

Climate Change and the Increase in Mosquito-Borne Illnesses in Coastal Areas

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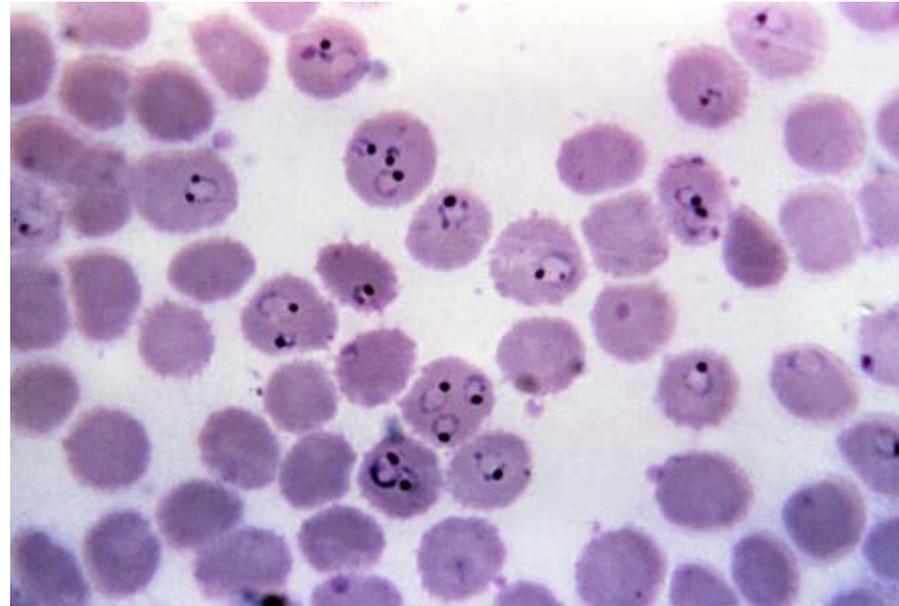
Malaria

Mosquito-borne parasite that infects the red blood cells of humans.

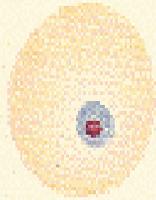
Caused by four *Plasmodium* parasites; *P. falciparum*, *P. vivax*, *P. ovale*, and *P. malariae*.

Malaria can cause flu-like symptoms, fever, chills, sweats, headaches, Nausea and vomiting, body aches, and malaise.

Severe cases of malaria can cause deadly complications such as organ failure, hemoglobinuria (hemoglobin in urine), acute respiratory distress syndrome, hyperparasitemia (more than 5% of red blood cells are infected), etc.



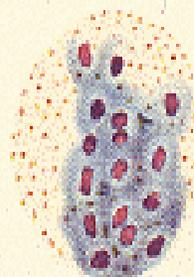
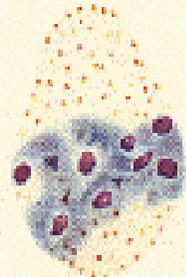
P. vivax



ring form

mature ring form

trophozoite

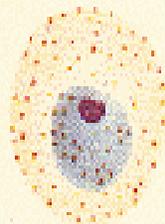


trophozoite

early schizont

schizont

mature schizont

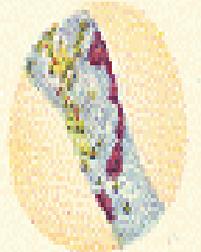
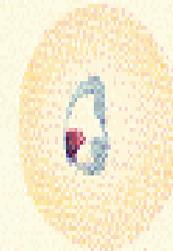


developing gametocyte

female gametocyte

male gametocyte

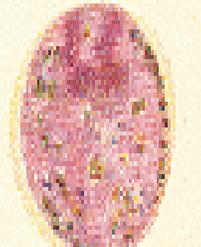
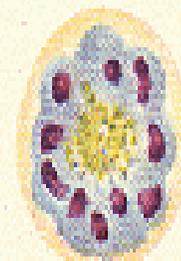
P. malariae



ring form

early band form

band form



early schizont

mature schizont

female gametocyte

male gametocyte

P. ovale



young ring



older ring



comet form



trophozoite



trophozoite



young schizont



schizont



mature schizont



female gametocyte



male gametocyte

P. falciparum



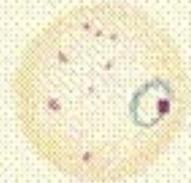
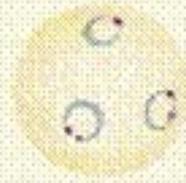
marginal form



ring form



double dotted rings



ring form



young trophozoite



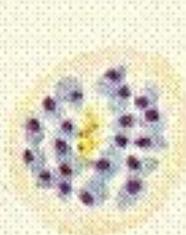
trophozoite



early schizont



schizont



mature schizont



female gametocyte



male gametocyte

Infection Rates

1,700 cases diagnosed in the United States each year

- Primarily in return travelers and immigrant populations (“import” malaria)

