



Modification of the general circulation of the atmosphere due to climate change

„Global change monitoring“

Martin König

Klima

Umweltbundesamt



Basics for the general circulation

- 4 Parameters for the atmospheric circulation are:
 - 1. Temperature and
 - 2. Moisture content of airmasses

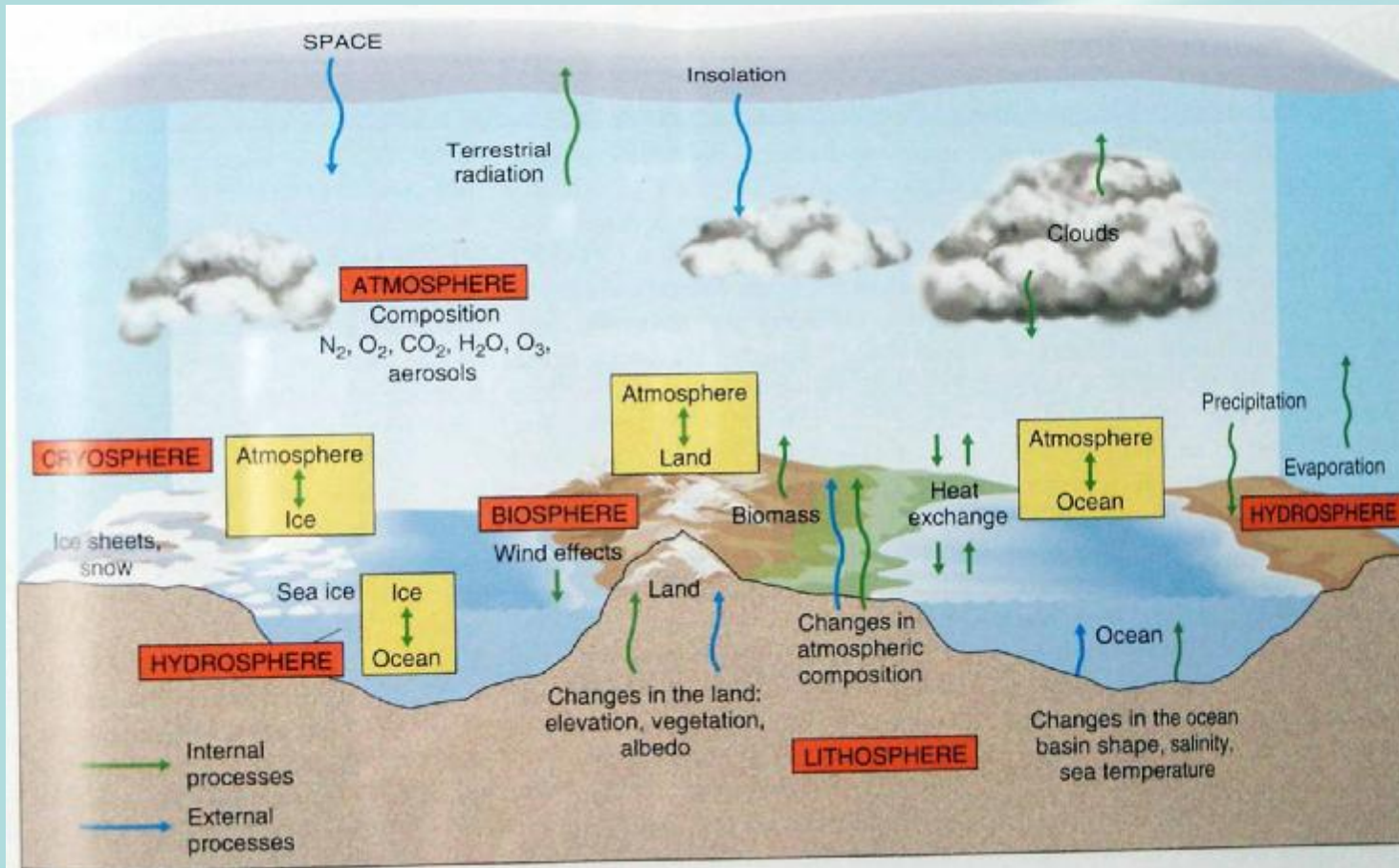
- 4 These result in regionally diversified (thermal/hydro) air pressure fields compensation movements which are:
 - on the local level – wind
 - on the regional level – cyclons and pressure fields
 - on the global level – general circulation of the atmosphere

Basics for the general circulation

- 4 Variable factors are:
1. Surface temperatures of oceans (SST) and continents
 2. The oceanic circulation
 3. Sea ice (albedo and interrupted heat transport)
 4. Snow coverage (albedo)
 5. Soil(moisture)
 6. Vegetation
 7. Land-use (sealing, acres, pasture, urban spaces,...)
 8. Sun activity, gravitation field and other extraterrestrial influences

Basics for the general circulation

4 interactions



Christopherson 2000

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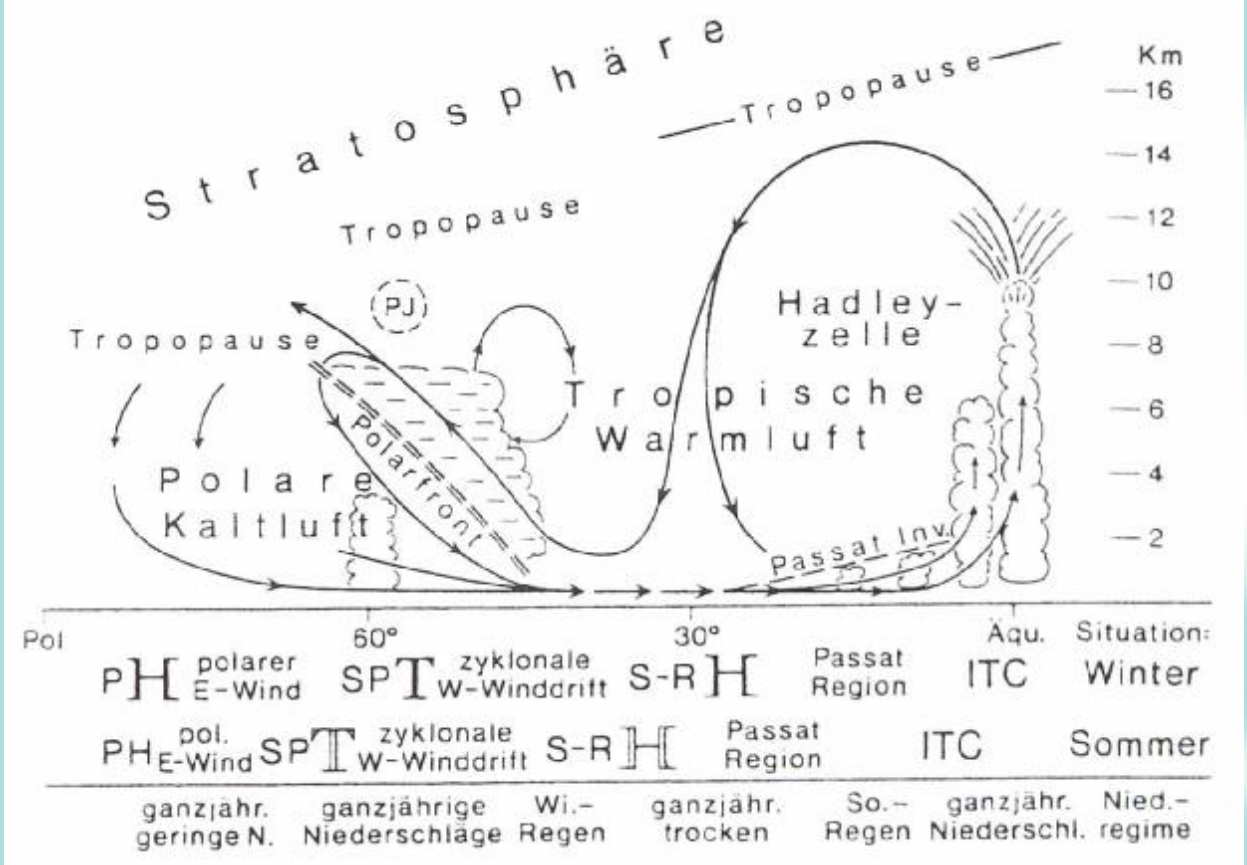
Basics for the general circulation

