

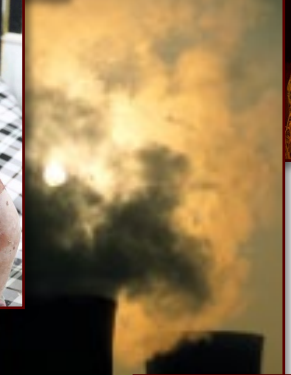


This One Will Not Be So Anti-Climactic:
*How Climate Change and Related Factors Will
Significantly Impact EMS - and Society*

Aileen M. Marty MD, FCAP

Distinguished University Professor, Infectious Diseases

Laboratory Director and Clinical Consultant for the FIU-Health Auxiliary, High Complexity CLIA Laboratory for COVID-19;
FIU Health Travel Medicine Program and Vaccine Clinic Commander, Emergency Response Team Development. USA



Changing of Earth's Climate by Living Things Is Primordial



Methanogenic archaea are the main producers of natural methane. Genetic analysis of an HGT event helps prove that methanogenic archaea are at least 3.5 billion years old. (Joanna Wolfe)

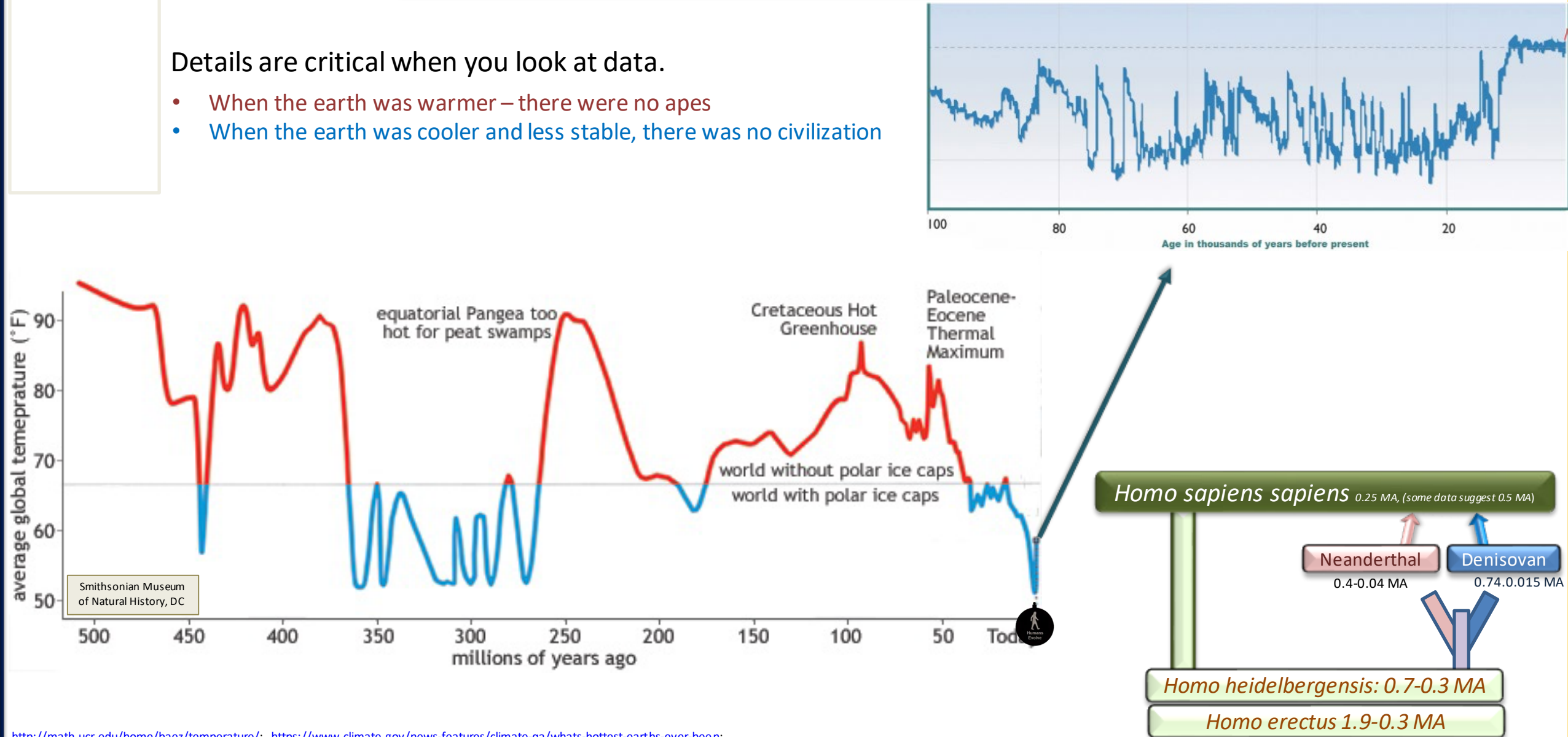
Recognition that the Environment Affects Health is at least as old as Hippocrates.



Estimated Global Temperature over the last 500 million years

Details are critical when you look at data.

- When the earth was warmer – there were no apes
- When the earth was cooler and less stable, there was no civilization

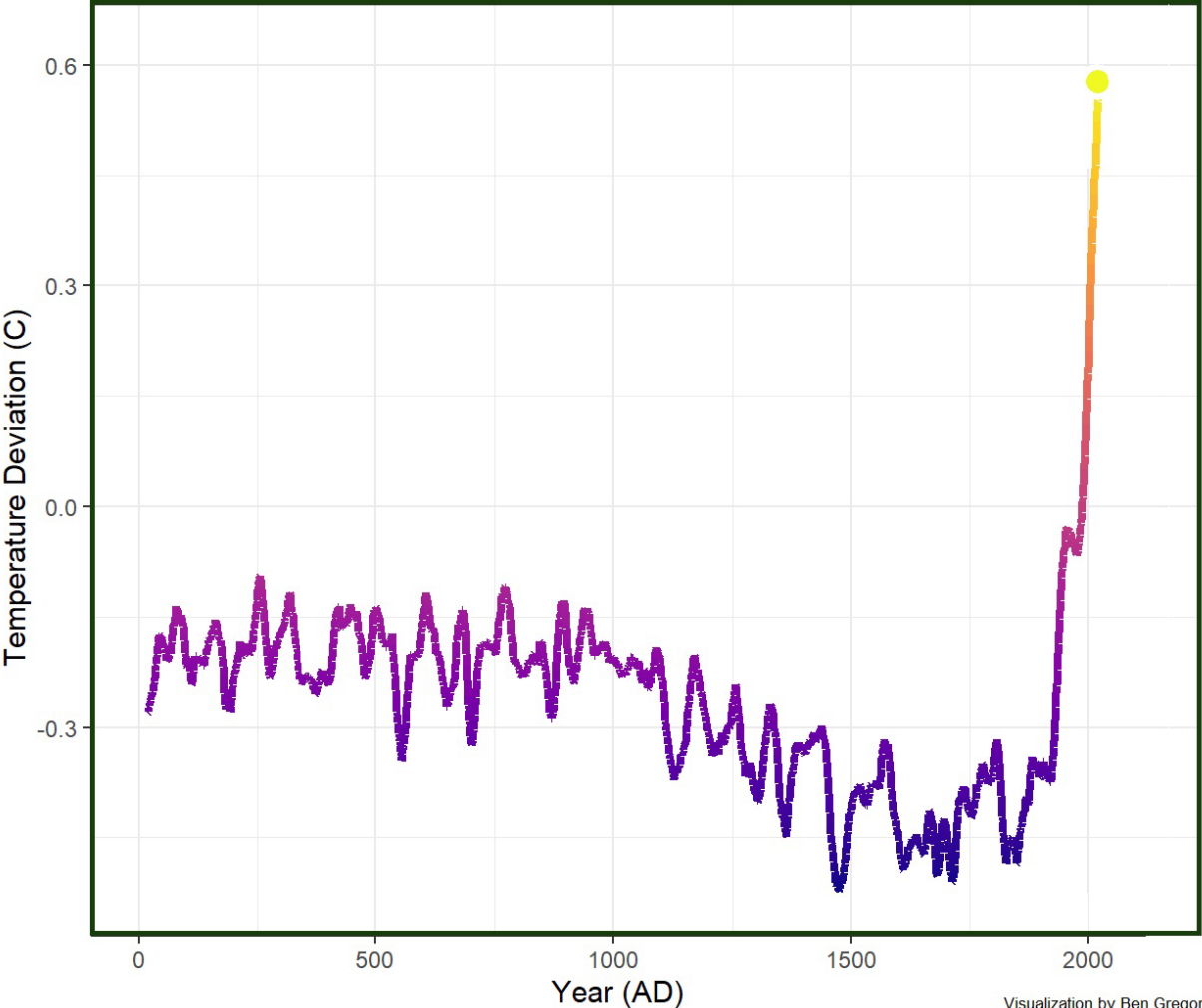


<http://math.ucr.edu/home/baez/temperature/>; <https://www.climate.gov/news-features/climate-ga/whats-hottest-earths-ever-been>;

Global Mean Surface Temperature (GMST) over the last 2000 years

Global Temperature Trend from 0 CE to 2023 CE

Temperature Deviation (C) based on the 1961 to 1990 Average



Visualization by Ben Gregory
(benpgregory@gmail.com)

- The most significant pre-industrial (1300-1800 CE) variability at multi-decadal timescales is due to volcanic aerosol forcing
- **Marked increase in global energy (heat) begins in the Industrial Age (late 18th century)**
- Dramatic warming trends at timescales of 20 years and longer begin during the second half of the 20th century, highlighting the unusual warming character of recent decades.

