

HEALTH & AIR QUALITY

EARTH SCIENCE
APPLIED SCIENCES

Identifying Public Health Applications of Satellite-derived Drought Indicators: Improved Monitoring for Respiratory Health (ROSES21)

Jesse E. Bell, PhD

April 23, 2024

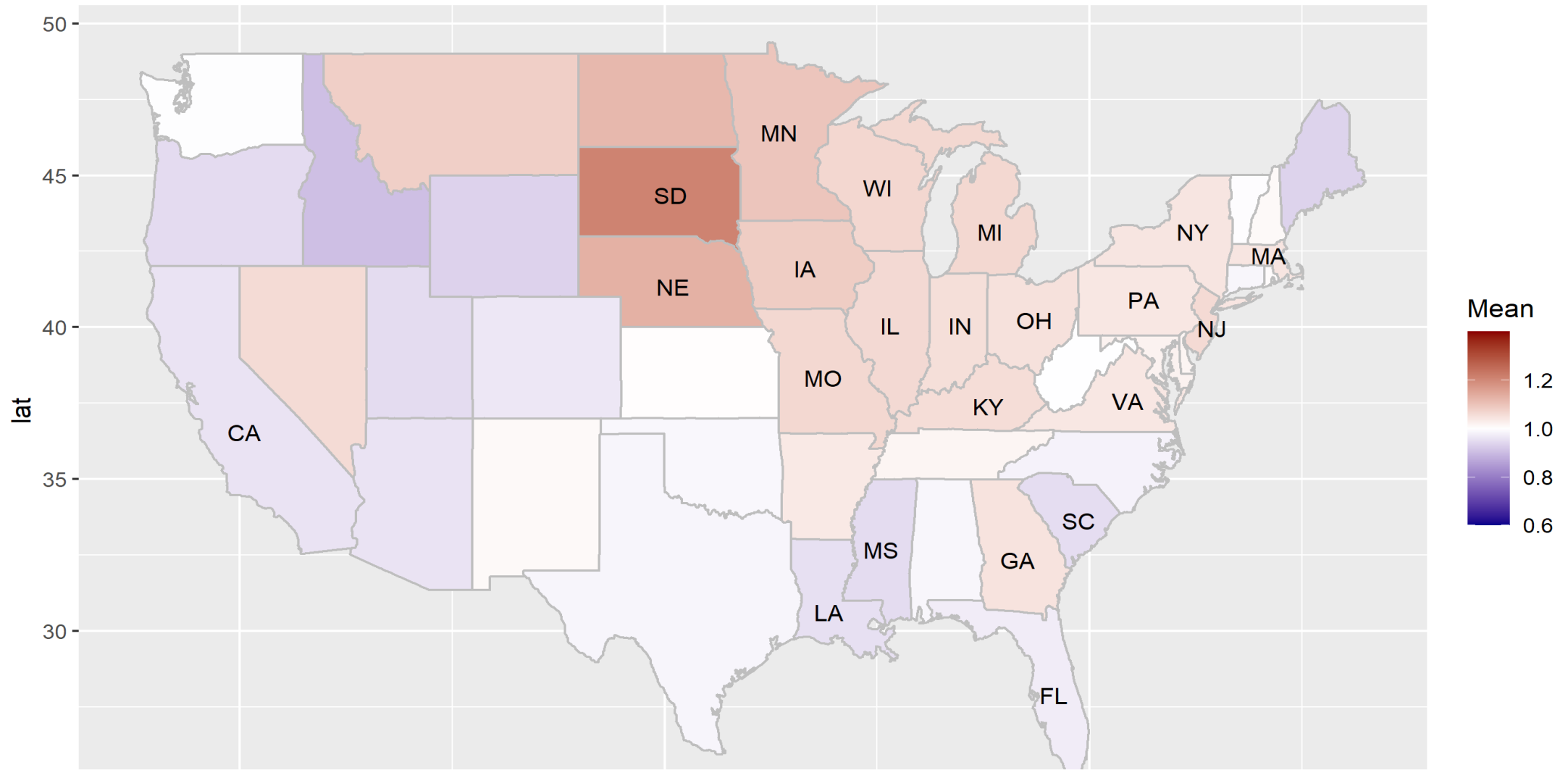
Project Summary

- Title
 - Identifying Public Health Applications of Satellite-derived Drought Indicators: Improved Monitoring for Respiratory Health
- Goals
 - Use existing satellite-derived drought monitoring tools to **analyze changes in air quality during droughts, and examine health risks and vulnerabilities** associated with these changes
 - With feedback from end users, **create decision-making tools** for drought preparedness and response
- Impact
 - Improved public health preparedness and capacity for adaptation to drought

