

Weather Based Modelling of
the Epidemiology of Malaria
&
Forecasting the Disease

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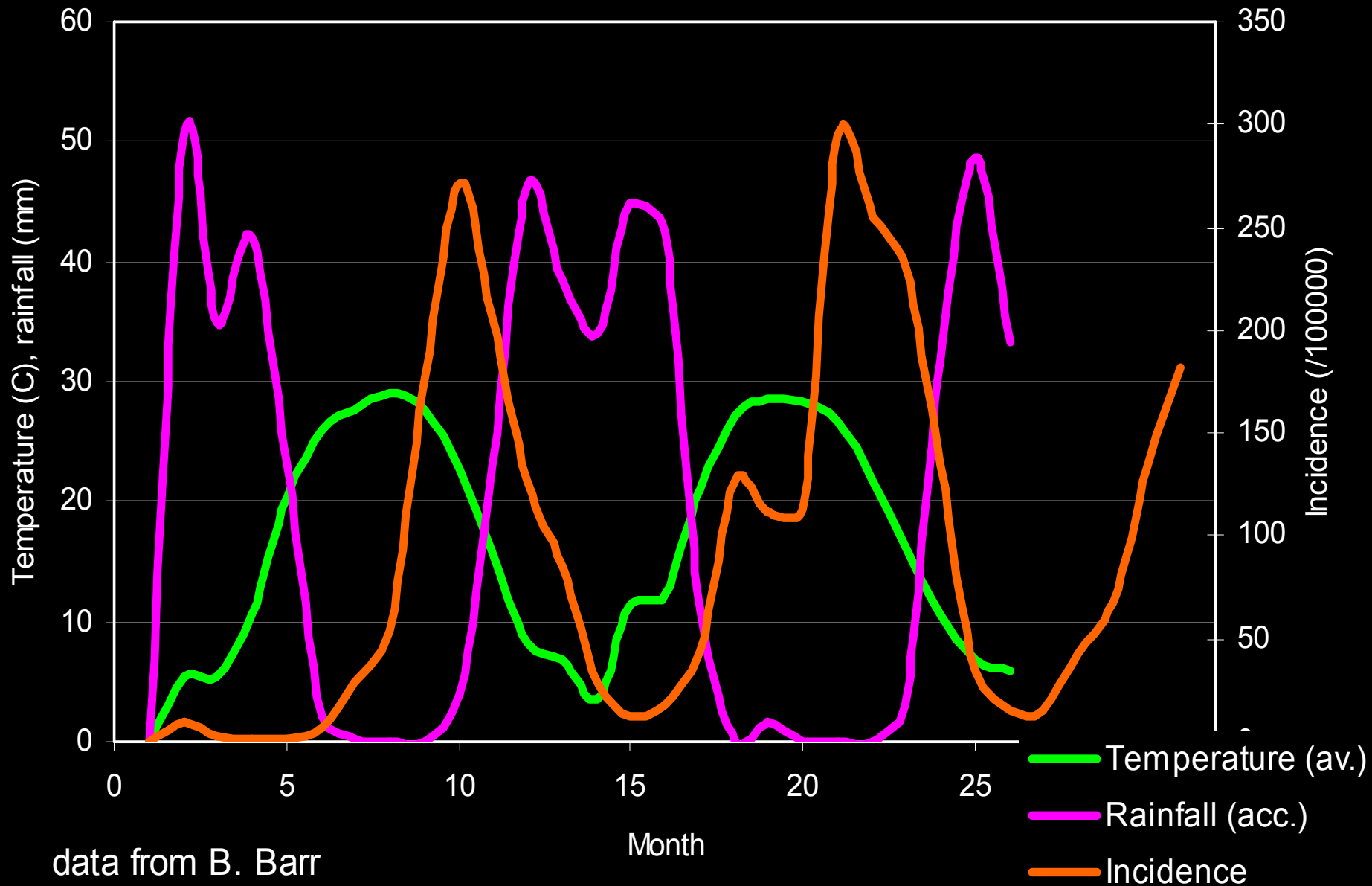
Motive for model:

- Early warning of epidemics
- Quantitative probabilistic prediction
- Economic evaluation of cost-effectiveness of intervention
- Relative evaluation of various control strategies

Method for creating warning

- Identifying risk areas
 - Non-endemic region
 - Population movement
 - Insecticide and drug resistance
- Weather conditions
 - Present and Past
 - Forecast
- Connecting weather with malaria
 - model

