

**On the Correspondence between Atmosphere-Only and Coupled Simulations for Radiative Feedbacks and Forcing from CO<sub>2</sub>**

Yi Qin<sup>1</sup>, Mark D. Zelinka<sup>1</sup>, Stephen A. Klein<sup>1</sup>

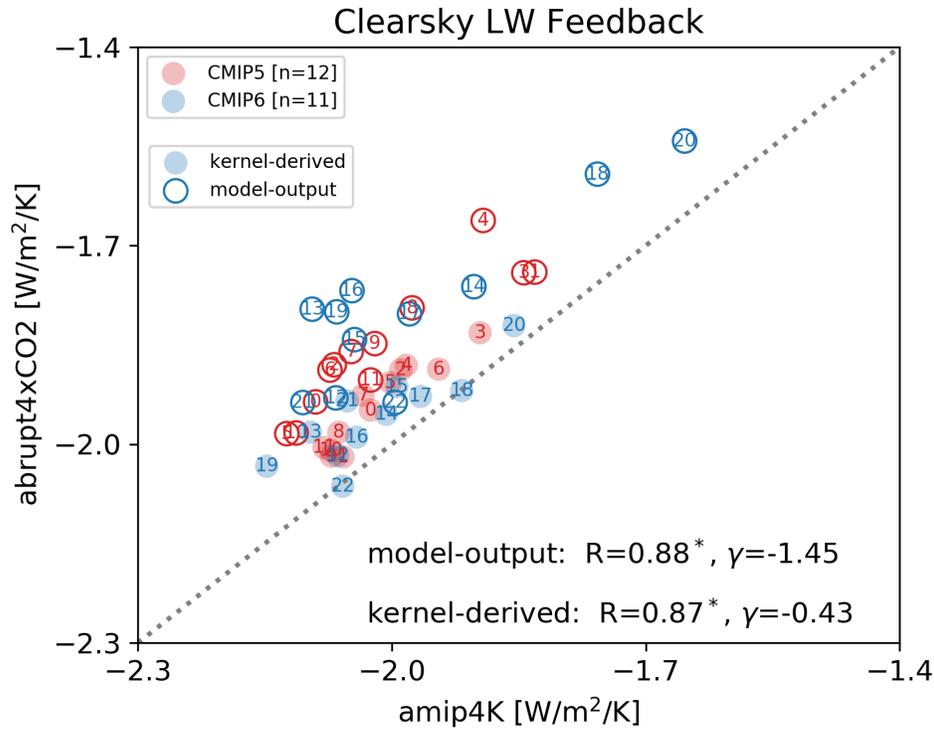
<sup>1</sup>PCMDI/Lawrence Livermore National Laboratory, Livermore, CA, USA

