We would like to thank the reviewer for their comments. In summary, in this new revision we have removed any references to the semi-direct effect being the main contributor to the anomalies depicted in the Figures. However, we still indicate that our analysis shows that the aerosols are contributing to the temperature anomalies, as the heating rate associated with the aerosols is significant and positive, and is not due to changes in water vapor. We note that to estimate the exact contribution of the smoke aerosols to the meteorological anomalies, a modeling study must be conducted. We have also changed the title to "California Wildfire Smoke Contributes to a Positive Temperature Anomaly over the Western United States" to reflect that the heating rate contributes to the positive temperature anomaly, but removes any reference to a semi-direct effect occurring.

In addition, a few sentences have been edited for clarity or accuracy.

The CALIPSO discussion is also confusing. CALIPSO data is fairly coincident temporally and spatially (albeit with a narrower footprint) with Aqua. That's the whole preimise of the A-train! The use of MERRA-2 for BC profiles may very well be an improvement, but representativeness in this sense is not plausibly the reason.

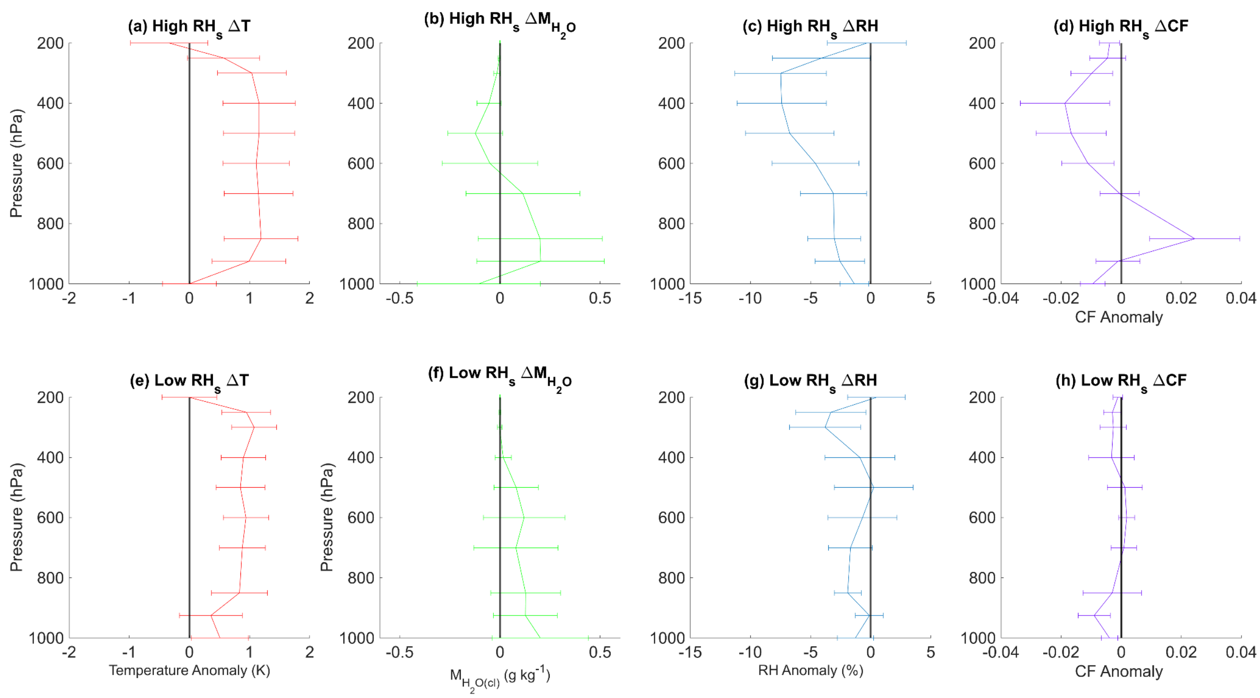
We apologize that this point was not made more clearly. The resolution of the gridded CALIPSO dataset is much too coarse to create profiles that are consistent with the AIRS generated profiles. Additionally, the gridded dataset is monthly. CALIPSO does not sample as large of an area as MODIS on the same overpasses, leading to missing data over wide regions on most days. This makes the MERRA-2 dataset more appealing, as it does not have missing data, and is available at finer timescales. Additionally, the MERRA-2 dataset is a finer resolution than MODIS, so it can be interpolated to 1 degree.

Additionally, CALIPSO started collecting data in 2006, while Aqua MODIS and AIRS data goes back to 2002. Therefore, the CALIPSO satellite is not temporally consistent with AIRS/MODIS in that the data is not available for the same time period.

