TROPOMI L1b status and updates

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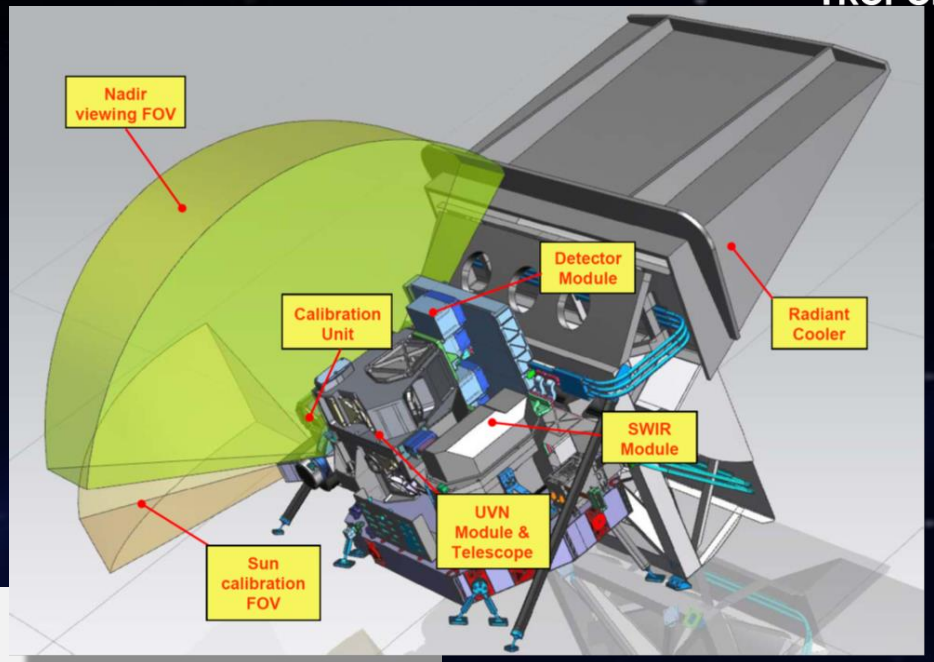
TROPOMI on-board Sentinel-5 Precursor

- Single payload
- Hyperspectral imager with 4 spectrometers
- Sun synchronous orbit (MLTAN 13.30)
- Pushbroom with ~ 2600 km swath
- High spatial sampling (down to 5.5 km x 3.5 km)
- Daily measurements of the Sun via Sun port
- Launched 10/2017
- Nominal operations since 30/4/2018



TROPOMI spectral bands – based on calibration data

Spectrometer	UV		UVIS		NIR		SWIR	
Band ID	1	2	3	4	5	6	7	8
Spectral range [nm]	267-300	300-332	305-400	400-499	661-725	725-786	2300-2343	2343-2389
Spectral resolution [nm]	0.45 - 0.5		0.45 - 0.65		0.34 - 0.35		0.227	0.225
Spectral sampling [nm]	0.065		0.195		0.126		0.094	
Spatial sampling [km^2]	5.5 x 28	5.5 x 3.5	5.5 x 3.5		5.5 x 3.5		5.5 x 7	
Detector binning factor	16	2	2	2	2	2	1	1

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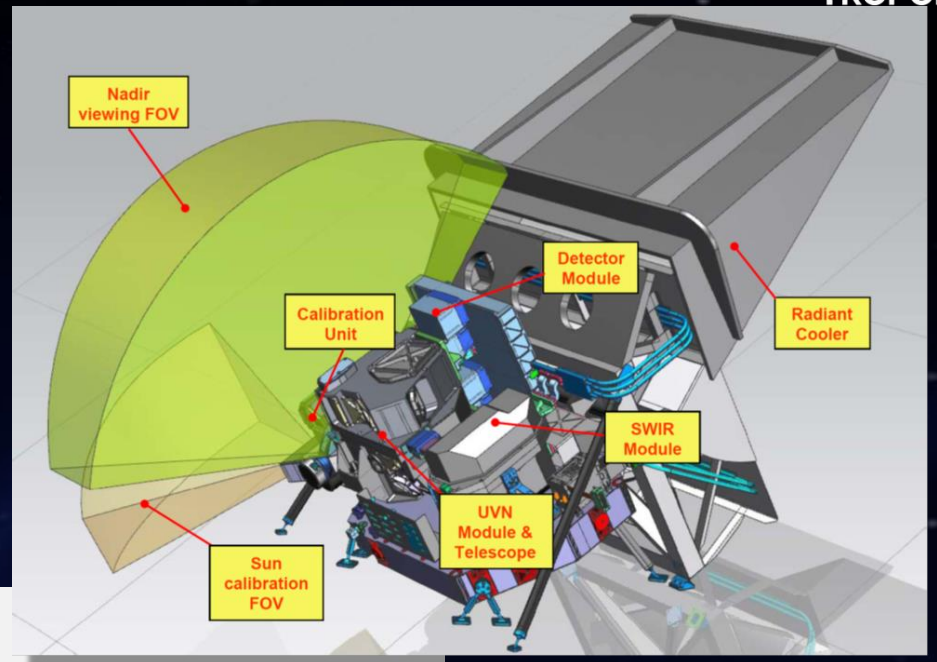

