Welcome to the

AIR QUALITY & CLIMATE CHANGE PANEL DISCUSSION

SESSION AGENDA

8:30 a.m. – Social half hour with light breakfast and coffee bar

9 a.m. – Welcome and Introduction by Dr. James Crooks

9:15-11 a.m. – Four Panel Speakers

11-11:45 a.m. – Q&A

11:45 a.m. – Closing statement

This event is brought to you by:

Boulder County

BOULDER COUNTY PUBLIC HEALTH

Image source: https://www.thebump.com/a/checklist-baby-essentials

Please welcome

DETLEV HELMIG

Associate Research Professor

Institute of Arctic Research at the University of Colorado

News Releases

News Releases from Region 08

EPA reclassifies Denver area to "Serious" nonattainment for ozone

Reclassification requires additional control measures to reduce emissions

12/16/2019

Contact Information:
Richard Mylott (mylott.richard@epa.gov)
303-312-6654

DENVER—The U.S. Environmental Protection Agency (EPA) today announced the agency is finalizing a determination to reclassify the Denver Metro/North Front Range ozone nonattainment area from Moderate to Serious nonattainment under the Clean Air Act.

Elevated levels of surface ozone can cause:

- Shortness of breath
- Chest pain when inhaling deeply
- Wheezing and coughing
- Increased susceptibility to respiratory infection
- Inflammation of the lungs and airways
- Increased risk of asthma attacks

….. (American Lung Association)

→ Increased risk of death;

~ 5000-6000 premature deaths
in US per year

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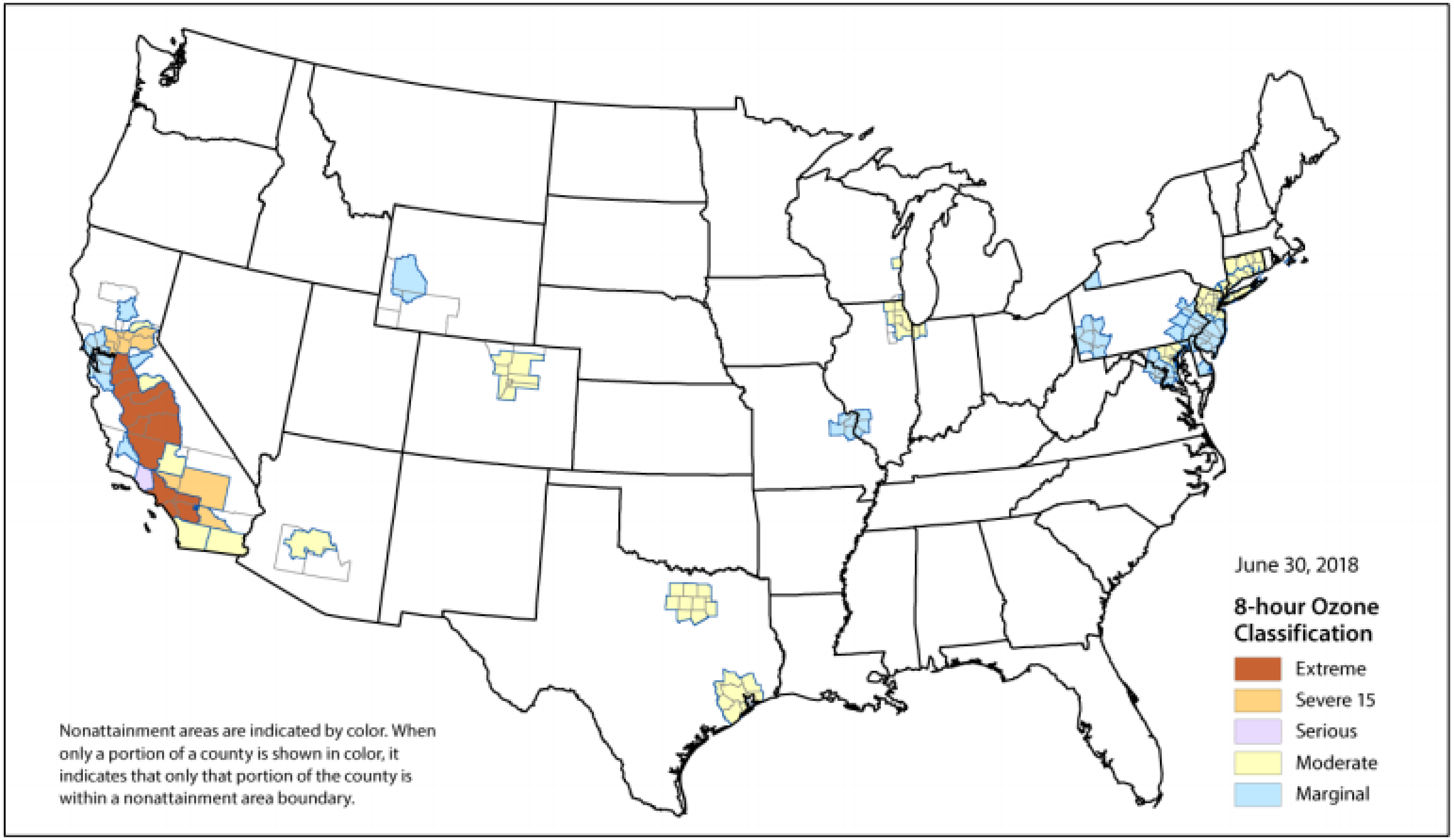
Also – Ozone in Greenhouse Gas:

1. CO_2 (60%)
2. Methane (15%)
3. Ozone (12%)

Figure 1. Ozone Nonattainment Areas (2008 Standard, 0.075 ppm) as of June 2018

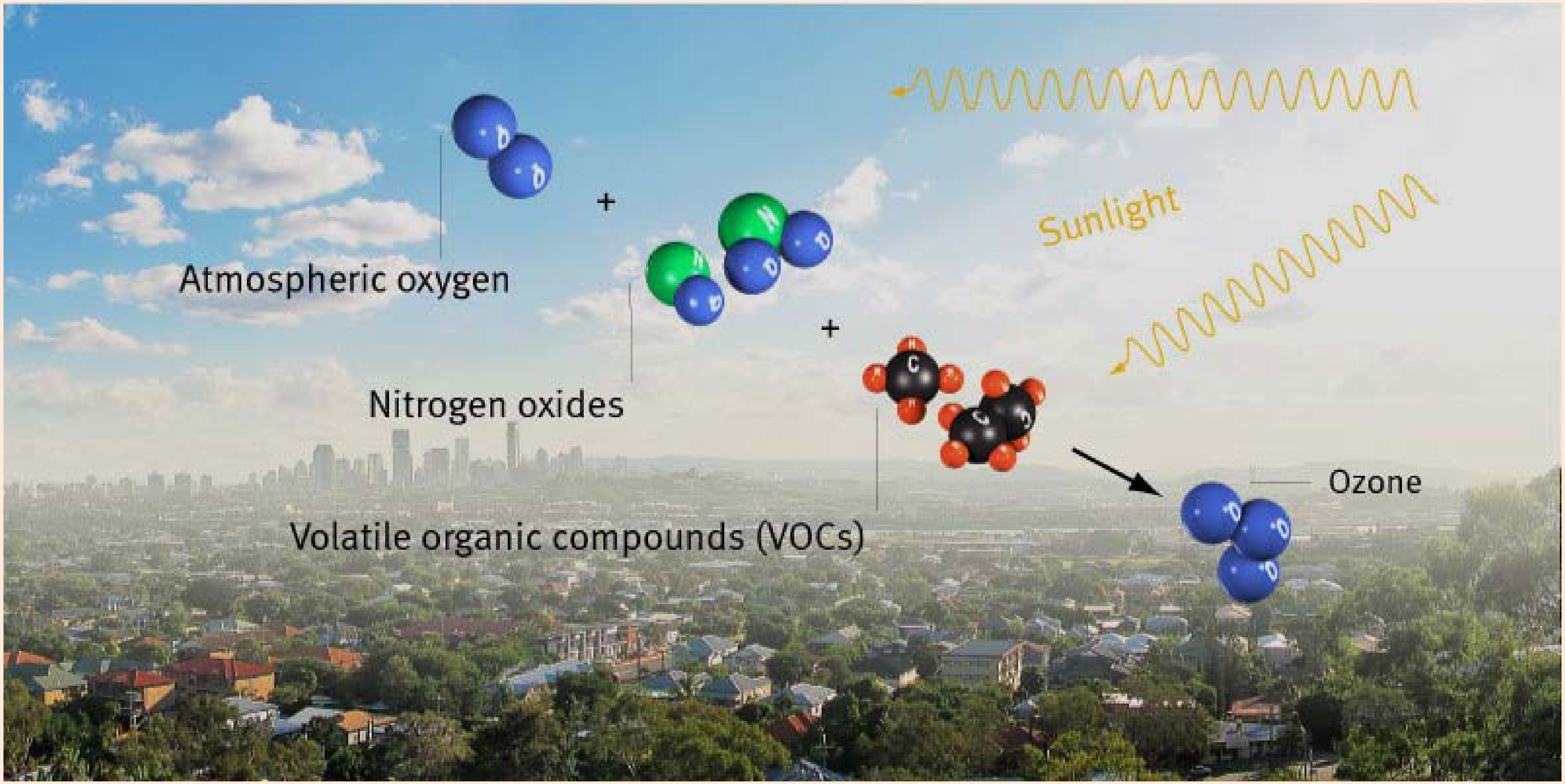


Source: U.S. EPA Green Book, https://www3.epa.gov/airquality/greenbook/map/map8hr_2008.pdf. Map shows areas designated nonattainment with respect to the 2008 ozone standard by EPA as of June 30, 2018.

Notes: Nonattainment designations were based on 2008-2010 monitoring data in most cases. Eighteen of the 38 areas shown now have monitoring data indicating attainment of the standard, but, as of June 2018, had not completed administrative requirements to be reclassified to "attainment."

(https://www3.epa.gov/airquality/greenbook/map8hr_2015.html).

Ozone is NOT an Emission
How is Ozone (O_3) formed in the Atmosphere?



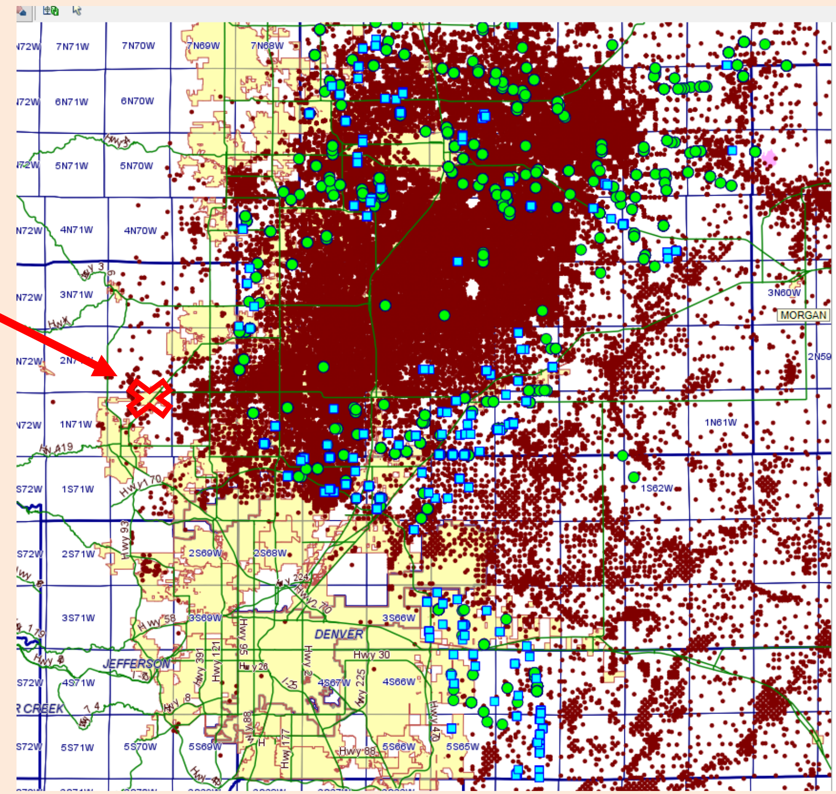
https://www.qld.gov.au/environment/pollution/monitoring/air/air-pollution/pollutants/ozone

Ozone Precursor Sources

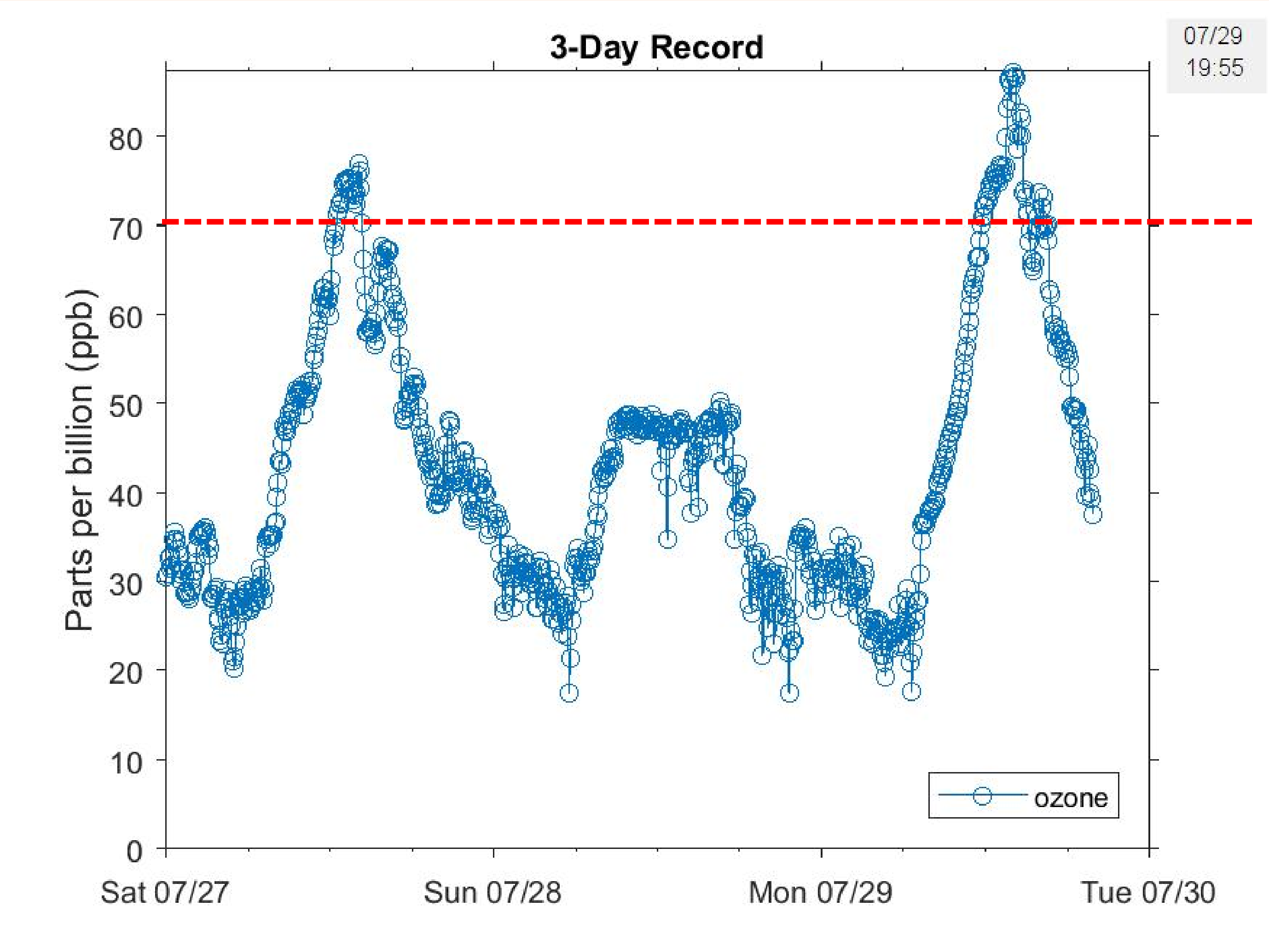
Boulder Reservoir Air Monitoring Shelter

Instrument Shelter (CDPHE)

Oil and Gas Well Locations

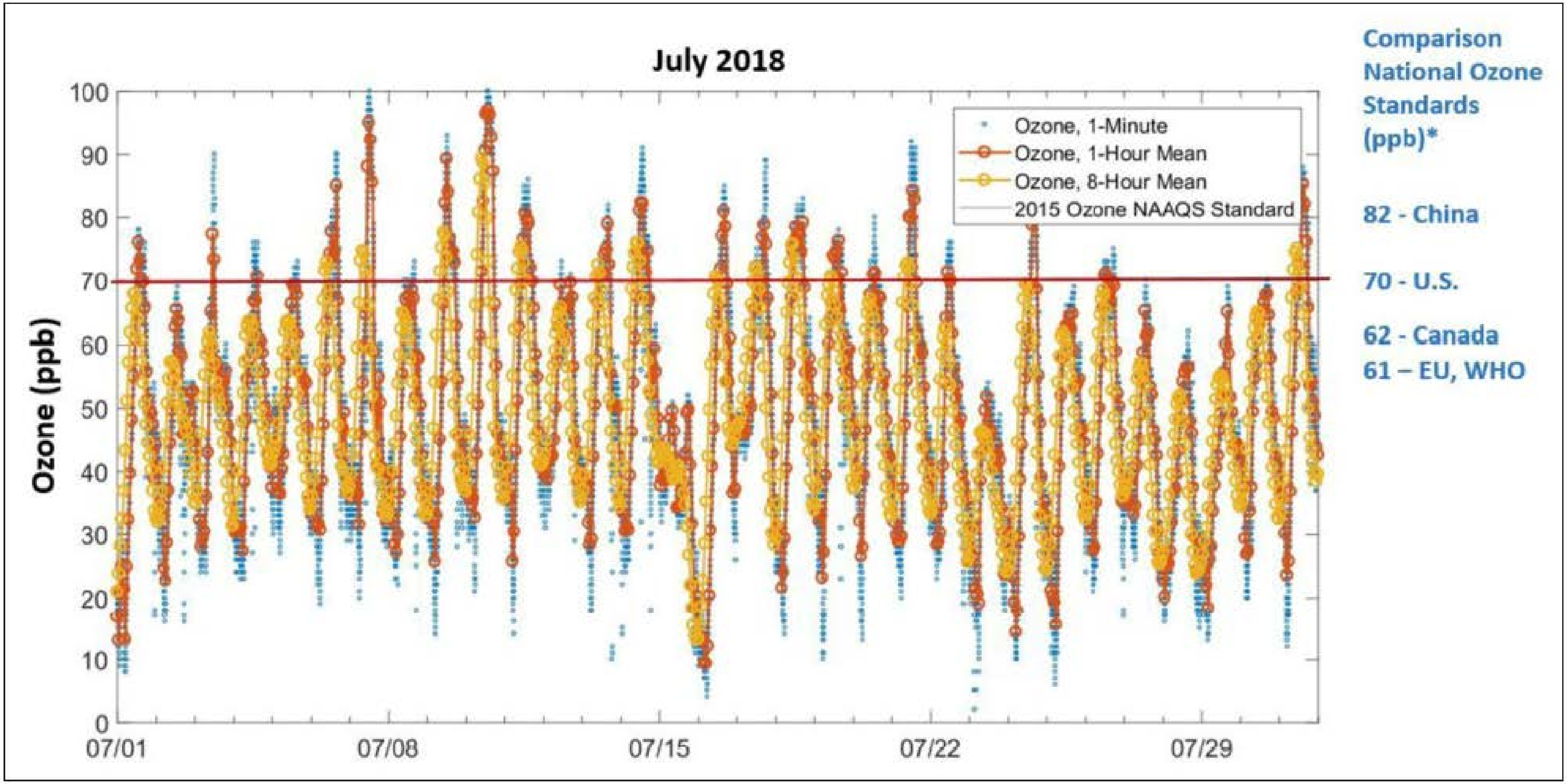


Ozone Behavior at Boulder Reservoir July 2019 (CDPHE data)



2015 8-hour National Ambient Air Quality Standard (NAAQS) (70 ppb)

Ozone at Boulder Reservoir July 2018 (CDPHE data)



Comparison National Ozone Standards (ppb)*

82 - China

70 - U.S.

62 - Canada

61 – EU, WHO

Compliance with ozone NAAQS is determined by 3-year running mean of 4th highest annual 8-hour ozone average (truncated).

*** DRAFT DATA ***

2018 8-Hour Ozone (Updated through September 30, 2018)

AQS Number	Site Name	1st Max 8-Hour (ppb)	Date 1st Max 8-Hour	2nd Max 8-Hour (ppb)	Date 2nd Max 8-Hour	3rd Max 8-Hour (ppb)	Date 3rd Max 8-Hour	4th Max 8-Hour (ppb)	Date 4th Max 8-Hour	5th Max 8-Hour (ppb)	Date 5th Max 8-Hour
08-001-3001	Welby	73	07/06	70	07/18	69	07/10	69	08/01	68	07/31
08-005-0002	Highland	88	07/06	78	08/02	77	06/06	77	07/16	77	07/17
08-005-0006	Aurora East	78	08/02	76	07/18	76	08/01	72	07/31	71	07/12
08-013-0014	Boulder Reservoir	89	07/10	79	06/13	79	08/02	77	07/09	76	08/16
08-019-0006	Mines Peak (non-regulatory)	89	06/11	82	08/02	79	06/12	78	08/10	77	07/09
08-031-0002	CAMP	79	07/06	74	07/16	72	07/14	71	07/18	70	07/10
08-031-0026	La Casa	78	07/16	76	07/06	73	07/17	72	07/18	71	06/06
08-035-0004	Chatfield State Park	88	07/06	87	06/06	86	07/16	83	07/14	82	08/13
08-041-0013	Colo. Spgs. - USAF Academy	76	04/17	76	08/02	74	07/06	73	07/14	72	06/12
08-041-0016	Manitou Springs	78	07/06	76	04/17	74	08/02	73	06/12	72	07/14
08-045-0012	Rifle - Health	70	06/19	66	06/02	66	06/12	65	05/27	65	08/02
08-059-0005	Welch	78	07/06	77	07/16	72	07/14	72	08/02	71	07/10
08-059-0006	Rocky Flats - N	86	06/13	83	08/13	81	07/10	81	07/14	81	08/02
08-059-0011	NREL	86	08/13	81	08/16	80	08/02	80	08/24	79	07/06
08-059-0013	Aspen Park	74	06/06	73	07/16	73	08/13	71	07/14	70	07/11
08-069-0011	Fort Collins - West	88	07/07	86	07/06	83	07/10	81	06/13	80	07/14
08-069-1004	Fort Collins - CSU	79	07/06	73	07/07	72	05/17	72	07/10	71	08/02
08-077-0020	Palisade - Water	78	06/11	72	08/01	72	08/02	69	06/19	68	06/02
08-081-0003	Elk Springs	73	06/11	68	08/01	64	05/27	64	07/31	64	08/02
08-083-0006	Cortez	72	08/06	70	08/07	69	08/01	67	04/08	67	08/02
08-085-0005	Paradox	77	06/11	68	06/19	68	08/02	66	07/31	66	08/01
08-123-0009	Greeley - Weld Tower	77	05/26	77	08/02	74	06/13	73	06/02	72	07/16
08-029-0007	BLM - Paonia	60	06/11	55	06/24	54	05/14	54	08/02	53	06/12
08-051-9991	EPA - Gothic CASTNET	88	06/11	72	08/02	70	08/01	69	05/27	69	06/24
08-067-1004	USFS – Shamrock (thru 6/30)	73	05/24	72	06/24	70	04/26	68	04/17	68	06/25
08-067-7001	SUIT - Ignacio	69	08/06	68	08/07	67	05/24	67	07/21	66	04/26
08-067-7003	SUIT - Bondad	69	08/06	68	04/26	68	08/07	67	05/24	66	07/21
08-069-0007	NPS - Rocky Mtn. NP	91	06/11	75	07/10	75	08/20	74	08/10	73	06/12
08-083-0101	NPS - Mesa Verde NP	75	08/06	72	07/21	72	08/01	72	08/02	70	05/24
08-103-0005	BLM - Meeker	71	06/11	66	08/02	64	08/01	63	06/25	62	05/27
08-103-0006	BLM - Rangely	73	08/01	72	06/11	70	08/02	68	06/25	68	07/11

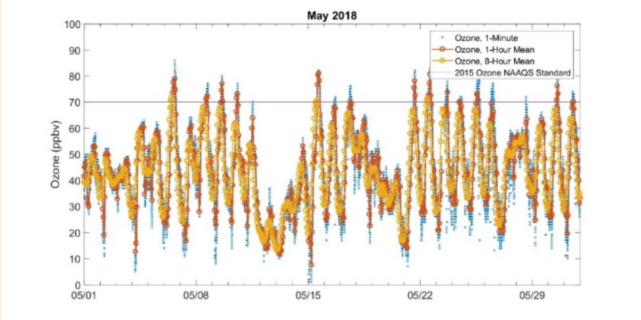
NOTE: Values above the level of the 70 ppb 8-hour standard are highlighted in yellow, above the 75 ppb standard in orange.

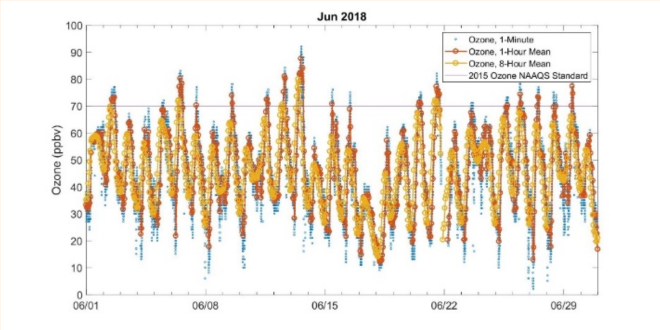
NOTE: Data influenced by natural event values, if any, are included.

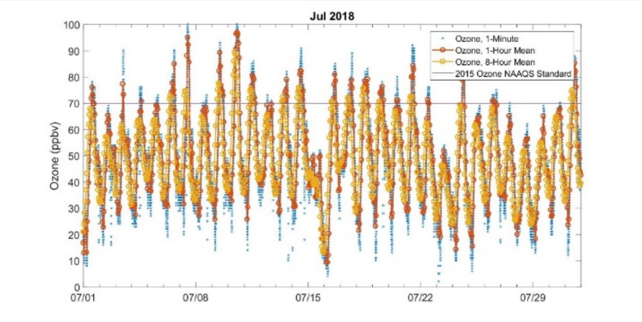
https://www.colorado.gov/airquality/html_resources/ozone_summary_table.pdf

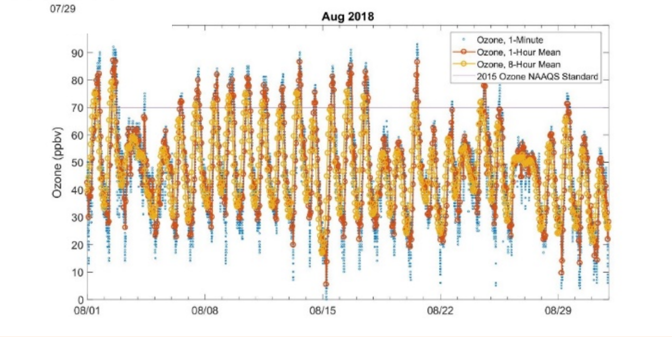
Boulder Reservoir 2018 Summer Ozone Summary

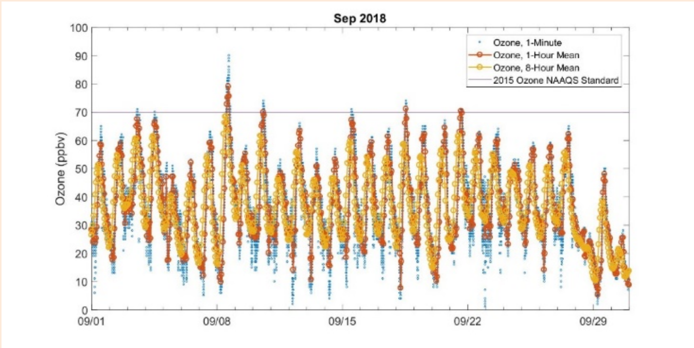
- Highest 8-hour ozone value was 89 ppb (highest ozone value seen 2018 in the Front Range)
- Stretch of 5 consecutive exceedance days in August
- 230 hours with ozone >70.9 ppb
- 100 hours with ozone 8-hour mean >70.9 ppb
- 32 days with 8-hour ozone >70.9 ppb
- Highest 8-hour ozone year in last ten years







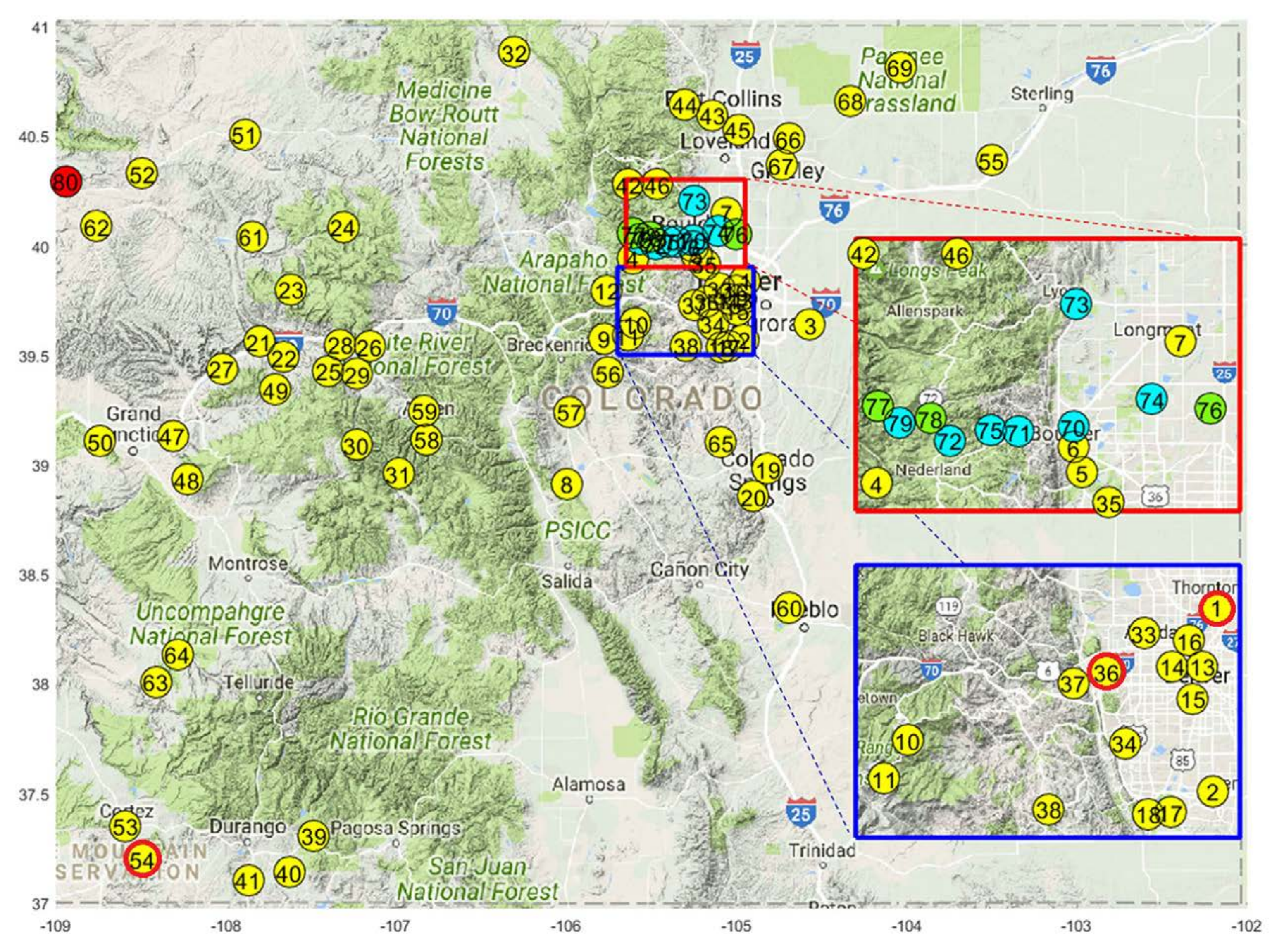




How has ozone changed over time?