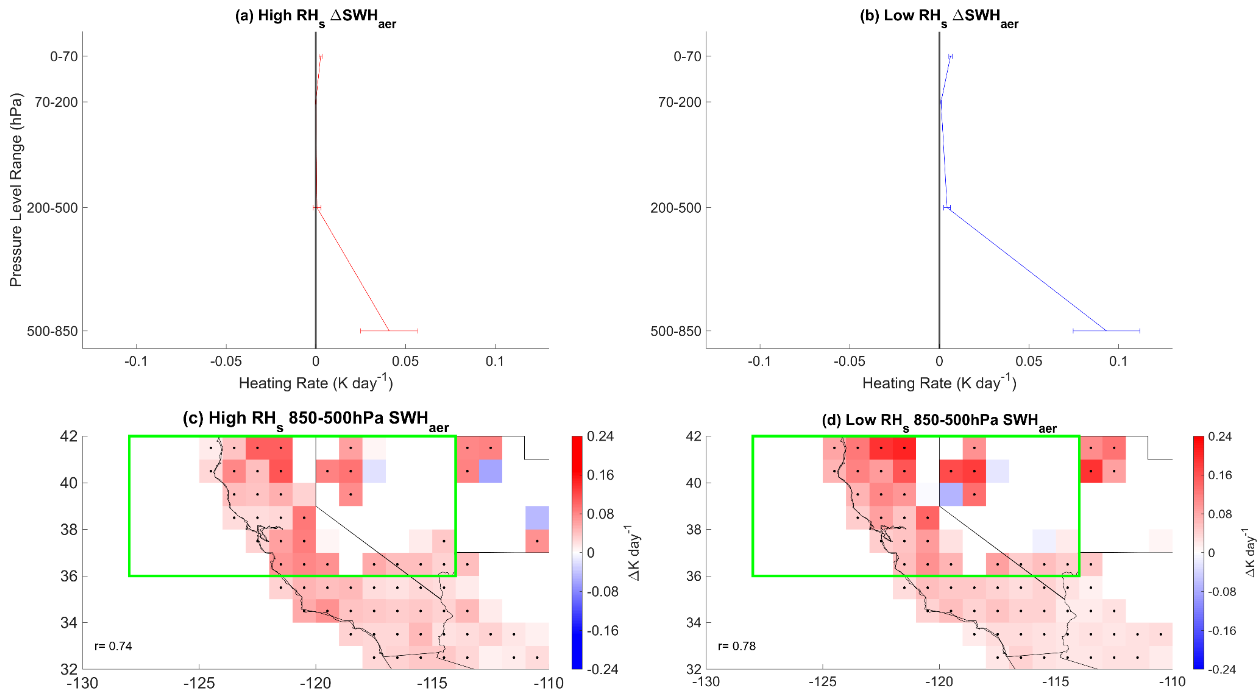
The heating rate discussion seems to assume that only DM could be contributing to the SW absorption, but water vapor could also both directly and via swelling of the aerosol particles and lensing effects.

We would like to thank the reviewer for this alternative interpretation of the dominant contributor to the heating rate. However, in the revision, this was already demonstrated to not be a possibility.

