The far-reaching distributional effects of global warming: evidence from half a century of climate and inequality data

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ONLINE APPENDIX

Appendix A. Data overview

Table A1. Overview of main variables and sources

Variable	Definition	Time Span	Source
I. Climatic variables			
Temp_50y_change	Long-run (50-year) change in mean temperature	1965-2015	Constructed using data from the World Bank Climate Change Knowledge Portal (CCKP) and the UEA's CRU-TS data. (See below for more detail)
Rain_50y_change	Long-run (50-year) change in mean rainfall	1965-2015	
Temperature	Mean annual average temperatures (in degree Celsius) over preceding 5 years	1955-2020	
Rainfall	Mean annual average rainfall (in mm per year) over preceding 5 years	1955-2020	
II. Inequality variables			
Gini	Gini coefficient for the income distribution	1950-2019	World Income Inequality Database (UNU-WIDER)
Top10	Share of income in the top 10 percentiles	1950-2020	
Middle50	Share of income between the 25th and 75th percentiles	1950-2020	
Bottom40	Share of income in the bottom 40 percentiles	1950-2020	
Top10_weatlh	Share of wealth in the 10 percentiles	2000-2020	World Inequality Database (WID)
SpatialGini	Spatial Gini coefficient, using alternative subnational divisions (More detail below)	1992-2013	Constructed using satellite data of night-time lights (NOAA) and maps from Global Administrative Areas (GADM).
IneLifeExp	Inequality in life expectancy (as measured by Gini coefficients)	2000-2020	UN Development Program (UNDP)
III. Other (control) variables			
GDPpc	Gross Domestic Product (GDP) per capita	1960-2020	Penn World Tables
Pop	Total population	1960-2020	World Development Indicators (World Bank)
Fertility	Fertility rate	1960-2020	
Urb	Urban rate	1960-2020	
AgriGDP	Agricultural share in GDP	1960-2020	
EmpAgr	Agricultural share in total employment	1960-2020	
Exports	Exports share to GDP	1960-2020	
Unempl	Unemployment rate	1995-2020	
Electricity	Access to electricity	1990-2020	
IndShare	Share of industry to GDP	1995-2020	
IV. Other variables			
Undernourish	Undernourishment(prevalence)	2000-2020	World Development Indicators (World Bank)
InfMortality	Infant mortality	1960-2020	
Tuberc	Tuberculosis (incidence)	1990-2020	
Malaria	Malaria (incidence)	1990-2020	
Stability	Government Stability. Range of values between 0=min to 12=max stability	1985-2020	Constructed using data from International Country Risk Guide (ICRG-PRS)
Corruption	Corruption index.	1985-2020	
IntConflict	Internal conflict. We re-arrange so 0 is low risk and 12 is high risk.	1985-2020	

Climate data

Our climatic variables are based on historical weather data, including temperature and rainfall observations, and are derived from monthly global gridded data, which have been aggregated to country means. The simple area-weighted country-level averages for rainfall and temperature (as used in column 1 of Table 1) were obtained from the World Bank's Climate Change Knowledge Portal (CCKP).[1] These data are in turn derived from the University of East Anglia's Climate Research Unit (CRU) time-series (TS) dataset of high resolution gridded monthly climatic observations (see Harris *et al.*, 2014). However, most of our analysis uses population-weighted versions of these variables, which we construct by combining gridded weather data from the CRU TS version 4.03 dataset from the University of East Anglia (Harris *et al.*, 2014) with gridded population data from the Global Population of the World v4 dataset.[2] As our focus is in long-run dynamics, in each case (for both area-weighted and population-weighted versions) we aggregate for every country in five-year periods from 1950-55 to 2015-20.[3]

Based on these data, we construct three distinct sets of climatic variables, as follows:

Long-run changes:

To begin with, we construct measures of long-run changes in temperature and rainfall, measured as the 50-year (1965-2015) change in average temperature or average rainfall. We label these as *temp_50y_change* and *rain_50y_change*. We compute this long-run changes using average temperature and rainfall in the last five years with those same averages 50 years ago. By doing so, we reduce potential noise introduced by particularly hot (wet) and cold (dry) years.