**Contents of this file**

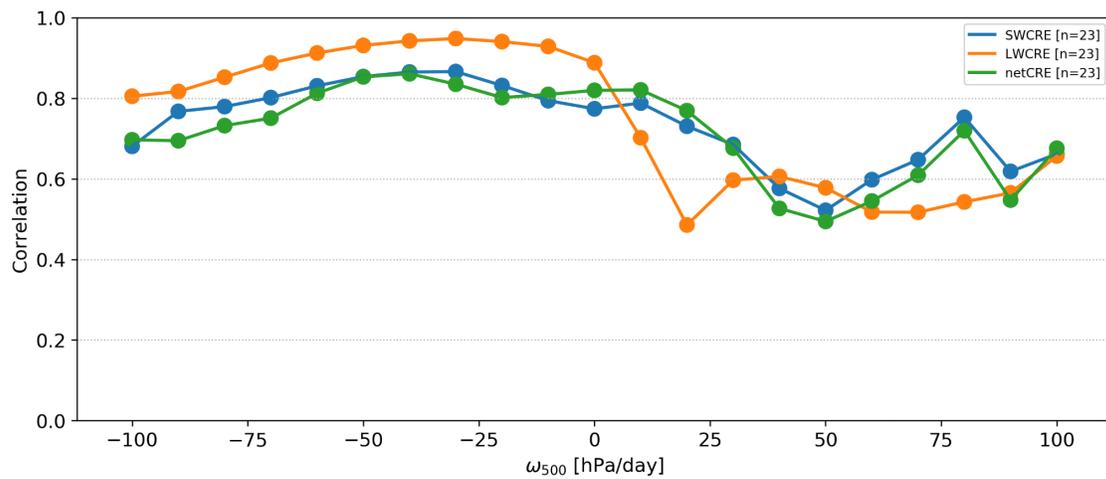
Figures S1 to S10

**Introduction**

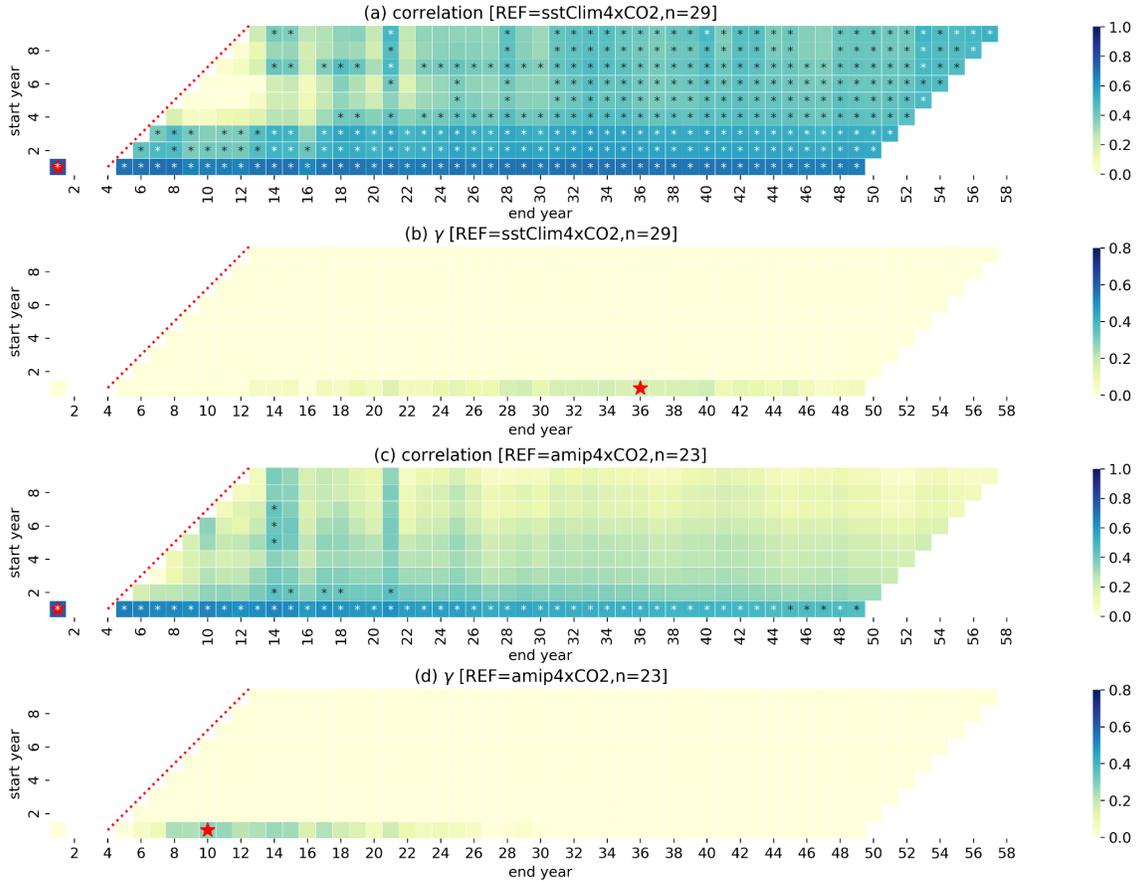
In this Supporting Information, we provide additional figures that support the results in the main text (Figure S1-S10).



