Global and Local Climate and our Future

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BREE High School Teams

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BREE
Basin Resilience to Extreme Events
in the Lake Champlain Basin

Vermont EPSCoR
CWDD
Center for Workforce Development & Diversity

Outline

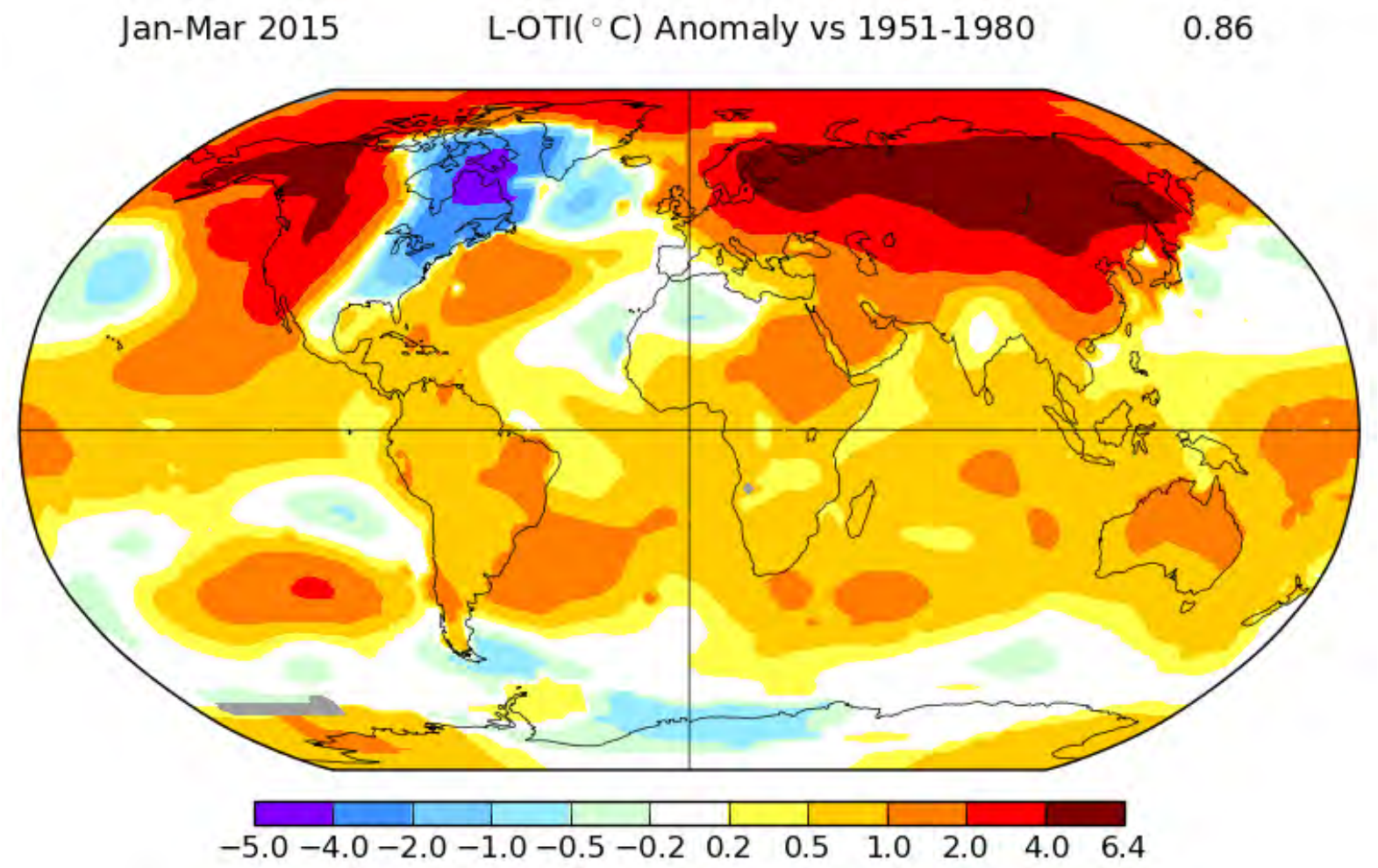
- **Science of climate change**
  - **Global and local**
  - **What is happening to Vermont?**
- **The transition we face**
  - **How can we stabilize the climate?**
  - ***Given opposition to change?***

