TOPAS ozone profile retrieval from TROPOMI ultraviolet spectral range in combination with CrIS infrared spectral range

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Why the need for nadir ozone profiling?

—measuring both stratospheric and tropospheric ozone (but nadir profiles have a rather low vertical resolution, ~10km)

—many nadir-viewing AC satellites available next two decades

—satellite measurements have to rely more on nadir observations in the future due to potential future gaps in limb observations (providing high vertical resolution, ~3 km)

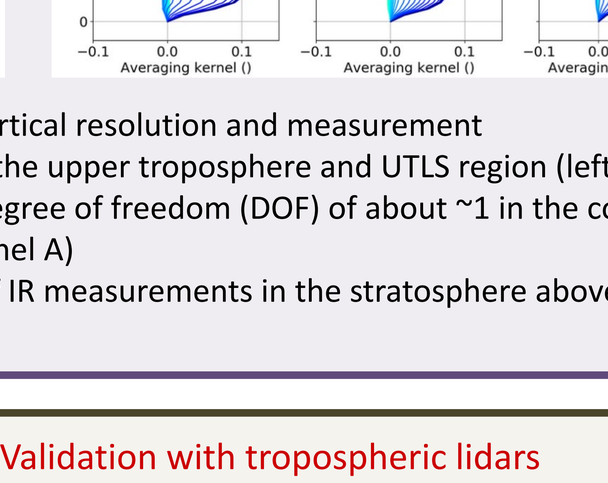
Why need to combine UV and TIR?

— improves vertical resolution in the UTLS (5-20 km) compared to UV-only retrievals

Instruments TROPOMI (UV) and CrIS (TIR)

	TROPOMI	CrIS
Platform	S5P (2018)	Suomi NPP (2011)
Spectral range	UV1: 270 – 299 nm UV2: 300 – 329 nm	TIR: 9.35 – 9.9 µm
Spectral resolution	0.065 nm	0.625 cm^{-1} (~5 nm)
Dataset	L1B Version 2: Radiance and Irradiance	CLIMCAPS L2: cloud clear radiances and surface temperature
Spatial resolution	Spatial binning to 48x48 km or to spatial sampling from CrIS pixels	3x3 14 km FOV covering a 42x42 km cell

