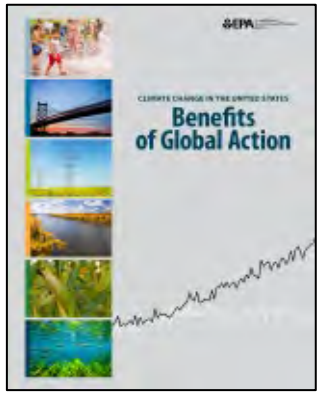
Climate Change & Children's Health and Well-Being Report

Making Mitigation Work

December 2023

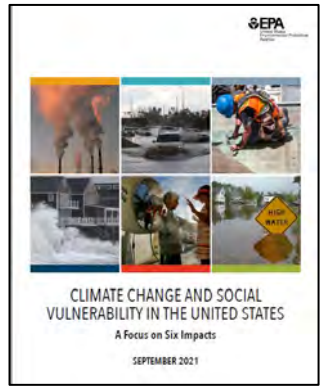
EPA's Climate Science & Impacts Branch
Climate Change Impacts and Risk Analysis (CIRA) Project

- Who is CSIB?
- Objective: quantify and monetize climate impacts across sectors of the U.S., including how risks can be reduced through GHG mitigation and adaptation.
  - Approach uses a common modeling framework (consistent inputs and assumptions) to simulate impacts across sectors.
  - CIRA's methods and sectoral impact models are supported by a rich literature consisting of >50 journal articles.
  - Three previous CIRA reports:



2015

2017



2021

Motivations & Scope

- Children face higher health risks from the impacts of climate change.
  - Report focuses on climate change stressors and some effects to children's health
    - Considers overburdened populations
    - Evaluates potential adaptive responses
- A national-scale, multi-sector report focused on quantification of climate risks to children has never been produced for the U.S.
- Report supports the Administration's priorities on climate, children's health, and environmental justice.

Climate Stressors and Analyses

Climate Stressors	Detailed Analyses*	Emerging Climate Impacts
Extreme heat	Learning losses	Emergency department (ED) visits
Air quality	$PM_{2.5}$, O_3, and children's health	Wildfire smoke and fetal health
Changing seasons	Aeroallergens and children's health	Recreation
Flooding	Coastal flooding and children's homes	Inland flooding and children's homes
Infectious diseases	Lyme disease	West Nile Virus

Select Methods & Results

Heat & learning

Lyme disease

Coastal flooding

- Each detailed analysis follows a standard three-step approach to estimating future impacts on children
- Impact results are presented for 2°C and 4°C increases in global average temperature

Stepwise Analytic Approach

Heat and Learning

Step 1
Determine existing learning, school A/C, and home A/C levels

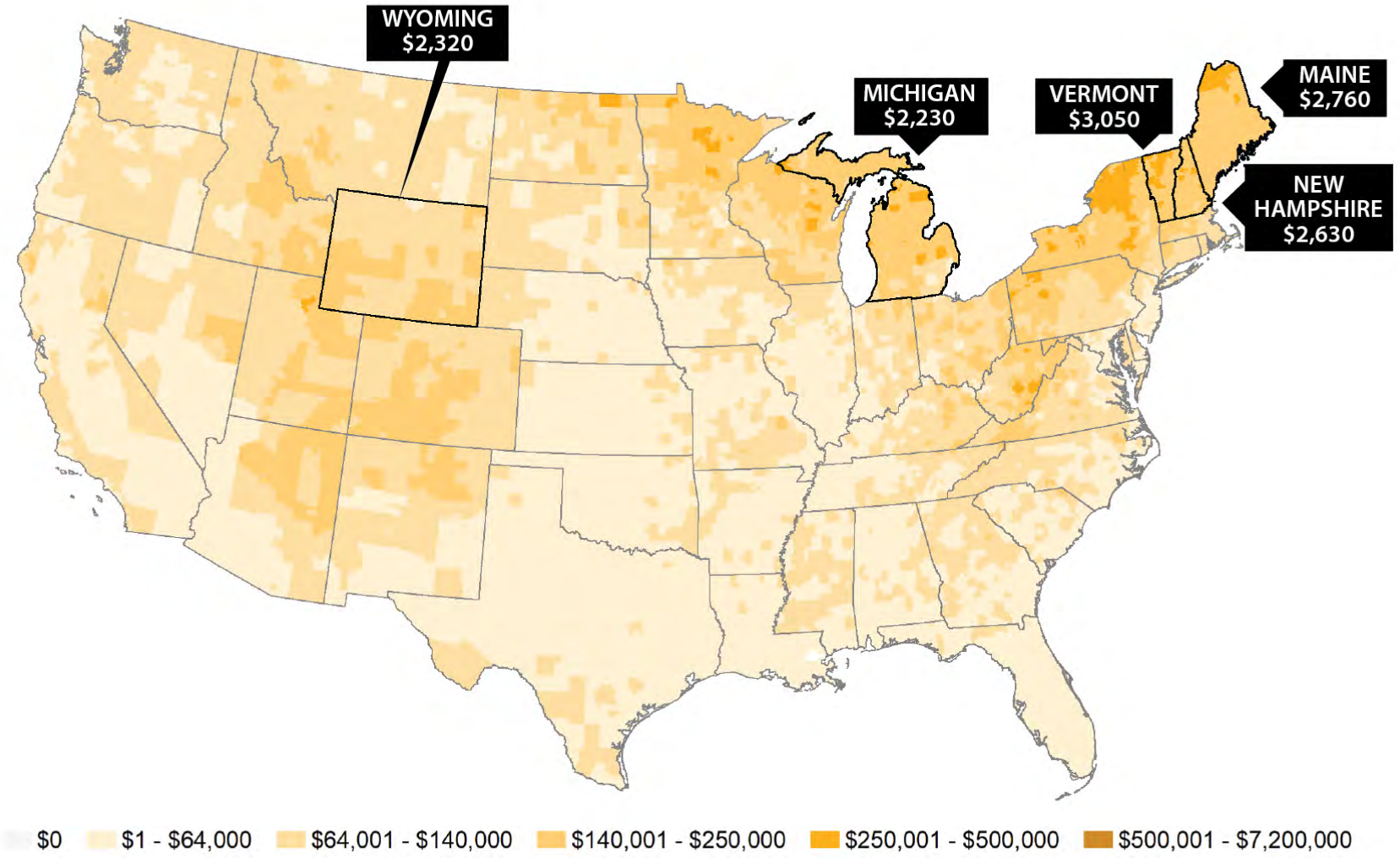
Park et al.

Step 2
Calculate future average daily max temperature during school year

Step 3
Quantify and value future learning losses

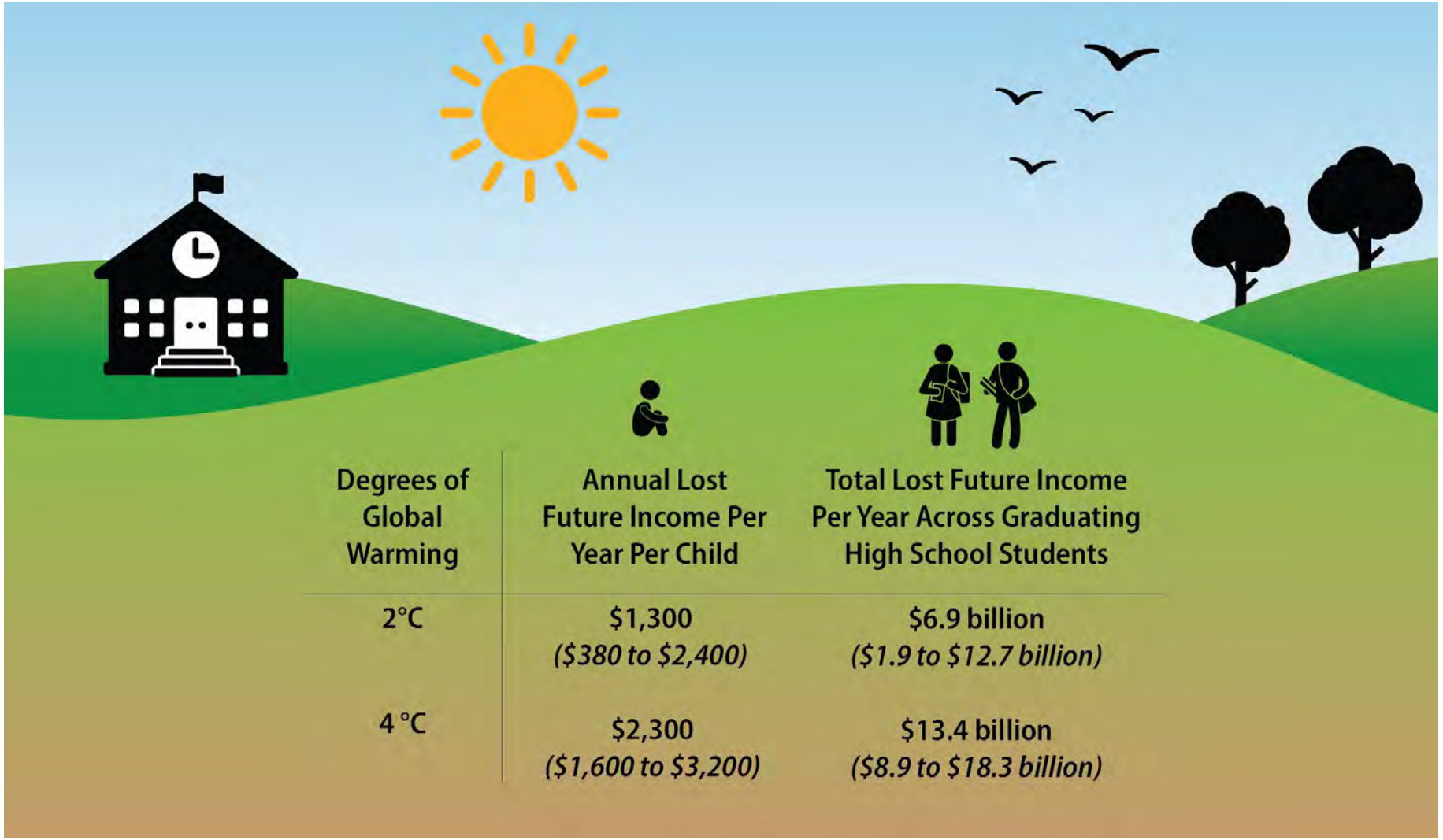
Chetty et al.

Estimated Distribution of Annual Lost Future Income Per Student, 2°C



Distribution of lost future income per child attributable to learning losses from heat exposure during school years. Areas with darker shading have higher rates of learning losses. The five states with the highest learning losses per child are highlighted.