Increase in Respiratory Mortality with Drought

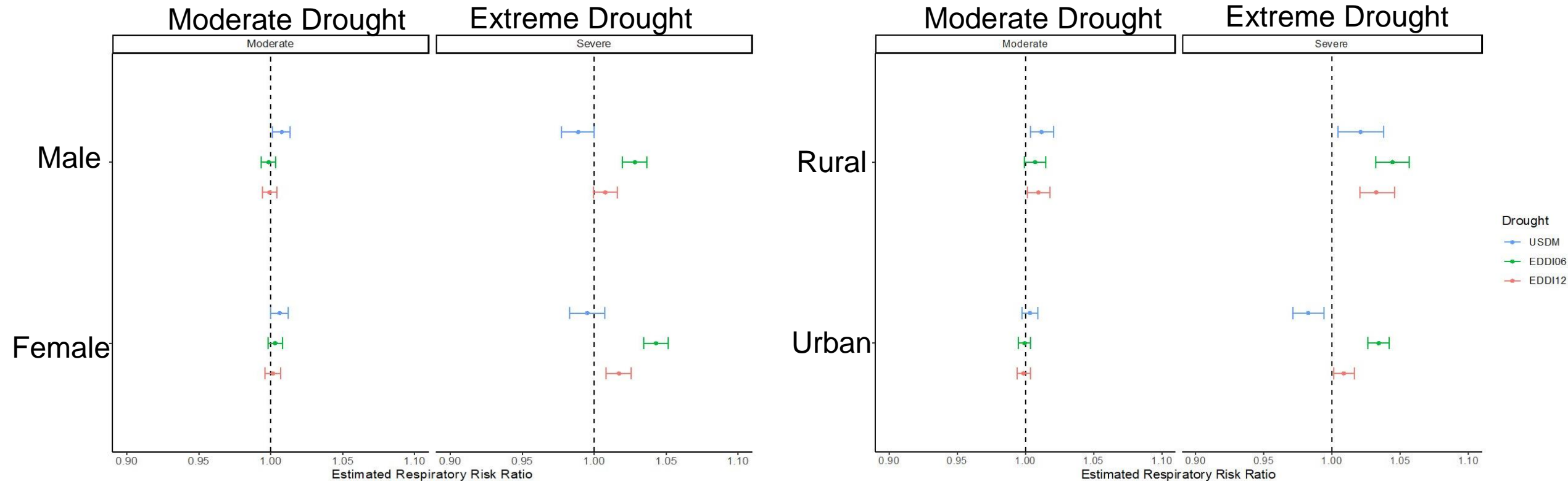


Quantity Incidence Ratio-S-EDDI-12





Respiratory Mortality Outcomes in the U.S.



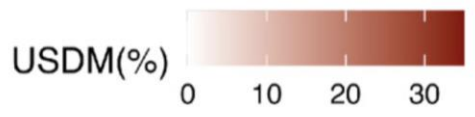
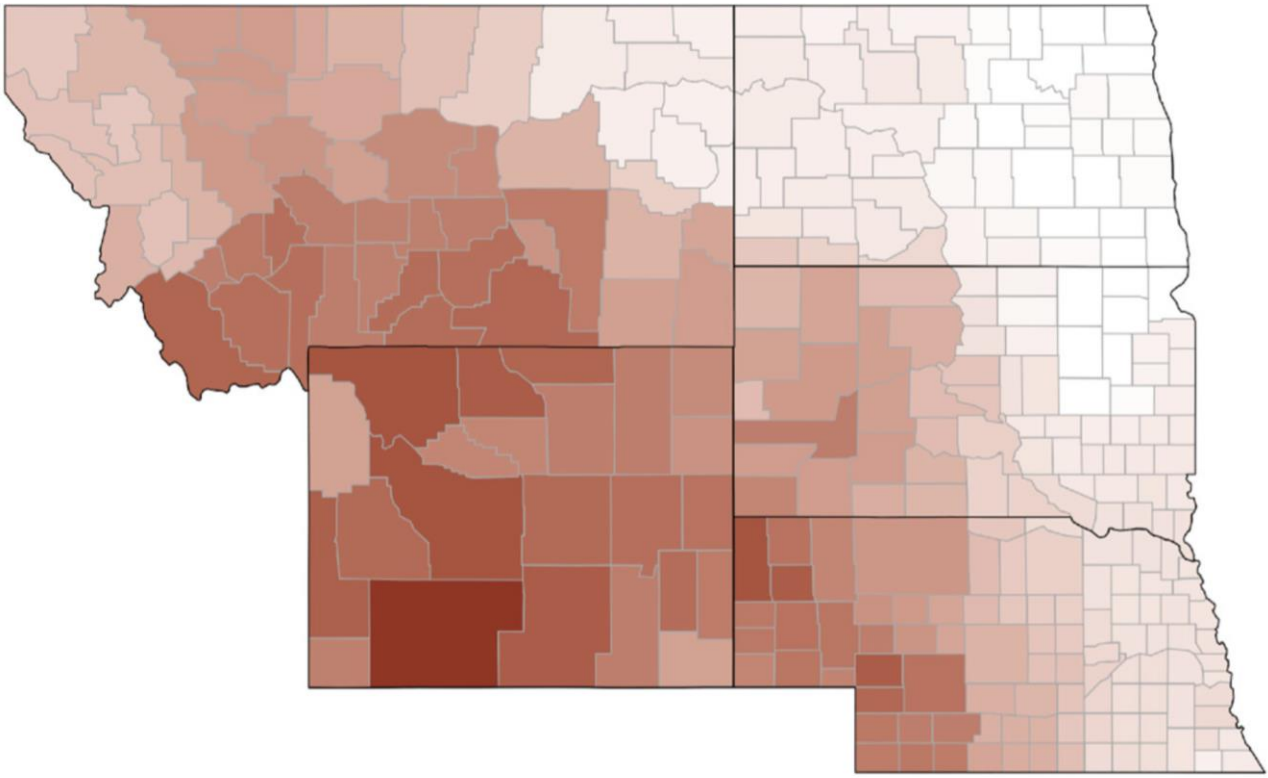
- Males and Females had increased respiratory related mortality with extreme drought.
- Females had a larger effect.

