Climate Models and the Prediction of Vector Borne Diseases

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Founding member of Health Earth (H-Earth) (http://health-earth.weebly.com/)

Thanks to Anne Jones[4,(3,1)], Cyril Caminade[3,2,(1)], Dave MacLeod[5,(1)]

Impacts World, Potsdam October 2017

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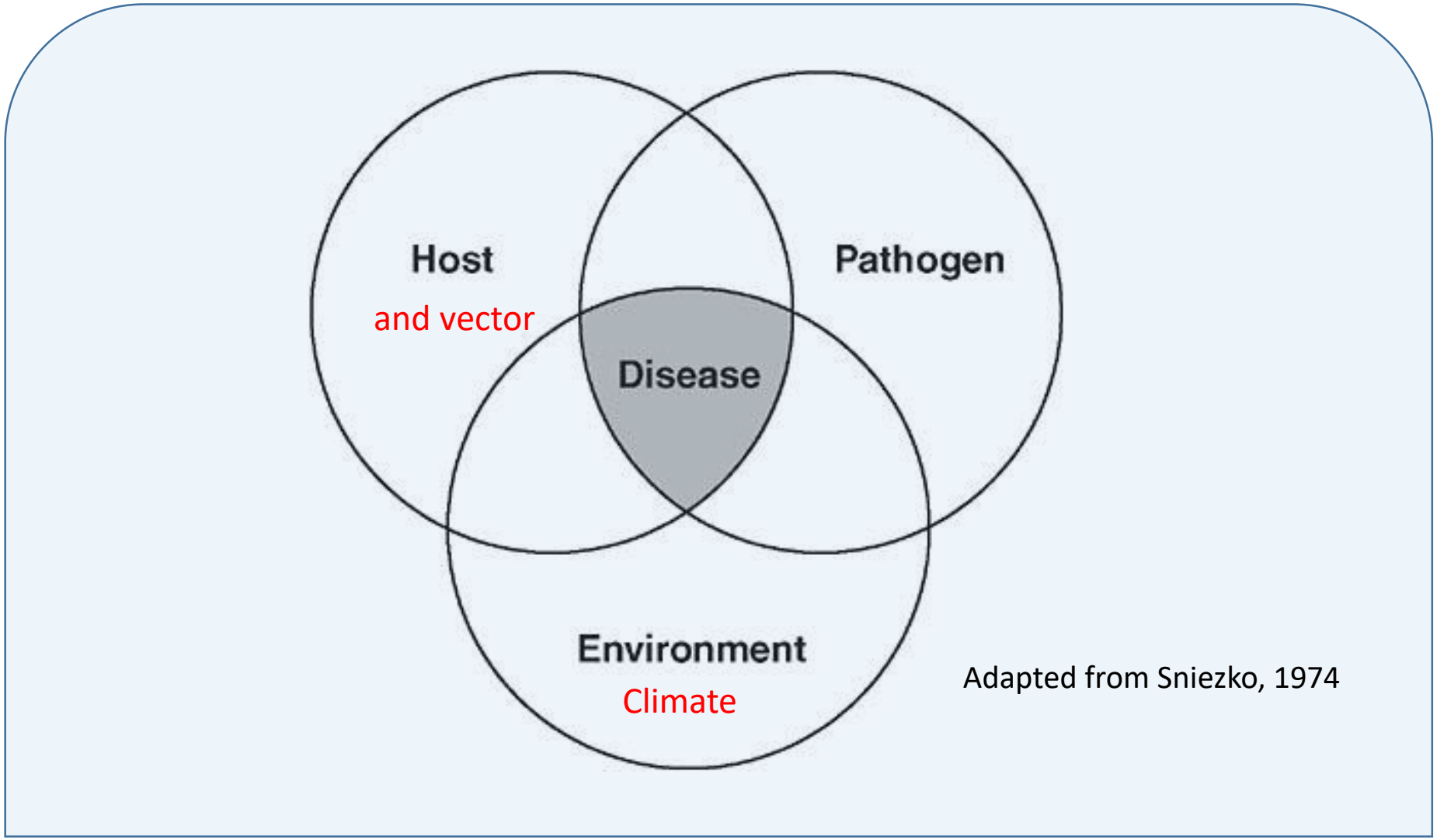
NHS National Institute for Health Research