5-year averages:

The variables *Temperature* and *Rainfall* measure mean average temperatures (in degree Celsius) and rainfall (in mm per year), at the national level, over 5-year time periods. Given that our regressions include country fixed effects, when we include *Temperature* or *Rainfall* as explanatory variables, estimation is based on the temporal variation in these measures for each country, i.e., the variation relative to that country's long-run average climate. Average annual temperatures and rainfall have been used in global analyses of the economic effects of weather variation for example in Dell *et al.* (2012). As noted, we have two versions of these average variables based on different methods for aggregating from gridded observations to national averages; area-weighted and population-weighted. In most of our analysis we rely on the population-weighted versions as better representing the weather experienced by the average person for a given country-time period observation in our data.

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[1] Available at http://sdwebx.worldbank.org/climateportal/index.cfm?page=downscaled_data_download&menu=historical (last accessed on 7 November 2018).

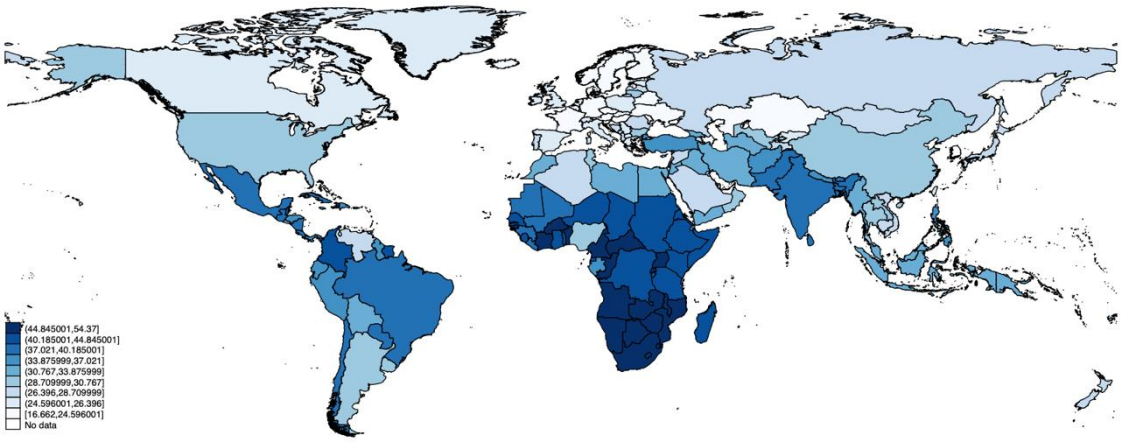
[2] The data are available from https://sedac.ciesin.columbia.edu/data/set/gpw-v4-population-count-adjusted-to-2015-unwpp-country-totals-rev11/data-download (last accessed June 2020). We use the version of the population data adjusted to match UN country totals, and we take population estimates for the earliest available year in the data (2000).

[3] Our 5-year aggregates are constructed to be backward looking, such that an observation of temperature in 2015 is actually the mean temperature in the preceding 5-year period (i.e., 2010-2014). This is so that outcomes in our analysis are always related to weather over the preceding period.

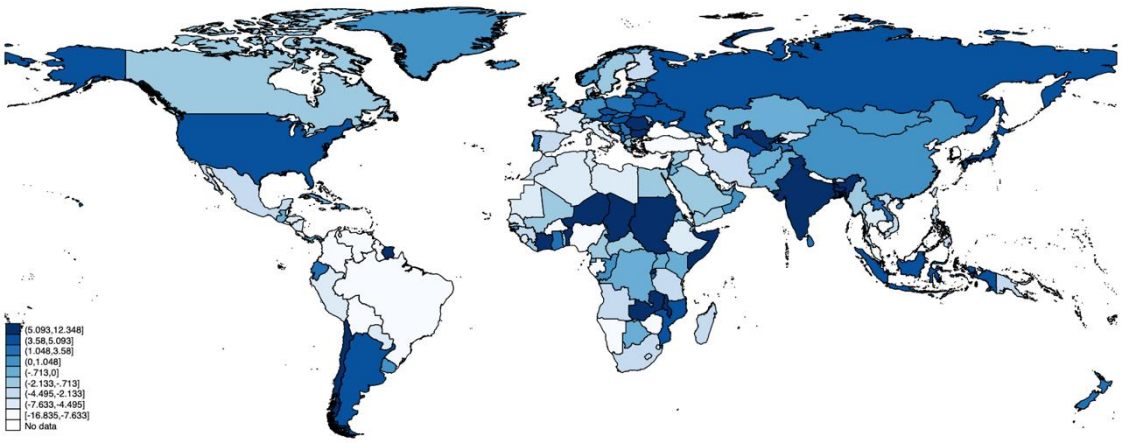
Each of our set of climatic variables thus captures distinct aspects of weather variation; for the long-run changes, the 50-year change in climatic conditions; and for 5-year averages, medium-term time scale variation in the levels of temperature and rainfall.

