IPCC AR6-WGI addendum to literature review

an update to the April 2021 carbon budgeting literature review

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1. **Carbon budgeting in climate action "consistent" with Paris goals**
2. **National carbon budgeting and the 2023 Global Stocktake**
3. **GHG emissions metrics and CDR**
4. **Methane (biogenic vs. fossil) in carbon budgeting**

In these slides:

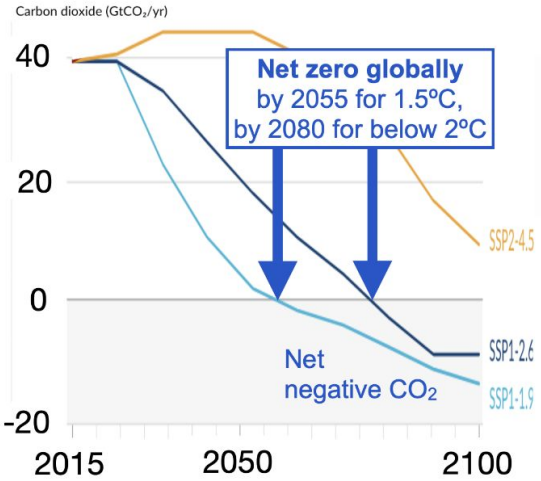
- **Black font = reporting of AR6-WGI assessment.**
- **Coloured font = updates & commentary**

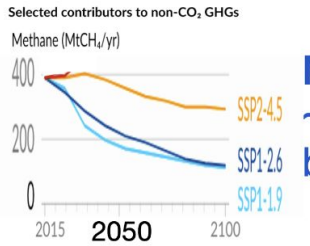
AR6-WGI SPM
From
Figs. SPM.4 & SPM.8
SPM global illustrative scenarios and warming.

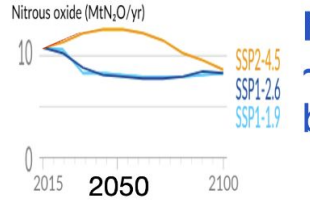
Figures adjusted & aligned to focus on Paris °C targets

Future emissions cause future additional warming, with total warming dominated by past and future CO_2 emissions

Carbon dioxide



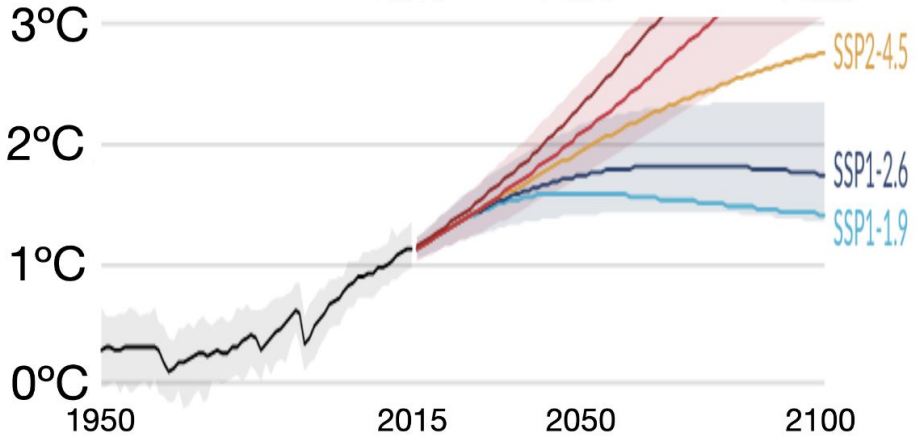




Paris °C scenarios

Methane
~50% cut
by 2050

Nitrous oxide
~20% cut
by 2050



Only SSP1 (Equity) 1.9 and 2.6 scenarios limit to 1.5°C (after some overshoot) or "well below 2°C"

