



Pandora Lunar Measurements



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Introduction

General goal:

Assess the possibilities of retrieving **trace gas columns from lunar measurements** by Pandora

In this WP (and beyond):

- Settle retrieval settings
- Test impact of lunar albedo correction
- Investigate potential limitations

All data shown in the following are from Rome, Pandora 117s1+s2



Lunar retrieval settings

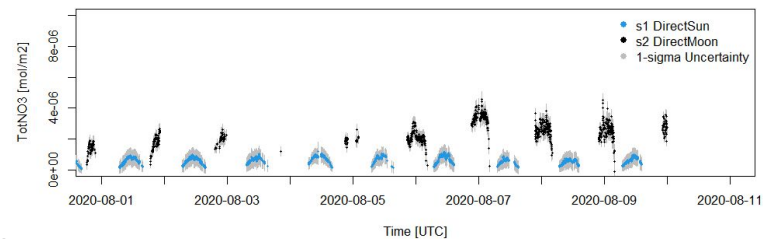
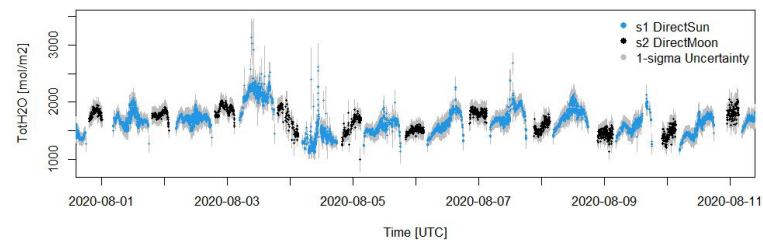
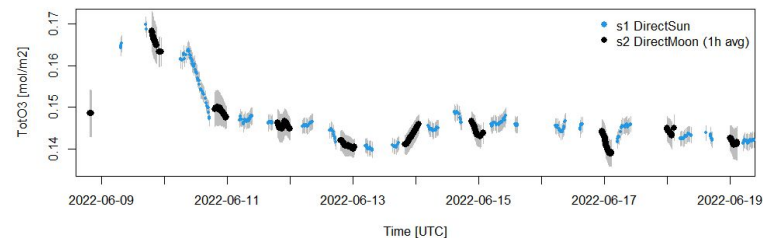
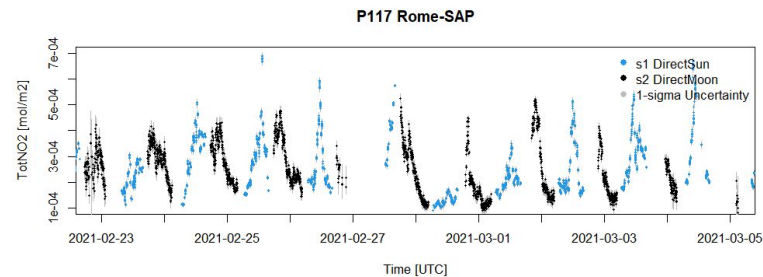
NO₂ (400-470 nm)
separation between
BL and strat NO₂!

O₃ (480-570 nm)

Lunar
retrievals use
solar
reference
spectra

H₂O (490-510 nm)