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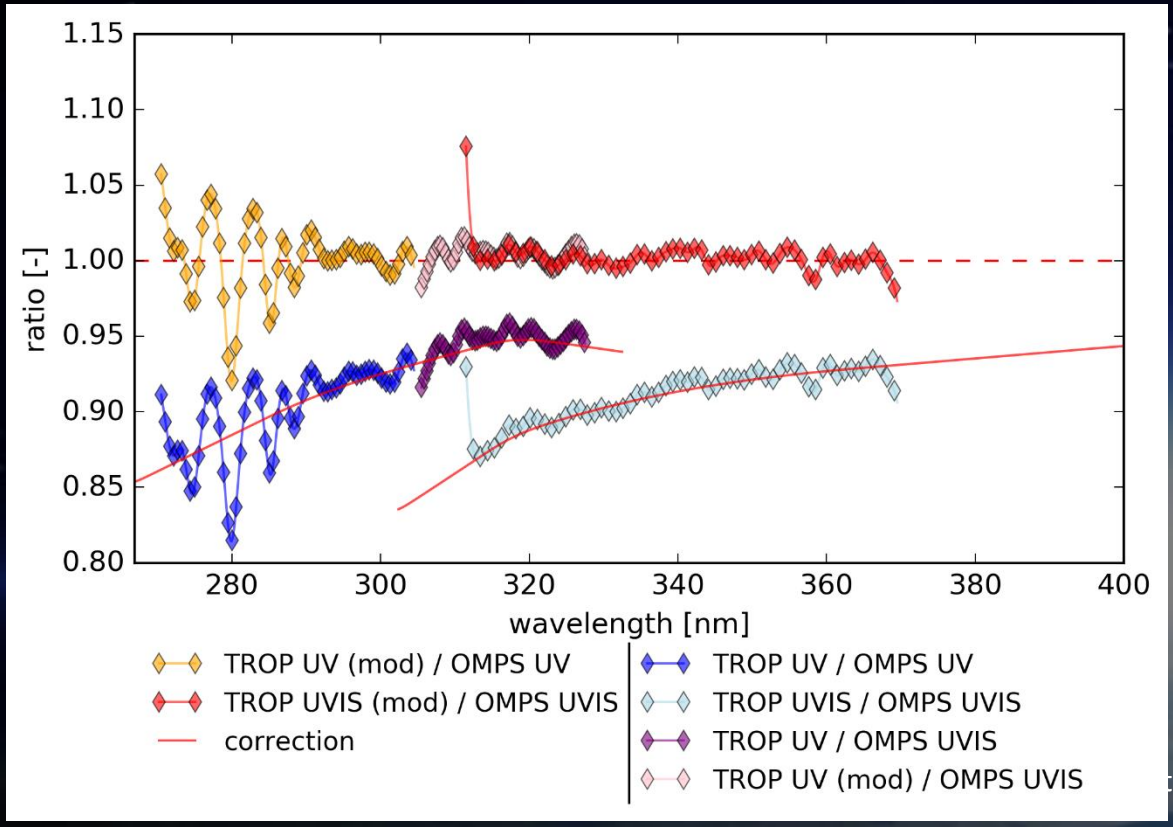
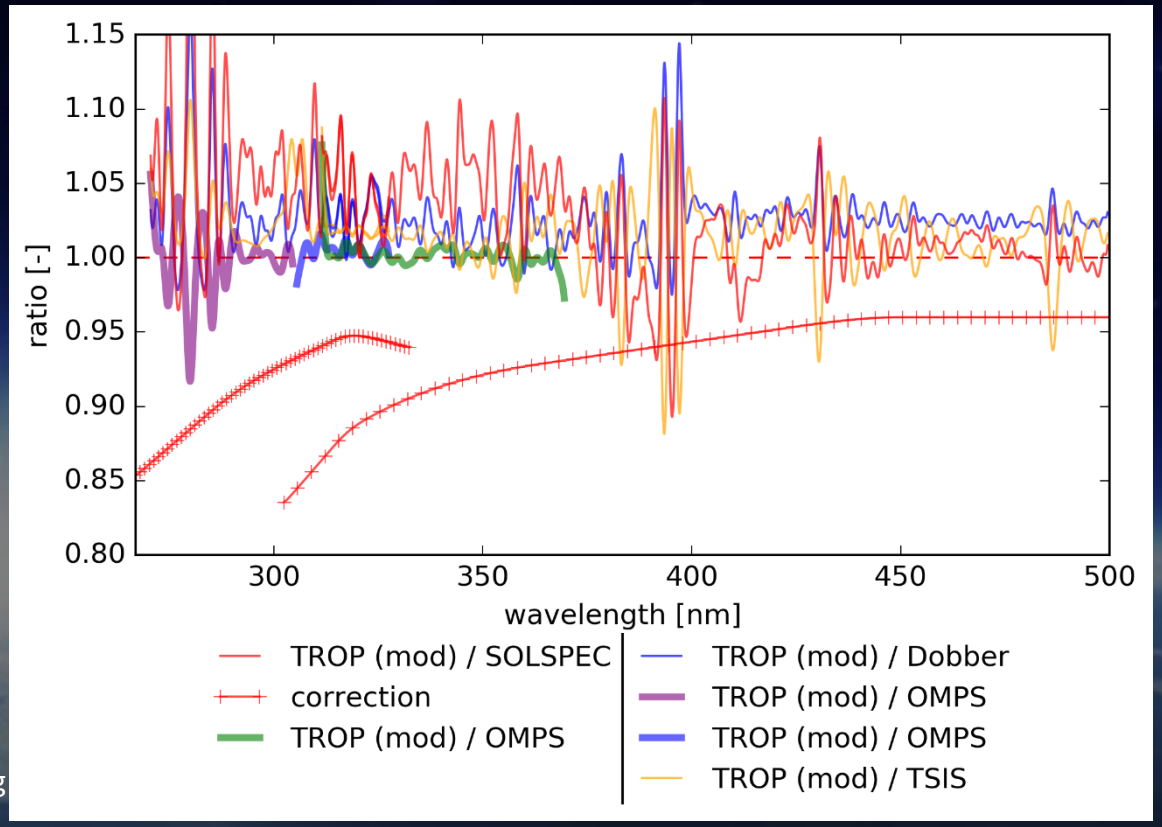
Overview