H-earth

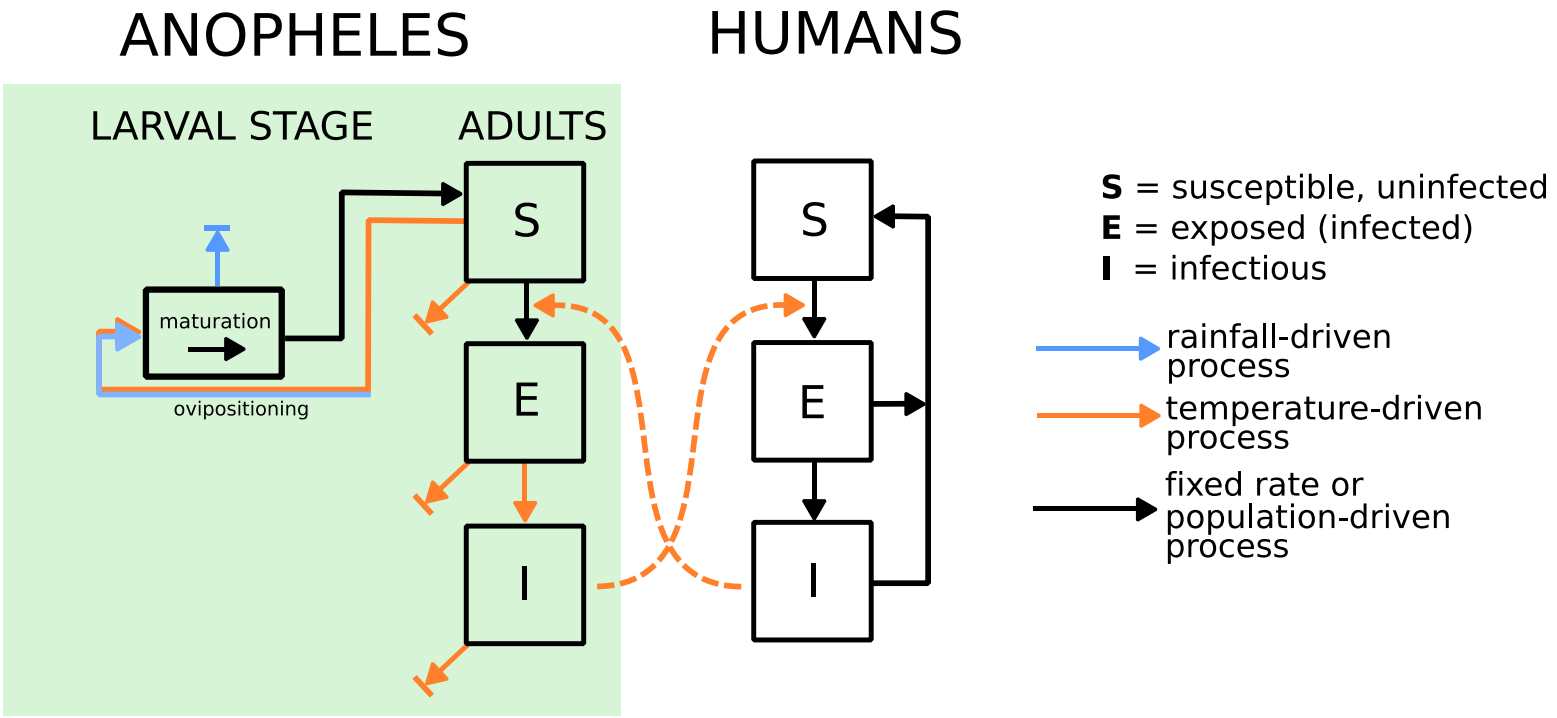
Background

Infectious Disease



Adapted from Sniezko, 1974

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



Hoshen and Morse, 2004

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

Daily time step

Climate drivers:

- 10 day accumulations of rainfall
- Temperature

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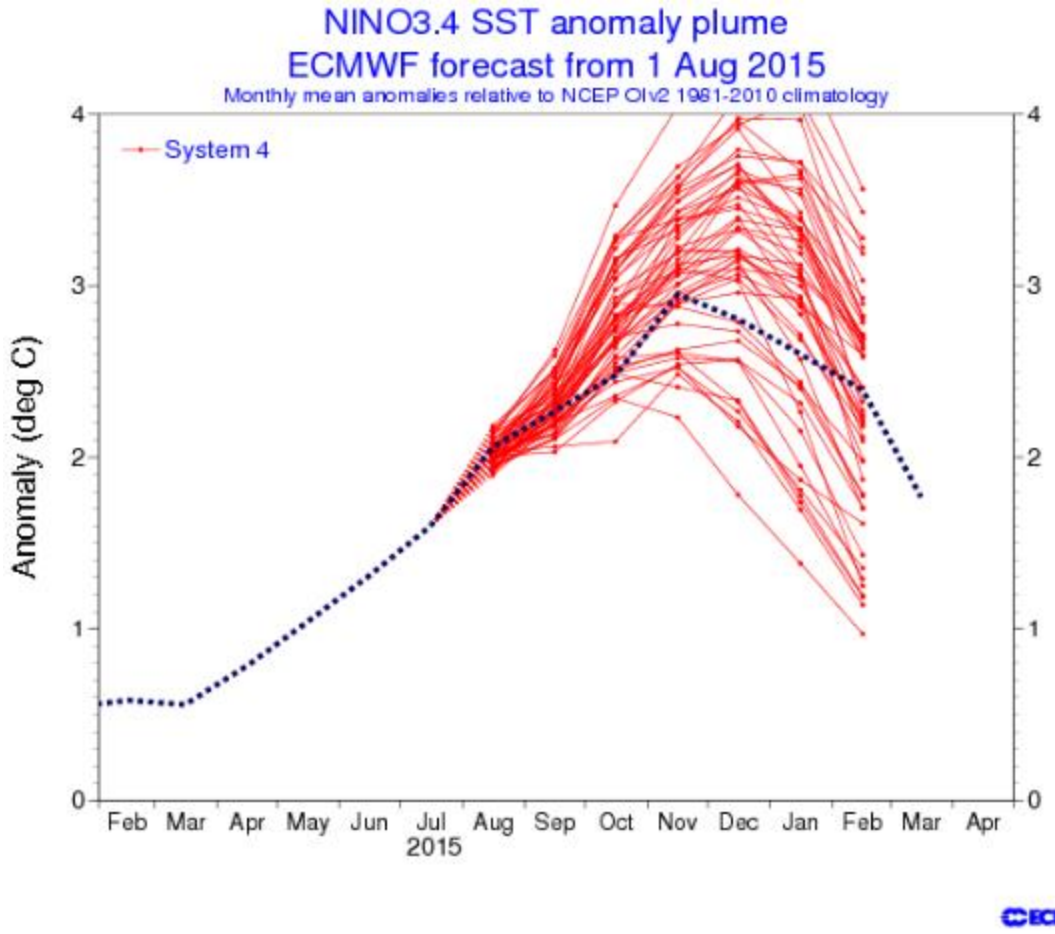
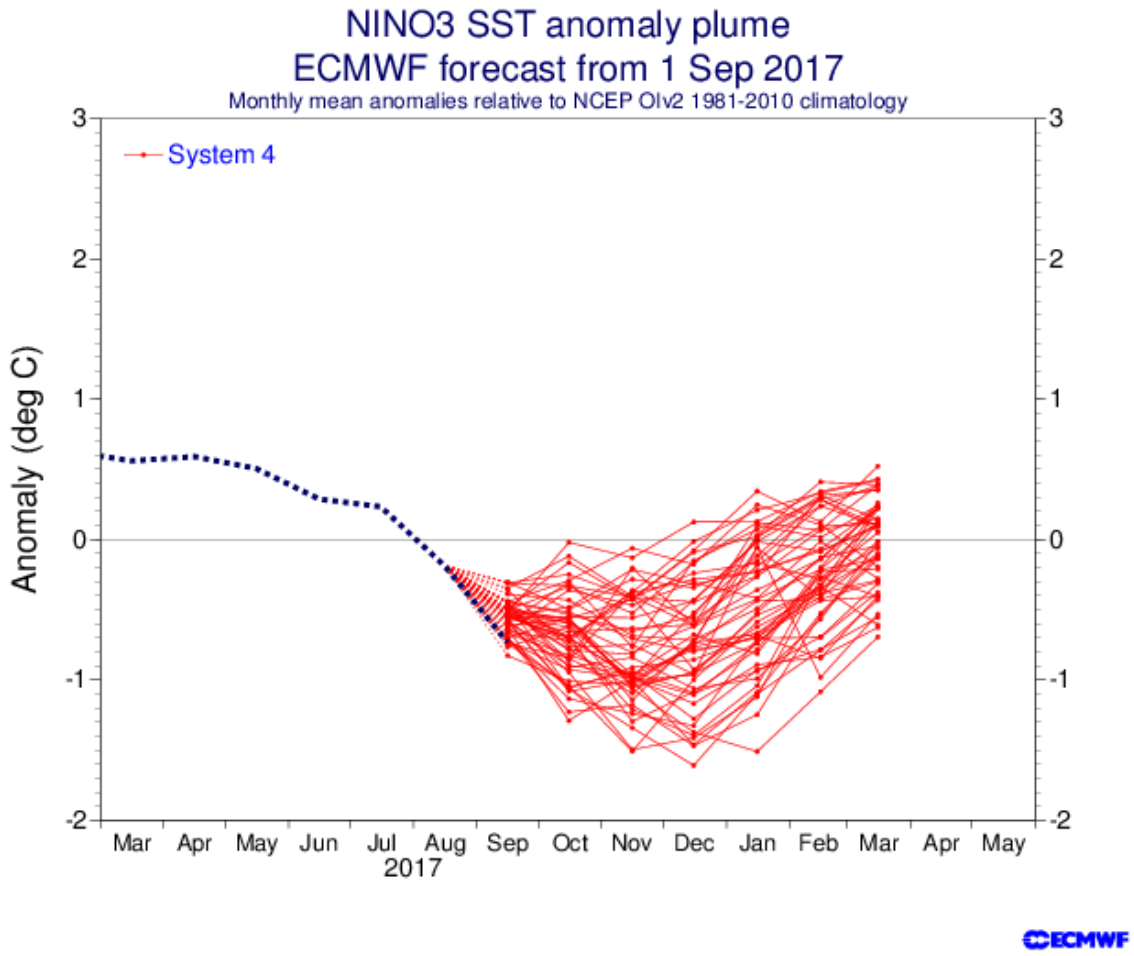
Seasonal Timescales