Heat: Projected Learning Losses & Effects on Future Income



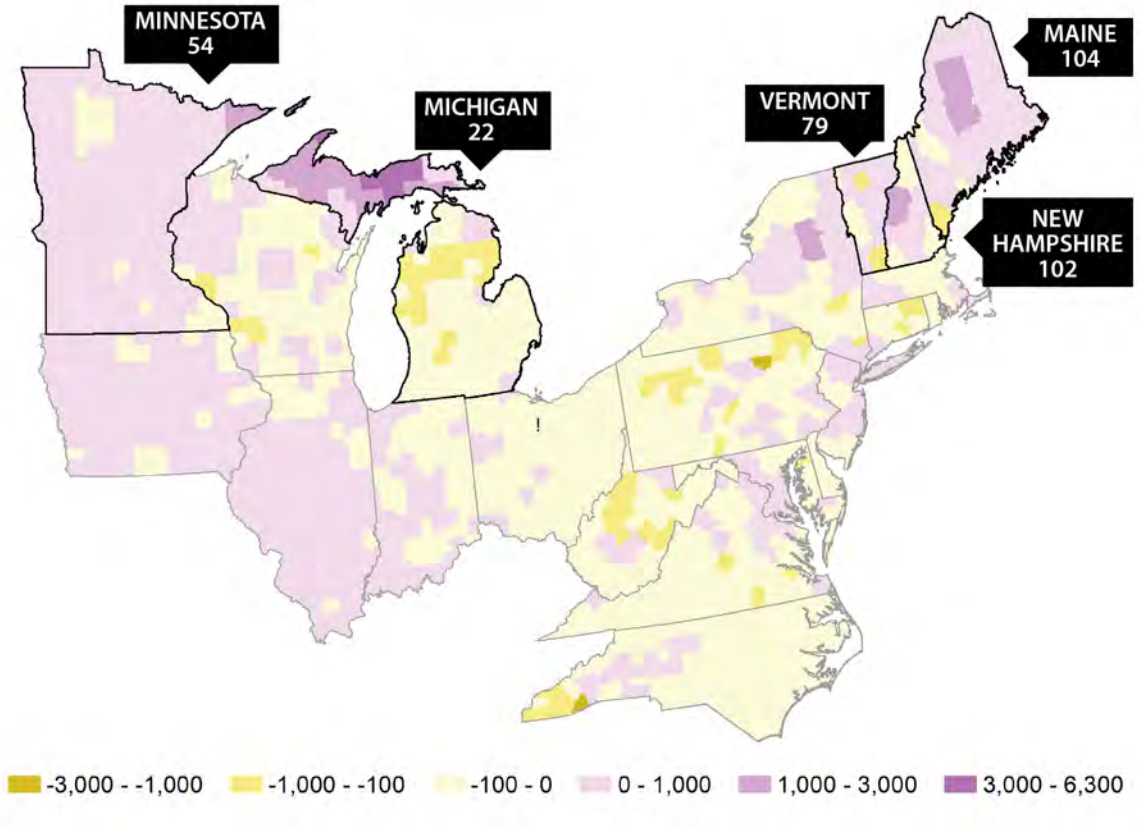
Degrees of Global Warming	Annual Lost Future Income Per Year Per Child	Total Lost Future Income Per Year Across Graduating High School Students
2°C	$1,300 *($380 to $2,400)*	$6.9 billion *($1.9 to $12.7 billion)*
4 °C	$2,300 *($1,600 to $3,200)*	$13.4 billion *($8.9 to $18.3 billion)*

Regarding Adaptation:

- Estimated annualized cost of installing and maintaining HVAC systems in U.S. public schools: approx. $4.2 billion (i.e., less than learning losses)
- A/C in school does not mitigate the potential for learning losses entirely; Park et al. show that learning losses are erased only with A/C in school *and* at home.

Infectious Disease: Climate-Driven Changes Lyme Disease Incidence, Eastern U.S.

Estimated Distribution of Rate of New Lyme Disease Diagnoses, 2°C



Distribution of rate of new annual Lyme disease diagnoses (per 100,000 children) attributable to climate-driven changes in temperature, land cover, and precipitation, and concurrent effects on tick and *B. burgdorferi* distribution. Areas with darker shading have higher rates of affected children.

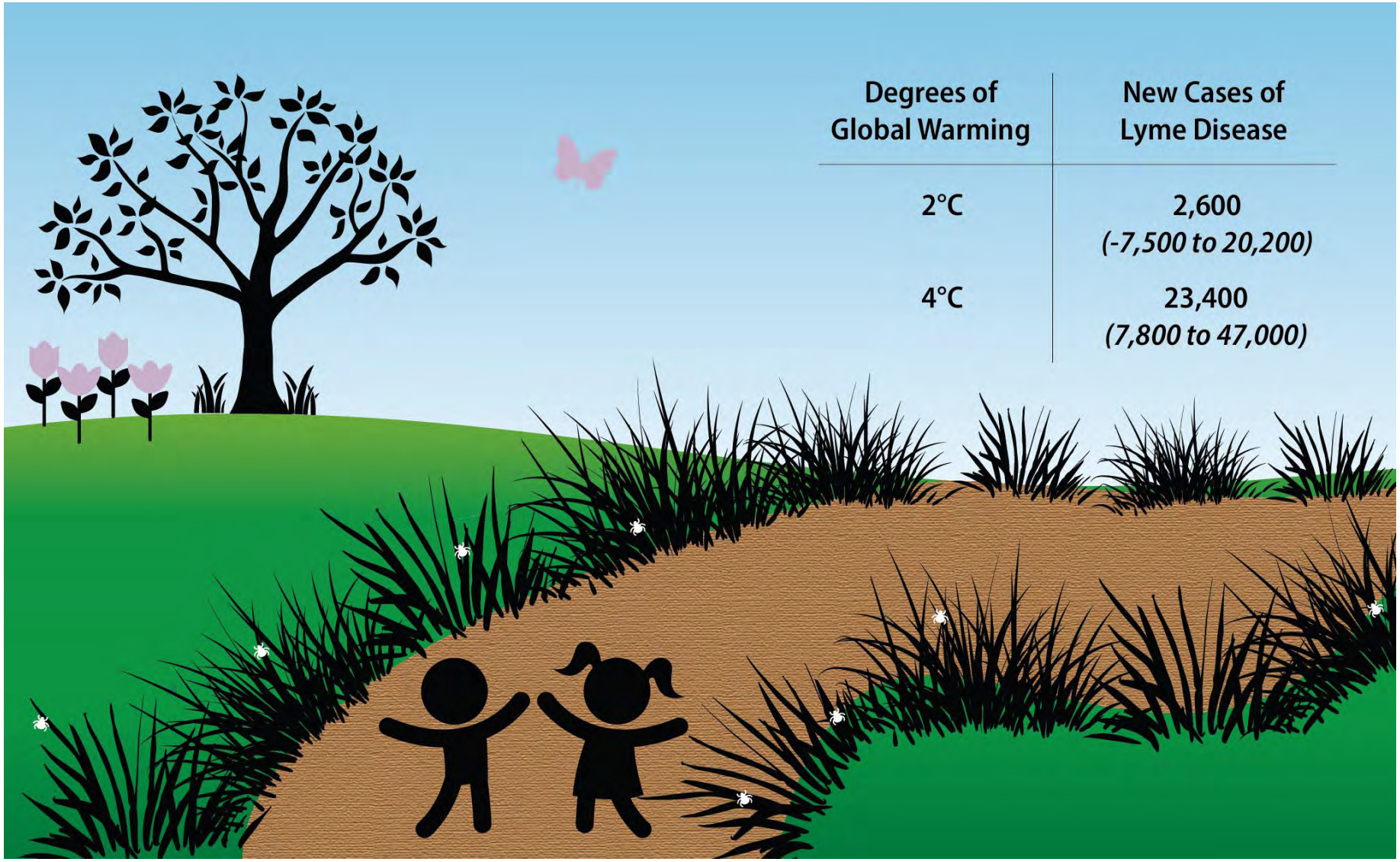
Step 1
Identify baseline number of new Lyme diagnoses each year

Step 2
Calculate changes in tick and bacteria presence related to future rainfall and temperature

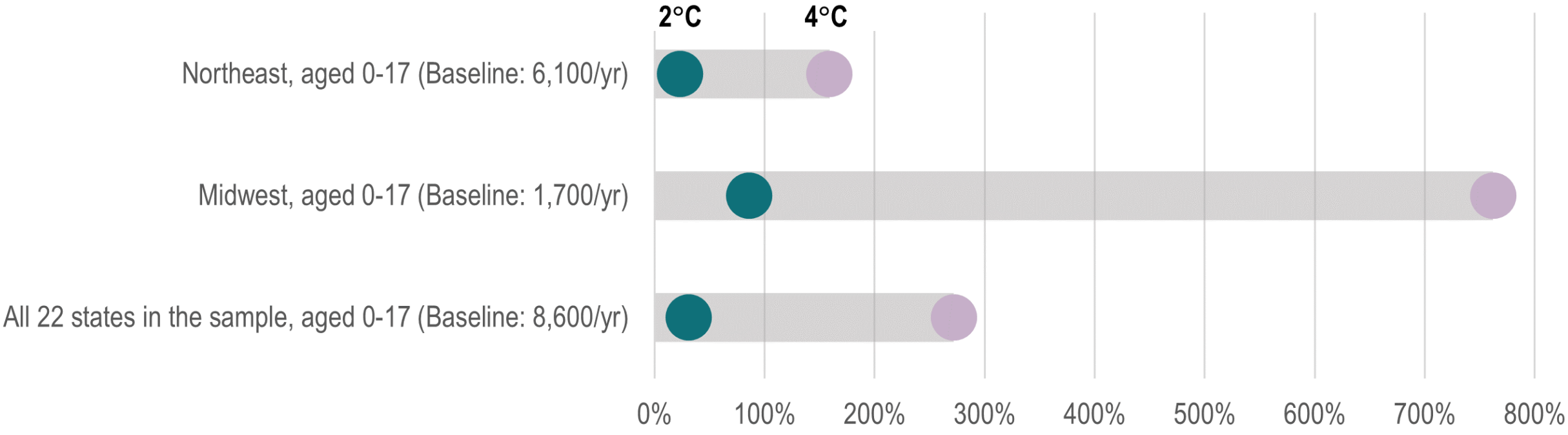
Yang et al., in rev.

