Supporting Information

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The Intergovernmental Panel on Climate Change's Fifth Assessment Report Models and Simulations

The Intergovernmental Panel on Climate Change's Fifth Assessment Report (IPCC AR5) model outputs are archived and made available to the scientific community by the Program Climate Model Diagnosis and Intercomparison at their website: http://pcmdi9.llnl.gov/esgf-web-fe/. These models' outputs have various spatial resolutions. We remap them and observations onto a 2.5° × 2.5° latitudinal and longitudinal grid to minimize the differences due to different resolutions in our comparison. Simulations by eight models that provide daily rainfall outputs are used to determine the changes of the dry-season length (DSL), dry-season end (DSE), and dry-season arrival (DSA).

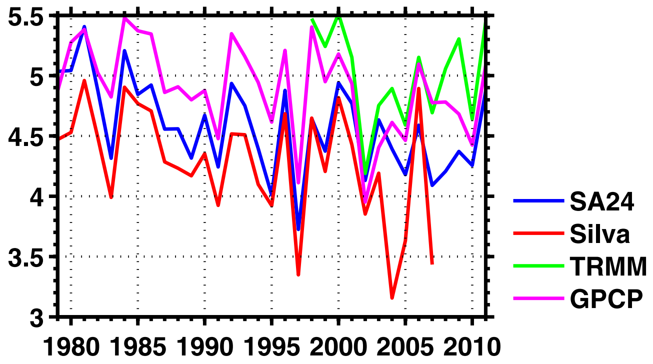

Fig. S1. Comparison of seasonal mean rain rate during the dry-to-wet transition in the austral spring season between different datasets in units of millimeters per day. The Silva dataset includes rain gauges across the Bolivian Amazonia, where rainfall deficit was very strong during the 2004–2005 drought, but has fewer rain gauges throughout the northeastern part of the southern Amazonian domain (5–15°S, 50–70°W). This may contributes to the lower daily rainfall in the Silva dataset during 2004 and 2005 than in other datasets. The monthly Global Precipitation Climatology Project (GPCP) rainfall and the Tropical Rainfall Measuring Mission (TRMM) rainfall data are also included to assess the differences among these rainfall datasets. The GPCP pentad rainfall dataset is not included because it shows significantly different rainfall monthly variability from that of the more rigorously validated GPCP monthly rainfall data.

