# EYE-CLIMA

Verifying Emissions of Climate Forcers

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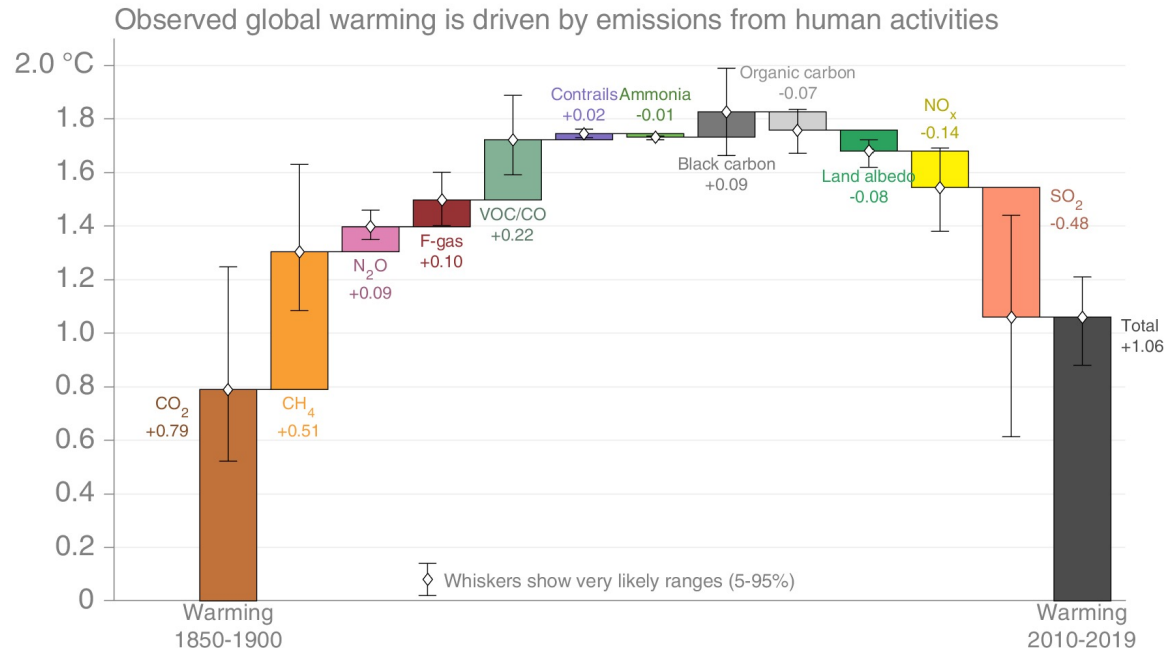
Project Objective

Address the need for independent verification of NGHGIs by developing TD methods to a level of readiness where they can be used to determine emissions at national and sub-national scale and incorporated into NGHGIs
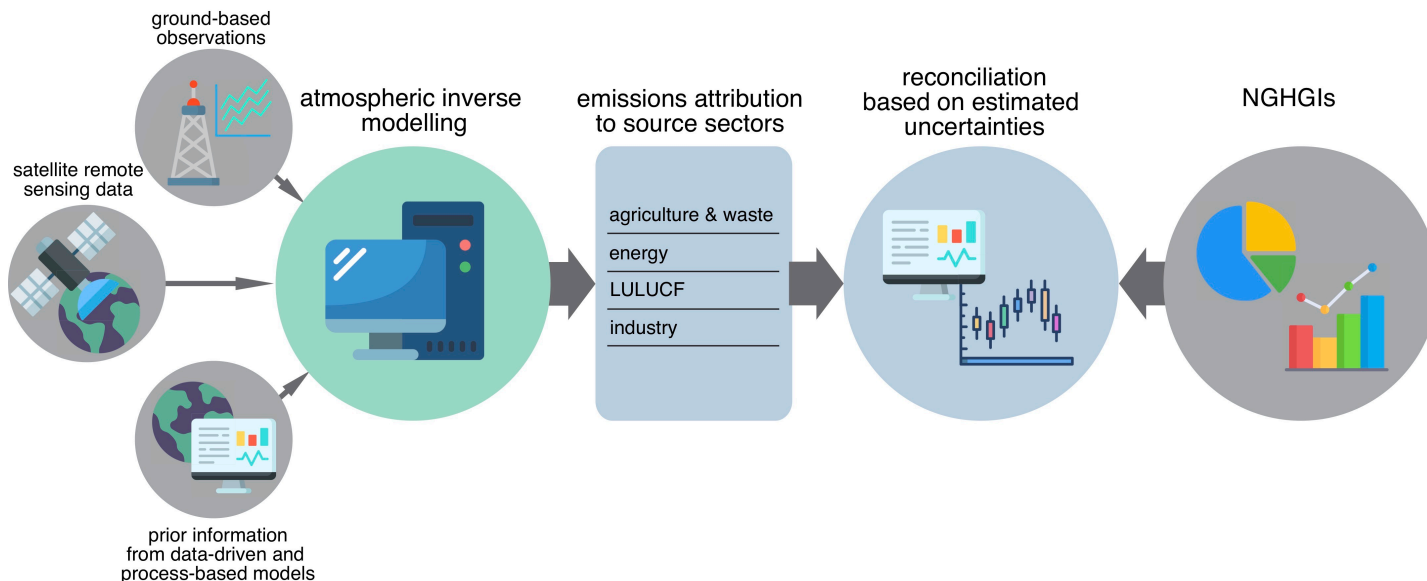
Climate forcers

