Building a sustainable future through research, teaching & outreach

Climate Change

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www.FloridaClimateInstitute.org

UF UNIVERSITY of FLORIDA

FLORIDA STATE UNIVERSITY 1851

Outline

- Florida Climate Institute
- Our changing climates
- Relevance to agriculture
- Example projects
- Final Comments

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- Address the complex issues and challenges associated with climate change, climate variability, sea level rise
- Target science to inform decision and policy responses

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Motivation for the FCI

- Targeting Science Opportunities
  - Climate or sector-driven science questions
  - New technologies, education
  - Regional, national, international opportunities
- Targeting societal needs (*state* & *regional*)
  - Engagement with Floridians, Florida issues (FCI)
  - Regional (SECC, others in & affiliated with FCI)
  - Research, extension, education, service

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Mechanisms

- Interdisciplinary proposals written to federal agencies (research and education)
- Stakeholder climate working groups (involving scientists, agencies, private sector) to co-learn about issues, solutions
- Technical working groups (or task forces) to respond to stakeholder needs
- Other FCI activities (symposia, seminars, etc.)

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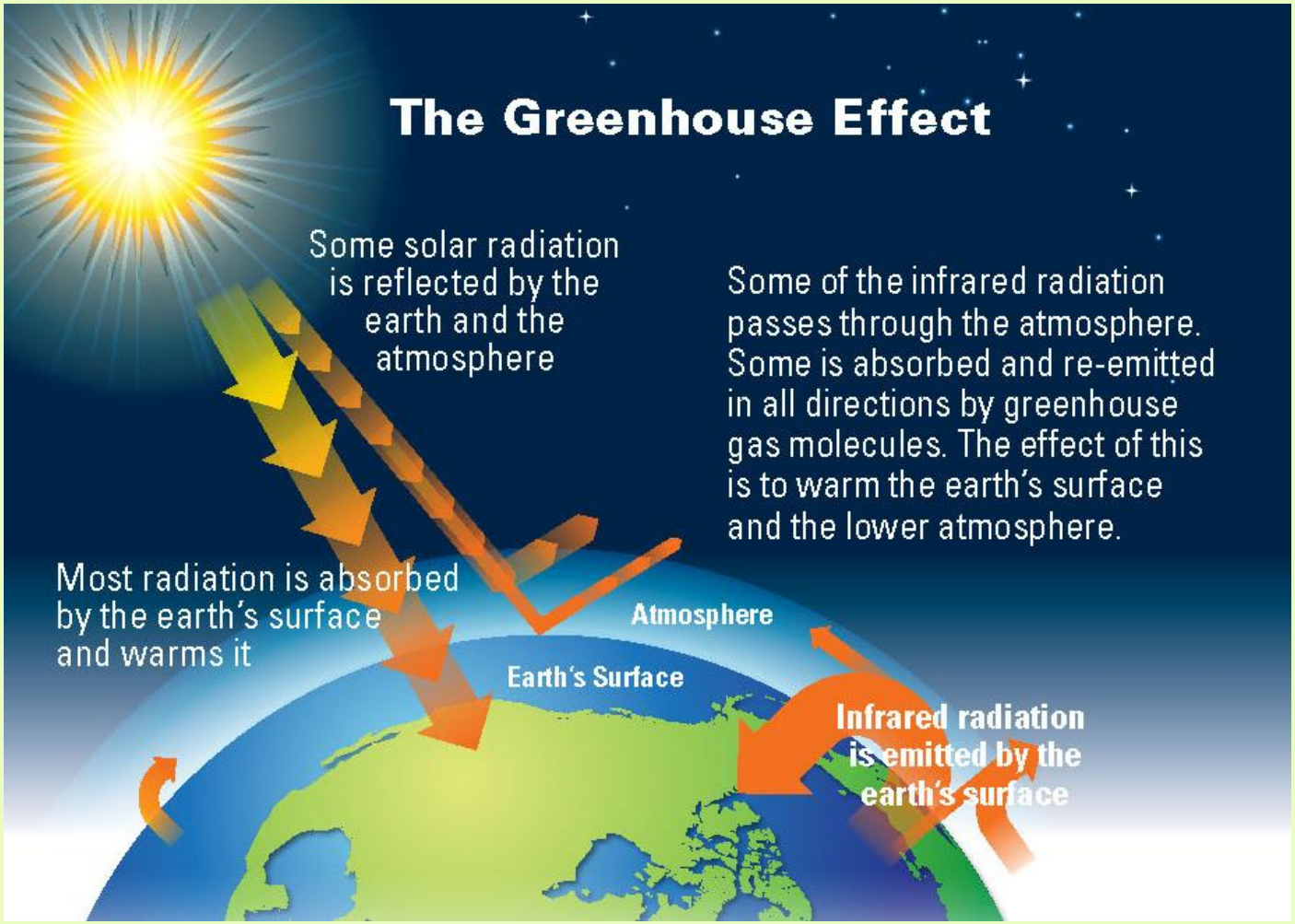
Changing Climates



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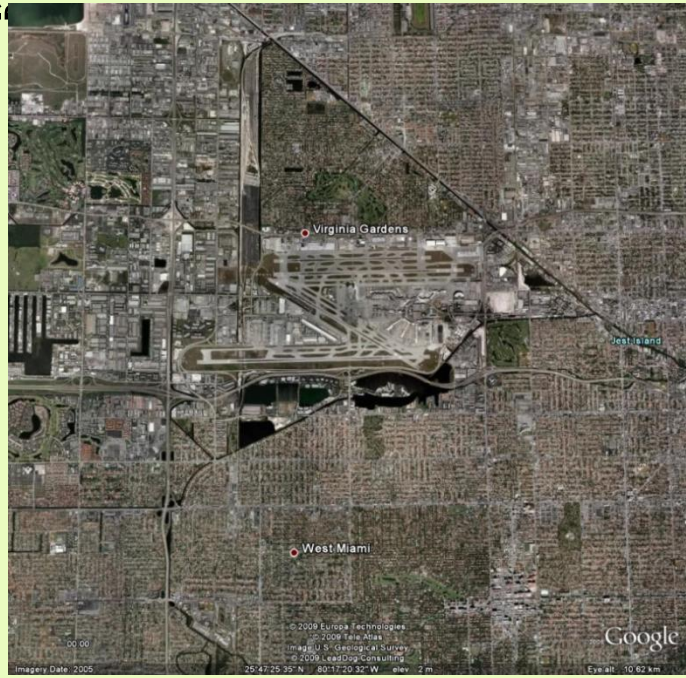
Climate change is ongoing and has many natural and man-made causes.

- Natural causes:
  - Changes in solar intensity
  - Eccentricity in the earth's orbit and "
  - Vegetation, albedo changes
  - Volcanic eruptions
  - Coupled ocean/atmospheric cycles

- Man-made causes:
  - Greenhouse gases
  - Urbanization
  - Land use changes
  - Aerosols



