Global Carbon Budget

2016

Published on 14 November 2016

PowerPoint version 1.0

Acknowledgements

The work presented here has been possible thanks to the enormous observational and modelling efforts of the institutions and networks below

Atmospheric CO_2 datasets
NOAA/ESRL (Dlugokencky and Tans 2016)
Scripps (Keeling et al. 1976)

Fossil Fuels and Industry
CDIAC (Boden et al. 2016)
USGS, 2016
UNFCCC, 2016
BP, 2016

Consumption Emission
Peters et al. 2011
GTAP (Narayanan et al. 2015)

Land-Use Change
Houghton et al. 2012
GFED4 (van der Werf et al. 2010)
FAO-FRA and FAOSTAT
HYDE (Klein Goldewijk et al. 2011)

Atmospheric inversions
CarbonTracker (Peters et al. 2010)
Jena CarboScope (Rödenbeck et al. 2003)
MACC (Chevallier et al. 2005)

Land models
CABLE-POP | CLASS-CTEM | CLM4.5BGC | DLEM | ISAM | JSBACH | JULES | LPJ-GUESS | LPJ | LPX | OCNv2 | ORCHIDEE | SDGVM | VISIT
CRU (Harris et al. 2014)

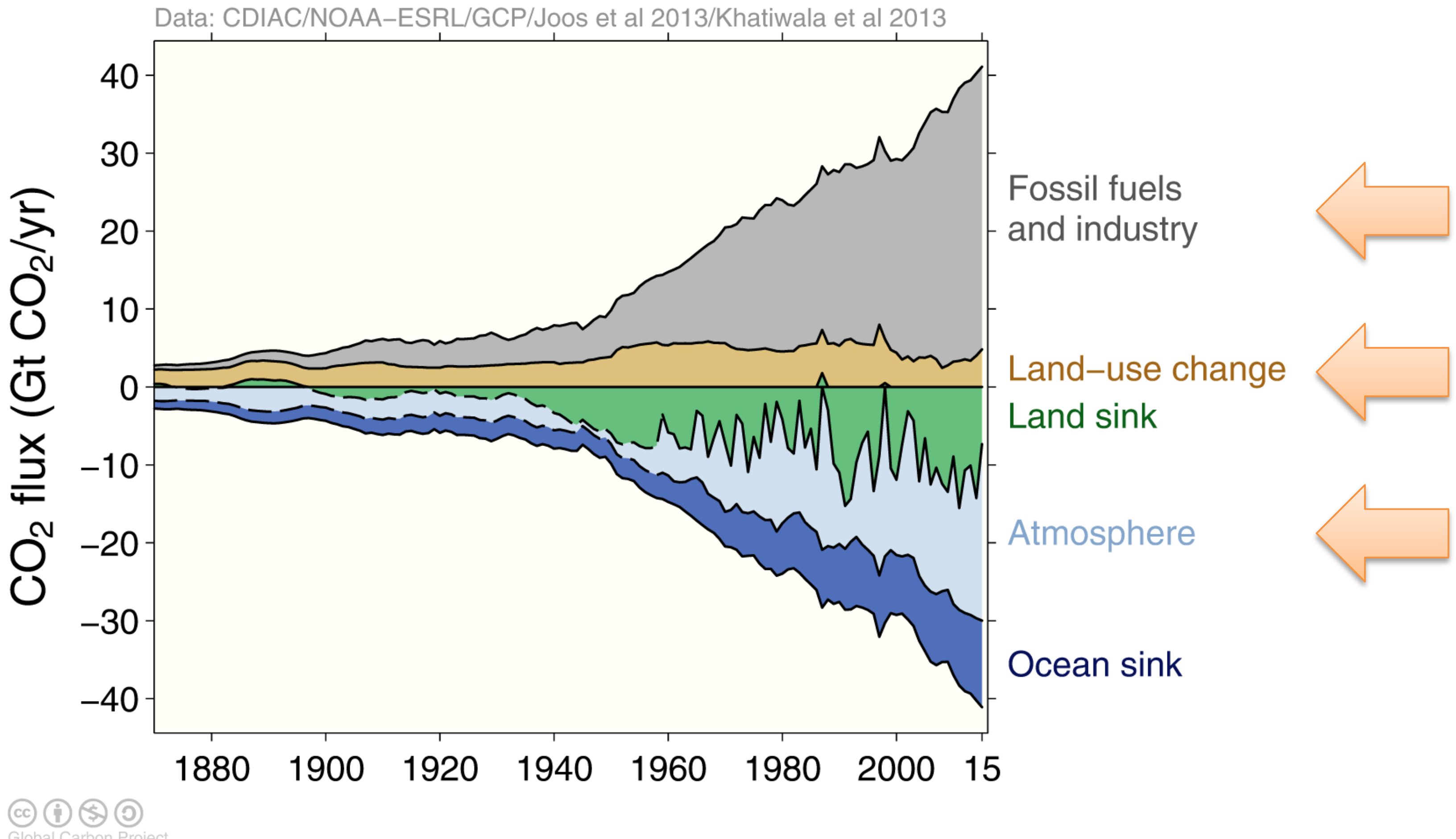
Ocean models
NEMO-PlankTOM5 | NEMO-PISCES (IPSL) | CCSM-BEC | MICOM-HAMMOC | NEMO-PISCES (CNRM) | CSIRO | MITgem-REcoM2
SOCATv4 (Bakker et al. 2016)

Ocean Data products
Jena CarboScope (Rödenbeck et al. 2014)
Landschützer et al. 2015

Full references provided in [Le Quéré et al 2016]

Global carbon budget

The carbon sources from fossil fuels, industry, and land use change emissions are balanced by the atmosphere and carbon sinks on land and in the ocean



