

Supplemental Information

January 8, 2024

Table S1: Raw dengue data sources and information. MoH = Ministry of Health

Country	Spatial resolution	Number of administrative units	Original temporal resolution	Start date	End date	Data source
BOL	Admin 1	9	weekly	12/1/13	12/31/19	PAHO
BRA	Admin 2	5570	weekly	1/1/01	12/31/19	MoH DATASUS
COL	Admin 2	1122	weekly	1/1/07	12/31/19	MoH SIVIGILA
CRI	Admin 1	6	weekly	1/1/12	12/31/19	MoH
DOM	Admin 2	32	weekly	1/1/07	12/31/18	MoH DIEPI
HND	Admin 1	18	weekly	1/1/17	6/30/19	PAHO
IDN	Admin 1	34	monthly	1/1/00	12/31/17	Tycho
KHM	Admin 1	25	monthly	1/1/98	12/31/10	Tycho
LAO	Admin 1	18	monthly	1/1/98	12/31/10	Tycho
LKA	Admin 2	25	monthly	1/1/10	12/31/19	MoH Epidemiology Unit
LKA1	Admin 1	9	monthly	1/1/96	12/31/04	Tycho
MEX	Admin 1	32	weekly	1/1/03	12/31/19	MoH
MYS	Admin 1	16	monthly	1/1/93	12/31/10	Tycho
NIC	Admin 1	17	monthly	1/1/00	12/31/04	Tycho
NIC	Admin 1	17	weekly	1/1/04	12/31/19	PAHO
PAN	Admin 1	13	weekly	1/1/18	12/31/19	PAHO
PER	Admin 2	196	weekly	1/1/10	12/31/19	CDC Peru
PHL	Admin 2	87	monthly	1/1/94	12/31/10	Tycho
SLV	Admin 1	14	monthly	1/1/00	8/31/09	Tycho
THA	Admin 1	77	monthly	1/1/93	12/31/10	Tycho
THA	Admin 1	77	monthly	1/1/11	12/31/19	MoPH
TWN	Admin 2	22	weekly	1/1/05	12/31/19	Taiwan NIDSS
VEN	Admin 1	25	monthly	1/1/99	3/31/05	Tycho
VEN	Admin 1	25	weekly	1/1/17	12/31/19	PAHO
VNM	Admin 1	63	monthly	1/1/94	12/31/10	Tycho

Table S2: GCM scenarios and variants included in projections.

	GCM	historical-natural	future
1	ACCESS-CM2	r1i1p1f1	r1i1p1f1
2	ACCESS-ESM1-5	r1i1p1f1	r3i1p1f1
3	AWI-CM-1-1-MR		r1i1p1f1
4	BCC-CSM2-MR	r1i1p1f1	r1i1p1f1
5	CAMS-CSM1-0		r1i1p1f1
6	CESM2	r1i1p1f1	r4i1p1f1
7	CESM2-WACCM		r1i1p1f1
8	CNRM-CM6-1	r1i1p1f2	r1i1p1f2
9	CNRM-ESM2-1		r1i1p1f2
10	FGOALS-f3-L		r1i1p1f1
11	GFDL-ESM4	r1i1p1f1	r1i1p1f1
12	GISS-E2-1-G	r1i1p1f2	r1i1p3f1
13	GISS-E2-1-H		r1i1p1f2
14	IITM-ESM		r1i1p1f1
15	KACE-1-0-G		r1i1p1f1
16	MCM-UA-1-0		r1i1p1f2
17	MIROC-ES2L		r1i1p1f2
18	MIROC6	r1i1p1f1	r1i1p1f1
19	MPI-ESM1-2-HR		r1i1p1f1
20	MPI-ESM1-2-LR		r1i1p1f1
21	MRI-ESM2-0	r1i1p1f1	r1i1p1f1
22	NorESM2-LM	r1i1p1f1	r1i1p1f1

