13 September 2011

Weather, Climate and Human Health

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NCAR

NSF

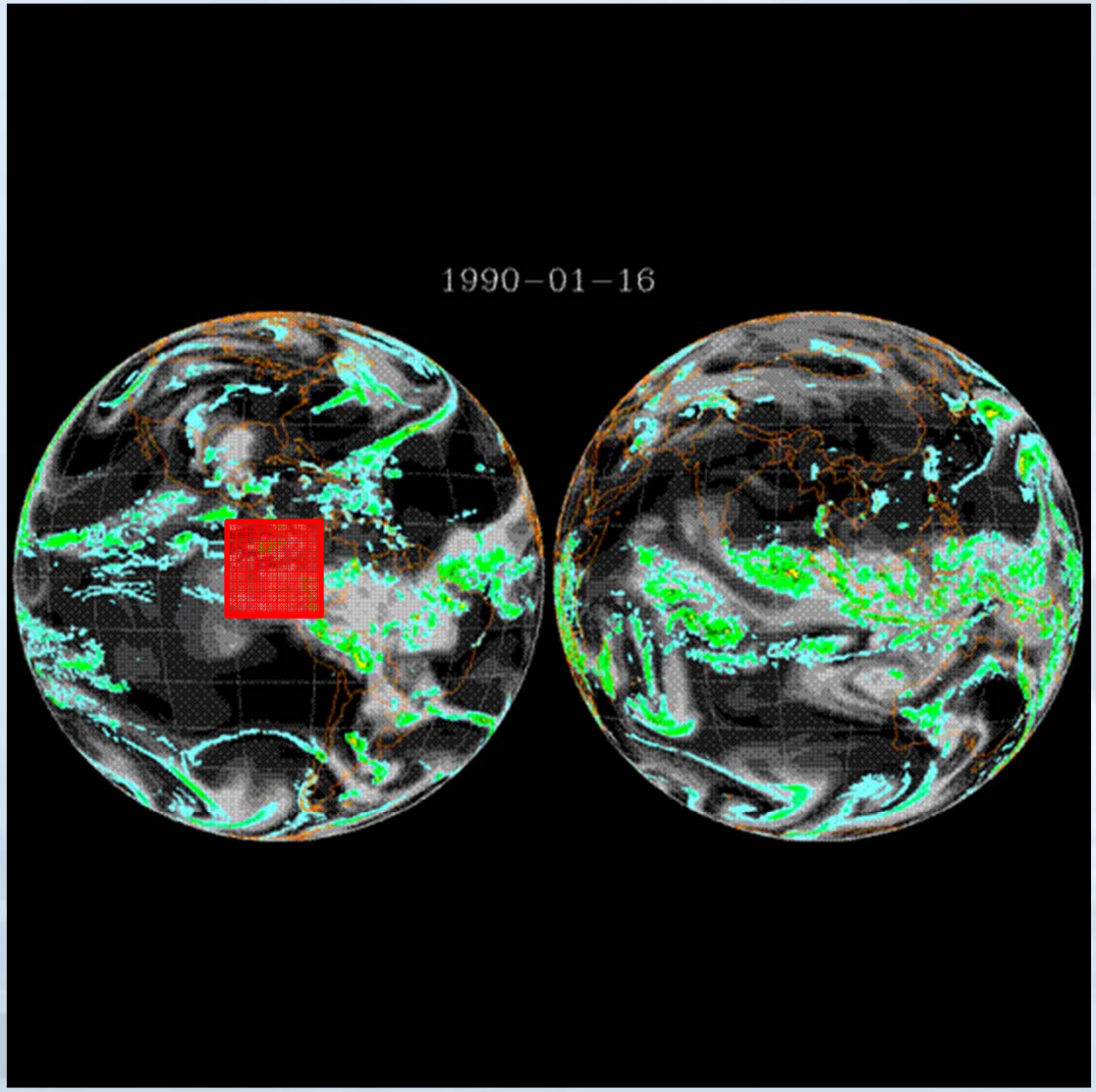
Weather/Climate & Health Program at NCAR

Strategy: An integrated approach to assessing and addressing health risks that encompasses both the physical environment and socio-economic drivers.

- **Extreme heat** (NASA IDS)
- **Meningitis** (Google)
- **Dengue Fever** (NSF CNH/EID, NASA PH)
- **Human Plague** (CDC/USAID)
- NCAR/CDC Postdoctoral Program
- Bi-annual colloquium on climate/health

For characterizing the physical environment, NCAR mainly uses atmospheric and land surface models.

How is modeling linked to remote sensing?



Models assimilate:

-AMSR/AMSU soundings

-GPS occultations

-AVHRR Cloud-track winds

-SRTM terrain

-ASTER terrain

-MODIS Land Use

-NLCD Land Use (Landsat)

