Early Warning: Climatic, Ecological Indicators and Risk Mapping

Rift Valley Fever Workshop
An Integrated Approach to Controlling Rift Valley Fever in Africa and the Middle East

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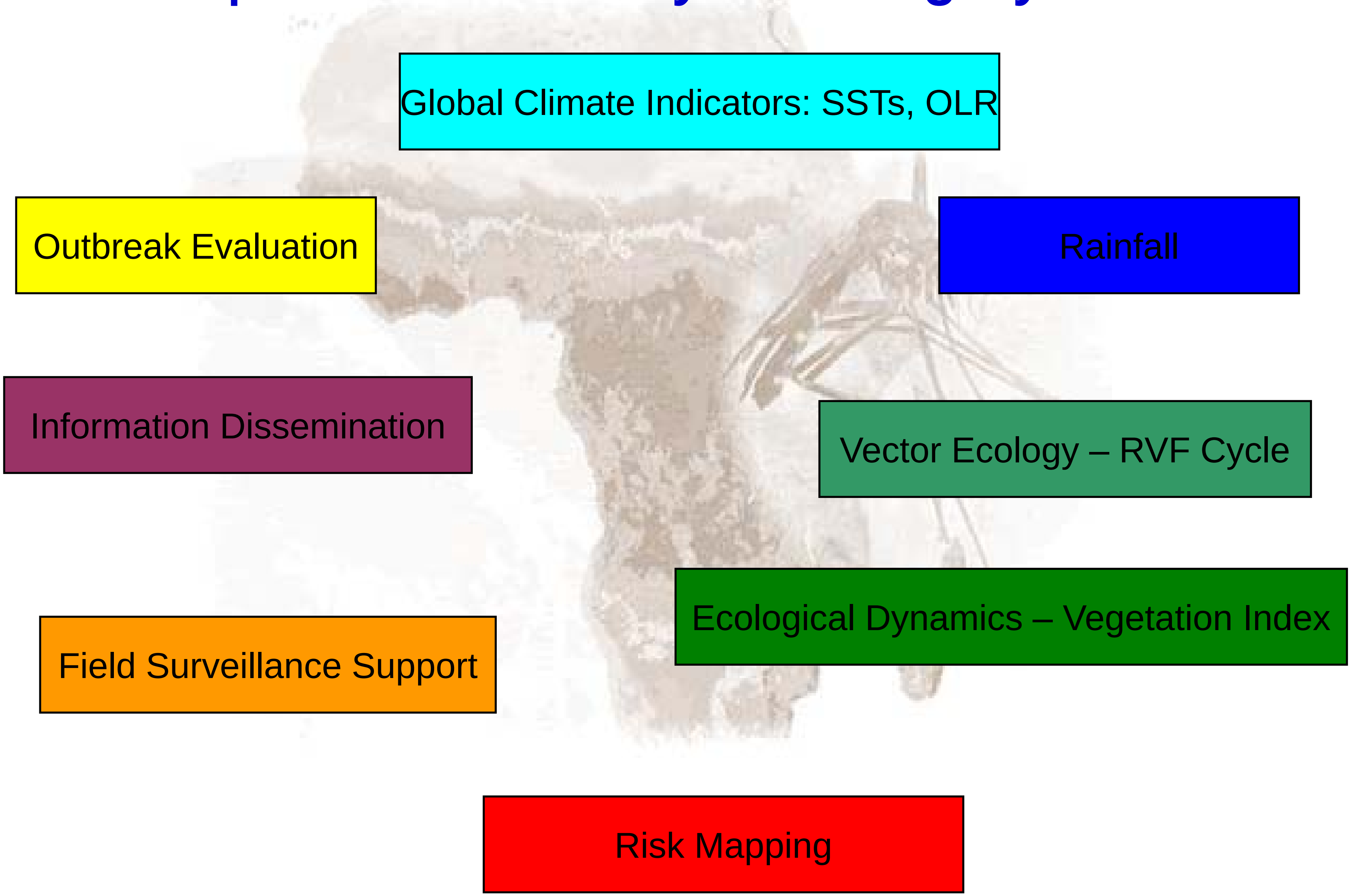
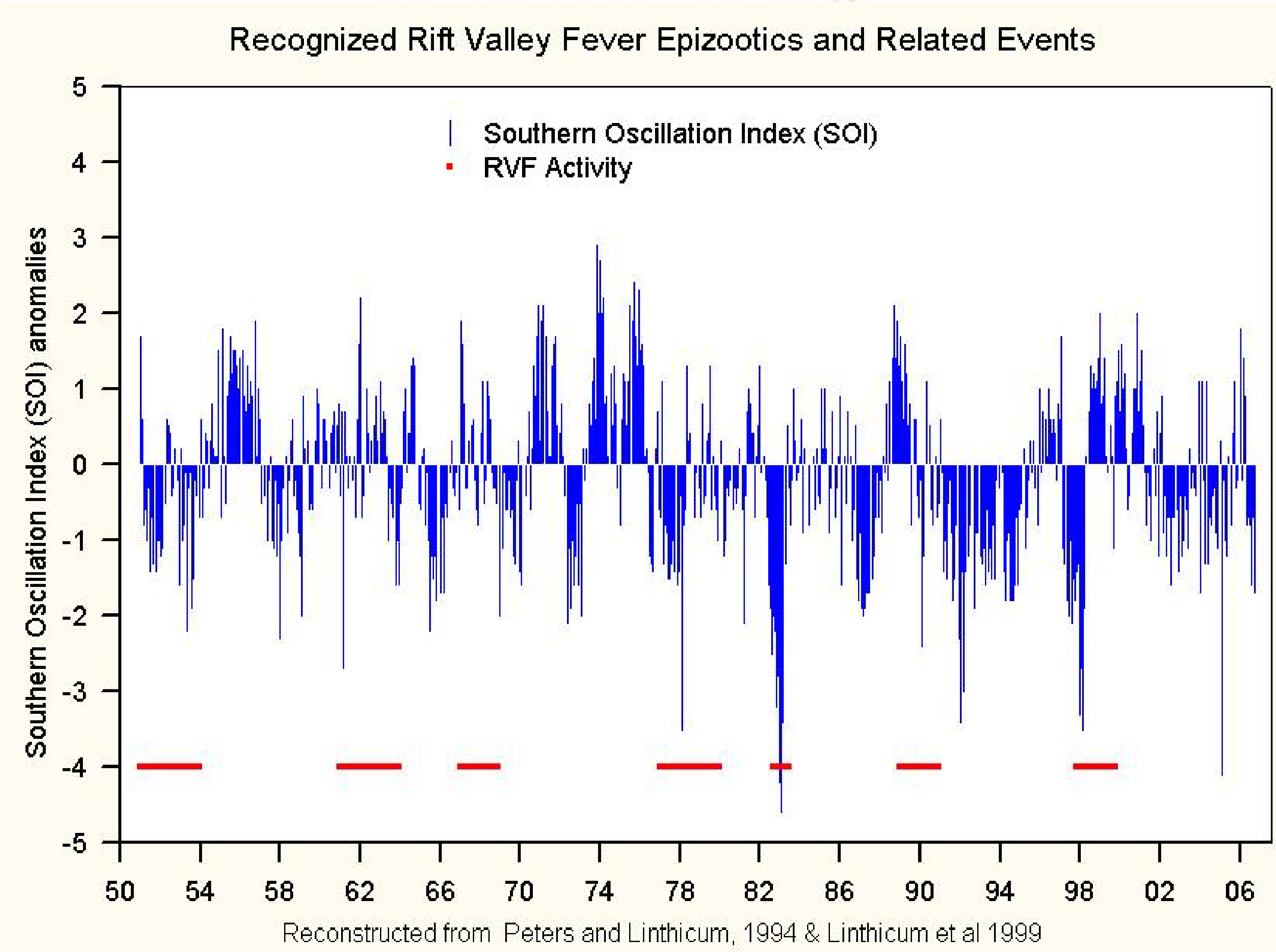
Components of Early Warning System



1a. Southern Oscillation Index



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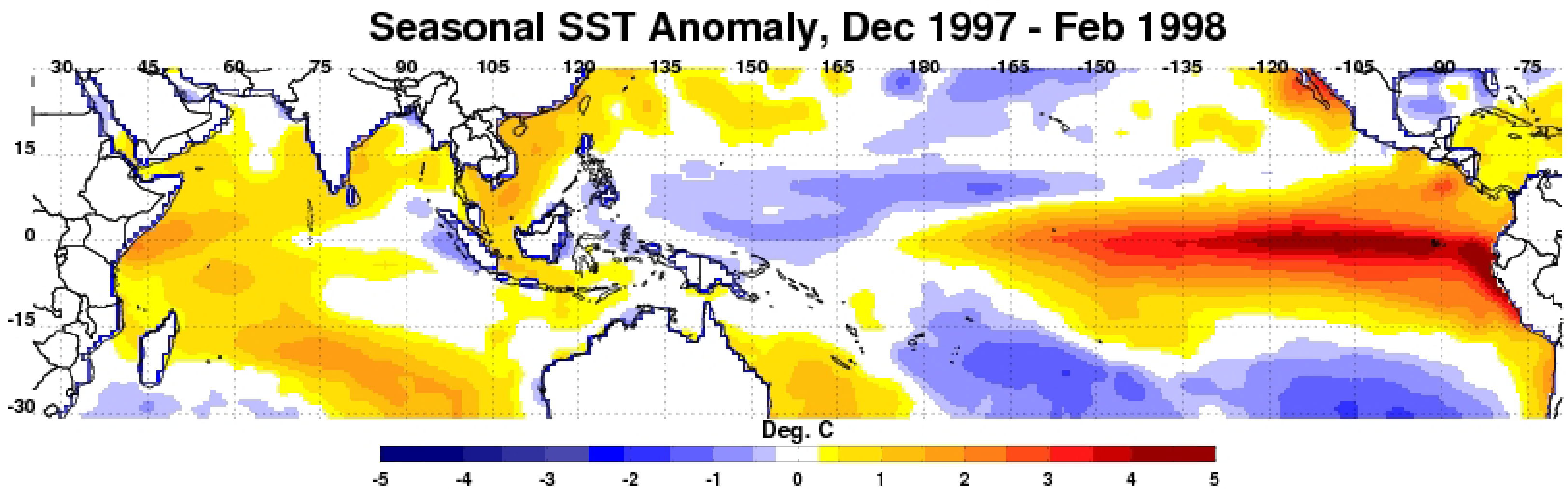
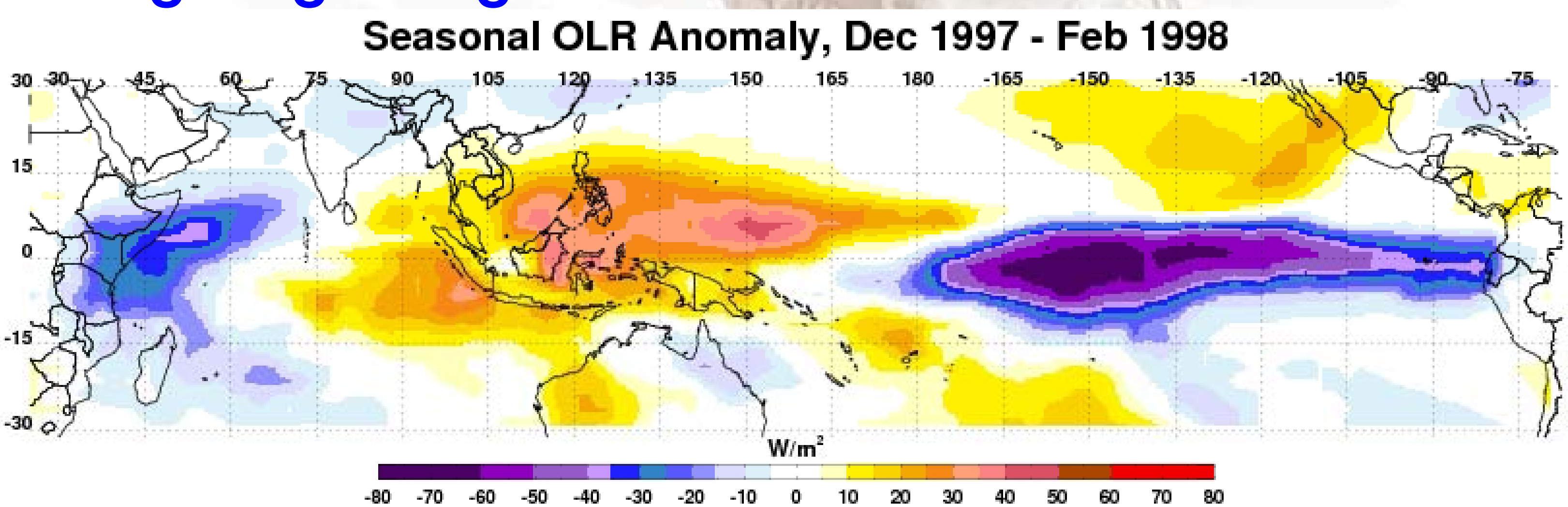
1b. Sea Surface Temperatures



