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CORRIGENDUM

Corrigendum: All options, not silver bullets, needed to limit global warming to 1.5 °C: a scenario appraisal (2021 *Environ. Res. Lett.* **16** 064037)

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Supplementary material for this article is available online

In the original version of this paper, the papers by Höglund-Isaksson *et al* (2020) and Ocko *et al* (2021) were erroneously interpreted, leading to an incorrect estimate of the medium upper bound for methane emissions reductions. After revisiting these two papers, we have revised our expert opinion on the upper bound for a 'realistic' methane emissions reduction in 2050 compared to 2018 from 54% (as in our original paper) to 48%, based on the 'technically feasible' scenario in Ocko *et al* (2021). As in the original justification of the medium upper bound, this scenario is a bottom up assessment of feasible methane emissions reductions, without taking into account demand-side changes. The high upper bound, adopted from van Vuuren *et al* (2018), does account for demand-side changes (i.e. shift in dietary preferences away from meat). This change has a very minimal effect on the findings of the paper. Nevertheless, it does result in small changes to several of the main and supplementary figures, as well as small changes to some secondary numbers. The result remains unchanged that none of the scenarios considered use all levers at reasonable levels. The changes affect figures 2–4 and 6 of the main text and figures S2(a) and S3 of the supplement. They also affect tables S1–S3.

Main text

Section 2.2

Table 1: Correction of medium upper bound from 54% to 48% reduction in 2050 methane emissions compared to 2018. Source has been changed to Ocko *et al* (2021).

Section 3.1.1

Paragraph 2: Correction of numbers associated with how many scenarios use all but one lever at reasonable levels. New text reads:

The scenarios appear to be most excessive in their use of CDR_{geo}, with only 20% (10/50) of all scenarios using this lever at reasonable levels; three of these scenarios use all other levers at reasonable levels (see table S3; figure S2(a) provides an overview of how the scenarios are distributed within each of the five parameters and includes alternative bounds for the mitigation levers found in the literature and used in this analysis). Only five scenarios use all but one lever at

Figure 2: Figure has been replaced. New figure accounts for the revised CH4 medium upper bound (48%) and is qualitatively very similar to the original figure. The changes slightly affects the value of the coverage parameter V and thus the order in which the scenarios are shown (order of increasing V).

reasonable levels. In three of these cases, CDR_{geo} is used at challenging levels, in one it is CDR_{AFOLU} and in one it is CI_{2050}.

Section 3.1.3

Paragraph 1: Correction of minimum and average value of V for entire ensemble to 0.52 and 0.90 respectively.

Section 3.1.4

Paragraph 2: Addition of the words 'somewhat above' in the following sentence: 'We find that the reduction in energy and CH_4 emissions in both the filtered and entire ensembles lie on average close to or somewhat above the medium upper bound, whereas CDR_{geo} tends to lie above it (i.e. it is overused)'.

