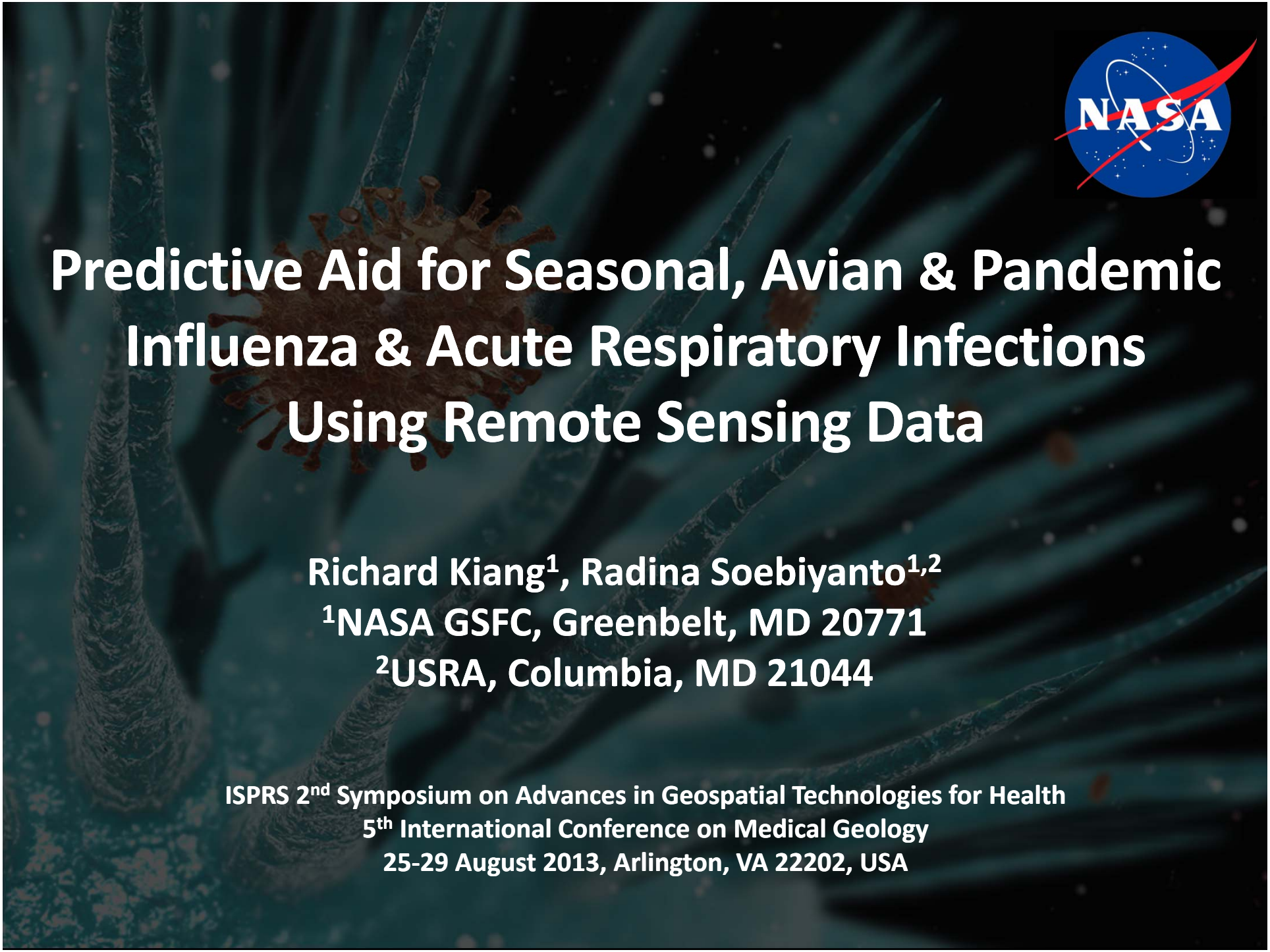

Predictive Aid for Seasonal, Avian & Pandemic Influenza & Acute Respiratory Infections Using Remote Sensing Data

