



SEEDS – General Assembly

SEEDS top-down BVOC emissions:
an outlook for CAMS



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CENTRE EUROPÉEN DE RECHERCHE ET DE FORMATION AVANCÉE EN CALCUL SCIENTIFIQUE



Objective

Biogenic VOCs have a large impact on air quality, yet their emissions are highly uncertain

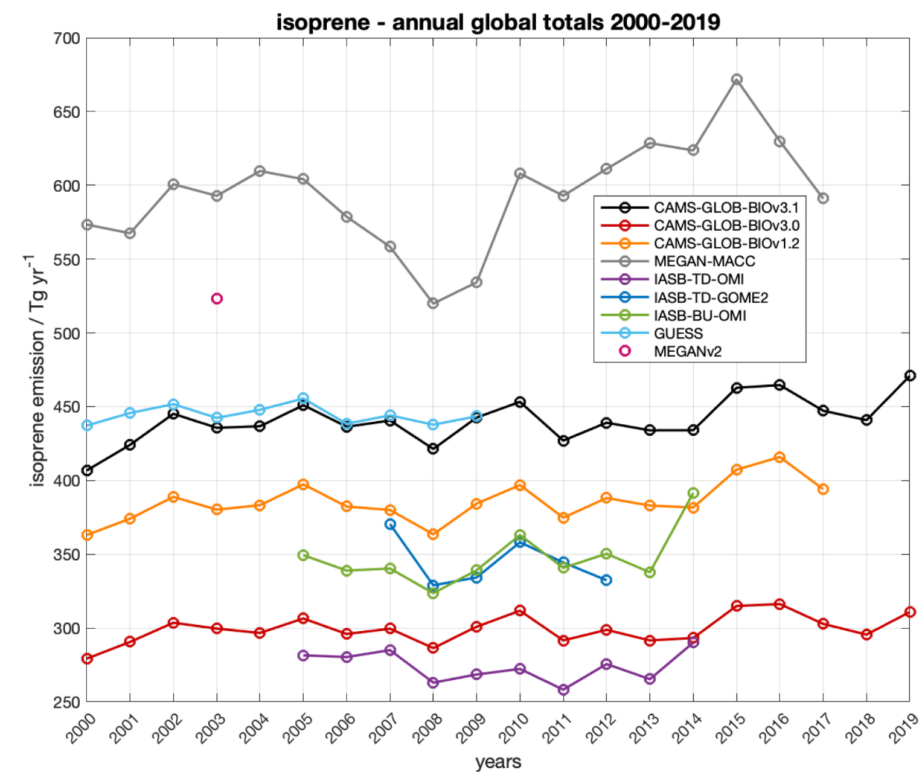


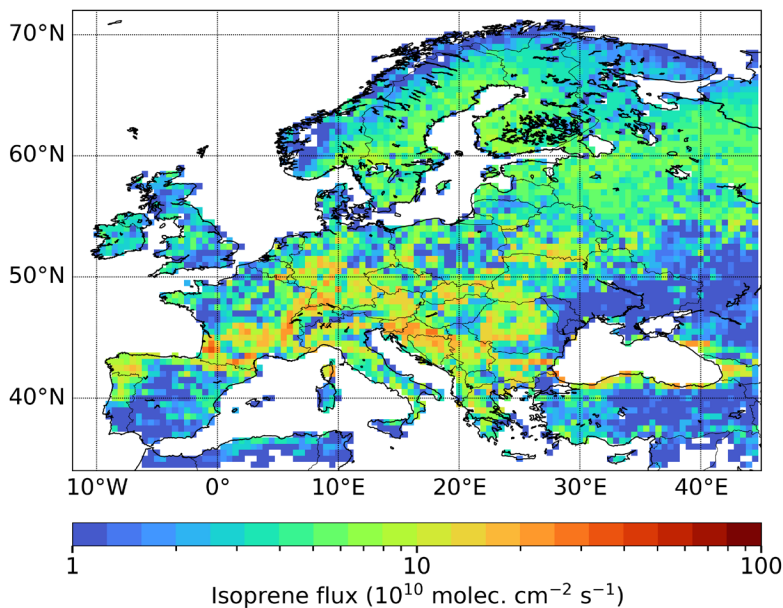
Figure 7. Comparison of isoprene global annual totals from CAMS-GLOB-BIOv3.1 (black), CAMS-GLOB-BIOv3.0 (red), CAMS-GLOB-BIOv1.2 (orange) and other available inventories within the 2000–2019 period.

Figure from: Sindelarova et al. (2022)

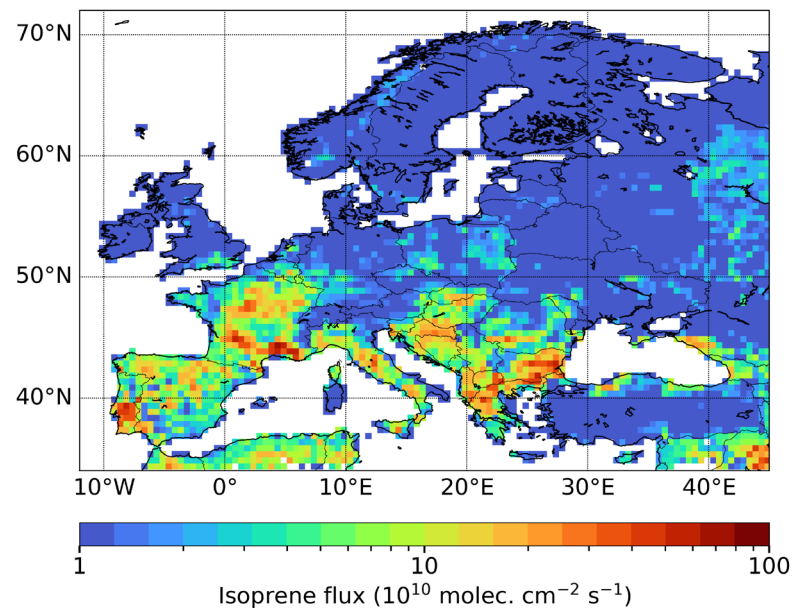
Comparison between bottom-up isoprene emissions

Isoprene emissions from different inventories, July 2019 at $0.5^\circ \times 0.5^\circ$ resolution

