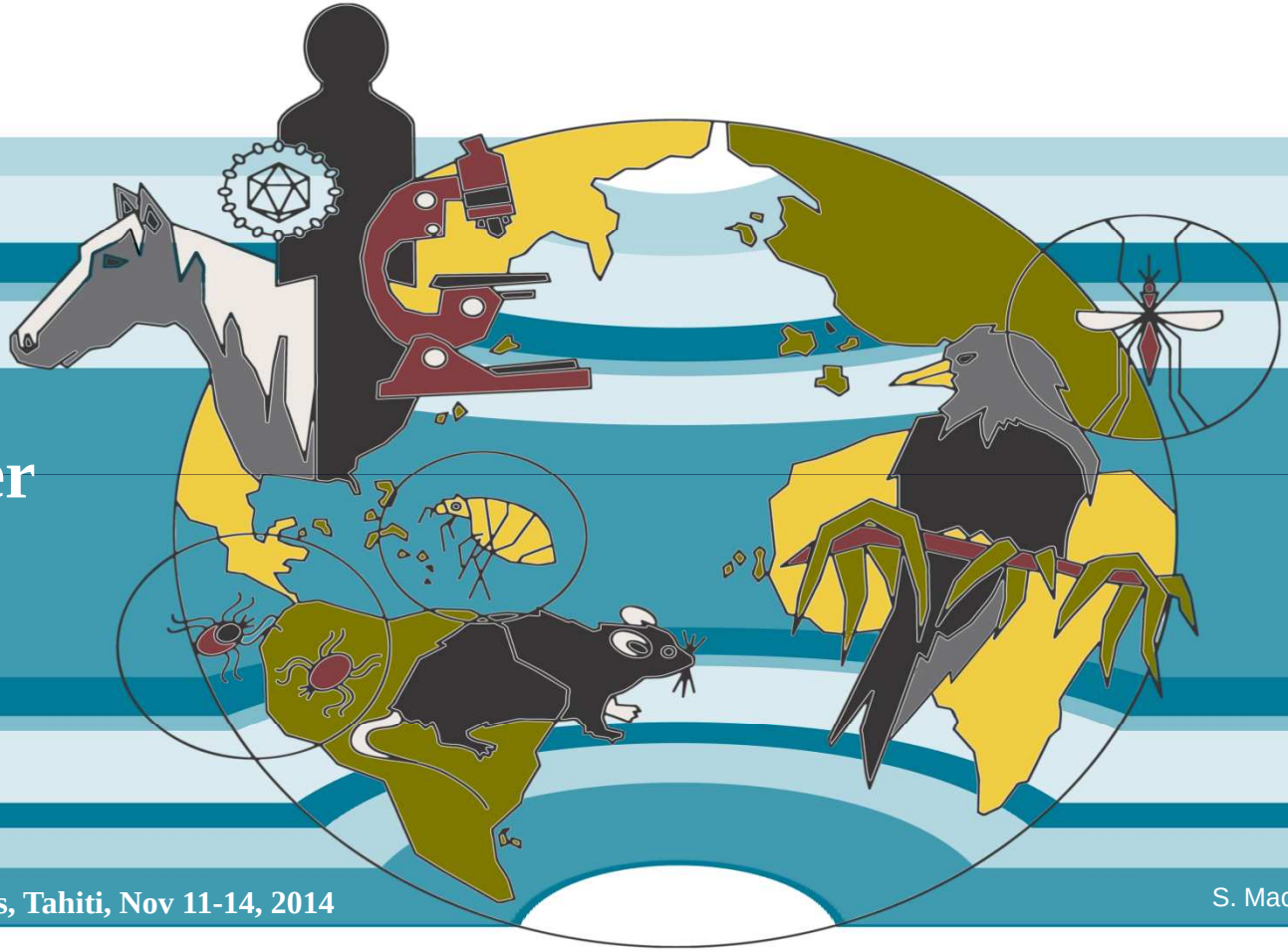
The Global Threat of Epidemic Emergent-Re-Emergent Arboviral Diseases

Duane J Gubler
Professor



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

S. Machado

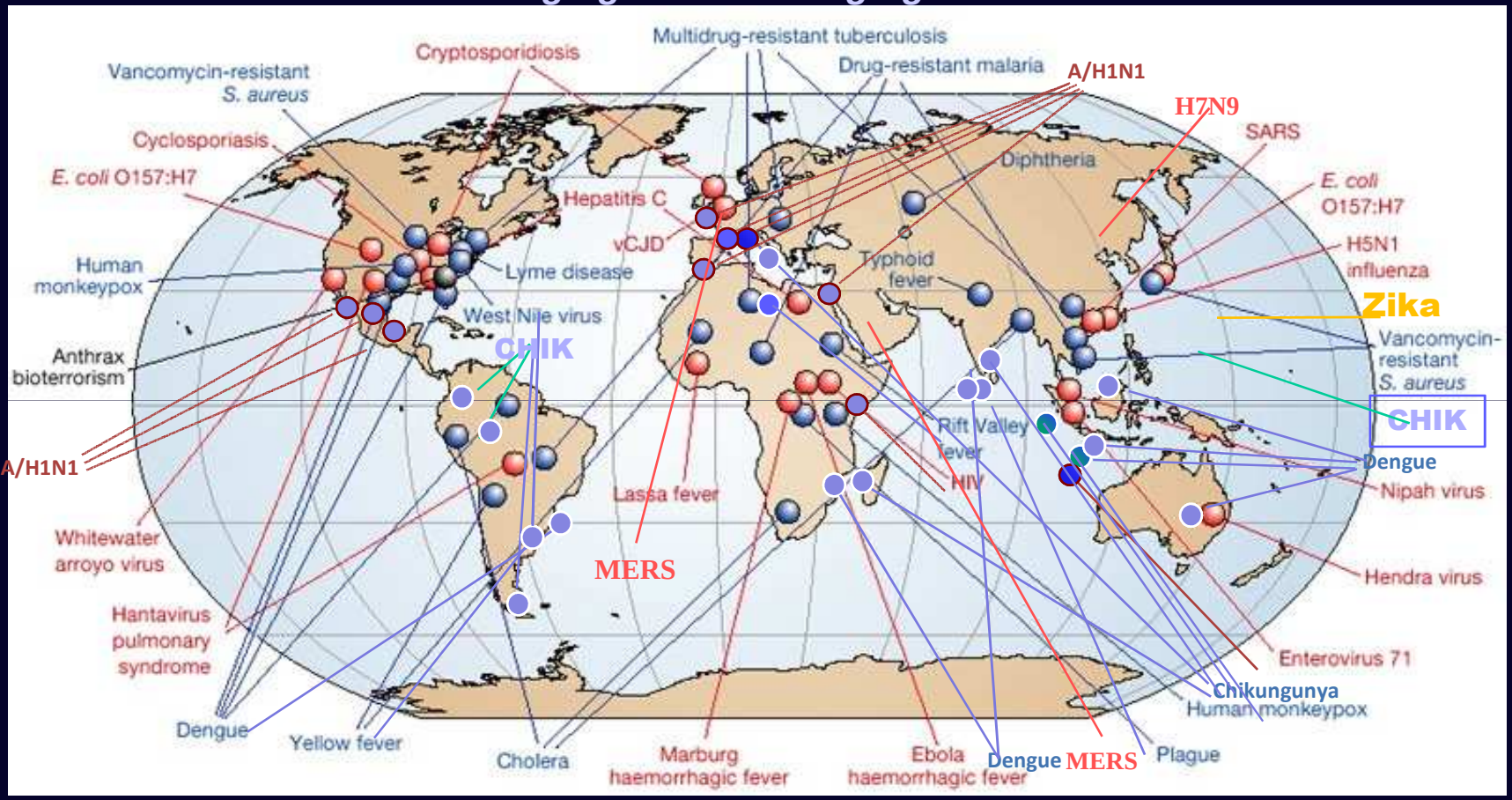
Signature Research Program in Emerging Infectious Diseases
Duke-NUS Graduate Medical School, Singapore

Control Dengue PDC Partnership

DUKE NUS GRADUATE MEDICAL SCHOOL SINGAPORE

The Global Threat of Infectious Diseases

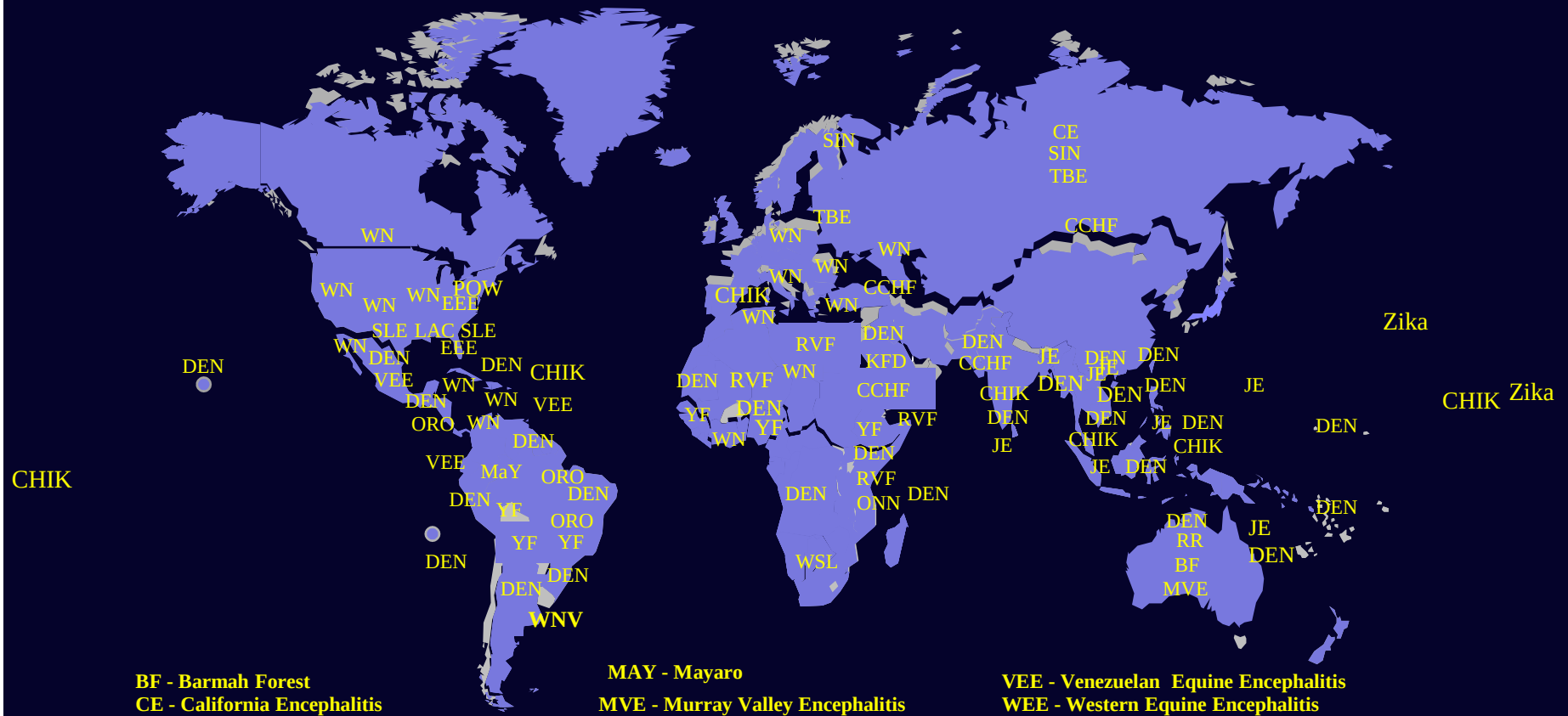
Emerging and re-emerging diseases



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

- Emerging diseases
- Re-emerging diseases

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

Control Dengue PDC Partnership

DUKE NUS GRADUATE MEDICAL SCHOOL SINGAPORE

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 Polyarthritis
- Barmah Forest
- Oropouche
- California Encephalitis
- Crimean-Congo Hemorrhagic Fever
- Zika
- Severe Febrile Thrombocytopenia Syndrome

