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MedEWSa

AeDES2 - An enhanced climate-and-health service for monitoring and forecasting Aedes borne disease transmission

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2-minute summary

- After the advent of COVID-19, there's a need to establish links between climate change and vector-borne disease transmission. Climate barriers are slowly eroding, allowing vectors to roam to previously unaffected areas

- *Among these vector-borne diseases, Aedes* mosquitoes are among the most deadly, as they're the main carriers of DENV, CHIKV and ZIKV. Their proliferation is strongly tied to climate conditions.

- **Can we bridge the gap between climate (change) and Aedes-borne outbreaks?**

Ae. Albopictus

Ae. Aegypti

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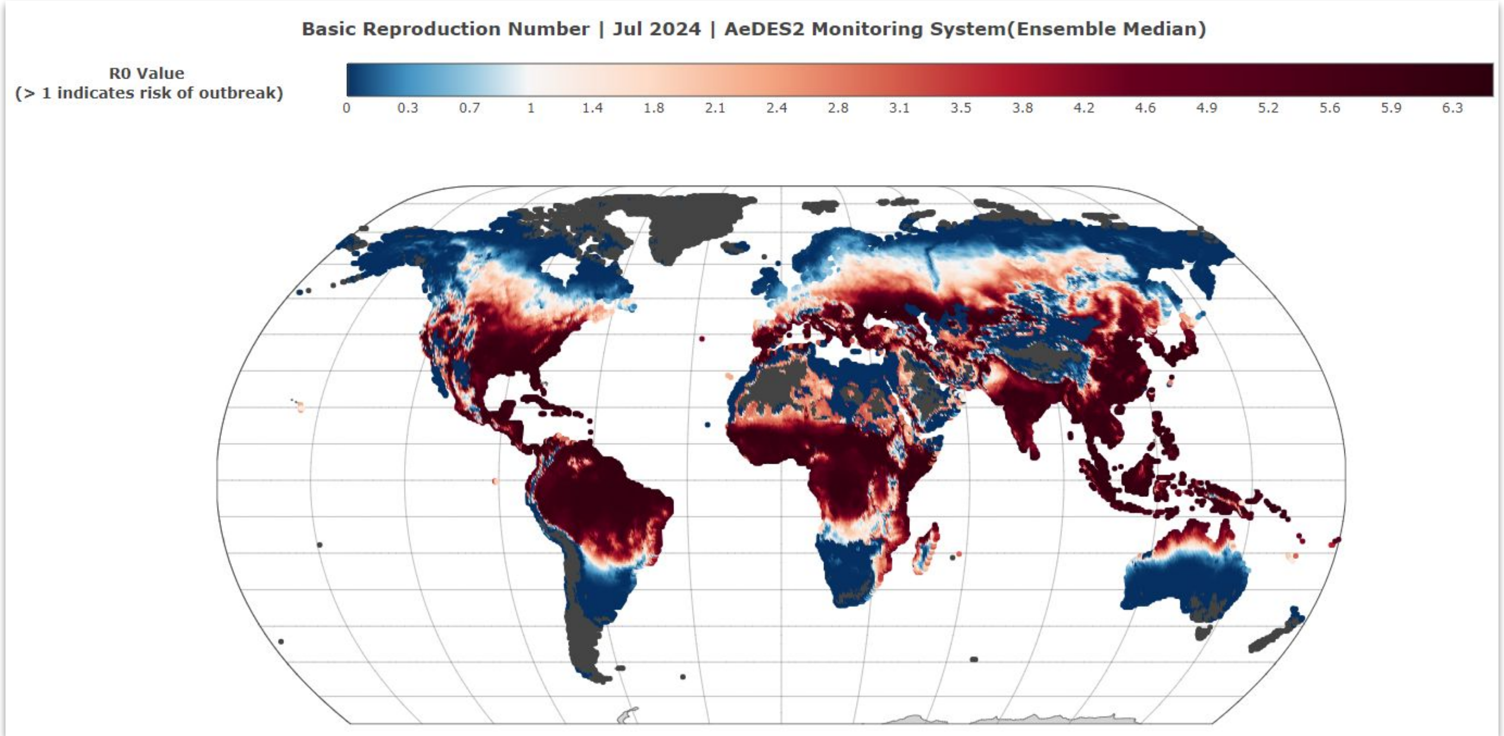
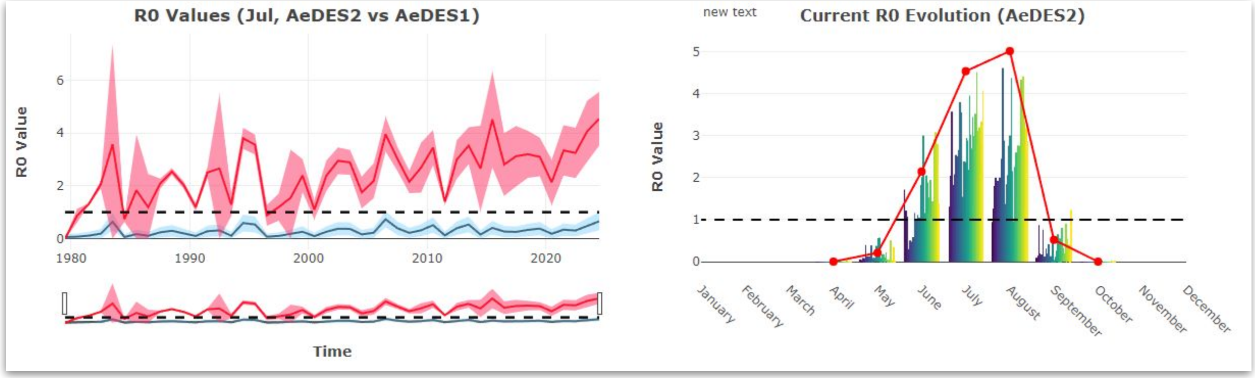
2-minute summary

- AeDES2 is a climate-and-health operational system that monitors the climate influence on the spread of Aedes diseases

- It uses mechanistic models that allow for climate variables to be transformed into R0 (a metric that quantifies the transmissibility of the disease)

- This tool can significantly aid health officials in resource allocation and develop EWWs to fight outbreaks ahead of time, and understand how climate patterns conditions diseases





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Background: Why Aedes?