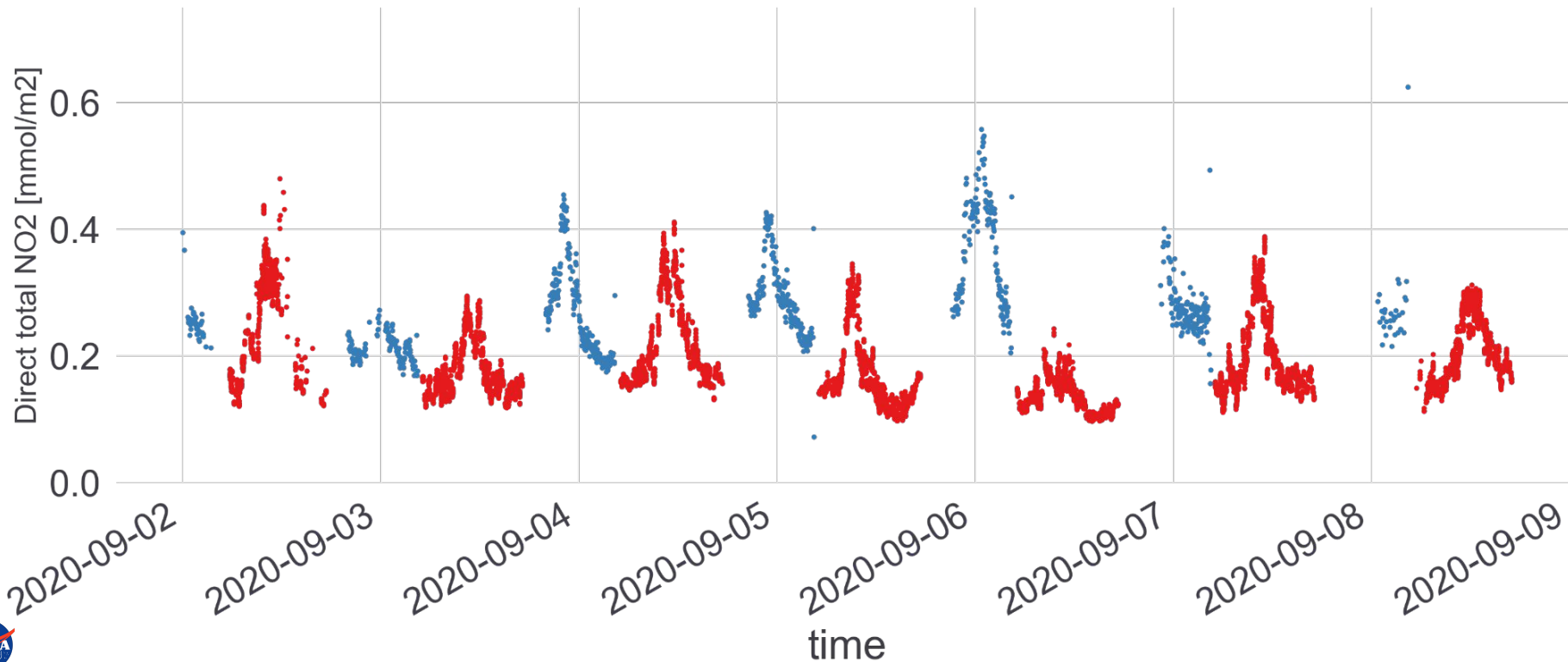
NO₃ (600-685 nm)





Impact of calibration source (solar or lunar spectrum)