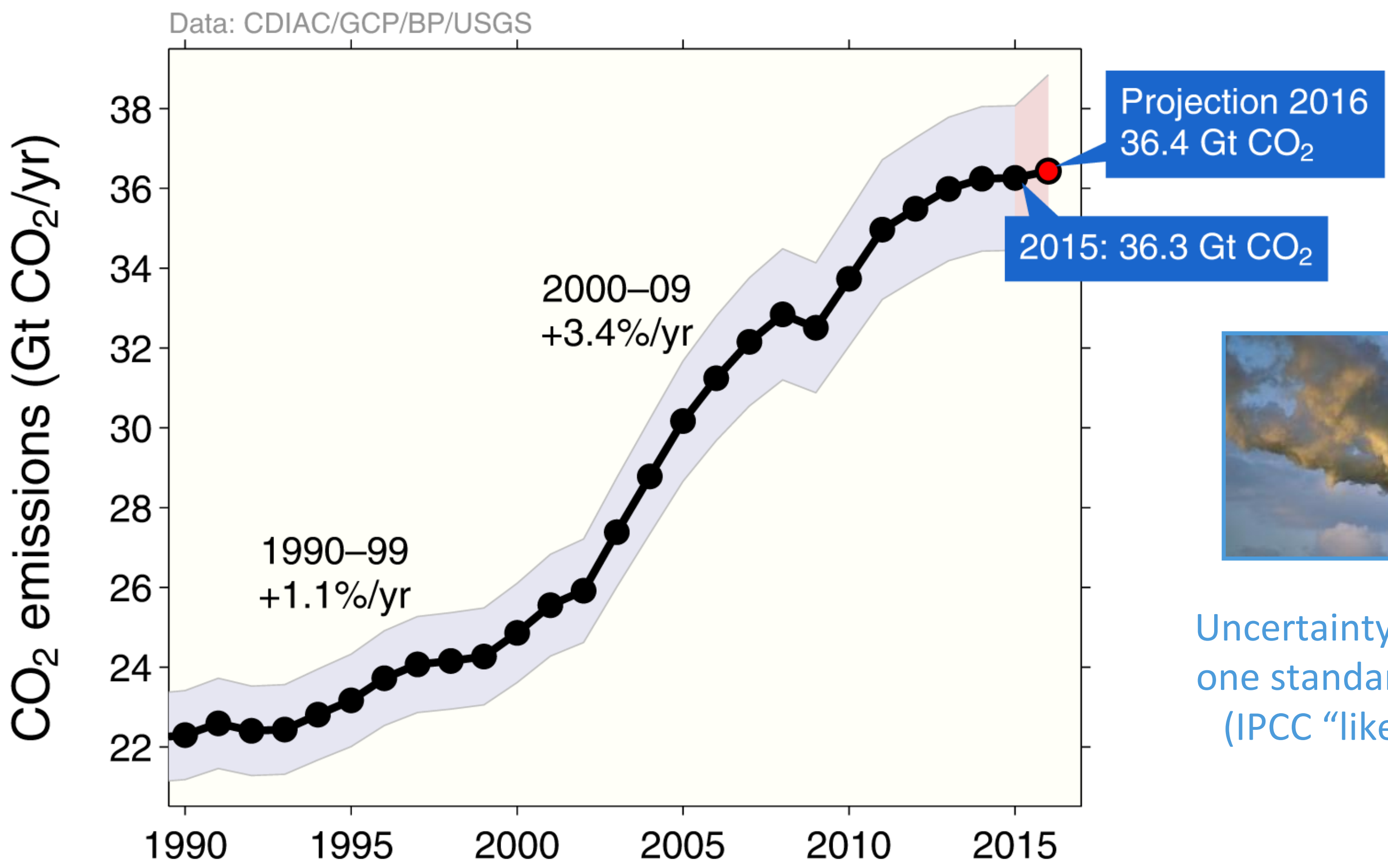
Source: CDIAC; NOAA-ESRL; Houghton et al 2012; Giglio et al 2013; Joos et al 2013; Khatiwala et al 2013; Le Quéré et al 2016; Global Carbon Budget 2016

Fossil Fuel and Industry Emissions

Emissions from fossil fuel use and industry

Global emissions from fossil fuel and industry: 36.3 ± 1.8 GtCO_2 in 2015, 63% over 1990

● Projection for 2016: 36.4 ± 2.3 GtCO_2, 0.2% higher than 2015



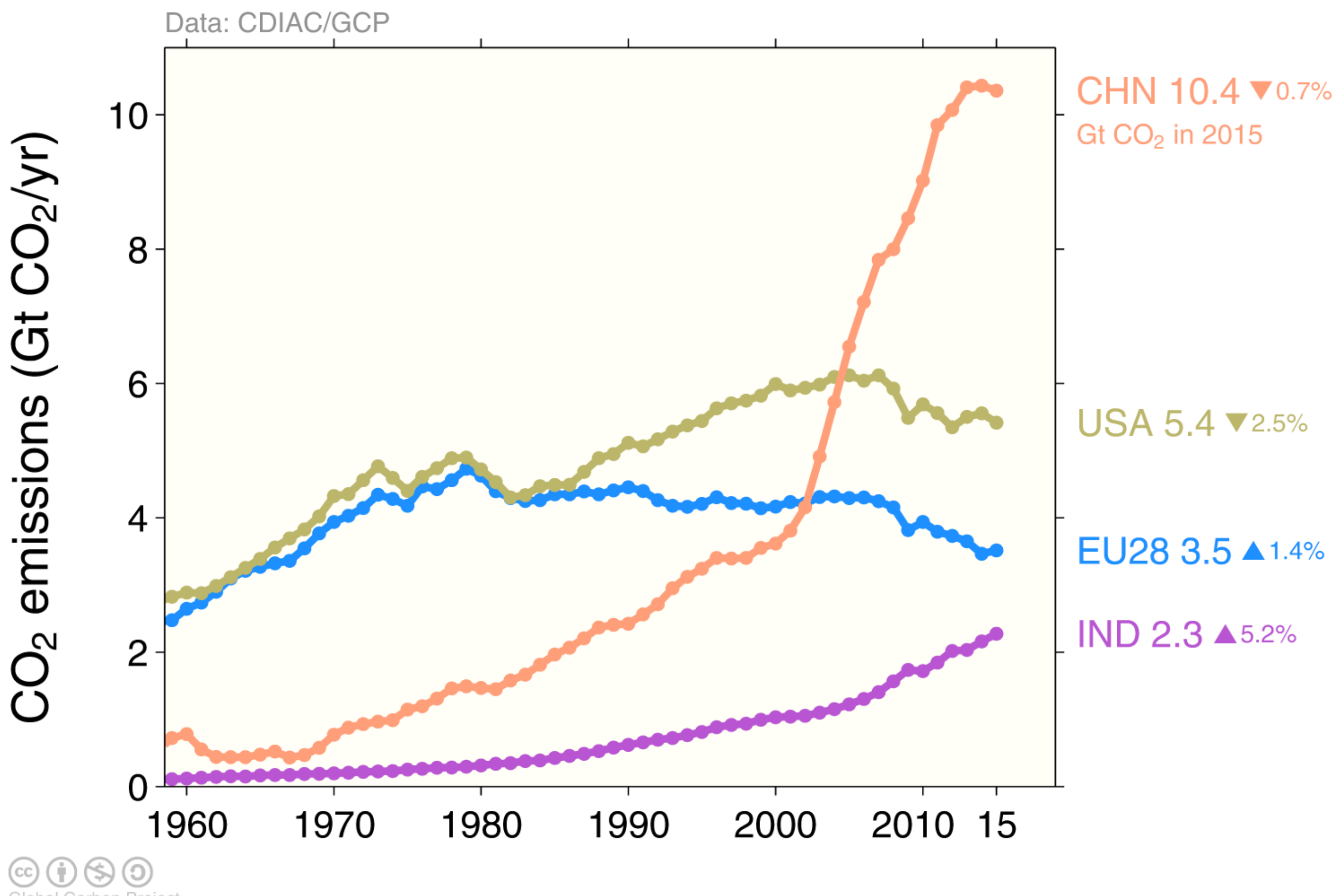
Uncertainty is ±5% for one standard deviation (IPCC "likely" range)