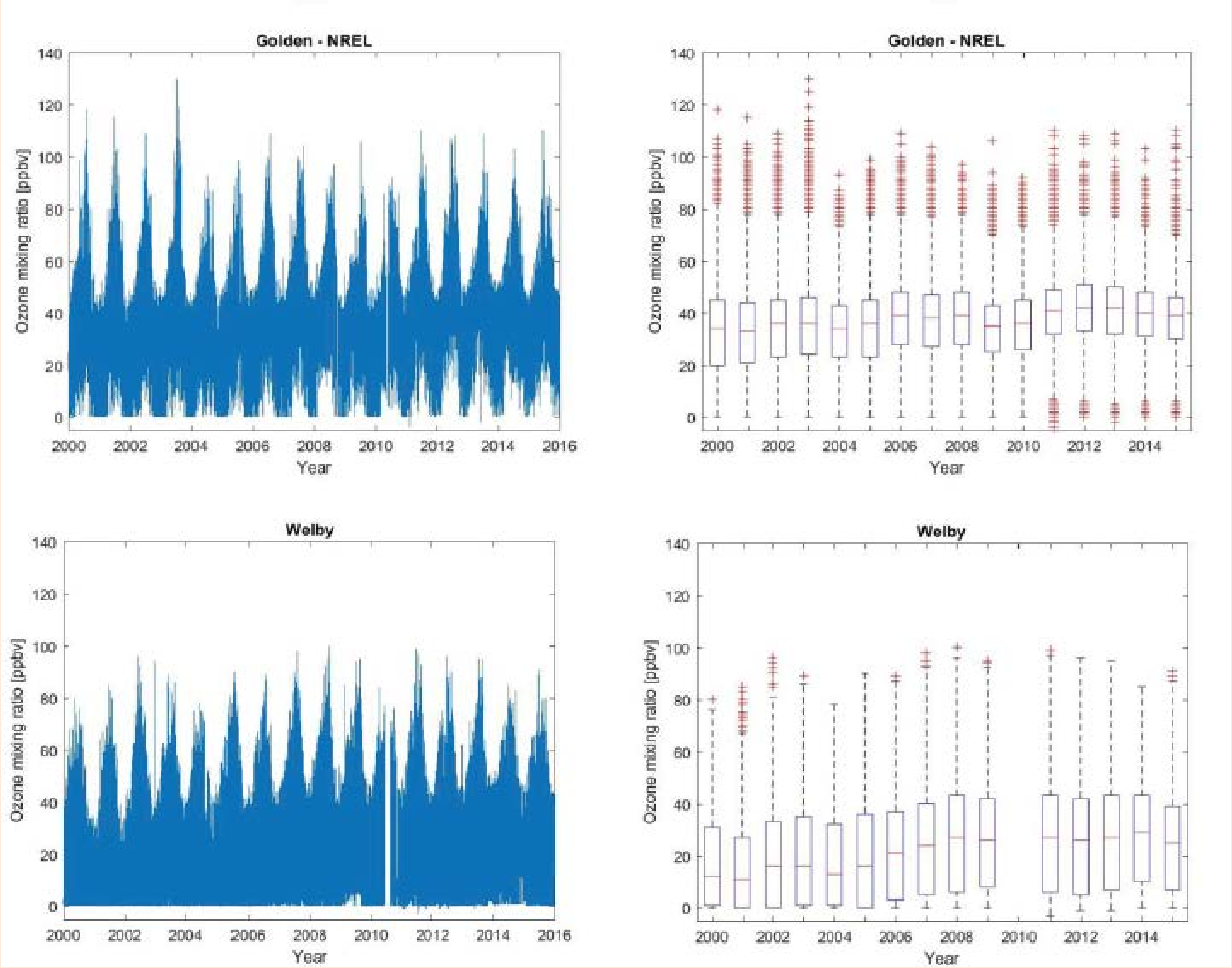
-> Trend Analysis

Ozone Monitoring in Colorado - NREL and Welby



Bien and Helmig, 2018

Ozone Trends at Golden and Welby



Bien and Helmig, 2018

Trend Analysis of Summer Ozone

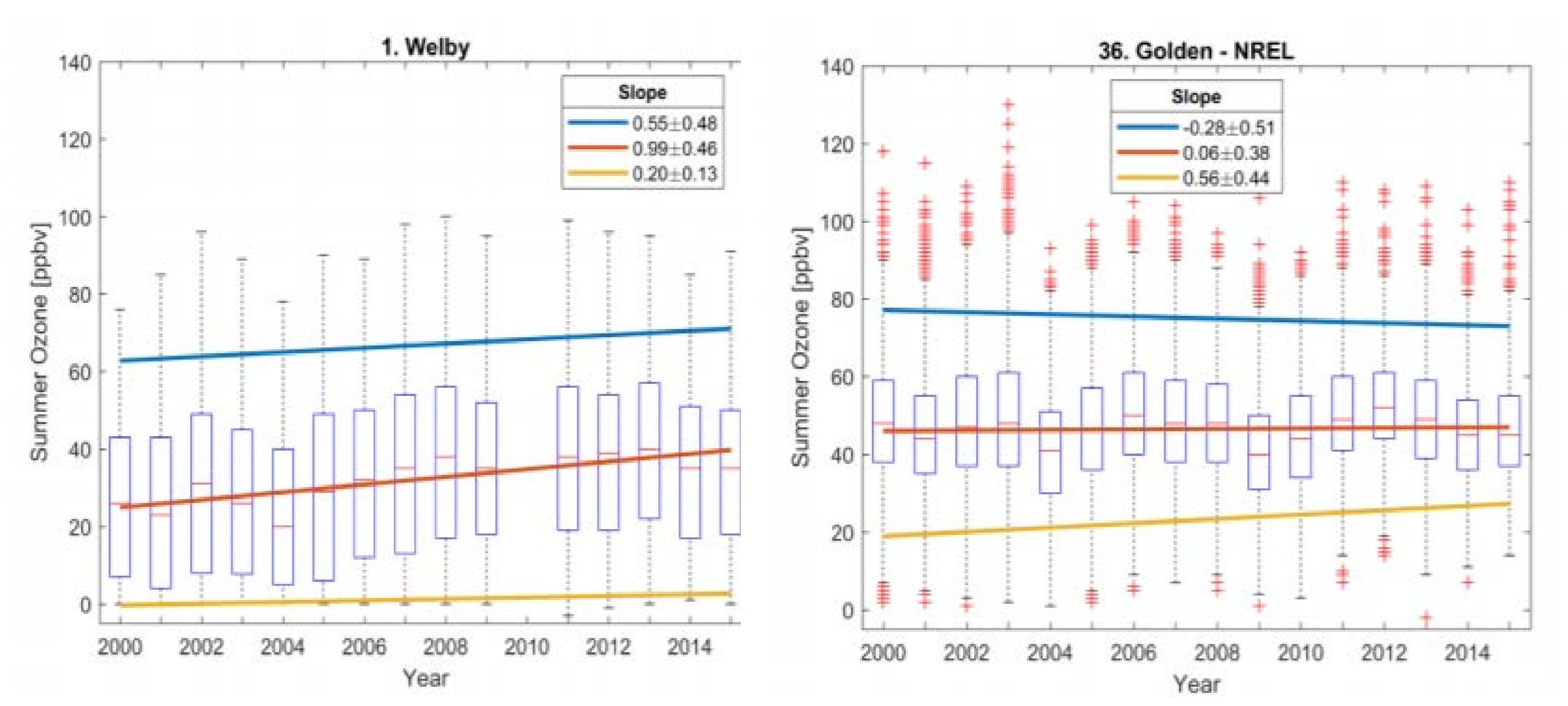


Figure 4. Trend analyses of ozone summer data from Welby and NREL, with trend results differentiated for the 5th percentiles, median, and 95th percentile data. For the box whisker plots, the horizontal lines show the median values, the boxes the 25 and 75 percentiles, the whiskers the 5th and 95th percentiles, and the crosses values that extend beyond two standard deviations from the median [*Bien and Helmig*, 2018]. The slope results in the legend represent the ozone trend in ppb/yr. At Welby, all ozone metrics show increasing ozone, with the 95th percentile being statistically significant trend. NREL has positive slopes for the 5th percentile and medians, and a negative slope for the high ozone distribution values.

Bien and Helmig, 2018

Ozone Trends

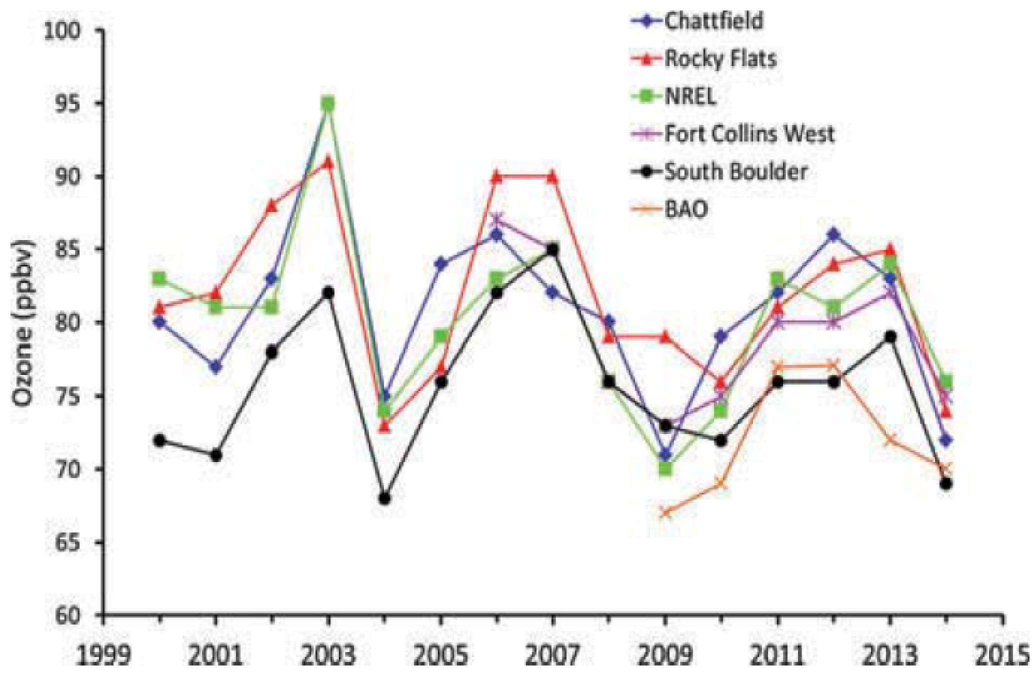
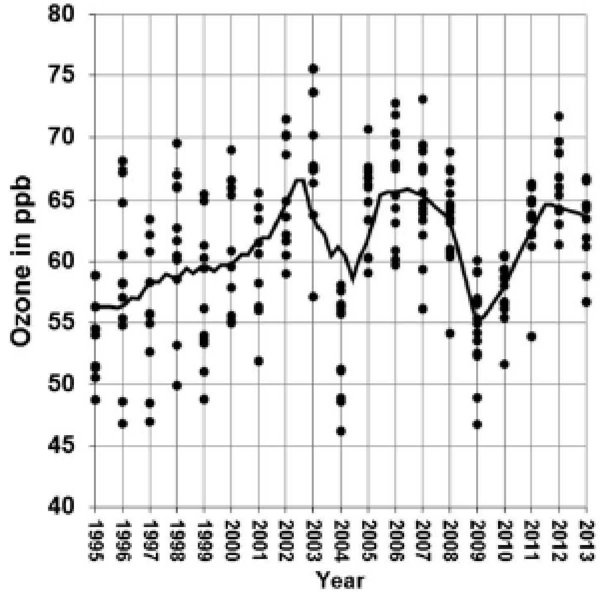
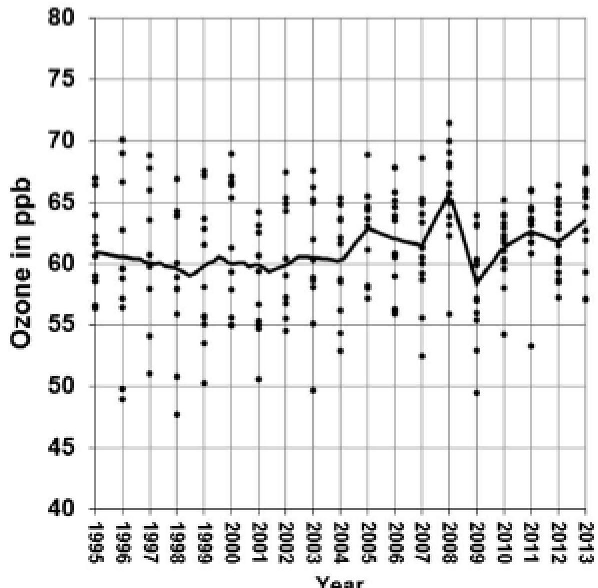


Figure 2. Time series of the fourth-highest 8-hr average O_3 values for selected ozone monitoring by the CDPHE and NOAA (BAO) in the Colorado Front Range from 2000–2014 (data considered for the BAO are from 2009–2014). Monitoring locations are indicated in Figure 1.

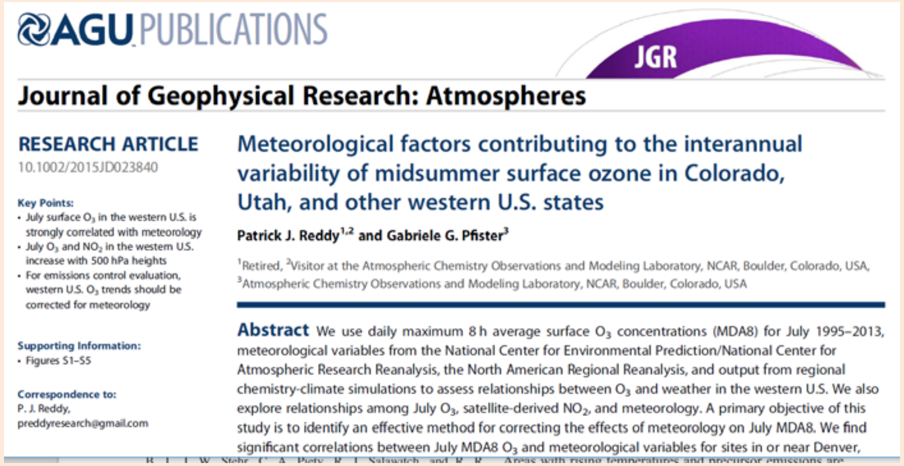
Evans and Helmig, 2017.



a) July MDA8 O_3 14 Front Range sites



c) July MDA8 corrected for 500 hPa heights
14 Front Range sites



AGU PUBLICATIONS JGR

Journal of Geophysical Research: Atmospheres

RESEARCH ARTICLE

10.1002/2015JD023840

Key Points:
- July surface O_3 in the western U.S. is strongly correlated with meteorology
- July O_3 and NO_2 in the western U.S. increase with 500 hPa heights
- For emissions control evaluation, western U.S. O_3 trends should be corrected for meteorology

Supporting Information:
- Figures S1–S5

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P. J. Reddy,
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Meteorological factors contributing to the interannual variability of midsummer surface ozone in Colorado, Utah, and other western U.S. states

Patrick J. Reddy[1,2] **and Gabriele G. Pfister**[3]

[1]Retired, [2]Visitor at the Atmospheric Chemistry Observations and Modeling Laboratory, NCAR, Boulder, Colorado, USA, [3]Atmospheric Chemistry Observations and Modeling Laboratory, NCAR, Boulder, Colorado, USA

Abstract We use daily maximum 8 h average surface O_3 concentrations (MDA8) for July 1995–2013, meteorological variables from the National Center for Environmental Prediction/National Center for Atmospheric Research Reanalysis, the North American Regional Reanalysis, and output from regional chemistry-climate simulations to assess relationships between O_3 and weather in the western U.S. We also explore relationships among July O_3, satellite-derived NO_2, and meteorology. A primary objective of this study is to identify an effective method for correcting the effects of meteorology on July MDA8. We find significant correlations between July MDA8 O_3 and meteorological variables for sites in or near Denver,

14 Front Range sites surrounding Denver …. for 1995–2013. Corrected trends show a ….. **general increase for the Front Range since 2004**, broken only by the recession of late 2008.

Ozone Trends Across the U.S. 2000-2014

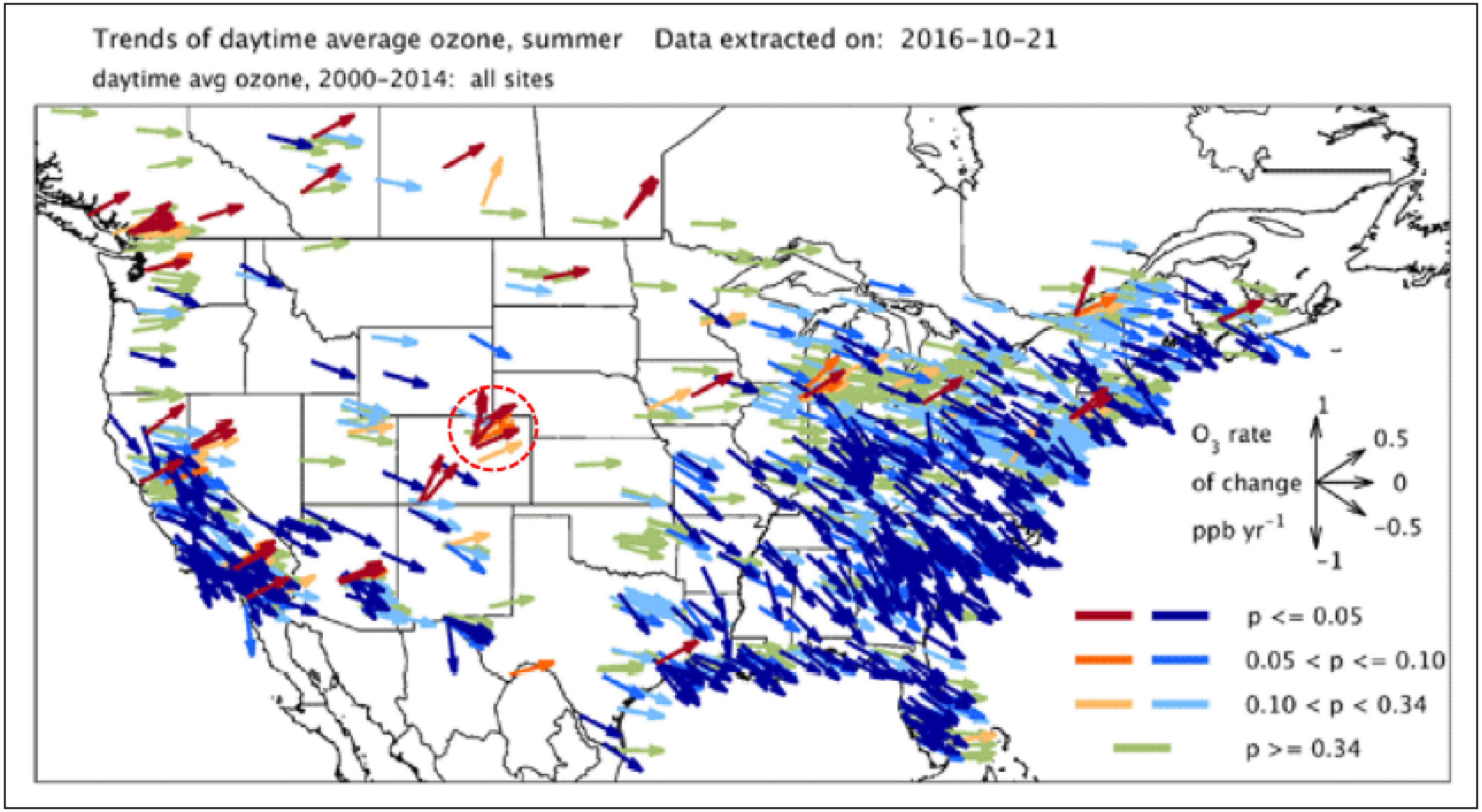
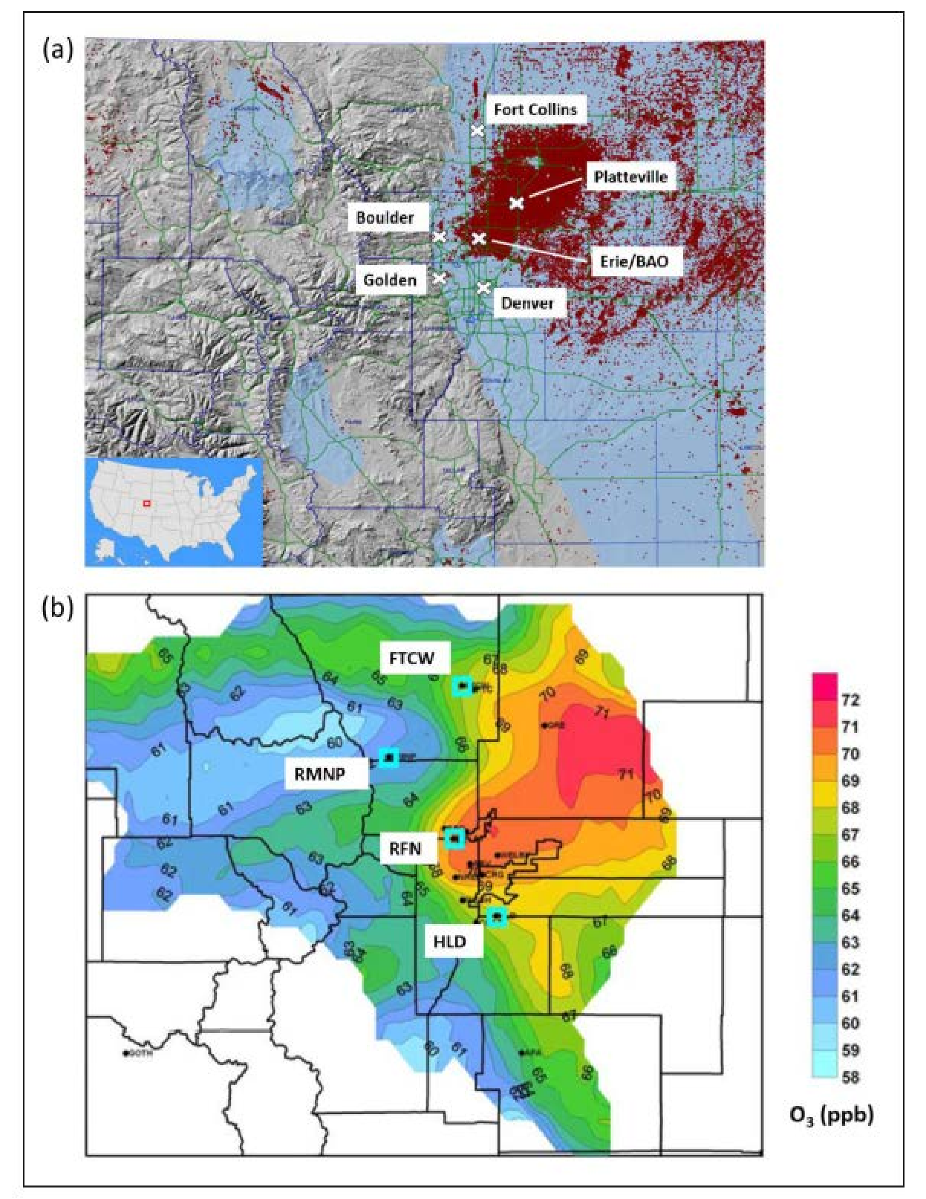


Figure 6: Regional trend analysis of surface ozone observations from monitoring in the U.S. and Canada. These results reflect the 2000–2014 changes in summer ozone [*Chang et al.*, 2017]. The arrow direction indicates the sign and magnitude of the ozone trend according to the scale given in the inset (i.e. downward arrows are indicative of declining ozone), and the color coding shows the statistical significance of the ozone change, with statistical significant changes (at P > 95%) indicated by the bold colors. The DMA/NCFR is indicated by the red circle. This figure is a partial reproduction of Figure 1 in *Chang et al.* (2017). DOI: https://doi.org/10.1525/elementa.398.f6

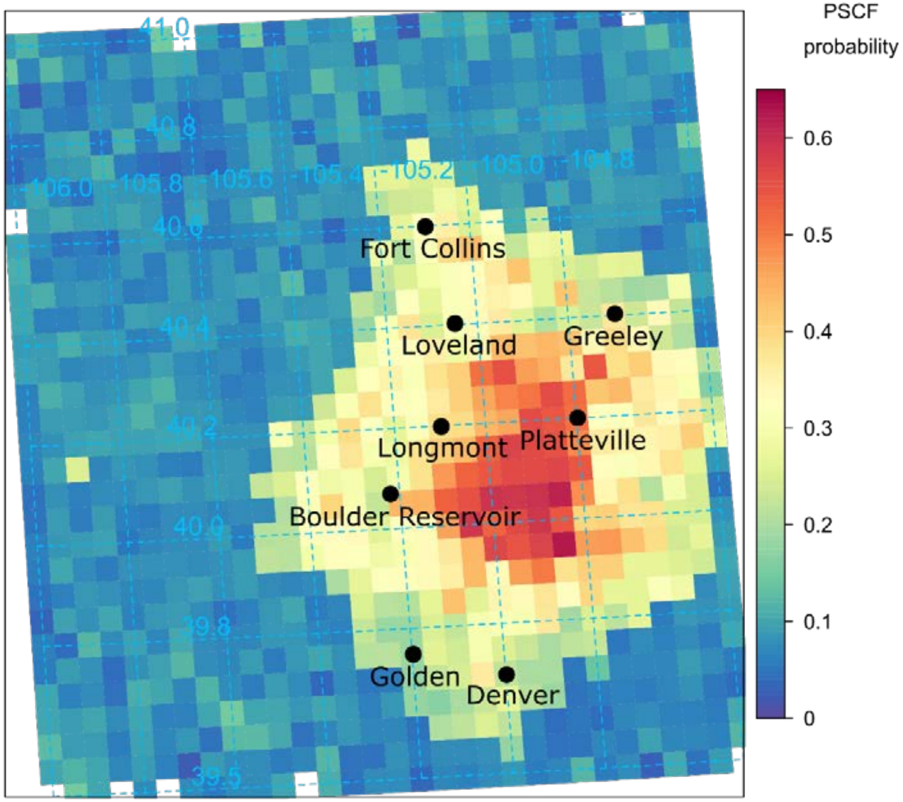
Influence of Oil and Gas Development on Colorado Ozone