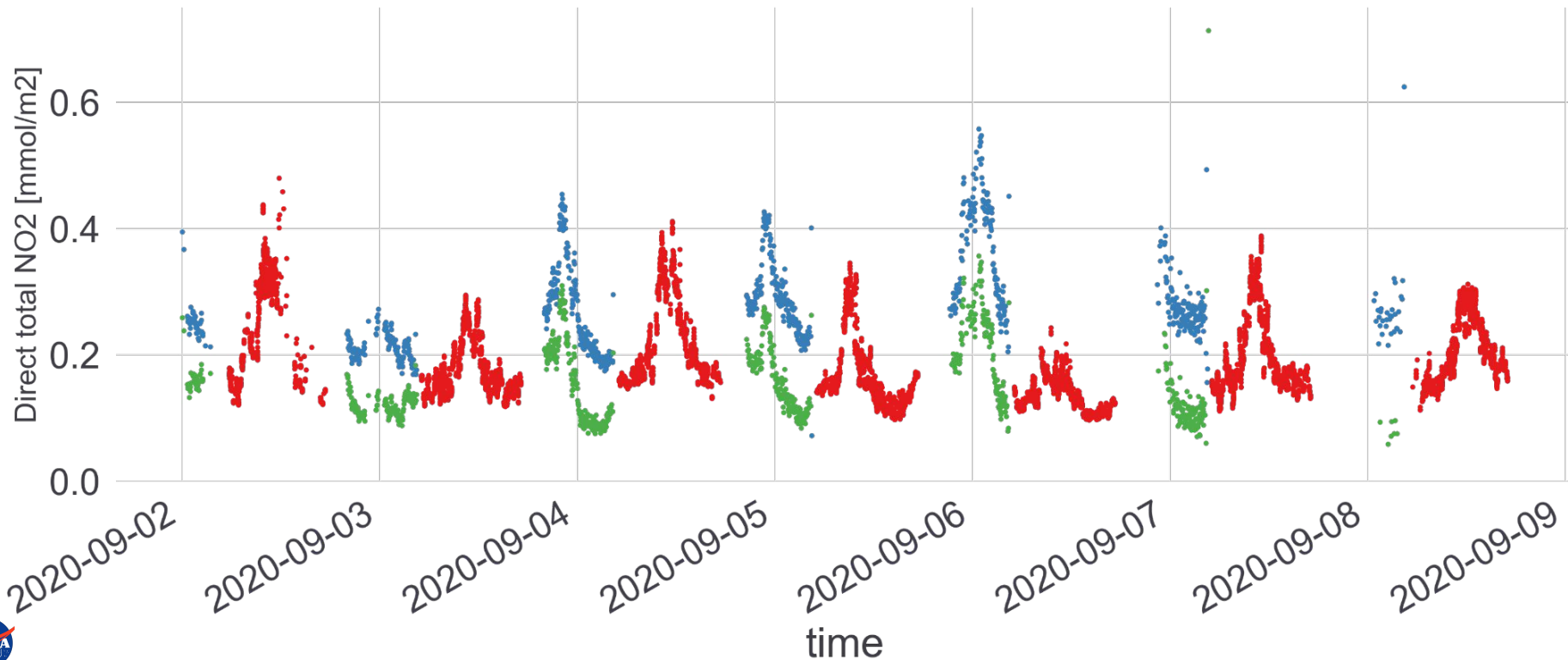
• sun-operational • lunar-sun ref





Impact of calibration source (solar or lunar spectrum)

