Author's response to editor:

(1) **In red: editor's comments**
(2) **In black: author's response**
(3) **In blue: author's changes in revised manuscript**. Strikethrough text is used to show removed text from the manuscript and underline text is used to show new text added to the manuscript.

We would like to thank the editor for his revision and the corresponding time dedicated to it. We also appreciate his positive decision for publication. We address his comments below in this document.

"…I agree with Referee #2's suggestion to remove the "takeaway messages" from figure captions…"

Author's response: Following the suggestion from Referee #2, the editor and ACP guidelines for figure captions, we decided to remove the "takeaway messages" from figure captions.

Author's changes: Bold "takeaway messages" removed from captions of Figures 1 to 9:

P5 of marked-up manuscript: 'Figure 1. ~~A more complex ice optical scheme leads to weaker SW and LW absorption.~~ Broadband…'
P7 of marked-up manuscript: 'Figure 2. ~~The Fu scheme predicts strong heating from ice clouds, especially at the coldest subzero temperatures.~~ 22 CRH profiles…'
P8 of marked-up manuscript: 'Figure 3. ~~Important CRH differences exist across ice optical schemes, for both the SW and LW components.~~ Heating rate…'
P9 of marked-up manuscript: 'Figure 4. ~~The variety of K_{abs} and g gradient found for q_i- and T-dependent schemes helps to explain the CHR differences.~~ Matrix visualizations…'
P10 of marked-up manuscript: 'Figure 5. ~~Ice optical schemes with higher complexity results in considerable weaker Cloud-average SW CRH.~~ SW (a), …'
P12 of marked-up manuscript: 'Figure 6. ~~CRH differences between optical schemes are "diluted" as we increase cloud depth.~~ Heating rate matrix…'
P13 of marked-up manuscript: 'Figure 7. ~~CRH differences for geometrically thin ice clouds are more pronounced at high altitudes than low ones.~~ Heating rate matrix…'
P15 of marked-up manuscript: 'Figure 8. ~~CRH interscheme differences increase and show complex vertical structures at higher IWPs.~~ Heatin rate matrix…'
P17 of marked-up manuscript: 'Figure 9. ~~CRH interscheme differences are largest for cold clouds with ice crystal size ranging from 25 to 40 μm.~~ Heating rate matrix…'

"l 30: 'CRH rather than CRE' you might consider replacing 'rather than' by 'besides'"

Author's response: We replaced 'rather than' by 'besides'.

Author's changes:
P2-L30 of marked-up manuscript: 'There are a number of motivations to study CRH ~~rather than~~ besides CRE.'

"Table 1: Consider removing the star for Baran14* (there is no direct reference to that star in the caption)"

Author's response: We removed the star from Baran14* in Table 1.

Author's changes:
P6- Table 1 of marked-up manuscript: 'Baran14~~*~~'.

"You may also consider rephrasing the entries of the 3rd column in: - no roughness, Both SW and LW and SW only"

Author's response: We rephrased the entries of the 3rd column in Table 1, following editor suggestions.

Author's changes: P6- Column 3 in Table 1 of marked-up manuscript:

Surface Roughness
~~✗~~ No roughness
~~✓ (Only in SW)~~ SW only
~~✓~~ Both SW and LW
~~✓ (Only in SW)~~ SW only

"Table 2, caption: 'middle cloud temperature' -> 'mid-cloud temperature' ?"

Author's response: Thanks for noticing this. We replaced 'middle cloud temperature' to 'mid-cloud temperature' not only in Table 2 caption but also in Figure 4 caption.

Author's changes:
P6-Table 2 caption of marked-up manuscript: 'The temperature values shown in the second column correspond to ~~middle cloud~~ mid-cloud temperature…'
P9-Figure 4 caption of marked-up manuscript: '…each for ~~middle cloud~~ mid-cloud temperatures from 201 K to 236 K (Test 1)…'

"Lin 185: 'Fig. 5' should be spelt out 'Figure 5' as it is the subject of the sentence"

Author's response: Thanks for reminding us of this guideline. We changed 'Fig. 5' to 'Figure 5'.

