WP7 Input to international programmes and society

- Contribution to scientific assessments of GHG
- Dissemination and coordination with global data synthesis efforts

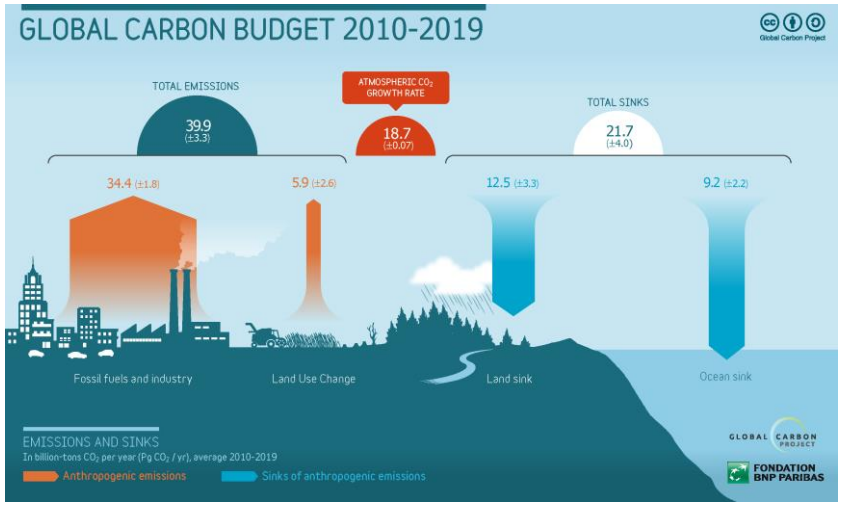
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 776810

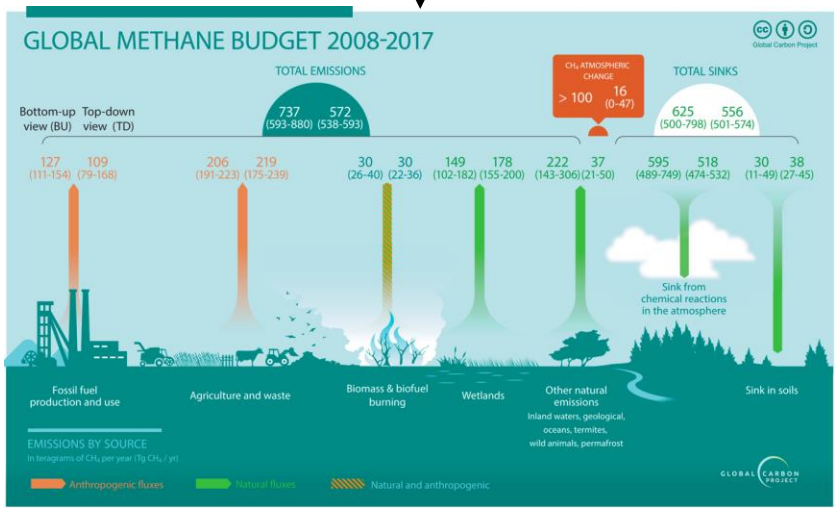
Main Achievements to Date

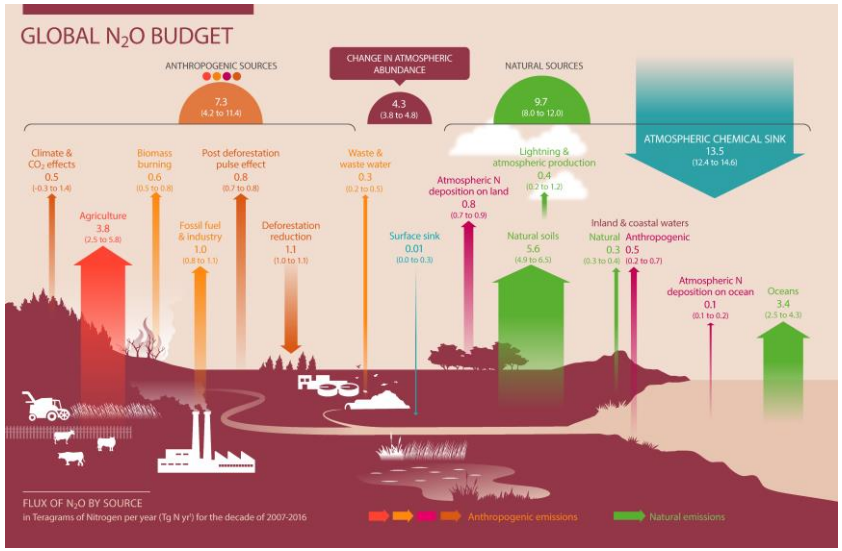
- Critical input to major science assessments of the Global Carbon Project.
  - Friedlingstein et al. (2019, 2020) *Earth System Science Data*: Global Carbon Budget.
  - Jones et al. (2021) *Nature Scientific Data*: Gridded global Fossil Emissions Dataset.
  - Tian et al. (2020) *Nature:* Global N_2O Budget.
  - Saunois et al. (2020) *Earth System Science Data*: Global Methane Budget.
- New analysis and insights
  - Le Quéré et al. (2020) *Nature Climate Change*: Impact of Covid-19 on emissions.
  - Le Quéré et al. (2021) *Nature Climate Change*: CO_2 stocktake since Paris Agreement.
  - Liu et al. (subm.) *Nature Geoscience*: Global Daily CO_2 emissions for the year 2020
- Extensive engagement and outreach
  - Side events and presentations at COP, participation in Earth Info Day, SBSTA, GCOS & GEO events.
  - Community and stakeholder consultation for future of Global Carbon Budget assessment.
  - Global Carbon Project 2020 reached 4 ***billion*** people.
  - Le Quéré et al. (2020) Top climate paper for impact in 2020 (CarbonBrief) and top 100 Altmetric.
  - 2 *ScienceBrief* Reviews on the impact of climate change on global wildfire risks (Jones et al. 2020, Smith et al. 2020). ~300 international articles online + print.

