Attributing and Verifying European and National Greenhouse Gas and Aerosol Emissions and Reconciliation with Statistical Bottom-up Estimates

Reconciling LULUCF emissions reporting with top-down estimates in AVENGERS

A project funded by European Union's Horizon Europe research and innovation programme

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JRC/EEA LULUCF workshop

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Coordinated by

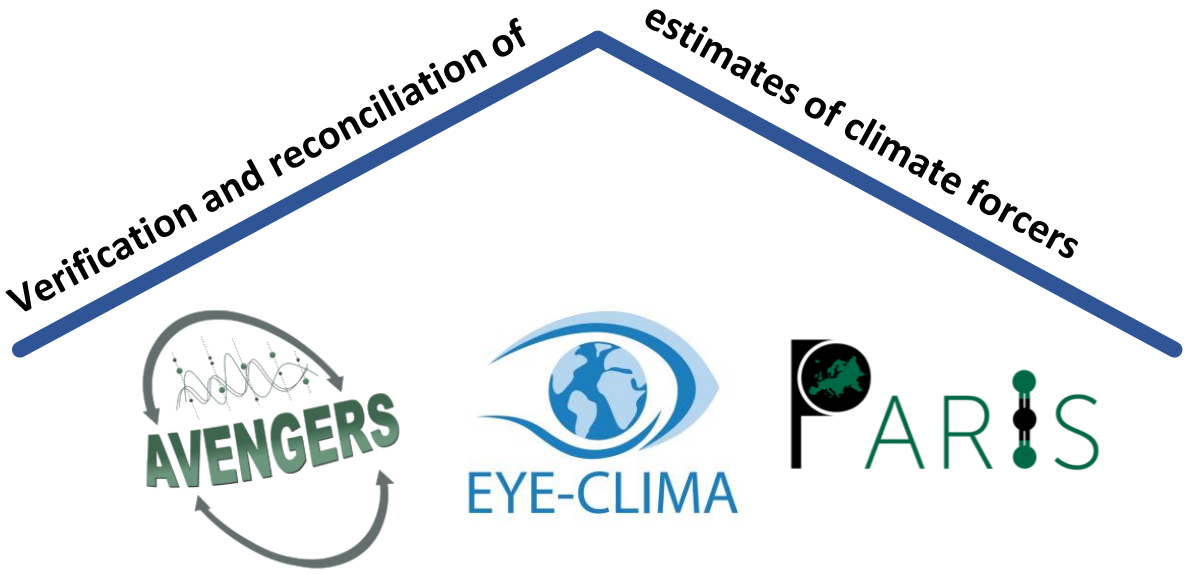
LUND UNIVERSITY

Some AVENGERS facts

- Horizon Europe project funded under the call on “Verification and reconciliation of estimates of climate forcers” (Cluster 5, Destination 1: Climate sciences and responses for the transformation towards climate neutrality).
- 48 months (01/2023 to 12/2026) and involves 15 partners (including inventory compilers) from 7 countries.
- 2 other projects funded under this call: EYE-CLIMA and PARIS

Part. No.	Participant organisation name	Country
1 Coordinator	LUNDS UNIVERSITET (ULUND)	Sweden
2	THE INVERSION LAB (iLab)	Germany
3	ISPRA	Italy
4	RIVM	The Netherlands
5	UNIVERSITAET HEIDELBERG (UHEI)	Germany
6	CMCC	Italy
7	TNO	The Netherlands
8	ICOS ERIC	Finland
9	UMWELTBUNDESAMT (UBA)	Germany
10	SVERIGES LANTBRUKS-UNIVERSITET (SLU)	Sweden
11	EMPA	Switzerland
12	SRON	The Netherlands
13 Co-Coordinator	STICHTING VU (VUA)	The Netherlands
14	Chalmers University of Technology (Chalmer)	Sweden
15	The Cyprus Institute (CyI)	Cyprus

Project Group AVEYPA



Similar Overarching Objective: To support and improve national greenhouse gas and SLCF emission estimates using atmospheric observations