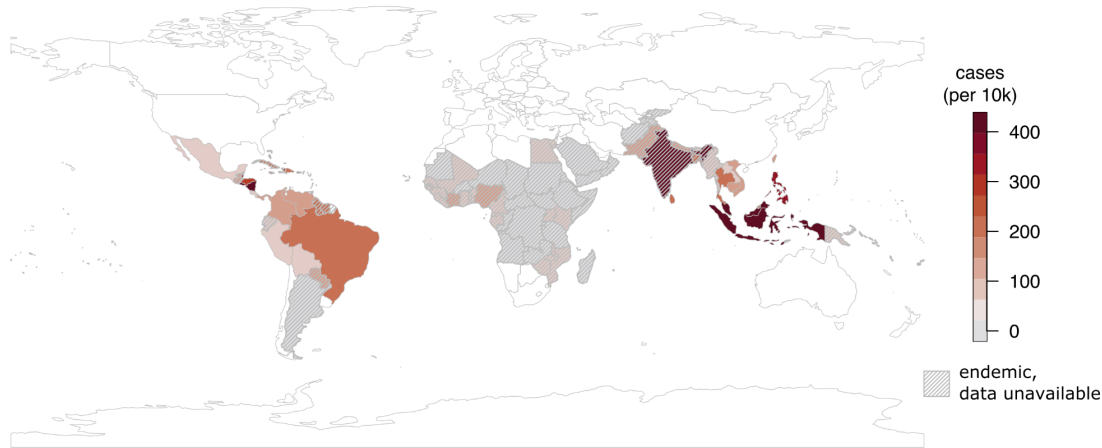


Figure S1: **Availability of dengue data in endemic areas.** Shading indicates no subnational subannual data was available for that country. Dengue cases are annual estimates (Zeng et al. 2021).

Table S3: Projected percent change in dengue incidence for countries under different climate scenarios. Numbers are median estimates followed by 95% CIs.

country	current vs no anthropogenic forcing	current vs SSP3-7.0	current vs SSP2-4.5	current vs SSP1-2.6	SSP1-2.6 vs SSP3-7.0
overall	-18.2% (-25.5- -12.1%)	57.3% (33.3-107.1%)	54.2% (27.6-98.3%)	39.9% (16.8-76%)	7.3% (0.9-19.6%)
BOL	-37.6% (-55.2- -24.6%)	178.5% (80.9-917.8%)	151.2% (69.1-754.4%)	104.7% (41.5-461.5%)	29.7% (3.8-80.7%)
PER	-39.3% (-50.3- -30.3%)	187.7% (88.5-389.3%)	162.8% (75-363.7%)	109.6% (48.2-306.1%)	27.9% (0.6-64.6%)
MEX	-31.1% (-40.6- -5.9%)	139.7% (84.2-354.5%)	132.4% (66.9-280.3%)	93.5% (35.2-232.5%)	22.6% (-3.5-56.3%)
COL	-29.2% (-43.3- -17.4%)	131% (58.5-305%)	111.4% (48.5-264.6%)	75.9% (31.1-181.4%)	19.5% (2.6-48%)
CRI	-32.4% (-42.8- -24.3%)	108.5% (40-212.3%)	95.7% (50.8-189.8%)	74.3% (23.8-146.9%)	20.6% (1.3-32.9%)
TWN	-14.6% (-21.6-0.7%)	91.1% (39.1-171%)	89% (27.5-162.1%)	70.1% (13.9-134.7%)	11.4% (-10.1-34.6%)
BRA	-32.4% (-49- -19%)	91.8% (44.8-138.8%)	81.4% (23.7-150.6%)	56.8% (27.6-105.9%)	15% (4.1-42.6%)
HND	-30.3% (-41.5- -18.1%)	81.7% (40.9-151.8%)	68.8% (31.9-129.5%)	54% (17-100.6%)	16.2% (5.3-27.9%)
SLV	-34.6% (-53.2- -21.5%)	65.3% (30.5-105.6%)	56.7% (21.4-94.6%)	42.9% (12.8-74.9%)	15.5% (5.4-33.7%)
LAO	-6.7% (-22.6-2.9%)	41.1% (5.1-80.2%)	45.1% (9.3-75.9%)	40.7% (11.5-95.7%)	-2.1% (-12.6-21.1%)
NIC	-23.3% (-34.5- -14.3%)	43.7% (25.6-69.2%)	39.9% (20.7-62.8%)	30.5% (12.2-52%)	8.6% (1.9-17.9%)
VEN	-18.3% (-27.5- -10.3%)	37.3% (22.3-60.9%)	34.8% (21.6-58.9%)	27.8% (12.3-48.9%)	4% (-1.2-12%)
VNM	0.9% (-9.5-9.3%)	30.3% (1.6-59.9%)	40.2% (5.1-71.7%)	38.5% (6.1-67.8%)	-4.1% (-11.9-15%)
DOM	-15.5% (-23.9- -7.2%)	22.9% (12.2-37.6%)	22% (12.4-37.9%)	18.4% (8-32.3%)	2.9% (-1.4-9.1%)
IDN	-15.2% (-22.3- -9.1%)	18.1% (9-30.1%)	17.2% (8.7-28.3%)	14.7% (7.6-26.1%)	2.6% (-0.9-6.6%)
PAN	-12.1% (-18.5- -7%)	9.9% (0.1-19.9%)	9.7% (0.4-18.5%)	8.6% (1.9-17.7%)	0.6% (-3.4-4.3%)
LKA	-9% (-18- -4.8%)	8.4% (0.3-18.2%)	8% (0.4-17.3%)	6.9% (0.9-15.5%)	-0.2% (-3.3-1%)
PHL	-7.1% (-12.4- -2.7%)	2.8% (-7.3-11.7%)	3.2% (-5.6-11.1%)	3.2% (-3.9-9.6%)	-0.9% (-5.8-2.6%)
MYS	-8.6% (-15.2- -3.1%)	0.7% (-11.6-9.4%)	1.2% (-9-9.2%)	1.9% (-6.4-7.9%)	-1.4% (-6.2-1.6%)
THA	-0.2% (-6.3-6.3%)	-9.1% (-24.6-0.3%)	-8.3% (-21.3-1.4%)	-5.6% (-18.9-2.9%)	-5.3% (-13.8-5.2%)
KHM	1.8% (-3.7-9.9%)	-16.8% (-35- -3.4%)	-16% (-33.9- -6%)	-12.2% (-28.1- -2.5%)	-6.5% (-15.4-4.5%)