• sun-operational • lunar-sun ref • lunar-lunar ref

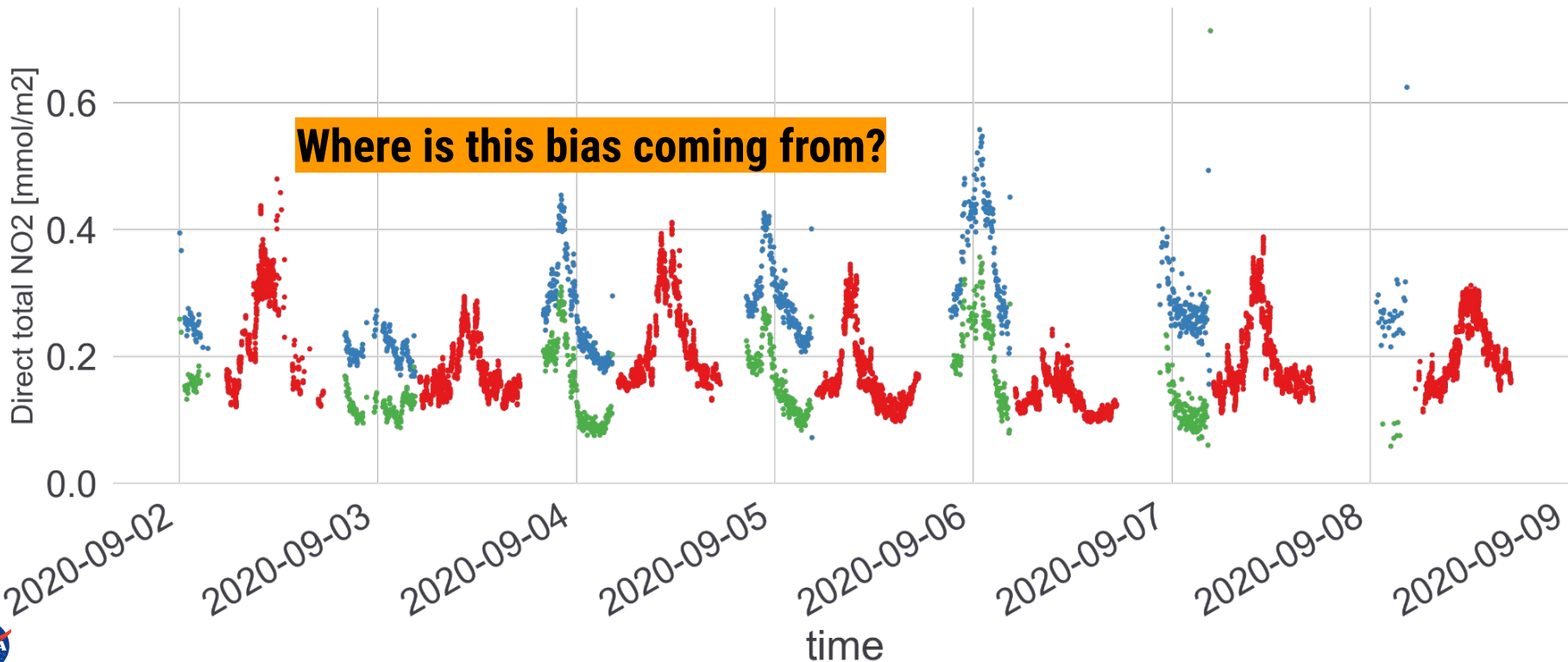




Impact of calibration source (solar or lunar spectrum)

• sun-operational • lunar-sun ref • lunar-lunar ref

Where is this bias coming from?

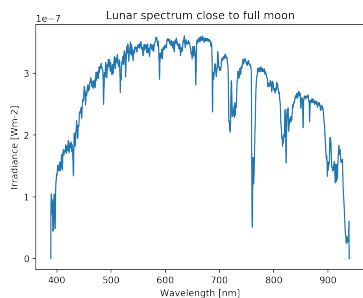




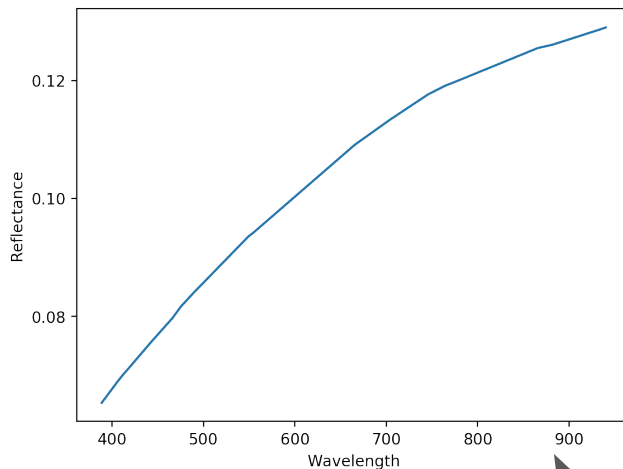
Bias due to lunar spectral albedo?

Lunar spectral albedo correction applied using parameterization derived from RObotic Lunar Observatory (ROLO)