- Status absolute radiometry
- Status degradation corrections
- Future work

Absolute irradiance adaptation UV+UVIS

- Spectra convolved with Gaussian σ = 1nm
- Spline correction to match OMPS in L01b v2
- Within 0.5-5% (flat bias) to other spectra



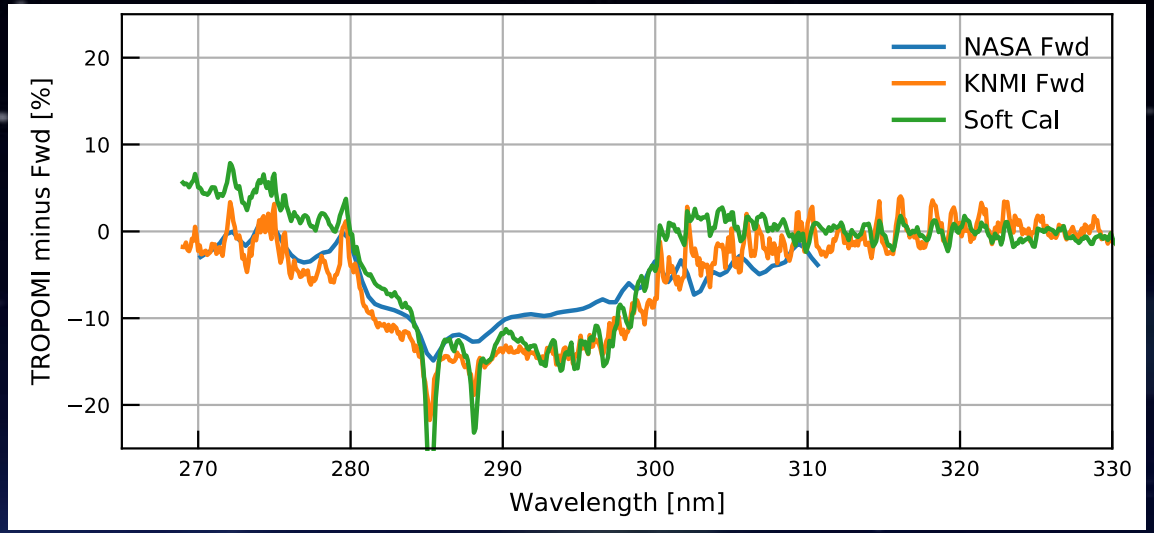


Ludewig et al. 2020 https://doi.org/10.5194/amt-2019-488

Absolute radiometry radiance

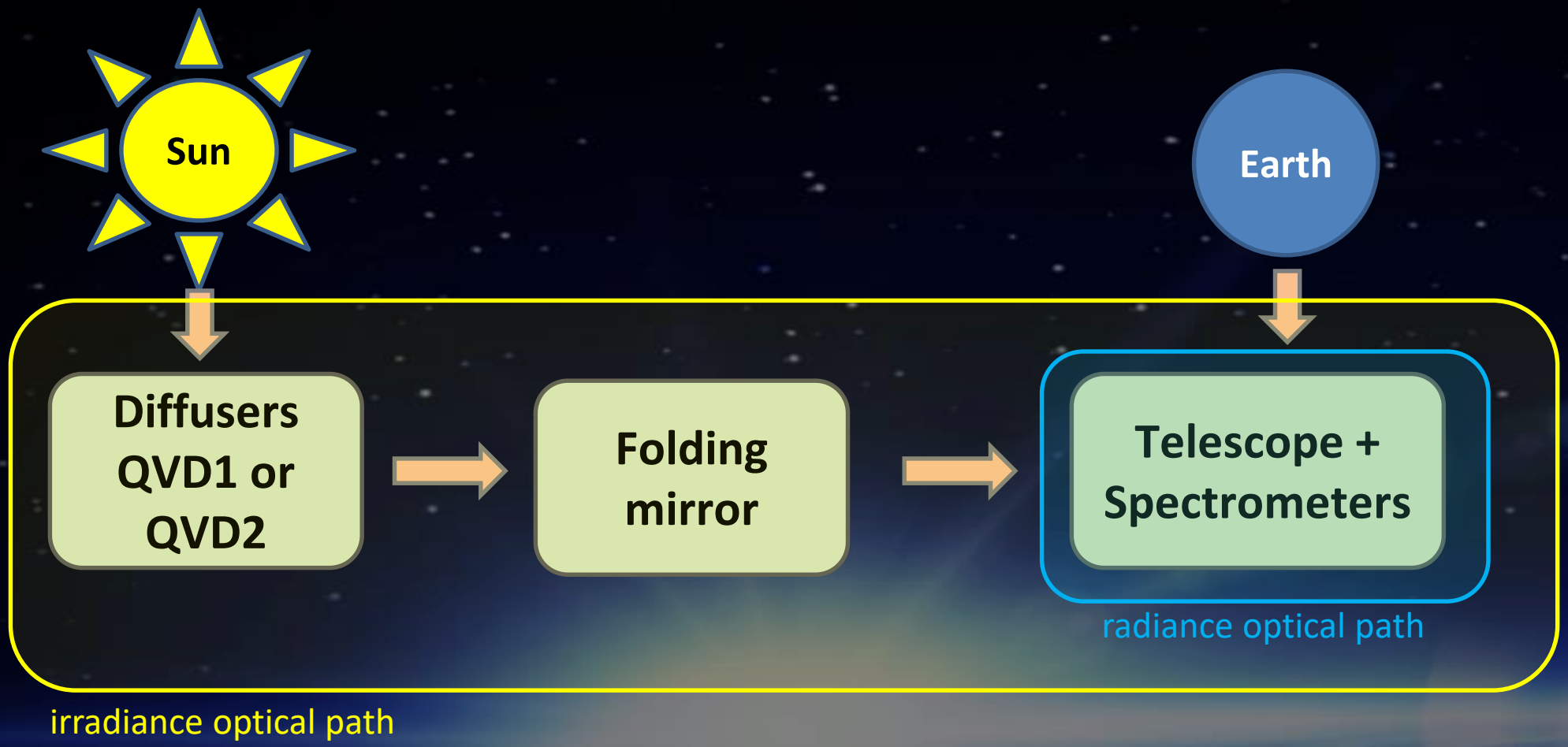
- Absolute radiometry below ~320 nm wavelength dependent deviation
- Comparison to O3 profile retrievals, forward models and OMPS
- Results from NASA (Seftor et al. 2020) Abs. radiometry radiance bands 1-4 (reflectance at most 8% +/-2% bd 1, 5% band 3, 2% band 4, > 320nm it's a bias)