1. Carbon budgeting for Paris "consistent" climate action

- **AR6-WGI**: much greater certainty in climate sensitivity and global carbon budgets.
- **For Paris temperature limits need net zero CO_2 emissions globally soon after 2050**, in parallel with deep cuts in anthropogenic emissions of other GHGs.
- **Greater emphasis on methane ⇒ "strong, rapid and sustained reductions"**.
- **Update to lit. review:** Ireland's multi-gas, national cumulative GHG quota (GWP*, 2015 basis) consistent with Paris goals, from 2021 onward, ranges tightened to:
  - **1.5ºC low overshoot: 90–130 $MtCO_2we$ $[CO_2+N_2O+CH_4]$**
  - **Well below 2ºC: 260–400 $MtCO_2we$ $[CO_2+N_2O+CH_4]$**
- **Ireland will imminently overshoot these quotas.**
- Only early, deep and sustained reductions in all GHGs, including CH_4, can limit Ireland's Paris-quota overshoot & limit tacit commitment to more CDR.

CO_2-only carbon budgets are given in Table SPM.2.

Warming level at peak CO_2 also strongly depends on non-CO_2 especially CH_4

AR6-WGI Table SPM.2: Estimates of historical CO_2 emissions and remaining carbon budgets.

Global warming between 1850–1900 and 2010–2019 *(°C)*	Historical cumulative CO_2 emissions from 1850 to 2019 *($GtCO_2$)*
1.07 (0.8–1.3; *likely* range)	2390 (± 240; *likely* range)

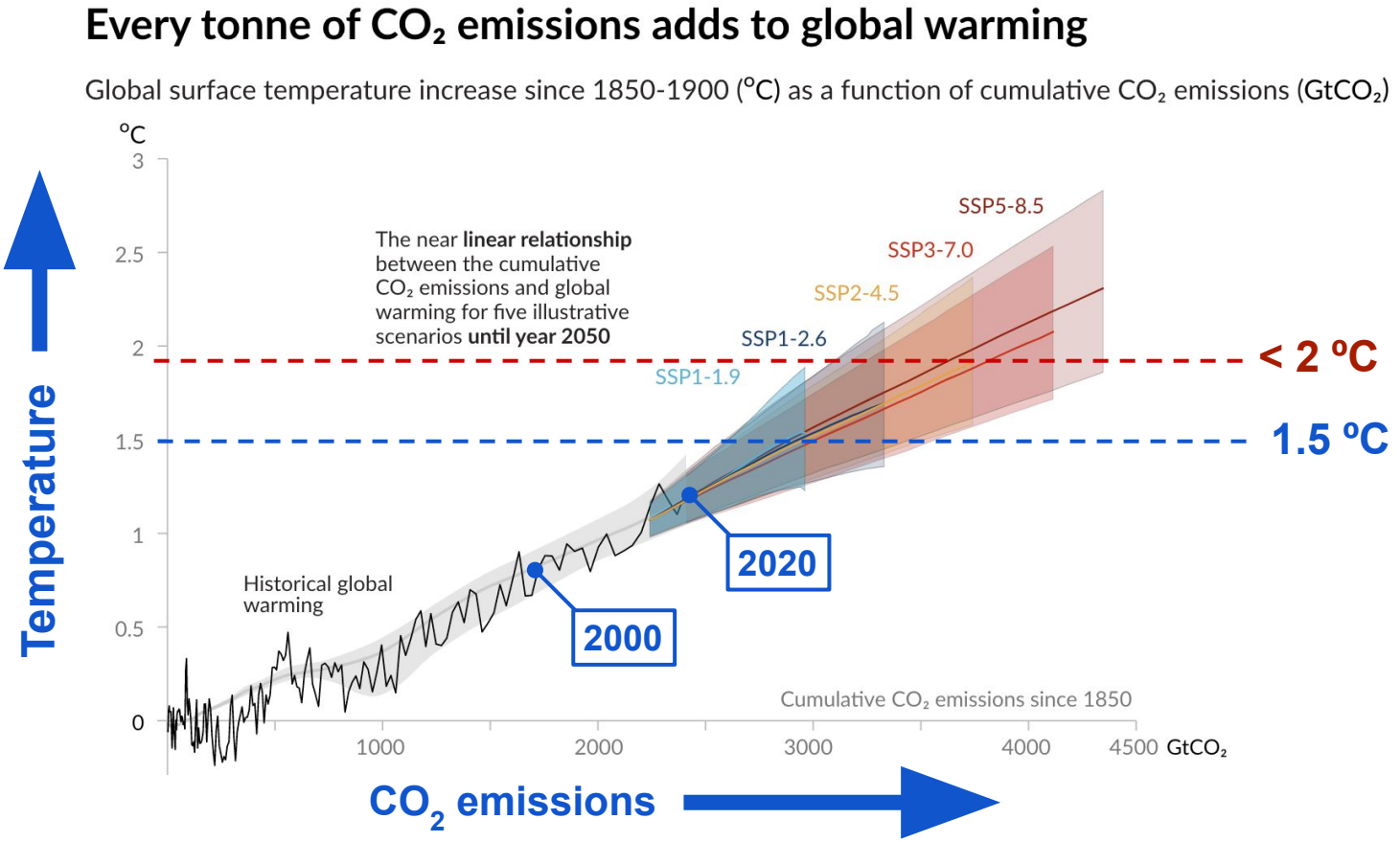
Approximate global warming relative to 1850–1900 until temperature limit *(°C)**(1)	Additional global warming relative to 2010–2019 until temperature limit *(°C)*	Estimated remaining carbon budgets from the beginning of 2020 *($GtCO_2$)* — *Likelihood of limiting global warming to temperature limit*(2)*					Variations in reductions in non-CO_2 emissions*(3)
		17%	*33%*	*50%*	*67%*	*83%*	
1.5	0.43	900	650	500	400	300	Higher or lower reductions in accompanying non-CO_2 emissions can increase or decrease the values on the left by 220 $GtCO_2$ or more
1.7	0.63	1450	1050	850	700	550	
2.0	0.93	2300	1700	1350	1150	900	

