Modelling vector borne diseases driven with climate model data – is there a role for EO?

Advancing planetary epidemiology through Earth Observation

Andy Morse

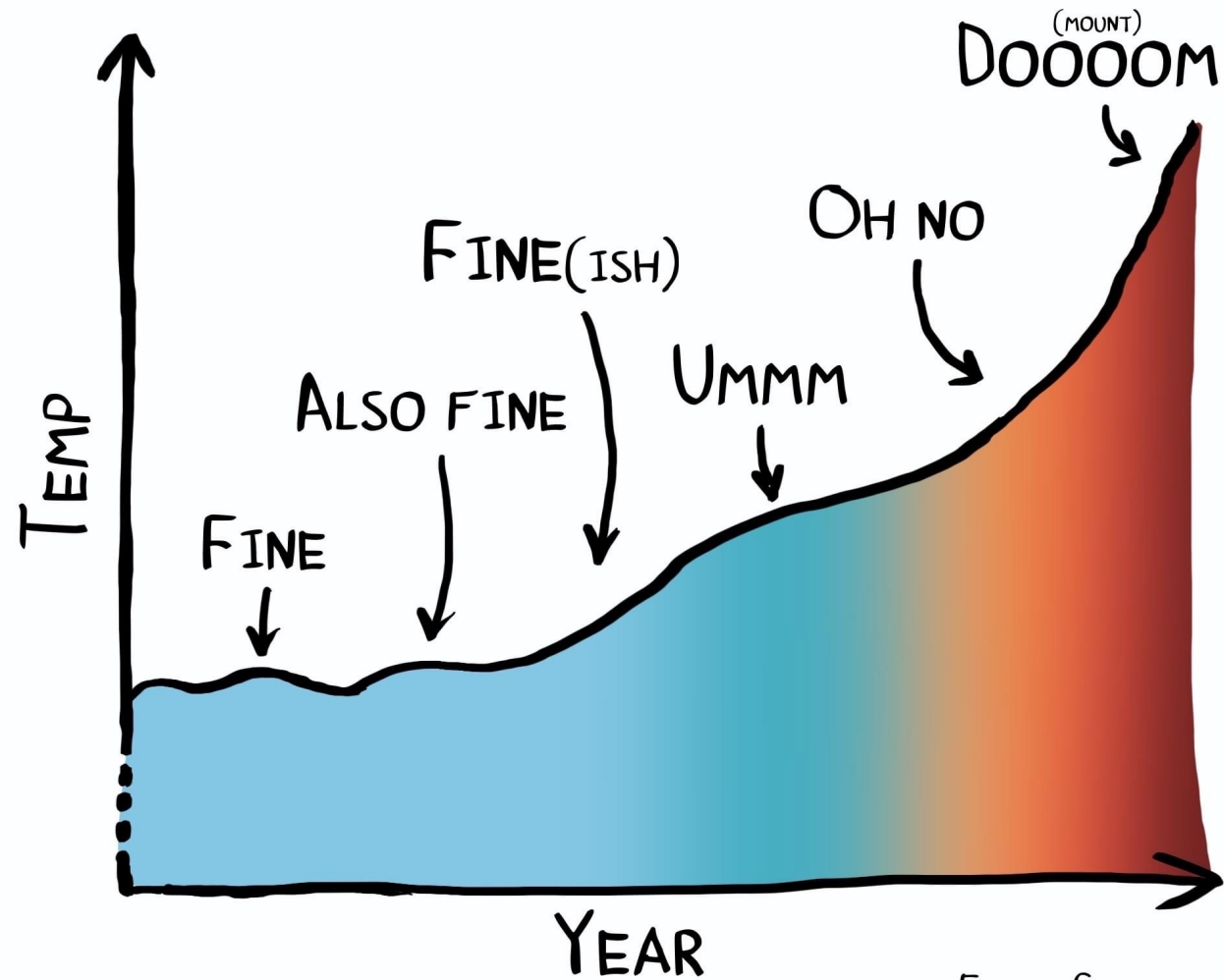Professor of Climate Impacts, University of Liverpool

