Before delving into the specific comments of the referee, we want to thank him for taking the time to read our work.

R1
This paper uses extensive analysis of changes in the radiation balance over the Arctic to consider the causes and effects of different trends.

A1
We consider that the referee has summarised some key elements of what is reported in this paper. More precisely, we focused initially on creating a long term record of the reflectance at the top of the atmosphere in the solar spectral regions. We then analysed the trends at pan-Arctic and regional scale. In spite of the melting of ice, we find in spring (April, May and June) and in summer (July, August and September) trends across the Arctic, which are smaller than that we expect for the reduction of the surface albedo averaged over the Arctic. This led us to investigate the origin of this behaviour. We investigated the behaviour of available cloud data products in the Arctic and their trends. Our explanation is that the loss of surface albedo and reflectance at the top of the atmosphere is compensated by an increase in cloud reflectance. We then went on to investigate the possible reason for this increasing cloud reflectance and we attribute it to a reduction in cloud ice optical thickness and an increase in cloud water optical thickness.

R2
It is a highly timely and very important study that should be published. It shows how satellite can be used to effectively address a question that has been very much deliberated in the scientific press; Do changes in clouds, either macrophysical or microphysical, due to climate change affect the radiation balance over the Arctic, especially when considering the accelerated ice melt and snow drawback and suggested changes in cloud microphysics and the potential importance in aerosols. It is very welcome and I do encourage the authors to revise and resubmit this paper.

A2
We thank the referee for his effort in reading our paper. We are disappointed in his overall assessment. We shall answer the issues the referee has raised. In the referee’s review, no scientific topic-related objections were raised, i.e. about the magnitude or sign of the trends retrieved, the patterns and spectral behaviour of the reflectances, the cloud properties, and
cloud radiative forcing. Similarly, the adopted technical solutions and approach to data harmonization, the assessment of statistical significance or error propagation have not been discussed. The section "Discussion and conclusions" was not read. The major criticism is that we have not written the paper in what the referee considers to be an understandable narrative. This was obviously not our intention. With few specific criticisms, it is more difficult for us to understand what should be revised.

R3
However, it is abundantly clear that the study is not finished yet; in fact, it is so poorly put together and presented that this is the reason I feel I have to recommend that the paper is rejected at this stage. Paired with poor writing this just simply goes beyond the scope of a major revision.

A3
We regret that the referee does not consider the manuscript worthy of publication. However, we would like to point out that prior to submission to ACP, the manuscript and its results have been confidentially brought to the attention of several (native English speaking) colleagues. They are active in Arctic research, both modeling and observation-based, algorithm development, and data generation. The encouraging feedback we received and the improvements that resulted from the discussions convinced us that our work was ripe for a, hopefully thorough, scientific scrutiny.

R4
The introduction has no real thread and just repeats various statements as if they were of the same significance and the text doesn't lead up to the motivation and background for this study.

A4
Whilst we accept the need for improvement of our paper and its introduction (also pointed out by the second referee), we consider that the introduction follows a clear logic and the corresponding narrative is briefly presented schematically below:

lines 11–17 Arctic climate change and Arctic Amplification are briefly introduced within the context of global climate change.

lines 18–26 The role of clouds is introduced and our work is justified as complementary to in situ measurement endeavours.

lines 27–34 A brief description of the Arctic environment is given. The spectral reflectance measurements at the top of the atmosphere are introduced.

lines 35–76 We introduce the first cloud property, relevant to Arctic climate change: cloud fractional cover (CFC). We review the main literature and extract the scientific findings that describe its influence on Arctic climate. We note that the role of CFC in Arctic warming is controversially debated.

lines 77–85 We discuss the optical and micro-physical properties of clouds (thickness, liquid water path and effective radius), which are important factors in modulating the SW and LW radiation budget across the Arctic.
We propose the investigation of spectral reflectance and cloud product trends to resolve disagreements found in the literature.

The structure and the aim of the paper are outlined.

We insert a new paragraph before lines 96–100 in which we explain that the use of spectral reflectance supports the assessment of the relative roles of CFC and optical and micro-physical cloud properties in modulating the radiation balance.

