Minnesota's Changing Climate:

What Family Physicians Need to Know Now About the Impacts on Patient Health

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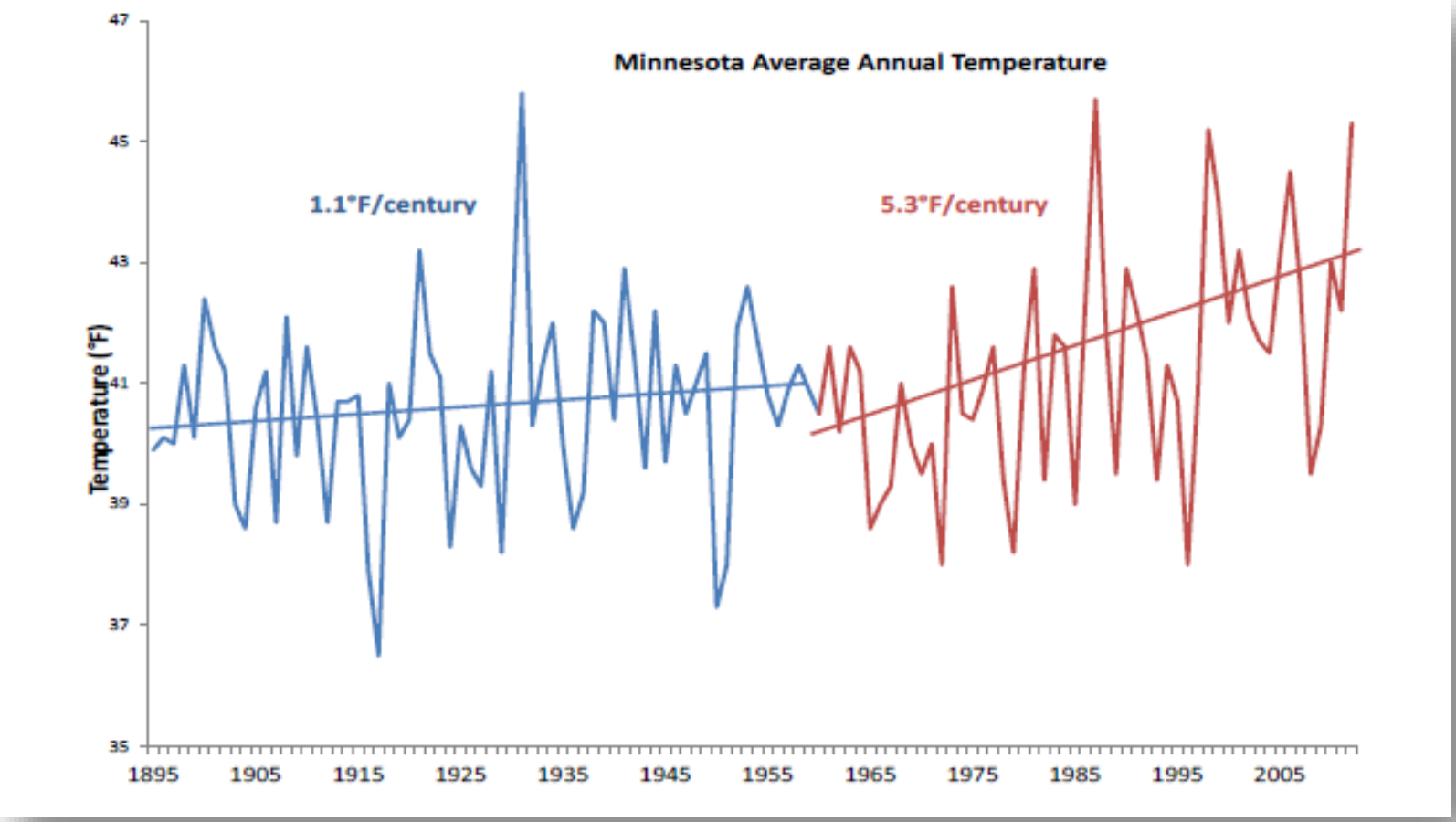
Learning Objectives

- **Explore the acute and long-term public health impacts of Minnesota's changing climate**
- **Describe the pathophysiologic mechanisms by which particulate matter pollution causes disease**
- **Overview of the significant implications of the recent MESA Air Study and the role of ambient air pollution as an additional cardiovascular risk factor**
- **Consider how physicians can prepare and prevent negative health effects of climate change**

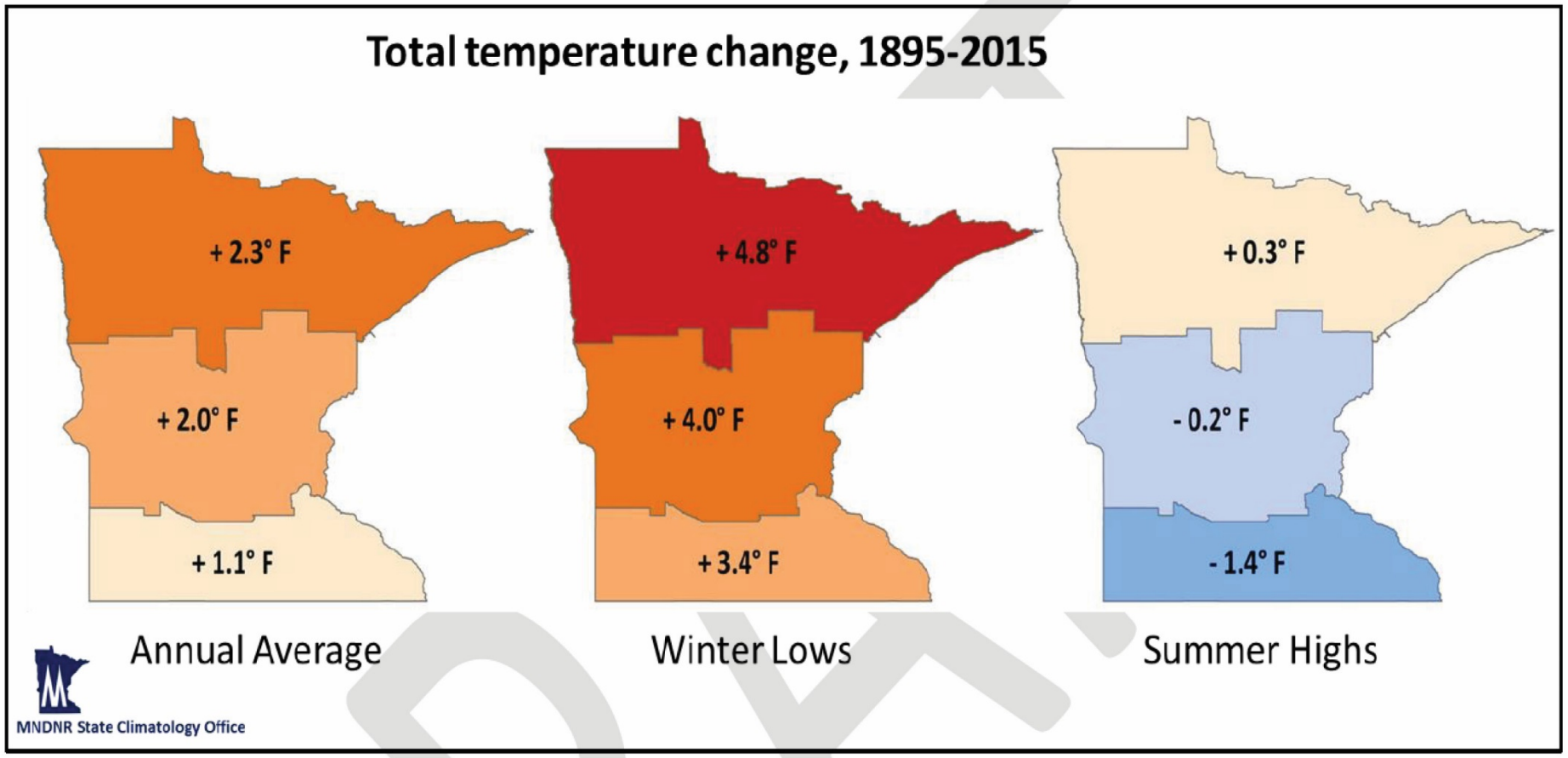
Temperature Increasing

Temperature has been rising in Minnesota.