Comparison using CAMS ozone profile

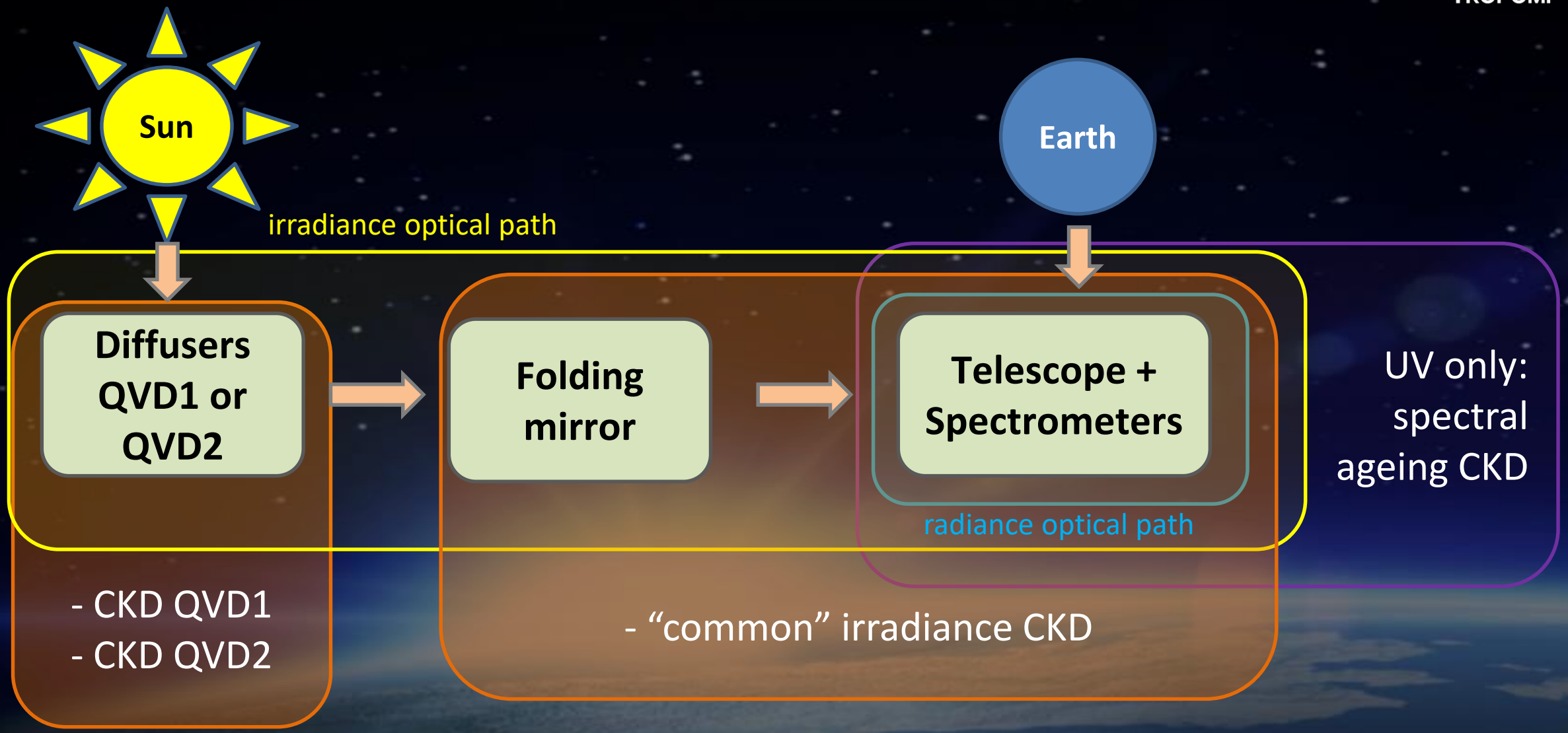


Courtsey P. Veefkind , The green line shows the softcal correction currently applied in the O3P retrieval (not applied to the Tropomi spectra in this comparison).

