



# Comparison of inversions with inventories of CO2, CH4 and N2O fluxes



Zhu Deng<sup>1, \*</sup>, Philippe Ciais<sup>2, \*</sup>, Zitely A. Tzompa-Sosa<sup>2</sup>, Marielle Saunois<sup>2</sup>, Chunjing Qiu<sup>2</sup>, Chang Tan<sup>1</sup>, Taochun Sun<sup>1</sup>, Piyu Ke<sup>1</sup>, Yanan Cui<sup>3</sup>, Katsumasa Tanaka<sup>2,4</sup>, Xin Lin<sup>2</sup>, Rona L. Thompson<sup>5</sup>, Hanqin Tian<sup>6</sup>, Yuanzhi Yao<sup>6</sup>, Yuanyuan Huang<sup>7</sup>, Ronny Lauerwald<sup>8</sup>, Atul K. Jain<sup>9</sup>, Xiaoming Xu<sup>9</sup>, Ana Bastos<sup>10</sup>, Stephen Sitch<sup>11</sup>, Paul I. Palmer<sup>12,13</sup>, Thomas Lauvaux<sup>2</sup>, Alexandre d'Aspremont<sup>14</sup>, Clément Giron<sup>14</sup>, Antoine Benoit<sup>14</sup>, Benjamin Poulter<sup>15</sup>, Jinfeng Chang<sup>16</sup>, Ana Maria Roxana Petrescu<sup>17</sup>, Steven J. Davis<sup>18</sup>, Zhu Liu<sup>1</sup>, Giacomo Grassi<sup>19</sup>, Clément Albergel<sup>20</sup>, and Frédéric Chevallier<sup>2</sup>

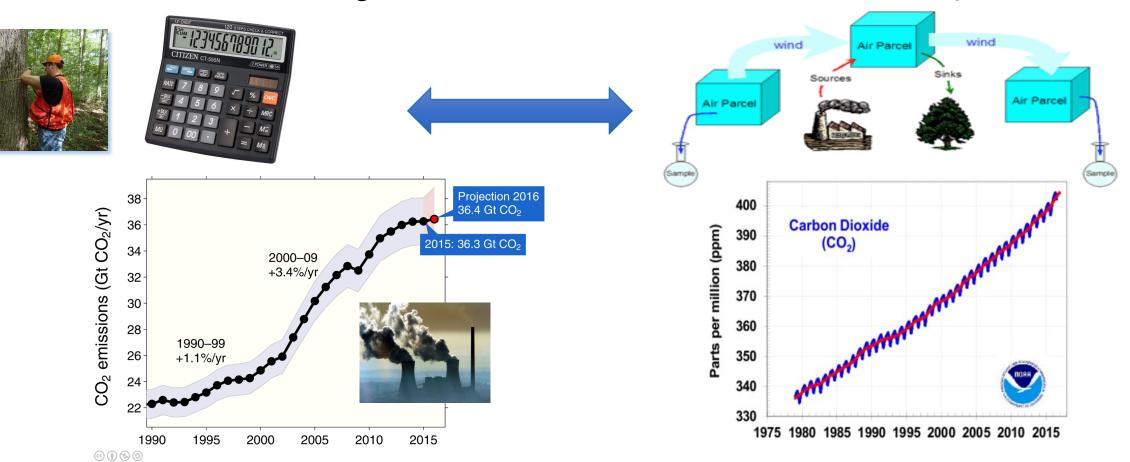
https://essd.copernicus.org/preprints/essd-2021-235/



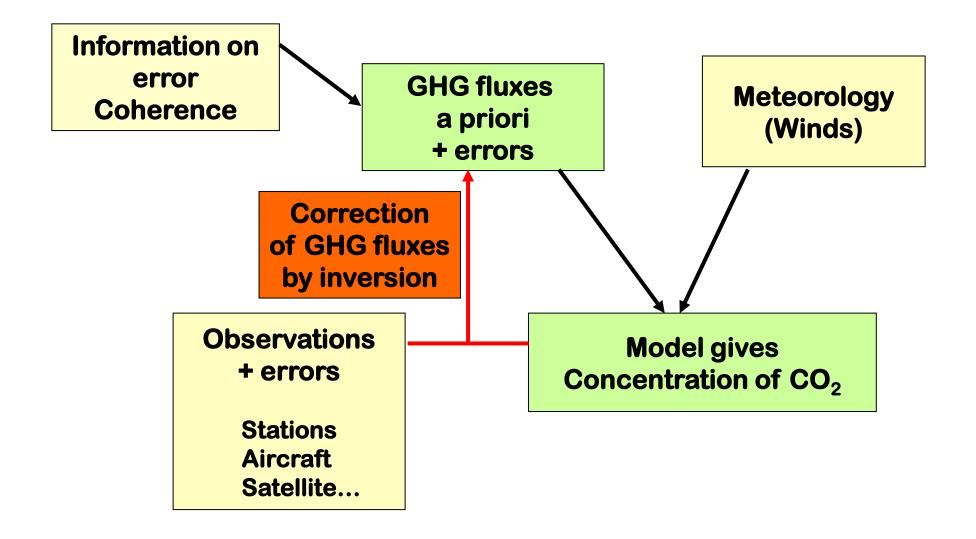


# **Bottom-up and top-down**

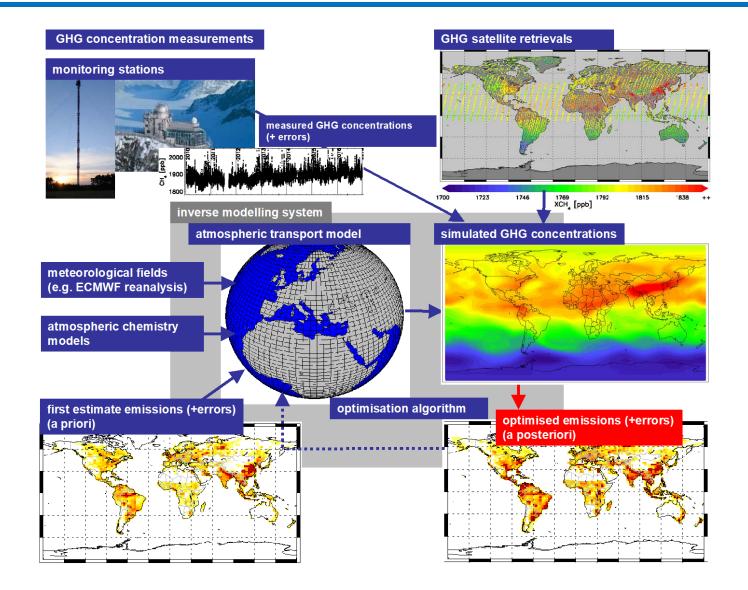
CO2 emissions and sinks: by bottom-up inventories : activity data + emission factors, biomass C and soil C stock change CO2 sinks : prior fossil emissions from inventories, concentration measurements and transport models



## Inversions



### Inversions



# **Global Inversions used in this study**

CO2 : 6 in-situ inversions up to 2019 Same prescribed fossil fuel emissions ; only the land flux is optimized Period 1979-2019 Available but not used : [ 2009 - ] GOSAT satellite inversions [ 2015 - ] = OCO2 satellite inversions

### CH4: 17 inversions up to 2017 Separation of sectors in priors in most of them 2000-2017 = 9 in-situ inversions & 2 combined inversions 2009-2017 = 8 satellite inversions (GOSAT)

N2O: 2 inversions up to 2017 2000-2017 = 3 in situ inversions

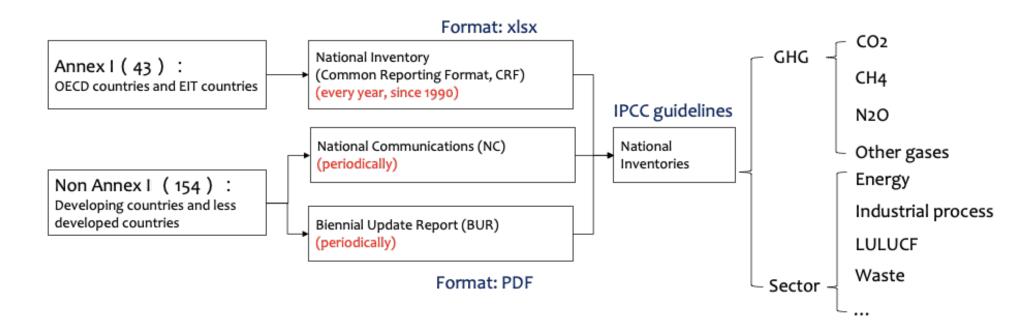
### Data from Global carbon project publications

# **Compilation and harmonisation of National Inventories**

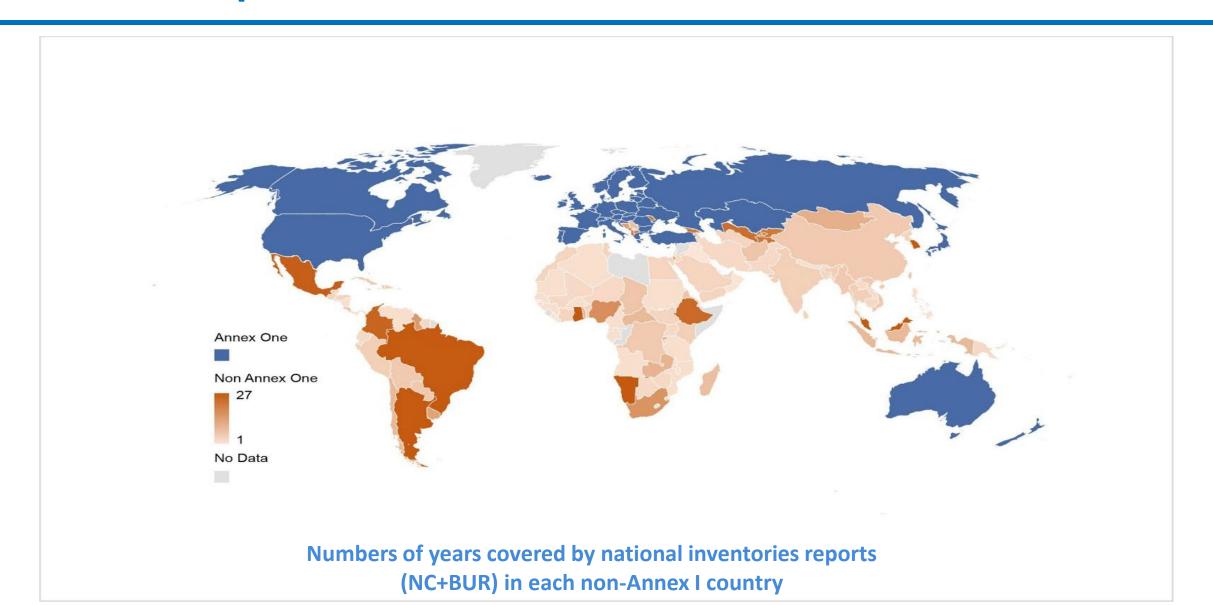
### Submitting national inventories periodically to UNFCCC - commitment of the parties



### Format: xlsx



# Number of updates of National Inventories



# National inventories submitted to UNFCCC (Non Annex I) July 2021

### National Communications (NC) & Biennial Update Report (BUR)

	Nationa	l Communications (Total: 396)		Biennial Update Report (Total: 113)			
NC cycle	Total	Recent submissions	BUR cycle	Total	Recent submissions		
		Equatorial Guinea, 25 October 2019			Zambia, 7 December 2020		
NC1	154	South Sudan, 19 August 2019	BUR1	63	Cuba, 23 November 2020		
		Somalia, 19 January 2019			Honduras, 19 November 2020		
		Andorra, 11 March 2021			Panama, 27 March 2021		
NC2	143	Timor-Leste, 17 November 2020	BUR2	32	Morocco, 31 December 2019		
		Oman (Sultanate of), 23 December 2019			Costa Rica, 23 December 2019		
		Vanuatu, 22 March 2021			India, 20 February 2021		
NC3	85	Malawi, 10 February 2021	BUR3	13	Malaysia, 31 December 2020		
		Bhutan, 3 February 2021			Thailand, 25 December 2020		
		Brazil, 31 December 2020			Andorra, 11 March 2021		
NC4	11	Ghana, 3 August 2020	BUR4	5	Namibia, 18 February 2021		
		Armenia, 17 May 2020			Chile,18 January 2021		
		Mexico, 6 December 2012					
NC5	2	Uruguay, 31 December 2019					
NC6	1	Mexico, 28 November 2018					