2. National carbon budgeting to 2030 and 2023 global stocktake

- **AR6-WGI does not give specific guidelines for national carbon budgeting** as this is subject to value judgements by decision makers. Quantify "fair share"?
- **2023 Global Stocktake:** In Cross-Chapter Box 1.1. AR6-WGI details material relevant to the Stocktake and quotes Paris Agreement on nations' responsibilities:
  - '*comprehensive and facilitative manner… and **in the light of equity** and the **best available science***' ... '*countries to report emissions of individual greenhouse gases separately for the global stocktake*'.
- **By-gas reporting enables use of GWP* or CGTP for Paris ºC policy analysis.**
  – So need to show by-gas paths for overall 5-yr national and sectoral budgeting.
  – To assess Paris "consistent" budgeting need GWP* or CGTP, or climate model.
- **BUT Climate Act for 51% reduction by 2030 is on GWP_{100} basis (**as per CCAC**).** Such a 51% reduction cannot be applied to GWP* values.

AR6-WGI Figure SPM.10:

Near-linear relationship between cumulative CO2 emissions and the increase in global surface temperature.



3. Carbon budgeting: GHG metrics & Carbon Dioxide Removal

GHG emissions metrics:

- **AR6-WGI [Box 7.3] guides emission metric choices, BUT** the "*report does not recommend an emission metric because the...choice depends on the purposes.*"
- **AR6-WGI finds "step-pulse" metrics like GWP* & CGTP can assess warming in multi-gas carbon budgeting including methane, in a defined equity context**. GWP_{100} cannot assess warming in high CH_4 budgets relative to Paris "consistent".

