VERIFY:
Observation-based system for monitoring and verification of greenhouse gases

NETWORKING MEETING

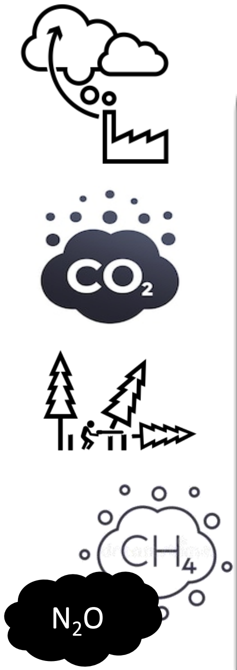
“Alternative methods for inventory verification: opportunities and limits”

VERIFY work package structure

WP1: GHG MRV user requirements
Contribution to IPCC task force on inventories
Inventory fact sheet for each EU MS

User requirements

Emission reporting



WP2: Verification method for fossil CO_2 emissions

WP3: Verification method for terrestrial CO_2 sources and sinks and C stocks

WP4: Verification methods for CH_4 and N_2O emissions

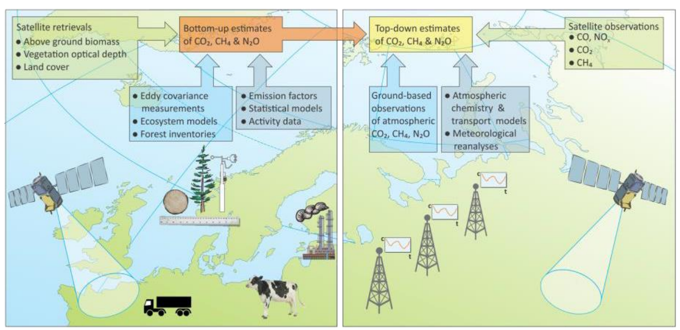
WP5: Reconciliation and assessment of different models and tools leading to verification of GHG inventories

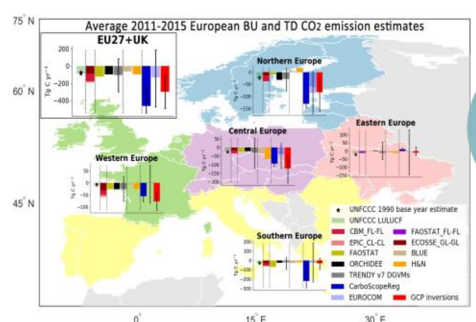
- Reconciliation of all VERIFY estimates
- Uncertainty analysis
- Budget fact sheet for each EU MS

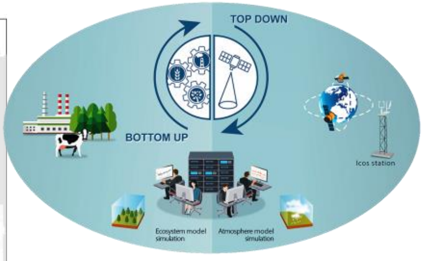
WP6: Prototype of an international GHG monitoring and verification system

- Budget fact sheets
- Policy makers support tool
- Application to other regions
- System prototype

WP7: Input to international programs and society
WMO, GCP, GEO, …







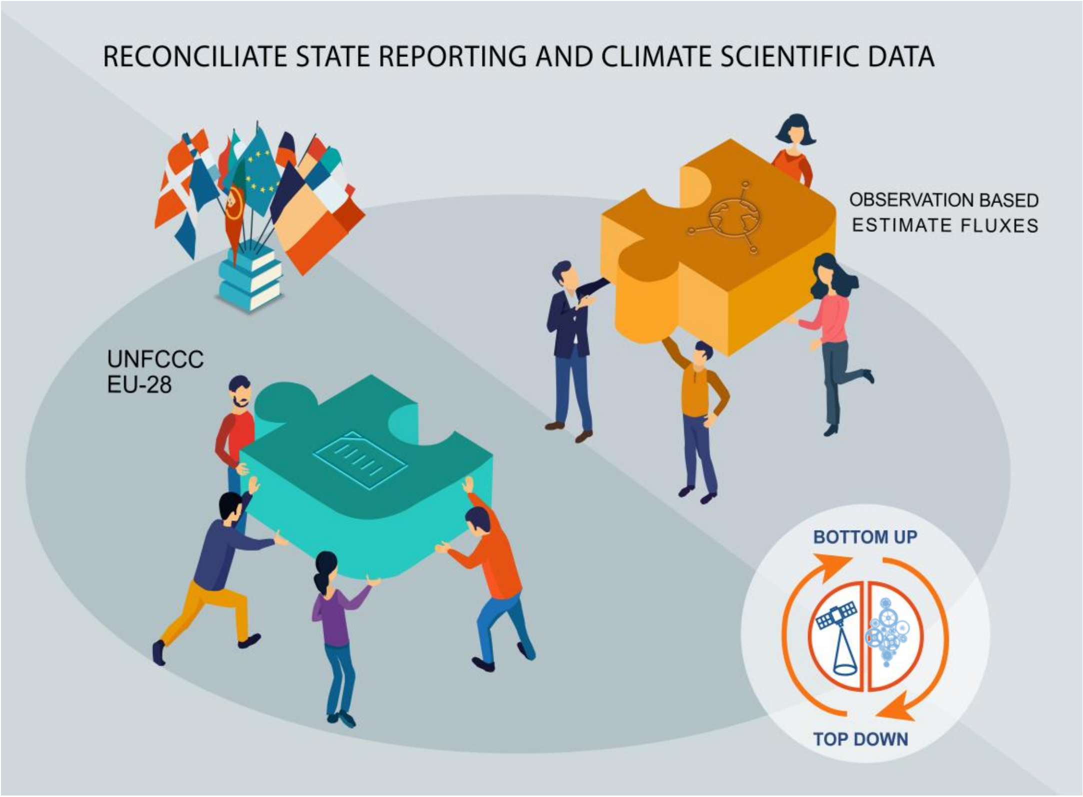
GROUP ON EARTH OBSERVATIONS

GLOBAL CARBON project

WMO

Networking meetings

- **Lead:** Paul Ruyssenaars (RIVM)
- **Objective**: interaction between national inventory agencies and the scientific community
- **Title**: ***Alternative methods for inventory verification: opportunities and limits***
- **Participants**: Verify WP representatives, inventory agencies in <u>and outside </u>the project
- **Format**: Teleconference



Second ad Hoc networking meeting

- General intro on the inventory needs (URD)
- Invited speaker from inventory agency using inversion models for verification (e.g. UK, Switzerland)
- Each section followed by questions from inventory agencies

- **CO_2FF** – 10 November
  - **77 Participants**
- **CO_2land** – 12 November
  - **70 Participants**
- **N_2O&CH_4** – 13 November
  - **60 Particiants**

NETWORKING MEETING
12/11: Land based CO_2

Objective: interaction between national inventory agencies and the scientific community

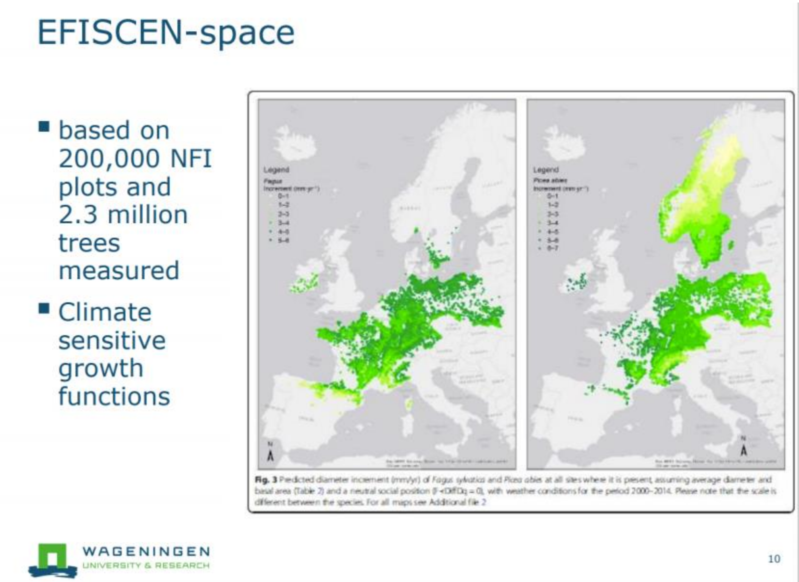
"Alternative methods for inventory verification: opportunities and limits"

