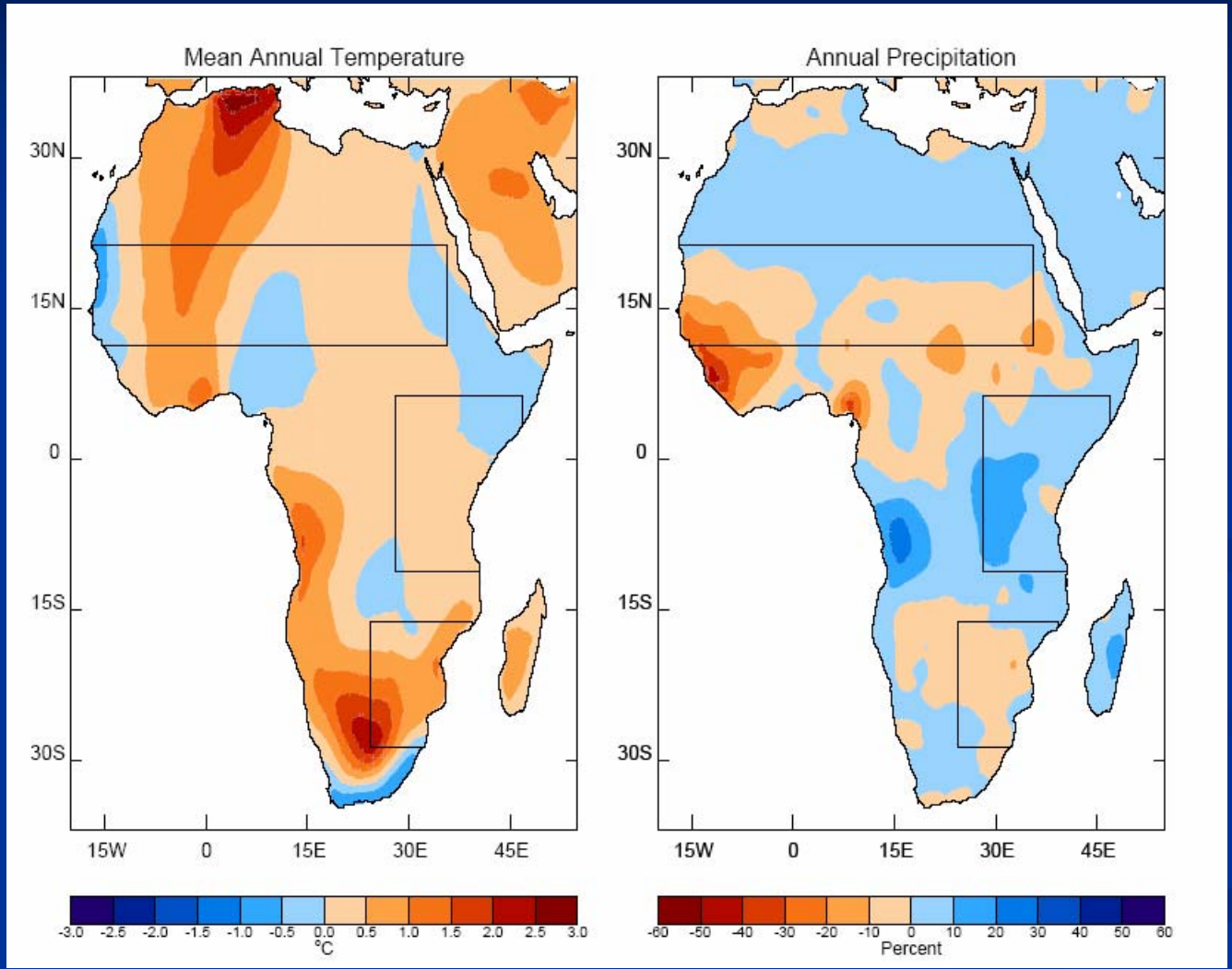
Changes in the Last Century

Continent