1c. Outgoing Longwave Radiation



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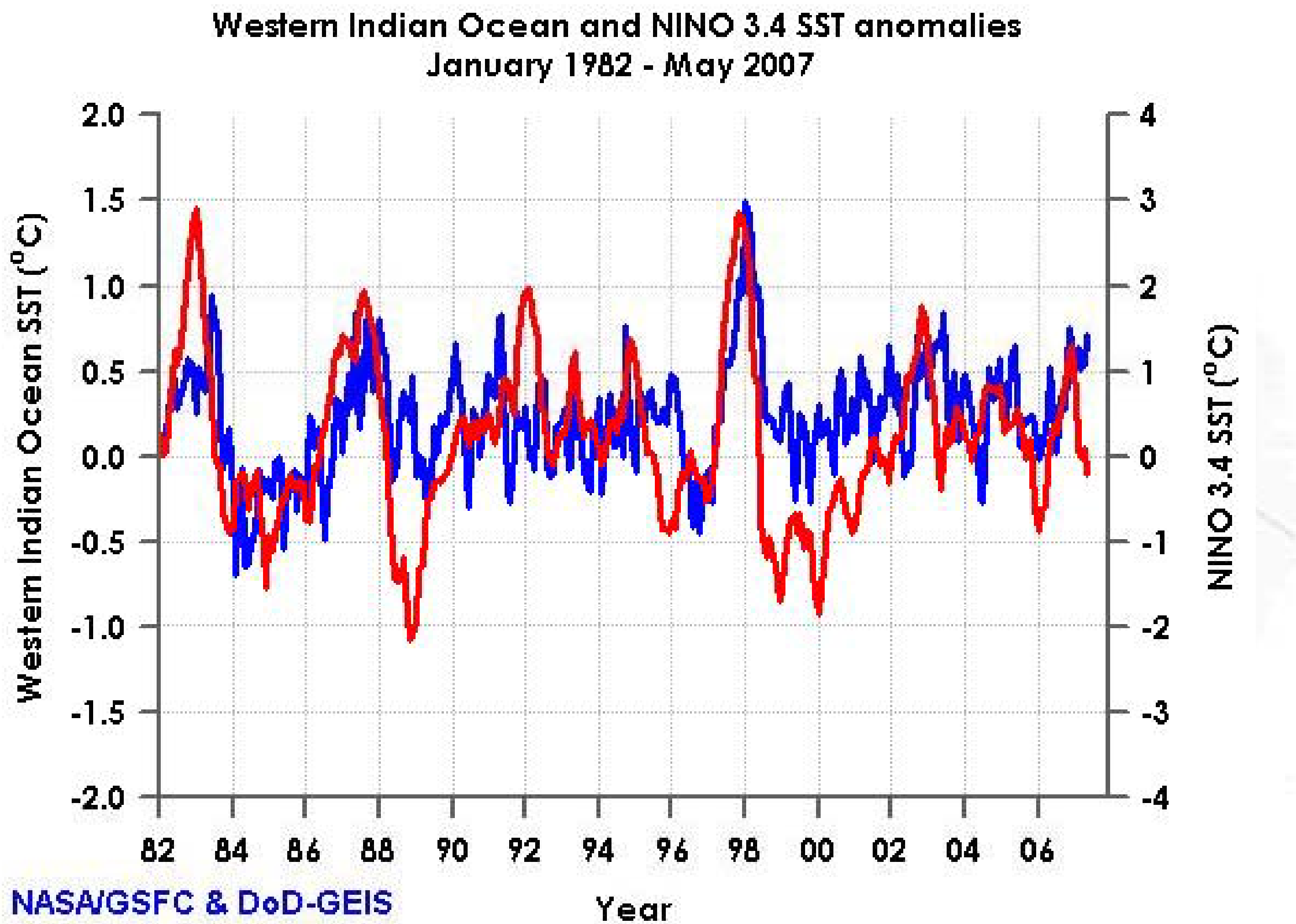
1d. SST Indicators: NINO3.4 SST, WIO



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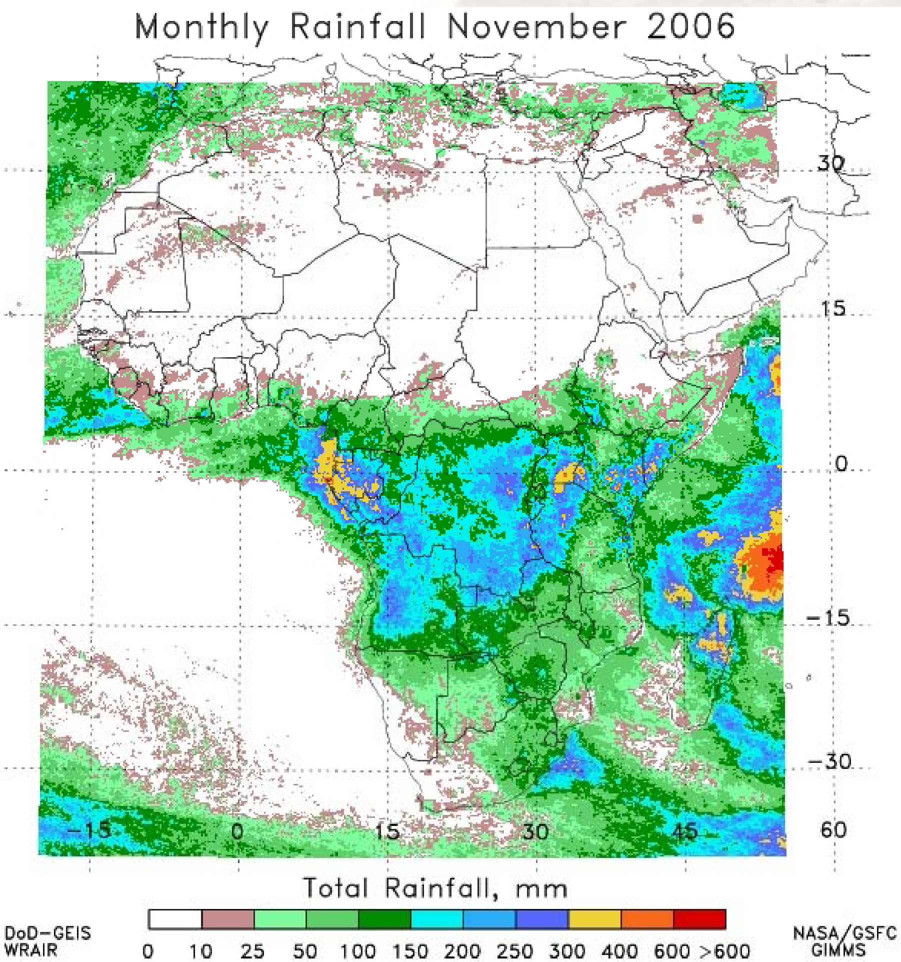
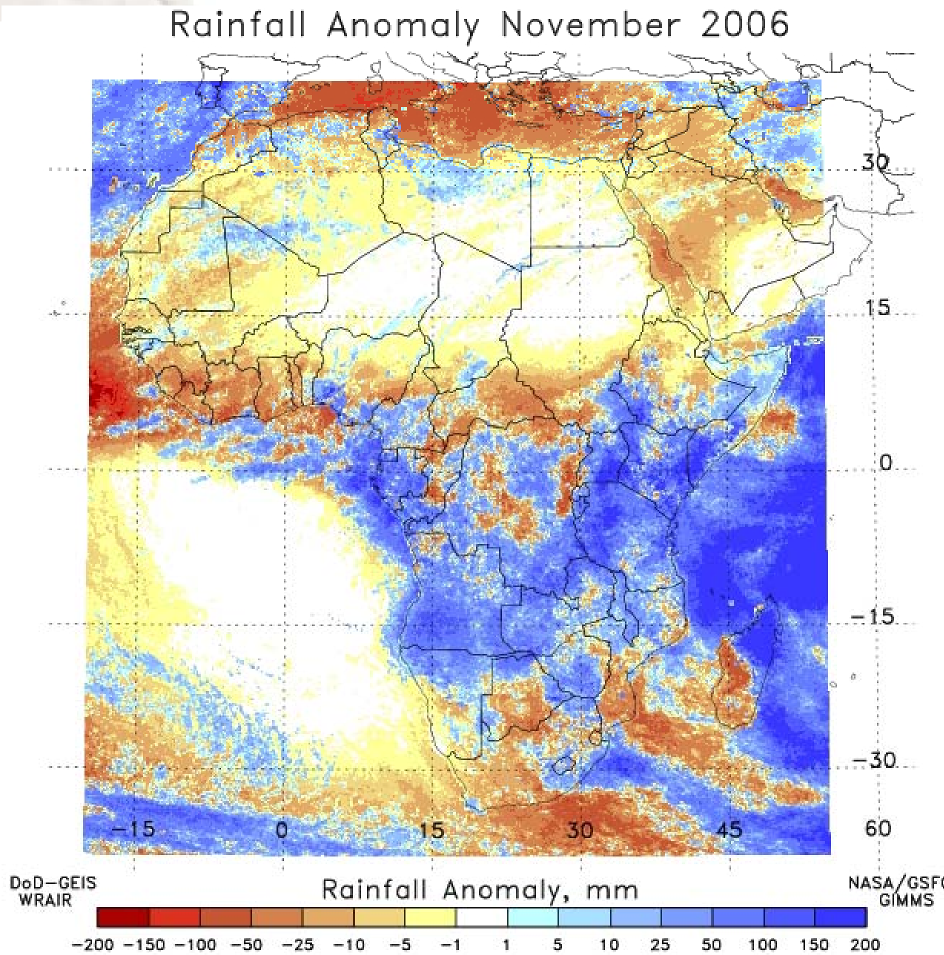
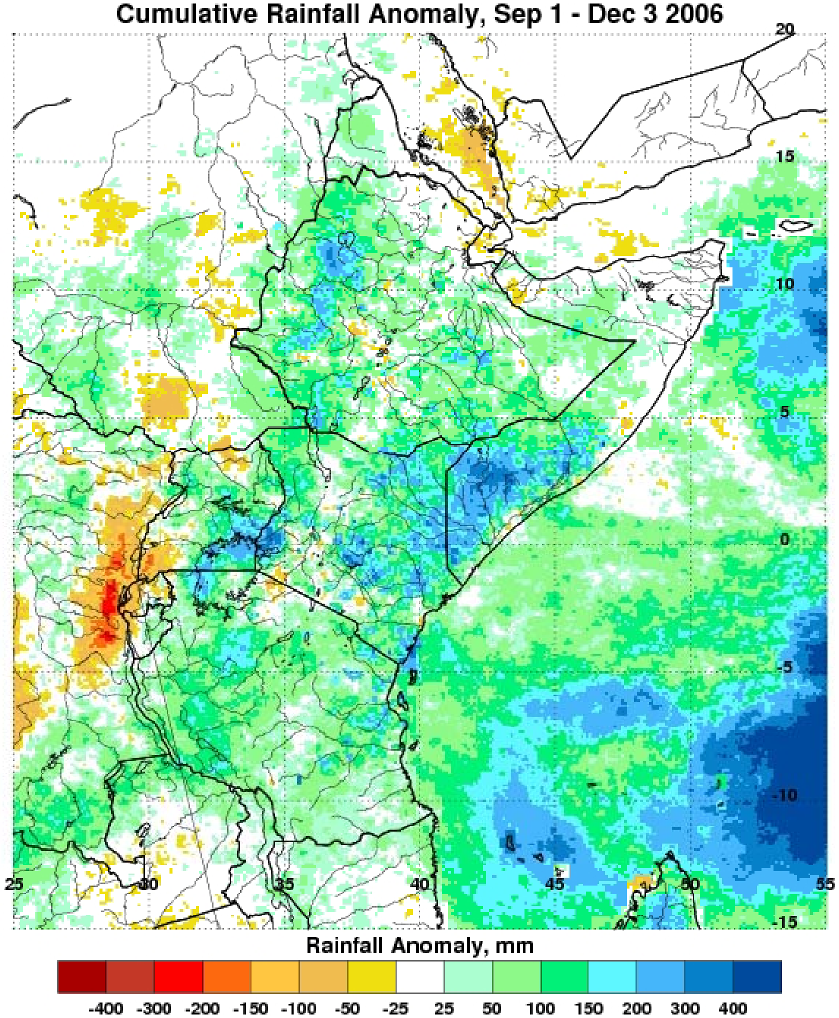
2a. Rainfall – Total + Anomalies



