VERIFY General Assembly

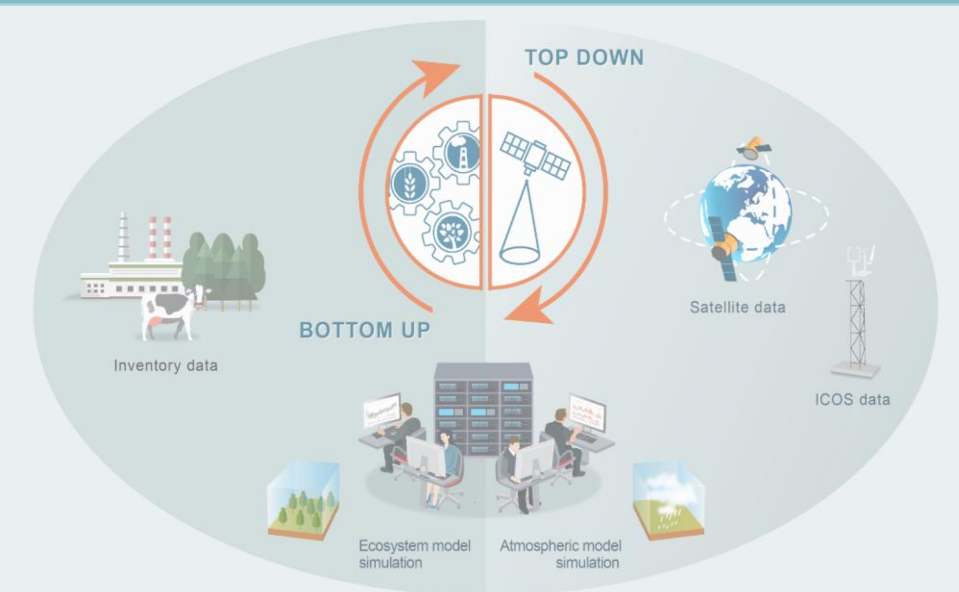
Summary and key messages from synthesis and deliverables

WP5 and WP6

28 April, 2021

By Teleconference (GoToMeeting)

Team: VUA, CICERO, LSCE, EC-JRC
Acknowledging all VERIFY consortium and outside contributors



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

Contents

WP5 – Summary of deliverables and progress

- Fossil CO_2 and EU temporal (monthly) time series with links to Carbon Monitor (Robbie Andrew)
- Results from the 2 x ESSD syntheses and countries factsheets (Roxana Petrescu)
- Extreme events and climate anomalies (Philippe Ciais)

WP6

- Results from the EU and USA factsheets (Greet Janssens-Maenhout)
- Results from China factsheets (Philippe Ciais)

Open discussion on how to improve the synthesis work in WP5 and WP6 (all)

WP5 Summary of Deliverables
Month 38

Month	Deliverable	Progress	Details
9	5.2	Report	First report on reconciliation of bottom-up and top-down methods
12	5.1	ESSD	Structural uncertainties in fossil CO_2 emissions

Month	Deliverable	Progress	Details
24	5.9	ESSD	First article on multi-gas GHG budgets
22	5.3	2xESSD	Second report on reconciliation of bottom-up and top-down methods
23	5.6	Factsheets	First fact sheets with national observation-based GHG budgets
34	5.4	Report (May)	Third report on reconciliation of bottom-up and top-down methods
35	5.7	Factsheets	Second fact sheets with national observation-based GHG budgets
34	5.11	Report/Journal	Projection of EU emissions
34	5.13	Journal	Impacts of extreme events on GHG budgets
36	5.12	Report	Climate anomalies and variability on GHG budgets

Month	Deliverable	Progress	Details
46	5.5	Report	Final report on reconciliation of bottom-up and top-down methods
47	5.8	Factsheets	Final fact sheets with national observation-based GHG budgets
48	5.10	ESSD	Final article on multi-gas GHG budgets

WP5 AS A COLLABORATION

Earth Syst. Sci. Data, 12, 961–1001, 2020
https://doi.org/10.5194/essd-12-961-2020

Open Access Earth System Science Data

European anthropogenic AFOLU greenhouse gas emissions: a review and benchmark data

Ana Maria Roxana Petrescu[1], Glen P. Peters[2], Greet Janssens-Maenhout[3], Philippe Ciais[4], Francesco N. Tubiello[5], Giacomo Grassi[3], Gert-Jan Nabuurs[6], Adrian Leip[3], Gema Carmona-Garcia[3], Wilfried Winiwarter[7,8], Lena Höglund-Isaksson[7], Dirk Günther[9], Efisio Solazzo[3], Anja Kiesow[9], Ana Bastos[10], Julia Pongratz[10,11], Julia E. M. S. Nabel[11], Giulia Conchedda[5], Roberto Pilli[3], Robbie M. Andrew[2], Mart-Jan Schelhaas[6], and Albertus J. Dolman[1]

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https://doi.org/10.5194/essd-2020-367
print. Discussion started: 17 December 2020

Open Access Earth System Science Data Discussions

The consolidated European synthesis of CH_4 and N_2O emissions for EU27 and UK: 1990-2018

Ana Maria Roxana Petrescu[1], Chunjing Qiu[2], Philippe Ciais[2], Rona L. Thompson[3], Philippe Peylin[2], Matthew J. McGrath[2], Efisio Solazzo[4], Greet Janssens-Maenhout[4], Francesco N. Tubiello[5], Peter Bergamaschi[4], Dominik Brunner[6], Glen P. Peters[7], Lena Höglund-Isaksson[8], Pierre Regnier[9], Ronny Lauerwald[9,23], David Bastviken[10], Aki Tsuruta[11], Wilfried Winiwarter[8,12], Prabir K. Patra[13], Matthias Kuhnert[14], Gabriel D. Orregioni[4], Monica Crippa[4], Marielle Saunois[2], Lucia Perugini[15], Tiina Markkanen[11], Tuula Aalto[11], Christine D. Groot Zwaaftink[3], Yuanzhi Yao[16], Chris Wilson[17,18], Giulia Conchedda[5], Dirk Günther[19], Adrian Leip[4], Pete Smith[14], Jean-Matthieu Haussaire[6], Antti Leppänen[20], Alistair J. Manning[21], Joe McNorton[22], Patrick Brockmann[2] and Han Dolman[1]

https://doi.org/10.5194/essd-2020-376
Preprint. Discussion started: 18 December 2020

Open Access Earth System Science Data Discussions

Earth Syst. Sci. Data, 12, 1–29, 2020
https://doi.org/10.5194/essd-12-1-2020

Open Access Earth System Science Data

The consolidated European synthesis of CO_2 emissions and removals for EU27 and UK: 1990-2018

Ana Maria Roxana Petrescu[1], Matthew J. McGrath[2], Robbie M. Andrew[3], Philippe Peylin[2], Glen P. Peters[3], Philippe Ciais[2], Gregoire Broquet[2], Francesco N. Tubiello[4], Christoph Gerbig[5], Julia Pongratz[6,7], Greet Janssens-Maenhout[8], Giacomo Grassi[8], Gert-Jan Nabuurs[9], Pierre Regnier[10], Ronny Lauerwald[10,11], Matthias Kuhnert[12], Juraj Balkovič[13,14], Mart-Jan Schelhaas[9], Hugo A. C. Denier van der Gon[15], Efisio Solazzo[8], Chunjing Qiu[2], Roberto Pilli[8], Igor B. Konovalov[16], Richard Houghton[17], Dirk Günther[18], Lucia Perugini[19], Monica Crippa[9], Raphael Ganzenmüller[6], Ingrid T. Luijkx[9], Pete Smith[12], Saqr Munassar[5], Rona L. Thompson[20], Giulia Conchedda[4], Guillaume Monteil[21], Marko Scholze[21], Ute Karstens[22], Patrick Brokmann[2] and Han Dolman[1]

A comparison of estimates of global carbon dioxide emissions from fossil carbon sources

Robbie M. Andrew
CICERO Center for International Climate Research, Oslo 0349, Norway

