

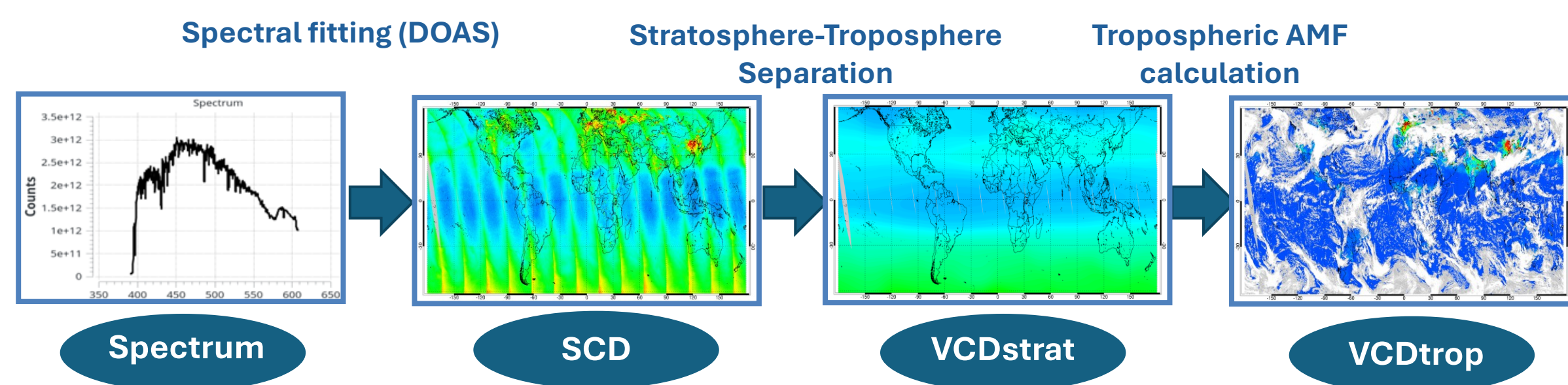
ASSESSMENT OF A NEW CLOUD TREATMENT ON S5P/TROPOMI

TROPOSPHERIC NITROGEN DIOXIDE OBSERVATIONS

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DLR TROPOMI TROPOSPHERIC NO₂ RETRIEVAL ALGORITHM

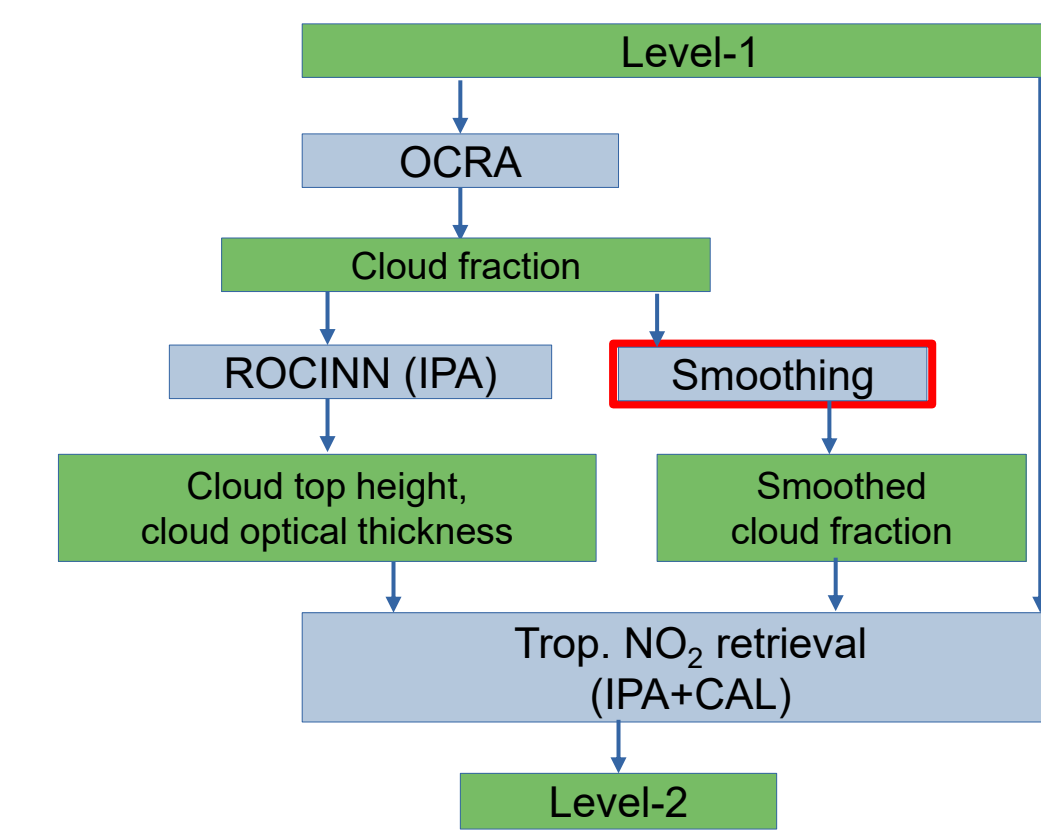


- DLR TROPOMI tropospheric NO₂ retrieval algorithm mainly follows a three-step (Liu et al., 2019):
 - Spectral fitting of NO₂ slant columns based on DOAS technique
 - Separation of slant columns into stratospheric and tropospheric contributions