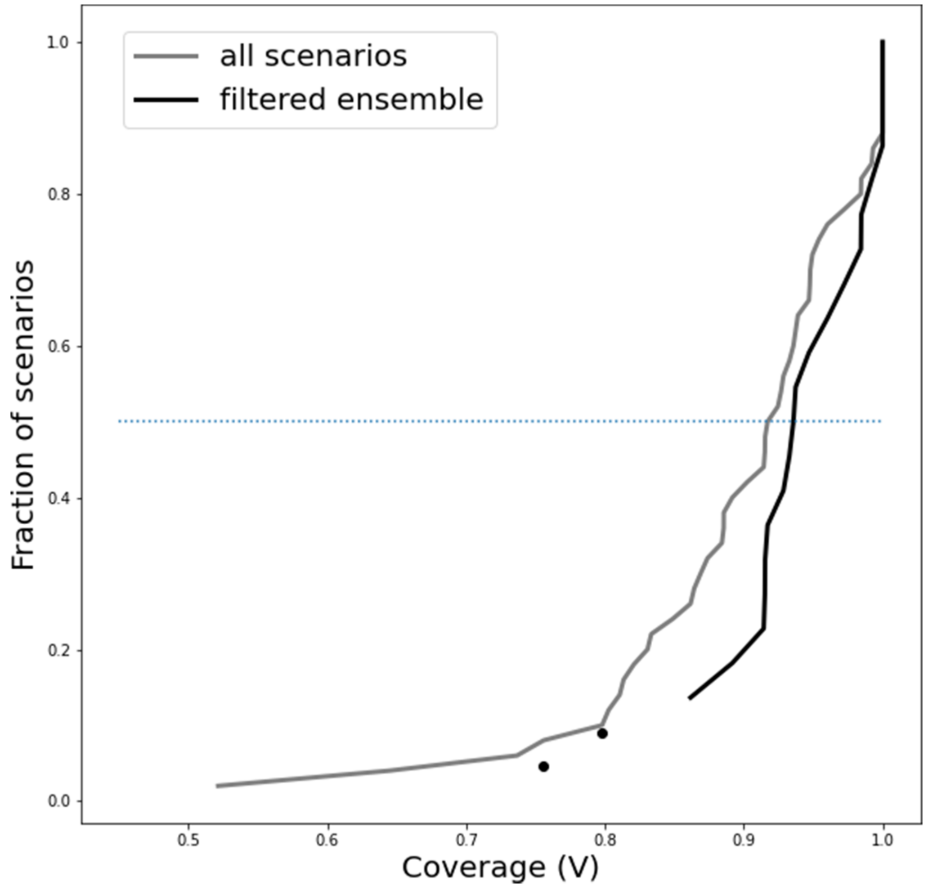

Figure 3: Figure has been replaced. New figure is qualitatively similar to old figure. The most notable difference is the slight increase in the median value of both distributions, resulting from the relative increase in the use of the CH4 lever.

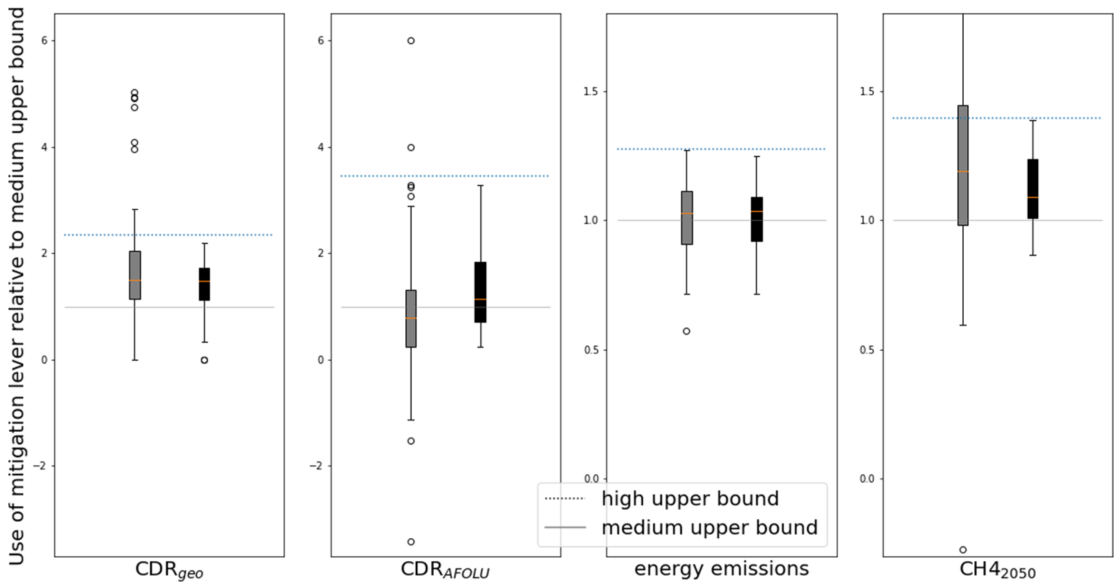

Figure 4: Right-most panel of figure has been replaced. For the filtered ensemble, the median and entire interquartile range now lie above the medium upper bound (i.e. above 1). A greater proportion of the interquartile range of the entire ensemble lies above the medium upper bound.