The text quotes huge amounts of numbers but doesn’t lead the reader to the important ones and it is much too long for the message (65 figure panels in the manuscript alone and another 44 in the appendices). The authors are piling definitions and numbers upon numbers and completely forget the narrative;

While only three numbers are given in the introduction (at lines 35 - 40), we report the climatological values of cloud fractional cover in the literature. In the rest of the paper numbers are provided because evidence-based research rests upon quantitative assessments. Regarding the number of panels and figures, we note that our analysis must be regional and seasonal, given the pronounced variability in the Arctic environment.

The paper is basically unreadable and I wouldn’t have read it if had not had the task of reviewing it - in fact, I gave up when I got to the discussion and conclusion section - which is almost a third of the paper. I’m just saying!

Whist we value the frankness of the reviewer and accept that improvements of the manuscript are needed, we do not share his view. We would have valued more specific criticisms. We consider it a pity that the referee did not read the complete manuscript as part of his scientific scrutiny. The "Discussion and Conclusions" section takes up a third of the text because the topic of Arctic climate change is complex, the body of literature is extensive and our approach is comprehensive in analysing the data.

For the sake of readability, we split the section "Discussion and conclusions". We will then discuss the results in the first part and list our conclusions in the latter.

A few examples: The statement that the sea ice will be gone by 2035 (line 11) is not representative of current understanding; yes, at the current rate it will eventually be gone but the recent IPCC report concludes that some ice will remain if we can keep the global warming below 2 degrees.

The IPCC report AR6 - Working Group I - Chapter 9 verbatim reports:
"The Arctic Ocean will likely become practically sea ice free during the seasonal sea ice minimum for the first time before 2050 in all considered SSP scenarios. There is no tipping point for this loss of Arctic summer sea ice (high confidence)."

Consequently we consider the cited work by Guarino et al. (2020), in which it is stated that the sea ice will have effectively vanished by 2035, a better representation of our current understanding.

This is not only because that paper is one of the most recent studies focusing on this topic, but also and foremost because in all CMIP6 scenarios, for almost all models, the Arctic is projected to be sea ice free well before 2050 (Notz D. & SIMIP Community, 2020).

Notz D. & SIMIP Community (2020) is the main reference in the IPCC report.

One of the co-authors of our work (Narges Khosravi) has co-authored that paper. We quote its conclusions:

"However, the clear majority of all models, and of those models that best capture the observed evolution, project that the Arctic will become practically sea ice free in September before the year 2050 ..."

Figure 3-c of the aforementioned paper shows that even for a scenario with temperatures below the 2 degrees (light blue dots, first column from the left), the majority of the model outputs predict the vanishing of Arctic sea ice by years 2035–2038.

The Arctic, with a remaining sea ice surface area < 1 million km², is termed "sea ice free" in the cited references and it is not our wording.


The Notz D. & SIMIP Community (2020) reference will be added to the introduction with an appropriate sentence.

R8
The Arctic warming (line 12) is, however, probably larger than twice the global average. Arrhenius (line 14) may be of historical importance but his method was likely incorrect and he was “lucky”

A8
Regarding the Arctic warming larger than twice the global average, we report here Fig. 1 in Ballinger et al. (2021). The reference belongs to the regularly updated Arctic Report Card series within the Arctic
Program managed by NOAA. We consider this source reliable.

From Figure 1 it can be seen that the ratio between the global average and the Arctic average of Surface Air Temperature (SAT) is approximately 2 (please, note how the Arctic region is defined north of the 60th parallel. See later comment by the referee.)

![Figure 1: Mean annual SAT anomalies (in °C) for weather stations located on Arctic lands, 60–90° N (red line), and globally (blue line) for the 1900–2021 period (n=122 years). Each temperature time series is shown with respect to their 1981–2010 mean. Source: CRUTEM5 SAT data are obtained from the Climate Research Unit (University of East Anglia) and Met Office.](image)

In addition, CMIP6 model mean shows that the median of multiplicative factor of Arctic warming with respect to the global average is roughly 2.2, excluding the 5th and 95th percentiles. See Fig. 2 from Södergren and McDonald (2022).


With regard to the luck of Arrhenius, we invite the referee to read the paper by Rohde et al. (1997). They highlight the merit and legacy of his work. Arrhenius not only thought of a realistic Sun-atmosphere-Earth model, but also considered the two “selective absorbers” known at the time: water vapor and carbonic acid. The latter be used by Arrhenius synonymously for carbon dioxide.