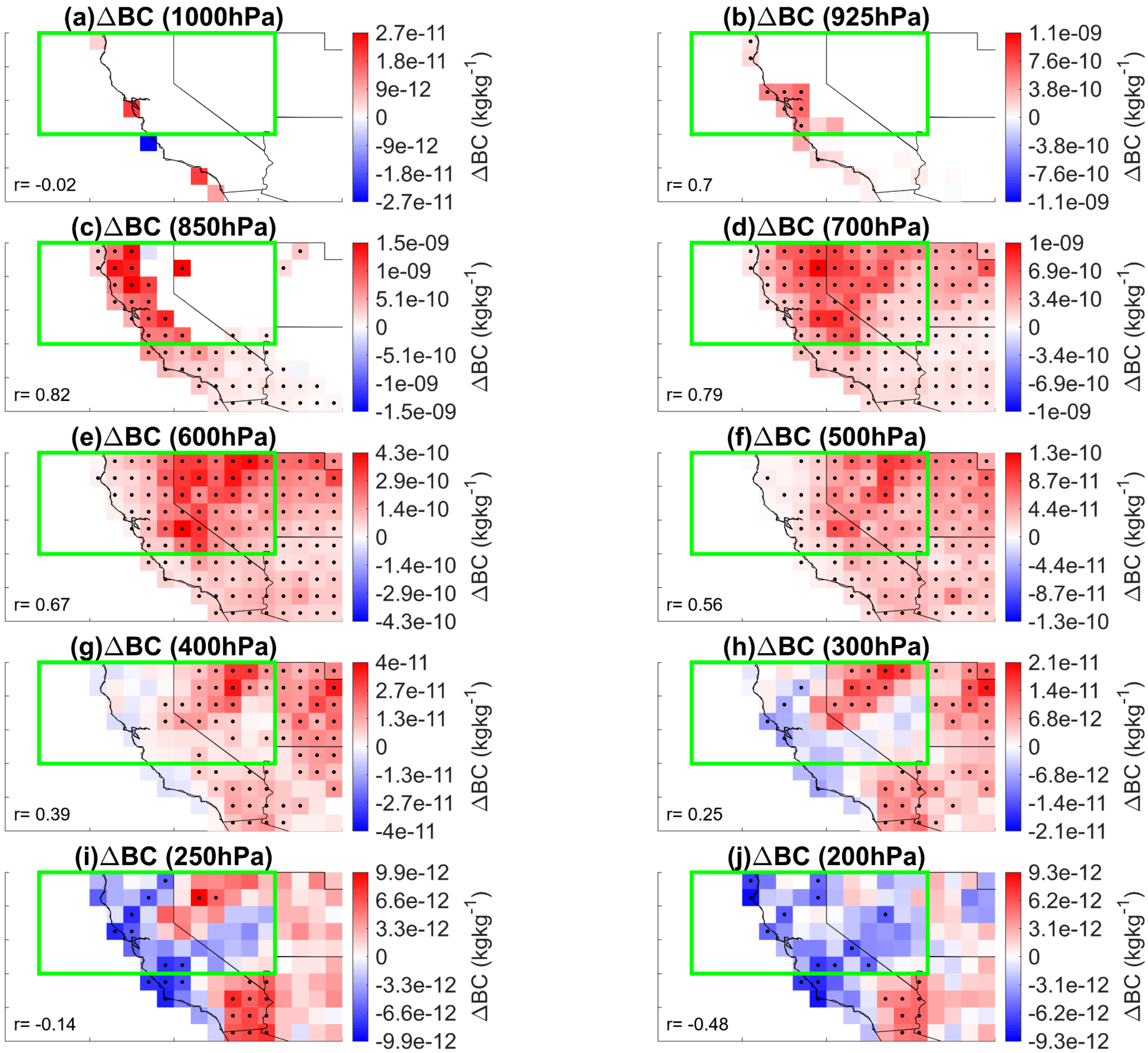
Below is Figure 6 from the revision. You may see that **regional average differences in specific humidity are insignificant throughout the troposphere, no matter the stratification (see panels b,f).** Therefore, this is not a valid explanation for the **significant** increase in aerosol shortwave heating. This has been made clearer in the revision. Therefore, the only plausible explanation is that the absorbing properties of the BC are leading to this absorption and heating. This heating rate therefore also addresses the issue of causality that is brought up. We can say with certainty that these aerosols therefore **contribute** to the observed temperature anomalies, and therefore likely contribute to the decrease in RH, though we don't know to what extent the aerosols contribute to these anomalies.