- Aedes vectors are now appearing in previously safe areas! (e.g. Paris Olympics… but also some areas in Europe)

- "DENV season" is expanding in the Americas with higher temperatures…

- Aedes mosquitoes are responsible for +400M! Their proliferation is strongly tied to temperature and precipitation, though how climate acts as a whole is not entirely understood

- Monitoring the disease and predicting potential outbreaks could significantly help prepare health officials, governments, populations…

Washington, DC, June 20, 2024 (PAHO) - With more than 9.3 million cases of dengue, Latin America and the Caribbean currently reports twice as many cases recorded in all 2023, according to the latest **epidemiological update** issued this week by the Pan American Health Organization (PAHO). However, the lethality rate is kept below the regional target of 0.05%.

PARiS 2024

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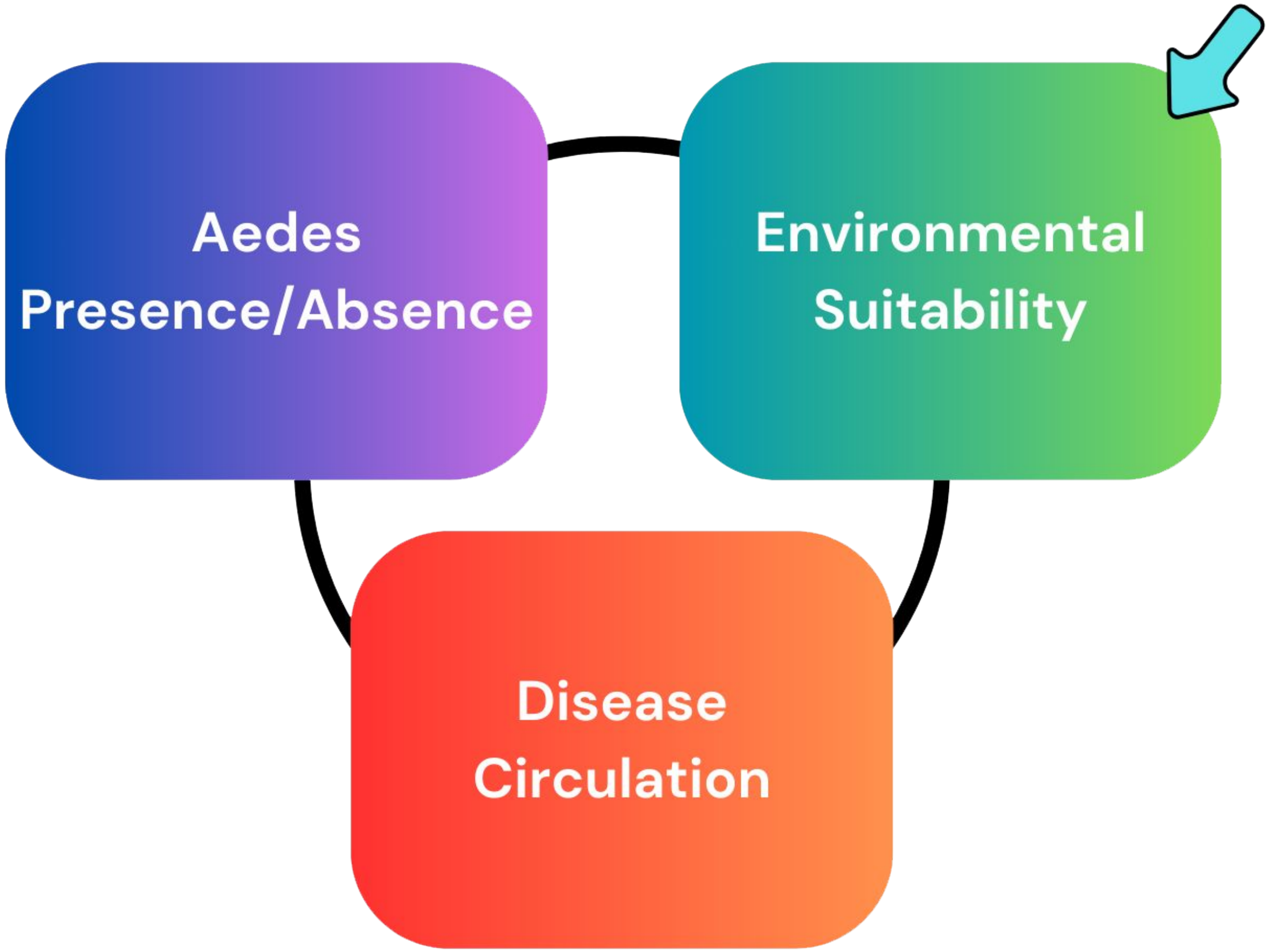
How can we predict a disease?



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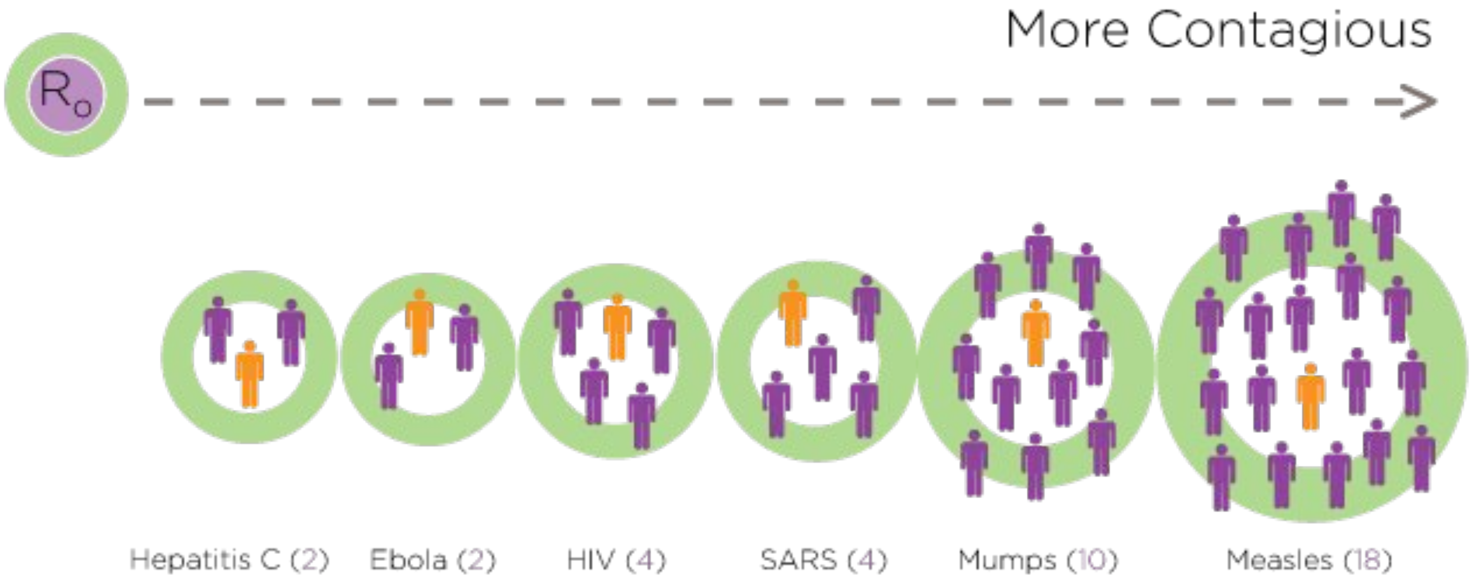
R0 as a metric for Aedes transmissibility