212 million cases globally

429,000 deaths in 2015

In Africa, malaria costs around \$12 billion a year in treatment, prevention, and premature death.

Preventative efforts and medical treatment from the CDC and WHO have saved around 6.8 million lives

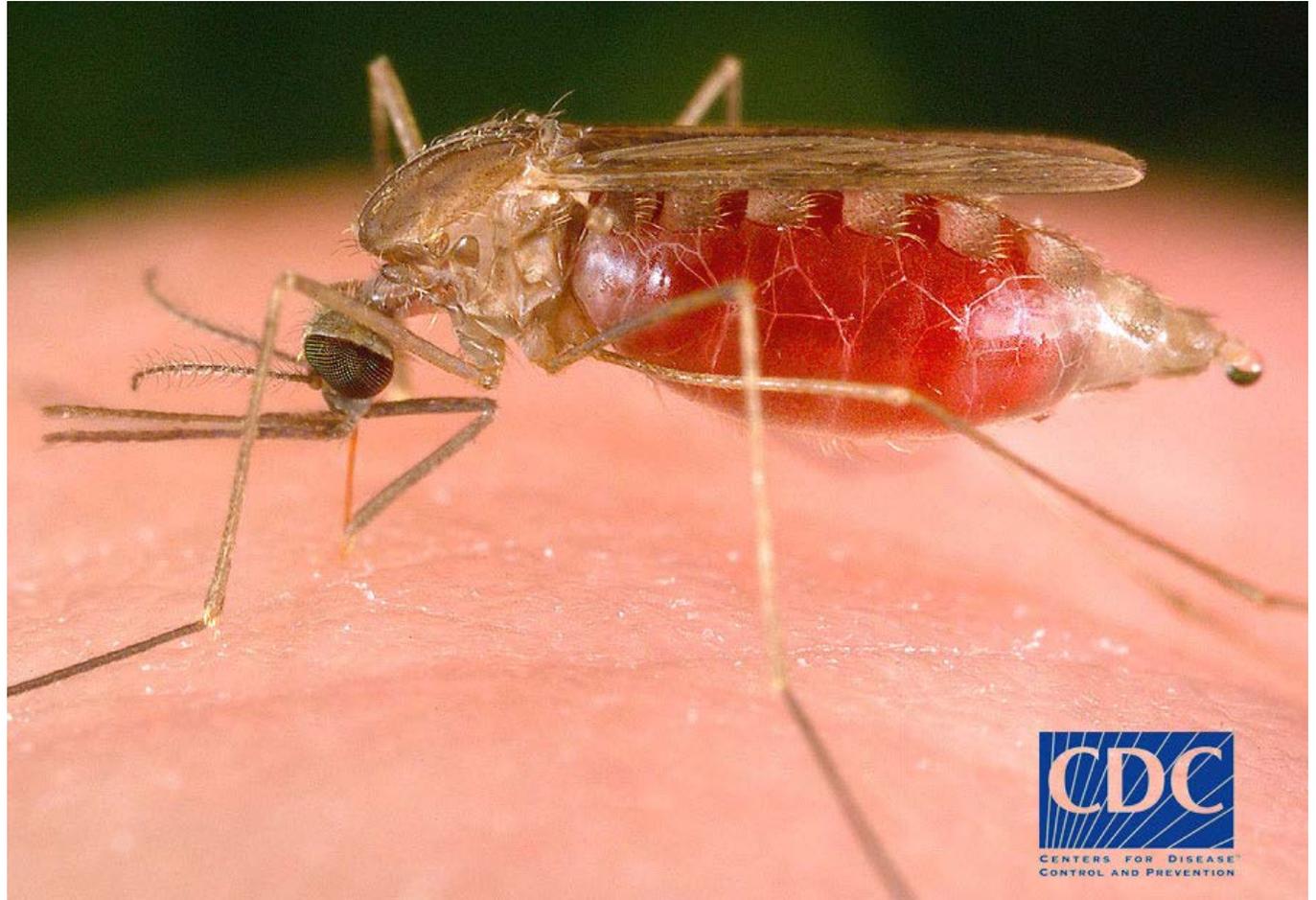
Vector

Malaria is spread by the bite of the female *Anopheles* mosquito.

