

Supplementary figures and methods

Table S1. Surface flask characteristics over the African continent. Data synthesized from NOAA website: <https://www.noaa.gov>.

Station name, Country	Parameter	First sample date	Status for the three GHG	Frequency	Elevation (in meters above mean sea level)	Cooperating Agencies
Assekrem, Algeria	CO ₂ CH ₄ N ₂ O	12/09/1995 12/09/1995 12/09/1995	Terminated since 26/08/2020	Discrete Monthly	2710	Algerian National Office of Meteorology
Gobabeb, Namibia	CO ₂ CH ₄ N ₂ O	13/01/1997 13/01/1997 13/01/1997	Ongoing	Discrete Monthly	456	Gobabeb Training and Research Center
Mahe Island, Seychelles	CO ₂ CH ₄ N ₂ O	15/01/1980 12/05/1983 13/06/1997	Ongoing	Discrete Monthly	2	Seychelles Bureau of Standards
Cape Point, South Africa	CO ₂ CH ₄ N ₂ O	5/01/1980 12/05/1983 13/06/1997	Ongoing	Discrete Monthly	230	South African Weather Service
Mt. Kenya, Kenya	CO ₂ CH ₄ N ₂ O	11/02/2010 11/02/2010 11/02/2010	Inactive since 21/06/2011	Discrete Monthly	3644	Kenya Meteorological Department

14 Table S2. List of African countries per group.

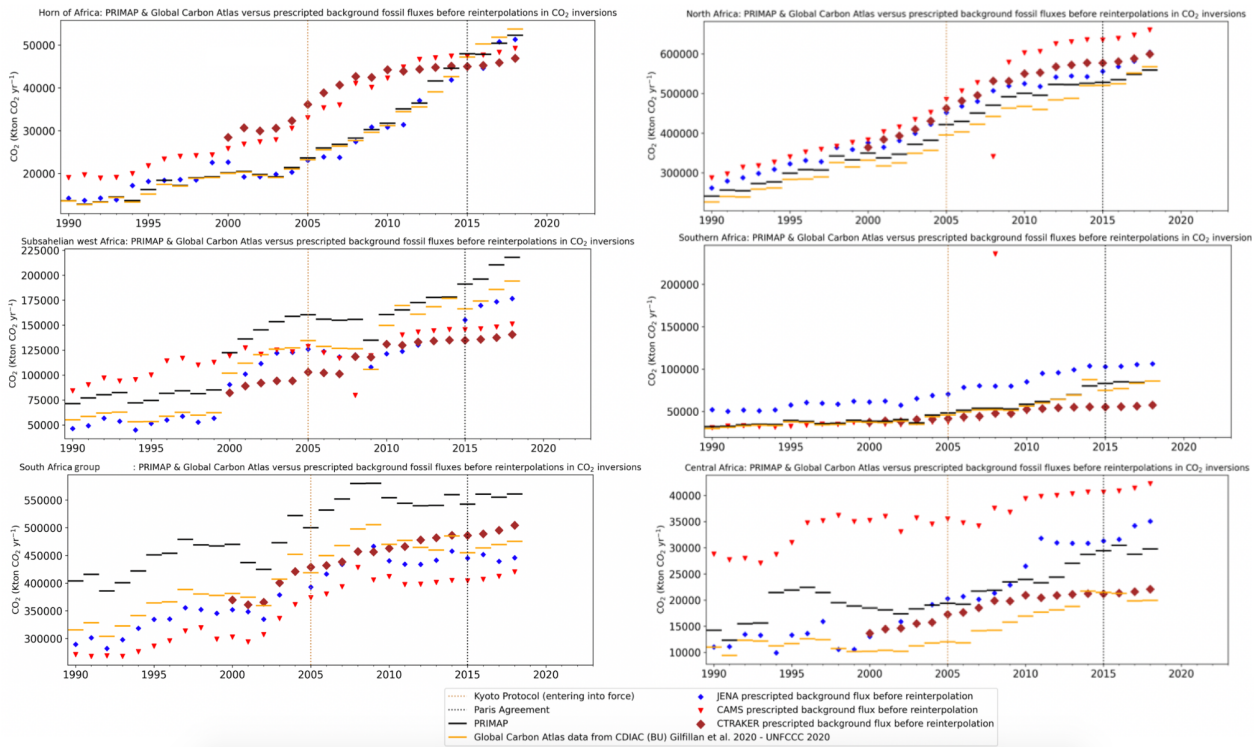
Country name	Group
Algeria Chad Egypt Eritrea Libya Mali Mauritania Morocco Niger Sudan Tunisia	Northern Africa
Benin Burkina Faso Cape Verde Ivory Coast Gambia Ghana Guinea Guinea-Bissau Liberia Nigeria Sao Tome and Principe Senegal Sierra Leone Togo	Subsahelian Western Africa
Cameroon Central African Republic Democratic Republic of the Congo Gabon Republic of the Congo South Sudan	Central African countries
Burundi Comoros Djibouti Ethiopia Kenya Rwanda Seychelles Somalia Uganda United Republic of Tanzania	Horn of Africa
Angola Botswana Madagascar Malawi Mauritius Mozambique Namibia Zambia Zimbabwe	Southern countries
Lesotho South Africa Swaziland	Group of South Africa

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16 **Methodological Supplementary M1 - discussion about the rescaling for CO₂ inversions**
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18 We operated a rescaling by subtracting back the prescribed fossil fuel fluxes to make sure that the
 19 inversions do not differ regarding prior fluxes for better comparability.
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21 **Figure S1. Comparison of PRIMAP-hist, GCP versus prescribed fossil fluxes for three CO₂ inversion models at the**
 22 **regional scale.**



Map of six groups of African countries



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Figure S2. Map of six African groups.

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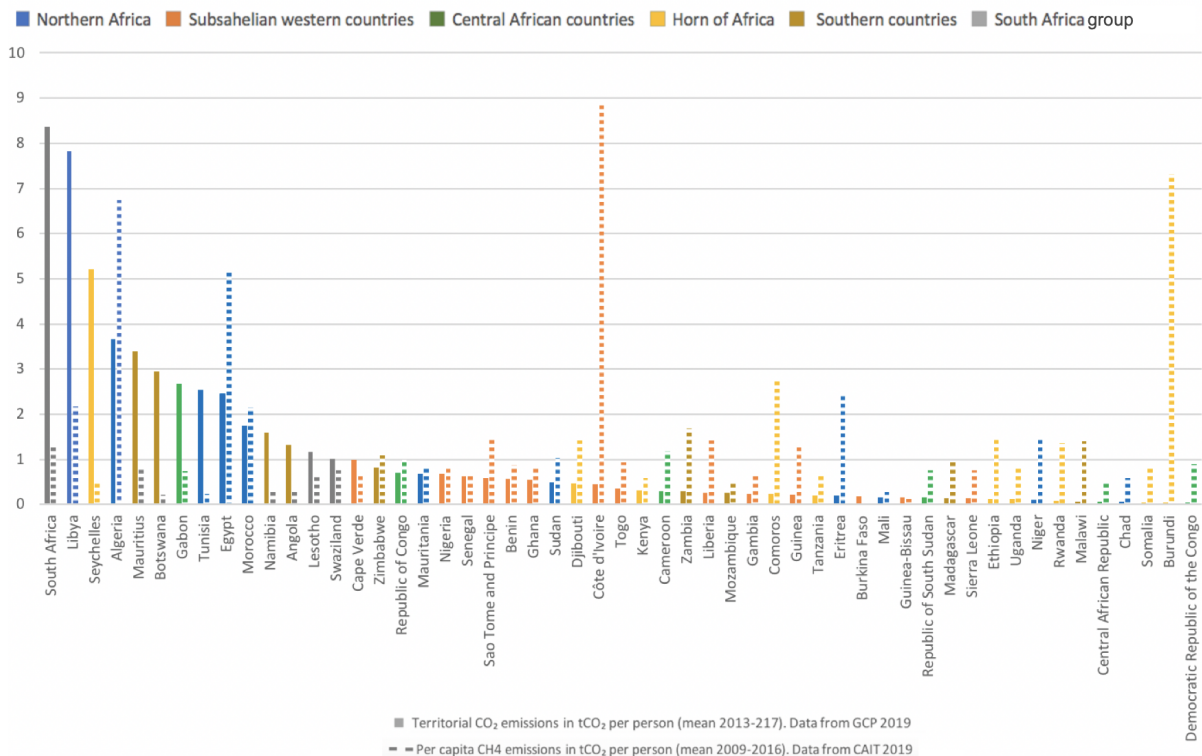
Table S3. Data sources for the anthropogenic fossil CO₂ emissions included in this study.

Method	Product type / file name	Species	Overall period covered	References
BU	GCP/CDIAC	CO ₂ fossil country totals with detailed emissions separating different subsectors	1990-2019	-GCP (Le Quéré et al., 2018; Friedlingstein et al., 2019) -CDIAC https://cdiac.ess-dive.lbl.gov/
BU	PRIMAP-hist	CO ₂ , CH ₄ and N ₂ O fossil country totals (excluding LULUCF) with detailed emissions separating different subsectors	1990-2019	-PRIMAP https://www.pik-potsdam.de/paris-reality-check/primap-hist/

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Per capita CO₂ and CH₄ emissions in tCO₂eq. for (2013-2017) per African country and color group



57 **Figure S3. Bar plots of detailed African emissions for the mean values of the recent five years for fossil CO₂ and**
 58 **anthropogenic CH₄ in tCO₂e per capita, and by group color for 2009-2016.**

