TO BRING ABOUT BREAKTHROUGHS IN INTERNATIONAL SPACE RESEARCH

S5P/TROPOMI XCH_4: current status and the path to cross-instrument harmonisation

Soumyajit (Jit) Mandal, Jochen Landgraf, Andrew Barr

SRON SPACE RESEARCH ORGANISATION NETHERLANDS

CEOS AC-VC-22
SRON Leiden
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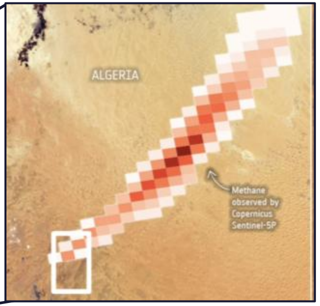
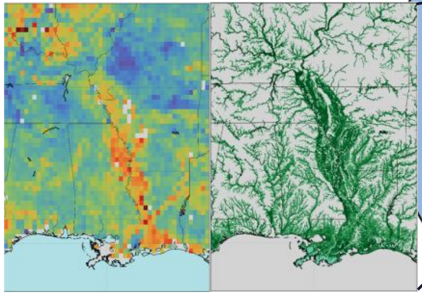
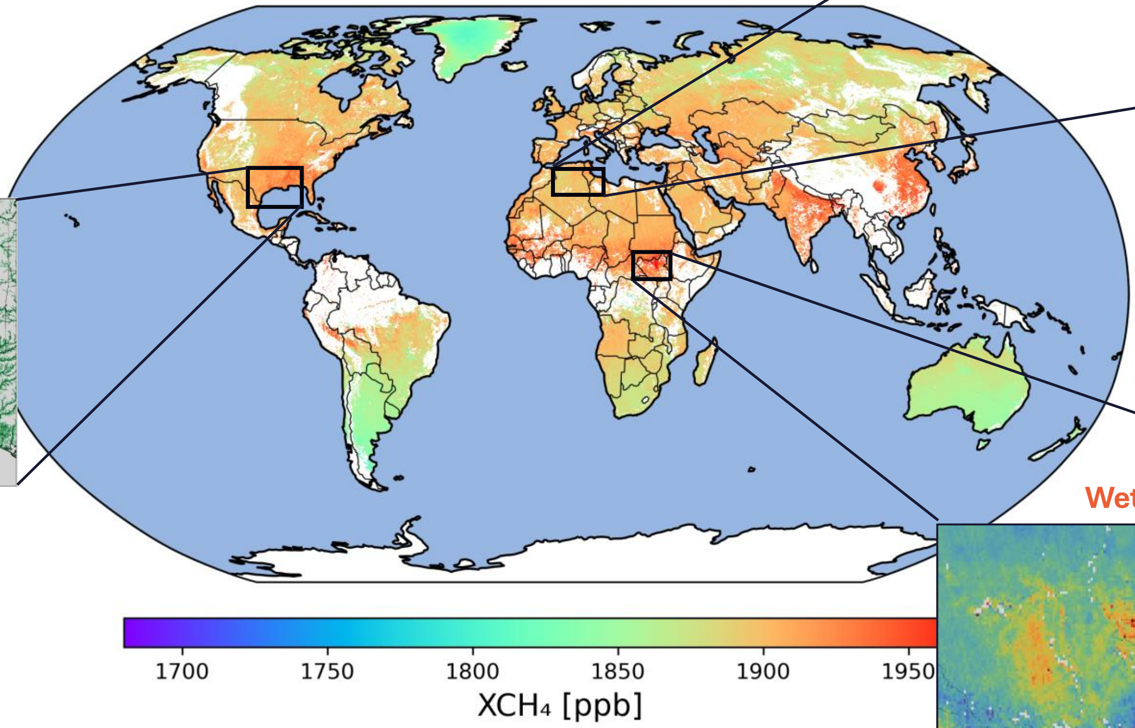
Tropomi Global Map