Author's changes:
P11-L181 of marked-up manuscript: '~~Fig. 5~~ Figure 5 shows the cloud-average radiative heating rate…'

"The quantity computed using Eq. 3 is not an average, but a mass integral of the CRH, and is not consistent with the units of K day-1 shown in Fig. 5. Shouldn't it be normalized by the mass of air (or of ice)"

Author's response: Thanks for noticing this important mistake. We have updated Eq. 3 in the manuscript, using now Eq. AR1 (see below), to correctly evaluate the CRH averaged over cloud layers only. We had used this equation to calculate SW CRH (Figure 5a, Figure S9a, and Figure S12a). However, we mistakenly used the incorrect Eq. 3 to evaluate both LW and

net CRH (Figure 5b and c, Figure S9b and c, Figure S12 b and c). We have updated those LW and net CRH figure panels with the correct equation:

$$\overline{CRH} = \frac{\int_z CRH\ q_i \rho_a dz}{\int_z q_i \rho_a dz} \quad \text{(AR1)}$$

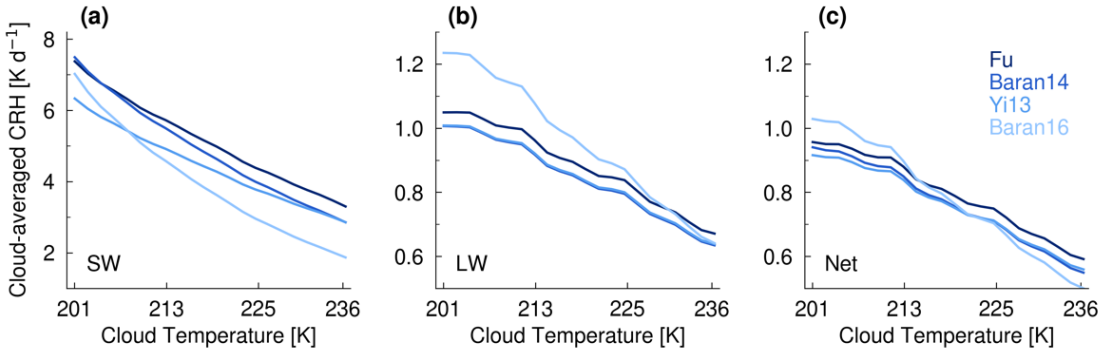
Other minor editions were applied to each figure 5, S9 and S12, as limits in the y-axis, position of panel labels and distribution of text legend. Calculations were performed in python. If the editor deems it necessary, the jupyter notebook corresponding to this calculation can be seen in the updated public repository https://github.com/EdgardoSepulveda/ice-crh-1column (Cell 7 under "Calculation of cloud-averaged CRH:" in files "3-figures_test1_v7b.ipynb", "3-figures_test2a_v7b.ipynb" and "3-figures_test2b_v7a.ipynb")

Additionally, paragraph starting from L187 has been updated. While absolute magnitudes of $\overline{CRH}$ changed in the LW and net radiative component, the trends, differences between schemes, and main takeaway from the figure are the same.

Author's changes:

Figure 5 change:

OLD Figure 5



NEW Figure 5

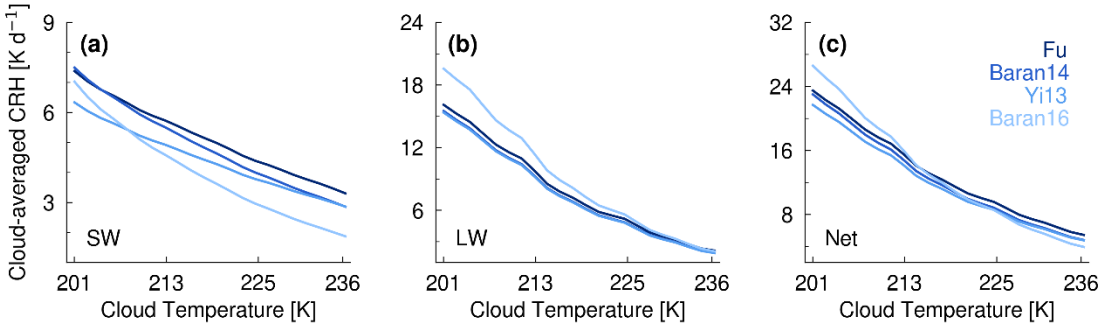
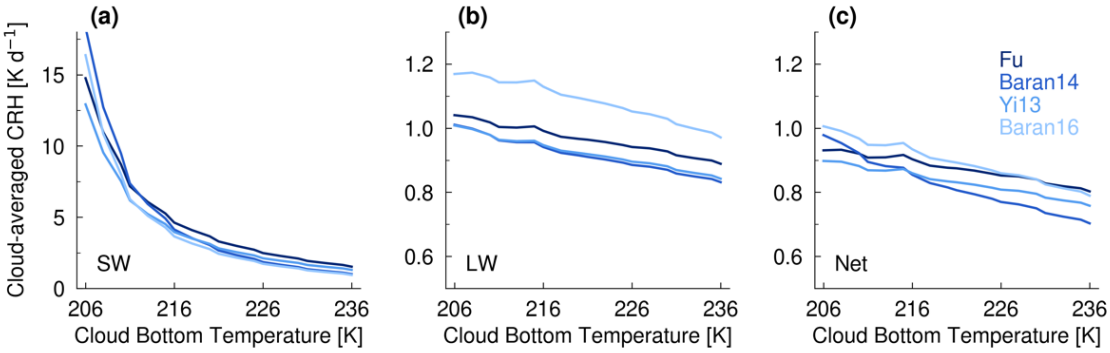