Fossil CO_2 and EU temporal (monthly) time series with links to Carbon Monitor

by Robbie Andrew

Achievements : CICERO

Eurostat

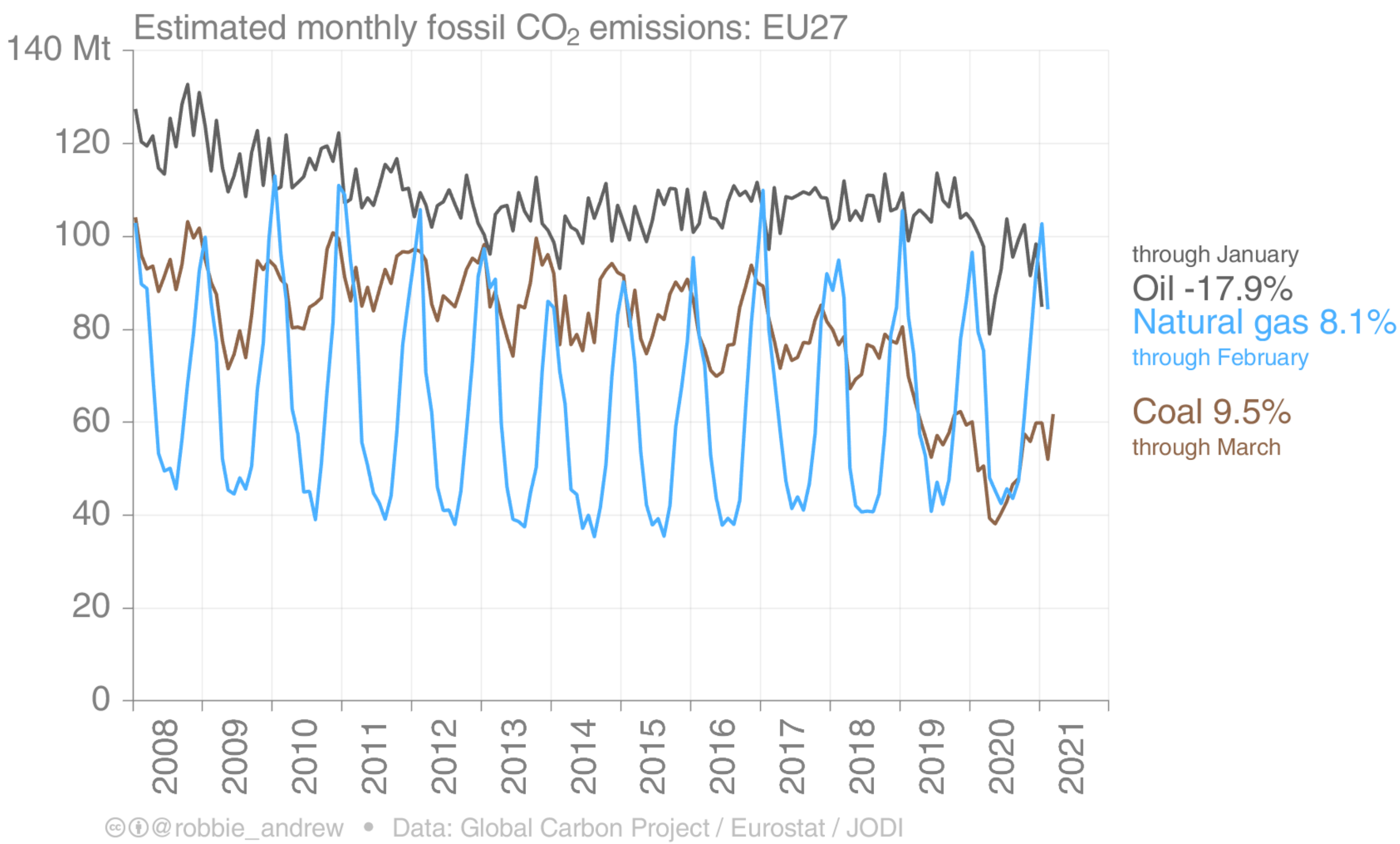
- Monthly energy data for European countries (EU+)
- Lag varies by country, flow, product
  - Most are reported within a couple of months (M+2)
  - But some have considerable lags
- Easily downloadable
- Updated continuously
- Various data quality issues
  - Monthly reporting is required but accuracy is not a high priority for many countries
- Automatic filling of data gaps
  - Given constraints: basically only fill in gaps if sufficient data are available from other countries
- Worst lag tends to be sales to international aviation

JODI: Joint Organisations Data Initiative

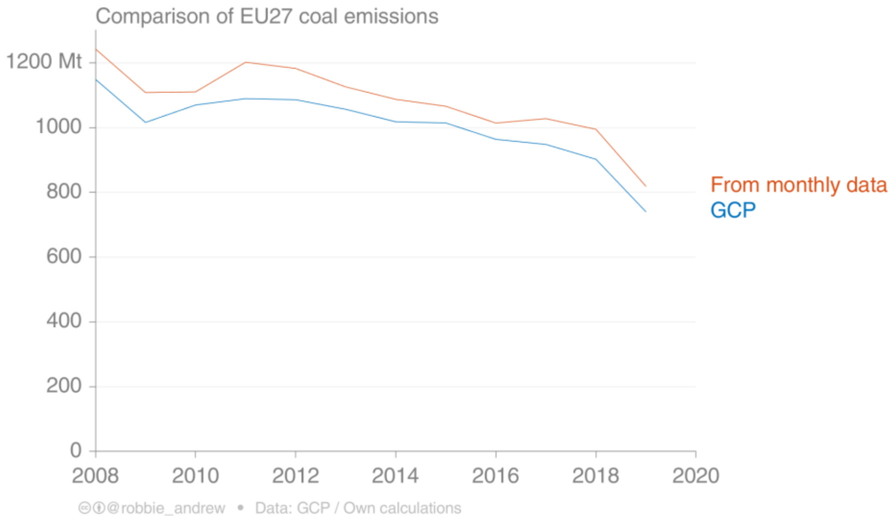
- Monthly energy data for most countries of the world
- Oil and natural gas (not coal)
- Lag of about 7 weeks
  - Often one more month than Eurostat
- Less detail than Eurostat
  - No information on sales to international aviation bunkers
  - No information on biofuel component
- Updated monthly
  - With exceptional revisions outside of this schedule

Calculating emissions

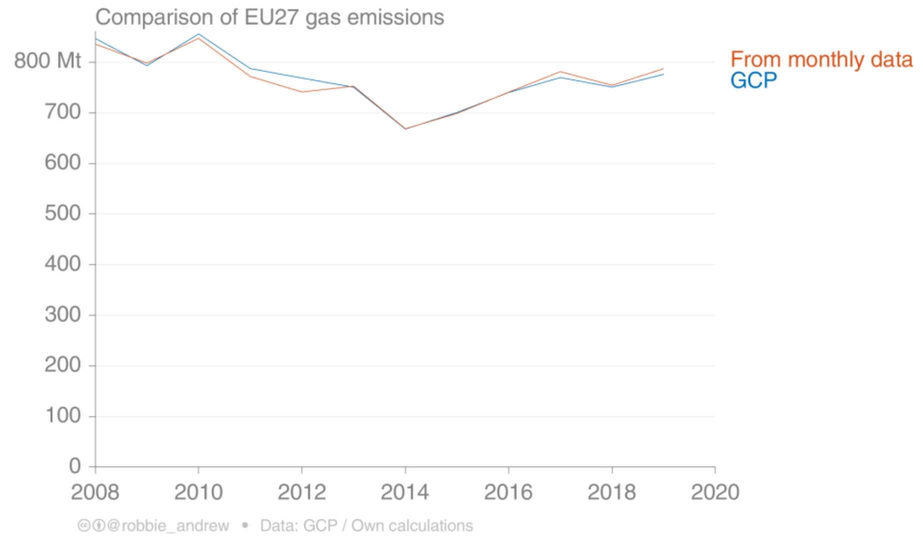
- Energy statistics, energy contents and emission factors
  - Currently IPCC defaults
  - Could switch to reported factors
- Scale to GCP estimates
  - For EU countries, these are taken directly from official reporting (CRF)
  - For some countries estimates are poor (e.g., NLD), but for EU this scale factor is often very close to unity
- Scale factor for last year with official data used for current year



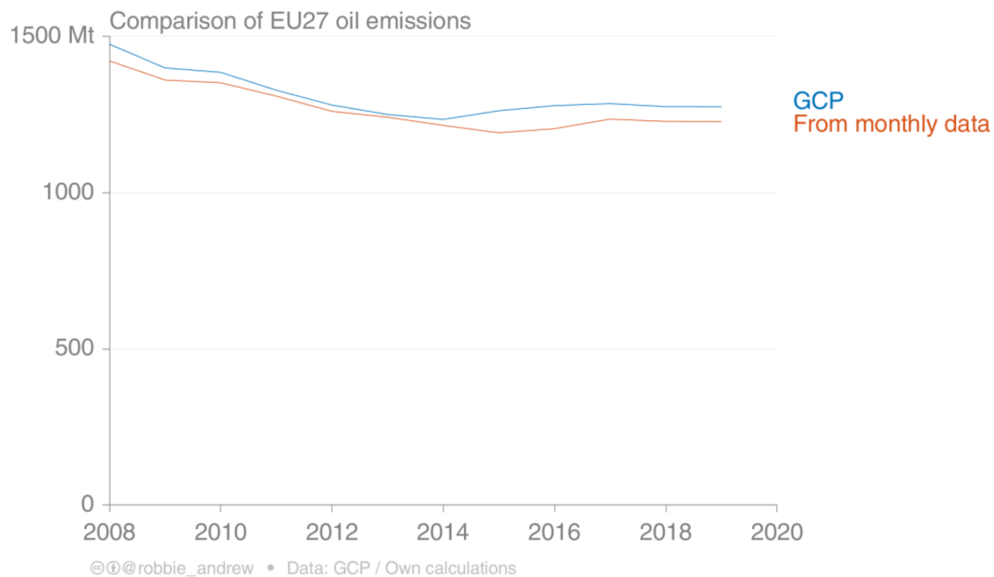
Estimated monthly fossil CO_2 emissions: EU27
140 Mt
120
100
80
60
40
20
0
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
through January
Oil -17.9%
Natural gas 8.1%
through February
Coal 9.5%
through March
@robbie_andrew • Data: Global Carbon Project / Eurostat / JODI



Comparison of EU27 coal emissions
1200 Mt
1000
800
600
400
200
0
2008
2010
2012
2014
2016
2018
2020
From monthly data
GCP
@robbie_andrew • Data: GCP / Own calculations



Comparison of EU27 gas emissions
800 Mt
700
600
500
400
300
200
100
0
2008
2010
2012
2014
2016
2018
2020
From monthly data
GCP
@robbie_andrew • Data: GCP / Own calculations



Comparison of EU27 oil emissions
1500 Mt
1000
500
0
2008
2010
2012
2014
2016
2018
2020
GCP
From monthly data
@robbie_andrew • Data: GCP / Own calculations

Contrasts:
Eurostat approach vs. Carbon Monitor

- Use of reported energy data more likely to aggregate to official annual statistics
    - But often monthly data are not revised
- Time of combustion
    - Eurostat and other similar data indicate supply to the market
    - The last mile of stock change is therefore not captured
    - CM uses activity data that coincide in time with combustion
- Two complementary approaches