- 4 stabilisation criteria:
- 4 There is a lower stability of air films where there is:
 1. High temperature on the ground (heating from the surface)
 2. Wet airmasses which accelerate convection (the higher the humidity of airmasses, the stronger is the convection = ascending of airmasses)



Resulting circulation patterns

4 Hadley circulation and inner-tropical convergence (ITC):



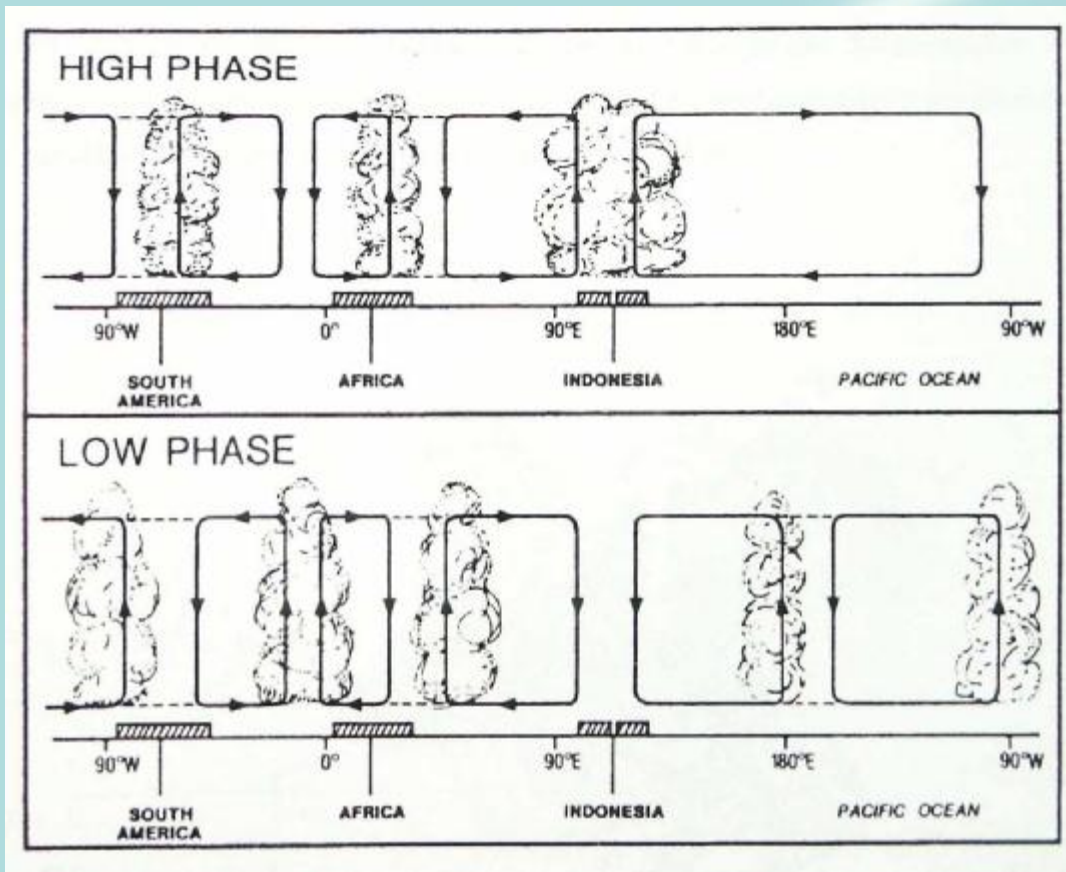
Weischet 1991

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Resulting circulation patterns

4 Walker circulation:

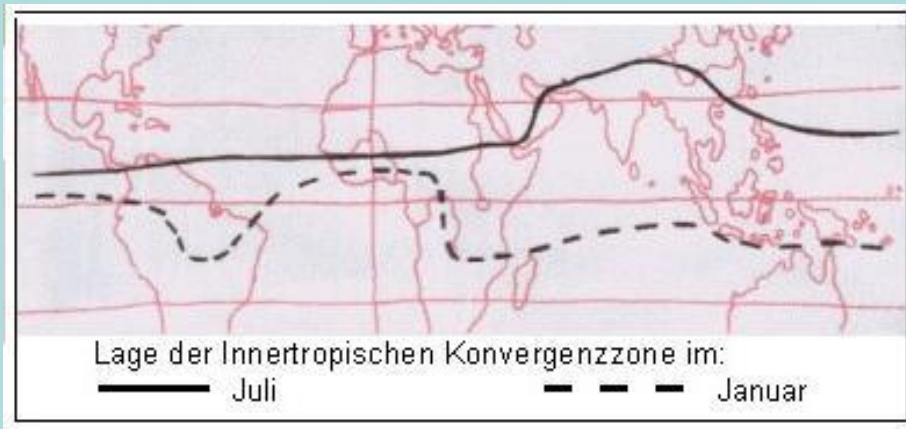


Lindesay/Tyson 1986

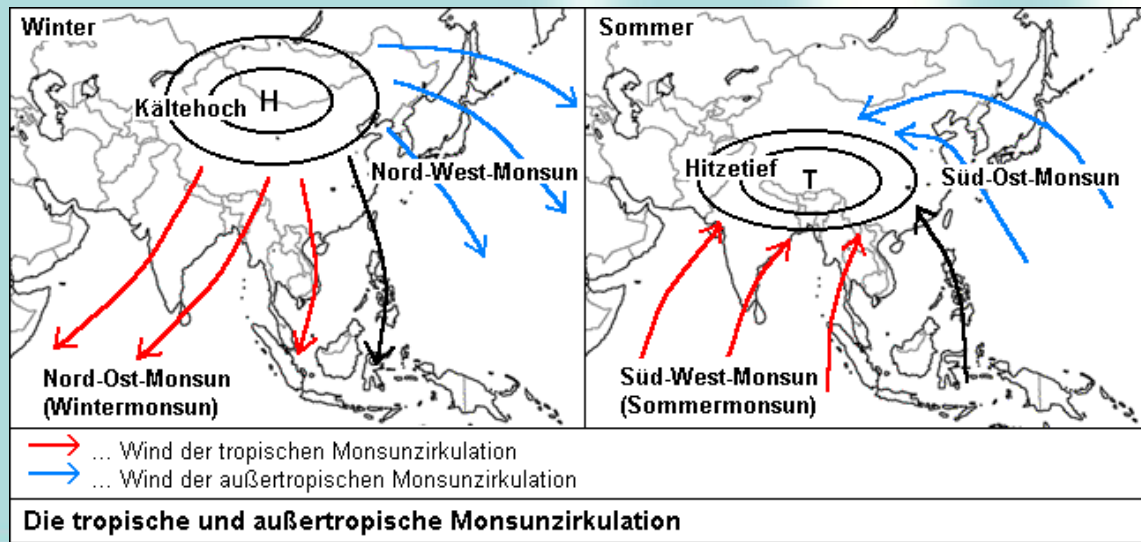
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Resulting circulation patterns

