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.

PN is time independent in Eq 1 – doesn't it vary in time - with temperature for instance?

Answer: Yes, it is true so we add on line 70 : "Additionally, the sensor noise P_N varies with temperature and, therefore, with time. However, these variations are slow compared to the dynamics of the atmosphere. In this study, the sensor noise is considered constant, despite its potential slow variation with the physical temperature of the sensor. The influence of T_N is discussed in Section 4."

L88-89 : to be clarified : do you mean that the values of T_A on the one hand and T_{atm} on the other hand do not vary with meteorological conditions ? which central frequencies are assumed to be close to each other ? not clear…..

Answer: The sentence "Furthermore, $t_{atm}(t)$ and $T_A(t)$ are assumed to have identical values in various meteorological conditions regardless of the channel used provided that their central frequency is close to each other Barthes et al. (2003)" in replaced by: "Furthermore, in this study we assume that $t_{atm}(t)$ and $T_A(t)$ do note vary significantly over the frequency band used (11 and 12 GHz) and can therefore be considered independent of frequency."

L96-103 :

Eq 2 and 3 don't really show the double impact of rain – the dependence of T_A on rain has not been detailed yet …..

Answer: Line 96 we replace "Equations (2) and (3) show the impact of rain as highlighted by Giannetti and Reggiannini (2021). Rainfall has a twofold influence:" by "The following sections show how T_{atm} and T_A vary with precipitation, the latter having a twofold influence on the terms of equation 1 (see also Giannetti and Reggiannini (2021) on this subject):"

Line 118, at the end of section 2.1 (Atmospheric transmissivity t_{atm}) we explain in one sentence how rainfall influences this term : "Finally, rainfall reduces t_R, thereby increasing rain attenuation A_R and reducing the total atmospheric transmissivity t_{atm}."

Modify last paragraph of 2.2 section: "Scattering effects of rain droplets are considered in simulations (Barthes et al., 2003), where the brightness temperature is studied in relation to atmospheric attenuation for different precipitation rates, showcasing the variability of natural radiation in the atmosphere. Figure 1 shows the *increase* of brightness temperature at 11 and 12 GHz and the corresponding *increase* of atmospheric attenuations for a homogeneous rain layer at different rain rates for a zenith angle of 45°. *Rainfall thus leads to an increase of the antenna radiation temperature.*"

Eq 11 and 12 :

I do not understand when and why the dependence of t_R (and tatm) on frequency (as shown in Eq 4, 5 and 6) was dropped

The simplifications made to go from Eq 2 – which as a strong dependence on f through tatm) to Eq 11 which has lost the dependence of tr to frequency have to be explained and justified.

In my understanding Eq 11 should have a term in trA and one in trB

Answer:

Indeed, thank you for your comment. We are making a series of changes, detailed below, to justify this simplification in the text.

Correction of equation 6 by replacing:

- $t_R(t) \rightarrow t_R(f,\theta, t)$
- $t_0(t) \rightarrow t_0(f, \theta\ t)$
- $A_R(t) \rightarrow A_R(f,\theta, t)$
- $A_0(t) \rightarrow A_0(f,\theta, t)$

Modify equation 11 by adding t_R^A et t_R^B, TA_R^A et TA_R^B to the numerator

Add to line 160: "Figure 1 shows that in clear sky conditions, for the frequencies considered in the study, the frequency dependencies of t_0 and T_{A0} are negligible."

Replace line 161 : "For an ideal LNB with $G_A = G_B$ and $T_{NA} = T_{NB}$ this equation reduces to t_R:" by "For an ideal LNB with with $G_A = G_B$ and $T_{NA} = T_{NB}$ and for sufficiently close A and B channel center frequenciers $t_R^A \approx t_R^B$ this equation reduces to t_R:"

Modify the paragraph on line 180: "Equation 12 shows that it is necessary to use two channels with different characteristics. Ideally, one should receive a standard satellite **level ($P_E^A > 0$)** while the other one should be tuned to a channel where it receives mainly atmospheric radiation and no (or almost no) satellite signal **($P_E^B \ll P_E^A$)** . This approach helps mitigate any dependency on frequency differences and ensures accurate estimations. This implies as well that the **t_R defined in Eq. (12) corresponds to the t_R^A** of Eq. (11) without needing the approximation about tr dependency on frequency."

Add in the paragraph line 315: "As explained previously in Sect.2.3, for the low-cost LNB, there is a gain offset ΔG between the two channels. When the Ku-sensor does not receive any signal from the satellite ($P_{Sat} = 0$), it is rather simple to estimate this parameter. Under this condition, we can derive from Eq.2 by neglecting the receiver noise."

L175-179 – The simplification in Eq 11 implies that trchannelA = trchannelB … These paragraph implies that this in not true

I believe some steps are needed for the reader to follow all simplifications leading to simplified Eq 12 from Eq 2 to 6

Answer: in previous paragraph if P_E^B is low t_R^B disappears in equation 11. Cf. the answer to the previous remark for details.

L225-229 : did the authors have a chance to make some comparisons between this ARPEGE iso0° and the one from the MeteoFrance high resolution model AROME ? or with the MeteoFrance radar data (where the iso0° can be extracted using some polarimetric variable)- Same questions with Radiosoundings (or statistics from a satellite based radar such as GPM DPR) to verify the reliability of those ARPEGE levels ?

