ENVIRONMENTAL DETERMINANTS OF ENTERIC INFECTIOUS DISEASE

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ENTERIC INFECTIOUS DISEASES ARE:

Deadly: the second-leading cause of death for children < 5 yrs old, globally

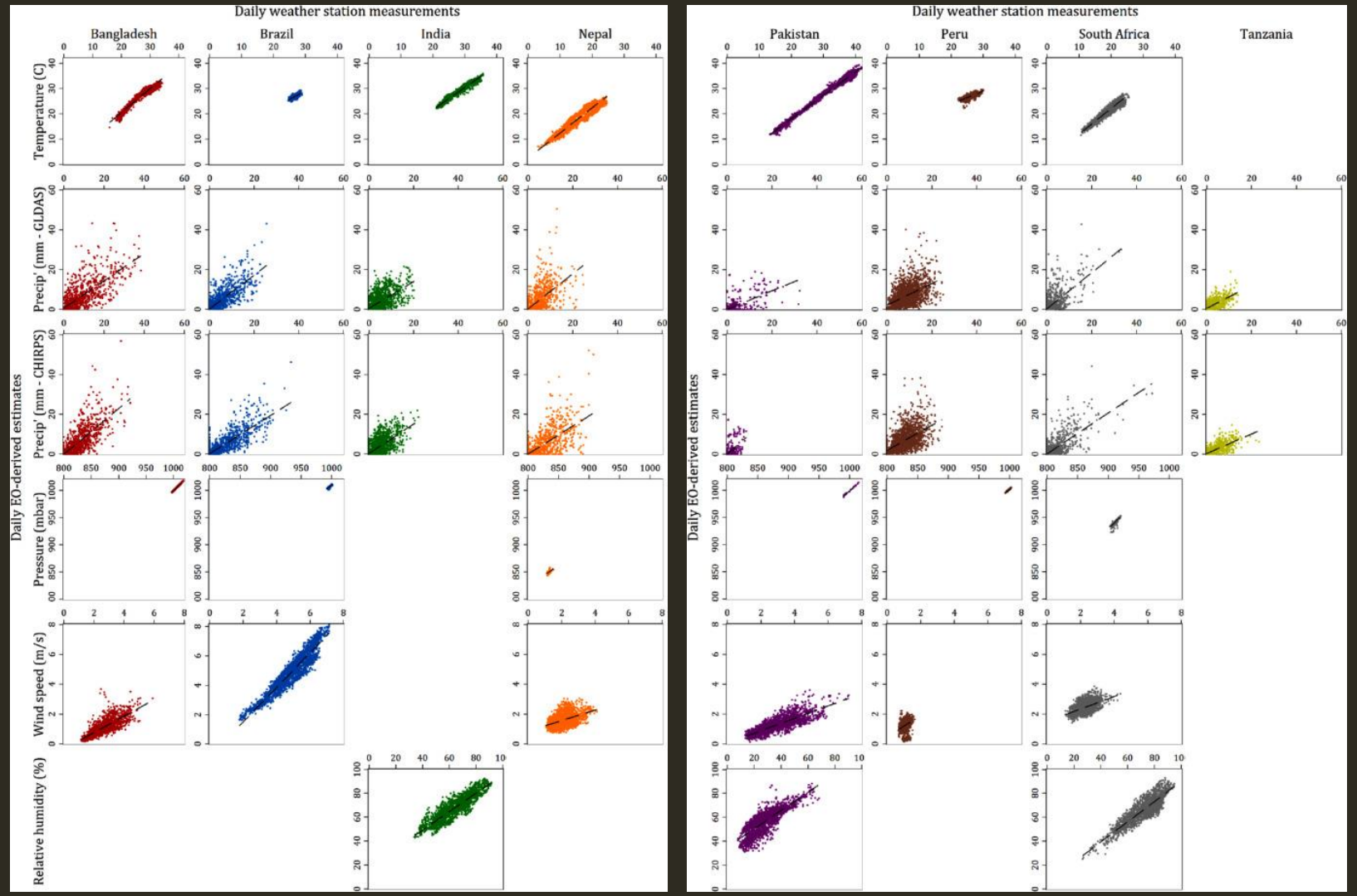
Burdensome: morbidities include impaired cognitive development, stunting, and reduced vaccine responsiveness

Preventable and treatable: WASH interventions, emerging vaccines, and simple rehydration therapies are available

THE GEO-HEALTH ENTERICS PROJECT

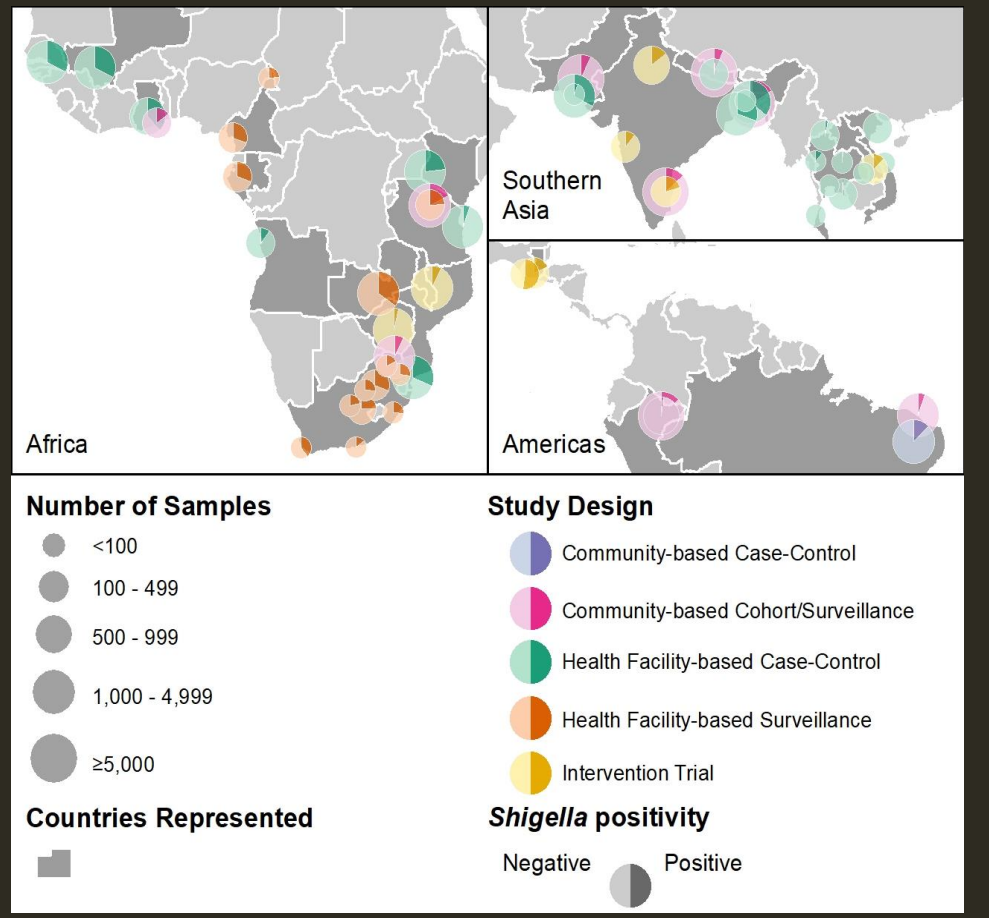
1. Can Earth Observations provide reliable environmental estimates to support enteric disease risk analysis?
2. What are the hydroclimatic sensitivities of major enteric pathogens?
3. Can we infer process and predict risk for specific pathogens?

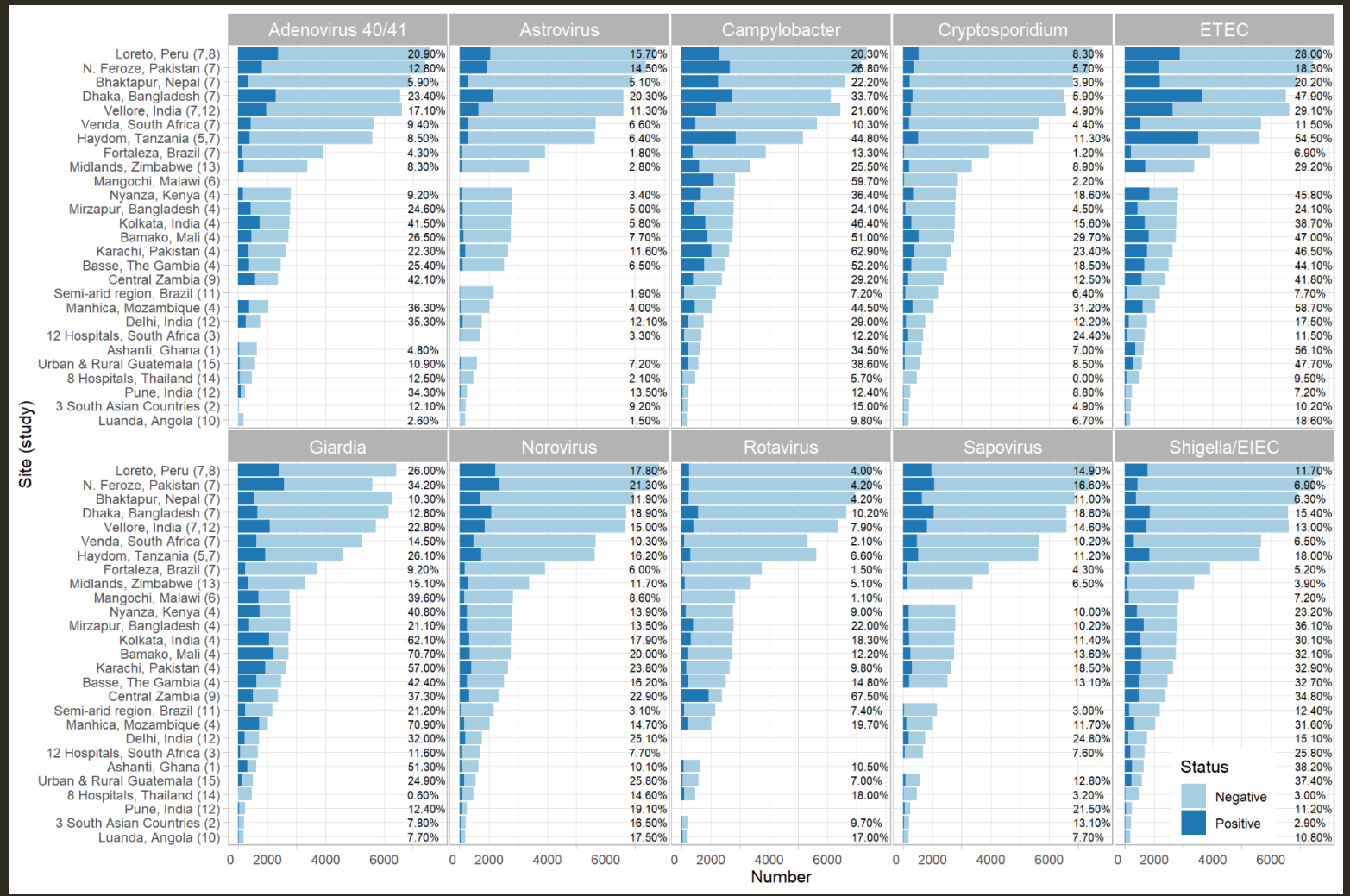
1. EVALUATE CONFIDENCE IN EARTH OBSERVATIONS