Step 3
Estimate change in new Lyme disease cases among children

Climate-Driven Changes in Annual Pediatric Lyme Disease Cases



Climate-Driven Changes in Lyme Disease Incidence, Relative to Baseline



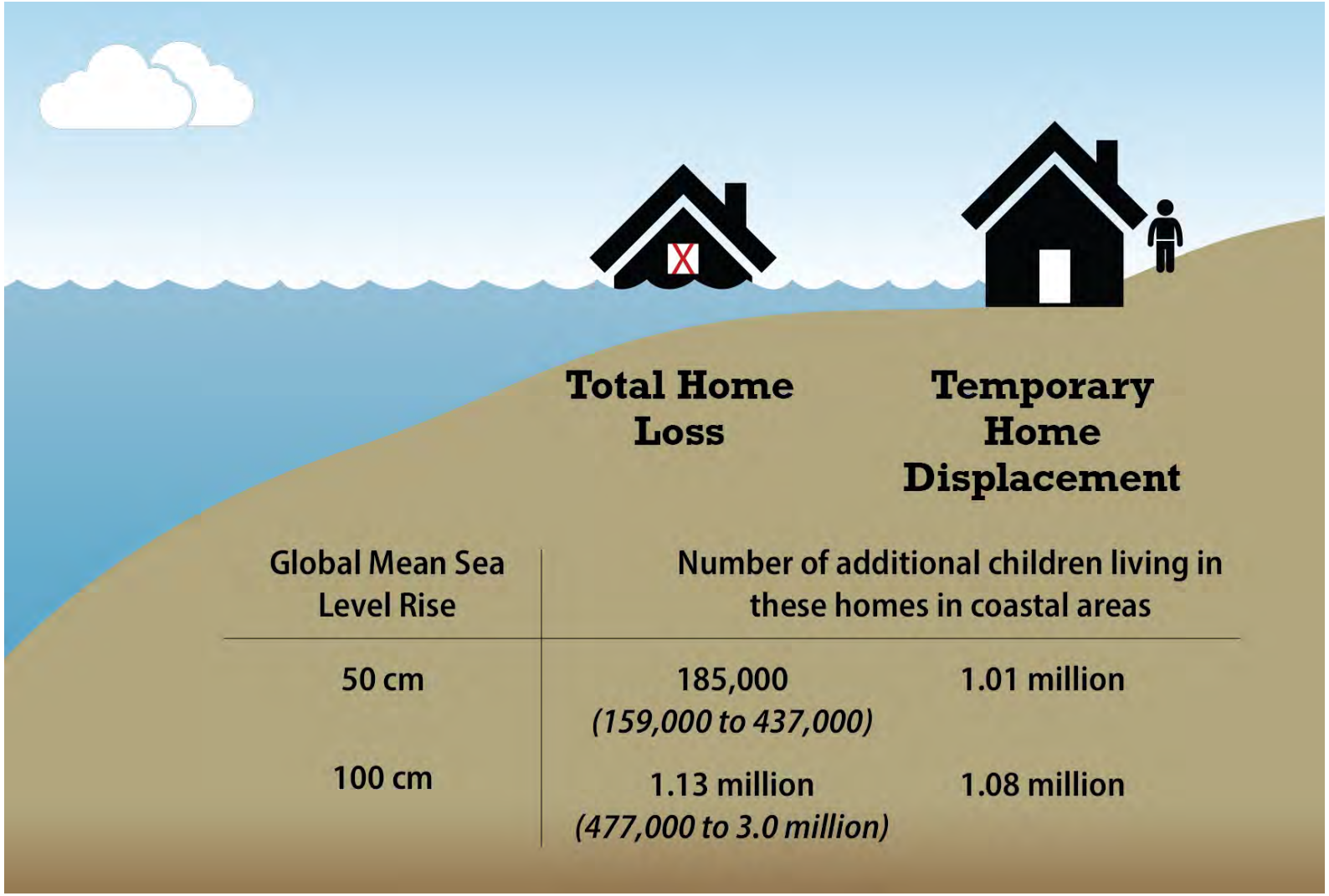
Coastal Flooding: Impacts on Children's Homes

Projected impacts to children's homes of coastal flooding from storm surge and from 50cm and 100cm of global mean sea level rise (SLR), assuming no additional adaptation. The impacts assume populations of children will increase over the 21st century and convey the impacts to children aged 0-17 assuming no additional adaptive actions.

Step 1
Determine number of children experiencing coastal floods in the baseline

Step 2
Forecast future coastal flooding from sea level rise and storm surge

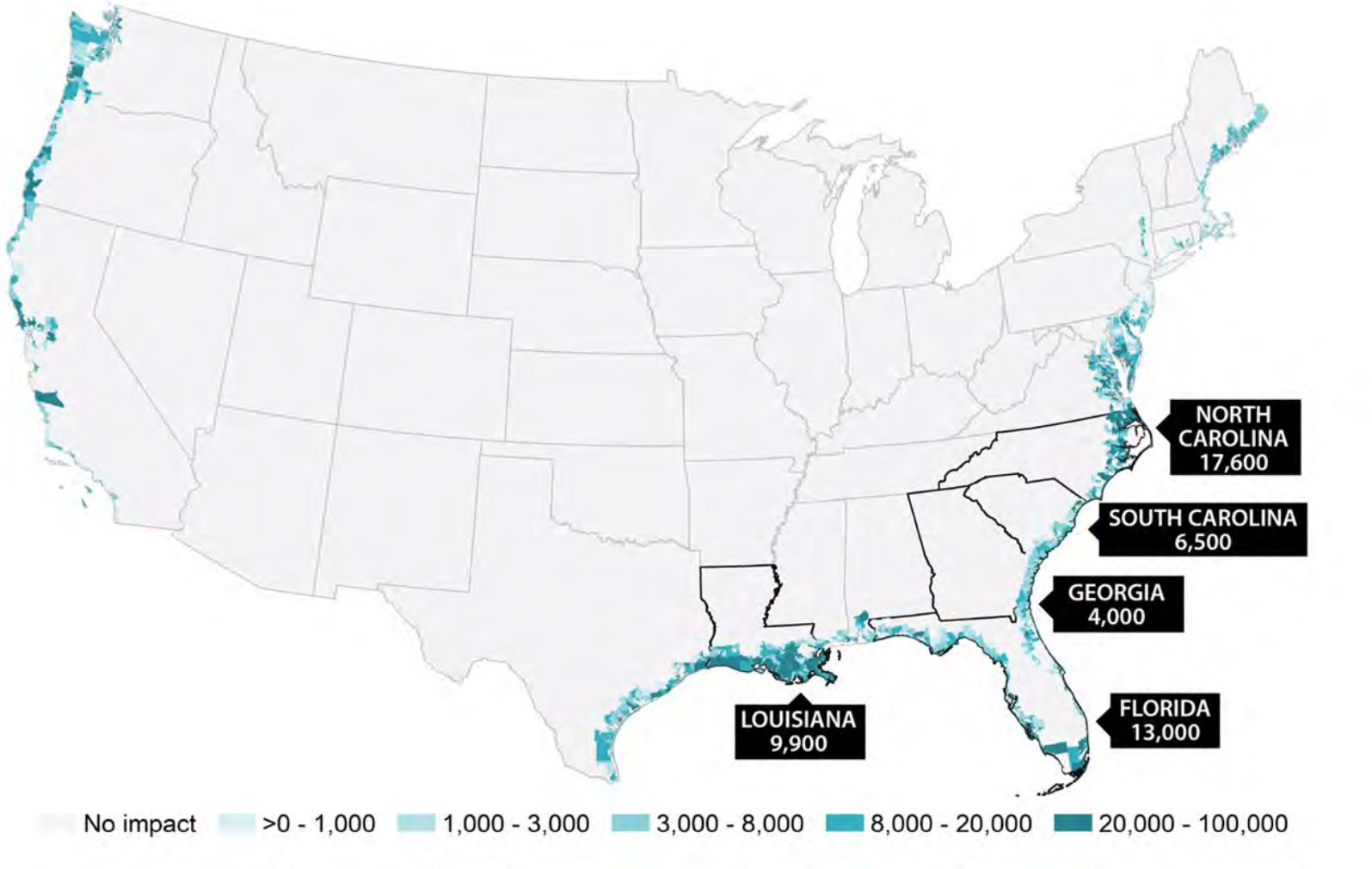
Step 3
Estimate the number of children in homes at risk of complete loss or temporary flooding



Global Mean Sea Level Rise	Number of additional children living in these homes in coastal areas	
50 cm	185,000 *(159,000 to 437,000)*	1.01 million
100 cm	1.13 million *(477,000 to 3.0 million)*	1.08 million

Based on Neumann et al. 2021

Coastal Flooding: Estimated Distribution of Children Affected by Home Loss at 100cm



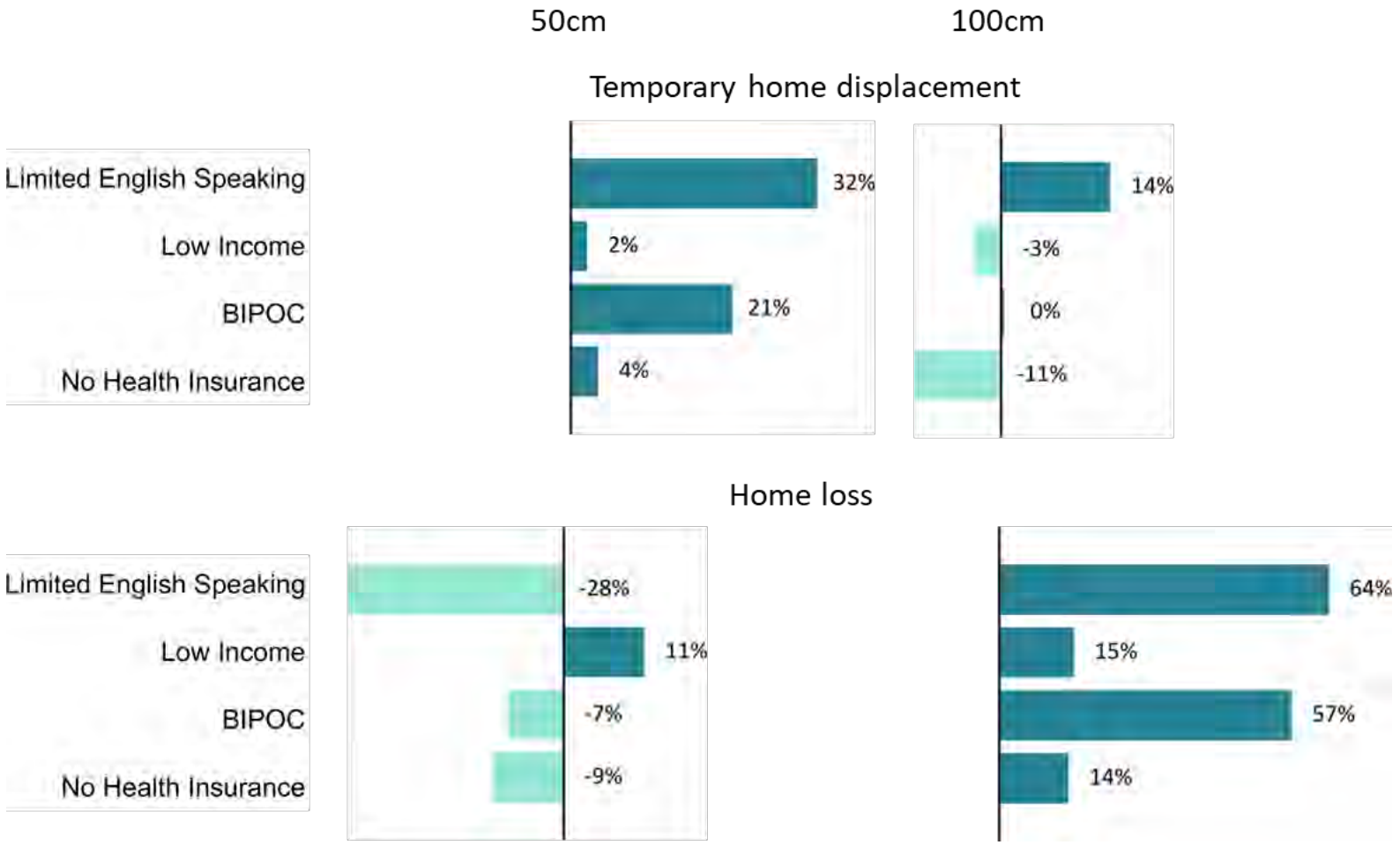
Projected distribution of children affected by home loss at 100cm of SLR assuming "no additional adaptation." Areas with darker shading have higher rates of affected children.

