Highlights of the IPCC Fourth Assessment Report (AR4) – food, agriculture and ecosystems

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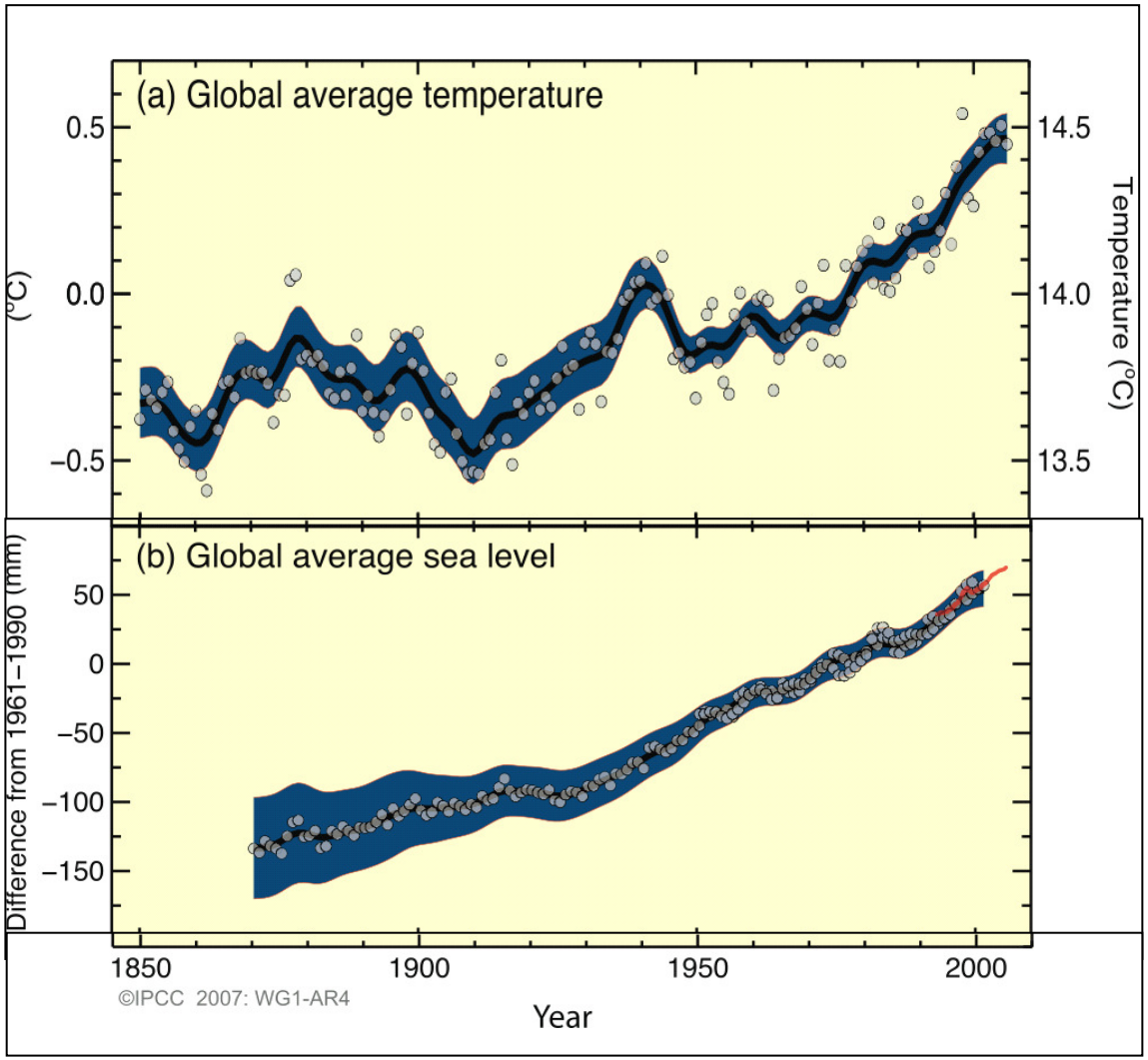
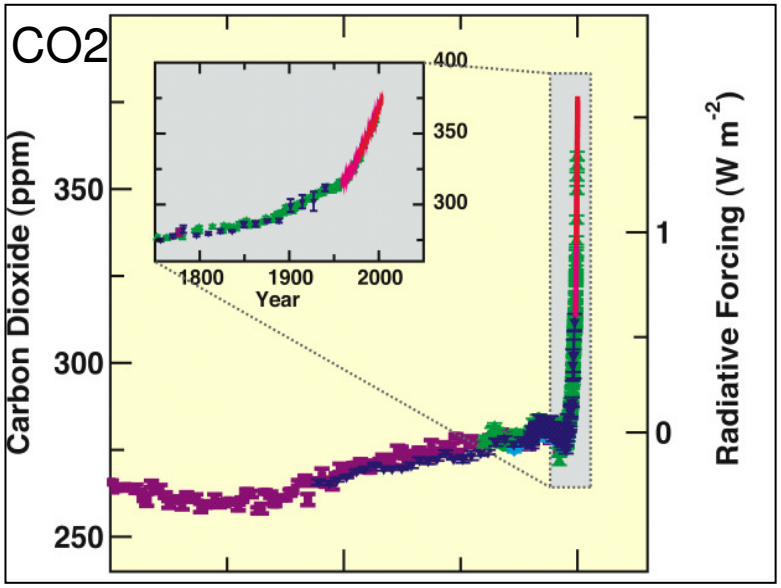
13 February 2008

