

Climate Change Health Problems & Healthy Solutions



26 May 2009



CENTER FOR HEALTH AND THE GLOBAL ENVIRONMENT

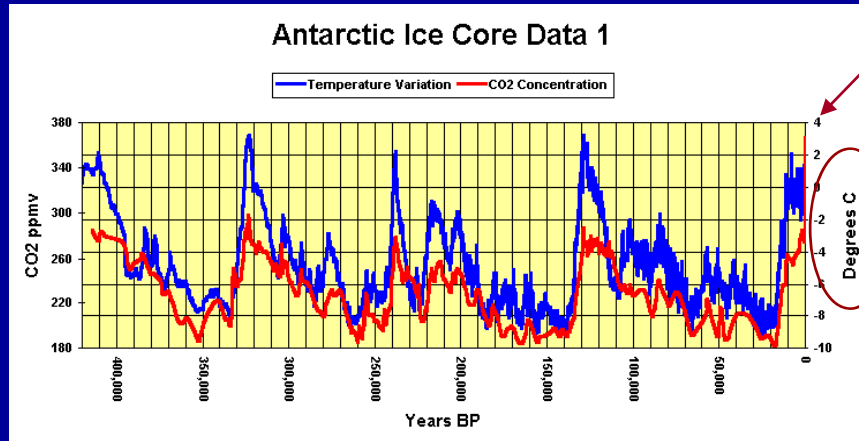
HARVARD MEDICAL SCHOOL



Why is Climate Changing Faster than Models Project?

1

CO₂



387 ppm

Stable states

?Small Caps

or cold reversal

280 ppm

Medium Polar Caps

180 ppm

Large Polar Caps

2

460 ppm CO₂e

CO₂ + NO_xs + CFCs + methane

(1.66 W/m²)

+H₂O - SO_xs + black soot =

(0.9 W/m²)

? ppm CO₂-equivalent or GWP

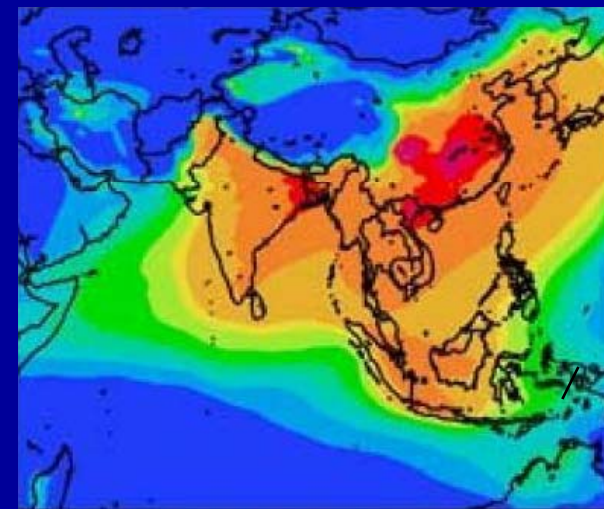
Tundra

Albedo

3

Ice melt is accelerating

Sea level rise

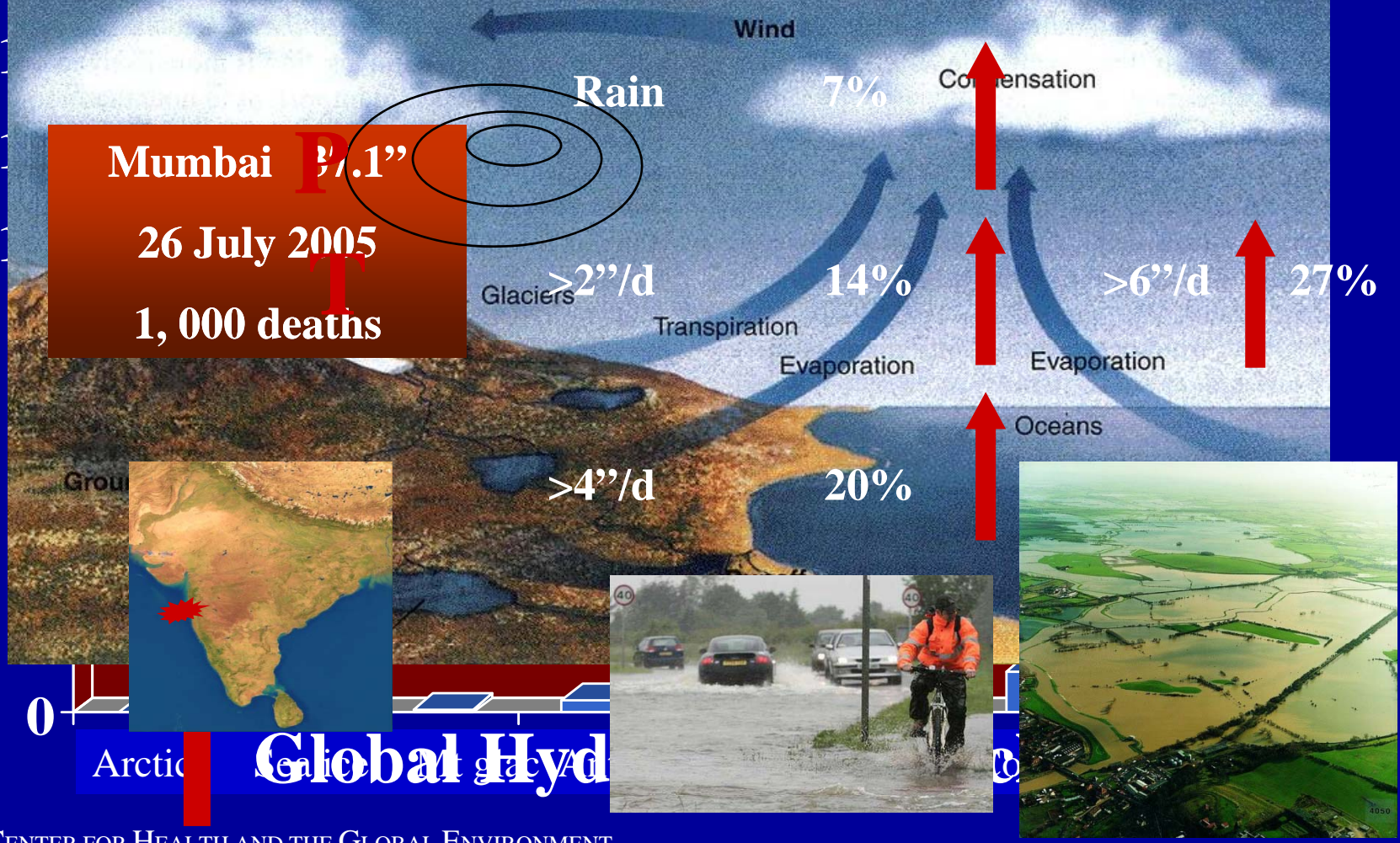


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Deep Ocean Warming

Precipitation over the Continental U.S since 1970



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Levitus et al. *Science* 2005

HEATWAVES

May/June 2003

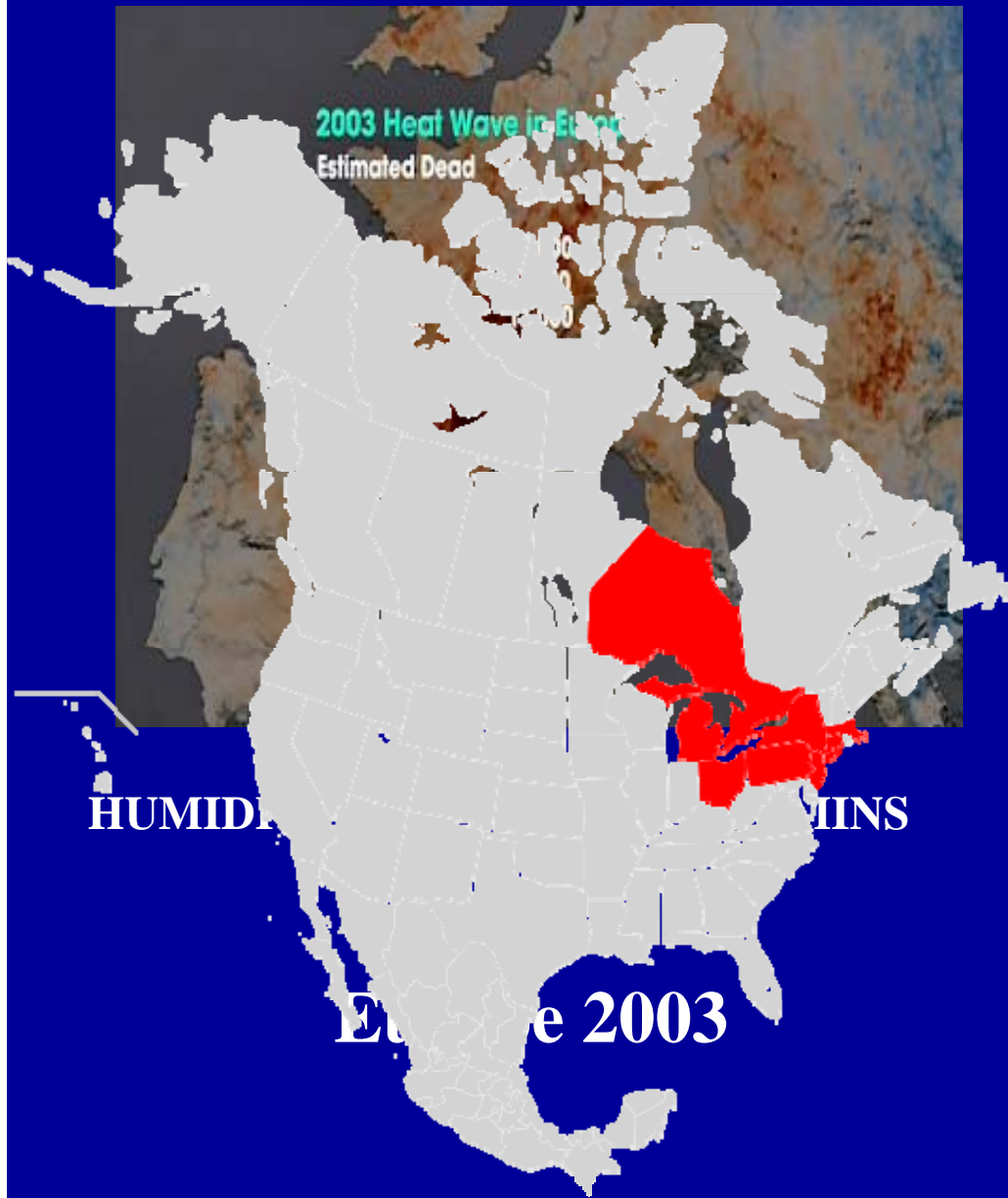
Andhra Pradesh

T 122°F

>1400 deaths



July Floods - Japanese B
encephalitis



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BEFORE 1970

Cold temperatures caused freezing at high elevations and limited mosquitoes, mosquito-borne diseases and many plants to low altitudes

