Climate Change and Food Security

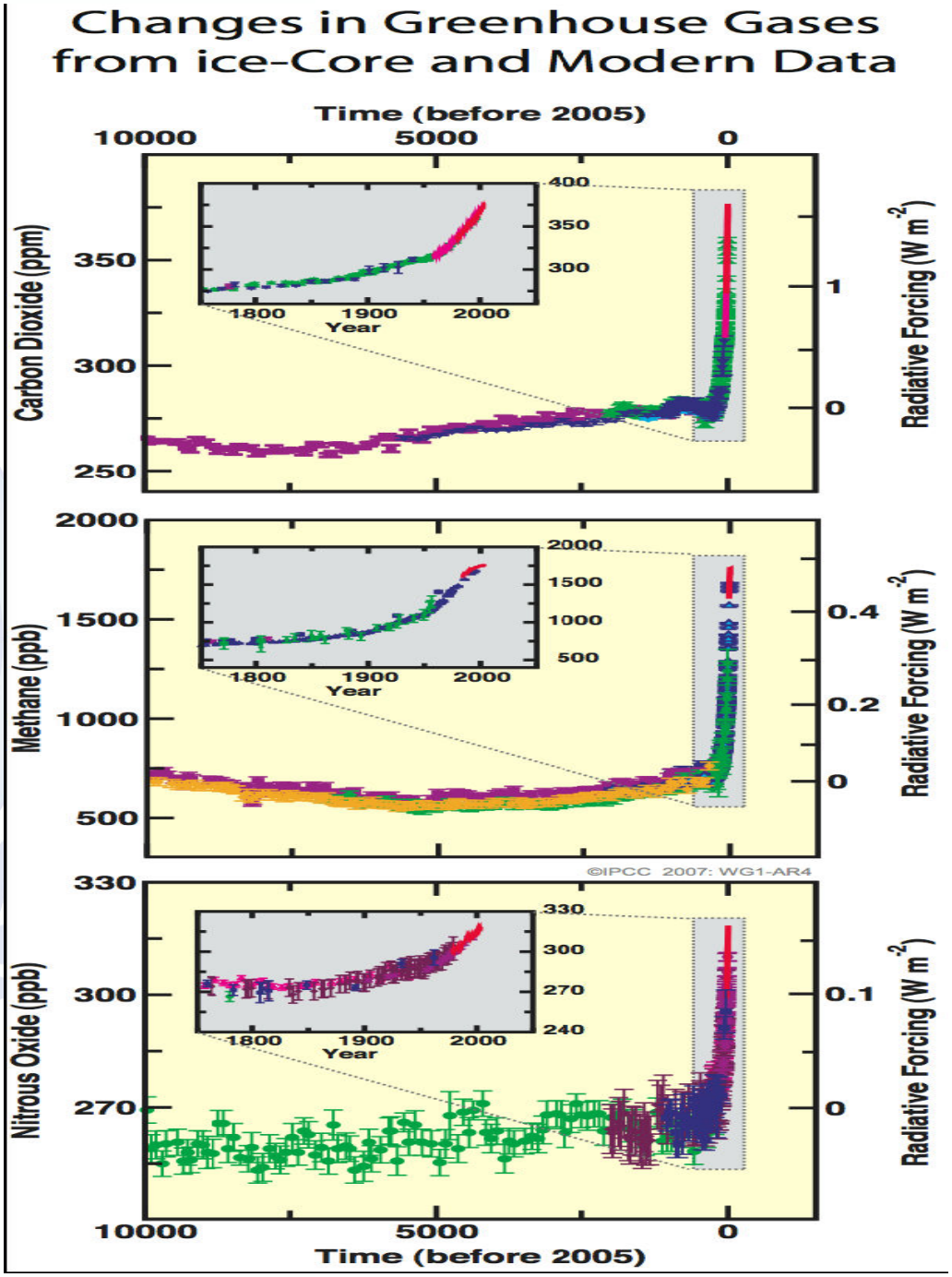
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World Meteorological Organization

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Presentation

- Climate change – current trends
- Climate change – future projections
- Why is climate change such an important issue for food security ?
- Climatic drivers of food insecurity
- Implications of future climate change for food security
- Agrometeorological strategies to enhance food security
- Agrometeorological research needs

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Changes in Greenhouse Gases
from ice-Core and Modern Data
Time (before 2005)
10000
5000
0
Carbon Dioxide (ppm)
350
300
250
400
350
300
1800
1900
2000
Year
1
0
Radiative Forcing (W m-2)
2000
1500
1000
500
Methane (ppb)
2000
1500
1000
500
0.4
0.2
0
©IPCC 2007: WG1-AR4
330
300
270
240
Nitrous Oxide (ppb)
0.1
0
Time (before 2005)

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Carbon dioxide

- Global atmospheric concentration of carbon dioxide has increased from a pre-industrial value of about 280 ppm to 379 ppm in 2005. This exceeds by far the natural range over the last 650,000 years (180 to 300 ppm) as determined from ice cores.

- The annual carbon dioxide concentration growth-rate of 1.9 ppm per year during the 10 year period 1995 – 2005 was larger than it has been since the beginning of continuous direct atmospheric measurements (1960 – 2005 average: 1.4 ppm per year).

- Annual fossil carbon dioxide emissions increased from an average of 6.4 GtC per year in the 1990s, to 7.2 GtC per year in 2000–2005.