The pioneering role of Arrhenius is also acknowledged in two aspects. First, he was able to bridge conceptually his paleo-glaciology studies with future scenarios of man-made greenhouse gas emissions. This was remarkable and well ahead of his time (i.e. Keeling initiated carbon dioxide monitoring only in 1957), given the lack of reliable atmospheric measurements of greenhouse gases.

Second, he advocated atmospheric chemistry as a fundamental pillar of Earth Sciences. Arrhenius approach paved the way for an interdisciplinary Earth Science, which is one of the cornerstone of the IPCC reports, as Rohde et al. clearly explain.
Fig. 2: Polar amplification factor from CMIP6 models (from Södergren and McDonald, 2022).


R9
While the concern of scientists and public about the fate of the Arctic (lines 15-17) is much more recent than the 1990’s. This was when the first IPCC report was published and if you download that and have a look, you will find that to the extent the Arctic is mentioned it is mostly either in the context of how little we know or how badly the models deal with the Arctic.

A9
The subject of the sentence is not the fate of the Arctic but the release of anthropogenic gases and its impact on surface temperatures. We quote again lines 15-17:
“The impact of the anthropogenic release of greenhouse gases on the surface temperature has become an increasingly important topic of scientific interest, public debate and concern and international environmental policy, since at least 1990.”

As a side note, one of the oldest headlines in the mainstream press raising the issue of a melting Arctic dates December 3, 1922. It appeared in the American Weekly magazine of the Washington Times. We invite the referee to read the column “Strange Things Happening in the Frozen Arctic”. It can be found at the end of this document, labeled Fig. III.


R10
All these superlatives seem to be used to underscore the importance of the study, but on me they act as a turn-off; if you need to exaggerate this way, the result cannot be very important. But it is and the framing of important facts is also important!

A10
Neither in the introduction nor in the discussion of our results, which has not been read (see R6), did we intend to exaggerate. It would have been more helpful for us if the referee would have given practical examples of where we exaggerated.

We regret the “turn-off” of the referee. Our aim was to provide a compelling message by logical reasoning based on evidence.

R11
Moving on, the reason that the clouds are considered a major reason for much of uncertainty in climate projections (line 18) is not that they affect the radiation (line 19-20); of course they are! It because models describe clouds so poorly, because it is so very difficult to model.

A11
We update the sentence accordingly as follows: “This is in large part because the modulation of Arctic radiation by clouds in the shortwave (SW) and longwave (LW) is not well reproduced with state-of-the-art models due to the difficulty of modelling the cloud fields.”

R12
Satellite observations are an important part of this but the work cited on line 24 does not “rely on” (line 25) on satellite observations.

A12
Our use of the English language seems appropriate (e.g. https://www.merriam-webster.com/dictionary/relyon/upon) and we consider that in situ measurement campaigns, like those described in Wendisch et al. (2019) and Shupe et al. (2021), rely on satellite observations to tackle the understanding of Arctic climate change. For the sake of clarity, we replace “rely on” by “are supported by”.

7
R13
It is well known that different retrievals based on AVHRR are very different (line 42-44); yet it is used again here without illustrating why we should now all of a sudden believe in this retrieval.

A13
In addition to this response, please see also A15, A19, A47 in the answer to the second referee.

The retrieval of cloud data products is comprehensively introduced citing the relevant literature. Section 2.2 of the paper describes the AVHRR data set used in this work. In that section we summarize the key points of the data set and how it has been improved. We correctly cite the references needed to understand and judge the generation, the validation and the quality assessment of the AVHRR cloud data set. We provide actual assessments of the biases of the broadband fluxes with respect to independent sources. We discuss our technical approach for its usage in Appendix B and C.

To facilitate the work of the referee, we list below the key points:

1. This AVHRR dataset is in its 3rd reprocessing and the algorithm used to generate it has 15 years of development starting with ATSR-2 onboard ERS-2.

2. Improvements and validation have been documented throughout the publications cited by us and are traceable.
   https://climate.esa.int/en/projects/cloud/key-documents/

3. Specifically, the Annex A of the following document lists the independent sensors the dataset used for validation.

4. AVHRR spectral channels have been spectrally and radiometrically calibrated by comparison with SCIAMACHY observations. SCIAMACHY is well known for its calibration. The first author personally helped DWD in this activity (see https://essd.copernicus.org/articles/12/41/2020/#section11).