- Respiratory mortality increase in metro and nonmetro areas during extreme drought.
- Nonmetro had a larger effect.

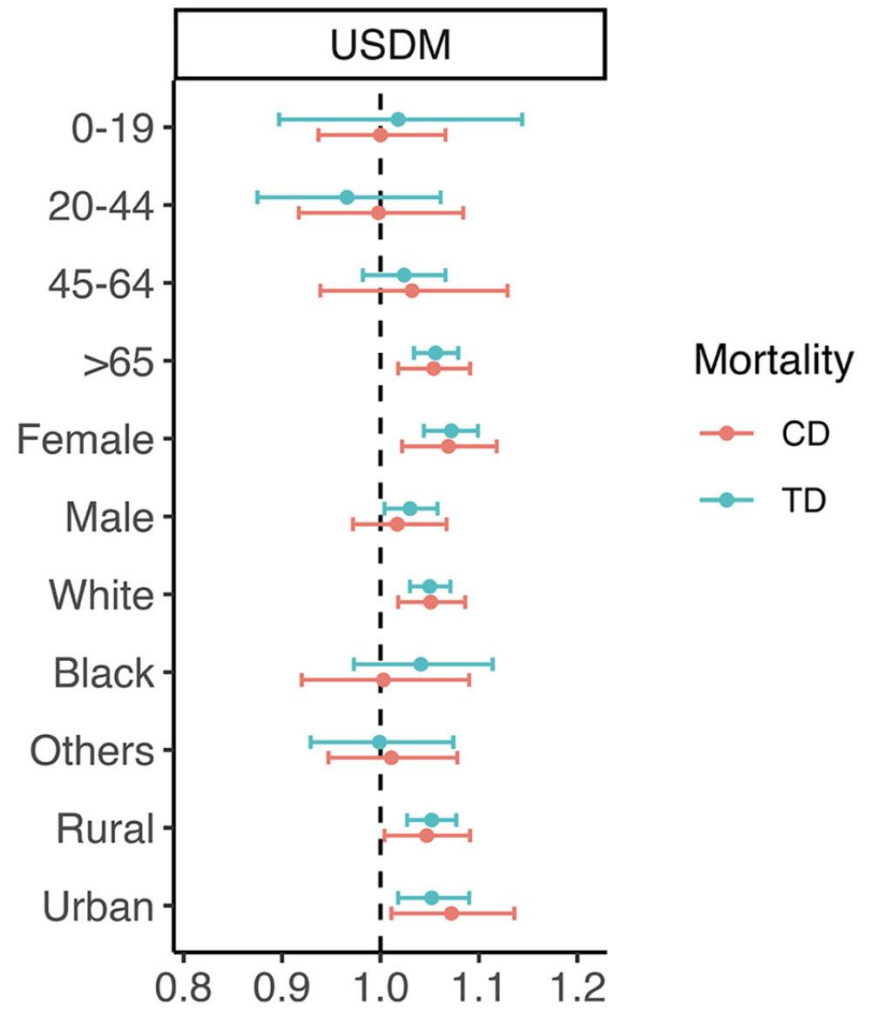
Increase in Cardiovascular and Total Mortality