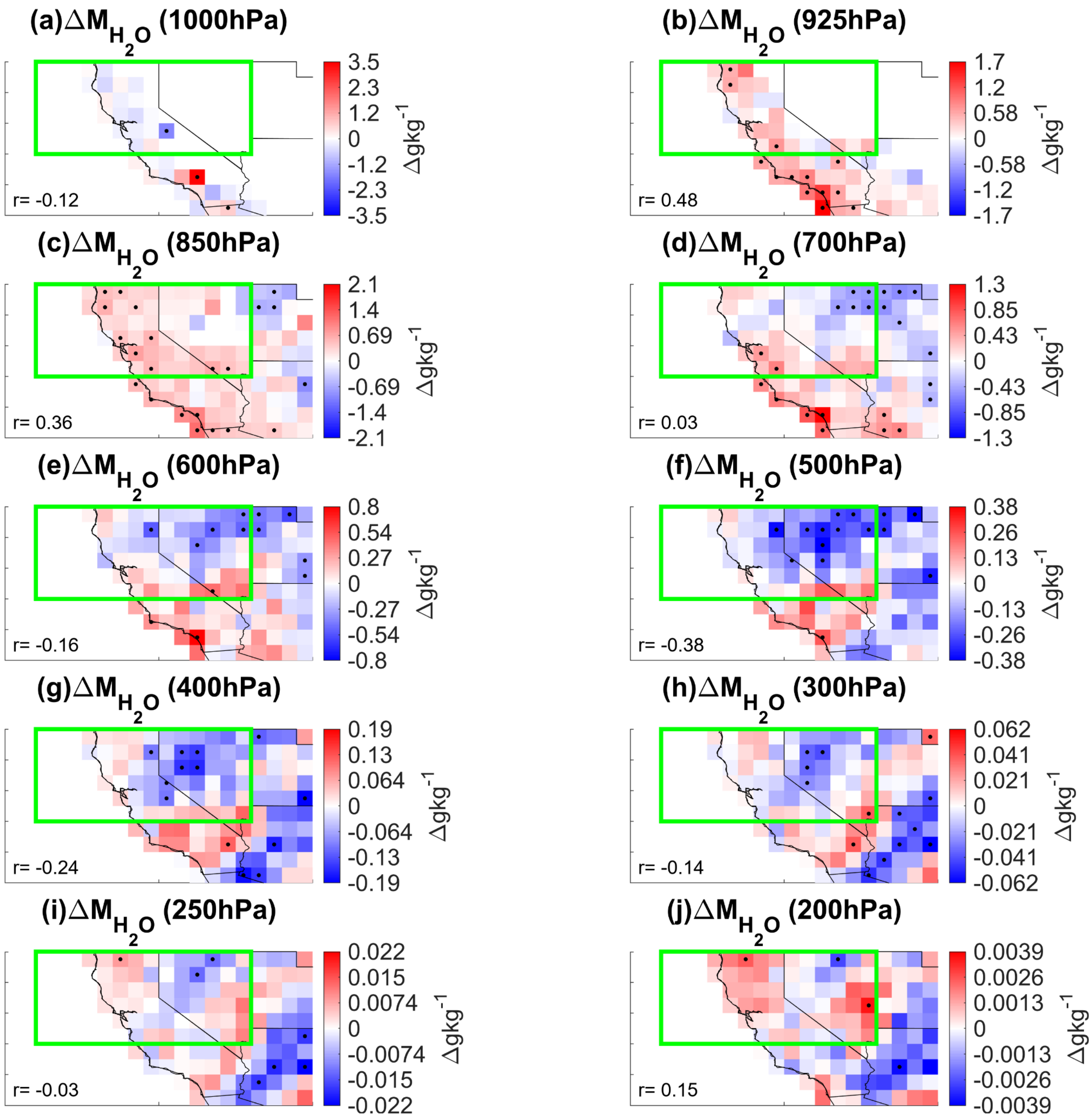
Furthermore, looking at a spatial scale, the heating rate from 850 hPa-500 hPa is spatially consistent with the widespread BC anomalies, not the scattered and scant significant water mass mixing ratio anomalies.



(a) High RH_s ΔSWH_{aer}
(b) Low RH_s ΔSWH_{aer}
Pressure Level Range (hPa)
0-70
70-200
200-500
500-850
-0.1
-0.05
0
0.05
0.1
Heating Rate (K day^{-1})
(c) High RH_s 850-500hPa SWH_{aer}
(d) Low RH_s 850-500hPa SWH_{aer}
r= 0.74
r= 0.78
42
40
38
36
34
32
-130
-125
-120
-115
-110
0.24
0.16
0.08
0
-0.08
-0.16
-0.24
ΔK day^{-1}



(a)ΔBC (1000hPa)
r= -0.02
2.7e-11
1.8e-11
9e-12
0
-9e-12
-1.8e-11
-2.7e-11
ΔBC (kgkg^{-1})
(b)ΔBC (925hPa)
r= 0.7
1.1e-09
7.6e-10
3.8e-10
0
-3.8e-10
-7.6e-10
-1.1e-09
ΔBC (kgkg^{-1})
(c)ΔBC (850hPa)
r= 0.82
1.5e-09
1e-09
5.1e-10
0
-5.1e-10
-1e-09
-1.5e-09
ΔBC (kgkg^{-1})
(d)ΔBC (700hPa)
r= 0.79
1e-09
6.9e-10
3.4e-10
0
-3.4e-10
-6.9e-10
-1e-09
ΔBC (kgkg^{-1})
(e)ΔBC (600hPa)
r= 0.67
4.3e-10
2.9e-10
1.4e-10
0
-1.4e-10
-2.9e-10
-4.3e-10
ΔBC (kgkg^{-1})
(f)ΔBC (500hPa)
r= 0.56
1.3e-10
8.7e-11
4.4e-11
0
-4.4e-11
-8.7e-11
-1.3e-10
ΔBC (kgkg^{-1})
(g)ΔBC (400hPa)
r= 0.39
4e-11
2.7e-11
1.3e-11
0
-1.3e-11
-2.7e-11
-4e-11
ΔBC (kgkg^{-1})
(h)ΔBC (300hPa)
r= 0.25
2.1e-11
1.4e-11
6.8e-12
0
-6.8e-12
-1.4e-11
-2.1e-11
ΔBC (kgkg^{-1})
(i)ΔBC (250hPa)
r= -0.14
9.9e-12
6.6e-12
3.3e-12
0
-3.3e-12
-6.6e-12
-9.9e-12
ΔBC (kgkg^{-1})
(j)ΔBC (200hPa)
r= -0.48
9.3e-12
6.2e-12
3.1e-12
0
-3.1e-12
-6.2e-12
-9.3e-12
ΔBC (kgkg^{-1})