Colston et al. (2018)
https://doi.org/10.1016/j.envres.2018.02.027

2. CHARACTERIZE SENSITIVITIES OF MAJOR PATHOGENS





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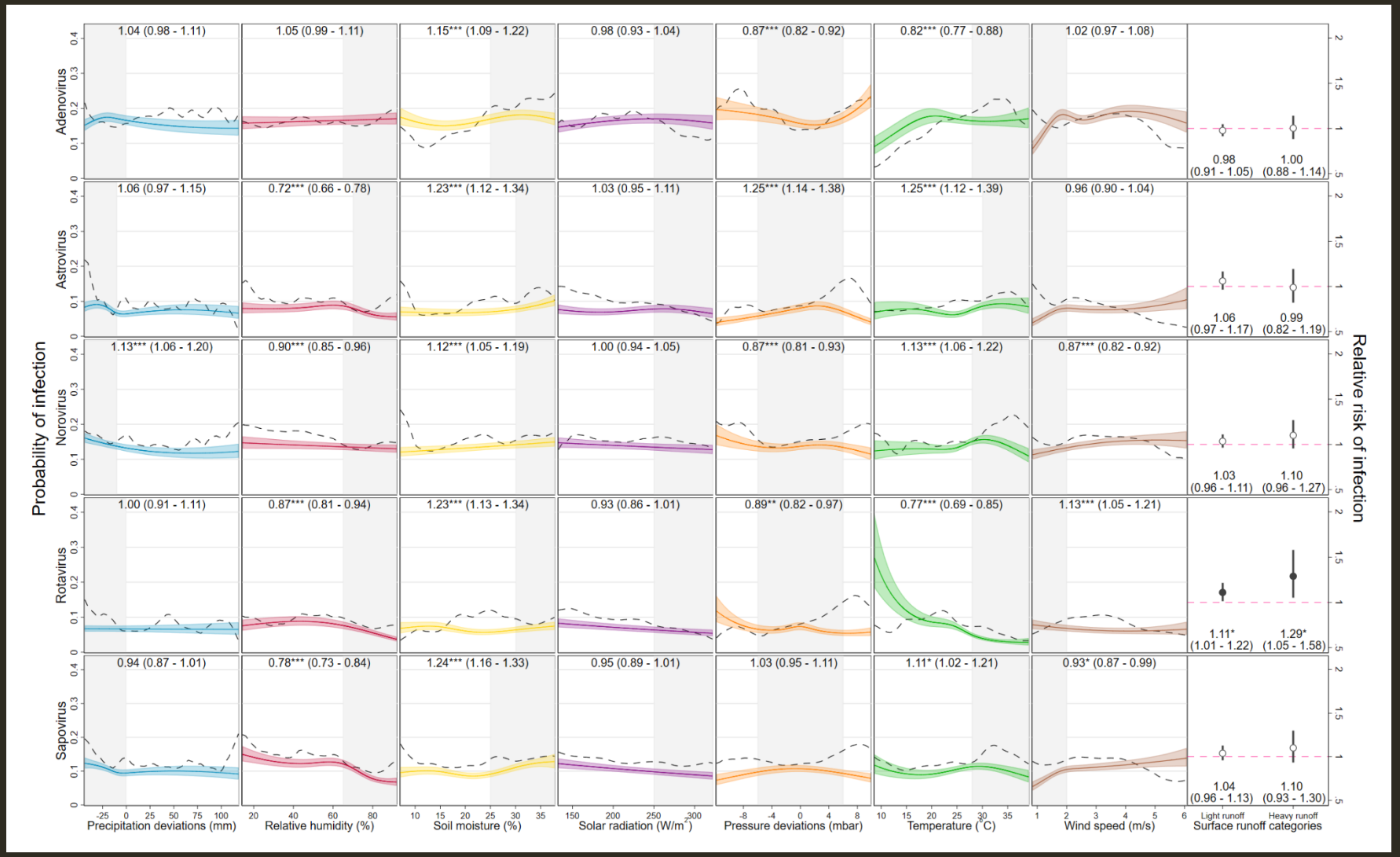

Colston et al. (2022)
https://doi.org/10.1029/2021GH000452

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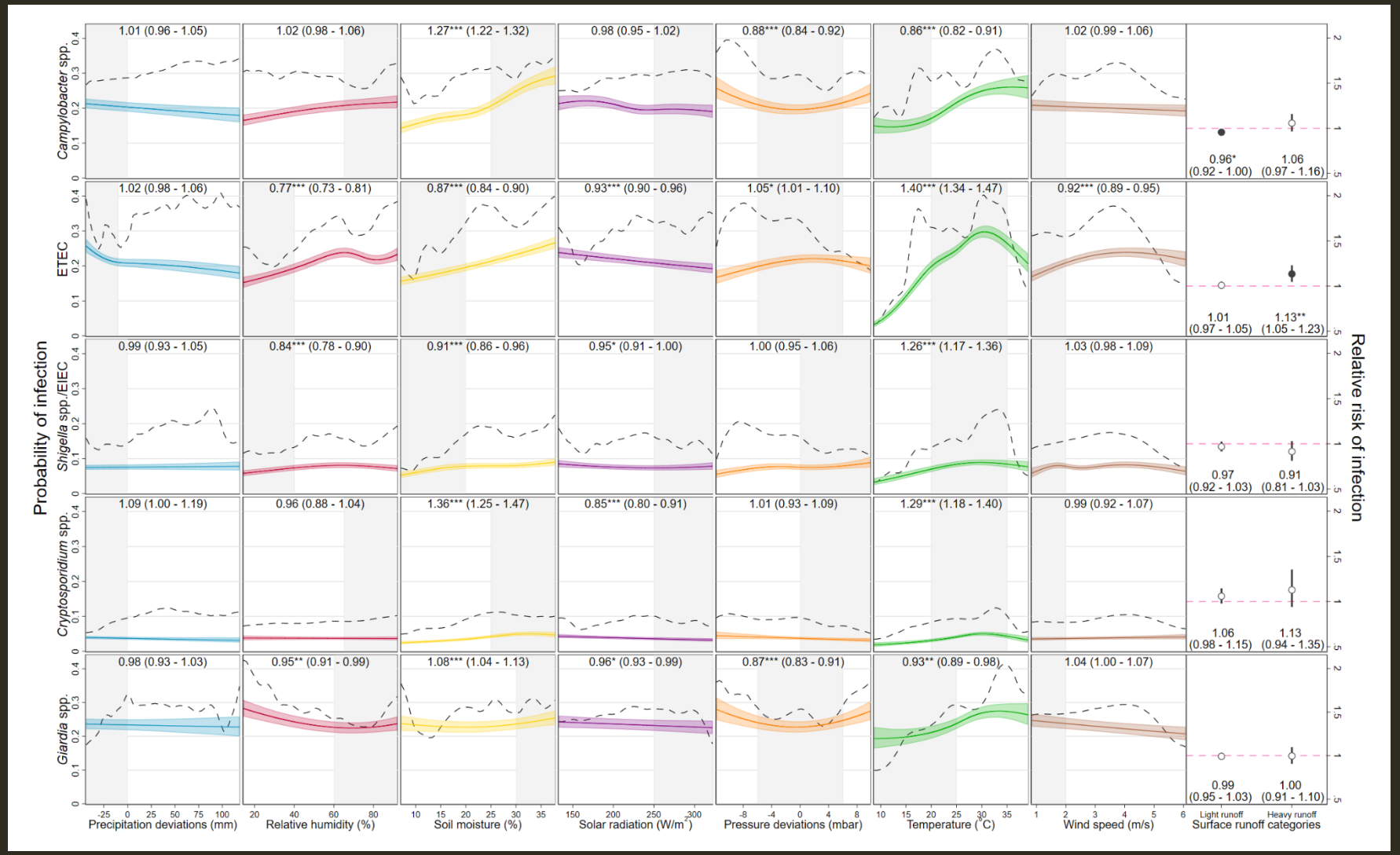

