Human Health Harms of a Changing Climate: What Family Physicians Should Know

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Learning Objectives

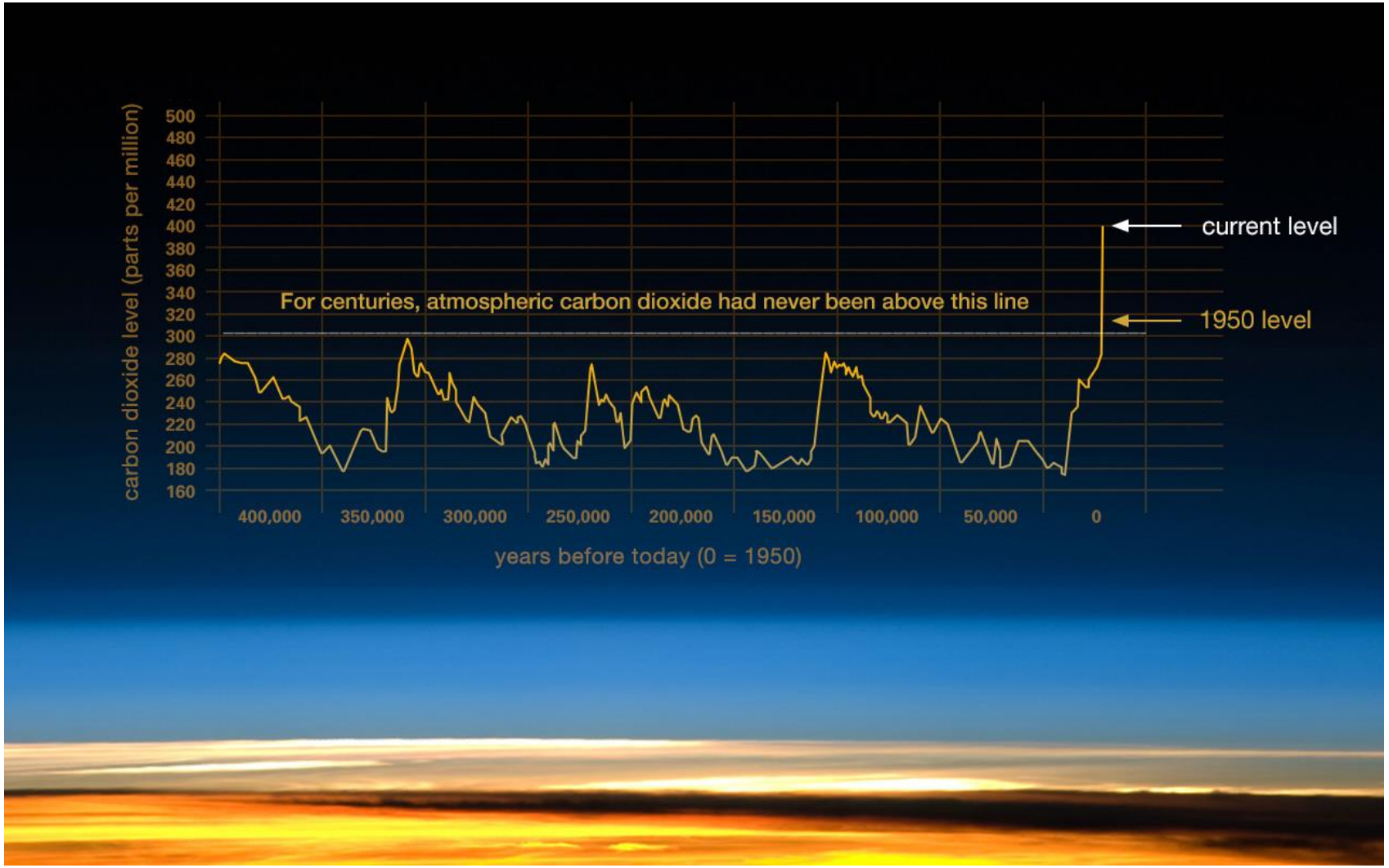
- 1. Understand how a changing climate impacts the public health
- 2. Recognize the clinical signs of climate change on individual health
- 3. Prepare to diagnose, intervene and protect patients from these harms

How do we know it's happening?

- Since mid 20th century, nearly 12,000 peer reviewed studies, with 97% of climatologists in agreement[1]
- We can measure the concentration of CO^2 over the millenia
- CO^2 levels at a high for past ½ million years (>400ppm, historical average 270ppm)[2]
- Radioisotopes implicate human activity for current concentration rises (^{16}O vs. ^{18}O, ^{12}C vs. ^{13}C)[3]

- 1. http://iopscience.iop.org/article/10.1088/1748-9326/11/4/048002
- 2. https://climate.nasa.gov/climate_resources/24/
- 3. Lockwood, AH. Heat Advisory. MIT Press. Pg 20-27. 2016.

