Supplementary Information

S1: Case

Internal migration in Mexico

During most of Mexico's history, there was little internal migration (Whetten and Burnight 1956).[1] However, beginning with the Mexican revolution in the early 20th century, civil war and political turmoil resulted in the end of the hacienda system—a colonial system of land holdings—and thereby released large numbers of workers to seek better livelihoods elsewhere via migration (Whetten and Burnight 1956). Following World War II, the Mexican government imposed high tariffs on imported goods and encouraged national investment, which led to the development of large-scale industries near major urban centers such as Mexico City, Guadalajara, and Monterrey (Fussell 2004; Portes and Roberts 2005). These industrial centers have served as magnets for rural-urban migrants in search of employment and higher wages (Partida Bush 1993). In the aftermath of the economic crisis of the 1980s, the Mexican government began implementing market liberalization reforms (Robertson 2004), which opened the country to foreign investment and to the development of export production zones along the Mexico-U.S. border (MacLachlan and Aguilar 1998). This reconfiguration of industrial activity resulted in a shift in internal migration towards the Mexico-U.S. border from other parts of the country (Villarreal and Hamilton 2012).

Important differences between migrants from rural and urban areas in Mexico have been observed (Villarreal and Hamilton 2012). A large proportion of internal migrants originate from urban areas (Partida Bush 2013) and these individuals tend to be better educated, wealthier, and migrate longer distances. In contrast, migrants from rural areas are less educated, prefer to migrate to destinations with a large informal sector, and are more likely to migrate to northern cities along the Mexico-U.S. border (Villarreal and Hamilton 2012). Gender differences among rural migrants have also been documented. Specifically, while male migration is frequently seasonal (e.g., with flexible employment as street vendors or day laborers) (Arizpe 1975; Arizpe 1985), female migrants move for longer durations characterized by more stable employment in the domestic and service sectors (Arias 1995; Szasz 1999).

Internal migration in Mexico is mostly directed to urban areas (see Table 1, main text). Migration to urban areas is a common strategy to pursue higher education (Cohen 2004) and secure employment and higher wages (Fussell 2004). For example, the tourist industry attracts both permanent and seasonal labor migrants who tend to be young, less educated, and originate from rural areas (Torres and Momsen 2005). Among other impacts, these migrations have led to explosive growth in urban squatter settlements and slums on the outskirts of major tourism centers (Torres and Momsen 2005).

Mexico's climate context

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[1] Three reasons have been proposed for this lack of mobility (Whetten and Burnight 1956): First, until 1910, the hacienda system—a colonial system of large land grants—dominated economic and social life, with the hacienda population essentially bound to the soil as indentured labor. Second, the Mexican economy operated at near subsistence level, with few opportunities for employment and wages to "push" and "pull" potential migrant workers from one place to another. Third, channels of communication were underdeveloped, which prevented the spread of information about opportunities elsewhere in the country. Additionally, the lack of infrastructure (e.g., paved roads and highways) and transportation technology (e.g., cars and bus services) was a major obstacle to traveling outside of one's place of residence. Accordingly, if migration occurred, it was marked by very short-term, seasonal moves for agricultural work and construction projects (Cohen 2004).

Mexico covers an area of about 2 million square kilometers with varying climatic zones. The northern states from the U.S. border to Mexico City are characterized by a semiarid dry to very dry climate, and the central-western part of the country by a temperate sub-humid climate. The southern coasts and the Yucatan Peninsula are warm and sub-humid, while warm humid conditions prevail in the area west of the Yucatan Peninsula to the south central interior (Boyd and Ibarraran 2009; Marty 1992). In these geographically diverse climatic zones, historically stable climate patterns have begun to change due to global warming (IPCC 2013). Historical climate records for Mexico as a whole show an increase in mean annual temperature of 0.6 °C between 1960 and 2003, with a concomitant increase in temperature extremes (McSweeney et al. 2008). Results from global climate models suggest that precipitation will decrease across Mexico (Christensen et al. 2013), mean temperatures will continue to rise, and temperature extremes will increase in frequency and intensity (Collins et al. 2013) during the 21st century. These trends are projected to lead to an overall increase in future drought occurrence and severity (Wehner et al. 2011). The severe drought of 1994-99 likely marked the dawn of an era of increasingly volatile and destructive weather patterns (Stahle et al. 2009).