Farhor, Tajikistan: Weather and incidence 2000-2002



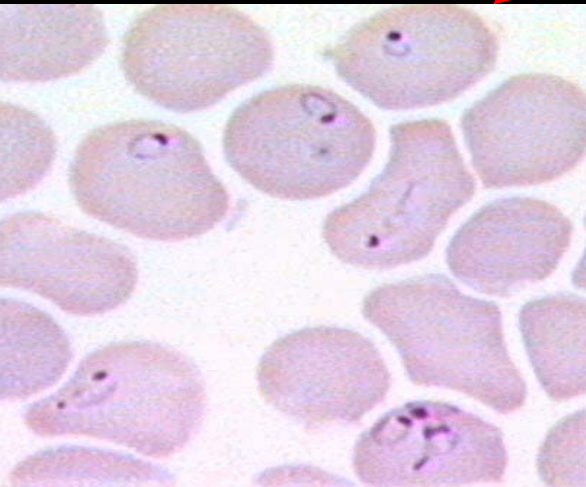
data from B. Barr

The malaria triangle

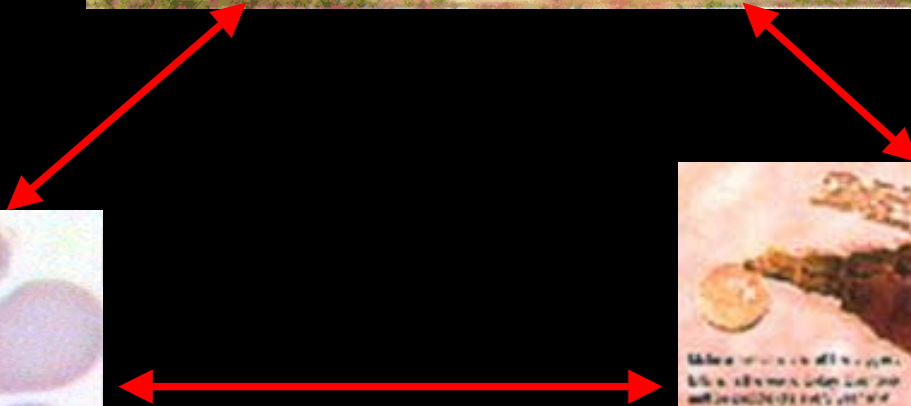


Host

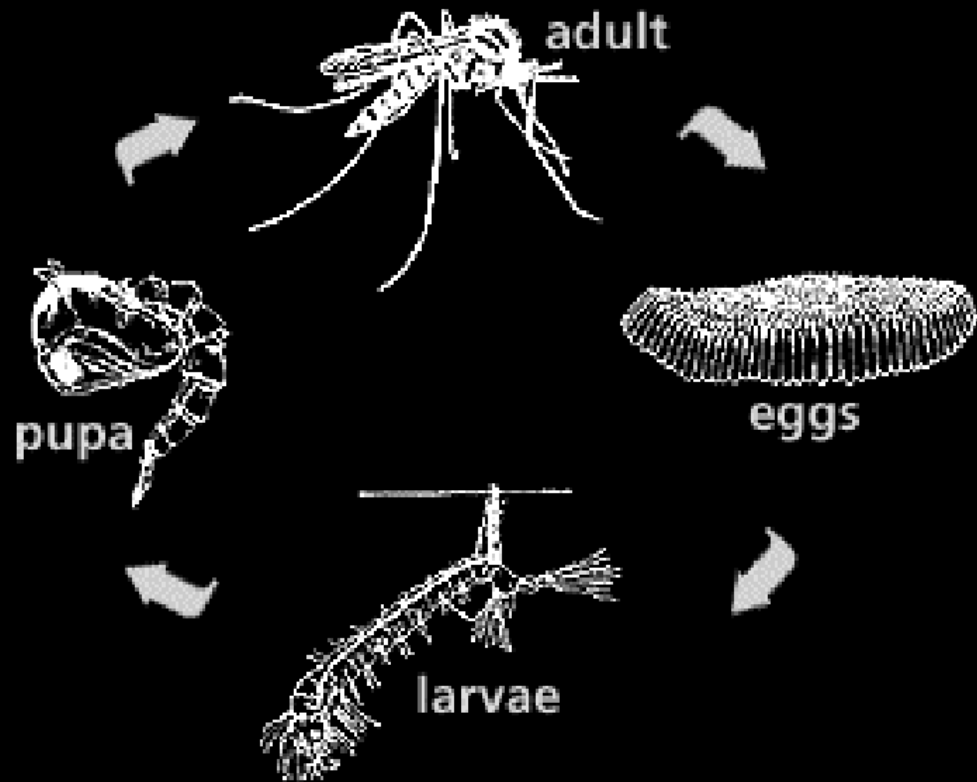
Parasite



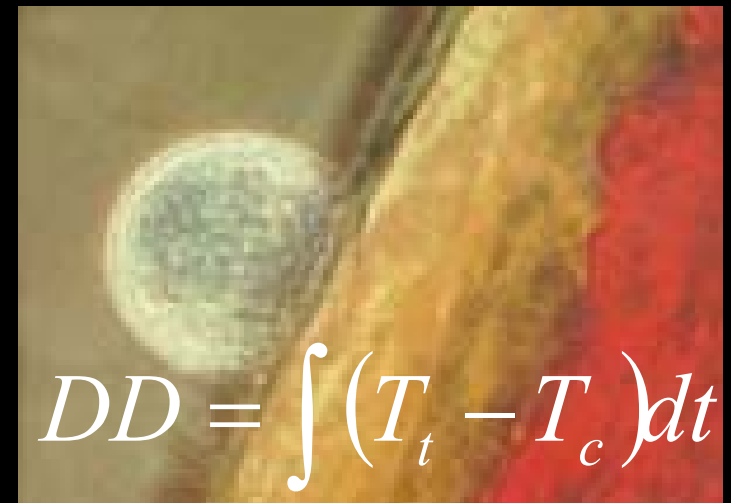
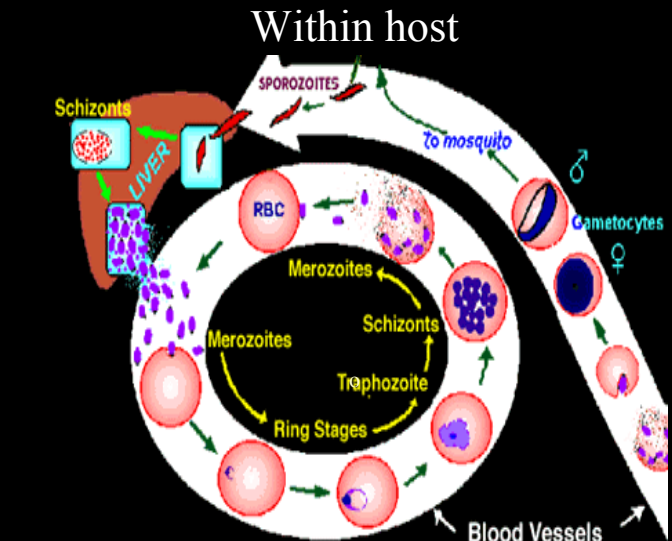
Vector