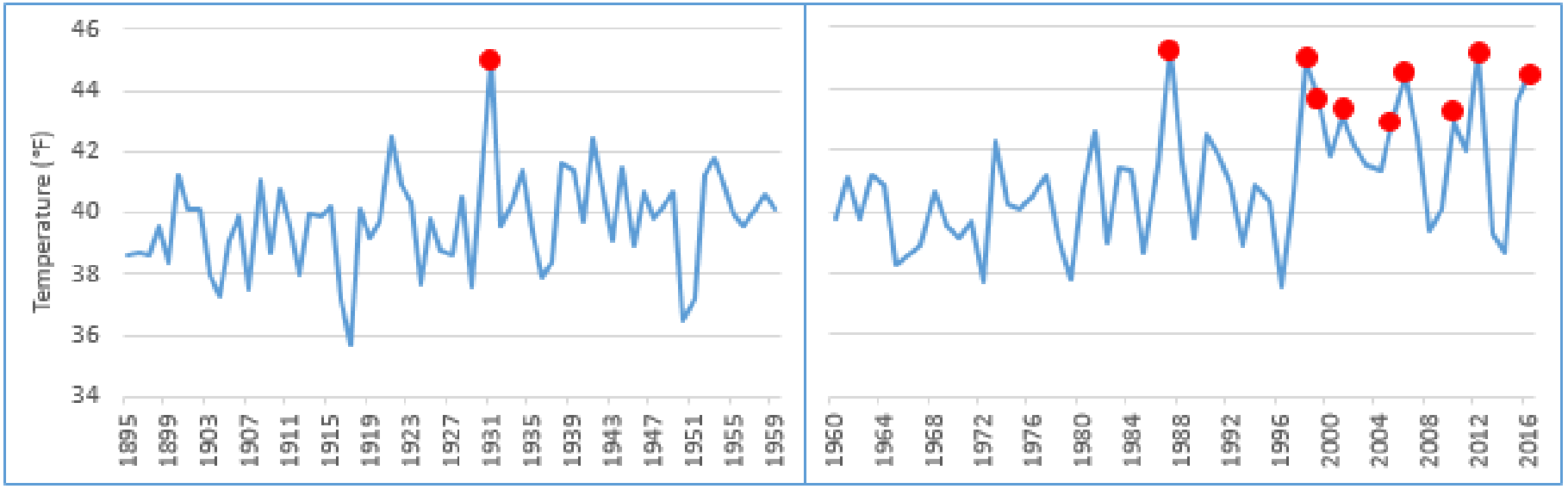


Source: MDH, 2015

GEOGRAPHIC, SEASONAL VARIATION



Minnesota Average Annual Temperature, 1895-2016



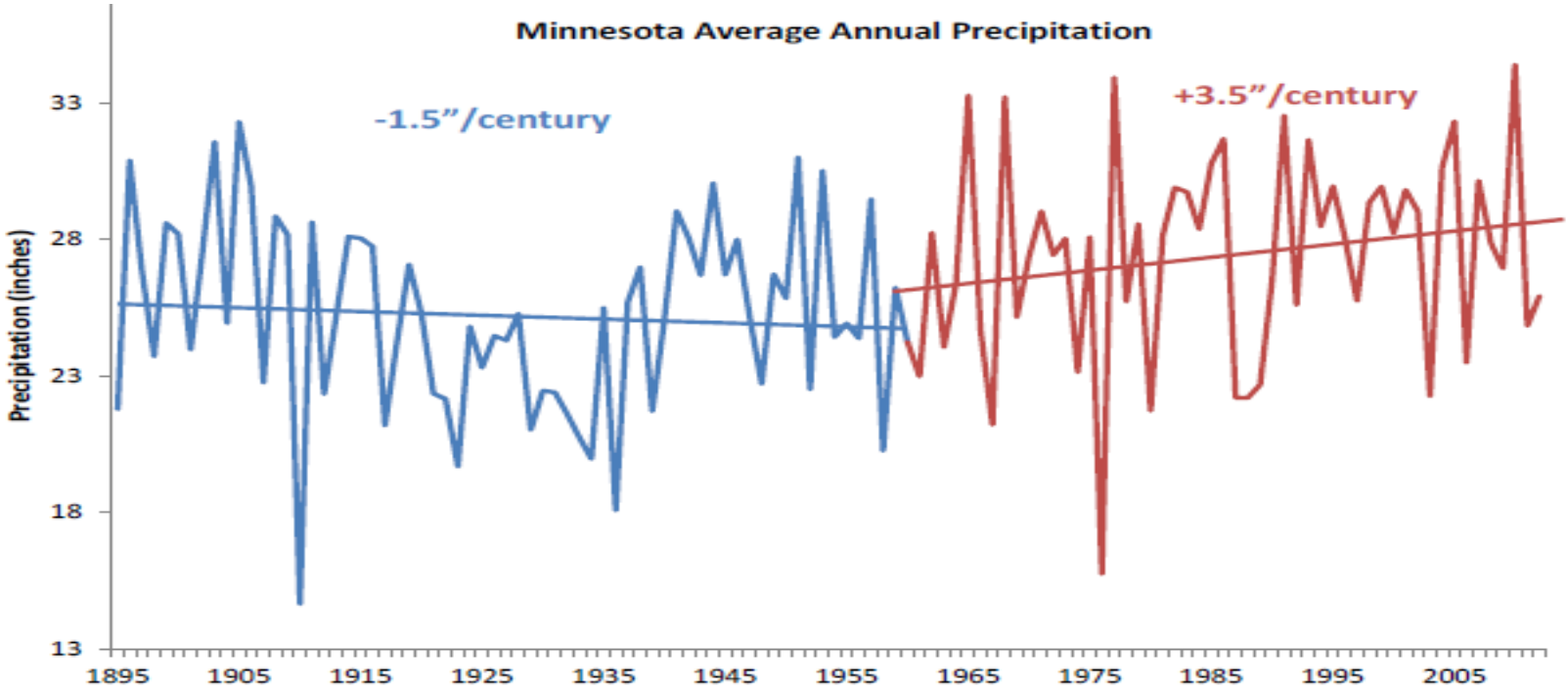
+0.2°F/decade

+0.5°F/decade

Source: NOAA, 2017

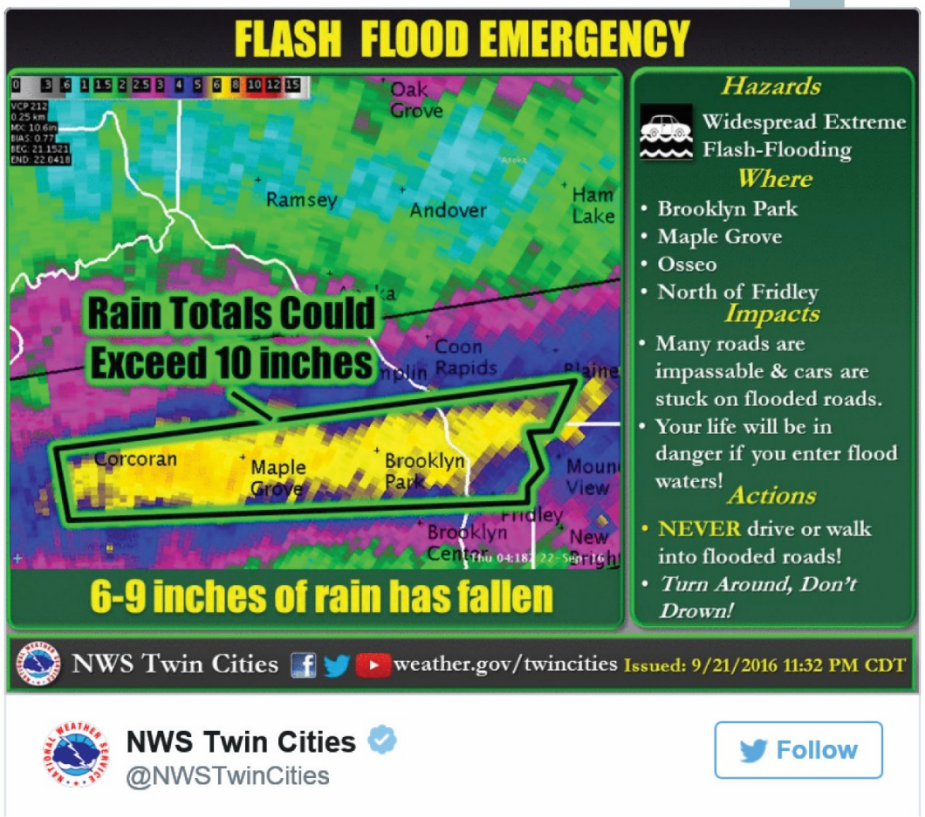
Precipitation Changes

On average, annual precipitation across the state has increased.