 - Conversion of tropospheric slant columns to vertical columns using air mass factors (AMFs)
- Independent from the operational processing, the DLR TROPOMI NO₂ retrieval algorithm is flexible and versatile, capable of accommodating new settings and input datasets for total and tropospheric NO₂ retrieval
- > investigating the influence of different cloud models on tropospheric NO₂ retrievals

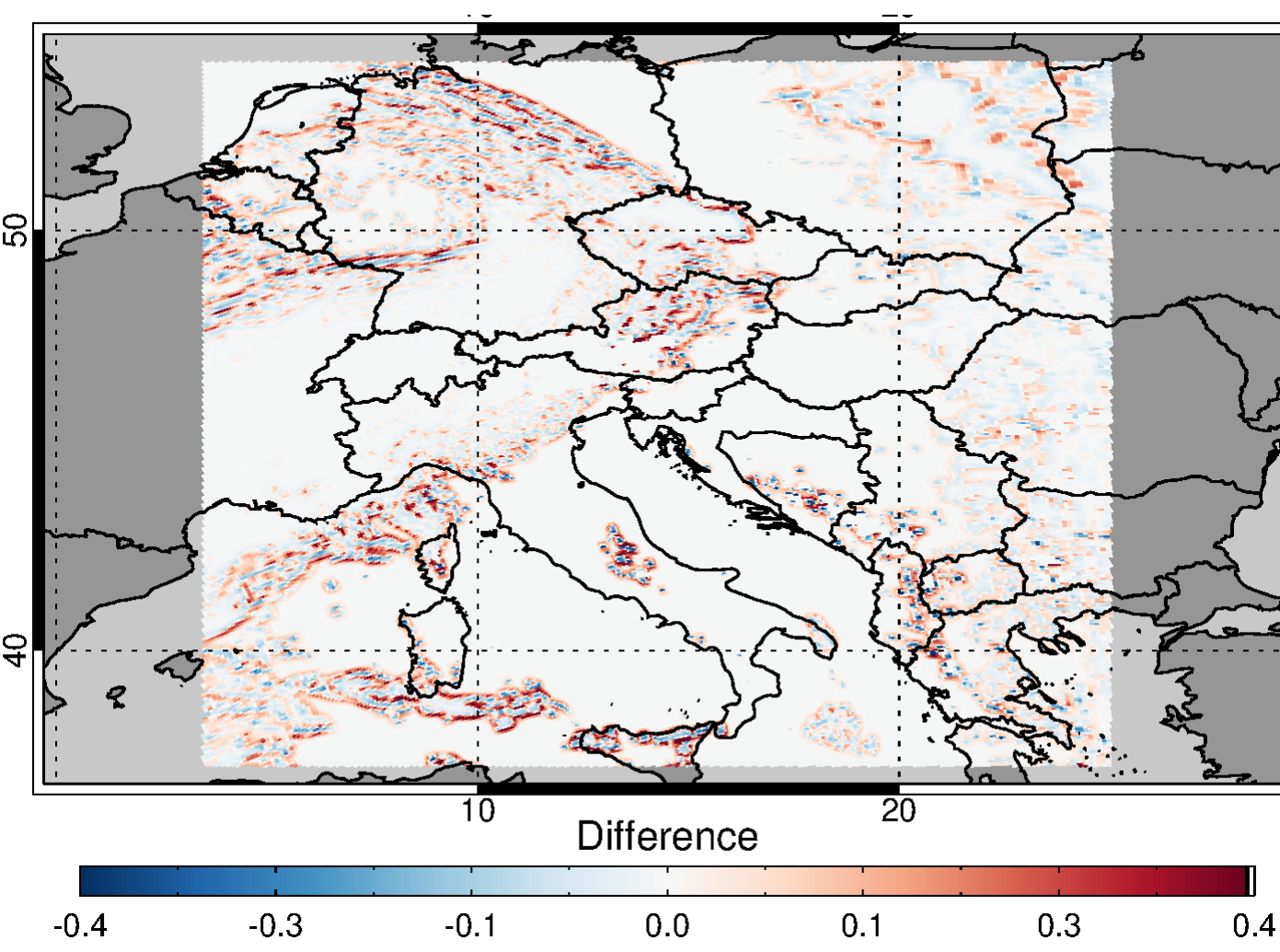
	DLR research algorithm (this study)	KNMI operational algorithm
Method	online AMF calculation	linear interpolation from the altitude-dependent AMF LUT
Surface albedo	TROPOMI DLER v2.0 climatology	OMI LER climatology (Processor version 1.0-2.3; until 2022-07) TROPOMI DLER v1.0 climatology (Processor version 2.4; from 2022-07)
A priori NO ₂ profile	CAMS global forecast (Global, 0.4° x 0.4°, 137 levels)	TM5-MP (Global, 1° x 1°, 34 levels)
Cloud parameter	(1) OCRA/ROCINN_CRB v2.4 (2) OCRA/ROCINN_CAL v2.4 (3) OCRA/ROCINN_surrogate CAL v2.4	FRESCO-S