Atmospheric CO2 Concentration

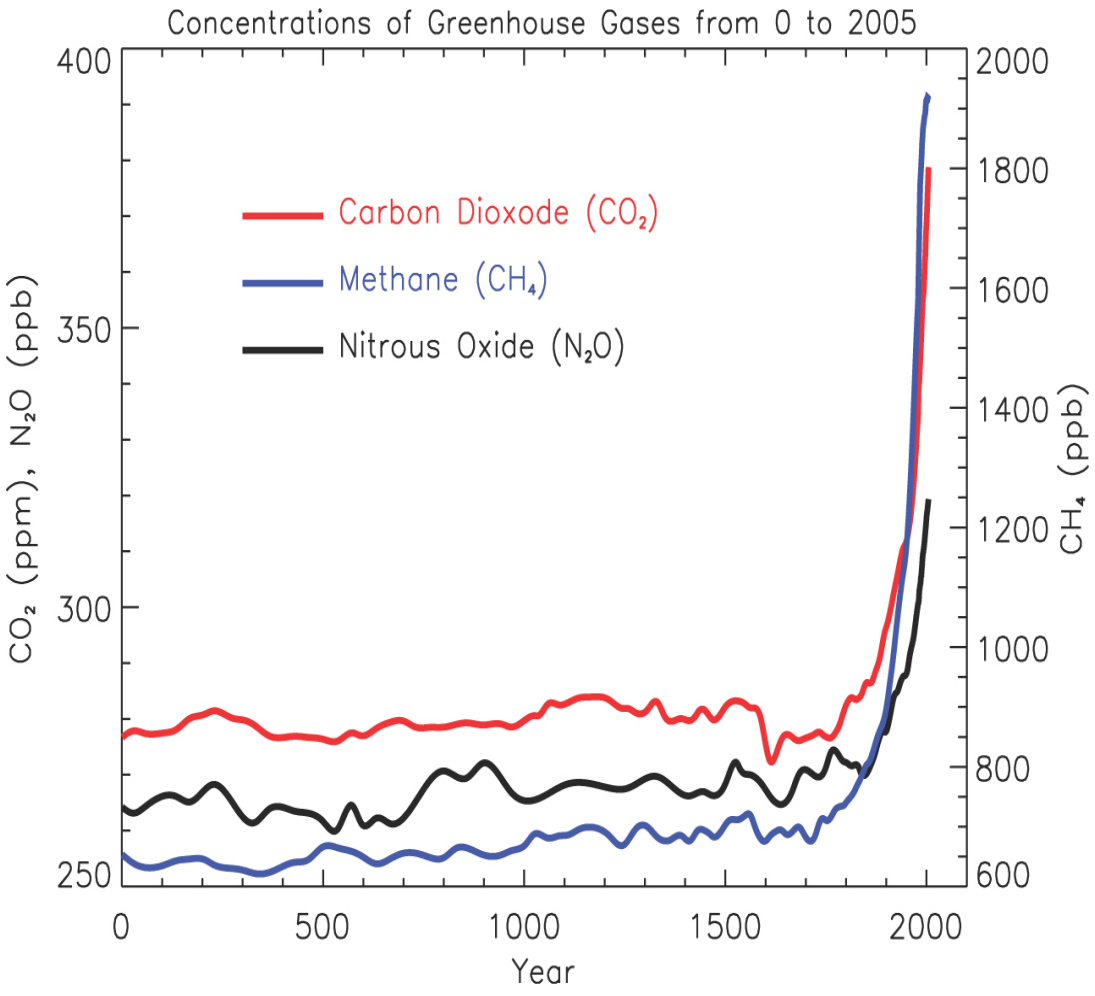


Source NASA (accessed 3/27/18): https://climate.nasa.gov/climate_resources/24/

CO^2 and Other Gases

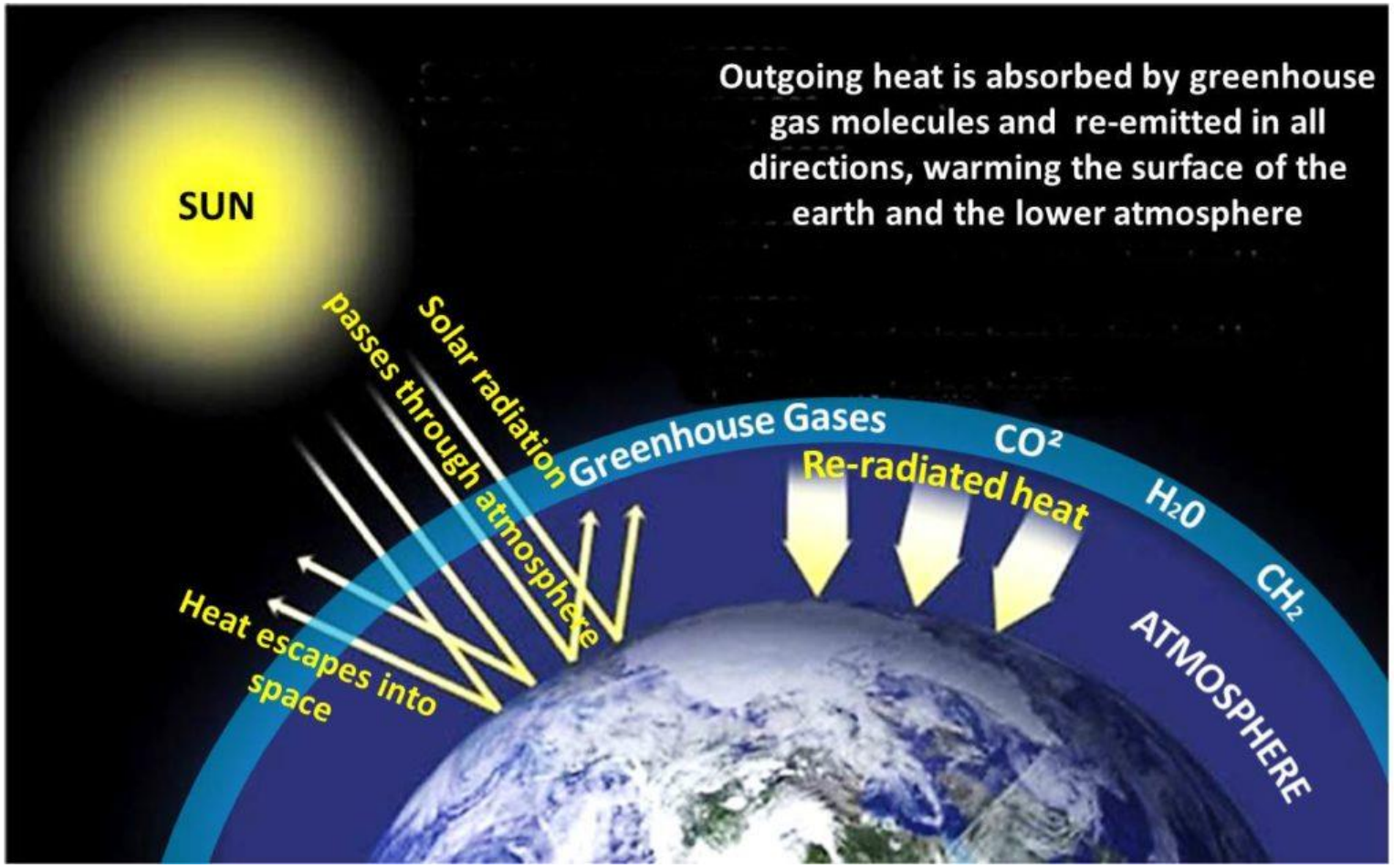
- Other noteworthy pollutants include sulfates, nitrates and methane
- Gas Life (Yr) RF

CO2	30,000	1
CH4	12	34-86
N2O	121	268-298



Source: IPCC 5th Assessment Report, United Nations

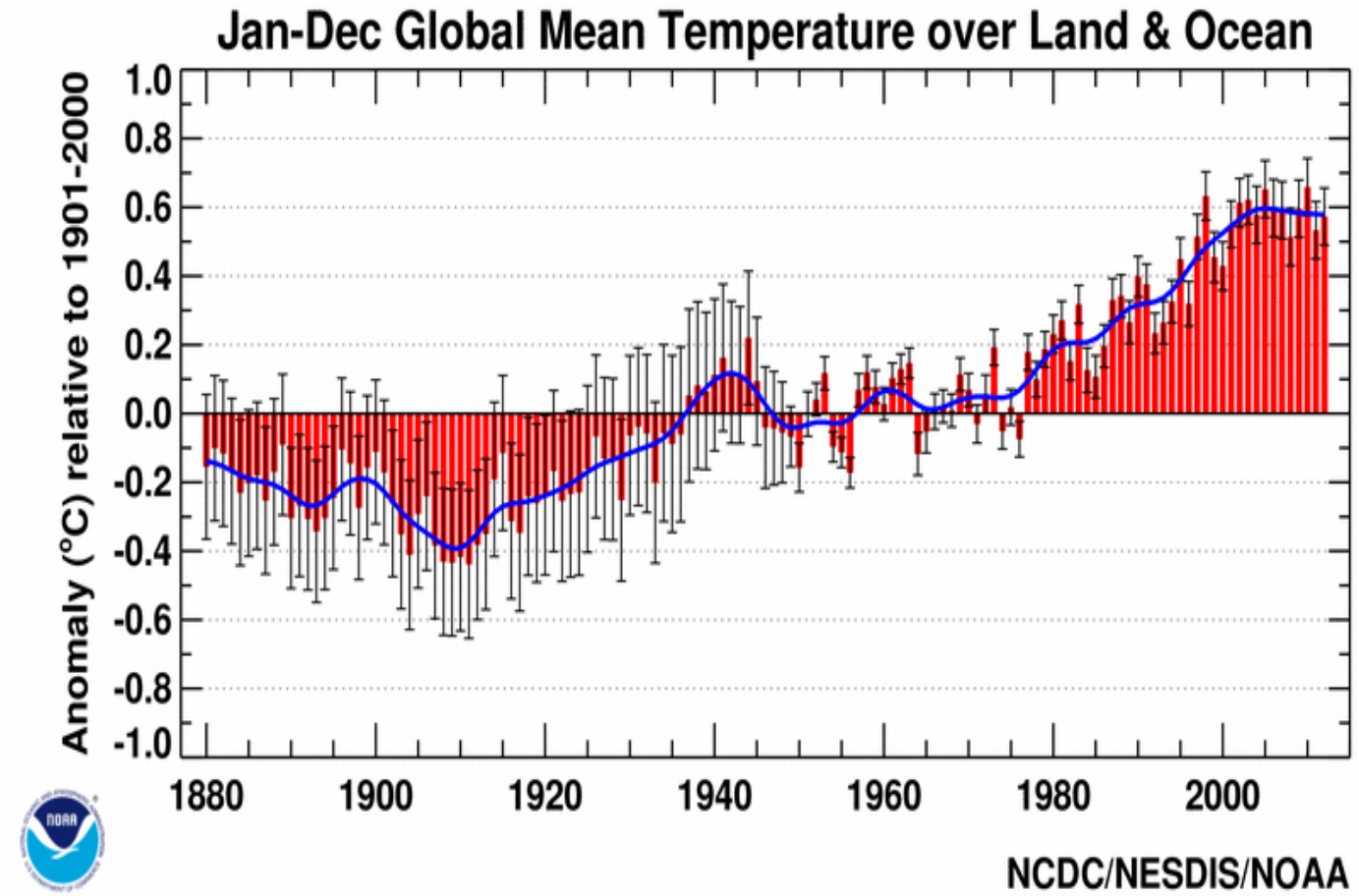
Greenhouse Gas Model



Is this different? Does this Matter?

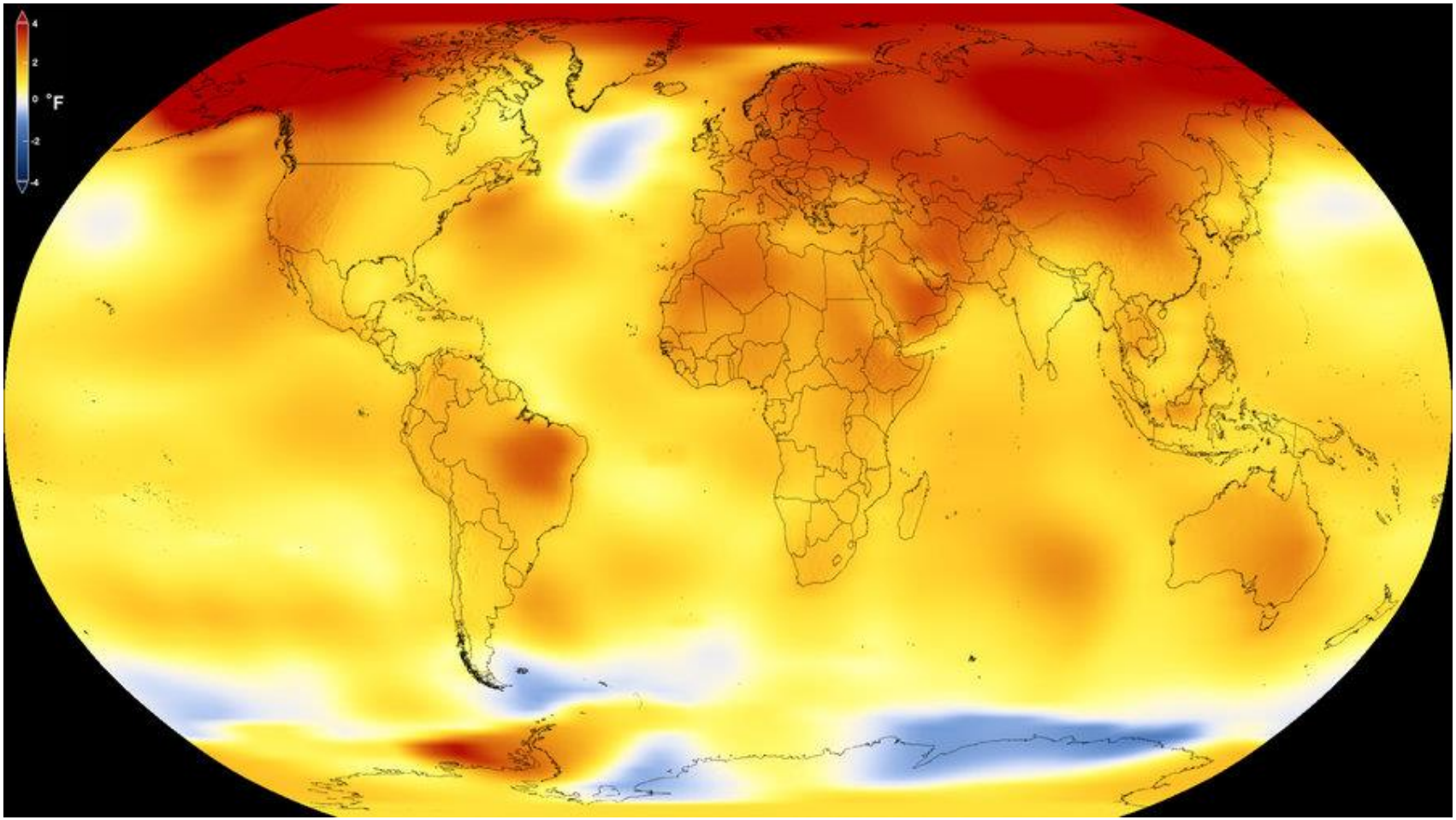
- Yes and big yes.
- Planet is warming faster than it has in 800,000 years
- Is different than in past in both intensity and rate
  - Ecologic systems have natural periodicity and event frequency, this is more accelerated than natural incidences of past geologic eras