# Harmonization and consistency checks (Non Annex I)

### Mongolia\_BUR1.pdf, P132-139

Inventory Year: 1990												
	Emissions (Gg)					nissions uivalents	(Gg)			issions (Gg)		
Categories	Net CO <sub>3</sub> (1)(2)	CH4	N,O	HFCs	PFCs	SF <sub>6</sub>	Other halogenated gases with CO <sub>2</sub> equivalent conversion factors (3)	Other halogenated gases without CO, equivalent conversion factors (4)	NOx	CO	NMVOCs	SO2
Total National Emissions and Removals	-12,096.57	327.27	13.39	0	0	0	0	0	1,78	63.63	0	
1 - Energy	10,708.95	13.56	0.31	0	0	0	0	0	0	0	0	0
1.A - Fuel Combustion Activities	10,708.95	7.33	0.31	0	0	0	0	0	0	0	0	
1.A.1 - Energy Industries	5,178.13	0.08	0.10						0	0	0	0
1.A.2 - Manufacturing Industries and	2,519.05	0.24	0.04						0	0	0	0
Construction 1.A.3 - Transport	1.385.81	0.52	0.14						0	0	0	0
1.A.4 - Other Sectors	1,076.30	3.83	0.02						0	0	0	
1.A.5 - Non-Specified	549.66	2.67	0.02						0	0	0	0
1.8 - Fugitive emissions from fuels	0	6.23	0	0	0	0	0	0	0	0	0	
1.B.1 - Solid Fuels	0	6.23	0	-	0	-			0	0	0	0
1.8.2 - Oil and Natural Gas	0	0.27	0						0	0	0	0
1.8.3 - Other emissions from Energy Production	0	0	0						0	0	0	0
1.C - Carbon dioxide Transport and Storage	0	0	0	0	0	0	0	.0	0	0	0	
1.C.1 - Transport of CO2	0								0	0	0	
1.C.2 - Injection and Storage	0								0	0	0	0
1.C.3 - Other	0								0	0	0	0
2 - Industrial Processes and Product Use	218.66	0	.0	0	0	0	0	0	0	0	0	0
2.A - Mineral Industry	206.34	0	0	0	0	0	0	0	0	0	0	0
2.A.3 - Glass Production	0											
						_						0 0
2.A.4 - Other Process Uses of Carbonates	0	0	0	_					0	6 3	0	0 0
2.A.5 - Other (please specify)	0	0	0	0	0				0		0	0 0
2.A.5 - Other (please specify) 2.8 - Chemical Industry	0	0	0	0	0	0	C	) (	0			0 0
2AS - Other (please specify) 28 - Chemical Industry 28.1 - Ammonia Production	0		0	0	0	0	G		0			0 0 0 0 0 0 0 0
2AS - Other (please specify) 28 - Chemical industry 28.1 - Ammonia Production 28.2 - Nitric Acid Production	0		0	0	0	0	C	) (				0 0 0 0 0 0 0 0
2A5 - Other (please specify) 28 - Chemical Industry 28.1 - Ammonia Production 28.2 - Nitric Acid Production 28.3 - Adipic Acid Production 28.4 - Capriolactam. Glyowil and Glyosylic Acid	0		0	0	0	0	C					
2A5-Other (please specify) 28 - Chemical industry 28.1 - Ammonia Production 28.2 - Nibic Acid Production 28.3 - Adipic Acid Production 28.4 - Caprolactam, Glyonal and Glyonylic Acid oduction	0	0	0	0	0	0	C	) (				
2.4.5 - Other (please specify) 2.8 - Chemical Industry 2.8 - Ammonia Poduction 2.8.2 - Native, Acid Production 2.8.3 - Adipic Acid Production 2.8.4 - Caprolecture, Giyonil and Giyonylic Acid oduction 2.8.5 - Carbide Production	0		0	0	0	0	C	)				0 0 0 0 0 0 0 0 0 0 0 0 0 0
2.A.SOther (please specify) 2.B.E Ammonia Production 2.B.E Nime: Add Roduction 2.B.S Adpice Add Roduction 2.B.A Capolacter Roduction 2.B.A Capolacter Roduction 2.B.S Capolacter Roduction 2.B.S Transimo Dioxide Production	0	0	0	0	0	0		) (				0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2.4.5 - Other (please specify) 2.8 - Chemical Industry 2.8 - Ammonia Poduction 2.8.2 - Native, Acid Production 2.8.3 - Adipic Acid Production 2.8.4 - Caprolecture, Giyonil and Giyonylic Acid oduction 2.8.5 - Carbide Production	0	0	0	0	0	0	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	) C				0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2.A.S. Other (please speck)) 28 Chemical Industry 28 Americal Industry 28.1 - Americal Industrian 28.2 - Neplik Acid Production 28.3 - Anglik Acid Poduction 28.4 - Capital Production 28.5 - Fachile Production 28.6 - Rannium Diaulde Poduction 28.6 - Renchemical and Carbon Black doubtion	0	0	0									0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2.A.SOher (please speck) 2.8.FAmerical Industry 2.8.FAmerical Industry 2.8.FAmerical Acid Production 2.8.SAdapic Acid Production 2.8.FCapitalse Production 2.8.SCapitalse Production 2.8.FCapitalse Production 2.8.FStanlah Robuction 2.8.FRounden Robuction 2.8.FRounden Robuction 2.8.FRounden Industrian 2.8.FRounden Industrian 2.8.FRounden-Industrian	000000000000000000000000000000000000000	0	0	0	0	0						0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2.A.SOther (please speck)) 2.B.SCharrical International 2.B.JRest Acid Production 2.B.JRepic Acid Production 2.B.JAngine Acid Production 2.B.SAngine Acid Production 2.B.SCharlie (Production 2.B.STeanion Broader Production 2.B.STeanocharmical and Carbon Black doubtion 2.B.STeanocharmical and Carbon Black doubtion 2.B.STeanocharmical and Carbon Black doubtion	000000000000000000000000000000000000000	0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0	0	0	0 0					
2.A.S. Offer (please speck) 2.B.I Chemical information 2.B.I Andrejic Acida Production 2.B.I Andrejic Acida Production 2.B.I Andrejic Acida Production 2.B.I Capitostamic Gyneal and Opportin Acida doubtion 2.B.J Exploritumic Disolate Production 2.B.J Exploritumical Induction 2.B.B.I Renothmenical Production 2.B.B.I Renothmenical Production 2.B.B.I Meral Induction 2.B.II Other (Please specify) - J.Meral Inducty y	0 0 0 0 0 0 0	0	0	0	0	0	0 0					
2.A.SOther (please speck)) 2.B.SChernical International Production 2.B.JAlternic Acid Production 2.B.JAlternic Acid Production 2.B.SCarbiels Production 2.B.SCarbiels Production 2.B.SCarbiels Production 2.B.SCarbiels Production 2.B.SPencehanismic all Production 2.B.SDenothermical Production 2.B.SDirochthermical Production 2.B.SDirochthermical Production 2.SCarbiel Industry 2.CNanial Roder Networks	0 0 0 0 0 0 0 0 0 0 0 0	0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0	0	0	0 0					
2.A.S. Offer (please speck) 2.B.I Cemercial involution 2.B.I Amonical involution 2.B.I Anglic Acid Roduction 2.B.I Anglic Acid Roduction 2.B.I Conference on Anglica Acid and Conference on Anglica Acid 2.B.S Tatanian Dioxide Roduction 2.B.S Tatanian Dioxide Roduction 2.B.S Recol-Involution 2.B.S Recol-Involution 2.B.O Reconstruction 2.B.O Main Induction 2.B.O Medi Induction 2.B.O Medi Induction 2.C.I Involution 2.C.I Involution	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0	0000	00000	0 0					
2.A.SOther (please speck)) 28.1Aermonia Production 28.1Aermonia Production 28.1Aermonia Production 28.1Aermonia Moduction 28.4Capositatin Giyosella red Giyosella Acid duction 28.5Capitale Production 28.7Sada Ash Production 28.7Sada Ash Production 28.1ProceDimensial Production 28.1Other (Please (specify)) 21.1Other (Please (specify)) 21.1International Steel Production 21.1International Steel Production 21.2International Production 21.2International Production 21.2Javantiking production		0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0	0	00000	0					
2.A.S. Offer (please specify) 2.B.I Americal involution 2.B.I Americal involution 2.B.I Angelsk Acid Production 2.B.I Angelsk Acid Production 2.B.I Capacitarion (Special and Gyorylic Acid addition) 2.B.F Tosola And Production 2.B.F Tosola And Production 2.B.F Tosola And Production 2.B.F Neuroschemical Production 2.B.F Neuroschemical Production 2.B.F Neuroschemical Production 2.B.F Media Industry 2.B.F Houseschemical Production 2.B Media Industry 2.C.I Ion and Skel Production 2.C.J Homating Production 2.C.J American Specify		0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0	0000	00000	0					
2.A.SOther (please speck)) 2.B.JAmerical industry 2.B.JAmerical industrian 2.B.JAlipic Acid Production 2.B.JAlipic Acid Production 2.B.JCarloke Production 2.B.SCarloke Production 2.B.SCarloke Production 2.B.SCarloke Production 2.B.SCarloke Production 2.B.SDeter (Please specify) 2.C.JMari Industry 2.C.JAmerical Production 2.C.JAmerican production 2.C.SAmerican production 2.C.SIsed Production 2.C.SIsed Production		0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0	0000	00000	0		) ) ) ) ) ) ) ) ) ) ) ) ) ) ) ) ) ) )			0         0           0         0           0         0           0         0           0         0           0         0           0         0           0         0           0         0           0         0           0         0           0         0           0         0           0         0           0         0           0         0           0         0           0         0           0         0           0         0
2.A.S. Other (please speck)) 2.B.S Chamical Industry 2.B.I Ammonia Production 2.B.I Nethic Acid Production 2.B.S Angles Acid Production 2.B.S Chamical Acid Production 2.B.S Explored Production 2.B.S Present Monder Production 2.C Neumanium production 2.C Neumanium production 2.C Advantism production 2.C Advantism production 2.C See Production		0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	00000	000000000000000000000000000000000000000	000000000000000000000000000000000000000	2 2 2 2					0         0           0         0
2.A.S. Other (please speck) 2.B.SAmerical industry 2.B.JAmerical industrian 2.B.SAdipic Acid Production 2.B.SAdipic Acid Production 2.B.SCaroliac Micro Openit Acid advices 2.B.SExclusion Boolder Production 2.B.SExclusion Boolder Production 2.B.SExclusion Boolder Production 2.B.SBenochemical Production 2.B.S Heard Industrian 2.B.S Heard Industrian 2.B.S Heard Industrian 2.B.S Marci Industrian 2.C.S Marci Industrian 2.C.S Neural Industrian		0	000000000000000000000000000000000000000	00000	000000000000000000000000000000000000000	000000000000000000000000000000000000000	000000000000000000000000000000000000000					
2.A.S. Other (please specify) 2.B.SAmerical industry 2.B.SAmerical industry 2.B.SAmprice, Acid Production 2.B.SAdapter, Acid Production 2.B.S Carlonk, Call Production 2.B.S Carlonk, Call Production 2.B.S Exclusion Bonder Production 2.B.S Exclusion Bonder Production 2.B.S Deteo Thermitian of Carbon Bick coduction 2.B.S Deteo Thermitian of Carbon Bick coduction 2.B.S Deteo Thermitian of Carbon Bick coduction 2.B.S Deteo Thermitian of Carbon Bick 2.B.S Production 2.C.S Head Production 2.C.S Ised Production 2.C.S Neurophashism 2.C.S Neurophashism 2.S.S Neurophashism 2.S.S Neurophashism 2.S.S Neurophashism 2.S.S Neurophashism 2.S.S Neurophashism 2.S.S Neurophashism 2.S.S Neurophashism 2.S.S Neurophashism 3.S.S.S Neurophashism 3.S.S.S.S.S.S.S.S.S.S.S.S.S.S.S.S.S.S.S	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	00000	000000000000000000000000000000000000000	000000000000000000000000000000000000000	000000000000000000000000000000000000000					
2.A.S. Other (please speck)) 2.B.S Chemical Introduction 2.B.S Aderik Cald Poduction 2.B.S Adepic Acid Poduction 2.B.S Adepic Acid Poduction 2.B.S Carbielle Poduction 2.B.S Carbiele Poduction 2.B.S Explored Poduction 2.B.S Reiner (Devide Poduction 2.B.S Reiner (Devide Poduction 2.B.S Pencil-hermical Poduction 2.B.S Pencil-hermical Poduction 2.B.S Pencil-hermical Poduction 2.B.S Pencil-hermical Poduction 2.C.S Reiner (Devide Poduction 2.C.S Adversition production 2.C.S Adversition production 2.C.S Lean And Sele Poduction 2.C.S Lean And Sele Poduction 2.C.S Lean And Sele Poduction 2.C.S Adversition production 2.C.S Adversition production 2.C.S Neuro-Neurop Poducts (from Yuels and 2.C.S Neuro-Neurop Poducts (from Yuels and 2.D Lubricont Use	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0	000000000000000000000000000000000000000	00000	000000000000000000000000000000000000000	000000000000000000000000000000000000000	000000000000000000000000000000000000000		) ) ) ) ) ) ) ) ) ) ) ) ) ) ) ) ) ) )			
2.4.5 - Other (please speck) 2.8.1 - Americal Industry 2.8.1 - Americal Industry 2.8.1 - Americal Industry 2.8.1 - Angle Acid Production 2.8.2 - Evolution Colored 2.8.3 - Angle Acid Production 2.8.3 - Evolution Industry 2.8.5 - Angle Production 2.8.7 - Evolution Industry 2.8.7 - Evolution Industry 2.8.7 - Note (Please speck) 2.8.7 - Markinery production 2.6.7 - American Industry 2.6.7 - Industry 2.6.7 - Industry 2.6.7 - Industry 2.6.7 - Reduction 2.6.7 - Reduction 2.7 - Reduction 2.6.7 - Reduction 2.6.7 - Reduction 2.	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0	000000000000000000000000000000000000000	00000	000000000000000000000000000000000000000	000000000000000000000000000000000000000	000000000000000000000000000000000000000					
2A5-Other (please speck) 28.1-Aemonia Production 28.1-Aemonia Production 28.1-Aemonia Action 28.1-Aemonia Action 28.1-Aemonia Action 28.1-Aemonia Action 28.1-Aemonia Action 28.1-Aemonia Action 28.1-Aemonia Action 28.1-Aemonia Antoine Production 28.1-Other (Please spech) 28.1-Aemonia Antoinet 28.1-Aemonia Action 28.1-Aemonia Area 28.1-Aemonia Area 28.1-Aemo	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0	000000000000000000000000000000000000000	00000	000000000000000000000000000000000000000	000000000000000000000000000000000000000	000000000000000000000000000000000000000					
2.A.S. Other (please speck) 2.B.SAmerical industry 2.B.JAmerical industry 2.B.JAmerical industrian 2.B.SAdipic Acid Production 2.B.SCaroliac Micro Colored 2.B.SCaroliac Micro Colored 2.B.S Exorcine Diode Production 2.B.S Exorcine Diode Production 2.B.S Exorcine Diode Production 2.B.S Neto Thermitian Micro Production 2.B.S Production and Carbon Black doubtion 2.B.S Production and Carbon Black 2.B.S Neto Thermitian Micro Production 2.C.S Med Production 2.C.S Hend Production 2.C.S Hend Production 2.C.S Neto Production 2.C.S Micro Productio	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0	000000000000000000000000000000000000000	00000	000000000000000000000000000000000000000	000000000000000000000000000000000000000	000000000000000000000000000000000000000					

