KEEP IT TRACEABLE.

Prototyping a satellite enabled tool-kit system for GHG verification in Austria

ASAP 18: LEITPROJEKT PILOT FÜR EINE INTEGRIERTE CO2-BILANZIERUNG UND -ÜBERWACHUNG MIT COPERNICUS

FFG ASAP 18 Ausschreibung *Integrierte Treibhausgasbilanzierung und -überwachung mit Copernicus*

- At international (UNFCCC and Paris Agreement) and EU level (Governance Regulation 2018/1999), national inventories form the basis for monitoring collective and country-level progress in implementing climate change mitigation
- Together with the BMK, and the FFG a flagship project was procured
- Main tasks:
  - Enhanced use of EO data to observe land use
  - **Develop** and **consolidate Austrian know-how** to utilise **new** and **upcoming** satellite observations of atmospheric CO_2 and CH_4 concentrations (CO2M)
- 2.4 Million EURO budget
- Call was open from 1st Sep 2021 until 25th Jan 2022

Bundesministerium
Klimaschutz, Umwelt,
Energie, Mobilität,
Innovation und Technologie

FFG
Forschung wirkt.

https://www.ffg.at/ausschreibung/Leitprojekt-18-asap-ausschreibung

Core Team

GeoVille Information Systems and Data Processing GmbH: Project Lead, EO data processing, EO-based LULUCF mapping and monitoring, Copernicus Land Monitoring Service, CLC+, dissemination (PR, public, etc.)

University of Vienna: Atmospheric and inverse modelling and development of the respective methods/tools, process modelling, simulation, scientific dissemination

GeoSphere Austria: Atmospheric EO and in-situ data, atmosphere and inverse modelling, simulation, scientific dissemination, quality management

SISTEMA GmbH: EO data processing, future satellite missions, biomass expert, geodata production, IT system development, quality management

Earth Observation Data Center (EODC): Computing infrastructure, geodata production, Copernicus Land Monitoring Service

Cloudflight AT: IT system developments, atmospheric EO data, geodata production, cloud system DevOps, Copernicus Land Monitoring Service, CLC+

Technical University Vienna: Geodata production, process modelling, scientific dissemination

EOX: commercial activities

Objectives

We have **several specific objectives** for this modular system:

- **Development** of a **methodology** for **greenhouse gas accounting** based on the use of data and information products from the **Copernicus** program to support national reporting requirements

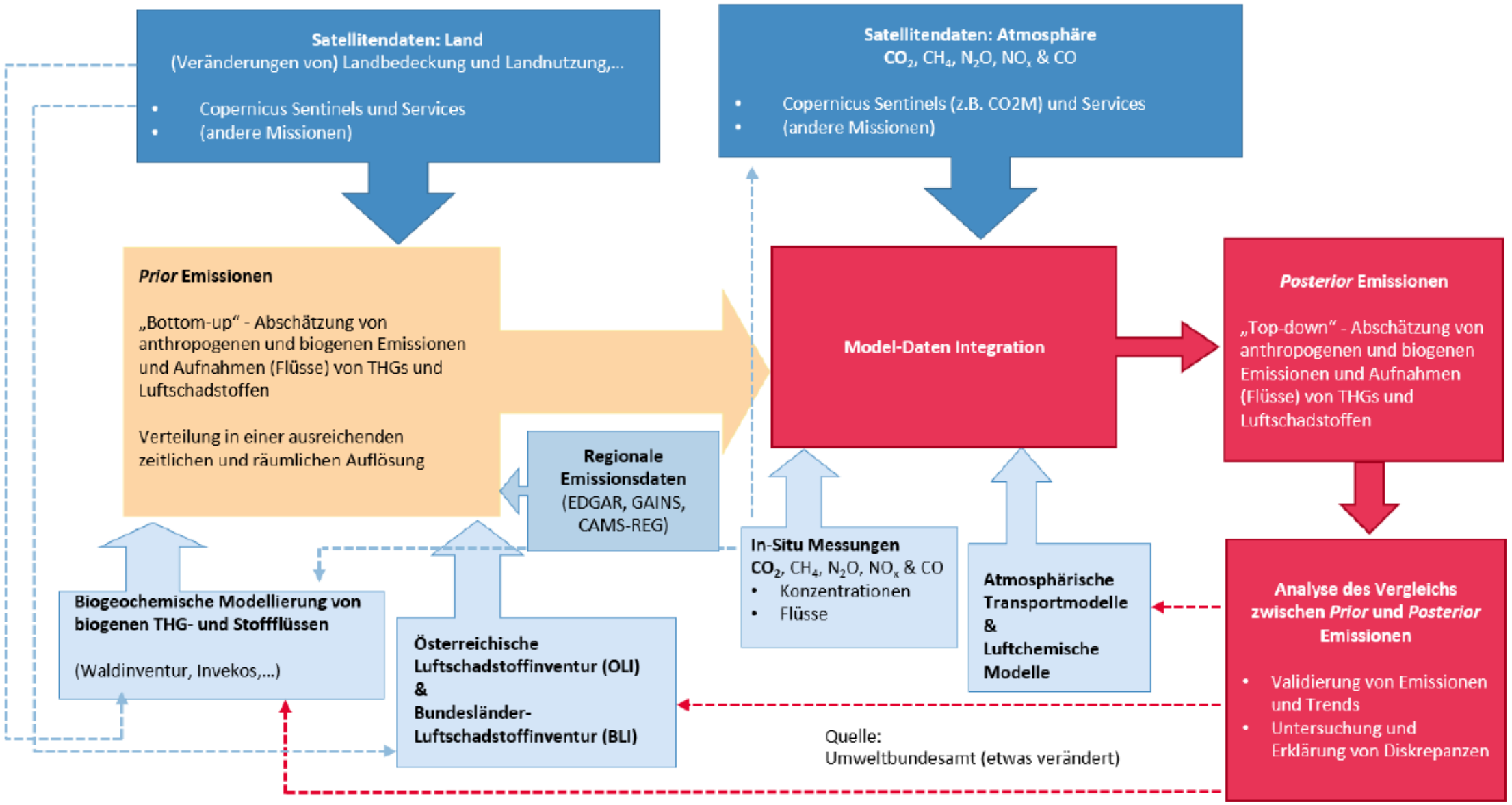
- Show the **benefit of EO-based** solutions and **data input** on the development of an independent **verification** capacity for UBA focusing on the top challenging inventory classes

- Show the benefit of EO-based solutions and data input for the **Land Use and Land Use Change and Forestry** (LULUCF) sector and improve the reporting and prepare for the upcoming standards

- Support and prepare the inventory approach for the use of current and future Copernicus data in **national emissions** monitoring

- **Simplify the data gathering process** and lead to cost and time savings in the overall GHG reporting process, the forest carbon trading processes and the global corporate sustainability processes

FFG Concept for EO-based GHG Emissions Monitoring



Quelle:
Umweltbundesamt (etwas verändert)

User Requirements collection

What is the current data basis or verification methodology?

