



# Viruses Emerging in Australia: The (Likely) Influence of Climate Change

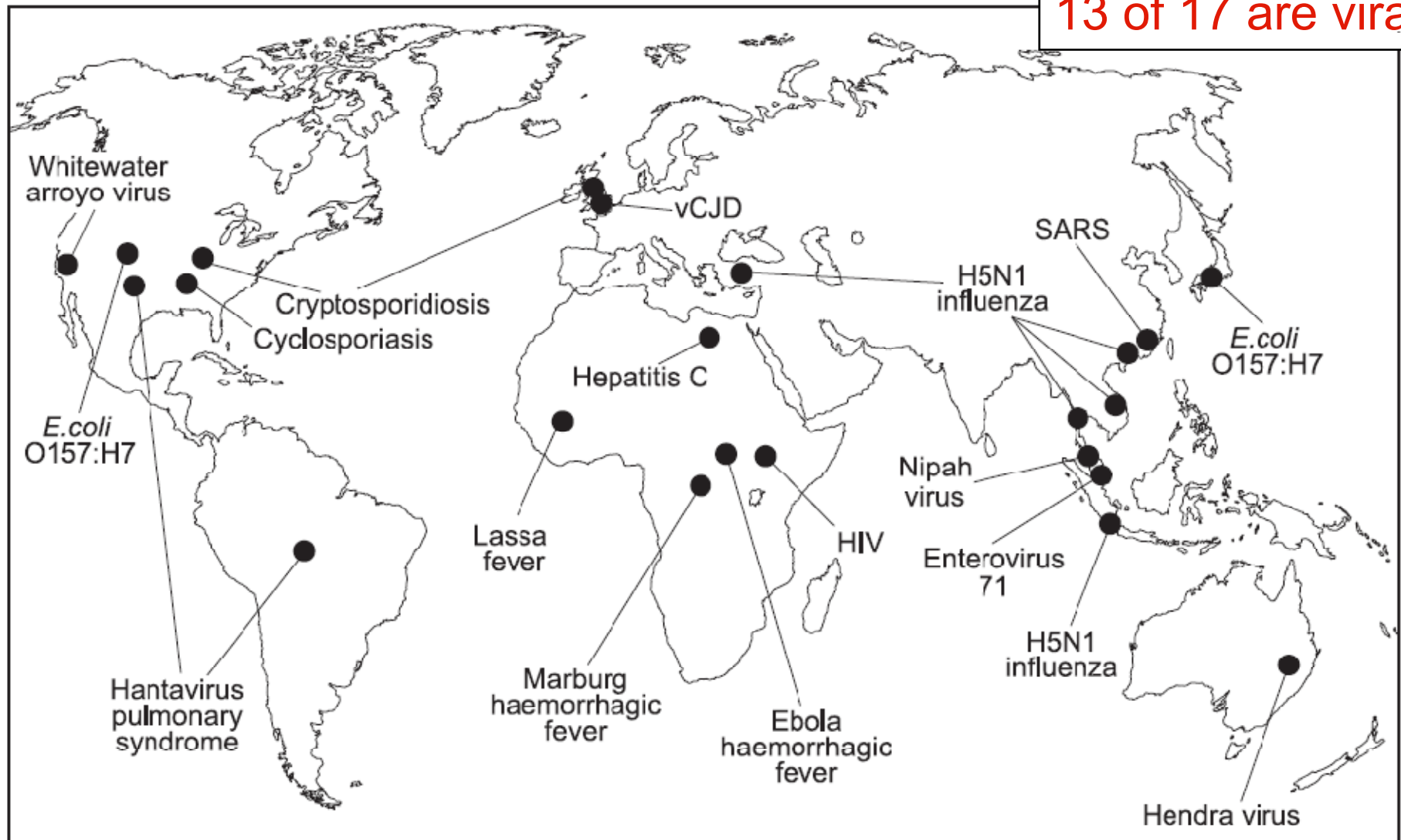
*Viruses in May, '10*  
*Katoomba*

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The Australian National University  
Canberra, Australia

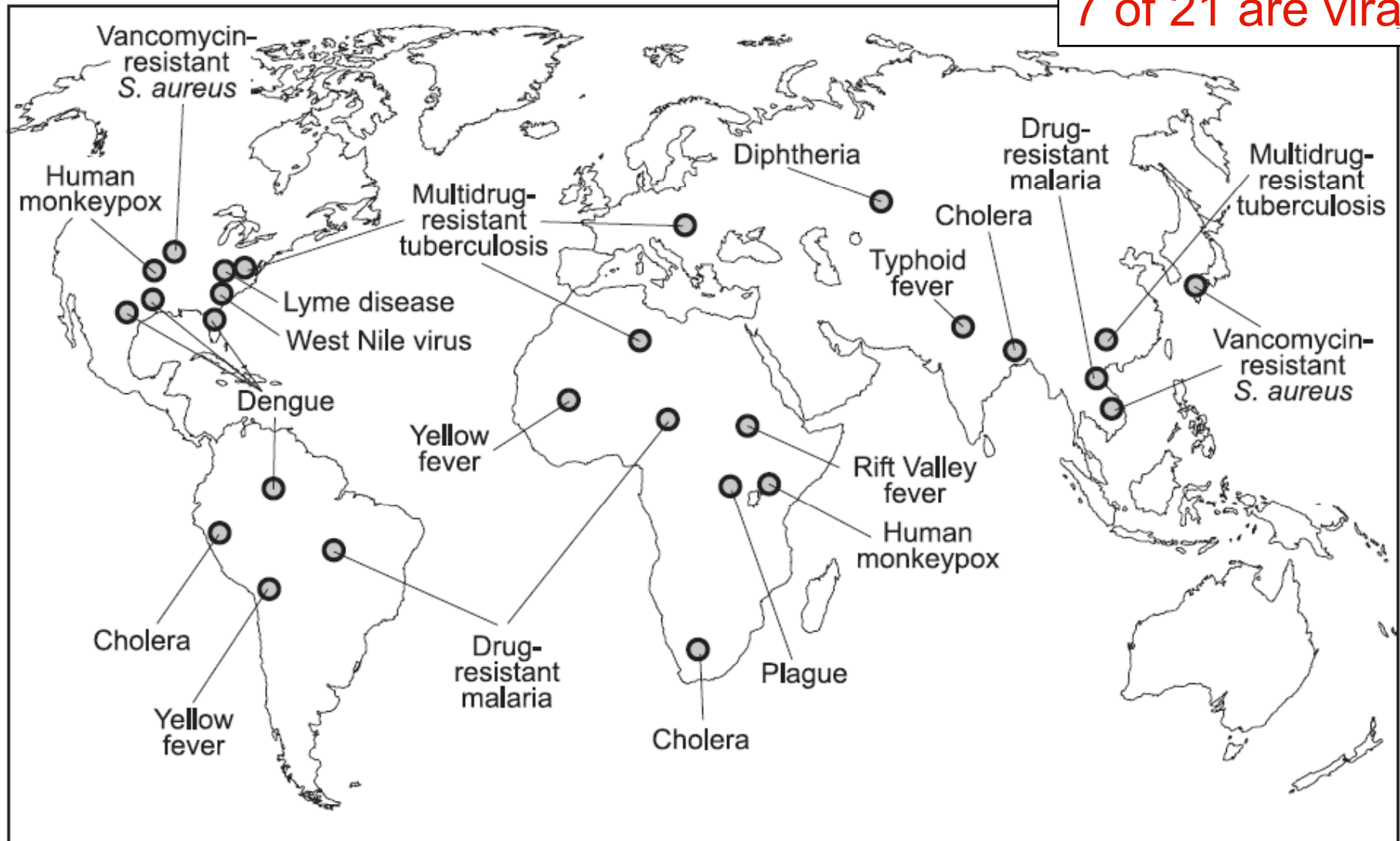
## Newly Emerging Diseases (Morens et al, 2004)

13 of 17 are viral



## Re-Emerging Diseases (Morens et al, 2004)

7 of 21 are viral



# Breaches in the species barrier:

## Selected emerging infections in humans since 1976



Infection	Animal linked to transmission	Year infection first reported
Ebola virus	Bats	1976
HIV-1	Primates	1981
<b>E. coli O157:H7</b>	Cattle	1982
<b>Borrelia burgdorferi</b>	Rodents	1982
HIV-2	Primate	1986
Hendra virus	Bats	1994
<b>BSE/vCJD</b>	Cattle	1996
Aust <sup>n</sup> lyssavirus	Bats	1996
H5N1 influenza A	Chickens	1997
Nipah virus	Bats	1999
SARS coronavirus	Palm civets	2003
Influenza (H1N1)	Swine	2009

# Major factors enhancing infectious disease emergence and spread

**Population growth, urban density:** crowds, contacts

**Peri-urban poverty:** privation, under-nutrition, poor hygiene

**Urbanization:** sexual relations, mobility, mixing, etc.

**Globalization:** distance/speed of travel/trade

**Intensified livestock production:** BSE/vCJD, Nipah virus, bird 'flu

**Live animal food-markets:** longer supply lines – SARS, HIV?, etc.

**Disrupted ecosystems:** dams, deforestation, biodiversity loss – e.g. various new Sth American rural haemorrhagic viral diseases