TODAY

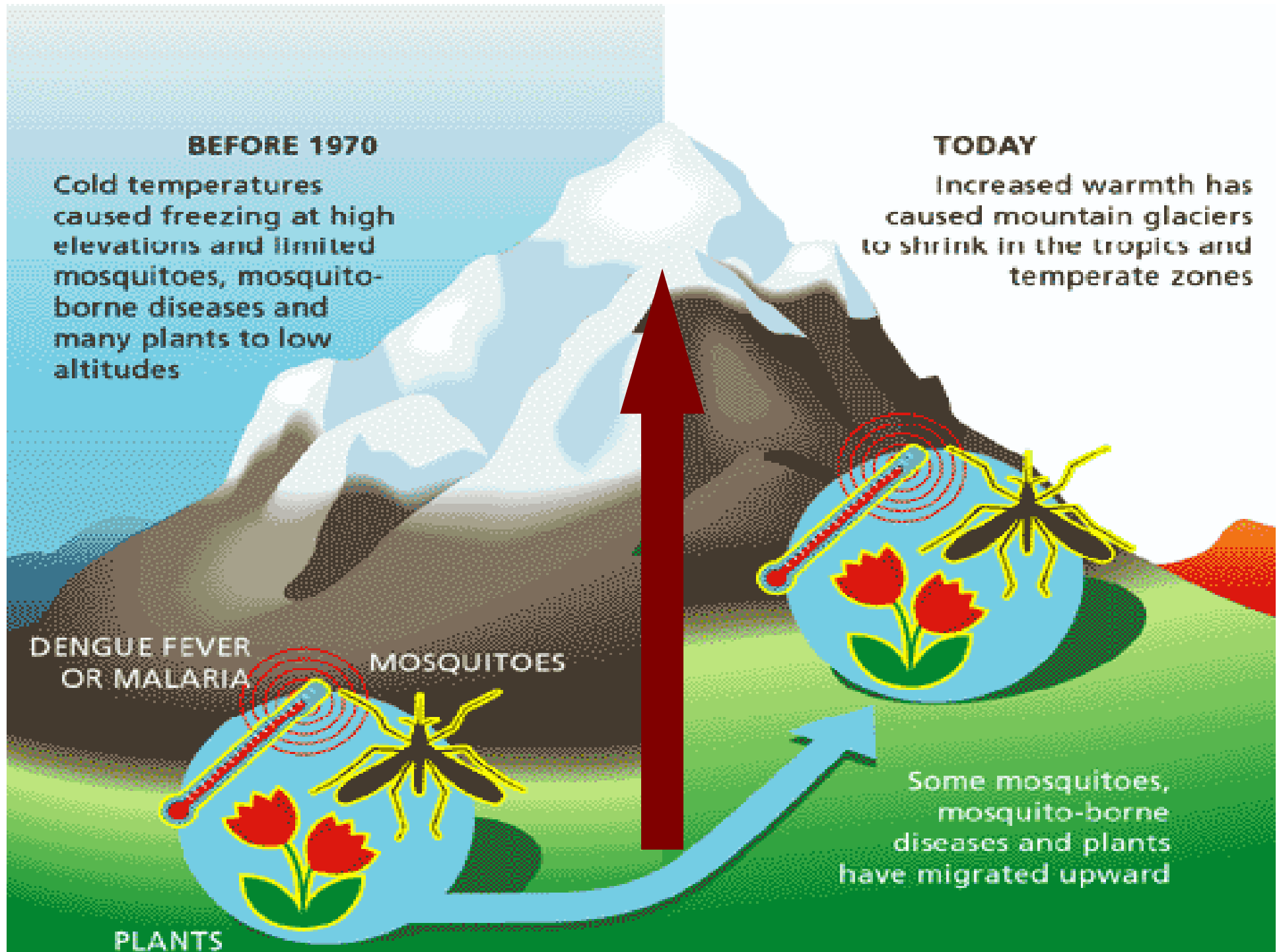
Increased warmth has caused mountain glaciers to shrink in the tropics and temperate zones

DENGUE FEVER
OR MALARIA

MOSQUITOES

PLANTS

Some mosquitoes,
mosquito-borne
diseases and plants
have migrated upward



Mozambique Floods 2000

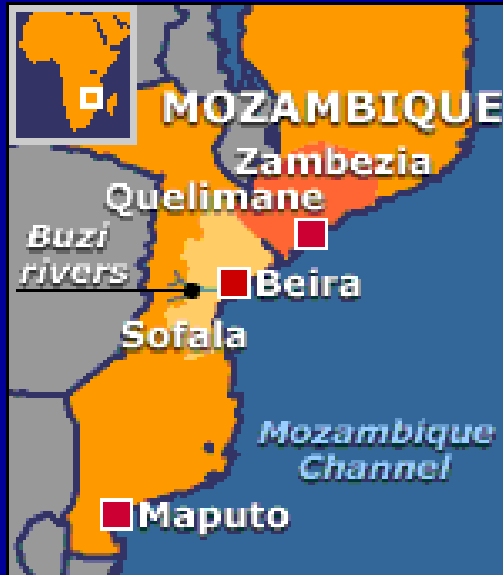
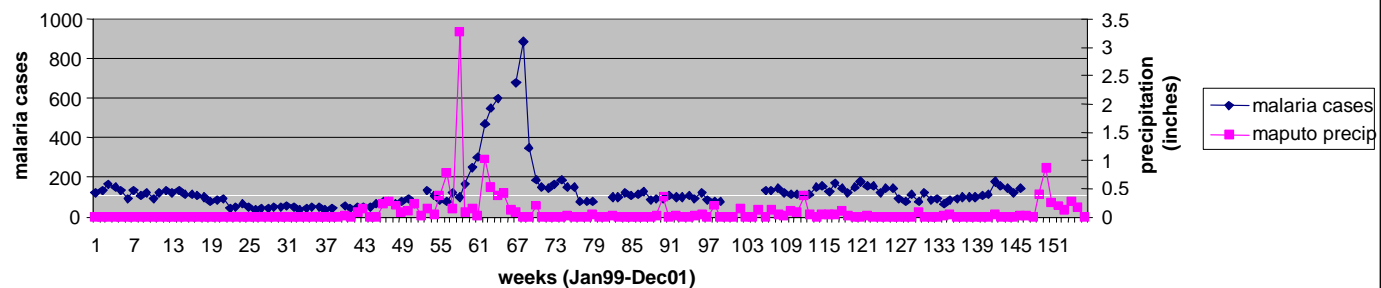