Estimates for 2014 and 2015 are preliminary. Growth rate is adjusted for the leap year in 2016.

Source: CDIAC; Le Quéré et al 2016; Global Carbon Budget 2016

Top emitters: fossil fuels and industry (absolute)

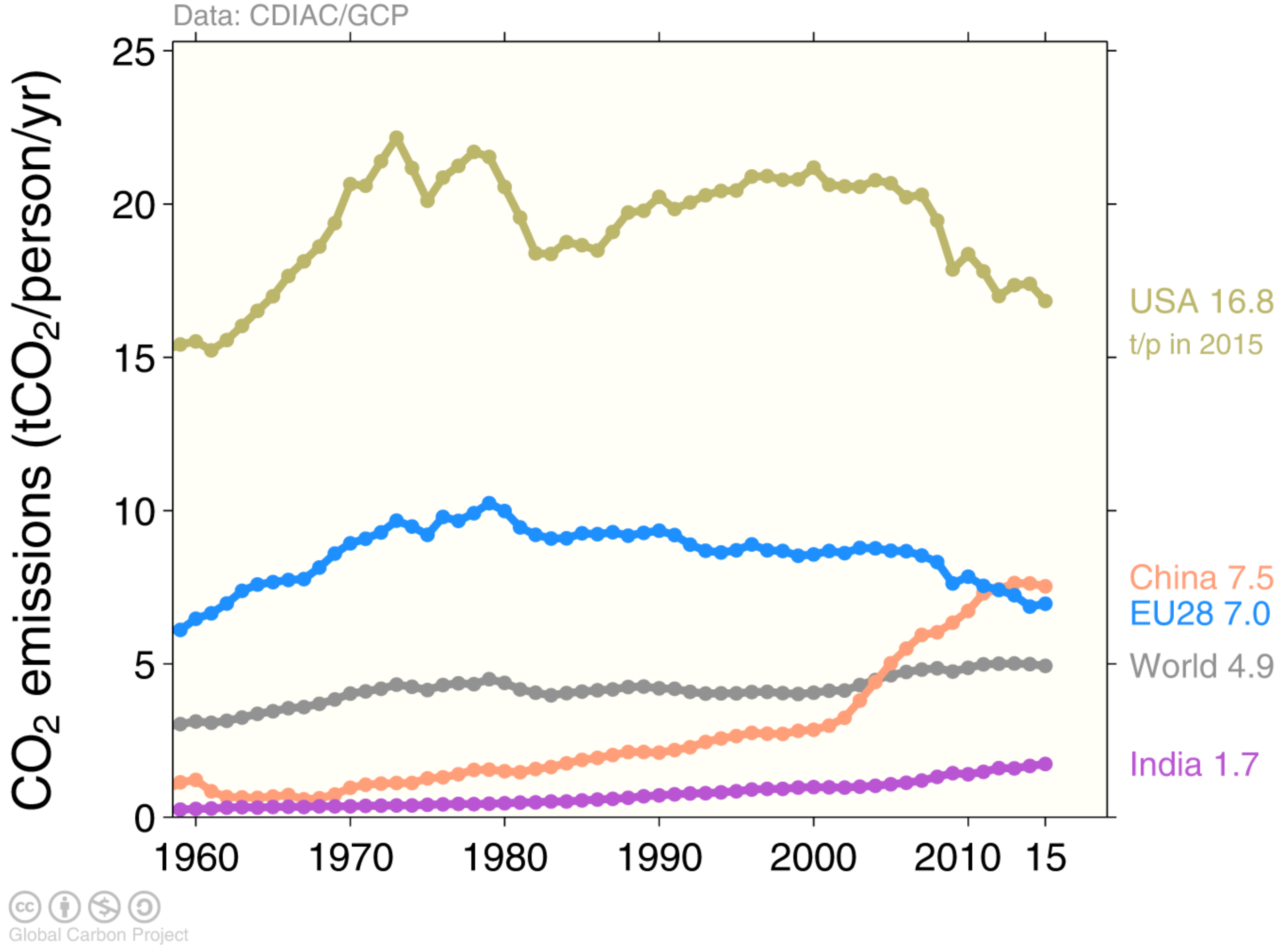
The top four emitters in 2015 covered 59% of global emissions
China (29%), United States (15%), EU28 (10%), India (6%)



