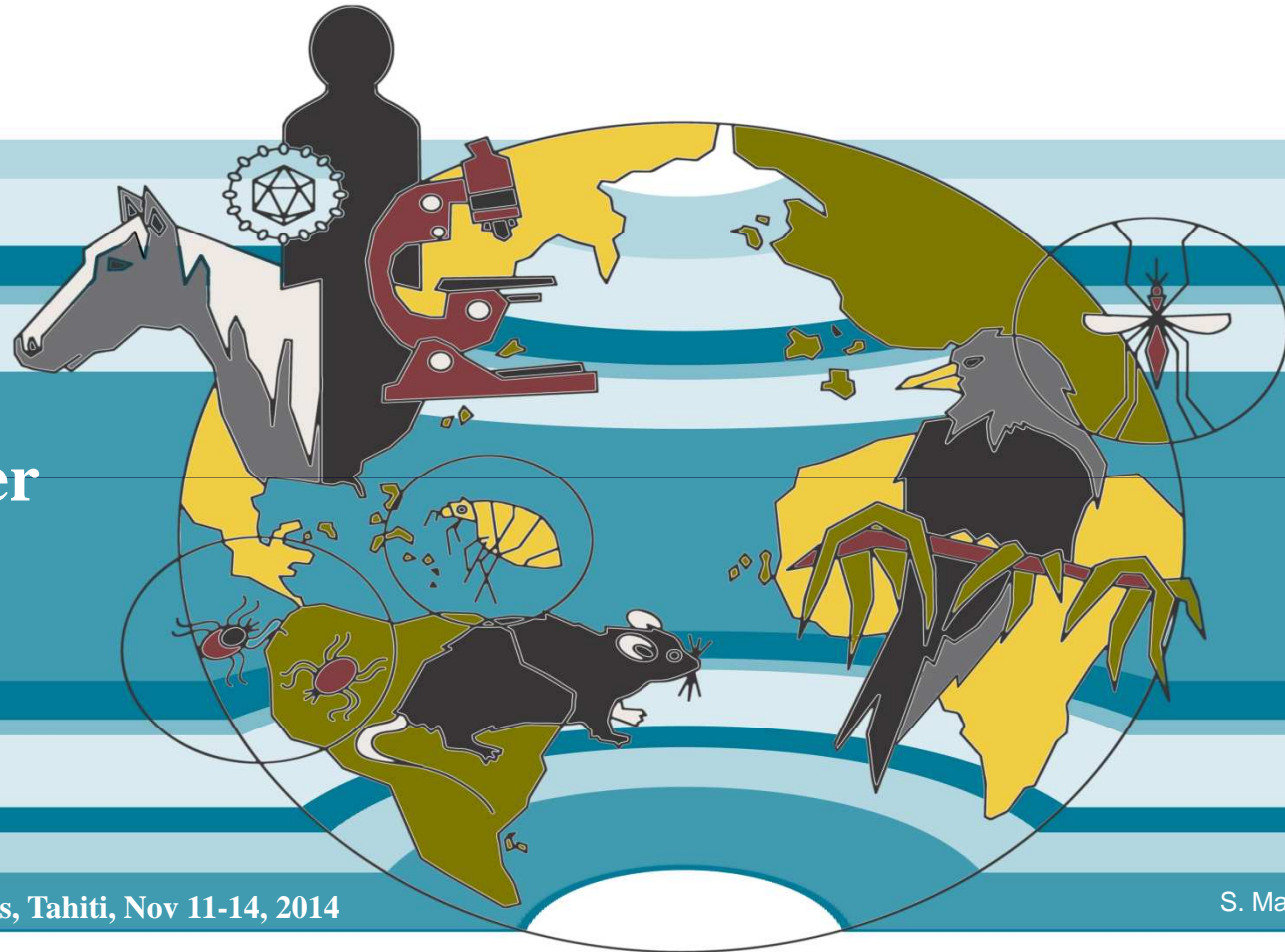


The Global Threat of Epidemic Emergent-Re-Emergent Arboviral Diseases

Duane J Gubler
Professor



Think Tank on Infectious Diseases, Tahiti, Nov 11-14, 2014

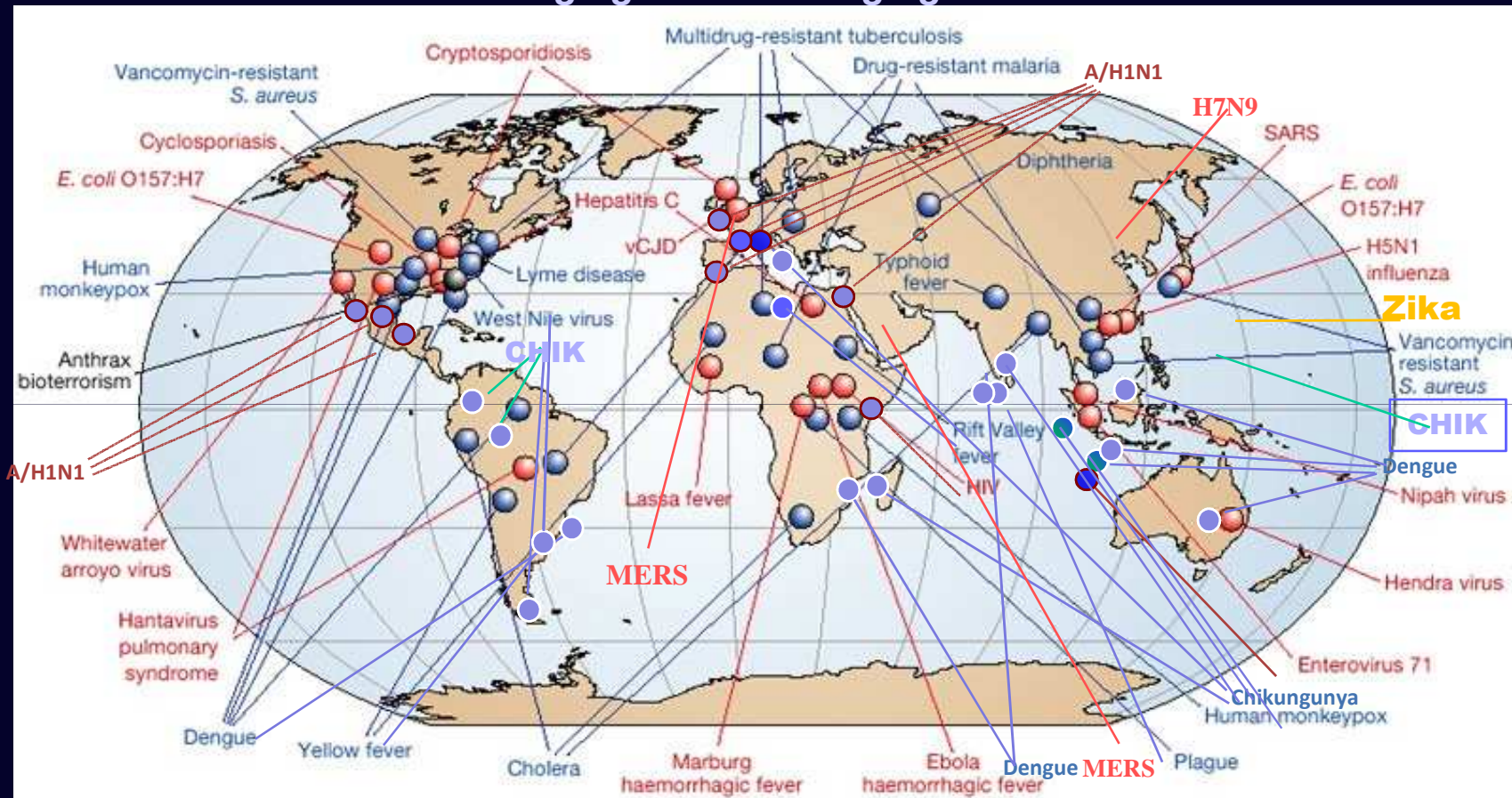
S. Machado

Signature Research Program in Emerging Infectious Diseases
Duke-NUS Graduate Medical School, Singapore



The Global Threat of Infectious Diseases

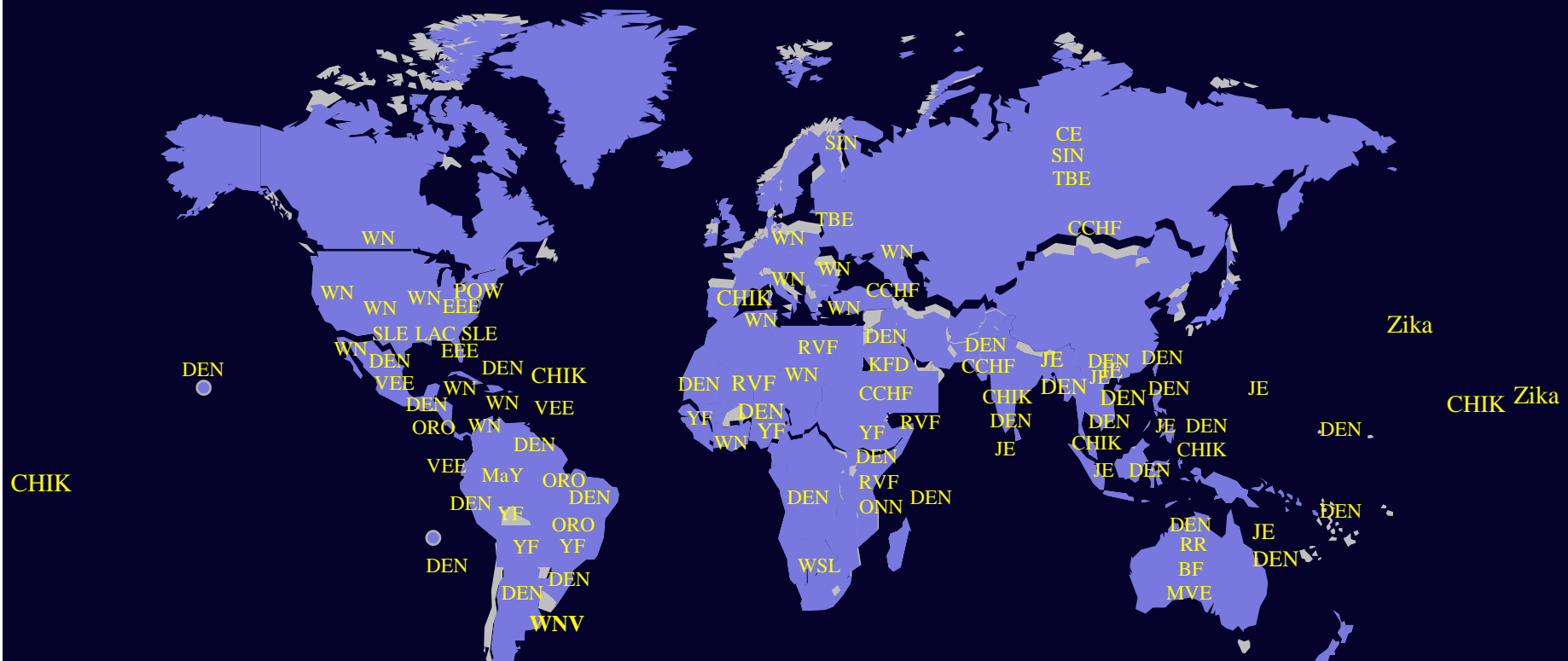
Emerging and re-emerging diseases



- Emerging diseases
- Re-emerging diseases

Adapted from Morens, Folkers, Fauci 2004 Nature 430; 242-9

Global Resurgence of Epidemic Arboviral Disease



BF - Barmah Forest
CE - California Encephalitis
Chik - Chikungunya
CCHF - Congo-Crimean Hemorrhagic Fever
DEN - Dengue
EEE - Eastern Equine Encephalitis
JE - Japanese Encephalitis
KFD - Kyasanur Forest Disease
LAC - LaCrosse Encephalitis

MAY - Mayaro
MVE - Murray Valley Encephalitis
ONN - O'nyong-nyong
ORO - Oropouch
RVF - Rift Valley Fever
RR - Ross River
SLE - St. Louis Encephalitis
SIN - Sinbis
TBE - Tick-Borne Encephalitis

VEE - Venezuelan Equine Encephalitis
WEE - Western Equine Encephalitis
WN - West Nile
WSL - Wesselsbron
YF - Yellow Fever
Zik - Zika virus
POW - Powassan