Exposure to Severe Drought Conditions



2000-2018



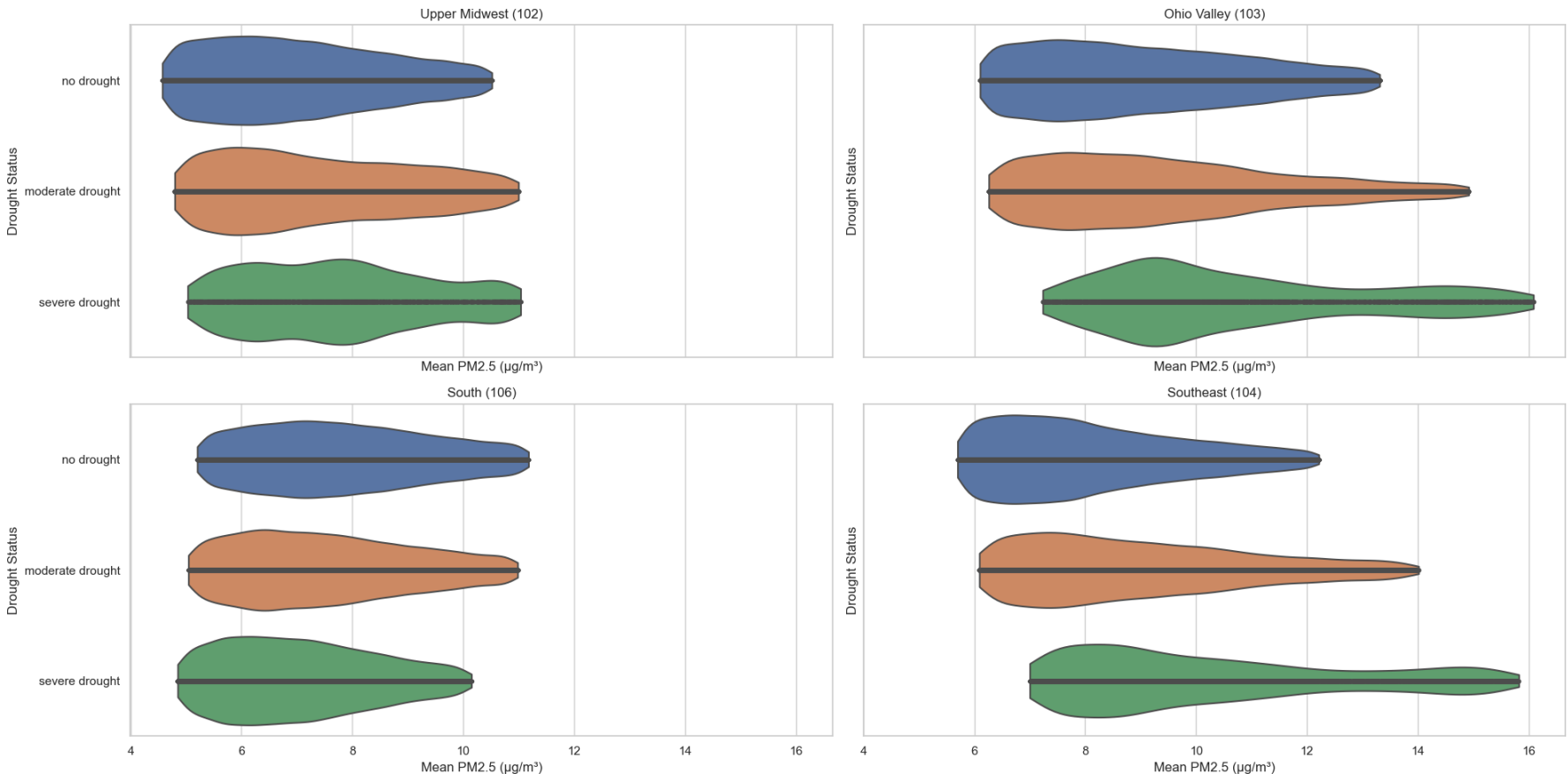
Increase in PM_{2.5} Concentrations with Drought



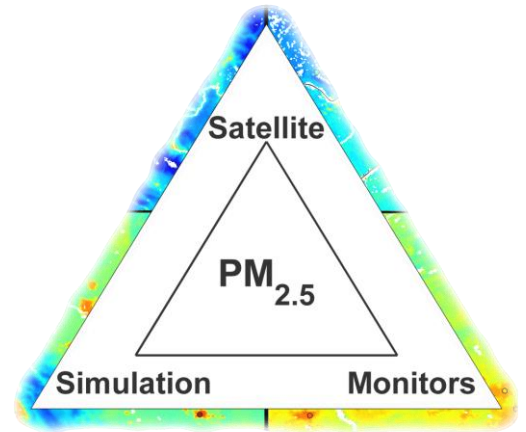
Satellite-derived PM_{2.5} from Atmospheric Composition Analysis Group



- MODIS, VIIRS, MISR, and SeaWiFS
- Dark Target, Deep Blue, MAIAC
- GEOS-Chem
- AERONET