Average Temperature



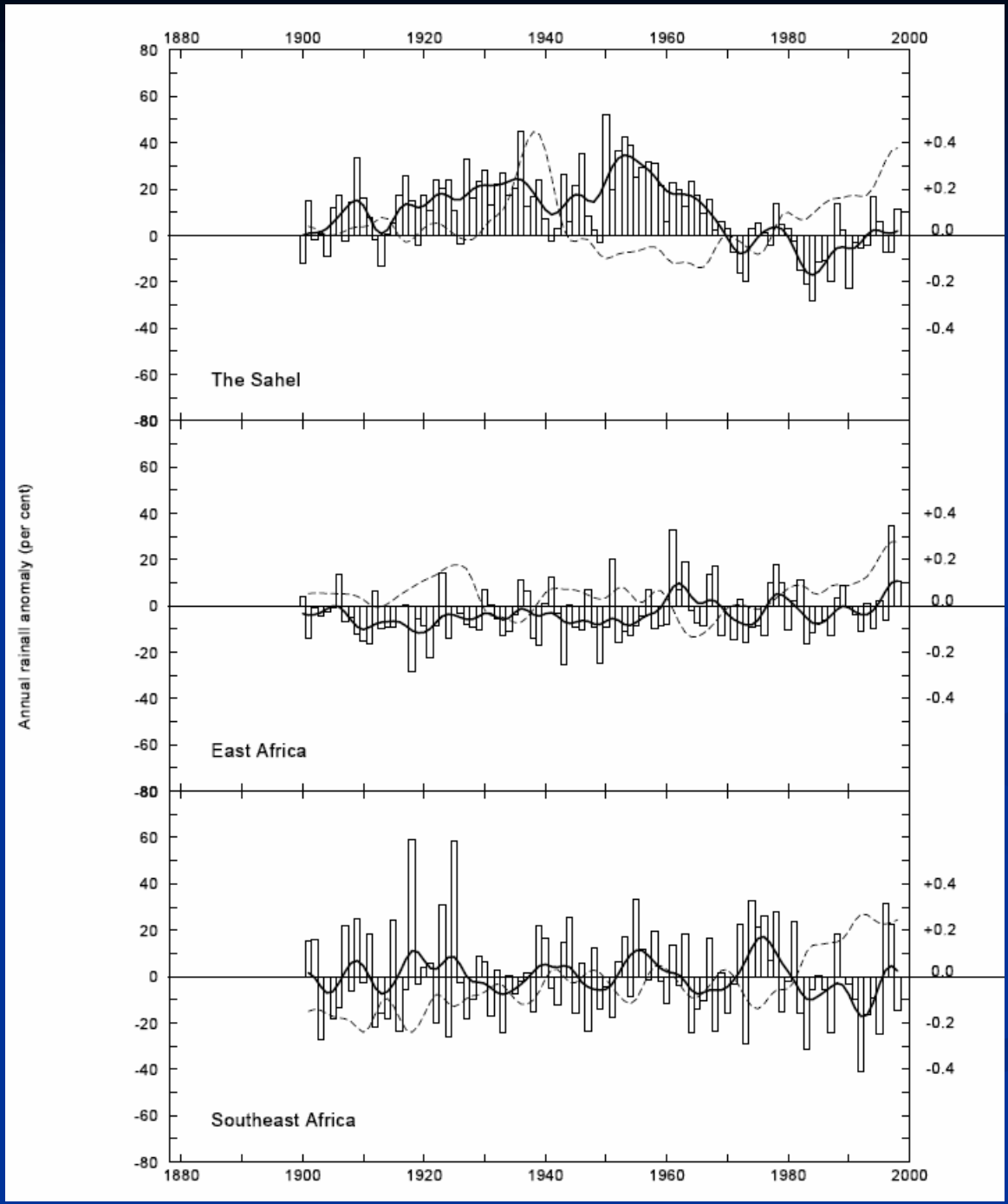
(Hulme et al. 2003)