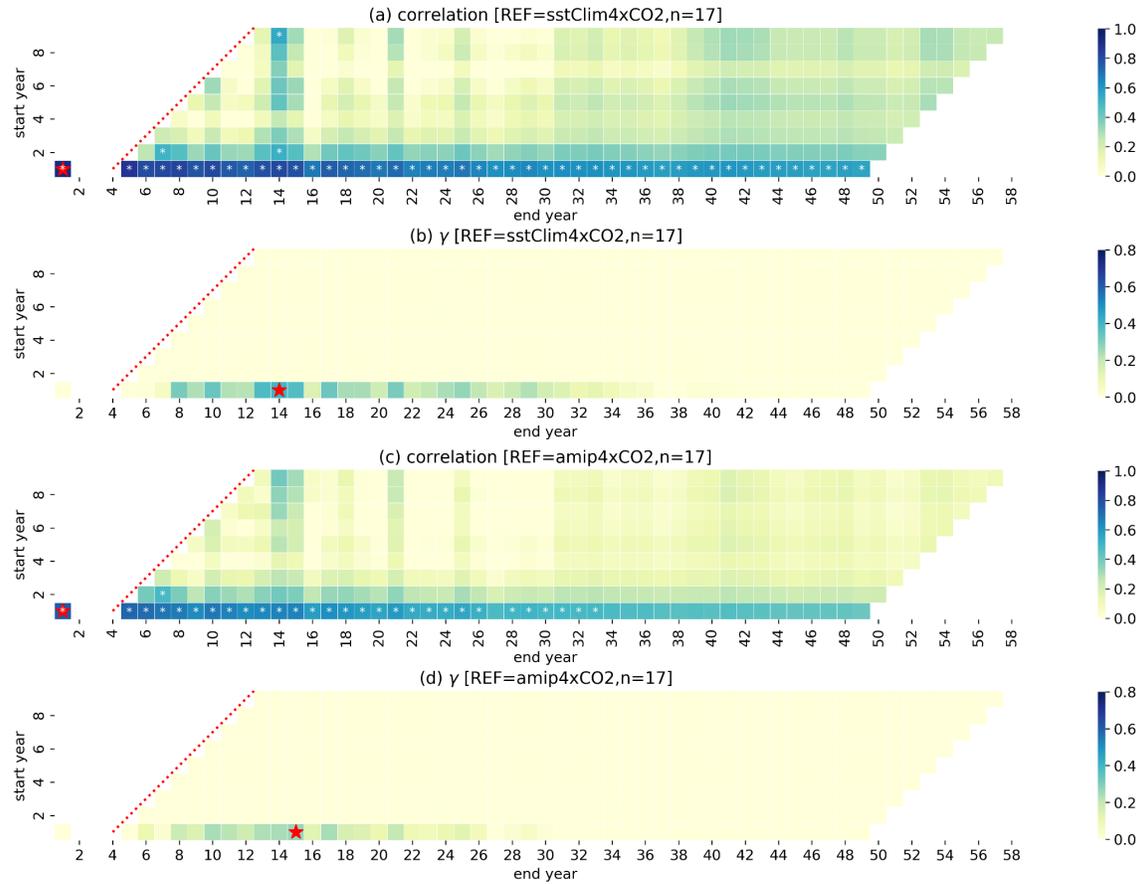
**Figure S1.** Global-mean net clear-sky LW radiative feedbacks ( $\text{W/m}^2/\text{K}$ ) calculated by adding contributions from primary contributors (water vapor, surface temperature, atmospheric temperature) determined using the radiative kernel method (filled markers) and directly calculated by the model output (unfilled markers) compared between amip4K and fully coupled abrupt4xCO<sub>2</sub> experiments. Red and blue dots denote CMIP5 and CMIP6 models respectively. Models used in later radiative kernel and cloud radiative kernel analysis are labelled by numbers as denoted in Table 1 and 2.



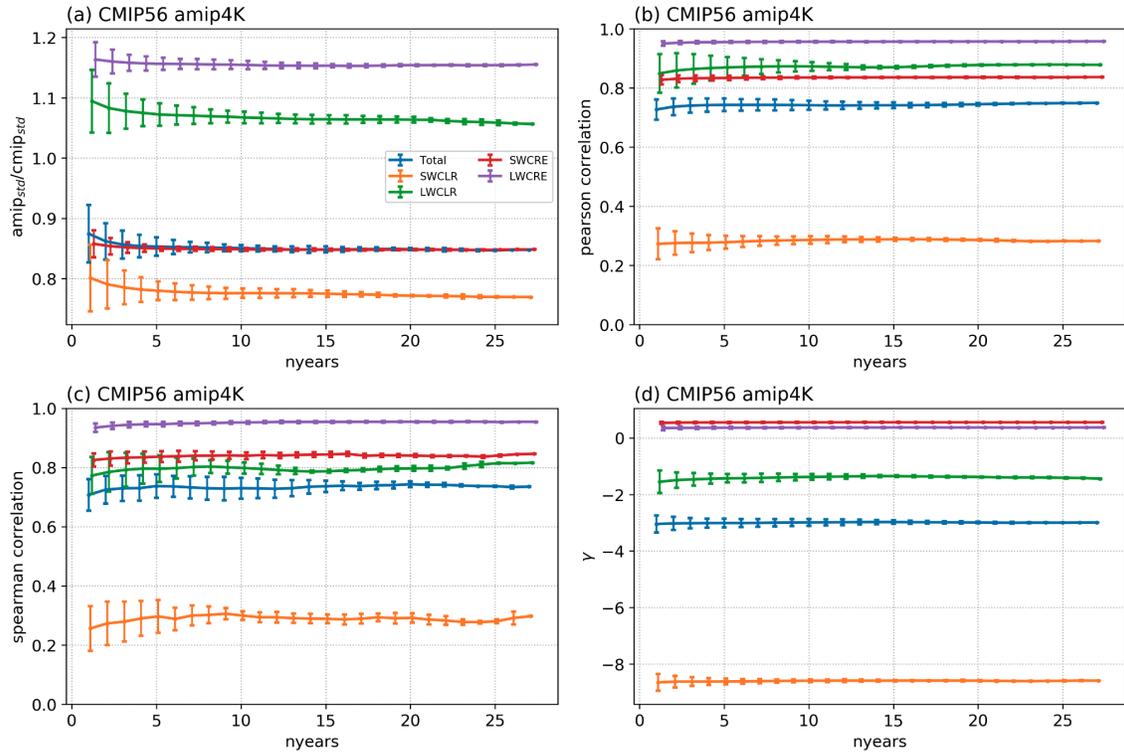
**Figure S2.** Across-model correlation of tropical (30°S-30°N) ocean unadjusted SW (blue), LW (orange) and net (green) CRE feedbacks (amip4K minus amip; abrupt4xCO<sub>2</sub> minus piControl) between amip4K and coupled experiments in each 500 hPa vertical velocity regime. Correlation coefficients significant at the 95% confidence level are marked by solid dots.