3D CLOUD EFFECT TREATMENT ON TROPOSPHERIC NO₂ RETRIEVALS

The surrogate cloud model, based on the Independent Pixel Approximation, was implemented in the OCRA/ROCINN CAL processor to account for 3D cloud effects by reflecting cloud shadow effects. Apply smoothing to the OCRA radiometric cloud fraction field (i.e. it uses real three-dimensional radiance field) with a Gaussian kernel with a 7 km width smoothing corresponding to 1-2 TROPOMI pixels.

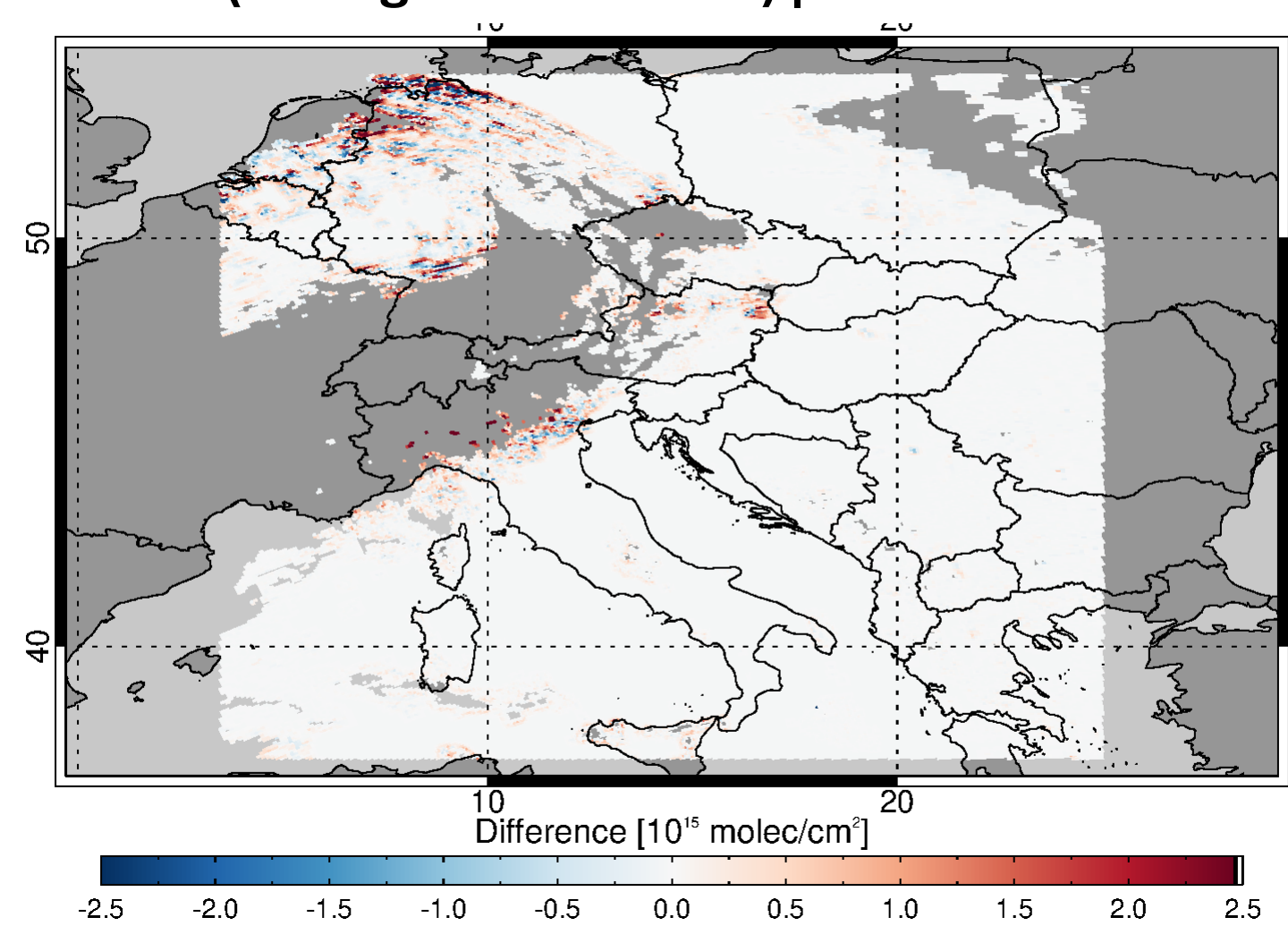


Difference in intensity weighted cloud fraction (surrogate CAL - CAL) | March 2023