Vector Dynamics

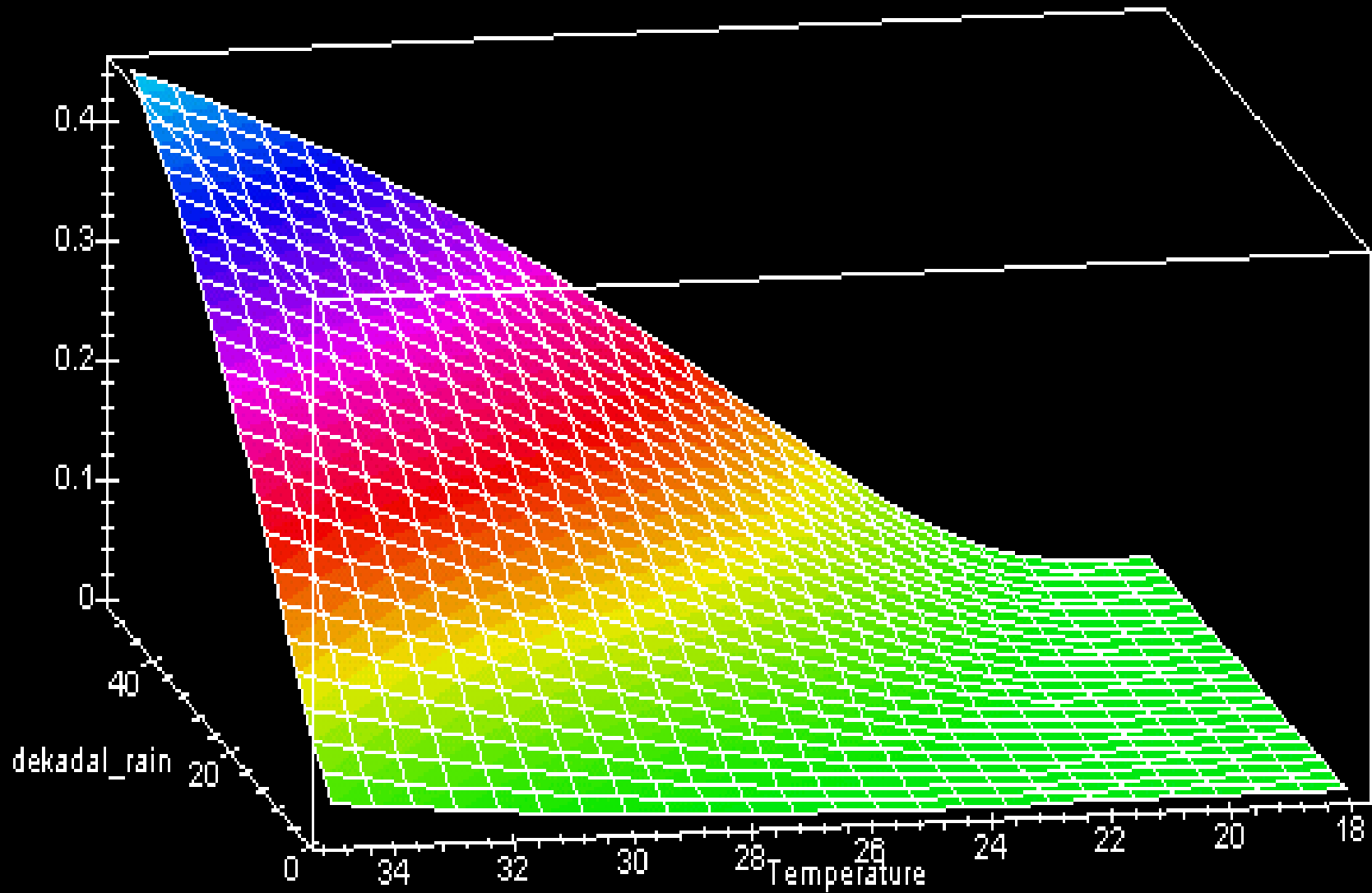


Parasite Dynamics



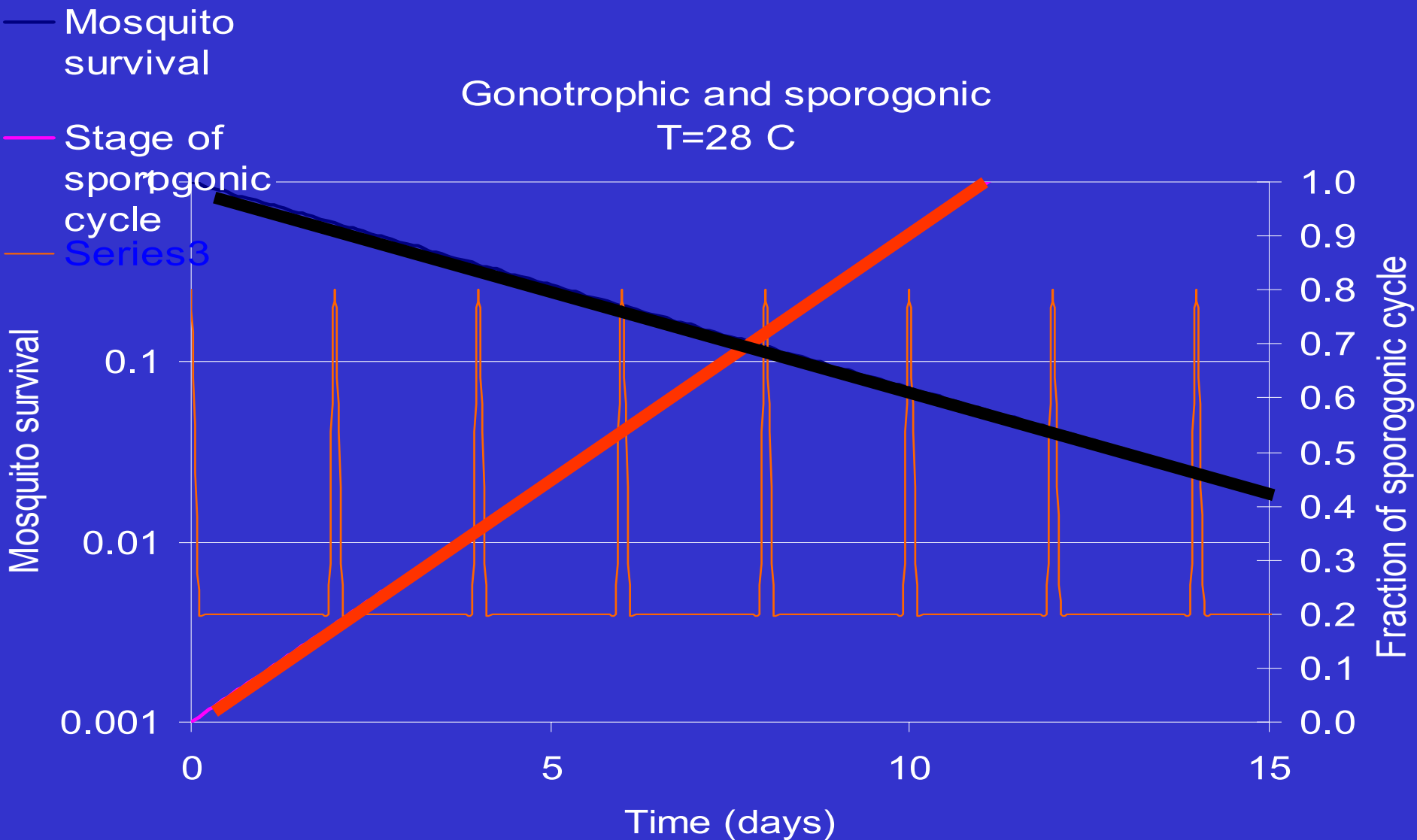
$$DD = \int (T_t - T_c) dt$$