Global T Mean



Source Wikipedia (accessed 3/27/18) https://en.wikipedia.org/wiki/File:Global-blended-temp-pg.gif

Higher Latitude = More Warming



2017 increases in global mean °C from 1951-1980 Baseline

Source: NASA data

Impact Will be Profound

- Rising global temperatures and heat waves
- Aberrant weather and more powerful storms
- Rising sea levels
- Expansion of infectious disease
- Crop failures
- Exacerbated refugee crises
- Massive loss of biodiversity

Climatologic Effects / Natural Disasters

- Increase desertification of arable land
- Change in precipitation patterns
- Link with tornadoes plausible but not well established
- Unlikely to cause hurricanes but can worsen them (average hurricane already produces 1,500 gigawatts of power = ½ world's daily production)
- Flooding, mudslides, wildfires will all become more common

Sea Level Rise

- 2% of Earth is <10m above sea level, but hosts 10% of world population (>700 million)
  - NM low point is 869m (Red Bluff Reservoir)
- Fossil records shows 150m swing in geologic time
- Ocean level up 0.2m in past century
- Contributes to destruction of coastal storms and hurricane damage

Human Health Harms

Human Health Harms

- Climate is changing NOW
- Negative impacts for human health
- Few positive ones
- Effects are disproportionately felt by the vulnerable (children, elderly, sick, poor)

Heat

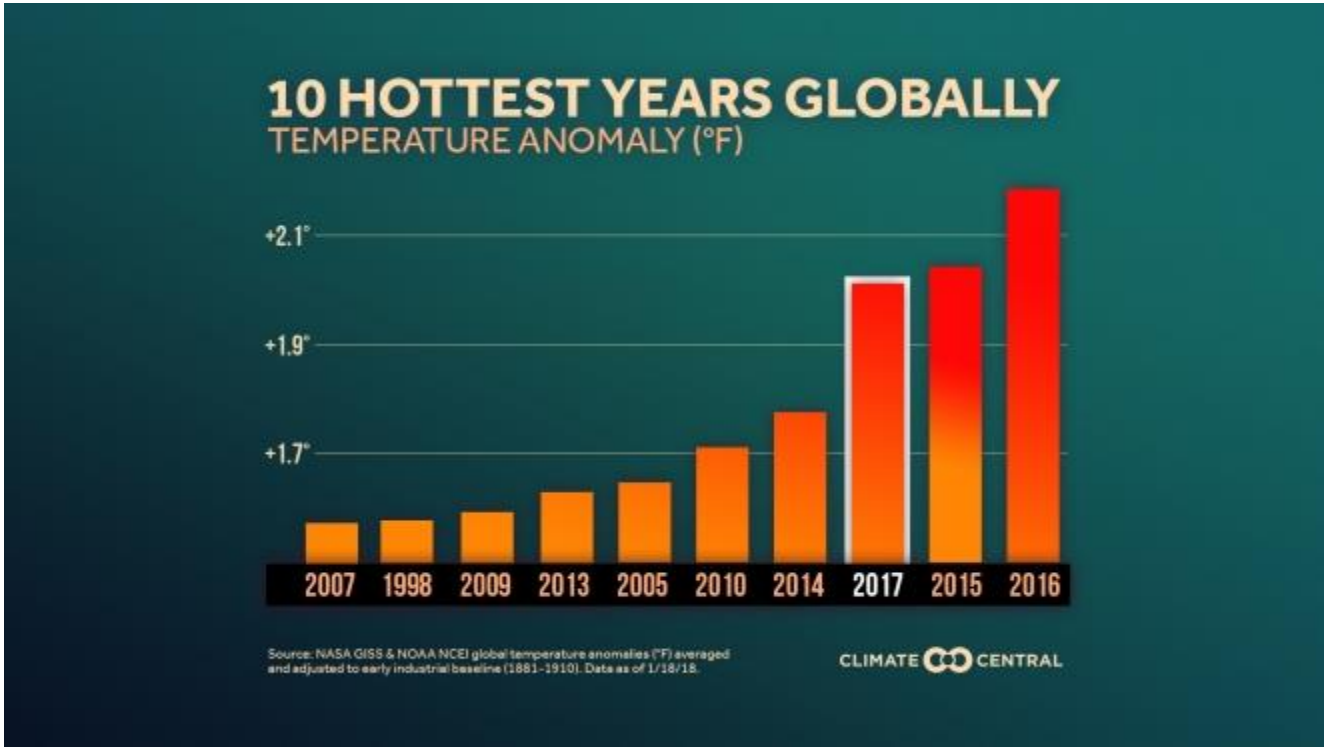
Whitewater-Baldy Complex Fire, Gila National Forest, 2012

Heat Related Illness

- Heat waves are difficult to define (>5 days for >5°C vs. average 1961-1990)[1]
- Heat exhaustion and heat stroke are principal diagnoses (latter has temp >40°C).
- WHO estimates 140,000 deaths annually
  - Effect calculated against past years around a 50 day period. RR 1.74 in a 1995 Chicago study[2]
- Elderly are especially effected
- 10 hottest years ever recorded in past 20 years

1. World Meteorological Association
2. Kaiser, LT, Schwartz, et al. "The effect of the 1995 Heat Wave in Chicago."

10 Hottest Years since 1880

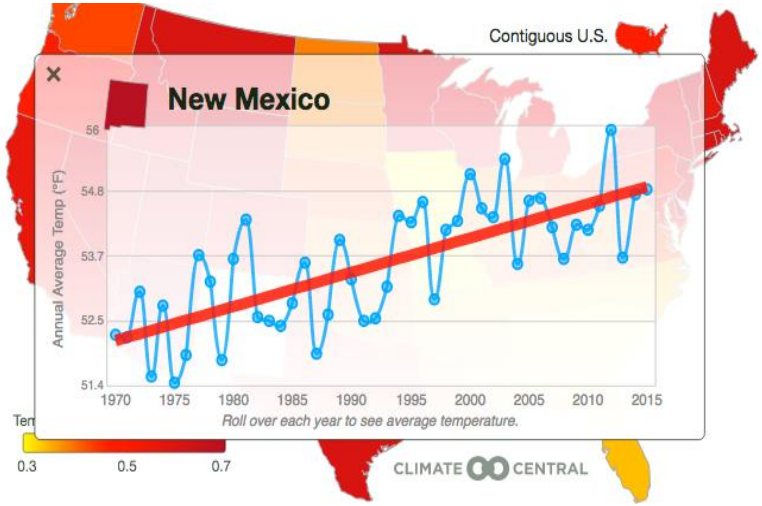


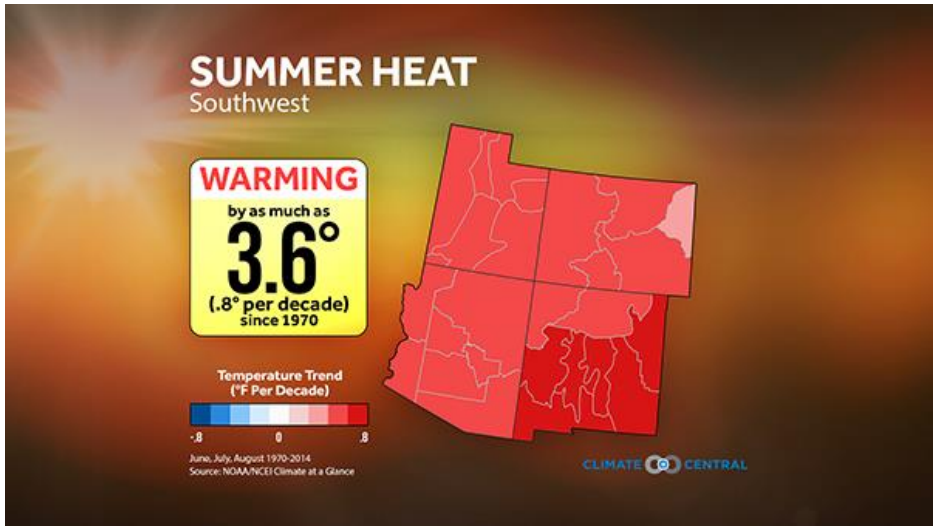
All in past 20 years

Source (accessed 3/27/18): http://www.climatecentral.org/gallery/graphics/the-10-hottest-global-years-on-record

New Mexico Heat

- New Mexico is at risk for increased heat
- 80,000 people in NM considered high risk
- Heat Wave Days may increase to 50+ by 2050 (vs. 15 in 2000)
- 3.6°F warmer than 1970
- Urban/rural summer temp delta in Albuquerque is 22°F (2nd most in US)