Emergent/Re-Emergent Arboviral Diseases of Humans

- Dengue Hemorrhagic Fever
- Yellow Fever
- West Nile virus
- Japanese Encephalitis
- Chikungunya
- Rift Valley Fever
- Alkhurma Virus
- Venezuelan Equine Encephalitis
- Blue Tongue
- Epidemic Polyarthrititis
- Barmah Forest
- Oropouche
- California Encephalitis
- Crimean-Congo Hemorrhagic Fever
- Zika
- Severe Febrile Thrombocytopenia Syndrome

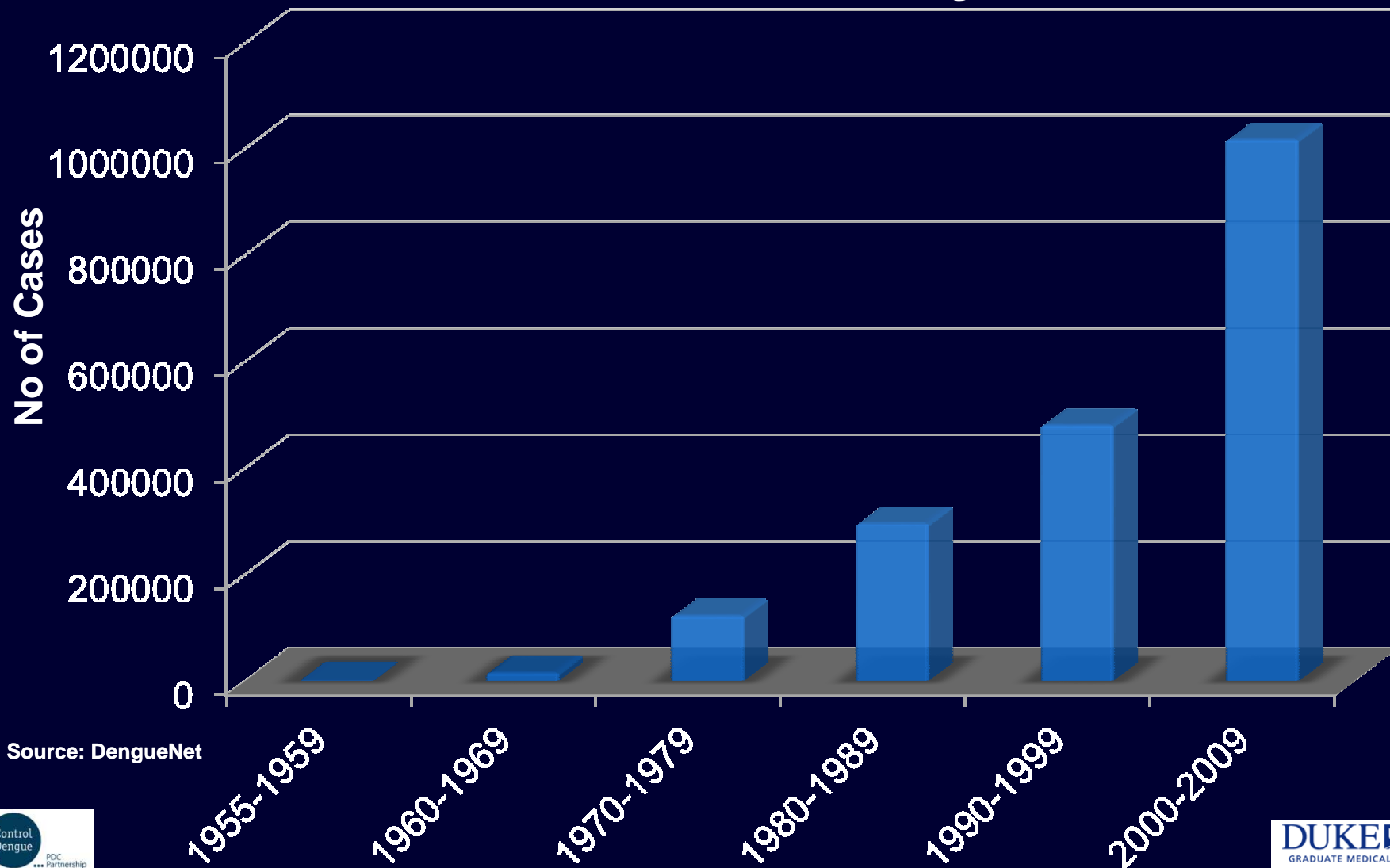
The changing epidemiology of dengue

Expanding geographic distribution

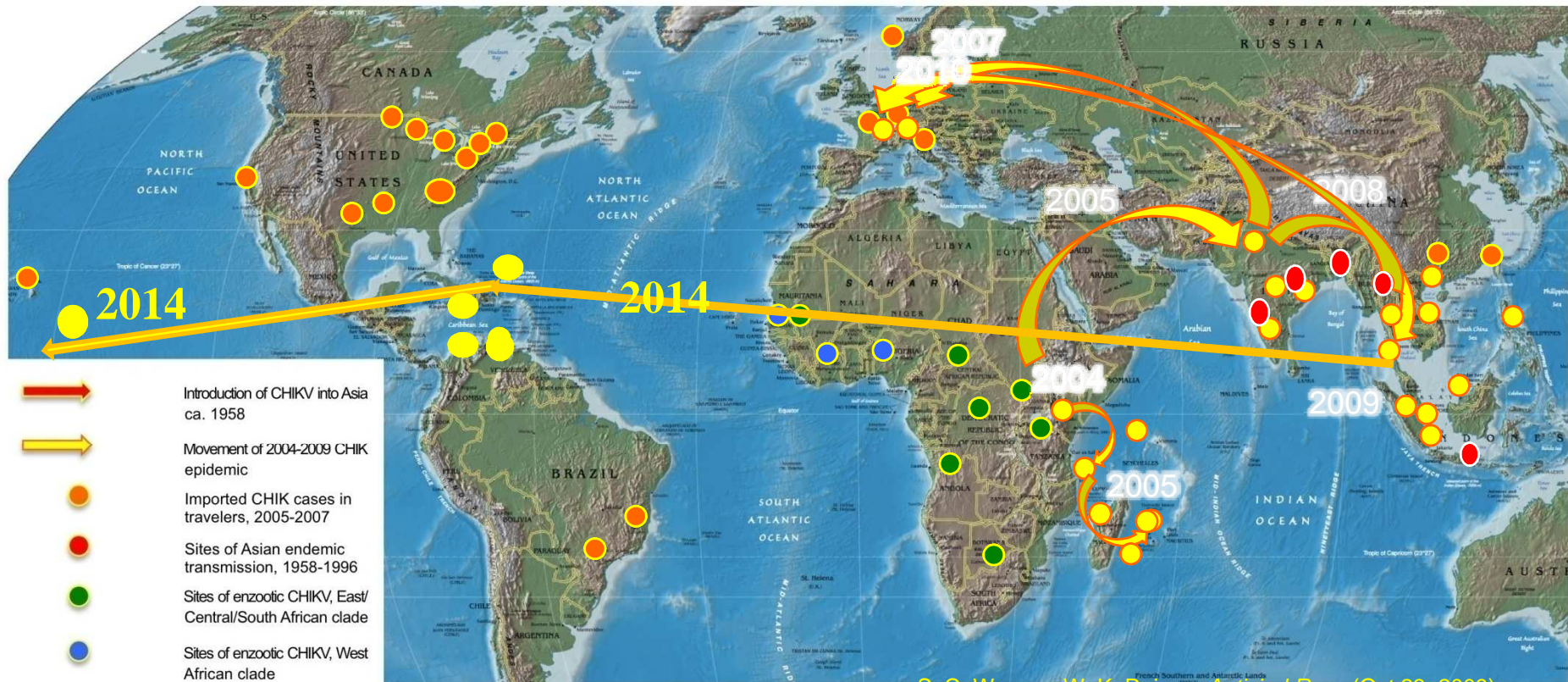
Hyperendemicity

Increased epidemic activity

Emergence of DHF