Answer: This is an idea that needs to be explored. We mention this at the end of the article (cf. line 610 in the original version). We will be working on this in the near future but have not yet done so for this article. In addition, iso0° can be estimated from ground-based or space-based radar observations, but these are not available in real time for the various measurement sites in this study (especially in Ivory Coast). Moreover, as mentioned in the discussion, uncertainty is introduced not only by the height of precipitation, but also by the vertical and horizontal structure of rainfall.

L229 : it would be nice to have more information about these experiments…. Context/data/results etc…

Answer: For simplicity's reason, and to avoid lengthening the paper which already contains experimental results, we feel it is not necessary to introduce further information on this experiment. In any case, this will be the subject of further in-depth work.

L405 and Fig10: Please be more precise : what do you lean but correlation between devices ? which data is compared ? time series of rain intensity ? which time step ? any filtering of outliers ?

Answer: Modify the legend for figure 10: "Correlations between all the measurements taken Cadarache as a function of the distance between the measuring instruments. The data compared are time series of precipitation rates with a resolution of 30 minutes for 2 and a half months, without correction for outliers.."

Add from line 414: "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, which measure spatially integrated over the entire height of the atmosphere." and correction of several elements in the following paragraphs: "Figure 10…" and "Figure 11…".

It would be interesting to see the scatter plots and more statistics on the timeseries (KGE ?) in addition to the QQplots which provide only partial information.

Answer: In fact, KGE, NSE, ...many indicators can be used to evaluate or calibrate models precisely, quantifying in a single figure the similarity between observations and simulations of

these observations. Scatter plot allow a point to point comparison. In our case, it's not a question of quantifying the discrepancy between KU-sensor and rain gauge observations, but of assessing whether or not the proposed dual channel retrieval of rain transmissivity applied to Ku-sensor measurement improves the estimation of average rain rate on the link. The problem is that we do not have ground truth for the quantity we are trying to evaluate. Rain gauge measurements are used for statistical comparisons because, in specific cases, precipitation can be observed on the link that is not detected by the rain gauge (e.g., at the start of an event) or vice versa (in the case of very localized events).At best, the inverse algorithm allows for perfect estimation of precipitation over the link; however, these estimations are not strictly identical to those of a rain gauge, which measures very localized precipitation within a few hundred meters. This discrepancy persists even when both types of observations are brought to a 30-minute resolution.

It is not clear from the paper which relationship is used for attenuation-rainfall estimation – are the ITU parameters mentioned in **L191-193** applied to all experiments (dual and single) ? Was there any adjustment/calibration ? if yes how ?

Answer: Add on line 203 : "For the numerical application, the T-matrix method (Mishchenko, Travis, and Mackowski 1996) is used to calculate the coefficients (alpha and k). Input parameters of this approach include: the temperature, defined as 10 degrees (mean over the rain column); the drop size distribution model, chosen as the Marshall-Palmer parameterization (Marshall and Palmer 1948); the frequency; the polarization; and the zenith angle between the ground sensor and the satellite."

Change paragraph "Error on k-R relationship": "we use an ITU attenuation - rainfall relationship" replace by "we use marshall-palmer parametrization"

STYLE/WORDING suggestions

L3 : link path and not path link : corrected ✓

L7 : which can be commercial (what is meant ? off the shelve) ? : delated ✓

THE measured attenuation : corrected

L19 : what is small-scale or medium-scale rainfall intensity ? are you talking about resolution or intensities values ? Needs to be clarified – If you mean intensities why single out small and medium , heavy rainfall is the most damaging for 'human/property damage' : ✓ modified "Accurately measuring rainfall intensity is crucial for understanding the water cycle, mitigating human and property damage, and managing water resources"

L21 : Earth Observation satellite (rather than remote sensing) ? ✓

L35 'previous studies ' – which ones ? delete : "Previous studies have shown the benefit of using such microwave satellite links for rainfall estimation. A full review of the various problems inherent in this technique can be found in \citet{giannetti2021opportunistic}." ✓

L40 : combination of the signal from the satellite and a background noise that depends on the state… ? ✓ « As a result, the received signal is a mixture of the satellite signal and background noise, which varies with atmospheric conditions. »

L43 : and the baseline signal measured during dry period . In the presence of high rainfall rates, however,… ✓

L47 : 'The present study …. dual channel'. long clumsy sentence – Just get to the point , which is improving rainfall estimation from dual-channel measurement of TV satellite signal by accounting for background noise. No need to repeat low cost etc….✓

L50 : the assumptions it relies on ? (rather than the hypotheses it presupposes) ✓

L52 inherent to rainfall estimation using…✓

L54 : section 2 introduces the physical principles (rather than 'context') ✓

L56 : a physical device whose characteristics …..✓

L60 : physical principles ✓

L61 : ground satellite : you should choose and keep one expression – Earth-Satellite as used before or ground-satellite …..LinkS or a link. ✓

Careful with missing articles along the paper….

L89 : the central frequency of what and compared to what ? not clear – what are each other ?– ✓

check format of the citation.

L104 : Various processes …. Links – do the process characterize the transparency ? do they influence the propagation of the link (or of the microwave signal along the link…) ? To be rephrased. ✓ « Atmospheric transparency is influenced by various processes that affect the propagation of microwave signals along the satellite link. »

L264 : data processing rather than data treatment ✓

L280 : not to go below the threshold (and not exceed …. Which means the opposite) ✓

L314 : Eq 17 and 18 are redundant – you can give directly Eq 18 in dB ….✓