4 Monsoon circulation:



http://muf.forkel.bei.t-online.de/klima/zirk_passat.html



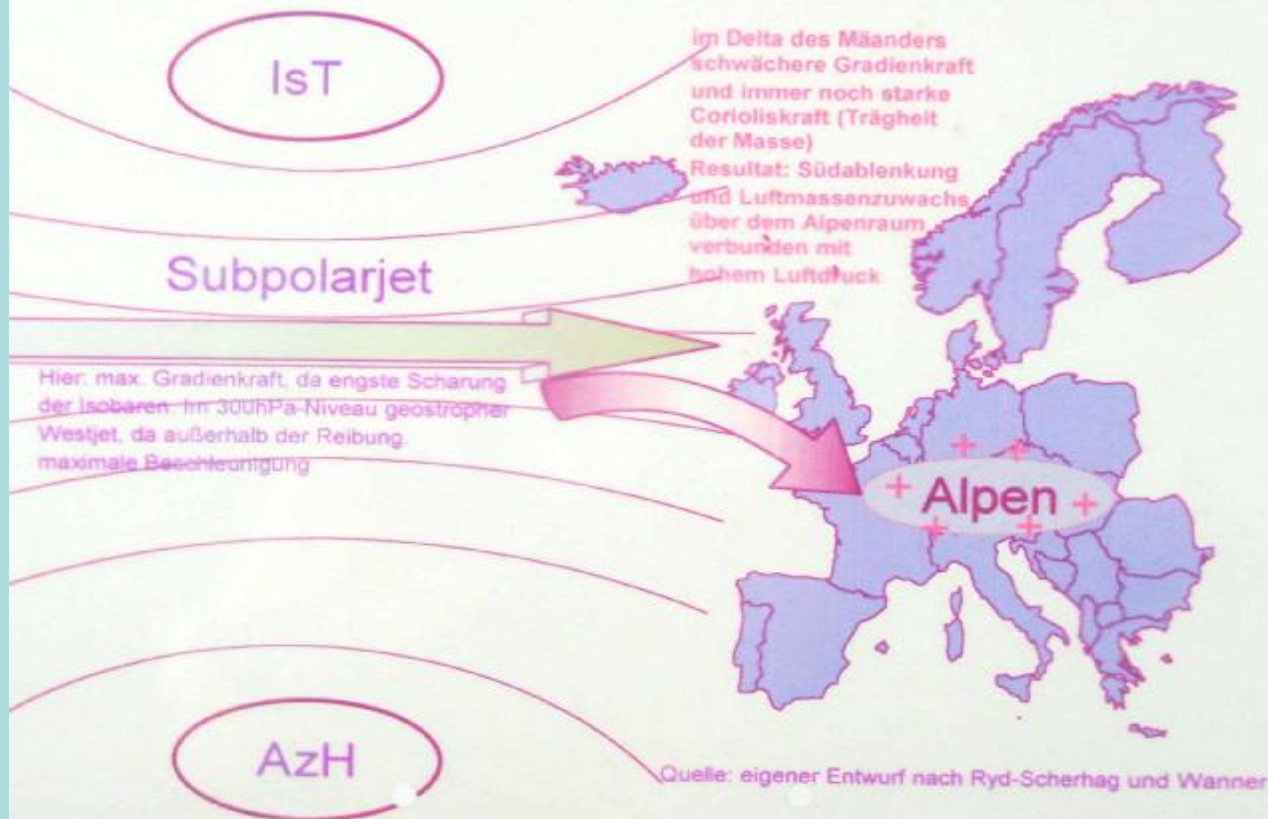
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Resulting circulation patterns

4 North Atlantic Oscillation (NAO) and dynamic air pressure fields:

Zirkulationsmuster bei stark positiver NAO im 300hPa-Niveau



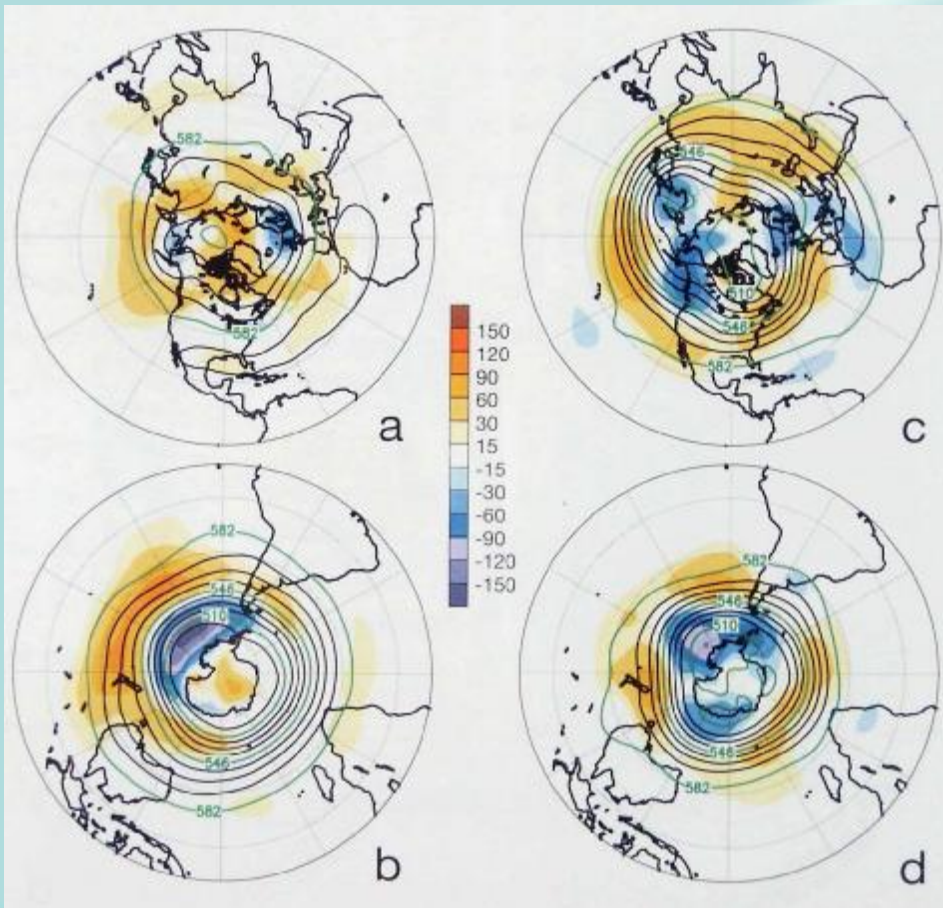
König 1996

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Resulting circulation patterns

4 Southern hemisphere circulation versus northern hemisphere circulation:



WMO 2003

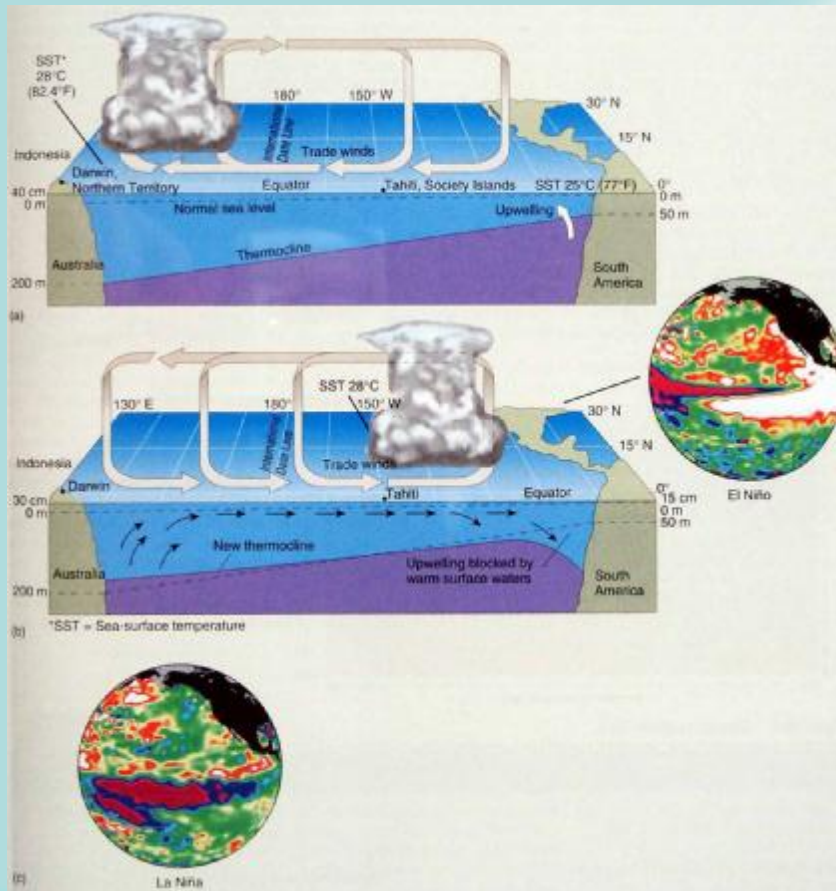
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Resulting circulation patterns