Seasonal Forecasts





from the European Centre for Medium-Range Weather Forecasts

https://www.ecmwf.int/en/forecasts/charts/catalogue/seasonal_nino_plumes_public?time=2017090100,0,2017090100&nino_area=3&forecast_type_and_skill_measure=plumes

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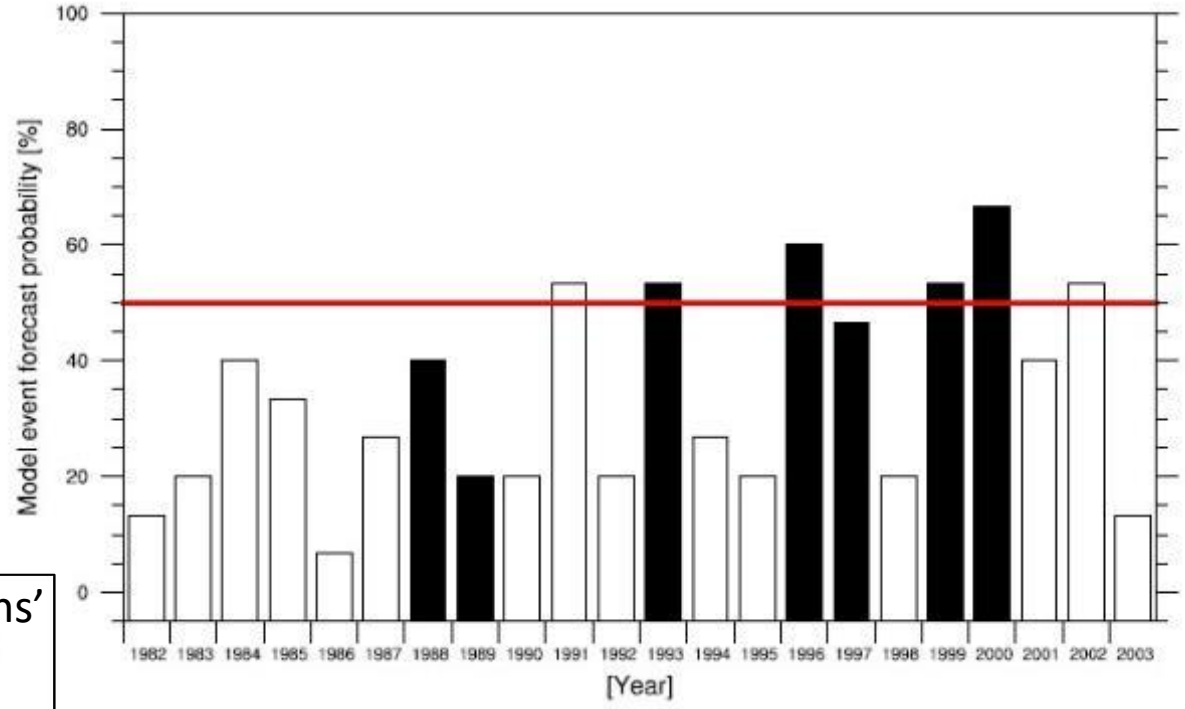
Liverpool Malaria Model forecasts Botswana past performance



4 hits
3 misses
2 false alarms
13 correct rejections
ROC area under curve = 0.86

Figure concept highlighted in BIS (UK Dept Business, Innovation and Skills) Foresight Disaster Risk Reduction report 2012

"scientists should routinely make available the track record of their predictions, and decision makers should insist on knowing the past reliability of the forecast before relying on it"

Figure concept Jones and Morse, 2010, J Climate.

'Making decisions'

ECMWF System 4 driven LMM incidence forecasts of above upper tercile events issued in **November** for MAM (5-7).
Black (white) bars indicate years where observed incidence is above (below) the upper tercile.

22 years correct 17 times. 77%.

after MacLeod, D.A., Jones, A., Di Giuseppe, F., Caminade, C. and **Morse, A.P.** (2015). **Environmental Research Letters,** 10 (4), doi:10.1088/1748-9326/10/4/044005