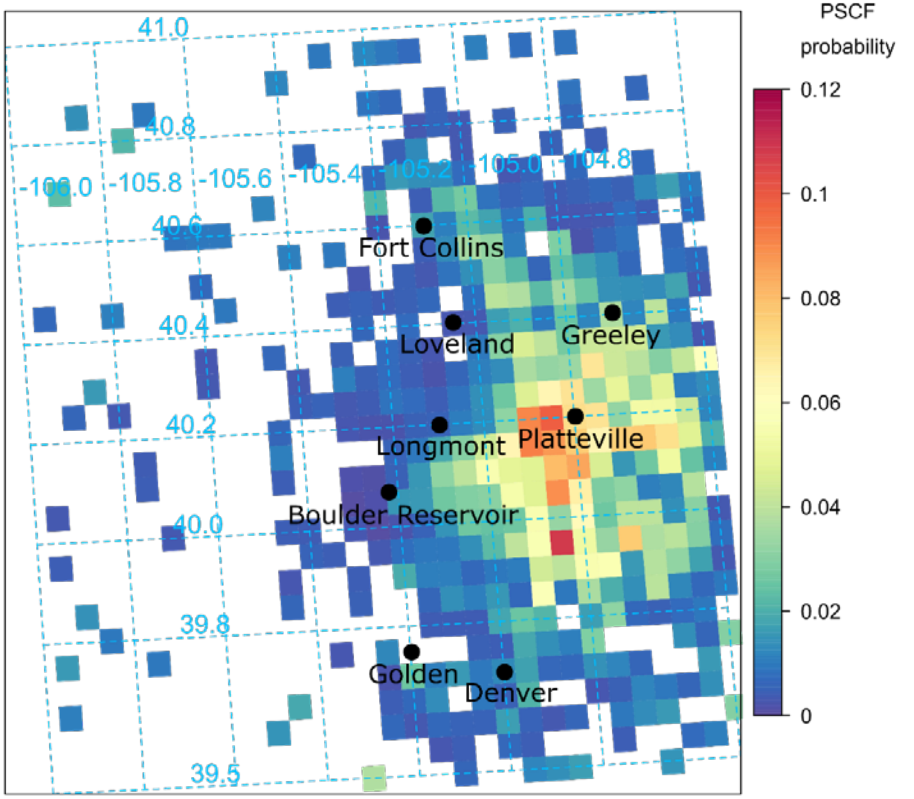
CDPHE, 2008 and Helmig, 2018

Footprint Analysis for High Ozone at the Boulder Reservoir

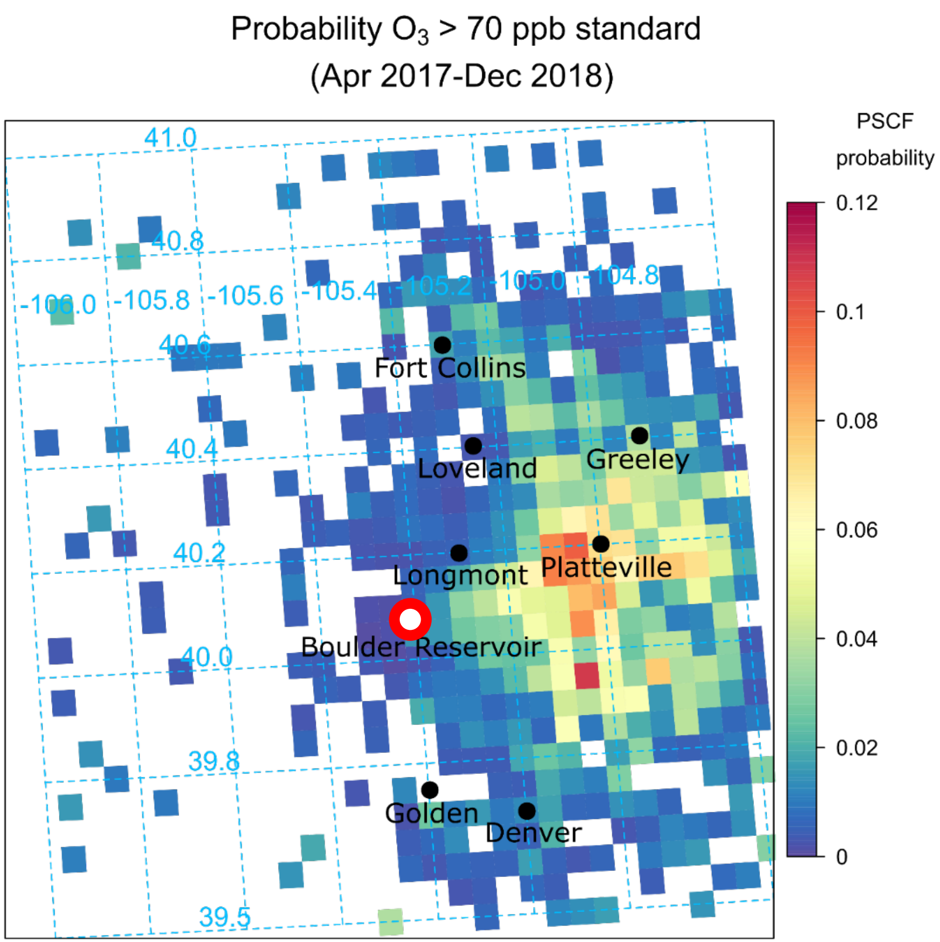
Probability O_3 > 50th percentile
(Apr 2017-Dec 2018)

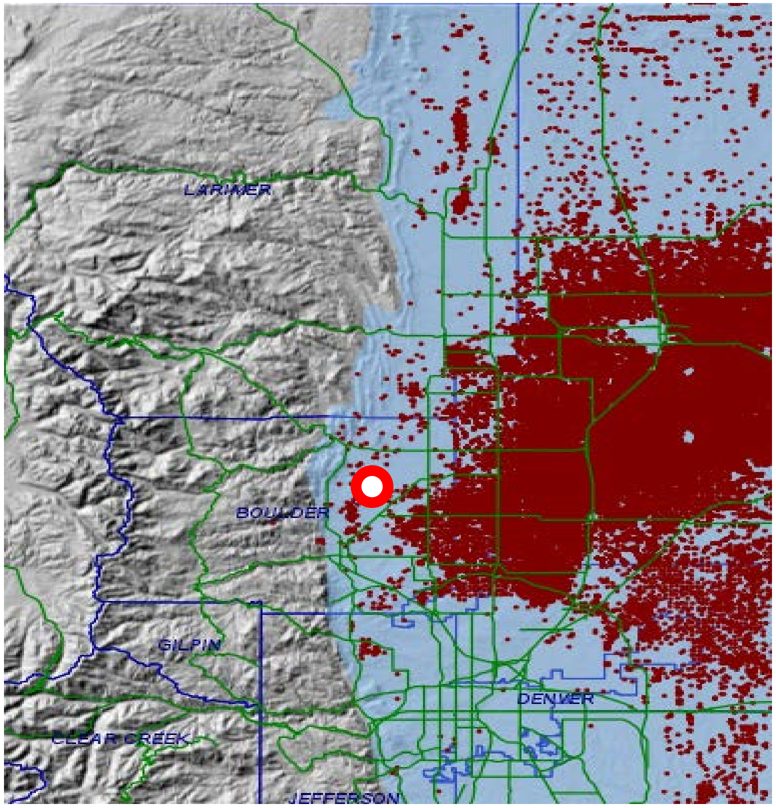


Probability O_3 > 70 ppb standard
(Apr 2017-Dec 2018)



Footprint Analysis for High Ozone at the Boulder Reservoir





Oil and Gas Emissions and Ozone

Pfister et al., 2017: "On average, **oil and gas emissions** show a stronger influence in the northern part of the NFRMA and the northern foothills, while mobile emissions dominate farther south and in the southern foothills. Both sectors **contribute, on average, 30-40%** each **to total NFRMA ozone production** on high ozone days."

Evans et al., 2017: "**Transport** from upwind areas associated with abundant **O&NG operations** accounts for on the order of **65%** (mean for both sites) **of 1-hr averaged elevated ozone levels**, while the Denver urban corridor accounts for 9%."

Cheadle et al., 2017: "On individual days, **oil and gas O_3 precursors can contribute in excess of 30 ppb to O_3 growth** and can lead to exceedances of the EPA O_3 National Ambient Air Quality Standard."

Oltmans et al., 2019: "The association of high O_3 days at the BAO tower with transport from sectors with intense oil and natural gas production toward the northeast suggests **emissions from this industry were an important source of O_3 precursors and are crucial in producing peak O_3 events in the NCFR**.

The Path Ahead – Ozone in a Warmer Climate

GEOPHYSICAL RESEARCH LETTERS, VOL. 36, L09803, doi:10.1029/2009GL037308, 2009

Observed relationships of ozone air pollution with temperature and emissions

Bryan J. Bloomer,[1,2] Jeffrey W. Stehr,[2] Charles A. Piety,[2] Ross J. Salawitch,[2] and Russell R. Dickerson[2]

Received 14 January 2009; revised 11 March 2009; accepted 27 March 2009; published 5 May 2009.

[1] Higher temperatures caused by increasing greenhouse gas concentrations are predicted to exacerbate photochemical smog if precursor emissions remain constant. We perform a statistical analysis of 21 years of ozone and temperature observations across the rural eastern U.S. The climate penalty factor is defined as the slope of the ozone/temperature relationship. For two precursor emission regimes, before and after 2002, the climate penalty factor was consistent across the distribution of ozone observations. Prior to 2002, ozone increased by an average of ~3.2 ppbv/°C. After 2002, power plant NO_x emissions were reduced by 43%, ozone levels fell ~10%, and the climate penalty factor dropped to ~2.2 ppbv/°C. NO_x controls are effective for reducing photochemical smog and might lessen the severity of projected climate change penalties. Air quality models should be evaluated against these observations, and the climate penalty factor metric may be useful for evaluating the response of ozone to climate change. **Citation:** Bloomer,

ship has been investigated in the past [*Sillman and Samson*, 1995; *Sillman*, 1999]. However, questions remain regarding how this relationship changes over time, by location, and with precursor emissions.

[4] Modeling studies suggest a penalty in ozone air quality resulting from forecast climate changes. *Wu et al.* [2008] forecast a penalty of 2 to 5 ppbv in daily maximum 8-hour averaged surface ozone amounts in parts of the eastern U.S., offsetting expected air quality improvement from emission reductions, between 2000 and 2050. *Jacob and Winner* [2009] provide a review of recent modeling of air quality changes under various scenarios of forecasted global climate change and indicate a climate change penalty from 1 to 8 ppbv ozone is likely in the eastern U.S. this century.

[5] Air quality models need evaluation using observations to assess model performance and to establish confidence in the effect of climate change on surface ozone.

The Path Ahead – Ozone in a Warmer Climate

GEOPHYSICAL RESEARCH LETTERS, VOL. 36, L09803, doi:10.1029/2009GL037308, 2009

Observed relationships of ozone air pollution with temperature and emissions

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Received 14 Ja

[1] Higher ... gas conce ... photochemi ... constant. We ... ozone and te ... U.S. The cli ... ozone/tempe ... regimes, bef ... was consistent across the distribution of ozone observations. Prior to 2002, ozone increased by an average of ~3.2 ppbv/°C. After 2002, power plant NO_x emissions were reduced by 43%, ozone levels fell ~10%, and the climate penalty factor dropped to ~2.2 ppbv/°C. NO_x controls are effective for reducing photochemical smog and might lessen the severity of projected climate change penalties. Air quality models should be evaluated against these observations, and the climate penalty factor metric may be useful for evaluating the response of ozone to climate change. **Citation:** Bloomer,

... *and Samson*, ... in regarding ... ocation, and ... n ozone air ... s. *Wu et al.* ... ly maximum ... parts of the eastern U.S., offsetting expected air quality improvement from emission reductions, between 2000 and 2050. *Jacob and Winner* [2009] provide a review of recent modeling of air quality changes under various scenarios of forecasted global climate change and indicate a climate change penalty from 1 to 8 ppbv ozone is likely in the eastern U.S. this century.

[5] Air quality models need evaluation using observations to assess model performance and to establish confidence in the effect of climate change on surface ozone.

With everything else (emissions, meteorology) the same:

-> More ozone in a warmer climate !

->-> More ozone will cause a warmer climate !!

Please welcome

GABRIELLE PETRON
Atmospheric Scientist
Cooperative Institute for Research in Environmental Sciences

PROTECTING OUR AIR:

A CASE FOR TRANSDISCIPLINARY RESEARCH TO SUPPORT EFFECTIVE POLICYMAKING

Gabrielle Pétron
CU BOULDER CIRES
NOAA Global Monitoring Division
Contact: Gabrielle.Petron@noaa.gov

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of their employers and sponsors.

Our Atmosphere has Vital Roles

- Without it, Earth mean surface temperature would be -18°C (0°F)
- It absorbs dangerous solar radiation
- It carries energy and water around

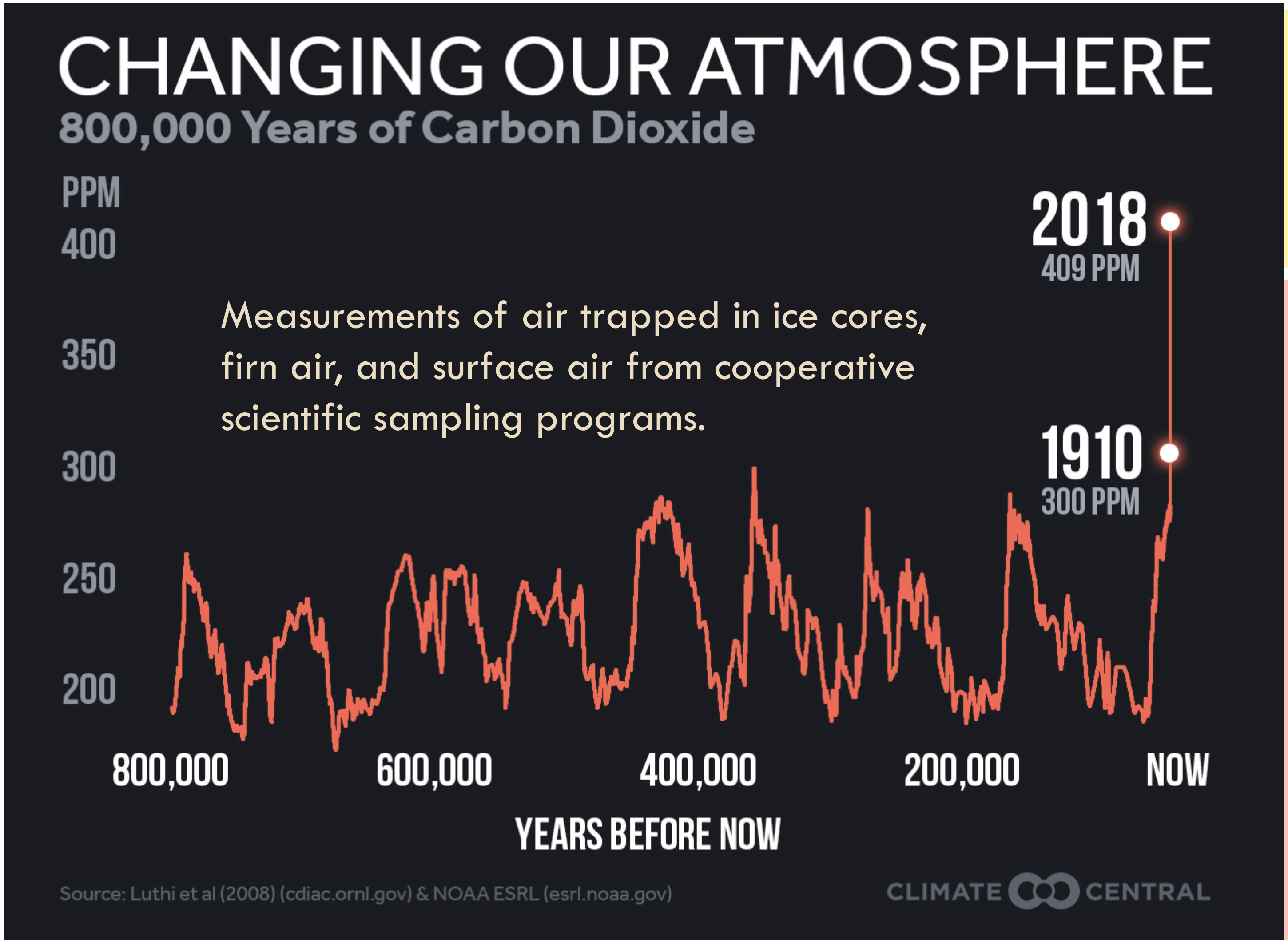
Air Quality, Climate and Health

- Emissions from human activities are changing the air composition at multiple scales:
  - GHG
  - Stratospheric Ozone Depleting Substances (ODS)
  - Ground-level Ozone Precursors
  - Particulate Matter (PM10 and PM2.5)
  - Air Toxics

High-quality Multiple Species Air Monitoring is ESSENTIAL

- **Background Air Composition:**
  - Document large scale (clean continental and marine air) "baseline" and how it changes
  - Can be used to study drivers and attribute large scale changes to natural or human causes
  - Can be used to evaluate emission inventories and atmospheric dispersion
  - Can be used directly to model and study climate response

Why now is a critical time?



End of 2019 Global mean ~ 411 ppm

The world and societies as we know them have never seen such high levels of GHG.

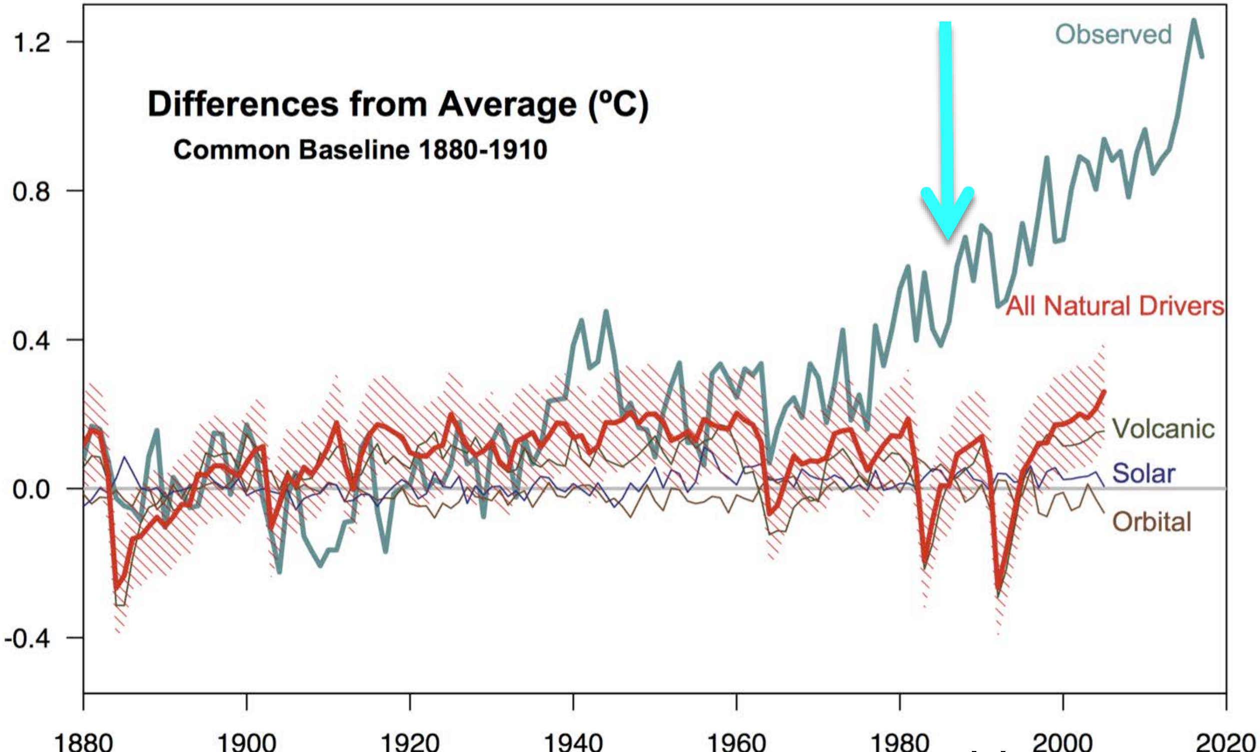
We have known this for a while.

1988- 2018 30 yr anniversary of J. Hansen Senate Testimony

Former NASA Scientist and NASA GISS Director.

"J. Hansen was correct to claim that greenhouse warming had been detected"

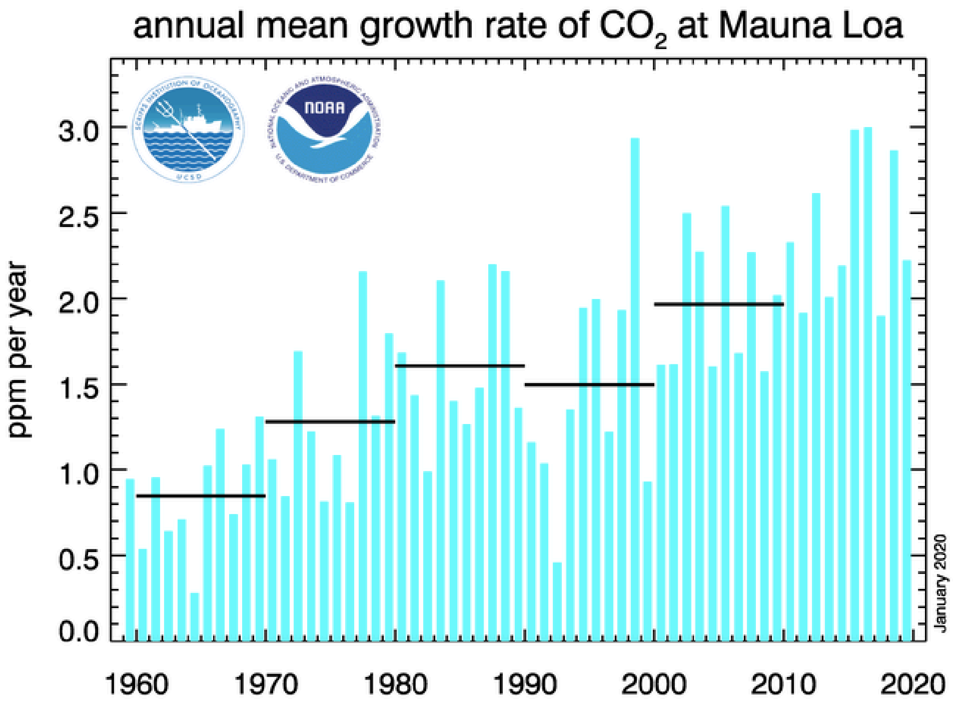
Natural drivers and natural variability cannot explain the observed rise in global mean temperature over land and oceans.



realclimate.org

Global fossil fuel CO_2 emissions: **1988-2018 + 70%**
In billion tonnes, 1960s: 10; late 1980s: 20; 2019: 37

2010-2019
Annual CO_2 growth rate > 2ppm/yr

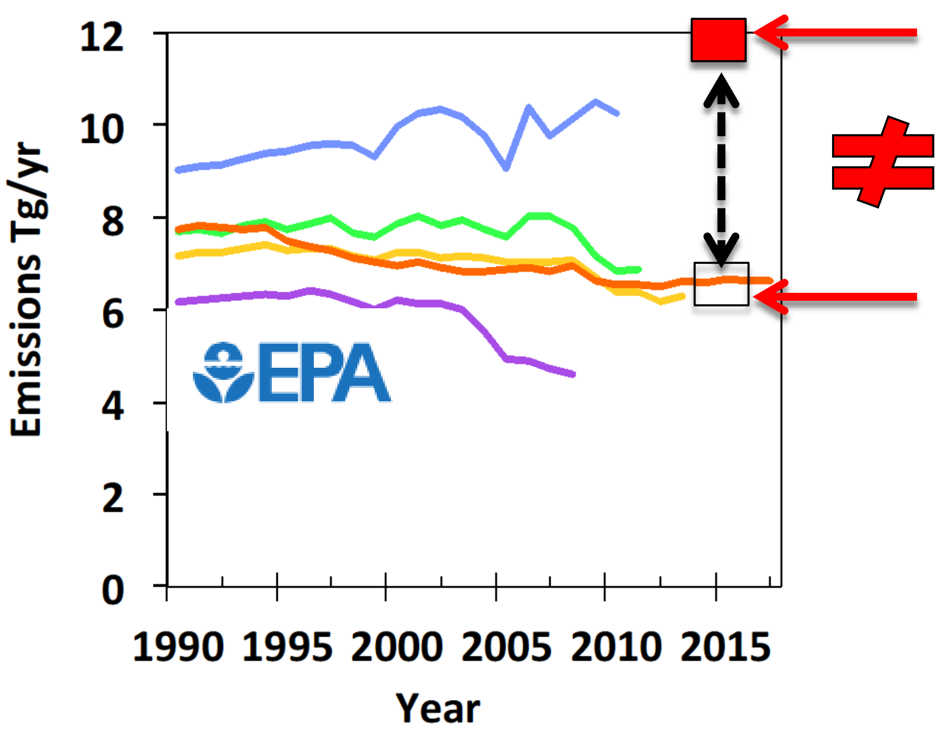


Atmospheric CO_2 annual increase has crept up over the past 40 years, as fossil fuel burning emissions have increased.

~ Half of anthropogenic CO_2 emissions stay in the the atmosphere. The other half is taken up by plants and the oceans.

- Will these natural sinks keep up?
- What will happen to the carbon buried in the melting permafrost?

Estimates of US CH_4 emissions from natural gas systems still disagree by A LOT !



EDF coordinated 16 scientific studies of CH_4 emissions from US O&G systems. Studies covered different scales and used an array of instrumentation. Several companies participated and provided site access.

Major studies reveal 60% more methane emissions

Extensive research led by EDF from 2012 to 2018 shows methane leaks in the U.S. are **a far greater threat** than the government's estimate suggests.

https://www.edf.org/climate/methane-studies

High-quality Air and Emission data for Cities, Counties and States are also ESSENTIAL

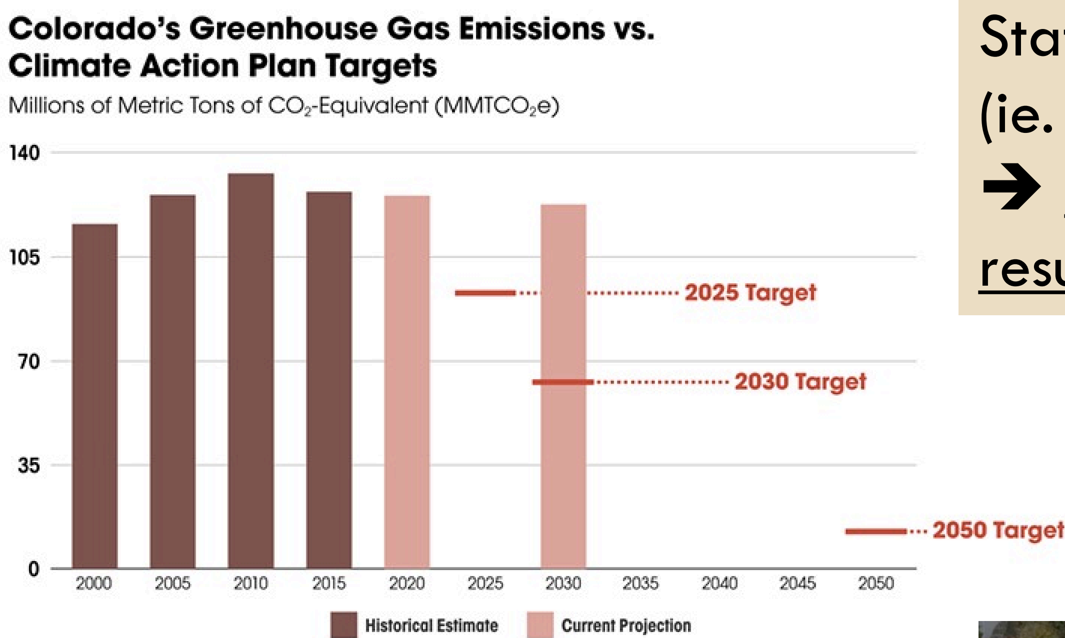
- **Regional / Urban Air Composition:**

  Do we have enough high quality data to assess pollution and impacts?

- **Regional / Urban Emissions:**

  How accurate are emission inventories and estimated trends?

Colorado GHG Emission Inventory and **non-binding** Future Targets



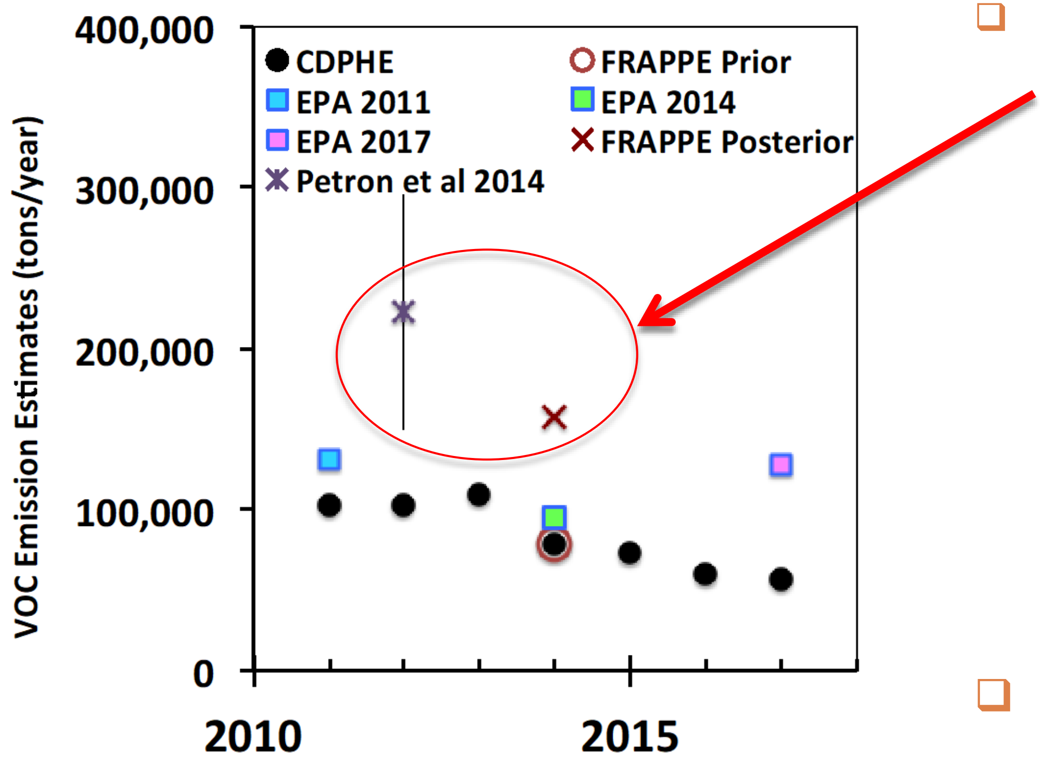
State uses EPA <u>State Inventory Tool</u> (ie. set of spreadsheets).
➔ <u>The accuracy of inventory results is not known.</u>

Projected emissions are much higher than targets.

How is the State (country!) going to tackle this huge challenge?
Which expertise and buy-ins are needed to lead to lasting meaningful decisions and actions?

We cannot continue to fail "miserably".