Bunker fuels are used for international transport is 3.1% of global emissions.
Statistical differences are between the global estimates and sum of national totals is 1.2% of global emissions.
Source: CDIAC; Le Quéré et al 2016; Global Carbon Budget 2016

Top emitters: fossil fuels and industry (per capita)

Countries have a broad range of per capita emissions reflecting their national circumstances



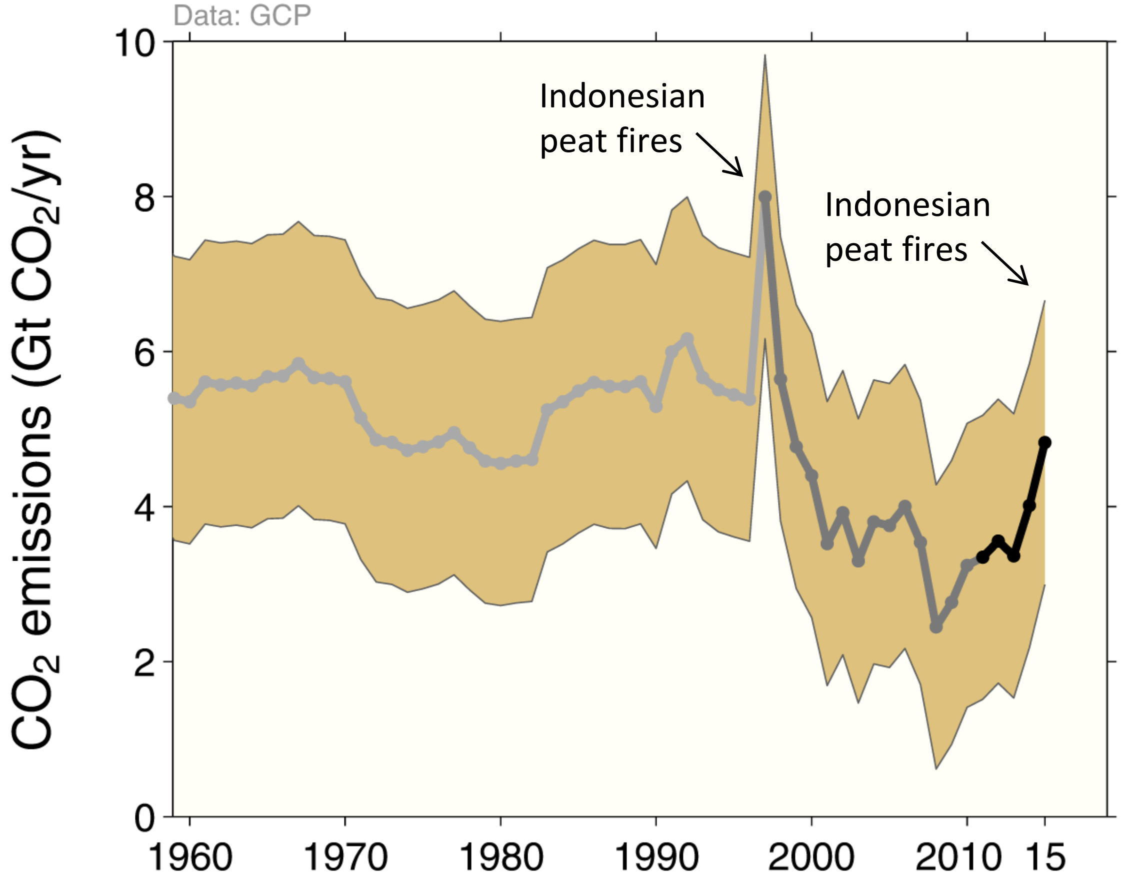
Source: [CDIAC](); [Le Quéré et al 2016](); [Global Carbon Budget 2016]()

Land-use Change Emissions

Land-use change emissions

Emissions in the 2000s were lower than earlier decades, but highly uncertain

Higher emissions in 2015 are linked to increased fires during dry El Niño conditions in Asia



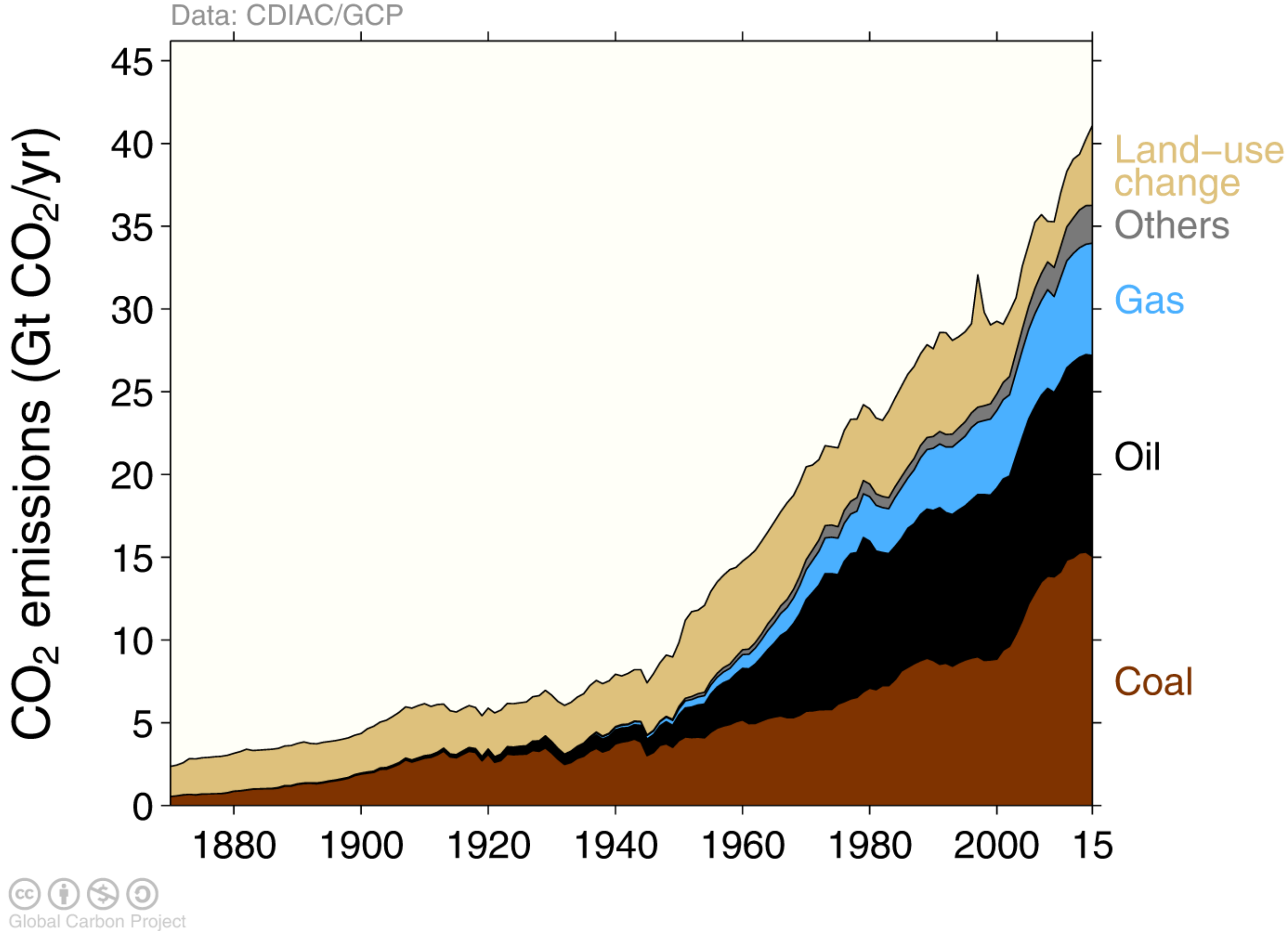
Three different estimation methods have been used, indicated here by different shades of grey

