



Climate Change Impacts on the future of agriculture and natural resources

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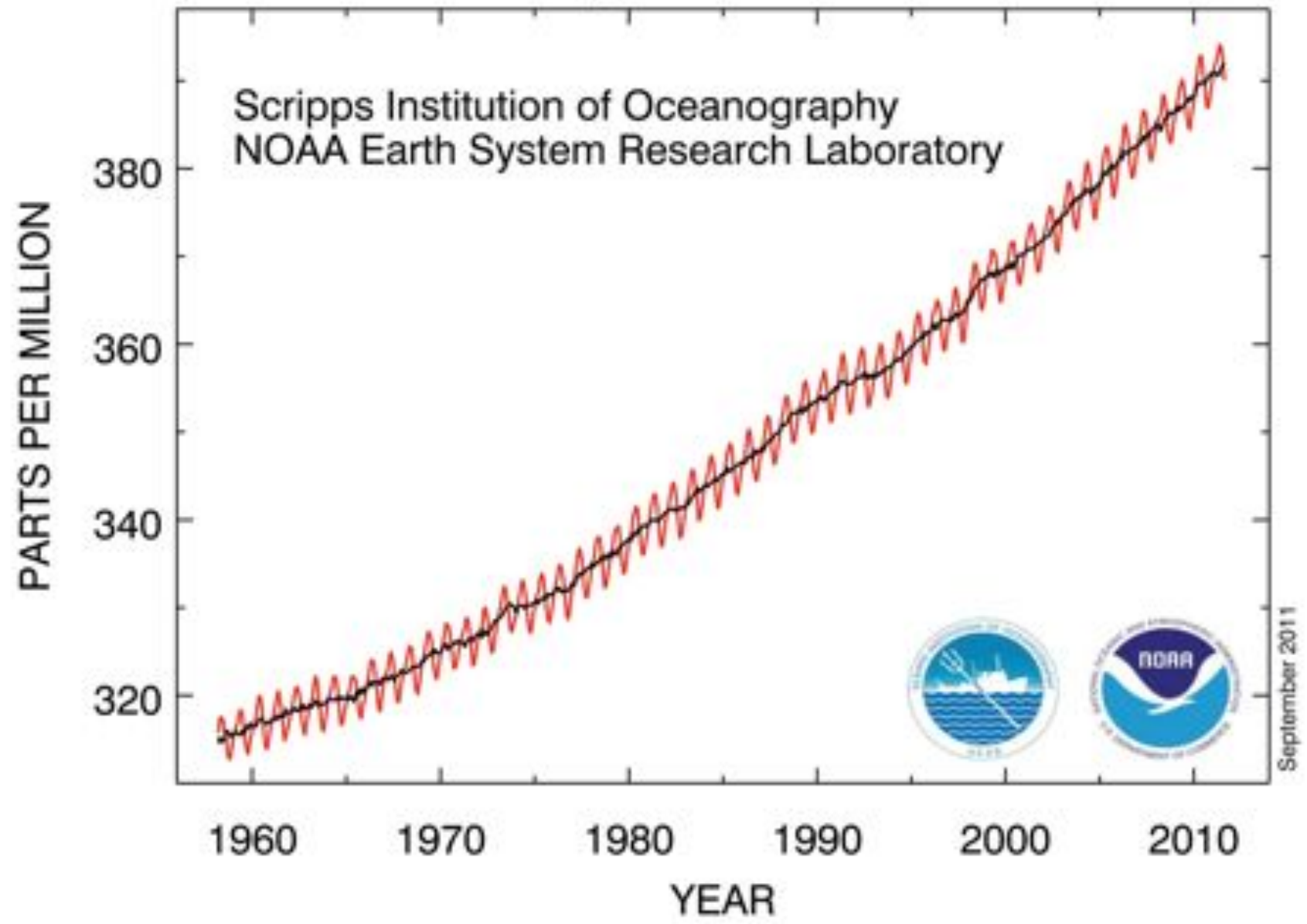
Cornell University, Ithaca

ESS/SAES/ARD Workshop 2011, Estes Park, CO

The basics:

- Climate vs. weather
- Greenhouse gases absorb infrared radiation (Tyndall 1863)
 - Sun emits mainly short wave radiation: most of sun's energy gets through the atmosphere, but earth's surface emits infrared radiation (heat). Hence greenhouse gases keep the heat in.
 - Without CO₂ - Earth would be very cold, with too much, very hot
- Fossil fuel signature
 - 3 isotopes of carbon: ¹⁴C, ¹³C and ¹²C (preferred by plants)
 - Burning of fossil fuels (ancient plants) releases ¹²C into the atmosphere
 - ¹²C now highest in past 10,000 years, with biggest increase since 1850's
 - Evidence from ice cores, tree rings
 - Direct link to human activity