State O&G VOC emissions have been very likely underestimated for a while

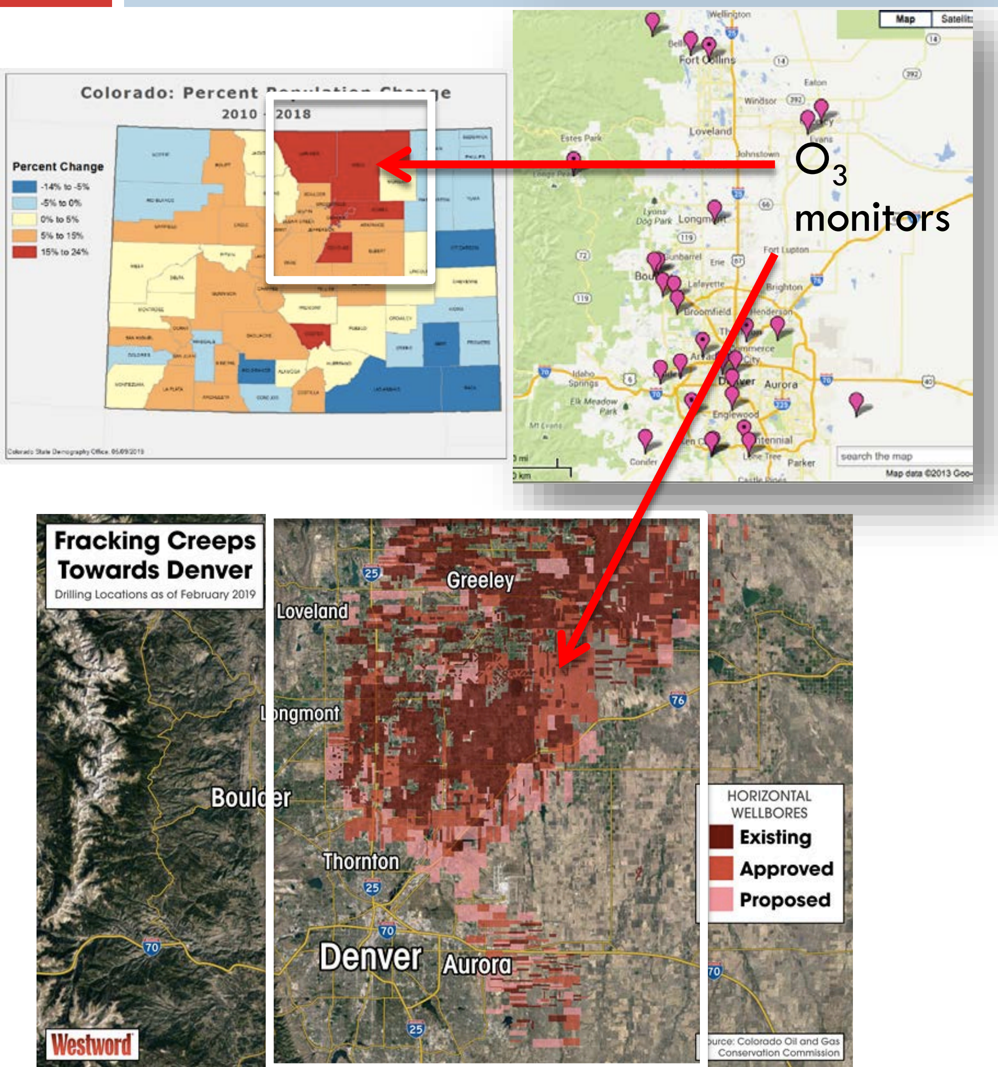


- Measurement-based scientific studies have found VOC and benzene emissions from O&G in NE Colorado are at least double what is in the State inventory (see Figure).
- **Need for transparency, objective evaluation and reconciliation**

What could be wrong?

- Underestimated emissions and/or missing sources
- Outdated emission composition profiles, most predate Niobrara drilling

Looking beyond Denver: Colorado NE Front Range transformation



- O&G operations and vehicles are the largest contributors to surface ozone in CO ozone non-attainment area.
- Population and O&G sites and production have been soaring in Colorado NE over the past ten years
- **Could/Should State deploy new air quality monitors in the O&G region?**

Large multi-well pads are the new normal esp. in urban/suburban drilling

22 well pad in West Greeley, 2018

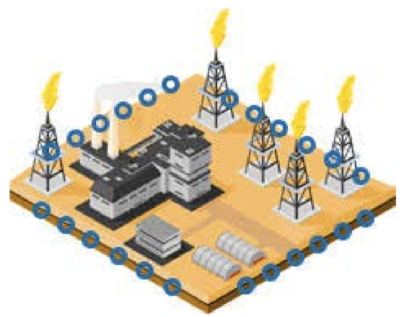
Ambient benzene regulation in the US has focused on refineries and vehicle emissions

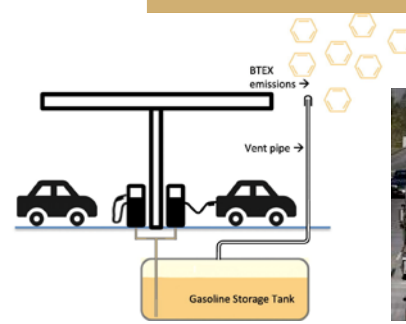
Oil and Natural Gas Extraction Sites and Waste Disposal Facilities

VERY few exposure studies for/near O&G upstream operations!

Oil and Natural Gas Refining/Processing

Gasoline and Natural Gas Distribution and Consumption





- US benzene content in gasoline ~ 1%

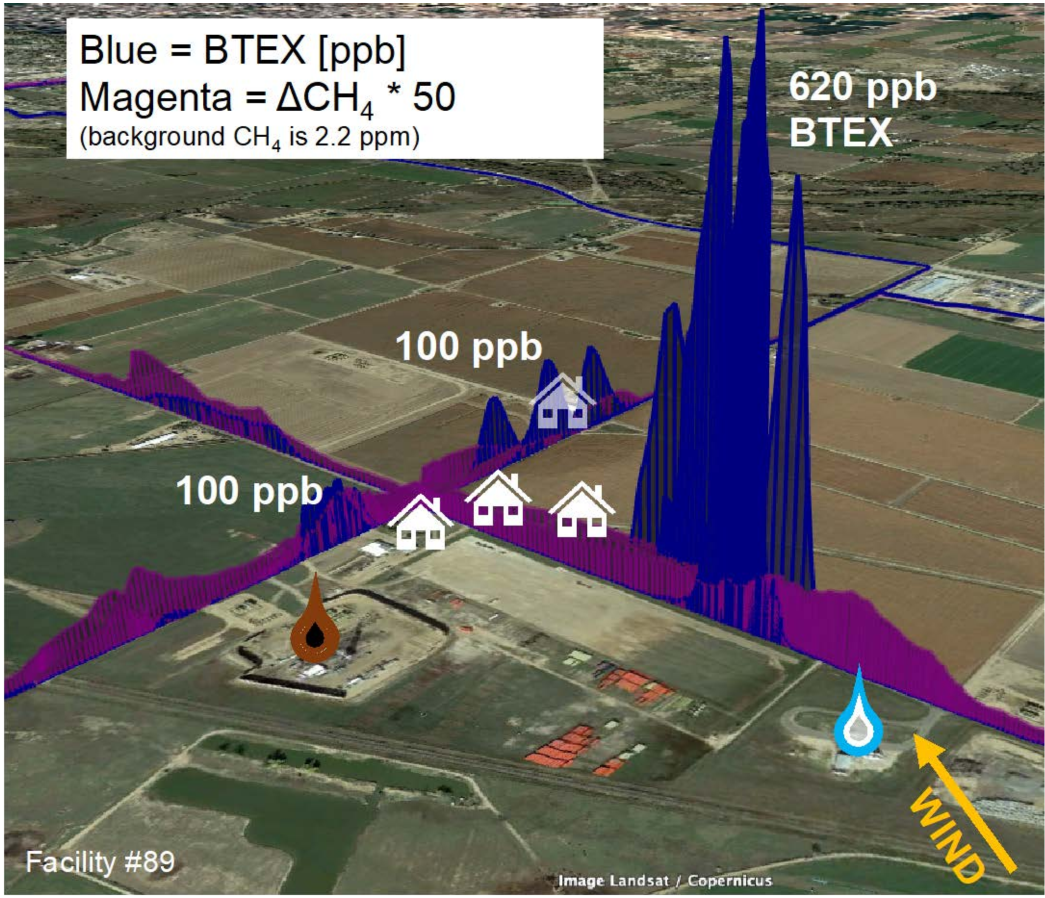
➔ Benzene in cities has gone down

- 52 countries have ambient benzene standards, the US is not one of them.

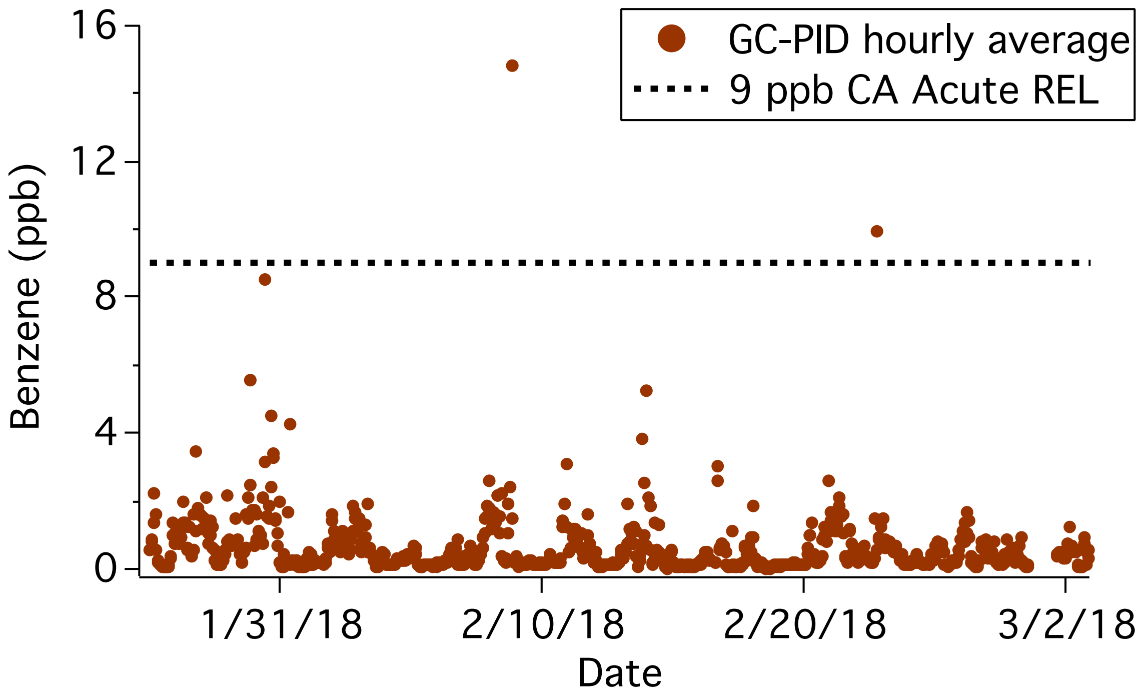
Air Toxic Studies (paper in preparation)

- University of Wyoming Mobile lab study found very high BTEX (10s to >100ppb benzene) downwind of Produced Water Injection Facilities, confirming finding from a few grab samples during 2014 FRAPPE.

Edie et al., in preparation



Air Toxic Studies (papers in preparation)



- 24/7 monitoring of BTEX for several weeks near 2 new large wellpads (early production and drilling) show variable hourly mean levels: sub-ppb to > 9 ppb.

Mielke-Maday et al.,
Madronich, Mund, Handley et al.,
Both in preparation

Summary I

Scientific evidence

- The accuracy of State and National inventories for GHG, ozone precursors and air toxics is poorly known.
- Air toxics O&G sources and exposure levels for workers and nearby population in CO are still poorly known.
- The CO Northern Front Range has been non-attainment for ozone for 15 years.

Other Factors Growing population and economic activities bring new environmental challenges.

Public perceptions of risks and impacts are valid and need adequate responses.

Hypothesis: Air pollution and climate change present real and likely growing risks for the State population, ecosystems and economy.

How could scientific inquiry, methods and findings further support local and State air resource management and sustainability programs?

Summary II

There is a need to better integrate public input, scientific investigation and different pieces of evidence into policy development

- Start with an objective scientific evaluation of existing AQ measurements (long-term and field studies)
  - Data quality? Is method okay? How representative are they?
- Identify and analyze other "useful" data sets
  - LDAR reports from inspectors versus company self reporting
- Evaluate and improve accuracy of emission inventories
- Prioritize Future Research
  - New measurements and analyses
  - Improve methods, data management, and transparency

Please welcome

JOHN PUTNAM

Director of Environmental Programs

Colorado Department of Public Health & Environment

Colorado Air Quality and Public Health

Status and Upcoming Efforts

John E. Putnam,
Director of Environmental Programs

COLORADO
Department of Public
Health & Environment

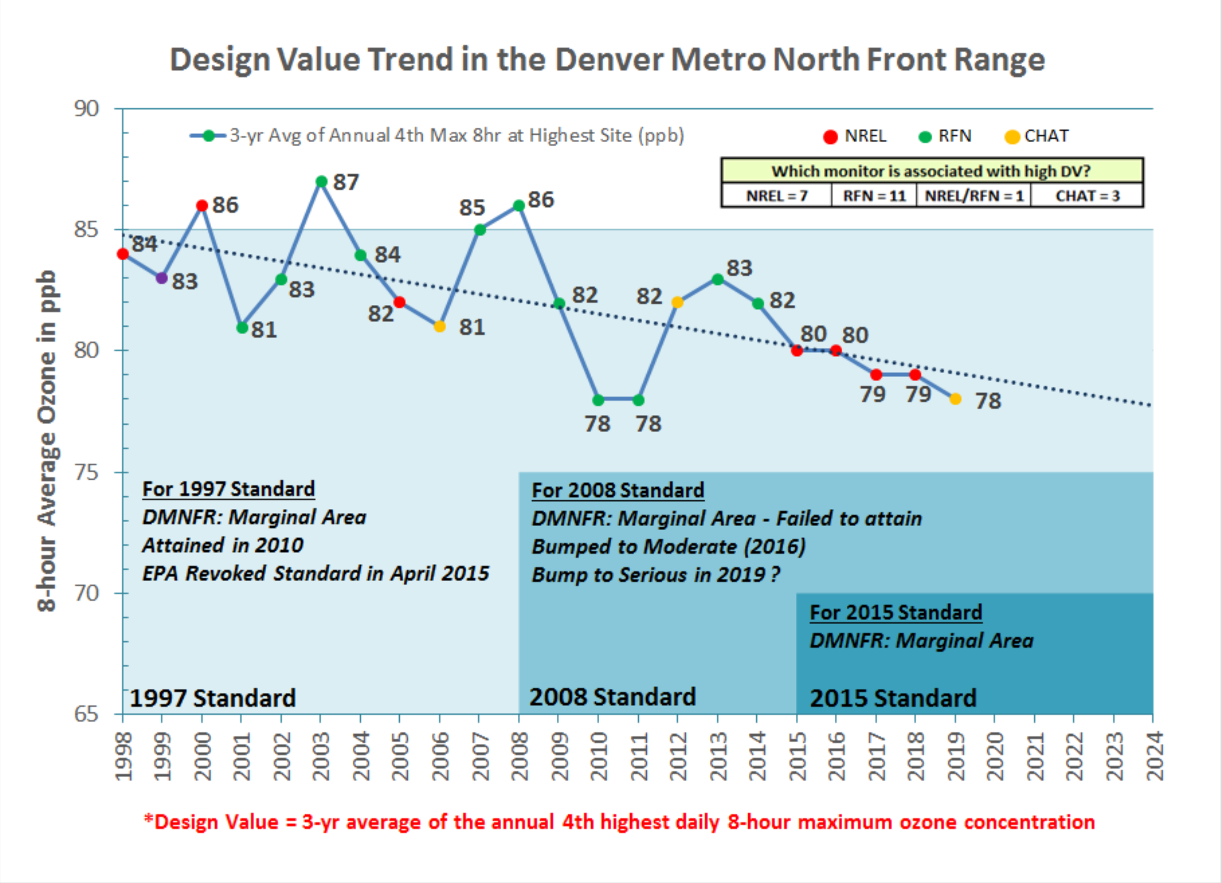
Air Pollution and Health in Colorado

Pollutant	Effects	Major Laws and Actions
Ground level ozone	Respiratory Cardiovascular	H.B. 19-181 Reclassification to Serious
Climate Change (CO_2, methane, hydrofluorocarbons, etc.)	Heat stress, wildfire smoke, ozone, infectious disease, economic stresses, etc.	H.B. 19-1261 S.B. 19-096 S.B. 19-236
Air toxics (benzene, etc.)	Wide array of acute and chronic, including cancer, respiratory, neurological	S.B. 19-181
Particulate Matter – Fine PM	Respiratory Cardiovascular	In compliance with federal ambient standards Are they sufficiently protective? Co-benefits with other laws
Indoor air quality	Wide range of acute and chronic effects	Co-benefits with other laws Asbestos and radon

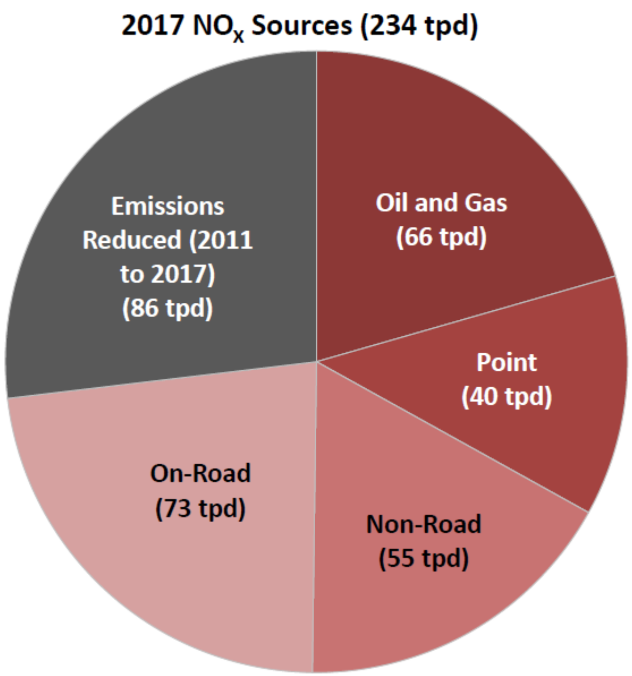
Denver Metro/North Front Range AQ Status

Fine Particulates ($PM_{2.5}$)	Attaining
Nitrogen Dioxide (NO_2)	Attaining
Sulfur Dioxide (SO_2)	Attaining
Lead (Pb)	Attaining
Carbon Monoxide (CO)	Attained in 1996 – Maintenance Area
Coarse Particulates (PM_{10})	Attained in 1993 – Maintenance Area
Ozone (O_3)	
1979 1-hour standard: 125 ppb	Attained 1987 (Standard Revoked)
1997 8-hour standard: 84 ppb	Attained in 2009 (Standard Revoked)
2008 8-hour standard: 75 ppb	Out of compliance
2015 8-hour standard: 70 ppb	Out of compliance

Ozone: Denver and North Front Range

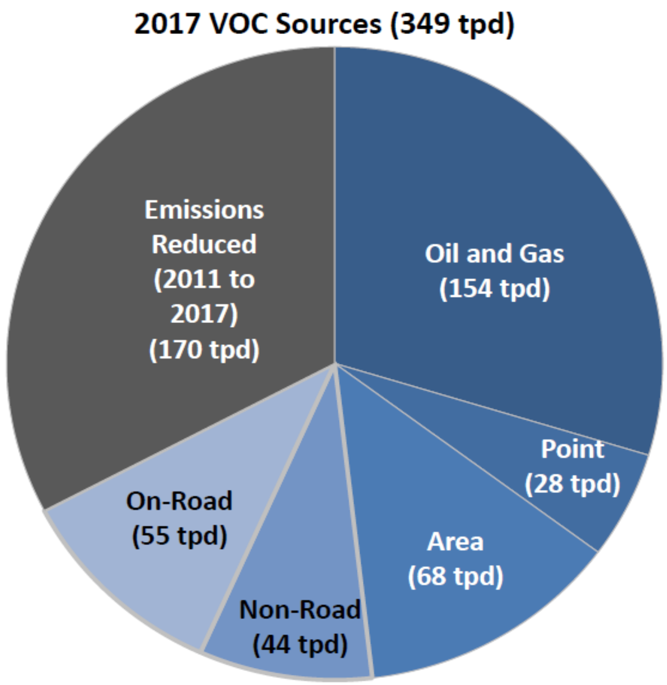


NOx Emissions Inventory and Controls (Denver and North Front Range)



- ✓ New car/truck standards
- ✓ Cleaner fuels/ Alternative fuels
- ✓ Inspection/maintenance programs
- ✓ Diesel retrofits
- ✓ New vehicle technologies
- ✓ Transportation/land use policies
- ✓ Travel reduction programs
- ✓ Power Plants
  - *Clean Air Clean Jobs Act*
  - *Regional Haze program*
  - *Renewable energy/ energy efficiency programs*
- ✓ Small engine standards
- ✓ Non-road engine standards
- ✓ Locomotive engine standards
- ✓ Emissions Standards for Large Engines and Boilers

VOC Emissions Inventory and Controls (Denver and North Front Range)

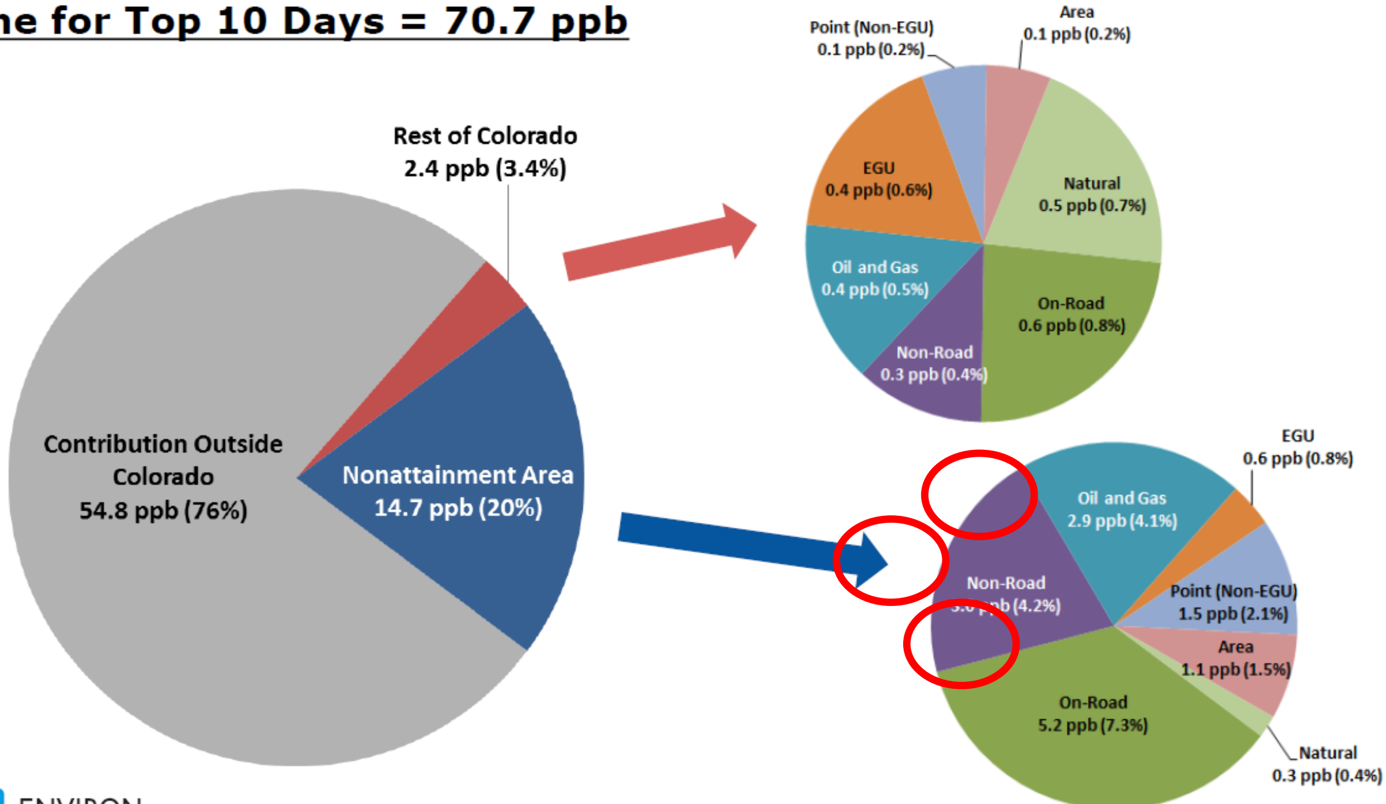


- ✓ New car/truck standards
- ✓ Cleaner fuels/ Alternative fuels
- ✓ Inspection/maintenance programs
- ✓ New vehicle technologies
- ✓ Transportation/land use policies
- ✓ Travel reduction programs
- ✓ Oil and Gas (O&G)
  - *New regulations established by Air Quality Control Commission in Feb. 2014*
- ✓ Lawn and garden equipment change-out programs

RAQC Regional Air Quality Council

2017 NREL – CO SOURCE & REGION CONTRIBUTIONS

Total Ozone for Top 10 Days = 70.7 ppb



RAMBOLL ENVIRON

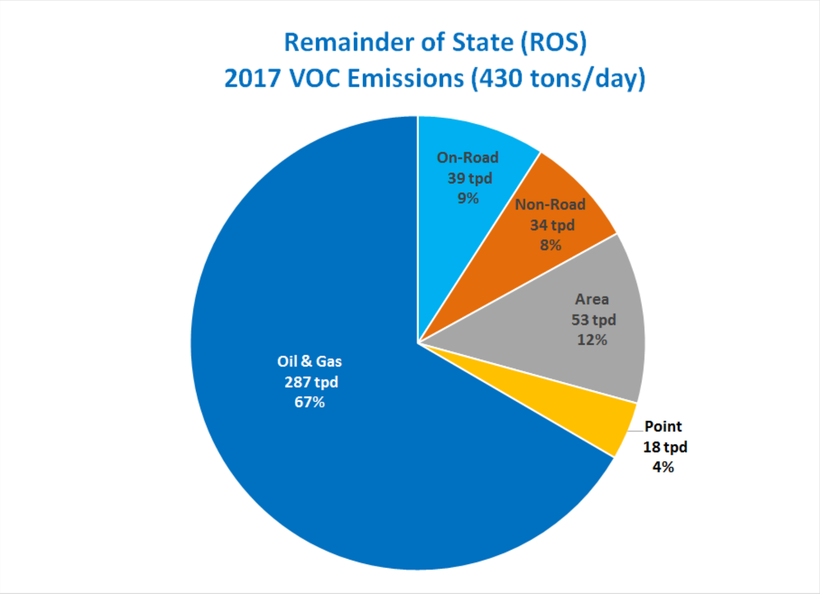
Rest of state ozone trend

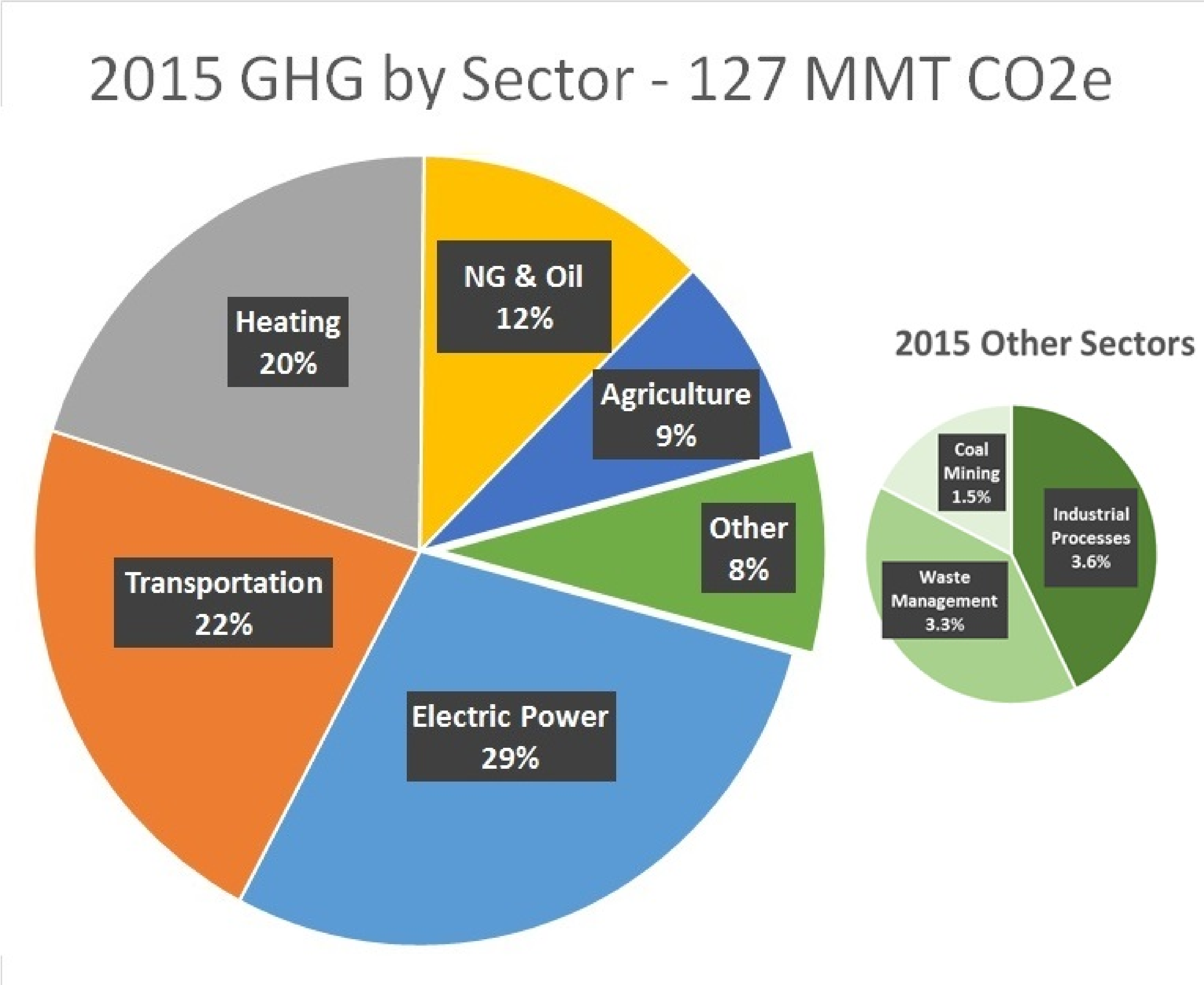
2019 8-Hour Ozone (Updated through Sept. 30, 2019)

AQS #	Site Name	2017 4th Maximum 8-Hour Average Value (ppb)	2018 4th Maximum 8-Hour Average Value (ppb)	2019 (thru 9/30) 4th Maximum 8-Hour Average Value (ppb)	2017 - 2019 3-Year Average 4th Maximum Value (ppb)	*2020 Highest Allowable 4th Maximum 8-Hour Average Value (ppb)*
08-029-0007	BLM - Paonia (started 4/6/18)	---	54	59	---	99
08-041-0013	Colo. Spgs. - USAF Academy	69	73	65	69	74
08-041-0016	Manitou Springs	70	72	64	68	76
08-045-0012	Rifle - Health	59	65	57	60	90
08-051-9991	EPA - Gothic CASTNET	66	69	67	67	76
08-067-1004	USFS – Shamrock (thru n/a)	66	71	n/a	n/a	n/a
08-067-7001	SUIT - Ignacio	69	67	63	66	82
08-067-7003	SUIT - Bondad	69	67	63	66	82
08-077-0020	Palisade - Water	64	69	63	65	80
08-083-0006	Cortez	59	67	60	62	85
08-083-0101	NPS - Mesa Verde NP	66	72	65	67	75
08-097-0007	Aspen/Pitkin	65	64	63	64	85
08-103-0006	BLM - Rangely	64	68	64	65	80

NOTE: Values above the 3-year average 4th maximum 8-hour standard of 70 ppb are highlighted in red, above the 75 ppb standard in orange.