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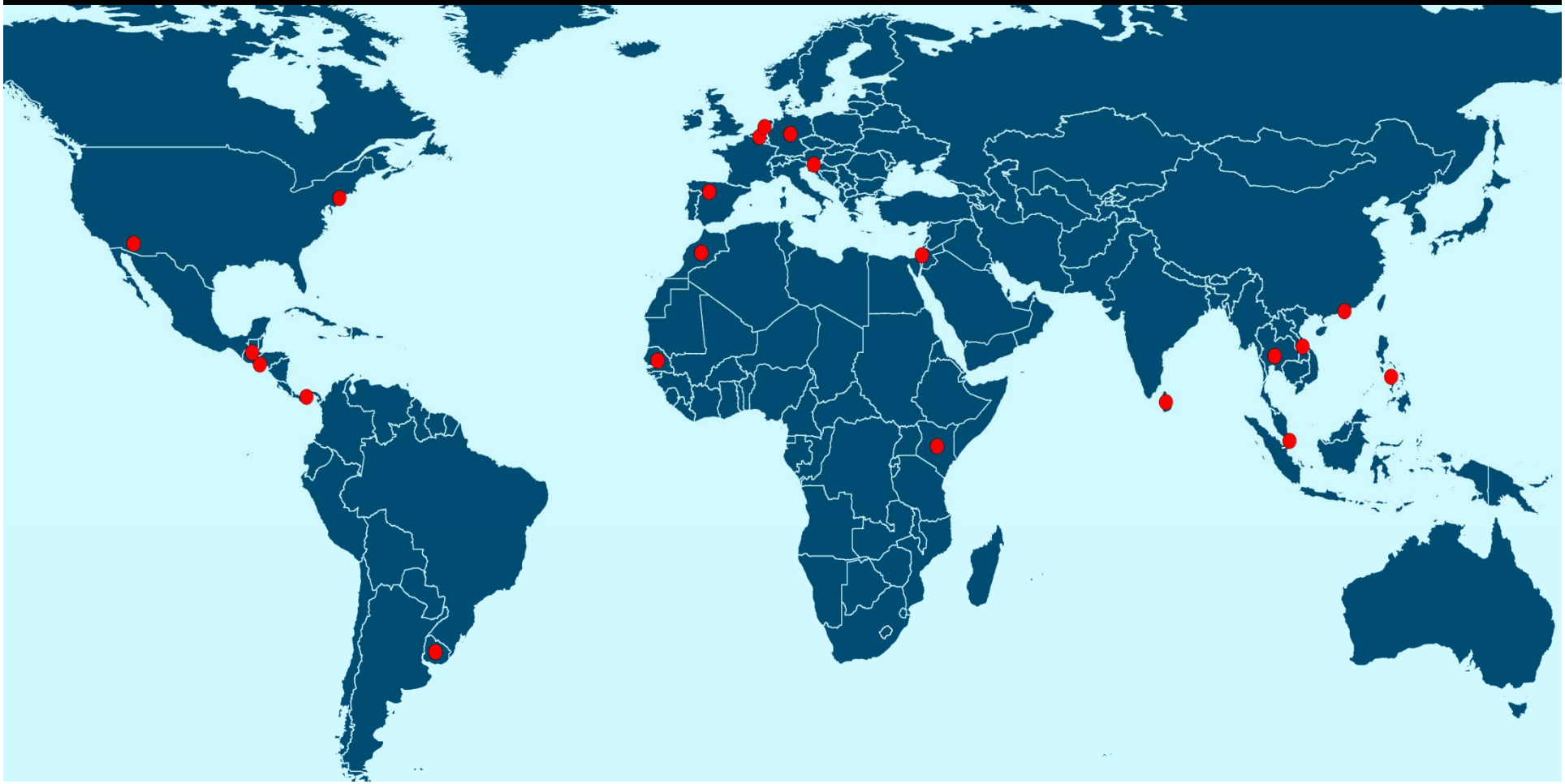
GOALS

- Reduce human morbidity and mortality
- Reduce economic loss

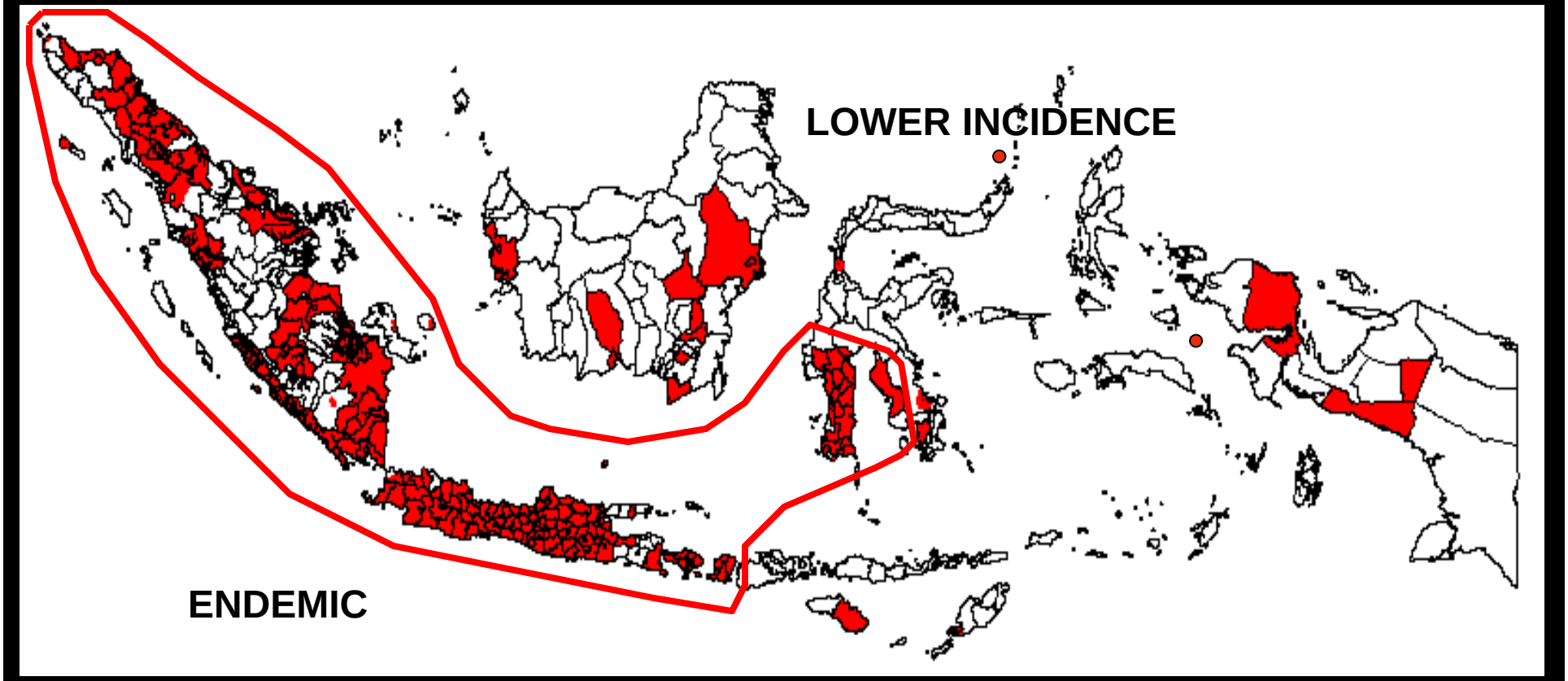
OBJECTIVES

- Model seasonality of influenza transmission at major population centers
- Predict short-term influenza activities
- Provide pandemic early warning
- Identify risk factors in HPAI transmission
- Model within- and between-farm avian influenza transmissions

Influenza data from regions in 20 countries covering temperate, subtropical and tropical zones have been analyzed and modeled.