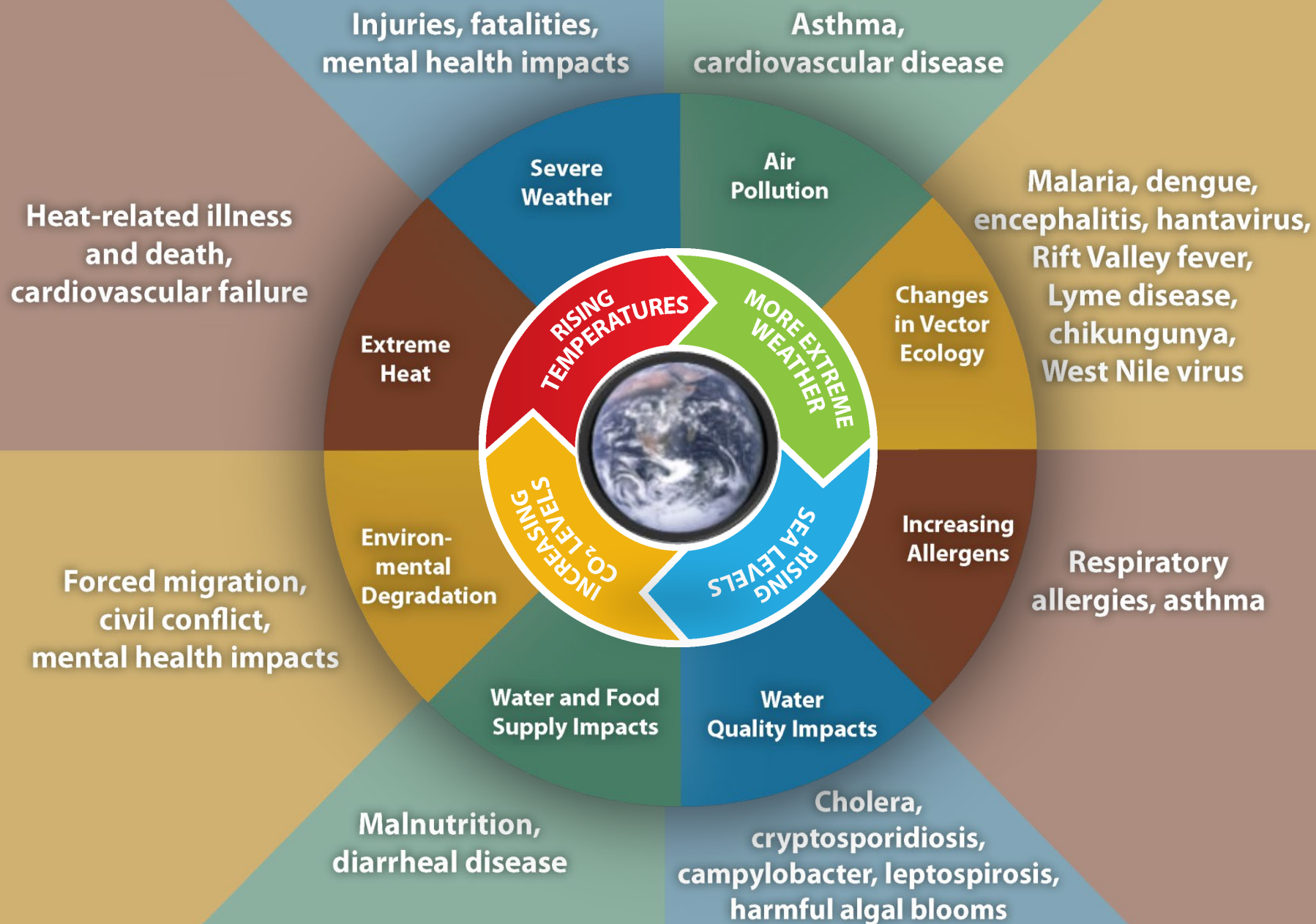
Period	Epoch	Time Frame: Millions of years
Quaternary	Anthropocene*	0.00176 MA to Present
	Holocene[∞]	0.0117 to 0.00176 MA
	Pleistocene	2.58 to 0.0117 MA
Neogene	Pliocene	5.33 to 2.58 MA
	Miocene	23.03 to 5.33 MA

- **Anthropocene:** Epoch corresponding to when humans began to impact the earth's environment significantly. Most estimates place the beginning of the Anthropocene with the industrial revolution ~1760 C.E.
- **Great Acceleration** – mid-20th century

A black and white photograph of a dry, cracked landscape. The ground is covered in a network of deep, irregular cracks, suggesting severe drought or arid conditions. In the upper right corner, there is a small, dark, scrubby bush or plant. The overall tone is somber and desolate.

Rate of Change
Matters

Adaptation
takes time



Categories of Human Health Impacts



Direct Health Risks

- Heat waves
- Wildfires
- Altered Precipitation
- Extreme weather events
- Concentrated air pollution

Animals and Plants

Quality & Quantity of Nutrients

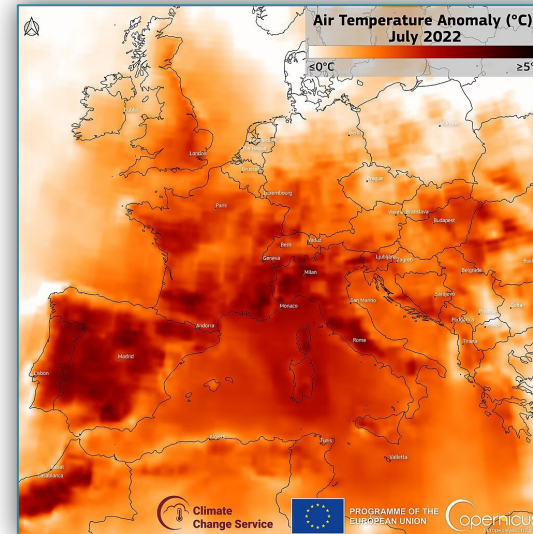
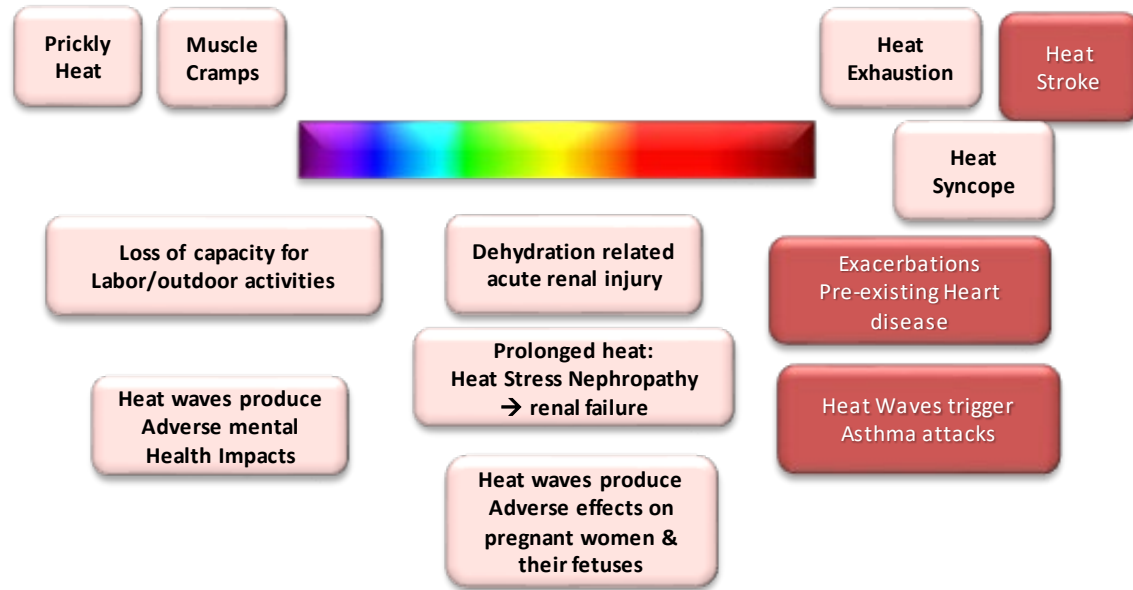
Indirect Geophysical & Geobiological Impacts

Food Shortage
Communicable diseases
Noncommunicable diseases
Habitat loss

Geopolitical, Economic, & Psychosocial Impacts

- Microbe, Flora and fauna changes
 - Vector life cycle
 - Pathogen amplification
 - Gender modification
 - Biodiversity
- Water availability, salinity, acidity
- Sea level rise (hot water expands, ice melts)
- Range of hot zones, days of heat
- Landscape changes from extreme weather
- Stress, Mental Health issues
- Migration
- War

Human Health Hazards of Excess Heat



Heat broke records around the world in summer 2022—first in South Asia, then in North America, Europe, and China 2023 is off to a hot start. Argentina suffered record late-summer heat in March; a heat wave struck India in April; Vietnam, Laos, and Thailand set records in May; the same month, heat left twelve million people under an advisory in the Pacific Northwest and fuelled forest fires in Canada. And it is only going to get worse.