AGENDA OF THE MEETING

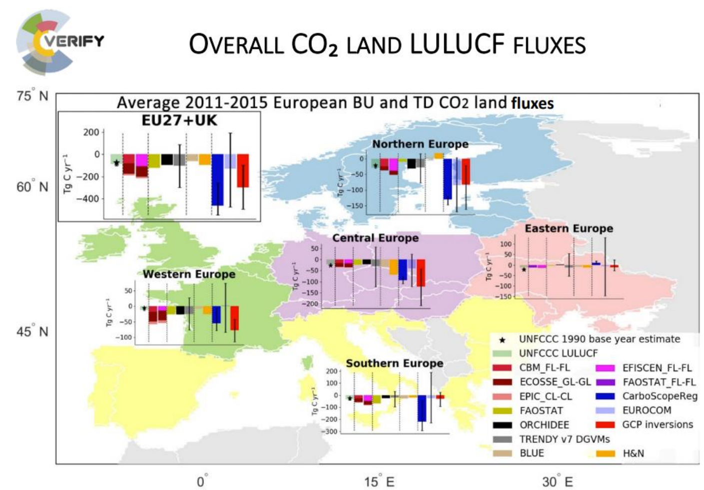
13:00	**Opening**	Chairs: Lucia Perugini, CMCC Dirk Günther, UBA Dessau
13:05	**Introduction : emission inventory bottom-up data/model requirements**	Marina Vitullo, ISPRA
13:20	**VERIFY latest synthesis results**	Han Dolman, VU Amsterdam
13:35	**Synthesis of bottom-up and top-down methods for terrestrial carbon fluxes related to land use, land use change, and forestry**	Matthew McGrath, LSCE
13:50	**What open data tells us: Reconstructing six decades of global land use change**	Karina Winkler, Wageningen University
14:05	**Groundbased forest inventory data in European LULUCF reporting; the role of synchronized data across countries**	Gert-Jan Nabuurs/ Martjan Schelhaas, Wageningen Env. Research
14:20	**Introduction survey**	Martin Herold, Wageningen University
14:35	**Discussion**	All
15:05	**Wrap up**	Giacomo Grassi, JRC
15:15	**End of meeting**	

What can be provided?

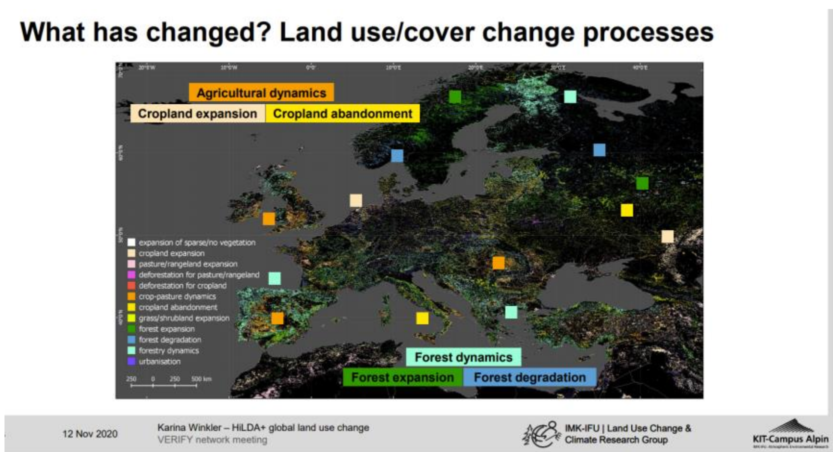
Improved Bookiping models



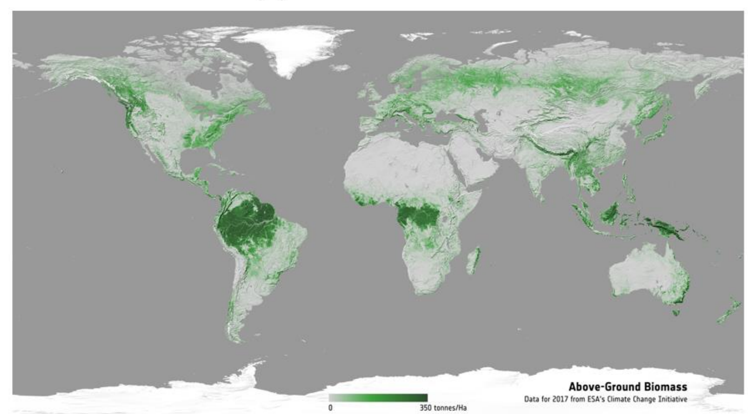
Synthesis of BU-TD data for land fluxes at EU level



LUC analysis at large scale

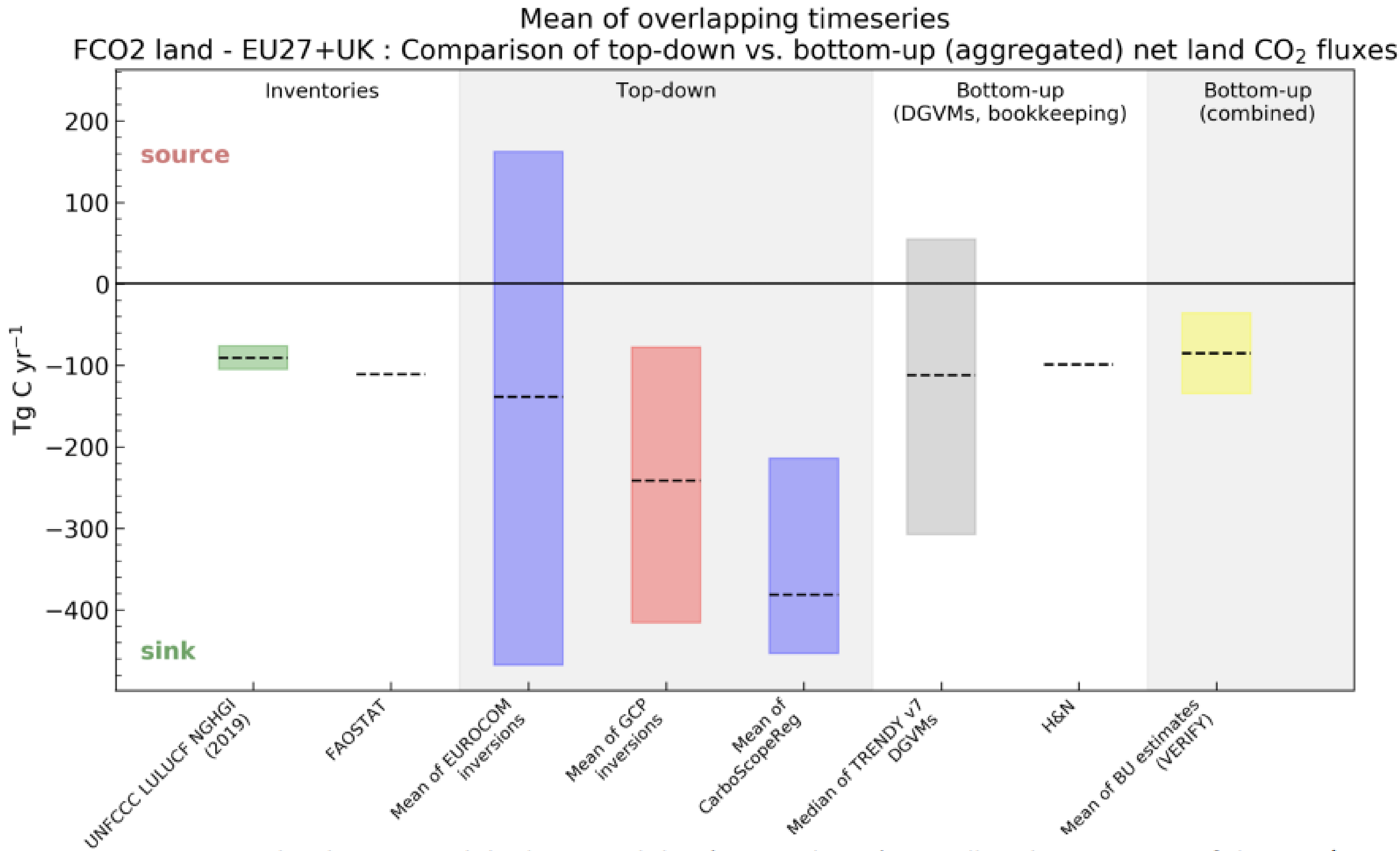


Biomass density maps are wall-to-wall predictions of biomass for woody plants and trees