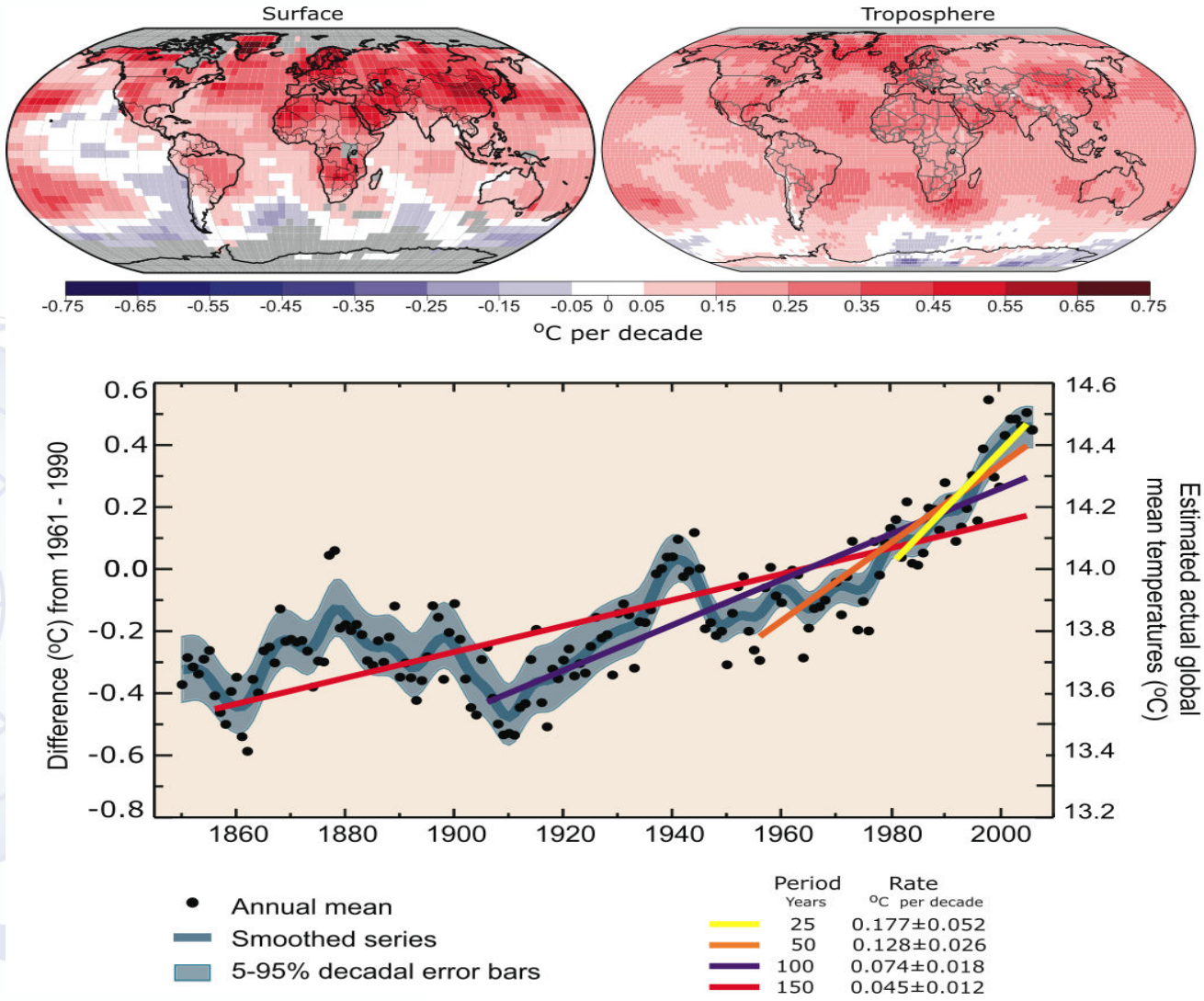
Methane and Nitrous Oxide

- The global atmospheric concentration of methane has increased from a pre-industrial value of about 715 ppb to 1732 ppb in the early 1990s, and is 1774 ppb in 2005.
- The atmospheric concentration of methane in 2005 exceeds by far the natural range of the last 650,000 years (320 to 790 ppb) as determined from ice cores.
- The global atmospheric nitrous oxide concentration increased from a pre-industrial value of about 270 ppb to 319 ppb in 2005.

The Land and Oceans have warmed

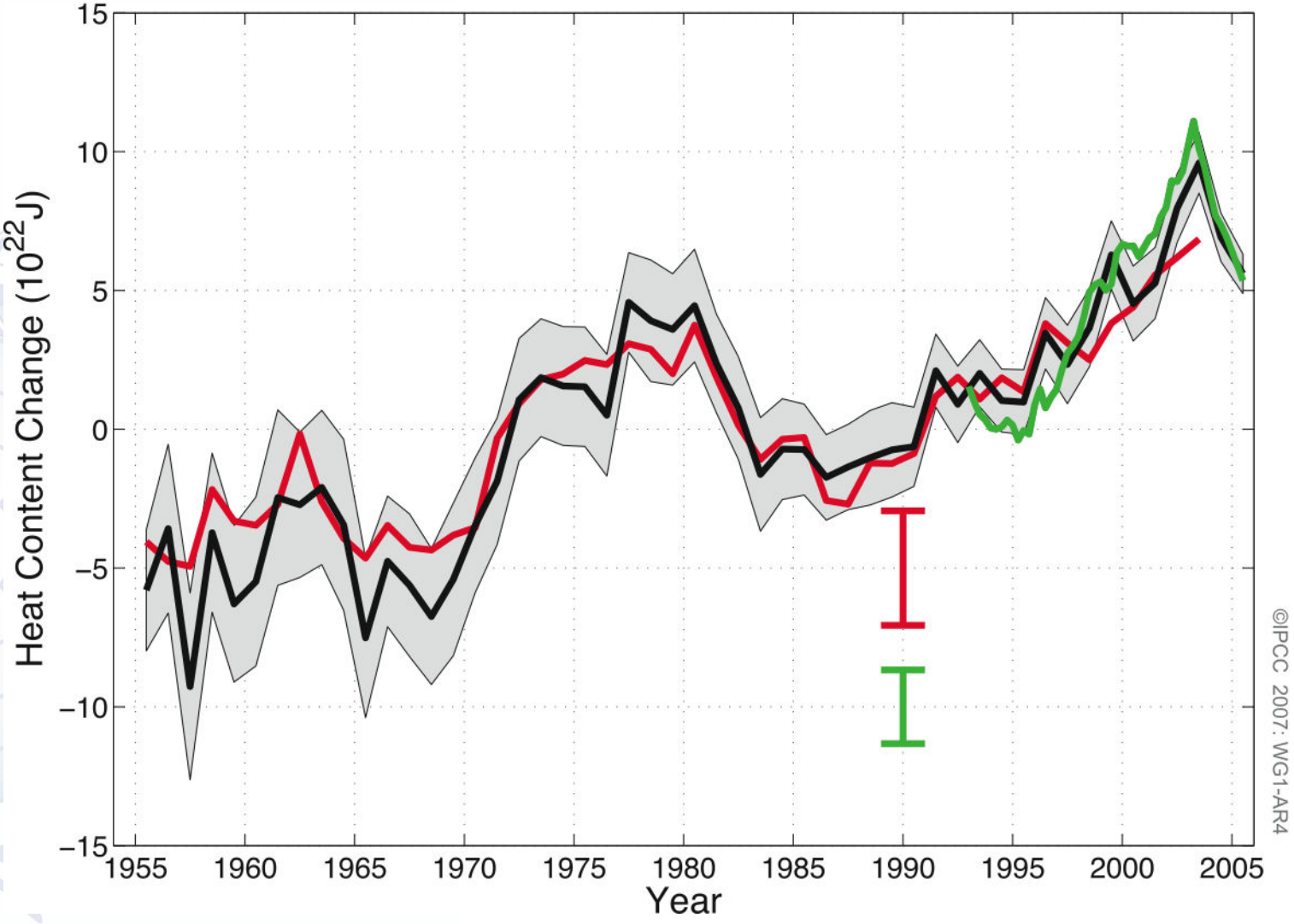
- Eleven of the last twelve years (1995 -2006) rank among the 12 warmest years in the instrumental record of global surface temperature (since 1850).
- The updated 100-year linear trend (1906–2005) of 0.74 °C is therefore larger than the corresponding trend for 1901-2000 given in the TAR of 0.6 °C.
- The linear warming trend over the last 50 years (0.13 °C per decade) is nearly twice that for the last 100 years.
- Observations since 1961 show that the average temperature of the global ocean has increased to depths of atleast 3000 m and that the ocean has been absorbing more than 80% of the heat added to the climate system.

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(Top) Patterns of linear global temperature trends over the period 1979 to 2005 estimated at the surface (left)and for the troposphere (Bottom) Annual global mean temperatures (black dots) with linear fits to the data.

