The authors would like to thank you for your constructive comments, which helped to improve the quality of the paper. Your feedback has been invaluable in refining the manuscript, and we sincerely appreciate the time you took to review it.

L23: "…low revisit time compared to rainfall dynamics." It is somehow clear what is meant here, but it should be formulated more precisely. Please rephrase.

Answer: line 21 has been changed: "While satellites can be used to monitor precipitation on a global scale, they require a low Earth orbit to achieve a resolution of a few kilometers, resulting in low revisit time (typically 3-hour average revisit time) compared to rainfall dynamics for which a few tens of minutes are required, especially in convective situations"

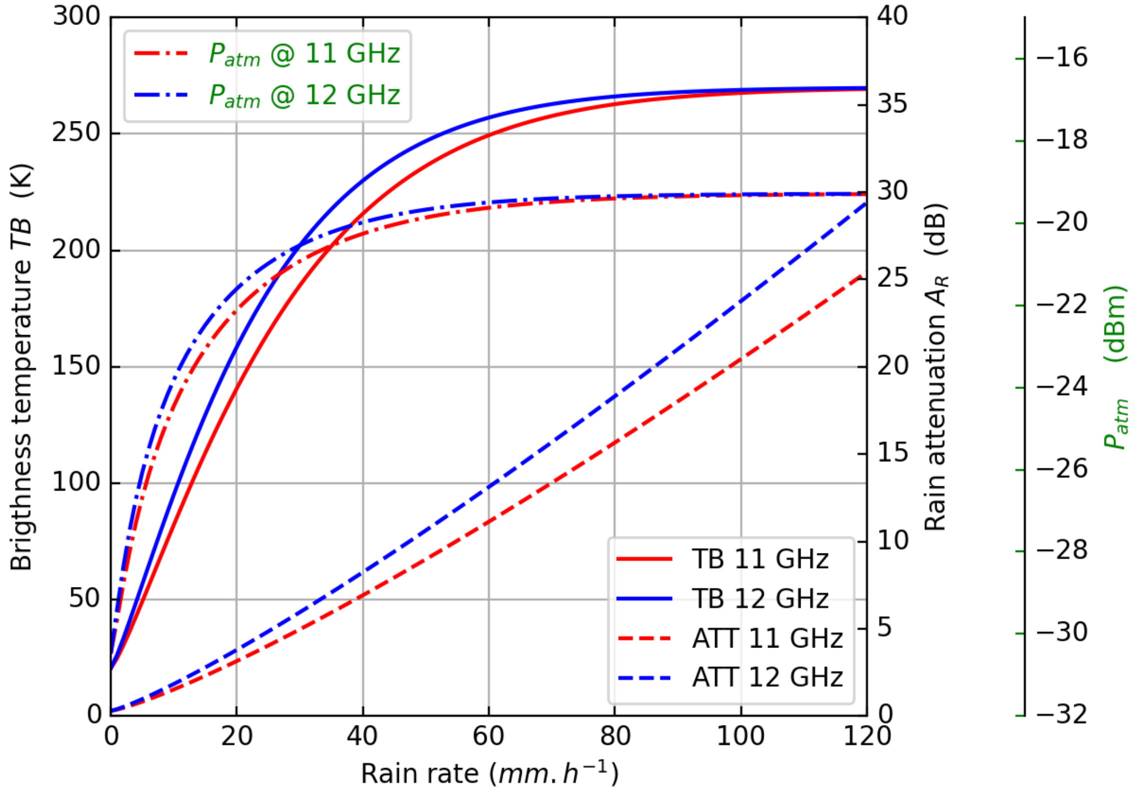
L60: General comment on Section 2. Each subsection is understandable, but I am missing condensed info on how the improved dual band method is actually applied. It is not directly clear from how the equations are linked in the text, how Delta_G impacts the rain rate estimation via the power law. Maybe there should be an additional subsection that links things together, from t_atm via A to the power law, but explaining how it is done with the Std and the Dual method. Maybe this also fits as an extension of section 2.4.

Answer: Following the first review, we have made a few changes to section 2 in order to clarify the assumptions we have made

Fig 1: What is the path length (affected by rain-induced attenuation) that is used for the calculation of the attenuation on the y-axis here?

Fig 1: Would it be possible to also show the increase in received signal strength for the increased brightness temperature for a given bandwidth, e.g. 1 GHz as used in your LNB?