The authors “assume linearity” to go from a 0.04-0.09 Kday−1 heating rate to “around a 0.4-0.9 K temperature anomaly.” I don’t understand why they would try to do the analysis in this way. Shouldn’t the heating rate itself be interpreted as the maximum change in temperature to be expected within one day due to shortwave absorption? I also have no idea why we would assume linearity holds for global-averaged values of lots of different regimes for BC perturbations versus the regional effects here.

This is a fair point, and we would like to thank the reviewer for this comment. We have removed this line. However we would like to reiterate that prior work indicates that our observed heating rate is consistent with another study that is regionally based. Thornhill et al., 2018 found that absorbing aerosols in a model, prescribed from aircraft observations, were associated with a maximum heating rate of 0.2 Kday-1, which is roughly 2x-5x that of the aerosol heating rate that we determined, which is consistent with their higher concentration of BC. They also witnessed a decrease in CF that was a similar magnitude to what we saw in our results, with significant negative CF anomalies of 0.08.

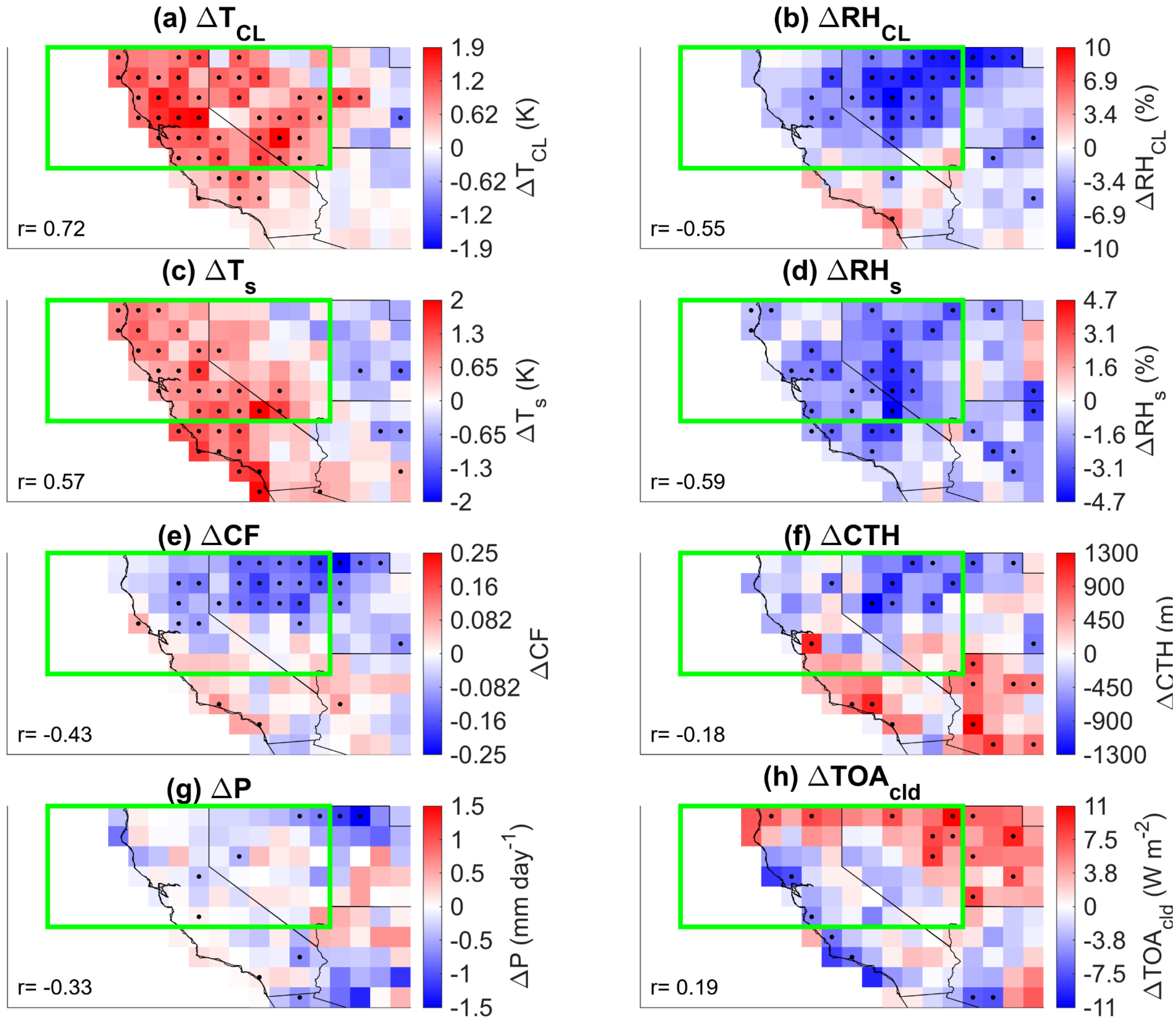
Are the authors sure that, within their RH quartiles, within-quartile variations in RH or other parameters aren't driving any of the observed meteorological differences between the high and low DM deciles? I don't see any analysis to rule this out. It would be difficult in any event, which is why it's hard to infer causality from observations in the first place!