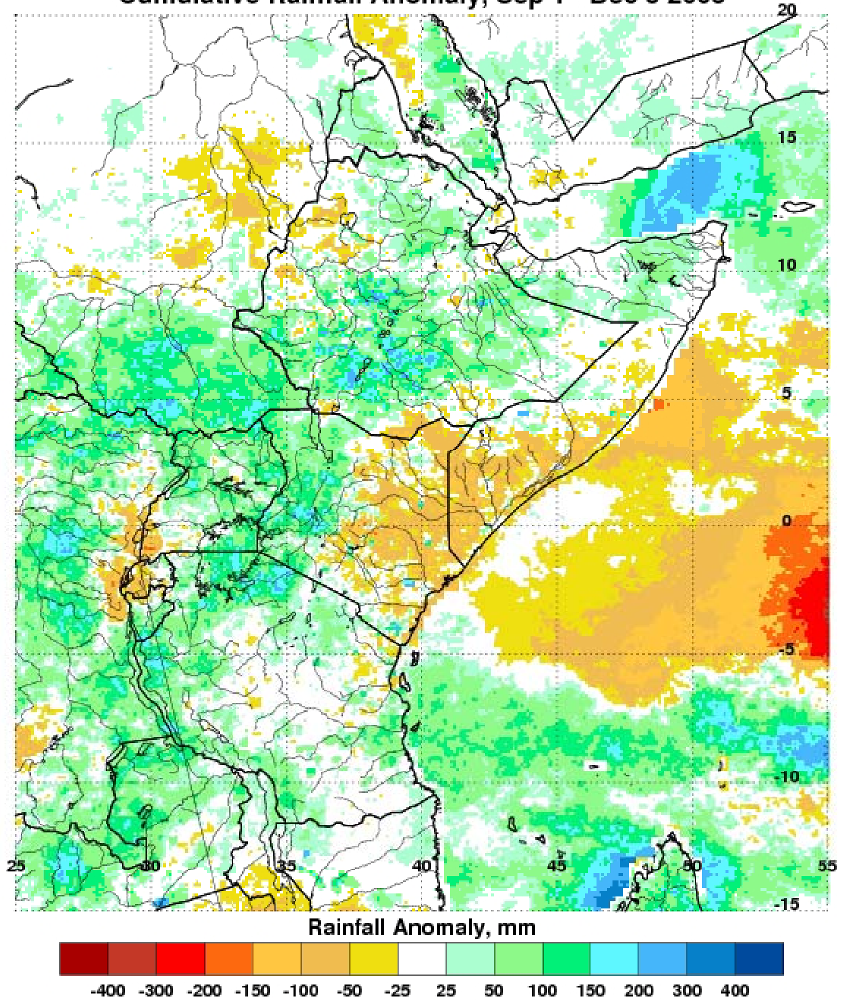


2b. Rainfall -- Cumulative

Cumulative Rainfall Anomaly, Sep 1 - Dec 3 2006



Cumulative Rainfall Anomaly, Sep 1 - Dec 3 2008



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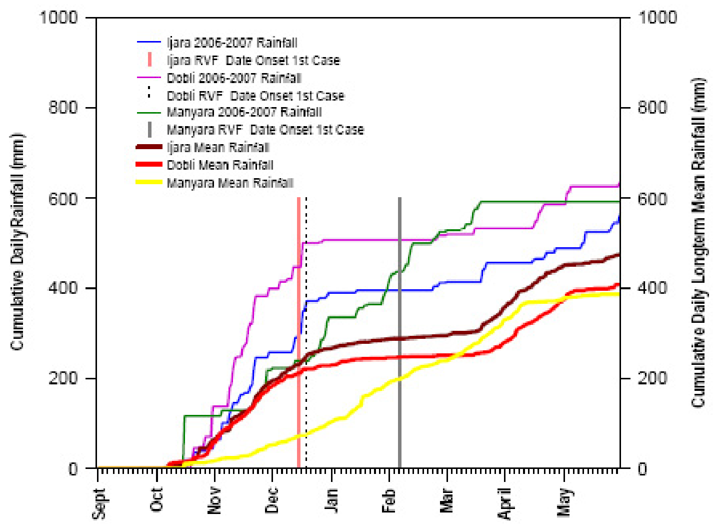
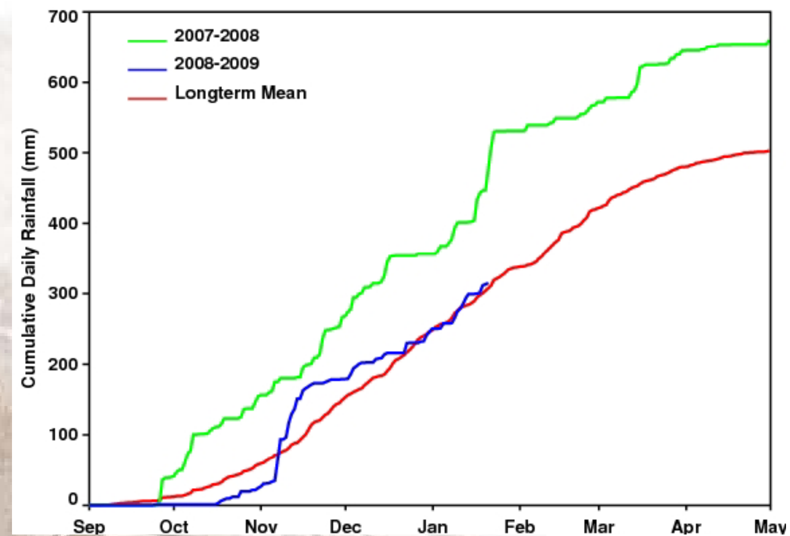
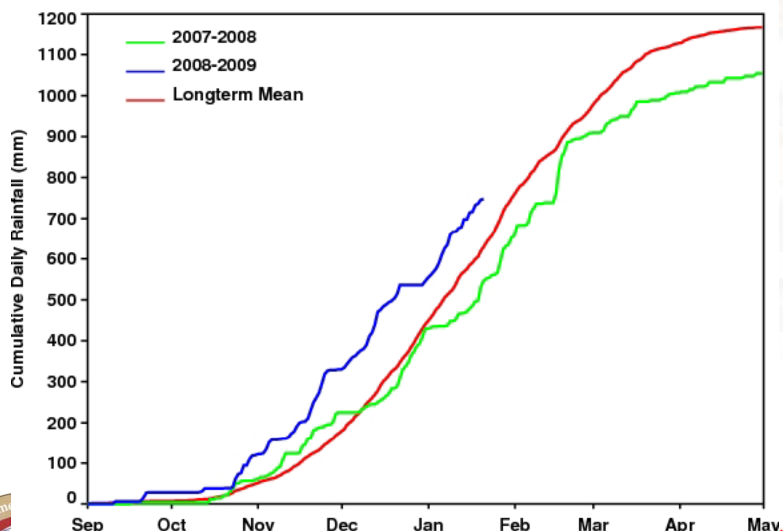
2c. Rainfall Time Series