Chikungunya Spread: 2005 - 2014

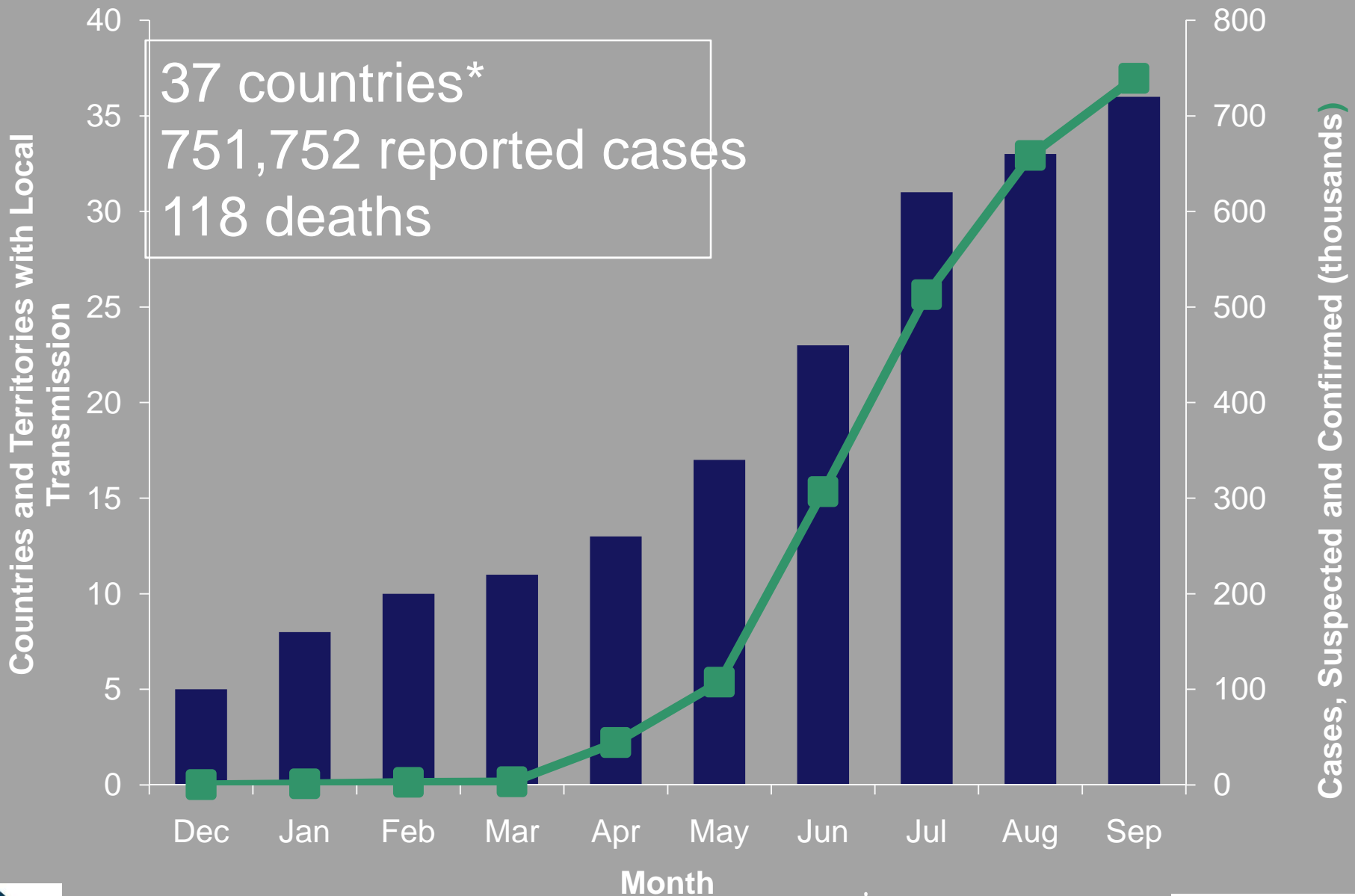


S. C. Weaver, W. K. Reisen, *Antiviral Res.*, (Oct 23, 2009).

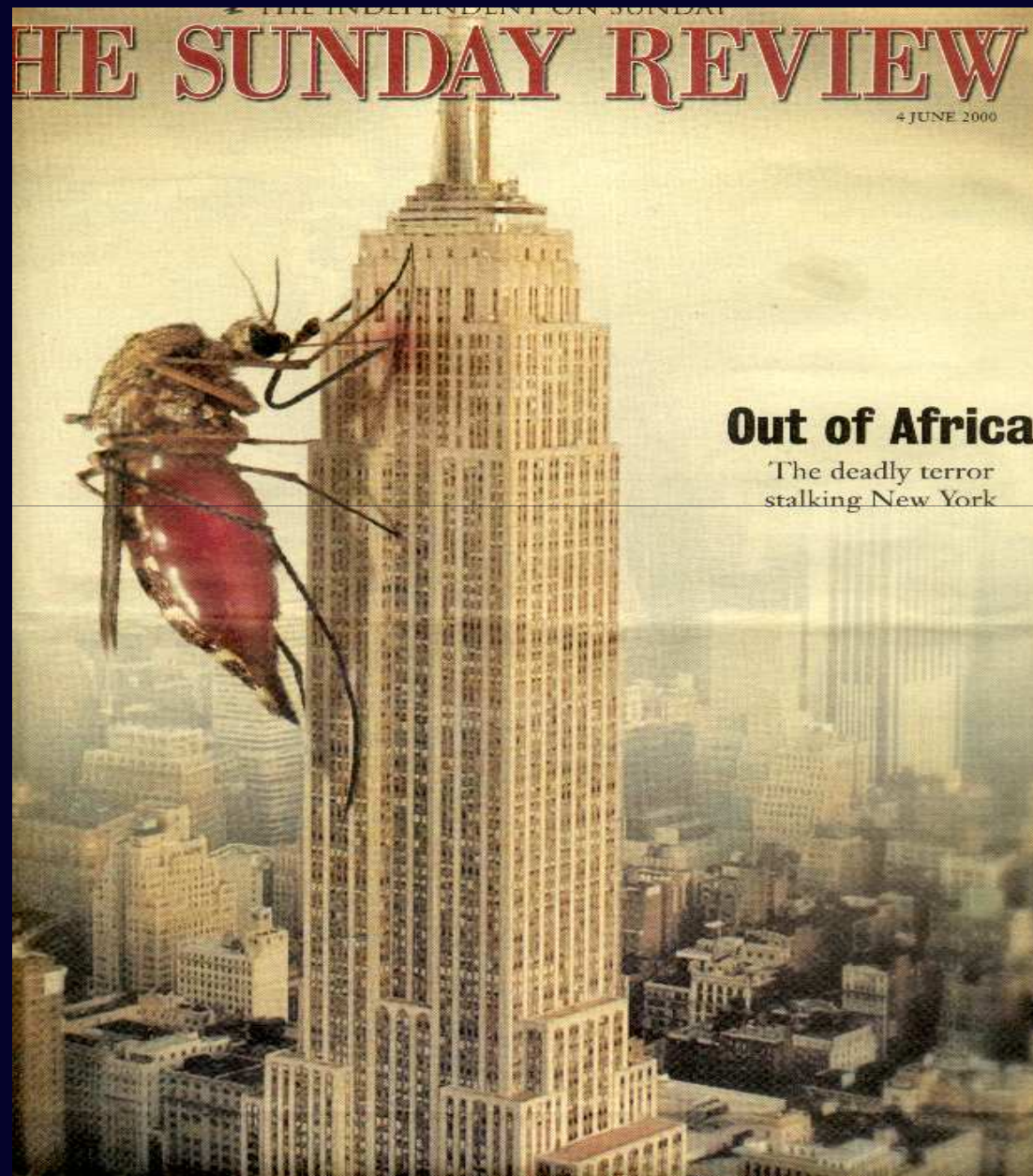
Factors contributing to CHIK spread

- Globalization
- Mutation in the E1 envelope glycoprotein adapting CHIKV for more efficient infection of *Aedes albopictus* (Schuffenecker *et al.*, 2006; Tsetsarkin *et al.*, 2007; Vazeille *et al.*, 2007)
- Lack of CHIK-specific immunity in human populations

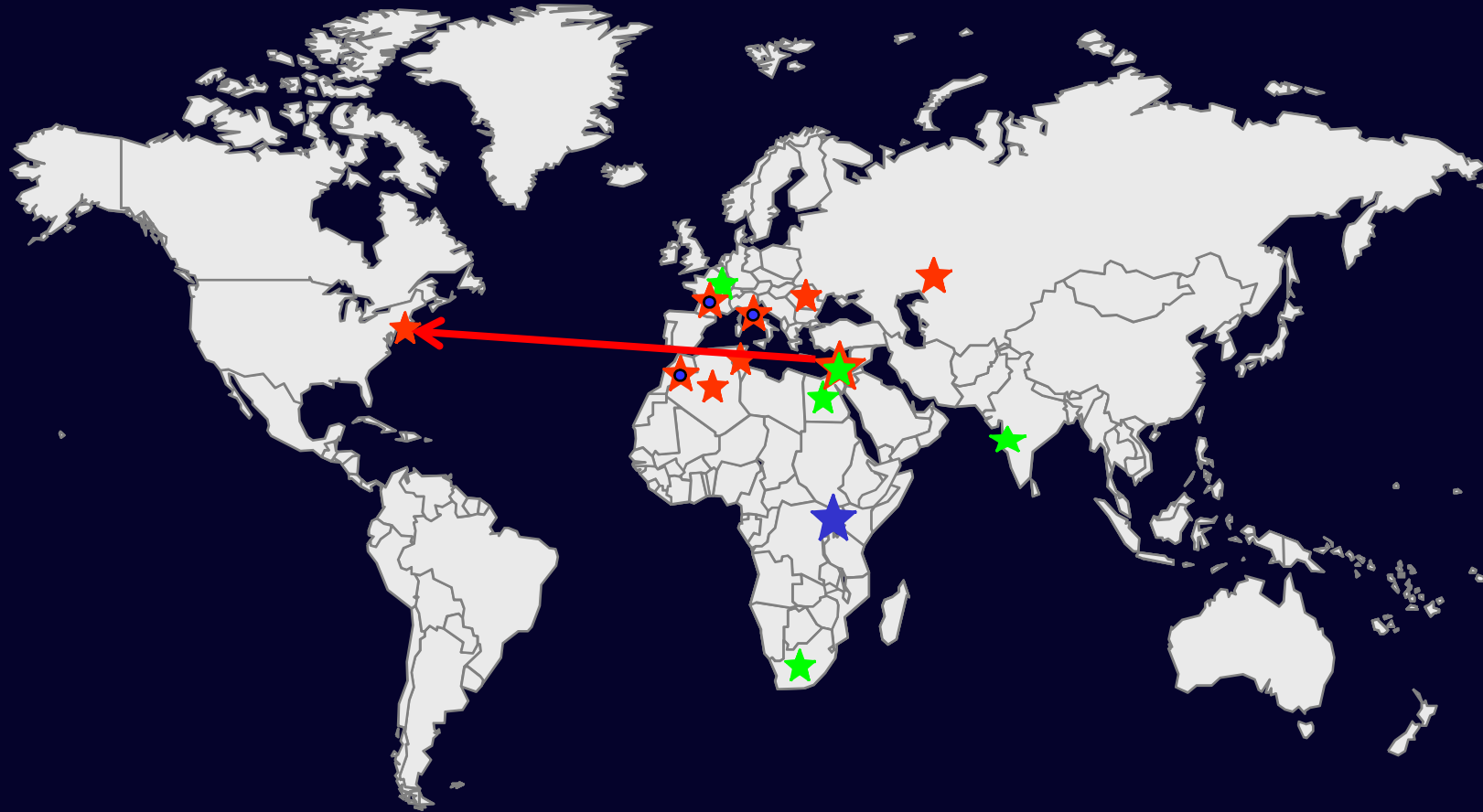
Chikungunya in the Americas



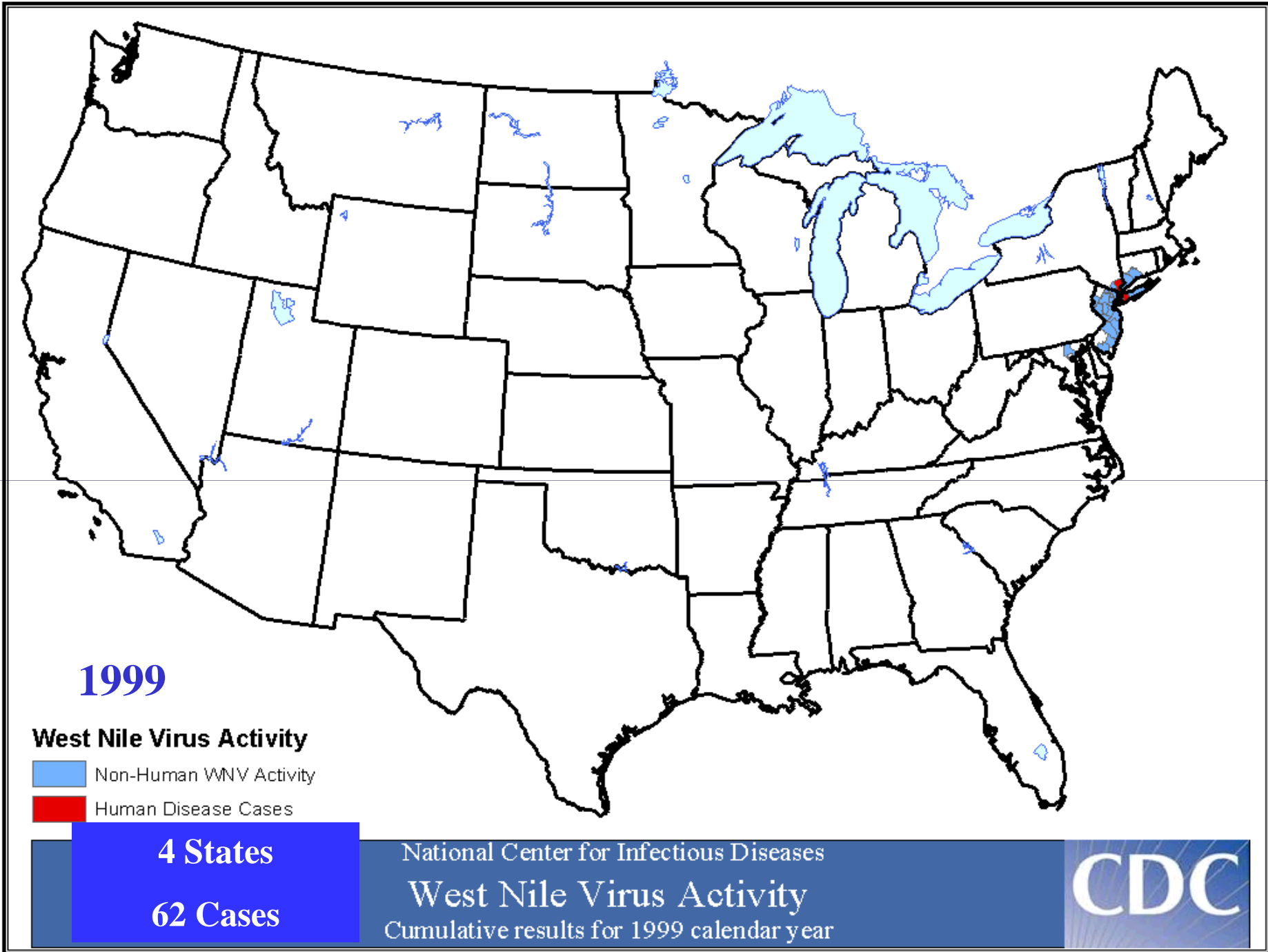
West Nile Virus in the Western Hemisphere