Europe reported > 15,000 heat-related deaths in 2022,

Body's Heat regulation Methods

- Evaporation – cooling from perspiration
- Conduction- direct contact with hot/cold surface
- Convection – air or fluid movement
- Radiation – exchange of electromagnetic waves

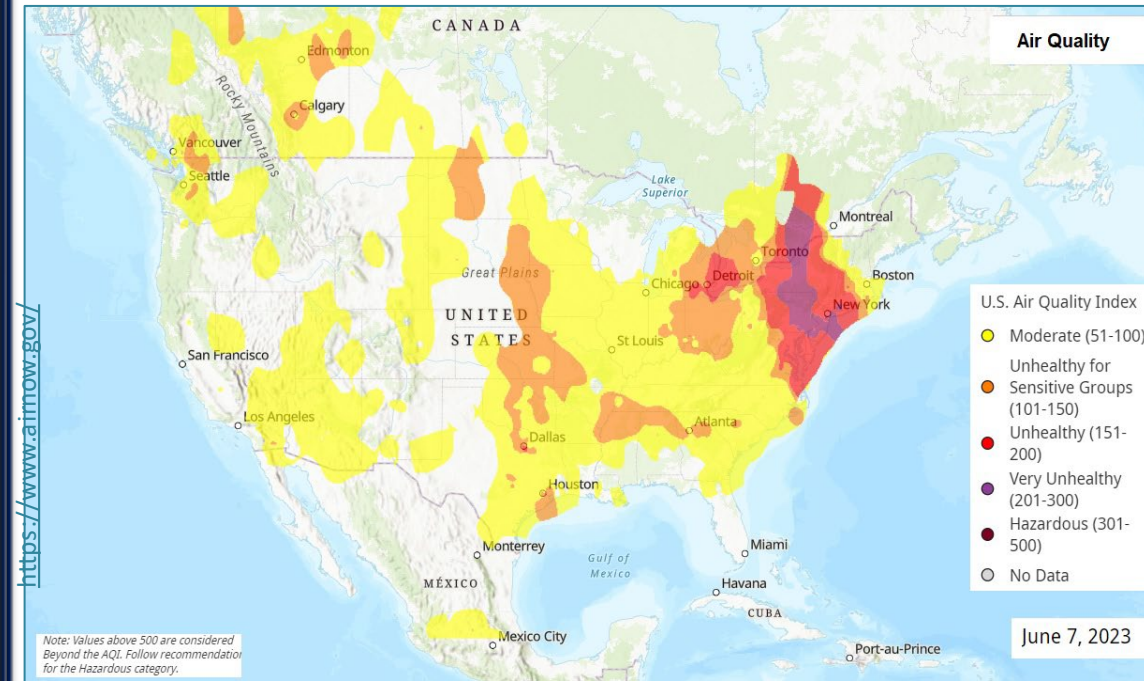
Accomplished by sweating, increased cardiac output, redirection of blood toward the skin,
And behavior, attire, habitat, and technological aids

Risk Factors for Serious Heat-Related Injury

- Dehydration
- Obesity
- Heavy clothing
- Poor physical fitness
- Cardiovascular disease
- Skin diseases (burns, eczema, scleroderma, and psoriasis)
- Febrile illnesses
- Hyperthyroidism
- Drugs
 - ❑ abuse (cocaine, alcohol, amphetamines, opiates, LSD, and PCP)
 - ❑ Medications (beta blockers, diuretics, anticholinergics, antipsychotics, Ca⁺ channel blockers, alpha agonists, sympathomimetics)
- Poor socioeconomic conditions

Angrier wildfires are expected in a warming world, especially in northern latitudes, where warming is happening fastest

June 2003 Wildfires in Canada led to Hazardous Air Quality Index levels in the NE USA



Fires are getting larger. Larger fires are hotter and thus more intense, allowing for rapid increase in size, which sends more smoke higher into the atmosphere and farther downwind.



- Wildfire smoke contains high levels of CO₂, CO, and Nitrogen oxide gases, volatile oxides, volatile organics, and fine particles from burning vegetation, building materials, and other materials.
- High levels of wildfire smoke in the air can make anyone – *even previously healthy people* – sick. **Smoke Inhalation injuries** – with wheezing and respiratory distress, hypoxia, coughing, or gagging. **Expect increased respiratory and cardiovascular hospitalizations**, ED visits, and medication dispensations for asthma, bronchitis, chest pain, COPD, respiratory infections, and medical visits for lung illnesses
- CO toxicity can lead to high **carboxyhemoglobin** presentations varying from a slight headache, nausea, or confusion to chest pain and vomiting. Severe or prolonged exposure can cause seizures, coma, and death

Some ways in which Climate Change impacts Respiratory Illness



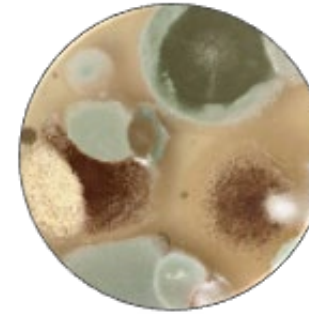
HEAT



POLLEN



SMOKE



MOLD



SMOG

- Heat waves → more dust mites → trigger Asthma attacks
- Heat + drought → wildfires → **smoke** can trigger asthma attacks
- Low pressure systems → storms → flooding → **mold** → trigger asthma, allergies, headache, sepsis
- Increased ground temperature → selects for subtypes of organisms that can survive in warmer temperature → **emerging infections**

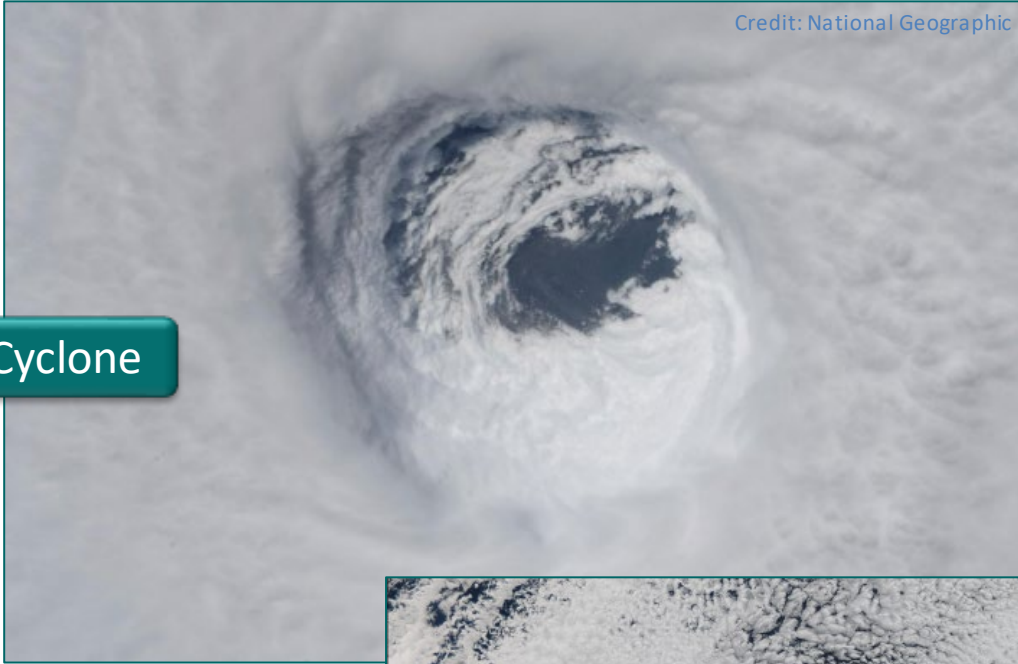
- Elevated CO₂ increases
 - **amount** of pollen
 - **toxin** levels in **pollen**
 - Increase **mold**
- Smog, Ground level Ozone
 - Powerful lung irritant