Five states with the highest rates of affected children relative to the county populations are outlined in black.

Coastal Flooding: Likelihood of Disproportionate Impacts to Populations

Social vulnerability analysis of coastal flooding impacts on children from SLR and storm surge assuming no additional adaptation.

Children from each demographic group are more likely to disproportionately experience temporary displacement from home at 50cm of SLR and total loss of home at 100cm.



Examples of Key Research Gaps

- Data limitations confined impact analyses to the contiguous U.S.
- Limited data on how climate change causes or exacerbates developmental and mental health effects in children
- Improve forecasting of likely adaptation measures, costs and benefits, and long-term effectiveness
- Expand studies focusing on compounded effects at a national scale and adjusting for different demographics

Report, Materials, and Website

Report

A report on health risks to children from climate change.

Download the report

Summaries

Summaries of health risks to children for clinicians and parents.

Browse the Summaries

Appendices and Data

The methods and data used in the analyses.

Appendices and Data

Climate Change and Children's Health Report Website

Questions?

EPA's Climate Science & Impacts Branch

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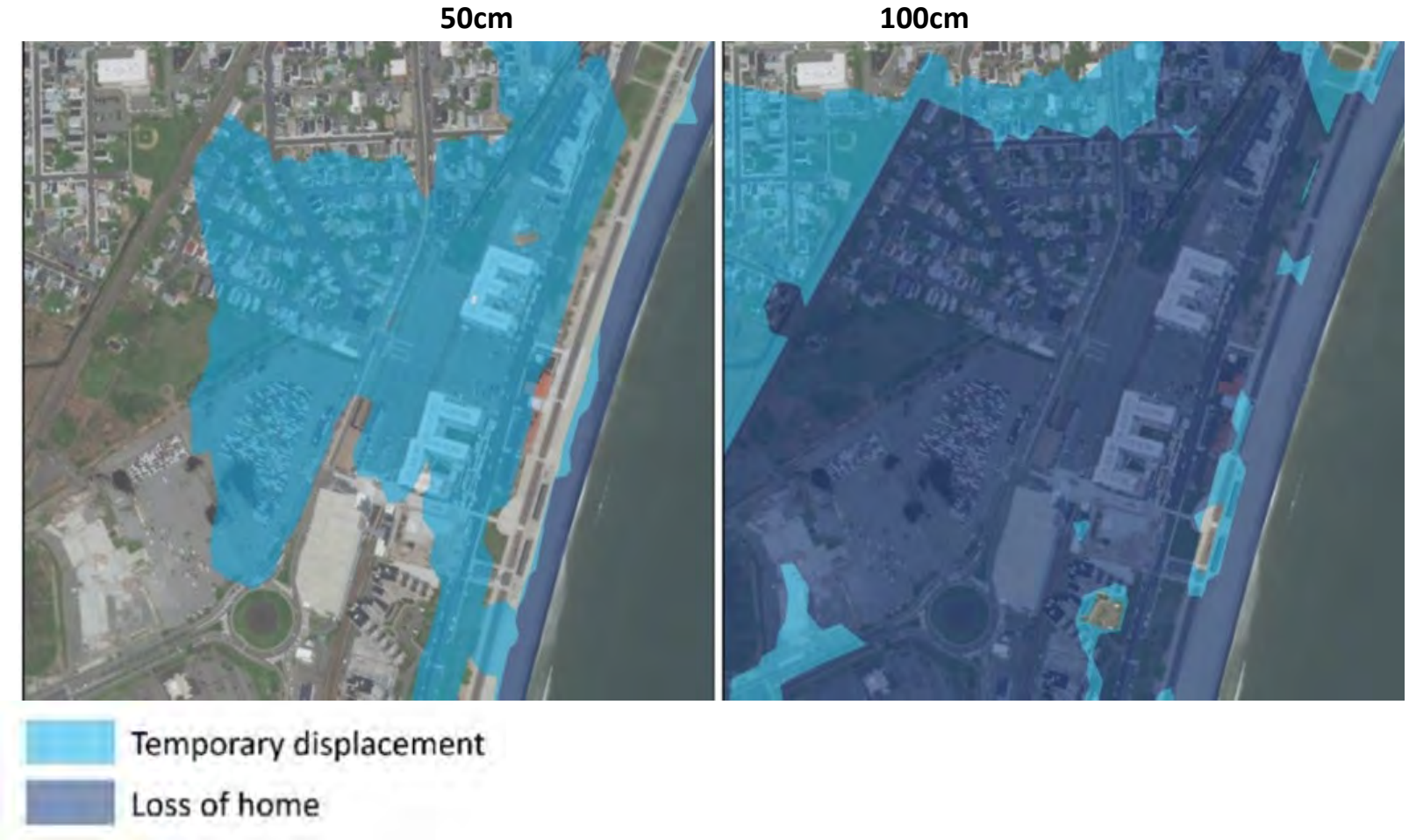
Martinich.Jeremy@epa.gov

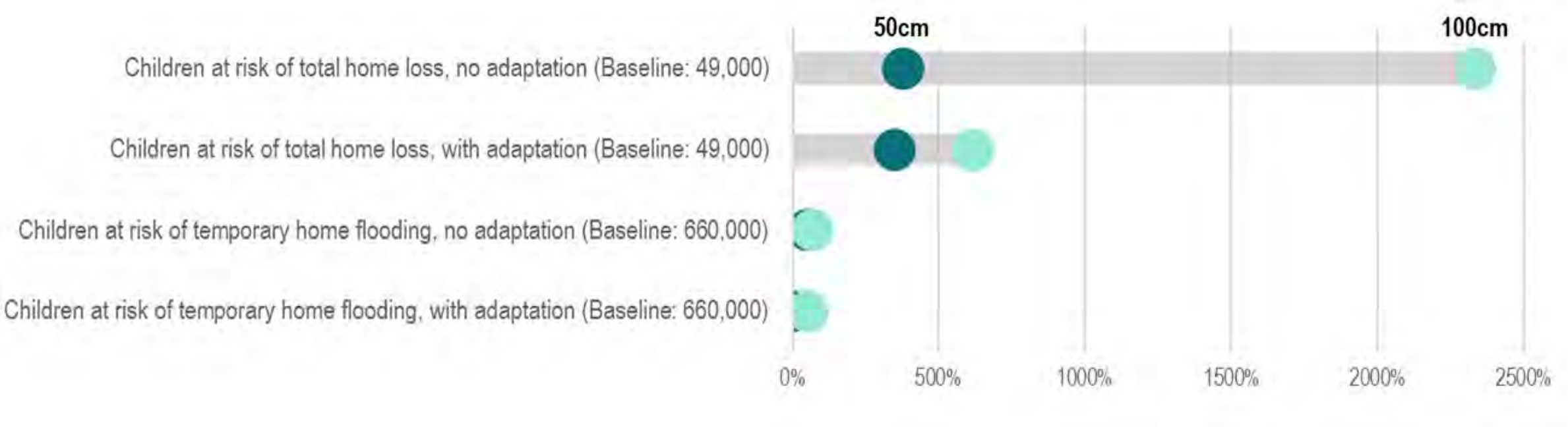
BACKGROUND SLIDES

Coastal Flooding



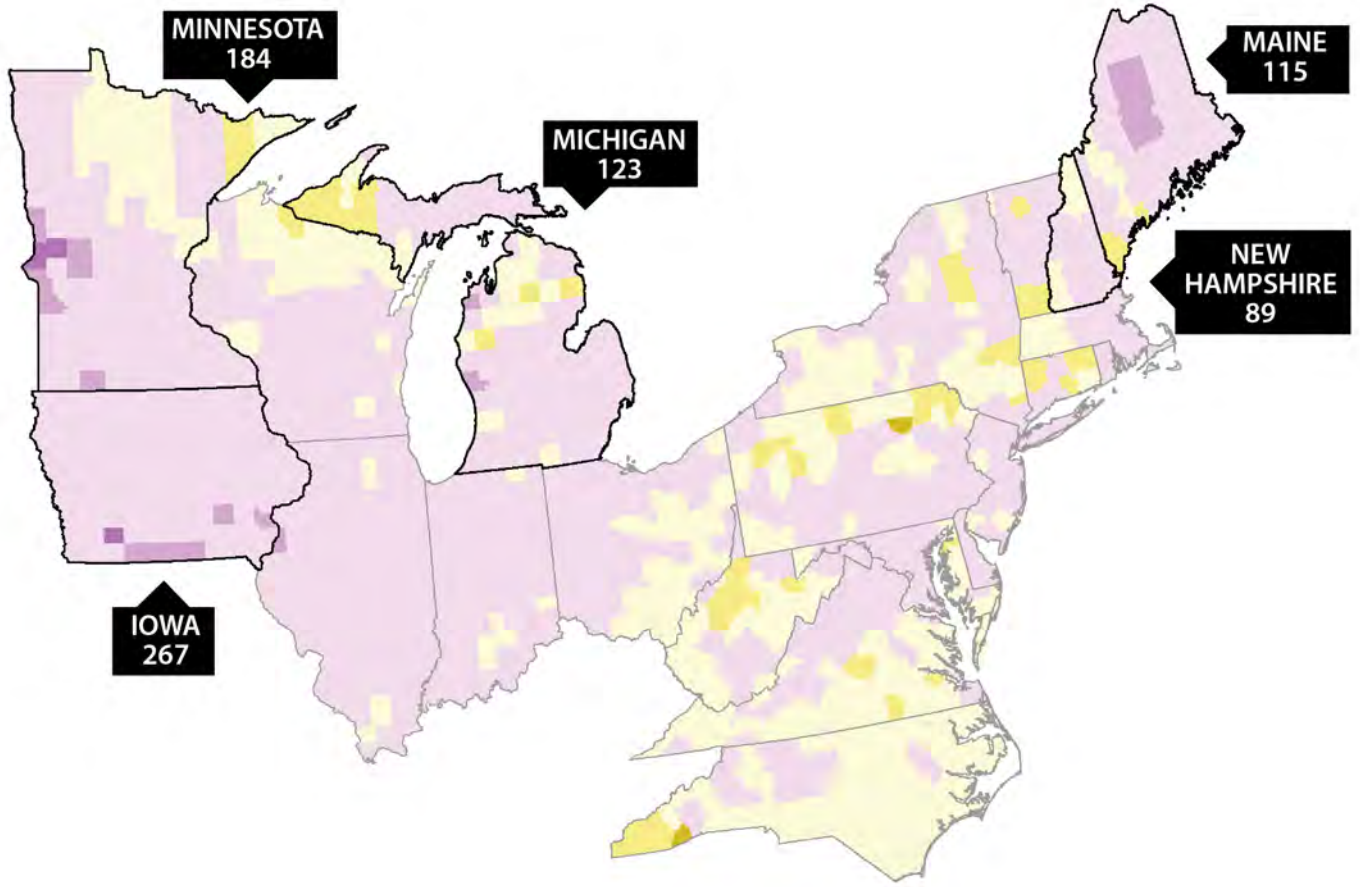
Coastal Flooding: Impacts from Storm Surge and SLR

Number of children affected by flooding damage to their homes annually relative to baseline conditions (1985-2005). The teal circles describe increases between baseline and 50cm of global sea level rise while the mint green circles convey increases at 100cm. The graphic includes both the temporary flooding displacement and total home loss impacts under both the “no additional adaptation” and “with adaptation” scenarios.