Answer: The received signal strength P_{atm} is linearly related to the brightness temperature (TB), so the curve will look like that of TB but it is in log scale. We change the figure 1 and his caption:



Caption to figure 1: "Sky brightness temperature TB (solid lines), atmospheric induced power P_{atm} at the LNB output (dashed-dotted lines) and atmospheric attenuation (dashed lines) at 11 and 12 GHz for a zenith angle of 45°, with a zero isotherm at 3 km as a function of rain rate for a standard commercial TV-SAT LNB (1 GHz bandwidth, 65 dB gain)"

We have modified lines 145: "Figure 1 shows the variation of the brightness temperature at 11 and 12 GHz as well as the increase of the induced atmospheric signal at the LNB output and the corresponding atmospheric attenuations for a homogeneous rain layer at different precipitation rates for a zenith angle of 45°."

And line 149: "For precipitation rates exceeding about 40 mm/h, a saturation of P_{atm} is clearly observed while the attenuation continues to increase."

L200: There is a lot of information provided in the paragraph that starts here, but it is not clear if one of the enhanced models is used, and if not, why?

Answer: In addition to taking atmospheric noise into account using the proposed algorithm (which is the central topic), the aim of this paragraph is to highlight the main sources of error that can affect rain rate estimation. For instance, the error in the rain's path length plays an important role (Eq. 15), and we believe it's important to address this issue in a separate paragraph, even if it's not the main topic of the article.

Section 3 data sets

L245: Since the lower and upper frequency band are directly adjacent, is there power leakage from one band to the other, i.e. for the described case where one TV-satellite only transmits in one of the two bands, how much does still leak into the other band of the receiver where it somehow contaminates the radiometer-like measurement?

L296: What does „almost no signal“ mean here. How is it different from the setup in France and how does/could it affect the rain rate retrievals?

Answer: There are no differences between the two setups, with the exception of the climate in the two regions

Collective answer: The potential leakage between the lower and upper frequency bands is quite negligible. First, it's not visible on our spectrum analyzer, suggesting that any leakage is negligible. Secondly, TV channels typically occupy a 30 MHz bandwidth, which makes them highly localized, reducing the likelihood of interference between adjacent channels.

But we think there is another possibility of leakage due to our sensors. The passband filter, designed to isolate the upper or lower frequency bands, may allow a small amount of signal from the band edges to pass through. The sensor would slightly detect signals from the lower band when measuring the upper band.

Or it can be because satellites in adjacent orbital positions can transmit in both bands and provide some signal on the 'radiometric' measurement.

This is why we use the wording 'almost no signal' in the document, which means that the signal in the radiometric band is weak compared to the signal band (at least 10 dB less in the case of clear skies).

Figure 3: Is there the potential of leakage of the Astra 19 signals into the receiver of the RS sensors? Or more specifically, what is the half-power beam width, or in general the gain pattern of the antennas? And how high is the noise floor of the radiometer channel of the RS sensors in relation to the potential leakage of Astra 19 signal into the RS receiver via the RS system's antenna side lobes?

Answer: The leakage potential between Astra and E5W seems very low, as the half-beam width of the antennas used is close to 1°, whereas the angular distance between Astra and E5W is 35°. Furthermore, the sidelobes are 40 dB below the main lobe, leading to negligible leakage.

L272: Is this method with the LSTM documented somewhere in more detail? What is the temporal granularity at which the classification is done?

Answer: The method used for the baseline has not been published, as there is a large literature on the subject. As Long short-term memory by Hochreiter and Schmidhuber, 1997, quoted in the paper.

Figure 3 and Figure 4: What are the assumed melting layer heights for the plotted path lengths? That would be interesting to know. In Abidjan the elevation angle of the antennas is probably much higher because of being close to the equators, hence, I expect a much shorter path that is relevant for a typical melting layer height.

Answer: As Abidjan is almost below the equator, the elevation angles can range from 0° (eastward or westward links) to about 90° (zenithal links). The 0° isotherm is quite constant around 4.5km. In France the elevation angles are around 40°, with 0° isotherm ranging from 0 (in case of snow) to about 4.5km (in mid-summer).

We add information in the captions: Figure 3: "The satellite link path is identified with colored lines corresponding to the distance between the sensor and the 0° isotherm (here taken at 2000m) in the satellite target " and Figure 4 : "the link path is identified by colored lines corresponding to the distance between the sensor and the 0°C isotherm (here taken to be 4500m) in the satellite target".