NOTE: Data includes values that may be influenced by natural events.





2015 GHG by Sector - 127 MMT CO2e
Heating 20%
NG & Oil 12%
Agriculture 9%
Other 8%
Transportation 22%
Electric Power 29%
2015 Other Sectors
Coal Mining 1.5%
Industrial Processes 3.6%
Waste Management 3.3%

Major Rulemaking and Planning Initiatives in 2020

- SB 19-096 Inventory and Reporting Rule
- GHG Reductions Roadmap
- SB 19-181 Rules
- SB 19-236 Utility Coordination
- Regional Haze Rulemaking
- Ozone SIP
- Hydrofluorocarbons
- Coal Methane

State Air Quality Opportunities and Constraints

- Political will and support
  - Governor Polis' direction to be bold on air quality and ozone
  - New legislation
- Legal authority
  - New authorities (S.B. 19-181, H.B. 19-1261, S.B. 19-236)
  - But, elements of "go slow" statutory provisions remain
- Resources
  - APCD kept very lean for years
  - No new resources for ozone, oil and gas in 2019-2020 budget
  - Seeking to double oil and gas stationary unit
  - Seeking funds for mobile monitoring capability
- Science and research
  - Lack of consistent, comprehensive funding program in recent past
  - Need better engagement with policy-relevant research
  - Critical for rulemaking, operations, planning

Role of Local Public Health and Governments

- PHIP update
- Public health and air quality data
  - Local monitoring (direct and by permit)
  - Complaints and health data
  - Standardization
  - Support
- Local Initiatives
  - GHG/sustainability plans
  - Built environment (transportation, structures, indoor)
  - Transportation

THANKS!

More questions?

John Putnam
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Colorado Department of Public Health & Environment

Please welcome

BRENDA EKWURZEL

Director of Climate Science

Union of Concerned Scientists

Climate and Air Quality

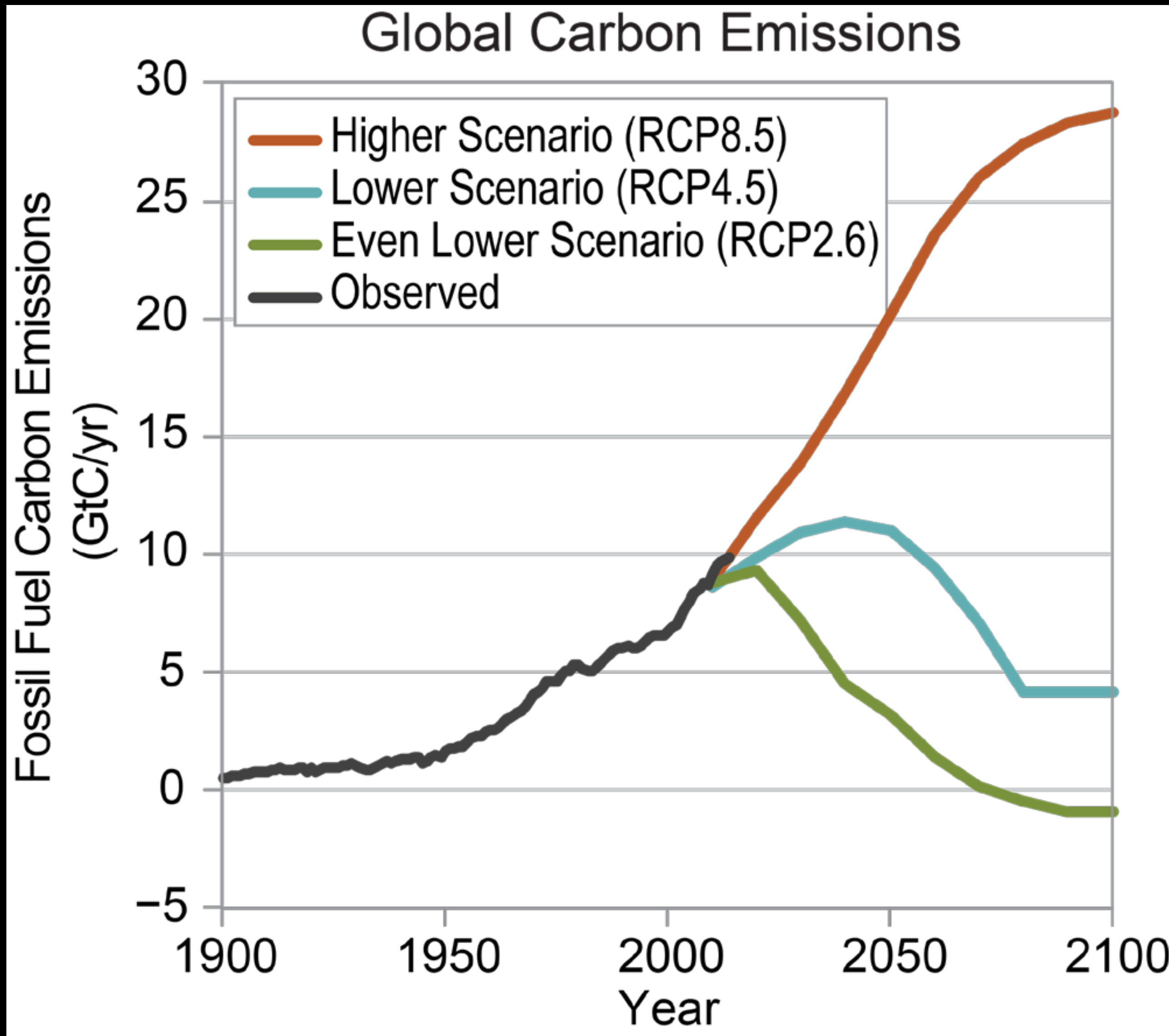
Brenda Ekwurzel, Ph.D.

Director of Climate Science

Union of Concerned Scientists

Denver, Colorado January 16, 2020

Projections based on future emissions scenarios



4.3 °C

2.5 °C

2 °C

Adapted from Wuebbles et al. 2017

Difference between 1986–2016 and 1901–1960 average temperature

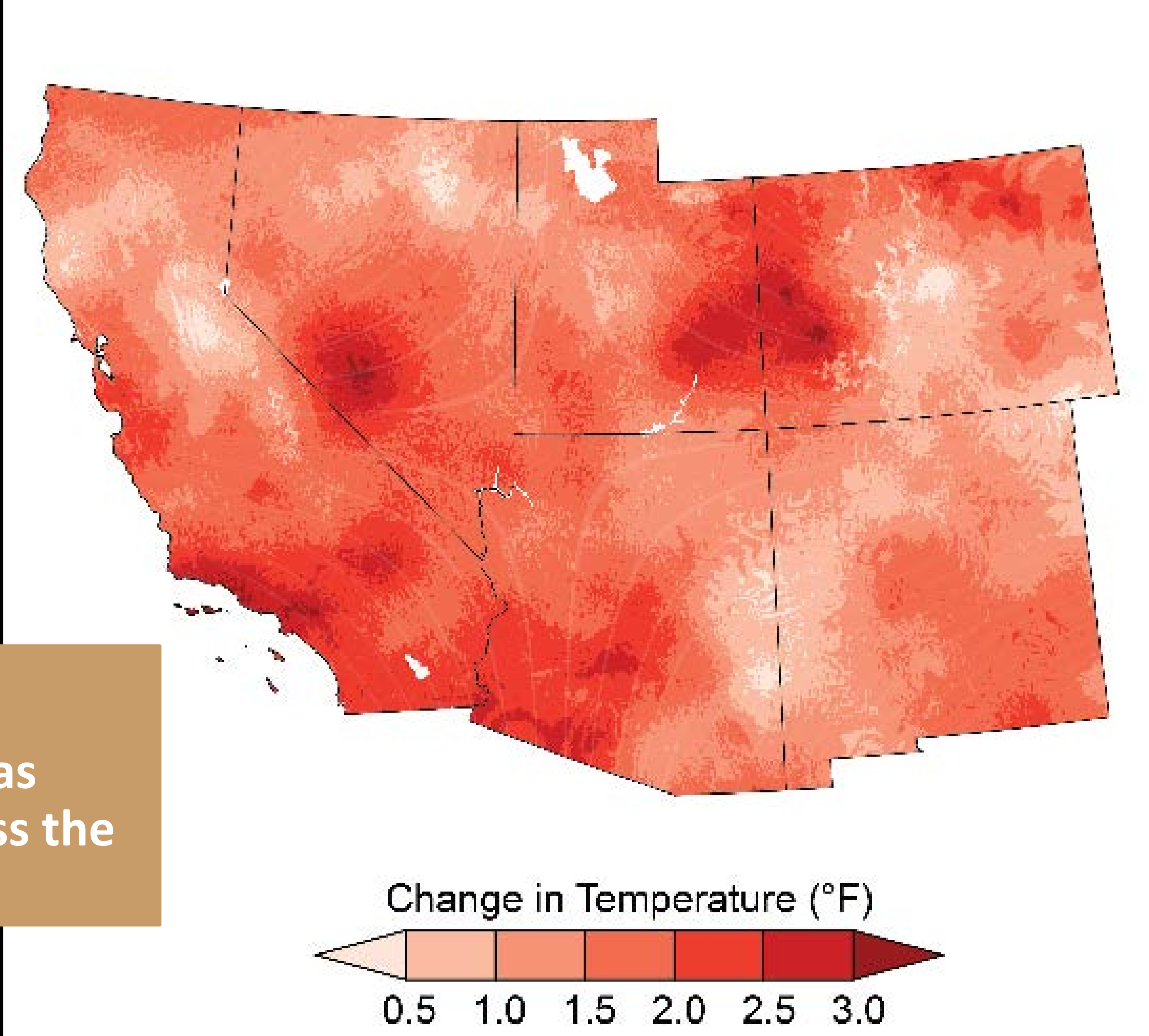
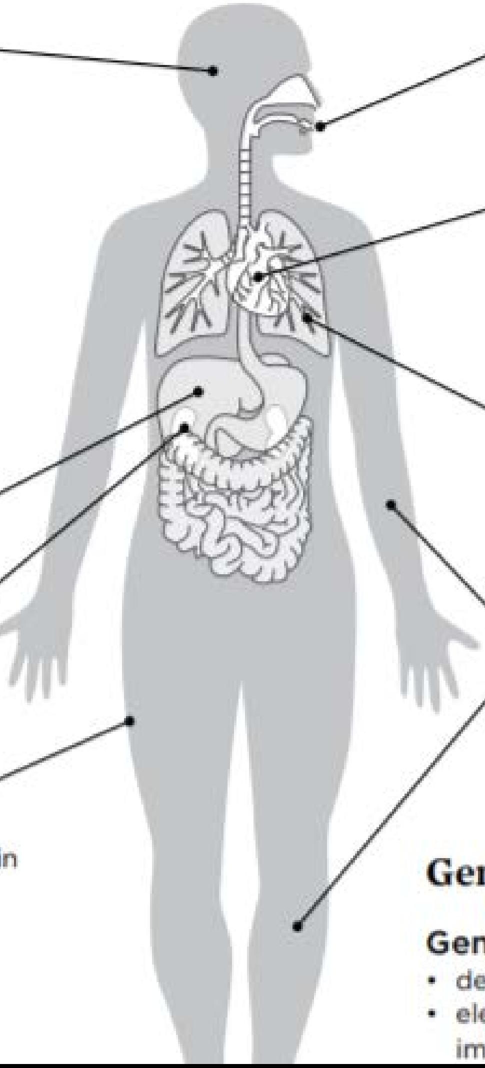


Fig. 25.1: Temperature Has Increased Across the Southwest

Left to right: AP Photo/Napa Valley Register, Liamme Milton; AP Photo/Julio Cortez; lzf/iStock; logoboom/Shutterstock

Union of Concerned Scientists

Killer Heat report available at www.ucsusa.org/killer-heat



Head
- headache
- dizziness
- irritability
- loss of coordination
- confusion
- delirium
- anxiety
- loss of consciousness
- seizures
- stroke
- coma

Liver
- liver injury

Kidneys
- kidney disease
- kidney failure

Skin
- flushed and clammy skin
- profuse sweating
- heat rash

Mouth
- intense thirst
- dry mouth

Heart
- rapid heartbeat
- irregular heartbeat
- reduced bloodflow to the heart
- heart attack

Lungs
- increased breathing rate
- worsened allergies and asthma
- worsened chronic obtrusive pulmonary disease

Arms and Legs
- heat cramps
- muscle spasms
- weakness

General Physiology and Unique Circumstances

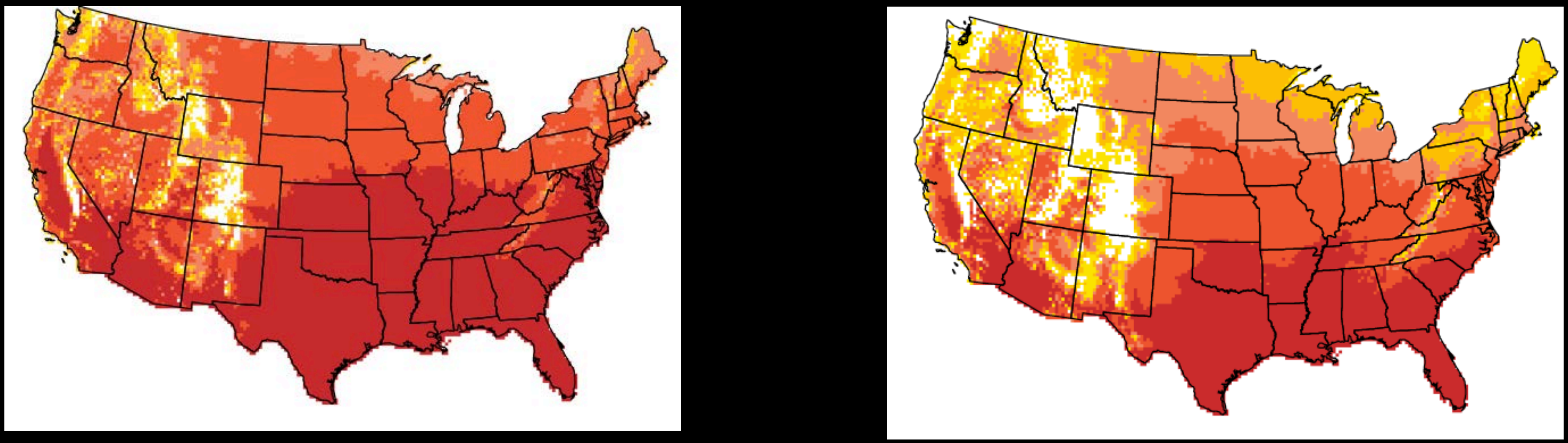
General
- dehydration
- electrolyte imbalance
- vomiting
- drop in blood pressure

Pregnant People
- fetal nutrition deficits
- preterm delivery

FIGURE 8. Frequency of Extreme Heat by Late Century Depends on the Choices We Make

Late Century No Action

Late Century Rapid Action



Heat Index 90°F +

Average Days per Year ☐ 0–1 | >1–10 | >10–25 | >25–50 | >50–100 | >100–200

Killer Heat report available at www.ucsusa.org/killer-heat

TYPE IN YOUR LOCATION (CITY OR COUNTY)

Denver County, CO

CHOOSE HOW HOT

Above 90°

GO

WHERE WE ARE NOW | WHERE WE ARE CURRENTLY HEADED | **WITH BOLD ACTION**

Historically

1971-2000 average

5

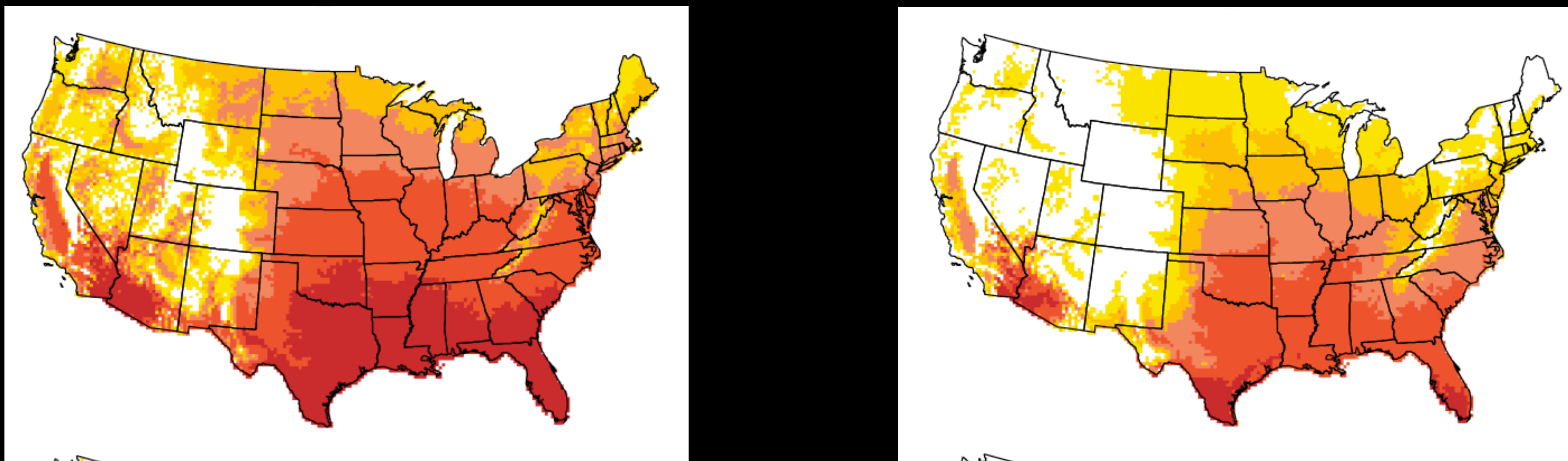
DAYS PER YEAR

[redacted]

FIGURE 8. Frequency of Extreme Heat by Late Century Depends on the Choices We Make

Late Century No Action

Late Century Rapid Action

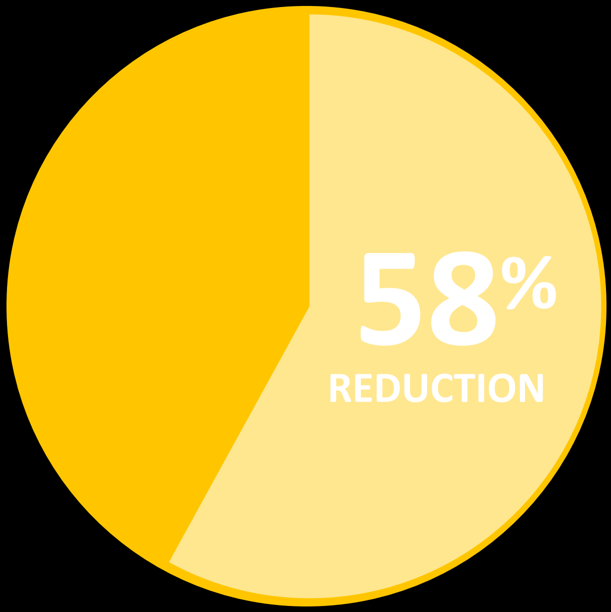


Heat Index 100°F +

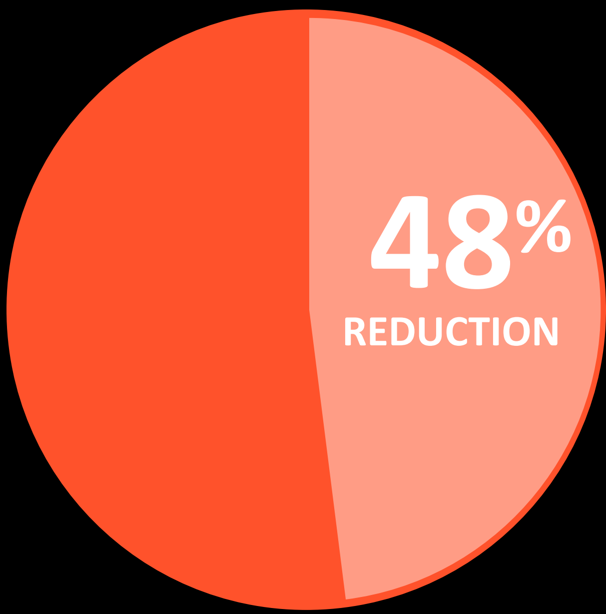
Average Days per Year 0–1 | >1–10 | >10–25 | >25–50 | >50–100 | >100–200

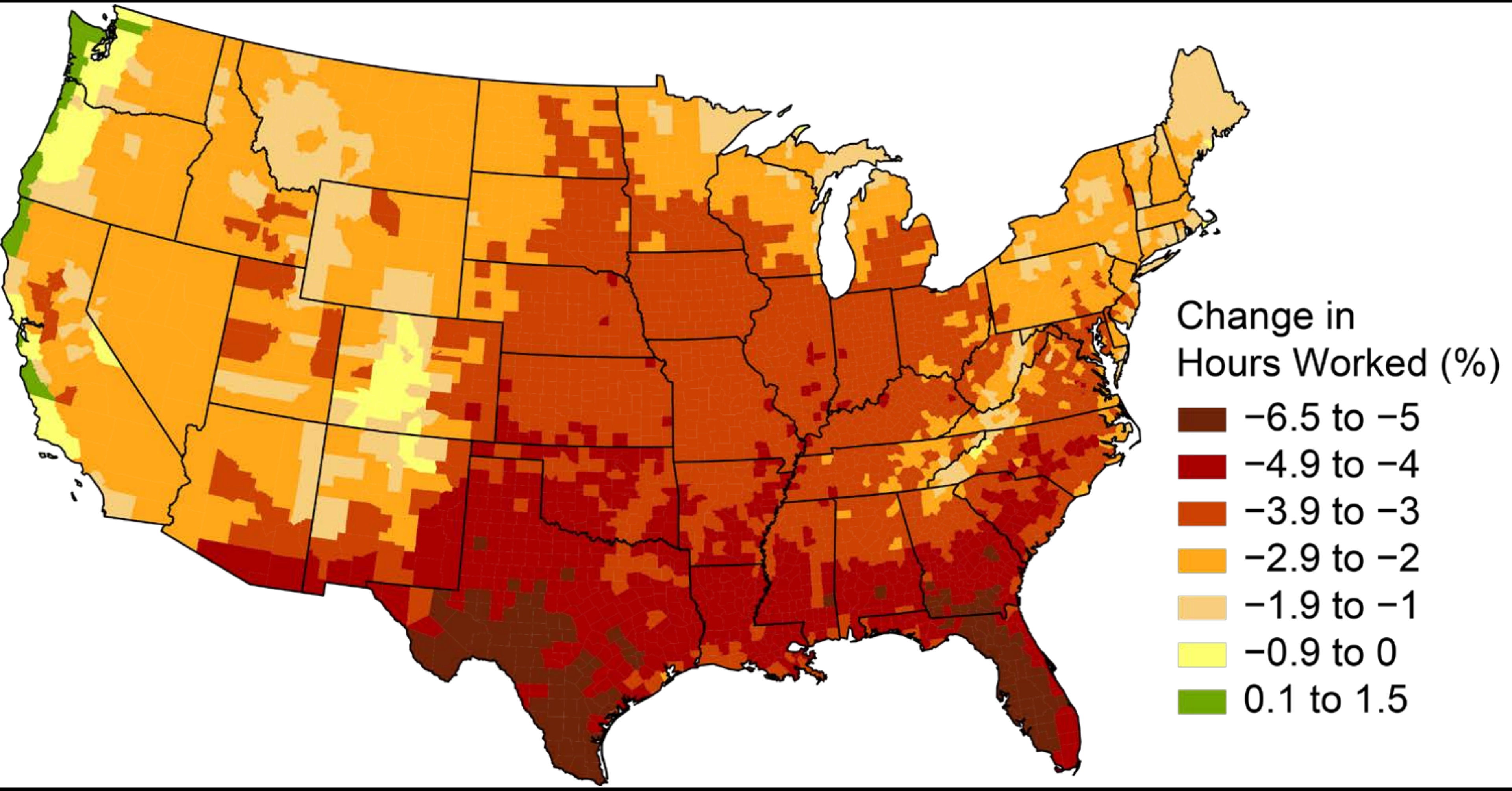
Killer Heat report available at www.ucsusa.org/killer-heat

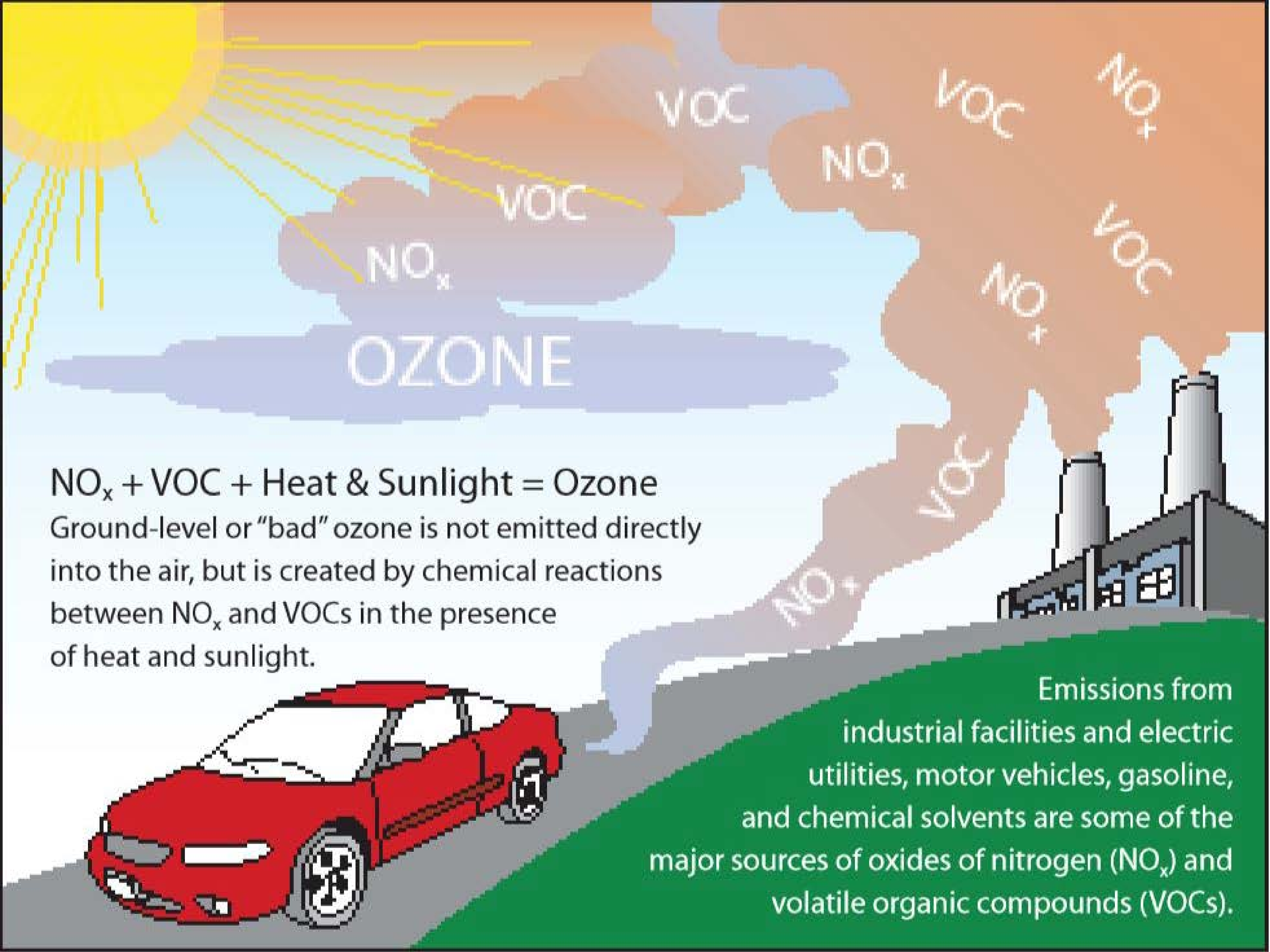
EXTREME TEMPERATURE MORTALITY



LABOR




Change in
Hours Worked (%)
−6.5 to −5
−4.9 to −4
−3.9 to −3
−2.9 to −2
−1.9 to −1
−0.9 to 0
0.1 to 1.5


VOC
VOC
NO_x
VOC
NO_x
VOC
NO_x
NO_x
VOC
OZONE
VOC
NO_x
NO_x + VOC + Heat & Sunlight = Ozone
Ground-level or "bad" ozone is not emitted directly into the air, but is created by chemical reactions between NO_x and VOCs in the presence of heat and sunlight.
Emissions from industrial facilities and electric utilities, motor vehicles, gasoline, and chemical solvents are some of the major sources of oxides of nitrogen (NO_x) and volatile organic compounds (VOCs).