-Satellite-derived SST

-MODIS Skin Temperature

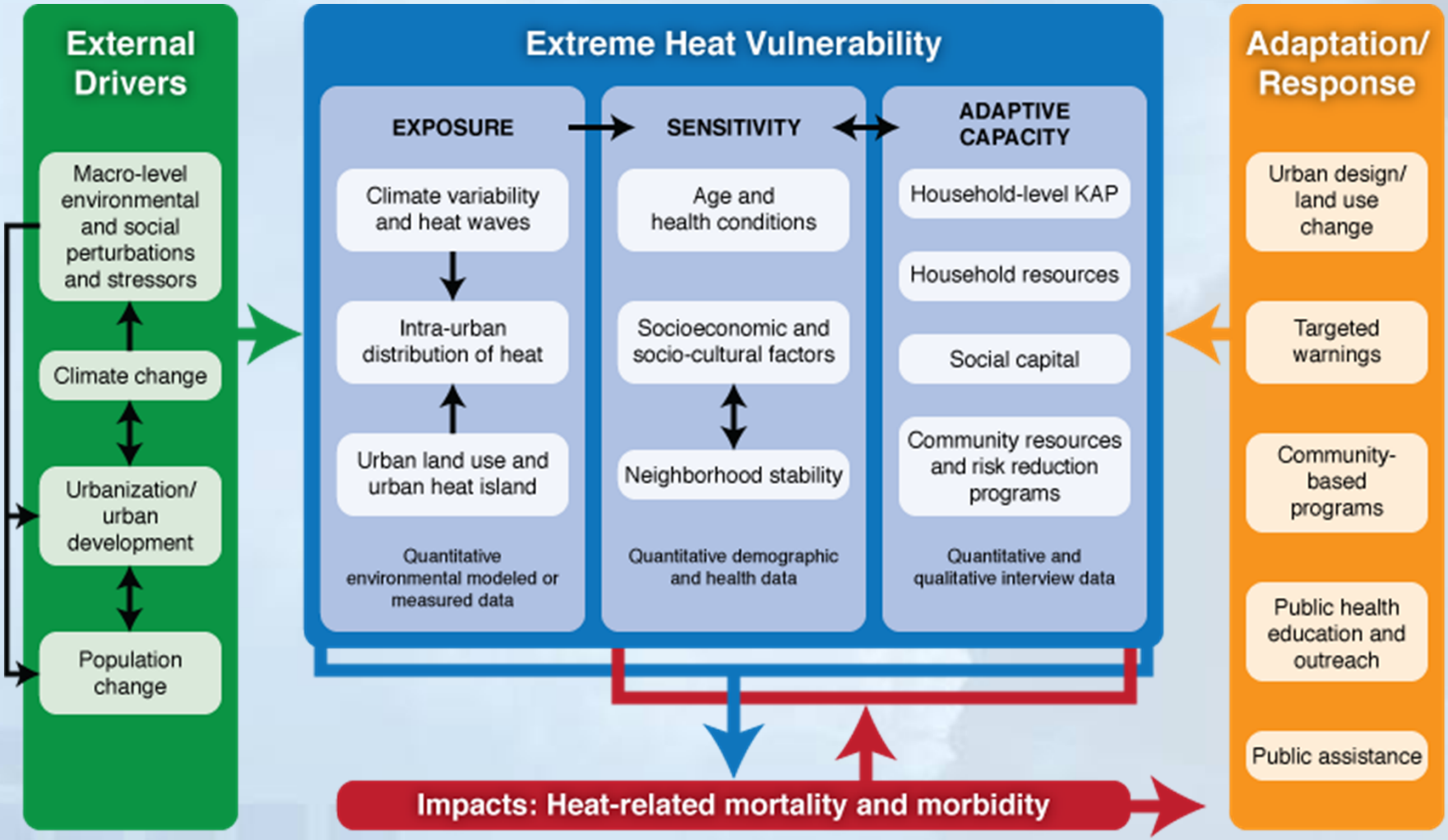
-MODIS NDVI

-GLDAS/NLDAS Soil Moisture/Temperature

Why use models when you have RS data directly?

Extreme Heat

Extreme heat vulnerability framework



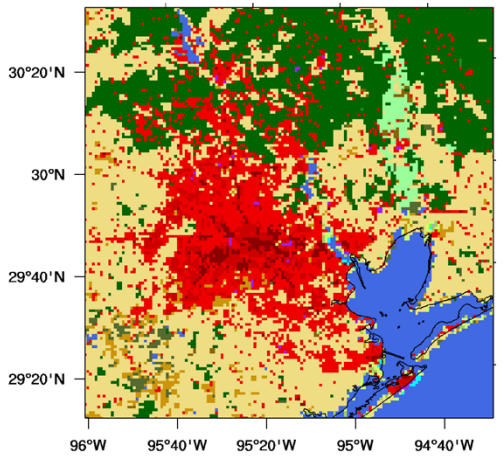
Wilhelmi and Hayden (2010)

SIMMER: System for Modeling of Metropolitan Extreme Heat Risk

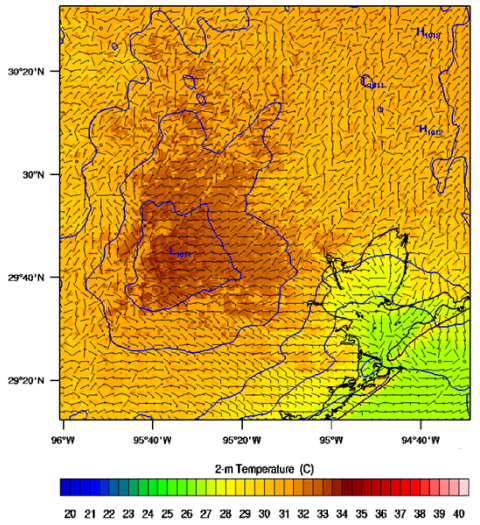
Focus: Houston and Toronto

- Investigate combined impact of extreme heat and the characteristics of urban environmental and social systems on human health
- Characterize societal vulnerability
- Improve representation of urban land cover and urban canopy models
- Characterize and model present and future extreme heat events at regional and local scales