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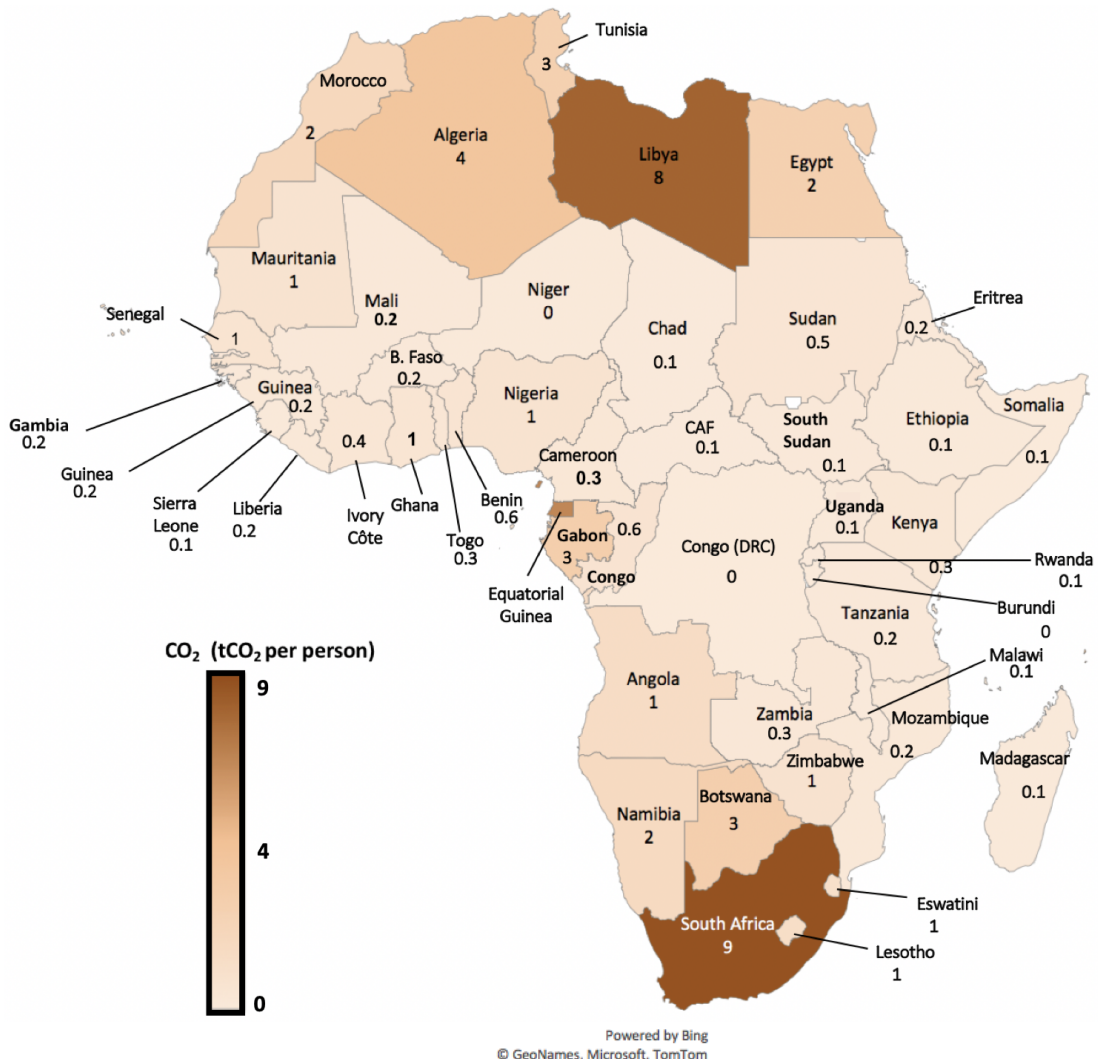


Figure S4. Map of African decennial 2009-2018 GCP CO₂ fossil fuel emissions per capita in tCO₂ per person - CDIAC.

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74 **Methodological supplementary M2. Steps for computing the GINI index of African country emissions.**

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76 The GINI index is a metric assessing the level of dispersion and therefore the level of inequalities among
77 the values of a given dataset. To show the inequalities of per capita emissions among the African countries,
78 we computed the continent GINI index for each of the last three decades using the Pareto principle for the
79 following fluxes: fossil CO₂ per capita emissions, CH₄ fossil + agriculture per capita emissions, CH₄ from
80 agriculture per capita emissions.

81 We computed the GINI using the Pareto method also named 20/80 or ABC method, using an excel file
82 for the several countries' data manipulation. We obtained the GINI index (γ) thanks to the formula:

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$$\gamma = \frac{[(\sum_{i=1}^n y_i \times x_i) - 5000]}{5000}$$

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86 When γ is bigger than 0.6, it means that the area delimited by the curve of the cumulated criterion and the
87 graph diagonal represents more than 60% of the surface of half of the graph, and that the dispersion of the
88 dataset is high. This method was built in the 19th century based on Vilfredo Pareto's observations
89 regarding the inequalities of repartition of the volume of housing taxes among the taxpayers (he realized
90 that 80% of this tax was paid by 20% of the taxpayer.) The different steps that we followed to compute the
91 GINI are detailed below:

- 92 1) computation of the territorial emissions per capita in every African country,
- 93 2) ranking in a decreasing order (from the highest to the smallest one),
- 94 3) computation of the cumulative emissions,
- 95 4) creation of a column with the cumulative emissions expressed as a percentage,
- 96 5) creation of a column with a rank (integer) for those ordered emissions from the biggest to the
97 smallest,
- 98 6) conversion of this rank as a percentage in another column,
- 99 7) distinction of the emissions representing less than 25% of emissions, less than 50%, and less than
100 75% of emissions.
- 101 8) computation of the GINI index (γ) thanks to the Pareto's formula given above.

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105 **Methodological supplementary M3. Computation of correlation coefficient.**

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107 In mathematics, the linear correlation between two variables that we can call X and Y implies that
108 two variables have a linear relationship between each other. If there is a linear relation between
109 two variables, it can be represented by a straight line. To compute this linear correlation coefficient,
110 we use the Pearson formula that is the computation of the covariance among variables ($\text{cov}(X,Y)$),
111 divided by the product of their standard deviation (σ_X and σ_Y). Thus, we can compute the linear
112 correlation ρ_{XY} among two variables by using the following formula: $\rho_{XY} = \frac{\text{cov}(X,Y)}{\sigma_X \sigma_Y}$

113 The higher the absolute value of a linear correlation coefficient between two variables, the more
114 the variables are linearly correlated.

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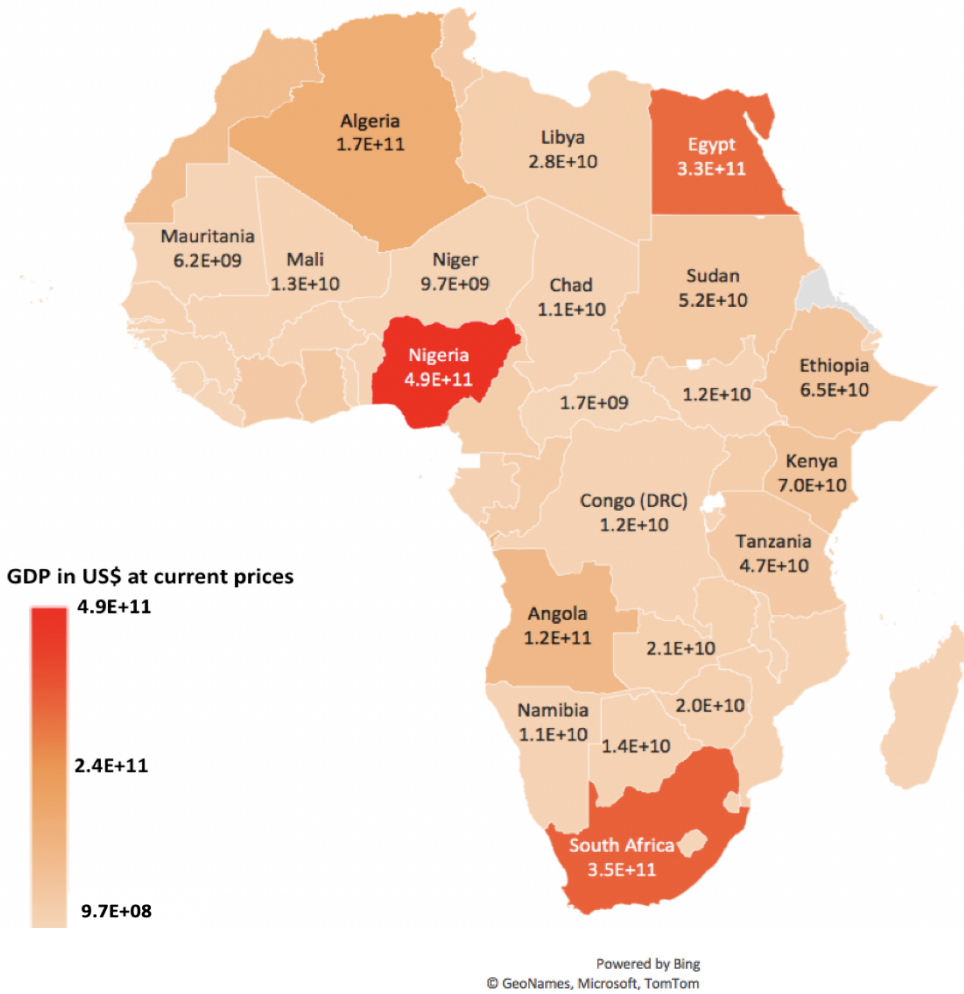
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130 **Figure S5. Bar plots and associated map of African GDP in US\$ for the year 2015, dataset taken from World Bank national**
 131 **accounts data/OECD (2020).**