Optical paths in TROPOMI



Calibration key data from irradiance measurements

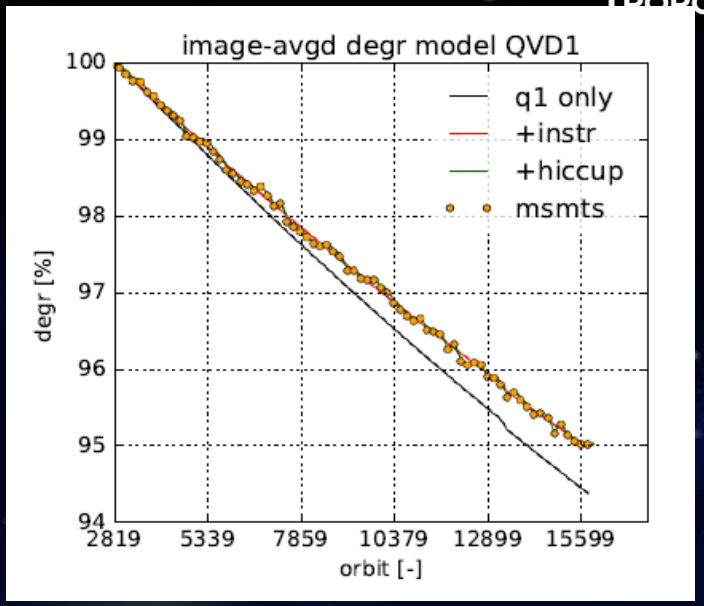


QVD and common degradation

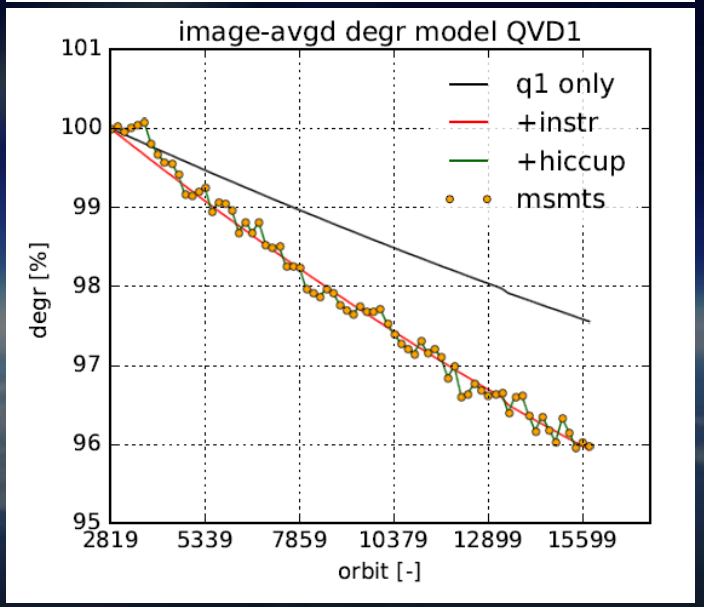
- QVD + common derived from irradiance data
- Spectral ageing in UV counteracts degradation
- Degradation (QVD+common) in irradiance is now up to 10% (7%) for UV (UVIS)
- Common (instr) can contain spectrometer/telescope degradation

Status orbit 15779	QVD1 + common [%]	common only [%]	spectral ageing [%]
Band 1	10.63	4.56	-1.96
Band 2	8.05	3.31	-7.44
Band 3	5.65	2.26	0.00
Band 4	2.53	1.10	0.00
Band 5	0.52	0.32	0.00
Band 6	0.46	0.30	0.00
Band2:317 nm	7.83	3.22	-10.18
Band3:317nm	7.80	3.28	0.00