4 El Nino Southern Oscillation (ENSO):



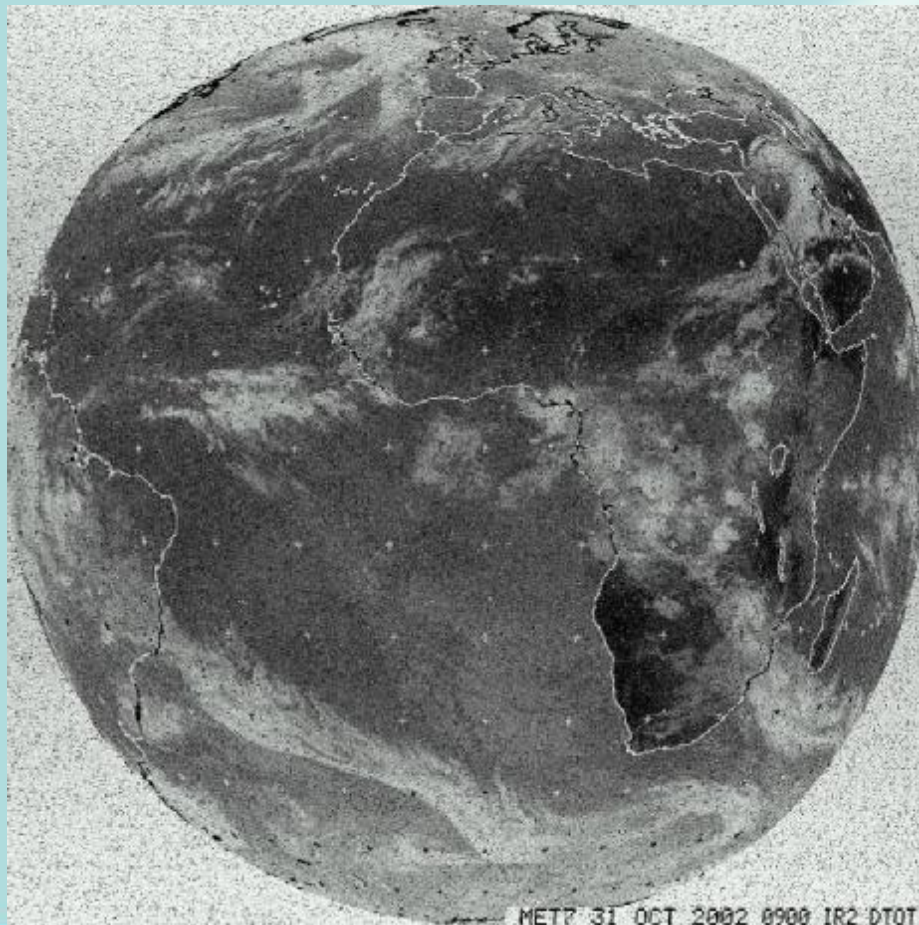
WMO 2003

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Resulting circulation patterns

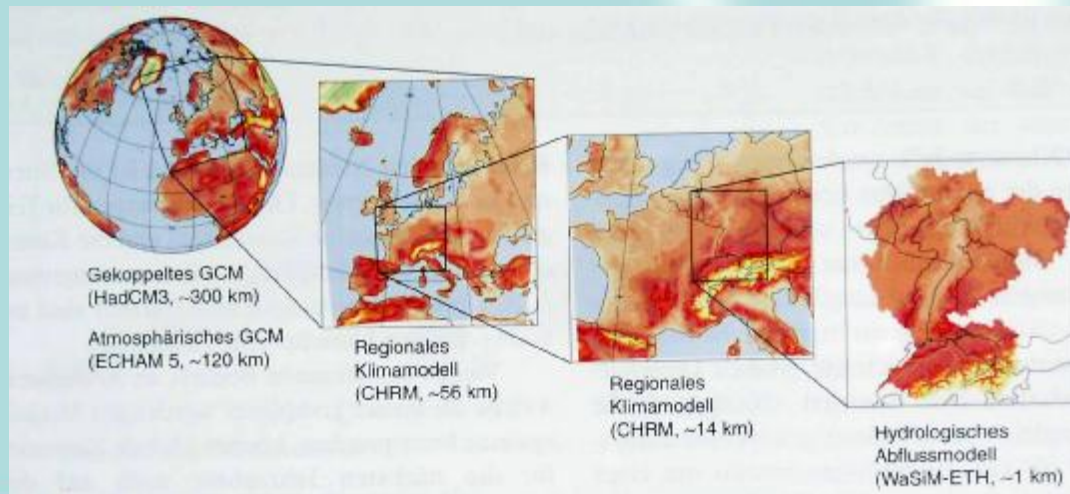
4 METEOSAT, 31rd October 2002:



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Excursus: climate models

- 4 Energy balance models (EBM) – history
- 4 Radiative convective models – history
- 4 Global circulation models (GCM)
 - 4 Only atmosphere – history
 - 4 Atmosphere coupled with ocean – state of the art
- 4 Resolution of global versus regional circulation models:



OcCC 2003

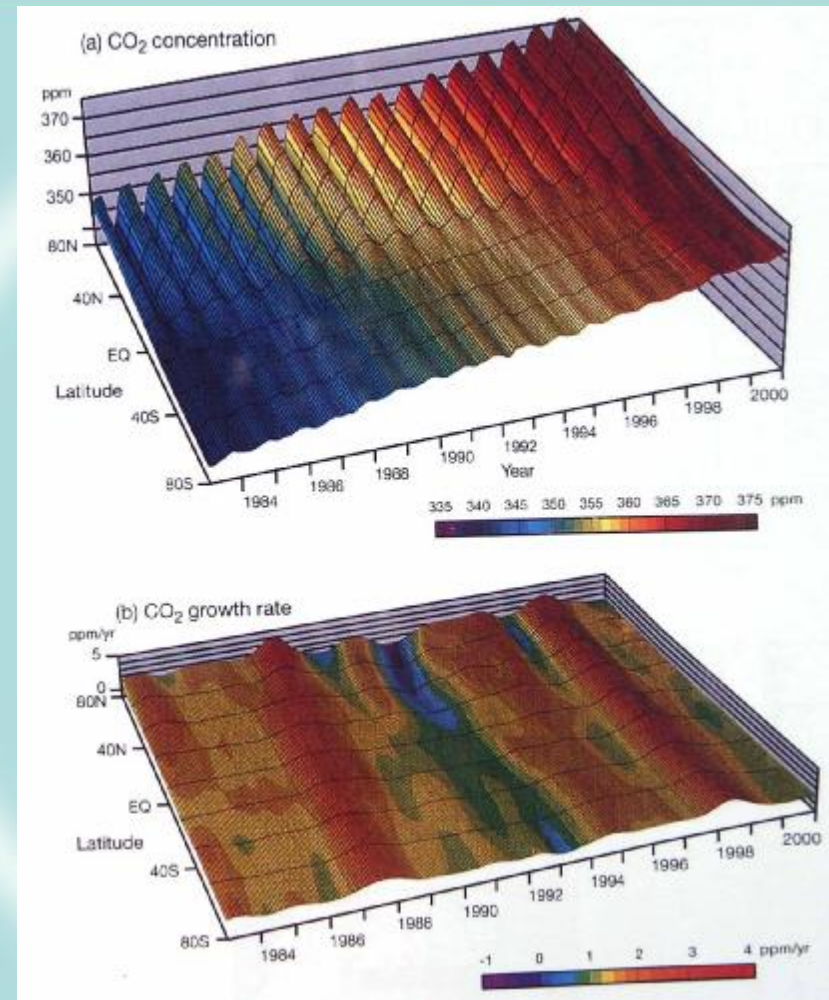
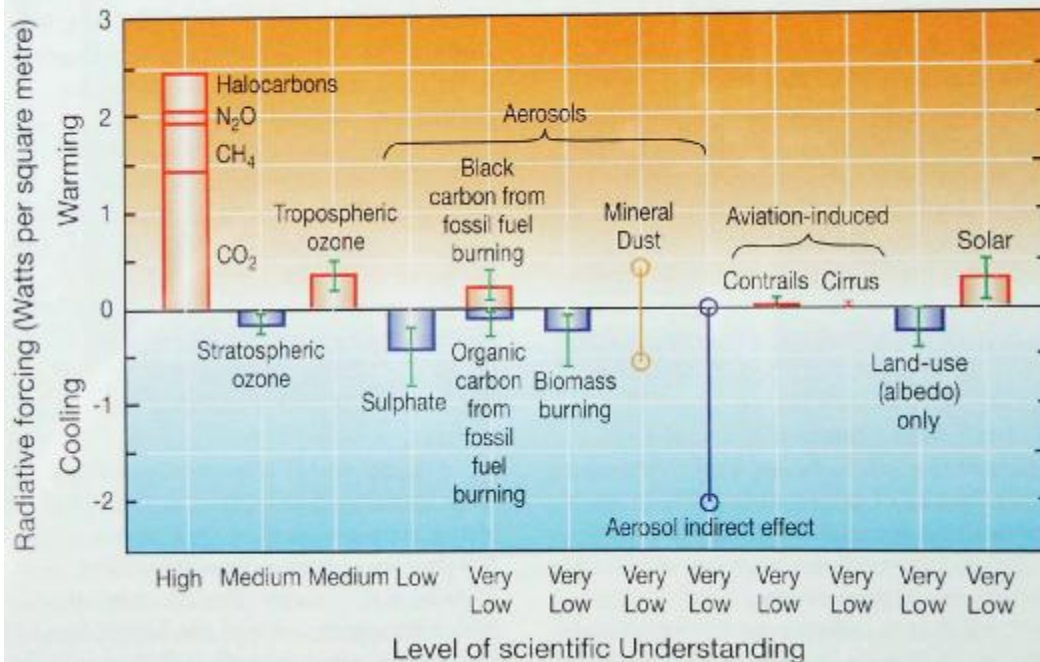
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Greenhouse gas concentration and impact

