

The global change challenge

the role of science

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The logo for the Council for Scientific and Industrial Research (CSIR) of South Africa. It features the letters 'CSIR' in a bold, blue, sans-serif font. The 'C' is a large, stylized letter that curves around the 'S'. The 'I' is a simple vertical bar with a dot above it. The 'R' is a simple, blocky letter.

our future through science

Human activities are messing with many aspects of the global metabolism...

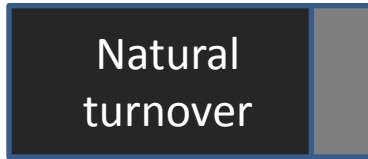
Natural

Human-induced alteration of cycle turnover

0%

400%

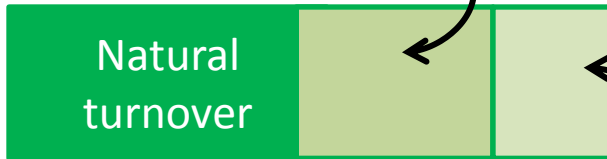
C



Natural turnover

Loading due to anthropogenic CO₂ emissions

N

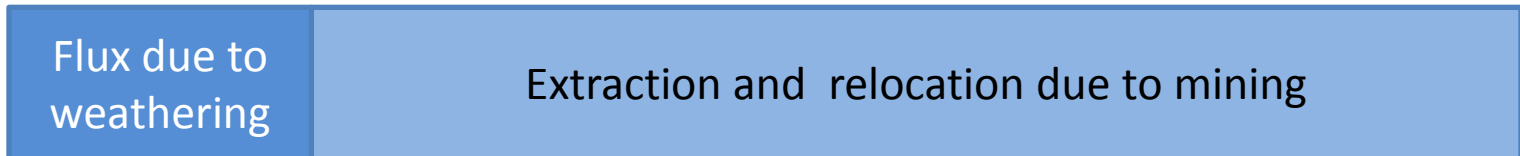


Natural turnover

Industrial conversion of N₂ to NH₃

Biological N fixation in agriculture

P



Flux due to weathering

Extraction and relocation due to mining

The present atmosphere has a composition not experienced in the past 0.4 million years (and probably longer)