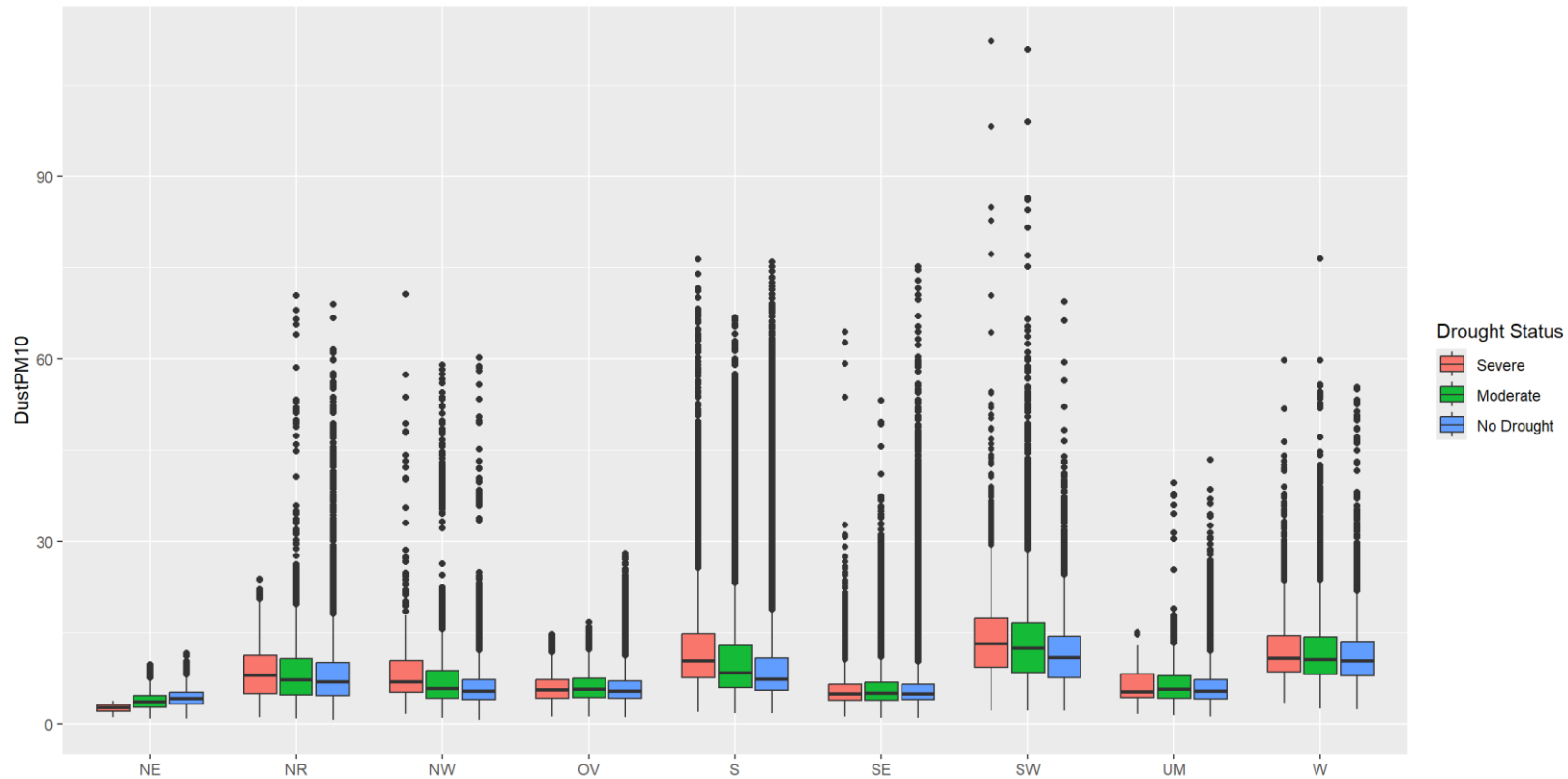
 No Drought  Moderate Drought  Severe Drought



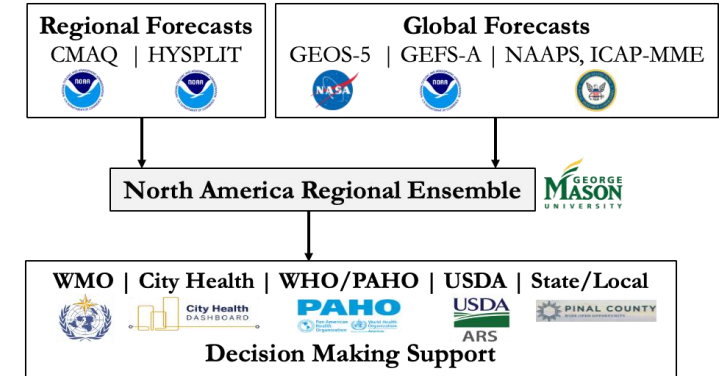
Increase in PM10 Dust Concentrations with Drought



Satellite-derived PM10 Dust Data from Daniel Tong



Multi-Model Ensemble

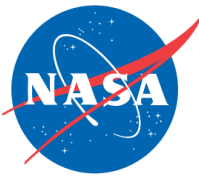




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Earth Observations, Models, and/or Technologies