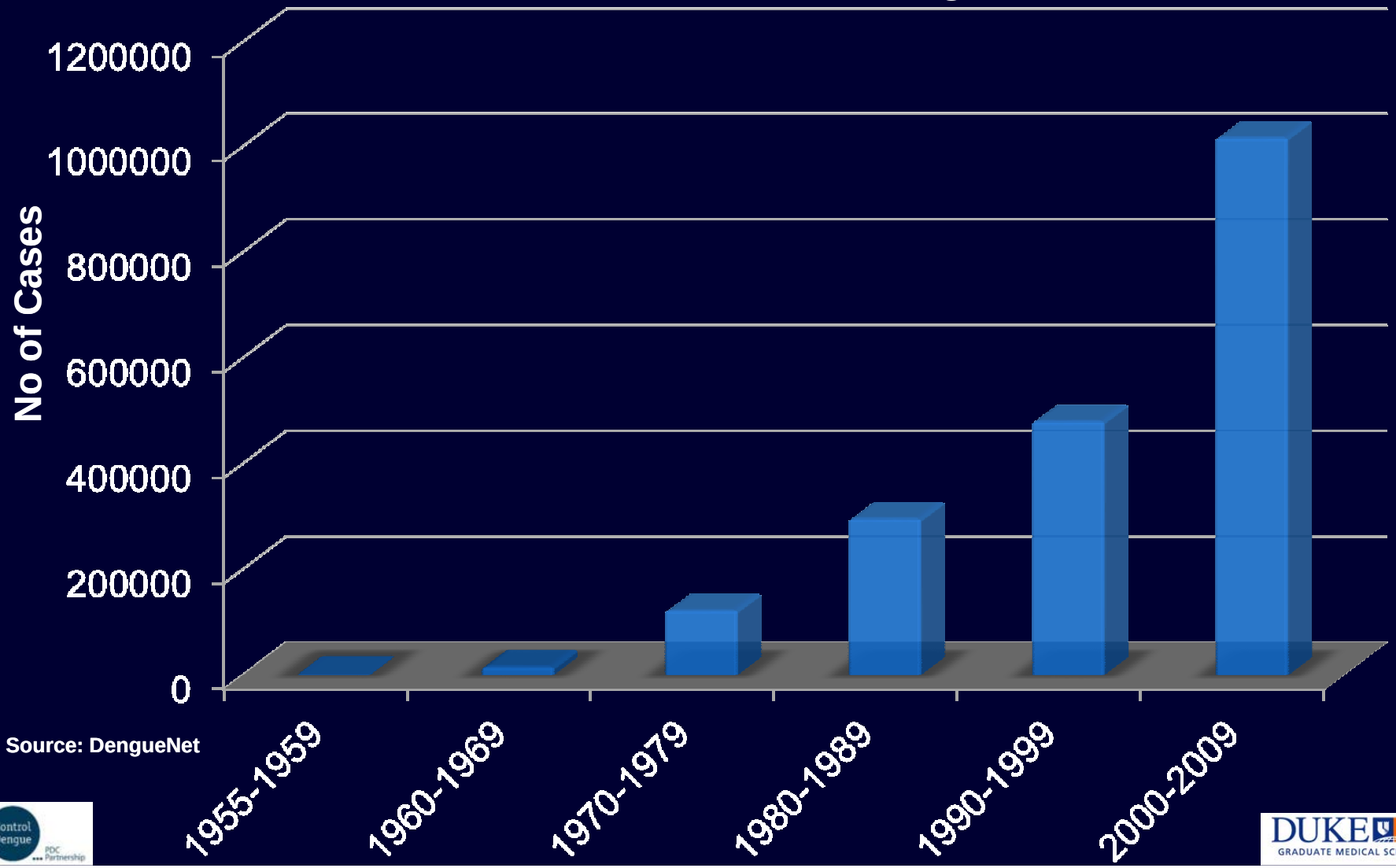
The changing epidemiology of dengue

Expanding geographic distribution

Increased epidemic activity

Hyperendemicity

Emergence of DHF

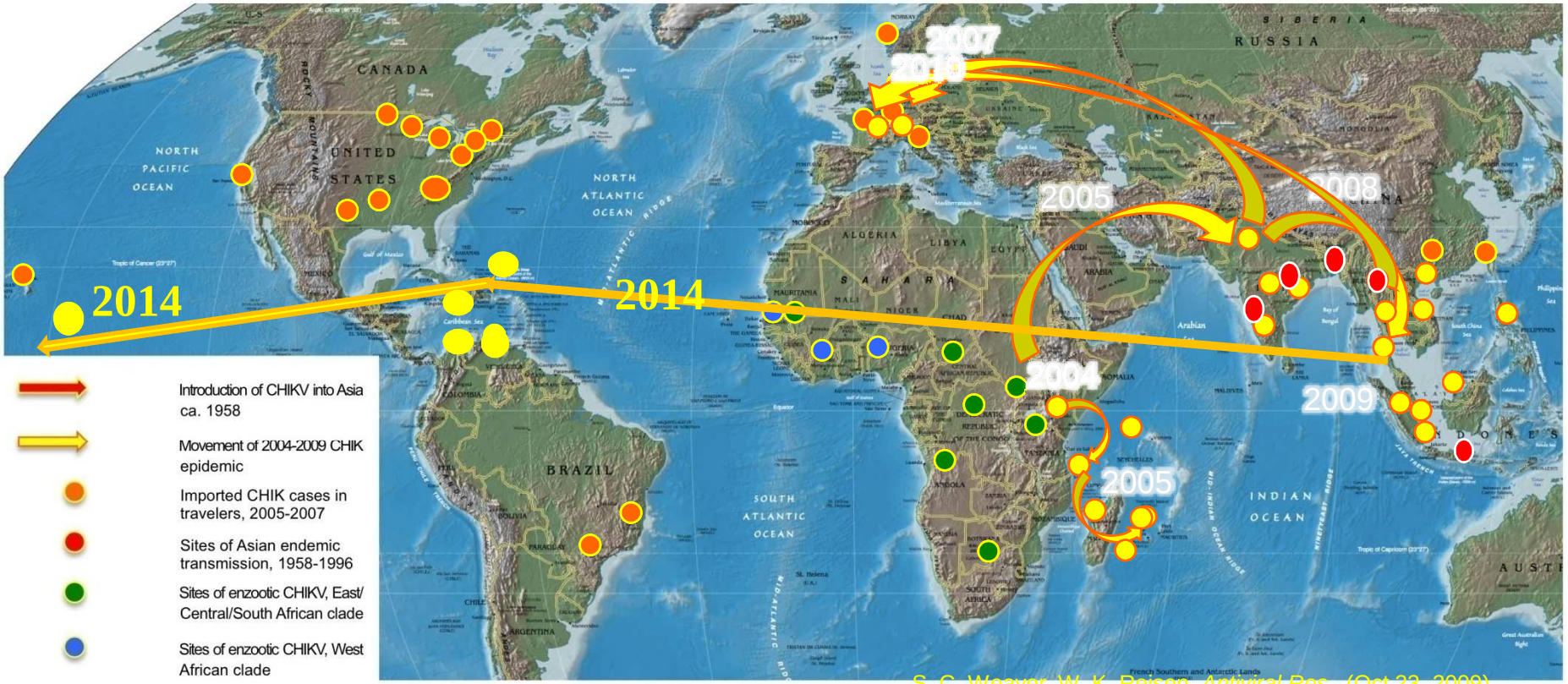


Source: DengueNet

Control Dengue PDC Partnership

DUKE NUS GRADUATE MEDICAL SCHOOL SINGAPORE

Chikungunya Spread: 2005 - 2014



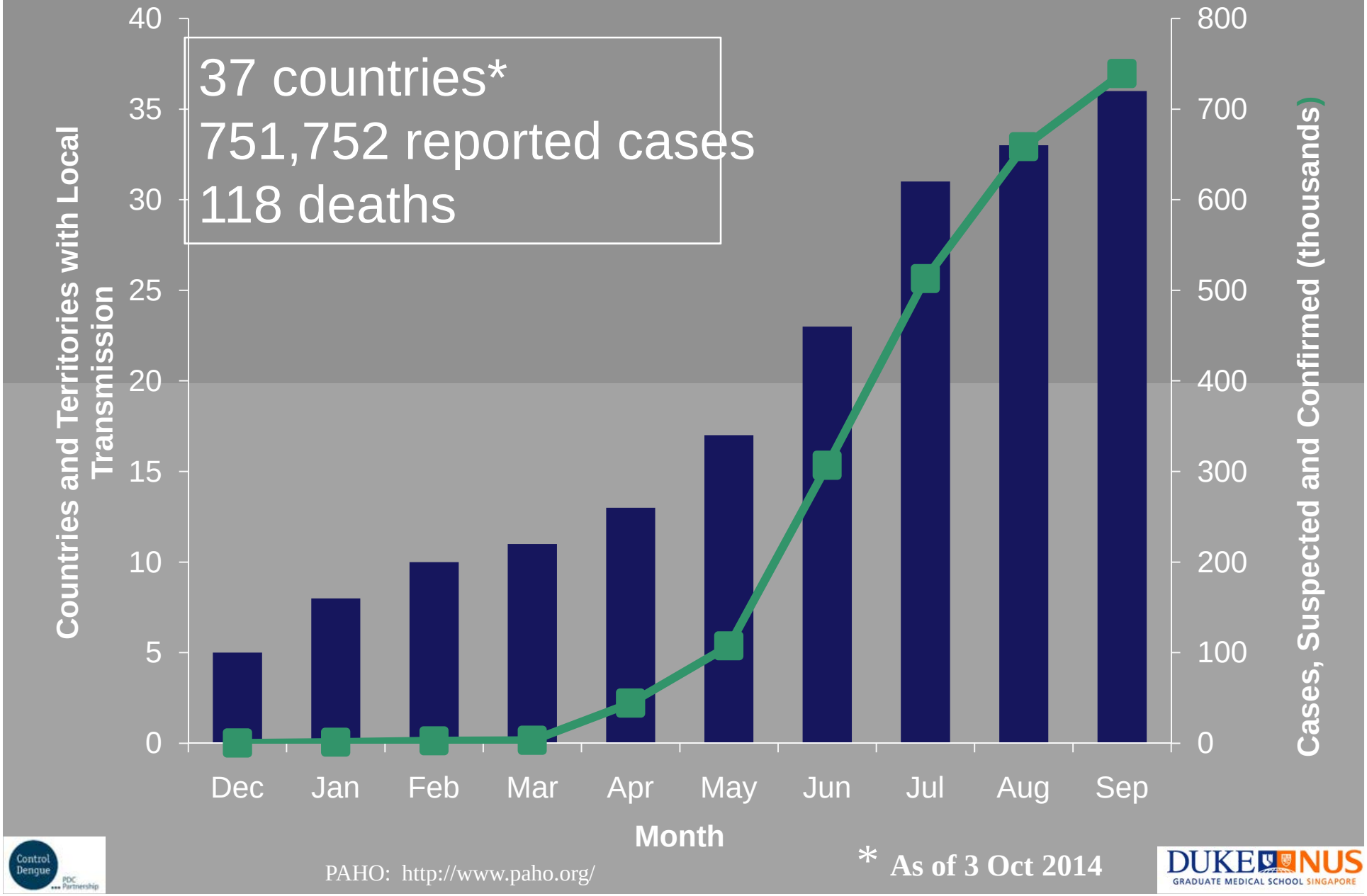
S. C. Weaver, W. K. Reisen, *Antiviral Res*, (Oct 23, 2009).

