How sensitive is the TROPOMI nitrogen dioxide retrieval to the surface albedo?

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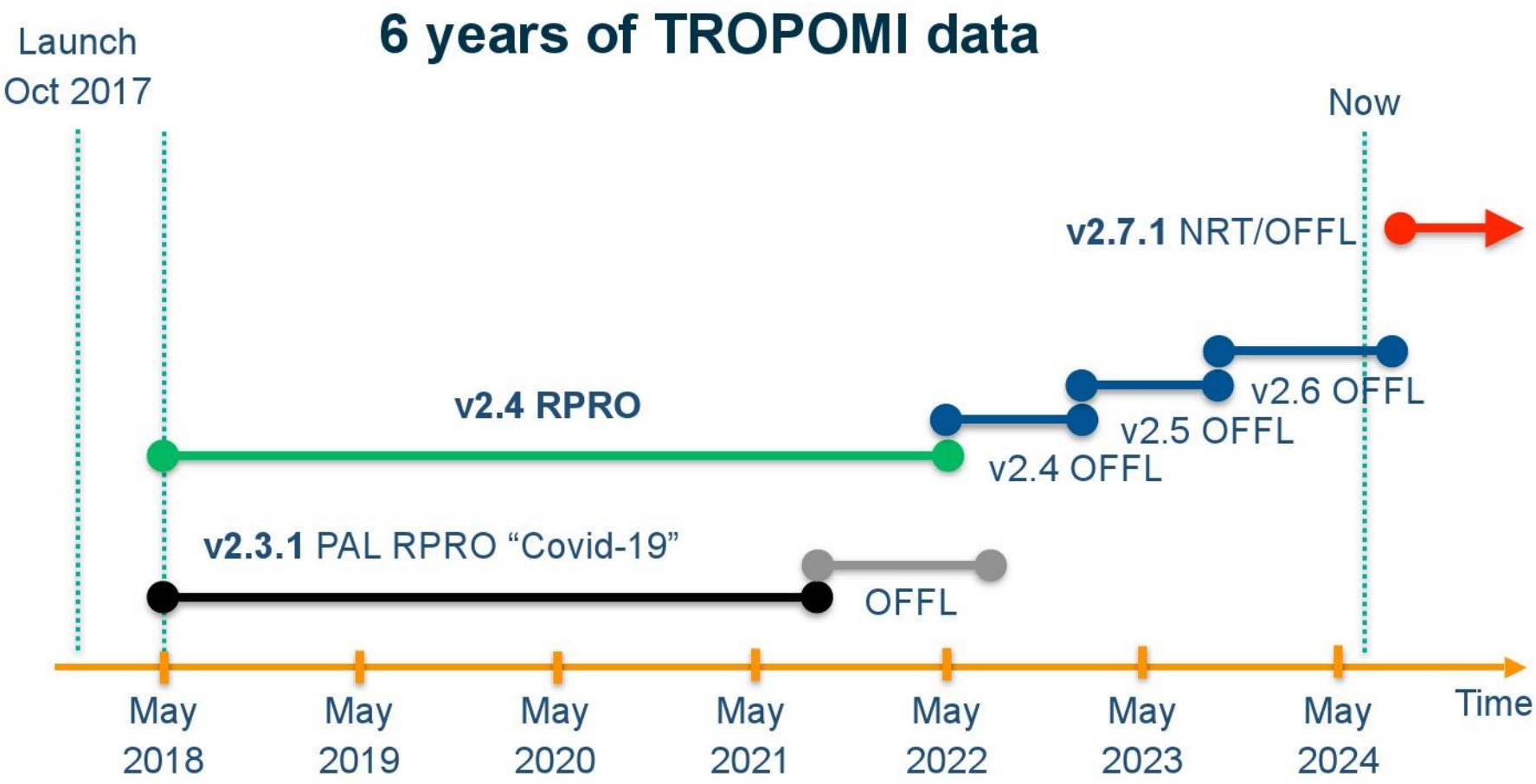
TROPOMI NO2: Upgrades and reprocessing



Surface Albedo

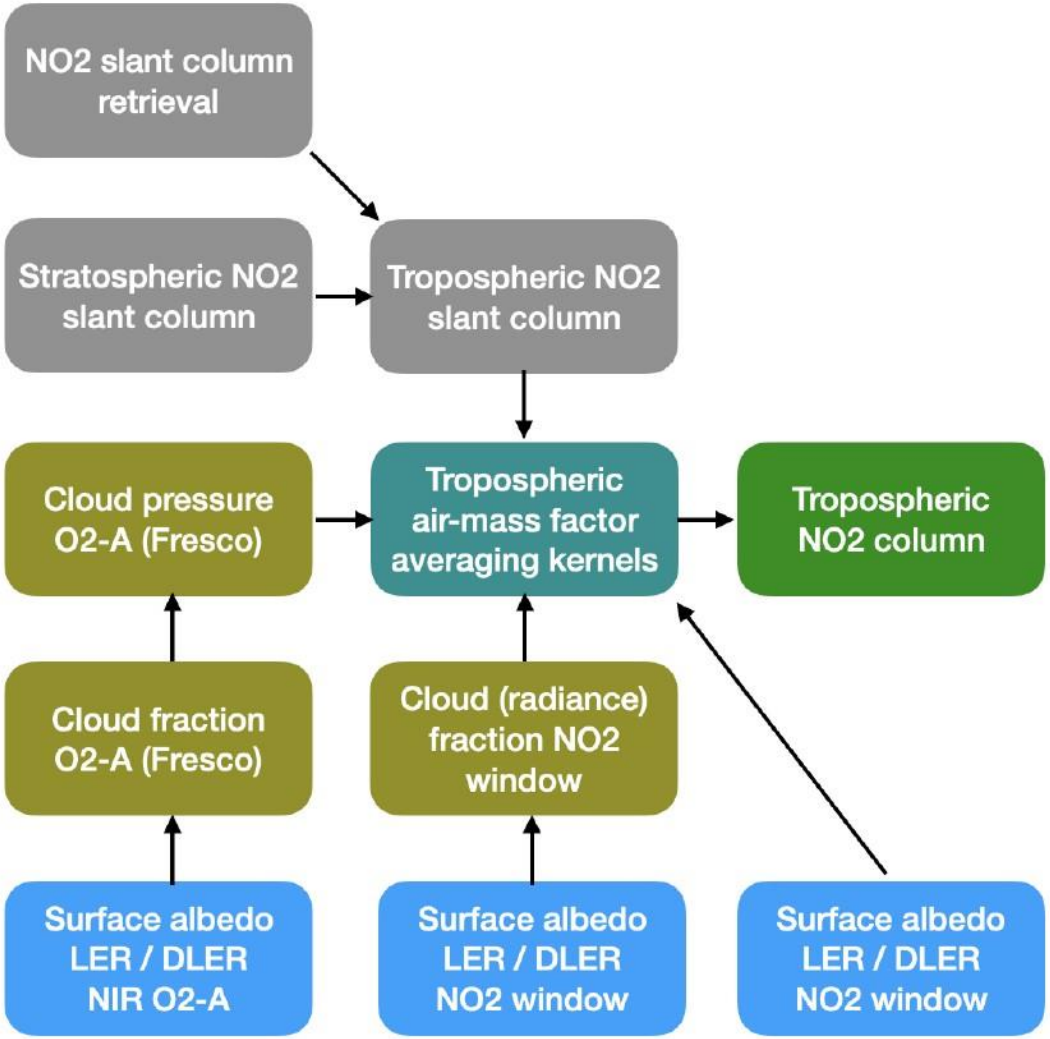
TROPOMI DLER v2.1 (based on L1B v2.1)

