



Supplement of

emIAM v1.0: an emulator for integrated assessment models using marginal abatement cost curves

Weiwei Xiong et al.

Correspondence to: Weiwei Xiong (weiwei.xiong@lsce.ipsl.fr) and Katsumasa Tanaka (katsumasa.tanaka@lsce.ipsl.fr)

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List

Table S1. Carbon price pathways of different initial levels with a 5% of growth rate1
Table S2. Equation forms and parameter ranges for fitting MAC curves
Table S3. Statistics for function choices 3
Table S4. Parameter values in global MAC curves for energy-related CO ₂ , CH ₄ , and N ₂ O emissions derived from nine ENGAGE IAMs
Table S5. Statistical validation of global emission pathways of ECB scenario without INDC reproduced from ACC2-emIAM with original emission pathways from nine ENGAGE IAMs
Table S6. Statistical validation of regional emission pathways of ECB scenario without INDC reproduced from ACC2-emIAM with original emission pathways from five ENGAGE IAMs5
Table S7. Available scenarios for each model in the ENGAGE Scenario Explorer
Figure S1. Overview of the methods to derive AIM MAC curves and limits on abatement7
Figure S2. Overview of the methods to derive MESSAGE MAC curves and limits on abatement
Figure S3. MAC curves defined with relative and absolute abatement for three models9
Figure S4. MAC curves of total anthropogenic CO ₂ emissions per five years for POLES10
Figure S5. Global energy-related CO ₂ MAC curves from nine ENGAGE IAMs11
Figure S6. Global non-energy-related CO2 MAC curves from nine ENGAGE IAMs11
Figure S7. Global total anthropogenic CH4 MAC curves from nine ENGAGE IAMs
Figure S8. Global energy-related CH4 MAC curves from nine ENGAGE IAMs12
Figure S9. Global non-energy-related CH4 MAC curves from nine ENGAGE IAMs13
Figure S10. Global total anthropogenic N_2O MAC curves from nine ENGAGE IAMs13
Figure S11. Global energy-related N2O MAC curves from nine ENGAGE IAMs14
Figure S12. Global non-energy-related N2O MAC curves from nine ENGAGE IAMs14
Figure S13. Global AIM MAC curves
Figure S14. Global COFFEE MAC curves15
Figure S15. Global GEM MAC curves
Figure S16. Global IMAGE MAC curves16
Figure S17. Global MESSAGE MAC curves17
Figure S18. Global POLES MAC curves17
Figure S19. Global REMIND MAC curves
Figure S20. Global TIAM MAC curves
Figure S21. Global WITCH MAC curves

Figure S22.	Regional AIM total anthropogenic CO2 MAC curves	19
Figure S23.	Regional AIM total anthropogenic CH4 MAC curves	20
Figure S24.	Regional AIM total anthropogenic N2O MAC curves	20
Figure S25.	Regional COFFEE total anthropogenic CO2 MAC curves	21
Figure S26.	Regional COFFEE total anthropogenic CH4 MAC curves	21
Figure S27.	Regional COFFEE total anthropogenic N2O MAC curves	22
Figure S28.	Regional GEM total anthropogenic CO2 MAC curves	22
Figure S29.	Regional GEM total anthropogenic CH4 MAC curves	23
Figure S30.	Regional GEM total anthropogenic N2O MAC curves	23
Figure S31.	Regional IMAGE total anthropogenic CO2 MAC curves	24
Figure S32.	Regional IMAGE total anthropogenic CH4 MAC curves	24
Figure S33.	Regional IMAGE total anthropogenic N2O MAC curves	25
Figure S34.	Regional MESSAGE total anthropogenic CO2 MAC curves	25
Figure S35.	Regional MESSAGE total anthropogenic CH4 MAC curves	26
Figure S36.	Regional MESSAGE total anthropogenic N2O MAC curves	26
e	Global MAC curves for total anthropogenic CO ₂ emissions derived from the se with the same carbon budgets available for five ENGAGE IAMs	
Figure S38.	Global GET - Distribution of first derivative of abatement levels	28
Figure S39.	Global GET - Distribution of second derivative of abatement levels	28
Figure S40.	Global AIM - Distribution of first derivative of abatement levels	29
Figure S41.	Global COFFEE - Distribution of first derivative of abatement levels	29
Figure S42.	Global GEM - Distribution of first derivative of abatement levels	30
Figure S43.	Global IMAGE - Distribution of first derivative of abatement levels	30
Figure S44.	Global MESSAGE - Distribution of first derivative of abatement levels	31
Figure S45.	Global POLES - Distribution of first derivative of abatement levels	31
Figure S46.	Global REMIND - Distribution of first derivative of abatement levels	32
Figure S47.	Global TIAM - Distribution of first derivative of abatement levels	32
Figure S48.	Global WITCH - Distribution of first derivative of abatement levels	33
Figure S49.	Global AIM - Distribution of second derivative of abatement levels	33
Figure S50.	Global COFFEE - Distribution of second derivative of abatement levels	34
Figure S51.	Global GEM - Distribution of second derivative of abatement levels	34
Figure S52.	Global IMAGE - Distribution of second derivative of abatement levels	35
Figure S53.	Global MESSAGE - Distribution of second derivative of abatement levels	35
Figure S54.	Global POLES - Distribution of second derivative of abatement levels	36

Figure S61. Regional AIM CH₄ - Distribution of second derivative of abatement levels 39 Figure S62. Regional AIM N₂O - Distribution of first derivative of abatement levels40 Figure S63. Regional AIM N₂O - Distribution of second derivative of abatement levels......40 Figure S64. Regional COFFEE CO₂ - Distribution of first derivative of abatement levels.....41 Figure S65. Regional COFFEE CO₂ - Distribution of second derivative of abatement levels 41 Figure S66. Regional COFFEE CH₄ - Distribution of first derivative of abatement levels.....42 Figure S67. Regional COFFEE CH₄ - Distribution of second derivative of abatement levels 42 Figure S68. Regional COFFEE N₂O - Distribution of first derivative of abatement levels 43 Figure S69. Regional COFFEE N₂O - Distribution of second derivative of abatement levels 43 Figure S71. Regional GEM CO₂ - Distribution of second derivative of abatement levels......44 Figure S73. Regional GEM CH₄ - Distribution of second derivative of abatement levels......45 Figure S75. Regional GEM N₂O - Distribution of second derivative of abatement levels46 Figure S76. Regional IMAGE CO₂ - Distribution of first derivative of abatement levels47 Figure S77. Regional IMAGE CO₂ - Distribution of second derivative of abatement levels..47 Figure S78. Regional IMAGE CH₄ - Distribution of first derivative of abatement levels 48 Figure S79. Regional IMAGE CH₄ - Distribution of second derivative of abatement levels..48 Figure S80. Regional IMAGE N₂O - Distribution of first derivative of abatement levels......49 Figure S81. Regional IMAGE N₂O - Distribution of second derivative of abatement levels.. 49 Figure S82. Regional MESSAGE CO₂ - Distribution of first derivative of abatement levels. 50 Figure S83. Regional MESSAGE CO₂ - Distribution of second derivative of abatement levels Figure S84. Regional MESSAGE CH₄ - Distribution of first derivative of abatement levels. 51 Figure S85. Regional MESSAGE CH₄ - Distribution of second derivative of abatement levels Figure S86. Regional MESSAGE N₂O - Distribution of first derivative of abatement levels 52

Figure S87. Regional MESSAGE N ₂ O - Distribution of second derivative of abatement levels
Figure S88. The earliest year of achieving net zero indicated by our emulator
Figure S89. The relationship between abatement level and carbon price with different discount rates for GET with different portfolios
Figure S90. Overview of the validation results for ACC2-emIAM with REMIND as an example
Figure S91. Test 1 – GET nine portfolios energy-related CO ₂ validation results55
Figure S92. Test 1 – Global nine IAMs total anthropogenic CO ₂ validation results
Figure S93. Test 1 – Global nine IAMs total anthropogenic CH ₄ validation results
Figure S94. Test 1 – Global nine IAMs total anthropogenic N_2O validation results
Figure S95. Test 1 - Regional AIM total anthropogenic CO ₂ validation results57
Figure S96. Test 1 - Regional AIM total anthropogenic CH ₄ validation results57
Figure S97. Test 1 - Regional AIM total anthropogenic N2O validation results
Figure S98. Test 1 - Regional COFFEE total anthropogenic CO ₂ validation results58
Figure S99. Test 1 - Regional COFFEE total anthropogenic CH4 validation results
Figure S100. Test 1 - Regional COFFEE total anthropogenic N ₂ O validation results
Figure S101. Test 1 - Regional GEM total anthropogenic CO ₂ validation results60
Figure S102. Test 1 - Regional GEM total anthropogenic CH ₄ validation results60
Figure S103. Test 1 - Regional GEM total anthropogenic N_2O validation results61
Figure S104. Test 1 - Regional IMAGE total anthropogenic CO ₂ validation result61
Figure S105. Test 1 - Regional IMAGE total anthropogenic CH ₄ validation results
Figure S106. Test 1 - Regional IMAGE total anthropogenic N ₂ O validation results
Figure S107. Test 1 - Regional MESSAGE total anthropogenic CO ₂ validation results 63
Figure S108. Test 1 - Regional MESSAGE total anthropogenic CH ₄ validation results 63
Figure S109. Test 1 - Regional MESSAGE total anthropogenic N_2O validation results64
Figure S110. Test $1 - GET$ - Reproducibility of energy-related CO ₂ 64
Figure S111. Test 1 - Global nine IAMs - Reproducibility of total anthropogenic CO ₂ 65
Figure S112. Test 1 - Global nine IAMs - Reproducibility of total anthropogenic CH465
Figure S113. Test 1 - Global nine IAMs - Reproducibility of total anthropogenic N_2O
Figure S114. Test 1 - Regional AIM - Reproducibility of total anthropogenic CO ₂
Figure S115. Test 1 - Regional AIM - Reproducibility of total anthropogenic CH467
Figure S116. Test 1 - Regional AIM - Reproducibility of total anthropogenic N ₂ O67
Figure S117. Test 1 - Regional COFFEE - Reproducibility of total anthropogenic CO ₂ 68

Figure S118. Test 1 - Regional COFFEE - Reproducibility of total anthropogenic CH4 68
Figure S119. Test 1 - Regional COFFEE - Reproducibility of total anthropogenic N ₂ O 69
Figure S120. Test 1 - Regional GEM - Reproducibility of total anthropogenic CO2
Figure S121. Test 1 - Regional GEM - Reproducibility of total anthropogenic CH4
Figure S122. Test 1 - Regional GEM - Reproducibility of total anthropogenic N_2O
Figure S123. Test 1 - Regional IMAGE - Reproducibility of total anthropogenic CO271
Figure S124. Test 1 - Regional IMAGE - Reproducibility of total anthropogenic CH ₄ 71
Figure S125. Test 1 - Regional IMAGE - Reproducibility of total anthropogenic N_2O 72
Figure S126. Test 1 - Regional MESSAGE - Reproducibility of total anthropogenic $CO_2 \dots 72$
Figure S127. Test 1 - Regional MESSAGE - Reproducibility of total anthropogenic CH_473
Figure S128. Test 1 - Regional MESSAGE - Reproducibility of total anthropogenic N_2O73
Figure S129. Test 2 – GET nine portfolios energy-related CO2 validation results
Figure S130. Test 2 – Global nine IAMs total anthropogenic CO ₂ validation results
Figure S131. Test 2 – Global nine IAMs total anthropogenic CH4 validation results
Figure S132. Test $2 - Global$ nine IAMs total anthropogenic N ₂ O validation results
Figure S133. Test 2 - Regional AIM total anthropogenic CO ₂ validation results76
Figure S134. Test 2 - Regional AIM total anthropogenic CH4 validation results76
Figure S135. Test 2 - Regional AIM total anthropogenic N2O validation results77
Figure S136. Test 2 - Regional COFFEE total anthropogenic CO2 validation results
Figure S137. Test 2 - Regional COFFEE total anthropogenic CH4 validation results
Figure S138. Test 2 - Regional COFFEE total anthropogenic N ₂ O validation results
Figure S139. Test 2 - Regional GEM total anthropogenic CO ₂ validation results
Figure S140. Test 2 - Regional GEM total anthropogenic CH4 validation results
Figure S141. Test 2 - Regional GEM total anthropogenic N_2O validation results
Figure S142. Test 2 - Regional IMAGE total anthropogenic CO ₂ validation results
Figure S143. Test 2 - Regional IMAGE total anthropogenic CH ₄ validation results
Figure S144. Test 2 - Regional IMAGE total anthropogenic N2O validation results
Figure S145. Test 2 - Regional MESSAGE total anthropogenic CO2 validation results82
Figure S146. Test 2 - Regional MESSAGE total anthropogenic CH4 validation results82
Figure S147. Test 2 - Regional MESSAGE total anthropogenic N_2O validation results83
Figure S148. Test 2 - GET - Reproducibility of energy-related CO ₂
Figure S149. Test 2 - Global nine IAMs - Reproducibility of total anthropogenic CO284
Figure S150. Test 2 - Global nine IAMs - Reproducibility of total anthropogenic CH4
Figure S151. Test 2 - Global nine IAMs - Reproducibility of total anthropogenic N2O85

Figure S155. Test 2 - Regional COFFEE - Reproducibility of total anthropogenic CO₂.......87 Figure S156. Test 2 - Regional COFFEE - Reproducibility of total anthropogenic CH₄........87 Figure S157. Test 2 - Regional COFFEE - Reproducibility of total anthropogenic N₂O...... 88 Figure S161. Test 2 - Regional IMAGE - Reproducibility of total anthropogenic CO₂90 Figure S162. Test 2 - Regional IMAGE - Reproducibility of total anthropogenic CH₄.......90 Figure S163. Test 2 - Regional IMAGE - Reproducibility of total anthropogenic N₂O91 Figure S164. Test 2 - Regional MESSAGE - Reproducibility of total anthropogenic CO₂....91 Figure S165. Test 2 - Regional MESSAGE - Reproducibility of total anthropogenic CH₄....92 Figure S166. Test 2 - Regional MESSAGE - Reproducibility of total anthropogenic N₂O....92 Figure S168. Test 3 – Global nine IAMs total anthropogenic CH₄ validation result......93 Figure S171. Test 3 - Regional AIM total anthropogenic CH₄ validation results......95 Figure S172. Test 3 - Regional AIM total anthropogenic N₂O validation results95 Figure S176. Test 3 - Regional GEM total anthropogenic CO₂ validation results......97 Figure S181. Test 3 - Regional IMAGE total anthropogenic N₂O validation results 100 Figure S182. Test 3 - Regional MESSAGE total anthropogenic CO₂ validation results 100 Figure S183. Test 3 - Regional MESSAGE total anthropogenic CH₄ validation results 101 Figure S184. Test 3 - Regional MESSAGE total anthropogenic N₂O validation results 101 Figure S185. Test 3 - Global nine IAMs - Reproducibility of total anthropogenic CO₂...... 102 Figure S186. Test 3 - Global nine IAMs - Reproducibility of total anthropogenic CH4...... 102 Figure S187. Test 3 - Global nine IAMs - Reproducibility of total anthropogenic N₂O..... 103 Figure S188. Test 3 - Regional AIM - Reproducibility of total anthropogenic CO2...... 103 Figure S189. Test 3 - Regional AIM - Reproducibility of total anthropogenic CH4..... 104 Figure S190. Test 3 - Regional AIM - Reproducibility of total anthropogenic N₂O 104 Figure S191. Test 3 - Regional COFFEE - Reproducibility of total anthropogenic CO₂..... 105 Figure S192. Test 3 - Regional COFFEE - Reproducibility of total anthropogenic CH₄..... 105 Figure S193. Test 3 - Regional COFFEE - Reproducibility of total anthropogenic N₂O..... 106 Figure S194. Test 3 - Regional GEM - Reproducibility of total anthropogenic CO₂ 106 Figure S195. Test 3 - Regional GEM - Reproducibility of total anthropogenic CH₄ 107 Figure S196. Test 3 - Regional GEM - Reproducibility of total anthropogenic N₂O 107 Figure S197. Test 3 - Regional IMAGE - Reproducibility of total anthropogenic CO₂ 108 Figure S198. Test 3 - Regional IMAGE - Reproducibility of total anthropogenic CH₄...... 108 Figure S199. Test 3 - Regional IMAGE - Reproducibility of total anthropogenic N₂O 109 Figure S200. Test 3 - Regional MESSAGE - Reproducibility of total anthropogenic CO2.. 109 Figure S201. Test 3 - Regional MESSAGE - Reproducibility of total anthropogenic CH₄.. 110 Figure S202. Test 3 - Regional MESSAGE - Reproducibility of total anthropogenic N₂O.. 110 Figure S203. Test 4 – GET nine portfolios energy-related CO₂ validation results......111 Figure S205. Test 4 – Global nine IAMs total anthropogenic CH₄ validation results 112 Figure S206. Test 4 – Global nine IAMs total anthropogenic N₂O validation results 112 Figure S207. Test 4 - Regional AIM total anthropogenic CO₂ validation results......113 Figure S208. Test 4 - Regional AIM total anthropogenic CH₄ validation results......113 Figure S209. Test 4 - Regional AIM total anthropogenic N₂O validation results114 Figure S211. Test 4 - Regional COFFEE total anthropogenic CH₄ validation results..........115 Figure S212. Test 4 - Regional COFFEE total anthropogenic N₂O validation results......... 115 Figure S213. Test 4 - Regional GEM total anthropogenic CO₂ validation results......116 Figure S214. Test 4 - Regional GEM total anthropogenic CH₄ validation results......116 Figure S215. Test 4 - Regional GEM total anthropogenic N₂O validation results117 Figure S216. Test 4 - Regional IMAGE total anthropogenic CO₂ validation results......117 Figure S219. Test 4 - Regional MESSAGE total anthropogenic CO₂ validation results 119 Figure S220. Test 4 - Regional MESSAGE total anthropogenic CH₄ validation results 119 Figure S221. Test 4 - Regional MESSAGE total anthropogenic N₂O validation results 120 Figure S222. Test 4 - GET - Reproducibility of energy-related CO₂......120 Figure S223. Test 4 - Global nine IAMs - Reproducibility of total anthropogenic CO₂...... 121 Figure S224. Test 4 - Global nine IAMs - Reproducibility of total anthropogenic CH4...... 121 Figure S225. Test 4 - Global nine IAMs - Reproducibility of total anthropogenic N₂O...... 122 Figure S226. Test 4 - Regional AIM - Reproducibility of total anthropogenic CO₂......122 Figure S227. Test 4 - Regional AIM - Reproducibility of total anthropogenic CH4..... 123 Figure S228. Test 4 - Regional AIM - Reproducibility of total anthropogenic N₂O 123 Figure S229. Test 4 - Regional COFFEE - Reproducibility of total anthropogenic CO₂..... 124 Figure S230. Test 4 - Regional COFFEE - Reproducibility of total anthropogenic CH4..... 124 Figure S231. Test 4 - Regional COFFEE - Reproducibility of total anthropogenic N₂O..... 125 Figure S232. Test 4 - Regional GEM - Reproducibility of total anthropogenic CO₂ 125 Figure S233. Test 4 - Regional GEM - Reproducibility of total anthropogenic CH₄......126 Figure S234. Test 4 - Regional GEM - Reproducibility of total anthropogenic N₂O 126 Figure S235. Test 4 - Regional IMAGE - Reproducibility of total anthropogenic CO₂ 127 Figure S236. Test 4 - Regional IMAGE - Reproducibility of total anthropogenic CH₄ 127 Figure S237. Test 4 - Regional IMAGE - Reproducibility of total anthropogenic N₂O 128 Figure S238. Test 4 - Regional MESSAGE - Reproducibility of total anthropogenic CO2.. 128 Figure S239. Test 4 - Regional MESSAGE - Reproducibility of total anthropogenic CH4.. 129 Figure S240. Test 4 - Regional MESSAGE - Reproducibility of total anthropogenic N₂O.. 129 Figure S241. Validation results for ACC2-emIAM with mean and upper MAC curves from

Scenario	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	2075	2080	2085	2090	2095	2100
T0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T1	1	1.3	1.6	2.1	2.7	3.4	4.3	5.5	7.0	9.0	11.5	14.6	18.7	23.8	30.4	38.8	49.6	63.3	80.7
T2	2	2.6	3.3	4.2	5.3	6.8	8.6	11.0	14.1	18.0	22.9	29.3	37.4	47.7	60.9	77.7	99.1	126.5	161.5
Т3	3	3.8	4.9	6.2	8.0	10.2	13.0	16.5	21.1	27.0	34.4	43.9	56.0	71.5	91.3	116.5	148.7	189.8	242.2
T5	5	6.4	8.1	10.4	13.3	16.9	21.6	27.6	35.2	44.9	57.3	73.2	93.4	119.2	152.1	194.2	247.8	316.3	403.7
Τ7	7	8.9	11.4	14.6	18.6	23.7	30.3	38.6	49.3	62.9	80.3	102.4	130.8	166.9	213.0	271.8	346.9	442.8	565.1
T10	10	12.8	16.3	20.8	26.5	33.9	43.2	55.2	70.4	89.9	114.7	146.4	186.8	238.4	304.3	388.3	495.6	632.5	807.3
T15	15	19.1	24.4	31.2	39.8	50.8	64.8	82.7	105.6	134.8	172.0	219.5	280.2	357.6	456.4	582.5	743.4	948.8	1211.0
T20	20	25.5	32.6	41.6	53.1	67.7	86.4	110.3	140.8	179.7	229.3	292.7	373.6	476.8	608.5	776.7	991.2	1265.1	1614.6
T25	25	31.9	40.7	52.0	66.3	84.7	108.0	137.9	176.0	224.6	286.7	365.9	467.0	596.0	760.7	970.8	1239.0	1581.4	2018.3
T30	30	38.3	48.9	62.4	79.6	101.6	129.7	165.5	211.2	269.6	344.0	439.1	560.4	715.2	912.8	1165.0	1486.8	1897.6	2421.9
T40	40	51.1	65.2	83.2	106.1	135.5	172.9	220.6	281.6	359.4	458.7	585.4	747.2	953.6	1217.1	1553.3	1982.5	2530.2	3229.2
T50	50	63.8	81.4	103.9	132.7	169.3	216.1	275.8	352.0	449.3	573.4	731.8	934.0	1192.0	1521.3	1941.6	2478.1	3162.7	4036.5
T60	60	76.6	97.7	124.7	159.2	203.2	259.3	331.0	422.4	539.1	688.0	878.1	1120.8	1430.4	1825.6	2330.0	2973.7	3795.3	4843.8
T70	70	89.3	114.0	145.5	185.7	237.0	302.5	386.1	492.8	629.0	802.7	1024.5	1307.5	1668.8	2129.8	2718.3	3469.3	4427.8	5651.1
T80	80	102.1	130.3	166.3	212.3	270.9	345.8	441.3	563.2	718.8	917.4	1170.9	1494.3	1907.2	2434.1	3106.6	3964.9	5060.3	6458.4
T90	90	114.9	146.6	187.1	238.8	304.8	389.0	496.4	633.6	808.7	1032.1	1317.2	1681.1	2145.6	2738.4	3494.9	4460.5	5692.9	7265.7
T100	100	127.6	162.9	207.9	265.3	338.6	432.2	551.6	704.0	898.5	1146.7	1463.6	1867.9	2384.0	3042.6	3883.3	4956.1	6325.4	8073.0
T110	110	140.4	179.2	228.7	291.9	372.5	475.4	606.8	774.4	988.4	1261.4	1609.9	2054.7	2622.4	3346.9	4271.6	5451.8	6958.0	8880.3
T120	120	153.2	195.5	249.5	318.4	406.4	518.6	661.9	844.8	1078.2	1376.1	1756.3	2241.5	2860.8	3651.2	4659.9	5947.4	7590.5	9687.6
T130	130	165.9	211.8	270.3	344.9	440.2	561.9	717.1	915.2	1168.1	1490.8	1902.6	2428.3	3099.2	3955.4	5048.2	6443.0	8223.1	10494.9
T140	140	178.7	228.0	291.0	371.5	474.1	605.1	772.2	985.6	1257.9	1605.4	2049.0	2615.1	3337.6	4259.7	5436.6	6938.6	8855.6	11302.3

Table S1. Carbon price pathways of different initial levels with a 5% of growth rate

	AIM	GEM	MESSAGE	IMAGE	COFFEE	TIAM	REMIND	WITCH	POLES	GET					
Equation 1					f(x) = a	$\times x^b + c \times x^d$	-		-						
а	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)					
b	[0.01,100]	[0.01,100]	[0.01,100]	[0.01,100]	[0.01,100]	[0.01,100]	[0.01,100]	[0.01,100]	[0.01,100]	[0.01,100]					
С	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)					
d	[0.01,100]	[0.01,100]	[0.01,100]	[0.01,100]	[0.01,100]	[0.01,100]	[0.01,100]	[0.01,100]	[0.01,100]	[0.01,100]					
Equation 2	$f(x) = a \times x + b \times (exp^{c \times x} - 1)$														
a	-	-	-	-	-	-	-	-	-	-					
b	-	-	-	-	-	-	-	-	-	-					
С	(-inf,50]	(-inf,50]	(-inf,50]	(-inf,50]	(-inf,50]	(-inf,50]	(-inf,50]	(-inf,50]	(-inf,50]	(-inf,50)					
Equation 3				<i>f</i> ($(x) = a \times x + b >$	$\times x^2 + c \times x^3 + c$	$d \times x^4$		·						
a	-	-	-	-	-	-	-	-	-	-					
b	-	-	-	-	-	-	-	-	-	-					
С	-	-	-	-	-	-	-	-	-	-					
d	-	-	-	-	-	-	-	-	-	-					
Equation 4					f(x) = a	$\times (b^{c \times x} - 1)$	·		·						
a	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)	[0,+inf)					
b	[0.001,+inf)	[0.001,+inf)	[0.001,+inf)	[0.001,+inf)	[0.001,+inf)	[0.001,+inf)	[0.001,+inf)	[0.001,+inf)	[0.001,+inf)	[0.001,+inf)					
С	(-inf,100]	(-inf,100]	(-inf,100]	(-inf,100]	(-inf,100]	(-inf,100]	(-inf,100]	(-inf,100]	(-inf,100]	(-inf,100]					

Table S2. Equation forms and parameter ranges for fitting MAC curves

Table S3. Statistics for function choices

The count indicates the number of times the corresponding equation was selected as the best-fitting equation for the IAM price-quantity data.

Function	Count	Percentage (%)
Equation 1	126	51.22
Equation 2	15	6.10
Equation 3	45	18.29
Equation 4	60	24.39
Total	246	100

Table S4. Parameter values in global MAC curves for energy-related CO₂, CH₄, and N₂O emissions derived from nine ENGAGE IAMs

No data are available for energy-related CH_4 and N_2O emissions from GEM and TIAM and energy-related N_2O emissions from COFFEE.

Model	Gas	a	b	c	d	MaxABL	Max1st	Max2nd
AIM	CO ₂	192.98	1.25	16.51	18.28	112.7	6.4	1.0
AIM	CH4	94.24	0.91	822.81	18.27	94.3	6.2	1.7
AIM	N_2O	171.87	1.41	1,249.37	12.65	87.2	5.7	1.1
COFFEE	CO_2	40.32	1.15	40.48	5.63	147.0	6.3	1.6
COFFEE	CH4	14.38	0.35	455.91	5.77	88.9	5.0	3.6
COFFEE	N_2O			_	_	_	_	
GEM	CO ₂	272.42	1.57	119.95	6.82	108.0	6.0	1.4
GEM	CH ₄			_	_	_	_	
GEM	N_2O			_	_	_	_	
IMAGE	CO ₂	309.98	1.23	83.50	24.63	107.6	6.0	1.1
IMAGE	CH ₄	283.45	1.18	879.73	11.96	91.8	4.8	1.0
IMAGE	N_2O	126.54	0.27	2.290×10^4	14.02	78.1	5.3	1.3
MESSAGE	CO ₂	471.55	3.02	179.97	30.24	112.0	5.0	0.8
MESSAGE	CH ₄	2,332.36	7.75	1.039×10^{5}	49.10	93.7	5.5	1.4
MESSAGE	N_2O	155.77	0.43	3.818×10^4	5.95	62.0	3.8	0.9
POLES	CO ₂	2,092.84	3.01	1,785.75	16.24	110.2	4.6	1.1
POLES	CH ₄	4,016.39	7.61	4,016.39	7.61	97.5	6.0	1.2
POLES	N_2O	630.22	1.71	1.469×10^{4}	7.56	87.4	5.5	1.0
REMIND	CO ₂	316.94	1.82	591.39	21.77	104.3	6.6	0.9
REMIND	CH ₄	143.80	1.02	2,139.05	14.81	97.7	5.4	1.6
REMIND	N ₂ O	44.00	0.17	5,558.24	2.93	47.8	2.9	1.0
TIAM	CO_2	394.27	1.39	183.59	11.93	116.2	4.6	0.8
TIAM	CH ₄			_		_	_	_
TIAM	N ₂ O			_	_	_	_	
WITCH	CO ₂	421.02	1.40	971.12	7.56	101.4	3.9	1.3
WITCH	CH ₄	153.56	3.52	1,528.23	36.27	99.6	5.9	3.6
WITCH	N ₂ O	97.19	0.73	4.379×10^{5}	8.98	50.8	3.5	1.4

Table S5. Statistical validation of global emission pathways of ECB scenario withoutINDC reproduced from ACC2-emIAM with original emission pathways from nineENGAGE IAMs

The table shows two indicators: i) ordinary Pearson's correlation coefficient r_P and ii) Lin's concordance coefficient r_c . The higher the value of the indicator is, the darker the color of the cell is.

