We would like to thank the referees for their comments. We have revised the manuscript according to the comments below.

Referee 1

The manuscript entitled "Forecasting the regional fire radiative power for regularly ignited vegetation fires" develops a model that can be used to predict the fire radiative power (FRP) and evaluates it against SEVIRI/MSG observations in the south-central African savannah. This paper is generally well written: the method is clearly presented, and the limitation for application in irregularly ignited fires is well discussed. However, I have a few concerns regarding the characteristics of the fire prediction model and its potential application.

Major comments:

While I was reading the introduction, I was confused about the advantage of predicting FRP rather than using fire indices directly. The authors touch a little bit on the advantages in Lines 55-56 but it is not enough. If we want to apply some indices to guide fire prevention or forest fire suppression, fire indices are probably enough as they provide fire danger/potential regardless of if fire will happen. What additional information can FRP provides regarding fire prevention compared to fire indices?

Response: The general aspiration is to be able to anticipate the actual strength of wild fires and their emissions as precisely as possible, which would also allow to improve air quality forecasting. Even though fire indices indicate fire danger, they weakly correlate with actually observed fires, and the amount of fire emissions cannot be inferred from them. The FRP prediction, unlike fire indices, can tell how fires and their activity evolve in time in the region. Furthermore the knowledge of temporal FRP can also be directly linked to wildland fire emission production rate and applied in air quality simulations.

On the other hand, the prediction of FRP uses previous FRF information at annual and daily scales, which inherently includes the stochastic processes that happened before. And as also mentioned by the authors, the FRP prediction is difficult for irregularly ignited fires. Yet, there are limited areas with regularly ignited fires except for the sub-Sahara African savannah, south-central African savannah, and South America savannah. Clarifications should be added where FRP can be used and if it provides additional information compared to fire indices – this may depend on which conditions it will be used.

Response: The manuscript focuses on examining the possibility of predicting FRP time-dependently. The manuscript indeed demonstrates that it is possible in at least certain areas of one region, and a method has also been provided for it. That was the aim. Finding all time-dependently predictable areas would require data from different geostationary satellites (SEVIRI, Himawari, GOES) and would incur large amount of work with no extra methodological value.
It is possible that there are other fire-rich regions in the world other than the savannah of south central Africa that can be predicted fairly well. On analysis of the results, it was found that if the observed annual FRE on cloudless days does not exceed a certain energy per area limit, the predictability is relatively low due to high stochasticity. In general, the method can be applied to any region on Earth with a regular diurnal and annual cyclicity in wildfires and a fire occurrence (which depends on the properties and chosen size of the area) of the same order of magnitude as in the areas of the African savannah region. Nevertheless because such predictable areas are the most productive of wildfire emissions, they would be good to locate and include in air quality simulations to improve simulation accuracy. This is a good topic for future work.

The introduction shall be expanded to provide a more comprehensive background to a broader audience:

1) The review of fire effects is concentrated on the climate and health effects of fire emissions, while other fire effects on the ecosystem, surface energy, climate system are not mentioned. At least a few lines shall be added to provide an overview of these effects

Response:
The following sentence has been added to the Introduction:
They can also have consequences on ecosystems by affecting vegetation and soil, the surface energy budget by changing the radiative characteristics of the atmosphere and surface, and the climate system by altering atmospheric chemistry and meteorology.

2) Why do you predict FRP rather than burned area? The latter is more commonly used and has more observations with a longer period?

Response: Burned areas do not provide time dependence of fire strength and are inaccurate in what concerns the fire timing. Also, as previously mentioned, dynamics of fire occurrence converted to emissions is important for air quality simulations.

After section 4.2, the authors shall include more comprehensive discussions regarding how the prediction of FRP can be applied in different parts of the world and their limitations.

Response:
To clarify this, the following paragraph has been added to the Summary: It is possible that there are other fire-rich regions in the world other than the savannah of south central Africa that can also be predicted fairly well. The method presented here is generally applicable to any region of the globe with a regular daily and annual occurrence of wildfires, which depending on the characteristics of the area and the size chosen, is of the same order of magnitude as in the African savannahs. The widest predictable regions are the most productive of wildfire emissions, representing the leading contributions to global wildfire emissions, and should therefore be primarily located and included in air quality simulations to improve simulation accuracy. Therefore, a general sensible strategy for implementing fire predictions in simulations is primarily to consider such regions either by the method described in this paper, which is very straightforward, or by some other similarly highly predictive method. Thereafter, efforts can be made to increase the number and extent of predictable regions by refining the model used towards limits where predictability breaks down. Stochasticity determines the limit of predictability which is a model-independent property and the most accurate predictions can only be based on the most complete and detailed data possible.

