Risks for Rural Communities

SwissRe Centre for Global Dialogue
8-10 October, 2007

Outlook of next 20 years – Risky for agro

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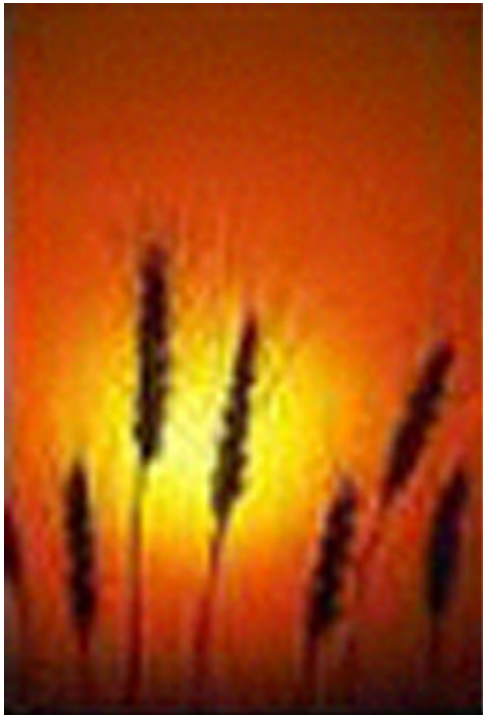
PAST AND FUTURE CLIMATE CHANGE



Direct Observations of Recent Climate Change

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level.

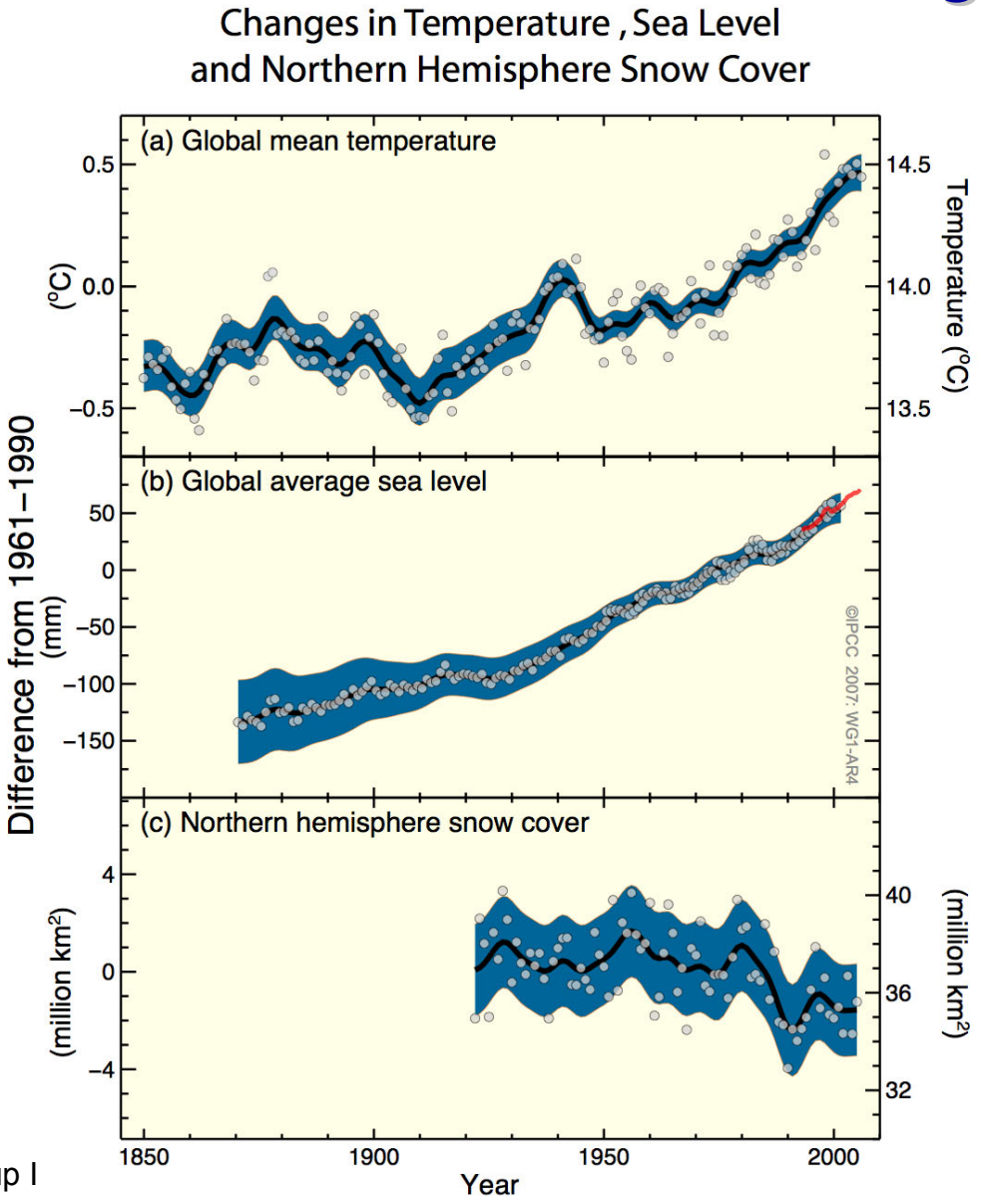
Source: IPCC Fourth Assessment Report, Working Group I