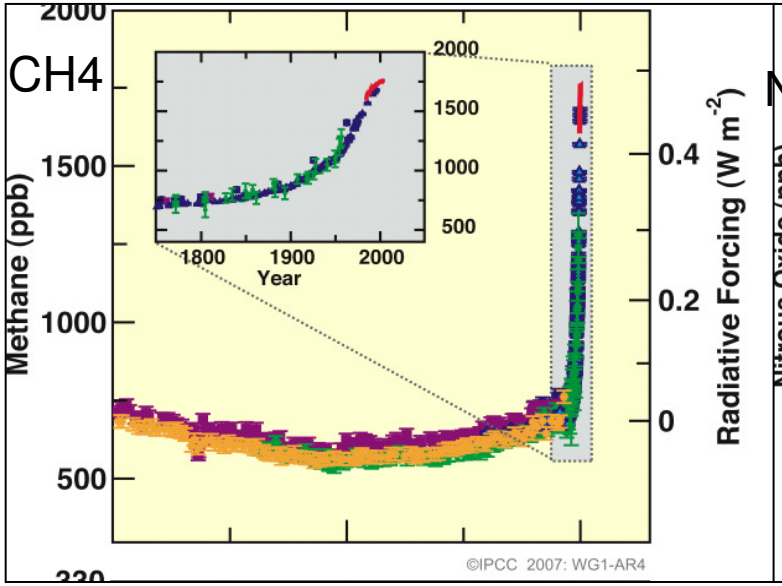
Observed changes since 1850

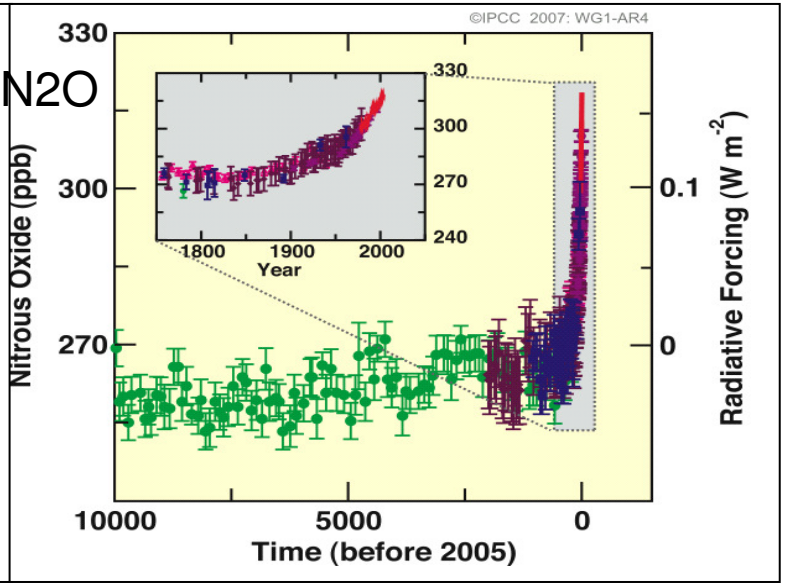


GHG concentrations variations over the last 10,000 years



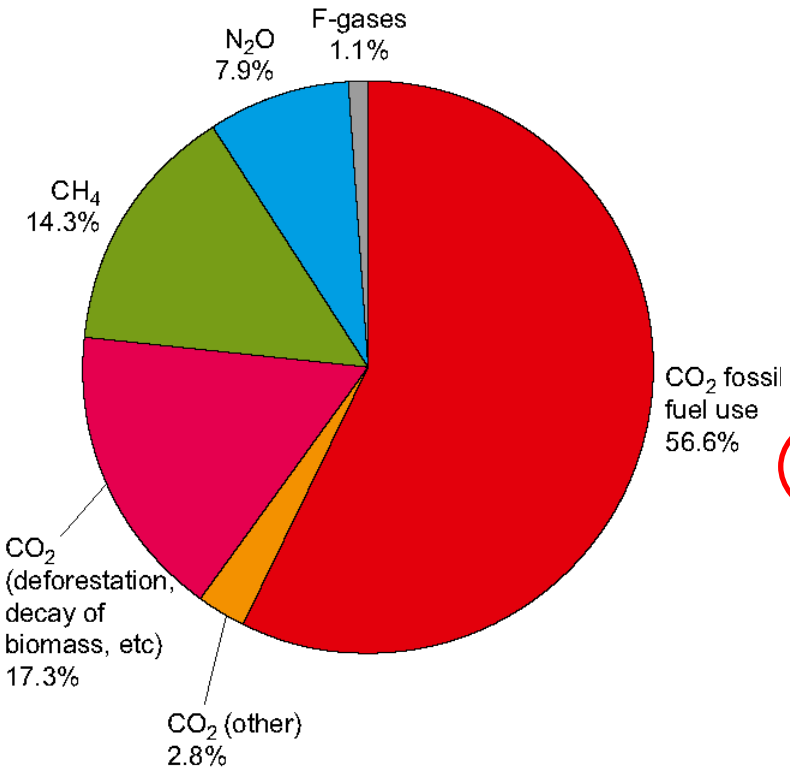
- Global GHG emissions have grown since pre-industrial times, with an increase of 70% between 1970 and 2004. (*high agreement, much evidence*)