>10 National Inventory Agencies/Compilers involved

Collaboration with Copernicus Atmosphere Monitoring Service (CAMS)

AVEYPA common activities

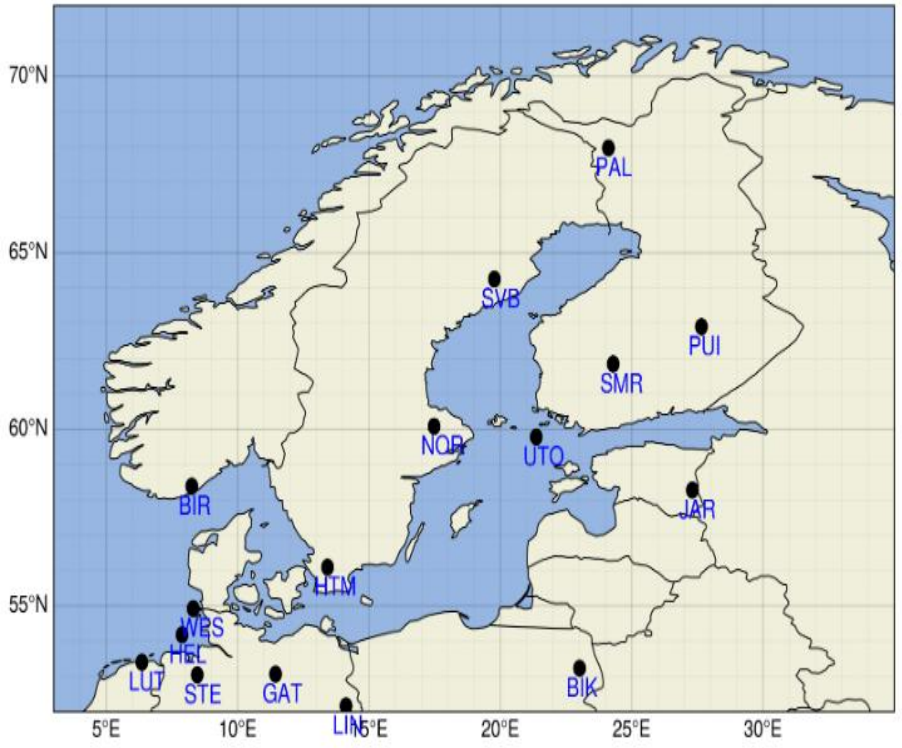
- **Inter-comparison of inversion results**
  - Inter-comparison tool to be available as a community Jupyter notebook
  - Hosted on the ICOS Carbon Portal
  - Allow easy (should also be useable by non-experts) and extensive analysis of the results from different inverse systems (created by MO, UNIVBRIS and EMPA)
- **Good practice guidelines**
  - Scientific guidance on atmospheric inversions in order to minimize errors
  - Guidance on how to calculate and report uncertainties
  - Guidance on how to compare inversion results with national emission inventories
- **Newsletter for stakeholders** (sent one to two times per year summarizing pertinent results)
- **Webinar series**
  - Aimed at scientists, inventory compilers and other interested persons
  - Scheduled twice a year on topics related to emissions estimation e.g.
    - Land surface modelling of GHG fluxes
    - Satellite remote sensing of CO_2 and CH_4
    - Satellite remote sensing of land biosphere and mapping biosphere and biosphere change
  - Next one **Thursday 5 June, 11-12 CEST**: F-gas emissions derived from atmospheric observations – what we have learned