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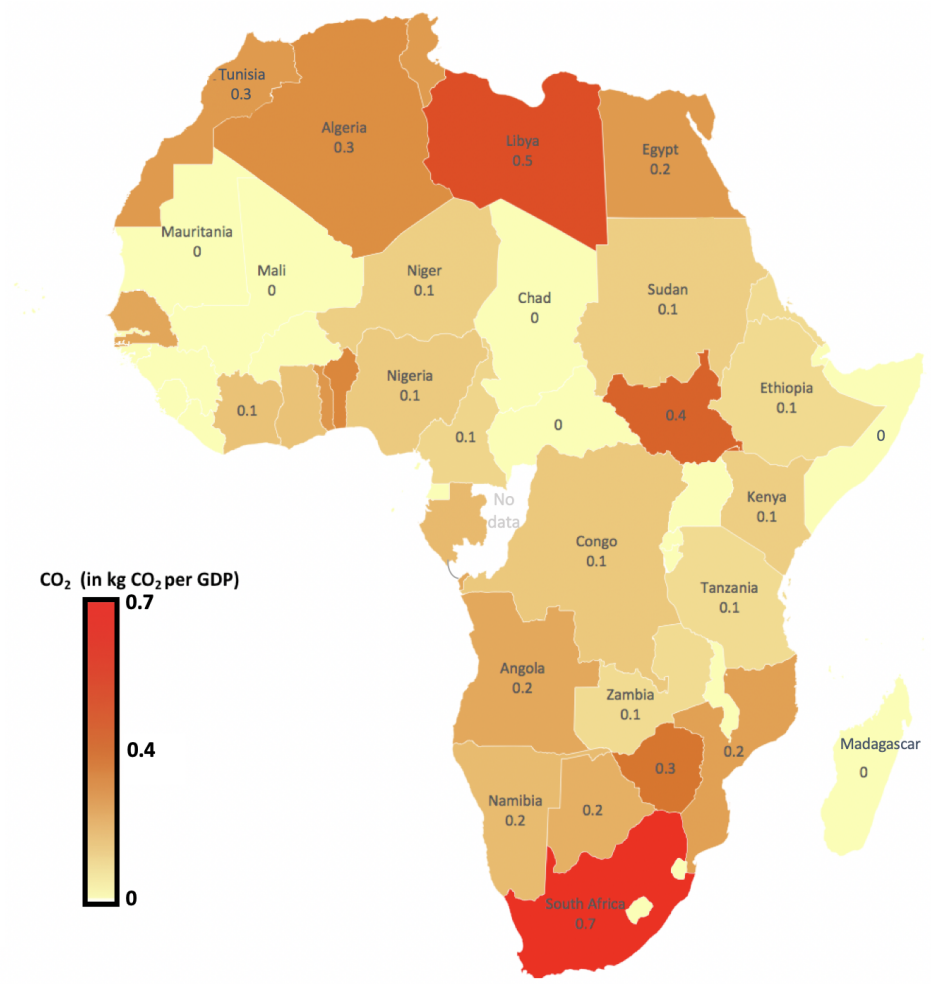
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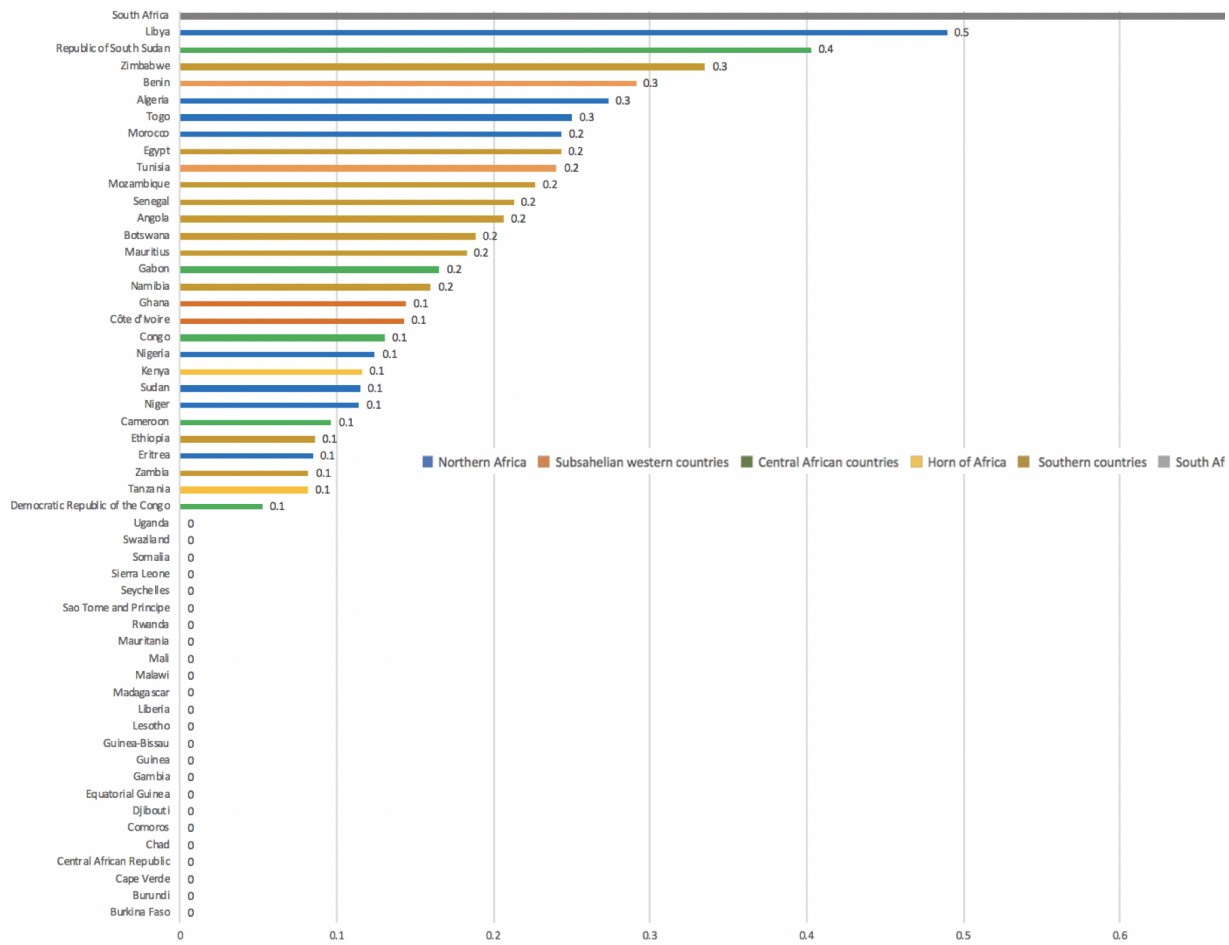
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147 **Figure S6. Map of territorial mean 2013-2017 emissions and its associated bar plots in kg CO₂ of GDP, dataset taken from**
148 **GCP 2019 (CDIAC).**

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156 **Figure S6 bis. Map of territorial mean 2013-2017 emissions and its associated bar plots in kgCO₂ per GDP, dataset taken**
 157 **from GCP 2019 (CDIAC).**

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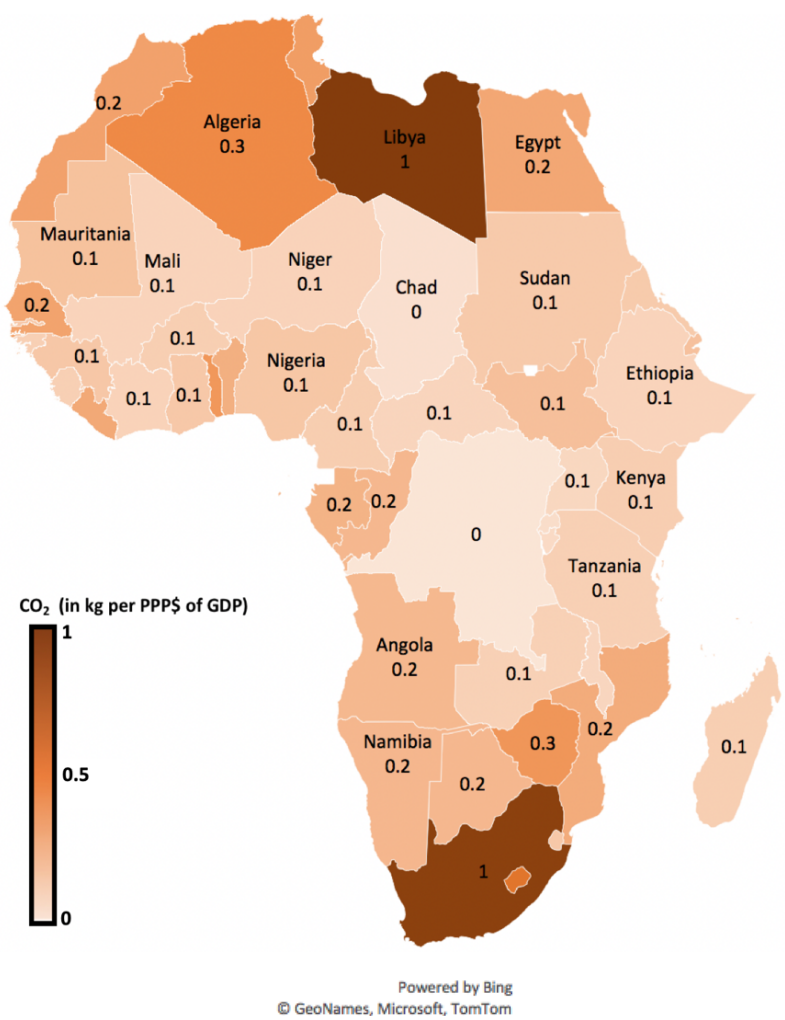
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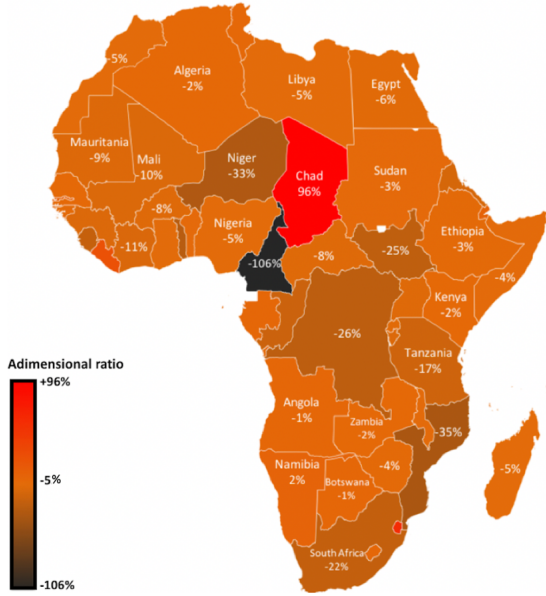
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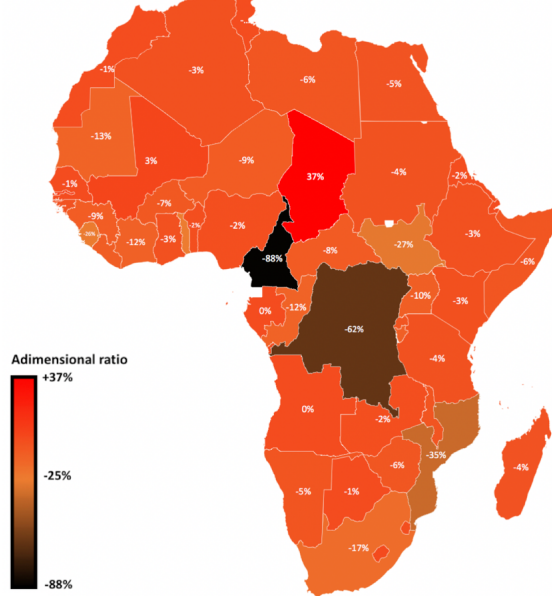
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Figure S7. Map of African CO₂ emissions expressed in kg per PPP\$ of GDP in 2016 - CDIAC.

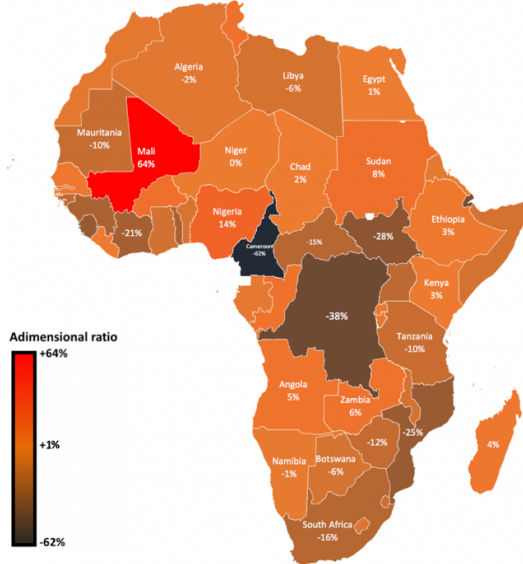
a) Map of African countries CO₂ fossil differences over 1990-1998 in terms of ratio percentage between GCP and PRIMAP-hist datasets : (GCP minus PRIMAP)/(mean(GCP, PRIMAP))



b) Map of African countries CO₂ fossil differences over 1999-2008 in terms of ratio percentage between GCP and PRIMAP-hist datasets : (GCP minus PRIMAP)/(mean(GCP, PRIMAP))



c) Map of African countries CO₂ fossil differences over 2009-2018 in terms of ratio percentage between GCP and PRIMAP-hist datasets : (GCP minus PRIMAP)/(mean(GCP, PRIMAP))



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Figure S8. Three maps of African countries fossil CO₂ emissions per decade: ratio percentage showing the discrepancies between GCP and PRIMAP-hist datasets over three decades (1990-2018).