A.P.Morse@liverpool.ac.uk

@AndyMorse @livuniwx

Future Earth Health : Knowledge Action Network

https://futureearth.org/networks/knowledge-action-networks/health/

UNIVERSITY OF LIVERPOOL

futurearth

Data and Uses

- **Climate data**

  Gridded reanalysis & satellite rainfall estimation, seasonal time scales - predictions, climate change time scales - projections. **Ensemble prediction systems and multiple climate models.**

- **Disease and Vector Models**

  Climate envelop approaches, thermally driven compartmental SEIR daytime step models data, to lagged ODE solving each time step with diurnal cycles and R_0 (blue tongue) and (rarely) statistical models

  - preference dynamical models with parameters – climate data driven.

- **Research Examples (eight infectious diseases, more in prep.)**
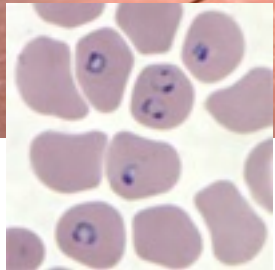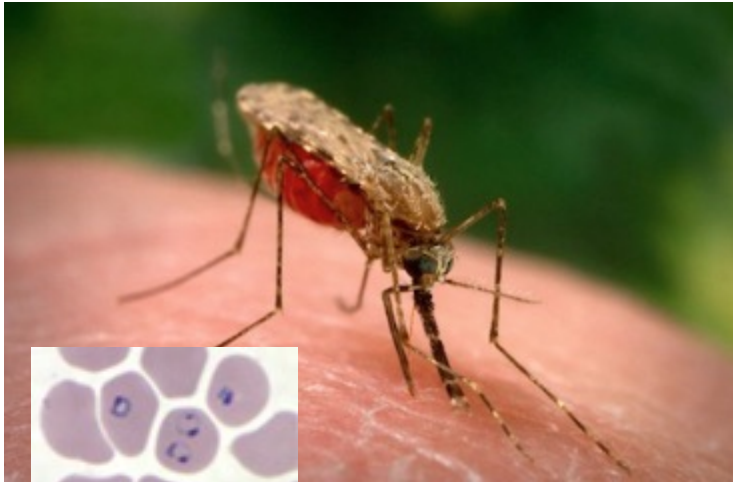
  blue tongue – Europe; malaria, Rift Valley fever – Africa, dengue – India, China
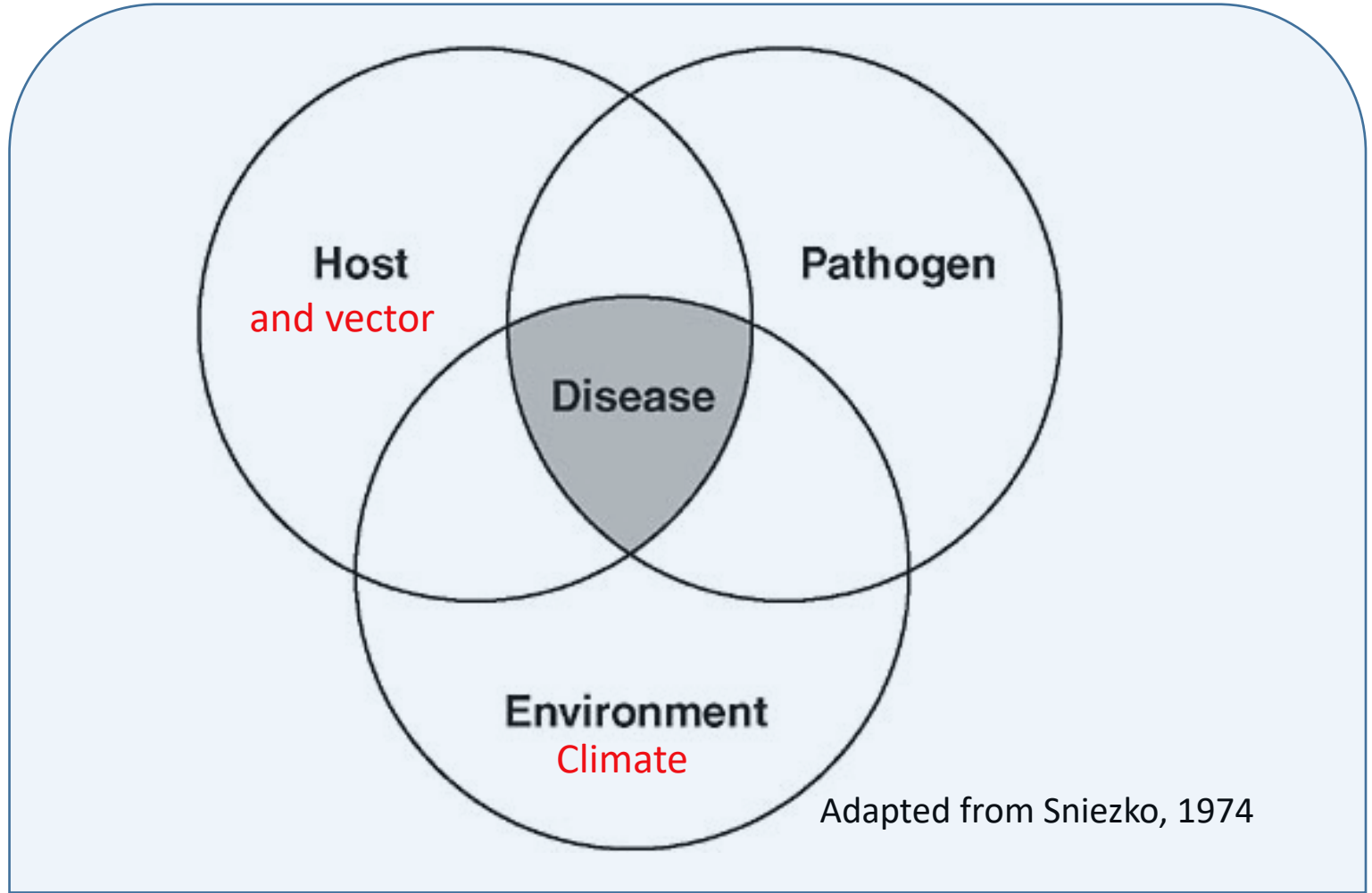 *Uncertainty, operationality …*