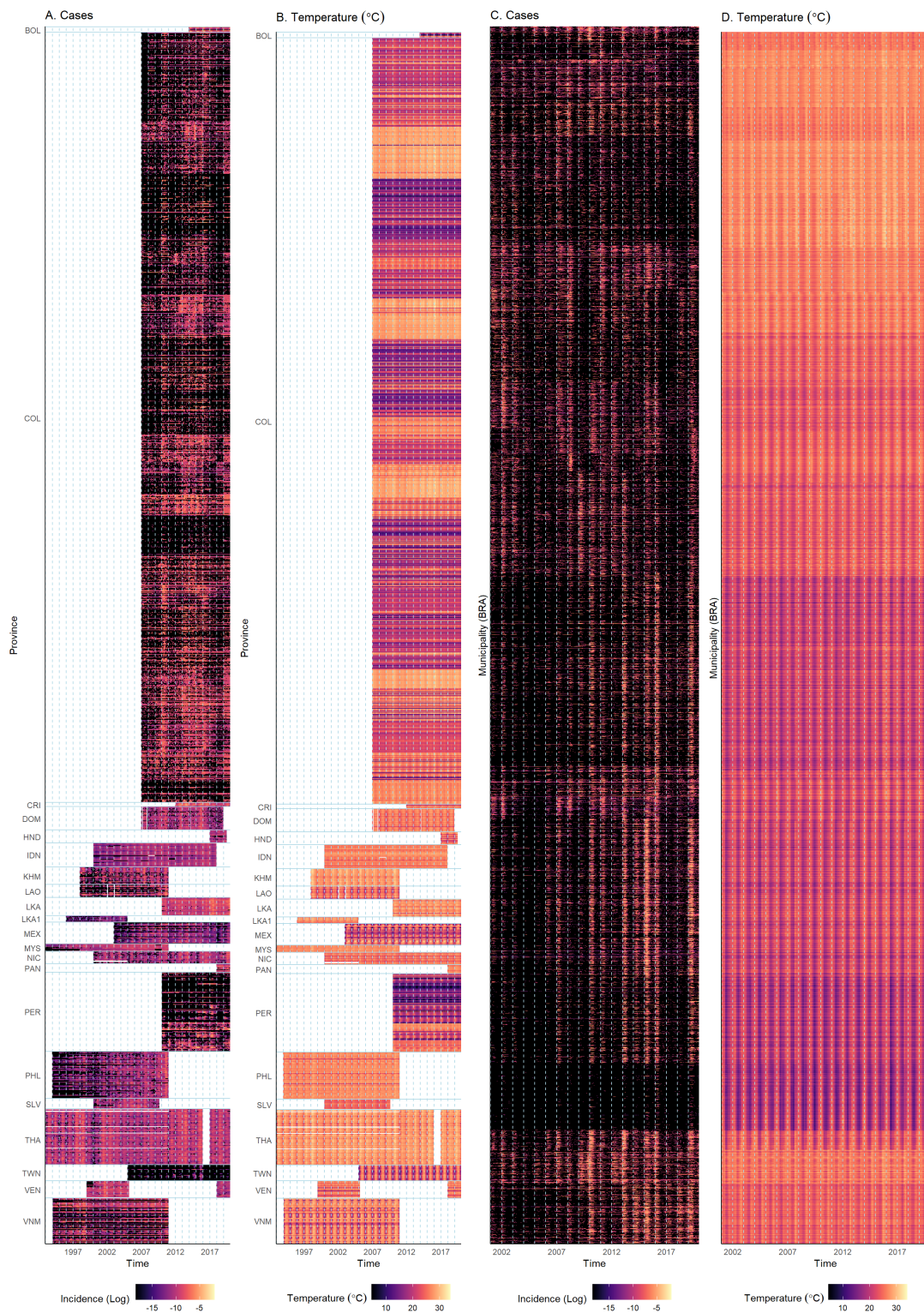


Figure S2: Heatmap of logged monthly dengue incidence and temperature for sub-national administrative units. Months with no data are indicated in white while months with no cases are indicated in black. Countries