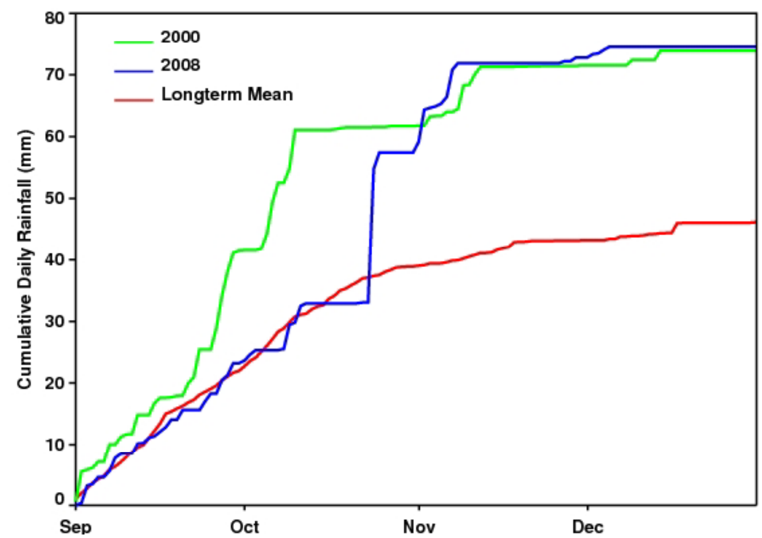
Buyskop Dairy Farm (South Africa): 28.28°E,24.88°S



Ambohimpandrano (Madagascar): 47.19°E,19.01°S



Jazir (Saudi Arabia): 42.63°E,17.33°N



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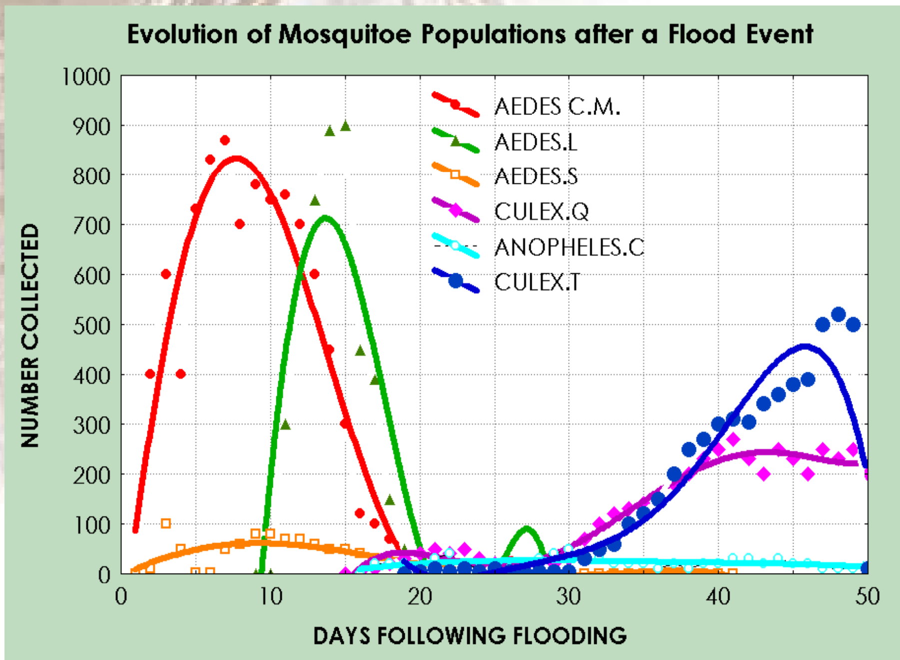
3a. Vector Dynamics and Ecology

• Emergence and population expansion of a number of disease vectors (mosquitoes, mice, locusts) often tends to follow the trajectory of the green flush of vegetation in semi-arid lands

•Dry – Wet cycles appear to maintain the virus cycle through time



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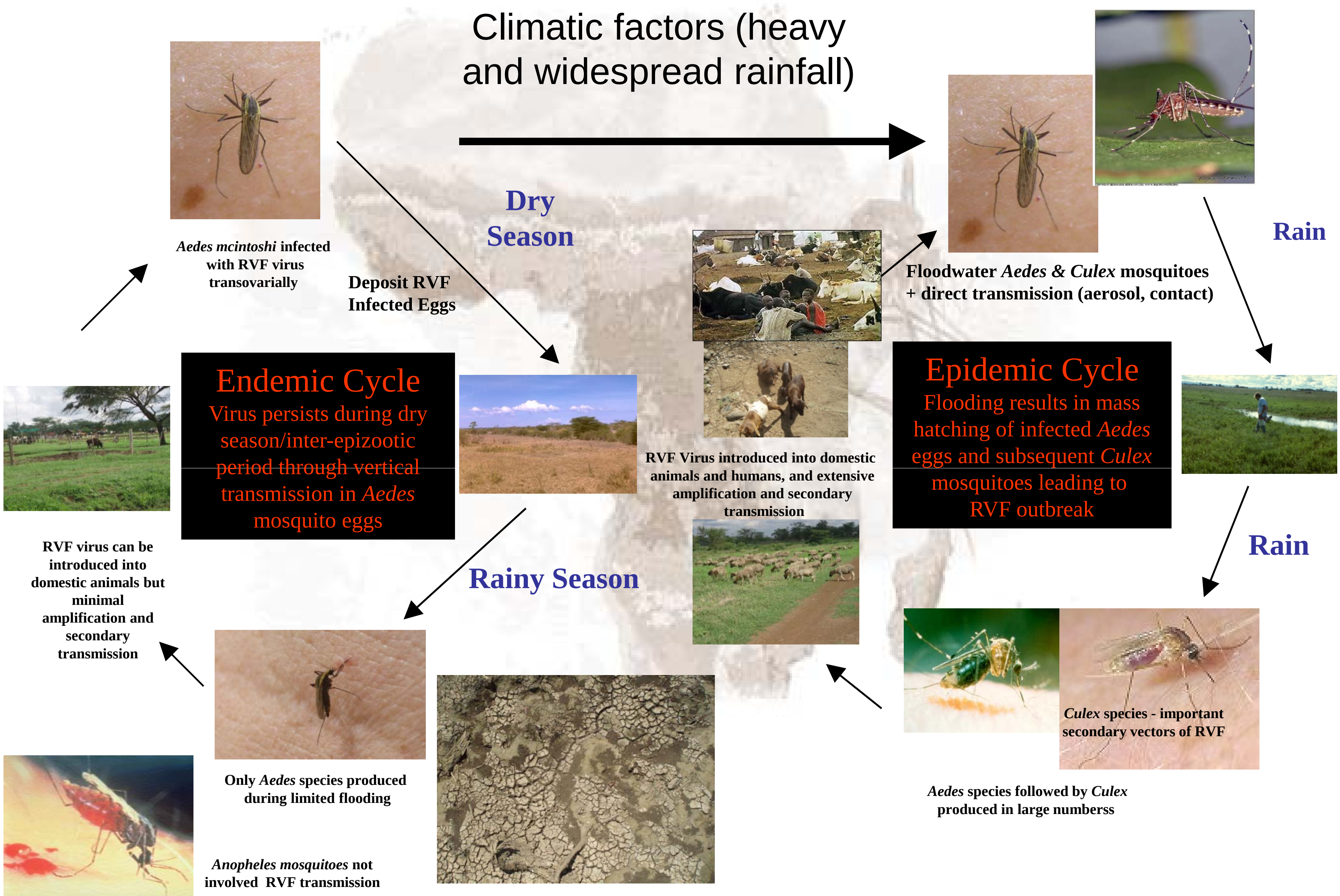
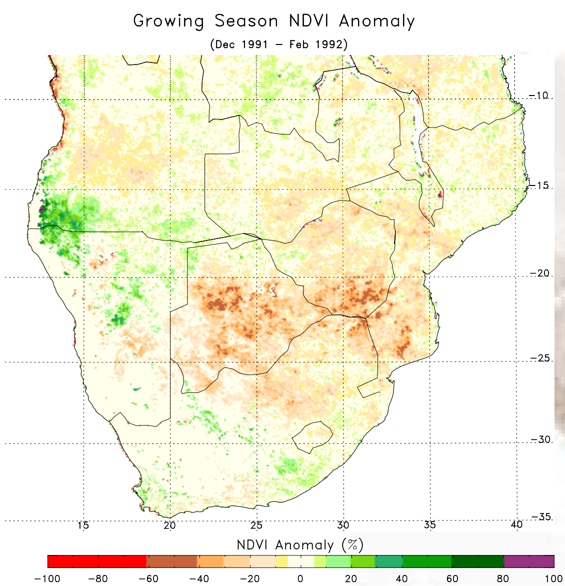
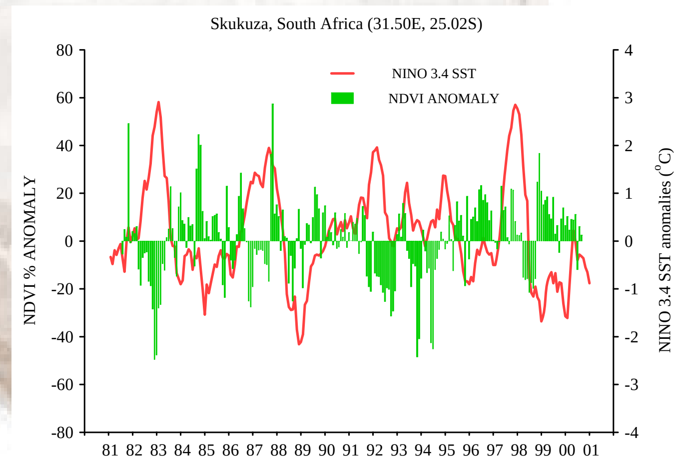
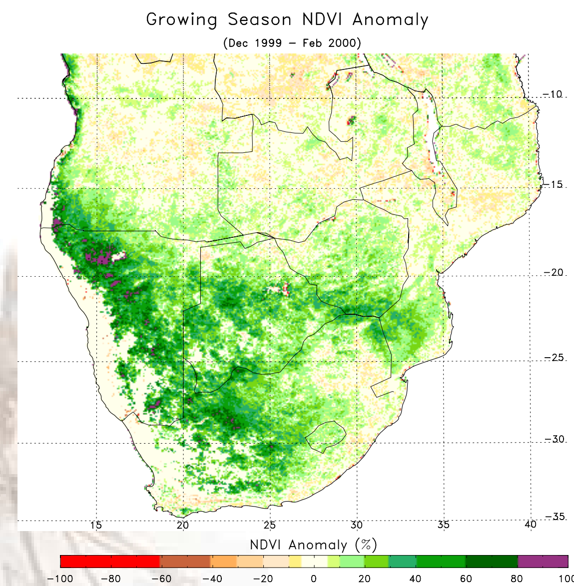
3b. RVF Life Cycle