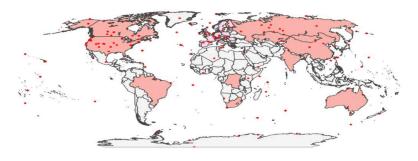
	E82		≜ ×	$\checkmark f_x$ 3C Agg	regate Sources and Non-CO <sub>2</sub> Emissions So	urces on Land			
	A	в	•   c	D	E	F	G	н	
	Party				Level 2	Level 3			
Bunders         Disk         Statis         Market         Disk         Statis         Statis <t< td=""><td>Malaysia</td><td></td><td>2014</td><td>Total National Emissions and Removals</td><td></td><td></td><td></td><td></td><td>5</td></t<>	Malaysia		2014	Total National Emissions and Removals					5
Name         Disc         Disc <thdisc< th="">         Disc         Disc         <thd< td=""><td>Malaysia Malaysia</td><td>BUR2 BUR2</td><td></td><td></td><td>14 Fuel Comhustion Activities</td><td></td><td></td><td></td><td>-</td></thd<></thdisc<>	Malaysia Malaysia	BUR2 BUR2			14 Fuel Comhustion Activities				-
	Malaysia					1A1 Energy Industries		2.46	
Name         No.         No. <td>Malaysia</td> <td></td> <td></td> <td></td> <td></td> <td>1A2 Manufacturing Industries and Construction</td> <td></td> <td></td> <td></td>	Malaysia					1A2 Manufacturing Industries and Construction			
Marcel         Displan         Displan <thdisplan< th=""> <thdisplan< th=""> <thdi< td=""><td>Malaysia</td><td></td><td></td><td></td><td>1A Fuel Combustion Activities</td><td></td><td>63019.56</td><td>19.73</td><td>1</td></thdi<></thdisplan<></thdisplan<>	Malaysia				1A Fuel Combustion Activities		63019.56	19.73	1
Name         Disc         Solit         Hole         Total         Hole         <	Malaysia				1A Fuel Combustion Activities		510.3	0.02	į
Bunch         Bunch <th< td=""><td>Malaysia</td><td>BUR2</td><td>2014</td><td>1 ENERGY</td><td></td><td></td><td>1728.93</td><td></td><td></td></th<>	Malaysia	BUR2	2014	1 ENERGY			1728.93		
Marge         Biolog         Solids         Index         Solids         Figure sensition for Market         Biolog         Solids	Malaysia							127	
Bunya         Bunya <th< td=""><td>Malaysia Malaysia</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>N</td></th<>	Malaysia Malaysia								N
Name         Bind         Solit         Interfunction         Int	Malaysia		2014	1 ENERGY	1C Carbon dioxide Transport and Storage				
Name         Bull         Solit         S	Malaysia								+
Name         BUR         2012         2012         RUSTIN MONECISS MAD PROCESS					1C Carbon dioxide Transport and Storage	1C2 Injection and Storage		1061	÷
Manya         BUR         2012         PLOSITINAL PROCESS AD PRODUCT UK         A. Marsi Radary         PLO         Line Phadzine         PLO         Line Phadzine         PLO         Marsi         BLO         Dist         Dist <thdist< th=""> <thdist< th=""> <thdist< th=""></thdist<></thdist<></thdist<>					2A Mineral Industry				
Name         Number         Number <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>T</td>									T
Margin Bill         Bill         All Statistics ADP ROUCH US         Margin Bill         Cale Statistics ADP ROUCH US         Cale ADP ROUCH US         Cale Statistics ADP ROUCH US         Cale Statistics ADP ROUCH US         Cale A			2014	2 INDUSTRIAL PROCESSES AND PRODUCT US	E 2A Mineral Industry		130.65	NA	+
Manya         BUZ         Alter ALLIAN RECISSEA AND PROCENCE US         Alter Internal Index         Po         D           Manya         BUZ         ADDIE / ALLIAN RECISSEA AND PROCENCE US         Alter ALLIAN AND AND AND AND AND AND AND AND AND A		BUR2	2014	2 INDUSTRIAL PROCESSES AND PRODUCT US	SE 2A Mineral Industry		28,44	NE, NO	t
Manya         BR2         AB02         Res         Res         AB02         Res         R	Malaysia	BUR2	2014	2 INDUSTRIAL PROCESSES AND PRODUCT US	SE 2A Mineral Industry		NO	NO	N
Manya         BUR2         ADD 2         PADDE SINAL RECISES AND PROJUCT US 20         Comma Natury         BUR 2         Bits         Rec Add Production         No.         NO.         NO.           Manya         BUR 2         Color Add Production         Sol Color Add Production         Sol Color Add Production         NO.         NO.         NO.           Manya         BUR 2         Color Add Production         Sol Color Add Production         NO.         NO.         NO.           Manya         BUR 2         Color Add Production         NO.         NO.         NO.         NO.           Manya         BUR 2         Color Add Production         NO.         NO.         NO.         NO.         NO.           Manya         BUR 2         Color Add Production         NO.         NO.         NO.         NO.         NO.           Manya         BUR 2         Color Add Production         NO.         NO.         NO.         NO.         NO.         NO.           Manya         BUR 2         Color Add Production         NO.         <	Malaysia								
Manya         BR2         Aboli A         Marka B         BR2	Malaysia								N
Marge         BR2         BR3         BR3 </td <td>Malaysia</td> <td>BUR2</td> <td>2014</td> <td>2 INDUSTRIAL PROCESSES AND PRODUCT US</td> <td>5E 2B Chemical Industry</td> <td>283 Adipic Acid Production</td> <td>NO</td> <td>NO</td> <td>N</td>	Malaysia	BUR2	2014	2 INDUSTRIAL PROCESSES AND PRODUCT US	5E 2B Chemical Industry	283 Adipic Acid Production	NO	NO	N
Manya         BR2         2001 / NUSTRAL PROCESS AND PROLUCE US         R Commain Marry         BR         BR2         State A Production         NO         NO           Marrya         BR2         State A Production         State A Production         State A Production         NO         NO           Marrya         BR2         State A Production         State A Production         State A Production         NO         NO           Marrya         BR2         State A Production         State A Production         State A Production         NO         NO           Marrya         BR2         State A Production         State A Production         State A Production         NO         NO           Marrya         BR2         State A Production         NO         NO         NO         NO         NO         NO           Marrya         BR2         State A Production         NO         NO <td>Malaysia</td> <td></td> <td>2014</td> <td>2 INDUSTRIAL PROCESSES AND PRODUCT US</td> <td>SE 28 Chemical Industry</td> <td>2B4 Caprolactam, Glyoxal and Glyoxylic Acid</td> <td></td> <td></td> <td>N</td>	Malaysia		2014	2 INDUSTRIAL PROCESSES AND PRODUCT US	SE 28 Chemical Industry	2B4 Caprolactam, Glyoxal and Glyoxylic Acid			N
Name         BBZ         Obd         P Ob	Malaysia					285 Carbide Production			N
Mayse         BitR         2012         2013         2014         2013         2014         2013         2014         2013         2014 <t< td=""><td>Malaysia</td><td></td><td></td><td></td><td></td><td>287 Soda Ash Production</td><td></td><td></td><td>N</td></t<>	Malaysia					287 Soda Ash Production			N
Mayse         Bill         State         Characterization         No         N	Malaysia					288 Petrochemical and Carbon Black			2 N
Maryan         BIRZ         Stable         Production         Stable         Control         Stable         Stable <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>110</td> <td>N</td>								110	N
Name         NR2         St02         PADUSTRAL PROCESSS AND PRODUCT USE         22. Mail Industry         R2.1         the and SteP Phatchino         NS         ME           Malays         BIR         St02         PADUSTRAL PROCESSS AND PRODUCT USE         22. Mail Industry         C2.1         Aurniam Phatchino         NS         ME           Malays         BIR         St02         PADUSTRAL PROCESSS AND PRODUCT USE         25. Mail Industry         C2.1         Aurniam Phatchino         NO         NO           Malays         BIR         St02         PADUSTRAL PROCESSS AND PRODUCT USE         25. Mail Industry         C2.1         Ised Phatchino         NO         NO         NO           Malays         BIR         St02         PADUSTRAL PROCESSS AND PRODUCT USE         20. Main Ferry Phatchino The site and Solvert Use         C2.1         Latricer Use         NO         NO <td></td> <td></td> <td></td> <td></td> <td></td> <td>2B10 Other (please specify)</td> <td></td> <td></td> <td></td>						2B10 Other (please specify)			
Name         NR         Static         Static <tbatic< th=""> <tbatic< th=""></tbatic<></tbatic<>	Malaysia		2014	2 INDUSTRIAL PROCESSES AND PRODUCT US	SE 2C Metal Industry	2C1 Iron and Steel Production			
Name         BIR         Soli         2 Notified         Production         No.         Soli           Marya         BIR         Soli         2 Notified         Model         No.         No.           Marya         BIR         Soli         2 Notified         Model         No.         No.         No.           Marya         BIR         Soli         2 Notified         Model         No.         No.         No.           Marya         BIR         Soli         2 Notified         Model         No.         No.         No.           Marya         BIR         Soli         2 Notified         No.         No. </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>N</td>									N
Mayse         BIR2         Stable         PADUSTRAL         POSISTERAL POSISTERA NO PROJUCTUSE         20         Main Markey         Constraints         Constraints         No           Mayse         BIR2         Stable         ADDITAL         Constraints         No         No <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>NA</td> <td>÷</td>								NA	÷
Maying         Bill R         2014         2 NOLSTRAL POCCSSS AND PROJUCT US         3 Cm Mail Madary         2 Cm Mail Madary <t< td=""><td></td><td></td><td>2014</td><td>2 INDUSTRIAL PROCESSES AND PRODUCT US</td><td>E 2C Metal Industry</td><td></td><td></td><td></td><td>t</td></t<>			2014	2 INDUSTRIAL PROCESSES AND PRODUCT US	E 2C Metal Industry				t
Mayse         BR/Z         Static 2 NOLTRIMA. POCCSSSS AND PROJUCT US         20         Non-Finergy Products from take and Solver Use         Tempolation         Non-Finergy Products from Take and Solver Use         Description         Non-Finergy Products from Take and Solver Use         Description Finergy P	Malaysia		2014	2 INDUSTRIAL PROCESSES AND PRODUCT US	SE 2C Metal Industry				
Mayse         BIR2         St01 2 NOLTREAL POCCSSS AND PROJUCT USE         20         Non-Finergy Products from Fask and Solver Use         201         Lubricant Use         NE           Malyse         BIR2         St01 2 NOLTREAL POCCSSS AND PROJUCT USE         20         Non-Finergy Products from Fask and Solver Use         201         Solver Use         No.         No.           Malyse         BIR2         St01 2 NOLTREAL POCCSSS AND PROJUCT USE         20         Non-Finergy Products from Fask and Solver Use         201         Solver Use         No.         No. <t< td=""><td>Malaysia</td><td></td><td></td><td></td><td></td><td>2C7 Other (please specify)</td><td></td><td></td><td>N</td></t<>	Malaysia					2C7 Other (please specify)			N
Mayse         BIR2         Static 2 NOLSTRAL PROCESSS AND PROJUCT USE         20         Number Static from free and solver Use         202         Paraffer Marcula         No.         No.           Mayse         BIR2         Static 2 NOLSTRAL PROCESSS AND PROJUCT USE         20         No.         No. </td <td>Malaysia</td> <td></td> <td></td> <td></td> <td></td> <td>2D1 Lubricant Use</td> <td></td> <td>INE, INU</td> <td>IN</td>	Malaysia					2D1 Lubricant Use		INE, INU	IN
Mayse         BR/Z         SD12         2 ND/STRAL POCCSSS AD PROJUCT US         20         Non-Instant Solver Use         Pack and Solver Use         Non         Non         Non           Mayse         BR/Z         SD12         A ND/STRAL POCCSSS AD PROJUCT US         20         Non-Instant Poccss         Non	Malaysia	BUR2	2014	2 INDUSTRIAL PROCESSES AND PRODUCT US	E 2D Non-Energy Products from Fuels and Solvent Use	2D2 Paraffin Wax Use		NE	N
Mayse         BitR         Stall 2         PLOSITERAL PROCESSIS AND PRODUCT USE         28         Electronic industry         Rest         PLOSITERAL PROCESSIS AND PRODUCT USE         28         Intropic Industry         Rest	Malaysia		2014	2 INDUSTRIAL PROCESSES AND PRODUCT US	SE 2D Non-Energy Products from Fuels and Solvent Use				
Mailyam         Bill Z         2012 / NUSTRAL PROCESSS AND PROJUCTUSE         2E Retrons loadary         2E1         Integrated Creat & Semiconductor         MA           Mailyam         Bill Z         2012 / NUSTRAL PROCESSS AND PROJUCTUSE         2E Retrons loadary         2E1         The Regrated Creat & Semiconductor         No           Mailyam         Bill Z         2012 / NUSTRAL PROCESSS AND PROJUCTUSE         2E Retrons loadary         2E1         The doublasts         No         No           Mailyam         Bill Z         2012 / NUSTRAL PROCESSS AND PROJUCTUSE         2E Retrons loadary         2E         The doublasts         No         No           Mailyam         Bill Z         2012 / NUSTRAL PROCESSS AND PROJUCTUSE         2F Poduct Uses Substatuse for Ozno Depireting Subtances         7E         Retrons loadary         No         No         No           Mailyam         Bill Z         2012 / NUSTRAL PROCESSS AND PROJUCTUSE         2F Poduct Uses Substatuse for Ozno Depireting Subtances         7E         Retrons and L Conditioning         MA         MA           Mailyam         Bill Z         2012 / NUSTRAL PROCESSS AND PROJUCTUSE         2F Poduct Uses Substatuse for Ozno Depireting Subtances         7E         Retrons Andres         MA         MA         MA         MA         MA         MA         MA         MA         MA	Malaysia Malaysia		2014	2 INDUSTRIAL PROCESSES AND PRODUCT US 2 INDUSTRIAL PROCESSES AND PRODUCT US	2D Non-Energy Products from Fuels and Solvent Use 2F Electronics Industry	2D4 Other (please specify)			N
Mayse         BIR2         St01 2         AUDITERAL PROCESSES AND PRODUCT USE         ZE Extrust industry         ZE Extrust ind	Malaysia					2E1 Integrated Circuit or Semiconductor		110	N
Mayse         BIR2         Static 2 NOLTREAL POCCESSS AND PRODUCT USE         R 28 bit Rest Index Frid         Mol         No         No           Mayse         BIR2         Static 2 NOLTREAL POCCESSS AND PRODUCT USE         R Externish Index Static Process Project Static Project Project Project Static Process Project Static Process Project Static Project	Malaysia								Γ
Makya         BitR         2012         2 NUSTRAL PROCESSS AND PROJUCTUSE         2 Electronics Industry         Product Uses a Substrates for Ozno Depiktrg Substrates         2 State         Other (plexe specify)         NO         NO           Malya         BIRZ         2012         A NUSTRAL PROCESSS AND PROJUCTUSE         2 Findact Uses a Substrates for Ozno Depiktrg Substrates         21         Refraemant AL Conditionary         NA	Malaysia						_		┝
Maryan         BIR2         Static 2 NOLTREAL PROCESSES AND PROJUCT USE         2F Product Uses a Substrates for Ozno Depiring Subtranes         F. Britgerston and A Conditiong         M.N. NO           Maryan         BIR2         S012 2 NOLTREAL PROCESSES AND PROJUCT USE         2F Product Uses a Substrates for Ozno Depiring Subtranes         21         Find grants and A Conditiong         NA. NO           Maryan         BIR2         S012 2 NOLTREAL PROCESSES AND PROJUCT USE         2F         Product Uses a Substrates for Ozno Depiring Subtranes         21         Fam Bioring Agerts         NE            Maryan         BIR2         S012 2 NOLTREAL PROCESSES AND PROJUCT USE         2F         Product Uses a Substrates for Ozno Depiring Subtranes         72         Fam Bioring Agerts         NA         NO           Maryan         BIR2         S012 2 NOLTREAL PROCESSES AND PROJUCT USE         2F         Product Uses a Substrates for Ozno Depiring Subtranes         75         Solverts         NO         NO           Maryan         BIR2         S012 2 NOLTREAL PROCESSES AND PROJUCT USE         2G         Other Product Manufacture and Use         76         No         NO           Maryan         BIR2         S012 2 NOLTREAL PROCESSES AND PROJUCT USE         2G         Other Product Manufacture and Use         76         No         NO         76           Maryan <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>NO</td> <td>NO</td> <td>N</td>							NO	NO	N
Maines         BIR2         2012         Product Uses         Statuture for Ozno Depitrog Subtances         P2         Fond Burgs         R2           Maines         BIR2         2012         Product Uses         Statuture for Ozno Depitrog Subtances         P2         Fond Burgs         R2         Fendet Uses         NE           Mainyas         BIR2         2012         Product Uses         Statuture for Ozno Depitrog Subtances         P2         Fendet Uses         R2         Aerosch         NE           Mainyas         BIR2         2012         Product Uses         Statuture for Ozno Depitrog Subtances         P2         Aerosch         NE           Mainyas         BIR2         2012         Product Uses         Statuture for Ozno Depitrog Subtances         P2         Other Apdact Manual Uses         P2         Fond Taget Manual Uses         P2         Fond Taget Manual Uses         P2         Other Apdact Manual Uses         P2         Fond Taget Manual Uses         P2         Fond Taget Manual Uses         P2         <	Malaysia							NO	N