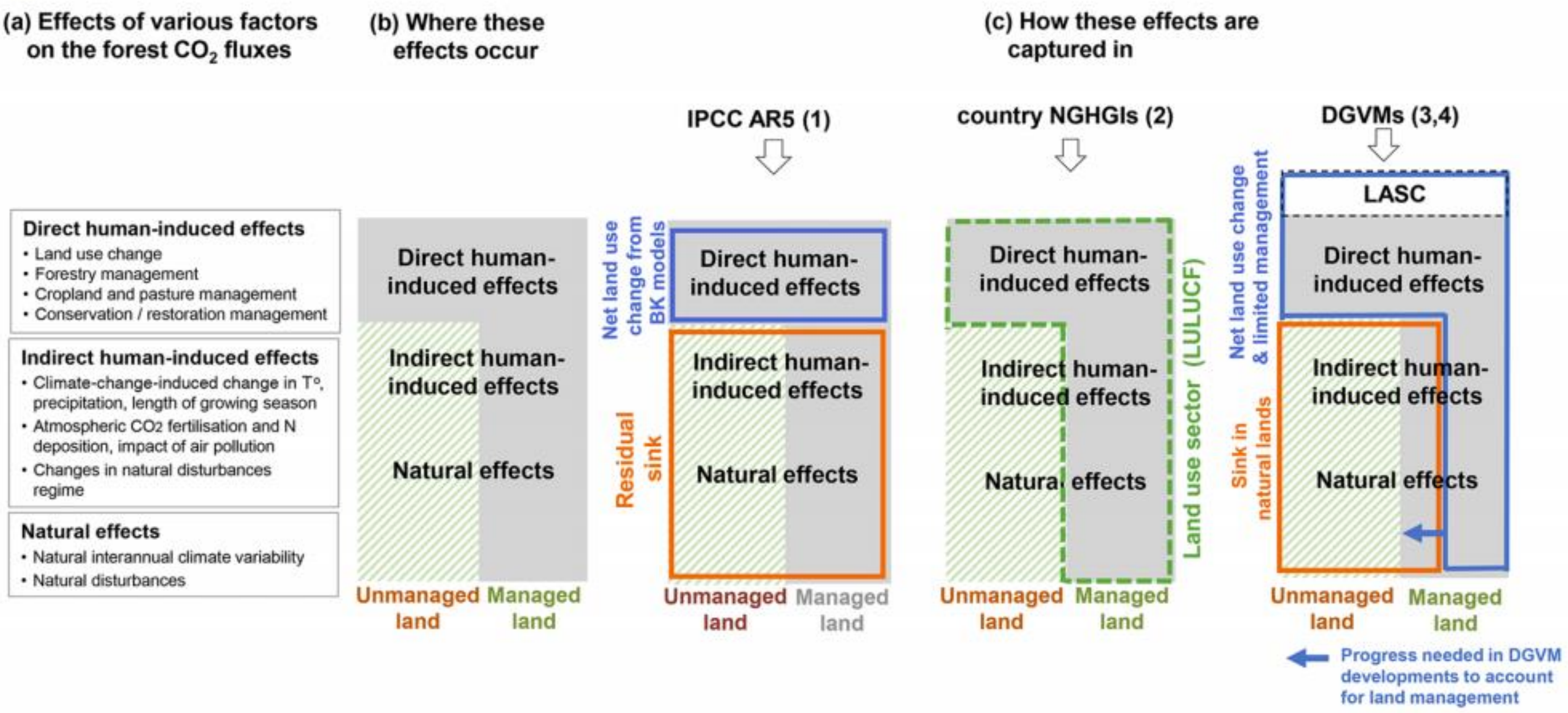
Global aboveground biomass derived from satellite data for at 100 m resolution for 2017, also 2010 and 2018, http://cci.esa.int/biomass

SUMMARY OF THE SYNTHESIS – CO_2 LAND



- TD results show a much higher variability (min and max) as well in the extremes of the min/max.
- Regional EUROCOM ensemble mean seems to be the closest to the NGHGI but it shows high variability:
- BB will be included in the next comparison with TD (in 2017, BB in EU27+UK emitted 4 Tg C)

BOUNDARY ISSUES IN DEFINING CO_2 LAND



(1) In IPCC AR5, the residual sink is inferred as a difference between FF emissions + net land use – growth rate – ocean uptake, and thus matches the observed CO_2 growth rate by construction. In this method, a bias on net land use change is transferred to the inferred residual sink.
(2) In NGHGI, the LULUCF C balance only covers direct management actions and does not match the CO2 growth rate. Any difference with the CO2 growth rate can be attributed to errors in NGHGI estimates and / or fluxes on unmanaged lands.
(3) In DGVMs, net land use change includes a source corresponding to the loss of additional sink capacity (LASC). Some models include limited land management (wood harvest, crop harvest). Nonmodeled management from forestry, cropland and pasture management, conservation / restoration management, being in the grey area part of the orange box.
(4) DGVMs have parameterizations and structural uncertainties, and their net land flux does not match the global CO2 growth rate, leading to a global BIM (budget imbalance).

ESSD Petrescu et al., 2020

Gaps and needs towards spatially-explicit estimations of forest-related GHG emissions and carbon removals

- Evolving set of spatially-explicit dataset and estimates, i.e. as part of VERIFY WP3 (land change, biomass, various models)
- Increasing requirements and interests by countries
- Survey: developed by WP1 and WP3 for better understanding of status and needs for spatially-explicit estimating and reporting for national GHG inventories
- Focus on LULUCF sector with a focus on forest-related categories (ref. Regulation (EU) 2018/841)
- Seven replies from national agencies in VERIFY (Ireland, Norway, Austria Netherlands, Germany, Italy & France)
- Survey open: https://forms.gle/rrSH5cUTEEk3LEzA6

Herold et al

Status and plans for spatially-explicit data

Q.2.2 To what extent is **spatially-explicit data currently being used** within the preparation of the GHG inventory of your country (N=7)

They are used for **activity data** (land-use, land use change and burned areas)	5
They are used for **biomass/carbon stocks** and change	4
They are used for **land management information**	3
They are **not used**	2

Q.2.3 Do you **plan to increase the use** of spatially-explicit data within your GHG inventory in the next few years?

Yes, we plan to increase the use with regards to **biomass/carbon stocks and change**	5
Yes, we plan to increase the use with regards to **activity data** (land-use, land use change and burned areas)	4
Yes, we plan to increase the use with regards to **land management information**	3

Herold et al

Requirements for relevant spatially-explicit datasets

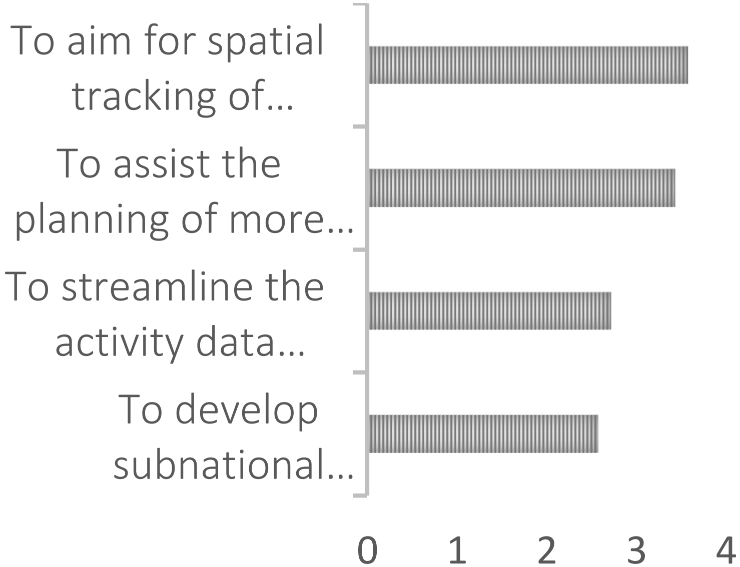
Criteria	Most common answer
Spatial resolution	10-30 m OR 0.01 – 0.09 ha (MMU)
Temporal frequency	Annual
Temporal range	Since 1990