Lyme Disease: Climate-Driven Changes in Incidence

New annual cases of Lyme disease at 4°C warming



This map presents the distribution of new annual Lyme disease diagnoses (per 100,000 children) attributable to climate-driven changes in temperature and precipitation. Areas with darker shading have higher rates of affected children. The five states with the highest rates of affected children relative to the county populations are highlighted.

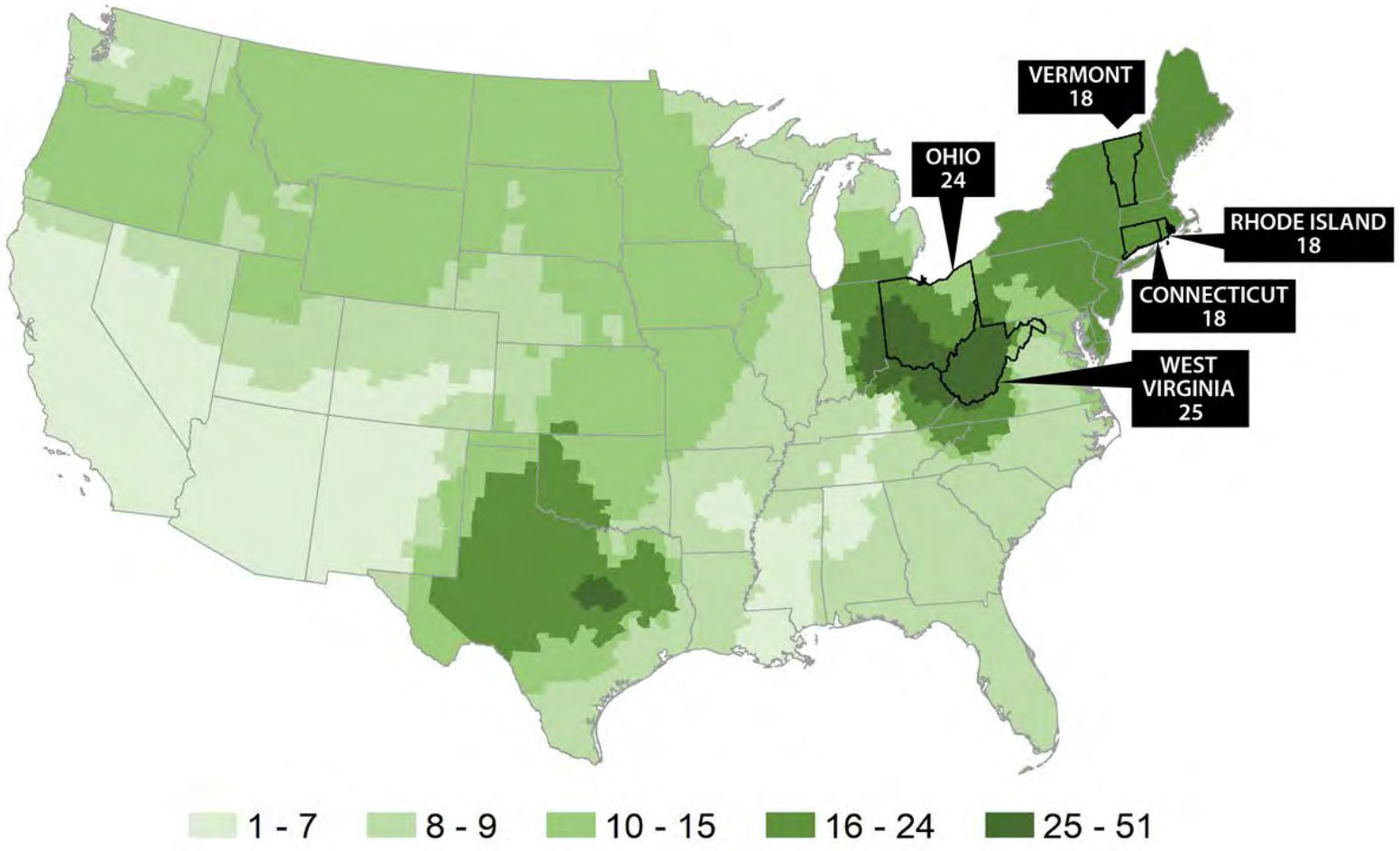
Changing Seasons: Estimated Distribution of Asthma-Related ED Visits in Children Annually at 4°C

Step 1
Identify baseline health impacts among children

Step 2
Calculate future pollen season length by pollen source

Step 3
Estimate increase in health impacts from lengthened pollen season

Based on Neumann et al. 2019 and Saha et al. 2021



This map presents the distribution of additional asthma-related ED visits (per 100,000 children) attributable to exposure to climate-driven changes in oak, birch, and grass pollen. Areas with darker shading have higher rates of affected children annually.

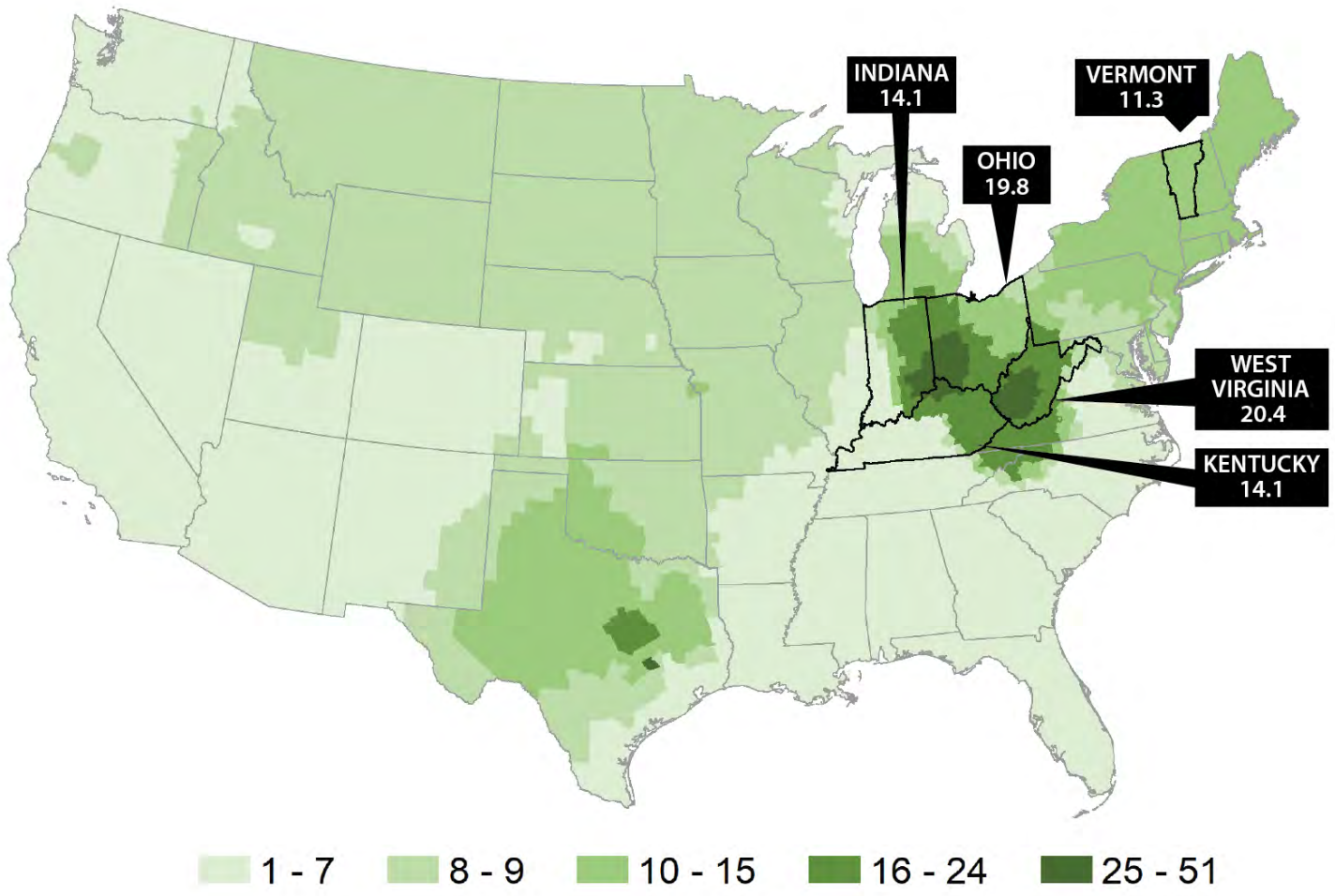
Changing Seasons: Estimated Distribution of Asthma-Related ED Visits in Children Annually at 2°C