Reported are the annual sums of GHG for different emission sectors for whole Austria. The emissions reported by UBA are calculated from activity data and emission factors. These are based as far as possible on **statistical data**, information on source level from companies and specific emission factors. UBA is involved in anthropogenic emission gathering and gets detailed information from companies, which is then disaggregated together with the federal governments. TU Graz is supporting by modelling traffic emissions. Relevant GHGs are CO_2, N_2O, CH_4 and F-gases.

How can EO data support reporting? What is the UBA missing?

- There is a need to **evaluate** the National Inventory Report (**NIR**) by an **independent dataset**, QA/QC of data produced by UBA
- For this purpose, **satellite** data (e.g., GHGSAT data on CH_4) and **in-situ** data will be used by the **inverse modelling** applications. The **two central aspects** are the **improvement of the estimated CO_2 and CH_4 emissions** and the **verification** of the current reporting process of UBA with **independent datasets** based on **earth observation**.

What are the highest uncertainties?

- According to UBA the biggest uncertainties lie in the area of N_2O emissions (~ 200%), **soil emissions** and **LULUCF** in general. Important aspects related to LULUCF emissions are the distinction between anthropogenic and biogenic emissions (activity data) and the distinction between Land Use (LU) and Land Cover (LC).
- **Anthropogenic CO_2 emissions are very well known** in contrast to **CH_4 emissions** e.g. caused by Neusiedlersee. If emissions are unknown, IPCC or Austrian emission factors are used. The reporting follows strict guidelines by IPCC, although the level of detail differs between countries.

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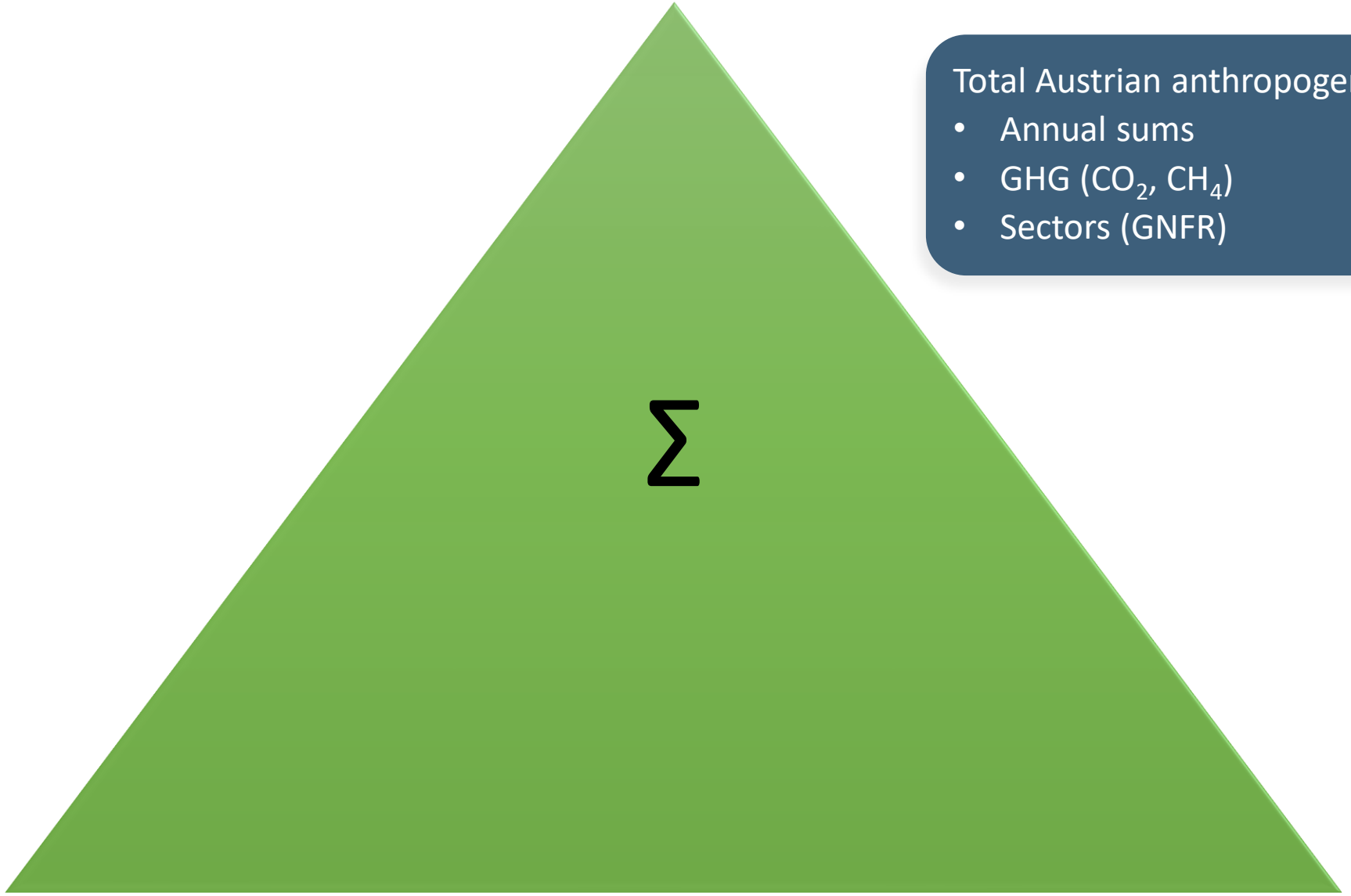
EO and (in-situ) data in GHG-KIT will be used:

- Improve the input data (e.g. land use for biogeochemical modelling, LULUCF)
- Inverse modelling
- Evaluation (independent data sets)