0			AIM	COFFEE	GEM	IMAGE	MESSAGE	POLES	REMIND	TIAM	WITCH
		CO ₂	0.986	0.990	0.985	0.978	0.986	0.989	0.969	0.994	0.975
	Test 1	CH_4	0.980	0.976	0.987	0.987	0.979	0.976	0.989	0.943	0.981
		N_2O	0.969	0.979	0.973	0.949	0.989	0.960	0.974	0.601	0.979
		CO ₂	0.984	0.994	0.985	0.977	0.990	0.991	0.954	0.997	0.970
	Test 2	CH_4	0.820	0.942	0.930	0.919	0.977	0.977	0.945	0.962	0.967
-		N ₂ O	0.961	0.982	0.979	0.943	0.988	0.969	0.970	0.652	0.984
r _P		CO ₂	0.982	0.992	0.985	0.976	0.980	0.990	0.970	0.767	0.971
	Test 3	CH_4	0.759	0.912	0.903	0.929	0.975	0.948	0.893	0.510	0.934
		N ₂ O	0.961	0.959	0.980	0.855	0.981	0.966	0.960	0.498	0.972
		CO ₂	0.990	0.992	0.987	0.993	0.988	0.991	0.982	0.995	0.981
	Test 4	CH_4	0.915	0.914	0.969	0.983	0.980	0.956	0.960	0.962	0.967
		N ₂ O	0.972	0.959	0.974	0.931	0.981	0.962	0.976	0.705	0.975
	Test 1	CO ₂	0.980	0.981	0.984	0.976	0.986	0.989	0.968	0.994	0.963
		CH_4	0.978	0.974	0.987	0.983	0.978	0.975	0.989	0.940	0.980
		N ₂ O	0.967	0.974	0.973	0.946	0.988	0.958	0.974	0.535	0.976
		CO ₂	0.978	0.989	0.984	0.976	0.990	0.991	0.953	0.997	0.961
	Test 2	CH_4	0.757	0.930	0.894	0.879	0.974	0.972	0.925	0.961	0.957
		N ₂ O	0.959	0.978	0.979	0.939	0.988	0.968	0.969	0.607	0.982
r _c		CO ₂	0.975	0.987	0.984	0.975	0.980	0.989	0.970	0.760	0.959
	Test 3	CH_4	0.660	0.910	0.875	0.905	0.974	0.947	0.855	0.430	0.916
		N_2O	0.957	0.956	0.977	0.828	0.981	0.948	0.953	0.453	0.962
		CO ₂	0.988	0.986	0.987	0.992	0.986	0.990	0.982	0.994	0.978
	Test 4	CH_4	0.901	0.912	0.964	0.966	0.975	0.949	0.949	0.958	0.964
		N_2O	0.967	0.956	0.966	0.920	0.978	0.943	0.973	0.598	0.968

Table S6. Statistical validation of regional emission pathways of ECB scenario withoutINDC reproduced from ACC2-emIAM with original emission pathways from fiveENGAGE IAMs

Ordinary Pearson's correlation coefficient r_P and Lin's concordance coefficient r_C are shown in the table. The higher the value of the indicator is, the darker the color of the cell is.

					Test :	1		Test 2				Test 3					Test 4					
			AIM	COFFEE	GEM	IMAGE	MESSAGE	AIM	COFFEE	GEM	IMAGE	MESSAGE	AIM	COFFEE	GEM	IMAGE	MESSAGE	AIM	COFFEE	GEM	IMAGE	MESSAGE
		SUBSAFR	0.961	0.977	0.979	0.979	0.988	0.958	0.984	0.975	0.977	0.989	0.964	0.977	0.973	0.972	0.990	0.970	0.977	0.986	0.989	0.991
		CHN	0.970	0.983	0.983	0.956	0.993	0.966	0.988	0.981	0.948	0.995	0.974	0.987	0.978	0.947	0.992	0.981	0.987	0.985	0.984	0.994
		EUWE	0.980	0.900	0.976	0.977 0.974	0.995	0.979	0.899	0.975	0.976	0.995	0.985	0.905	0.980 0.971	0.976	0.993	0.985 0.980	0.904	0.977	0.993	0.995
		SOUASIA LATAME	0.970	0.896	0.973	0.974	0.978	0.966	0.910	0.970	0.970	0.975 0.974	0.972	0.908	0.971	0.972	0.979 0.968	0.980	0.908	0.977	0.988	0.986
	co,	MIDEAST	0.983	0.892	0.978	0.959	0.985	0.982	0.940	0.972	0.955	0.985	0.986	0.943	0.968	0.955	0.982	0.988	0.913	0.978	0.942	0.980
	002	NORAM	0.982	0.931	0.962	0.958	0.992	0.981	0.943	0.966	0.954	0.993	0.987	0.938	0.968	0.953	0.992	0.984	0.937	0.964	0.978	0.989
		PACOECD	0.972	0.955	0.968	0.963	0.994	0.970	0.963	0.972	0.959	0.994	0.977	0.962	0.972	0.959	0.993	0.980	0.962	0.976	0.973	0.995
		REFECO	0.986	0.938	0.945	0.973	0.995	0.985	0.948	0.951	0.972	0.996	0.988	0.944	0.948	0.971	0.994	0.989	0.944	0.953	0.980	0.996
		OTASIAN	0.983	0.959	0.973	0.961	0.991	0.981	0.969	0.968	0.957	0.992	0.986	0.966	0.969	0.953	0.988	0.987	0.966	0.979	0.978	0.989
		ROW	0.851	0.942	0.930	0.921	0.000	0.846	0.939	0.901	0.918	0.000	0.869	0.946	0.903	0.920	0.000	0.880	0.946	0.954	0.936	0.000
		SUBSAFR	0.983	0.929	0.983	0.936	0.984	0.856	0.791	0.833	0.841	0.852	0.810	0.754	0.863	0.853	0.850	0.948	0.759	0.964	0.882	0.928
		CHN	0.985	0.991	0.986	0.988	0.979	0.864	0.976	0.882	0.918	0.982	0.824	0.970	0.902	0.935	0.986	0.940	0.971	0.972	0.976	0.992
		EUWE	0.947	0.991	0.960	0.967	0.936	0.793	0.979	0.923	0.851	0.933	0.737	0.971	0.890	0.883	0.933	0.893	0.972	0.925	0.962	0.932
		SOUASIA LATAME	0.948	0.486	0.980	0.979	0.970 0.984	0.741	0.380	0.841	0.868	0.854	0.671	0.381	0.867	0.895	0.866	0.865	0.382	0.969	0.939	0.929
r.	CH₄	MIDEAST	0.982	0.963	0.985	0.862	0.984	0.848	0.913	0.845	0.852	0.946	0.763	0.902	0.895	0.849	0.848	0.928	0.904	0.976	0.855	0.877
• •	CIT	NORAM	0.943	0.948	0.979	0.970	0.980	0.764	0.920	0.839	0.844	0.978	0.698	0.935	0.870	0.868	0.975	0.882	0.938	0.971	0.946	0.979
		PACOECD	0.943	0.875	0.947	0.928	0.972	0.732	0.753	0.795	0.837	0.939	0.660	0.759	0.799	0.853	0.957	0.865	0.763	0.922	0.912	0.976
		REFECO	0.971	0.759	0.987	0.959	0.972	0.821	0.555	0.896	0.777	0.854	0.765	0.584	0.913	0.818	0.880	0.919	0.588	0.977	0.922	0.946
		OTASIAN	0.978	0.974	0.982	0.985	0.996	0.813	0.942	0.895	0.915	0.965	0.757	0.935	0.903	0.932	0.971	0.916	0.937	0.972	0.975	0.988
		ROW	0.932	0.000	0.974	0.000	0.000	0.790	0.000	0.866	0.000	0.000	0.763	0.000	0.884	0.000	0.000	0.848	0.000	0.969	0.000	0.000
		SUBSAFR	0.985	0.951	0.925	0.898	0.951	0.983	0.960	0.935	0.892	0.925	0.990	0.952	0.943	0.886	0.895	0.990	0.952	0.939	0.900	0.898
		CHN	0.984	0.934	0.980	0.984	0.954	0.980	0.939	0.981	0.983	0.951	0.986	0.949	0.987	0.980	0.946	0.979	0.949	0.985	0.988	0.944
		EUWE	0.945	0.961	0.883	0.921	0.977	0.931	0.959	0.867	0.905	0.974	0.958	0.967	0.855	0.863	0.973	0.962	0.967	0.840	0.932	0.975
		SOUASIA LATAME	0.971	0.818	0.973	0.946	0.928	0.964	0.802	0.973 0.978	0.937	0.931 0.922	0.976	0.764	0.982	0.943	0.928	0.976 0.966	0.763	0.985	0.949	0.935
	N ₂ O	MIDEAST	0.957	0.799	0.978	0.108	0.934	0.965	0.790	0.978	0.990	0.922	0.967	0.696	0.985	0.994	0.918	0.968	0.697	0.985	0.128	0.969
		NORAM	0.956	0.965	0.934	0.931	0.933	0.942	0.967	0.951	0.926	0.935	0.966	0.970	0.960	0.919	0.945	0.965	0.970	0.954	0.955	0.944
		PACOECD	0.924	0.834	0.922	-0.017	0.971	0.901	0.836	0.946	-0.036	0.962	0.951	0.817	0.948	-0.130	0.957	0.953	0.817	0.948	-0.031	0.954
		REFECO	0.945	0.649	0.549	0.524	0.810	0.930	0.700	0.601	0.518	0.811	0.955	0.534	0.644	0.444	0.865	0.961	0.534	0.679	0.545	0.847
		OTASIAN	0.964	0.858	0.967	0.793	0.977	0.954	0.888	0.969	0.786	0.975	0.973	0.824	0.973	0.718	0.971	0.966	0.824	0.960	0.787	0.972
		ROW	0.000	0.000	0.905	0.000	0.000	0.000	0.000	0.921	0.000	0.000	0.000	0.000	0.931	0.000	0.000	0.000	0.000	0.946	0.000	0.000
		SUBSAFR	0.941	0.965 0.974	0.976 0.981	0.977	0.988	0.938	0.977	0.971 0.978	0.984 0.976	0.988 0.994	0.952	0.964 0.976	0.967 0.972	0.971	0.988	0.962	0.964 0.976	0.980 0.981	0.989 0.982	0.988
		CHN EUWE	0.957	0.974	0.981	0.950	0.992	0.950	0.982 0.887	0.978	0.976	0.994	0.966	0.976	0.972	0.941	0.990	0.975	0.976	0.981	0.982	0.993
		SOUASIA	0.964	0.882	0.968	0.974	0.995	0.972	0.831	0.955	0.990	0.995	0.968	0.833	0.963	0.974	0.995	0.985	0.833	0.958	0.992	0.983
		LATAME	0.964	0.891	0.942	0.924	0.962	0.962	0.908	0.935	0.953	0.965	0.972	0.903	0.927	0.918	0.955	0.971	0.902	0.949	0.938	0.959
	CO2	MIDEAST	0.979	0.854	0.977	0.958	0.981	0.977	0.882	0.970	0.997	0.980	0.984	0.876	0.962	0.952	0.979	0.988	0.875	0.974	0.979	0.976
		NORAM	0.976	0.900	0.961	0.952	0.986	0.975	0.916	0.964	0.961	0.987	0.984	0.907	0.965	0.949	0.988	0.984	0.907	0.959	0.977	0.984
		PACOECD	0.963	0.928	0.962	0.952	0.994	0.961	0.940	0.965	0.938	0.994	0.972	0.931	0.966	0.949	0.992	0.979	0.931	0.973	0.973	0.994
		REFECO	0.981	0.899	0.940	0.961	0.995	0.979	0.913	0.945	0.950	0.996	0.985	0.905	0.941	0.959	0.993	0.988	0.905	0.950	0.974	0.995
		OTASIAN	0.978	0.929	0.972	0.957	0.991	0.976	0.946	0.966	0.972	0.991	0.984	0.935	0.967	0.948	0.987	0.986	0.935	0.978	0.976	0.988
		ROW SUBSAFR	0.829	0.655	0.894	0.651	0.000	0.822	0.643	0.883	0.959	0.000	0.854	0.672	0.888	0.668	0.000	0.864	0.671	0.949	0.678	0.000
		CHN	0.982	0.921	0.981	0.908	0.982 0.979	0.836	0.771	0.740	0.814	0.763	0.756	0.749	0.819	0.839	0.814	0.948	0.754	0.961	0.808	0.917
		EUWE	0.980	0.987	0.985	0.961	0.979	0.693	0.970	0.802	0.845	0.975	0.601	0.968	0.805	0.849	0.985	0.925	0.969	0.966	0.959	0.990
		SOUASIA	0.944	0.329	0.976	0.974	0.960	0.656	0.231	0.756	0.808	0.744	0.546	0.243	0.824	0.863	0.796	0.846	0.244	0.962	0.911	0.905
		LATAME	0.976	0.976	0.981	0.916	0.984	0.780	0.946	0.765	0.770	0.913	0.698	0.964	0.840	0.805	0.944	0.914	0.966	0.970	0.856	0.978
rc	CH₄	MIDEAST	0.980	0.957	0.979	0.829	0.887	0.747	0.906	0.808	0.676	0.773	0.654	0.899	0.863	0.702	0.779	0.909	0.902	0.971	0.825	0.834
		NORAM	0.930	0.947	0.979	0.959	0.966	0.665	0.829	0.769	0.793	0.976	0.565	0.907	0.839	0.838	0.968	0.850	0.912	0.966	0.910	0.962
		PACOECD	0.936	0.875	0.943	0.901	0.971	0.644	0.698	0.761	0.796	0.917	0.535	0.738	0.794	0.819	0.955	0.841	0.743	0.911	0.842	0.971
		REFECO	0.964	0.672	0.985	0.939	0.964	0.735	0.419	0.830	0.652	0.755	0.640	0.466	0.882	0.716	0.811	0.896	0.470	0.973	0.886	0.923
		OTASIAN	0.973	0.966	0.982	0.982	0.996	0.733	0.934	0.836	0.864	0.932	0.640	0.933	0.875	0.899	0.950	0.898	0.936	0.965	0.961	0.982
		ROW SUBSAFR	0.826	0.000	0.960	0.000	0.000	0.615	0.000	0.819	0.000	0.000	0.559	0.000	0.842	0.000	0.000	0.744	0.000	0.917	0.000	0.000
		CHN	0.981	0.845	0.918	0.870	0.933	0.981	0.862	0.926	0.866	0.902	0.989	0.946	0.941	0.882	0.865	0.988	0.946	0.939	0.891	0.864
		EUWE	0.975	0.929	0.792	0.978	0.936	0.908	0.954	0.784	0.892	0.920	0.975	0.941	0.750	0.828	0.911	0.971	0.941	0.984	0.982	0.908
		SOUASIA	0.970	0.760	0.968	0.928	0.911	0.963	0.742	0.968	0.921	0.915	0.967	0.608	0.981	0.937	0.926	0.969	0.607	0.984	0.943	0.934
		LATAME	0.966	0.823	0.974	0.105	0.908	0.959	0.882	0.975	0.115	0.887	0.973	0.818	0.984	0.070	0.871	0.960	0.818	0.981	0.126	0.862
	N ₂ O	MIDEAST	0.957	0.736	0.975	0.987	0.961	0.947	0.745	0.976	0.987	0.960	0.961	0.529	0.983	0.993	0.963	0.957	0.530	0.970	0.996	0.964
		NORAM	0.947	0.952	0.933	0.925	0.924	0.931	0.957	0.950	0.919	0.925	0.957	0.969	0.959	0.900	0.936	0.955	0.969	0.950	0.947	0.939
		PACOECD	0.920	0.819	0.907	-0.010	0.954	0.892	0.817	0.936	-0.022	0.936	0.947	0.747	0.933	-0.088	0.926	0.949	0.747	0.930	-0.020	0.921
		REFECO	0.928	0.424	0.506	0.475	0.748	0.906	0.465	0.558	0.468	0.746	0.949	0.283	0.609	0.378	0.828	0.954	0.283	0.655	0.492	0.811
		OTASIAN	0.961	0.811	0.966	0.764	0.974	0.950	0.859	0.967	0.754	0.973	0.967	0.736	0.972	0.663	0.963	0.960	0.736	0.953	0.753	0.962
_		ROW	0.000	0.000	0.866	0.000	0.000	0.000	0.000	0.894	0.000	0.000	0.000	0.000	0.891	0.000	0.000	0.000	0.000	0.902	0.000	0.000

Table S7. Available scenarios for each model in the ENGAGE Scenario Explorer

0 means that the model does not provide the corresponding scenario, while 1 means that the model provides the corresponding scenario.



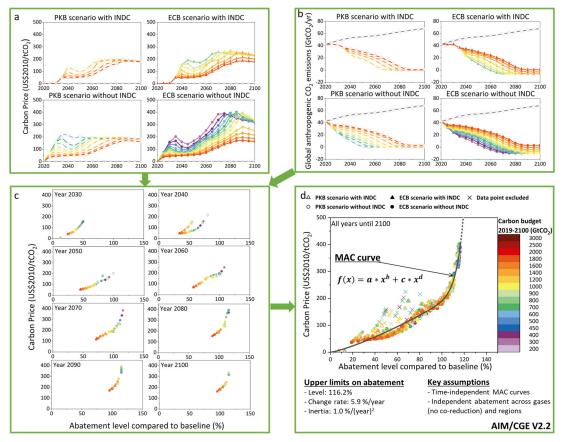


Figure S1. Overview of the methods to derive AIM MAC curves and limits on abatement The description of the figure can be found in the caption of Figure 1.

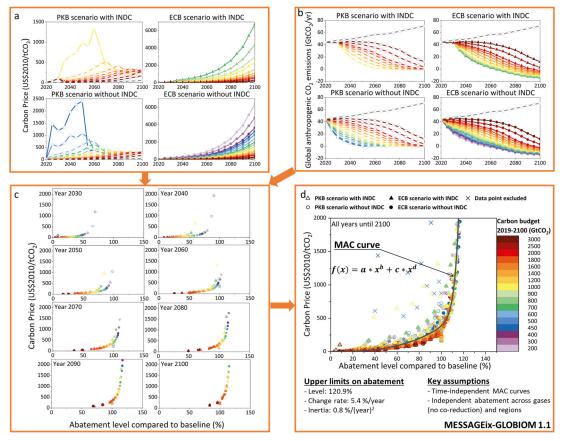


Figure S2. Overview of the methods to derive MESSAGE MAC curves and limits on abatement

The description of the figure can be found in the caption of Figure 1.

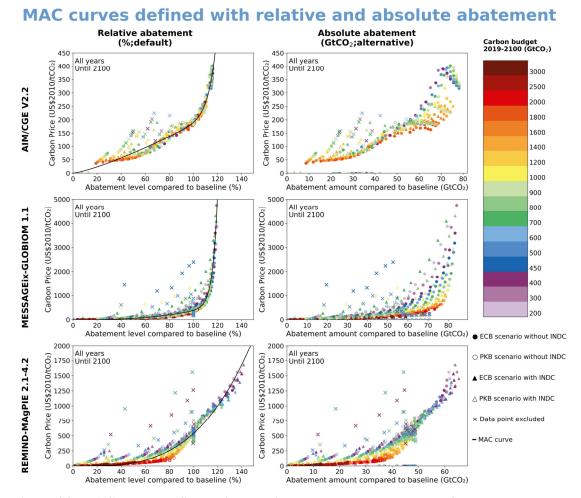


Figure S3. MAC curves defined with relative and absolute abatement for three models The left three panels show the relationship between carbon price and relative abatement level, while the right three panels show the relationship between carbon price and absolute abatement level. Black lines in the left three panels are MAC curves in percentage used in our study.

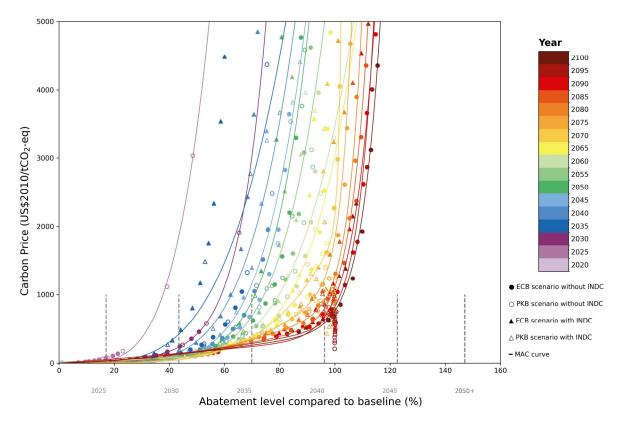


Figure S4. MAC curves of total anthropogenic CO₂ emissions per five years for POLES The dots are original data from the POLES model, and the lines are MAC curves derived from these data for different years.

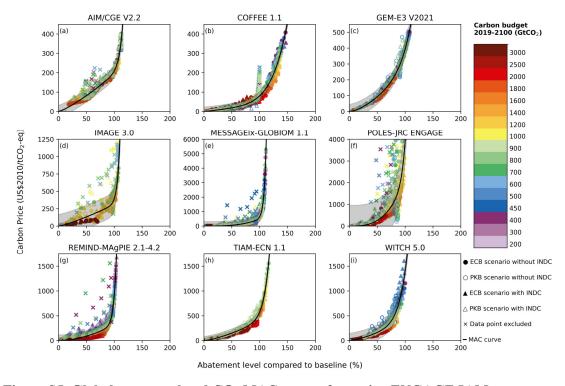


Figure S5. Global energy-related CO₂ MAC curves from nine ENGAGE IAMs The description of the figure can be found in the caption of Figure 2. The same below.

