

Supporting Information

Bala *et al.* 10.1073/pnas.0711648105

SI Text

1. Gedney N, *et al.* (2006) Detection of a direct carbon dioxide effect in continental river runoff records. *Nature* 439:835–838.
2. Trenberth KE, Dai A (2007) Effects of Mount Pinatubo volcanic eruption on the hydrological cycle as an analog of geoengineering. *Geophys Res Lett* 34:L15702.
3. Held IM, Soden BJ (2006) Robust responses of the hydrological cycle to global warming. *J Climate* 19:5686–5699.
4. Govindasamy B, Caldeira K (2000) Geoengineering Earth's radiation balance to mitigate CO₂-induced climate change. *Geophys Res Lett* 27:2141–2144.

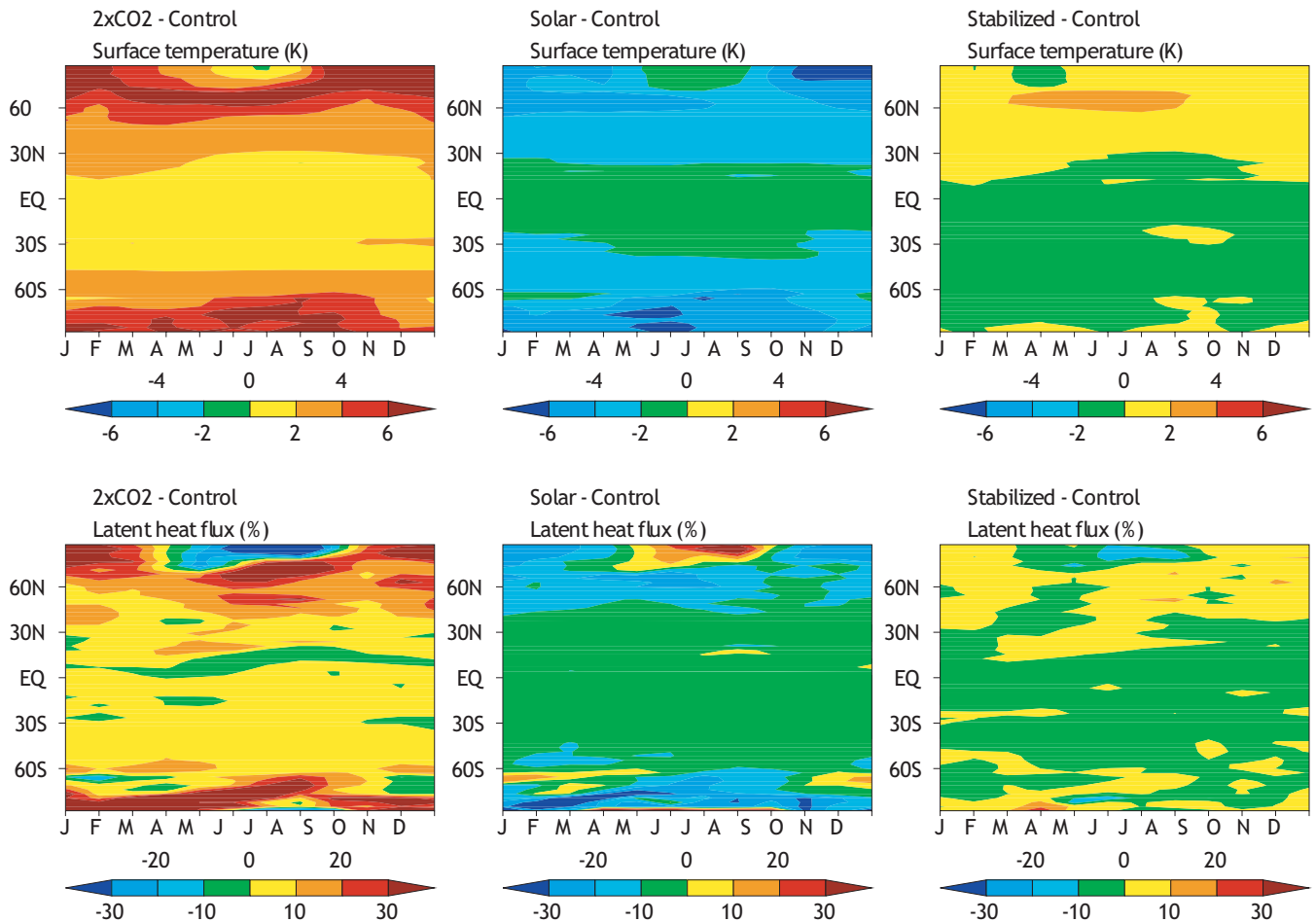


Fig. S2. Seasonal cycle of the changes in the zonally averaged surface temperature (*Top*) and latent heat fluxes (*Bottom*) in the $2\times\text{CO}_2$, solar, and stabilized cases relative to the control. Seasonal variations in temperature response mostly occur in the high latitudes with stronger response in the winter and weaker response in the summer. Although CO_2 and solar forcings have spatially and temporally differing patterns (4), the response patterns are similar (except for sign) in the $2\times\text{CO}_2$ and solar cases with some amplification of the temperature response in the high latitudes. The changes in the stabilized case show little seasonal variations, which is in agreement with earlier studies (4). The residual changes in the stabilized case do show a spatial pattern that reflects the influence of the $2\times\text{CO}_2$ case over NH high latitudes and the influence of solar forcing in the tropical ocean areas (see also Fig. 1).

Table S1. Changes in precipitation (P) and evaporation (E) and $P - E$ in the $2\times\text{CO}_2$, solar, and stabilized experiments relative to the control (units = cm/year)