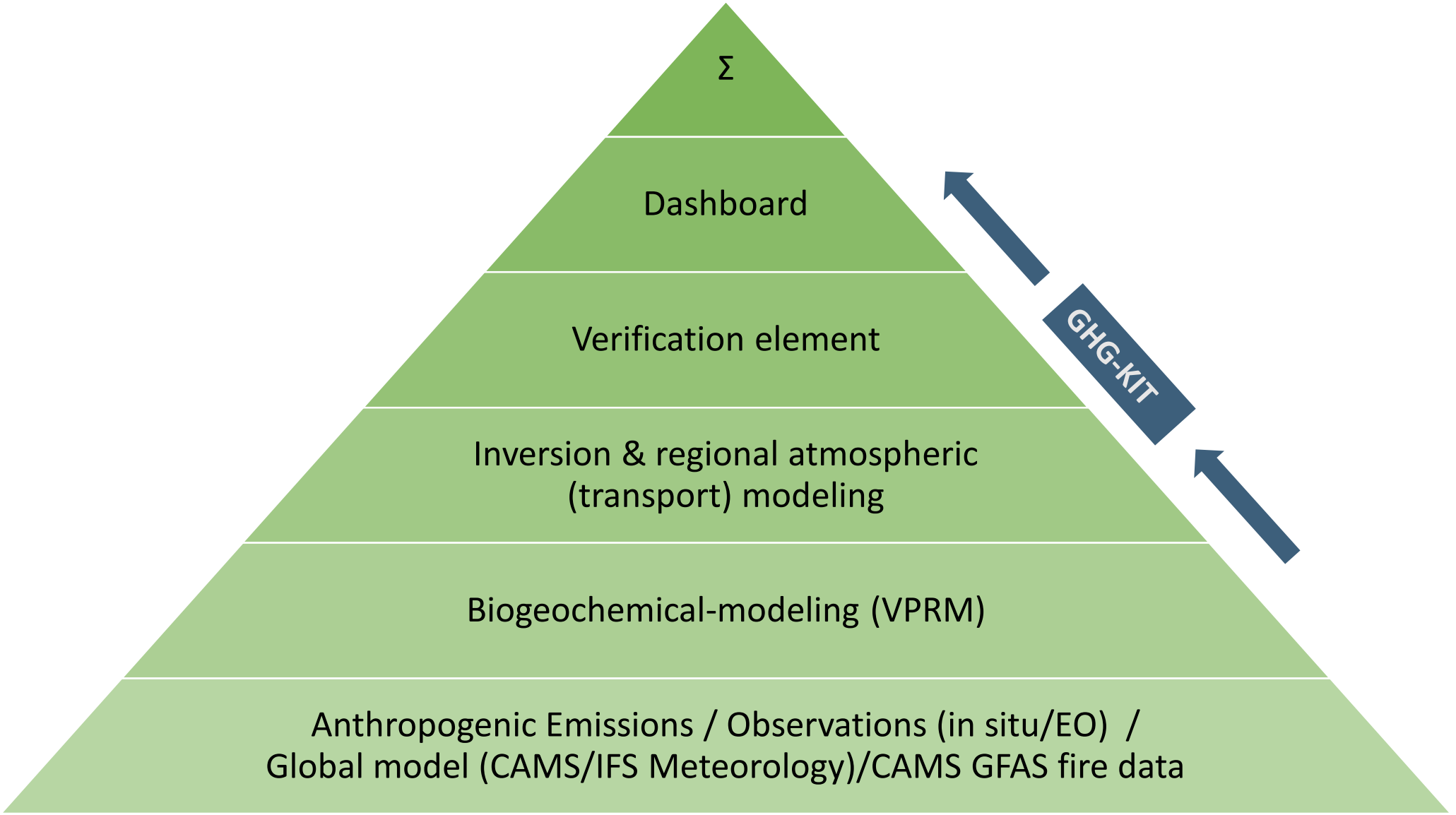
UBA reporting



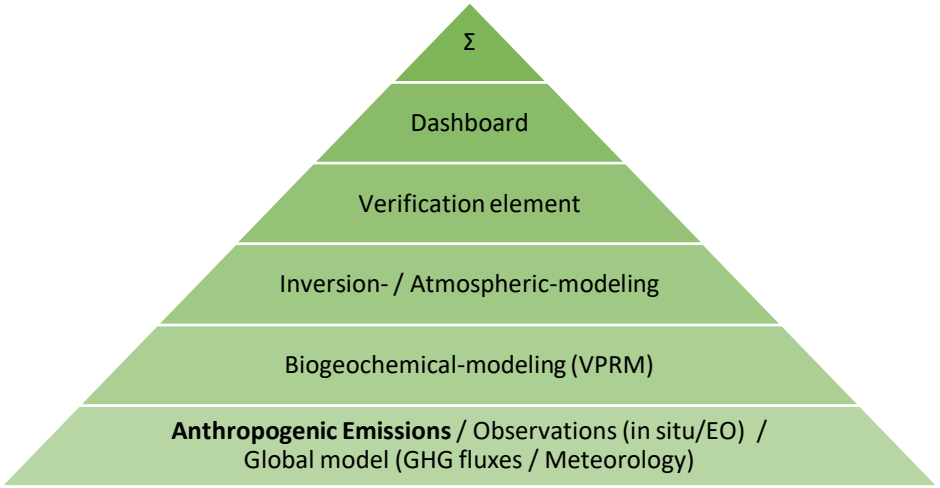
Total Austrian anthropogenic emissions

- Annual sums
- GHG (CO_2, CH_4)
- Sectors (GNFR)