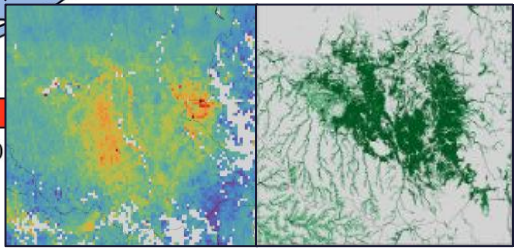
Plume Hotspot



Wetlands Mississippi delta



Wetlands Sudd



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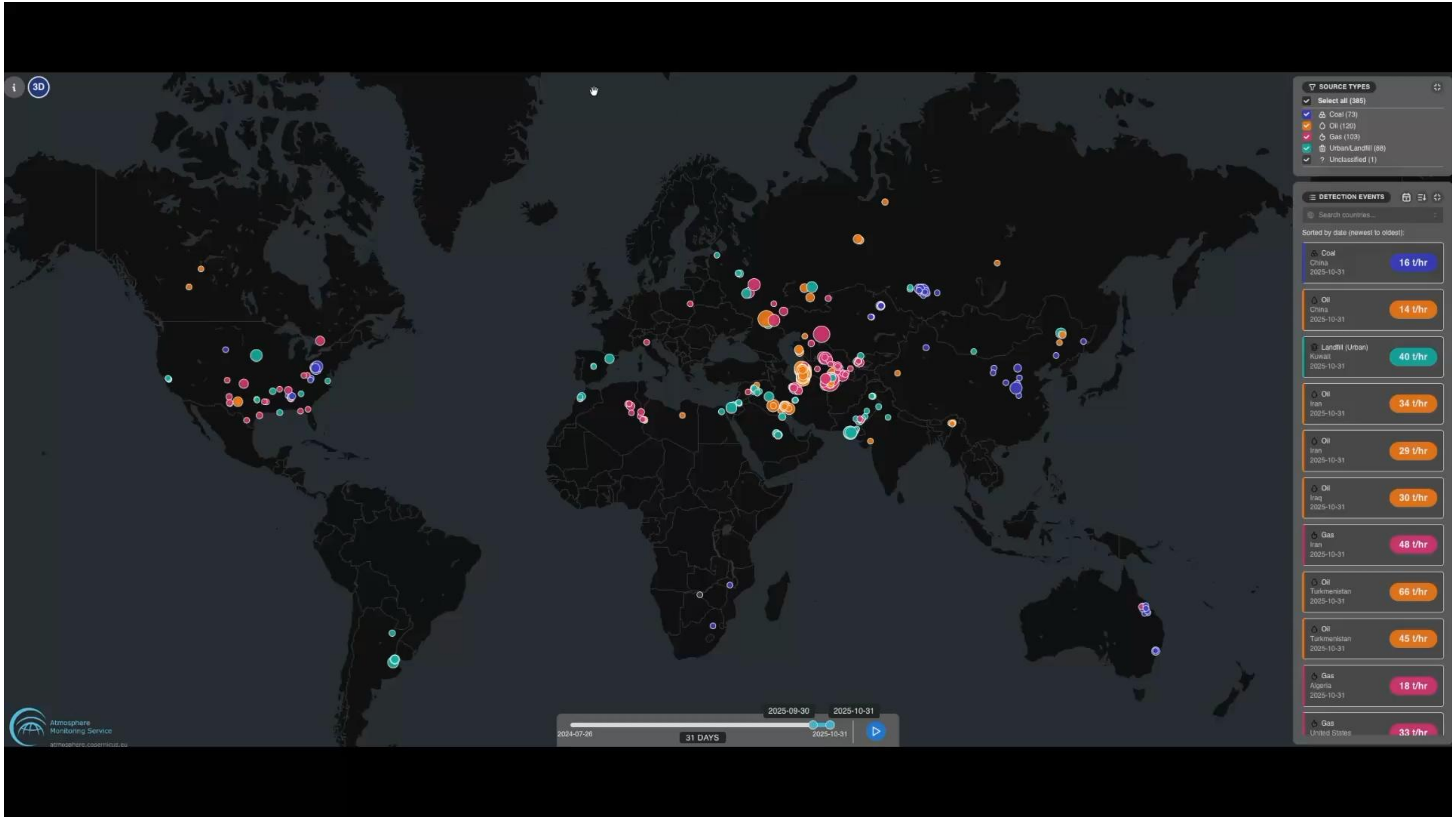
CAMS Methane Hotspot Explorer