Figure 1: Malaria Cases and Maputo Precipitation, 1999-2001

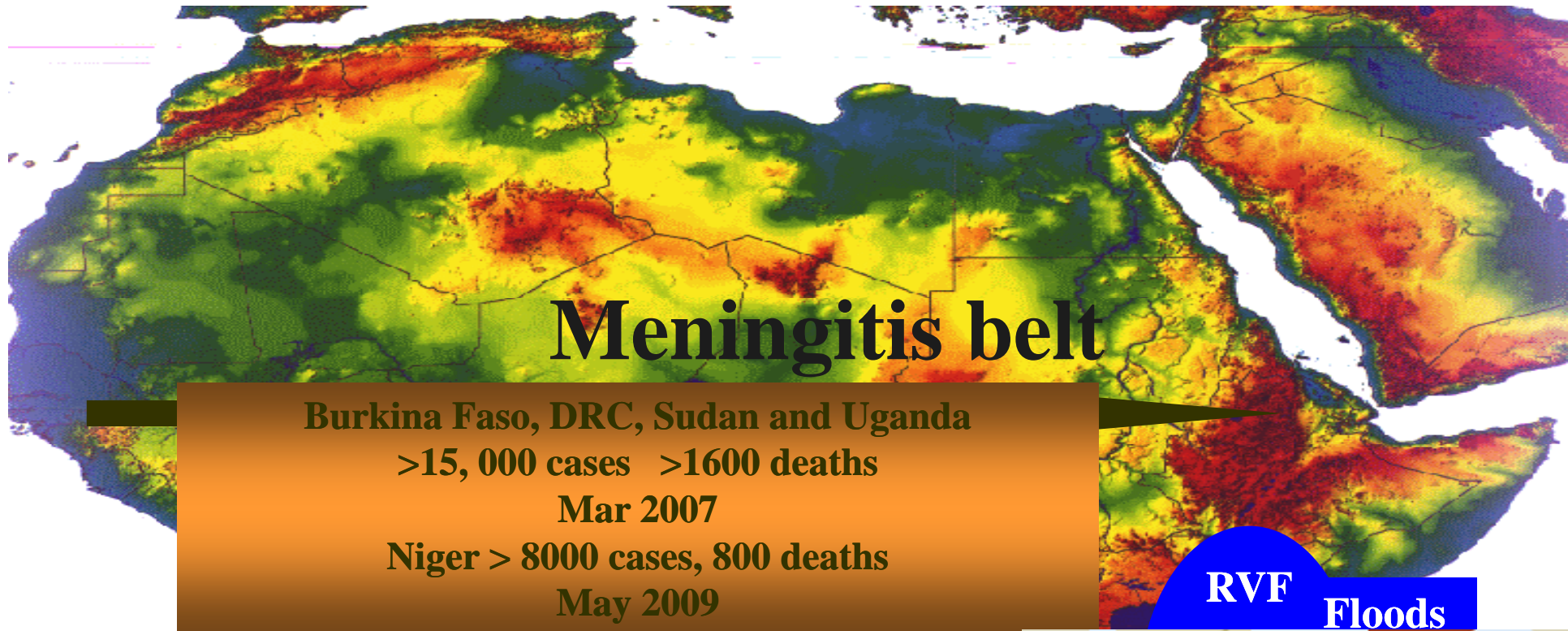


Five-fold spike in malaria incidence



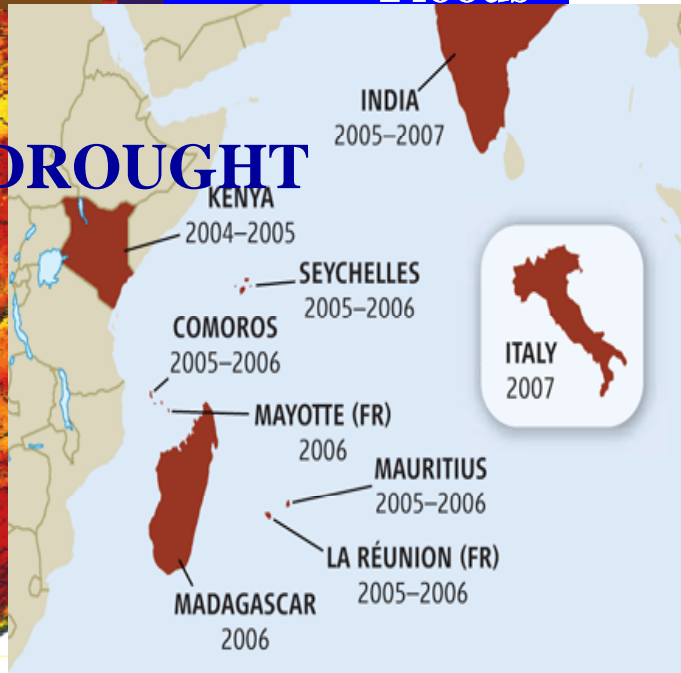
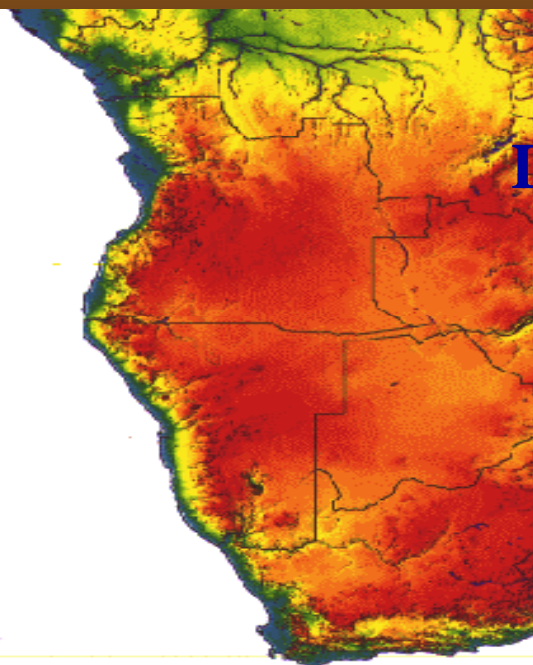
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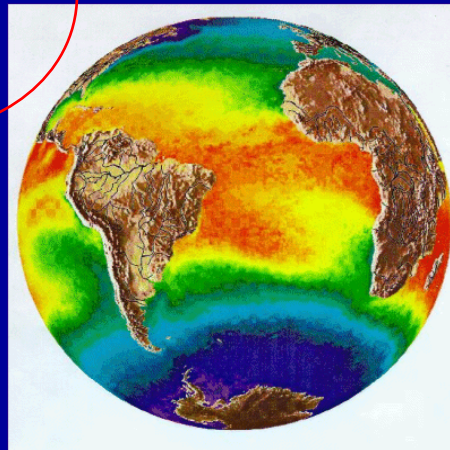


Elevation Data of Africa
 Digital Chart of the World
 DCW Political Boundaries and Hydrology
 30 arc-second cell size
 Approximate Scale 1:35520000

Meters	Elevations	Feet
0 & less		0 & less
1 - 150		1 - 492
151 - 250		493 - 820
251 - 300		821 - 984
301 - 400		985 - 1312
401 - 500		1313 - 1640
501 - 600		1641 - 1968
601 - 700		1970 - 2297
701 - 800		2298 - 2625
801 - 1100		2626 - 3609
1101 - 1400		3610 - 4593
1401 & greater		4594 & greater



Bark Beetles and Forest Fires



**Injury, Respiratory
Disease, Water,
Wildlife, Property,
Carbon Pulse**

Timber industry

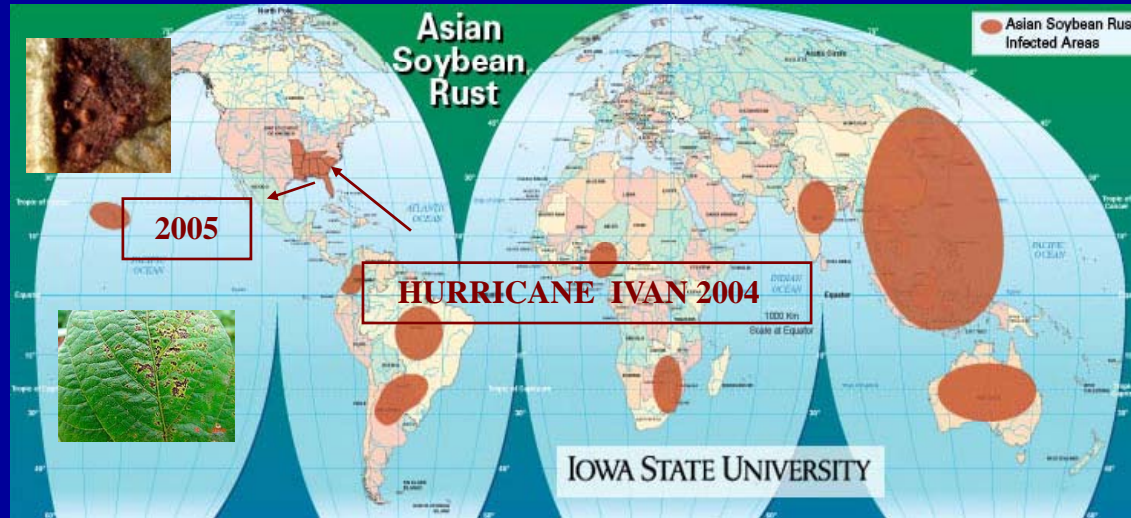


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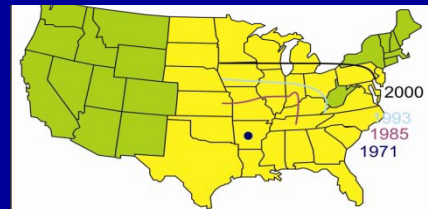
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AGRICULTURE

STORMS



RANGE CHANGE:



SOYBEAN
SUDDEN
DEATH
SYNDROME

FLOODS: Fungi and Nematodes

DROUGHTS: Aphids, Whiteflies, Locust



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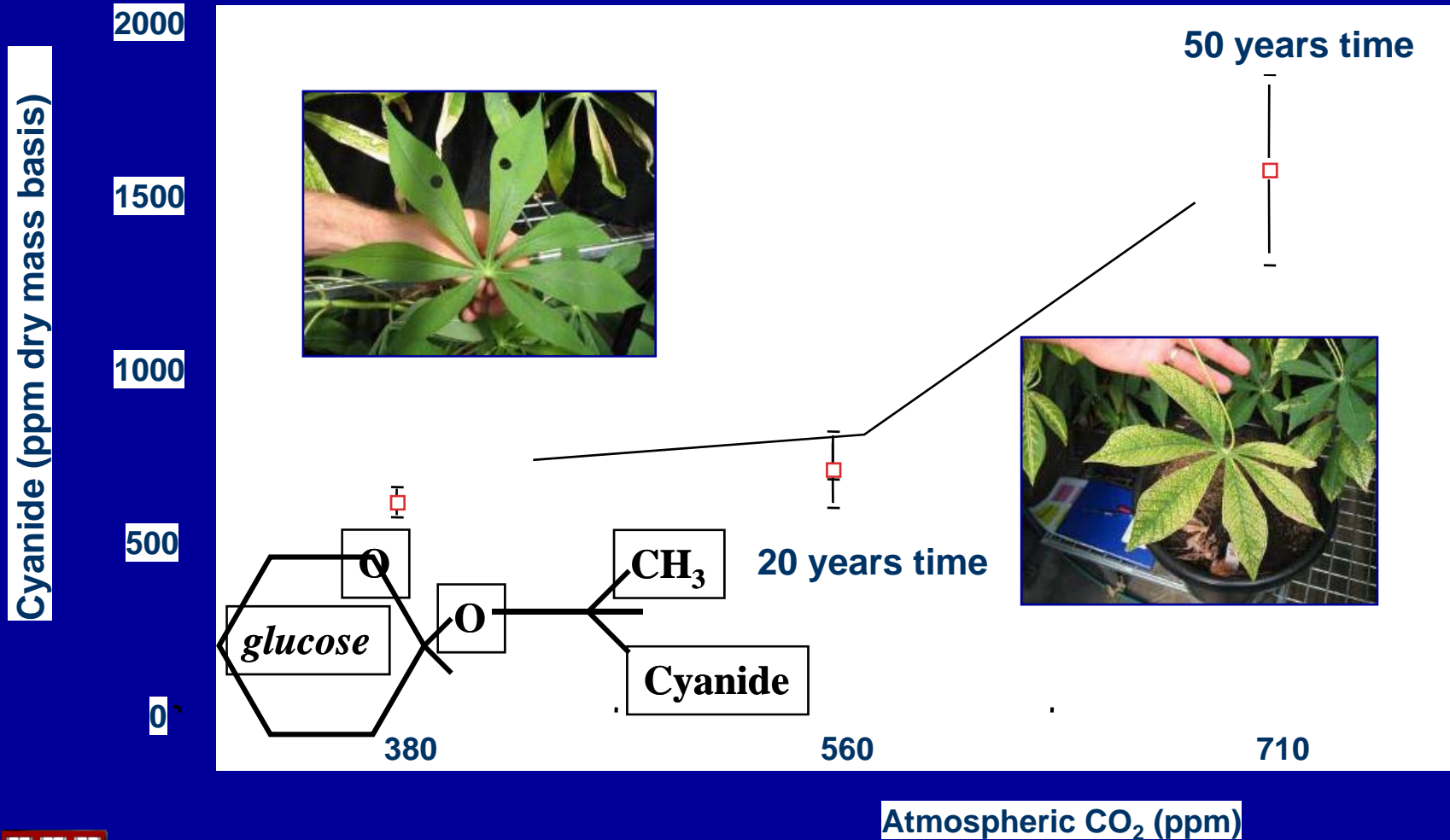
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Severe drought associated with konzo epidemic