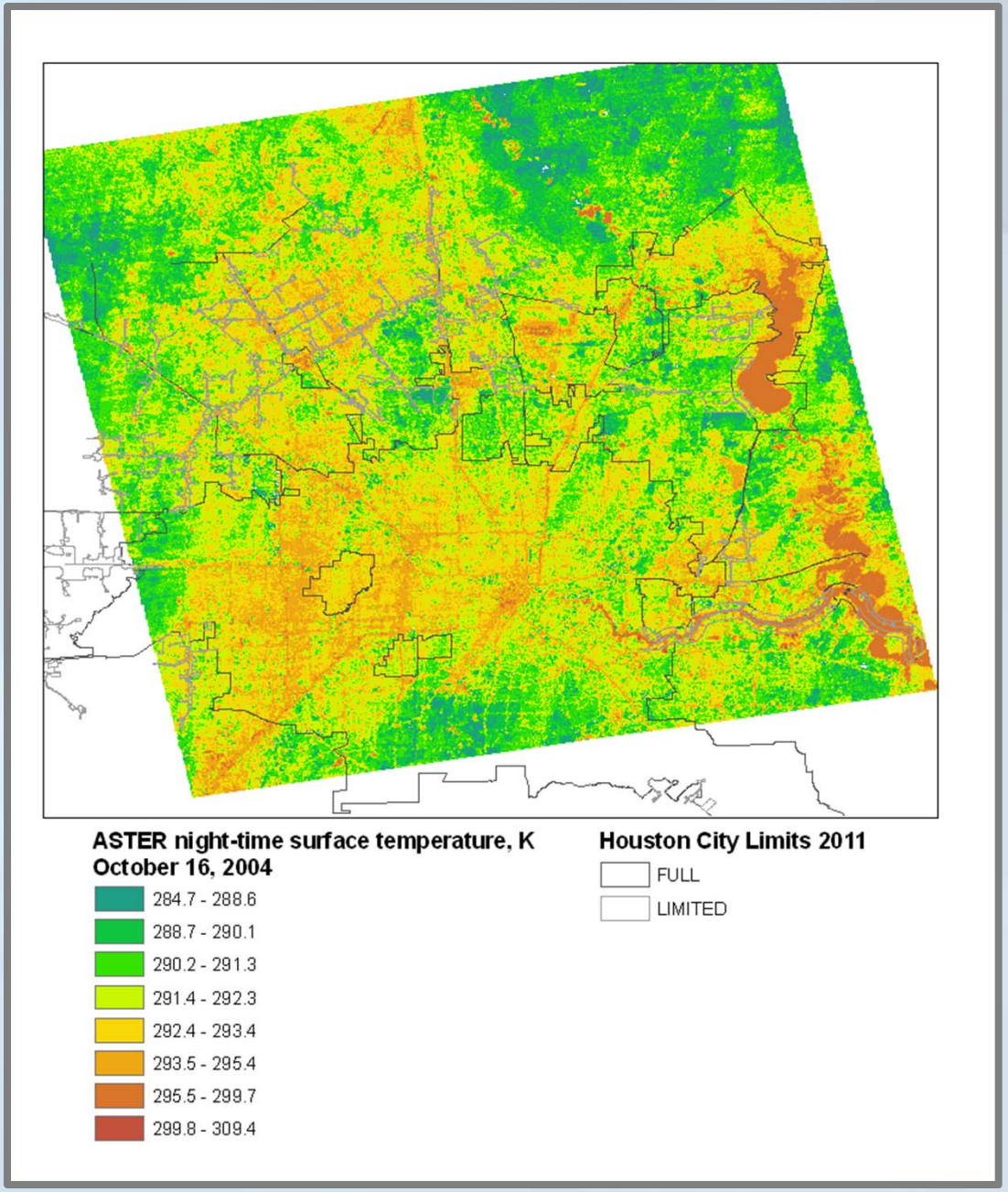
WRF: Houston Land Use



WRF: Houston Heat Island



Employing ASTER for vulnerability modeling, and validation



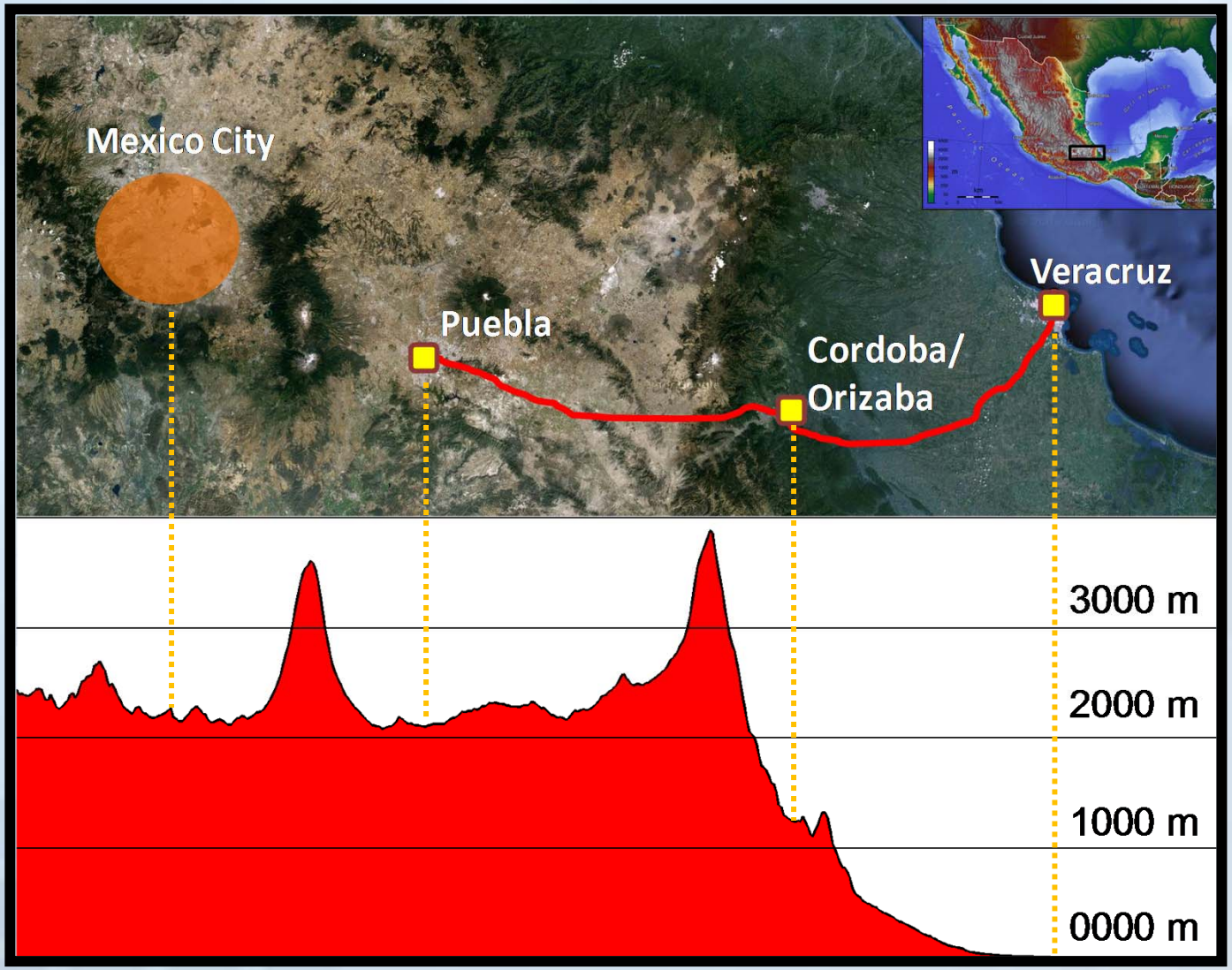
Dengue Fever

Dengue Fever

- Dengue Fever and Dengue Hemorrhagic Fever are caused by dengue viruses transmitted by *Aedes* mosquitoes

- Annually, about 50-100 million people contract dengue worldwide
  - 500,000 people develop severe dengue hemorrhagic fever every year
  - No vaccine available
  - Increasing number and severity of cases in the Americas

Aedes aegypti at the margins of transmission: sensitivity of a coupled natural and human system to climate change



Climate change and *Aedes aegypti*

Study Aims

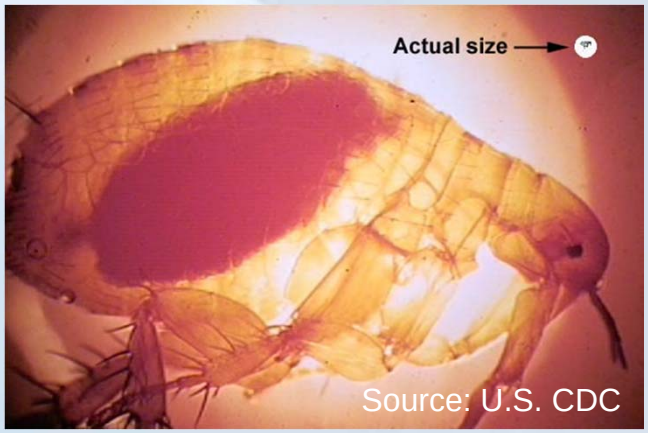
(1) Along transect, measure how climatic, socio-economic, and infrastructure factors are coupled with mosquito vector abundance.

(2) Develop a spatial predictive model for mosquito abundance with the field results from Aim 1.

(3) Employ the model to determine which aspects of climate, human behavior and infrastructure are most closely coupled with *Aedes aegypti* populations now and in the future.

(4) Engage students and community members through “participatory epidemiology”.