Highly Pathogenic Avian Influenza A(H5N1) Endemic Regions in Indonesia



Source: E. Sawitri/Indonesian MoA

COLLABORATORS

- CDC
- NAMRU2
- USDA APHIS
- WHO EURO
- Public health agencies in collaborating countries

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Earth Observing Data

- **Satellites**

  TRMM – precipitation

  MODIS – land surface temperature

  ASTER – radiance

- **Climate Model**

  GLDAS – precipitation, temperature, specific humidity

- **Ground Stations**

  min/max/mean temperature, relative humidity, dew point , solar irradiance, etc.

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Epidemic-prone acute respiratory diseases have no borders, and can be spread rapidly around the world. Global, coordinated surveillance & control efforts are essential.

2003 SARS

Spread to 37 countries in weeks

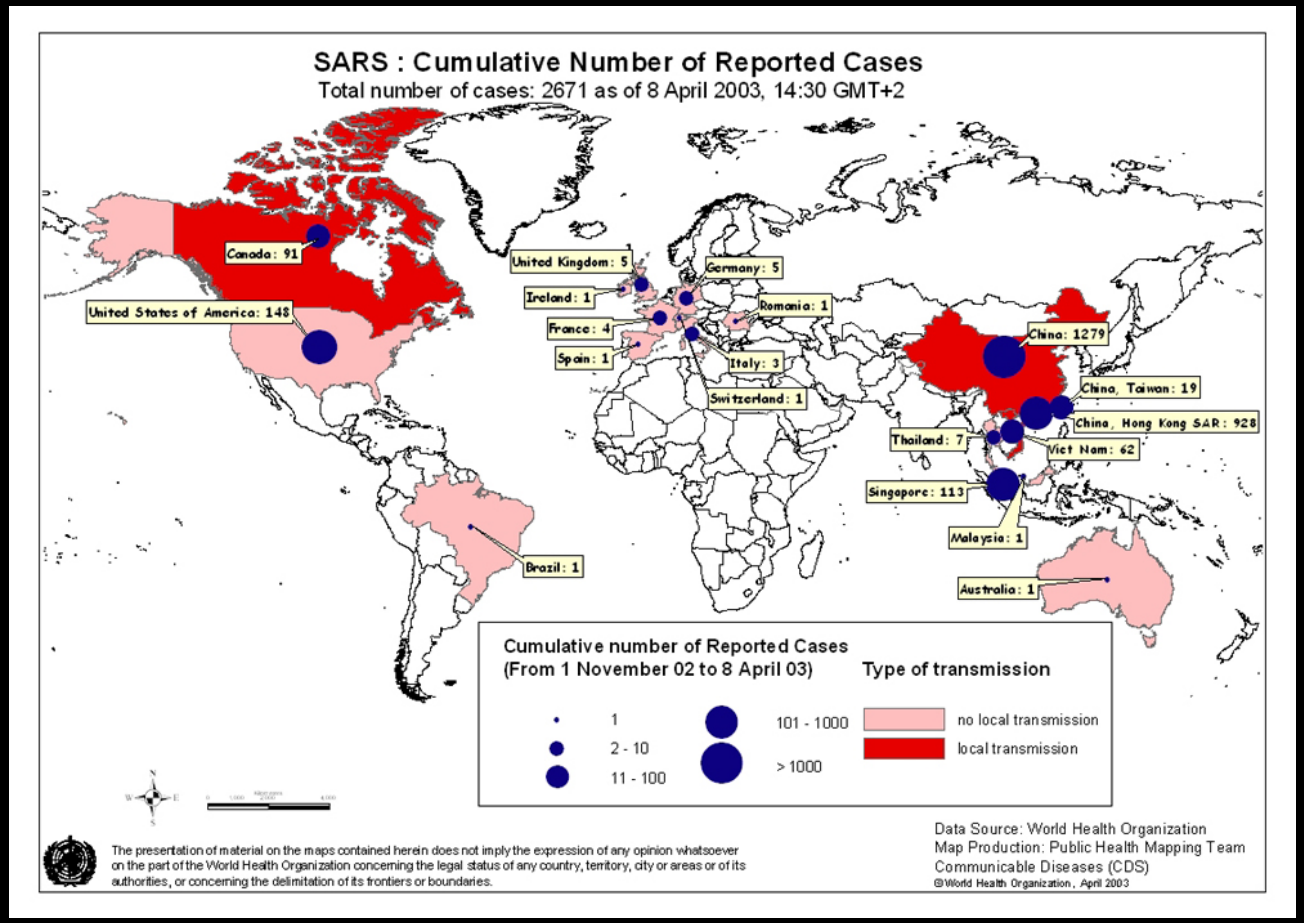
2004 Avian Influenza – A(H5N1)v

Spread to 62 countries since 2004. There are still frequent outbreaks in Indonesia, Egypt, and some Southeast Asian countries.

2009 Pandemic – A(H1N1)pdm09

Spread to 48 countries in a month despite heightened public awareness and substantial preventive and control efforts

The 2003 SARS Outbreaks



horseshoe bat

masked palm civet

human coronavirus

SARS increased public health as well as the general public's awareness of the seriousness of pandemic, and provided a real test ground for preventing and controlling respiratory disease.