Climate vulnerability in rural and urban areas

Rural and urban areas differ in ways that strongly shape vulnerability to climate variability. Despite the trend toward growing employment in non-agricultural wage-labor (Eakin 2005; Scott 2007), agriculture nonetheless contributes in important ways to sustenance and livelihood portfolios of rural Mexicans (Conde et al. 2006; Wiggins et al. 2002; Winters et al. 2002). A large proportion of the agricultural land in Mexico is cultivated by small-holder agrarian communities known as *ejidos* (de Janvry and Sadoulet 2001). Rural populations are characterized by disproportionately high levels of poverty, illiteracy, and infant mortality (de Janvry and Sadoulet 2001; Scott 2007). For the rural poor, agricultural production is an important safety net and provides a critical means to improve welfare (Scott 2007).

Against this backdrop, lack of financial resources prevents rural populations from securing and employing technology (e.g., irrigation systems) to mitigate climate impacts. As a result, the majority of the agricultural production in Mexico is rainfed (Carr et al. 2009), thus rendering rural areas and the populations therein highly vulnerable to climate impacts (Endfield 2007). Climate vulnerability in rural areas is further aggravated by smaller labor markets, lower incomes, and imperfect and/or incomplete access to public services (Romero-Lankao et al. 2014). Given this vulnerability, it is estimated that climate change and extreme weather events were responsible for approximately 80% of economic losses in Mexico between 1980 and 2005 (Saldana-Zorrilla and Sandberg 2009).

Climate also has important impacts on non-agricultural economic sectors (Boyd and Ibarraran 2009; Hsiang 2010), and therefore on urban livelihoods (IPCC 2014; Revi et al. 2014). Urban areas, such as Mexico City, rely heavily on constrained water resources from surrounding regions (Connolly 1999). Droughts limit access to these water resources, with adverse impacts on residents and businesses (Romero-Lankao 2010; Satterthwaite et al. 2007). An increase in temperature may impact urban energy consumption for cooling and heating (Mideksa and Kallbekken 2010), making industrial production more expensive. Climate change related increases in temperature and heat waves will be intensified in urban areas by the urban heat island effect (Adachi et al. 2012; Wilby 2007). Urban tourism, one of Mexico's most important sectors, is sensitive to climate impacts, as employment and income opportunities depend on whether and to what extent droughts and heat waves alter the attractiveness of urban tourist destinations (Amelung et al. 2007; Lise and Tol 2002). Finally, thermal stress can also adversely impact labor productivity (Hsiang 2010), air quality (Jacob and Winner 2009; Weaver et al. 2009), and human health (WHO and WMO 2012).

The above said, there are strong connections between the rural agricultural sector and the urban manufacturing and production sectors (Wackernagel et al. 2006). For example, while employment in urban coffee mills clearly depends on rural productivity, urban residents are also employed in the agricultural sector near urban areas (Satterthwaite et al. 2007). The mutual dependence of rural and urban livelihoods is most pronounced in peri-urban areas in which individuals hold urban non-farm employment, but continue to rely heavily on agricultural production for food provision and as an insurance strategy against volatile labor markets (Lerner et al. 2013). Additionally, adverse climate impacts on agricultural production have the potential to increase food prices in cities, with especially negative implications for poor urban wageworkers who, as consumers, spend a significant proportion of their income on food (Ahmed et al. 2009).

S2: Control variable construction

Internal migration is influenced by many characteristics operating at multiple levels of scale (White and Lindstrom 2006). Whenever possible, we included control variables as time varying measures, but we also used time-constant measures for a few municipality characteristics that were only available for certain years.

At the individual-level, we account for basic demographic differences by including variables for gender (male=1, female=0) and age (in years). The age variable refers to the age of each person five years prior to the census when residing in the origin municipality. Educational attainment was measured using a continuous variable for the number of years of schooling completed prior to the census. To account for international migration as one possible alternative livelihood strategy to internal migration (Lindstrom and Lauster 2001), we included an indicator variable for whether one or more members of the household in which the individual lived during the census year migrated abroad during the 5-year observation period (international migrant in household = 1, no international migrant in household = 0) . While unavoidable given our data, there is some uncertainty with this variable, as the household composition may have changed during the observation period.