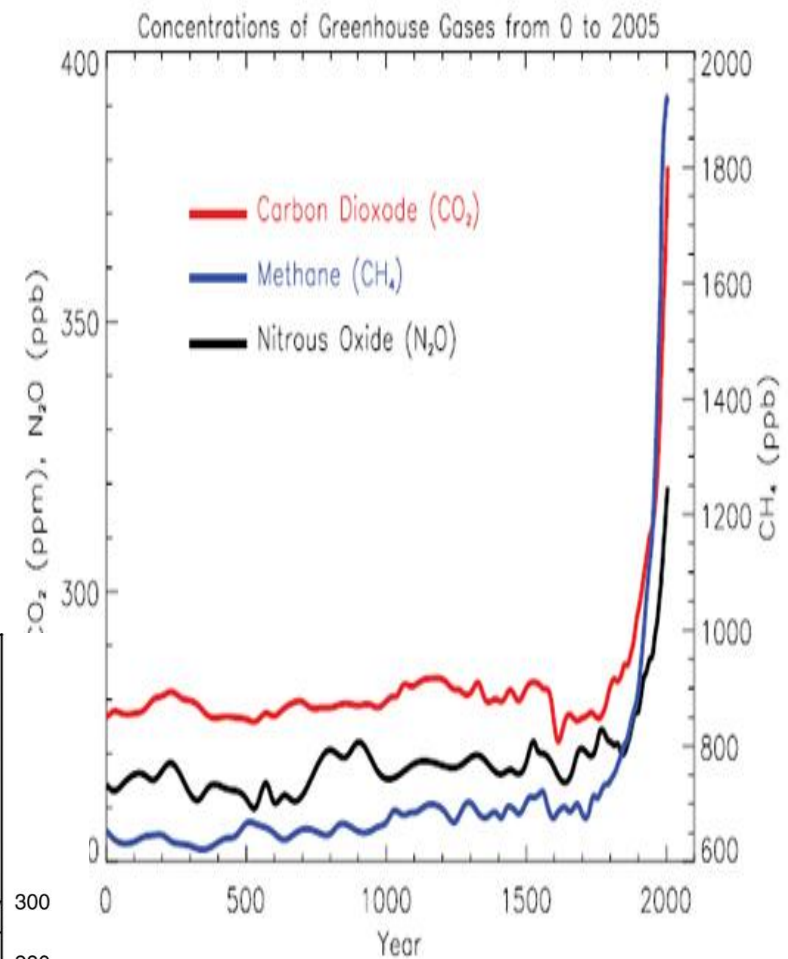
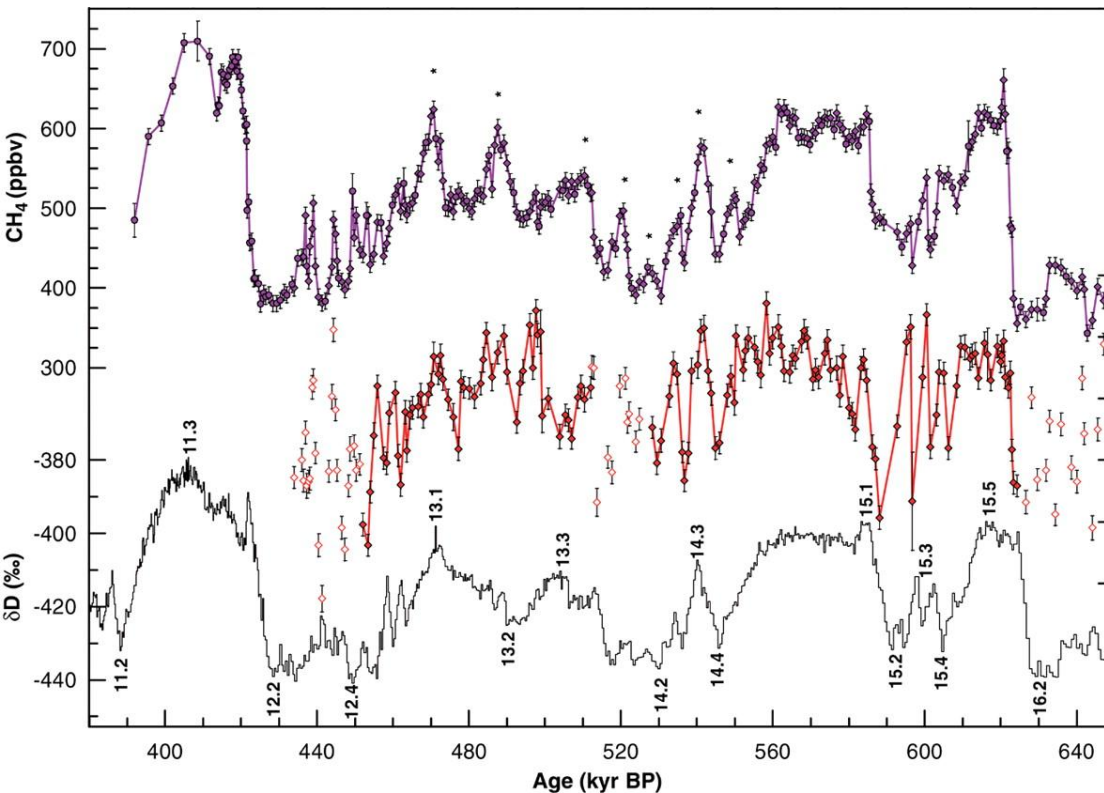
