

Intercomparison of NO₂ from ACE-FTS, SAGE III/ISS, and OSIRIS

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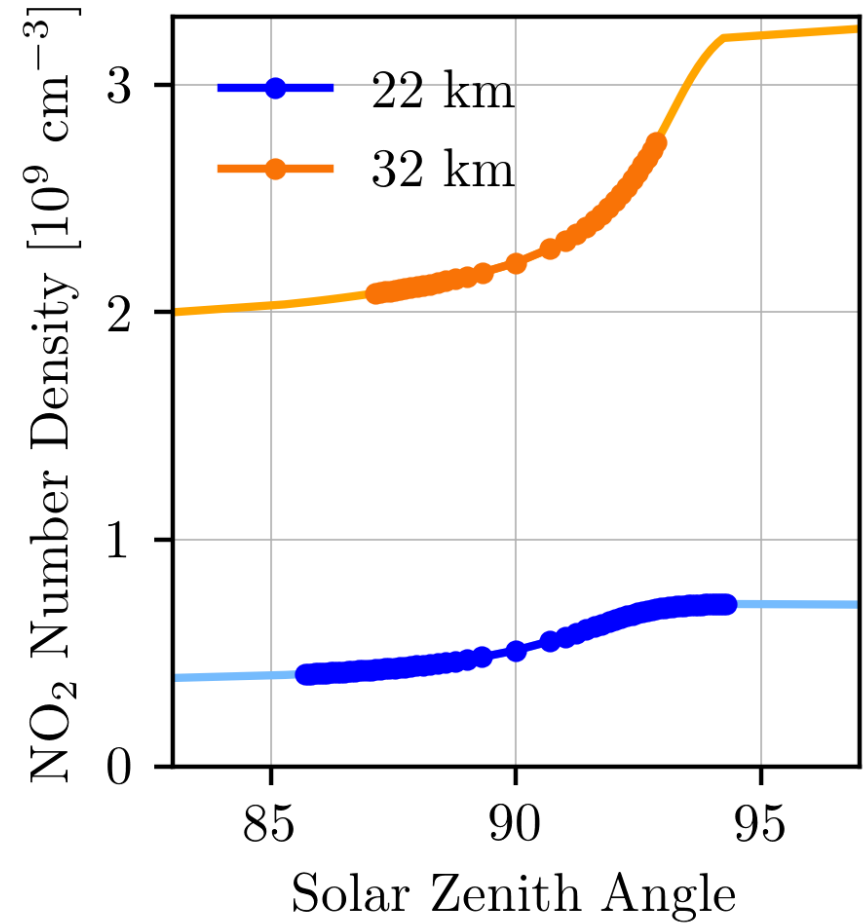
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Introduction

- ACE-FTS, SAGE III/ISS, and OSIRIS all take limb measurements of stratospheric NO₂.
- New versions of the retrievals were recently developed for each of these:
 - ACE v4.1
 - SAGE v5.2
 - SAGE diurnally varying (DV) – Dubé et al. 2021
 - OSIRIS v7.1
- Coincident NO₂ profiles are compared to assess the agreement between each dataset.

