

Environmental Determinants of Enteric Infectious Disease

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What are EID?

What are EID?



Viruses



What are EID?



Bacteria



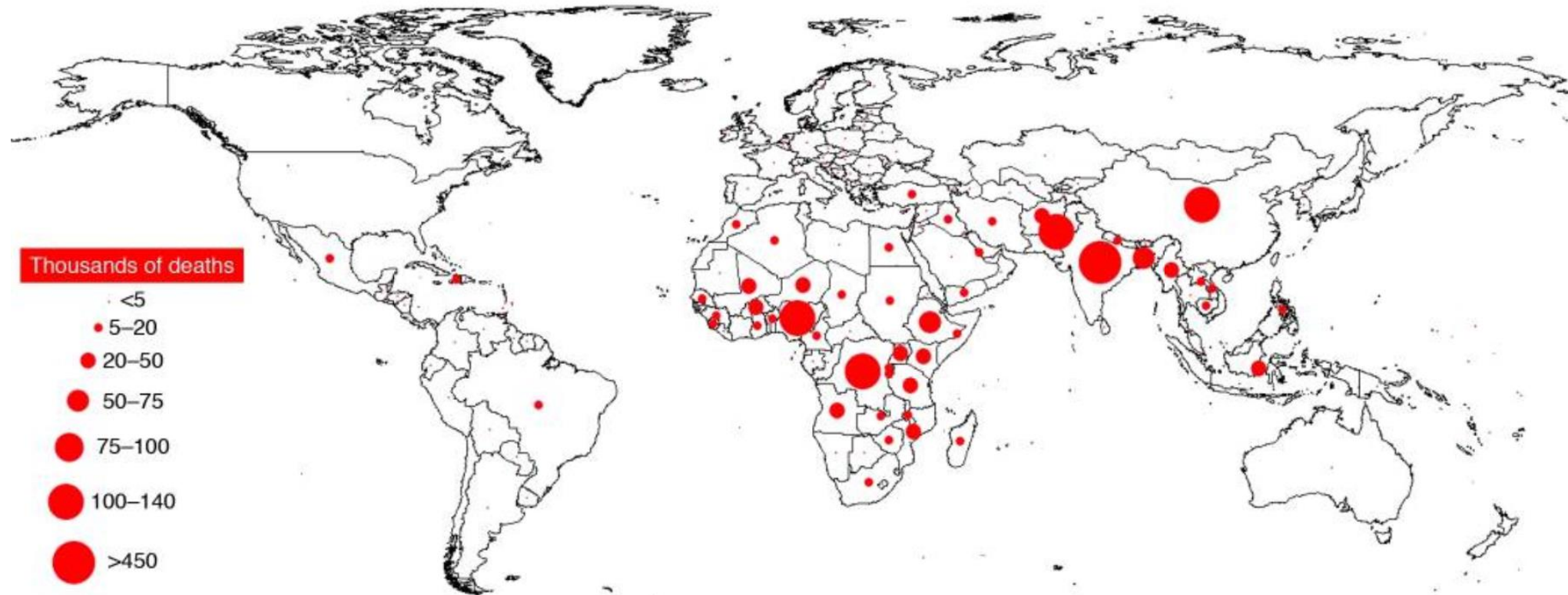
What are EID?



Protozoa



Why do they matter?



Worldwide distribution of deaths caused by diarrhea in children under 5 years of age in 2000.

Why do they matter?



Growth



*Cognitive
Development*



*Vaccine
Response*

Is there a role for Earth Observation?

