The Health-Climate Landscape for Zika transmission in Latin America and the Caribbean

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Countries with active zika transmission (as of May 26, 2016)
A downward trend of cases of Zika virus disease in Central and South America continues to occur while in most Caribbean countries and territories the trend continues to rise. This trend should be interpreted with caution due to delays in notification which may subsequently alter the trend of the previous 4 to 6 weeks.
Zika cases in the US (2015-2016) as of June 01, 2016

618 Travel associated cases
11 STI cases
1 GG case
Is it valid to use the same parameters for dengue to estimate Zika risk?

How is Zika different from dengue?
• STI. Perinatal transmission. Blood transfusions. Other modes of transmission?
• First wave of invasion (all are susceptible, See Perkins et al.)
• Other mosquito vectors?
• Evidence of Sylvic transmission cycle similar to YF
• Long persistence in semen
• Association with birth complications and neurological disorders (microcephaly, GB)

How is it the same?
• Clinical presentation of most cases similar to mild dengue
• Flavivirus (like dengue, yellow fever)
• Dominant urban transmission cycle
• Same mosquito vector (*Aedes aegypti* and *Aedes albopictus*)
• High proportion of asymptomatic cases
Early predictions of zika risk use a range of modeling approaches, which incorporate climate information

These early models provide important first attempts to characterize disease transmission, which will be validated using field and epi data in the coming months and years.

Examples:

Bogoch et al – ENM – spatial distribution of risk
Messina et al – ENM statistical modeling – spatial distribution of risk
Perkins – R01 first wave modeling – predictions of pregnant women infected
Monaghan et al 2016 – Meteorological model with mosquito mechanistic model to diagnose historical monthly risk across the US
Mordecai et al – Mechanistic modeling of vector parameters (R0) with temperature

Mordecai’s work shows that temperature is a key driver of Zika risk

- Temperature is an important driver due to mosquito physiology, and our studies show that it is an important predictor of Zika-dengue-chikv transmission (Mordecai et al, in prep, prior studies by Stewart et al in Ecuador).
- We know that RH and rainfall are important for Aedes sp., but effects on disease risk are more complex (depend on local social context, e.g., water storage) and spatially heterogenous.
Transmission models

Field validation in Ecuador and Kenya

General framework for VBD transmission

Local adaptation of thermal responses

Existing empirical data - 13 diseases

New dengue field data

Metabolic theory general predictions

New lab data

Existing field data

NSF EEID: Erin Mordecai, Matt Thomas, Sadie Ryan, Anna Stewart, Leah Johnson, Jason Rohr, Van Savage
Temperature defines fundamental risk

Data: weekly PAHO incidence data, relativized by cumulative cases up to the previous week, plotted against mean temperature two weeks prior to each case report, from Weather Underground. Filled points: maxes within each temperature bin (20 bins per virus).

E. Mordecai et al. in prep
So, how important is climate for Zika, compared to other key factors?

For example:

Dengue

- Climate
- Immunology & Socio-economic conditions
- Human behavior

Malaria

- Climate
- Immunology & Socio-economic conditions
- Human behavior
How important is climate for Zika, compared to other key factors?

Zika

Can we use DENV as a proxy for ZIKV? Within a year our team will know!

Dengue

Malaria
Can we forecast Zika? Not yet... BUT

Zika

Climate  Immunology & Socio-economic conditions  Human behavior

Extremely Unpredictable!

GAME OVER
Can we forecast Zika? Not yet... BUT

Zika

Chiasticite: Immunology & Socio-economic conditions

- Partially Predictable
- Knowable

Human behavior: Extremely Unpredictable!

?
Health landscape

Immunology & Socio-economic conditions

(Knowable)

(Using DENV vulnerability as a proxy)

Fullerton, Dickin, Schuster-Wallace (2014)
Rainfall anomaly

more rain than normal

less rain than normal

Temperature anomaly

warmer than normal

colder than normal

Climate

(Partially Predictable)

Climate landscape

Muñoz, Thomson, Goddard, Aldighieri (2016)
Timescale Decomposition (à la IRI)

Climate varies at different timescales... remember Goddard's video

Muñoz, Thomson, Goddard, Aldighieri (submitted)
Timescale decomposition (Jan-Dec)
What to expect for 2016-2017?

Climate

Rainfall for “typical” La Niña

Towards a climate-health service for ZIKV in the Latin American Observatory

Visit our poster this afternoon!

http://datoteca.ole2.org/maproom/Sala_de_Salud-Clima/
Summary

• The end of this year will most likely (>70%) see a weak-to-moderate La Niña, associated with cooling Pacific Ocean temperatures.

• If La Niña is too weak, other modes (e.g., in the Atlantic) could be important for Latin America and the Caribbean.

• Our decomposition indicates that we will see warmer than average temperatures in most of Brazil and northern South America despite La Niña, due to decadal variability and long term trend (climate change).

• We anticipate above-normal rainfall in northern South America, and below-normal rainfall in south eastern South America.
Summary

What does this mean for Zika in late 2016 and early 2017?

• The first wave of infection will have passed, suggesting herd immunity, lowered active transmission, and lower Zika cases reported. However, we anticipate increased reporting of birth complications due to infected mothers from 2016, and increased surveillance efforts.
• Above-normal temperatures will increase the risk of Zika transmission.
• In areas with more rainfall, interventions should focus on elimination of abandoned/discard water bearing containers around the home.
• In areas with less rainfall, interventions should target neighborhoods with problematic access to piped water, and should focus on covering or using larvicide in containers used for water storage.
• Social political context (e.g., conflict in Venezuela, and earthquakes in Ecuador) increase dramatically the vulnerability of the population to Zika.
Interested in Zika and Climate?

It’s a date! Come tomorrow to Room 205 at 14:00 h

(Best anti-Zika alcoholic beverage will be available)
Extra slides
Consecutive months in which temperature predicts $R_0 > 0$ for *Aedes* spp. transmission at >97.5%, >50%, and >2.5% posterior probability.

E. Mordecai et al. in prep

Fig. 1. U.S. map showing 1) Ae. aegypti potential abundance for Jan/July (colored circles), 2) approximate maximum known range of Ae. aegypti (shaded regions) and Ae. albopictus (gray dashed lines), and 3) monthly average number arrivals to the U.S. by air and land from countries on the CDC Zika travel advisory. Additional details can be found in the text.
Figure 2. Maps of (A) global environmental suitability for Zika virus, ranging from 0 (grey) to 1 (red), showing greater detail for (B) the Americas, (C) Africa, and (D) Asia and Oceania.
Model-based projections of Zika virus infections in childbearing women in the Americas

Figure 1. Gridded spatial projections of component variables (a-c) that combine to yield a gridded spatial projection of Zika infections in childbearing women across Latin America and the Caribbean (d). Projections of total numbers of Zika infections in all people (e) and in childbearing women (f) for the top eight countries in each category were derived from 5x5 km gridded spatial projections such as (d). Numbers in e and f represent mean (lower bound – upper bound) with respect to relationships between environmental variables and transmission potential.