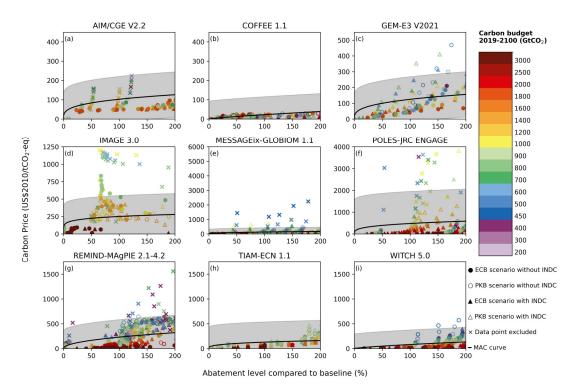


Figure S6. Global non-energy-related CO2 MAC curves from nine ENGAGE IAMs

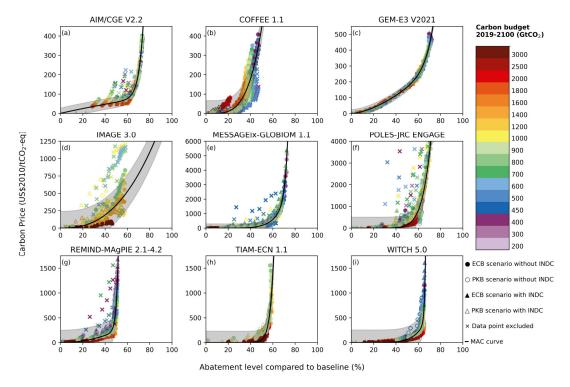


Figure S7. Global total anthropogenic CH4 MAC curves from nine ENGAGE IAMs

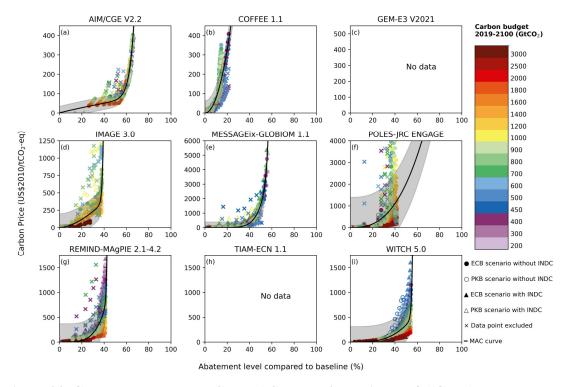


Figure S8. Global energy-related CH4 MAC curves from nine ENGAGE IAMs

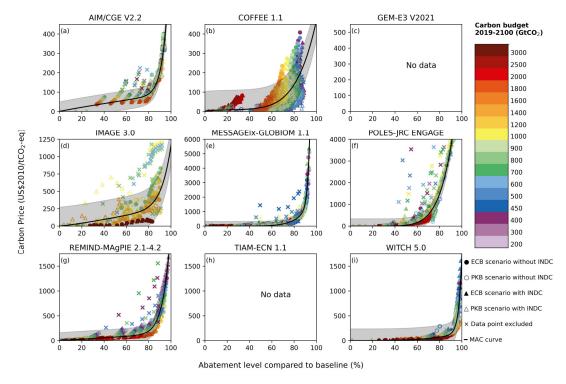


Figure S9. Global non-energy-related CH4 MAC curves from nine ENGAGE IAMs

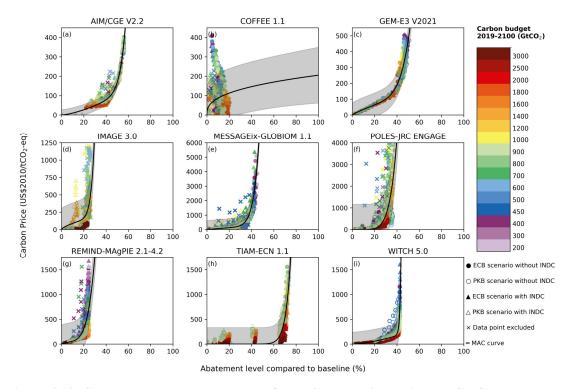


Figure S10. Global total anthropogenic N₂O MAC curves from nine ENGAGE IAMs

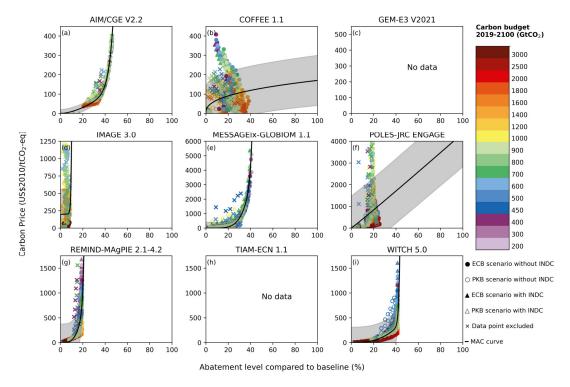


Figure S11. Global energy-related N₂O MAC curves from nine ENGAGE IAMs

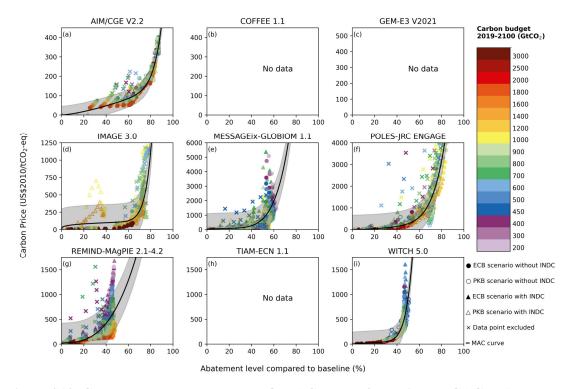


Figure S12. Global non-energy-related N₂O MAC curves from nine ENGAGE IAMs

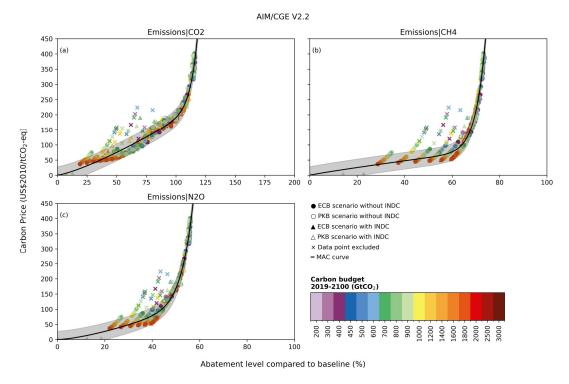


Figure S13. Global AIM MAC curves

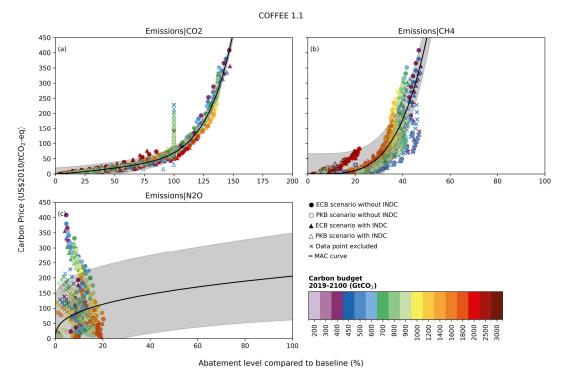


Figure S14. Global COFFEE MAC curves

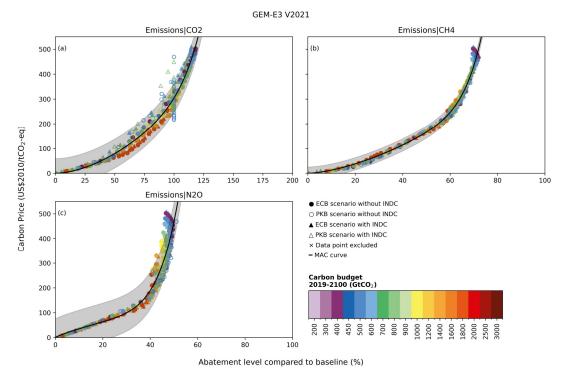


Figure S15. Global GEM MAC curves

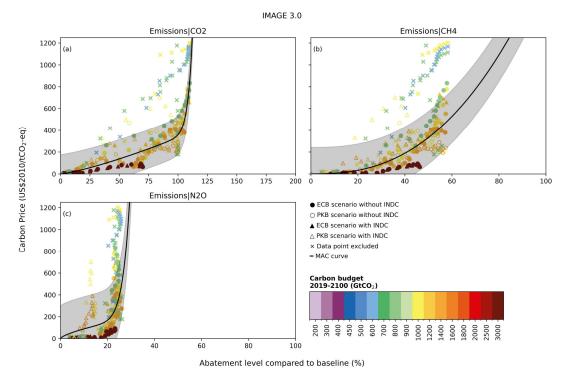


Figure S16. Global IMAGE MAC curves

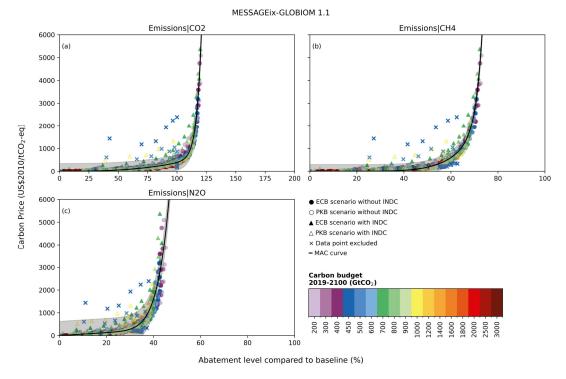


Figure S17. Global MESSAGE MAC curves

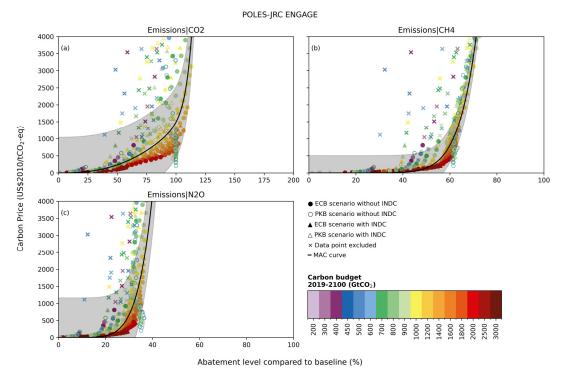


Figure S18. Global POLES MAC curves

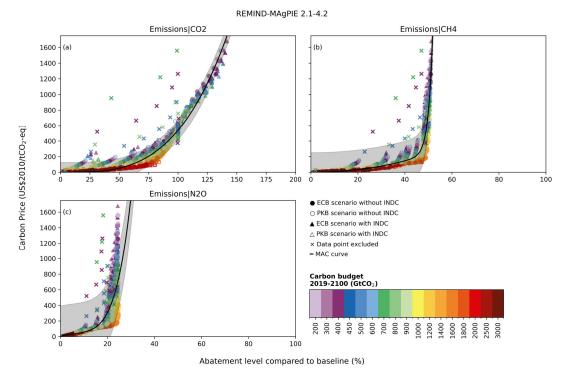


Figure S19. Global REMIND MAC curves

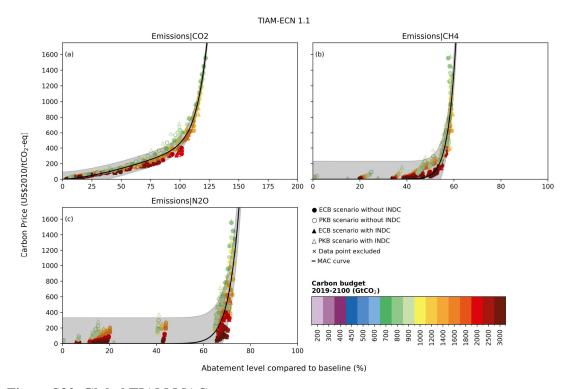


Figure S20. Global TIAM MAC curves

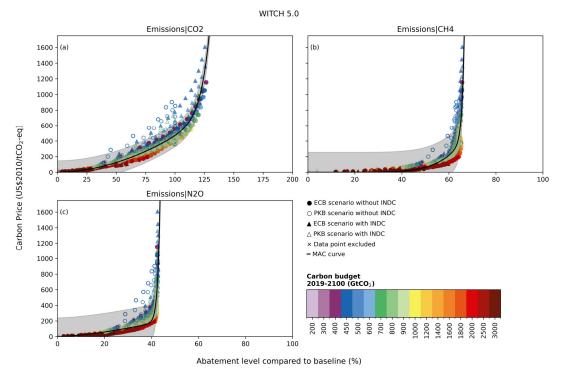


Figure S21. Global WITCH MAC curves

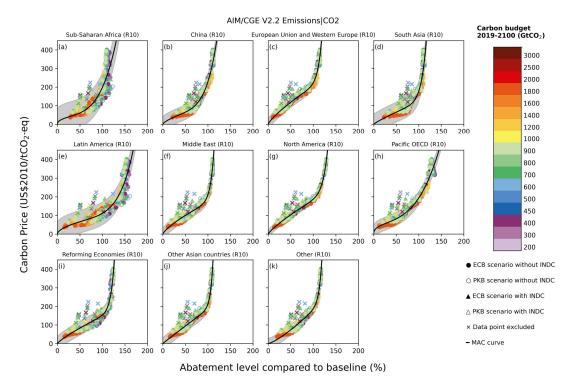


Figure S22. Regional AIM total anthropogenic CO₂ MAC curves

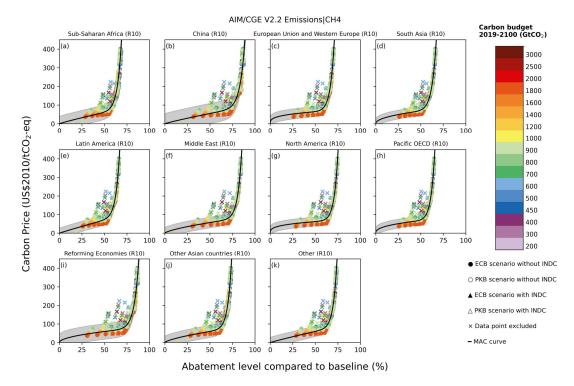


Figure S23. Regional AIM total anthropogenic CH₄ MAC curves

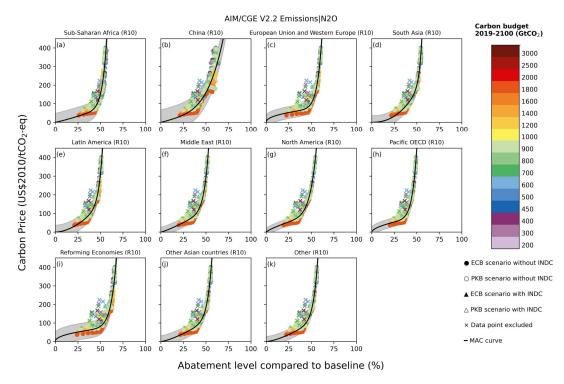


Figure S24. Regional AIM total anthropogenic N₂O MAC curves

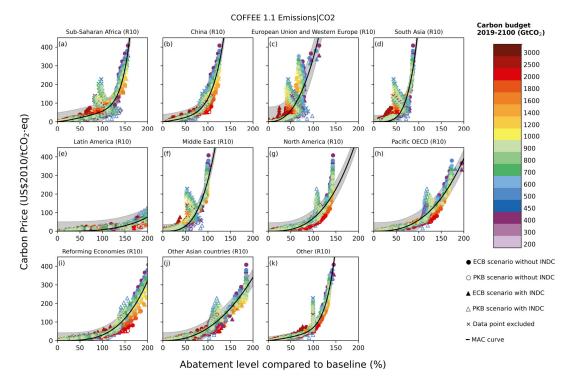


Figure S25. Regional COFFEE total anthropogenic CO2 MAC curves

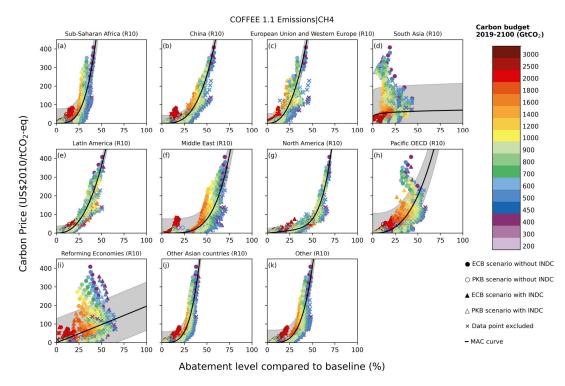


Figure S26. Regional COFFEE total anthropogenic CH₄ MAC curves

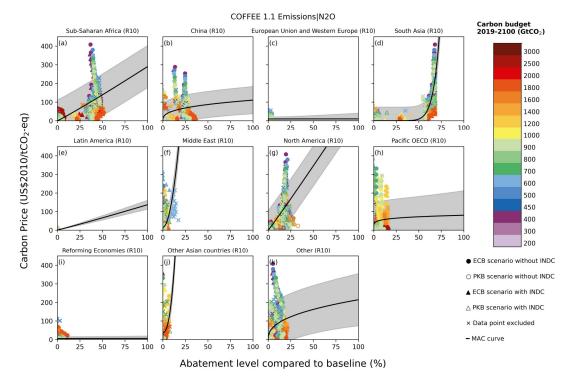


Figure S27. Regional COFFEE total anthropogenic N₂O MAC curves

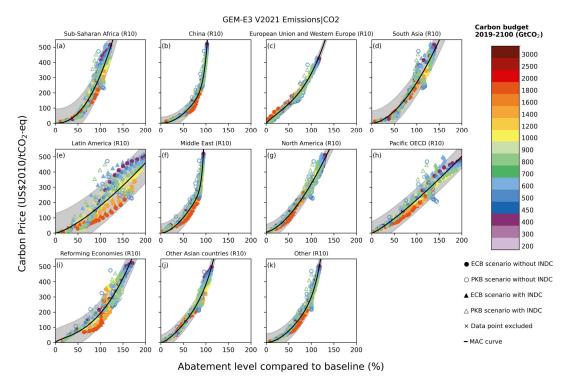


Figure S28. Regional GEM total anthropogenic CO₂ MAC curves

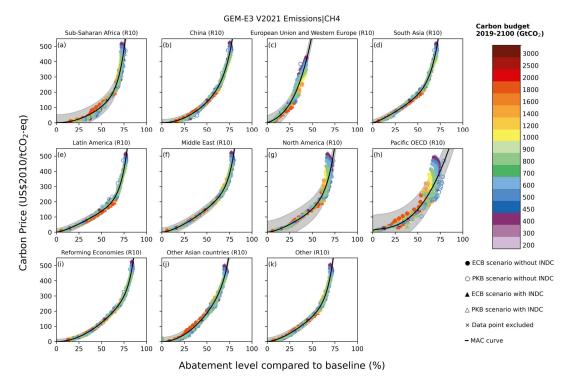


Figure S29. Regional GEM total anthropogenic CH₄ MAC curves

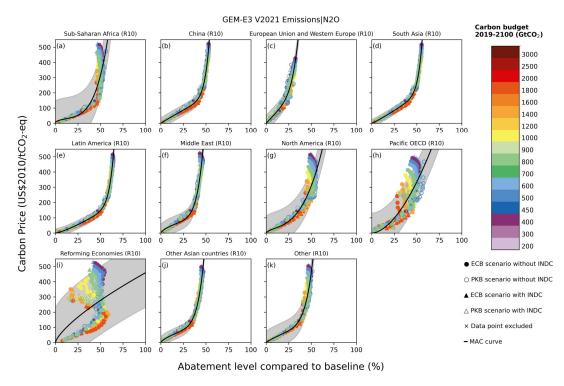


Figure S30. Regional GEM total anthropogenic N₂O MAC curves

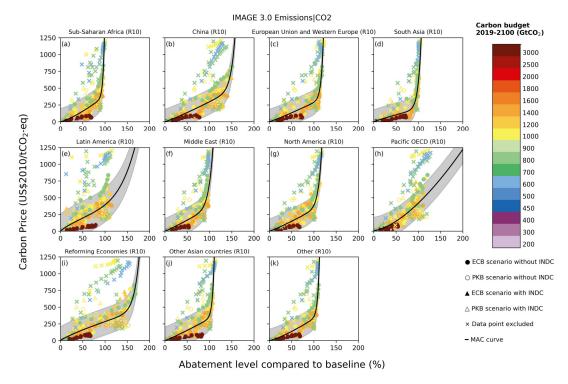


Figure S31. Regional IMAGE total anthropogenic CO2 MAC curves

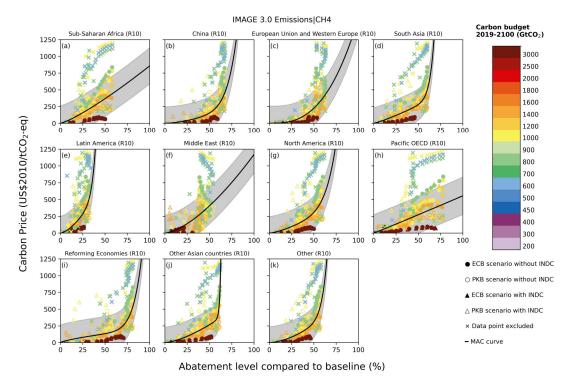


Figure S32. Regional IMAGE total anthropogenic CH₄ MAC curves

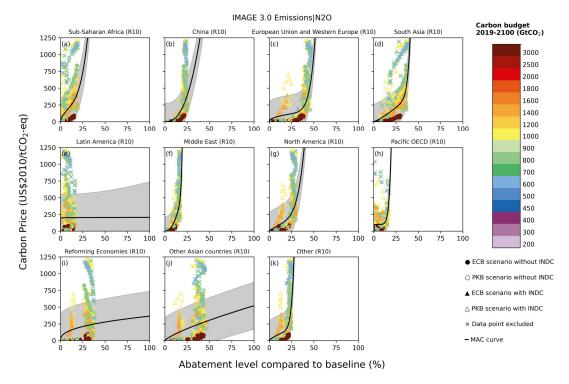


Figure S33. Regional IMAGE total anthropogenic N₂O MAC curves

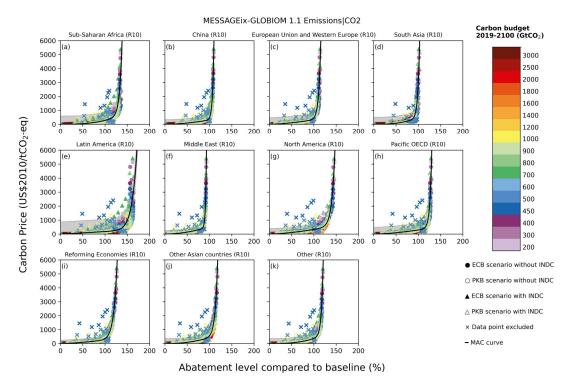


Figure S34. Regional MESSAGE total anthropogenic CO₂ MAC curves

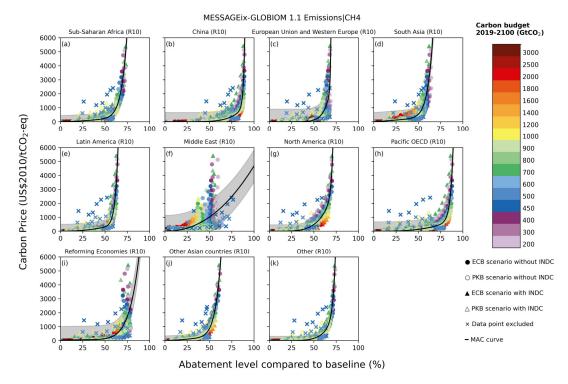


Figure S35. Regional MESSAGE total anthropogenic CH₄ MAC curves

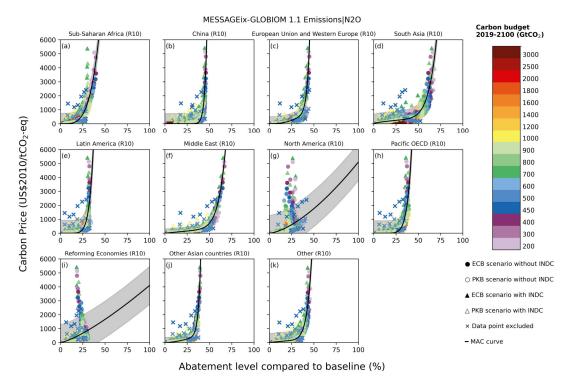
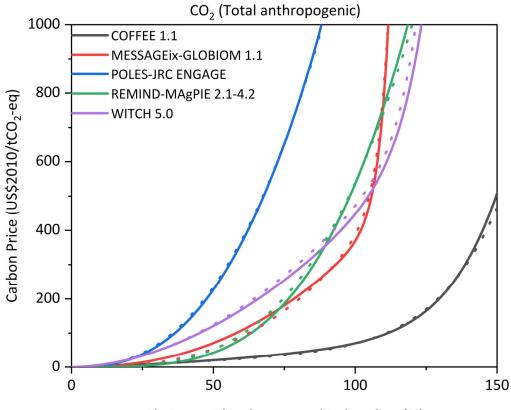
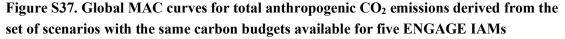


Figure S36. Regional MESSAGE total anthropogenic N₂O MAC curves



Abatement level compared to baseline (%)



The solid lines are MAC curves derived from the subsample (a total of 19 scenarios with the same carbon budgets available commonly for all five IAMs (Table S7)), and the dotted lines are MAC curves derived from the full sample (all scenarios available for each IAM). No upper limit of abatement level is shown for MAC curves.

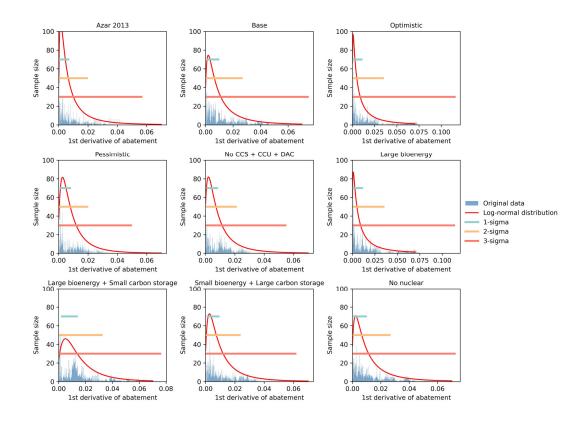


Figure S38. Global GET - Distribution of first derivative of abatement levels

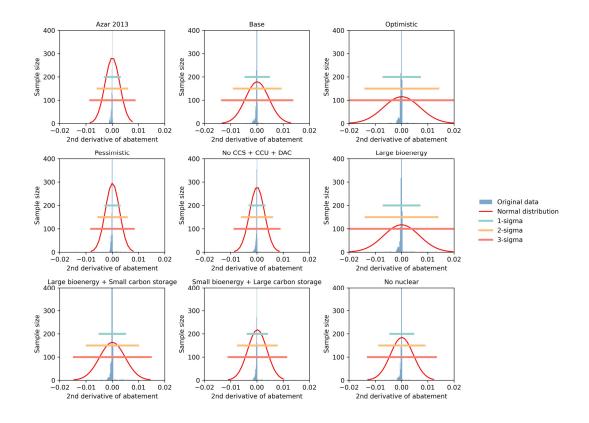


Figure S39. Global GET - Distribution of second derivative of abatement levels

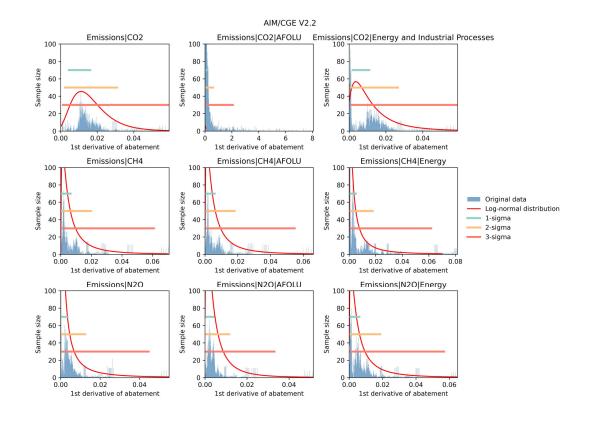


Figure S40. Global AIM - Distribution of first derivative of abatement levels

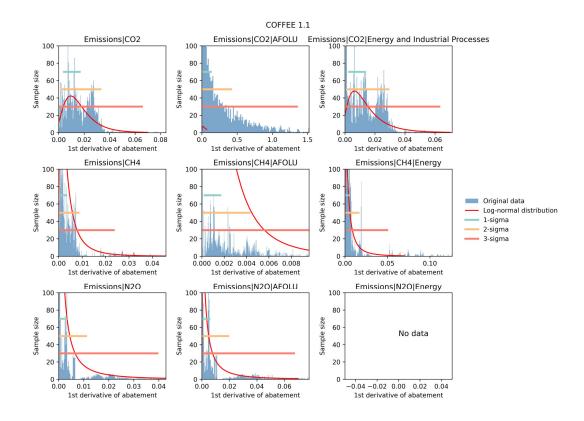


Figure S41. Global COFFEE - Distribution of first derivative of abatement levels

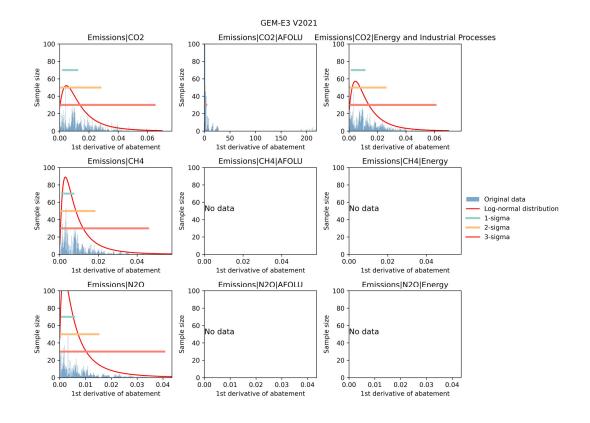


Figure S42. Global GEM - Distribution of first derivative of abatement levels

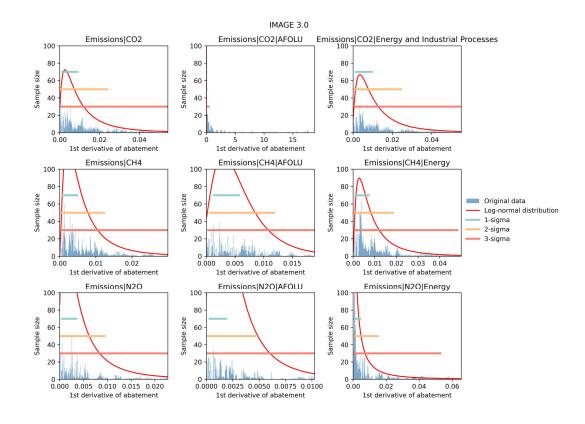
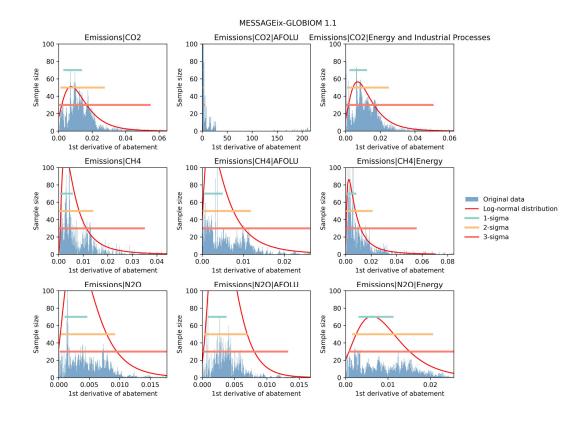


Figure S43. Global IMAGE - Distribution of first derivative of abatement levels





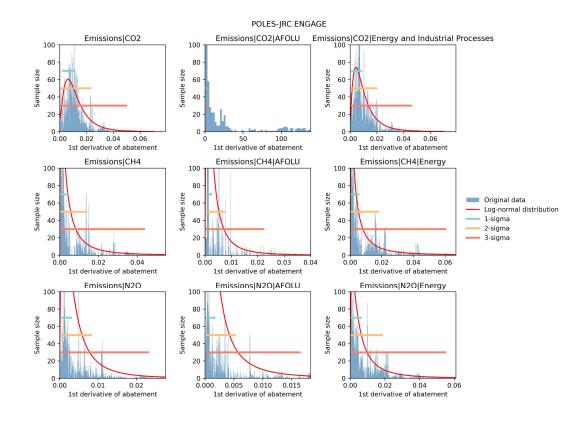


Figure S45. Global POLES - Distribution of first derivative of abatement levels

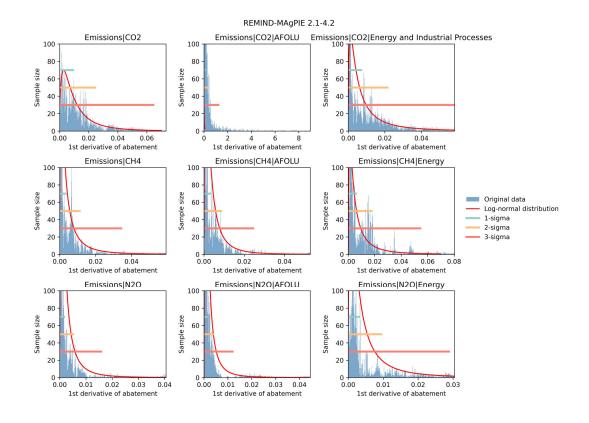


Figure S46. Global REMIND - Distribution of first derivative of abatement levels

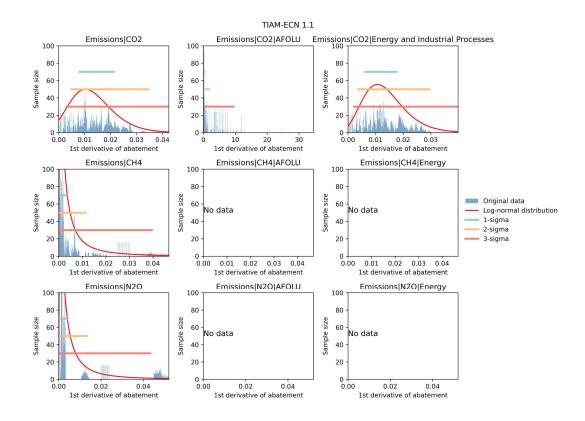
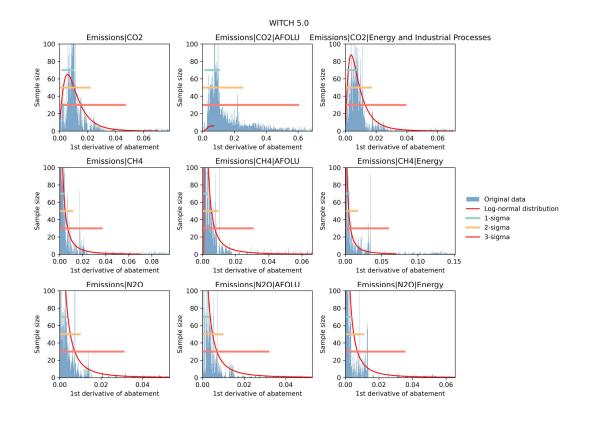
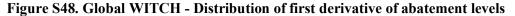


Figure S47. Global TIAM - Distribution of first derivative of abatement levels





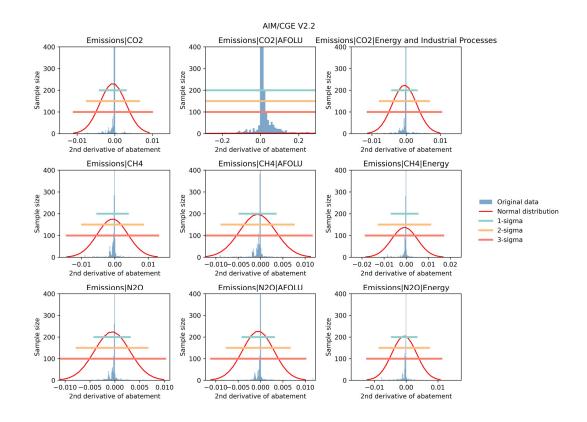
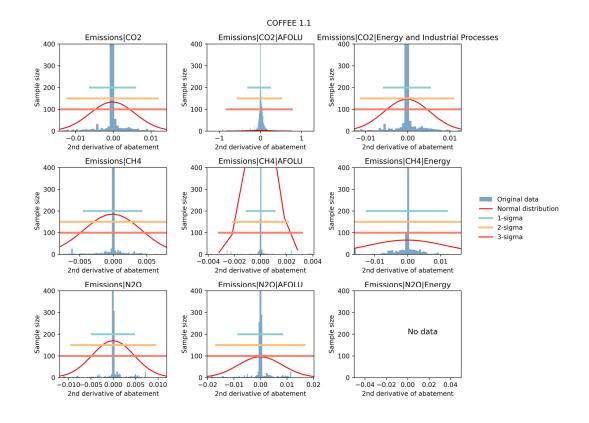


Figure S49. Global AIM - Distribution of second derivative of abatement levels





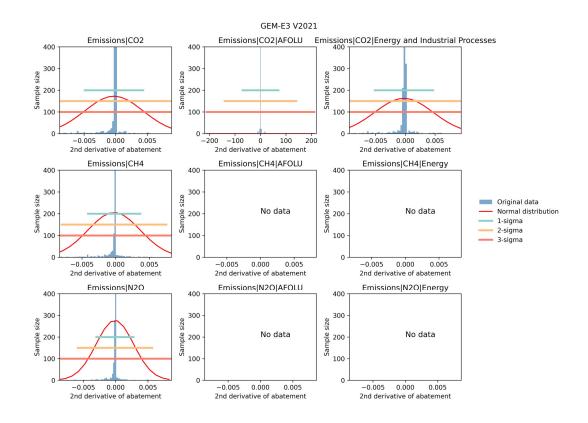
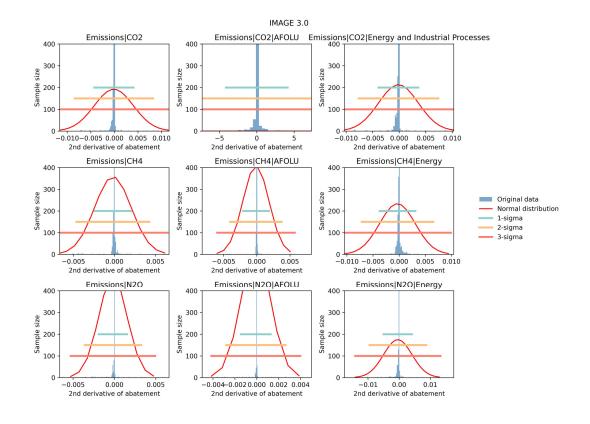
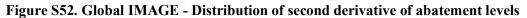


Figure S51. Global GEM - Distribution of second derivative of abatement levels





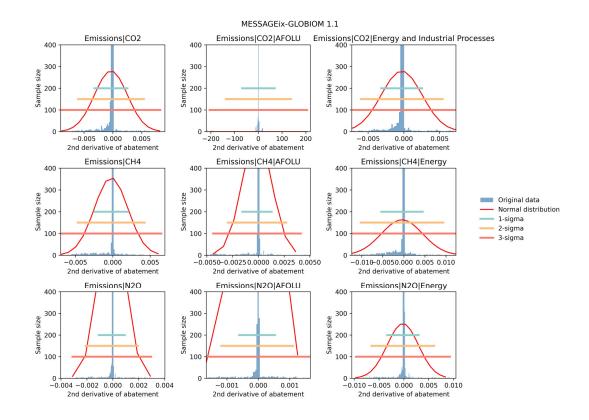
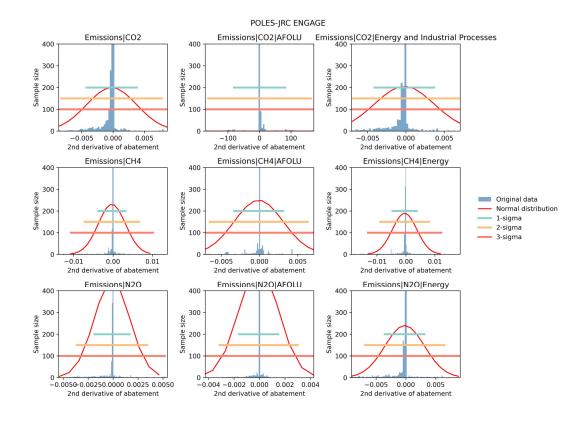
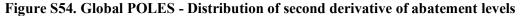


Figure S53. Global MESSAGE - Distribution of second derivative of abatement levels





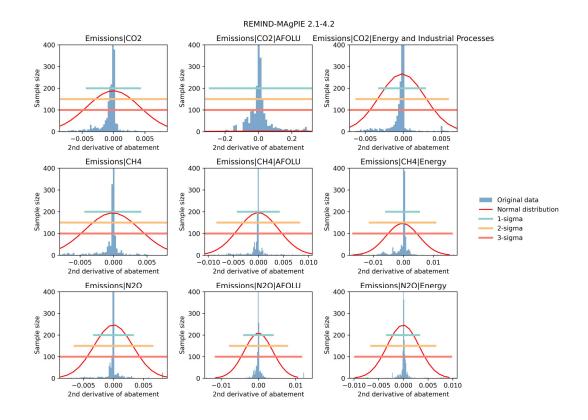


Figure S55. Global REMIND - Distribution of second derivative of abatement levels