GHG-KIT concept

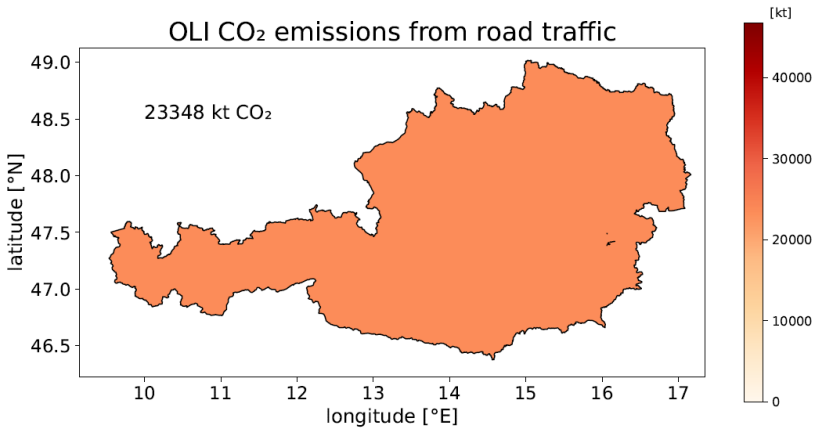


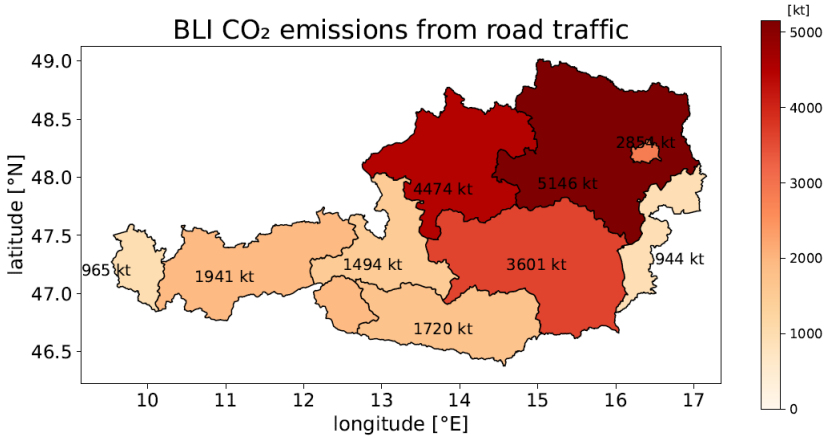
GHG-KIT processing chain

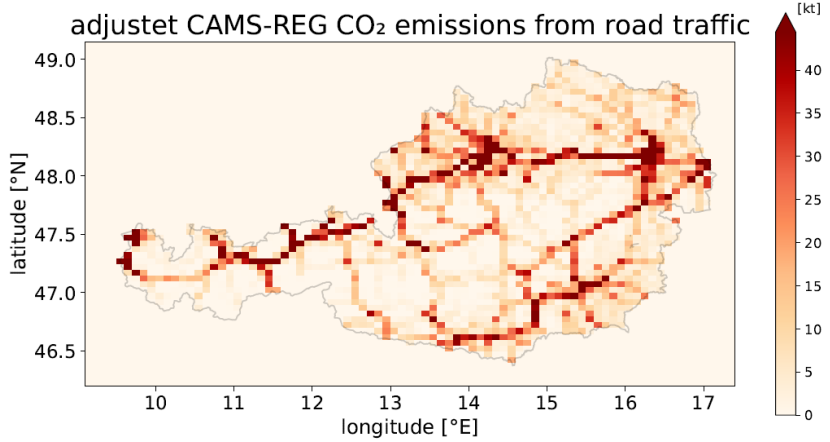


For all sectors:

- Gridded data sets
- CAMS-REG Scaled with OLI







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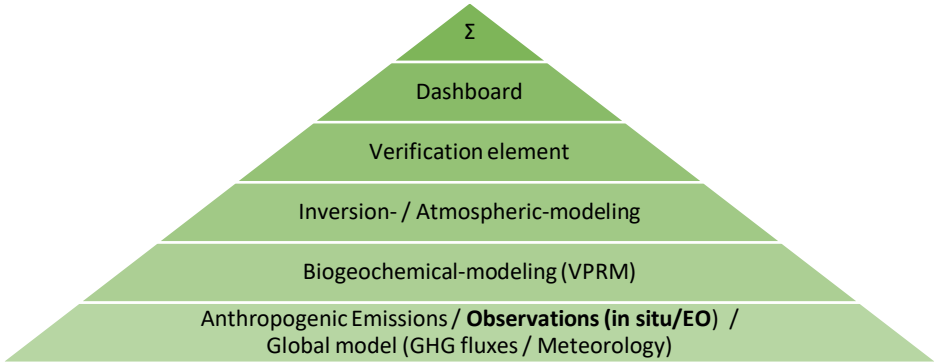


In-situ observations:

Atmospheric CO_2 and CH_4 concentration:

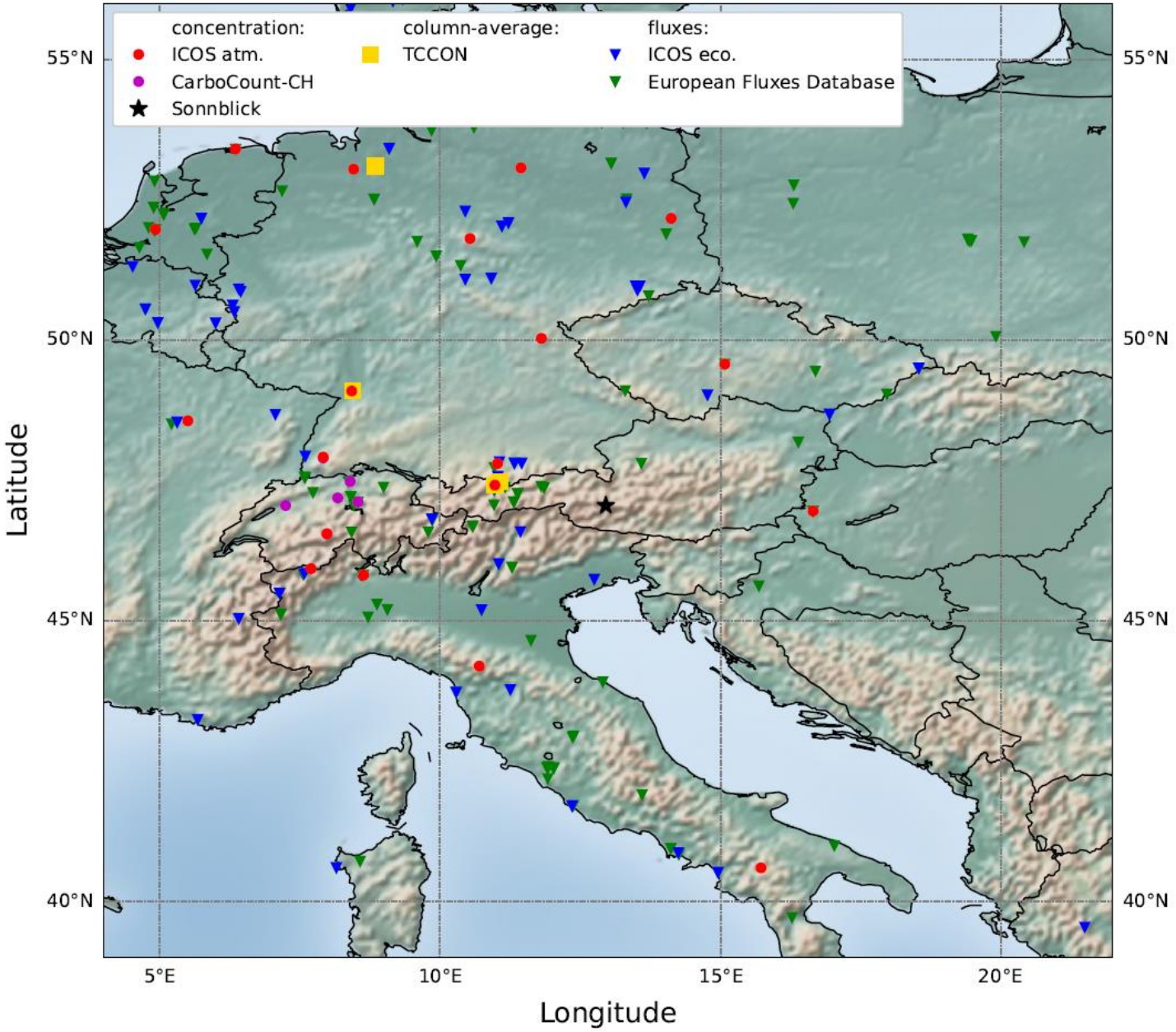
- ICOS - Integrated Carbon Observation System: *research infrastructure across Europe*
- CarboCount-CH-network: *4 sites in Switzerland*
- Sonnblick Observatory

Column-averaged abundances of CO_2 and CH_4:

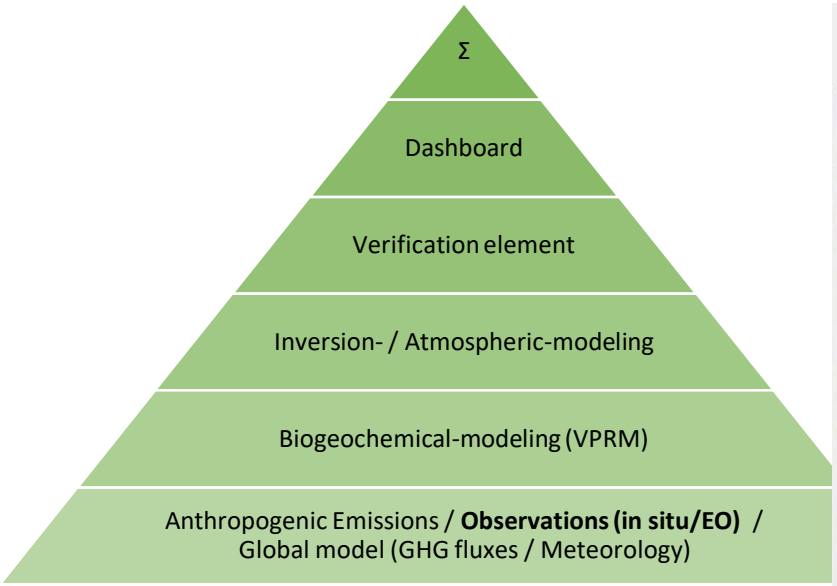
- TCCON - Total Carbon Column Observing Network: *worldwide network of Fourier Transform Spectrometers*

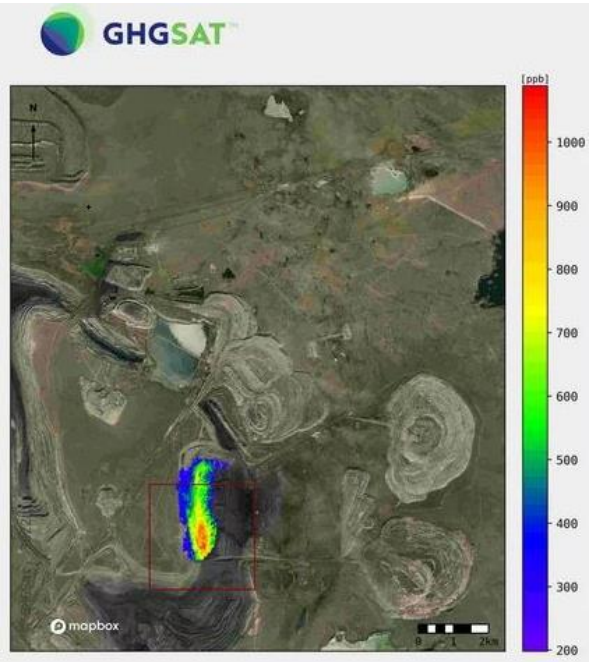
CO_2 and CH_4 fluxes between ecosystems and atmosphere:

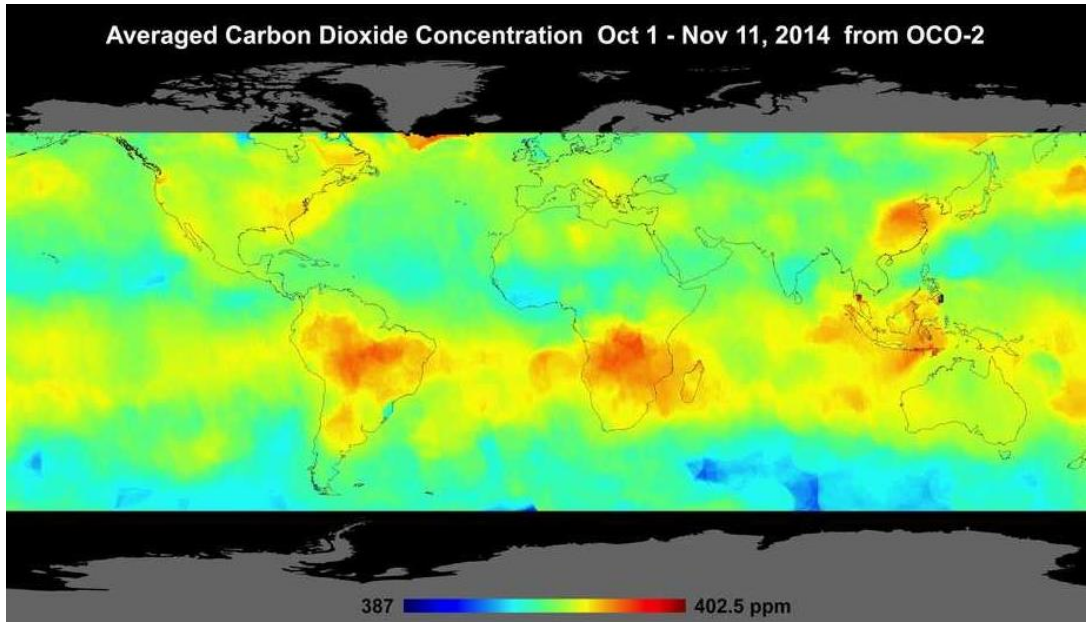
- ICOS - Integrated Carbon Observation System
- European Fluxes Database: *combines databases that are part of European research projects*