TROPOMI DLER v1.0 (based on L1B v1)

OMI LER (UV-VIS), GOME-2 LER (NIR)

TROPOMI DLER: Tilstra et al., 2024

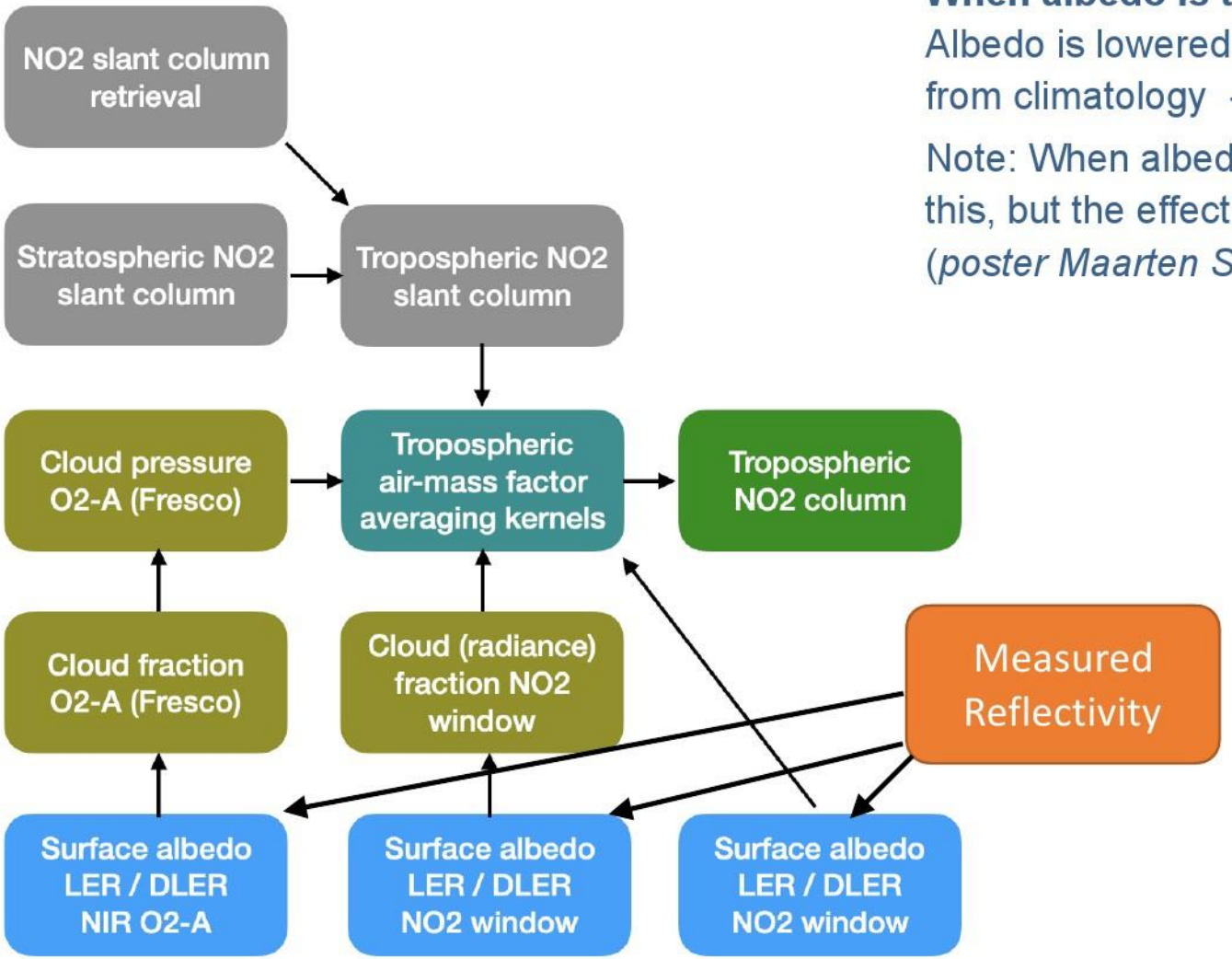
Retrieval scheme: surface albedo impact



Albedo impacts:

- Cloud fraction in the NO2 fit window
- Cloud pressure and fraction from the O2-A NIR band
- Air-mass factor calculation

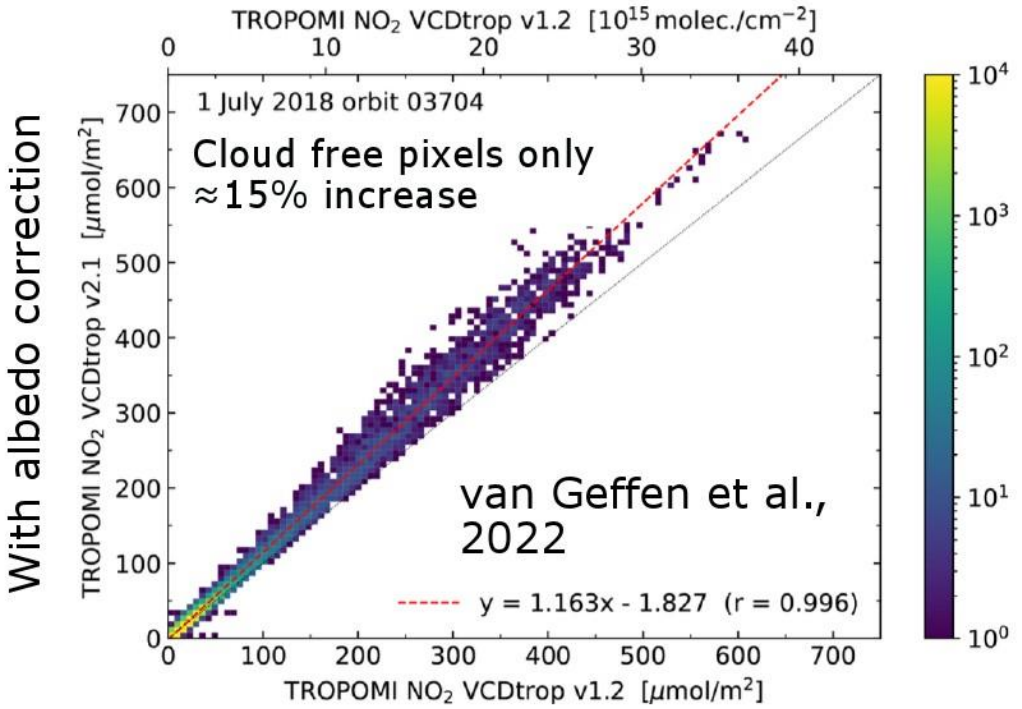
Retrieval scheme: surface albedo corrections