The authors state that binning by the quantiles as they've done means the effect of "fires can be discerned independent of the meteorological conditions that come with high DM extremes", but this is simply not true in a rigorous sense. Pretty much all of my original objections still apply to the revised work. I therefore cannot recommend publication barring major revisions in analysis or framing.

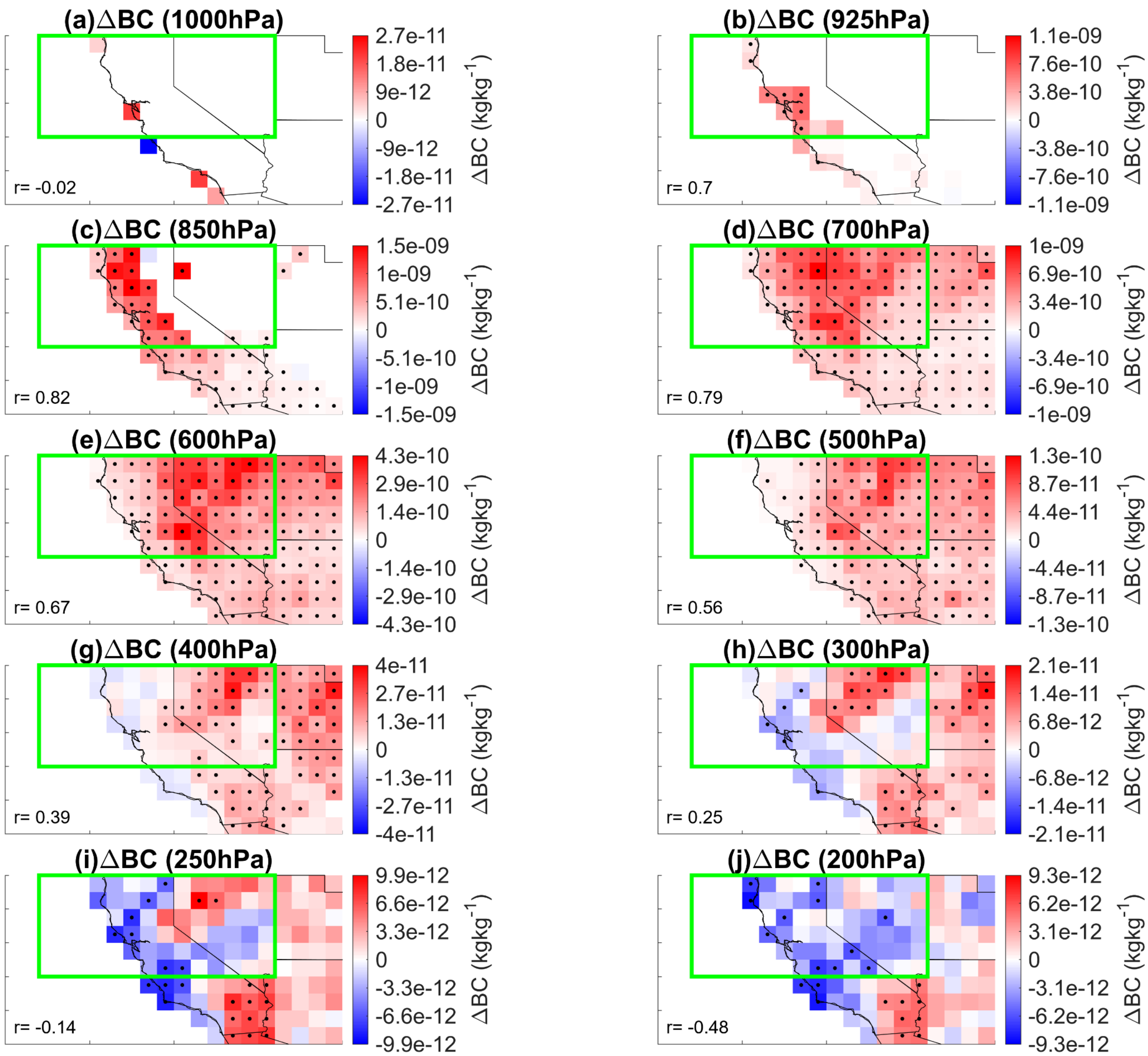
This is a fair point, and we will include the caveat that causality is difficult to discern using this method. However, there is evidence that the fires are contributing to the T anomalies outside of the anomalies present in this stratification alone.

