

Colocation Day 1 BOG template

PIRAMID

Progress in the Interpretation of Remotely-sensed Atmospheric climate products using Modelling, Inversion and Data assimilation

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24-26 March 2026

In response to ESA ITT AO/1-12469/24/I-LR of Earth Watch CLIMATE SPACE programme

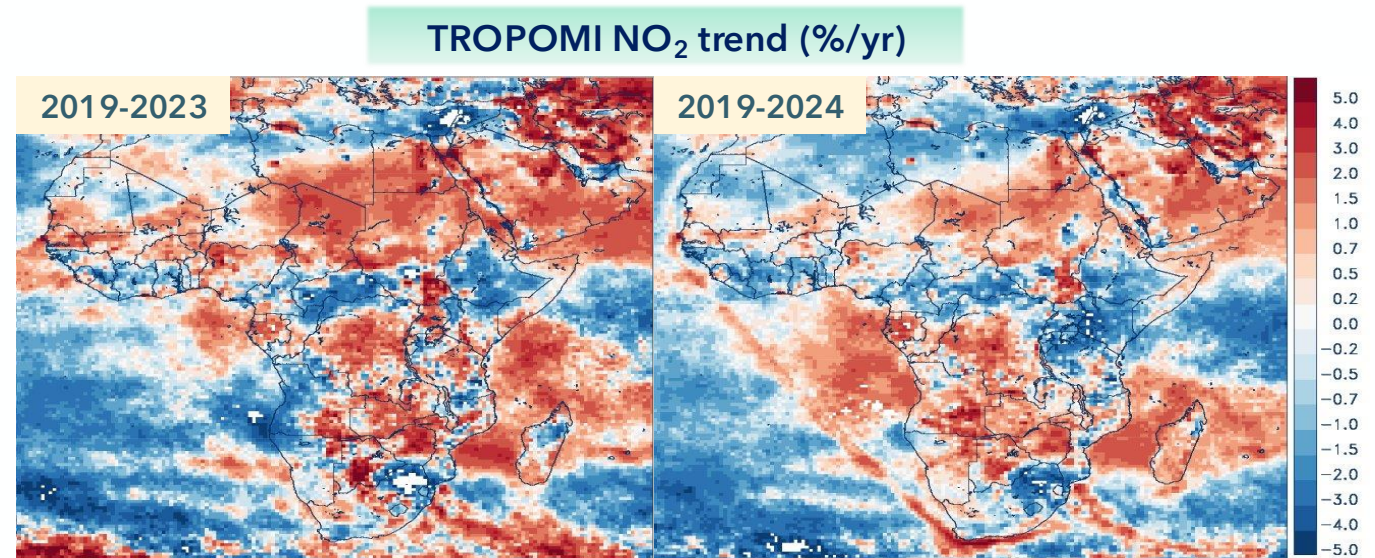
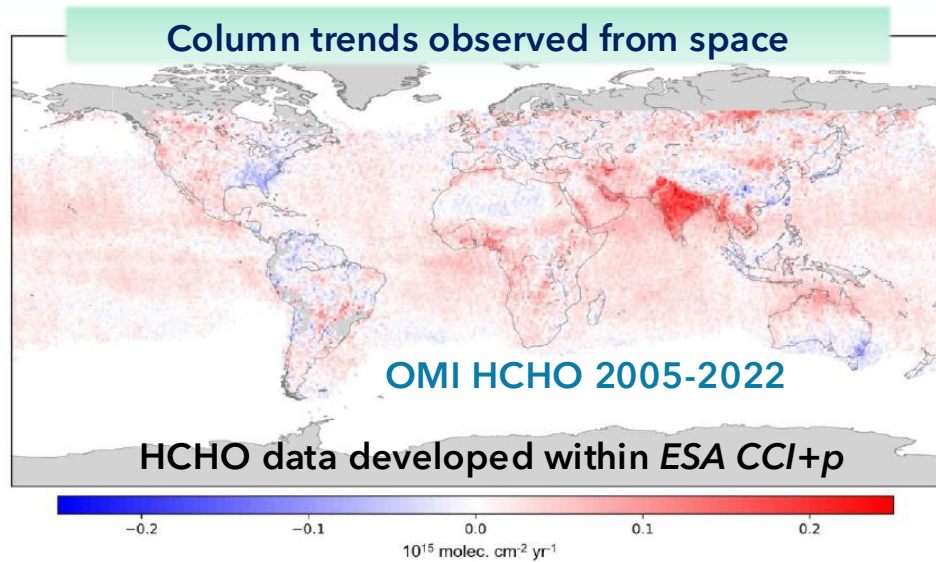
Goal : To make progress in the interpretation of the variability and trends of long-term atmospheric data records using models and inversion techniques