4 CO₂-concentration

4 Radiative forcing

The global mean radiative forcing of the climate system for the year 2000, relative to 1750

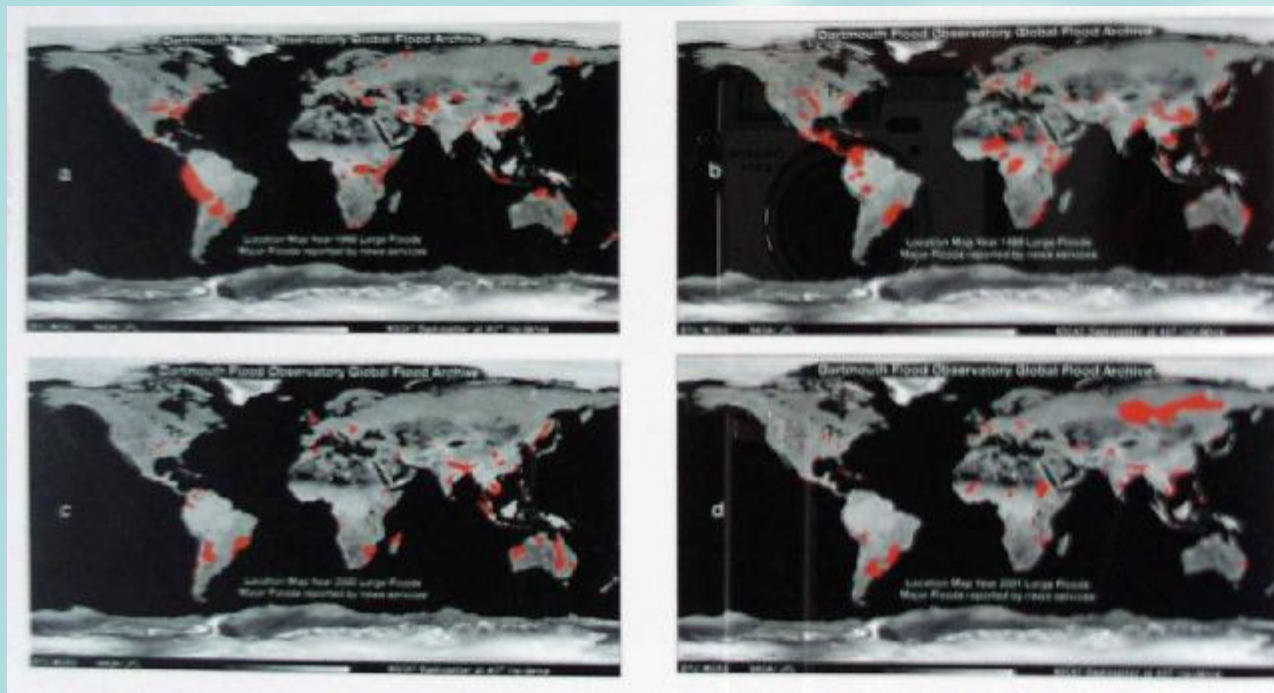


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Possible changes of circulation patterns

- 4 More extreme events (?) e.g. floodings, droughts, heat waves, storms/hurricanes, mudflows, avalanches,...