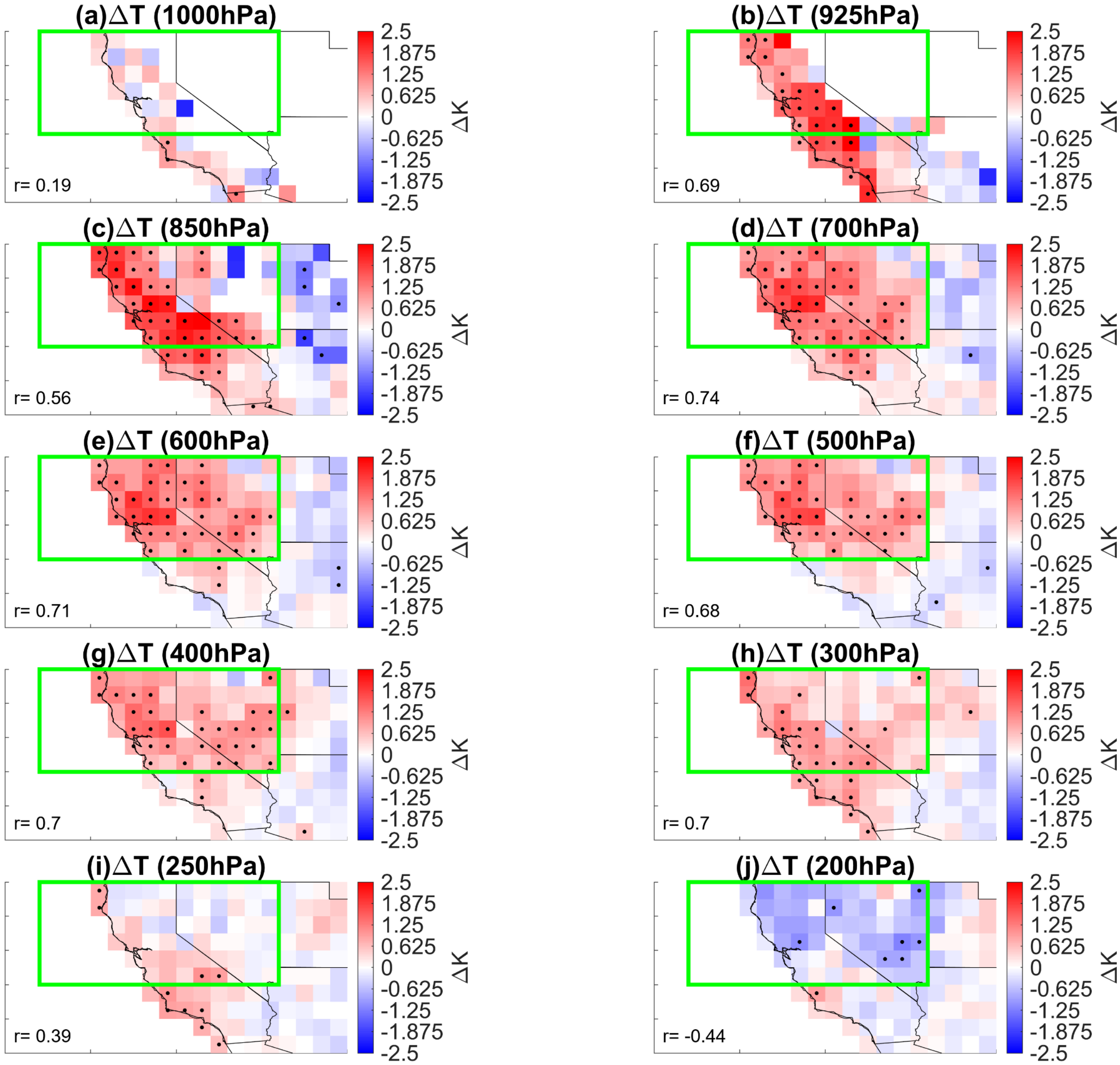
Firstly, there is the aforementioned aerosol heating rate. The fact that this heating rate is significant and positive, and we know it is not specific humidity driven, indicates that the aerosols are highly likely to be contributing to the temperature anomalies, at least from 850 hPa-500 hPa.