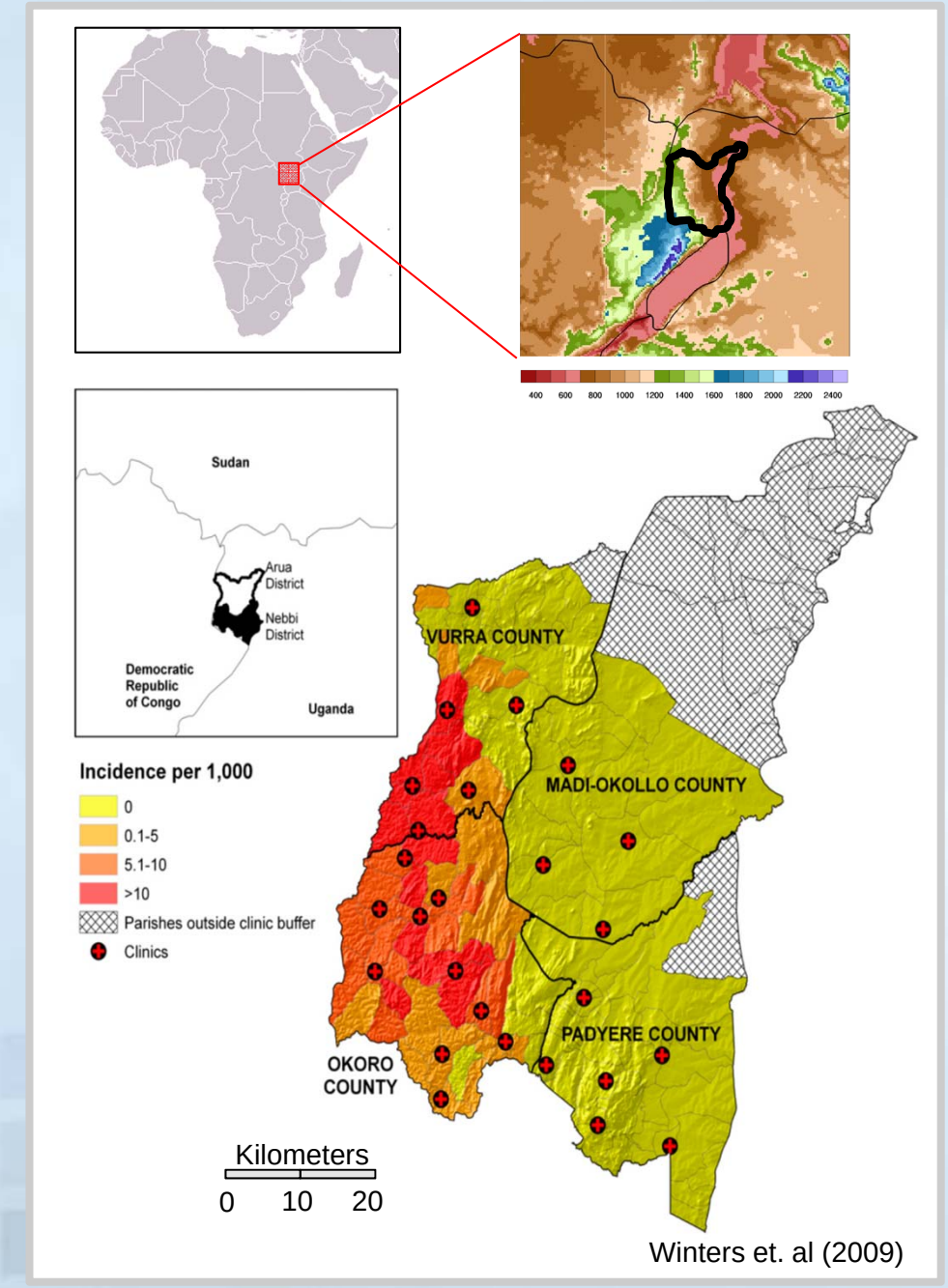
Human Plague



Plague in Uganda

- **Plague is an often fatal flea-borne disease caused by *Yersinia pestis*.**
- **Infected fleas travel on rats that intermittently come into contact with humans**
- **Local rat and flea populations fluctuate in response to weather and climate variability**

Background



Winters et. al (2009)

From 1999-2007, approximately 2,000 suspect human plague cases were reported from the West Nile Region in NW Uganda.

CDC is developing models based on ecological correlates with plague

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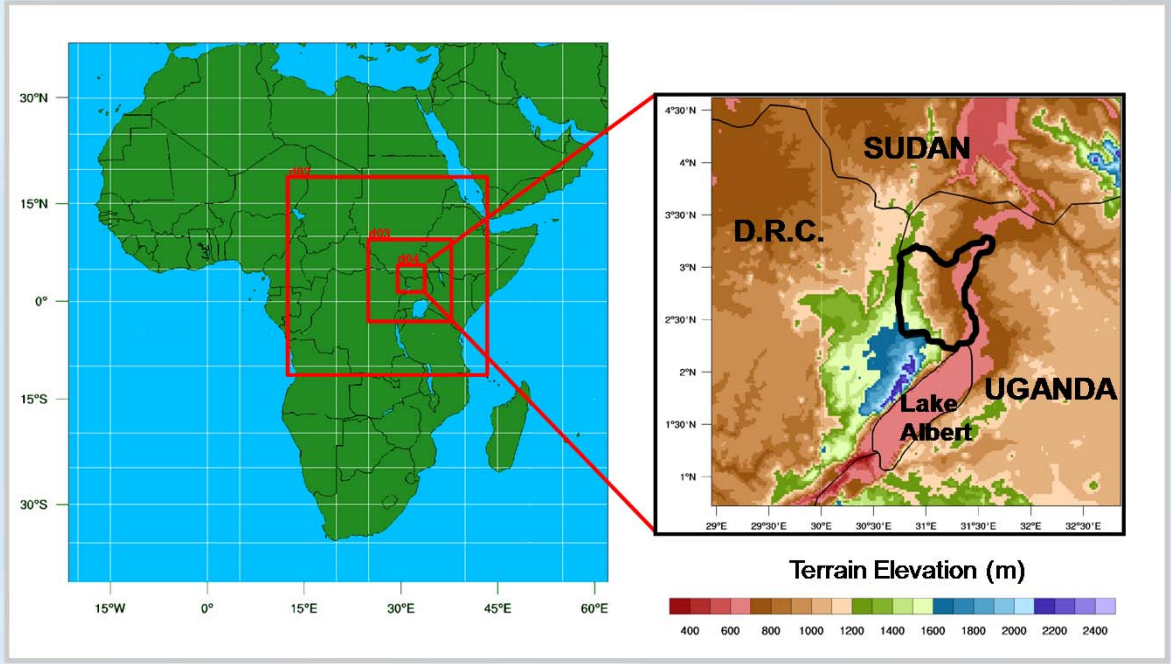
NCAR is working with CDC to:

(1) Simulate a multi-year high resolution climate dataset over Uganda for development of a model to simulate plague incidence

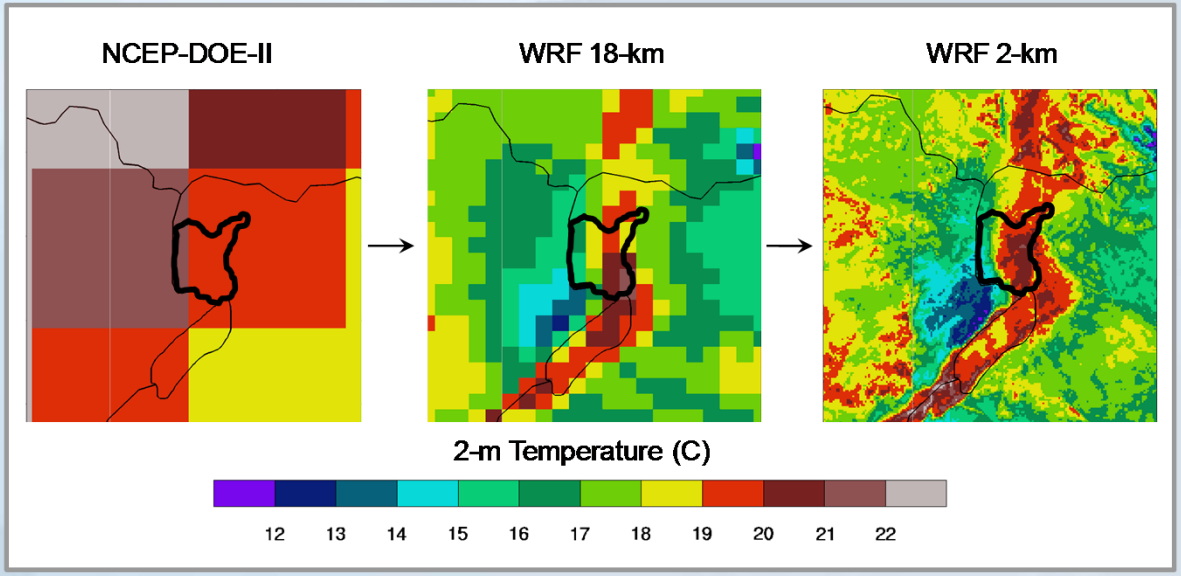
(2) Improve treatment of plague cases by training the regional network of traditional healers to diagnose and refer suspect plague cases to clinics