Miami

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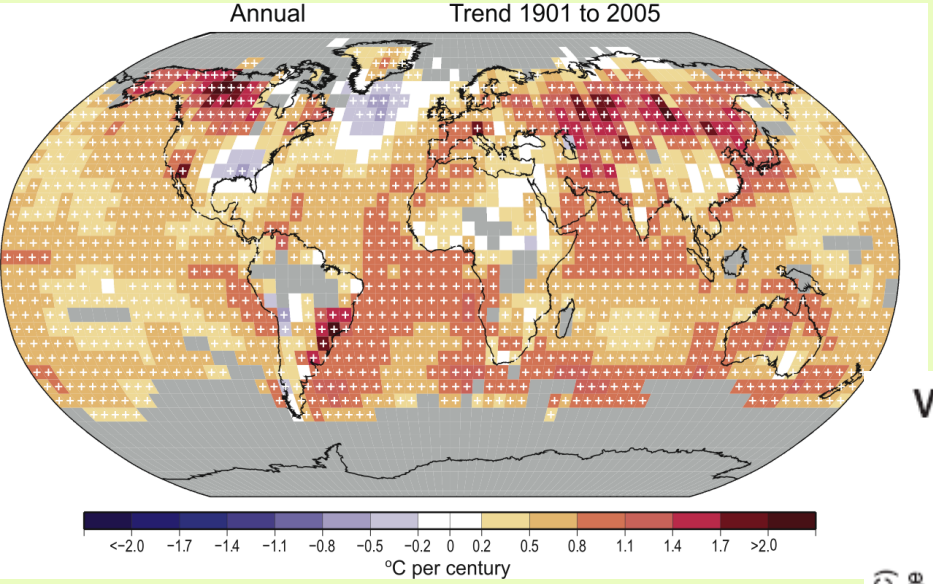
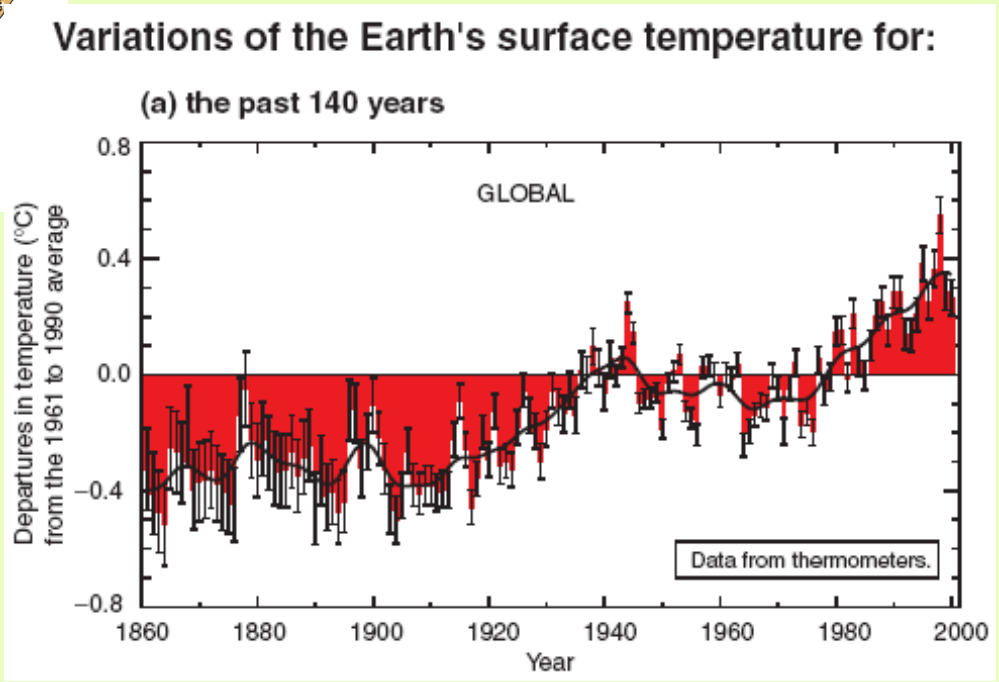
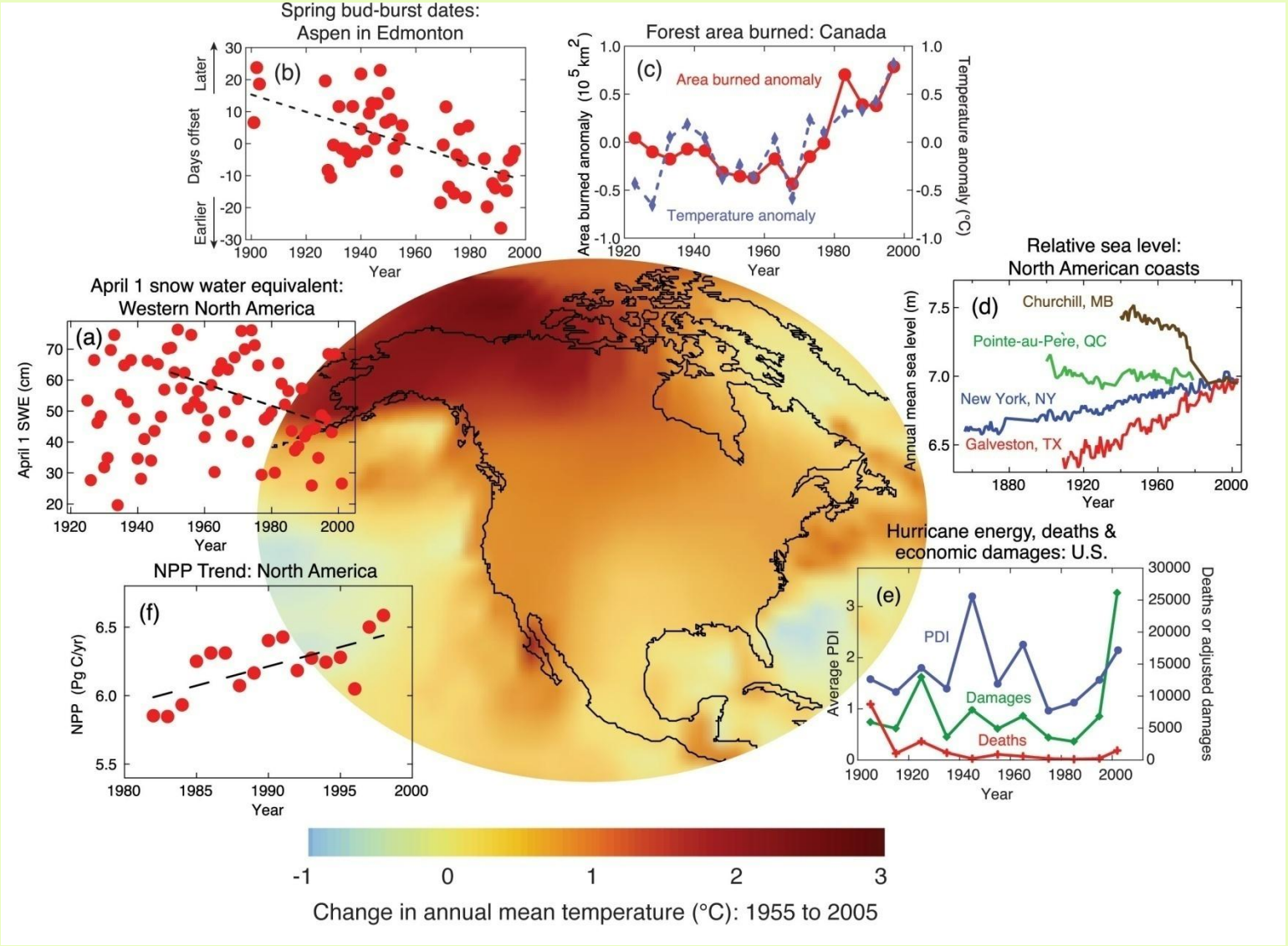
Historical Global Temperatures





North America Changes since 1955



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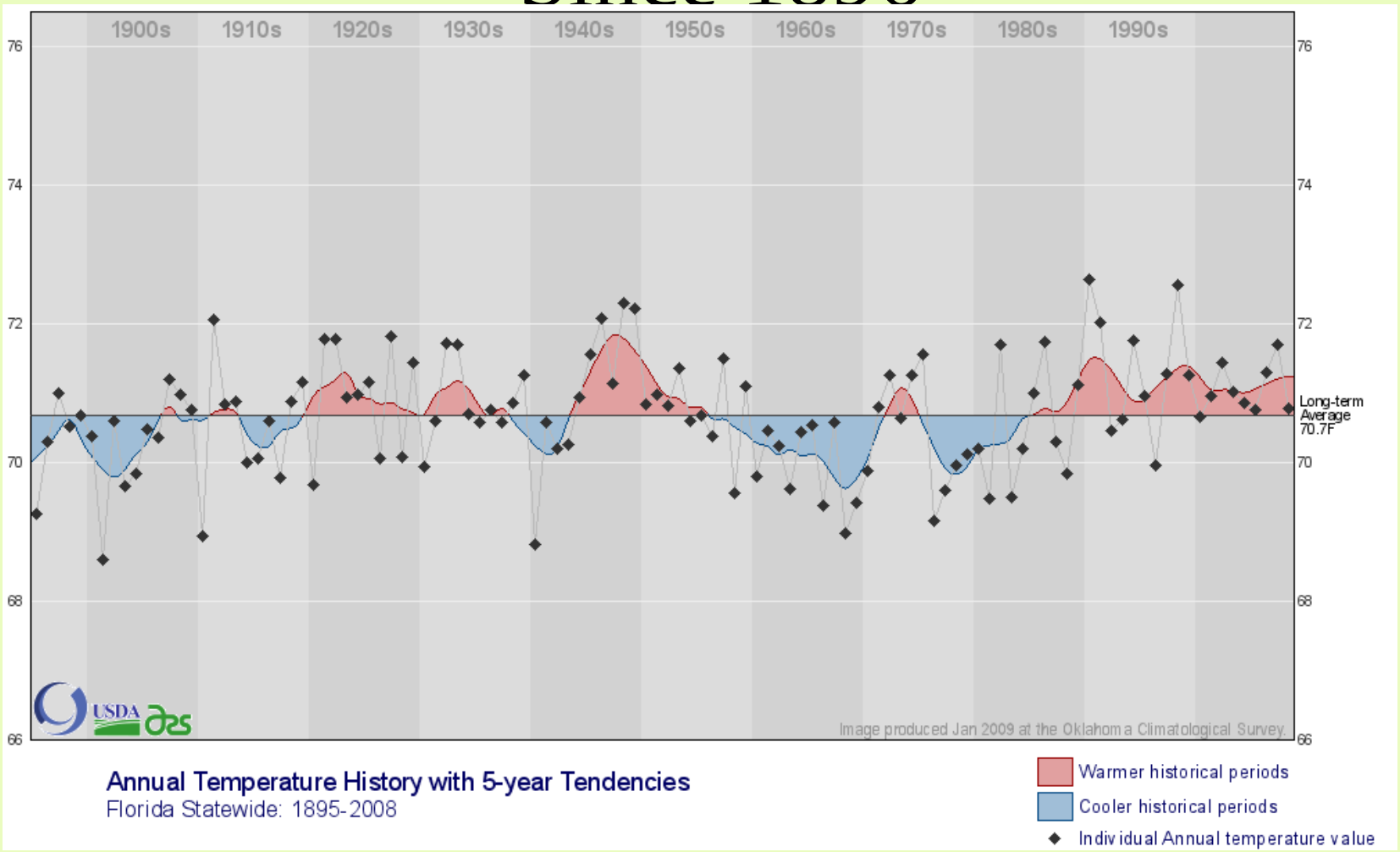
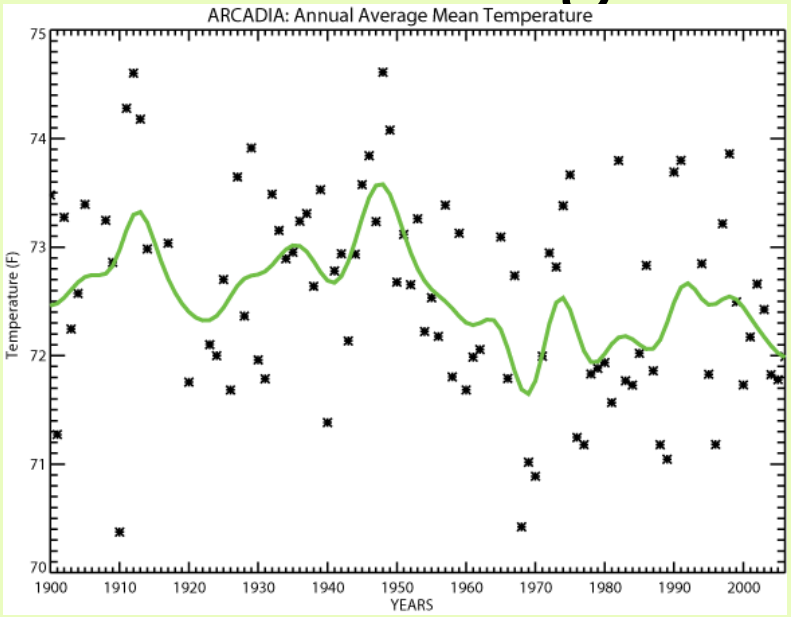
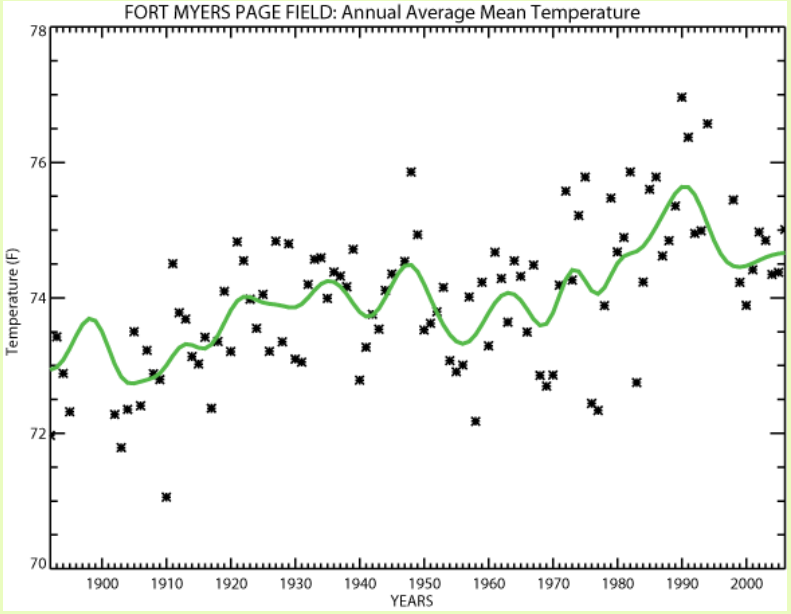
Florida Temperature Trends Since 1896