GHG-KIT processing chain

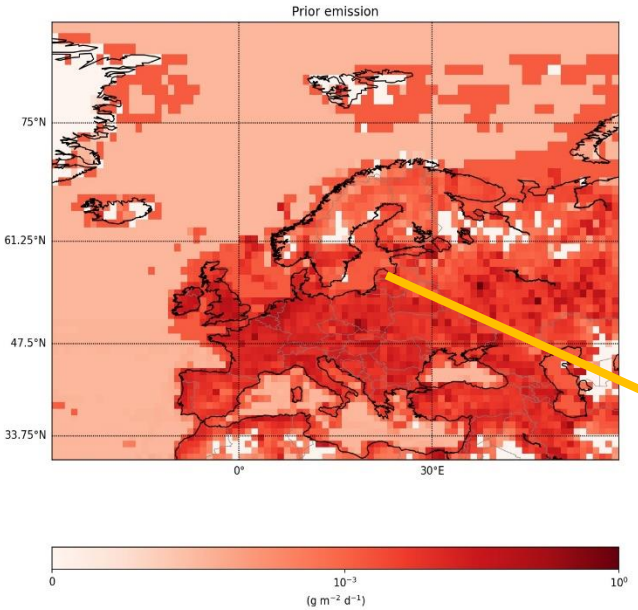




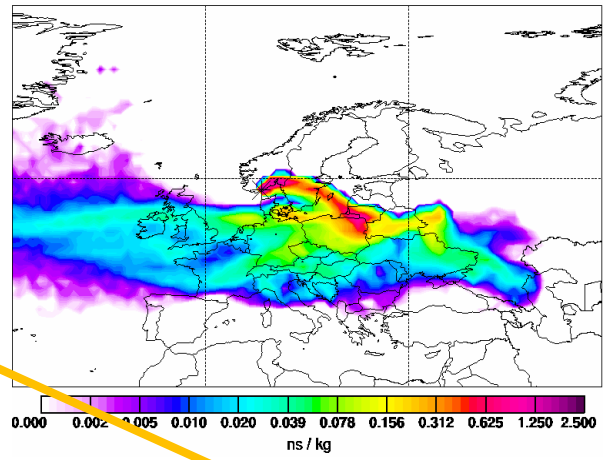


Mission	Organisation	Status	Launch date	Spatial resoluti	Revisit period	Sensor/ System	Atmospheric measuremen t	Description	Access	Task	Potential Use in GHG-	Overall System*	LULUCF Inventor y	Verification Elemen	Expert Partner (consortiu	Notes
Sentinel-2 A/B	EC ESA	Operational	2015	10m	5 days	multispectral		Optical, multispectral high-resolution Sentinel-2 MSI data in full (10, 20, 60m) spatial resolution processed to bottom-of-atmosphere reflectance	Open access	WP3, T6.1	x	yes	yes		GeoVille	
Sentinel-1 A/B	EC ESA	Operational	2014	5m - 20 m	1-3 days (with two satellites 2-6 days (with only Sentinel-1A)	RADAR		High-resolution C-band SAR observations resampled to 10m spatial resolution processed to calibrated, terrain corrected and georeferenced, Available from 2014, will be used in data-sparse (high cloudiness) regions to support the derivation of LULC information	Open access	WP3, T6.1	x	yes	yes		GeoVille (EODC)	
Sentinel-5P (TROPOMI)	EC ESA NSO	Operational	2017	7.5km	daily	multispectral	O3, SO2, NO2, CO, HCHO, aerosols	Satellite carrying the Tropospheric Monitoring Instrument (TROPOMI) which is an imaging spectrometer providing data in coarse spatial resolution (7x7 km²), provides trace gas information including total columns of ozone, sulphur dioxide, nitrogen dioxide, carbon monoxide, formaldehyde, vertical profiles of ozone, cloud & aerosol information	Open access	WP3, WP5, T7.3	x	yes		yes	Cloudflight (Sistema)	Level-1/Level-2 data available https://registry.opendata.aws/sentinel5p
Copernicus CO2 Monitoring (CO2M) Mission (planned launch in 2025)	EC ECMWF ESA EUMETSAT	Development	planned 2025	4km	11 days	multispectral	CO2	Carry a near-infrared and shortwave-infrared spectrometer to measure atmospheric carbon dioxide produced by human activity. These measurements would reduce current uncertainties in estimates of emissions of carbon dioxide from the combustion of fossil fuel at national and regional scales. This provides EU with unique and independent source of information to track their impact towards decarbonising Europe	Open access	WP3, WP5, T7.3	x	yes	yes	yes	Cloudflight (GeoVille)	Synthetic data (level-1/level-2) available but limited, understanding what data will look like
BIOMASS (planned launch in 2023)	EC ESA	Development	planned 2024	50m - 200m		RADAR		Carrying a novel P-band synthetic aperture radar, the Biomass mission is designed to deliver crucial information about the state of our forests and how they are changing, and to further our knowledge of the role forests play in the carbon cycle.	Open access	WP3, T6.1, T7.3	x	yes	yes	yes	Sistema (GeoVille)	Sample data available, limited but representative, synthetic data level-1/level 2
NASA-ISRO SAR (NISAR)	NASA	Development	planned 2024	5m - 10m	weekly	RADAR		NISAR will observe Earth's land and ice-covered surfaces globally with 12-day regularity, sampling Earth on average every 6 days for a baseline 3-year mission.	Open access	WP3, T6.1, T7.3		yes	yes	yes	Sistema	
Landsat 5	NASA USGS	Finished	1984 - 2013	30m	16 days	multispectral		Optical, multispectral high-resolution Landsat 5 imagery (Thematic Mapper (TM) and Multi Spectral Scanner (MSS)) with similar spectral characteristics as Sentinel-2 data in 30m spatial resolution;	Open access	WP3, T6.1	x		yes		GeoVille	for historical period 1990-2015