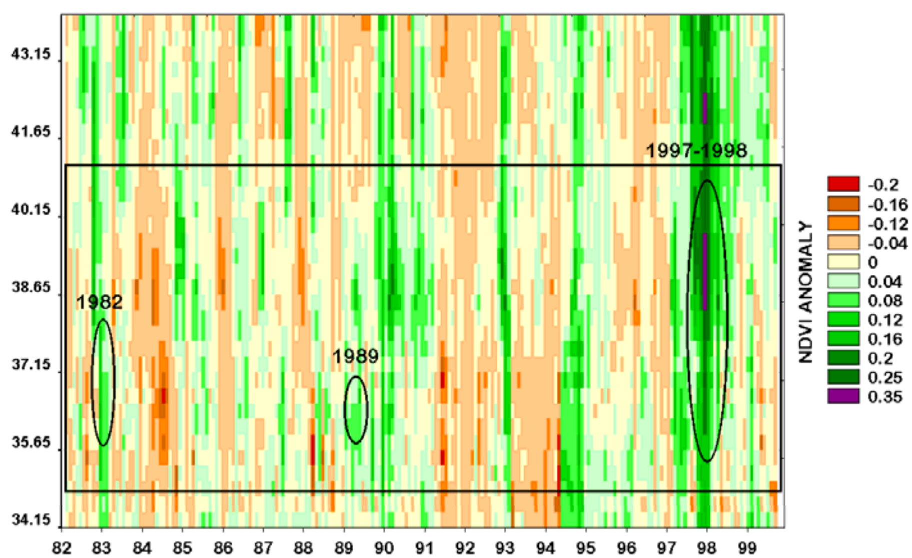


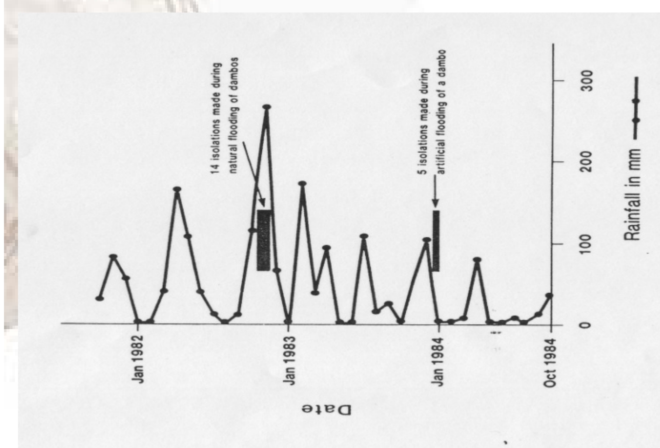
3c. Moisture/Ecological Fluxes = Vector Abundance



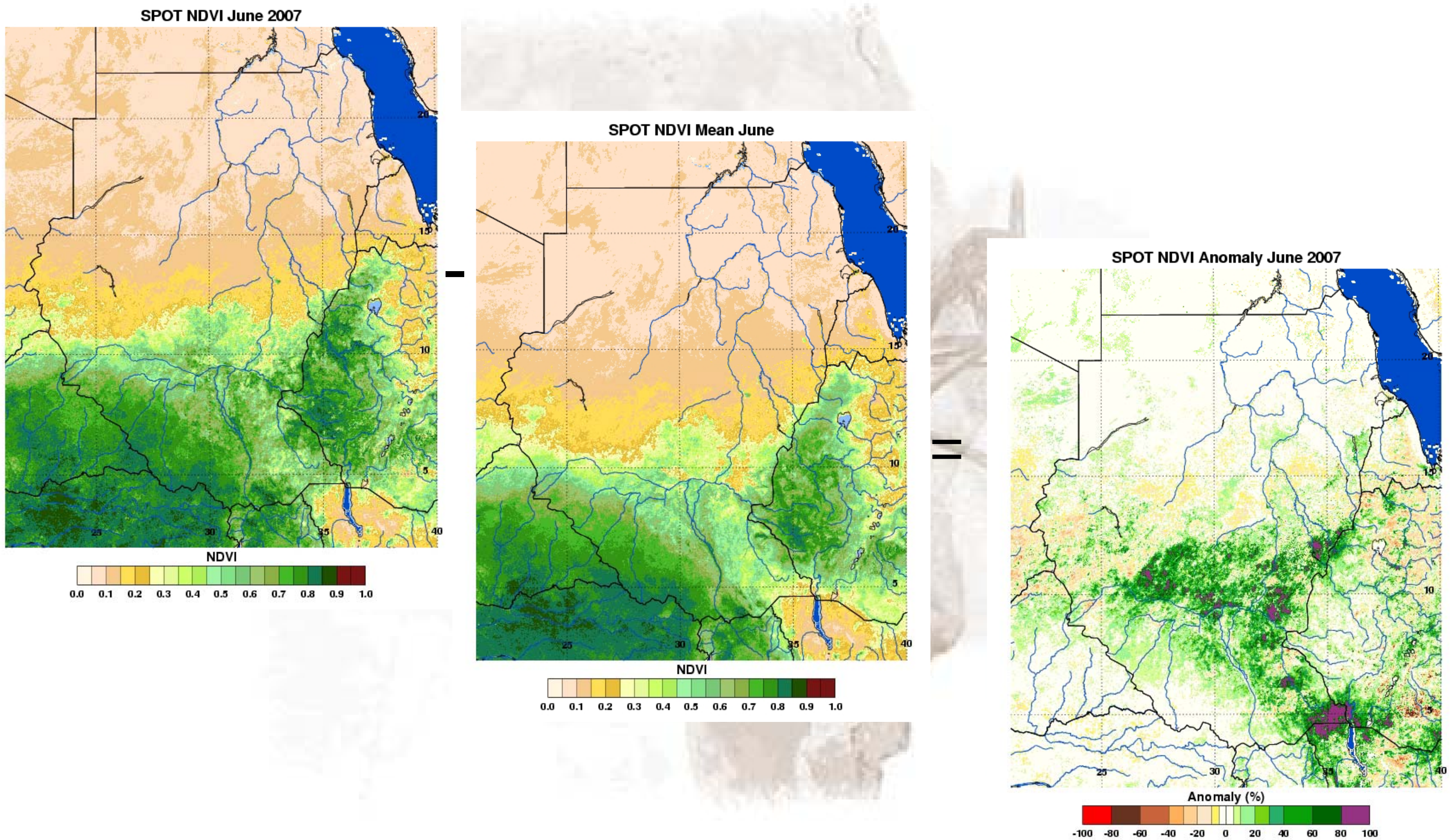








4a. Ecological Indicators: NDVI + anomalies



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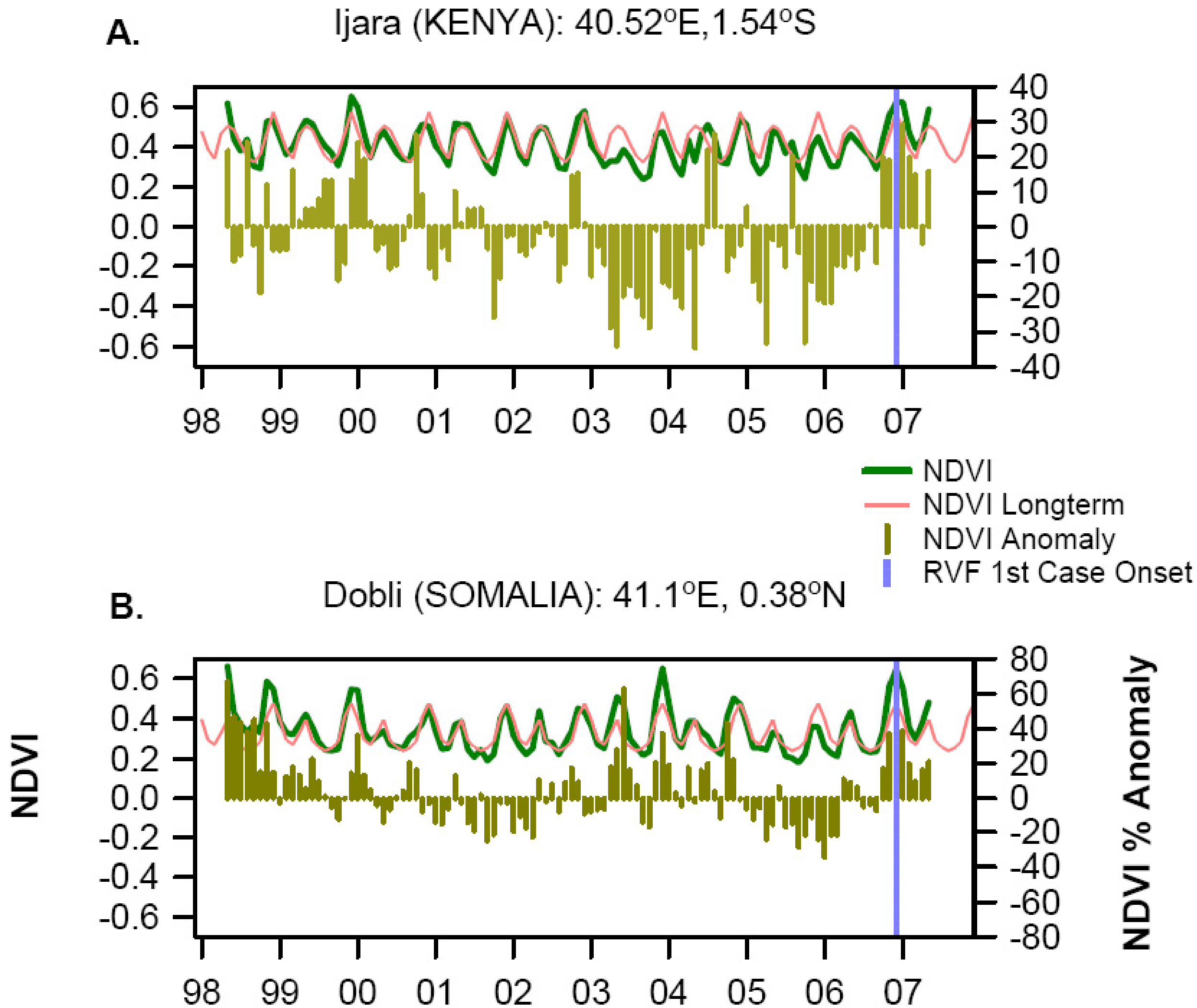
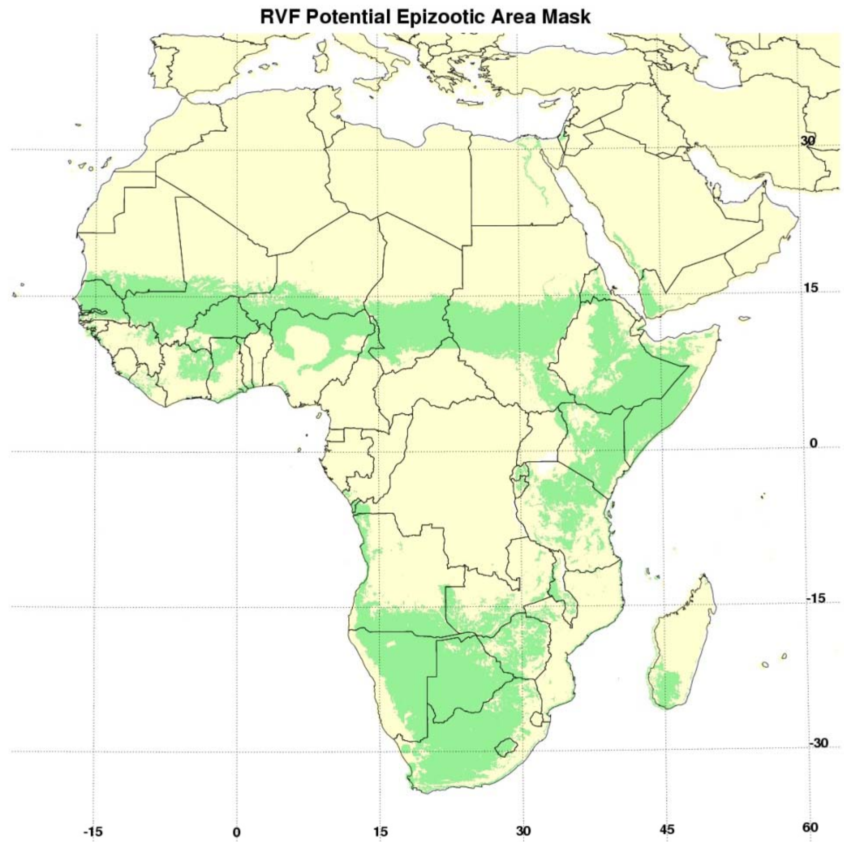
4b. NDVI Time Series