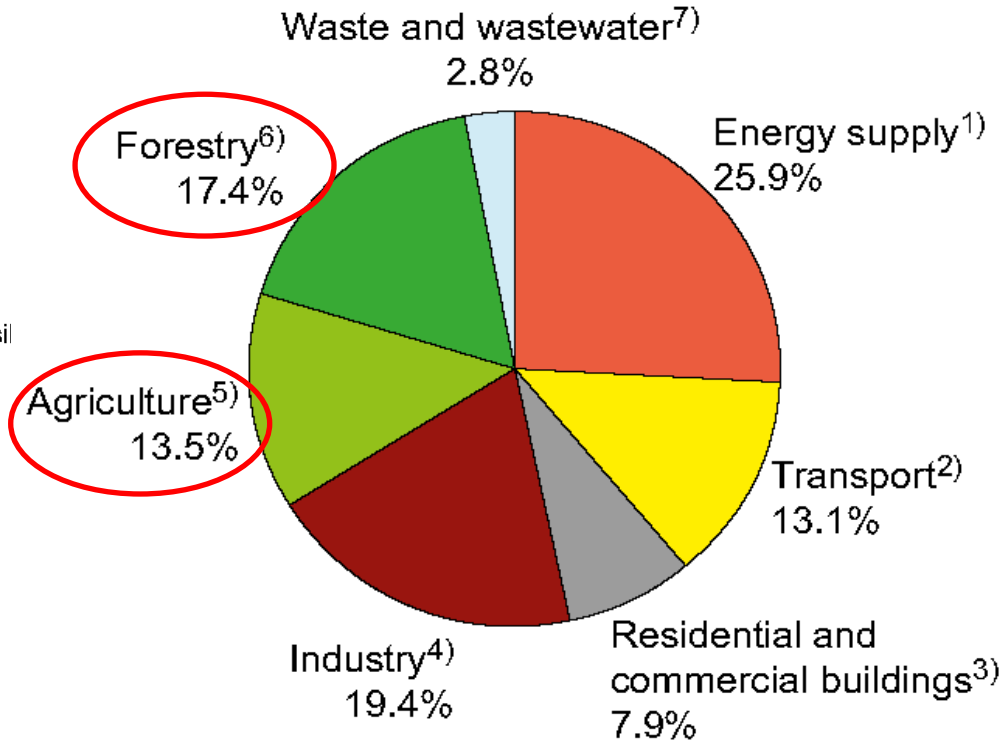


Emissions – by GHG & sector (2004)

