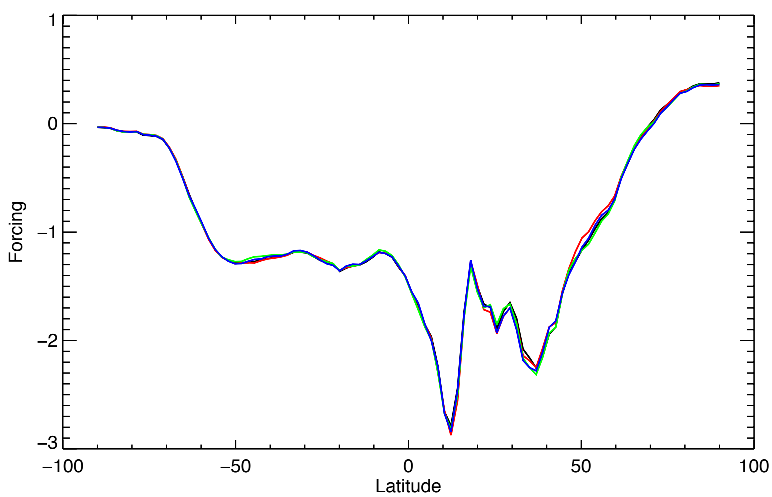
Response to reviewer 2

We would like to thanks the reviewers for their many helpful comments and appreciate their careful reading of this paper. We hope that their constructive reviews will lead to an improved paper. We will address the comments in the order received, highlighting them in italics.

(1)*Referee #2 makes the very helpful suggestion related to the sensitivity of results to time-varying species that are coupled to climate state.* We will add a section between the existing section 5 and section 6. This new section follows:

Sensitivity of aerosol radiative forcing to climate state.

Aerosol distributions and microphysical states may be correlated with cloud distributions and water vapor distributions. This could lead to errors in estimates of the radiative forcing, especially when coupled with the coarse time sampling. In CAM4 aerosols are implemented as a time series of monthly-average mean values, so we need to test the sensitivity of aerosol radiative forcing to climate. To test the sensitivity of radiative forcing of aerosols to climate, we sampled CAM model states for 4 years and computed the present-day radiative forcing of aerosols relative to no aerosols. Looking at annual



averages as can be seen in the Figure, the maximum deviation at any latitude from the 4-year zonal average is less than .08 W/m^2. This is in comparison to the global average forcing of -1.3 W/m^2. The global average forcing from any year is less than 0.003 W/m^2 different from the 4-year mean. As models advance to include more direct coupling between chemistry and climate, the sensitivity of PORT to the correlations between chemical state and climate will need to be reevaluated.

(2)*The abstract will be modified as follows*

The Parallel Offline Radiative Transfer (PORT) model is a stand-alone tool, driven by model-generated datasets, that can be used for any radiation calculation that the underlying radiative transfer schemes can perform, such as diagnosing radiative forcing. In its present distribution, PORT isolates the radiation code from the Community Atmosphere Model (CAM4) in the Community Earth System Model (CESM1). The current configuration focuses on CAM4 radiation with the constituents as represented in present- day conditions in CESM1, along with their optic properties. PORT also has an implementation of stratospheric temperature adjustment under the assumption of fixed dynamical heating, which is necessary to perform radiative forcing computations in addition to the simpler instantaneous radiative forcing. The model can be extended to use radiative constituents from other models, model simulations and/or other radiation models. As illustrations, we perform the computation of radiative forcing from doubling of carbon dioxide, from the change of tropospheric ozone concentration from year 1850 to 2000, and from aerosols illustrates the use of PORT. The radiative forcing from tropospheric ozone (with respect to 1850) generated by a collection of model simulations under the Atmospheric Chemistry and Climate Model Intercomparison Project is found to be 0.34 (with an intermodel standard deviation of 0.07) W/m**2**. Present day aerosol direct forcing (relative to no aerosols) is found to be -1.3 W/m**2**.

