

Review of EGU sphere-2026-1482

## Towards a Remote Sensing Solution to Quantify Nitrous Oxide Emissions by Integrating Shortwave and Thermal Infrared Bands

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### *General comments.*

The authors present the detectability of column-integrated N<sub>2</sub>O mixing ratio (XN<sub>2</sub>O) using a joint SWIR-TIR setting. In the conventional approach for space-based N<sub>2</sub>O observation, TIR signal is only used for retrieval. In contrast, SWIR signal is weak for N<sub>2</sub>O retrieval and challenging to improve the accuracy and precision. Thus, the authors developed a joint SWIR-TIR retrieval framework and applied to both airborne and spaceborne instruments to evaluate the influence of platform characteristics on retrieval performance. This approach is quite attractive and innovative to retrieve XN<sub>2</sub>O, precisely. I understand that this activity is important to assess, improve and extend the XN<sub>2</sub>O observation for the future remote sensing based observatory. However, some description and assumption are unclear or missing in the text.

The authors describe the stronger N<sub>2</sub>O features are found in 4.4 or 7.8 μm spectral region. However, the N<sub>2</sub>O absorption lines in 7.8 μm spectral regions are only considered for a joint SWIR-TIR retrieval. The retrieval precision and accuracy of XN<sub>2</sub>O is also affected by the spectral resolution, spectral coverage and spectral windows. However, it is not clear how to identify the designed instrument (spectral coverage, spectral resolution and spectral windows). I understand the designed instrument is based on the current technology, however, at least, spectral resolution and selected windows (combined spectral region between SWIR and TIR) have to be assessed.

In addition, I understand the observation geolocation between CrIS soundings (Fig.1, observed 23 Aug. 2023) and MAIZE campaign (Fig. 2,

May.2022) have different geolocation and observation time. It is unclear why do the authors not extract and/or merge CrIS data from the same time and location with MAIZE. It is also unclear that the land type is equal or not between CrIS soundings region (Fig.1) and MAIZE campaign region (Fig.2). The authors have to explain the acceptance to combine the different observation condition between MAIZE and CrIS data.

For these reasons, I recommend this paper for publication with minor changes to the technical content.

### ***Specific comments.***

#### ***Abstract***

1. Page 1, line 5: Spell out "SPLAT-VLIDORT".

#### ***2. Data***

2. Page 4, line 109: I understand the standard definition of SWIR is covering between ~900nm to ~2500nm. The spectral coverage of CrIS is 3.9 to 15.4  $\mu\text{m}$ . Then, the wording of SWIR is not preferred. Mid infrared (MIR) is preferred instead of SWIR.

#### ***2.1 Realistic geophysical quantities from CrIS Level 2 product***

3. Page 5, line 120: Why the authors select 23 August 2023? In addition, how about the variation of surface albedo at 2.3  $\mu\text{m}$  and land use type for interesting region in Fig.1?

#### ***3.1 Theory***

4. Page 9, line 206: How many layers do you treat in the radiative transfer calculation? The simulation condition is unclear. The authors have to explain the simulation conditions for radiative transfer

#### ***3.1.3 Instrument design parameters and observational constraints***

5. Page 12, line 256: What condition do you select as a typical sounding? Generally, solar zenith angle, surface albedo, aerosol condition and surface temperature are key parameters for signal intensity both SWIR and TIR. In addition, the spectral

resolution of Fig.5 is not clear. Then, clear explanation for calculation condition is needed.

### ***3.1.4 Radiative transfer simulation***

6. Page 13, line 285: It is unclear that “a typical Midwest summer environmental conditions”. The authors have to add clear explanation.
7. Page 14, Figure6: How many layers consider in this calculation?

### ***4 Results***

8. Page 17, Figure 7: “near-surface layers” is unclear. I understand the original output from calculation is “pressure height”. Then, the describing with pressure height is needed. For the measurement error estimation, I understand solar zenith angle, surface albedo, and surface temperature for each sounding are considered. At least, the mean values for those parameters have to address in the text as well.

### ***References***

9. Page 31, line 692: change the order of the Spurr et al’ s list. Now, Spurr et al, 2006 is last the list.

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