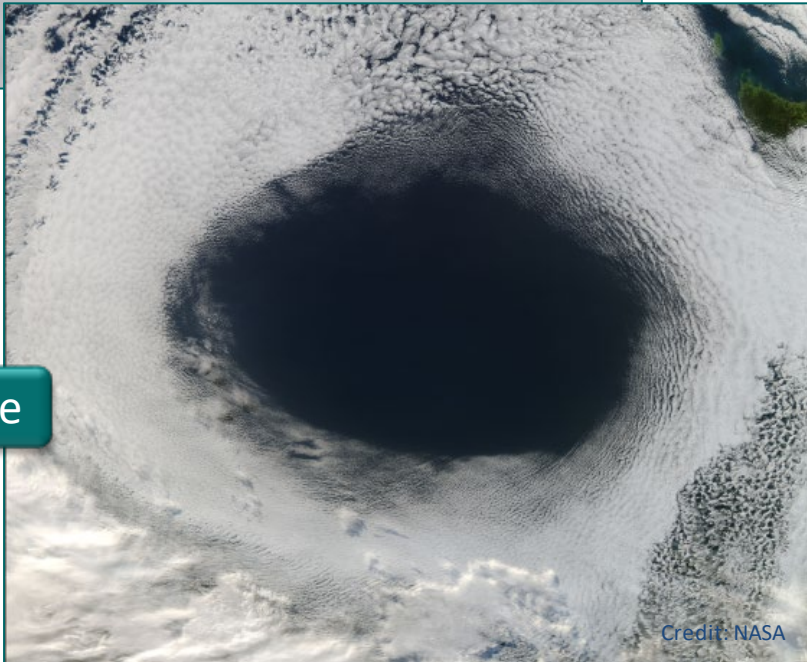
Heat is Energy

Credit: National Geographic

Cyclone



Anticyclone



Credit: NASA

Health Effects of Extreme Weather Events:

- **Direct Effects**

- Injuries

- External trauma
- Organ damage

- Psychosocial Mental Health-related

- Cardiovascular events

- **Indirect Effects**

- Flooding-related

- Injuries, Drownings
- Intoxications
- Infections
- Infestations
 - Allergic reactions
- Psychosocial / Mental Health related issues

- Fire and Smoke related

- Cardiopulmonary injuries
- Eye, Skin, Throat, Neurologic injury
- Death

- Shelters/Migration/Relocation

- Infections
- Infestations
- Psychosocial / Mental Health related issues



Current Saffir/Simpson Scale and Future Storms

Wind's force increases exponentially with increases in wind speed (as does potential damage)

- **1971**, Herbert **Saffir**, a civil engineer, and Robert **Simpson**, Director of the National Hurricane Center, unveiled a 5-category scale of increasing intensity to describe the likely effects of hurricanes based on their energy levels. The top was > 155 mph (and each level was 15 to 24 mph different from the next)
- Hurricanes with winds ≥ 180 should likely be called Category 6, and those with winds > 200 Category 7
- **Since 1980, there have been six storms with ≥ 180 mph winds:**
 - Allen (190 mph), 1980
 - Gilbert (185mph) 1988
 - Mitch (180 mph) 1998
 - Rita (180 mph) 2005
 - Irma (180 mph) 2017
 - Dorian (185 mph) 2019

Category	Wind speed	Storm surge (height > normal)	Atmospheric pressure (millibars)	Damage
1	74–95 mph	4–5 ft	>979	Minimal: No real damage to buildings. Damage to unanchored mobile homes. Some damage to poorly constructed signs. Some coastal flooding and minor pier damage.
2	96–110 mph	6–8 ft	965–979	Moderate: Some damage to building roofs, doors, and windows. Considerable damage to mobile homes. Damage to piers from flooding. Small craft in unprotected moorings may break their moorings. Some trees blown down. Evacuation of some shoreline residences and low-lying areas required.
3	111–130 mph	9–12 ft	945–964	Extensive: Some structural damage to small residences and utility buildings. Large trees blown down. Mobile homes and poorly built buildings are =destroyed. Flooding near the coast destroys smaller structures with larger structures damaged by floating debris. Terrain may be flooded well inland. Evacuation of low-lying residences within several blocks of the shoreline may be required.
4	131–155 mph	13–18 ft	920–944	Extreme: More extensive failure on non-bearing, exterior walls with some complete roof structure failure on small residences. Major erosion of beach areas. Terrain may be flooded well inland. Massive evacuation of residential areas as far inland as 6 mi (10 km) may be required.
5	>155 mph	>18 ft	<920	Catastrophic: Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Flooding causes major damage to the lower floors of all structures near the shoreline. Massive evacuation of residential areas on low ground within 5 to 10 mi (8 to 16 km) of the shoreline may be required.

Direct: Decrease quantity & quality of water

- Dehydration

Indirect:

- **Damage to Crops and Livestock**
 - Decreased quantity & quality of food
 - Starvation, malnutrition
 - Increased vulnerability to infections
 - Mismanaged alternative foods
 - » Charmak disease; neurolathyrism; Konzo; aflatoxicosis; etc.
 - Civil disobedience, war
- **Increased toxicity of water**
 - Pathogens
 - Toxins
- **Decrease Hygiene**
 - Infestations, infections
- **Dusty air**
 - Particulates
 - Toxins
 - Pathogens (e.g., Valley fever)
- **Migration/Relocation**
 - Increased disease risk
- **Wars**
- **Mental Health Issues**

Health Effects of Droughts



Credit: Afghanistan's Water Scarcity: Unfolding Challenge. Alwaght; Sunday 4 March 2017:
<http://alwaght.com/en/News/89824/Afghanistan%E2%80%99s-Water-Scarcity-Unfolding-Challenge>

Most Pathogens with PHEIC Capacity result from Spillover events

“Approximately 60%–80% of human EIDs originate from wildlife, as shown by the typical examples of hemorrhagic fever, avian influenza, and henipavirus -related lethal neurologic and respiratory diseases that originated from rodents, wild birds and bats”

Wu, Z., Yang, L., Ren, X. *et al.* *ISME J* 10, 609–620 (2016);
<https://doi.org/10.1038/ismej.2015.138>

Spillover is facilitated by Climate change.

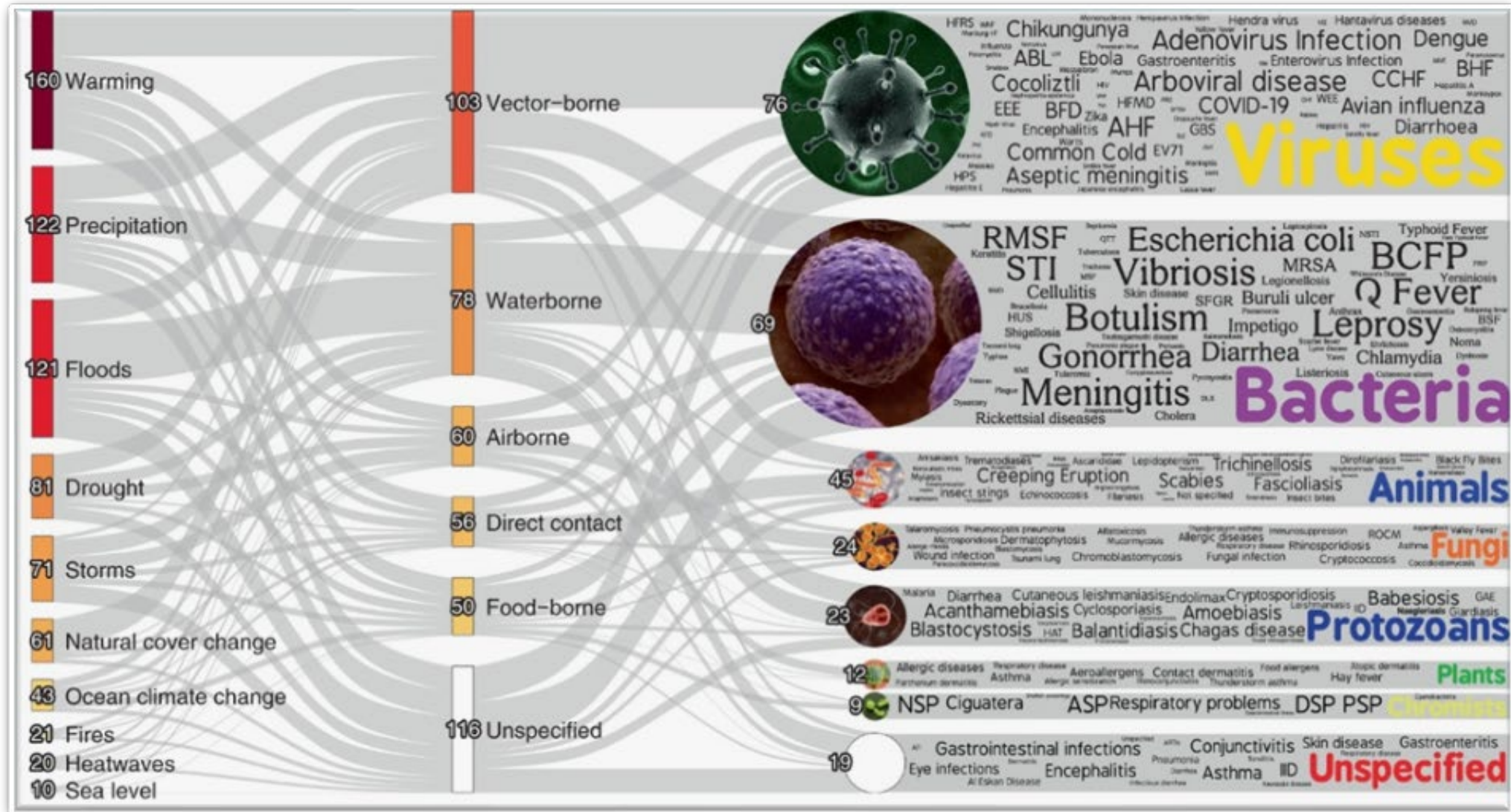
- Climatic hazards cause habitat changes that bring *pathogens closer to people*, especially by bringing vectors closer to people
- Climatic hazards bring *people closer to pathogens* since climatic changes can drive people into land-use/water-use changes that increase the risk
- Climatic changes can *enhance the virulence of pathogens* and *decrease the resilience of hosts*