Carbon Dioxide Removal (CDR):

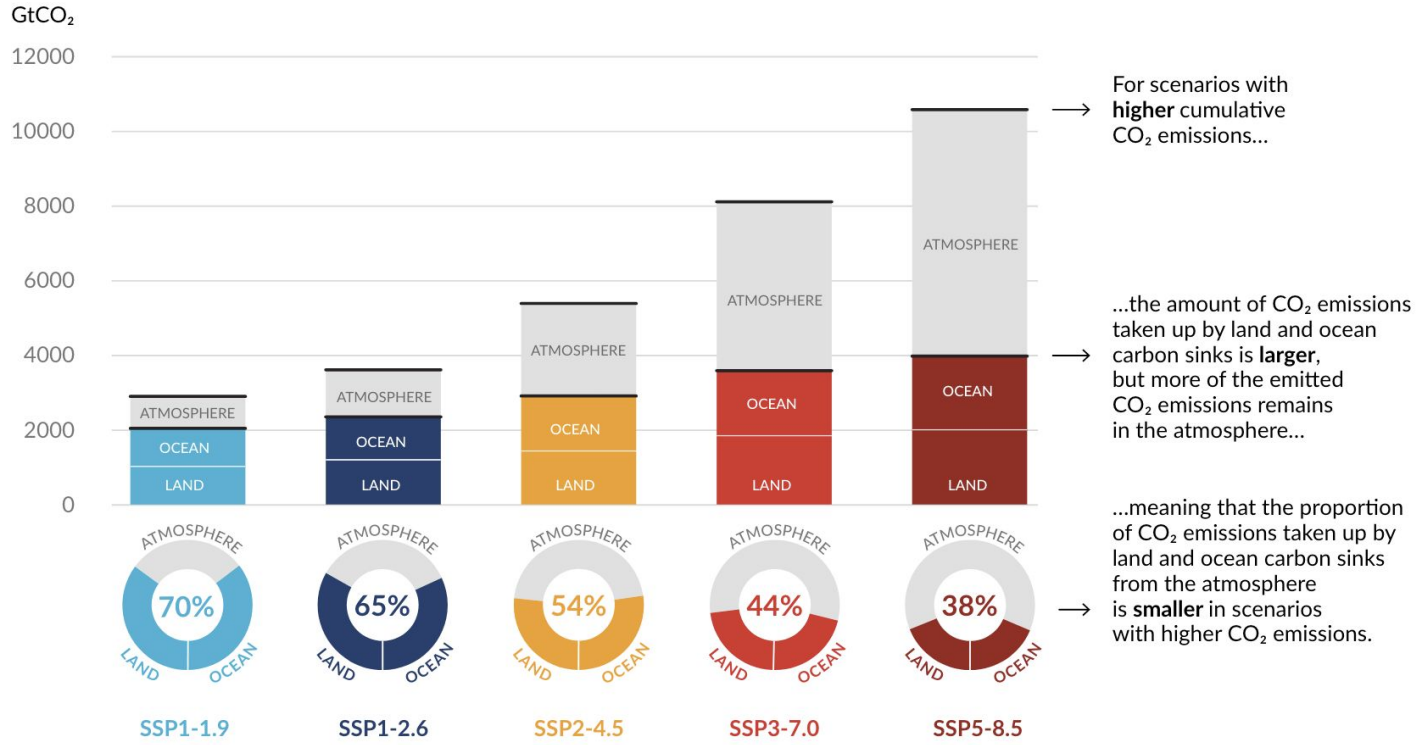
- CO_2 removal (CDR) warming reduction has an effect ~10% smaller than the warming from the same quantity of fossil CO_2 emissions.
- SPM: *"Potential negative and positive effects of CDR for biodiversity, water and food production are methods-specific"* – more on this in WGII and WGIII reports.
- **Globally, higher total future CO_2 emitted = less CO_2 taken up in natural sinks.**

AR6-WGI Fig.SPM.7:

The proportion of CO_2 emissions taken up by land and ocean carbon sinks is smaller in scenarios with higher cumulative CO_2 emissions

Total cumulative CO_2 emissions **taken up by land and oceans** (colours) and remaining in the atmosphere (grey) under the five illustrative scenarios from 1850 to 2100