are indicated on the left by their three-letter codes and horizontal lines separate spatial units in different countries. Vertical dashed lines separate years.

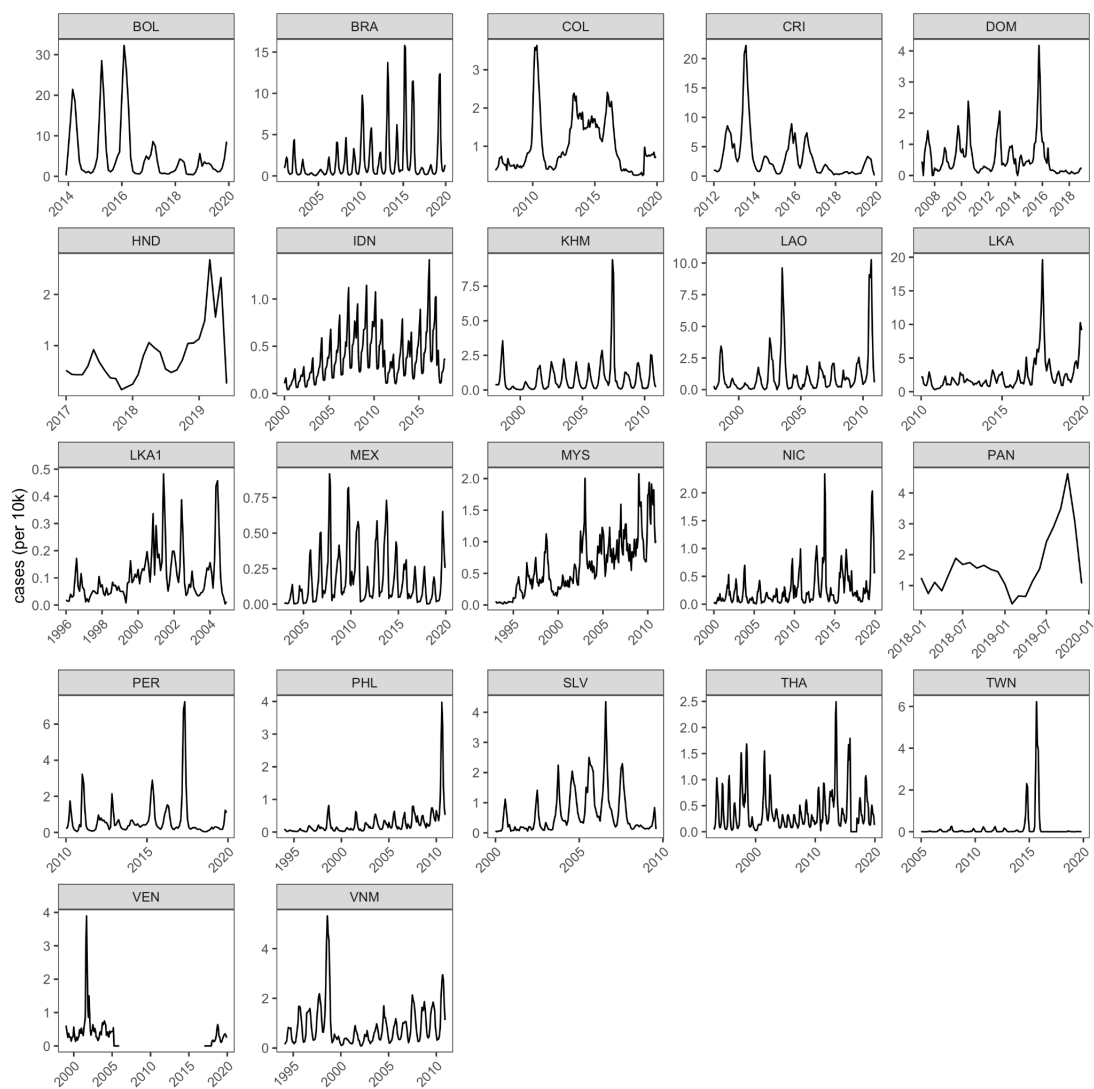
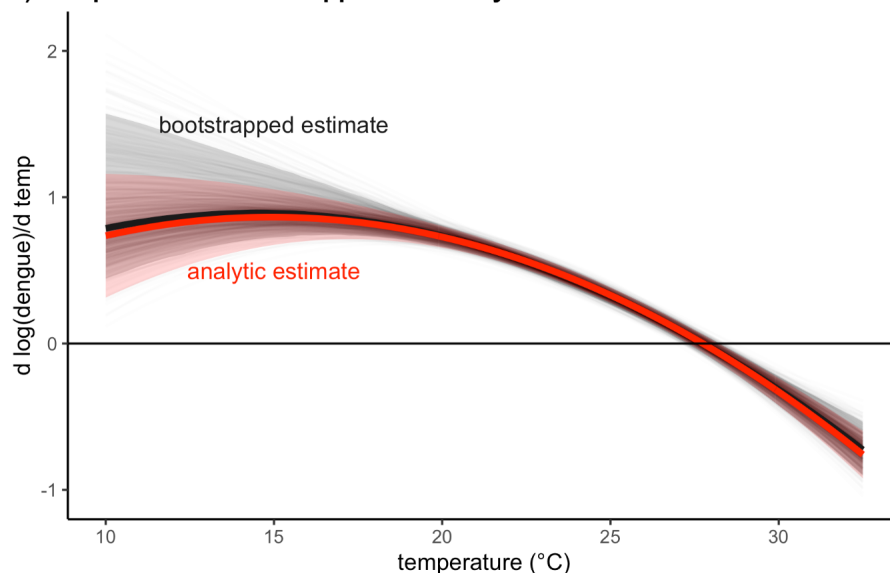