This species of mosquito is located world wide including in the United States.

The mosquito becomes infected with the *Plasmodium* parasite by feeding on the blood of an infected human.

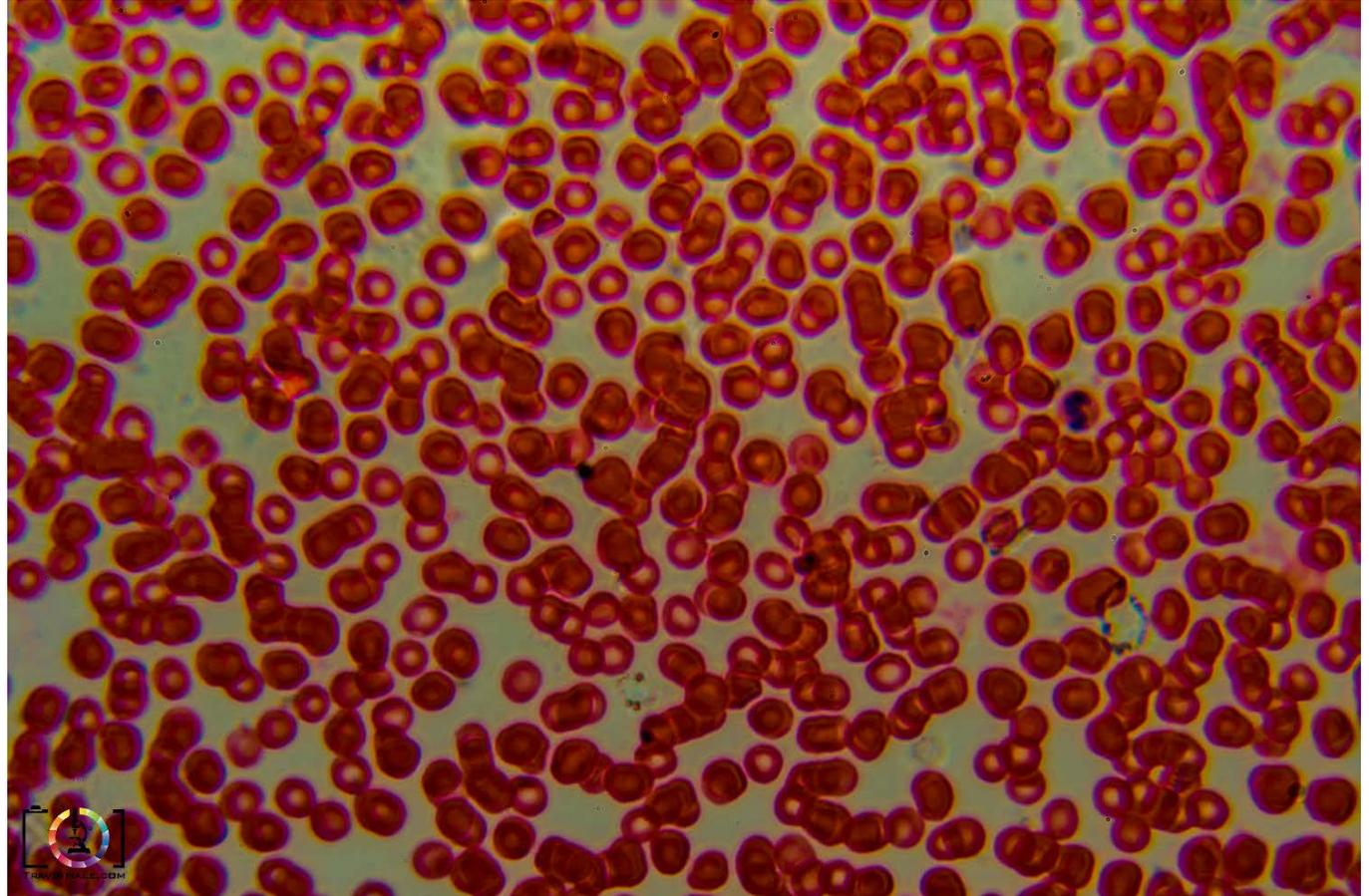
The mosquito ingests the gametocytes (Sexually reproducing cells) of the parasite, which will take between 10-18 days to grow inside the mosquito.



