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Projected future changes in extreme precipitation over China under stratospheric aerosol intervention in the UKESM1 climate model

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Figure S1 shows spatial distribution of observed and simulated mean precipitation over China during the control period (CP; 1981-2010) and comparisons between the two datasets. While the general pattern of the simulated precipitation (Fig.S1(b)) was similar to the observed precipitation (Fig.S1(a)), the amount of precipitation simulated tends to be somewhat larger than the observed over much of China, as indicated in Fig.S1(c). Both results show a general decreasing trend from the southeast coastal regions to the northwest inland areas. The wet bias in daily precipitation is evident in most parts of southern China (SC, CC, and SWC), particularly on the south-eastern flanks of the Qinghai-Tibet Plateau (QTP). Regions with dry bias are relatively small (shown by the negative values and brown contours in Fig.S1(c)), with bias values less than 1 mm day^{-1}.

To further compare the results between simulations and observations, particularly focusing on extreme precipitation values, a scatter plot between the ensemble mean simulations and observations is provided as Fig.S1(d) (the scatter plots comparing the simulations of the three model ensembles with the observations are provided in Fig.S2). For the purpose to evaluate the model performance at different level of precipitation, the daily precipitation was as classified in to several intervals: P10 (the smallest 10%), P10-50, P50-90, P90-95, and P95 (the largest 5%). In order to indicate the bias as a percent, relative changes (compared to the observations) for different intervals have been calculated, as listed in Table S1.

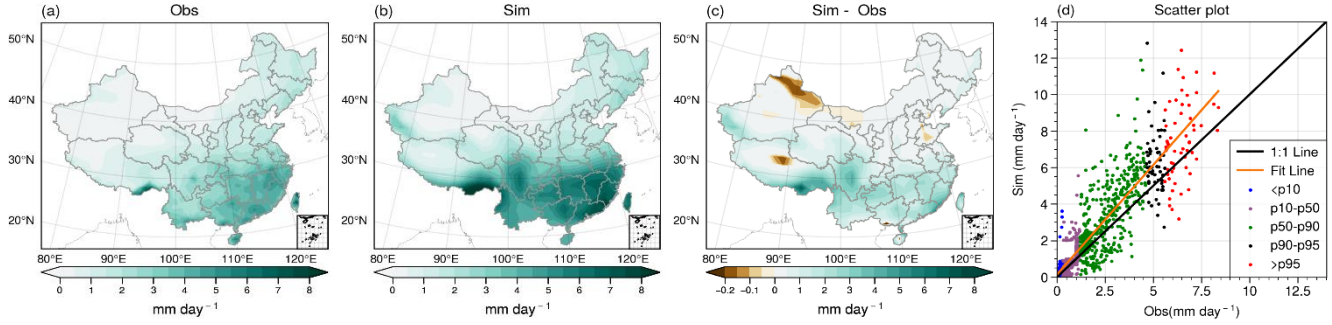

Figure S1. Spatial distributions of mean land precipitation (units: mm day^{-1}) over China during the control period of 1981-2010 for (a) the observations (Obs), (b) the simulations (Sim), (c) the bias (Sim-Obs), and (d) a scatter plot between the observations and simulations at different level of precipitation.

Table S1: Relative changes of the model results (compared to the observations)

intervals	Ensemble mean	r1i1p1f2	r4 i1p1f2	r8i1p1f2
<P10	89.81%	93.95%	89.44%	86.04%
P10-50	30.05%	30.38%	31.85%	27.13%
P50-90	30.50%	28.95%	31.36%	31.16%
P90-95	24.03%	22.79%	24.85%	24.44%
>P95	15.76%	15.09%	16.27%	15.92%

The scatter plots (Fig.S1(d) and Fig.S2) indicate a close relationship between the observations and the simulations. However, the simulations are generally higher than observations, possibly because of the different resolution of the data. Since our study has been mainly focused on the relative changes between the future results and that of control period for different scenarios, the systematic bias would not affect the conclusions significantly. As expected, relative changes are very large at small values (below the 10th percentile), both for the ensemble mean and the model members. For the results at the 10-50th and 50-90th percentiles, relative changes are around 30%. When larger than the 95th percentile, relative changes are relatively small, near 15%. The differences among ensemble members are not significant, which suggests the uncertainty in the ensembled results is reasonable and acceptable.