	EID	Seasonality	Rainfall	Air Temp.	Humidity	Soil moisture	Wind speed	Surface pressure	Solar radiation	Travel	Water exposure	Eating/food habits	Indoor crowding	Animal contact
Viral	<u>Adenovirus</u>	Unknown	-	-	-	-	-	-	-	-	↗	-	-	-
	Astrovirus	Winter	-	(↘)	-	-	-	-	-	-	↗	-	-	-
	Norovirus	Winter	↗	↘	(↘)	-	-	-	-	↗	-	-	(↗)	-
	<u>Rotavirus</u>	Winter	↘	↘	↘	(↘)	(↗)	↗	-	-	-	-	-	-
Bacterial	<i>Aeromonas</i> spp	Unknown	-	↗	-	-	-	-	-	↗	-	-	-	-
	<u>Campylobact.</u>	Spring	-	↗	-	-	-	-	(↘)	↗	↗	(✓)	-	(↗)
	Diarrh. <i>E. coli</i>	Summer	-	↗	-	-	-	-	-	↗	↗	(✓)	-	(↗)
	<i>P. shigelloides</i>	Summer	-	↗	-	-	-	-	-	↗	↗	✓	-	-
	Salmonellosis	Spring/summer	-	↗	-	-	-	-	-	(↗)	-	(✓)	-	(↗)
	Shigellosis	Late summer	-	-	-	-	-	-	-	↗	↗	-	-	-
	Cholera	Rainy season	↗	↗	↗	-	-	-	↗	-	-	-	-	-
	<i>Y. enterocolitica</i>	Winter	-	↘	-	-	-	-	-	-	-	-	-	(↗)
Parasitic	<u>Cryptosporid.</u>	Late summer	↗	↗	-	-	-	-	-	↗	↗	-	-	(↗)
	Cyclosporiasis	Rainy season	↗	-	-	-	-	-	-	-	(↗)	(✓)	-	(↗)
	Giardiasis	Late summer	↗	↗	-	-	-	-	-	↗	↗	-	-	(↗)
	Amebiasis	Summer/autumn	-	-	-	-	-	-	-	(↗)	-	-	-	-
	Helminthiasis	Rainy season	(↘)	↗	↗	(↘)	-	-	-	-	-	-	-	-

Distinct seasonality

Elevated risk during extreme climate events

But . . .

Relationship varies by EID and climate context

EID are typically not characterized in a disease specific manner.

Enter . . . MAL-ED



Etiology, Risk Factors and Interactions of Enteric Infections and Malnutrition and the Consequences for Child Health and Development (MAL-ED)

MAL-ED



At least 200 children from each site participated



from birth to age 2

Scientists evaluated:

The infographic displays the following evaluation categories with corresponding icons:

- NUTRITIONAL STATUS**: Represented by a plate of food.
- PATHOGEN EXPOSURE**: Represented by a virus particle and a microscope.
- ILLNESS**: Represented by a thermometer.
- PHYSICAL GROWTH**: Represented by a vertical bar chart.
- COGNITIVE DEVELOPMENT**: Represented by a silhouette of a head with gears.
- VACCINE RESPONSE**: Represented by a syringe and a glass of orange juice.
- SOCIOECONOMIC FACTORS**: Represented by a stack of money, a hand pump, and a woman with books.

