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Supplementary Materials for

Irreversible Does Not Mean Unavoidable

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The relationship between cumulative emissions and temperature change, and its independence of the timescale in question, can be seen in Figure S1, which shows the temperature change produced by every ton of carbon emitted (or every 3.7 tons of CO_2), for four different RCP (Representative Concentration Pathways) scenarios, between 2015 and 2030, 2065 and 2100. On all three timescales represented here, the warming per unit CO_2 emitted is approximately the same across all emissions scenarios. Hence, this decade's CO_2 emissions will define the increase of CO_2-induced global warming that occurs in this decade. This near-constancy of the temperature response to cumulative emissions means that the increased CO_2-induced warming in both the near-term (2030) and long-term (2100) will be determined primarily by the cumulative CO_2 emitted in each decade of this century.

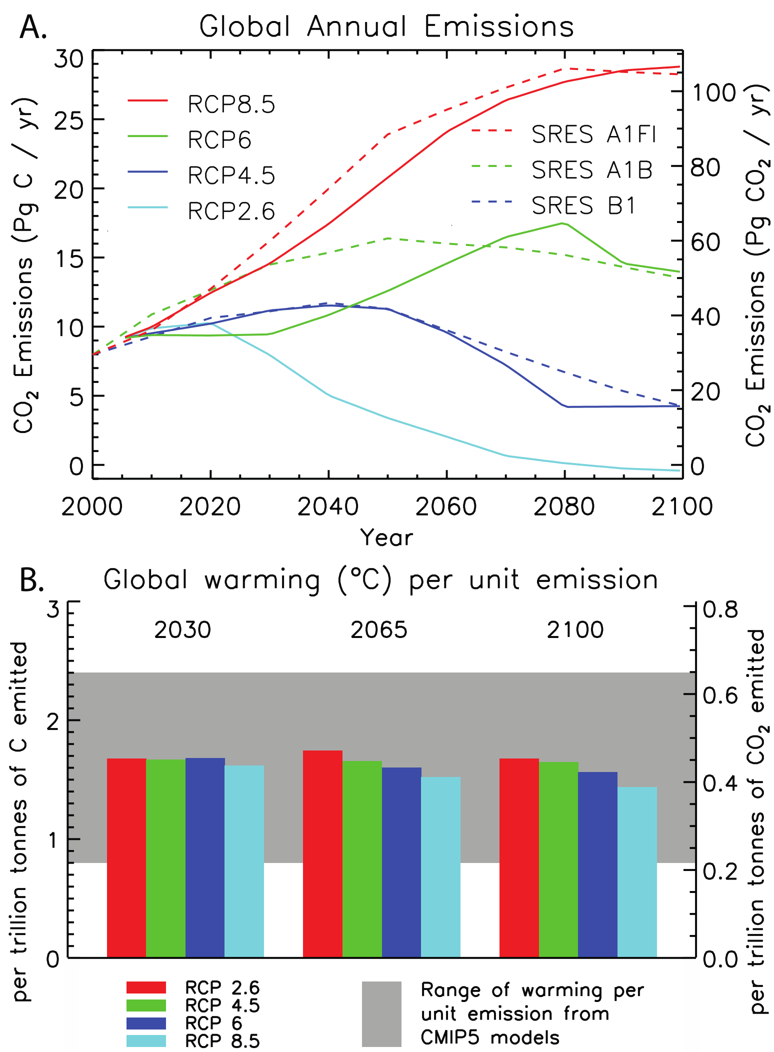

Figure S1. Global annual CO_2 emissions (A) and temperature change per unit CO_2 emission (B) for four Representative Concentration Pathway (RCP) scenarios. Each tonne of CO_2 emitted results in approximately the same increase in global temperature, regardless of either scenario or time interval. Therefore, simulated warming over the near-term (2015-2030) medium term (2015-2065) and the long-term (2015-2100) depends on the cumulative CO_2 emitted during the time interval in question (with some decrease in the per-unit-emission climate response to larger cumulative emissions(*1*)). Temperature changes plotted here were simulated using the University of Victoria Earth System Climate Model(*2,3*); the gray shaded region shows the range of temperature responses to cumulative CO_2 emissions from current CMIP5 global climate models(*4*). The version of the UVic model used here does not include representation of permafrost carbon pools, which could contribute to some amount of additional long-term warming commitment, though this feedback is not a significant contributor to near-term warming(*5*).