Maryang         BIR2         2012         PAUSTRAL PROCESSES AND PRODUCT USE         2* Product Uses a Substrates for Ozno Depikerg Substrates         273         Fee Protection         NE           Maryang         BIR2         2012         PAUSTRAL PROCESSES AND PRODUCT USE         2* Product Uses a Substrates for Ozno Depikerg Substrates         274         Aerook         —           Maryang         BIR2         2012         PAUSTRAL PROCESSES AND PRODUCT USE         2* Product Uses a Substrates for Ozno Depikerg Substrates         275         Solerts         —         Mol         MO           Maryang         BIR2         2012         PAUSTRAL PROCESSES AND PRODUCT USE         2* Product Uses a Substrates for Ozno Depikerg Substrates         270         Decret Agelactions         NO         NO           Maryang         BIR2         2012         PAUSTRAL PROCESSES AND PRODUCT USE         20         Other Apdet Underscope         201         Decret Agelactions         NO         NO           Maryang         BIR2         2012         PAUSTRAL PROCESSES AND PRODUCT USE         20         Other Product Uses         201         Perced Lease Society         NO         NO         NO           Maryang         BIR2         2012         PAUSTRAL PROCESSES AND PRODUCT USE         20         Other Product Uses         201         Perced Leases	Malaysia								+
Maryang         BIR2         2012         A NUSTRIAL PROCESSES AND PRODUCT USE         2F Product Uses a Substrate for Ozno Depikting Substrates         274         Aenodic         No         No           Maryang         BIR2         2012         A NUSTRIAL PROCESSES AND PRODUCT USE         2F Product Uses a Substrate for Ozno Depikting Substrates         276         Other Apdications         NO         NO           Maryang         BIR2         2012         A NUSTRIAL PROCESSES AND PRODUCT USE         2F Product Uses a Substrate for Ozno Depikting Substrates         276         Other Apdications         NO         NO           Maryang         BIR2         2012         A NUSTRIAL PROCESSES AND PRODUCT USE         2G Other Product Manufacture and Use         201         Betrifica Substrates         NO         NO           Maryang         BIR2         2012         A NUSTRIAL PROCESSES AND PRODUCT USE         2G Other Product Manufacture and Use         201         More Product Manufacture and Use         201         A Product Manufacture and Use         NO         NO           Maryang         BIR2         2012         A NUSTRIAL PROCESSES AND PRODUCT USE         2G Other Product Manufacture and Use         201         A Product Manufacture and Use         NO         NO           Maryang         BIR2         2012         A NUSTRIAL PROCESSES AND PRODUCT USE         <									t
Matyse         BitR         Statute 2 NOLTREAL PROCESSIS AND PROJUCT USE         27 Podact Uses a Substrate for Ozno Depiterg Subtrances         27 Select         Select         NO         NO           Malyse         BitR         S014 2 NOLTREAL PROCESSIS AND PROJUCT USE         27 Podact Uses a Substrate for Ozno Depiterg Subtrances         27 Select         NO	Malaysia	BUR2	2014	2 INDUSTRIAL PROCESSES AND PRODUCT US	E 2F Product Uses as Substitutes for Ozone Depleting Substances	2F4 Aerosols			Ľ
Mailyam         Bil/R         2014 2 NUSTRIAL PROCESSIS AND PROJUCT USE         28 Other Phoduck Manufacture and Use         Detectival Equiment         NO         NO           Mailyam         Bil/R         2014 2 NUSTRIAL PROCESSIS AND PROJUCT USE         28 Other Phoduck Manufacture and Use         2012 Exercical Equipment         Image: Control Phoduck Manufacture and Use         2012 SFs and Ffsch from Other Phoduck Uses         Image: Control Phoduck Manufacture and Use         2012 SFs and Ffsch from Other Phoduck Uses         Image: Control Phoduck Manufacture and Use         2012 SFs and Ffsch from Other Phoduck Uses         Image: Control Phoduck Manufacture and Use         2012 SFs and Ffsch from Other Phoduck Uses         Image: Control Phoduck Manufacture and Use         2012 SFs and Ffsch from Other Phoduck Manufacture and Use         Image: Control Phoduck Manufacture and Use         2012 SFs and Ffsch from Other Phoduck Manufacture and Use         Image: Control Phoduck Manufactur	Malaysia	BUR2	2014	2 INDUSTRIAL PROCESSES AND PRODUCT US	SE 2F Product Uses as Substitutes for Ozone Depleting Substances				ŧ.
Mailyam         Bill?         2014         2 Not/STRAL PROCESSIS AND PROJUCT USE         28 0 Other Product Manufacture and Use         2011         Electrical Fagement         5011           Mailyam         Bill?         2014         2 NOLSTRAL PROCESSIS AND PROJUCT USE         28 0 Other Product Manufacture and Use         2011         Product Manufacture and Use         0         Prod	Malaysia	BUR2				2ro Other Applications			N
Mailysing         BUR2         2012         2 NOLSTRIAL, ROCCSSISS AND PROJUCT USE         320 Other Product Manufacture and Use         2302         2 F8 and FPCs from Other Product Uses         1           Mailysing         BUR2         2012         2 NOLSTRIAL, ROCCSSISS AND PROJUCT USE         320 Other Product Manufacture and Use         331         2000 C mm Product Manufacture and Use         331         2014         2 NOLSTRIAL, ROCCSSISS AND PROJUCT USE         320 Other Product Manufacture and Use         331         2014         2 NOLSTRIAL, ROCCSSISS AND PROJUCT USE         320 Other Product Manufacture and Use         331         2014         2 NOLSTRIAL, ROCCSSISS AND PROJUCT USE         320 Other Product Manufacture and Use         741         Pale and Paler Industry         NE, NO, NO, NO, NO, NO, NO, NO, NO, NO, NO	Malaysia				SE 2G Other Product Manufacture and Use	2G1 Electrical Equipment			t
Mainya         BUR2         2014 2 NOUSTRAL POCCSSS AND PROJUCT US         20 Other (base spech)         NO         NO           Mainya         BUR2         2014 2 NOUSTRAL POCCSSS AND PROJUCT US         20 Other (base spech)         NE, NO. NE, NO.           Mainya         BUR2         2014 2 NOUSTRAL POCCSSS AND PROJUCT US         210 Other (base spech)         211. Pain and Pajer Industry         NE. NO. NE, NO.           Mainya         BUR2         2014 2 NOUSTRAL POCCSSS AND PROJUCT US         214 Other (base spech)         212. Point and Beer Industry         NE. NO.           Mainya         BUR2         2014 2 NOUSTRAL POCCSSS AND PROJUCT US         214 Other (base spech)         NO.         NO.           Mainya         BUR2         2014 2 NOUSTRAL POCCSSS AND PROJUCT US         214 Other (base spech)         NO.         NO.           Mainya         BUR2         2013 1 AROULT US, FORSTRY AND OTHER LAND US AN Uncotock         240 Other (base spech)         NO.         NO.           Mainya         BUR2         2013 1 AROULT US, FORSTRY AND OTHER LAND US AN Uncotock         240 Mainya         S40 Mainya	Malaysia	BUR2	2014	2 INDUSTRIAL PROCESSES AND PRODUCT US	SE 2G Other Product Manufacture and Use	2G2 SF6 and PFCs from Other Product Uses			F
Mailyam         Bull 2         Obj 2 (2 NUSTRIAL PROCESSES AND PROLUCT USE 3/10 for (place specify)         ME         ME         ME         No.         ME, NO.	Malaysia		2014	2 INDUSTRIAL PROCESSES AND PRODUCT US	SE 2G Other Product Manufacture and Use		NC	NO	÷
Mainya         Bil/Z         2014 2 ND/STRAL ROCCSSSS AND PROJUCT USE         2H Other (place specify)         Pil         Ne         ME           Mainya         Bil/Z         2014 2 ND/STRAL ROCCSSSS AND PROJUCT USE         2H Other (place specify)         Pil         Pil         And and Reversals Markary         NE         NE           Mainya         Bil/Z         2014 2 ND/STRAL ROCCSSSS AND PROJUCT USE         2H Other (place specify)         NO         NO           Mainya         Bil/Z         2014 2 ND/STRAL ROCCSSSS AND PROJUCT USE         2H Other (place specify)         NO         NO           Mainya         Bil/Z         2014 1 AMERCUITURE (DESTIFY AND OTHER LAND USI AL Watch AND AND AND INTERLAND USI AL Watch AND AND AND INTERLAND USI AL Watch AND	Malaysia		2014	2 INDUSTRIAL PROCESSES AND PRODUCT US 2 INDUSTRIAL PROCESSES AND PRODUCT US	E 28 Other Product Manufacture and Use E 2H Other (please specify)	204 Other (please specify)			N
Mailyam         Bull 2         2012 2 NUSTRAL PROCESSIS AND PROJUCT USE         241 Other (plave specify)         P26         Food and Beerages Hodary         NE         NE           Mailyam         Bull 2         2012 2 NUSTRAL PROCESSIS AND PROJUCT USE         241 Other (plave specify)         P26         Food and Beerages Hodary         NO         NO         NO           Mailyam         Bull 2         2012 3 ADRICUIT USE (POSTST AND OTHER LAND USE ALL VALUE (POSTST AND OTHER LAND USE AL VALUE (POSTST AND OTHER LAND	Malaysia	BUR2	2014	INDUSTRIAL PROCESSES AND PRODUCT US	E 2H Other (please specify)	2H1 Pulp and Paper Industry	NE	NE	ť
Mainya         BuR2         2014         3 AGROULTURE (DOSTIN' AND OTHER LAND USA Livetock         -250255         TEX           Malnya         BUR2         2014         3 AGROULTURE, (DOSTIN' AND OTHER LAND USA Livetock         37           Malnya         BUR2         2014         3 AGROULTURE, (DOSTIN' AND OTHER LAND USA Livetock         34         Enters Femeration         55           Malnya         BUR2         2014         3 AGROULTURE, (DOSTIN' AND OTHER LAND USA Livetock         34         Manume Miniagement         212           Malnya         BUR2         2014         3 AGROULTURE, (DOSTIN' AND OTHER LAND USA Livetock         34         Manume Miniagement         212           Malnya         BUR2         2014         3 AGROULTURE, (DOSTIN' AND OTHER LAND USB Livetock         34	Malaysia				SE 2H Other (please specify)	2H2 Food and Beverages Industry			ŧ.
Mainya         BuR2         2014         JAGRULTURE (FORSTRY AND OTHER LAND US 34 Livetock         1         7           Mainya         BuR2         2014         JAGRULTURE (FORSTRY AND OTHER LAND US 34 Livetock         31         Feferic Fermentation         55           Mainya         BuR2         2014         JAGRULTURE (FORSTRY AND OTHER LAND US 34 Livetock         32         Manuse Minagement         55           Mainya         BuR2         2014         JAGRULTURE (FORSTRY AND OTHER LAND US 34 Livetock         32         Manuse Minagement         5504/376 K cm           Mainya         BuR2         2014         JAGRULTURE (FORSTRY AND OTHER LAND US 36 Livetock         32         Manuse Minagement         -5502/32 K Live           Mainya         BuR2         2014         JAGRULTURE (FORSTRY AND OTHER LAND US 36 Livetock         34         Manuse Minagement         -5502/32 K Live           Mainya         BuR2         2014         JAGRULTURE (FORSTRY AND OTHER LAND US 36 Livetock         38         Createrd         -5502/32 K Live           Mainya         BuR2         2014         JAGRULTURE (FORSTRY AND OTHER LAND US 38 Livetock         38         Createrd         -5502/32 K Livetock         -5502/32 K	Malaysia					2H3 Other (please specify)		NO 166 0/	N
Malayia         BUR2         2014 3 AGRCULTURE (FORSTRY AND OTHER LAND USI AL luetock         3/4         Enters: Enternetation         5/5           Malayia         BUR2         2014 3 AGRCULTURE (FORSTRY AND OTHER LAND USI AL luetock         3/4         Interves: Management         -25/8/25         Z           Malayia         BUR2         2014 3 AGRCULTURE (FORSTRY AND OTHER LAND USI BL luetock         3/4							-203203.5	77.15	
Mainya         B/RZ         2014 3 AGRCULTURE (FORSTRY AND OTHER LAND USB Land        5684756 E.N.N.           Mainya         B/RZ         2014 3 AGRCULTURE (FORSTRY AND OTHER LAND USB Land         381         Forest Land         -2526225 E.N.N.           Mainya         B/RZ         2014 3 AGRCULTURE (FORSTRY AND OTHER LAND USB Land         381         Forest Land         -2526225 E.N.N.           Mainya         B/RZ         2014 3 AGRCULTURE (FORSTRY AND OTHER LAND USB Land         381         Greaterd         -455522 E.N.N.           Mainya         B/RZ         2014 3 AGRCULTURE (FORSTRY AND OTHER LAND USB Land         380         Greaterd         -456522 E.N.N.           Mainya         B/RZ         2014 3 AGRCULTURE (FORSTRY AND OTHER LAND USB Land         380         Vetlands         E.N.N. N. NO           Mainya         B/RZ         2014 3 AGRCULTURE (FORSTRY AND OTHER LAND USB Land         380         Vetlands         E.N.N. N. NO           Mainya         B/RZ         2014 3 AGRCULTURE (FORSTRY AND OTHER LAND USB Land         380         Vetlands         2029 B.N. NO           Mainya         B/RZ         2014 3 AGRCULTURE (FORSTRY AND OTHER LAND USB Land         380         Vetlands         2029 B.N. NO           Mainya         B/RZ         2014 3 AGRCULTURE (FORSTRY AND OTHER LAND USB Land)         380         Vetlands <t< td=""><td>Malaysia</td><td></td><td></td><td></td><td></td><td></td><td></td><td>55.66</td><td></td></t<>	Malaysia							55.66	
Makyana         BIRZ         2010 J AGRCUTURE (FORSTRY AND OTHER LAND USB Land         381         Freet Lind						3A2 Manure Management	000047-00	21.49	
Mainyan         Burg         2014         JAGRICULTURE_FORSTIFY AND OTHER LAND USB Land         S2E         Credited         14552.2         E.W.           Mainyan         Burg         2014         JAGRICULTURE_FORSTIFY AND OTHER LAND USB Land         380         Greaterd         NA. NO. NA. NO           Mainyan         Burg         2014         JAGRICULTURE_FORSTIFY AND OTHER LAND USB Land         381         Wetlands.         E.F.N. NO. NA. NO           Mainyan         Burg         2014         JAGRICULTURE_FORSTIFY AND OTHER LAND USB Land         384         Wetlands.         E.F.N. NO. NA. NO           Mainyan         Burg         2014         JAGRICULTURE_FORSTIFY AND OTHER LAND USB Land         384         Wetlands.         2019         JAGRICULTURE_FORSTIFY AND OTHER LAND USB Land         385         Wetlands.         2019         JAGRICULTURE_FORSTIFY AND OTHER LAND USB Land         380         Wetlands.         2019         JAGRICULTURE_FORSTIFY AND OTHER LAND USB Land         380         Wetlands.         2019         JAGRICULTURE_FORSTIFY AND OTHER LAND USB Land         380         Wetlands.         2019         JAGRICULTURE_FORSTIFY AND OTHER LAND USB Land         380         Wetlands.         2019         JAGRICULTURE_FORSTIFY AND OTHER LAND USB Land         380         Wetlands.         2019         JAGRICULTURE_FORSTIFY AND OTHER LAND USB Land         380						3B1 Forest Land			E,
Makyai         BUR2         2014 3 AGRICUTURE (FORSTRY AND OTHER LAND US 38 Lind         383         Greatind         NN,	Malaysia	BUR2	2014	3 AGRICULTURE, FORESTRY AND OTHER LAN	ID USI 38 Land	382 Cropland	-14535.21	IE, NA	E,
Malayia         B/RZ         2014 3 AGRCUTURE (FORSTRY AND OTHER LAND US 88 Land         386         Settlements         2299 IAA.NO           Malayia         B/RZ         2014 3 AGRCUTURE (FORSTRY AND OTHER LAND US 88 Land         386         Other Land         NO           Malayia         B/RZ         2014 3 AGRCUTURE (FORSTRY AND OTHER LAND US 88 Land         386         Other Land         NO           Malayia         B/RZ         2014 3 AGRCUTURE (FORSTRY AND OTHER LAND US 28 Land         386         Other Land         NO           Malayia         B/RZ         2014 3 AGRCUTURE (FORSTRY AND OTHER LAND US 28 Land         Settlements         594.35         88           Malayia         B/RZ         2014 3 AGRCUTURE (FORSTRY AND OTHER LAND US 26. Anoreast Sources on Land         401         Branes Burneg         NO	Malaysia	BUR2	2014	3 AGRICULTURE, FORESTRY AND OTHER LAN	ID USI 38 Land	3B3 Grassland	NA NO	NA NO	N
Mahyai BUR2 2014 3 AGROLUTURE FORSTRY AND OTHER LAND US 38 Land Non-CO-Emistions Sources on Land 386 Other Land NO NO NO Non Non Non-Line Control Non-CO-Emistions Sources on Land 584.35 88 Non-CO-Emistions Sources on Land 584.35 Non-Co-Emistions Sources on Land 584.35 Non-Co-Emistions Sources on Land 584.35 Non-Co-Emistry Sources on Land 586.35 Non-Co-Emistry Sources on L	Malaysia		2014	3 AGRICULTURE, FORESTRY AND OTHER LAN	D USI 38 Land		IE, NA, NO	NA, NO	E,
Malaysia BUR2 2014 3 AGRCULTURE, FORESTRY AND OTHER LAND US <u>3C. Accessate Sources and Non-CO-Invision Sources on Land</u> 594.35 88 Malaysia BUR2 2014 3 AGRCULTURE, FORESTRY AND OTHER LAND US <u>3C. Accessate Sources and Non-CO-Invision Sources on Land</u> 501 Bornas Burning NO	Malaysia						3299.9 NO	NO NO	N N
Malaysia BUR2 2014 3 AGRICULTURE, FORESTRY AND OTHER LAND US 3C. Apprendix Sources and Non-CO+ Emissions Sources on Land SC1 Biomass Burning NO	Malaysia	BUR2	2014	3 AGRICULTURE, FORESTRY AND OTHER LAN	D USI 3C Appreciate Sources and Non-CO+ Emissions Sources on Land		584.35		3
	Malaysia		2014	3 AGRICULTURE, FORESTRY AND OTHER LAN	ID US 3C Addredate Sources and Non-CO+ Emissions Sources on Land			0.6	C
Malaysia BURZ 2014 3 AGRCULTURE, FORESTRY AND OTHER LAND USI 3C. Aggregate Sources and Non-CO <sub>2</sub> Emissions Sources on Land 3C2 Liming 907 Sheet 1 +	Malaysia	BUR2		and the second sec	ID USI 3C Aggregate sources and Non-CO <sub>2</sub> Emissions Sources on Land	3C2 Liming	9.07		1