Urban Heating Effects



Arcadia: Small Town surrounded by pastures, citrus groves, pine stands, and lowlands



Fort Myers: has had tremendous urban sprawl (last 40 years), area population growing from 60,000 to over a half million

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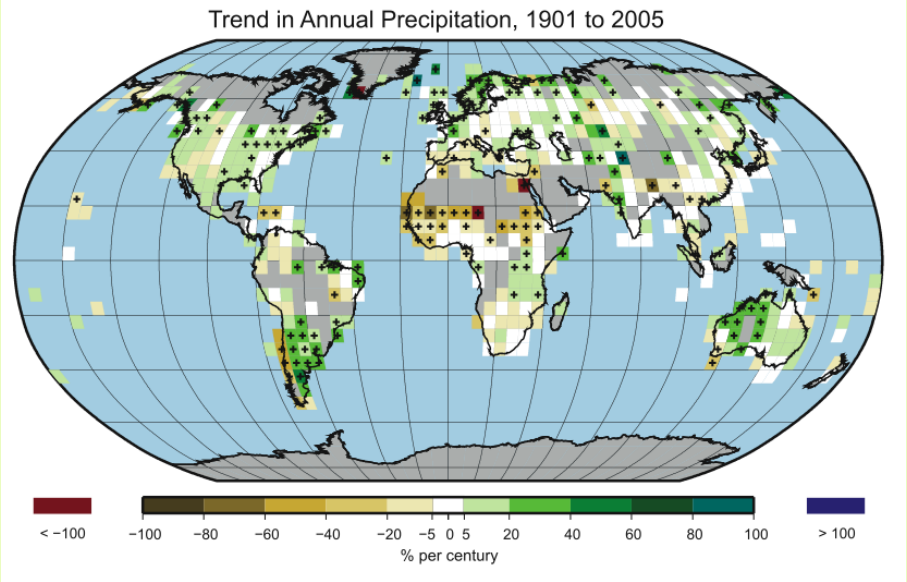
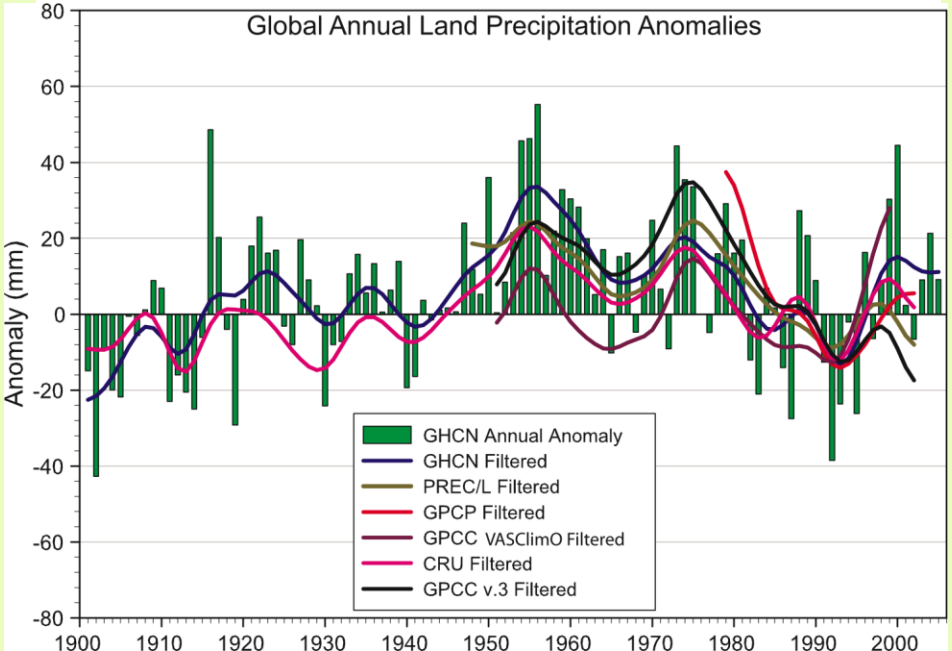
Global Precipitation Trends





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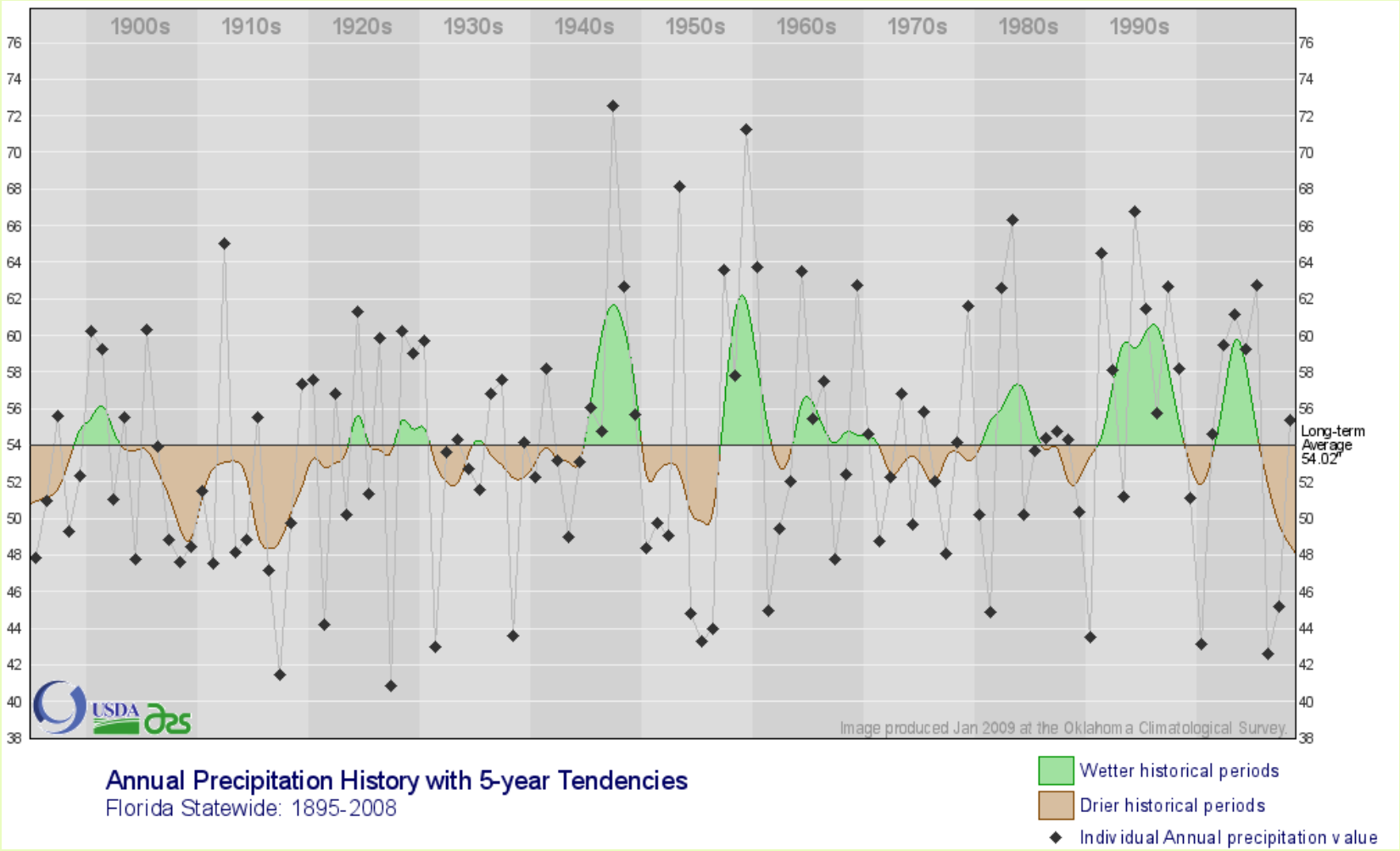
Florida Precipitation Trends Since 1896