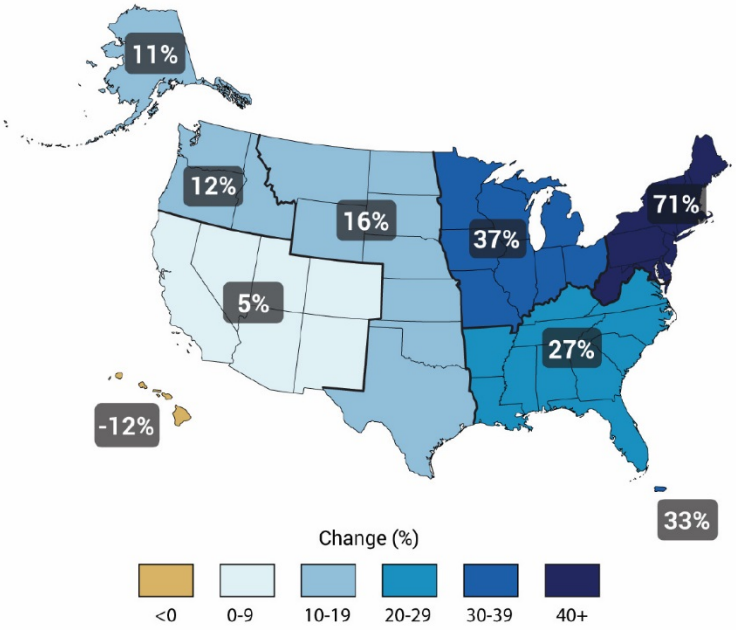


Source: MDH, 2015

Paul Huttner September 21, 2016, 5:07 PM 0 Co

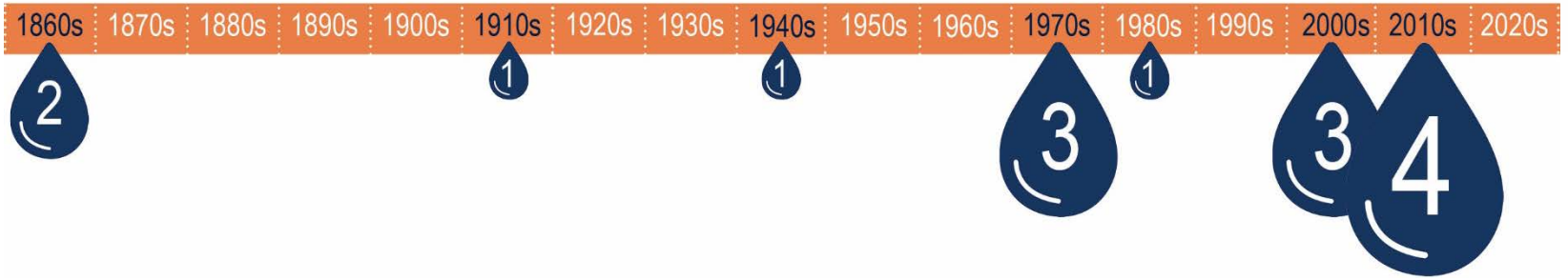


Heaviest 1% of all daily events : 1958-2012



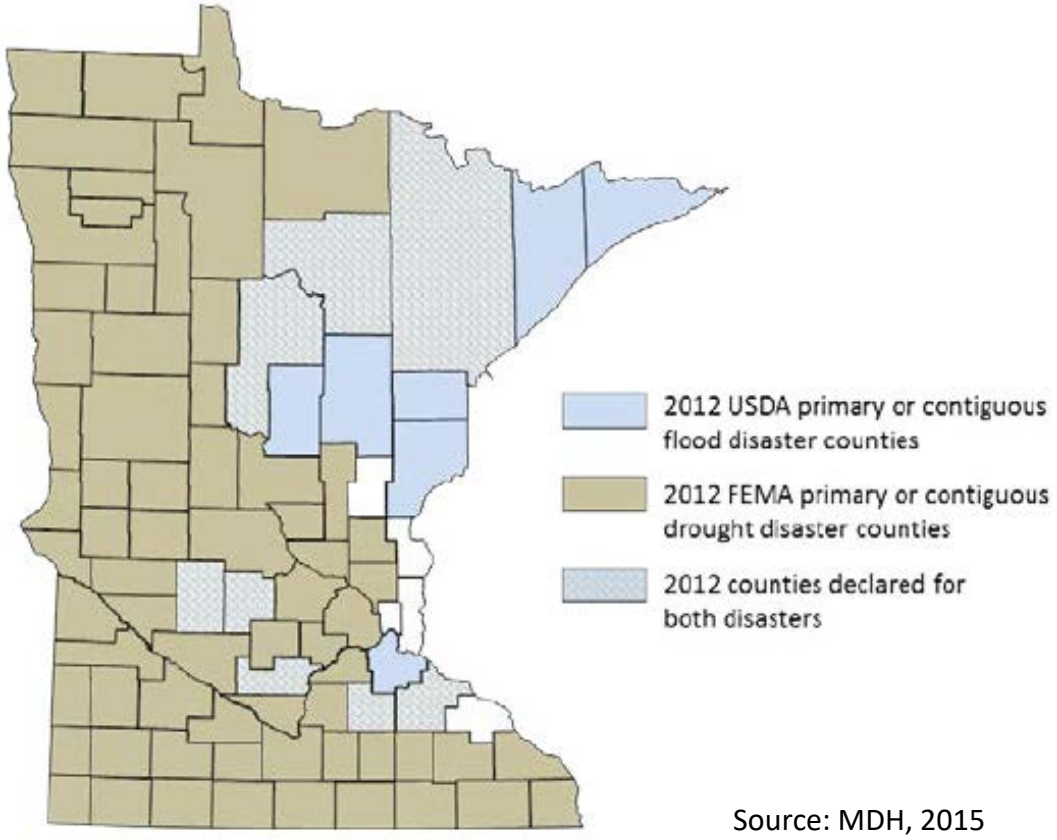
MINNESOTA MEGA-RAIN EVENTS

DATA SOURCE: MNDNR, 2016; GRAPHIC SOURCE: MDH, 2016



Precipitation Changes

The character of precipitation in Minnesota is becoming more extreme



Source: MDH, 2015

Minnesota 2012 disaster declarations.
Counties in blue were declared disaster areas due to flooding while counties in brown were declared primary or contiguous disaster areas due to drought. Light blue counties with cross-hatching received both designations.

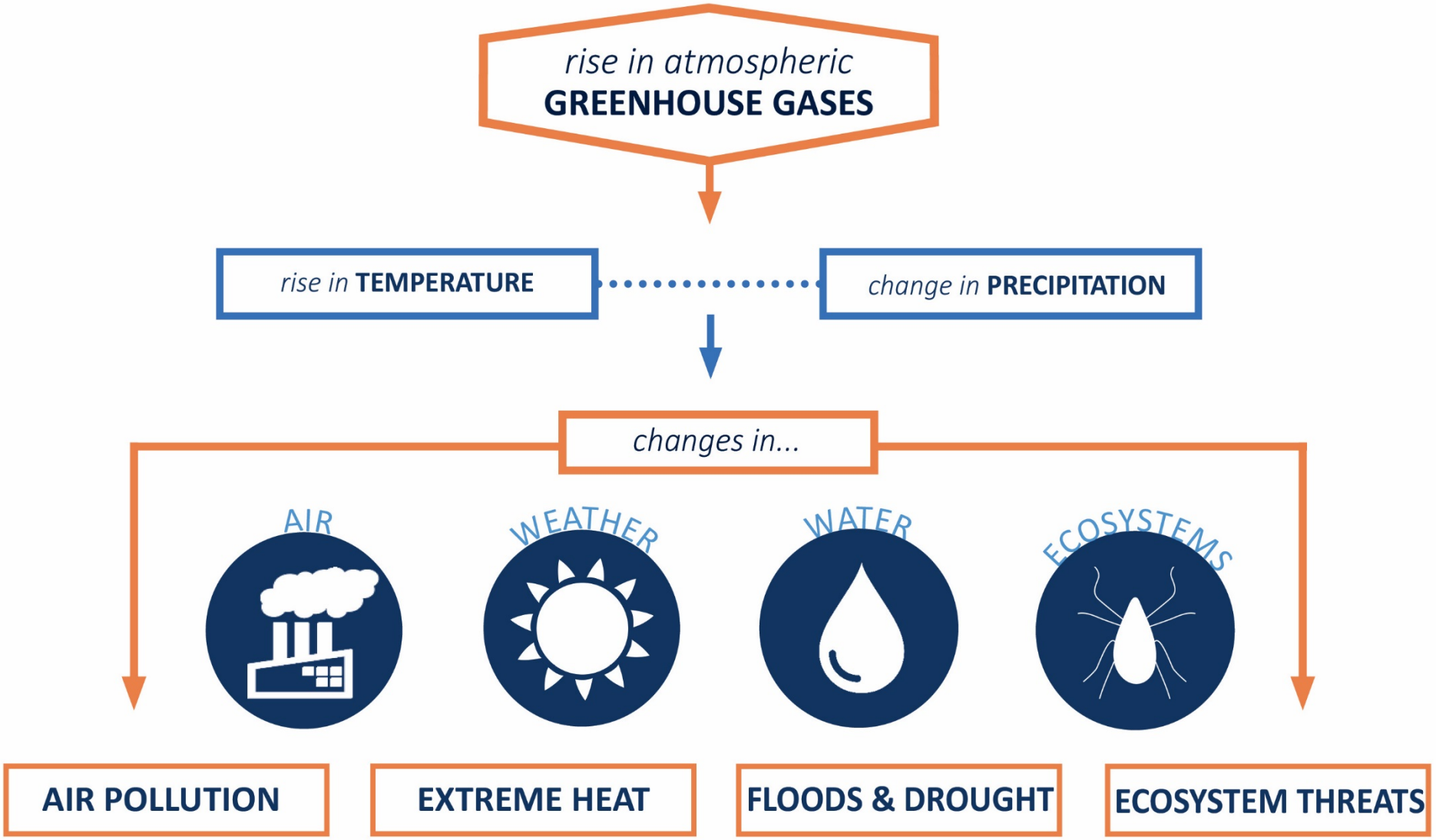
Confidence that climate change will impact common Minnesota weather/climate hazards through 2025