Atmospheric CO₂ at Mauna Loa Observatory



Carbon Dioxide

1800 - 270 PPM

2010 - 390 PPM

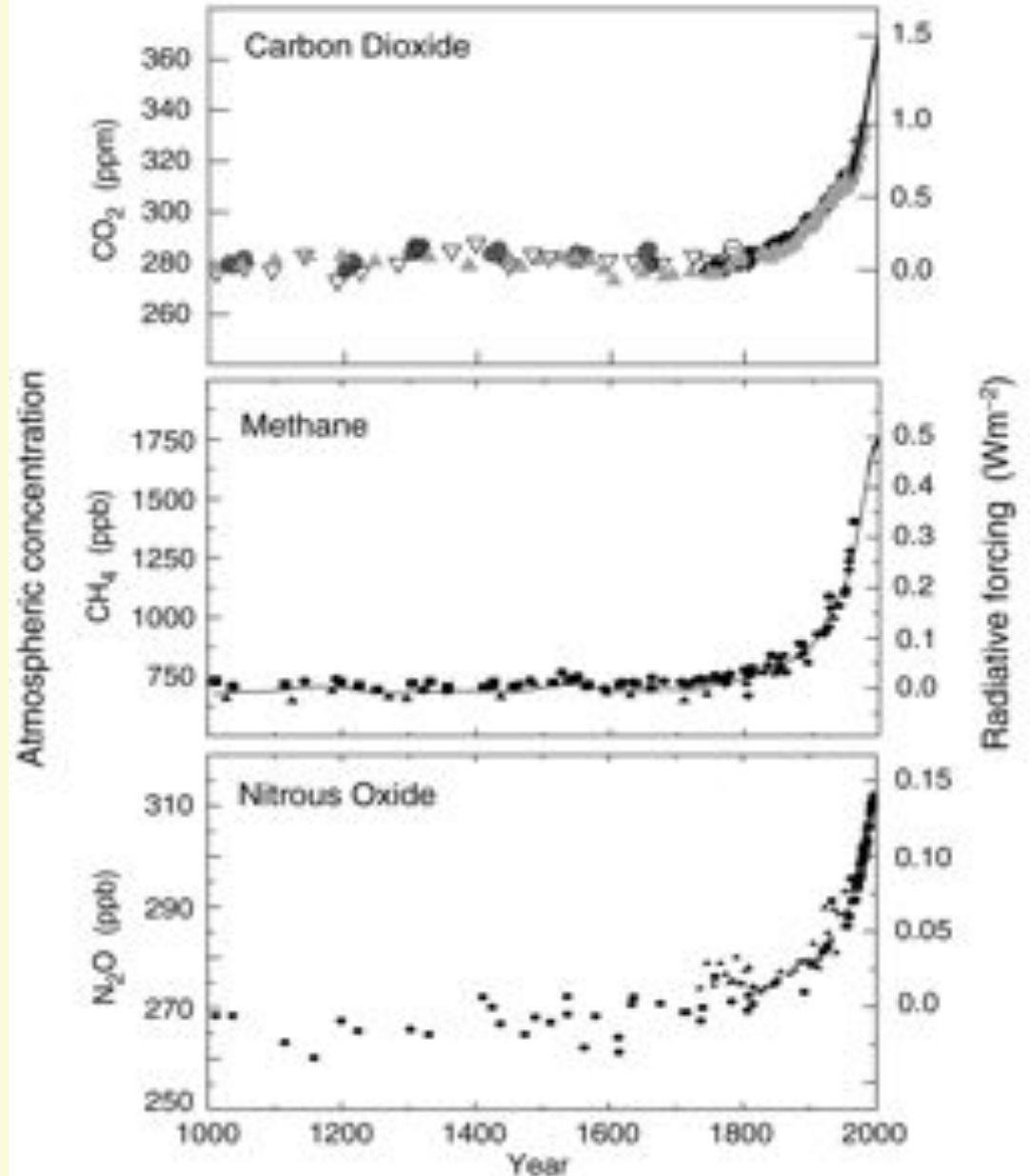
2020 - 410 PPM

2030 - 430 PPM

2050 - 450 PPM

- 350 is important!
- Inertia
 - 100's-1,000's yrs

(a) Global atmospheric concentrations of three well mixed greenhouse gases





Thermometers work!

- 1.5⁰F increase globally (warmer at poles)
 - Alaska, Antarctica
- Hottest decade ever: 2000-2009
- Longer summers, warmer winters
- Warming very fast (100X)
- 8-10⁰F by 2100 (usual business)
 - 5,000 land based stations,
1000 buoys, ships
- Data from satellites



Evidence: It's Not Just Increasing Average Temperature

- Sea level rise
- Acidification of oceans
- Extreme weather events
- Glaciers melting
- Greenland
- Arctic sea ice retreating
- Plant hardiness zones moving north
- Pines in Rocky's

And then there are those tipping points ...