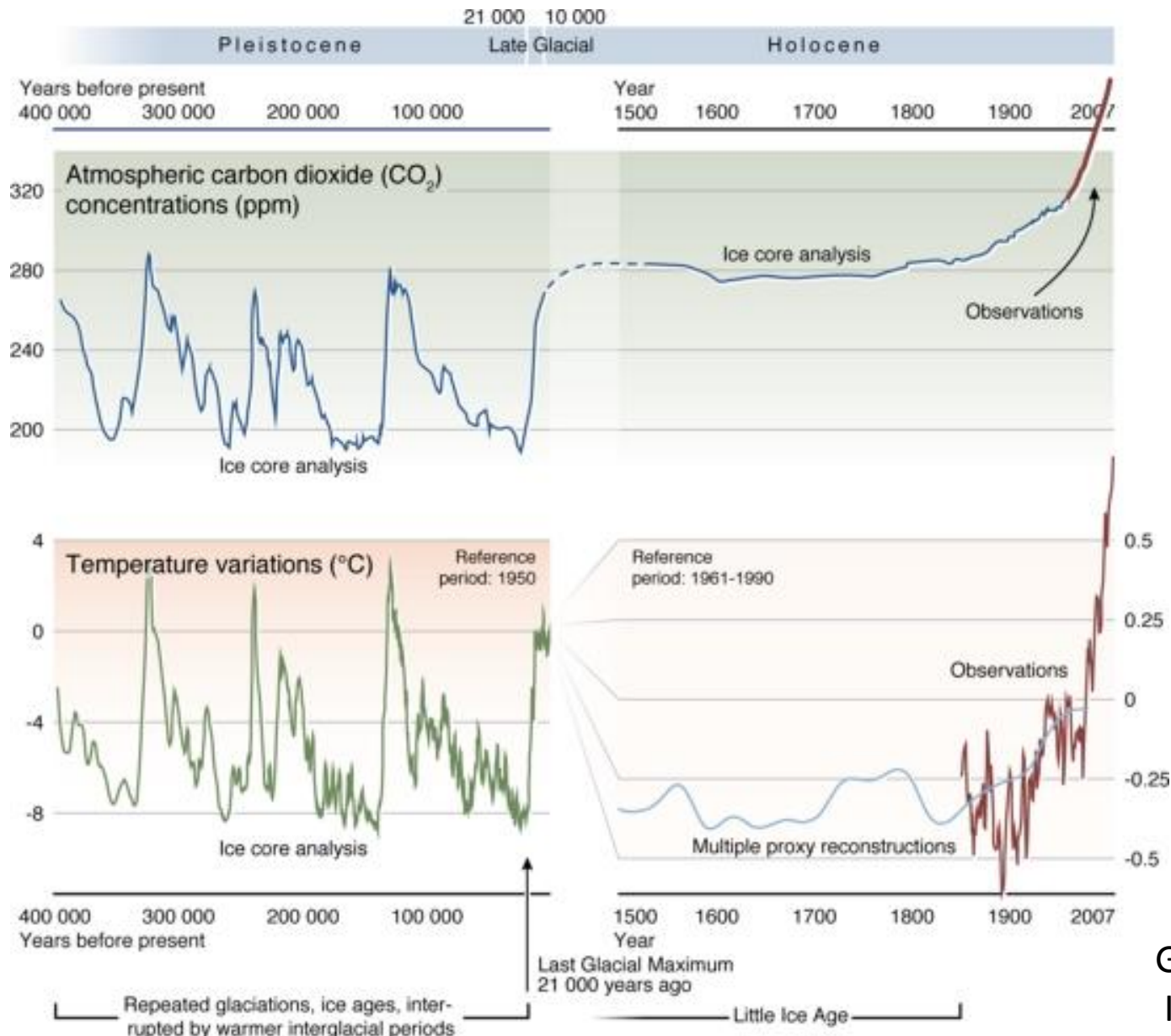