- Most important gases contributing to warming are CO_2, CH_4, N_2O, and F-gases
- Most important aerosol contributing to warming is black carbon (equivalent to that from N_2O but with very large uncertainty)

Observed global warming is driven by emissions from human activities

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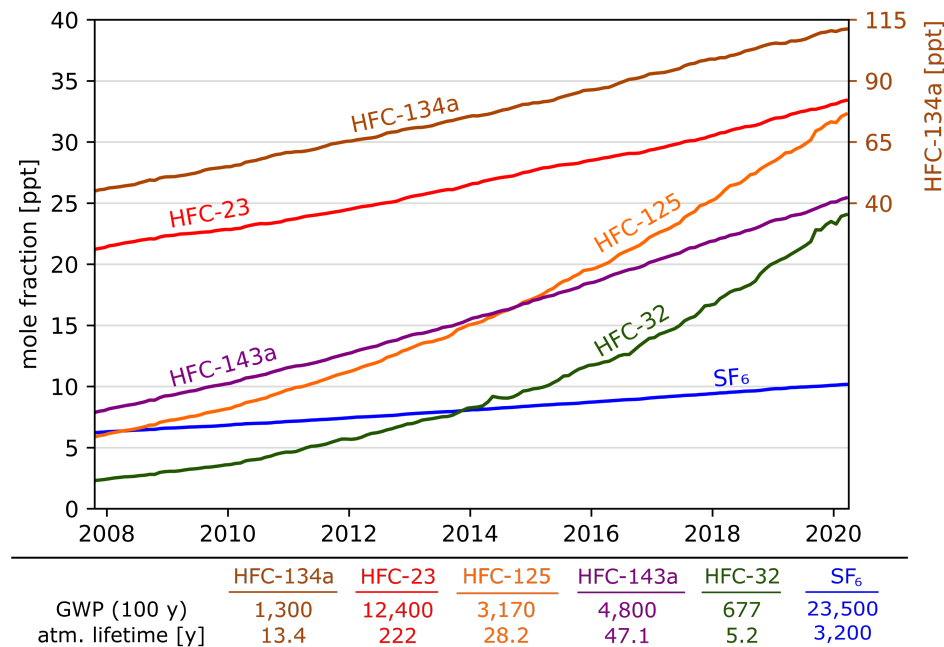
Focus on most uncertain species and sectors

- **CO_2**
  - LULUCF – 25% of pledged emission reductions in Paris agreements but large uncertainty
  - Not covering fossil fuel emissions (focus of CoCO2)

- **CH_4**
  - Energy: 62% total GHG uncertainty
  - Agriculture: 24% total GHG uncertainty
  - Waste: 76% total GHG uncertainty