At the municipality level, we accounted for well-documented influences of access to migrant networks (Curran and Rivero-Fuentes 2003; Fussell 2004). Access to migrant networks may reduce the cost and uncertainties associated with migration by, for example, providing information about employment and housing opportunities in potential destinations. To approximate access to internal migrant networks (Davis et al. 2002), we constructed a measure of the percentage of adults in a given municipality with internal migration experience five years prior to the start of the observation window using data from the previous two censuses (1990 and 2000) (cf., Villarreal and Hamilton 2012), taken from IPUMS International (MPC 2015). To approximate access to international migrant networks (Lindstrom and Lauster 2001), we used the migration intensity index, which was developed by the Mexican Consejo Nacional de Población (CONAPO) for the two census years 2000 and 2010 (CONAPO 2002; CONAPO 2012). The migration intensity index was constructed by CONAPO as a standardized composite measure that takes into account international return and circular migration, as well as remittances.

Migration is often economically motivated, as individuals may leave poor marginalized areas and move to places with improved access to resources, infrastructure, and employment opportunities (Massey et al. 1993). To account for the marginalization of a municipality, we employed CONAPO's marginalization index, constructed for the two census years 2000 and 2010 (CONAPO 2001; CONAPO 2011). The marginalization index was computed separately for each census year as a standardized scale based on principal component analysis of nine socioeconomic indicators capturing the quality of housing and infrastructure (access to piped water, sanitation, electricity, and quality of building material), living conditions (overcrowding of dwellings), education levels (literacy rates and the proportion of the population with primary education), and income-based poverty.[2]

The migration intensity index and the marginalization index were not available for the year 1990, preventing us from using information on preceding (vs. concurrent) conditions. Nonetheless, we consider the use of this information during the census year as valid approximations of the local situation because socioeconomic conditions tend to change slowly over time. It is a common practice in migration research to use concurrent information if data restrictions prevent the use of preceding information (e.g., Loebach 2016; Villarreal and Hamilton 2012).

Climate and weather have strong impacts on the agricultural sector (Boyd and Ibarraran 2009), and may impact migration through agricultural pathways (Nawrotzki and Bakhtsiyarava 2016). To measure agricultural dependence in a municipality, we calculated the percentage of adults employed in agriculture and forestry using census data. Because the sensitivity of the agricultural sector differs by the crop type farmed, we obtained measures of municipality area (sqm / 10 ha) harvested with corn and wheat as the two crop types of primary economic importance in Mexico (CIA 2014). Crop measures were obtained from TerraPop (Kugler et al. 2015; MPC 2013), and were originally constructed by the Global Landscape Initiative (GLI) to reflect conditions around the year 2000 (Monfreda et al. 2008). The sensitivity of agricultural production to climate effects strongly depends on the availability of technological infrastructure, such as irrigation (Howden et al. 2007). We therefore also obtained information on the percentage of irrigated farmland averaged across the years 2004-2009 from the Mexican agricultural census (INEGI 2012).

Prior research shows that historic climatic conditions can influence the climate-migration relationship in Mexico (Nawrotzki et al. 2013). As such, we computed the average monthly precipitation and maximum temperature during the climate normal period 1961-1990 based on climate data from the University of East Anglia's Climate Research Unit (CRU) (Harris et al. 2014) available via TerraPop. The years 1961-1990 have been recommended by the World Meteorological Organization (WMO) as the baseline period of normal climate conditions for the analysis of climate variability and change (Arguez and Vose 2011).

Internal migration flows differ substantially in size and socio-demographic composition by rural and urban origins (Villarreal and Hamilton 2012). To account for these differences and model origin- and destination-specific migration streams, we classified origin municipalities as rural and urban using satellite based information on the proportion of the municipality covered with "urban build up", based on MODIS urban extents (Schneider et al. 2009) available from TerraPop. "Urban build up" is defined as contiguous patches of land, greater than 1 skm, covered by the built environment, which "includes all non-vegetative, human-constructed elements, such as roads, buildings, runways, etc. (i.e. human-made surfaces)" (Schneider et al. 2009, pp. 2-3).

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[2] To test for the sensitivity of our results to the inclusion/exclusion of the marginalization index, we omitted this variable from the set of control variables and reran the models. The effect size and directionality of the climate coefficients changed little and all measures retained their significance.

Based on a median split, we classified municipalities with no detectable urban build up as rural, and municipalities with at least some urban build up (0.001 to 78.3% of municipality area) as urban. We used a median (instead of a mean) split due to the highly skewed distribution of the "% area urban" measure. Using the median split, 36% of all municipalities are classified as urban. These urban municipalities contain 62.24% of the population in our sample, who are considered "urban" in this study. As a sensitivity test, we varied the threshold used in our indicator variable for urban municipalities (see S6: Sensitivity tests) and found our results to be robust.