## Global climate change

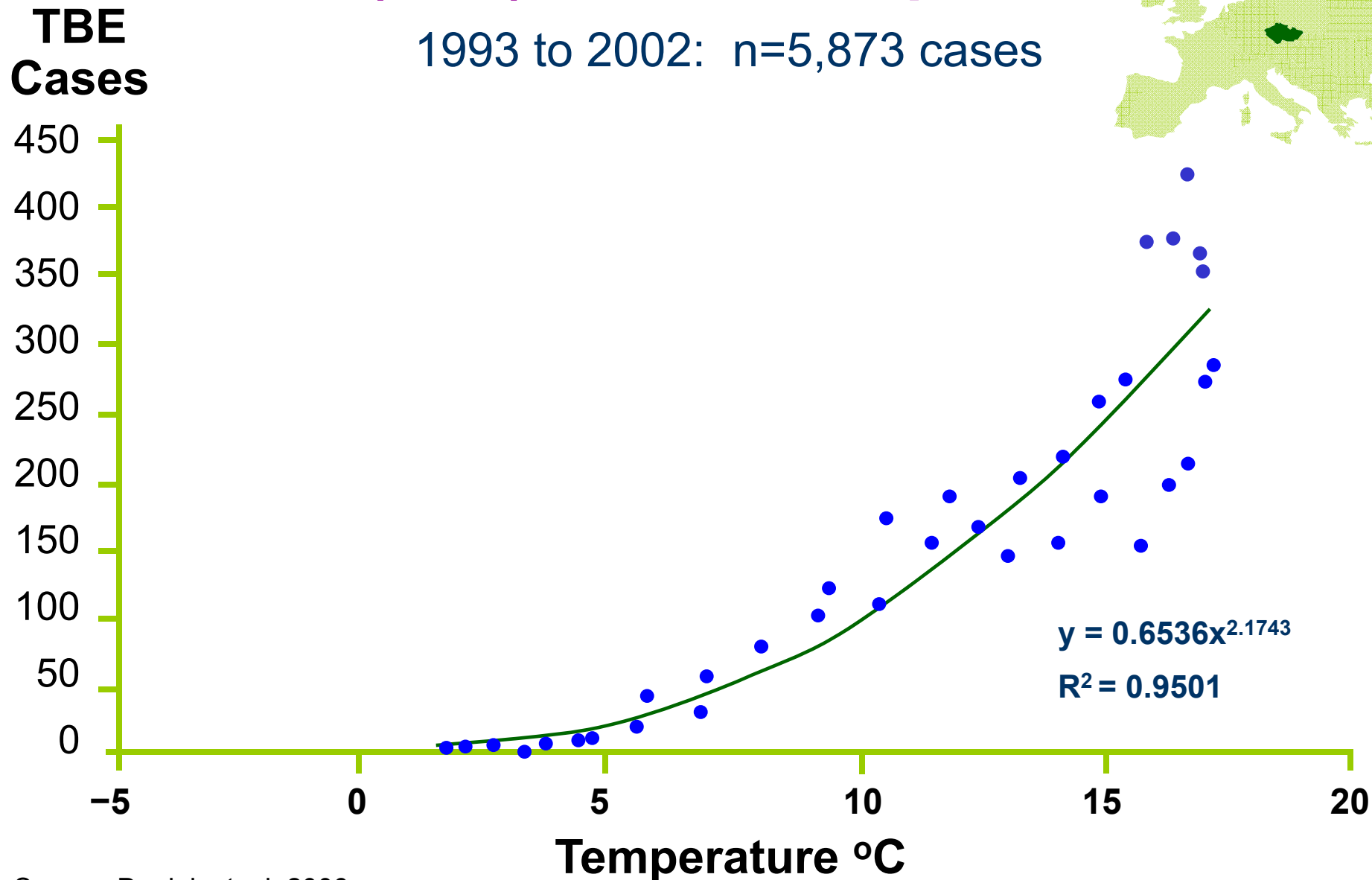
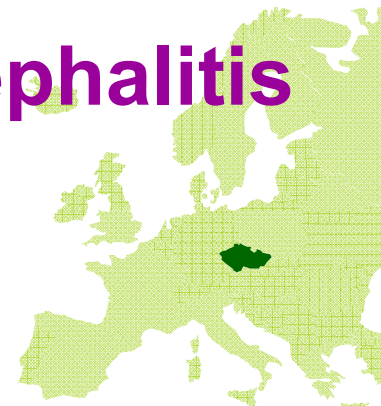
**Biomedical exchange of human tissues:** transfusion, transplants