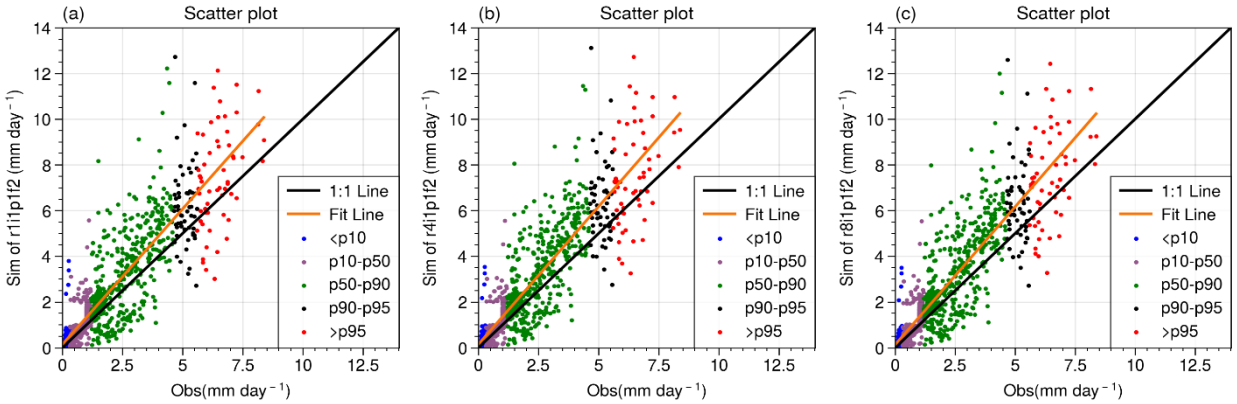

Figure S2. Scatter plots between the observations and model results (a) ensemble number 'r1i1p1f2', (b) ensemble number 'r4i1p1f2', and (c) ensemble number 'r8i1p1f2' at different level of precipitation.

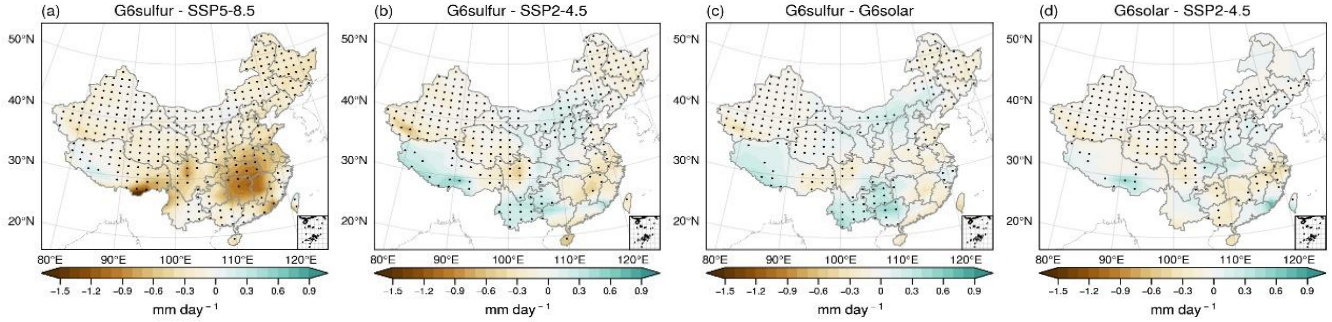

Figure S3. Differences in precipitation (mm day^{-1}) for the future period of 2071-2100 between G6sulfur and SSP5-8.5 (a), SSP2-4.5 (b), and G6solar (c), as well as between G6solar and SSP2-4.5 (d). The dotted areas indicate where the difference is statistically significant at the 95% confidence level using a Wilcoxon rank sum test.

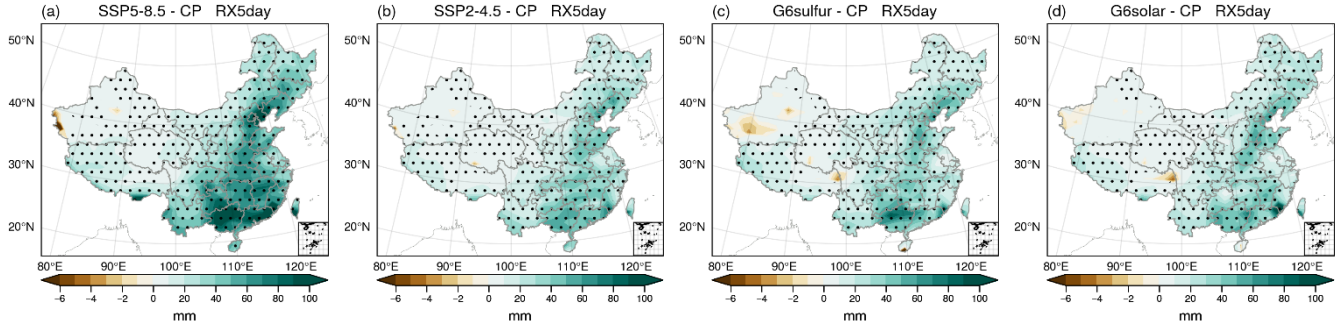

Figure S4. Relative changes in RX5day for the future period of 2071-2100 compared to the CP. The dotted areas indicate where the difference is statistically significant at the 95% confidence level using a Wilcoxon rank sum test.