Step 1
Identify baseline health impacts among children

Step 2
Calculate future pollen season length by pollen source

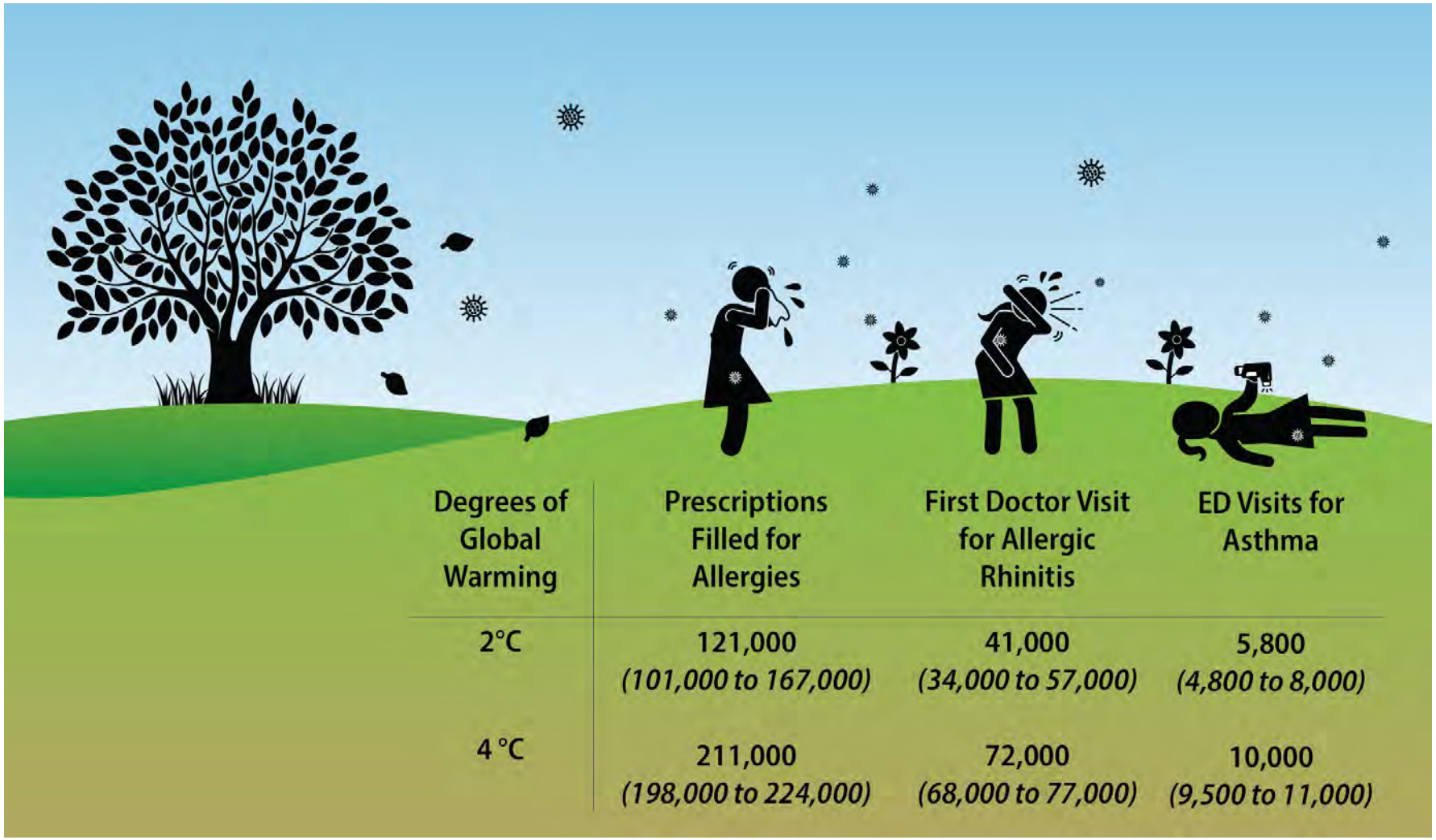
Step 3
Estimate increase in health impacts from lengthened pollen season

Based on Neumann et al. 2019 and Saha et al. 2021



This map presents the distribution of additional asthma-related ED visits (per 100,000 children) attributable to exposure to climate-driven changes in oak, birch, and grass pollen. Areas with darker shading have higher rates of affected children annually.

Changing Seasons: Climate-Driven Changes in Pollen Exposure

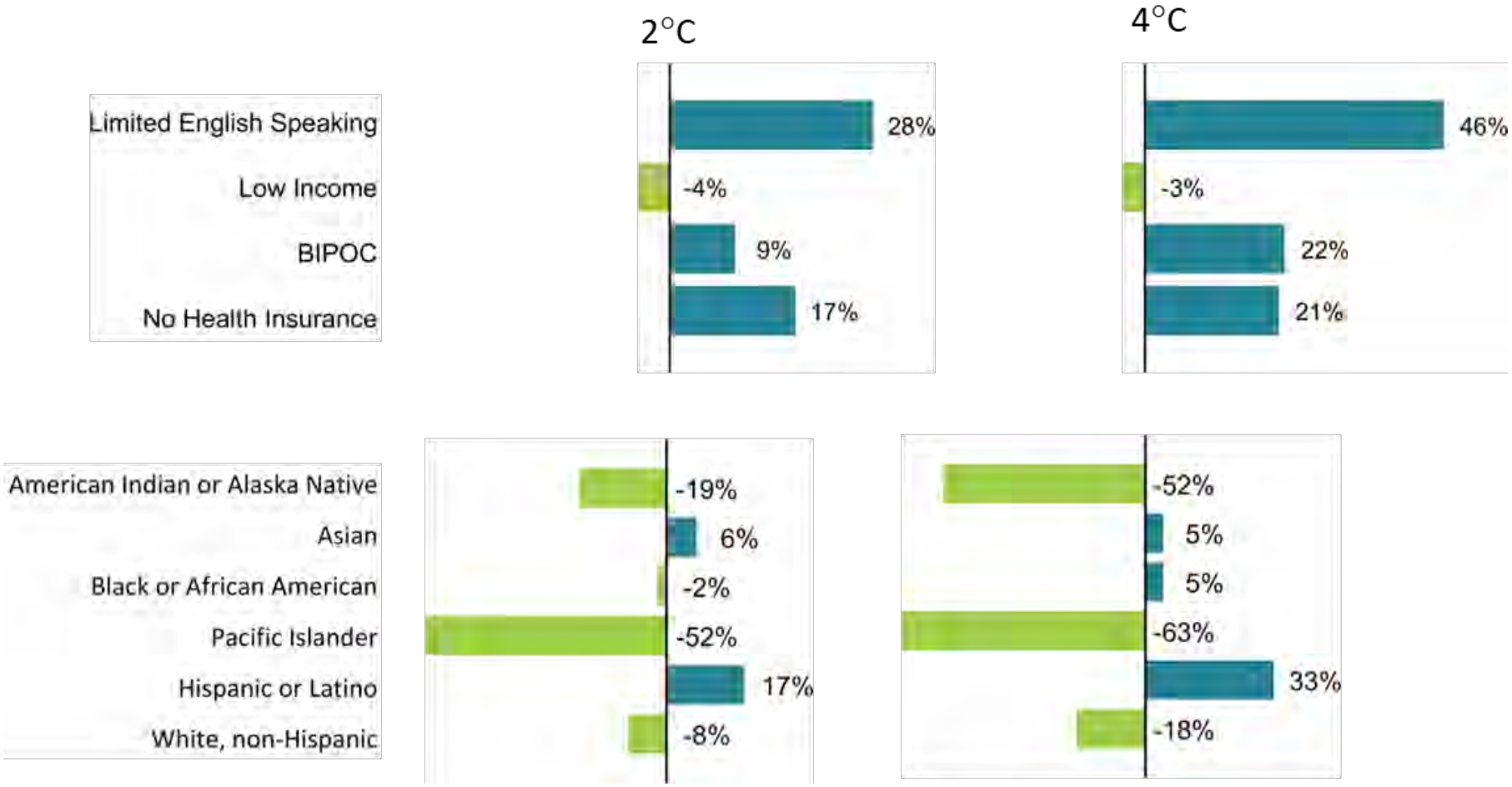


Degrees of Global Warming	Prescriptions Filled for Allergies	First Doctor Visit for Allergic Rhinitis	ED Visits for Asthma
2°C	121,000 *(101,000 to 167,000)*	41,000 *(34,000 to 57,000)*	5,800 *(4,800 to 8,000)*
4 °C	211,000 *(198,000 to 224,000)*	72,000 *(68,000 to 77,000)*	10,000 *(9,500 to 11,000)*

For oak, birch, and grass under 2°C and 4°C of global warming. The results convey the annual impacts for children ages 0-17 and assumes populations of children will increase over the 21st century.

Changing Seasons: Likelihood of Disproportionate Asthma-Related ED Visits From Oak Pollen

Likelihood that children live in areas with the largest annual increases in asthma-related ED visits attributable to climate-driven changes in oak pollen.



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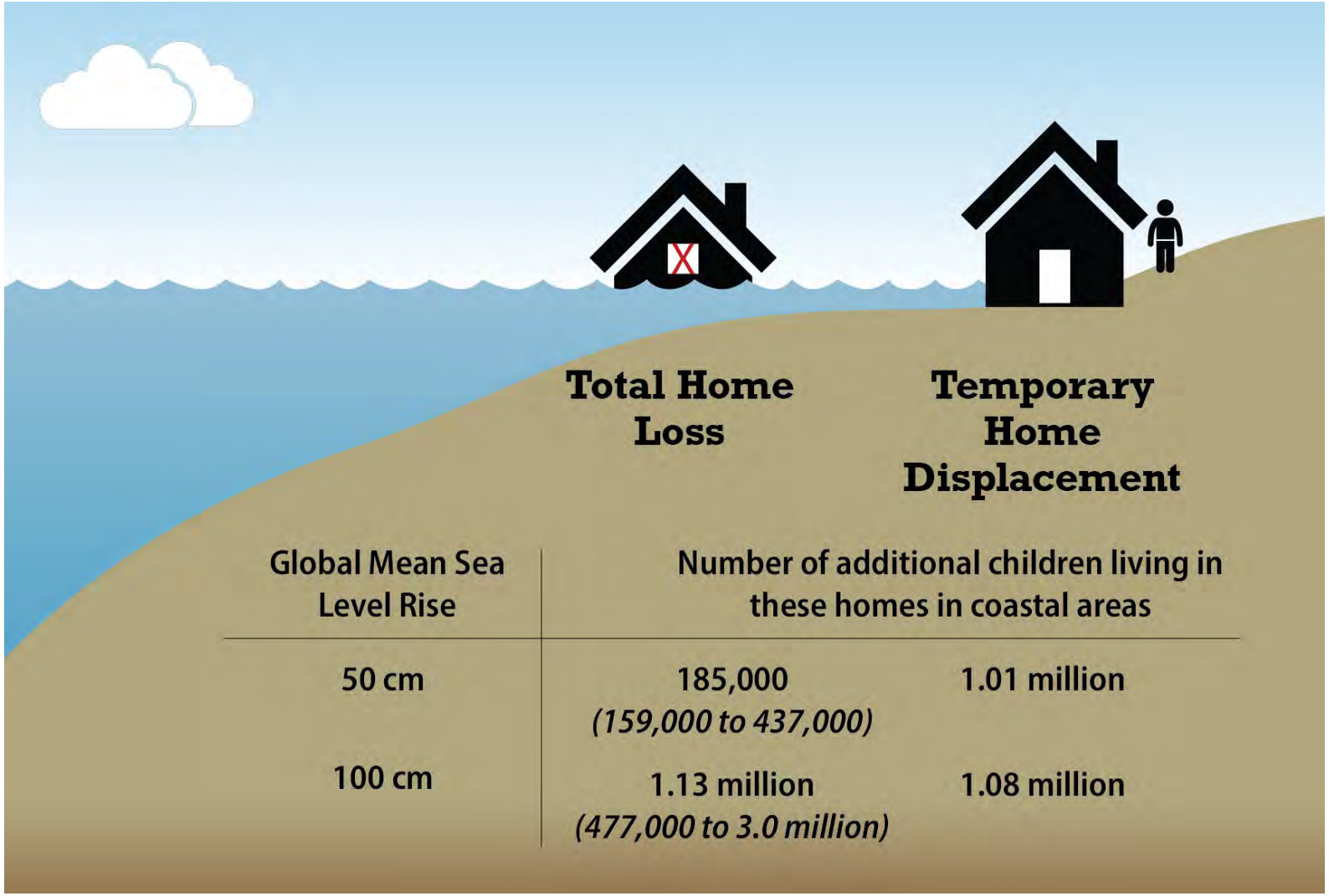