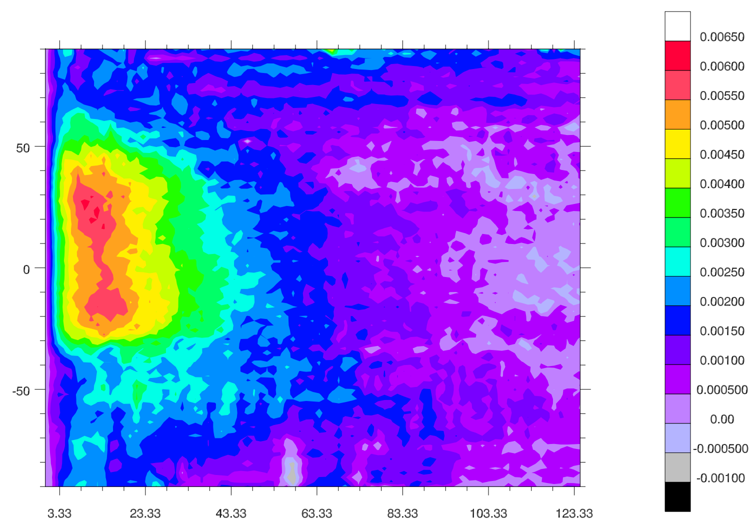
(3)*Fig1.caption*: We will add to the existing caption the following:

PORT uses the file cam4_base.nc that contains all fields needed to perform radiative computations with the CAM-RT radiative transfer scheme; these fields were generated by a present-day simulation with CESM1 and output every 73 time steps. This file therefore contains fields such temperature, humidity, clouds, albedo, aerosols, ozone, ... In the reference case (top row), the file cam4_base.nc is used as such. In the perturbation case (bottom row), a specific field (for example tropospheric ozone for year 1850) is replaced in cam4_base.nc (step 1). The two radiative calculations using PORT are therefore performed using those two separate files (step 2). The differencing of the radiation calculation results (step 3) leads to the estimate of the radiative forcing associated with the tropospheric ozone change. If users were interested in using PORT to compute ozone forcing for their model, they would replace the ozone field in the cam4_base.nc used for the reference case with their simulated 2000 ozone field, and replace the ozone field in the cam4_base.nc used for the perturbation case with their simulated 1850 ozone field. Steps 2 and 3 would then follow as indicated in Figure 1.

(4)Minor comments:

P2689, line 1: We will replace CFC with halocarbons. And we will include the statement: Aerosols implemented in PORT are identical to those implemented in CAM4. Any aerosol can be evaluated with PORT if the aerosol optics for the radiation package are available.
P2691, Eq4. Reviewer is correct. T_m should be T_p.
P2691, Eq7. The M in the term $Q(T - M * T_sa, c_p)$ is required. In the stratosphere, $T-M * T_sa = T_p$ and in the troposphere, $T - M * T_sa = T$. We will add the following sentence to help clarify for the reader: The mask, M, is a function of time, latitude, longitude, and altitude.

P2692, sec 3. This appears to be the same issue raised by Referee #1.
We believe that the added section (above) will answer that concern.
P2694, line 15: We agree. The section on aerosol radiative forcing elucidates the meaning of this sentence and it can now be removed.
P2694, line 22: We will modify the introductory paragraph of this section to state that the three targets are tropospheric, stratospheric, and combined forcing.
Fig 4 vs Table 1: Figure 4 is the relative error in the net flux at the tropopause, but Table 1 shows an error in the forcing. Since the forcing is 2 orders smaller, the relative error in the forcing can me much larger. We will replace Fig 4 with the following figure of error in flux and change the caption for Fig 4 to read: Plot of the error in net longwave flux at the tropopause due to time sub-sampling as a function of latitude and days. When CO_2 is doubled, the temperatures in the stratosphere relax over a period of 2 to 3 months. The difference between the net longwave flux due to sampling every time step and every 73rd time step in zonal average net flux at the tropopause is less than .006 **W/m**^{2} during this relaxation period.



Additional note: in the process of reviewing our results, the scale markings on Figure 3 are off by a factor of 2. We will provide a new figure with a corrected scale where the heating rates are twice as large. This was due to unit conversion error. This does not affect our conclusions.