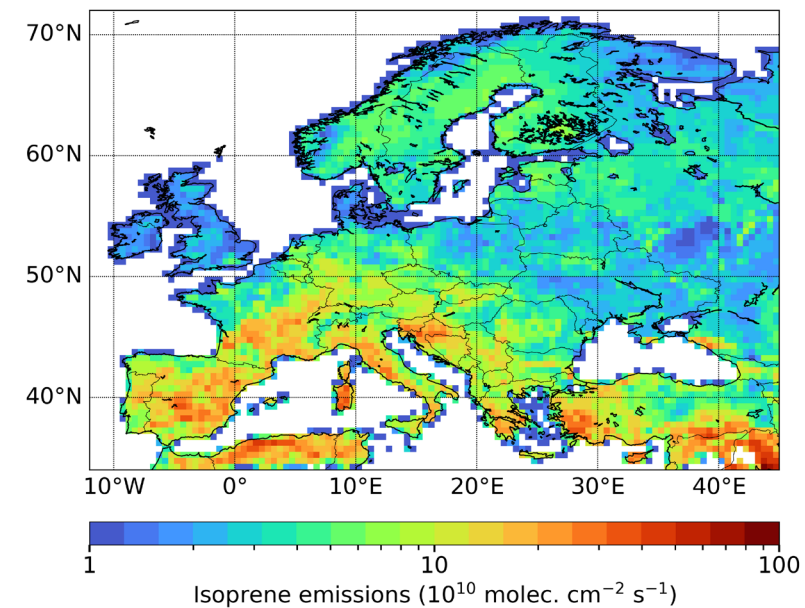
MEGAN-SURFEX
(produced in SEEDS)



CAMS-GLOB-BIOv3.1
Sindelarova et al. (2022)



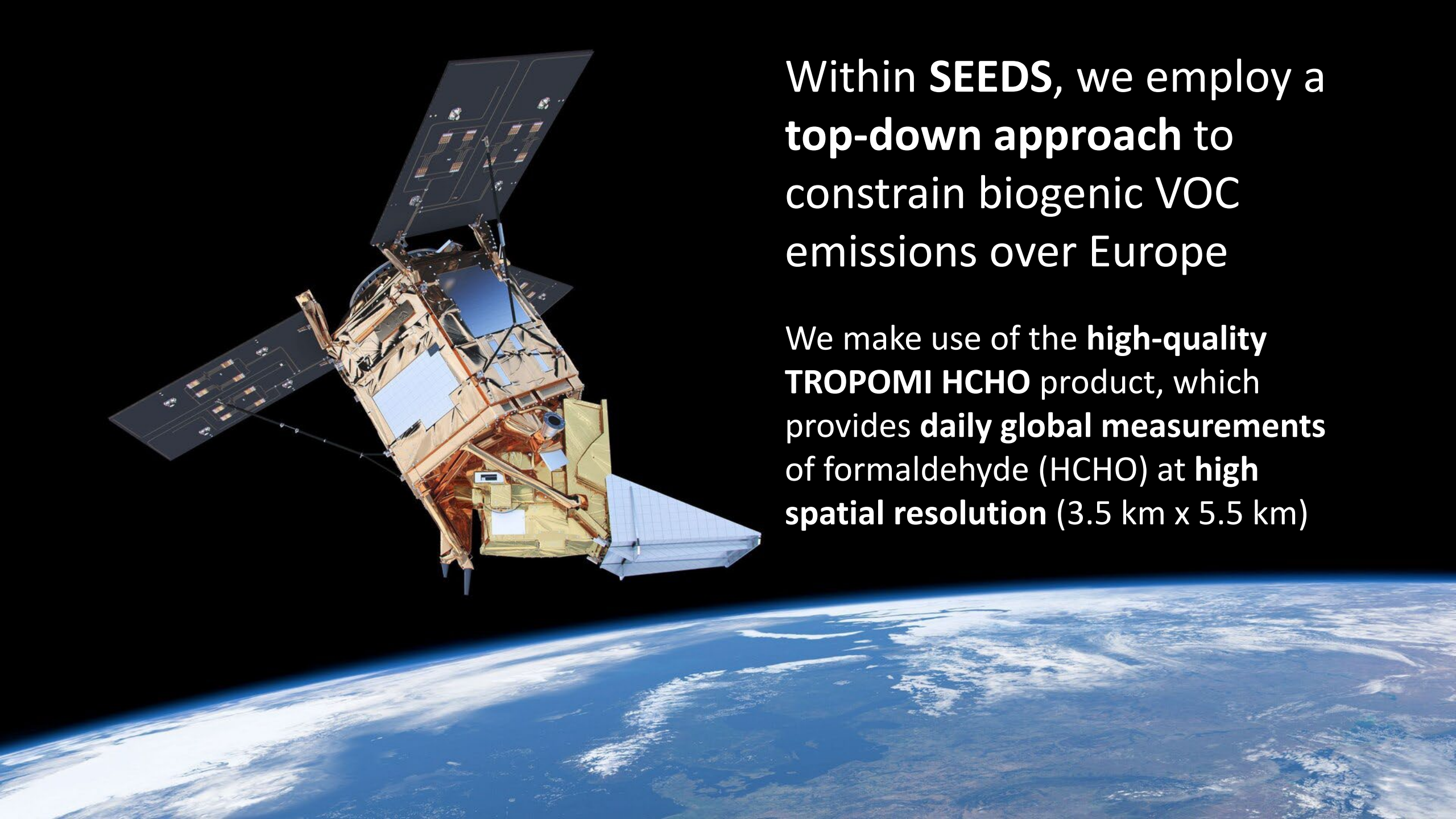
MEGAN-MOHYCAN
Stavrakou et al. (2018)