MAL-ED

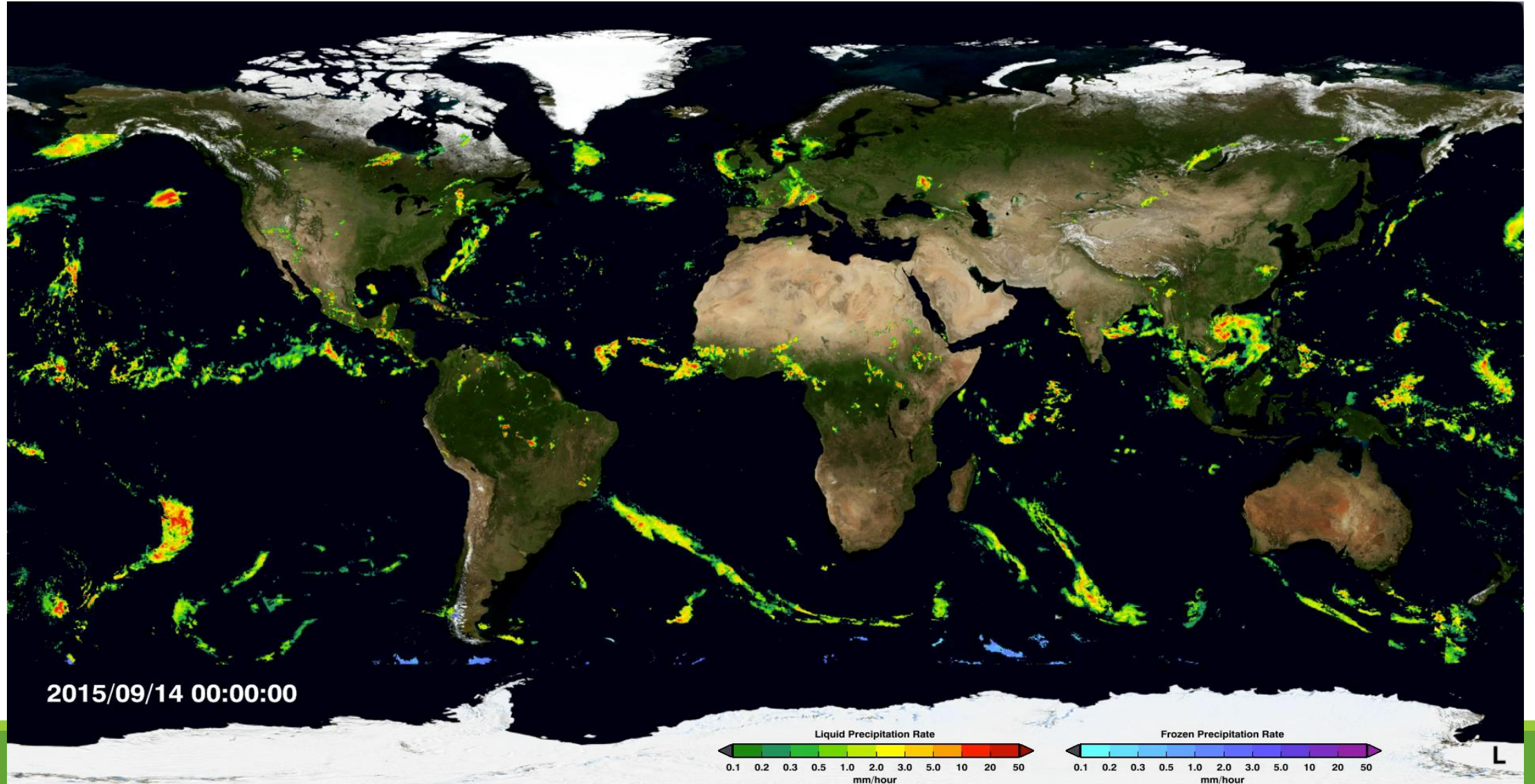


And, of course, the study collected detailed environmental data, including meteorological and hydrological variability.

Just kidding.

They didn't measure that stuff at all.

Enter . . . NASA



What do we propose to do?

Project goal:

Establish the feasibility of Earth Observation-informed EID risk mapping, monitoring, and prediction systems

Objectives

Develop process-informed statistical models to **predict EID burden**

Use objective regionalization to create **a global EID-oriented classification system**

Apply statistical models and regionalization to generate **global maps of the potential burden and dominant seasonality of each EID**

Implement a **map-based data server and visualization platform**

PY1 Results: Evaluation of EO



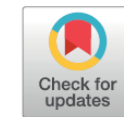
Contents lists available at [ScienceDirect](#)

