We would like to thank the reviewer for his/her important and meaningful questions. Below(in blue) are the replies to the comments and questions. The referred figures and references are at the end of this doc.

Comment on acp-2021-1086:

The paper has identified the irregularity of the biomass burning in the Amazon Forest for 2020 compared to the previous 6 years, which has involved the Pantanal biome. Evidence of the hotspot counts, AOD from MODIS and AERONET and retrieved solar irradiance have clearly shown the burning anomaly of the year. The statements are well discussed and proved but the contributing factors of the anomaly are not discussed in the paper.

Firstly, there is less specification on the main anomaly that is discussed whether it is a burning or emission or something else? Secondly, the factors that cause these anomalies should be understood, such as reason of burning (natural forest fire/human activities), source of burning (where and type of land cover burnt), weather condition (local or transported emission/conducive to sustain burning/conducive to fire spread). Since the year of 2020 is the COVID year, please do mention whether it played a role in the 2020 burning condition. A good background information would be helpful for the audience and further analysis.

R: First, we would like to clarify that, following both reviewers comments, we reassess the identification of anomalies in the context of Pantanal and Brazil 2020 biomass burning season. We change the time frame of the analysis, looking also for the other biomes (Amazonia and Cerrado, not just Pantanal), for the period between 2003-2020.

Looking further into the past, it shows that, from a regional perspective and when compared with the mean scenario (within the period 2003-2020), 2020 biomass burning season could not be identified as an unprecedented and exceptional anomalous year, either based on fire count or smoke loading. As illustrated in Figure 1, the years 2004, 2007 and 2010 were more polluted and presented higher fire counts (Figure 2), regionally speaking (Amazonia+Cerrado+Pantanal). Therefore, regionally, the focus has been changed to the intercomparison between 2020 and the most polluted regional smoke plume (2004, 2005, 2007 and 2010) occurred between 2003 and 2020.

However, when focusing specifically on the Pantanal domain, there are two aspects evidencing that 2020 exceptionally differs from typical years (considering the period 2003-2020): the fire count observed in September and the mean AOD over the Pantanal biome during October (Figure 2). The high fire count over Pantanal in September 2020 has not been seen in previous years. Since there is already a detailed study on the climate conditions and its potential role on the Pantanal 2020 Biomass burning season (Marengo et al. 2021) we try to better understand the relationship between smoke levels over Pantanal and local fire count and smoke in the Amazon, from where transport to Pantanal is important (Figure 3).

To contextualize the factors associated with Pantanal exceptional fire count in 2020, as background information for the new version of the manuscript, we cited Marengo et al. (2021) and Libonati et al. (2020) studies as follow:

Fire activity in Brazil biomes historically has a strong relationship with mankind intervention and there is a vast literature supporting this. Therefore, 2020 fire activity in Pantanal and the exceptional anomalous fire activity observed had, as usual, the mankind component. However, recent researches support that mankind traditional intervention was propelled by two distinct

aspects:

a) A fire-prone environment (Marengo et al. 2021, Libonati et al., 2020). According to Marengo et al. (2021), the years of 2019 and 2020 were characterized by the worst drought in 50 years in Pantanal. The accumulated precipitation during the wet season of these years was between 50 and 60% less than normal.

b) An unfavorable governance (poor management and lax laws). According to Libonati et al. (2020), a combination of climate extremes, poor management and lax laws was behind Pantanal anomalous fire activity. Outdated environmental regulations, slashing of resources for environmental protection and climate actions in recent years certainly contributed to build-up the mentioned unfavorable governance.

One must also point out that the two concurrent aspects were not exclusive to Pantanal in 2020, and yet the fire count figures across Cerrado and Amazonia were not exceptionally far from those of recent years. Therefore, there are still open questions about the specific behavior of mankind intervention in Pantanal in 2020, a lack of studies of human causes and responses to fires in the Pantanal has been recognized as a challenge to a full comprehension of what happened (Libonati et al., 2020).

In a recent study (Vale et al., 2021), the conclusion was that the current administration took advantage of the COVID-19 pandemic to intensify a pattern of weakening environmental protection in Brazil. The study examined the effects of the pandemic on environmental protection and legislation in Brazil in the current administration and showed 57 legislative acts aimed at weakening environmental protection, almost half of which in the seven-month period of the pandemic in Brazil. The study also found a 72% reduction in environmental fines during the pandemic, despite the increase observed in Amazonian deforestation during the analyzed period. It is important to stress that this context encouraged people to set fire around the country, particularly in indigenous and protected areas. This background is being considered in the new version of the manuscript.

