<u>Response to Reviewer #1</u>

We thank Reviewer #1 for their valuable and helpful comments. Our responses to the comments are provided below in bold font with the reviewer's comments in italicized font.

The paper reports a comprehensive study of the climate and air quality impacts of residential solid fuel combustion. The paper reports the first assessment of the impacts of carbonaceous aerosol from residential solid fuel combustion through changes in ice nuclei as well as a comprehensive assessment of aerosol indirect effects through changes in liquid clouds.

The paper makes an important contribution to our understanding of residential solid fuel combustion on climate and is suitable for publication in ACP. Importantly the manuscript highlights that the overall climate impact of carbonaceous aerosol from residential solid fuel combustion is uncertain and that even the sign of the impact is still ambiguous. The paper certainly motivates further study of this important issue and highlights where some of the major uncertainties lie.

The manuscript is very well written and clear. I only have a few minor comments. I suggest publication in ACP after the following minor comments have been addressed.

Minor Comments:

Page 5. Have you stated the size of the emitted carbonaceous aerosol? This is important for the impacts of carbonaceous aerosol on cloud condensation nuclei and aerosol indirect effects.

Response: We have added the size range of the emitted carbonaceous aerosols in the text (Page 5, Lines 155-156): "Specifically, BC and POM from solid fuel cookstove emissions are treated in the accumulation mode, with size range of 0.058-0.27 μm (Liu et al., 2012)."

Page 12. Most models do not simulate the impacts of BC on ice nuclei. I think it would be useful to provide a brief summary of how this was treated in the Methods section of the paper.

Response: We agree with the reviewer. We have moved part of the contents from Section 3.4.4 to a new section in Methods as Section 2.5 and added the description of BC as IN following Barahona and Nenes (2008, 2009) in the text (Page 7, Lines 197-212):

2.5 Simulations: BC active as IN

"In default CAM5-Chem, BC is not treated as IN (Liu et al., 2012; Tilmes et al., 2015). IN concentrations from homogeneous nucleation are calculated as a function of vertical velocity (Liu et al., 2007). Several lab and field studies indicate that BC particles can act as IN (Cozic et al., 2008; DeMott et al., 1999; Koehler et al., 2009; Kulkarni et al., 2016). Therefore, we conduct additional simulations that treat BC as an effective IN applying the ice nucleation scheme of Barahona and Nenes (2008, 2009). The scheme estimates maximum supersaturation and ice crystal concentrations and considers competition between homogeneous and heterogeneous freezing. Homogeneous nucleation occurs in solution droplets formed on soluble aerosols (mainly sulfate), while heterogeneous nucleation occurs on IN, which here are a small subset of mineral dust and black carbon particles. The heterogeneous freezing of BC and dust is described as a generalized ice nucleation spectrum.

We perform three additional model simulations, with model configurations identical to those in Table 2, except for the treatment of BC particles as effective IN. In addition, for each model simulation, we alter the plausible maximum freezing efficiency (MFE) of BC as 0.01, 0.05 and 0.1 that provides an uncertainty range in the global climatic impact assessment."

Page 15. As stated by the authors the aerosol indirect effect is considerably larger than other studies. Ward et al. (2012) also found a large aerosol indirect effect using the CAM model (although a different version) to study carbonaceous aerosol from fires. It might be useful to point this out in the text.

Response: We have added (Page 16, Lines 489-490): "Consistent with our study, Ward et al. (2012) also found a large AIE (-1.74 to 1.00 W m^{-2}) for carbonaceous aerosols from fires using CESM CAM4-Chem."

Fig. 4 and 5. Please clarify whether these are reported at ambient conditions or at standard temperature and pressure.

Response: We have clarified the reporting units for BC and POM under standard temperature and pressure, which have been added in the caption of Fig. 4 as (Page 36, Lines 916-917) "Figure 4. Annual zonal mean BC concentrations from (a) the BASE simulation, (b) the global and (c) India solid fuel cookstove emissions. BC concentrations are calculated under standard temperature and pressure conditions (273 K, 1 atm)."