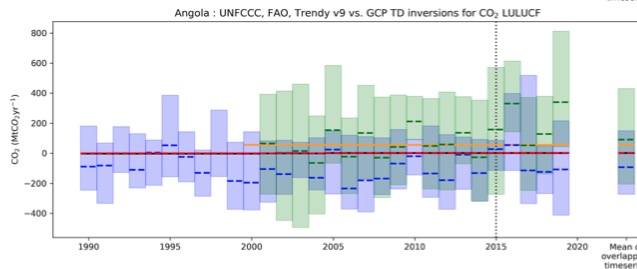
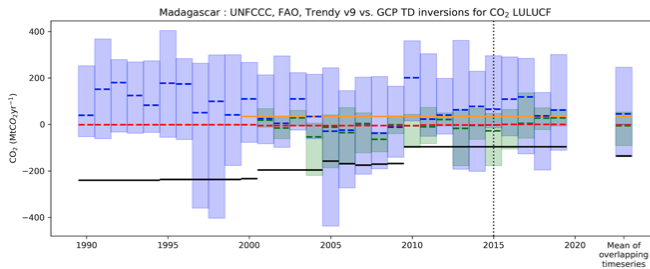
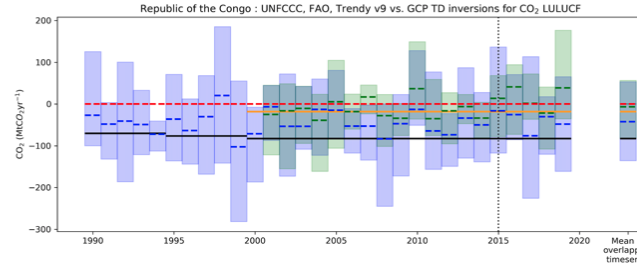
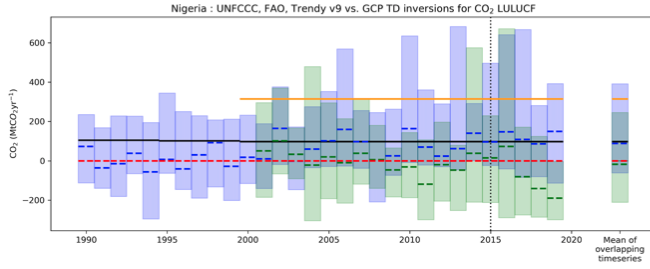
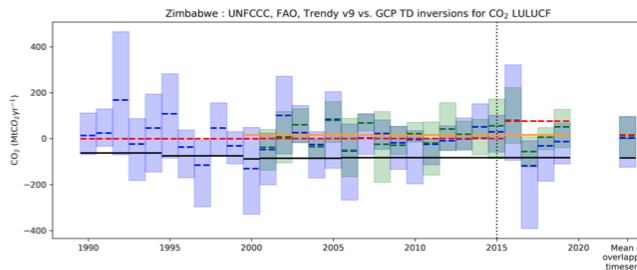
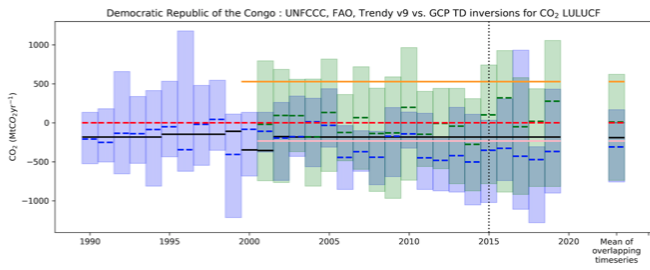
Table S4. List of Least Developed Countries and Small Islands Developing States in Africa.

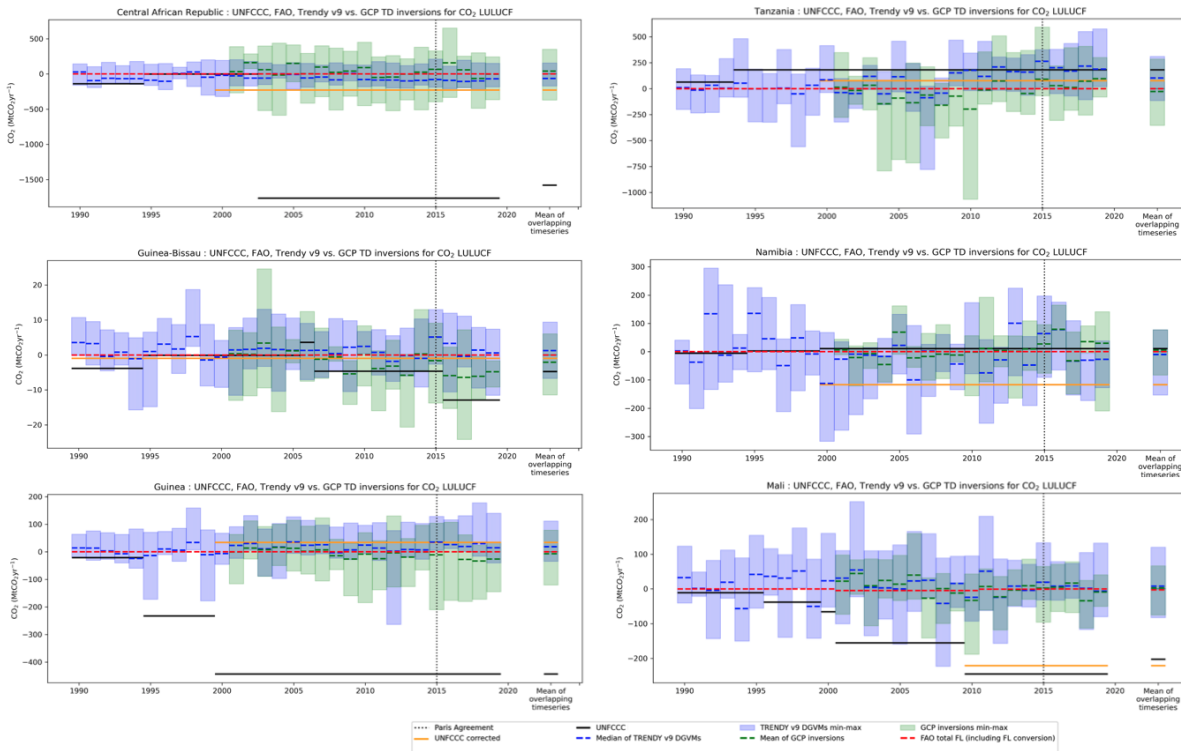
33 Least Developed Countries (LDCs)	6 Small Islands Developing States (SIDS)
Angola, Benin, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, D.R. Congo, Djibouti, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Rwanda, São Tomé and Príncipe, Senegal, Sierra Leone, Somalia, South Sudan, Sudan, Tanzania, Togo, Uganda, Zambia.	Cape Verde, Comores, Guinea-Bissau, Mauritius, Sao Tomé and Príncipe, Seychelles.

Table S5. List of corrected countries for CO₂ LULUCF (in MtCO₂) - corrections in line with Grassi (2022)

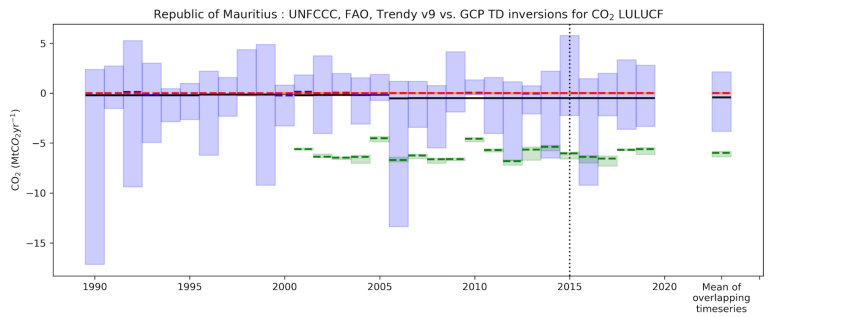
Country	Year of most recent outlier report	Outlier value and source	Year corrected data	Corrected data and source	Mean corrected value over 2000-2020	Mean difference over 2000-2020	Comments on the chosen correcting method.
CAF	2010	-1766 (NC2)	2016	-229 (NDC)	-229	1537	NDC 2016 because more recent than NC2 (2015), and sink in most recent NDC 2021 biophysically impossible.
Guinea-Bissau	2001	-11288 (NC1)	2010	-1 (NC2)	-1	-11287	NC1 value reports an unrealistically high sink.
Tanzania	1994	810 (NC2)	2022	77 (NDC 2022 ¹)	77	566	NDC is more recent and underlines a more realistic order of magnitude.
Guinea	2000	-444 (NC2)	2021	34 (NDC 2021)	34	478	NDC 2021 chosen because more recent than NC2 (2018), and the sink in NC2 is biophysically impossible (-444 MtCO ₂ .yr ⁻¹ over only 5 Mha of forest). However, a remaining problem with the corrected value from nc2 is that no forest sink at all is reported.
Namibia	2000	11 (NC3)	2019	-117 (NIR 2019 ²)	-106	-117	NIR 2019 chosen because more recent than NC3 (2015) and more complete than NDC 2021 which is more recent.
Mali	2010	-245 (NC3)	Mean 2000 and 2010	-221 (mean of NC2 and NC3)	-155	66	Mean of NC2 and NC3 as more complete than REDD+. The sink in NC3 is high and here considered implausible, but it is however consistently reported in various official UNFCCC documents.
Democratic Republic of the Congo	2015	-235 (NC3)	2021	529 (NDC 2021)	529	761	NDC 2021 chosen because more recent than the NC3 (2015) and broadly consistent with REDD+ (2018). But a weakness of this correction source is that it does not report any carbon sink from forest.
Madagascar	2010	-97 (NC3)	2017	34 (REDD+ 2018)	34	131	REDD+ (2018) chosen because more recent than NC3 (2017), but it covers only deforestation. NC3 reports a biophysically impossible sink over only 9 Mha of forest.
Nigeria	2014	98 (NC2)	2017	315 (BUR2)	287	189	BUR2 (2021) chosen because more recent than NC2 (2014) and more detailed than NDC 2021 which report different numbers.
Zimbabwe	2006	-83 NC3 (2017)	2021	16 (BUR1)	11	95	BUR1 (2021) as more recent than the NC3 (2017) and more complete than NDC 2021.
Congo	Since 2000	-83 (NC2)	2009	-18 (NC2)	-18	65	NDC2021 chosen because more recent than the NC2 (2009).
Angola	2012	0.7 (NC1)	2021	55 (NC2)	55	54	NC2 (2021) chosen because more recent than NC1 (2012).
Mauritius	2013	-490 (NC3)	2016	0 (NIR 2021)	0	490	NIR 2021 more recent than NC3 (with unrealistically high value).

¹Using Tanzania GHGs Inventory Report and MRV System (2018).²NIR = National Inventory Report (NIR).





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Figure S9. Country details for LULUCF CO₂ emissions and sinks from UNFCCC corrected (strictly consistent with Grassi et al. 2022) for 13 African countries that we identified as outliers vs. UNFCCC uncorrected data, TRENDY v9, DGVMs and GCP (2020) inversions. Unit is in MtCO₂. Black lines denote the PRIMAP-hist estimates for total anthropogenic emissions including all IPCC sectors. Shaded green areas represent the minimum and maximum ranges from GCP inversions. Shaded blue areas represent the minimum and maximum ranges for TRENDY v9 DGVMs. Green dashes denote the median of GCP inversions, blue dashes denote the median of TRENDY v9 DGVMs, green dashes the median of GCP inversions. The positive values represent a source while the negative values refer to a sink.