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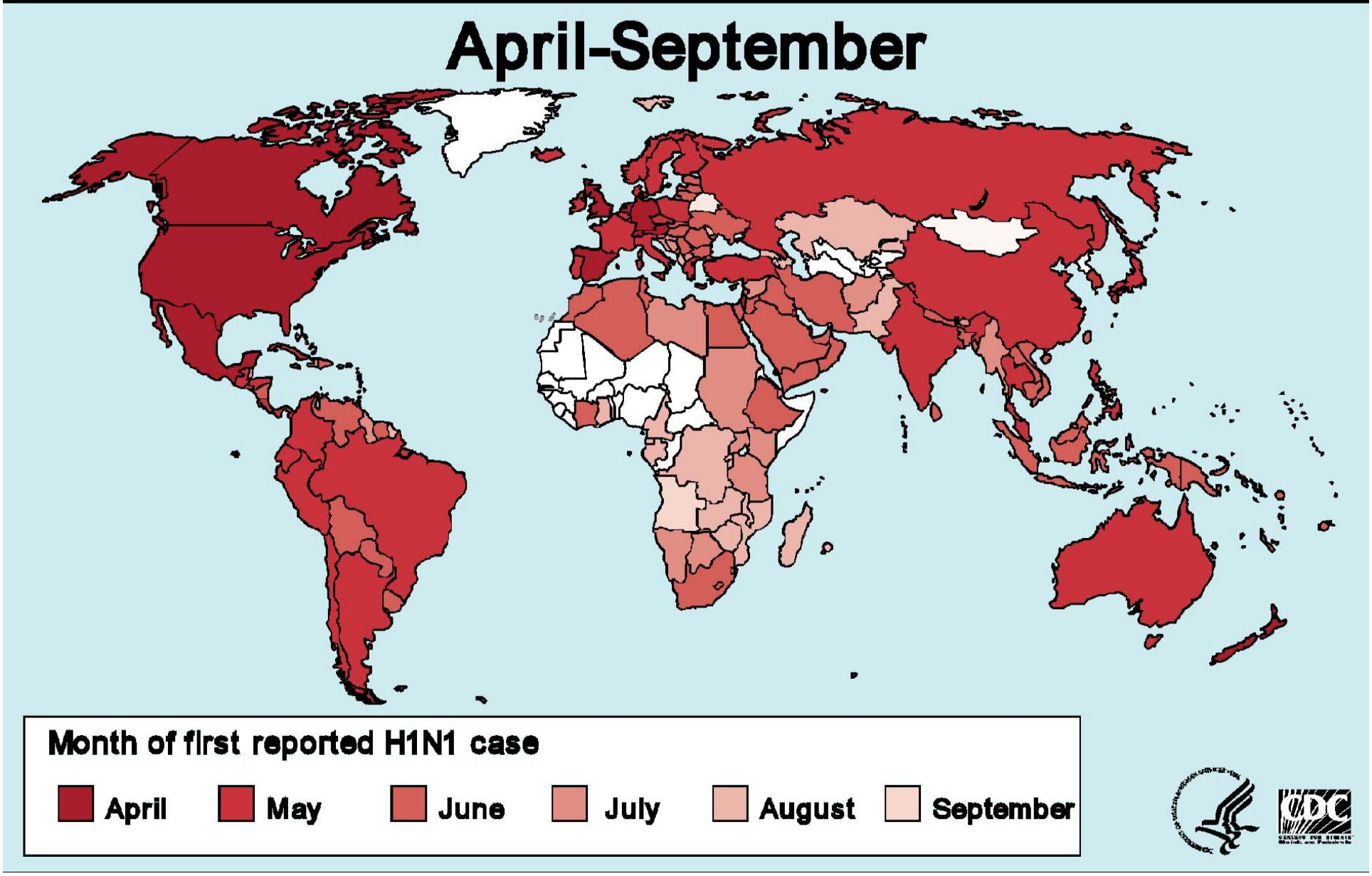
Global Spread of A(H1N1)pdm09



Burden of Influenza

US

- 0.2 M hospitalizations and 36,000 deaths annually
- Hospitalization rate highest in children
- 90% of deaths are older than 65 years
- 75% of deaths are not coded pneumonia or influenza

World

- 3-5 M severe cases annually
- 0.25-0.5 M deaths annually

Economic Burden

- Direct health care?
- Societal costs?
- Nearly $10 B annual economic loss for US alone