In the result analysis (Section 3.2, 3.3), the analysis time frame of the data should be consistent. Hotspot, AOD and solar radiance data from 2003-2020 (Figure 6 – 8) were used for the chronological change of the burning events in Pantanal biome, but not for the spatial map (Figure 4 – 5) where the anomaly is identified. The inclusion of long-term dataset could assist on the understanding of spatial distribution of the burning condition more clearly.

R: In the revised version of the manuscript, we kept the time series plots of fire count and AOD (Figure 2) from 2003 to 2020, and we extended it to Cerrado and Amazonia biome, but the time frame was changed for the spatial maps. We included maps for September and October of the more recent years (between 2003 to 2020) identified as the most polluted in terms of the regional smoke plume(Figure 1) to be compared to the results for 2020 (2004, 2005, 2007, 2010, 2017). So, instead of plotting all the maps of September from 2003 to 2020, we focus on the most polluted years and add maps for October to highlight the atypical high level of smoke over Pantanal at the end of the bb season. We did it for both, AOD (Figure 1) and Surface Solar Radiance anomaly (Figure 4). The remaining years, from the previous time frame, would be added as supplementary material.

In the discussion section (Section 3.3) 2020 has been referred to the previous burning season in 2000s several times, in terms of the similarity of hotspot amount and AOD level. No detailed information is

provided on the cause of the burning, even there are multiple similar occasions that have had happened in the past, which might not be so much of an anomaly but reoccurrence if longer period data (2003-2020) is considered.

R: The reviewer is corrected and the revised version of the manuscript tries to make it clearer what the authors considered anomalous in 2020. In fact, in terms of the regional smoke plume, in 2007 higher AOD values were detected and covered a larger area in South America. As mentioned previously, in Pantanal, however, in 2020, the fire count detected in September and the mean AOD over the Pantanal biome during October differ from previous years values. So, regionally (Brazil), within the time frame analyzed, 2020 was not different from past bb season (Figure 1) in terms of smoke loading and total fire count, it was Pantanal that present aspects not seen in the previous years, as mentioned.

Overall, the paper is not well structured, and information are clumped together in long paragraphs. Please split the lengthy paragraph or introduce sub-section for clarity. A major revision is required before the paper is deemed suitable for acceptance and publication.

R: We reformulate the structure of the paper, we expect that the revised version is better structured, making the readability easier.

Specific comments:

Line 56-60: Please provide the basic information on the size and the typical cause of burning in the different biomes. It would be helpful to elaborate the uniqueness of burning/emission condition in Pantanal.

R: In general, slash and burn practices are tools in the deforestation process of the original vegetation. Fires are also set to clear the land from residues from the previous crop season. Particularly in 2020, analyzing fire count map over EVI map, mankind intervention over indigenous and protected areas was clearly identified (Figure 3). The social and economic motivations, specially during 2020 season, need to be better studied but they are out of the scope of the present work, although as pointed before, the current administration's efforts to weaken environmental protection in Brazil (Vale et al., 2021), lax laws and lack of fiscalization must have contributed to this scenario (Libonati el al, 2020).

Line 222-223: How about 2003?

R: Yes, 2003 could be included since it is the beginning of the time series, nevertheless, the fire count and AOD over Pantanal in 2003 were much lower than those identified as polluted. This has been adjusted in the new version of the manuscript.

Line 234-237: The role of weather anomaly is mentioned here but just for year of 2015-2016. How about the other year of extreme burning between 2003-2010 (Line 222-225)? More explanations need to be provided.

R: Considering the new arrangement, to focus the spatial comparison between 2020 and the most polluted years between 2003 and 2020, what we found in common among the polluted years(including 2020) is the prevalence of drought conditions over the center-west region of Brazil and southern Amazonia (Figure 5). As in 2020, the drought conditions also spread across Pantanal in 2010. This again points out to the particularity of the human component in the explosion of fire in september of 2020. This has been addressed in the new version of the manuscript.