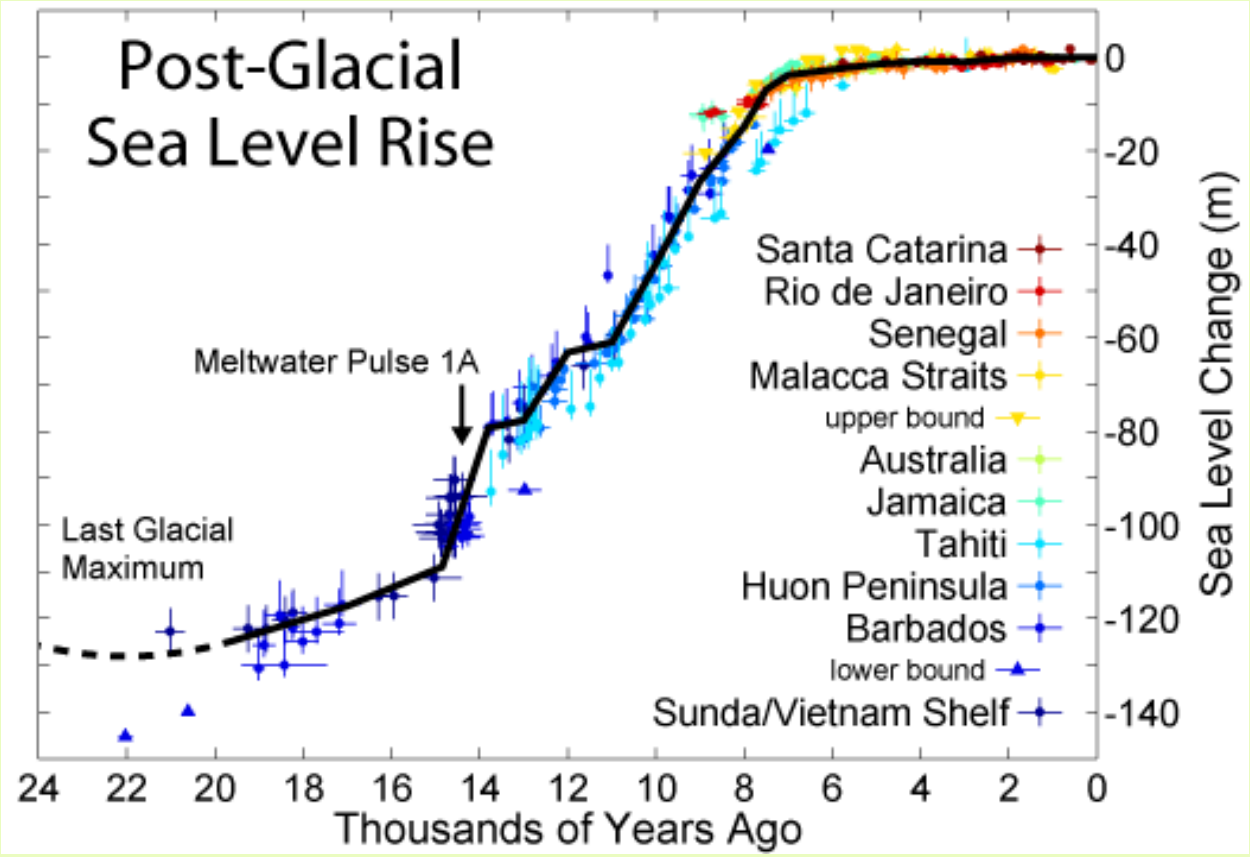


Sea Level Rise

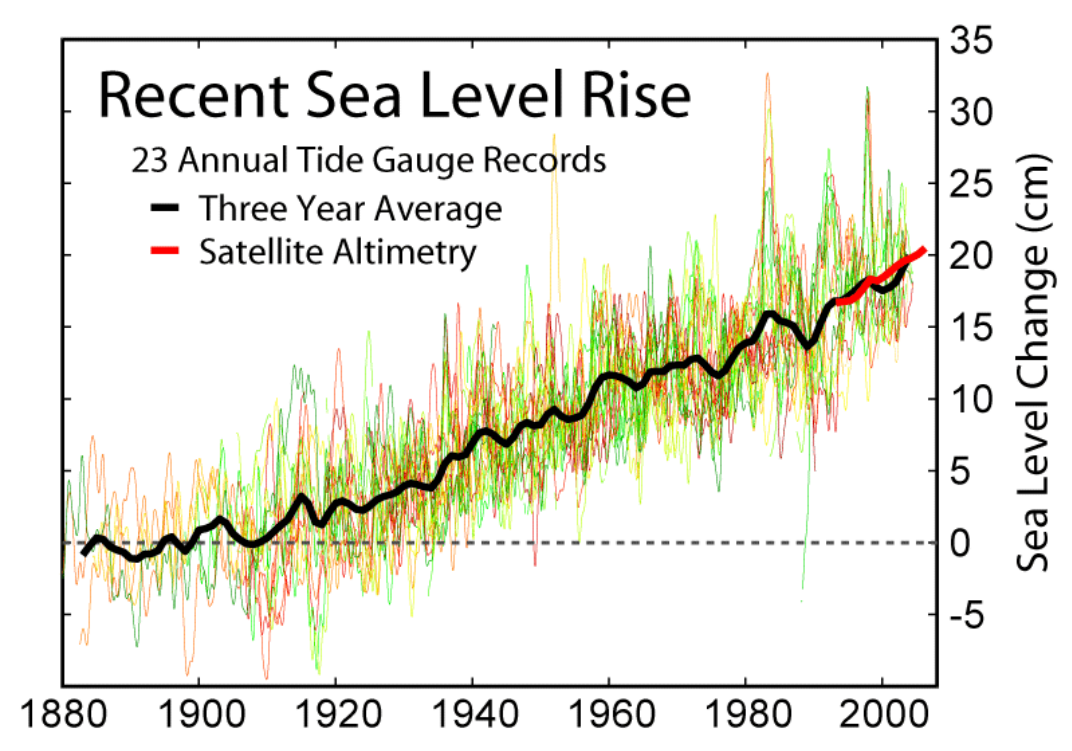
Global sea level can rise from two primary causes:

1) Warming of the oceans (thermal expansion)

2) Melting of ice caps and glaciers

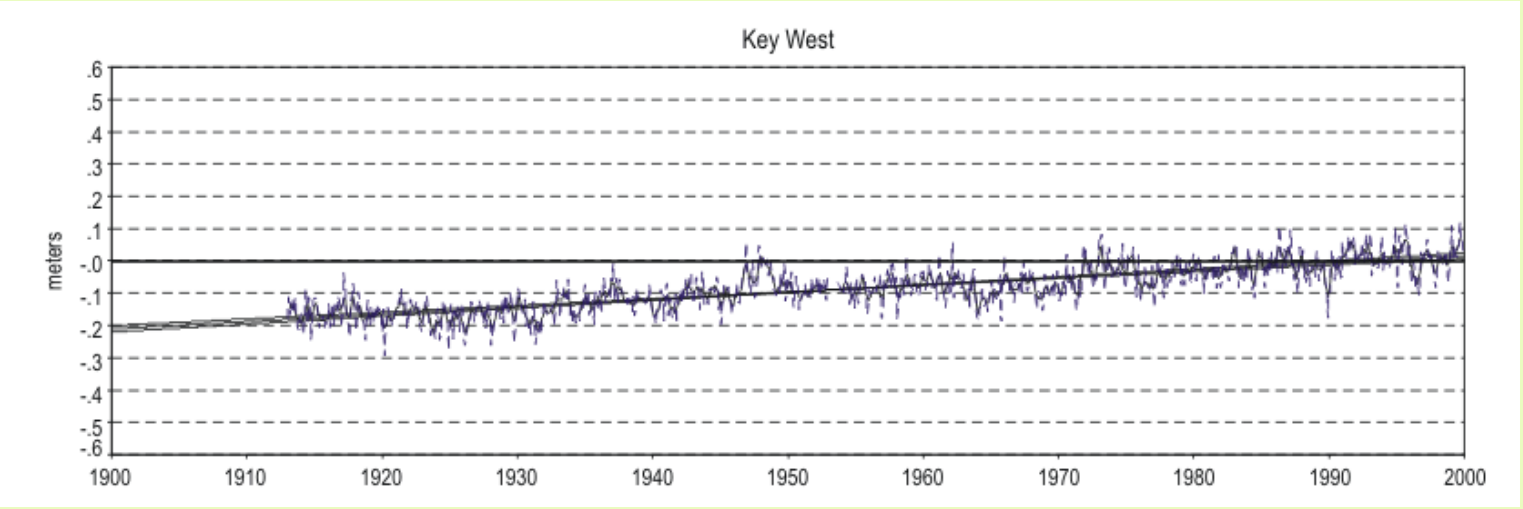


Historic sea level rise



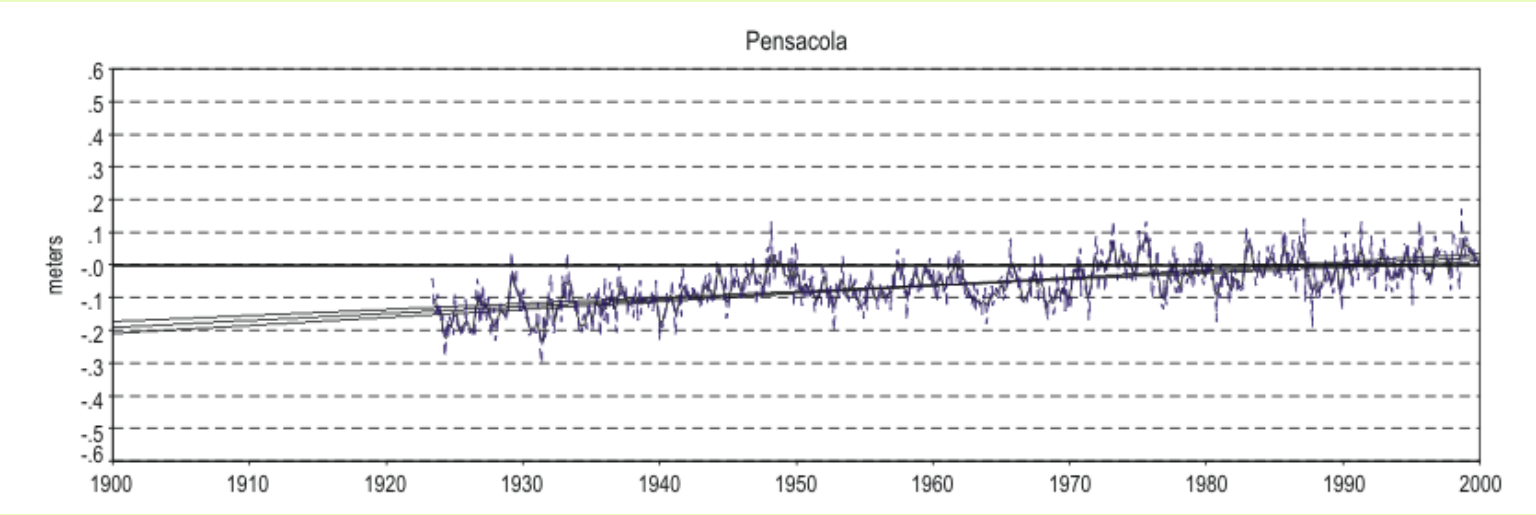
- Sea level measurements from 23 highest quality tidal stations around the world.
- Estimates of sea level rise from 1 mm/yr to 2 mm/yr.
- Satellite measurements (altimeters) since 1992 indicate a rise of around 3mm/yr.
- IPCC third assessment report stated "No significant acceleration in the rate of sea level rise during the 20th century has been detected."