### Selected countries (top 12 emitters)

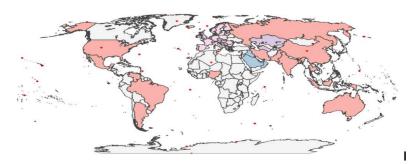
Gas	Sector	Country List
CO <sub>2</sub>	Net Land Flux	AUS, BRA, CAN, CHN, COD, EUR, IND, KAZ, MNG, RUS, USA, ZAF
CH <sub>4</sub>	Anthropogenic	ARG, AUS, BRA, CHN, EUR, IDN, IND, IRN, MEX, PAK, RUS, USA
	Fossil (including oil, gas, coal)	CHN, EUR, GULF, IDN, IND, IRN, KT, MEX, NGA, RUS, USA, VEN
	Agriculture & waste	ARG, BGD, BRA, CHN, EUR, IDN, IND, MEX, PAK, RUS, THA, USA
N <sub>2</sub> O	Anthropogenic	AUS, BRA, CHN, COD, COL, EUR, IDN, IND, MEX, SDN, USA, VEN

### **Coverage by in-situ networks & (for CH4) by GOSAT soundings**

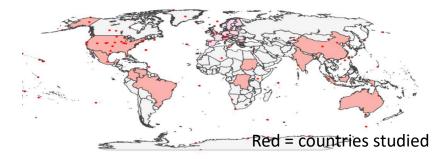
CO2 network

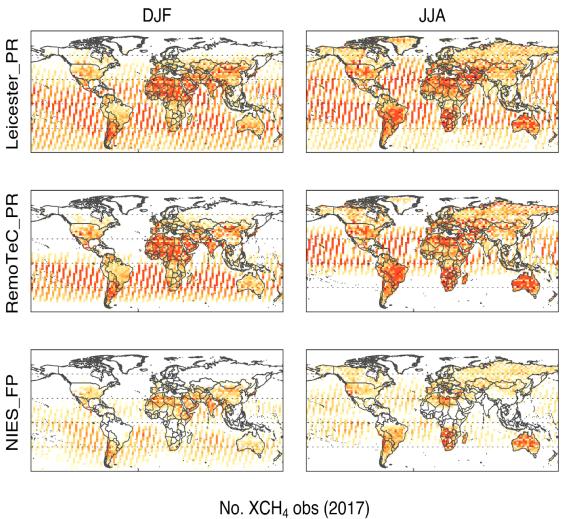


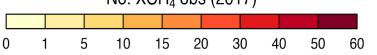
#### CH4 network











# **Grouping of sectors from National Inventories to match inversions**

Gas	Aggregated sectors in this study	Inversions	Inventories		
CO <sub>2</sub>	Net Land Flux	Total - Fossil	Net emissions - (Energy + Industrial Processes)		
CH <sub>4</sub>	Total Anthropogenic	Ũ	Energy + Industrial Processes + Agriculture + Waste + Biomass Burning		
	Fossil (including oil, gas, coal)	Fossil	Energy + Industrial Processes - Biofuel Burning*		
	Agriculture & Waste	Agriculture & Waste	Agriculture + Waste - Field burning of agricultural residues**		
$N_2O$	Anthropogenic	Total - pre-industrial	Agriculture + Waste direct + anthropogenic		

### Processing of inversions to make them comparable to inventories

100

80

60

40

20

0

-20 -40

-60

-80

-100

100

80

60

40

20 0

-20

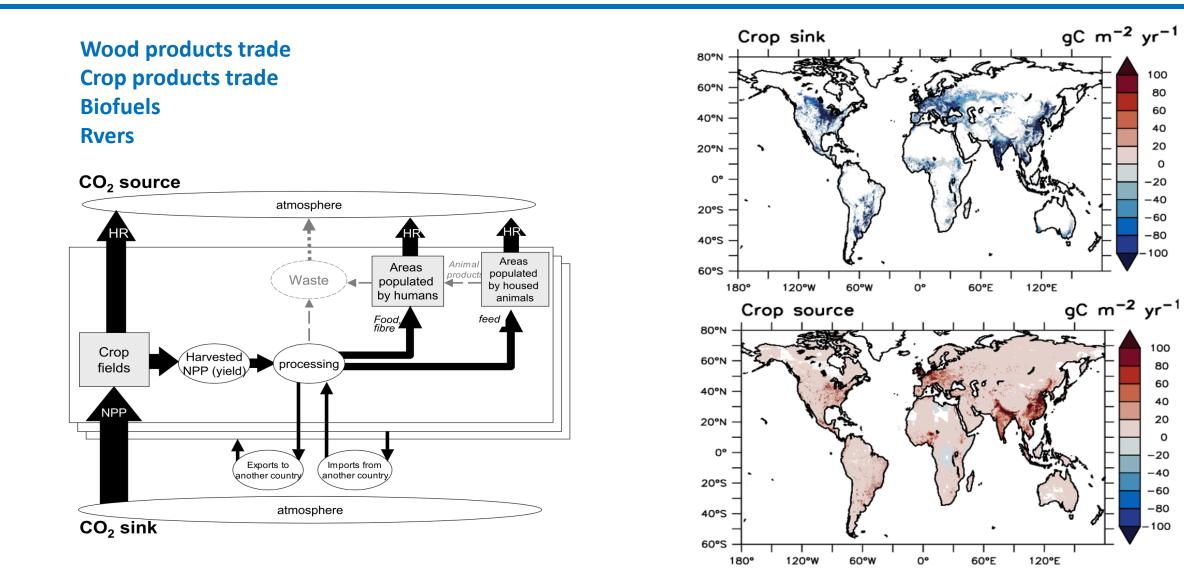
-40

-60

-80

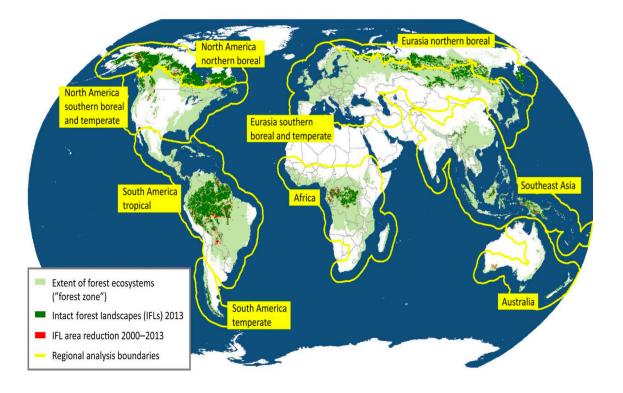
100

### Removing CO2 fluxes that give no stock change and are not surveyed by inventories

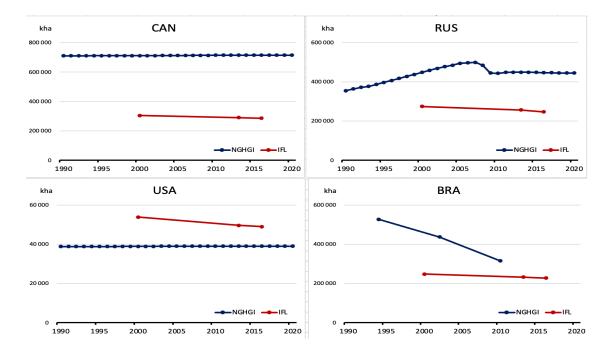


### Restricting gridded inversion fluxes to spatially explicit 'intact land' as a proxy of unmanaged

Removal of (spatially explicit) un-managed land using remote sensing data Potapov et al. for <u>intact forests Landscapes</u> and Chang et al. for <u>natural grasslands</u>