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Table S6. Data sources for the land CO₂ emissions in this analysis.

Method	Product type / file name	Species	Overall period covered	References
BU	TRENDY v9 (2019) 14 DGVMs : CABLE, CLASS, CLM5, DLEM, ISAM, JSBACH, JULES, LPJ, LPX, OCN, ORCHIDEE- CNP, ORCHIDEE, SDGVM, SURFEX	Land-related Carbon emissions (Net Biome Productivity)	1900-2019	Met Office UK/ Le Quéré et al. (2018) www.icos-cp.eu/GCP
BU	UNFCCC	LULUCF Net CO ₂ emissions / removals	1990-2015	UNFCCC https://unfccc.int/non-annex-I-NCs
TD	GCB 2019	Total CO ₂ inverse flux (Net Biome Productivity)	2000-2018	Friedlingstein et al. (2020)
	Carbon Tracker Europe (CTE)		2000-2018	van der Laan-Luijke et al. (2017)
	CAMS (in-situ)		2000-2018	Chevallier et al. (2005) Rödenbeck (2005)
	Jena CarboScopeReg (in situ)		2006-2010	Kountouris et al. (2018)

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Table S7. Data sources for total CH₄ emissions in this analysis.

Method/observations	Product type / number of inversions	Overall period covered	References
TD (surface stations)	Carbon Tracker-Europe CH ₄ , CTE_SURF (FMI)/ 1	2000-2017	Tsuruta et al. (2017)
TD (GOSAT NIES L2 v2.72)	Carbon Tracker-Europe CH ₄ , CTE_GOSAT (FMI)/ 1	2000-2017	Tsuruta et al. (2017)
TD (surface stations)	GELCA_SURF (NIES)/ 1	2000-2015	Ishizawa et al. (2016)
TD (surface stations)	LMDZ_PYVAR (LSCE)/ 2	2010-2016	Yin et al. (2020)
TD (GOSAT 7.2 Leicester v2)	LMDZ_PYVAR (LSCE)/ 4	2010-2016	Yin et al. (2020)
TD (GOSAT 7.2 Leicester v2)	LMDZ_PYVAR (LSCE)/ 2	2010-2017	Zheng et al. (2018)
TD (surface stations)	MIROC4- ACTM (JAMSTEC)/ 1	2010-2016	Patra et al. (2016)
TD (surface stations)	NICAM-TM (NIES)/ 1	2000-2017	Niwal et al. (2017)
TD (surface stations)	NIES-TM-FLEXPART-VAR (NETFVAR), (NIES)/ 1	2010-2017	Maksyutov et al. (2020); Wang et al. (2019)
TD (GOSAT NIES L2 v2.72)	NIES-TM-FLEXPART-VAR (NETFVAR), (NIES)/ 1	2010-2017	Maksyutov et al. (2020); Wang et al. (2019)
TD (surface stations)	TM5-CAMS (TNO)/1	2000-2017	Segers and Houweling (2018), Bergamaschi et al. (2013, 2018)
TD (GOSAT/CCI v2.3.8 and surface observations)	TM5-CAMS (TNO)/1	2010-2017	Segers and Houweling (2018), Bergamaschi et al. (2013, 2018)
TD (surface stations)	TM5-4DVAR (EC_JRC)/2	2000-2017	Bergamaschi et al. (2013, 2018)
TD (GOSAT/CCI v2.3.8 and surface observations)	TM5-4DVAR(EC_JRC)/2	2010-2017	Bergamaschi et al. (2013, 2018)
TD (surface stations)	TOMCAT (University of Leeds)/	2003-2015	McNorton (2018)

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212 **Table S8. Data sources for total N₂O inverse flux over Africa (in situ).**

Method	Product type / file name	Period covered	References
TD	PyVAR	1998-2017	Thompson et al. (2014), Tian et al. (2020)
TD	TOMCAT- INVICAT	1998-2015	Wilson et al. (2014), Tian et al. (2020)
TD	MIROC4- ACTM (JAMSTEC)	1998-2016	Patra et al. (2018), Tian et al. (2020)

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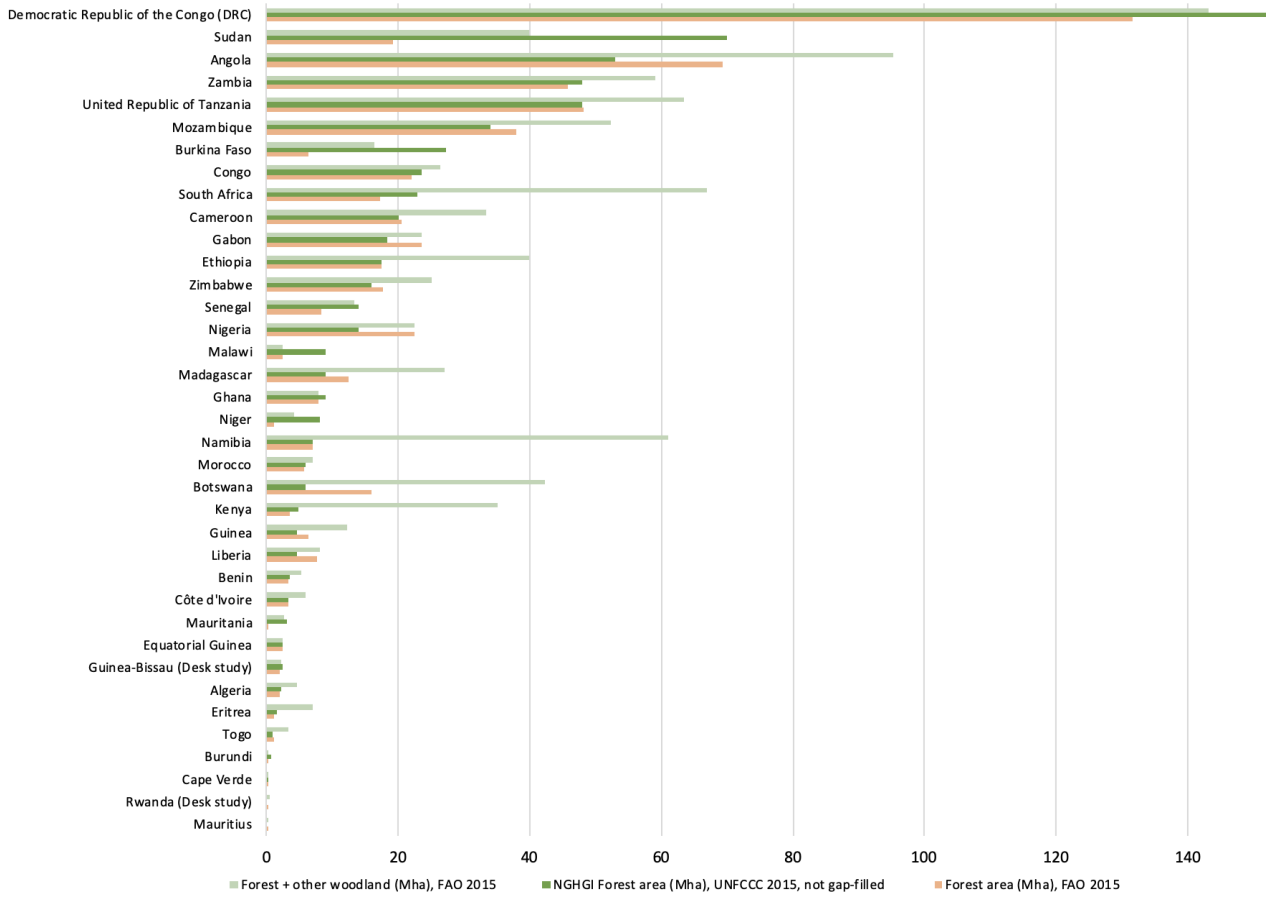
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Table S9. Area of managed land reported in NC/BUR/REDD+ versus FAO forest land (2015) and FAO forest land + other woodlands (2015) for Africa.

Country	Forest area in Mha. Data: FAO (2015)	Inventories forest area in Mha. Data: UNFCCC/REDD+	Forest land area + other woodland area in Mha. Data : FAO (2015)
Mauritius	0.04	0.00	0.05
Rwanda	0.27	0.00	0.53
Cape Verde	0.04	0.04	0.08
Burundi	0.28	0.71	0.28
Togo	1.22	1.00	3.33
Eritrea	1.07	1.59	7.03
Algeria	1.96	2.14	4.53
Guinea-Bissau	2.02	2.46	2.19
Eq. Guinea	2.49	2.50	2.49
Mauritania	0.34	3.00	2.74
Côte d'Ivoire	3.40	3.40	5.96
Benin	3.39	3.59	5.34
Liberia	7.77	4.52	8.07
Guinea	6.39	4.60	12.24
Kenya	3.52	4.75	35.14
Botswana	15.85	5.83	42.34
Morocco	5.68	6.00	6.97
Namibia	6.99	7.00	61.07
Niger	1.14	8.00	4.28
Ghana	7.88	8.97	7.88
Madagascar	12.50	9.00	26.96
Malawi	2.45	9.00	2.45
Nigeria	22.44	14.00	22.44
Senegal	8.27	14.00	13.42
Zimbabwe	17.67	16.00	25.13
Ethiopia	17.43	17.43	39.83
Gabon	23.59	18.27	23.59
Cameroon	20.62	20.00	33.34
South Africa	17.23	23.00	66.91
Congo	22.02	23.52	26.39
Burkina Faso	6.47	27.30	16.45
Mozambique	37.94	34.00	52.36
Tanzania	48.09	48.00	63.38
Zambia	45.76	48.00	58.97
Angola	69.38	53.00	95.31
Sudan	19.21	70.00	39.96
Dem. Rep. Congo	131.66	152.00	143.17

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Comparison of UNFCCC vs. FAO forest land area and FAO forest + other wood land (year 2015) in Mha



246 **Figure S10. Bar plots comparing areas of managed land reported in Mha for NC/BUR/REDD+ versus FAO forest land**
 247 **(2015) in Mha and FAO forest land + other woodlands areas (2015) for African countries. (Source: Forest Resource**
 248 **Assessment, FAO). See also Table S7 for detailed values.**

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264 **Table S10. Synthesis of TD and BU mean CH₄ emissions and removals in MtCO₂e.yr⁻¹ for the overlapping time series**
 265 **(2010-2017) for whole Africa and for the six groups using Method 1 (Foss+ AGRIW + BBUR - wildfires).**

Region	Rank median PRIMAP	Rank median GOSAT	Rank median surface inversions	Rank wetlands median GMB	Rank wildfires	Rank wetlands median GMB
North Africa	1	1	1	5	3	5
Subsahelian West Africa	2	3	2	4	5	4
Horn of Africa	3	2	3	3	4	3
Southern Africa	4	5	5	2	1	2
Central Africa	5	4	4	1	2	1
South Africa Group	6	6	6	6	6	6