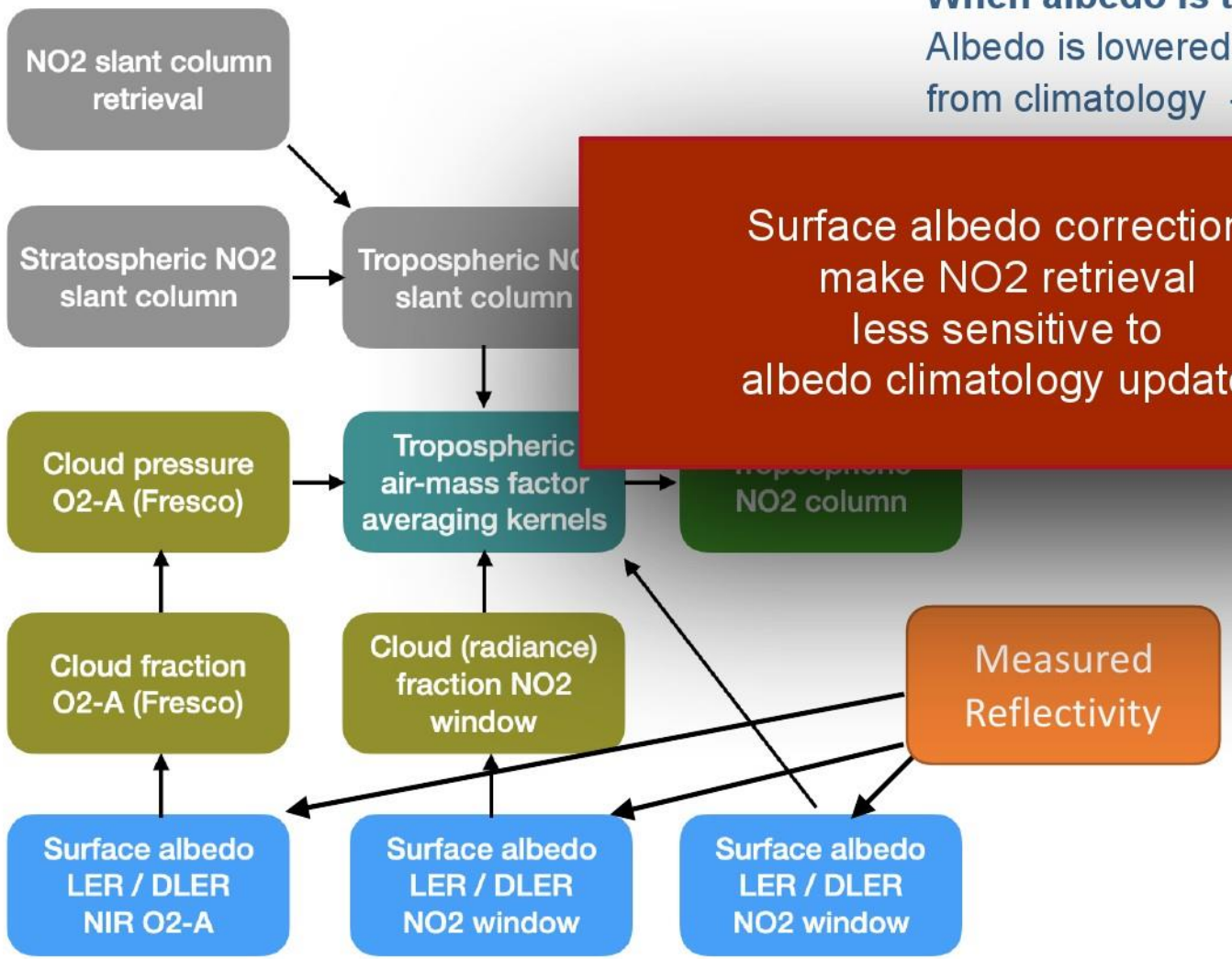
When albedo is too high:

Albedo is lowered (since v2.2) when reflectivity is lower than expected from climatology -> Increase NO2

Note: When albedo is too low, the cloud retrieval will (partly) correct for this, but the effective cloud pressure should be realistic (*poster Maarten Sneep on FRESCO cloud retrieval*)



Retrieval scheme: surface albedo corrections

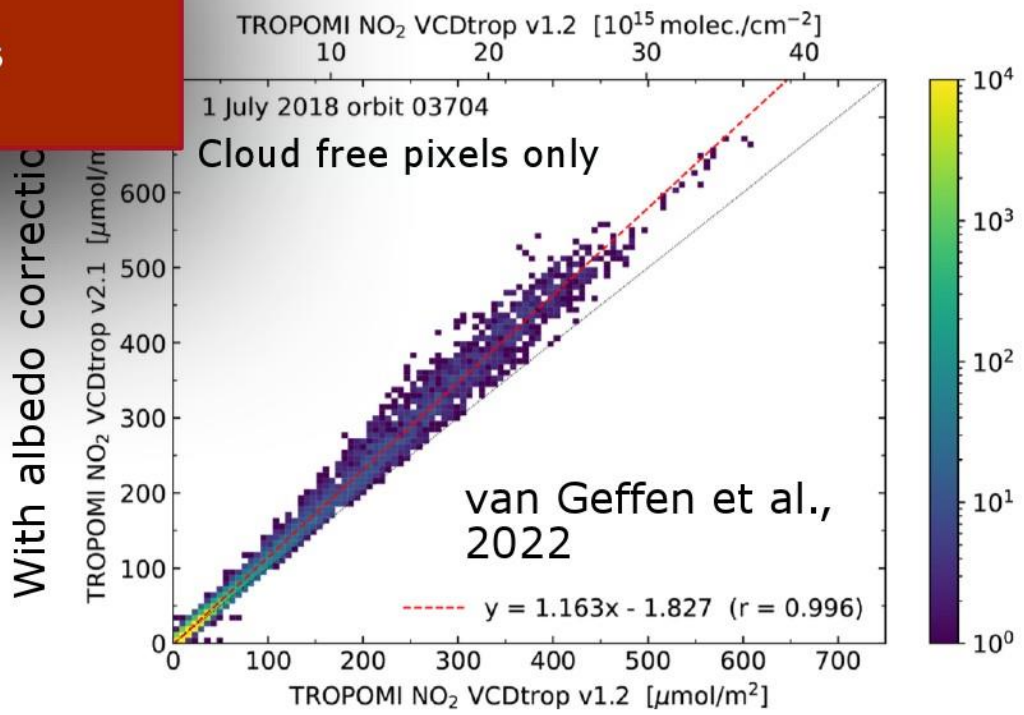


When albedo is too high:

Albedo is lowered (since v2.2) when reflectivity is lower than expected from climatology -> Increase NO2

the cloud retrieval will (partly) correct for
essure should be realistic
ESCO cloud retrieval)

Surface albedo corrections make NO2 retrieval less sensitive to albedo climatology updates