Figure S3: **Epidemic dynamics of dengue in each of 21 countries.** Monthly time series of dengue incidence by country.

a) comparison of bootstrapped and analytic confidence intervals



b) marginal response under different modeling choice

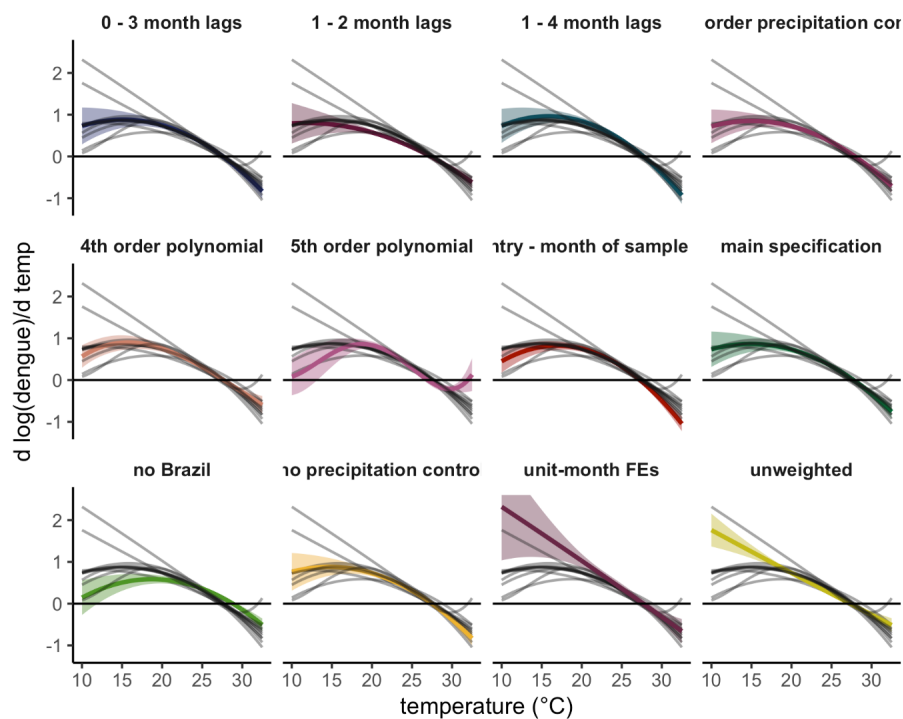
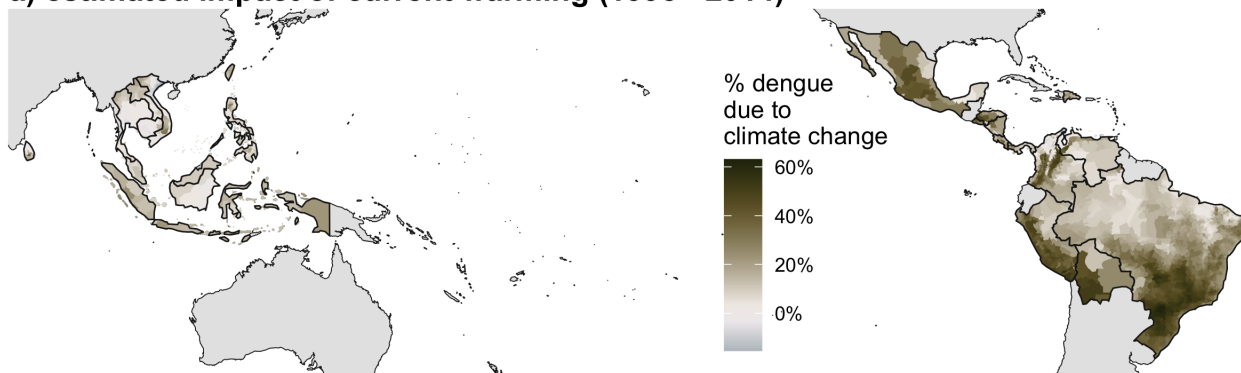