Figure S9 change:

OLD Figure S9



NEW Figure S9

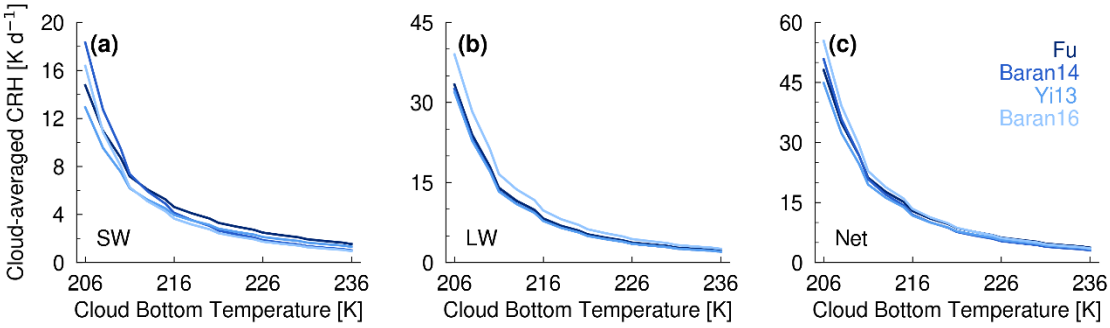
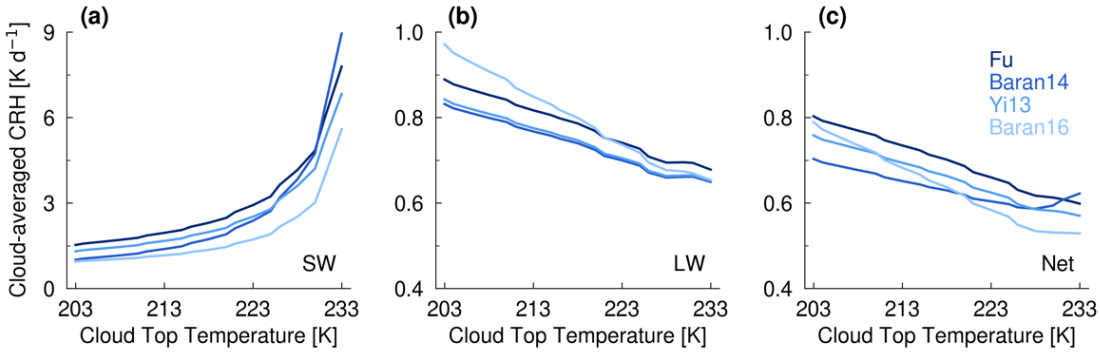
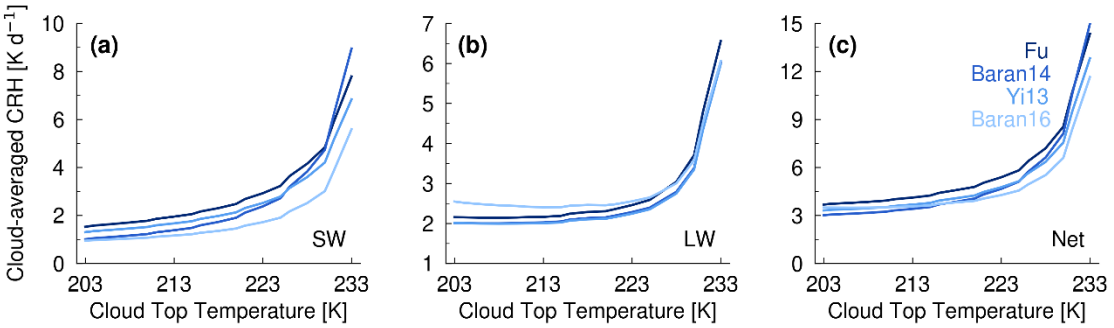


Figure S12 change:

OLD Figure S12



NEW Figure S12



Equation 3:

$$\overline{CRH} = \int_z CRH\ q_i \rho_a dz \qquad \overline{CRH} = \frac{\int_z CRH\ q_i \rho_a dz}{\int_z q_i \rho_a dz}$$

