Comparing Vertical Columns of Ozone Measured by Nadir and Limb Viewing Instruments

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Introduction

Nadir viewing satellite instruments such as OMI/Aura can only observe ozone column above clouds. To build a total ozone column, some climatological values are used for the troposphere.

Limb viewing optical instruments such as GOMOS/Envisat and OSIRIS/Odin measure O3 profiles with high vertical resolution. The measurements is also limited by clouds on the line of sight.

Methods

Assume the lowest inverted GOMOS altitude as the cloud top height (inversion fails when we hit the cloud during the star occultation measurement).

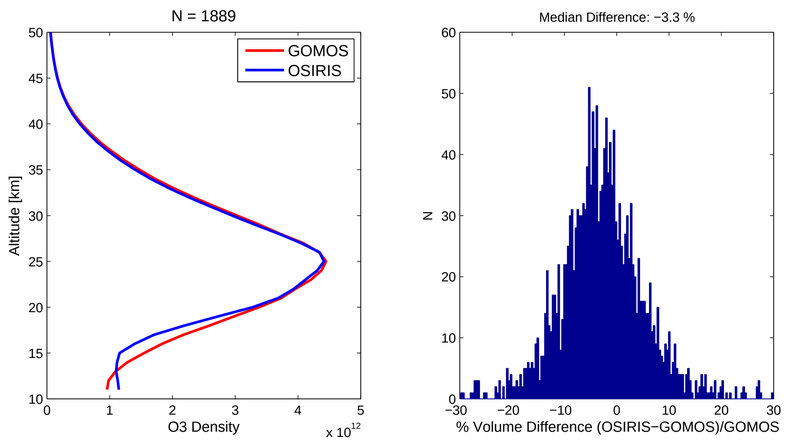
Investigate cases where OMI and GOMOS show the same cloud height and location with less than 1 day time difference (GOMOS measures during the night while OMI and OSIRIS during the day).

Calculate ozone column also for the corresponding OSIRIS measurements. OSIRIS does not detect clouds very well, so we have to use the same altitude region as with GOMOS.

Limb observations

Altitudes below 20 km are typically difficult for limb viewing instruments. Multiple scattering makes OSIRIS measurements specially challenging. OSIRIS profiles are therefore quite sensitive (at low altitudes) for the parameters in the retrieval.

Differences in vertical profiles below 20 km typically convert to 3-5 % differences in the total O_3 volume above the cloud top height. The difference is largest at the equator region.

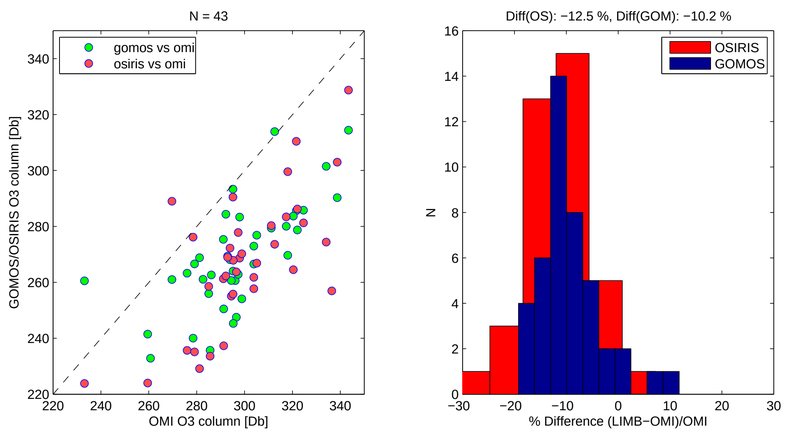


Comparison of vertical profiles of GOMOS and OSIRIS (left) and integrated total column densities (right)

Limb columns vs. OMI

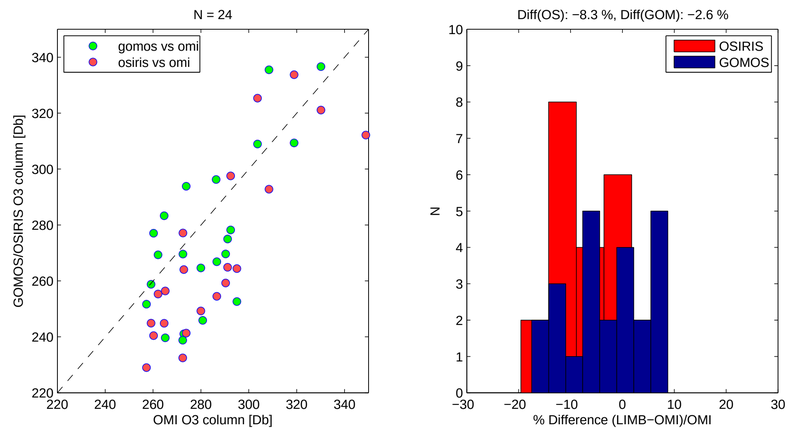
Latitude difference less than 2 °, longitude difference less than 3 °, time difference less than 1 day and cloud fraction more than 0.1.

If the clouds observed by OMI are more than 400 hPA lower than clouds observed by GOMOS, OMI sees around 10 % more ozone than the both limb instruments.



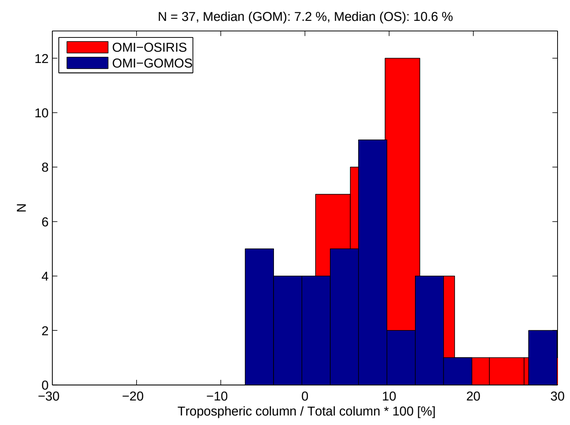
Scatter plot of OMI column vs GOMOS and OSIRIS columns (left) and histogram of relative differences (right)

With the cloud top pressure difference less than 100 hPa clouds are approximately at the same altitude. GOMOS and OMI are now within 2.6 % and OSIRIS and OMI within 8.3 %.



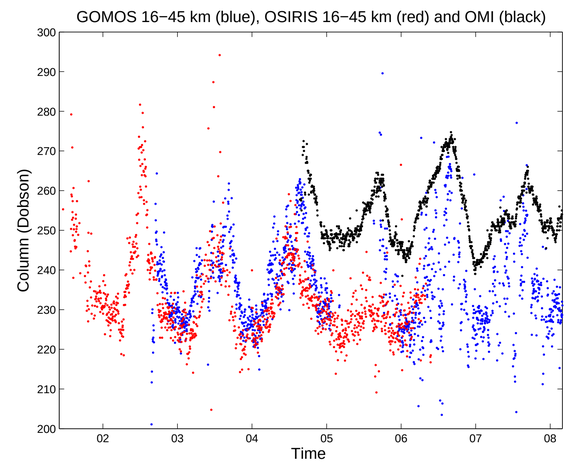
Tropospheric ozone

For clear sky cases, we can calculate tropospheric ozone by subtracting limb column from OMI total column (which now goes down to Earth).



Time series

GOMOS, OSIRIS and OMI time series between 20S and 20N.



Conclusions

Using cloud information we can directly compare total ozone columns from nadir and limb viewings instruments.

OSIRIS measures about 3-5 % less ozone above clouds than GOMOS.

GOMOS measures about 2-4 % less ozone above clouds than OMI.

References

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