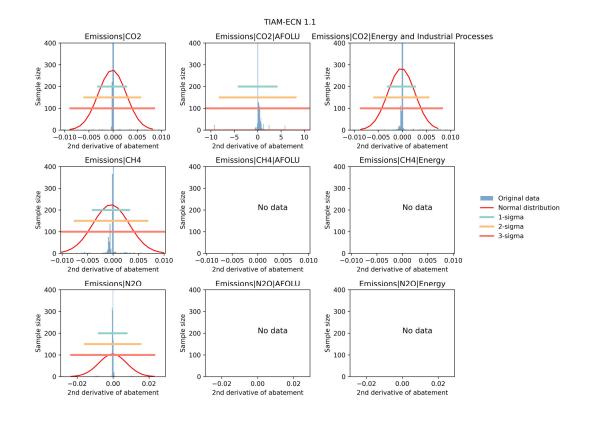


Figure S56. Global TIAM - Distribution of second derivative of abatement levels

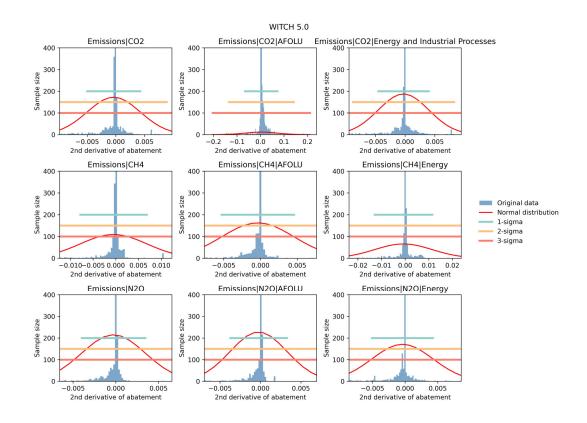
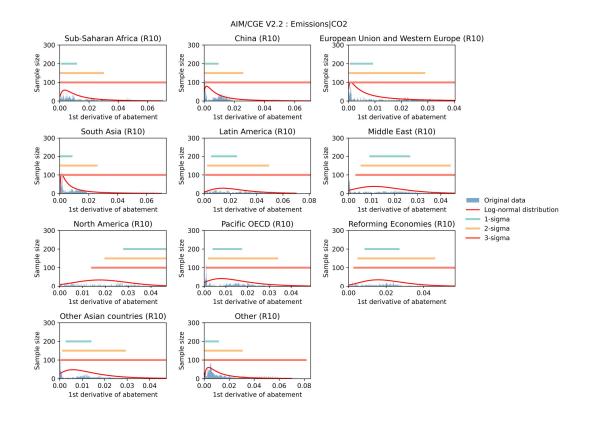
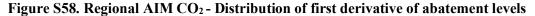


Figure S57. Global WITCH - Distribution of second derivative of abatement levels





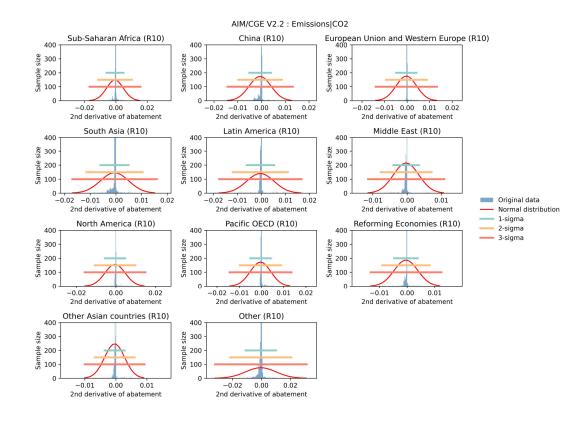
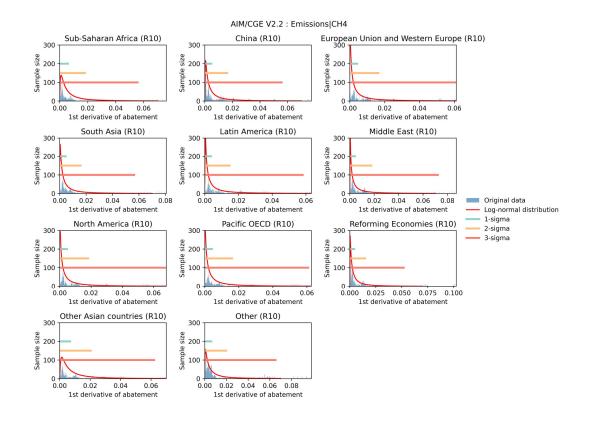


Figure S59. Regional AIM CO₂ - Distribution of first derivative of abatement levels





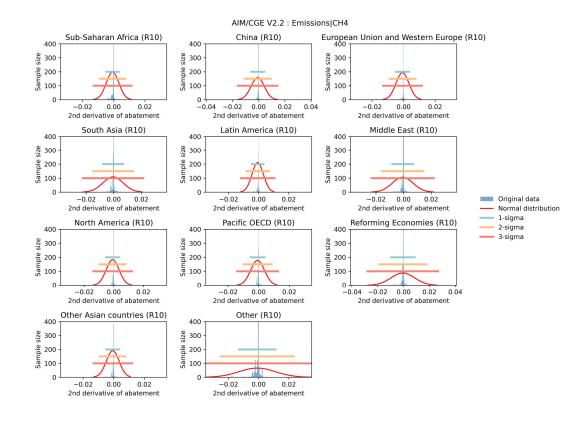
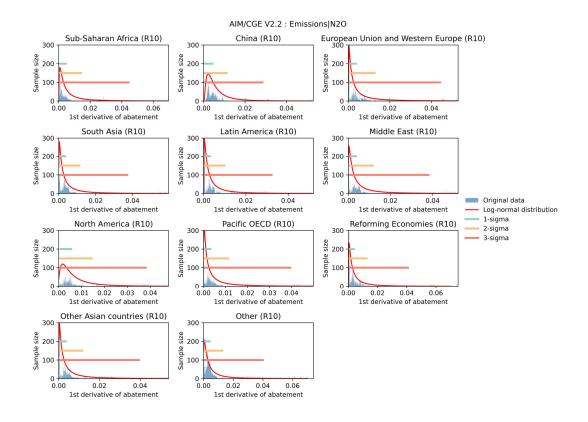
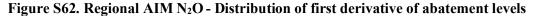


Figure S61. Regional AIM CH₄ - Distribution of second derivative of abatement levels





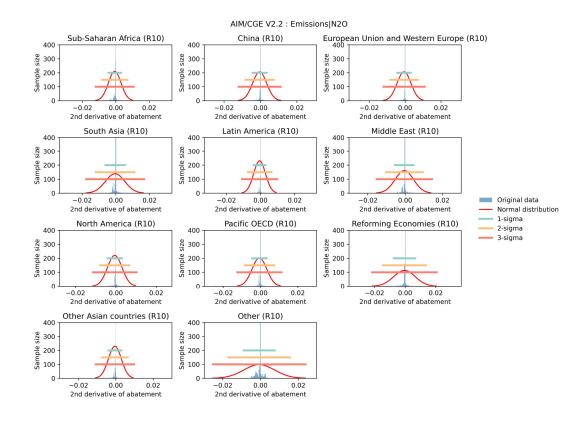


Figure S63. Regional AIM N₂O - Distribution of second derivative of abatement levels

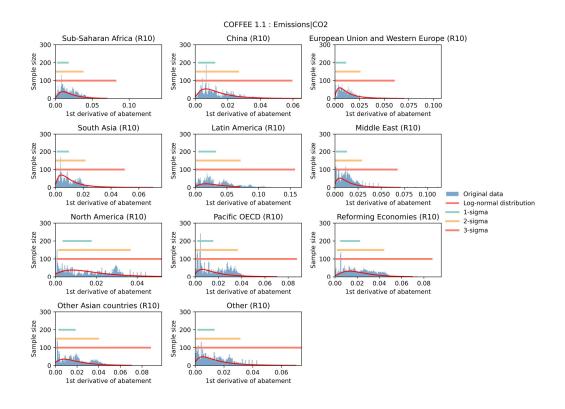


Figure S64. Regional COFFEE CO₂ - Distribution of first derivative of abatement levels

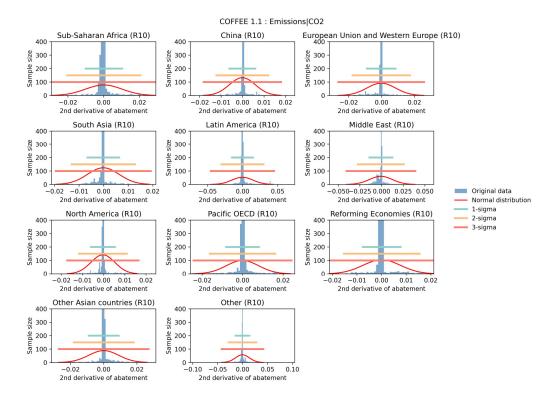


Figure S65. Regional COFFEE CO₂ - Distribution of second derivative of abatement levels

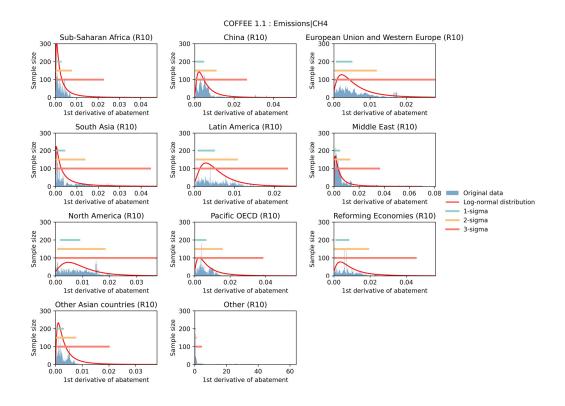


Figure S66. Regional COFFEE CH₄ - Distribution of first derivative of abatement levels

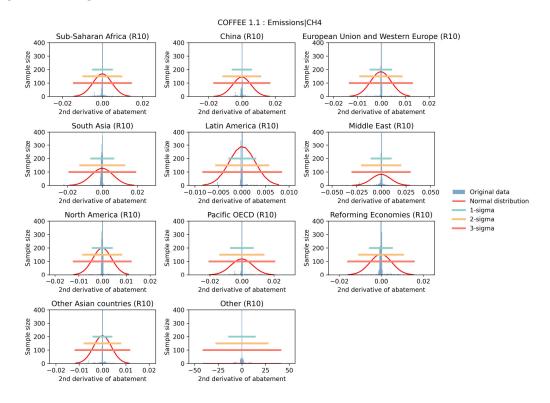


Figure S67. Regional COFFEE CH₄ - Distribution of second derivative of abatement levels

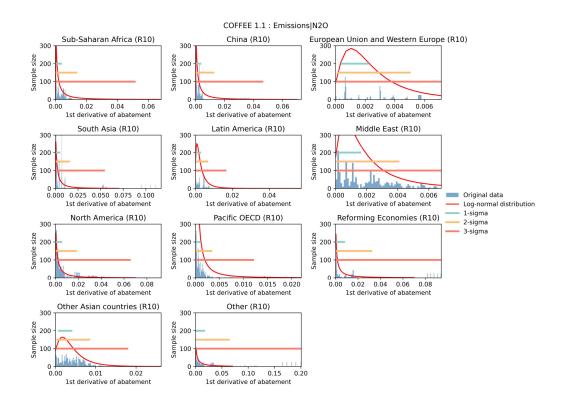


Figure S68. Regional COFFEE N₂O - Distribution of first derivative of abatement levels

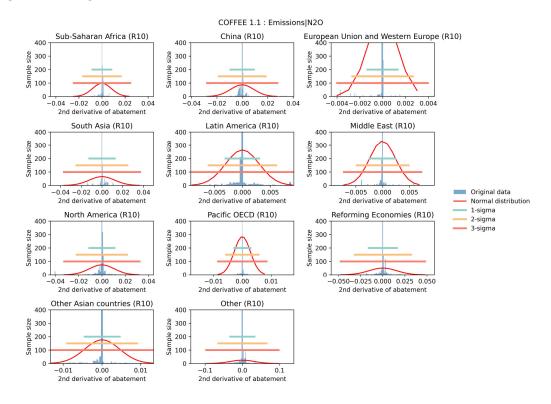
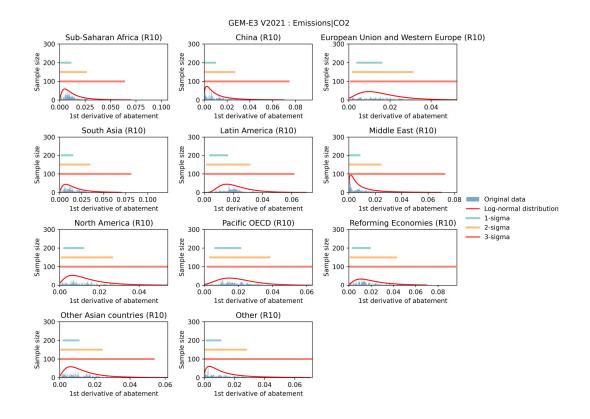


Figure S69. Regional COFFEE N₂O - Distribution of second derivative of abatement levels





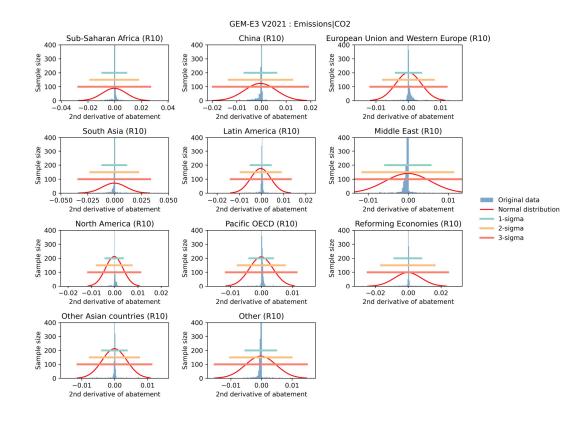


Figure S71. Regional GEM CO₂ - Distribution of second derivative of abatement levels

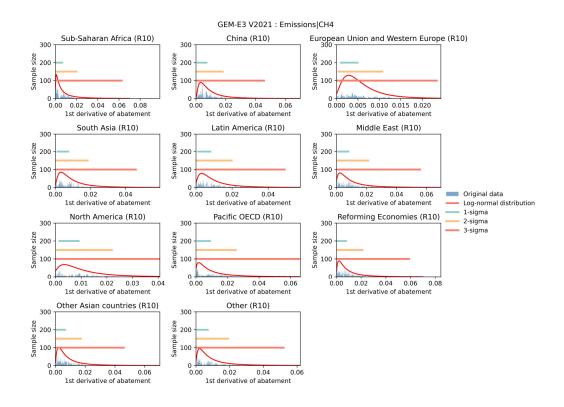


Figure S72. Regional GEM CH₄ - Distribution of first derivative of abatement levels

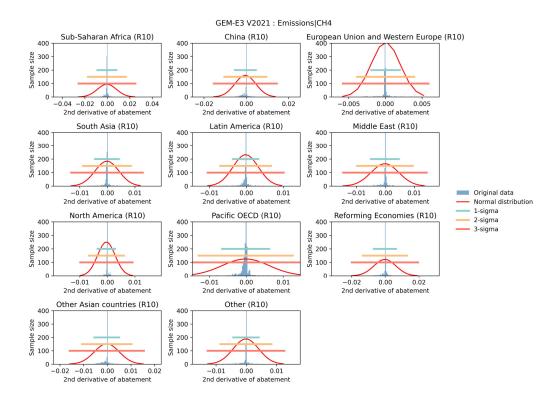


Figure S73. Regional GEM CH₄ - Distribution of second derivative of abatement levels

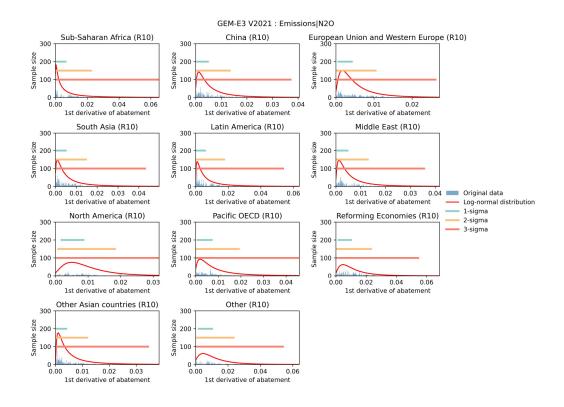


Figure S74. Regional GEM N₂O - Distribution of first derivative of abatement levels

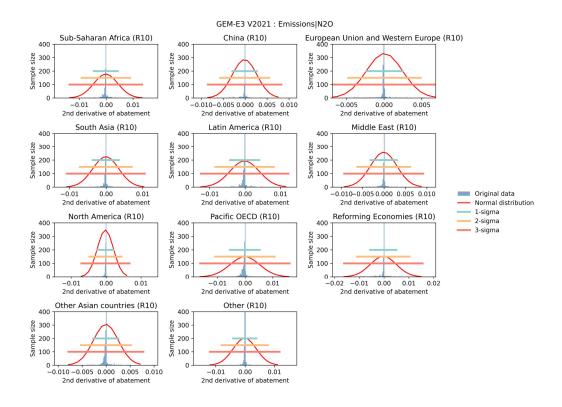


Figure S75. Regional GEM N₂O - Distribution of second derivative of abatement levels

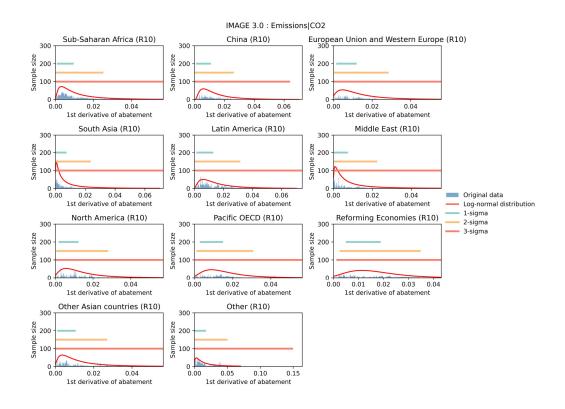


Figure S76. Regional IMAGE CO₂ - Distribution of first derivative of abatement levels

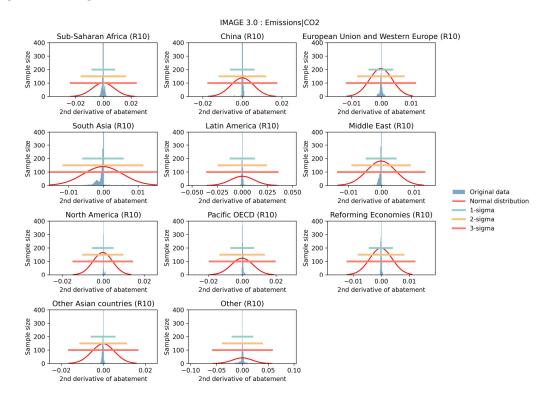


Figure S77. Regional IMAGE CO₂ - Distribution of second derivative of abatement levels

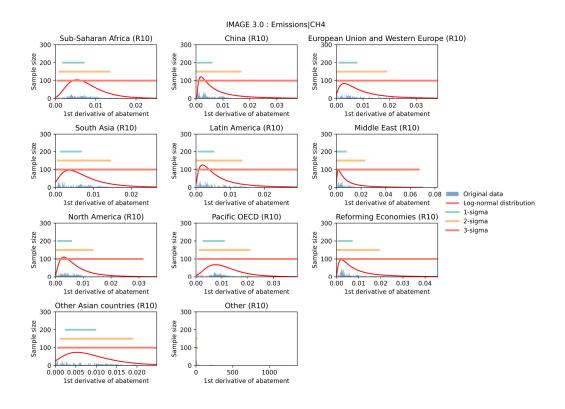


Figure S78. Regional IMAGE CH₄ - Distribution of first derivative of abatement levels

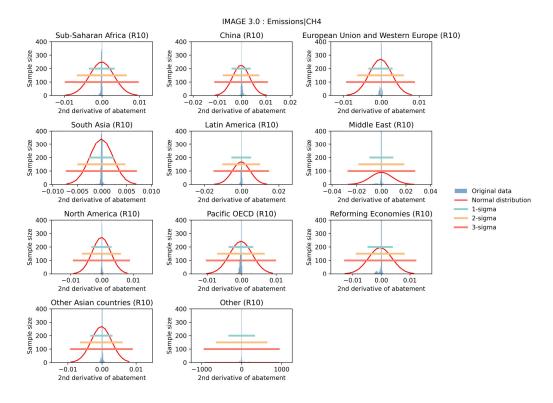


Figure S79. Regional IMAGE CH₄ - Distribution of second derivative of abatement levels

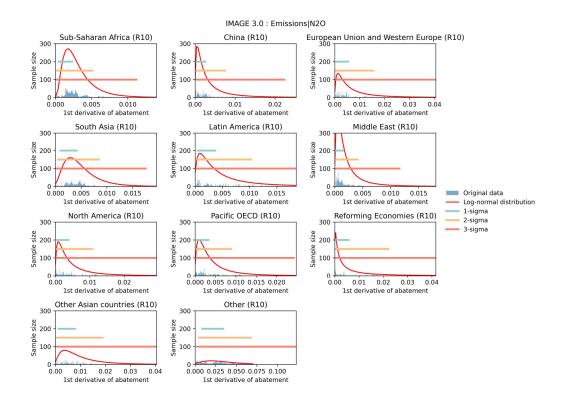


Figure S80. Regional IMAGE N₂O - Distribution of first derivative of abatement levels

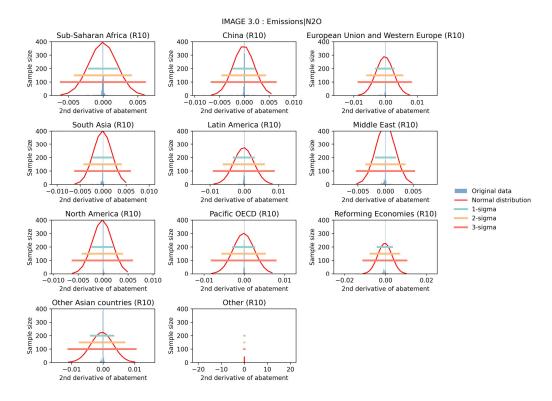


Figure S81. Regional IMAGE N₂O - Distribution of second derivative of abatement levels

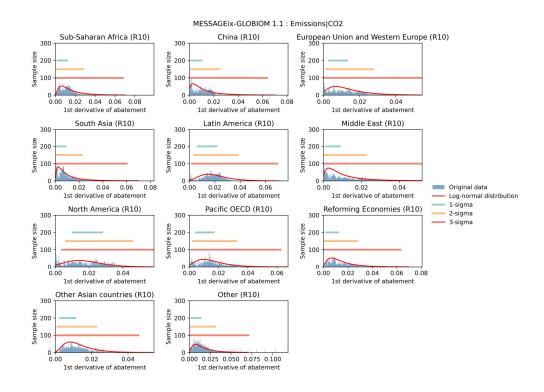


Figure S82. Regional MESSAGE CO₂ - Distribution of first derivative of abatement levels

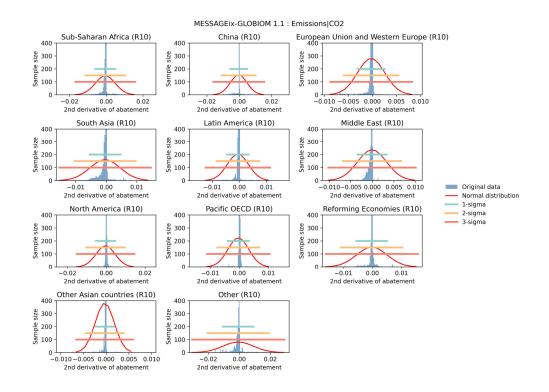


Figure S83. Regional MESSAGE CO₂ - Distribution of second derivative of abatement levels

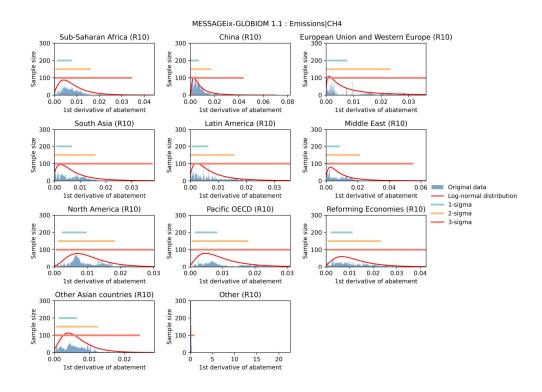


Figure S84. Regional MESSAGE CH₄ - Distribution of first derivative of abatement levels

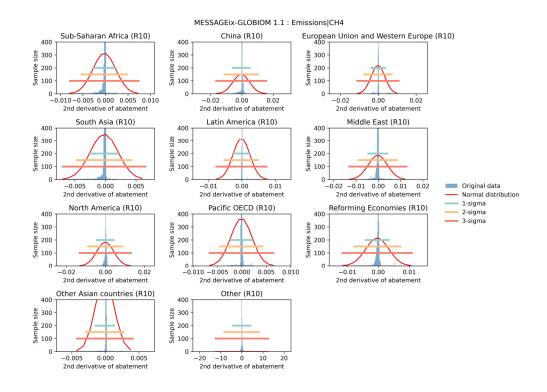


Figure S85. Regional MESSAGE CH₄ - Distribution of second derivative of abatement levels

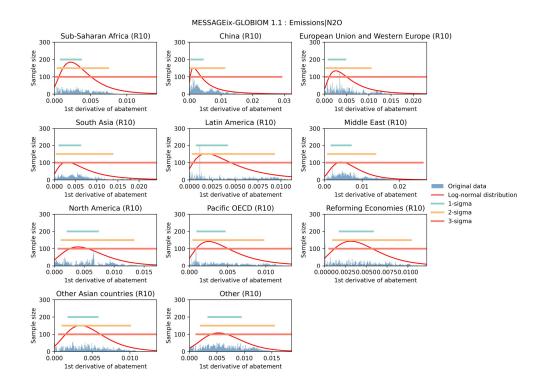


Figure S86. Regional MESSAGE N₂O - Distribution of first derivative of abatement levels

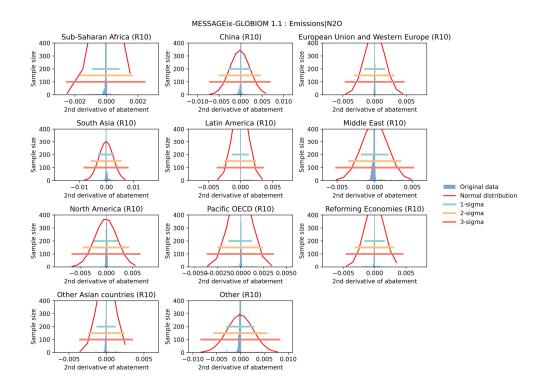


Figure S87. Regional MESSAGE N₂O - Distribution of second derivative of abatement levels

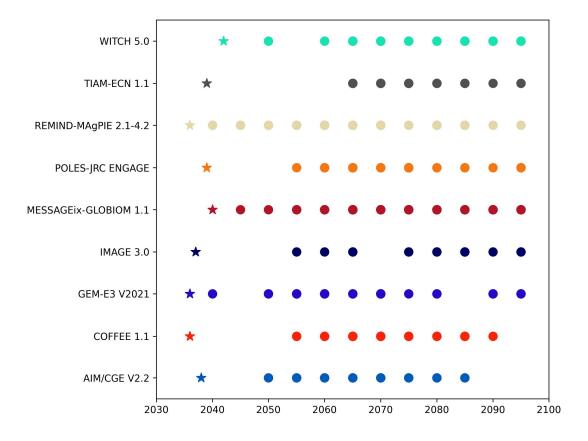
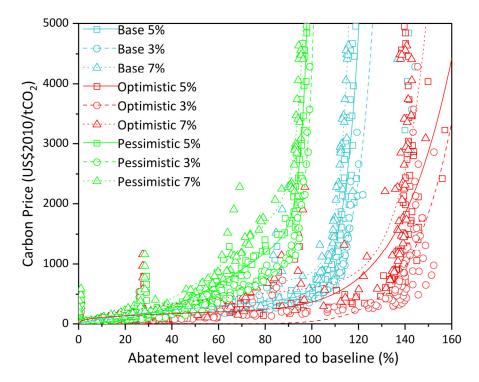
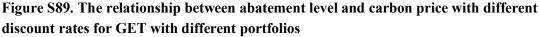


Figure S88. The earliest year of achieving net zero indicated by our emulator

We calculated the earliest year of achieving net zero based on the upper limits of the 1st and 2nd derivatives of abatement changes as shown in stars. The distribution of net-zero years in the carbon budget scenarios of each ENGAGE IAM is shown in circles.





The discount rate in the GET model is changed to 3%, 5% (default), and 7%, respectively.

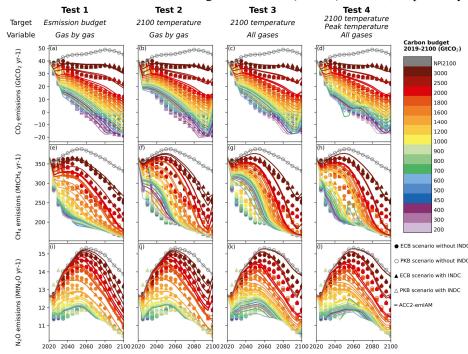


Figure S90. Overview of the validation results for ACC2-emIAM with REMIND as an example

The points show the original emission pathways from REMIND obtained from the ENGAGE Scenario Explorer; the lines show the emission pathways reproduced from ACC2-emIAM. The same color is used for each pair of original and reproduced pathways. The figure shows the comparisons from all scenarios.