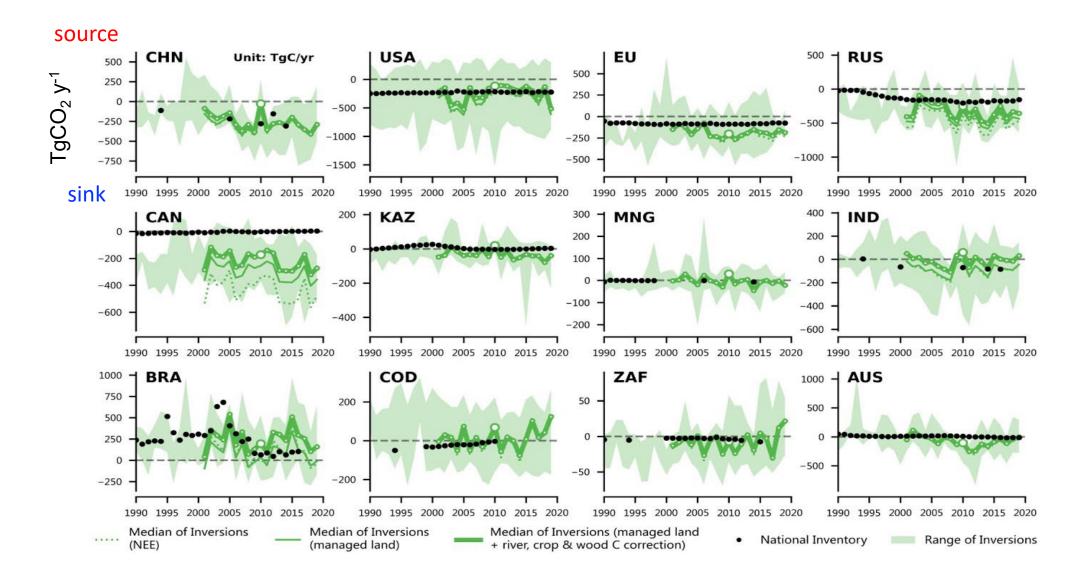


### 'Intact forest' vs 'Unamanaged'



Note that Ogle et al. 2018 published spatially explicit maps of unmanaged land for Canada, USA, Brazil

### $CO_2 - LULUCF$ fluxes (sink = negative values)



### **CO**<sub>2</sub> – LULUCF fluxes : global sum

### **Global land CO2 sink**

	GtC y <sup>-1</sup>	GtCO <sub>2</sub> y <sup>-1</sup>	ref.	period
NGHGI	-0.3	-1.6	Grassi et al. 2021	2000-2015
NGHGI UNFCCC data interface + gap filled	-1.5	-5.4	Grassi et al. 2022	2000-2020
FAOSTAT	+0.3	+1.1	Grassi et al. 2022	
Inversions (managed land)	-2.7	-9.9	Deng et al. 2022	2007-2017
Inversion (unmanaged land)	+0.2	+0.7		

FAO – NGHGI difference :

Due to a much greater forest sink for non-Annex I countries in the NGHGI database than FAOSTAT.

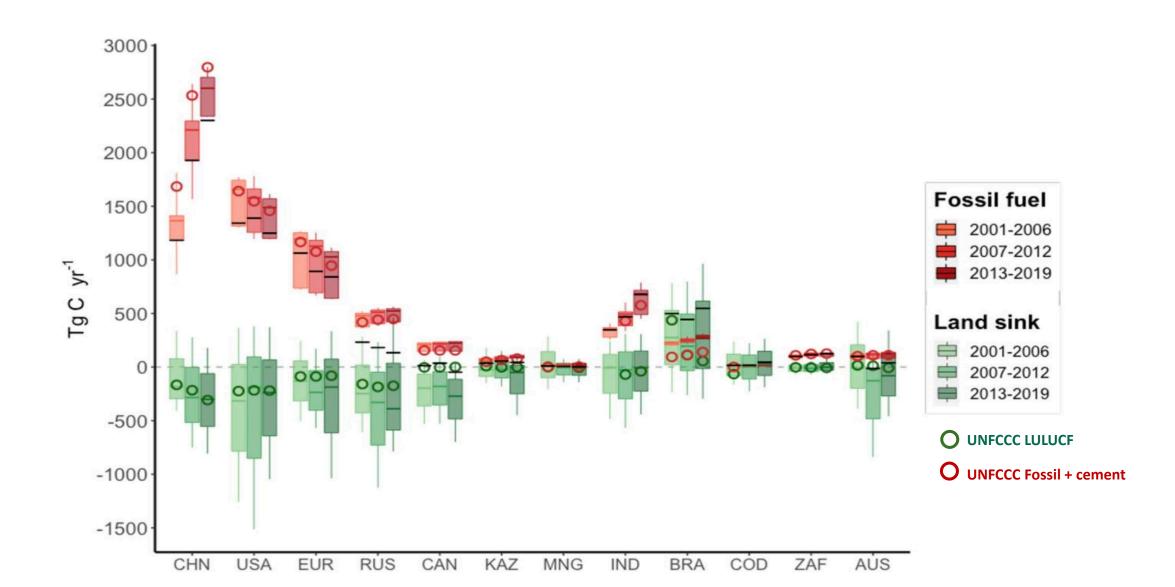
### Inversions – NGHGI difference :

Due to a smaller forest sink for Annex I and for some non-Annex-1 countries in the NGHGI database than inversions / indirectly confirmed by the upward revision of the sink in non Annex 1 countries from Grassi et al. 2022

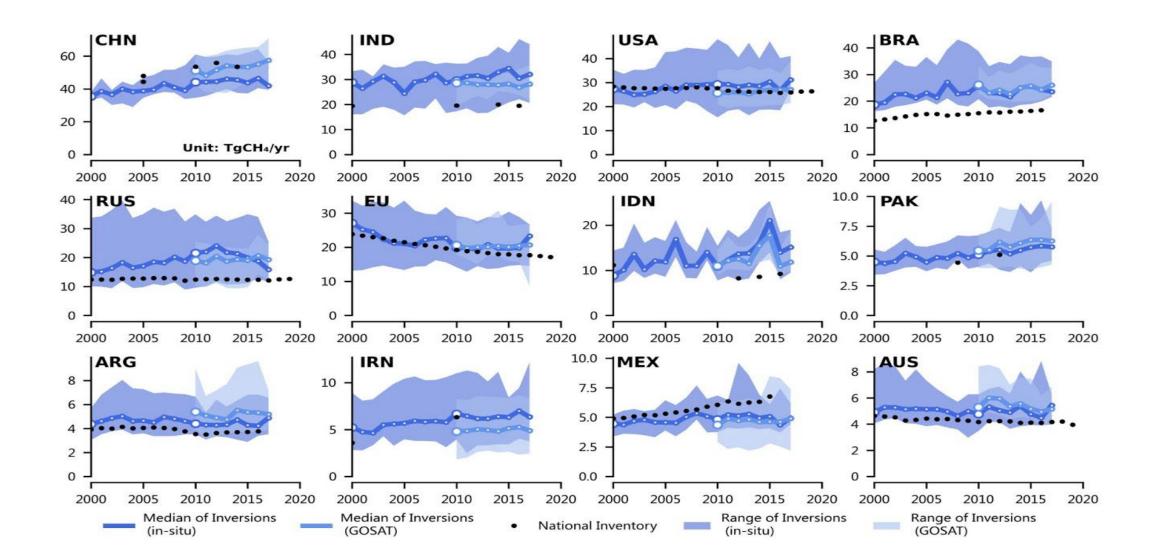
Even with the latest NGHGI data compilation, inversions find a 80% larger CO<sub>2</sub> sink in managed land than inventories

Although unmanaged land area is globally a source, it is a sink in Canada (+40% more than managed land ) and Russia (+16%)

# Summary CO2 Emissions and sinks from Top fossil CO2 Emitters

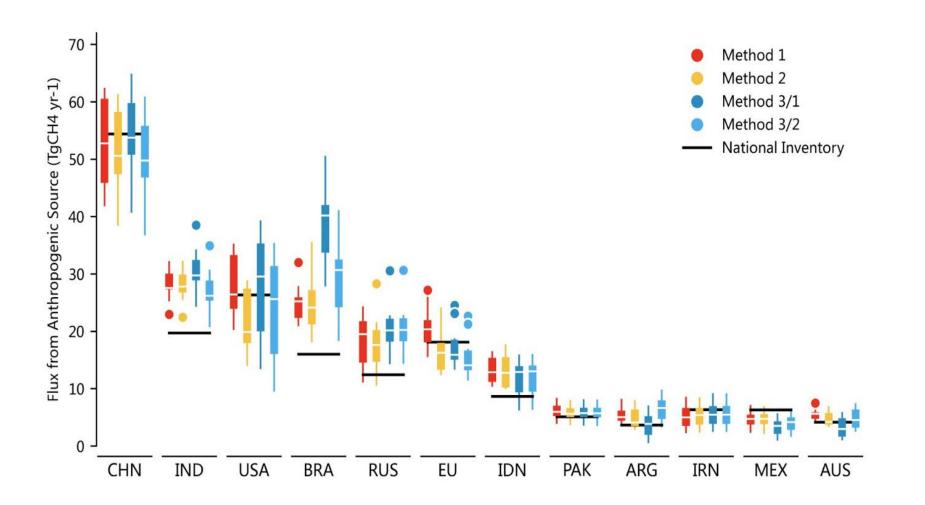


### CH<sub>4</sub> – total anthropogenic emission (in-situ and GOSAT inversions)

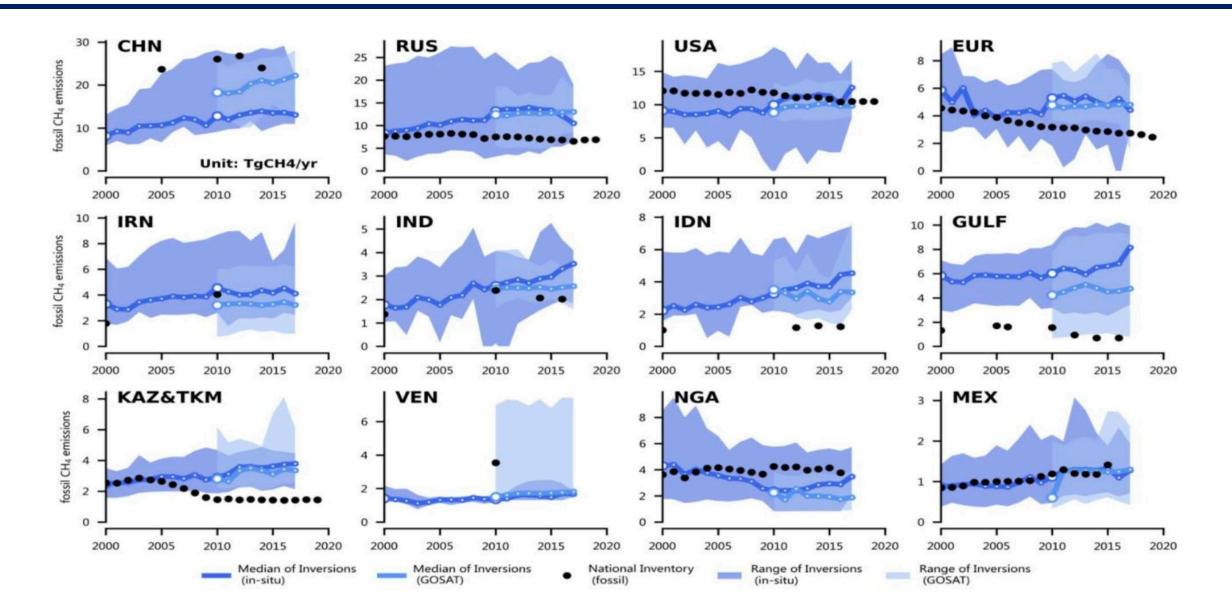


Background

# Robustness of inversions anthropogenic CH4 emissions to the choice of a separation method for natural sources



# CH<sub>4</sub> – Fossil emissions (in-situ & GOSAT inversions)

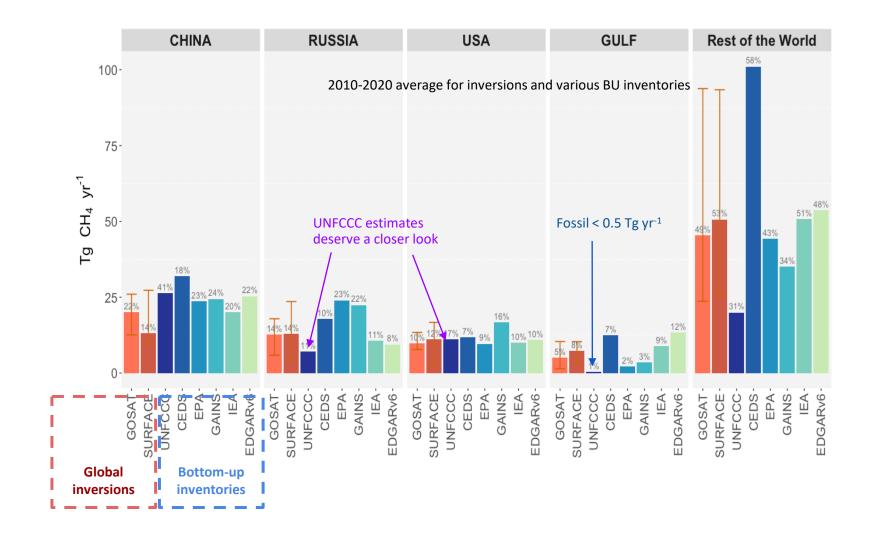


Introduction

Background

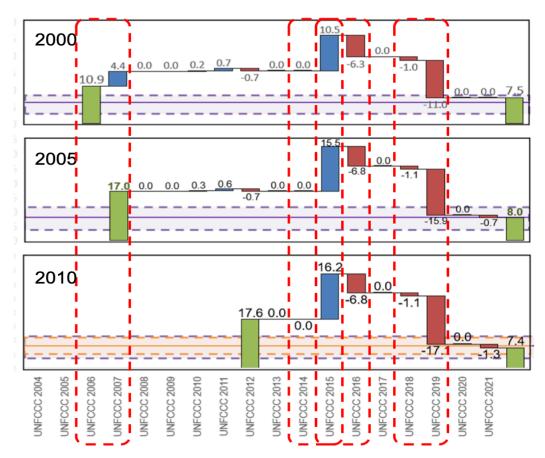
### Reconciliation

# Inventories from countries in the Middle East (Gulf) and rest of the underestimate fossil CH4 emissions



### **Different versions of UNFCCC reported emissions have** larger variability than inversions uncertainty

# **Key changes from Russia CH<sub>4</sub> oil and gas emissions** Emissions from coal and Oil/Gas - Russia (Tg CH<sub>4</sub>/yr)



Increase Decrease Total

Changing points	Change type	Change of	Details
2007	increase	Methodology + Emfacs	Inclusion of new sources - oil and gas exploration and distribution, venting/flaring; Updation of several emfacs
2015	increase	Methodology	Change in calculation for oil emissions, massive change in emfacs
2016	decrease	Emfac	change in emfac for NG production - massive decrease
2019	decrease	Emfac	change in emfacs for oil systems - probably looks like correction

Superimposing the inversion data can tell if the changes going towards right direction

(shaded region - Purple: SURFACE | Orange: GOSAT inversions).