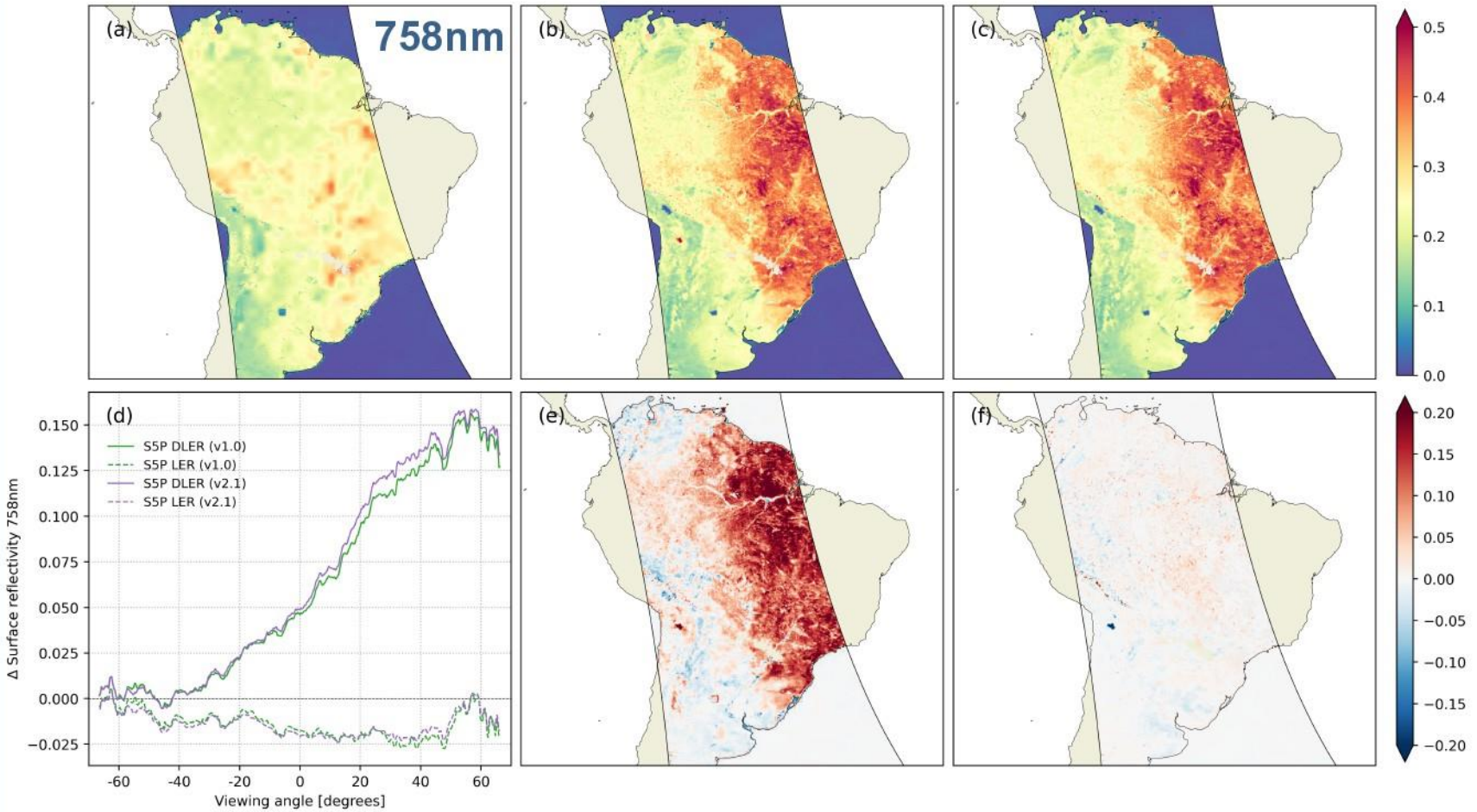


Surface albedo, DLER directionality in the NIR

v2.3.1
GOME-2 LER

v2.4.0
TROPOMI DLER v1.0

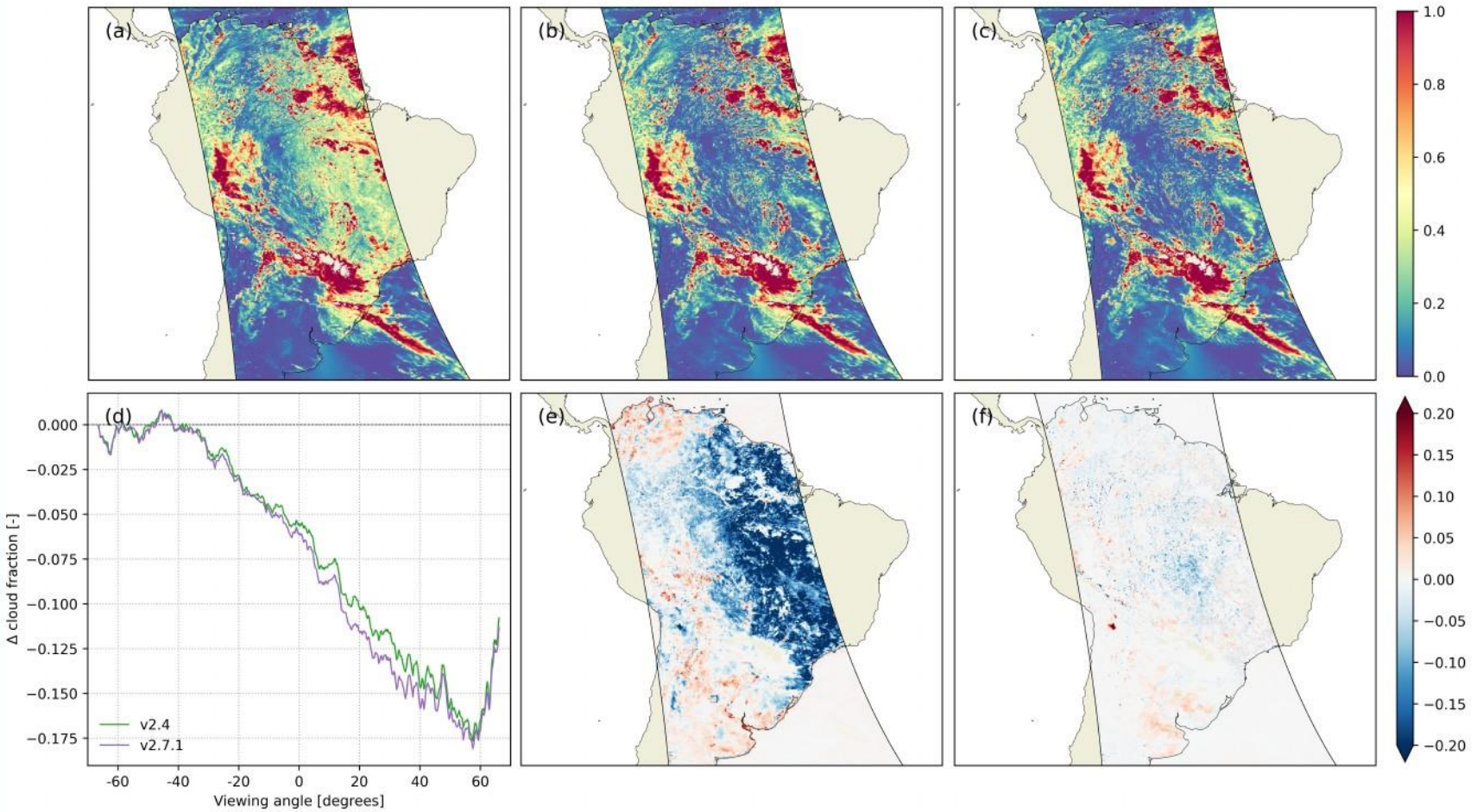
v2.7.1
TROPOMI DLER v2.1



NIR albedo (758nm):
Strong East-West directional asymmetry over vegetation in DLER albedo:

(East - West) ≈ 0.10 - 0.15

Cloud fraction and pressure in the NIR



NIR cloud fraction:

Large cloud fraction bias of about 0.15 on East side in v2.3.1.