Confidence	Hazard	Expectations through 2025
Highest	**Extreme cold**	Continued decline in severity, frequency
	Extreme rainfall	Continued increases in number and size of heavy events
Moderately High	**Heavy snowfall**	Major events still likely as increased moisture offsets increased temperatures
Moderately Low	**Heat waves**	Becoming more likely as baseline temperatures increase
	Drought	
Low	**Severe thunderstorms & tornadoes**	Little evidence to suggest impacts would stand out from historical record

Confidence that climate change will impact common Minnesota weather/climate hazards beyond 2025

Confidence	Hazard	Expectations beyond 2025
Highest	Extreme cold	Continued rapid decline
	Extreme rainfall	Unprecedented events expected
High	Heat waves	Increases in severity, coverage, and duration expected
Moderately High	Drought	Increases in severity, coverage, and duration possible
Moderately Low	Heavy snowfall	Large events less frequent as winter warms
Moderately Low	Severe thunderstorms & tornadoes	More "super events" possible, even if frequency decreases

CHANGES IN OUR ATMOSPHERE LEAD TO HEALTH EFFECTS



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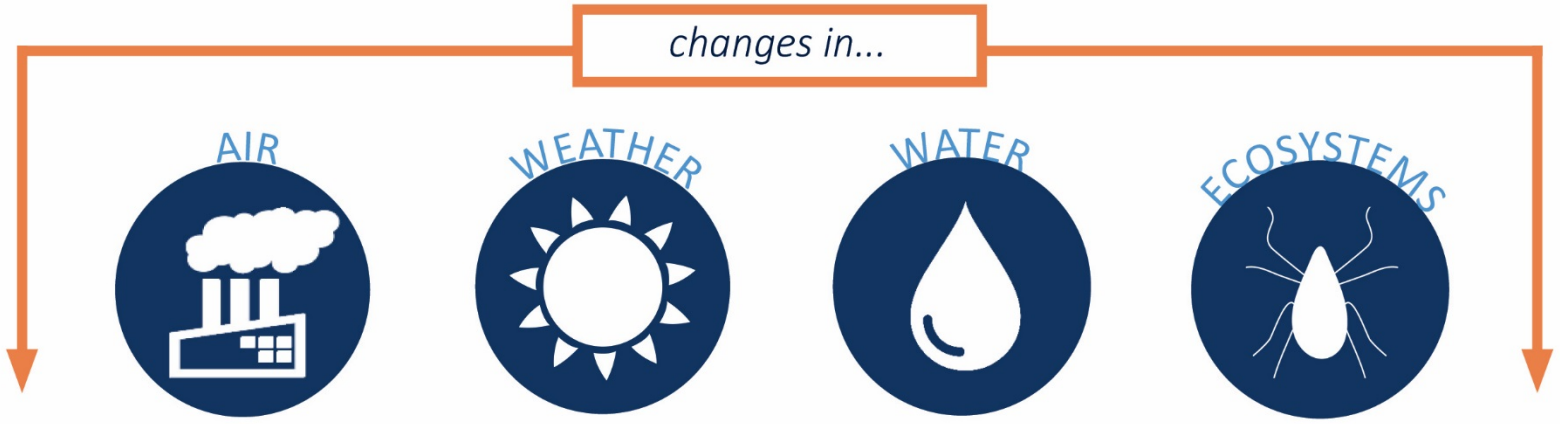


AIR POLLUTION

Direct effects

- Initiate or worsen respiratory, cardiovascular and other diseases

Indirect effects

- Reduced visibility
- Reduced productivity at work or school
- Degradation of crops and water bodies

EXTREME HEAT

Direct effects

- Heat stress and illness
- Worsening of pre-existing conditions
- Heat-related mortality

Indirect effects

- Infrastructure failures
- Strain on essential services
- Disruption to key social networks

FLOOD & DROUGHT

Direct effects

- Mental stress
- Waterborne disease
- Drowning and injuries

Indirect effects

- Respiratory ailments
- Disruption to economic and social networks
- Strain on essential services
- Wildfires

ECOSYSTEM THREATS

Direct effects

- West Nile virus
- Lyme disease
- Liver, respiratory, nervous, skin disorders (from harmful algal blooms)

Indirect effects

- Threats to livelihood
- Financial strains

AIR POLLUTION

OZONE
POLLEN
PARTICULATE MATTER

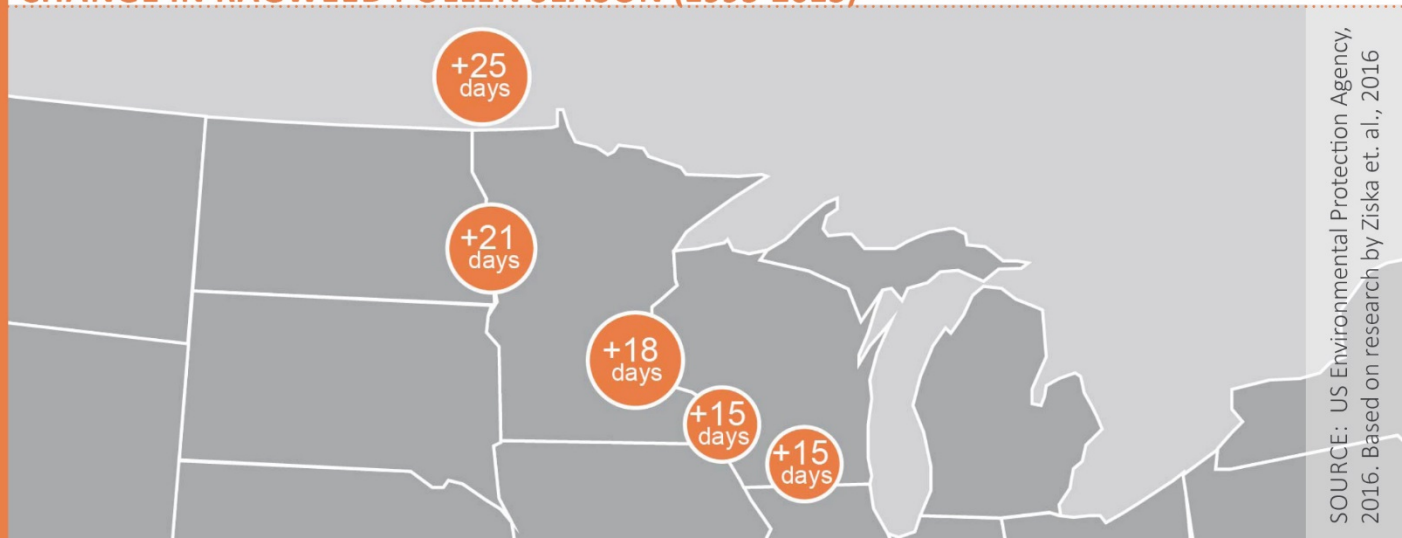
DIRECT EFFECTS

» Cause or aggravate chronic pulmonary disease, lung cancer, cardiovascular diseases, allergies or asthma

INDIRECT EFFECTS

» Reduced visibility
» Reduced productivity at work or school
» Degradation of crops and water bodies

CHANGE IN RAGWEED POLLEN SEASON (1995-2015)



SOURCE: US Environmental Protection Agency, 2016. Based on research by Ziska et. al., 2016

EXTREME HEAT

DIRECT EFFECTS

» Heat stress, heat exhaustion or heat stroke
» Worsening of existing disease or death

INDIRECT EFFECTS

» Infrastructure failures
» Strain on essential services
» Disruption to social and economic networks