Temperature and Precipitation Change Since 1900

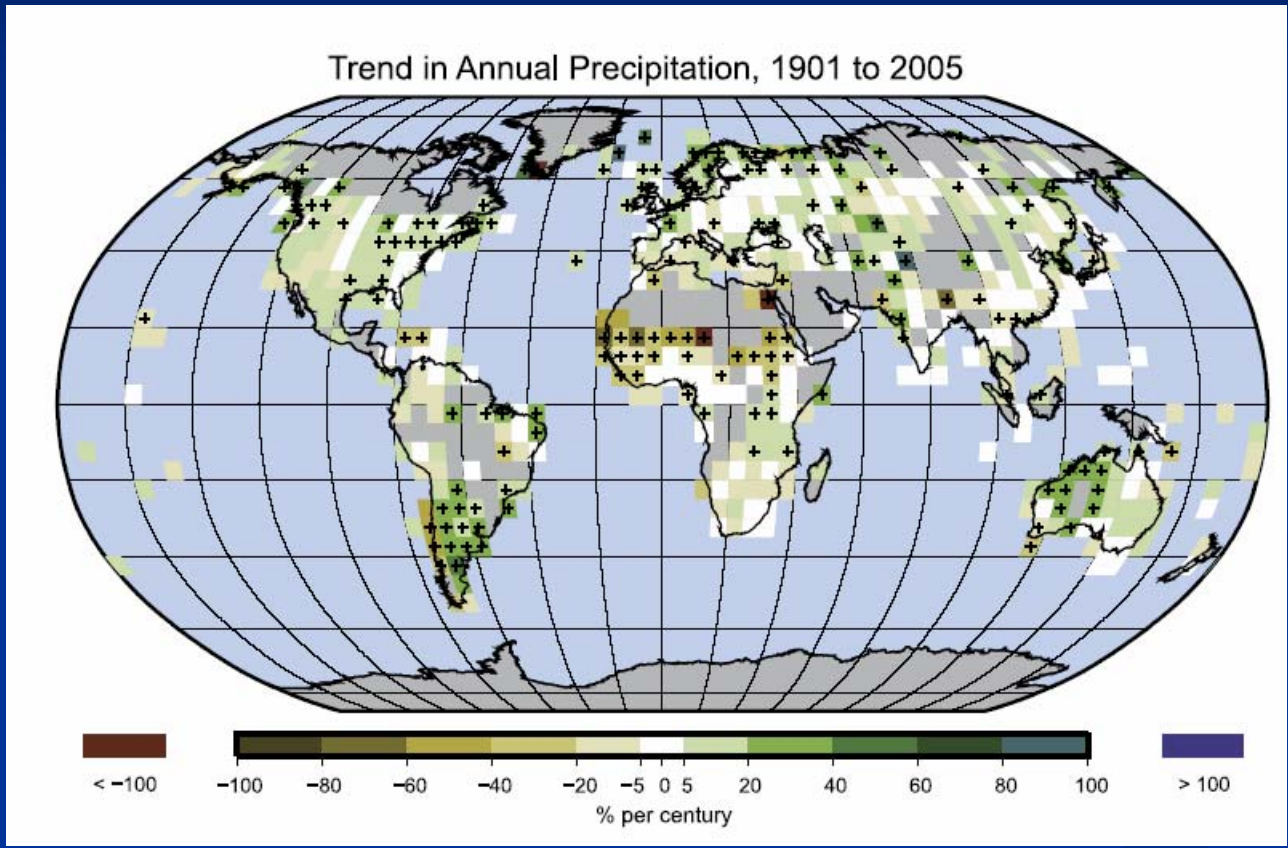


(Hulme et al. 2003)