UV

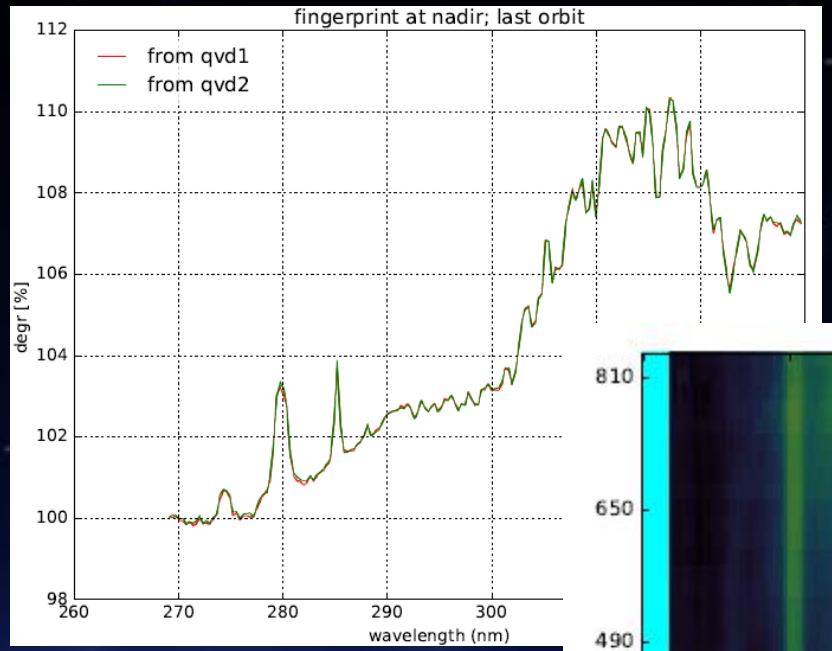


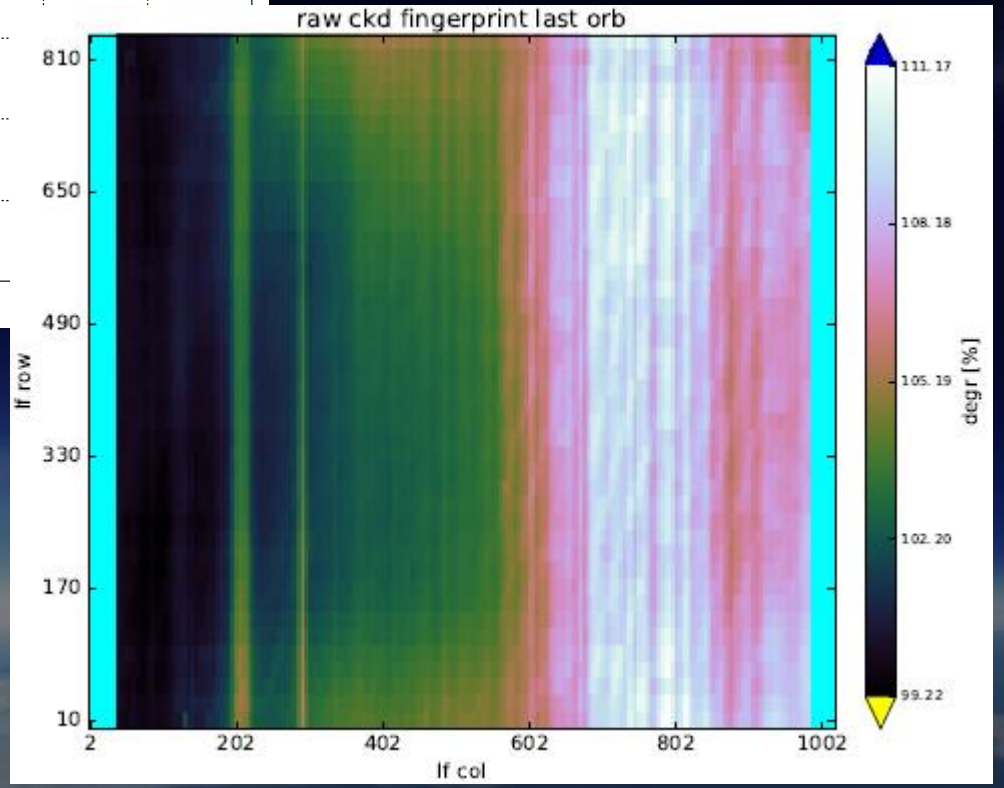
UVIS



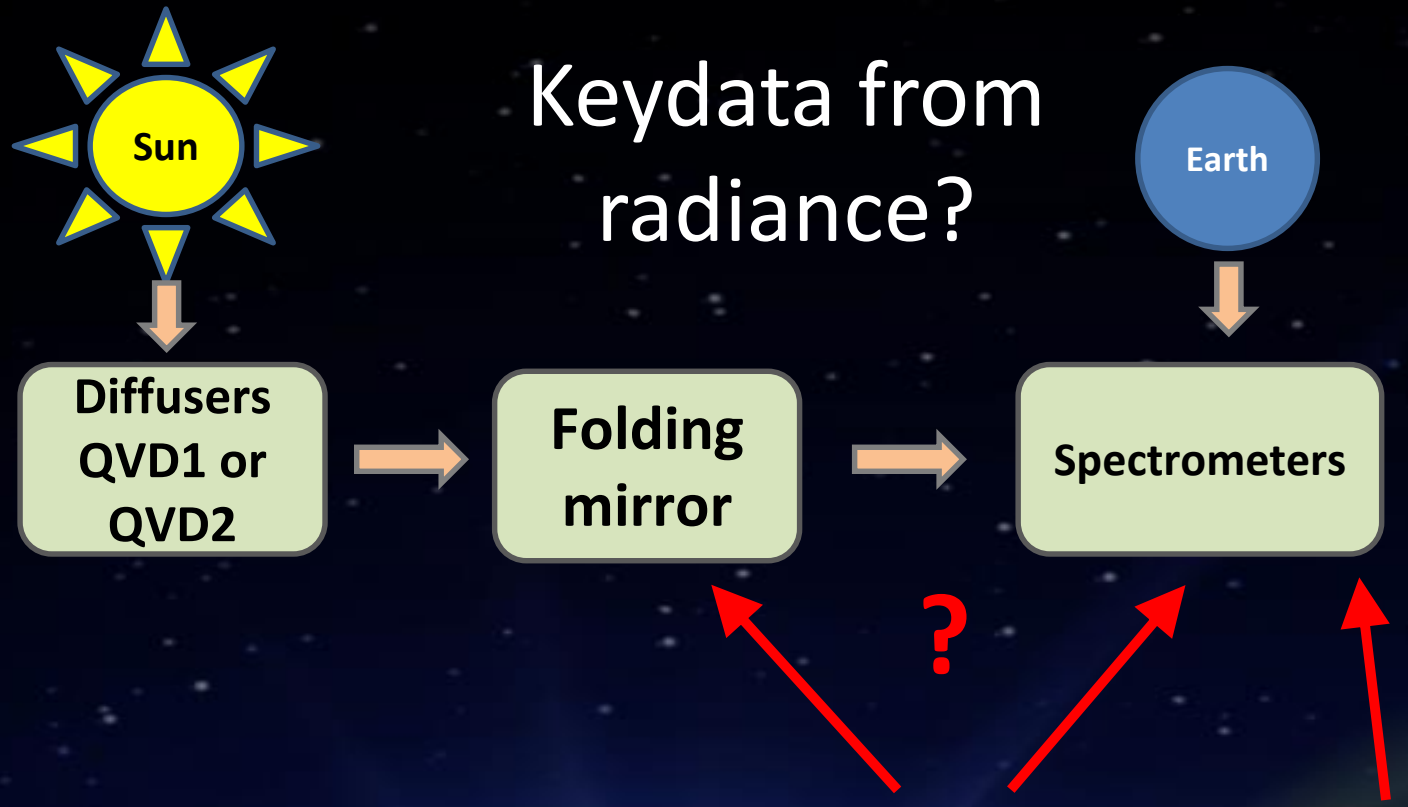
Spectral ageing UV (“fingerprint”)

- Degradation with strong spectral features
- Features correlate with solar spectrum
- “Bleaching” – signal increases over time
- Coating of detector or lens before detector suspected
- Correction derived from irradiance data
- Applied to radiance and irradiance (in v2)





Keydata from radiance?