In the absence of a complete time series, most respondents would consider the product, if the method to **reconstruct the time series with ancillary data can ensure consistency with IPCC guidelines**

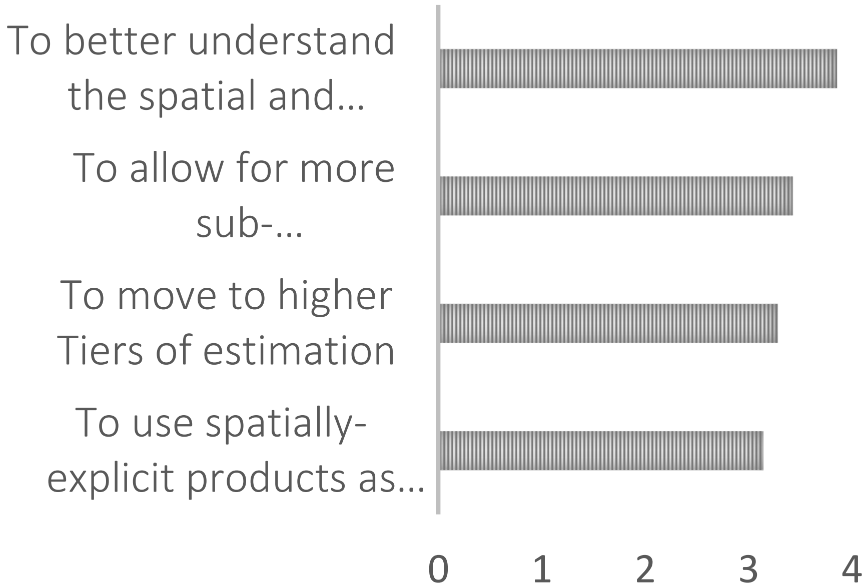
Herold et al

Main motivations to further develop spatially-explicit estimations

"Political" motivations



"Technical" motivations



Herold et al

Awareness of evolving data sources and approaches

Q 3.1 Identify in the list below, what are the **data sources and approaches you are fully familiar with**

Available land cover/land use datasets for area change estimation	7
Remote sensing time series approaches for tracking forest dynamics and disturbances (e.g., forest change, fire and burned area data sets)	4
Forest and forestry **information models**	4
Process-based carbon models	3
Biomass density maps from remotely derived data	3

Herold et al

Limitations / challenges on spatially-explicit estimating

Criteria	# replies
Limited availability of data sources and approaches (e.g., spatial or temporal resolution)	5
Limited potential to ensure a consistent land representation and/or consistency with **national definitions** (e.g., of forests)	5
Lack of temporal consistency or **complete time series**	4
Concerns that accuracy and consistency of national estimations will decline	4
Limited accuracy of available datasets and approaches	3
Lack of guidance on how to integrate novel spatial data sources/approaches with current approaches for national estimation	3
Lack of national capacity to deal with novel data sources and approaches (e.g., difficulties to process large size datasets)	2

Herold et al

First conclusions

- Countries are moving to spatially-explicit estimations of forest-related GHG emissions and removals
- Prominent **motivations**: better understand spatio-temporal patterns and for tracking of mitigation activities and related planning/management
- Current use and awareness mostly for land use change; less so for biomass maps and forest/carbon models
- Most need for "high-resolution" (i.e. 10-30 m, annual)
- Consistency is key: long-term, national definitions
- Sense of limited availability/accuracy/consistency of data sources and approaches ... at the same time limited awareness for some new development

Herold et al

NETWORKING MEETING
Day 3: CH4 N2O

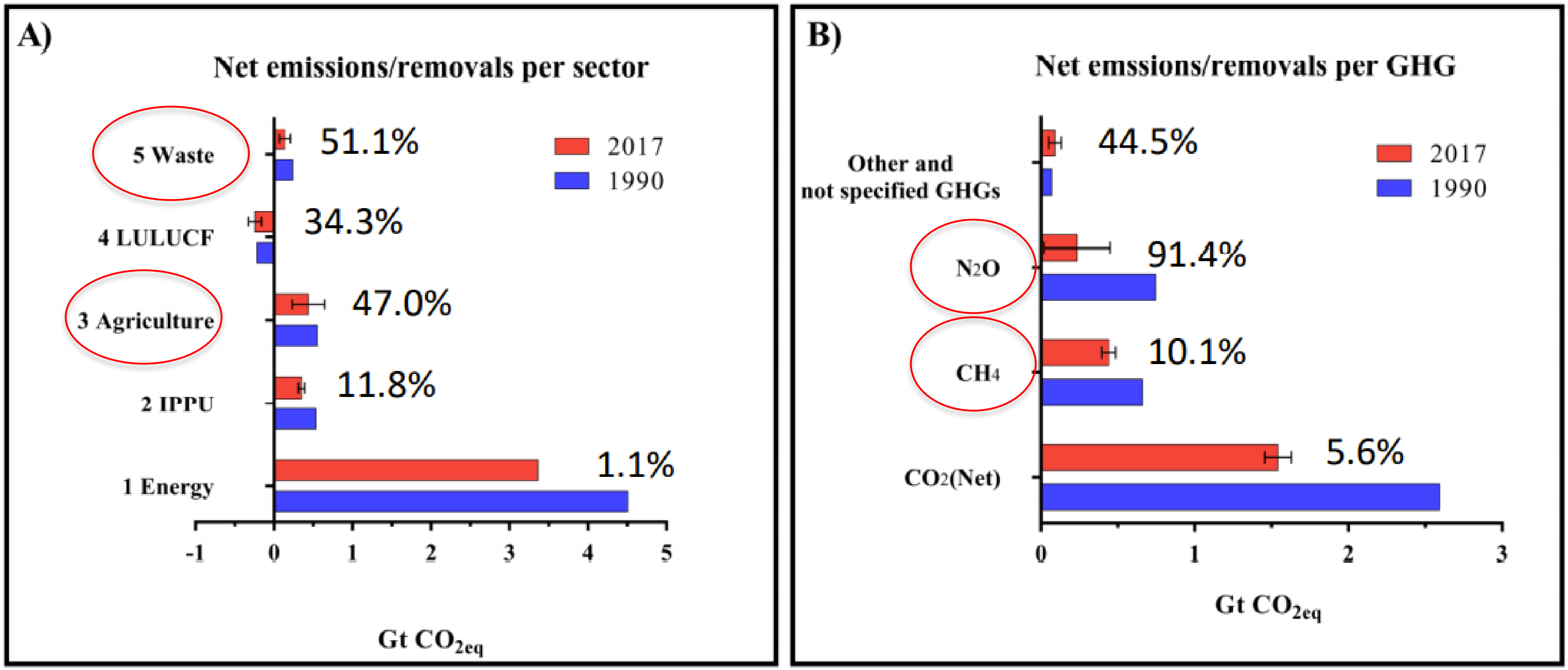
Objective: interaction between national inventory agencies and the scientific community

"Alternative methods for inventory verification: opportunities and limits"

13:00	Opening	Chair: Lucia Perugini, CMCC
13:05	Introduction : emission inventory bottom-up data/model requirements for CH_4 and N_2O	Jean-Pierre Chang/ Anaïs Durand, CITEPA France
13:25	Experience on using inversions for UNFCCC reporting requirements	Alistair Manning, MetOffice UK
13:40	VERIFY latest synthesis results	Roxana Petrescu, VU Amsterdam
13:55	Top-down CH_4 approaches	Dominic Brunner, Empa
14:10	Top-down N_2O approaches	Rona Thompson, NILU
14:25	Discussion	Jean-Pierre Chang, CITEPA France Dirk Günther, UBA Dessau &
15:00	Wrap up	Greet Janssens-Maenhout
15:15	End of meeting	