- The basic reproduction number (R0, dimensionless) outlines the **number of *expected* additional cases that one infected person can generate**, on average, over the course of its infectious period

- R0 depends on many complex socioeconomical and epidemiological factors, though **if only climate information is considered, R0 then highlights how environmentally suitable a region is for Aedes vector-borne diseases**

Objective:

Find ento-epidemiological models that use climate variables!



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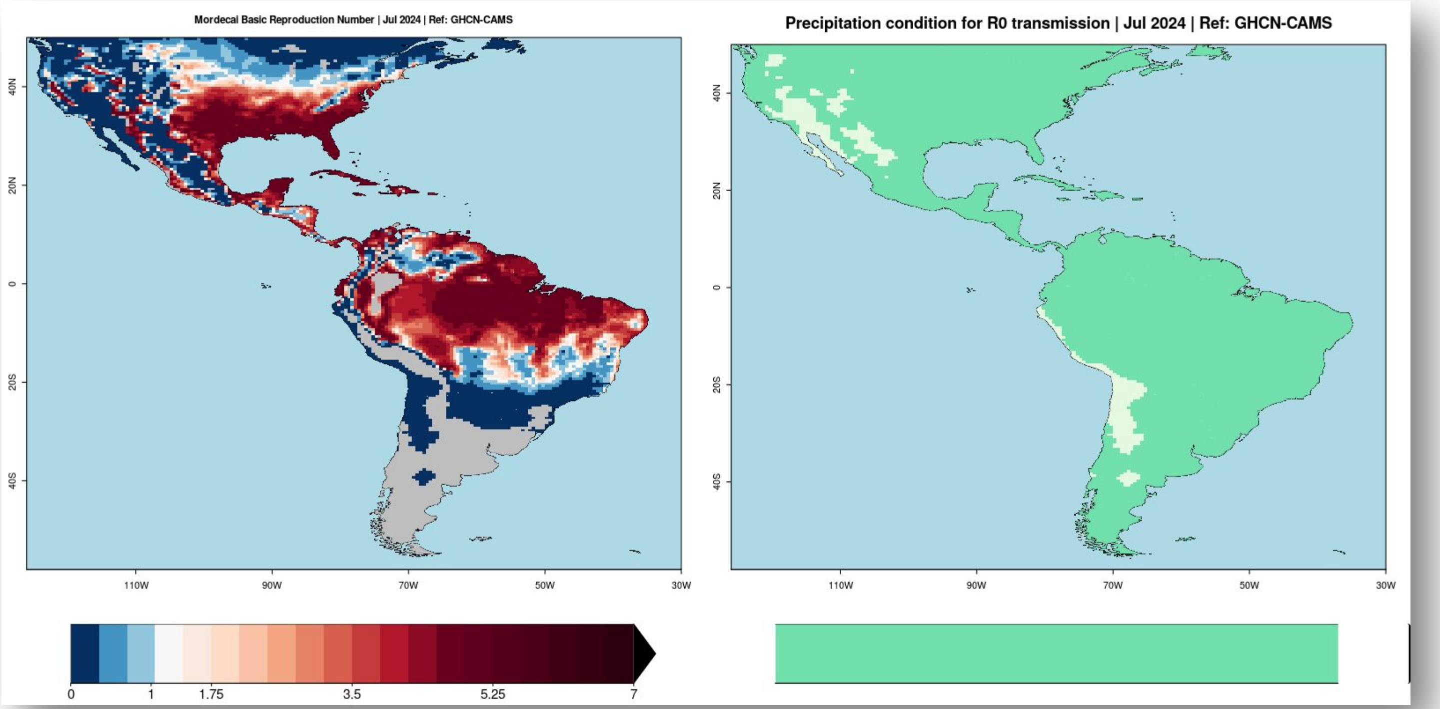
Transforming Climate Variables into R0 outputs

- Caminade et al., 2015
- Mordecai et al, 2014
- Liu-Helmerssohn et al., 2017
- Wesolowski et al., 2015

(Contain temperature thresholds for disease transmissibility)

If total precipitation in the five months prior surpass 80mm, R0 =/= 0

(Mapping Malaria Risk in Africa project framework)



Which R0 model to choose?