Totals: **1.23 Tg**

1.07 Tg

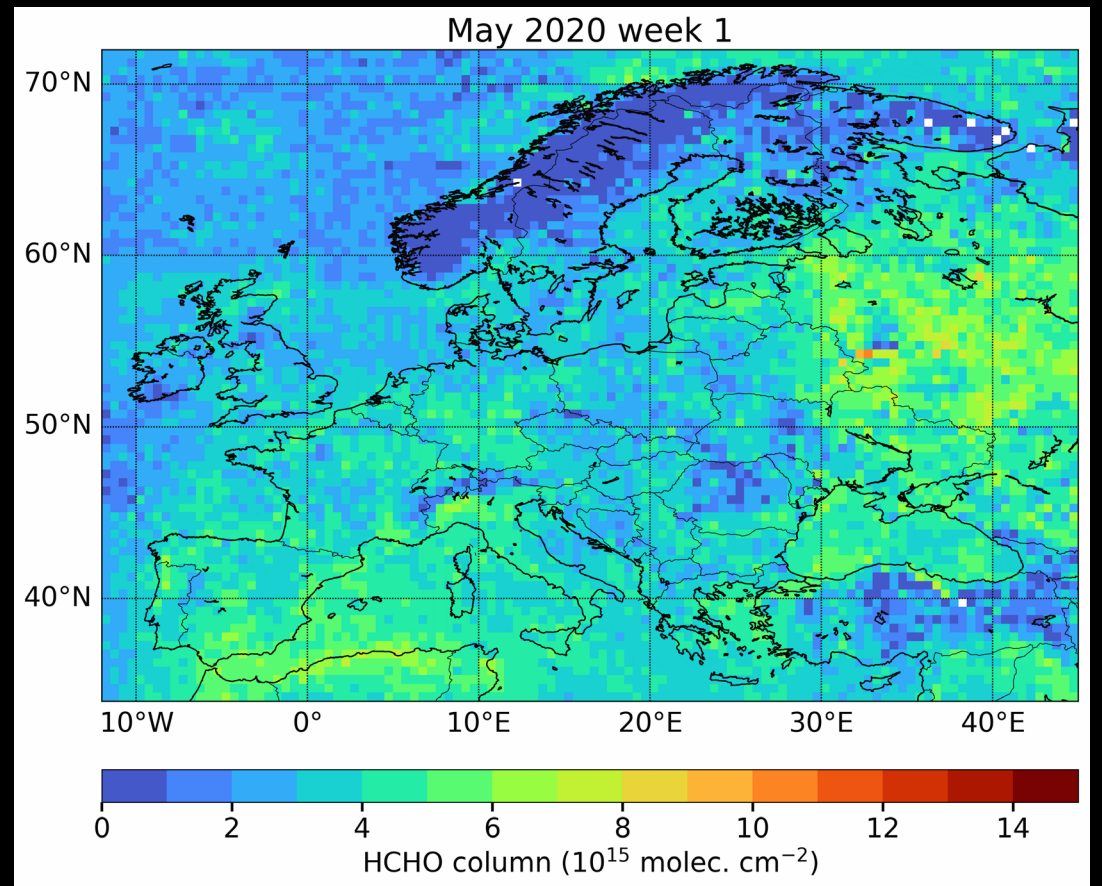
2.10 Tg



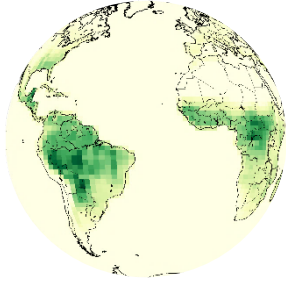
Within **SEEDS**, we employ a **top-down approach** to constrain biogenic VOC emissions over Europe

We make use of the **high-quality TROPOMI HCHO** product, which provides **daily global measurements** of formaldehyde (HCHO) at **high spatial resolution** (3.5 km x 5.5 km)

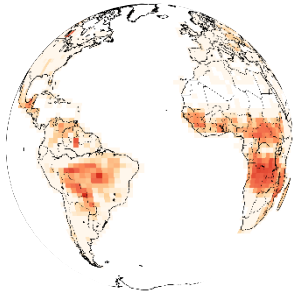
TROPOMI formaldehyde (HCHO) vertical columns