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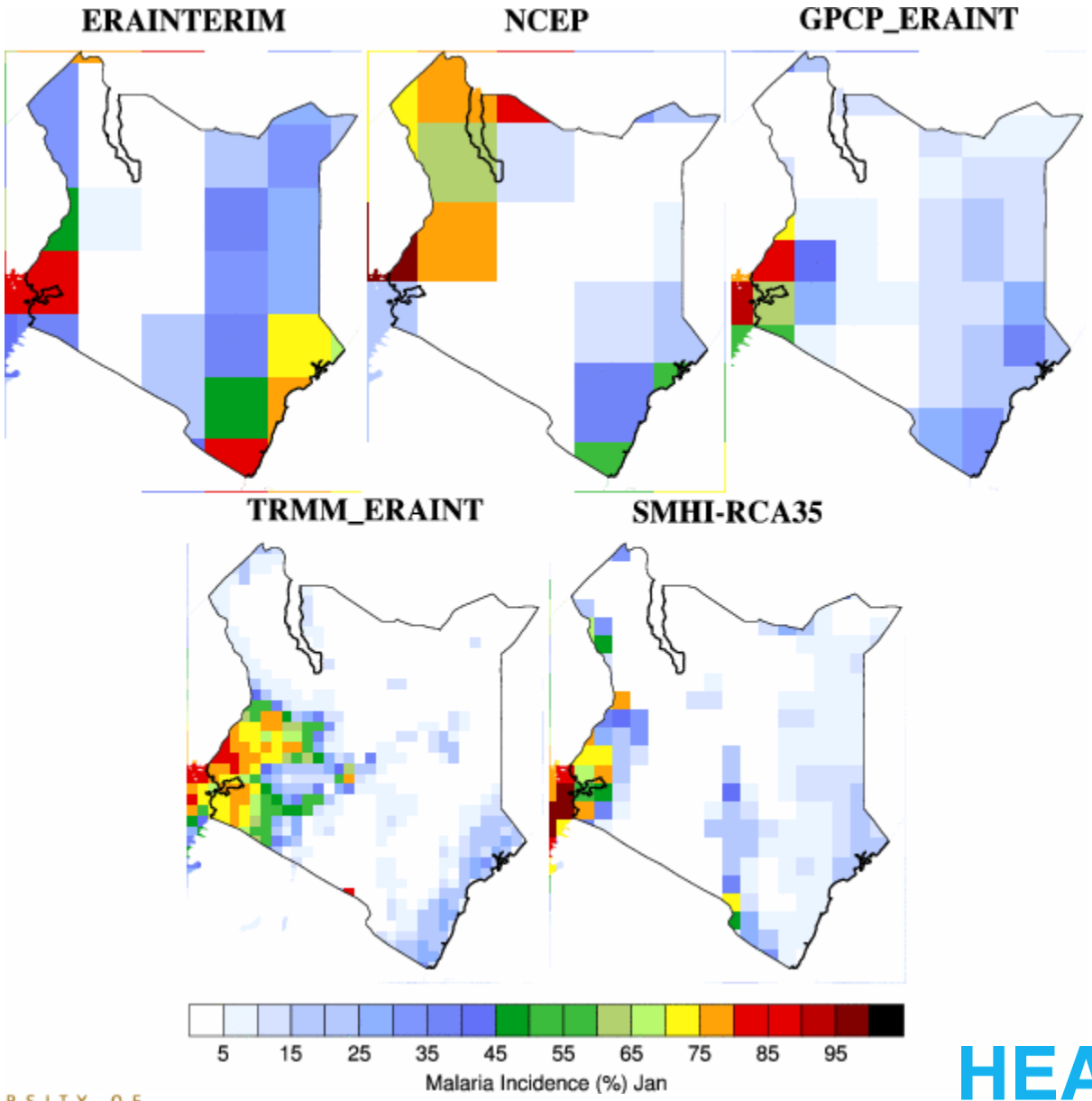
Climate Change Timescales

Simulated mean malaria seasonal cycle animation



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HEALTHY FUTURES

One malaria model LMM - Length of season change
23 bias corrected climate models including ISIMIP