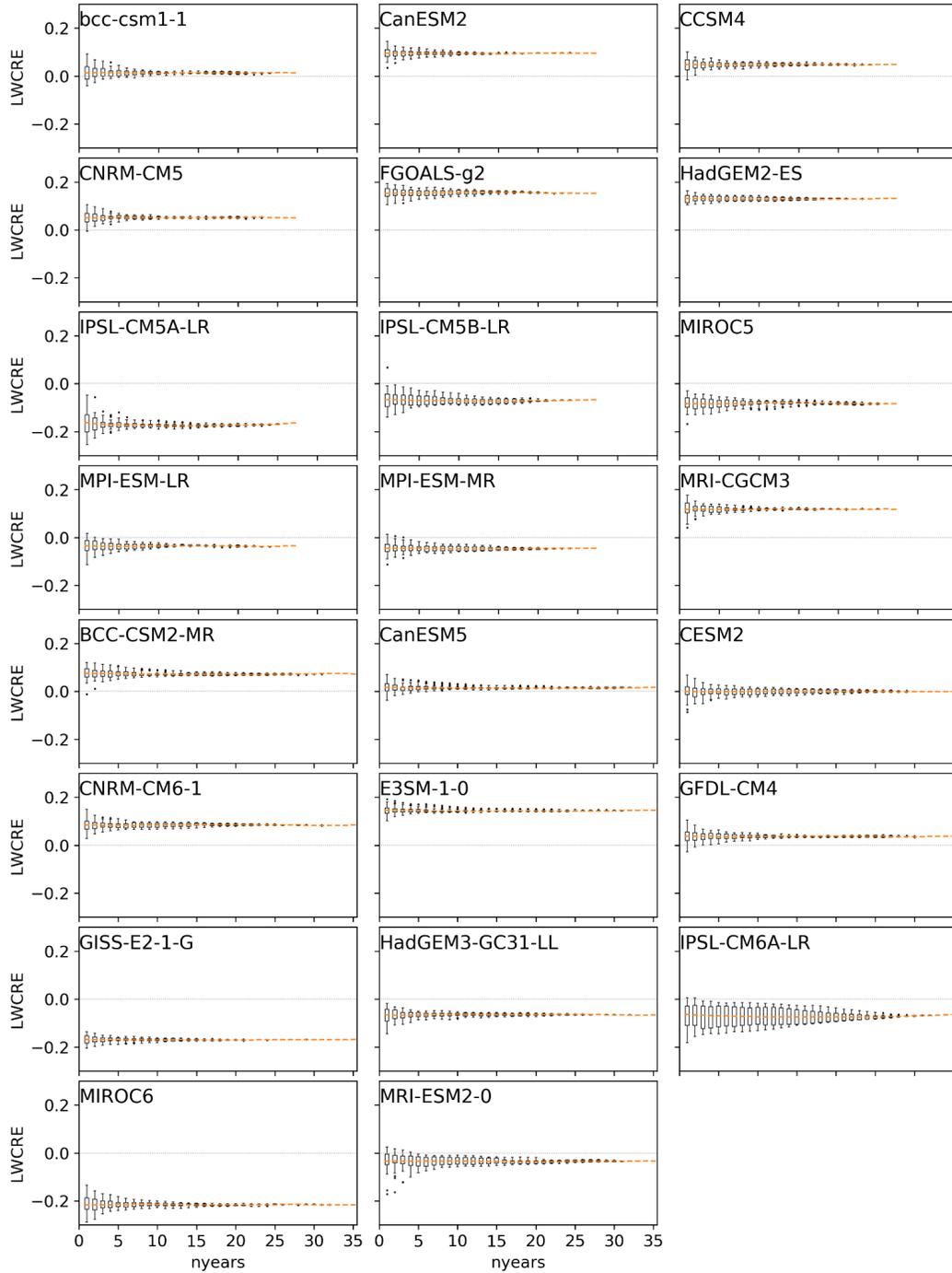
**Figure S3.** The (a, c) correlation and (b, d)  $\gamma$  matrix between (a-b) sstClim4xCO<sub>2</sub>/ (c-d) amip4xCO<sub>2</sub> forcing and coupled forcing derived using varying starting and end years. The selected minimum length of coupled experiments is 5 years (red dotted lines). Single asterisk indicates correlations significant at the 95% level. Red stars denote the largest correlation/ $\gamma$ . The starting year ranges from 1 to 10 and the total duration considered ranges from 5 to 50. The year-1 coupled radiation anomaly is also considered.