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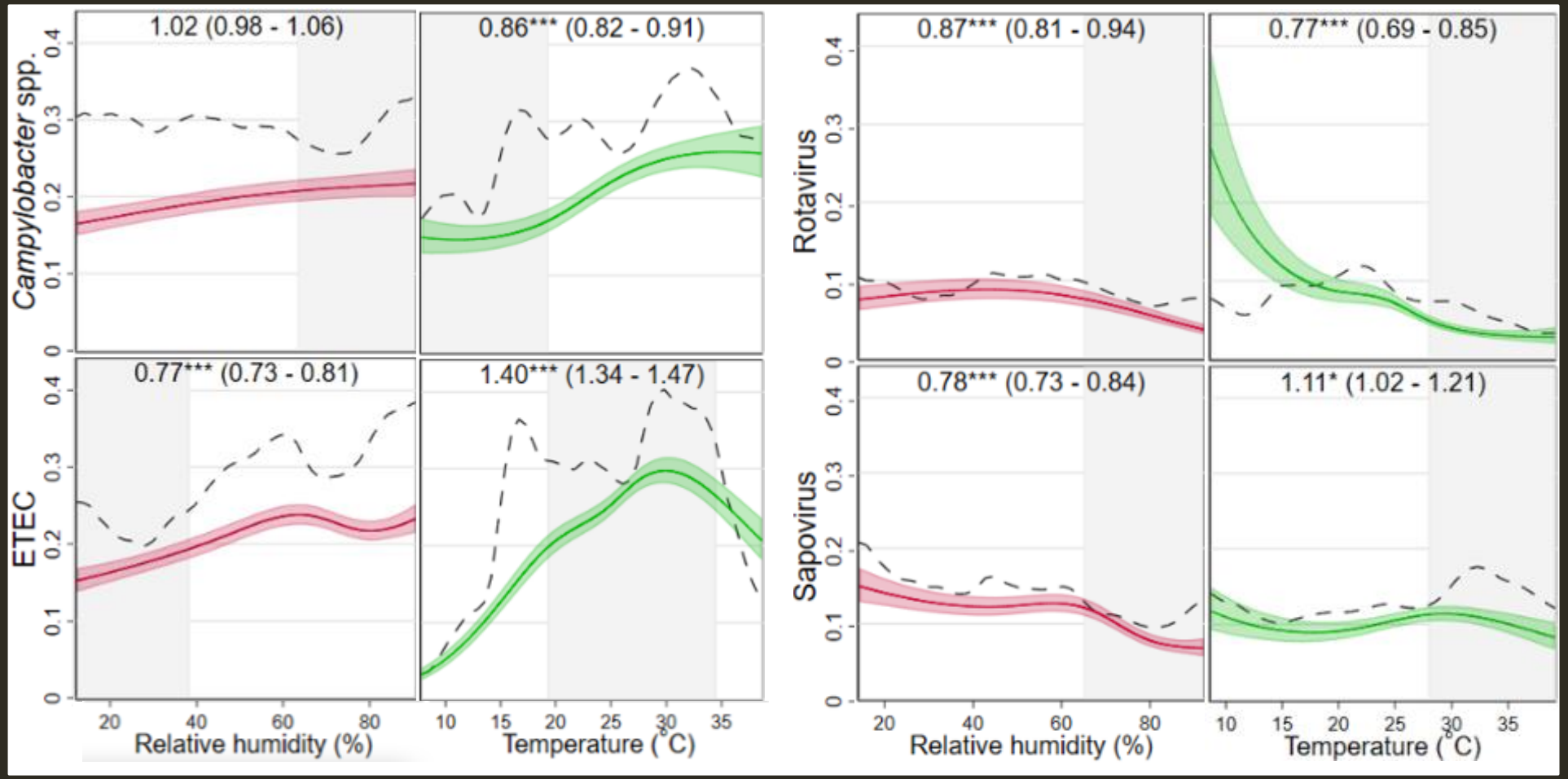

Warmer, wetter conditions =

Reduced viral pathogen risk

But

Increased bacterial pathogen risk

Colston et al. (2022)
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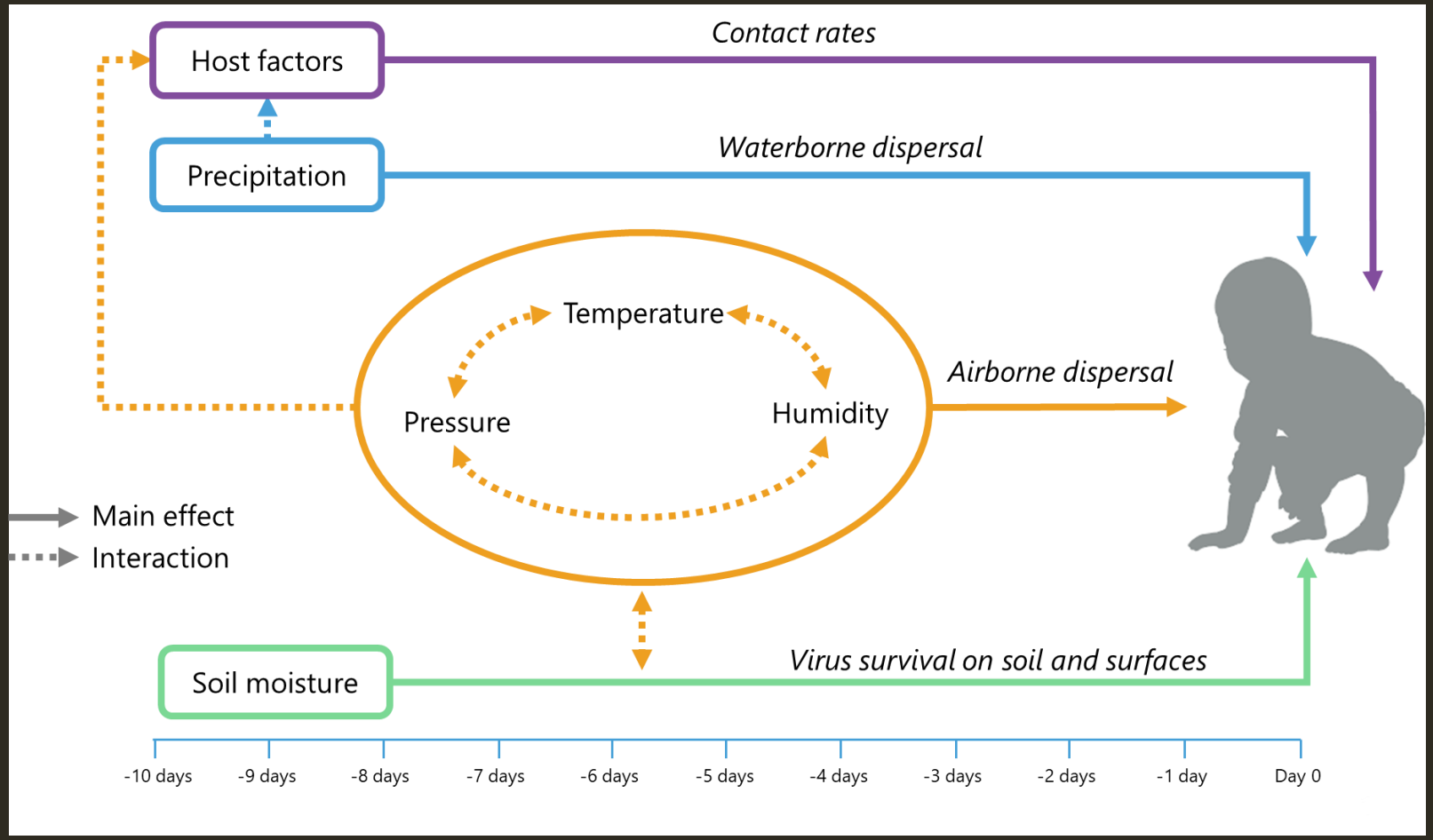
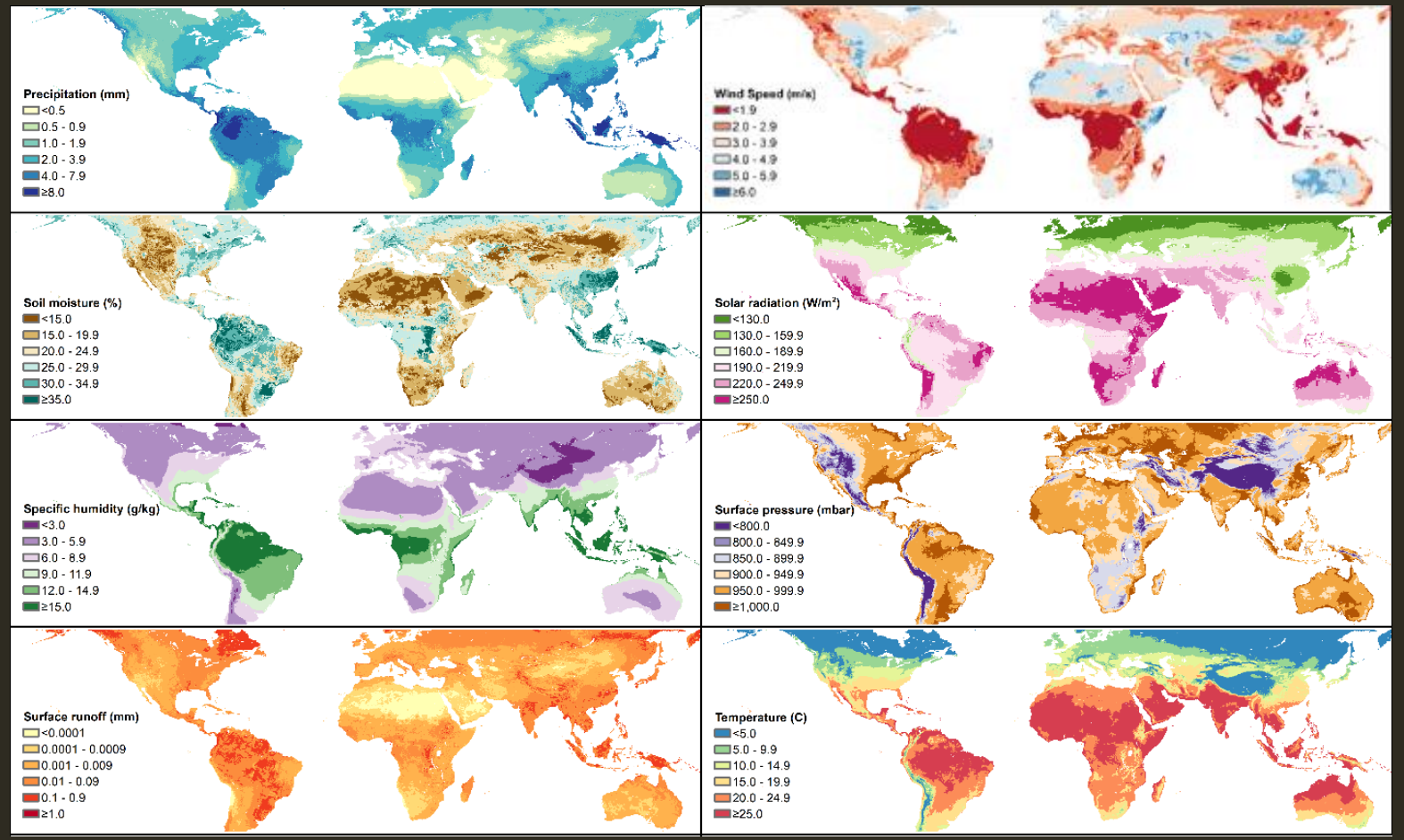
3A: INFER MECHANISM – ROTAVIRUS



