Environmental Determinants of Enteric Infectious Disease

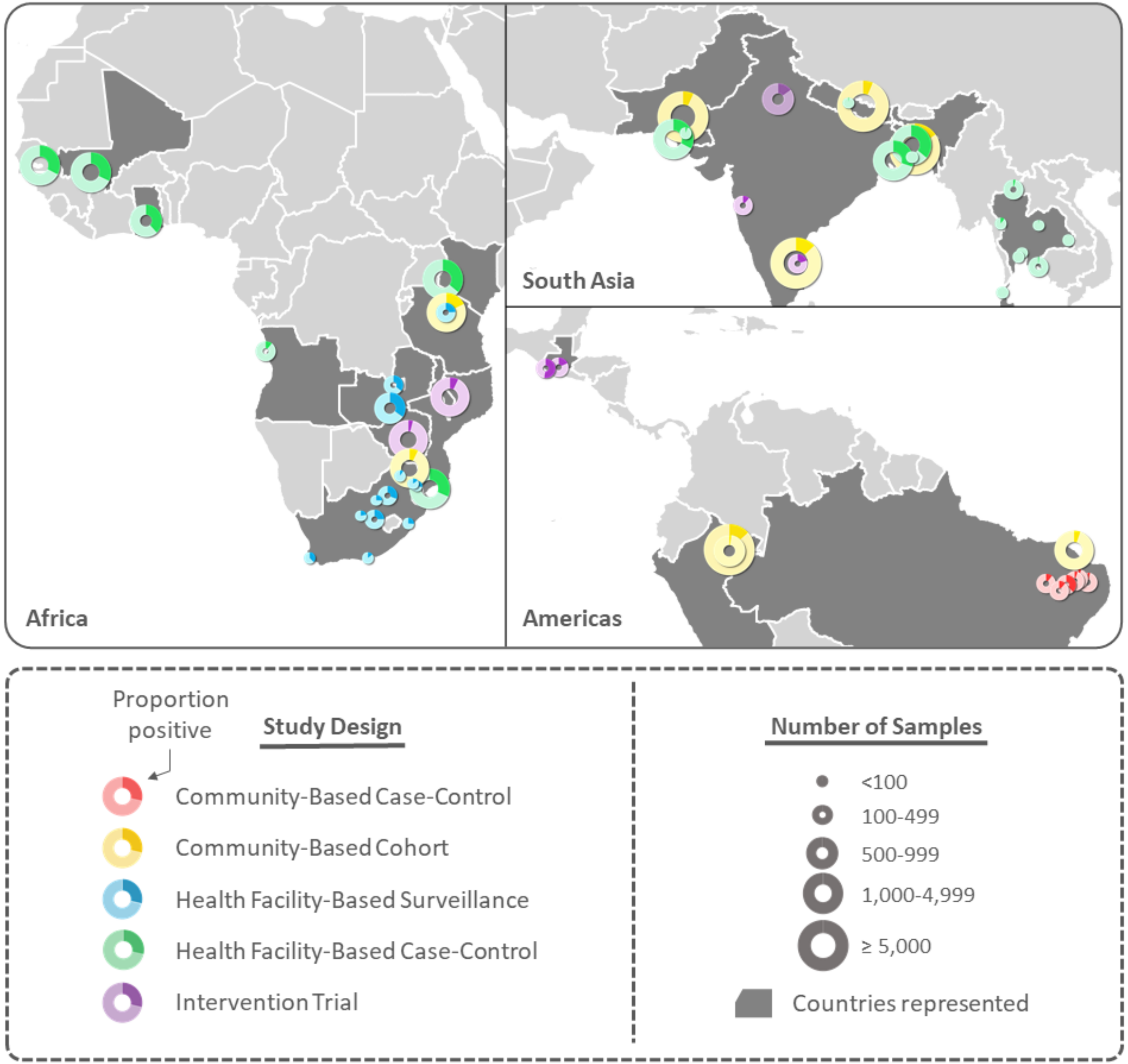
PI: BENJAMIN ZAITCHIK, JOHNS HOPKINS UNIVERSITY
CO-I: MARGARET KOSEK, UNIVERSITY OF VIRGINIA
CO-I: HAMADA BADR, JOHNS HOPKINS UNIVERSITY
CO-I: JIM NELSON, BRIGHAM YOUNG UNIVERSITY
POSTDOC: JOSH COLSTON, UNIVERSITY OF VIRGINIA

Project goal

Establish the feasibility of Earth Observation-informed Enteric Infectious Disease (EID) risk mapping, monitoring, and prediction systems

We are doing this through collaboration with multiple EID studies performed at sites around the world

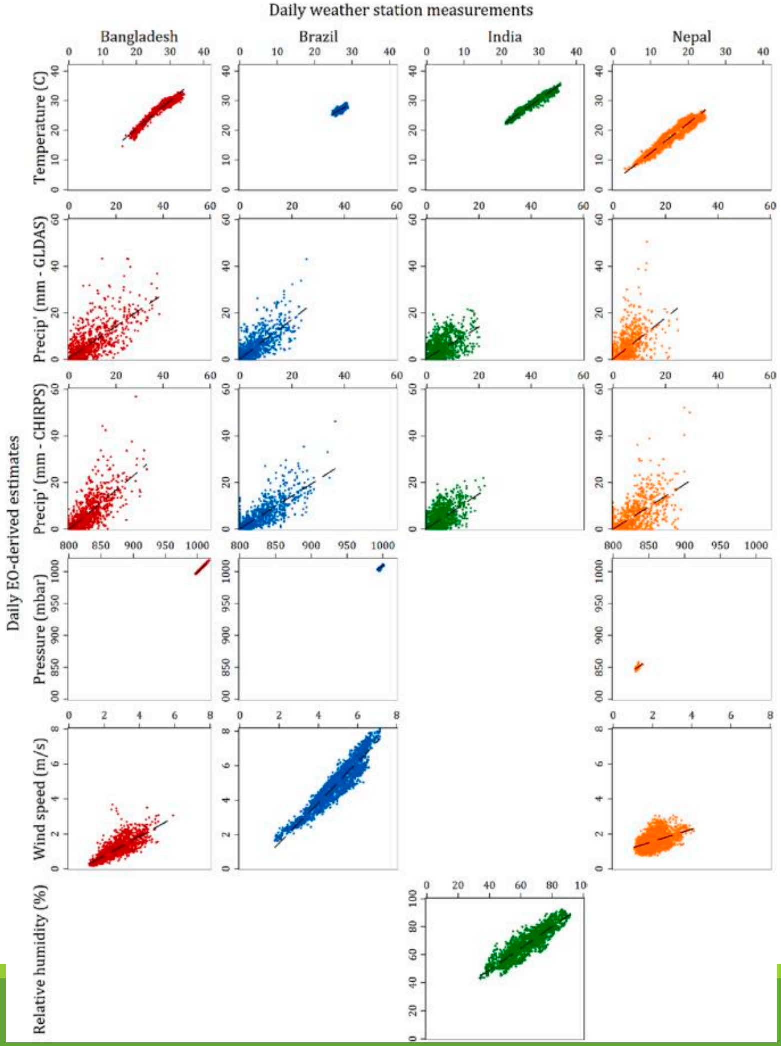
Collaborating studies



Earth Observation data

None of these infection studies included collection of data on climate or environment.

Earth Observations offer an opportunity to fill this gap.