**Antibiotic use/misuse:** humans, livestock production, house-plants

**Increased human susceptibility:** under-nutrition, population ageing, HIV, IV drug use, etc.

# Temperature and tick-borne encephalitis (TBE) in Czech Republic

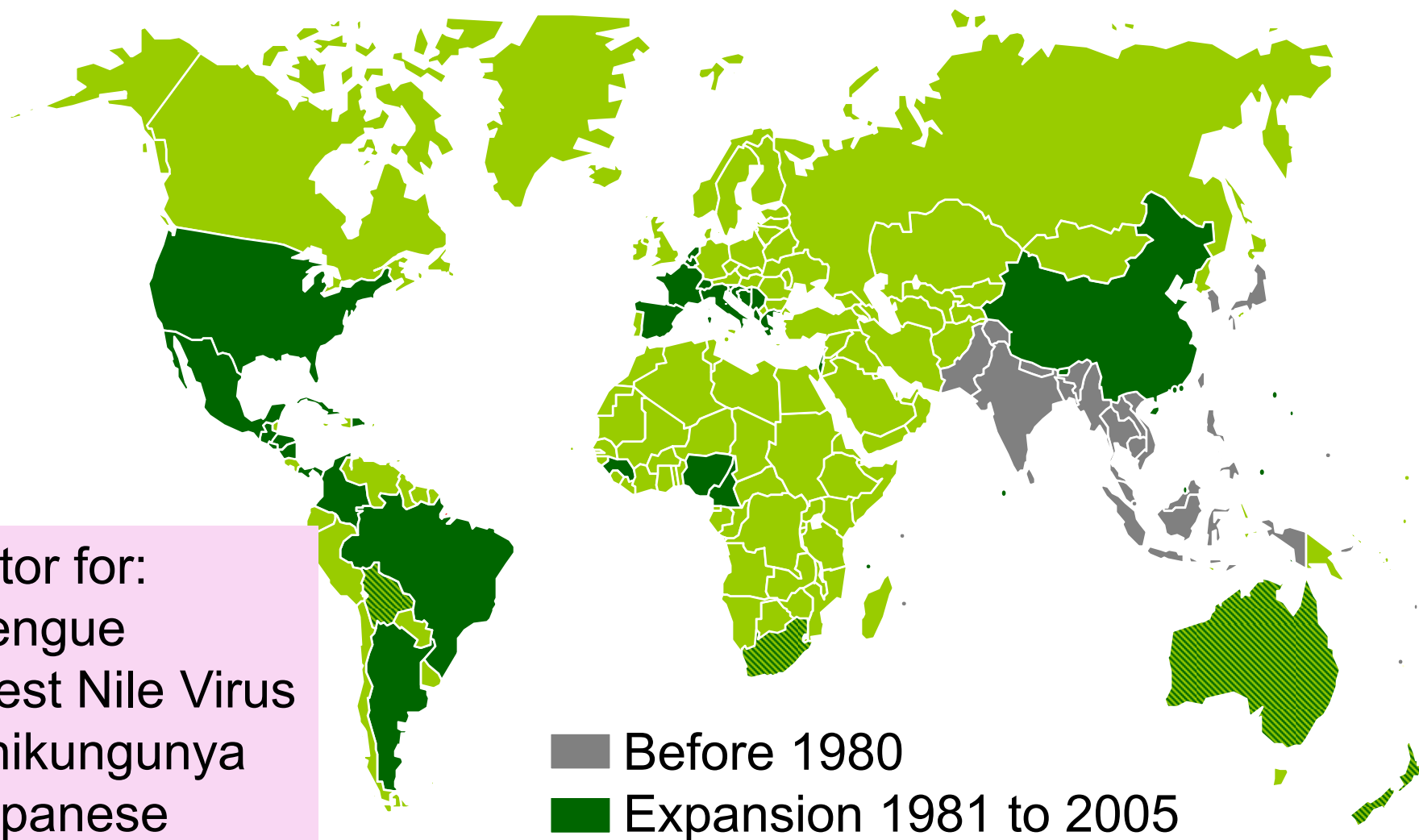
1993 to 2002: n=5,873 cases



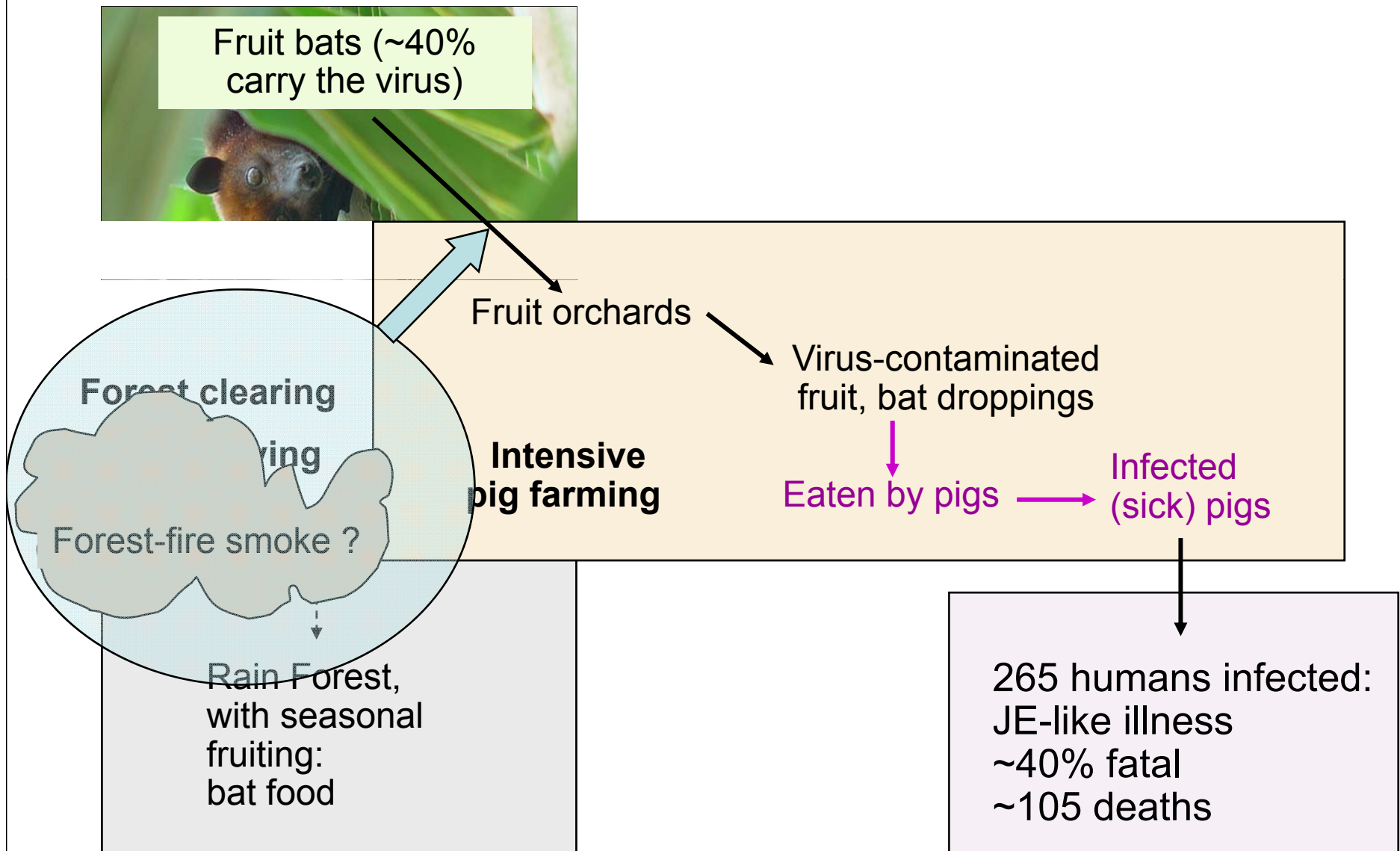
# Geographical distribution of *Aedes albopictus*\* mosquito

Vector for:

- Dengue
- West Nile Virus
- Chikungunya
- Japanese encephalitis

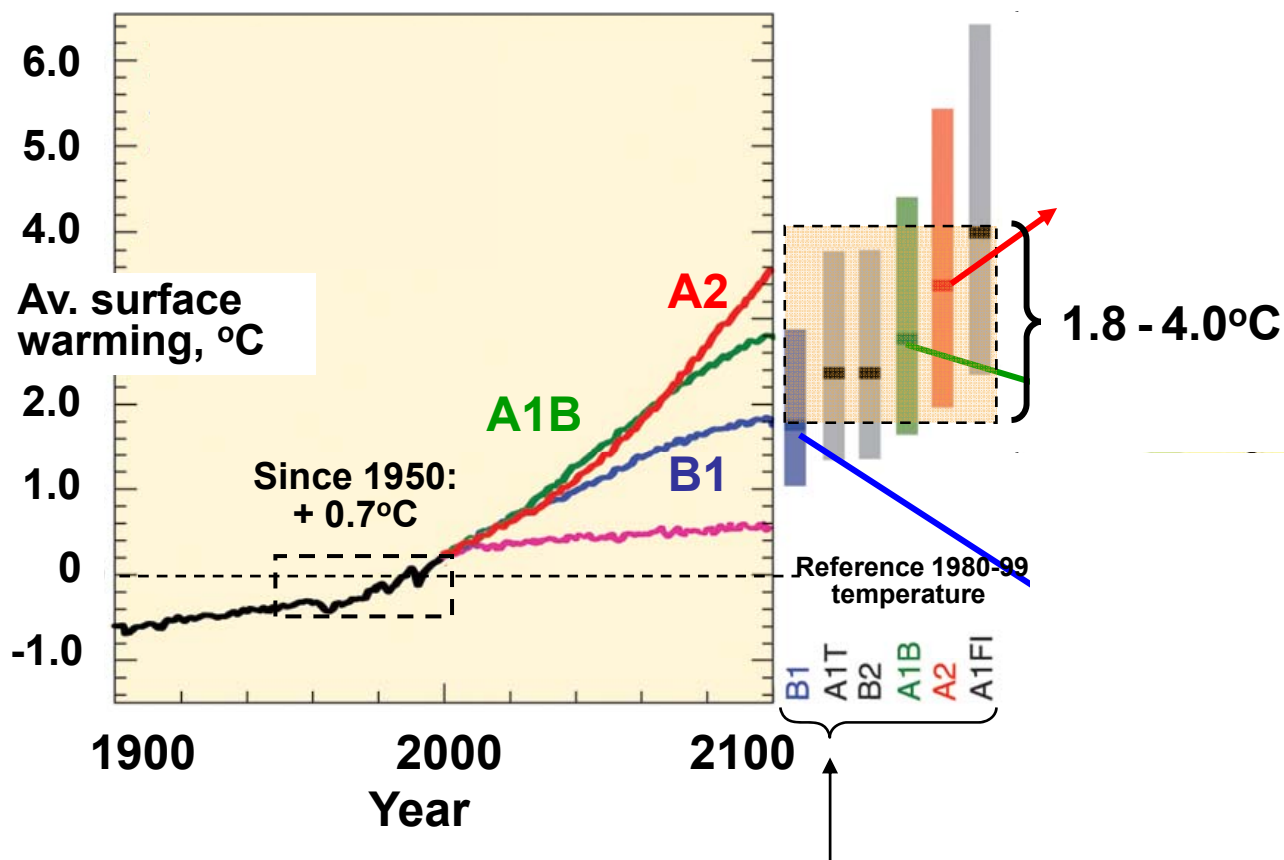


# Nipah Virus Disease: Outbreak in Malaysian Pig Farmers, 1997-1999



# Projected Global Warming: IPCC (2007)

combined results of multiple model runs published by ~20 different modelling groups around world