5a. RVF Risk Mapping: Setup

- RVF – epizootics occur under favorable and persistent eco-climatic conditions
- Can be mapped – either as rainfall or vegetation – through NDVI integrates all the required conditions
- Algorithm:
  - Mapping of potential epizootic areas – based on literature survey and climate variable thresholding= potential epizootic area mask (PEAM) – (C. J. Peters & K.J. Linthicum in Handbook of Zoonoses)
  - A given pixel is included within the potential epizootic area if and only if it satisfies one of the following rules for Africa and SW Arabia: (1)[(longitude between 25 and 33 E) OR (latitude < than 25 N and longitude > 33 E) OR (latitude < 20 N and longitude < 25 E) AND (mean monthly NDVI between 0.15 and 0.5 NDVI units) AND (mean annual total precipitation between 100 and 850 mm)]; OR (2)[(latitude between 24 and 36 N) AND (longitude between 30 and 35 E) AND (mean monthly NDVI between 0.15 and 0.5 NDVI units)].
  - NDVI anomaly calculation -- + anomalies > 0.025 threshold (desert calibration) over 3 month period
  - Persistently + anomalies must have three month mean > 0.1
  - All “pixels” that meet this criteria and are within the PEAM are mapped to have conditions necessary for the occurrence of RVF activity



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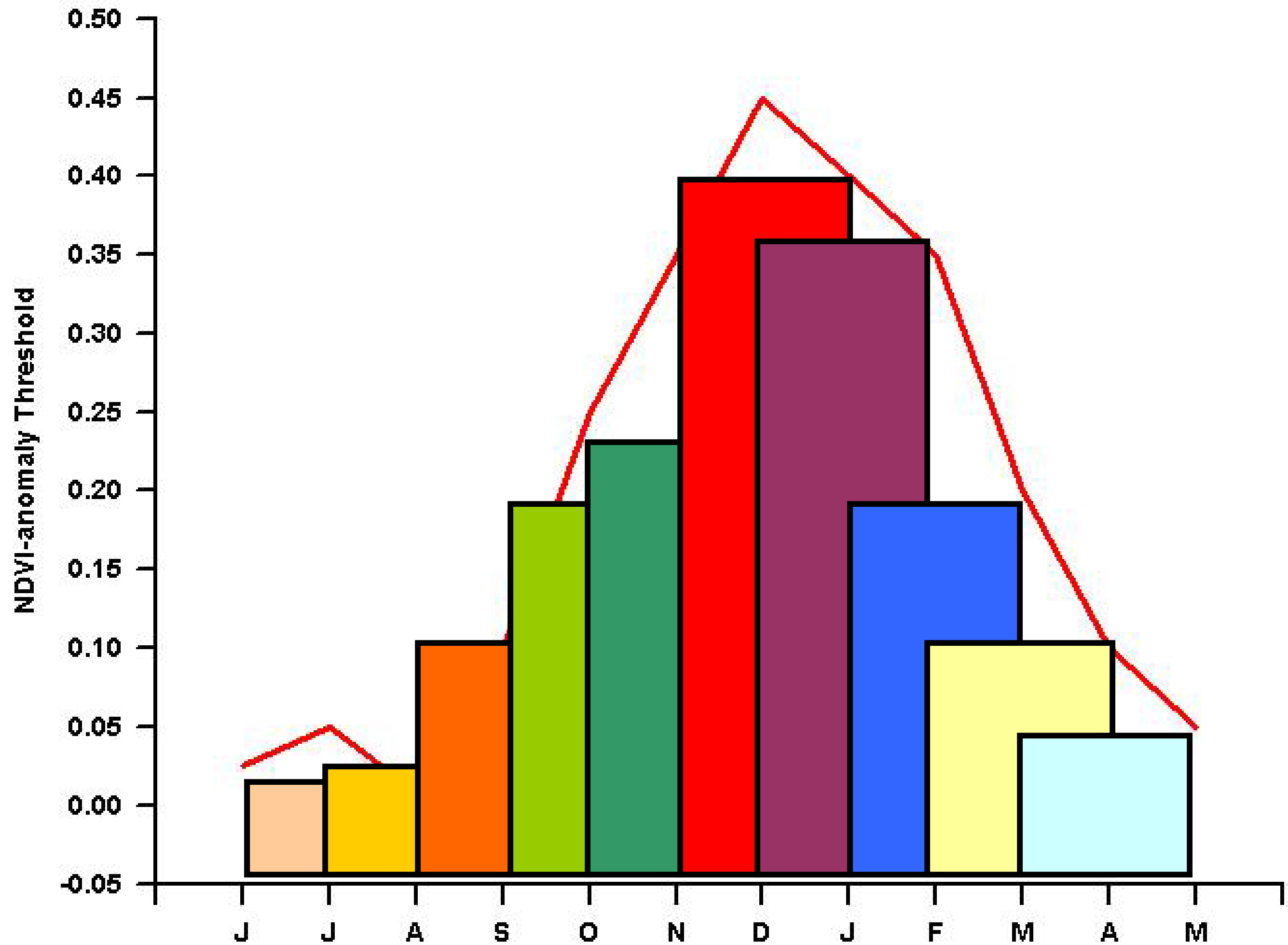
5b.RVF Risk Mapping – Dynamic Implementation



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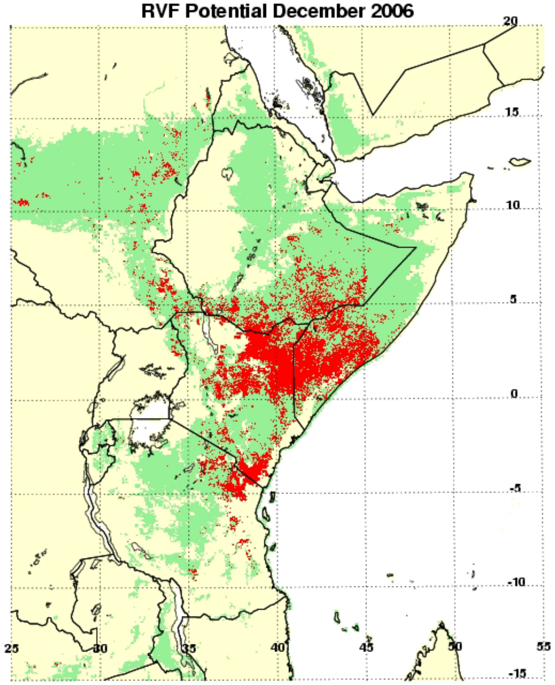
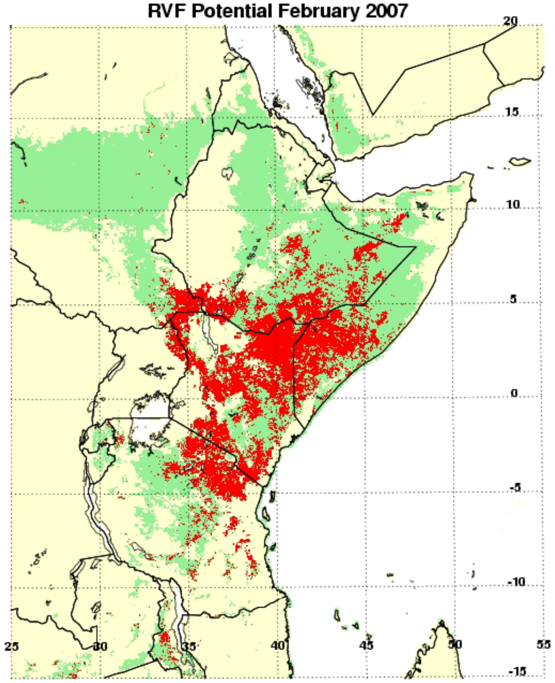
3c. RVF Potential Risk Products