Nampula 1981

CO₂ and Cyanide in Cassava Leaves

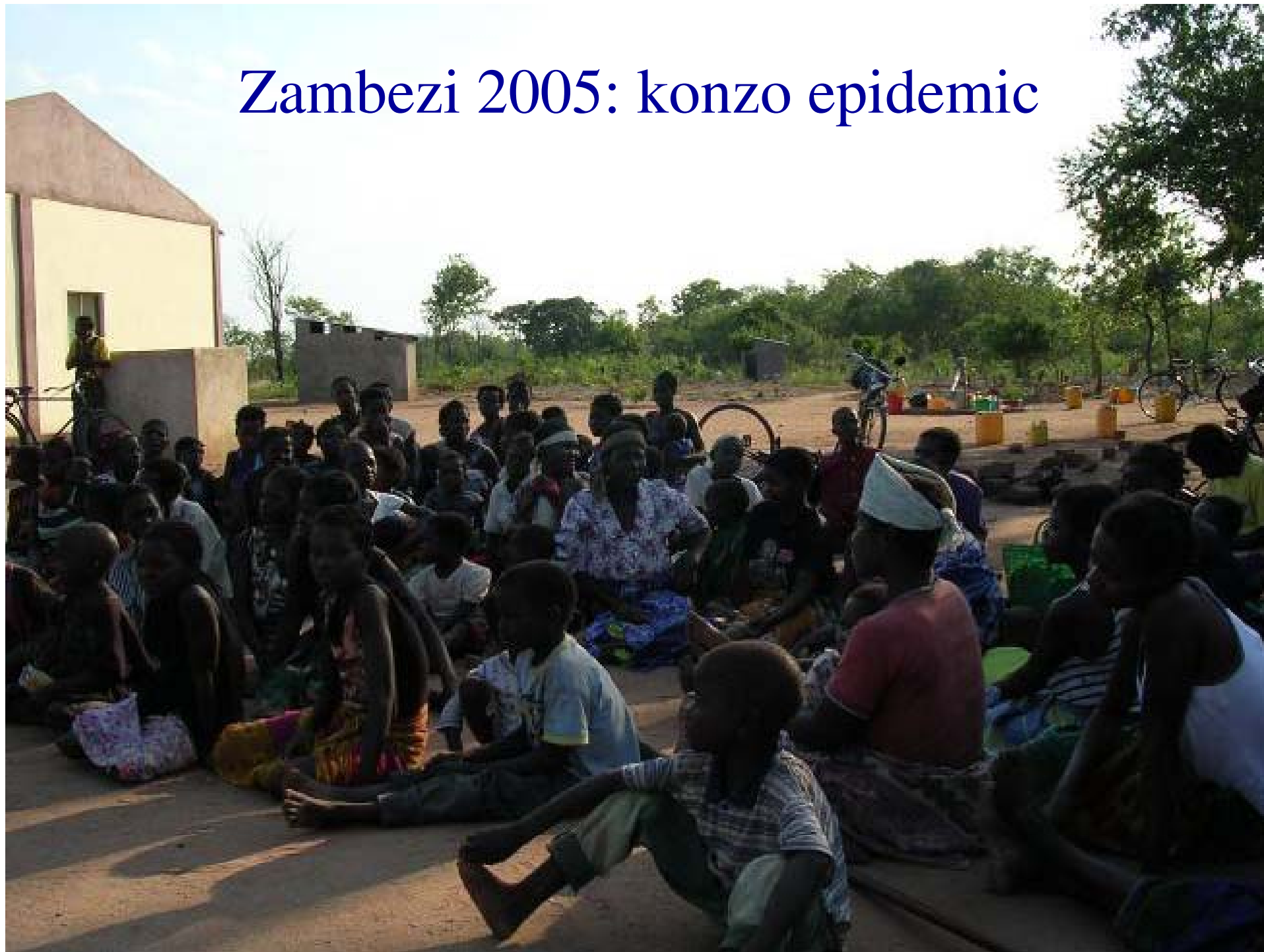


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Atmospheric CO₂ (ppm)

Zambezi 2005: konzo epidemic



Konzo related to high cyanide diet



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**Tuber growth
TODAY'S AIR**

TODAY'S AIR

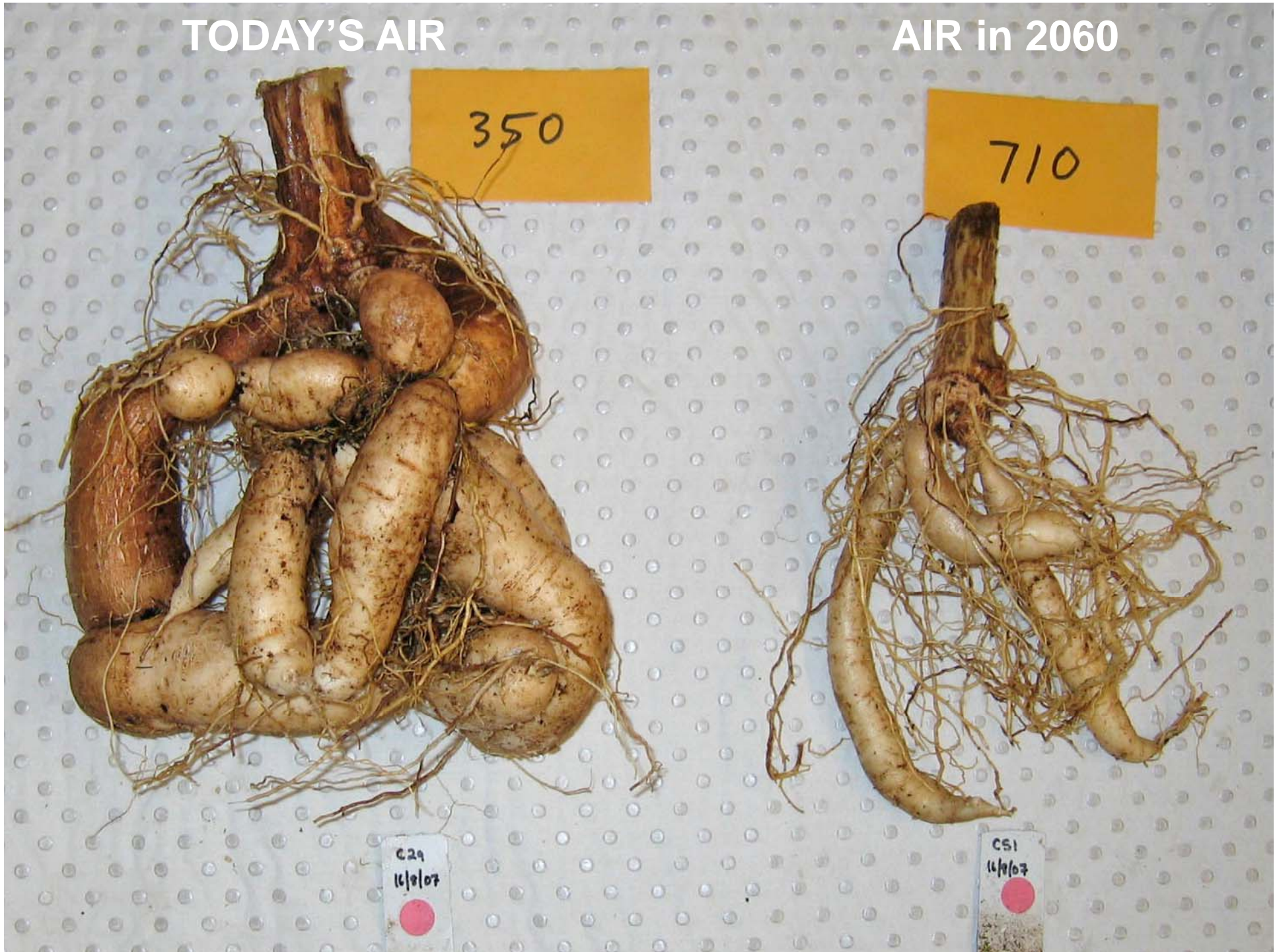
AIR in 2060

350

710

C29
10/10/07

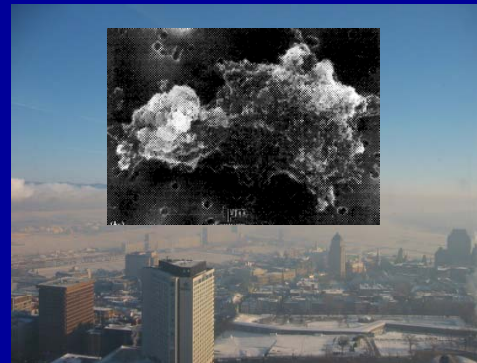
C51
10/10/07



Climate Change in Our Backyards



CO₂



Mold

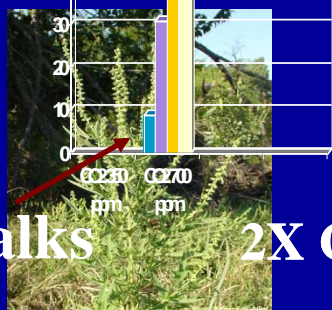
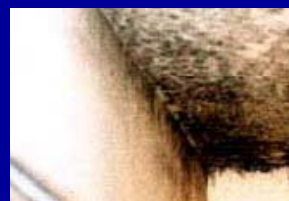
Heatwaves & smog
Particulates & pollen



Tree pollen



Pollen



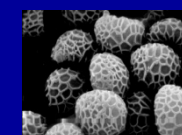
Stalks

2X CO₂



Poison Ivy

WNV*



Mushroom spores

Ragweed



Ag weeds



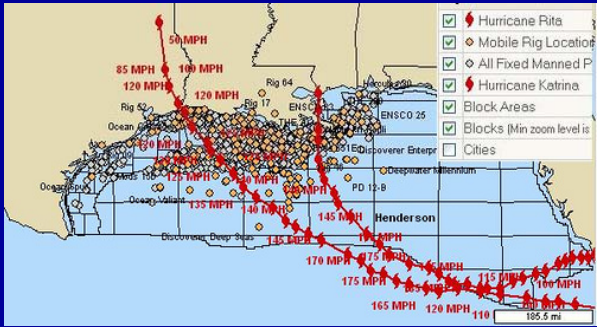
Lyme



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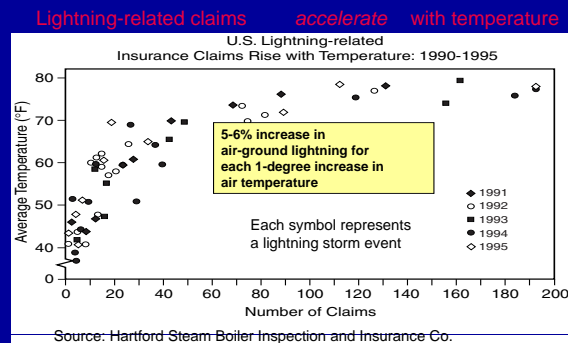
Energy Infrastructure Vulnerabilities



- Storms and interruptions
- Heatwaves/blackouts/DG
- Cooling water and nuclear power plants
- Melting permafrost and pipelines
- Warming ↑ Lightning



24 of 104: H₂O shortages loom



• Montane glacier loss
hydropower

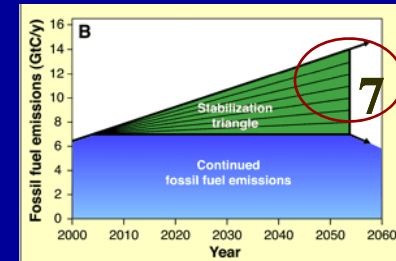
→ Coal-fired plants



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Stabilization Wedges



Energy Efficiency & Conservation

1. Public Transport & Plug-in Hybrids
2. 'Smart grid:' Distribution, Storage & Use
3. Green Buildings
4. Healthy Cities

Natural Sinks

9. Forest sequestration
10. Soil sequestration
11. Waste management & CH₄ capture

Renewables

5. Wind
6. PV/Solar thermal
7. Geothermal
8. Biofuels

One wedge:
One Yucca Mt q 5-10 years

Fossil Fuel-based

12. Switch from Coal to Nat. Gas
13. C Capture & Storage (CCS)
14. H₂ Fuel Cells
15. Coal-to-Liquid w/ CCS
16. Nuclear fission