Moreover, as the fire prediction model method constructs the equation based on historical FRP information, it is not clear if the model performance is sensitive to different training years (as only 2010 is used for training in this paper).

Response: Due to the regular diurnal and annual cyclicity in the tested savannah region, temporal FRP patterns of each area are expected to recur annually. This is reflected in the evaluation: the prediction is based on parameterization made with several years older data; still, the predicted results are well in line with observations. The fires in the predicted areas are related to standard regional agriculture practices and come in great quantities on a daily basis, which reduces stochasticity and thus sensitivity to different training years. Sometimes, however, it is a good idea to update the parameterization according to the latest data due to possible significant changes in properties of the areas that are responsible for fires. To clarify this, the following sentence has been added to the Results and Discussion section: The selection of distant years for training and evaluation demonstrates the stability of the method - and highlights the persistence of the regional fire ignition patterns, which did not change over almost a decade.

In addition, can we apply the model to predict FRP in the background of climate change?

Response: Long term predictions would be unreliable because the properties of the areas may and probably will change drastically over long periods of time.

Minor Comments

Line 19: "anticipated in (Pechony and Shindell 2010)" shall be "anticipated in Pechony and Shindell (2010)". Revise here and other places in the remaining paragraphs.

Response: They have been corrected.

"Lines 46: Unfortunately, globally, neither all fires (ideally with a full FRP time dependence) nor their sources are observed remotely." The authors may want to emphasize a lack of FRP data on the global scale, yet the sentence is misleading. There are multiple remote sensing fire products worldwide. Please modify it to be more accurate

Response:
The text has been modified as follows: Globally, only a fraction of fires is observed by satellites. Many of them are masked by clouds or are simply too small to be detected even by orbital satellites. In addition, a large fraction of fires are too short to be detected by orbital satellites due to their infrequent overpasses, and some may be completely outside the coverage of geostationary satellites.

Line 61: "It is estimated that of about 90 % of wildfires are human-induced (Lobert et al., 1999)." This is not accurate — please add time periods and regions.

Response: The estimatad number should be understood as a general rule of thumb. It is global without any specific time period. Locally the number can vary. To remove ambiguity, the sentence has been modified as follows: It is estimated that as much as 90 % of all wildfires over the globe may be human-induced (Levine et al., 1999; Lobert et al., 1999).

Line 75-76: should it be “we developed” and “we improved”?

Response: These have been corrected.

Line 90: Please merge the single line with the previous paragraph.

Response: This has been corrected.

Line 120: Define the biomass burning rate

Response: The definition has been added as follows: i.e., the time derivative of the mass of the burning biomass fuel

Line 125: Are there any references for the assumption?

Response: It is assumed that not only fires are seasonal but also during daylight time the chances of ignition are higher due to human activity and conditions for wildfires are better. In addition, based on an examination of SEVIRI data, this is very distinct in the studied savannah region in Africa. The sentence has been modified as follows: Based on the analysis of the SEVIRI data used in this work (see also (e.g. Roberts and Wooster, 2008; Roberts et al.,2009; Sofiev et al., 2013)), it is expected that wildfires are not only seasonal, but also that their occurrence is greater during the day than night time presumably due to higher human activity and better weather conditions.

Line 139: It is a typo? “Julian-day-” should be “time-” to represent the daily shape curve?

Response: The comment probably refers to line 143 instead of 139. No it is not a typo. It refers to the meteo component (the first term of Eq.1).

Line 199: When you split the Southern Africa Savanna into different grids, do you consider the land cover effects? In other words, does your method reflect the effects of land cover types on FRP?

Response: No, it predicts FRP as it is emitted by each grid cell. Land cover types would only come into question if FRP is converted into emissions.

Line 200-201: Why do you use 2010 for model training and 2018 for evaluation? Back to my major comment #3, is the model performance sensitive to different training years?

Response: We deliberately used distant years to verify the stationarity of the pattern. The difference between the training and evaluation year emphasizes the invariance of regional FRP, which is reflected in the results.
To clarify this, the following sentence has been added to the Results and Discussion section: The selection of distant years for training and evaluation demonstrates the stability of the method - and highlights the persistence of the regional fire ignition patterns, which did not change over almost a decade.

This may be a methodology question but it came to me when I was looking at Fig 1a: Why do you include time (Julian day) information when you describe the meteorological impact on FRP (the first term of Eq.1)? The Julian-day information is already included in the second term of Eq.1.