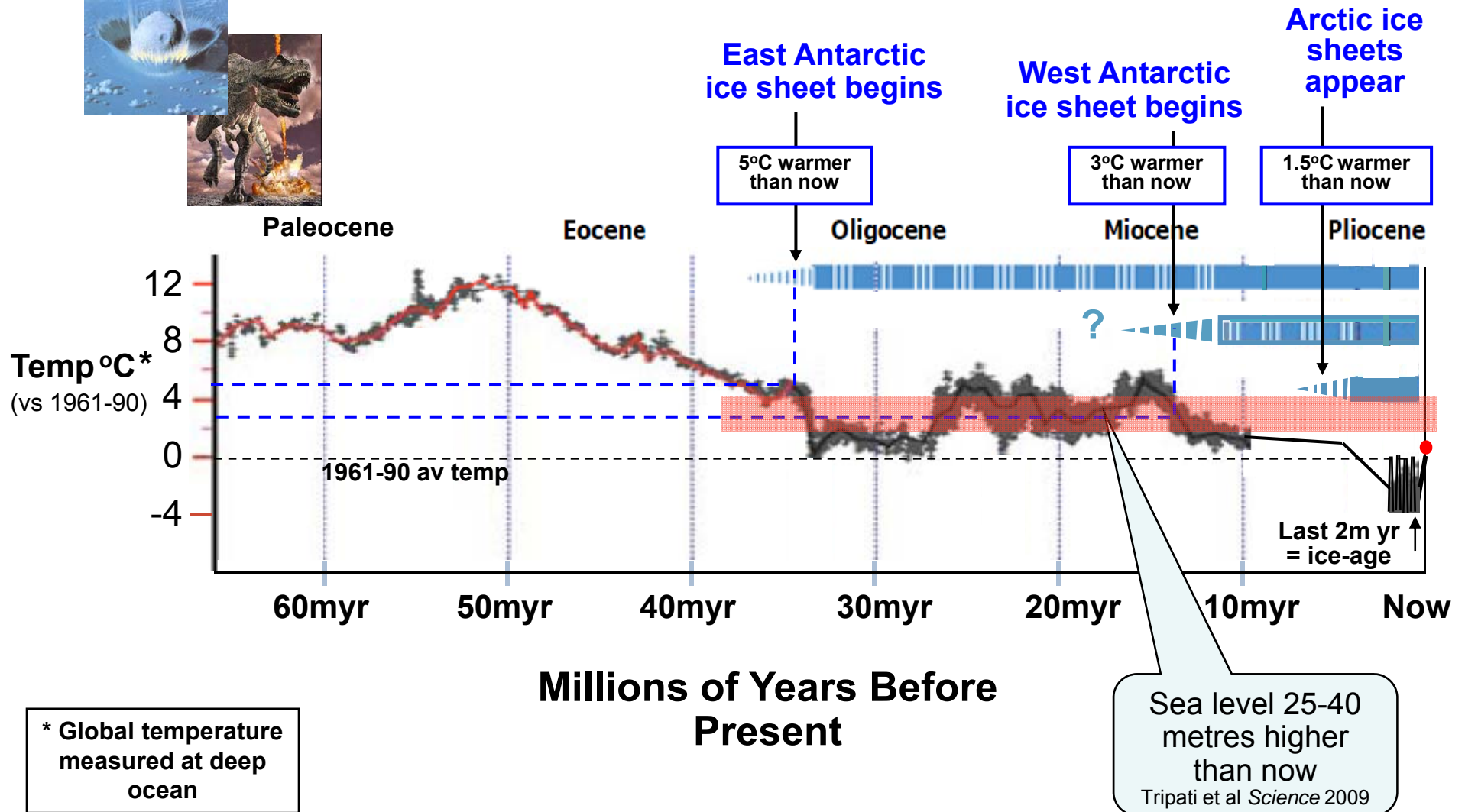


Temperature projections, for 3 (of 6) different emissions projections:

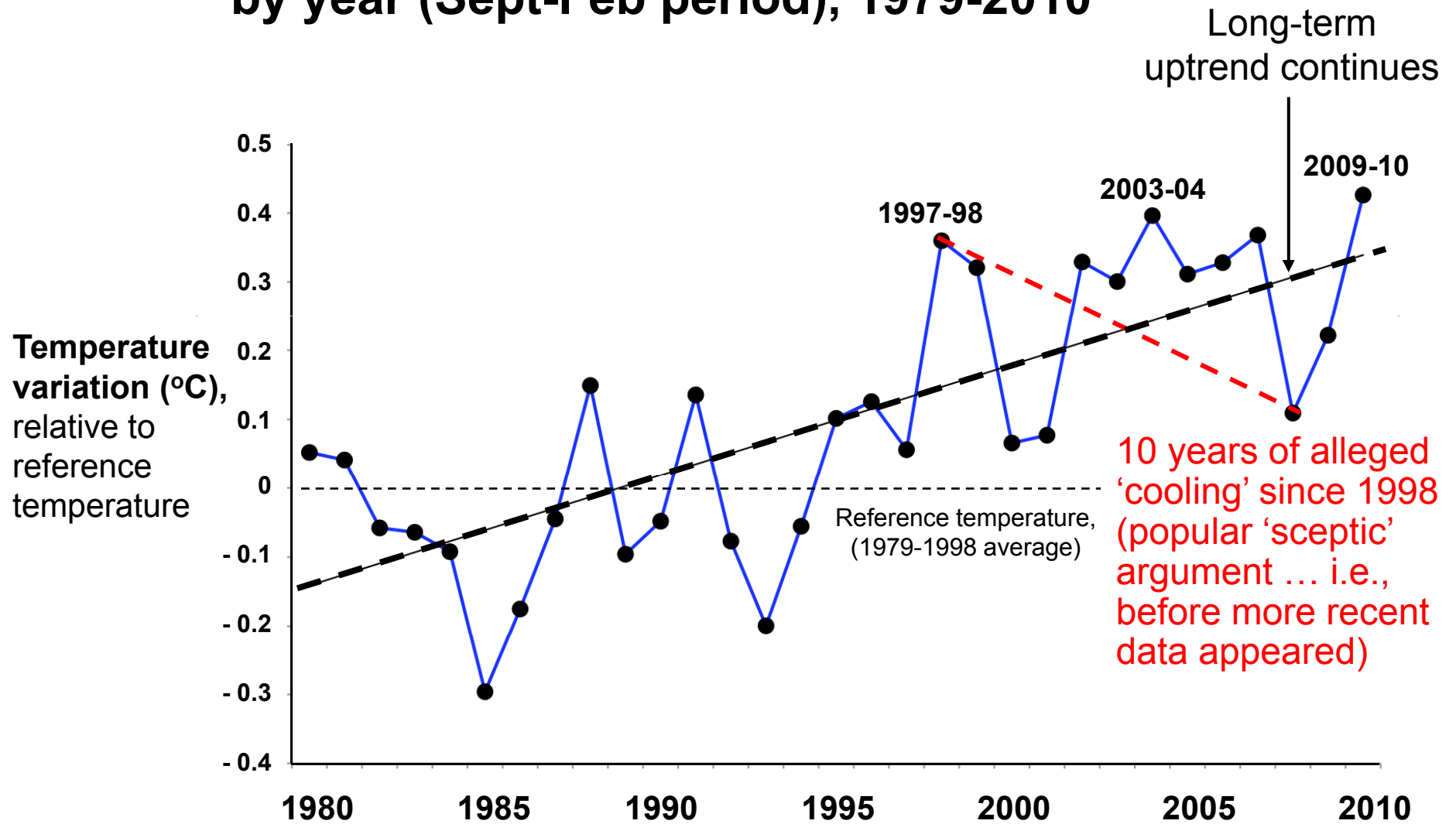
- A2** relatively high
  - A1B** mid-level
  - B1** low
- emissions
- Atmosphere concentrations remain as in 2000

INTERGOVERNMENTAL PANEL ON  
CLIMATE CHANGE, 2007

# Earth's Temperature Chart, since Dinosaur Extinction 65m yrs ago



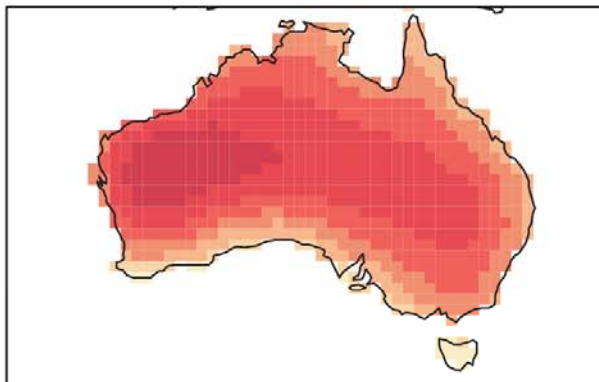
# Satellite-based measures of average global temperature (near-surface lower atmosphere), by year (Sept-Feb period), 1979-2010



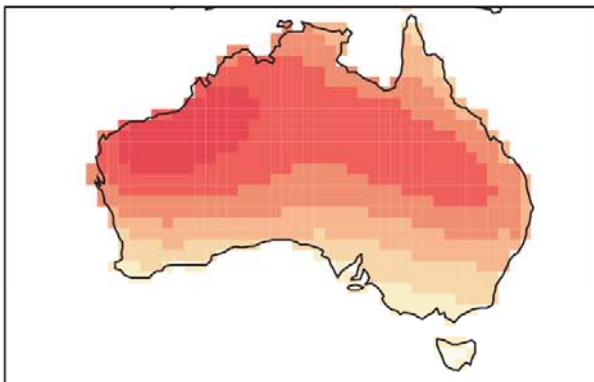
Monthly data from: <http://data.giss.nasa.gov/gistemp/tabledata/GLB.Ts+dSST.txt>