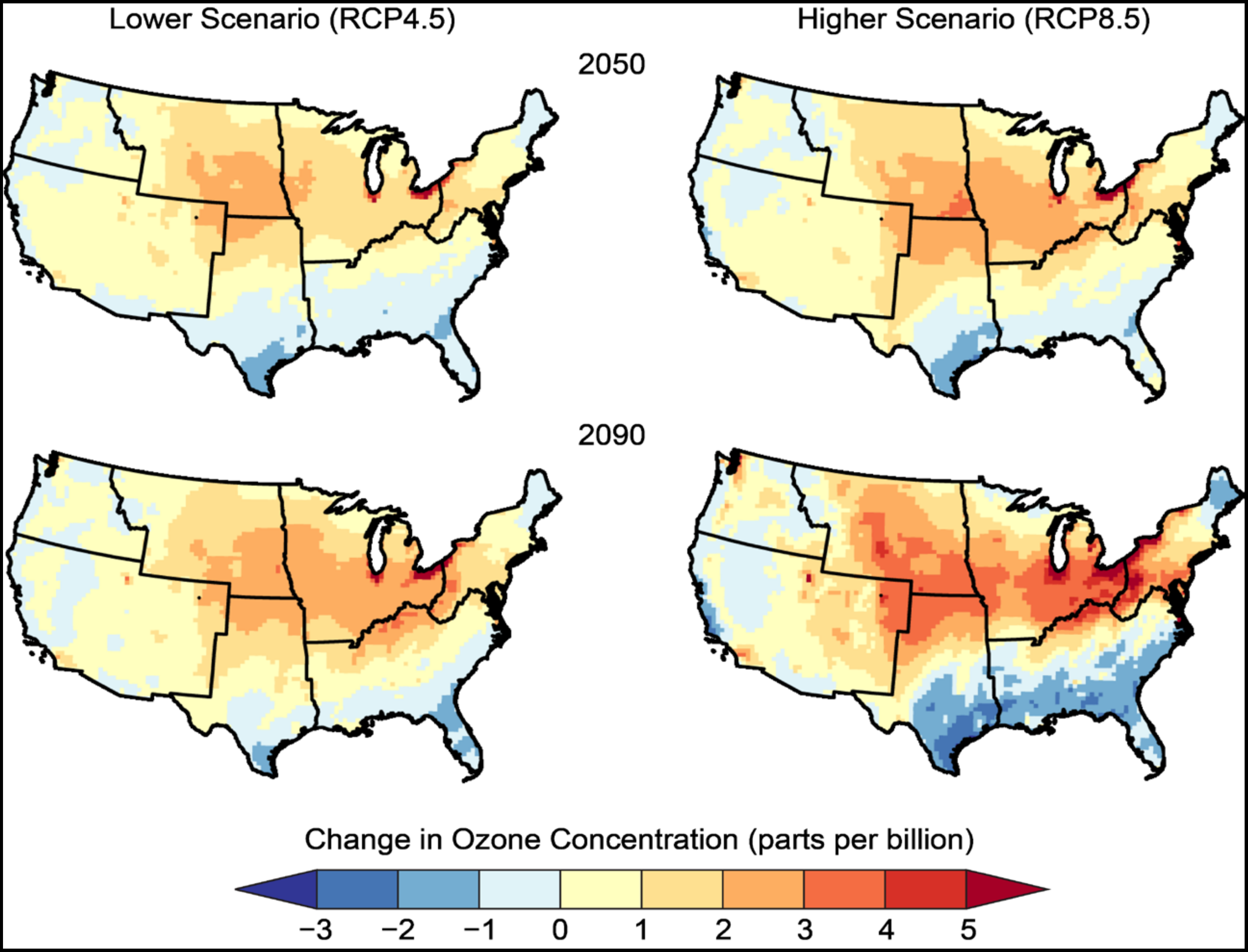
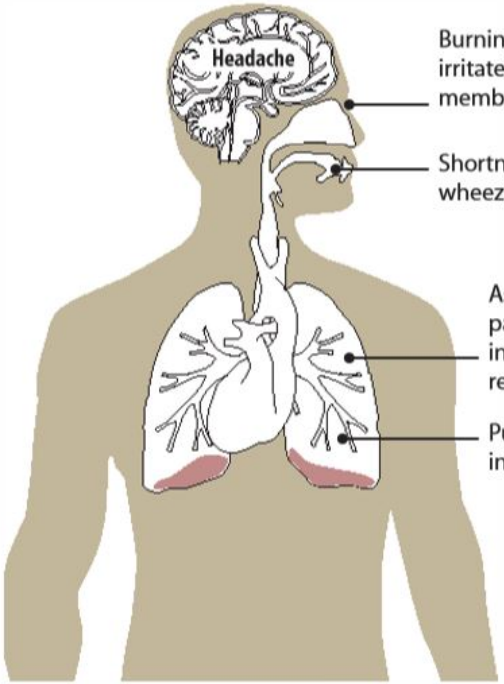

Lower Scenario (RCP4.5)
Higher Scenario (RCP8.5)
2050
2090
Change in Ozone Concentration (parts per billion)
−3
−2
−1
0
1
2
3
4
5

FIGURE 6. How Ozone Affects the Human Body



Source: Adapted from Schoof 2010.

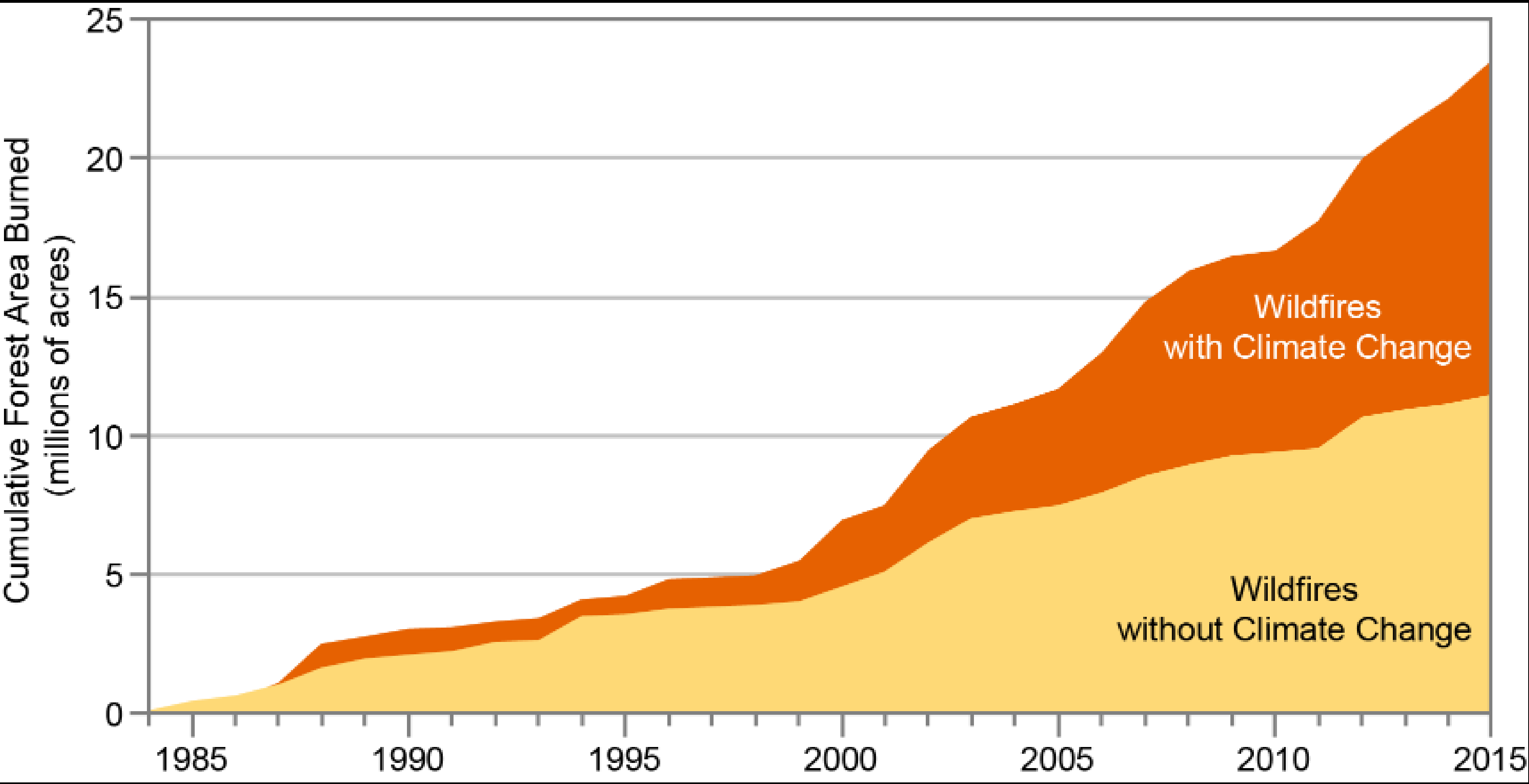
People who do not suffer from lung conditions often fail to appreciate what they feel like, how dangerous they are, and why the quality of life for the sufferer can be compromised. This is what breathing ozone can feel like if you have a lung condition: you may find it difficult to breathe deeply and vigorously; you may be short of breath and be in pain when taking a deep breath; you may cough, wheeze, and have a chronically sore or scratchy throat; and your asthma attacks may become more frequent. Inside your body, repeated ozone exposures may inflame and damage your lung lining and make the lungs more susceptible to infection.


PUBLIC
E.V.
PARKING
ONLY

Waldo Canyon Fire 2012

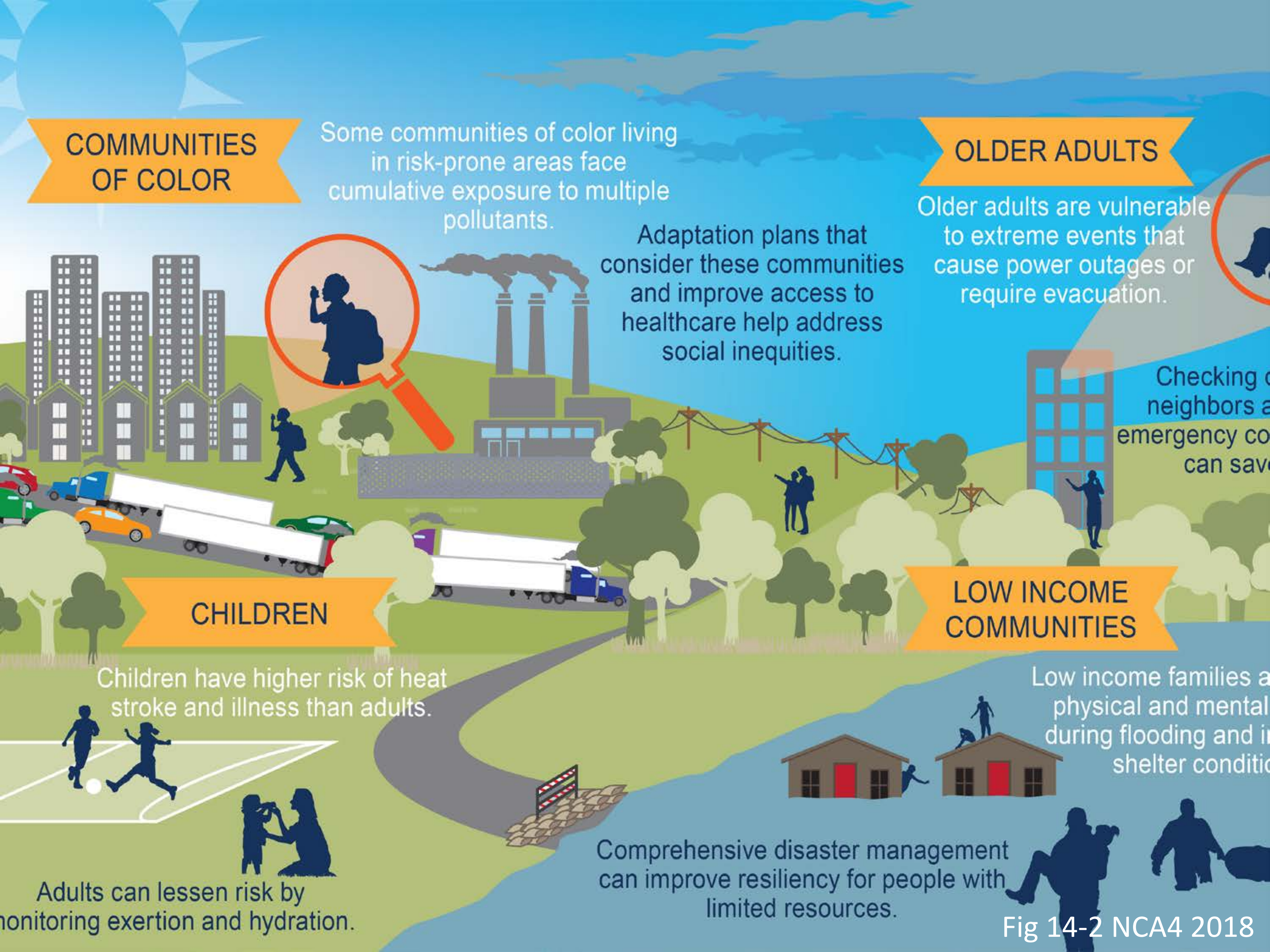

U.S. Air Force photo by Master Sgt. Jeremy Lock, 28 June 2012, Mt. St Francis Colorado Springs

Fig. 25.4: Climate Change Has Increased Wildfire




High Park Fire
22 June 2012
US Air Force


FLickr, Don Graham


COMMUNITIES OF COLOR
Some communities of color living in risk-prone areas face cumulative exposure to multiple pollutants.
Adaptation plans that consider these communities and improve access to healthcare help address social inequities.
OLDER ADULTS
Older adults are vulnerable to extreme events that cause power outages or require evacuation.
Checking
neighbors
emergency co
can sav
CHILDREN
Children have higher risk of heat stroke and illness than adults.
Adults can lessen risk by
monitoring exertion and hydration.
LOW INCOME COMMUNITIES
Low income families a
physical and mental
during flooding and i
shelter conditio
Comprehensive disaster management can improve resiliency for people with limited resources.
Fig 14-2 NCA4 2018

Key Message #2

The Risks of Inaction

Under scenarios with high emissions and limited or no adaptation, annual losses in some sectors are estimated to grow to hundreds of billions of dollars by the end of the century.

Annual Economic Damages in 2090		
Sector	**Annual damages under RCP8.5**	**Damages avoided under RCP4.5**
Labor	$155B	48%
Extreme Temperature Mortality◊	$141B	58%
Coastal Property◊	$118B	22%
Air Quality	$26B	31%
Roads◊	$20B	59%
Electricity Supply and Demand	$9B	63%
Inland Flooding	$8B	47%
Urban Drainage	$6B	26%
Rail◊	$6B	36%
Water Quality	$5B	35%
Coral Reefs	$4B	12%
West Nile Virus	$3B	47%
Freshwater Fish	$3B	44%
Winter Recreation	$2B	107%
Bridges	$1B	48%
Munic. and Industrial Water Supply	$316M	33%
Harmful Algal Blooms	$199M	45%
Alaska Infrastructure◊	$174M	53%
Shellfish*	$23M	57%
Agriculture*	$12M	11%
Aeroallergens*	$1M	57%
Wildfire	−$106M	−134%

Source: adapted from EPA 2017

(in 2015 dollars)

Who Pays for Damages and Adaptation?

Debris flow covers US Highway 14 (Poudre Canyon) after the High Park Fire in 2012

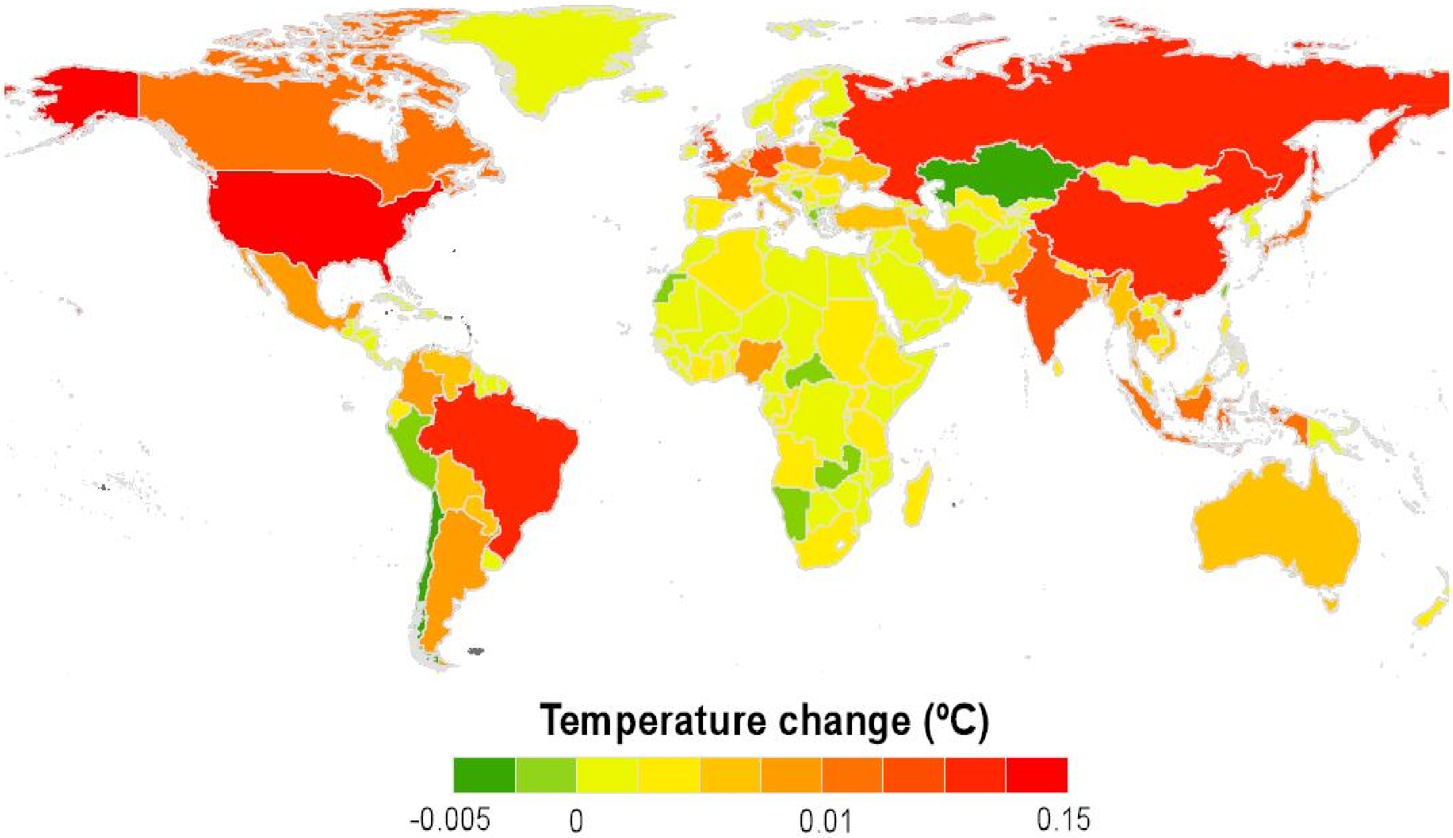
Photo: Justin Pipe, Colorado Department of Transportation

1.5 °C or 2 °C World (2.7 °F or 3.6 °F)

“common but differentiated responsibilities” among nations

UNFCCC 1992

Contribution of National Emissions to Global Warming



Matthews et al 2014

ArchCoal

ConocoPhillips

Peabody ENERGY

Chevron

bp

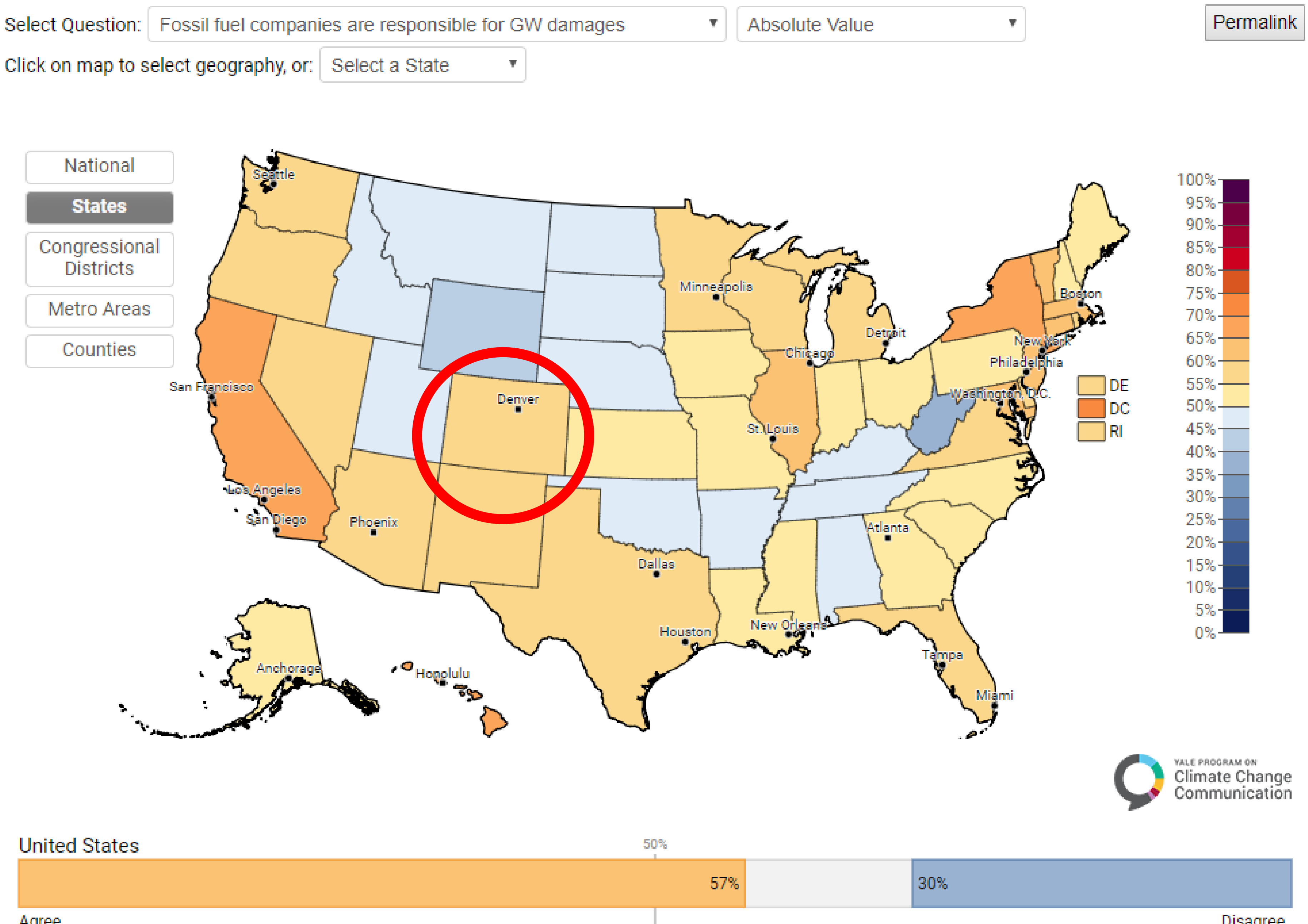
ExxonMobil

CONSOL ENERGY
AMERICA'S ENERGY STARTS HERE.

Public Opinion in Colorado on Climate Accountability

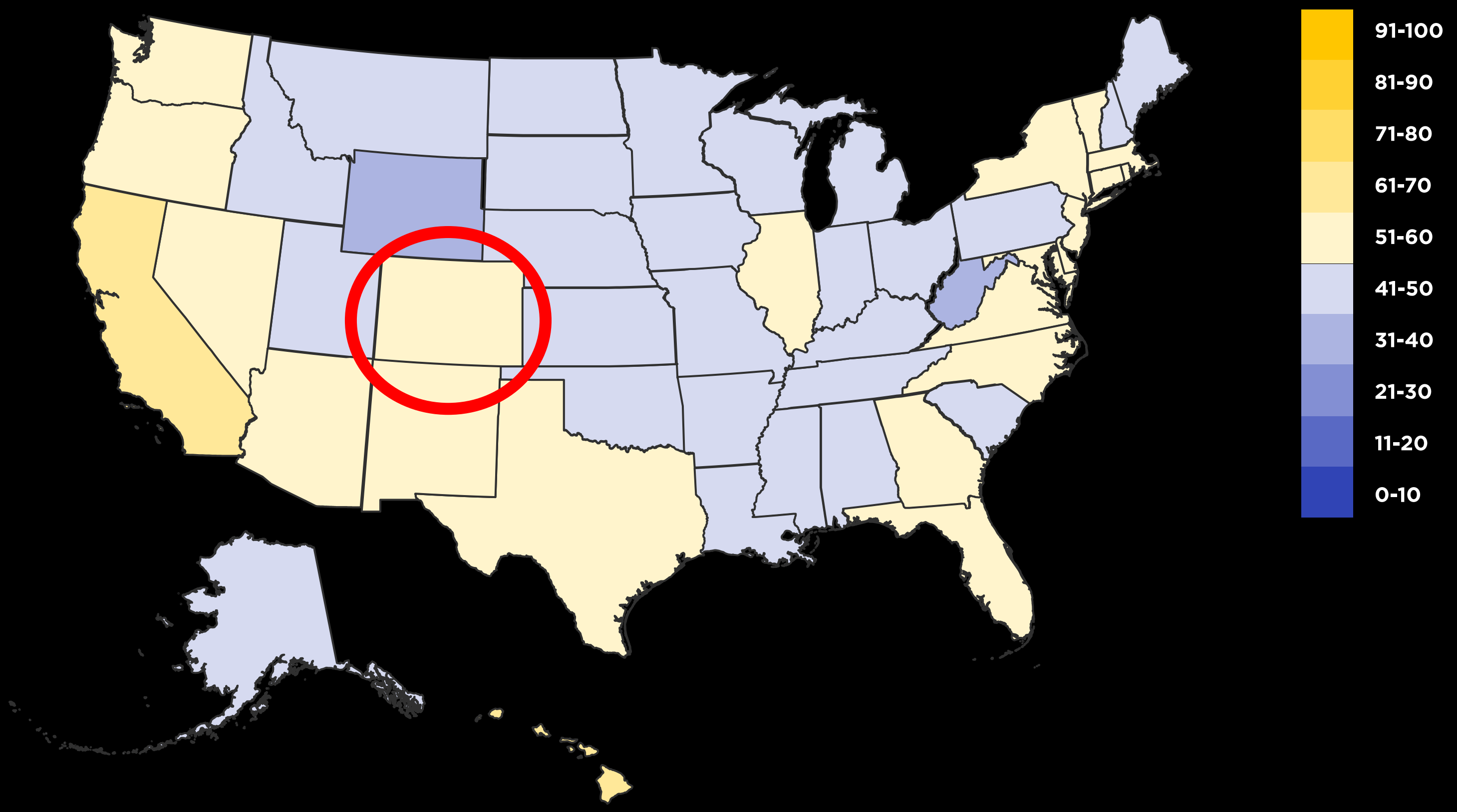
Union of Concerned Scientists

Estimated % of adults who think fossil fuel companies are responsible for GW damages, 2019