- **N_2O**
  - Agriculture: 74% total GHG uncertainty
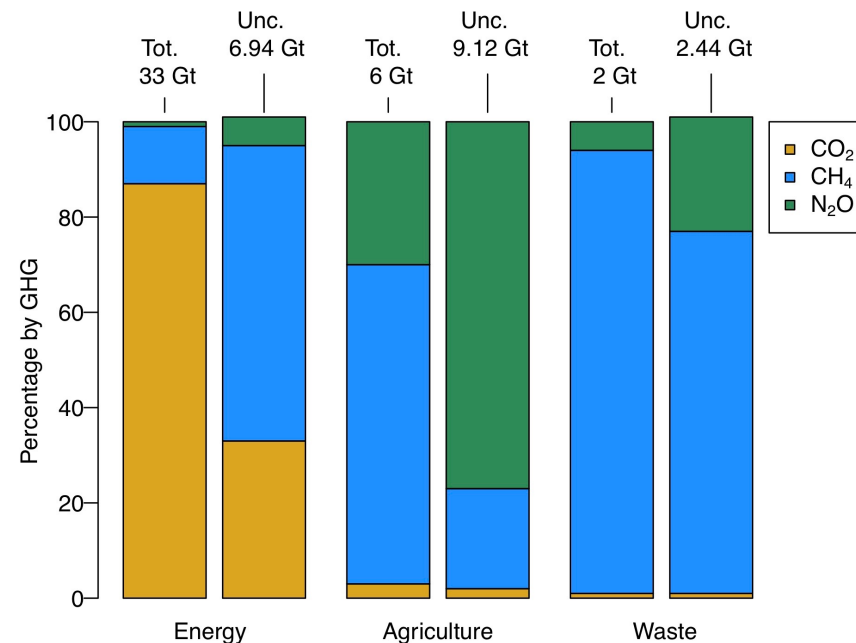

Based on Solazzo et al. 2021

F-gas species

- Will cover 6 species selected based on GWP and trends in emissions
- HFC species covered under Kigali amendment to Montreal protocol
- EU adopted F-gas regulation to reduce F-gas emissions 66% by 2030 relative to 2014 levels

|	HFC-134a	HFC-23	HFC-125	HFC-143a	HFC-32	SF$_6$
GWP (100 y)	1,300	12,400	3,170	4,800	677	23,500
atm. lifetime [y]	13.4	222	28.2	47.1	5.2	3,200

Project Structure

- Work packages organised around methodology
- Four technical WPs and one outreach WP
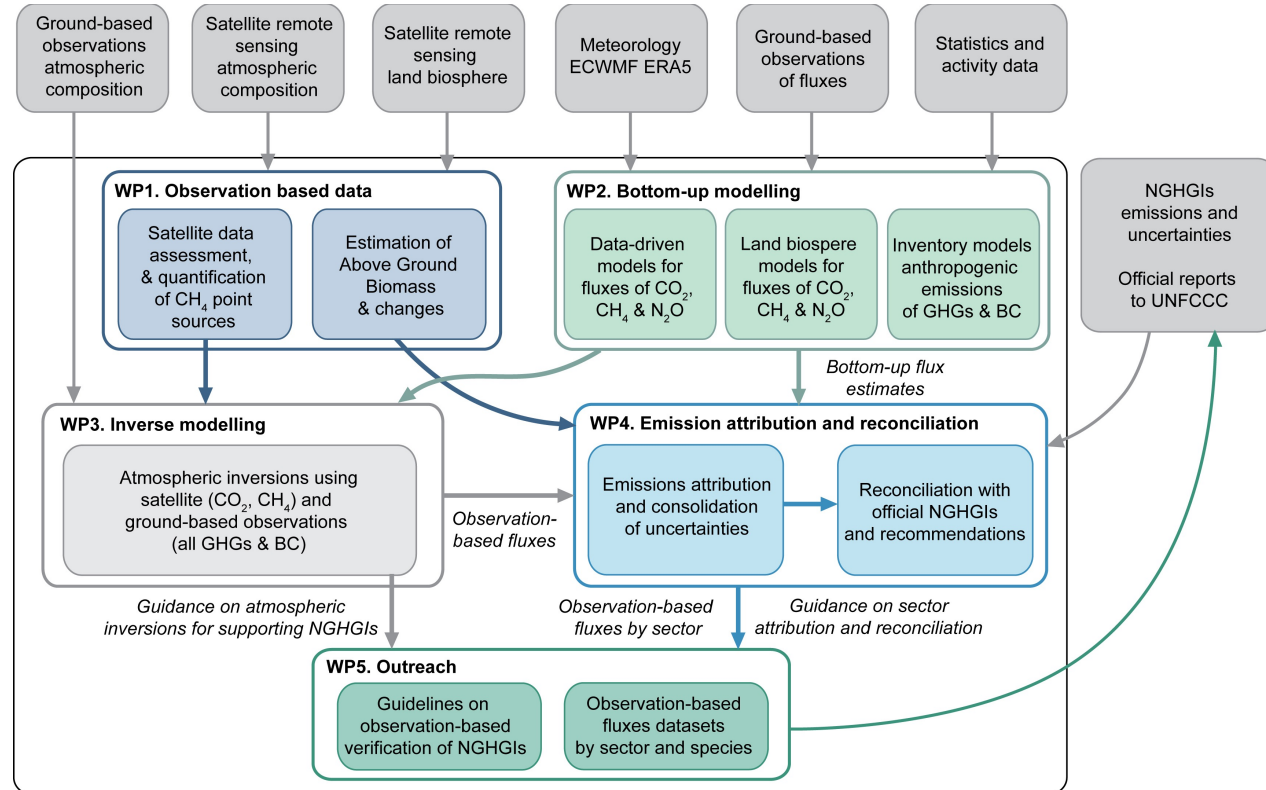
Research focus: CH_4 detection from space