Colston et al. (2019) https://doi.org/10.1016/S2542-5196(19)30084-1

3B: PREDICT – SHIGELLA



Badr et al., In Review

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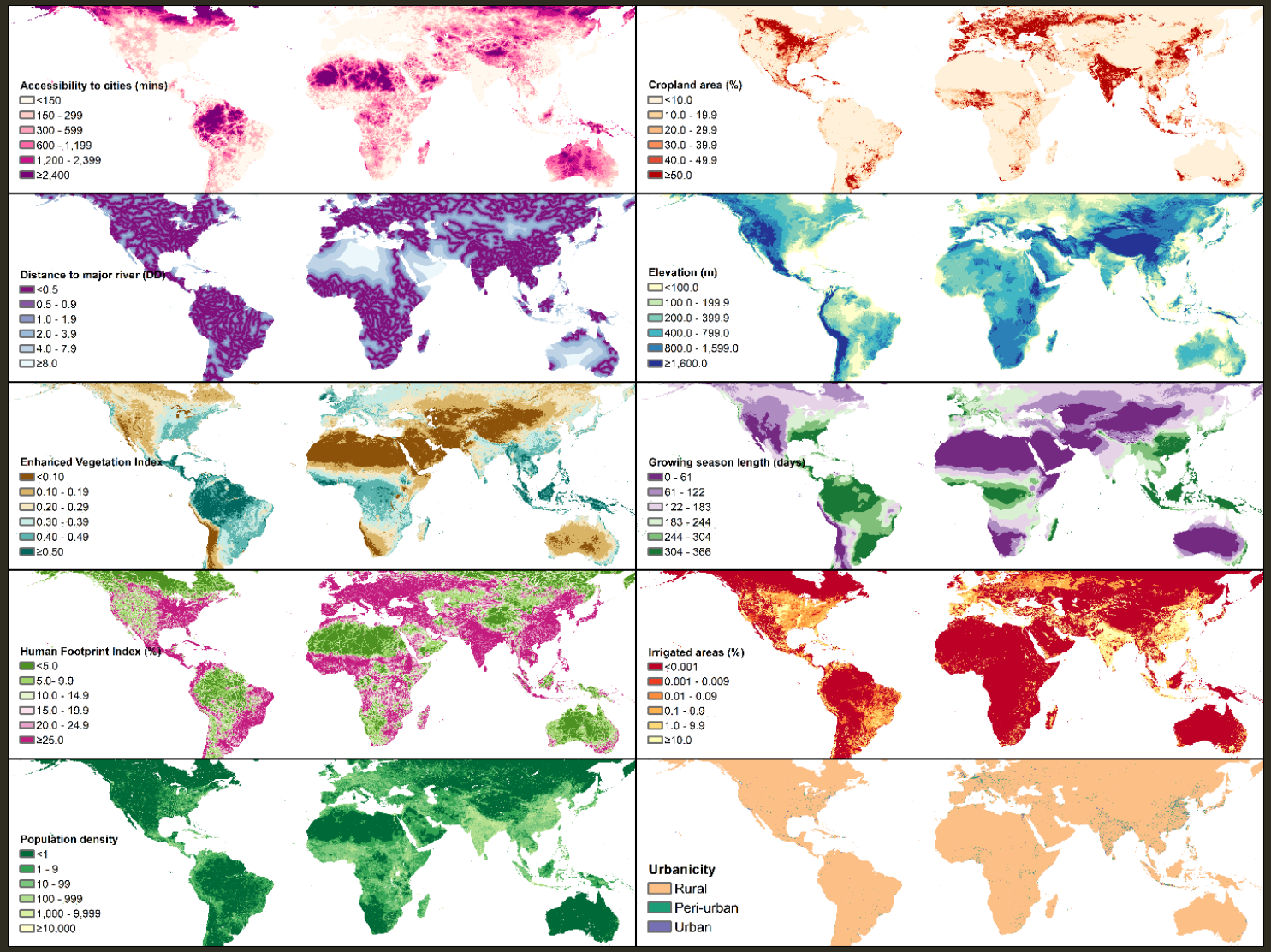

Badr et al., In Review

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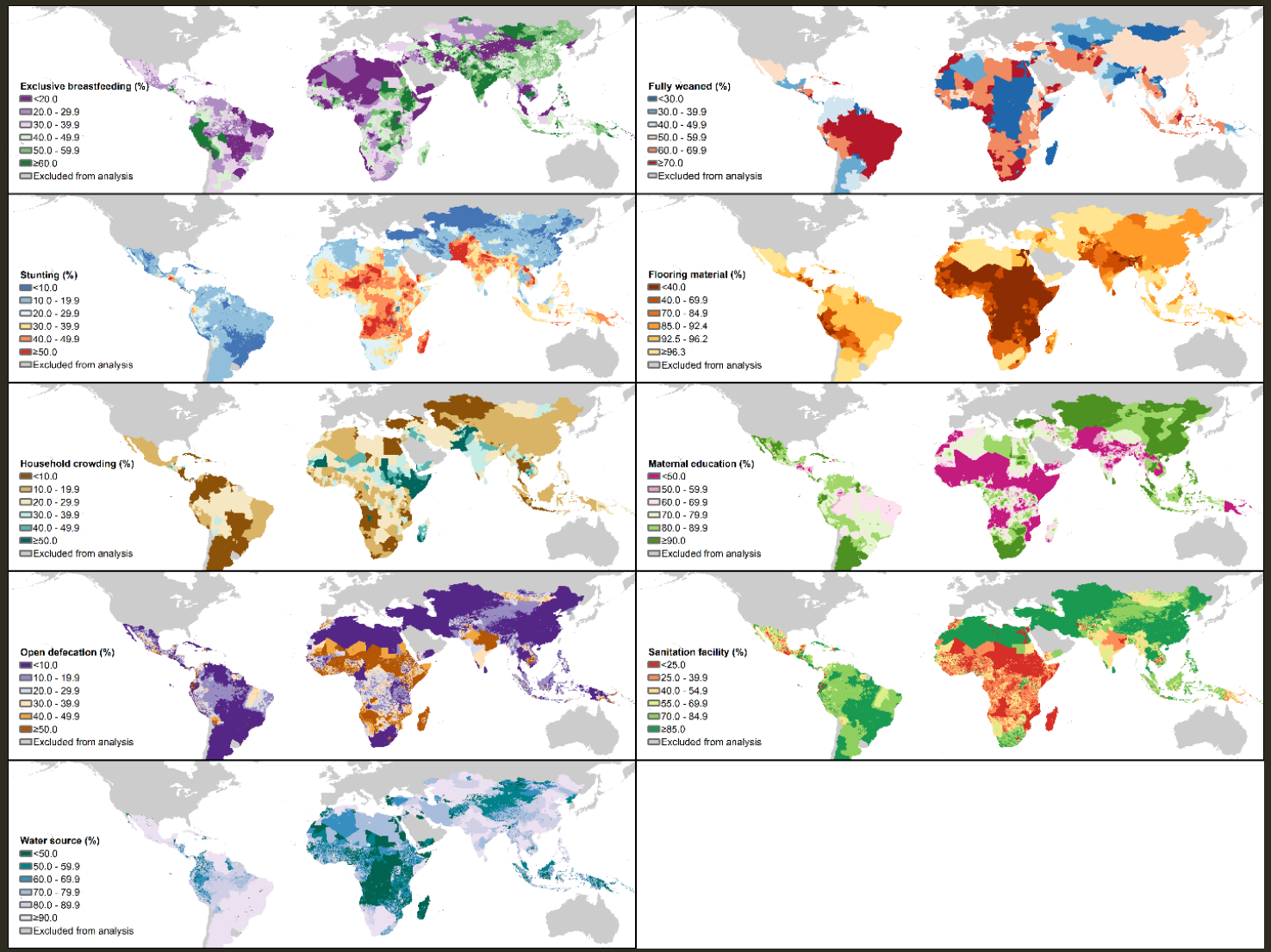