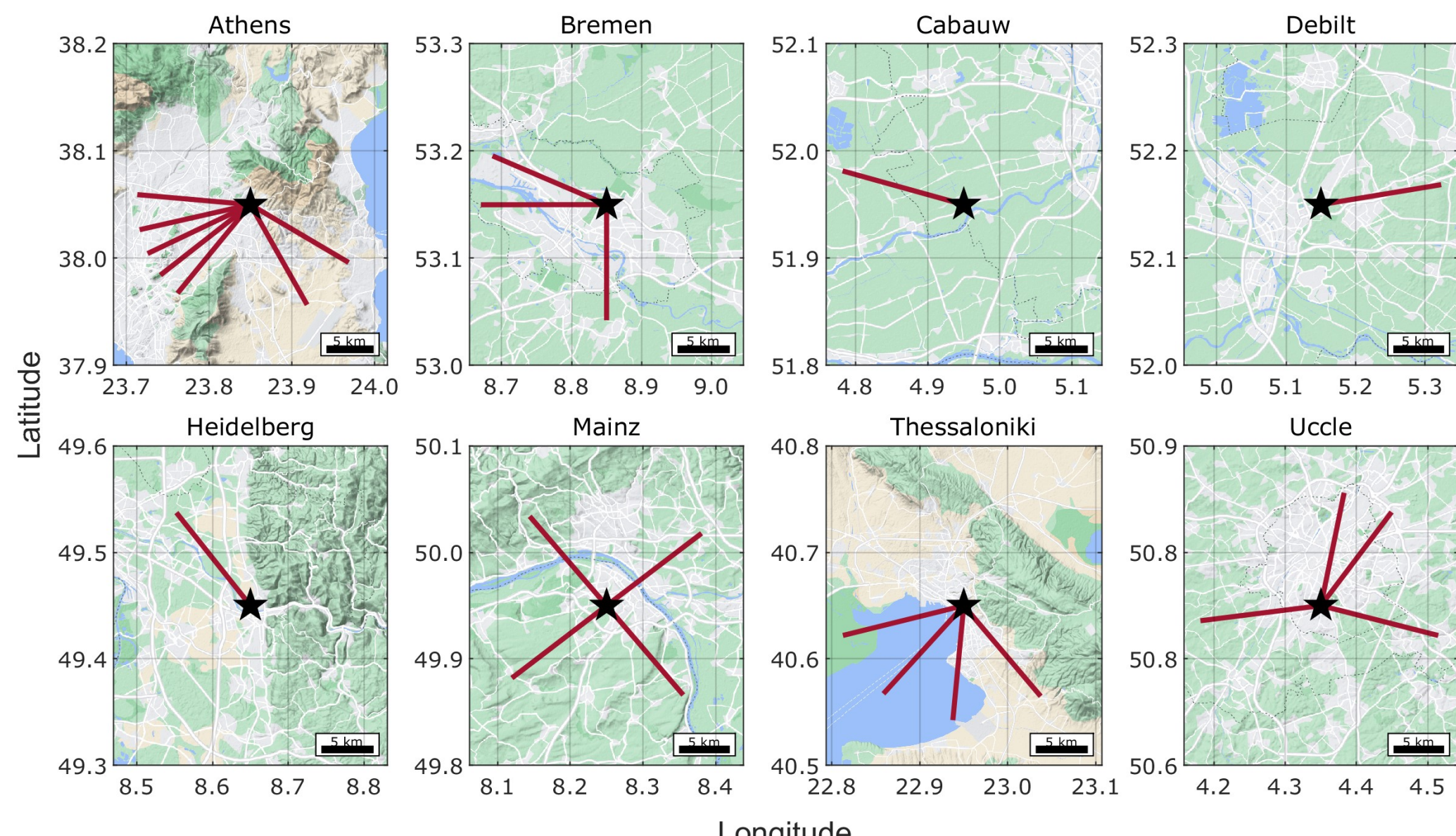
The effect of surrogate cloud model on the intensity weighted cloud fraction is pronounced at the cloud edges.