- Focus on TROPOMI, PRISMA and Sentinel-2 (S2) missions – detect major emitters so only limited number of observable sources in Europe

- 2-step machine learning approach to identify plumes and quantify emissions

- Exploration of data from new missions, MethaneSAT and CarbonMapper, and commercial satellites, Worldview-3 (WV-3) and GHGSat

WV-3 observations over Middle East
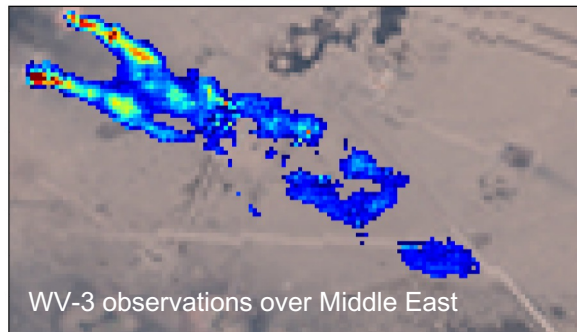
0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
XCH4 vertical column [ppm]

IME = 2321.45 kg; L = 1552.19 m; Q = 10495.76 kg h-1

PRISMA observations over Turkmenistan
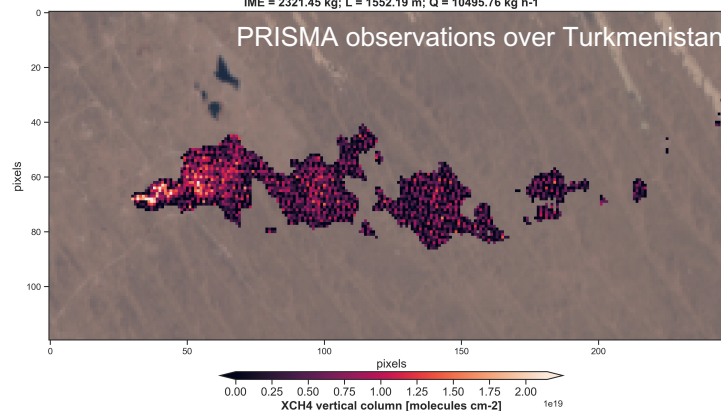
0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00
XCH4 vertical column [molecules cm-2]   1e19
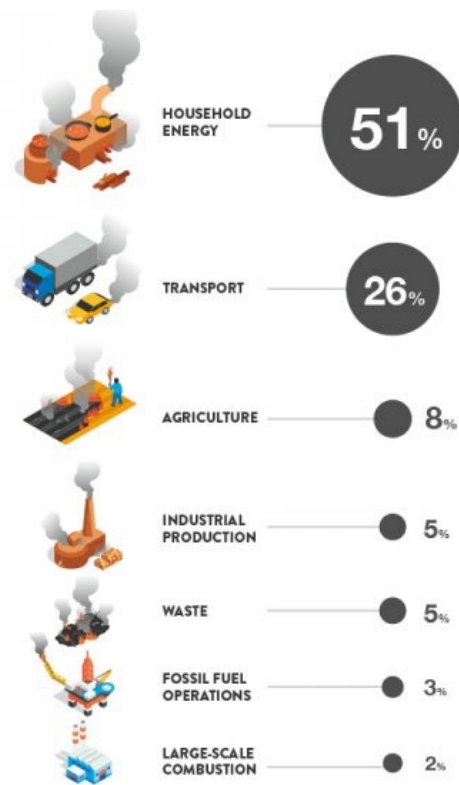
Research focus: CO$_2$ LULUCF