		Control, cm/yr*	$2\times\text{CO}_2$, cm/yr (%) [†]	Solar, cm/yr (%) [†]	Stabilized, cm/yr (%) [†]	$2\times\text{CO}_2$ + solar, cm/yr (%) [†]
Global	P	115.1	4.3 (3.7)	-6.7 (-5.8)	-2.0 (-1.7)	-2.4 (-2.1)
	E	115.1	4.3 (3.7)	-6.7 (-5.8)	-2.0 (-1.7)	-2.4 (-2.1)
	$(P-E)$	0	0	0	0	0
Land	P	86.6	7.5 (8.7)	-6.6 (-7.6)	-0.2 (-0.2)	0.9 (1.0)
	E	58.4	5.1 (8.7)	-4.6 (-7.9)	0.2 (0.3)	0.5 (0.9)
	$(P-E)$	28.2	2.4 (8.5)	-2.0 (-7.1)	-0.4 (-1.4)	0.4 (1.4)
Ocean	P	127.0	2.9 (2.3)	-6.8 (-5.3)	-2.7 (-2.1)	-3.9 (-3.1)
	E	138.7	3.9 (2.8)	-7.6 (-5.5)	-2.9 (-2.1)	-3.7 (-2.7)
	$(P-E)$	-10.3	-1.0 (9.7)	0.8 (-7.8)	0.2 (-1.9)	-0.2 (1.9)

In the control case, mean evaporation rate over land is $\approx 42\%$ of the evaporation rate over ocean, but this fraction is 68% for precipitation in our model. This implies $P - E$ is positive over land and negative over ocean. The excess water over land reaches the ocean as runoff. In the $2\times\text{CO}_2$ case, $P - E$ increases over land by 8.5% indicating increased runoff in a warmer world (1). $P - E$ decreases by a roughly similar amount (7%) over land in the solar case. Over ocean, $P - E$ decreases (increases) in the $2\times\text{CO}_2$ (solar) case to balance the increase (decrease) over land. In the stabilized case, $P - E$ decreases indicating decreased runoff over land, which is in agreement with the caution raised in a recent study (2) that geoengineering could lead to reduced runoff. Note the nonlinearity in the stabilized case by comparing the last two columns.

*The column corresponding to the control experiment shows the baseline values of P , E , and $P - E$.

[†]Percentage changes in the $2\times\text{CO}_2$, solar, and stabilized cases are given in parentheses.