  * Hydrometeorlogy and agrometeorology but no disease equivalent

Vector Borne Infectious Disease

Rift Valley fever

malaria

Host
and vector

Pathogen

Disease

Environment
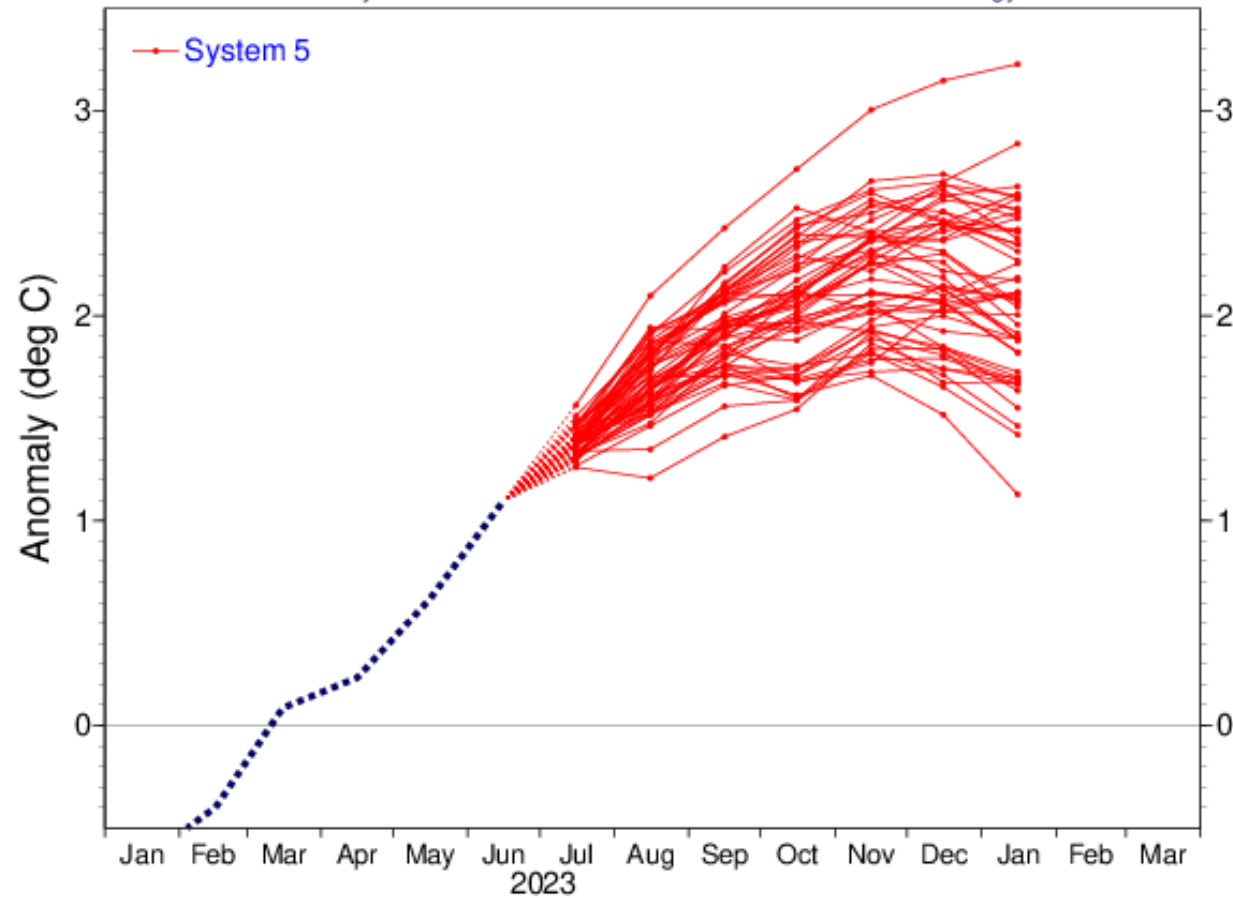Climate

Adapted from Sniezko, 1974

UNIVERSITY OF
LIVERPOOL

El Niño is here!