Finally, changes in macroeconomic conditions may influence decisions to migrate (Milne 1993). We therefore computed the inflation-adjusted change in GDP from the prior year for each state and available years. We then computed the average change across the 6-year period prior to the census, the same period for which we constructed our climate measures.

S3: Model fitting details

The multilevel models were fit using the *lme4* package (Bates 2010; Bates et al. 2014) within the R statistical environment (RCoreTeam 2016). For improved speed and better convergence properties, we modified the integer scalar settings (nAGQ = 0) in order to optimize (optimizer = "bobyqa") the random and fixed-effects coefficients in the penalized iteratively reweighted least squares step (Bates et al. 2014). For the multinomial contrasts, we employed the Begg and Gray method (Begg and Gray 1984) and fit a series of separate logit models (see also, Agresti 2002; Allison 1984).

S4: Baseline model results

We constructed a multivariate baseline model to account for demographic and contextual factors that may influence the decision to migrate internally. Model 1 includes only the time fixed effects control. Model 2 adds individual- and household-level control variables. Model 3 is the fully adjusted baseline model that also includes municipality- and state-level control variables (Table S1).

Table S1 Baseline model estimating the effect of sociodemographic predictors on internal migration in Mexico during 2000 and 2010

	Model 1		Model 2		Model 3	
	b	sig.	b	sig.	b	sig.
Variables						
Intercept	-3.41	***	-2.95	***	-4.05	***
Year 2010	0.15	***	0.13	***	0.15	***
Male			-0.02		-0.02	
Age [a]			-0.25	***	-0.25	***
Education			0.03	***	0.03	***
International migrant household			-0.12	***	-0.11	***
Migrant networks (domestic) [a]					0.03	
Migrant networks (international)					-0.19	***
Marginalization index					-0.44	***
Agriculture employment [a]					0.02	
Corn area harvested					-0.07	***
Wheat area harvested					0.06	
Irrigated cropland [a]					-0.01	
Baseline max temp (1961-90) [a]					0.42	***
Baseline precip (1961-90) [b]					0.06	
GDP change					-0.07	***
Model statistics						
Variance (municipality)	0.900		0.863		0.602	
Variance (state)	0.164		0.150		0.077	
BIC	304,328		302,494		301,985	
N (individuals)	683,518		683,518		683,518	
N (municipalities)	2,321		2,321		2,321	
N (states)	32		32		32	

Notes: Parameter estimates reflect log odds; [a] coefficients reflect an incremental change of 10 units; [b] coefficient refers to a change of 100 mm monthly precipitation; estimating the variance inflation factor (VIF) produced values <4.1 for all variables, indicating that multicollinearity did not bias the estimates;
* p<0.05; ** p<0.01; *** p<0.001

As is evident from the year fixed effects coefficient, internal migration was higher in 2010 than in 2000. While gender differences did not emerge (cf., Cohen 2004), the typical internal migrant was younger and more educated (Gray and Bilsborrow 2013). Consistent with the idea that international migration is an alternative livelihood strategy to internal migration (Lindstrom and Lauster 2001), access to international migrant networks and living in a household with one or more members with international migration experience reduce the odds of internal migration. Our sample and prior research (Villarreal and Hamilton 2012) suggests higher migration rates from urban municipalities. In line with this observation, our baseline model results reveal that internal migration tends to be lower from marginalized rural municipalities with high dependence on corn production. However, because migration is often used as a livelihood strategy to improve one's economic position (Massey et al. 1993), we observe that internal migration is most pronounced from states that have experienced a decline in GDP. Finally, in agreement with research on international migration from Mexico (Nawrotzki and DeWaard 2016), we observe important differences in migration based on the baseline temperature of a given municipality, with an increase in internal migration from historically warmer regions.

S5: Nonlinear specifications

Quadratic transformations are widely employed to explore nonlinearities in climate-migration associations (Bohra-Mishra et al. 2014; Feng et al. 2010; Joseph et al. 2014), while cubic transformations have only recently been used (Gray and Wise 2016). In the first step of exploring nonlinearities in the relationship between climate shocks and internal migration, we estimated models in which we included either a linear, quadratic, or cubic transformation for both climate measures (Table S2).

Judging by the BIC statistic, linear climate measures produced the best model fit among models of migration to rural destinations. A quadratic transformation results in the best model fit for models of migration to urban destinations. The cubic transformation results in the poorest model fit in both cases.