Figure S4: Sensitivity of results to modelling choices. (a) Comparison of 95% confidence intervals produced through bootstrapping (gray shaded region) to those produced through an analytic approach (red shaded region). Individual bootstraps are shown in gray lines. (b) The marginal response of dengue to temperature under model variations.

a) estimated impact of current warming (1995 - 2014)



b) projected changes under future climate scenarios (2040 - 2059)

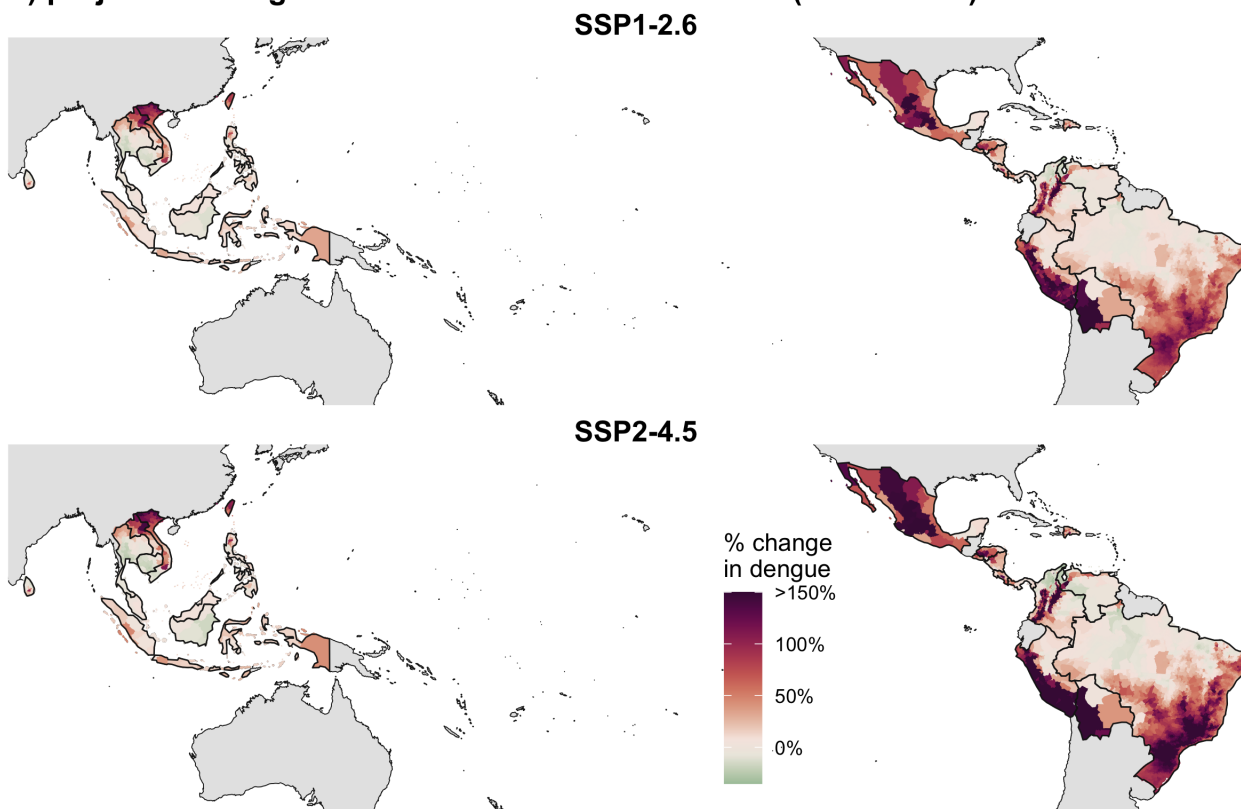
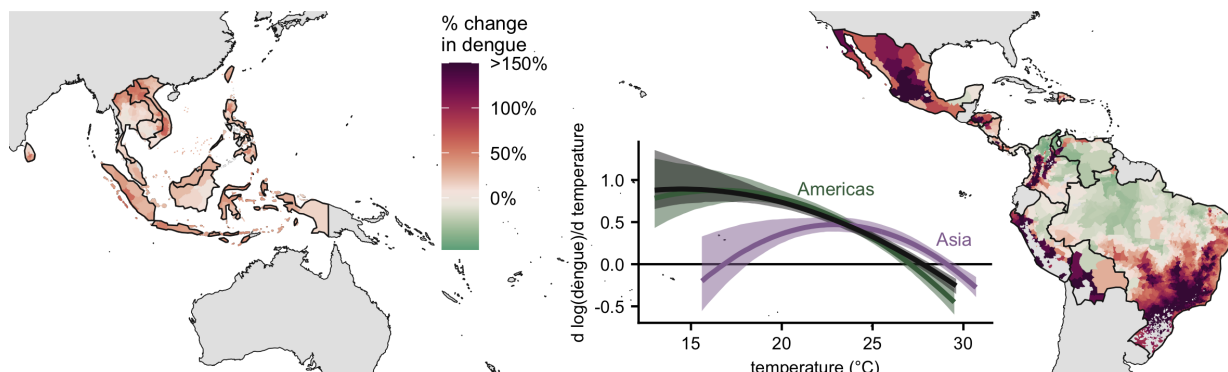