EU CONTRIBUTION TO THE GLOBAL BUDGETS FOR CO_2, CH_4, AND N_2O

- Review of anthropogenic GHG sinks and sources estimated across three Global Carbon Project (GCP) assessments.
- 2020 is the **first year with GCP assessments of the three major GHGs!**
  - Friedlingstein et al. (2020), ESSD
  - Tian et al. (2020), Nature
  - Saunois et al. (2020), ESSD

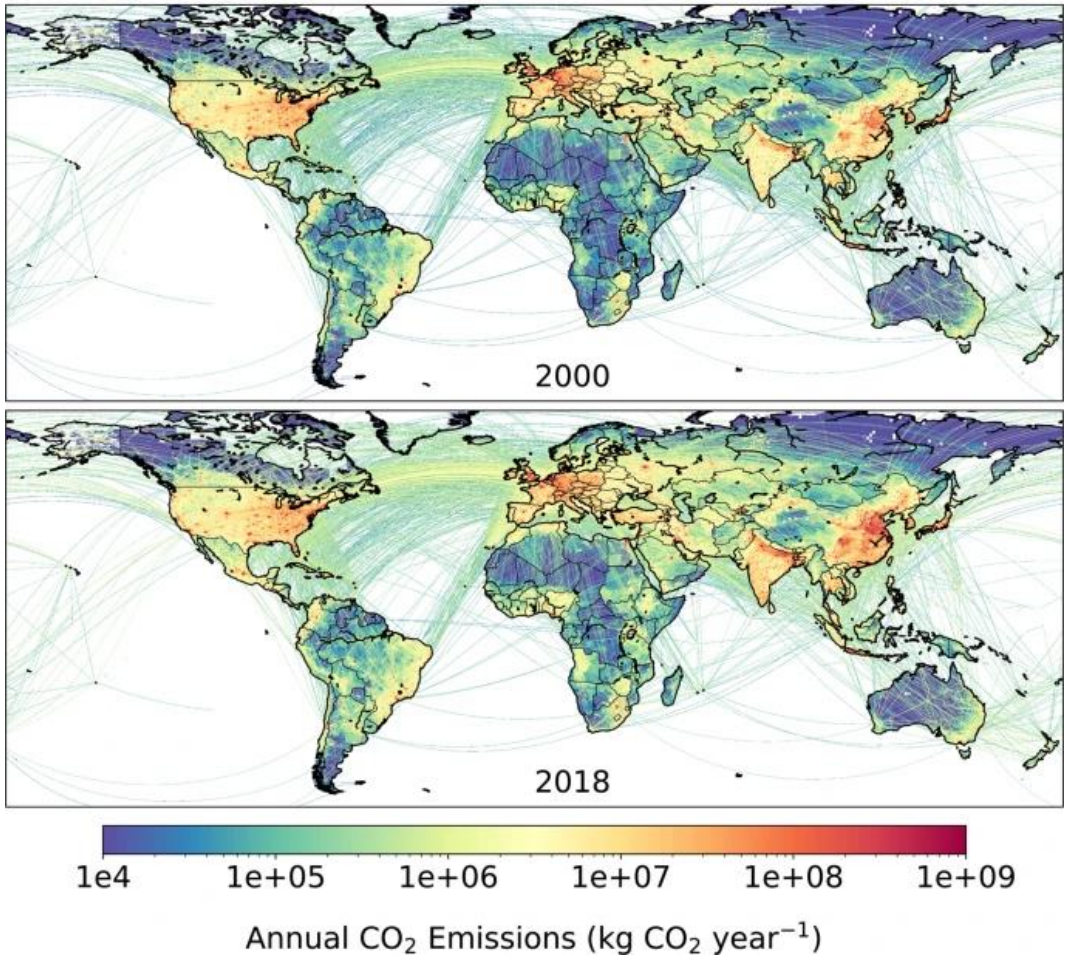