Direct Observations of Recent Climate Change

Global mean temperature

Global average sea level

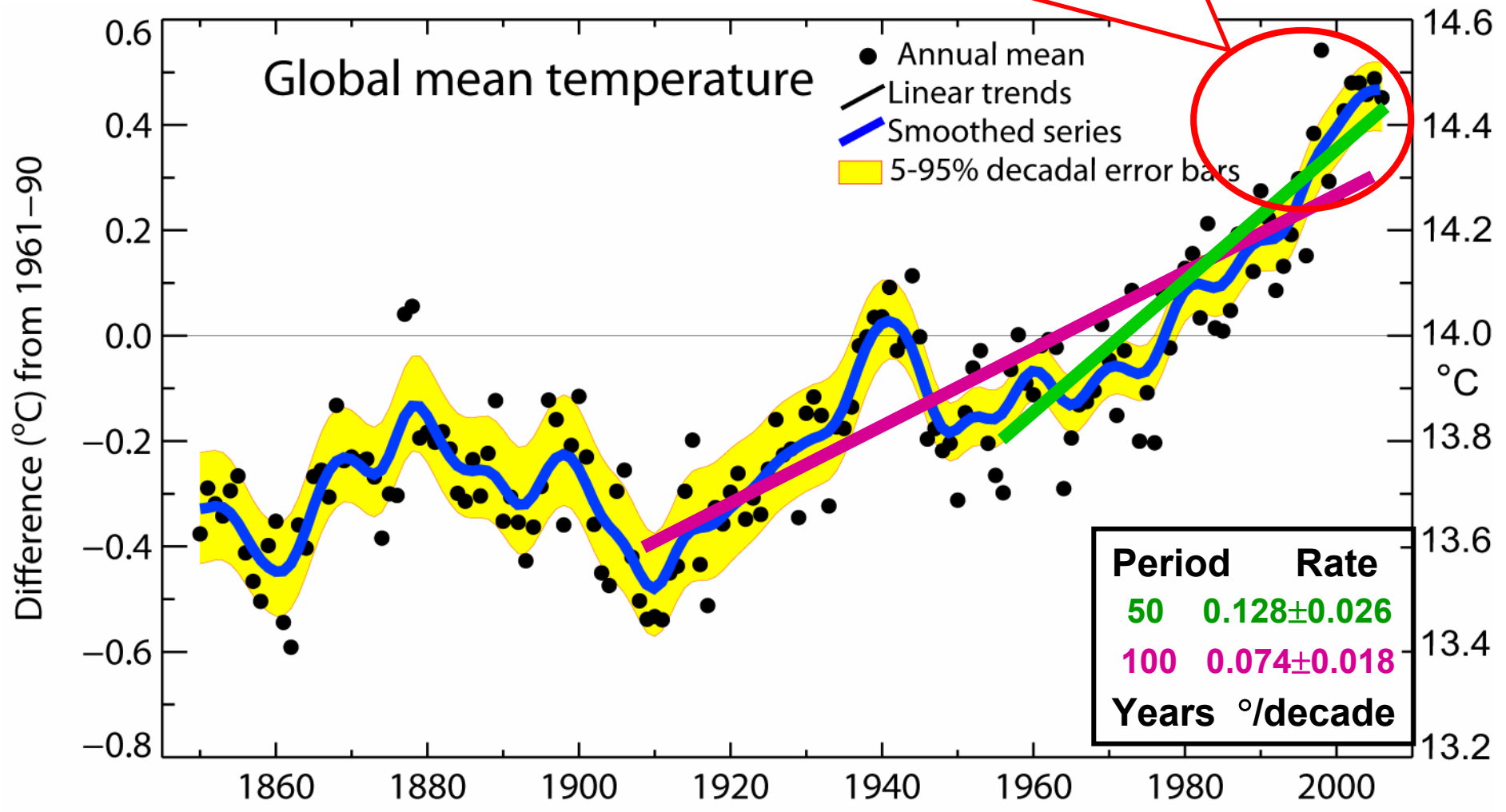
Northern hemisphere Snow cover



Source: IPCC Fourth Assessment Report, Working Group I

Global mean tempe … time

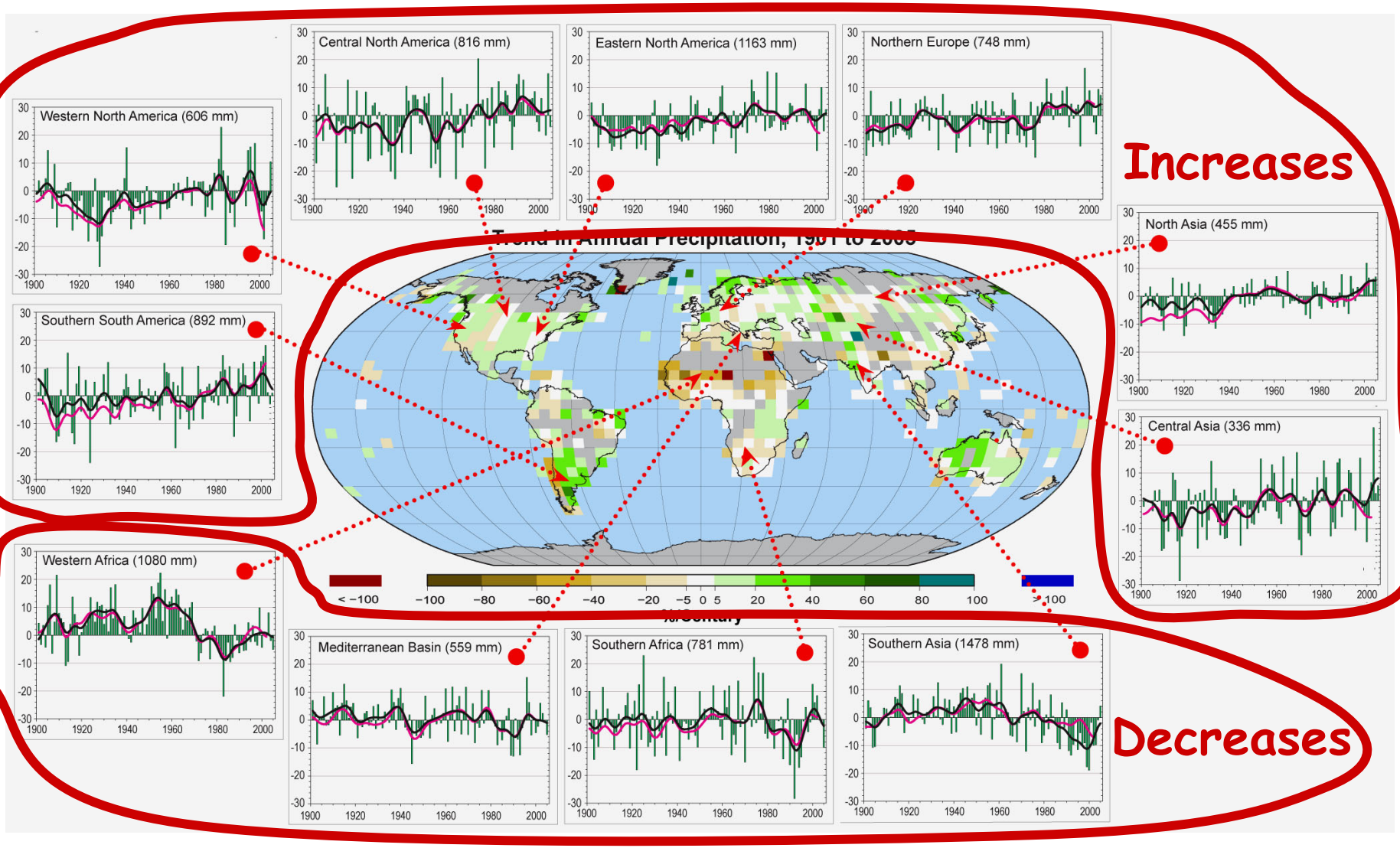
Warmest 12 years:
1998, 2005, 2003, 2002, 2004, 2006, 2001, 1997, 1995, 1999, 1990, 2000



Source: IPCC Fourth Assessment Report, Working Group I

Heavier precipitation, more intense and longer droughts….

Land precipitation is changing significantly over broad areas



Smoothed annual anomalies for precipitation (%) over land from 1900 to 2005; other regions are dominated by variability.

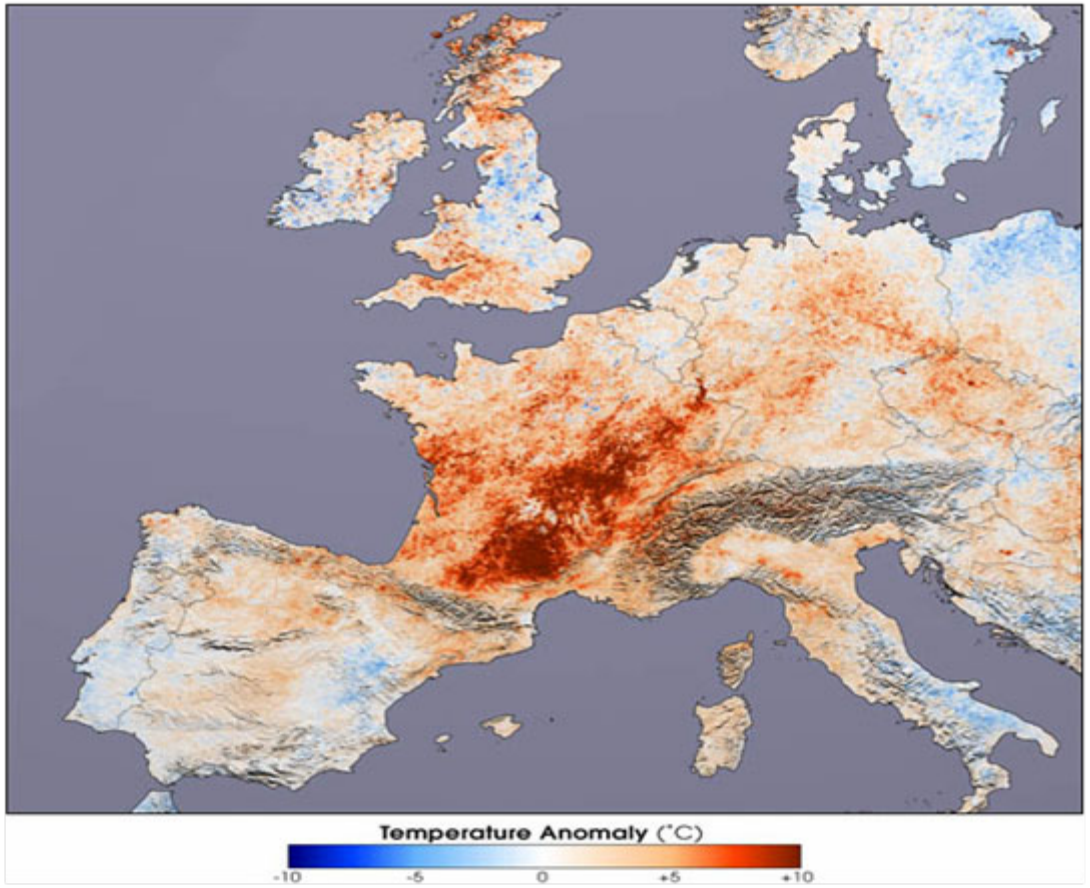
Source: IPCC Fourth Assessment Report, Working Group I

Other Changes in Extreme Events

- Widespread changes in extreme temperatures observed.
- Cold days, cold nights and frost less frequent.
- Hot days, hot nights, and heat waves more frequent.
- Observational evidence for an increase of intense tropical cyclone activity in the North Atlantic since about 1970, correlated with increases of tropical sea surface temperature.

Source: IPCC Fourth Assessment Report, Working Group I

The 2003 Summer Heat Wave in Europe
(after a 2002 wet season with many floods)



MODIS data

Productivity of natural ecosystems reduced by 30%.

Reduction and losses in agriculture (13 billion €).

Many deaths caused by excessive heat (about 35,000).

Increased number of forest fires.

Increased emissions of CO_2 from soils.

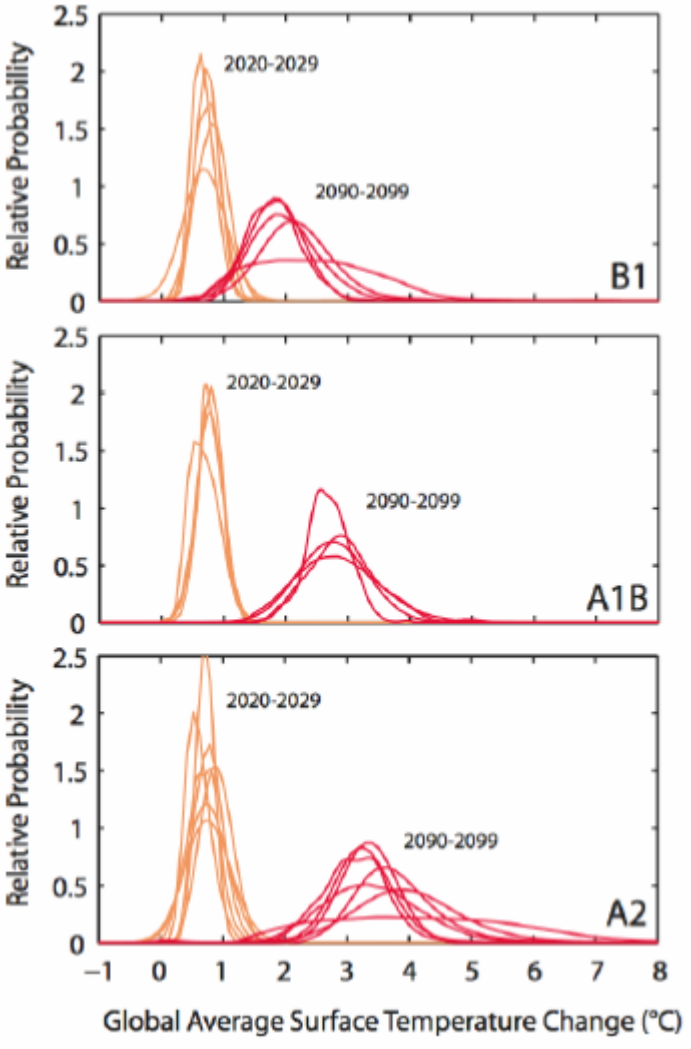
Negative records of water levels for many rivers affecting ecosystems, irrigation and production of hydro-electricity.

Source: IPCC Fourth Assessment Report, Working Group II

Projections of Future Changes in Climate

Near term projections insensitive to choice of scenario (about 0.2°C per decade).

Longer term projections depend on scenario and climate model sensitivities.

