

Response to Anonymous Referee #1 comments on “FRESCO-B: A fast cloud retrieval algorithm using oxygen B-band measurements from GOME-2” by Marine Desmons et al.

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The authors are grateful to the referee for the constructive evaluation and useful comments on the paper. In the following, a point-by-point reply is given, with the Referee's comments in italics.

This paper presents the new FRESCO-B algorithm, which retrieves cloud properties using measurements at the oxygen B-band regions. This new algorithm adopts the same infrastructure of the robust and well-tested FRESCO model. The paper gives the theoretical basis, radiative transfer simulations and performance evaluation. The work is helpful in further understand the cloud retrievals with oxygen A- and B-bands. The paper is well written and the topic is suitable for publication in AMT. I recommend publication after some minor revisions. Some comments are as follows:

1) Trying to understand the simulation results shown in Figure 6. Using Fig 6a as an example (it's easier to analyze since the surface albedo is the same for both FRESCO- B and FRESCO), why do you think the pressure difference is negative for the thin-and- low cloud case? There are three factors that contribute to the pressure difference: (a) the photon path differences inside clouds; (b) the photon path differences below clouds; and (c) the differences in the effective cloud fraction. The only one that can cause negative pressure difference is (c). Since FRESCO-B has a slightly larger effective cloud fraction, the total photon path for the clear part of the pixel should be smaller than FRESCO. I'm thinking if you force the effective cloud fraction to be the same, the negative cloud pressure difference will probably disappear for Fig6a.

This is a very interesting observation by the reviewer: for the case of a thin low cloud the FRESCO-B pressure is a bit lower than the FRESCO pressure. This holds for both the ocean and vegetation cases, except for the most oblique geometry for vegetation. In addition to the three factors mentioned by the reviewer there is also the factor of the light path above the cloud, which could be influenced by reflection by the cloud. Since the B-band is weaker than the A-band, multiple scattering between the cloud particles and the molecular Rayleigh scatterers above, inside, and below the cloud is stronger in the B-band than in the A-band. At 685 nm there is 50 % more Rayleigh scattering than at 760 nm. Most Rayleigh scattering is above 5 km, so by scattering above the cloud the B-band pressure would be lower than the A-band pressure.

The effective cloud fraction appears to be slightly larger in the B-band than in the A-band, which is well observed by the reviewer. This effect would counteract the above effect, since a larger cloud fraction means that more photons come from the cloud level instead of the clear sky. We followed the suggestion of the reviewer, and forced the effective cloud fraction in the B-band to be equal to that in the A-band. We obtain the same negative pressure difference. The values are resumed in the following table:

$c_{\text{eff}}=0.4679$	$P_{\text{FRESCO-B}}=685.285 \text{ hPa}$
	$P_{\text{FRESCO}}=689.318 \text{ hPa}$
$c_{\text{eff}}=0.4558$	$P_{\text{FRESCO-B}}=685.067 \text{ hPa}$
	$P_{\text{FRESCO}}=689.139 \text{ hPa}$

We changed the manuscript accordingly, section 4.3, p19:

...For the case of a thin low cloud, the FRESCO-B pressure is a bit lower than the FRESCO pressure. This holds for both the ocean and vegetation cases, except for the most oblique geometry for vegetation. This feature can be due to the Rayleigh scattering. Since the B-band is weaker than the A-band, multiple scattering between the cloud particles and the molecular Rayleigh scatterers above, inside, and below the cloud is stronger in the B-band than in the A-band. At 685 nm there is 50 % more Rayleigh scattering than at 760 nm. Most Rayleigh scattering is above 5 km, so the pressure retrieved in the B-band is lowered by the scattering happening above the cloud, leading to a smaller (negative) difference of pressures....

Specific comments:

P5 Fig 3: Please check the vertical axis of the figures. It doesn't look right.

Thanks for identifying this mistake. In Fig. 3 we plotted the reflectance at top-of-atmosphere, whereas we intended to plot the transmittance at the surface, to clearly show the absorption bands of oxygen. We corrected this. The atmospheric set-up and geometry is now given in the caption.

Here is the new figure:

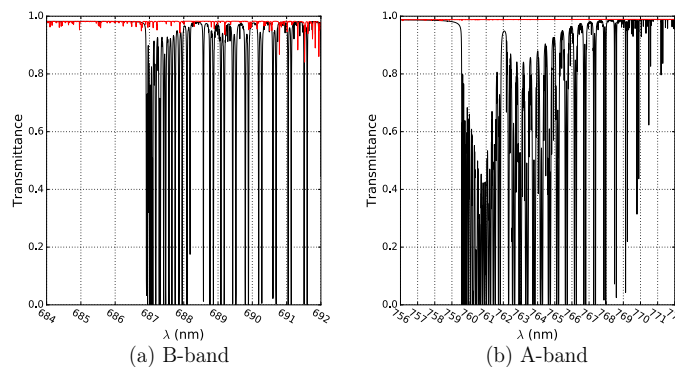


Figure 3: Line-by-line transmittances in the oxygen A (b) and B (a) bands (black lines). The transmittances of the overlapping water vapor lines are represented in red. The calculations are computed using the HITRAN 2016 database (Gordon, 2017) and for a solar zenith angle of 0° .

P18 Fig 9: Missing the (b) panel caption

Added. Thanks for noticing this oversight.