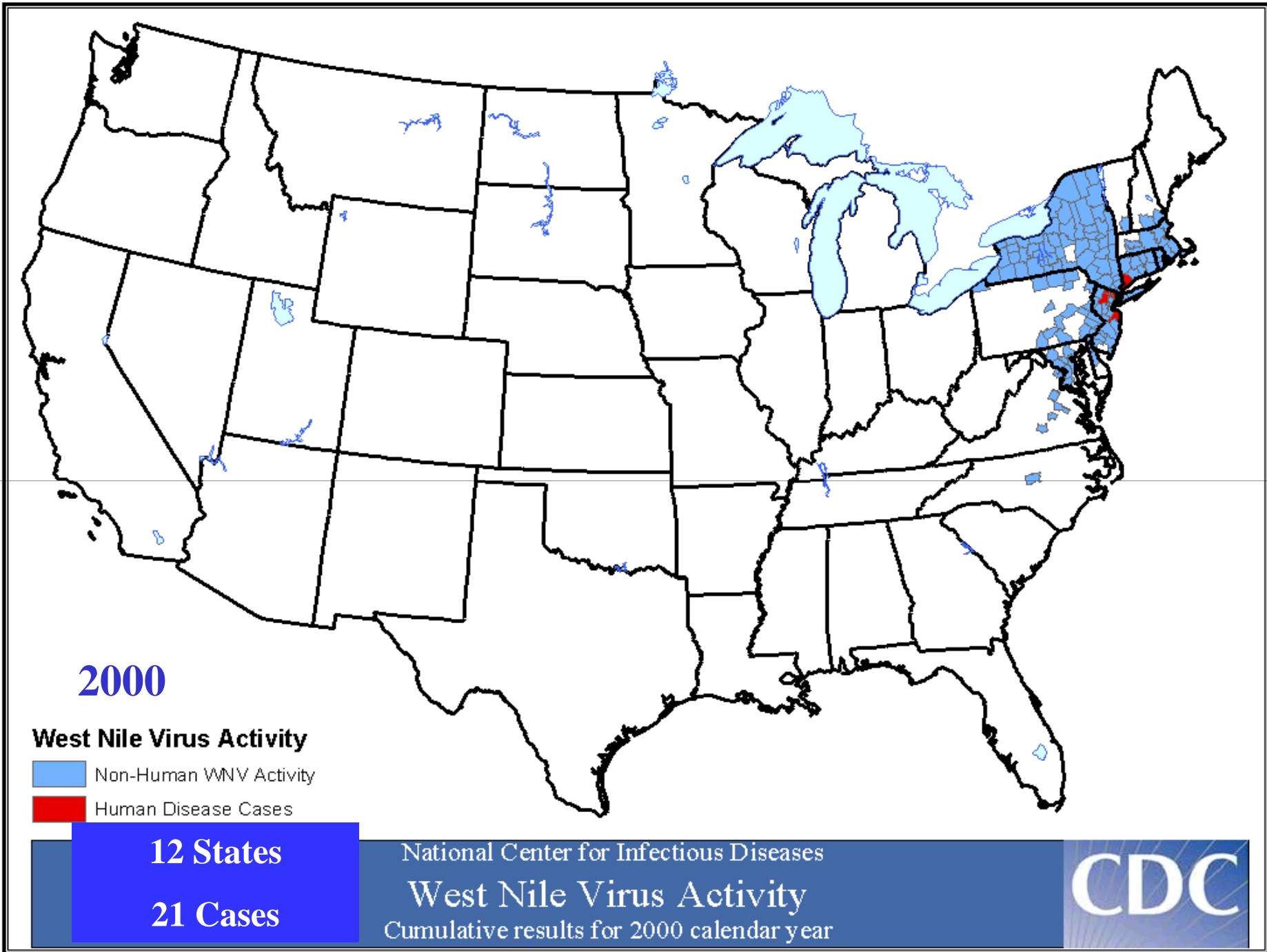


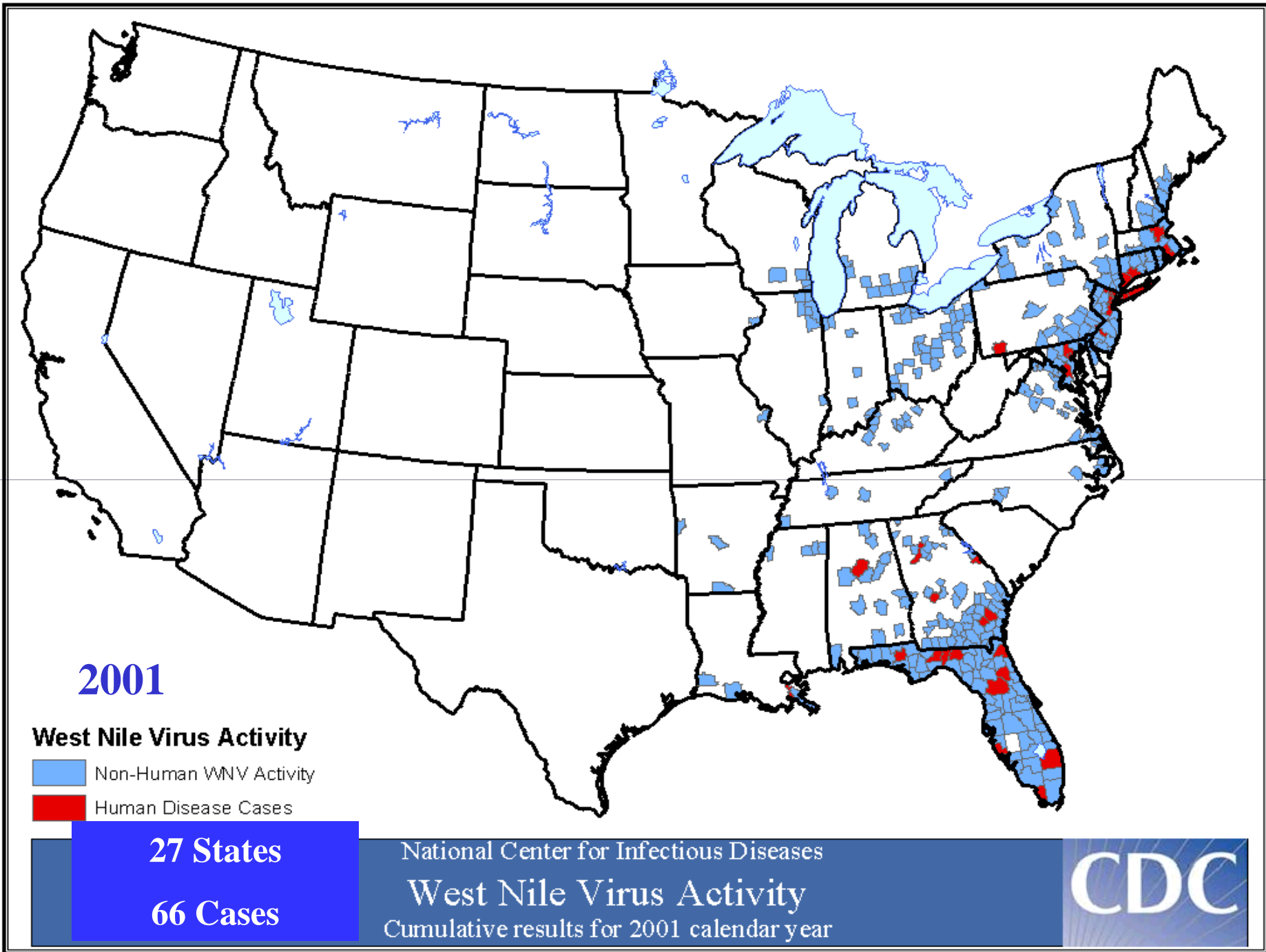
Epidemic/Epizootic West Nile Virus

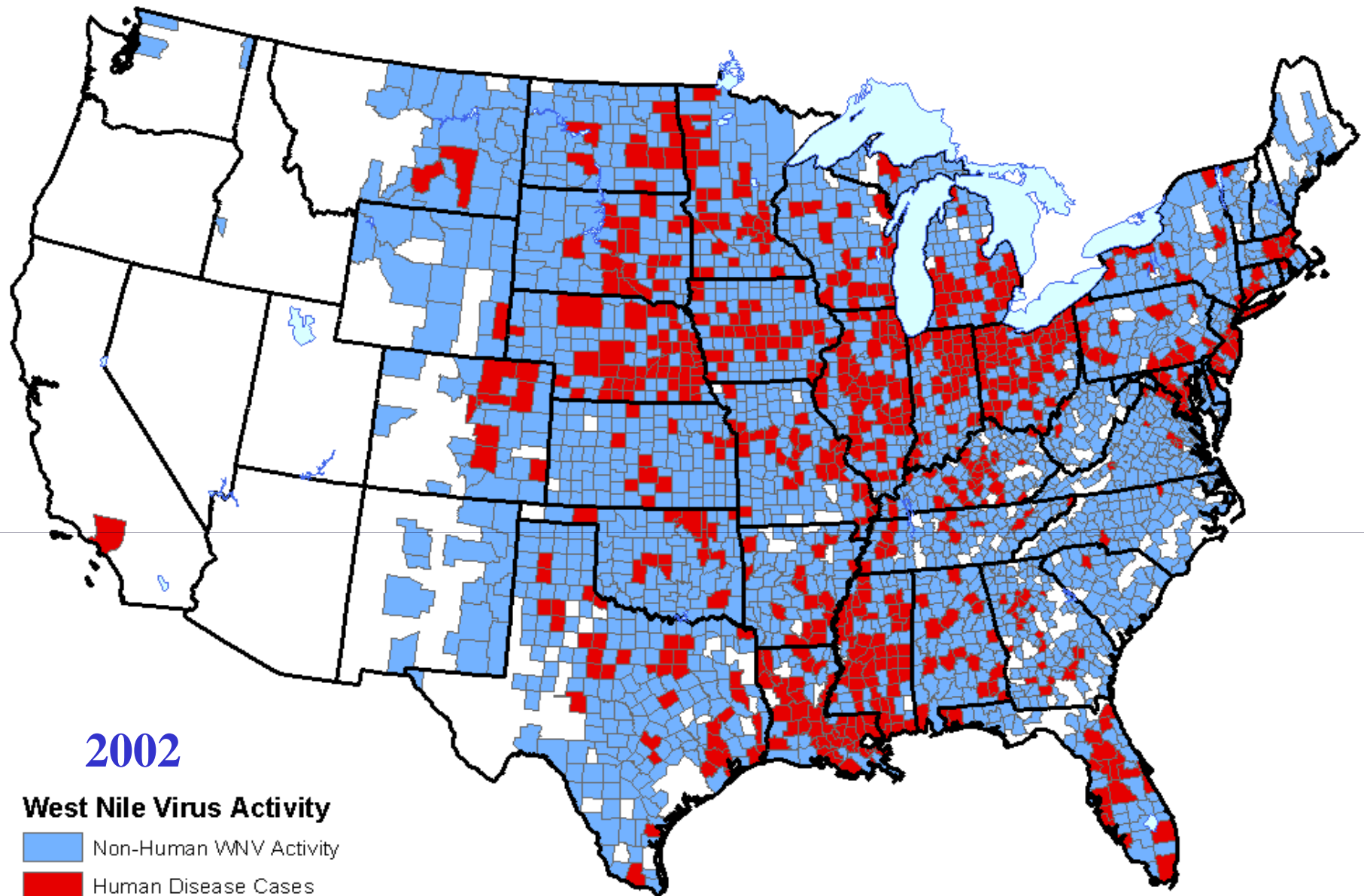


- ★ 1937
- ★ 1950-75
- ★ 1994 - 1999











2002

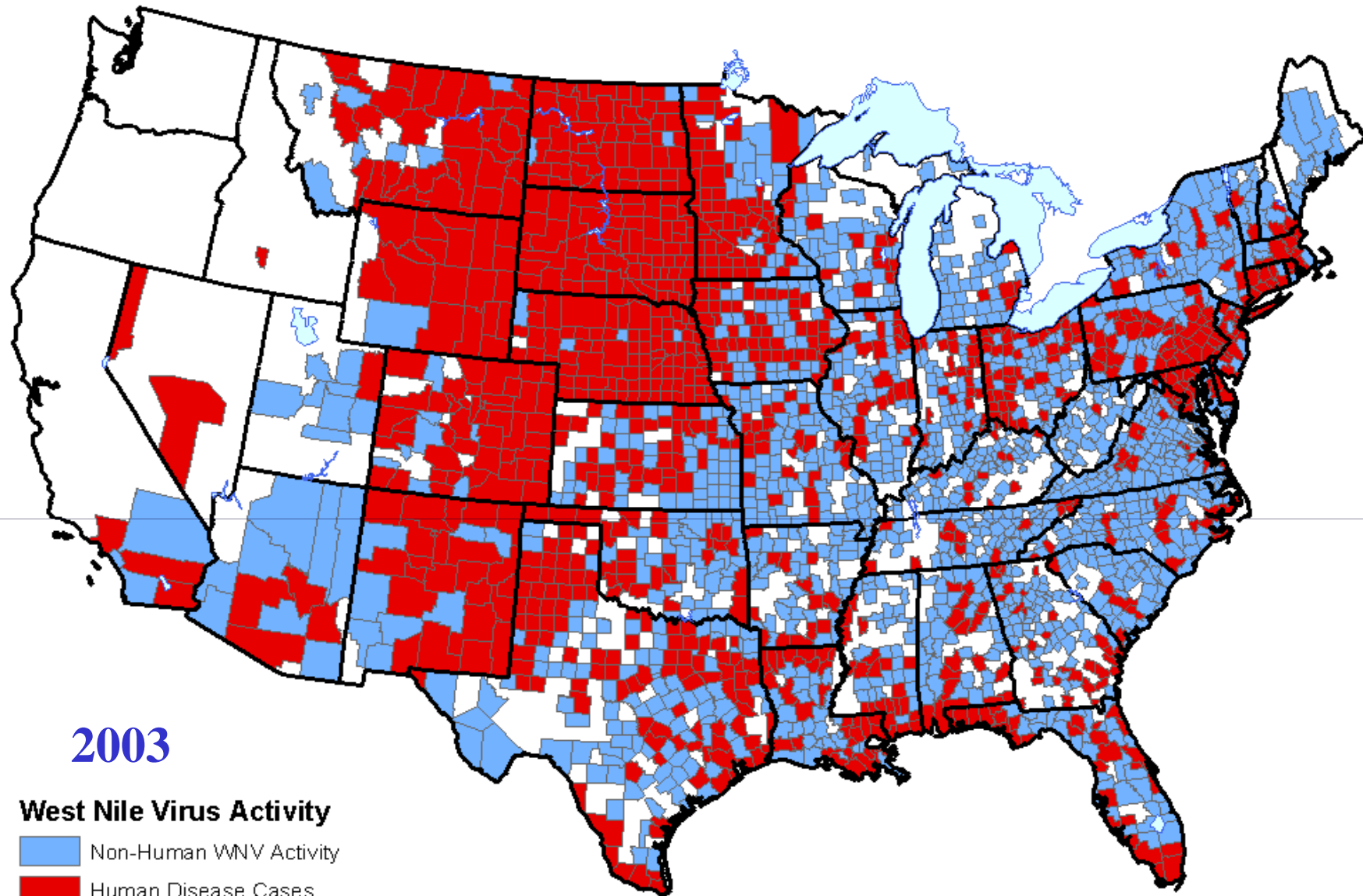
West Nile Virus Activity

-  Non-Human WNV Activity
-  Human Disease Cases

44 States
4156 Cases

National Center for Infectious Diseases
West Nile Virus Activity
results for 2002 calendar year reported as of April 15, 2003