- 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

Control Dengue PDC Partnership

DUKE NUS GRADUATE MEDICAL SCHOOL SINGAPORE

Chikungunya in the Americas

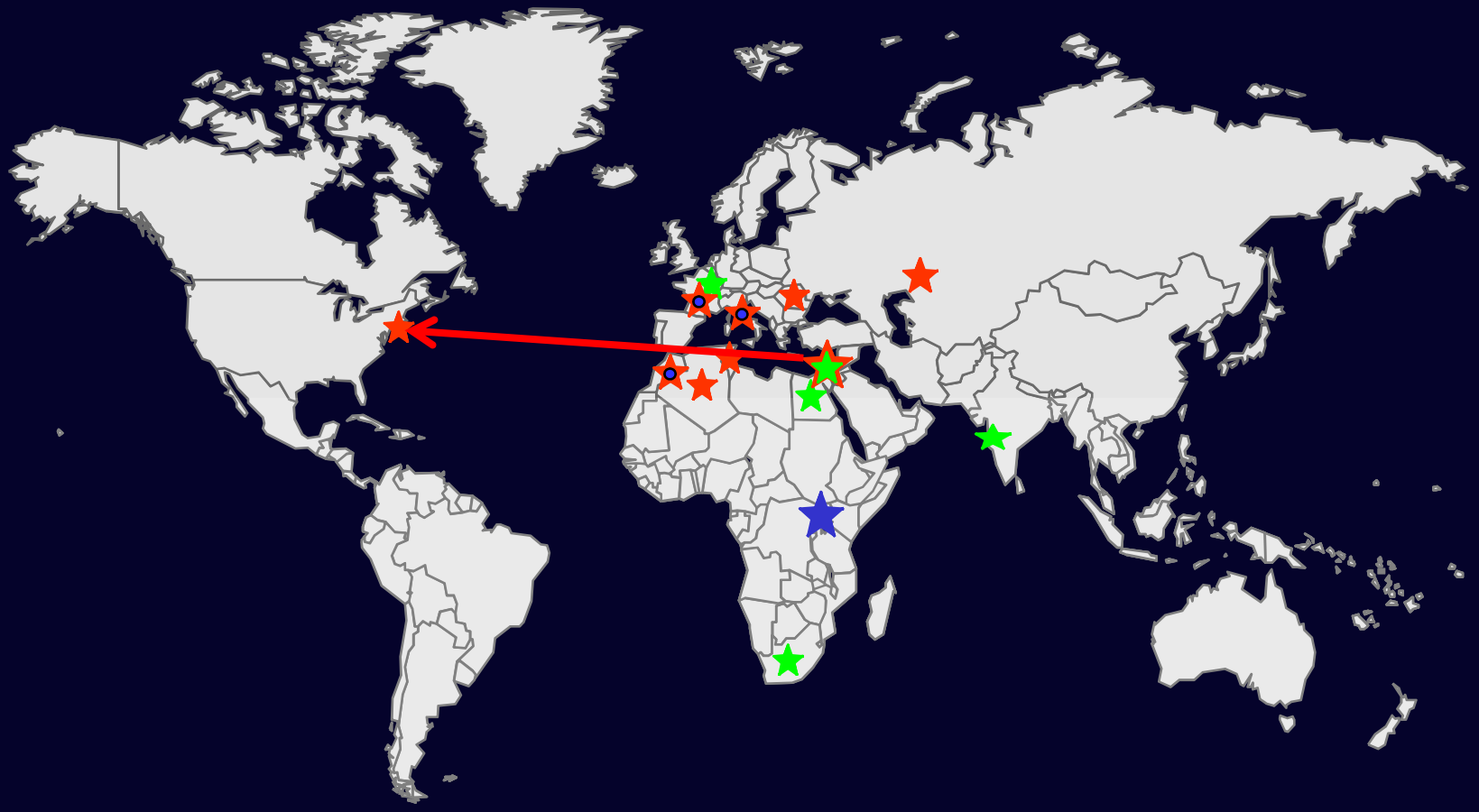


PAHO: http://www.paho.org/

* As of 3 Oct 2014

West Nile Virus in the Western Hemisphere

Epidemic/Epizootic West Nile Virus