Life Cycle

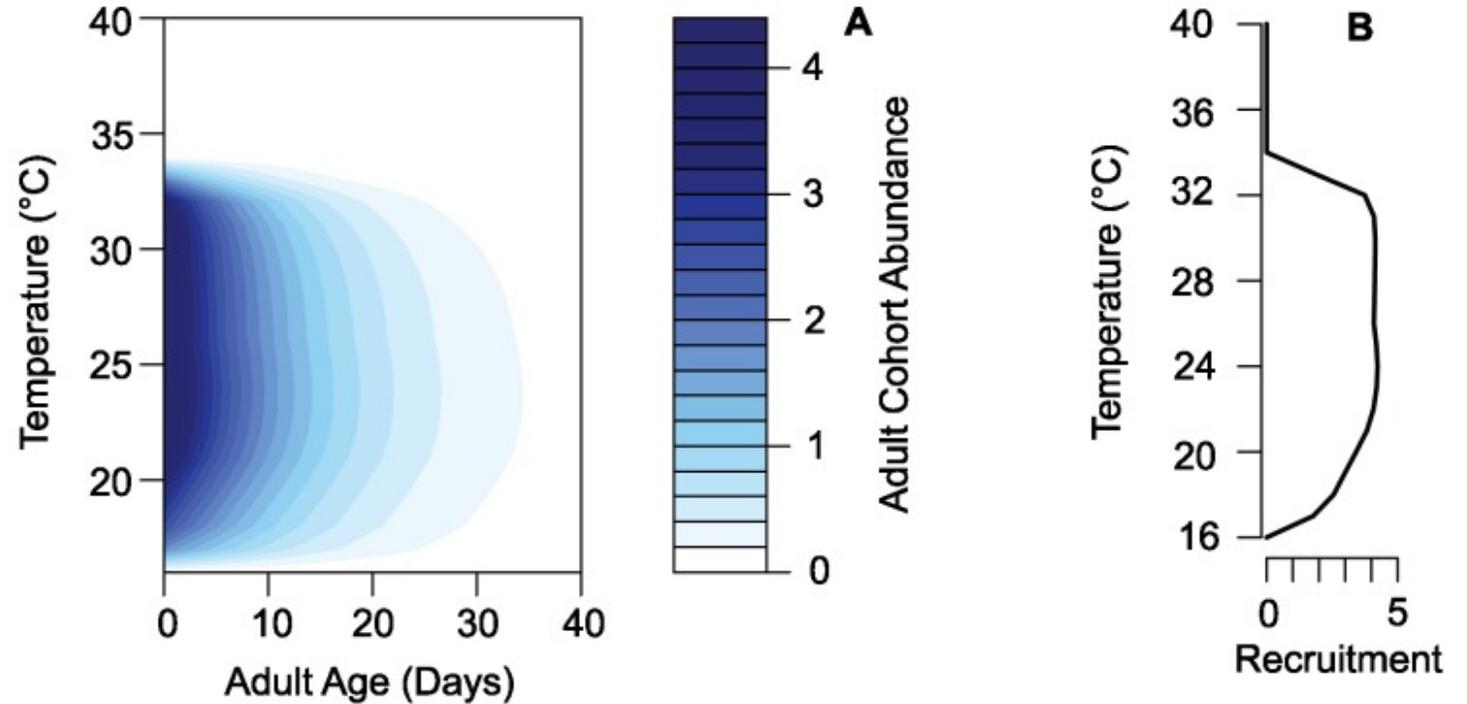
Once the parasite mature into a motile stage it migrates to the salivatory glands of the mosquito. It gets injected into a human when the mosquito goes for a blood meal.

The parasite infects liver cells where it further matures into a schizont (asexual reproduction). This stage allows the parasite to reproduce asexually. In two weeks the parasite will multiply into thousands of cells and will migrate to the red blood cells. This is when symptoms start to arise. The parasites then have the ability to become gametocytes (sexual reproduction) and spread to another mosquito to infect more hosts.