Difference in TROPOMI tropospheric NO₂ column (surrogate CAL - CAL) | March 2023

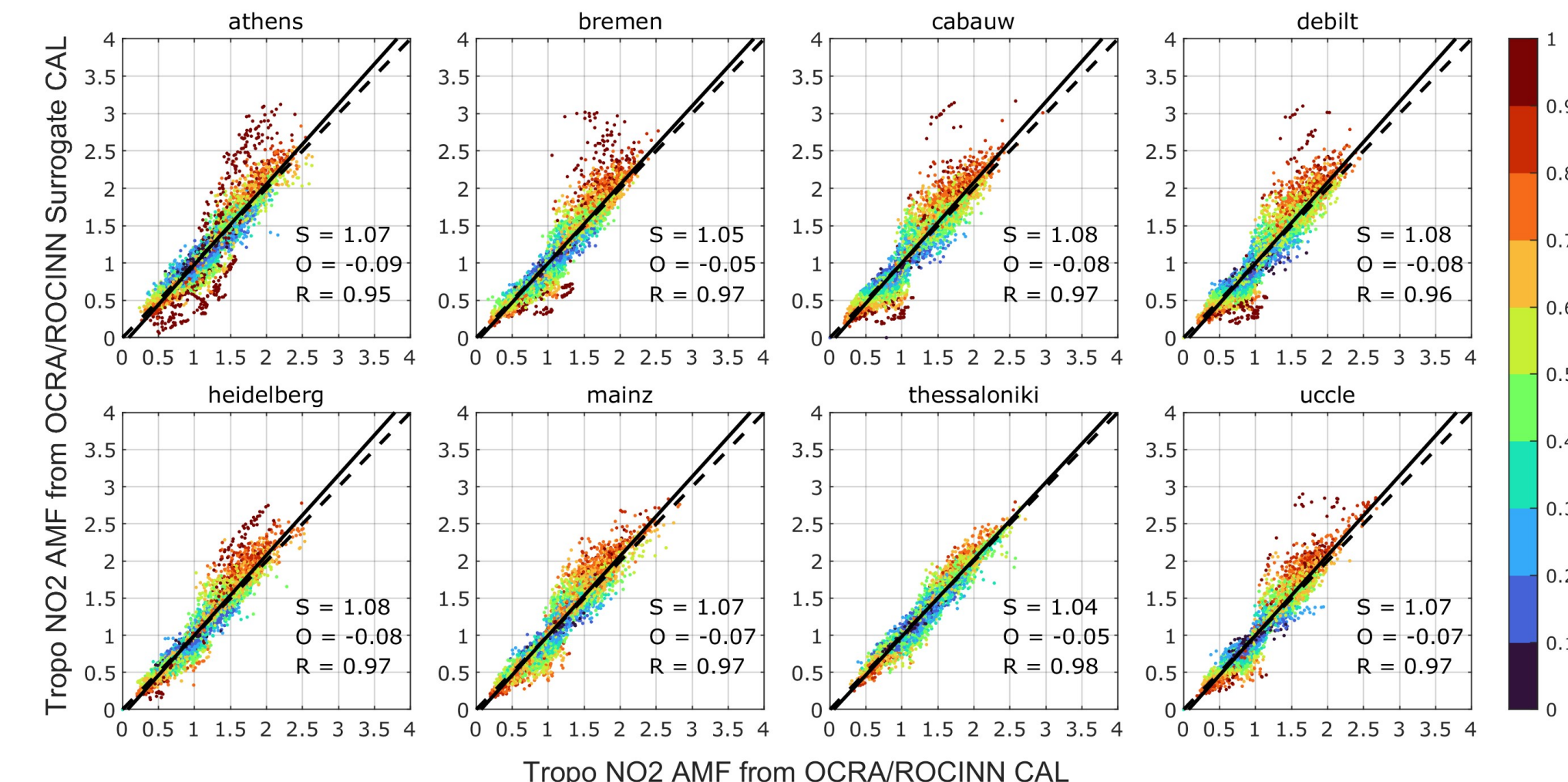


Differences in retrieved tropospheric NO₂ levels are pronounced in regions with high pollution and strong spatial variability in cloud coverage