RESULTS FROM THE 2 X ESSD SYNTHESES AND COUNTRIES FACTSHEETS

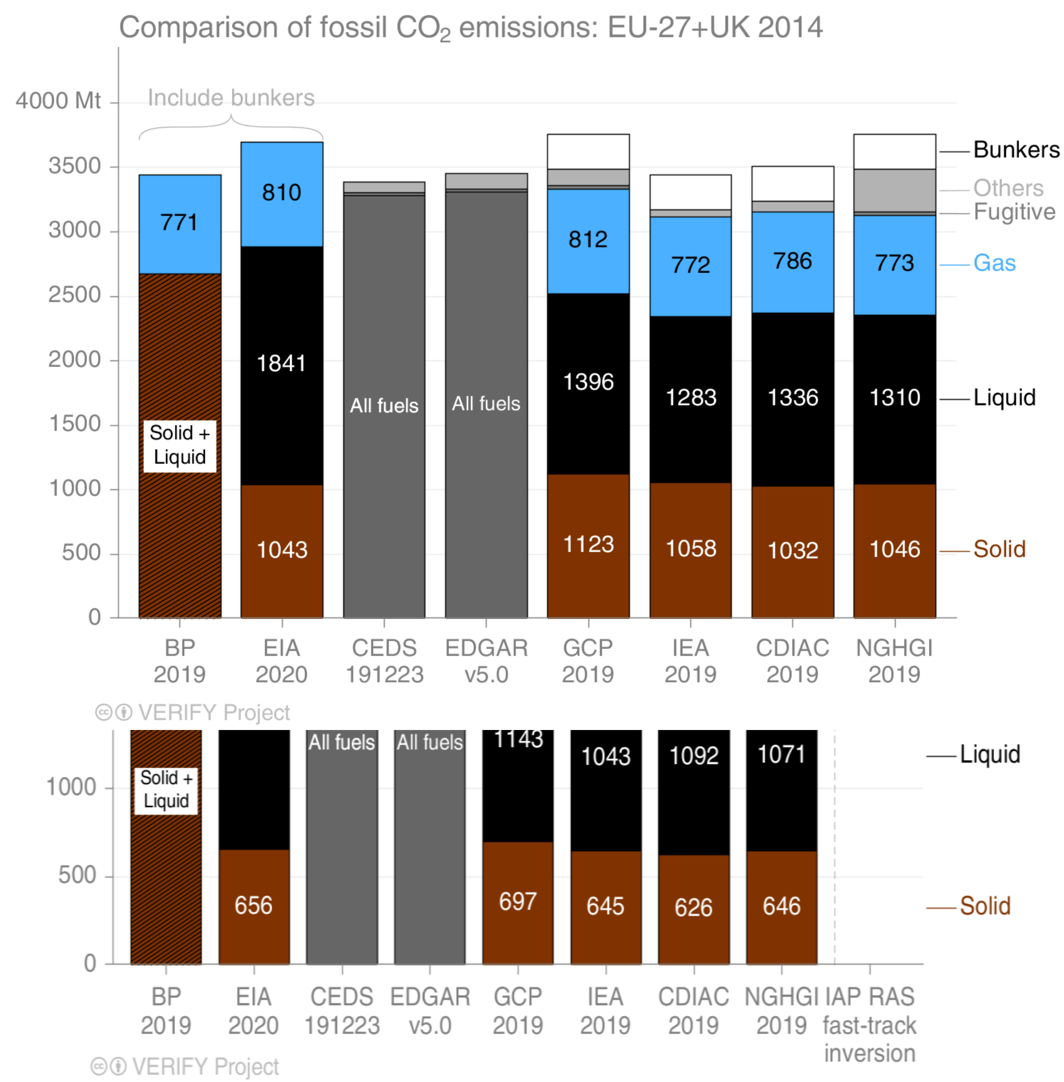
BY ROXANA PETRESCU/GLEN PETERS

THANKING TO ALL VERIFY CONSORTIUM AND OUTSIDE CONTRIBUTORS

RESULTS – CO_2 SYNTHESIS

CO_2 fossil

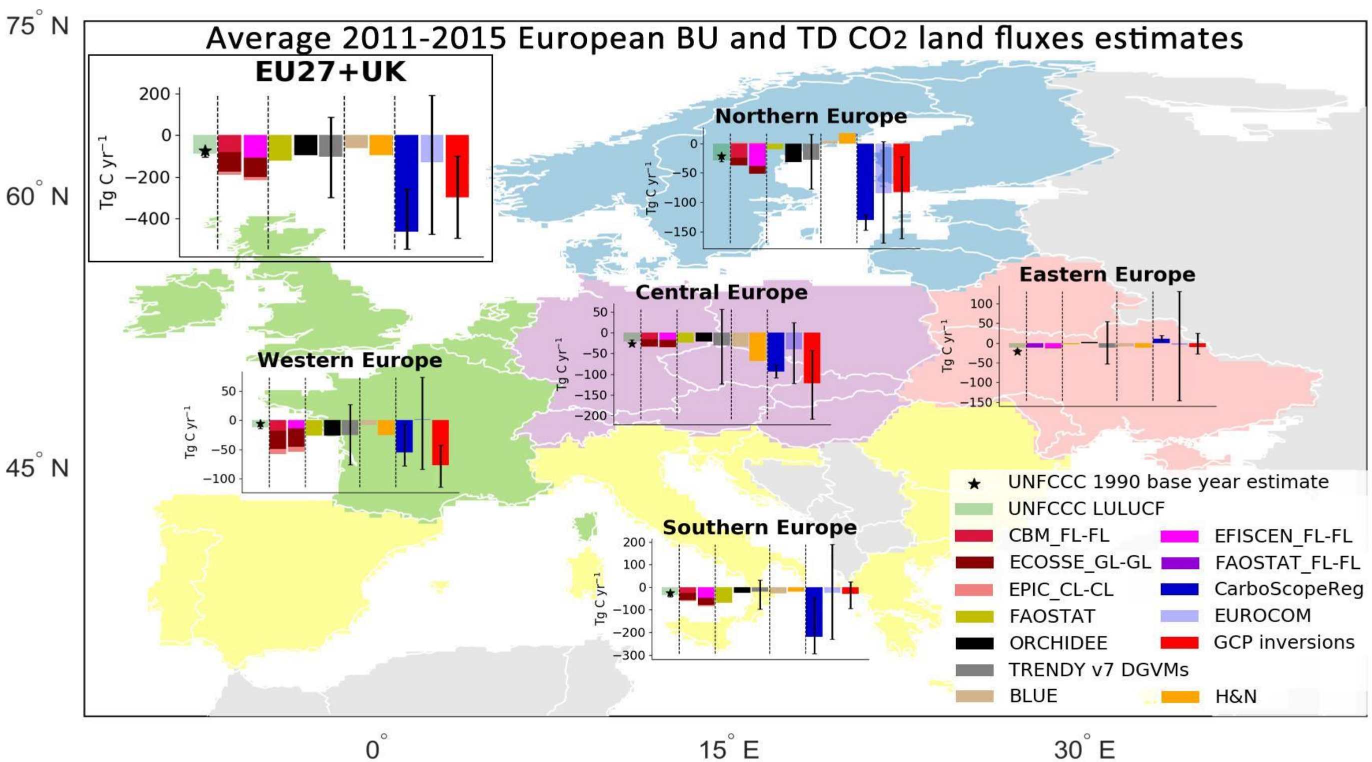
- We have compared a single year across all datasets, allowing comparison of sub-totals, here by fuel type.
- Uncertainties in fossil CO_2 emissions estimates are 1-4% for the EU27+UK
- Differences are mainly due to system boundary issues
- The single fast track inversions gives credible estimates for the EU11+CHE (right), but with large uncertainty (~17%)



RESULTS (CONTINUED)

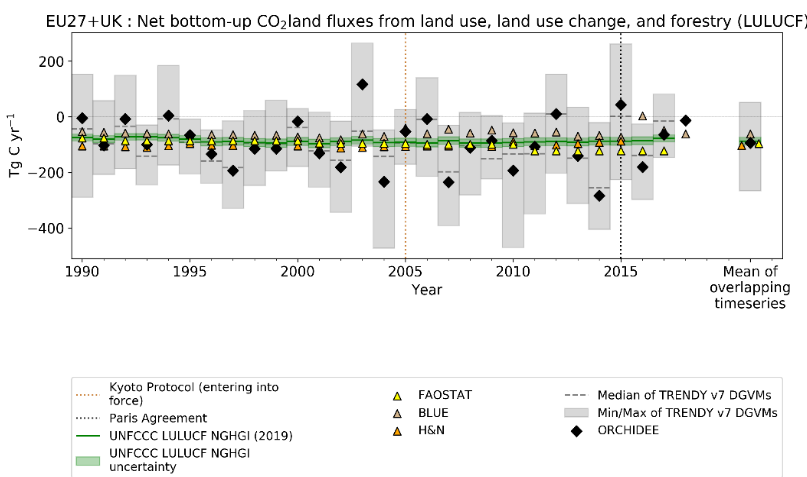
CO_2 land

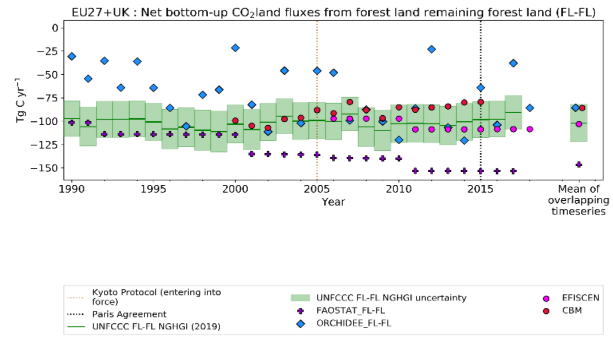
- Overall, for our five selected European regions, the CO_2 land 5-year flux averages show high variability between BU and TD estimates
- Differences we see between regions' TD and BU results are linked to model-specific set-ups and definition issues

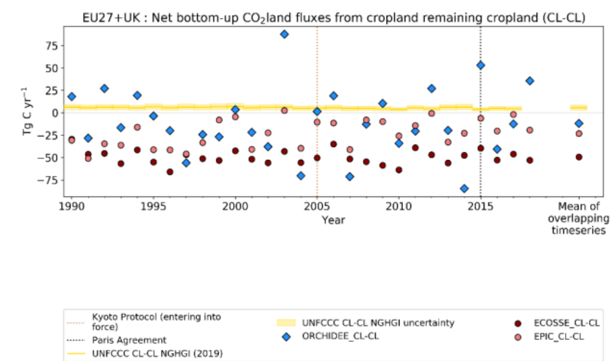


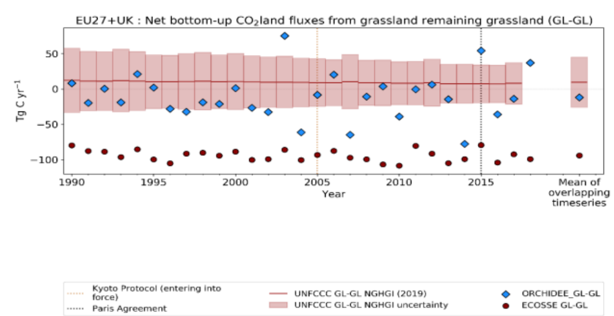
RESULTS (CONTINUED)

- The EU27+UK land emissions (NGHGI) have remained relatively flat since 1990, given uncertainties.
- Sector specific models produce estimates for Forest, Croplands and Grasslands
- These BU methods agree in general on average well with the NGHGI estimates.
- Differences occur when vegetation models (e.g. ORCHIDEE, DGVMs) that are driven by daily/hourly weather produce much more inter-annual variability than traditional stock change methods.