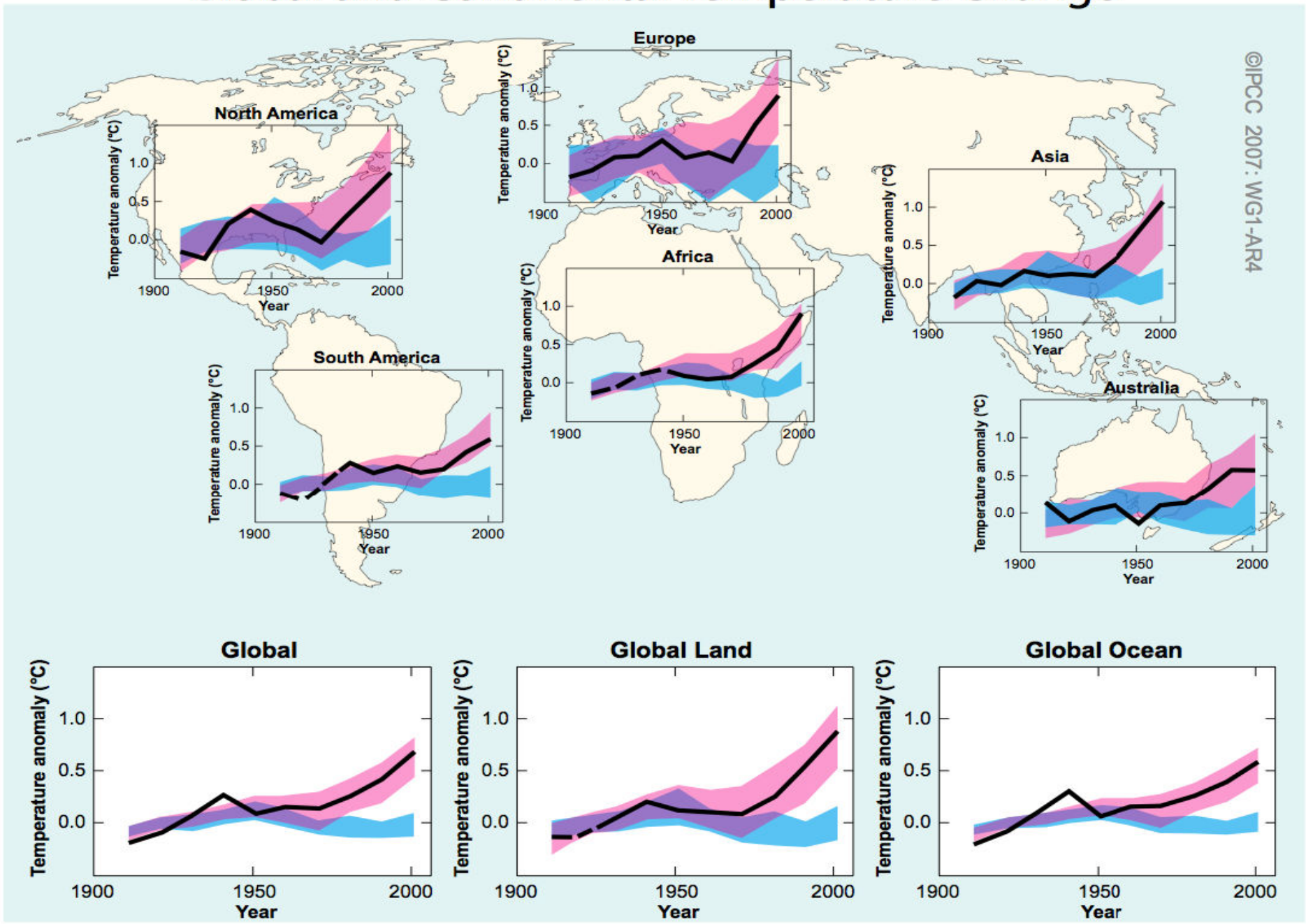
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Time series of global ocean heat content (10^{22} J) for the 0 to 700 m layer.

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Global and Continental Temperature Change

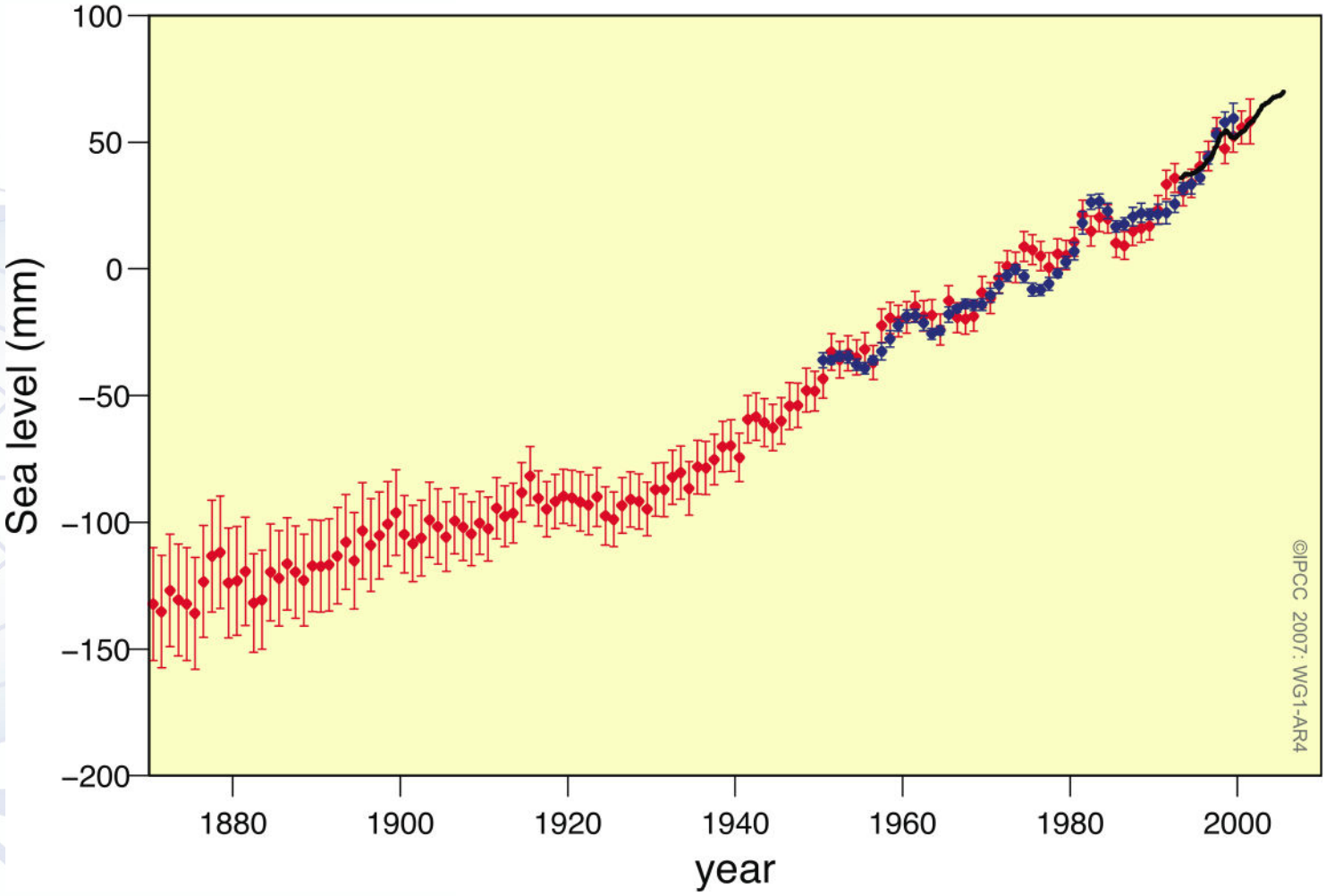


Precipitation patterns have changed

- More intense and longer droughts have been observed over wider areas since the 1970s, particularly in the tropics and subtropics.
- Increased drying linked with higher temperatures and decreased precipitation have contributed to changes in drought.
- Changes in sea surface temperatures, wind patterns, and decreased snow pack and snow cover have also been linked to droughts.
- Frequency of heavy precipitation events increased over most land areas, consistent with warming and observed increases of atmospheric water vapour.

