

***Interactive comment on* “The effect of optically thin cirrus clouds on solar radiation in Camagüey, Cuba” by B. Barja and J. C. Antuña**

Anonymous Referee #2

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The manuscript "The effect of optically thin cirrus clouds on solar radiation in Camagüey, Cuba" gives an estimate of the solar radiative forcing and the heating rate of three cirrus cases probed with lidar (opaque, thin, and subvisible Ci). In general, a negative radiative forcing is calculated for all cases at all altitudes, including top-of-atmosphere (TOA) and the surface, and heating rates are positive at the cirrus altitudes. The effect is concentrated in the near infrared spectral range. The maximum of the radiative forcing is shifted from local noon by the combined effect of the diurnal cycles of optical path and incoming irradiance; this effect is found to start only at cloud optical depths larger than 0.083.

The paper is ok for publication after a few minor revisions.

Abstract

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The first few sentences of the abstract are too general and should be moved to the introduction, if their statement is not already there. The abstract should give a condensed summary of what is done and found in the paper, but not statements like "clouds are important". It might start at "We analyze ..." (line 7). Also the last sentence is too general and can easily be made more specific. In fact, I think that the time shift from noon of the forcing maximum is the most interesting finding in this paper and should get more attention in the abstract, as the general effects (sign of the forcing and heating rate and dominance of the NIR contribution) of the cirrus clouds are not very much surprising.

Introduction

Page 8779, lines 4-7: More recent information about global distribution of cirrus and its optical depth might be available from the space-borne lidar CALIPSO.

Lines 10-11: the last sentence is too general; shorten and merge it with the preceding

Last paragraph: This is a little messy, with some results already given here. You might want to just outline the steps taken in the different parts of the manuscript.

Data and methods The dataset consists of 132 lidar profiles, but only three of them are shown and analyzed here. The number 132 is misleading. Did the authors actually calculate the radiative effects of all 132 cases? If yes, they should give a statement about the statistics and how representative the chosen three examples are. If no, mentioning 132 cases gives a false impression of a good statistic that actually contains only three samples.

It is good that the authors mention that their dataset is biased. Cases from certain conditions were chosen. It would be highly interesting to know how often those conditions occur in Camagüey. 36 days in five years is not very often. Is that how rarely such cirrus clouds can be observed in Camagüey, or are there other reasons, such as technical reasons, that led to this sparsity of measurement nights?

Page 8781, lines 18-19: Shift wording to "The "adding" technique is used to obtain

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vertical profiles of flux densities and heating rates.'

Lines 19-21: I do not understand the last sentence. What is compared to what? What do you mean by accuracy?

"surface albedo average value of 0.22": Is this a spectrally constant value? Valid for which spectral range? The value is pretty high; I'd suppose the site is on barren ground or concrete, this would be good to specify.

3 Results and discussion

UTC and local time are mixed in this chapter; at least state the difference between both.

Page 8783, line 11: "dominant": Absorption is certainly not dominant in a cirrus, especially in broadband considerations, but it's enough here to cause heating.

Line 16: "Two maximum values...": The numbers are negative, so the extrema are minima, not maxima.

Line 18: "local time", not "local hour"

Whenever you give the times of the strongest forcing, you should also give the corresponding solar zenith angle. The extrema are symmetric around noon, so the SZA should be the same in the morning case and the afternoon case.

Page 8784, line 5: I do not understand this sentence; rephrase it to make the grammatical references clear.

Line 12: "water vapor": how much?

Line 15-16: divide part 1 of this sentence (line 15) from the second part (line 16) by a dash or colon; or re-phrase it

Line 18-19: 0800 and 1700 local time: which SZA?

Page 8785, line 20: "The maximum values"

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Line 24: "A possible explanation": the word "possible" is inappropriate here, as it implies guessing, whereas the authors to provide calculation results in the next paragraphs

Page 8786, second paragraph: In determining the threshold, the model was used with which parameters? Which cloud structure, cirrus altitude, date, minimum SZA, atmospheric structure?

Last paragraph: Did Khvorostyanov and Sassen use the same fixed parameters in modeling the the diurnal cycle as the authors in this manuscript? How does that affect the comparability?

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Page 8787, line 14: "dispersion": I think you mean scattering rather than dispersion (which means something like wavelength dependence of the speed)

"at the surface" and "at TOA", not "in"

Line 22: "have a similar behavior"

Page 8788, line 1: "Figure 4a shows ..."

The authors explain the difference in downward irradiance with water vapor in the lower layers. This would be much easier to see in a spectral calculation (with a few nm resolution) which should clearly show the water-vapor absorption bands. Also, $F_{net}(z)$ might be better suited to indicate absorption below z .

Line 21: "linear": this is not obvious from the log plot. Maybe add a linear fit curve to the plot?

Lines 25-29: The concentration of the radiative effect in the near infrared is clear, that is where the spectral absorption bands are.

Page 8789, line 11: "ice crystal distribution represented by droplets": droplets are

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liquid, do you mean "spheres"?

Conclusions

Again, 132 cases are mentioned although only 3 are shown here.

Page 8791, line 10: "probably": If your finding is so weak that you have to say "probably", you should do and show more calculations of SCRF vs. SZA for a number of COD cases.

Figures 3-5: Replace "Infrared Band" by "Near-infrared band", and "flux" by "irradiance" or "flux density"

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