This calibration improves the value of our study, because the part of the study dealing with TOA reflectance uses radiometrically consistent with those retrieved from SCIAMACHY. Thus, the trends in reflectance can be readily related to those in cloud properties derived from AVHRR.

5. The algorithm deriving cloud properties uses optimal estimation: full uncertainties are provided. They are accounted for calculating the correlation length of cloud properties as function of the subsampling of the cloud fields. See Section 2.4.1, Eqs. 1–5, in https://essd.copernicus.org/articles/9/881/2017/essd-9-881-2017.pdf

6. AVHRR cloud mask utilises an ANN (Artificial Neural Network) - trained on CALIOP surface mask, which is the gold standard in Arctic atmospheric research.
7. In-cloud profiles are corrected with CALIOP profiles to account for photon penetration depth, so that the retrieved cloud altitude is not the radiative height of a cloud, but the scattering height. The latter is closer to the physical top of the cloud.

8. AVHRR fluxes are computed using the cloud properties of the algorithm itself and are not from other sources. This eliminates co-registration issues and it enables direct relationships between cloud properties and fluxes to be determined.

9. The AVHRR record is constructed from different sensors with different overpass times and different calibration issues. This is accounted for in the trend model, in which we instruct the objective function to infer anomalies for each sensor at a time (see Appendix C of our paper).


We consider that bullet 4 about cross-calibration between AVHRR and SCIAMACHY channels is of importance to measure and we plan add this to Section 2.2 accordingly, together with relevant information from the response to the second referee.

R14
The ice-mass loss for Greenland is attributed to a reduction in cloud fraction in summer (line 53-54) without a proper reference; I tend to believe that global warming has some influence as well.

A14
The logical reasoning is to be followed in its entirety until the end of the paragraph. The reference exists and reads Hofer et al. (2017) at line 55.
We will clarify this issue by stating that a decrease in cloudiness is not an independent process per se, but is also affected by large-scale synoptic meteorological processes.


R15
Ocean areas are quoted frequently without accounting if they are ice covered or not (first on line 59) which is a very important distinction; not all of the Arctic Ocean is always ice covered which is an important part of this study. Moreover, the Arctic seems to be defined as being everything between 60 and 85 degrees north. Not only does that miss a fair portion of the central Arctic; it also includes most of the Northern North Atlantic including Iceland and the Faroe Islands, large parts of which is never affected by sea ice, half of Sweden and Norway and almost all of Finland; much of this would not be considered Arctic at all.

A15
Please, see also A25 in the response to the second referee.
In Section 2.1 we discuss the reason for the latitudinal threshold at 85N. Figure 2-c clearly demonstrates that the three sensors used for reflectance have different terminators. The 85N parallel is the northernmost meaningful threshold for common sampling. We have already reported the time series of Arctic temperatures in Fig.1 in this document, which are averaged in the latitudinal belt 60–90N. We consider the source of Fig.1 reliable. In literature the south parallel defining the Arctic can be also placed at 65N. However, this latitude would still include parts of the land masses adjoining the more central Arctic zones. Nevertheless, they are of interest because the central Arctic exchanges energy, momentum, and fluxes with adjacent low-latitude regions. Well aware of this geographic conformation, we opted also for a regional analysis, subsetting the Arctic into twelve climatic zones to highlight shared, or distinct, patterns of behavior.

R16
While it is true that Pithan et al. (2014) identifies the vertical structure of the atmosphere (the lapse-rate effect) as the primary factor for Arctic amplification the difference to the next important process - the albedo feedback - is not large and the whole argument rests on models; not observations. By the way, saying that “temperature-related processes dominate the Arctic warming” is just plain thoughtless; what else is warming but a change in temperature?

A16
We agree that the sentence seems obscure. We have not written “temperature dominates the Arctic warming” but we have written “Temperature-related processes dominate the Arctic warming”. Please see A8 in the response to the second referee.

R17
On Line 96 we are told there are three reasons for this paper only to be given four reasons.

A17
We will replace “three” with “four”.

R18
The whole introduction is just confusing, sometimes borderline wrong, and doesn’t lead the reader to the conclusion that this study is important at all.