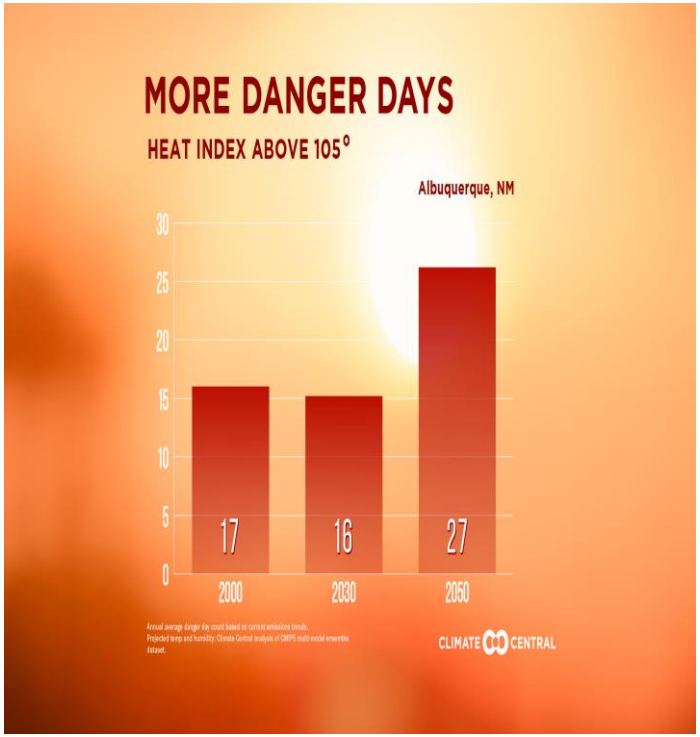




1. States at Risk (accessed 6/27/18): http://statesatrisk.org/new-mexico/extreme-heat

New Mexico Heat

- Albuquerque may be >10°F warmer by end of century (akin to TX/Mexico border)
- Albuquerque hasn't NOT recorded a summer temp below 100 in 10 years



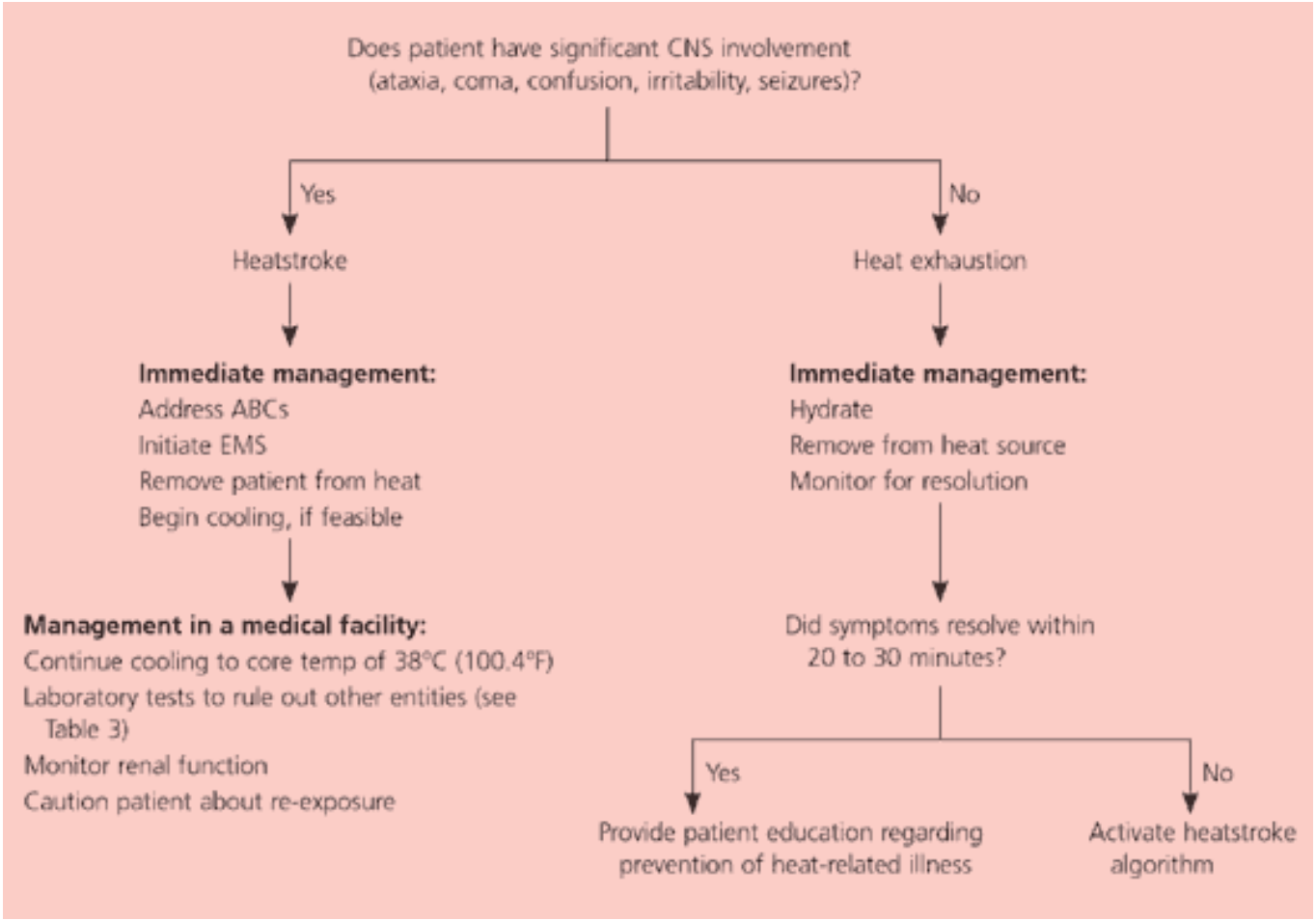
Source: States at Risk (accessed 6/27/2/18): http://statesatrisk.org/new-mexico/extreme-heat

Heat Exhaustion and Heat Stroke

- Exhaustion (37-40C)
  - Signs: anxiety, confusion cutaneous flushing, oliguria, tachycardia, vomiting
  - Symptoms: nausea, headache, dizziness, weakness, anorexia
- Stroke (40C+)
  - Signs: mental status changes, arrhythmia, pulmonary edema, hepatic failure, DIC, hyperventilation
  - Symptoms: (same)

Source: AAFP, J Glazer, 2005. https://www.aafp.org/afp/2005/0601/p2133.html

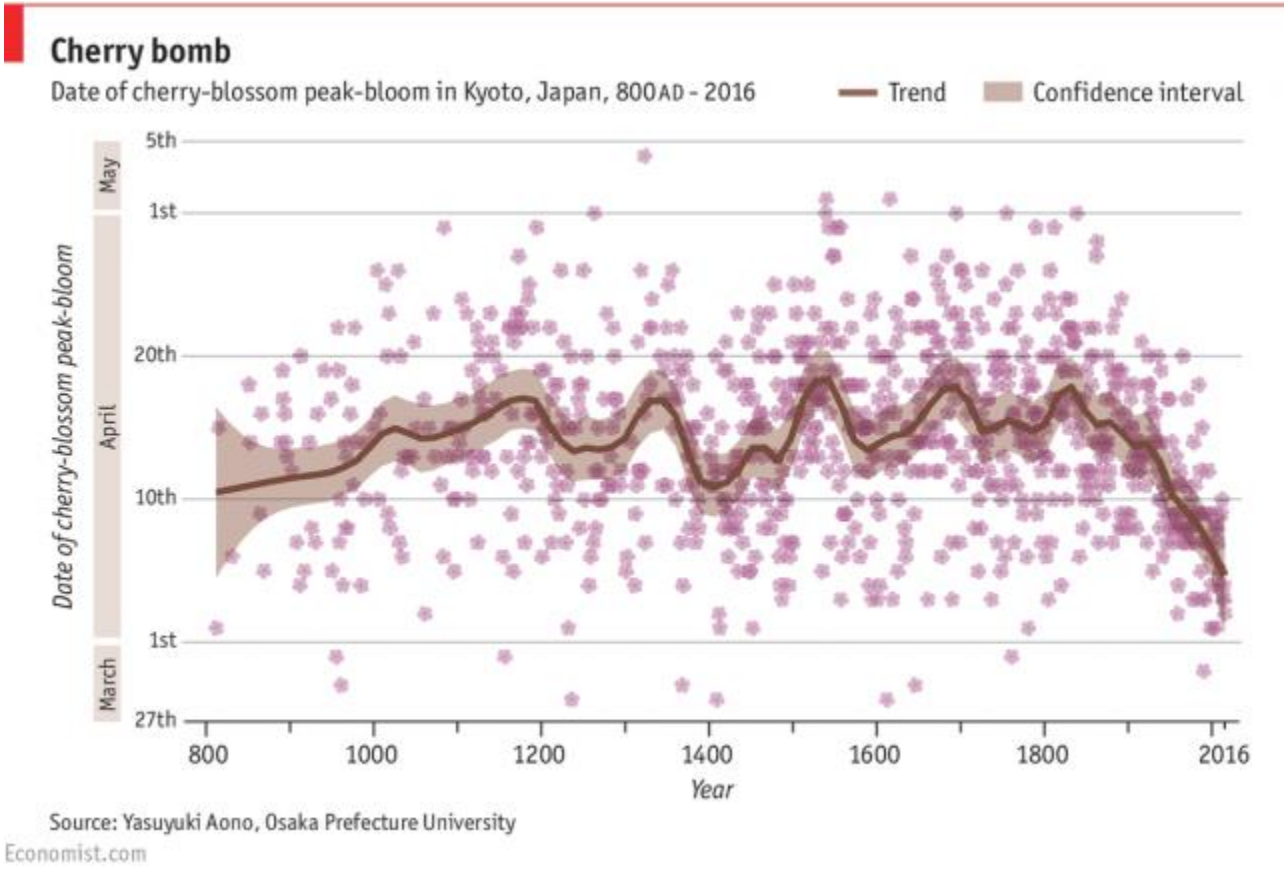
Clinical Intervention



Source: AAFP, J Glazer, 2005. https://www.aafp.org/afp/2005/0601/p2133.html

Respiratory/Allergy

Spring Coming Sooner (everywhere)