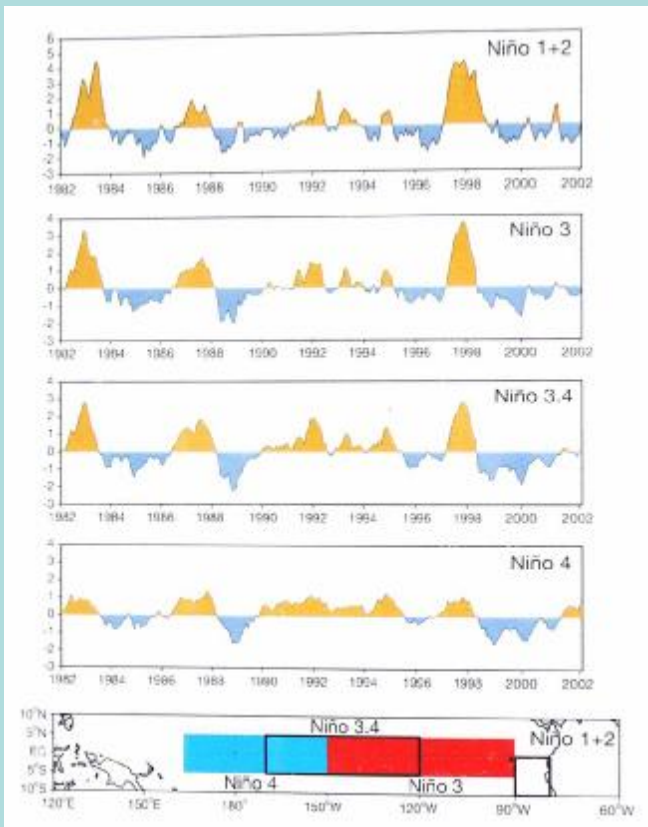
WMO 2003

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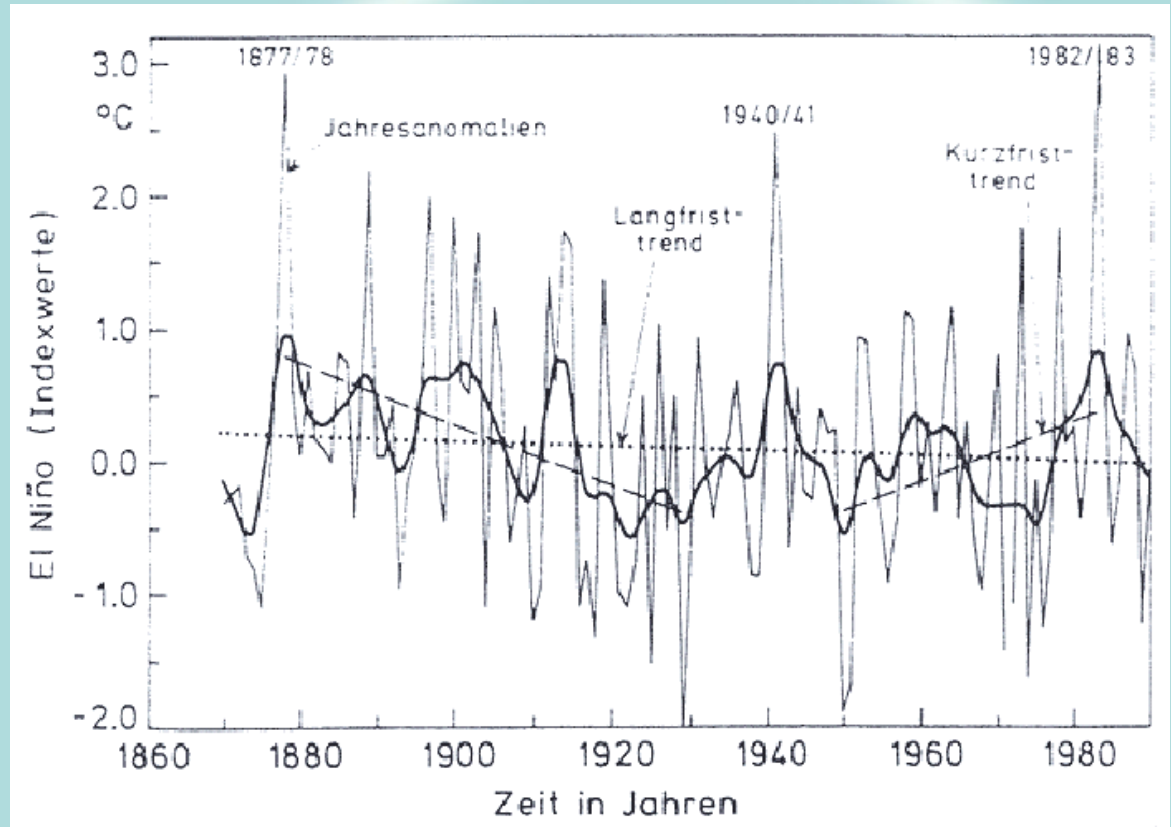


Possible changes of circulation patterns

4 Long-term changes in ENSO (?)



WMO 2003



Schönwiese 1995

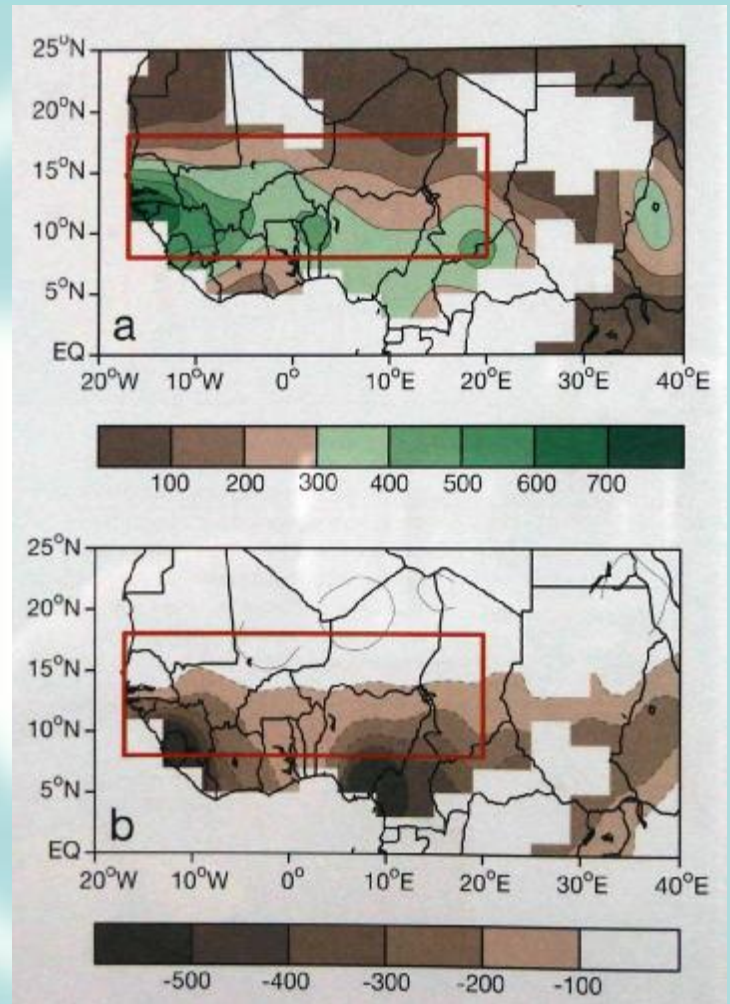
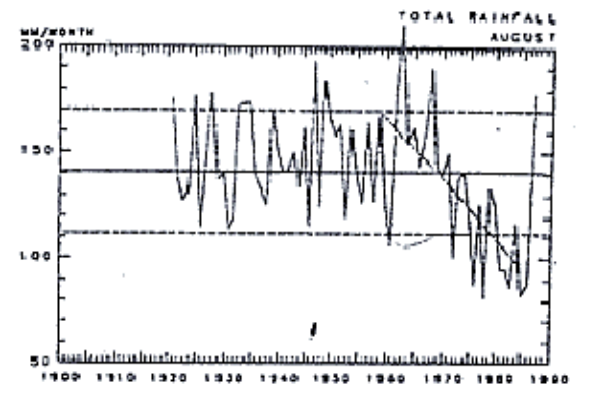
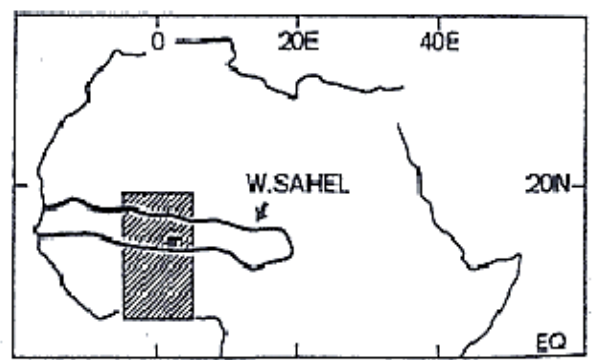
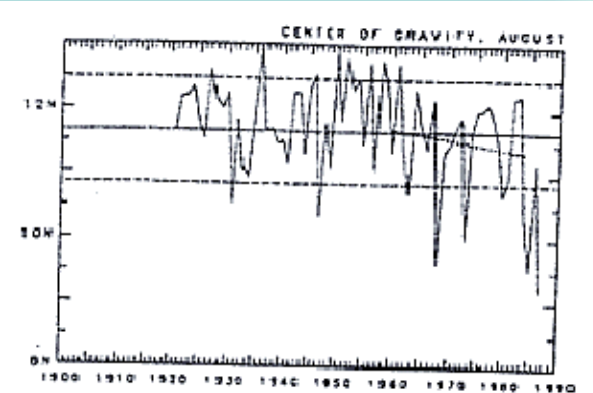
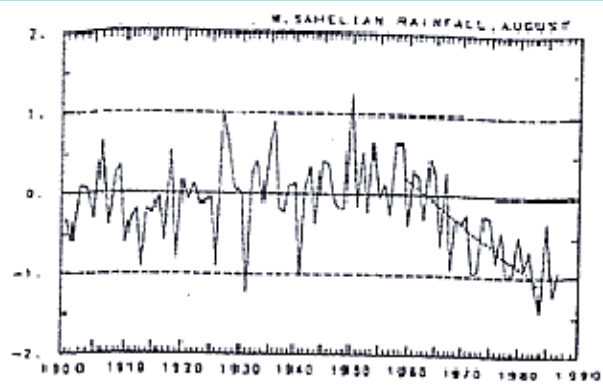
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Possible changes of circulation patterns