Colston et al. (2018)

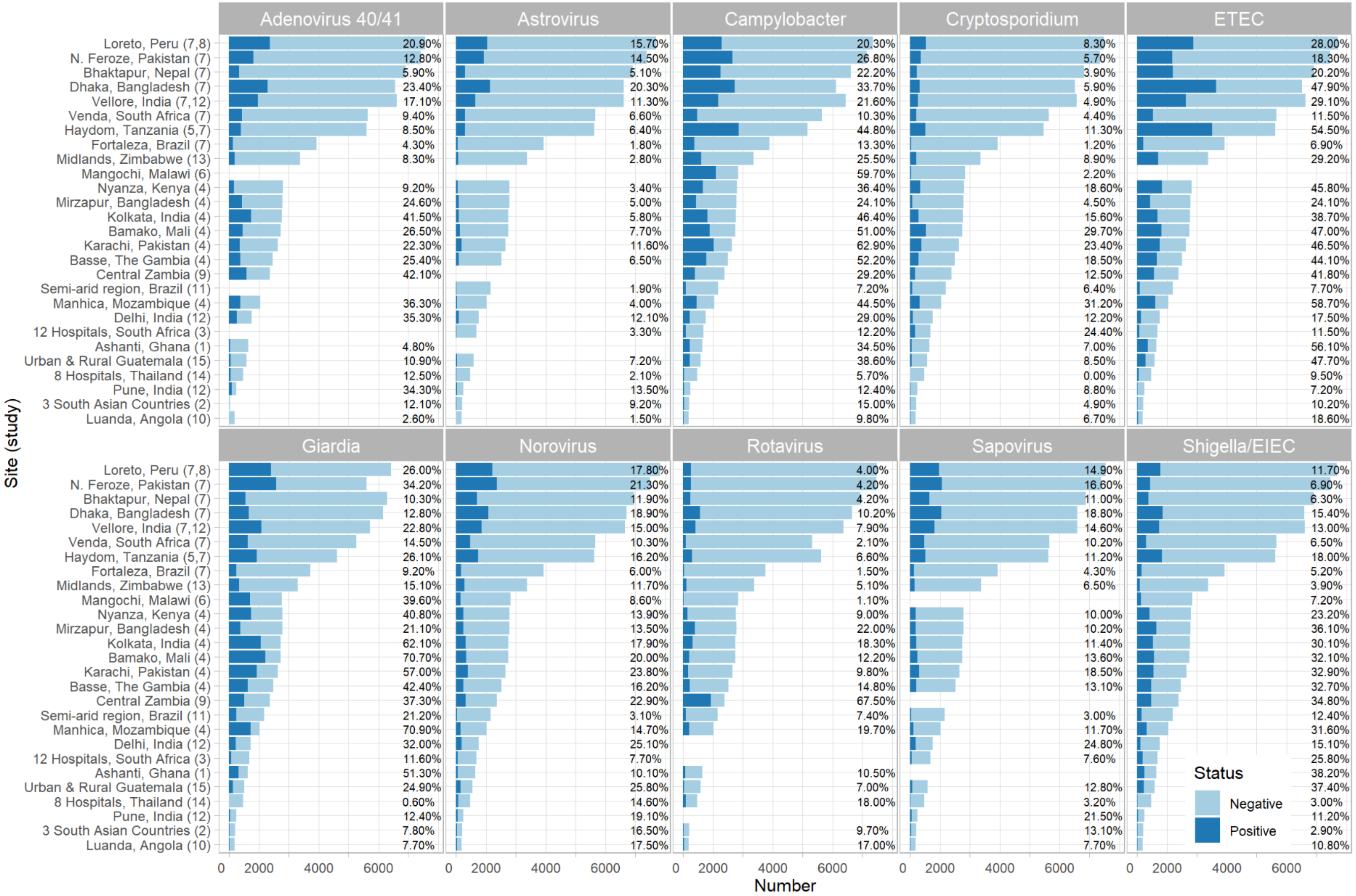
Accomplishments from previous years

1. Evaluated EO performance at MAL-ED sites, and published results collaboratively with MAL-ED site PIs (Colston et al., 2018)
2. Published the results of the rotavirus model collaboratively with site PIs (Colston et al., 2019)
3. Participated in NASA's pilot commercial data buy program
4. Performed a targeted study of ENSO influence on EID at our Peru MAL-ED site (Colston et al., 2020a)
5. Published a study of static household-level factors associated with pathogen-specific disease risk (Colston et al., 2020b)
6. Disseminated rotavirus and shigella risk to partners at study sites and health ministries
7. Piloted online visualization tool