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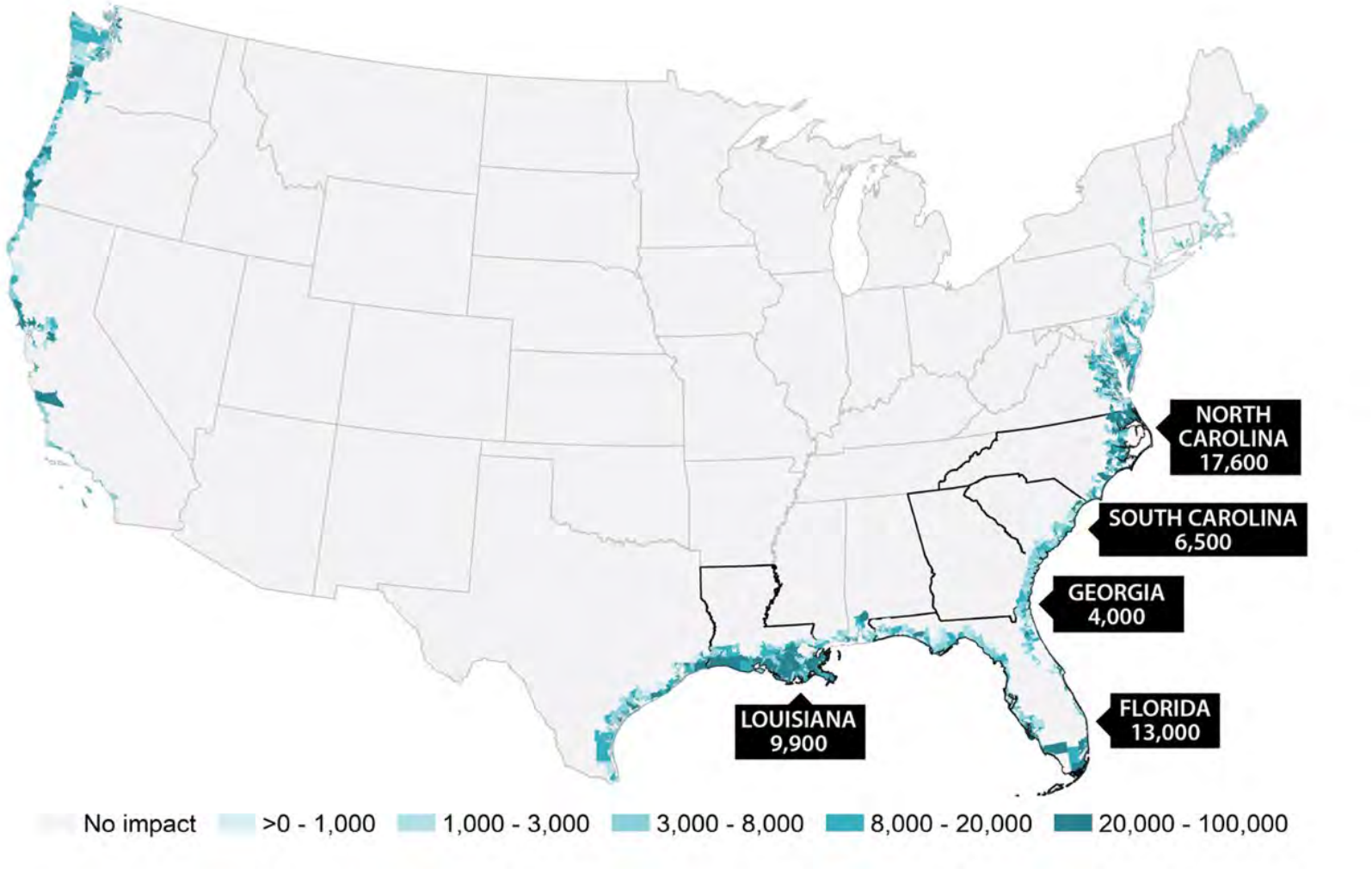

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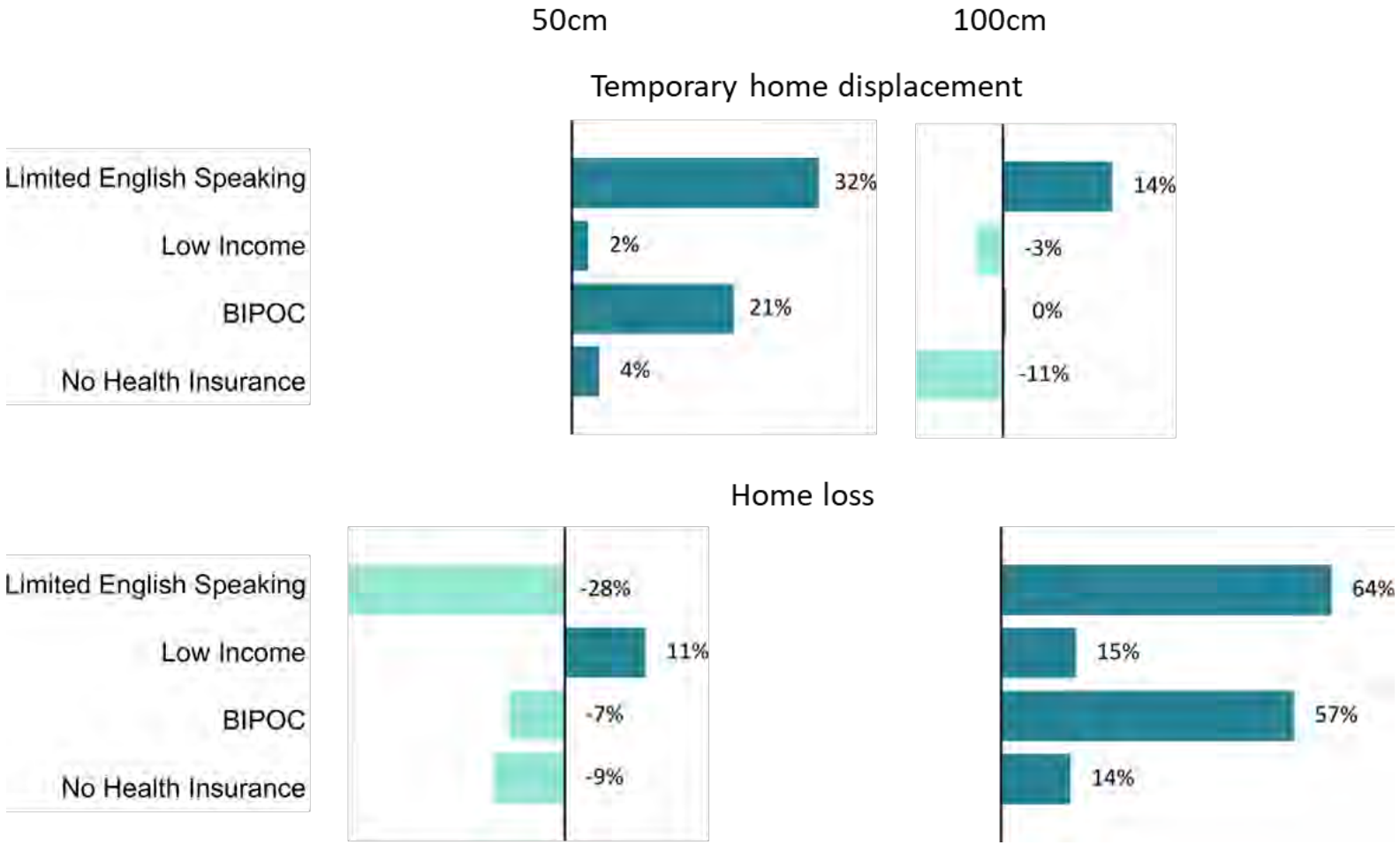
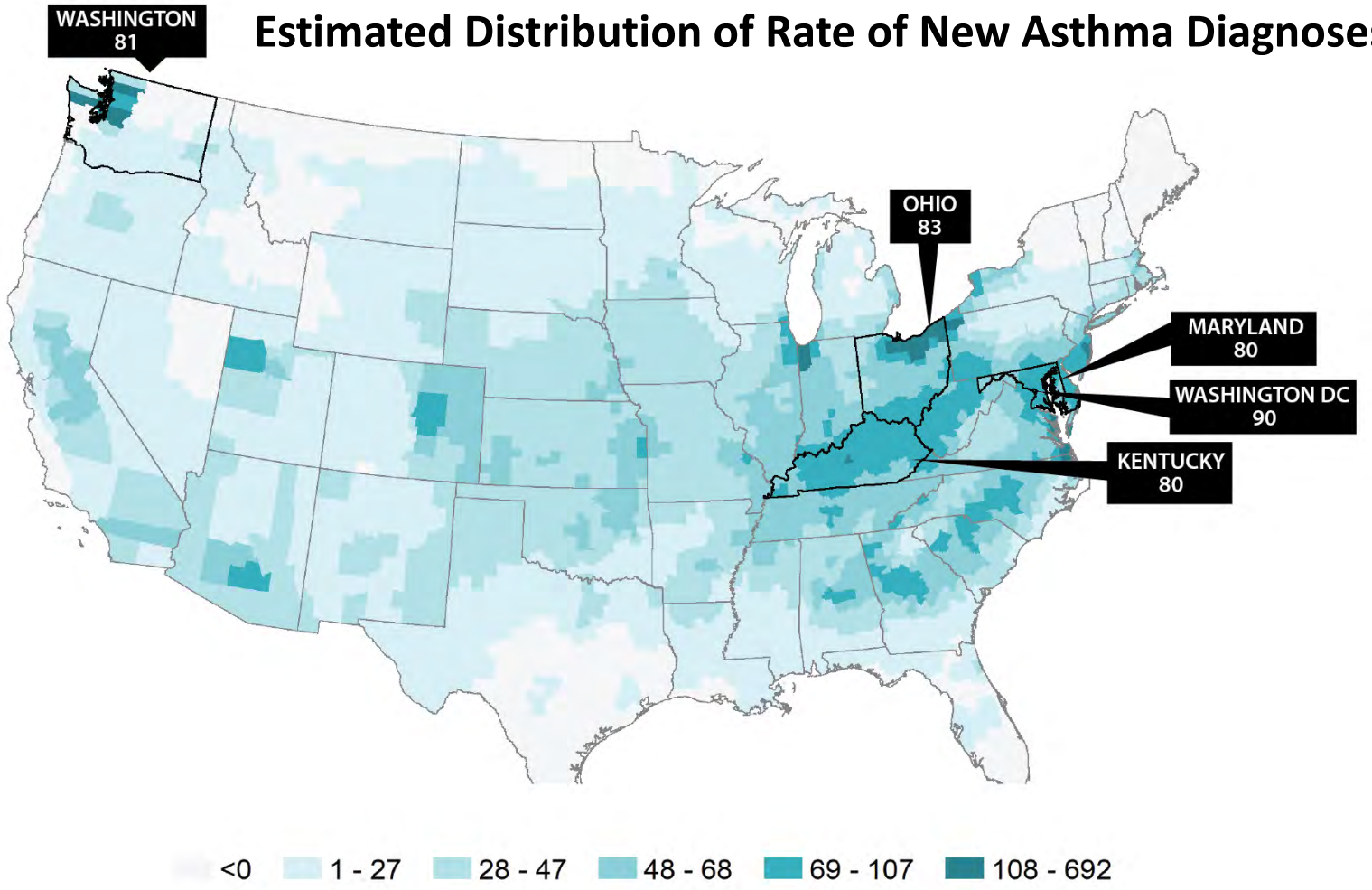