# Aust. Bureau of Meteorology: Projected Temperature Rises to 2030

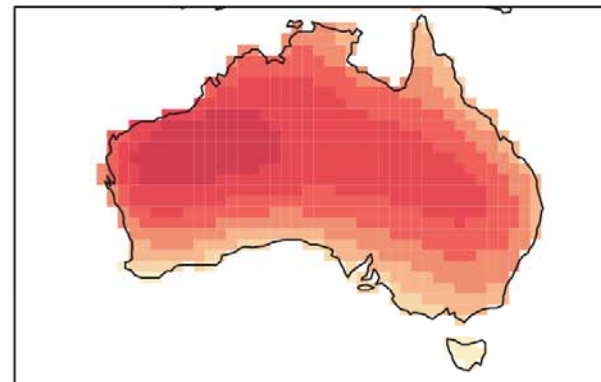
Summer



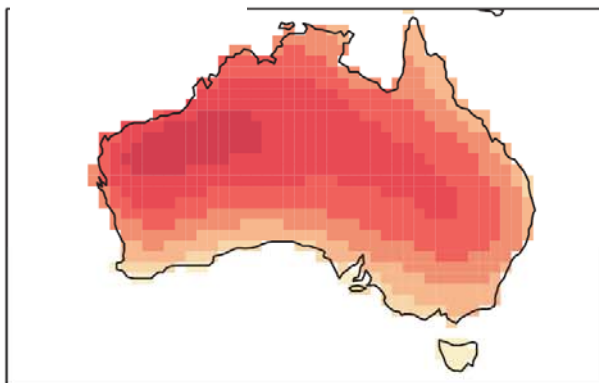
Winter



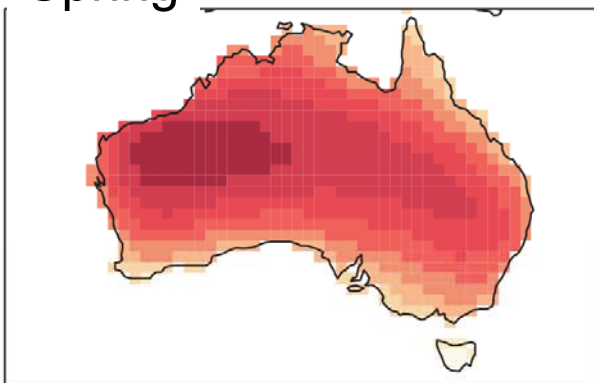
ANNUAL



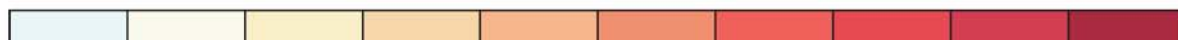
Autumn



Spring

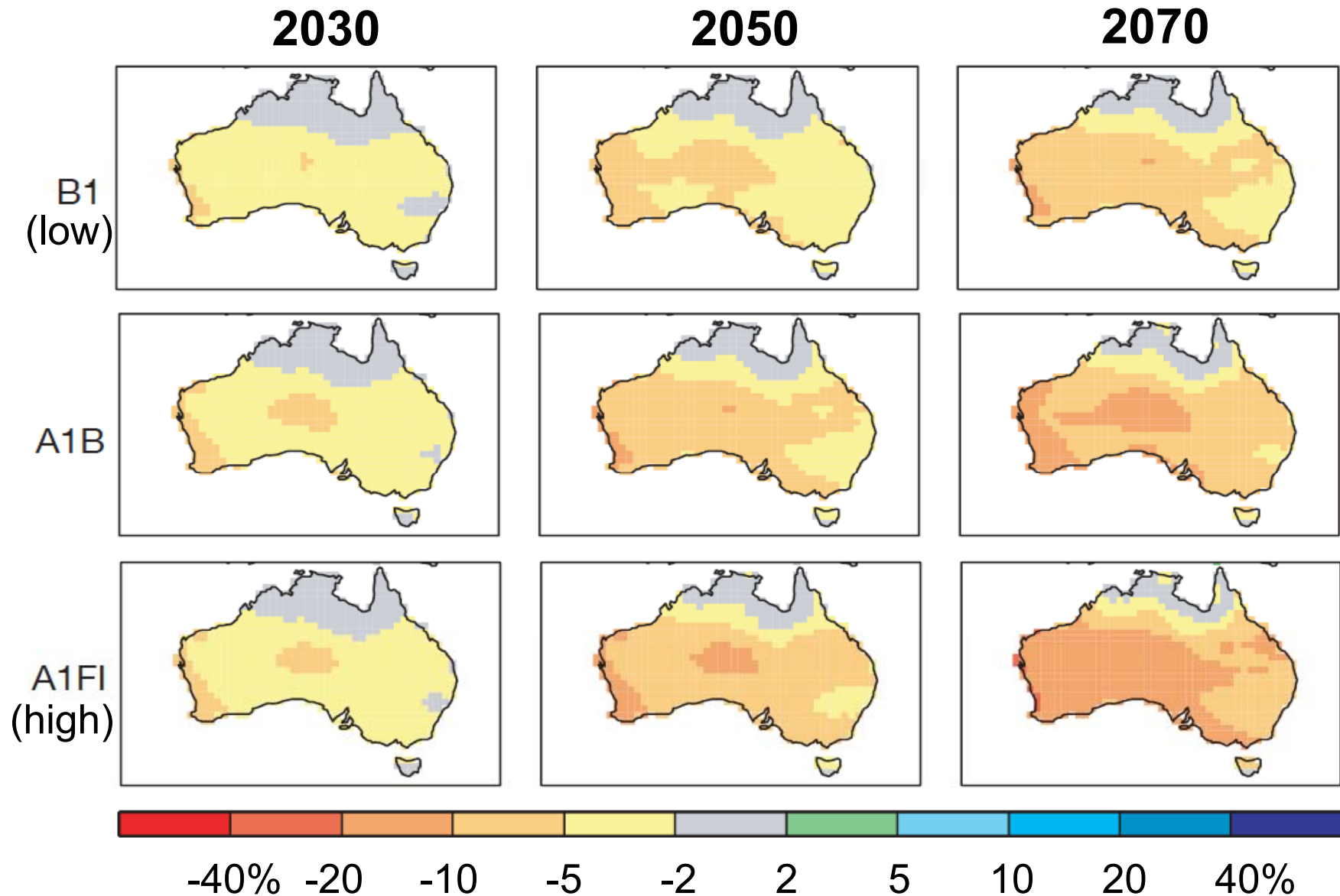


Best estimate (50<sup>th</sup> percentile) of change in average temperature (°C) over land by 2030 for A1B emission ('medium') scenario



0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3

# BoM: Best estimates of annual % change in precipitation (3 global emissions scenarios)



# Climate and Infectious Disease

Climatic conditions set the geographic and seasonal boundaries of *potential transmission*.

Other environmental, social and behavioural factors – and public health strategies – determine where/when *actual transmission* occurs.