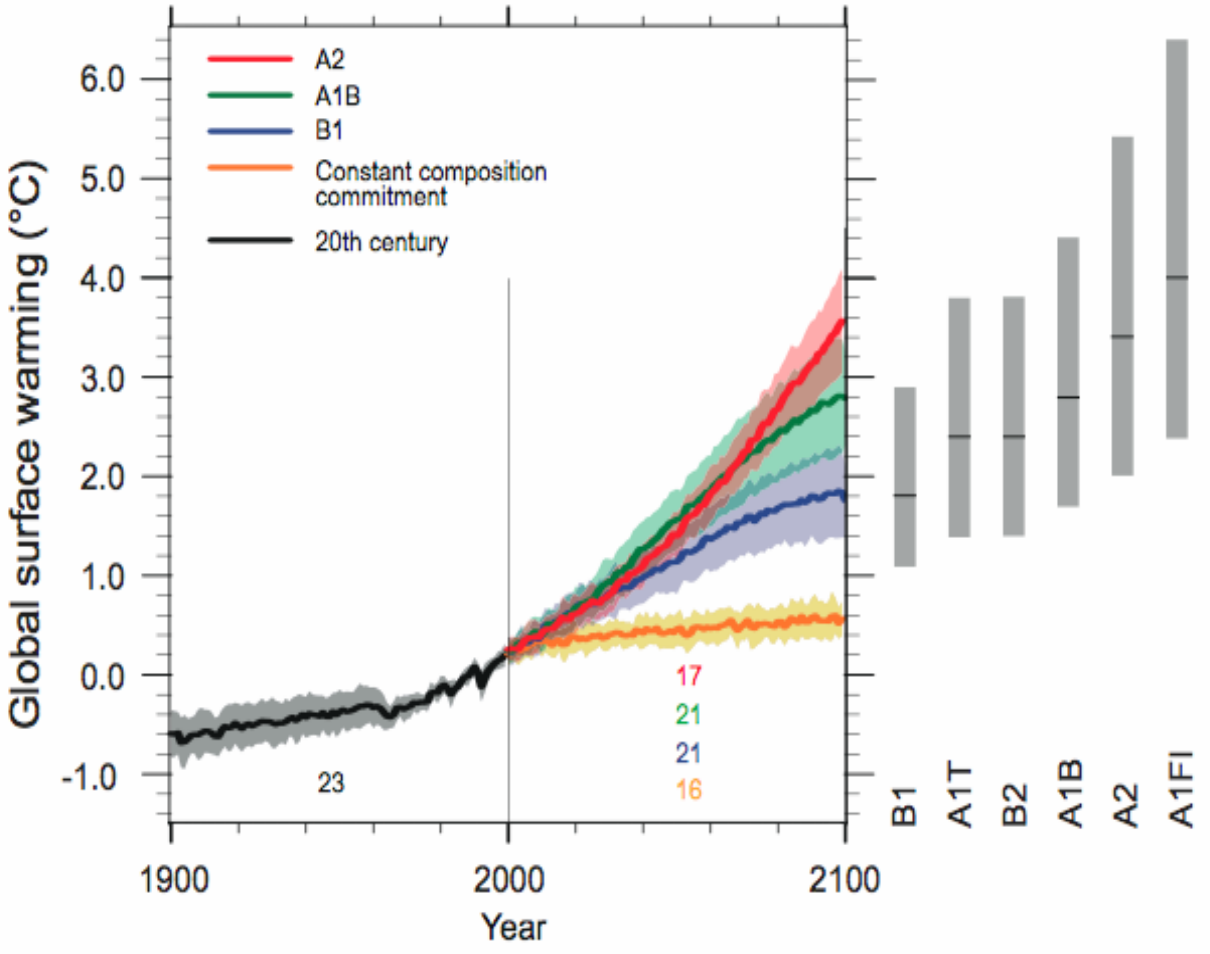


Source: IPCC Fourth Assessment Report, Working Group I

Projections of Future Changes in Climate

Best estimate for low scenario (B1) is 1.8°C (*likely* range is 1.1°C to 2.9°C), and for high scenario (A1FI) is 4.0°C (*likely* range is 2.4°C to 6.4°C).

Broadly consistent with span quoted for SRES in TAR, but not directly comparable



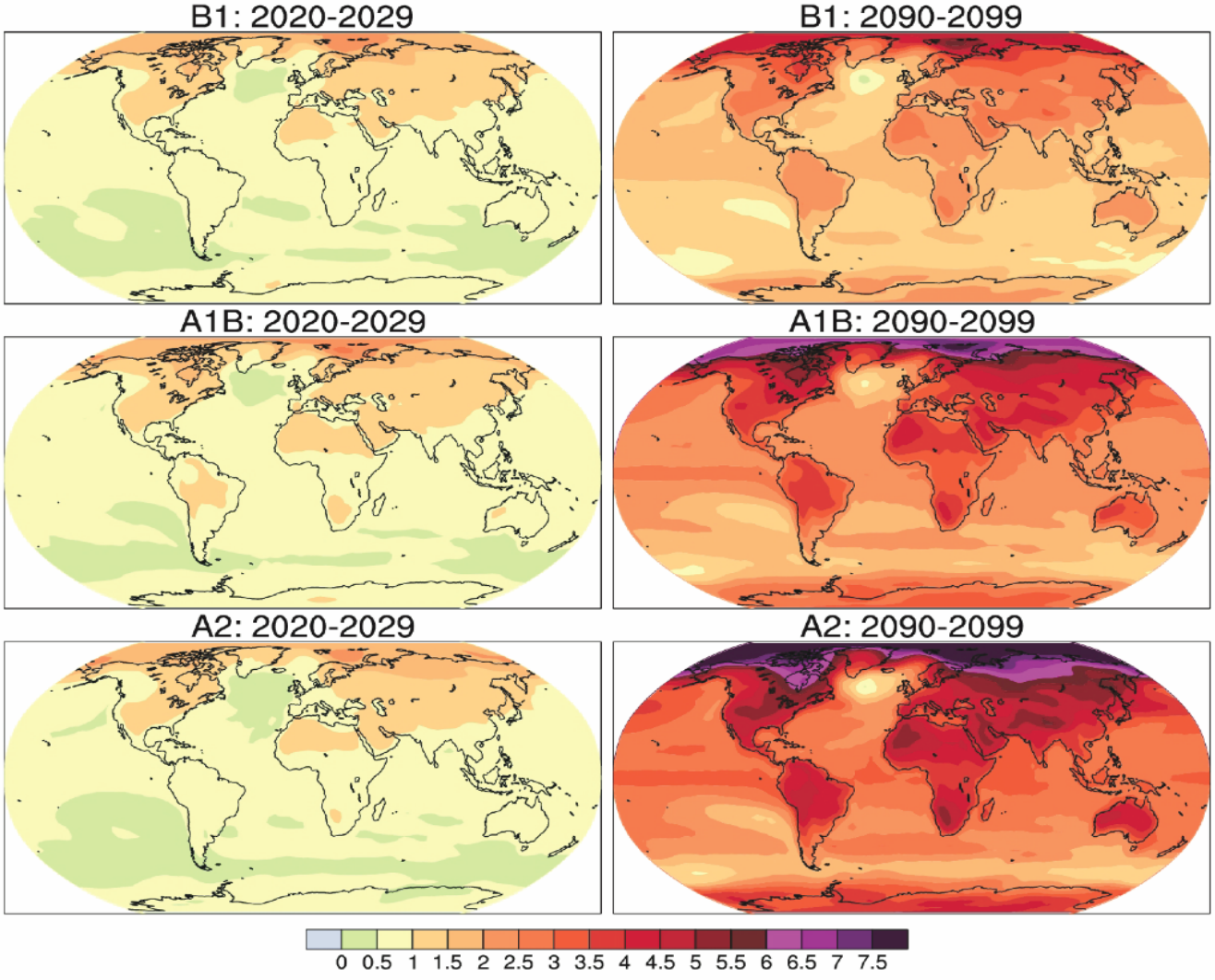
Source: IPCC Fourth Assessment Report, Working Group I

Projections of Future Changes in Climate

Projected warming in 21st century expected to be

greatest over land and at most high northern latitudes

and least over the Southern Ocean and parts of the North Atlantic Ocean.



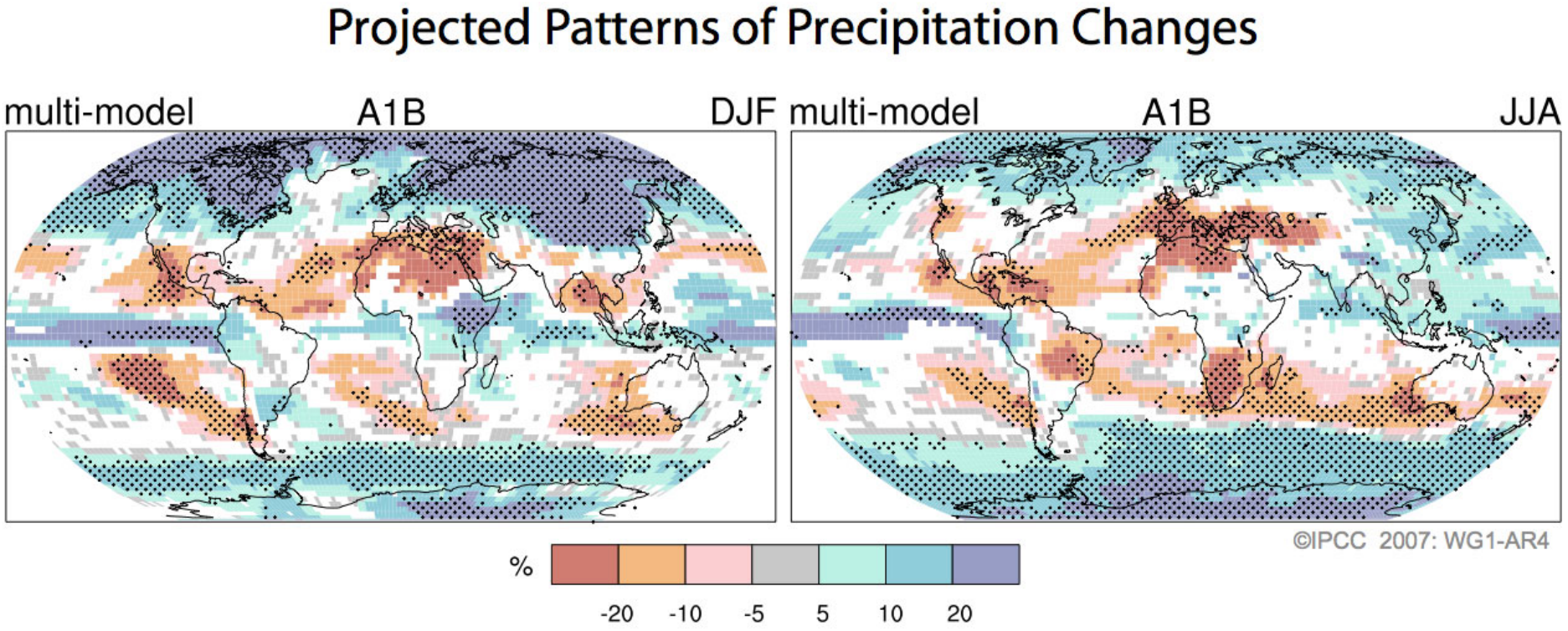
Source: IPCC Fourth Assessment Report, Working Group I

Projections of Future Changes in Climate

- *Very likely* that hot extremes, heat waves, and heavy precipitation events will continue to become more frequent.
- *Likely* that future tropical cyclones will become more intense, with larger peak wind speeds and more heavy precipitation.
- Extra-tropical storm tracks projected to move poleward with consequent changes in wind, precipitation, and temperature patterns.