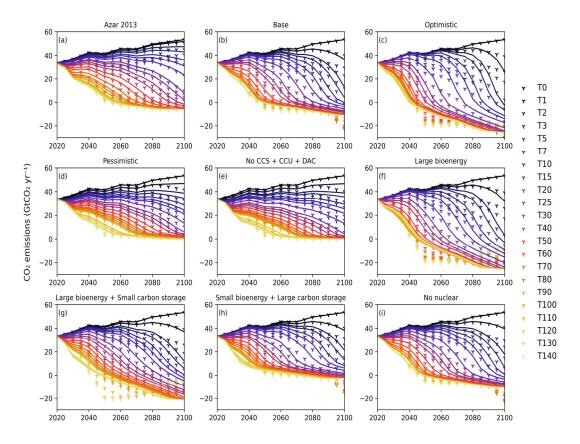


Figure S91. Test 1 – GET nine portfolios energy-related CO₂ validation results

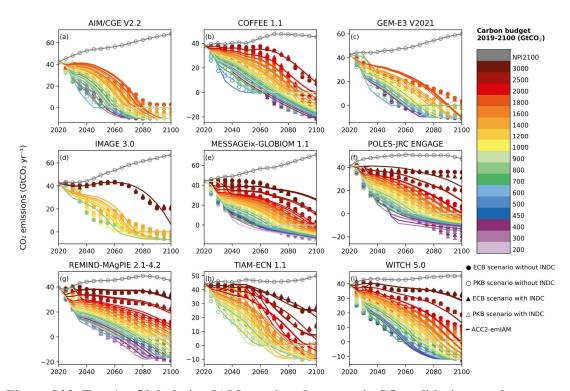


Figure S92. Test 1 – Global nine IAMs total anthropogenic CO₂ validation results

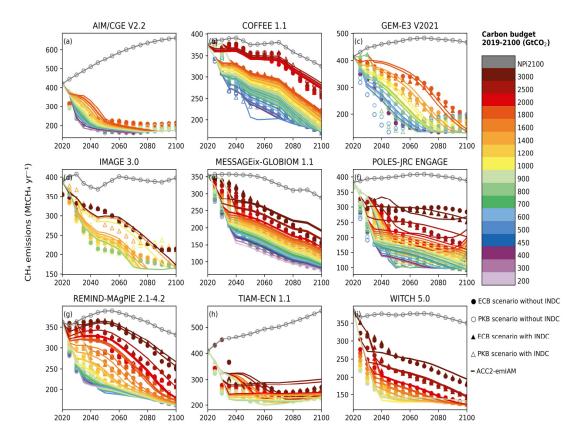


Figure S93. Test 1 – Global nine IAMs total anthropogenic CH₄ validation results

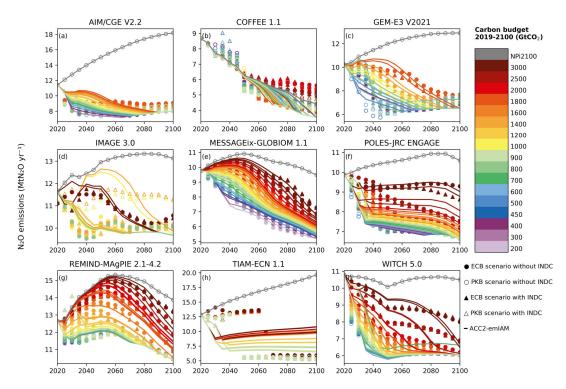


Figure S94. Test 1 – Global nine IAMs total anthropogenic N₂O validation results

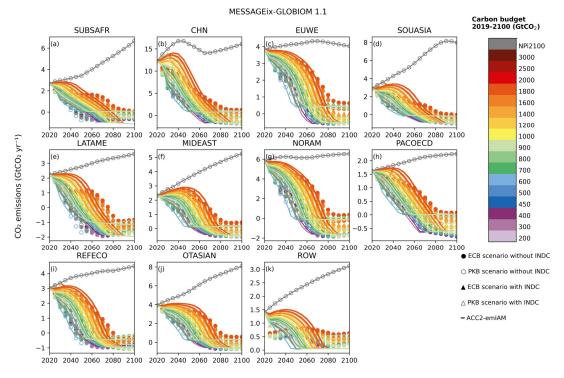


Figure S95. Test 1 - Regional AIM total anthropogenic CO₂ validation results

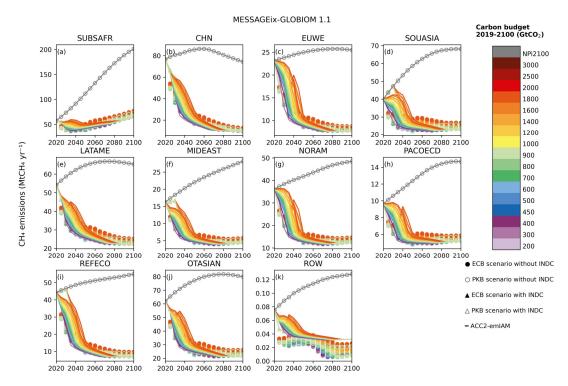


Figure S96. Test 1 - Regional AIM total anthropogenic CH₄ validation results

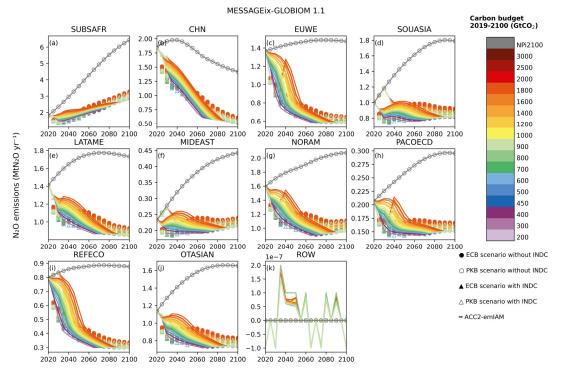


Figure S97. Test 1 - Regional AIM total anthropogenic N₂O validation results

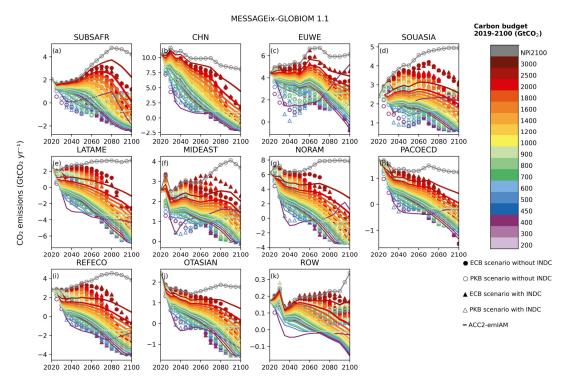


Figure S98. Test 1 - Regional COFFEE total anthropogenic CO₂ validation results

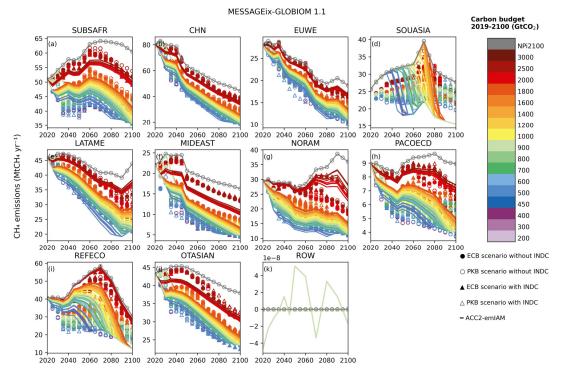


Figure S99. Test 1 - Regional COFFEE total anthropogenic CH₄ validation results

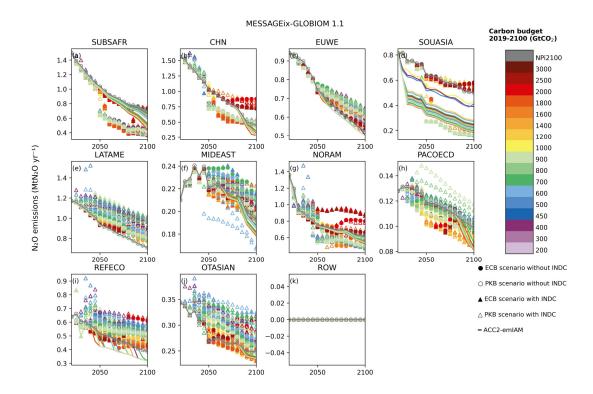


Figure S100. Test 1 - Regional COFFEE total anthropogenic N₂O validation results

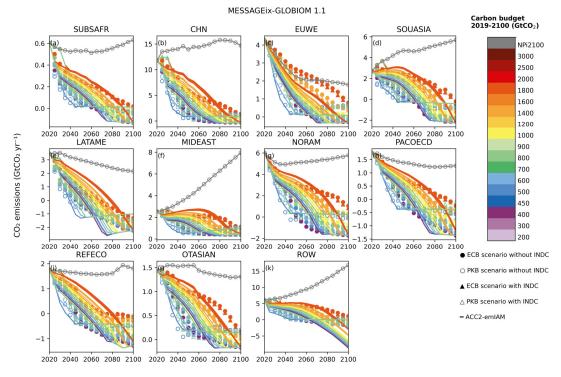


Figure S101. Test 1 - Regional GEM total anthropogenic CO2 validation results

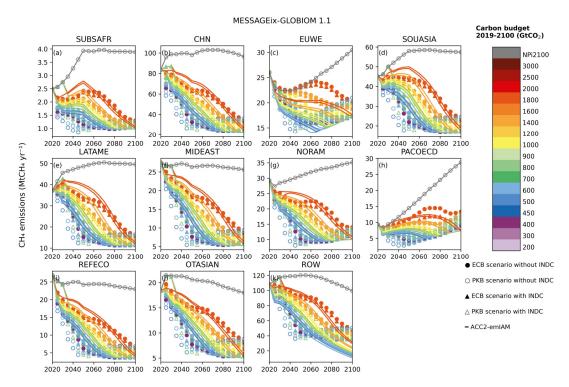


Figure S102. Test 1 - Regional GEM total anthropogenic CH₄ validation results

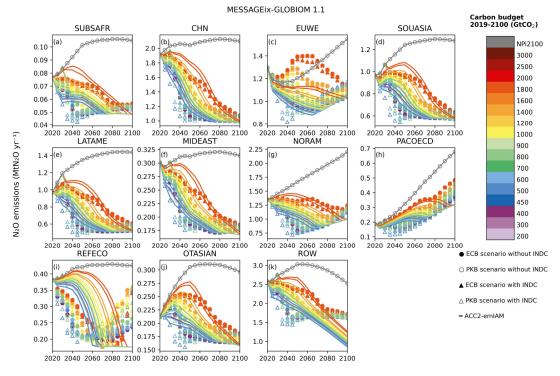


Figure S103. Test 1 - Regional GEM total anthropogenic N₂O validation results

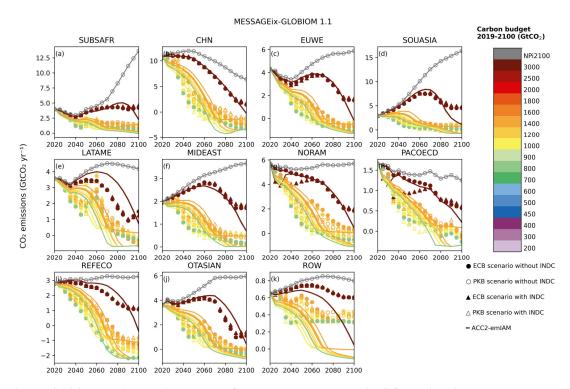


Figure S104. Test 1 - Regional IMAGE total anthropogenic CO₂ validation result

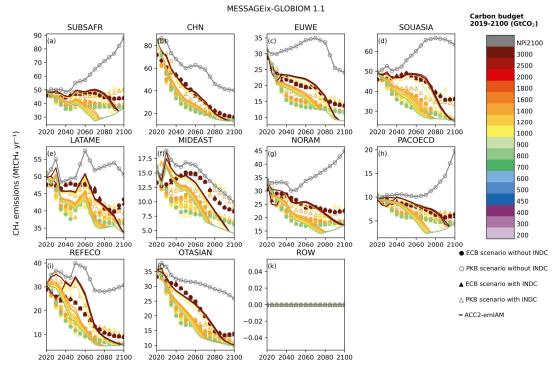


Figure S105. Test 1 - Regional IMAGE total anthropogenic CH₄ validation results

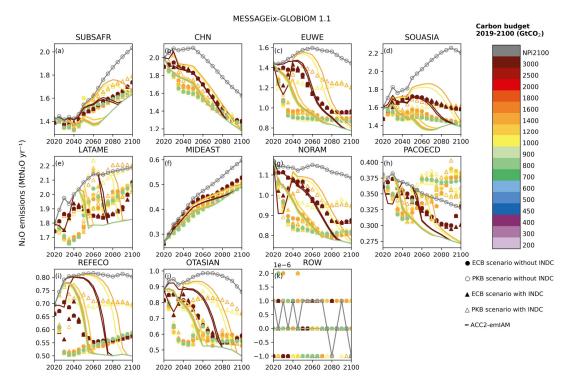


Figure S106. Test 1 - Regional IMAGE total anthropogenic N₂O validation results

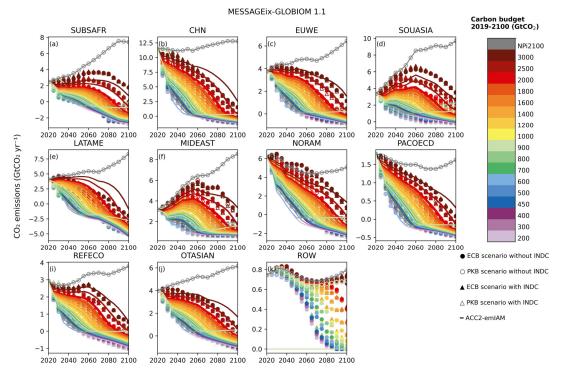


Figure S107. Test 1 - Regional MESSAGE total anthropogenic CO₂ validation results

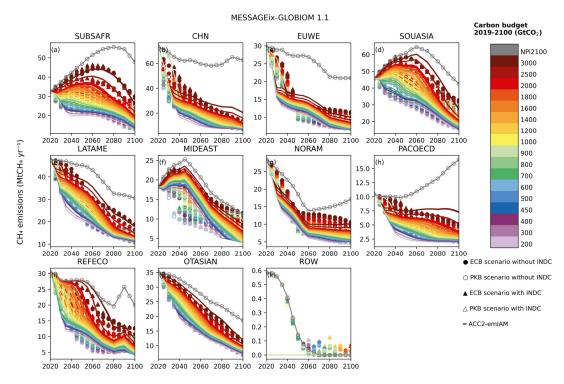


Figure S108. Test 1 - Regional MESSAGE total anthropogenic CH₄ validation results

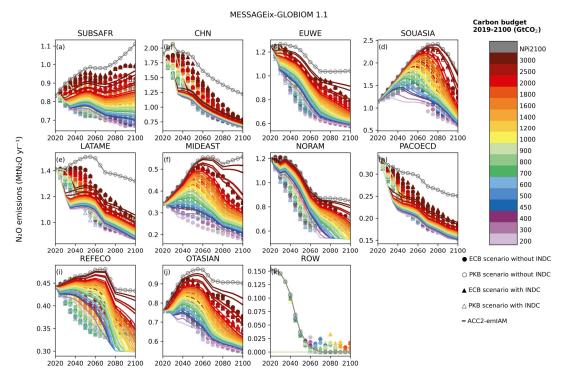


Figure S109. Test 1 - Regional MESSAGE total anthropogenic N₂O validation results

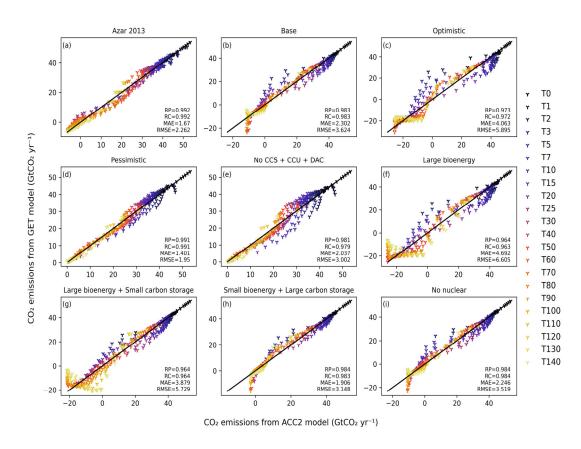


Figure S110. Test 1 – GET - Reproducibility of energy-related CO2

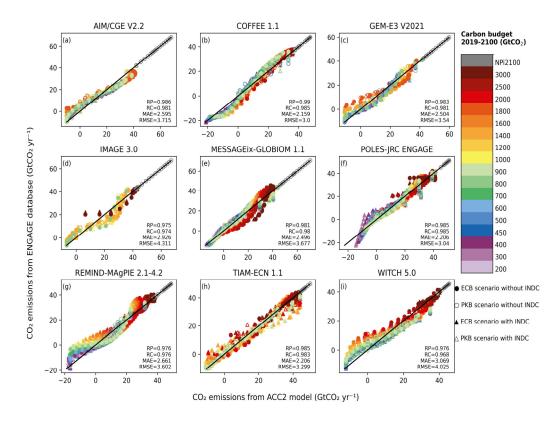


Figure S111. Test 1 - Global nine IAMs - Reproducibility of total anthropogenic CO2

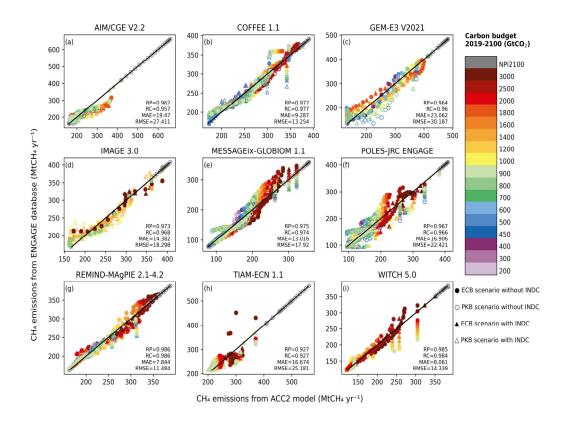


Figure S112. Test 1 - Global nine IAMs - Reproducibility of total anthropogenic CH4

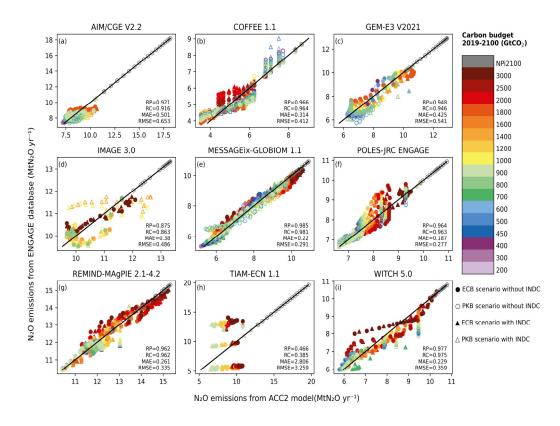


Figure S113. Test 1 - Global nine IAMs - Reproducibility of total anthropogenic N₂O

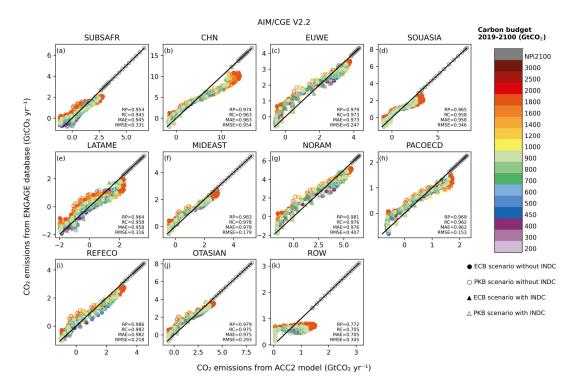


Figure S114. Test 1 - Regional AIM - Reproducibility of total anthropogenic CO2

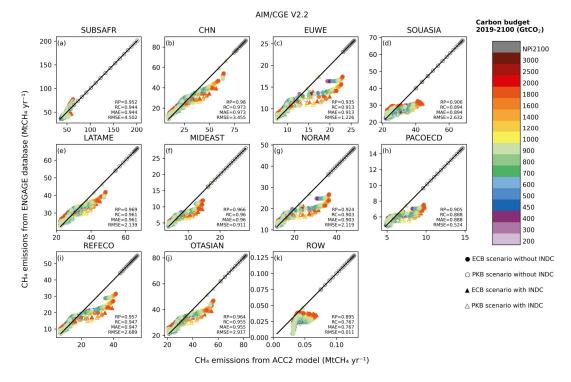


Figure S115. Test 1 - Regional AIM - Reproducibility of total anthropogenic CH4

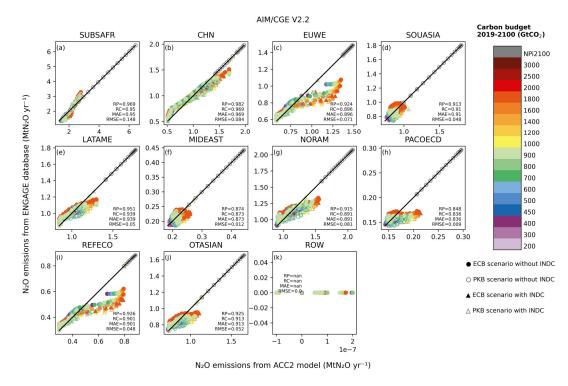


Figure S116. Test 1 - Regional AIM - Reproducibility of total anthropogenic N2O

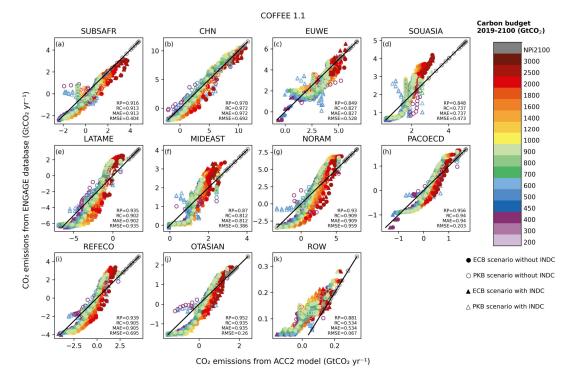


Figure S117. Test 1 - Regional COFFEE - Reproducibility of total anthropogenic CO2

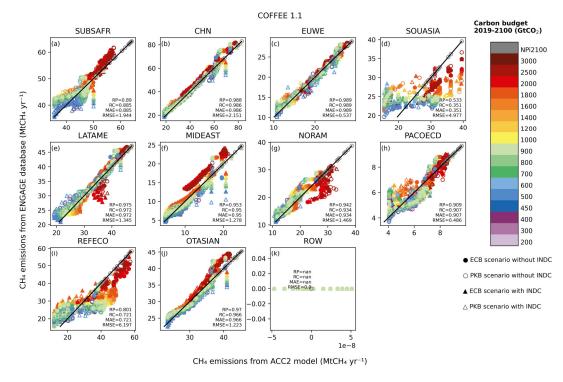


Figure S118. Test 1 - Regional COFFEE - Reproducibility of total anthropogenic CH4

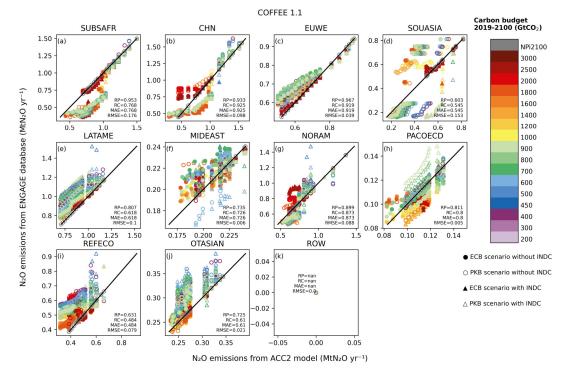


Figure S119. Test 1 - Regional COFFEE - Reproducibility of total anthropogenic N2O

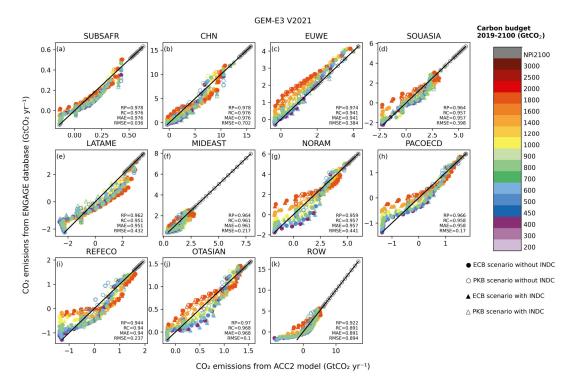


Figure S120. Test 1 - Regional GEM - Reproducibility of total anthropogenic CO2

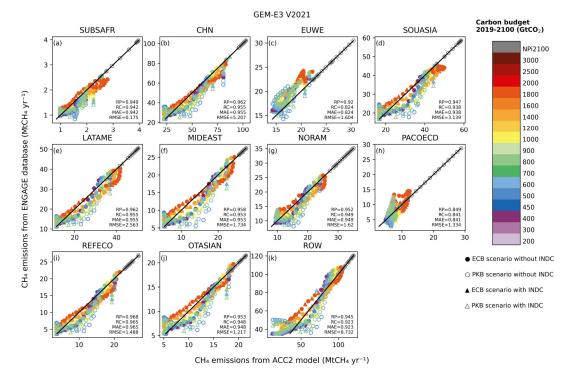


Figure S121. Test 1 - Regional GEM - Reproducibility of total anthropogenic CH4

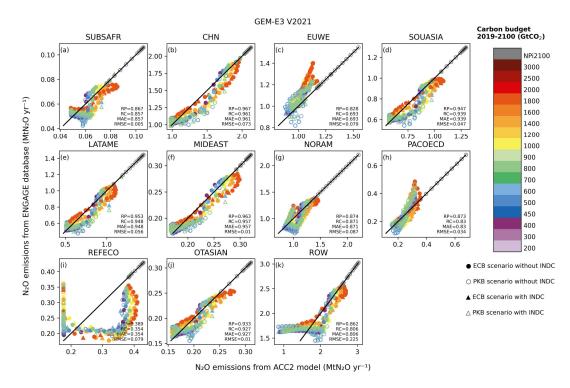


Figure S122. Test 1 - Regional GEM - Reproducibility of total anthropogenic N2O

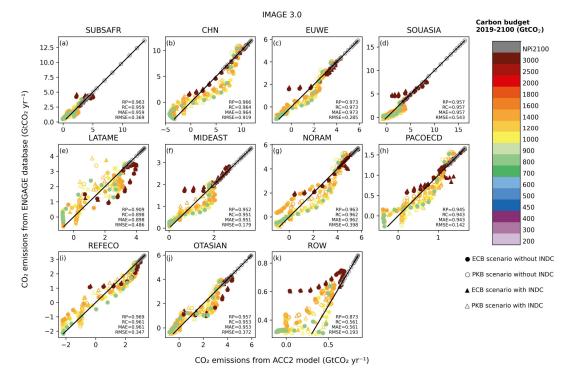


Figure S123. Test 1 - Regional IMAGE - Reproducibility of total anthropogenic CO2

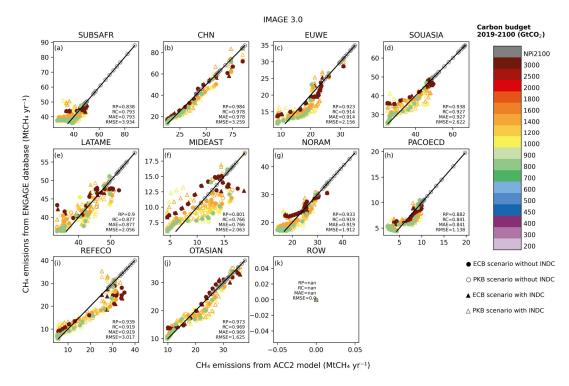


Figure S124. Test 1 - Regional IMAGE - Reproducibility of total anthropogenic CH4

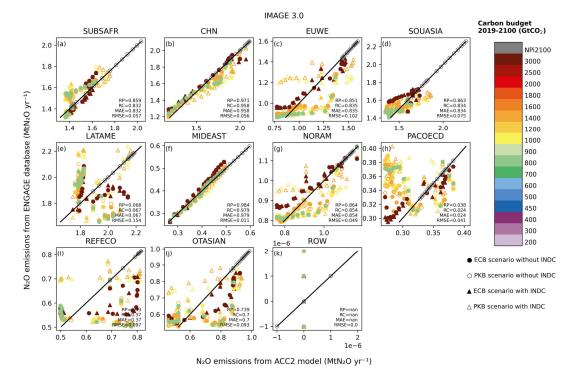


Figure S125. Test 1 - Regional IMAGE - Reproducibility of total anthropogenic N₂O

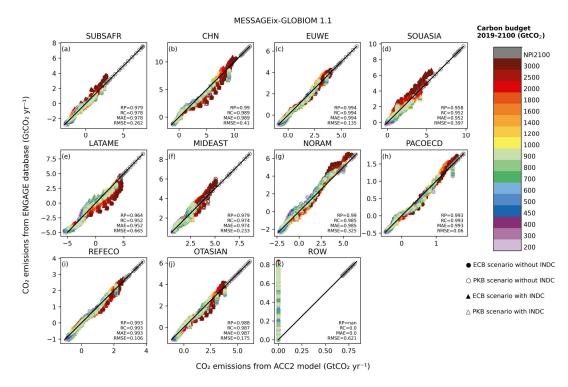


Figure S126. Test 1 - Regional MESSAGE - Reproducibility of total anthropogenic CO2

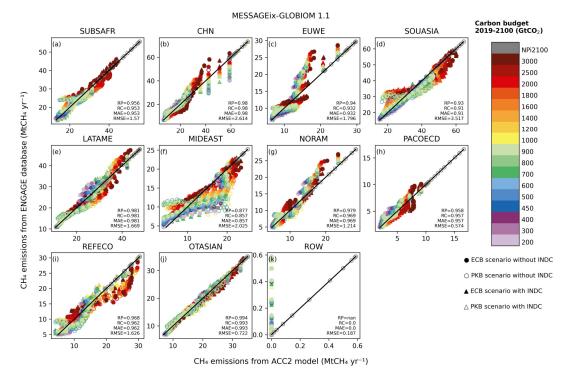


Figure S127. Test 1 - Regional MESSAGE - Reproducibility of total anthropogenic CH4

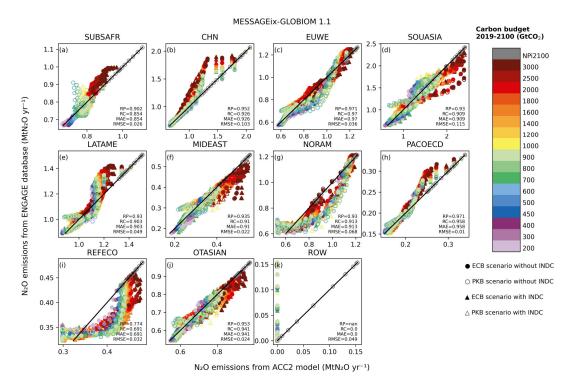


Figure S128. Test 1 - Regional MESSAGE - Reproducibility of total anthropogenic N₂O

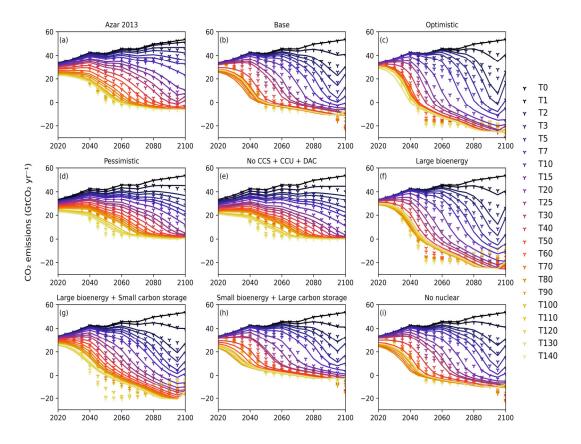


Figure S129. Test 2 – GET nine portfolios energy-related CO₂ validation results

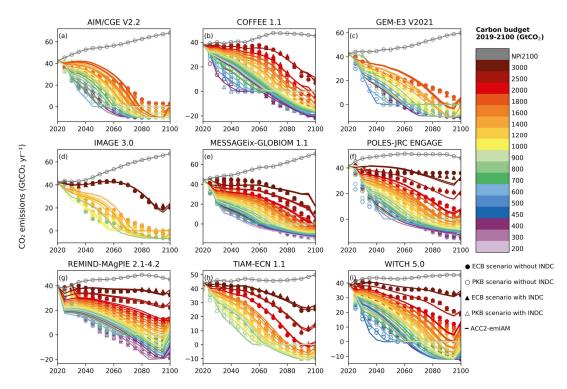


Figure S130. Test 2 – Global nine IAMs total anthropogenic CO₂ validation results