Larvae, pupae

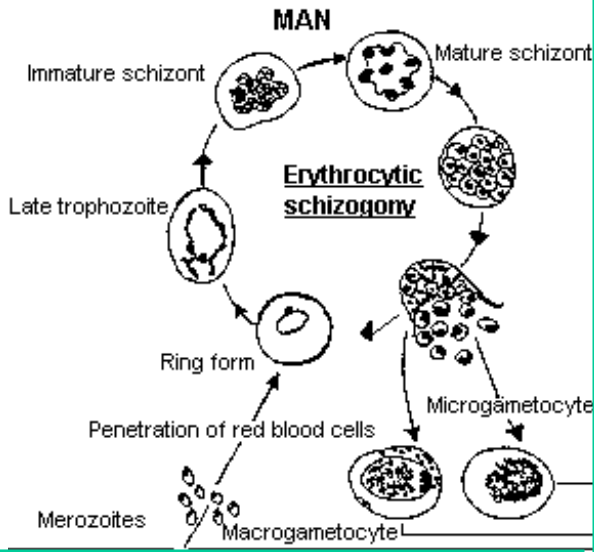




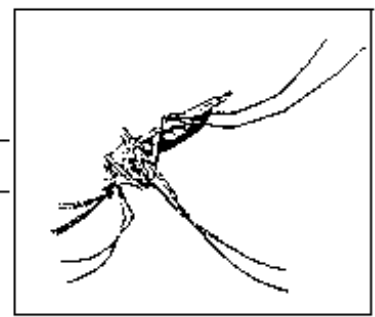
To combine the cycles: at constant temperature:



Asexual stage
48 hour cycle
1 week+ to
detection

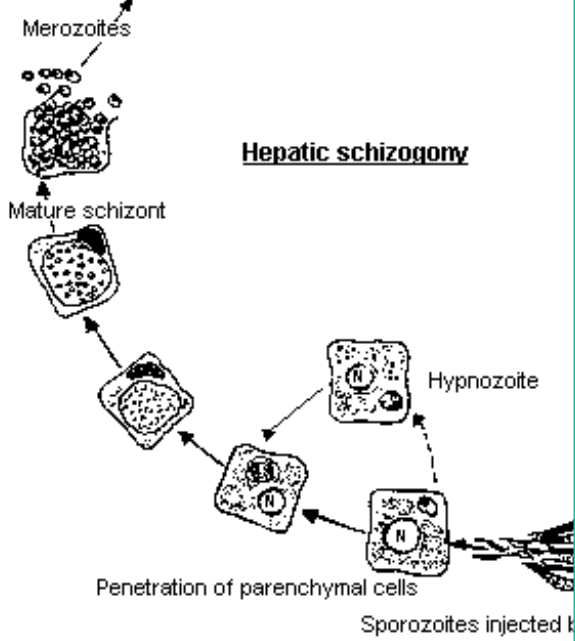


Vector stage
Minimal time 111 degree days

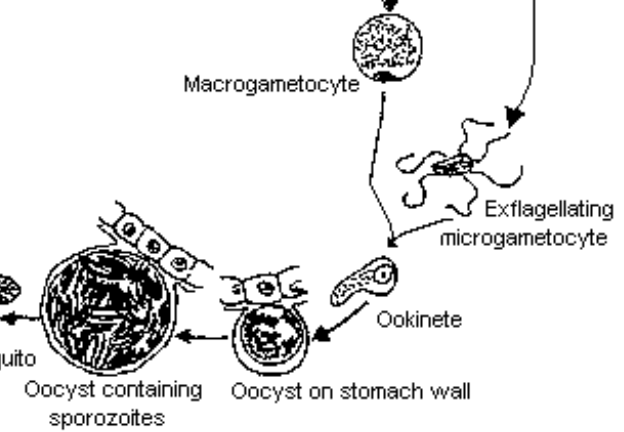