https://www.icos-cp.eu/news-and-events/events/webinar-f-gas-emissions-aveypa

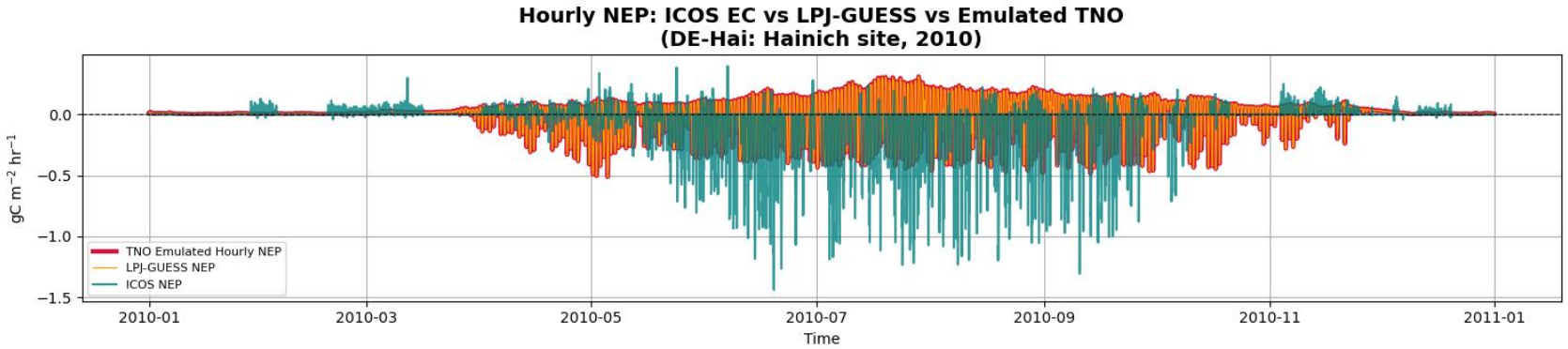
AVENGERS focus regions (case studies)

- LULUCF sector
  - Forestry: Sweden
  - Land use mapping: Italy, Sweden & The Netherlands
- Germany: largest economy in EU, UBA partner
- Switzerland: front-runner of top-down aided emission reporting
- Cyprus & MEME region: Hop-on objective
- EU+UK: GhG and aerosol (pre-cursor) emissions of SO_2, OC (organic carbon), and BC (black carbon) and their uncertainty

Case study: High resolution inversion for estimating Sweden's emissions



- Using reported LULUCF emissions (only Qc carbon stock change) as a prior in a regional inversion
- Spatially gridded based on the land cover in the CORINE Land Cover dataset
- Biomass burning (GFAS) and fossil emissions (national reported) prescribed
- Need to temporally downscale reported annual emissions to hourly using a process-based model (LPJ-GUESS) for forests and grassland
- Daily posterior emission estimates at 0.1° x 0.1° resolution -> end of this year