Response: It is just a consequence of how the overall equation (eq. 1) is broken down into components with specific actions. The first two components indeed have a day number dependence. The meteo component (the first term of Eq.1) is a day number dependent because it depends i.a. on a set of meteorological variables of the predicted day.

There are no figures showing the observed and predicted FRP magnitude on the regional scale. I would suggest adding a figure similar to Figure 4 but for FRP magnitude.

Response: Such a figure would not bring any substantial value because the end result of it would be very closely the same as that of figure 4. The relationship between the observed and predicted FRE is similarly proportional to the ones of maximum FRP. FRE is simply a more justified quantity to use than maximum FRP, since it is directly proportional to emissions and takes into account all daily FRP values and not just one daily value.

Explain the red dots in Fig. 5

Response: The explanation has been added in the caption of the figure.

Line 317: where do you show the "anthropogenic drivers of fires"?

Response: Should be: ...accounting for the effects of both natural and anthropogenic drivers... Regional FRP is truly the result of both without a detailed breakdown. The sentence has been clarified.

Referee 2

The aim of the paper "Forecasting the regional fire radiative power for regularly ignited vegetation fires" is to develop a predictive model for fire radiative power (FRP) based on climatic curve of FRP and weather parameters. The model is trained and evaluated against SEVIRI/MSG observations. It seems to performs reasonably well in the south-central African savannah but not so well in irregularly ignited fire regions.

This paper is sufficiently clear in its methods and results, but the motivation and contest of work could be explained better. Also I have few concerns regarding the predictant used for the fire prediction model and its potential application in real time.

My main concerns are:
Contest of work. I suppose the real aim is to develop a method to forecast fire emissions for air quality applications in a similar way of what done in Di Giuseppe et all 2017 and 2018 for GFAS. This is important as in absence of a fire predictive model, fire emissions are usually kept constant during the forecast integration. Another application could be to estimate a FRP to FRE conversion based on a realistic fire emissions diurnal cycle instead then a constant or flat one. This ia also important as it could improve the conversion between FRE and dry-matter. If these are the main aims, as I think they are, they should be clearly state in the introduction which instead drift between fire danger, problems in identifying or predicting an ignitions and climate change. A more structured introducton with a clear statemnt of the problem would certainly enhance understanding of the problem.

Response: The following two paragraphs have been added to better explain the problems of FRP forecasting and the aims of this paper. One has been added to the Introduction as follows: With no fire prediction model at hand, emission forecasts are typically based on the persistence of the current state by keeping the most recent fires constant for a forecasting period of a few days. Such a method is used e.g. in the Global Fire Assimilation System (GFAS) of the Copernicus Atmosphere Monitoring Service (CAMS) and IS4FRIES-SILAM system, which both employ FRP observations by MODIS. As an improvement to the persistence approach, this work aims to predict regional FRP at each moment of time for subsequent use in air quality forecasts. The high temporal resolution of the FRP predictions raises the problem of parameterization of the FRP diurnal cycle, which is explicitly included in the model and identified during the model fitting to retrospective data. Therefore, this work is based on a time-wise comparatively complete FRP information from SEVIRI, which is retrieved at a temporal resolution of 15 minutes.

The other paragraph has been added to the Constructing the fire predicting model section as follows: This model goes beyond any time period averages by predicting FPR with proper time-dependence. In order to obtain as precise predictions as possible, the model aims to realistically imitate the date, weather, and area location and size dependent diurnal FRP patterns time-dependently. The predictions are made without dependencies on other areas or previous days. The FRP of each area is predicted individually based on a daily weather forecast or archived meteorological data in the cases of future predictions and past reconstructions, respectively. The model explicitly accounts for the cloud mask, thus filtering out the incorrect zero-FRP values - by using only cloud-free days in the model training. If the cloud mask is ignored, each regional FRP value obtained from observations represents simply an unknown arbitrary fraction of the actual value, providing erroneous information for model training.

Predictors for the FRP model. The FRP predictive model is only based on weather parameter as integrated into fire danger metrics. By the author own discussion (line 120) FRP is directly related to fuel amount that is notoriously not included in fire danger formulations. This means that you could have an ignition with very little fuel available but severe weather conditions and your method would not be able to pick up on this. I understand that real time monitoring of fuel amount is not easy to obtain but I wonder if at least the inclusion of some vegetation parameter in the form of LAI, NDVI would make sense. At least a discussion of this issue should be added to the paper.

