

Interactive comment on “Fifty-six years of Surface Solar Radiation and Sunshine Duration at the Surface in São Paulo, Brazil: 1961–2016” by Marcia Akemi Yamasoe et al.

Anonymous Referee #1

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General comments

The paper discusses the long-term trends of downwelling solar irradiance at earth's surface in Sao Paolo, Brazil, one of the longest periods of such observations worldwide (1964-2016). The authors have identified in this dataset the well-known from other studies global dimming period of surface irradiance up the end of the 1980s. However, the brightening period that has been found in other locations over the world has not been confirmed at this station. The authors using other ancillary information, such as sunshine duration, cloudiness, diurnal temperature range, and days of fog have attempted to explain, to a certain degree, this unexpected behavior. The scien-

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tific questions addressed in this manuscript are well within the scopes of ACP. The innovation of the paper lies in the uniqueness of the dataset as well as in the use of measurements of additional geophysical parameters in order to test and explain their findings.

The methods of data analysis are quite standard for this type of studies but could be improved, as suggested in the specific comments below, especially as far as it concerns the use of deseasonalized data to derive the annual means for the calculation of the trends. Overall, the paper is well structured and presented with adequate clarity, although there is room for further improvements. Most of the conclusions drawn from the results are supported by appropriate references.

Generally, the language of the paper is adequate, but some parts should be be further improved to enhance readability. I have provided suggestions for some cases in the Technical Comments section, but there are more sentences that need fixing. Particular effort should be put to the Conclusions section which seems to have been written hastily with and several sentences are difficult to read.

Specific comments

Title: I suggest rephrasing to:

Fifty-six years of Surface Solar Radiation and Sunshine Duration over São Paulo, Brazil: 1961–2016

or

Long term changes of Surface Solar Radiation and Sunshine Duration over São Paulo, Brazil (1961–2016)

Line 17: Please include in the abstract some quantitative estimates of the trends in the two periods, at least for solar irradiation. The abstract is quite generic expressing mainly the intentions and not so much the findings.

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47: The acronym SSR is defined here as surface solar radiation while later in line 88 is defined as surface solar irradiation. Please fix this because it is important to have a clear distinction between the two quantities.

89: The term “cloud cover fraction” (CCF) is more common in literature, and in essence, than term “sky cover fraction”

118: Has the calibration of the instrument been monitored during the 56 years of operation? From the cited reference (1988) I understand that the 5% uncertainty characterizes the type of this instrument and does not include the uncertainty of the long-term stability of the instrument’s sensitivity. Please discuss this in more detail.

126: Annual averages are biased by the high summer values therefore are not representative for the year. I suggest using monthly anomalies (deviations from the long term monthly mean) and from them to calculate the annual means and derive the trends. This approach will probably alter the significance level of the trends.

146: It is not clear whether the 9-day limit refers to each month (July to October) or to the entire 4-month period.

148: Please clarify whether in the calculation of the atmospheric transmittance the solar irradiance (TSR) been adjusted for the variation of sun-earth distance.

153: As the station is located about 800 m above sea level, I assume that in many cases fog may occur below this altitude and on these occasions it would not affect the solar radiation measured and the station. Are these conditions distinguishable in the dataset?

154-155: Please clarify whether days with fog have been excluded from the clear sky averages.

155: Is the “fraction of cloud free days with foggy conditions” the FFD used in figure 3? If not, please explain how this index has been calculated. Figure 3 suggests that FFD can be as high as 0.8. Would this mean that in the particular year 80% of clear days

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are foggy?

159: Table 1 could be removed because it does not add any information that is used in the analysis.

187: Are the annual averages of the different variables computed for the common days of data or for each variable all available data have been included? This might influence the results in case of a large number of missing observations.

196: In Figure 3 the upward trend in cloud cover does not extend to 1988 and ends in 1983. Is 1988 a typographical error or there is really a difference between the total cloud cover (this paper) and the trend of the two cloud types reported in Rosas 2019?