Temperature
Precipitation
Change
Since 1900

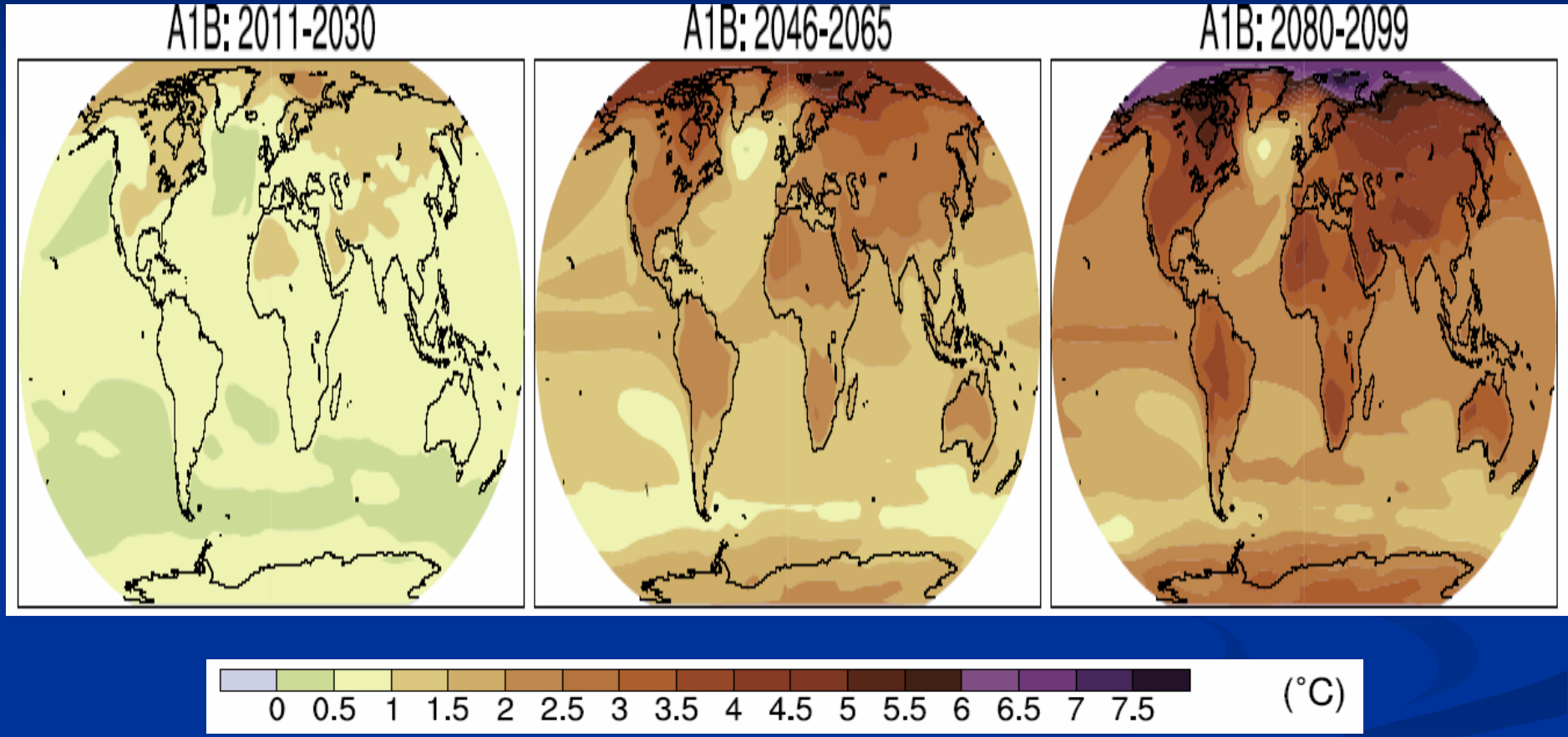


(Hulme et al. 2003)