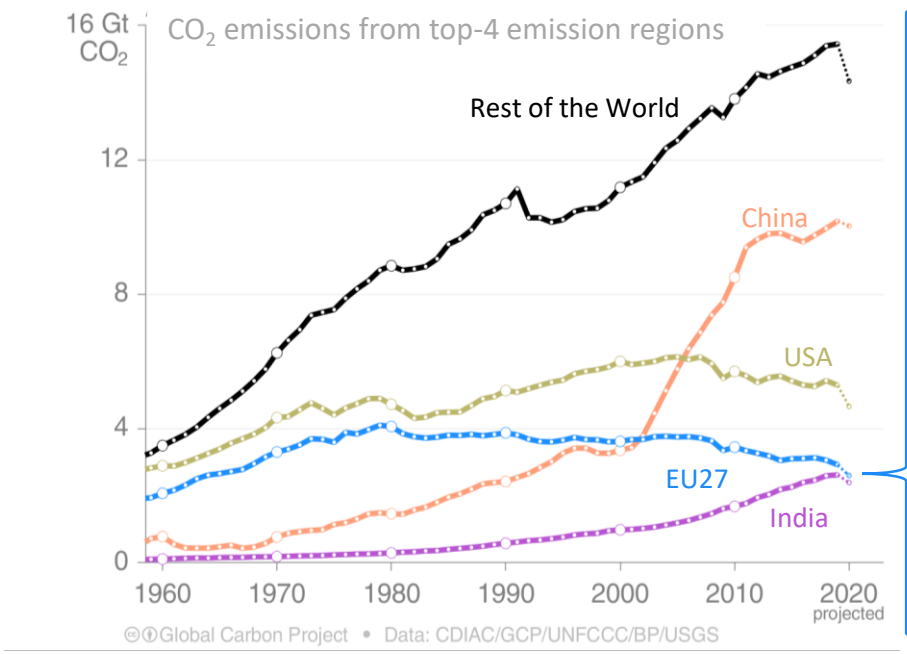
WP7 Gridded Fossil Emissions Dataset (GridFED)

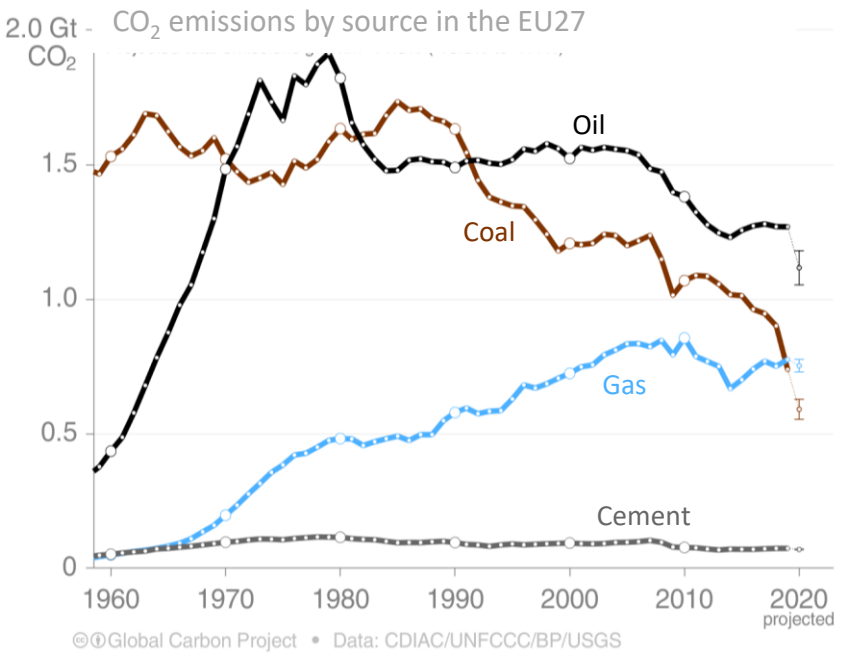
- New global dataset of gridded CO_2 emissions, 1959-2019.
- Underpins the top-down contribution to the global carbon budget.
- Brings inversion models into closer agreement on the land & ocean sinks.
- Monthly resolution supports advanced assessments of interannual variability.