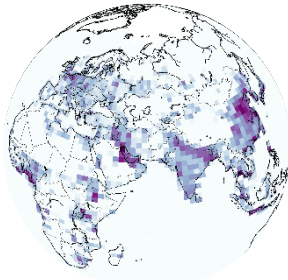
Top-down inversion methodology



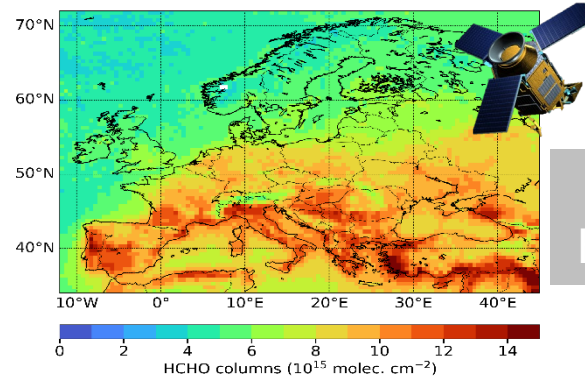
Biogenic emissions
MEGAN-MOHYCAN



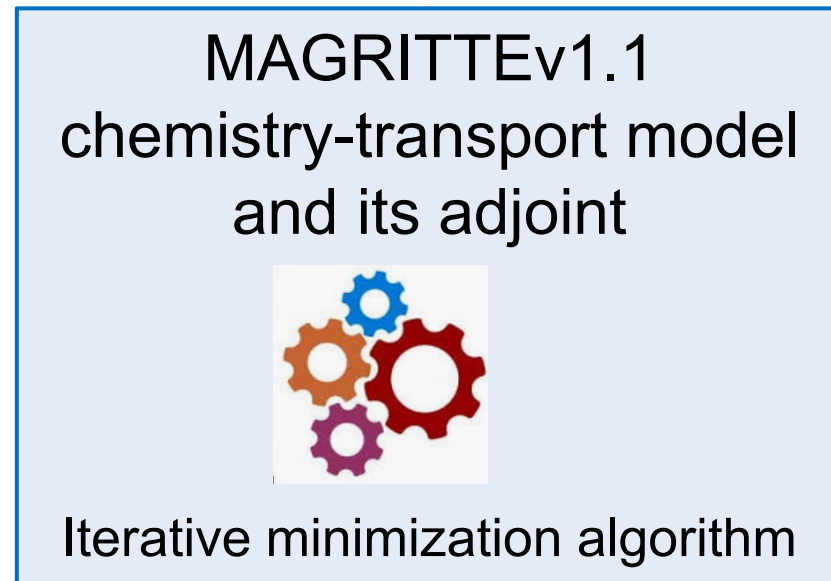
Fire emissions
QFEDv2.4



Anthropogenic emissions
CAM5-GLOB-ANTv4.3



Inversion constrained
by weekly averages



Top-down biogenic
VOC fluxes

Top-down biomass
burning fluxes

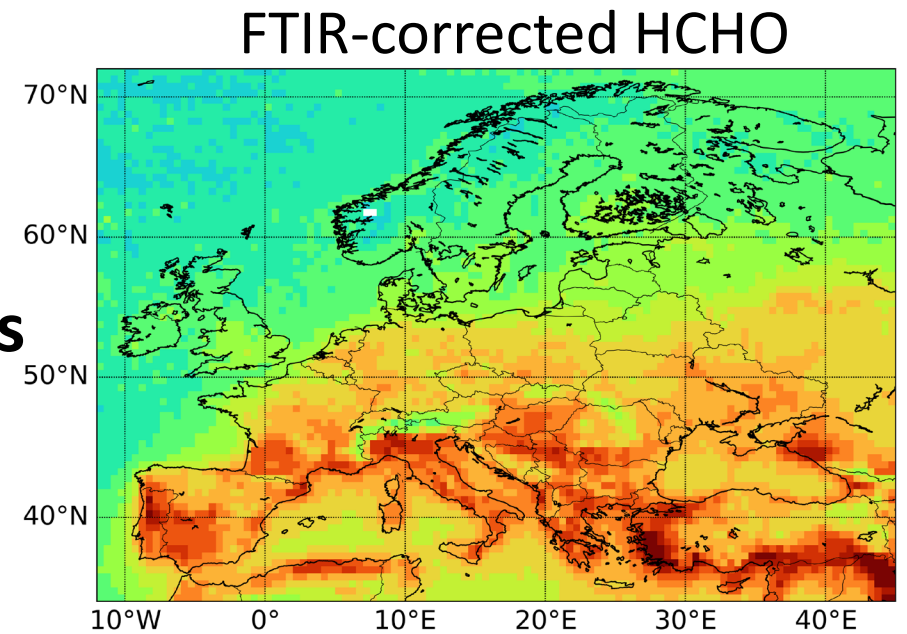
Top-down
anthropogenic fluxes

The inversion is run for **5 years** (2018—2022)
The spatial resolution of the inversion is $0.5^\circ \times 0.5^\circ$
and the emissions are updated with **weekly increments**

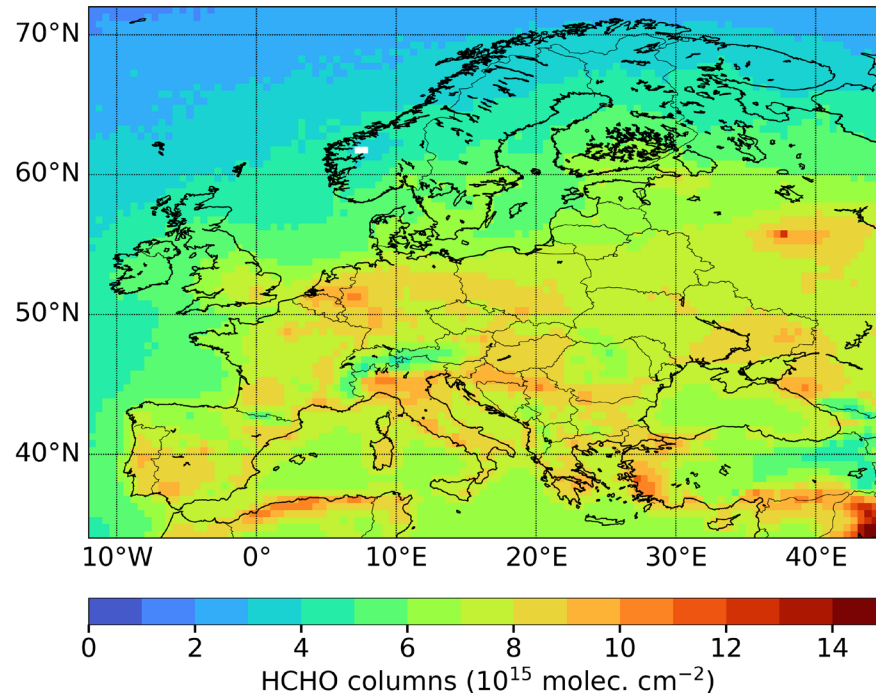
Inversion results: HCHO columns

Model columns are **smoothed** using TROPOMI averaging kernels and are **temporally collocated** with the measurements