Bias disappears in the TROPOMI DLER

Cloud pressure change:

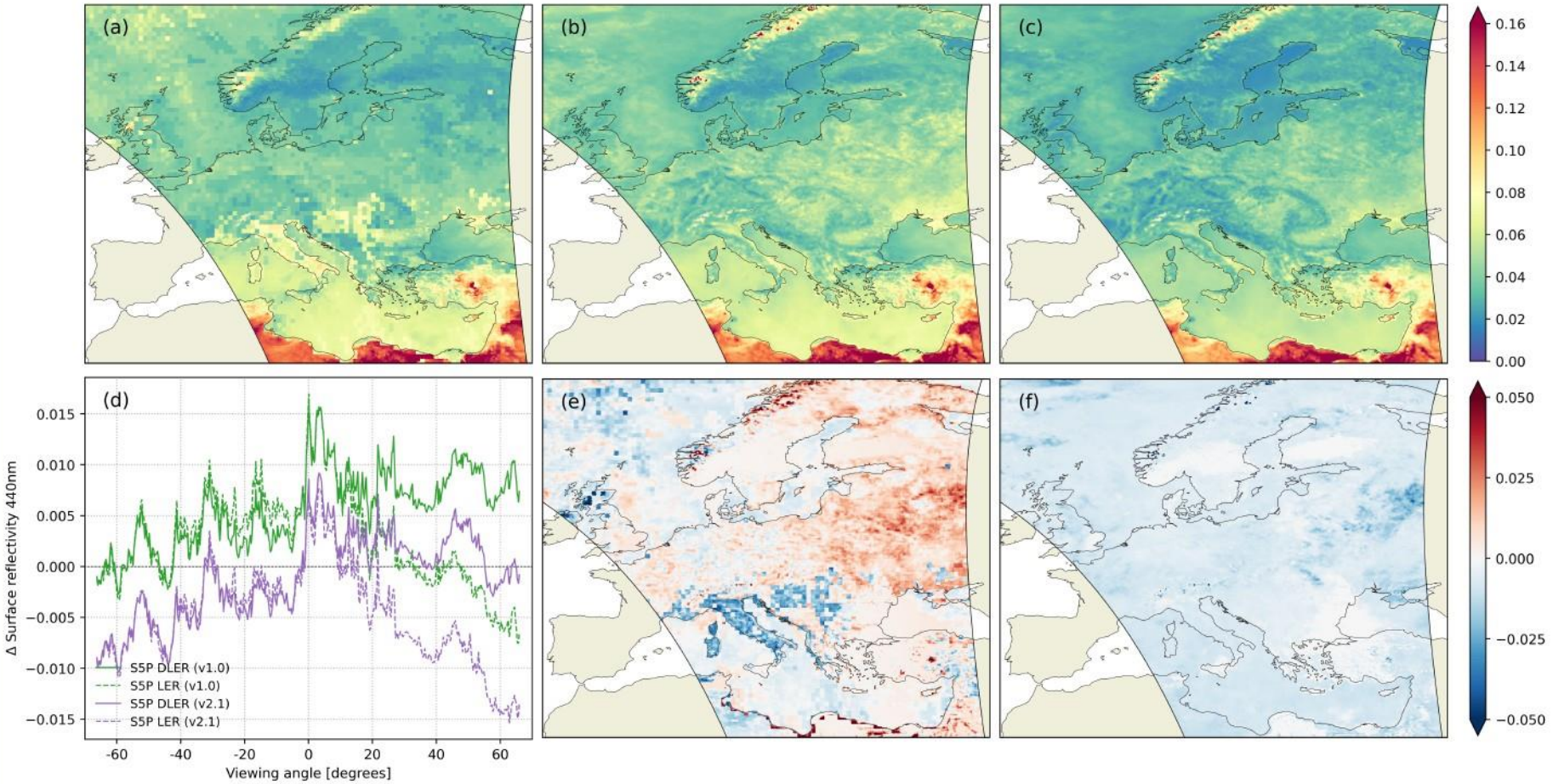
v2.4 - v2.3.1 ≈ – 150 hPa (east side orbit)

Surface albedo, DLER directionality in the NO2 fit window (440nm)

v2.3.1
OMI LER

v2.4.0
TROPOMI DLER v1.0

v2.7.1
TROPOMI DLER v2.1



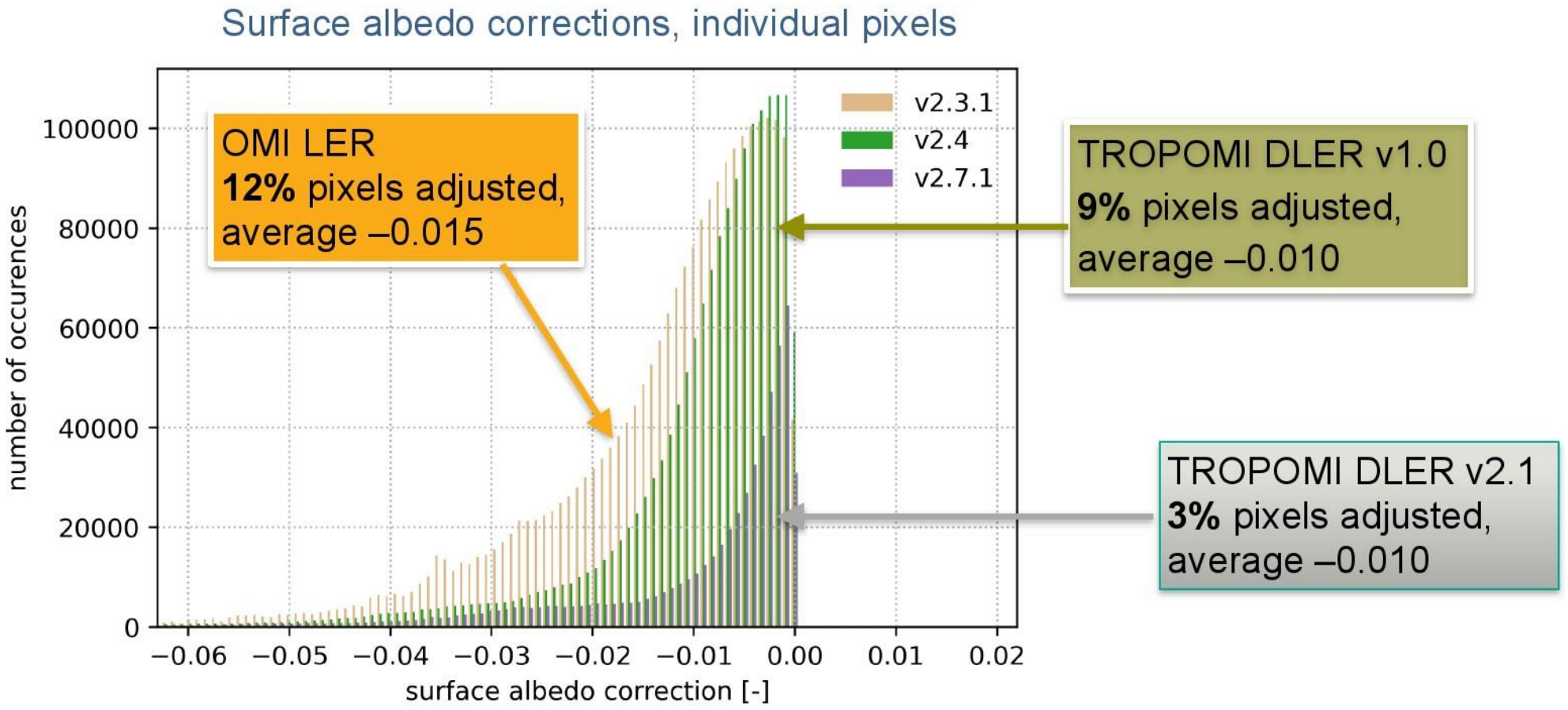
UV-Vis albedo (440nm):
Smaller East-West directional asymmetry in DLER albedo:

(East - West) ≈ 0.01

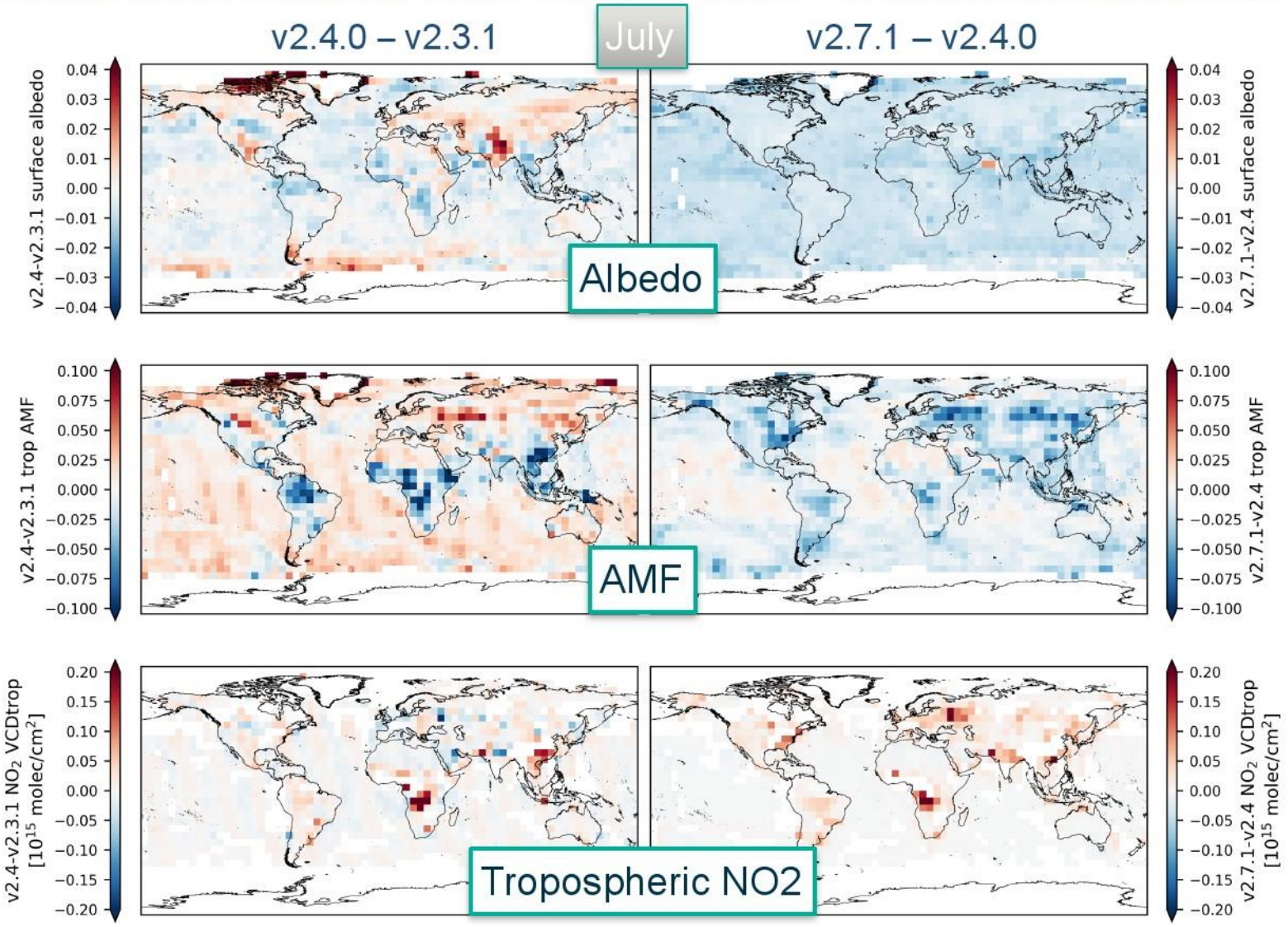
Calibrated radiances in L1B-v2 lead to uniform lower albedo:

v2.1 - v1.0 ≈ – 0.008

Surface albedo corrections, using reflectance



Impact on NO2



Impact on NO_2 not very large,
within +- 2e14 molec / cm2
linked to albedo adjustments

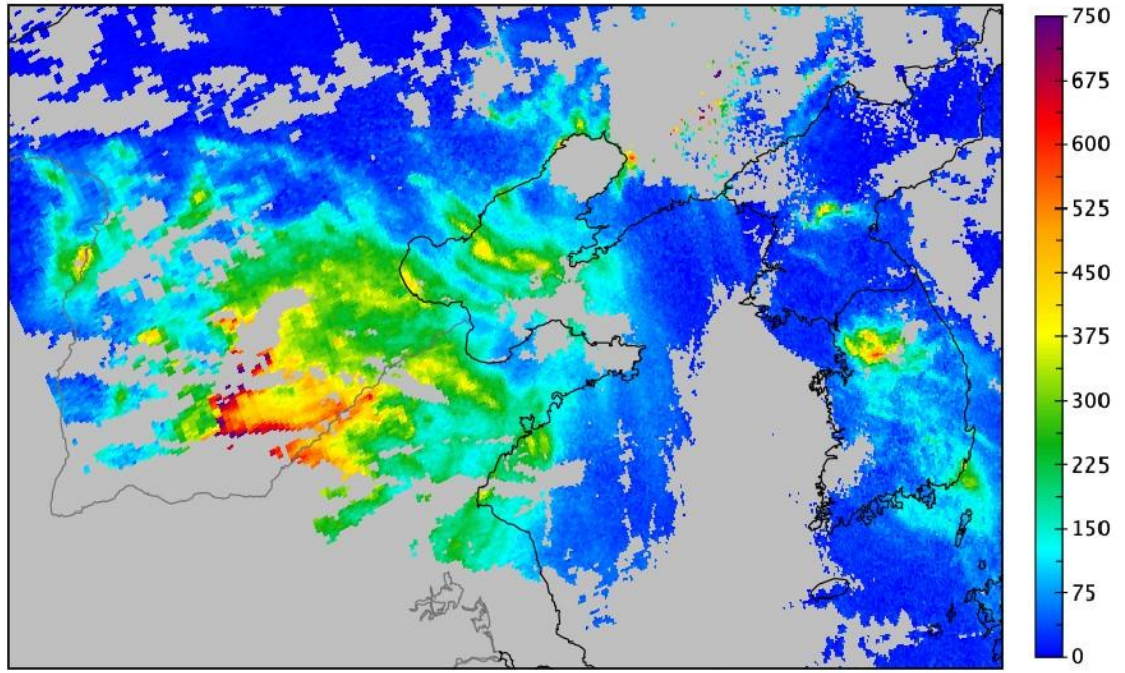
Signals over tropical biomass burning linked to LER -> DLER