2003

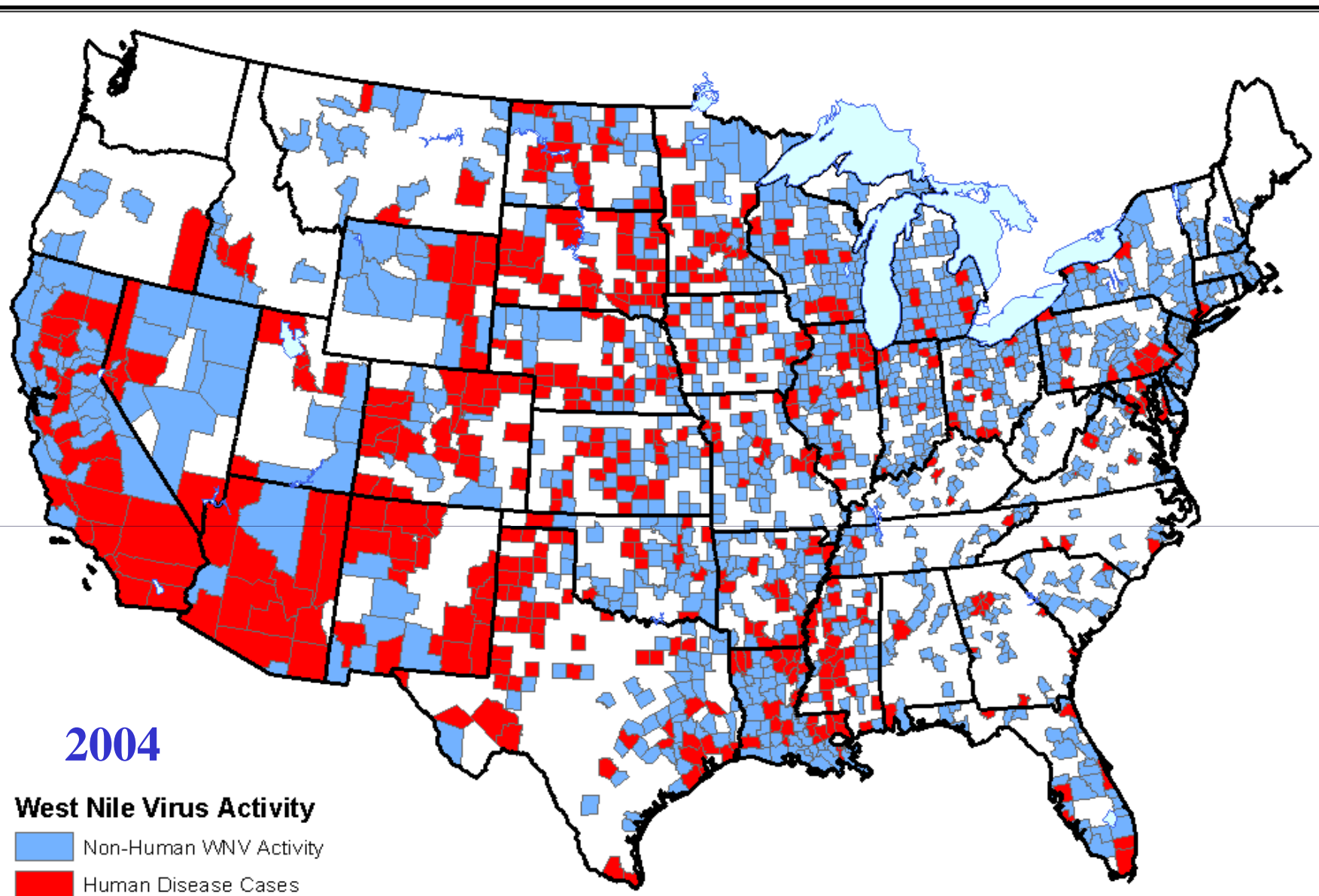
West Nile Virus Activity

- Non-Human WNV Activity
- Human Disease Cases

46 States
9862 Cases



National Center for Infectious Diseases
West Nile Virus Activity
results for 2003 calendar year reported as of May 20, 2004





2004

West Nile Virus Activity

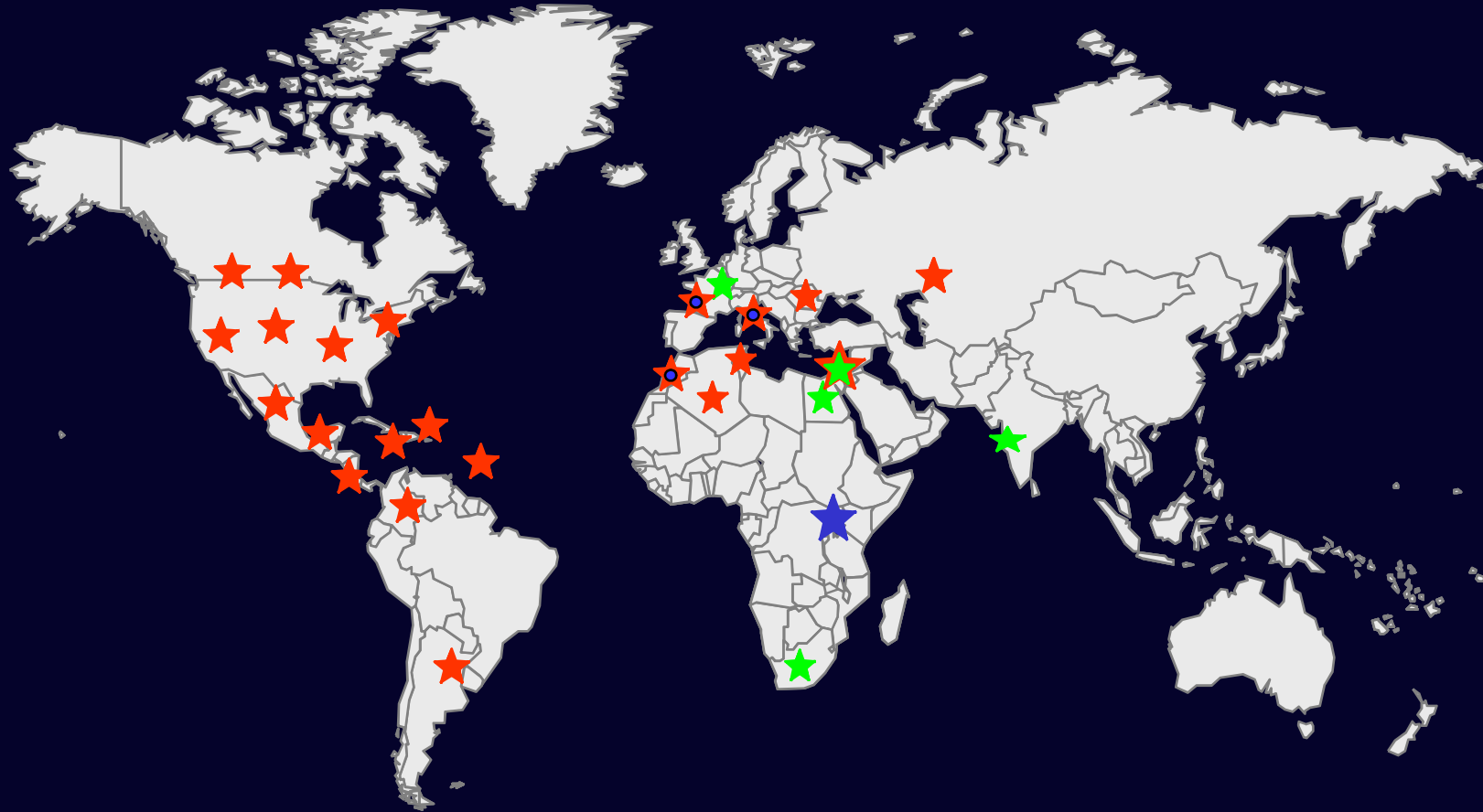
-  Non-Human WNV Activity
-  Human Disease Cases

47 States
2535 Cases

National Center for Infectious Diseases
West Nile Virus Activity
Positive results for 2004 calendar year reported as of January 11, 2005