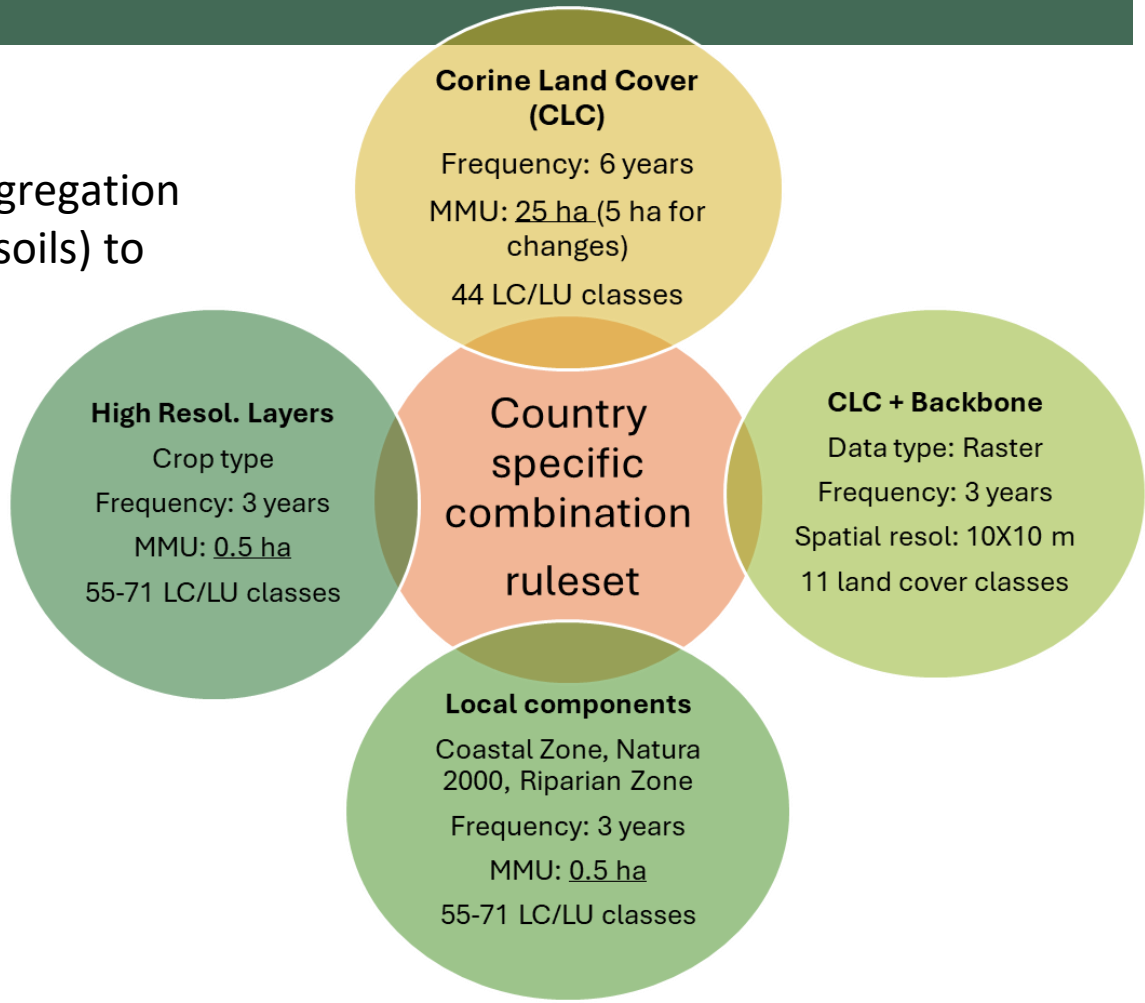
Test new Copernicus land cover/use products for the spatial disaggregation of emissions

Aim:

To evaluate the potential of a mix of CLMS products for spatial disaggregation of land-based emissions (LULUCF and N_2O emissions from managed soils) to be used as priors for top-down inversions

Combination of a selection of CLMS products to reconcile surfaces for each land use category with inventory activity data for **Italy, Netherland and Sweden**.

Comparison with **LULUCF instance:** 100m grid dataset, derived in the CLC+ Core web-application by combining land use and land cover (LU/LC) information already ingested in the system with an **EU wide homogeneous ruleset**



EXPECTED IN 06/2026: MAPS OF SPATIALIZED 2019 EMISSIONS FOR IT, NL, SE

In future the methodology developed could be applied to prepare wall-to-wall maps useful for spatially explicit estimate of LULUCF emissions

THANK YOU!