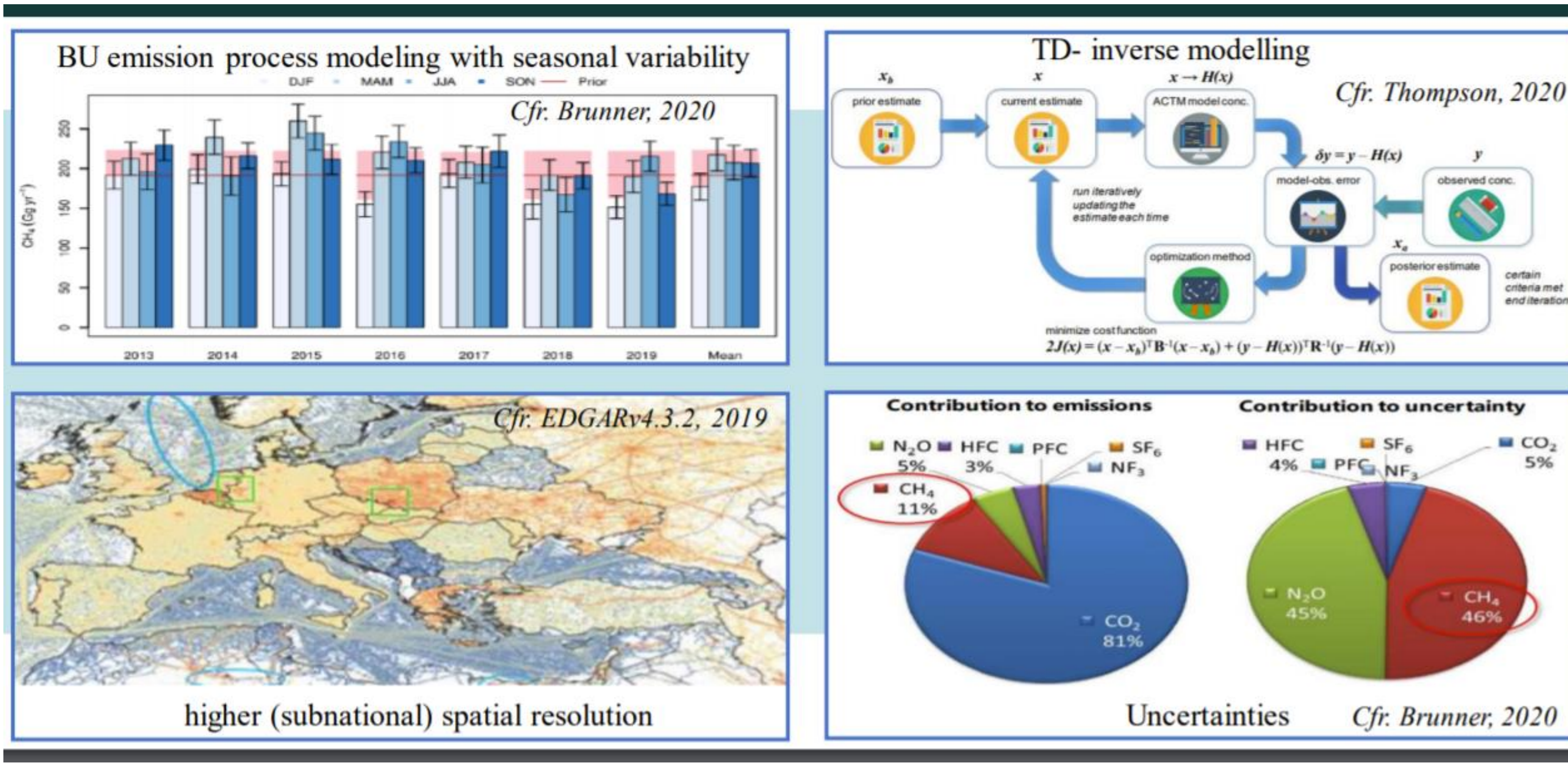
Main sources of CH4 and N2O Agriculture and Waste sectors

EU28 + Iceland

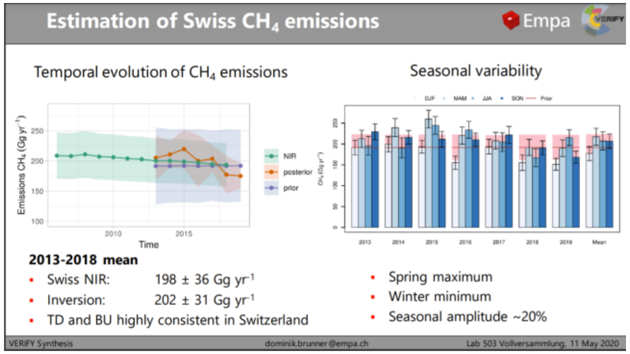


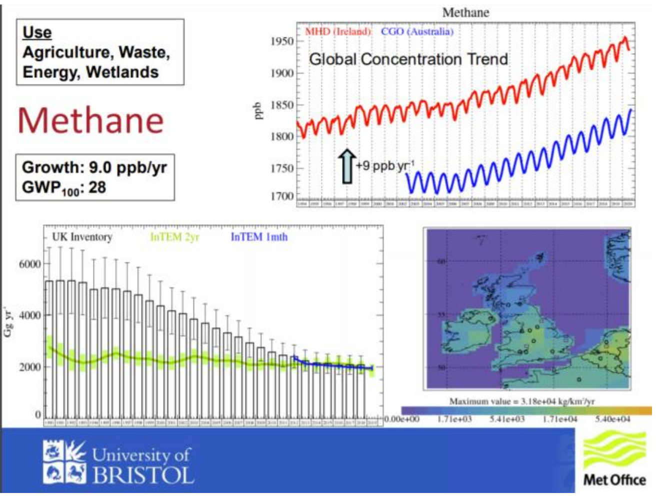
Source: EU National GHG inventory data 2019