Local sea level measurements



Key West

2.27 mm/yr



Pensacola
2.14 mm/yr

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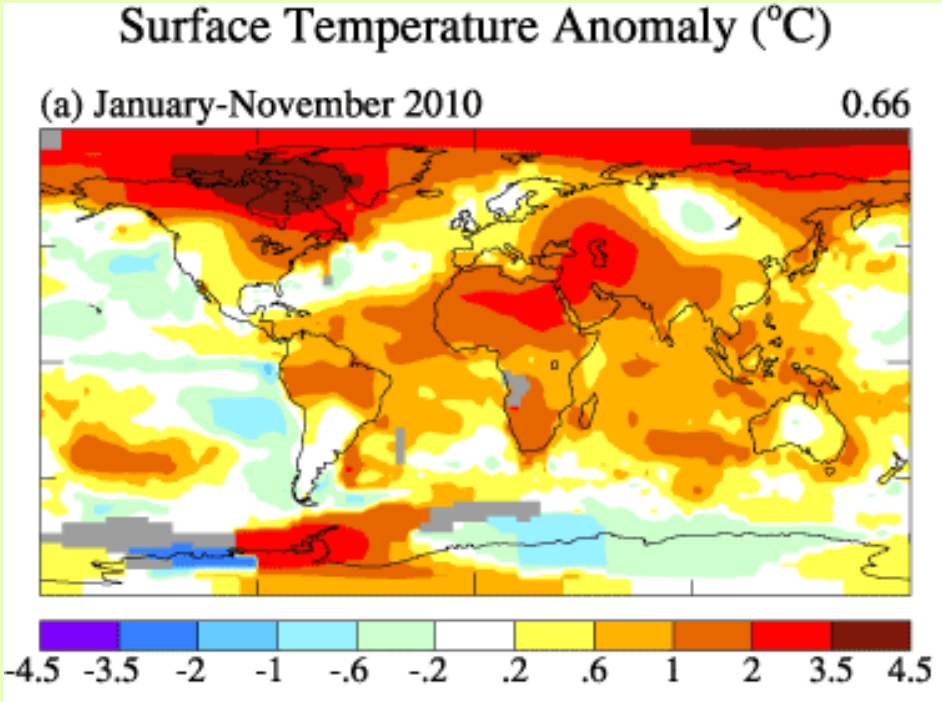
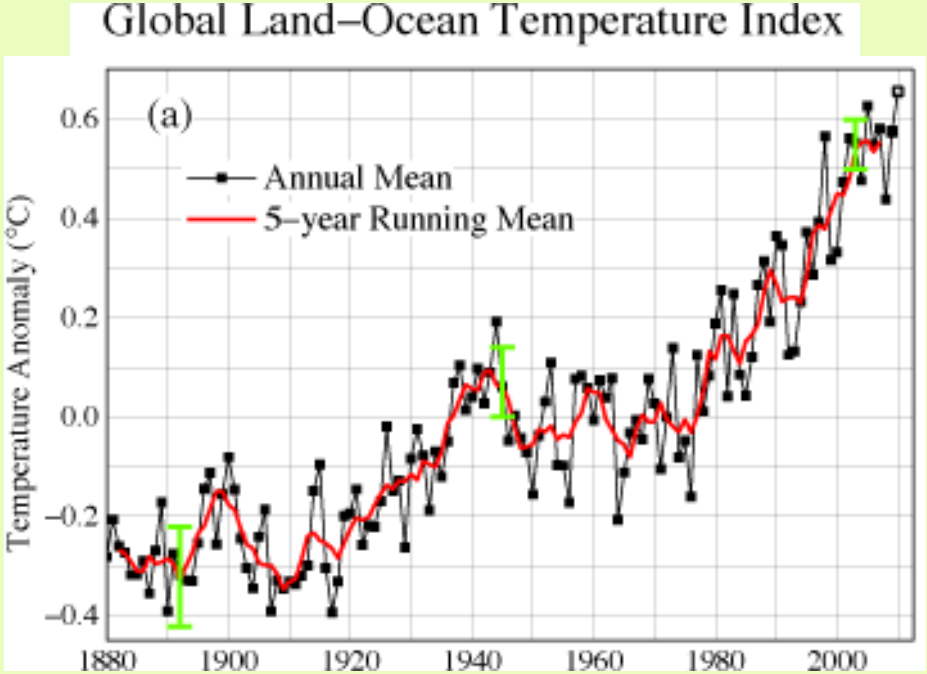
Relevance to Agriculture

2010 Tied with 2005 for Warmest Year on Record





- The two years differed by less than 0.018 degrees Fahrenheit.
- The difference is smaller than the uncertainty in comparing the temperatures of recent years, putting them into a statistical tie.
- In the new analysis, the next warmest years are 1998, 2002, 2003, 2006, 2007 and 2009, which are statistically tied for third warmest year.
- The analysis found 2010 approximately 1.13°F warmer than the average global surface temperature from 1951 to 1980.
- The temperature trend, including data from 2010, shows the climate has warmed by approximately 0.36°F per decade since the late 1970s.
- The analysis produced at GISS is compiled from weather data from more than 1000 meteorological stations around the world, satellite observations of sea surface temperature and Antarctic research station measurements.
- The record temperature in 2010 is particularly noteworthy, because the last half of the year was marked by a transition to strong La Niña conditions, which bring cool sea surface temperatures to the eastern tropical Pacific Ocean.

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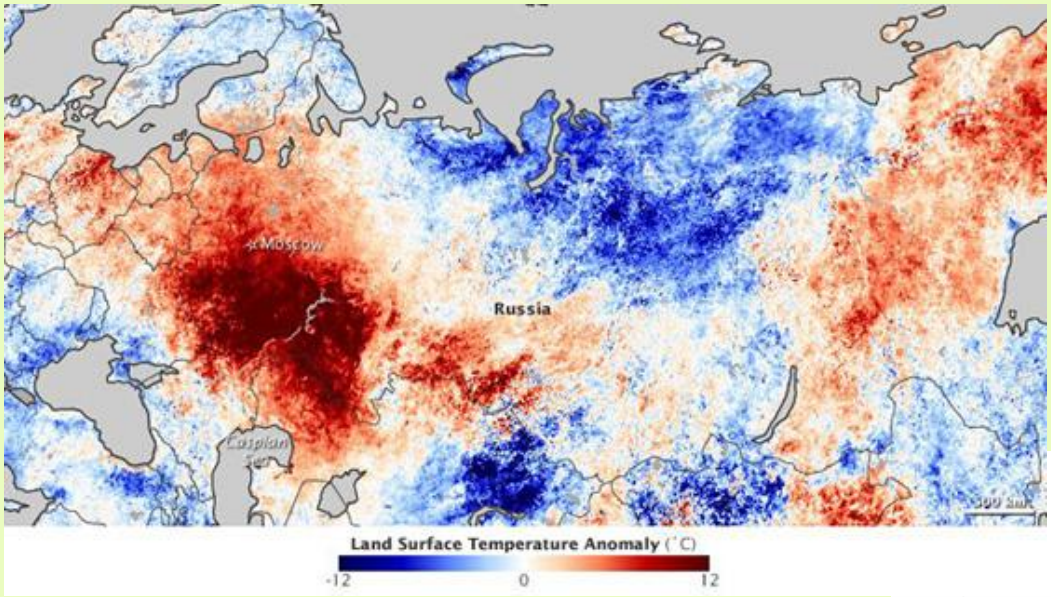
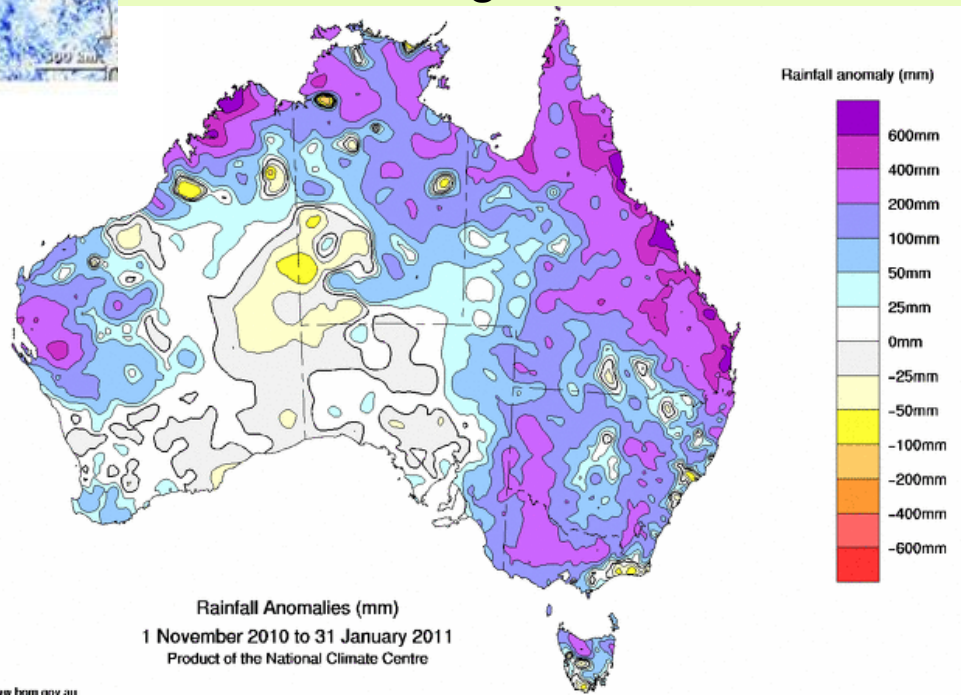
Weather Extremes Update

2010 Extreme Heat wave → Drought in Russia



- **Back-to-back 100-year floods in the Northern Great Plains during 2009 and 2010**
- **Recent floods in Australia**

Extreme Precipitation → Flooding in Australia



- **2010 failure of the Ukrainian grain crop due to heat wave**
- **Russia froze wheat exports Aug. 15 2011 . . .**

- **Devastating drought in Niger during summer of 2010.**
- **Central US floods May, 2011**

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Longer Term Issues
Land Availability & Yield Plateaus