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300 **Table S11. Anomalies in ranking for TD and BU mean values on the overlapping time periods (2010-2017) for whole**
 301 **Africa, and for six African groups using Method 1 for anthropogenic CH₄ (FOSS + AGRIW + BBUR - wildfires) in**
 302 **MtCO₂e.yr⁻¹.**

Region	PRIMAP	Median GOSAT inv.	Max GOSAT inv.	Min GOSAT inv.	Median surface inv.	Max surface inv.	Min surface inv.	Max wetlands GCB	Median wetlands GCB	Min wetlands GCB	Wildfires
Africa Total	1231	1117	1390	903	1094	1330	853	946	827	481	110
North Africa	293	270	330	174	302	396	245	146	69	34	11
Subsahelian West Africa	272	186	329	174	249	396	245	161	77	48	8
Horn of Africa	252	242	551	206	237	302	183	171	86	47	9
Southern Africa	212	114	173	99	114	146	91	214	102	65	41
Central Africa	123	130	170	106	123	142	88	615	428	195	40
South Africa Group	78	91	168	75	88	124	65	21	13	2	1

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 305 **Table S12. Synthesis of wetlands (GCB) mean CH₄ emissions and removals in MtCO₂e.yr⁻¹ for the overlapping time**
 306 **series (2010-2017) for the whole Africa and six African groups.**

Region	Max wetlands GCB	Median wetlands GCB	Min wetlands GCB
Africa	946	827	481
North Africa	146	69	34
Subsahelian West Africa	161	77	48
Horn of Africa	171	86	47
Southern Africa	214	102	65
Central Africa	615	428	195
South Africa group	21	13	2

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308 Table S13. Comparison between N₂O PRIMAP-hist mean values and the median of inversions on the overlapping
 309 period (2010-2017) for Africa and the six African groups in MtCO₂e.yr⁻¹.

Region	PRIMAP-hist	Median global inversions
Africa total	360	1647 (1502 to 1760)
North Africa	106	330 (274 to 419)
Subsahelian West Africa	68	271 (68 to 330)
Horn of Africa	46	240 (217 to 265)
Southern Africa	62	263 (214 to 310)
Central Africa	182	461 (424 to 517)
South Africa group	24	68 (51 to 81)

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311 Table S14. Synthesis for the three main GHGs net African budget: comparative net emissions and removals
 312 computation by TD methods for Africa as a whole and for six sub-groups of African countries over the overlapping
 313 period (2001-2017), in MtCO₂e. Use of Method 1 for CH₄ (FOS+AGRIW+BBUR-wildfires) excluding UNFCCC
 314 outliers, and including the range for GCP CO₂ LULUCF.
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Region	TD Method 1 and GCP for FCO ₂				TD Method 1 and PRIMAP for FCO ₂			
	CH ₄ median GOSAT inversions + median N ₂ O inversions	CH ₄ median SURF inversions + median N ₂ O inversions	CH ₄ median SURF inversions + PRIMAP N ₂ O	CH ₄ median GOSAT inversions + PRIMAP N ₂ O	CH ₄ median GOSAT inversions + median N ₂ O inversions	CH ₄ median SURF inversions + median N ₂ O inversions	CH ₄ median SURF inversions + PRIMAP N ₂ O	CH ₄ median GOSAT inversions + PRIMAP N ₂ O
Africa total	3889 ⁷²⁵⁷ ₁₂₉₆	3866 ⁷¹⁹⁷ ₁₂₄₆	2579 ⁵⁷⁹⁷ ₁₀₄	2602 ⁵⁸⁵⁷ ₁₅₄	3983 ⁷⁶²¹ ₁₃₉₀	3960 ⁷²⁹¹ ₁₃₄₀	2673 ⁵⁸⁹⁰ ₁₉₈	2696 ⁵⁹⁵⁰ ₂₄₈
North Africa	1014 ¹⁴³⁸ ₅₅₃	1046 ¹⁵⁰⁴ ₆₂₄	822 ¹¹⁹⁰ ₄₅₆	790 ¹¹²⁴ ₃₈₅	1022 ¹⁴⁴⁶ ₅₉₁	1054 ¹⁵¹¹ ₆₃₂	830 ¹²³² ₄₆₄	798 ¹¹³² ₃₉₃
Central Africa	758 ²⁰⁶⁴ ₇₅₈	751 ²⁰³⁶ ₇₇₆	344 ¹⁵⁷³ ₁₁₄₅	351 ¹⁶⁰² ₁₁₂₈	766 ²⁰⁷² ₇₅₀	759 ²⁰⁴³ ₇₆₈	352 ¹⁵⁸² ₁₁₃₈	359 ¹⁶¹⁰ ₁₁₂₀
Subsahelian West Africa	546 ¹²⁸² ₉₅	609 ¹³⁴⁹ ₂₄	406 ¹⁰⁸⁶ ₂₄	343 ¹⁰¹⁹ ₉₅	542 ¹²⁷⁸ ₉₈	605 ¹³⁴⁵ ₂₇	403 ¹⁰⁸³ ₂₇	340 ¹⁰¹⁶ ₉₈
Southern Africa	616 ¹⁷²⁶ ₁₇₅	616 ¹⁶⁹⁹ ₁₈₆	415 ¹⁴⁵¹ ₃₃₈	415 ¹⁴⁷⁸ ₃₃₁	618 ¹⁷²⁸ ₃₄₀	618 ¹⁷⁰¹ ₃₄₈	416 ¹⁴⁵² ₃₃₇	416 ¹⁴⁷⁹ ₃₂₉
South Africa group	458 ⁷¹⁰ ₁₀₃	455 ⁷⁴⁷ ₉₃	411 ⁶⁸⁹ ₁₁₆	414 ⁷³⁴ ₁₂₆	537 ⁸⁷¹ ₁₈₄	534 ⁹²⁷ ₁₇₂	490 ⁷⁶⁹ ₁₉₆	493 ⁸¹³ ₂₀₆
Horn of Africa	399 ¹²¹⁵ ₂₇₄	394 ⁹⁶⁶ ₂₉₇	201 ⁷⁴⁸ ₄₆₇	206 ⁹⁹⁷ ₄₄₄	401 ¹²¹⁶ ₂₇₃	395 ⁹⁶⁷ ₂₉₆	202 ⁷⁴⁹ ₄₆₇	207 ⁹⁹⁸ ₄₄₄

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Table S15. Synthesis for the three main GHGs net African budget: comparative net emissions and removals computation by TD methods for Africa as a whole and for six sub-groups of African countries over the overlapping period (2001-2017), in MtCO₂e. Use of Method 1 for CH₄ (FOS+AGRIW+BBUR-wildfires) excluding UNFCCC outliers, and excluding the range for GCP CO₂ LULUCF (possible outliers).

Region	TD Method 1 and GCP FCO ₂				TD Method 1 and PRIMAP FCO ₂			
	CH ₄ median GOSAT inversions + median N ₂ O inversions	CH ₄ median SURF inversions + median N ₂ O inversions	CH ₄ median SURF inversions + PRIMAP N ₂ O	CH ₄ median GOSAT inversions + PRIMAP N ₂ O	CH ₄ median GOSAT inversions + median N ₂ O inversions	CH ₄ median SURF inversions + median N ₂ O inversions	CH ₄ median SURF inversions + PRIMAP N ₂ O	CH ₄ median GOSAT inversions + PRIMAP N ₂ O
Africa total	3889 ⁴²⁷⁶ ₃₅₃₀	3866 ⁴²¹⁶ ₃₄₈₀	2579 ²⁸¹⁵ ₂₃₃₈	2602 ²⁸⁷⁵ ₂₃₈₈	3983 ⁴⁶³⁹ ₃₆₂₄	3960 ⁴³⁰⁹ ₃₅₇₄	2673 ²⁹⁰⁹ ₂₄₃₂	2696 ²⁹⁶⁹ ₂₄₈₂
North Africa	1014 ¹¹⁶⁴ ₈₆₂	1046 ¹²³⁰ _{933.1}	822 ⁹¹⁶ ₇₆₅	790 ⁸⁵⁰ ₆₉₄	1022 ¹¹⁷¹ ₈₇₀	1054 ¹²³⁷ ₉₄₁	830 ⁹⁵⁸ ₇₇₃	798 ⁸⁵⁸ ₇₀₂
Central Africa	758 ⁸⁵³ ₆₉₇	751 ⁸²⁶ ₆₇₉	344 ³⁶³ ₃₀₉	351 ³⁹¹ ₃₂₇	766 ⁸⁶² ₇₀₅	759 ⁸³³ ₆₈₇	352 ³⁷¹ ₃₁₇	359 ³⁹⁹ ₃₃₅
Subsahelian West Africa	546 ⁷⁴⁸ ₃₃₁	609 ⁸¹⁵ ₄₀₂	406 ⁵⁵³ ₄₀₂	343 ⁴⁸⁶ ₃₃₁	542 ⁷⁴⁵ ₃₂₈	605 ⁸¹² ₃₉₉	403 ⁵⁵⁰ ₃₉₉	340 ⁴⁸³ ₃₂₈
Southern Africa	616 ⁷²² ₅₅₂	616 ⁶⁹⁵ ₅₄₄	415 ⁴⁴⁷ ₃₉₂	415 ⁴⁷⁴ ₄₀₀	618 ⁷²⁴ ₃₉₀	618 ⁶⁹⁷ ₃₈₂	416 ⁴⁴⁸ ₃₉₃	416 ⁴⁷⁵ ₄₀₁
South Africa group	458 ⁴⁶⁷ ₃₇₄	455 ⁵⁰⁴ ₃₆₄	411 ⁴⁴⁶ ₃₈₈	414 ⁴⁹¹ ₃₉₈	537 ⁶²⁸ ₄₅₃	534 ⁵⁸⁴ ₄₄₃	490 ⁵²⁶ ₄₆₇	493 ⁵⁷⁰ ₄₇₇
Horn of Africa	399 ⁷³³ ₃₄₀	394 ⁴⁸⁴ ₃₁₇	201 ²⁶⁶ ₁₄₇	206 ⁵¹⁵ ₁₇₉	400 ⁷³⁴ ₃₄₁	395 ⁴⁸⁵ ₃₁₈	202 ²⁶⁷ ₁₄₈	207 ⁵¹⁶ ₁₇₁

338 **Table S16. Mean net total Africa and regional groups from mean TD (excluding the range for CO₂ LULUCF due to**
 339 **outliers) and mean best fitted BU Methods excluding outliers. (For TD approaches, N₂O inversions were excluded and**
 340 **replaced by PRIMAP estimates. For DGVMs the range for GCP CO₂ LULUCF was not considered due to probable**
 341 **outliers. UNFCCC outliers are also excluded.) Net emissions and removals are expressed in MtCO₂e.yr⁻¹ over the**
 342 **overlapping period (2001-2017).**