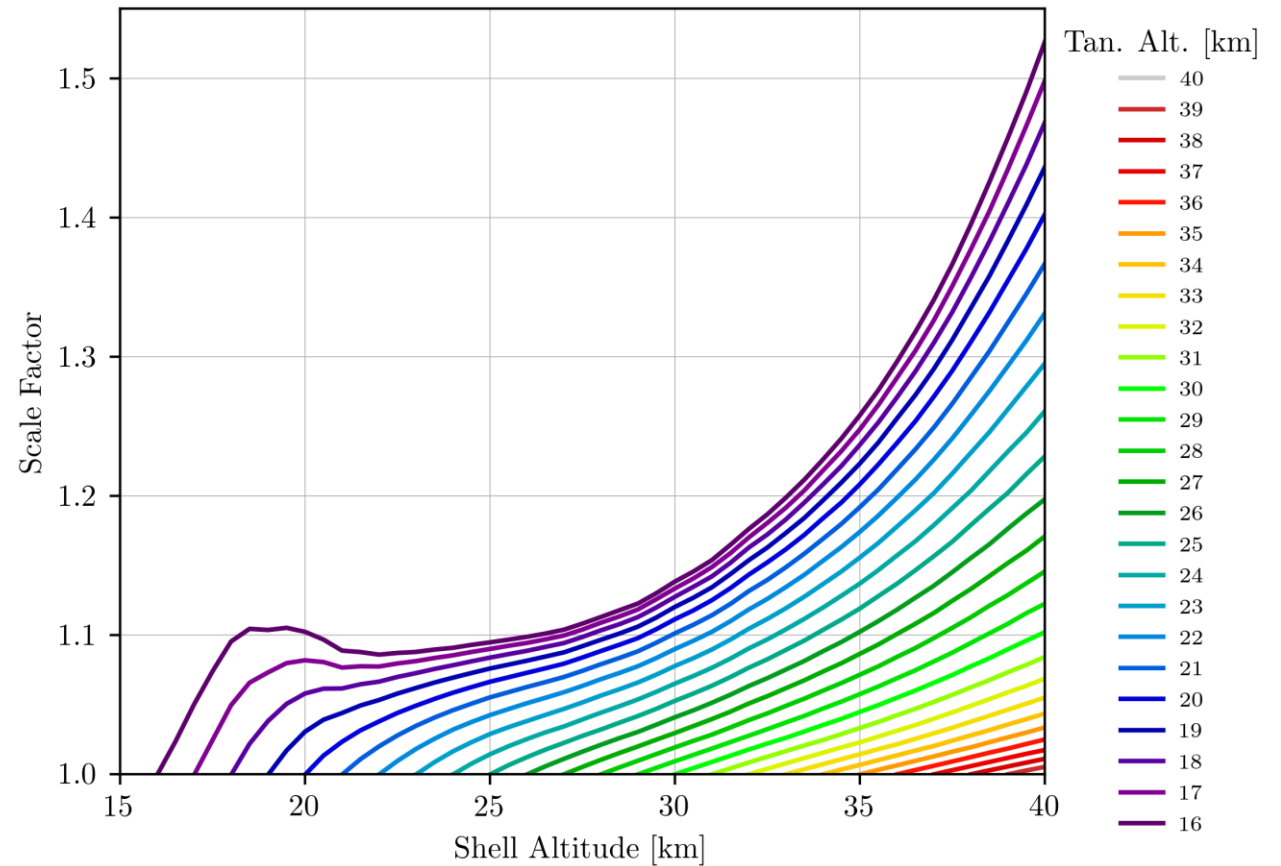
SAGE III DV retrieval

- Photochemistry causes the stratospheric NO_2 concentration to vary with solar zenith angle (SZA).
- The standard SAGE retrieval assumes that the NO_2 number density has a constant gradient within each layer of the atmosphere.
- This results in data that is biased high, especially below 30 km.



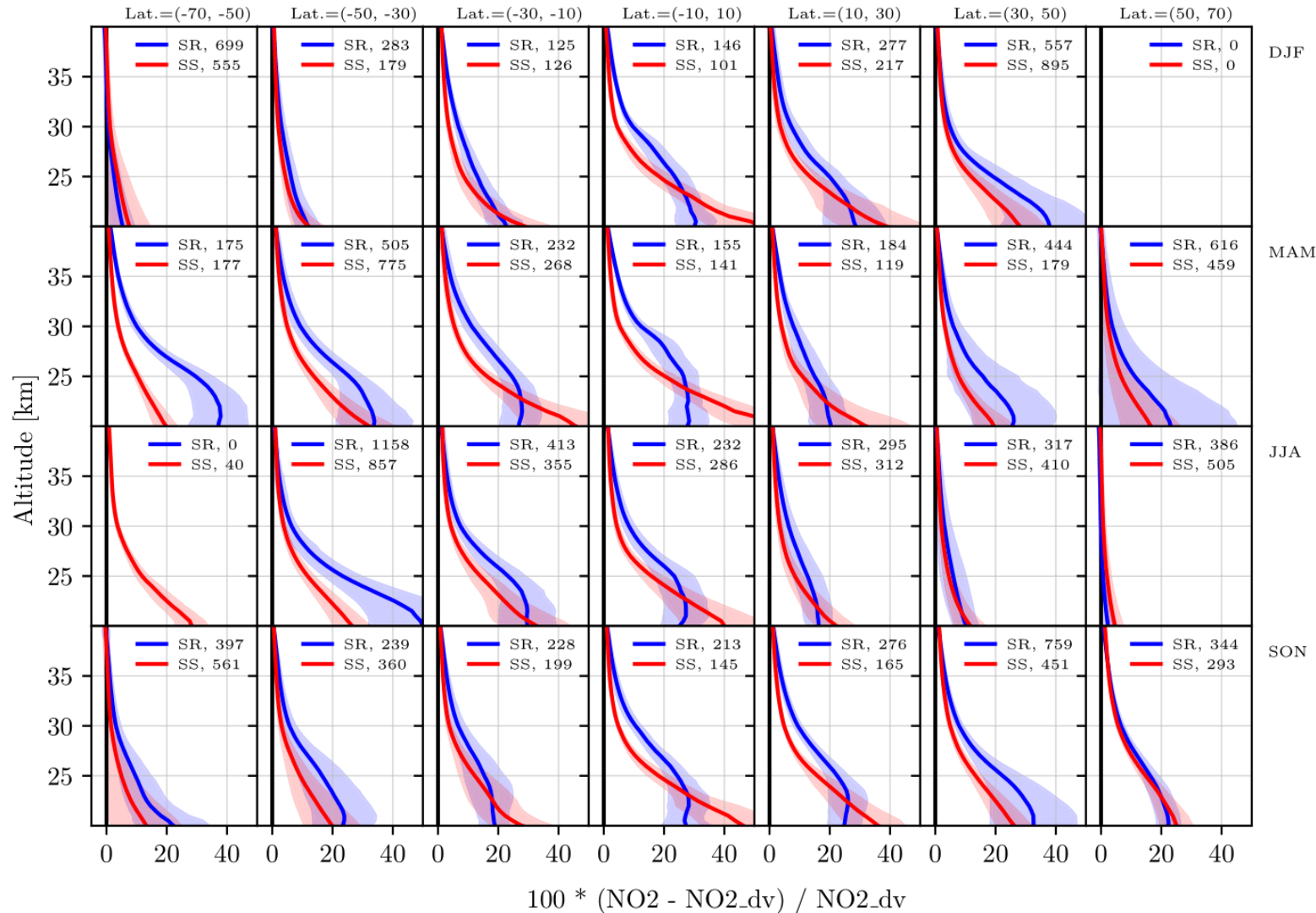
SAGE III DV retrieval

- The DV retrieval includes a scaling factor, calculated with the PRATMO photochemical box model, to account for changes in SZA along the SAGE III/ISS line of sight.



Scale factor along each LOS for a simulated sunset occultation.