Source: IPCC Fourth Assessment Report, Working Group I

Projections of Future Changes in Climate

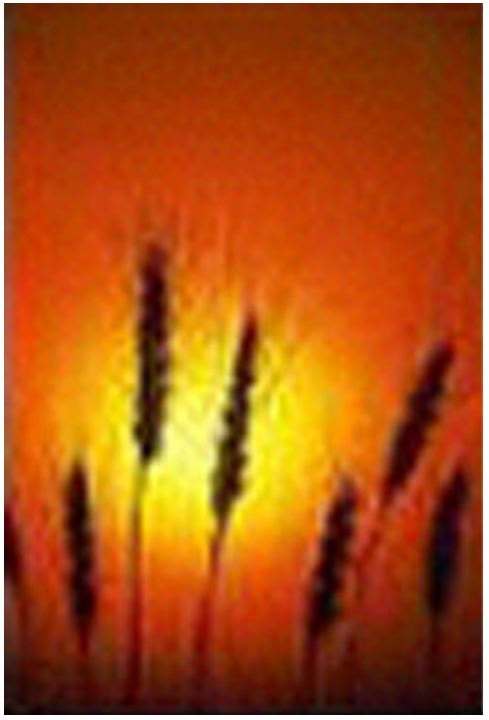


Precipitation increases *very likely* in high latitudes.

Decreases *likely* in most subtropical land regions.

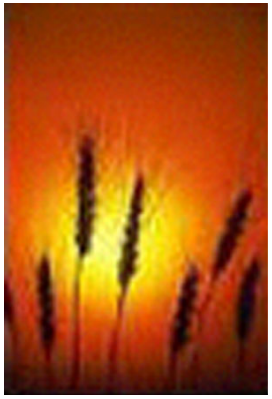
Source: IPCC Fourth Assessment Report, Working Group I

AGRO-ECOLOGICAL IMPACTS OF CLIMATE CHANGE



Sensitivity of Agro-ecosystems to Global Environmental Change

- Global warming +/-
  - \+ Removal of cold temperature limitations
  - \+ Longer growing season
  - – Faster growing period
  - – Exceedance of temperature thresholds
  - – Increased crop water requirements
  - – Increased incidence of pests and diseases
- Changes in composition of atmosphere +
  - \+ Yield increases due to CO2 fertilization
  - \+ Increased water-use-efficiency
  - – Pollution (e.g. tropospheric ozone)
- Alterations in precipitation patterns, soil moisture conditions, surface runoff +/-
- Increased occurrence of extreme weather events -
- Increased climate variability -



Temperate yields tend to thrive until +3°C

Cereal Yield Response to Warming—Temperate vs. Tropical Regions

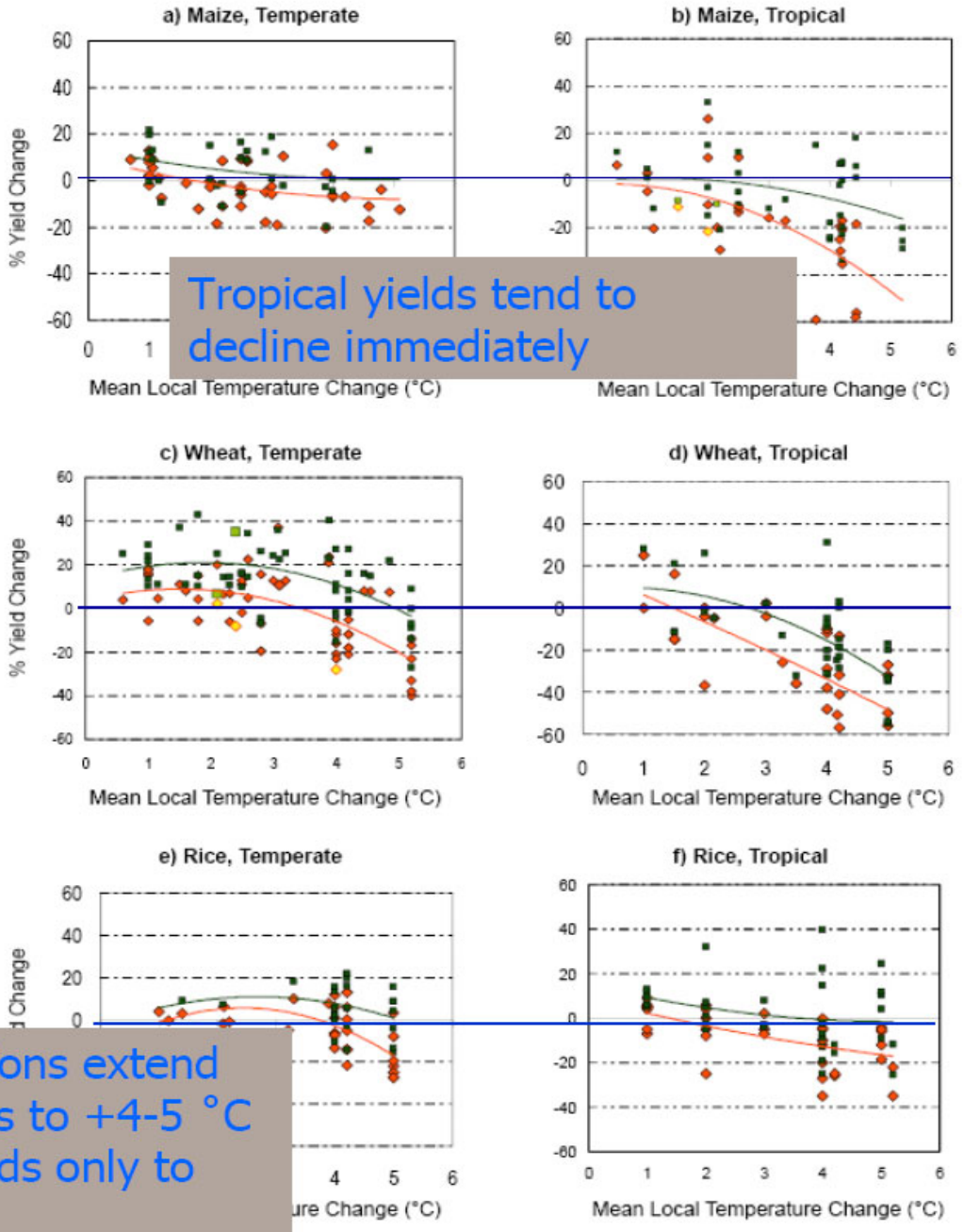
(with and without simulated adaptation)

Red = without adaptation

Green = with adaptation

—— = reference line for current yields

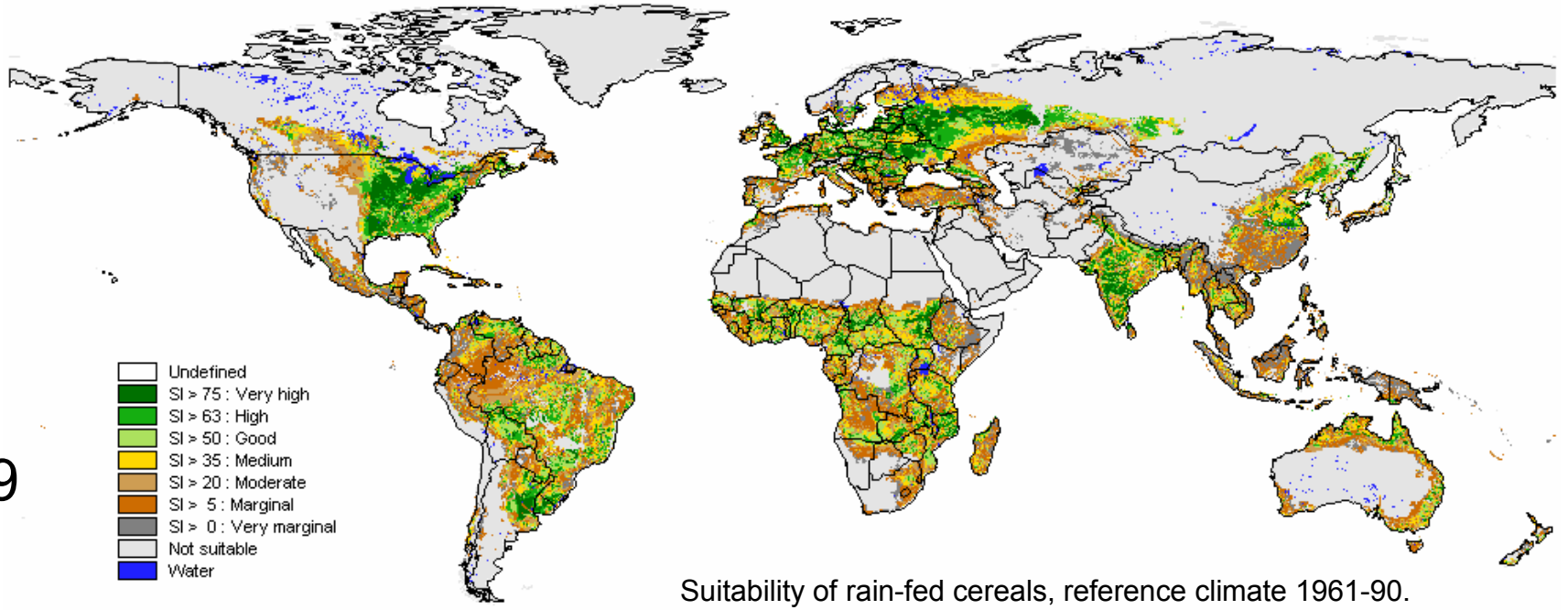
Simple adaptations extend temperate crops to +4-5 °C but tropical yields only to +2-3°C