2011 SUMMER EXTREME HEAT EXAMPLE

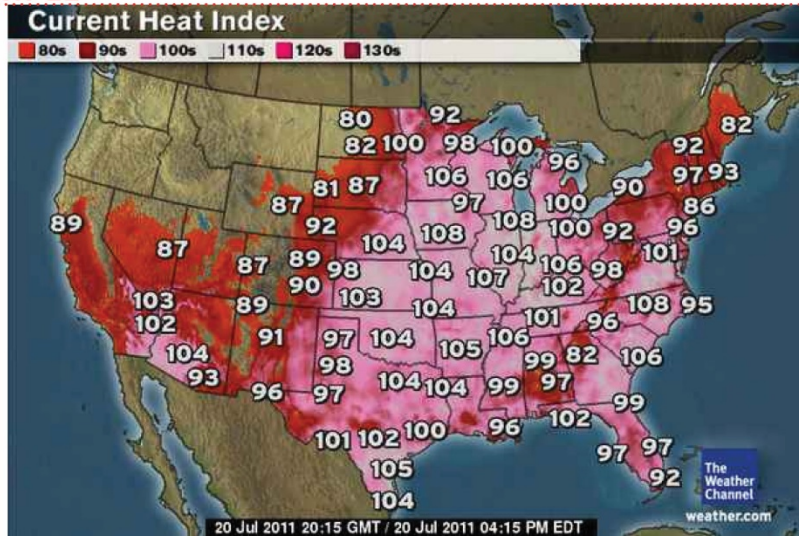
IN THE
SUMMER OF 2011
WE DOCUMENTED

1,255 ED VISITS

AND

3 DEATHS

DUE TO HEAT IN MINNESOTA



FLOOD & DROUGHT

DIRECT EFFECTS (FLOOD)

» Mental stress
» Decrease safety and availability of drinking water
» Injury or drowning

INDIRECT EFFECTS (FLOOD)

» Worsen respiratory ailments
» Disruption to social and economic networks
» Strain on essential services
» Loss of safe & secure housing

INDIRECT EFFECTS (DROUGHT)

» Reduce water supply
» Cause fiscal strain
» Threaten community cohesion
» Increase risk of wildfires

DESTROYED BUSINESSES; INFRASTRUCTURE

ECOSYSTEM THREATS

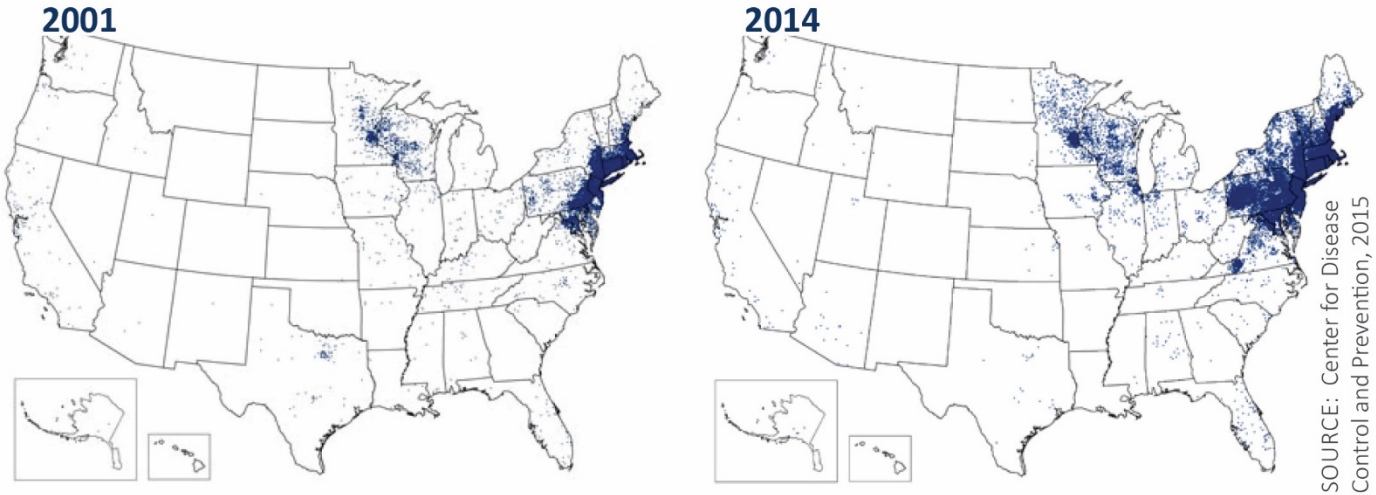
DIRECT EFFECTS

» Lyme disease, West Nile virus, and other vector-borne diseases
» Disorders from harmful algal blooms

INDIRECT EFFECTS

» Financial strains

REPORTED CASES OF LYME DISEASE



SOURCE: Center for Disease Control and Prevention, 2015

American Thoracic Society Member Survey on Climate Change & Health (2014)

- **89%-climate change is happening**
- **68%-driven by human activity**
- **65%-relevant to patient care (a great deal/ a moderate amount)**

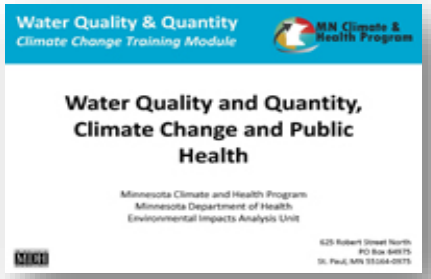
Already observed the following impacts:

- **77%-increases in chronic disease severity from air pollution**
- **58%-increases in allergic symptoms from exposure to plants or mold**
- **57%-increases in severe weather injuries**

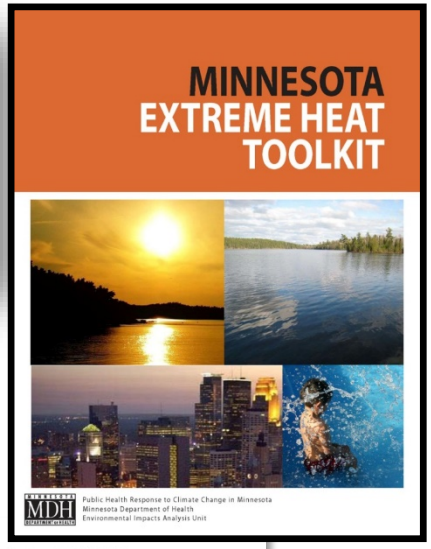
Sarfaty, M, et. al. (2015) Ann Am Thorac Soc Vol 12, No 2, pp 274-278

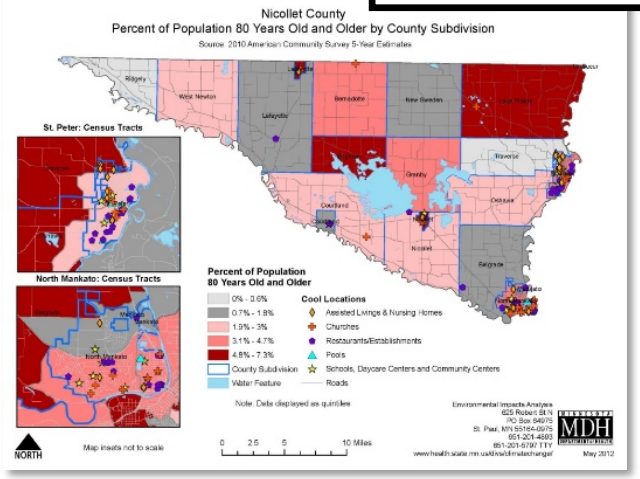
MN Climate & Health Program

- **Education**
- **Developing tools & products**
- **Researching impacts of climate change on health**
- **Analyzing policies**
- **Planning**
- **Technical assistance**



http://www.health.state.mn.us/divs/climatechange/communication.html





Find all our resources here:
www.health.state.mn.us/divs/climatechange/

Thank you!