Figure 1. Atmospheric concentrations of important long-lived greenhouse gases over the last 2,000 years. Increases since about 1750 are attributed to human activities in the industrial era. Concentration units are parts per million (ppm) or parts per billion (ppb), indicating the number of molecules of the greenhouse gas per million or billion air molecules, respectively, in an atmospheric sample. IPCC AR4 FAQ

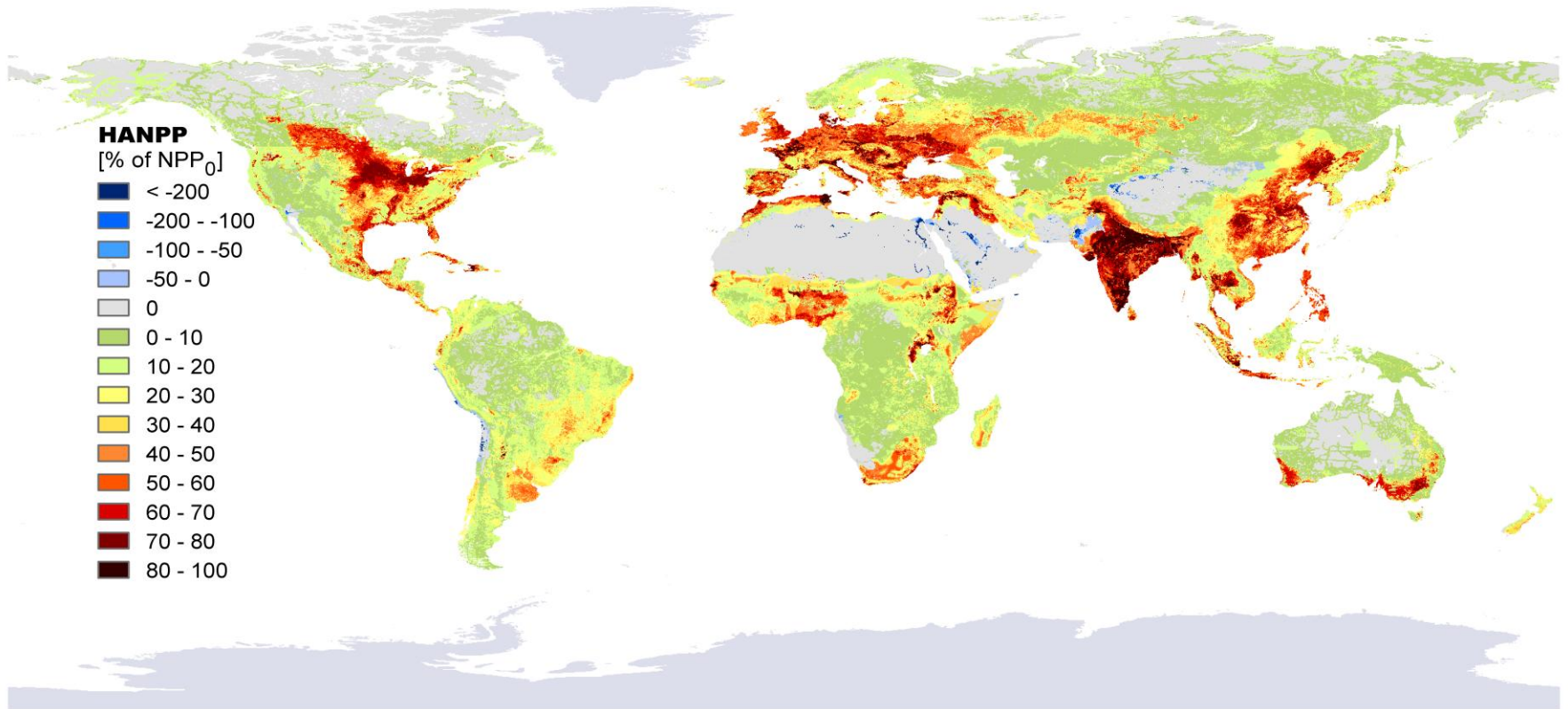
Spahni et al. (2005) , Science 310: 1317-1321

The climate has changed relative to the norm during the period over which human civilisation developed