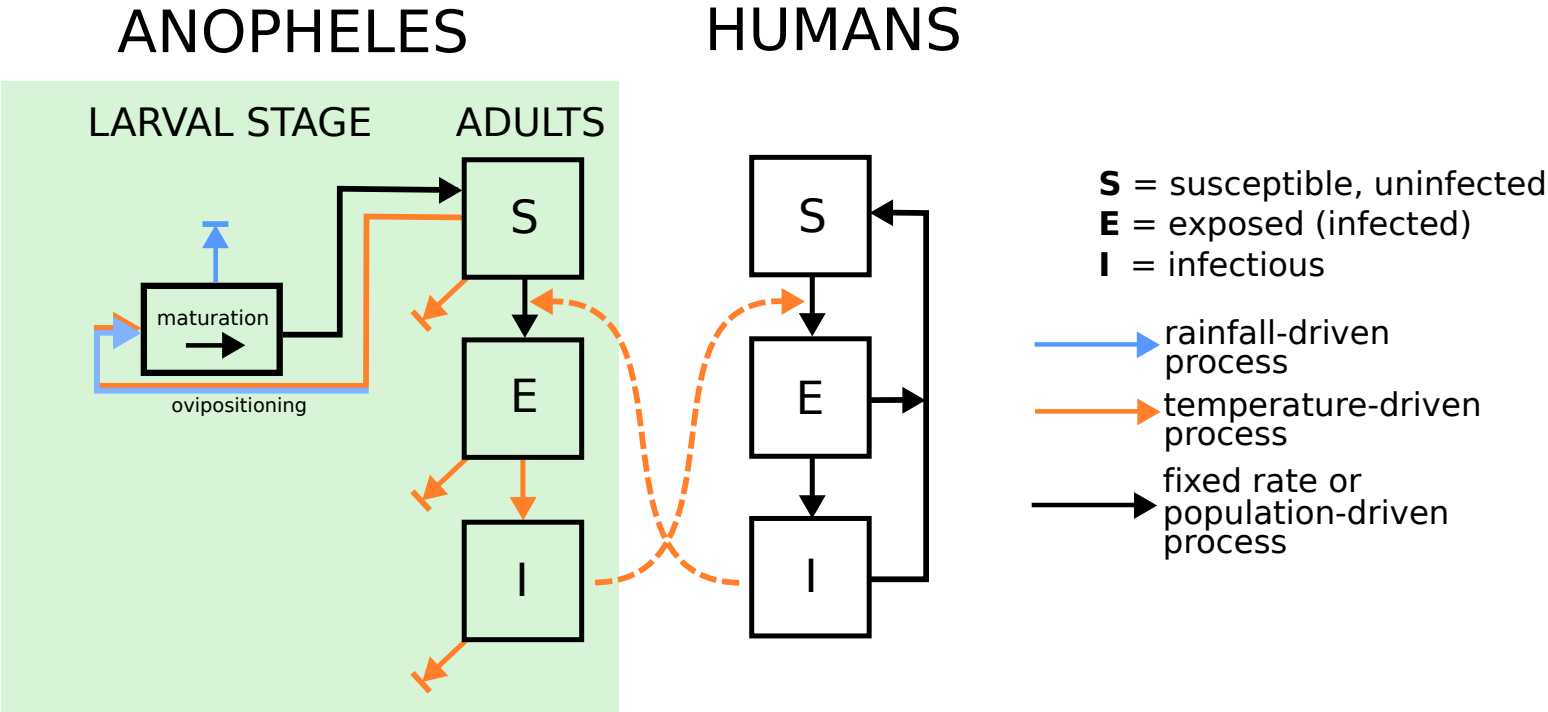NINO3.4 SST anomaly plume
ECMWF forecast from 1 Jul 2023
Monthly mean anomalies relative to ERA5 1981-2010 climatology

https://charts.ecmwf.int/products/seasonal_system5_nino_plumes?base_time=202307010000&nino_area=NINO3-4

Liverpool Malaria Model (also developed into Liverpool Rift Valley Fever Model)

ANOPHELES   HUMANS

LARVAL STAGE   ADULTS

S = susceptible, uninfected
E = exposed (infected)
I = infectious

rainfall-driven process

temperature-driven process

fixed rate or population-driven process

Hoshen and Morse, 2004

Key difference from Aron & May basic model is temperature-dependent latent period in mosquito (sporogonic cycle) which requires T>18°C

Daily time step
Climate drivers:
• 10 day accumulations of rainfall
• Temperature

UNIVERSITY OF LIVERPOOL

Moshe Hoshen now CLALIT Institute, Tel Aviv

Summarizing

- We can model climate variability driven vector borne diseases – with forecast skill.

- Coupled with seasonal scale ensemble prediction systems an operationalised integrated climate – vector borne disease model is well within reach.

- Uses of EO already using RFE (CHIRPS)

- Potential uses of EO
- … high spatial resolutions initial conditions for forecast sub-grid scales e.g. 1km or less.
- Bias correction & validation of habitat temperatures and surface water presence & temperatures (water <5m scale)
- Flooding
- Habitat types (historically NDVI) e.g. ESA ECV Land Cover CCI for Horn of Africa.
- Settlements, human migration
- Near surface air flow patterns?
- Uses of AI now? Future potential within the Fifth Paradigm of Science?

UNIVERSITY OF
LIVERPOOL