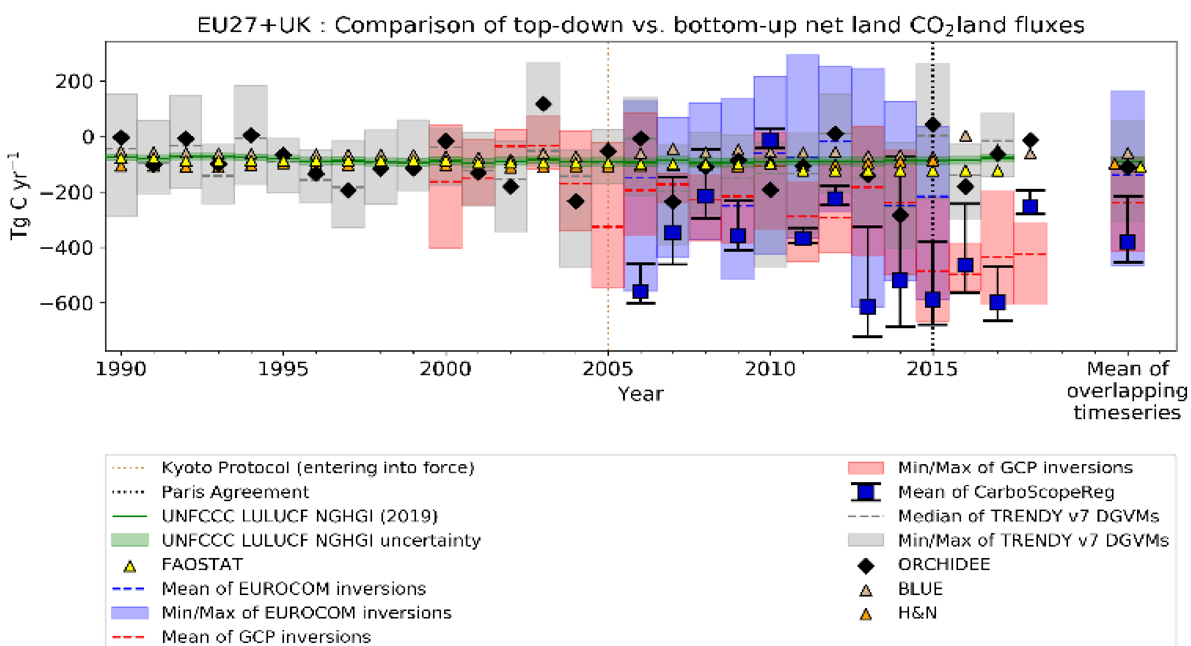




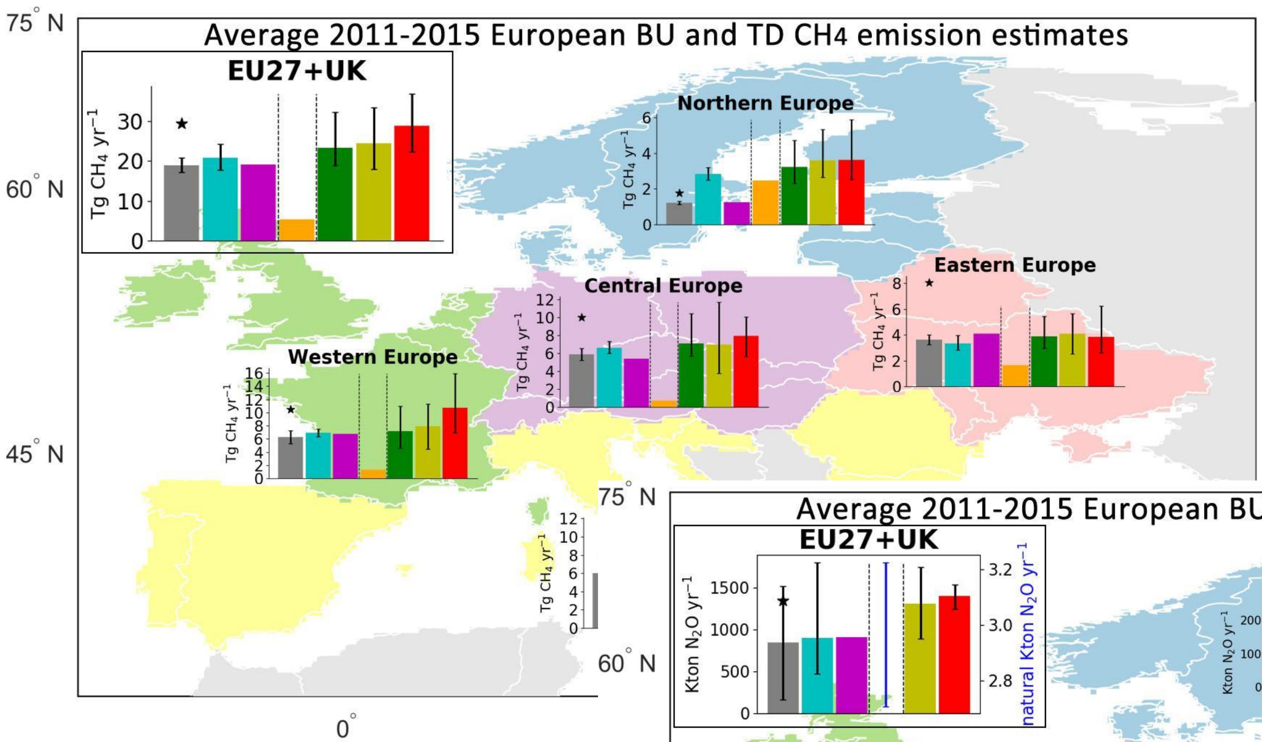


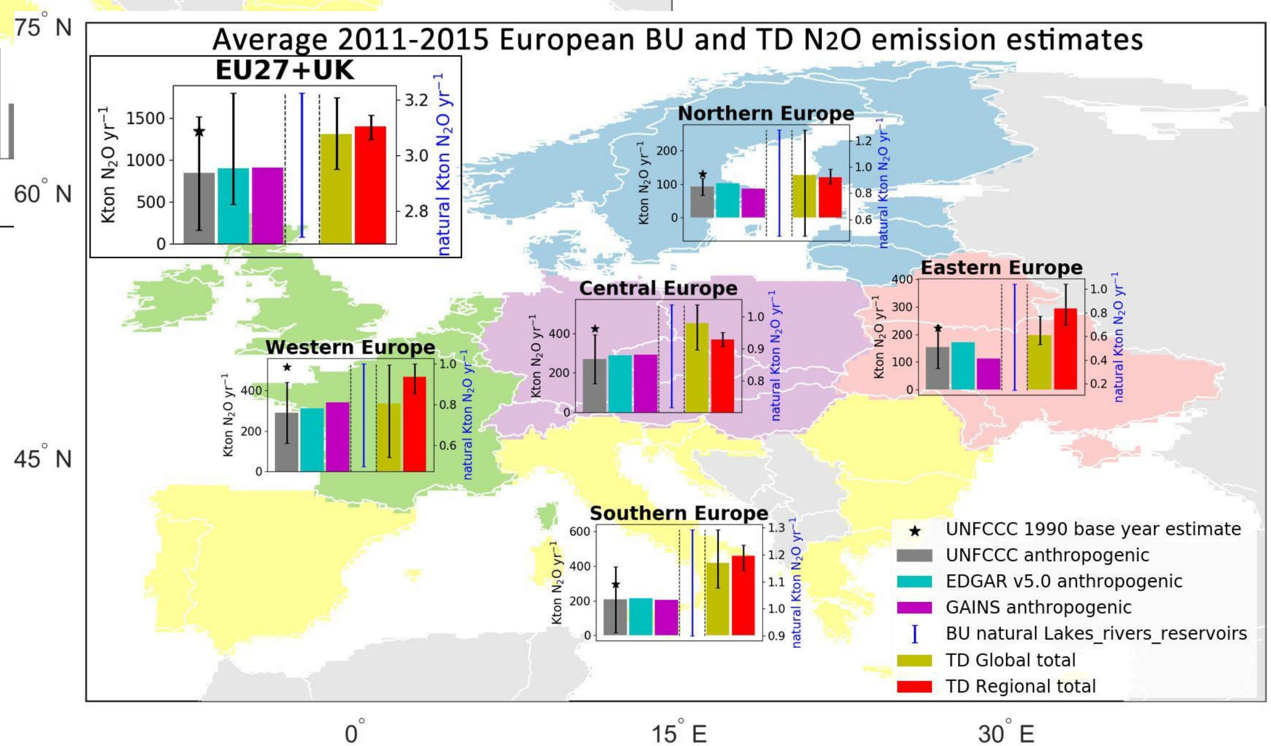
RESULTS (CONTINUED)

- Inversion methods for CO_2 land show much more variability than the NGHGI and BU models, but ensembles of European inversions (EUROCOM) show good agreement with the average.
- There are large uncertainties due to atmospheric transport modelling and uncertainty inherent to the limitation of the observation network.
- These models are mainly designed for large scale flux estimates and are still developing their lateral boundary regional conditions.