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No regrets
Study needed

10 faults lie within a 20-mile
radius of Yucca Mt.
USGS 5/21/07

Technologies Warranting LCA Study

Formaldehyde & Acetaldehyde \blacktriangleright O_3



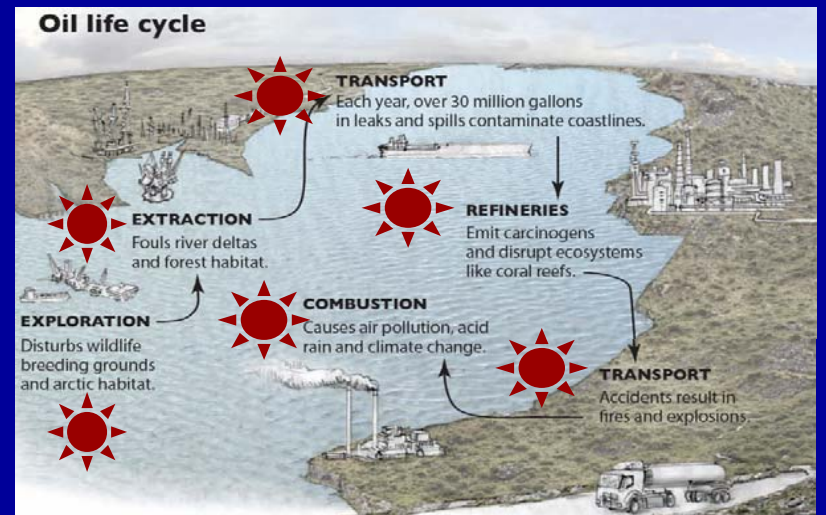
Liquid fuels

Oil

Shale oil

Oil (tar) sands

Biofuels



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Coal life cycle

MOUNTAINTOP REMOVAL

- ▶ Deforestation
- ▶ Water contamination
- ▶ Cancer clusters

UNDERGROUND MINING

- ▶ Silicosis
- ▶ Injuries
- ▶ Mortality



100 Mt/yr toxic fly ash, bottom ash & scrubber sludge: landfills & wet ponds → Cancer clusters

COMBUSTION

- ▶ NO_xs and SO_xs
- ▶ O₃ and brown haze
- ▶ Particulates
- ▶ Mercury
- ▶ CO and CO₂



Harmful algal blooms
Dead zones



CCS

TRANSPORTATION

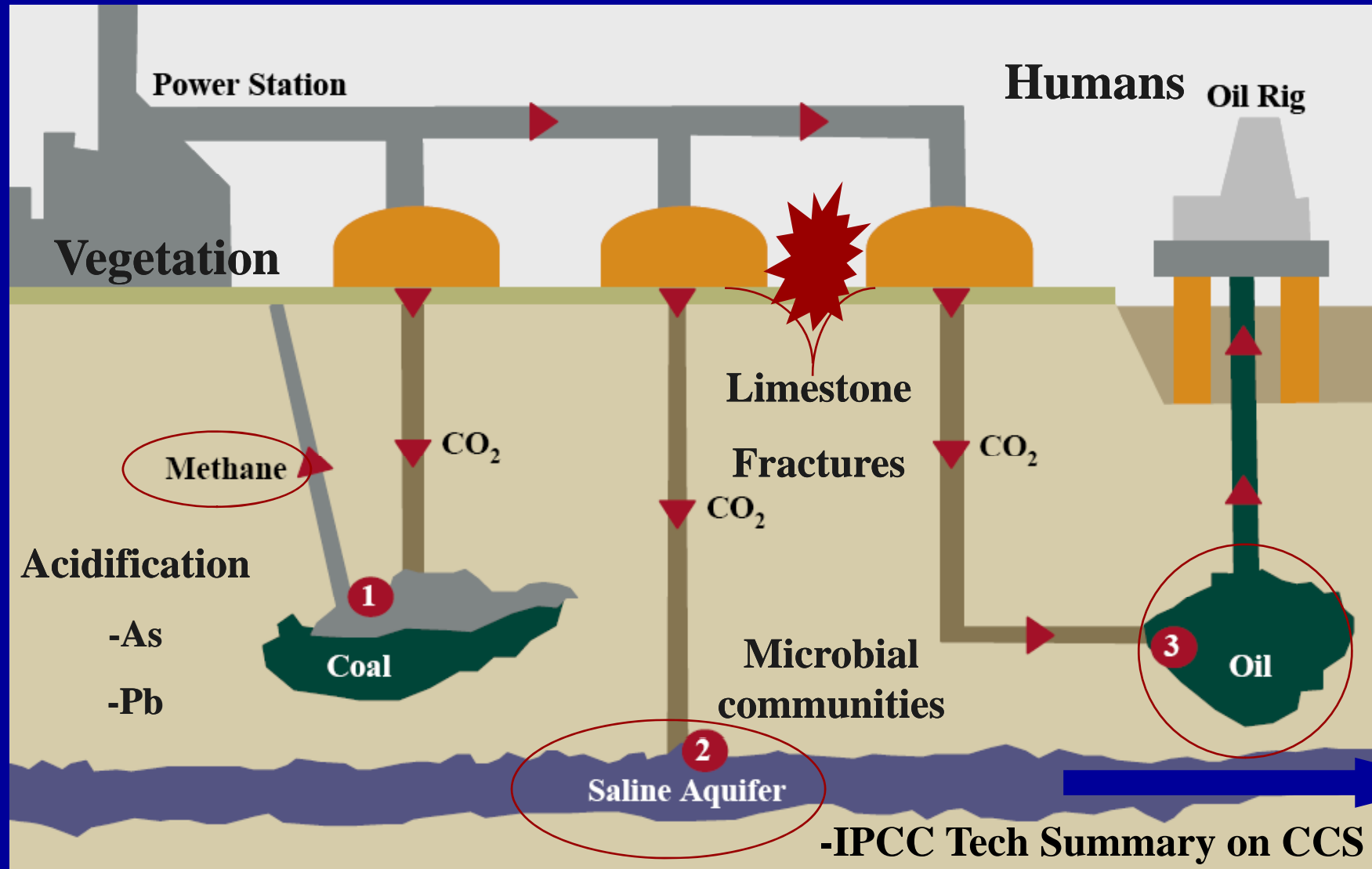
- ▶ 70% of U.S. rail traffic



Retention ponds



Carbon Dioxide Capture and Storage



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1 GtC → 5,700 M²
-E. Rubin. CMU

Complementary Suite of Measures to Scale Up, *Fast*



PHEVs & EVs

Cars

Trucks

Trains

Buses

Ships

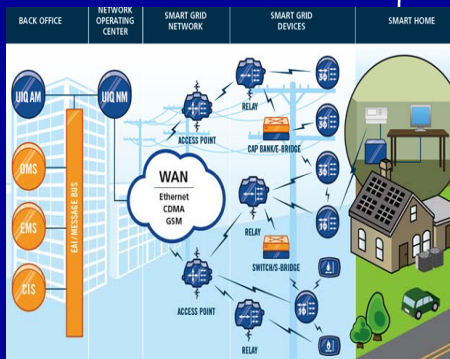
Planes



Light-rail

Cleanly-powered, smart grid

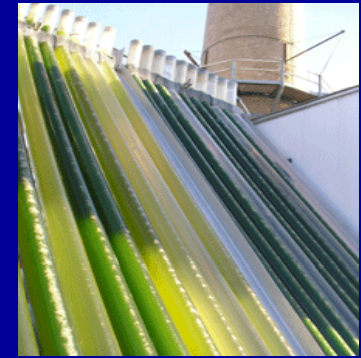
Healthy Cities



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Cleanly-Powered, Smart Grids



Cogen Plant



Renewables
+
Nat. Gas

Regional



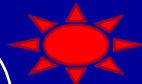
Co-Gen



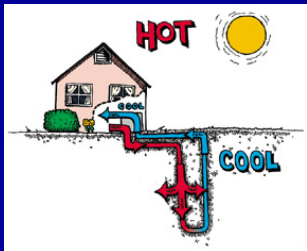
MW



Dist.
Generation



Central



Ground source heat pumps → A/C

Bat.



Co-Gen



SW

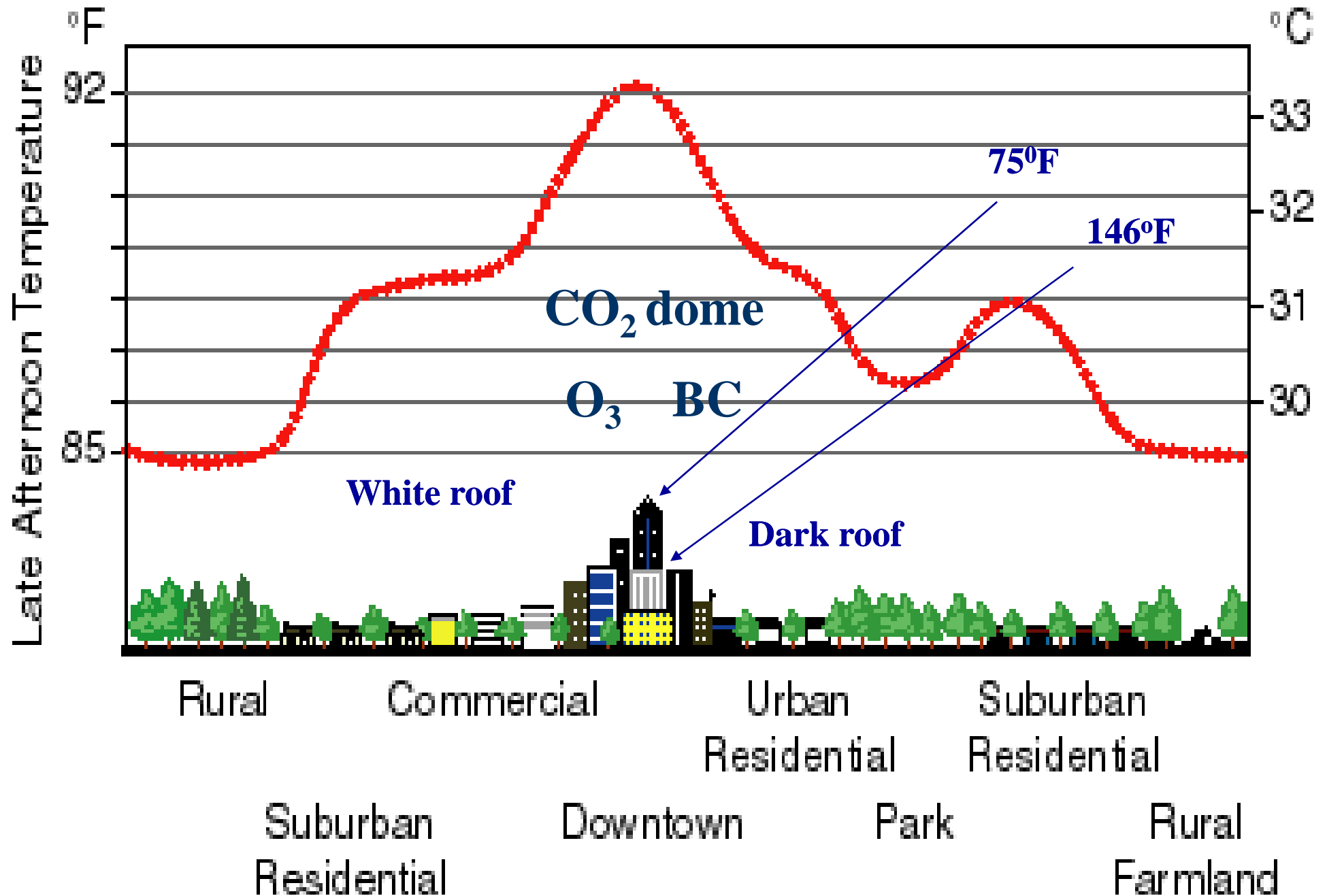
Hydro/Natural Gas



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Sketch of an Urban Heat-Island Profile