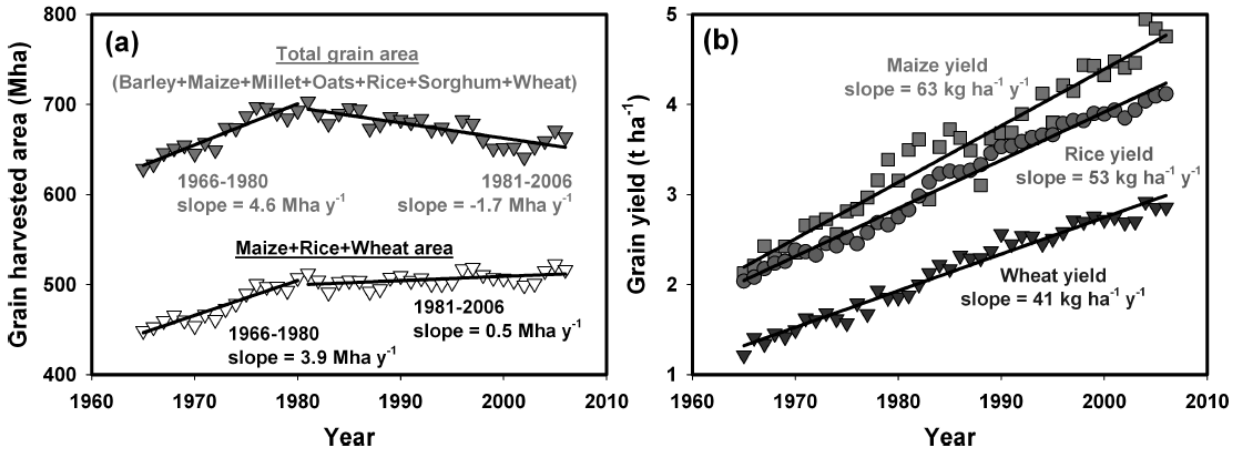

Fig. 1. (a) Global land area used in cereal production. (b) Global trends in grain yield of the three major cereal crops.

Cassman et al., 2011

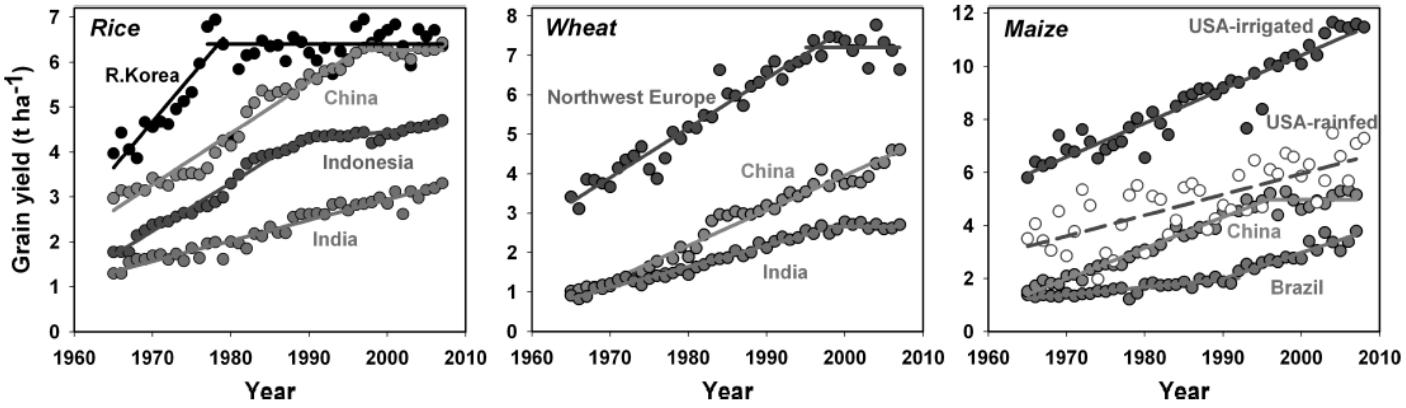

Fig. 2. Grain yield trends of the three major cereals in selected countries. USA maize yields are means for the western Corn Belt and Great Plains states: CO, KS, NE, ND, OK, SD, TX, and WY.

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Biofuels

www.keetsa.com

Almost all of the increase in global maize production from 2004 to 2007 went to bio-fuels production (World Bank 2008)

In the United States, as much as one third of the maize crop goes to ethanol production, up from 5 percent a decade ago, and biofuel subsidies range between US$11-13 billion a year (IISD, 2007).

Increased biofuel demand in 2000-2007 is estimated to have contributed to ~30 percent of the weighted average increase of cereal prices.

US biofuel subsidies still in place, may change as priorities change

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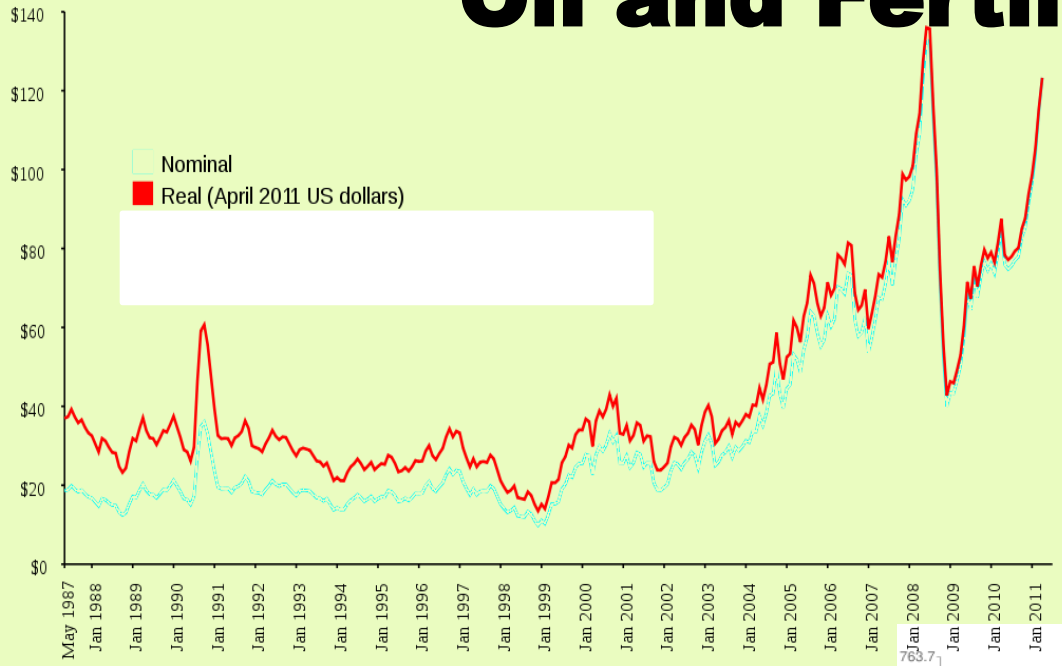
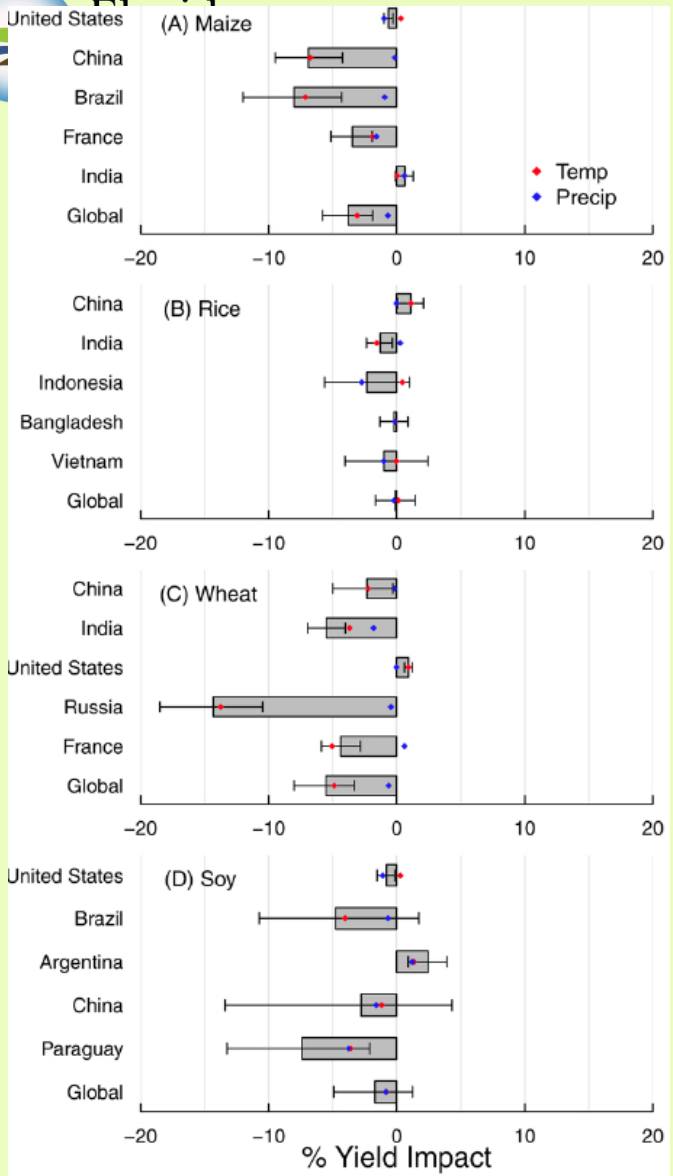
Oil and Fertilizer Prices



EIA, 2011

World Bank

Effects of Temperature Trends on Crops



Efforts to anticipate how climate change will affect future food availability can benefit from understanding the impacts of changes to date.

Here we show that in the cropping regions and growing seasons of most countries, with the important exception of the United States, temperature trends for 1980-2008 exceeded one standard deviation of historic year-to-year variability.

Models that link yields of the four largest commodity crops to weather indicate that global maize and wheat production declined by 3.8% and 5.5%, respectively, compared to a counterfactual without climate trends.

For soybeans and rice, winners and losers largely balanced out. Climate trends were large enough in some countries to offset a significant portion of the increases in average yields that arose from technology, CO2 fertilization, and other factors.

Lobell et al., 2011

Fig. 3. Estimated net impact of climate trends for 1980-2008 on crop yields for major producers and for global production. Values are expressed as percent of average yield. Gray bars show median estimate and error bars show 5-95% confidence interval from bootstrap resampling with 500 replicates. Red and blue dots show median estimate of impact for T trend and P trend, respectively.