- Methane
- Ocean acidification
- Droughts in the Amazon



Climate Change and Food Security

- Challenges and Opportunities -



ESCOP Science Roadmap

- **Grand Challenge: We must adapt to and mitigate the impacts of climate change on food, feed, fiber, and fuel systems in the United States**
- A grand challenge, a different challenge
 - Global in scope
 - Decision making under uncertainty
 - Timescale issues in ag decisions and policy
 - Complexity and interconnectedness of supply chains
 - Nonclimate factors – population growth, energy costs...
 - Need to mitigate AND adapt
- Local, regional, global – challenges and opportunities

Eastern Canada and Northeastern US

- Regional Collaboration -

- Public and private sector “think tank” – climate change and agriculture – challenges, opportunities
 - Universities, government, private sector - leaders
 - To catalyze and facilitate multi-disciplinary and multi-institutional collaborations
 - Leverage our collective capacity to address the needs of the region
 - Between now and 2025
 - Set the stage for beyond 2025





Agriculture in the Region

- US: 374,000 farms, 64 million acres
- Canada: 100,000 farms, 25 million acres
- \$58 billion total farm gate value
 - Dairy, vegetables, field crops, fruit, ornamentals...
- Employing 100,000's of people
- Add retail, wholesale... big business

The Region and Climate Change

- The Challenges

- Extreme weather: floods, droughts, storms
- New pests, high temp stress



- The Opportunities

- Adequate precipitation
- Warmer conditions (longer growing seasons, warmer winters)
- Shifts in productivity elsewhere
 - Reduced glacial melt – Alberta
 - Changes in precip. patterns in Sierras
 - Ag-urban competition for water
 - High temps and grapes/wine - CA



The Opportunities

- Potential to increase intensity and diversification of agriculture in region
 - New crops, new varieties - winter canola, wine grapes...
 - Double cropping
 - Longer seasons - higher yields
- Markets
 - 116 million people (75% of Canadian, 30% of US population) – great cities to feed
 - Local grown, lower carbon footprint food supply
 - Job creation, economic development



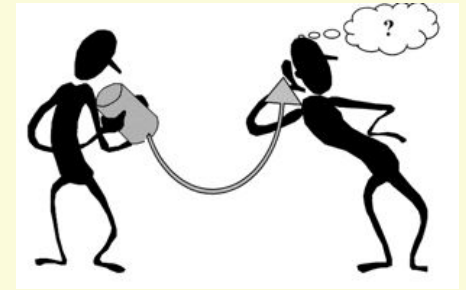
Recommendations

- To Succeed – Partnerships critical
 - A model
- Farm level impact needed
 - Identify trends, research needs, priorities
 - What happened in 2011?
- Improved water management
 - Too much (drainage) or too little (irrigation)
- New crops and cropping systems – adapted to region
- Recoupling of plant and animal systems



Recommendations

- New and better decision tools based on economics
 - Cooling for dairies, new crops
- Communication strategies
 - To farmers, policy makers
- An increase in public sector investment in climate change research and education is imperative



Contributing Institutions/Organizations

- ACA Associates, Inc.
- Agriculture and Agri-Food
- Agriculture et Agroalimentaire Canada
- Canadian Agri Food Policy Institute
- Cornell University
- Croplife Canada
- Dow AgroSciences Canada, Inc.
- Lilly and Company
- Maple Leaf Bio-Concepts
- McGill University
- Michigan State University
- National Center for Food and Agricultural Policy
- New Brunswick Dept. of Agriculture
- North Central Regional Assoc. of State Agric. Experiment Station Directors (NCRA)
- Northeastern Regional Assoc. of State Agric. Experiment Directors (NERA)
- Nova Scotia Agricultural College
- NYS Dept. of Ag. and Markets
- Ohio State University
- PEI BioAlliance
- Penn State University
- Purdue University
- Queen's University
- Smithsonian Environmental Research Center
- South Dakota State University
- Twin River Technologies - Entreprise de Transformation de Graines Oleagineuses (TRT ETGO)
- Université Laval
- University of Connecticut
- University of Guelph
- University of Illinois at Urbana-Champaign
- University of Maine
- University of Maryland
- University of Nevada
- University of New Hampshire
- University of Rhode Island
- University of Vermont
- West Virginia University

Hoffmann and Smith. 2011. *Feeding our great cities: Climate change and opportunities for agriculture in Eastern Canada and the Northeastern US*

Conclusions

- Climate Change -

- One of the greatest challenges ever
- Global, affecting all people and their life support systems
- Agriculture has the opportunity to mitigate and must adapt
- Partnerships are critical
- A grand challenge for the Agricultural Experiment Stations, for the Land Grant System



In 2050, what will my daughters say about their dad?

Did he try?

We are on trial!