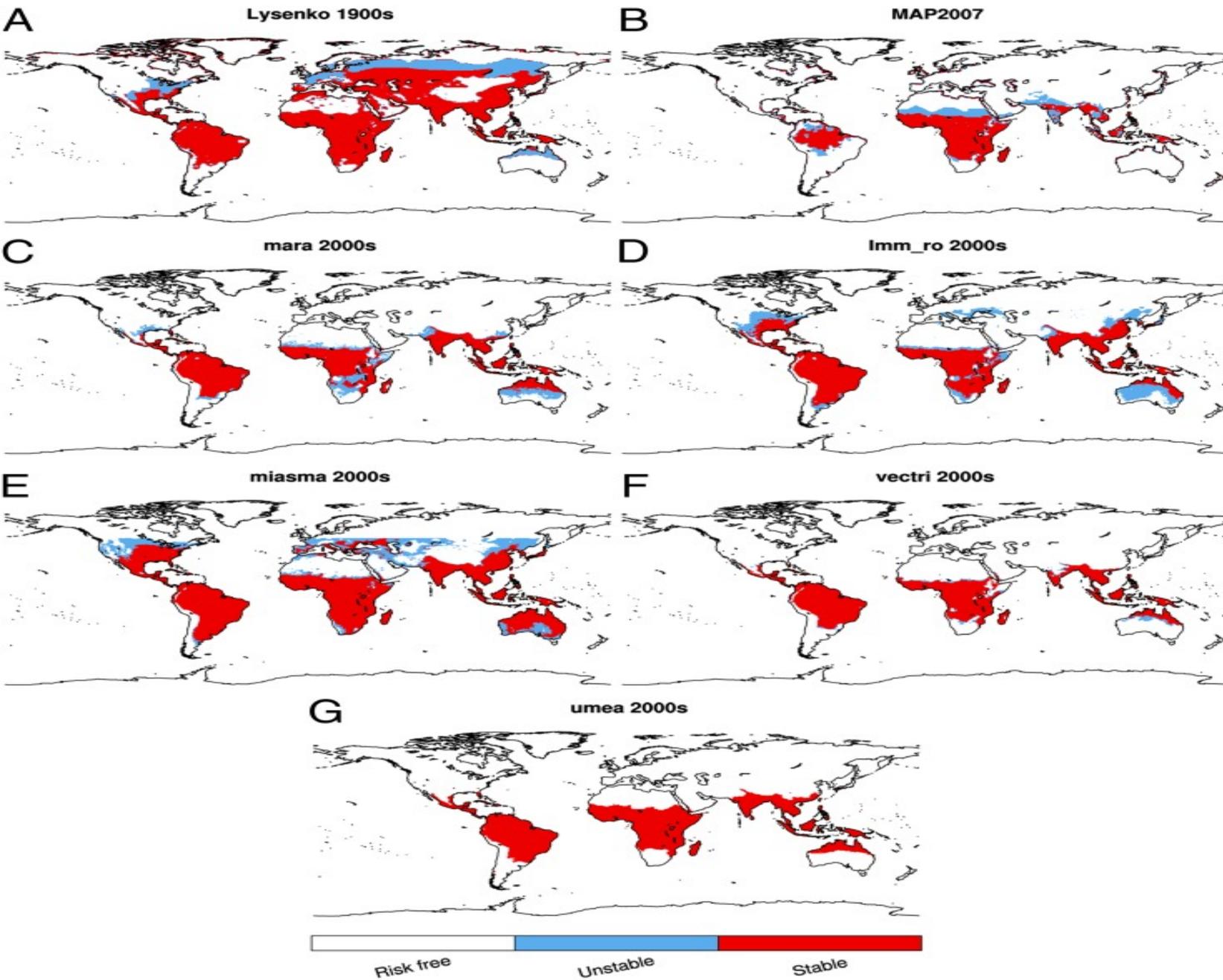


Temperature and Malaria

- Between the temperatures of 17°C - 33°C adult *Anopheles* mosquitos can survive up to 35 days.
- Between the temperatures of 16°C - 35°C allows for more juvenile mosquitos to develop into adulthood.
- 30°C is the optimal temperature for the *Plasmodium* parasites to grow.
- Temperatures below 15°C will not support the growth of *P. vivax*.
- Temperatures below 20°C will not support the growth of *P. falciparum*.