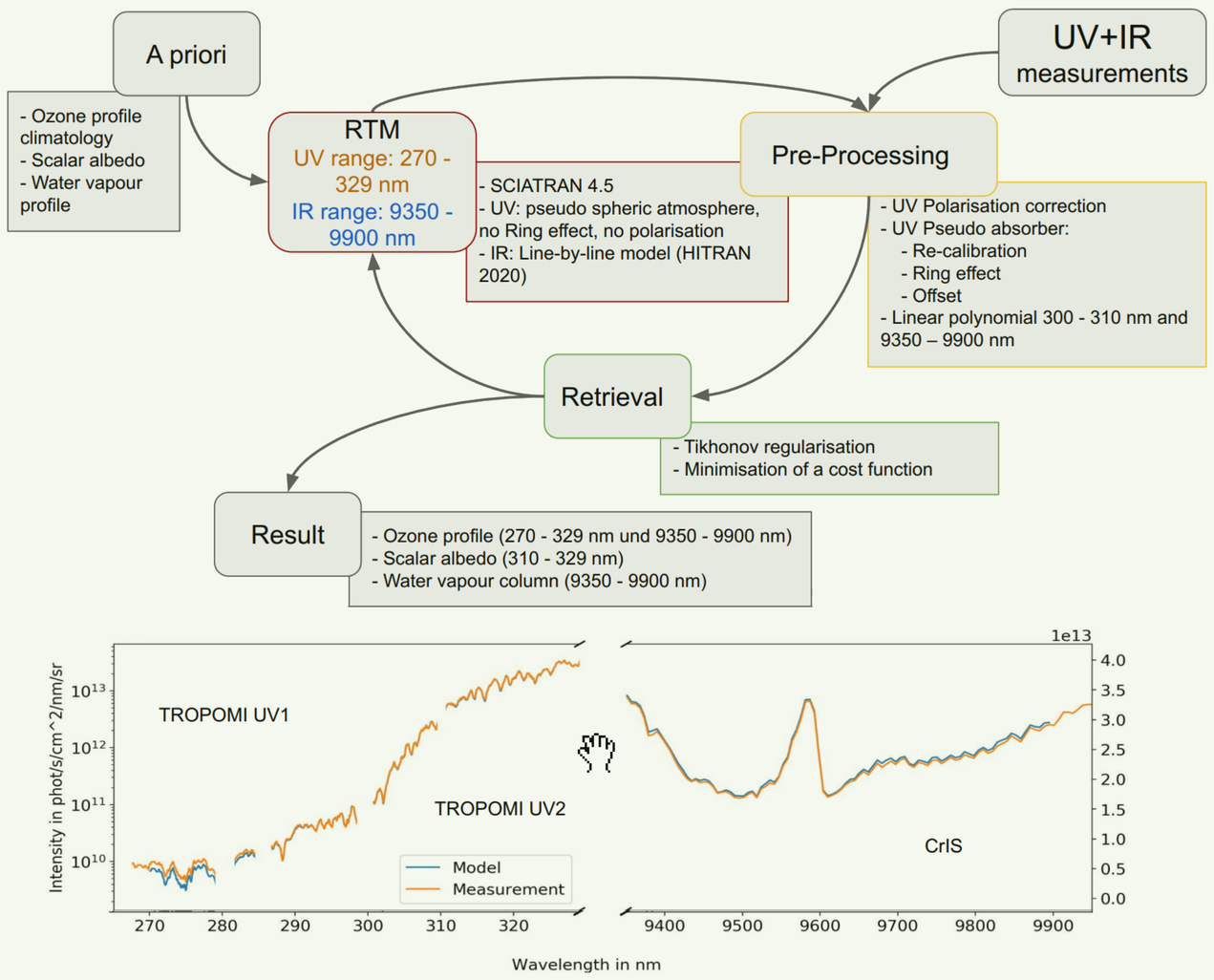
S5P (TROPOMI) ~4 min behind

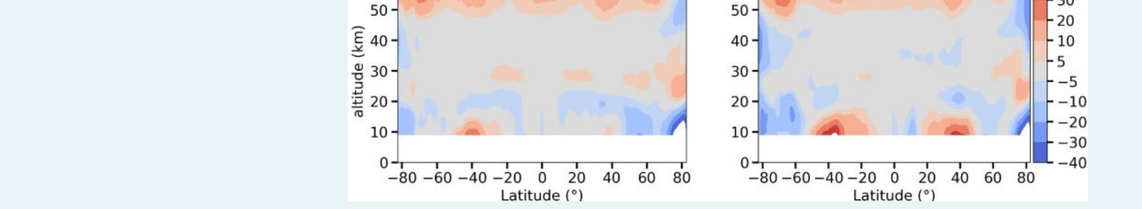


Suomi NPP (CrIS)

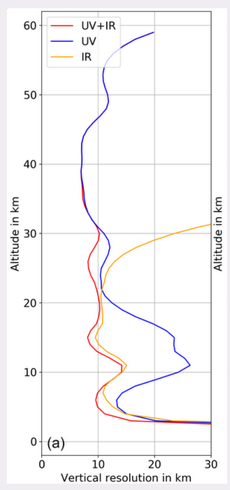
Combined UV and IR retrieval and sample spectra

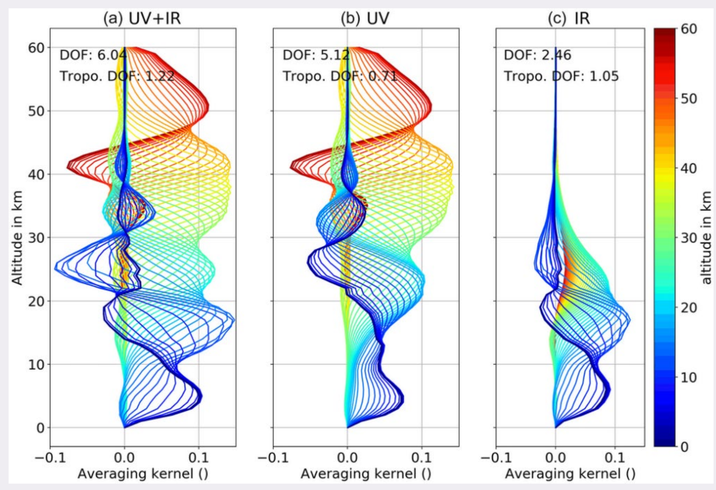
TOPAS - Tikhonov regularized Ozone Profile retrievAl with SCIATRAN