Environmental Research

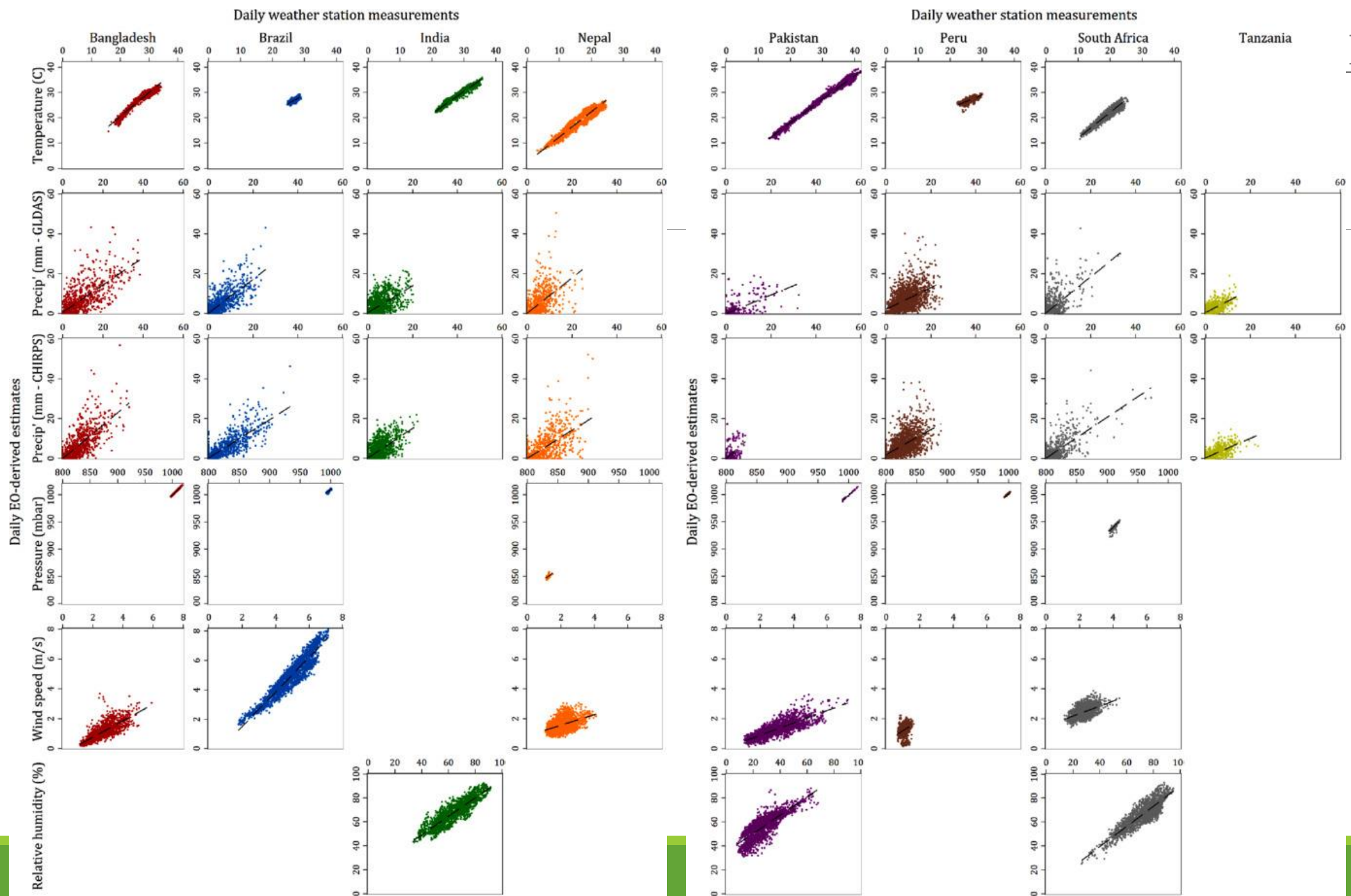
journal homepage: www.elsevier.com/locate/envres