Trend in Annual Precipitation, 1901 to 2005
< −100
−100
−80
−60
−40
−20
−5
0
5
20
40
60
80
100
> 100
% per century

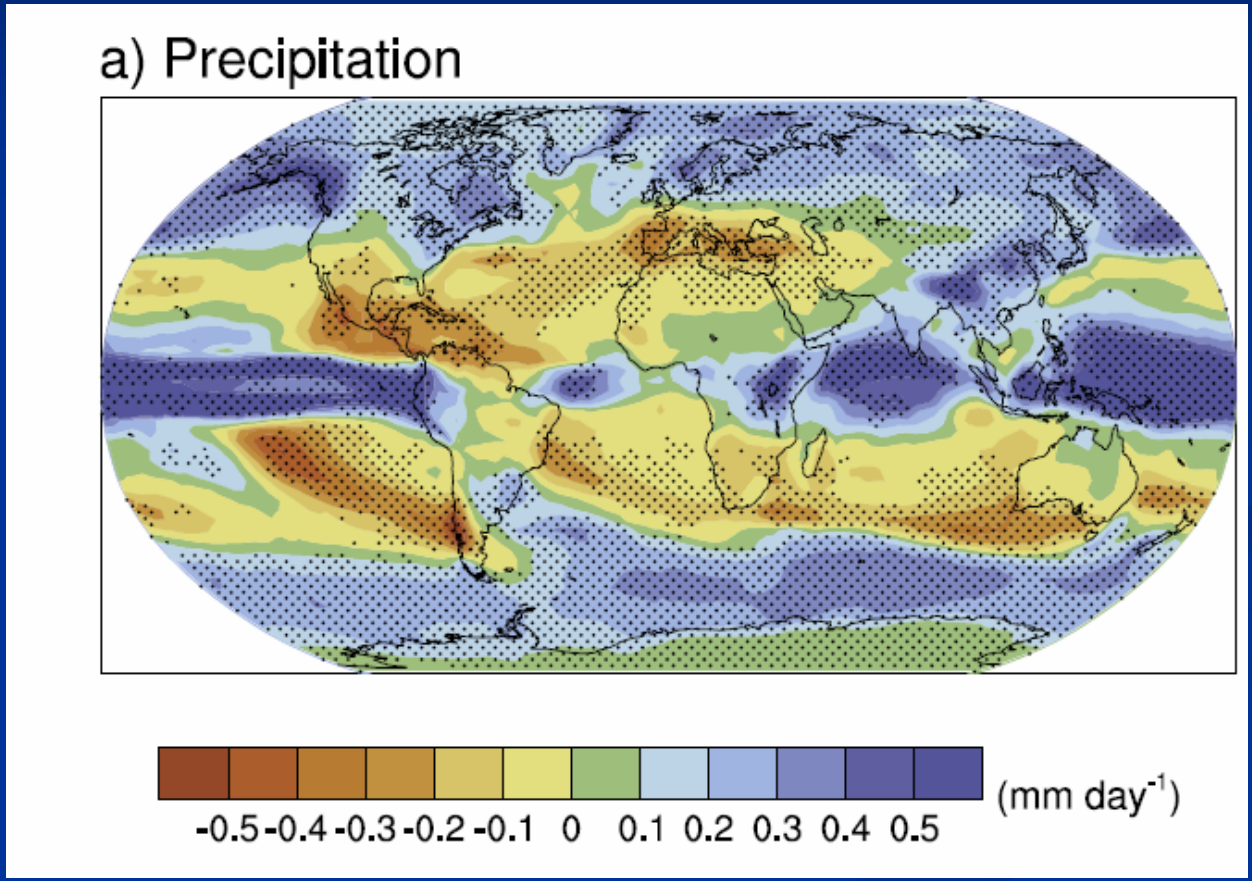
Projection for the Future

Projected Temperature Change



(IPCC 2007)