Sources: WHO, Thompson et al., Widdowson

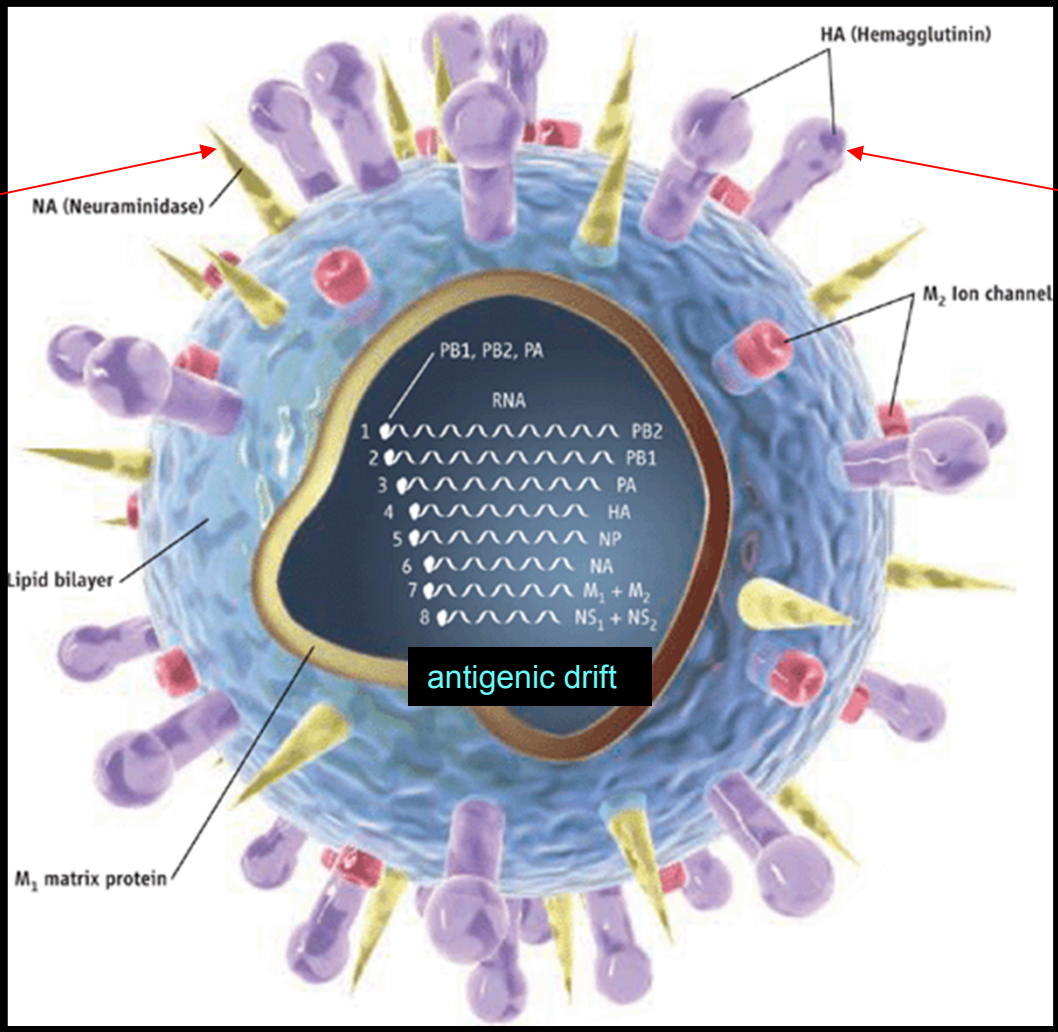
170 Subtypes and Innumerable Strains

NA

Neuraminidase

An enzyme for splitting mucoprotein in order to release progeny

10 subtypes



HA

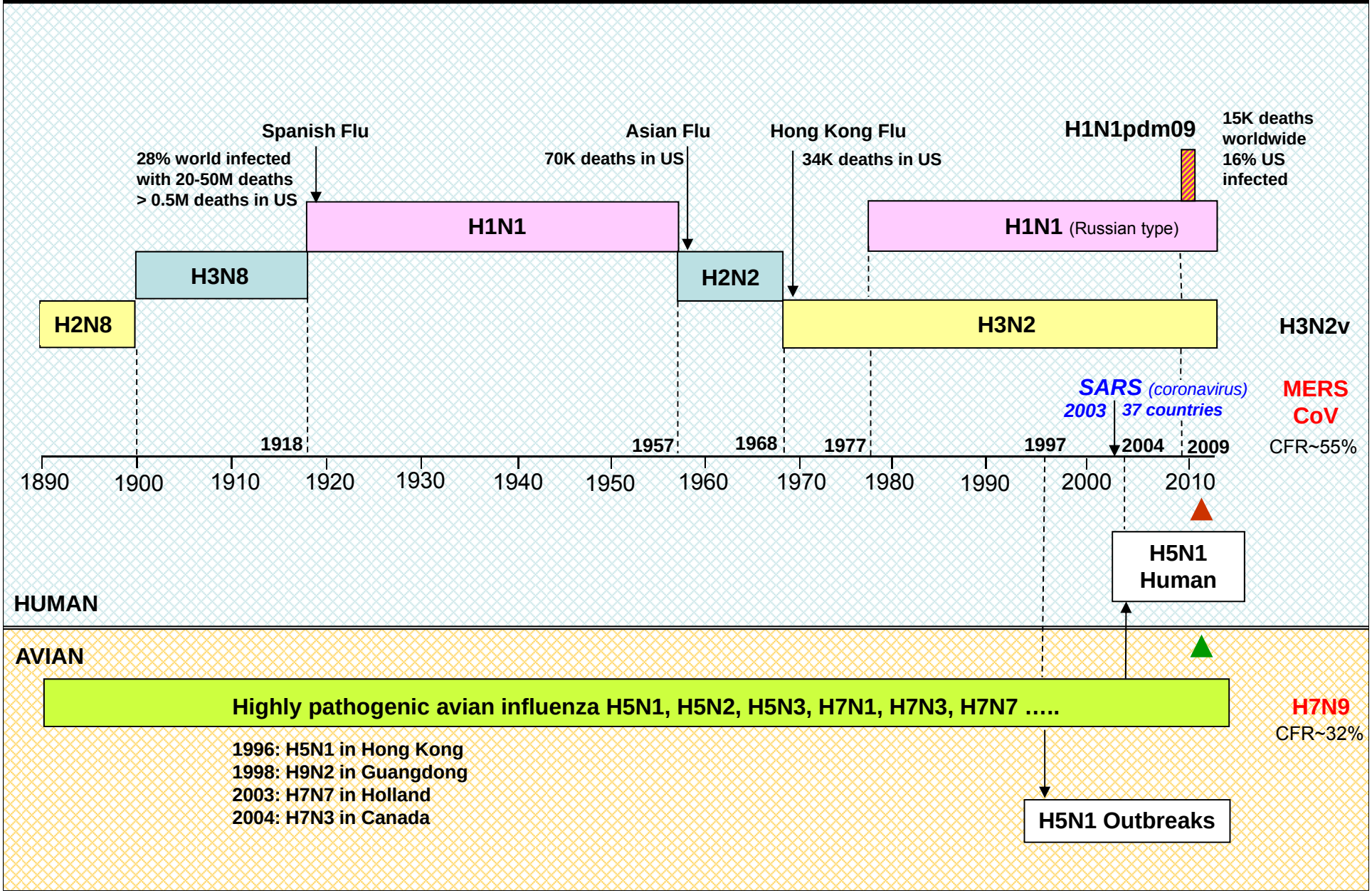
Hemaglutinin

A glycoprotein for binding to the host cell

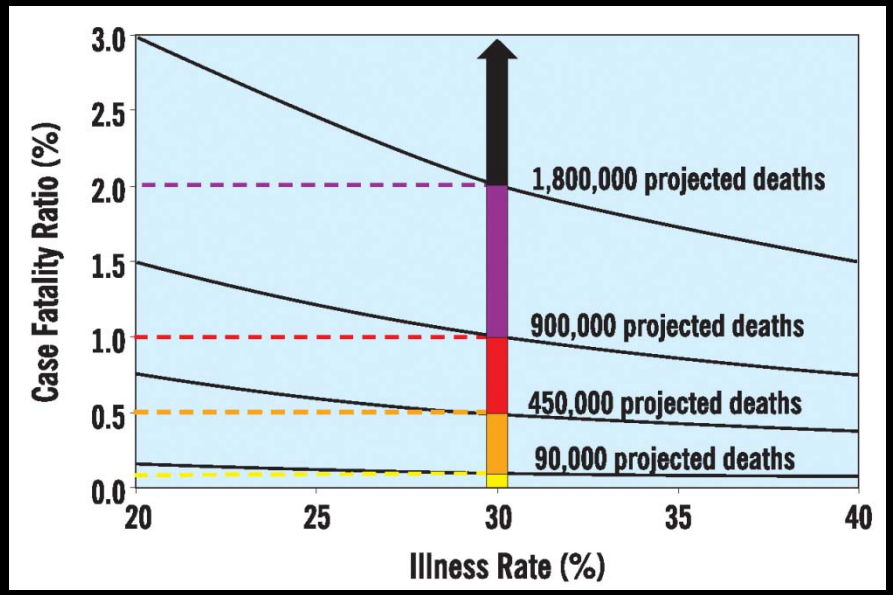
17 subtypes

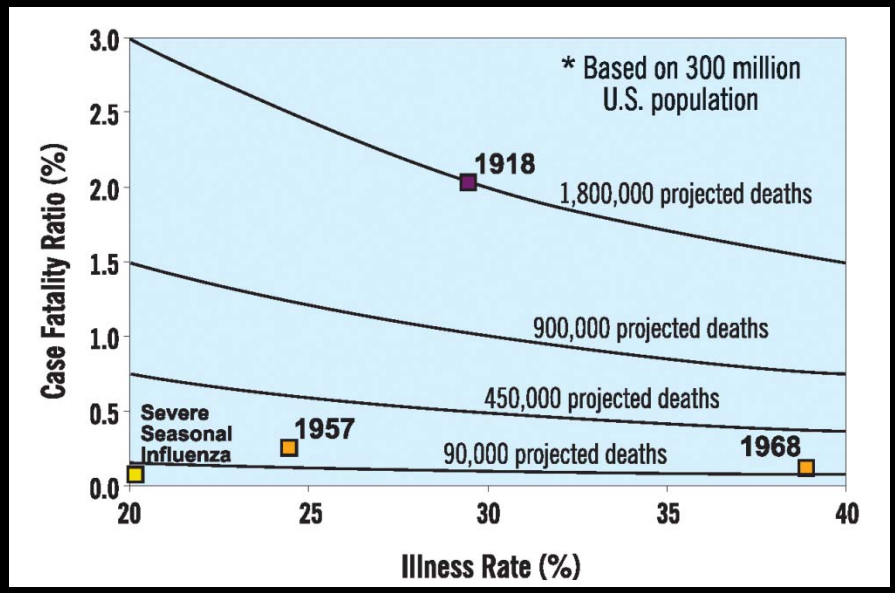
antigenic shift: H1N1 + H2N2 → H1N1, H2N2, H1N2, H2N1

Human & Avian Influenza Epdemics & Pandemics



Projected Deaths in US
For Pandemics With Severity 1–5





Category	CFR
1	< 0.1 %
2	0.1 – 0.5 %
3	0.5 – 1.0 %
4	1.0 – 2.0 %
5	> 2.0 %

Pandemic	Deaths in US
1918 Spanish Flu	500-675 K
1957 Asian Flu	70 K
1968 HK Flu	34 K

Source: USG Prepandemic Plannig Guidance

Environmental & Sociological Factors Affecting Human Influenza Transmissions

Change in Transmission with Increase in Factor

Virus Survivorship	Temperature	↓
	Humidity	↓
	Vapor pressure	↓
	Solar irradiance	↓
Host Susceptibility	Sunlight exposure	↓ ↓
	Nutrition	varies
	Previous infections	↓ ↓
Transmission Efficiency	Temperature	↓ ↓
	Humidity	varies
	Vapor pressure	↓ ↓
	Precipitation	↑
	ENSO	↑
	Air travel	↑
	Holidays	↑

Biological Evidence
Empirical Evidence

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Modeling Techniques Used

- ARIMA (Autoregressive integrated moving average)
- Binomial regression
- Hilbert Huang empirical mode decomposition
- Neural network
- Poisson regression
- Wavelet transform
- SEIR
- Markov Chain Monte Carlo