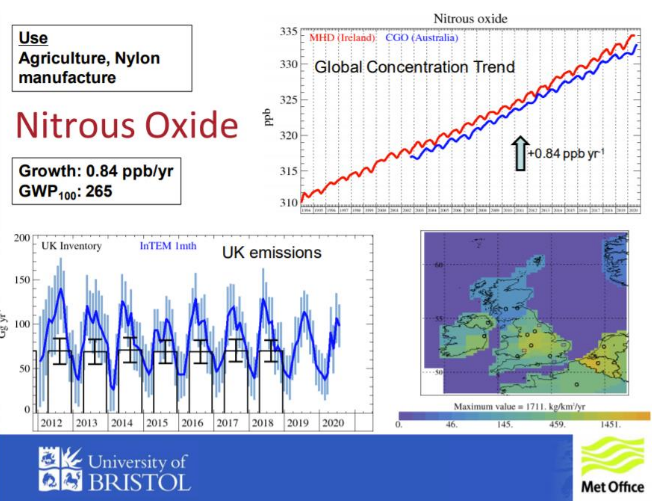
Challenges and proposed tools



NGHGI Verification with inversion models

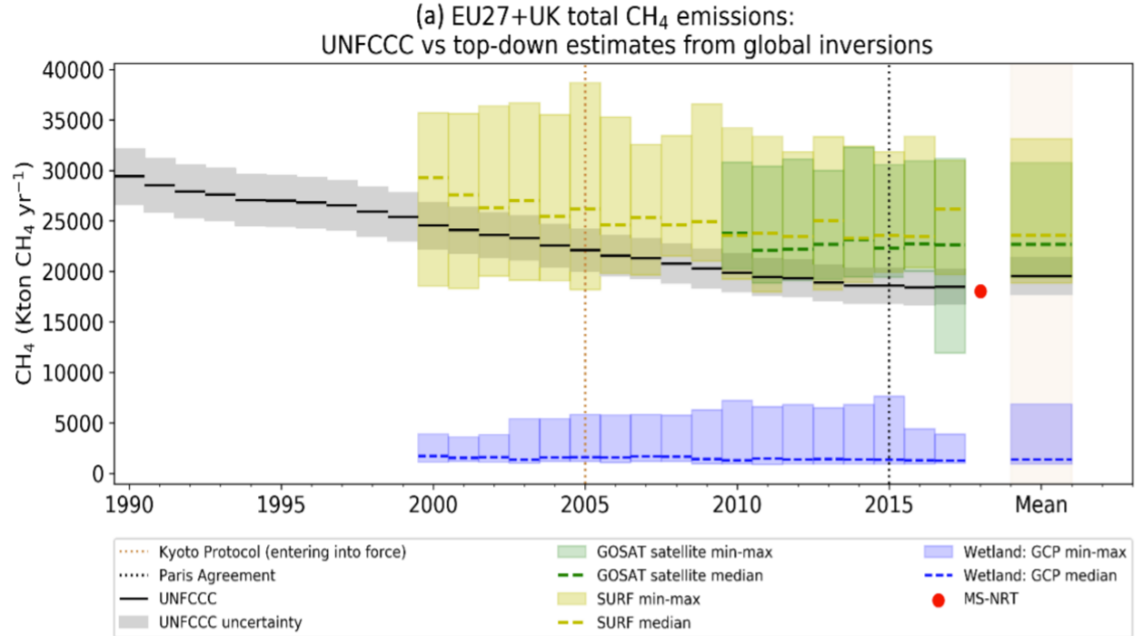




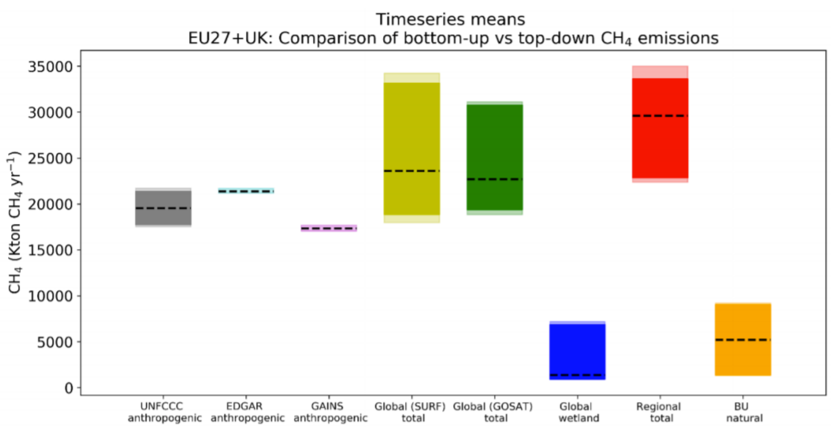


- Examples from **UK and Switzerland**
- Collaboration with scientific institutes have been proved to be fruitful
- Range of TD estimates for Europe still large, reasons not well understood (model resolutions, observation input, a priori?)
- Provide insight and estimates for SECTOR specific emissions
- Robust estimation of long-term emission trend requires long-term continuity in observation coverage

Synthesis TD-BU

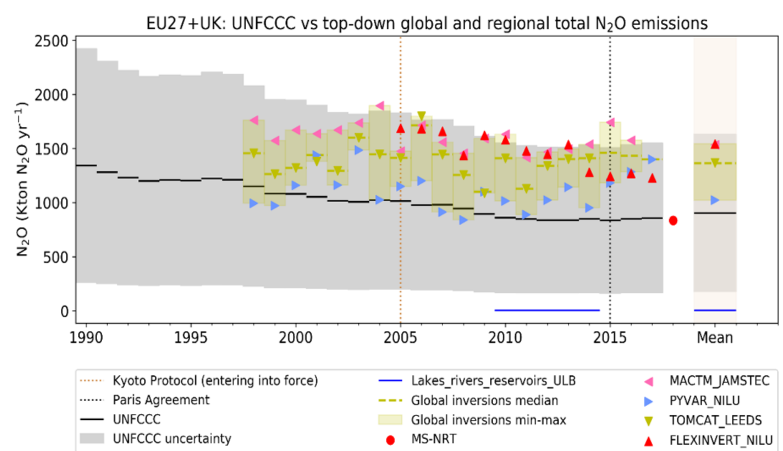


OVERLAPPING 2010-2012 MEANS – CH_4



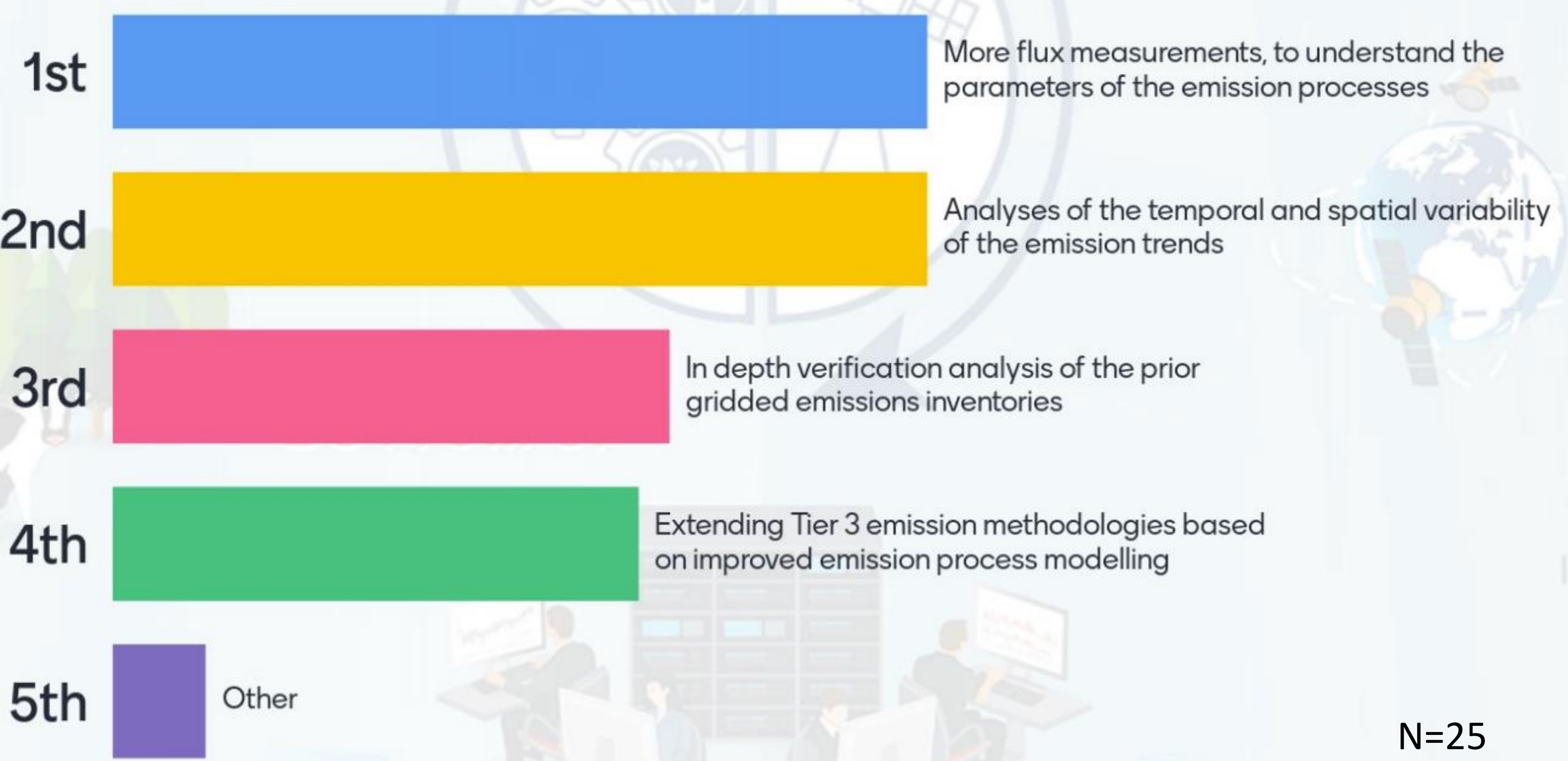
Future need of better quantification of natural BU CH_4 fluxes which at both global and regional level might be the key for explaining the differences between anthropogenic BU and total TD estimates