Clean Energy: Adaptation and Mitigation



Finance



Water

Purification

Pumping

Irrigation

Desalination

Underwriting



Swiss Re

Munich Re

Distributed Generation

Distributed Development

Cooking

Clinics

Schools

Homes

Computers



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MDGs: Haines et al. Lancet 2008

Financial and Policy Instruments

Aligning Rewards and Regulations

Private sector

Investments
Insurance
Ratings

Public sector

Incentives
Infrastructure
R&D
Procurement practices

TAXES, SUBSIDIES,
FUNDS

REGULATIONS
EFFICIENCY STDS

INSTITUTIONAL
FRAMEWORK

“Carrots”

Public Health

Security

Economy

Climate Stability

“Sticks”

New Energy Plan

Transport
Utilities
Buildings

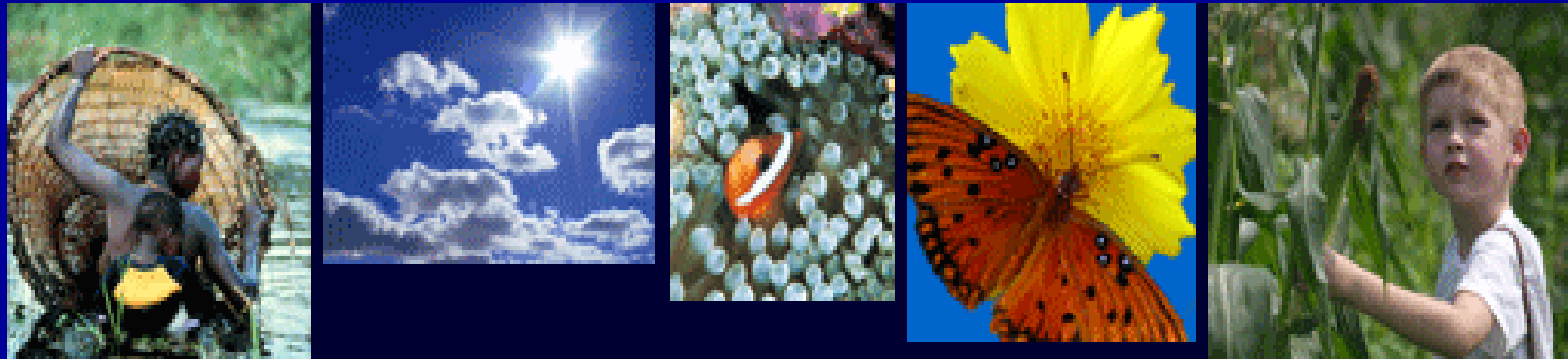
Corn Coal Nuclear
Lobbies

THE ECONOMIC
ENGINE
for the
21st CENTURY



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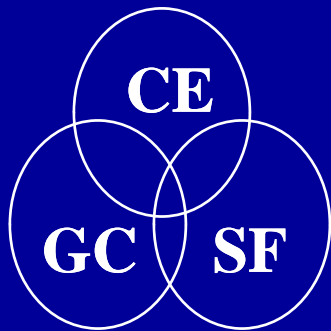
<http://chge.med.harvard.edu>

<http://www.climatechangeofutures.org>



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Green Buildings



Estimated Savings

Respiratory disease: \$6 to \$14 billion

Allergies and asthma: \$1 to \$4 billion

Sick building syndrome: \$10 to \$30 billion

Worker performance: \$20 to \$160 billion

Studies

Lawrence Berkeley National Lab

Schools with natural light

20% faster on math tests

26% faster on reading tests



Stores with natural light: 40% more sales

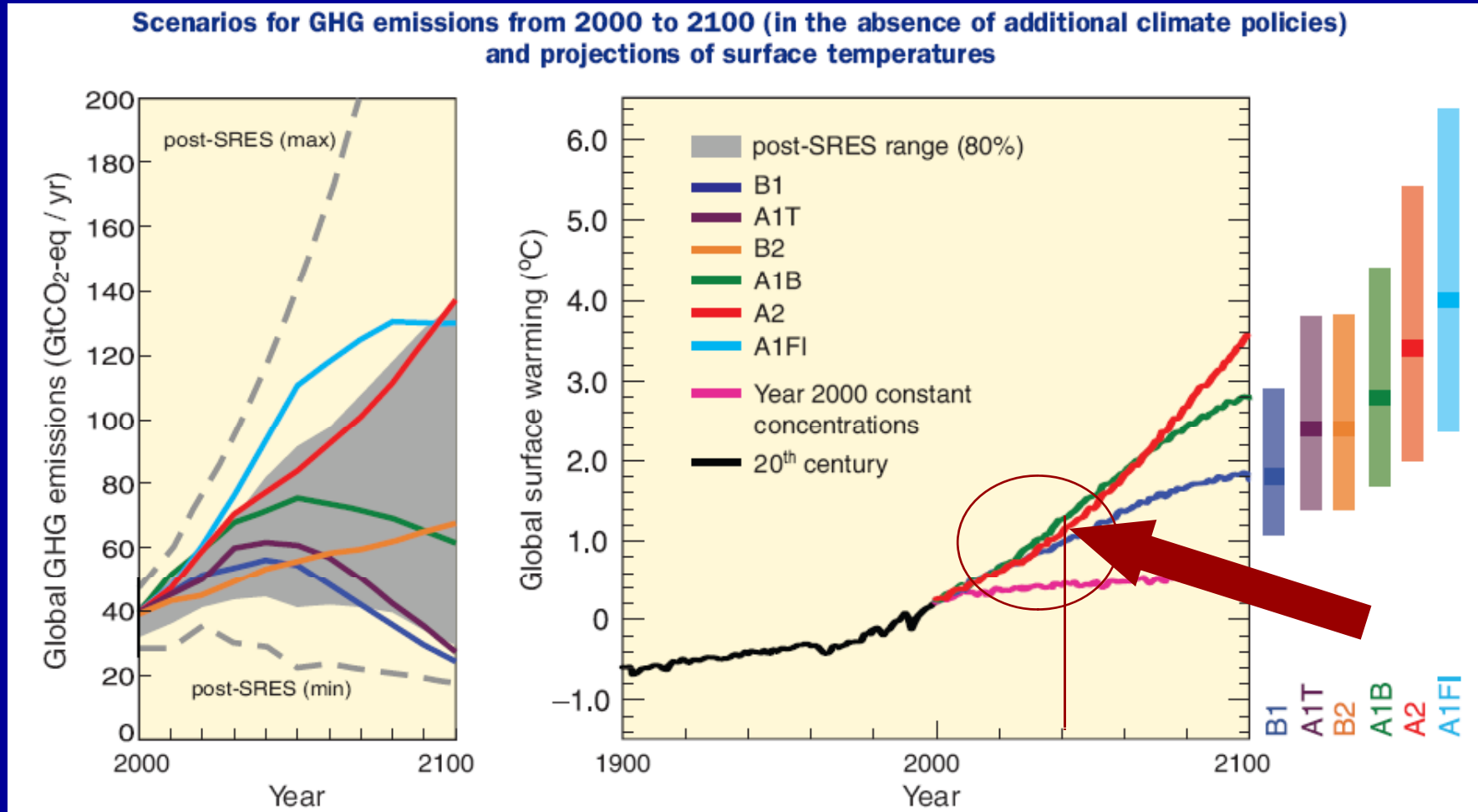
**Hospitals with better lighting & ventilation:
improved patient outcomes**



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Emissions Scenarios and Radiative Forcing



Scenario Projections diverge ~ 2040



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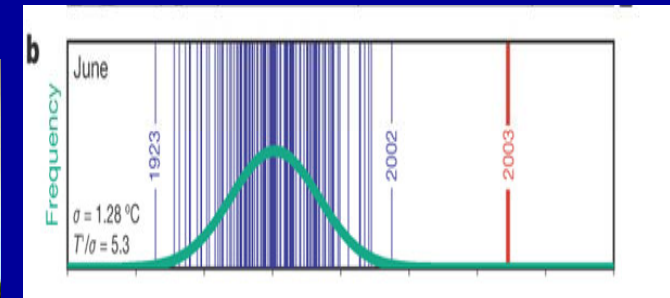
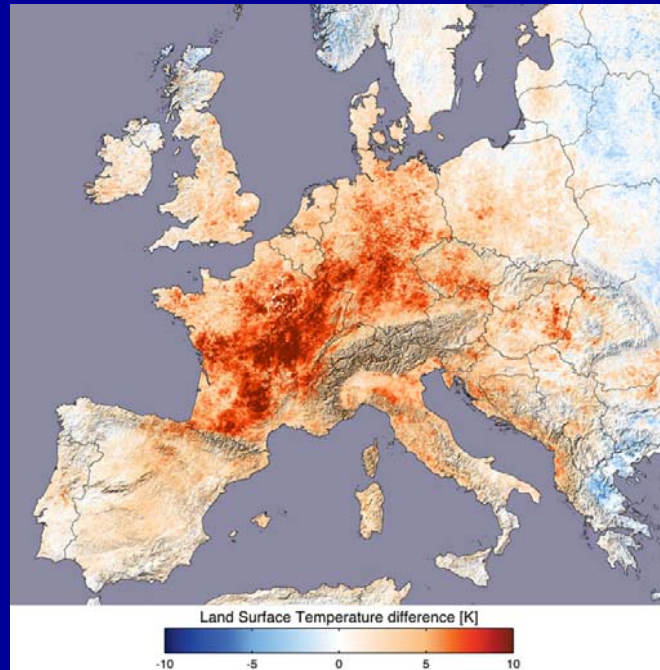
Changes in the Cryosphere