Land-use change also emits CH_4 and N_2O which are not shown here

Source: Houghton et al 2012; Giglio et al 2013; Le Quéré et al 2016; Global Carbon Budget 2016

Total global emissions by source

Land-use change was the dominant source of annual CO_2 emissions until around 1950



Others: Emissions from cement production and gas flaring

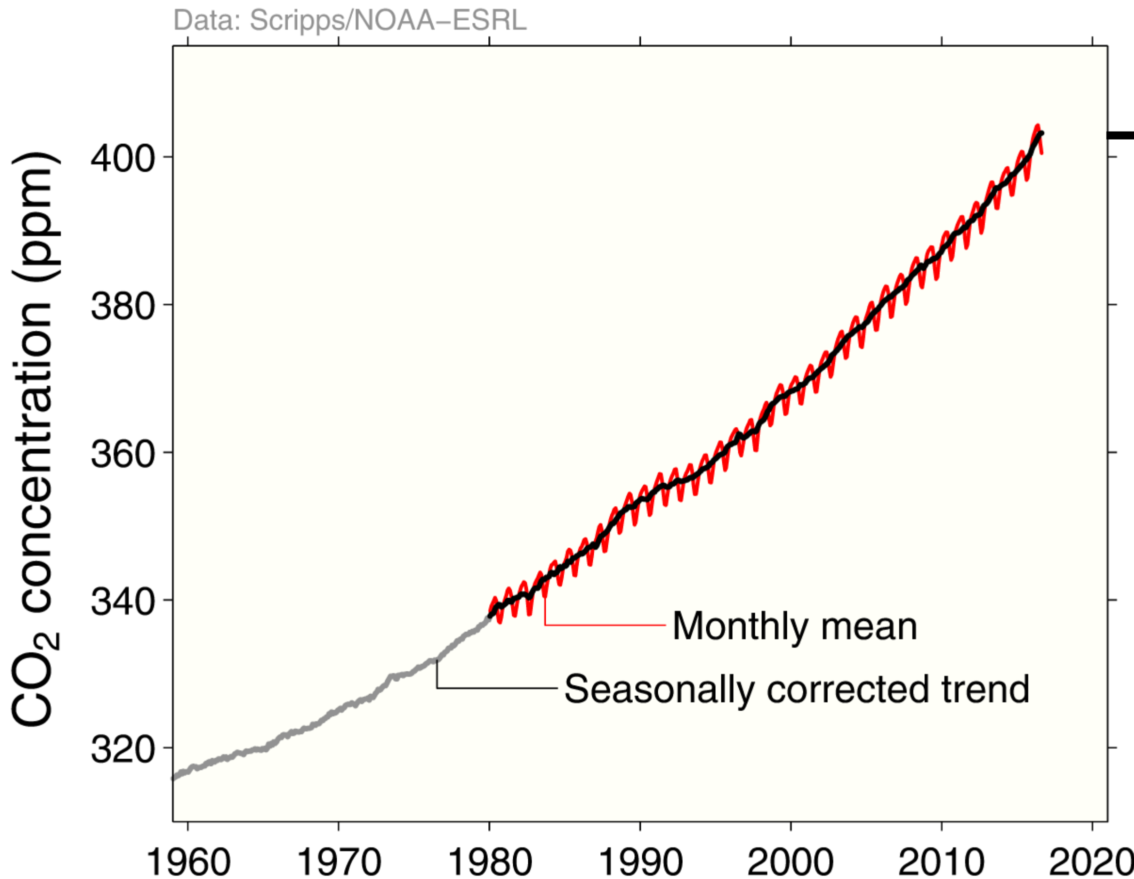
Source: CDIAC; Houghton et al 2012; Giglio et al 2013; Le Quéré et al 2016; Global Carbon Budget 2016

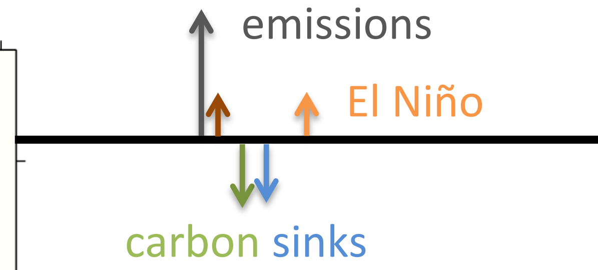
Atmospheric Concentration

Atmospheric concentration

The global CO_2 concentration increased from ~277ppm in 1750 to 399ppm in 2015 (up 44%)