(a)
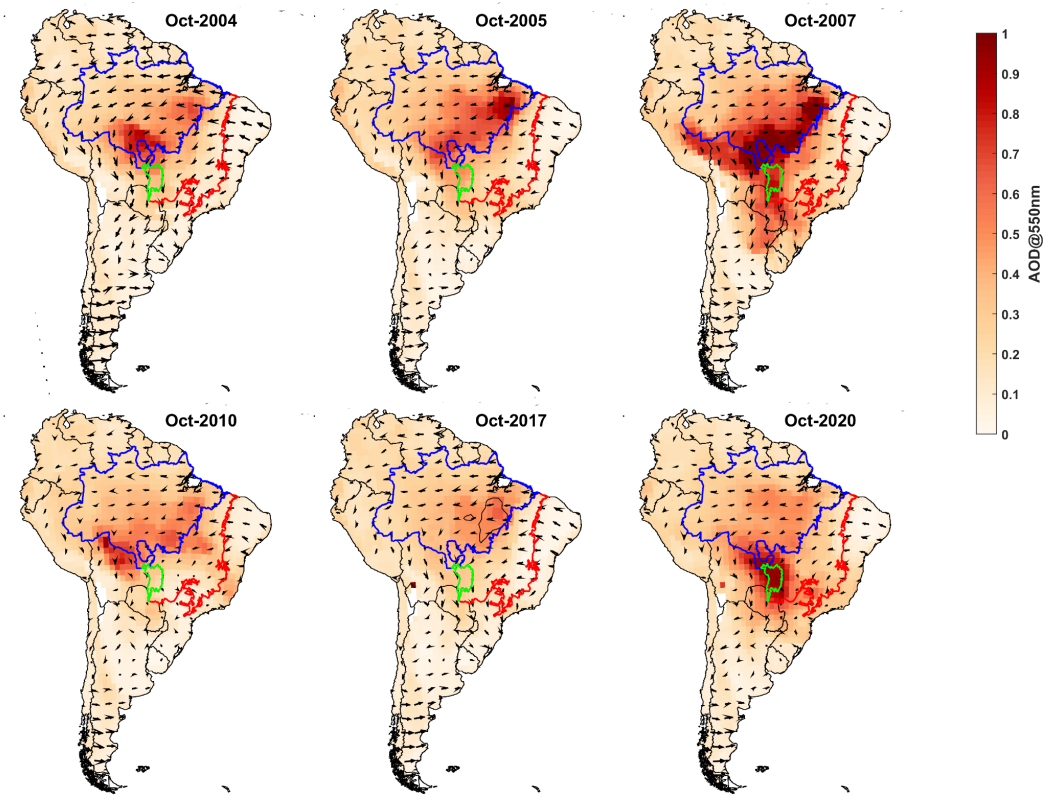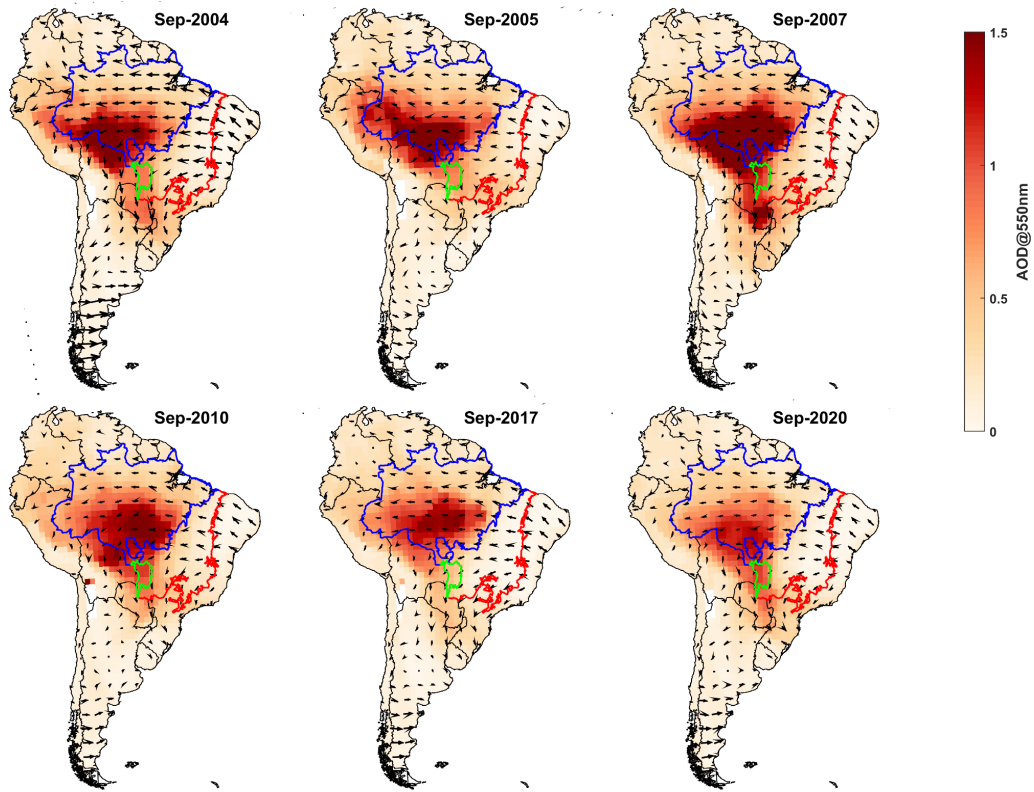
(b)