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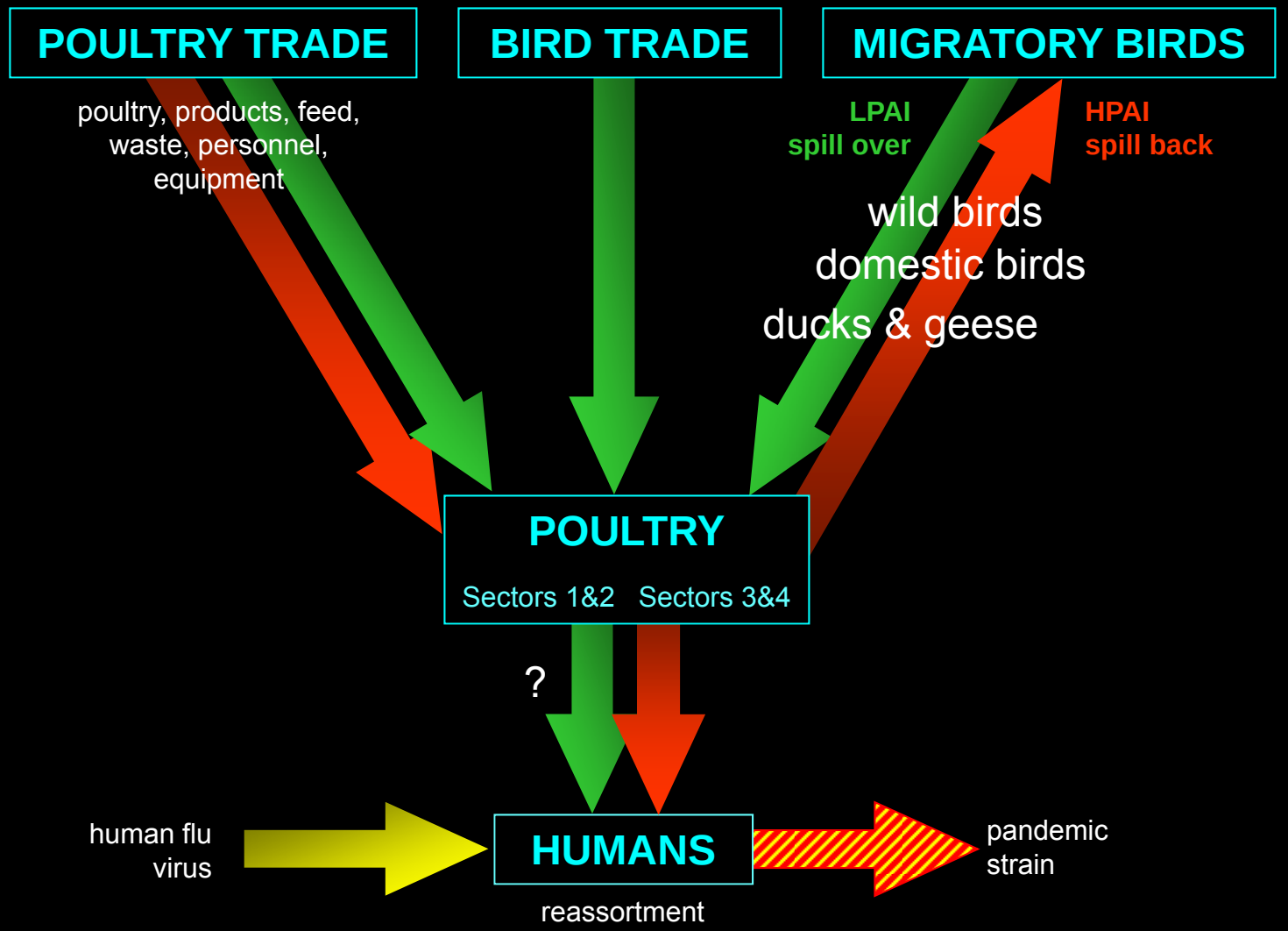
H5N1 TRANSMISSION PATHWAYS



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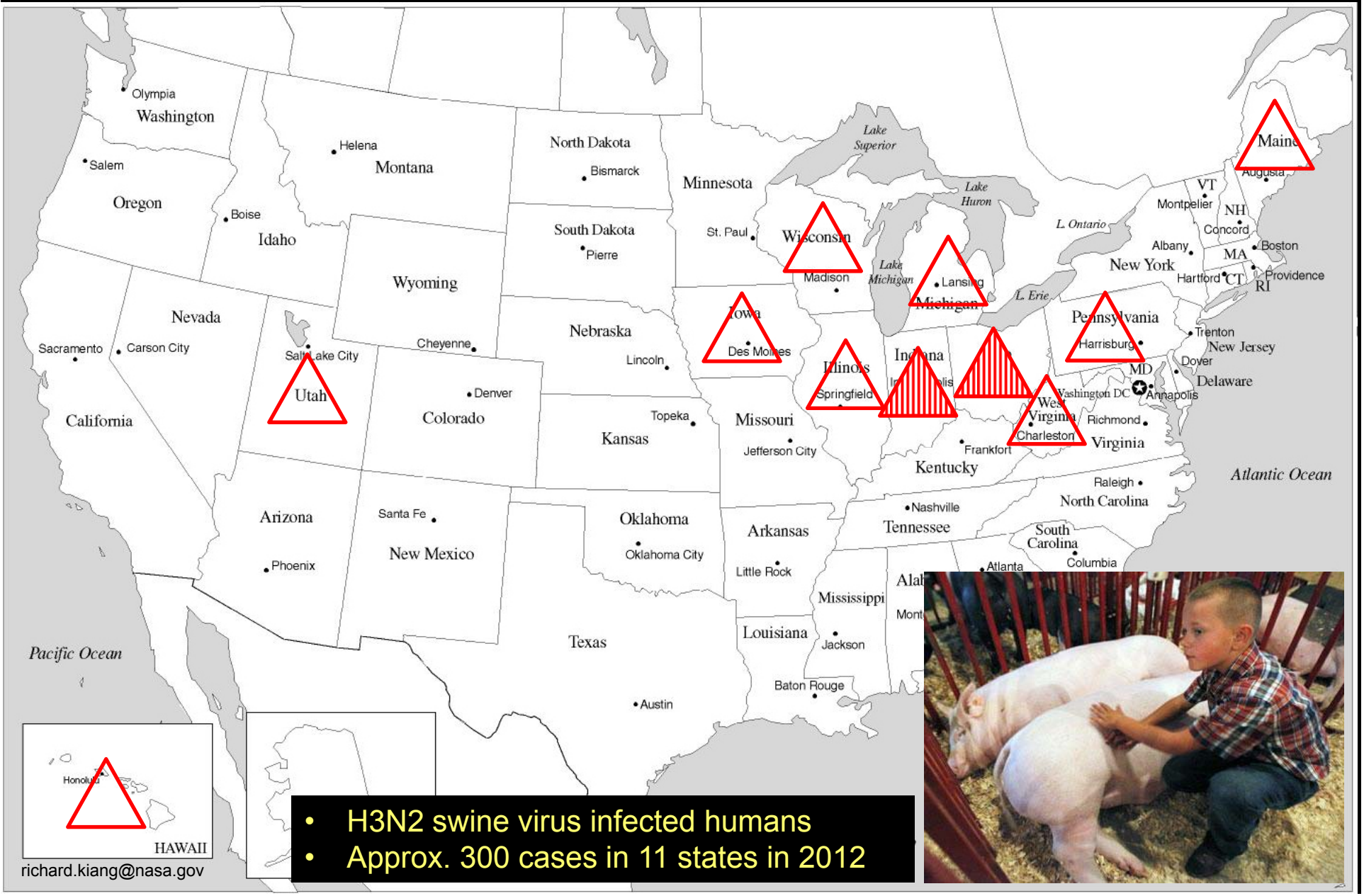
A(H3N2)v Swine Influenza Virus