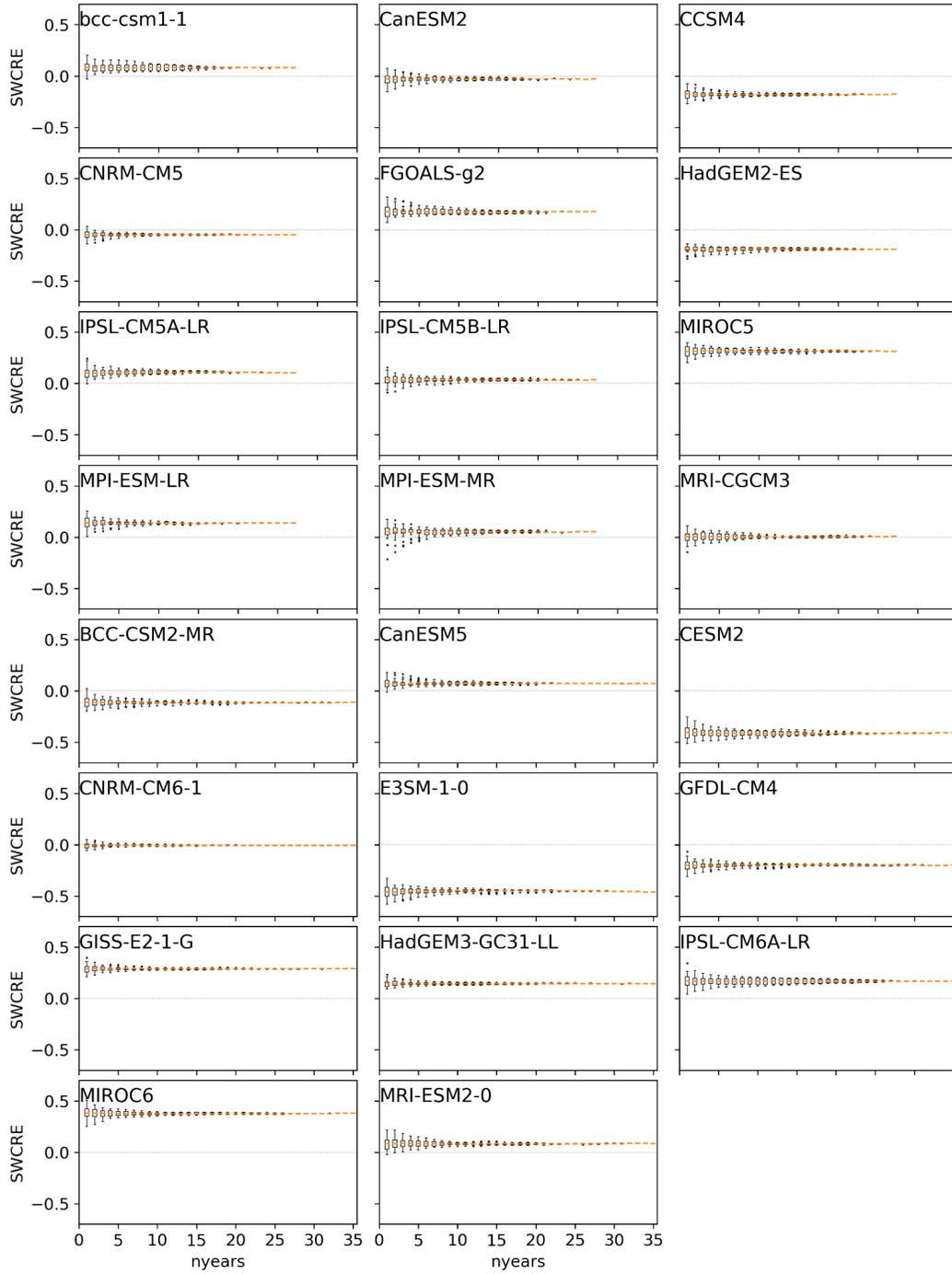
**Figure S4.** As in Figure S3, but for those models with both sstClim4xCO<sub>2</sub> and amip4xCO<sub>2</sub> experiments.