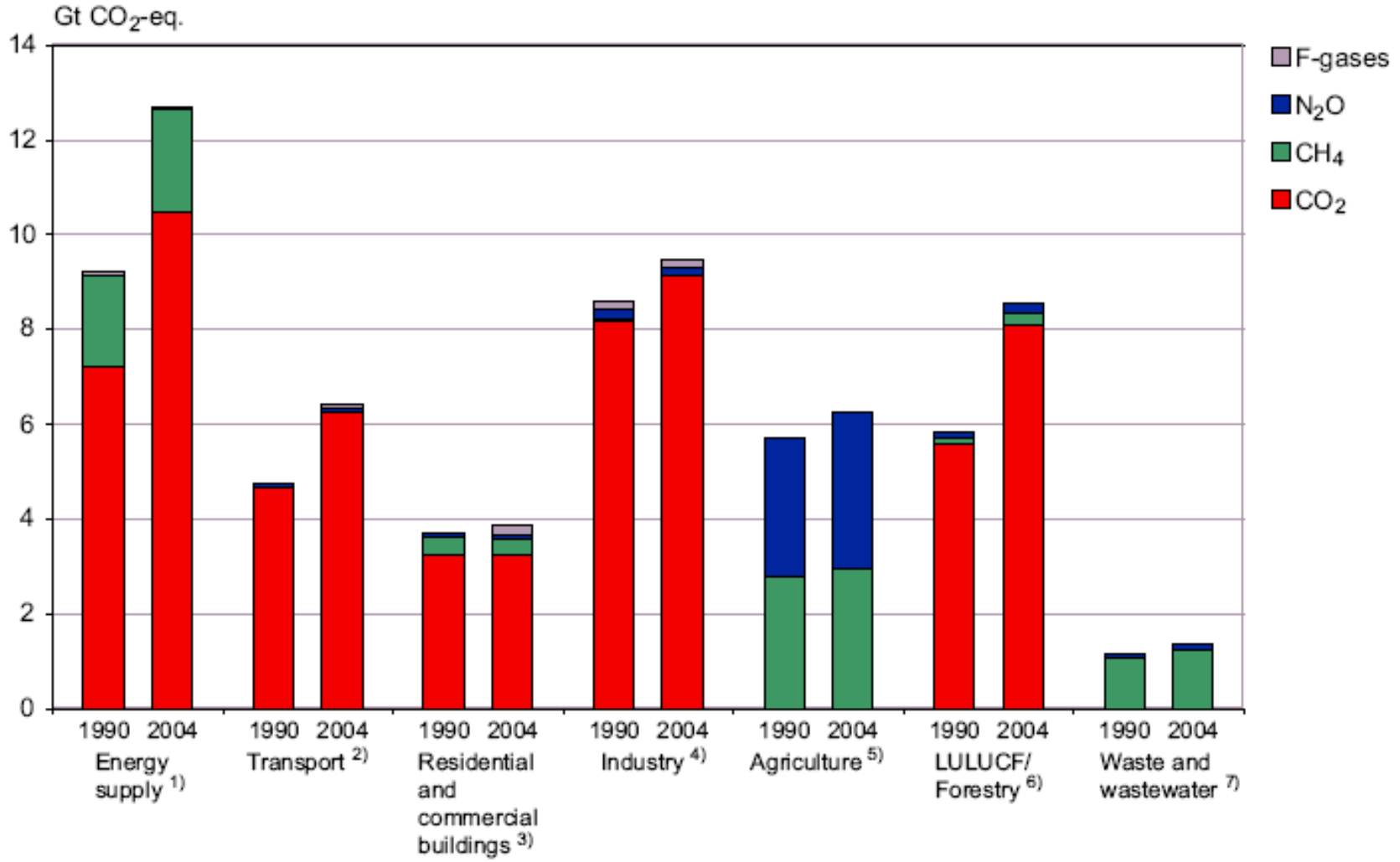
By GHG