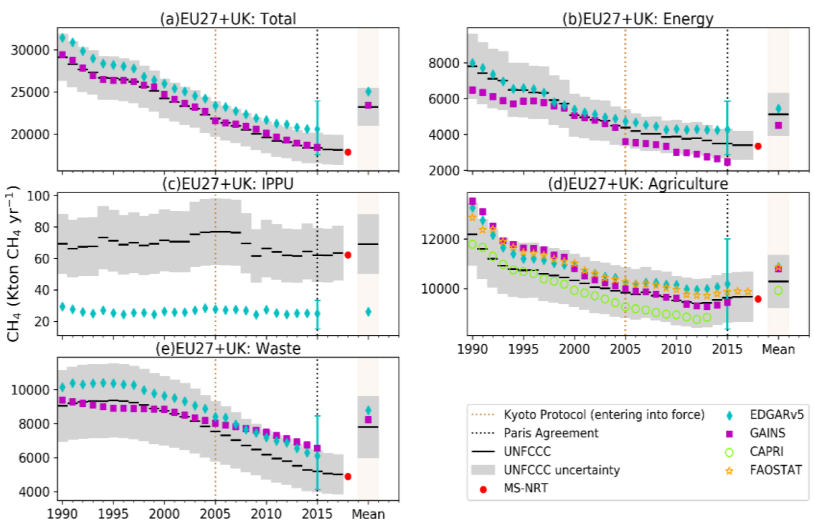
RESULTS – CH_4 AND N_2O

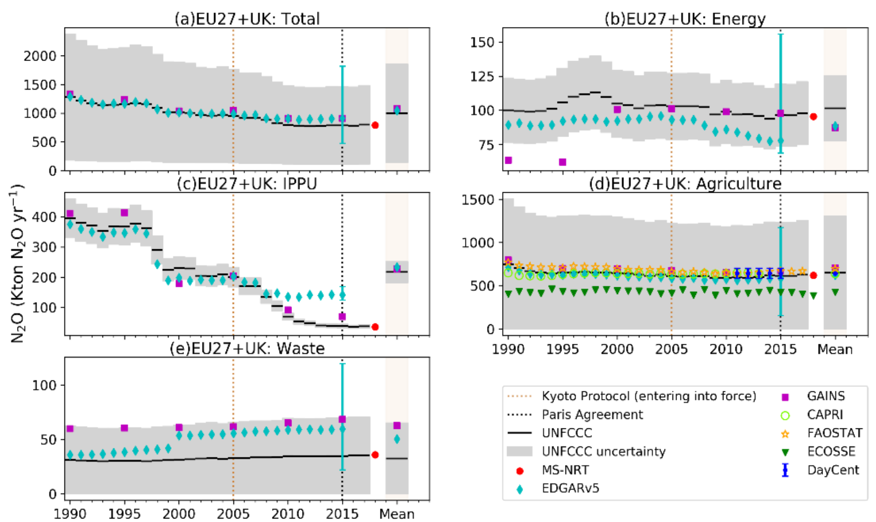




CH_4 AND N_2O – BU

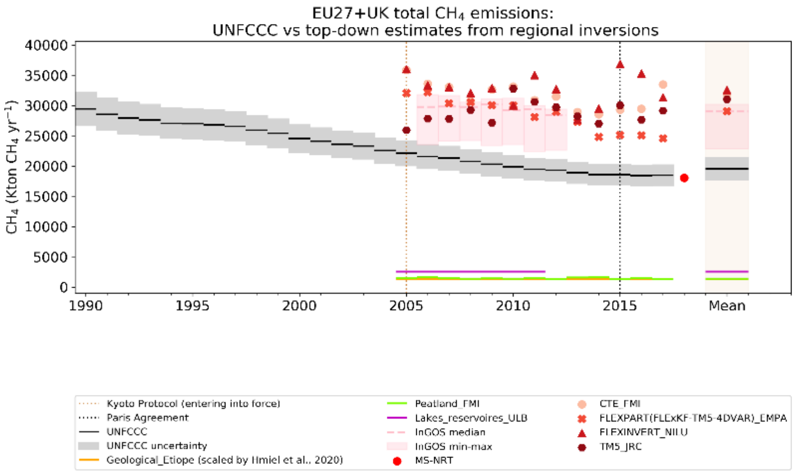
- Good agreement between BU sources
- The NGHGI data shows decreasing trends in CH_4 emissions (average 2011-2015 reported 35% reduction for the European Union with respect to the 1990 base year value) with Energy and Waste having the highest reduction shares.
- The BU N_2O emissions are dominated by large uncertainties in the NGHGI estimates.
- For both gases, Agriculture shows the best fit between the BU estimates, all within the 10% uncertainty reported by NGHGI.

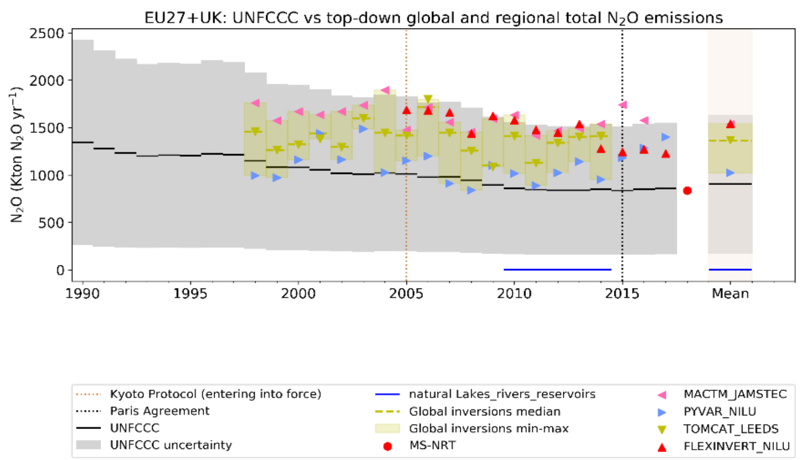




CH_4 AND N_2O – TD

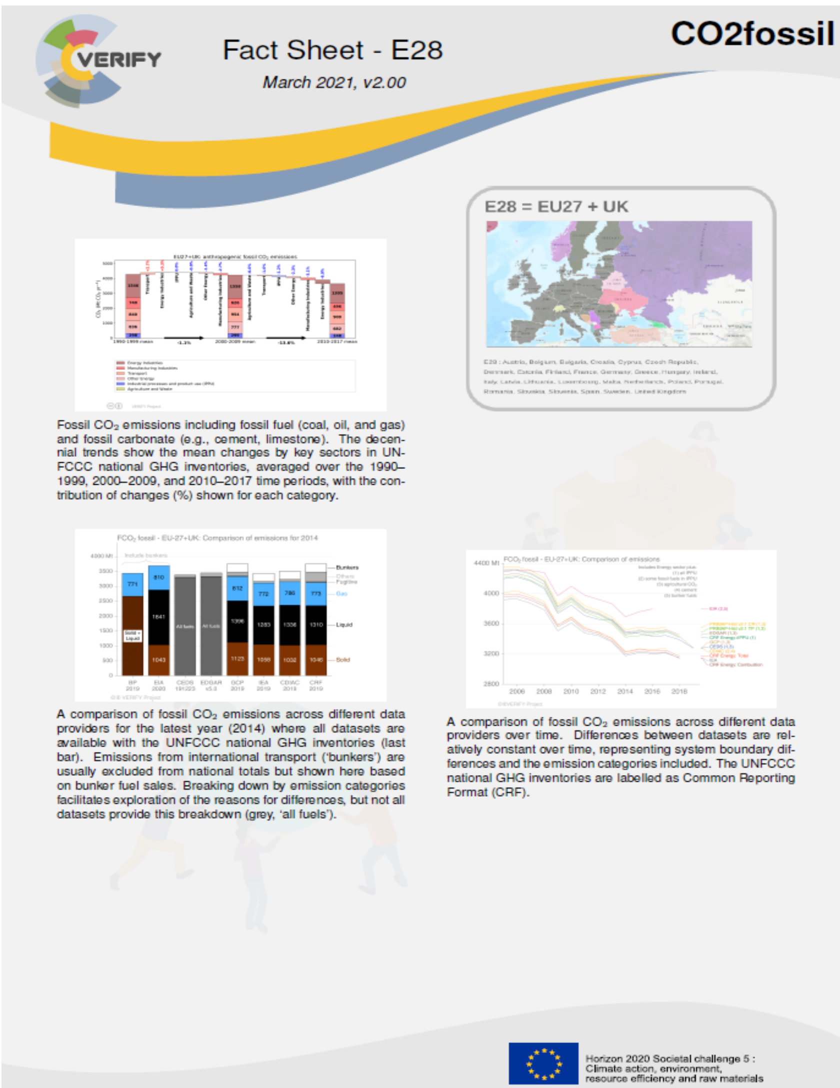
- For the use of TD as verification and complementarity tools, at both global and regional level, we need better quantification of emissions when explaining the differences between anthropogenic BU and total TD estimates.
- For *N_2O emissions* the gap observed between BU and TD estimates could be explained (~13%) from N_2O emissions from natural soils.
- Improvement of inverse methods for N_2O is needed to determine the total level of emissions and, most importantly, the trends, looking as well at seasonality variations/emissions to sector allocation.