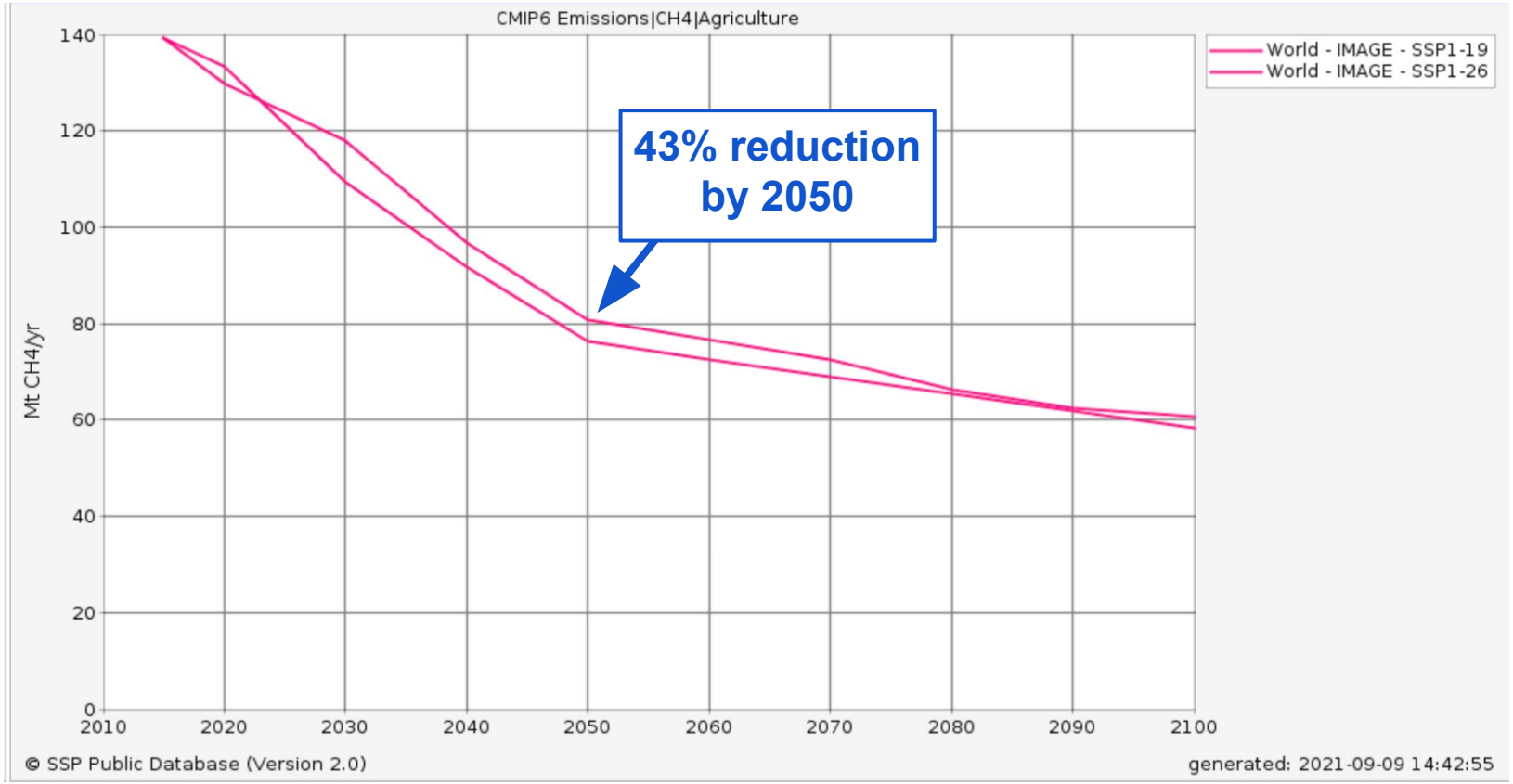
Globally, **higher total future CO_2 emissions** results in less CO_2 taken up in natural sinks, and **more warming per tonne of CO_2 emitted.**



4. Anthropogenic methane (biogenic vs. fossil) in carbon budgeting

- **AR6-WGI SPM** makes no distinction between anthropogenic methane sources – the word “biogenic” is not mentioned.
- **Technical Summary:** “[m]ethane from fossil fuel sources has slightly higher emission metric values than those from biogenic sources”.
- **Table 7.15:** adjusted GWP_{100} value of 27.2 is given for biogenic methane and 29.8 for fossil methane. This minor difference is outweighed by total metric uncertainty
- Given GWP_{100} values are **CH_4 = 28** **N_2O = 273** AR6 values include feedbacks.
- **Summary:** AR6-WGI does not evidence any substantive ‘d*istinct characteristics of biogenic methane*’ relative to fossil methane that would make a meaningful difference to Ireland’s carbon budgeting decision-making.