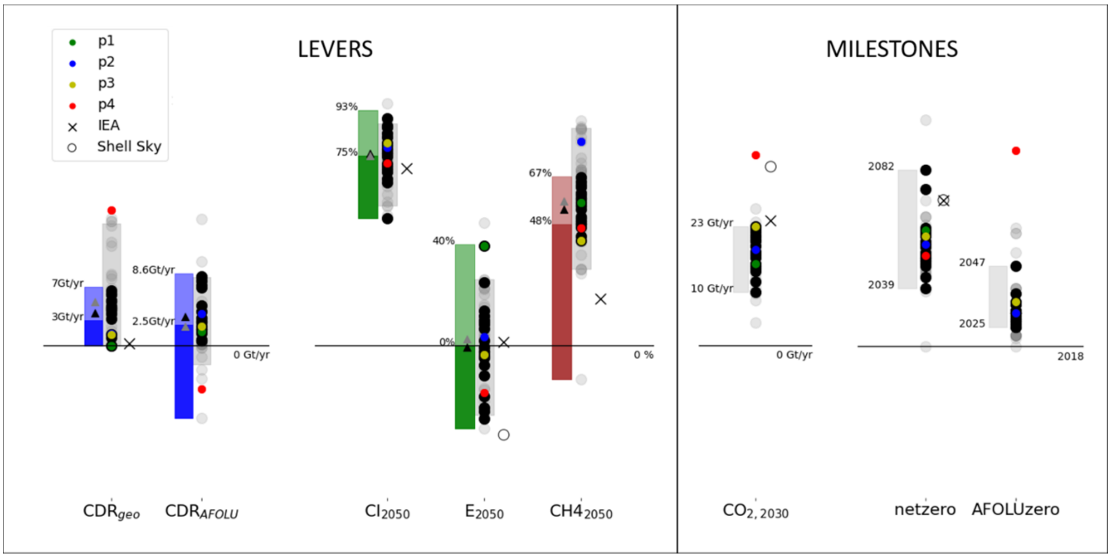

Figure 6: Figure has been replaced but remains qualitatively very similar to original. Only the column 'CH4$_{2050}$' is affected. The black triangle showing the mean value of the filtered ensemble now lies between the medium and high upper bounds. In the original version of the paper it lay below the medium upper bound.

Supplementary information

Section: 'Reduction in non-CO_2 emissions (CH4$_{2050}$)'

Paragraph 3: Replacement of falsely-interpreted reference Höglund-Isaksson *et al* (2020) with Ocko *et al* (2021). Removal of final two sentences. Paragraph now reads:

The medium upper bound on methane reduction in 2050 relative to 2018, 48%, is based on the 'technically feasible' scenario developed in the bottom-up analysis in Ocko *et al* (2021), in which only supply-side mitigation options are considered. This scenario draws on the baseline scenario developed by Höglund-Isaksson *et al* (2020), which provides values for 2015 (343.7 MtCH4 yr^{-1}) and 2020 (354.7 MtCH4 yr^{-1}). We assumed 2018 emissions to be approximately equal to the 2020 value. The high upper bound is drawn from the lowest alternative 1.5 °C pathway (67%) in van Vuuren *et al* (2018) ('IMAGE 3.0.1: IMA15-TOT'), which is also a bottom-up scenario including the implementation of the best available technologies for reducing non-CO_2 emissions (supply side), as well as demand-side options including full adoption of cultured meat in 2050, and a transition to a less meat-intensive diet conforming to health recommendations.

Table S1: Colour-coding has been corrected to reflect change in CH4 medium upper bound (available here: https://zenodo.org/record/7925677).

Table S2: Final row of table has been updated: Error in written formula for the calculation of the mitigation potential has been corrected to 28 × U_{CH4} × $CH4_{2018}$ and the values for the both the medium and high upper bounds in units of GtCO2eq yr^{-1} have been corrected to 5.07 and 6.30 respectively.

Lever, L_x		Units of upper bound, U_x	Formula for calculation of mitigation potential, M_x, based on upper bound, U_x	Mitigation potential in 2050, $M_{med/high,x}$ (GtCO2eq yr^{-1})	Weighting based on medium mitigation potential
Geologic CDR	CDR_{geo}	GtCO2 yr^{-1}	$U_{CDR\text{-}geo}$	3/7	0.09
AFOLU CDR	CDR_{AFOLU}	GtCO2 yr^{-1}	$U_{CDR\text{-}AFOLU}$	2.5/8.6	0.07
Carbon intensity	CI_{2050}	% reduction rel. to 2018	CI_{2018}-U_{CI} × CI_{2018}	—	—
Final energy demand	E_{2050}	% reduction rel. to 2018	E_{2018}-U_{CI} × E_{2018}	—	—
Energy emissions	$C_{E,2050} = CI_{2050} \times E_{2050}$	(GtCO2 yr^{-1})	$E_{2050} \times CI_{2050} - C_{E,2018}$	23.45/29.96	0.69
Methane emissions	$CH4_{2050}$	% reduction rel. to 2018	28 × (U_{CH4} × $CH4_{2018}$)	5.07/6.30	0.15

Table S3: Number of scenarios staying within the medium upper bound on CH4 reduction for the entire and filtered ensemble have been corrected to 13 and 3 respectively.