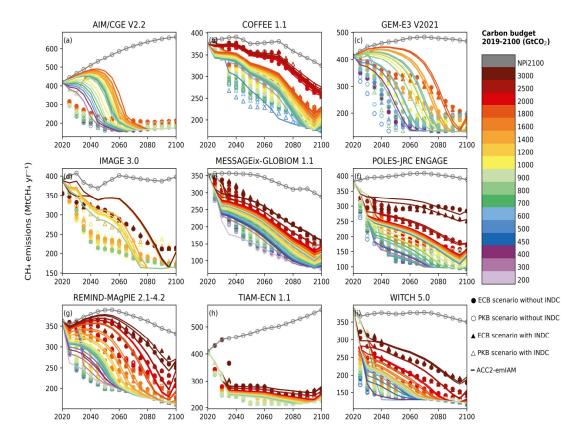


Figure S131. Test 2 – Global nine IAMs total anthropogenic CH₄ validation results

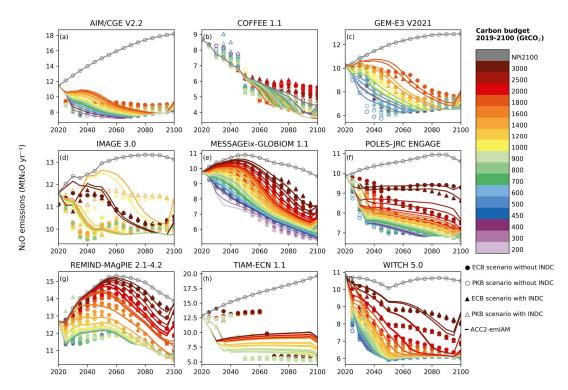


Figure S132. Test 2 – Global nine IAMs total anthropogenic N₂O validation results

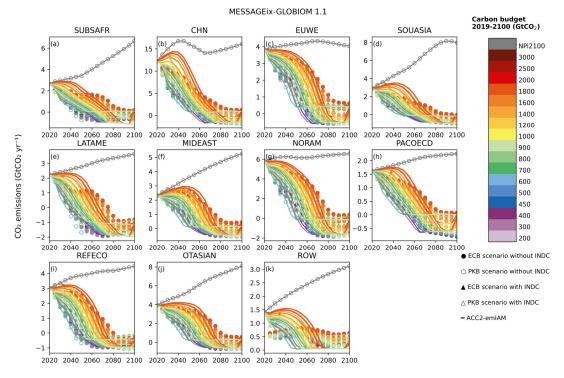


Figure S133. Test 2 - Regional AIM total anthropogenic CO₂ validation results

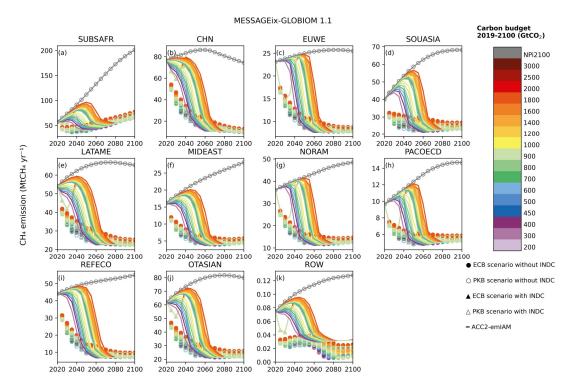


Figure S134. Test 2 - Regional AIM total anthropogenic CH₄ validation results

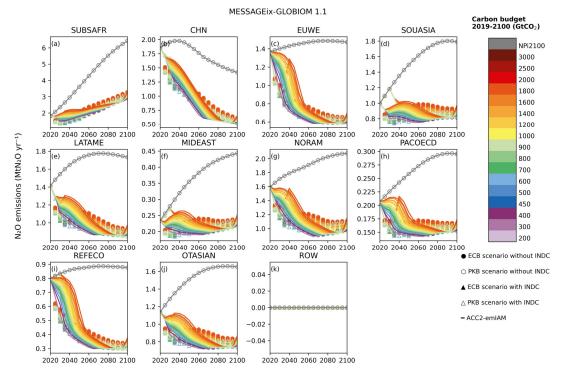


Figure S135. Test 2 - Regional AIM total anthropogenic N₂O validation results

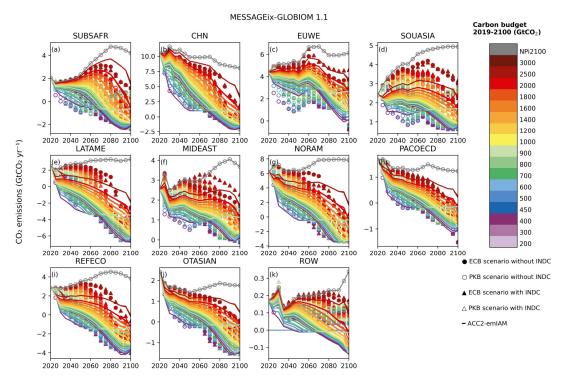


Figure S136. Test 2 - Regional COFFEE total anthropogenic CO₂ validation results

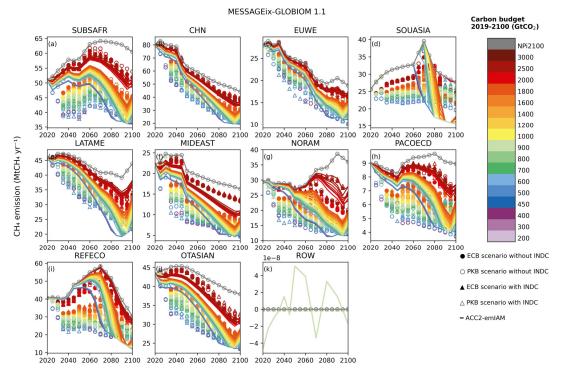


Figure S137. Test 2 - Regional COFFEE total anthropogenic CH₄ validation results

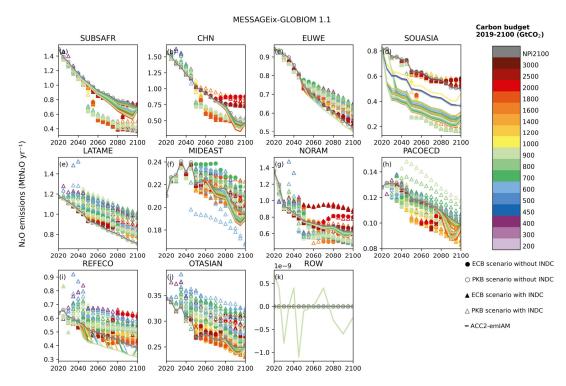


Figure S138. Test 2 - Regional COFFEE total anthropogenic N₂O validation results

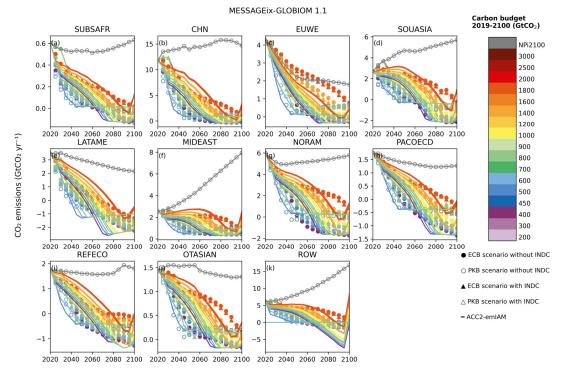


Figure S139. Test 2 - Regional GEM total anthropogenic CO₂ validation results

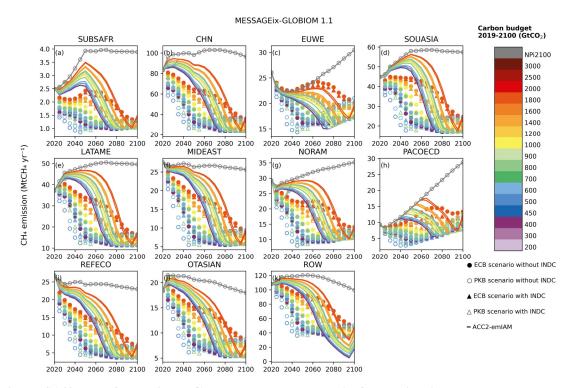


Figure S140. Test 2 - Regional GEM total anthropogenic CH₄ validation results

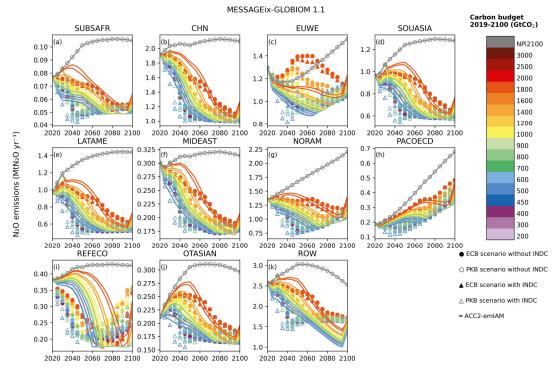


Figure S141. Test 2 - Regional GEM total anthropogenic N₂O validation results

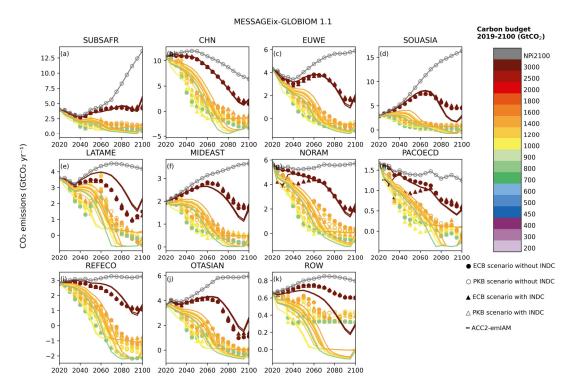


Figure S142. Test 2 - Regional IMAGE total anthropogenic CO₂ validation results

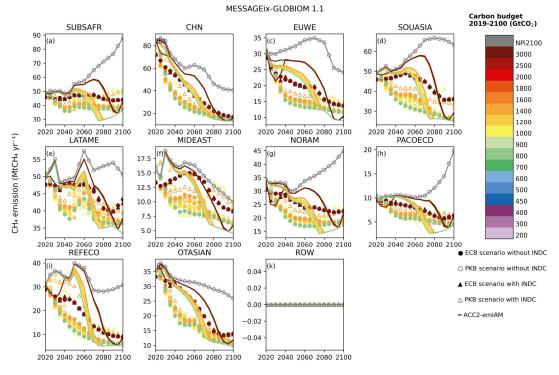


Figure S143. Test 2 - Regional IMAGE total anthropogenic CH₄ validation results

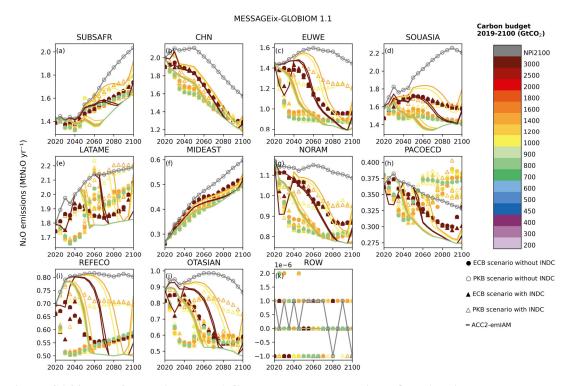


Figure S144. Test 2 - Regional IMAGE total anthropogenic N₂O validation results

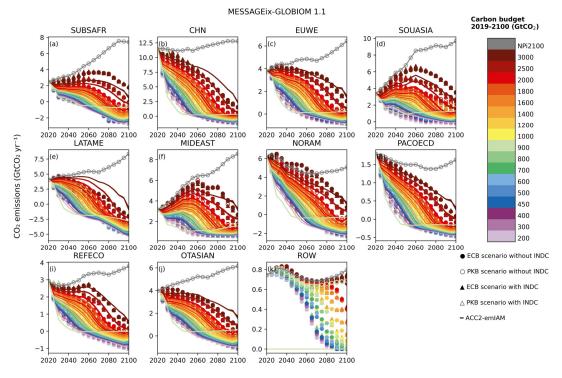


Figure S145. Test 2 - Regional MESSAGE total anthropogenic CO₂ validation results

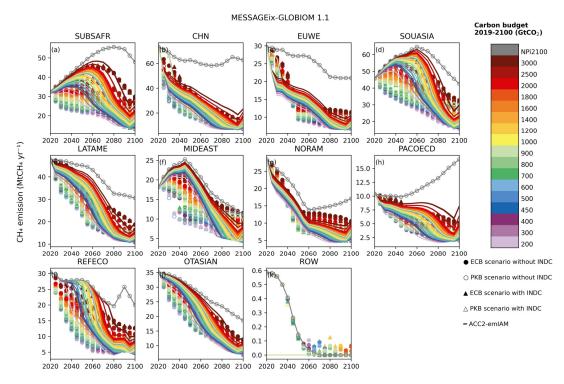


Figure S146. Test 2 - Regional MESSAGE total anthropogenic CH₄ validation results

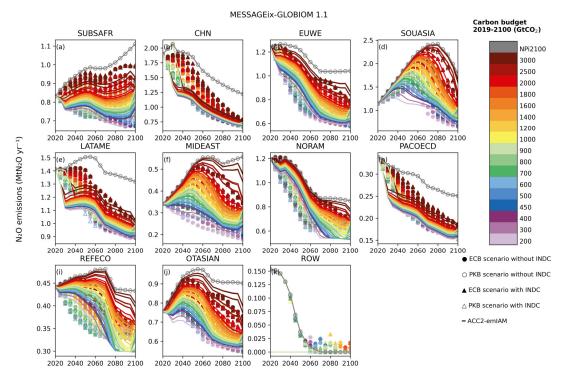


Figure S147. Test 2 - Regional MESSAGE total anthropogenic N₂O validation results

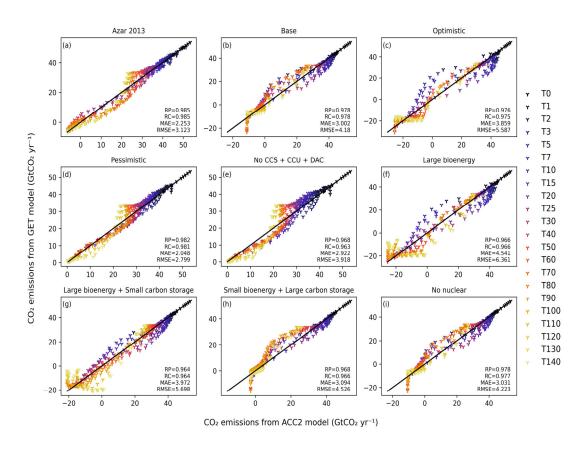


Figure S148. Test 2 - GET - Reproducibility of energy-related CO2

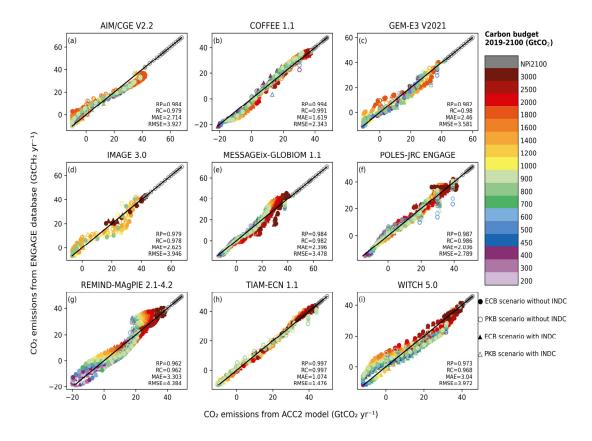


Figure S149. Test 2 - Global nine IAMs - Reproducibility of total anthropogenic CO2

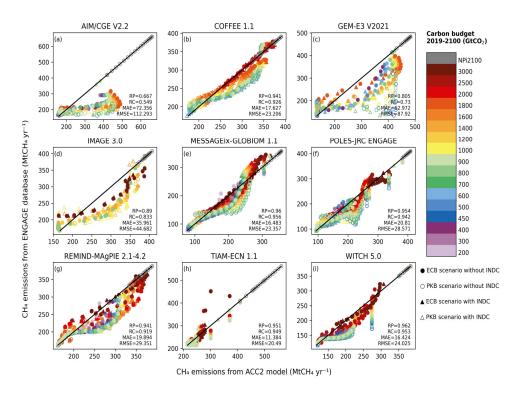


Figure S150. Test 2 - Global nine IAMs - Reproducibility of total anthropogenic CH4

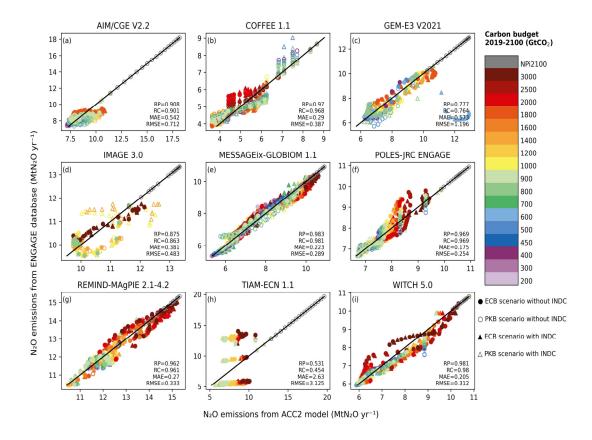


Figure S151. Test 2 - Global nine IAMs - Reproducibility of total anthropogenic N₂O

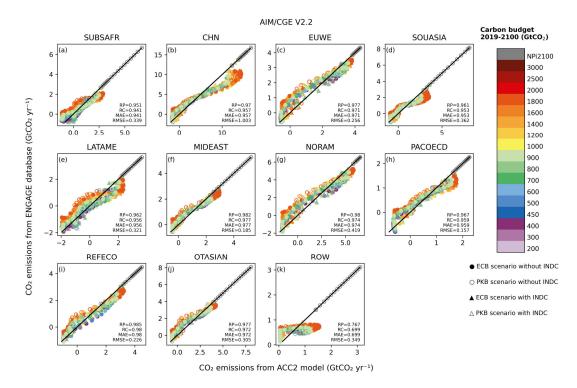


Figure S152. Test 2 - Regional AIM - Reproducibility of total anthropogenic CO2

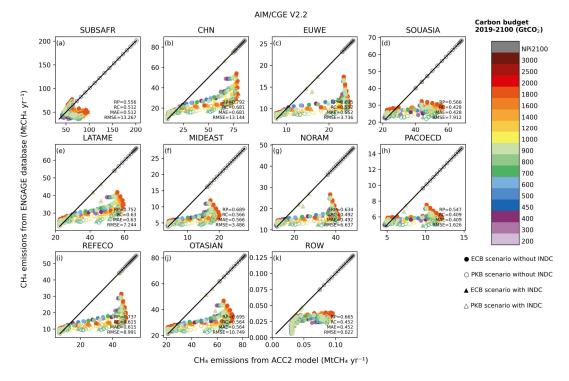


Figure S153. Test 2 - Regional AIM - Reproducibility of total anthropogenic CH4

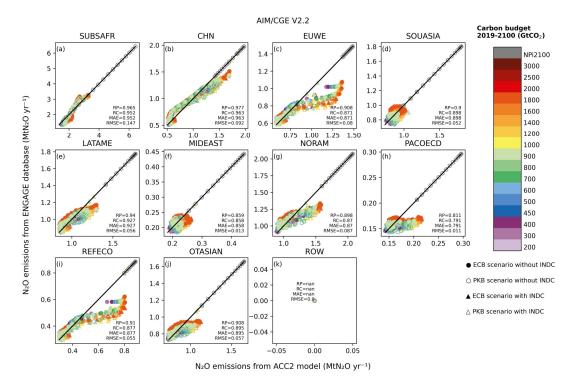


Figure S154. Test 2 - Regional AIM - Reproducibility of total anthropogenic N₂O

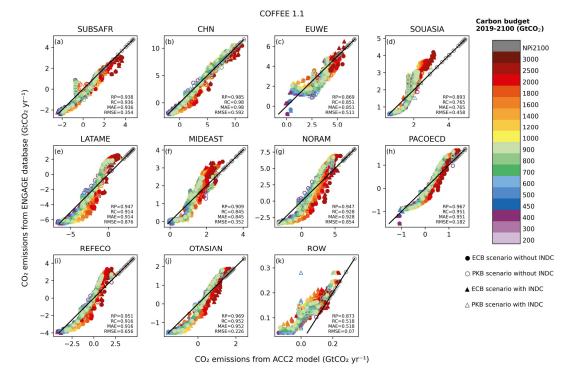


Figure S155. Test 2 - Regional COFFEE - Reproducibility of total anthropogenic CO2

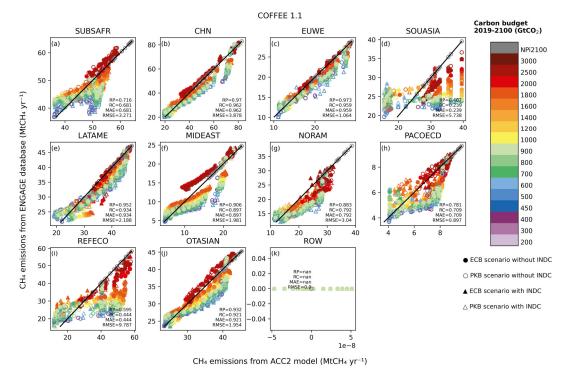


Figure S156. Test 2 - Regional COFFEE - Reproducibility of total anthropogenic CH4

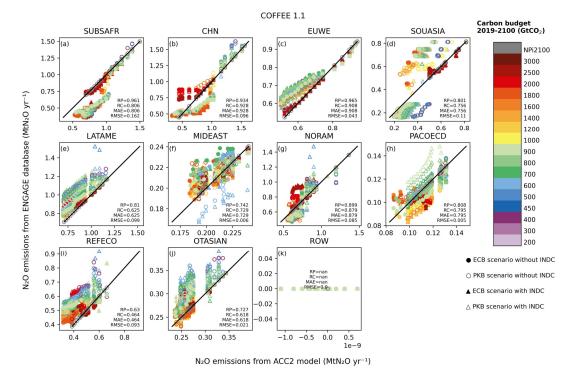


Figure S157. Test 2 - Regional COFFEE - Reproducibility of total anthropogenic N₂O

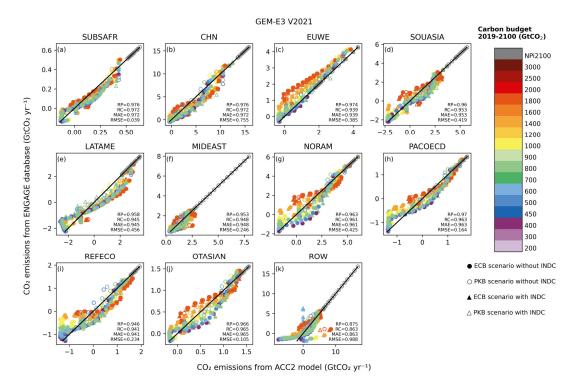


Figure S158. Test 2 - Regional GEM - Reproducibility of total anthropogenic CO₂

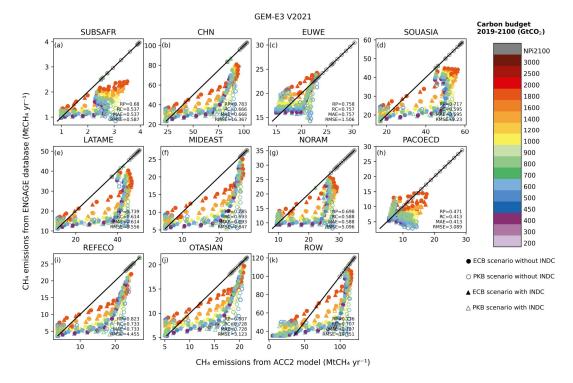


Figure S159. Test 2 - Regional GEM - Reproducibility of total anthropogenic CH4

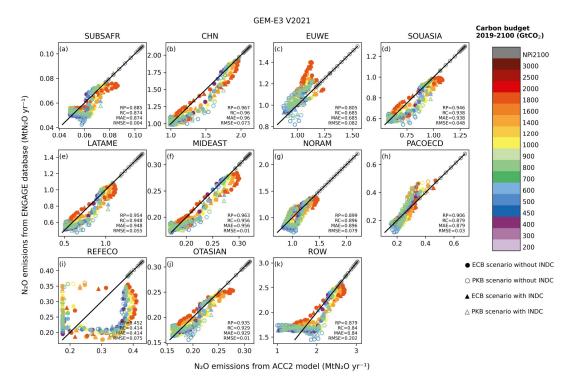


Figure S160. Test 2 - Regional GEM - Reproducibility of total anthropogenic N2O

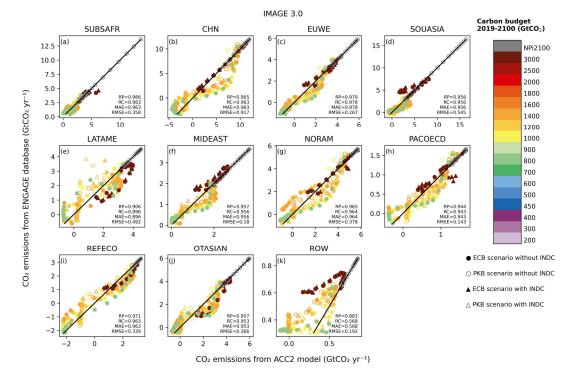


Figure S161. Test 2 - Regional IMAGE - Reproducibility of total anthropogenic CO2

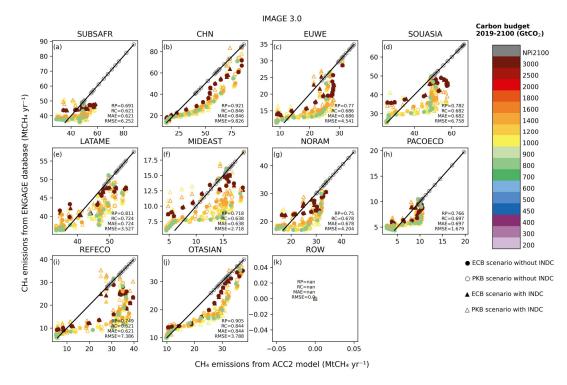


Figure S162. Test 2 - Regional IMAGE - Reproducibility of total anthropogenic CH4

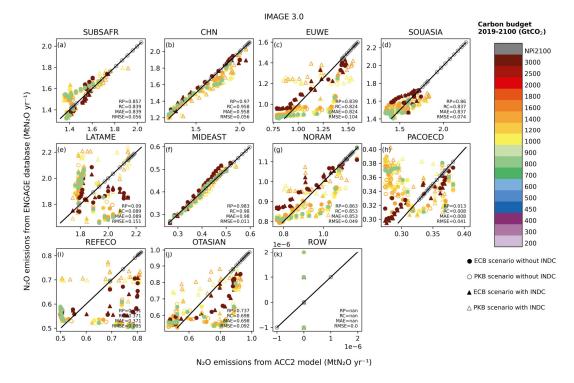


Figure S163. Test 2 - Regional IMAGE - Reproducibility of total anthropogenic N₂O

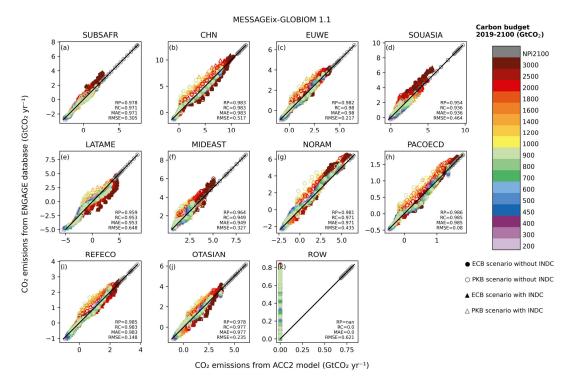


Figure S164. Test 2 - Regional MESSAGE - Reproducibility of total anthropogenic CO2

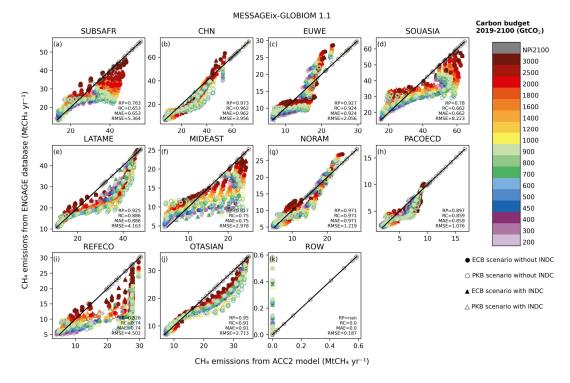


Figure S165. Test 2 - Regional MESSAGE - Reproducibility of total anthropogenic CH4

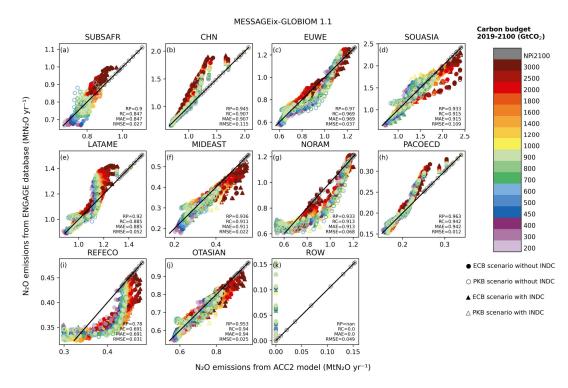


Figure S166. Test 2 - Regional MESSAGE - Reproducibility of total anthropogenic N₂O

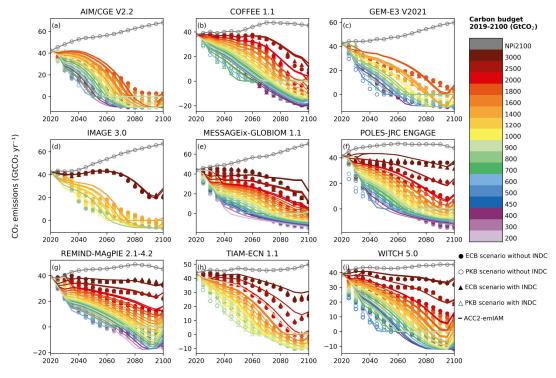


Figure S167. Test 3 – Global nine IAMs total anthropogenic CO₂ validation results