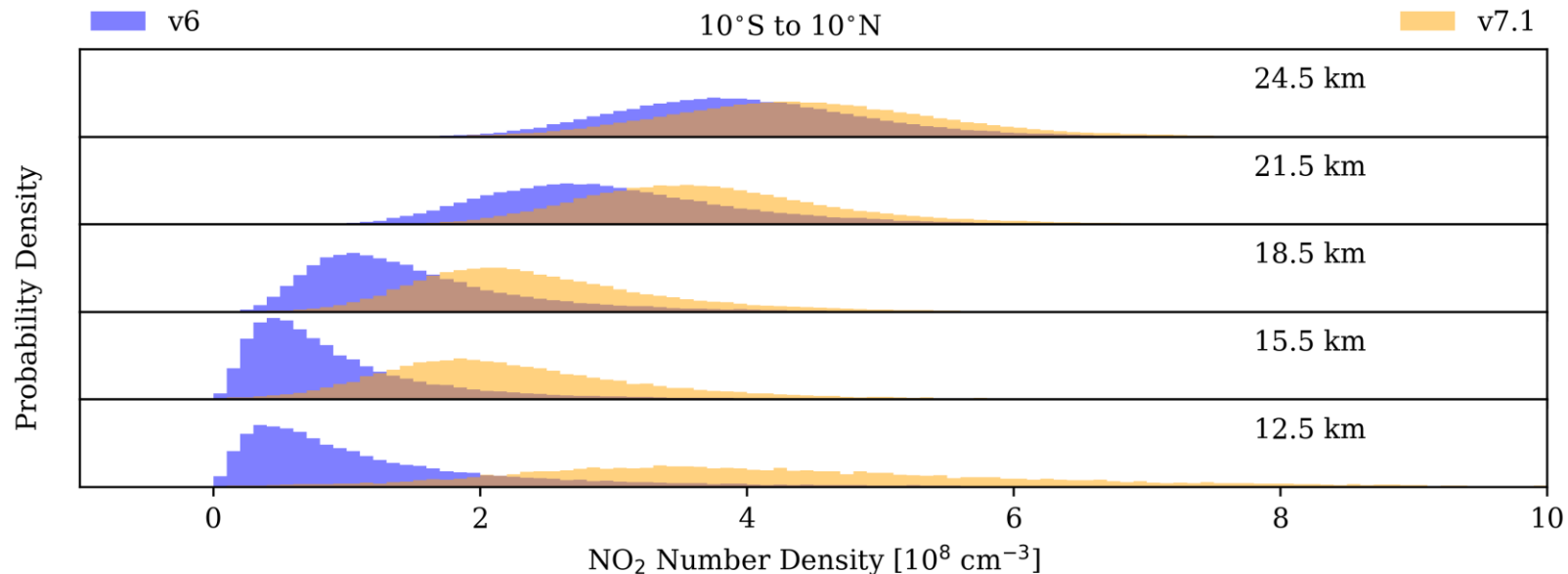
SAGE III DV retrieval



- Difference between SAGE v5.1 retrieval and diurnally varying retrieval.
- Difference becomes greater than 10% below 30 km.
- Greatest difference at high latitudes in winter.

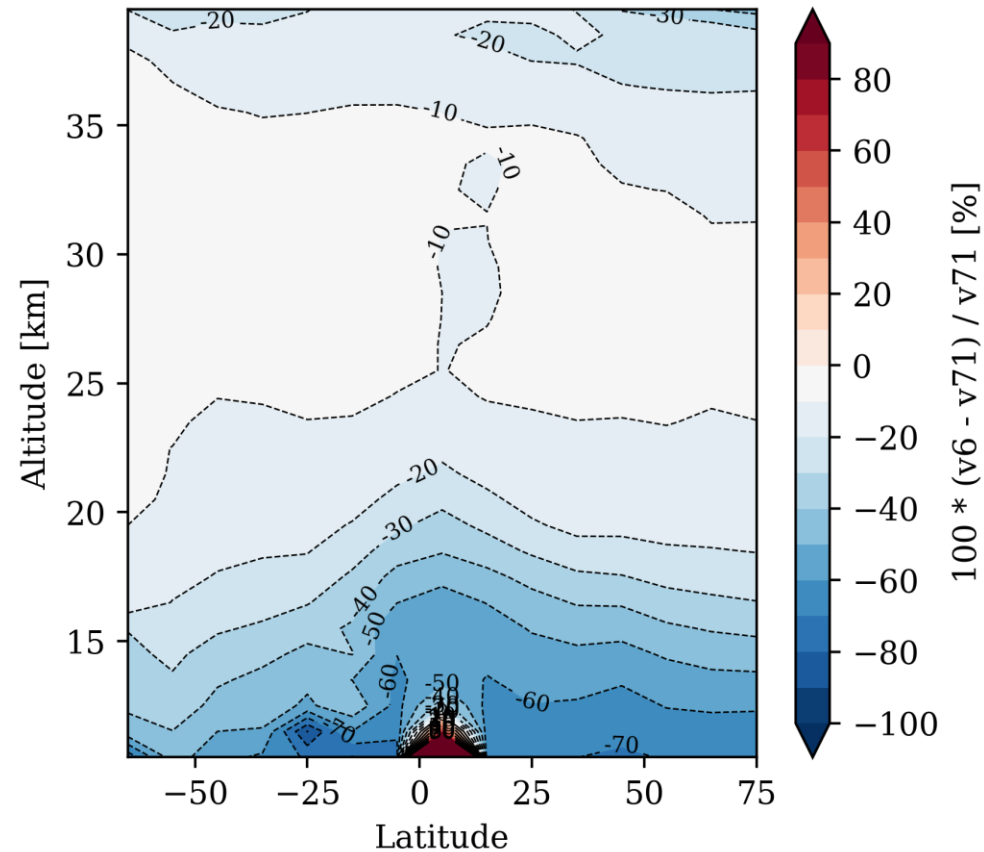
OSIRIS v7.1

- The OSIRIS v7.1 NO₂ retrieval was designed to fix a low bias and to improve performance in the UTLS.
 - The cloud and aerosol discrimination is refined to improve the detection of cloudy scenes.
 - Number density is retrieved instead of the logarithm of number density.