P11-L183, 184 of marked-up manuscript: ~~$\overline{CRH}^{SW}$~~ SW $\overline{CRH}$
P11-L184 of marked-up manuscript: '...showing the limitations ~~of~~ when analyzing a not vertically-resolved CRH'
P11- L184 of marked-up manuscript: weaker ~~clod-top~~ cloud-top heating
P11- L185 of marked-up manuscript: ~~$\overline{\Delta CRH}^{SW}$~~ SW $\Delta\overline{CRH}$
P11-L186 of marked-up manuscript: ~~$\overline{CRH}^{LW}$~~ LW $\overline{CRH}$
P11-L187 of marked-up manuscript: '...uniform weakening of 5% in LW $\overline{CRH}$ ~~through~~ throughout all temperatures ranges'
P11-L187 of marked-up manuscript: '~~The~~ However, it is not possible to detect the inversion in Baran16...'
P11-L188 of marked-up manuscript: '...in the previous paragraph ~~can be found again, where~~, ~~-~~with Baran16 LW-$\overline{CRH}$ ~~in all three components changes from negative values to a *CRH* enhancement relative to Fu, at colder levels~~, always being higher than the other schemes. In contrast, Baran16 Net $\overline{CRH}$ changes from lower to higher values than the other schemes, mainly due to the contribution of the SW component. While some features of the CRH...

"l210: 'at cloud top layers' -> 'at cloud top' ?"

Author's response: Thanks for this suggestion. We corrected this sentence to avoid confusion, and also to follow referee#1 comment ("again, useful to specify that the 'stronger absorption than in Fu' is only at the very low end of cloud thicknesses")

Author's changes:
P11-L209 of marked-up manuscript: 'the temperature-dependent K_{abs}^{SW} causes stronger absorption than in Fu, ~~at cloud top layers~~ at the top of thin clouds.'

Additional changes:

In addition to the editor's comments, we included the next minor changes:

P1-L18 of marked-up manuscript: '...determines ~~the~~ temperature~~ and~~, pressure gradients...'
P2-L25 of marked-up manuscript: '...satellite ~~or~~ and ground-based ~~remote sensing~~ measurements...'
P3-L66 of marked-up manuscript: 'calculations' included in '...radiative transfer calculations and a variety...'
P3-L72 to L74, P10-L165 of marked-up manuscript: 'Section' to 'Sect.', following https://www.atmospheric-chemistry-and-physics.net/submission.html#manuscriptcomposition guidelines.
P3-L80 of marked-up manuscript: 'RRTM~~-G~~', as RRTM is the general radiative transfer model on which RRTM-G is based.
P4-L98 of marked-up manuscript: 'the effective radius tested in most of our simulations' and ', as described in Sect 2.2' included in '...Fu for ~~our effective radius in this test~~ the effective radius tested in most of our simulations (30 μm, as describes in Sect. 2.2)...'
P4-L120 of marked-up manuscript: 'tropical' included in '... corresponding tropical temperatures'
P5-Figure 1 and Figure 1 caption, Table 1 and Table 1 caption, P19 L354, L356 and L368 of marked-up manuscript: 'r_e' replaced by 'r_{eff}' to be consistent in all manuscript.
P5-L127 of marked-up manuscript: 'direct' included in '...have no direct dependence on ice crystal...'
P5-L130 of marked-up manuscript: '...by fixing the IWP ~~to 30 g m^{-2}~~ and calculating...'
P5-L131 of marked-up manuscript: 'A fix IWP of 30 g m^{-2} is used in Tests 1, 2 and 4. The IWP depends on qi...'
P6-Table2 caption of marked-up manuscript: 'temperature' included in '...cloud bottom and cloud top temperature ranges...'
P8-Figure 3 caption of marked-up manuscript: 'from least to more ~~complicated~~ complex'.
P8-Figure 3 caption of marked-up manuscript: new sentence included: 'As in Fig. 2, yellow lines in the color bar indicate the corresponding ΔCRH range for each panel'.
P10-L180 of marked-up manuscript: '...has a stronger effect ~~on the optical properties~~ than a non-temperature...'
P17-L309 of marked-up manuscript: '...simpler ensemble, of ice crystals habits~~, together with surface roughness~~ including surface roughness in the SW calculations, and Yi13 a more elaborate one, including hollowness and surface roughness properties in both SW and LW parameterizations.'
P18-L354 of marked-up manuscript: '~~Although the~~ The idealized single-column tests...'
P18-L355 of marked-up manuscript: 'However, the perturbation...'
P18-L357 of marked-up manuscript: '...the sensitivity tests ~~showed~~ shown here offer...'
P18-L361 of marked-up manuscript: '...as it ~~increases~~ changes the chances of radiation...'
P19-L363 of marked-up manuscript: '...and therefore~~,~~ on the interscheme...'
P19-L369 of marked-up manuscript: Updated github link from private repository to public repository: ~~https://github.com/EdgardoSepulveda/ice-optics-crh-sensitivity/tree/main/1D_ecrad_analysis~~ https://github.com/EdgardoSepulveda/ice-crh-1column.