4 Long-term changes in the ITC (?)



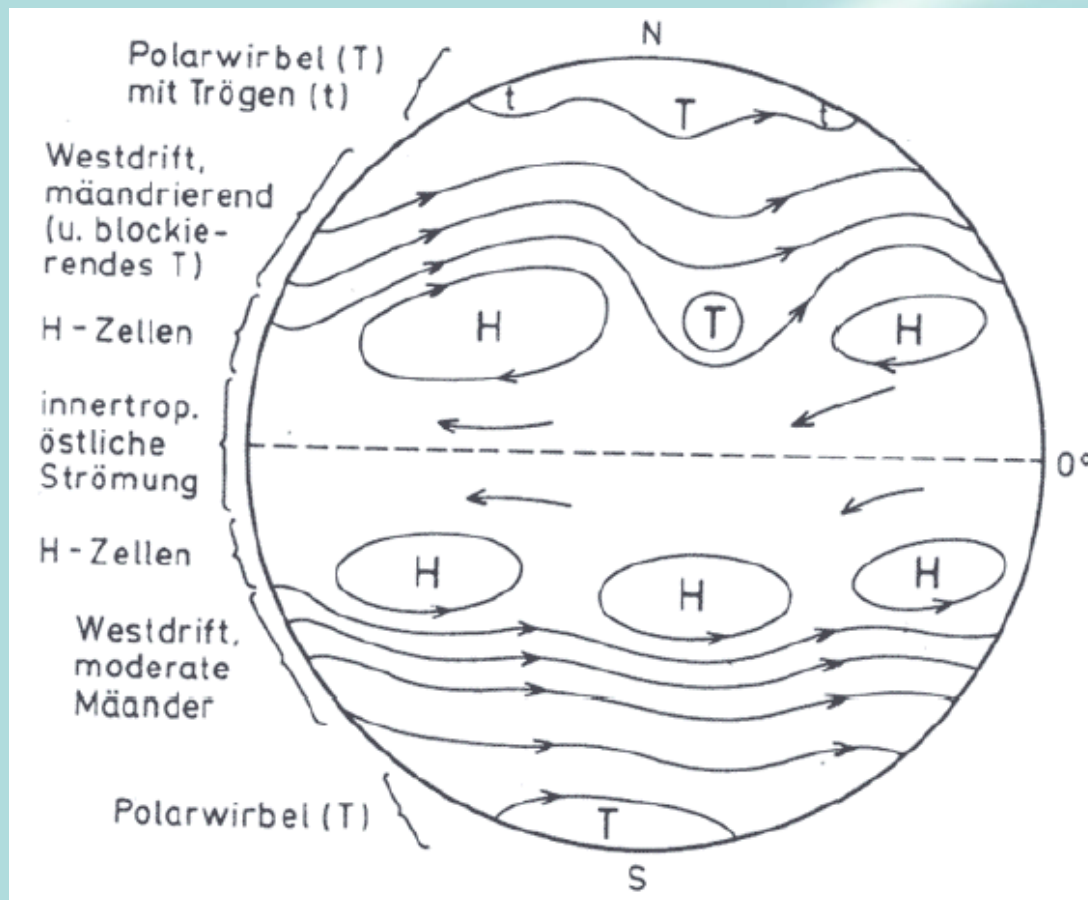
Shinoda/Kawamura 1994

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Possible changes of circulation patterns