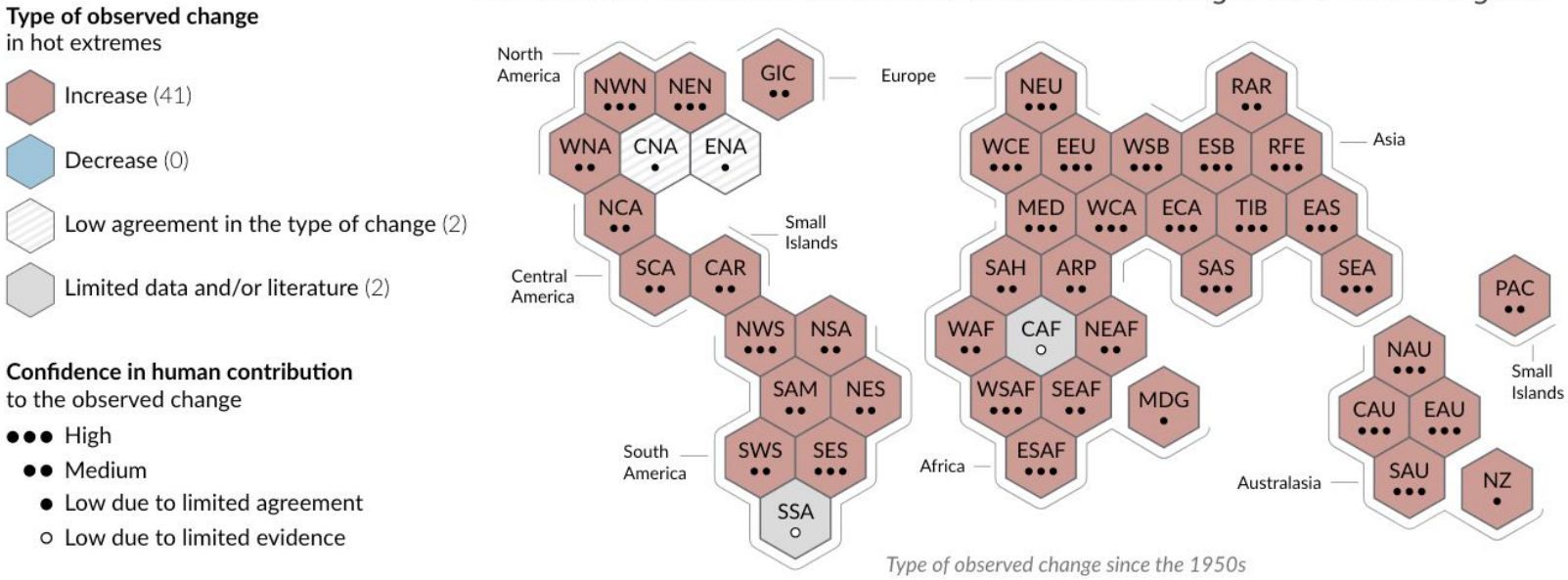
Agricultural methane in the global illustrative scenarios meeting Paris goals
(chart from SSP database)



Increases in **Hot Extremes** are worldwide, rising with total emissions

Climate change is already affecting every inhabited region across the globe with human influence contributing to many observed changes in weather and climate extremes

a) Synthesis of assessment of observed change in **hot extremes** and confidence in human contribution to the observed changes in the world's regions



AR6-WGI Figure SPM.3a: Synthesis of assessed observed and attributable regional changes