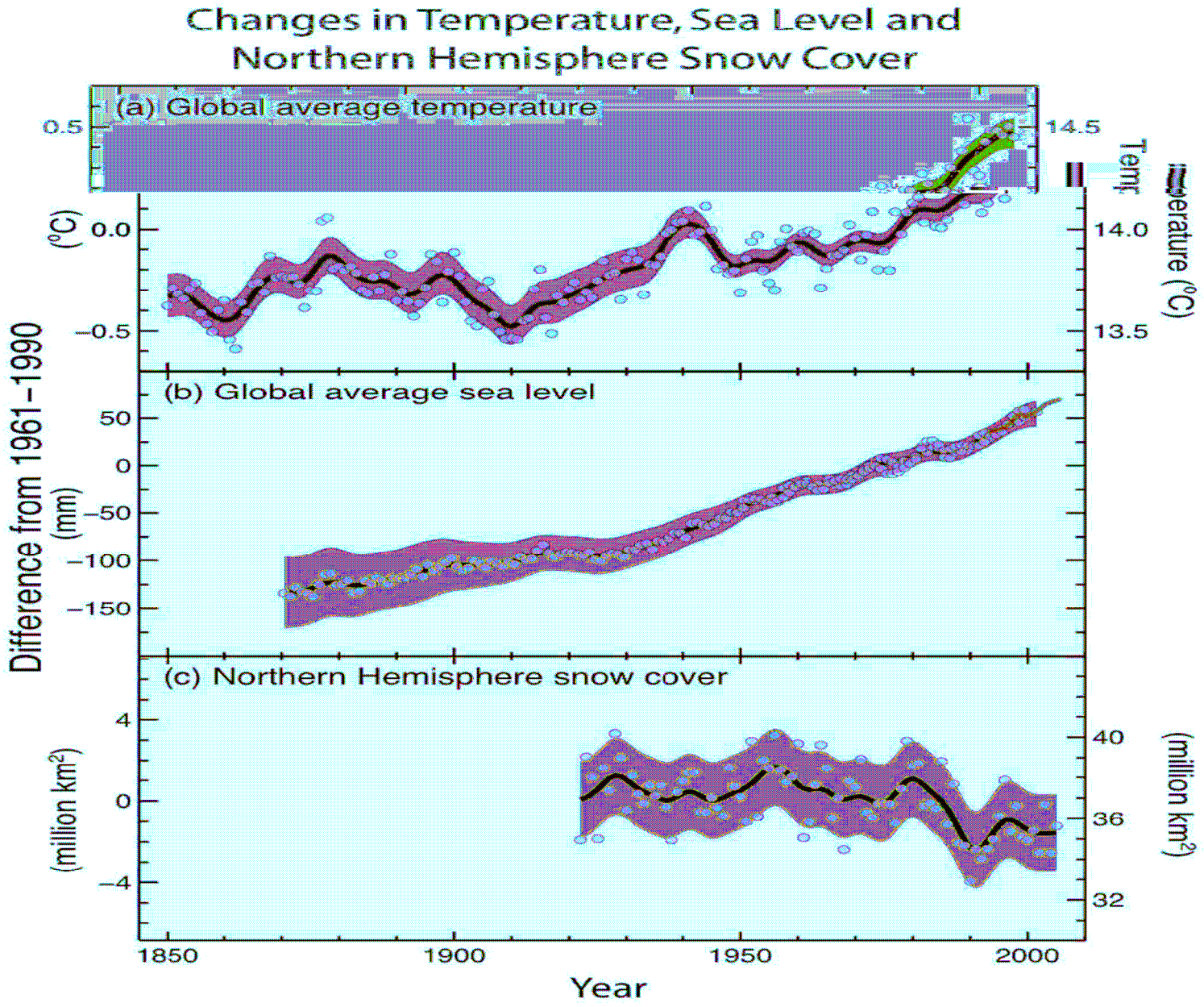
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Sea Levels have risen



Annual averages of the global mean sea level based on reconstructed sea level fields since 1870 (red), tide gauge measurements since 1950 (blue) and satellite altimetry since 1992 (black). Units are in mm relative to the average for 1961 to 1990.

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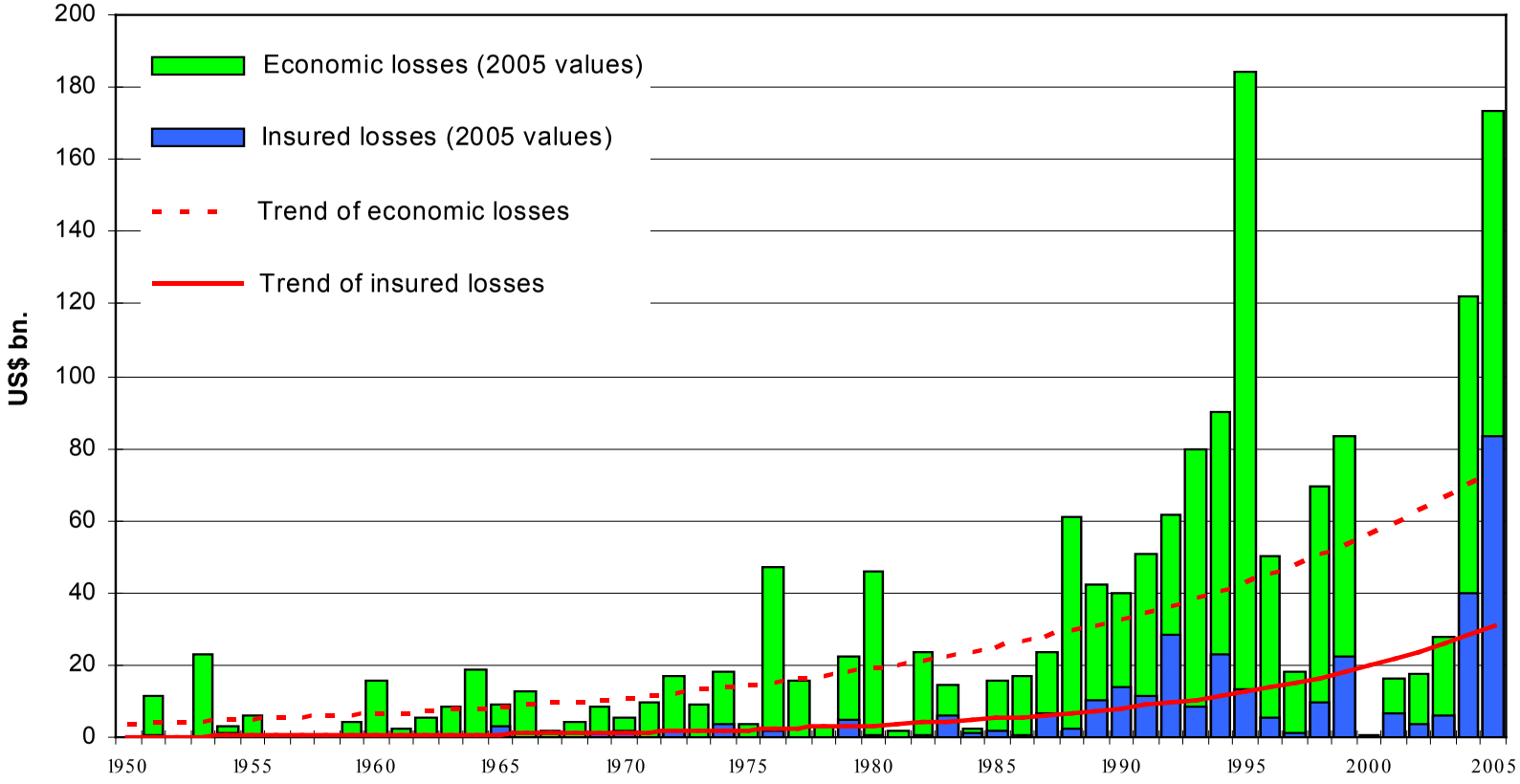