Malaria Distribution Models



A. Malaria distribution prior to 1952

B. Current Malaria distribution

C – F. Malaria distribution if current preventative measures continue

D. Malaria distribution based on climate data for *P. falciparum*

E. Malaria distribution without preventative measures

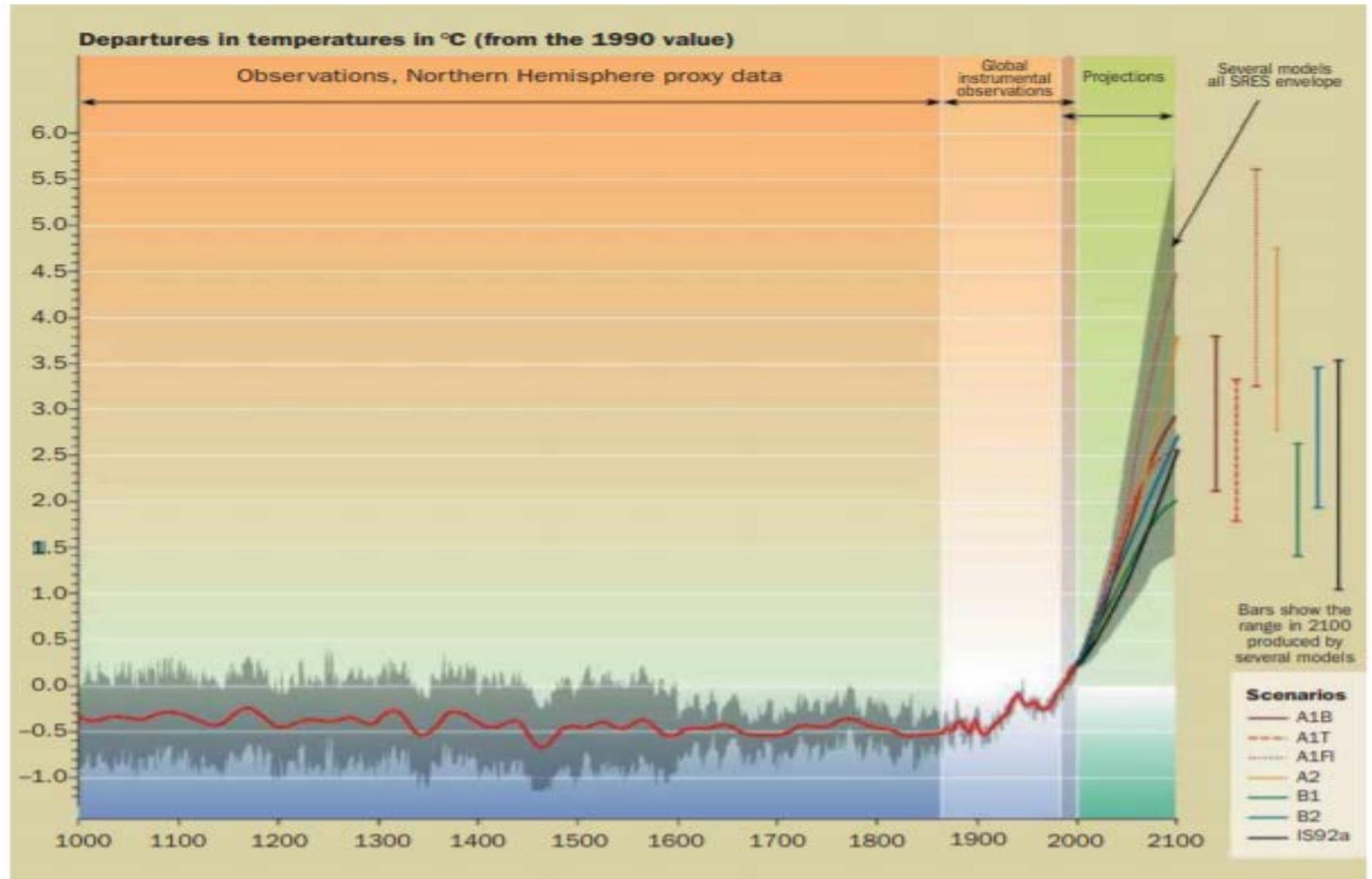
G. Malaria distribution focusing on arid areas