- Satellite observations of L-VOD from SMOS to derive above ground biomass (AGB) and its change from 2010
- L-VOD linearly related to AG carbon density using maps of forest carbon (at low frequency)
- Atmospheric inversions for land-biosphere fluxes, separation of manage versus unmanaged fluxes, correction for lateral carbon flows (crop harvest, rivers)
- Comparison of estimates from L-VOD and inversions
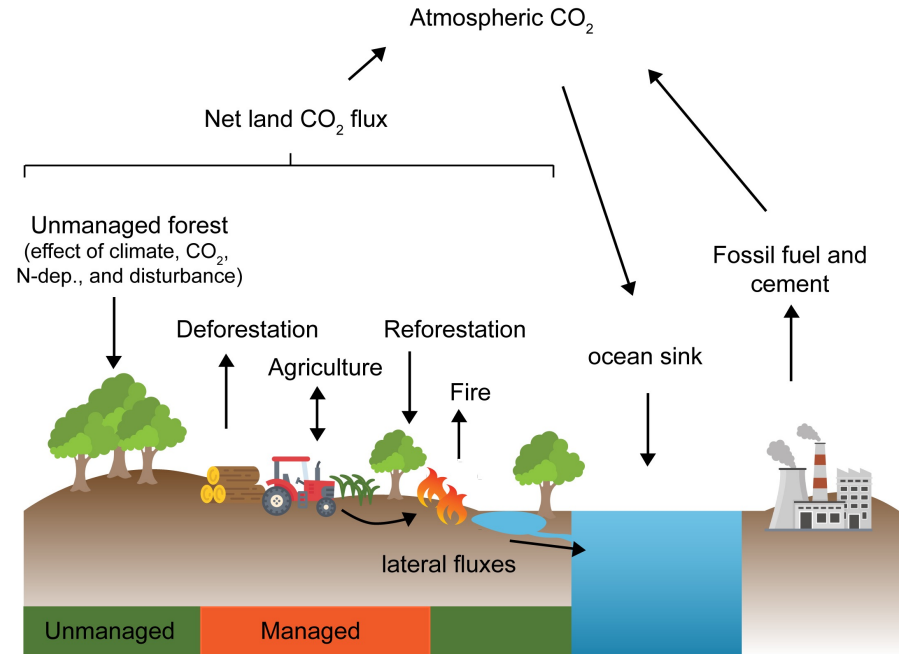
Research focus: Black Carbon

- Aim: better quantification of sources, aging and thus radiative forcing of BC
- Apportionment of BC measurements (from Aethalometers) into 2 source categories: i) traffic and power-plants, and ii) residential and biomass burning
- Atmospheric inversions:
  - European-scale: using FLEXPART with ensemble of scavenging parameters to determine uncertainty
  - Global-scale: using TM5-MP with aerosol microphysics and the CarbonTracker data assimilation shell
- Observations:
  - Harmonized observations from ACTRIS and EMEP (Europe) and NOAA Federated Aerosol Network (FAN) (Global)

SOURCES OF BLACK CARBON

HOUSEHOLD ENERGY — 51%

TRANSPORT — 26%

AGRICULTURE — 8%

INDUSTRIAL PRODUCTION — 5%

WASTE — 5%

FOSSIL FUEL OPERATIONS — 3%

LARGE-SCALE COMBUSTION — 2%

Collaboration with NGHGI agencies

- Pilot projects on specific species and sectors
  - Agricultural N_2O emissions from inversions and NGHGIs in Germany and France (CITEPA, TI)
  - CH_4 fluxes from drained, restored and natural peatlands in Finland (FMI, Statistics Finland)
  - CH_4 fluxes from agriculture and waste in France, Germany and Finland (CITPEA, TI, Statistics Finland)
  - CO_2 fluxes from LULUCF sector in France (CITPEA)
- Preparation of guidelines on observation-based NGHGI verification in collaboration with NGHGI agencies to be published through IG3IS