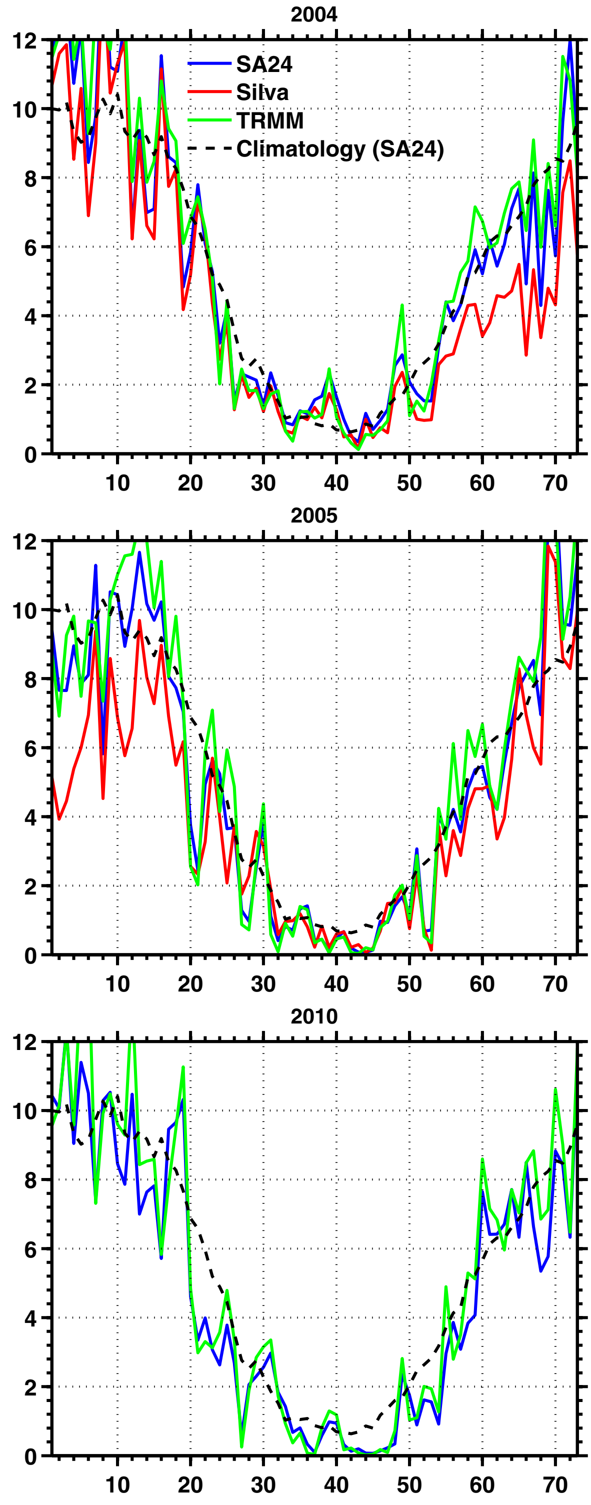

Fig. S2. Seasonal cycle of pentad rainrainfall (millimeters per day) for 2004, 2005, and 2010, respectively, derived from the SA24, Silva, and TRMM daily rainfall data, respectively. The black dashed line shows the climatological seasonal cycle derived from the SA24 dataset for the period 1979–2011.

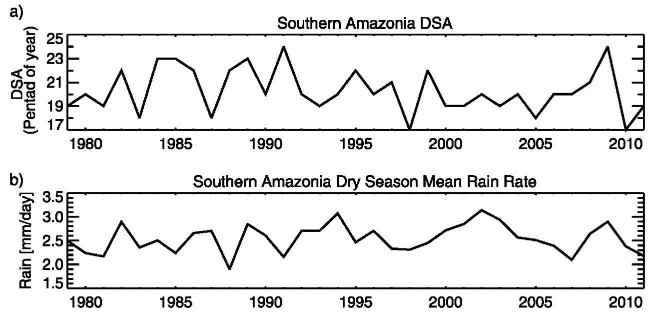

Fig. S3. (*A*) The time series of the pentad (5-d mean) DSA dates. The 17th pentad corresponds to March 26–30 and the 25th pentad corresponds to April 6–10. (*B*) Seasonal mean dry season rainrate (millimeters per day). These variables are derived from the merged daily rainfall (P_M) dataset.

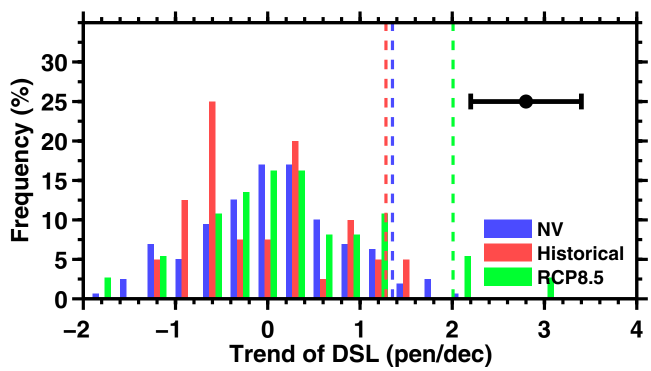

Fig. S4. Distributions of the nonoverlapped 27-y trends of the DSL generated by the natural variability simulations (blue, 158 samples), historical simulations (red, 40 samples), and projections of future changes under the RCP8.5 scenario (green, 38 samples), respectively suggest that the modeled DSL changes are significantly weaker than that which was observed. The top 5% of the modeled trend samples are marked by blue, red and green vertical dashed line for the natural variability, historical simulations, and Representative Concentration Pathway 8.5 (RCP8.5) scenario, respectively. The observed 27-y trend and confidence interval with uncertainty of $P < 5\%$ are marked by the black circle and horizontal bar in the upper right corner and they are derived from the P_M daily rainfall data following the method of Santer et al. (1).

1. Santer BD, et al. (2000) Statistical significance of trends and trend differences in layer-average atmospheric temperature time series. *J Geophys Res* 105(6):7337–7356.