We'll just combine all of them in an ensemble…

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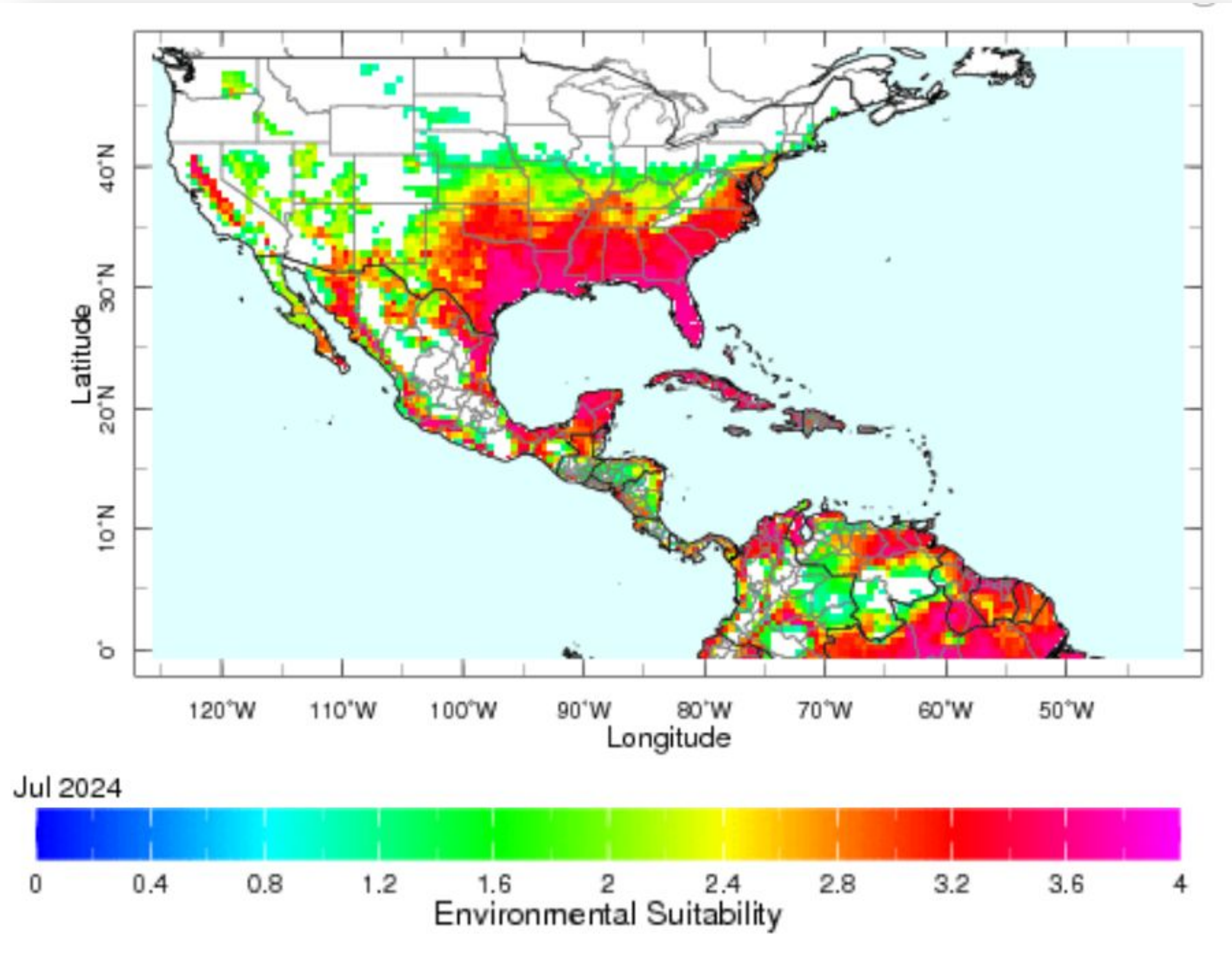
Caveats and Possible Improvements



(Only R0 > 1 values are mapped)

First Problem:

Using only a singular observational reference may induce posible biases in certain areas/regions (GCMs have some biases in temperature measurements…)

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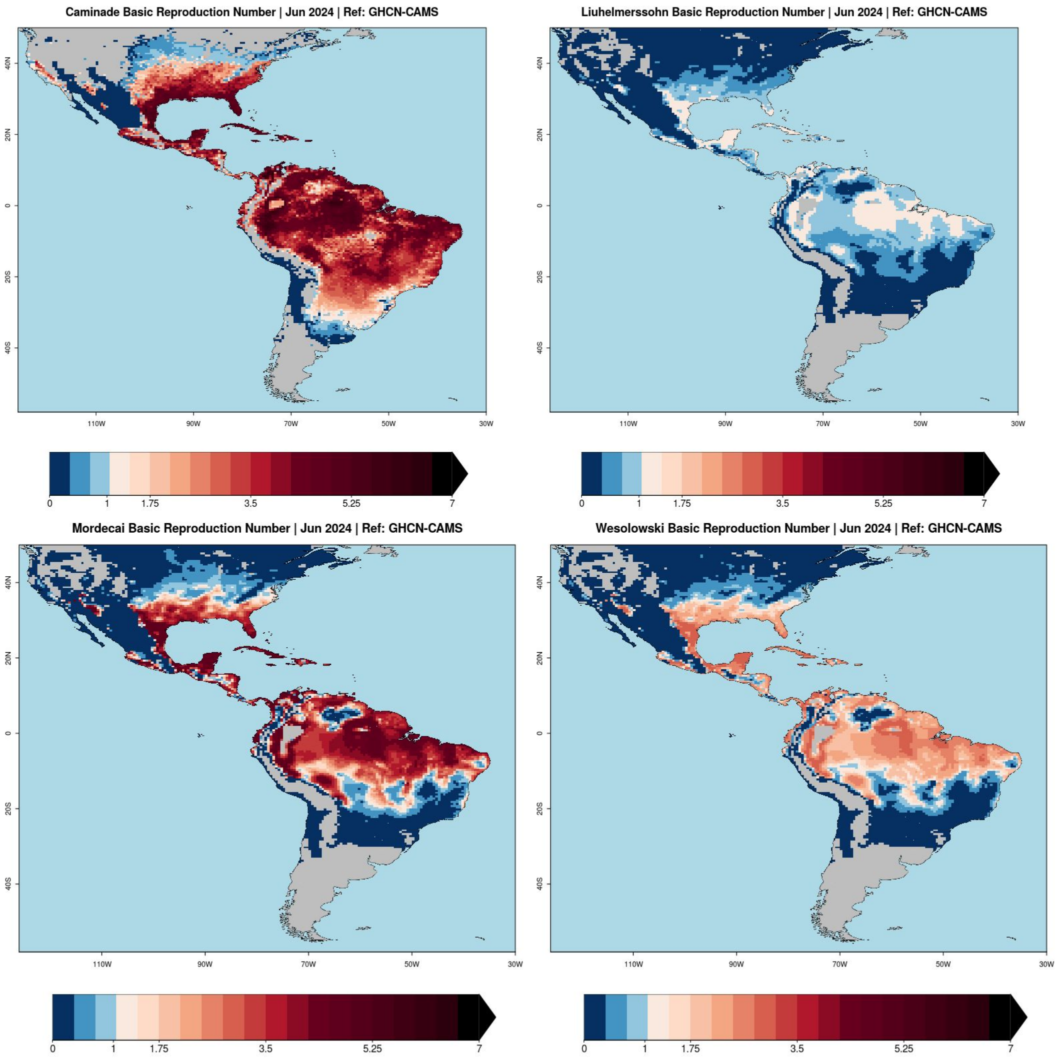
AeDES1: Caveats and Possible Improvements