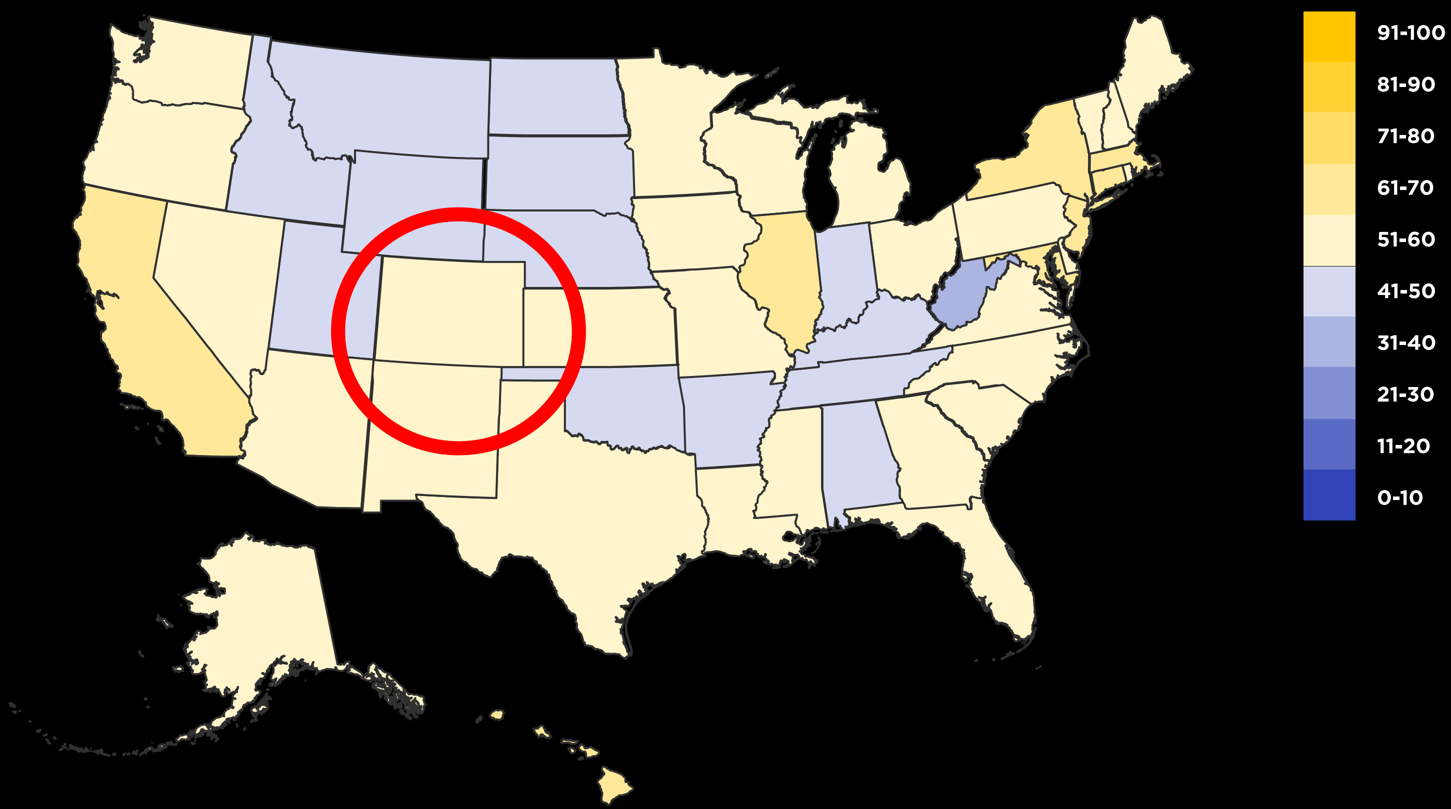


54% of Colorado adults

think global warming is harming their local community



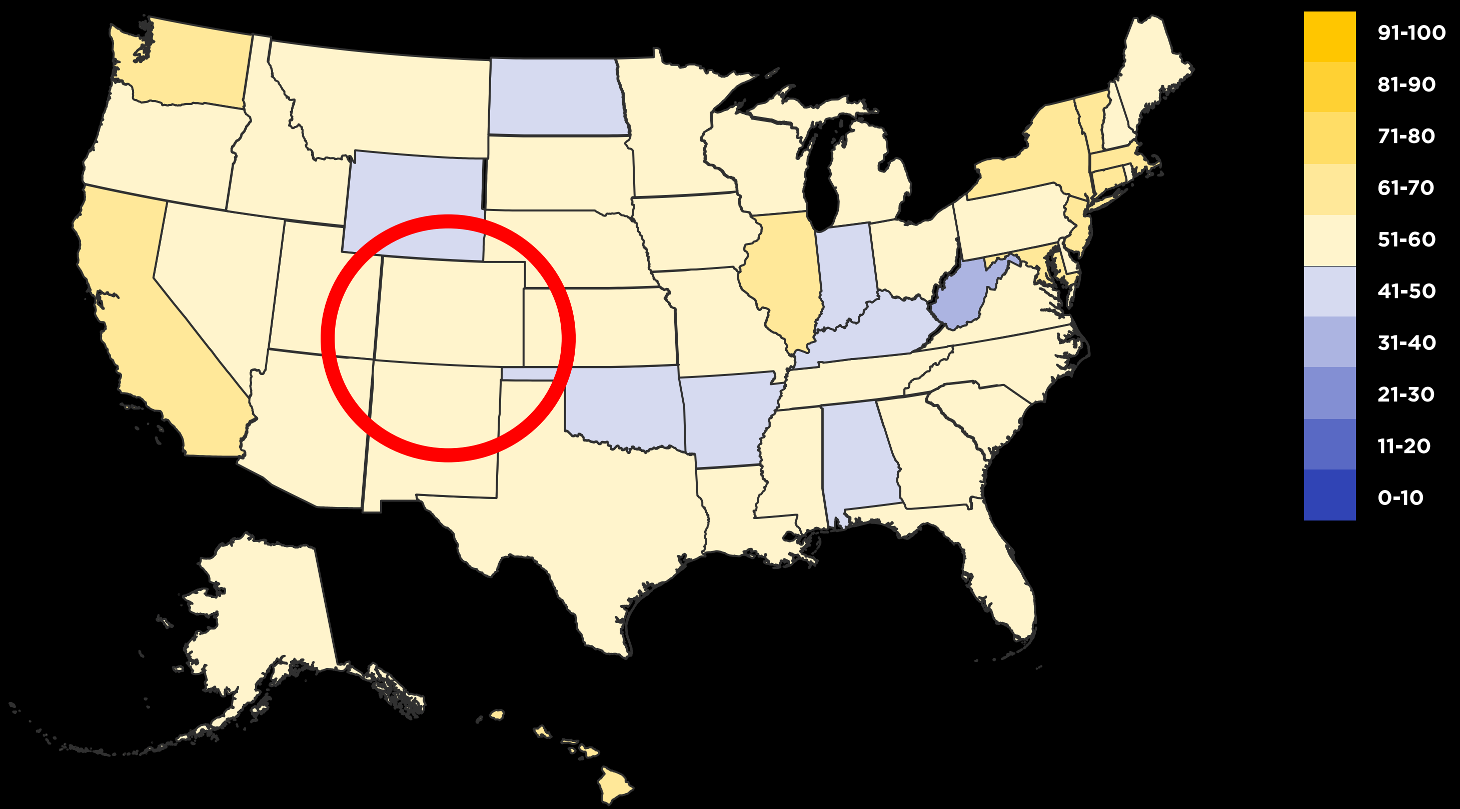
57% of Colorado adults
think *fossil fuel companies are responsible for global warming damages*



Survey data collection and analysis conducted by the Yale Program on Climate Change Communication

56% of Colorado adults

support fossil fuel companies paying for global warming damages



Survey data collection and analysis conducted by the Yale Program on Climate Change Communication

Courtesy San Miguel County Sheriff's Office

Questions

US Air Force

High Park Fire
22 June 2012

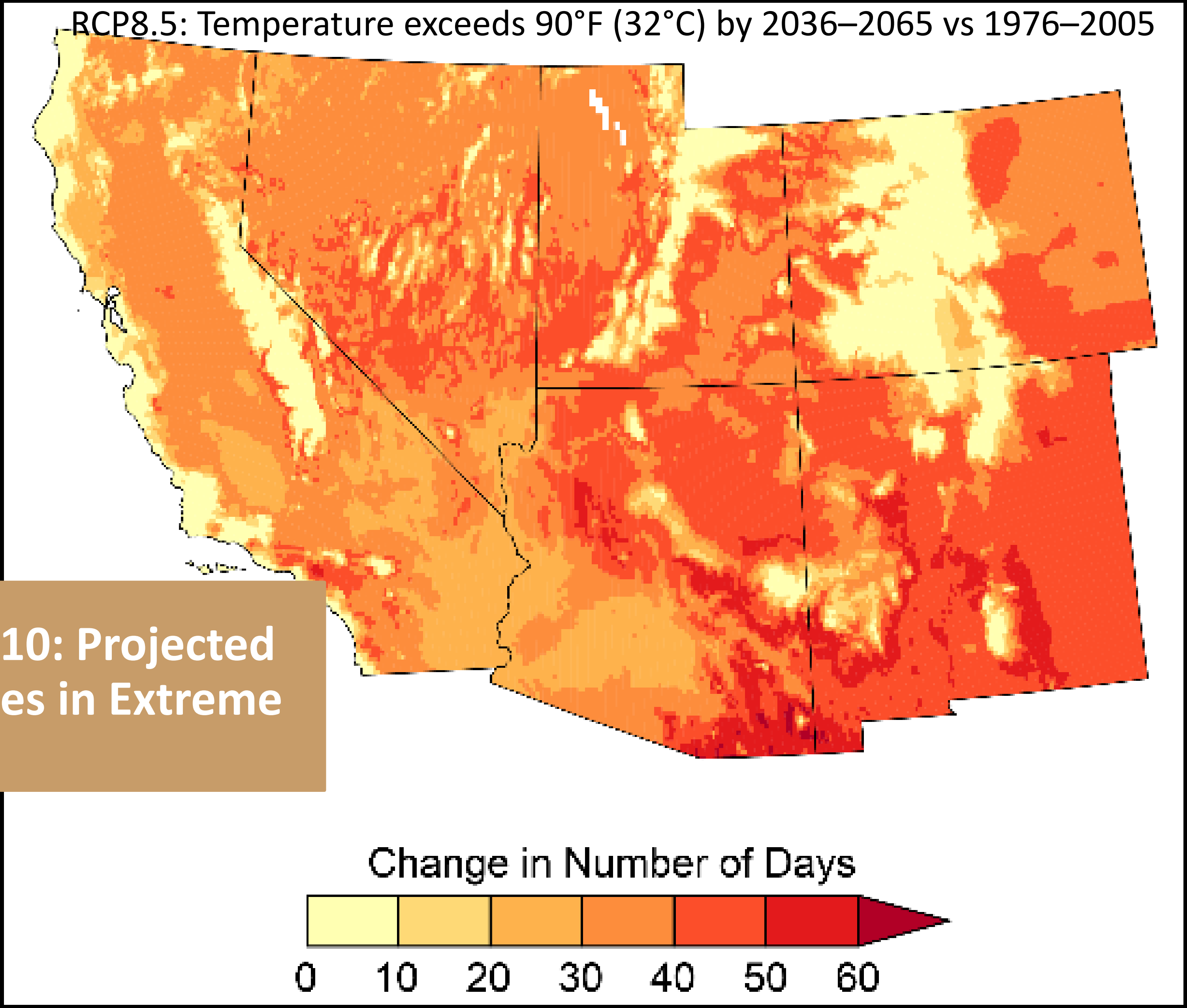
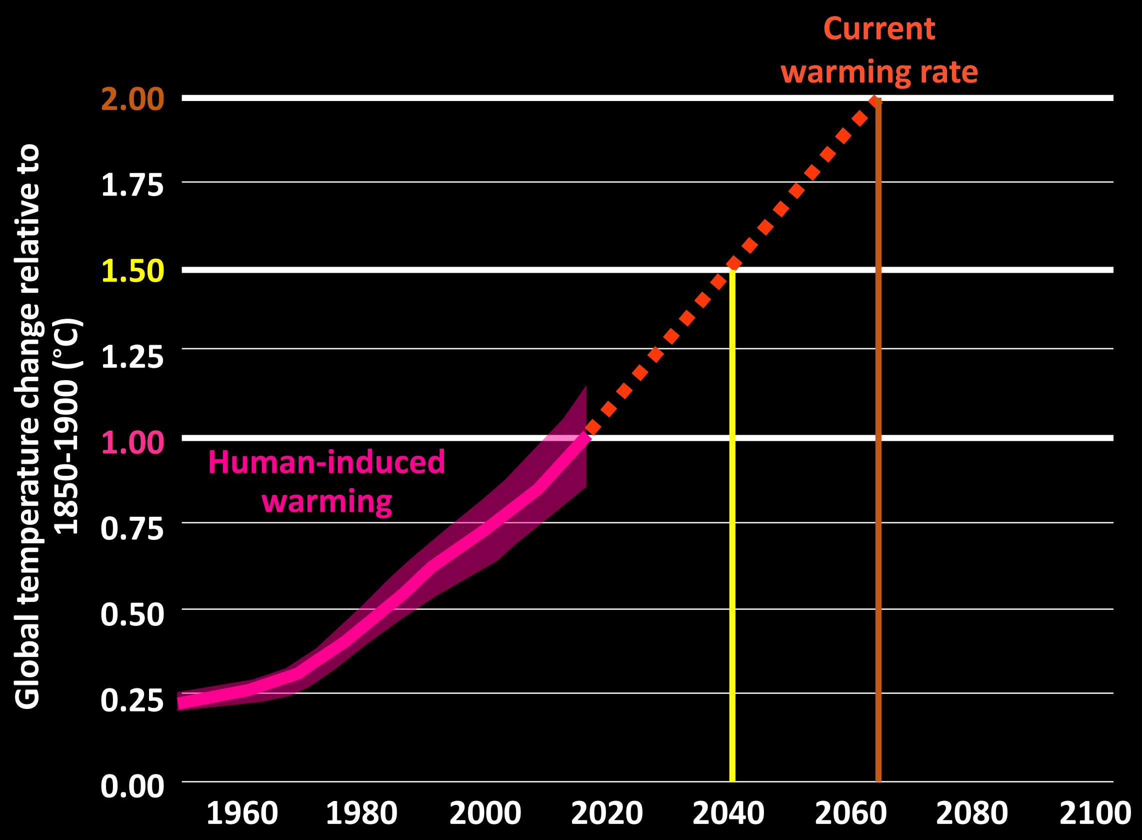
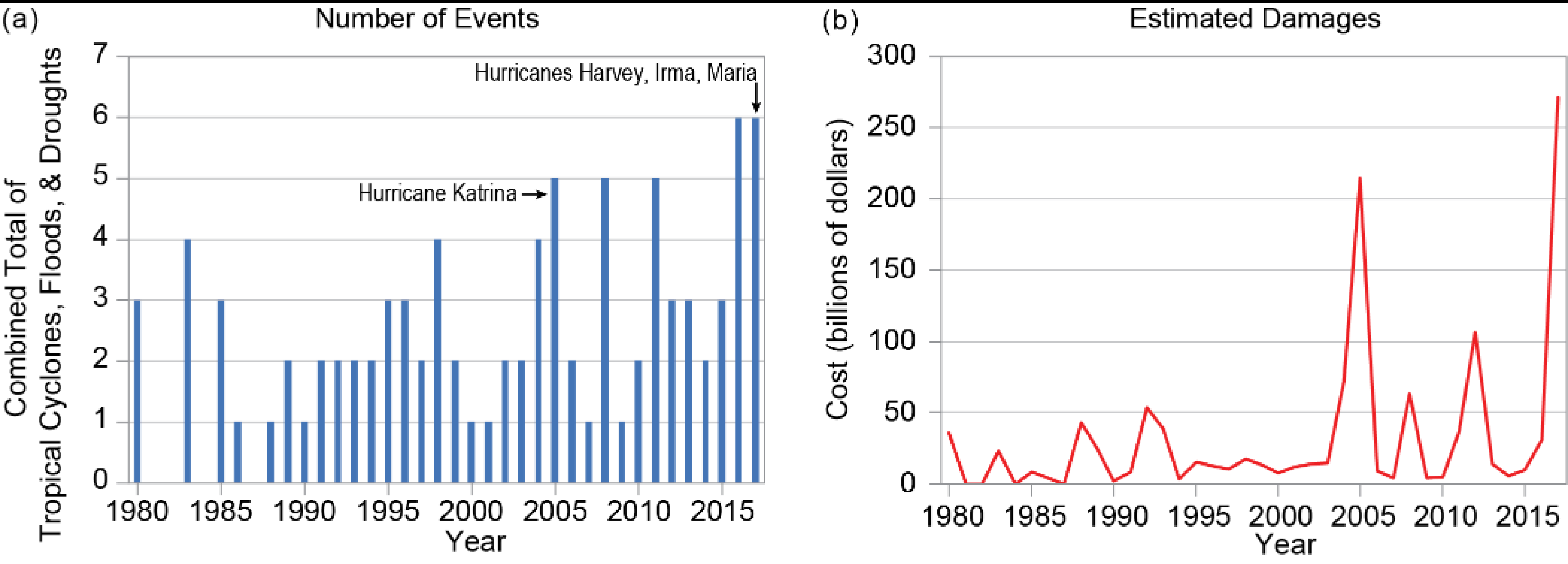


Fig. 25.10: Projected Increases in Extreme Heat

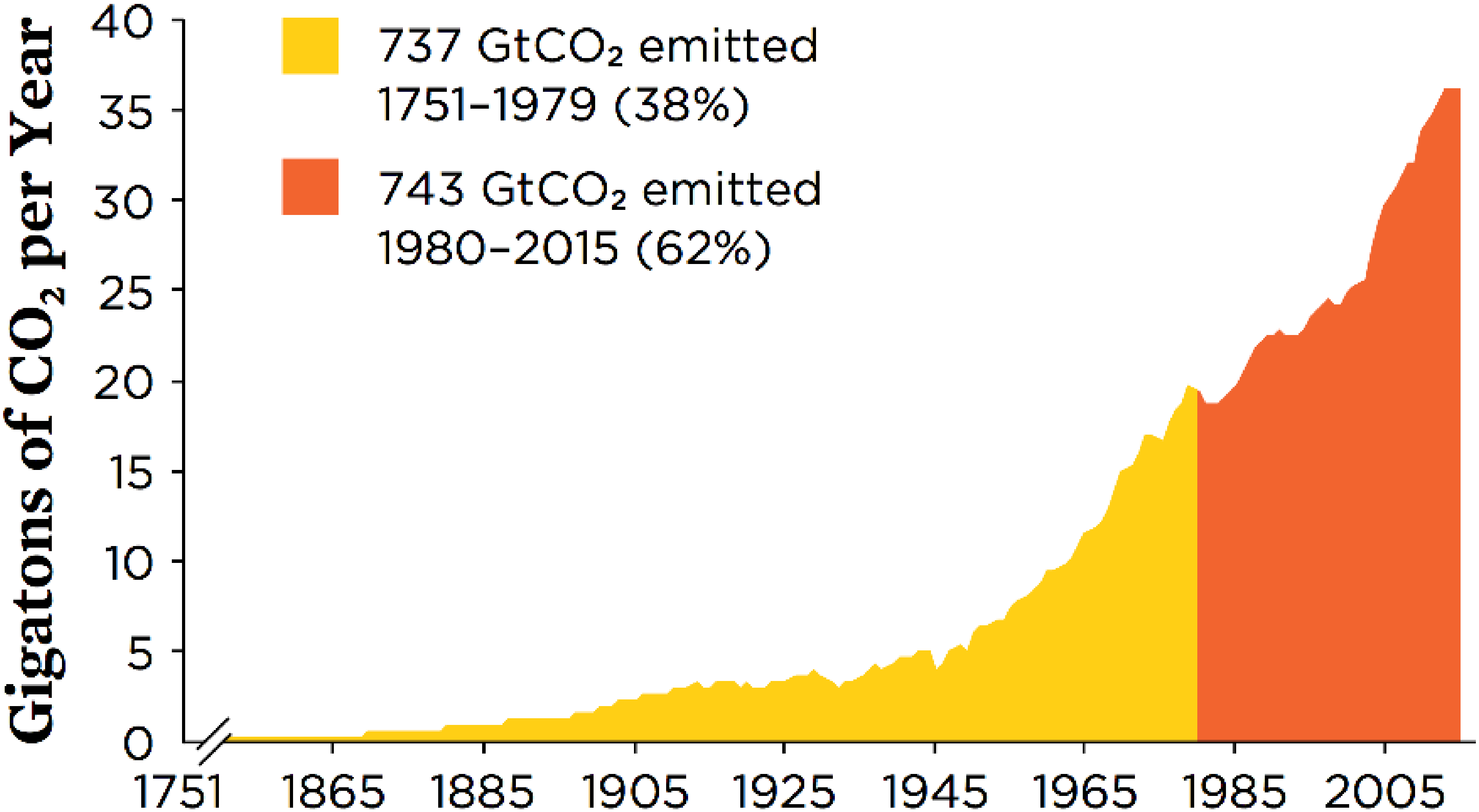


IPCC 2018 SR15 Fig FAQ 1.2

Fig. 3.1: Billion-Dollar Weather and Climate Disaster Events in the United States



Annual Global CO_2 Emissions from Fossil Fuel and Cement, 1751–2015



Data source: Boden, Marland, and Andres 2013; Image source: Union of Concerned Scientists

ALEC
American Legislative Exchange Council

AMERICA'S POWER®
American Coalition for Clean Coal Electricity

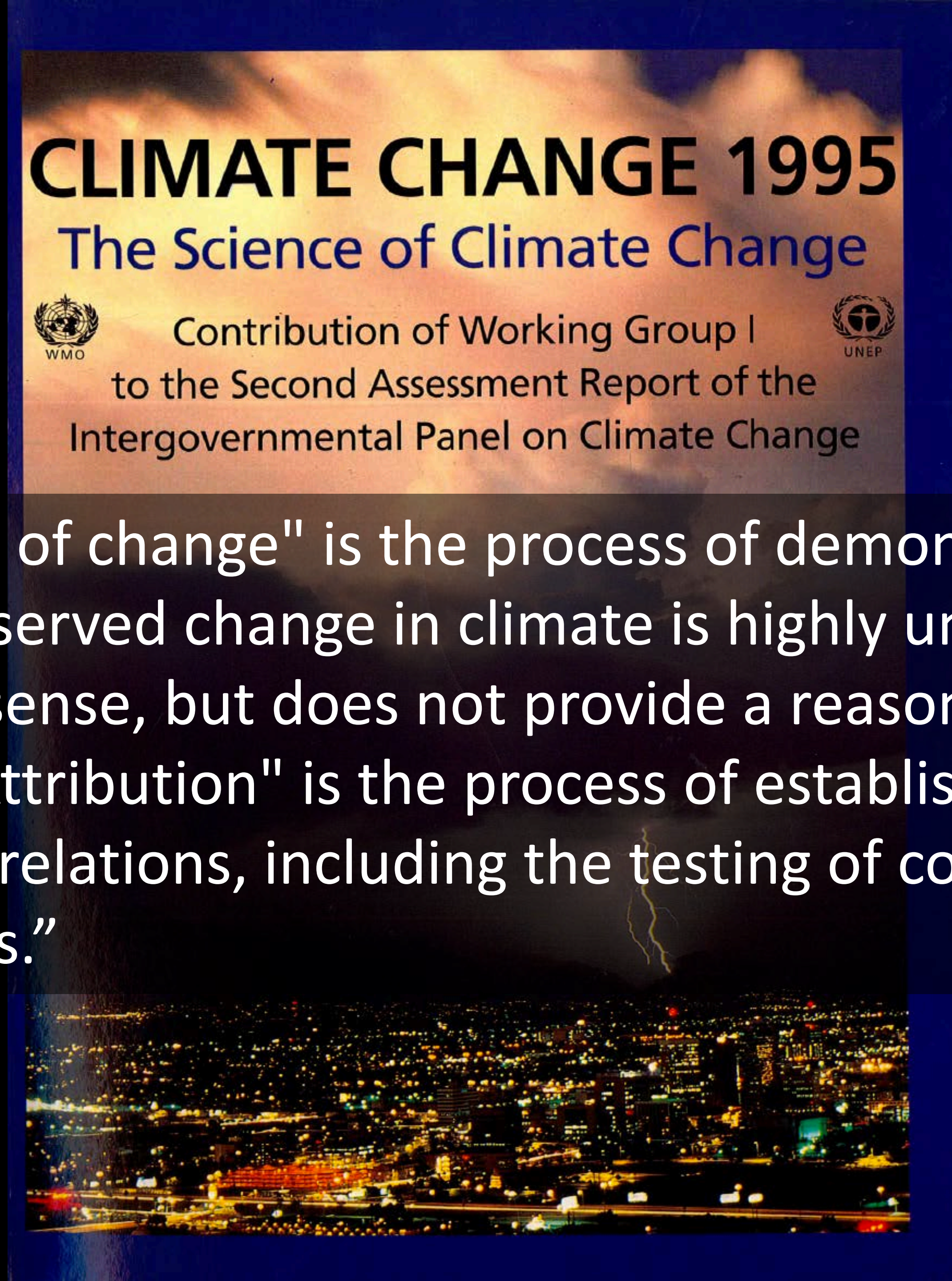
NMA®
THE AMERICAN RESOURCE

THE SPIRIT OF ENTERPRISE
U.S. CHAMBER OF COMMERCE
U.S. Chamber of Commerce
Standing Up for American Enterprise

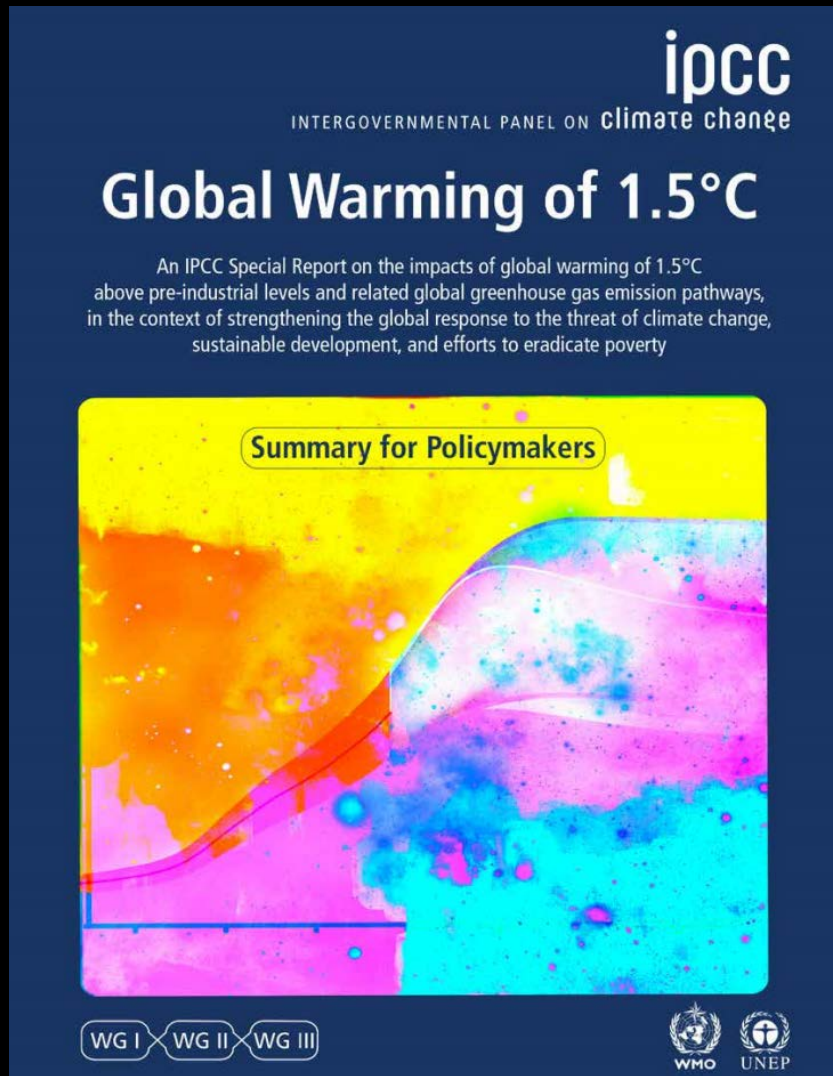
WSPA
Western States Petroleum Association

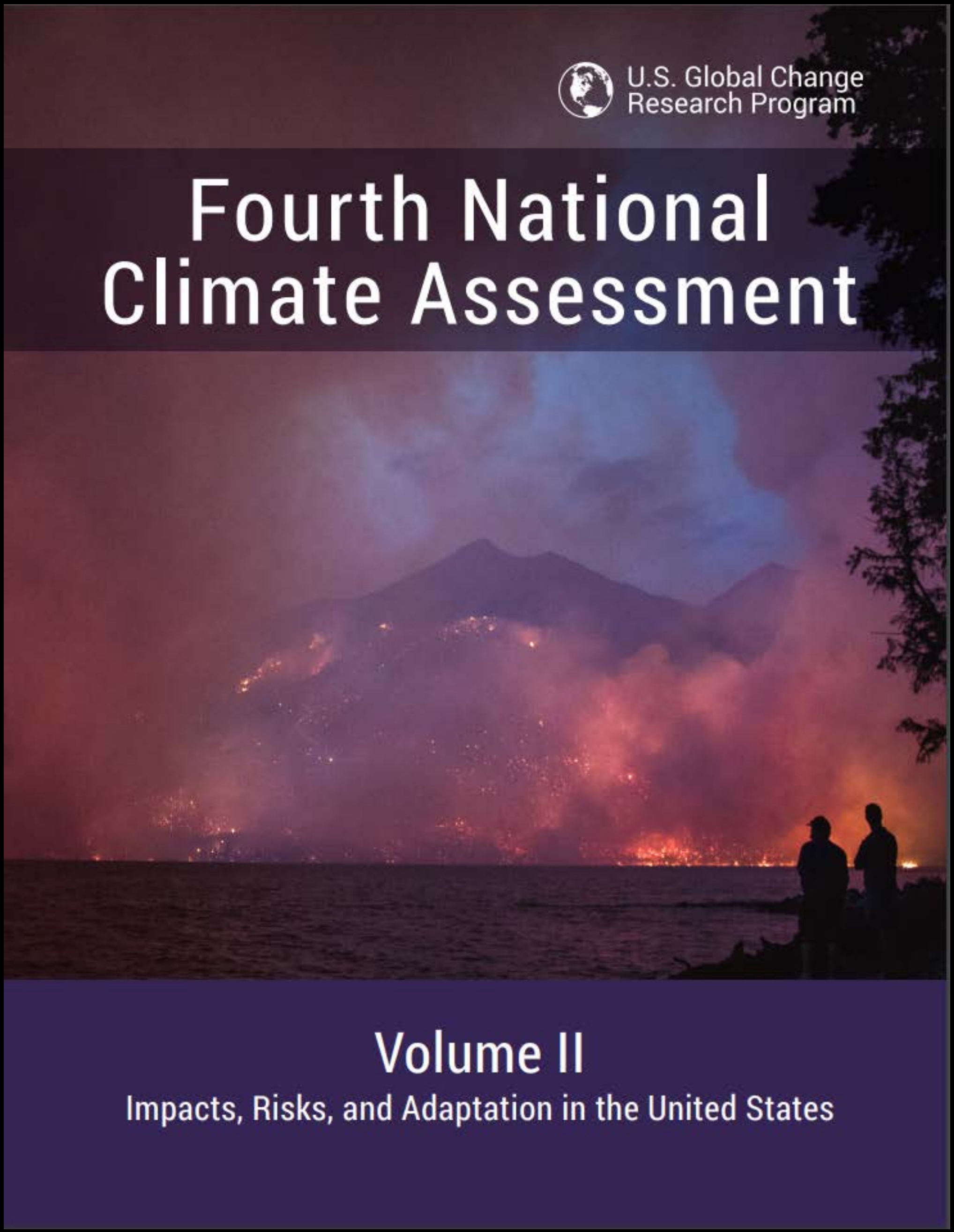
energy API®
AMERICAN PETROLEUM INSTITUTE

NATIONAL ASSOCIATION OF
Manufacturers



"Detection of change" is the process of demonstrating that an observed change in climate is highly unusual in a statistical sense, but does not provide a reason for the change. "Attribution" is the process of establishing cause and effect relations, including the testing of competing hypotheses."


ipcc
INTERGOVERNMENTAL PANEL ON climate change
Global Warming of 1.5°C
An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty
Summary for Policymakers
WG I
WG II
WG III
WMO
UNEP


U.S. Global Change
Research Program
Fourth National
Climate Assessment
Volume II
Impacts, Risks, and Adaptation in the United States