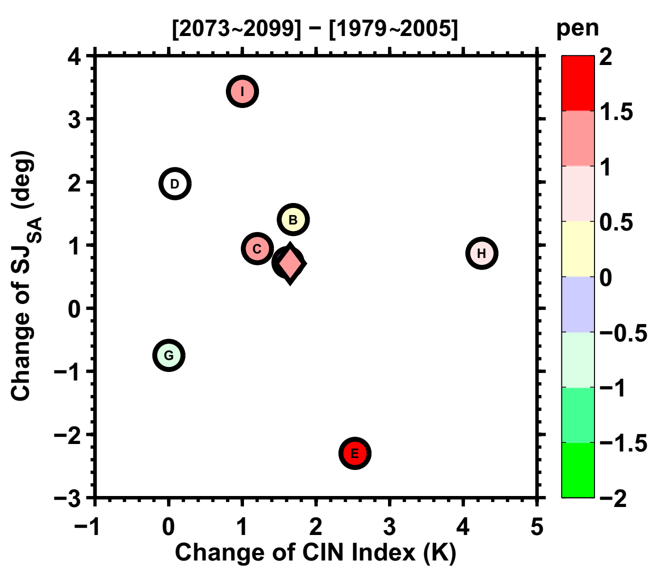

Fig. S5. Projected changes of DSE (color shades) as a function of the changes of the subtropical jet over South America (SJ_{SA}) (*y* axis) and convective inhibition energy (CIN) index (*x* axis) for the period 2073–2099 under the RCP8.5 scenario relative to those of 1979–2005 provided by the historical simulations by the eight climate models. Model A overlaps with the multimodel ensemble projection (diamond); the color scale of the DSE change is indicated by the color bar to the right in units of pentads.

Table S1. Correlation coefficients between the unfiltered detrended CIN, the SJ_{SA}, and tropical sea surface temperature indices during June–August (JJA) for the period 1979–2011

PCON	PDO (JJA)	AMO (JJA)	NINO3 (JJA)	NINO4 (JJA)
CIN (JJA)	**−0.31**	0.22	−0.13	−0.26
SJ (JJA)	0.25	−0.02	−0.06	−0.160

The significance of these correlation coefficients is estimated based on the effective number of freedom following Bretherton et al. (1). None of the correlation coefficients is significant with uncertainty of $P < 5\%$, and that with uncertainty $P < 10\%$ is shown in bold. AMO, Atlantic Multidecadal Oscillation; NINO3, Nino3 Index; Nino4, Nino4 index; PCON, preconditions for DSE; PDO, Pacific Decadal Oscillation.

1. Bretherton CS, Widmann M, Dymnikov VP, Wallace JM, Blade I (1999) The effective number of spatial degrees of freedom of a time-varying field. *J Clim* 12(7):1990–2009.

Table S2. Description of the climate models that participated in the IPCC AR5 used in this study

Model (Fig. S5 marker)	Institute (country)	Available ensembles	Components (resolutions)	Calendar
CCSM4 (A)	National Center for Atmospheric Research (USA)	6	F09_g16 (0.9×1.25_gx1v6)	No leap
GFDL-CM3 (B)	NOAA/Geophysical Fluid Dynamics Laboratory (USA)	5	Atm: AM3 (2.0° lat ×2.5° lon) Ocn: MOM4.1 (1.0° lat ×1.0° lon, enhanced tropical resolution: 1/3 on the equator)	No leap
GFDL-ESM2M (C)	NOAA/Geophysical Fluid Dynamics Laboratory (USA)	1	Atm: AM2 (AM2p14, M45L24) Ocn: MOM4.1 (1.0° lat ×1.0° lon, enhanced tropical resolution: 1/3 on the equator)	No leap
GISS-E2-H (D)	NASA/Goddard Institute for Space Studies (USA)	5	Atm: GISS-E2 (2.0° lat × 2.5° lon) Ocn: H	No leap
GISS-E2-R (E)	NASA/Goddard Institute for Space Studies (USA)	5	Atm: GISS-E2 (2.0° lat × 2.5° lon) Ocn: R	No leap
HadGEM2-CC (G)	Met Office Hadley Centre (UK)	3	Atm: HadGAM2 (N96L60) Ocn: HadGOM2 (lat: 1.0–0.3 lon: 1.0 L40)	360 d/y
HadGEM2-ES (H)	Met Office Hadley Centre (UK)	4	Atm: HadGAM2 (N96L38) Ocn: HadGOM2 (lat: 1.0–0.3 lon: 1.0 L40)	360 d/y
MPI-ESM-LR (I)	Max Planck Institute for Meteorology (Germany)	3	Atm: ECHAM6 (T63L47) Ocn: MPIOM (GR15L40)	Gregorian

The available ensembles are referred to the number of historical simulations available for each model. Atm, atmospheric model; Lat, latitude; lon, longitude; NASA, National Aeronautics and Space Administration; NOAA, National Oceanic and Atmospheric Administration; Ocn, ocean model.