Badr et al., In Review

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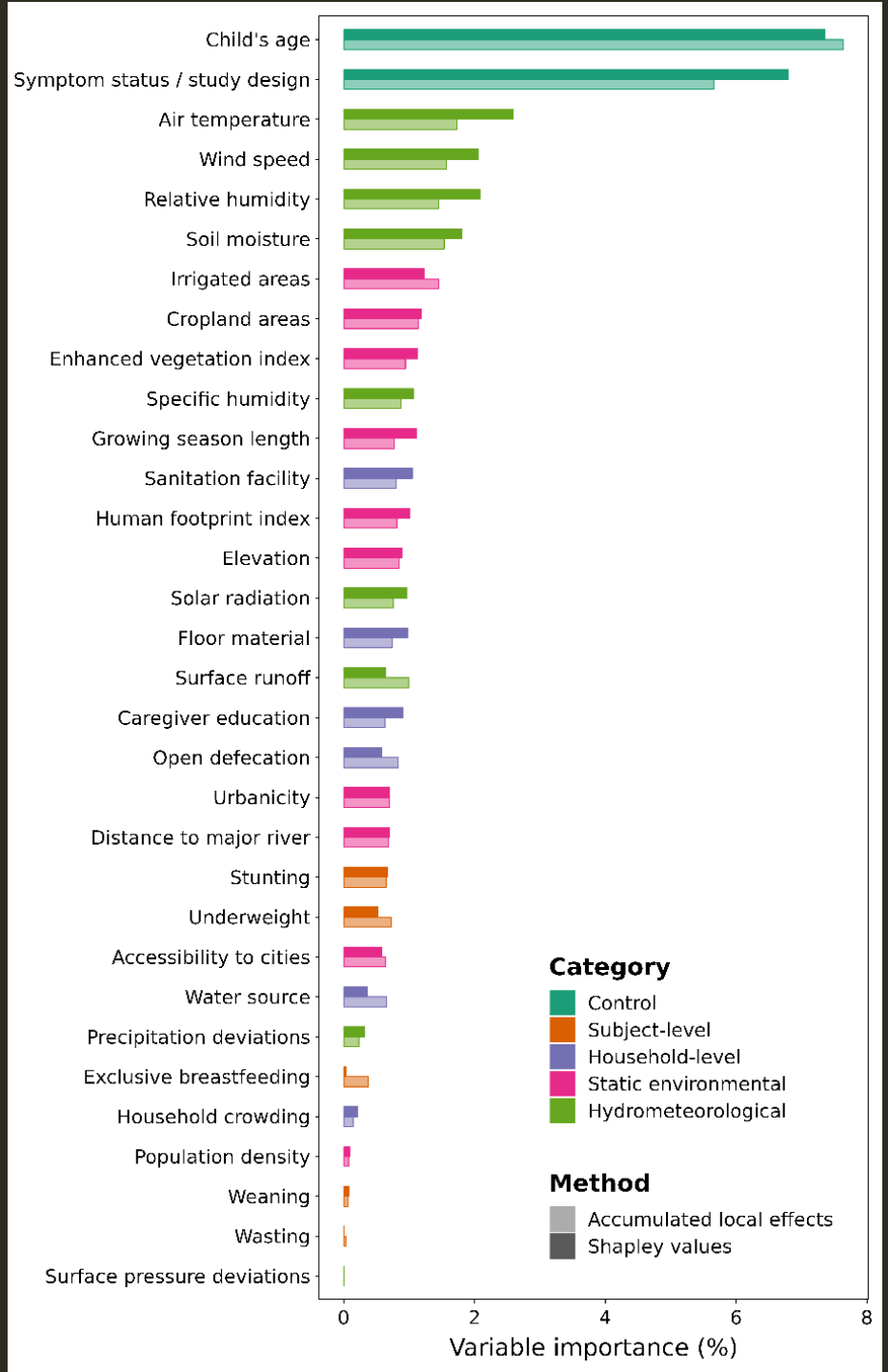

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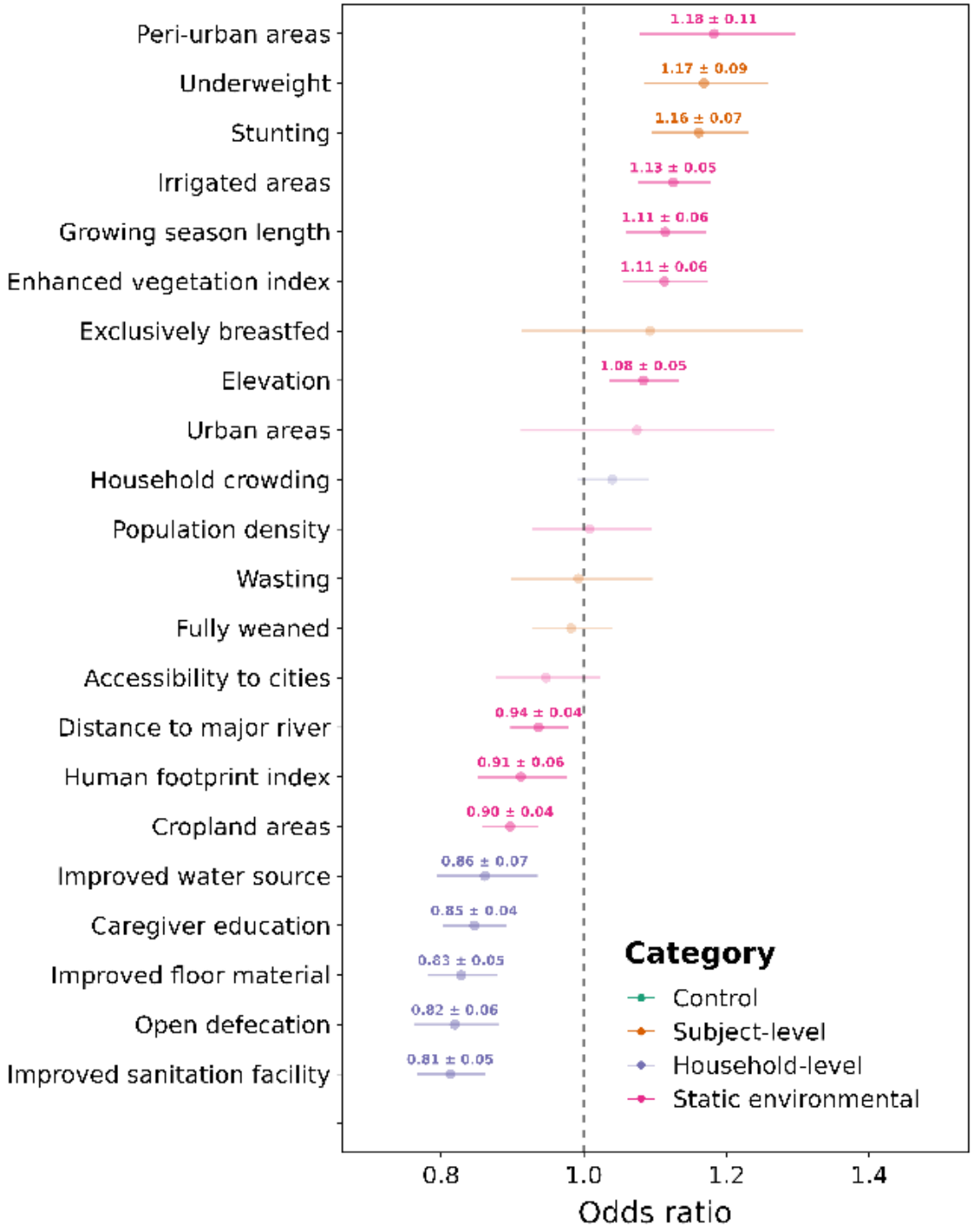

