REVIEW OF MANUSCRIPT NHESS-2023-211

"On the potential of using smartphone sensors for wildfire hazard estimation"

We thank the reviewer for his/her constructive criticism and comments on the paper. We have addressed all comments below and have made the appropriate changes to the revised manuscript.

Summary and recommendation

The manuscript presents a study of using smartphone-based T/RH measurements to estimate VPD and subsequently assess wildfire hazard. The use of smartphone-based data is certainly a novel aspect of the work presented and something that the wildfire community could examine in the future for assessing wildfire hazard or/and fire danger. However, despite the arguments presented by the authors in the manuscript, I, unfortunately, remain skeptical towards the added value of the proposed approach. I recommend to reconsider the manuscript for publication subject to a major revision that, in my view, would allow for better highlighting any possible added value of the proposed use of smartphone-based data for assessing the conduciveness of weather to wildfires.

This paper presents a proof-of-concept idea that is novel and should be expanded on by future researchers when better smartphone data is available. At the moment we are limited by the accessibility to smartphone data due to privacy issues, and hence this paper used anonymous data provided by a third party. With all the limitations of the data, we still feel this paper is worthy of publication due to the novelty of using smartphone sensors in estimating fire hazard and danger. The added value will occur when the high spatial resolution data will be available in real time to fire weather experts and forecast centers. This may be available to companies like Google, IBM, Microsoft, and others. So this paper provides a new direction for monitoring in real time fire weather indicators.

Major remarks

1. In L41, the authors claim that smartphone microsensor data "*ay provide additional and highly complimentary data*", as compared to traditional weather station data. Further, in L91-93, the authors state that "*smartphone sensors have the potential for providing useful information about VPD at high spatial resolution and high temporal resolution even in remote areas with few official weather stations*".

I am very worried that the analysis conducted by the authors and the results presented do not support the above two arguments made to support the added value of using smartphone data.

First, the authors conduct their analysis on a 1 x 1 degree grid, on which they interpolate the smartphone-based VPD estimates. This spatial resolution is too coarse for any assessment of wildfire hazard/danger and hence, the presented results cannot be used for supporting the authors' claim about smartphone microsensors providing information about VPD at high spatial resolution.

We started our analysis in the paper with comparisons with single weather station data in Israel (control experiments Figure 2) and in Spain (see Figure 3). Due to the difficulty of obtaining surface observations at the specific locations of the smartphones, we performed the control experiments (Figure 2) to show the ability of the smartphone sensors to measure environmental parameters reliably, and then we used two meteorological station in Spain for additional comparisons (point data) in Figure 3, showing the added value of the smartphone data to the normal meteorological stations, after simple calibrations.

The additional 1x1 degree analysis was performed on the regional scale due to the lack of smartphone data in many locations, and the variability of the data in space and time. We do not do any interpolation, only averaging. If there is no data, we do not present a value for VPD. For regions with lots of data we could use 0.1 degree boxes (~10km), but for the regional plots (due to a small amount of smartphones) we used 1 degree grids for better visualisation. We were also limited in in our case studies since the smartphone data available to us was only for the period of 2013-2017. Again, this paper is to show the value of these smartphone data in detecting anomalies in VPD. Having millions of data points in the future would allow us to show the VPD on much finer spatial scales. This is the vision for the future, but not possible with the data we have now.

Second, the authors computed gridded VPD data by taking the daily mean values of T and RH. This is a rather crude approach that introduces significant implications. By considering the daily mean T/RH values, the authors put together data that may have been collected both outdoors (daytime) and indoors (nighttime). In addition, there have been recent studies highlighting the importance of nighttime VPD for the effectiveness of fire suppression operations. During nighttime, fuels may recover part of their moisture content; when VPD remains high at night, this process is hindered and fuels' flammability remains high, thus supporting the rapid spread of fire. By taking a daily mean T/RH value to estimate a kind of daily mean VPD, this important information is neglected.

