Response to the anonymous referee #2 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. In the following, a point-by-point reply is given, with the Referee's comments in italics.

This paper presents a new FRESCO-B algorithm that was built up on the FRESCO algorithm but uses spectral measurements in the O2 B-band, whereas FRESCO algorithm uses the O2 A-band measurements. Both FRESCO-B and FRESCO algorithms retrieve cloud effective fraction and cloud top pressure from three 1-nm wide bands around the corresponding O2 absorption bands. The development of FRESCO-B algorithm is motivated for its valuable application over vegetation surface that has much lower surface albedo in the O2 B-band. This work demonstrated the promising retrievals using the FRESCO-B algorithm with both the synthetic data and the GOME- 2 measured data. The study is well designed and matches the scope of AMT. The manuscript is well written. I only have a few minor comments as below.

(1) For the algorithm, why select only three 1-nm wide windows instead of performing spectral fitting at all wavelengths of GOME-2 measurements around O2 A- and B- band? Is it supposed to have more information if more wavelengths are used?

The use of a selected number of wavelengths in the O2 A-band is one of the key features of the FRESCO method as devised by Koelemeijer et al. (2001). The basic idea is that the A-band (and B-band) contains much dependent information, since it consists of hundreds of lines. The reflectances in the selected three wavelength windows contain nearly all independent information that is available in the O_2 A band for instruments with the spectral resolution of GOME-2 (Kollewe et al., 1992, Fischer et al., 1992). Using the entire O2 A-band (or B-band) would unnecessarily slow down the retrieval.

(2) Can authors include the definition for "effective cloud fraction" and explain why cloud effective fraction can exceed 1 (Figure 5)?

The definition of effective cloud fraction is now given in Sect. 4.2. p7:

...In Figure 5, we can see that the retrieved effective cloud fraction is sometimes higher than 1. This is due to the principle of the FRESCO algorithm. Indeed, the effective cloud fraction is the part of the pixel that the Lambertian cloud has to occupy to match the observed reflectance while the geometric cloud fraction is the part of the pixel that is covered by the true clouds. The effective cloud fraction is strongly coupled to the choice of the cloud albedo Ac. The choice of Ac=0.8 has been made in the FRESCO algorithm (Koelemeijer et al., 2001, Stammes et al., 2008) for different reasons (correction of trace gases for clouds, consistency of the Lambertian model, ability to approach the measured reflectivities by simulations), and can lead to effective cloud fractions somewhat higher than 1....

(3) Figure 5 and 6. Need to label the left and right panels with (a) and (b), as these are indicated in the figure caption.

Done, we apologize for this omission

(4) Page 7 line 15: "Figure 4b" -> "Figure 5b".

Corrected.

(5) Table 2&3: As shown in the simulated retrievals in section 4, cloud effective fraction is larger from O2-B retrievals. Why the differences are negative for Land and Vegetation cases of GOME-2 retrievals? Ok, I found this is discussed on page 10.

Ok

(6) Figure 7a is not discussed in the text.

This figure is described in paragraph 5.1.1, p10

(7) It seems to me Figure 7b shows substantial land areas with negative cloud pressure difference. However, global average of this difference over Land is positive in Table 4, which may not consistent with Figure 7b. Please double check.

We have checked and both the table and the figure are correct. We understand your concern, but there are also many land areas with a positive difference, which balance the areas with a negative difference. We have added the histograms of the cloud effective fraction differences and of the cloud pressures differences over ocean and land in the paper in section 5.1 p13, and changed the text accordingly.

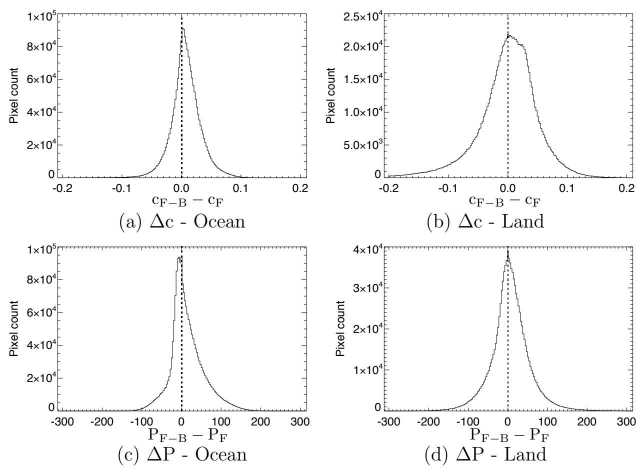
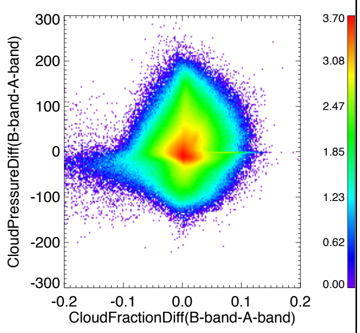
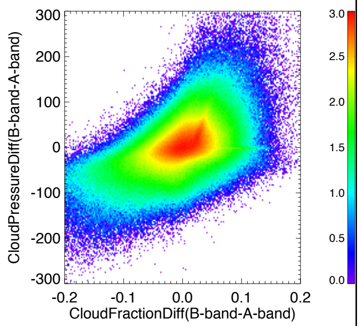
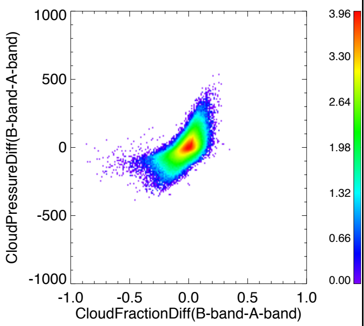


Figure 8: Histograms of the differences of effective cloud fractions (panels a and b) and of cloud pressures (panels c and d) between FRESCO-B and FRESCO for July 2014, over ocean (panels a and c) and over land (panels b and d).}

.... Over land, the cloud pressure difference is also positive on average with a mean value of 6.31±49.1hPa. However, as we can see on Figure 8d, the range of the values is larger than over ocean with a lot of pixels having a negative difference of pressure. This is again due to the high variability of the surface albedos for this type of surface and is coherent with the observations we have made on the simulations. Over land, the coefficient of correlation between the difference of pressures and the difference of cloud effective fractions is 0.523....

(8) In Figure 7, it appears some correlation may exist between the differences in effective cloud fraction and the differences in cloud top pressure. For instance, areas over land with negative cloud pressure difference tend to have negative cloud fraction difference. It seems a low bias in cloud fraction may lead to low bias in cloud pressure?

We have checked this point and plot the correlation between the difference of pressures and the difference of effective cloud fraction for different surfaces:

Over ocean	Over land	Over vegetation
		
cc=0.049	cc=0.523	cc=0.620

Consequently, the correlation between the difference of pressures and the difference of effective cloud fractions is inexistent for ocean pixels and moderate for land and vegetation cases. However, we think that the O_2 A- and B-bands react differently to cloud fraction and cloud albedo, which both influence effective cloud fraction, and to cloud vertical structure. These three cloud parameters represent different cloud properties that are not generally correlated. Thus, we think that the hints towards such a correlation are not strong enough.

We have added the value of those correlation coefficients in the paper, section 5.1.2:

.... Over ocean, the coefficient of correlation between the difference of pressures and the difference of cloud effective fractions is 0.0949....(p14)

.... Over land, the coefficient of correlation between the difference of pressures and the difference of cloud effective fractions is 0.523.... (p15)

(9) Figure 9: Need to add label "(b) Multi-layer clouds"

Done, thanks for noticing this oversight.