We thank the reviewer for reading carefully our manuscript and for the helpful comments and suggestions. Please find below a discussion of the reviewer's comments (italic lines). Changes/additions made to the text are underlined.

Reply to Reviewer 1:

First, a statement regarding impacts of absorbing aerosol in the layer between the surface and the level of flight, and a statement to the geographical regions where aerosol conditions are nominally outside of the sensitivity analysis performed. In particular, an absorbing aerosol above a reflective surface could result in a measured albedo at flight level less than at the surface [Torres, O. et al., 1998, for example]. I did not see that the authors investigated the robustness of their fits and parameterizations to absorbing aerosols (the paper mentions only an aerosol single scattering albedo = 0.98). Per Bergstrom et al. [2007], who compiled a library of these values over a number of intensive measurement campaigns conducted in different geographical regions, some representative values of aerosol ssa were as low as 0.75 over the 400-1000 nm spectral range.

In our first version it was not clearly stated which single scattering albedo was used for the radiative transfer simulations. For most of the simulations a SSA of 0.75 was used. The given SSA of 0.98 was just valid for the measurement case from the INSPECTRO campaign. However, for the new version of the manuscript we performed additional simulations for a broader range of aerosol properties (asymmetry parameter *g* between 0.65 and 0.85, SSA between 0.65 and 0.98) to cover the effect of absorbing and scattering aerosols on the critical distance. We found that the effect of *g* is negligible, whereas using the SSA in our parameterization leads to an improvement of the results. Several text passages were added discussing the impact of the SSA. Furthermore, the Fig. 3a and Fig. 3b were revised.

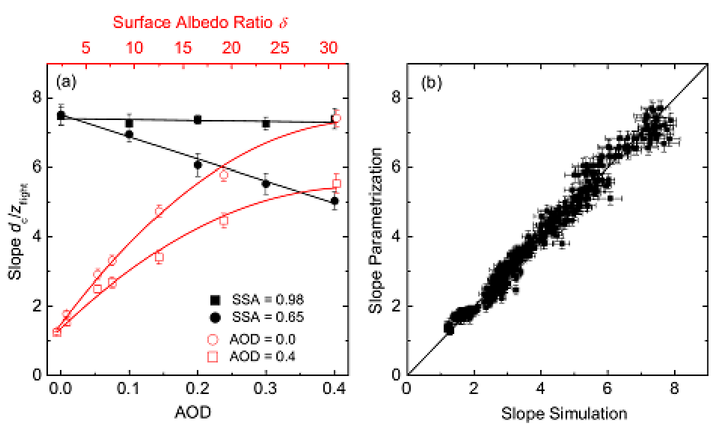

Fig. 3. (a) Slope d_c/z_{flight} as a function of aerosol optical depth (θ_0 = 30°, δ = 30.8, g = 0.75, $\tilde{\omega}$ = 0.65 and 0.98), and surface albedo ratio $\delta = \rho_{\text{land}}/\rho_{\text{sea}}$ (θ_0 = 30°, $\tilde{\omega}$ = 0.75, g = 0.65, AOD = 0.0 and 0.4). (b) Relationship of the slopes derived from the radiative transfer simulation and the parameterized slopes. Additionally, the one-to-one line is plotted.

<u>The sensitivity of d_c on the aerosol properties are tested for AOD-values between 0.0 and 0.4, a ω-range of 0.65 to 0.98 and asymmetry parameters between 0.65 and 0.85.</u>[..]

Fig. 3a shows that the slope and AOD have a linear relationship, which is more pronounced for absorbing aerosols with lower single scattering albedo. In contrast, the slope is not sensitive to the AOD of highly scattering aerosols (ω = 0.98).[…]

Also the effect of asymmetry parameter is negligible within the uncertainties of the linear regression of the slopes. […]

Several multiple regressions were performed with different combinations of dependent variables (e.g., θ_0, λ, AOD, ω, δ, ln δ, and ρ_{sea}). The correlation coefficients of the parameterizations were within a range of 0.62 to 0.98. Finally, just the parameters AOD, ω, and δ and their combination were chosen for the parametrization which has the following form:

$$\frac{d_c}{z_{\mathrm{flight}}} = a_0 + a_1 \cdot \ln\delta + a_2 \cdot \mathrm{AOD} + a_3 \cdot \frac{\mathrm{AOD}}{\delta} + a_4 \cdot \tilde{\omega} \cdot \delta \qquad , \tag{12}$$

with: a0= 0.1620.079, a1= 1.4010.049, a2= -2.7710.135, a3= 6.5260.721, and a4=0.0820.004. This parametrization shows a correlation coefficient of 0.98. […]

Please note, that we added a second parameterization of the critical distance for δ-values lower than 2.

So far the parametrization was considered for surfaces with a lower albedo than the albedo of the adjacent surface ($\delta > 1$) and a surface albedo ratio δ defined as the ratio between land and sea albedo. To generalize δ is now defined as:

$$\delta = \rho_1 / \rho_2 \qquad , \tag{13}$$

with: ρ_1 is the surface albedo of the adjacent area and ρ_2 is the surface albedo of the area which is overflown. Exemplarily, to derive the critical distance over land, δ is calculated by $\delta = \rho_{sea} / \rho_{land}$. Out of it a separate parameterization is derived for $0 < \delta < 2$. Since the aerosol has low impact for this δ-range on the slope (cf. Fig. 2b over land), the parametrization is given by:

$$\frac{d_c}{z_{\mathrm{flight}}} = \left| (-1.448 \pm 0.018) + (1.334 \pm 0.0334) \cdot \delta \right| \qquad . \tag{14}$$

Note, the right hand side of Eq. (14) needs to be written in absolute value bars otherwise the slope would be negative when $\rho_1 < \rho_2$.