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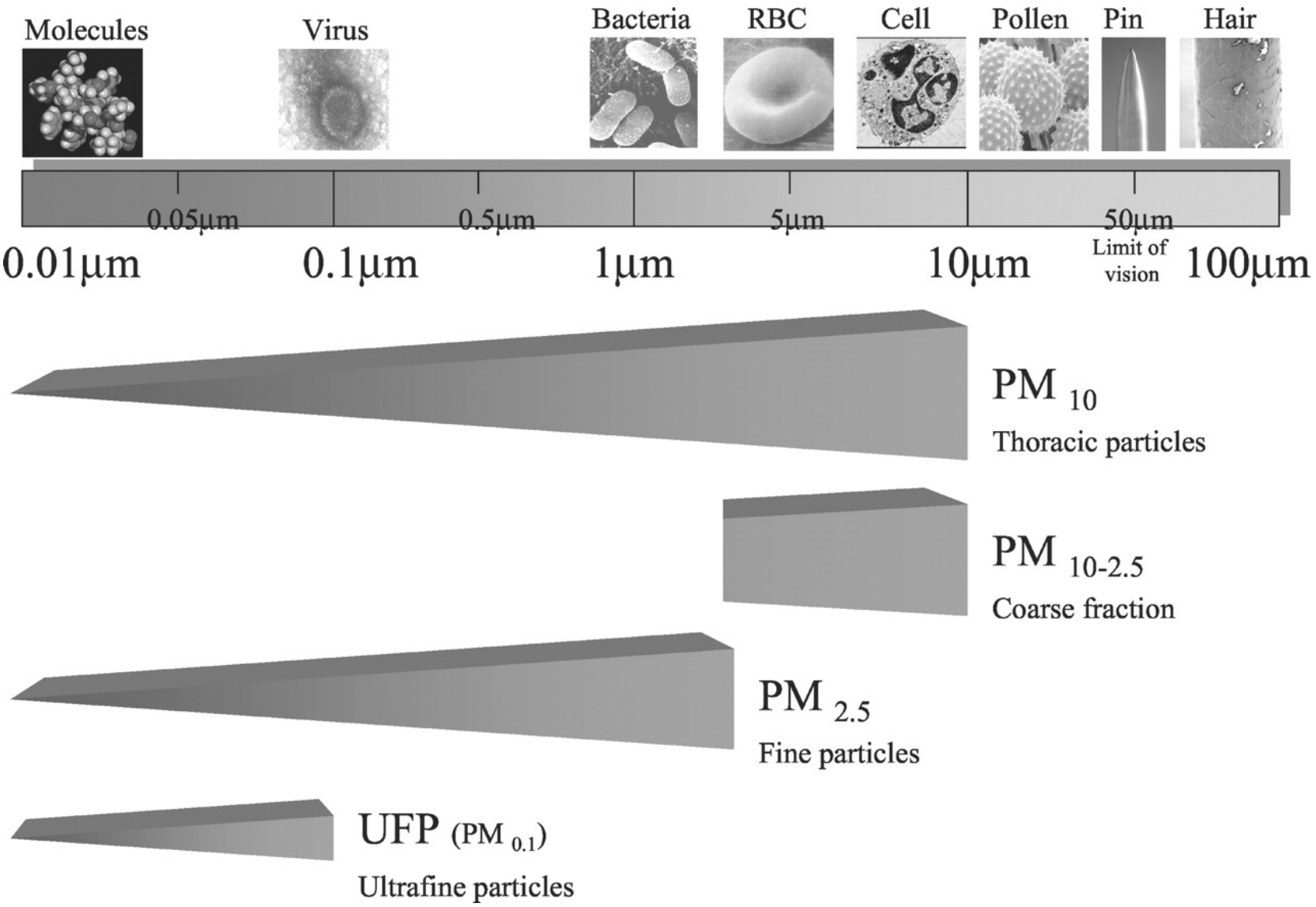
Minnesota Department *of* Health

Air pollution

Particulate matter air pollution size distribution



From **Air Pollution and Cardiovascular Disease: A Statement for Healthcare Professionals From the Expert Panel on Population and Prevention Science of the American Heart Association**, Brooke et al. Circulation June 1, 2004, pp. 2657.

Transmission Electron Micrograph of the alveolar-duct-terminal bronchiolar region in the lungs: proximity of alveolar wall to capillary network

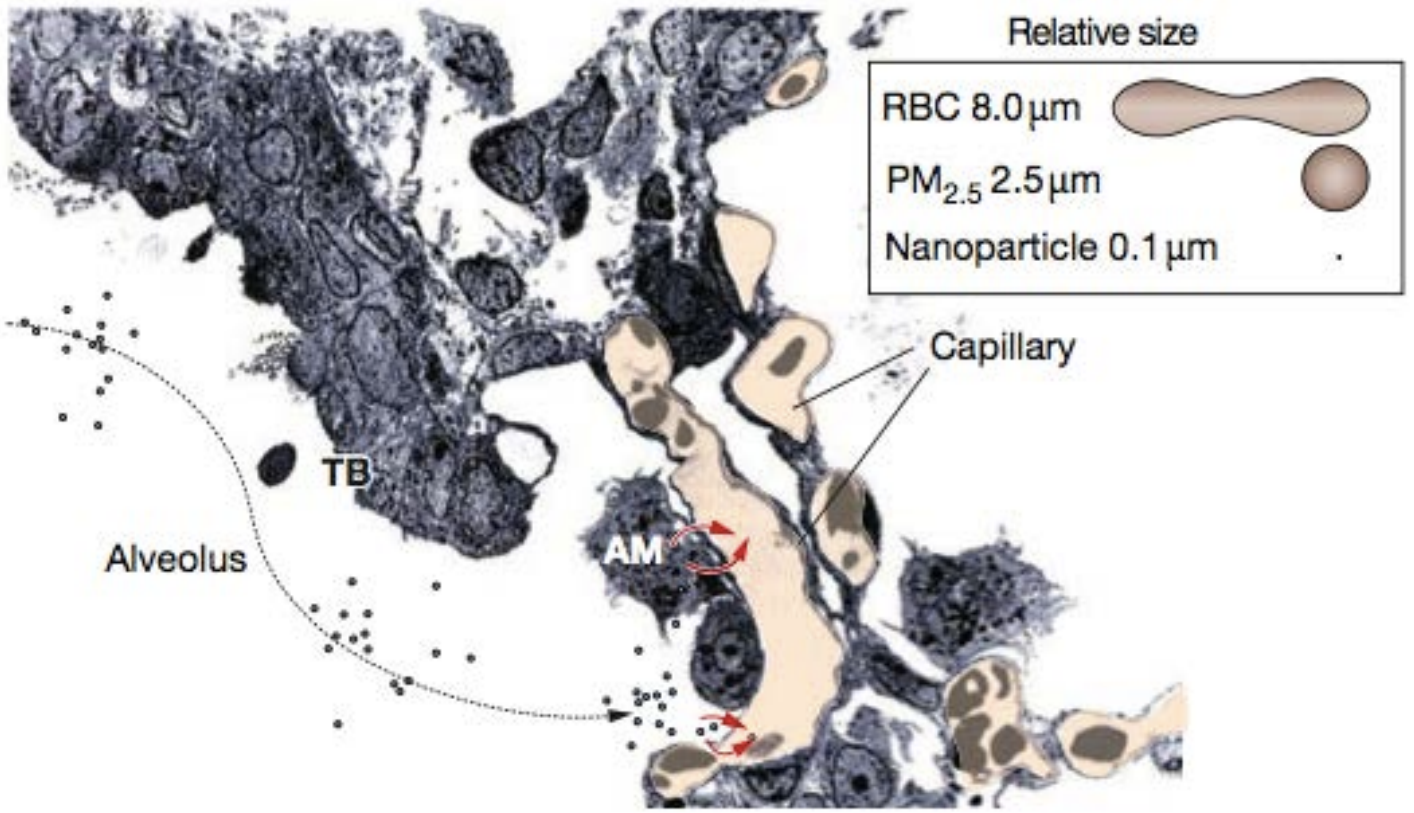


Figure is from **Adverse cardiovascular effects of air pollution**. Mills et al. Nature Clinical Practice Cardiovascular Medicine, January 2009, Vol 6, No 1, p 38.

Hypothetical pathways through which airborne particulate matter influence cardiovascular risk