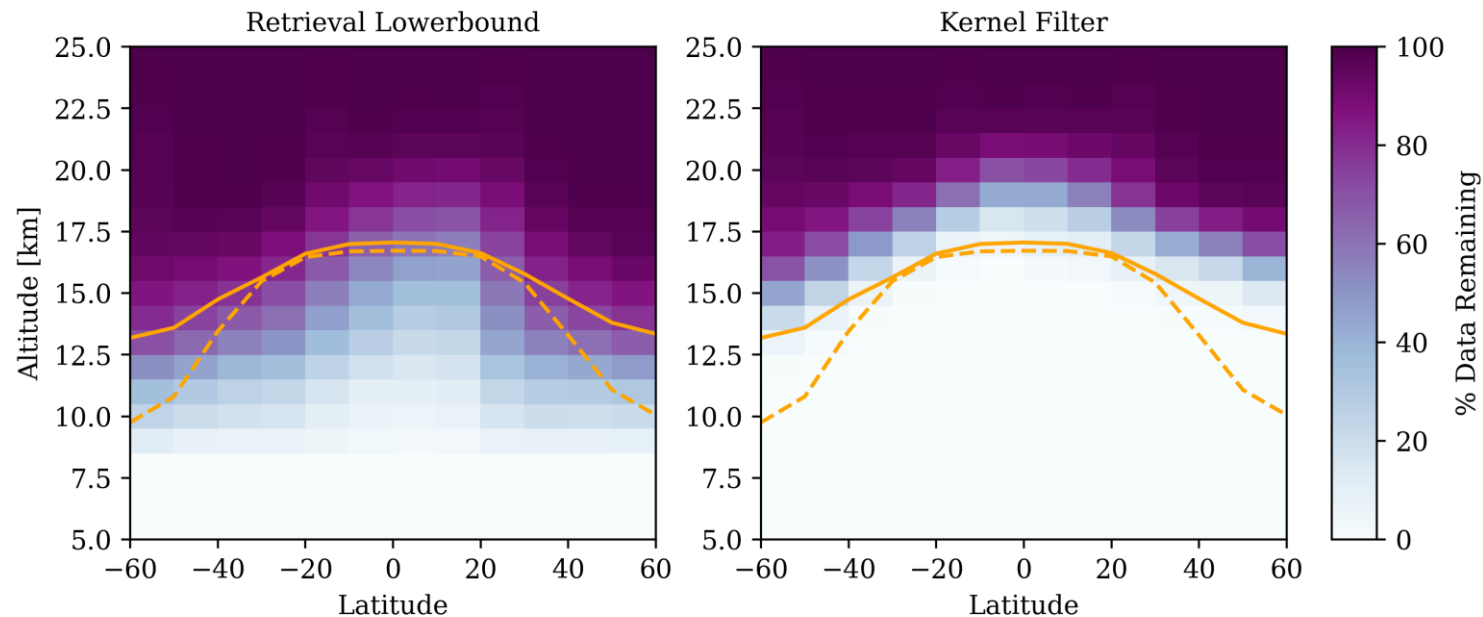
OSIRIS v7.1

- The resulting v7.1 NO₂ is higher than the v6 NO₂, with the largest differences occurring below 20 km.



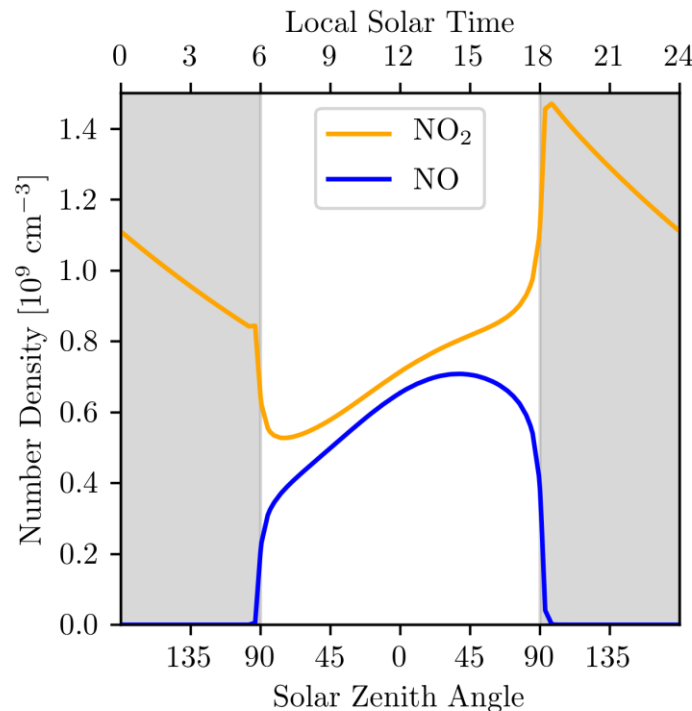
OSIRIS v7.1

- A lower-bound based on the averaging kernel was calculated to determine the altitude at which the NO₂ data stops containing useful information.
- Based on this filter, only about 20% of the NO₂ profiles extend down to ~17 km in the tropics and ~13 km at higher latitudes.