First Problem:

Using only a singular observational reference may induce posible biases in certain areas/regions (GCMs have some biases in temperature measurements…)

Second Problem:

All four R0 models have different ranges in values, and are not calibrated to an empirical, real-life reference…

This could lead to high uncertainty in the ensemble!

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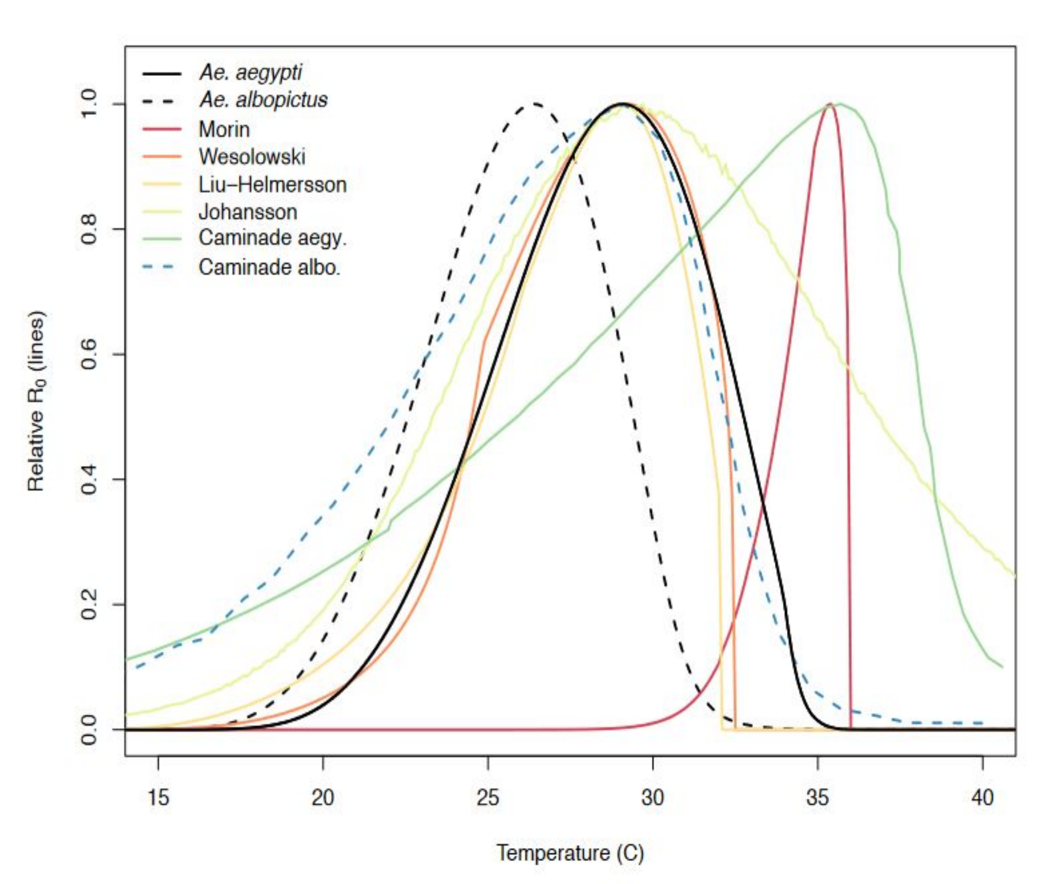
AeDES1: Caveats and Possible Improvements



First Solution:

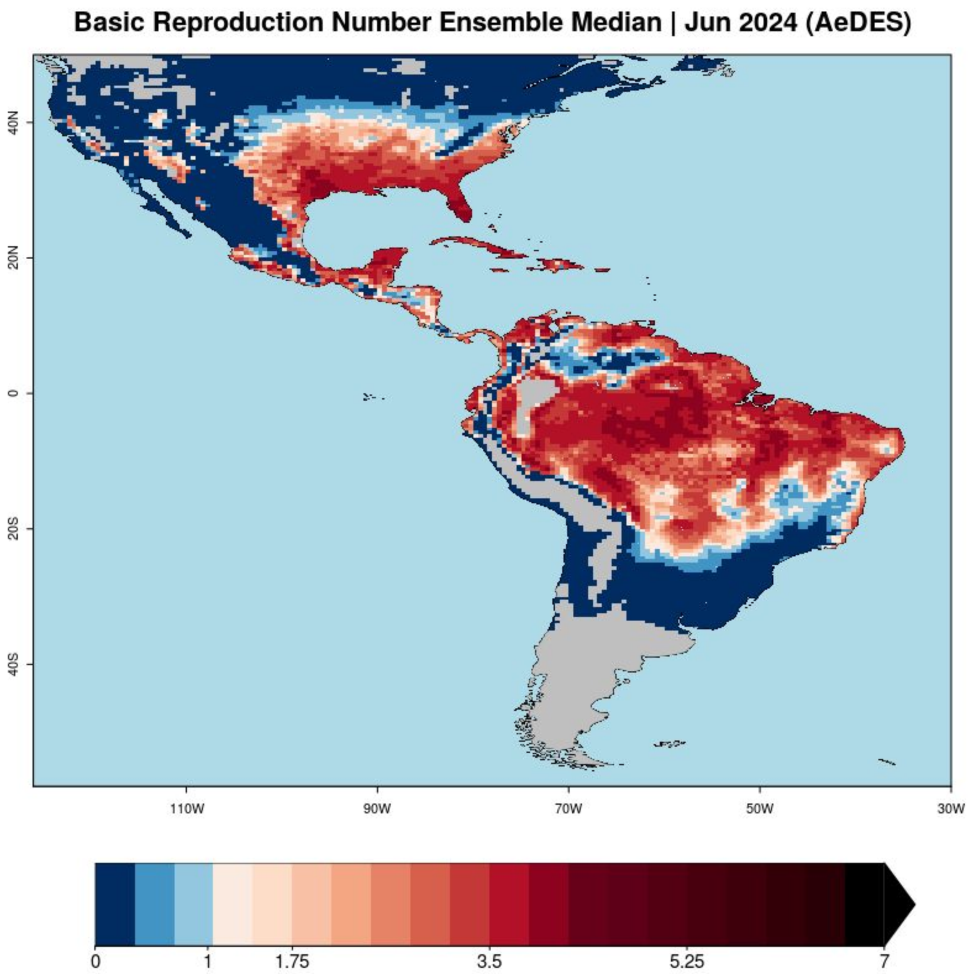
Use 3 climate references, each with 4 R0 models (12 members total in the ensemble between GHCN-CAMS, CPC Global Unified and Era5Land data)