Response: The occurrence of fires in each area in all its complexity is unique to each area. However, a common feature of well-predictable fires considered in the paper is that they are set regularly as a part of agriculture / forestry practices, i.e. the fire processes and vegetation state are controlled. It greatly reduces the variability of the fuel load, which is not an easily observable quantity. As a result, it was easier to include it indirectly by calibrating the model with the past fire strength than predict from indirect indices, such as LAI.

Impact in real time simulations. It would be interesting to see what the application of the model means in terms of fire emsions. I wonder if it could be possible to calculate the CO_2 budget difference between the model and an assumption for persistence for exemple (i.e. FRP of today equal to yesterday). This could give an idea of the difference in atmospheric composition budget that the use of this method could bring.

Response: A comparison with the persistence forecasting is indeed a natural demonstration of the model skills. However, in our case it is not applicable: the model is made for predicting autonomously, without any fire information for the prediction period. Please note that our application year is 2018 whereas the training year is 2010. One cannot formulate any reasonable persistence algorithm for such forecasting time scale.

Split between training and testing dataset. For what I understand the mean FRP curve was derived for the 2010 year and the verification is conducted for the same year. Testing should be performed on a dataset that hasn't been used for training. I would like the author to comment on this as this is quite anusual.

Response: The training data are not predicted. The FRP curves in Fig. 1 are not predictions but represent the training set, a full 2010 (i.e. they are fit to 2010 data). The evaluation time period is 2018, Figs. 2-4.
A clarification 'training dataset' has been added in the caption of Figure 1.

I have few minor points:

Line 20; This incrising fire activity.... I am not sure this is the case as climate change can induce different human behaviours which might offset the increase in fire activities. We have already seen a reduction in burned areas due to achanges in human practices.

Response: This is the result in the paper by Pechony and Shindell (2010) referred to in the previous sentence (line 19). The sentence has been modified to: Global simulations over 1250 years (850 - 2100) suggested that precipitation amount was the main factor controlling the fire activity in preindustrial times, changed to an anthropogenic stress controlling the fires since 18th century, and temperature being the major factor in the future.

Line 33 please check the use of parenthesis in citation when should be in line citations

Response: They have been corrected.

Line 46 "Unfortunately..", please revisit this sentence as it is not clear

Response: The text has been modified as follows: Globally, only a fraction of fires is observed by satellites. Many of them are masked by clouds or are simply too small to be detected even by orbital satellites. In addition, a large fraction of fires are too short to be detected by orbital satellites due to their infrequent overpasses, and some may be completely outside the coverage of geostationary satellites.

Line 49 "...of fire occurrence " you mean ignition ?

Response: The fire occurrence meant both the fire ignition and evolution in time. To clarify this, the sentence has been modified to: To date, no successful predictive model has been developed for short-term forecasting of the time-dependent occurrence of fires with a reasonable spatial resolution.

Line 50 and afterwards. Please be aware that FWI and the like are not fire risk indices. They provide a measure of hazard and not risk. A better definition is fire danger indices.

Response: These have been corrected.

Line 103 I disagree that fire extension and spread cannot be measured or predicted. There are fire behaviours models that do this with very good results

Response: The sentence referres to wildfires that have not yet occurred and also implied regional scales. The sentence has been clarified as follows: In practice it is not possible to predict the ignition time and location of a single random wildfire, not to mention its duration and the extent to which it spreads before it ends or even exists.

Line 118 and afterwards. The connection with the fire emissions I belive is the main scope of this work and this should be clarified. How this work would allow that estimation to be more accurate ?

Response: To clarify this, the paragraph given earlier above has been added to the Constructing the fire predicting model section.

Line 145: fire risk -> fire danger

Response: This has been corrected.

Line 150: "or a best fit line", you mean a climatological estimation

Response: It means a regression line. The sentence has been clarified as follows: ...a best-fit regression line through its values over fire season.

Line 229 FRE should be defined

Response: The definition has been added in line 273:
In order to assess the predictive power of the method, comparisons are made between observed and predicted daily FREs (given by the time integral of temporal FRP over the period of a day) over the course of the dry season.

Figure 1. Left panels. There is clearly an annual cycle in the fire index chosen but a linear fit is used. Thus, December for exemple will have very unreasonable values. Can you comment on this ?

Response: The value of the meteo component, which is a part of the product of the three components of the FRP function Eq. (1) (the first component of the right hand side of the equation), becomes irrelevant outside fire season. The reason for this is that the FRP reference component (the middle component) is zero (or small) outside fire season (Fig. 1 right panels), which makes the entire FRP function zero.