Region	Mean of TD methods excluding N ₂ O inversions replaced with N ₂ O PRIMAP and excluding the range for GCP CO ₂ LULUCF (with probable outliers)	Ranking with TD methods	Mean net of best fitted BU methods (excluding uncorrected UNFCCC data)	Ranking with BU methods
North Africa	806 ⁸⁸³ ₇₃₀ (GCP FCO ₂) 814 ⁹⁰⁸ ₇₃₇ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 810 ⁸⁹⁵ ₇₃₃	1	713 ⁸⁰⁷ ₆₄₁ (GCP FCO ₂) 720 ⁸¹⁶ ₆₄₉ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 717 ⁸¹² ₆₄₅	1
South Africa group	412 ⁴⁶⁸ ₃₉₃ (GCP FCO ₂) 491 ⁵⁴⁷ ₄₇₂ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 452 ⁵⁰⁸ ₄₃₂	2	534 ⁶¹³ ₄₄₃ (GCP FCO ₂) 613 ⁶⁹² ₅₂₂ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 574 ⁶⁵³ ₄₈₃	3
Horn of Africa	203 ³⁹⁰ ₁₅₈ (GCP FCO ₂) 204 ³⁹¹ ₁₅₉ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 204 ³⁹¹ ₁₅₉	6	432 ⁵²⁴ ₂₉₆ (GCP FCO ₂) 433 ⁵²⁵ ₂₉₇ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 433 ⁵²⁵ ₂₉₇	4
Subsahelian West Africa	375 ⁵²⁰ ₃₆₇ (GCP FCO ₂) 371 ⁵¹⁶ ₃₆₃ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 373 ⁵¹⁸ ₃₆₅	4	612 ⁷⁷⁶ ₅₃₉ (GCP FCO ₂) 609 ⁷⁷² ₅₃₅ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 610 ⁷⁷⁴ ₅₃₇	2
Southern Africa	415 ⁴⁶⁰ ₃₉₆ (GCP FCO ₂) 416 ⁴⁶² ₃₉₇ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 416 ⁴⁶¹ ₃₉₇	3	228 ⁵²⁹ ₃₇₈ (GCP FCO ₂) 355 ⁵³¹ ₁₇₉ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 292 ⁵³⁰ ₁₇₈	5
Central Africa	348 ³⁷⁷ ₃₁₈ (GCP FCO ₂) 356 ³⁸⁵ ₃₂₆ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 352 ³⁸¹ ₃₂₂	5	-70 ¹⁶⁸ ₋₂₁₀ (GCP FCO ₂) -62 ¹⁷⁶ ₋₂₀₂ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): -66 ¹⁷² ₋₂₀₆	6
Africa total	2591 ²⁸⁴⁵ ₂₃₆₃ (GCP FCO ₂) 2684 ²⁹³⁹ ₂₄₅₇ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 2638 ²⁸⁹² ₂₄₁₀		2576 ³²²⁸ ₂₁₄₀ (GCP FCO ₂) 2669 ³²⁵¹ ₂₂₃₃ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 2623 ³²⁴⁰ ₂₁₈₆	

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352 Table S17. Mean net total Africa and regional groups from best fitted mean TD and mean BU Methods excluding outliers.
 353 For TD approaches, N₂O inversions were excluded and replaced by PRIMAP estimates. For DGVMs, the range for GCP
 354 CO₂ LULUCF was considered. UNFCCC outliers are also excluded. Net emissions and removals are expressed in MtCO₂.yr⁻¹
 355 ¹ over the overlapping period (2001-2017).

Region	Mean net of TD methods (including range for CO ₂ LULUCF from GCP inversions with outliers but excluding N ₂ O inversions (N ₂ O PRIMAP)	Ranking with TD methods	Mean net of best fitted BU methods (excluding uncorrected UNFCCC data)	Ranking with BU methods
North Africa	806 ¹¹⁵⁷ ₁₂₉ (GCP FCO ₂) 814 ¹¹⁸² ₄₂₈ (PRIMAP FCO ₂) Mean GCP & PRIMAP: 810 ¹¹⁷⁰ ₂₇₉	1	713 ⁸⁰⁷ ₆₄₁ (GCP FCO ₂) 720 ⁸¹⁶ ₆₄₉ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 717 ⁸¹² ₆₄₅	1
South Africa group	412 ⁷¹² ₁₂₁ (GCP FCO ₂) 491 ⁷⁹¹ ₂₀₁ (PRIMAP FCO ₂) Mean GCP & PRIMAP: 452 ⁷⁵¹ ₁₆₁	2	534 ⁶¹³ ₄₄₃ (GCP FCO ₂) 613 ⁶⁹² ₅₂₂ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 574 ⁶⁵³ ₄₈₃	3
Horn of Africa	203 ⁸⁷² ₋₄₅₆ (GCP FCO ₂) 204 ⁸⁷³ ₋₄₅₅ (PRIMAP FCO ₂) Mean GCP & PRIMAP: 204 ⁸⁷³ ₋₄₅₆	6	432 ⁵²⁴ ₂₉₆ (GCP FCO ₂) 433 ⁵²⁵ ₂₉₇ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 433 ⁵²⁵ ₂₉₆	4
Subsahelian West Africa	375 ¹⁰⁵³ ₃₆ (GCP FCO ₂) 371 ¹⁰⁵⁰ ₃₆ (PRIMAP FCO ₂) Mean GCP & PRIMAP: 373 ¹⁰⁵¹ ₃₅₆	4	612 ⁷⁷⁶ ₅₃₉ (GCP FCO ₂) 609 ⁷⁷² ₅₃₅ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 610 ⁷⁷⁴ ₅₃₇	2
Southern Africa	415 ¹⁴⁶⁴ ₋₃₃₅ (GCP FCO ₂) 416 ¹⁴⁶⁶ ₋₃₃₃ (PRIMAP FCO ₂) Mean GCP & PRIMAP: 416 ¹⁴⁶⁵ ₋₃₃₄	3	228 ⁵²⁹ ₁₇₈ (GCP FCO ₂) 355 ⁵³¹ ₁₇₉ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 292 ⁵³⁰ ₁₇₈	5
Central Africa	348 ¹⁵⁸⁸ ₋₁₁₃₇ (GCP FCO ₂) 356 ¹⁵⁹⁶ ₋₁₁₂₉ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 352 ¹⁵⁹² ₋₁₁₃₃	5	-70 ¹⁶⁸ ₋₂₁₀ (GCP FCO ₂) -62 ¹⁷⁶ ₋₂₀₂ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): -66 ¹⁷² ₋₂₀₆	6
Africa total	2583 ³⁰³⁷ ₂₅₁ (GCP FCO ₂) 2654 ³⁰⁸⁹ ₂₃₂₂ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 2638 ⁵⁸⁷³ ₁₇₆₁		2576 ³²²⁸ ₂₁₄₀ (GCP FCO ₂) 2669 ³²⁵¹ ₂₂₃₃ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 2623 ³²⁴⁰ ₂₁₈₆	

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366 Table S18. Mean net total of best fitted mean TD and mean BU methods excluding N₂O inversions (replaced by
 367 PRIMAP estimates), using Method 1 for CH₄ (FOS+AGRIW+BBUR-wildfires) excluding UNFCCC outliers, and
 368 including the range for GCP CO₂ LULUCF, for Africa total and for regional groups, with associated ranking.

Region	Mean of best fitted TD and BU methods using both GCP and PRIMAP FCO ₂ (excluding UNFCCC outliers and N ₂ O inversions, but including range for CO ₂ LULUCF from GCP inversions)	Ranking with TD methods
North Africa	761 ⁹⁸⁸ ₄₆₀	1
South Africa group	513 ⁷⁰² ₁₆₁	2
Horn of Africa	318 ⁶⁹⁹ ₋₈₀	5
Subsahelian West Africa	492 ⁹¹³ ₂₈₆	3
Southern Africa	354 ⁹⁹⁸ ₋₇₈	4
Central Africa	143 ⁸⁸² ₋₆₇₀	6
Africa total	2630 ⁴⁵⁵⁷ ₁₉₇₄	

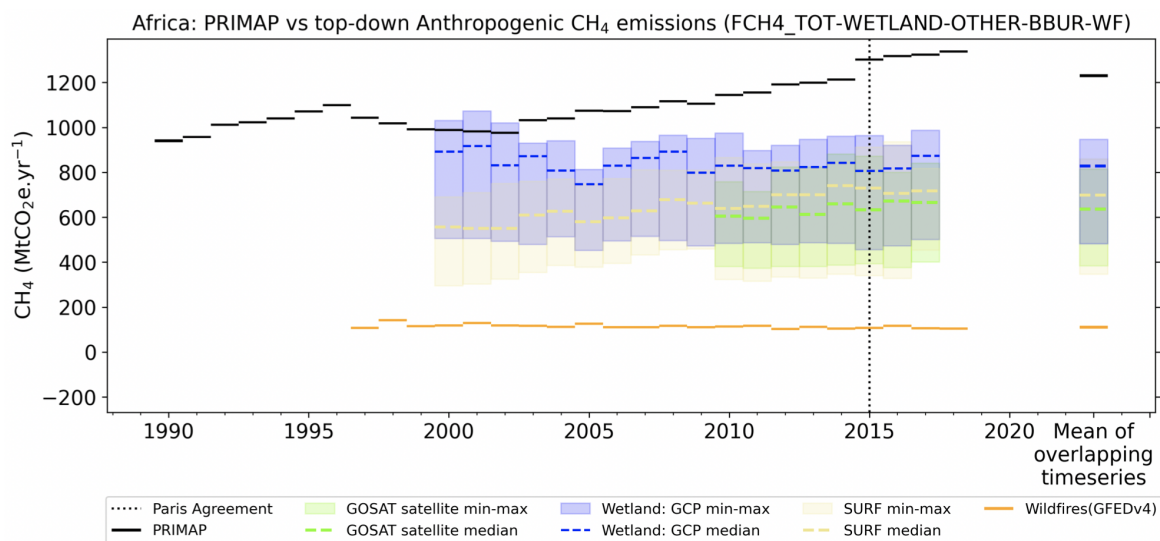
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384 **Table S19. Mean net total Africa and regional groups from TD inversions only including N₂O inversions (and the range**
 385 **for CO₂ LULUCF from GCP inversions). For BU methods, UNFCCC outliers are excluded.**

Region	Mean TD from inversions only (including range for CO ₂ LULUCF from GCP inversions and N ₂ O inversions)	Ranking with BU methods
North Africa	1030 ¹⁴⁷¹ ₅₈₉ (GCP FCO ₂) 1038 ¹⁴⁷⁹ ₅₁₂ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 1034 ¹⁴⁷⁵ ₆₀₀	1
South Africa group	457 ⁷²⁹ ₉₈ (GCP FCO ₂) 536 ⁸⁹⁹ ₁₇₈ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 496 ⁸¹⁴ ₁₃₈	5
Horn of Africa	397 ¹⁰⁹⁰ ₋₂₈₆ (GCP FCO ₂) 398 ¹⁰⁹¹ ₋₂₈₅ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 397 ¹⁰⁹¹ ₋₂₈₅	6
Subsahelian West Africa	577 ¹³¹⁵ ₋₆₀ (GCP FCO ₂) 574 ¹³¹² ₋₆₃ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 576 ¹³¹³ ₋₆₁	4
Southern Africa	616 ¹⁷¹³ ₋₁₈₁ (GCP FCO ₂) 618 ¹⁷¹⁴ ₋₃₄₄ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 617 ¹⁷¹³ ₋₂₆₂	3
Central Africa	755 ²⁰⁵⁰ ₋₇₆₇ (GCP FCO ₂) 763 ²⁰⁵⁸ ₋₇₅₉ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 759 ²⁰⁵⁴ ₋₇₆₃	2
Africa total	3787 ⁷²²⁶ ₁₂₇₄ (GCP FCO ₂) 3971 ⁷⁴⁵⁶ ₁₃₆₅ (PRIMAP FCO ₂) Mean GCP & PRIMAP (FCO ₂): 3879 ⁷³⁴¹ ₁₃₂₀	