Satellite Sensor/Model/Tech.	Product Used	Temporal Coverage and Latency required
MODIS	Land Use Land Cover	2000-present
MODIS	NDVI	2000-present
AQS	PM2.5, PM10, O3	Hourly
IMPROVE	PM2.5 composition	3-Day
MODIS	AOD Collection 6	Daily
MODIS	Fire Radiative Power	Daily
QuickDRI	Drought Indicator	Weekly
VegDRI	Drought Indicator	Weekly
ESI	Drought Indicator	Weekly
GRACE	Soil Moisture	Weekly
NLDAS	Soil moisture	Daily

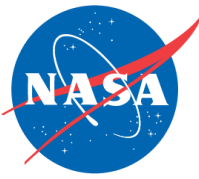


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Project Partners/Collaborators

List project Co-Investigators, collaborators, and other partners

Role	Name	Affiliation	Organization Type
Principal Investigator	Jesse Bell	UNMC	Academic
Co-investigator	Azar Abadi	University of Alabama	Academic
Co-investigator	Yeongjin Gwon	UNMC	Academic
Co-investigator	Rachel Lookadoo	UNMC	Academic
Co-investigator	Siddhi Munde	UNMC	Academic
Co-Principal Investigator	Jesse Berman	University of Minnesota	Academic
Graduate Research Assistant	TBN	University of Minnesota	Academic
Co-investigator	Daniel Tong	George Mason University	Academic
Graduate Research Assistant	TBN	George Mason University	Academic
Co-investigator	Brian Wardlow	University of Nebraska-Lincoln	Academic
Co-investigator	Zhining Tao	Morgan State University	Academic
Project Manager	Christine Allmon	UNMC	Academic



Project End-users & Stakeholders

List organization names and organization types

Organization Name	Organization Type
Nebraska Association of Local Health Directors	Association
Nebraska Department of Health and Human Services	Agency
Arizona Department of Health Services	Agency
National Oceanic and Atmospheric Administration	Agency
National Integrated Drought Information System	Agency
Centers for Disease Control and Prevention	Agency
Winnebago Public Health Department	Agency

Engagement plan and recent updates

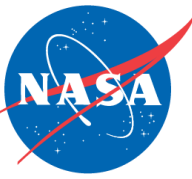
Plans are in place to begin engagement with end-users and stakeholders in the next quarter of this project.

Schedule & Milestones

Harnessing the Heartland: Regional Workshop hosted by UNMC and NASA; focusing on environmental data and public health (February 2024)

Next 6 months

- Evaluating changes in air quality with drought, including Ozone, PM_{2.5}, and PM₁₀
- Start a comprehensive air quality modeling system to simulate the underlying processes linking drought to air quality
- Evaluate and analyze the components of the health and earth observation datasets together (Annual and monthly ground-level fine particulate matter (PM_{2.5}) for 1998-2022 were estimated by combining Aerosol Optical Depth (AOD) retrievals from the NASA MODIS, MISR, SeaWiFS, and VIIRS instruments with the GEOS-Chem chemical transport model, and subsequently calibrating to global ground-based observations using a Geographically Weighted Regression (GWR).
- Confirmed venue in Omaha, NE on **June 11-12, 2024 for NASA tool development workshop**. A draft invitation list has been developed and will be finalized over the next month.



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Schedule & Milestones

Year 2

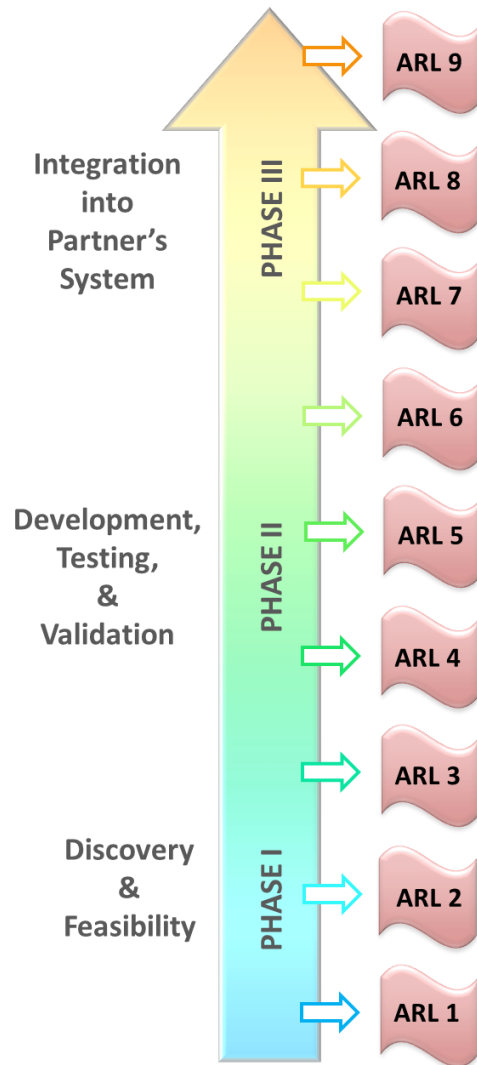
- Understanding links to health outcomes from drought
- Understanding links to health outcomes from air quality
- Evaluate at-risk populations
- Determine regional differences