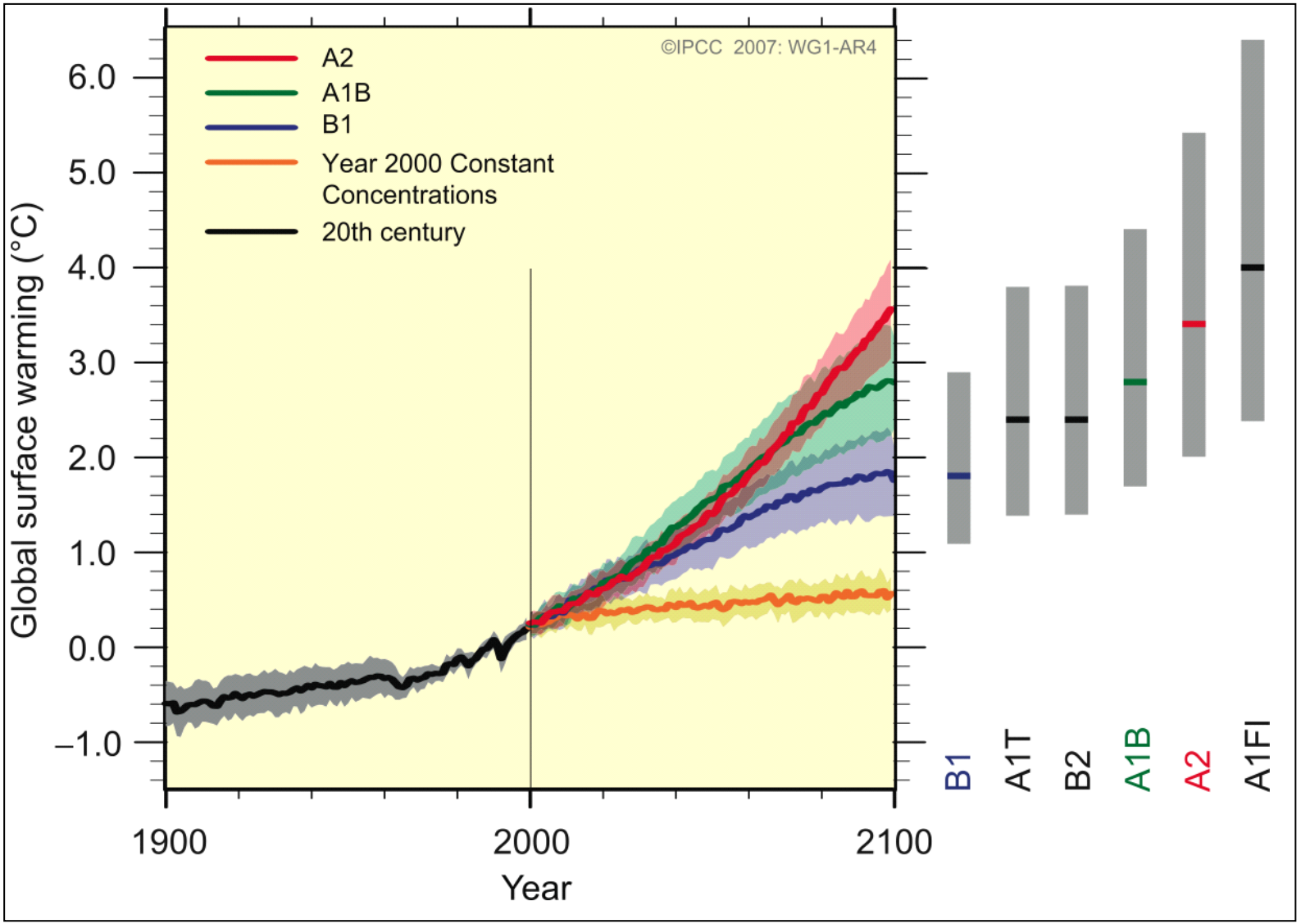
By sector (CO_2 eq)