Illustration by Dr. Aileen M. Marty MD

Climate Change will drive more PHEICs:

~ 58% of *Known* Pathogenic diseases are aggravated by climatic hazards



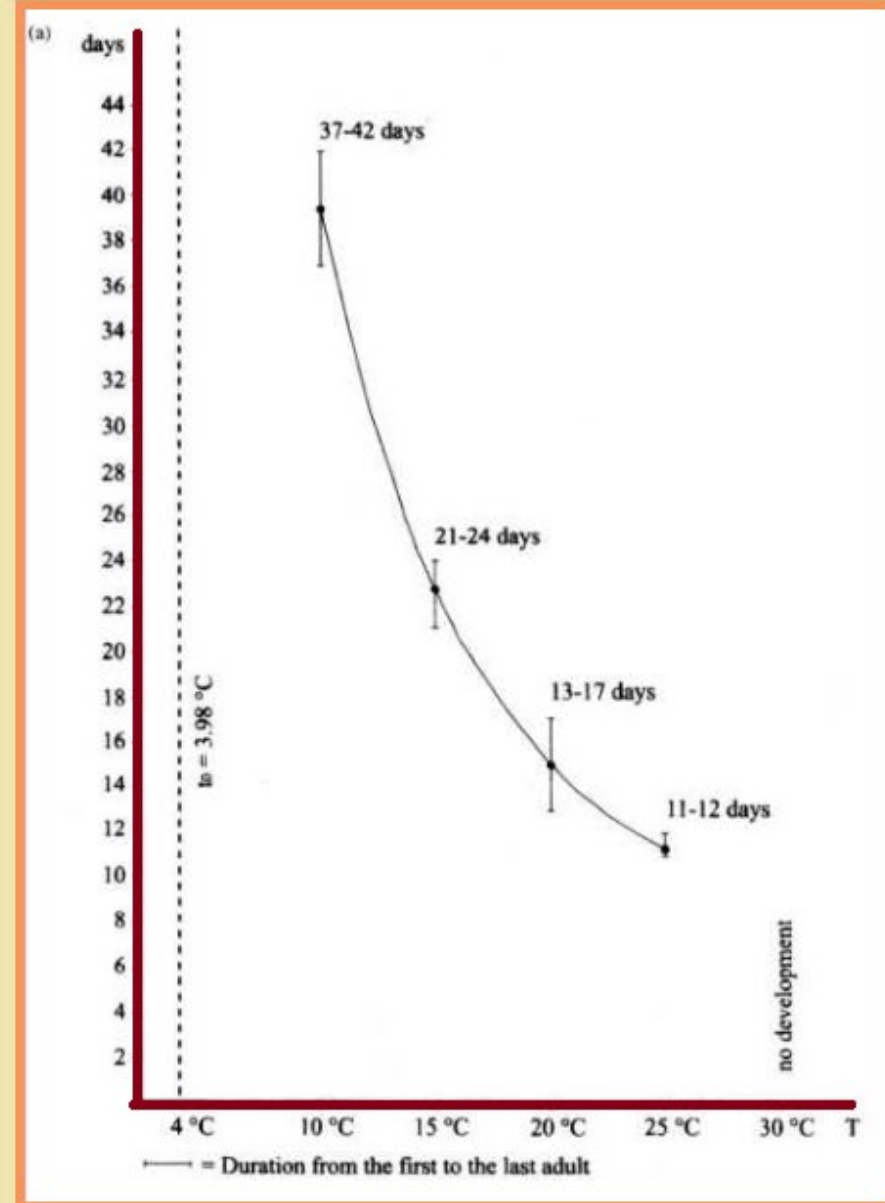
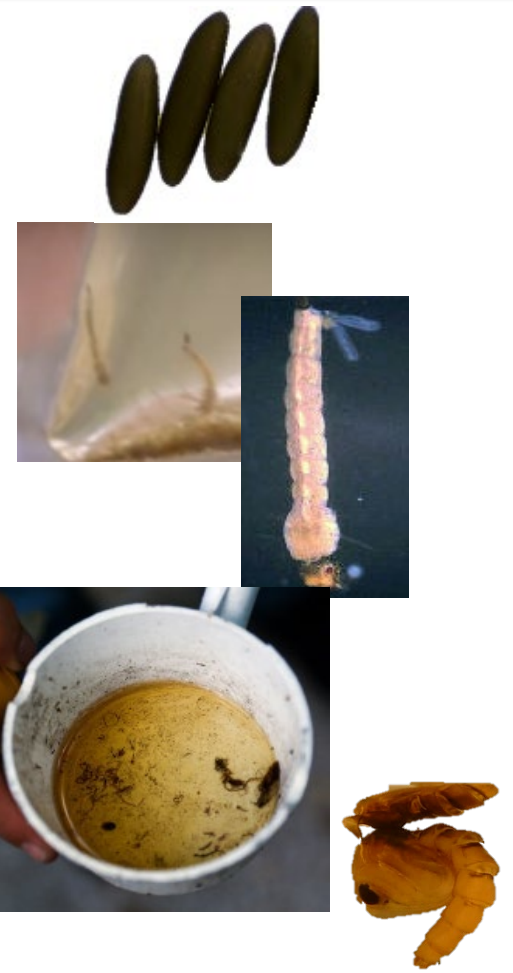


Figure 2.9a. Larval and pupal development of *Ochlerotatus cantans* in relation to water temperature. (t_0 = theoretical temperature where no development is possible.)