In addition to using the same transformation for drought and heat months in each model, we further examined all possible combinations of transformations. Judging by the BIC statistic, a linear-linear specification (linear drought months and linear heat months) produces the best fit for the model of migration to rural destinations, while a linear specification for drought months and a quadratic specification for heat months results in the best model fit for the model of migration to urban destinations (see Table 3, main text). Parameter estimates for these best fitting models are shown below in Table S3.

Table S2 Estimates of nonlinear effects for drought and heat months predicting the log odds of internal migration in Mexico during 2000 and 2010

	Rural destination		Urban destination	
	b	sig.	b	sig.
Specification A: Linear				
Drought months	0.23	***	0.31	***
Heat months	-0.20	***	-0.11	***
Urban origin	0.25	***	0.70	***
Drought months x Urban origin	-0.25	***	-0.47	***
Heat months x Urban origin	0.08		0.12	***
BIC	107,563		238,004	
Specification B: Quadratic				
Drought months	0.29	***	0.41	***
Drought months squared	-0.15		-0.21	**
Heat months	-0.20	***	-0.16	***
Heat months squared	0.03		0.12	***
Urban origin	0.11		0.70	***
Drought months x Urban origin	-0.39	***	-0.60	***
Drought months squared x Urban origin	0.50	***	0.35	***
Heat months x Urban origin	0.08		0.17	***
Heat months squared x Urban origin	0.03		-0.09	***
BIC	107,575		237,989	
Specification C: Cubic				
Drought months	0.48	***	0.46	***
Drought months squared	0.34	*	-0.01	
Drought months cubic	-0.47	***	-0.19	
Heat months	-0.14	*	-0.12	*
Heat months squared	0.05		0.14	***
Heat months cubic	-0.03		-0.02	
Urban origin	0.20	*	0.75	***
Drought months x Urban origin	-0.61	***	-0.79	***
Drought months squared x Urban origin	-0.01		0.02	
Drought months cubic x Urban origin	0.51	**	0.51	***
Heat months x Urban origin	0.08		0.16	**
Heat months squared x Urban origin	0.02		-0.10	***
Heat months cubic x Urban origin	0.01		0.01	
BIC	107,605		238,011	

Notes: Parameter estimates reflect log odds; All models include the full set of control variables shown in Table S1; Coefficients of climate variables reflect an incremental change of 10 units; climate variables were grand mean centered;
* p<0.05; ** p<0.01; *** p<0.001

Table S3 Estimates of linear and nonlinear effects for drought and heat months for the best fitting models of internal migration in Mexico during 2000 and 2010

	Rural destination		Urban destination	
	b	sig.	b	sig.
Variables				
Drought months	0.23	***	0.31	***
Heat months	-0.20	***	-0.17	***
Heat months squared			0.13	***
Urban origin	0.25	***	0.78	***
Drought months x Urban origin	-0.25	***	-0.48	***
Heat months x Urban origin	0.08		0.18	***
Heat months squared x Urban origin			-0.10	***
Model statistics				
Variance (municipality)	0.894		0.674	
Variance (state)	0.116		0.153	
BIC	107,563		237,982	
N (individuals)	649,570		671,637	
N (municipalities)	2,321		2,321	
N (states)	32		32	

Notes: Parameter estimates reflect log odds; All models include the full set of control variables shown in Table S1; Coefficients of climate variables reflect an incremental change of 10 units; climate variables were grand mean centered;
* p<0.05; ** p<0.01; *** p<0.001

The inflection point for the quadratic heat relationship (ϕ_{heat}) can be computed as $\phi_{heat} = -\beta_1/(2*\beta_2)$ (Nawrotzki et al. 2014), with β_1 and β_2 representing the linear and quadratic coefficient for heat months, respectively. The coefficients refer to an incremental change of 10 units, and the heat months variable was grand mean centered (mean value = 27.322). As such, the inflection point occurs at around 34 heat months, computed as $\phi_{heat} = (-(-0.17)/(2*0.13))*10+27.322 = 33.86$.

S6: Sensitivity tests

In line with the focus of this article, we performed a number of sensitivity tests for rural-urban migration based on the best fitting model of migration to urban destinations (linear drought months and quadratic heat months).

Most importantly, we varied the cutoff used to construct the indicator variable for urban origin. In addition to the median value (0.0% urban build) that was used as the default in the main text, we tested levels of 0.5% urban build, 1.0% urban build, 4.0% urban build, and 8.0% urban build. Municipalities with less or equal to this percentage of satellite-detected urban build were classified as rural, while remaining municipalities were classified as urban.[3] Results (Table S4) show that the linear effect of drought months on rural-urban migration remained statistically significant and positive under all urbanization specifications. While the squared term for heat lost statistical significance for a level of 0.5% urban, the directionality (sign of coefficient) remained stable, indicating a U-shaped functional form under all specifications.