Surface Temperature Change Over Time

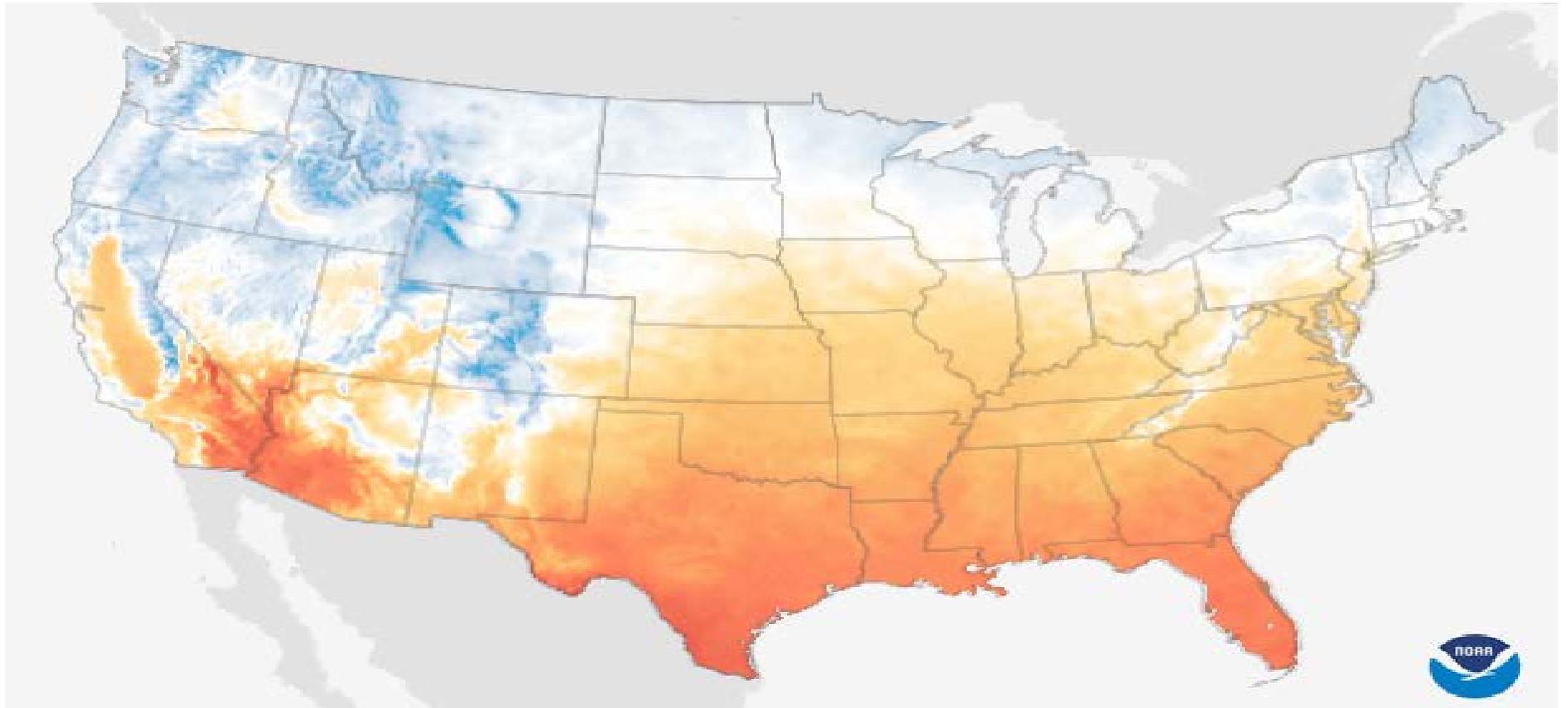
Variations of the Earth's Surface Temperature: 1000 to 2100

Average surface temperature is shown in centigrade, relative to 1990 (i.e., 1990 temperature is indexed to 0). Observations prior to the mid-19th century are based on proxy data derived from tree rings, corals, ice cores, and other historical records. Observations from the mid-19th century to the present are based on instrumental data. The shaded area represents uncertainty ranges for the estimates. Projected average temperatures are shown from 1990 to 2100 for a range of models used by the IPCC, along with the uncertainty range for all projections.