Figure S5: **Maps of impacts of current and future climate warming.** (a) Projected change in dengue under climate scenarios SPP1-2.6 and SPP2-4.5 from 2040-2059. (b) Estimated change in dengue due to current warming (1995-2014) estimated from observed temperatures relative to a model with no anthropogenic forcing.

a) projected change in dengue incidence under SSP3-7.0 with continent-specific estimates



b) comparison projected changes with main and continent-specific estimates

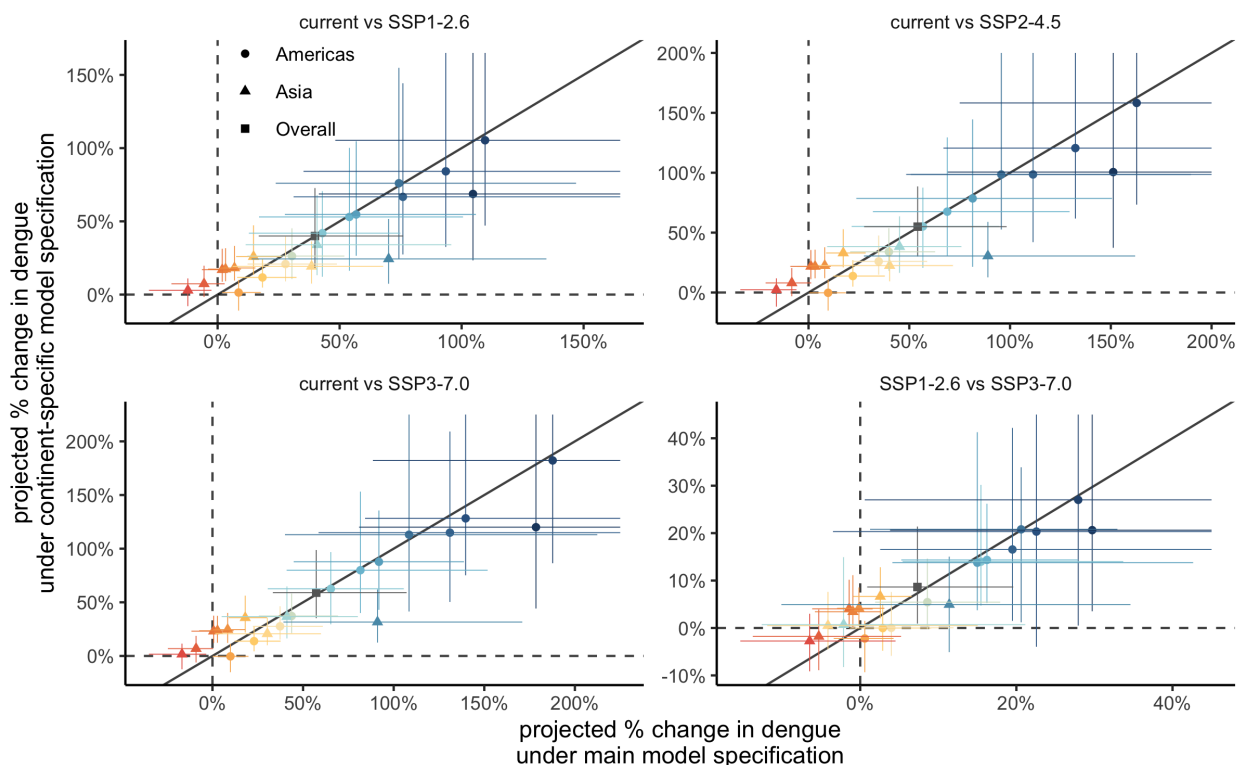


Figure S6: **Projections with continent-specific temperature responses** (a) Projected change in dengue incidence under climate scenario SSP3-7.0 from 2040-2059 based on continent-specific temperature responses. Inset figure shows continent-specific temperature responses for the Americas (green) and Asia (purple) as well as main specification (black) for comparison, (b) Comparison between country average projected