And shorten the path link of the Ku sensor targeting SES5 because it was not representative, the angle of elevation is around more than 75°.

L310 and following: It is clear from the explanations here and from the shown plots that channel A and B have different P_atm which can be attributed to G_A and G_B. Did you also check that there isn't an offset or some other inaccuracy due to the low-cost electronics of the LNB, which is not optimised to give accurate readings of received signal level?

Answer: In figure 5, channel A receives the satellite signal, while channel B only receives atmospheric noise. At around 09:40 (left-hand figure), the antenna was de-pointed for 2 minutes so that both channels received the same atmospheric noise, to evaluate delta_G. The antenna was then returned to its initial position. The existence of an offset is discussed lines 350-355 through a possible difference between T_N^A and T_N^B.

We add to line 323: "Then, PB, in Eq. (12), becomes $\hat{P}^B = \alpha P^B$

Figure 5: Just a tiny detail, but you could use aligned y-axes here (they are slightly misaligned) and then remove the y-axis tick labels of the plot on the right. Done

Figure 5: What is the unit on the y-axis. If it is not dBm, what is the reference level for the dB given here?

Answer: Yes, the unit is dBm (same error on figure 6 and figure 7 upper).

L321: How do you want to assure that the rain-induced attenuation is strong enough to have t_R approx. 0? Please explain in the text how you identify these events.

Answer: We are aware that this procedure is rather empirical and that it is not possible to be sure that t_R is zero. However, in Abidjan there have been extremely heavy rains for which it is easy to identify a plateau showing signal saturation as explained in section 2. Even if t_R is not strictly zero, this guarantees a t_R value close to 0. The procedure is described in lines 370 to 375.

L339: Where does the difference of P_A_Tot and P_B_Tot during normal operation (not pointing away form the satellite) come from? Is this due to different transmit power of the satellite in the two bands or can this also be an effect of different gains of the electronics for band A and B?

Answer: During normal operations when targeting a satellite (such as at 9:37 in Figure 5), the discrepancy is primarily attributed to variations in the satellite's transmit power (particularly in cases like Figure 5, where the targeted satellite emits minimal signal on one band). However, an additional variation arises from delta_G and Delta_TN, as explained at the conclusion of section 4.1.1.

L350 and following: I unterstand the argumentation here on why Delta_G_p3 is used. But doesn't this, the difference of Delta_G depending on what the current brightness temperature is, mean that Delta_G varies with rain rate? If yes, does this affect your results?

Answer: Delta_G depends on the LNB's electronics, so there may be slightly different characteristics from one LNB to another. However, as far as we know, there's no reason why delta_G should depend on the rainfall rate.

L374: Why does the existence of a dry season „explain the need for sufficient data to calculate Delta_G"? Do you mean that it is harder to get enough data with heavy rain due to the dry season? Please rephrase.

Answer: line 381 has been reworded: "In addition, there is a dry season in August and September, which explains the need for sufficient data to calculate the ΔG." by "Furthermore, due to the dry season in August and September with almost no rain, it is necessary to collect data over a period of several months (3 months in this case) to calculate the ΔG"

Figure 7: What happened during the period in September 2022 where signal levels for A and B both are increased for several days?

Answer: The rise in signal levels (particularly in radiometric mode) is caused by solar radiation. At this inclination and time of year, the sun aligns directly with the sensor.

Figure 8: I would put the box plot with Delta_G_ref in the middle. But if you redo this plot, you might consider doing it with something else than boxplots since, here, the spread and distribution of the rainfall sums of the individual Ku sensors is not something we care about, at least not in this plot.

Answer: We believe it would be of interest to the reader to examine the impact of delta_G on the variability of rain rate retrievals. For example, Figure 8 shows that the interquartile range is approximately 250 mm for Delta_G - 0.9 and 400 mm for Delta_G + 0.9.

L388: This is a bit confusing. Does this mean that the values of Delta_G, as explained in L376 and 377, are used. Or did you do another analysis. Please clarify in the manuscript.

Answer: In line 396, we replace: "For the rest of the study, Delta G is estimated by a dedicated analysis for each sensor during saturation events in order to minimize the error on its estimation." by "For the rest of the study, ΔG is estimated for each sensor using calibration procedure 3 based on a selection of heavy rain events leading to signal saturation."