Jones et al. *Nature Sci. Data* 2021

EU CONTRIBUTION TO GLOBAL CO_2 EMISSIONS





- The contribution of the EU27 to global fossil CO_2 emissions fell from 23% in the 1960s to 8% in the 2010s.
  - Partially due to falling emissions in the EU27 (~14% decline between 1990s and 2010s).
  - Predominantly due to rising emissions elsewhere.
- Prior to its departure from the EU, the UK accounted for 16% of total emissions in the EU (2010s).
- 15 of the EU27 member states significantly reduced their territorial fossil CO_2 emissions while maintaining a growing economy during the 2010s. (updated analysis after Le Quéré et al., 2019)

EU CONTRIBUTION TO GLOBAL CH_4 EMISSIONS

		Global (Tg CH_4 $year^{-1}$) *Saunois et al., 2020, ESSD*				Europe (% of Global) *Saunois et al., 2016, ESSD*	
		2000-2009		2008-2017		2003-2012	
		BU	TD	BU	TD	BU	TD
Anthropogenic Sources	Agriculture and Waste	192	202	206	217	9%	9%
	Fossil Fuels	110	101	128	111	5%	7%
	Biomass and Biofuels	31	29	30	30	4%	2%
	Total	334	331	366	357	7%	7%

- Good agreement on global anthropogenic CH_4 emissions between bottom-up (BU) and top-down (TD) approaches.
- ~8-10% growth in global CH_4 emissions between 2000s and 2008-2017.
- Europe (≠ EU) contributes ~7% of global anthropogenic CH_4 emissions.
- Agriculture and waste responsible for ~60% of global emissions, higher in Europe (~70%).
- Regional CH_4 budget for the EU27 is in preparation by VERIFY-affiliated researchers (Stavert et al., *in prep*), to complement the Global Methane Budget 2000-2017.

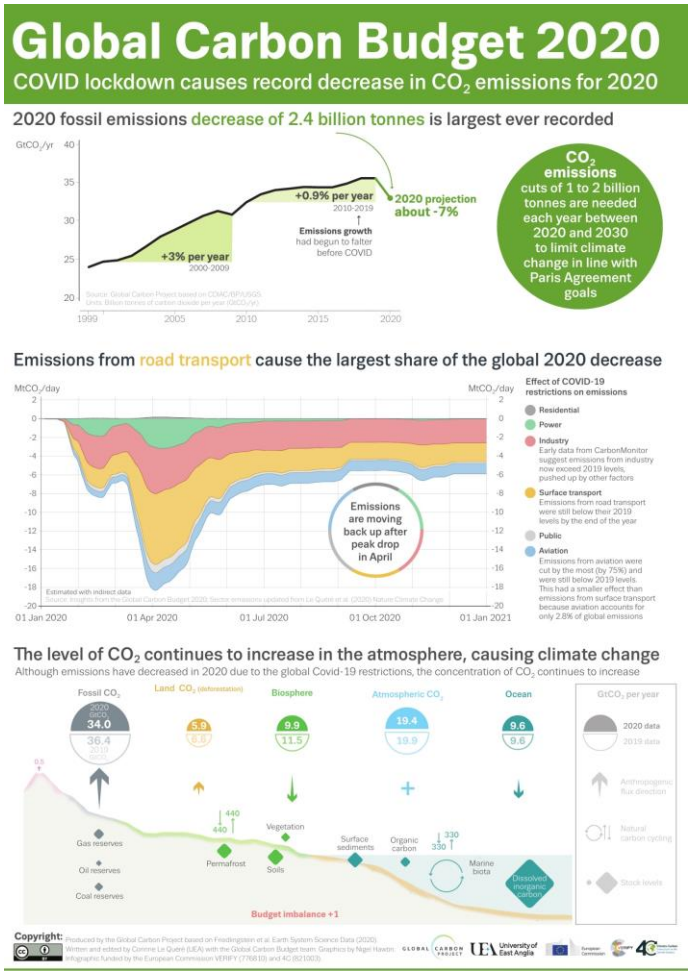
EU CONTRIBUTION TO GLOBAL N_2O EMISSIONS

		Global (Tg N2O year^{-1})				Europe (% of Global)
		1980s	**1990s**	**2000s**	**2007-2016**	**2007-2016**
Anthropogenic Sources	Agriculture	2.6	3	3.4	3.8	14%
	Other direct emissions	1.8	1.9	1.8	1.9	11%
	Indirect effects of anthropogenic change (N deposition, climate and vegetation).	1.2	1.3	1.5		
	Total	5.6	6.2	6.7	7.3	13%

- Blend of bottom-up (BU) and top-down (TD) approaches provides the most comprehensive global budget for N_2O to date - published in *Nature*.
- ~30% growth in global N_2O emissions between 1980s and 2007-2016.
- Europe (≠ EU) contributes ~13% of global direct anthropogenic N_2O emissions.
- Agriculture and other direct emissions (fossil fuels, biomass burning, waste management)