Source: Asthma and Allergy Foundation of America

Allergens

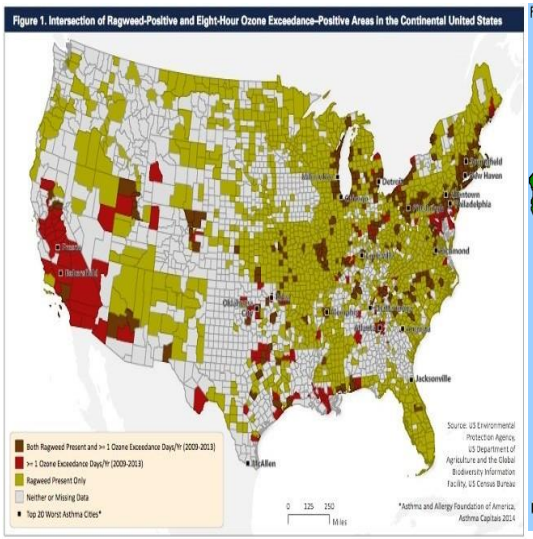
NM is blessed with fewer allergens than many places but not immune
- juniper, poplar, elm and cottonwood were heavy in 2018

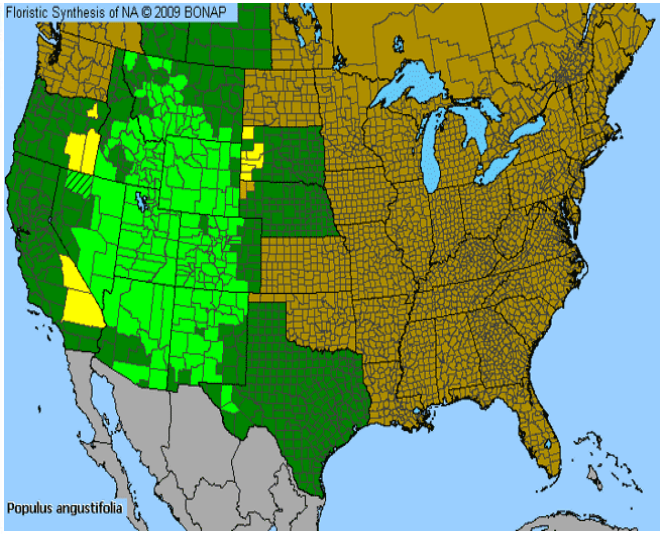
Increase atmospheric CO_2 may worsen these over time

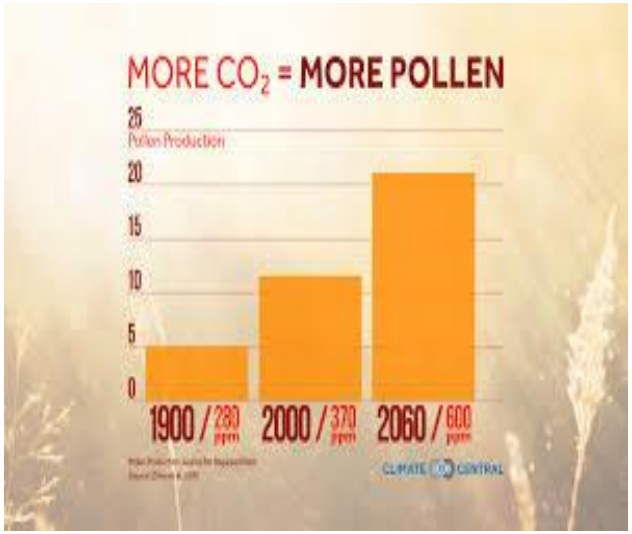
NATIONAL RANKINGS (Factors are not weighted equally) — Worse Than Average — Average — Better Than Average

2018 National Spring Rankings (**77th)	Overall	2016 Spring Rank	Metropolitan Area	Total Score (Avg. 56.48)	Subtotal: Pollen Score**	Subtotal: Medicine Utilization per Patient	Subtotal: Board-Certified Allergists per Patient
33	▲	54	Pittsburgh, PA	62.76	■	▲	▲
34	▲	39	Detroit, MI	62.69	▲	■	▲
35	▲	32	Greenville, SC	62.58	▲	■	▲
36	▲	43	Grand Rapids, MI	62.50	■	▲	▲
37	▲	28	Charleston, SC	62.03	▲	■	▲
38	▲	49	Albany, NY	61.91	■	▲	▲
39	▲	42	Cleveland, OH	61.28	▲	▲	▲
40	▲	16	Tulsa, OK	60.24	▲	▲	▲
41	▲	35	St. Louis, MO	59.69	▲	▲	▲
42	▲	24	Tucson, AZ	59.67	■	▲	▲
43	▲	40	Greensboro, NC	59.29	●	■	▲
44	▲	47	Cape Coral, FL	59.07	▲	●	■
45	▲	33	Augusta, GA	58.87	●	■	●
46	▲	19	Winston-Salem, NC	58.31	●	■	▲
47	▲	59	Scranton, PA	58.05	●	▲	■
48	▲	69	Bridgeport, CT	57.99	■	●	●
49	▲	58	Austin, TX	57.90	■	▲	▲
50	▲	52	Virginia Beach, VA	57.81	▲	▲	■
51	▲	50	Jacksonville, FL	57.57	▲	▲	▲
52	▲	46	Allentown, PA	57.19	▲	▲	▲
53	▲	36	Fresno, CA	55.84	●	▲	▲
54	▲	27	Nashville, TN	55.21	●	■	▲
55	▲	38	Albuquerque, NM	54.56	▲	▲	▲
56	▲	37	Charlotte, NC	54.49	●	▲	▲
57	▲	26	Madison, WI	54.26	▲	▲	●
58	▲	30	Omaha, NE	54.04	●	■	▲
59	▲	60	Houston, TX	53.68	▲	▲	▲
60	▲	87	Orlando, FL	53.29	▲	▲	■
61	▲	48	Riverside, CA	52.67	▲	●	■
62	▲	76	Lakeland, FL	51.92	▲	▲	▲
63	▲	74	Cincinnati, OH	51.90	●	▲	▲
64	▲	72	Tampa, FL	51.42	▲	▲	▲
65	▲	81	Chicago, IL	51.10	▲	▲	▲
66	▲	67	Los Angeles, CA	50.41	▲	●	▲

Asthma and Allergy Foundation of America — Allergy Capitals Spring 2018 — allergycapitals.com 6 — ©2018 Asthma and Allergy Foundation of America

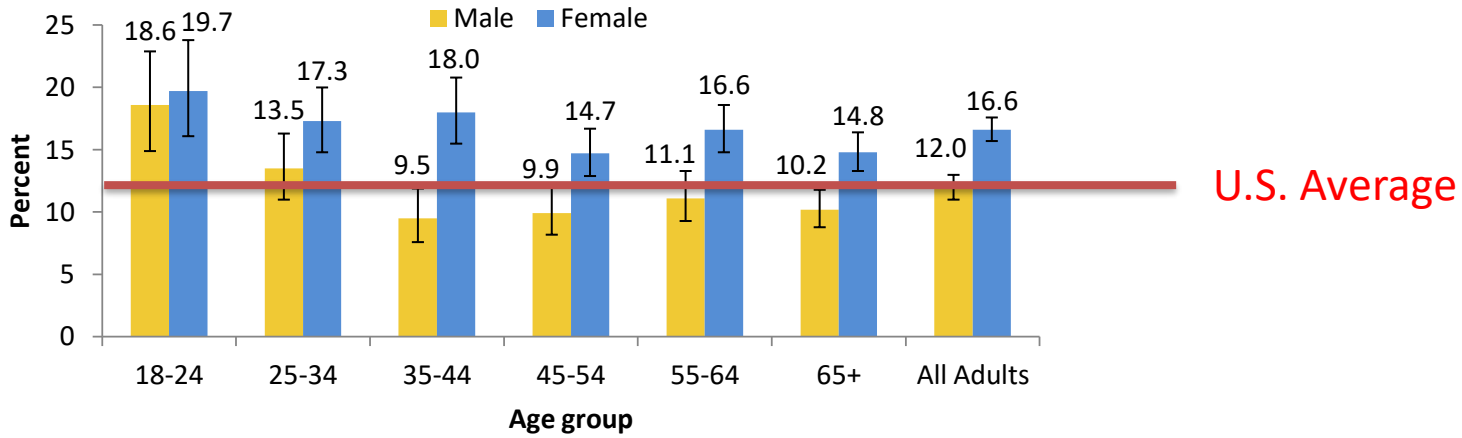






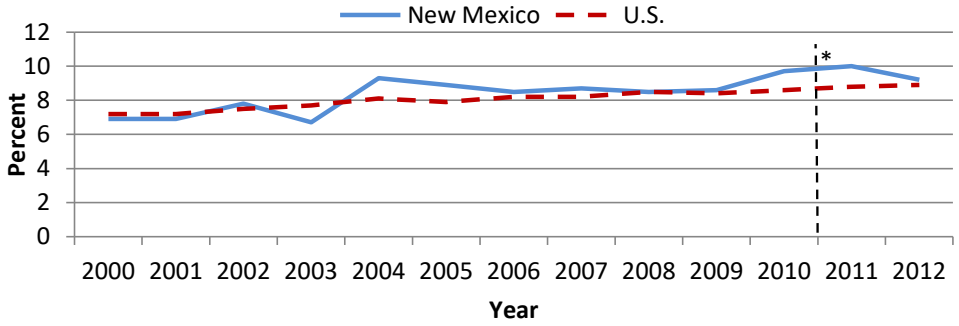
Source: Climate Central, 2015

Figure 2. Lifetime asthma prevalence among adults by sex and age group, New Mexico, 2011-2012



SOURCE: New Mexco BRFSS, 2011-2012

Figure 3. Current asthma prevalence among adults by year, New Mexico and U.S., 2000-2012



SOURCE: New Mexico and U.S. BRFSS, 2000-2012
NOTES: U.S. estimates include all 50 states plus the District of Columbia
* Due to changes in survey methodology, 2011 and 2012 estimates should be compared to prior year estimates with caution.