Constructing measures of spatial concentration of economic activity

To construct measures proxying for the spatial concentration of economic activity, we rely on satellite data on night-time lights. In particular, we use data from the Defence Meteorological Satellite Program's Operational Linescan System, operated by the National Oceanic Administration Agency, and available at the pixel level (30 arc seconds, corresponding to <1 square kilometer at the equator) as a yearly panel from 1992 to 2013. These data have become established as a proxy for local economic activity in recent years (see Henderson *et al.*, 2012; Donaldson and Storeygard, 2016). We rely on the top-coding correction applied by Bluhm and Krause (2022) to adjust for maximum brightness in cities. Using this data, we compute Gini coefficients in lights across spatial units. We do this aggregating night-time lights at two different spatial levels relying on maps from the Database of Global Administrative Areas (GADM): we use the first subnational division in GADM (*gadm1*) or, alternatively, the second subnational division (*gadm2*). To calculate the Gini coefficients across spatial units, we either weight by the area of each spatial unit (*area-weighted ginis*), or, alternatively, weighting by the population of each unit (*population-weighted ginis*). Because of their gradual changes, we assign the first year of the lights data, 1992–1990 as well as the last year, 2013–2015, to match the quinquennial structure of our data (1990, 1995, 2000, 2005, 2010, 2015).



Panel A: 2015



Panel B: 1965-2015 change

Figure A1. Top10.

Notes: Panel A shows the concentration of income at the 10% richest by country in 2015, according to data from WIID. Panel B shows the change in this concentration by country over a 50-year period (1965-2015).

Table A2. Main variables, descriptive statistics (Global panel, national level data)

Panel A: Climatic variables					
	Obs.	Mean	Std. Dev.	Min	Max
5-year panel:					
Temperature (area-weighted)	1,859	18.10	8.42	-7.38	29.14
Temperature (pop-weighted)	1,859	18.36	7.48	-2.26	29.34
Rainfall (area-weighted)	1,859	1015.54	735.18	27.35	3331.46
Rainfall (pop-weighted)	1,859	1027.94	661.45	31.17	3361.95
50-year changes:					
Temp 50-y	143	0.84	0.34	-0.08	1.73
Rain 50-y	143	-8.27	107.96	-383.00	437.00
Panel B: Income inequality variables					
	Obs.	Mean	Std. Dev.	Min	Max
5-year panel:					
Gini	1,859	44.28	11.84	15.16	77.09
Top10	1,859	34.99	10.00	16.66	68.77
Middle50	1,859	50.12	5.26	28.11	60.30
Bottom40	1,859	14.90	5.32	1.95	30.55
50-year changes:					
Gini 50-y	143	-0.90	7.07	-21.76	15.71
Top10 50-y	143	-1.37	5.68	-16.84	8.96
Panel C: Inequality in life expectancy					
	Obs.	Mean	Std. Dev.	Min	Max
5-year panel:					
IneLifeExp	282	16.41	12.15	2.72	48.62

Notes: Temperatures here are in degrees Celsius, and rainfall in mm. 50-year changes are calculated as the change from 1965-2015 (change in 5-year averages for climatic variables). Variables in panel B are from the WIID data, while Inequality in Life Expectancy (panel C) is from the UN's HDR data, as described elsewhere.