Projected Precipitation Change for Years 2080-2099

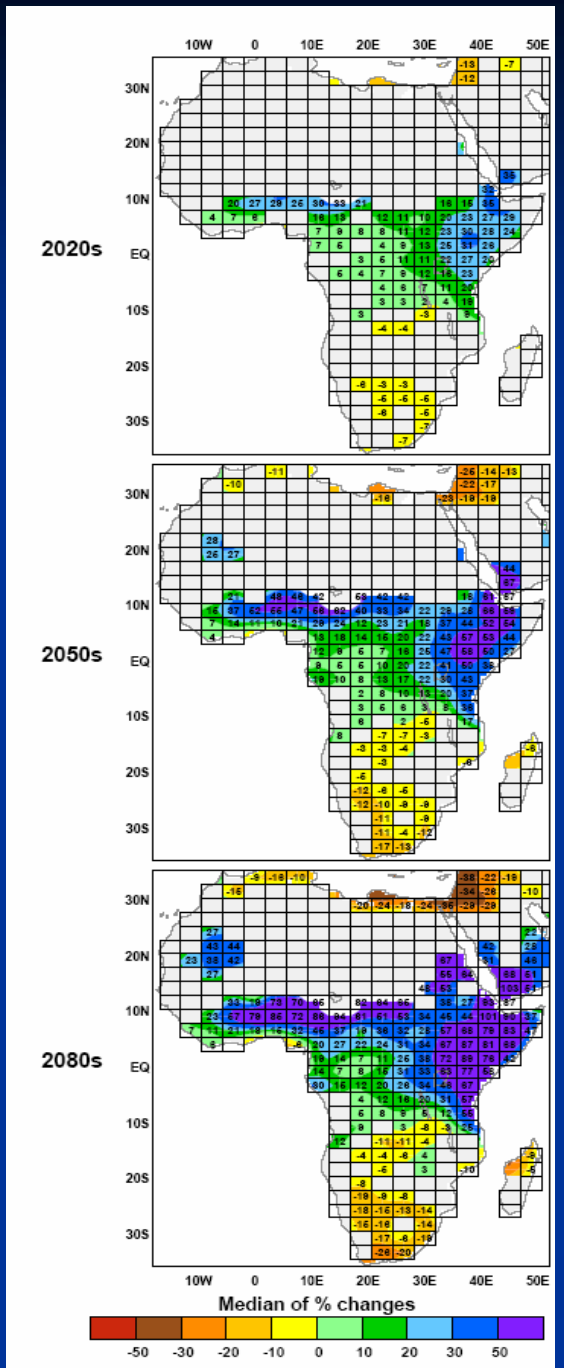


(IPCC 2007)