Satellite observations



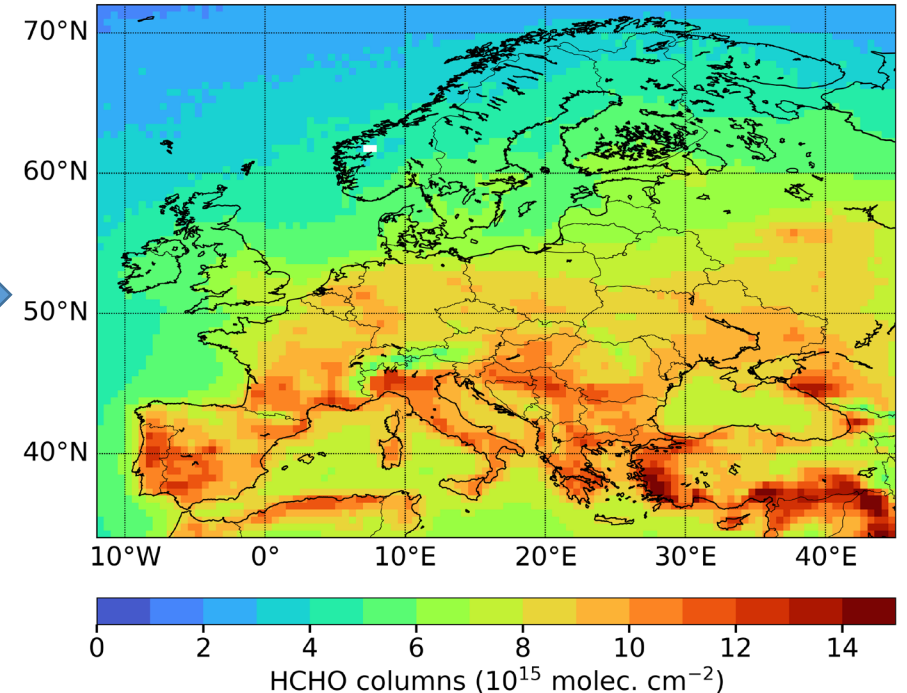
A priori



Model

Top-down
inversion

Top-down optimization



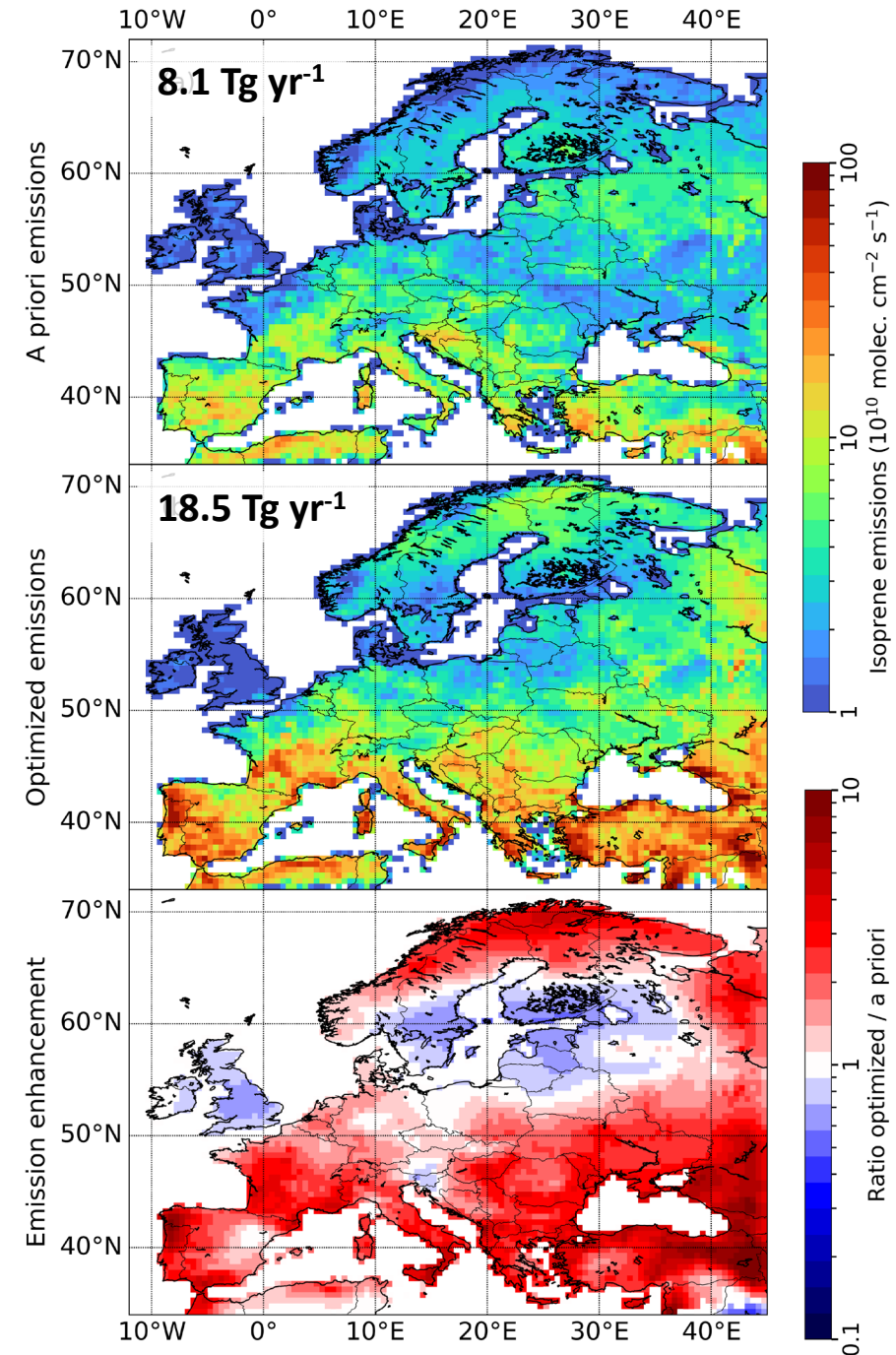
Top-down emissions

A priori isoprene emissions
from MEGAN-MOHYCAN

Optimized emissions:

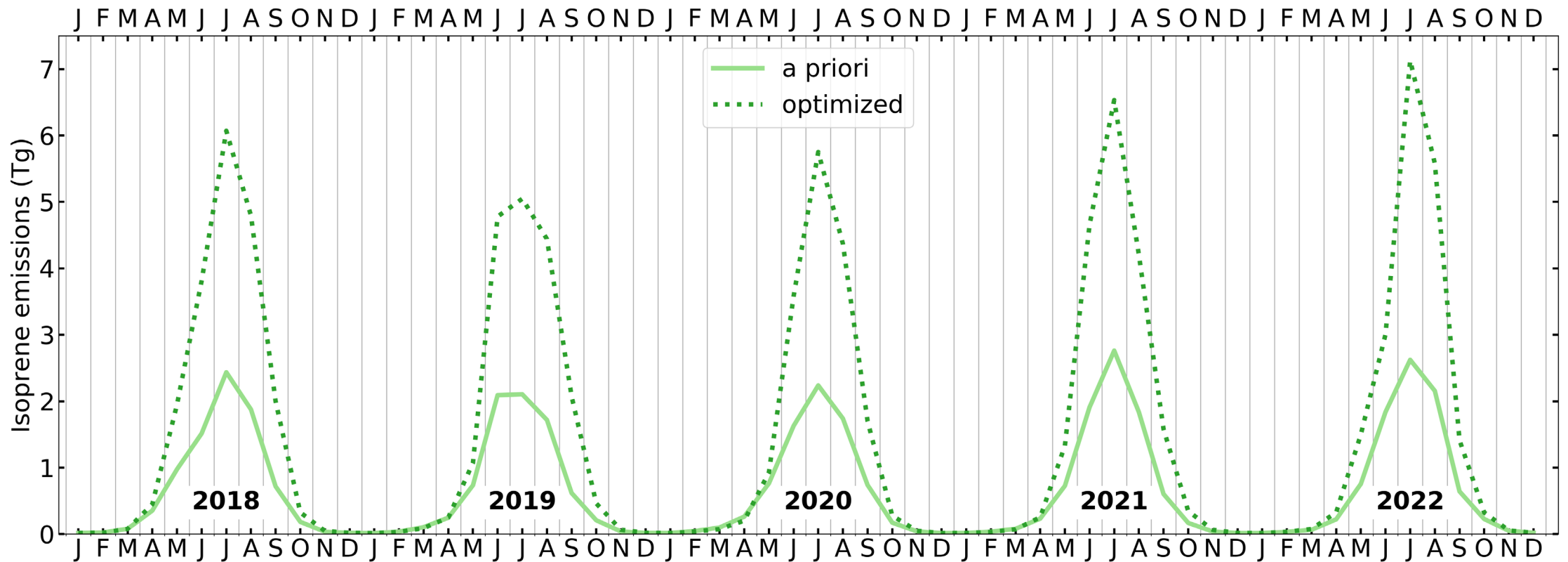
8.1 → 18.5 Tg yr⁻¹

Large increase in total emissions
due to high (bias-corrected)
HCHO columns in southern
Europe

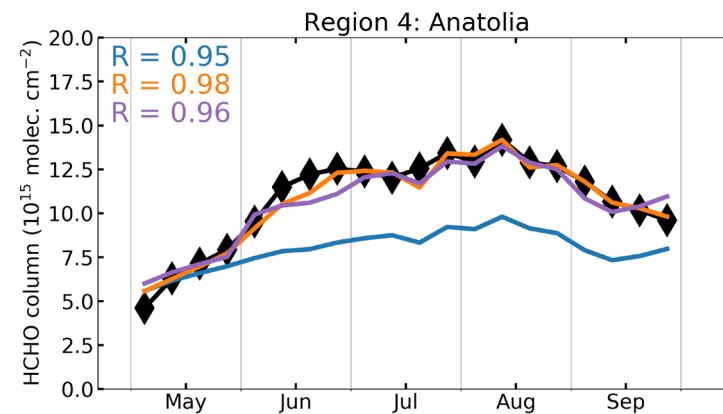
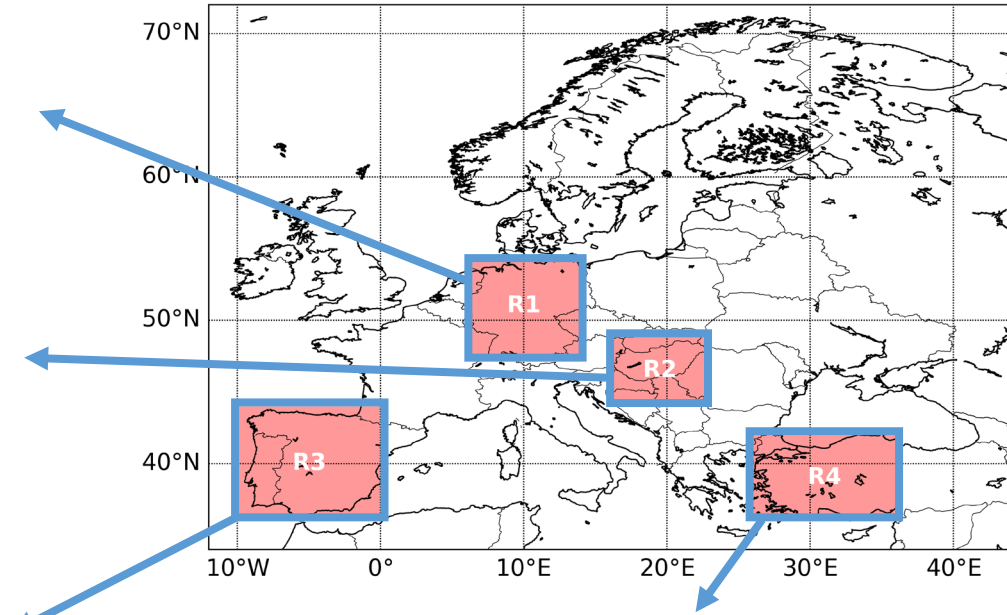
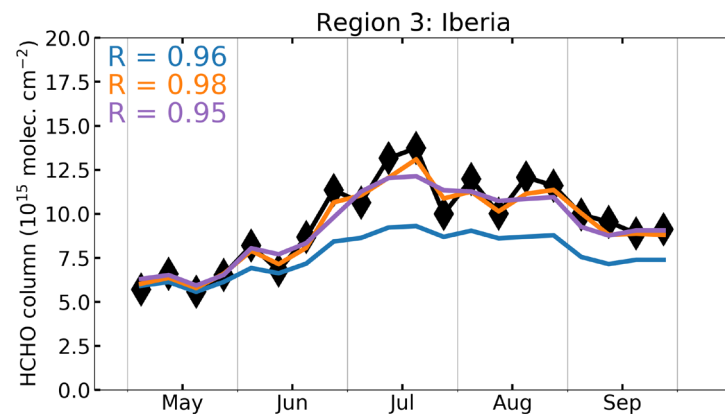
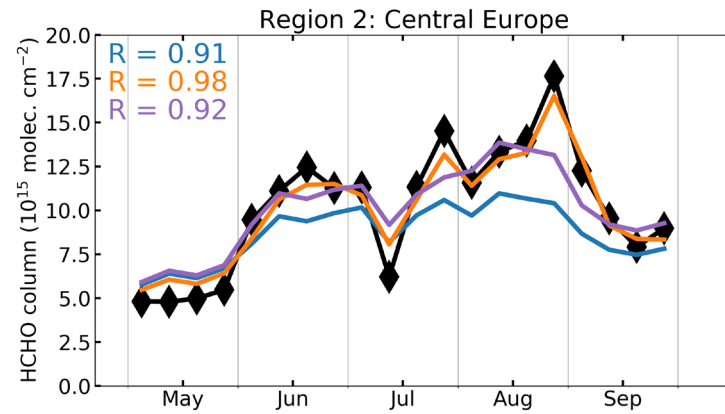
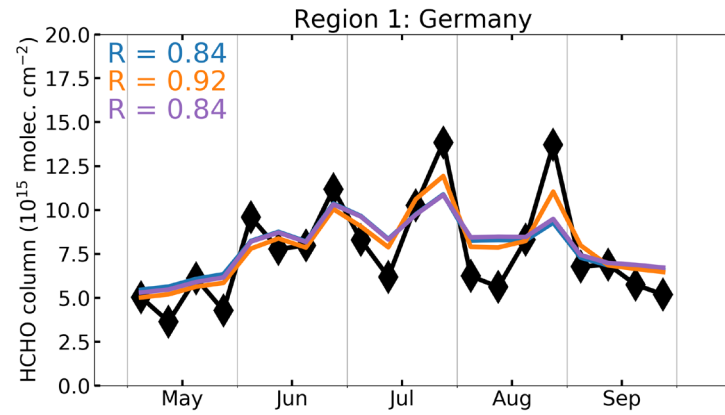