sexual

Liver-stage
~ 1 week



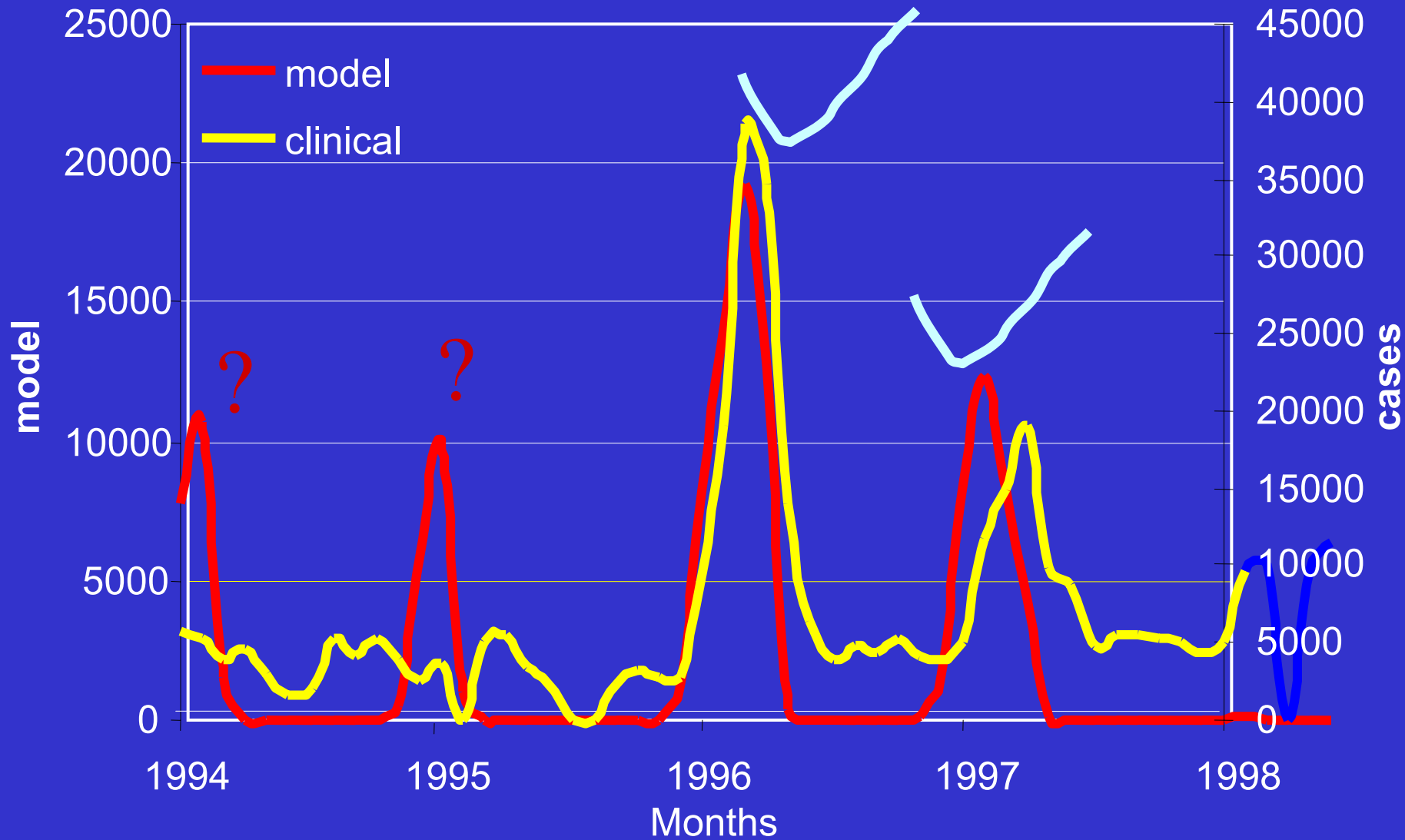
Sporogonic phase



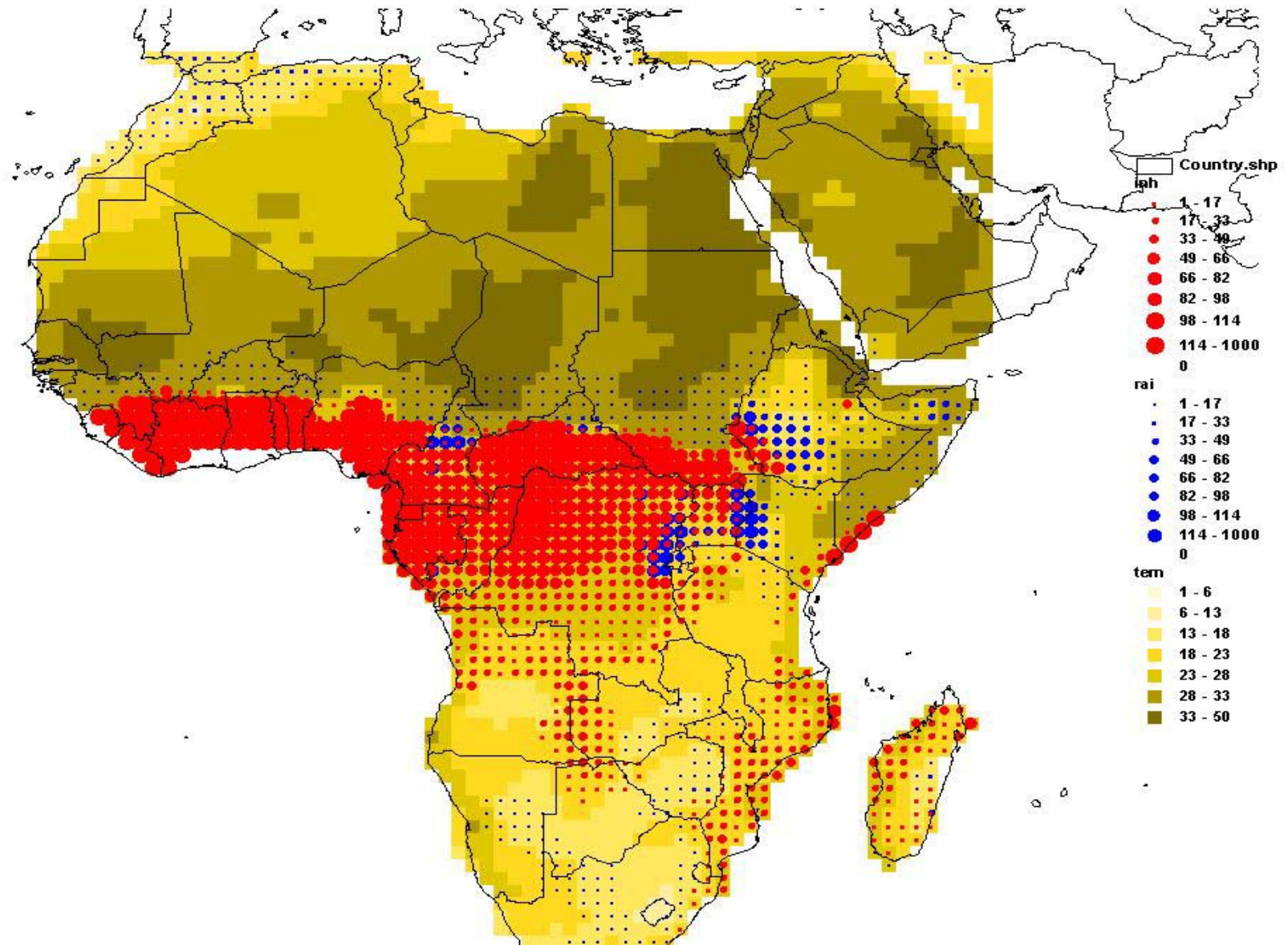
LIFE CYCLE of *PLASMODIUM* spp.