Examples of countries factsheets

Factsheets (4 deliverables) follow each of the reconciliations and compare against UNFCCC NGHGI
Automation: 80 countries/regions, 4 fact sheets each, over 320 individual factsheets

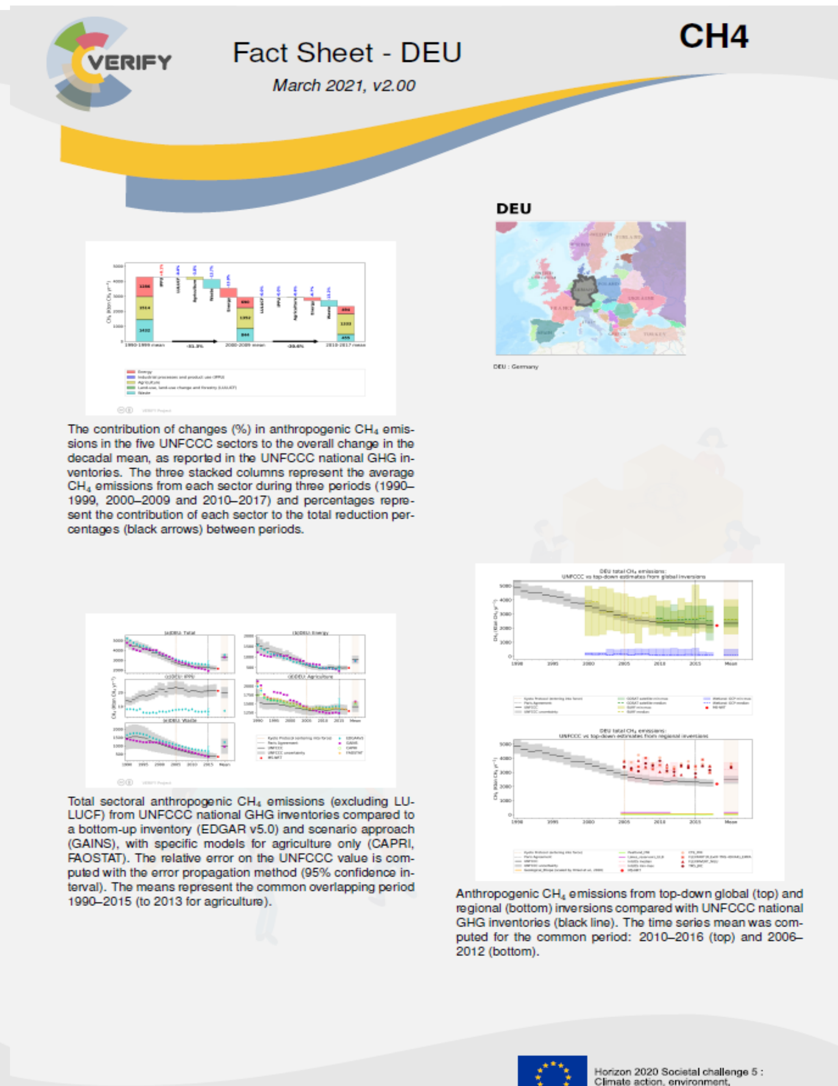


Fossil CO_2 emissions including fossil fuel (coal, oil, and gas) and fossil carbonate (e.g., cement, limestone). The decennial trends show the mean changes by key sectors in UNFCCC national GHG inventories, averaged over the 1990–1999, 2000–2009, and 2010–2017 time periods, with the contribution of changes (%) shown for each category.

A comparison of fossil CO_2 emissions across different data providers for the latest year (2014) where all datasets are available with the UNFCCC national GHG inventories (last bar). Emissions from international transport ('bunkers') are usually excluded from national totals but shown here based on bunker fuel sales. Breaking down by emission categories facilitates exploration of the reasons for differences, but not all datasets provide this breakdown (grey, 'all fuels').

A comparison of fossil CO_2 emissions across different data providers over time. Differences between datasets are relatively constant over time, representing system boundary differences and the emission categories included. The UNFCCC national GHG inventories are labelled as Common Reporting Format (CRF).

Horizon 2020 Societal challenge 5 : Climate action, environment, resource efficiency and raw materials



The contribution of changes (%) in anthropogenic CH_4 emissions in the five UNFCCC sectors to the overall change in the decadal mean, as reported in the UNFCCC national GHG inventories. The three stacked columns represent the average CH_4 emissions from each sector during three periods (1990–1999, 2000–2009 and 2010–2017) and percentages represent the contribution of each sector to the total reduction percentages (black arrows) between periods.

Total sectoral anthropogenic CH_4 emissions (excluding LULUCF) from UNFCCC national GHG inventories compared to a bottom-up inventory (EDGAR v5.0) and scenario approach (GAINS), with specific models for agriculture only (CAPRI, FAOSTAT). The relative error on the UNFCCC value is computed with the error propagation method (95% confidence interval). The means represent the common overlapping period 1990–2015 (to 2013 for agriculture).

Anthropogenic CH_4 emissions from top-down global (top) and regional (bottom) inversions compared with UNFCCC national GHG inventories (black line). The time series mean was computed for the common period: 2010–2016 (top) and 2006–2012 (bottom).

Horizon 2020 Societal challenge 5 : Climate action, environment, resource efficiency and raw materials

Extreme events and climate anomalies

by Philippe Ciais

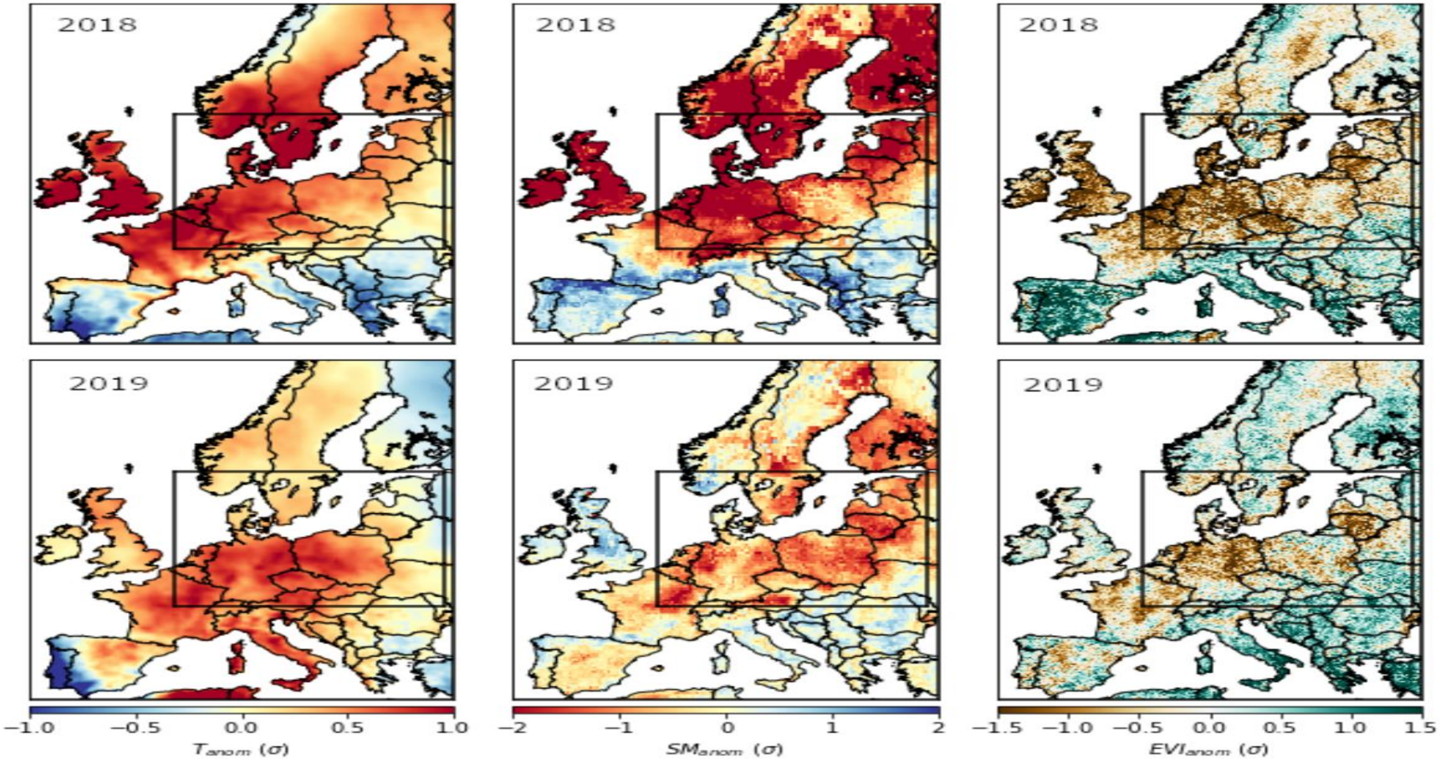
Results

Analysis of annual carbon fluxes anomalies in response to climate variations

- Separate GPP and ecosystem respiration (ER) to assess inter-annual sensitivity to temperature: *the sensitivity to a warmer year is positive below a mean annual of 7°C*