Table A3. Descriptive statistics, additional datasets

Panel A: Sub-national data					
	Obs.	Mean	Std. Dev.	Min	Max
US – state level (2010, 2015, 2020)					
Temperature	147	12.07	4.60	-0.50	23.60
Gini	147	46.06	1.90	41.90	51.38
US – county level (annual: 2010-2019)					
Temperature	2,440	13.51	4.47	-2.64	25.47
Gini	2,440	44.62	3.57	32.88	60.11
Panel B: Wealth inequality					
Top 10 wealth (WID)	680	63.23	7.43	40.84	81.71
Panel C: Spatial inequality (nightlights)					
SpatialGini1sqkm	810	0.51	0.21	0.05	0.94
SpatialGini1pc	810	0.30	0.16	0.03	0.90
SpatialGini2sqkm	738	0.67	0.19	0.16	0.96
SpatialGini2pc	738	0.41	0.14	0.09	0.88

Notes: In panel A, the inequality data are based on official national statistics of each country. In panel B, wealth inequality is from WID, while in panel C the spatial inequality measures are constructed using night lights data, as described in Appendix A above.

Appendix B

Table A4. Balance tests, Global Sample (N=143)

	Low Warming (1)	High Warming (2)	Difference (1) – (2)	t-stat
Log(GDPpc)	7.86	8.55	-0.69***	4.12
Urb Rate %	27.46	42.08	-14.61***	4.11
Fertility rate	6.03	4.81	1.22***	4.15
Agri Share %	30.23	19.53	10.70***	3.47

Note: The table shows the mean value (in columns (1) and (2)) of each variable for the earliest observation in the data, across countries with above and below median warming over 1965-2015 in our data. *** p<0.01.

Table A5. Robustness to Long differences results – alternative outcome

	(1)	(2)	(3)	(4)
Dependent variable: Top10 (50y change)				
Temperature (50y change)	3.963***	3.638**	3.453*	4.173**
	(1.282)	(1.805)	(1.828)	(1.930)
Region FE	NO	YES	YES	YES
Initial climate	NO	NO	YES	YES
Controls	NO	NO	NO	YES
Observations	143	143	143	133

Notes: This table reports results of long differences specifications as in Equation (1) in Data & Methods. Variables are calculated as the change over a 50-year period (1965-2015). Initial climate includes average annual temperature and rainfall at the beginning of our sample (1960-1964). Controls include changes in average rainfall and GDP per capita growth over the 50-year period, as well GDP per capita, export share and agricultural valued added (to GDP) in levels (each lagged one period). Robust standard errors (clustered by country) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A6. Warming and income inequality, panel results

Dependent variable:	Gini	Gini	Gini	Gini
Temperature	0.898***	1.006***	1.008***	1.265**
	(0.0901)	(0.0986)	(0.0992)	(0.526)
Rainfall	0.750	0.842	0.846	-0.404
	(0.992)	(1.169)	(1.176)	(1.360)
Year FE	NO	NO	YES	YES
Country FE	NO	NO	NO	YES
Observations	1,859	1,859	1,859	1,859
No. of countries	143	143	143	143

Notes: This table reports results of specifications based on Equation (2) and as described in the text. The dependent variable is the Gini coefficient (as reported by WIID). Temperature is average temperature in degrees Celsius over the preceding 5-year period. Rainfall is average total rainfall in meters per year over the preceding 5-year period. Columns 2 onwards weight climate variables by population. Robust standard errors (clustered by country) in parentheses. *** p<0.01, ** p<0.05.

Table A7. Alternative time periods and panel specifications

	(1) Temporal placebo	(2) 1980+	(3) 1990+	(4) Region-trends	(5) Country-trends	(6) Dynamic Model	(7) Difference GMM	(8) System GMM
Dependent variable:	Gini	Gini	Gini	Gini	Gini	Gini	Gini	Gini
Temperature	0.834	1.495**	1.261**	0.948**	0.922***	0.647**	0.787**	0.162***
	(0.531)	(0.591)	(0.606)	(0.448)	(0.332)	(0.253)	(0.357)	(0.033)
L.Gini						0.835***	0.586***	0.866***
						(0.0224)	(0.041)	(0.022)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES	-	-
Time-trends	NO	NO	NO	YES	YES	NO	NO	NO
Observations	1,716	1,144	858	1,859	1,859	1,716	1573	1716
Countries	143	143	143	143	143	143	143	143

Notes: This table reports results of specifications based on Equation (2) and as described in the text. The dependent variable in each column is the Gini coefficient. Temperature is average temperature in degrees Celsius over the preceding 5-year period. All specifications control for average rainfall. Column 7 computes a two-step difference GMM estimation. Column (8) computes a two-step System GMM. Robust standard errors (clustered by country) in parentheses. *** p<0.01, ** p<0.05.