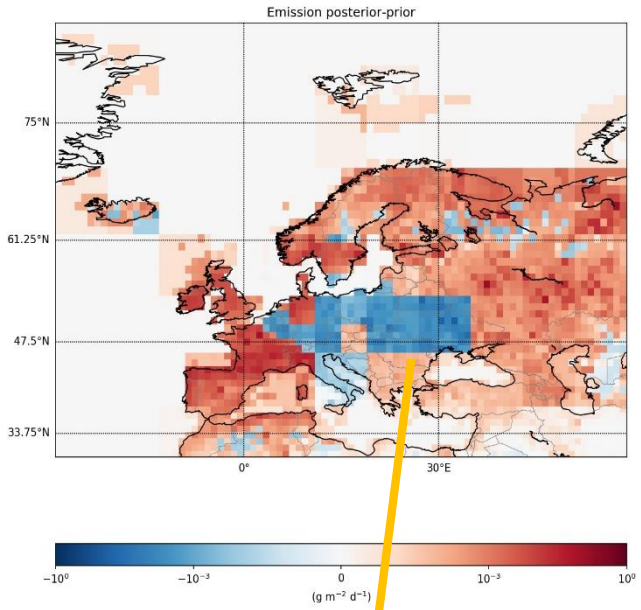
Inverse modelling in a nutshell



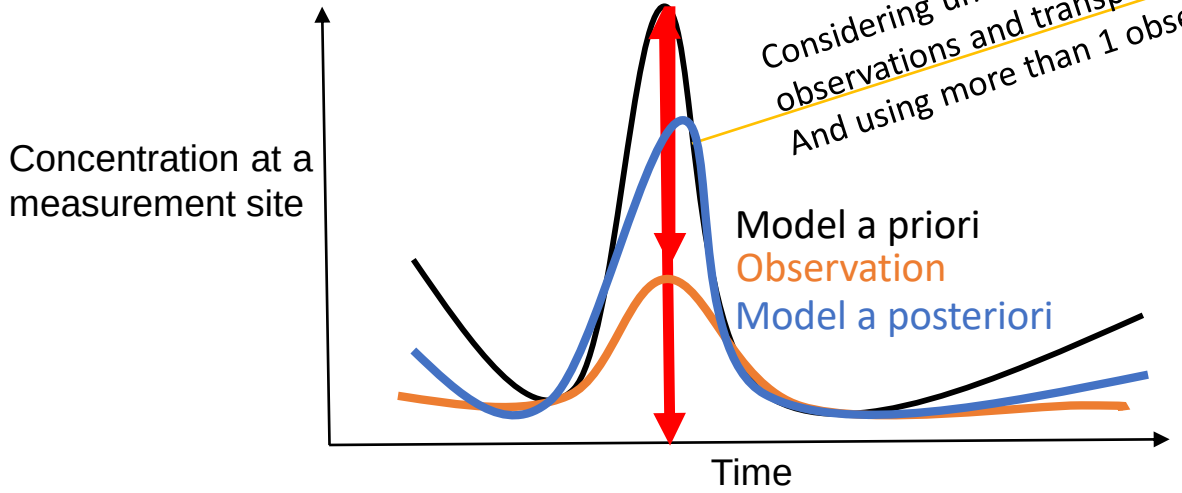
A priori emission inventory



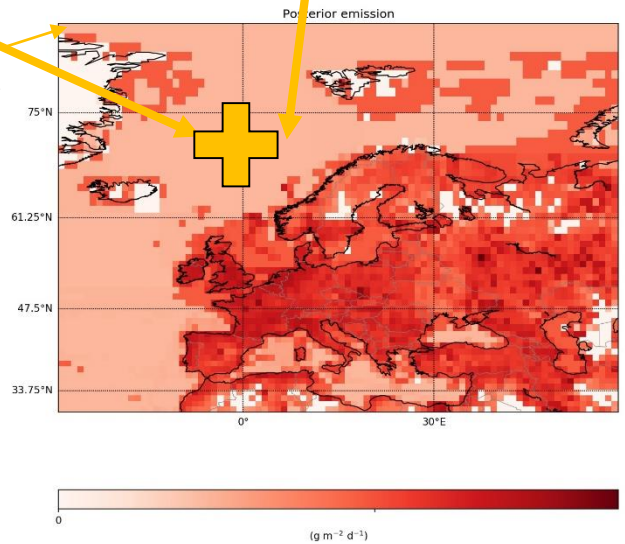
Emission sensitivity for one measurement site at one time



Emission change

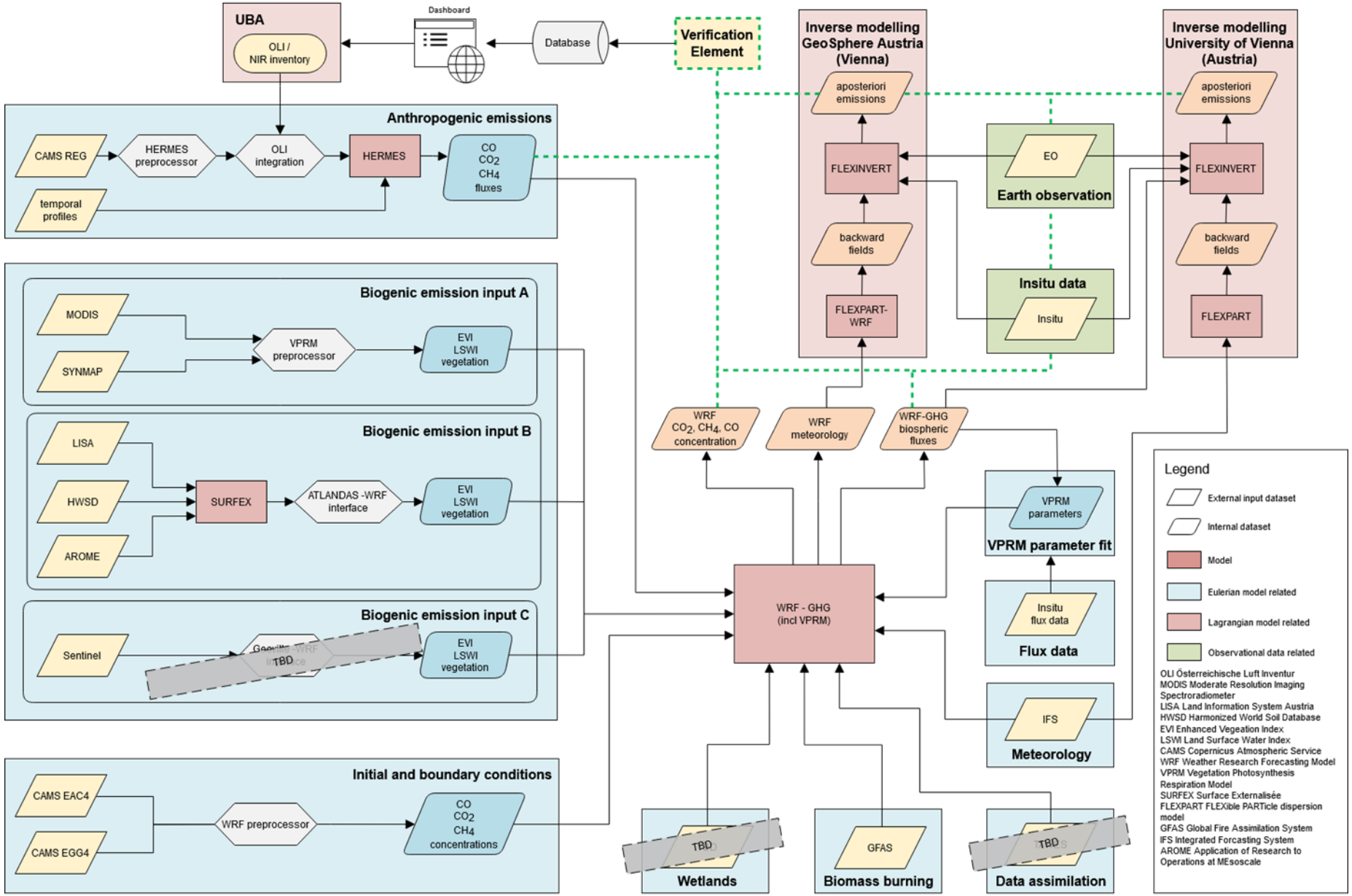


Considering uncertainties in emissions, observations and transport model.
And using more than 1 observation!