Changes in Temperature, Sea Level and Northern Hemisphere Snow Cover
(a) Global average temperature
0.5
14.5
Temperature (°C)
(°C)
0.0
−0.5
14.0
13.5
(b) Global average sea level
Difference from 1961–1990 (mm)
50
0
−50
−100
−150
(c) Northern Hemisphere snow cover
(million km²)
4
0
−4
40
36
32
1850
1900
1950
2000
Year

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Observed regional changes in temperature have been associated with observed changes in physical and biological systems

- Non-polar glacier retreat
- Satellite data show that annual average Arctic sea ice extent has shrunk by 2.7% per decade, with larger decreases in summer of 7.4 % per decade.
- Earlier flowering and longer growing and breeding season for plants and animals in the Northern Hemisphere (N.H.)
- Poleward and upward (altitudinal) migration of plants, birds, fish and insects; earlier spring migration and later departure of birds in the N.H.
- Increased incidence of coral bleaching

Weather-related economic damages have increased



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Future projections

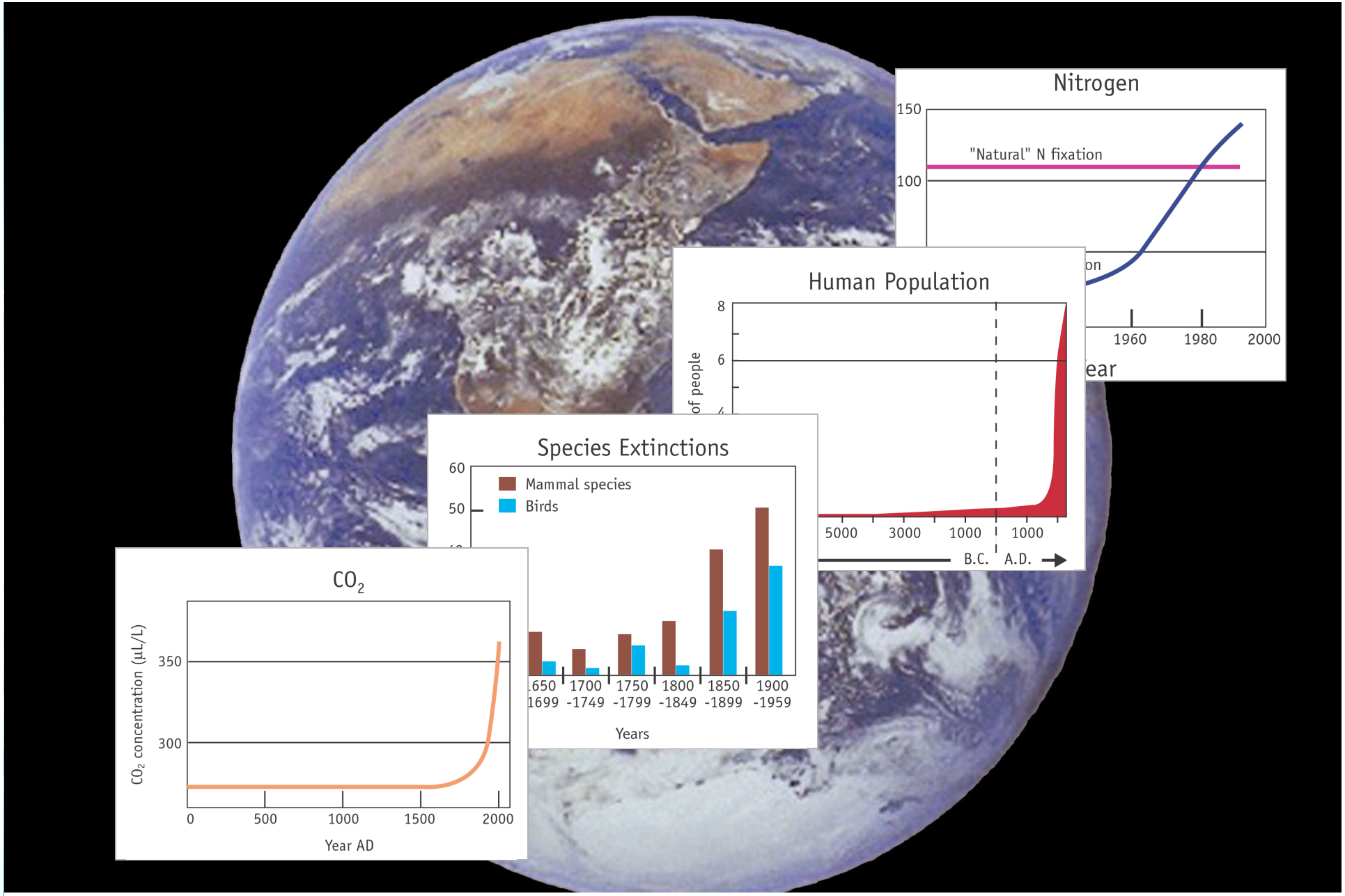
- The globally averaged surface temperature is projected to increase by 1.8 to 4.0°C (2090-2099 relative to 1980-1999).

- The projected rate of warming is much larger than the observed changes during the 20th century and is very likely to be without precedent during at least the last 10,000 years.

- Global mean sea level is projected to rise by 0.18 to 0.59 metres (2090-2099 relative to 1980-1999).

Future projections

- Snow cover is projected to contract.
- Sea ice is projected to shrink in both the Arctic and Antarctic. In some projections, Arctic late-summer sea ice disappears almost entirely by the latter part of the 21st century.
- It is *very likely* that hot extremes, heat waves, and heavy precipitation events will continue to become more frequent.
- It is *likely* that future tropical cyclones (typhoons and hurricanes) will become more intense, with larger peak wind speeds and more heavy precipitation



The Challenge: Sustainable Management of an Ever-Changing Planet

"Climate Change is a far greater threat to the world than international terrorism"

Sir David King, UK Chief Scientific Advisor

"I'm no longer skeptical…I no longer have doubts...I think climate change is the major challenge facing the earth"

Bill Clinton, Former US President

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What is Food Security ?

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Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life. Household food security is the application of this concept to the family level, with individuals within households as the focus of concern.

Food insecurity exists when people do not have adequate physical, social or economic access to food as defined above.

FAO (2002)

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Food Insecurity – a Human Tragedy

- Each day 800 million people go hungry
- Among them are 170 million children under 5 years of age



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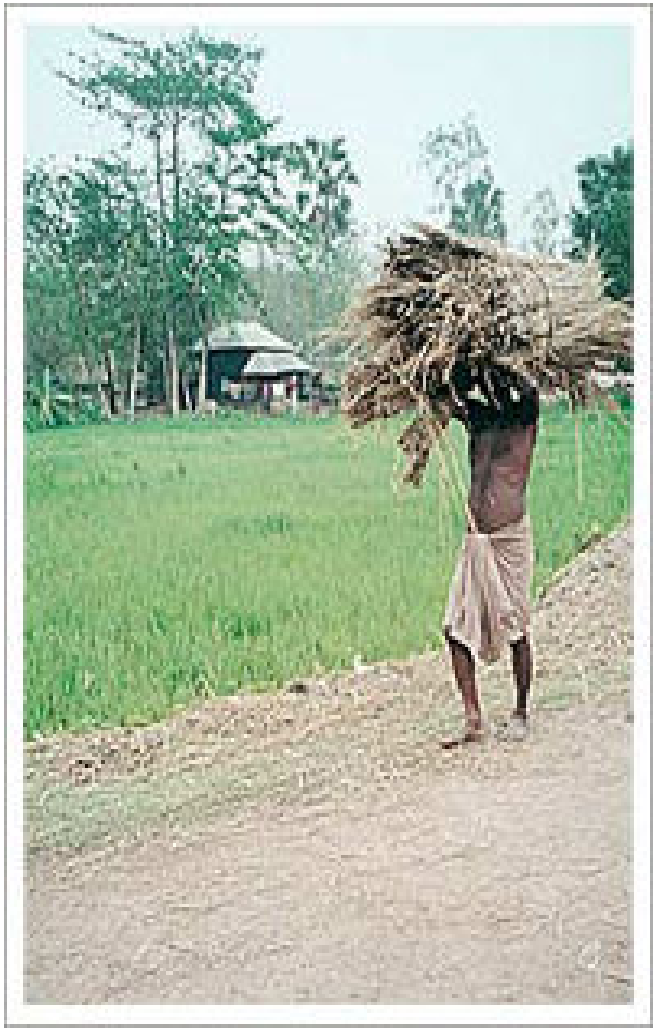
Why is Climate Change such an Important Issue for Food Security ?