Table S4 Sensitivity of climate effects (linear drought months, quadratic heat months) on rural-urban migration in Mexico during 2000 and 2010

Spec	Description	Drought months		Heat months		Heat months squared	
		b	sig.	b	sig.	b	sig.
Urbanization (MODIS)							
A	0.0% urban build	0.31	***	-0.17	***	0.13	***
B	0.5% urban build	0.25	***	-0.12	***	0.03	
C	1.0% urban build	0.29	***	-0.13	***	0.04	*
D	4.0% urban build	0.33	***	-0.08	**	0.06	***
E	8.0% urban build	0.32	***	-0.01		0.04	*
Urbanization (IPUMS)							
A	25% urban people	0.37	***	-0.10	*	0.09	***
B	30% urban people	0.37	***	-0.06		0.10	***
C	35% urban people	0.37	***	-0.06		0.09	***
D	40% urban people	0.41	***	-0.06		0.09	***
E	45% urban people	0.38	***	-0.09	**	0.08	***
F	50% urban people	0.40	***	-0.08	**	0.06	***
G	60% urban people	0.34	***	-0.10	***	0.05	**

Notes: Parameter estimates reflect log odds; Each row represents a fully adjusted model of which only the relevant drought and heat months effects on rural-urban migration are shown; Coefficients of climate variables reflect an incremental change of 10 units; climate variables were grand mean centered;
* $p<0.05$; ** $p<0.01$; *** $p<0.001$

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[3] Satellite-based classification of municipalities as urban or rural based on the percentage of urban build results in the following percentages of our sample residing in urban and rural municipalities: 0.0% urban build = 62.24% urban and 37.76% rural; 0.5% urban build = 43.01% urban and 56.99% rural; 1.0% urban build = 36.83% urban and 63.17% rural; 4.0% urban build = 23.80% urban and 76.20% rural; 8.0% urban build = 19.64% urban and 80.36% rural.

However, the sensitivity analysis using satellite-based data is limited to an exploration of changes in the urbanization level above the median value of 0.0% urban build and does not permit testing differences among more rural locations. To investigate the effects of a reclassification at the more rural end of the rural-urban spectrum, we computed the percentage of urban people for each municipality based on information provided by the Mexican census. This measure shows a median urbanization level for municipalities of around 40% (38.5%). We therefore classified municipalities with greater than 40% urban residents as urban and as rural otherwise. We varied the cutoff point used to define a municipality as urban from 25% to 60%.[4] Results from these models revealed positive drought effects regardless of the selected cutoff point. The linear heat months coefficient, indicating the slope of the predicted migration curve at the average number of heat months (given centering), was not significant in a few cases (30%, 35%, and 40% urban). However, the nonlinear squared term, denoting the exponential increase in migration at higher levels of heat exposure was significant across all urbanization levels. In combination, the consistent negative coefficient of the linear heat months coefficient as well as the strong positive squared term suggest a U-shaped migration-heat months relationship that is robust to various urbanization levels.

To investigate possible gender differences, we estimated separate models for males and females, and observed similar relationships with slightly stronger effects among males (Table S5). Climate effects on rural-urban migration may differ by socioeconomic characteristics. We therefore estimated models for less educated (0-6 years schooling; completed primary school or less), average educated (7-11 years schooling; completed some middle school), and highly educated (12-18 years schooling; completed high school and above) subpopulations and observed similar effects in direction and magnitude, with the strongest effects for drought months among the subgroup of average educated individuals. To investigate differences by age, we stratified our sample into younger ages (15-25 years) and older ages (26-39 years) based on a mean split (mean = 25.8 years). The directionality and magnitude of the effects were similar, with somewhat stronger climate effects among members of the younger age group.

We further examined period differences between the two censuses (2000 and 2010). We found a similar directionality, but a weaker effect for drought months, which is not statistically significant during the 2000 census period. For the quadratic effect of heat, we observed an accelerating positive trend in the heat slope even at lower levels of heat months during 2000 census period, and a largely linear increase of domestic migration with an increase in heat months during the 2010 census period.