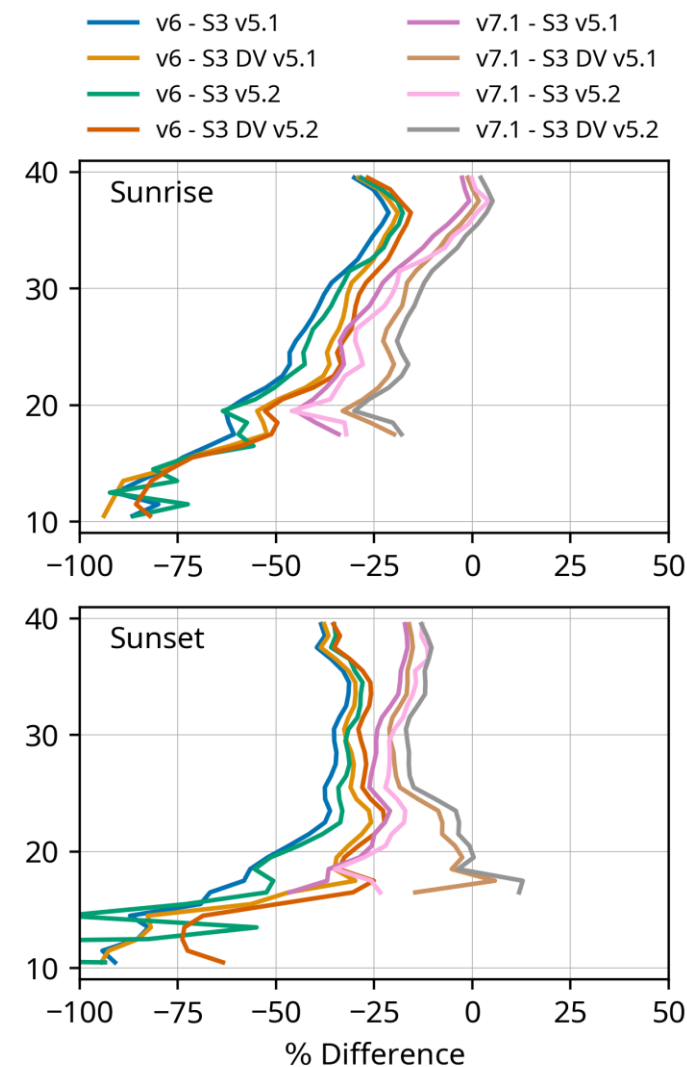
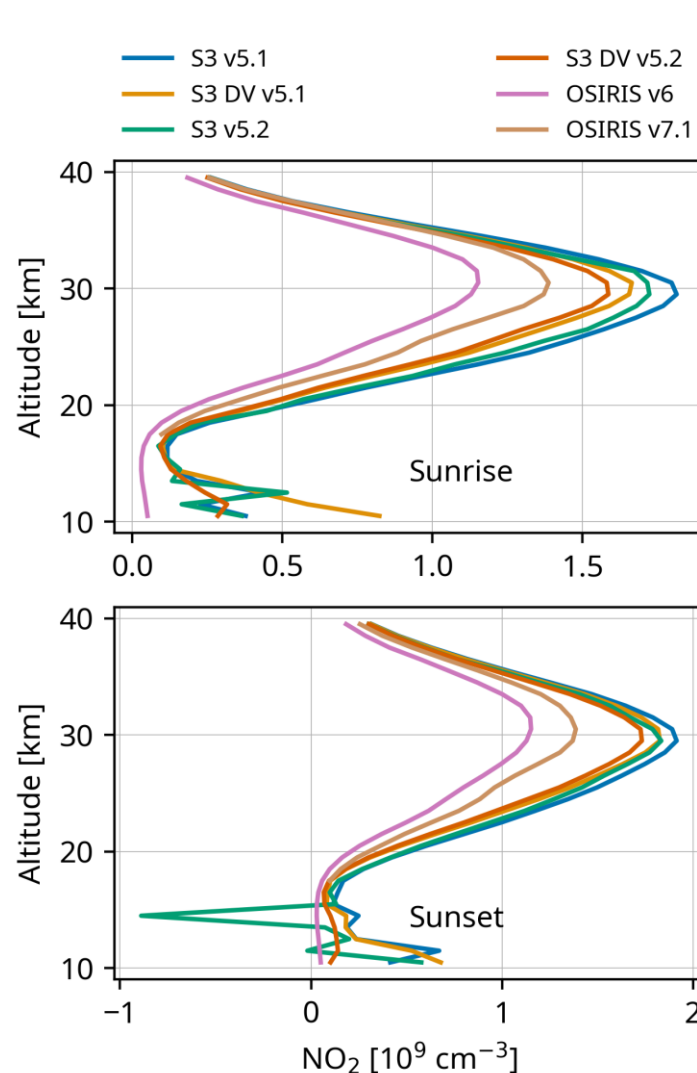
Comparing the Datasets

- The NO_2 concentration varies greatly over the course of a day
 - Use photochemical box model to scale values to a common time of 12:00 pm.
- The coincidence criteria are 1 day, 5° latitude, and 10° longitude.