Monthly emission variability

Isoprene emissions show a strong seasonal cycle and are strongly enhanced

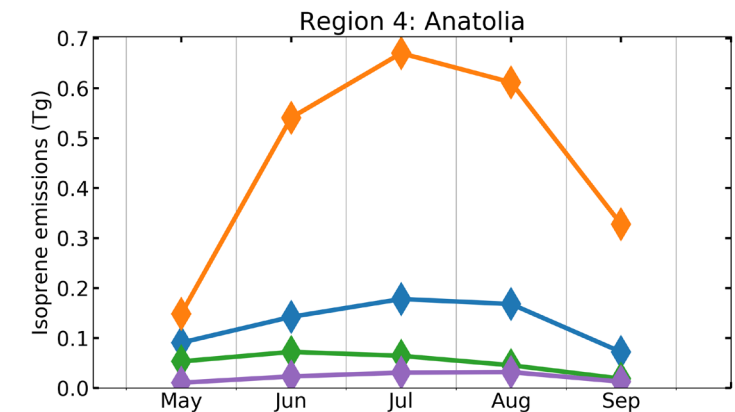
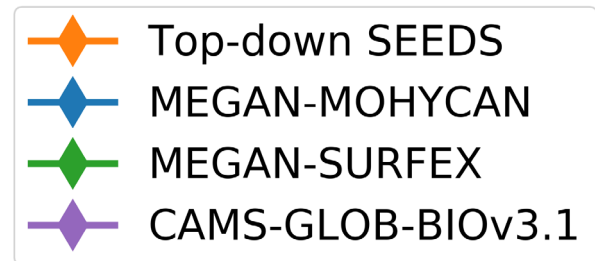
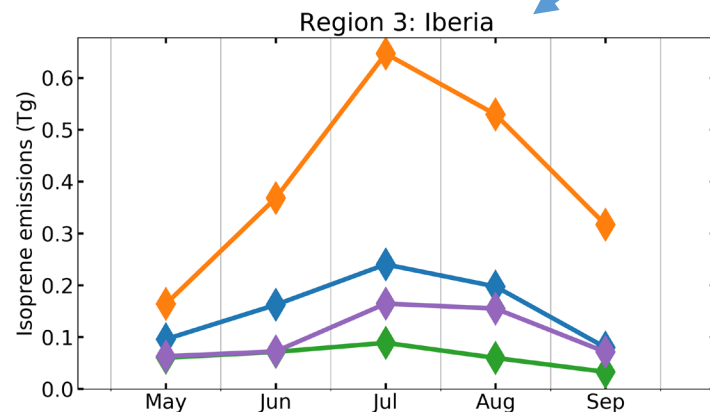
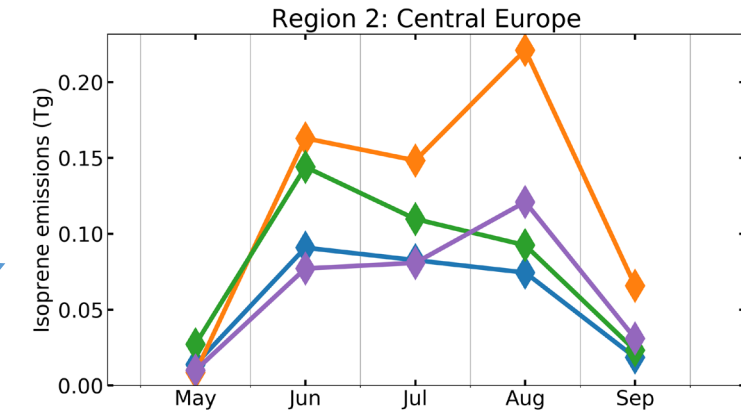
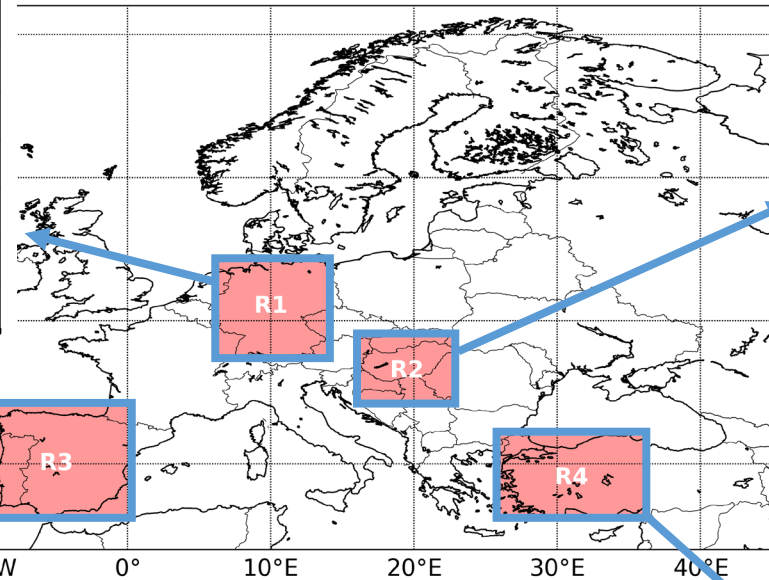
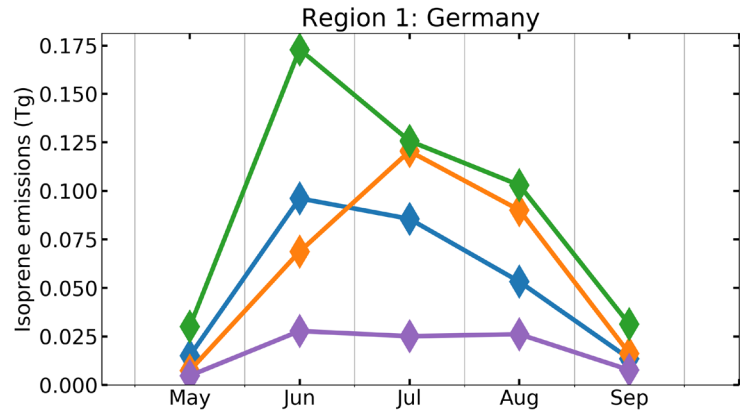