Cumulative emissions for the four RCP scenarios shown in Figure S1A, as well as three SRES scenarios (Special Report on Emission Scenarios), which are broadly comparable to the RCP scenarios RCP4.5, RCP6 and RCP8.5, are shown in Figure S2. Also shown are SRES cumulative emissions by region (Annex 1 vs. non-Annex countries: Figure S1B) as well as per capita cumulative emissions by region (Figure S1B). While total future cumulative emissions from developing (non-Annex) countries (dotted lines in B and C) are expected to exceed soon those from developed (Annex 1) countries (dashed lines in B and C), this is not the case for per capita cumulative emissions. In all scenarios, per capita cumulative CO_2 emissions and consequent contributions to global temperature change remain far higher for individuals living in developed countries than for those in developing regions. In addition, for most of the next century, these scenarios suggest that non-Annex countries are expected to develop on approximately five times less cumulative carbon per person compared to per capita cumulative CO_2 emissions in the developed world.

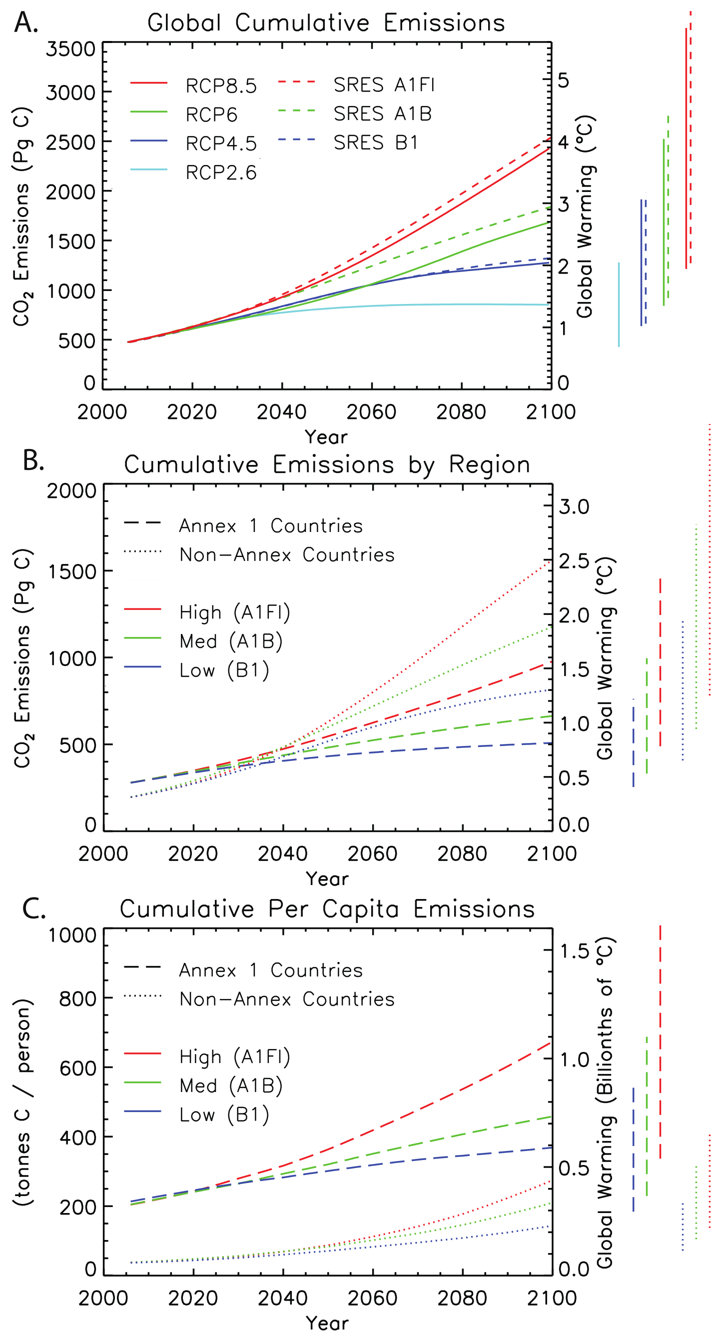

Figure S2. Global cumulative CO_2 emissions (A), cumulative emissions by region (B) and cumulative per capita emissions (C) for three SRES and four RCP scenarios. For each scenario, CO_2-induced global warming is plotted on the right axis, using a multi-model average of 1.6 °C(*1*) (axis values), and an inter-model range for CMIP5 models of 0.8-2.4 °C(*4*) (vertical bars) per trillion tonnes of carbon emitted.

References

1. H. D. Matthews, N. P. Gillett, P. A. Stott, K. Zickfeld, *Nature* **459**, 829–832 (2009).

2. A. J. Weaver *et al.*, *Atmos Ocean* **39**, 1–67 (2001).

3. M. Eby *et al.*, *Journal of Climate* **22**, 2501–2511 (2009).

4. N. P. Gillett, V. K. Arora, H. D. Matthews, M. R. Allen, *Journal of Climate*, in press (2013).

5. A. H. MacDougall, C. A. Avis, A. J. Weaver, *Nature Geoscience* **5**, 719–721 (2012).