Modeling Work

WRF Model Domain and Topography

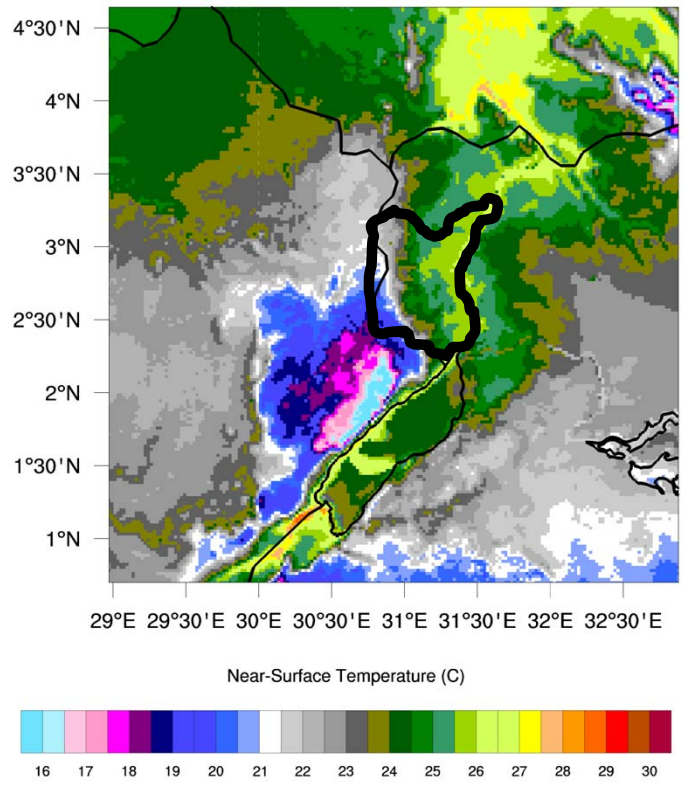


Example of downscaling 2-m temperature

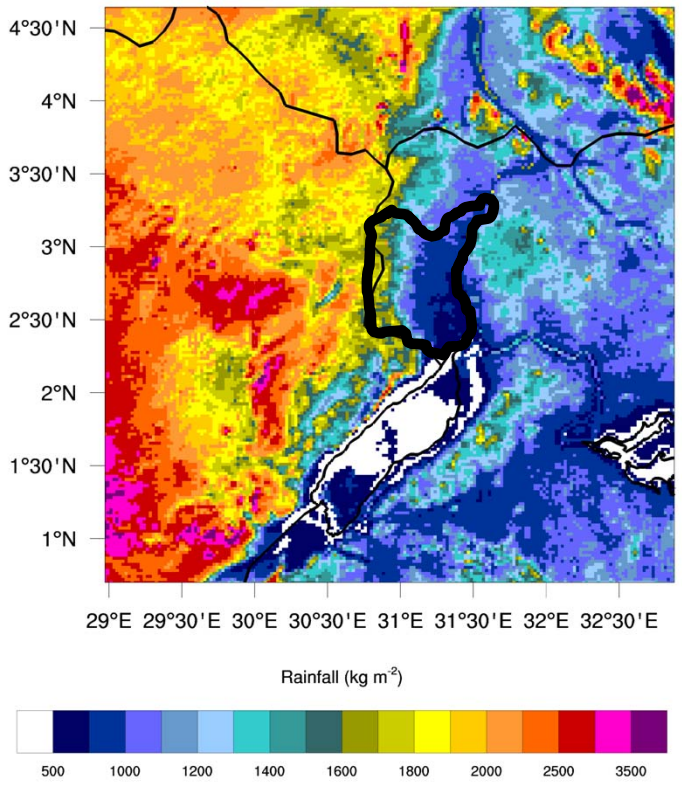


1999-2009 Annual Mean Climate Fields

Near-surface Temperature



Total Rainfall



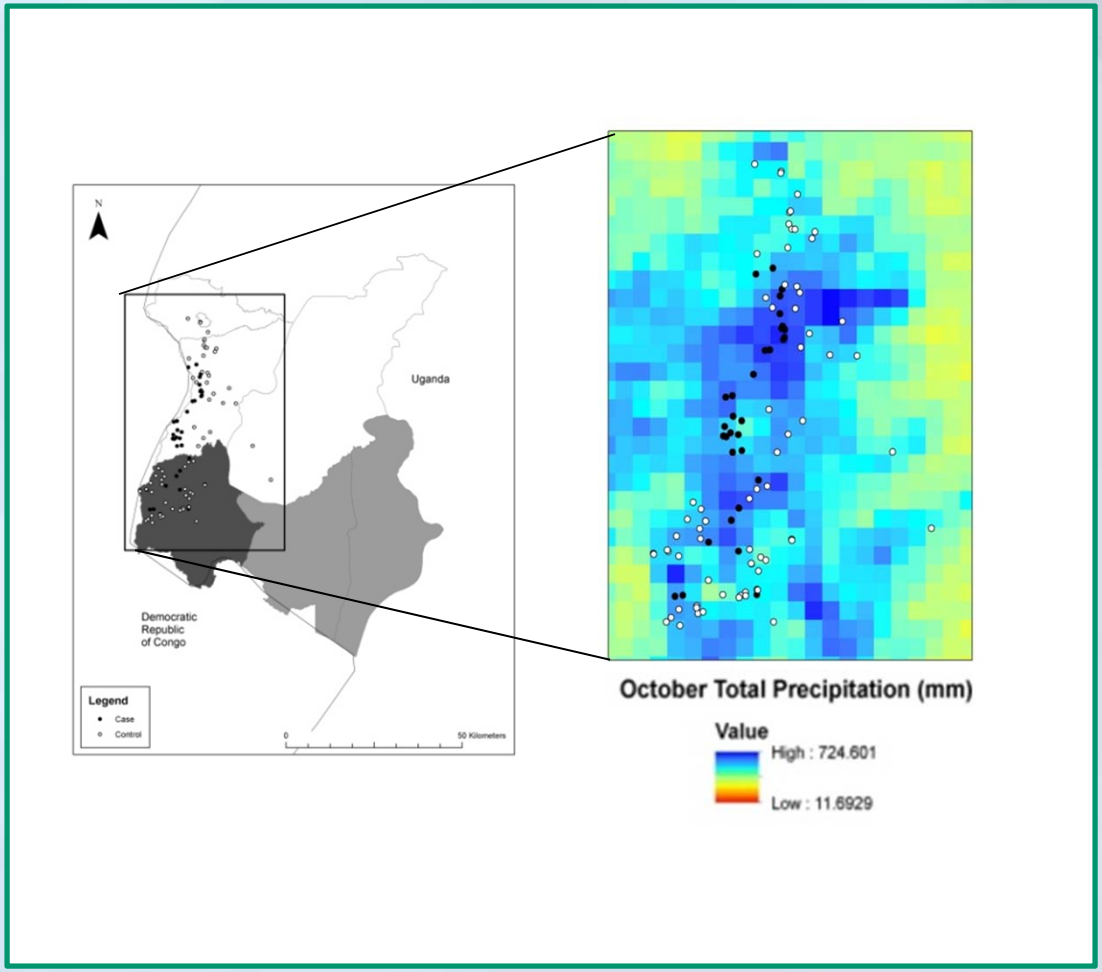
Monaghan et al., submitted

Plague cases are associated with higher-elevation regions that are cooler and wetter

Case and control locations were discriminated based on the following climatic variables (10 yr averages).