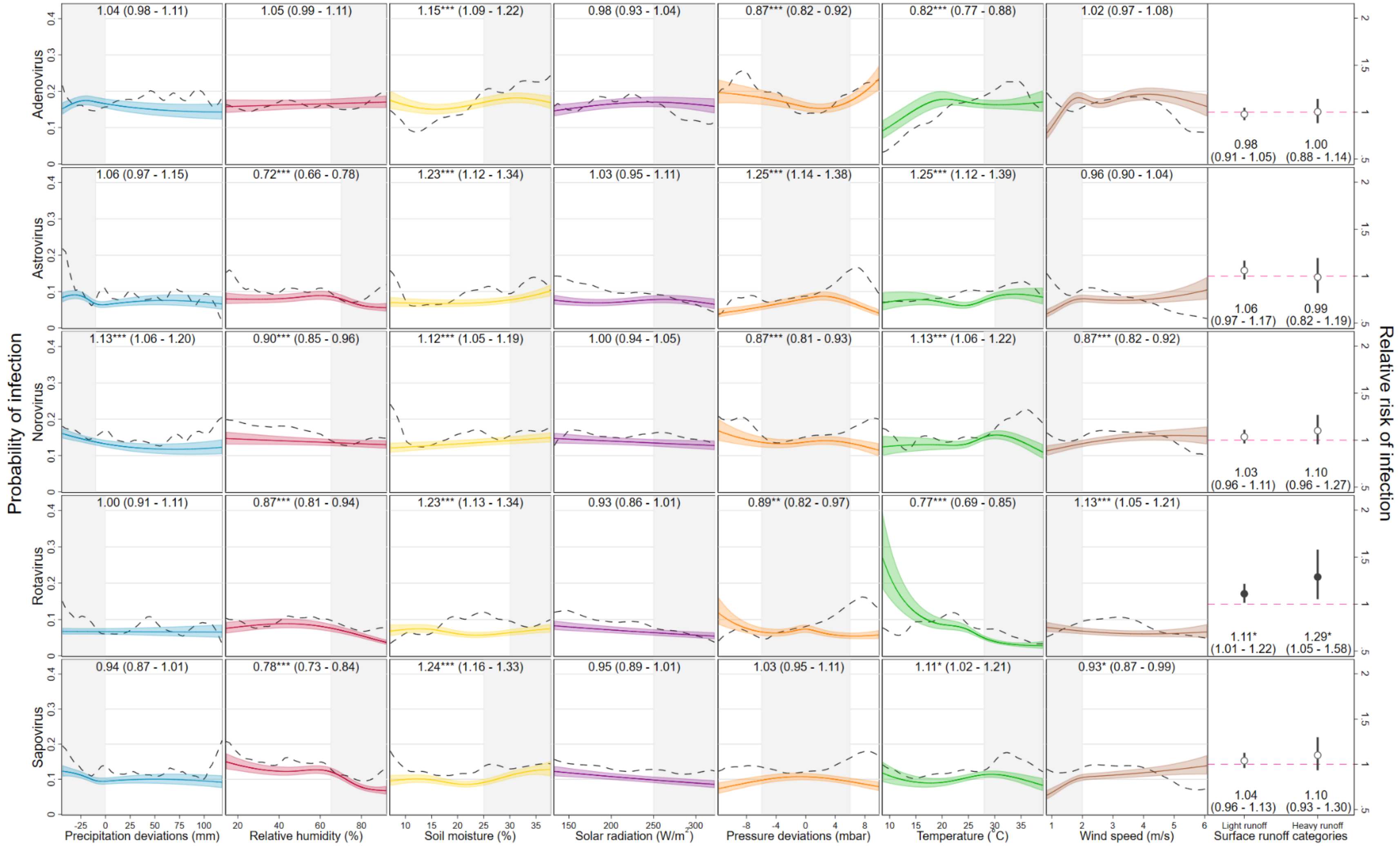
Accomplishments this year

1. Completed multi-pathogen modeling analyses (Colston et al., *In Review*)
2. Implemented optimized Bayesian predictive modeling approach and completed application to Shigella (Badr et al., *In preparation*)
3. (Nearly) finalized online visualization tool