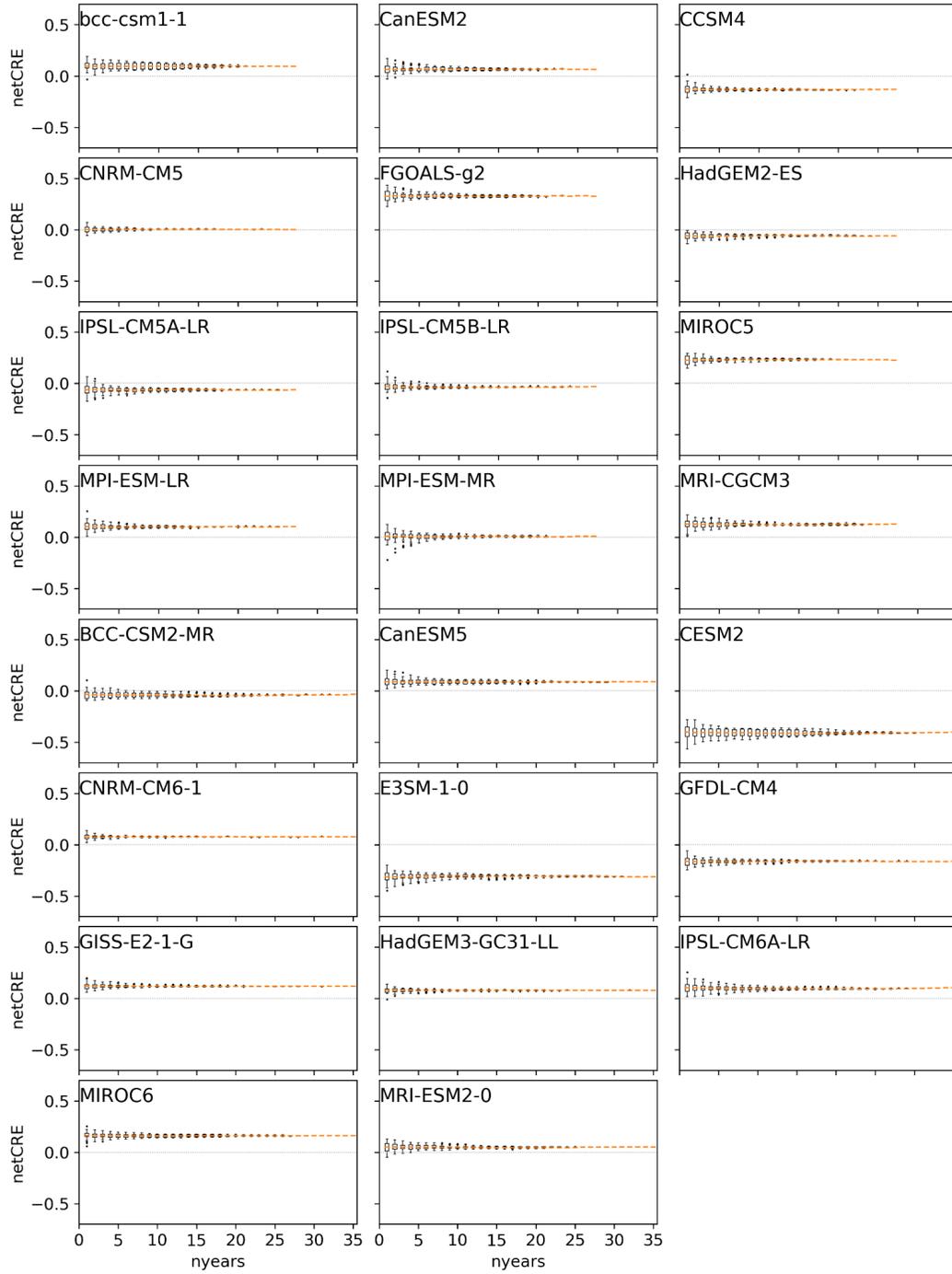
**Figure S5.** (a) the ratio of amip4K cross-model standard deviation (std) to abrupt-4xCO<sub>2</sub> cross-model standard deviation, (b) Pearson linear correlation coefficient, (c) Spearman rank correlation coefficient and (d)  $\gamma$  for (blue) total, (orange) SWCLR, (green) LWCLR, unadjusted (red) SWCRE and (purple) LWCRE feedbacks between abrupt4xCO<sub>2</sub> and amip4K experiments as a function of years used to calculate amip4K cloud feedbacks. The error bar denotes the standard deviation of each variable due to the variation of selected time slices.