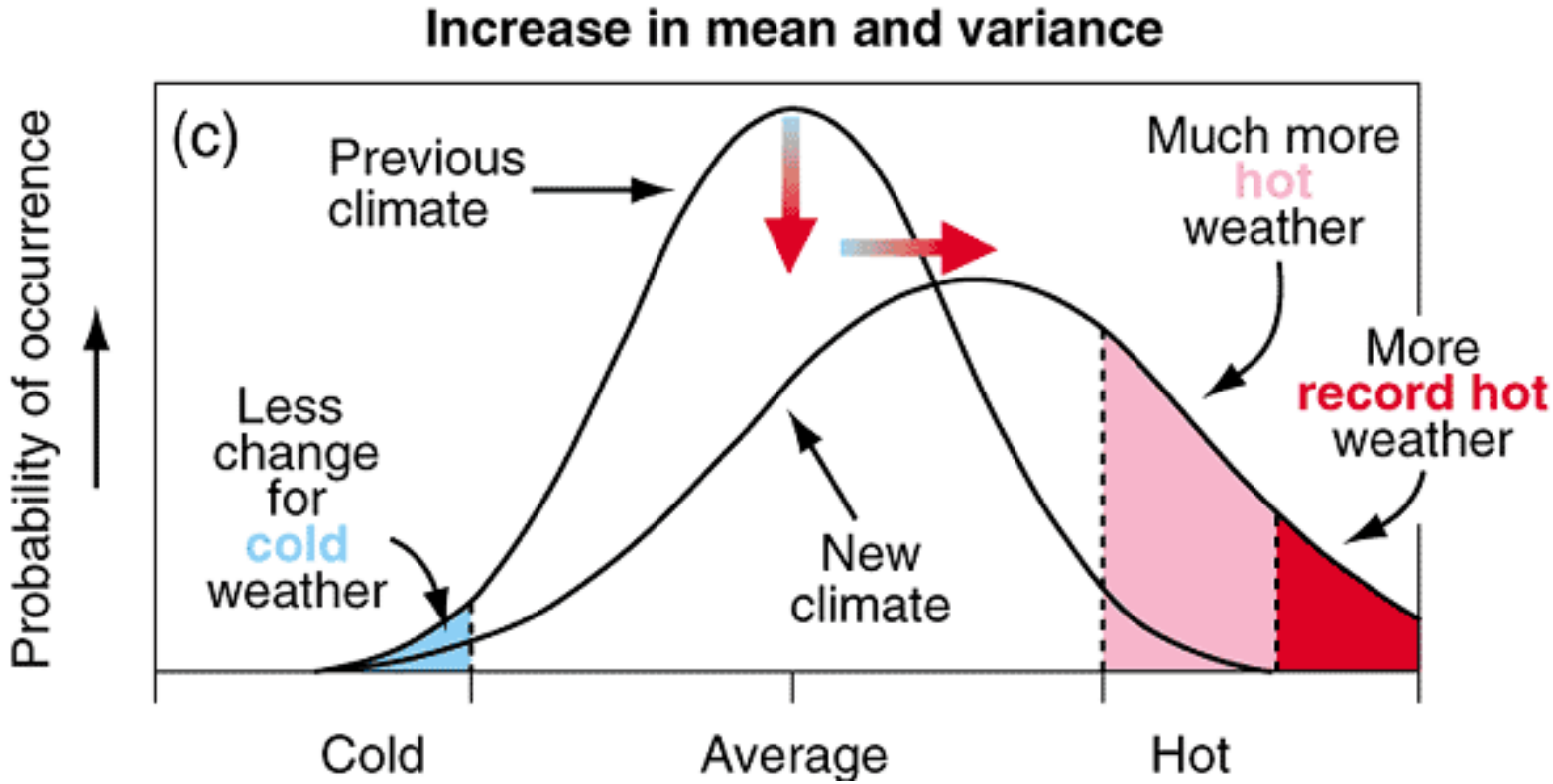
Emissions by Sector and GHG



Surface warming projections



Projections of extreme events



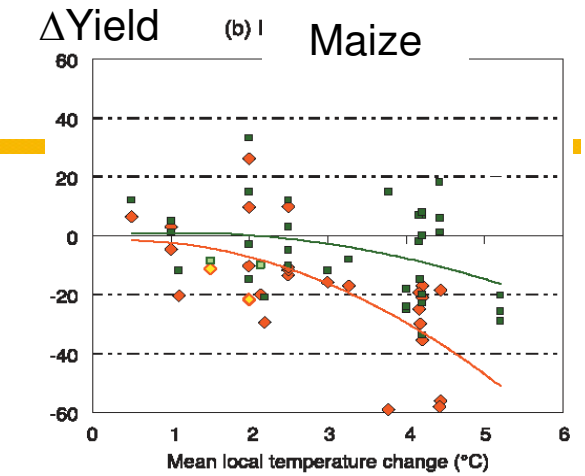
- Warmer and fewer cold days and nights, warmer and more frequent hot days and nights (*Virtually certain*)
- Increase in frequency of hot extremes, heat waves, and heavy precipitation. (*very likely*)
- Increase in tropical cyclone intensity, drought affected area. (*likely*)

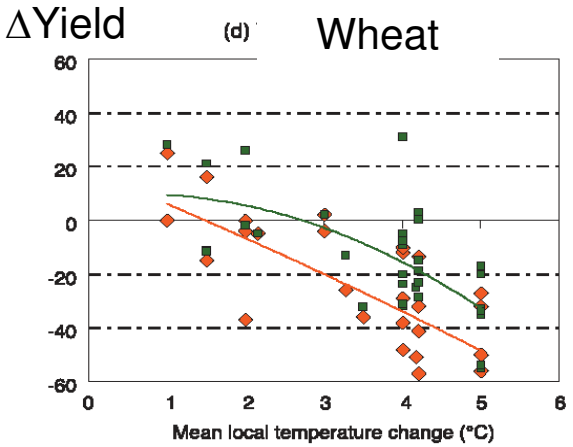
Impacts – agriculture

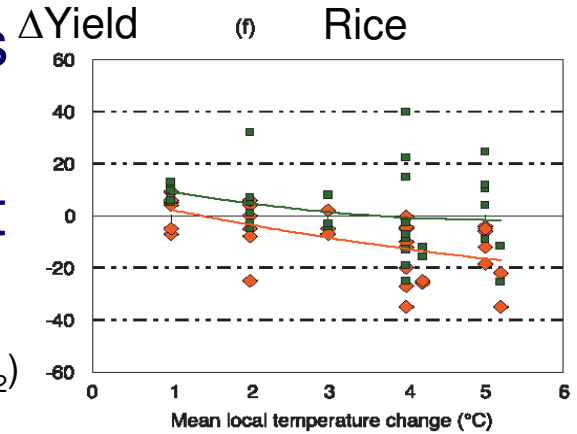
Causes: ↑temp & evaporation, rainfall variability, extreme events

Impacts:

- HL:↑yields for ↑temp 1-3℃, ↓yields >3℃
- LL: ↓yields even for ↑temp 1-2℃
- CO_2 benefits outweighed by Δtemp, rainfall
- Effects extreme events > Δmean climate?
- fire risks, pests and diseases
- ↑irrigation water demand +5-20% by 2080s (globally)
- Livestock: diseases (e.g. bluetongue), heat and water stress, Δforage quality