https://atmosphere.copernicus.eu/ghg-services/cams-methane-hotspot-explorer



Credits: Bram Maasakkers, Ilse Aben & L4 team at SRON

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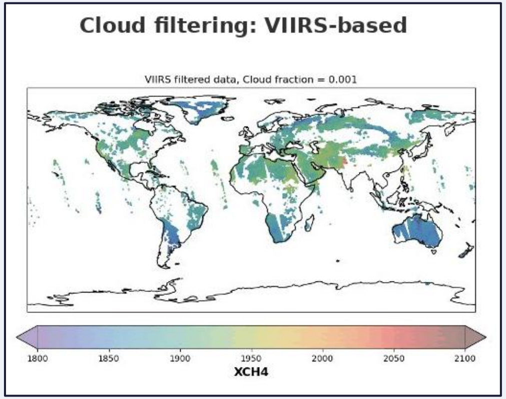
S5P TROPOMI – Continuous Improvements

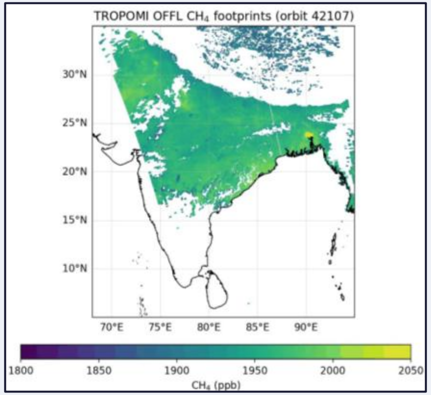
Cloud Filtering

No SNPP/VIIRS dependency — future proof ahead of VIIRS decommissioning



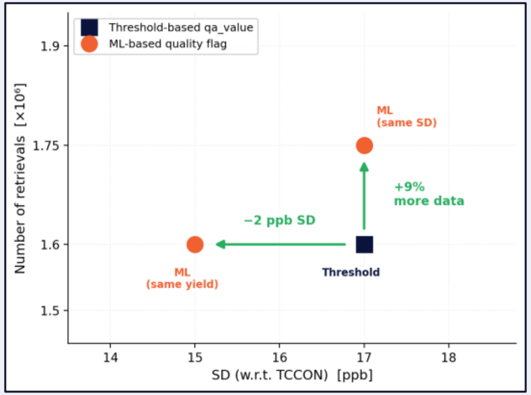
Near Real-Time Product

New cloud filtering enables a near real-time XCH_4 data product



ML-based Quality Filtering

Learned quality flag replaces the threshold-based qa_value



All described in detail in the latest CH4 ATBD: https://sentiwiki.copernicus.eu/web/s5p-products

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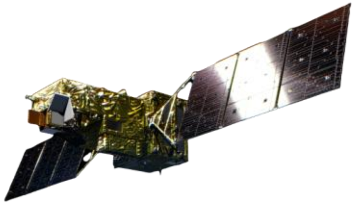
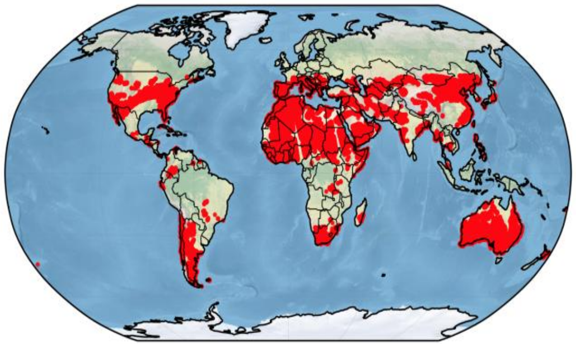
Looking ahead: cross-instrument harmonisation