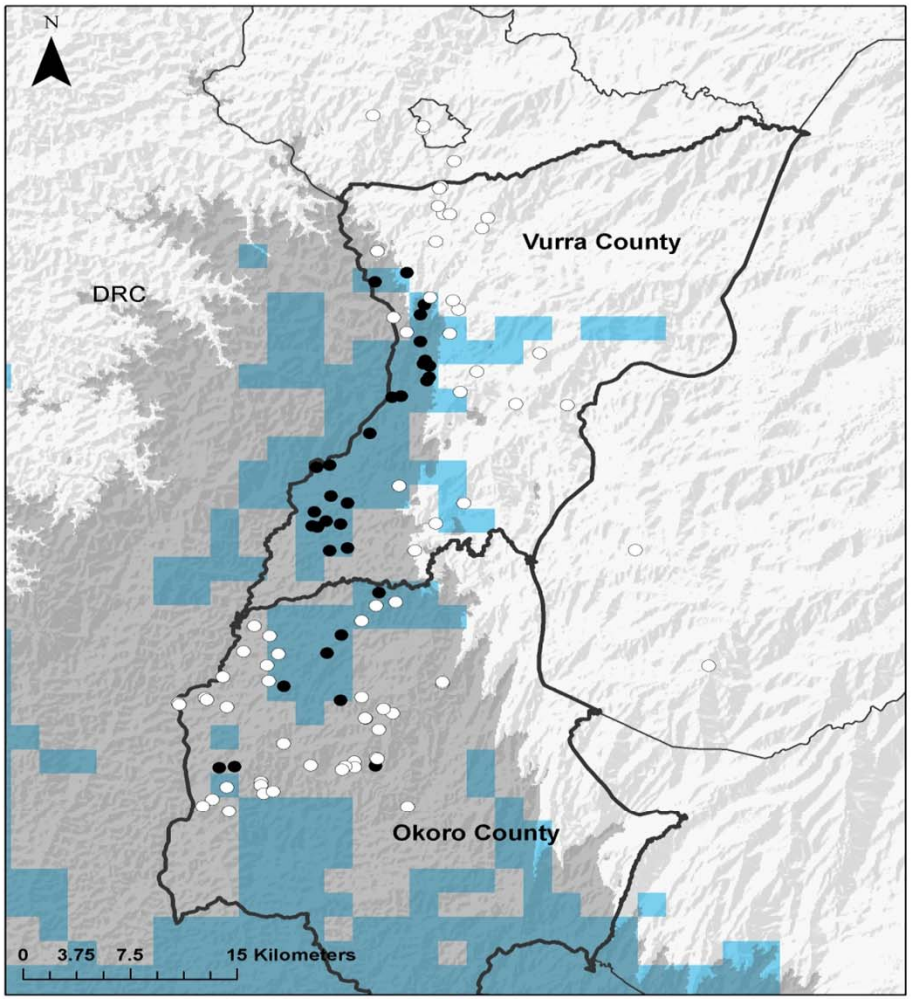
- Total precipitation in February (dry season) (+)
- Total precipitation in October/November (wet season) (+)
- Total precipitation in June (-)
- Above 1300 m (+)

AUC = 0.94

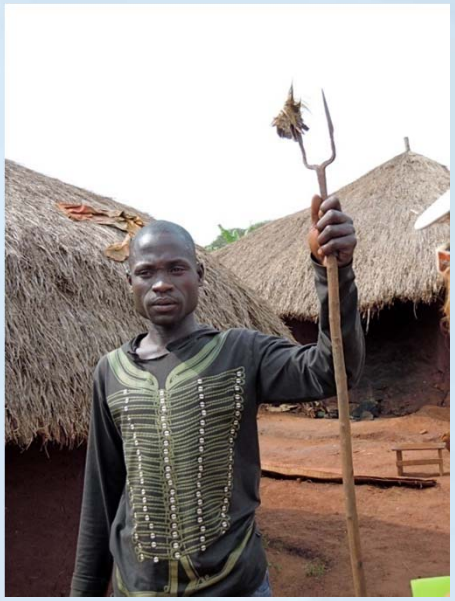


MacMillan et al., submitted

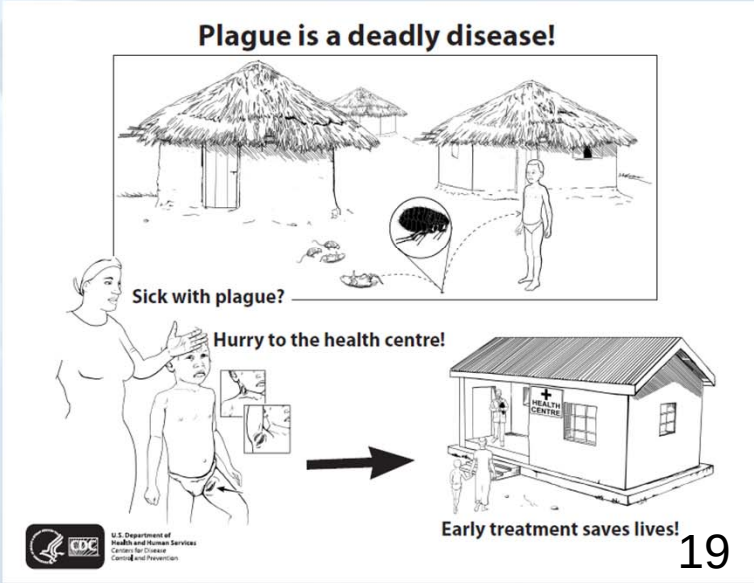
Regions of Elevated Plague Risk



MacMillan et al., submitted



Training Traditional Healers



Summary

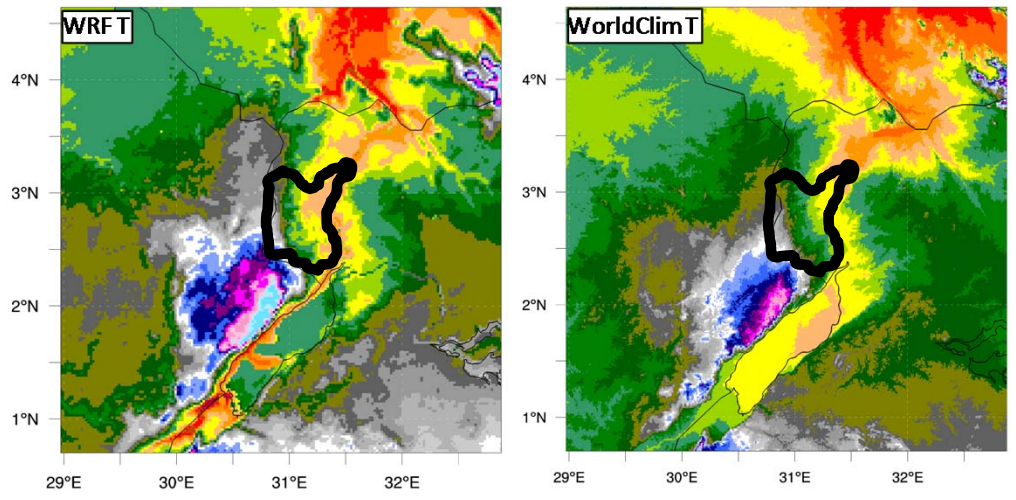
Our long-term goal is to generate comprehensive, quantitative models of climate-related health risks so that:

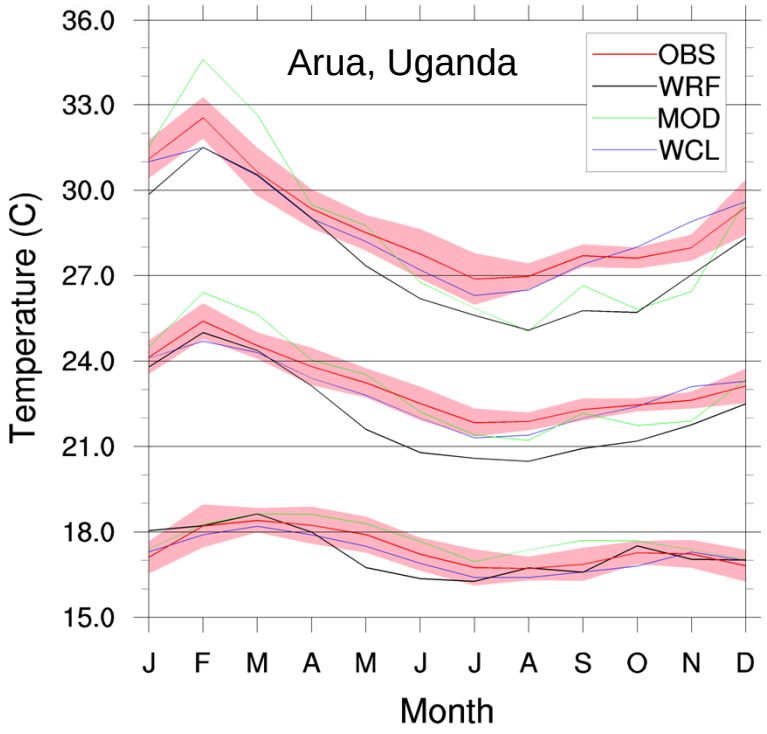
- We can understand the non-linear linkages among humans, climate and health
- We can project climate-related health risks ahead of time
- Policy makers and communities can implement intervention and mitigation measures.

Remotely sensed data is critical for achieving these objectives!