Validation against MAX-DOAS observations around Europe



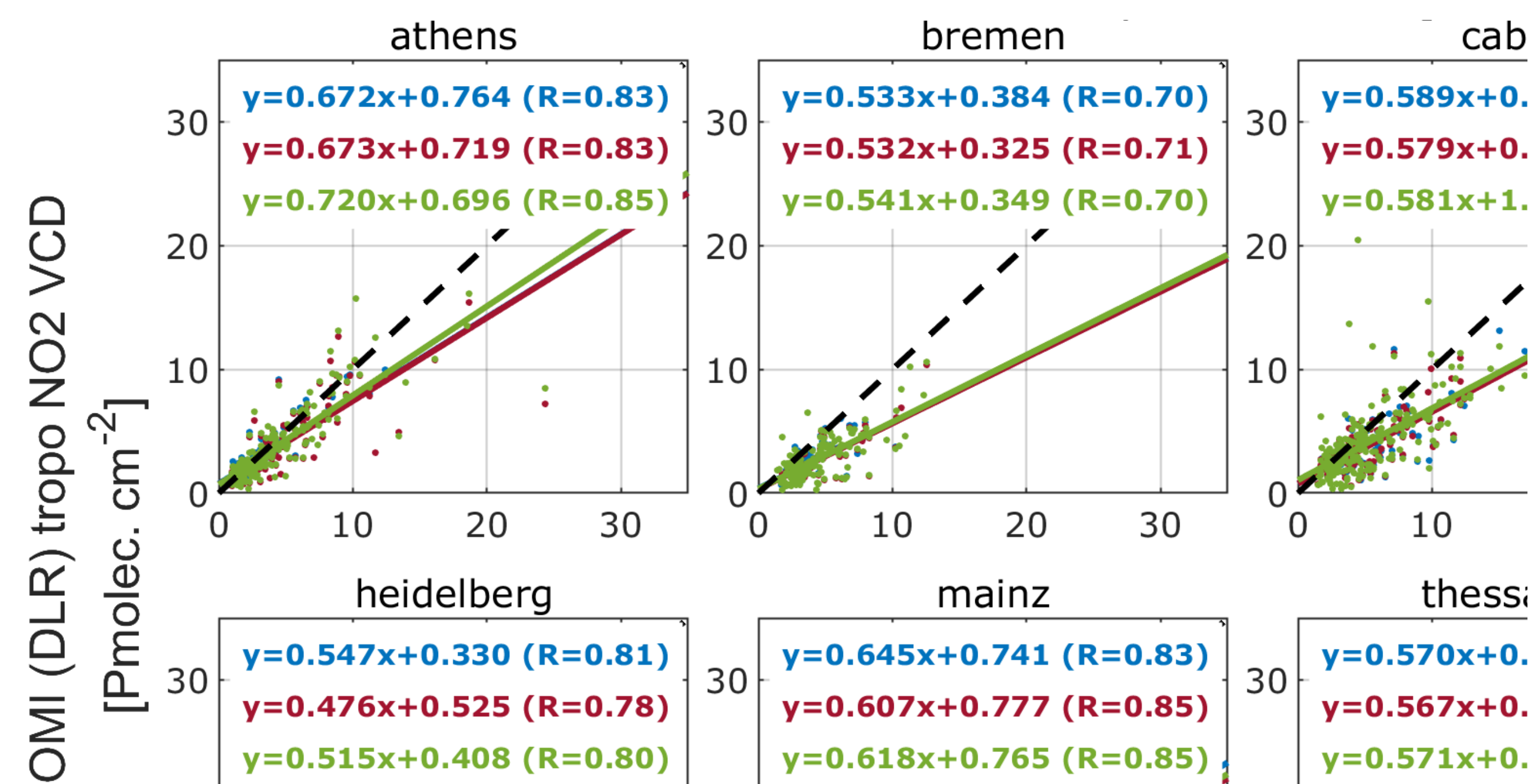
MAX-DOAS data that are used for validating the TROPOMI tropospheric NO₂ products were collected through the ESA Atmospheric Validation Data Centre, EVDC, <https://evdc.esa.int/>, commonly processed by the Fiducial Reference Measurements for Ground-Based DOAS Air-Quality Observations, FRM4DOAS, <https://frm4doas.aeronomie.be/>, settings.