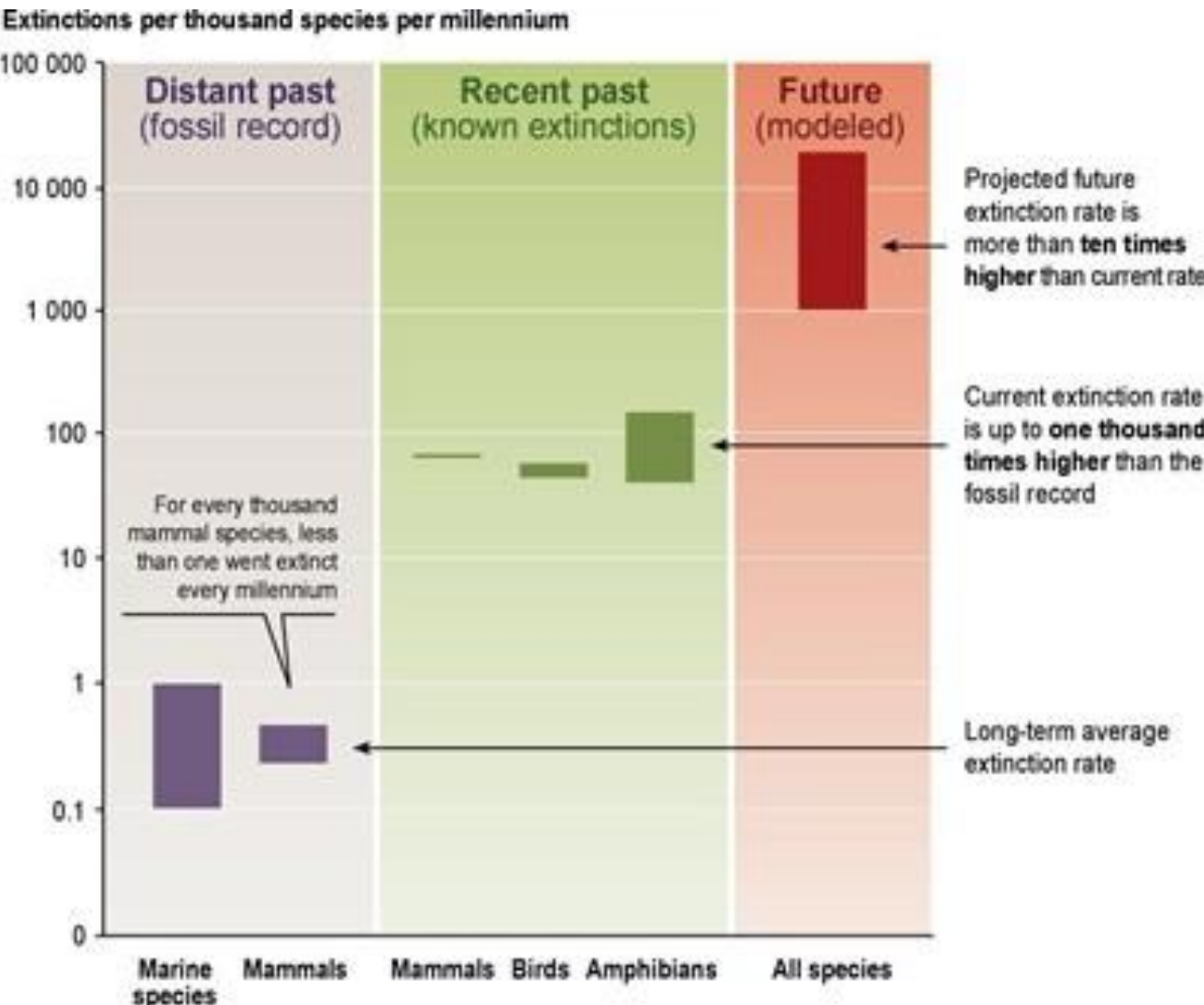
Graphic source:
IPCC

Humans and their livestock now appropriate a quarter of global primary production



Source: Social Ecology Institute, Vienna

The world is losing biodiversity 100 times faster than the historical rate of extinction



- Deletions from the 'book of life
- Less resilient ecosystems
- Reduction in ecosystem services

See also Global Biodiversity Outlook 3,(2011)

Source: Millennium Ecosystem Assessment

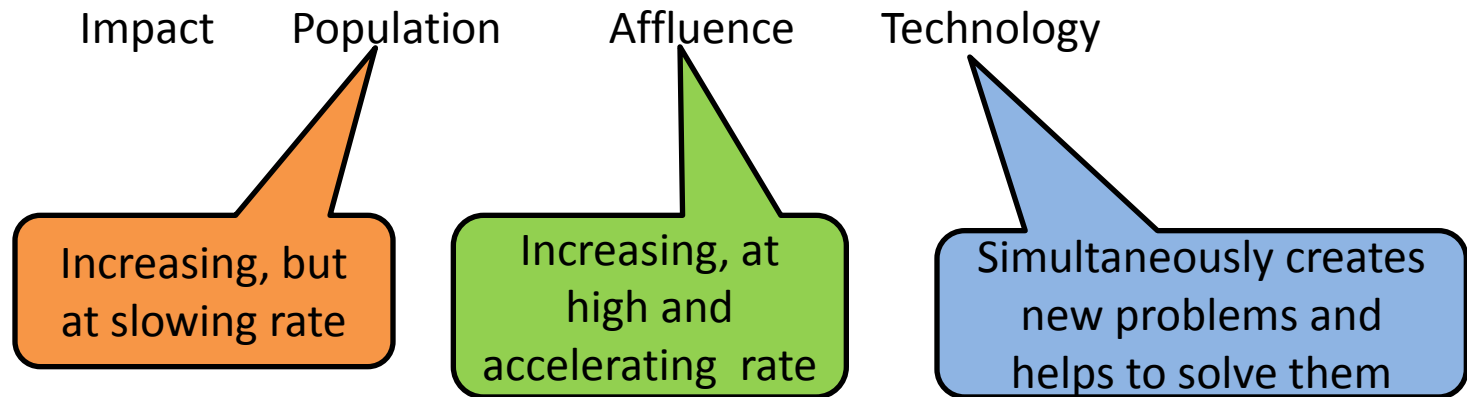
Welcome to the Anthropocene



...the era during which humans are the dominant influence on the functioning of the Earth System

The roots of the problem...