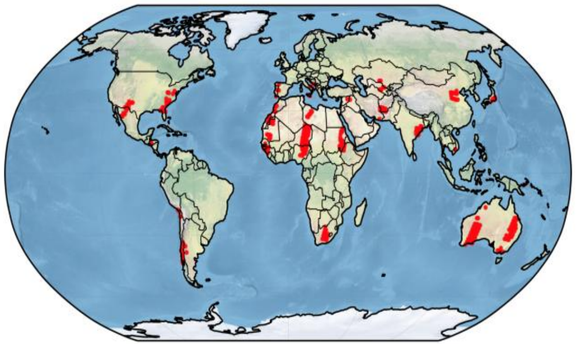
TROPOMI
2018 -

GOSAT-2
2019 -

TROPOMI XCH_4



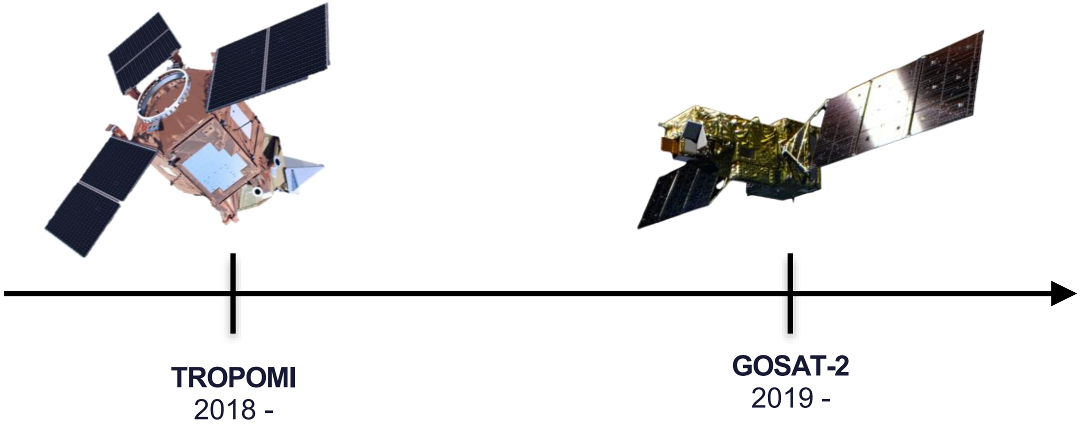
GOSAT-2 XCH_4



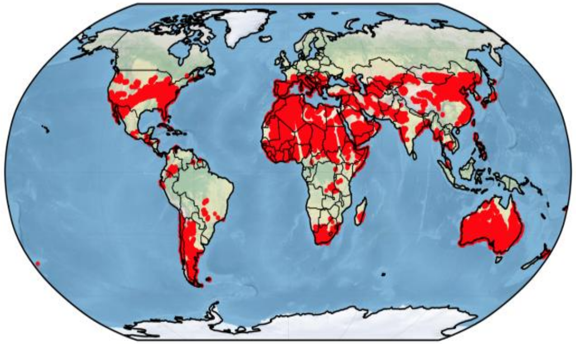
Current approach: bias corrected as a function of surface albedo — validated against sparse TCCON sites at 300 km colocation radius

Daily coverage map Keya et al. 2026

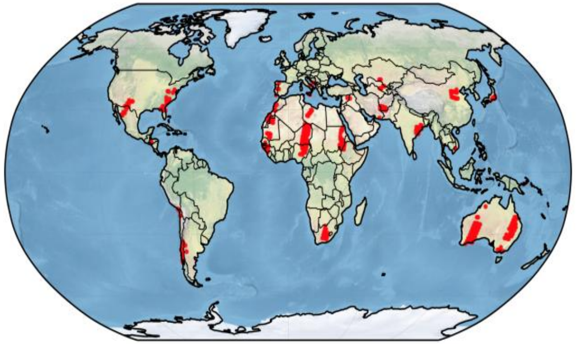
Looking ahead: cross-instrument harmonisation