Systematic increase over hotspots for S5P DLER v2.1 - v1.0

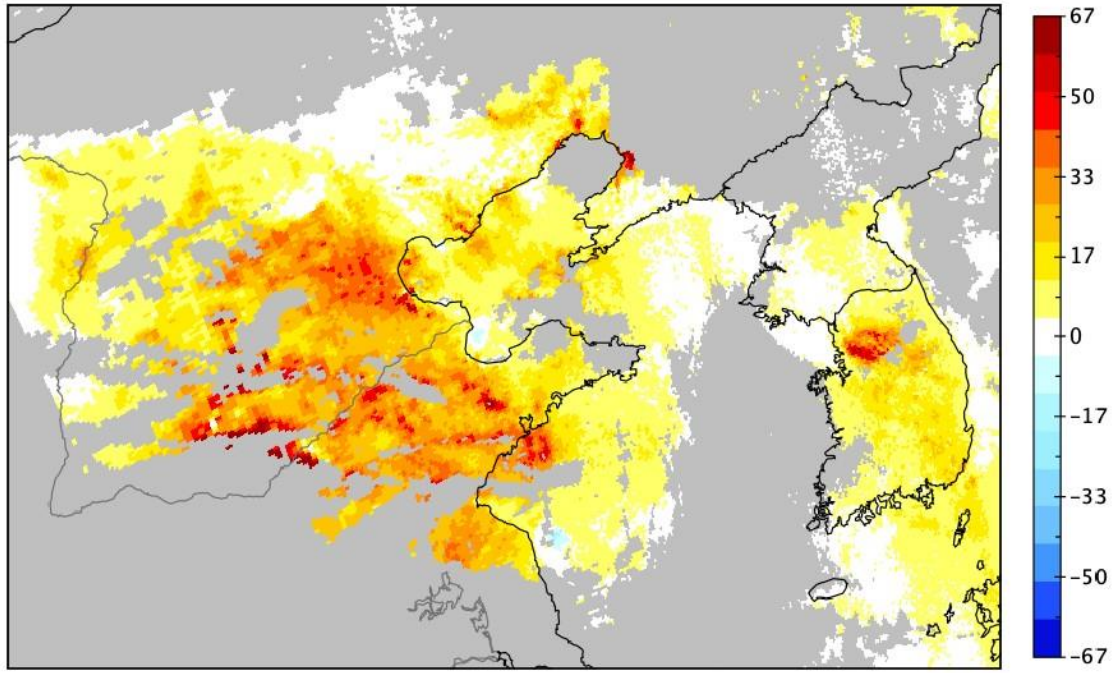
Impact on NO2, v2.7.1 – v2.4.0

Larger impacts observed over East Asia in Winter …

Tropospheric NO_2, v2.7.1



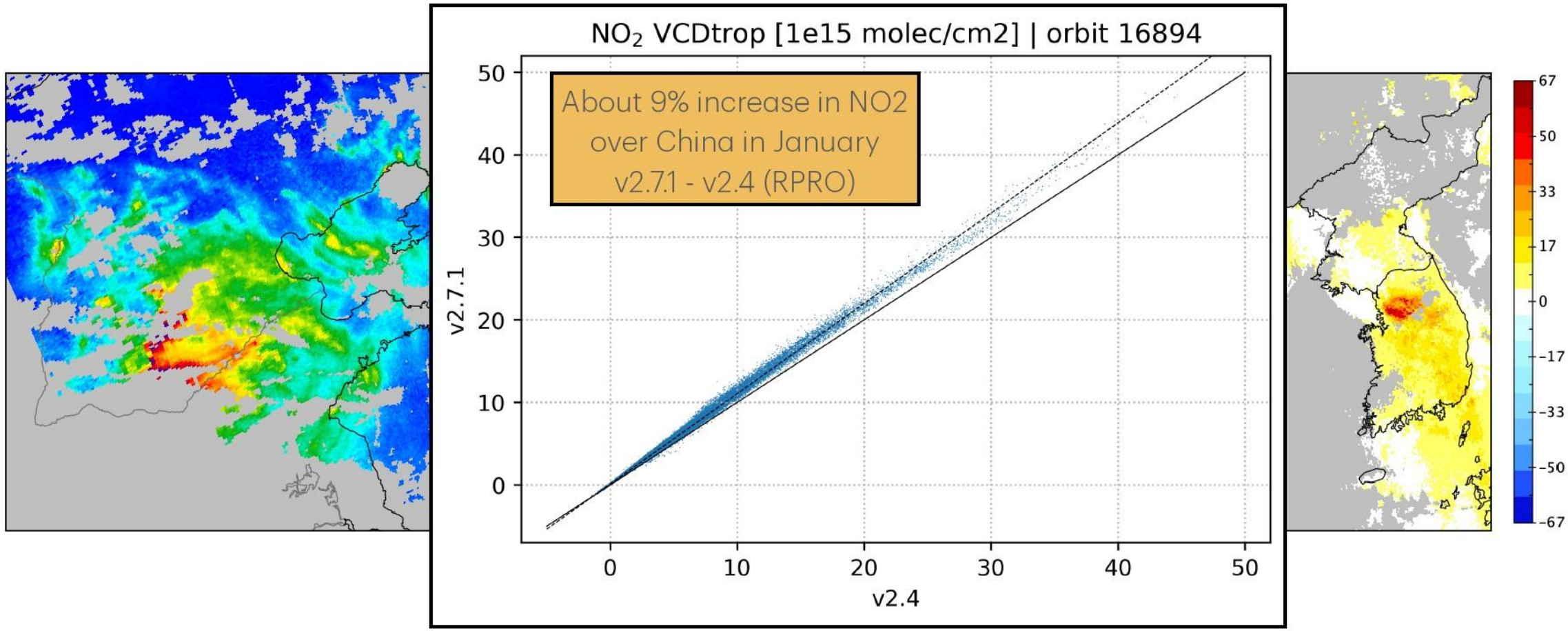
Tropospheric NO_2, v2.7.1 – v2.4.0



16 January 2021, East Asia, cloud filtered

Impact on NO2, v2.7.1 – v2.4.0

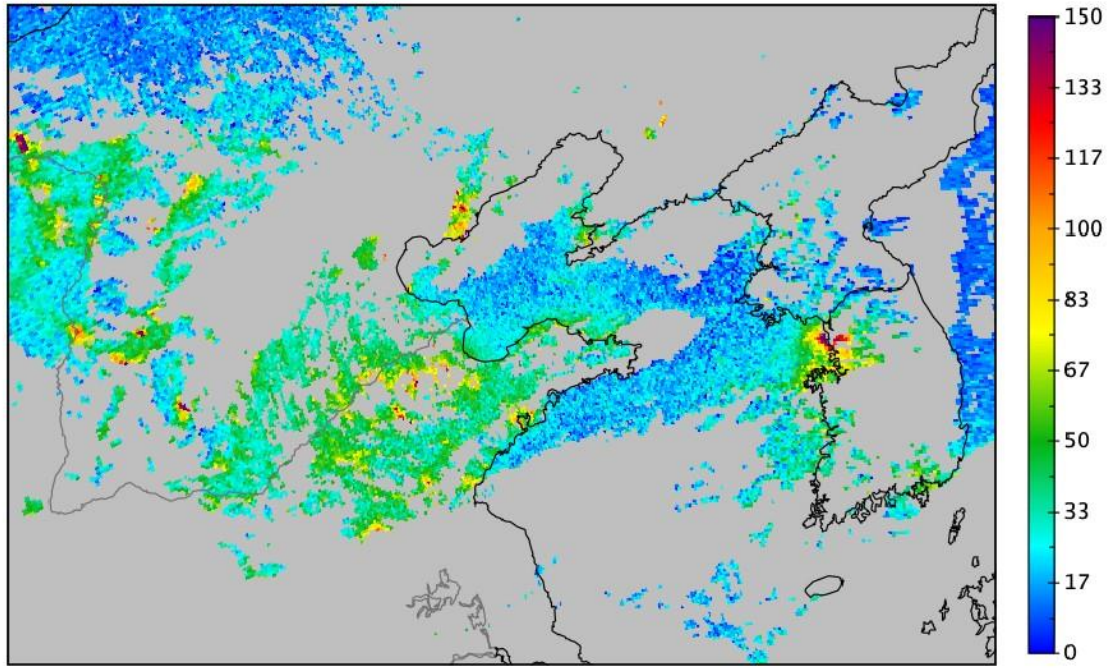
Larger impacts observed over China in Winter



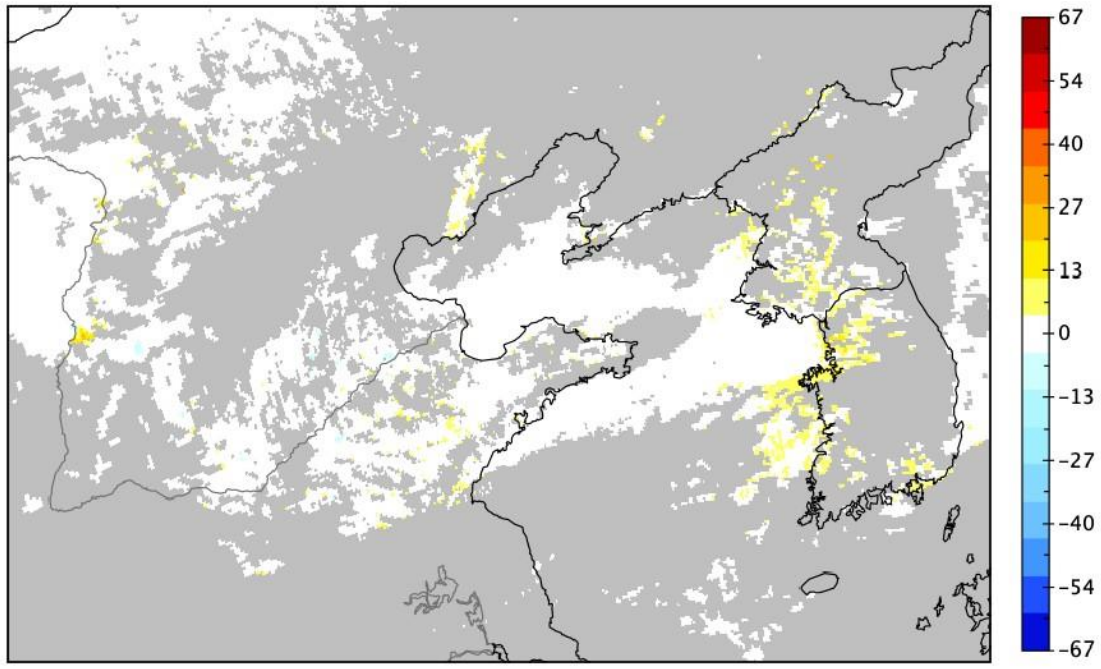