# Different versions of UNFCCC reported emissions have larger variability than inversions uncertainty

### Key changes from USA CH<sub>4</sub> oil and gas emissions

Emissions from coal and Oil/Gas - USA (Tg CH, /yr)

Increase Decrease Total 3.8 2000 0.0 **EMISSIONS** 0.0 <u>10.0 0.2 0.2</u> 0.0 -0.6 0.3 0.2 -0.7 -0.1 0.0 11 42 2005 0.3 11.3 9.4 -0.2- - -0.1 -11 15.4 2010 0.3 11.6 0.0 -0.8 0 0 UNFCCC 2011 UNFCCC 2012 UNFCCC 2014 UNFCCC 2015 JNFCCC 2009 UNFCCC 2010 JNFCCC 2013 UNFCCC 2016 UNFCCC 2017 UNFCCC 2018 UNFCCC 2006 UNFCCC 2007 JNFCCC 2008 JNFCCC 2019 JNFCCC 2020 JNFCCC 2005 JNFCCC 2004 JNFCCC 202

Changing points	Change type	Change of	Details
2011	Increased w.r.t. previous	Emfac	Change in implied emfacs for gas production/processing, (nearly 2.4 times)
2013	Decreased w.r.t previous	Methodology + Activity data	<ul> <li>Input data for calculating emissions from "liquids unloading were updated from a survey conducted by API/ANGA (API/ANGA 2012).</li> <li>Activity data on well counts was updated using DI Desktop data.</li> </ul>
2016	Increased w.r.t. previous	Activity data + Methodology	<ul> <li>Updated activity factors for fugitives, pumps and controllers</li> <li>Using the GHGRP data, the EPA developed new technology-specific activity data and emission factors for pneumatic controllers.</li> </ul>

Superimposing the inversion data can tell if the changes going towards right direction

(shaded region - Purple: SURFACE | Orange: GOSAT inversions).

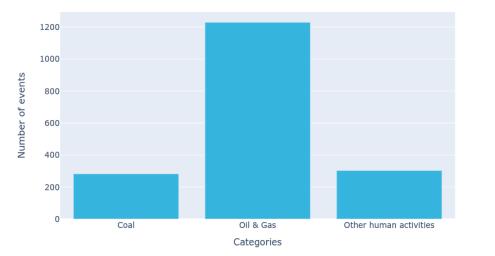
Background

### Introduction

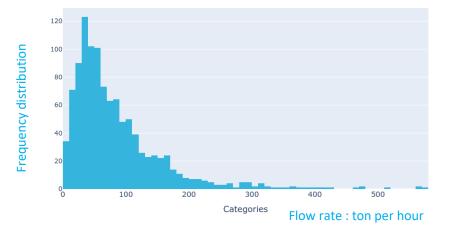
Reconciliation

### CH<sub>4</sub> – Resolving discrepancies using ultra emitters TROPOMI inversion (assuming they are seen in the total emissions by global inversions but may be missed by inventories )

#### Categories associated with the detections (2019-2020)



Histogram of the emission rate associated with the quantified detections (2019-2020)







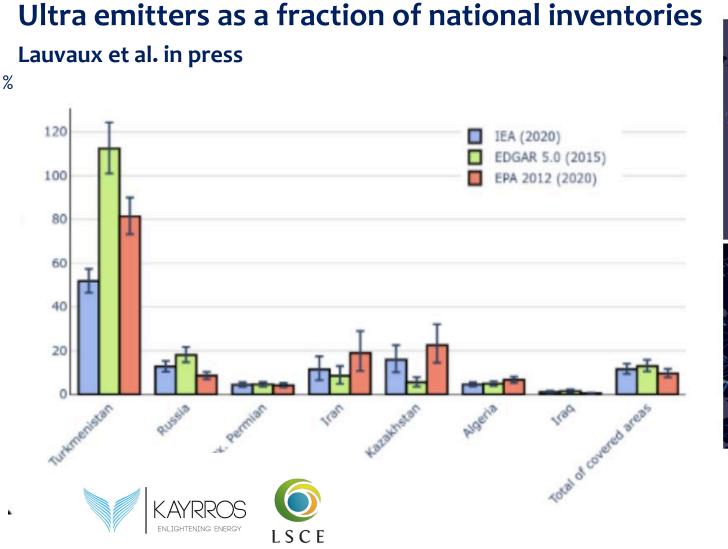
Background

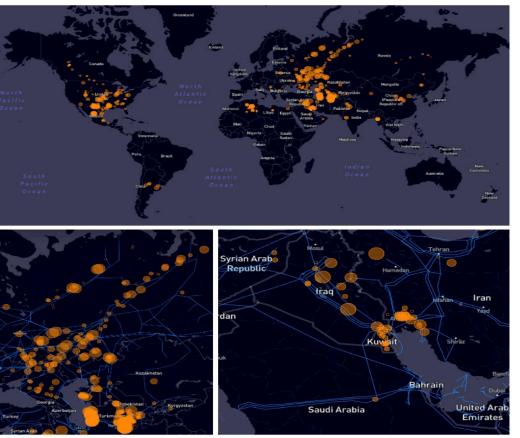
Introduction

Reconciliation

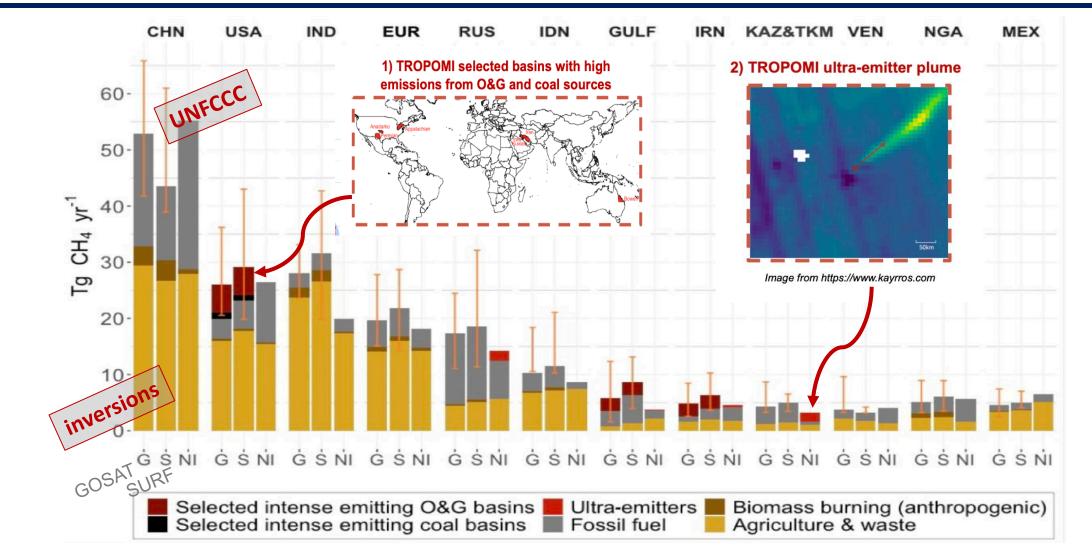
### CH<sub>4</sub> – Resolving discrepancies using ultra emitters TROPOMI inversion (> 20 tCH4 per h)

(assuming they are seen in the total emissions by global inversions but may be missed by inventories )



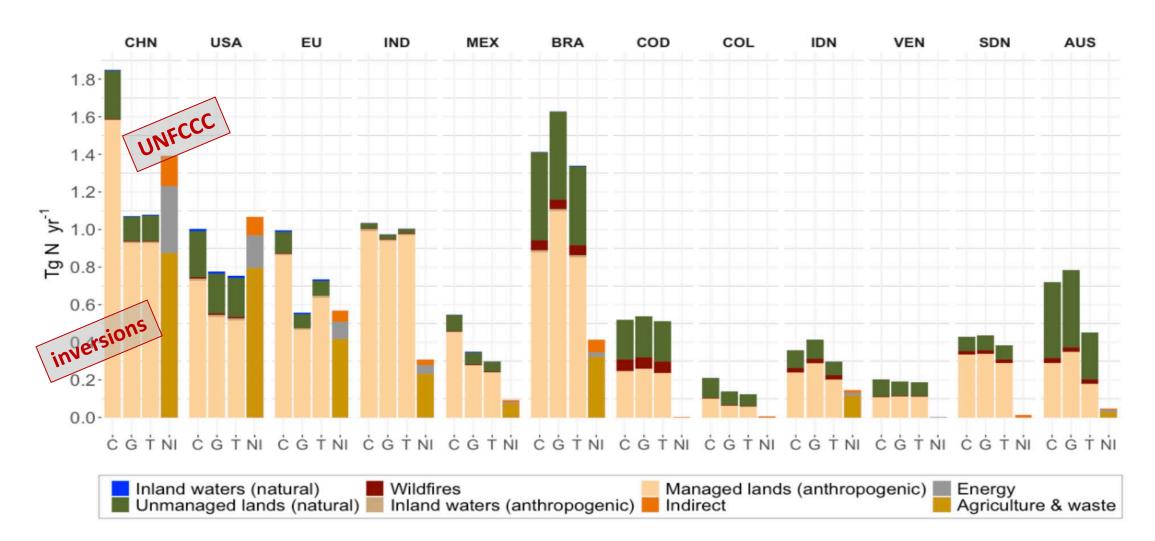


### Summary of CH4 anthropogenic inversions (last 5 years)



Ultra emitters assumed not captured by UNFCCC inventories / basins emissions assumed as part of inversions fossil emissions

### Summary N2O anthropogenic emissions (last 5 years)



• Note the overlooked importance of natural emissions (including fires in BRA and IDN) in tropical countries

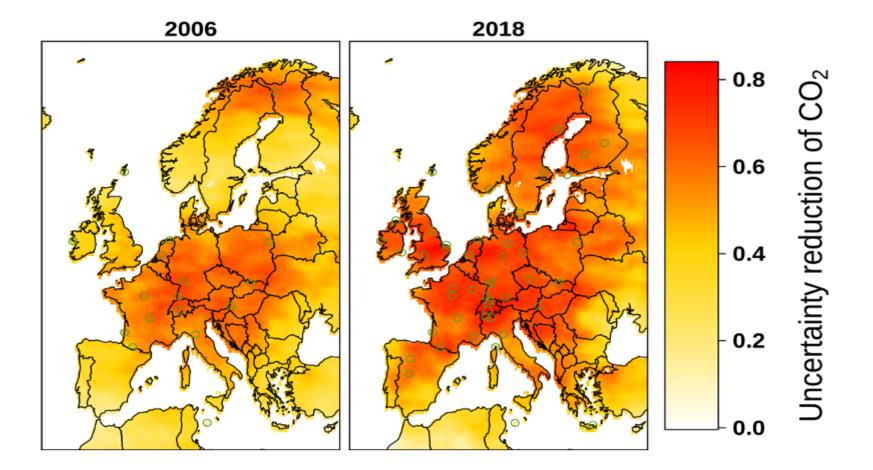


# Conclusions

- Importance of sampling inversions over managed lands
- Need to correct CO<sub>2</sub> inversions for lateral fluxes
- Most northern countries under-estimate LULUCF carbon sinks
- UNFCCC fossil CH<sub>4</sub> emissions lower than inversions for key O&G extraction countries
- N<sub>2</sub>O emissions < inversions in EU, India, DRC, Australia
- Perspectives
  - Regional higher resolution inversions
  - Lack of in-situ data in many countries
  - Assimilate satellite XCO2 concentration data
  - ✓ Inversions using GOSAT and OCO-2 data
  - ✓ Complete global CH4 inversions by ultra emitters and basins-scale regional inversions
  - Criteria to benchmark inversions (cross-validation)
  - Weighed ensembles
  - Analysis of inversions sources of uncertainties



# Can we hope to beat the proble with data ?



CarboScopeRegional uncertainty reduction maps computed as 1-  $(\sigma_{post} / \sigma_{prior})$  for 2006 and 2018 using a Monte Carlo approach