Table A8. Robustness to different time-varying controls, and model uncertainty

Panel A: Adding time-varying controls

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	Gini	Gini	Gini	Gini	Gini	Gini
Temperature	1.280**	1.294**	1.305**	1.444***	1.014**	1.393*
	(0.534)	(0.531)	(0.529)	(0.491)	(0.473)	(0.763)
L.GPDpc	0.586	1.089	0.464	5.536	5.303	18.167*
	(0.528)	(3.007)	(3.247)	(3.665)	(3.743)	(9.628)
L.GPDpc^2		-0.0285	0.00378	-0.261	-0.234	-1.035*
		(0.166)	(0.179)	(0.203)	(0.207)	(0.541)
L.Pop			2.62e-09	6.13e-09**	5.52e-09*	2.04e-08**
			(3.13e-09)	(3.06e-09)	(3.18e-09)	(8.59e-09)
L.Fertility				0.994***	0.889***	1.441*
				(0.285)	(0.289)	(0.780)
L.Urb					-0.107**	0.028
					(0.0461)	(0.082)
L.Electricity						-0.010
						(0.038)
L.Trade						0.009
						(0.012)
L.IndShare						-0.036
						(0.041)
L.Unempl						0.088*
						(0.052)
Year FE	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES
Observations	1,716	1,716	1,716	1,566	1,566	459
No. of countries	143	143	143	143	143	130

Notes: This panel reports results of specifications based on Equation (2) and as described in the text. The dependent variable in each column is the Gini coefficient. Temperature is average temperature in degrees Celsius over the preceding 5-year period. All specifications control for average rainfall. Robust standard errors (clustered by country) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Panel B: Addressing model uncertainty

	(1) BMA	(2) WALS	(3) WALS
Dependent variable:	Gini	Gini	Gini
Temperature	0.496***	1.240**	1.215**
	(0.035)	(0.659)	(0.659)
PIP	1		
Year FE	YES	YES	YES
Country FE	YES	YES	YES
Observations	459	459	459
No. of countries	130	130	13

Notes: This panel reports results of specifications based on Equation (2) and as described in the text. The dependent variable in each column is the Gini coefficient. Temperature is average temperature in degrees Celsius over the preceding 5-year period. All columns include all variables in column (6) of panel A as controls. Column (1) shows Bayesian Model Averaging (BMA) over 598 models (with all possible combination of variables included in column (6) of panel A). PIP indicates the posterior inclusion probability. Columns (2) and (3) show Weighted-Average Least Squares (WALS) estimates, column (2) using Pareto as the prior distribution, while column (3) using horseshoe. All specifications control for average rainfall. Robust standard errors (clustered by country) in parentheses. *** p<0.01, ** p<0.05.

Table A9. Panel First-Difference (FD) specification

	(1) FD	(2) FD	(3) FD
Dependent variable:	Gini_g	Gini_g	Gini_g
Temperature	1.731***	2.156***	2.494***
	(0.451)	(0.523)	(0.620)
Time FE	NO	YES	YES
Controls	NO	NO	YES
Observations	1716	1716	1400
No. of countries	143	143	140

Notes: This table reports results of first-difference specifications. All variables are defined as changes over 5-year periods. Temperature is average temperature in degrees Celsius over the preceding 5-year period. All specifications control for (changes in) average rainfall. Controls include GDP per capita, its square, population, fertility and urbanisation. Robust standard errors (clustered by country) in parentheses. *** p<0.01.

Table A10. Warming and income inequality, alternative estimators for bounded outcomes

	(1) Logit	(2) Logit	(3) Probit	(4) Beta
Dependent variable: Gini				
Temperature	0.042***	0.055***	0.035***	0.038***
	(0.001)	(0.015)	(0.009)	(0.011)
Year FE	YES	YES	YES	YES
Country FE	NO	YES	YES	YES
Observations	1,859	1,859	1,859	1,859
No. of countries	143	143	143	143

Notes: This table reports results of specifications based on Equation (2) and as described in the text. The dependent variable is the Gini coefficient (as reported by WIID), but from 0 to 1 (rather 0 to 100). Temperature is average temperature in degrees Celsius over the preceding 5-year period. Columns (1) to (3) computes quasi-likelihood estimators, based on logit in columns (1) and (2) and probit in column (3). Column (4) uses maximum likelihood estimator based on the beta distribution. All specifications control for average rainfall. *** p<0.01.