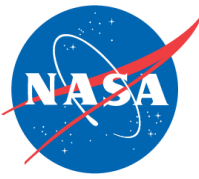
Year 3

- Working with end-users for pre-product development
- Product development
- Workshop with end-users
- Transition products to CDC and NIDIS

ARL Performance

- Start-of-Project ARL = 1: Basic Research
- Goal ARL = 8: Application Completed and Qualified
- Current ARL = 5



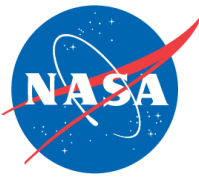


Current ARL-Supporting Evidence

- Application components integrated into a functioning prototype application system with realistic supporting elements
 - Accessed and formatted the drought data, as well as a large percentage of the air quality system, evaluation to continue through quarter 2.
 - First workshop will be held in June with state/local public health practitioners to understand the potential local impacts of drought on their populations, provide user-friendly data products for public health decision-makers, make findings available at the resolution and location that are most useful for actions to be implemented, and determine which at-risk populations are most in need of improved messaging.
- The application system's potential to improve the decision making activity determined and articulated (e.g., projected impacts on cost, functionality, delivery time, etc.)
 - Determined relationship between ozone and drought (publication in process)
 - Monthly all-hands meetings for program related updates, and monthly technical meetings to serve as a platform for in-depth discussion on more specific aspects of the project continue.

Current ARL-Supporting Evidence

- ARL 5
 - Application components integrated into a functioning prototype application system with realistic supporting elements.
 - Accessed and formatted the drought data and a large percentage of the air quality system evaluation to continue through quarter 2.
 - Creation and release of a messaging framework on drought and health .



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Accomplishments since Last Update

Manuscripts

Gwon, Y., Ji, Y., Bell, J. E., Abadi, A. M., Berman, J. D., Rau, A., ... & Rennie, J. (2023). The Association between Drought Exposure and Respiratory-Related Mortality in the United States from 2000 to 2018 <https://www.mdpi.com/1660-4601/20/12/6076>

Bell, J.E., R.E. Lookadoo, K. Hansen, A. Sheffield, M. Woloszyn, S. Reeves & B. Parker. Drought and Public Health: A Roadmap for Advancing Engagement and Preparedness. <https://www.drought.gov/documents/drought-and-public-health-roadmap-advancing-engagement-and-preparedness>

Gwon, Y., Ji, Y., Abadi, A. M., Rau, A., Berman, J. D., Leeper, R. D., ... & Bell, J. E. (2024). The effect of heterogeneous severe drought on all-cause and cardiovascular mortality in the Northern Rockies and Plains of the United States. *Science of The Total Environment*, 912, 169033.

Berman, J.D., Abadi, A.M. & Bell, J.E. Existing Challenges and Opportunities for Advancing Drought and Health Research. *Curr Envir Health Rpt* (2024). <https://doi.org/10.1007/s40572-024-00440-z>

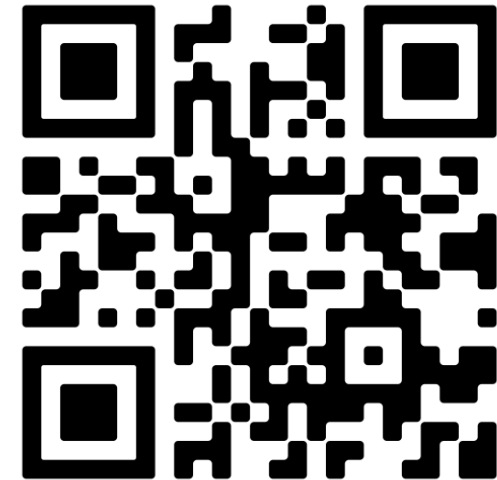
Accomplishments since Last Update

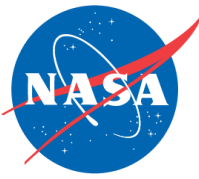


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Publications

Lookadoo R.E., Bell J.E., & Woolsey S.L. [Drought and Health: A Messaging Framework for Public Health Professionals & Healthcare Providers](#)





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Accomplishments since Last Update

Partnerships

United Nations Convention to Combat Desertification 21st Session of the Committee for the Review of the Implementation of the Convention: The Global Impact of Drought Side Event, 17th November 2023

Drought Resilience +10 Session at World Water Week 2023: Cooperation for Drought Resilience - Integrating Practice and Knowledge, August 2023

Upcoming: 10th World Water Forum in Indonesia, Side Session The Many Faces of Drought: Monitoring Societal Impacts and Building Resilience, May 2024

Manuscripts under Active Review

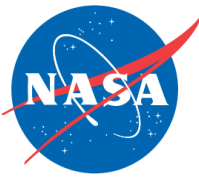
Rau A, Baldomero AK, Bell JE, Rennie J, Wendt CH, Tarr GAM, Alexander BH, Berman JD. Compound drought and heatwave effects on mortality risk in United States Veterans with chronic obstructive pulmonary disease.