Air Quality

London, 1952

Air pollution is a major threats to human health, posing immediate and delayed effects on the respiratory, cardiac and other systems.

Donora, PA, 1948

- In 1948, 28 people died outside Pittsburgh from a 5 days smog event requiring the shutdown of the local plant (albeit for 1 day)
- In 1952, 4,000 people died in the London Fog, a combination of fossil fuel burning and meteorological conditions. 8,000 more would die in the subsequent months

Air Quality

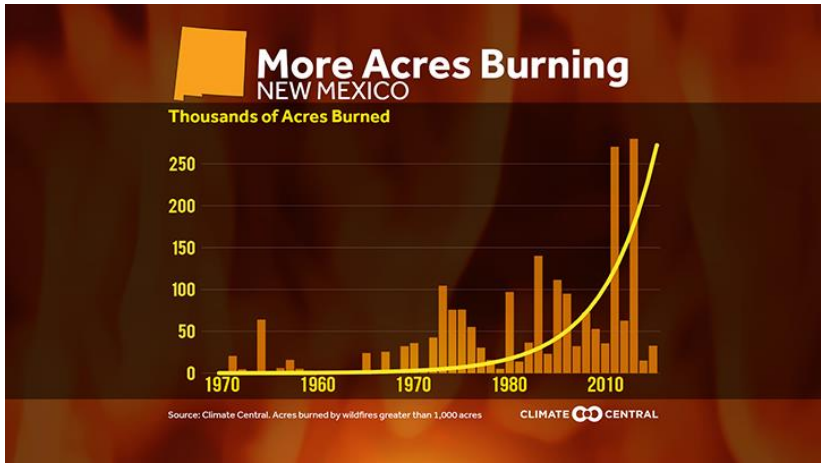
- Investigations of the Donora smog lead to the Clean Air Act (1963) a precursor to the formation the EPA in 1970. Regulatory authority given over
  - Carbon dioxide
  - Ozone
  - Lead
  - Nitrogen dioxide
  - Sulfur dioxide
  - Other particulates
- By 2020, EPA estimates suggest $65B cost to industry but save $2T in health costs

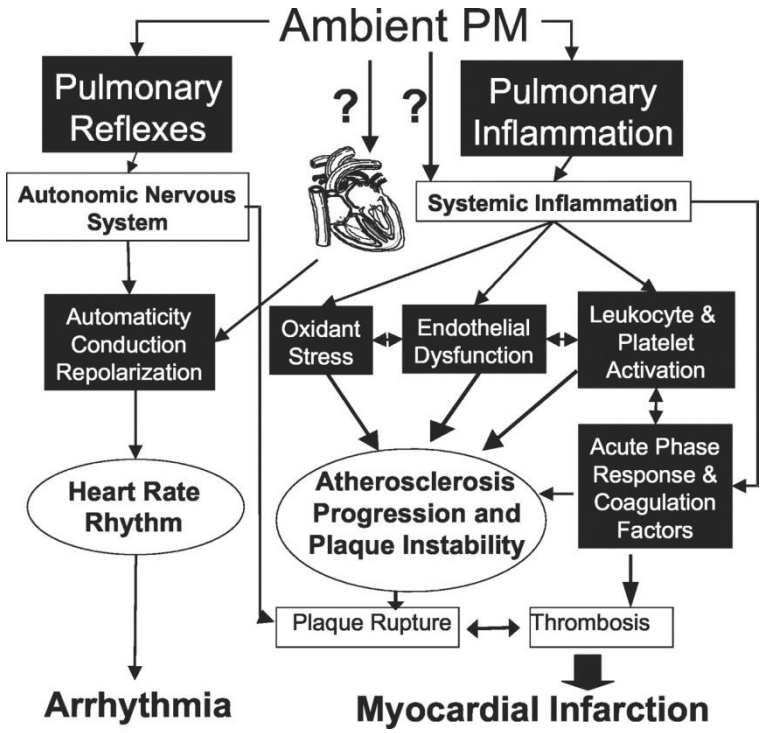
Air Quality

- CO2 is harmless to human health (at atmospheric concentrations) but is not the only gas produced by fossil fuel burning
- **Nitrous oxide, sulfur based chemical and ozone are all direct irritants to human respiratory epithelium**
- Ozone is a powerful oxidizing agent, combines with a host of particulate and organic gases to cause respiratory damage (mediated through inflammatory responses)
  - Exacerbated during warm weather
  - Asthmatics, elderly and preexisting pulmonary disease are risk factors

Air Quality – Particulate Matter

- Particulate matter (PM) is broad term
- Smallest particles (2.5 microns) most dangerous
- Wildfires release PM





Source: States at Risk (accessed 6/29/18): http://statesatrisk.org/new-mexico/extreme-heat

Source: *Circulation*, AHA, 2004

Air Quality- Colorado

- No metro areas in NM rank in top 25 for poor air or ozone quality per ALA
  - http://www.lung.org/our-initiatives/healthy-air/sota/city-rankings/most-polluted-cities.html
- Dry and hot climates are particularly sensitive to ozone concentration increases (e.g., southwest US)
- Daily EPA air quality
  - https://airnow.gov/index.cfm?action=airnow.local_state&stateid=3

Clinical Intervention

- Be aware of high risk patients advise outdoor exposure and exertion on high risk days[1]
- Have action plans for all asthmatics
- Empower patients with up to date air quality information[2]
- AAFP has articles with great resources[3]

1. AAFP. 2001. https://www.aafp.org/afp/2001/0315/p1221.html
2. Air Now. https://www.airnow.gov/
3. 3. AAFP. C. Wellbury and M. Sarfaty. 2017. https://www.aafp.org/afp/2017/0201/p146.html

Natural Disasters

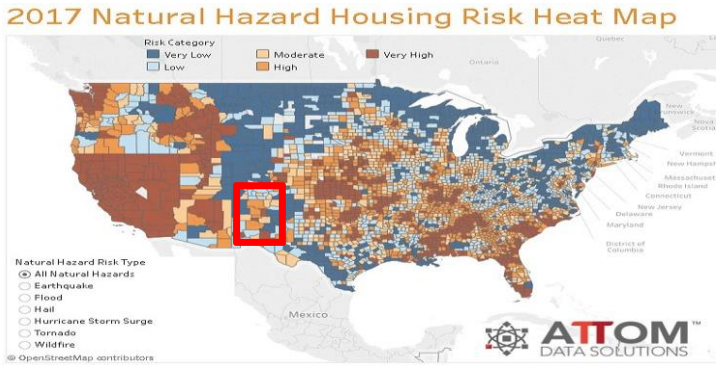
Natural Disasters

- Highly destructive, difficult to fully prepare for (though effects can be mitigated)
- Flooding more common with changes in precipitation[1]
- Hurricanes more powerful with warming waters, more destructive with sea rise[2]
- Earthquakes unaffected
- Tornadoes are possibly affected but link unclear[3]
- Wildfires (see next)

1. EPA. https://www.epa.gov/climate-indicators/climate-change-indicators-coastal-flooding
2. NASA. https://earthobservatory.nasa.gov/Features/RisingCost/rising_cost5.php
3. Center for Climate and Energy Solutions. https://www.c2es.org/content/tornadoes-and-climate-change/

Natural Disasters

- New Mexico is at risk for natural disasters from climate change, especially disasters driven by heat and changes in precipitation
  - For example, wildfires and drought may be most significant
  - Risks are largest in south and southeast part of state (largely flooding) and away from population centers



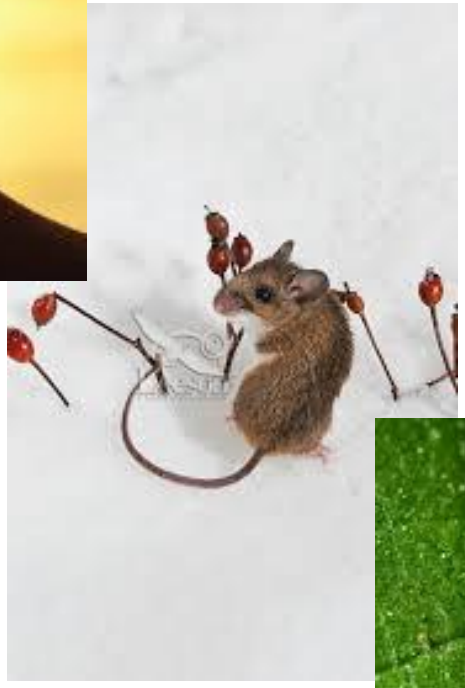
Source: Tableau Public (accessed 6/29/18): https://public.tableau.com/profile/darenjblomquist#!/vizhome/2017NaturalHazardHousingRiskHeatMap/Dashboard1

Clinical Intervention

- NM physicians should advise patients to have disaster plans, especially in high risk areas (flood plains, though snow is decreasing)
- Wildfire planning per Respiratory plans (avoidance, adherence to treatment plans, seek help for symptoms, especially high risk groups)
- AAFP has a preparedness toolkit (personal, practice and community)[1]

1. https://www.aafp.org/patient-care/emergency/disasters.html

Infectious Disease



Infectious Disease

Vector Borne Disease

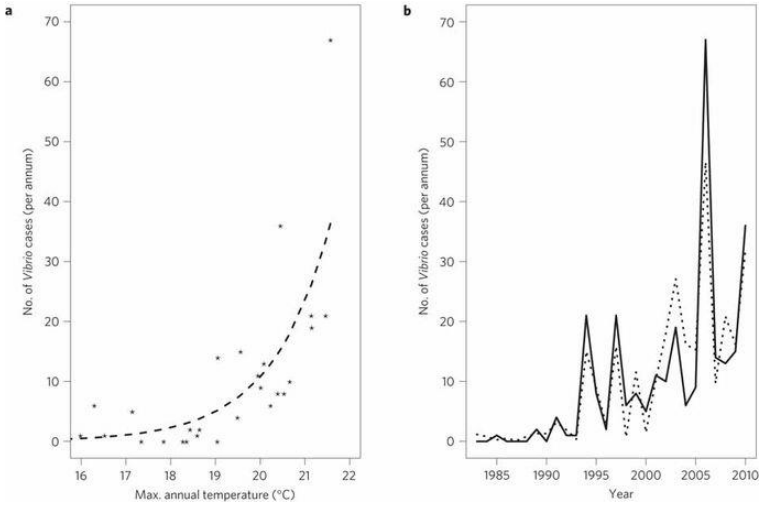
Source: Lockwood, AH. Heat Advisory. MIT Press. Pg 20-27. 2016.