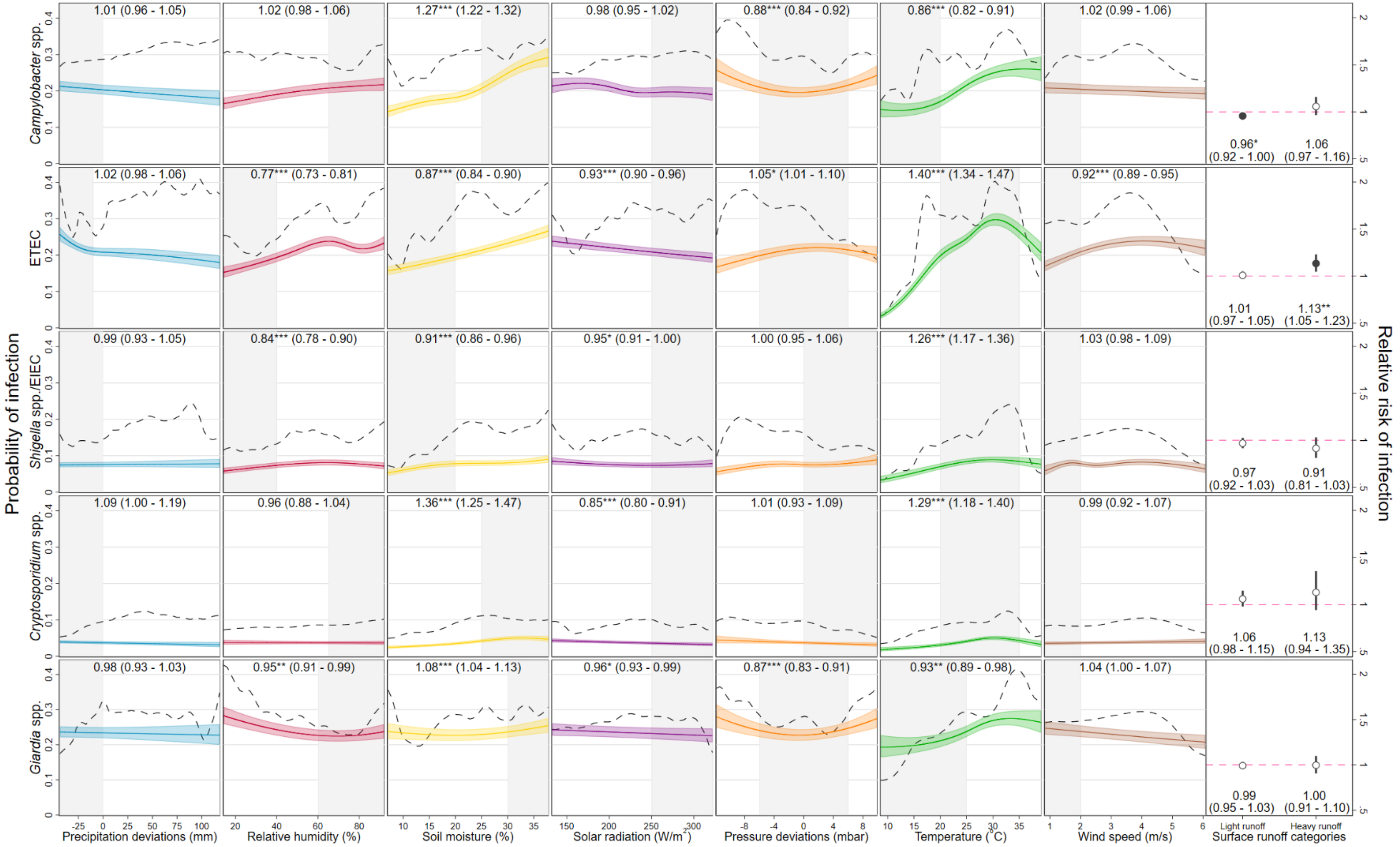
Multi-pathogen modeling



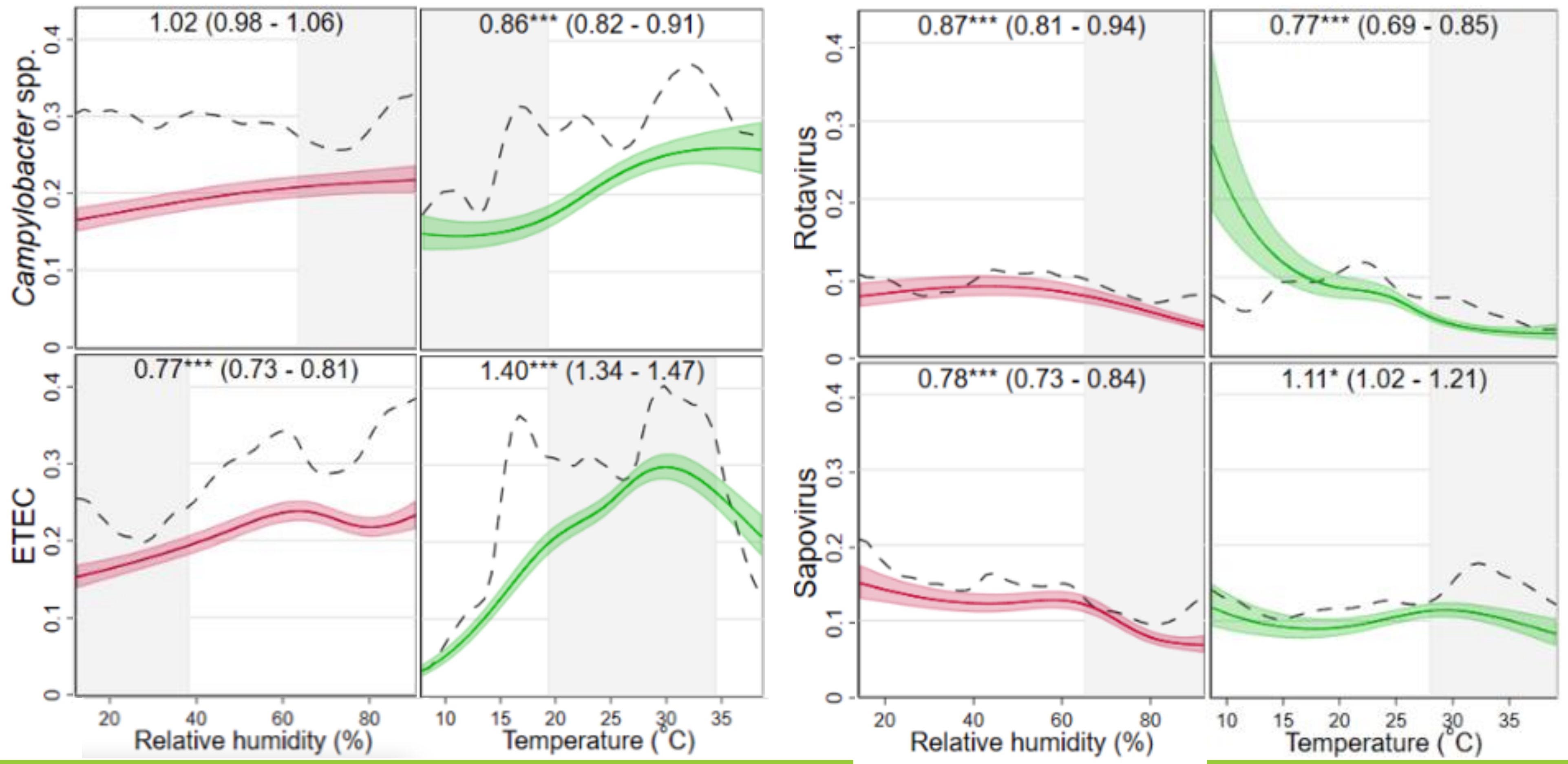
Multi-pathogen modeling



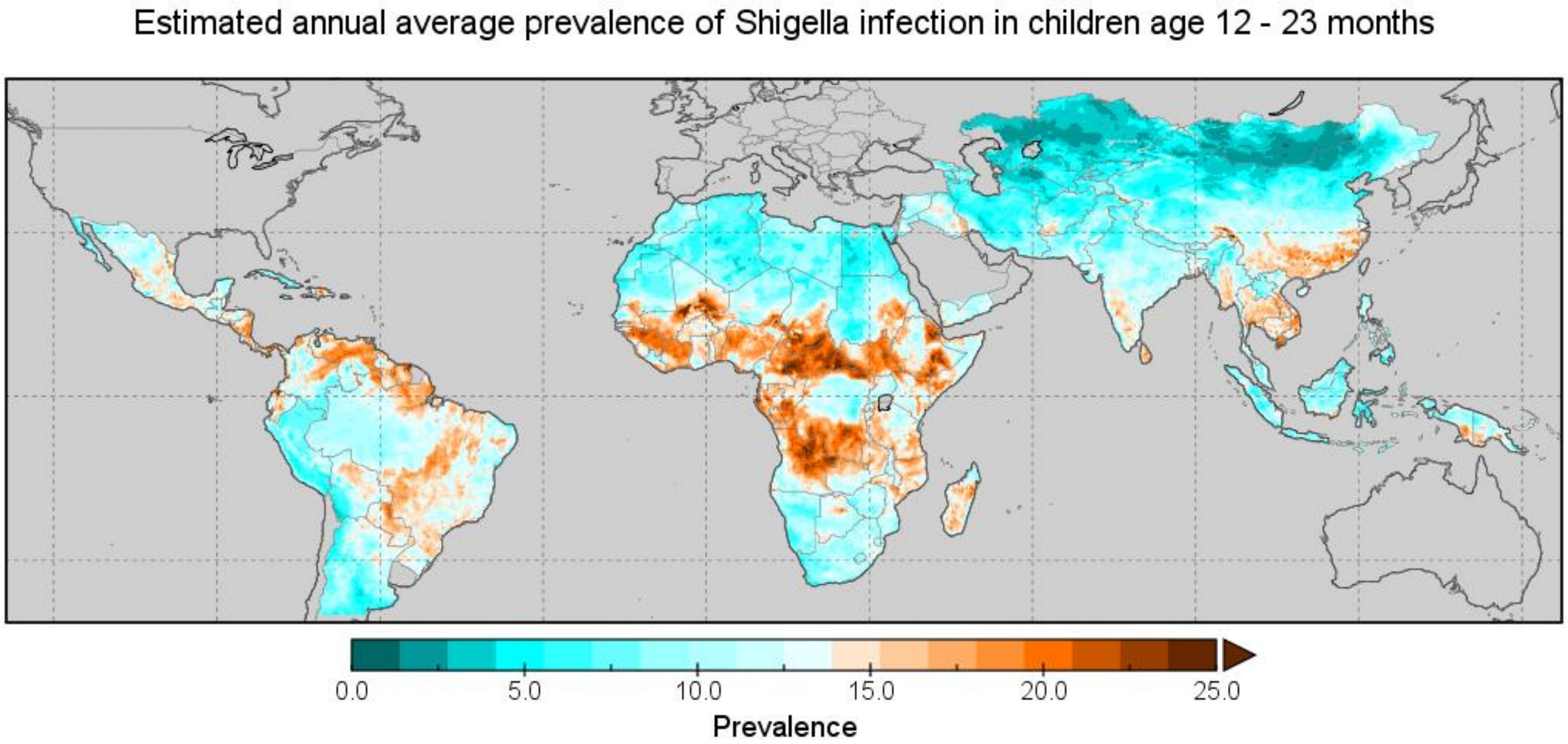
Multi-pathogen modeling



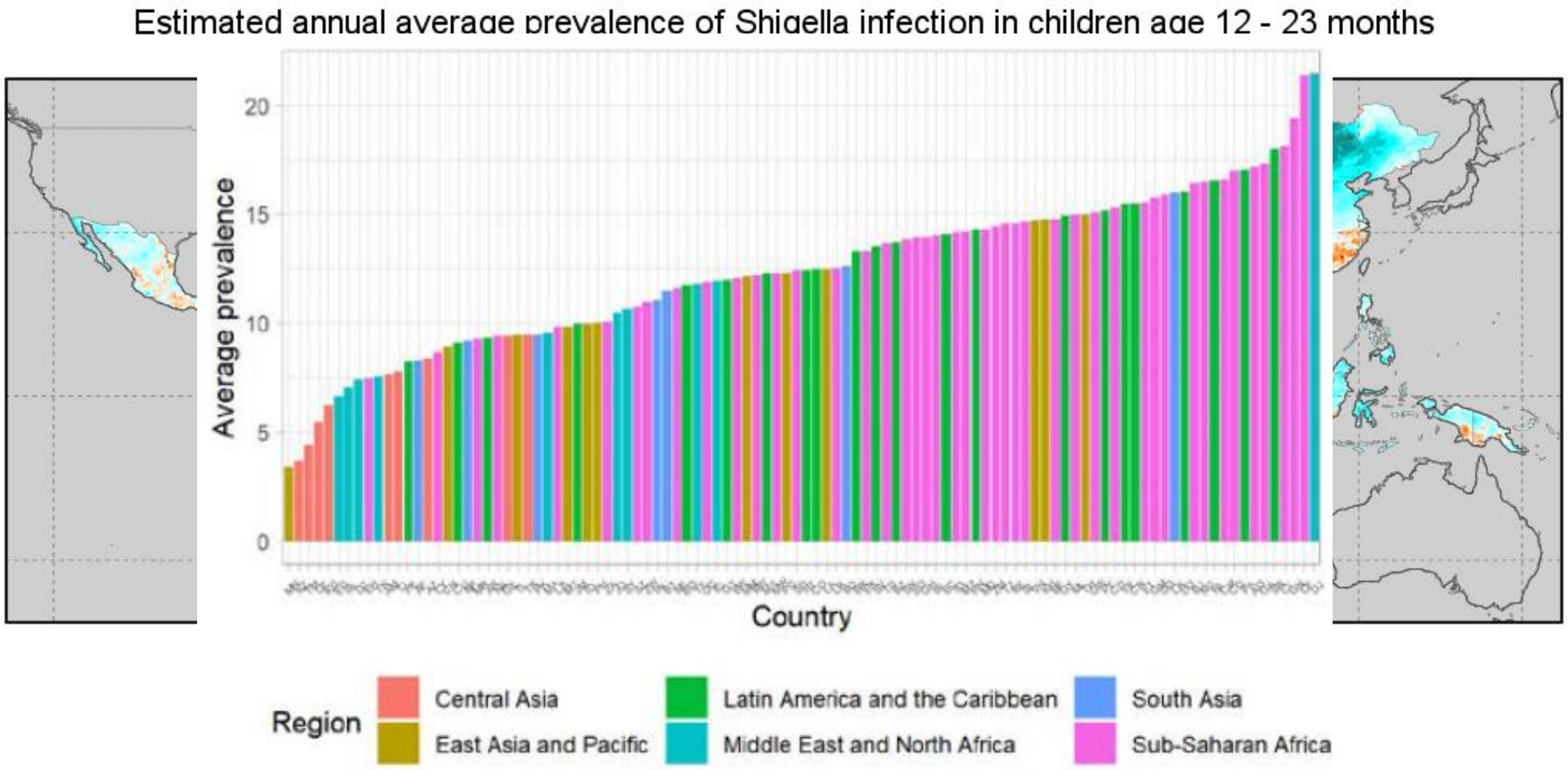
Differing sensitivities



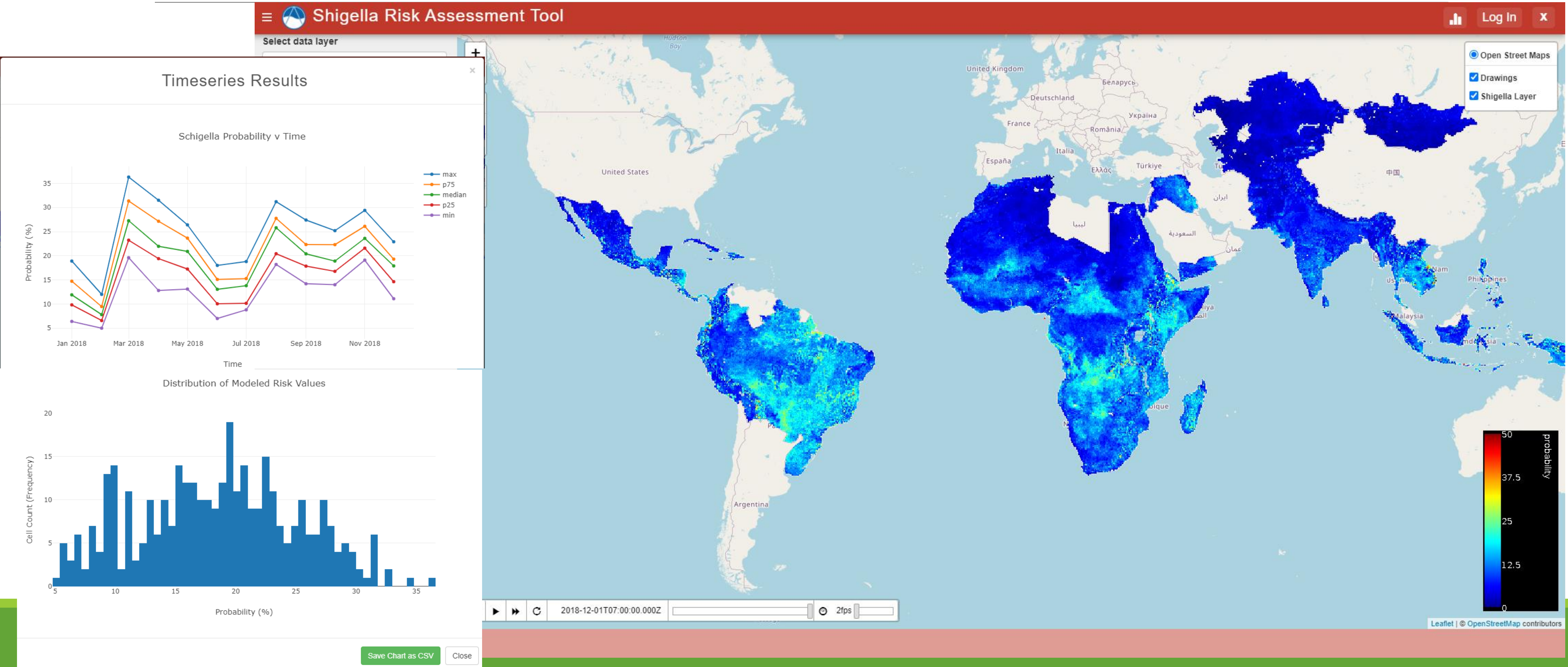
Shigella modeling



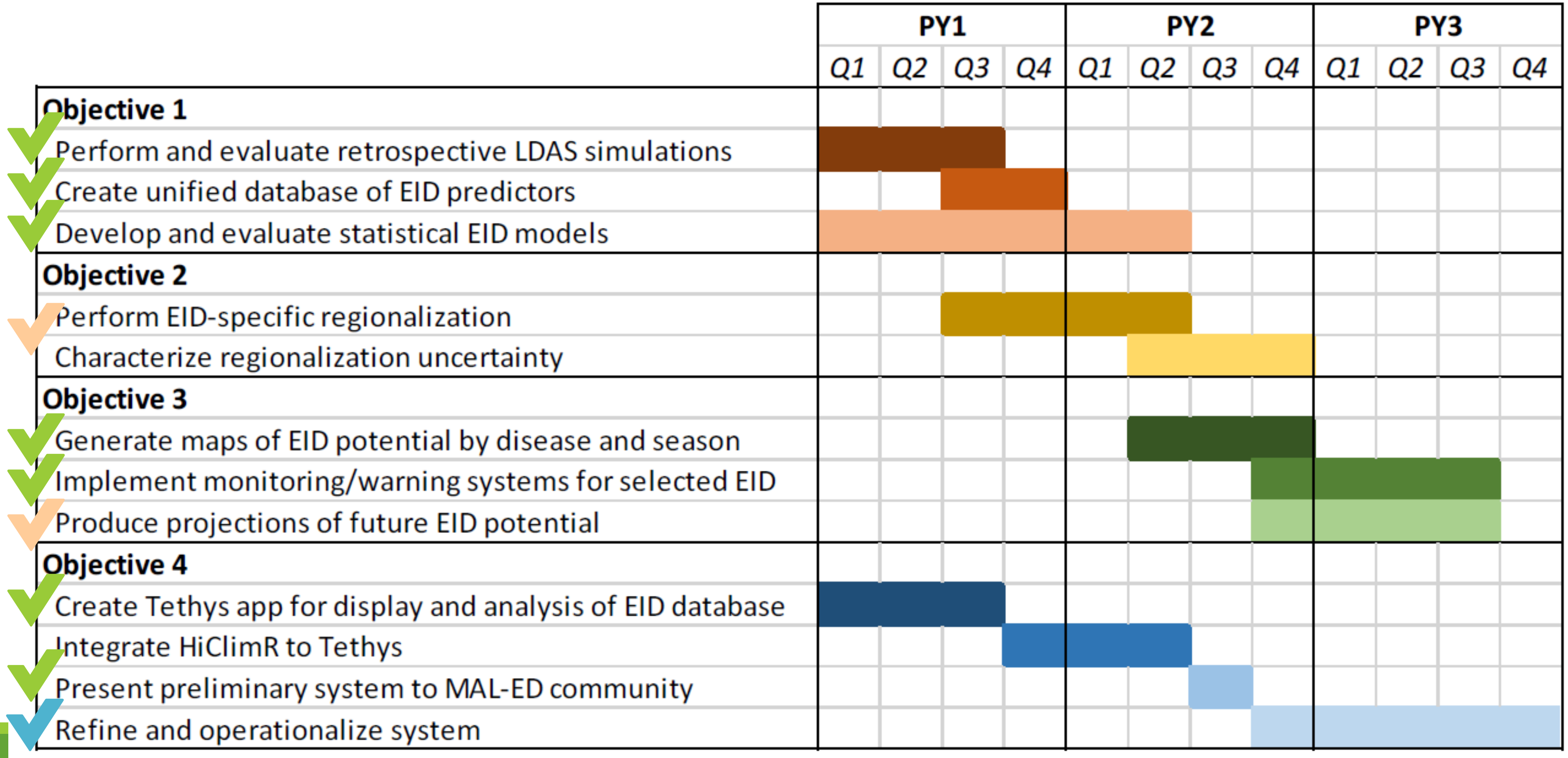
Shigella modeling



Visualization tool



Timeline



PY1
PY2
PY3
Q1
Q2
Q3
Q4
Objective 1
Perform and evaluate retrospective LDAS simulations
Create unified database of EID predictors
Develop and evaluate statistical EID models