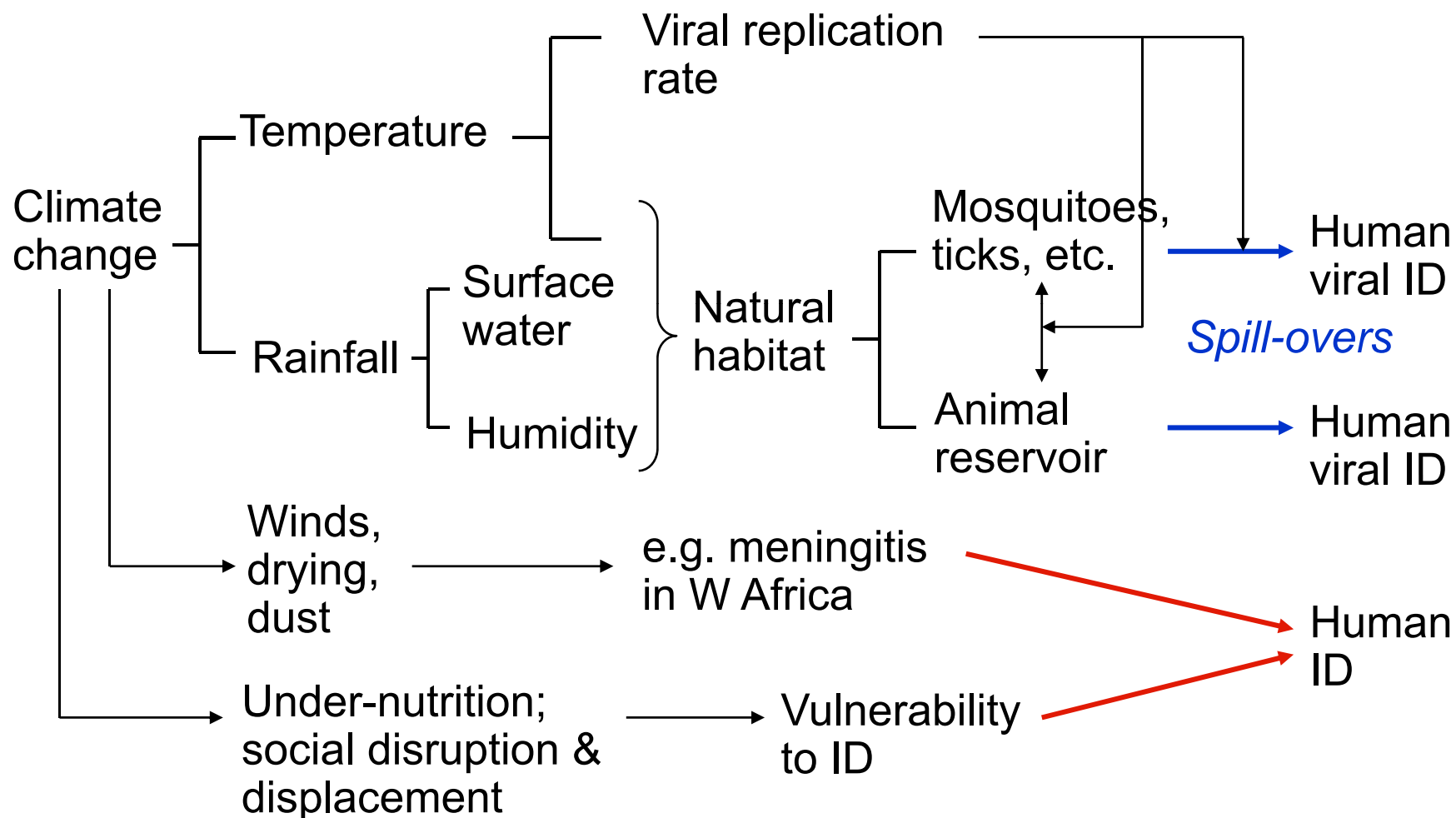


Lyme disease: white-footed mouse and its acorn feed

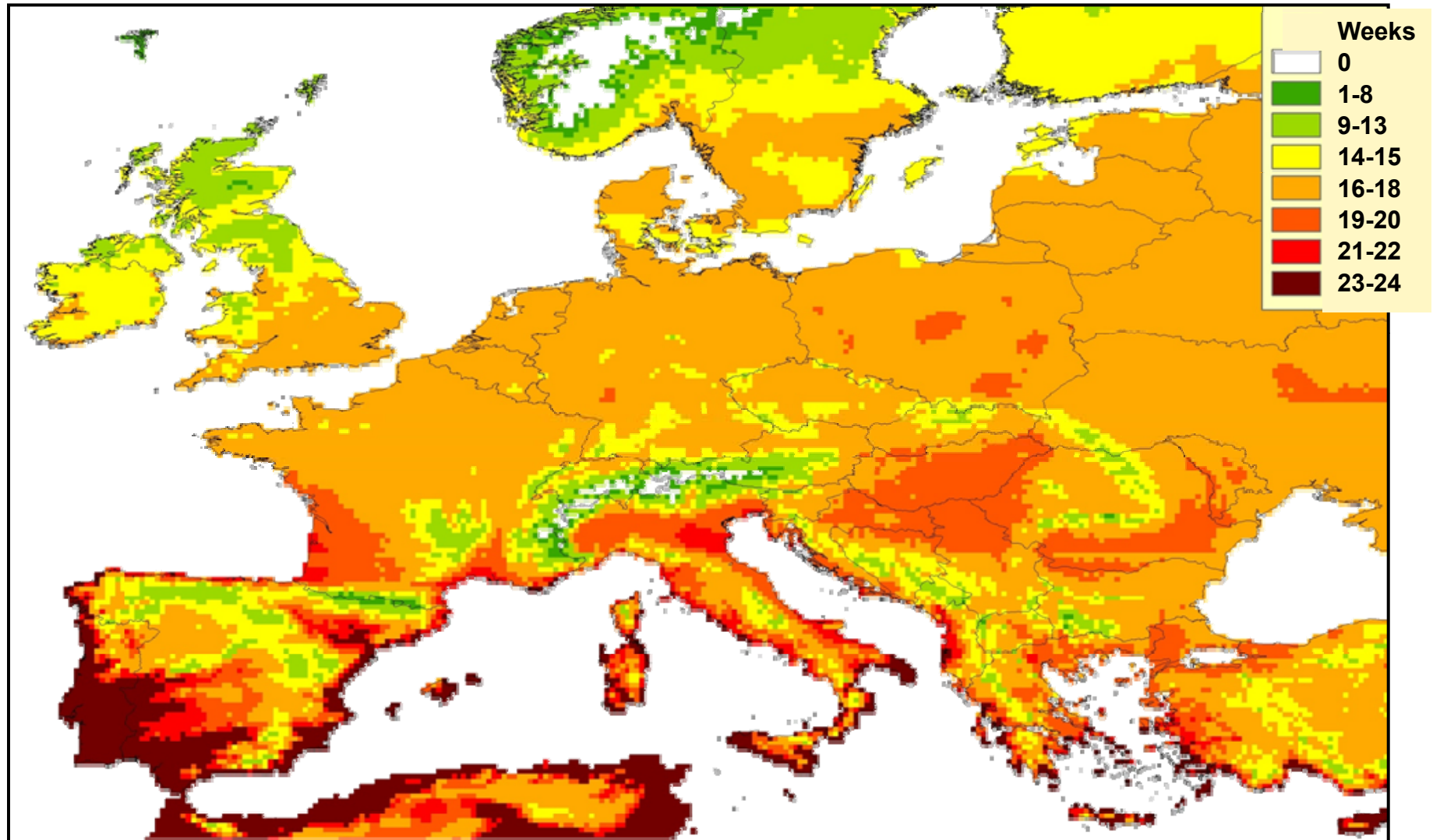
# Zoonoses: Climatic and Seasonal Variations in Vector and Host-Species

- **Vector-borne zoonoses mostly maintained by wildlife**
  - Humans are incidental to their ecology
- **Vectors and animal host species undergo seasonal and inter-annual variations in numbers and activities**
  - Vector activity reflects temperature and humidity
  - Host species population size and distribution affected by weather and (climate-related) resource availability
- **Pathogen may also be affected by climatic conditions**

# Climatic Influences on Viral Disease Occurrence



## Potential weeks of activity of *Aedes albopictus* mosquito in Europe (current): Spring hatching to Autumn diapause



Schaffner F, et al. Development of *Aedes albopictus* risk maps. ECDC, Stockholm 2008. (Forthcoming.)

# Climate Change and Viral Diseases of Interest in Australia

## Vector-borne

*Human only:* Dengue fever, Chikungunya (?)

*Zoonotic:* Ross River, Barmah Forest, MVE, Kunjin, Japanese encephalitis

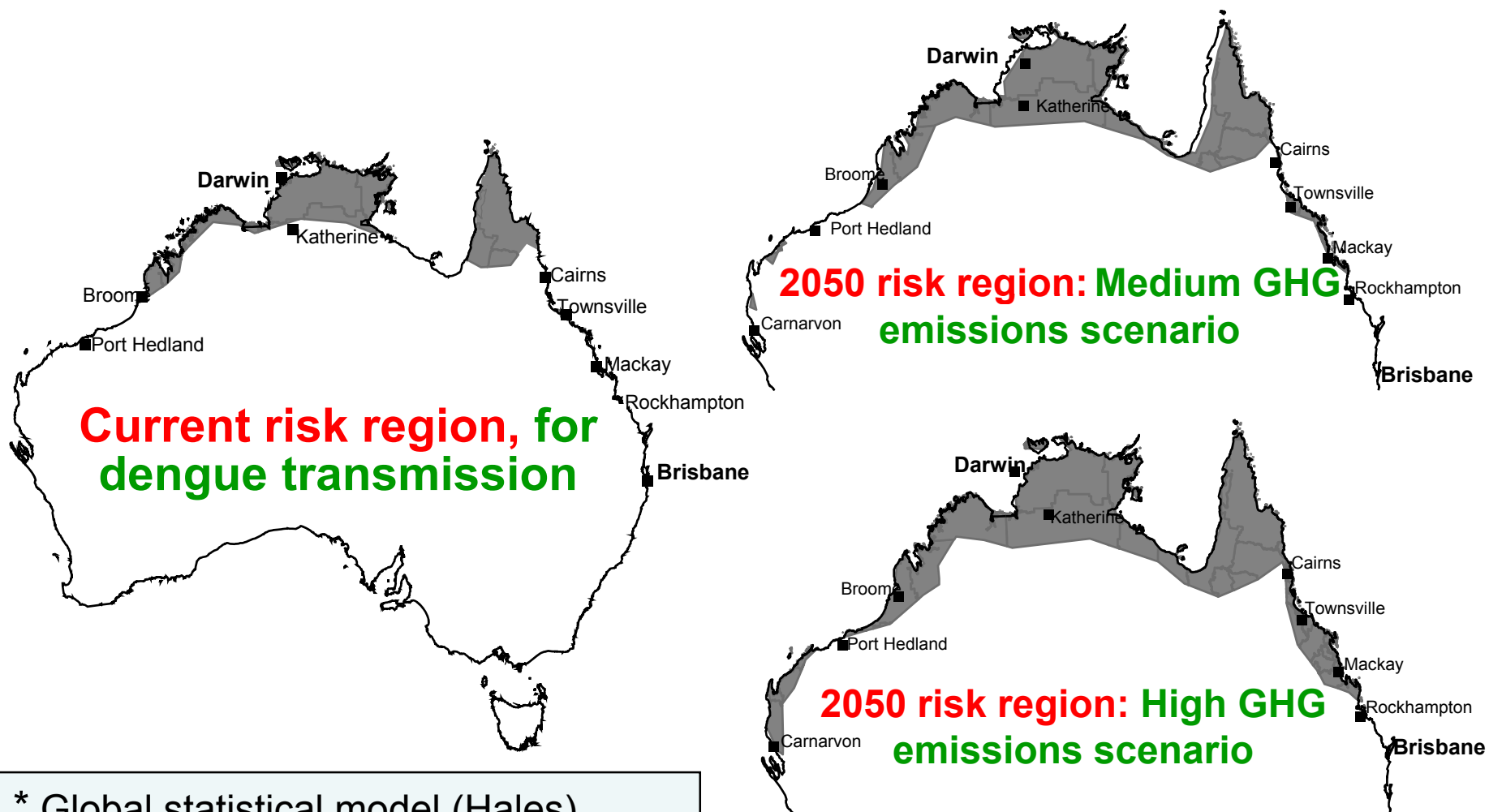
## Contagious, person-to-person

Influenza (emergence and spread of new strains)

