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 2:**

*[…] the paper can be significantly shortened and unnecessary details can be removed, so it would be easier for the reader to follow the main points in the paper.*

We tried to shorten the text at some passages (e.g., description of Fig. 2 and conclusion). In general, we did not find longer passages which could be removed without losing information.

*I would recommend to include some discussion of influence of single-scattering albedo and asymmetry parameter on the area-retrieved albedo, critical distance, and parameterization describing by the eq. 12.*

*In my opinion as least scattering albedo, related to absorbing properties of aerosols, has significant impact on surface albedo retrieved from airborne observation of upward and downward fluxes.*

*Could you provide some information about sensitivity study of both optical quantities on results presented in the section 3?*

For convenience we copy the reply we already given to reviewer 1 since both reviewers asked for the effect of the aerosol properties SSA and *g* on the critical distance.

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.

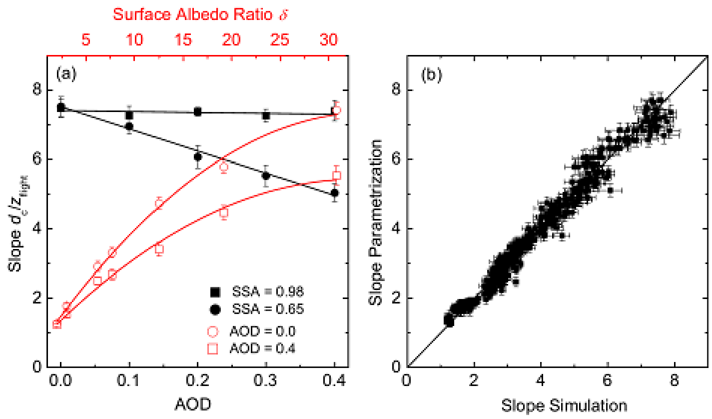


**Fig. 3.** (a) Slope $d_c/z_{\text{flight}}$ as a function of aerosol optical depth ($\theta_0$ = 30°, $\delta$ = 30.8, $g$ = 0.75, $\tilde{\omega}$ = 0.65 and 0.98), and surface albedo ratio $\delta = \rho_{\text{land}}/\rho_{\text{sea}}$ ($\theta_0$ = 30°, $\tilde{\omega}$ = 0.75, $g$ = 0.65, AOD = 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.

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.[..]

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., $\theta_0$, λ, AOD, ω, δ, ln δ, and $\rho_{sea}$). 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:

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

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. […]

*Page 7461, line 18, it is true but only in the first approximation, which should be mention.*

Checking this page and line we couldn't get the point of the comment. Maybe it is the wrong page or line.

*Page 7461, between 5 and 20. Could you add information about albedo implementation in the 3-D Monte Carlo, it is Lambert or BRDF?*

We added in the Modeling chapter:

Furthermore, Lambertian surface reflection is assumed in this study.

*Page 7463, line 19, some reference to these values should be provided here. Alpha=1.3 and beta=0.044 are long-term mean values or estimated for specific day? What kind of lidar was used, elastic or Raman and so on?* AND *Page 7463, line 21, why you assumed such single-scattering albedo and asymmetry parameter?*

As written above: 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.

In chapter Airborne Radiation Measurements we added:

These values were derived from the data set of a ground-based elastic backscattering lidar system (Gobbi et al., 2000) which measured within the time frame of the flights during INSPECTRO. According to Kylling et al. (2005) the single scattering albedo $\omega$ and asymmetry parameter $g$ of the maritime aerosol particles are set to $\omega = 0.98$ and $g = 0.75$, respectively.

*Page 7466, line 18, Why the water albedo is fixed? What about water BRDF and strong albedo dependence from solar and viewing zenith angle? For large zenith angle water albedo can be significantly larger than assumed 0.026.*

As seen from Eq. (11) the critical distance is mainly dependent on the albedo ratio itself, not on the individual sea or land surfaces. However, we tested also combination of sea and land surface albedos which differed from the fixed sea surface albedo of 0.026. In these tests we didn't see any significant change of the slopes. This study focuses on the derivation of the surface albedo from airborne irradiance measurements which cannot be used to derive the BRDF. Therefore we didn't include the BRDF into our simulations. However, we are aware of the fact, that sun glint can enhance the albedo significantly. Also here, it can be considered by using an adjusted albedo ratio.

In a first step, the sea albedo is fixed to 0.026 following Bowker et al. (1985) at $\lambda = 450$ nm, whereas the land albedo is varied with respect to different reflectivity properties to test various sea-land surface albedo ratios $\delta$. For some cases, also the sea albedo is adjusted.

*Page 7467, line 16, The sentence: "The larger the flight altitude the larger is the critical distance" not clear, should be revised.*

We changed it as follows:

The larger the flight altitude the more impact gets the adjacent surface and the aircraft needs to fly in a larger distance to the coastline to measure an undisturbed surface albedo. For higher optical depth this effect gets smaller and the critical distance decreases, which is more obvious over sea.

*Page 7468, eq. 12. Could you add information about range of the AOD and delta parameter for which this parameterization is correct? For example, for delta=2 and AOD=0 we get $d/z_{flight}$=-0.8 which is wrong.*

We restricted the parameterization (Eq. 12) to delta-values larger than two. A separate equation is now given also for delta-values lower than two.

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 $\delta$ defined as the ratio between land and sea albedo. To generalize $\delta$ is now defined as:

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

with: ρ1 is the surface albedo of the adjacent area and ρ2 is the surface albedo of the area which is overflown. Exemplarily, to derive the critical distance over land, $\delta$ 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 $\delta$-range on the slope (cf. Fig. 2b over land), the parametrization is given by:

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

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

*Page 7468, line 21-25, "For wavelengths lower than 400 nm, where Rayleigh scattering is predominated, and for wavelength regions with strong molecular absorption, Eq. (12) should not be applied" It means that Rayleigh scattering is not taken into account in the 3D model? It would be strange because this effect is relatively simple to implemented in the radiative transfer model. It is not clear here.*

Rayleigh scattering is implemented in the model. We changed the sentence as follows:

The validity of this parametrization was tested to wavelengths where extinction is mainly caused by aerosols. For wavelength regions with strong molecular absorption or scattering, Eq. (12) should not be applied. Therefore, the parametrization is restricted to a wavelength range between 400 and 1000 nm.

*Page 7470, line 16 and 22, Why the different asymmetry parameter is assumed here 0.65 instead of 0.75. One more time could you addend some discussion of impact of g and omega on the area-averaged albedo retrieval?*

We used several asymmetry parameters in our simulations. This is just one example.