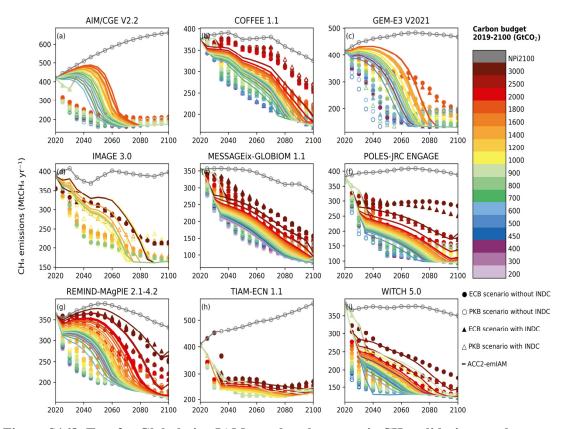


Figure S168. Test 3 – Global nine IAMs total anthropogenic CH₄ validation result

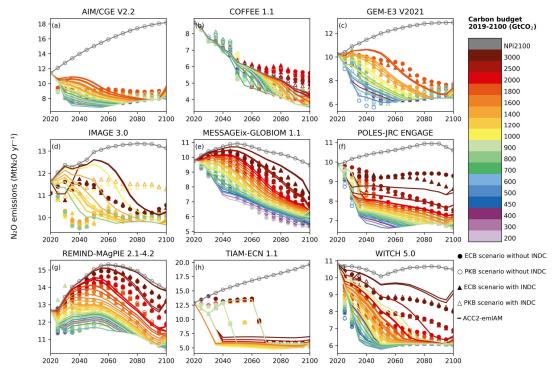


Figure S169. Test 3 – Global nine IAMs total anthropogenic N₂O validation results

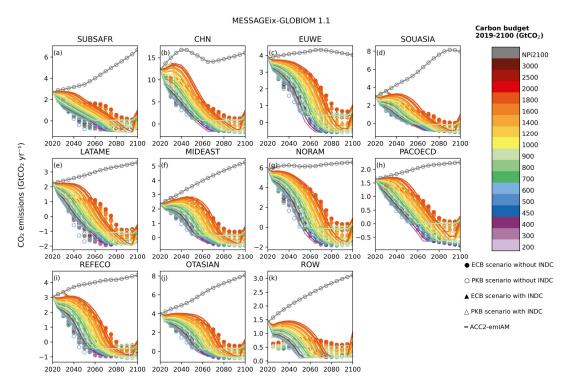


Figure S170. Test 3 - Regional AIM total anthropogenic CO₂ validation results

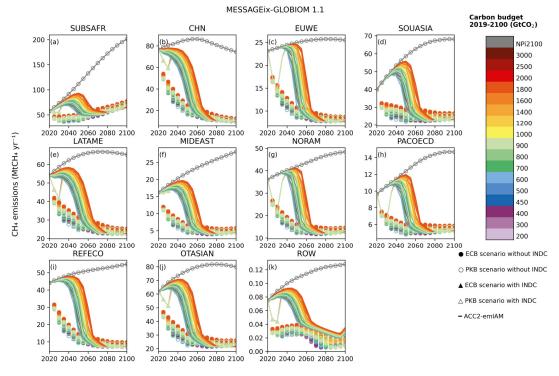


Figure S171. Test 3 - Regional AIM total anthropogenic CH₄ validation results

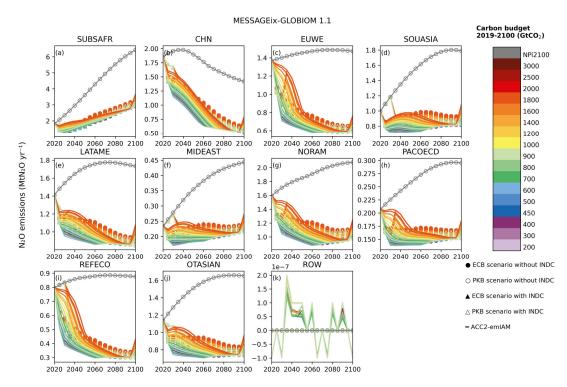


Figure S172. Test 3 - Regional AIM total anthropogenic N₂O validation results

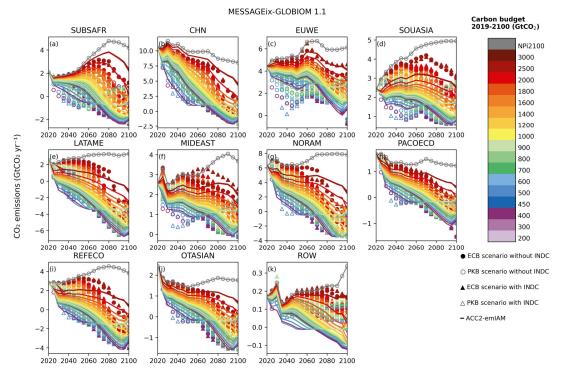


Figure S173. Test 3 - Regional COFFEE total anthropogenic CO₂ validation results

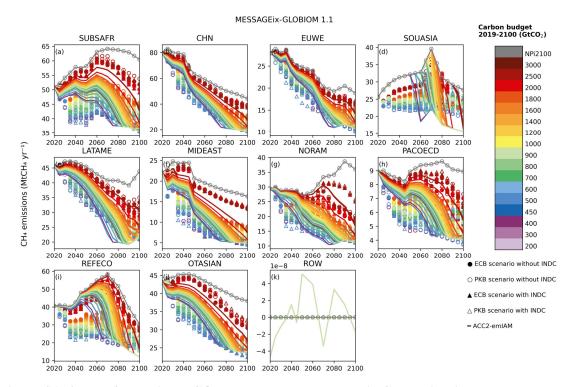


Figure S174. Test 3 - Regional COFFEE total anthropogenic CH₄ validation results

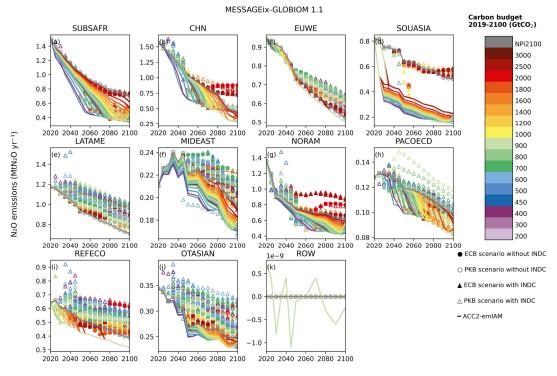


Figure S175. Test 3 - Regional COFFEE total anthropogenic N₂O validation results

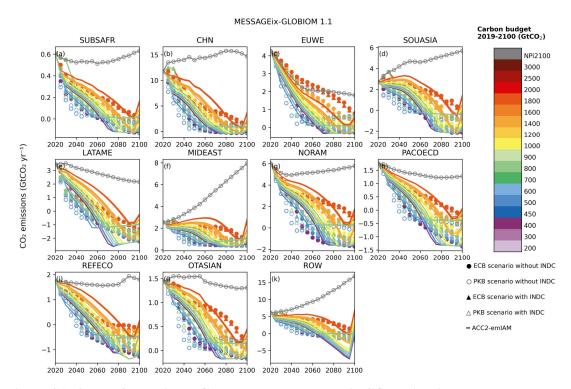


Figure S176. Test 3 - Regional GEM total anthropogenic CO₂ validation results

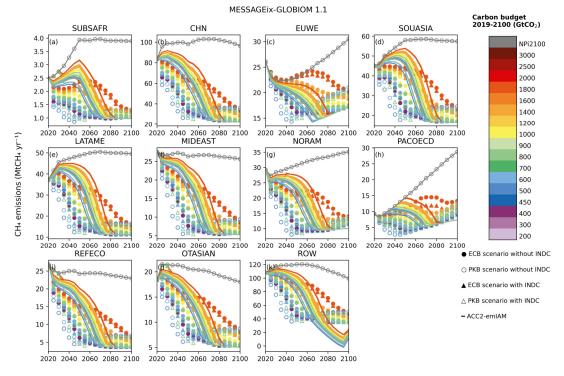


Figure S177. Test 3 - Regional GEM total anthropogenic CH₄ validation results

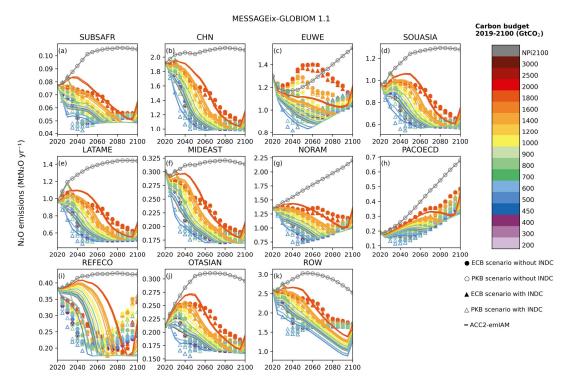


Figure S178. Test 3 - Regional GEM total anthropogenic N₂O validation results

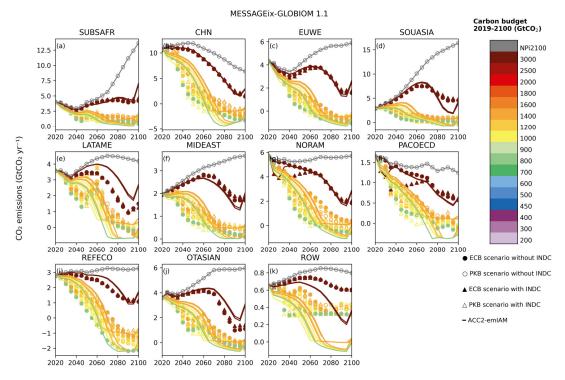


Figure S179. Test 3 - Regional IMAGE total anthropogenic CO₂ validation results

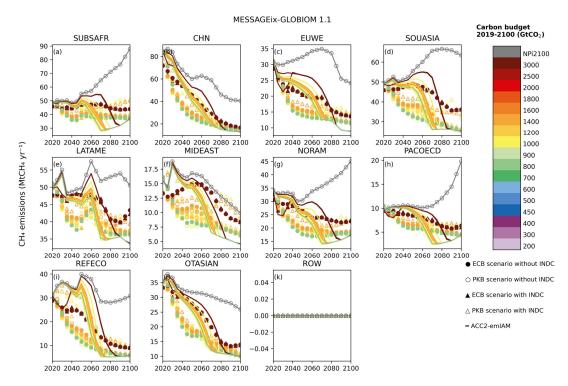


Figure S180. Test 3 - Regional IMAGE total anthropogenic CH₄ validation results

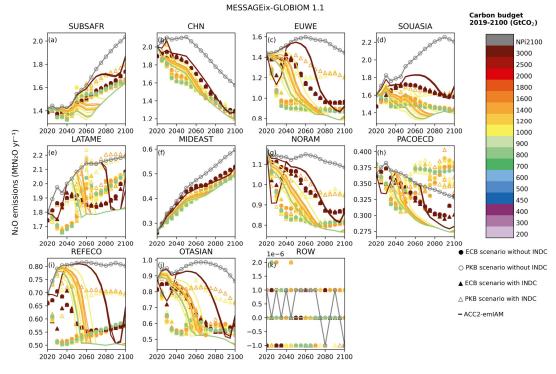


Figure S181. Test 3 - Regional IMAGE total anthropogenic N₂O validation results

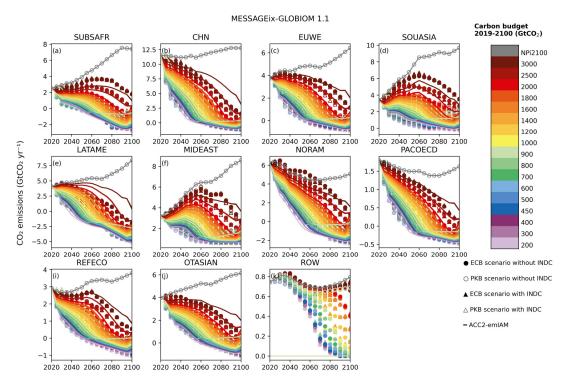


Figure S182. Test 3 - Regional MESSAGE total anthropogenic CO₂ validation results

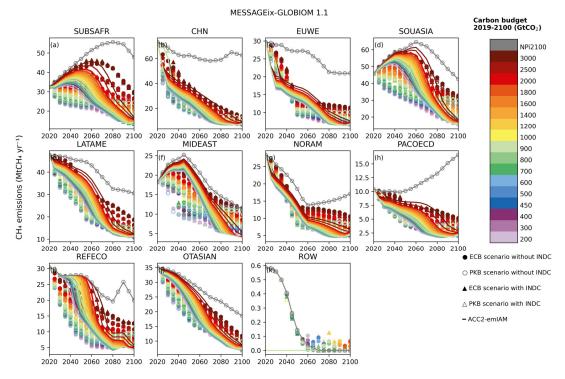


Figure S183. Test 3 - Regional MESSAGE total anthropogenic CH₄ validation results

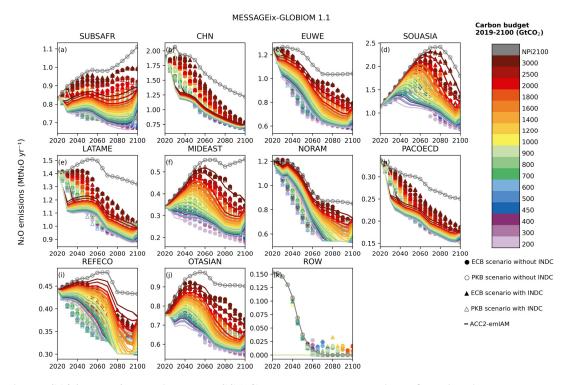


Figure S184. Test 3 - Regional MESSAGE total anthropogenic N₂O validation results

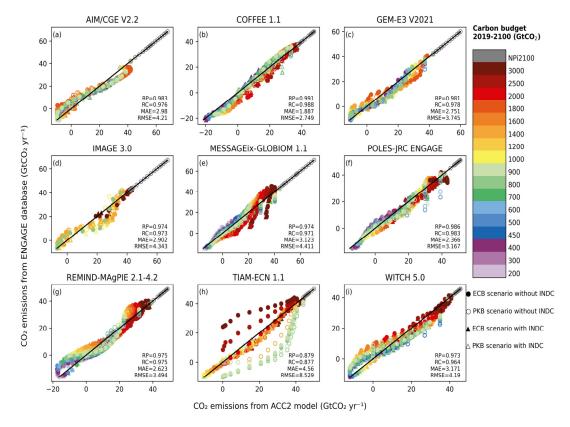


Figure S185. Test 3 - Global nine IAMs - Reproducibility of total anthropogenic CO2

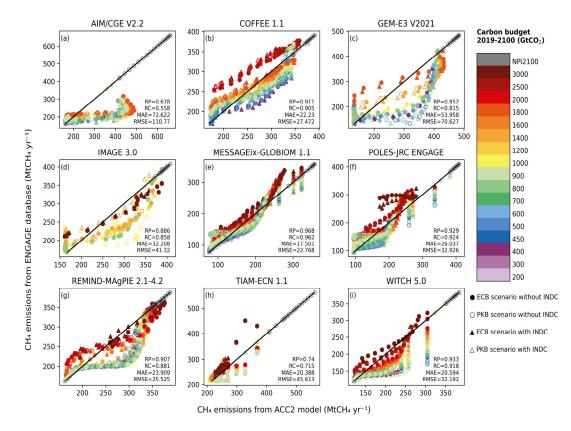


Figure S186. Test 3 - Global nine IAMs - Reproducibility of total anthropogenic CH4

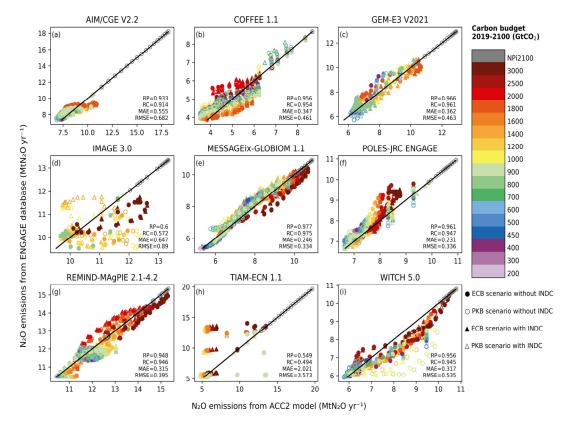


Figure S187. Test 3 - Global nine IAMs - Reproducibility of total anthropogenic N₂O

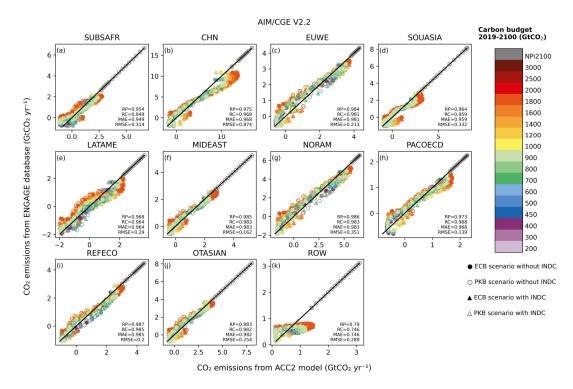


Figure S188. Test 3 - Regional AIM - Reproducibility of total anthropogenic CO2

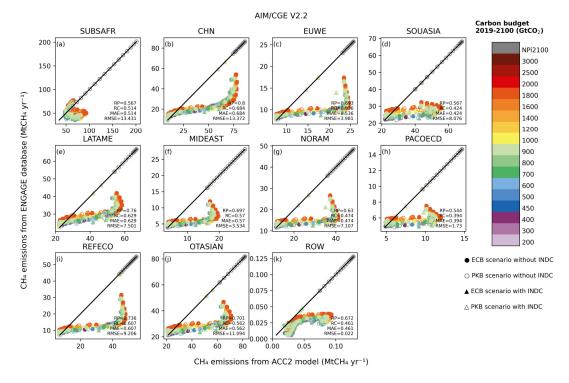


Figure S189. Test 3 - Regional AIM - Reproducibility of total anthropogenic CH4

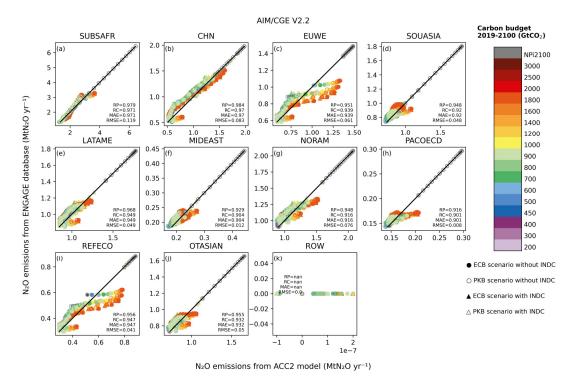


Figure S190. Test 3 - Regional AIM - Reproducibility of total anthropogenic N₂O

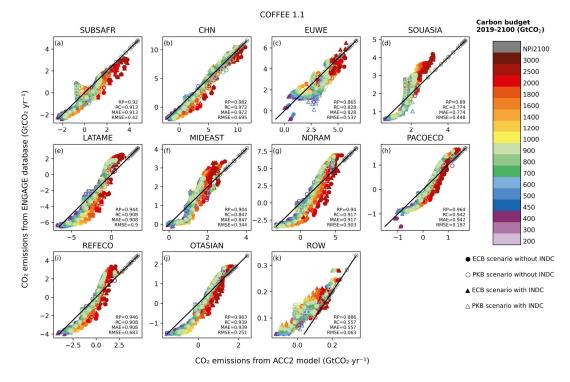


Figure S191. Test 3 - Regional COFFEE - Reproducibility of total anthropogenic CO2

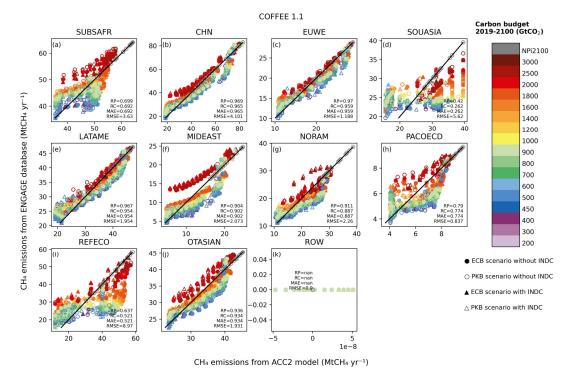


Figure S192. Test 3 - Regional COFFEE - Reproducibility of total anthropogenic CH4

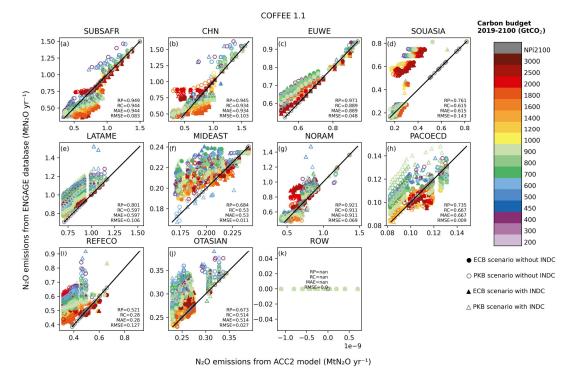


Figure S193. Test 3 - Regional COFFEE - Reproducibility of total anthropogenic N₂O

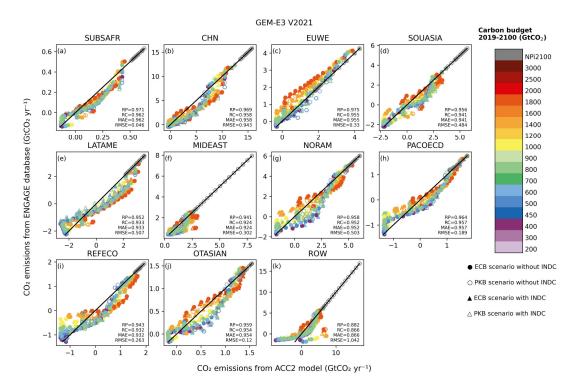


Figure S194. Test 3 - Regional GEM - Reproducibility of total anthropogenic CO2

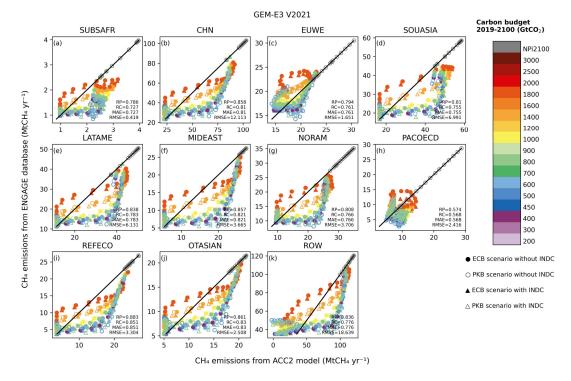


Figure S195. Test 3 - Regional GEM - Reproducibility of total anthropogenic CH4

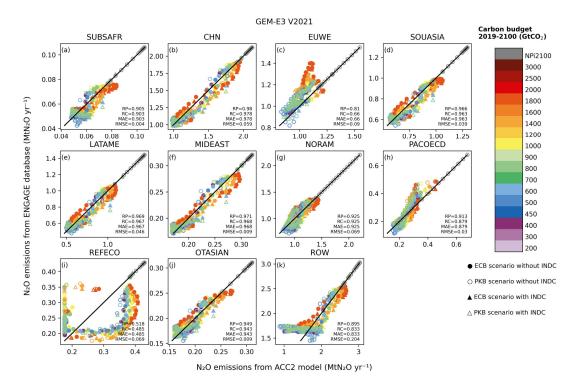


Figure S196. Test 3 - Regional GEM - Reproducibility of total anthropogenic N2O

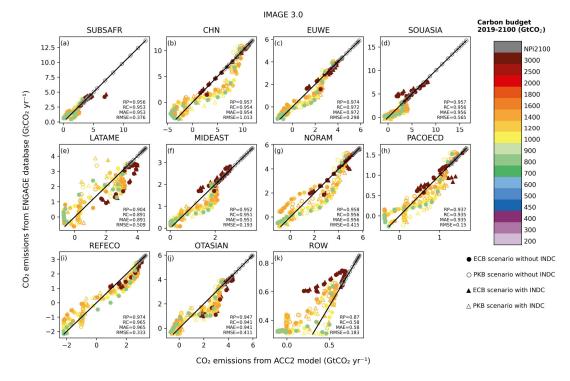


Figure S197. Test 3 - Regional IMAGE - Reproducibility of total anthropogenic CO2

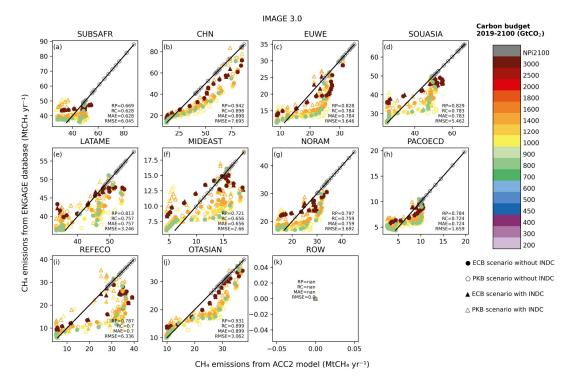


Figure S198. Test 3 - Regional IMAGE - Reproducibility of total anthropogenic CH4

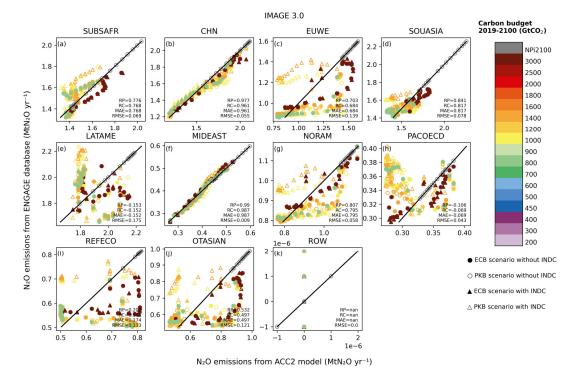


Figure S199. Test 3 - Regional IMAGE - Reproducibility of total anthropogenic N₂O

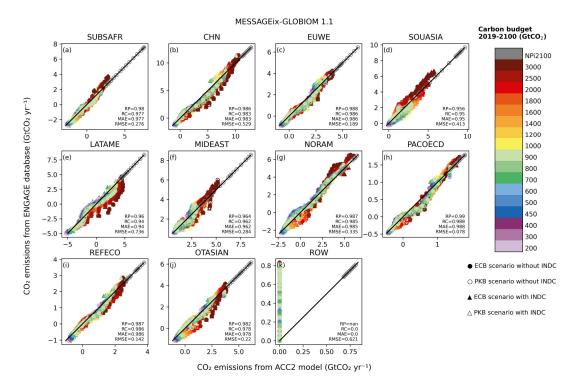


Figure S200. Test 3 - Regional MESSAGE - Reproducibility of total anthropogenic CO2

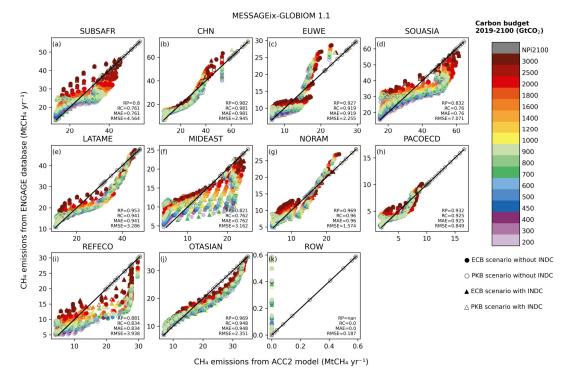


Figure S201. Test 3 - Regional MESSAGE - Reproducibility of total anthropogenic CH4

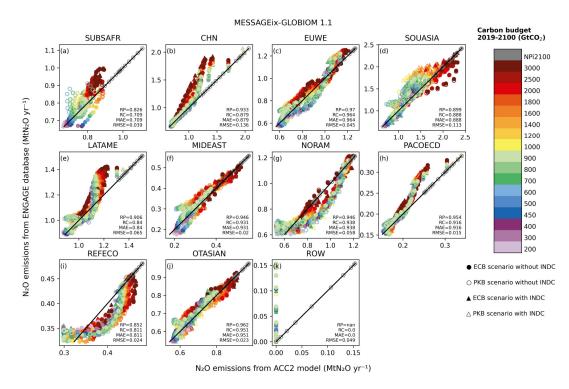


Figure S202. Test 3 - Regional MESSAGE - Reproducibility of total anthropogenic N₂O

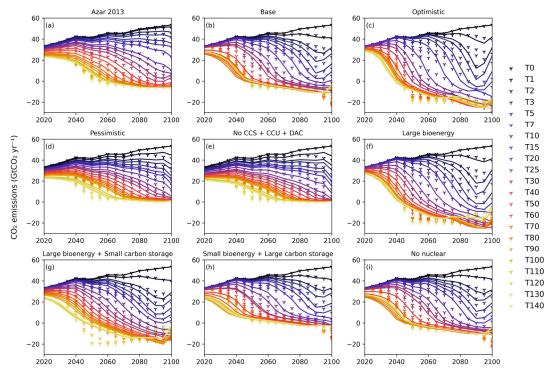


Figure S203. Test 4 – GET nine portfolios energy-related CO₂ validation results

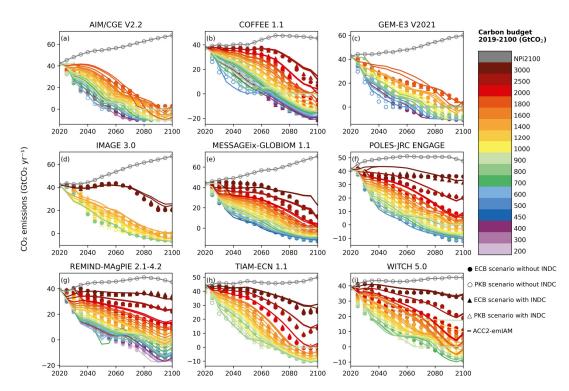


Figure S204. Test 4 – Global nine IAMs total anthropogenic CO₂ validation results

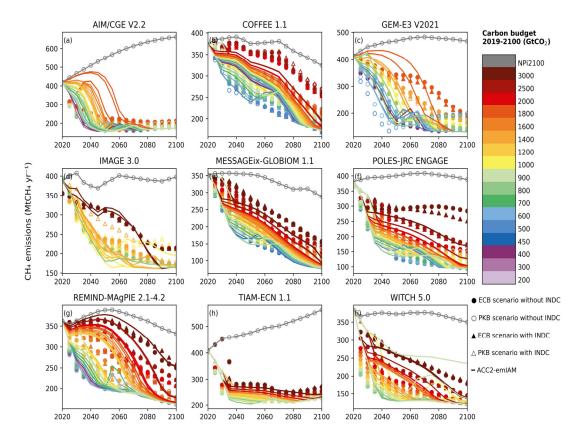


Figure S205. Test 4 – Global nine IAMs total anthropogenic CH₄ validation results