Tropical yields tend to decline immediately

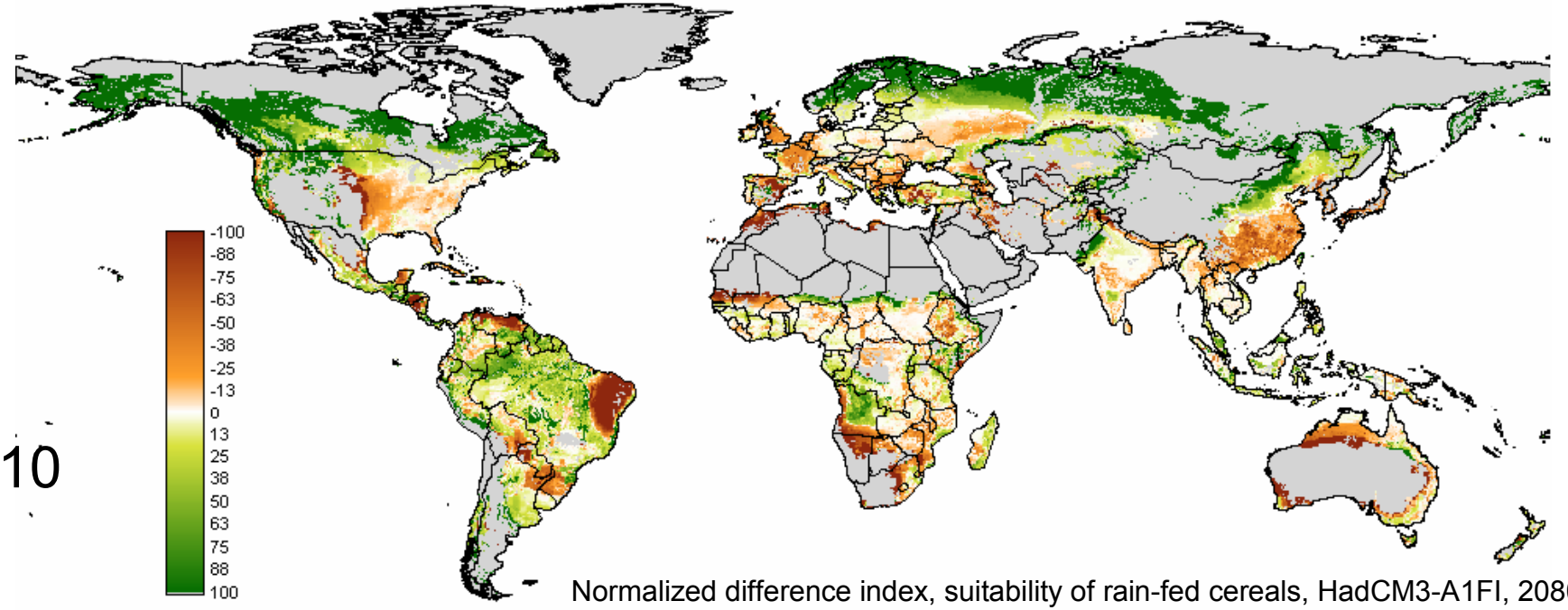
Source: W. Easterling, CLA Chapter on Food, Fibre and Forest products (2007)

3.9

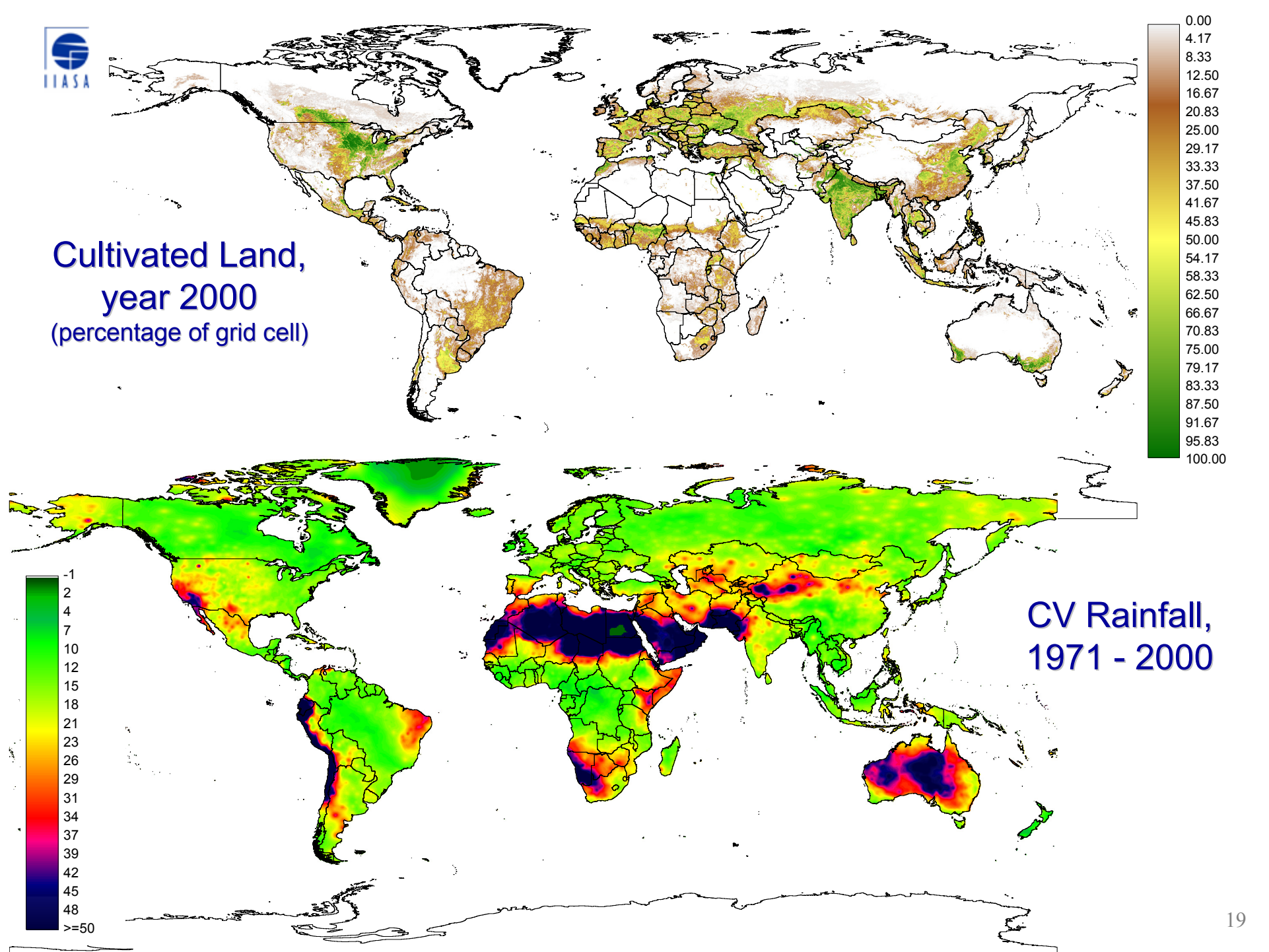


Suitability of rain-fed cereals, reference climate 1961-90.

3.10



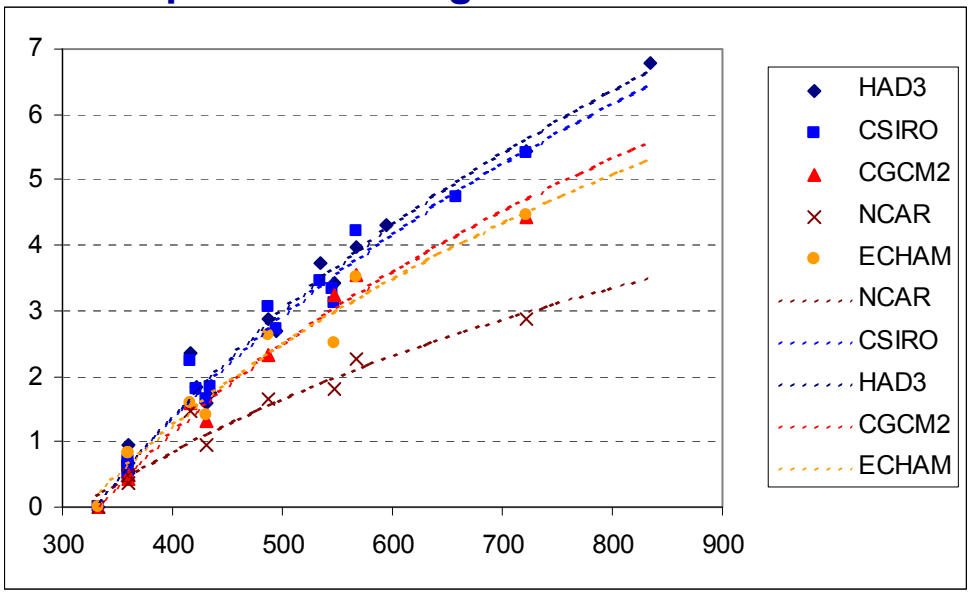
Normalized difference index, suitability of rain-fed cereals, HadCM3-A1FI, 2080s.