- H3N2 swine virus infected humans
- Approx. 300 cases in 11 states in 2012

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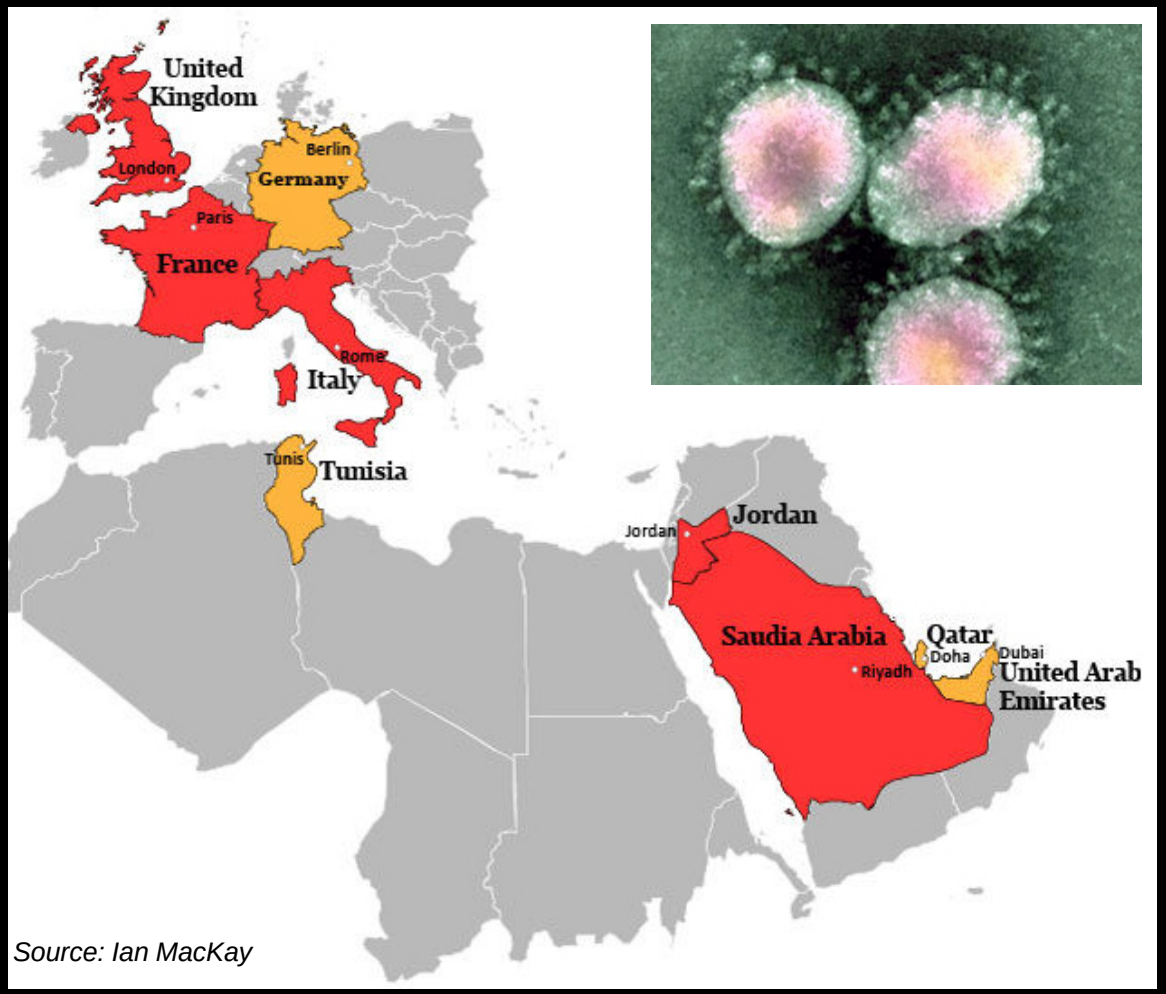
MERS-CoV / nCoV Middle East Respiratory Syndrome Coronavirus



Source: Ian MacKay

Pipistrellus pipistrellus

Taphozous perforatus

- First detected in Saudi Arabia in Sept. 2012
- As of mid-July, 82 cases worldwide with ~55% case mortality
- Possible reservoir & hosts: *Pipistrellus* bat, Egyptian tomb bat, and dromedary camel

A(H7N9) Avian Influenza Virus

- First reported in China on March 31, 2013
- As of August 10, 2013, 134 cases with ~32% case fatality
- One case spread to Taiwan
- Situation stabilized due to containment efforts or seasonal decrease of avian influenza circulation
- Human infection due to contact with infected poultry or contaminated environment
- No evidence for sustained human-to-human transmission
- 0.08% of samples from farms and markets tested positive
- Less pathogenic in poultry, asymptomatic human case discovered
- A(H7N7) was discovered and may pose more threats

Three Criteria for a Pandemic

- Novel virus
- Lack of population immunity
- Human-to-human transmission


THANK YOU