Source: Intergovernmental Panel on Climate Change (IPCC)



Average Temperature by May 2030

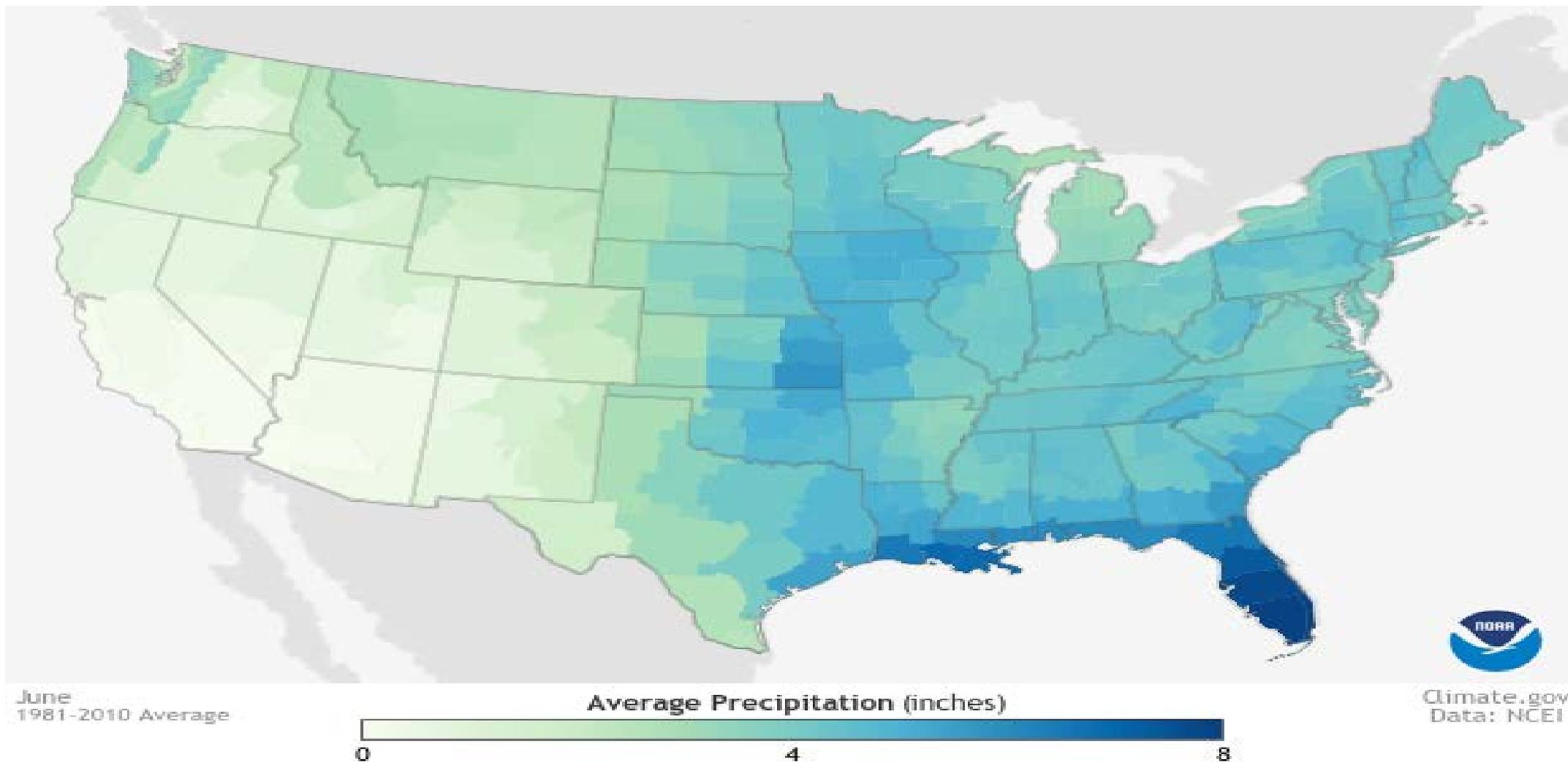


May 2030-2039
High emissions
(RCP 8.5)



Climate.gov
Data: LOCA

Average Precipitation Rates from June 1981-2010



What Can be Done?

The best method to prevent the spread of mosquito-borne illnesses would be to cut emissions entirely.

Prevent the formation of wetlands and marshlands by cutting back on deforestation and dam production.

Improve water purification systems and chlorinate pools and inevitable bodies of stagnant water.

Improvement on public health services and insurance coverage for low income and minority communities.

Provide chemoprophylaxis and other medical preventative measures to people in high risk areas.

Public efforts to combat vectors through the use of pesticides and mosquito repellants.

- Currently, DDT is the most used pesticide against malaria carrying *Anopheles*. So the development of safer pesticides is necessary.

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