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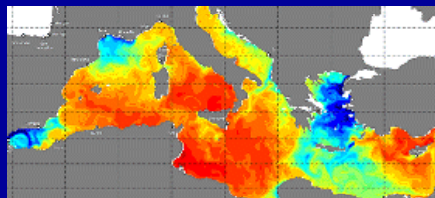
Heatwaves: Europe 2003



↑
Temperatures 11°F >30year average
6 std. dev. from the mean



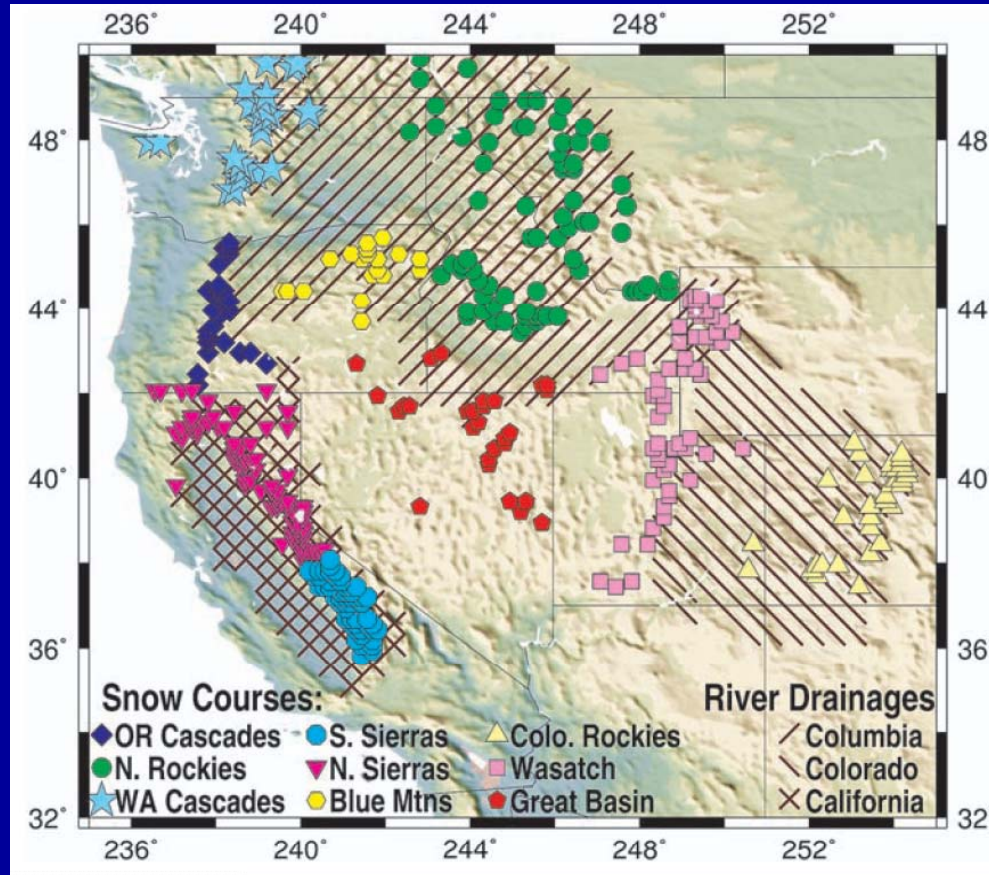
- Deaths: >50,000
- Crops & livestock:
US\$12.3 billion
- Wildfires:
1.2 million acres
- Nuclear plant shutdowns
- Hydropower reduced
- Alpine glaciers: 10% lost



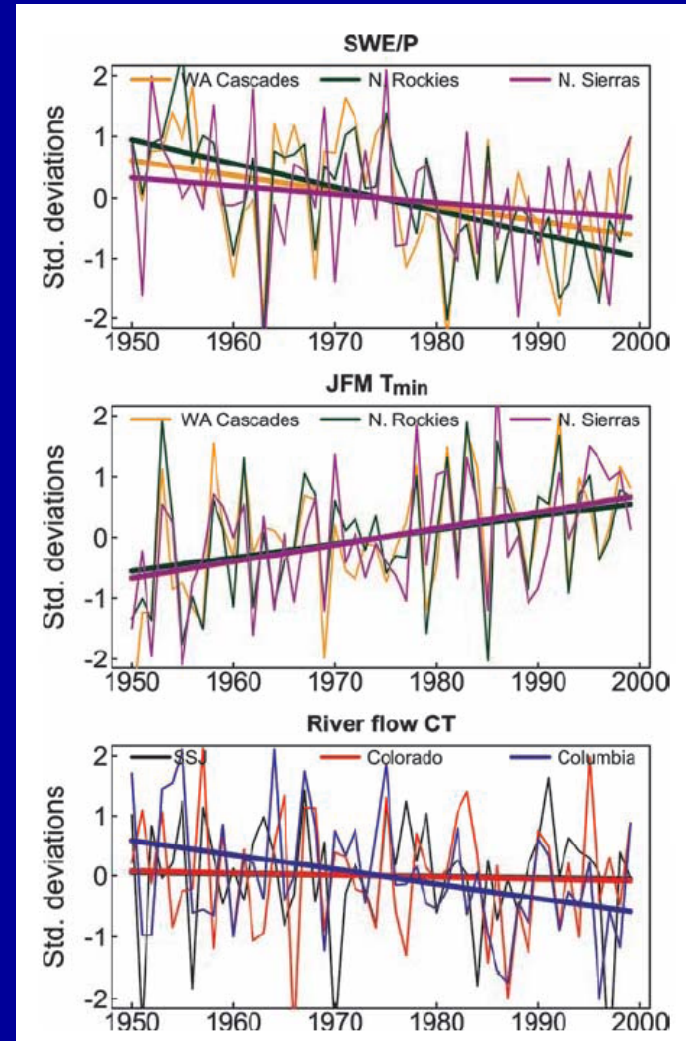
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Human-Induced Changes in the Hydrology of the Western US



Snow water equivalent or SWE/Precip Oct - March

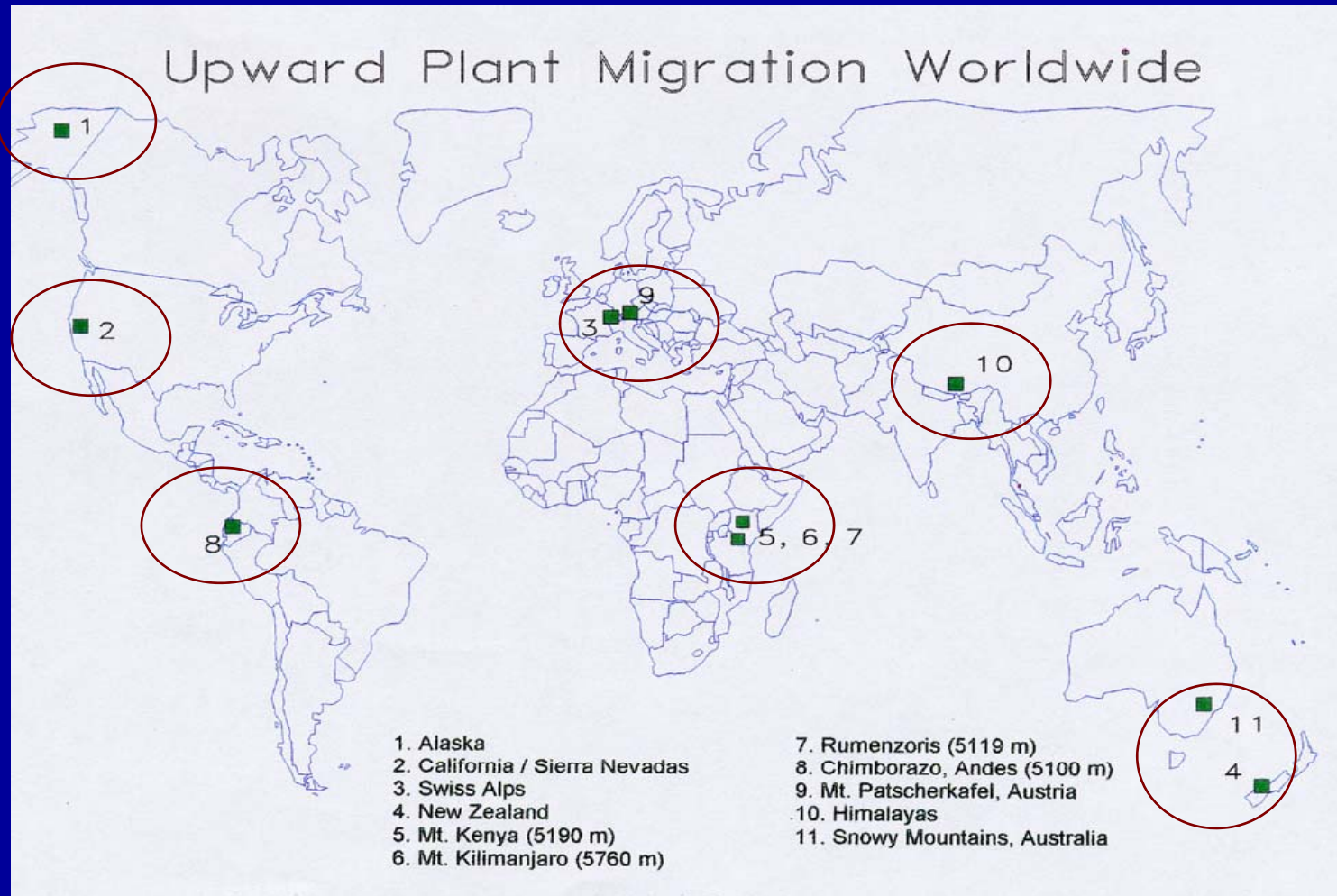


Processing cassava

- Grating
 - highly efficient
- Sun drying
 - less labour intensive but not as effective