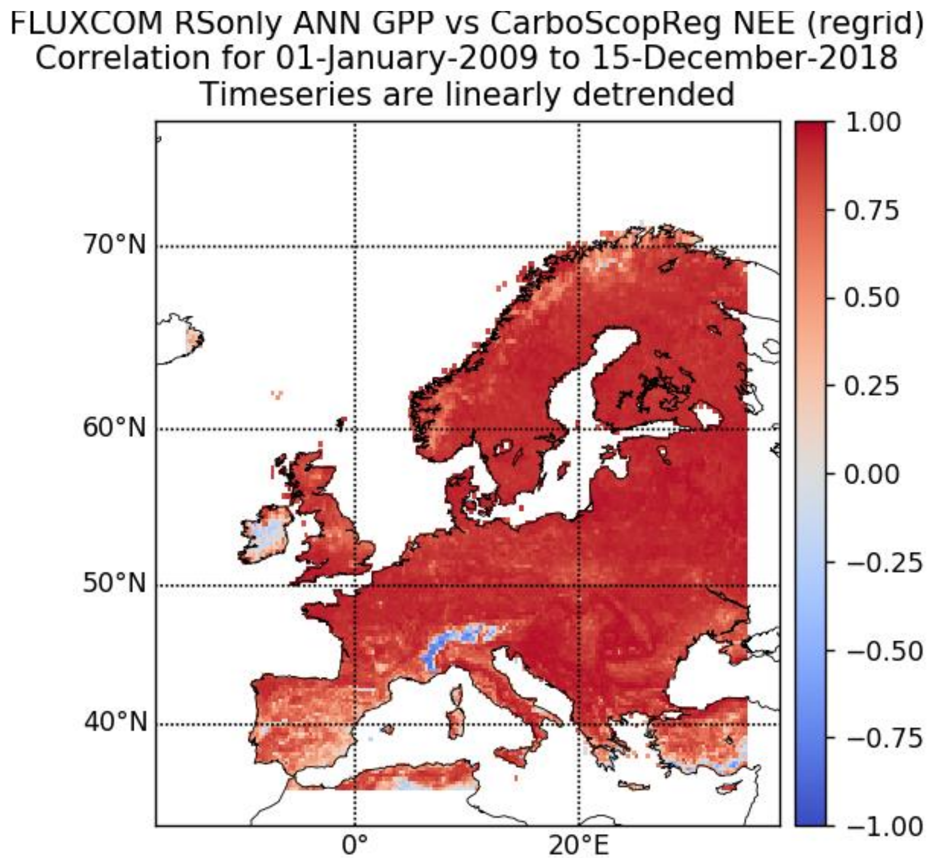
Analysis of legacy effects of recent extreme droughts in Europe:

- Seasonal effects: spring drought higher uptake -> Summer and Autumn uptake deficit
- Annual effects: double drought in 2018 and 2018 -> some ecosystems with a non-linear 'collapse' behaviour



RESULTS (CONTINUED)

Hypothesis 1: In Europe the inter-annual variability (IAV) of the net ecosystem exchange (NEE) is controlled by gross primary production (GPP) in most of Europe, but by ecosystem respiration (TER) in few wet regions (Atlantic coast, Alps).



WP6

Results from the EU and USA factsheets

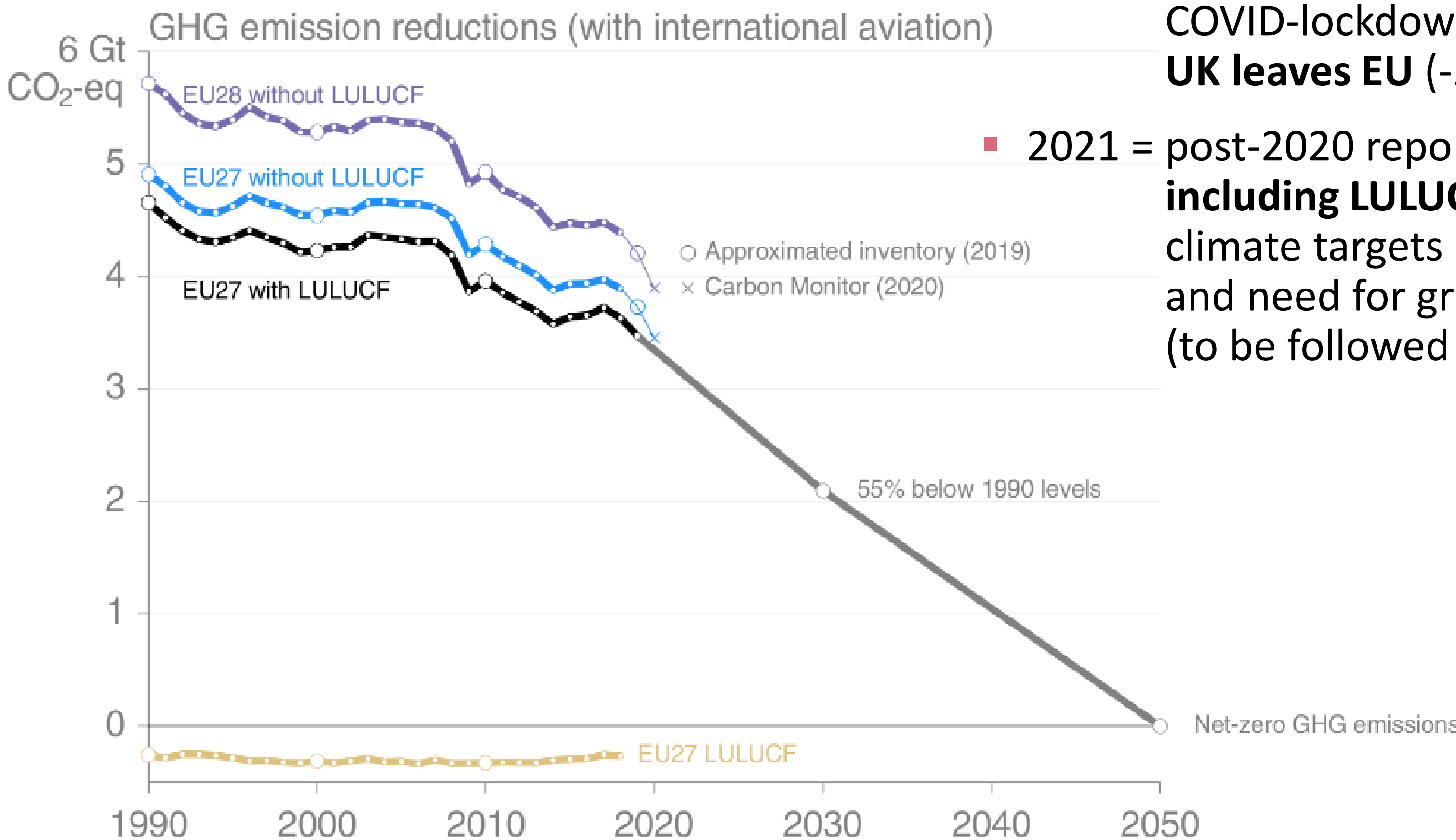
by Greet Janssens-Maenhout

WP6 OVERVIEW OF TASKS AND DELIVERABLES

WP6: Prototype System			% complete	Planned months	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Task 6.1	**Actionable info for EU**			**M1-M30**																		
	D6.1	EU factsheet	100%	**M24**						+4												
	D6.2	Best Practices		**M34**																+7		
Task 6.2	**Outreach beyond EU**			**M24-M42**																		
	D6.3	USA factsheet	67%	**M30**												+7						
	D6.4	China factsheet		**M30**												+9						
	D6.5	Indonesia factsheet		**M42**																		
	D6.6 D6.7	USA/CHN/IDN workshop international workshop	0%	**M42**																		
Task 6.3	**Data base & management**			**M12-42**																		
	D6.8	DB+DMS 1.0	50%	**M19**																		
	D6.9	DB+DMW 2.0		**M43**																		
	D6.10	legacy DB+DMS 2.x		**M43**																		
Task 6.4	**Visualising GHG budget & trend**			**M12-M46**																		
	D6.12	Nat. Inventories+ obs. budget + NDC targets	25%	**M42**																		
Task 6.5	**Visualising uncertainty reduction potential**			**M12-M46**																		
	D6.13	Identifying uncertainty reduction potential	0%	**M46**																		

RESULTS – EU AND USA FACTSHEETS

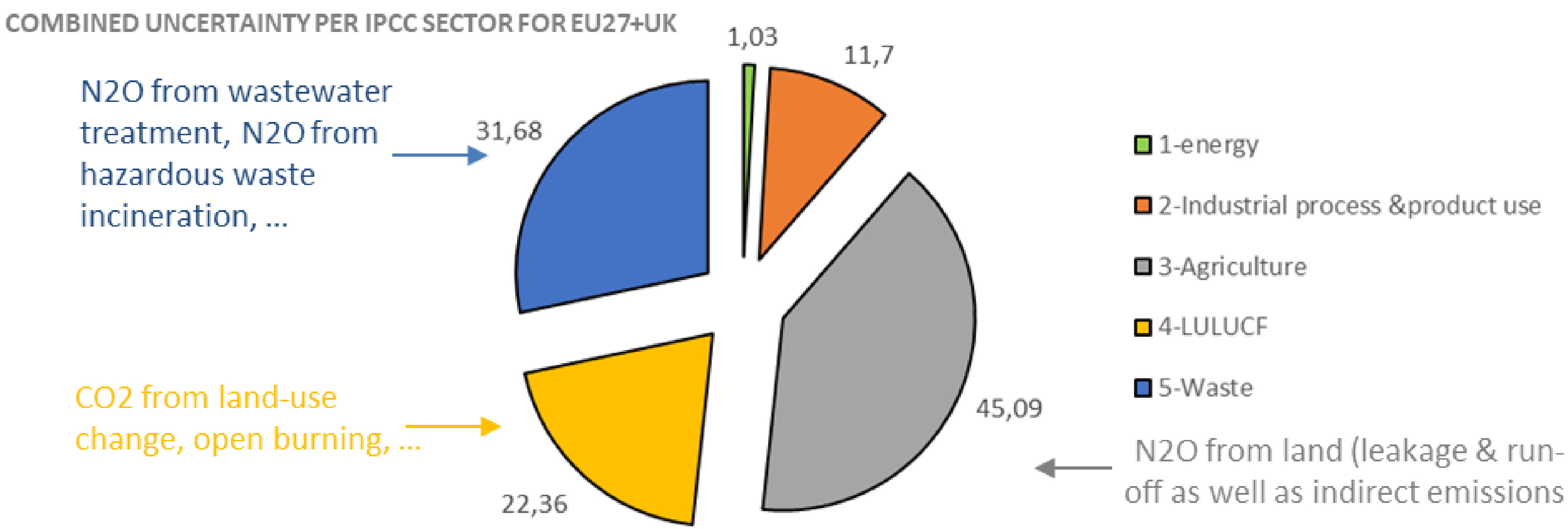
Factsheets for EU policymakers (JRC)