Timeframe: 2025-2028

- Establish interactions with international programmes (WCRP, CMIP7), emissions modelling and inverse modelling initiatives (GEIA, AMIGO), global atmospheric chemistry programme (IGAC), potential stakeholders from EU, EUMETSAT and CAMS
- Develop links with CAMS and Horizon projects, e.g. EU CAMEO (2023-2025), HE EU CONCERTO (2025-2028), HE EU CAMBAS (2026-2030)
- Organize workshop in 2028, to be advertised through multiple channels

Skeleton overview of the approach (1)

- ESA CCI supported the development of satellite ECVs and use in climate science
- ECVs improve our understanding of the Earth system to predict future changes
- ESA CLIMATE SPACE includes development of new satellite-based ECVs + support for the scientific exploitation of ECVs through modelling



- ✓ Accurately simulate the observed satellite data records using models
- ✓ Foster collaboration between modelling and satellite communities
- ✓ Engage the research community in support of international treaties, climate policy, future projections

Skeleton overview of the approach (2)

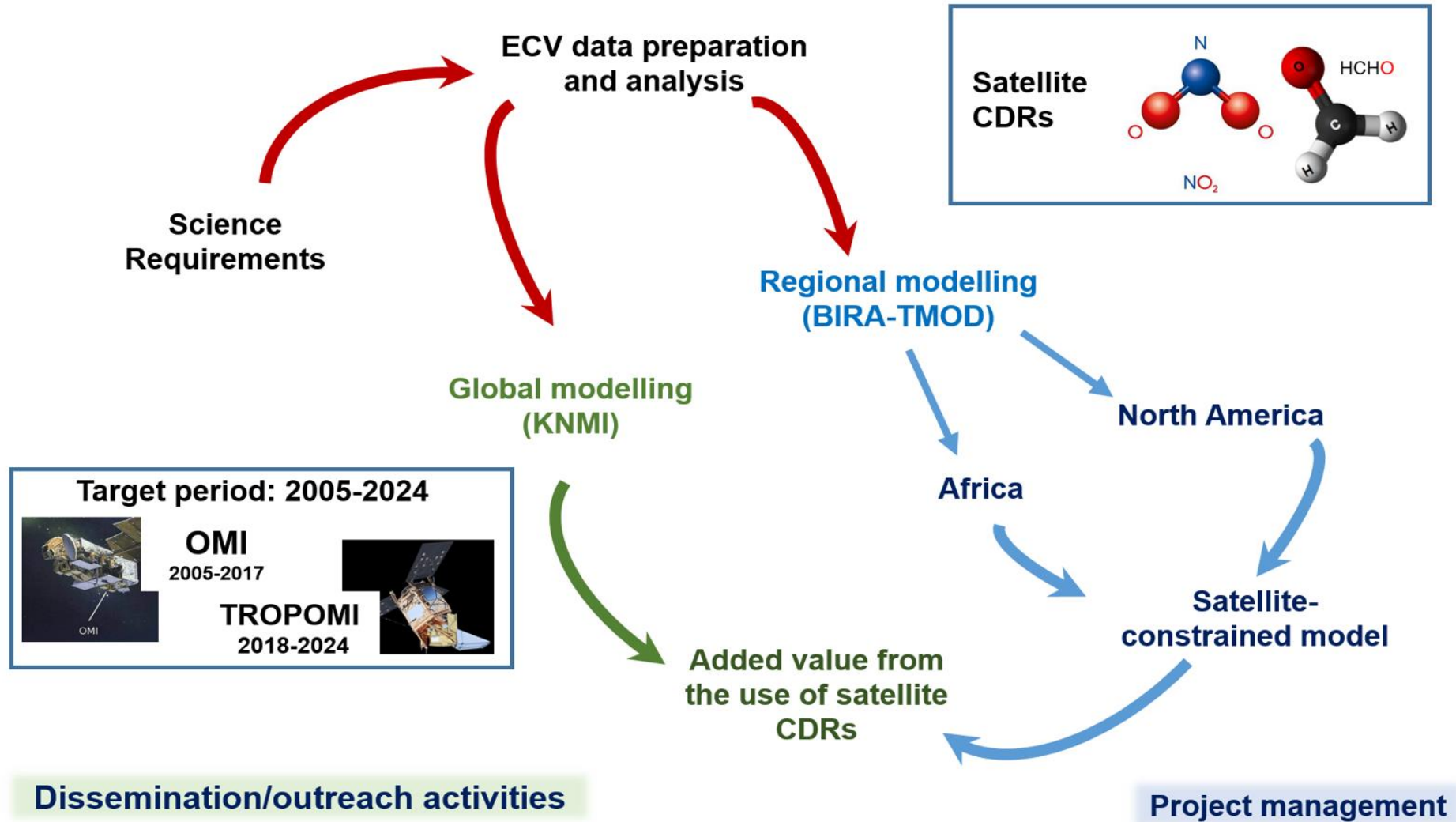
- Various issues with the use of satellite column data (filtering, uncertainties, averaging kernels, biases)
- Extra challenge of combining multiple satellites
- Need for feedback from modellers on data quality, fitness-for-purpose, and consistency among data sets
- Need for detailed assessment of limitations, proper usage of data