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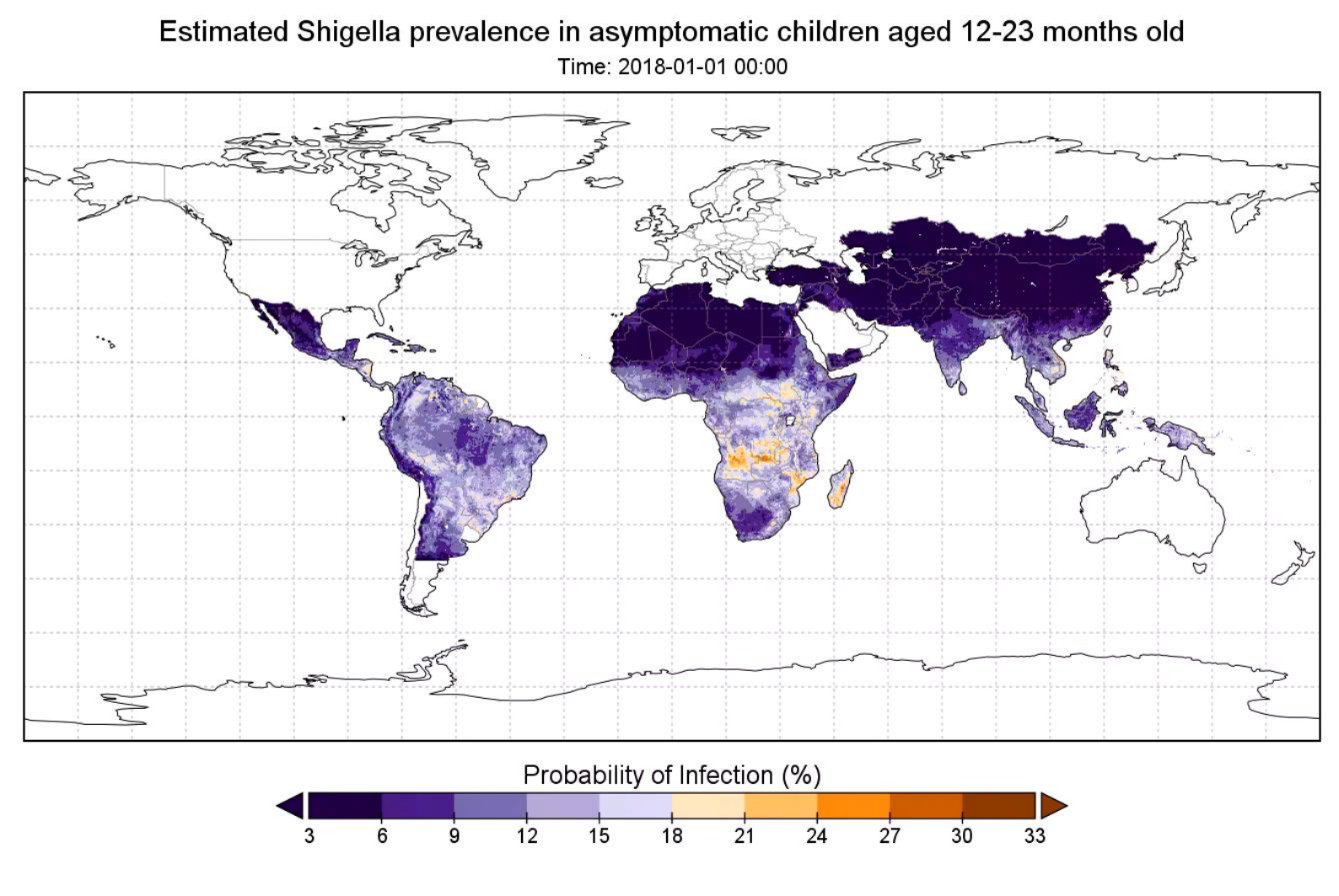

Badr et al., In Review

WHAT WE'VE LEARNED

Environmental sensitivities of enteric infectious diseases are **pathogen-specific**

Satellite-informed meteorological and hydrological estimates **contribute significantly** to pathogen risk modeling

This supports improved **understanding** of environmental sensitivities and **prediction and projection** of pathogen-specific infection risks

FUTURE DIRECTIONS

We need **coordinated data collection**: disease surveillance, genomics analysis, and environmental conditions

Environmentally-mediated risk profiles vary within communities as well as across communities: **multiscale studies are required**

More sophisticated integration of information on **human movement and other behavioral factors** will advance understanding and prediction skill

Environmentally-informed spatiotemporal risk analyses can be applied to **health system interventions**, including vaccination campaigns

PUBLICATIONS

Colston, J., et al. "Evaluating meteorological data from weather stations, and from satellites and global models for a multi-site epidemiological study." *Environmental research* 165 (2018): 91-109.

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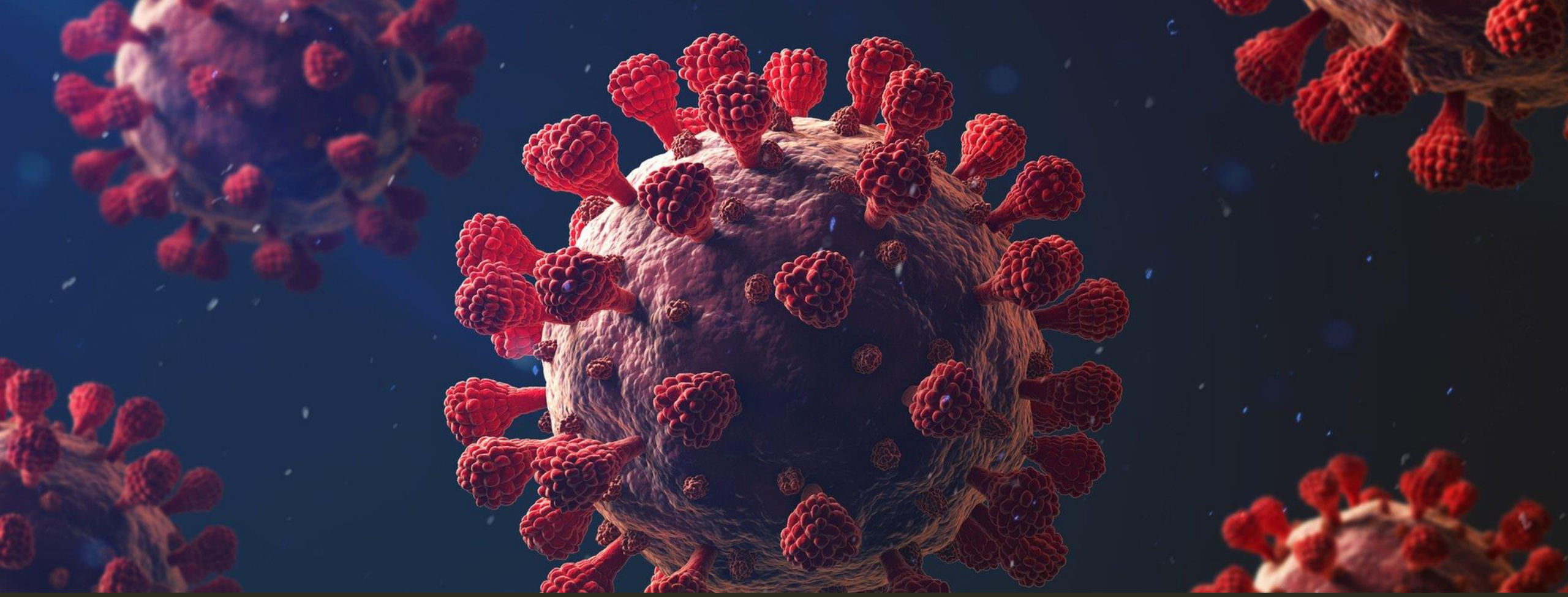
Colston, J., et al. "Use of earth observation-derived hydrometeorological variables to model and predict rotavirus infection (MAL-ED): a multisite cohort study." *The Lancet Planetary Health* 3.6 (2019): e248-e258.

Colston, J., et al. "Associations between household-level exposures and all-cause diarrhea and pathogen-specific enteric infections in children enrolled in five sentinel surveillance studies." *International journal of environmental research and public health* 17.21 (2020): 8078.

Colston, J., et al. "Associations Between Eight Earth Observation-Derived Climate Variables and Enteropathogen Infection: An Independent Participant Data Meta-Analysis of Surveillance Studies With Broad Spectrum Nucleic Acid Diagnostics." *GeoHealth* 6.1 (2022): e2021GH000452.

Badr, H., et al. "Spatiotemporal variation in risk of Shigella infection in childhood: a global risk mapping and prediction model using individual participant data." *medRxiv* (2022). [In Review at The Lancet Global Health]