1980-2000ref

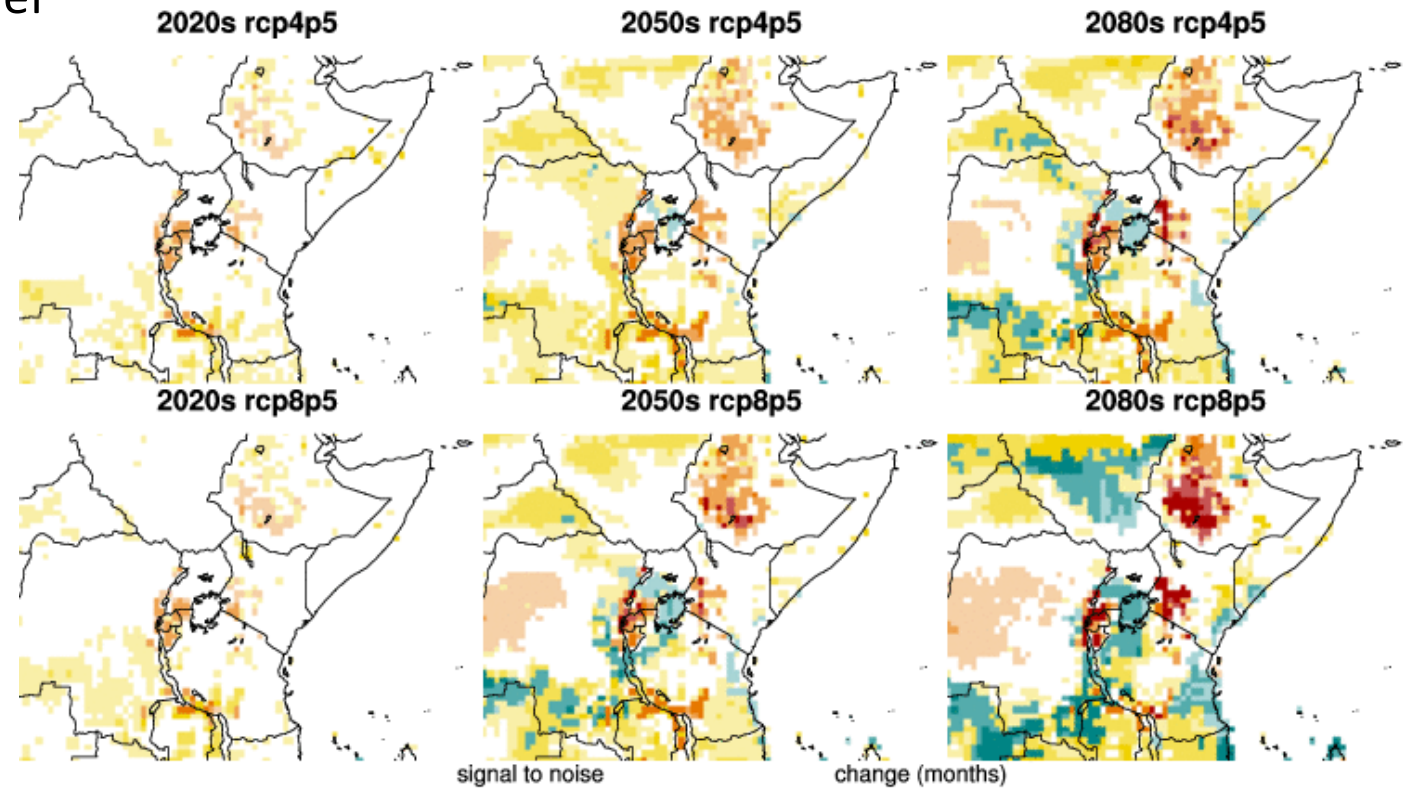
2020s

2050s

2080s

RCP 4.5

RCP 8.5



For global ISIMIP runs see Caminade et al. (2014), PNAS doi: 10.1073/pnas.1302089111

After Leedale, J. et al. (2016) Geospatial Health, doi:http://dx.doi.org/10.4081/gh.2016.393

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HEALTHY FUTURES

LMM and current interests.

Underpinning field research: NERC DFID El Niño malaria (*Anopheles sp.*) University of Liverpool, U.K., University of Glasgow, U.K., Ifakara Health Institute, Tanzania project ends December 2017

Going operational? NCEP cfsv2 seasonal to sub-seasonal ensembles (quasi-operational footing) 1 deg resolution, 24 ensemble members per week, 4 x 6 days; 9m,123d,45d runs – VBD forecasts – no direct funding. http://cfs.ncep.noaa.gov NOAA Climate Prediction Center, Development Branch, Africa Desk

Climate Change: ISIMIP2? Have been using NASA NEX GDDCP climate change scenarios RCP4.5 and RCP8.5 from 21 models in CMIP5 archive downscaled to 25km, daily data for others VBDs in UK and Europe.

Applied Use - MSF: Democratic Republic of Congo, with ICTP and University of Salzburg (HEALTHY FUTURES spin off) – on emergence of upland malaria – at Kivu Mission stations > 1400m