Table A11. Warming and income inequality, heterogeneity

Panel A: Income and Agricultural share in employment				
	(1)	(2)	(3)	(4)
Dependent variable:	Gini	Gini	Gini	Gini
	Cross-section	Dynamic		
Temperature	-0.300	0.905	1.856***	1.503**
	(3.672)	(0.875)	(0.709)	(0.708)
Temperature*GDPpc	0.182		-0.088	
	(0.417)		(0.056)	
Temperature*Agr		-0.0194		0.001
		(0.025)		(0.005)
Year FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES
Observations	1859	715	1716	572
No. of countries	143	141	143	143

Notes: The dependent variable in each case is the Gini coefficient (as reported by WIID). Temperature is average temperature in degrees Celsius over the preceding 5-year period. In columns (1) and (2) we allow for cross-sectional differences in the temperature-Gini relationship by interacting temperature with initial (earliest available) value of *GDPpc,* GDP per capita in logs, for each country in the data (in column (1)) and with initial employment share in agriculture *Agr*, again taking the initial (earliest available) value for each country in the data (in column (2)). In columns (3) and (4), we allow for dynamic differences in temperature-inequality relationship over time by interacting temperature with lagged values of *GDPpc* and *Agr*. In columns (3) and (4), the lagged values of *GDPpc* and *Agr* are also included as separate controls. All columns control for rainfall. Robust standard errors (clustered by country) in parentheses. *** p<0.01, ** p<0.05.

Panel B: By income groups			
	(1)	(2)	(3)
Dependent variable:	Gini	Gini	Gini
	High	Middle	Low
Temperature	-0.133	0.925	1.665
	(0.682)	(0.853)	(1.325)
Year FE	YES	YES	YES
Country FE	YES	YES	YES
Observations	480	912	324
No. of countries	40	76	27

Notes: This panel reports results of specifications based on Equation (2) as described in the text. Here the sample is divided between High (column (1)), Middle (column (2)) and Low (column (3)) income countries, as defined by the World Bank. Middle income here includes Upper Middle and Lower Middle. The dependent variable in each case is the Gini coefficient (as reported by WIID). Temperature is average temperature in degrees Celsius over the preceding 5-year period. In each case we also control for total rainfall and include country and year fixed effects. Robust standard errors (clustered by country) in parentheses.

Table A12. Quadratic specifications

Dependent variable:	Gini	Gini	Gini	Gini
Temperature	0.357	1.480**	1.481**	2.871**
	(0.285)	(0.662)	(0.664)	(1.105)
Temperature^2	0.020**	-0.013	-0.013	-0.0682**
	(0.009)	(0.019)	(0.019)	(0.0329)
Year FE	NO	NO	YES	YES
Country FE	NO	NO	NO	YES
Observations	1,859	1,859	1,859	1,859
No. of countries	143	143	143	143

Notes: This table reports results of specifications based on Equation (2) and as described in the text. The dependent variable is the Gini coefficient (as reported by WIID). Temperature is average temperature in degrees Celsius over the preceding 5-year period. All specification control for Rainfall and Rainfall squared. Columns (2) onwards weight climate variables by population. Robust standard errors (clustered by country) in parentheses. ** $p<0.05$.