WP7 Outreach: Global Carbon Budget 2019 & 2020

- 2 Papers, 2 commentaries, 2 media articles:
  - Friedlingstein et al., ESSD (2019, 2020)
  - Peters et al. Nature Climate Change link
  - Jackson et al. Environmental Research Letters link
  - Canadell et al., The Conversation 2019, 2020
- 15 press releases (UK, Norway, Australia, Germany, Japan, France, USA, Future Earth [international]).
- 5 press briefings (London, Canberra, Paris, Madrid, Tsukuba); 5 streamed press conferences (International).
- COP25: press briefing + 2 side events
- Infographics in 4 languages
- Twitter: “1.5°C Bucket” + numerous threads



NEW ANALYSIS AND INSIGHTS – COVID-19

nature climate change ARTICLES

Temporary reduction in daily global CO_2 emissions during the COVID-19 forced confinement

Corinne Le Quéré, Robert B. Jackson, Matthew W. Jones, Adam J. P. Smith, Sam Abernethy, Robbie M. Andrew, Anthony J. De-Gol, David R. Willis, Yuli Shan, Josep G. Canadell, Pierre Friedlingstein, Felix Creutzig and Glen P. Peters

Based on the product of:
Δemissions/**Δ**confinement
emissions by sector
level of confinement each day
(only decreased in emissions by design, no recovery effect)

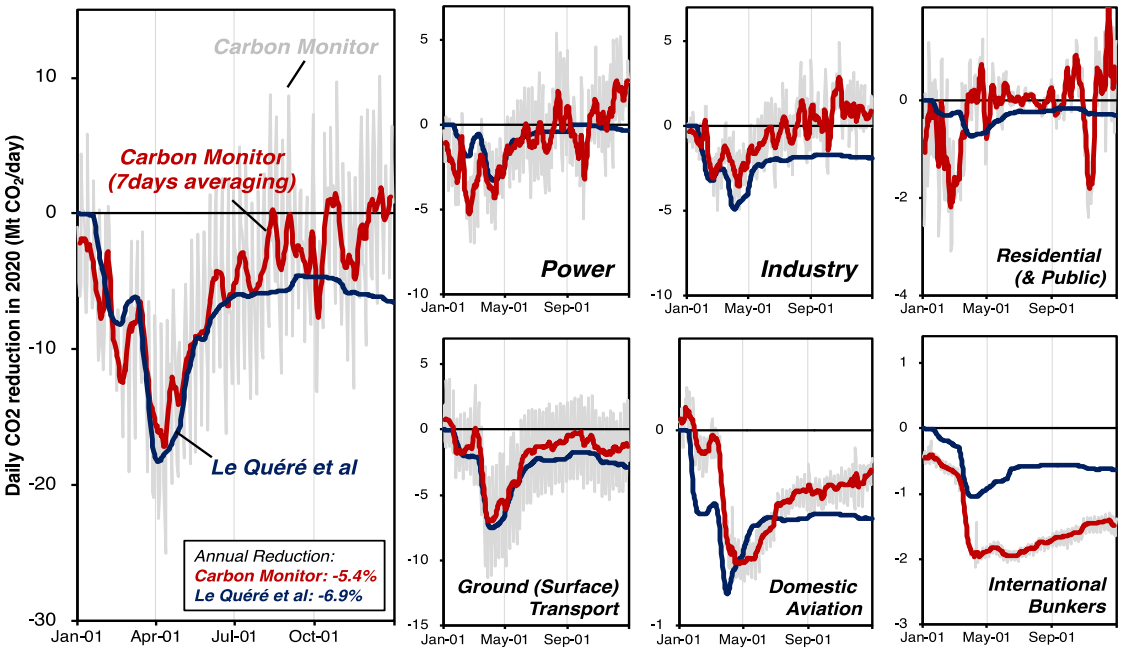
nature COMMUNICATIONS

ARTICLE OPEN

Near-real-time monitoring of global CO_2 emissions reveals the effects of the COVID-19 pandemic

Zhu Liu et al.*

Based on activity data by sector converted to country emissions



Liu et al. subm.

- The two methods generally track each-other in first half of 2020
- Similar weight to ground transport, and to some extent power and industry
- Divergence from mid-2020, probably due to economic stimulus
- New Liu et al. analysis (subm.) estimates -5.4% emissions decrease in 2020 (compared with -5.8% from IEA, -7% from GCB 2020)