2016 will be the first full year with concentration above 400ppm





Drivers of recent changes (carbon-cycle feedback)

CO_2 driver of long-term changes

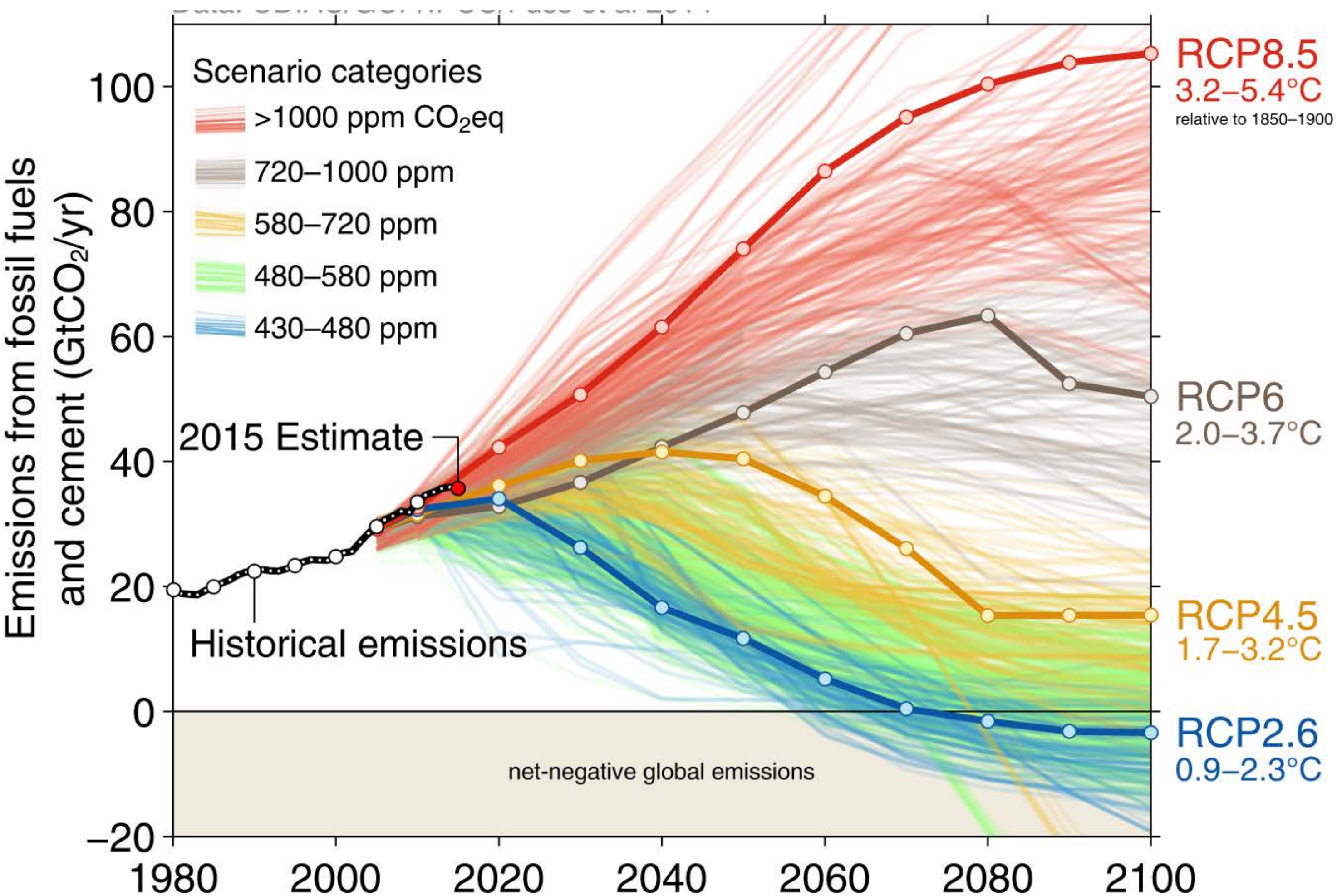
Globally averaged surface atmospheric CO_2 concentration. Data from: NOAA-ESRL after 1980;
the Scripps Institution of Oceanography before 1980 (harmonised to recent data by adding 0.542ppm)

Source: NOAA-ESRL; Scripps Institution of Oceanography; Le Quéré et al 2016; Global Carbon Budget 2016

The Future

Observed emissions and emissions scenarios

Joeri, add a figure. Perhaps EGR?