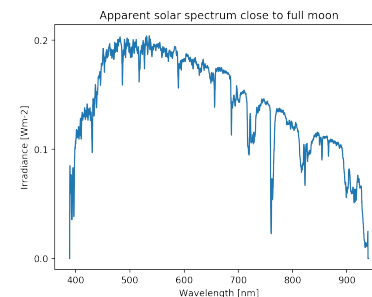
Lunar spectrum



Lunar albedo close to full moon



“Solar” spectrum



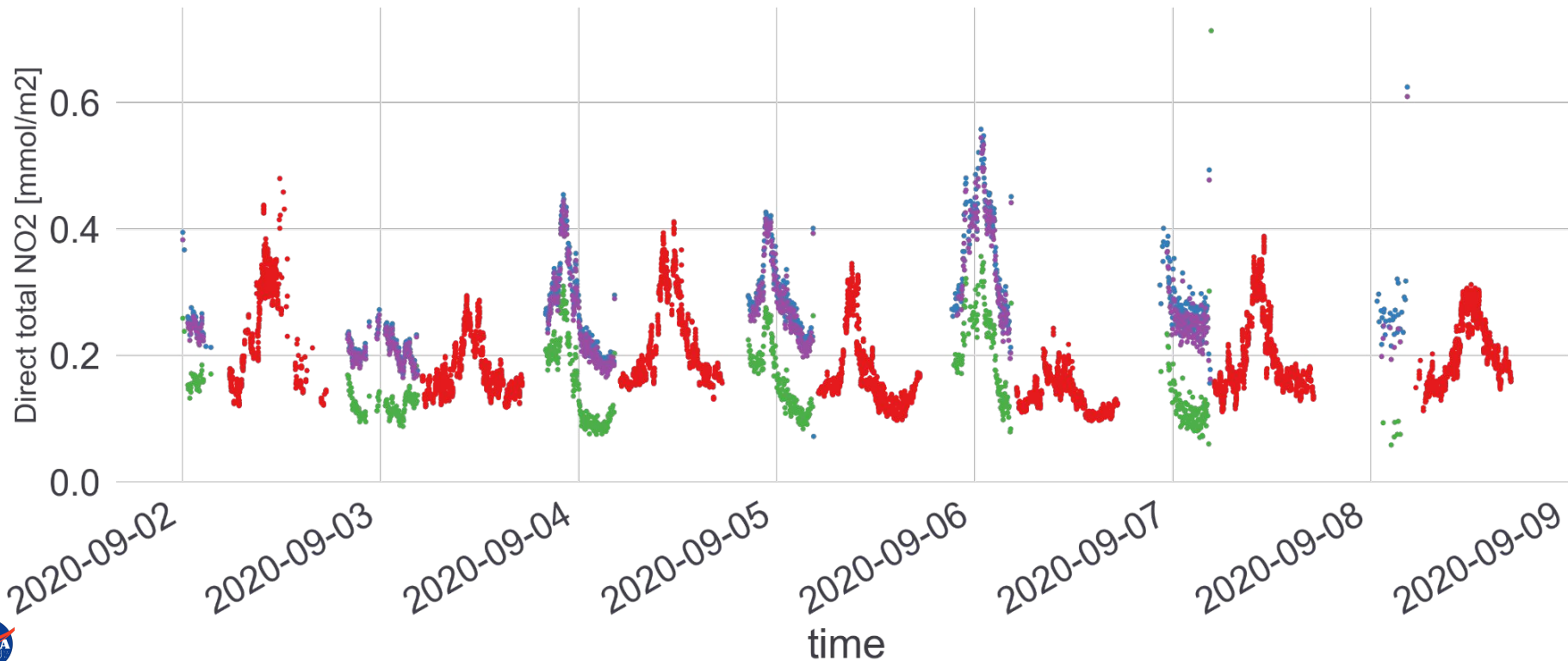
astronomical geometrical variables
(SPICE observation geometry information system from the NASA)

ROLO model



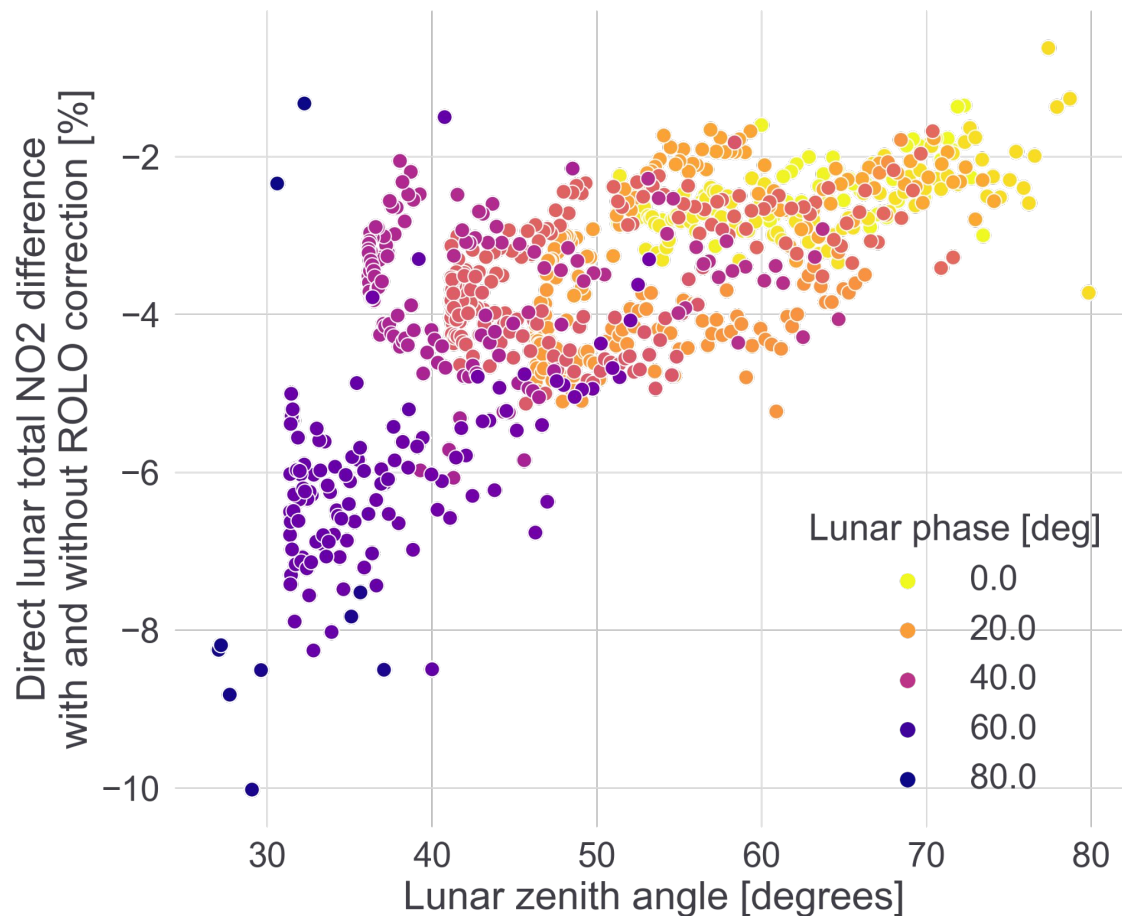
Bias due to lunar spectral albedo?