	Number of scenarios staying within upper bound		
	Medium upper bound	High upper bound	Medium upper bound (filtered ensemble only)
CDR_{geo}	10/50 (20%)	41/50 (82%)	5/22 (22%)
CDR_{AFOLU}	31/50 (62%)	48/50 (96%)	10/22 (45%)
CI_{2050}	22/50 (44%)	49/50 (98%)	8/22 (36%)
E_{2050}	22/50 (44%)	49/50 (98%)	13/22 (59%)
Both energy levers	10/50 (20%)	48/50 (96%)	5/22 (22%)
$CH4_{2050}$	13/50 (26%)	34/50 (68%)	3/22 (14%)
All levers	0/50 (0%)	22/50 (44%)	0/22 (0%)

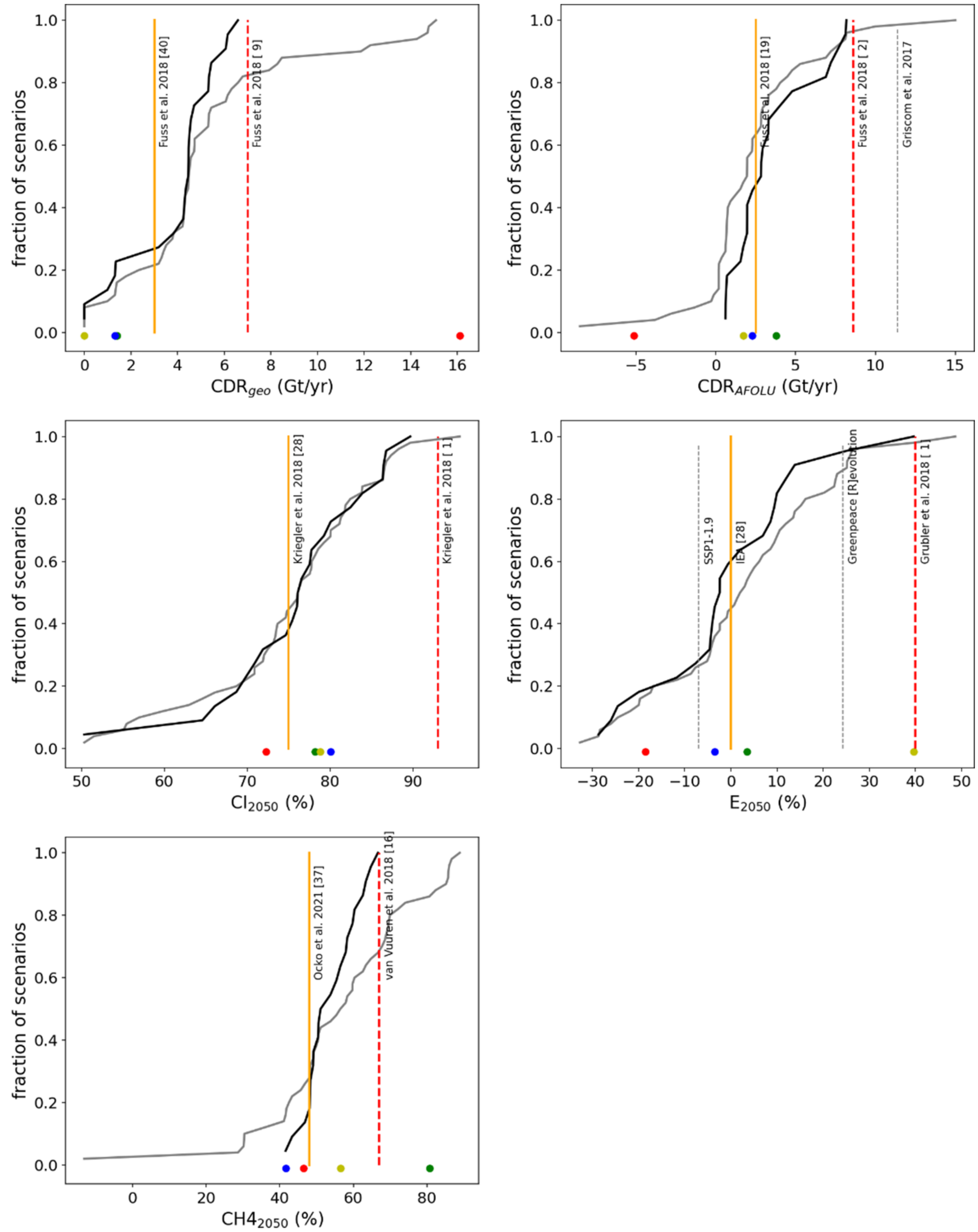

Figure S2(a): Final panel has been replaced. The medium upper bound now lies in the range