Response to SC1

We thank Mr. Nowack for his comments. Our responses are itemized below.

1. "In reference to the comment in your short summary concerning previous studies on cloud adjustments to ozone forcing (also discussed in section 1 of your discussion paper), please see the opposing clear-sky and cloud radiative long-wave effects of upper tropospheric and lower stratospheric ozone changes and high clouds in
   • Nowack, P. J., Abraham, N. L., Maycock, A. C., Braesicke, P., Gregory, J. M., Joshi, M. M., Osprey, A., and Pyle, J. A.: A large ozone-circulation feedback and its implications for global warming assessments, Nature Climate Change, 5, 41–45, doi:10.1038/nclimate2451, 2015.
   Note in particular Figure 4 and the discussion on Supplementary Figure S6. Can you say more about the nature of the positive tropical ozone long-wave forcing you find?"

Response: The ozone change in our paper is an idealized stratospheric ozone recovery (SOR) scenario (see Figure 1), in comparison to the ozone depletion in the upper troposphere and lower stratosphere in Nowack2015 (Figure 3a). The warming in the tropopause induced by SOR results in the decrease of high clouds in UTLS, which is consistent with the increase of cloud seen in Nowack2015 (Figure 4). We have pointed this out in Section 5 in the revised paper.

One aspect of our idealized ozone prescription is that the ozone change is positive throughout the stratosphere, including the tropical UTLS region. This renders very positive forcing across all the latitudes. We have also pointed this out in the revised paper.

2. Finally, you mention in section 2 the representation of coupling between wind stress and sea ice dynamics in the model. Do you know whether the choice of a slab ocean model as compared to a deep ocean model could affect dynamical atmosphere-ocean interactions?

Response: A number of previous works (DeConto et al., 2007;Cvijanovic and Caldeira, 2015) investigated the role of sea ice with the slab-ocean model. Particularly, Danabasoglu and Gent (2009) compared the slab ocean and the fully coupled configurations of CCSM3 (similar configuration to ours) and showed that the slab ocean setup provides a good estimate of the climate sensitivity of the fully coupled model. Moreover, we compared our CAM3-slab ocean simulations results to the coupled atmosphere-ocean simulations by CESM1 (CAM5), the climatology and variability of the sea ice extent have similar magnitude in the slab-ocean model. All these suggest the sea-ice responses simulated in our experiments are likely valid, although, as we have acknowledged in the revised

Conclusion Section, it warrants further research to test the robustness of the sea ice, as well as cloud, responses across different models and in reality.

3. Out of interest, what part of the sea ice responses do you think is driven by the regional cloud forcings (in that sense the sea ice feedback and the regional cloud feedback are, as you say, partly related)?

Response: The sea ice and clouds are coupled components in the high latitude climate system, which implies their feedbacks are potentially related. It is beyond the scope of this paper to elucidate how they are coupled. However, in an accompanying study of us (Hu et al., 2016), we find both cloud and sea ice responses to SOR tend to cool the local surface climate. We have mentioned this in the revised paper.

In our results, cloud-induced decrease of downward IR is only a small part of the total downward IR decrease, less than one-third.

Reference:

Cvijanovic, I., and Caldeira, K.: Atmospheric impacts of sea ice decline in CO2 induced global warming, Climate Dynamics, 44, 1173-1186, 10.1007/s00382-015-2489-1, 2015.

Danabasoglu, G., and Gent, P. R.: Equilibrium Climate Sensitivity: Is It Accurate to Use a Slab Ocean Model?, J Climate, 22, 2494-2499, 2009.

DeConto, R., Pollard, D., and Harwood, D.: Sea ice feedback and Cenozoic evolution of Antarctic climate and ice sheets, Paleoceanography, 22, n/a-n/a, 10.1029/2006PA001350, 2007.

Hu, Y., Xia, Y., Liu, J., and Huang, Y.: Stratospheric ozone-induced indirect radiative effects on Antarctic sea ice, To be submitted to Nature - Climate Change, 2016.