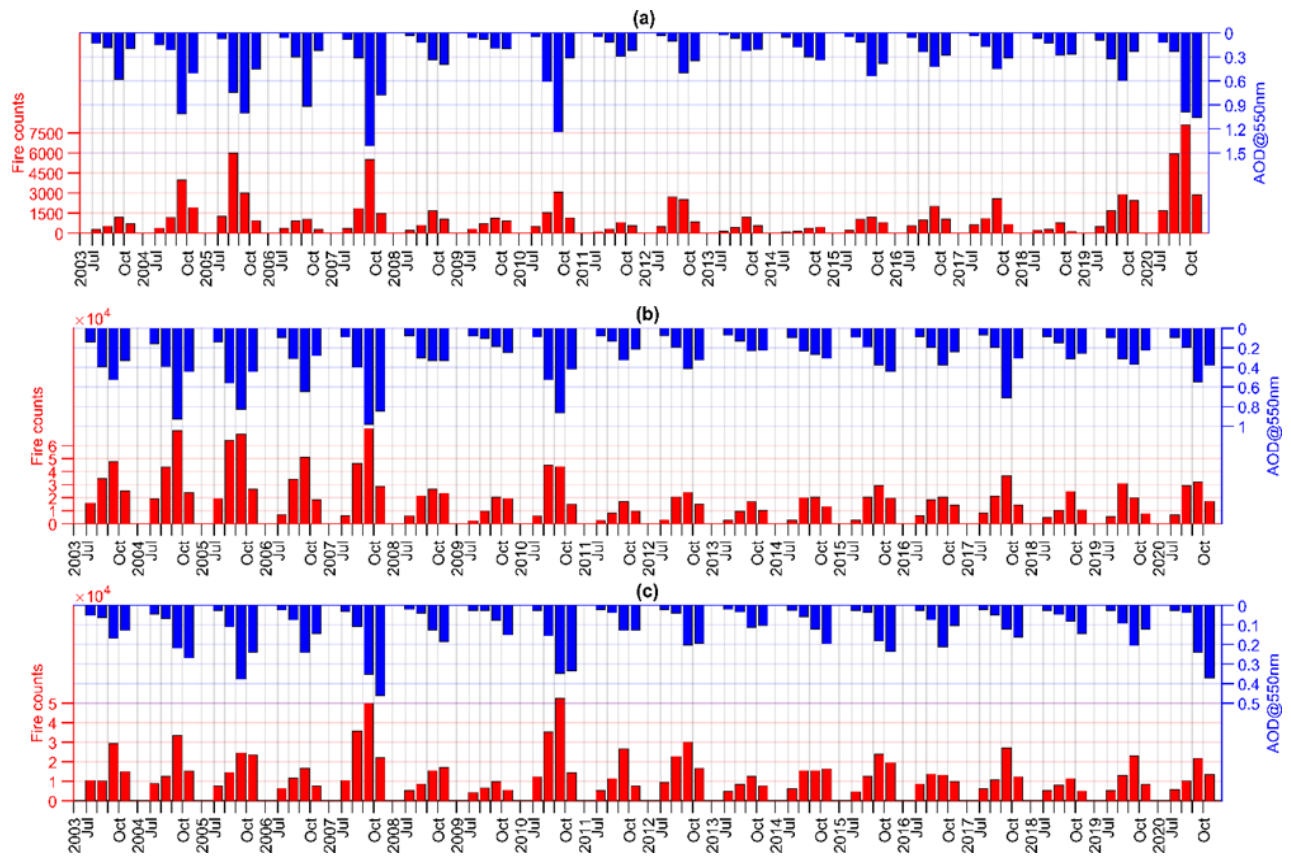Figure 1: Regional Smoke Plume (a) September ; (b)October