Disease	Agent	Vector	Note
Chikungunya	Alphavirus	Aedes sp. (egyptii or albopictus)	Severe pain,
Dengue	Flavirus	Aedes sp. (egyptii)	"Breakbone fever", 1/1,000 mortality, 4 serotypes allow multiple infections
Hantavirus	Hantavirus	Rodents & Ungulates (various)	More common in southwest, esp. HPS (>HFRS)
Lyme	Borrelia burgdorferi	Ixodes sp.	Rash/Headache/Fever/Arthralgias, Delayed immunoglobulin testing
Malaria	Plasmodium sp.	Anopheles sp.	<1/2M deaths in 2015, has changed human evolution, 4 Nobel prizes
RMSP	Rickettsia rickettsii	Ticks (various)	Fever, rash. Expanding in southwest
West Nile	Flavirus	Culex sp.	Generlized symptoms, mortality from viral encephalitis 1/1,000
Zika	Flavirus	Anopheles sp.	Minor symptoms, consequential in pregnancy, long lived in males

Water Borne Disease

Many water borne disease are temperature and salinity dependent, factors that will be exacerbated with warming climate (Vibrio sp, salmonella, campylobacter, etc.)

Source: Nature. 2012.

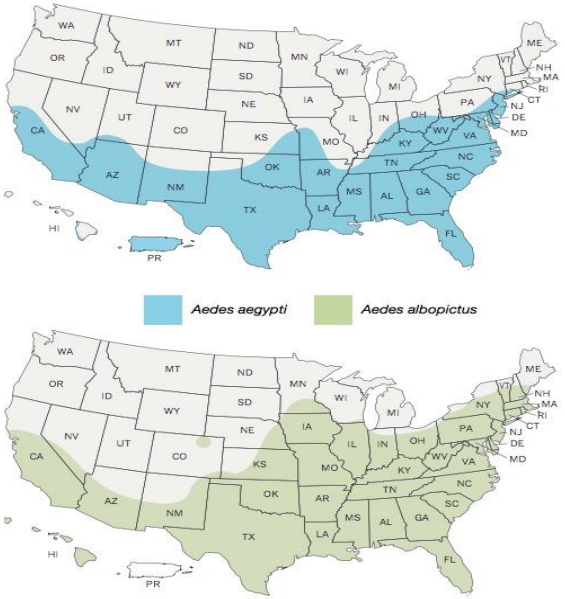


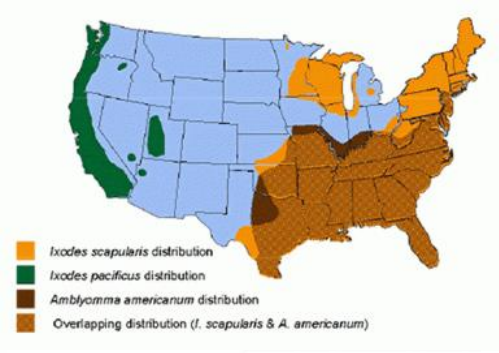
Infectious Disease

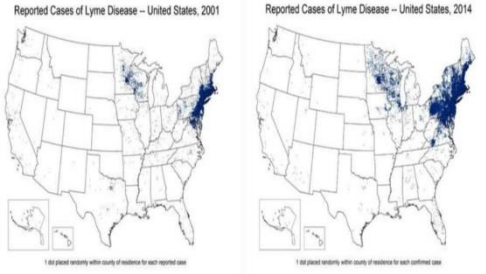
Source: CDC

Source; CDC, 2015

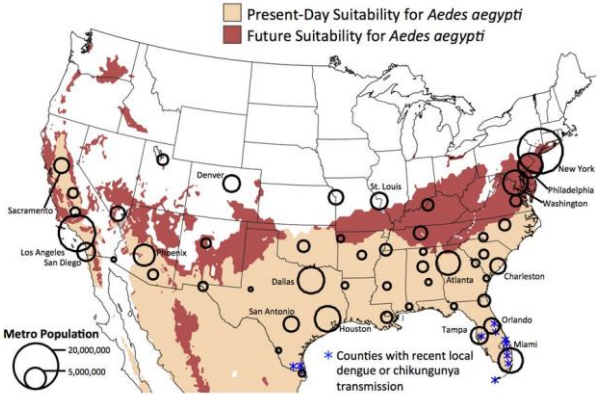
Source: Malaria Atlas Project, 2013



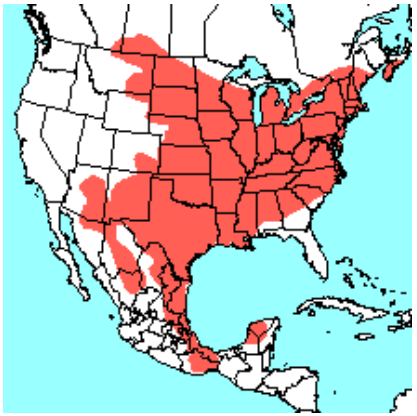




Source: Research Gate, 2011

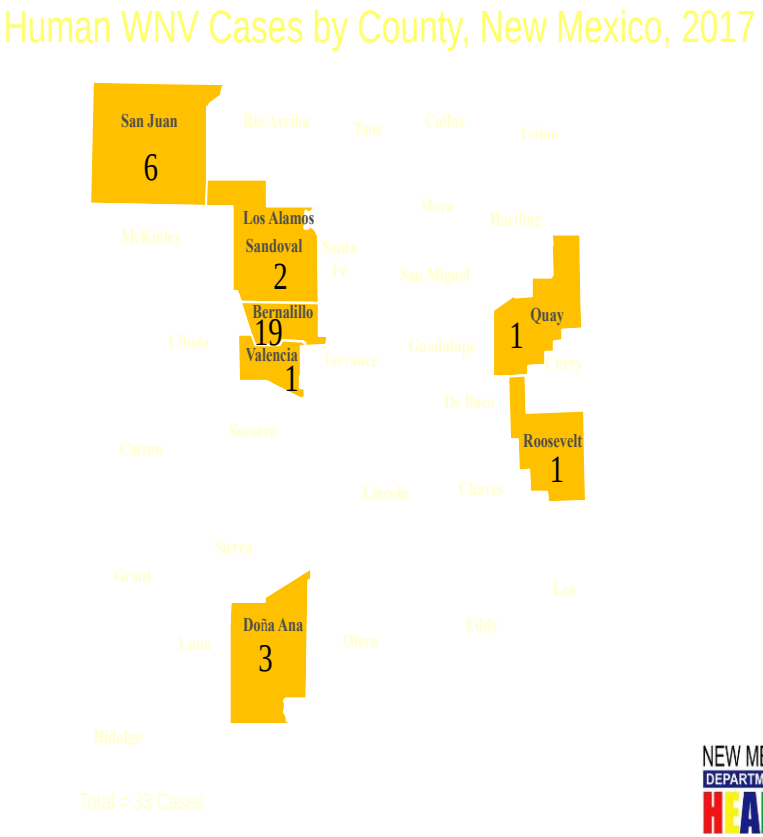


Source: The Conversation, 2016



Source: Smithsonian

Mosquito Borne Disease



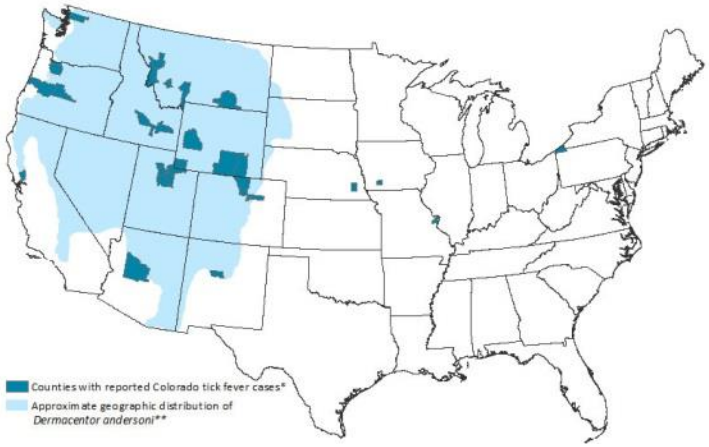
- Both concerning Aedes species exist in NM
- Culex sp. present statewide
- West Nile (68 cases in 2017, see left)
- Malaria is difficult to predict but is expected to increase in nearby Mexican states by end of century

Source: NM Dept. of Health (accessed 6/29/18): https://nmhealth.org/data/view/infectious/1966/

Other Infectious Diseases

- Tick Borne Disease[1]
  - Negligible Lyme risk (last confirmed 2012)
  - Colorado tick fever rare but possible
  - RMSF incidence in NM is 0.1-1.0/million

- Hantavirus[2]
  - No cases in 2018
  - 1 case in 2017
  - 4 cases in 2016



1. CDC: https://www.cdc.gov/rmsf/stats/index.html
2. Denvhttps://nmhealth.org/about/erd/ideb/zdp/hps/

Accessed 6/29/18

Clinical Intervention

- Have a heightened sense of suspicion about for previously rare infectious diseases
- Be familiar with lab processes for ordering tests, testing parameters (e.g., Lyme)
- Recommend common sense measures
  - Long sleeves
  - Avoid outdoor exposure at dusk/dawn
  - Remove standing water sources around the home

Agriculture

Agriculture

- But CO2 is plant food, right?
- Reduced crop yields likely. Plants grow faster but are less nutritious
- Many plants harder to grow
- Drought, flood are perturbations from natural cycles that mess up plant growth
- C4 to C3 exchange happens (corn would get edged out by less nutritious grasses)
- Reduced total biomass
- Less nutritious foods (faster growth decreases protein and nutrient acquisition by plant)
- 1-3.5°C rise by century's end would result in 45-80% failure of US corn crop
- Food shortages exacerbated by low crop yields have been implicated as a contributor to the Arab Spring (and political turmoil across an entire region of the globe)

Source: Lockwood, AH. Heat Advisory. MIT Press. Pg 20-27. 2016.