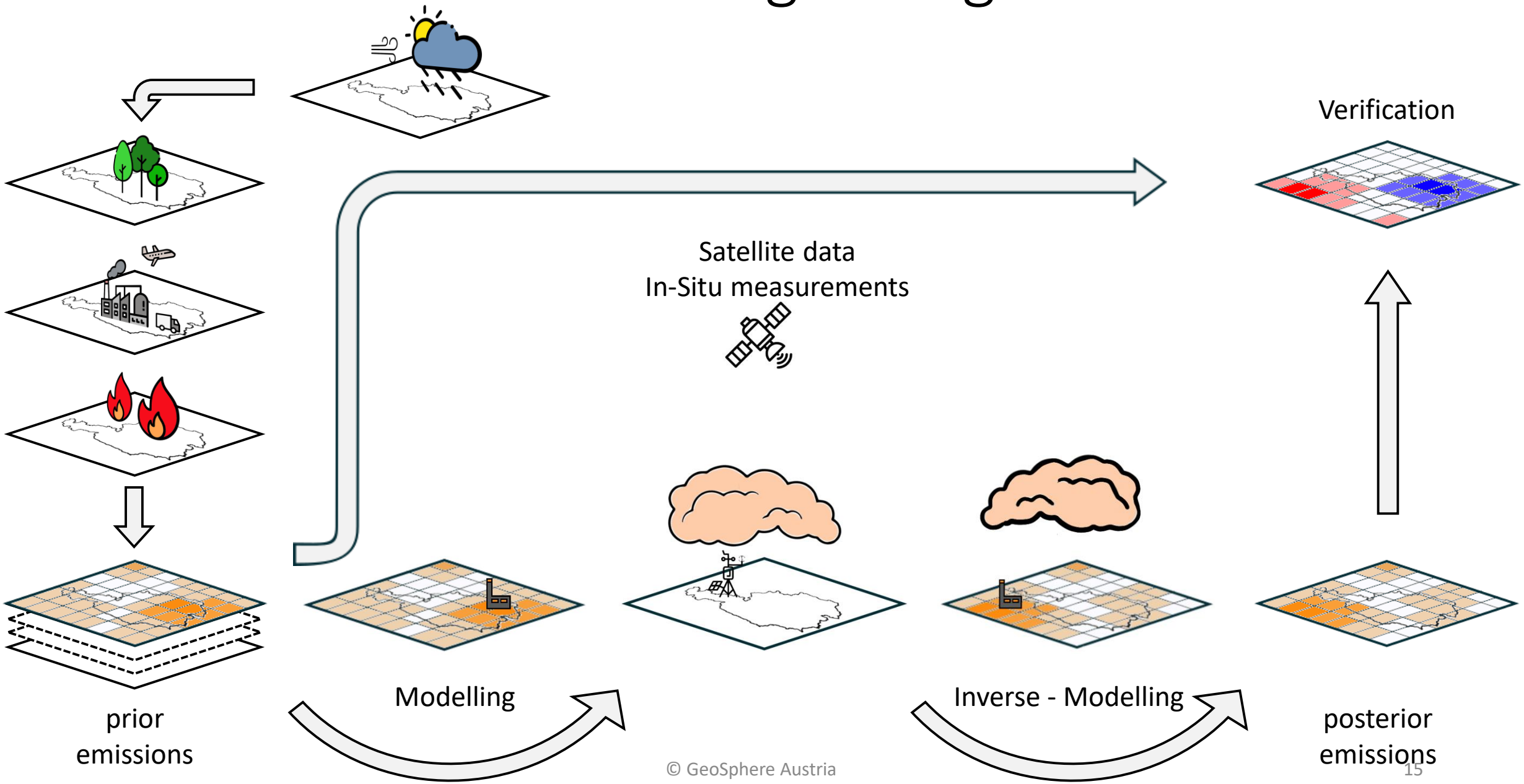


A posteriori inventory

GHG-KIT Concept – Detailed Overview



Inverse-Modelling Pictogram



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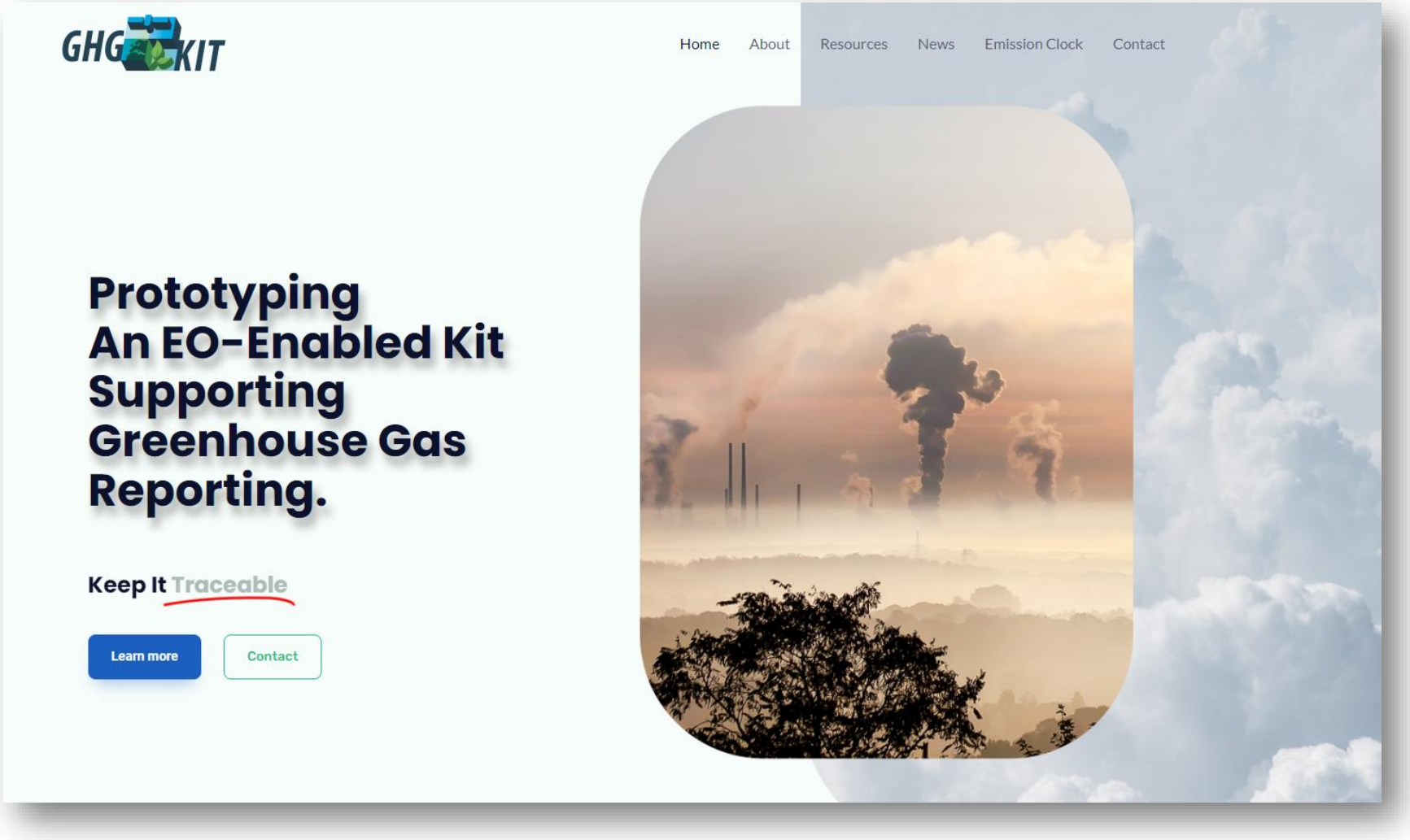
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