Cultivated Land,
year 2000
(percentage of grid cell)
0.00
4.17
8.33
12.50
16.67
20.83
25.00
29.17
33.33
37.50
41.67
45.83
50.00
54.17
58.33
62.50
66.67
70.83
75.00
79.17
83.33
87.50
91.67
95.83
100.00
CV Rainfall,
1971 - 2000
-1
2
4
7
10
12
15
18
21
23
26
29
31
34
37
39
42
45
48
>=50

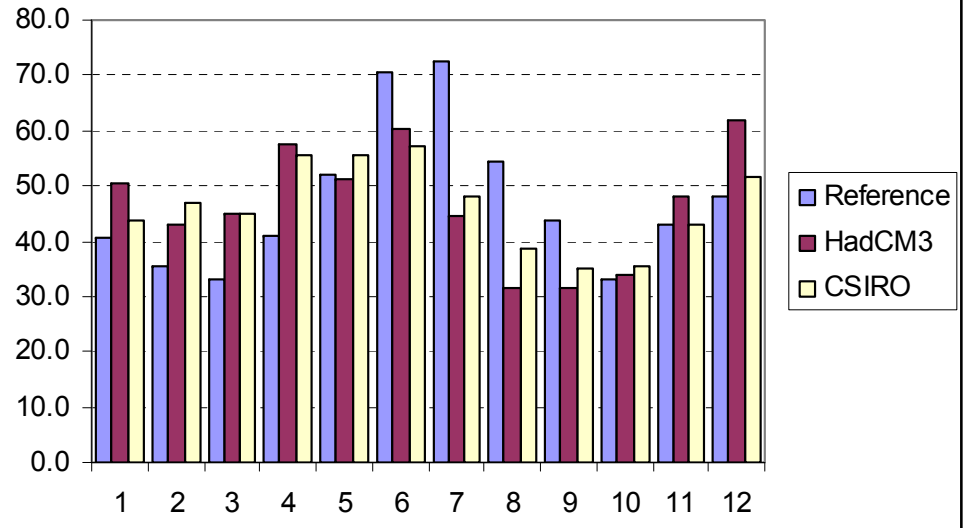
Climate Change, Ukraine

For the IPCC SRES A2 scenario, temperature increases in 2080s by 4.4 – 5.4 deg. C. Precipitation increases in winter and spring and decreases in summer

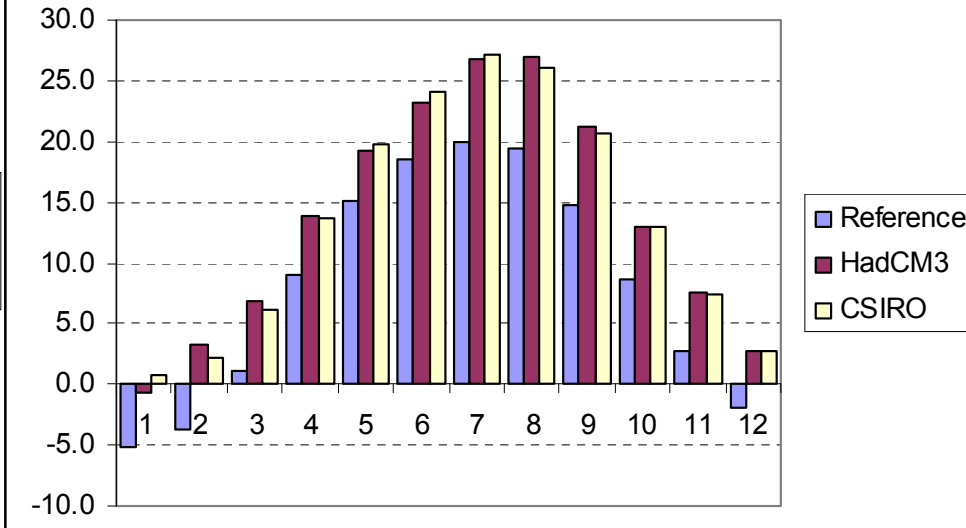
Temperature change vs CO2 concentration



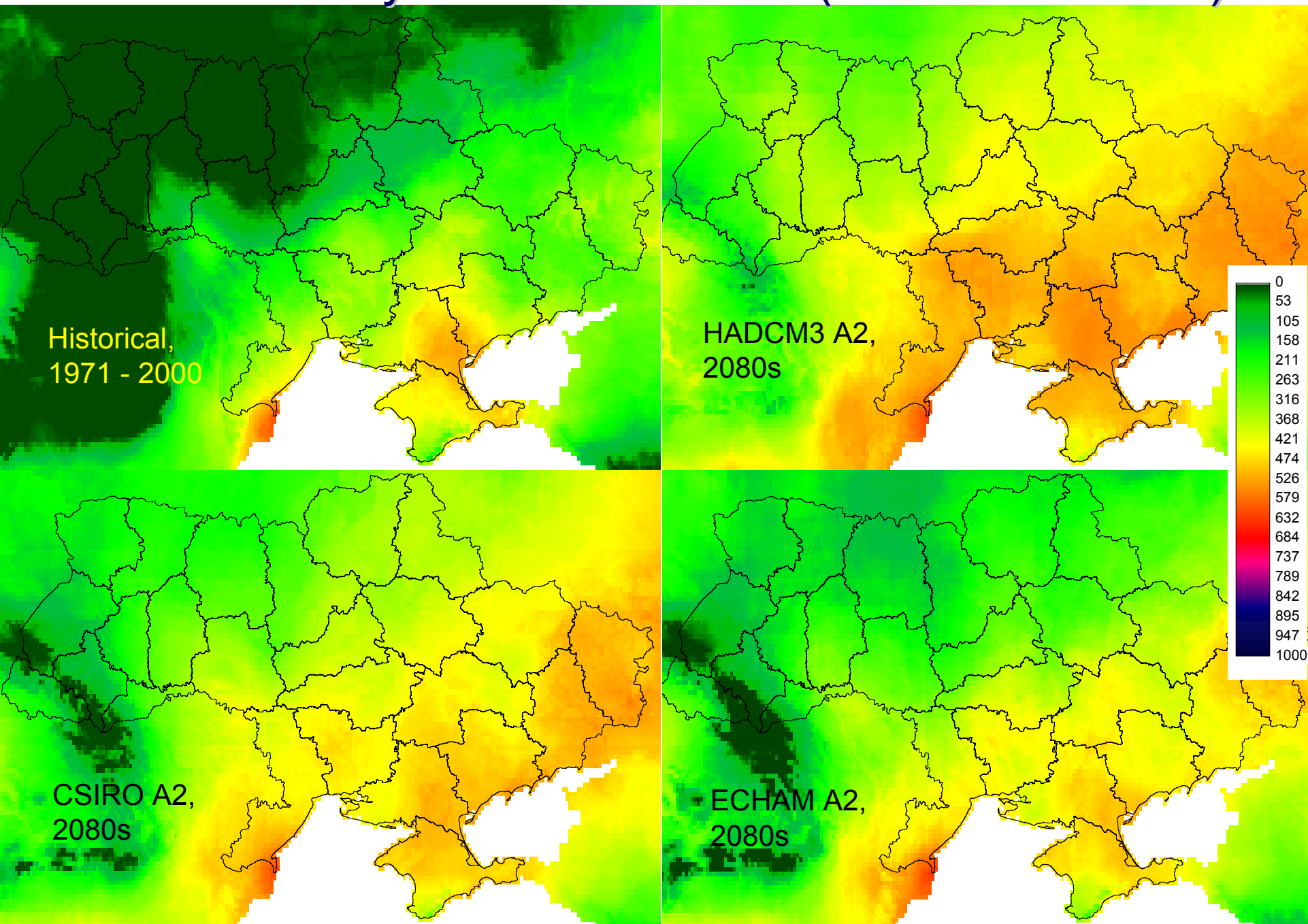
Monthly precipitation



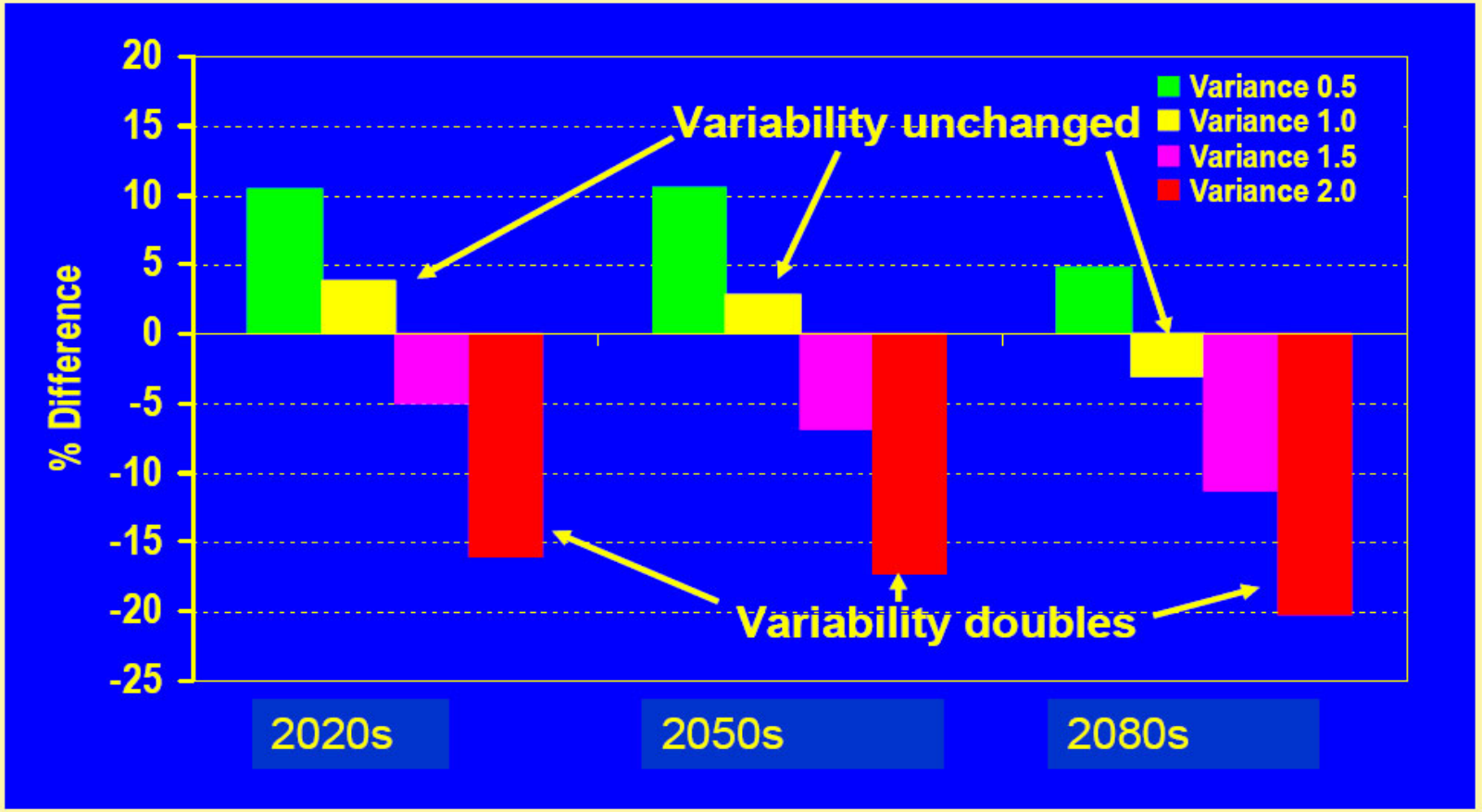
Monthly temperature



Median of Dry Share of LGPt=5 (current vs 2080s)