- Climate change impacts the physical, social or economic access to food.
- There are several climatic drivers of food insecurity.

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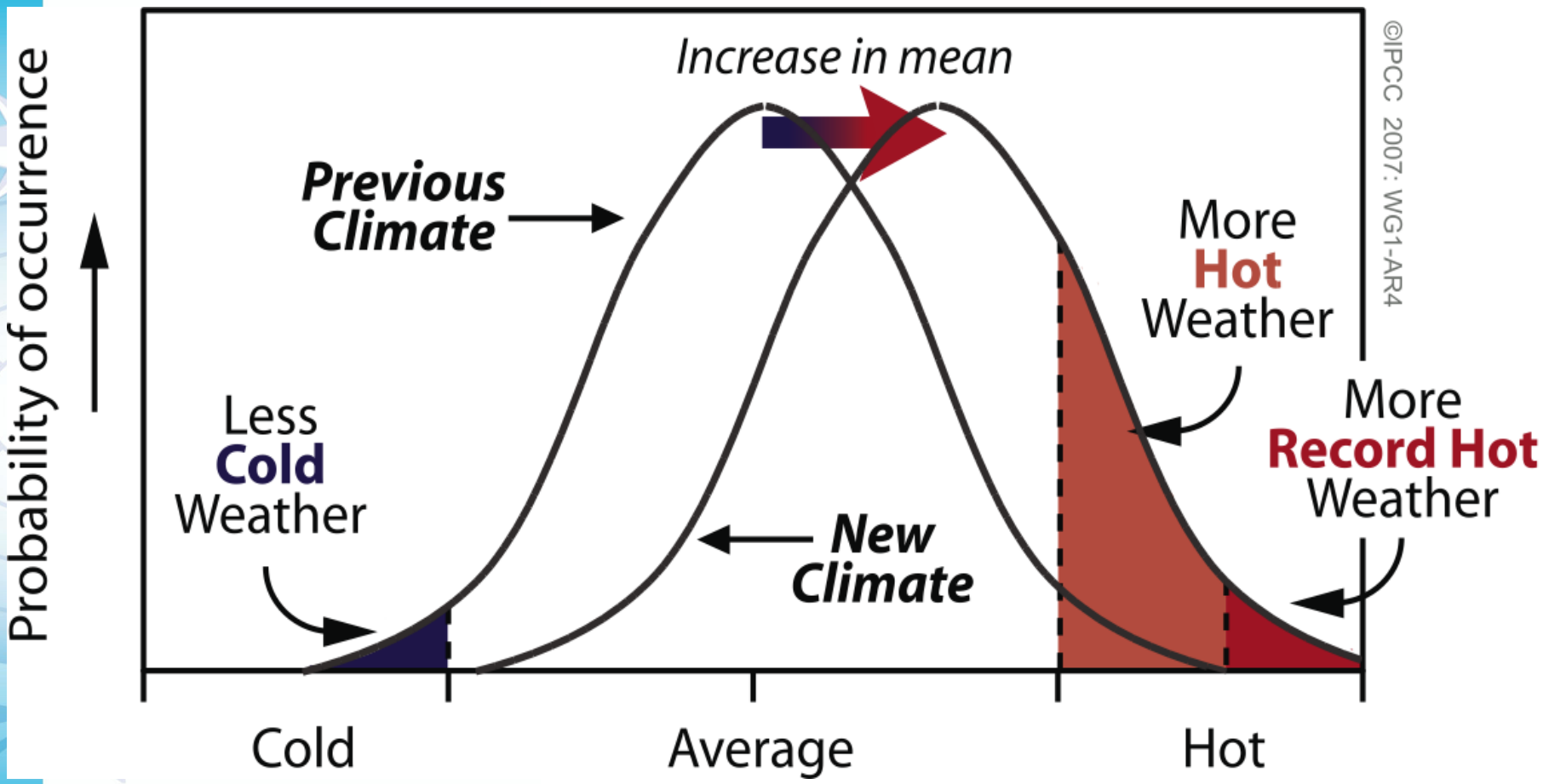
Climatic Drivers of Food Insecurity: Weather Risks

- In many developing countries where rainfed agriculture is the norm, a good rainy season means good crop production, enhanced food security and a healthy economy.
- As much as 80% of the variability in agricultural production is due to the variability in weather conditions
- Failure of rains and occurrence of natural disasters such as floods and droughts could lead to crop failures, food insecurity, famine, loss of property and life, mass migration, and negative national economic growth.



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Climatic Drivers of Food Insecurity: Increasing Extremes



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Climatic Drivers of Food Insecurity: Natural disasters

- Climate change and the associated severe weather events that are responsible for natural disasters impact the socio-economic development of many nations
- Annual economic costs related to natural disasters estimated at about US$ 50–100 billion.



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Drivers of Food Insecurity: Natural Resource Degradation and Technology Deprivation

- ✓ Current degradation of natural resources
- ✓ Poor access to technologies
- ✓ Low investments in production



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Implications of Future Climate Change for Food Security

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Sources of world food production

- Total arable and permanent cropped area of the world = 1.497 billion ha
- Irrigated agriculture practiced over 272 million ha (18%) contributes 40% of total production and employs 30% of population in agriculture
- Rainfed agriculture practiced over 1226 million ha (82%) contributes 60% of total crop production and employs 70% of population in agriculture

Climate change will impact the sources of food production through its effects on:

- Water resources
- Productivity levels



Vulnerabilities

- Food and water security
- Incomes and livelihoods



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Impacts on Freshwater Resources

By mid-century, annual average river runoff and water availability decrease by 10-30% over some dry regions at mid-latitudes and in the dry tropics, some of which are presently water-stressed areas. Drought-affected areas will likely increase in extent.

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Climate Change Impacts on Water Resources in Asia

- Glacier melt in the Himalayas projected to increase flooding, and rock avalanches from destabilised slopes, and to affect water resources within the next two to three decades.
- This will be followed by decreased river flows as the glaciers recede.
- Freshwater availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease which, alongwith population growth and increasing demand, could adversely affect more than a billion people by the 2050s.
- Coastal areas, especially heavily-populated megadelta regions in South, East and South-East Asia, will be at greatest risk due to increased flooding from the sea and, in some mega deltas, flooding from the rivers.

Coastal Systems and Low-lying Areas

- Coasts are projected to be exposed to increasing risks, including coastal erosion. The effect will be exacerbated by increasing human-induced pressures on coastal areas.
- Coastal wetlands including salt marshes and mangroves are projected to be negatively affected by sea-level rise especially where they are constrained on their landward side, or starved of sediment.
- Many millions more people are projected to be flooded every year due to sea-level rise by the 2080s.
- Those densely-populated and low-lying areas where adaptive capacity is relatively low, and which already face other challenges such as tropical storms or local coastal subsidence, are especially at risk.
- The numbers affected will be largest in the mega-deltas of Asia and Africa while small islands are especially vulnerable.