A18
We consider that we have demonstrated that the introduction is well structured (see A4), that it cites the full body of literature relevant to the purpose of our study, that it is scientifically accurate and precise in extracting and presenting the correct information.

Following the suggestions of both referees, we plan therefore to make a major revision of the introduction.

R19
On Line 131 is an unexplained “common north parallel” and on the following line there is an unexplained “darkening of the Arctic”. On line 142-143 there is a transition in June while the figures show a transition through the entire spring. This is followed by “transitions increasingly approaching the summer
solstice” which I don’t understand and an argument that the day with the largest solar radiation needs to be the seasonal demarcation; why then is spring followed by summer and not autumn? I can buy the seasonal division based on what I see in the figures; that makes sense to me. So please don’t add unjustified arguments that only muddies the water.

**A19**
The “common north parallel” is clearly explained as the northernmost latitude that is sensed by all three sensors GOME, SCIAMACHY and GOME-2. Their swath widths differ, so does their latitudinal sampling. Figure 2-c demonstrates this effect (see lines 129–138).

The “darkening of the Arctic” is also clearly explained at lines 129–138, by looking at the colors of the annual cycle of spectral reflectance for all three panels of Figure 2: brighter colors (1996) have greater values than the darker ones (2018), meaning a brighter Arctic at the beginning of the time series and a darker Arctic at the end of the time series. The yearly cycle of spectral reflectances shows a darkening of the Arctic as function of time, but only between April and September.

To explain the transitions of reflectances between months and the demarcation of the seasons we need a more articulated reasoning. This refers to lines 139–145 of the manuscript.

We recall that the definition of seasons is arbitrary and is determined by the breakpoints of the variable under consideration. In general, seasons can be astronomical, meteorological or climatological. Provided that our study deals with 20 years of data, meteorological seasons are not useful and we will not discuss them hereinafter. The astronomical seasons for the Northern Hemisphere are April May June (AMJ) for spring and June August September (JAS) for summer. See Figure 1 in Cannon (2005). Climatological seasons are defined ad-hoc. One example is the Indian monsoon season. It stretches beyond the traditional breakpoints. There was the need to redefine the monsoon seasons looking at a more meaningful variable (i.e. vertically integrated moisture transport) than rainfall rates. See Fasullo & Webster (2003).

A more subtle but fundamental motivation of ad-hoc season definition is to calculate trends that are attributable to specific and different processes, which in turn determine the breakpoints in the time series of the variable under study (in our case, the spectral reflectance).

Also said: a trend by a certain process 1 in AMJ should not be mixed with a trend by process 2 in JAS. The question is if we have a clear breakpoint in the time series.

Figure 2 of our manuscript shows the annual cycle of measured TOA reflectance. It is evident from the measurements that the Arctic reflectance has a breakpoint between June and July. From April to June the reflectivity of the Arctic is dynamically decreasing (high-to-low). From July to September is flat.

Do the measurements point to different processes causing the steep decrease of pan-Arctic reflectivity in AMJ and flat reflectivity in JAS? Yes, they do. Recent studies show that Arctic albedo flattens by April and May due to snow cover changes and by June due to sea ice changes (Smith et al., 2020) and the timing of this breakpoint over Arctic waters is increasingly approaching summer solstice (Letterly et al. 2018).
Therefore, we do not define Arctic spring as the customary MAM (March April May) but as AMJ
instead. Likewise, we do not define Arctic summer as the customary JJA (June July August) but as JAS instead.


We will update the section adding a paragraph with more background about the seasonal demarcation and the implication of adopting a different temporal subsetting.

R20
Line 152; what do you mean by “individual downstream methodology”; downstream of what?

A20
Any geophysical algorithm, and related data set, is a “downstream methodology”. The measured spectra, and related calibration activity, are the “upstream technology”.

In the broad, and common, context of technological supply chains, upstream means the provision of a technology, while downstream means the exploitation of that technology.

Specific to our satellite and algorithmic realms, the sentence of our paper “individual downstream methodology” stands for “distinct algorithms, deployed by distinct research groups, using the same L1 data set (the provisioned technology) to create distinct L2 data (the geophysical parameter generated by the algorithm: the exploited technology)”.