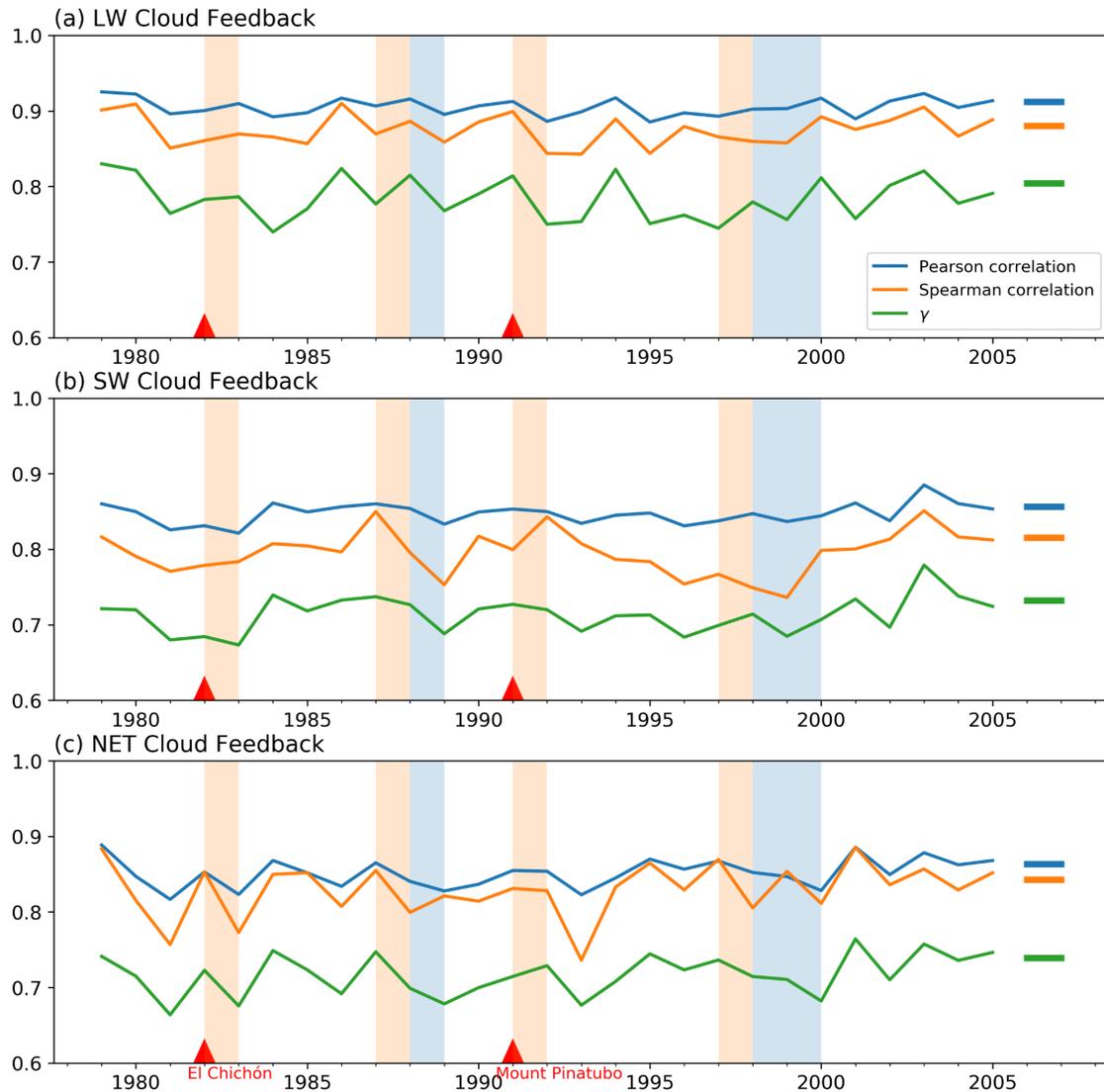
**Figure S6.** The adjusted LWCRE feedback ( $W/m^2/K$ ) difference between amip4K and coupled experiments as a function of years used in calculating amip4K feedbacks for available CMIP models. The box extends from the 25th percentile (Q1) and 75th percentile (Q3) with the horizontal line at the mean. The whiskers indicate the range of the nonoutliers [outliers are either  $> (Q3 + 1.5 * IQR)$  or  $< (Q1 - 1.5 * IQR)$ ;  $IQR = Q3 - Q1$ ]. Outliers are plotted as separate dots.