L391: Section 4.2 would maybe benefit from adding two or three subsections when discussing the results since there are different analyses carried out and discussed (gauges vs Ku, Ku SR - Std vs KU SR - Dual).

Answer: This section presents many results, but we have chosen not to separate them according to the instruments used. We therefore feel that rewriting it in this way would make it less clear.

L395: without correction means that L does not use the +0.360 km (to account for melting layer) and the 0.2 dB for wet antenna? Yes.

Section 2.4 does not specify what "with correction" and "without correction" precisely means, in particular for the melting layer height.

Answer: In line 460, we replace "this correction" with "these corrections" for greater clarity.

L398: Since you mention that it is important to account for both error sources, wouldn't it be good to show both corrections (melting layer and wet antenna) separately in an updated Figure 9?

Answer: In fact, we could have separated these points into two figures. We made this choice because there are already many figures and because these points are not at the heart of the document and will be studied in later research.

L402: It is not clear from the figure that the SR estimates are better than the ones from S sensors. In the plot we do not see which rain gauges corresponds to which Ku sensor. Most rain gauges are placed very close to a Ku terminal. Maybe the plot could be optimised to show e.g. each Ku sensor in a separate row of subplots each only with the rain gauges in the vicinity of its location or its path.

Answer: The main purpose of this figure is to show that corrections play an important role in some situations and that it is important to take them into account. Moreover, the dual-channel procedure is more interesting for heavy rain; it does not improve the estimation much in the presence of not very heavy rain as is the case in this figure

L406: What does HDR mean here? Probably HD Rain. But this abbreviation was not introduced.

Answer: We made a mistake in the wording, HDR station means Ku sensors: "It can be seen that the correlation between the *Ku sensors* is mainly above the trend line (84%), indicating consistency between *the sensors."*

L408: One reason why the correlation between rain gauges might drop faster with increasing distance compared to the Ku sensors is that the Ku sensors provide a path-averaged rain rate estimate which smoothens spatial extremes compared to the rain gauge measurements. This should be mentioned here in the text, because now the text sounds as if the gauges are inferior devices for rainfall measurement with the statement in the sentence before about the consistency of the HDR devices.

Answer: The sentence line 420: In contrast, the correlation for the rain gauges, which provide a direct measurement, is fairly heterogeneous, falling below 0.5 at a difference of 4 km

Is replaced by:

On the other hand, and as expected given the point measurements of the rain gauges, the correlation is fairly heterogeneous, falling below 0.5 for a distance of 4 km.

L415-L417: I do not unterstand the argumentation in these two sentences. Please rewrite.

Answer: The sentence: "Given the difference of nature between the rain gauges and the Ku-sensors, obviously, we cannot expect similar values for both instruments. We suppose that these differences are largely mitigated by working at a 30-minutes resolution. On the contrary, it is clear that at high resolution, for instance 5-minutes, we would expect smoother records for the Ku-sensors."

Is replaced by:

"Given the difference in spatial resolution between rain gauges and Ku sensors, we cannot expect similar values for both instruments. We assume that this difference in spatial resolution can be mitigated by integrating over time the precipitation rates measured by each device."

Figure 11: Is this done with data from all gauges and all Ku sensors (separated by the applied method) or done with one pair of gauge and Ku sensor?

Answer: The data includes all gauges and all Ku sensors.

L425: What is a "directing coefficient"? Please clarify in the manuscript what is calculated here.

Answer: The sentence: We compute the linear regression line and find a directing coefficient of 0.96, which is very close to the trendline (ideal curve in black dotted lines).

Is replaced by:

The slope of the linear regression is 0.96, which is very close to the trendline (ideal curve in black dotted lines)

L428: I guess you mean “S-Std” here and not “SR-Std” based on what is described here. If not, I understood things wrongly. But maybe the text could be clearer.

Answer: The sentence is correct, but some things need to be clarified: SR-Std means that an SR Ku device is used but with the std algorithm instead of the dual algorithm.

The caption of figure 11 is modified: “Quantiles (mm/h) from the 1st to the 100th percentile (colored points) of 30 min resolution records for Ku-sensors using dual algorithm (red) and std algorithm (green and light red) vs. rain gauges (after excluding days when none of the devices detect rainfall).”