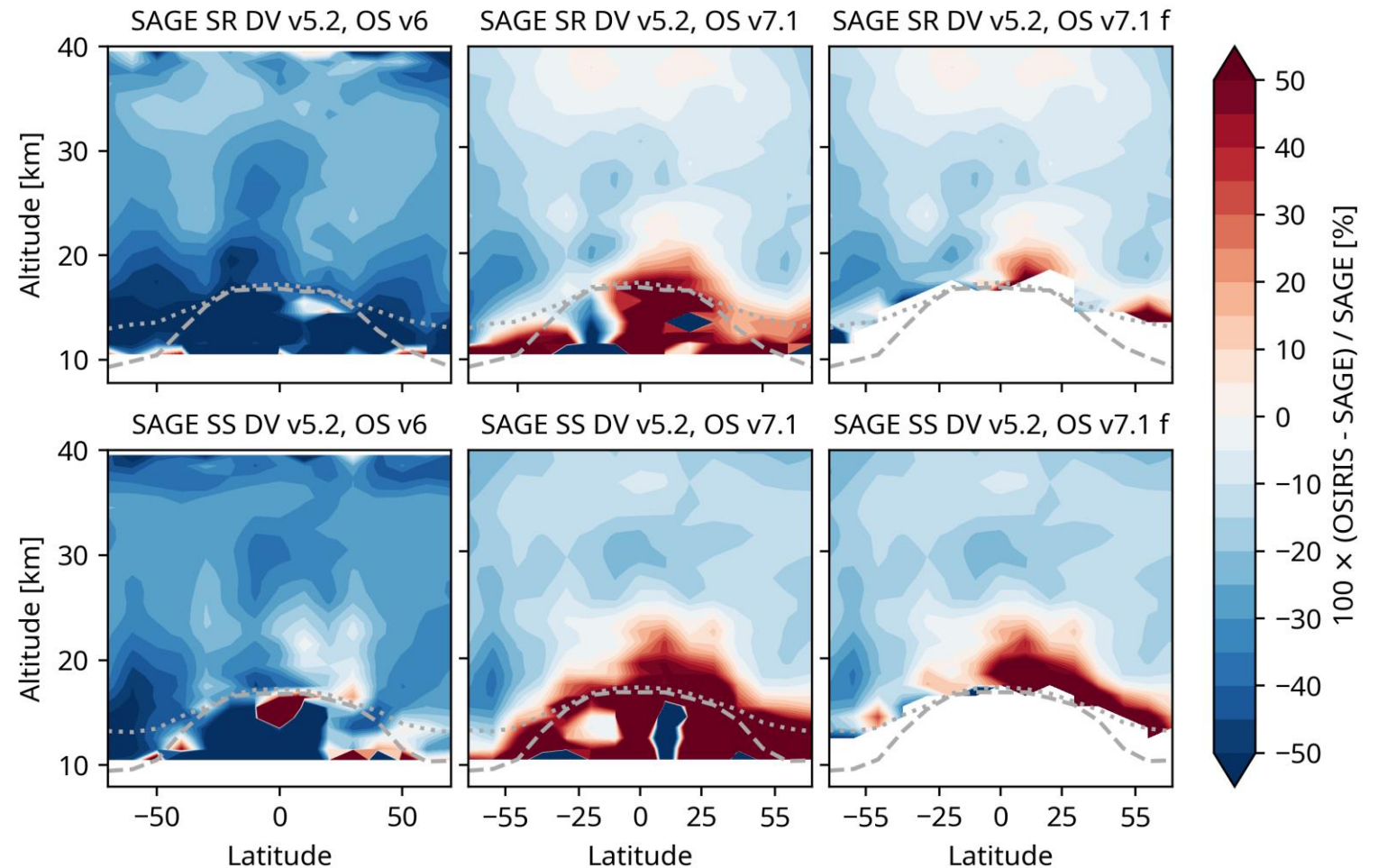
OSIRIS and SAGE III/ISS

- -25° to -15° latitude.
- SAGE v5.2 is $\sim 5\%$ lower than SAGE v5.1
- OSIRIS v7.1 shows improved agreement with SAGE III.
- The best agreement is between the SAGE v5.2 DV and OSIRIS v7.1 retrievals.



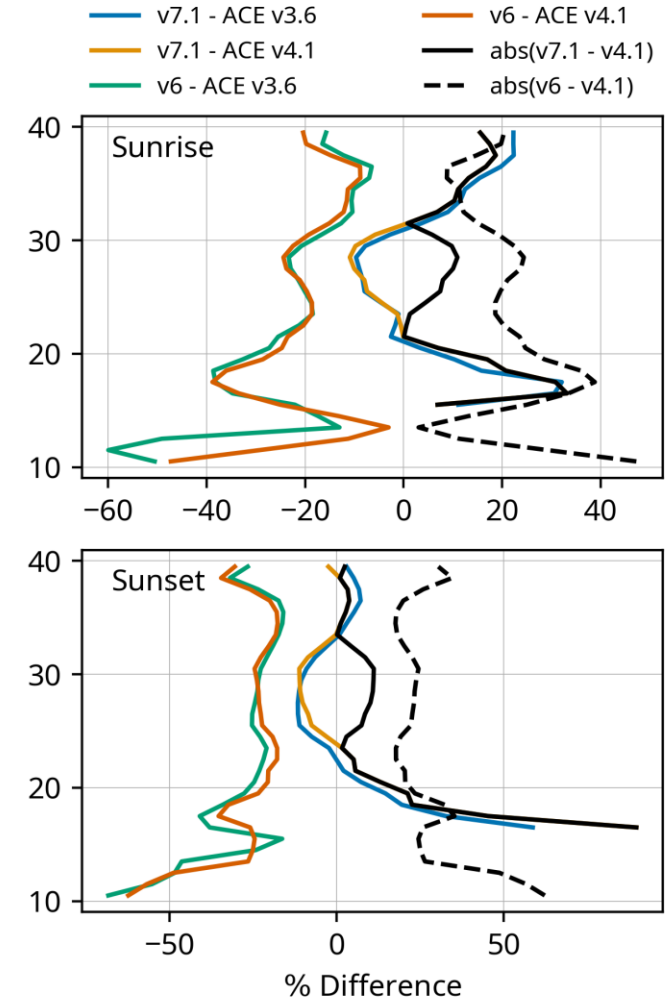
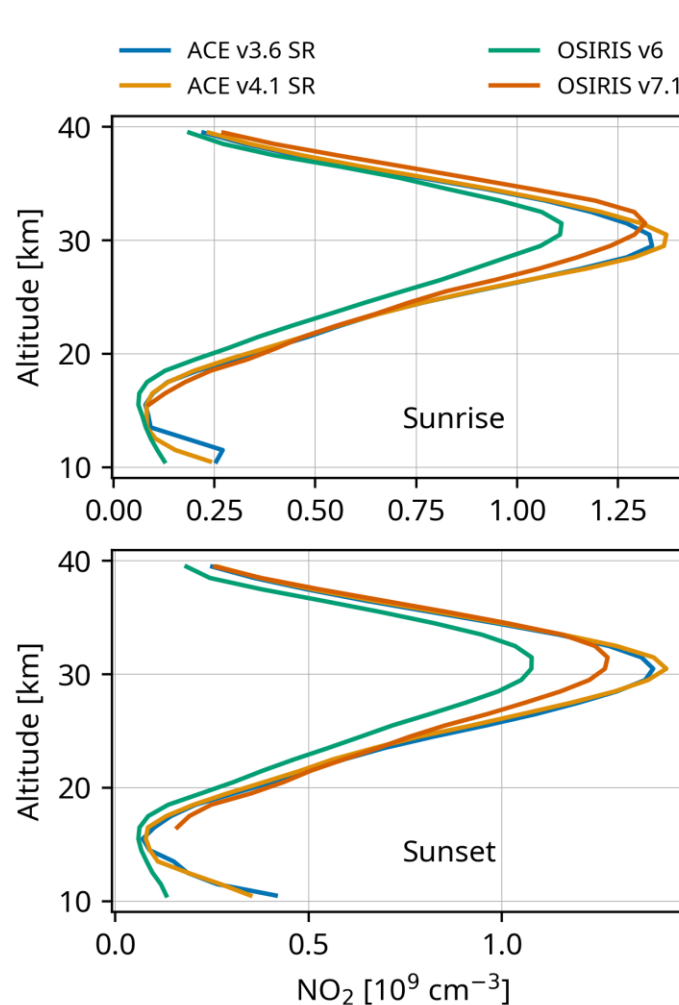
OSIRIS and SAGE III/ISS