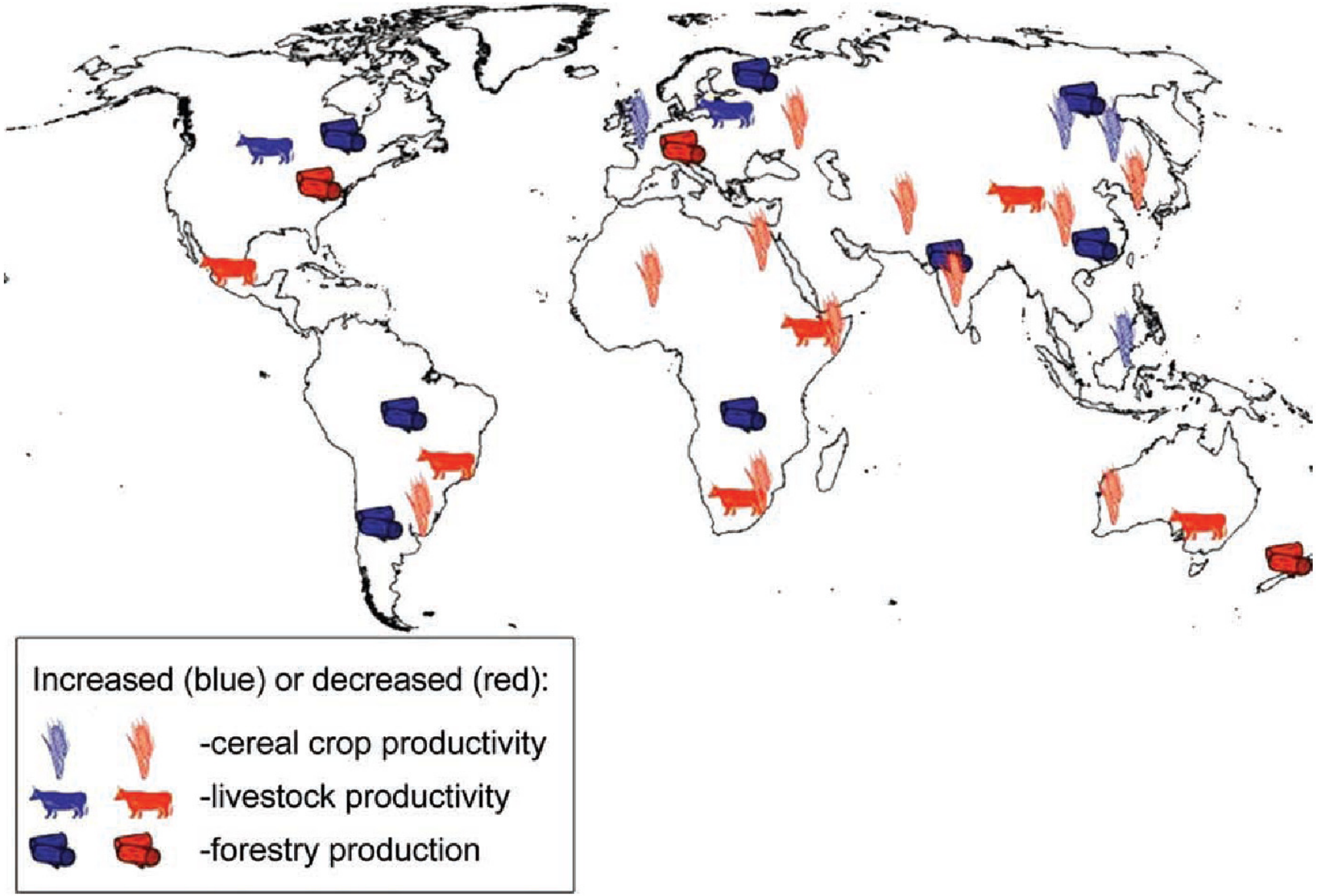


ΔYield as f(Temp, rainfall, CO_2)
With, Without adaptation

Impacts – forestry

- land-use change/deforestation more important
- Δproduction: globally modest↑; short-term ↑production in LL, long term ↑production in HL
- ↑fuelwood use possible due to ↑energy prices/biofuels
- Interaction between disturbances (storm, insects, droughts, fires)

Δ Agricultural production in 2050



Impacts – fisheries

- Causes: ↑temp stress & pH, ↑extreme events & diseases, conflict with coastal defense
- Local extinction of fish species at edges of ranges (e.g., salmon, sturgeon), long-term impacts of coral reef damages
- Δprimary production
- Long-term: slowing MOC affects marine ecosystem productivity

- Lake Tanganyika: ↓fish yields ~-30%
- Lower Mekong: Δfood chain due to ↓water quality, Δvegetation pattern, salt water intrusion

Impacts – food security

- ↑global food production for ↑temp < 3℃, beyond ↓production, ↑cereal prices
- Globally, only slight ↑people at risk of hunger due to socio-economic development (at favorable end of scenario)
- Small holders threatened (notably Africa, parts of Asia), by 2080 ~75% of people at risk of hunger from Africa
- ↑food-import dependence of many developing countries

Impacts – Coasts

Coastal ecosystems

→ all vulnerable, esp. corals, salt marshes and mangroves

→ ↑coral bleaching and mortality due to ↑SST +1-3℃ in 21st century

→ Global loss of ~1/3 of coastal wetlands for 36 cm SLR (2000-80), largest losses: Atlantic & Gulf of Mexico coasts, Mediterranean, Baltic, small-islands

↑ Coastal flooding in low-lying areas due to SLR & intense storms,2-3x population currently at risk

Impacts – Marine & terrestrial ecosystems

Causes: CC associated disturbances (flood, drought, wildfire, insects, ocean acidification), other global change drivers (notably, land-use change)