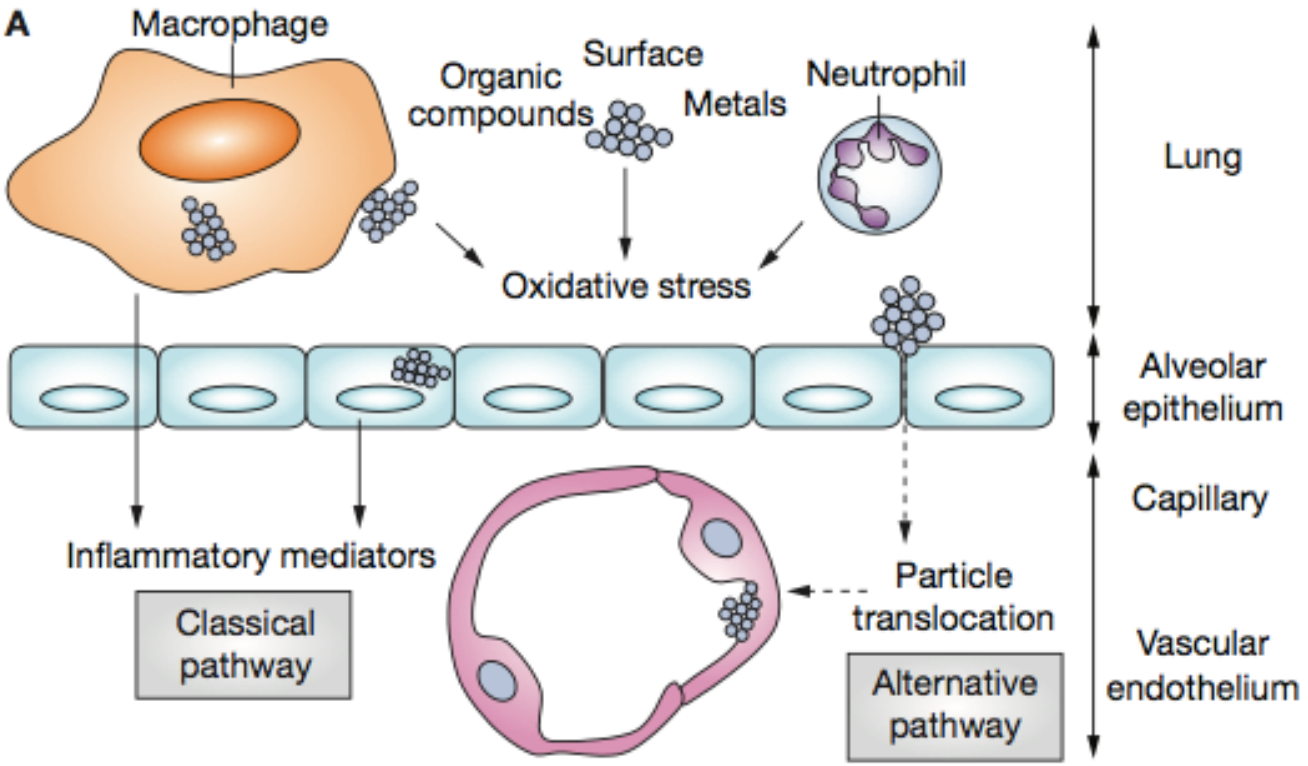


Figure is from **Adverse cardiovascular effects of air pollution**. Mills et al. Nature Clinical Practice Cardiovascular Medicine, January 2009, Vol 6, No 1, p 38.

Mechanism of PM-derived CV pathology

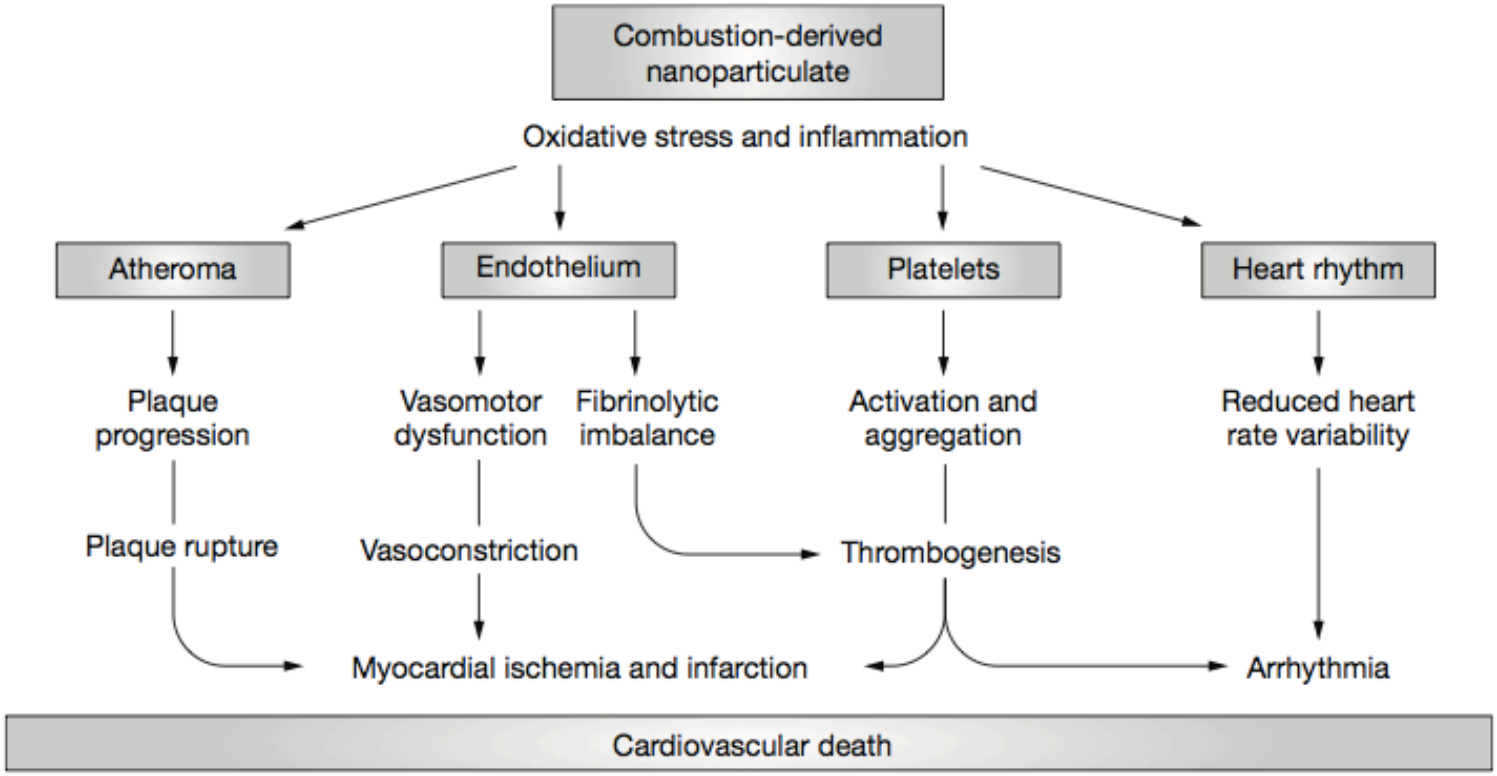
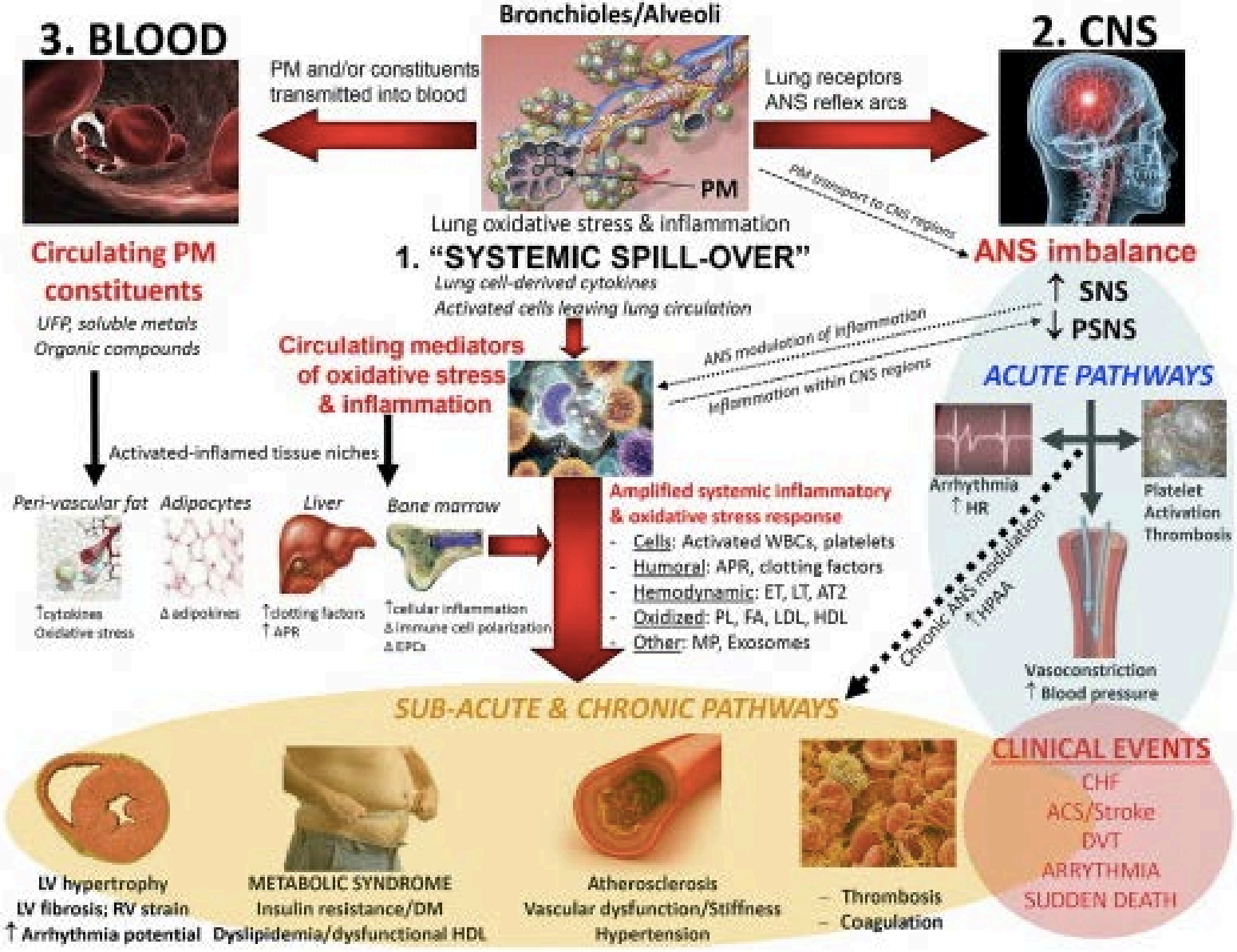


Figure 2 The mechanisms through which combustion-derived nanoparticulate matter causes acute and chronic cardiovascular disease.