Discussion

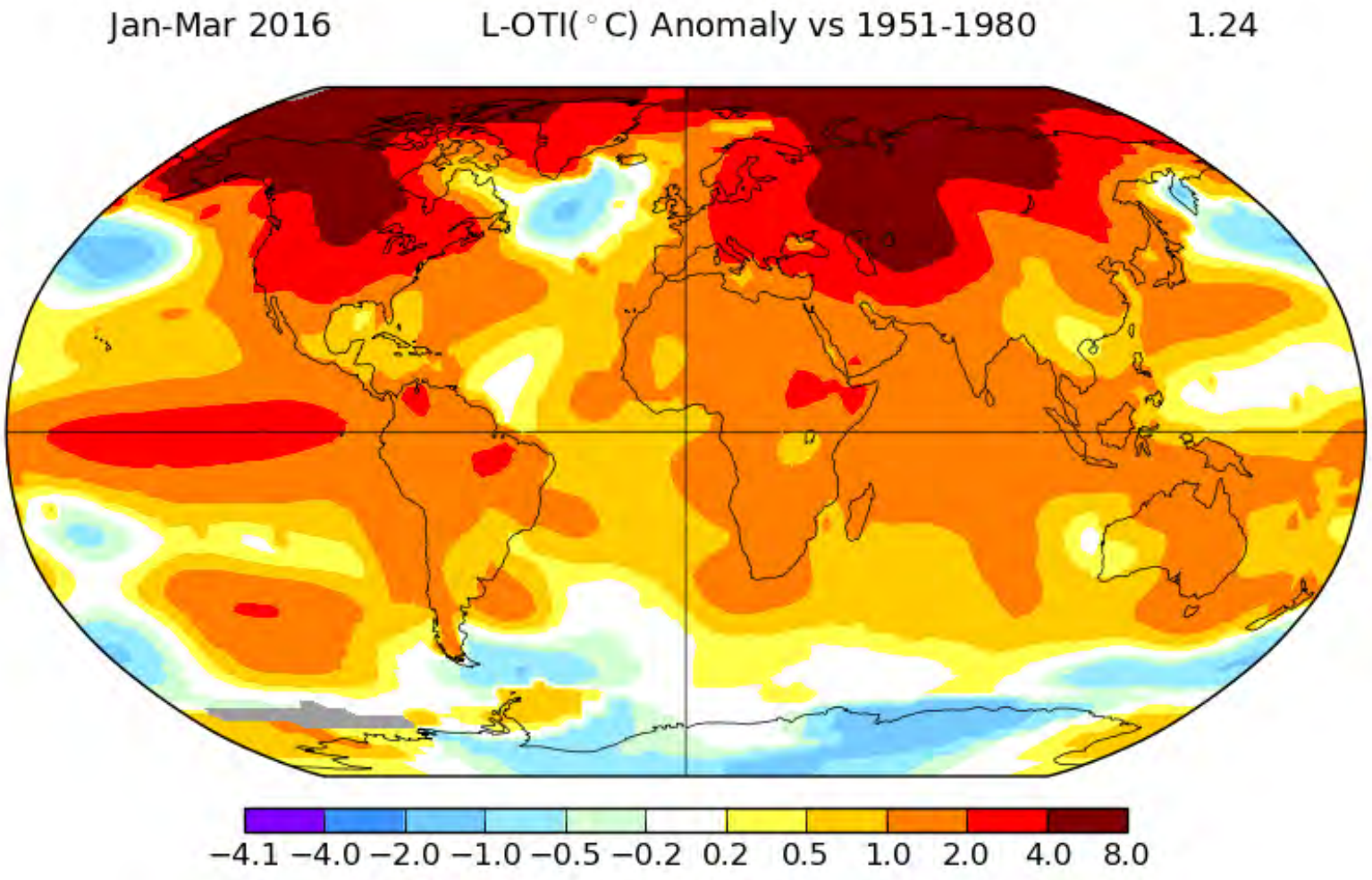
Earth's climate sustains life

- Burning fossil fuels is increasing greenhouse gases
- Climate is warming: ice is melting, extreme weather is increasing
- Water plays crucial amplifying role
- Planetary modes crucial