changes with the main model (horizontal axis) and continent-specific model (vertical axis) for different future scenarios. Points are median estimates and line segments indicate 95% CIs. Black diagonal line indicates 1-1. Colors match country colors in Fig. 5.

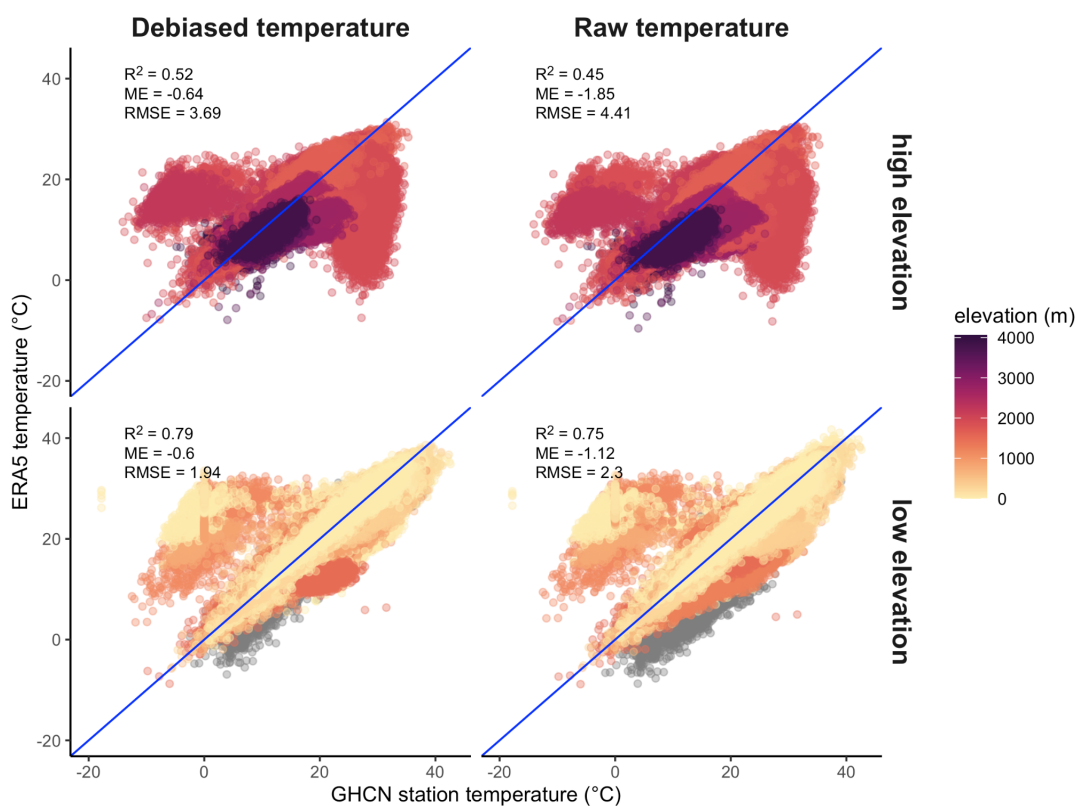


Figure S7: **ERA5 temperature is debiased using WorldClim.** ERA5 temperature is shown against GHCN weather station data. The ERA5 temperature bias, especially prevalent at high elevations, is reduced using monthly WorldClim climatology. Each point is a station-day with points colored by station elevation. High elevation is defined as stations above 1500 meters. Grey points are missing elevation information in the GHCN data set and are included in the low elevation category. R^2 from a linear regression of ERA5 temperature on GHCN station temperature, mean error (ME), and root mean squared error (RMSE) are shown in each panel.