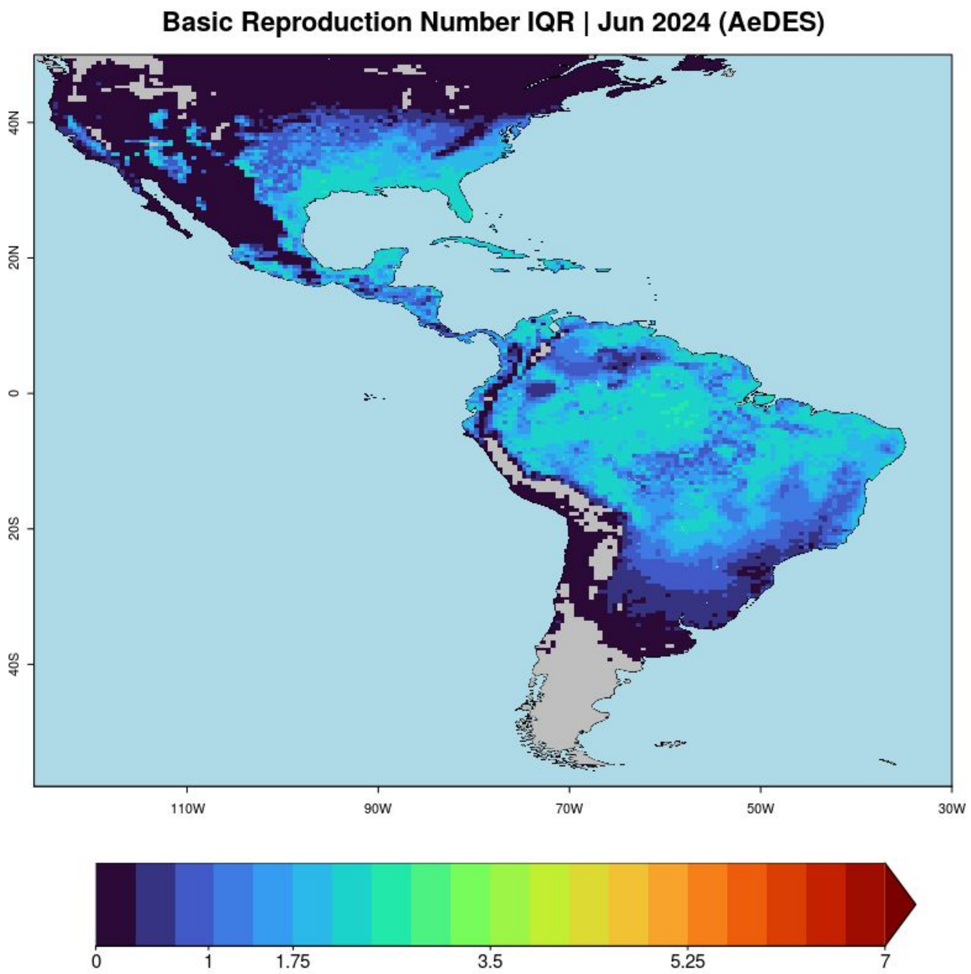
Second Solution:

Calibrate all four R0 models before merging them into an ensemble with quantile mapping

(IRL data source: Weekly case reports of DENV, CHIKV, and ZIKV in the Americas and the Caribbean between 2014-2016)