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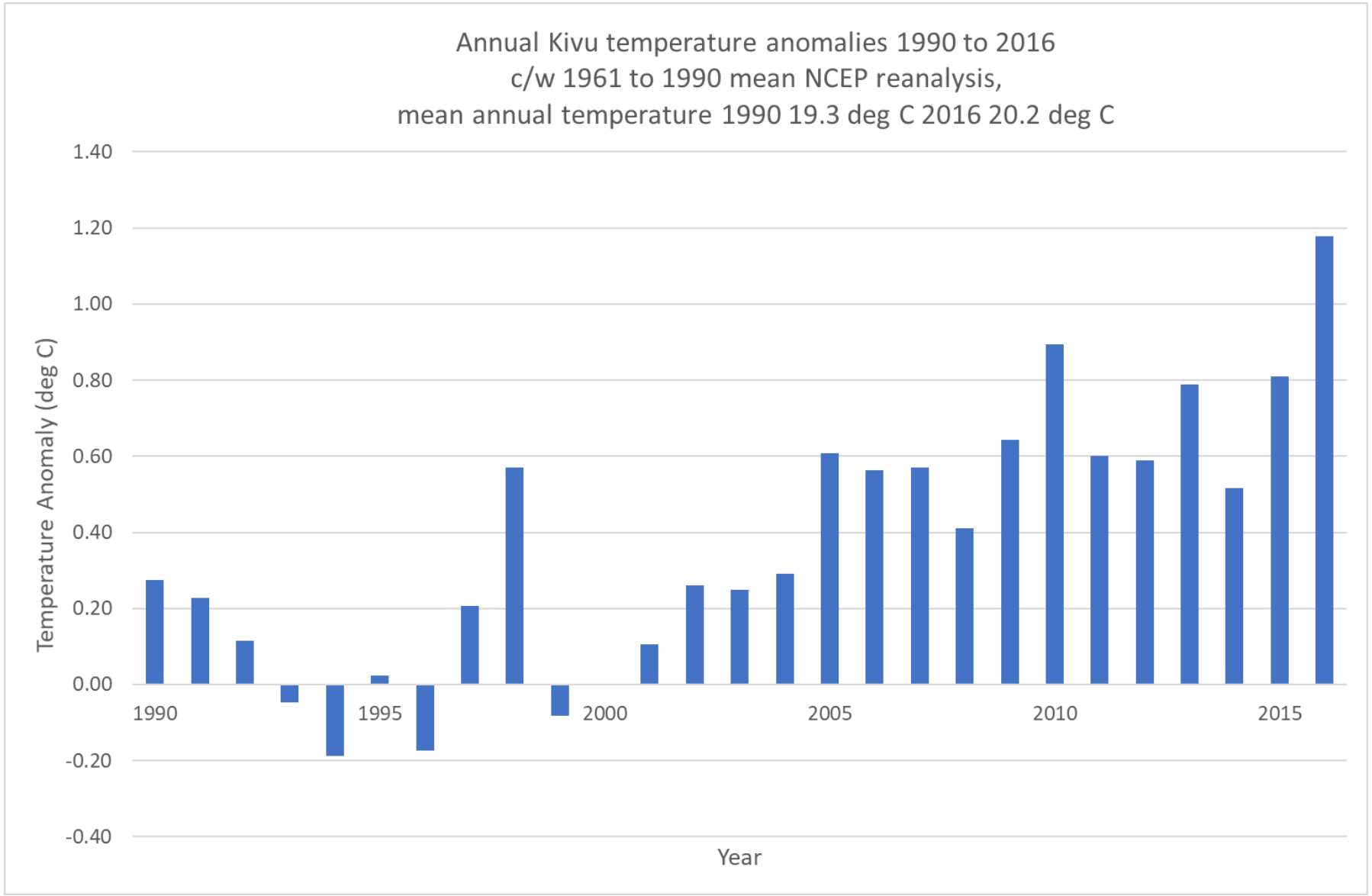
HEALTHY FUTURES


Annual Kivu temperature anomalies 1990 to 2016
c/w 1961 to 1990 mean NCEP reanalysis,
mean annual temperature 1990 19.3 deg C 2016 20.2 deg C
Temperature Anomaly (deg C)
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
1990
1995
2000
2005
2010
2015
Year

Summarizing – disease, climate information - future

- Big Data – routinely produced forecasts & emerging IoT
- Low level of health applications of the climate data – seasonal and longer time scales
- Low up-take of the information in Africa … but information hungry
- Seasonal Forecasts – for certain regions – have skill
- Climate change impacts on malaria East Africa
- Example is infectious disease – data, processing, approaches
  – common to water, energy, food etc. Nexus approach to maximize efficiencies. **ISIMIP**
- Need to develop information and early warning systems

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Communicating at a village level - Senegal

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Questions?

Thank you for listening.

Thanks to our funders and project partners.

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HORN regional OneHealth in the GHA

www.equip.leeds.ac.uk