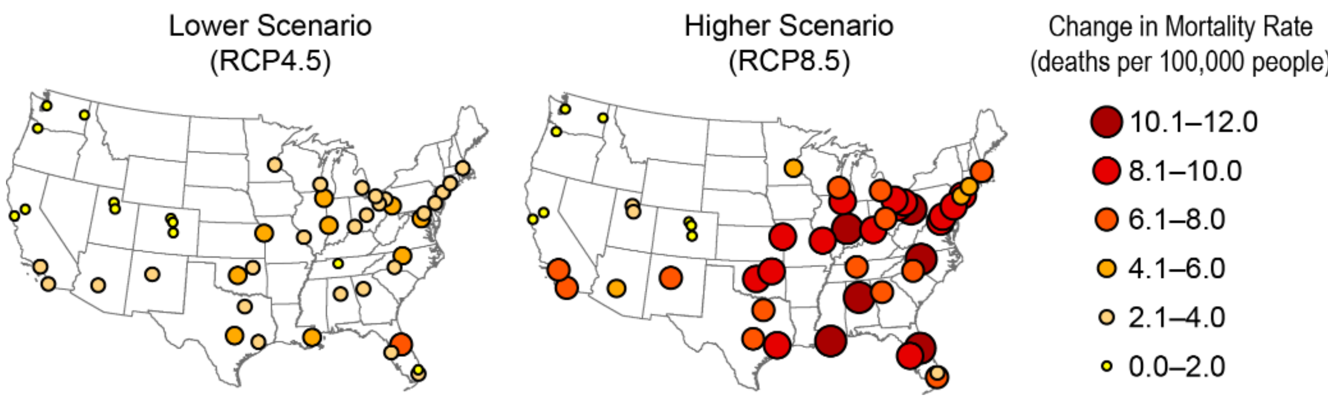
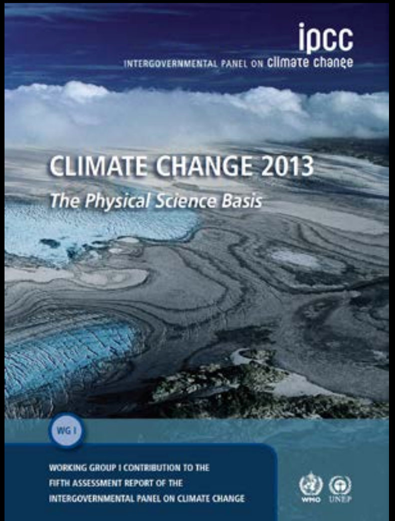


Fig. 14.4: Projected Change in Annual Extreme Temperature Mortality

The maps show estimated changes in annual net mortality due to extremely hot and cold days in 49 U.S. cities for 2080–2099 as compared to 1989–2000. Across these cities, the change in mortality is projected to be an additional 9,300 deaths each year under a higher scenario (RCP8.5) and 3,900 deaths each year under a lower scenario (RCP4.5). Assuming a future in which the human health response to extreme temperatures in all 49 cities was equal to that of Dallas today (for example, as a result of availability of air conditioning or physiological adaptation) results in an approximate 50% reduction in these mortality estimates. For example, in Atlanta, an additional 349 people are projected to die from extreme temperatures each year by the end of century under RCP8.5. Assuming residents of Atlanta in 2090 have the adaptive capacity of Dallas residents today, this number is reduced to 128 additional deaths per year. Cities without circles should not be interpreted as having no extreme temperature impact. Data not available for the U.S. Caribbean, Alaska, or Hawai‘i & U.S.-Affiliated Pacific Islands regions. *Source: adapted from EPA 2017.*[157]

Detection of change

"Warming of the climate system is **unequivocal**, and since the 1950s, many of the observed changes are unprecedented over decades to millennia." – IPCC 2013

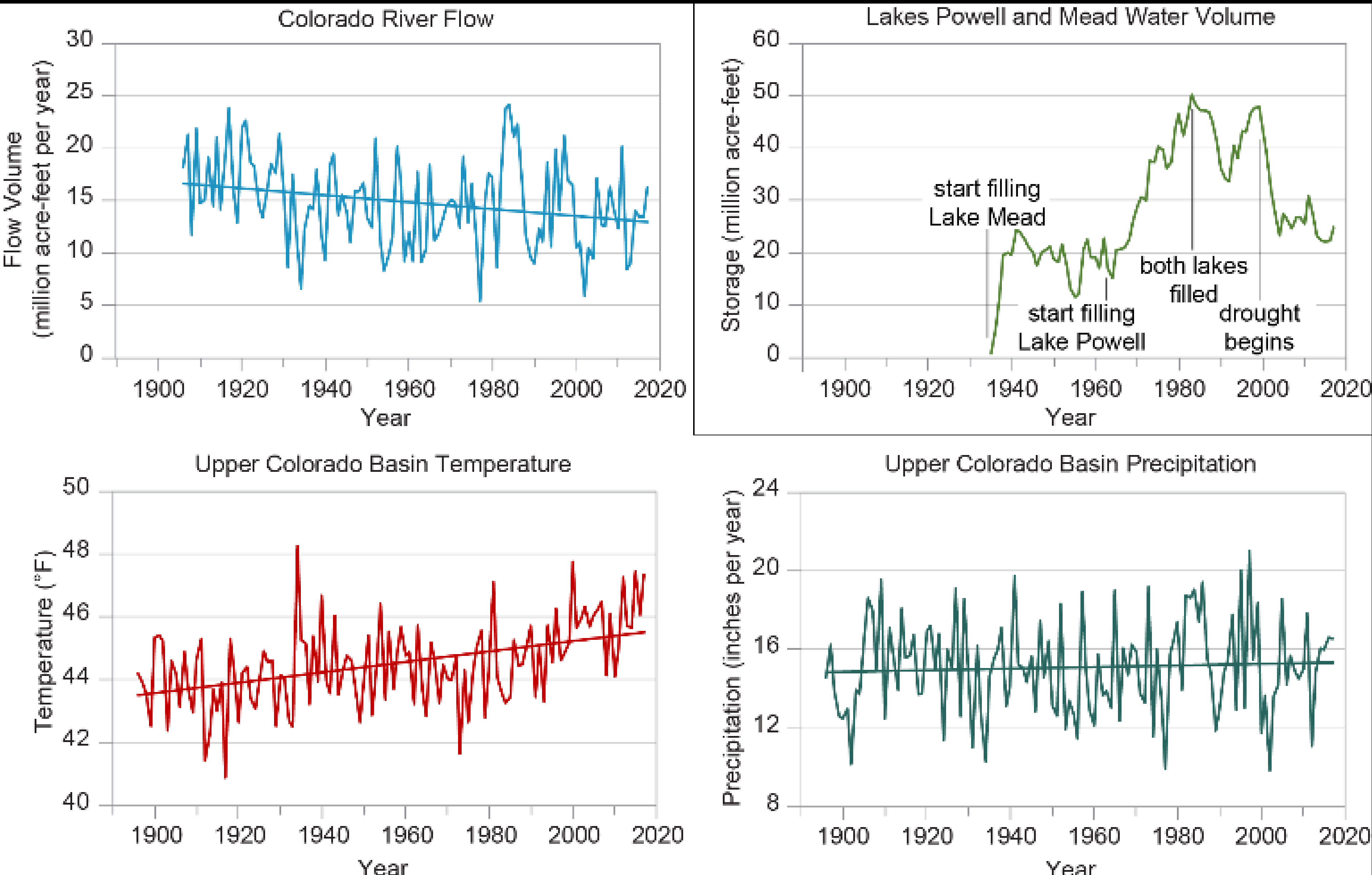


Attribution

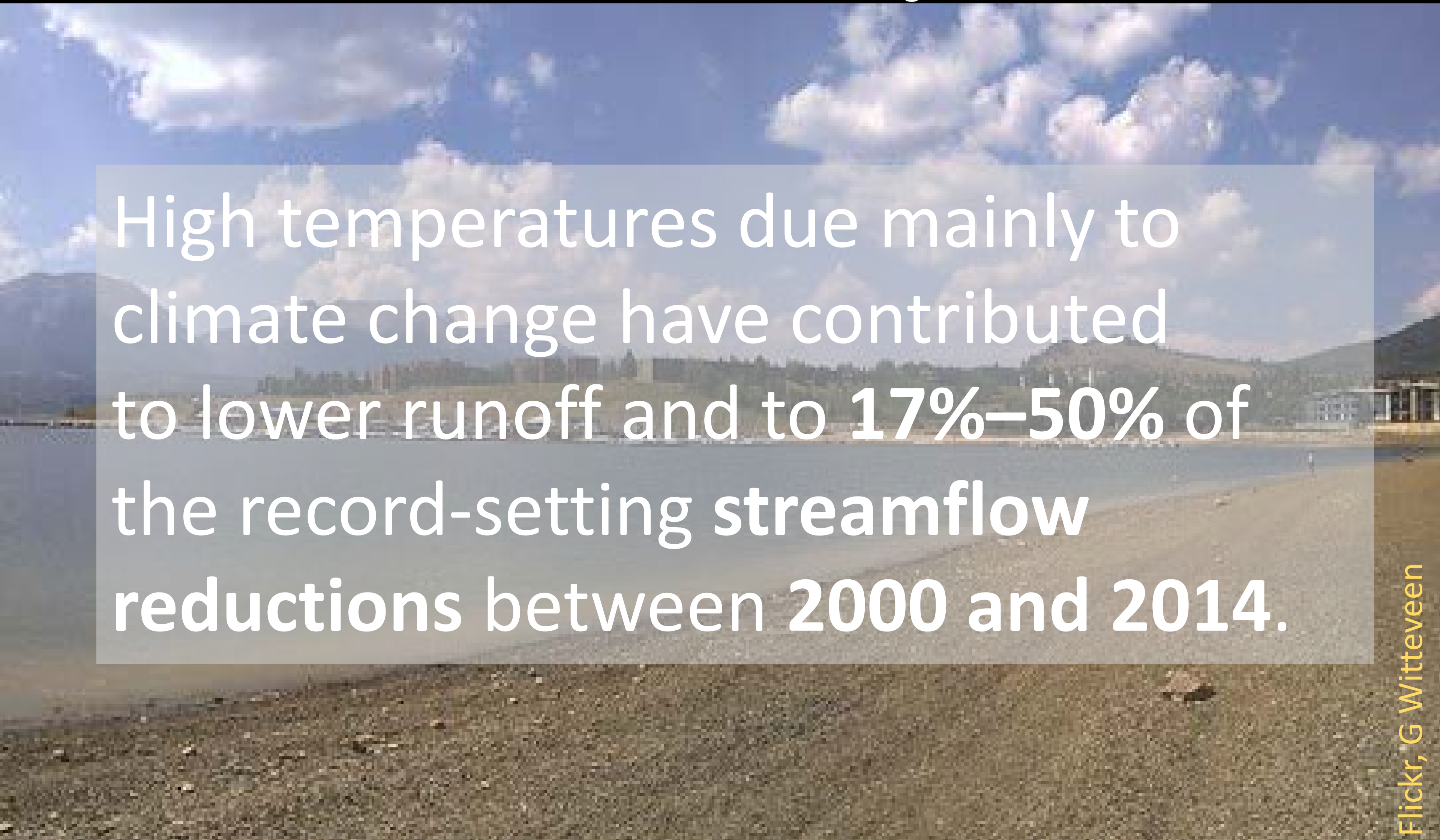
"It is **extremely likely*** that **human influence** has been the **dominant cause** of the observed warming since the mid-20th century."

*extremely likely = **95-100% probability of an outcome or result**.

Fig. 25.3: Severe Drought Reduces Water Supplies in the Southwest



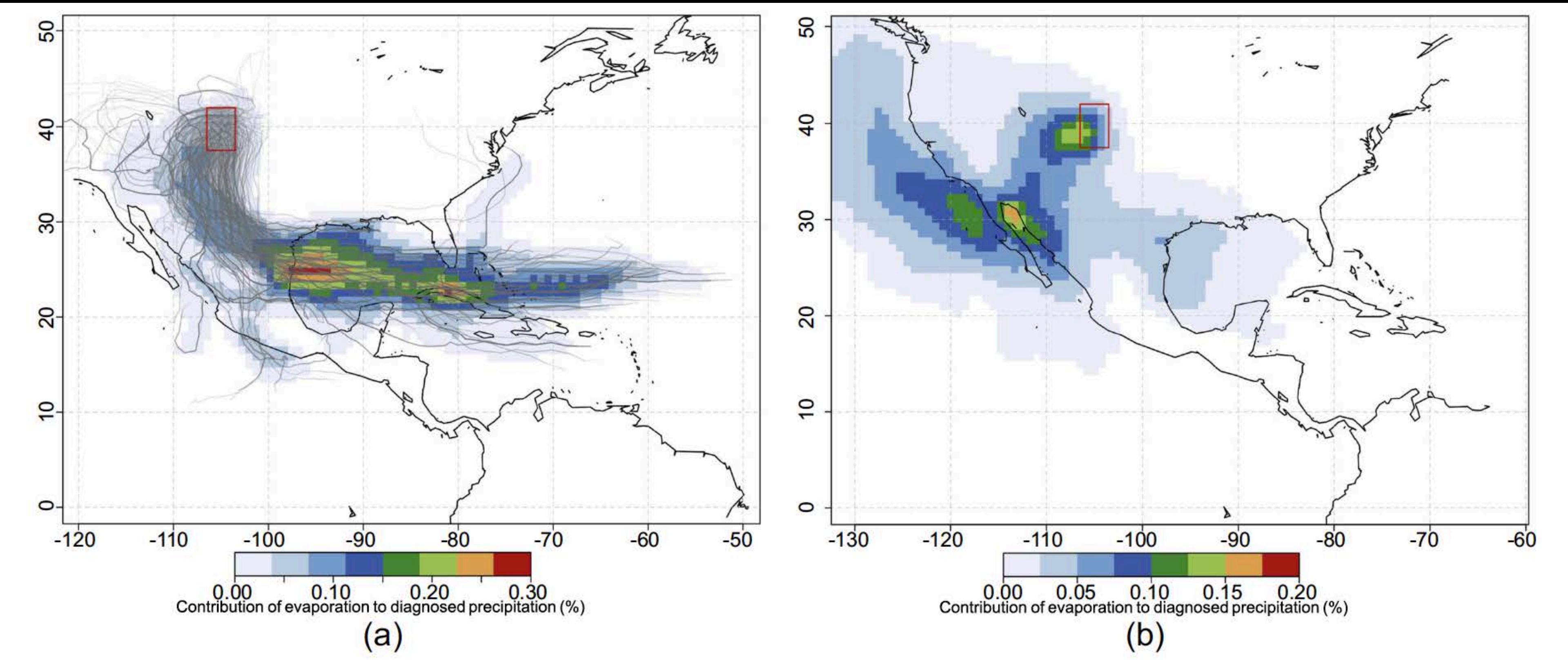
Colorado River Basin Drought



High temperatures due mainly to climate change have contributed to lower runoff and to **17%–50%** of the record-setting **streamflow reductions** between **2000 and 2014**.

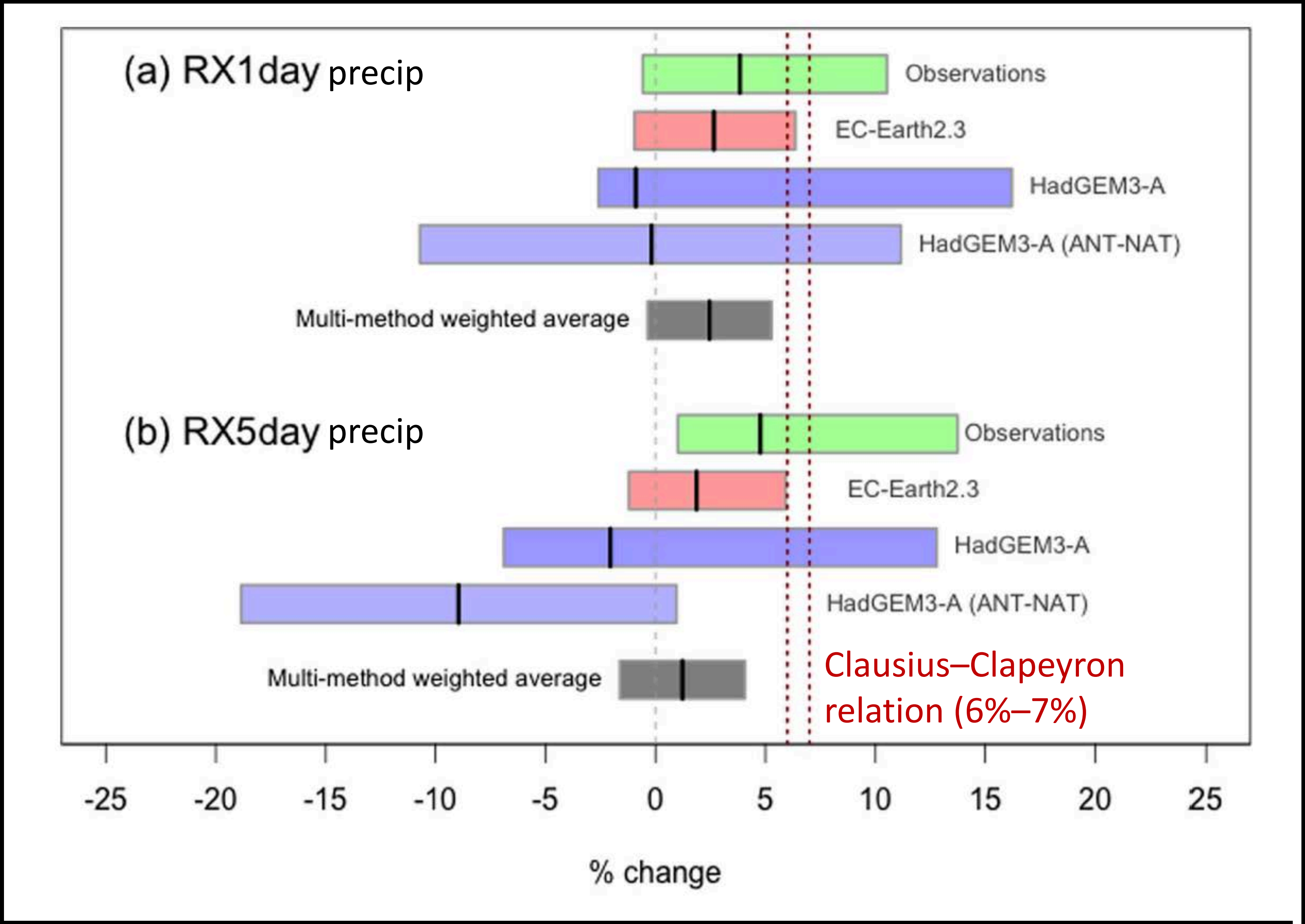
Flickr, G Witteveen

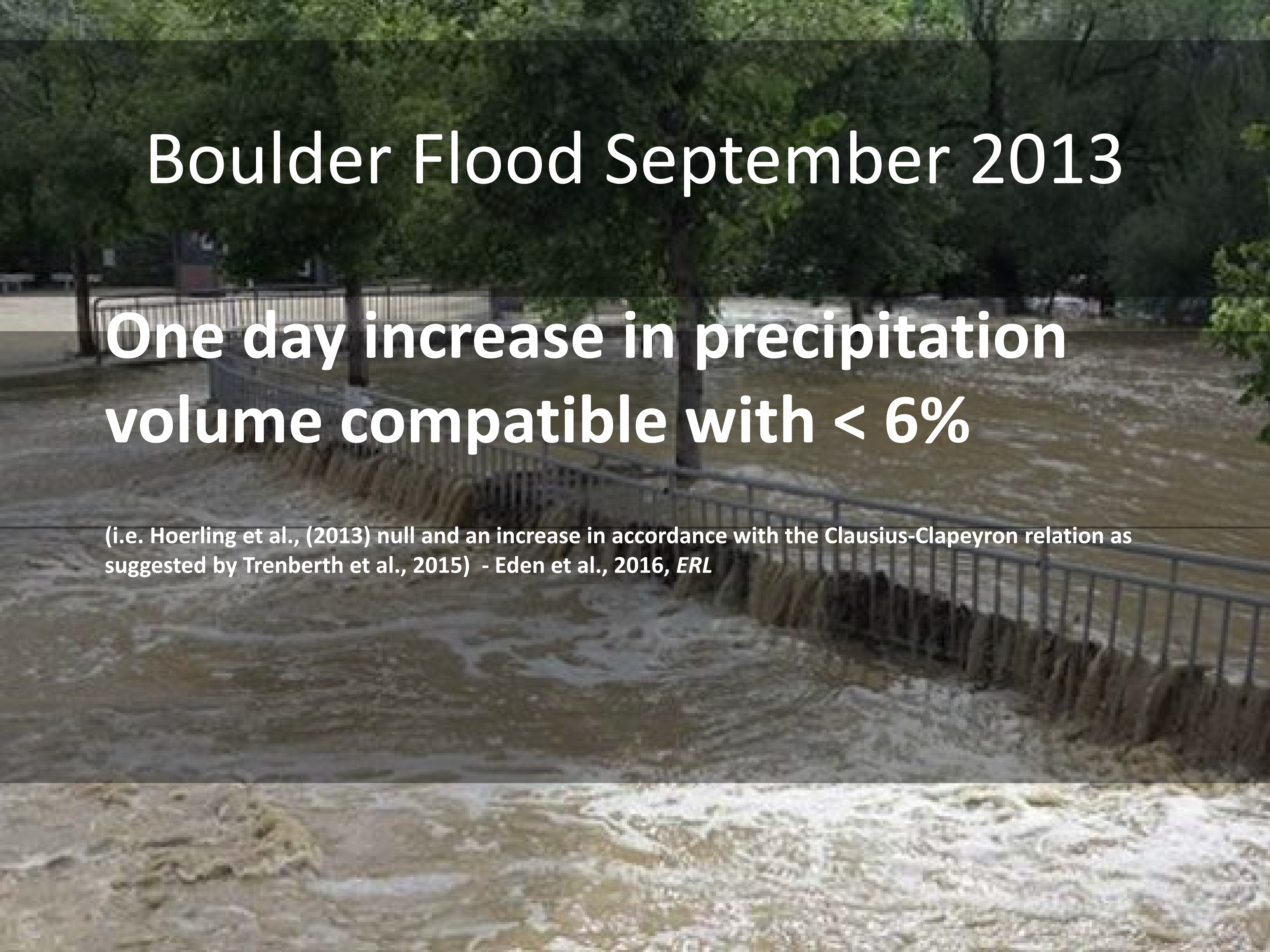
Boulder Flood September 2013



Eden et al 2016 Environ. Res. Lett. 11 124009

Boulder Flood September 2013





Boulder Flood September 2013

One day increase in precipitation volume compatible with < 6%

(i.e. Hoerling et al., (2013) null and an increase in accordance with the Clausius-Clapeyron relation as suggested by Trenberth et al., 2015) - Eden et al., 2016, *ERL*

Species to LOSE OVER HALF of their climatically determined GEOGRAPHIC RANGE for global warming

	INSECTS	PLANTS	VERTEBRATE
+2°C	18%	16%	8%
+1.5°C	9.6%	8%	4%

IPCC SR15 2018 SPM

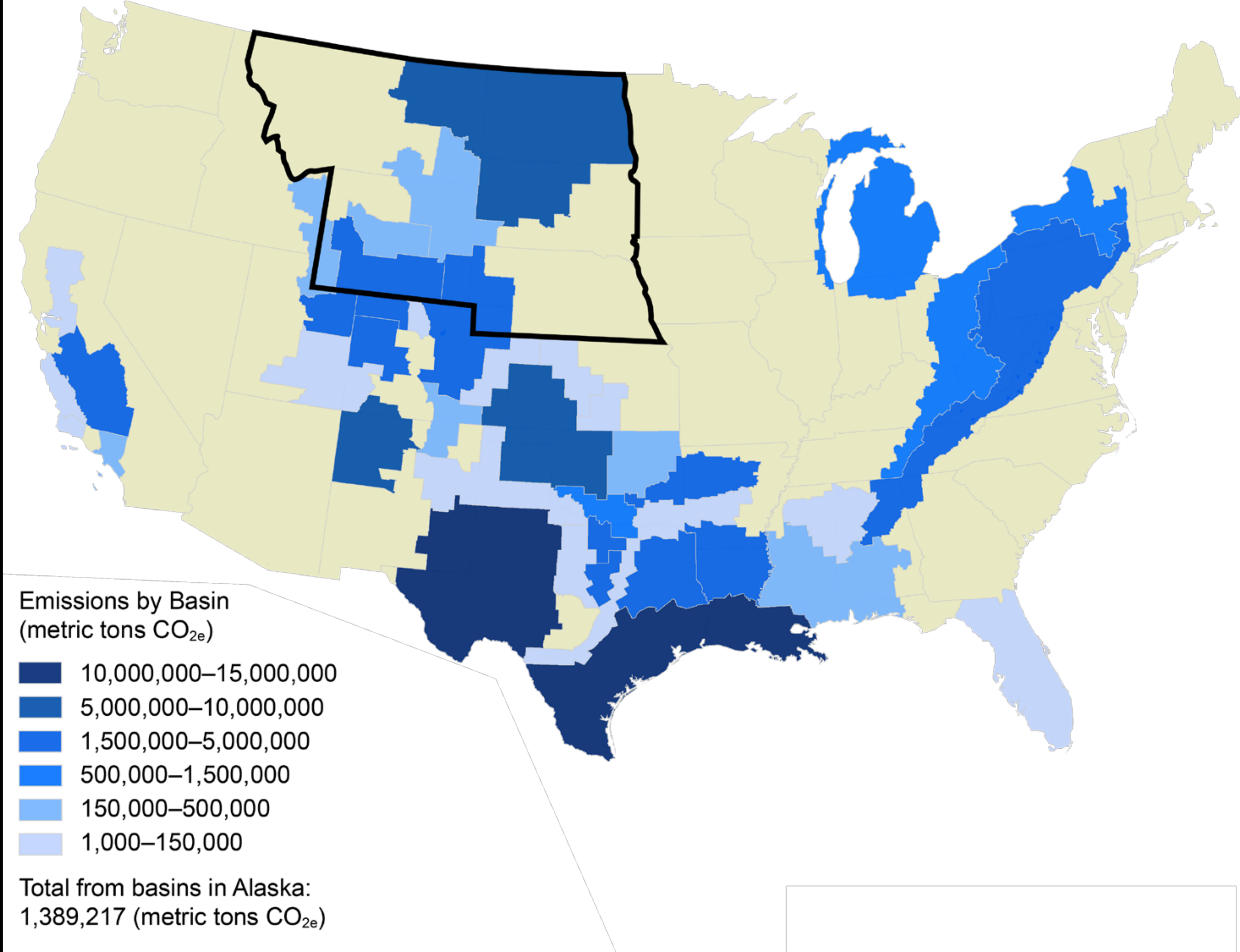
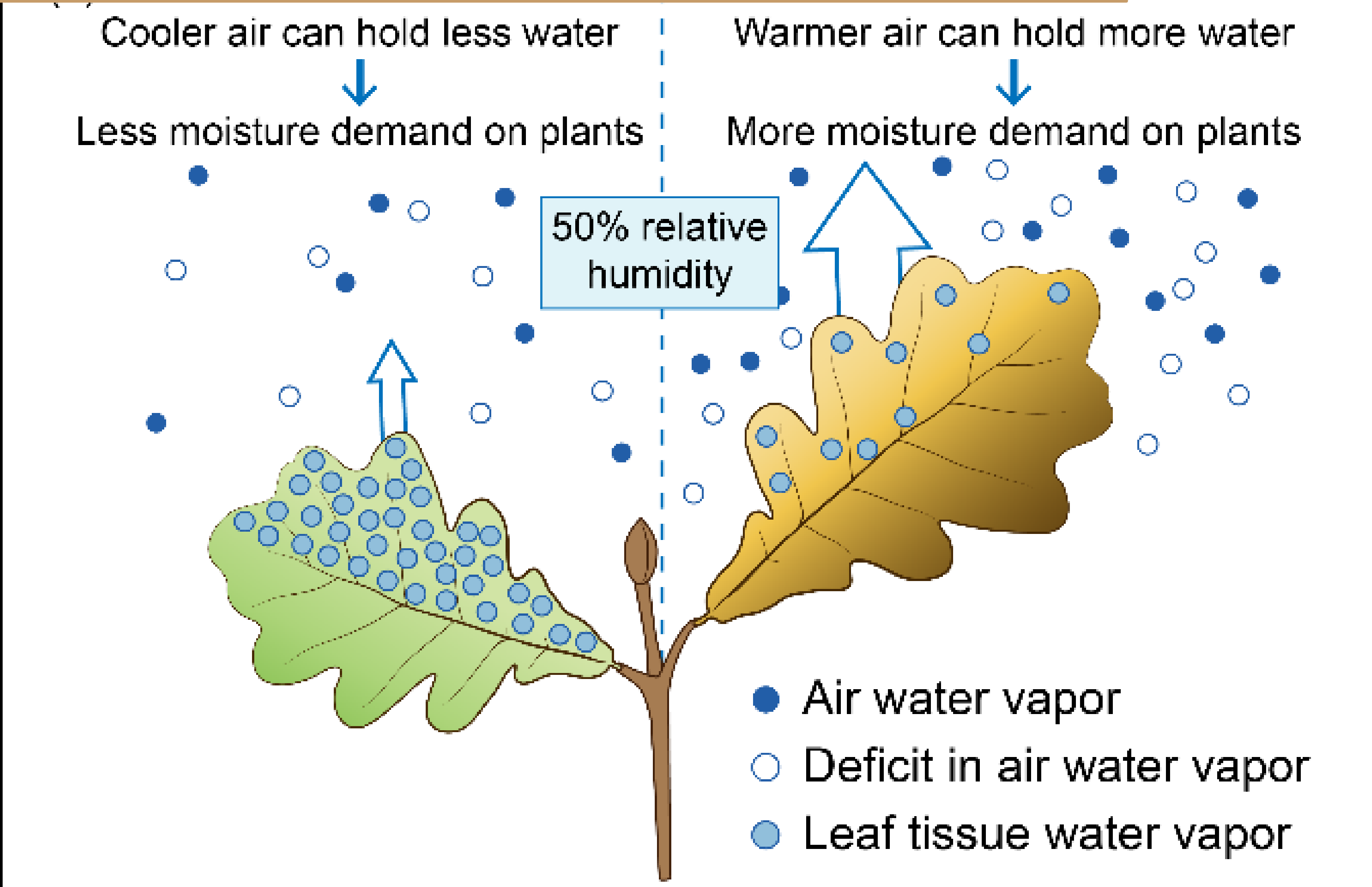

Emissions by Basin
(metric tons CO2e)
10,000,000–15,000,000
5,000,000–10,000,000
1,500,000–5,000,000
500,000–1,500,000
150,000–500,000
1,000–150,000
Total from basins in Alaska:
1,389,217 (metric tons CO2e)

Fig. 21.3: Drying Effect of Warmer Air on Plants and Soils



What questions do you have?

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Image source: https://www.thebump.com/a/checklist-baby-essentials