Extra Slides

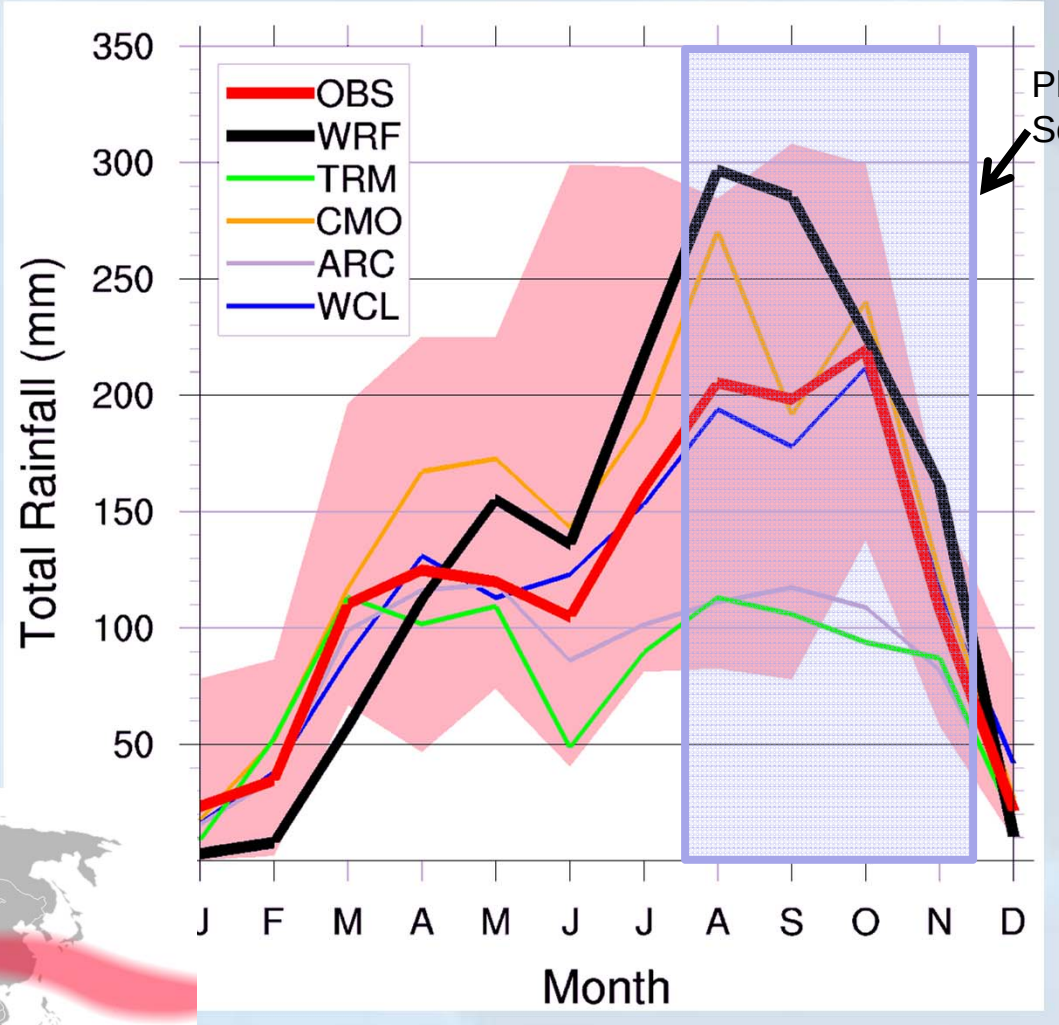
2-m Temperature Comparison

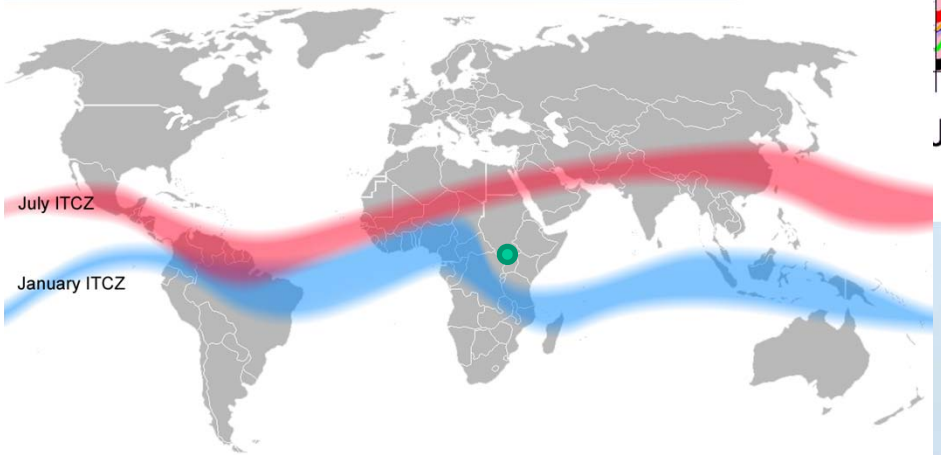




Monaghan et al., submitted

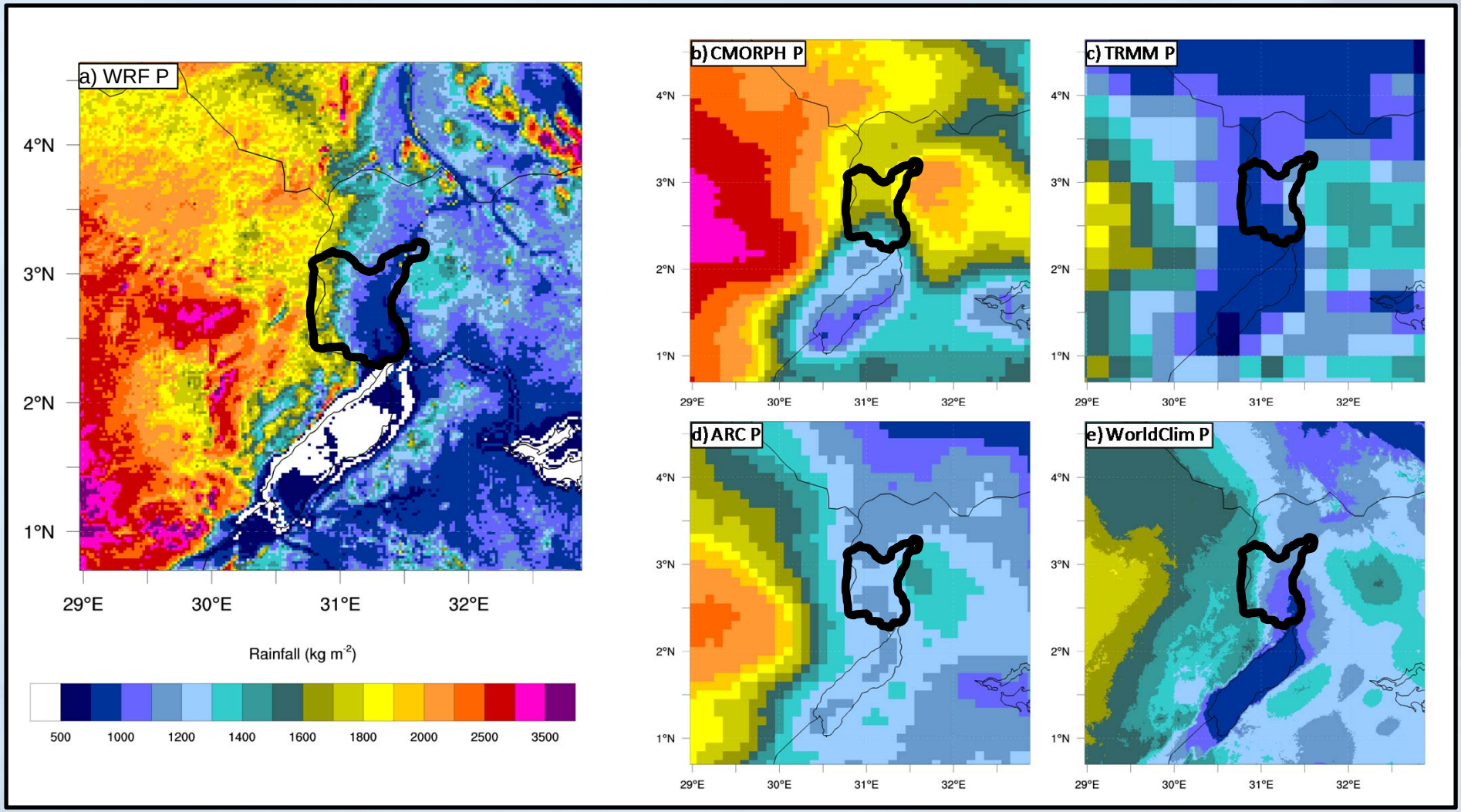
Mean Annual Cycle of Rainfall, Arua, Uganda





Monaghan et al., submitted

2003-2009 Annual Rainfall Comparison



Monaghan et al., submitted

"The System for Integrated Modeling of Metropolitan Extreme Heat Risk (SIMMER)"

Collaborators:

- M. Shepherd (University of Georgia)
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- A. de Sherbibin (CIESIN, Columbia University),
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- U. Bickis and A.Yagouti (Climate Change and Health Office, Health Canada HQ, Ottawa)
- M. Campbell and S. Gower (Environmental Protection Office, Toronto Public Health)
- C. De Jong (Toronto Environment Office, City of Toronto)
- E. Fetzer (NASA JPL)
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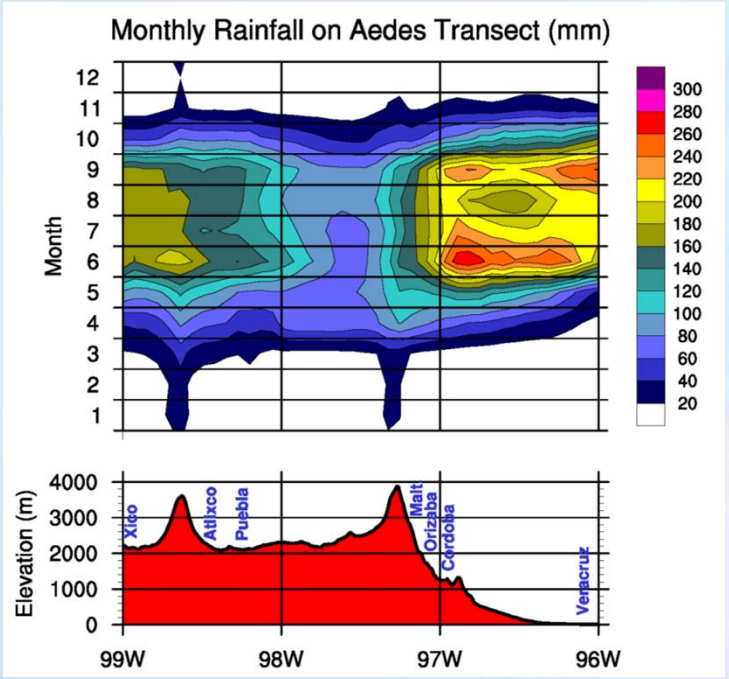
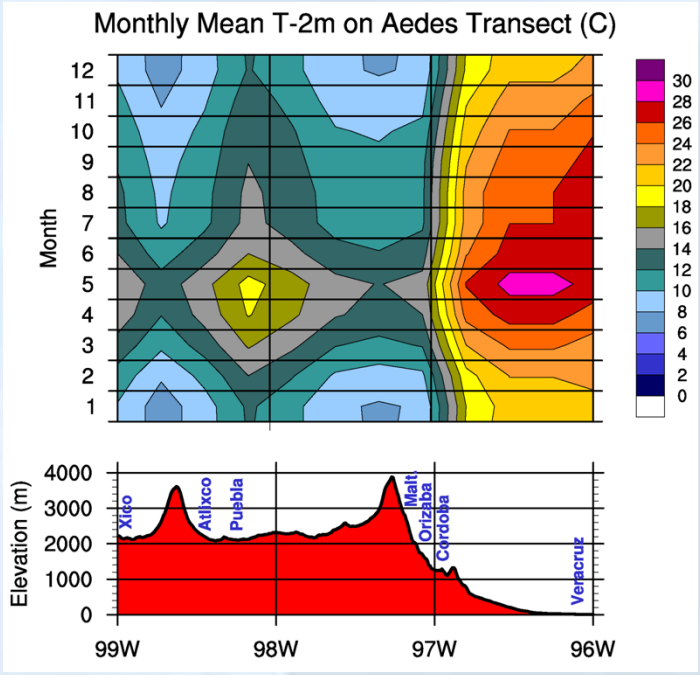
Funded by NASA ROSES (09-IDS09-34)


Monthly Rainfall on Aedes Transect (mm)
Month
12
11
10
9
8
7
6
5
4
3
2
1
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
Elevation (m)
4000
3000
2000
1000
0
Xico
Atlixco
Puebla
Malt.
Orizaba
Córdoba
Veracruz
99W
98W
97W
96W


Monthly Mean T-2m on Aedes Transect (C)
Month
12
11
10
9
8
7
6
5
4
3
2
1
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
Elevation (m)
4000
3000
2000
1000
0
Xico
Atlixco
Puebla
Malt.
Orizaba
Córdoba
Veracruz
99W
98W
97W
96W