Supporting Information

Ramanathan and Xu 10.1073/pnas.1002293107

SI Text

Data Source Used in the Model. Historical data used to run the energy balance model are from various data sources. CO_2 emission data (fossil fuel combustion and land use change from the Carbon Dioxide Information Analysis Center) is used as input for a carbon-cycle model (1) to generate CO_2 concentration trends. CH_4 and N_2O radiative forcing are directly retrieved from the RCP database (version 2.0). Aerosol or its precursor gases (BC, organic carbon, SO_2, NO + NO_2) emission data are also from the RCP database. Solar input change and land use change-induced radiative forcing are also included in the model. The historical radiative forcing attributable to each species is estimated based on its current radiative forcing, which is provided in the article by Forster et al. (2).

Projection of Radiative Forcing Attributable to Individual Species Not Explained in Text. CO_2 emissions in the BAU and mitigation cases are illustrated in Fig. 1*A* and Fig. S1*A*. N_2O radiative forcing is projected to increase by 50% at 2050, and no mitigation policy is proposed. CH_4 and CO emissions in the BAU case are projected to increase by 40% in 2030 (3). BC emission in the BAU case is expected to increase by 15% by 2015 and to level off afterward. Organic carbon emission is projected to decrease by 35% if mitigation takes effect because it has a similar source of emission as BC. CH_4, CO, and BC mitigation is explained in the text. As a result of the Montreal Protocol, radiative forcing from CFCs is projected to decrease by half by 2050. Radiative forcing from HFCs is projected to increase by 0.3 Wm^{-2} by 2050 if no mitigation policy is adopted.

1. Ramanathan V, Carmichael G (2008) Global and regional climate changes due to black carbon. *Nat Geosci* 1:221–227.
2. Forster P, et al. (2007) Changes in atmospheric constituents and in radiative forcing. *Climate Change 2007: The Physical Sciences Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, eds Solomon S, et al. (Cambridge Univ Press, Cambridge, UK), pp 129–234.
3. Cofala J, Amann M, Klimont Z, Kupiainen K, Hoglund-Isaksson L (2007) Scenarios of global anthropogenic emissions of air pollutants and methane until 2030. *Atmos Environ* 41:8486–8499.

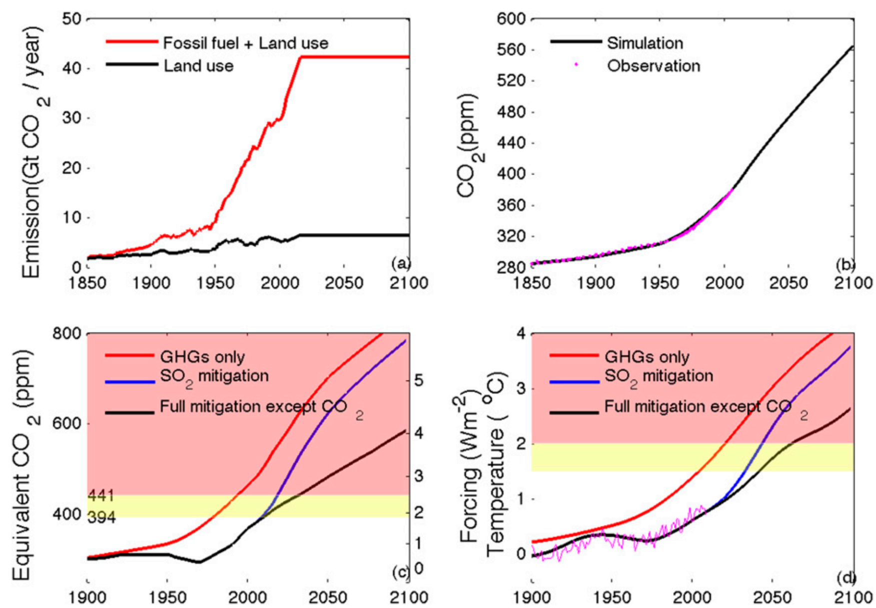

Fig. S1. CO_2 BAU case. CO_2 emission is projected to stay constant after 2015 rather than to decline, as in Fig. 1*A*, attributable to mitigation policy, which will lead to a CO_2 atmospheric concentration of 565 ppm at the end of the 21st century. In the CO_2 BAU case, even with mitigation of other GHGs and BC, the temperature will exceed 2 °C (black line in *D*). If there is no mitigation of other GHGs and BC, it will rise up to 4 °C (blue line in *D*). This highlights the importance of CO_2 mitigation as the first avenue to solve global warming problem.

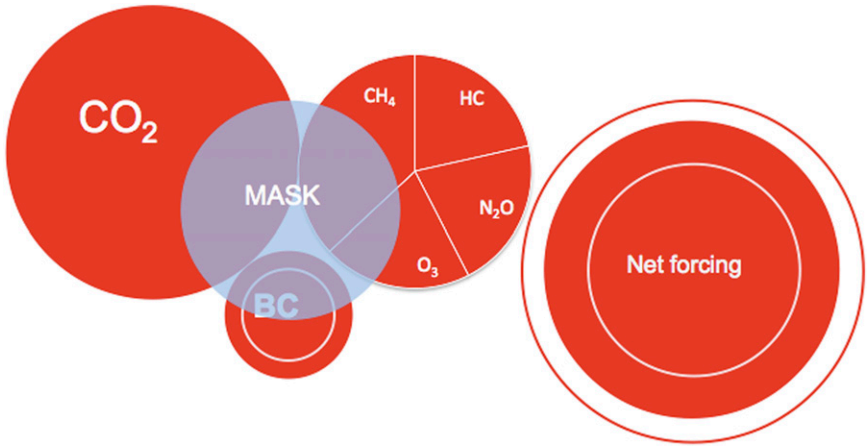

Fig. S2. Radiant energy addition in 2050. The pie charts shown here are similar to those in Box 2 but for the year 2050 for the FMA case. The pie charts for 2100 are almost identical to those shown for 2050, because, except for CO_2, the concentrations of all other species do not change after 2050. The CO_2 concentration does not change much after 2050 (Fig. 1*B*). The area of each red-shaded circle is proportional to the energy addition. From the preindustrial era to 2050, CO_2 (2.3 Wm^{-2}) and the non-CO_2 GHGs (1.0 Wm^{-2}) have added 3.3 Wm^{-2} of radiant energy. The BC energy addition is 0.45 Wm^{-2}, and the SON_Mix is −1.3 Wm^{-2}.