1937

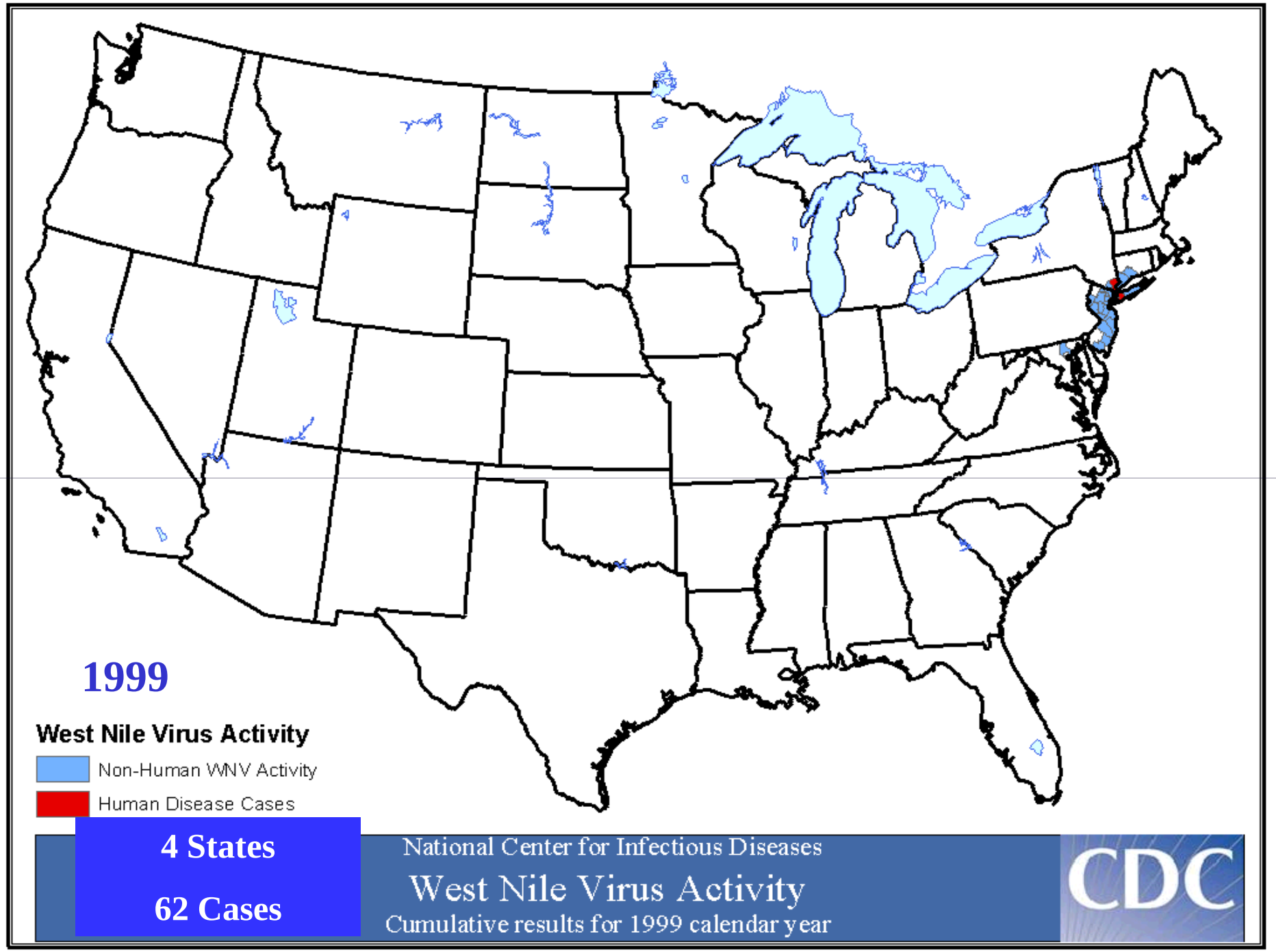
1950-75

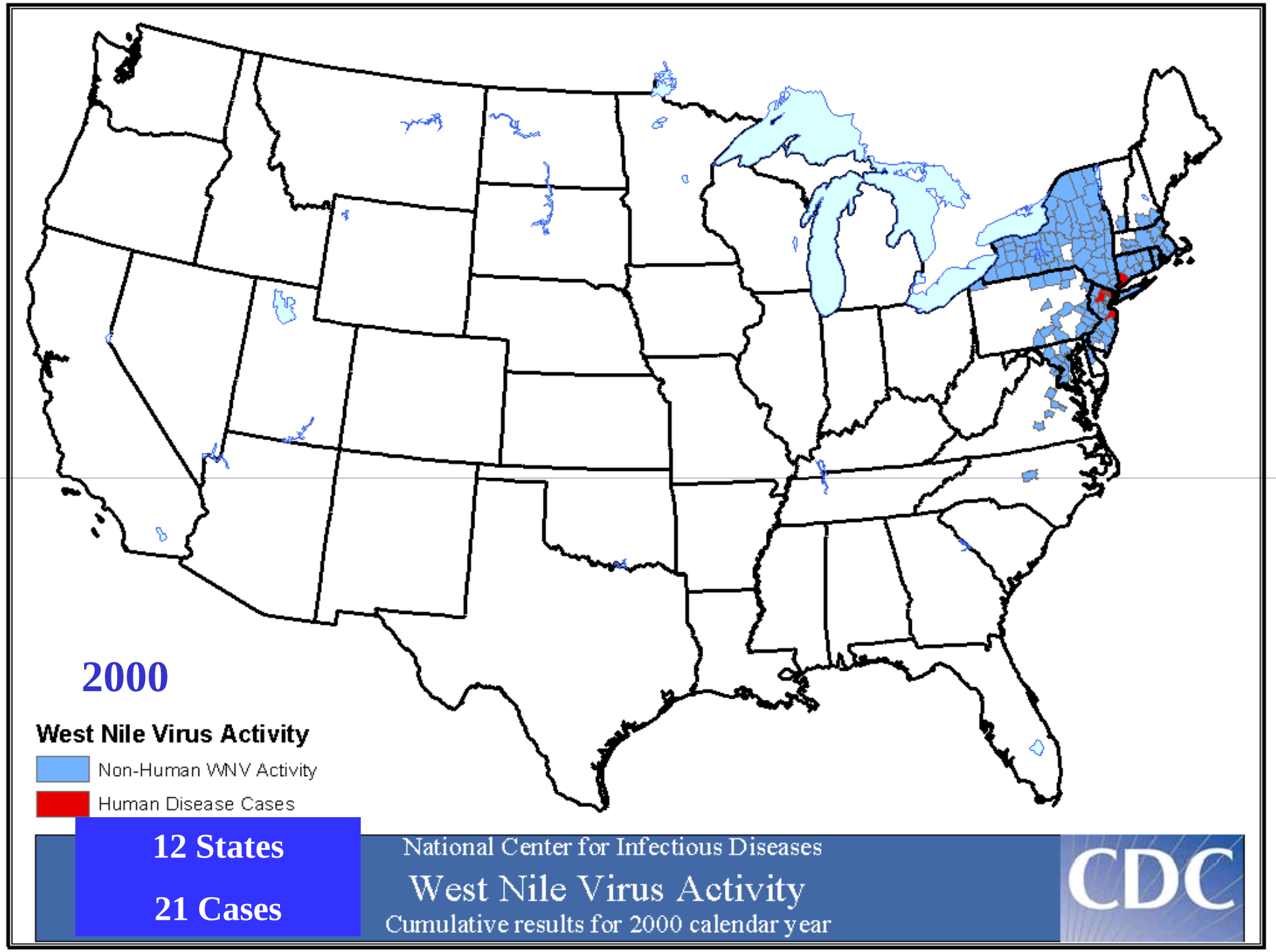
1994 - 1999

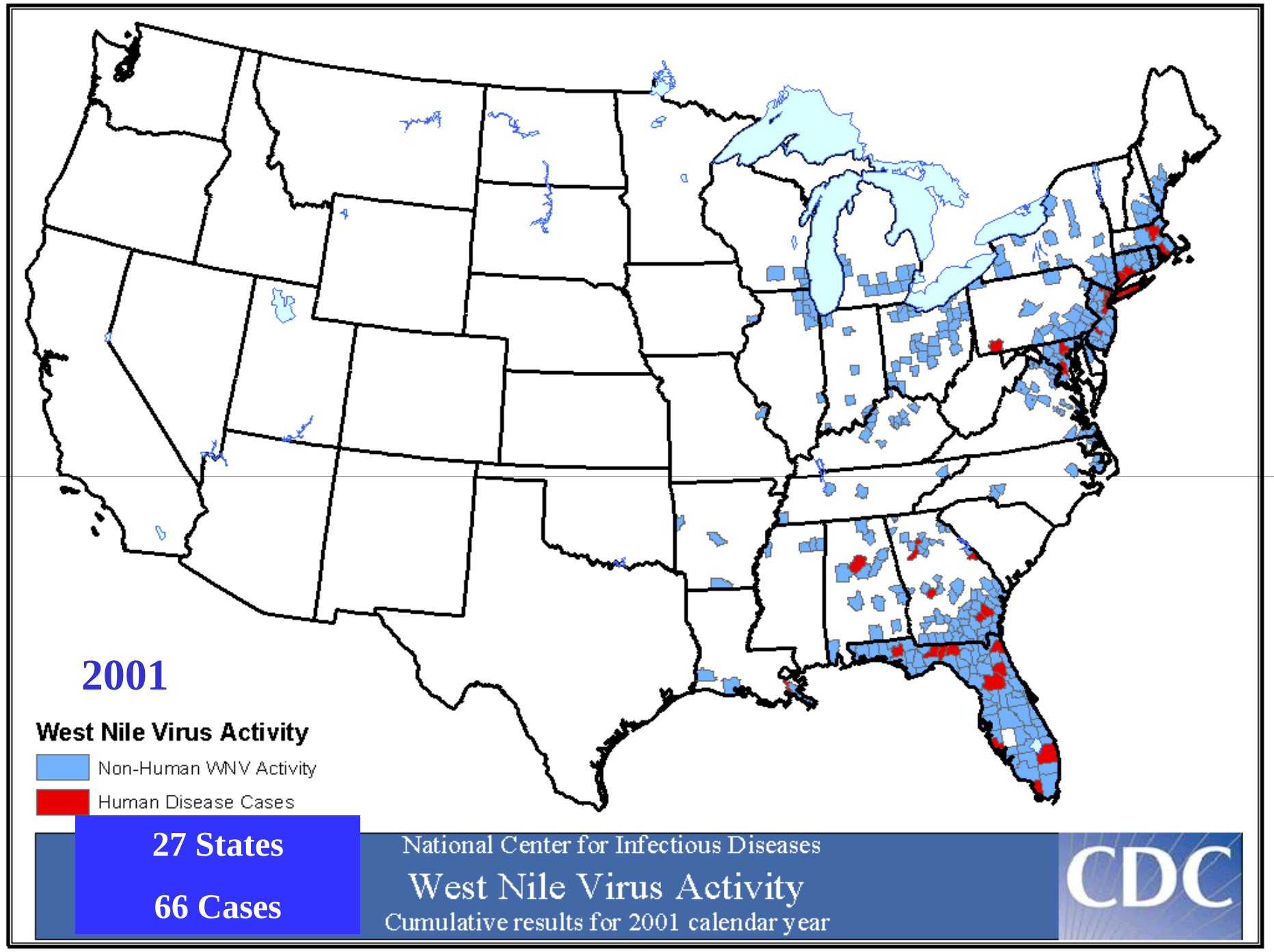
Adapted from Gubler, 2007

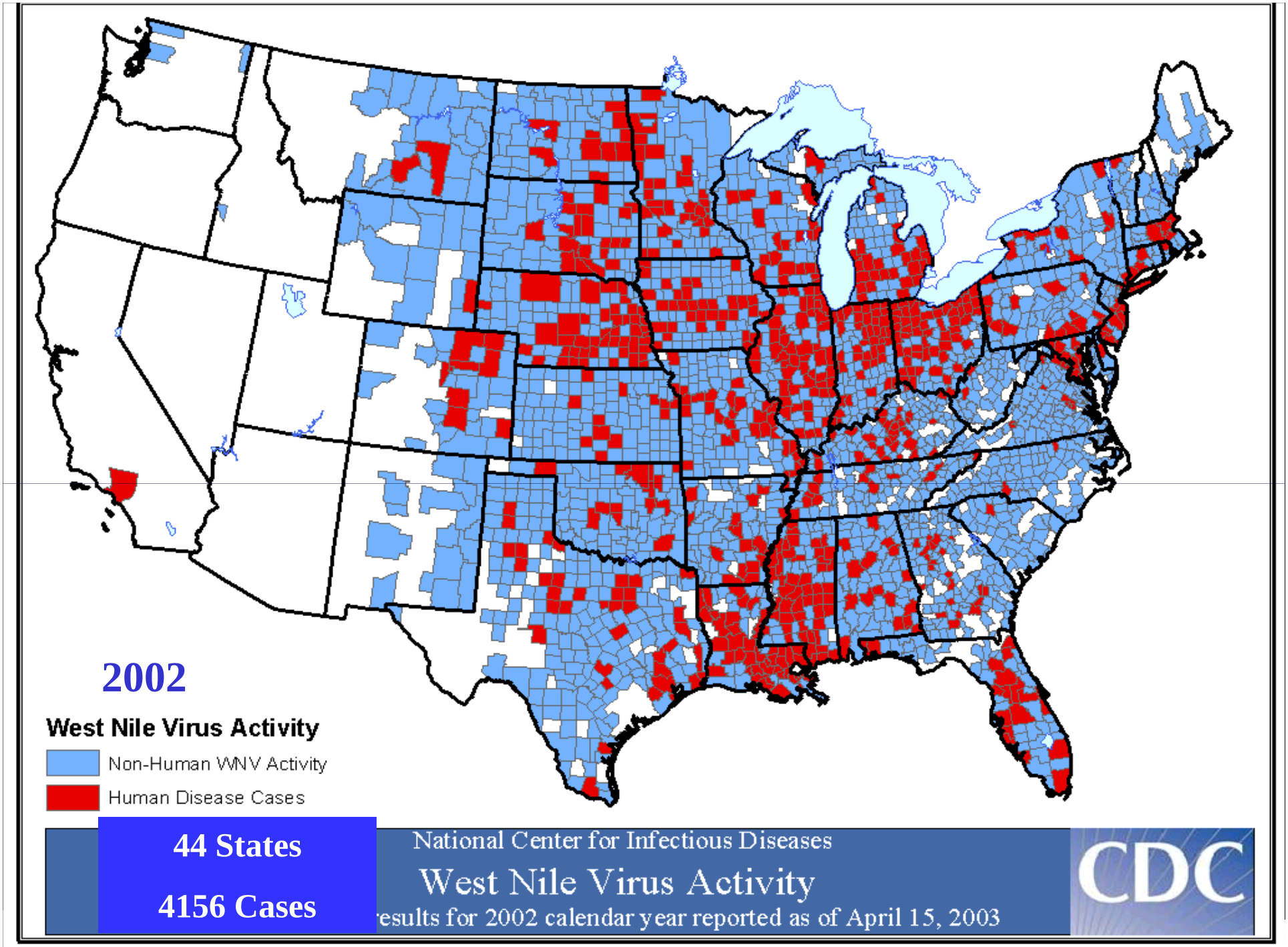
Control Dengue PDC Partnership

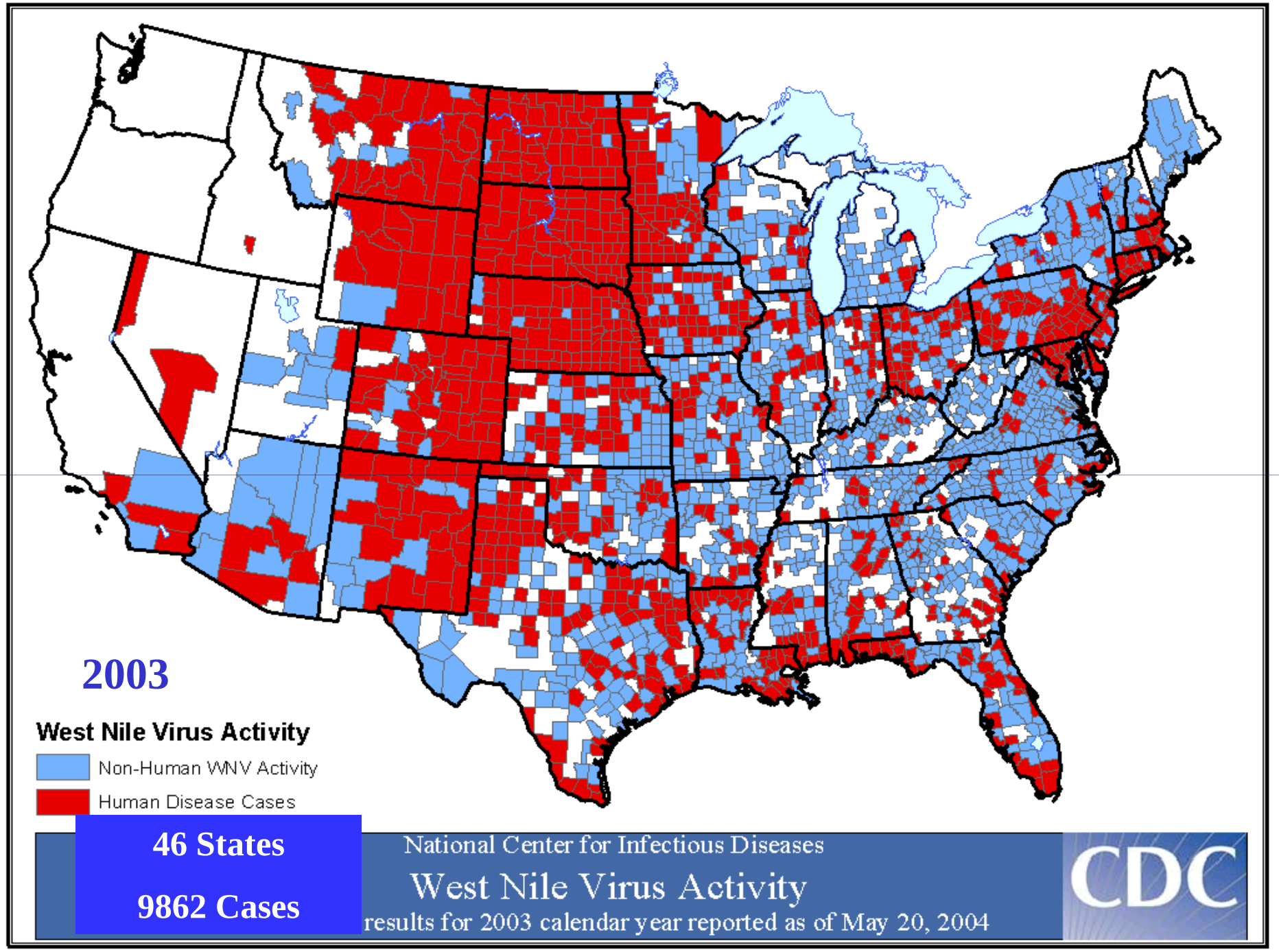
DUKE NUS GRADUATE MEDICAL SCHOOL SINGAPORE