• sun-operational • lunar-sun ref • lunar-lunar ref • lunar-sunr ref + ROLO





Bias due to lunar spectral albedo?



Impact of correction higher for larger lunar phase, but generally small.

This confirms that smooth spectral features (line lunar albedo) are well captured by closure polynomials in the retrieval.

Not driver for bias !





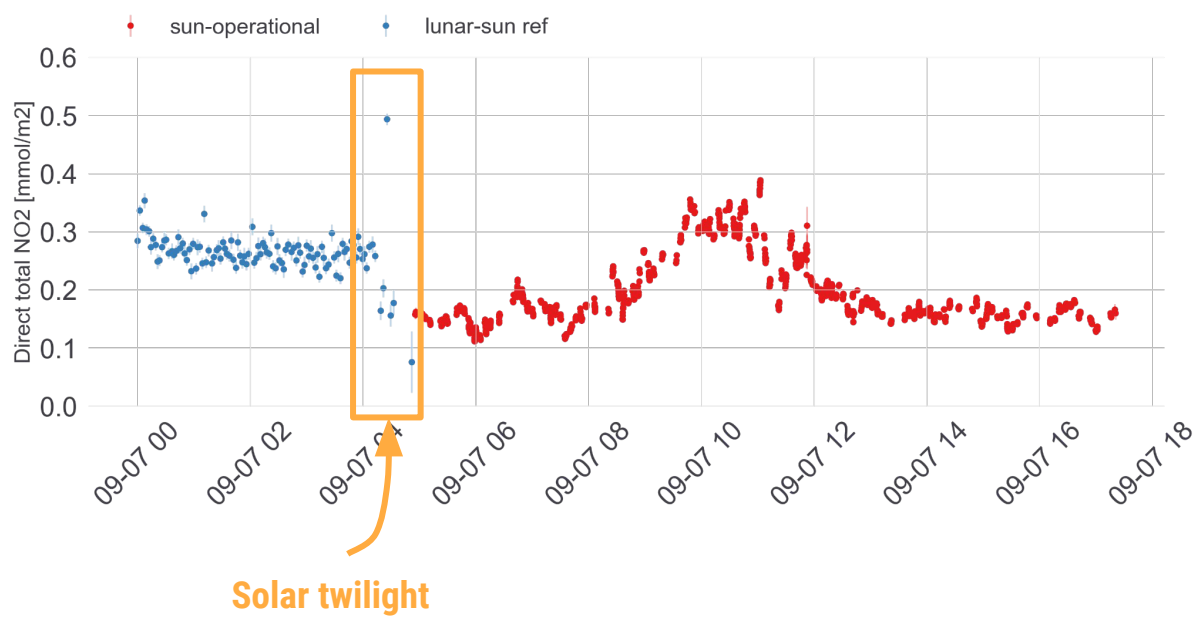
Bias due to instrumental artifacts?

Since lunar spectral albedo correction does help much, **instrumental artifacts** seem to **drive the bias** !