Build collaboration to improve the development and exploitation of satellite-based ECVs in climate modelling

Interpret the variability and trends of long-term ECV atmospheric data using models and inverse techniques

Assess the satellite-observed NO₂ and HCHO variability and trends for 2005-2024 on global/regional scale, with focus on Africa/N. America using MAGRITTE (BIRA-IASB) and TM5-MP (KNMI) CTMs

Skeleton overview of the approach (3)



- **Focus on NO_x and VOCs: why?** Key drivers of tropospheric chemistry through their impact on ozone and OH (hence the atmospheric oxidising capacity and CH₄ lifetime)
- **Chemical interactions between VOCs and NO_x** → feedbacks to be considered to understand NO₂ and HCHO time series, given NO_x emission changes (US, Africa)
- **Yet unclear** whether models can faithfully predict the long-term evolution of BVOC fluxes → *Satellite HCHO is a proxy for BVOC emissions*
- Challenges related to **satellite data** → cross-sensor calibration, harmonisation of auxiliary data, sensor degradation, tailored L3 data in models (measurement/sampling uncertainties, etc.)
- **Integrate EO data in models** → narrow down uncertainties in land-atmosphere processes, rationalise the observed trends; Assess magnitude, trends and impacts of fluxes on Earth system

Can models replicate the variability and trends of satellite NO₂ and HCHO over 20+ years? What are the knowledge gaps? To what extent the observed long-term evolution of HCHO columns can be attributed to climate variability and land use changes? What is the role of fires?