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391 **Figure S11. Comparison of the total anthropogenic CH₄ emissions from PRIMAP-hist and 22 top-down global**
 392 **ensembles using Method 2 for total Africa, including wildfire emissions. Anthropogenic CH₄ emissions from TD**
 393 **TD methods were computed by withdrawing the sum of available data regarding natural emissions from the total flux**
 394 **(wetlands, “other natural” emissions, biomass burning, and wildfires (GFEDv4)). Black lines denote the PRIMAP-**
 395 **hist estimates for total anthropogenic emissions including all IPCC sectors. Shaded green areas represent the**
 396 **minimum and maximum ranges from satellite concentration observations (GOSAT) inversions. Shaded blue areas**
 397 **represent the minimum and maximum ranges for wetlands. Shaded yellow areas represent the minimum and**
 398 **maximum ranges for surface stations (SURF). Green dashes denote the median of 11 global GOSAT satellites, blue**
 399 **dashes denote the median of wetlands, yellow dashes the median of inversions using surface stations (SURF). The**
 400 **orange lines represent wildfire emissions. Following the atmospheric convention, positive numbers represent an**
 401 **emission to the atmosphere.**

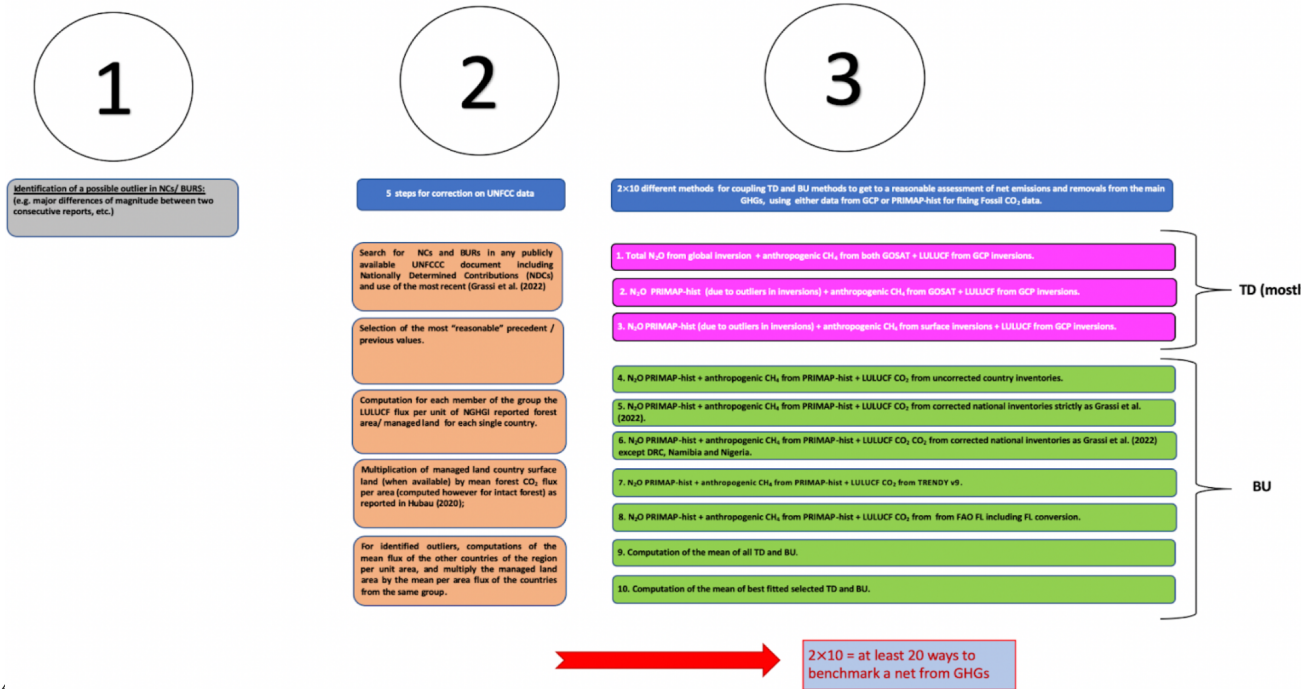
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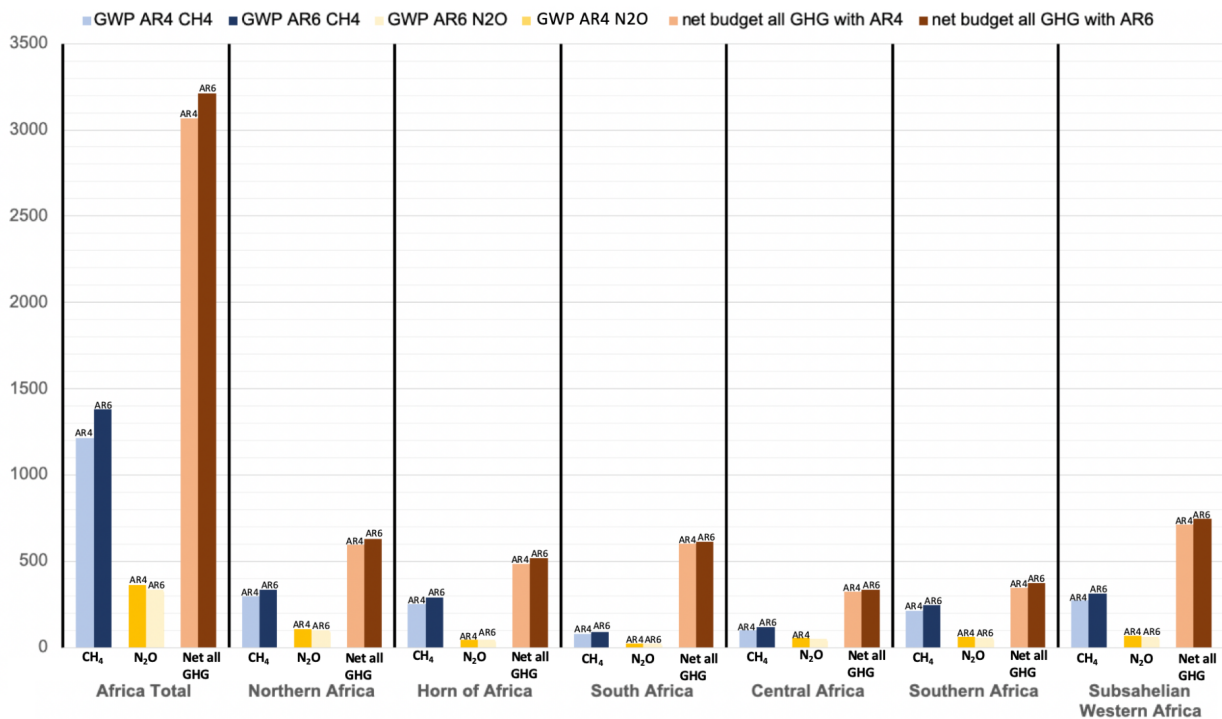
Proposal for innovative systematic correction methods for non Annex I countries in the face of net GHGs assessment uncertainty under the PA regime.

What is the « true » country net estimate?

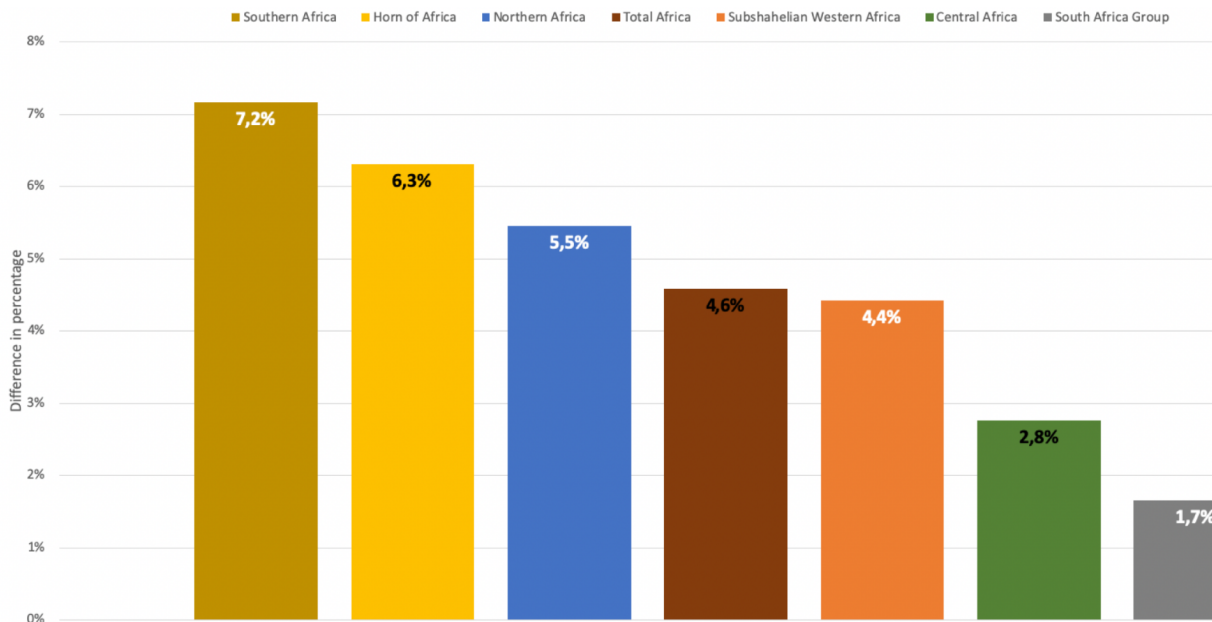


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Figure S12. Synthesis of the different methodological steps used in this paper for assessing net African GHG trends.



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 420 Figure S13. Differences in MtCO₂e in the CH₄ emissions, N₂O emissions and total GHG net budget coming from the use of
 421 AR4 and AR6 GWP-100 for CH₄ and N₂O with PRIMAP fossil CO₂ emissions and LULUCF CO₂ for the 6 African regions
 422 and Africa total, using PRIMAP-hist for fossil CO₂ and UNFCCC data consistent with Grassi et al. (2022).
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432 **Figure S14. Percentage of difference in the 2001-2018 net budget coming from the difference between the use of AR6 GWP-**
433 **100 and AR4 GWP-100 for CH₄ and N₂O, with PRIMAP fossil CO₂ emissions and UNFCCC LULUCF CO₂ (Grassi, 2022)**
434 **for the 6 African regions and Africa total.**

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