UNFCCC ANTHROPOGENIC, REGIONAL AND GLOBAL TOP-DOWN TOTAL AND NATURAL BOTTOM-UP N_2O EMISSIONS

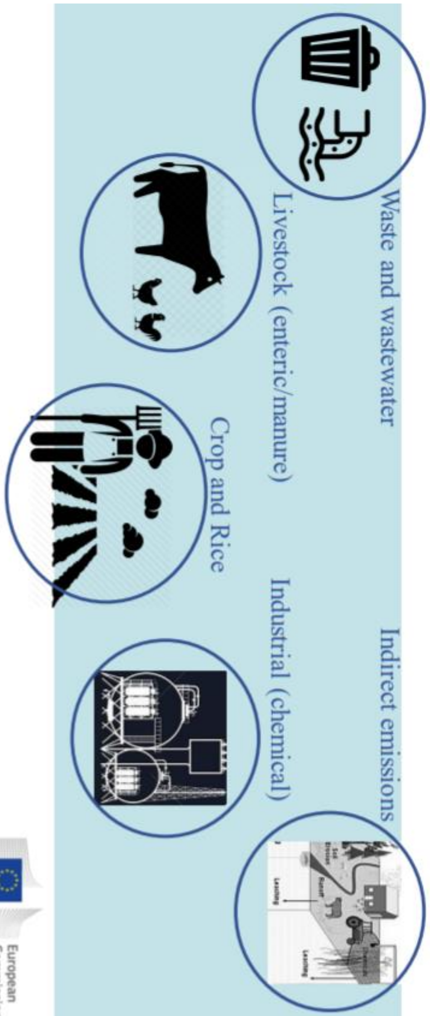


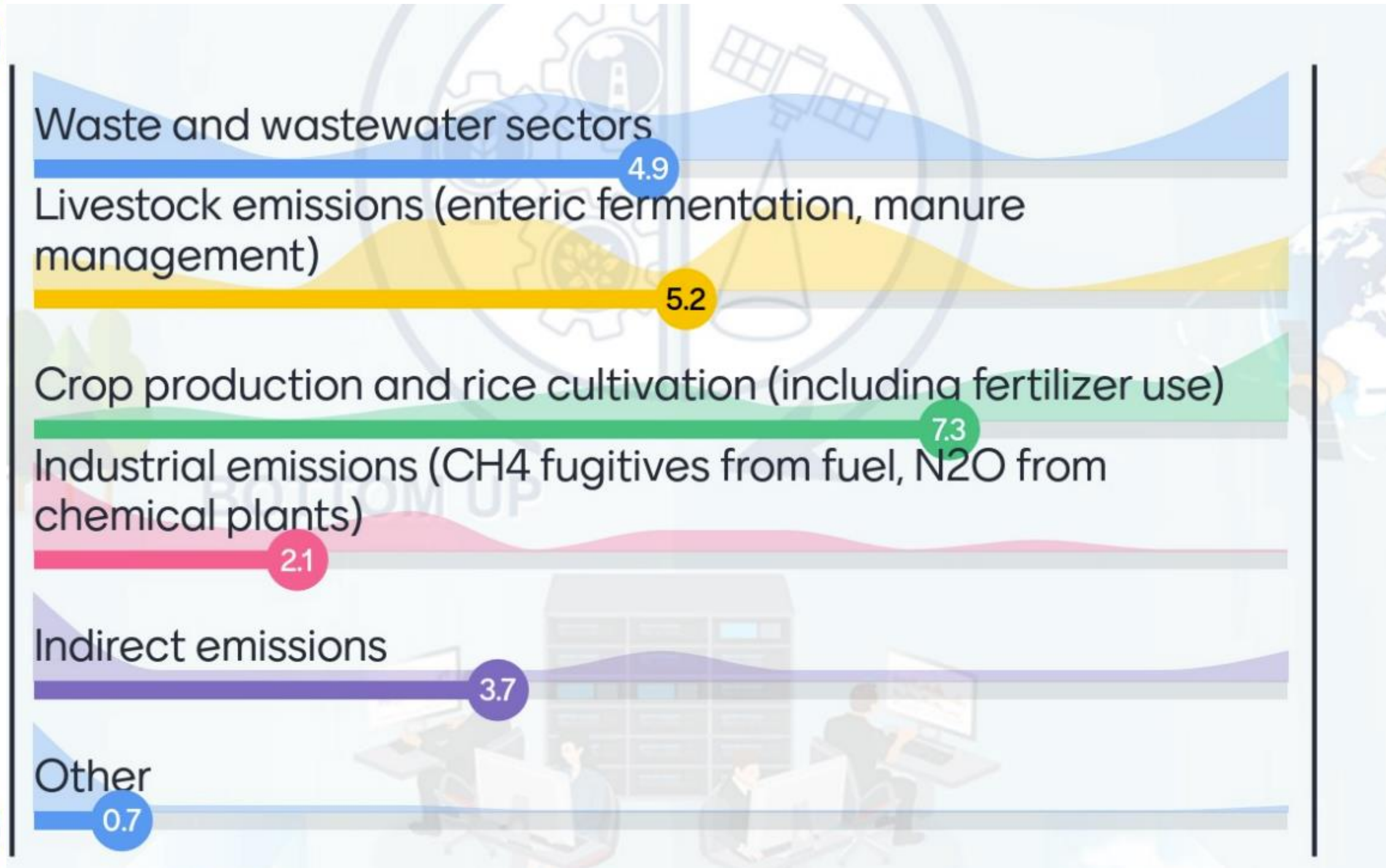
ESSD Petrescu et al 2020

Where and how do we need to improve our understanding from CH4 top down observations?



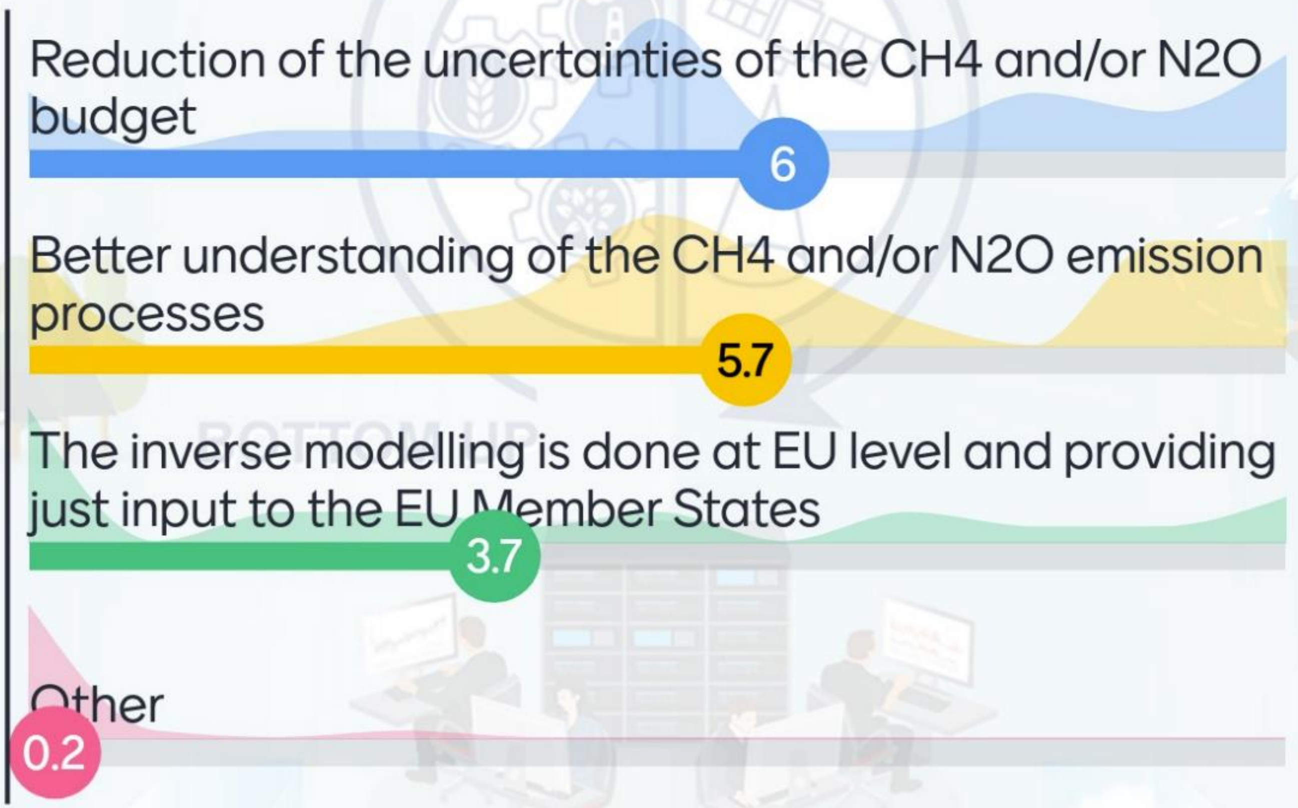
For which emissions sources would new atmospheric and/or flux measurements significantly help revising the emission factors most?