Respiratory syncytial virus

?? Changes in contact probabilities and behaviours  
- hep B, hep C, HPV, HIV

# DENGUE FEVER: Estimated geographic region suitable\* for *A. aegypti* vector, and hence transmission: Climate conditions now and in alternative scenarios for 2050

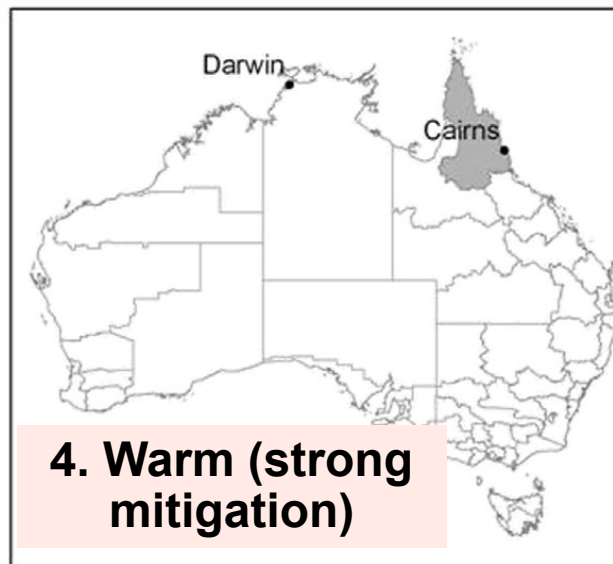
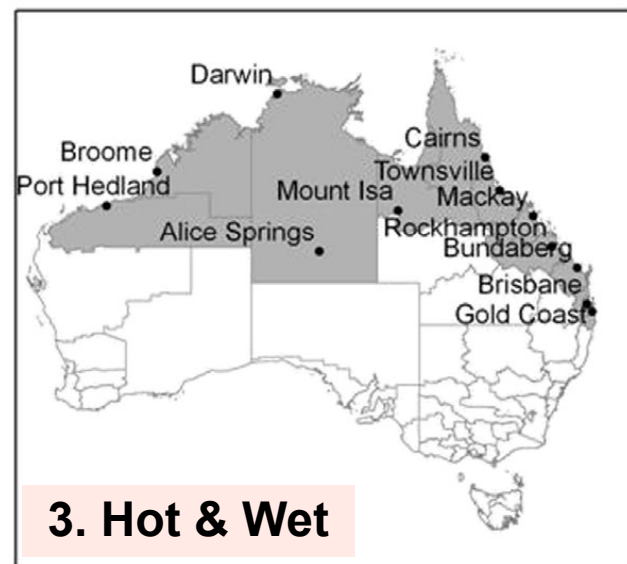
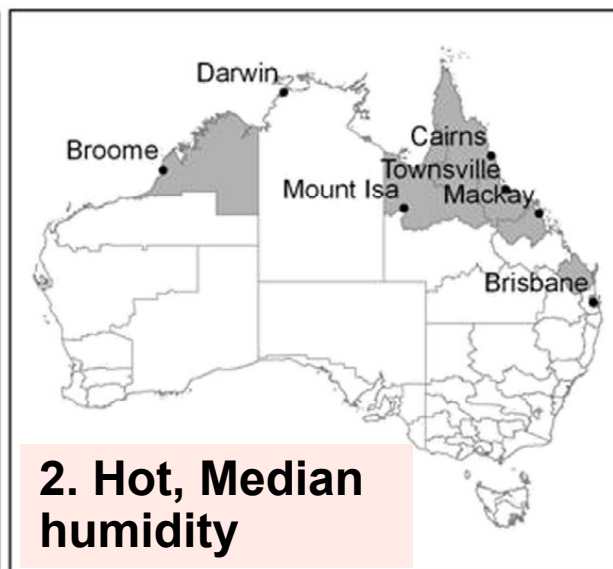
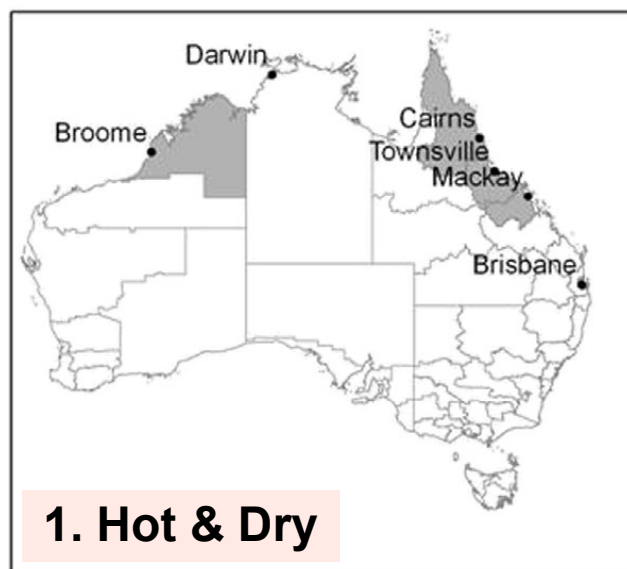


\* Global statistical model (Hales), applied to Australia: Function of water vapour pressure (rainfall humidity).

NCEPH/CSIRO/BoM/UnivOtago, 2003

# Areas suitable for **dengue transmission** in 2100 under 4 climate change scenarios (grey = $\geq 50\%$ likelihood of transmission)