TROPOMI XCH_4



GOSAT-2 XCH_4



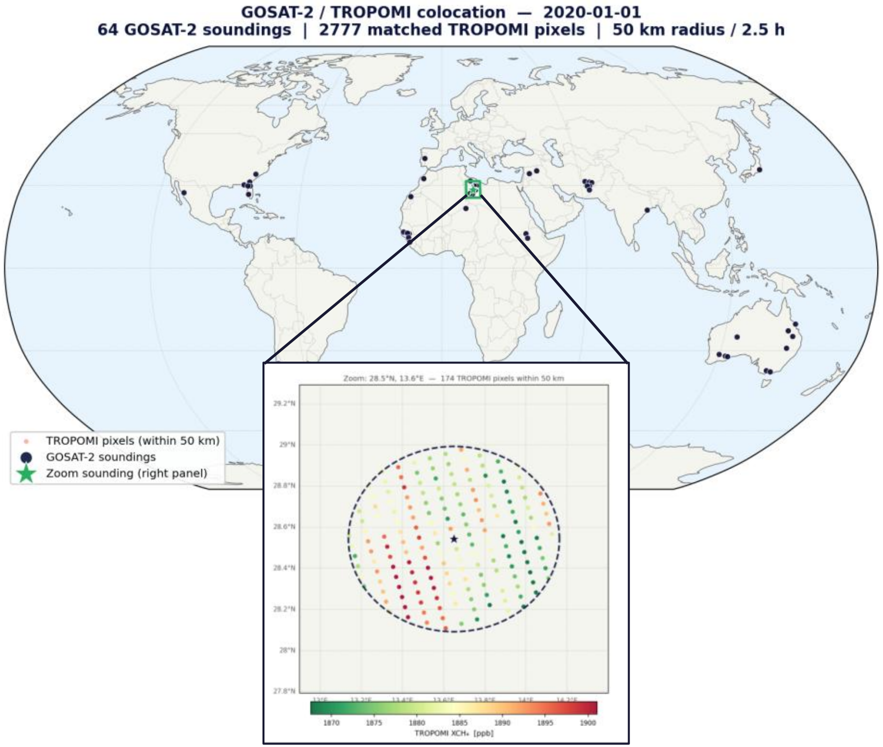
Daily coverage map Keya et al. 2026

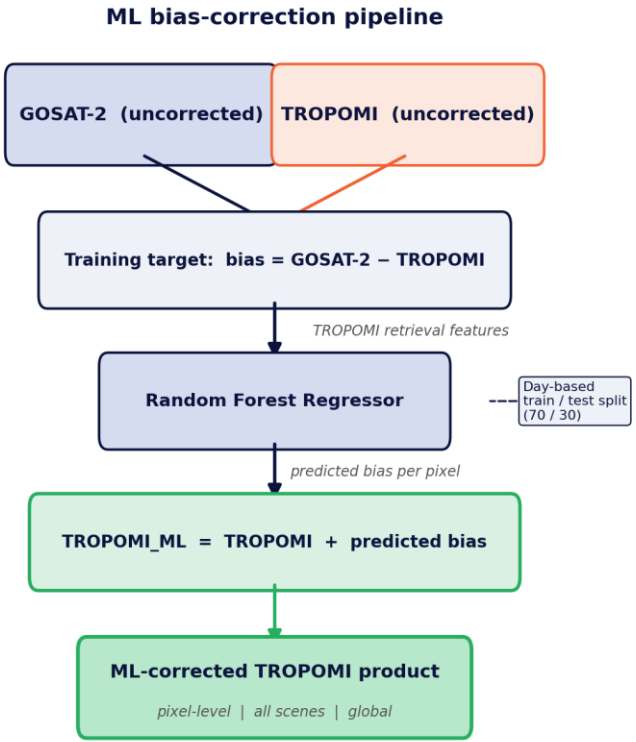
Can TROPOMI bias be corrected using GOSAT-2 as an anchor — two instruments sharing the same retrieval algorithm?