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[4] Census-based classification of municipalities as urban or rural based on the percentage of urban residents results in the following percentages of our sample residing in urban and rural municipalities: 25% urban people = 77.91% urban and 22.09% rural; 30% urban people = 75.26% urban and 24.74% rural; 35% urban people = 72.75% urban and 27.25% rural; 40% urban people = 70.20% urban and 29.80% rural; 45% urban people = 67.39% urban and 32.61% rural; 50% urban people = 64.09% urban and 35.91% rural; 60% urban people = 56.56% urban and 43.44% rural.

Table S5 Sensitivity of climate effects (linear drought months, quadratic heat months) on rural-urban migration in Mexico during 2000 and 2010

Spec	Description	Drought months		Heat months		Heat months squared	
		b	sig.	b	sig.	b	sig.
Sociodemographic characteristics							
A	All cases	0.31	***	-0.17	***	0.13	***
B	Males	0.30	***	-0.13	**	0.14	***
C	Females	0.25	***	-0.08	*	0.10	***
D	Less educated	0.26	***	-0.12	**	0.11	***
E	Average educated	0.36	***	-0.07		0.15	***
F	Highly educated	0.23	**	-0.11	*	0.10	**
G	Younger age	0.29	***	-0.13	***	0.12	***
H	Older age	0.22	**	-0.06		0.11	***
Period effects							
A	Years 2000 & 2010	0.31	***	-0.17	***	0.13	***
B	Year 2000	0.08		0.15	*	0.10	*
C	Year 2010	0.19	*	0.22	**	0.07	
Climate specifications							
A	1.0 SD Level	0.31	***	-0.17	***	0.13	***
B	1.5 SD Level	0.45	***	-0.03		0.02	
C	2.0 SD Level	1.38	***	0.27	***	-0.13	
D	Magnitude	1.52	***	-0.77	***	2.32	***
E	Spell length	1.75	***	-0.48	***	0.69	*
F	Negative controls	0.32	***	-0.17	***	0.13	***
Seasonality							
A	All months	0.31	***	-0.17	***	0.13	***
B	Rainy 1 (MAY-OCT)	0.69	***	-0.07		0.19	*
C	Rainy 2 (JUN-SEPT)	0.69	***	0.09		0.11	
D	Rainy 3 (JUN-NOV)	0.60	***	-0.25	***	0.44	***
E	Rainy 4 (JUL & AUG)	0.88	***	-0.28	*	0.35	
F	Warm CA (SEP-NOV)	0.67	***	-0.85	***	1.71	***
G	Warm MX (APR-SEPT)	0.63	***	0.08		0.12	
H	Corn (JUN-OCT)	0.68	***	-0.17	*	0.34	**
I	Wheat (NOV-APR)	-0.03		-0.46	***	0.36	***

Notes: Parameter estimates reflect log odds; Each row represents a fully adjusted model of which only the relevant drought and heat months effects on rural-urban migration are shown; Coefficients of climate variables (except magnitude) reflect an incremental change of 10 units; climate variables were grand mean centered;
* p<0.05; ** p<0.01; *** p<0.001

We also revisited the climate measure specification, using cutoffs of 1.5 SD and 2.0 SD (vs. the default 1.0 SD cutoff) to classify a given month during the six-year observation window as a drought or heat month, relative to the 30-year long-term climate normal period. Use of these higher cutoffs, which are sometimes employed in other studies (e.g., Diffenbaugh et al. 2015; Hunter et al. 2013), singles out more extreme climate shocks. The linear drought effect drastically increases in magnitude at higher SD cutoffs. Changes in the non-linear relationship can be attributed to the masking of lower-level effects. For example, the U-shaped heat effect flattened out at a 1.5 SD cutoff, and became linear and positive for the 2.0 SD cutoff.

We also constructed alternative climate measures to capture the magnitude and duration (spell length) of the climate signal (see Table S5: Climate specifications). Magnitude was computed by subtracting the long-term (1961-1990) municipality mean from monthly temperature and precipitation during the observation period, divided by the long-term standard deviation (Dillon et al. 2011; Mastrorillo et al. 2016). Months with negative z-scores (i.e., above average precipitation and below average temperature) were assigned a value of zero prior to computing the mean z-score for the observation period months (for an example of this approach see Mastrorillo et al. 2016). Spell length was computed as the maximum number of consecutive drought or heat months using the same 1 SD cutoff for the cumulative exposure measure. The cumulative exposure measures are highly correlated with the magnitude and spell length measures.[5] The models reveal that an increase in drought magnitude and spell length linearly increases rural-urban migration. For heat months, a similar non-linear functional form emerged. In addition, we tested the sensitivity of our findings to the inclusion of variables capturing the climate effects at the opposite end of the spectrum. To this end, we constructed variables of cold snaps and excessive precipitation measuring the cumulative occurrence of temperatures below 1 SD and precipitation anomalies above 1 SD of the long term average. Adding these "negative controls" to the model, revealed no significant association between excessive precipitation and migration to urban destinations (b=0.003, n.s.), while cold snaps slightly increased the probability of a move (b=0.018, p<0.001). Most importantly, controlling for these extremes at the opposite end of the spectrum had only negligible effect on the drought and heat coefficients.