Second, it is implicit in the iterative approach to correct for the nonlinear atmospheric contributions to the measured signal at flight level [Wendisch et al., 2004] that the measured and modeled downwelling irradiance at flight level are equivalent. Although I'm sure this condition was met in the current work, it is not mentioned in the manuscript and it likely should be; the implications of an uncorrected mismatch between a measured and modeled downwelling irradiance at flight level would imply a mismatch in the reflected signal from the surface even for the same surface conditions.

We added the following :

The method requires that the measured and simulated spectra of the downward irradiances in z_{flight} agree within the measurement uncertainties.

Third, please discuss the application of equation (10) to spectral bands where the local surface albedo of the sea is higher than that of land, which is shown to be the case from 400-500 nm (per your Figure 4a).

The reviewer is right, Eq.(10) is not valid when the albedo of the sea is larger than that of the land. As written here:

Since the local surface albedo of the sea is lower than that of land we can write […]

For $\rho_{sea} > \rho_{land}$ we could say $\rho_{ret} = 0.9 * \rho_{sea}$. It would not change the conclusion of the equations that the area-averaged surface albedo solely depends on the surface albedo ratio when atmospheric masking can be neglected.

Lastly, I'm having some difficulty interpreting the results of Figure 2b with respect to Figure 2a. I was assuming that I could "reverse" the direction of flight from land toward sea, say at 2 km flight altitude. According to Figure 2b, I would expect that the corresponding critical distance from coastline would be 4 km, at which point there would be no land surface 'contamination' in the measurements at flight altitude. However, if I then examine the AOD = 0.3 for 'sea' (filled triangle symbols) in Figure 2b), it suggests a critical distance of 6 km. I'm not sure if a) I'm simply not seeing the convergence to a 10% threshold criterion line on the left-hand side of the plot, or b) I have misinterpreted the approach.

From Fig. 2a the critical distance is really hard to read. For AOD = 0.3 d_c is indeed larger than 4 km Therefore we have shown in Fig. 2 the meaning of the critical distance for the flights above land, where the 10 % deviation is more obvious for the reader.

p. 7458, Line 19 – "For moderate aerosol conditions (optical depth less than 0.4) and the visible wavelength range,.." please amend specified wavelength range to reflect your analysis out to 1000 nm.

We changed it as follows:

For moderate aerosol conditions (optical depth less than 0.4) and a wavelength range between 400 and 1000 nm, the altitude and the heterogeneity of the surface albedo are the dominant factors determining the mean deviation between local and area-averaged surface albedo.

p. 7460, Line 8 – "In remote sensing applications instead of irradiances, radiances are measured: : :". Perhaps you are referencing strictly to satellite measurements? Airborne (remote) measurements can be irradiances, as does the SMART-Albedometer presented in your work.

We added "satellite-based":

In satellite-based remote sensing applications instead of irradiances, radiances are measured to retrieve atmospheric or surface parameters.

p. 7460, Line 26 – Indent for new paragraph.

We will take care of it in the new online version.

p. 7463, Line 22 – " The up- and downward irradiances in flight level zflight were used in to: : :". Remove the last occurrence of word 'in'.

We changed it:

The up- and downward irradiances in flight level z_{flight} were used to retrieve the area-averaged surface albedo ρ_{ret} (Wendisch et al., 2004).

p. 7464, Line 20 – "In case no atmospheric masking: : :". Add word "where" in between "case" and "no".

We changed it:

In case where no atmospheric masking is considered, the area-averaged surface albedo retrieved from aircraft measurements ρ_{ret} (x,y, z_{flight}) is a mix of the local surface albedo (ρ_{loc}) of sea and land.

p. 7472, Line 6 – "gets about one in Eq. (15)". Awkward phrasing. How about "approaches unity" instead?

We changed it:

This becomes reasonable when for altitudes z much larger than the pixel size *s*, the cosine of $\theta=\arctan(s/z_{flight})$ approaches unity in Eq. (17)…

Figure 8 – It would aid interpretation if a distance (km) scale could be added to the x-and y- axis of longitude and latitude.

We added a scale bar to the figure.

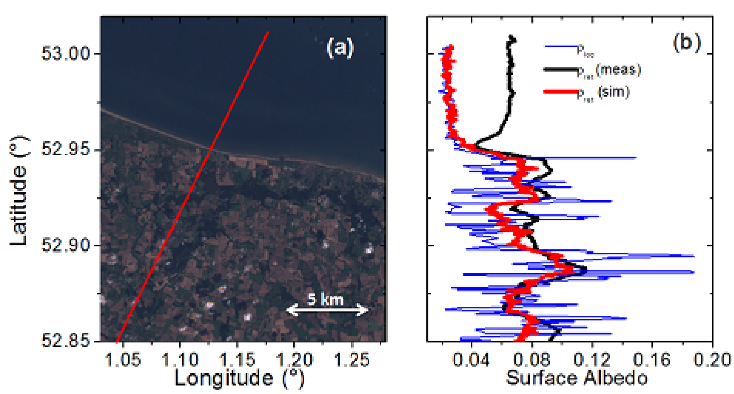

Fig. 8. (a) Landsat image and flight track of the studied area over East Anglia, (b) Retrieved area-averaged surface albedo from simulations and local surface albedo taken from Landsat at 660 nm along the flight leg. Additionally, the retrieved area-averaged surface albedo from aircraft measurements is shown.