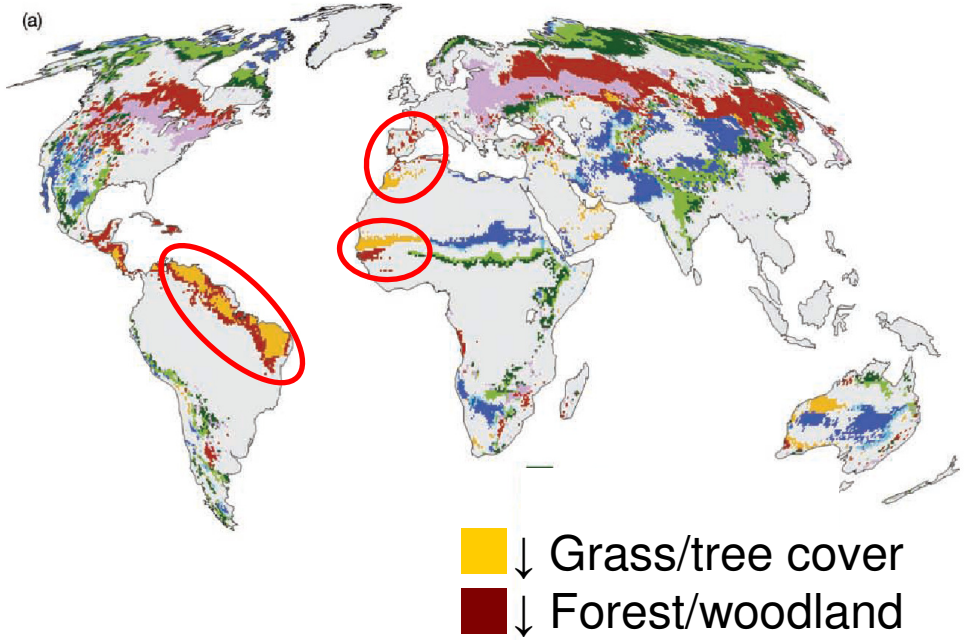
Resilience of many ecosystems likely to be exceeded by 2100 → threshold responses, many irreversible (e.g. biodiversity loss, changes in ecosystem structure)

Several major carbon stocks are vulnerable to climate change and land-use changes; the terrestrial biosphere is likely to become a net carbon source before 2100.

Impacts – Marine & terrestrial ecosystems

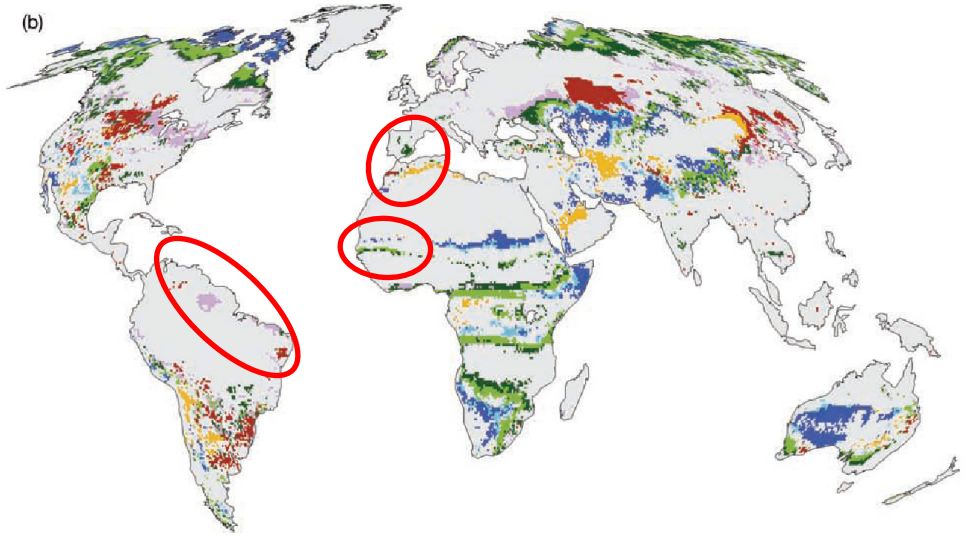
- 20-30% of plant and animal species are likely to be at increasingly high risk of extinction (with a warming of 2-3 degrees C).
- Negative impacts on marine organisms particularly in the Southern Ocean.
- By 2100, some positive impacts on terrestrial ecosystems in Africa and Southern Hemisphere arid regions, but extensive forest and woodland decline in mid- to high latitudes and in the tropics.

Impacts – Terrestrial ecosystems Δ 2000-2100



DGVM LPJ + HadCM3

SRES A2



DGVM LPJ + ECHAM5

SRES B1

Impacts – Marine & terrestrial ecosystems

+1-2℃: negative impacts for some systems (e.g. coral bleaching, endemic plants & fauna in S-Africa, polar systems)

+2-3℃: major biome changes very likely (e.g. coral mortality, 20-80% loss of Amazonian rainforest, globally 20-30% species extinction)

> +3℃: widespread, heavy impacts on biomes, globally significant extinctions

Inter-linkages between temporal and spatial scales

- Biosphere (global): centuries to millennial
- Biomes (continental): decadal to millennial
- Organisms (regional): years to centuries
- Populations (interbreeding individuals of the same species): months to centuries
- Micro-organisms, plants and animals (physiological): seconds to months.

Five key issues - ecosystems

- Is ecosystem resilience sufficient to tolerate anthropogenic future climate change?
- What's the relationship of climate change with other human-induced pressures (extractive use of goods, degradation of natural habitats) for ecosystems?
- What are the consequences of exceeding critical thresholds, which could trigger non-linear biosphere responses?
- What are time-lags in ecosystem responses
- What are the impacts of global extinction of species on ecosystem maintenance?