NM Agriculture

- >24,000 farms creating $2.5 billion in economic productivity[1]
  - 2:1 (livestock:crops)
  - Very susceptible to draught (Sangre de Cristo 20-60% reduction in snowpack since 1955)[2]
- Studies show a -10% precipitation results from 1.5-2.5°C temp increase, causing -30-40% crop yield[3]

1. Farm Flavor (accessed 6/29/18): httphttps://www.farmflavor.com/new-mexico-agriculture/
2. EPA (accessed 6/29/18): https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-nm.pdf
3. UW Milwualkee (accessed 4/2/18): http://uwm.edu/centerforwaterpolicy/wp-content/uploads/sites/170/2013/10/Colorado_Agriculture_Final.pdf

Clinical Intervention

- What to say about this one?
- Social Services, food assistance programs
- Recommending Meatless Mondays to patients is good for environment and patient health (if done right!)

Psychologic

Psychologic

- Climate change has the potential for increasing frequency and severity of depression and anxiety
- Univ. of AZ study has categorized domains of psychogenic stress[1]
  - Egoistic: concern for self (worsening asthma, home lost in flood)
  - Altruistic: concern for others (grandparent in a heat wave, refugees)
  - Biospheric: concern for planet, other species (loss of biodiversity)

1. Science daily (accessed 3/29/18): https://www.sciencedaily.com/releases/2018/01/180117164010.htm

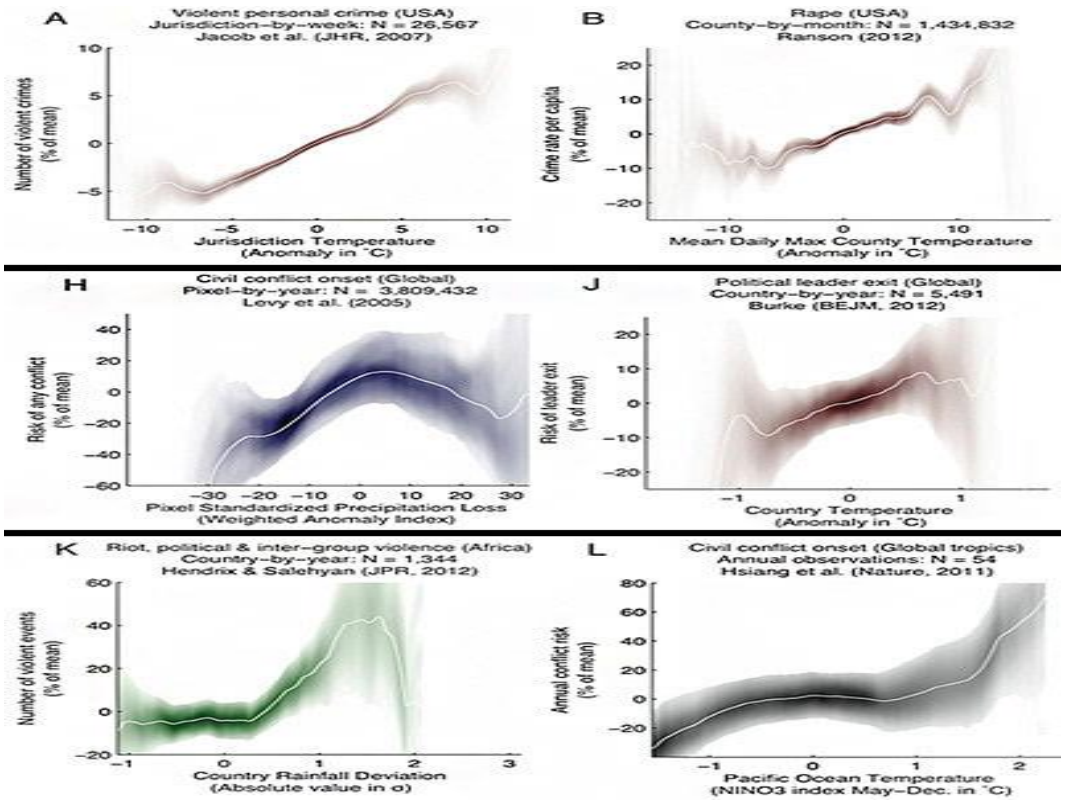
Violence, Societal Effects

- Numerous studies link heat to violent crime and intergroup violence
- Increased heat and reduced precipitation have been implicated in numerous major world events (Mongol raids, fall of Ming dynasty, Arab Spring, ISIS expansion in sub Saharan Africa)

Violence and Rain

- 1SD +/- in rainfall resulted in 6.1/9.2% violent events in African study[1]

1. Journal of Peace Research (49)1, 2012



Source: SciTechDaily, 2018

Clinical Intervention

- Regularly screen patients for depression and anxiety
  - reliance on Family Medicine for providing services
- Empower individuals to take action to combat climate change- collective action offers optimistic vision of future
- NM suicide rate 59% higher than US average, 2nd most leading cause of death age 15-44[1]

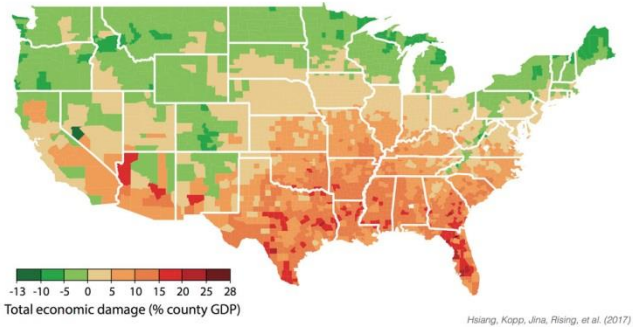
1. NM Dept of Health (accessed 6/29/18): https://nmhealth.org/publication/view/help/1830/

What can be done

- It’s not all doom and gloom!
- Docs can recognize signs of these illnesses, be prepared for increased incidence and burden of disease
- State AFP lobby days! Physicians have a strong voice, especially when advocating for patients and the public health

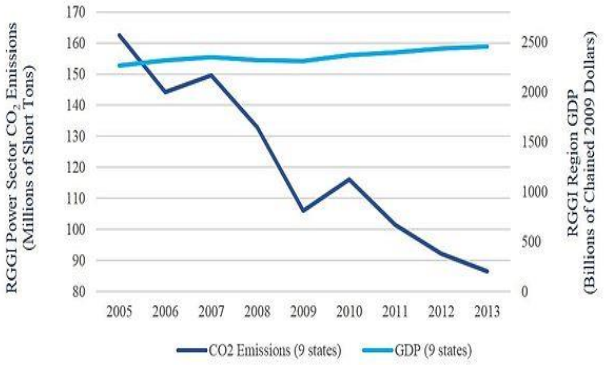
Economic Impact of (In)Action

- Of course we focus on health, but there are real financial risks as well
- Colorado's envious position doesn't mean it doesn't stand to lose
- Impacts may be worse in eastern CO and urban areas



Regional Greenhouse Gas Initiative (RGGI)

- 9 states (New England, NY, DE and MD)
- 1st major voluntary cap and trade scheme in US, applies to large MW producers
- Benefits:
  - 300-800 lives saved
  - 8-10,000 asthma attacks avoided
  - 35-390 MIs avoided
  - $5.7B in health savings
  - No state loss of GDP
  - Savings to utility payers
- Effects felt regionally (e.g., NJ)



Source: Abt (accessed 3/29/18): http://www.abtassociates.com/NewsReleases/2017/RGGI-Improves-Health,-Saves-Lives,-and-Generates-$.aspx

State Specific Activity

New Mexico Renewable Energy

- NM has 1112 MW of installed wind power, 11% of state need
- Could generate 100%

- 41 MW of installed solar with 365 MW capacity accounts for 2.8% of state's energy portfolio

Peetz Table (power for 120,000 homes)

State Specific Activity

- In general NM is quite progressive, comparable to CA or NY
- Pushing renewable energy
- Has climate mitigation strategies in place

Medical Society Consortium on Climate and Health

- Lead by Dr. Mona Sarfaty, a family physician from Bethesda, MD
- Based out of George Mason University in Fairfax, VA
- 20 signatory medical membership societies, including AAFP, AMA, ACP and AAP (~500,000 physicians)
- Dedicated to promoting physician awareness of the public health threats of climate change and supporting efforts to mitigate these health threats
- https://medsocietiesforclimatehealth.org

Summary

- Climate change is real, it's happening now and it's affecting patients now
- It presents few novel clinical challenges, but is likely to exacerbate numerous conditions (heat related, infections, cardiopulmonary conditions and psychiatric concerns)
- Physicians should have heightened index of suspicion for these events, add to patient awareness (and thereby preparedness)
- Interested physicians would make great advocates for broader changes to enhance the public health

Questions?

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