- 2020 = end KP period
  COVID-lockdown (impact ~10%)
  UK leaves EU (-23.2% ⇒ -20.7%)
- 2021 = post-2020 reporting scheme,
  including LULUCF for 2030
  climate targets of -55%
  and need for green recovery
  (to be followed "near real time")

RESULTS (CONTINUED)

EU Factsheet and best practices for GHG inventories (JRC)

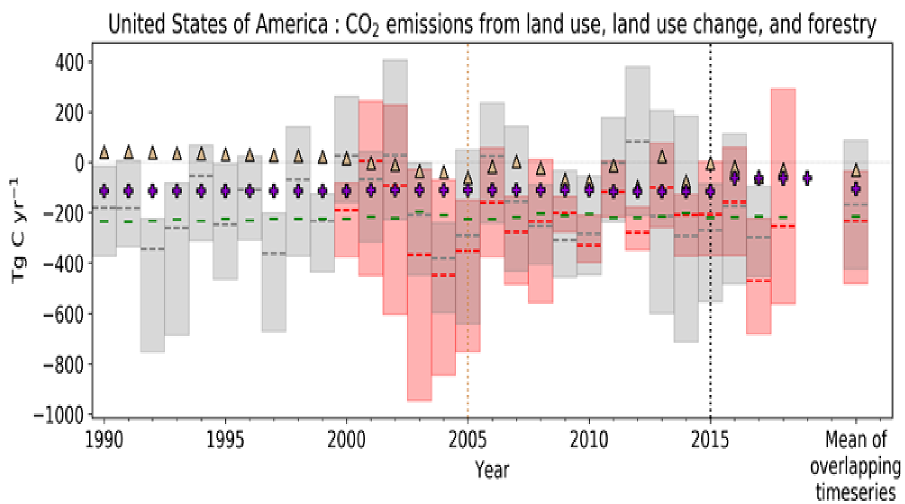


- Higher spatial and temporal resolution of the GHG inventories (NRT tracking?)
- More uptake of top-down information for assessing uncertain CH_4 and N_2O and CO_2 land emissions
- Combining information collected under different regulations: ETS 2003/87/EC, ESD 2009/406/EC, MMR 2013/525/EU, EED 2021/27/EU, EBD 2018/844/EU, FQD 1998/70/EC, MMR+ 2018/1999/EU, ESD+ 2018/842/EU, ETS+ 2019/1842/EU, Road 2009/443/EC + 2011/510/EU + 2018/956/EU + 2019/1242/EU, LULUCF 2018/841/EU, EPRTR 2006/166/EC+2019/1010/EU, AQD 2008/50/EC, NECD 2016/2284/EU, MCP 2015/2193/EU, IED 2010/75/EU

Results (continued)

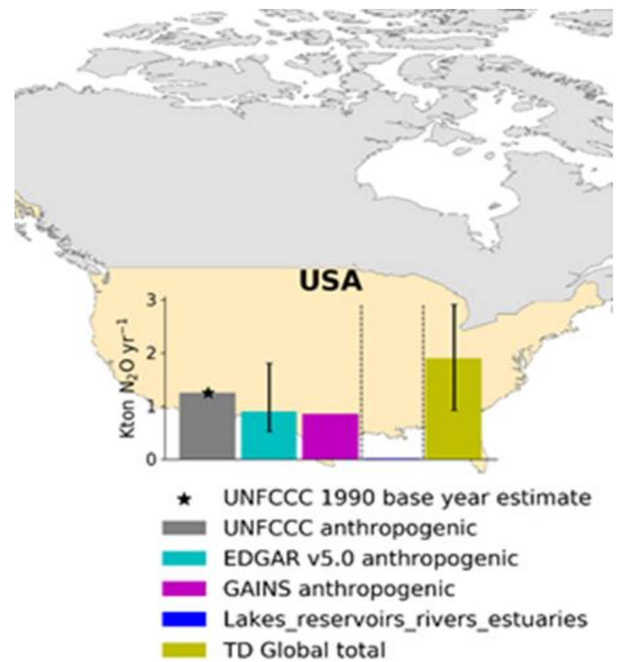
USA factsheets (JRC+CEA+Cicero)

CO_2 land



- Unknown fraction of unmanaged land was brought up by US EPA

N_2O



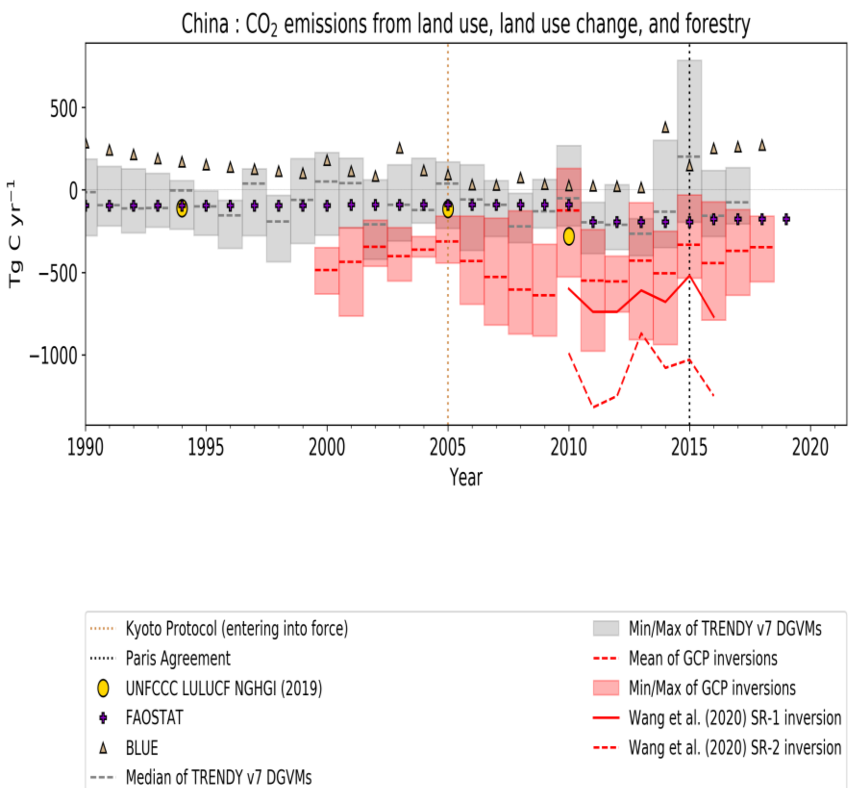
- Large uncertainty because of the seasonality and natural component of the emissions

RESULTS FROM CHINA FACTSHEETS

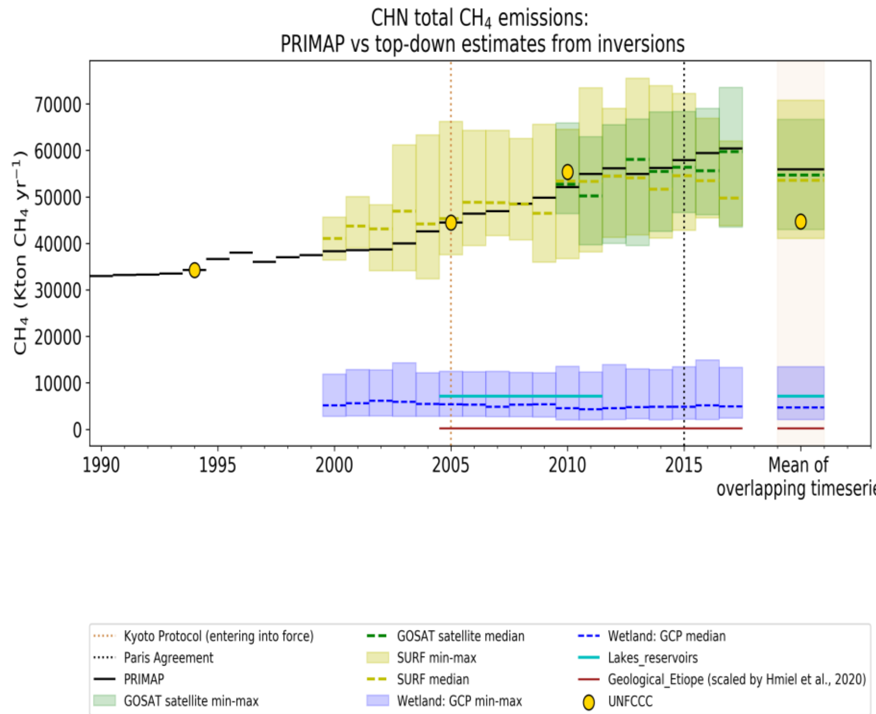
BY PHILIPPE CIAIS

CHINA factsheets (CEA, Cicero)

CO_2 land



CH_4



- Global inversion of Wang with extra 4 flux towers in China and 1 in Siberia

Generally, inversions give a higher land CO_2 uptake that carbon stocks increase from inventories

- Global inversions of Saunois with data from SURF and GOSAT, not yet TROPOMI

Fair agreement of total anthropogenic with last national communication. Agreement breaks down for sectors that inversions have problems to separate

OPEN DISCUSSION ON HOW TO IMPROVE THE SYNTHESIS WORK IN WP5 AND WP6

- per gas reporting vs. CO_2eq reporting?
- annual, biannual or 5-year averages, or all?
- can we find common grounds for the model selection?
- can more products report their uncertainties?
- can TD models reduce their uncertainty (e.g. CSR)?
- allocate more attention to regions or countries?
- including missing flows (e.g. trade)
- links with $CoCO_2$ project and city dimension

Thank you for your attention

For questions/comments please send an email to:
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