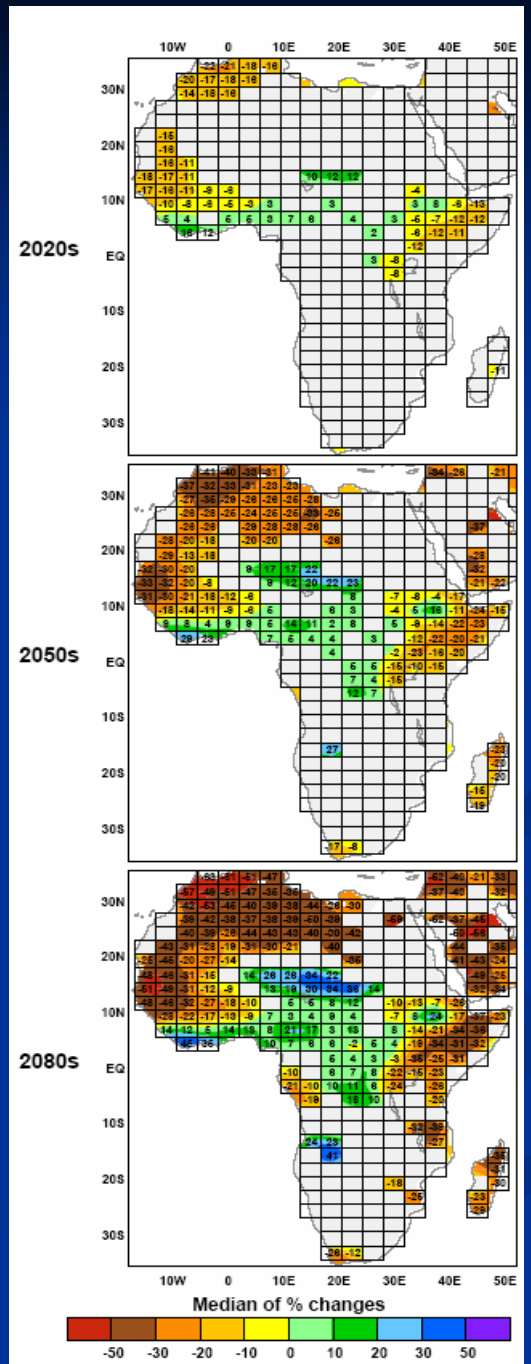
Seasonal Dependence of Rainfall Change

Projected Precipitation Change

(DJF)

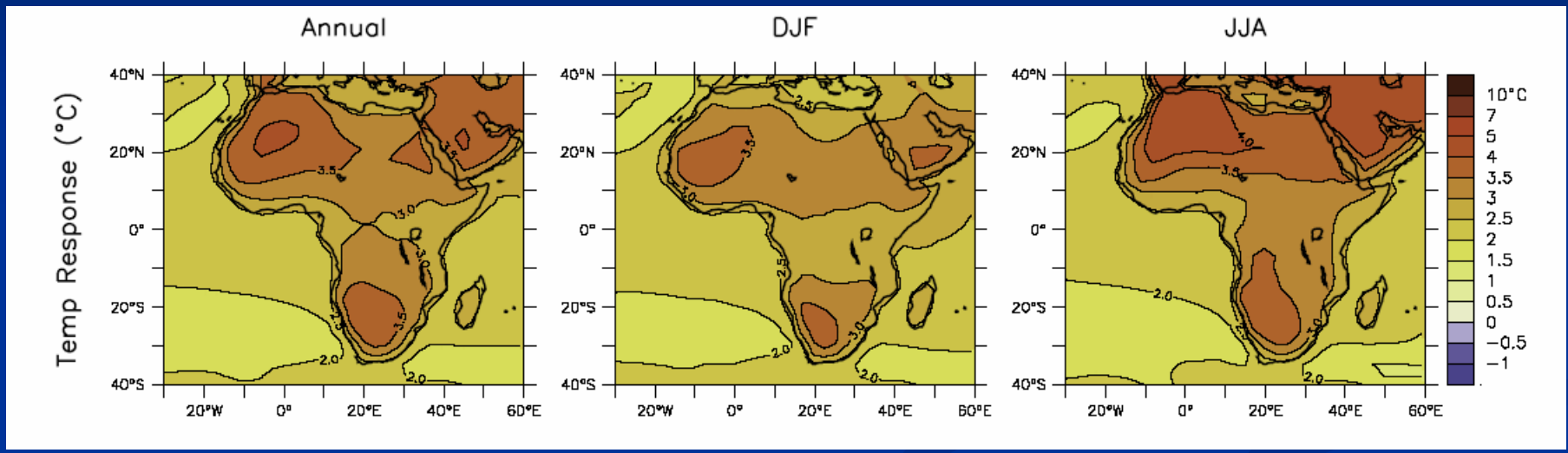


(JJA)



(Hulme et al. 2007)

Projected Temperature Change for Years 2080-2099



(IPCC 2007)

The Message

1. Past Changes
   Dominated by interannual and decadal variations

2. Future Changes:
   Wet season wetter
   Dry season drier
   Warmer all seasons