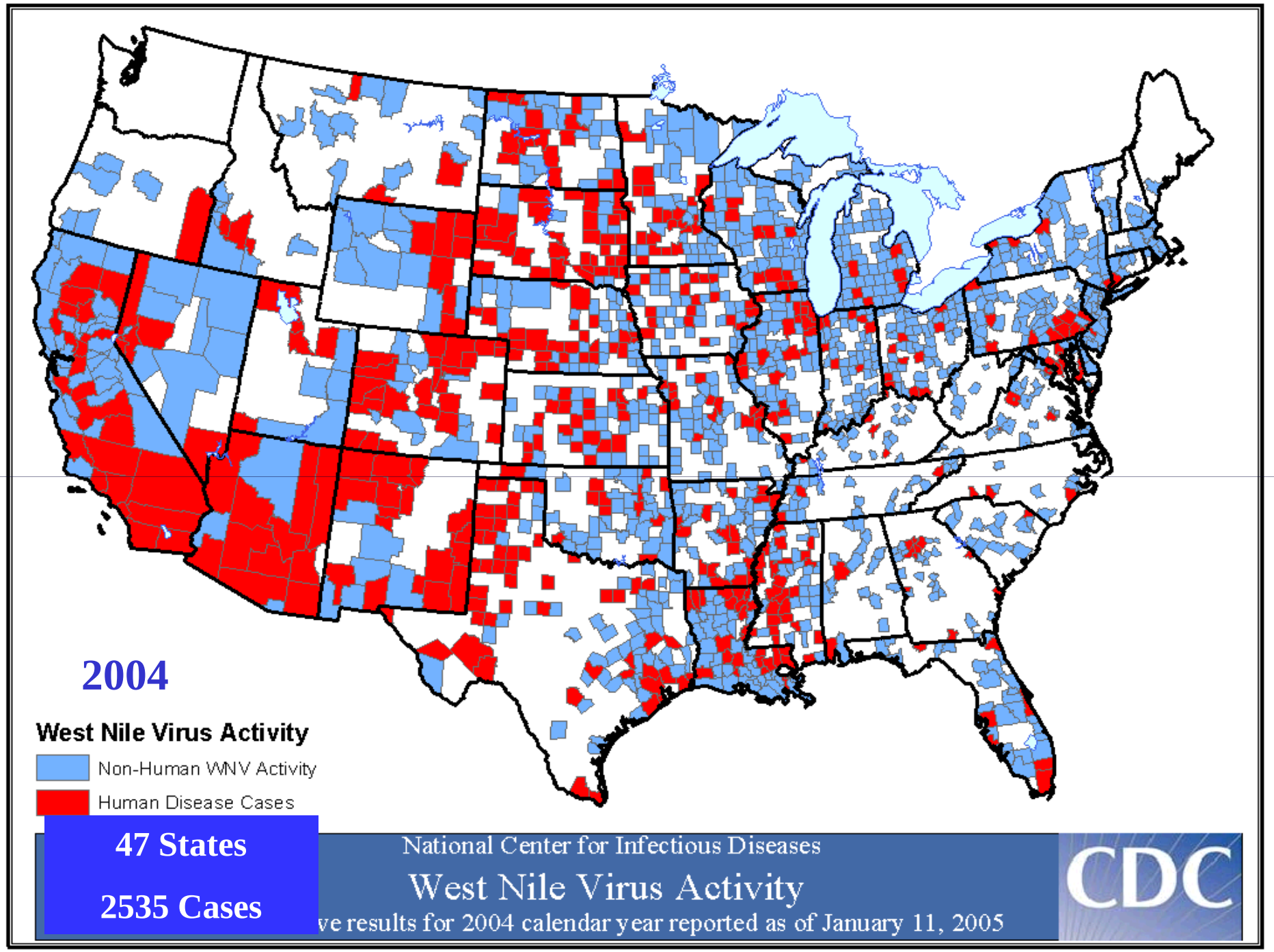

1999
West Nile Virus Activity
Non-Human WNV Activity
Human Disease Cases
4 States
62 Cases
National Center for Infectious Diseases
West Nile Virus Activity
Cumulative results for 1999 calendar year
CDC


2000
West Nile Virus Activity
Non-Human WNV Activity
Human Disease Cases
12 States
21 Cases
National Center for Infectious Diseases
West Nile Virus Activity
Cumulative results for 2000 calendar year
CDC

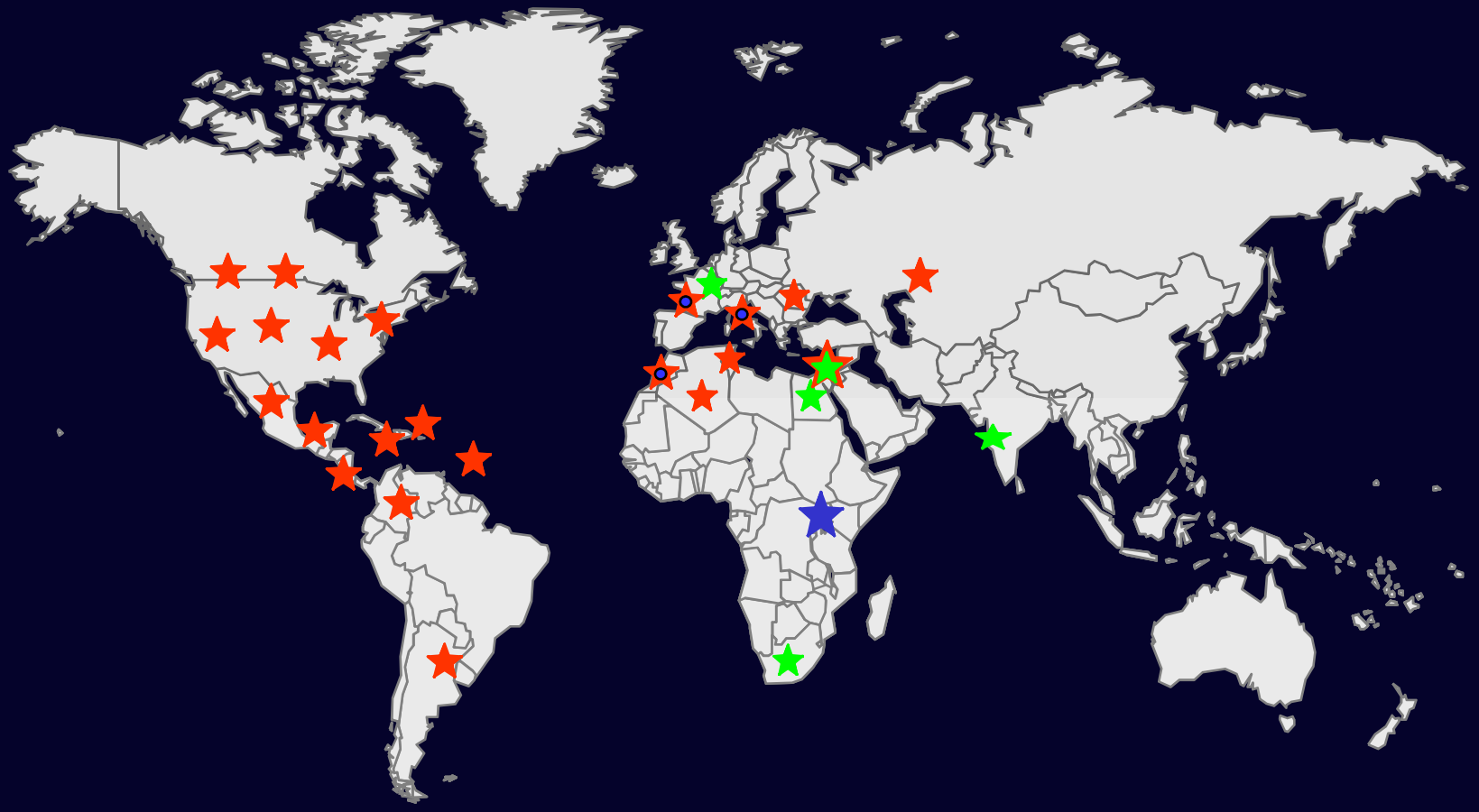

2001
West Nile Virus Activity
Non-Human WNV Activity
Human Disease Cases
27 States
66 Cases
National Center for Infectious Diseases
West Nile Virus Activity
Cumulative results for 2001 calendar year
CDC


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
esults for 2002 calendar year reported as of April 15, 2003
CDC


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
CDC


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
ve results for 2004 calendar year reported as of January 11, 2005
CDC