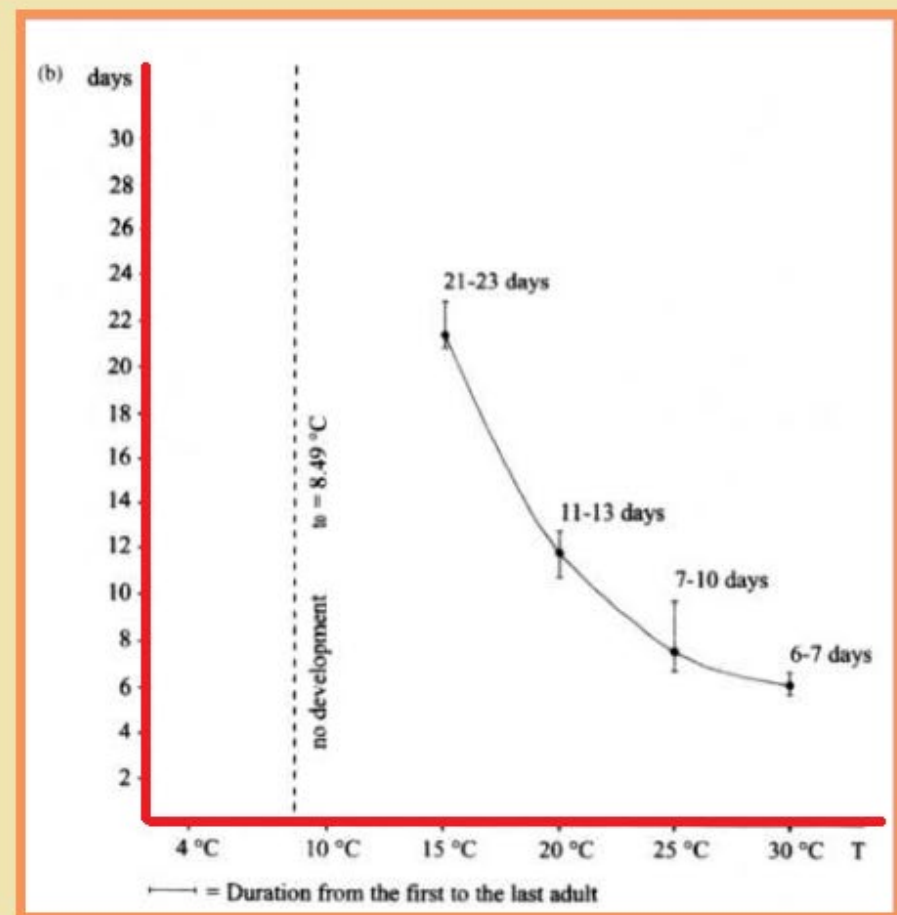
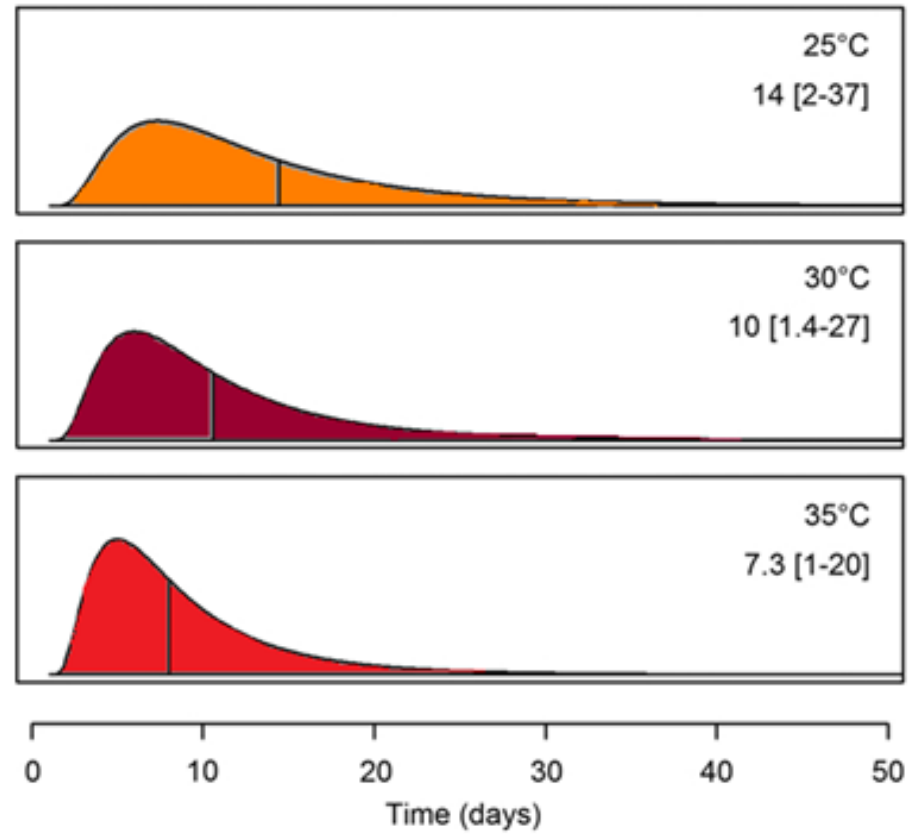
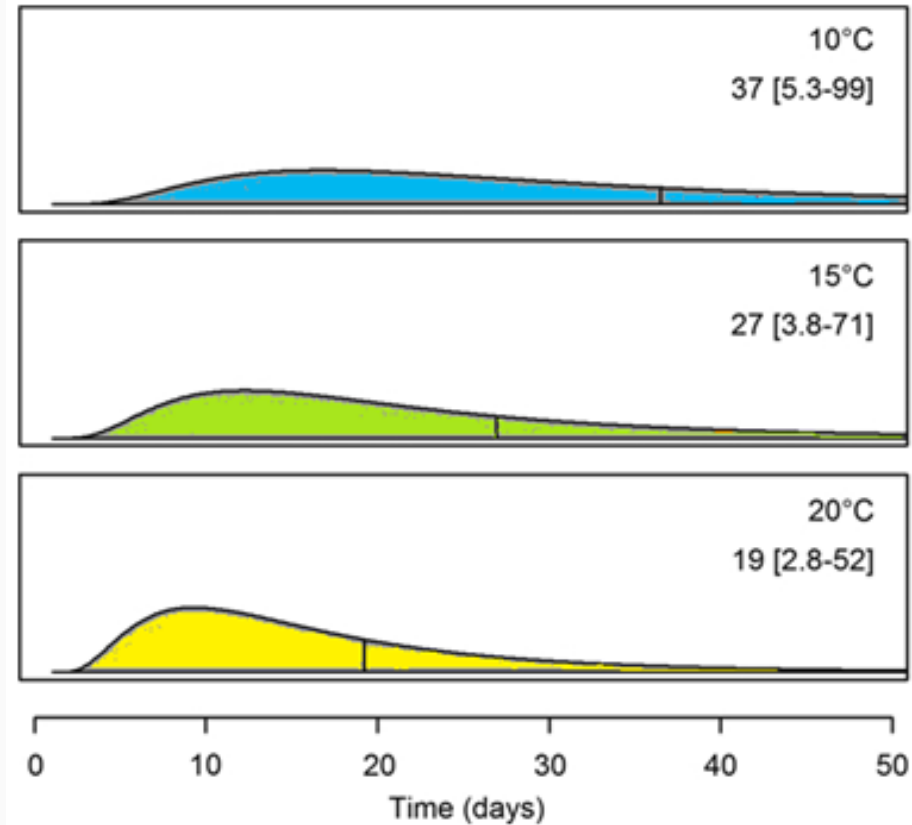


Figure 2.9b. Larval and pupal development of *Aedes vexans* in relation to water temperature.

Climate Change

Climate Change

Extrinsic incubation periods at selected temperatures



These data are for arboviruses,

At least 200 dead, more than 130,000 infected: Peru battles major dengue outbreak



Natalie Neysa Alund

USA TODAY

Published 2:39 p.m. ET June 12, 2023



Northwestern region has been the worst hit. Authorities there have been forced to construct emergency field wards in tents on sports pitches to deal with a deluge of cases, bringing back grim memories of the country's Covid crisis and leading to media reports of "overwhelmed" health facilities.

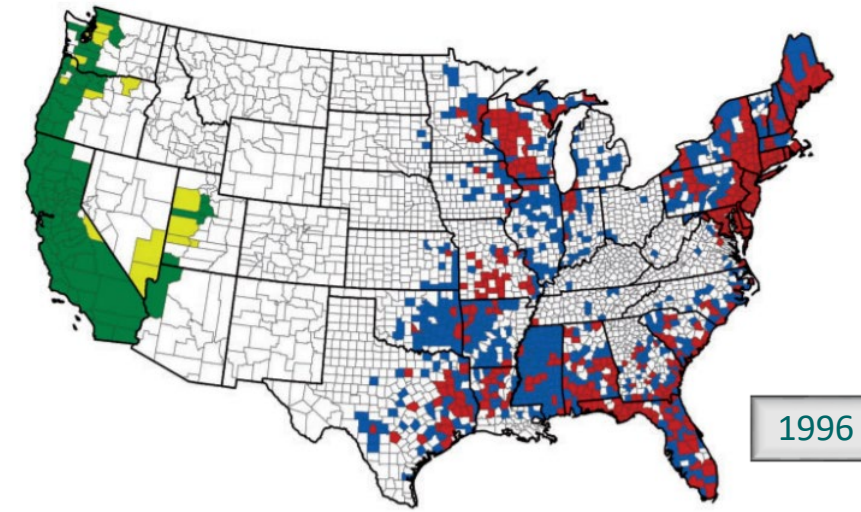
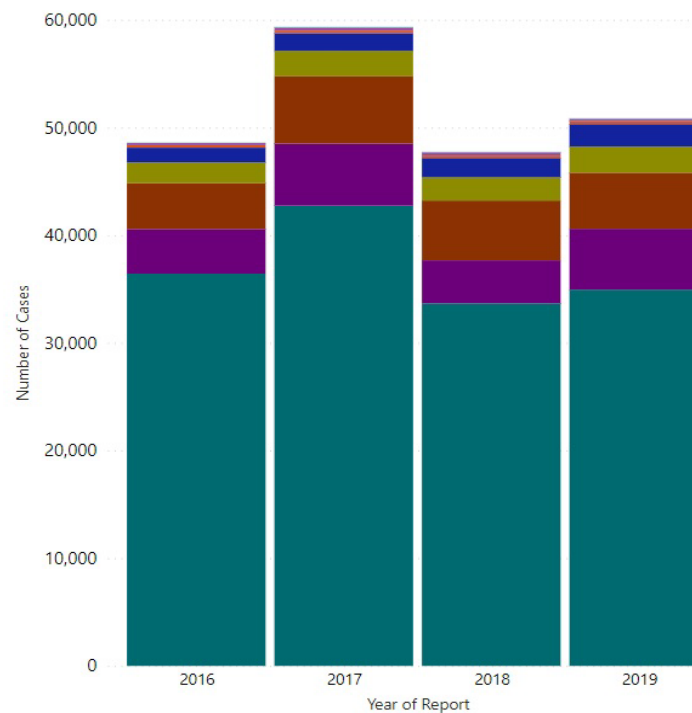
Moisture and Temperature affect Tick-transmitted disease.