- Better agreement with sunrise occultations.
- At the lowest altitudes, the DV correction becomes large, resulting in the region of positive bias.



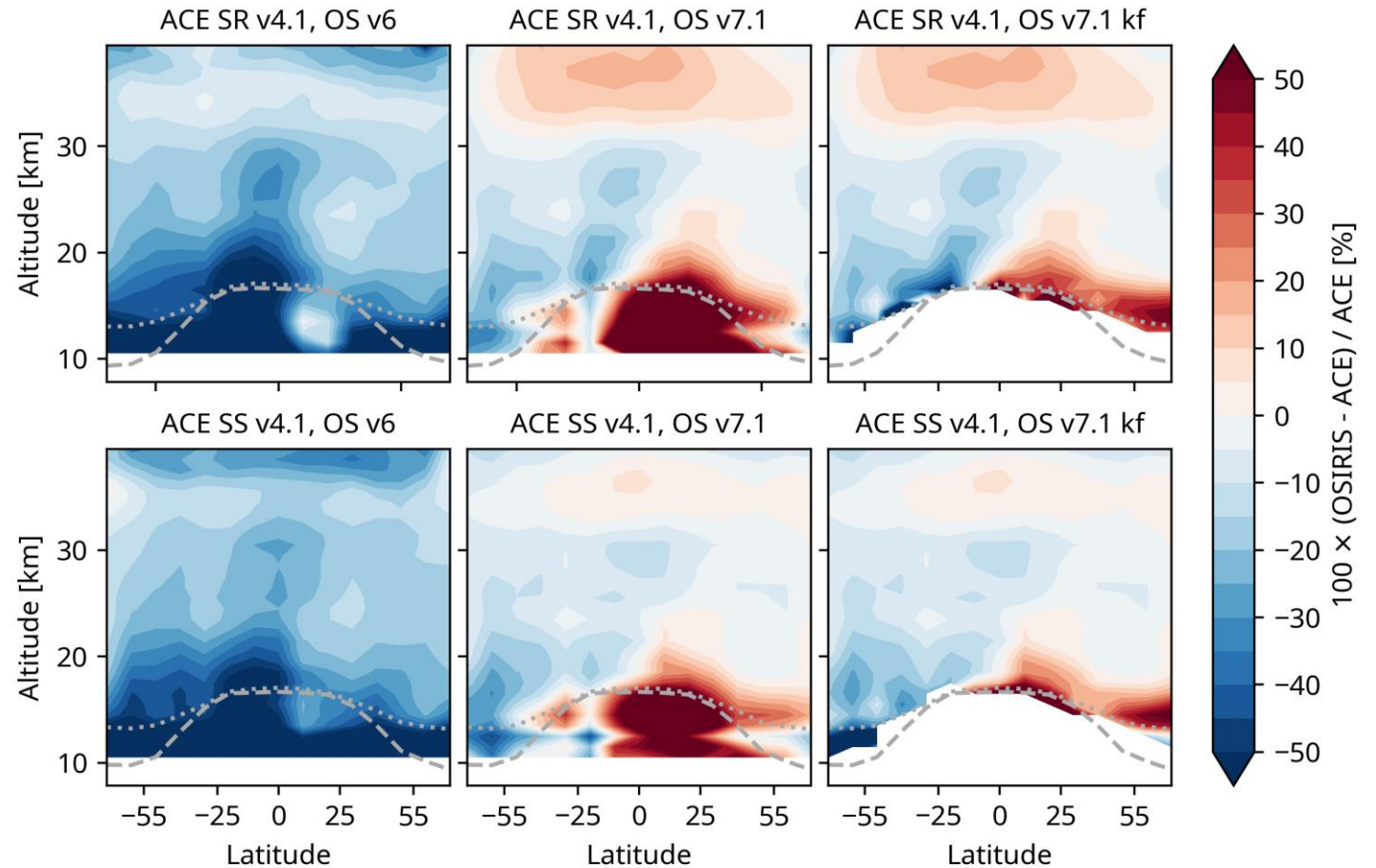
OSIRIS and ACE-FTS

- 5° to 15° latitude.
- Minimal difference between ACE v3.6 and ACE v4.1.
- OSIRIS v7.1 agrees better with ACE than OSIRIS v6 in the mid-stratosphere.
- ACE retrieval does not account for diurnal variations.