Adapted and redrawn from NUDC

Clinical cases and model incidence Hwange

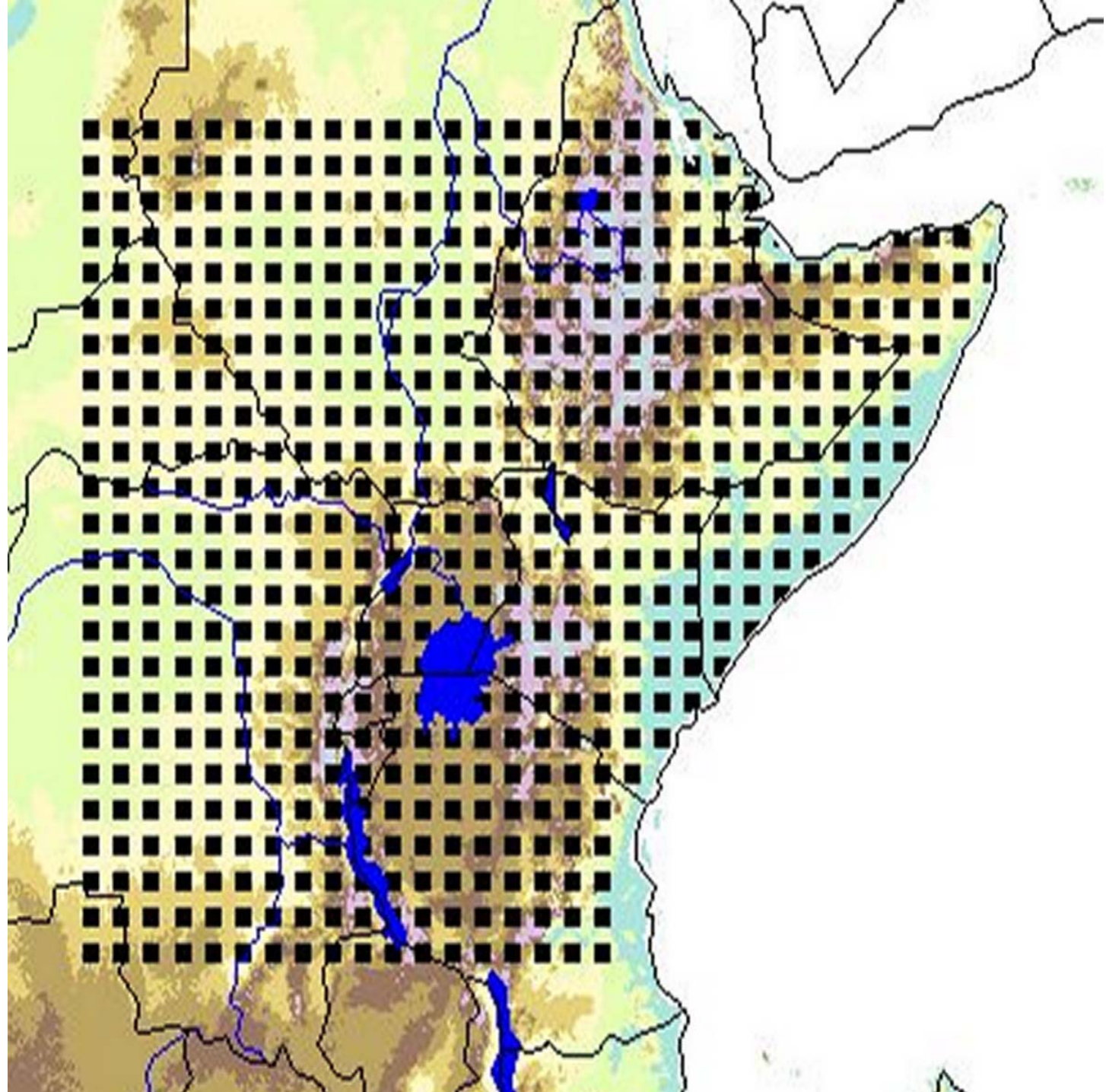


Malaria prevalence (model) September 88

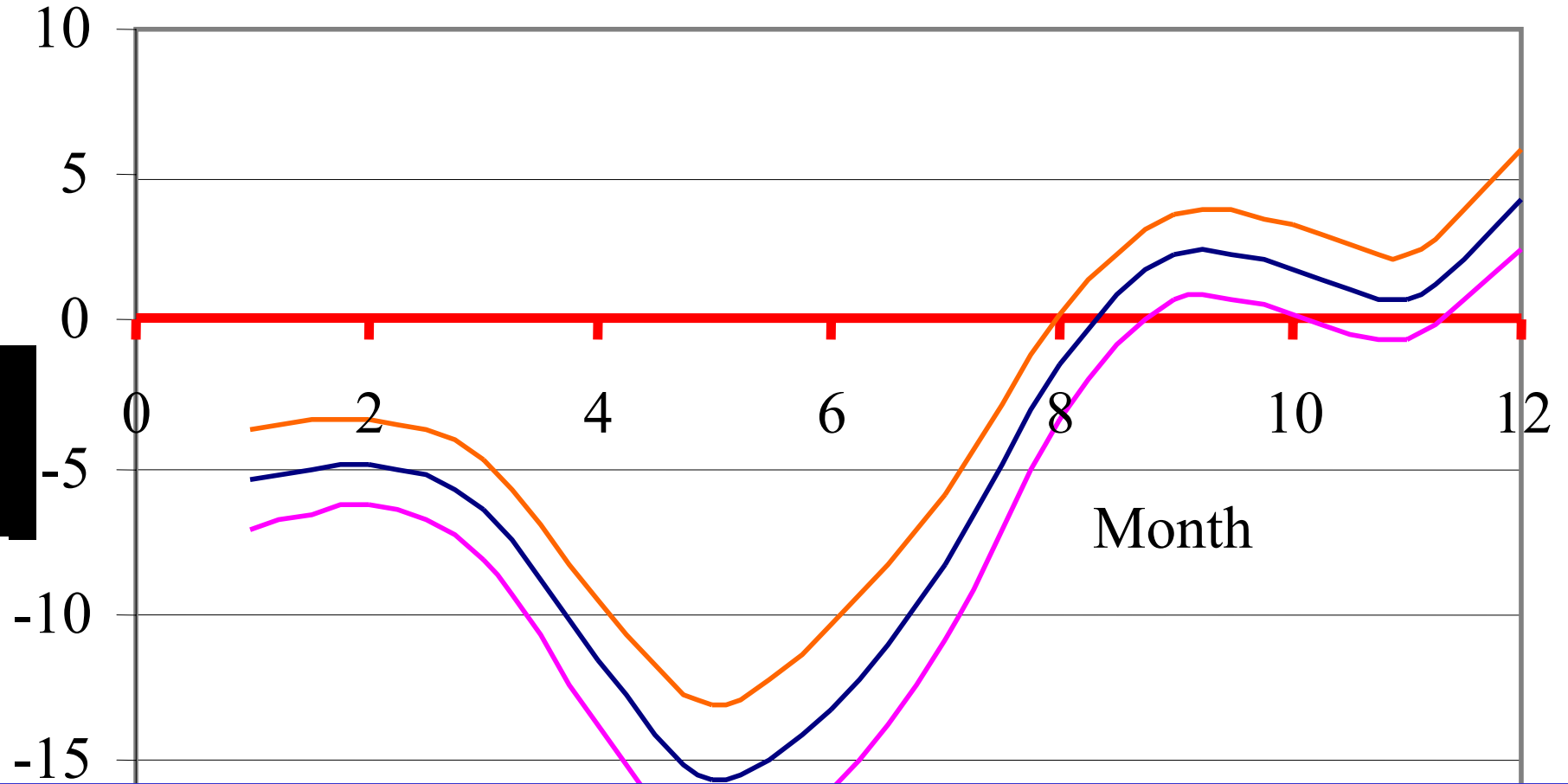


Forecasting

- **El Nino (or ENSO)**
typically associated with increased rainfall
- **Main impact in Africa in East Africa**
- **Can we predict the weather anomaly?**
- **Can we predict the health anomaly?**



Prevalence difference



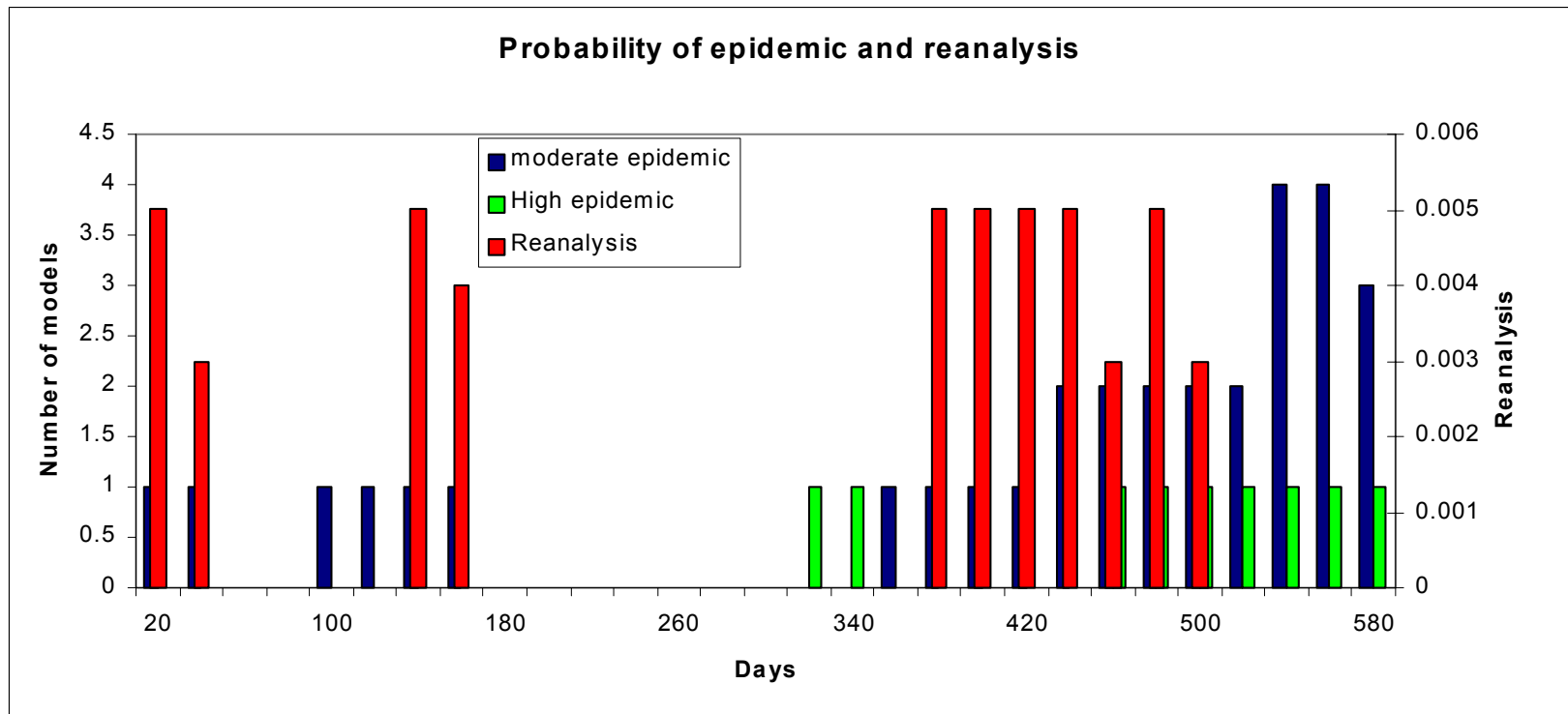
Conclusion

El Nino period=higher prevalence

Conclusions regarding model

- A mathematical-biological model for mosquito and host infection dynamics
- Weather data can be taken from reanalysis for a model
- Results are consistent with general epidemiology of malaria
- Parameters are not all known, and must be fitted to optimise model
- This must be done at regional level.

Using seasonal weather forecast East Africa: predicting ENSO influence



Future work

- **Use clinical studies datasets for improved parameterisation**
- **Examining downscaling + data bias**
- **Extending time scale to validate model – Now runs on eight years**
- **Predict malaria based on the improving weather forecasts**
- **Application to climate change**