- Higher moisture levels allow tick survival in warmer environments
- Minimum Temperature helps define the northern distribution of vectors
- Warmer temperatures and moisture increase
 - reproductive capacity of ticks producing larger population and increased disease transmission risk
 - Behavior, including bite behavior
- Cumulative days of heat affect disease seasonality
 - Expanded tick range (north and south)
 - Increased human exposure
 - Increased exposure of domestic animals

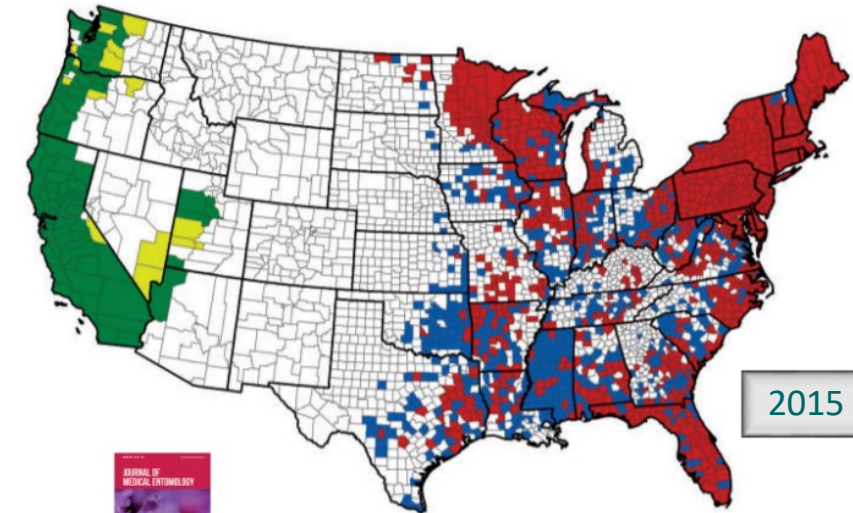
Disease

- Lyme disease
- Anaplasmosis
- Spotted Fever Rickettsiosis
- Babesiosis
- Ehrlichia chaffeensis ehrlichiosis
- Tularemia
- Undetermined ehrlichiosis/anaplasmosis
- Ehrlichia ewingii ehrlichiosis
- Powassan virus disease

Selected Tickborne Diseases-United States, 2016-2019



1996

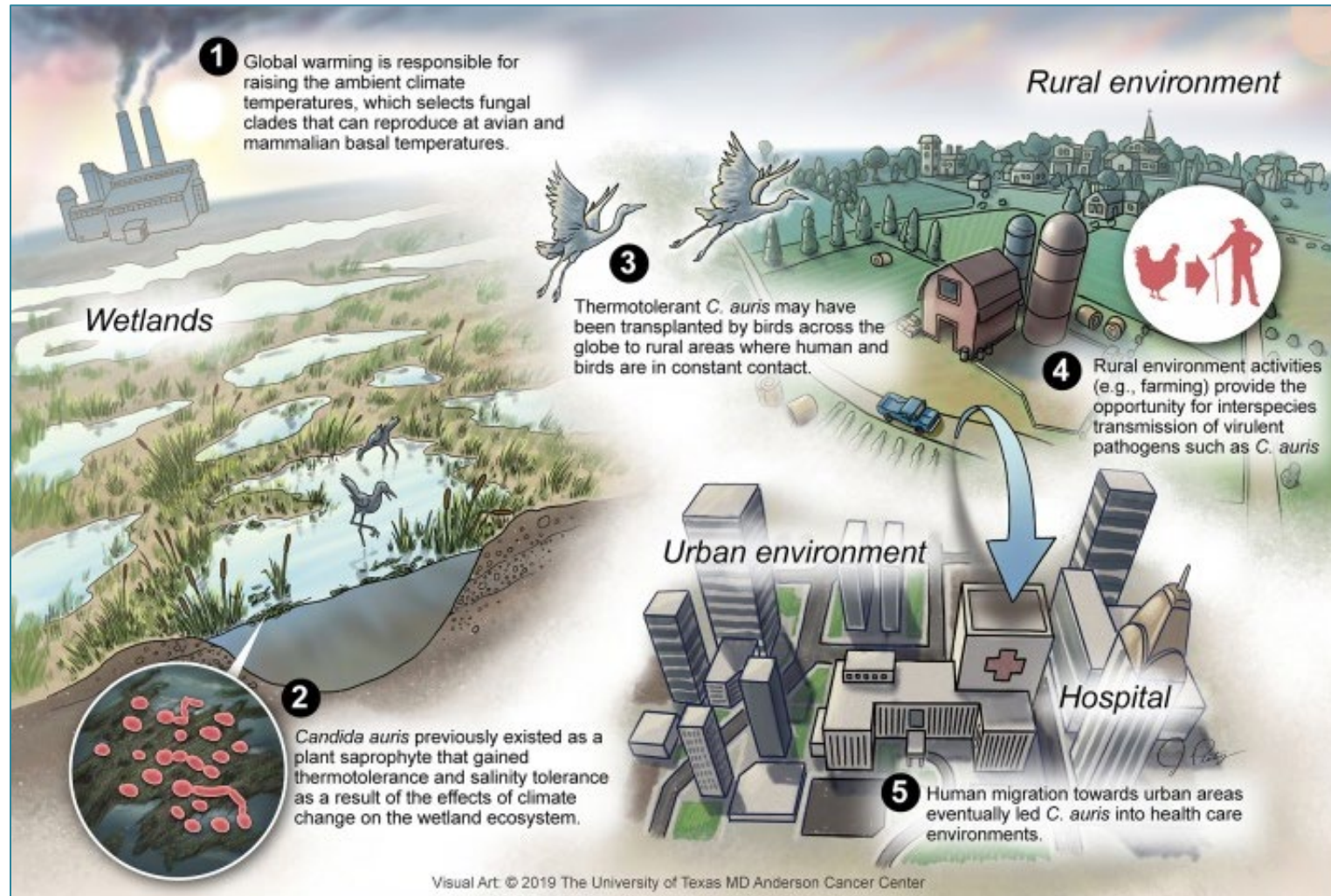


2015



Credit: Eisen RJ, et al. J Med Entomol. 2016 Mar;53(2):345-386

Emergence of *Candida auris*: Climate Change, Azoles, Swamps, and Birds



The hot topic during the
PACCARB meeting

PACCARB

Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria

July 10-11, 2019 - Public Meeting



mBio. 2019 Jul-Aug; 10(4): e01397-19

The Human Ability to Ignore Painful Truths



THE INTERNATIONAL RAOUL WALLENBERG FOUNDATION <http://www.raoulwallenberg.net/saviors/diplomats/list/jan-karski-820/>

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Jan Karski

Consul for Poland

Polish diplomat Jan Karski was a witness to the conditions in the Warsaw ghetto and the Izbica camp near the Belzec death camp. Karski prepared written eyewitness accounts of the German atrocities in Nazi occupied Poland. Later, he was smuggled out of Poland and into the United States, where he reported to US Supreme Court Justice Felix Frankfurter. Frankfurter arranged for Karski to report to President Roosevelt. Frankfurter was skeptical of the report: "I did not say that he was lying, I said that I could not believe him. There is a difference." Karski gave hundreds of talks to organizations all over the United States and Great Britain to bring pressure to intervene to save Jews from the Holocaust. Karski was declared a Righteous Among the Nations and made an honorary citizen of the state of Israel.



*There's a little ditty
They're singing in the city
Especially when they've been on the gin, or the beer
If you've got the patience, Your own imaginations
Will tell you just exactly what you want to hear...
They all suppose what they want to suppose, When
they hear... oom-pah-pah!!
Lionel Bart, Oom-pah-pah; Oliver!*



Credit: Judith Dubois April 2, 2015 <http://tpis-witch.com/the-emperor-has-no-clothes/>

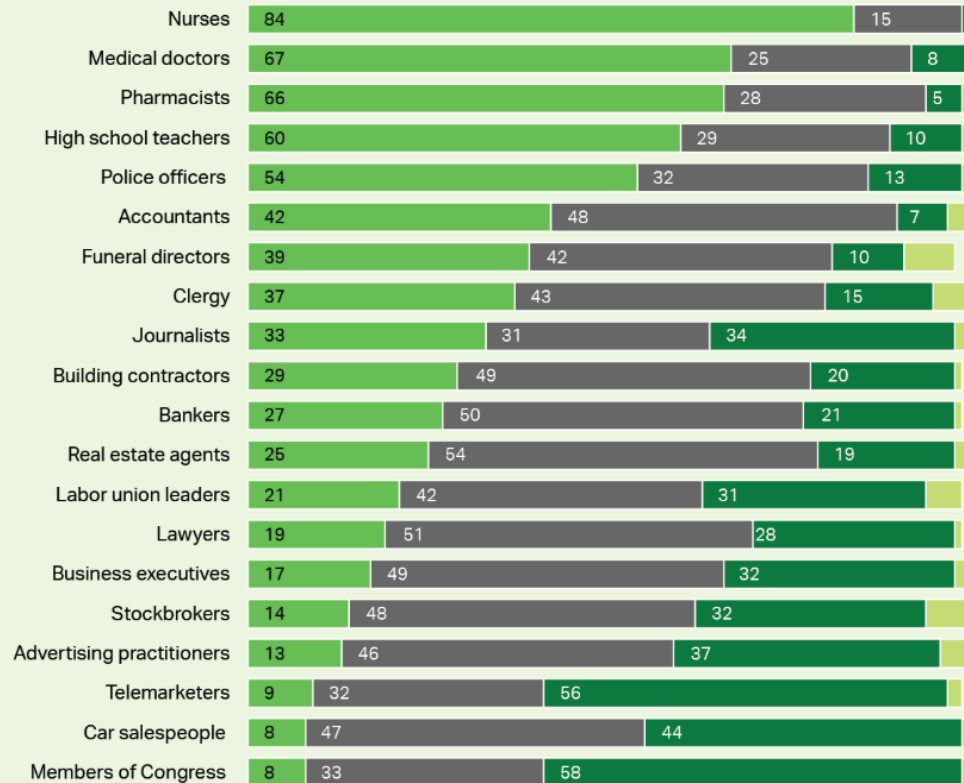
Psychology: Cognitive Bias, Perceived Risk, Tribal Instincts, Cultural Coding

Social Norms

Communicate with Trusted Messengers providing credible, reliable data

Please tell me how you would rate the honesty and ethical standards of people in these different fields -- very high, high, average, low or very low?