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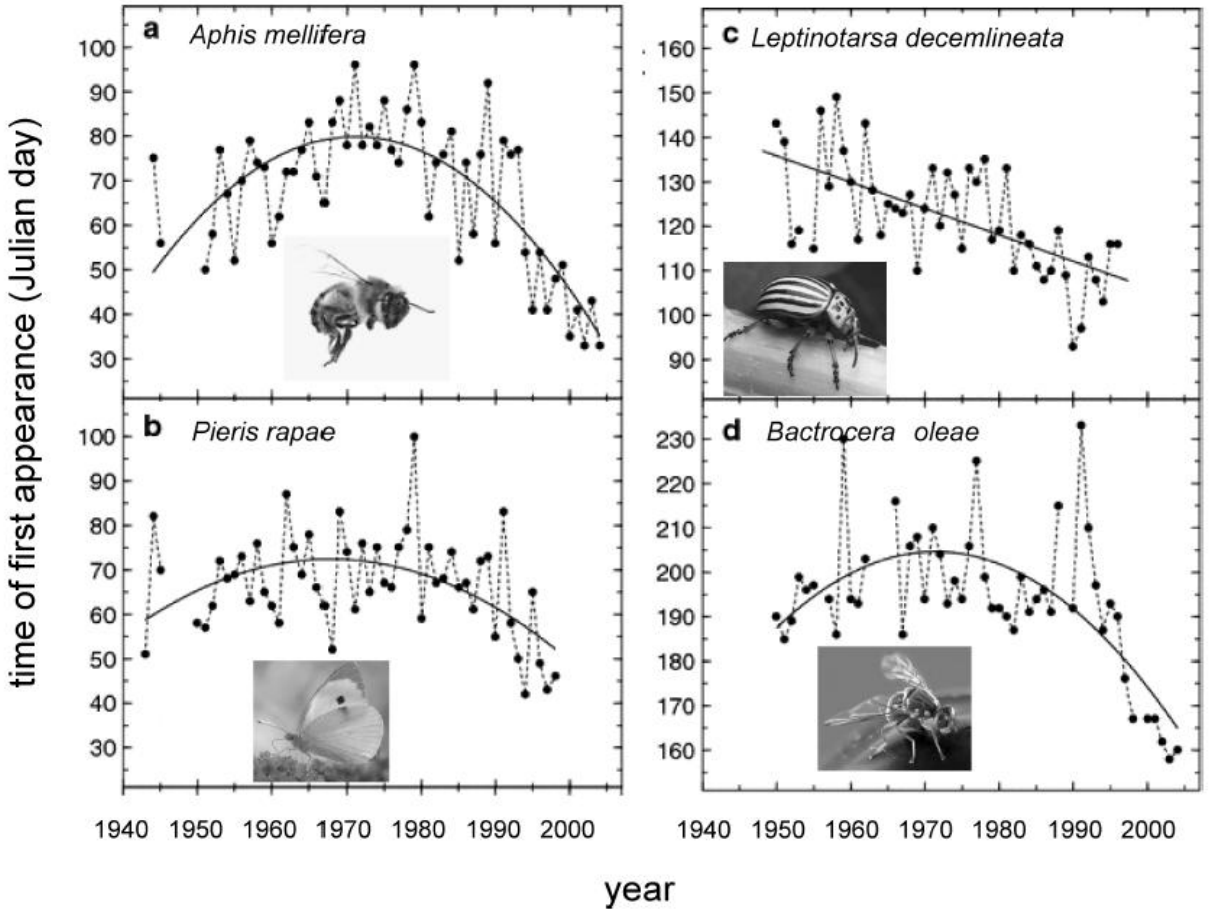
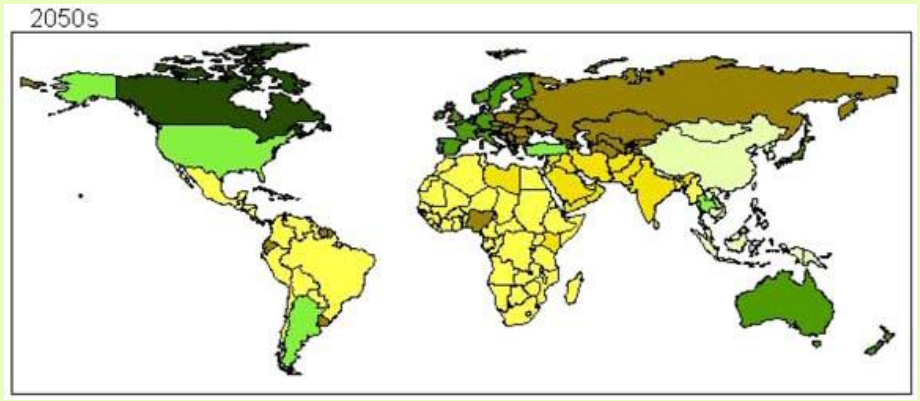
Earlier Emergence of Insects

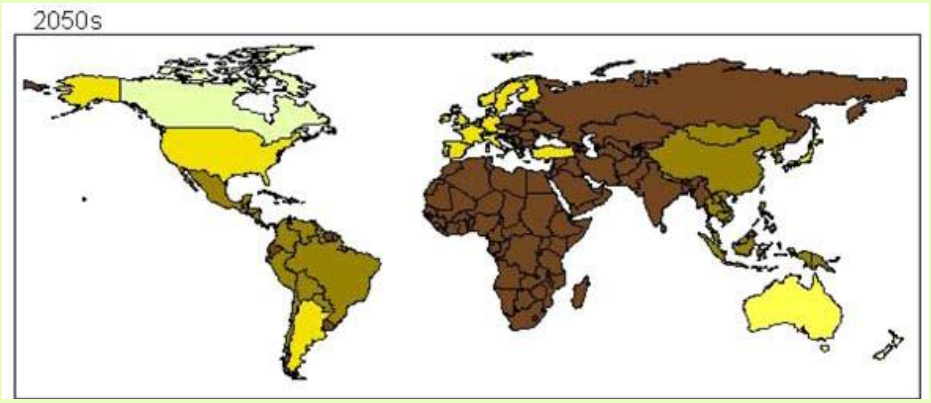


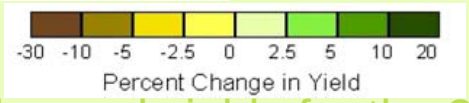
In a six-decade long study at a biological research station in Spain, increasing earlier time of first appearance for the honey bee, cabbage white butterfly, potato beetle and olive fly were found.

Gordon and Sanz, 2005; Gutierrez et al., 2010

Projected Yield Changes 2050s

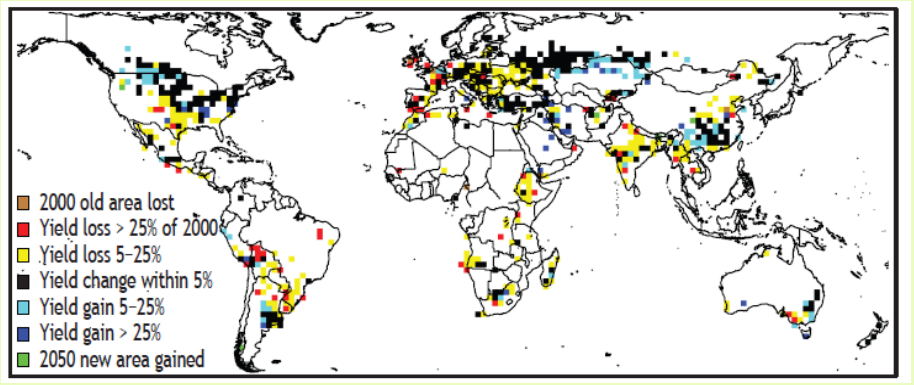






Parry et al., 2004

Potential changes (%) in national cereal yields for the 2050s (compared with 1990) under the HadCM3 SRES A2a scenario with and without CO_2 effects (DSSAT)



IFPRI 2011

Yield Effects with CO_2, rainfed wheat CSIRO A1B (DSSAT)

Parry et al.	-30% to +20%
IFPRI	-25% to +25%
GAEZ	-32% to +19%

GAEZ IIASA 2009 rain-fed cereals Hadley A2
North America -7 to -1%; Europe -4 to 3;
Central Asia 14-19%; Southern Africa -32 to -29

Schlenker & Lobel Africa multi GCMs -22 to -2% statistical approach

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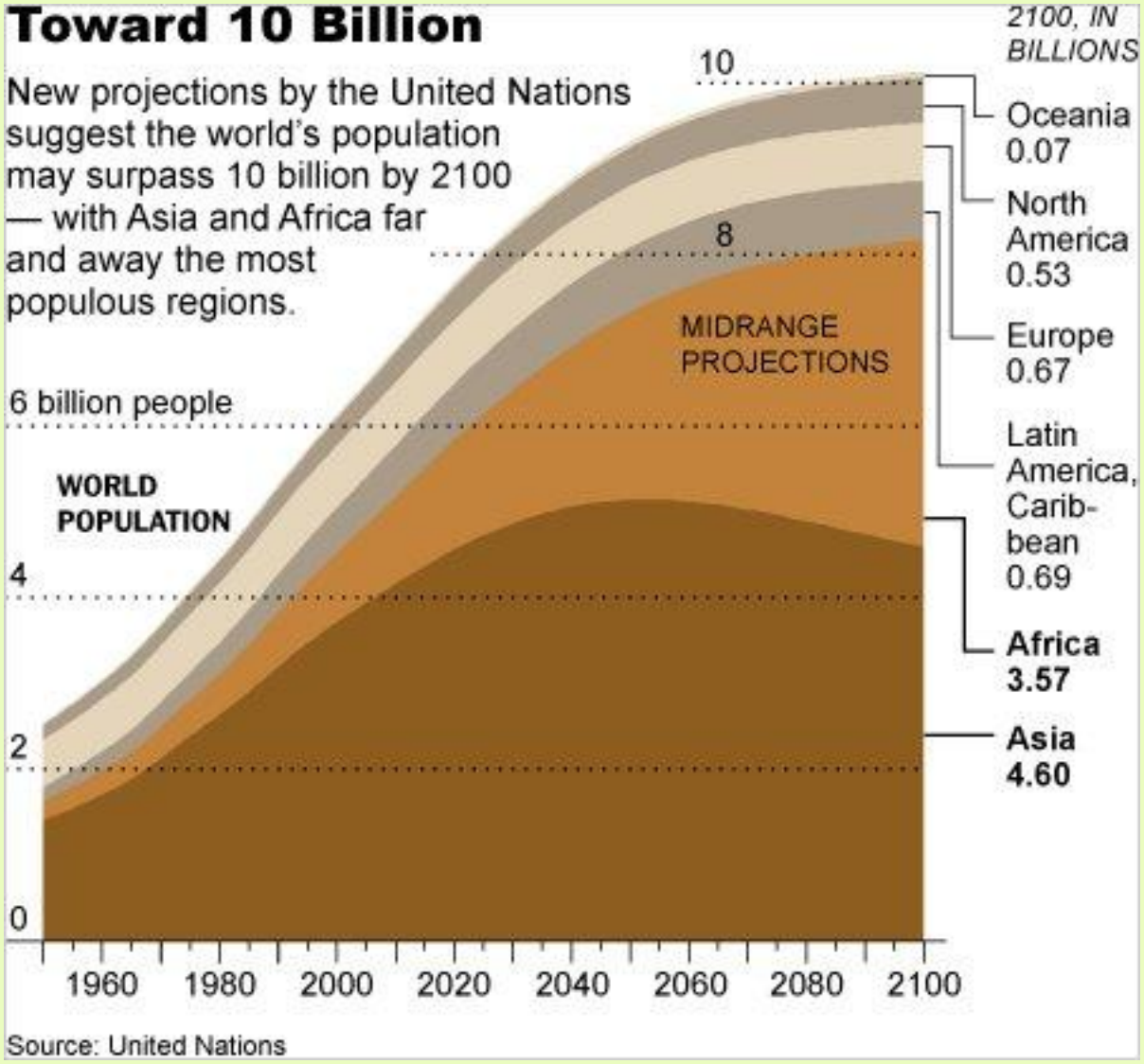
Global Population Projections