COVID-19 SUPPLEMENT

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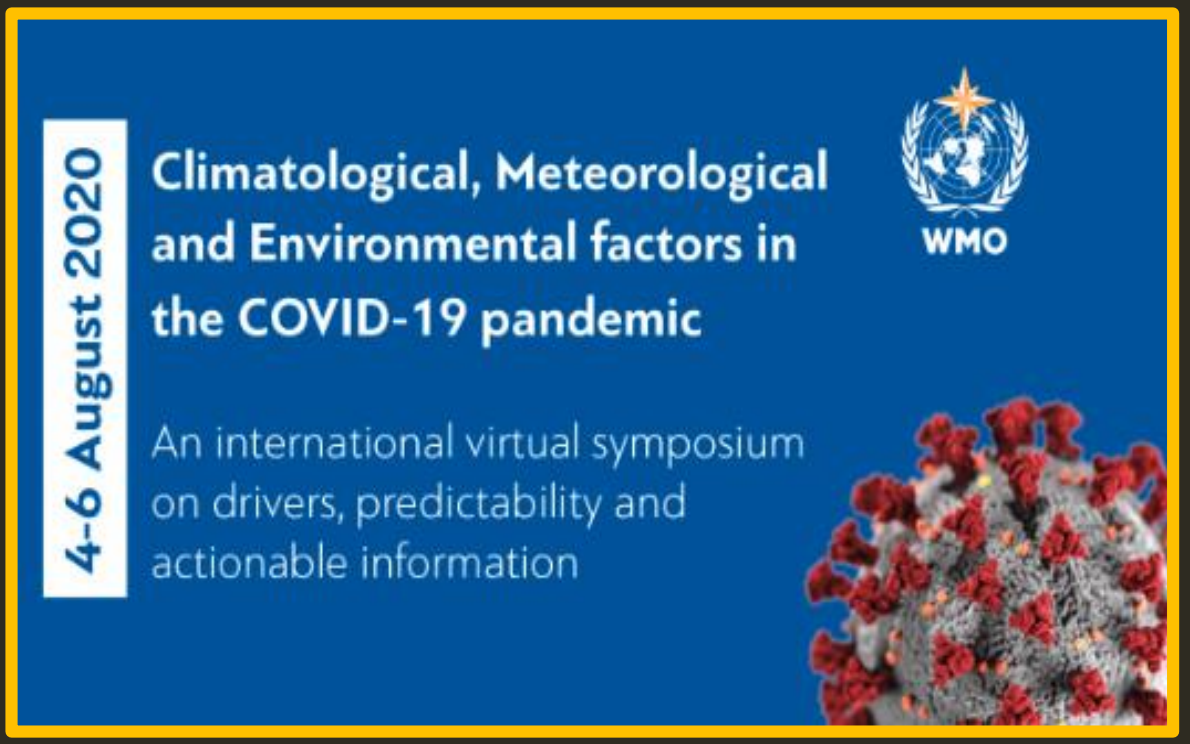
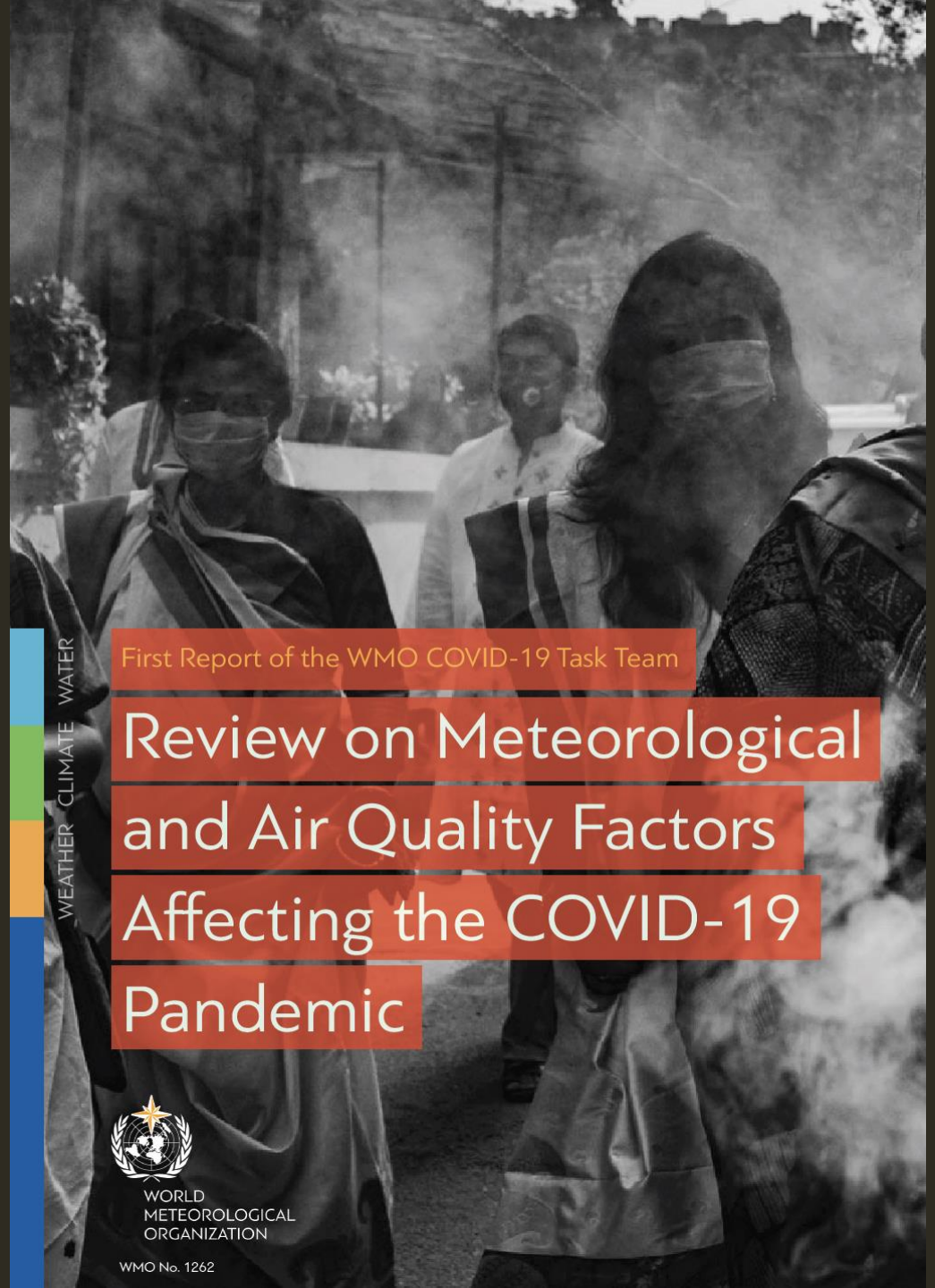


https://public.wmo.int/en/events/meetings/covid-19-symposium

https://www.nature.com/articles/s41467-020-19546-7



https://library.wmo.int/index.php?lvl=notice_display&id=21857#.YNmy7i2w3UI

CREATE A UNIFIED, RELIABLE DATA RECORD

United States:

US	36	061	10476
Admin 0	Admin 1	Admin 2	Admin 3
Country	State	County	District
ISO 3166 1 2 letters	**FIPS** + 2 digits	**FIPS** + 3 digits	**ZCTA** + 5 digits

Europe:

DE	2	1	H
Admin 0	Admin 1	Admin 2	Admin 3
Country	State *	County **	District
ISO 3166 1 2 letters	**NUTS 1** + 1 digit/letter	**NUTS 2** + 1 digit/letter	**NUTS 3** + 1 digit/letter

Global:

AU	ACT		
Admin 0	Admin 1	Admin 2	Admin 3
Country	Province/State	County	District
ISO 3166 1 2 letters	**ISO 3166 2** principal divisions	**Local 2** country specific	**Local 3** country specific

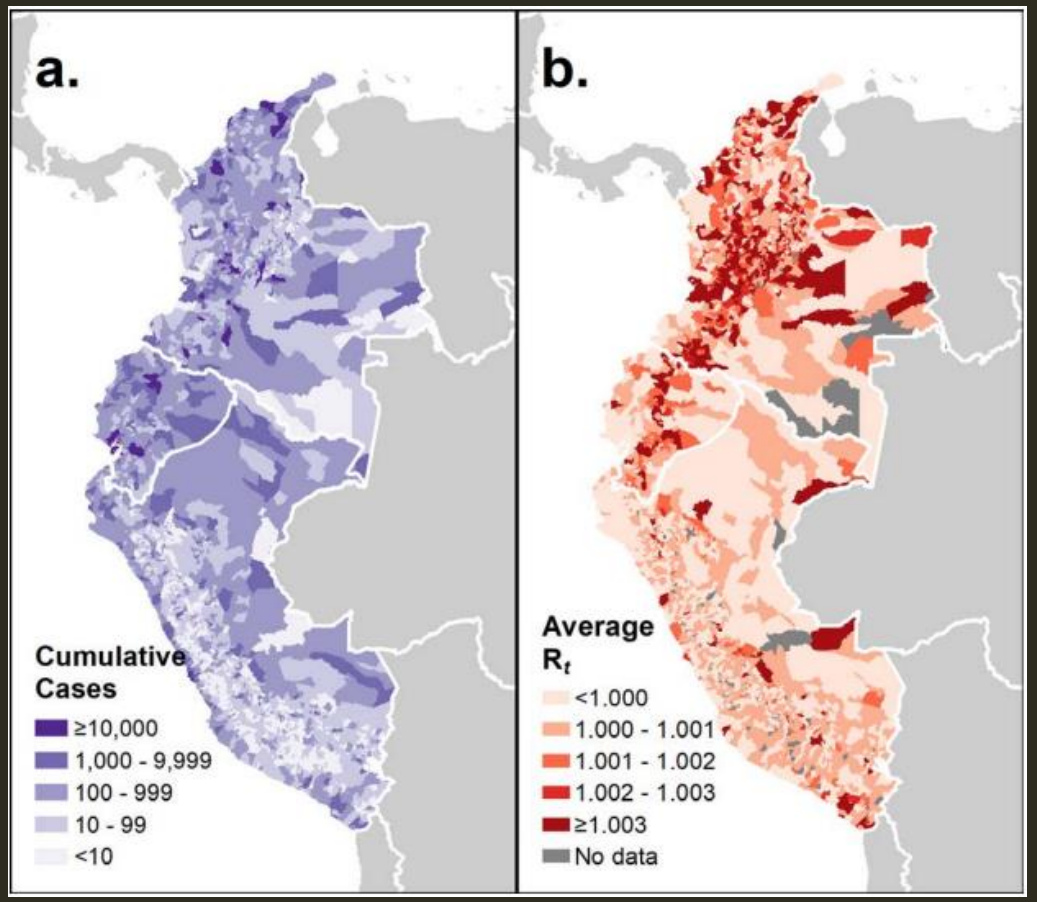
* *NUTS 1 level represents groups of subregions (or equivalent) for some European countries (e.g., Italy).*
** *NUTS 2 level represents subregions (or equivalent) for some European countries (e.g., Italy).*