Impact on NO2, v2.7.1 – v2.4.0

… but almost no difference in August

Tropospheric NO_2, v2.7.1

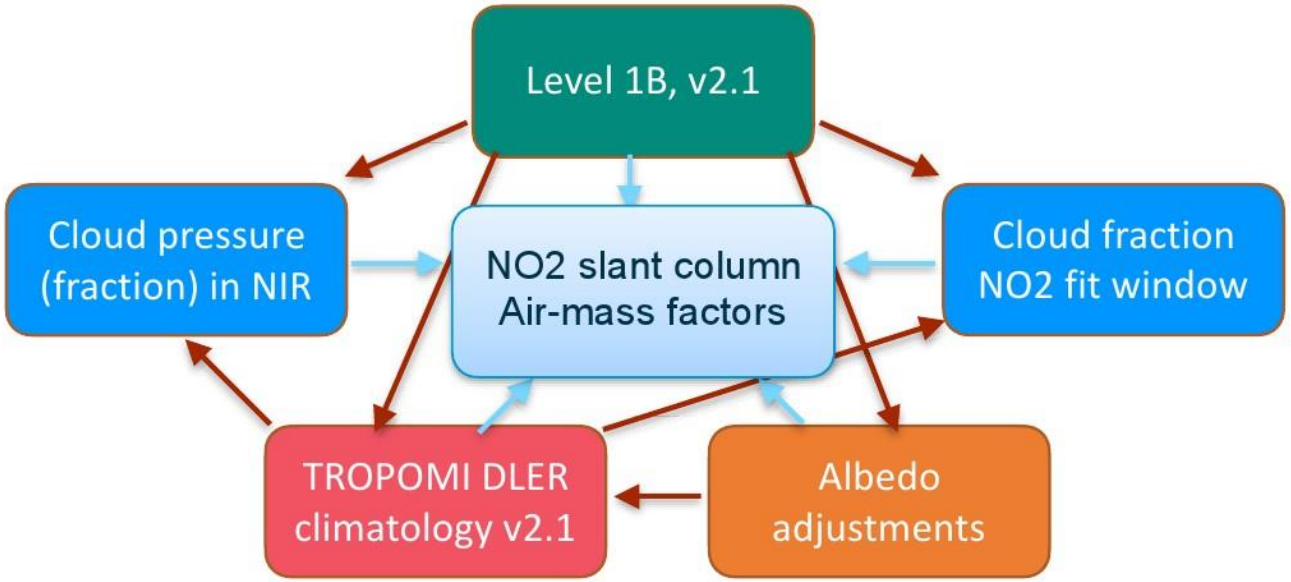


Tropospheric NO_2, v2.7.1 – v2.4.0



16 August 2021, East Asia, cloud filtered

Conclusions



TROPOMI v2.7.1 (Sept 2024) will introduce the TROPOMI DLER v2.1

This will bring for the first time **full internal consistency (radiance closure)**

All inputs for the AMF are derived from same Level 1B v2.1 degradation-corrected reflectances


Thanks for your attention