Small Islands

- Small islands, whether located in the tropics or higher latitudes, have characteristics which make theme specially vulnerable to climate change, sea-level rise and extreme events.
- Deterioration in coastal conditions, for example through erosion of beaches and coral bleaching, expected to affect local resources, e.g. fisheries, and reduce the value of these destinations for tourism.
- Sea-level rise expected to exacerbate inundation, storm surge, erosion and other coastal hazards, thus threatening vital infrastructure, settlements and facilities that support the livelihood of island communities.
- Climate change projected by mid-century to reduce water resources in many small islands, e.g. in the Caribbean and Pacific, to the point where they become insufficient to meet demand during low-rainfall periods.

Climate Change Impacts on Crop productivity

- At lower latitudes, especially seasonally dry and tropical regions, crop productivity is projected to decrease for even small local temperature increases (1-2°C), which would increase the risk of hunger.

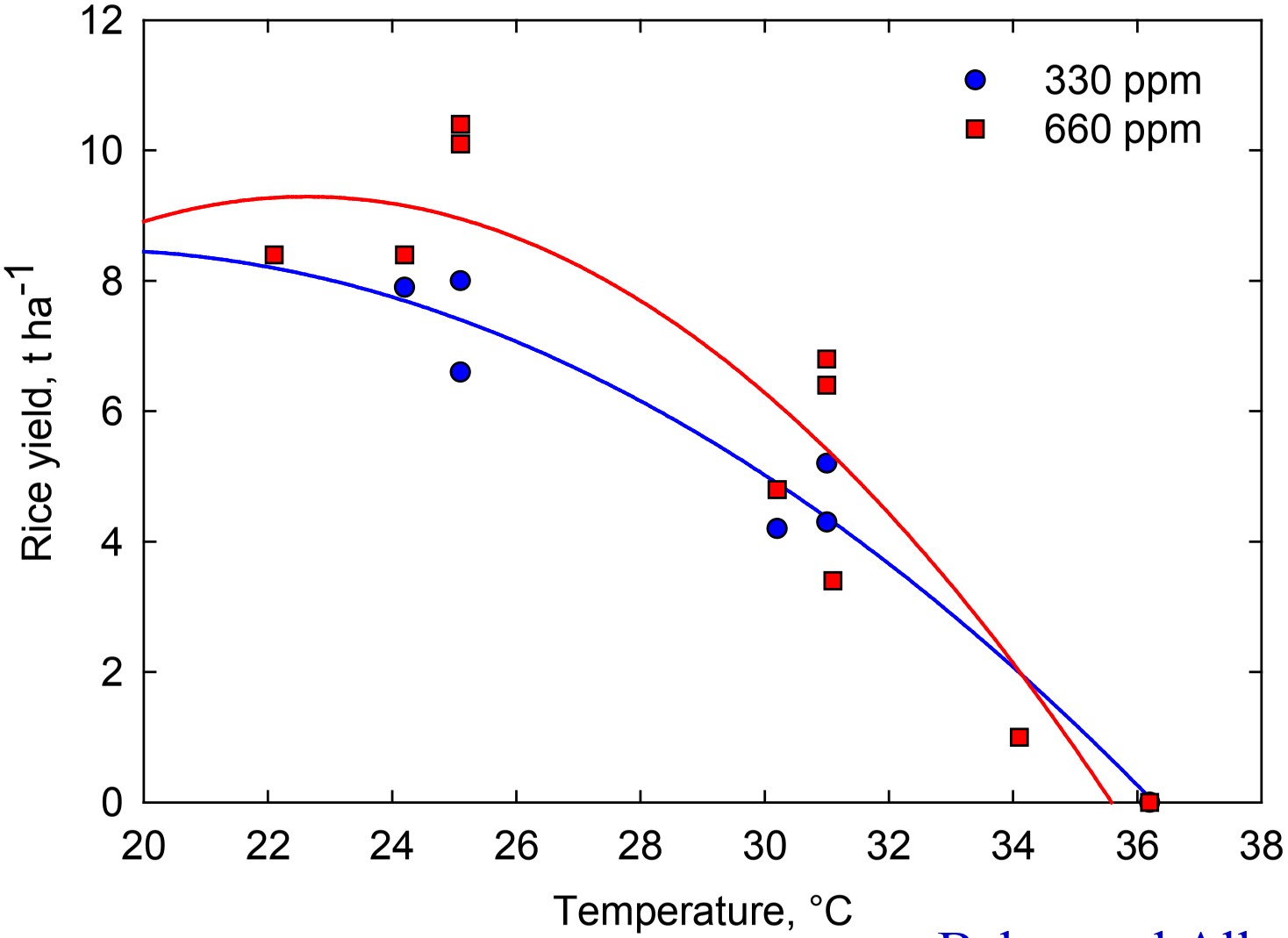
- Increases in the frequency of droughts and floods are projected to affect local crop production negatively, especially in subsistence sectors at low latitudes.

Climate Change Impacts on Crop Productivity and Sustainable Development in Asia

- Climate change projected to impinge on sustainable development of most developing countries, as it compounds the pressures on natural resources and the environment associated with rapid urbanisation, industrialisation, and economic development.
- Crop yields could increase up to 20% in East and South-East Asia while they could decrease up to 30% in Central and South Asia by the mid-21st century.
- Taken together, and considering the influence of rapid population growth and urbanisation, the risk of hunger is projected to remain very high in several developing countries.

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Rice yield variations with temperature and CO_2



Baker and Allen, 1993

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Projected Climate Change Impacts on Crop Productivity in India

Temp +2.5^{o} to 4.9^{o} C

Rice yield - 15% to - 42%

Wheat yield - 25% to - 55%
(without carbon fertilization effect)

With fertilization - smaller but similar impact

Parikh and Kavi Kumar

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Climate Change Impacts on Society

- Poor communities can be especially vulnerable, in particular those concentrated in high-risk areas. They tend to have more limited adaptive capacities, and are more dependent on climate-sensitive resources such as local water and food supplies

- Where extreme weather events become more intense and/or more frequent, the economic and social costs of those events will increase, and these increases will be substantial in the areas most directly affected.

- Climate change impacts spread from directly impacted areas and sectors to other areas and sectors through extensive and complex linkages.

Adaptive Responses

The array of potential adaptive responses available to human societies is very large, ranging from purely technological (e.g. sea defences), through behavioural (e.g. altered food and recreational choices), to managerial (e.g. altered farm practices) and to policy (e.g. planning regulations).