Sensitivity of southeastern U. S. corn yields (% of 1960-1995 baseline modeled yields) to *different frequencies of extreme events* assumed in 2020-2080 climate change



Source: W. Easterling, CLA Chapter on Food, Fibre and Forest products (2007)

General response:

- ✓Temperature thresholds
- ✓Short episodes
- ✓Sensitive period (near anthesis)
- ✓Reduce yield via seed/fruit-set

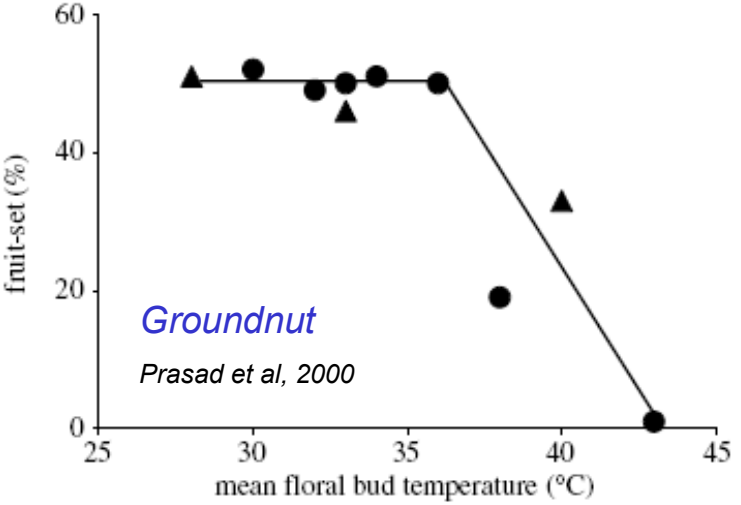
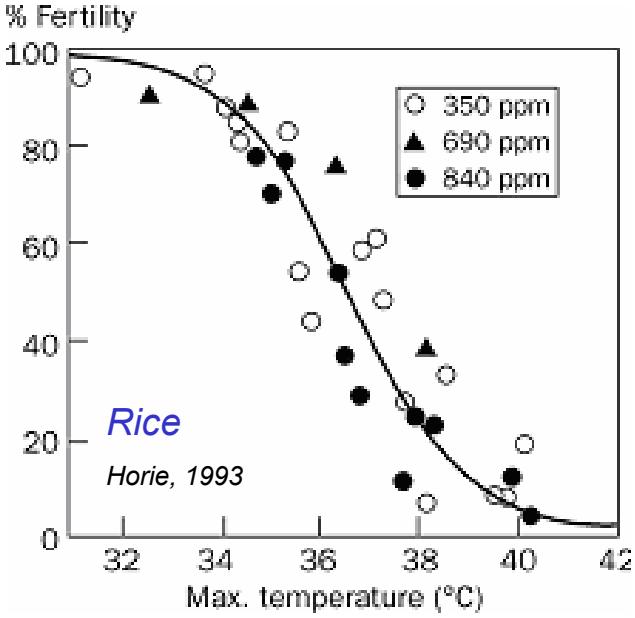
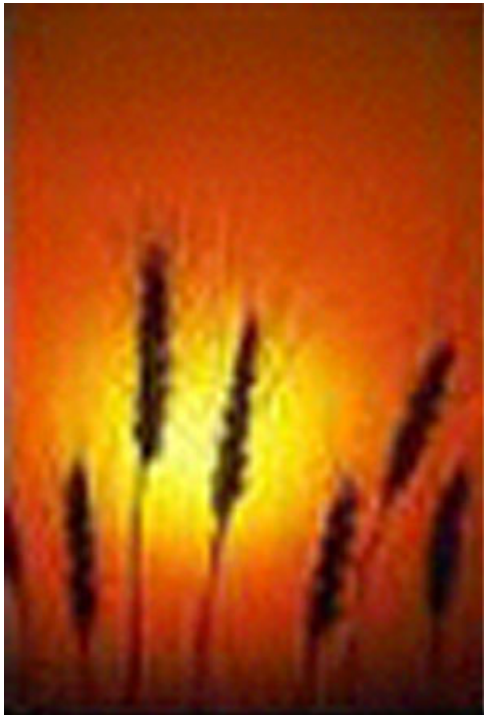


Figure 5. Relationship between percentage fruit set (angular transformed data) and mean floral temperature, from 08:00 to 14:00 h, 9 days after flowering in groundnut (Vara Prasad *et al.* 2000).



WATER RESOURCES AND IRRIGATION WATER REQUIREMENTS



Three categories

of water problems:

* Too little water

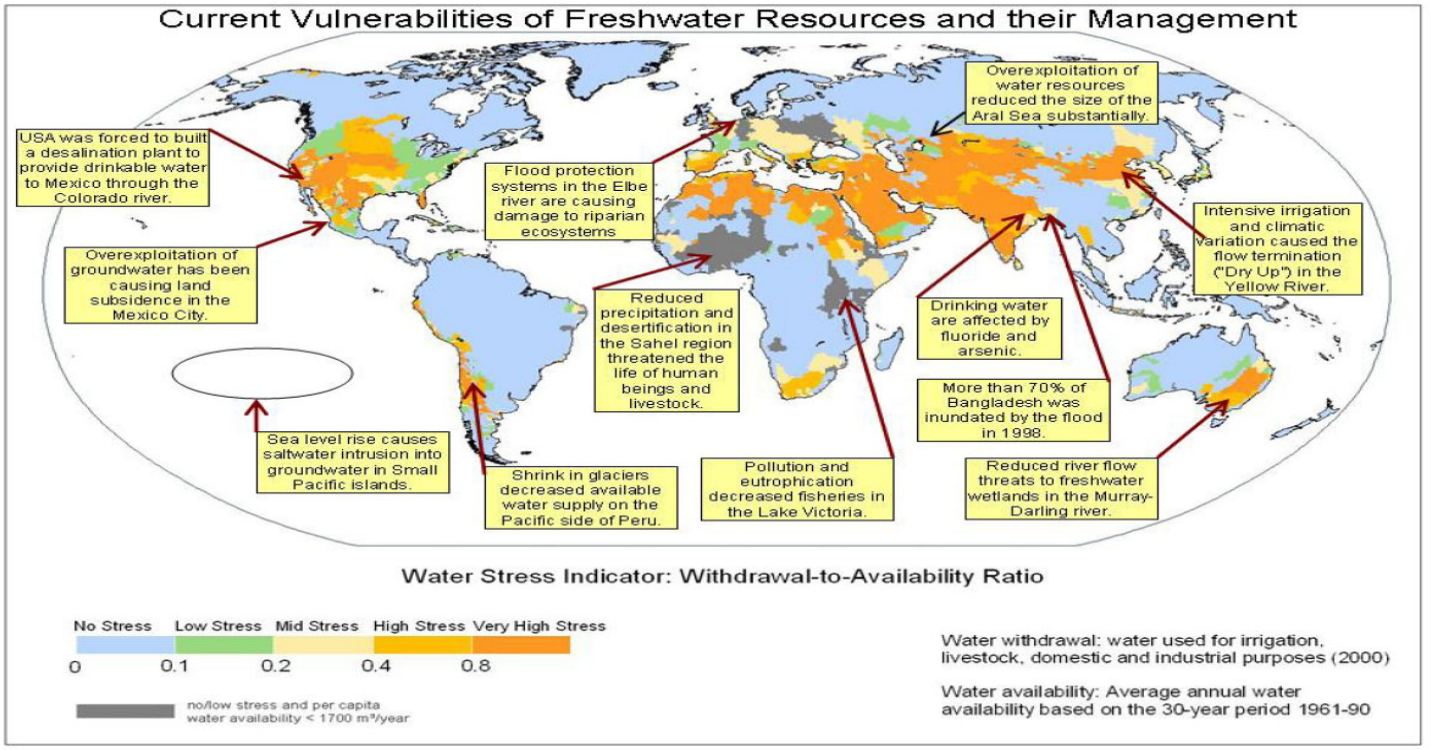
* Too much water

* Polluted water

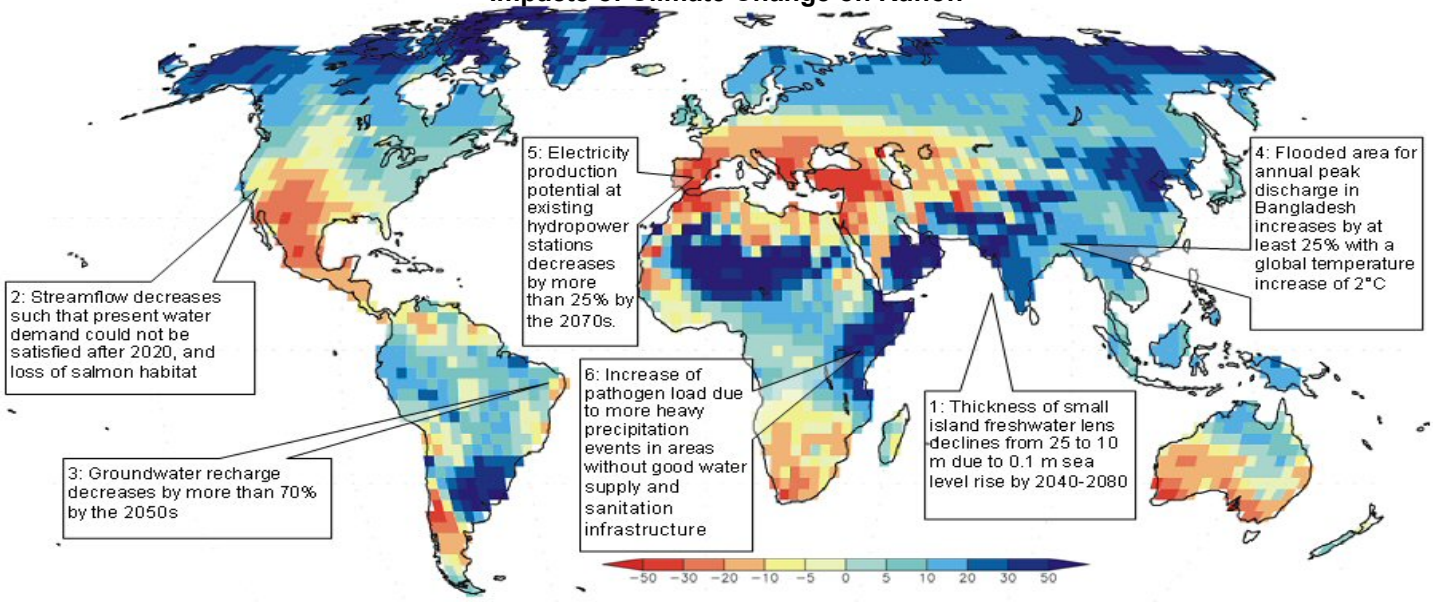
can be exacerbated by climate change

WMO

UNEP

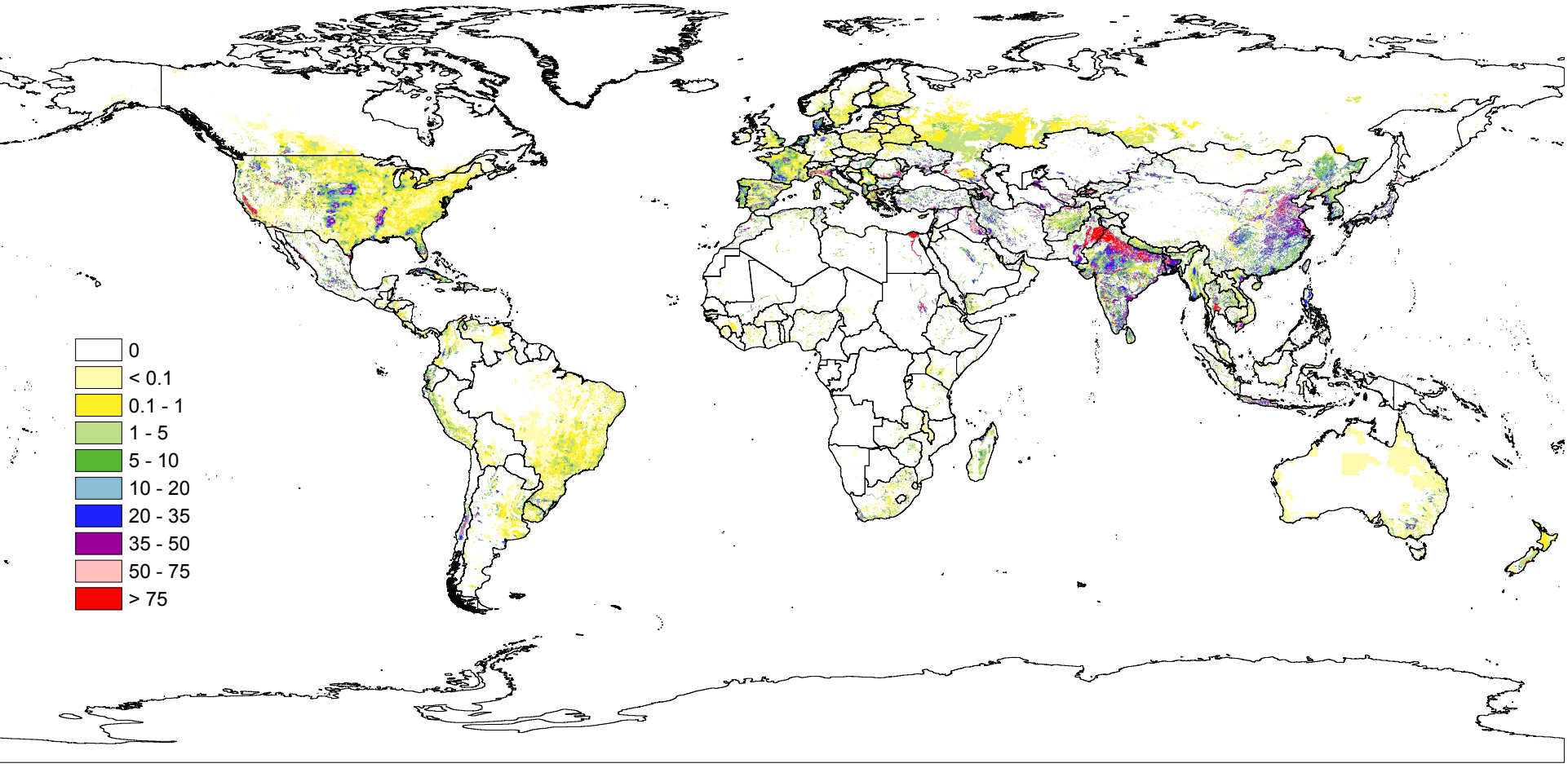


Impacts of Climate Change on Runoff



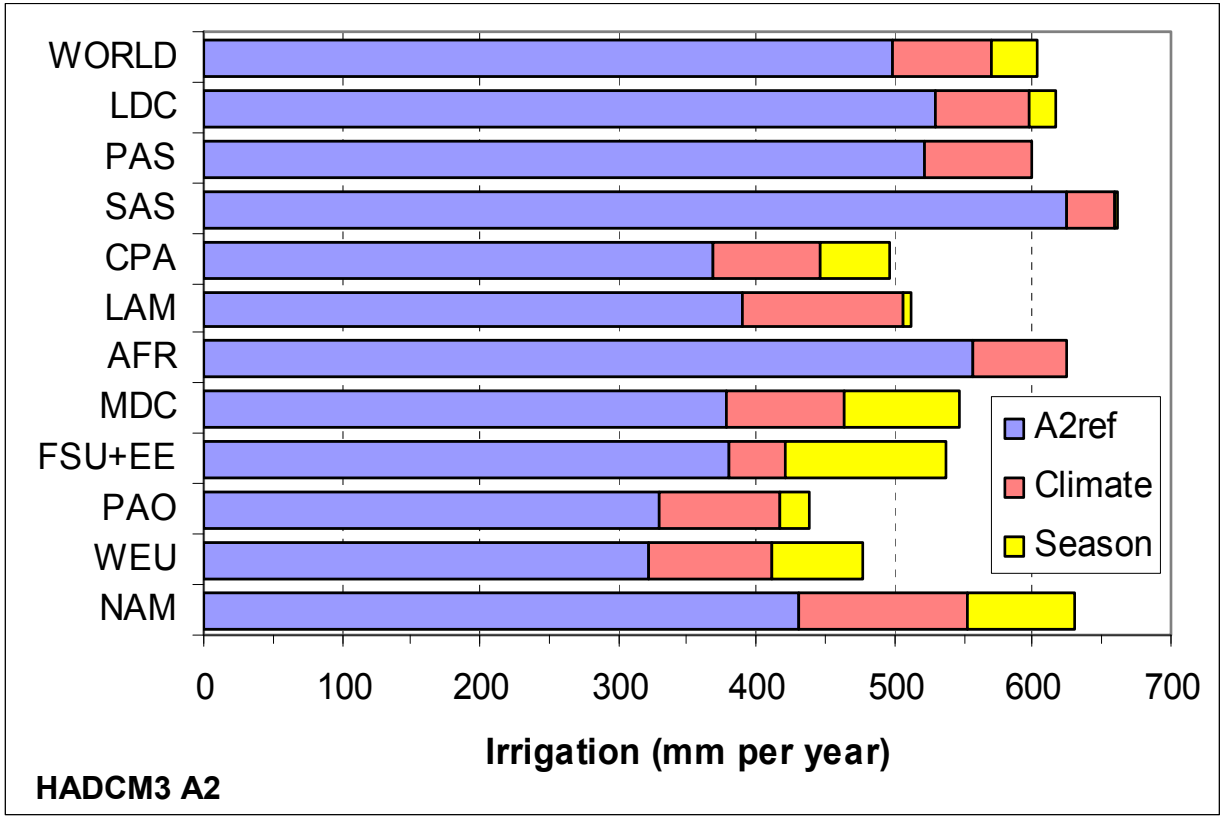
Source: IPCC Fourth Assessment Report, Working Group II

Global Map of Irrigated Areas



Source: GMIA ver 4, FAO/University of Frankfurt (2007)

Impacts of climate change on regional net irrigation water requirements in 2080



- 271 million ha irrigated out of total 1540 million ha cultivated (~ 18 %).
- Agriculture uses 2630 billion m^3 out of 3816 billion m^3 annual water withdrawals (~ 70%).
- On average, annual global crop water deficit is 500 mm (i.e., 1350 billion m^3 in 2000); about 970 mm water per irrigated hectare were applied.

Mexico: Climate Change Impacts (% change) on Indicators of Agricultural Water Use – 2080

	Precipitation	Crop Water Requirements	Crop Water Deficits	Internal Water Resources
H3A2	-4.8	12.5	17.3	-28.1
CSA2	-2.5	8.1	14.1	-12.1
C2A2	-10.9	8.4	18.1	-19.4
NCA2	-3.7	4.4	8.5	-13.9
EHA2	-0.9	8.5	16.5	-8.4
H3B1	-8.7	8.9	16.5	-25.8
CSB1	-0.8	6.5	11.1	-7.7

Note: percent change relative to respective reference projection without climate change. Crop water requirements calculated as crop-specific potential evapotranspiration (plus special allowance for paddy).

- 6.3 million ha irrigated out of total 27.3 million ha cultivated (~ 23 %)
- Agriculture uses 60.3 billion m^3 out of 78.2 billion m^3 annual water withdrawals (> 75%)
- On average, annually about 1000 mm water per irrigated hectare applied

Climate change: some final thoughts

- The impacts of climate change on crop production are geographically very unevenly distributed and aggregate global figures reveal little.
- Autonomous adaptation (planting dates, cultivar changes, moisture conservation tillage, deploying irrigation where economical, switching crops) will offset some (gradual) warming (temperate climate +3-5°C, tropics +0-2°C).
- Aggregate impacts of projected climate change on the global food system are relatively small. The global balance of food demand and supply is not likely to be challenged until second half of the century.
- Climate change effects will likely further widen the gap between developed and developing countries.

Climate change: risks for agriculture

- Extreme rainfall events and flash floods;
- Coastal zone flooding due to storminess and sea level rise;
- More frequent and intense droughts;
- Increased evaporative demand of crops;
- Higher fire risk in the Mediterranean; catastrophic drained peatland fires in continental Europe;
- Growing risk of yield damage due to extreme high-temperature episodes;
- Likely increasing risks of pest and disease outbreaks.

Changes in frequencies of extreme events (droughts, heat waves, severe storms) are more troublesome than gradual changes in average conditions!

THANK YOU!

http://www.iiasa.ac.at/Research/LUC