# Thank you for your attention





Philippe.ciais@lsce.ipsl.fr

12

13

14 15

16

17 18

19

20

21 22 23

24 25

26

27

# National inventories submitted to UNFCCC (Annex I)

### **Common Reporting Format (CRF)**

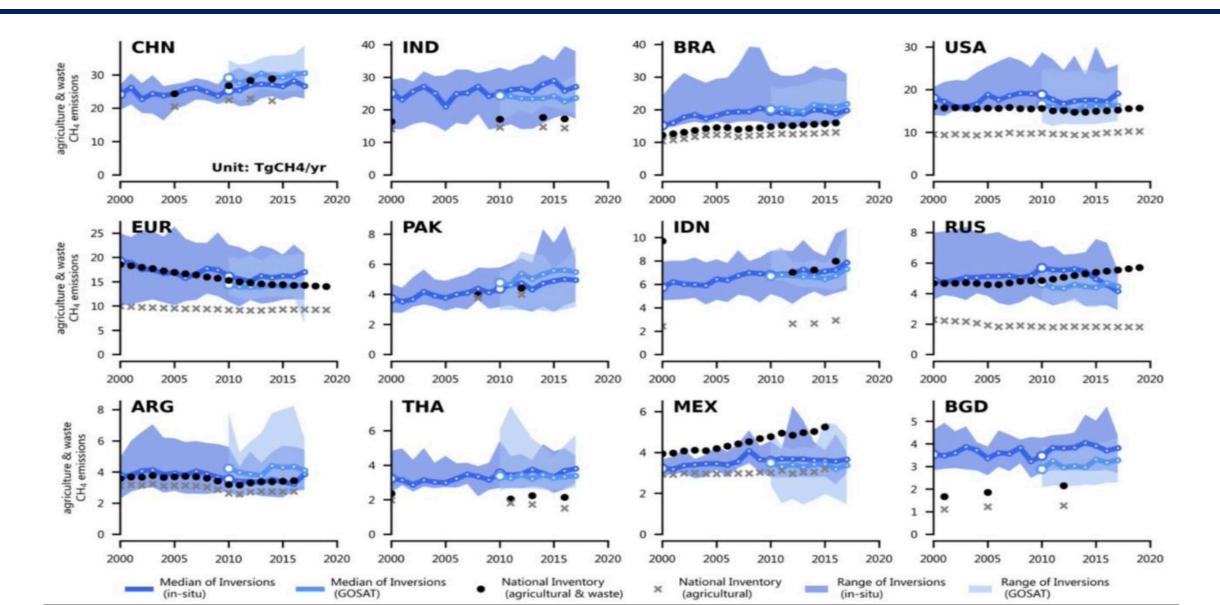
<sup>¬</sup>At its eighth session, the Conference of the Parties requested the secretariat to publish on its web site the **annual inventory submissions** consisting of the national inventory report (NIR) and common reporting format (CRF) of all Parties included in Annex I to the Convention. The NIRs contain detailed descriptive and numerical information and the <u>CRF tables contain all greenhouse gas (GHG) emissions and removals</u>,

AUS\_2020\_2018\_27052020\_132359.xlsx implie( AUS\_2020\_2017\_27052020\_132240.xlsx and AUS\_2020\_2016\_27052020\_132121.xlsx AUS\_2020\_2015\_27052020\_132001.xlsx AUS\_2020\_2014\_27052020\_131843.xlsx AUS\_2020\_2013\_27052020\_131727.xlsx AUS\_2020\_2012\_27052020\_131612.xlsx AUS\_2020\_2011\_27052020\_131457.xlsx AUS\_2020\_2010\_27052020\_131340.xlsx AUS\_2020\_2009\_27052020\_131223.xlsx AUS\_2020\_2008\_27052020\_131105.xlsx AUS\_2020\_2007\_27052020\_130947.xlsx AUS\_2020\_2006\_27052020\_130828.xlsx AUS\_2020\_2005\_27052020\_130711.xlsx AUS\_2020\_2004\_27052020\_130554.xlsx AUS\_2020\_2003\_27052020\_130436.xlsx AUS\_2020\_2002\_27052020\_130316.xlsx AUS\_2020\_2001\_27052020\_130159.xlsx AUS\_2020\_2000\_27052020\_130042.xlsx AUS\_2020\_1999\_27052020\_125924.xlsx AUS\_2020\_1998\_27052020\_125806.xlsx AUS\_2020\_1997\_27052020\_125648.xlsx AUS\_2020\_1996\_27052020\_125532.xlsx AUS\_2020\_1995\_27052020\_125420.xlsx AUS\_2020\_1994\_27052020\_125306.xlsx AUS\_2020\_1993\_27052020\_125155.xlsx AUS\_2020\_1992\_27052020\_125045.xlsx AUS\_2020\_1991\_27052020\_124933.xlsx

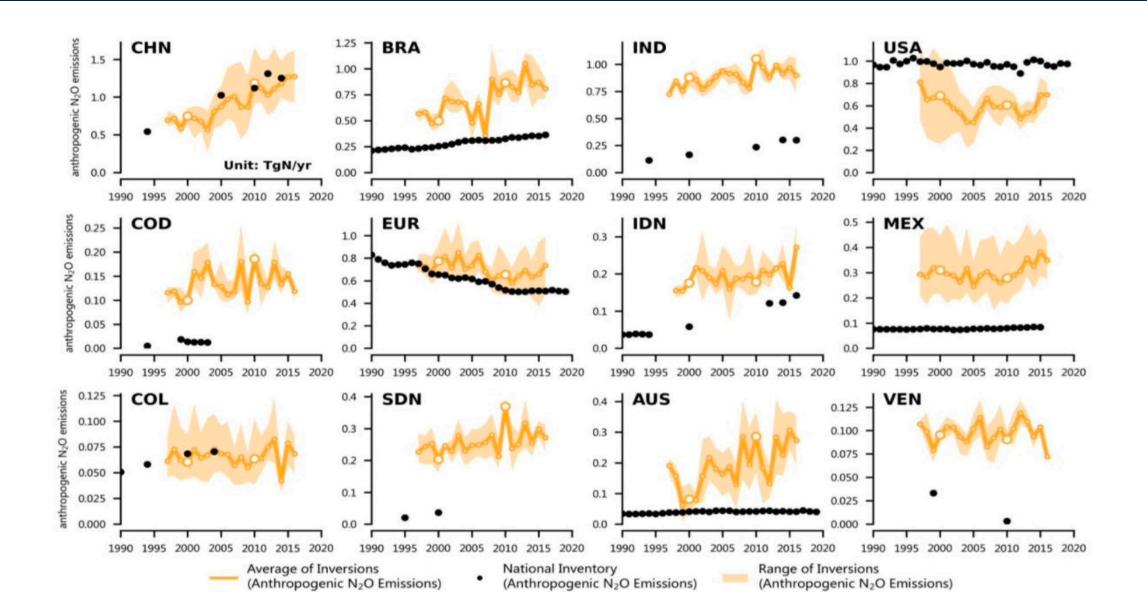
AUS\_2020\_1990\_27052020\_124811.xlsx

	🔍 🔴 🔂 🕤	ა∗ ტ ₹		AUS_202	AUS_2020_2018_27052020_132359					<u> </u>
开始	计 插入 绘图	页面布局 2	、式 数据	审阅 视图						+ 共享 →
1	A			D ENERGY						
1	$  \times \sqrt{f_x}$	TABLE I SECI	ORAL REPORT FO	RENERGY						
		А		В	С	D	Е	F	G	Н
TA	ABLE 1 SECTORA	<b>AL REPORT F</b>	OR ENERGY							Inventory 2018
(SI	heet 1 of 2)								Sul	bmission 2020 v1
	,									AUSTRALIA
-										AUSTRALIA
GR	EENHOUSE GAS SOURC	CE AND SINK CAT	FCORIES	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	NOx	CO	NMVOC	SO <sub>2</sub>
		ching block chin	LOONILD			1120	(kt)		Mirroc	502
Tot	tal Energy			393408.22	1562.20	10.43	2693.12	2261.93	783.95	636.13
	Fuel combustion activities	(sectoral approach)		376140.74	77.92	10.18	2689.12	2238.96	539.18	636.13
	1. Energy industries			212312.80	25.12	3.00	1188.60	248.63	76.39	542.83
)	a. Public electricity	and heat production		181906.70	23.91	2.23	670.89	97.64	13.01	525.64
	b. Petroleum refinin	g		3075.20	0.05	0.01	19.77	2.55	0.05	5.75
;	c. Manufacture of solid fuels and other energy industries			27330.90	1.15	0.76	497.94	148.44	63.34	11.44
	2. Manufacturing indust	ries and constructior	1	40222.09	2.37	1.47	751.13	241.30	100.46	57.69
-	a. Iron and steel			1548.21	0.03	0.02	17.54	2.78	0.27	7.39
5	b. Non-ferrous meta	ils		12259.23	0.21	0.13	76.91	12.89	1.30	22.82
j 7	c. Chemicals			6842.07	0.22	0.08	50.09	16.03	9.86	3.89
3	d. Pulp, paper and p			998.31	0.21	0.14	7.90	5.71	0.51	1.33
)	f. Non-metallic min	beverages and tobacc	20	2523.25 4928.92	0.84	0.54	23.43	23.36	1.67 15.10	3.00 7.98
)	g. Other (please spec			11122.10	0.29	0.03	500.49	157.45	71.74	11.30
_	3. Transport	·957		98973.04	14.33	4.91	302.48	1083.14	239.32	24.33
2	a. Domestic aviation	1		9000.09	0.04	0.06	30.37	19.96	1.99	1.06
5	b. Road transportation			83980.68	9.13	3.29	174.60	780.52	189.94	16.90
	c. Railways			3564.91	0.20	1.53	77.98	10.29	3.62	2.91
5	d. Domestic navigat	ion		1593.73	4.81	0.03	16.40	267.20		3.45
;	e. Other transportati	on		833.64	0.15	0.00	3.13	5.17	0.72	0.01
		1								-
	Index sheet	Table1s1	Table1s2	Table1.A(a)s1	Table1.A(a)s	2 🔒 Table1.	A(a)s3 🛛 🔒 Tab	ole1.A(a)s4	Table1.A(b)	<b>●</b> T <b>+</b>
										+ 125%

### CH<sub>4</sub> – Agricultural and waste emissions (in-situ & GOSAT inversions)

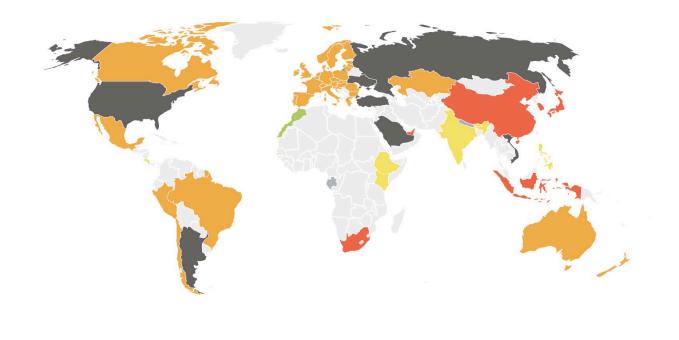


# N<sub>2</sub>O – anthropogenic emissions

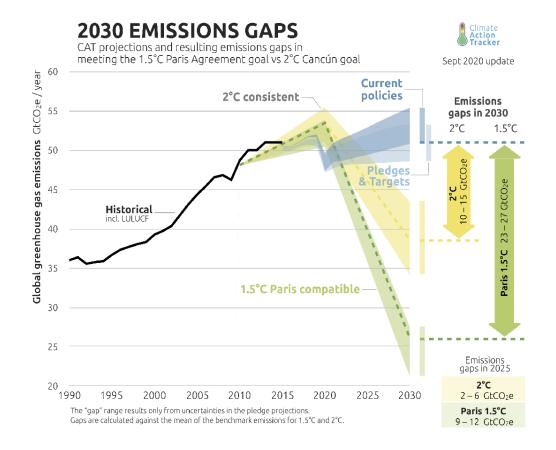




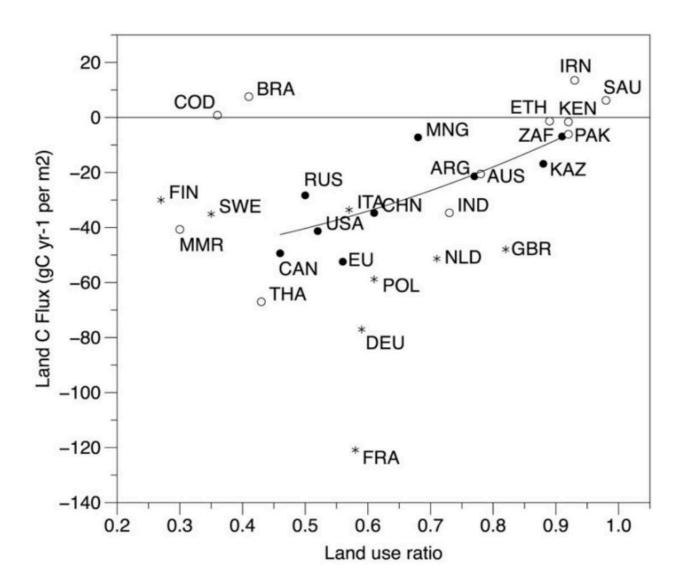
# **Current policies lead to a 3°C warming**



CRITICALLY INSUFFICIENT HIGHLY INSUFFICIENT	INSUFFICIENT	2°C COMPATIBLE	1.5°C PARIS AGREEMENT COMPATIBLE	ROLE MODEL	
---	--------------	----------------	-------------------------------------	------------	--

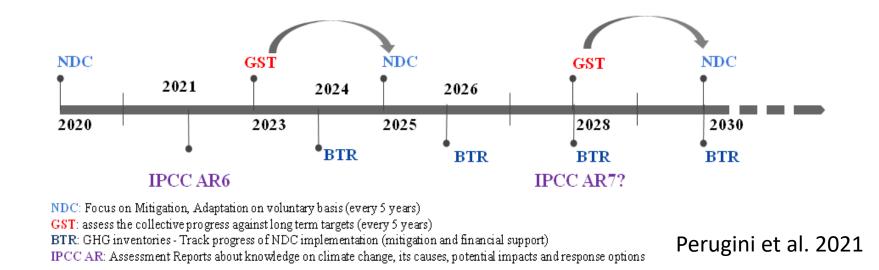


### LULUCF CO2 sinks decreases with increasing land use ratio in temperate countries





# **Global stock take in 2023**



- The GST shall include information about **mitigation and adaptation processes**, and the **means of implementation and support**, based on the best available science and the equity concept.
- The process should inform Parties whether the **cumulated efforts** of all the Parties is in track with the "well-below 2°C" trajectory, thus providing indication on how to enhance and update their actions at national level and through cooperation.
- The outputs of the GST should, thus, provide indication of opportunities and challenges for **enhancing action and support**.
- The process needs to be **transparent**, in the light of **equity and best available science** and it is strictly Party driven, although external experts are invited to participate to support the process.