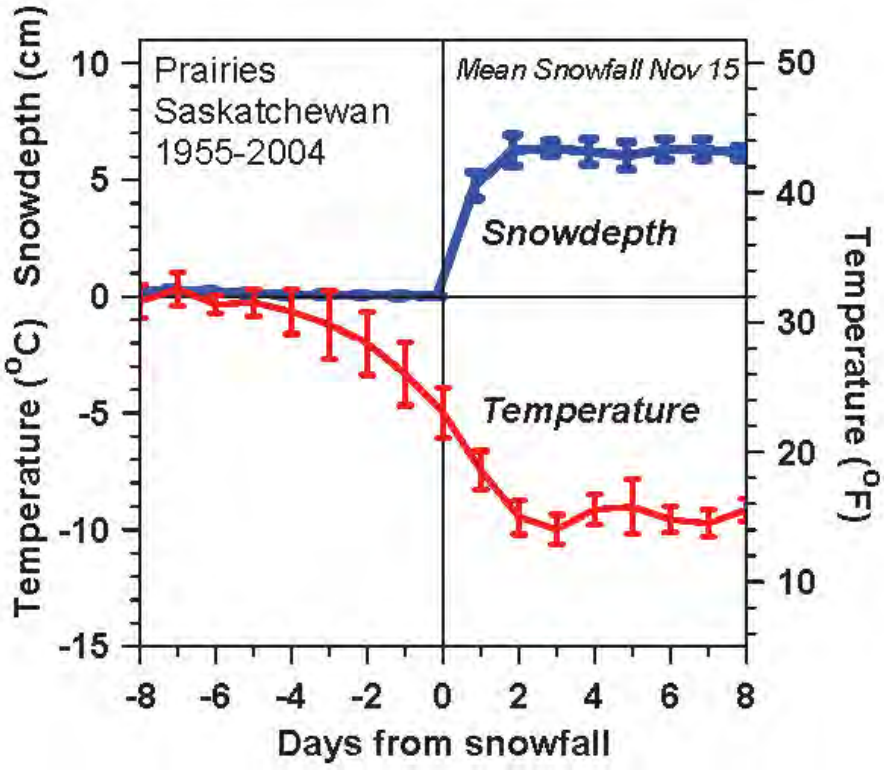
Jan-Feb-Mar 2015

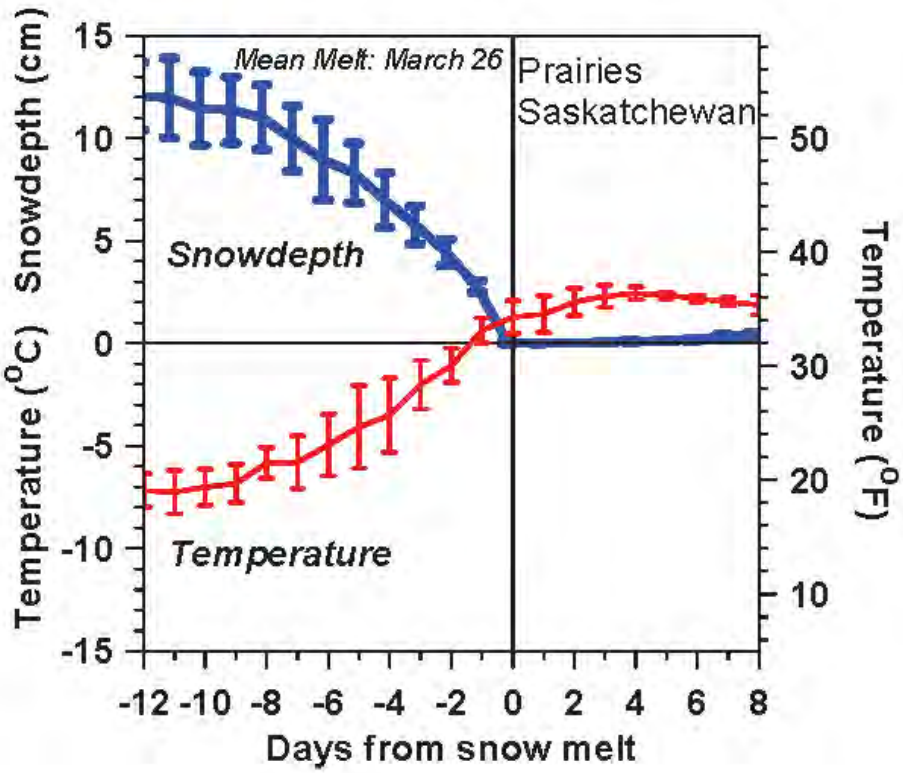


Jan-Feb-Mar 2016



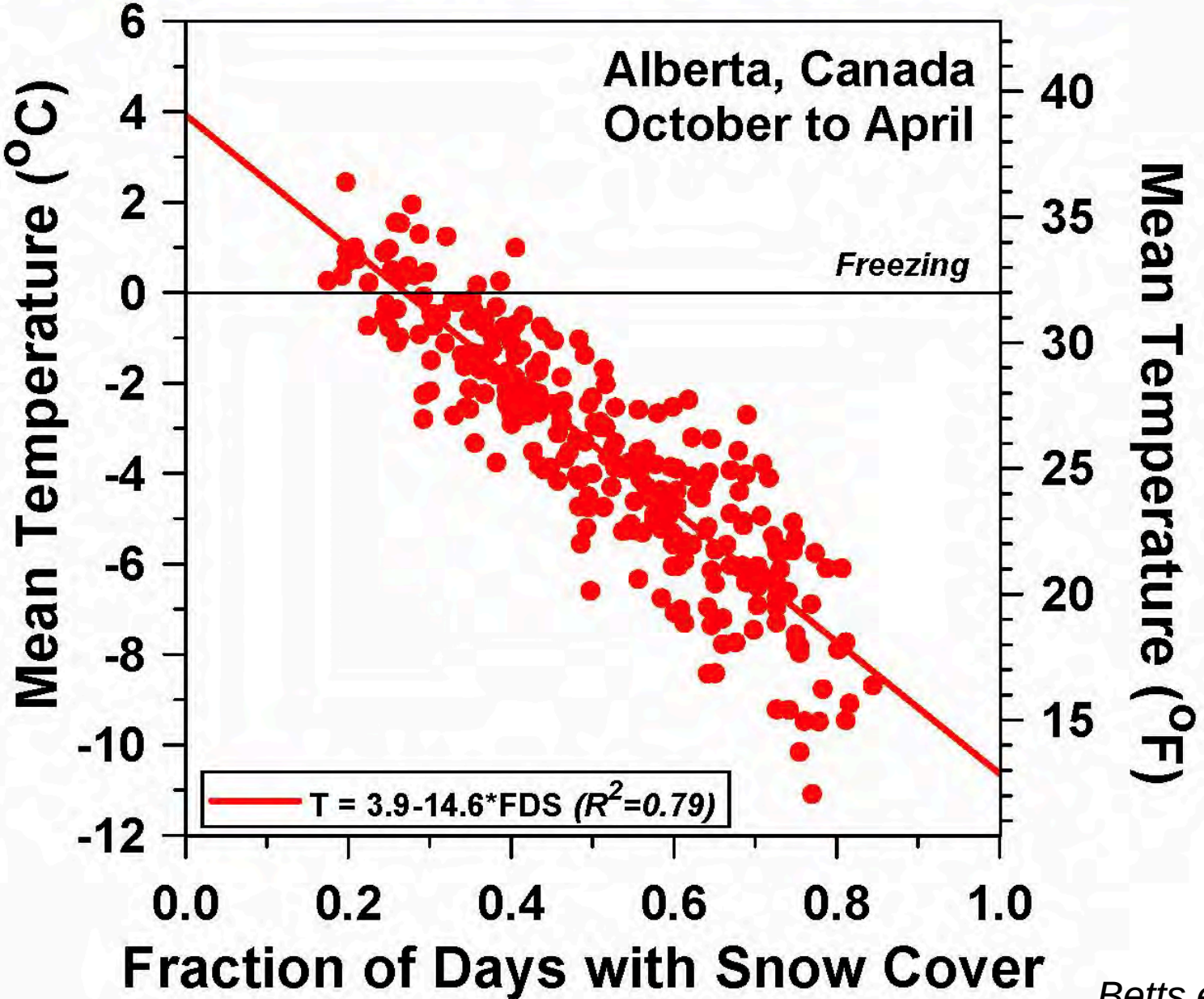
Snowfall and Snowmelt





- **Temperature changes 10°C with snow cover**