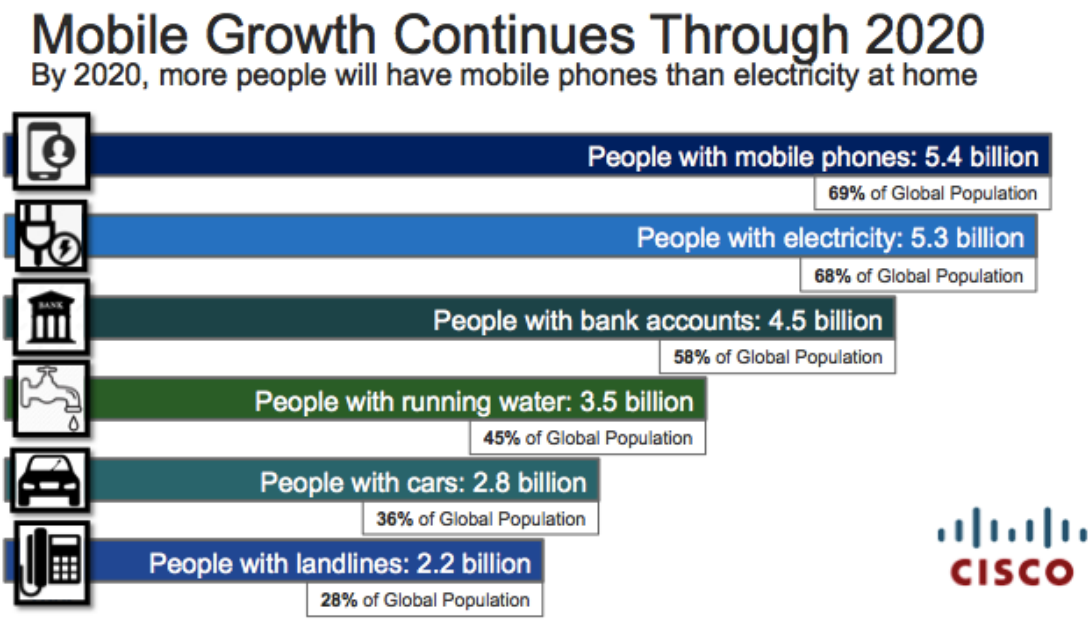
Good point. We appreciate and understand the finer diurnal dynamics of VPD and the impact on the fire hazard. Unfortunately, as mentioned above our data was limited to the WeatherSignal App data, and hence separating the data into day and night would have resulted in even less data per region and gridbox. We agree that ideally, we should separate the data to even hourly if possible. We have added

some discussion on this aspect of the diurnal VPD in the revised paper. We have added the reference to the recent paper by Balch et al. (2022)

Balch, J.K., Abatzoglou, J.T., Joseph, M.B. *et al.* Warming weakens the night-time barrier to global fire. *Nature* **602**, 442–448 (2022). https://doi.org/10.1038/s41586-021-04325-1

Third, smartphone data availability is directly related to the population density. Where more people gather, more data will be available. This typically includes populated areas and very less often remote areas. In addition, when the smartphone data are gathered from people located in an urban area, one should take into account that conditions may be significantly different from a remote, mountainous area. By using these data to assess conditions in another totally different environment (in terms of land cover, topography, etc.), one should be aware of the significant uncertainty introduced through the extrapolation of the data.

This comment is not clear to us. No extrapolation is done regionally. The training and testing data are for the same regions. The VPD is calculated for each gridbox individually, and ideally the calibration of the smartphone data will be done for each gridbox separately. Hence, an urban area will have it's own calibration and calculation of VPD, while a remote rural region will have it's own calibration and VPD values. However, the primary use and benefit of such a novel technique would be in remote regions where we have less meteorological measurements and infrastructures (and where fires may be more important) while also in developing countries, where in some locations there are more people with mobile phones than people with electricity or running water. See infographics below.



In summary, I highly encourage the authors to reconsider the entire structure of their work to better highlighted the possible added value of smartphone data for wildfire applications. Some suggestions may include:

- Decrease the spatial resolution of the grid on to which the smartphone data are interpolated, possibly to match the resolution of one of the publicly available reanalysis datasets (e.g., ERA5 at 0.25 x 0.25 degrees).

  As mentioned above, we have shown the agreement between the smartphones and individual weather stations in our paper (Figures 2 and 3). However, when looking at regional smartphone data from WeatherSignal, the distribution is not uniform in space or time. We have tried to grid the data at 0.25 degrees, but due to the low number of data points in each 0.25 gridbox, the results are much noisier. Given new data sets that may be available to Google, IBM, and others, this may be possible in the future. We added some discussion on this issue in the revised manuscript.

- Comparison of the smartphone-based VPD against ERA5-based (or any other data source) VPD and VPD obtained from interpolation from weather stations. This would allow evaluating whether smartphones can provide additional information or not.

  In the paper we DO present the comparison of VPD from the smartphones and ERA5 in Figures 10 (Israel) and 13 (Portugal)

- Refrain from averaging daily T/RH values and focus on examining nighttime/daytime data.

  As mentioned above, the scarcity of WeatherSignal data in each location limits what we can do with the present data. We added some discussion on this point for future researchers in this field. We had our hands tied since we did not collect the data ourselves, but were using a data set supplied to us, and collected originally for other purposes.