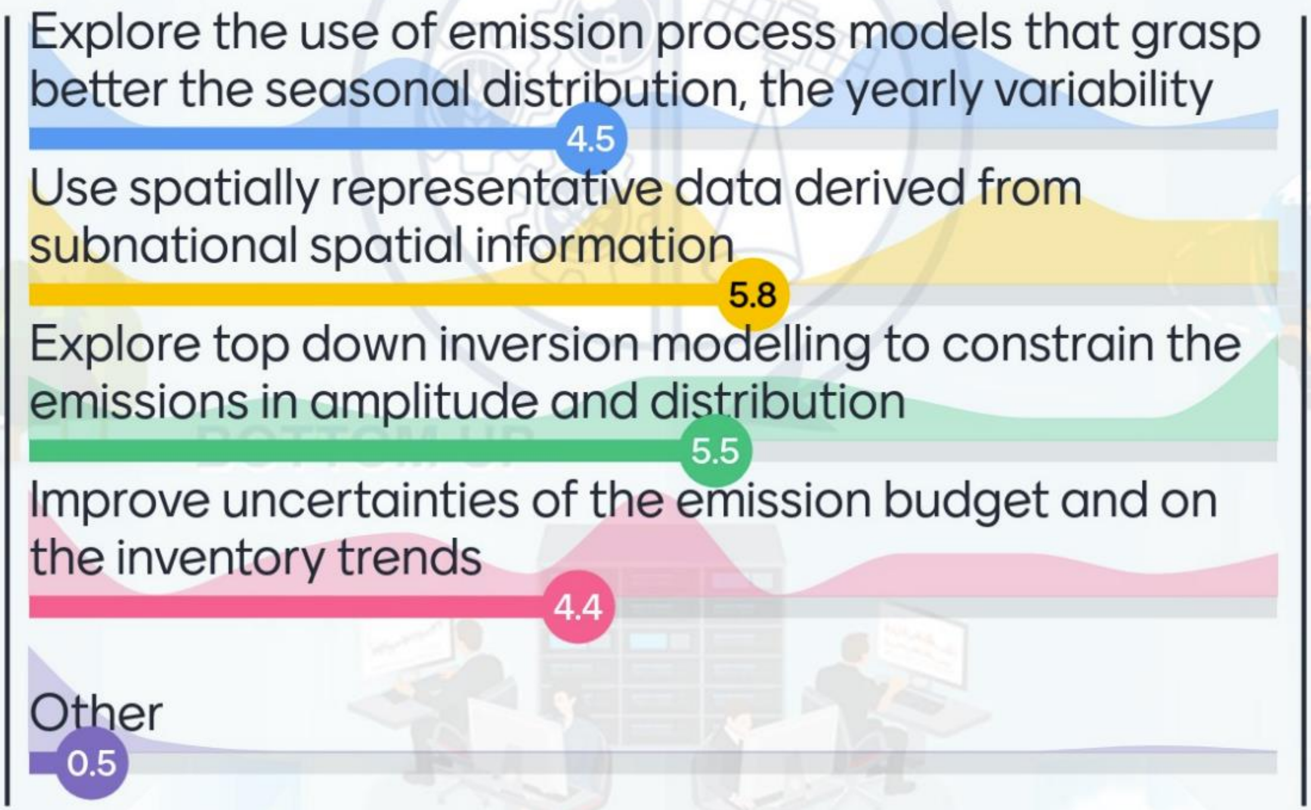
N=25

What would be the convincing arguments for the EU Member States to start using the VERIFY system for emissions data verification?



N=25

Which task would you tackle first for further improvement of CH4 and N2O emission NGHGI estimates?



Concluding (?) remarks

- The bottom-up mean agrees generally well with the UNFCCC estimates, but show larger (climate) variability (i.e. ORCHIDEE)
- The **top-down ensemble estimates show large variability and uncertainty**
- For CO2 and LULUCF sector, there is the need to reduce the gap between inventories and models by **defining common definitions** in land use reporting
- **The uncertainty is a fundamental parameter**. It is essential to correctly compare emission/removal estimates.
- **Verification is an important issue** for all these levels (AD, IEF, emissions/removals) as all the results necessarily need to match.
- **The spatial resolution** of current top-down models could be a limiting factor for the application of these instruments for verification purposes
- **Categories and sectors** need to be identified
- **Dissemination** of new tools is important (low awareness of availability of new tools)

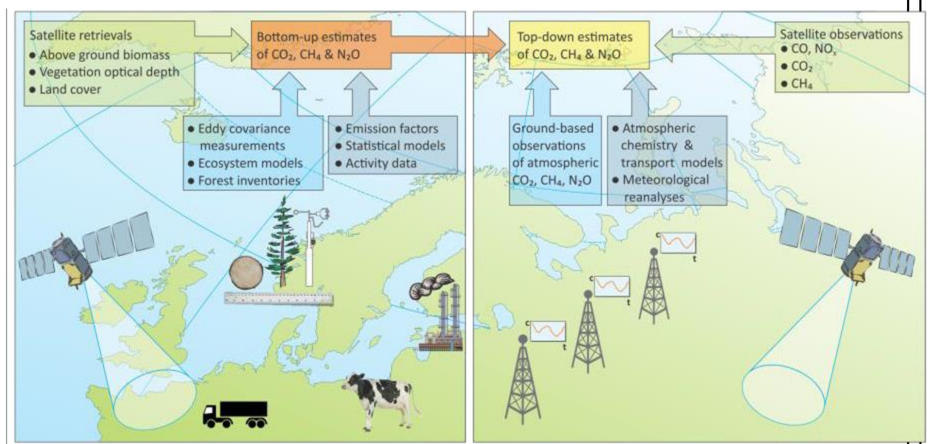
Thanks!

parlando: CMCC-Lucia Perugini
Visualizza fotocamere attive
CMCC-Lucia Perugini
LSCE-Aurélie Paquirissa...
LSCE - Matt McGrath
IT- ISPRA marina vitullo
WUR/KIT Karina Winkler
Roxana Petrescu
CMCC - Guido Pellis
Giacomo Grassi
Citepa - Colas ROBERT
Free University - Han D...
Matthews Bradley
Peylin
ECMWF - Richard Engel...
JRC Matteo Vizzarri
Smith, Professor Pete
Kuhnert, Matthias
Werner Kutsch
NL-RIVM Paul Ruyssen...
madhuban Kumar
Herold, Martin
Glen Peters
Dirk Günther
SCSI / Johann Thorsson
SCSI - Leone Tinganelli
Gunnhild Søgaard, NIBIO
Microfono
Fotocamera
Schermo
Abbandona

VERIFY Project

Aim:
Quantify more accurately C Stocks & fluxes of CO2, CH4, and N2O across the EU

Web site for more details
http://verify.lsce.ipsl.fr/



How:
Based on independent observations and modelling.

Why:
To support the Paris Climate Agreement

Project Duration:
48 month

Project Funding:
10 ME (2.5 ME/year)

Consortium Numbers
40 partners
Institutes

Work Content Numbers
9 work-packages:
3-Verification science,
1-Inventories
1-Synthesis & Products
2-Policy relevance & Intl program input

Considerations on TD vs BU

- For **TD it is impossible to separate the natural from anthropogenic** sources (uncertainty introduced by definitions*). Natural soils (unmanaged) can have both natural and anthropogenic emissions while anthropogenic (managed) agricultural soils can also have a level of natural emissions.
- Sectors and categories need to be defined
- Further improvement of **inverse methods** for N_2O and CH4 is needed to determine the total level of emissions and, most importantly, the trends.
- The UNFCCC 2019 Refinement advices the MS to actively try to include total TD estimates in their country reporting