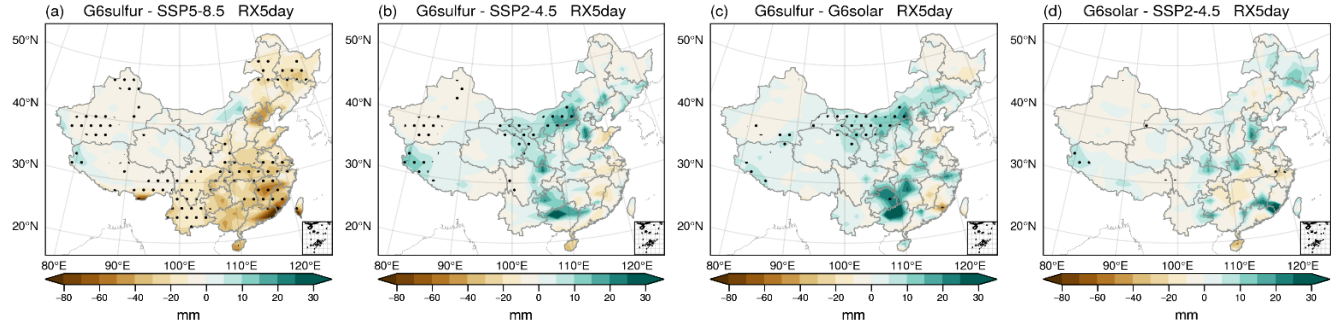

Figure S5. Same as Fig.S3 but for RX5day.

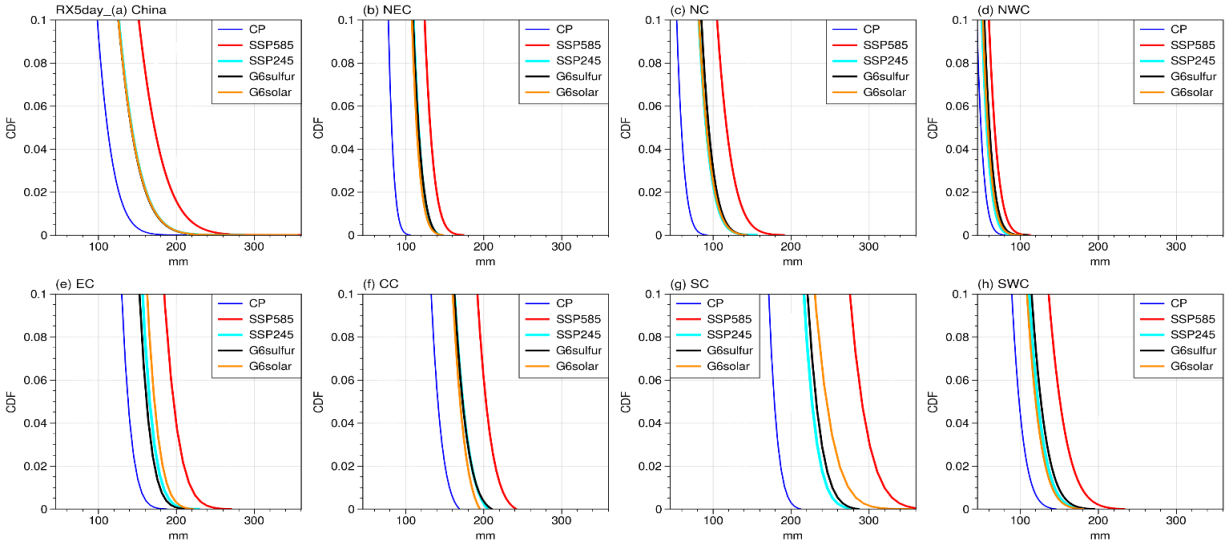

Figure S6. Cumulative distribution functions of RX5day in China and seven subregions for different scenarios.

Table S2: Amelioration effect of G6solar compared to SSP5-8.5 in indices threshold.

	China	NEC	NC	NWC	EC	CC	SC	SWC
RX1day	-	+	-	+	+	+	-	+
RX5day	+	+	+	+	+	+	+	+
R50mm	+	+	+	**0**	+	+	+	+
CWD	+	+	+	+	-	-	+	+
R95p	+	+	+	+	+	+	+	+
DD	-	-	-	-	-	-	+	-
CDD	-	-	-	-	+	+	+	-

Table S3: Amelioration effect of G6sulfur compared to SSP2-4.5 in indices threshold.

	China	NEC	NC	NWC	EC	CC	SC	SWC
RX1day	+	+	+	+	+	+	+	+
RX5day	-	+	-	-	+	+	+	+
R50mm	+	+	+	+	+	+	+	+
CWD	+	-	+	-	+	+	-	+
R95p	+	+	+	+	+	+	+	+
DD	+	+	+	+	+	+	+	+
CDD	+	+	+	+	+	+	+	-

Table S4: Amelioration effect of G6solar compared to SSP2-4.5 in indices threshold.

	China	NEC	NC	NWC	EC	CC	SC	SWC
RX1day	-	+	+	+	+	+	-	+
RX5day	+	-	-	+	+	+	+	+
R50mm	+	+	+	+	+	+	+	+
CWD	-	+	+	-	+	+	-	-
R95p	+	+	+	+	+	+	+	+
DD	+	+	+	+	+	+	+	+
CDD	+	+	+	+	-	-	+	+