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Example Projects

- Climate risk management; using climate forecasts to reduce costs, increase profits
- Global Futures; plant breeding for tolerance to high temperatures, drought, flooding, pests and diseases
- Projecting yields and economic implications at regional and global scales

Temperature Rising:
A Warming Planet Struggles to Feed Itself

Josh Haner
The New York Times
June 4, 2011

Southeast ClimateConsortium

AgroClimate.org: Climate Risk Management Information & Decision Support System

AgroClimate
A Service of the Southeast Climate Consortium

Current Climate Phase: Neutral
The Pacific Ocean has returned to Neutral conditions signaling the end of La Niña.

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SUPPORTING ORGANIZATIONS

NOAA — National Oceanic and Atmospheric Administration, U.S. Department of Commerce

News

Greenhouse Gas Mitigation in Agroculture (April 6, 2009)»
March rain relieves Georgia drought (March 30, 2009) »
NOAA Unveils New Alert System for La Niña and El Niño »
Southeast drought situation improves »
Argentine farmers face ruin as drought kills cattle, crops »
Post-freeze reports paint grim picture »
AgroClimate is now providing monthly climate summaries for the States of Florida, Georgia and North Carolina »
Louisiana farmer tells Senate about hurricanes' impact »
AgClimate.org is now AgroClimate.org »
More News »

Outlooks

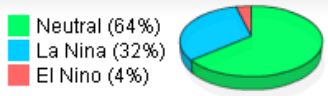
SECC Spring/Early Summer Climate Outlook (April 7, 2009):La Niña returns suddenly to the Pacific Ocean, winter forecast is now for warm and dry conditions...

Agricultural Outlook (February 8, 2009):La Niña Impacts on Agriculture in the Southeast

Climate Phase Forecast (January 11, 2009):La Niña conditions have abruptly returned to the Pacific Ocean...

Outlook Archive »

Climate Phase Forecast for Apr-May-Jun



Source: The International Research Institute for Climate and Society

AgroClimate meeting with producers at the Headland County Extension office, Alabama.

State Weather Networks

GAEMN — FAWN

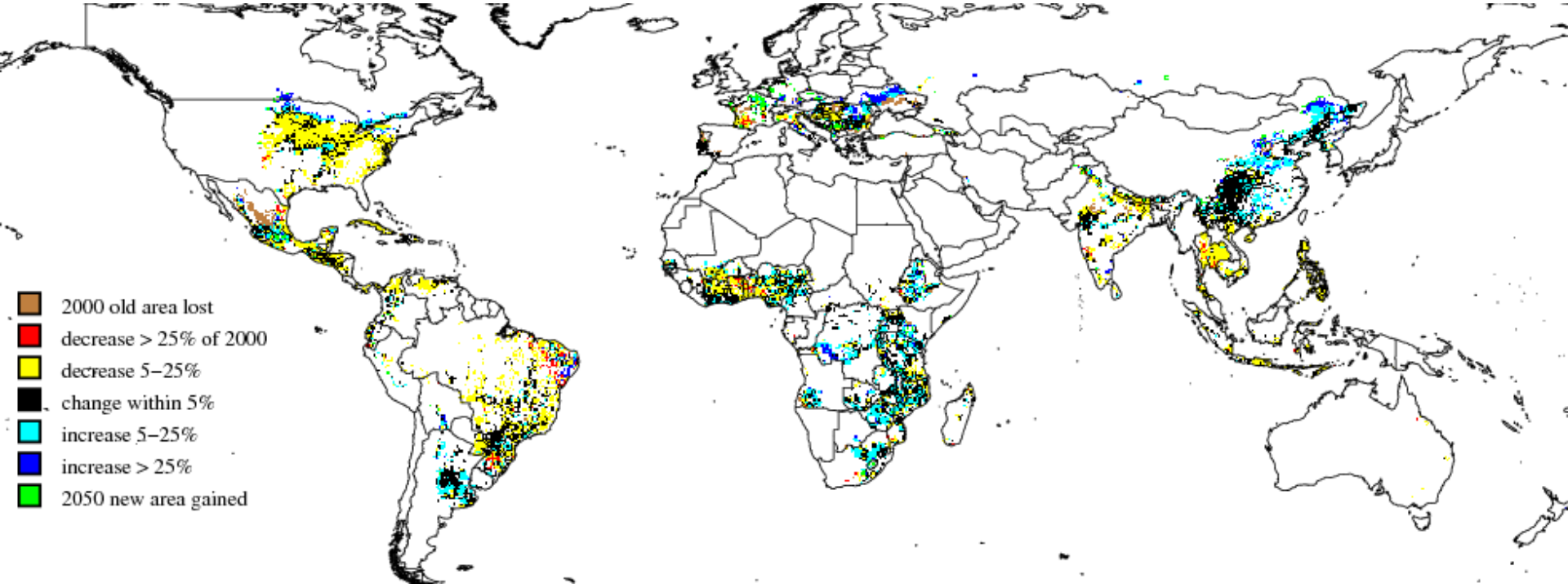
SECC CONSORTIUM MEMBERS

Florida State University Center for Ocean-Atmospheric Prediction Studies

The University of Georgia

UF University of Florida IFAS

Global Futures Project
International Food Policy Research Institute (IFPRI)
Led by Gerald Nelson



EXAMPLE

Climate change lowers maize yields (maize yields with 2050 climate relative to yields with 2050 climate)

CSIRO with A2 scenario, rainfed

J. Koo and R. Robertson 2009

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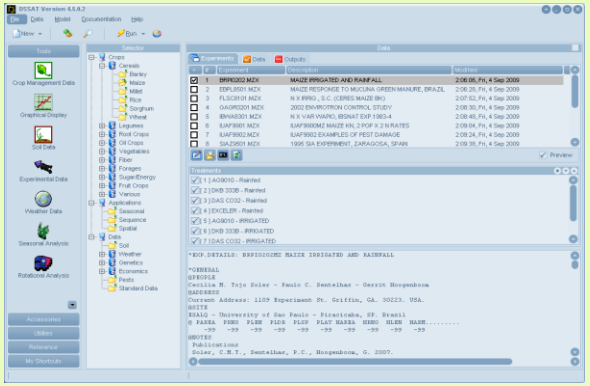
DSSAT

Decision Support System
for Agrotechnology Transfer

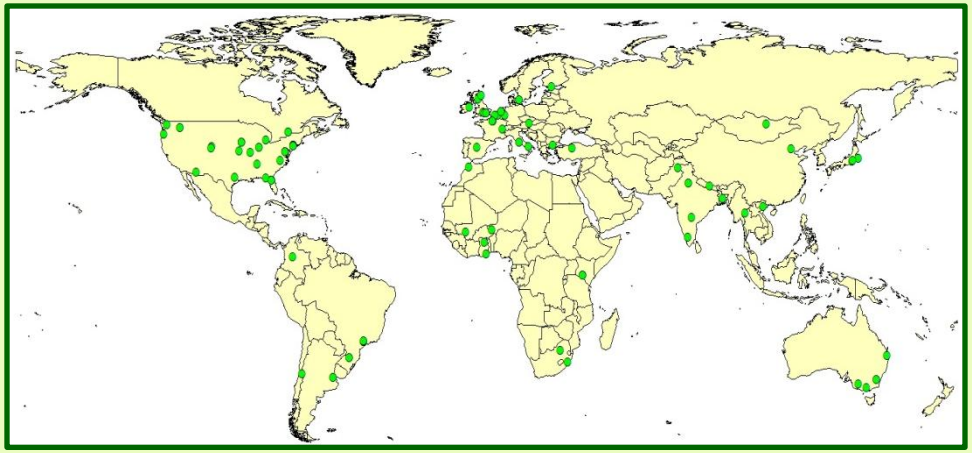
- Research tool for crop production analyses
- Incorporates:
  - Crop-Soil-Weather-Management models
    - CERES for cereal crops
    - CROPGRO for legume crops
    - SUBSTOR for potato
    - … etc
  - CENTURY for SOM dynamics
  - Software package
    - Data (weather, soil, experiments)
    - Analysis tools (Evaluation, Uncertainty, Economics)
    - Support software (Graphics, Weather generator, Genetic coefficient estimator)
    - GIS linkage
- Its core is the Crop Systems Model (CSM)



The Agricultural Model Intercomparison and Improvement Project (AgMIP)

Cynthia Rosenzweig, *NASA Goddard Institute for Space Studies*
Jim Jones, *University of Florida*
Jerry Hatfield, *USDA Agricultural Research Service, Ames, IA*
and the AgMIP Leadership Team

AgMIP Kick-off Workshop
October 28-30, 2010



Website, forum, and list-serve at
http://www.agmip.org

AgMIP The Agricultural Model Intercomparison and Improvement Project

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Final Comments