New analysis and insights – First stocktake of CO_2 Emissions since the Paris Agreement

nature climate change

BRIEF COMMUNICATION

https://doi.org/10.1038/s41558-021-01001-0

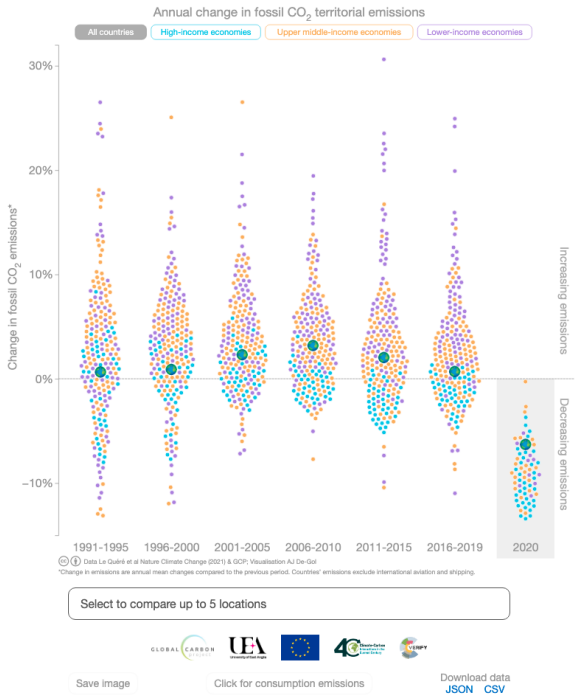
Check for updates

Fossil CO_2 emissions in the post-COVID-19 era

Corinne Le Quéré[1,2]✉, Glen P. Peters[3], Pierre Friedlingstein[4,5], Robbie M. Andrew[3], Josep G. Canadell[6], Steven J. Davis[7], Robert B. Jackson[8,9,10] and Matthew W. Jones[1,2]

- The ~2.6 $GtCO_2$ decrease in 2020 is comparable to the 1-2 $GtCO_2$ decrease needed each year to keep climate change aligned with the Paris Agreement goals
- Emissions during 2016-2019 compared to 2011-2015
  - decrease in 64 countries, for total cuts of 0.16 $GtCO_2$ per year
  - increased in 150 countries, for total rise of 0.37 $GtCO_2$ per year
- Contradictory effect of post-COVID-19 investments in fossil fuel-based infrastructure and strengthened climate goals need to be addressed with new policy choices