Figure is from **Adverse cardiovascular effects of air pollution**. Mills et al. Nature Clinical Practice Cardiovascular Medicine, January 2009, Vol 6, No 1, p 39.



From **Air Pollution and Cardiovascular Disease** Current Problems in Cardiology, Franklin et al. Vol 40, issue 5, May 2015 pp 207-238.

Summary of Pathophysiologic Mechanism

- **Pollutants are inhaled and trigger inflammatory response**
- **Inflammatory response includes:**
- **Damage to lining of blood vessels (endothelium) occurs; inflammatory response in pulmonary tree also**
- **Damage can result in immediate adverse health event (heart attack/MI, stroke/CVA, asthma attack)**
- **Damage can result in a slow buildup of tissue injury that can result in chronic disease (CAD, lung cancer)**

MESA Air Study
(Multi-Ethnic Study of Atherosclerosis and Air Pollution)

- **Prospective 10-year cohort study comparing metropolitan and non-metro areas**
- **Primary aim to examine association between CAD and carotid a. thickness and long term exposure ambient air pollutant concentrations**
- **Examined markers of atherosclerosis (carotid artery intima-media thickness via US) and CT aa calcification**
- **FINDINGS: PM2.5 and traffic related air pollution are associated with progression in coronary calcification, consistent with acceleration of atherosclerosis.**

Association between air pollution and coronary artery calcification within six metropolitan areas in the USA (the Multi-Ethnic Study of Atherosclerosis and Air Pollution): a longitudinal cohort study Kaufman et al. Published online May 24, 2016: http://dx.doi.org/10.1016/S0140-6736(16)00378-0.

Physicians care about climate change

"We are Minnesota physicians, public health professionals and students dedicated to the best possible health of our patients and our communities.

…fossil fuels are responsible for the emission of dangerous pollutants…into our air and waters that increase the risks and costs of heart and lung disease, heat related illnesses, allergies and asthma."

-- *Health Professionals for a Healthy Climate*

from a February 2016 document

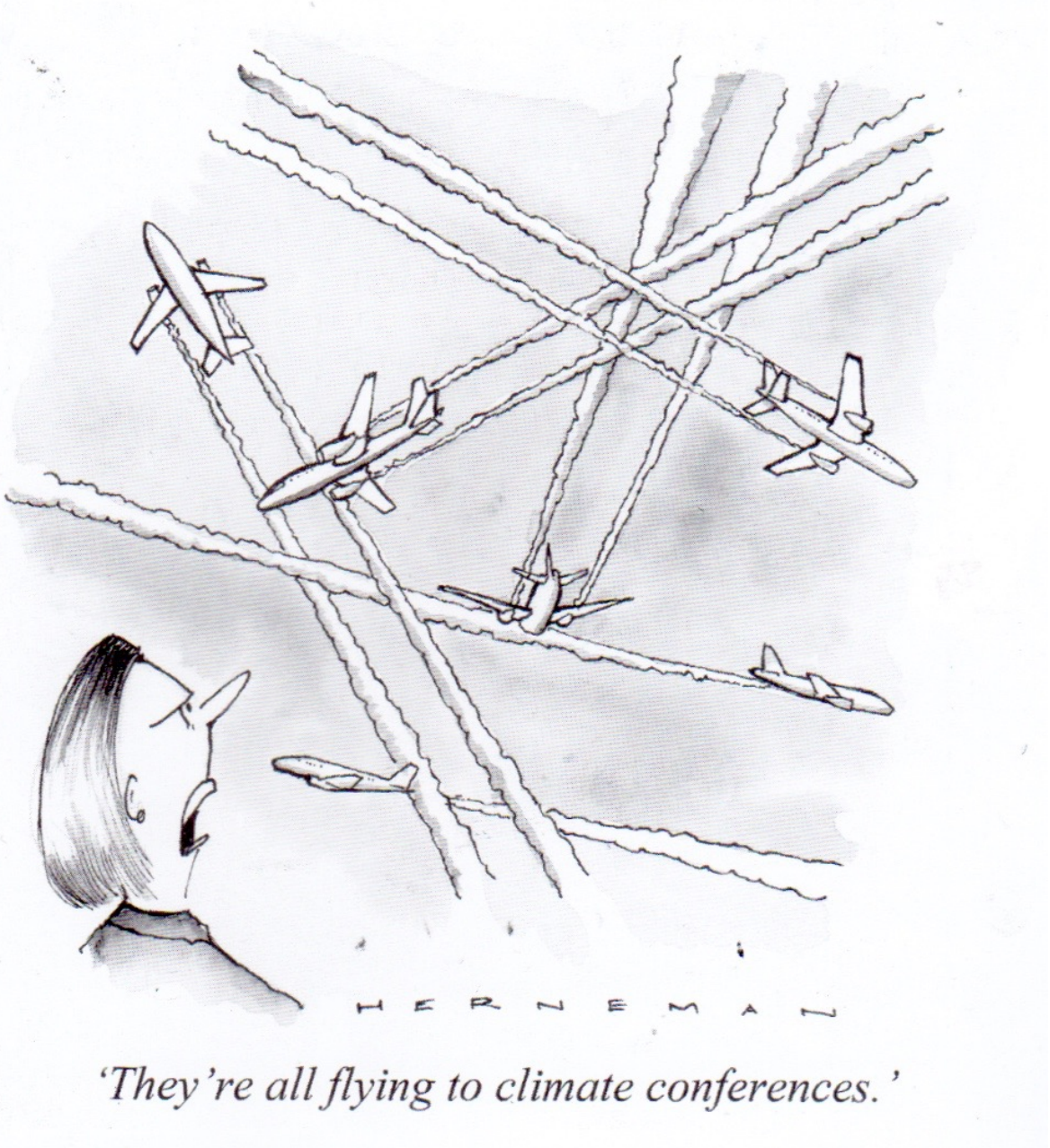
2007 Sports Illustrated Cover Story

Summary

- **Minnesota's climate is changing**
- **Changes in climate are a public health concern and impact our physical and mental health**
- **Consider exposure to air pollution as a cardiovascular risk factor due to pathophysiologic effects**
- **Family physicians can prepare for and help prevent the adverse health impacts of climate change**

References and Further Reading

- **Medical Alert! Climate Change is Harming Our Health from the Medical Society Consortium on Climate & Health, 2017 available at http://medsocietiesforclimatehealth.org/wp-content/uploads/2017/03/medical_alert.pdf.**
- **Health Implications of a Changing Climate, K Raab Minnesota Medicine, May 2015, pp. 41-43.**
- **Association between air pollution and coronary artery calcification within six metropolitan areas in the USA (the Multi-Ethnic Study of Atherosclerosis and Air Pollution): a longitudinal cohort study Kaufman et al. Published online May 24, 2016: http://dx.doi.org/10.1016/S0140-6736(16)00378-0.**
- **Global Environmental Change: What Can Health Care Providers and the Environmental Health Community Do About It Now? Schwartz et al. Environmental Health Perspectives, vol 114, No 12, December 2006, pp 1807-1812.**
- **Air Pollution and Cardiovascular Disease Current Problems in Cardiology, Franklin et al. Vol 40, issue 5, May 2015 pp 207-238**
- **Main Air Pollutants and Myocardial Infarction: A Systematic Review and Meta-Analysis, Mustafic et al. JAMA, February 15, 2012, Vol 307, No. 7, pp. 713-721.**
- **Adverse cardiovascular effects of air pollution. Mills et al. Nature Clinical Practice Cardiovascular Medicine, January 2009, Vol 6, No 1, pp. 36-43.**



'They're all flying to climate conferences.'

Thank you

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