Response to Editor Comment 1: K. Gierens

Thank you to the Editor for the comments. Our response is written below (in red).

I have a few comments/questions concerning several equations in the manuscript. Please consider them for your revised version.

1) Eq. 3: a better explanation of f is needed. How does the choice of f guarantee that α_{atm} remains bounded by 0 and 1? Also it should be stated that S in equation 2 is identical to $SW_{in,TOA}$ in eq. 4.

For explanation of f, see response to Referee #1. We have rephrased our description in section 2.2 to address this confusion.

The variable f does not guarantee that α_{atm} is bounded by 0 and 1. However, the editor is correct in noting that such a limit should be in place. We set this limit in our calculation of α_{plt} and α_{sfc}. Under low-light conditions (winter, high-latitudes), the denominators of equation 4 and 5 ($SW_{in,TOA}$) can become small relative to the numerator, resulting in a value of $\alpha_{plt} > 1$ or $\alpha_{sfc} > 1$ across a latitudinal band. Therefore, we limit α_{plt} and α_{sfc} to be between 0 and 1. If α_{plt} and α_{sfc} are greater than 1, we assign them with a value from the next closest month in time where α_{plt} and α_{sfc} are appropriately defined. However, we note that these are months with low incoming light ($SW_{in,TOA}$), so the effect of α_{plt} and α_{sfc} on local radiative balance is negligible. In short, we do limit α_{atm} through a limit on α_{plt} and α_{sfc}. With these limits, α_{plt} is bounded by 0 and 1. We have added a sentence explaining this in our description of new α_{atm} with CERES data (section 2.2).

We have adjusted S in eq. 2 so that it now uses the consistent variable "$SW_{in,TOA}$" as in eq. 4.

2) Eqs. 11 and 12: The argument that albedo values are not additive leads you to formally consider the ratio $\alpha_{atm,perturbed}/\alpha_{atm,CERES}$ in eq. 11, however it is necessary to subtract one from this ratio. Mathematically, we then have the difference of the albedo values back, since
$(\alpha_{atm,perturbed}/\alpha_{atm,CERES}) - 1 = (\alpha_{atm,perturbed} - \alpha_{atm,CERES})/ \alpha_{atm,CERES}$.

In eq. 12 this expression is then multiplied by $\alpha_{atm,CERES}$, and the simple difference of the albedo values returns back. So this argumentation seems to add unnecessary complexity.

Yes, the editor is correct in noting that the 1 is mathematically unnecessary. However, in defining the atm albedo feedback this way (centered around zero), it is easier to demostrate when the feedback is positive and when it is negative. By association, we feel the plots of the atm albedo feedback are more illustrative when centered around zero.

3) Eqs. 12 and 15: I wonder whether these equations are used at every timestep. If so, how do you distinguish climatological temperature variations from diurnal and seasonal temperature variations? Should a feedback not work only on the long climatological time scales? Furthermore, are these equations applied to each grid point independently or are they averaged over, e.g., latitude zones?

As stated in section 2.3, these equations are used at every timestep. We assess these cloud radiative feedbacks ($\alpha_{atm}FB$ and $OLW_{cloud}FB$) over a 12-month climatology to incorporate any seasonality in the feedbacks (e.g. monsoon impacts, etc). In addition, $\alpha_{atm}FB$ and $OLW_{cloud}FB$ are applied at each grid cell to incorporate the spatial patterns in the cloud feedbacks that are unique to each source GCM. We have attempted to clarify this in our revised manuscript.

4) Page 11, line 4: Why do you write $F_{2\times CO_2} = F_{4\times CO_2}/2$ when there is a logarithmic relation between radiative fluxes and the CO_2 concentration? Is this close to linear because the absolute change is very small?

Yes, there is a logarithmic relationship between CO2 radiative forcing and concentration. In UVic, it looks like this:

$$F_{CO2} = CO2FOR * ln\frac{[CO2\ (ppm)]}{280\ ppn},$$

where CO2FOR is the CO2 radiative forcing term (5.35 W m^{-2}), equivalent to 3.71 W m^{-2} for a doubling of CO2.

The forcing of $4xCO_2$ (1120 ppm) is mathematically equivalent to 2x the forcing of a doubling of CO_2 (560 ppm). Therefore, $F_{2xCO2} = F_{4xCO2}/2$