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Agrometeorological Strategies to enhance food security

- Assess Past Impacts
- Develop good Monitoring
- Improve Forecasts/Scenarios
- Explore/Propose Responses

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Translating Climate Information into Food Security Information

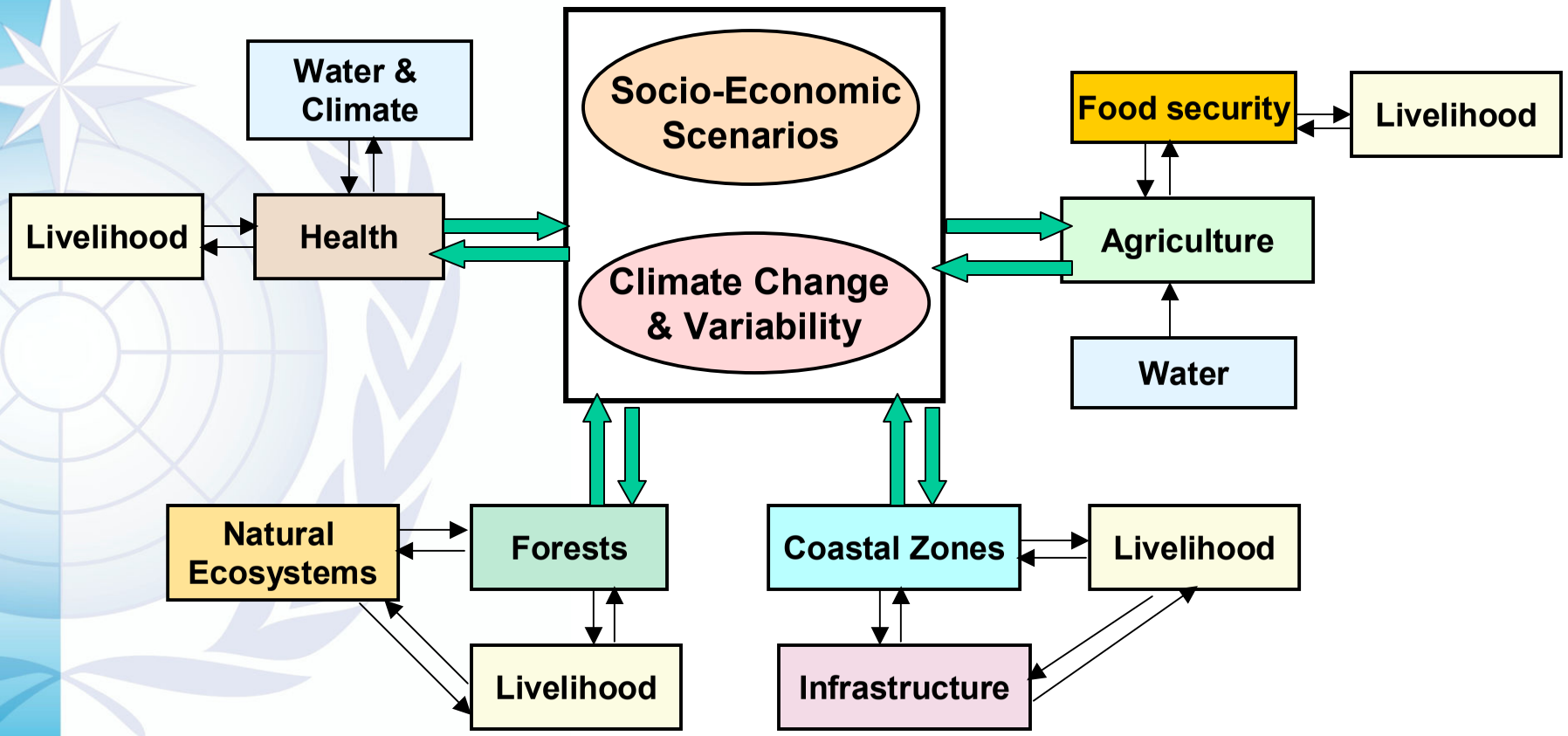
Develop regional food security outlooks based on climate forecast-derived projections of crop yields, livestock condition and other food security-related variables, and use them as input into a livelihoods-based food security analysis

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Need to strike a balance between Technical and Structural solutions and Social and Institutional Constraints

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Balancing Solutions and Constraints through Integrated Assessments

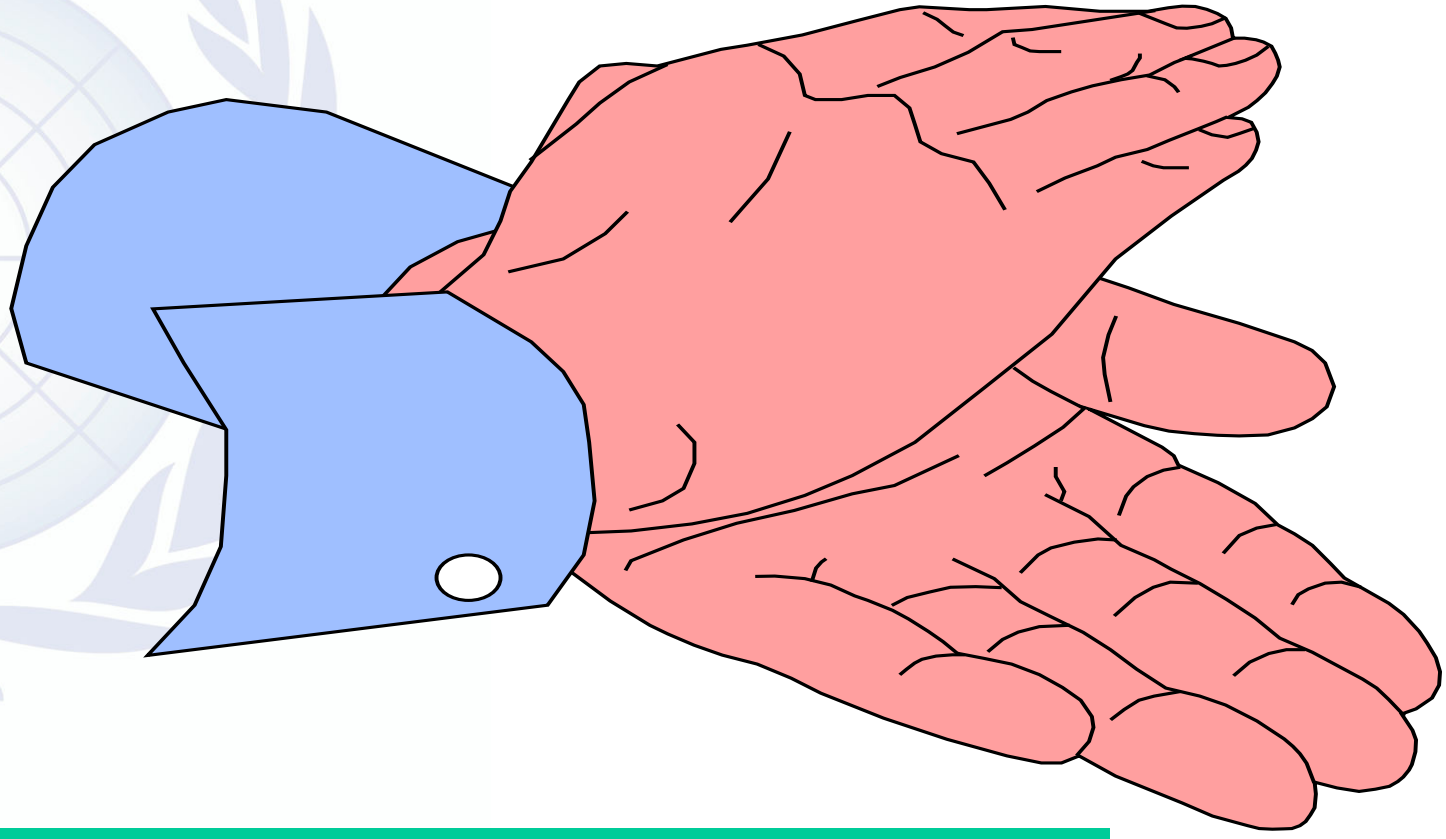


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Climate Change and Food Security – Agrometeorological research Needs

- Improved and reliable regional climate models and climate projections for impact assessment
- Improved climate change impact or response models - *Sectoral, Regional, & Integrated*
- Assessment of impacts at regional level and identification of vulnerable regions, socio-economic systems
- Risk-assessment framework for analyzing critical thresholds of climate impact and adaptation strategies for coping with changed climate conditions in the agricultural sector

Thank you very much for your attention



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