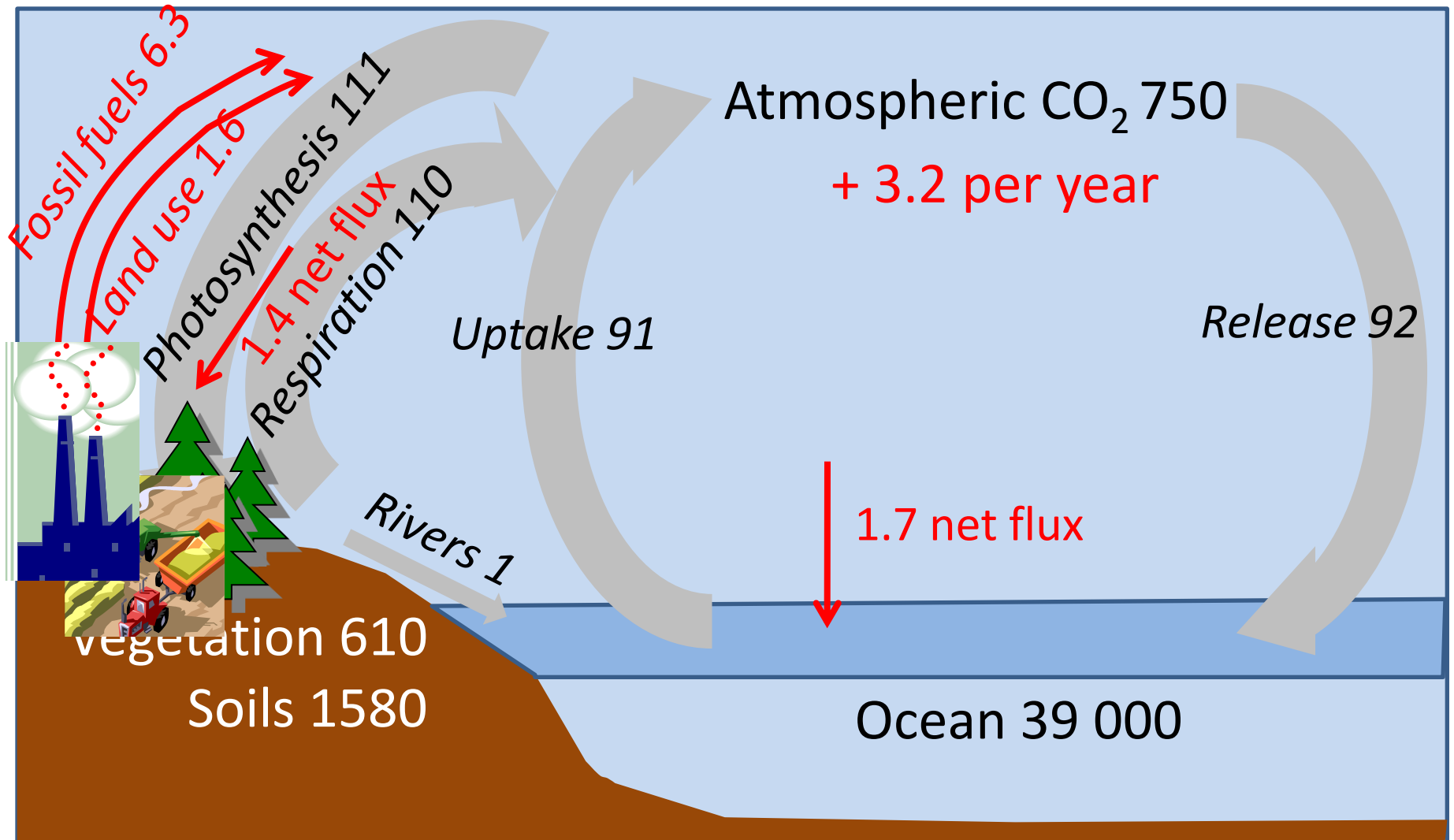
$$I = P \times A \times T$$

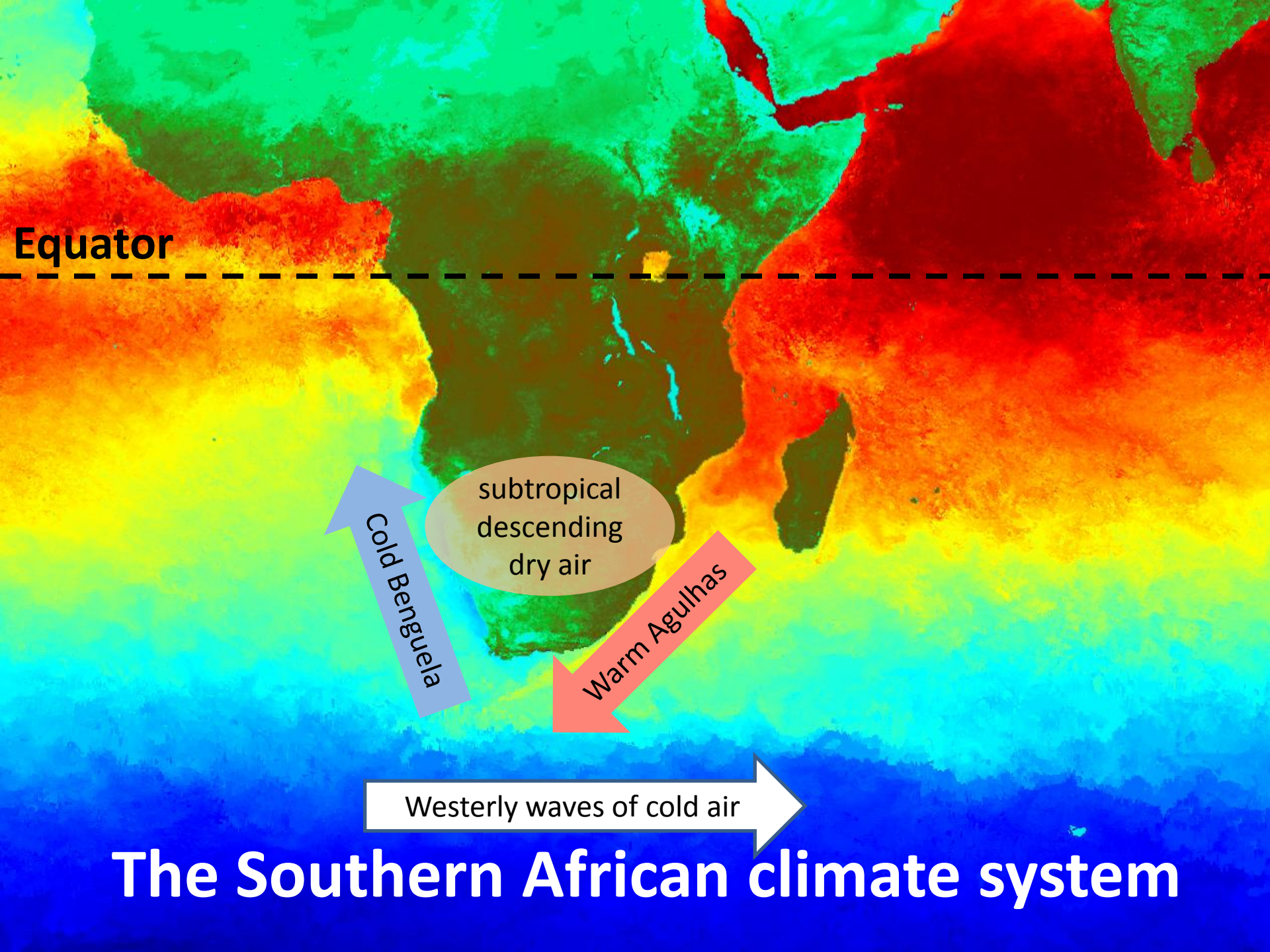


The original IPAT was introduced by Commoner, B. (1972) *Bull. At. Sci.* 28, 17, 42–56 and Ehrlich, P. R. & Holdren, J. P. (1972) *Bull. At. Sci.* 28, 16–27. It led to the ‘Kaya identity’ by economist Yoichi Kaya; see Waggoner, P. E.; J. H. Ausubel (2002). A framework for sustainability science: A renovated IPAT identity. *PNAS* 99 (12):

Climate change: a disruption of the global carbon metabolism

stocks in billion tonnes C, fluxes in billion tonnes C/y





Equator

Cold Benguela

subtropical descending dry air

Warm Agulhas

Westerly waves of cold air

The Southern African climate system

How will global change affect us?

- No relief for our water shortage problem
 - Supply unchanged or reduced, but less usable
- Human health
 - Heat stress, vector-borne diseases
- Global food insecurity: pressure on South Africa
 - Reductions of cereal, deciduous fruit and livestock production mainly due to rising temperatures
- More frequent natural hazard extreme events
 - Strong winds, big fires, heat waves, heavy rains and coastal floods
- Biodiversity under stress
 - Fragmented habitat, invaded by aliens, and on the move