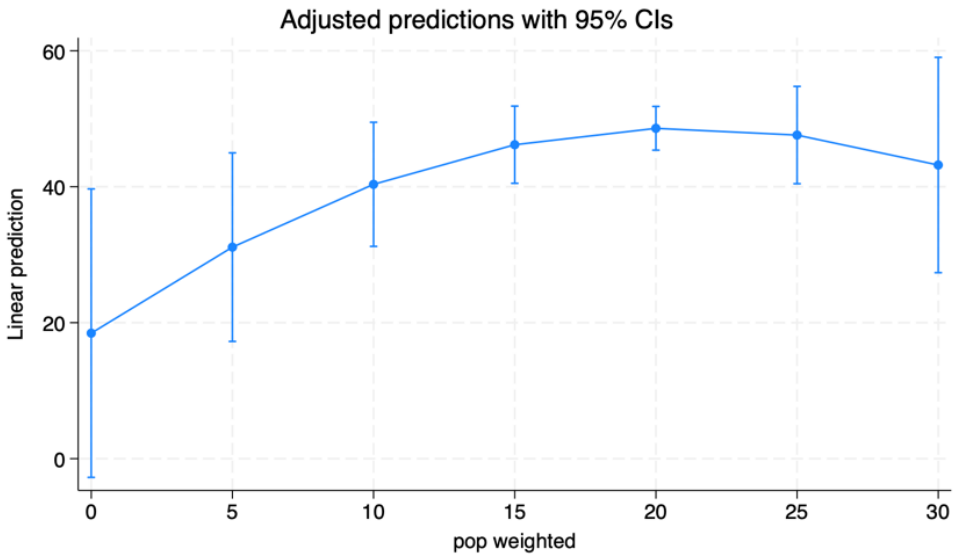


Figure A2. Margins plot for the temperature-Gini relationship across the temperature distribution.

Notes: This figure shows estimated prediction and 95% confidence intervals for the Gini coefficient (on the y-axis) across a range of values of temperature (on the x-axis). These are based on the estimated coefficients reported in column (4) of Table A12 above.

Table A13. Warming and income inequality, subnational results

Panel A: US (state-level)

Dependent variable:	Gini	Gini	Gini
Temperature	0.236***	0.234***	0.281***
	(0.0305)	(0.0307)	(0.0463)
Year FE	NO	YES	YES
Region FE	NO	NO	YES
Observations	147	147	147
No. of FE units			4
Panel B: US (county-level)			
Dependent variable:	Gini	Gini	Gini
Temperature	0.185***	0.184***	0.198***
	(0.0216)	(0.0217)	(0.0749)
Year FE	NO	YES	YES
State FE	NO	NO	YES
Observations	2,440	2,440	2,440
No. of FE units			49

Notes: This table reports results of specifications based on Equation (2) and as described in the text. The dependent variable in each case is the Gini coefficient. US county level inequality data are an annual panel (2010-2019), but for the purposes of the analysis here we only use the observed values in 2010, 2015 and 2019. US state-level data include observations for three periods (2010, 2015, 2020). Temperatures are measured in degrees Celsius. Weather data for the US are from NOAA, based on county level data, available at https://www.ncei.noaa.gov/pub/data/cirs/climdiv/. As usual, we aggregate the weather data to the preceding 5-year period: i.e. we match 2010 inequality with average weather conditions for 2005-2009. 2019 inequality (US counties) is matched to weather from 2015-2018. Robust standard errors (clustered by spatial unit) in parentheses. *** p<0.01.

Table A14. Warming and spatial concentration of economic activity

	(1)	(2)	(3)	(4)
Dependent variable:	SpatialGini1sqkm	SpatialGini1pc	SpatialGini2sqkm	SpatialGini2pc
Temperature	0.020**	0.033**	0.004	0.019*
	(0.009)	(0.013)	(0.008)	(0.011)
Year FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES
Observations	810	810	738	738
No. of countries	135	135	123	123

Notes: In columns (1) and (2) the spatial gini is calculated using first-level subnational divisions (i.e., gadm1 maps), while in columns (3) and (4) using second-level subnational divisions (i.e., gadm2 maps). In columns (1) and (3), we use area-weighted spatial ginis, while in columns (2) and (4) we use population-weighted spatial ginis. Temperature is average temperature in degrees Celsius over the preceding 5-year period. All columns control for rainfall. Robust standard errors (clustered by country) in parentheses. ** p<0.05, * p<0.1.

Appendix C

Table A15. Warming and concentration of income

	(1)	(2)	(3)
Dependent variable:	Top10	Middle50	Bottom40
Temperature	1.276***	-0.812***	-0.464*
	(0.406)	(0.265)	(0.271)
Year FE	YES	YES	YES
Country FE	YES	YES	YES
Observations	1,859	1,859	1,859
No. of countries	143	143	143

Notes: This table reports results of specifications based on Equation (2) and as described in Data & Methods. Temperature is average temperature in degrees Celsius over the preceding 5-year period. All specification control for rainfall and its lag. Robust standard errors (clustered by country) in parentheses. ***p<0.01, *p<0.1

Table A16. Warming and concentration of income (controlling for country-specific trends)

	(1)	(2)	(3)
Dependent variable:	Top10	Middle50	Bottom40
Temperature	0.527**	-0.00412	-0.523***
	(0.259)	(0.180)	(0.175)
Year FE	YES	YES	YES
Country FE	YES	YES	YES
Country-specific trends	YES	YES	YES
Observations	1,859	1,859	1,859
No. of countries	143	143	143

Notes: This table reports results of specifications based on Equation (2) and as described in the text. Temperature is average temperature in degrees Celsius over the preceding 5-year period. All specification control for rainfall and its lag. Robust standard errors (clustered by country) in parentheses. *** p<0.01, ** p<0.05.