The context of these words is (and I quote lines 150–153 of the manuscript):

“The primary reason for choosing these records is the abundance of studies using these data in the Arctic. This has the required coherent radiometric calibration before the implementation of individual downstream methodology to assess changes across the Arctic. The cloud and flux records, version 3, are presented by Stengel et al. (2020).”

In other words, our choice is driven by the maturity of the AVHRR data set of measurements, its popularity, and by the advanced, most recent, retrieval algorithm exploiting it.
What is an “aggregated IWP histogram” (line 157) and how is it different from any other IWP histogram?

IWP retrievals are averaged by using the approach described in Stengel et al. (2015). IWP validation of aggregated histograms is described in Section 3.5 of Stengel et al. (2015) against the DARDAR data set. It is not a pixel-based validation, but a validation of IWP distributions, aggregated in space and time, instead. We will clarify this issue.


The sentence “Broadband ... instead” (line 163-164) must be missing some words.

The sentence at lines 163–164 reads: “Broadband fluxes are not derived by incorporating reanalysis data but the retrieved cloud properties instead.”

In other words: the algorithm ingests retrieved cloud properties and calculates broadband fluxes without using reanalysis data.

Observations cannot be derived from models (line 185)

We replace “observed by models” with “calculated by models”.

and I for one cannot see the trends in Figure 4 (line 188); it may be there but it is not obvious from looking at the figure

We quote line 188 of the paper that introduces Figure 4: “A small downward trend of reflectance for the three wavelengths in the solar range is seen in the anomalies of Fig. 4”. Alongside the fitted trend line, we report the function \( F(T) \) in each panel:

\[
F(T) = (\text{intercept } \pm \text{ confidence}) + (\text{slope } \pm \text{ confidence}) \times T, \text{ with } T = 10 \text{ years.}
\]

All slope values are negative and do not exceed the 95% confidence interval threshold. This is one of our scientific findings: the spectral reflectance has slightly decreased and its trend is small.

We will clarify this by describing the Figure with “A negligibly small and statistically insignificant
downward trend of . . .”.

R25
and a change in one area cannot be “compensated” (line 203) by a change in another area.

A25
Because the sentence at lines 203–204 of the paper follows a section where trends in reflectance at pan-Arctic level are discussed, it is our intention to highlight the dipole nature of reflectance trends across the Arctic. Namely, the above mentioned pan-Arctic negligible trend is a result of the compensation of increasing and decreasing trends on a regional scale. We will clarify this in the text.

R26
On line 215-216 you “infer” things from changes in clouds without reference to what it is you actually do; the paragraph just ends with this statement.

A26
Coherent with the meaning of the word, we end the paragraph concluding with the deduction of a scientific concept from the facts explained in the previous lines.

R27
The red markers in Figure 6 are not mentioned in the fig caps

A27
The red markers are mentioned in the captions. This is exactly what the following sentence in the Figure’s caption stands for: “Stippling in red indicates significant trends at 95% confidence”. The wording is not unusual in literature. See, for instance, the caption of Figure 4 and following in Rinke et al. (2019).


R28
and the different parts of Figure 7 (that could benefit from breaking into two) are sometimes referred to as “upper” and “bottom” (line 233) panels and sometimes as “left” and “right” (fig caps).

A28
Agreed. We split Figure 7 in the manuscript and adapt the placement references accordingly.

R29
Changes in CTH are given in percent; is that wise? A 100 m change is a 100 m change and corresponding to roughly the same temperature change regardless of it is at 1 or 10 km, but the percentage change is quite different.

A29
This is appropriate when the parameter under consideration is only one, in this case cloud top altitude.
We consider that it is a choice of convention and that we analyze changes of parameters of different physical meaning (reflectance, cloud properties, radiative forcing). Consequently, we consider the changes in % relative to the parameter's value at the beginning of the time series. We have consistently adopted this convention from Figure 5 till the end of the paper to give the reader the ability to compare changes in different variables with a single yardstick.

R30
On Line 245 you discuss a decrease “especially where statistically significant”; is there any point in discussing changes that are not statistically significant?

A30
Yes, certainly. Statistical significance implies that the null hypothesis is not verified. In our case, the null hypothesis is that the variation of a parameter is within natural variability. This is also a result, especially when analyzing atmospheric quantities, for which the long-range modulation of recurring meteorological patterns may not be negligible.

R31
Conversely the change in CTH is once quoted to be 6 m; is that a difference you feel comfortable with give the measurement accuracy, statistically significant or not?