https://avengers-project.eu

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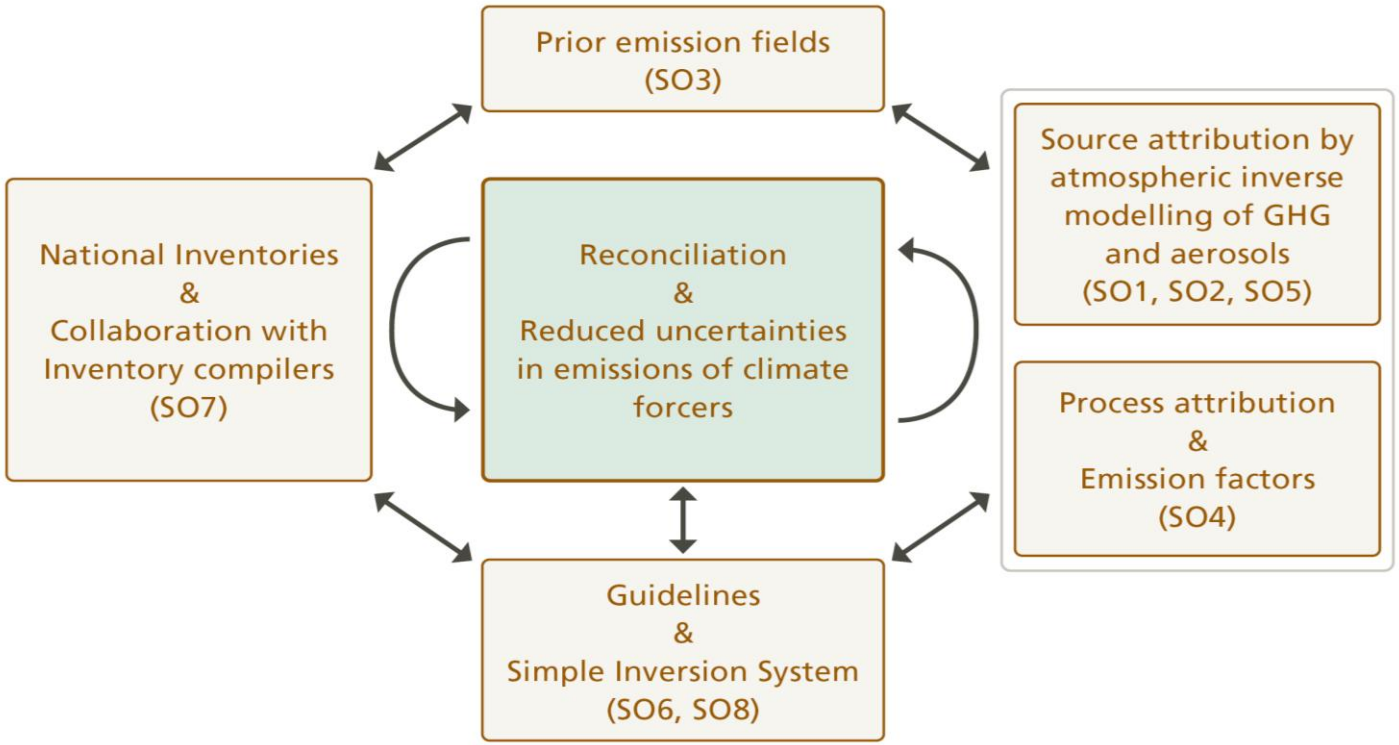
Objectives

To reconcile reported GHG emissions with independent information from atmospheric observations using top-down methods and process-based models, aiming at reducing the most important uncertainties of national emission inventories



Expected results (some highlights…)

- **Good practice guidelines** on how top-down emission estimation systems can support GHG inventories and the Global Stocktake.
- **A Flexible Inversion Tool for Inventory Compiler** for demonstrating the strengths and weaknesses in estimating GHG emissions, made available to national inventory compilers incl training events.
- **Observation-based estimates of GHG (CO_2, CH_4, N_2O) and aerosol emissions and their uncertainties** for European countries (with a specific focus on Germany, The Netherlands, Sweden and Switzerland such that they can **be used as input in the respective GHG inventories)**.
- **Improved estimates of uncertain emission factors** used in the inventories, based on process modelling in ORCHIDEE and LPJ-GUESS of Sweden and Italy for the AFOLU sector.
- Estimates of the **climate impact of national emissions in terms of radiative forcing** taking into account the **radiative impact of aerosols and GHGs**.
- An **evaluation of future observing systems (both satellite and in-situ)** in terms of their **potential to further reduce uncertainties** in the estimated GHG and aerosol emissions and corresponding guidelines on the design of the networks.

Expected results (some highlights…)

Most importantly:

A better understanding of how the different communities work and what is needed to effectively work together among atmospheric scientists, process-based land surface modellers and inventory compilers!