Interactive data product

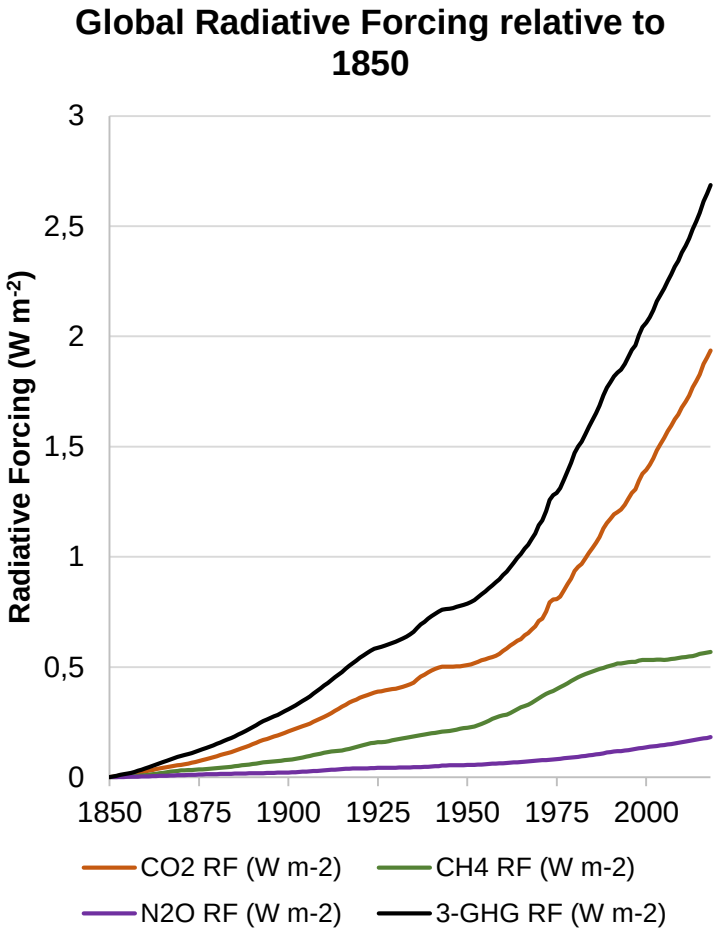


https://enactivescience.com/gcp/

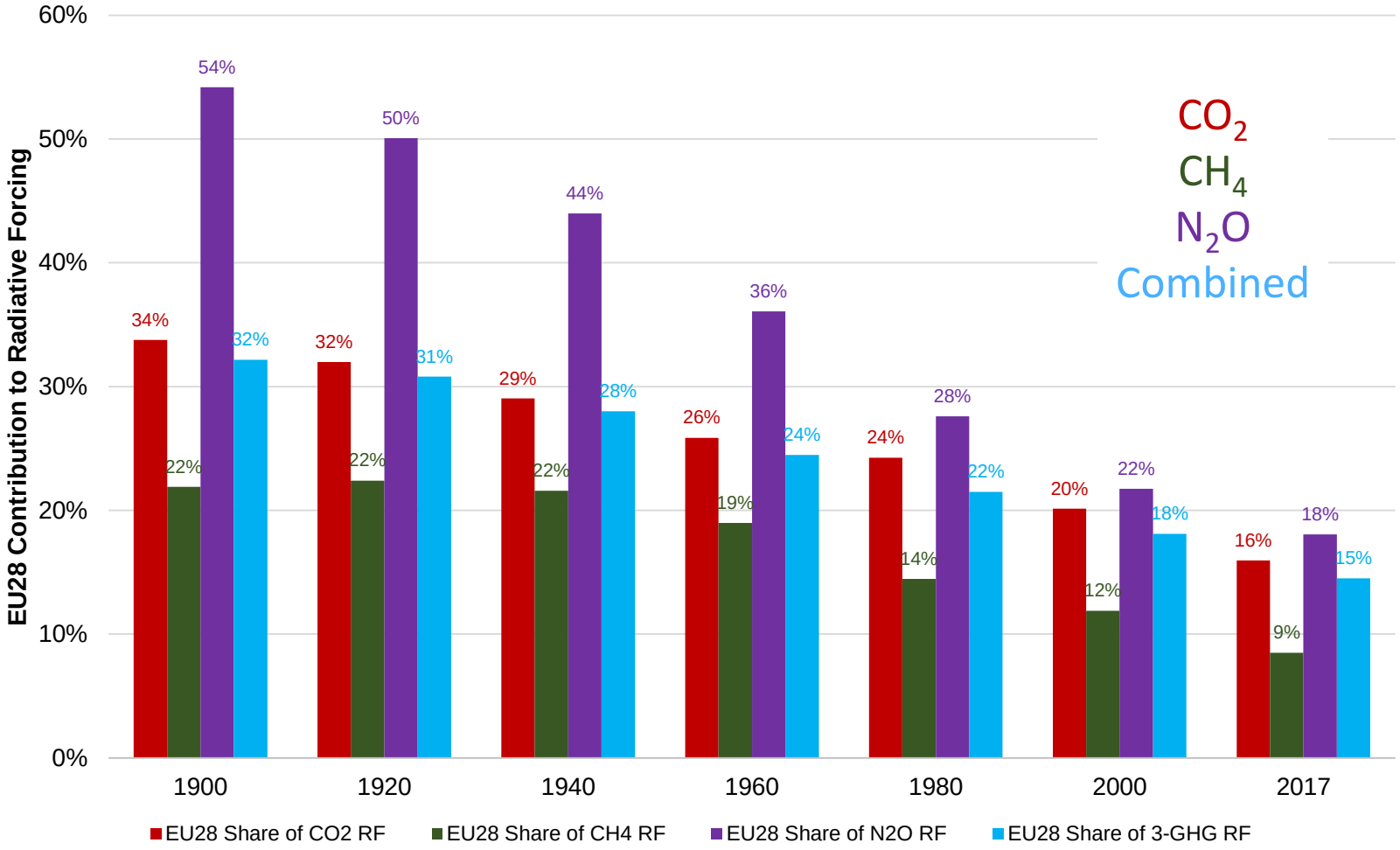
EU CONTRIBUTION TO GLOBAL RADIATIVE FORCING

- Global radiative forcing (RF) relative to 1850 is calculated based on direct atmospheric measurements + observational records (CO_2, CH_4, NO_2).

- EU contribution to global RF is based on the EU fraction of historical emissions since 1850 that remain in the atmosphere in 'target years'.
  - Emission estimates from the GCP budgets & other sources (fossil + land use emissions).
  - Model for the atmospheric lifetime of each gas. For CO_2, the model was optimised to fit observations.

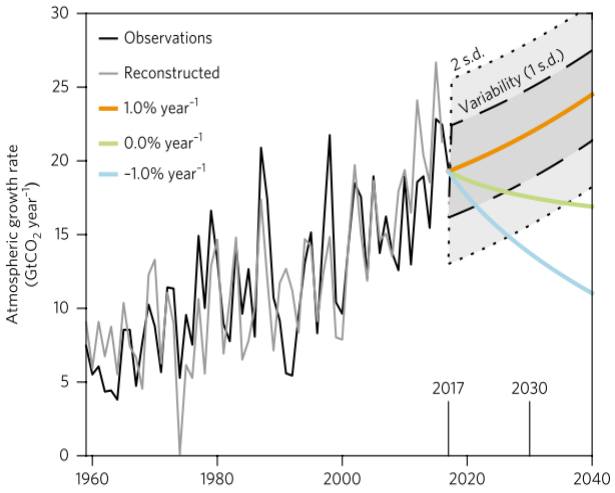


EU27+UK Contribution to Global Radiative Forcing



First report on the research needs for verification

- So far: analysis of biases and sources of uncertainties in the global carbon budget analysis.
- Community and stakeholder consultation to assess evolving needs and opportunities (116 responses, 77 academia / 39 users).