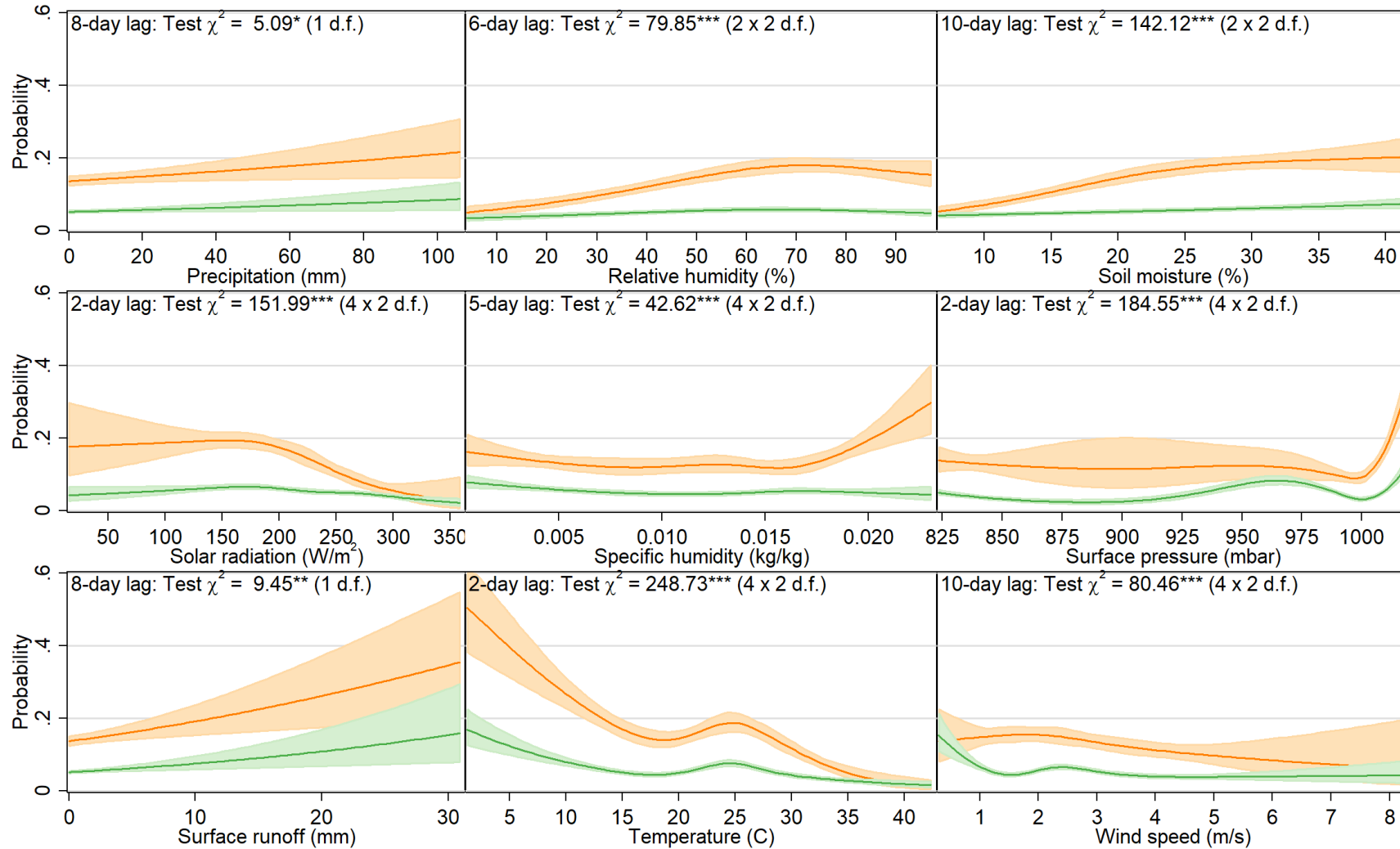
Evaluating meteorological data from weather stations, and from satellites and global models for a multi-site epidemiological study



Josh M. Colston^{a,*}, Tahmeed Ahmed^b, Cloupas Mahopo^c, Gagandeep Kang^d, Margaret Kosek^a, Francisco de Sousa Junior^e, Prakash Sunder Shrestha^f, Erling Svensen^g, Ali Turab^h, Benjamin Zaitchikⁱ, The MAL-ED Network



PY1 Results: Rotavirus



		Lag lengths									
		2	3	4	5	6	7	8	9	10	
Precipitation (mm)	Absolute effect							▲			
	Adjusted effect							▲	▲		
Relative humidity (%)	Absolute effect					▲					
	Adjusted effect									▲	
Soil moisture (%)	Absolute effect								△	▲	
	Adjusted effect					△	▲				
Solar radiation (W/m ²)	Absolute effect	△									
	Adjusted effect	▲									
Specific humidity (kg/kg)	Absolute effect										
	Adjusted effect										
Surface pressure (mbar)	Absolute effect	▲									
	Adjusted effect		▲								
Surface runoff (mm)	Absolute effect							△			
	Adjusted effect	△	△					△	△		
Temperature (C)	Absolute effect	△		▲							
	Adjusted effect	△							▲		
Wind speed (m/s)	Absolute effect		△					▲	▲	▲	
	Adjusted effect							△			