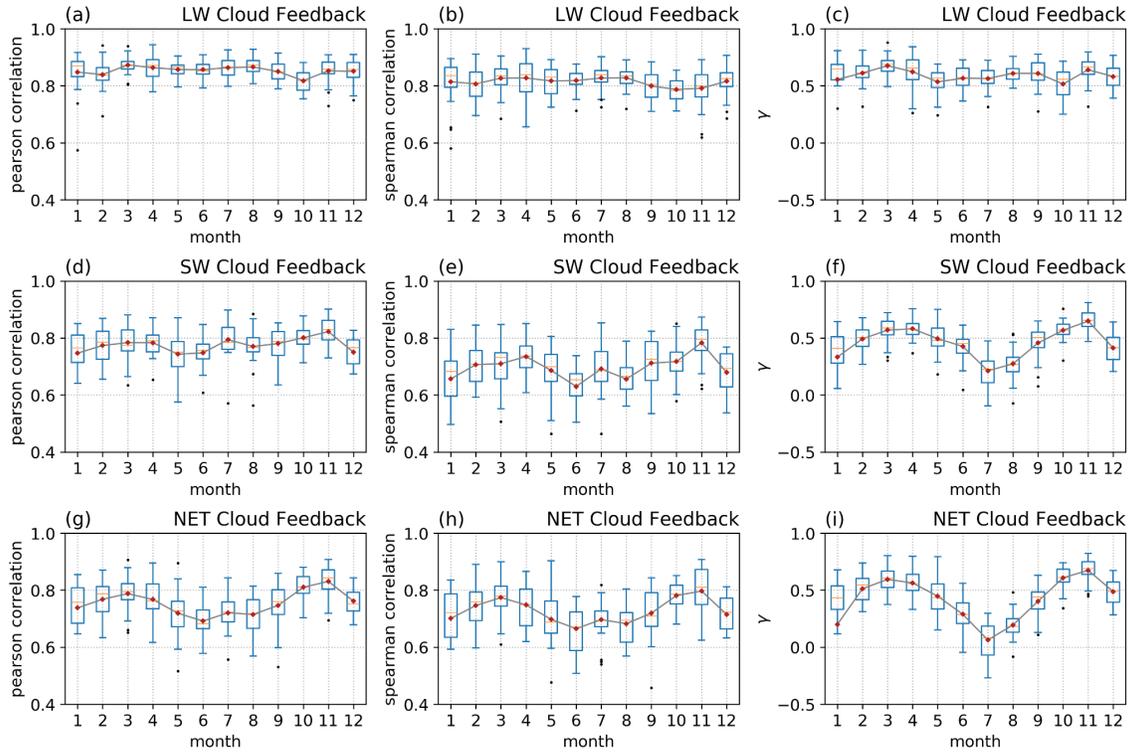
**Figure S7.** As in Figure S6, but for adjusted SWCRE feedback.



**Figure S8.** As in Figure S6, but for adjusted net CRE feedback.



**Figure S9.** The (blue) Pearson linear correlation, (orange) Spearman rank correlation, and (green)  $\gamma$  for adjusted (a) LW, (b) SW and (c) net CRE feedbacks between 1-year amip and coupled experiments as a function of the simulation year varying from 1979 to 2005. Two volcanoes (El Chichon in 1982 and Mount Pinatubo in 1991) are labelled by red triangles. Red shades denote El Nino events, and blue shades denote La Nina events.



**Figure S10.** The (a, d, g) Pearson correlation, (b, e, h) Spearman correlation, and (c, f, i)  $\gamma$  for adjusted (a-c) SW, (d-f) LW and (g-i) net CRE feedbacks between 1-month amip and coupled experiments as a function of the used month for amip feedback varying from January to December. The box extends from the 25th percentile (Q1) and 75th percentile (Q3) with the horizontal line at the median and the red dot at the mean. The whiskers indicate the range of the nonoutliers [outliers are either  $> (Q3 + 1.5 * IQR)$  or  $< (Q1 - 1.5 * IQR)$ ;  $IQR = Q3 - Q1$ ]. Outliers are plotted as separate black dots.