Prior work: Balasus et al. (2023, AMT) presented a blended TROPOMI+GOSAT product using a similar ML framework — a key reference for this work. Our approach is distinct: we use **GOSAT-2** (same retrieval algorithm as TROPOMI) and compare **both instruments uncorrected** — disentangling instrumental bias from retrieval corrections

GOSAT-2 / TROPOMI colocation strategy

Match criteria: spatial radius (~50km) + temporal window (2.5h)





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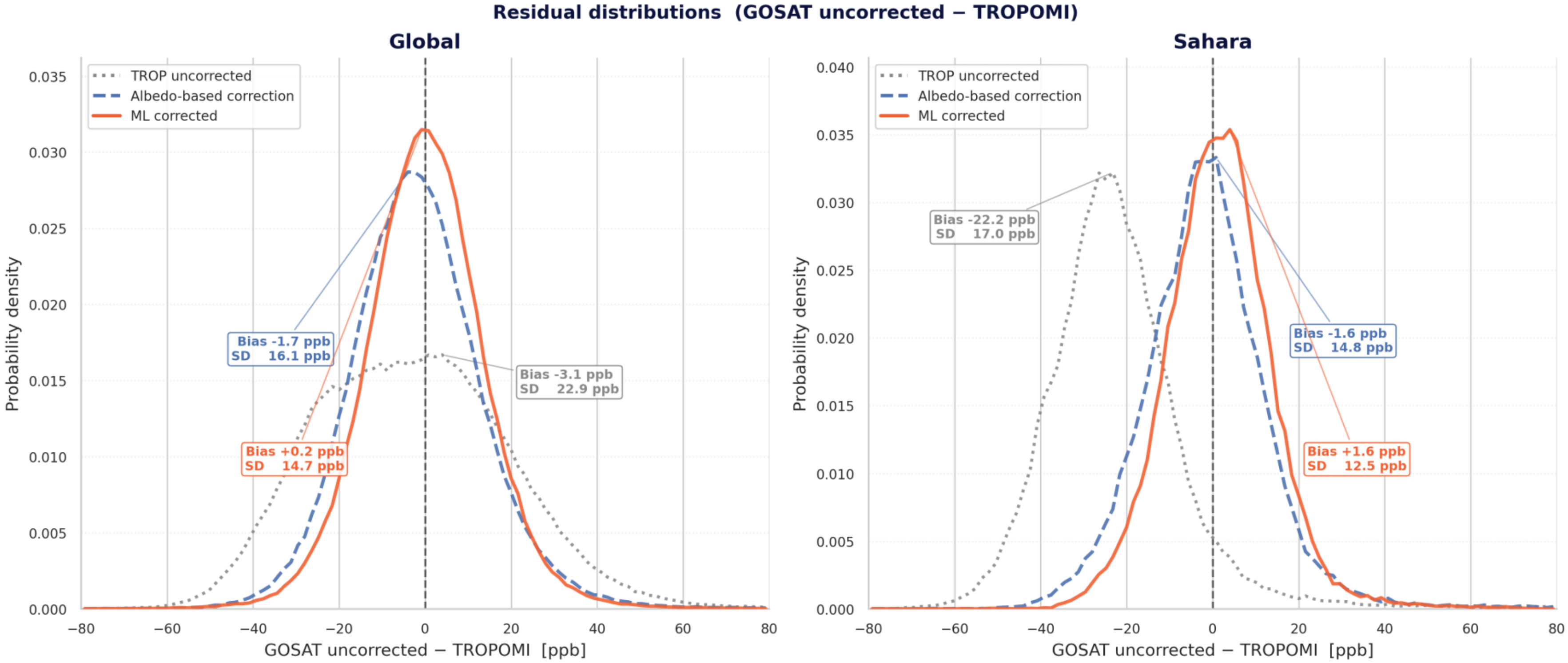
preliminary