ROSES21



Accomplishments



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Presentations

Jesse Bell, PhD presented, “Identifying the Public Health Applications of Satellite-Derived Drought Indicators” at the American Geophysics Union Conference in San Francisco, CA. (12/11/23)

Yeongjin Gwon, PhD presented a poster titled, “The Effect of Heterogeneous Severe Drought Pattern on All-Cause and Cardiovascular Mortality in the Northern Rockies and Plains of the United States” (invited at the American Geophysics Union Conference in San Francisco, CA. (12/12/23)

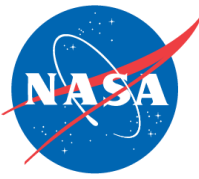
Raheleh Mohammadi, MPH presented a poster titled, “Spatial and Temporal Trends in Vector-Borne Disease Mortality Patterns, United States, 2003-2018” at the American Geophysics Union Conference in San Francisco, CA. (12/12/23)

Jesse Bell, PhD presented a poster titled, “Public Health Preparedness for Drought: Engaging and Equipping Stakeholders” (invited) at the American Geophysics Union Conference in San Francisco, CA. (12/12/23)

Babak Fard, PhD presented a poster titled, “Suitability Analysis for Heat-Health Adaptation and Mitigation Strategies for the City of Omaha, Nebraska” at the American Geophysics Union Conference in San Francisco, CA. (12/13/23)

Rau A, Baldomero AK, Bell J, Rennie J, Wendt CH, Tarr GAM, Alexander BH, Berman JD. Compound drought and heatwave risk effects on mortality risk in United States Veterans with Chronic Obstructive Pulmonary Disease. American Geophysical Union Conference. December 2023.

Accomplishments



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Presentations

Gwon, Y. “Bayesian regression model with suppressed mortality: An application to drought and health impact study. 2023 Annual Meeting of the Western North American Region of the International Biometric Society. (2023)

Bell, J., Lookadoo, R., Abadi, A., Judd, L., Kriz-Wickham, B., Woloszyn, M. (2023).Coping with the impacts of drought on human health. 2023 Water for Food Global Conference

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Accomplishments



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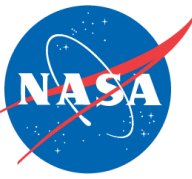
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Jesse Bell, PhD presented “Identifying Public Health Applications of Satellite-derived Drought Indicators” at the AGU Chapman Conference. 2/12/24-2/16/24. Hawaii

Jesse Bell, PhD presented “Human Health and Environmental Well Being in an Age of Global Change and Climate Resilience”. 2/26/23. Lincoln, NE

Jesse Bell, PhD presented, “Interactive Cross-Sectoral and Transdisciplinary Solution-building Panel Discussions with Public Participation” for a conference titled, “Communities, Climate Change, and Health Equity – Exploring Flood Adaptation Strategies to Support Health Equity” for the National Academies Sciences Engineering and Medicine. 3/18/24.

Jesse Bell presented, “Drought and Health in the U.S.” at the Second Annual Climate & Health Conference in the 406. 4/13/24. Billings, Montana.



Accomplishments

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Accomplishments



News/Media:

Laura Nagengast, MPH and Jesse Bell, PhD were featured on the “CropWatch” podcast series called "Fridays with a Scientist". Available at <https://cropwatchpodcast.podbean.com>. (12/8/23)

Yeongjin Gwon, PhD had an article recently highlighted in NIDIS’ “Dry Times” newsletter. See Dr. Gwon’s article on his drought research here: <https://www.drought.gov/news/severe-drought-increases-mortality-risk-northern-rockies-and-plains-2024-03-06>

Jesse Bell, PhD was a guest on the Daugherty Water for Food Podcast on an episode titled, “Impacts of Climate Change in the U.S.” <https://waterforfood.nebraska.edu/our-work/communication/podcast>

Jesse Bell, PhD was a guest on “Rural Health Matters” 3/11/24. <https://www.youtube.com/watch?v=YyblrA9-Prc&list=PLmTSmZOYN5Y7Ehfl5KXrvb1SLnMI-hcdr&index=3>

Thank you!

- Jesse Berman, PhD – University of Minnesota
- Azar Abadi, PhD – University of Alabama
- Daniel Tong, PhD – George Mason University
- Rachel Lookadoo, JD – UNMC
- Zhining Tao, PhD – Morgan State University
- Sophie Shea, MPH – UNMC
- Brian Wardlow, PhD – UNL
- Siddhi Munde, MS – UNMC
- Yeongjin Gwon, PhD – UNMC
- Christine Allmon- UNMC



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