Over 1000 scenarios from the IPCC Fifth Assessment Report are shown

Source: Fuss et al 2014; CDIAC; Global Carbon Budget 2015

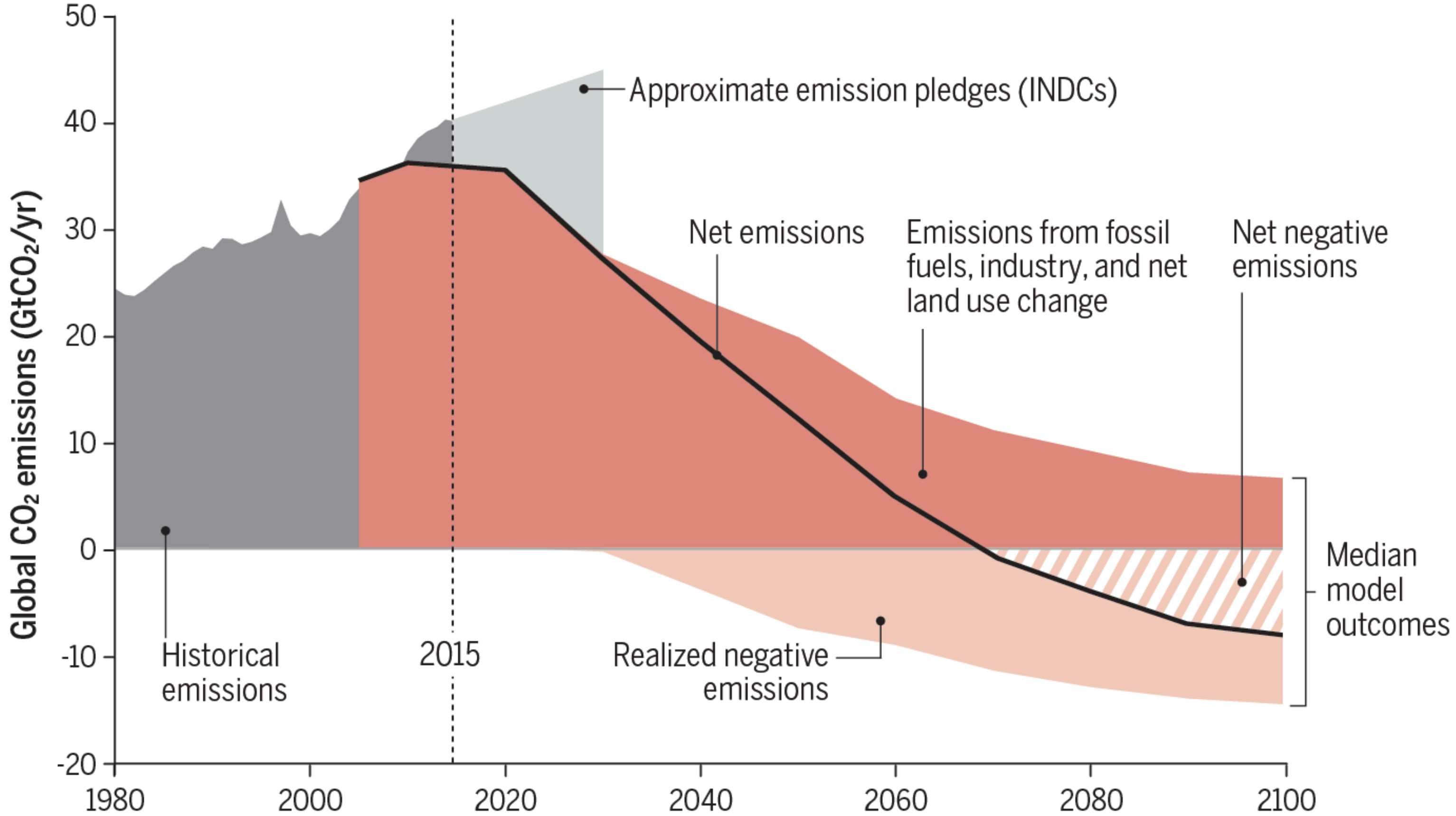
Going into “debt” with negative emissions

Sabine Fuss, MCC-Berlin

Negative emissions required for 2°C

To achieve net-negative emissions globally after 2050 requires deployment as early as 2020-2030

If negative emission technologies do not work at scale, society is locked into higher temperatures

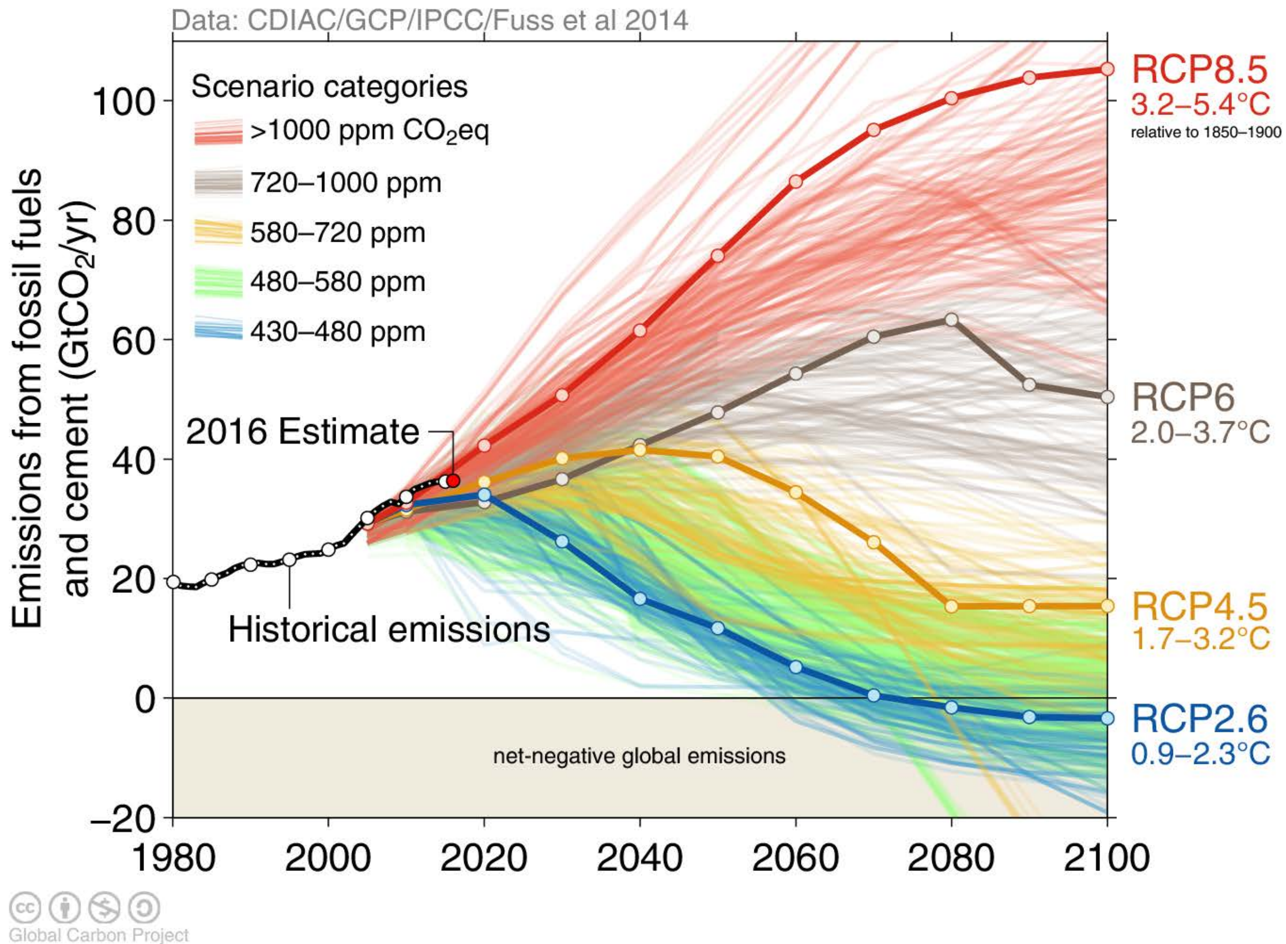


Source: [Anderson & Peters 2016]()