From uncalibrated outputs (Muñoz et al., 2020)…





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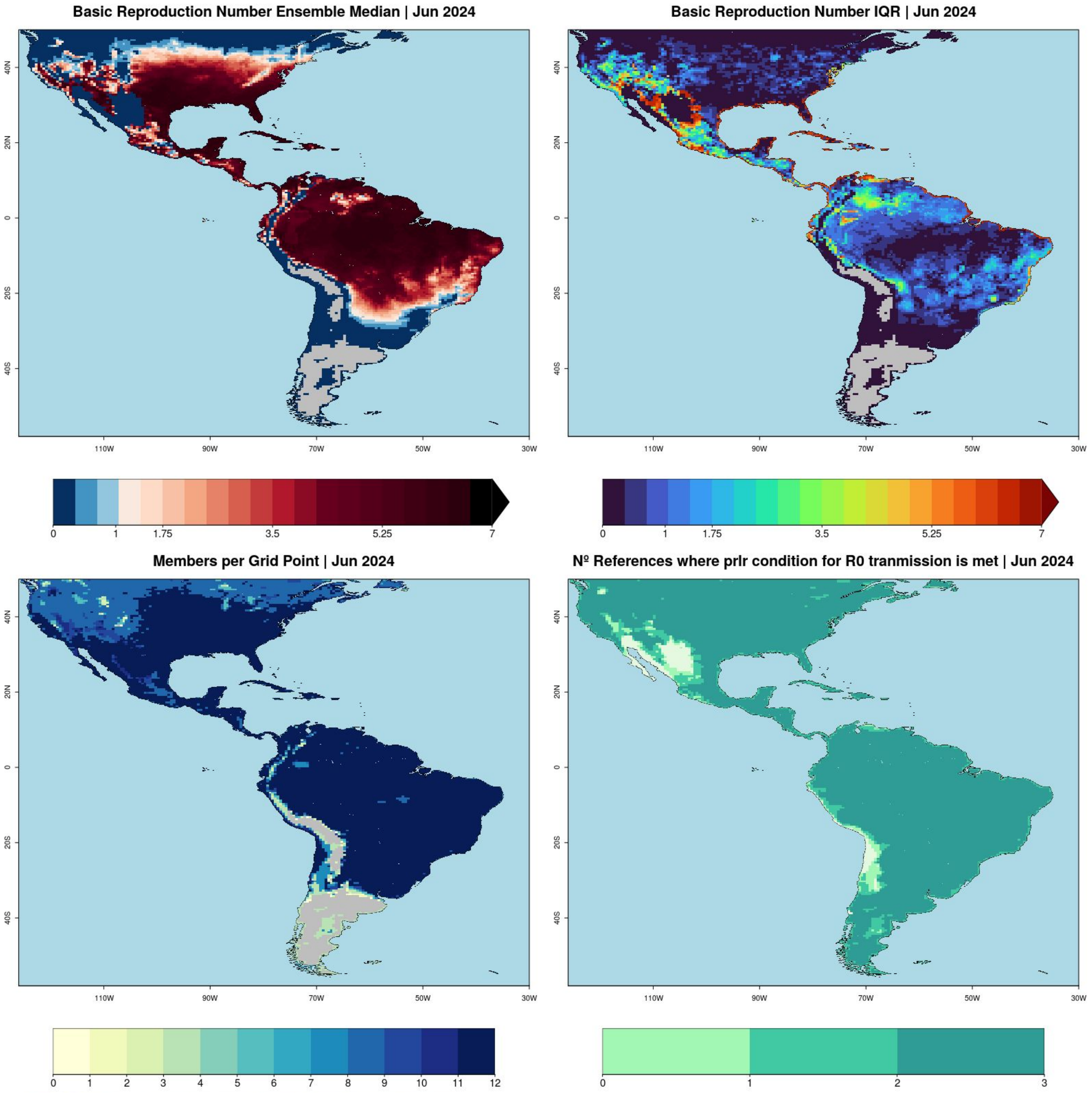
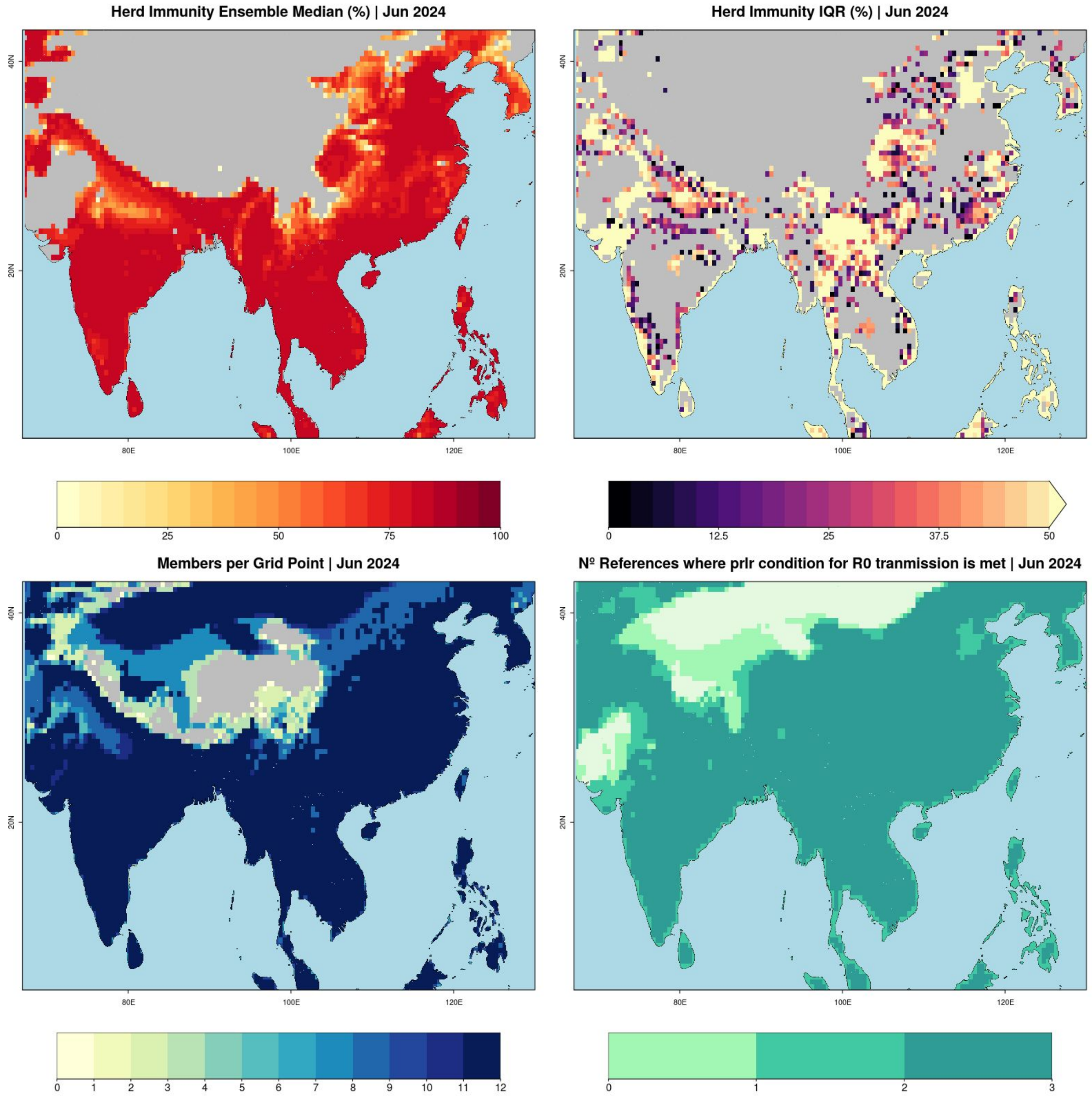
...to AeDES2's monitoring system