Finally, we investigated different temporal specifications of our climate measures because the climate-migration relationship may be influenced by seasonality (Nawrotzki and Bakhtsiyarava 2016). As the default specification, we used all months in the analysis presented in the main text. To explore possible seasonal effects, we reconstructed the heat and drought measures for a subset of months. Published articles use different rainy season definitions for Mexico, including the months May-October (Rainy 1) (Pearce and Smith 1990; Schwartz 1977), the months of June-September (Rainy 2) (Fuentes-Franco et al. 2015), and the months of June-November (Rainy 3) (McSweeney et al. 2008; Mercer et al. 2012). In addition, we explore climate effects when focusing on the two highest rainfall months of July and August (Rainy 4), as has been done in prior research on international climate migration from Mexico (Barrios Puente et al. 2015). The strongest effects emerged when drought months occurred during the two months of highest rainfall (July and August, Rainy 4). While the nonlinear relationship between heat months and rural-urban migration is somewhat sensitive to the rainy season definition, we observed the strongest U-shaped functional form for the months of June-November (Rainy 3).

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[5] The measure of cumulative exposure for drought is highly correlated with the average drought magnitude (r=0.73), as well as the drought spell length (r=0.80). The measure of cumulative exposure for heat is likewise highly correlated with average heat magnitude (r=0.97), as well as the heat spell length (r=0.71).

The warm season in Mexico spans the months of April-September (Warm MX) (Marty 1992). In addition, prior research has demonstrated strong effects of temperature increases on economic performance among countries in Central America and the Caribbean during the warm months of September-November (Warm CA) (Hsiang 2010). While the impact of droughts was comparably strong for both warm season definitions, the most pronounced U-shaped functional form for temperature effects emerged for the period of September-November.

Owing to the importance of agricultural pathways for the climate-migration relationship (Nawrotzki and Bakhtsiyarava 2016), we also investigated climate effects during the corn growing season of June-October (Sacks et al. 2010), and during the winter wheat growing season of November-April (Sacks et al. 2010). While an increase in drought months significantly increased rural-urban migration during the corn growing season, we detected no effect during the winter wheat growing months. In contrast, we observed nonlinear effects of heat months on rural-urban migration during both seasons.

Overall, these sensitivity tests show that the positive effect of drought months on rural-urban migration was strong and statistically significant for nearly all specifications. The U-shaped functional form of heat months was more sensitive and, for a number of specifications, a positive linear effect seems to better reflect the relationship with rural-urban migration (e.g., year 2010, 2.0 SD cutoff, and urban build of 0.5%). In sum, the various sensitivity tests demonstrate a high degree of robustness of our findings.

S7: Limitations

While carefully conducted, this study has several important limitations. *First*, locating people in their municipality of residence five years prior to each census permits us to use only basic demographic characteristics (e.g., age, gender, and education). Because we do not know the composition of households in the origin municipality, we were unable to include measures of household income, marital status, and employment as these are only recorded for the census year (i.e., after migrations had already occurred). *Second*, although we followed an established methodology (Dillon et al. 2011; Nawrotzki and Bakhtsiyarava 2016; Thiede et al. 2016), more sophisticated climate variables may be constructed based on daily climate records. We suggest that future research build on this study to test for more nuanced differences between climate measures. *Third*, we do not know exactly when during the observation window individuals migrated. The crudeness in the employed migration measure, which is unavoidable given our data, therefore prevented us from detecting more temporally explicit effects in the climate-migration association. *Finally*, the employed random effects approach separates the error term in three components, operating at the individual, municipality, and state level. Because not all variation is captured by the set of predictors, there is a possibility for unobserved variable bias. However, we consider this bias to be limited, given the exogenous nature of climate variability (O'Loughlin et al. 2012) and our controls for important municipality-level factors including baseline climatic conditions, irrigation infrastructure, crop type planted, and agricultural dependence.

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