■ % Very high/High ■ % Average ■ % Low/Very low ■ % No opinion



GALLUP, DEC. 3-12, 2018

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How our health is harmed by
climate change

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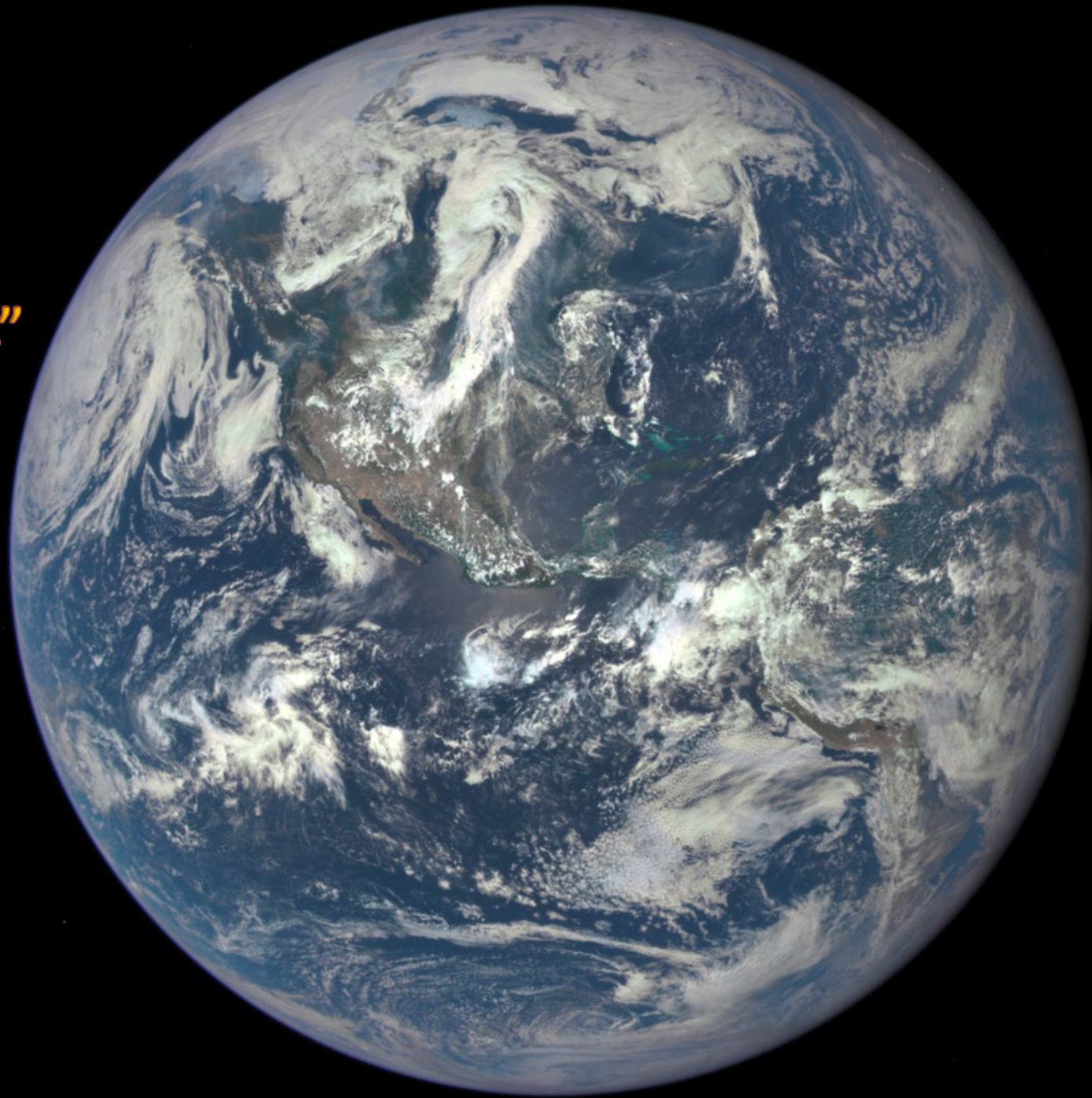
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Credit: <https://news.gallup.com/poll/245597/nurses-again-outpace-professions-honesty-ethics.aspx>

<https://medsocietiesforclimatehealth.org/>

**It's not just a
problem "over
there", It's not a
problem for the
"next generation."**



**It is here, it's now,
it's us who are
affected...and it is
incumbent on us to
fix it ...while it can
still be fixed**

Thank you, The End



Questions?

Questions?



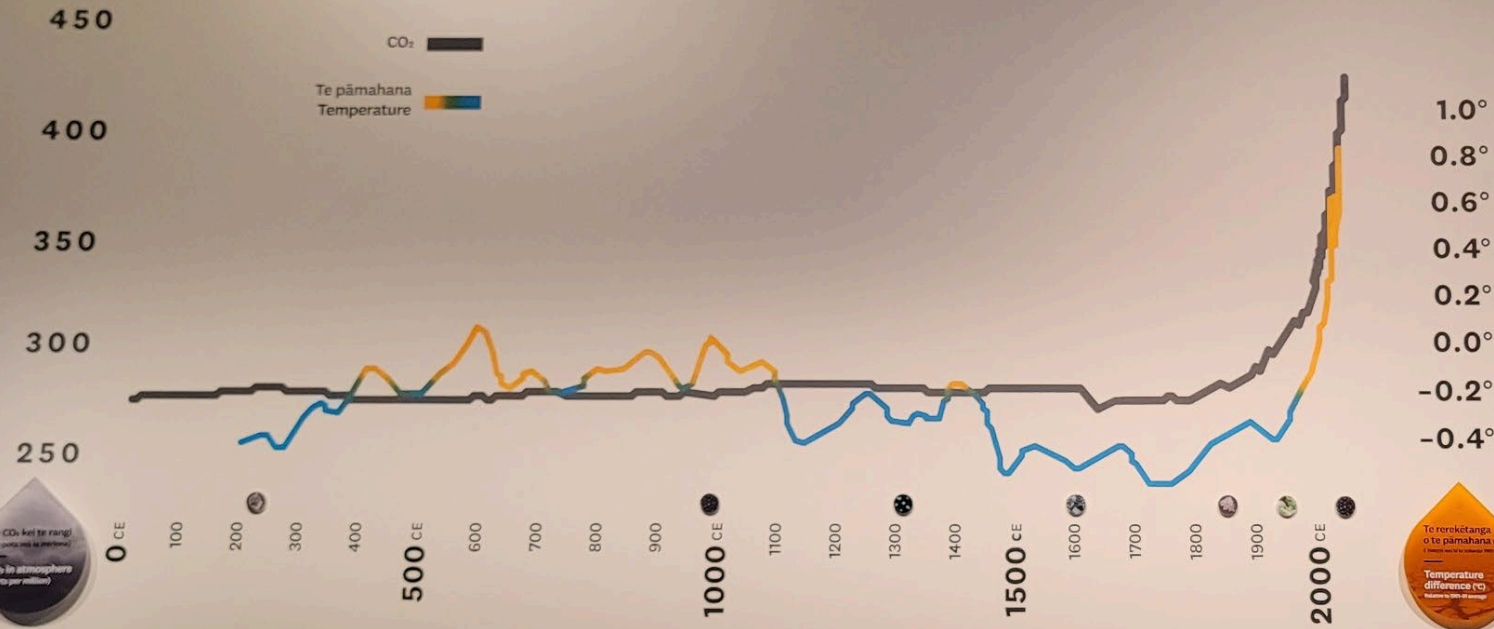
Questions?

Questions?

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He wā taka āhuarangi Climate timeline



Te whakamahana o te ao:
He reo nō te haupapa

He waka whakarewa wā te haupapa
o Te Tai Huka-ā-Pia.

I te tau, takoto ana he whakapaparanga hou
o te wai kua totoka, mau iho ana ki roto he mōhiio
o te whakamahana ao me ētahi atu mea.

Tirohia te pou kōpaka - he mea tango hei mātā.

Global warming:
Ice-cold evidence

Antarctic ice is a time capsule.

Every year, a new layer of water freezes, trapping
evidence of global warming and other events.

Ice cores are extracted for study - explore ours.

Te haerenga
pou kōpaka

Tirohia te mahi tango mōhiio ā ngā
kaipūtaiao mai i Te Tai-Huka-ā-Pia.