Objective 2
Perform EID-specific regionalization
Characterize regionalization uncertainty
Objective 3
Generate maps of EID potential by disease and season
Implement monitoring/warning systems for selected EID
Produce projections of future EID potential
Objective 4
Create Tethys app for display and analysis of EID database
Integrate HiClimR to Tethys
Present preliminary system to MAL-ED community
Refine and operationalize system

ARL

Current: ARL 6

Expectation: ARL 7 at our next partner feedback session

Goal: ARL 7

COVID-19

BEN ZAITCHIK, HAMADA BADR, LAUREN GARDNER, JUSTIN LESSLER – JHU

MARGARET KOSEK, JOSH COLSTON - UVA

Why have studies of environmental sensitivity of COVID-19 been so mixed?

A short and unreliable COVID-19 data record

Inconsistent and sometimes inappropriate definition of response variable

Inconsistent and sometimes inappropriate scales of analysis

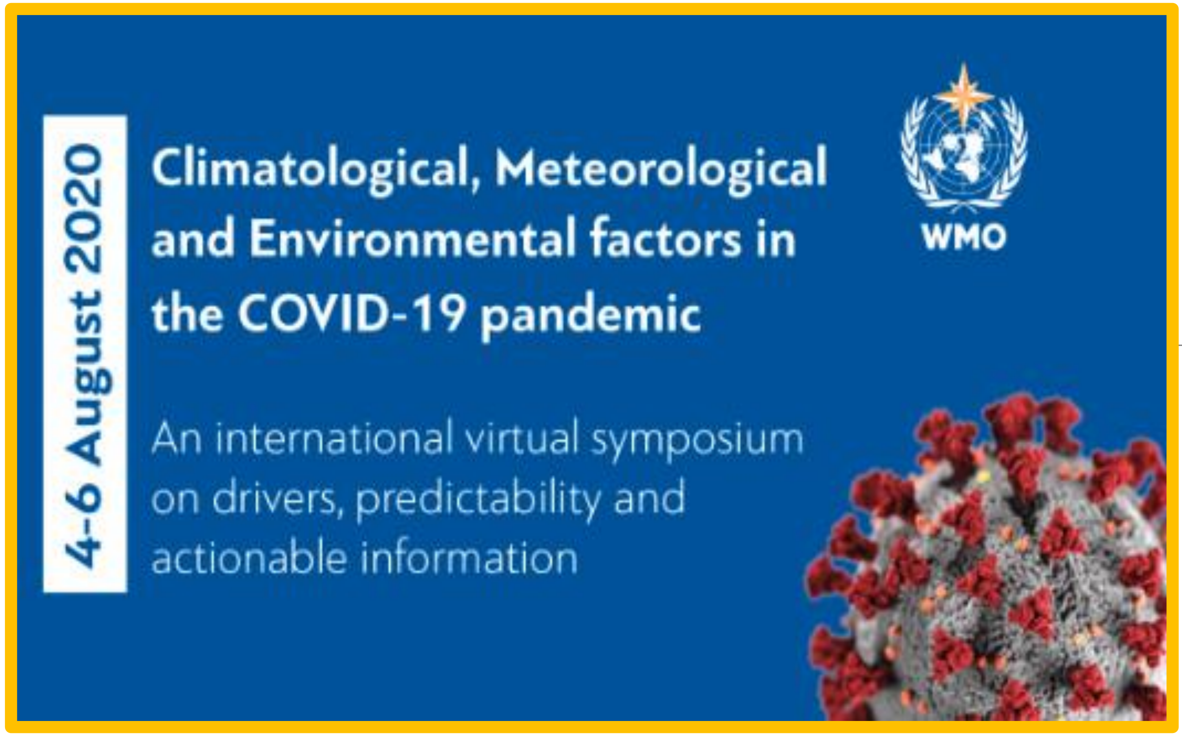
Difficulty of accounting for non-meteorological predictors: behavior, policy, demographics, cultural practices, etc.

Differences between climate zones

Diverse and sometimes questionable methodologies

Challenge of isolating climate influence early in the pandemic

Kerr et al. (2021)