Epidemic/Epizootic West Nile Virus



1937

1950-93

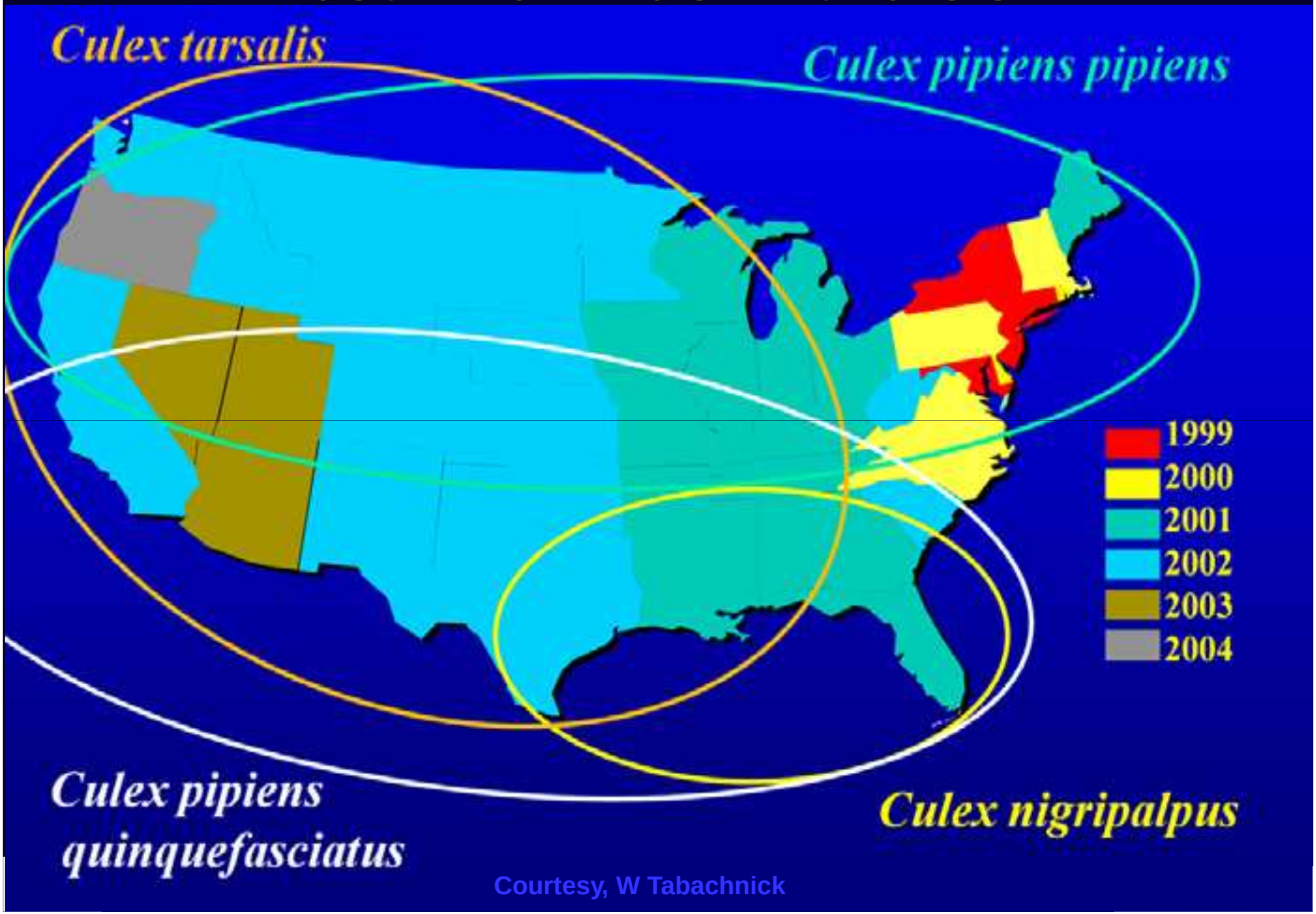
1994 - 2007

Adapted from Gubler, 2007

Control Dengue PDC Partnership

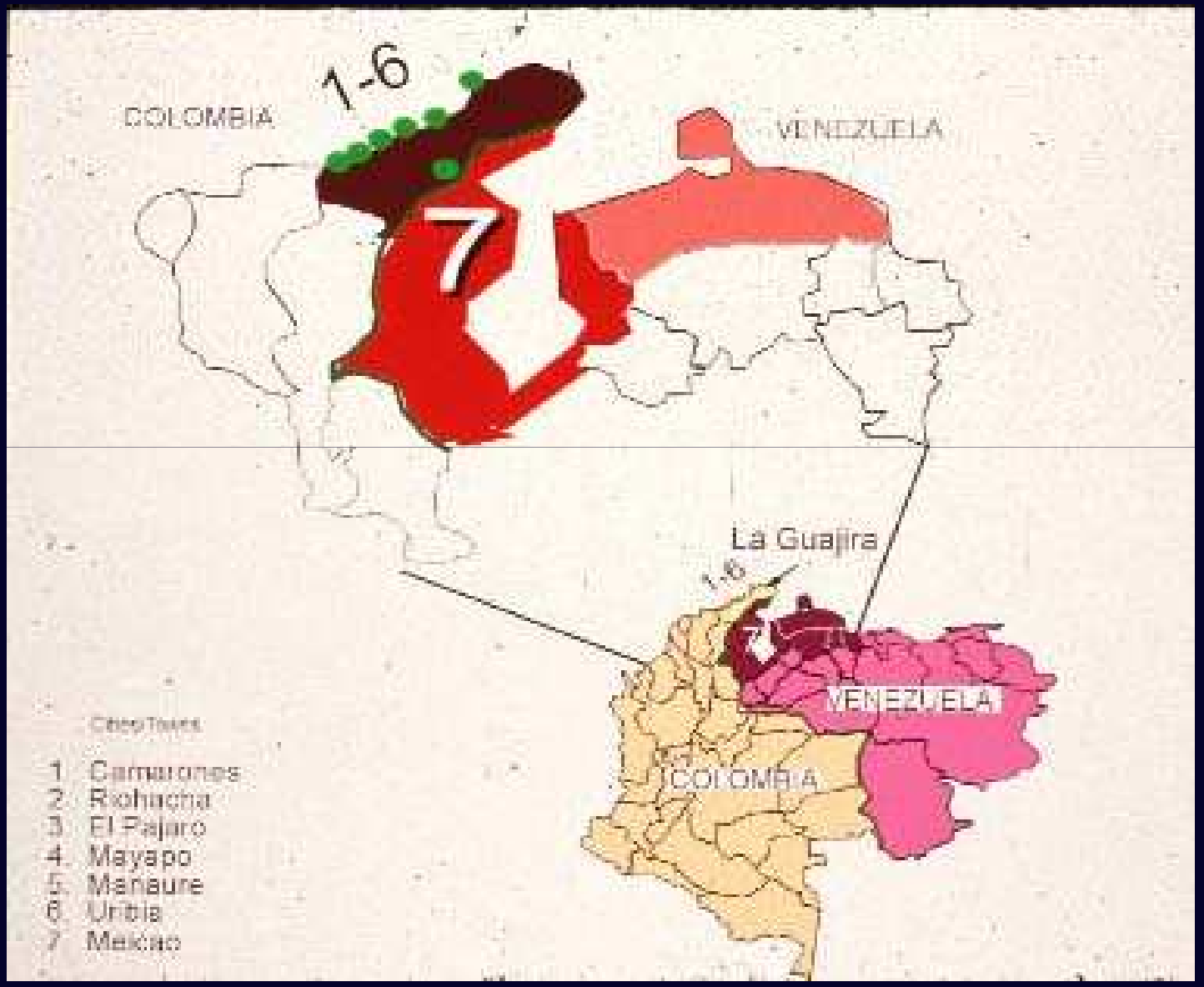
DUKE NUS GRADUATE MEDICAL SCHOOL SINGAPORE

West Nile Virus in the US



Courtesy, W Tabachnick

Venezuelan Equine Encephalitis



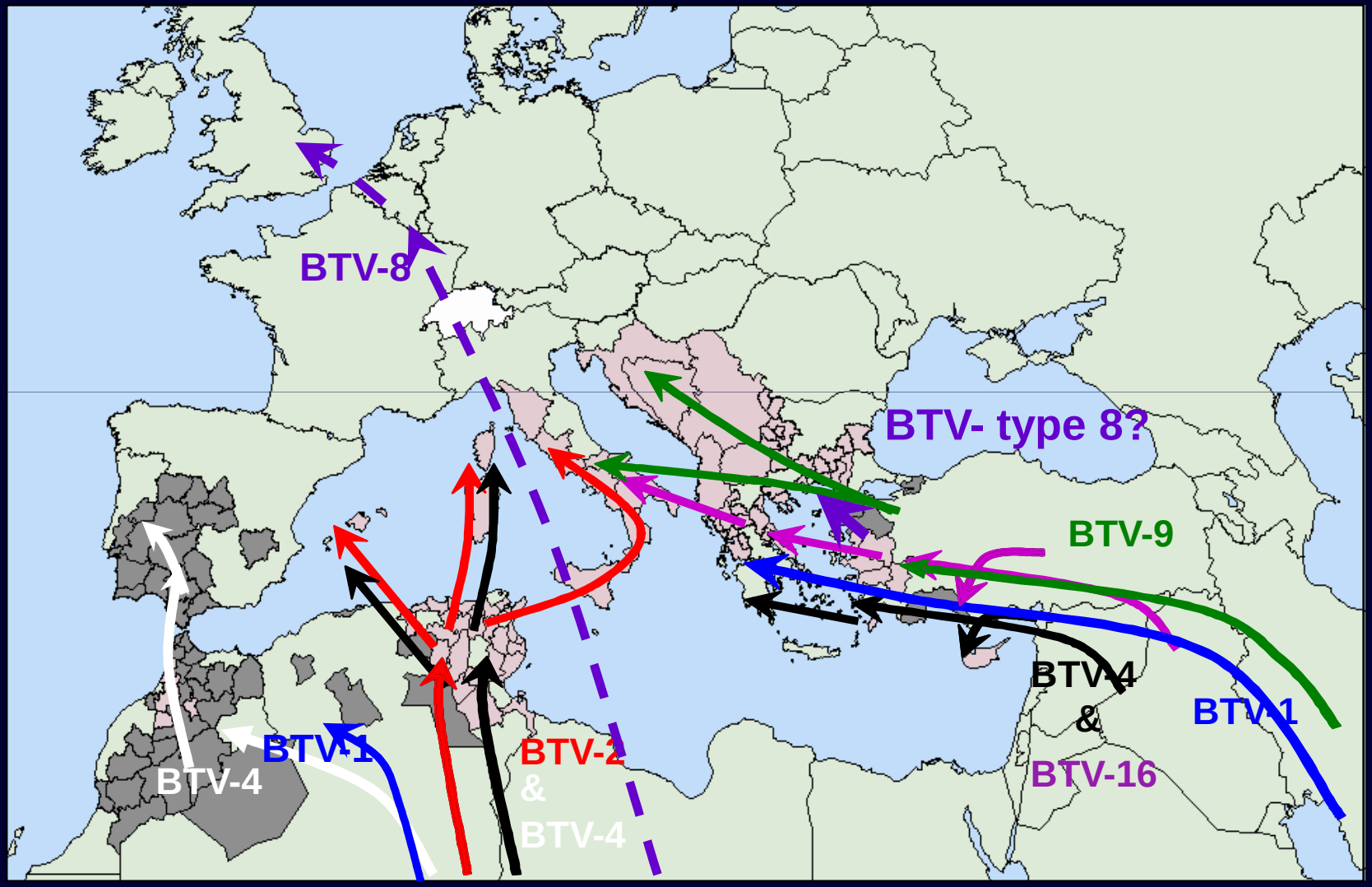
Rift Valley Fever

Alkhurma Virus (Kyasanur Forest Disease Virus)