Results



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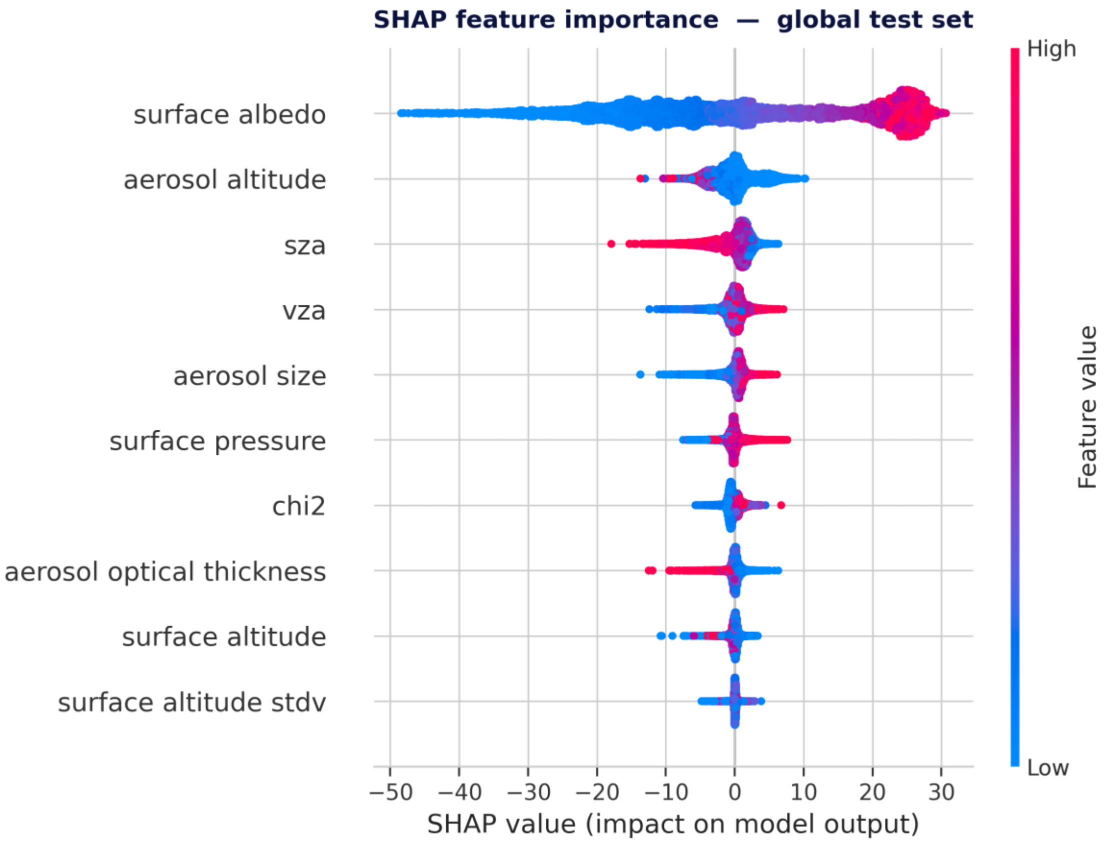
Model interpretability — SHAP analysis



- Surface albedo dominates — high albedo pushes bias up, low albedo pushes it down
- Aerosol altitude, geometry and scene properties all contribute — beyond a single-variable correction