Air Quality: Climate-Driven Changes in Ozone and PM2.5, Ambient Dust in the Southwest, & Wildfire Activity in the West



Distribution of rate of new annual asthma diagnoses (per 100,000 children) attributable to climate-driven changes in air quality. Areas with darker shading have higher rates of affected children.

Step 1
Identify baseline health impacts among children

Step 2
Project climate-driven changes in PM2.5 and O3 concentrations

Nolte et al.
Fann et al.
Neumann et al.
Achakulwisut et al.

Step 3
Estimate increase in health impacts from degrading air quality

Note on this analysis

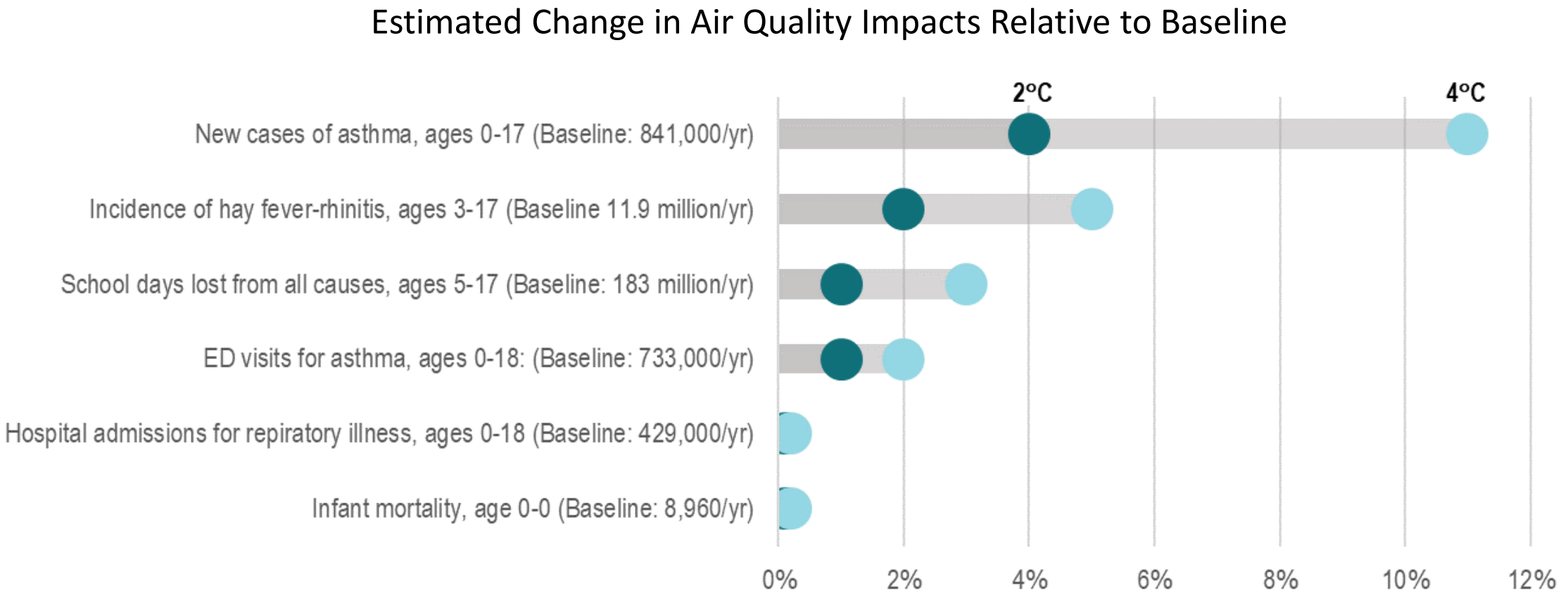
Considers all areas of the contiguous U.S. except for changes in southwest dust exposure, which is restricted to four states in the Southwestern U.S. Future impacts are quantified using BenMAP*

* https://www.epa.gov/benmap - EPA software that estimates the health impacts and economic value of changes in air quality

Climate-Driven Changes in Air Quality: Annual Effects

Degrees of Global Warming	New Asthma Cases	Incidence of Hay Fever/ Rhinitis	ED Visits for Asthma	Hospital Admissions for Respiratory Illness	Infant Deaths	School Days Lost
2°C	34,500 *(27,900 to 42,800)*	228,000 *(179,000 to 276,000)*	6,240 *(5,210 to 7,330)*	332 *(230 to 430)*	7 *(4 to 10)*	2,240,000 *(1,850,000 to 2,630,000)*
4 °C	89,600 *(74,100 to 108,000)*	554,000 *(447,000 to 662,000)*	15,800 *(14,500 to 17,200)*	785 *(353 to 1,220)*	15 *(6 to 25)*	5,480,000 *(5,170,000 to 5,790,000)*

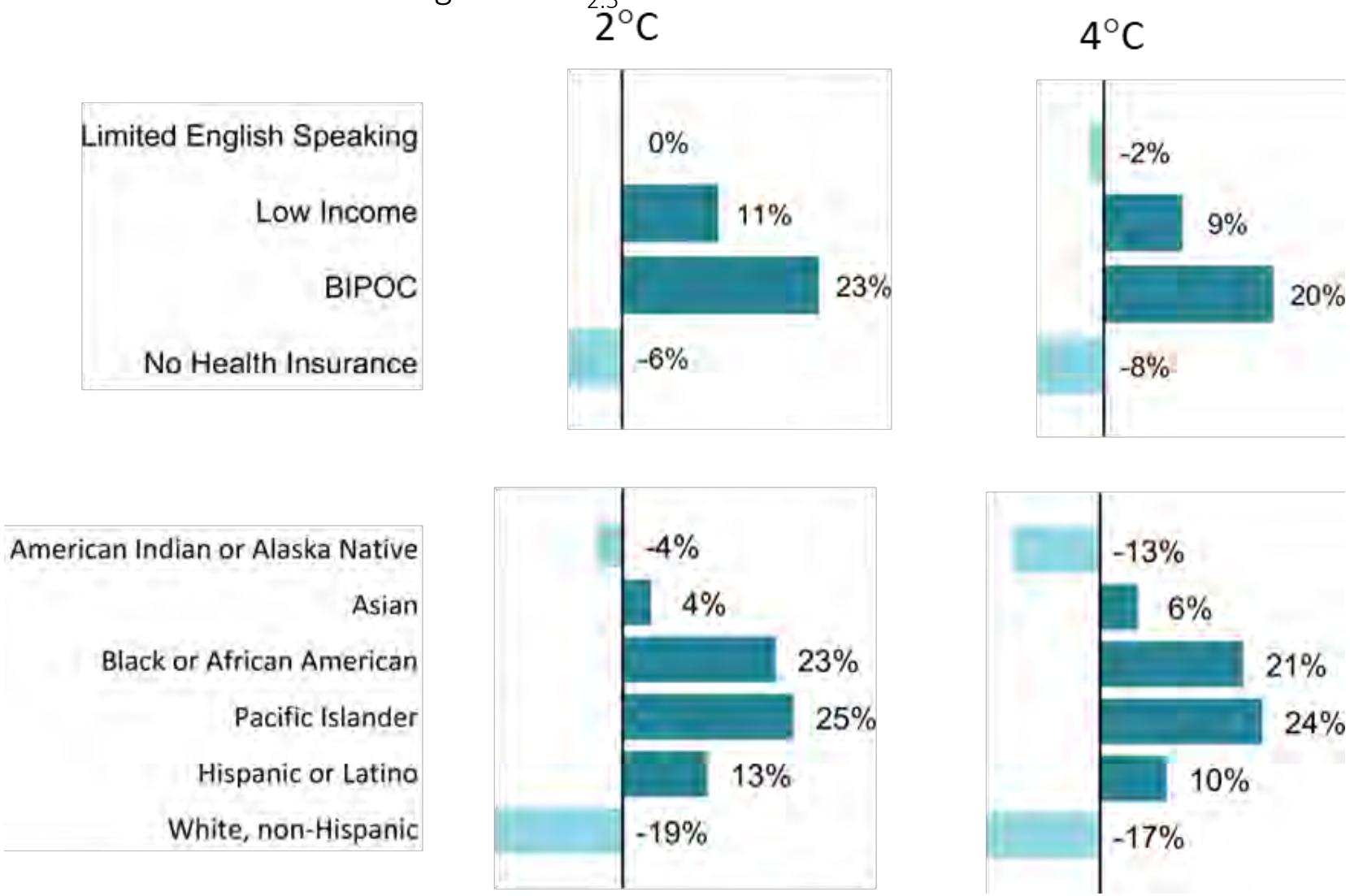
Air Quality: Climate-Driven Changes in Incidence



This graphic describes how the health impacts associated with air quality increase relative to baseline conditions (1986-2005), as listed in the figure and under assumptions described in Appendix C. The teal circles describe increases between baseline and 2°C of global warming; the light blue circles convey increases at 4°C.

Climate-Driven Changes in Air Quality: Disproportionality

Likelihood of Populations Living in Areas of the Contiguous U.S. with the Largest Increases in New Asthma Diagnoses Attributable to Climate-Driven Changes in $PM_{2.5}$



Those identifying in these groups, but living in the contiguous U.S.