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


nature COMMUNICATIONS

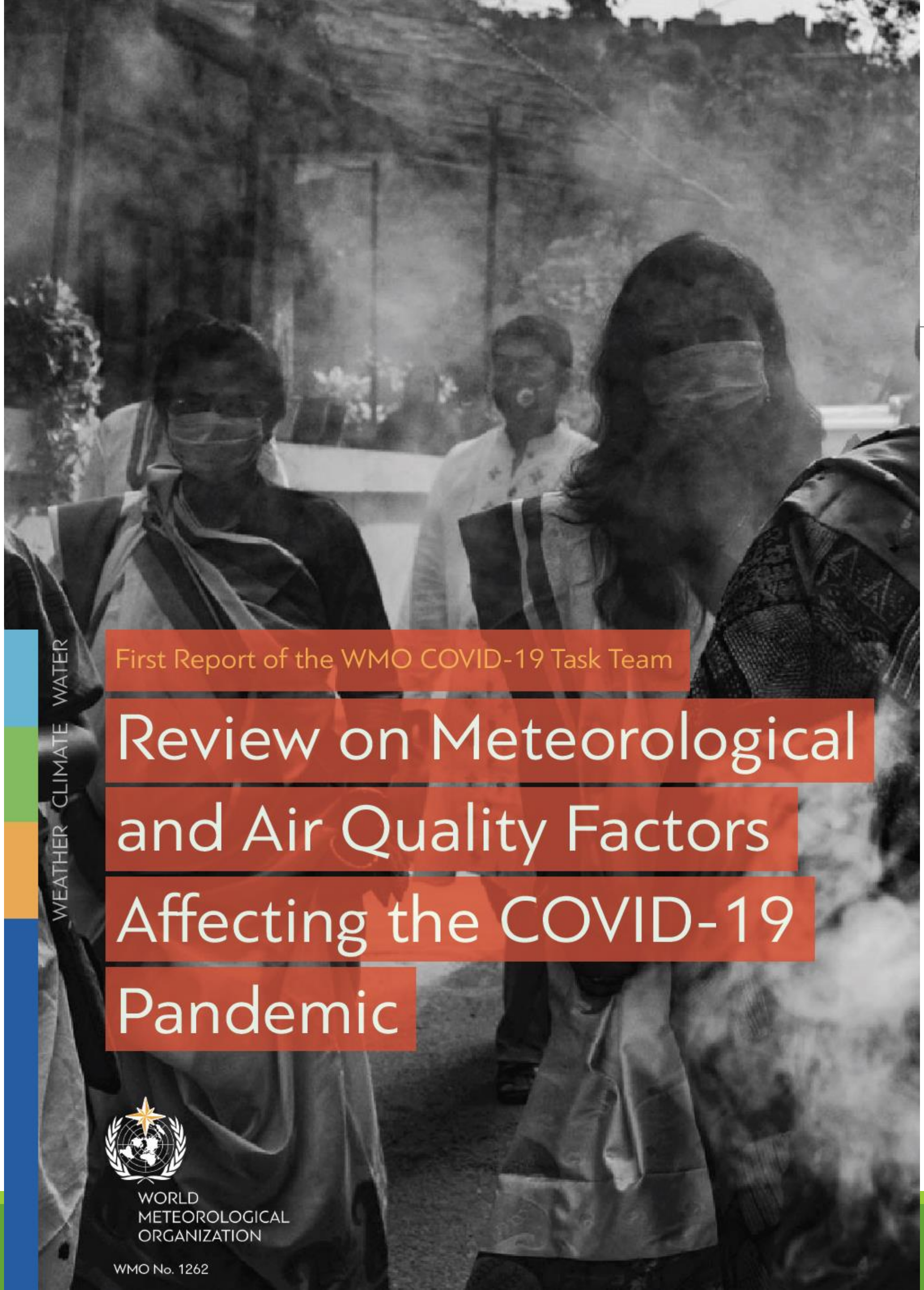
COMMENT

https://doi.org/10.1038/s41467-020-19546-7 OPEN

A framework for research linking weather, climate and COVID-19

Benjamin F. Zaitchik[1✉], Neville Sweijd[2], Joy Shumake-Guillemot[3], Andy Morse[4], Chris Gordon[5], Aileen Marty[6], Juli Trtanj[7], Juerg Luterbacher[8], Joel Botai[9], Swadhin Behera[10], Yonglong Lu[11], Jane Olwoch[12], Ken Takahashi[13], Jennifer D. Stowell[14] & Xavier Rodó[15]

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

- 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.