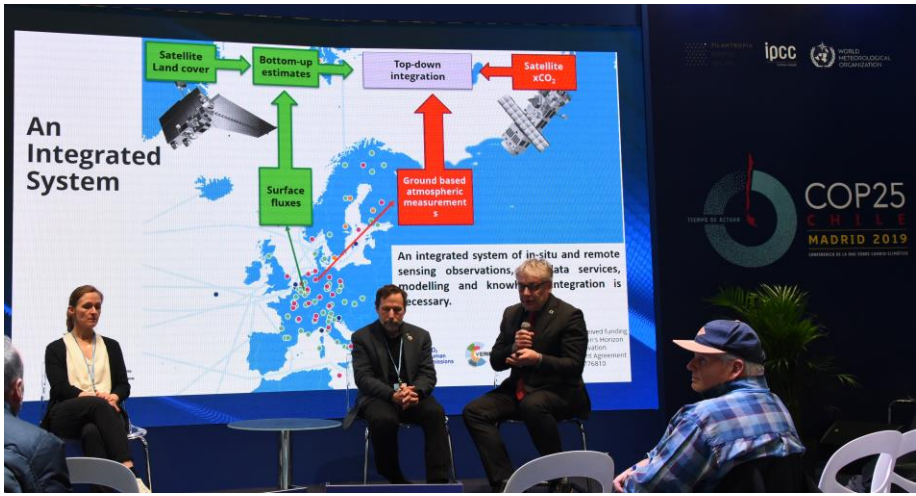


Resolving these issues will improve verification capacity

Flux	Biases	Uncertainties
E_{FOS}	• Boundary conditions e.g. bunkers. • Cement carbonation. • Carbon content of coal.	• Varying energy datasets • Frequent revisions to Chinese energy data. • Emission factors.
E_{LUC}	• Lost additional sink capacity (LASC). • Missing processes.	• Land Cover change • Vegetation carbon density.
S_{LAND}	• CO_2 fertilisation. • Reduction in tropical land sink by climate change.	• CO_2 fertilisation (across models). • Reduction in the tropical land sink by climate change (across models). • Vegetation growth rates. • Water use efficiency.
S_{OCEAN}	• River fluxes.	• High latitude variability.

PROGRESS REPORT ON THE VERIFY COOPERATION WITH GLOBAL INITIATIVES INCLUDING UNFCCC/SBSTA, GCOS AND WMO/IG3IS

- Side events and presentations at COP 25
- Participation in COP Earth Info Day
- Participation in (informal) SBSTA Science Dialogue during COVID-19
- Participation in two events by GCOS/TOPC on terrestrial indicator for climate change
- Participation in newly built GEO working group on Climate Change
- Publications and videos during shutdown



POTENTIAL NEW ACTIVITY TOWARDS GCOS

- GCOS has started to update the implementation plan for global climate observations (including GHGs) recently.
- VERIFY experiences are very valuable for this process.
- The GCOS implementation plan should not simply list observations but the entire ‚value chain' including the modelling related to an ECV.
- 2nd Climate Observation Conference, 30. August – 3. September 2021

HUMAN DIMENSION	Anthropogenic water use	Water used by humans for drinking water, reservoir storage and agricultural or industrial purposes	None Areas of irrigated land can be estimated from land-use information; other information from census data No network, but a single georeferenced database (AQUASTAT) for irrigation exists based on national data reported to FAO. Several datasets are available to be merged into one single dataset indicating water use and availability		AQUASTAT UN Water http://www.unwater.org/statistics/en/
	Anthropogenic greenhouse gas fluxes	Emissions from fossil-fuel use, industry, agriculture and waste sectors	Estimated from fuel and activity statistics CDIAC, BP, IEA for global estimates, national reporting to UNFCCC	IPCC (2006) IPCC (2013) GFOI (2014)	National reporting to UNFCCC CDIAC Global Carbon Project
		Emissions/removals by land-use sectors	Estimated by IPCC methods using statistics and satellite observations of changes in land cover (see ECV land cover and above ground biomass) National reporting to UNFCCC		
		Emissions/removals by "land sink"	Improved knowledge on afforestation, reforestation and forest growth rates Direct measurements of fluxes such as FluxNet		Global Carbon Project
		Estimated fluxes by inversions of observed atmospheric composition	Observations of atmospheric composition, in situ and satellite; modelling of atmospheric transport and processes in a data-assimilation scheme GAW, IG3IS, GEOCarbon, ICOS, CEOS Carbon Observations Strategy, Copernicus C3S/CAMS, Global Carbon Project		Global Carbon Project

Thank you for your attention.

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