Bambrick et al., 2009, *Global Hlth Action*

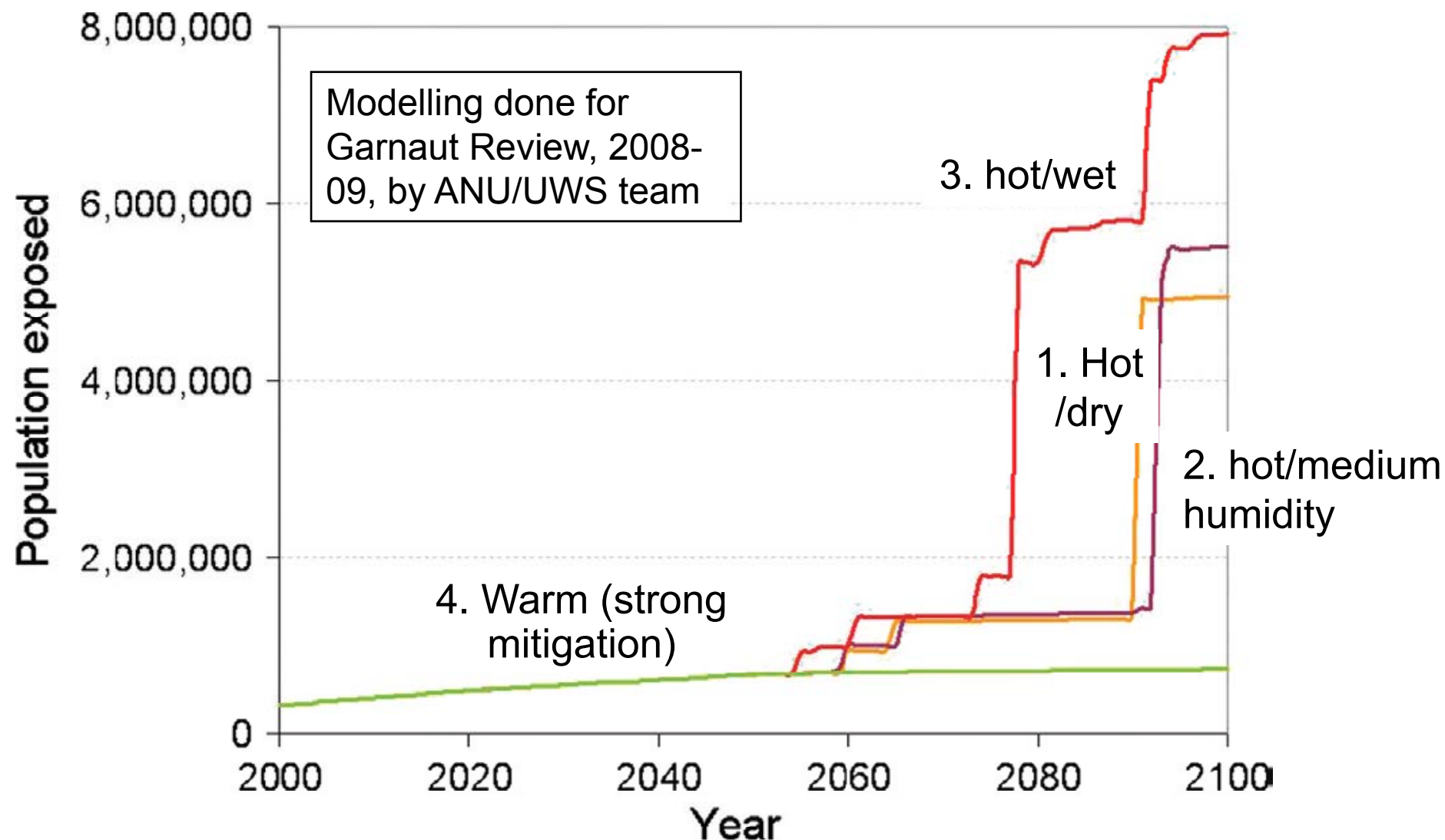


- Major towns
- Statistical Divisions (SD)
- SD with dengue risk in 2100

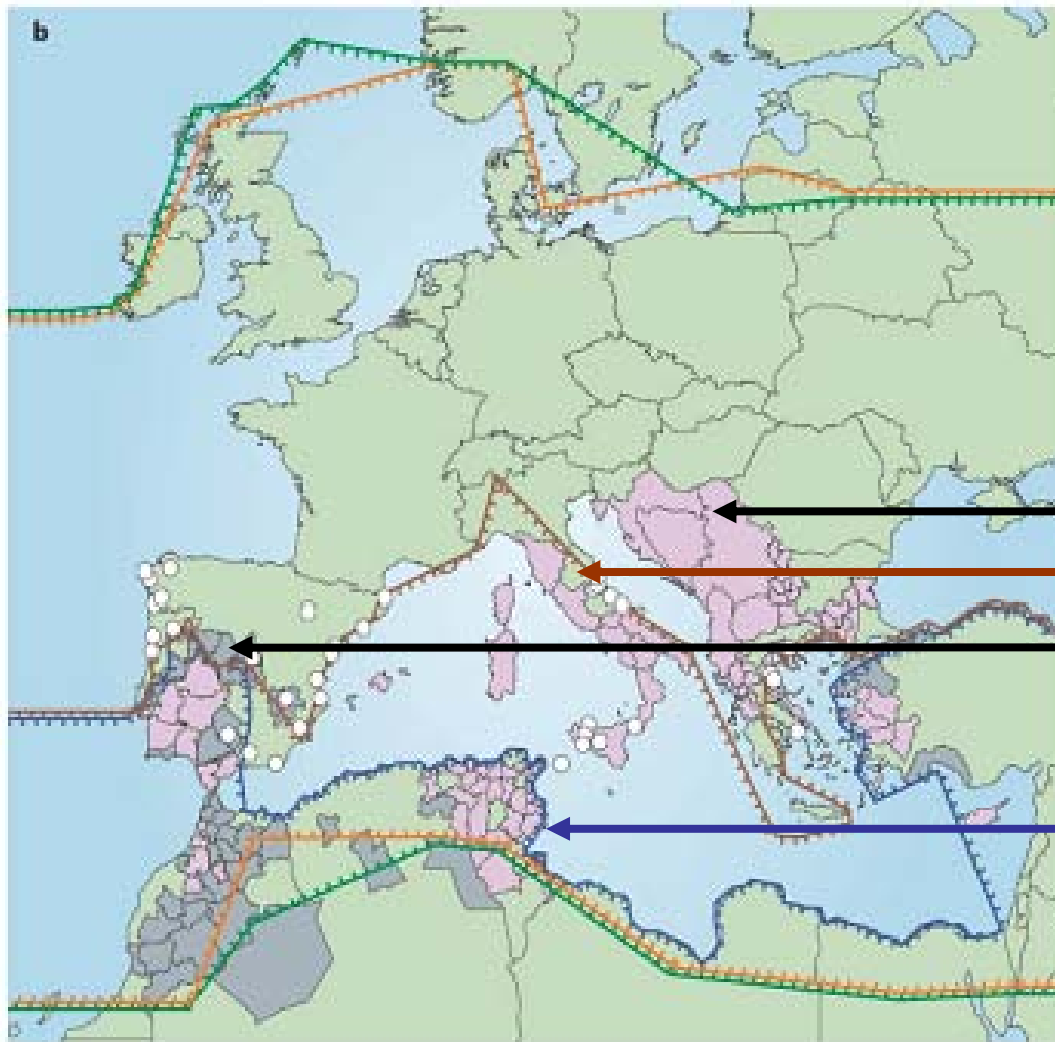
Map-projection of changes to rainfall across Australia to 2100 under 'dry' and 'wet' scenarios. Based on published literature, then modelled how these changes would affect disease distribution over space and time.

0 1,000 2,000  
Kilometres

## No. of people in regions at high risk ( $\geq 50\%$ ) of dengue transmission, under four climate change scenarios



Is climate change increasing the northern limit of *Culicoides* vectors of Bluetongue virus in Europe?



Northern range of virus: **2004**

Northern limit, *C. imicola* group: **2004**

Northern range of virus: **< 1998**

Northern limit, *C. imicola* group: **< 1998**

○ Sampled absences before 1998    ■ BTV or AHSV affected before 1998    ■ BTV affected 1998–2004

***C. pulcaris***

***C. Obselitus***

***C. imicola***



Northern limit



Current northern limit



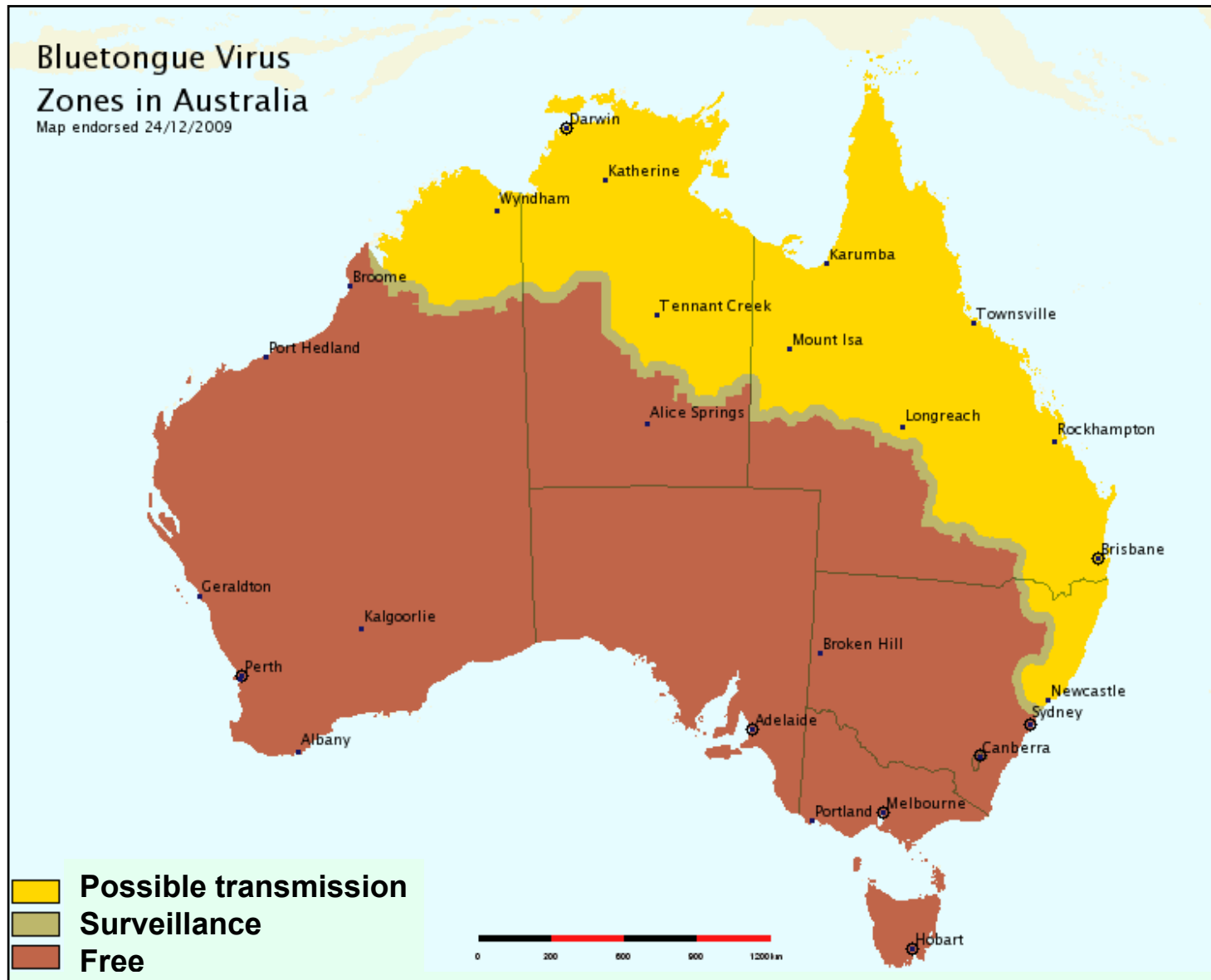
Southern limit



Northern limit < 1998

Source: Purse et al, 2005  
*Nature Reviews Microbiology*

## Bluetongue Virus Zones in Australia, December 2009



Surveillance data on distribution of bluetongue and culicoides vector from National Arbovirus Monitoring Program, administered by Animal Health Australia

**Eric Barron: Beyond Climate Science**

***Science* 2009; 326: 643**

**Editorial**

**“Currently, 40 years of intensive climate model development is being coupled to what amounts to a cottage industry of impact sciences.**

**“The result is that our understanding of how ecosystems, water, human health, agriculture, and energy will respond to climate change advances only slowly.”**