$p < 0.001$



$p = 0.001 - 0.01$



$p = 0.01 - 0.05$



$p < 0.05$ in DLM

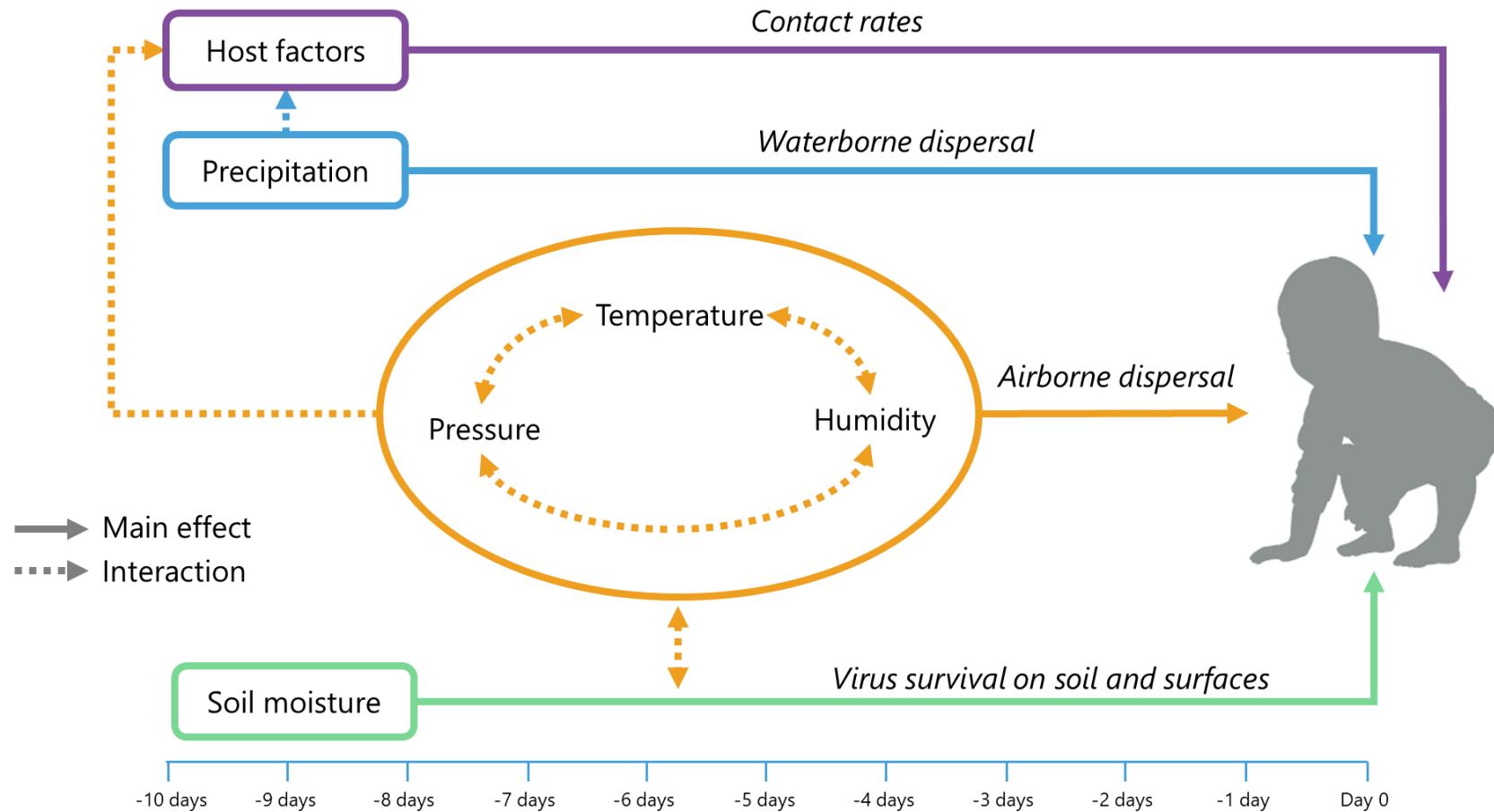


Included in stepwise selection



Selected by stepwise selection

PY1 Results: Rotavirus

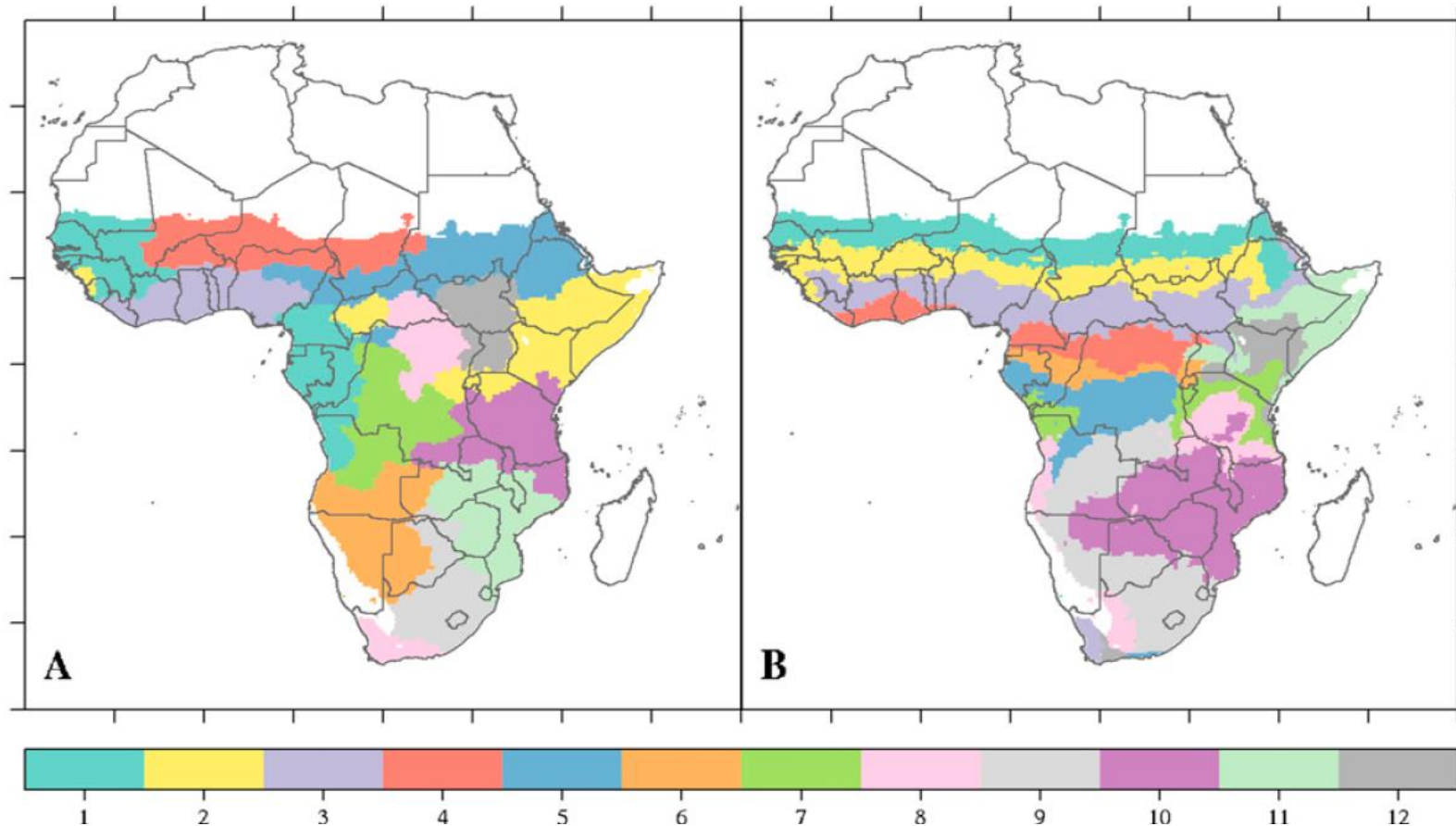


Next Steps for Rotavirus

Develop process-informed statistical models to **predict EID burden**

Use objective regionalization to create **a global EID-oriented classification system**

Regionalization



Next Steps for Rotavirus

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Preliminary system by end of PY1

Risks and response

Risk: MAL-ED has only eight sites and a short data record.

Response: We are currently working to add Global Enteric Multicenter Study (GEMS) data to our analysis

Risk: Poor performance of EO products at study sites.

Response: multiproduct comparisons, with potential for custom products

ARL

Current: ARL 3

Expectation: ARL 4 by end of the year for at least one EID

Goal: ARL 7

Thank You