274-275: Please clarify whether the threshold of 0.1 for the cloud fraction refers to the average of all measurement during the day or to each measurement during the day.

274-275: Please state how the limit of 9 cloud free days per year has been determined. Isn't it too small, representing only $\sim 2.5\%$ of the available days? Is it related to the 2nd percentile representing the absolute maximum of the data?

280: July-October: Fig 3 caption states July-September. Which of the two is correct?

297: Figure 3: It would be interesting to show how the DTR is behaving for clear-sky conditions.

306: Visibility in 1963 is also quite low (possibly related to the Agung eruption?), which may have partly contributed to the reduction of SSR in this year.

325: I don't understand what is meant by "the AOD exceeds 2 sunshine duration recorders". Please rephrase.

328-329: I cannot understand why effects on sunshine duration will be stronger when most of radiation is in the diffuse component. I would expect the opposite, i.e. that under prevalence of diffuse radiation the sunshine recorder would be less sensitive and effects of fog would not make any difference.

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341-350: This section discusses the heat island effect which is not relevant to trends in cloud free irradiation. It would better fit in the next section where it could be connected to temperature changes and DTR or in the introduction.

370: The increasing trend in the daily minimum temperature is indeed qualitatively in line with increasing cloudiness, but the latter is very small and insignificant (Table 2). The heat island discussed for the fog trend should have also played a role in the temperature trend.

381: Figure 4: It would be interesting to show how these variables behave for clear skies only. A second set of lines with clear-sky values could be added with different color or symbol.

385-390: Please try to split this long sentence in to two. It is difficult to read.

428: Please state the wavelength of the aerosol optical depth data.

442: Does the SSA from AERONET show any trend after 2000? What about the AOD from this instrument?

433: The variability of the AAI and the AOD cannot be compared in absolute terms because these two qualities are not the same.

436: From Figure 5 is evident that there is an abrupt change in AAI between 1992 and 1994 which should not be neglected. The AAI after 1995 has been almost doubled and remained fairly constant. Considering the years 1984-2016 as one period for a trend is probably not a good choice since the trend is not linear.

470: “their distinct patterns”. If I understand correctly, the other factors may have affected the SSR and not the SD and DTR, thus it should be changed to “the distinct changes in SSR”.

503-506: See my comment for line 436 above.

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- 30: Delete “still”
- 34: Replace “encouraged” by “planned”
- 55: Insert “comprising” before “both”, and delete the two occurrences of “in”
- 67: Replace “the” by “increasing”
- 92: Replace “propose to answer” with “are addressing”
- 95-97: Better use “section” instead of “part”
- 148: Insert “by” after “estimated”
- 150: Delete “also”
- 182: Please define that the dry season is July-October.
- 242-243: There is a long blank after the P in word Period (two occurrences)
- 270: Replace “solely” with “sole”
- 271: Replace “clue” by “quantitative estimate”
- 275: Please add after “spring” the months corresponding to winter and spring season, just to avoid confusion for the readers living in the northern hemisphere.
- 291: Delete “decade”
- 292: Replace “mention” by “mentioning”
- 293: Replace “n/N” by normalized sunshine duration”
- 331: Delete (FFD) as it is has been already defined
- 333: Please replace “scenarios” with “conditions”
- 339: Replace “decay” with “reduction” since decay usually implies a gradual decrease but here we have a rather abrupt change.

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357: Replace “it” by “DTR”

360: Please add after “space”, “during daytime” and after “surface”, “during the night”

400: Delete “jumping”

401: Add “and” before “decreasing”

423: Replace “relative” with “relatively”

431,432: Something is missing in this sentence.

434: Please replace “1980 and 1990 decades” with “in the 1980s and 1990s”.

471: Delete “a restrict analysis of”

475-476: Delete “is a potential candidate to”

477: Replace “Although” with “However,”

Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2020-848>, 2020.

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