where the cumulative distributions (of both the complete and filtered ensembles) rise most steeply.

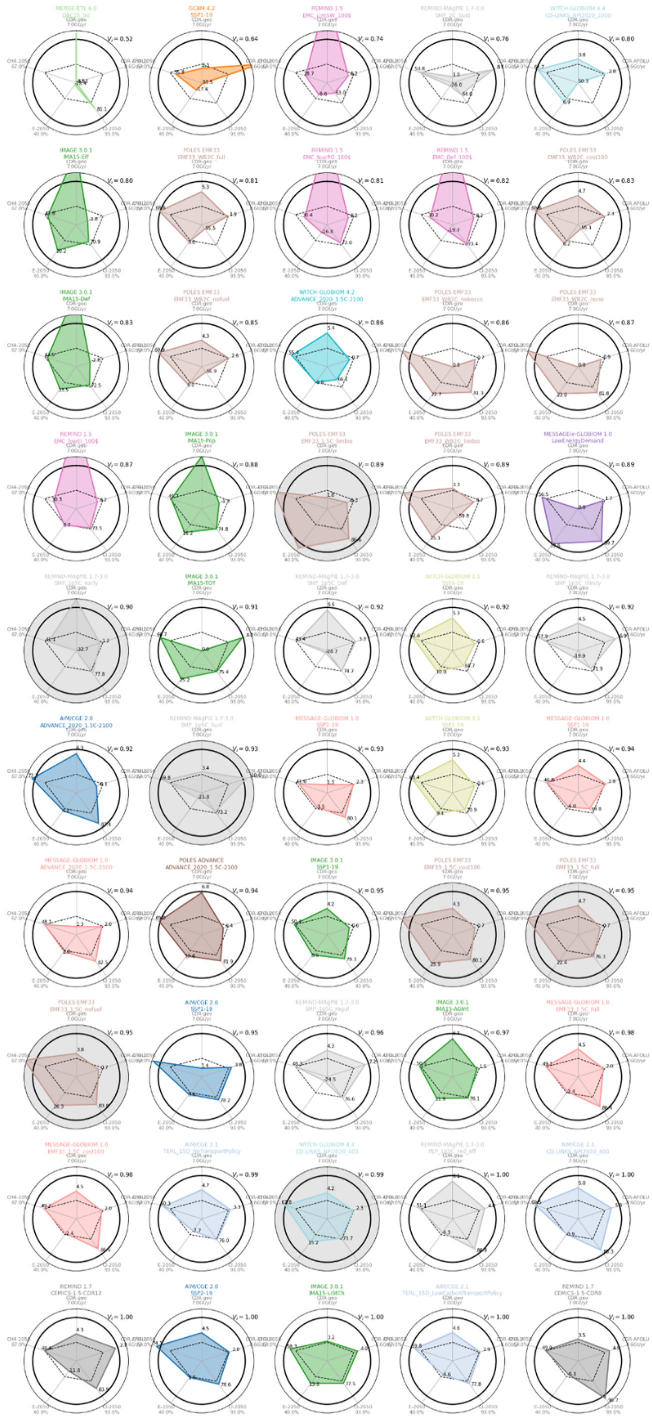

Figure S3: Figure has been replaced. New figure accounts for the revised CH4 medium upper bound and is qualitatively very similar to the original figure. The changes slightly affects the value of the coverage parameter V and thus the order in which the scenarios are shown (order of increasing V). A high-resolution version of the figure can be downloaded here: https://zenodo.org/record/7760056.

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