RVF Potential December 2006



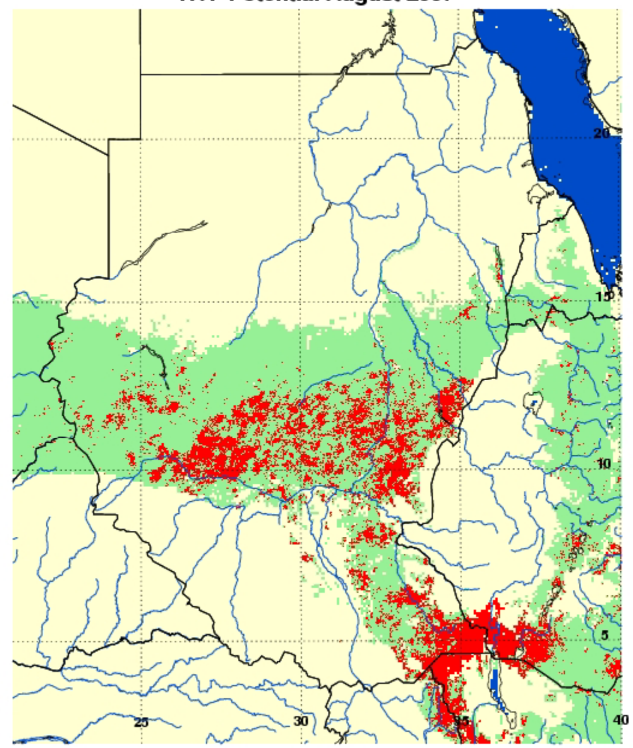
RVF risk areas   RVF endemic regions

RVF Potential February 2007



RVF risk areas   RVF endemic regions

RVF Potential August 2007



RVF Risk Area   RVF Potential Epizootic Area

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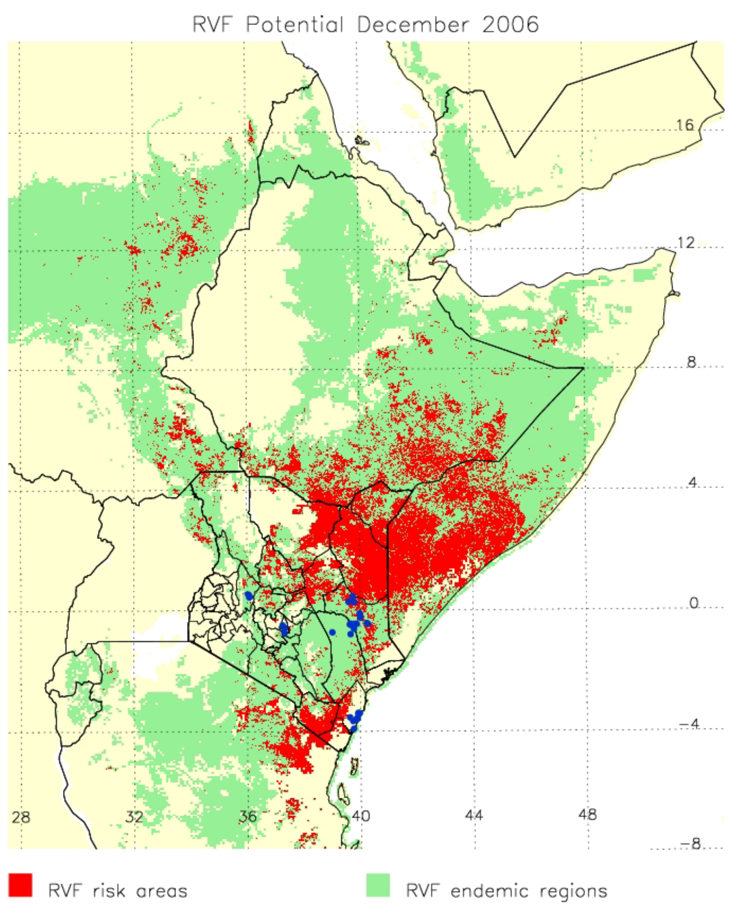
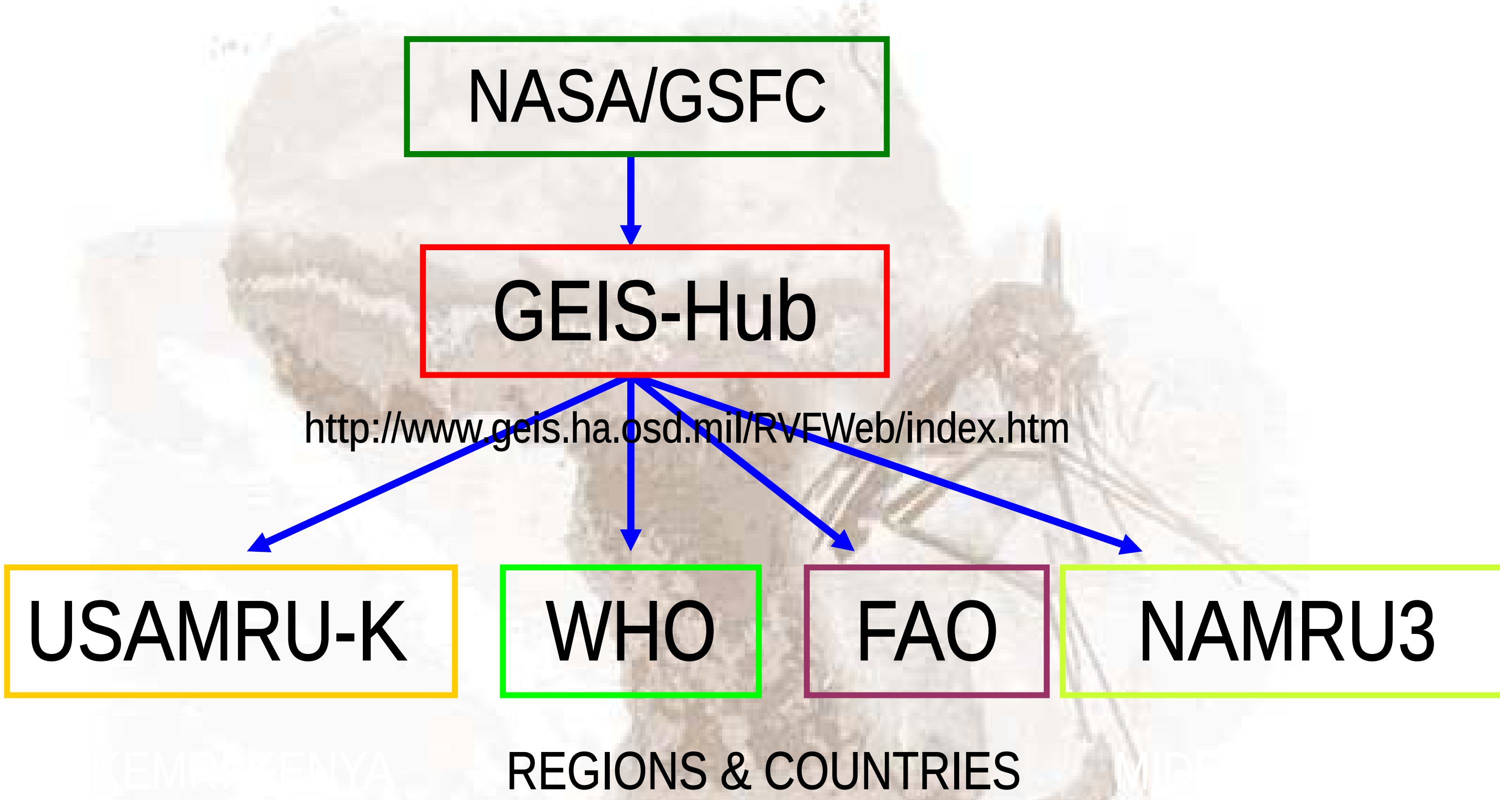
6. Supporting Field Surveillance



- USAMRU/GEIS-K Mosquito samplings sites

7a. Information Dissemination Infrastructure



Early warnings – incremental monthly public domain, Alerts – customized e.g. EMPRES

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7b. FAO Alerts: Emergency Prevention System (EMPRES) for Transboundary Animal and Plant Pests and Diseases

EMPRES WATCH

emergency prevention systems

Possible RVF activity in the Horn of Africa

1. Introduction

Rift Valley fever (RVF) is an arthropod-borne viral disease of ruminants, camels and humans. It is a significant zoonosis which may present itself from an uncomplicated influenza-like illness to a haemorrhagic disease with severe liver involvement and ocular or neurological lesions. In animals, RVF may be unapparent in non-pregnant adults, but outbreaks are characterised by the onset of abortions and high neonatal mortality. Transmission to humans may occur through close contact with infected material (slaughtering or manipulation of runts), but the virus (Phlebovirus) is transmitted in animals by various arthropods including 6 mosquito genus (*Aedes, Culex, Mansonia, Anopheles, Coquillettidia* and *Eretmapodites*) with more than 30 species of mosquitoes recorded as infected and some of them been proved to have a role as vectors. Most of these species get the infection by biting infected vertebrates, yet some of these (specifically *Aedes* species) transmit the virus to their eggs. These infected pools of eggs can survive through desiccation during months or years and restart the transmission after flooding, and then other species (*Culex* spp.) may be involved as secondary vectors.

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This vertical infection explains how the disease can persist between outbreaks.

RVF virus (RVFV) is recorded to occur from South Africa to Saudi Arabia including Madagascar, in varied bioclimatic ecotypes, ranging from wet and tropical countries such as the Gambia, irrigated regions such as the Senegal River Valley or the Nile Delta, to hot and arid areas such as Yemen or Chad. The occurrence of RVF can be endemic or epidemic, depending on the climatic and vegetation characteristics of different geographic regions. In the high rainfall forest zones in coastal and central African areas it is reported to occur in endemic cycles which are poorly understood. Currently available evidence suggests that this may happen annually after heavy rainfall, but at least every 2-3 years otherwise. In contrast, in the epidemic areas in East Africa, RVF epidemics appear at 5 to 15 year cycles. These areas are generally relatively high rainfall plateau grasslands, which may be natural or cleared from forests. In the much drier bushed Savannah grasslands and semi-arid zones, which are characteristic for the Horn of Africa, epidemic RVF has manifested itself only a few times in the past 40 years, in 1961-62, 1982-83, 1989 and in 1997-1998.

In addition the possibility exists that RVFV may spread outside traditionally endemic areas, or even out of the continent of Africa, mostly due to the large range of vectors capable of transmitting the virus and requires a level of viraemia in ruminants and humans that is sufficiently high to infect mosquitoes. Such a situation occurred following the unusual floods of 1997-1998 in the Horn of Africa countries, and subsequently the disease spread to the Arabian Peninsula in 2000.

2. Disease ecology and climatic drivers in the horn of Africa

The ecology of RVF has been intensively explored in East Africa. Historical information has shown that pronounced periods of RVF virus activity in Africa have occurred during periods of heavy, widespread and persistent