Figure 2: Fire count and AOD@550 nm interannual variability (a) Pantanal; (b) Amazonia; (c) Cerrado
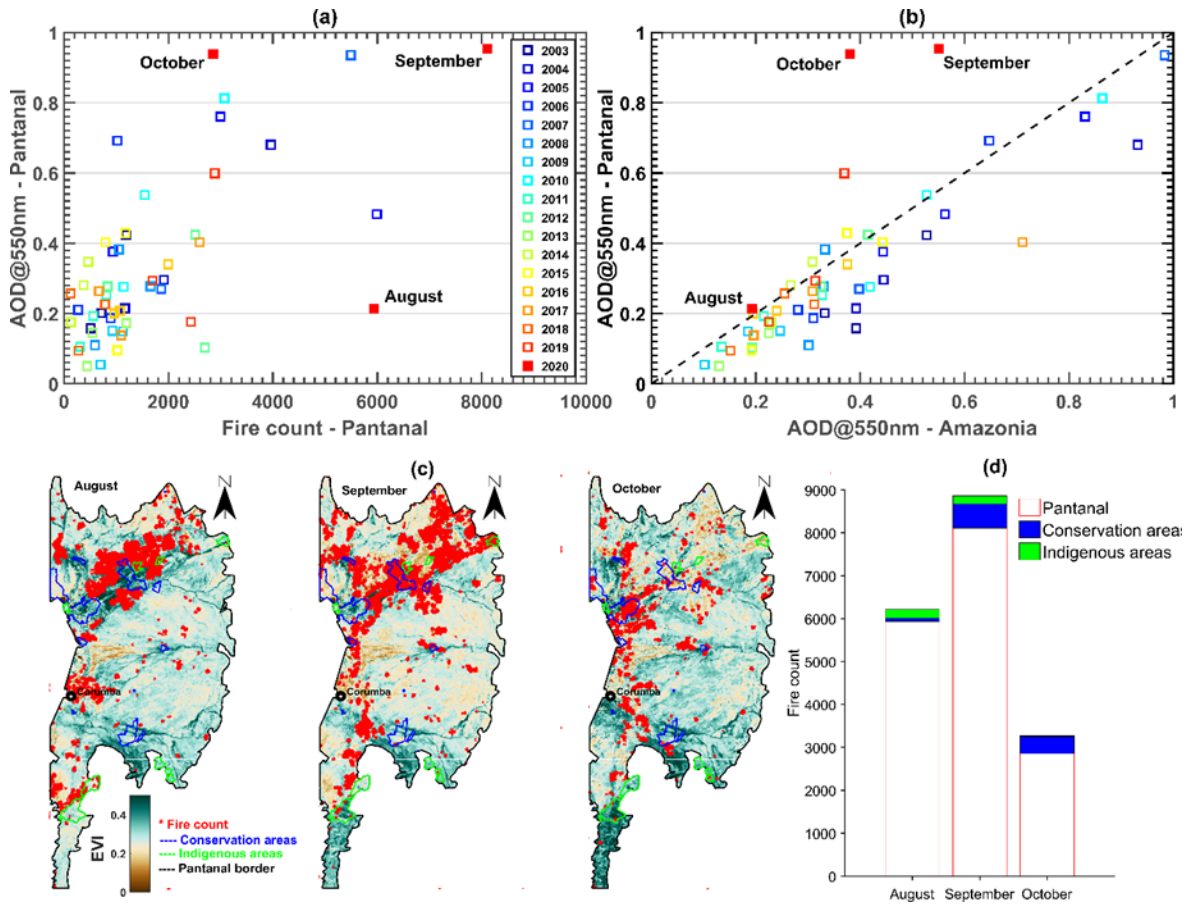
Figure 3: (a) AOD@550 nm Pantanal versus Fire count Pantanal; (b) AOD@550 nm Pantanal versus AOD@550 nm Amazonia; (c) Fire spots distribution across Pantanal for August, September and October of 2020 using Enhanced Vegetation Index(EVI) as background and highlighting Indigineous and conservation areas; (d) Pantanal total fire count and fire count within Conservation and Indigenous areas.