Per 1000 orbits @15779	QVD1 + common [%]	common only [%]	spectral ageing [%]
Band 1	0.820	0.352	-0.151
Band 2	0.621	0.256	-0.574
Band 3	0.436	0.174	-
Band 4	0.195	0.085	-

Remaining instrument features after next (v2) update

- Abs. radiometry radiance bands 1-4 (reflectance at most 8% +/-2% bd 1, 5% band 3, 2% band 4, > 320nm it's a bias)
- Degradation in radiance band 1-4 (upper estimate 0.352% /1000 orbits bd1)
- Short term irradiance variations (residual in irradiance (0.1 - 0.4%)
- UVIS spectrometer scratch (remains in radiance)

Conclusion & future work

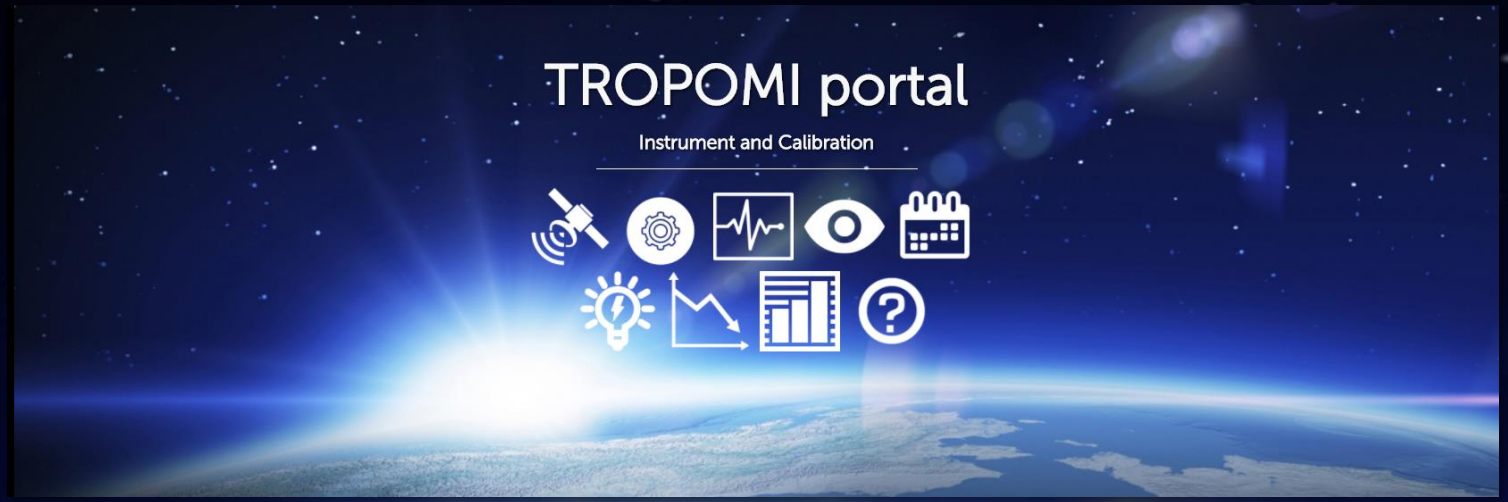
- Version 2 addresses most of the known instrument and calibration features
- Irradiance degradation corrects for most of the observed L2 degradation
- Correction key data for degradation in radiance is still work in progress, but is already foreseen in processor
- L01b Version 2 expected to be operational in June/July 2021

Thank you!

general information: http://www.tropomi.eu/

more on TROPOMI calibration: Kleipool et al. 2018 https://doi.org/10.5194/amt-11-6439-2018

Ludewig et al. 2020 https://doi.org/10.5194/amt-2019-488



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Backup

Most relevant CKD updates in V2

- Time dependent electronic drift UVN (bands 1-6)
- Time dependent diffuser degradation (until now bands 1-6)
- Time dependent UV spectral ageing correction (bands 1-2)
- Absolute radiometry irradiance bands 1 to 4 (not needed for 5 to 8)
- Extended on-ground PRNU / RELRAD to cover more CCD pixels
- Small bugfix in on-ground radiometry irradiance and radiance
- New fix for spectral features in on-ground ABSRAD / BSDF calculation all bands
- Cross-track radiometry irradiance (spot-map)
- Relative angular radiometry irradiance
- UV slit irregularity anomaly (bands 1-2)
- Wavelength annotation (UV,UVIS, SWIR)

L01b version 2 algorithm updates

Most relevant updates:

- CCD blooming detection and flagging
- Transient signal detection and flagging
- Degradation correction radiance and irradiance possible for all bands
- Electronic drift correction
- UV spectral ageing correction
- Monitoring algorithms for wavelength and degradation
- Instrument thermal instability warning and flagging
- Fixed scanline handling for partially missing scanlines