A32
Yes, certainly. Although the trend was computed from anomalies and not from absolute CTH values, such variation can be confidently considered to be negligible over the considered period of measurement. This is exactly the message: the macro-physical properties of clouds (CFC and CTH) remained substantially unchanged, but not the optical properties (COT).

R33
On line 261-262 you discuss a change that is “marked” on spatial but not temporal scales, but what is a change if it is not temporal?

A33
We do not understand the referee’s objection. A change can occur within several domains, these being spatial, temporal, phase, amplitude, velocity etc. It is not only in the temporal dimension. The sentence at lines 261–262 reads:

“The rightmost polar plots of Fig. 7 show seasonal trends in cloud albedo (CA), for which a marked change of the spatial rather than temporal scale is observed.”

Looking at Figure 7 in the manuscript, we see that the cloud albedo does not change strongly between seasons, also temporally, but rather shows a spatial change.

For the sake of clarity, we propose to improve the sentence use the following text: “The right hand side of the polar plots in the lower panel of Fig. 7 show seasonal trends in cloud albedo (CA) for AMJ and JAS. The magnitude of the positive trends in JAS is larger than those of AMJ but the spatial distribution of changes of the CA values are similar in both seasons.”
The whole section on CRF is very interesting and would benefit from knowing where this is; surface or TOA? By the way, what is BOA (Line 293); not in the list of acronyms.

Table A1 at page 26 lists only the abbreviations of platforms, sensors, measurement campaigns and datasets. Geophysical and geometrical quantities or variables are described in the main text. Consistently, the acronyms TOA and BOA are defined in the main text at lines 32 and in the caption of Figure 1, when they first appear. BOA stands for "Bottom Of Atmosphere".

At the beginning of Section 3.2 on cloud radiative forcing it is clearly stated that:

"The multi-year mean and trends of SW, LW and total CRF at the surface are plotted in Fig.9 " (line 280).

In the caption of Figure 9 it is clearly stated that:

"For Arctic spring (AMJ, top) and summer (JAS, bottom), the multiyear mean Cloud Radiative Forcing (CRF) and total change $\Delta CRF$ at the surface."

The labels of the y-axis of Figure 10 clearly reads:

"Mean CRF Total at BOA".
Strange Things Happening in the Frozen Arctic

Science Puzzled by Surprising News from the Far North Which Indicates That the Polar Sea Is Warming Up and the Great Ice Cap Is Slowly Melting Away Which May Soon Reveal the Hidden Secrets of the Unknown Polar Continent

Strange things are happening in the frozen Arctic. Science is being stunned by the surprising news from the far north which indicates that the polar sea is warming up and the great ice cap is slowly melting away, which may soon reveal the hidden secrets of the unknown polar continent.

Photograph of the Frozen Arctic

Interesting Facts:
-記載 of North Pole having ice caps
-記載 of polar ice cap melting
-記載 of polar sea warming up
-記載 of hidden secrets of the unknown polar continent

From the difficulties the great Arctic adventure has been a bit of a toughness for the photographers and the explorers, but they have now completed their mission.

The present Polar Ice Cap is but a remnant of what it formerly was. Thirty thousand years ago, it is believed, it covered the entire Earth. It has been reduced to its present form by the action of the sun and the wind, and since then has been slowly melting away. The present ice cap is but a remnant of the former one, and it is believed that it will eventually disappear entirely.

The climate in the Arctic has been undergoing a great change in the past two hundred years. Formerly, the Arctic was the coldest part of the world, with temperatures dropping to below freezing. However, in recent years, the temperatures have been rising, and this has led to the melting of the ice cap.

The melting of the ice cap has led to the discovery of new land which was previously covered by glaciers. These new lands are home to a variety of flora and fauna that were previously hidden from view.

The discovery of new lands has also led to the realization that the Arctic is not as remote as it once was. The melting of the ice cap has also led to the discovery of new resources, such as oil and gas, which can be used to fuel the growing global economy.

While the melting of the ice cap is a cause for concern, it is also a cause for celebration. The discovery of new lands and resources has opened up new possibilities for exploration and development in the Arctic region.

Fig. 3: "Strange Things Happening in the Frozen Arctic". American Weekly magazine, Washington Times, December 3, 1922.