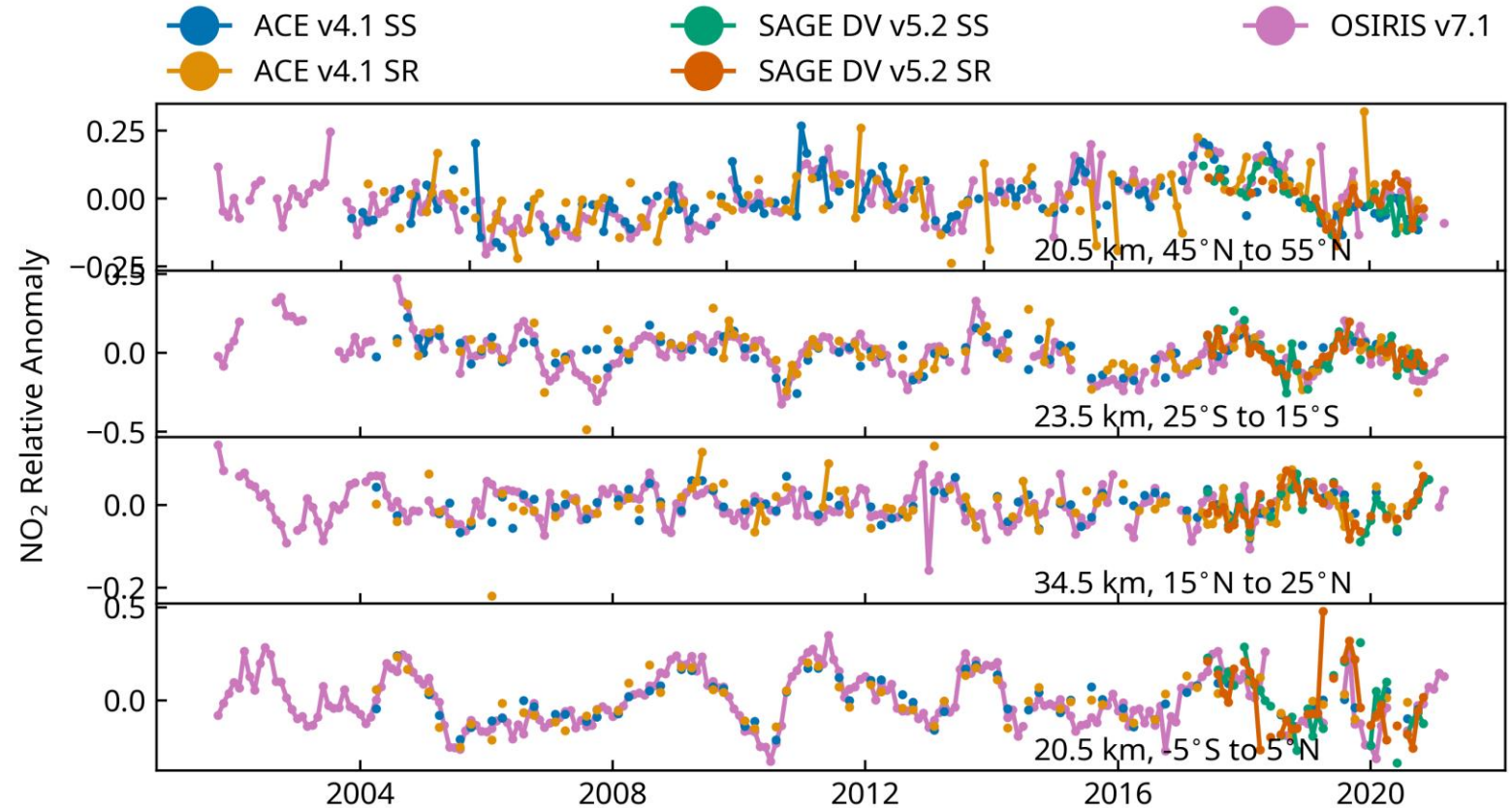
OSIRIS and ACE-FTS

- OSIRIS v7.1 agrees better with ACE than v6 in most bins.
- Better agreement with sunset occultations.
- Hemispherical asymmetry in the difference is possibly related to sampling of coincident profiles.



Anomaly Time Series

- All datasets show very similar variability.
- Correlation of OSIRIS with both ACE > 0.7 at most latitudes from 20 to 35 km.
- Correlation of OSIRIS with SAGE III > 0.6 at most latitudes above 20 km.



Conclusion

- The latest version of the OSIRIS NO₂ retrieval agrees better with both ACE-FTS and SAGE III/ISS than the previous version.
- The agreement is within 20% at most latitudes and altitudes.
- Overall OSIRIS agrees better with ACE than with SAGE III/ISS, but this could be due to the much greater number of coincidences.
- The SAGE III DV retrieval agrees better with OSIRIS than the standard SAGE retrieval.
- SAGE v5.2 agrees better with OSIRIS than SAGE v5.1.
- The anomaly time series from each dataset shows very similar variability.