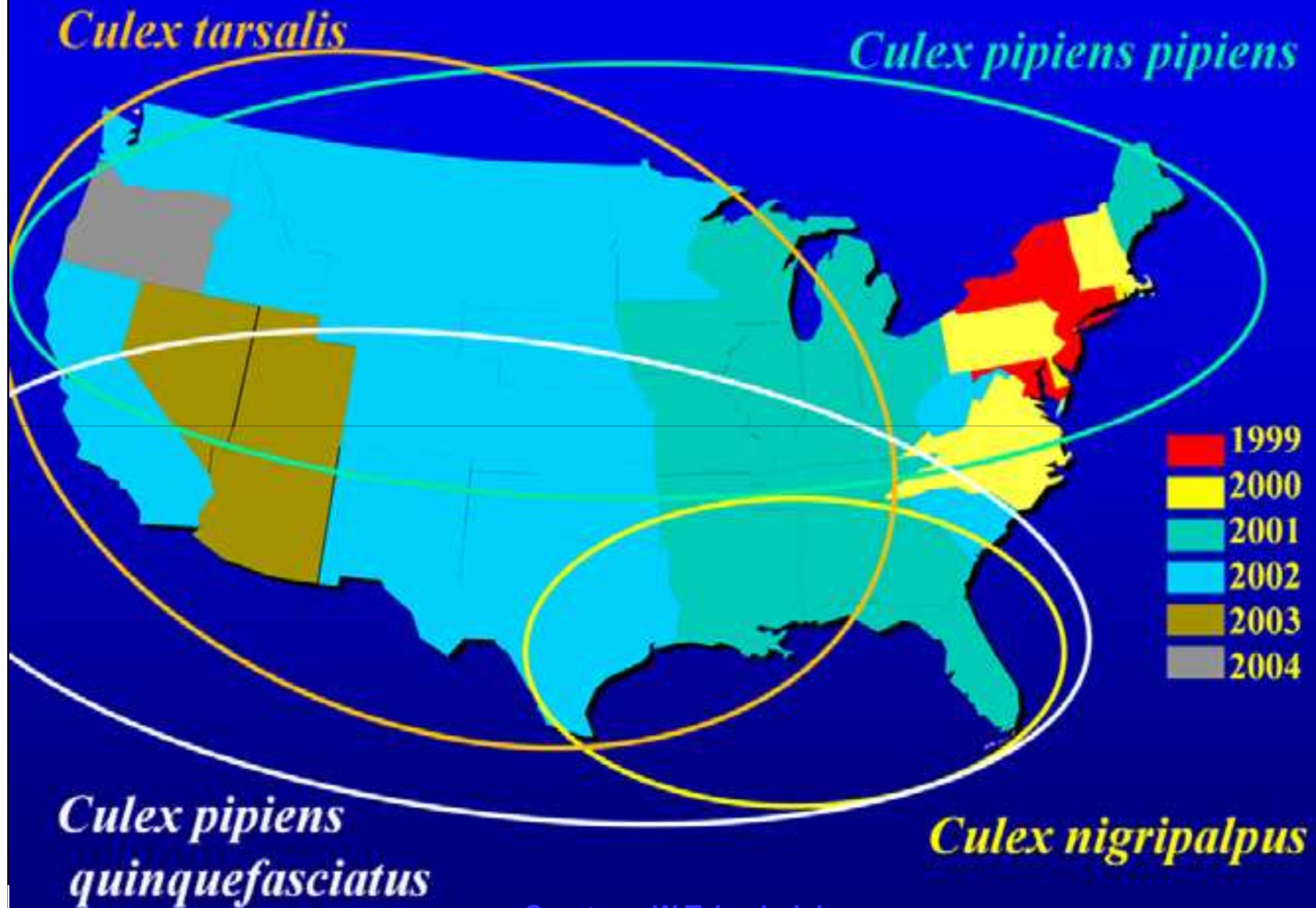
Epidemic/Epizootic West Nile Virus



- ★ 1937
- ★ 1950-93
- ★ 1994 - 2007

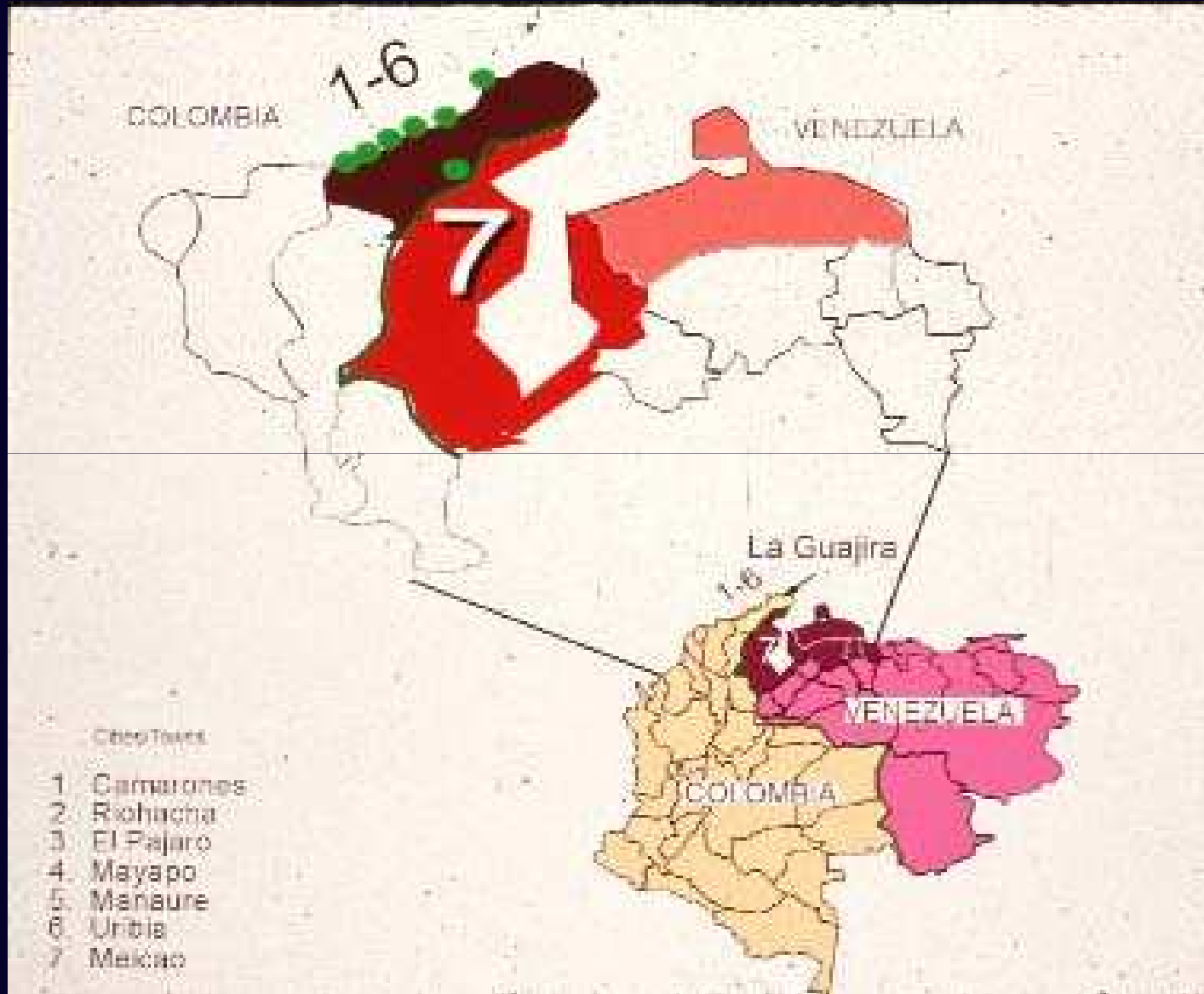
Adapted from Gubler, 2007

West Nile Virus in the US



Courtesy, W Tabachnick

Venezuelan Equine Encephalitis



Rift Valley Fever



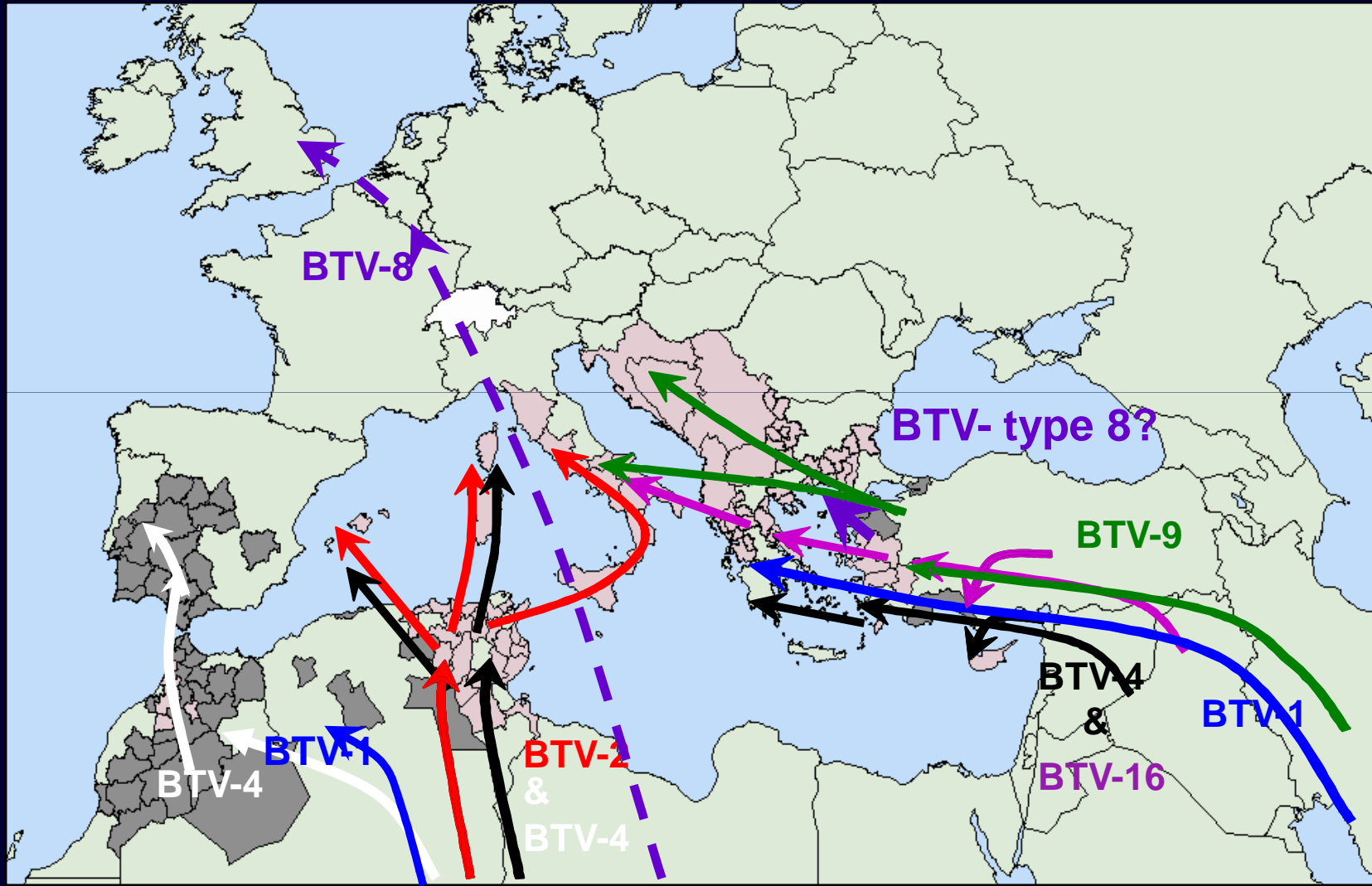
Alkhurma Virus (Kysanur Forest Disease Virus)



Kysanur Forest Disease Virus

- ▶ 2 Fatal cases, hemorrhagic disease
- ▶ Both butchers
- ▶ IgM and IgG antibody in abattoir workers
- ▶ Reservoir hosts?
- ▶ Vectors?

Blue Tongue Virus: 10 introductions of new strains into north Africa & Europe since 1998

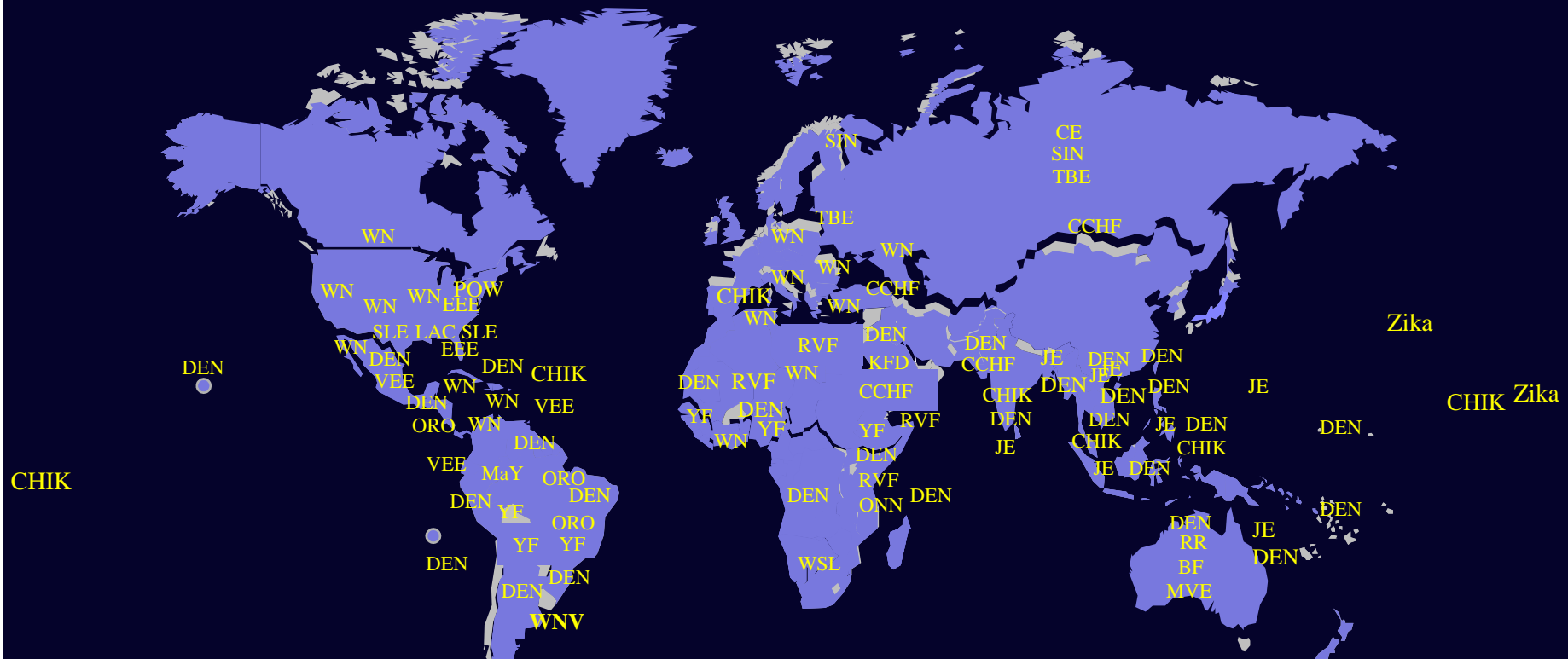


Courtesy, M Nathan

Introductions of BTV into Europe since 1998

Italy
Belgium
The Netherlands,
Germany
France
Luxembourg
Czech Republic
Hungary
Sweden
Switzerland
United Kingdom

Global Resurgence of Epidemic Arboviral Disease



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Why Have we Seen Such a Dramatic Increase in Epidemic Arboviral Diseases?