Retrieval diagnostics



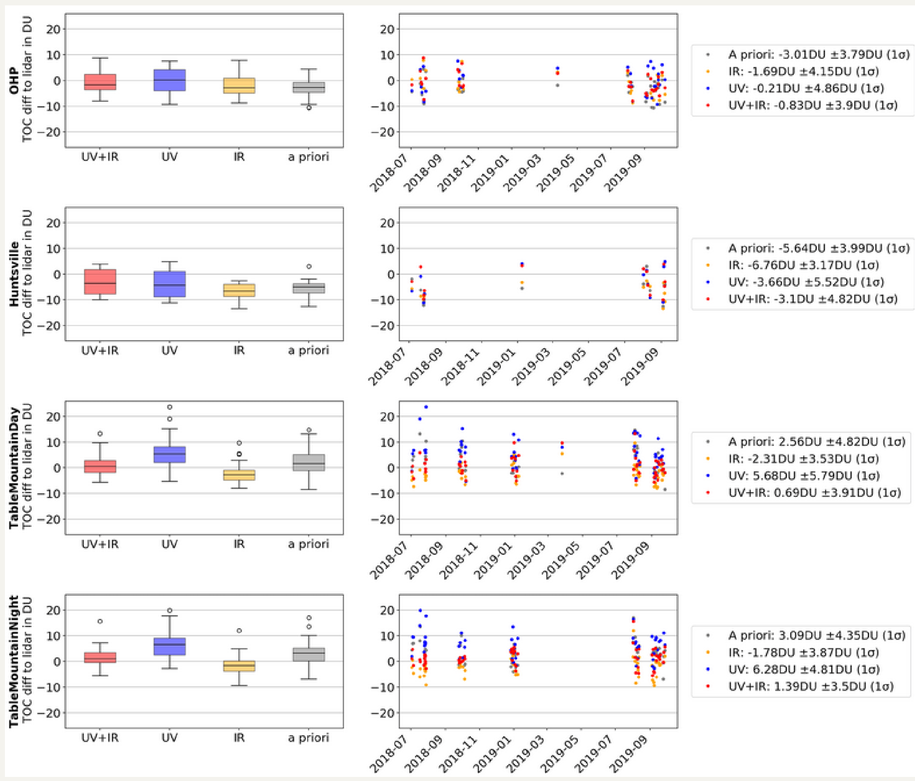


- improved vertical resolution and measurement response in the upper troposphere and UTLS region (left panel)
- enhanced degree of freedom (DOF) of about ~1 in the combined retrieval (panel A)
- no impact of IR measurements in the stratosphere above 30 km (panel C)

Comparisons with MLS and OMPS limb observations (1 orbit , Oct 1, 2018)

- between 20 – 50 km very good agreement
- above 50 km positive bias (maybe artefact from re-calibration)
- below 20 km, some positive and negative differences
- results improve when limb profiles are convolved with TOPAS AVKs

Validation with tropospheric lidars



- comparisons in OHP, Huntsville, and Table Mountain (day and night)
- improved bias and scatter in the UV+IR retrieval
- validation results from comparisons with **stratospheric lidars** and **ozonesondes** can be found in Mettig et al. (2022)

References:

Mettig, N., Weber, M., Rozanov, A., Arosio, C., Burrows, J. P., Veefkind, P., Thompson, A. M., Querel, R., Leblanc, T., Godin-Beekmann, S., Kivi, R., and Tully, M. B.: Ozone profile retrieval from nadir TROPOMI measurements in the UV range, Atmos. Meas. Tech., 14, 6057–6082, doi.:10.5194/amt-14-6057-2021, 2021.

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