HCHO columns : weekly vs monthly inversion



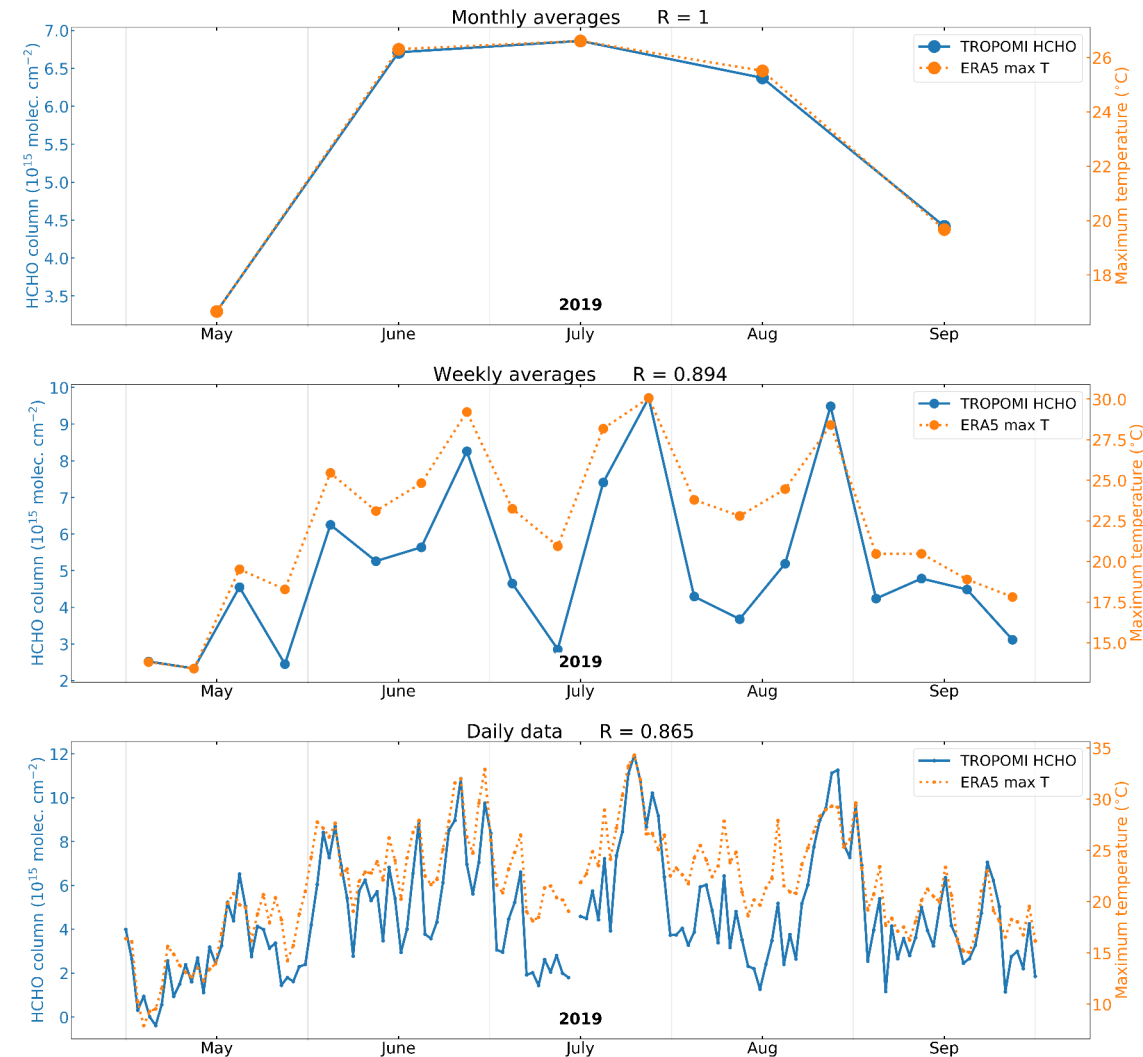
-  TROPOMI observations
-  a priori model
-  top-down weekly inversion
-  top-down monthly inversion

Top-down vs bottom-up emissions for 2019



Lessons learnt from SEEDS: an outlook for CAMS

- TROPOMI HCHO data **correlate very well** with **max temperature** data → Indicates **high data quality**
- TROPOMI HCHO data show **strong variability** → **Challenging to model**
- Application of **bias correction** has **large impact** on inversion results → Use **FTIR and Pandora** data to derive bias correction and use latest TROPOMI version
- **Global daily** assimilation of HCHO is **computationally expensive** → Potential of using a simplified chemistry scheme for the oxidation of isoprene (CAMEO project)



Summary

- ✓ **Oomen et al.** Weekly-derived top-down VOC fluxes over Europe from TROPOMI HCHO data in 2018–2021, *Atmos. Chem. Phys.*, accepted
- ✓ Isoprene emission datasets are provided at **high spatiotemporal resolution** (daily, $0.1^\circ \times 0.1^\circ$) from 2018 to 2022 at the **SEEDS data portal**: <https://www.seedsproject.eu/data>

Main result: **large top-down BVOC** emissions in **southern Europe** due to high (bias-corrected) HCHO column measurements from TROPOMI