The **source** of these artifacts has **not** been **identified yet!**

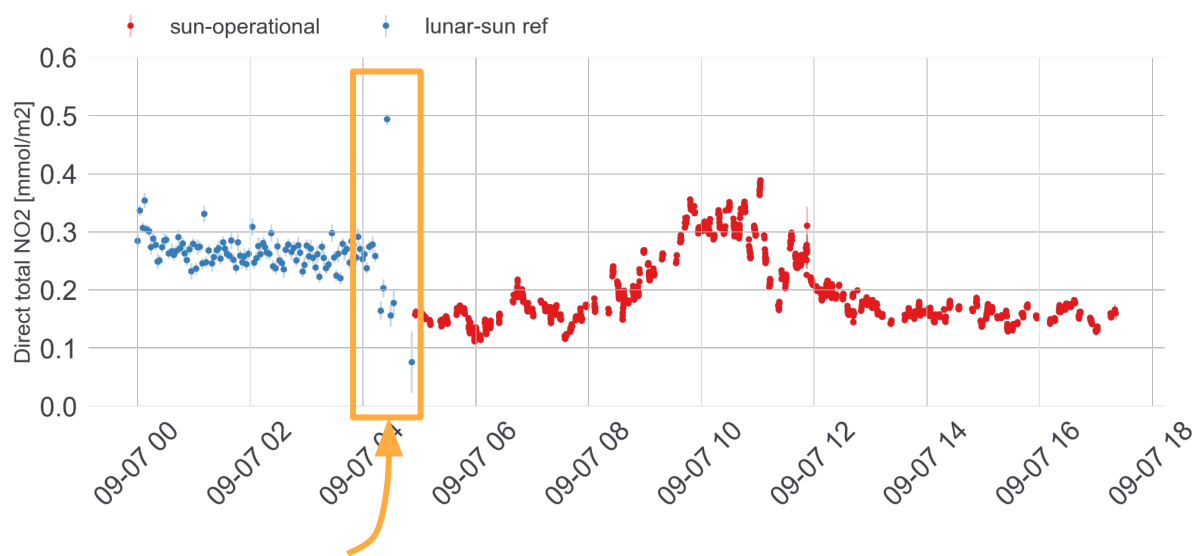


Impact of radiance “dilution” during twilight

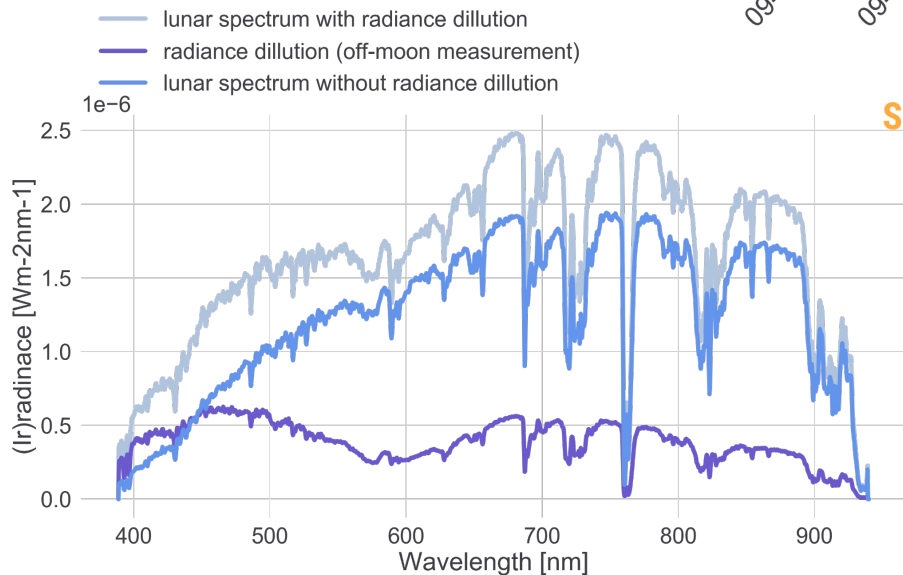




Impact of radiance “dilution” during twilight



Solar twilight



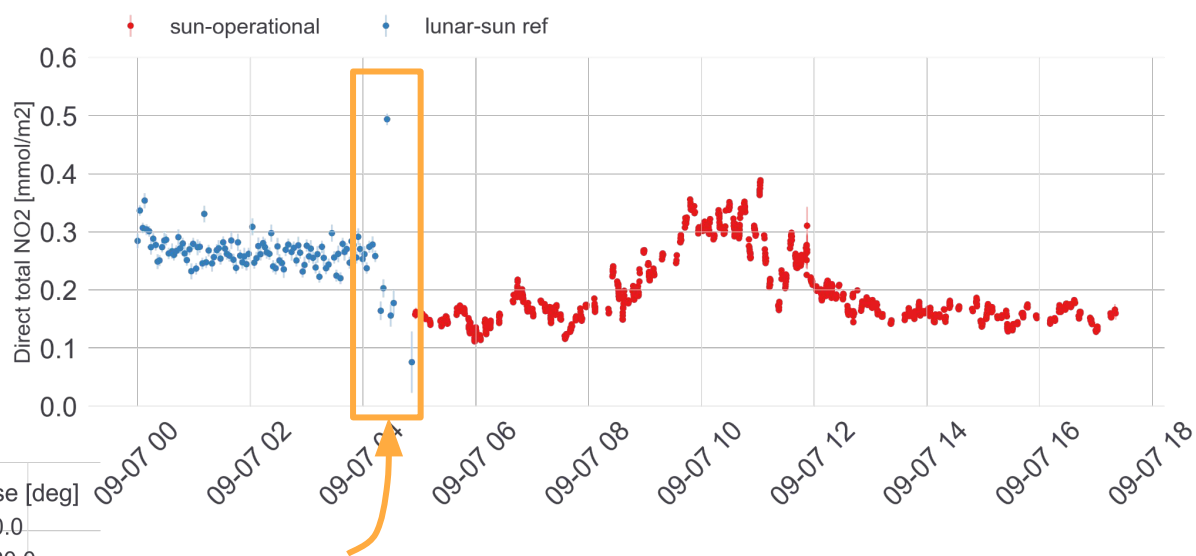
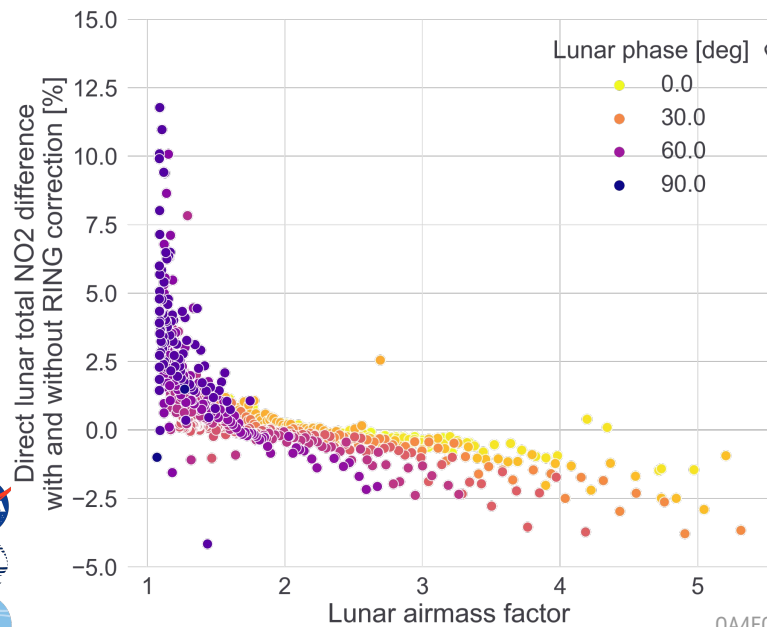
Enhance spatial stray light!

Tested approach: off-moon measurements
to correct for radiance “dilution”.

Fine tuning needed!



Impact of radiance “dilution” during twilight



Solar twilight

Scattered light includes inelastically scattered part → Raman scattering

First tests revealed ~ 10% bias if not considered well.

Further tests needed!



Suggested WP extensions

- The **source of the bias** (dependency on the calibration source) needs to be studied further. Is it a consequence of missing or improper instrument characterization? Note that this task would also impact other data products in the PGN in a positive way.
- **Radiance “dilution”** corrections during solar twilight will be developed. “Active” correction techniques, like radiance measurements recorded next to the moon and close in time, have been prototyped already, but would need further refinement. Feasibility studies towards “passive” correction techniques including modeling or aerosol proxies (like O2O2 columns as utilized in MAX-DOAS) would be carried out.
- Investigate the improvement capability by considering the **Raman effect** under **solar twilight conditions**. Test in particular what gasses (respectively spectral regimes) are affected most and if molecular absorption (molecular Ring effect) needs to be considered for strong absorbers (e.g. H₂O or O₃).





Thanks for your attention!