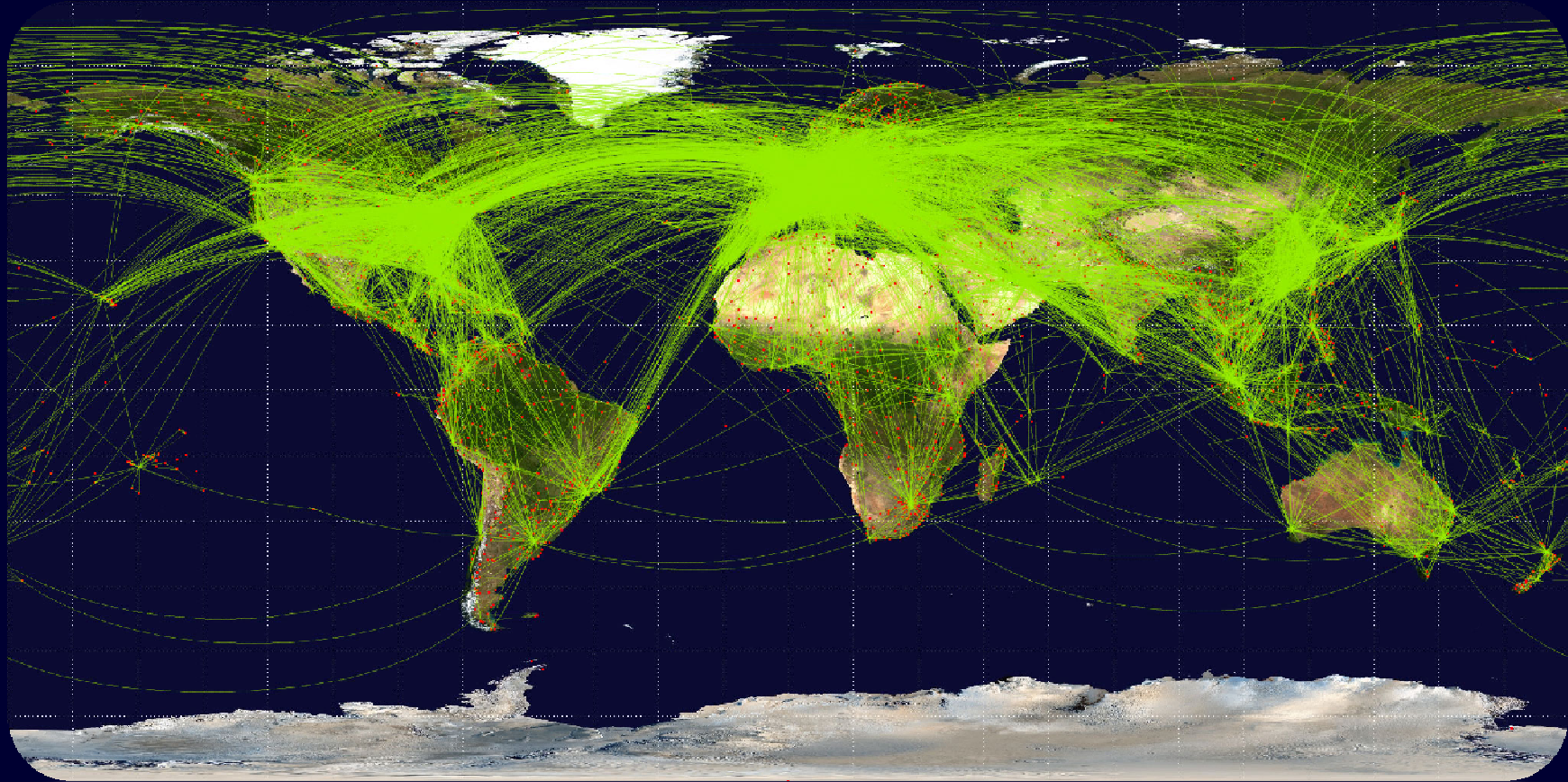
- **Complacency, Lack of Political Will**
- **Policy Changes**
- **Changes in Public Health**
- **Changing Life Styles/Behavior**
- **Microbial Adaptation**
- **Technology**
- **Intent to Harm**
- **Climate Change?**

Why Have we Seen Such a Dramatic Increase in Epidemic Arboviral Diseases?

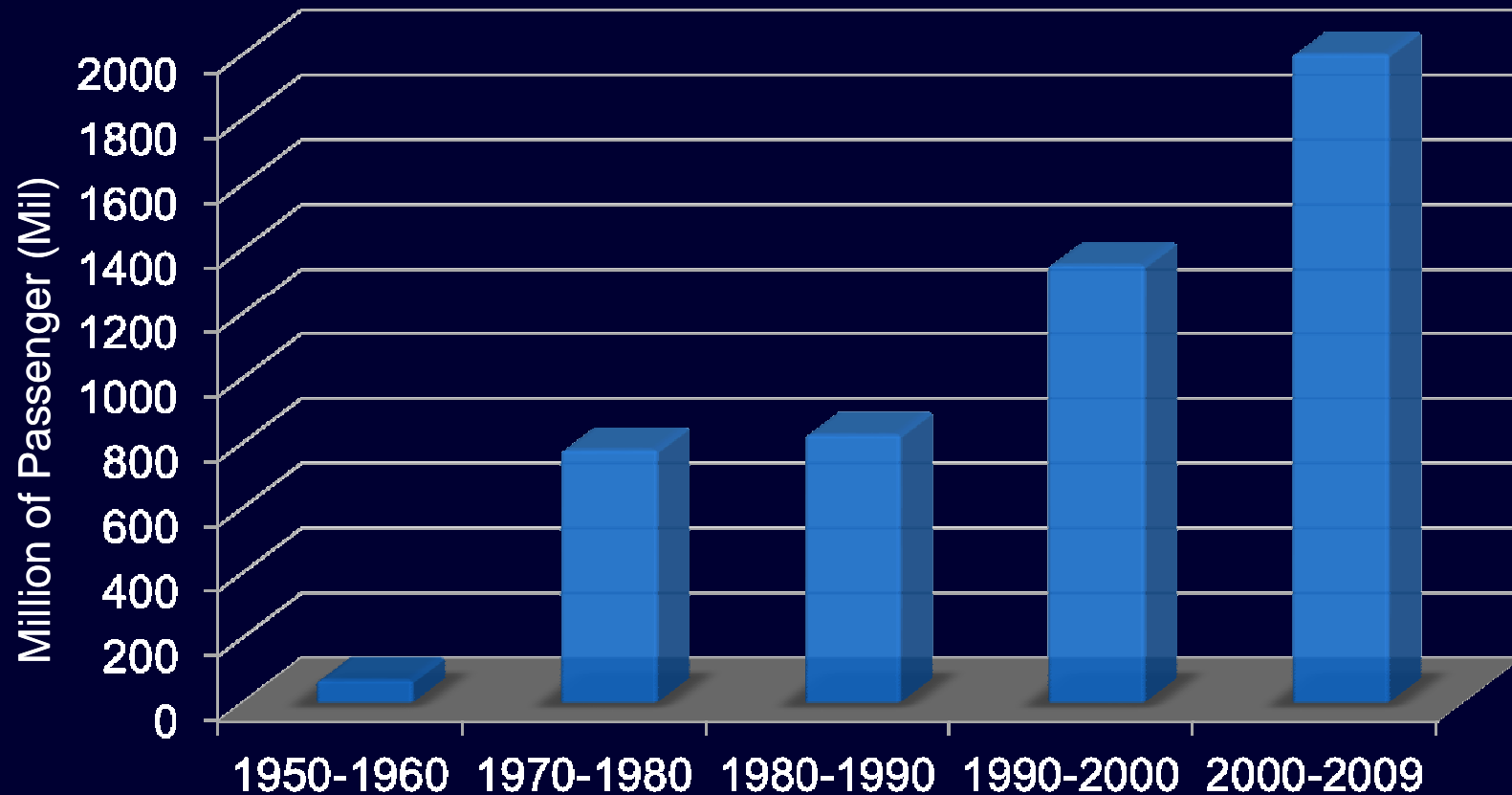
Major Drivers

- Demographic Changes (Pop Growth)
 - Environmental Change
 - Uncontrolled Urbanization
 - Agricultural/Land Use Practices
 - Deforestation
 - Animal Husbandry
- Modern Transportation (Globalization)
 - Increased Movement of People, Animals, Commodities and pathogens
- Lack of Public Health Infrastructure