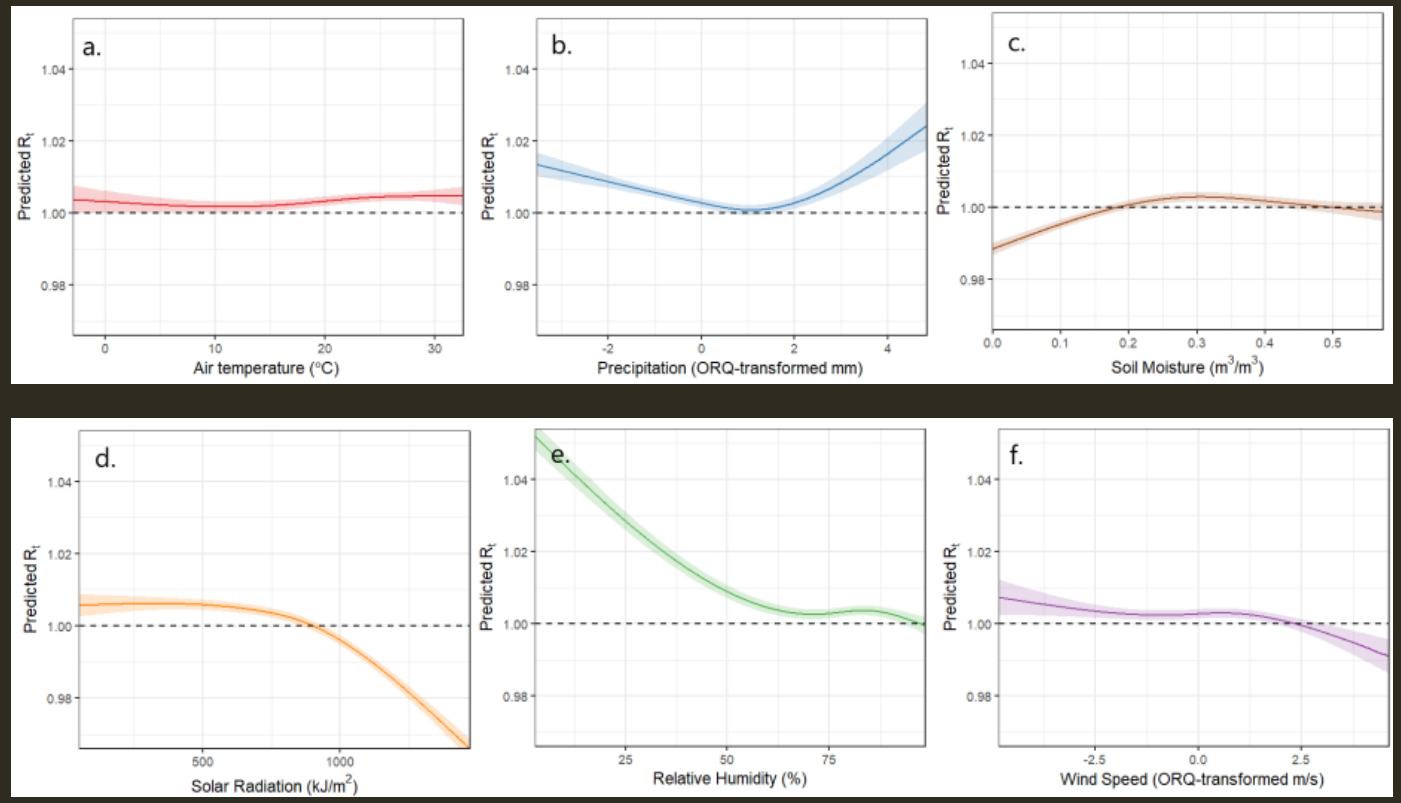
- Maps all geospatial units globally into a unique standardized ID.
- Standardizes administrative names and codes at all levels.
- Standardizes dates, data types, and formats.
- Unifies variable names, types, and categories.
- Merges data from all credible sources at all levels.
- Cleans the data and fixing confusing entries.
- Integrates hydrometeorological variables at all levels.
- Optimizes the data for machine learning applications.

https://github.com/hsbadr/COVID-19

https://www.medrxiv.org/content/10.1101/2021.05.05.21256712v1

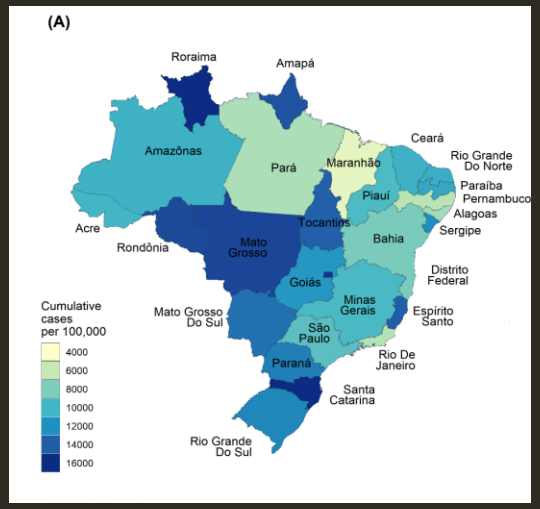
METEOROLOGICAL SENSITIVITIES: WESTERN SOUTH AMERICA

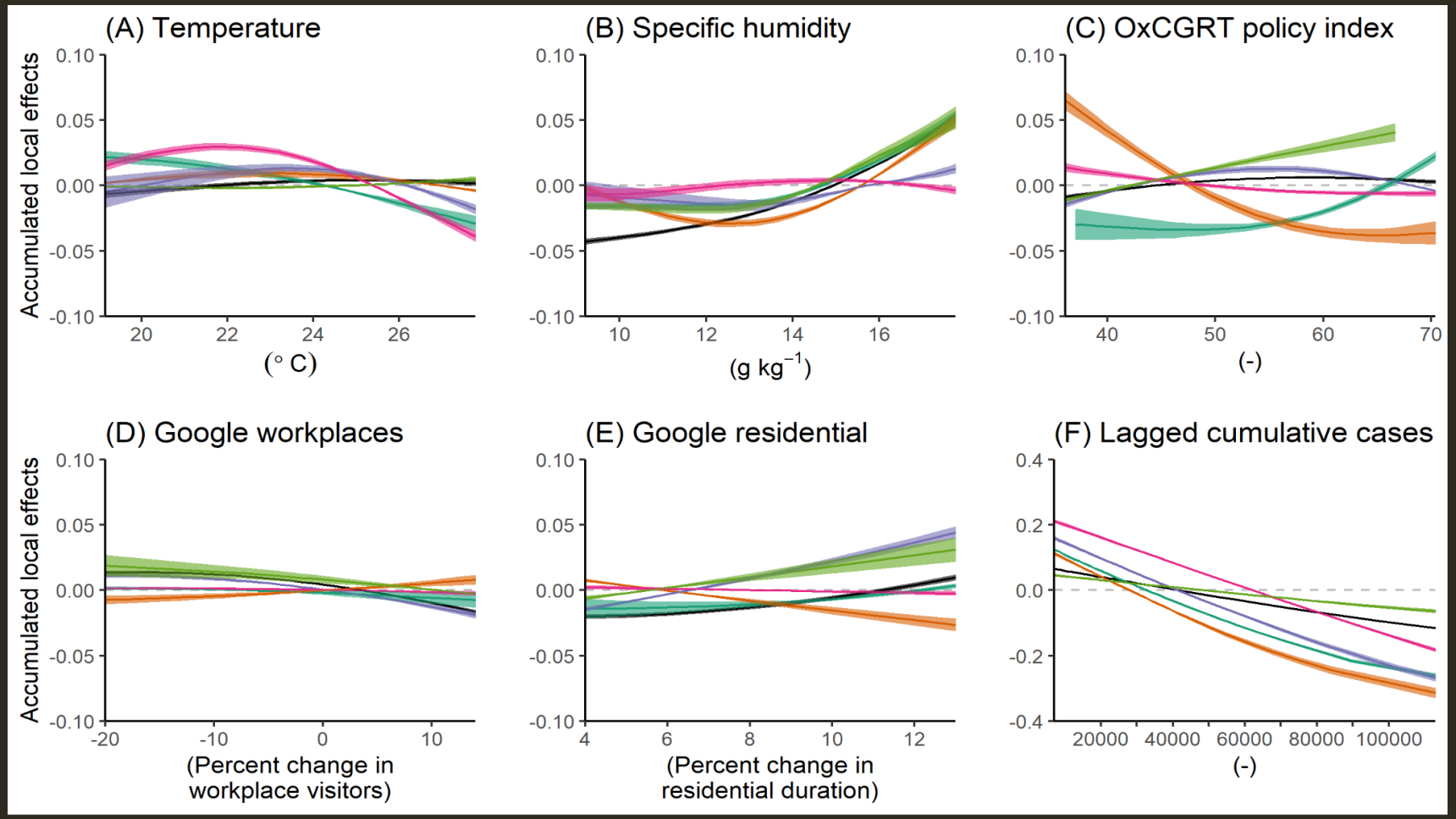




Colston et al. *In Review*

METEOROLOGICAL SENSITIVITIES: BRAZIL





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Kerr, G., et al. "Associations between meteorology and COVID-19 in early studies: Inconsistencies, uncertainties, and recommendations." *One Health* 12 (2021): 100225.

Zaitchik, B., et al. "A framework for research linking weather, climate and COVID-19." *Nature communications* 11.1 (2020): 1-3.

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Colston, J., et al. "Effects of hydrometeorological and other factors on SARS-CoV-2 reproduction number in three contiguous countries of Tropical Andean South America: a spatiotemporally disaggregated time series analysis." *medRxiv* (2022). [In Review at The Lancet Regional Heath: The Americas]

Kerr, G., et al. "Evolving drivers of Brazilian SARS-CoV-2 transmission: a spatiotemporally disaggregated time series analysis of meteorology, policy, and human mobility." *In Prep.*

Contributed to: Pan, William, et al. "Heterogeneity in the Effectiveness of Non-Pharmaceutical Interventions during the first SARS-CoV2 wave in the United States." *Frontiers in public health* (2021): 1857.

THANK YOU

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