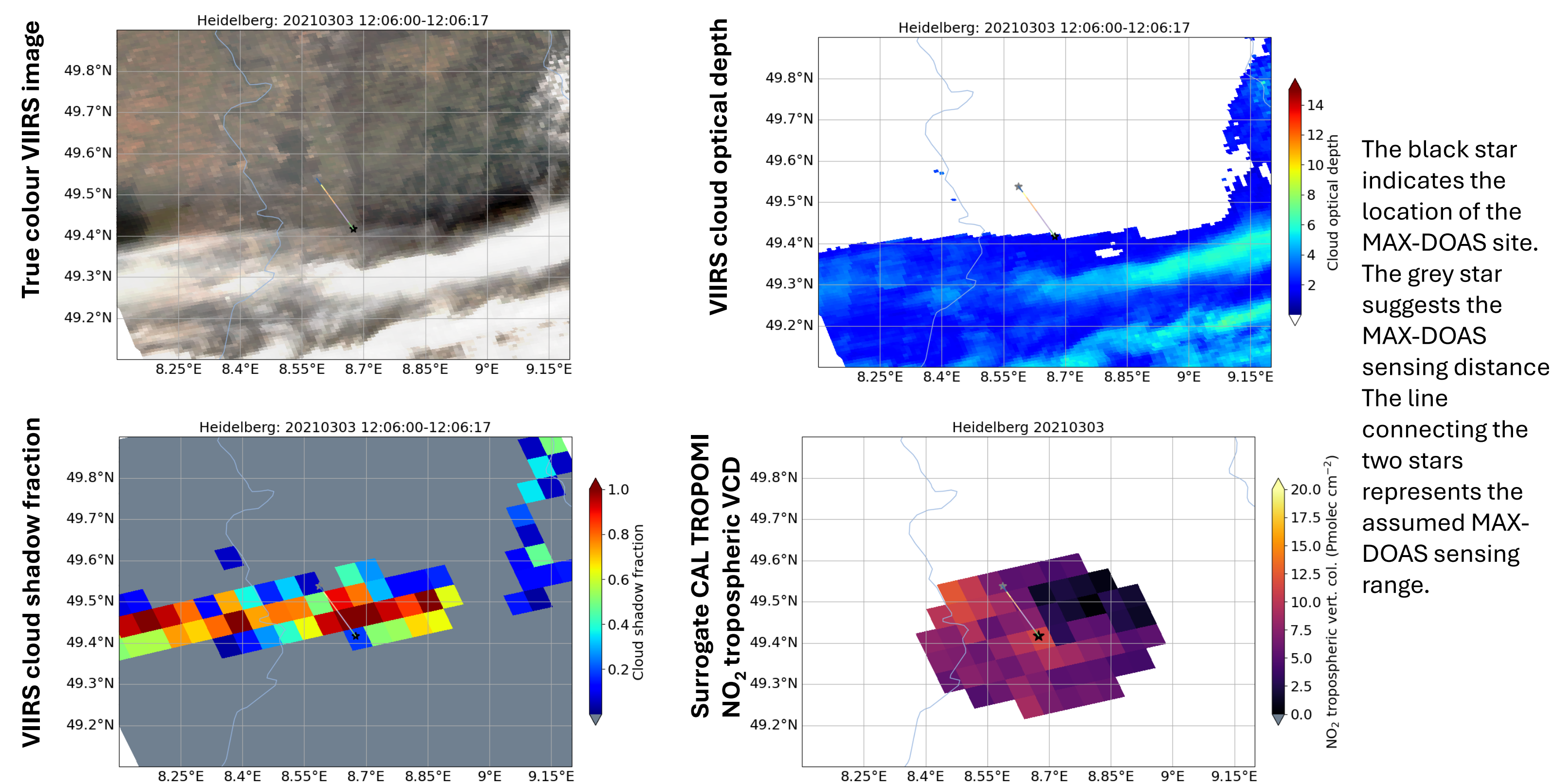
Scatter plots of the tropospheric AMF using CAL and CAL surrogate cloud treatments for all MAX-DOAS systems. AMFs data are coloured by the OCRA/ROCINN Surrogate CAL Intensity Weighted Cloud Fraction (IWCF).

RESULTS

Comparison of the TROPOMI CRB (blue), CAL (red) and CAL surrogate model (green) tropospheric NO₂ VCDs and the ground-based MAX-DOAS for all stations. Data filtered by cloud fraction < 20%.



3D cloud effect treatment on tropospheric NO₂ retrieval Case study over Heidelberg on 03.03.2021



Instrument name	S5P time (hh:mm:ss)	DOAS time (hh:mm:ss)	DOAS (Φ°)	NO ₂ ^{oper} (Pmol/cm ²)	NO ₂ ^{DLR} (Pmol/cm ²)	NO ₂ ^{surr} (Pmol/cm ²)	NO ₂ ^{DOAS} (Pmol/cm ²)
uheidelberg001	12:06:09	12:04:19	324.0	6.740	6.568	7.505	13.009

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