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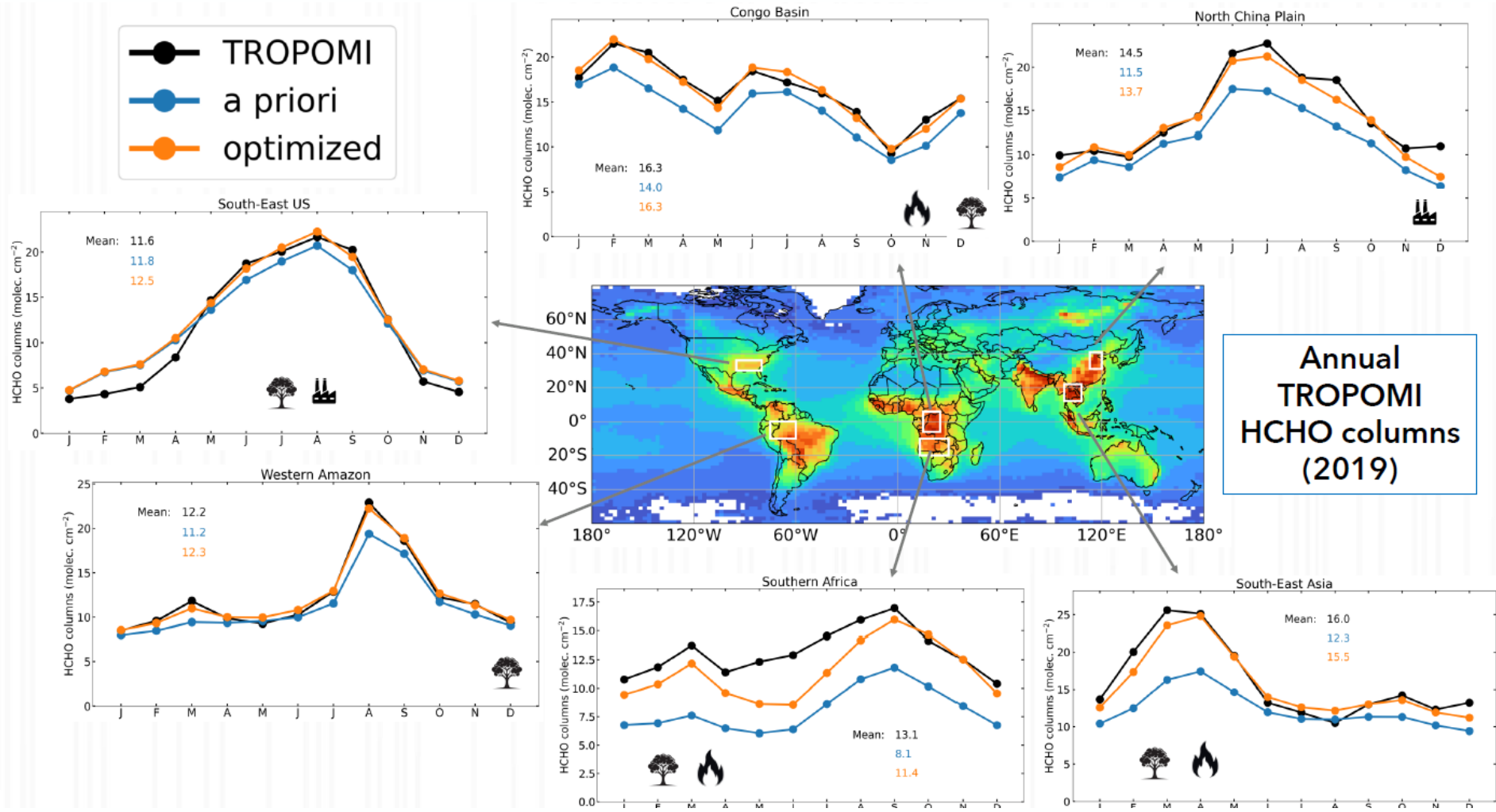


Results & relevance to the CCI community

✓ Ingestion of TROPOMI HCHO CCI+p L3 data in the MAGRITTE CTM

✓ Successful first inverse estimation of VOC emissions inferred from TROPOMI HCHO CCI+p L3 data

✓ Strong increase of BVOC fluxes after inversion (Oomen et al. in preparation)



Thanks for your attention!

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