Kyasanur 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

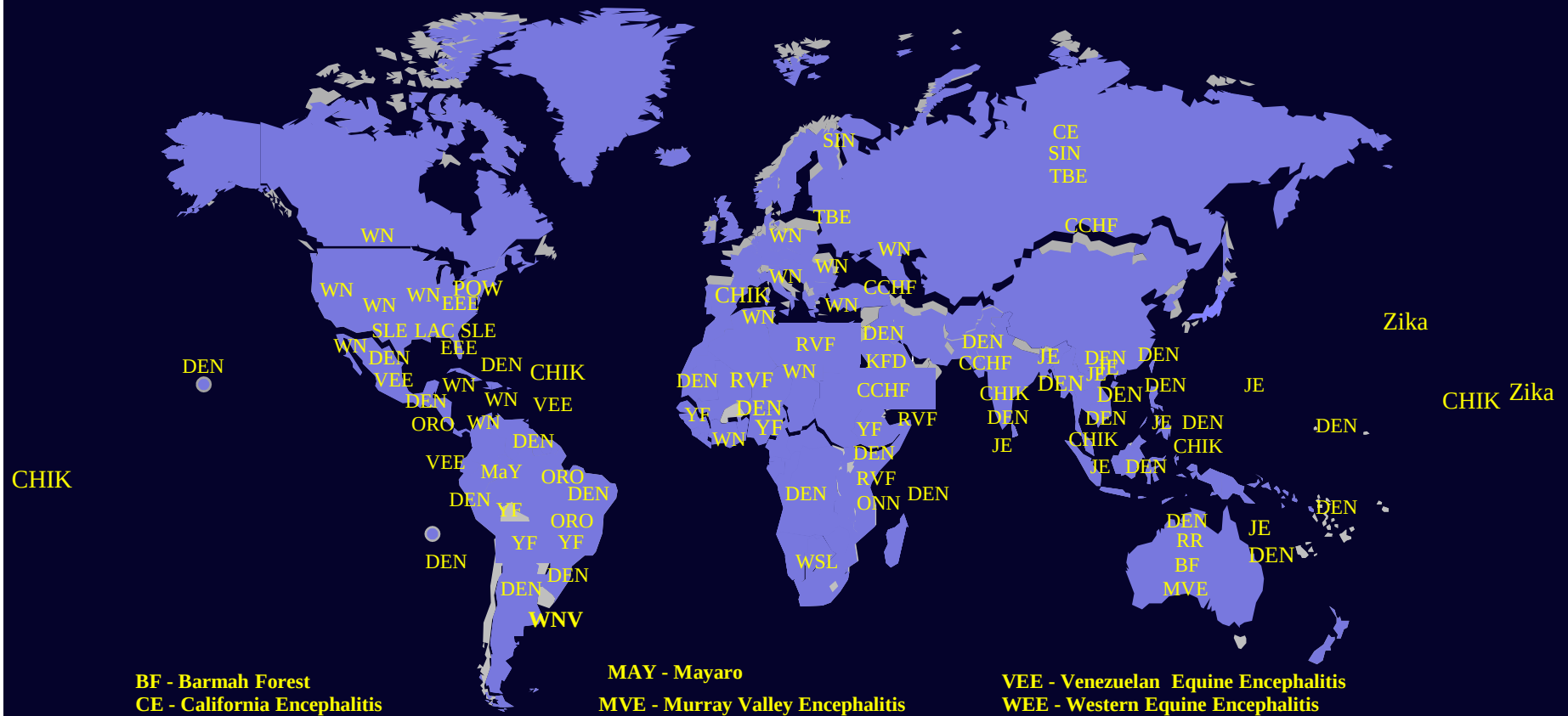


Courtesy, M Nathan

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



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

Control Dengue PDC Partnership

DUKE NUS GRADUATE MEDICAL SCHOOL SINGAPORE

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

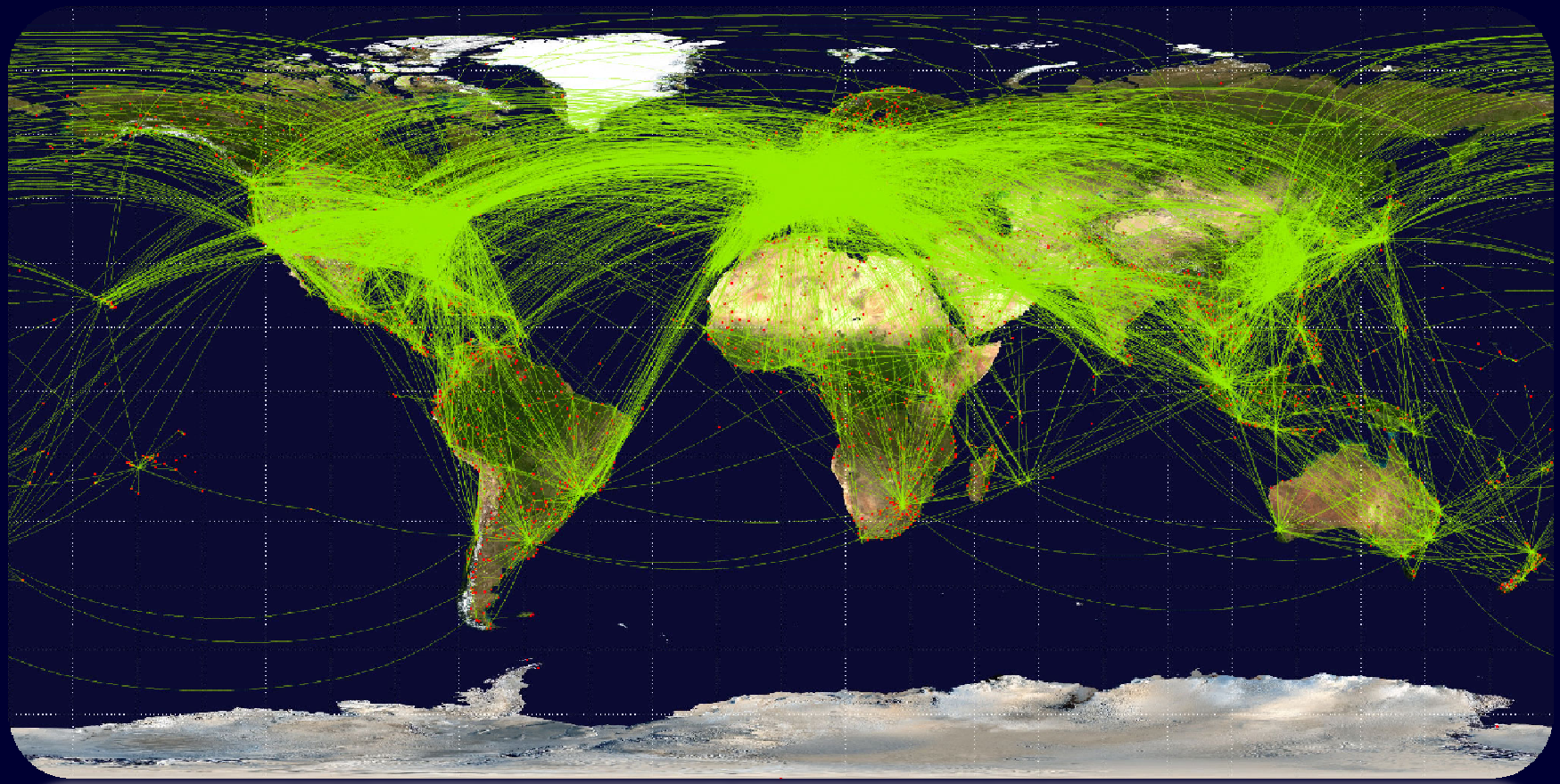
- **Complacency, Lack of Political Will**
- **Policy Changes**
- **Changes in Public Health**
- **Changing Life Styles/Behavior**
- **Microbial Adaptation**
- **Technology**
- **Intent to Harm**
- **Climate Change?**

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

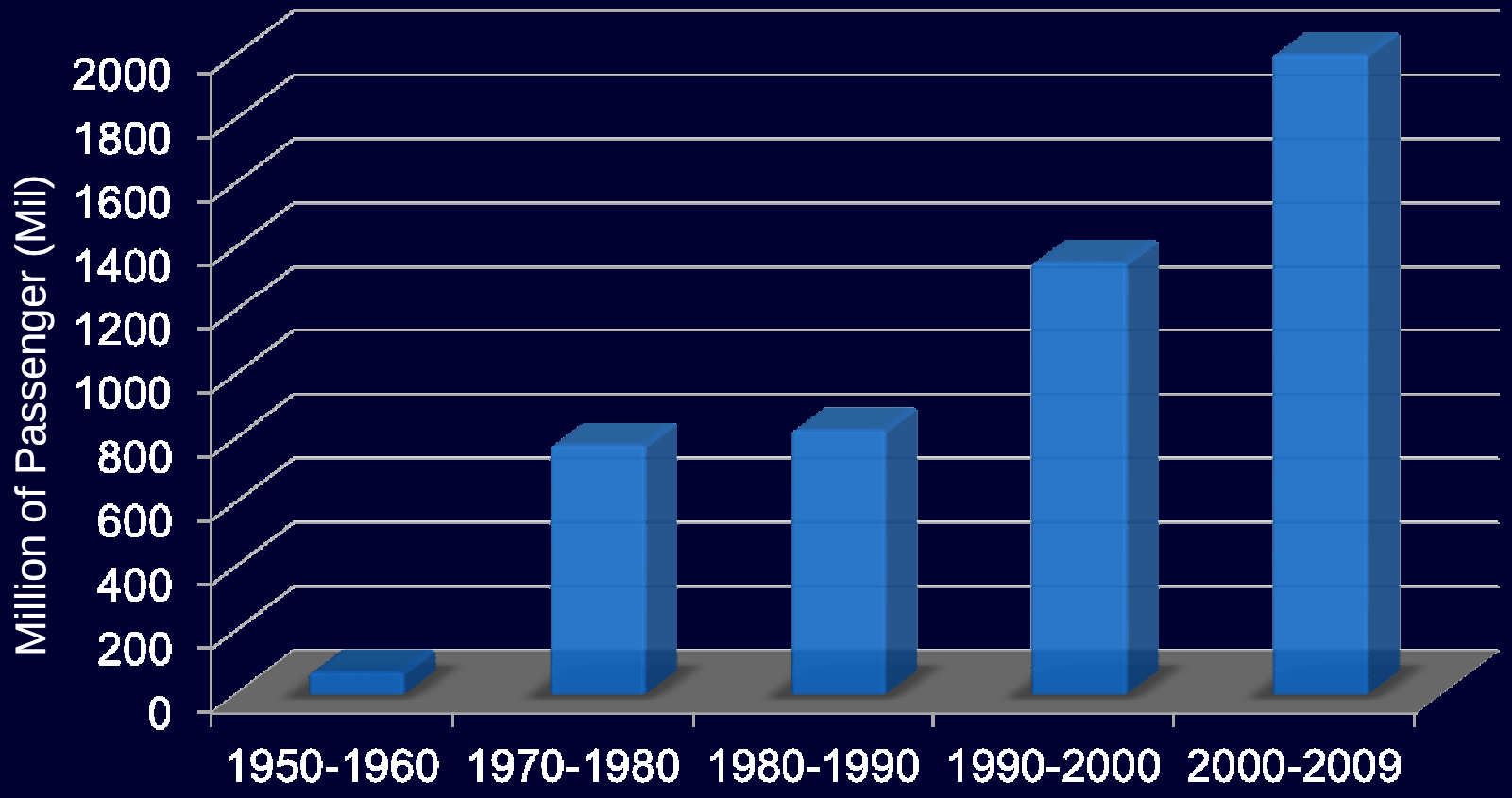
The global air network



Control Dengue PDC Partnership

DUKE NUS GRADUATE MEDICAL SCHOOL SINGAPORE

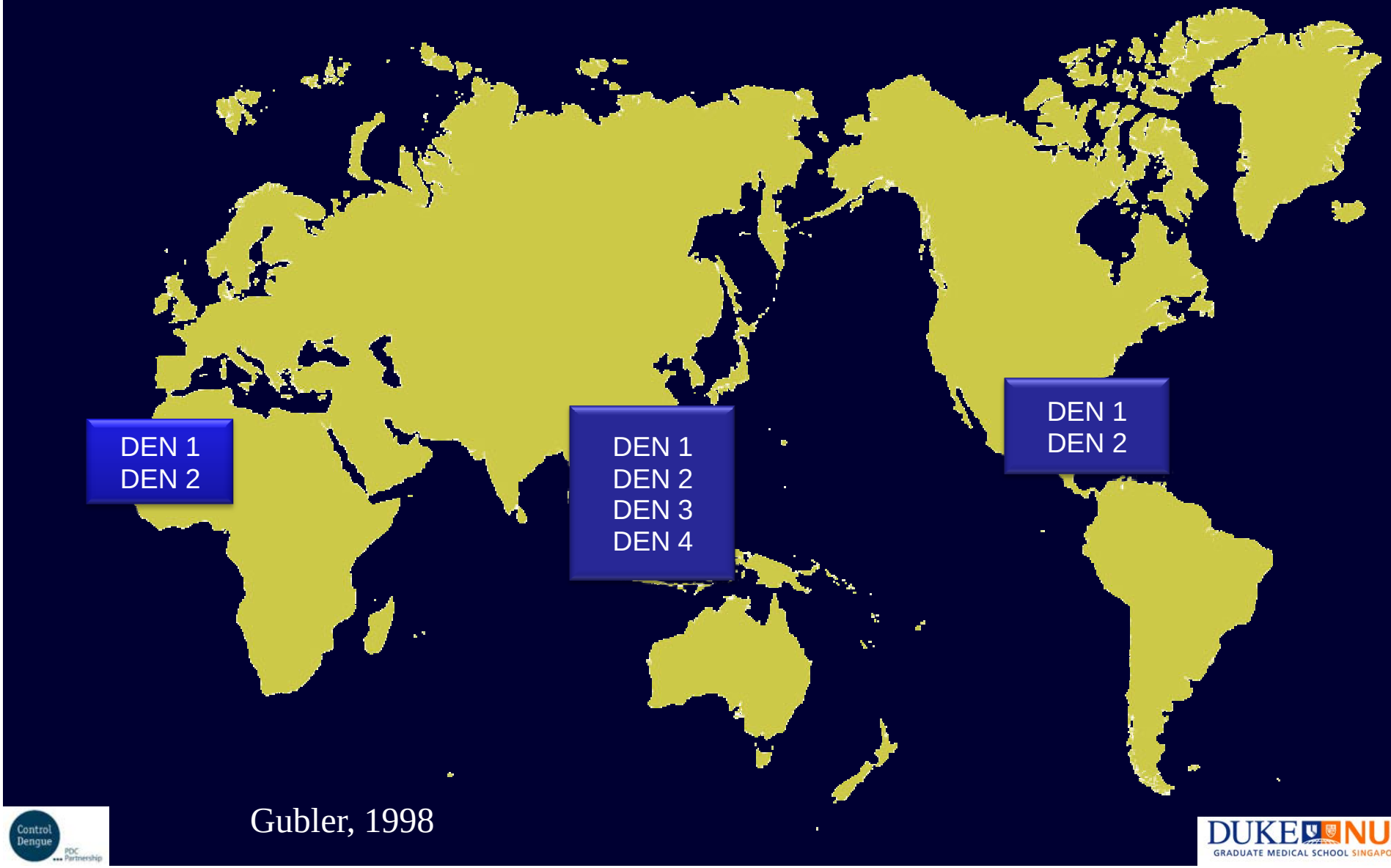
Average annual number of global airline passengers by decade, 1950-2010