Table A17. Warming and wealth inequality, panel results

Panel A				
Dependent variable:	Top10_wealth	Top10_wealth	Top10_wealth	Top10_wealth
Temperature	0.382***	0.457***	0.479***	0.652
	(0.065)	(0.073)	(0.073)	(0.525)
Year FE	NO	NO	YES	YES
Country FE	NO	NO	NO	YES
Observations	680	665	660	660
No. of countries	136	133	132	132
Panel B				
Dependent variable:	Top10_wealth	Top10_wealth	Top10_wealth	Top10_wealth
Temperature	-0.336	-0.201	-0.342	0.504
	(0.466)	(0.304)	(0.306)	(0.537)
L.Temperature	0.716	0.682**	0.835***	1.576***
	(0.457)	(0.296)	(0.296)	(0.539)
Year FE	NO	NO	YES	YES
Country FE	NO	NO	NO	YES
Observations	678	663	660	660
No. of countries	136	133	132	132

Notes: This table reports results of specifications based on Equation (2) and as described in the text. The dependent variable is the concentration of wealth (as reported by WID). Temperature is average temperature in degrees Celsius over the preceding 5-year period. Columns (2) onwards weight climate by population. All specifications control for average rainfall. Robust standard errors (clustered by country) in parentheses. *** p<0.01, ** p<0.05.

Appendix D

Table A18. Pairwise correlations, inequality and alternative development outcomes

	gini	stability	iconflict	unempl.	undernur	inf_mort	tubercu
stability	**-0.15**						
iconflict	**0.41**	0.38					
unemployment	**0.09**	-0.06	-0.06				
undernur	**0.53**	0.02	-0.38	0.01			
inf_mortal~y	**0.51**	-0.28	-0.50	-0.08	0.73		
tubercu	**0.45**	0.09	-0.19	0.22	0.44	0.55	
malaria	**0.41**	0.12	-0.10	-0.21	0.32	0.69	0.13

Table A19. Warming and alternative outcomes

Panel A:			
Dependent variable:	Stability	Corruption	IntConflict
Temperature	-0.523**	0.400***	1.012***
	(0.222)	(0.137)	(0.313)
Year FE	YES	YES	YES
Country FE	YES	YES	YES
Controls	YES	YES	YES
Observations	830	830	830
No. of countries	121	121	121

Panel B:					
Dependent variable:	Undernourish	InfMortality	MotherMortality	Tuberc	Malaria
Temperature	1.724*	7.061***	37.988**	19.818*	44.092**
	(1.008)	(2.524)	(18.151)	(11.079)	(21.878)
Year FE	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES
Observations	381	1436	840	564	359
No. of countries	127	140	140	141	91

Notes: This table reports results of specifications based on Equation (2) and as described in the text, but changing the outcome variable. *Stability* and *IntConflict* here go from 0 (low) to 12 (high). Temperature is average temperature in degrees Celsius over the preceding 5-year period. Controls include rainfall, GDPpc and its square, total population, fertility rates and urban rates. Robust standard errors (clustered by country) in parentheses. *** p<0.01, ** p<0.05, * p<0.

References

Bluhm R and Krause M (2022) Top Lights: bright cities and their contribution to economic development. *Journal of Development Economics* **157**, 102880.

Castells-Quintana D, Dienesch E and Krause M (2021) Air pollution in an urban world: a global view on density, cities and emissions. *Ecological Economics* **189**, 107153.

Donaldson D and Storeygard A (2016) The view from above: applications of satellite data in economics. *Journal of Economic Perspectives* **30**, 171–198.

Henderson JV, Storeygard A and Weil D (2012), Measuring economic growth from outer space. *American Economic Review* **102**, 994–1028.