The global air network



Average annual number of global airline passengers by decade, 1950-2010



IATA 2010



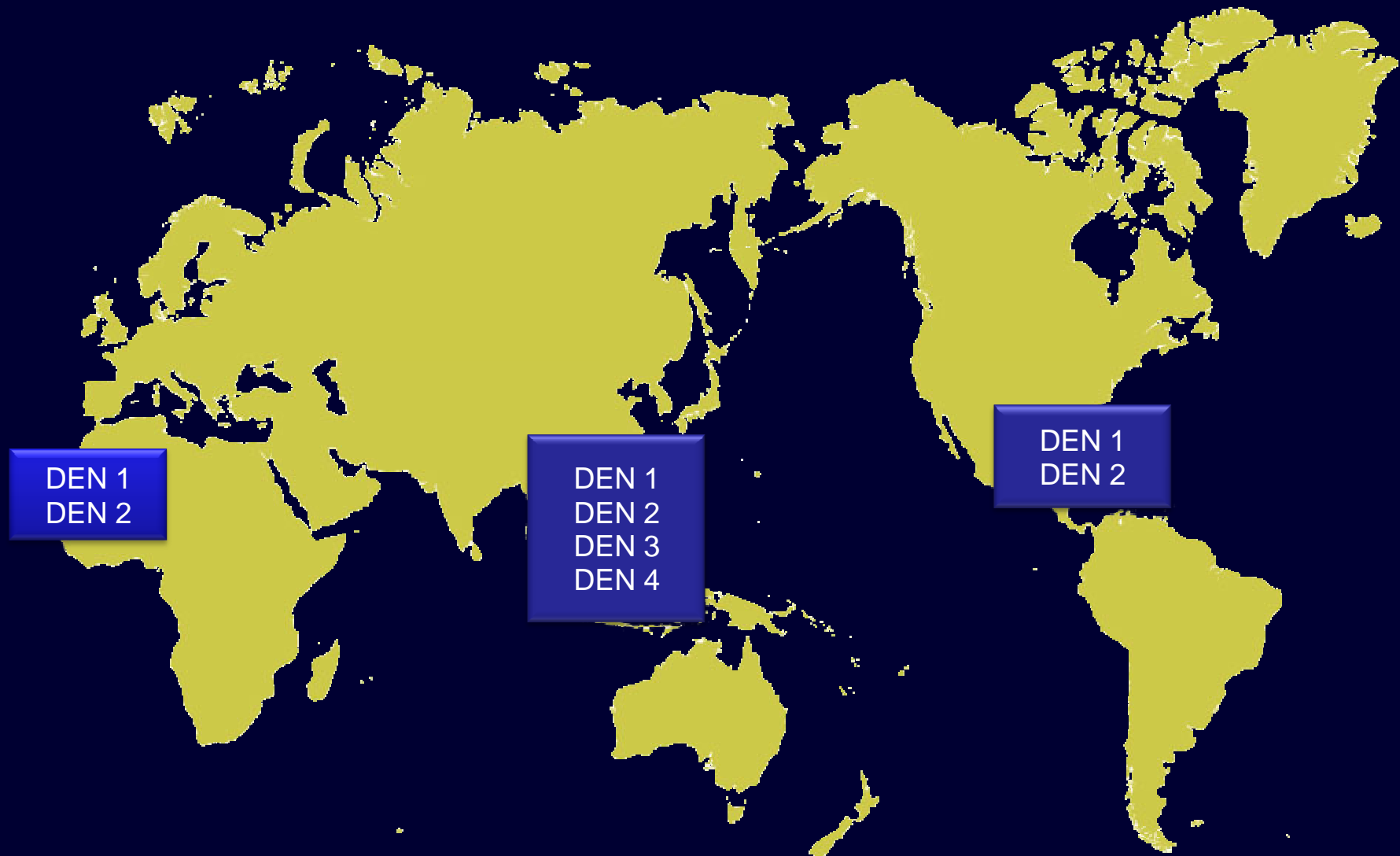
Decade



Commercial Air Traffic Over a 24 Hour Period

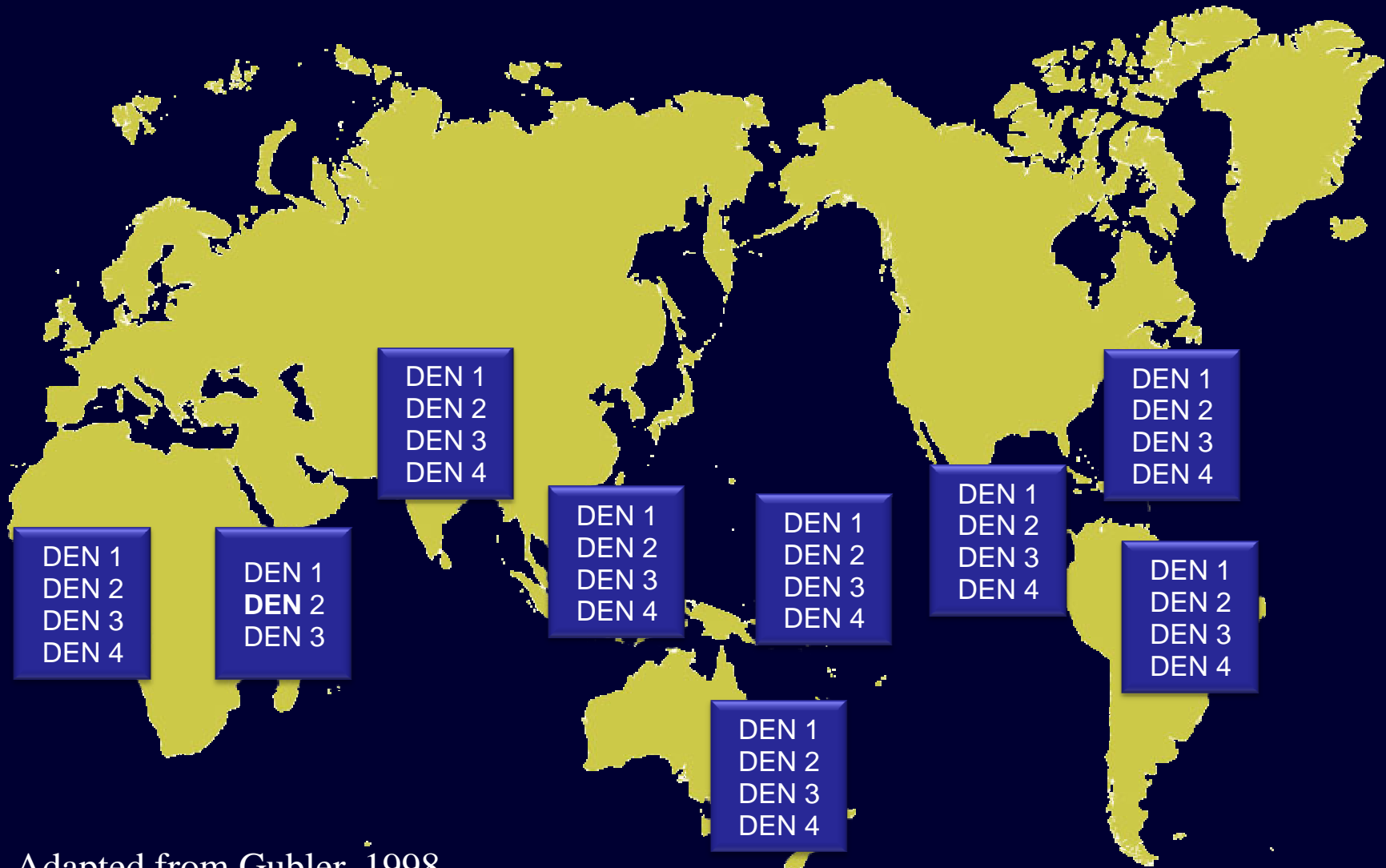


Global distribution of dengue virus serotypes, 1970



Gubler, 1998

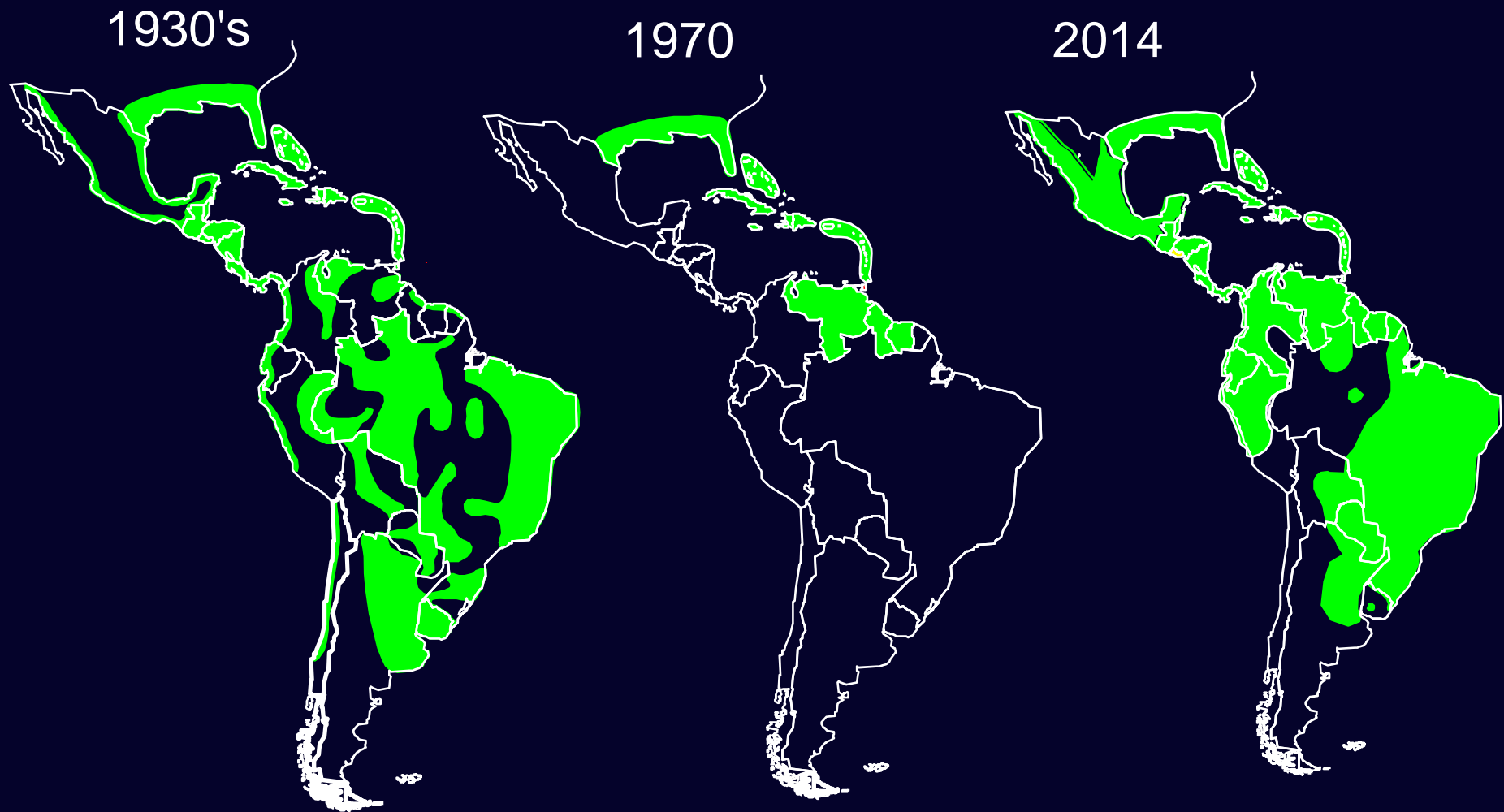
Global distribution of dengue virus serotypes, 2014



Adapted from Gubler, 1998



Aedes aegypti Distribution in the Americas

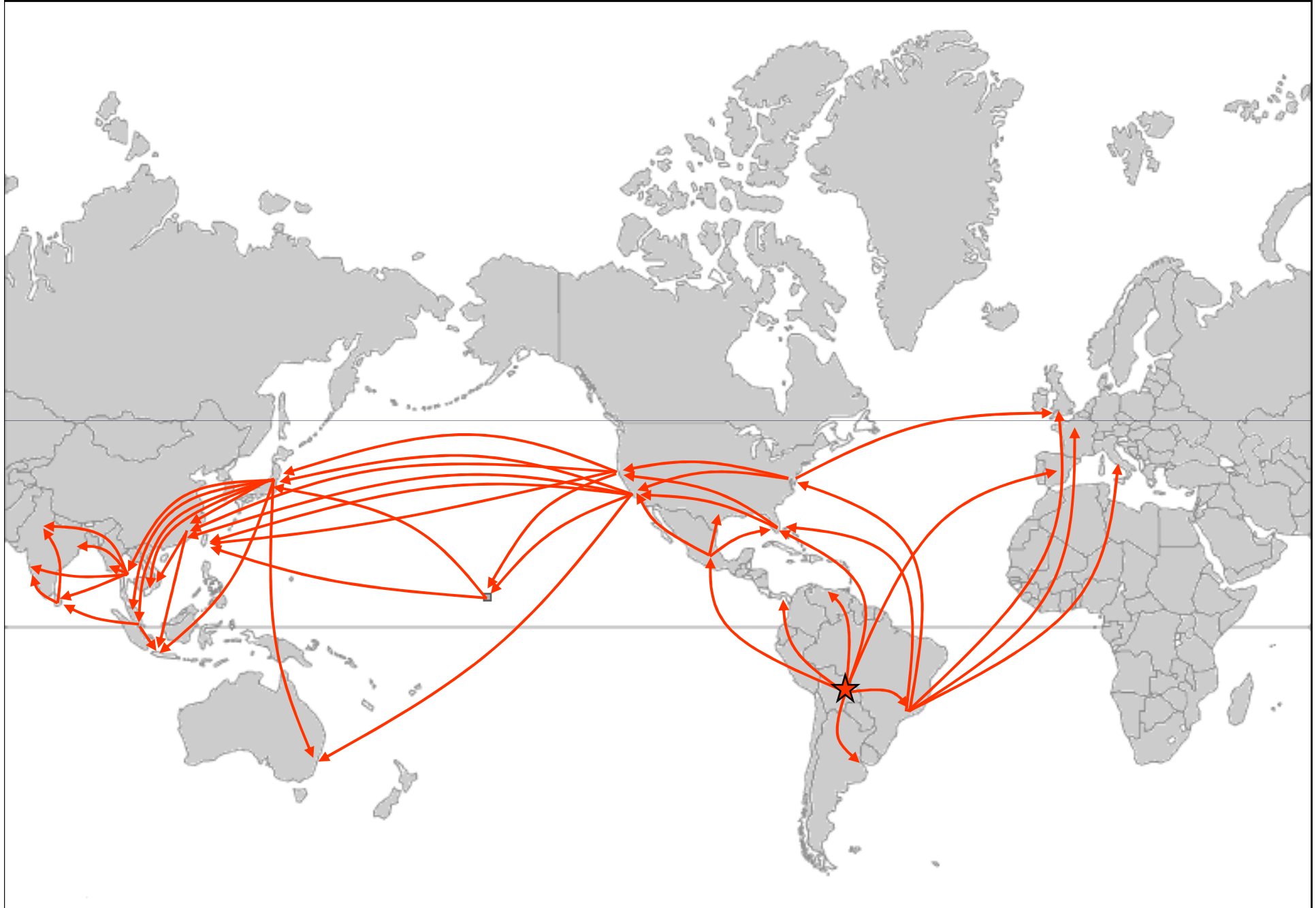


Adapted from Gubler, 1998

Potential for Urban Yellow Fever Epidemics in the Americas



POTENTIAL GLOBAL SPREAD OF URBAN YELLOW FEVER



Global Threat of Epidemic Infectious Diseases

- Disease and Trade-interwoven History
 - 14th century, Europe discovers exotic goods from Asia
- Global Trade Flourishes
 - 18th, 19, 20th centuries
- New Millennium
 - Integrated global economic system with a transnational flow of knowledge, capital, products, people, animals, and pathogens
 - Rapid spread of epidemic infectious disease from point of origin

The Global Threat of Arboviral Diseases

Global Trends, 2012-2025

- **Most of global economic growth in Asian countries**
 - Increased trade
 - Increased movement of people, animals and commodities from Asia to rest of world
- **Most of global population growth in cities of Asia**
 - Rural to urban circular migration
- **Globalization**
- **Increased movement of pathogens**
- **Threat to public health and economic security**