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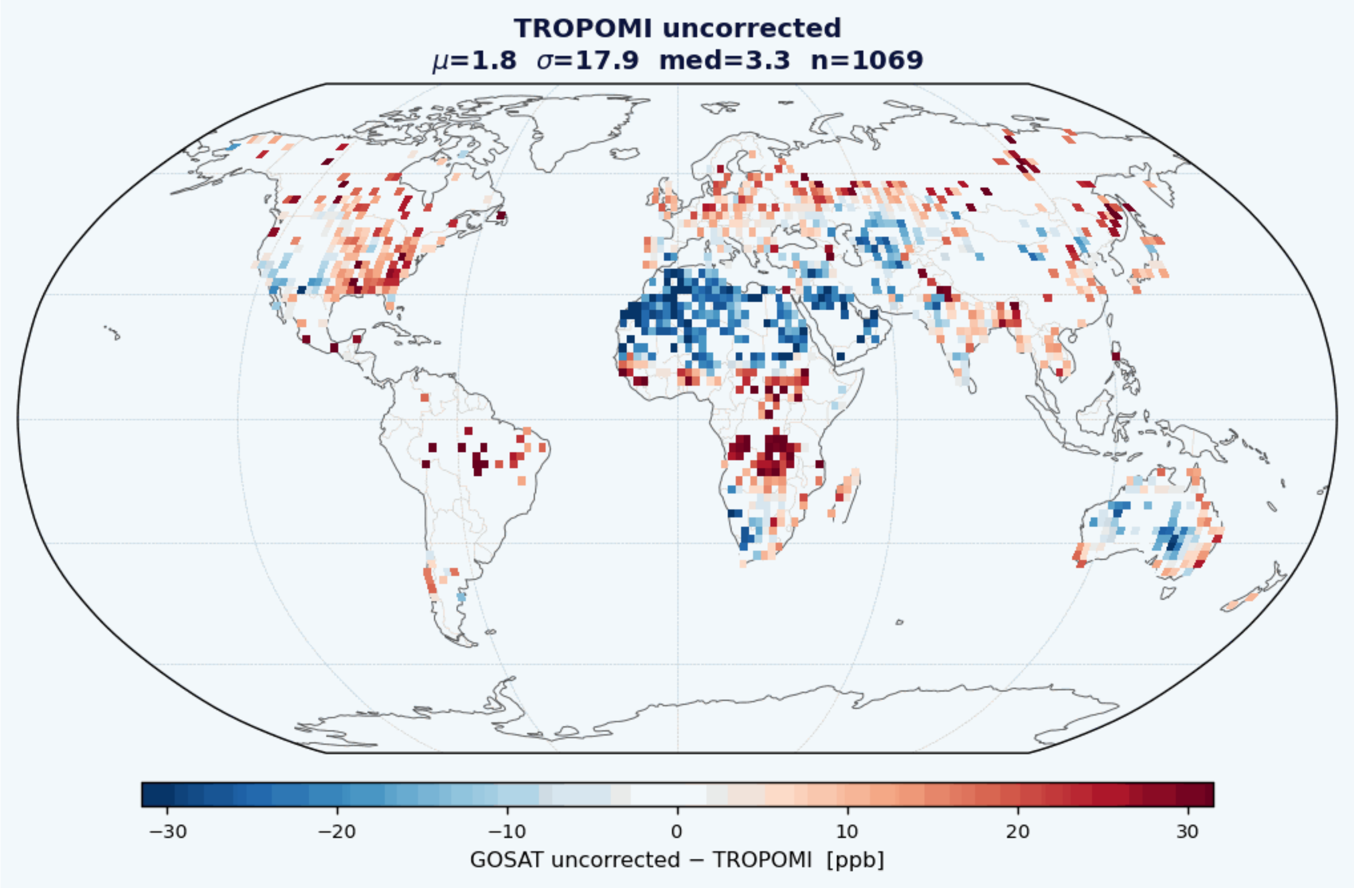
Spatial diagnostics — 2°×2° grid, test set



Conclusions

Summary

- ML bias correction outperforms the albedo-based approach
- Model learns physically interpretable corrections

Next steps

- Validate the learned correction against an independent reference (TCCON)
- Investigate simulation-based correction to separate instrumental from model-induced bias — enabling cleaner cross-instrument harmonisation [ongoing]