Upward Plant Migration

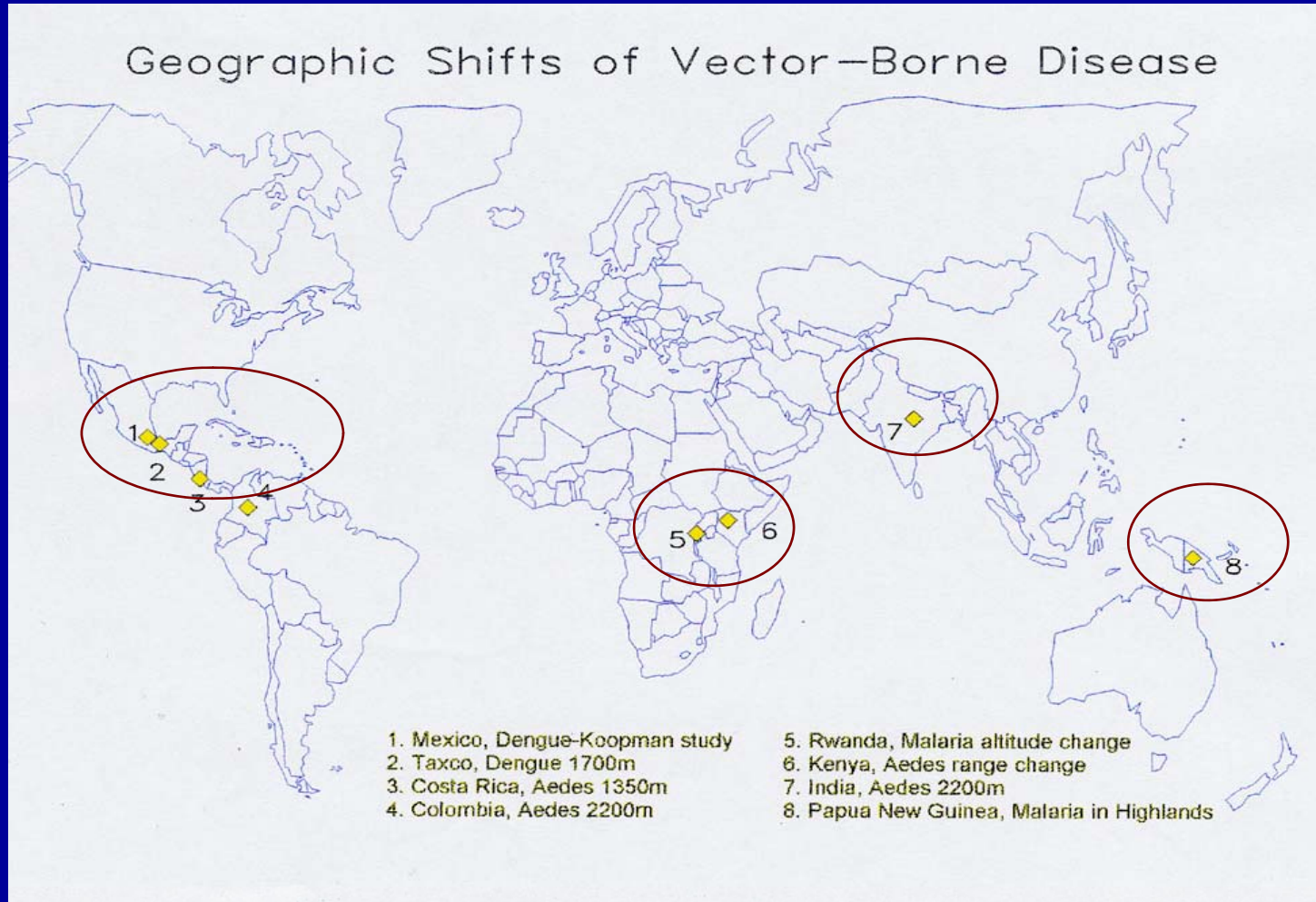


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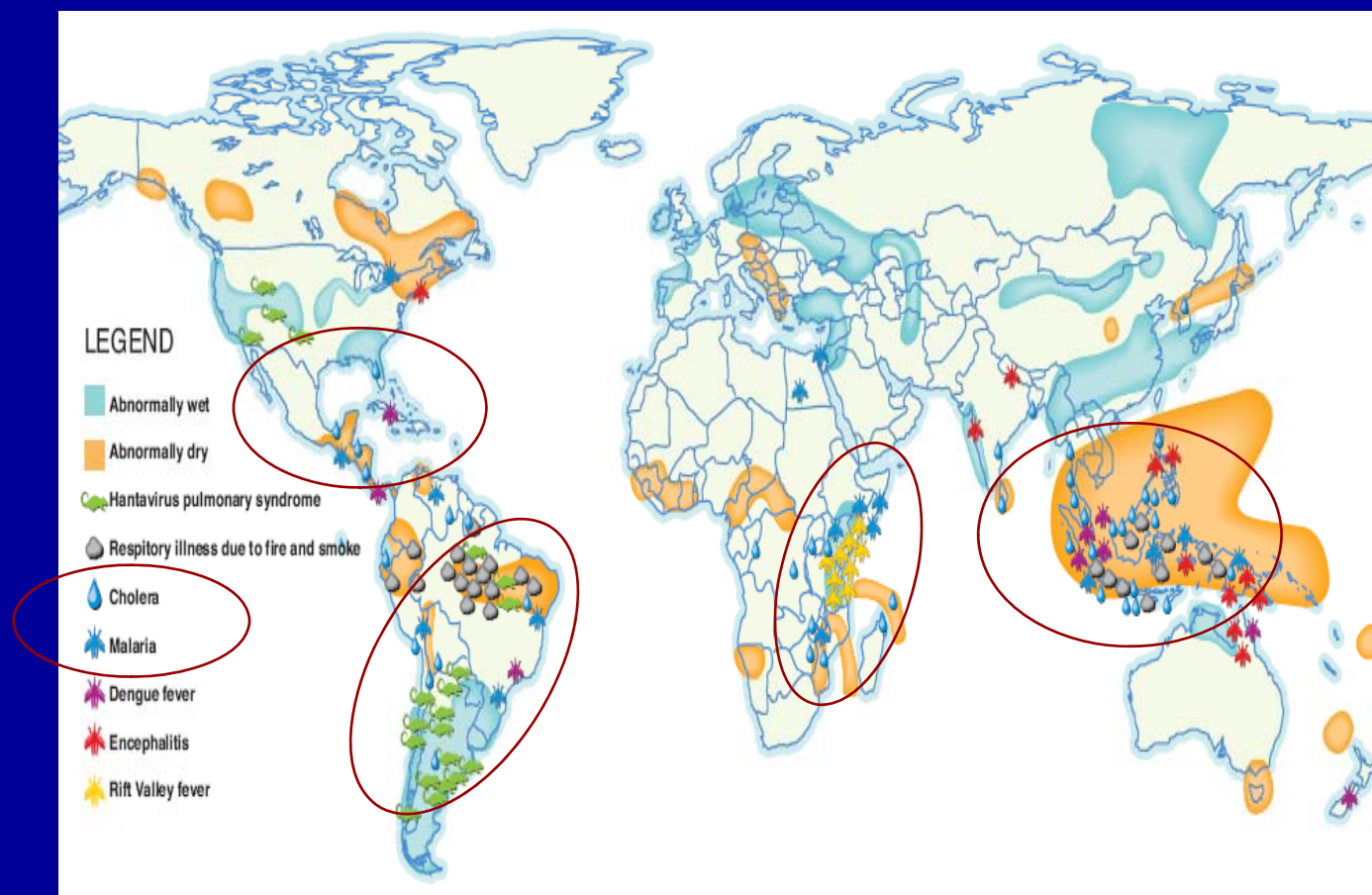
Geographic Shifts of Disease Vectors



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DISASTERS AND DISEASE 'CLUSTERS'



1997/98 El Niño Event



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Rodents

Heavy rains following droughts



→ New food supplies & floods drive rodents from burrows

Plague: Malawi/Moz border

Emerging Arenaviruses: Zambia/SA



Crop
&
stored-grain losses

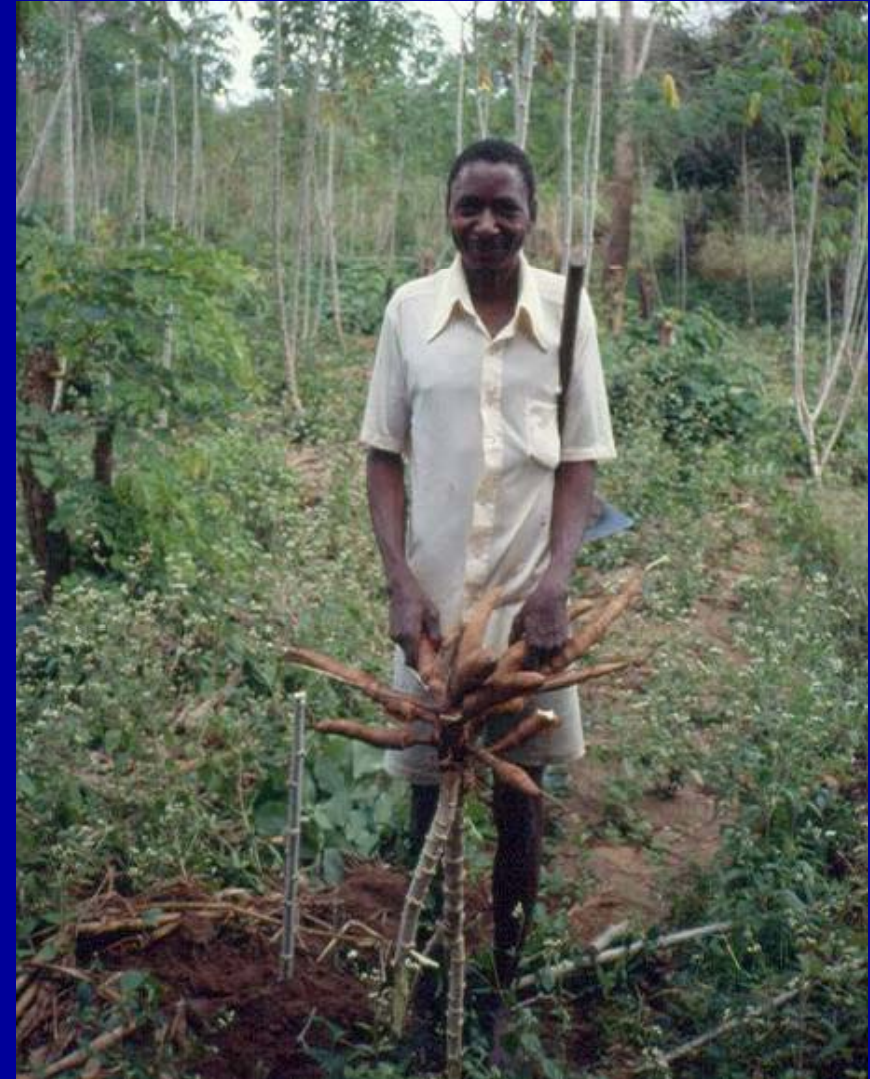


AND THE GLOBAL ENVIRONMENT

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Cassava, Yucca, Manioca, Tapioca

- Staple food >750 million people
 - 45% of sub-Saharan Africa
- Cultivation increasing worldwide
- In Africa
 - Production tripled between 1980 and 2005



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