The future

Observed emissions and emissions scenarios

The emission pledges to the Paris Agreement avoid the worst effects of climate change (4-5°C)
Most studies suggest the pledges give a likely temperature increase of about 3°C in 2100

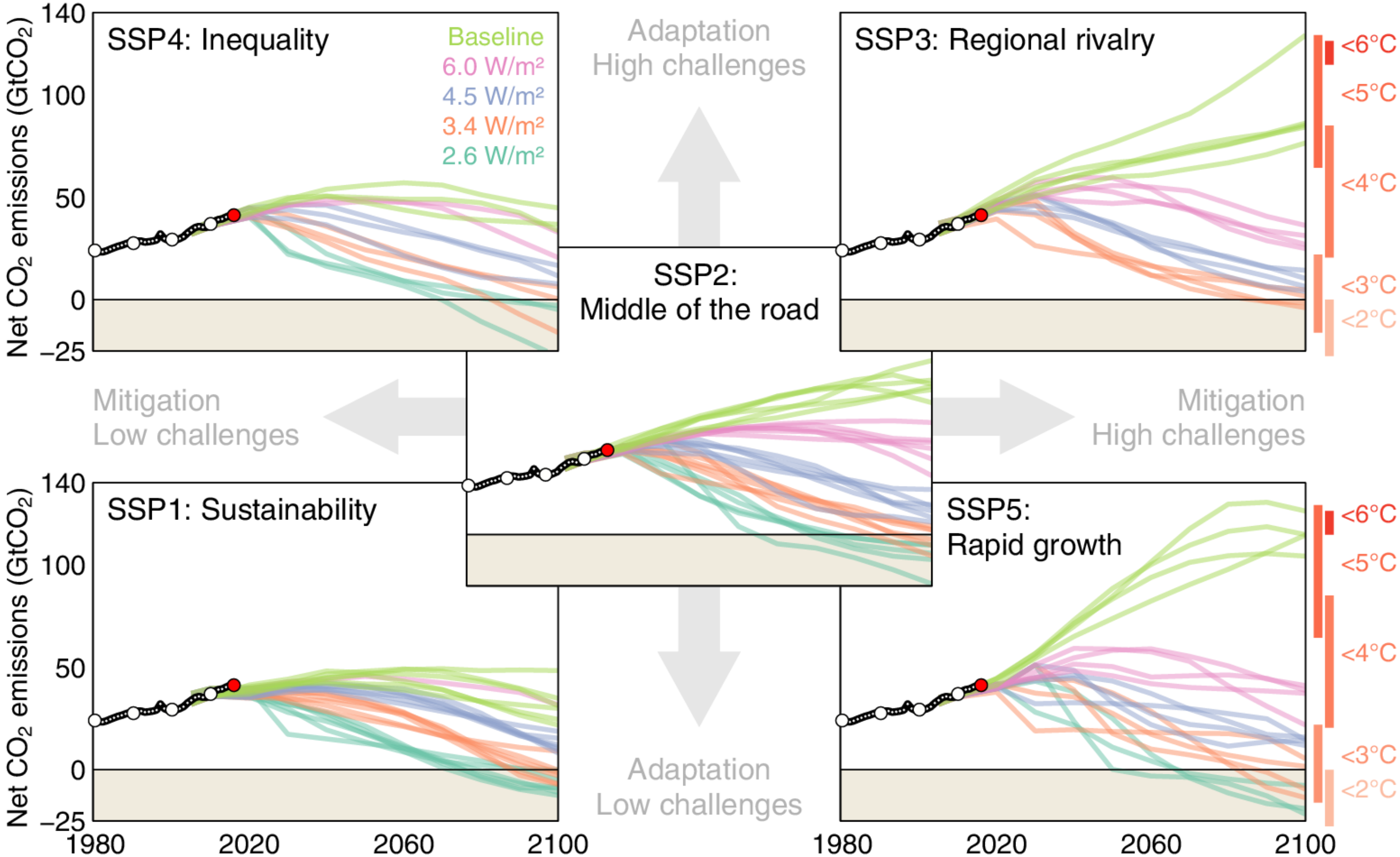


The IPCC Fifth Assessment Report assessed about 1200 scenarios with detailed climate modelling on four Representative Concentration Pathways (RCPs)

Source: [Fuss et al 2014]; [CDIAC]; [IIASA AR5 Scenario Database]; [Global Carbon Budget 2016]

New generation of scenarios

In the lead up to the IPCC's Sixth Assessment Report new scenarios have been developed to more systematically explore key uncertainties in future socioeconomic developments



Five Shared Socioeconomic Pathways (SSPs) have been developed to explore challenges to adaptation and mitigation. Shared Policy Assumptions (SPAs) are used to achieve target forcing levels (W/m²).

Source: Riahi et al. 2016; IIASA SSP Database; Global Carbon Budget 2016

Key messages

- Global fossil fuel and industry CO_2 emissions are nearly flat for third year in a row, driven primarily by China
- It is possible that the trajectory of global emissions has permanently deviated from the long-term growth trend
- Record growth in atmospheric CO_2 in spite of flat emissions due to weak carbon sinks, driven by El Niño
- Many alternative pathways to 1.5°C and 2°C
  - *Joeri Rogelj*: Remaining CO_2 quota has reduced another 40GtCO_2 and significant gap between emission pledges and 2°C pathways
  - *Sabine Fuss*: Emissions need to go to zero, and this will require the use of negative emissions
  - *Alice Larkin*: Insufficient mitigation in some sectors (aviation and shipping) mean more mitigation and negative emission in others