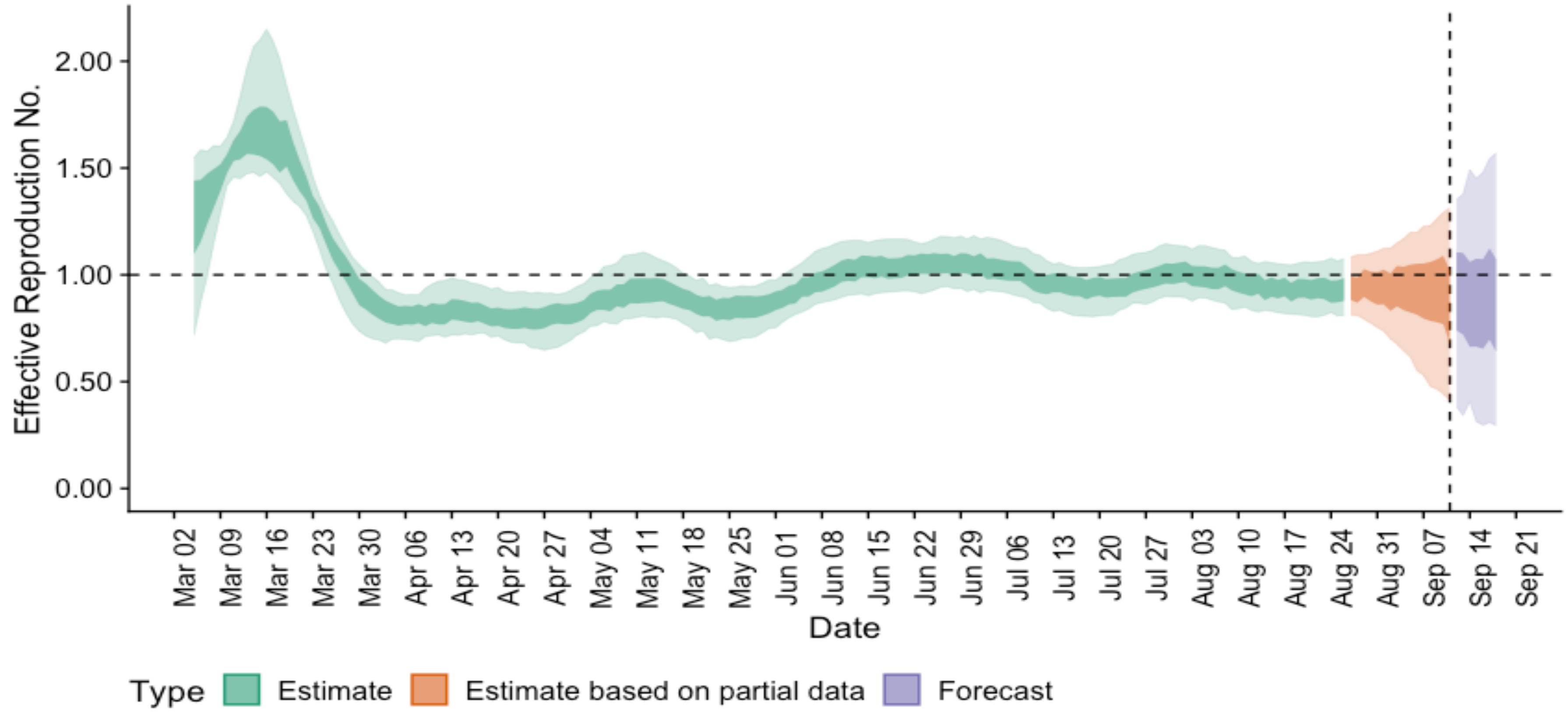
https://github.com/hsbadr/COVID-19

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

* *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).*

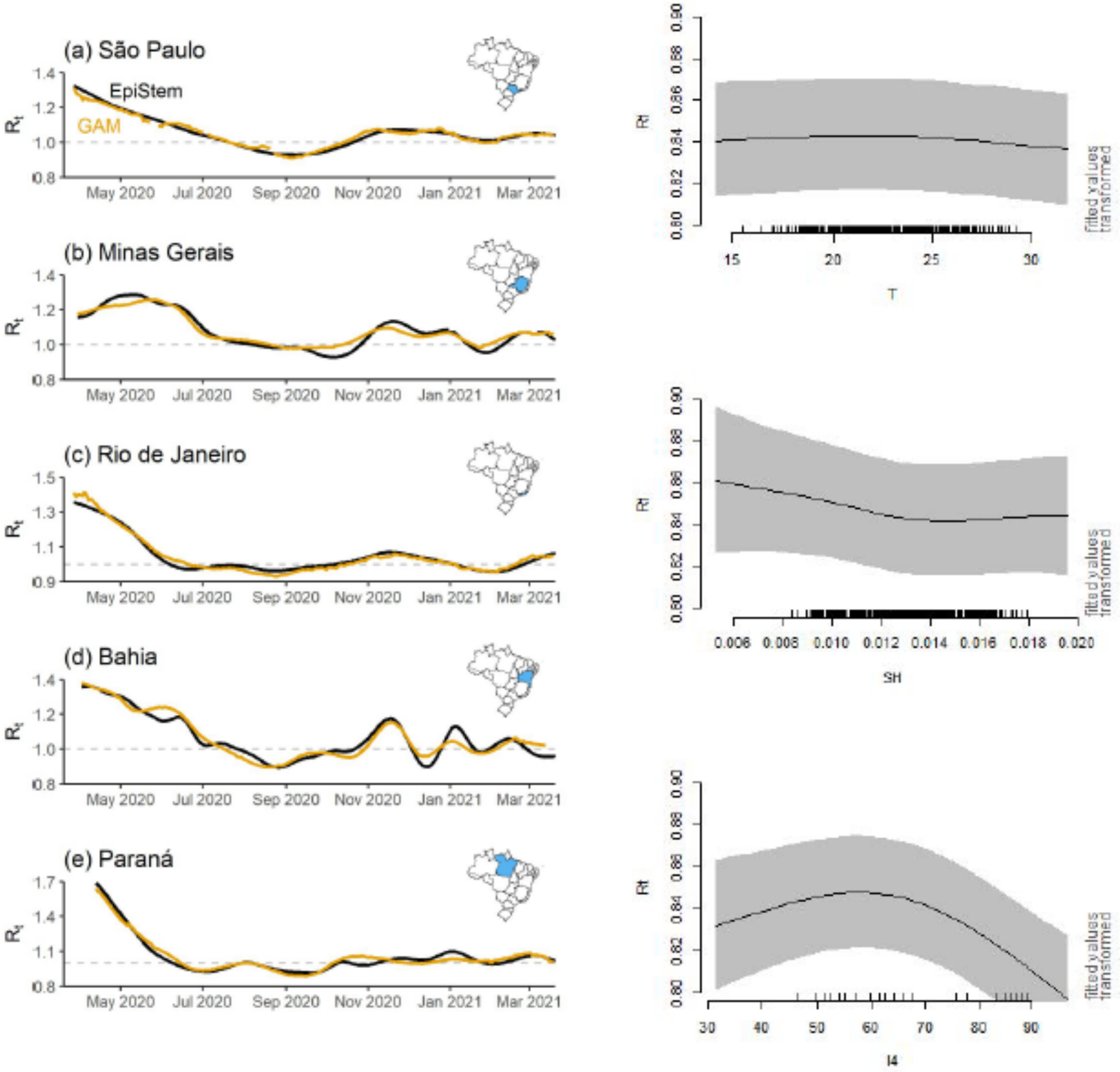
Generate a response variable

New York City, NY

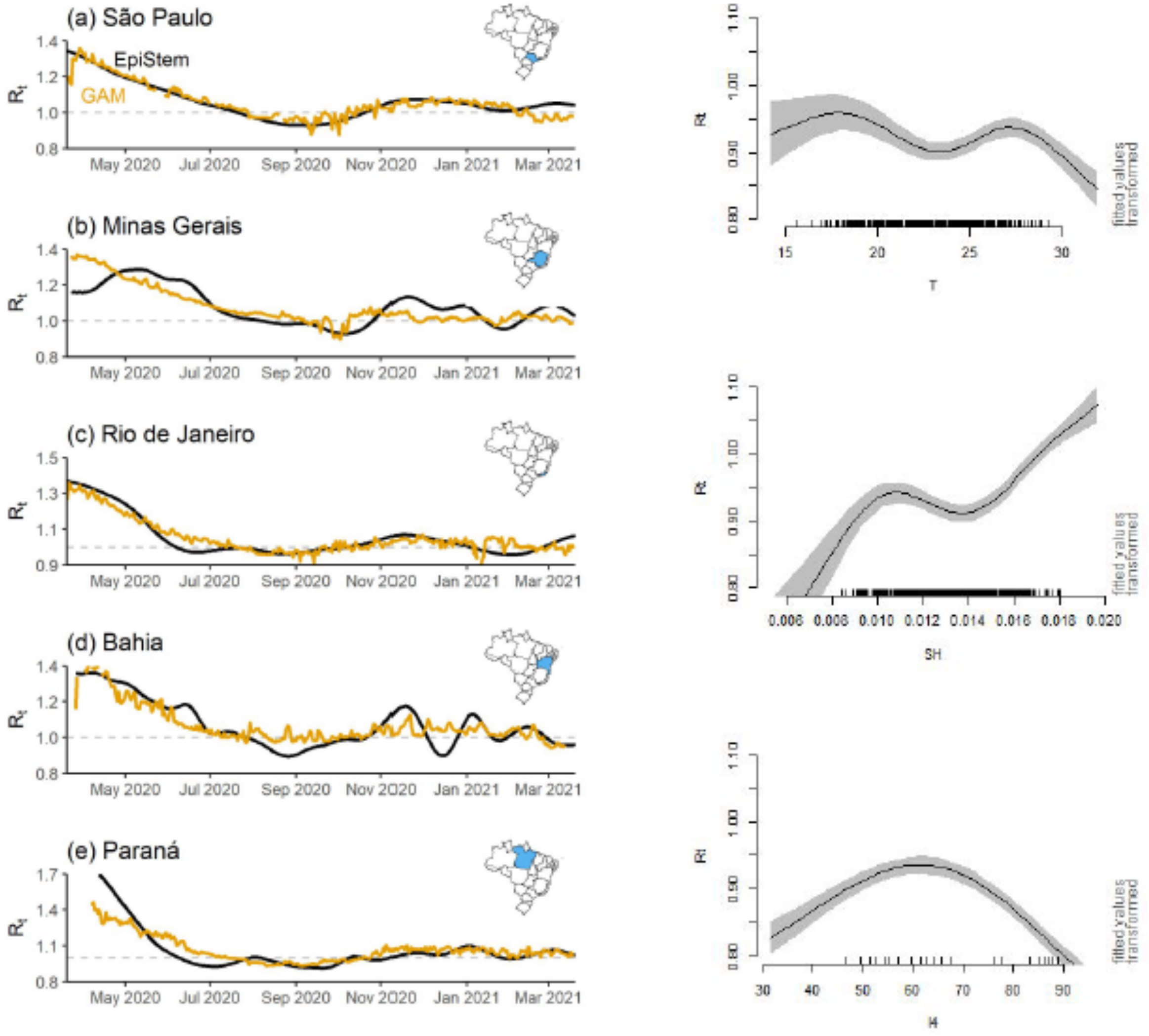


EpiNow2

Rt ~s(T) + s(SH) + s(I4) + ti(Tstatestd, SH)* + ti(I4, Date) + ti(T, SH) + te(Date, Latitude, Longitude) + s(state)**



Rt ~s(T) + s(SH) + s(I4) + ti(Tstatestd, SH) + ti(I4, Date) + ti(T, SH) + s(state)



Left plot in each panel: example of predicted Rt
Right plot: smooth terms

Kerr et al. (In Prep)

Thank You