- Median values for R0 are overall higher post-calibration
- Uncertainty values (IQR) overall lower (save for areas with differing temperature or precipitation between climate references)
- Nº of members per grid point also shown as another uncertainty source

…versus AeDES2's monitoring system



- Median values for R0 are overall higher post-calibration
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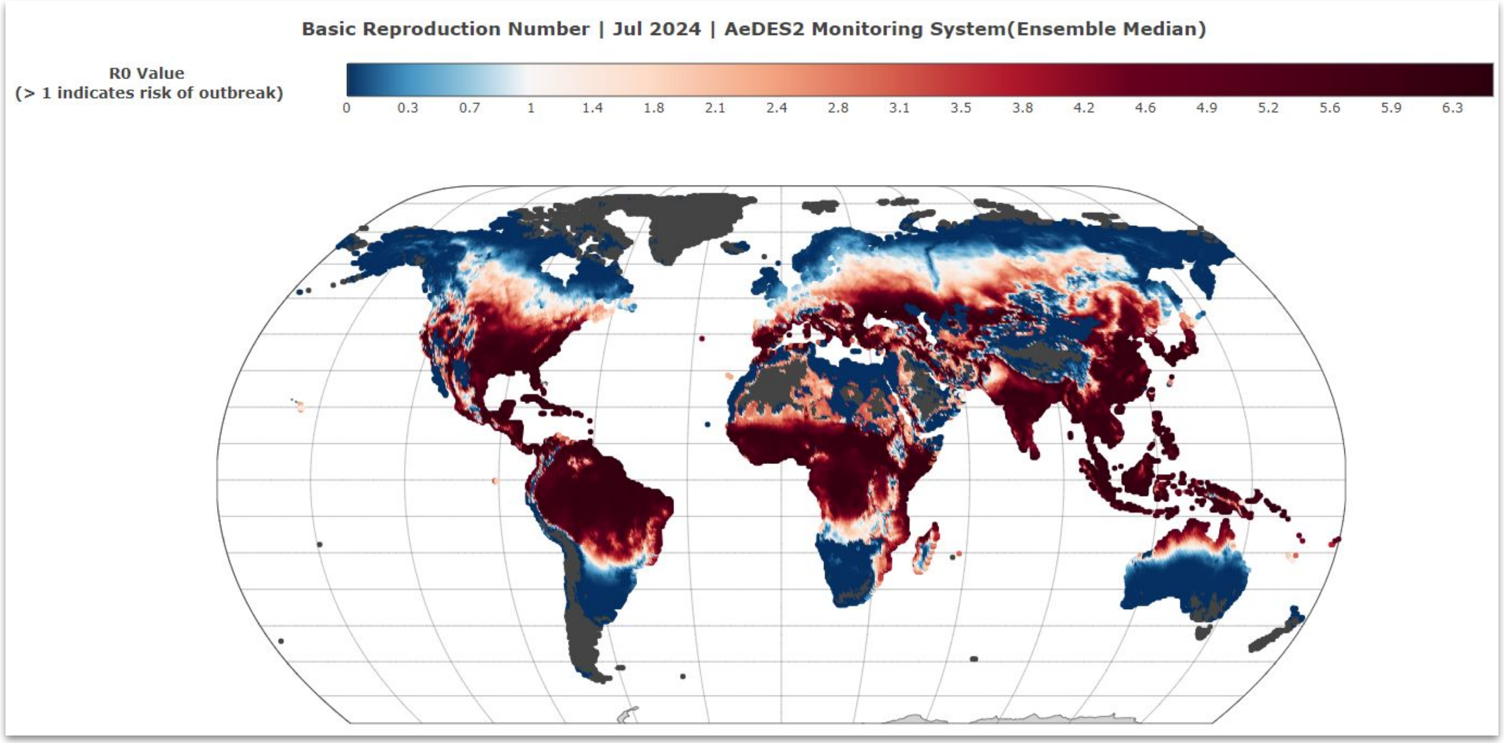
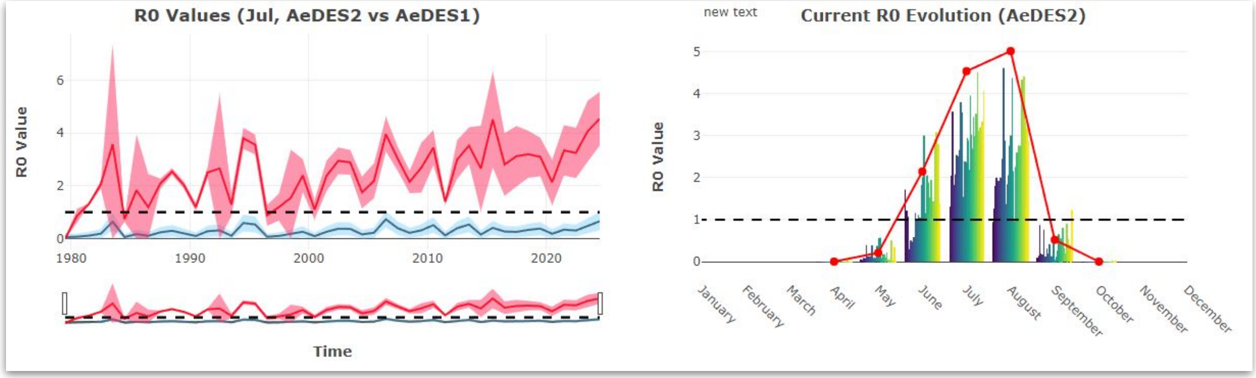
- Nº of members per grid point also shown as another uncertainty source

- Scope broadened to global outputs versus original implementation for Americas in Muñoz et al., 2020
- Herd immunity % (defined as the percentage needed to stop the spread of the disease) has also been computed from R0
- Fully operational (1979-present), updates once all three climate references are available

In-development Shiny App





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Next steps for AeDES2

- ***Understanding the change in R0 patterns through timescale decomposition**, to outline disease climatology, which can help in resource allocation*

- ***Outline the relationship between R0 and the climate patterns** like El Niño Southern Oscillation to determine whether R0 outbreaks can be more strongly predicted*

- ***Enhance this system further using climate patterns for R0 instead of temperature**, as climate patterns are a better aggregate of multiple climate variables and influences over Aedes-diseases*

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Thank you!

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