Additionally, in every spatial map, we have an r-value that depicts the cross correlation between AOD and the variable of interest. These cross correlations are generally statistically significant and large in magnitude, especially for cloud layer temperature, indicating that there is a relationship between intensified AOD and these anomalies in each gridcell.



Furthermore, the temperature spatial distribution, both horizontally and vertically, of the temperature anomalies are consistent with the location of the BC. See Figures 7 and 8 below, which depict BC and T and multiple vertical levels under the same conditions as the figures above. The spatial distribution of temperature anomalies and BC anomalies in CA and southern/eastern Nevada are spatially consistent, and the positive temperature anomalies generally become weaker and/or disappear at the same pressure levels that the positive BC anomalies become weaker and/or disappear.


(a)ΔBC (1000hPa)
2.7e-11
1.8e-11
9e-12
0
-9e-12
-1.8e-11
-2.7e-11
ΔBC (kgkg-1)
r= -0.02
(b)ΔBC (925hPa)
1.1e-09
7.6e-10
3.8e-10
0
-3.8e-10
-7.6e-10
-1.1e-09
ΔBC (kgkg-1)
r= 0.7
(c)ΔBC (850hPa)
1.5e-09
1e-09
5.1e-10
0
-5.1e-10
-1e-09
-1.5e-09
ΔBC (kgkg-1)
r= 0.82
(d)ΔBC (700hPa)
1e-09
6.9e-10
3.4e-10
0
-3.4e-10
-6.9e-10
-1e-09
ΔBC (kgkg-1)
r= 0.79
(e)ΔBC (600hPa)
4.3e-10
2.9e-10
1.4e-10
0
-1.4e-10
-2.9e-10
-4.3e-10
ΔBC (kgkg-1)
r= 0.67
(f)ΔBC (500hPa)
1.3e-10
8.7e-11
4.4e-11
0
-4.4e-11
-8.7e-11
-1.3e-10
ΔBC (kgkg-1)
r= 0.56
(g)ΔBC (400hPa)
4e-11
2.7e-11
1.3e-11
0
-1.3e-11
-2.7e-11
-4e-11
ΔBC (kgkg-1)
r= 0.39
(h)ΔBC (300hPa)
2.1e-11
1.4e-11
6.8e-12
0
-6.8e-12
-1.4e-11
-2.1e-11
ΔBC (kgkg-1)
r= 0.25
(i)ΔBC (250hPa)
9.9e-12
6.6e-12
3.3e-12
0
-3.3e-12
-6.6e-12
-9.9e-12
ΔBC (kgkg-1)
r= -0.14
(j)ΔBC (200hPa)
9.3e-12
6.2e-12
3.1e-12
0
-3.1e-12
-6.2e-12
-9.3e-12
ΔBC (kgkg-1)
r= -0.48



Due to all the above presented evidence, especially the positive aerosol heating rate, we are confident that the black carbon aerosols contribute to the temperature anomalies at the very least. We have included the caveat that while the aerosols are contributing to the temperature anomaly, we do not know to what extent they are, and by extent we do not know how they are affecting the RH or CF anomalies. We note in the discussion that there are other possible contributors to these anomalies, such as sensible heat release from the fires, the circulation anomaly over northeastern Nevada, or random weather fluctuations. We also now include the caveat that the stratification analysis does not completely remove the issue of causality. However due to the aformentioned heating rate of the aerosols, as well as the spatial consistency between the location of the aerosols and the T anomalies from 925 hPa-500 hPa, we are confident that the aerosols at least contribute to the temperature anomalies that are observed. We indicate that modeling is needed to determine the exact amount to which the smoke contributes to the increase in temperature, and decreases in CF/RH.