L455: Why are the satellite signals received in Ivory Coast much weaker? Please explain in the text.

Answer: In Ivory Coast, from the satellites are weaker than main satellites used in Europe (Astra 19 and Hotbird) because their EIRP (Equivalent Isotropically Radiated Power) is lower

L484 (and following sentences): “…as the rain may be too light to be detected by the rain gauge”. Since the satellite link rainfall estimation also has a lower detection limit I would not agree with this argumentation. If you want to use this argument, please provide info on the lower threshold of the rain gauge data and of your rainfall estimates. A more likely cause for these false-positive rainy days could be that the rain event detection method, briefly described in section 3.2 but not explicitly validated, might produce false-positive rain events. This is a common challenge when processing attenuation data from terrestrial microwave links for which the raw data time series look very similar to the ones from satellite microwave links. Please elaborate on this and/or updated the text.

Answer: Yes, we agree with your remark. Another phenomenon leading to such cases is the heterogeneity of the rain. We have therefore replaced line 495: “This is probably due both to the heterogeneity of the rain (rain passing somewhere above the link but not at the location of the rain gauge) and to one-off errors in the rain detection algorithm leading to false positives.”

Figure 13: These plots should be larger. ok

L552: “…given their difference of nature” is not very precise. You probably mean the different spatial integration characteristics and different operating principle in general. But it should be more precise in the text. Also, why exactly do we expect that the lowest quantiles are overestimated by the Ku-sensors?

Answer: We add to line 565: ‘Ku-sensors records the mean rainfall over a few kilometers long link while rain gages do punctual measurements. This will lead to smoother records for Ku-sensors, with more rain occurrence and so larger small-quantiles and less heavy rainfall and so smaller high-quantiles'

L556: "…but also that the intensity-dependence of this underestimation seems to have been solved". Please be more precise in the text. I do not understand what is meant here.

Answer: We modify line 571 with "However, it also demonstrates that while the sensor error initially showed a strong dependence on rainfall intensity (as seen in the increasing green curve in Fig. 16), this dependency is significantly reduced after correction, with the blue curve remaining relatively stable between 1.5 and 2."

L559: You could cite Polz et al. (2023), which you already cited in the introduction, again here because they have analysed this effect in detail for terrestrial microwave links.

Answer: We did on line 577.

L581: This is the first time I read about "quasi vertically pointing" in the manuscript. This should be either explained here, or maybe better, in the section describing the setup in Abidjan.

Answer: We have added the elevation angles in sections 3.3 and 3.4

Figure A1: If I understand the caption correctly, I would name the data shown in the plot on the top "FP" for false-positive (gauge has no rain, Ku detectors rain) and the data shown in the plot at the bottom "FN" false-negative (gauge has rain, Ku detects no rain).

Answer: we have modified the figure A1 and its caption.

Technical corrections (only partly documented, mainly done for section 4 and 5, due to limited time spent on this task):

L3: "link path" instead of "path link" ✓

Equation 2: Should appear at end of sentence and not a top of the page.

L192: I have not seen the word "lineic" been used a lot in this context. You might consider writing "path attenuation". In the case of equation 13 here it is the "specific path attenuation". ✓

L413: The figure caption says that 30-minute resolution data is used. Here you write 1h. Please correct. ✓

L429: Delete the „of in „of the atmospheric… " ✓

L443: Better write „analysis“ instead of „study“ here because you only refer to the results of this section and not the results of the whole manuscript.

L448: Write „satellite with low signal strength“.

L454: There is a „was“ or „is“ missing in this sentence.

L512: Unclear what „by both of the rain gauges…“ means here. Please rephrase.

L527: I do not see „red crosses“ in Figure 14. I guess it should be „black crosses“ here.

L528: Same here. No „cyan dots“, maybe should be „blue dots“.

L545: Write „…more homogeneous rainfall distribution along the path affected by rain“ or something similar.

L547: From the text it seems Fig 15 and Fig 16 are not the ones that should be refered to here.

Fig 15: y-axis should maybe not be called „Station quantiles“ but something like „Ku-sensor quantiles“. On the x-axis write „gauge“ instead of „gage“.

Fig 16: „HDR“ on the y-axis is not used in the text except for two individual occasions. Maybe use something else here.

L573: write „rain rate“ instead of just „rain“.

L600: you maybe meant „because of the power-law“ instead of „but power-law…“