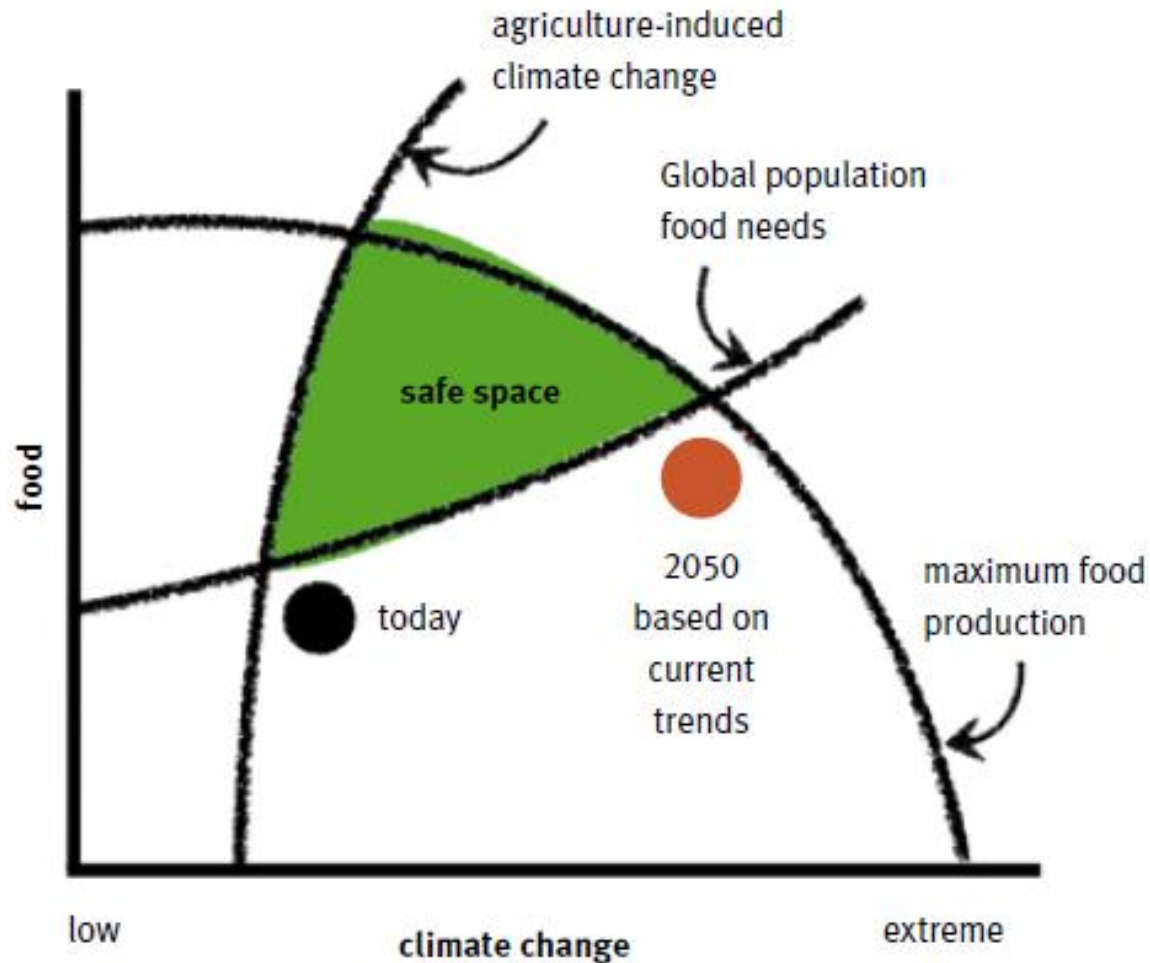
3 reasons for South Africa to get ahead of the curve



- A carbon-intensive South African economy will hurt our trade in a global economy focussed on climate mitigation
- We need to be part of the emerging market in green technologies, especially renewable energy
- Anticipation and planning will help to reduce ultimate costs

Mitigation

keeping the world in a safe space



Beddington J, Asaduzzaman M, Clark M, Fernández A, Guillou M, Jahn M, Erda L, Mamo T, Van Bo N, Nobre CA, Scholes R, Sharma R, Wakhungu J. 2012. *Achieving food security in the face of climate change: Final report from the Commission on Sustainable Agriculture and Climate Change*. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available online at:

Adapting to what can't be avoided

3 general principles

1. Leave a safety margin
 2. Become a learning society
 3. Encourage diversity
- It spreads the risk and accelerates the learning



The role of the CSIR



- CSIR has been formally involved in global change research since 1992
- CSIR has one of the largest and most diverse pools of global change researchers in Africa
 - Earth System Science, carbon cycle, climate models
 - Impact on water, ecosystems, built environment
 - Solar and biomass energy, land use mitigation
 - Monitoring by remote sensing and *in situ* observation