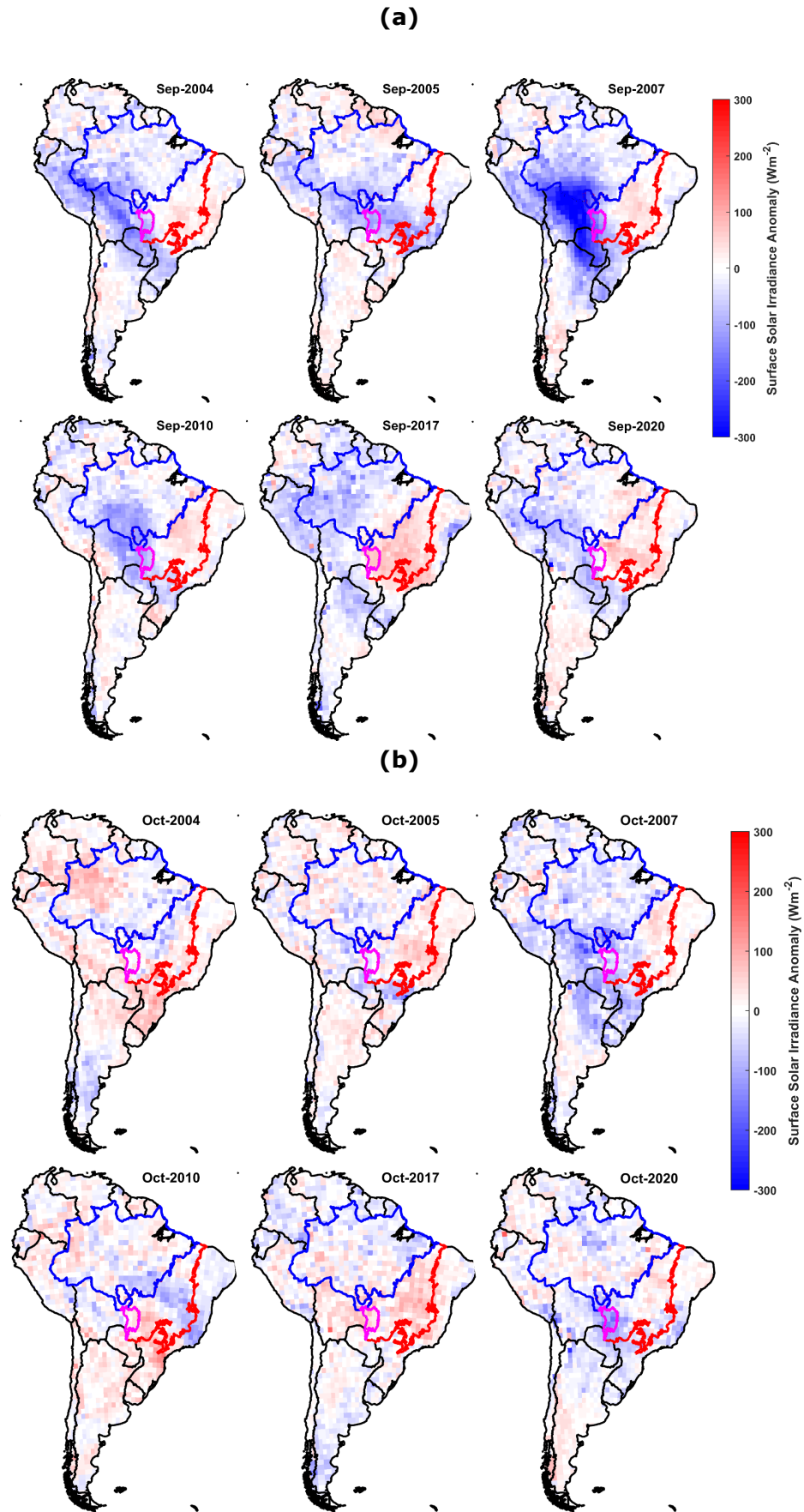
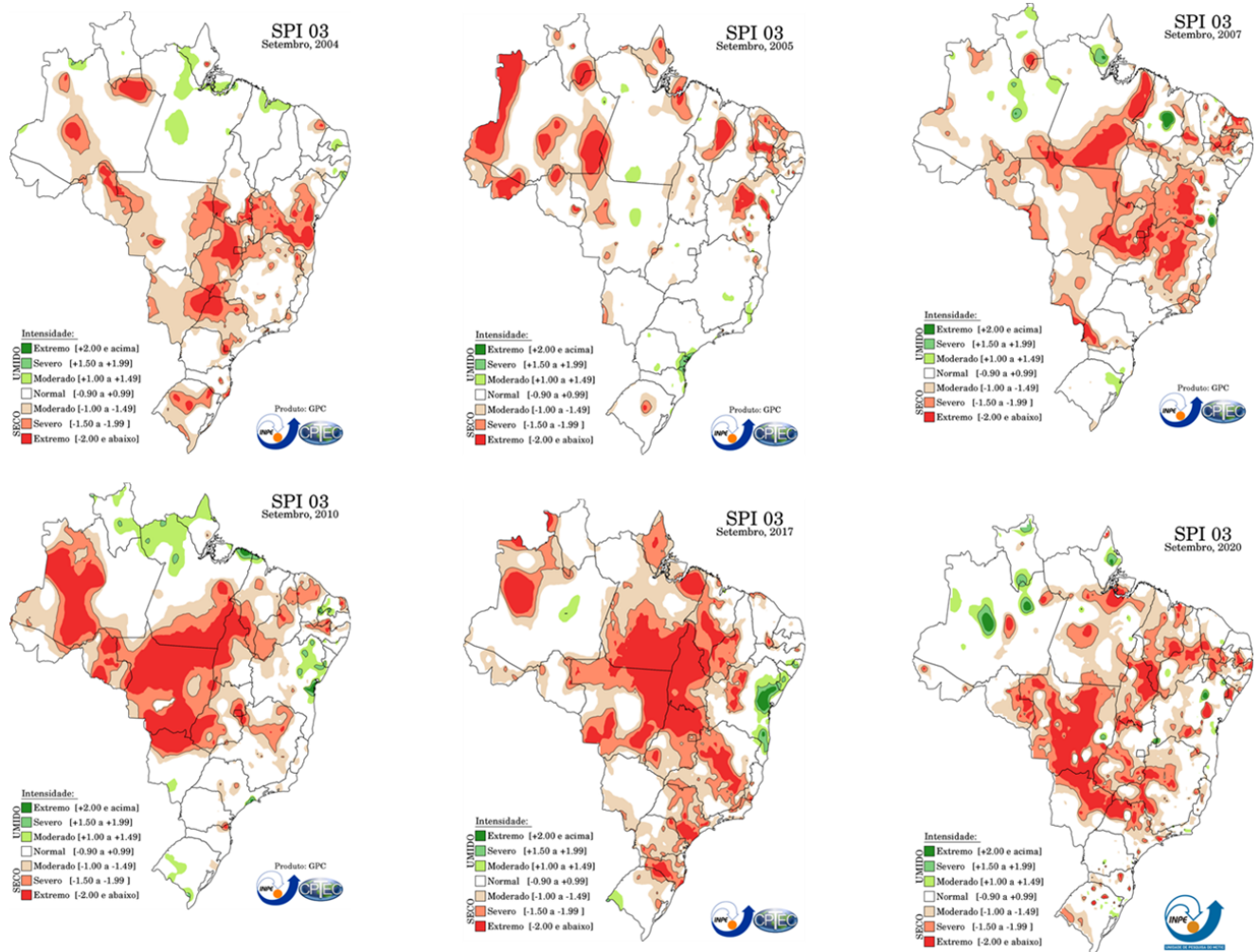Figure 4 - Surface Solar Radiance anomaly: (a) September; b) October

Figure 5 - Brazil Standard Precipitation Index (SPI) in September for the 3 month scale and for the years 2004, 2005, 2007, 2010, 2017 and 2020. Red areas represent extremely dry conditions
(source: http://clima1.cptec.inpe.br/spi/pt)

References:

LIBONATI R ET AL. 2020. Rescue Brazil's burning Pantanal wetlands. Nature 588: 217-219. https://doi.org/10.1038/d41586-020-03464-1.

Marengo, J. A. et al. Extreme drought in the Brazilian Pantanal in 2019–2020: Characterization, causes and impacts. Front. Water3, 639204 (2021).

Vale, M. M., Berenguer, E., Argollo de Menezes, M., Viveiros de Castro, E. B., Pugliese de Siqueira, L., & Portela, R. (2021). The COVID-19 pandemic as an opportunity to weaken environmental protection in Brazil. Biological

conservation, 255, 108994. https://doi.org/10.1016/j.biocon.2021.108994