4 Shift in air pressure belts due to stronger Hadley circulation



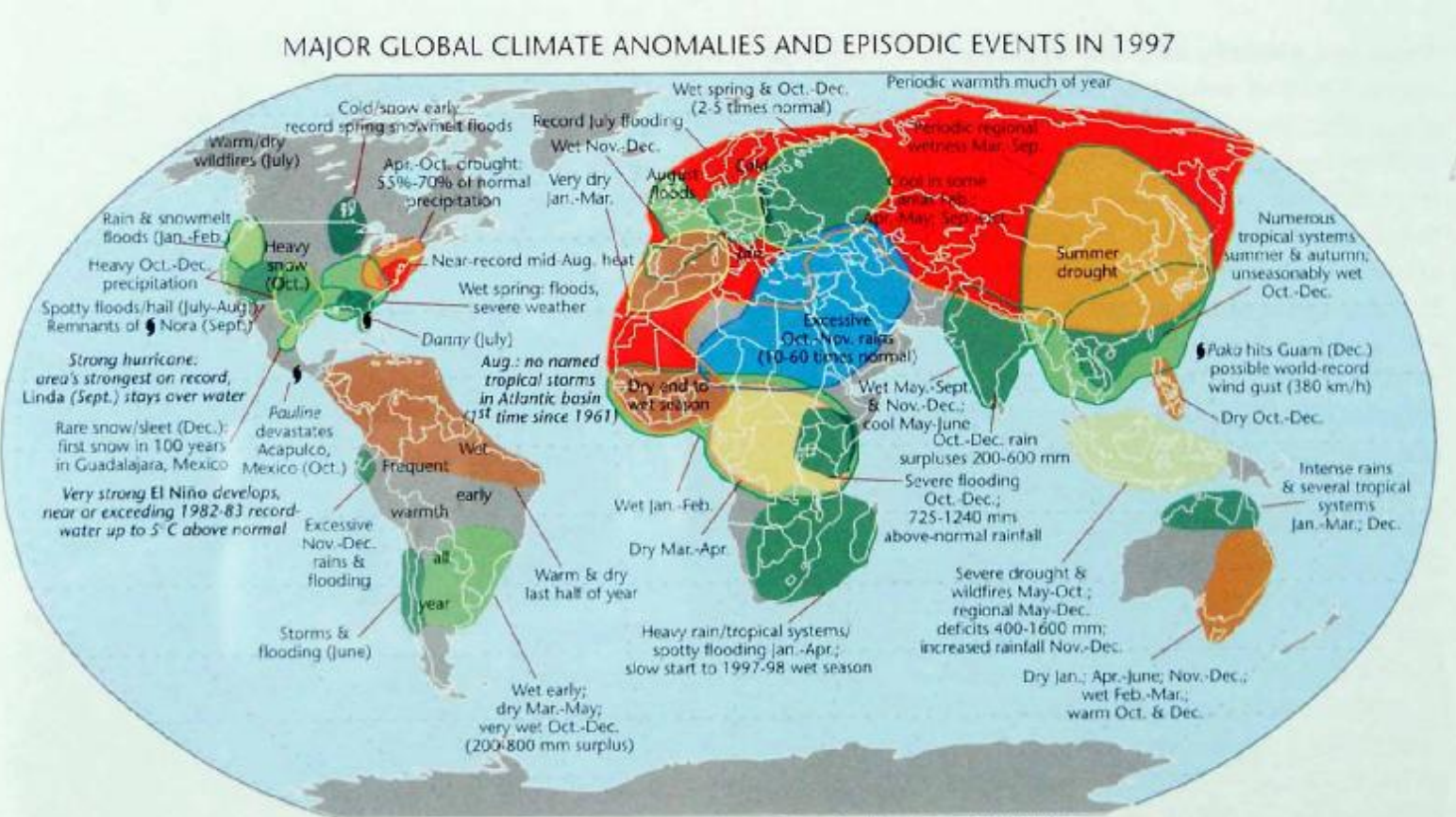
Flohn 1975

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Anomalies of recent years

4 Anomalies 1997



Source: Climate Prediction Center, NOAA, USA

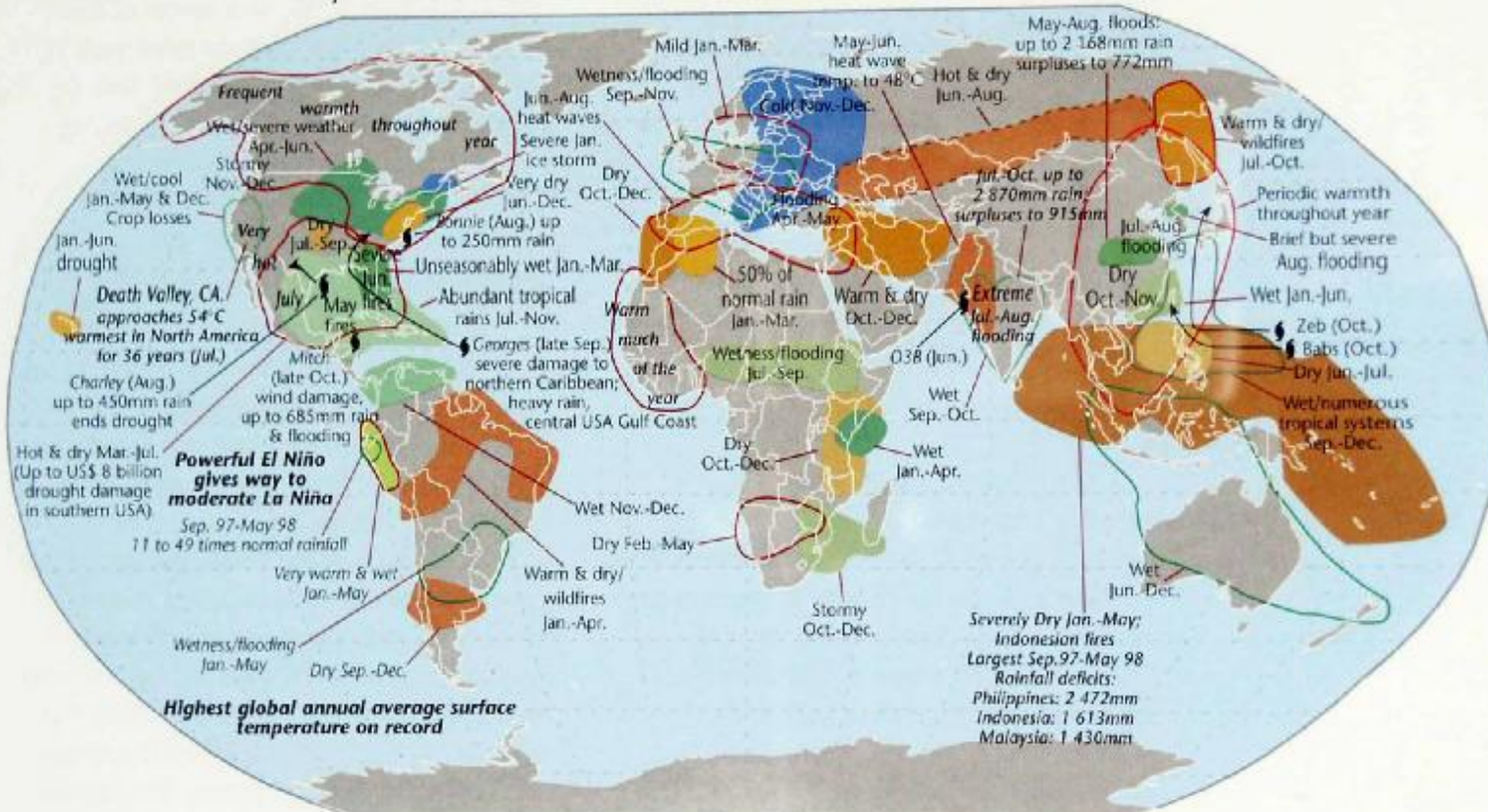
WMO 2003



Anomalies of recent years

4 Anomalies 1998

MAJOR GLOBAL CLIMATE ANOMALIES AND EPISODIC EVENTS IN 1998



Source: Climate Prediction Center, NOAA, USA

WMO 2003

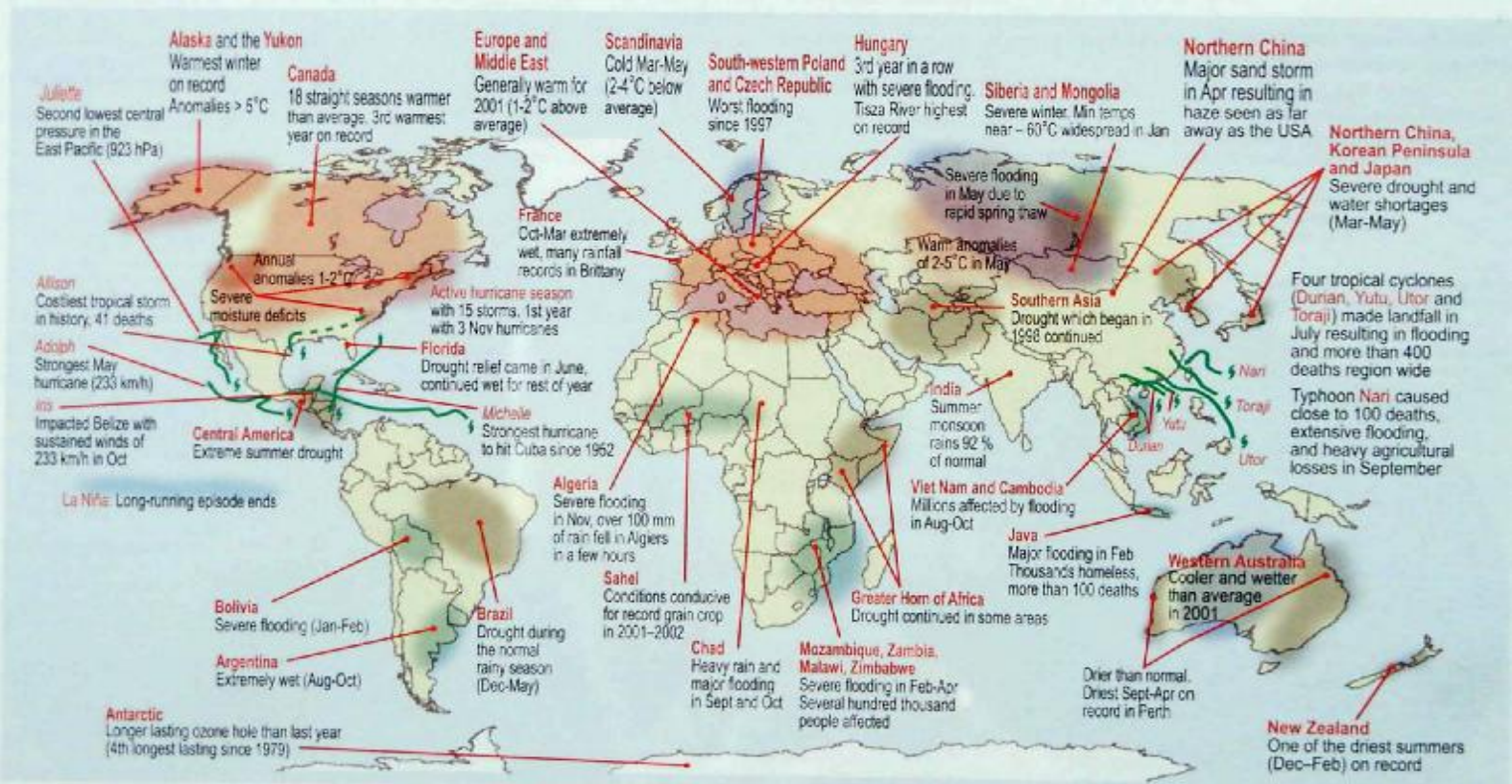
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Anomalies of recent years

4 Anomalies 2001

MAJOR GLOBAL CLIMATE ANOMALIES AND EPISODIC EVENTS IN 2001



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Literature to read on

Recommended actual literature:

- 4 IPCC (2001): Climate Change 2001 (TAR)
- 4 OcCC (2003): Extremereignisse und Klimawandel
- 4 WMO (2003): The Global Climate System Review

Recommended basic literature:

- 4 Christopherson (2000): Geosystems
- 4 Lauer (1993): Klimatologie
- 4 Schönwiese (1995): Klimatologie
- 4 Schultz (1995): Die Ökozonen der Erde
- 4 Weischet (1991): Einführung in die allg. Klimatologie