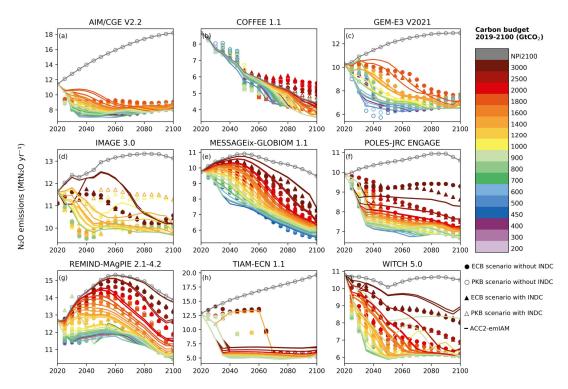


Figure S206. Test 4 – Global nine IAMs total anthropogenic N₂O validation results

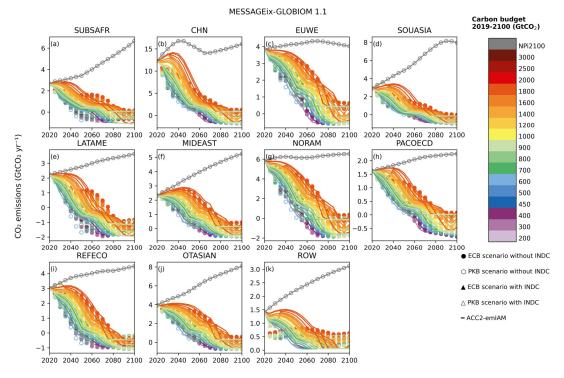


Figure S207. Test 4 - Regional AIM total anthropogenic CO₂ validation results

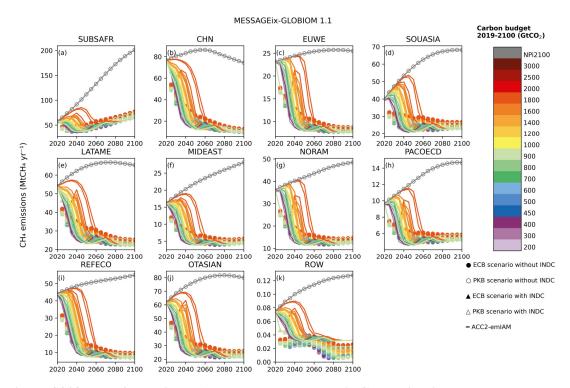


Figure S208. Test 4 - Regional AIM total anthropogenic CH₄ validation results

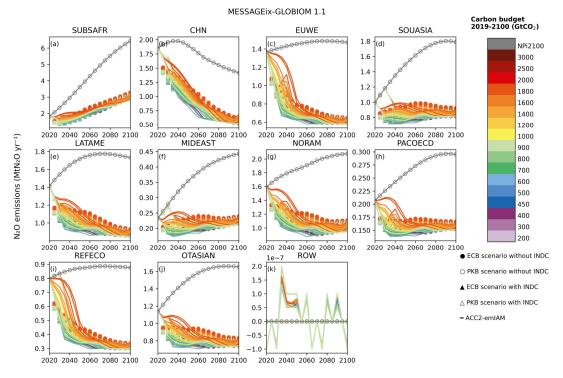


Figure S209. Test 4 - Regional AIM total anthropogenic N₂O validation results

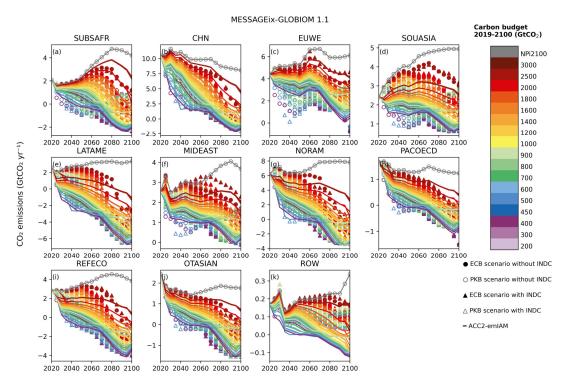


Figure S210. Test 4 - Regional COFFEE total anthropogenic CO₂ validation results

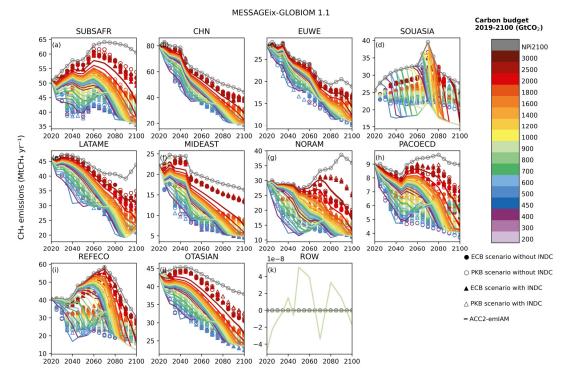


Figure S211. Test 4 - Regional COFFEE total anthropogenic CH₄ validation results

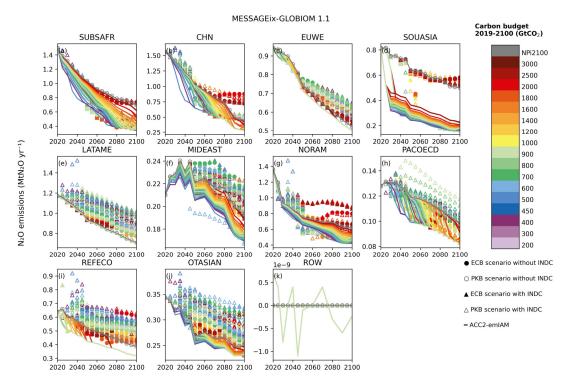


Figure S212. Test 4 - Regional COFFEE total anthropogenic N₂O validation results

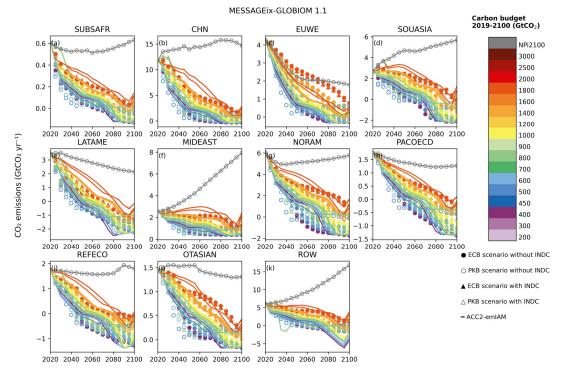


Figure S213. Test 4 - Regional GEM total anthropogenic CO₂ validation results

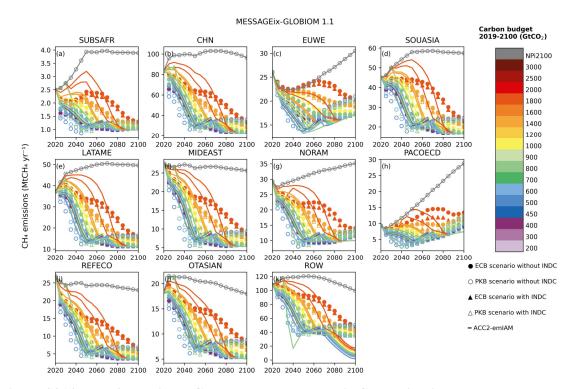


Figure S214. Test 4 - Regional GEM total anthropogenic CH₄ validation results

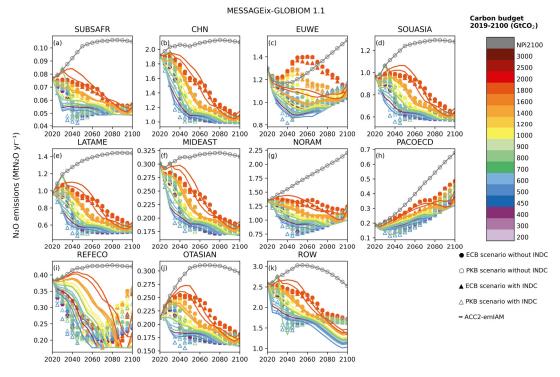


Figure S215. Test 4 - Regional GEM total anthropogenic N₂O validation results

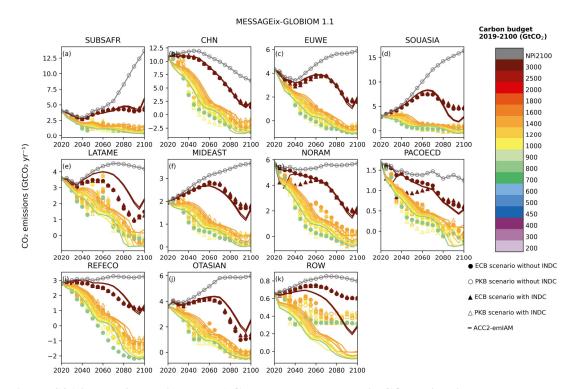


Figure S216. Test 4 - Regional IMAGE total anthropogenic CO₂ validation results

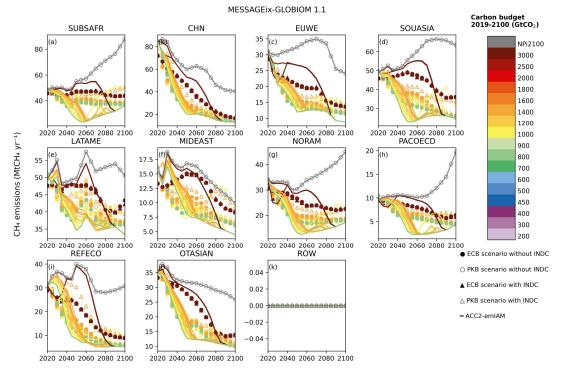


Figure S217. Test 4 - Regional IMAGE total anthropogenic CH₄ validation results

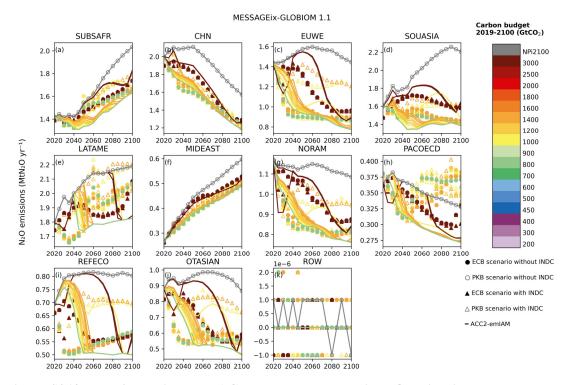


Figure S218. Test 4 - Regional IMAGE total anthropogenic N₂O validation results

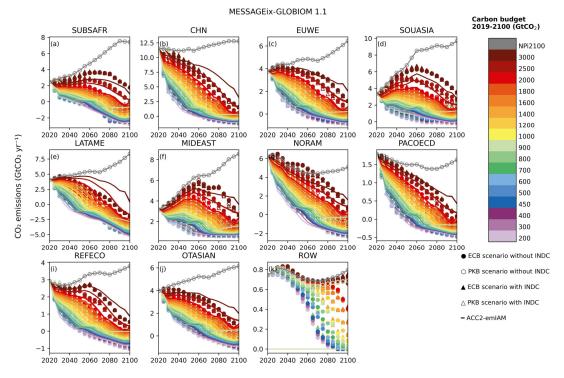


Figure S219. Test 4 - Regional MESSAGE total anthropogenic CO₂ validation results

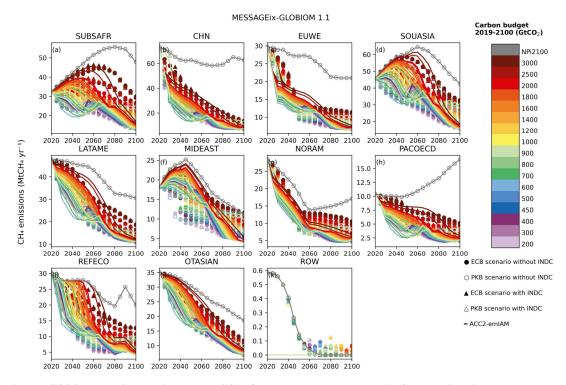


Figure S220. Test 4 - Regional MESSAGE total anthropogenic CH₄ validation results

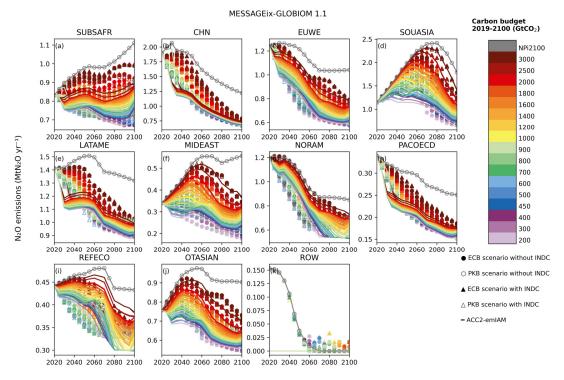


Figure S221. Test 4 - Regional MESSAGE total anthropogenic N₂O validation results

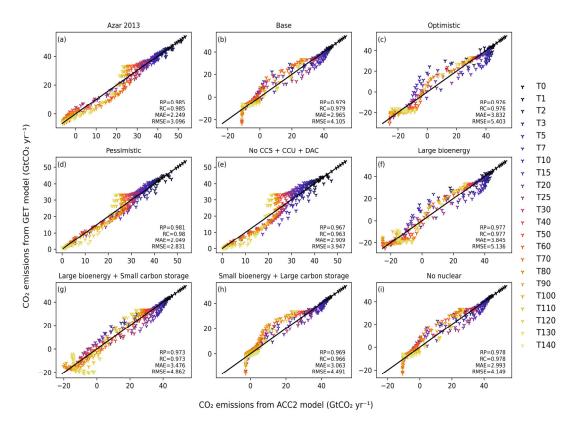


Figure S222. Test 4 - GET - Reproducibility of energy-related CO2

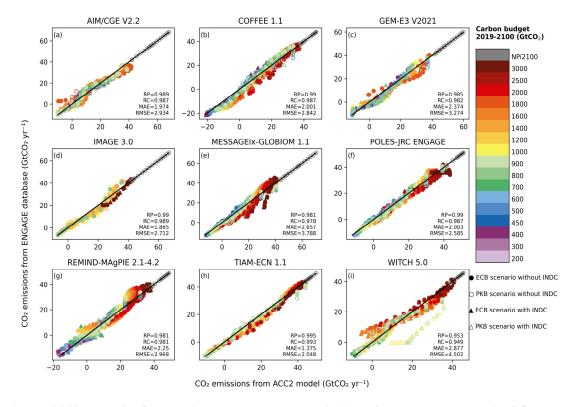


Figure S223. Test 4 - Global nine IAMs - Reproducibility of total anthropogenic CO2

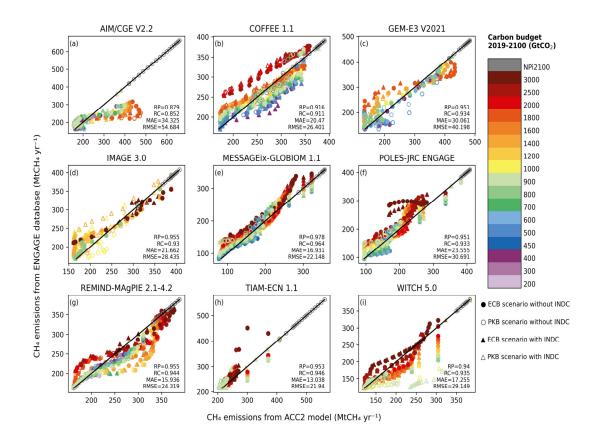


Figure S224. Test 4 - Global nine IAMs - Reproducibility of total anthropogenic CH4

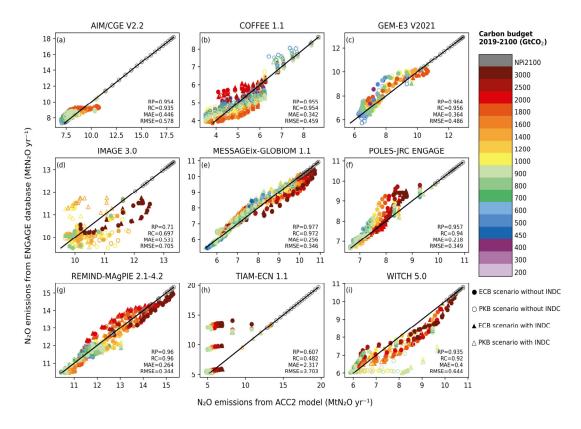


Figure S225. Test 4 - Global nine IAMs - Reproducibility of total anthropogenic N₂O

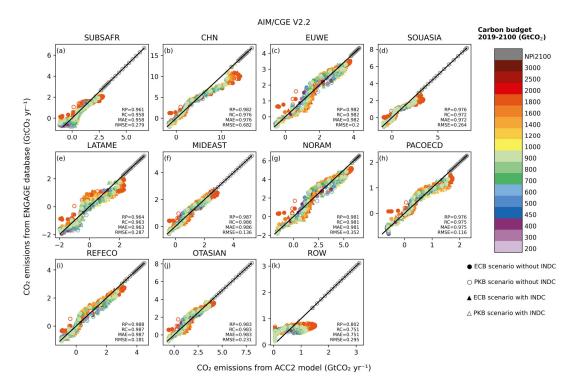


Figure S226. Test 4 - Regional AIM - Reproducibility of total anthropogenic CO2

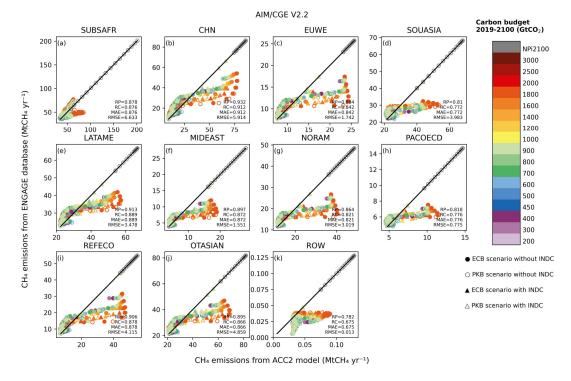


Figure S227. Test 4 - Regional AIM - Reproducibility of total anthropogenic CH4

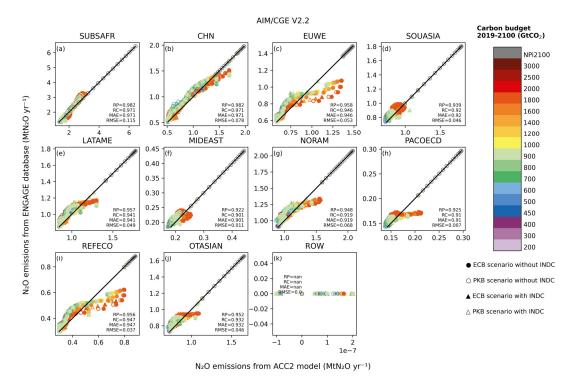


Figure S228. Test 4 - Regional AIM - Reproducibility of total anthropogenic N₂O

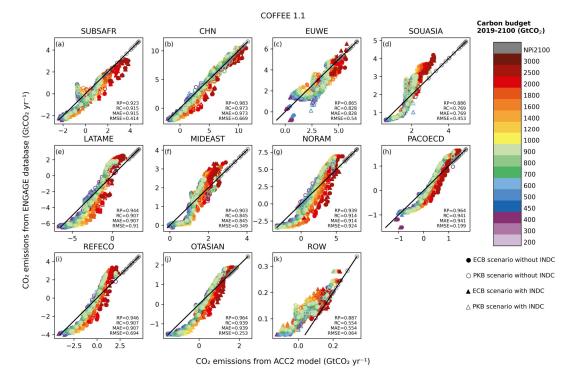


Figure S229. Test 4 - Regional COFFEE - Reproducibility of total anthropogenic CO2

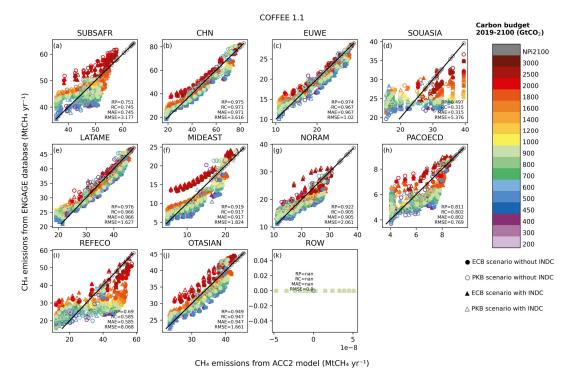


Figure S230. Test 4 - Regional COFFEE - Reproducibility of total anthropogenic CH4

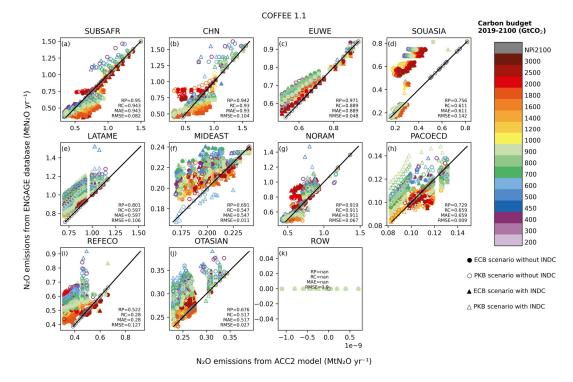


Figure S231. Test 4 - Regional COFFEE - Reproducibility of total anthropogenic N₂O

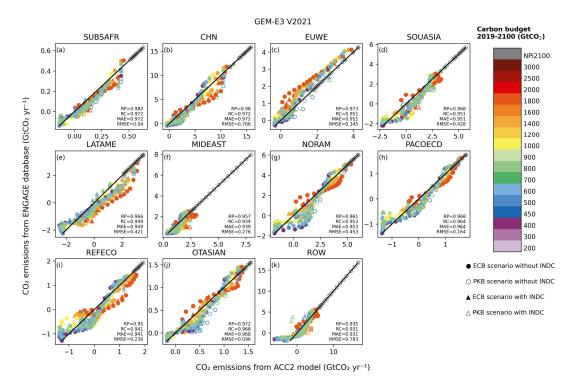


Figure S232. Test 4 - Regional GEM - Reproducibility of total anthropogenic CO₂

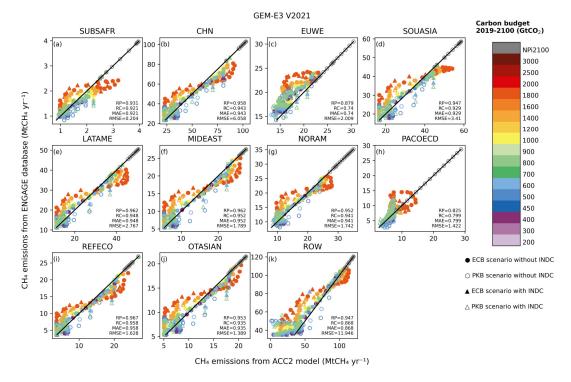


Figure S233. Test 4 - Regional GEM - Reproducibility of total anthropogenic CH4

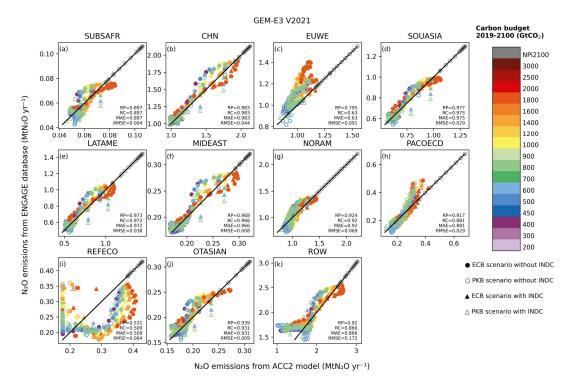


Figure S234. Test 4 - Regional GEM - Reproducibility of total anthropogenic N2O

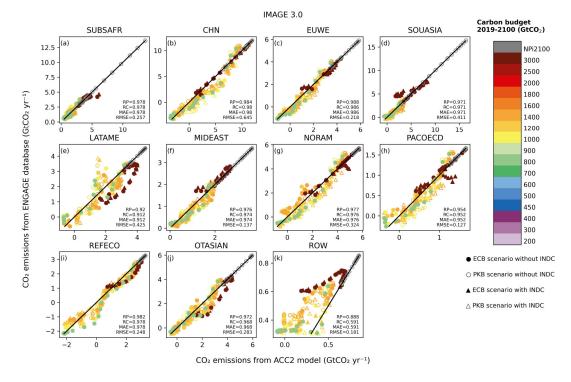


Figure S235. Test 4 - Regional IMAGE - Reproducibility of total anthropogenic CO2

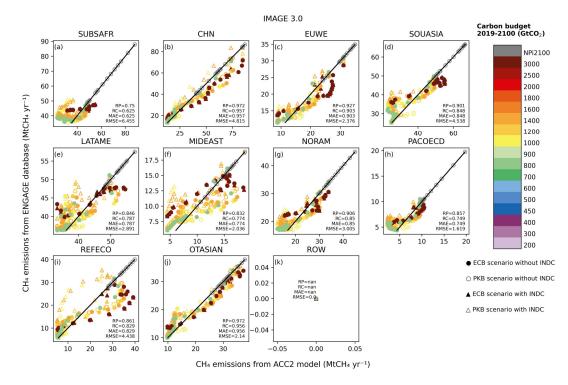


Figure S236. Test 4 - Regional IMAGE - Reproducibility of total anthropogenic CH4

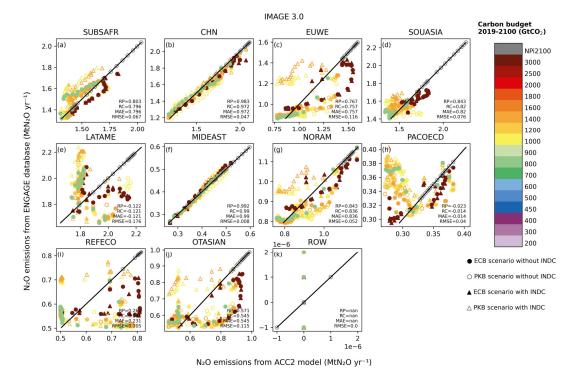


Figure S237. Test 4 - Regional IMAGE - Reproducibility of total anthropogenic N₂O

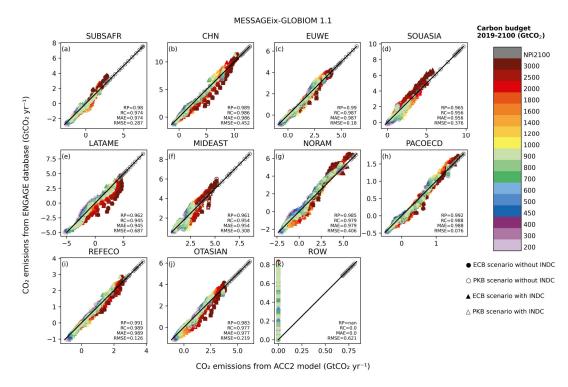


Figure S238. Test 4 - Regional MESSAGE - Reproducibility of total anthropogenic CO₂

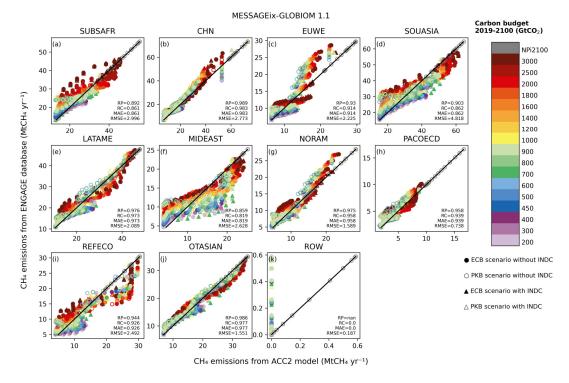


Figure S239. Test 4 - Regional MESSAGE - Reproducibility of total anthropogenic CH4

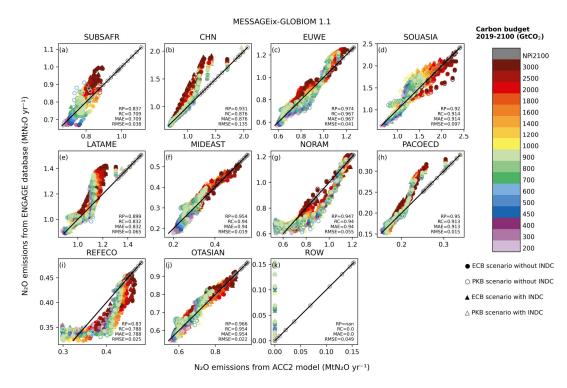


Figure S240. Test 4 - Regional MESSAGE - Reproducibility of total anthropogenic N₂O

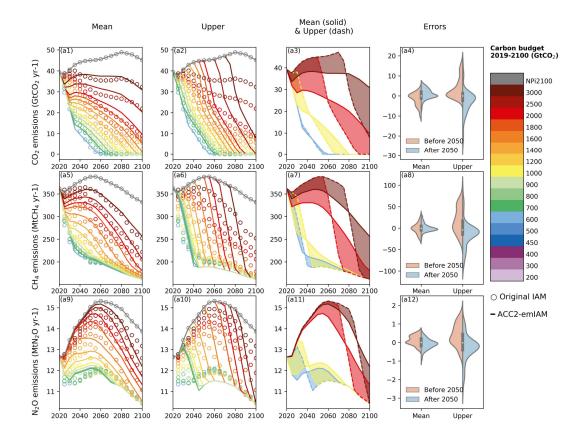


Figure S241. Validation results for ACC2-emIAM with mean and upper MAC curves from REMIND

The points show the original emission pathways from REMIND obtained from the ENGAGE Scenario Explorer; the lines show the emission pathways reproduced from ACC2-emIAM by using the mean (the first column) and upper (the second column) MAC curves. The third column presents the uncertainty (shaded band within two emissions pathways) of ACC2-emIAM by using different MAC curves (only cases with the carbon budgets of 600, 1000, 2000, and 3000 GtCO₂ are shown here). The fourth column shows the errors from the reproduced scenarios (ACC2-emIAM) relative to the original scenarios (REMIND). Positive values indicate ACC2-emIAM gives higher estimates than REMIND and vice versa. The same color is used for each pair of original and reproduced pathways. For the sake of presentation, only the outcomes of the PKB scenarios without INDC are presented. It should be noted that we only report the reproducibility results based on the upper range of the MAC curve (95% confidence interval). We tried with the lower range of the MAC curve (95% confidence interval) as well, but we were not able to obtain reasonable results because of the negative segment of the lower MAC curve. The negative segment requires re-defining the problem as a new type of mathematical problem (a discontinuous nonlinear program (DNLP)), which either made it too complex to solve in our GAMS CONOPT3/4 computational environment or made the optimal solution unreliable (i.e., the solution becomes dependent on initial conditions).