IATA 2010

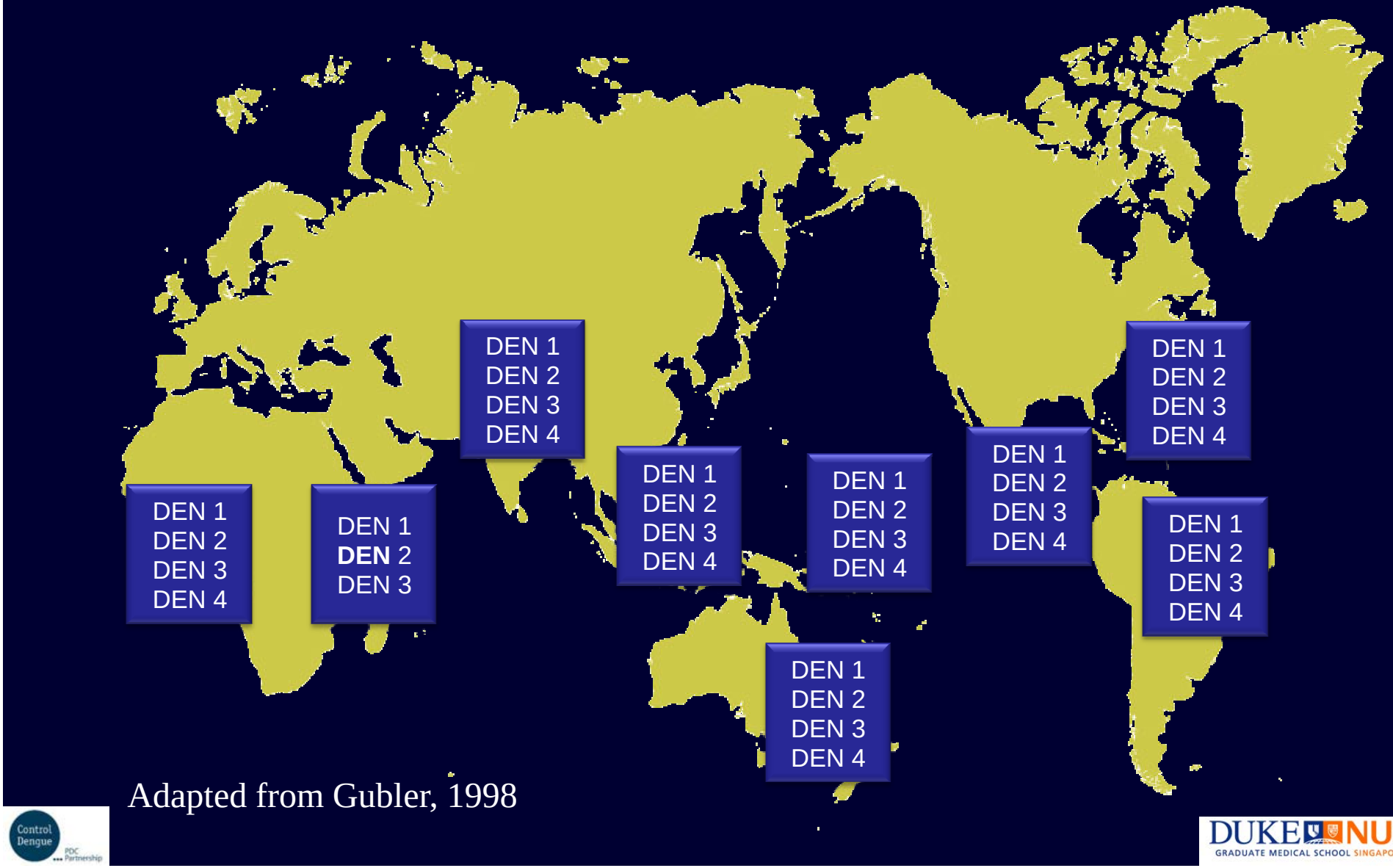
Commercial Air Traffic Over a 24 Hour Period

Global distribution of dengue virus serotypes, 1970



Gubler, 1998

Global distribution of dengue virus serotypes, 2014



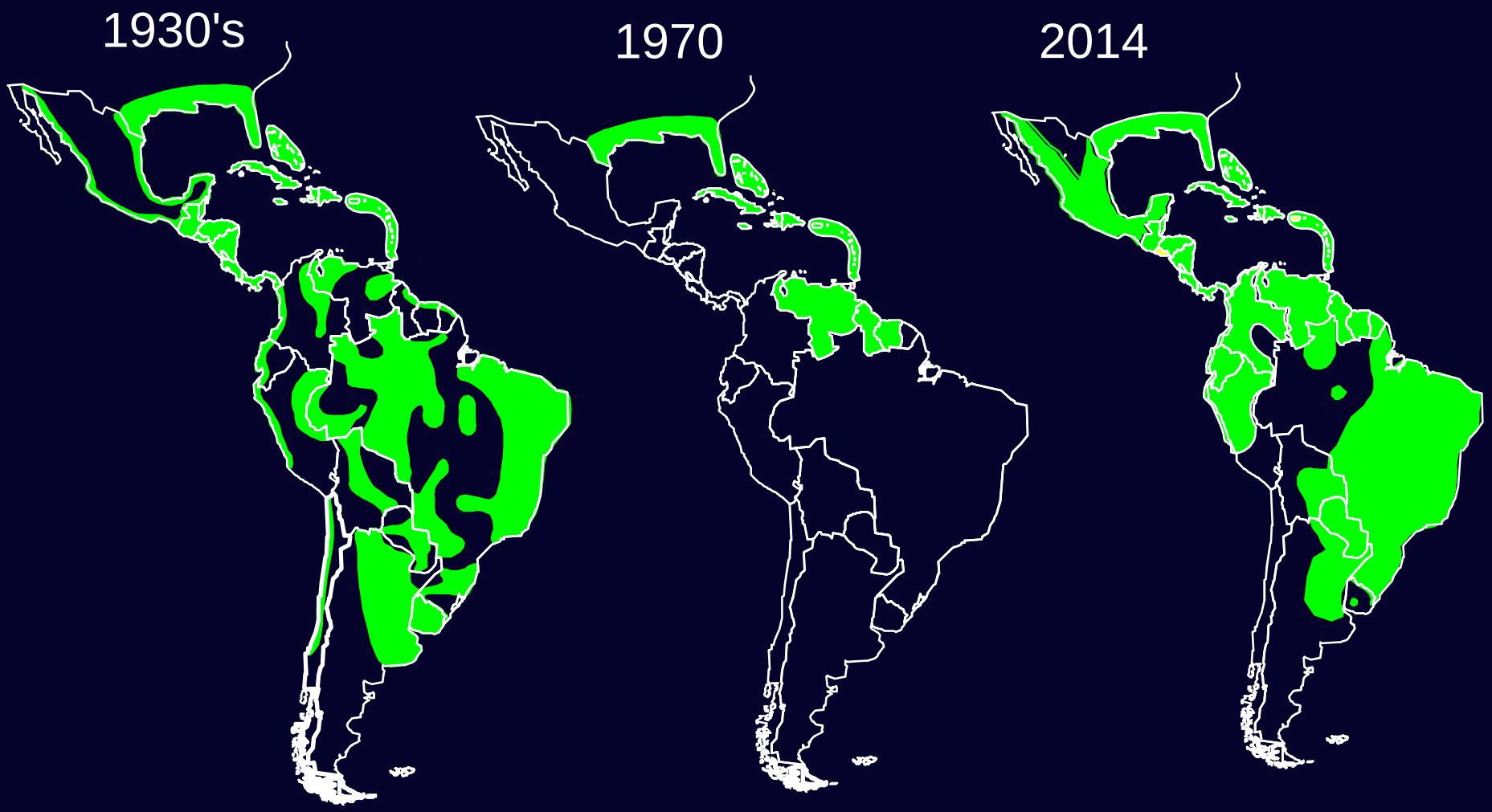
Adapted from Gubler, 1998

Control Dengue PDC Partnership

DUKE NUS GRADUATE MEDICAL SCHOOL SINGAPORE


New York City
YELLOW
JACK

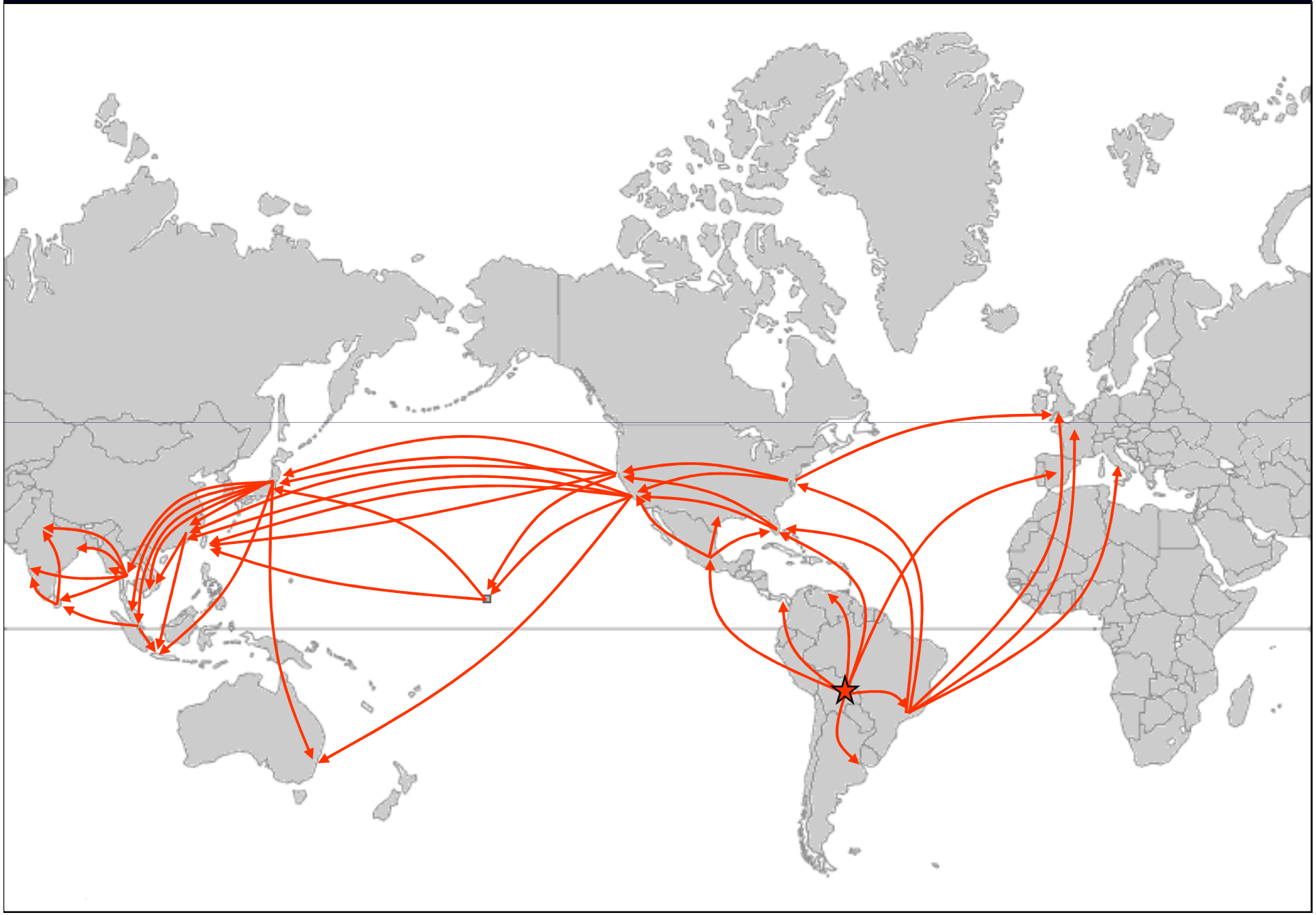
Aedes aegypti Distribution in the Americas



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, 2012-20025

- **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**

Control Dengue PDC Partnership

DUKE NUS GRADUATE MEDICAL SCHOOL SINGAPORE