http://www.fao.org/ag/againfo/programmes/en/empres/home.asp

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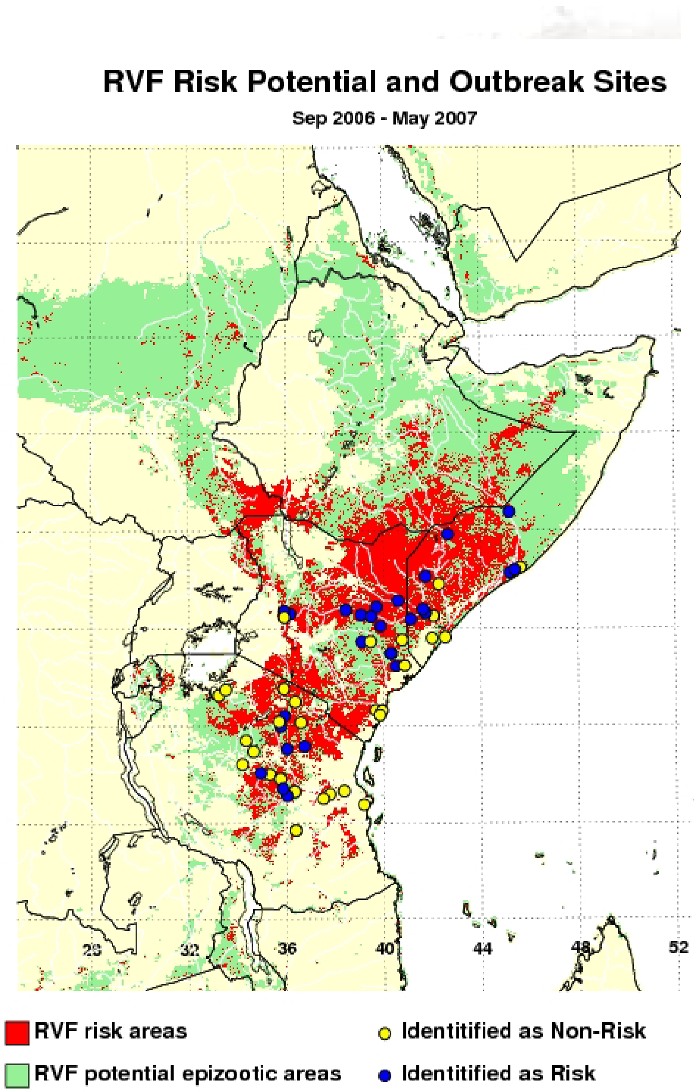
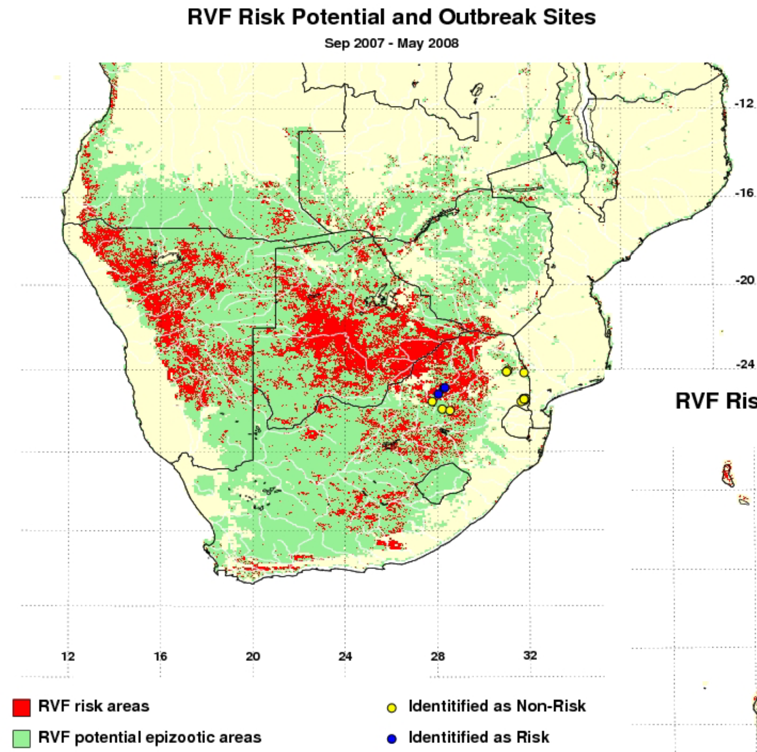
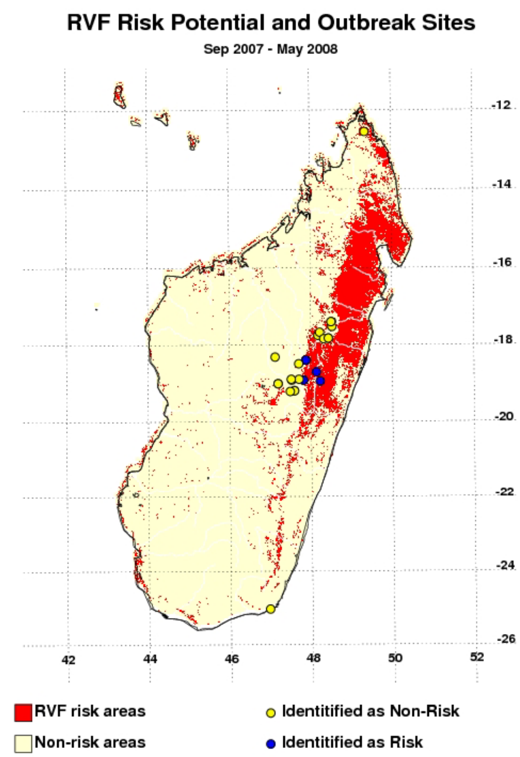
8a. Outbreak Validation and Assessment - Field Data







Collaboration with Partners: WHO, FAO, CDC, GEIS, NCID

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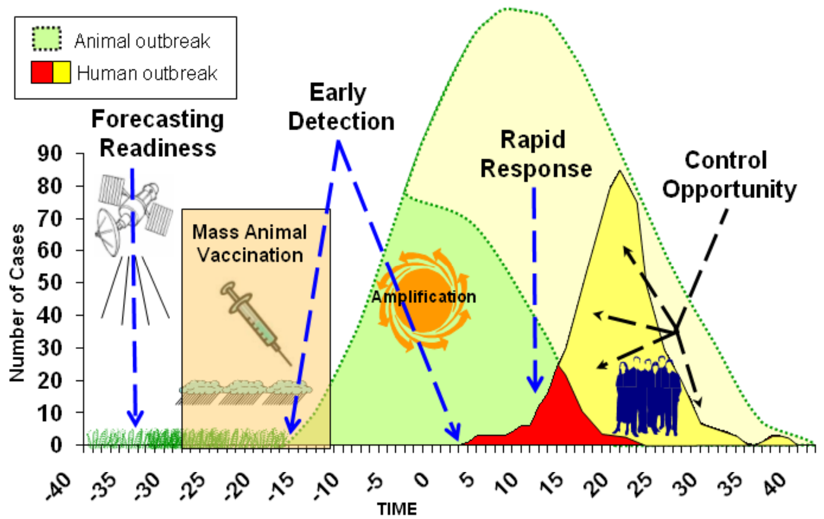
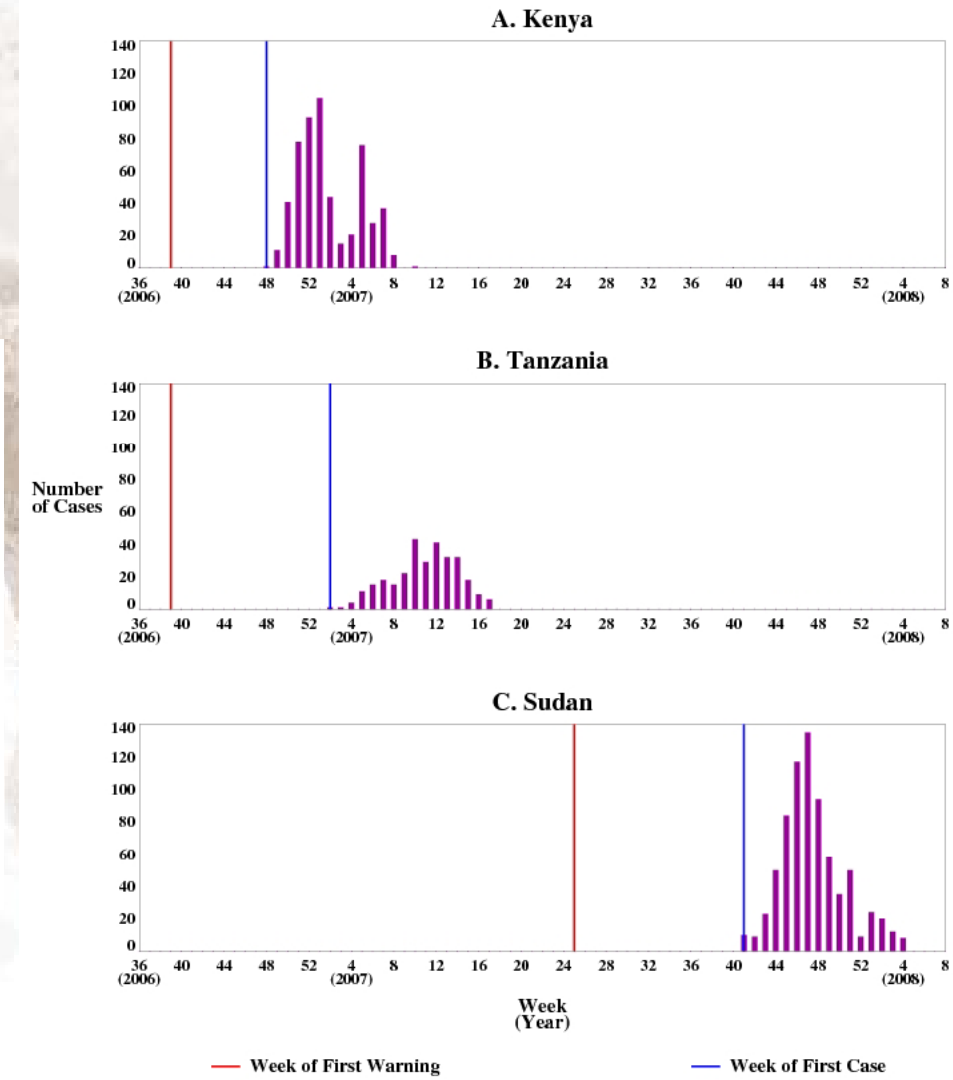
8b. Prediction vs. Outbreak Timing – 2006 - 2008

Kenya, Tanzania, Somalia: 4-5 months

Sudan: 5-6 months

Southern Africa: 2-3 Months





Anyamba et al (In Review AJTMH)

Conclusions

- Early warning provided framework for response 1.5 – 2 months compared to 1997-98, mid-Dec vs. mid-Feb
- An unusual event in the WIO region developed leading to excess rainfall over Sudan and the Sahel region in the summer of 2007 leading to the potential for a RVF outbreak
- Forecasting conditions associated with vector-borne disease outbreaks is critical for timely and efficient planning of operational control programs
- Global and resultant regional, local climate anomalies can be used to forecast potential disease risks that will give decision makers additional tools to make rational judgments concerning disease prevention and mitigation strategies
- Public Health & Trade – Economy Sectors of the economy that can benefit most from climate/environmental and short term climate forecasts.

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Conclusions

- Good Early Warnings/Predictions are not Good Enough without Field Surveillance and Response Planning
- Early Warnings should be used to structure systematic response planning i.e. what can be done with a 3, 4, 5 month early warning – social mobilization, vector control, vaccination, resource mobilization etc
- Need for enhanced cooperation between MoH, Met Services and Livestock Development – use of customized regional and country level seasonal climate forecasts

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- Clair Witt, Jean-Paul Chretien - Department of Defense, Global emerging Infections System, Division of Preventive Medicine, Walter Reed Army Institute of Research, Washington, DC.
- NOAA Climate Prediction Center, Camp Springs, Maryland.
- USDA Foreign Agricultural Service (FAS), Washington D.C.

Field Surveillance & Data Support

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- Rosemary Sang & KEMRI Field Team
- Robert Breiman, Allan Hightower CDC Team – Kenya
- Pierre Formenty, WHO;
- Stephan De La Rocque, FAO
- Bob Swanepoel, NCID, South Africa

Collaborators

- Department of Defense, Global Emerging Infections Surveillance & Response System (DoD-GEIS)
- World Health Organization – Pandemic Alert and Response Department, Geneva
- Food and Agricultural Organization (FAO), Rome.

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