Overall concept for verification of NGHGIs
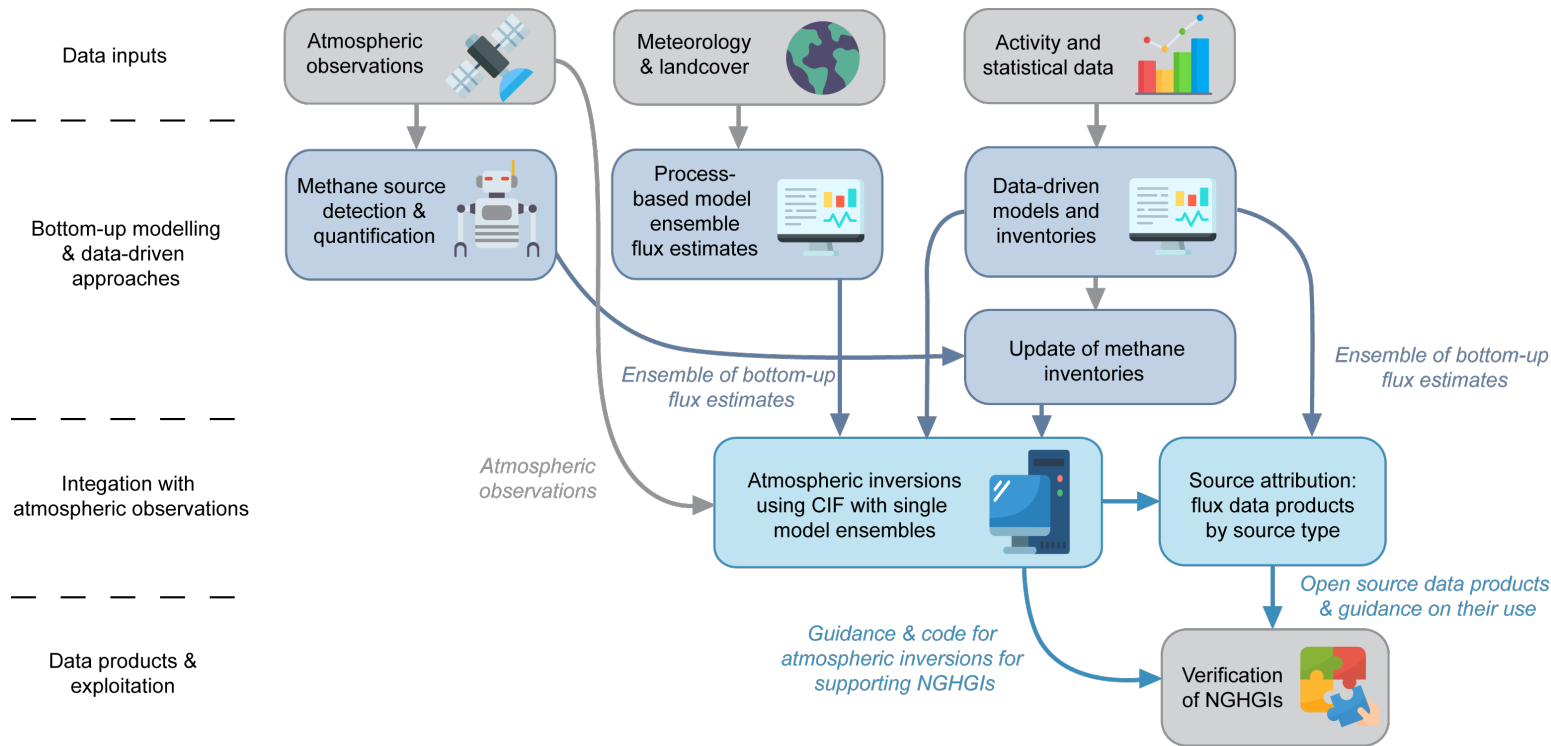
Partners and practical information

Coordinator: Norsk Institutt for Luftforskning (NILU)	
Partner Institutes:	
University of Vienna	Finnish Meteorological Institute
CICERO Senter for Klimaforskning	CITEPA
University of Leicester	ETHZ
University of Crete	WMO
Karlsruhe Institut für Technologie	Thühnen Institute
CNRS	CEA
ICOS	EMPA

- Project over 4 years potential start date late Autumn 2022
- Total budget of 5 M€

- partners
- associated partners
- partners with NGHGI compilers