- **Snow cover is a ‘climate switch’**
- ***Fast transitions in ‘local climate’***
  - ***Snow reflects sunlight***
  - ***Reduces evaporation and water vapor greenhouse***

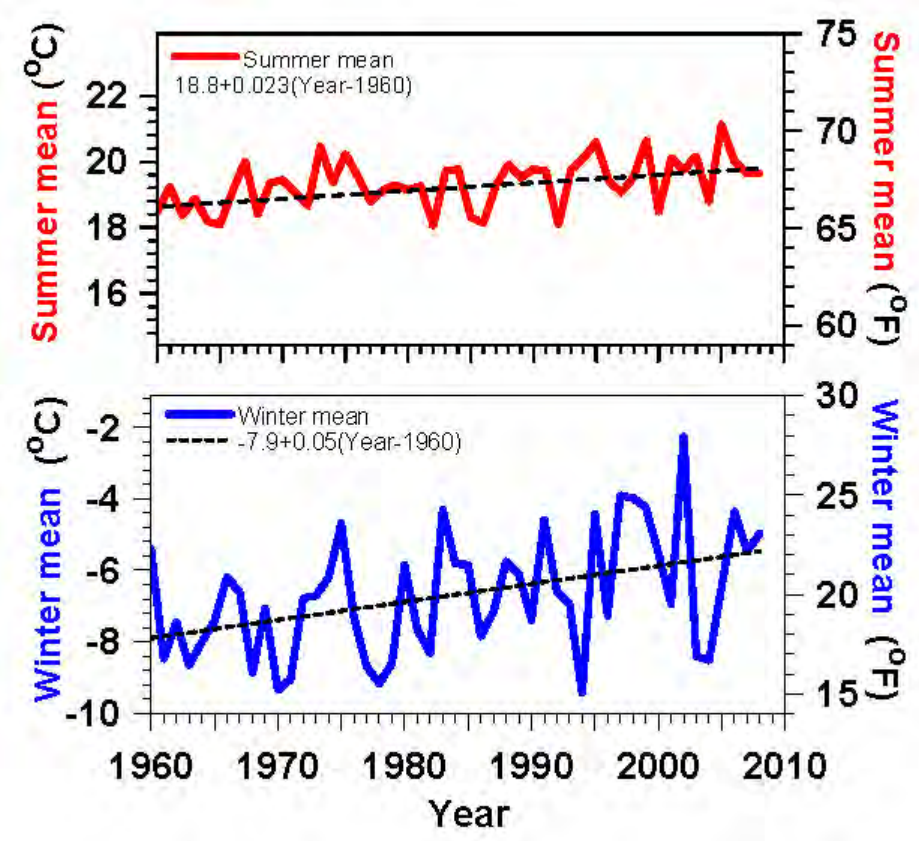
More snow cover - Colder temperatures



Betts et al. 2014

Vermont Temperature Trends 1961-2008

- **Summer +0.4°F / decade**
- **Winter +0.9°F / decade**
- **Larger variability, larger trend**
- ***Less snow (and increased water vapor) drive larger winter warming***

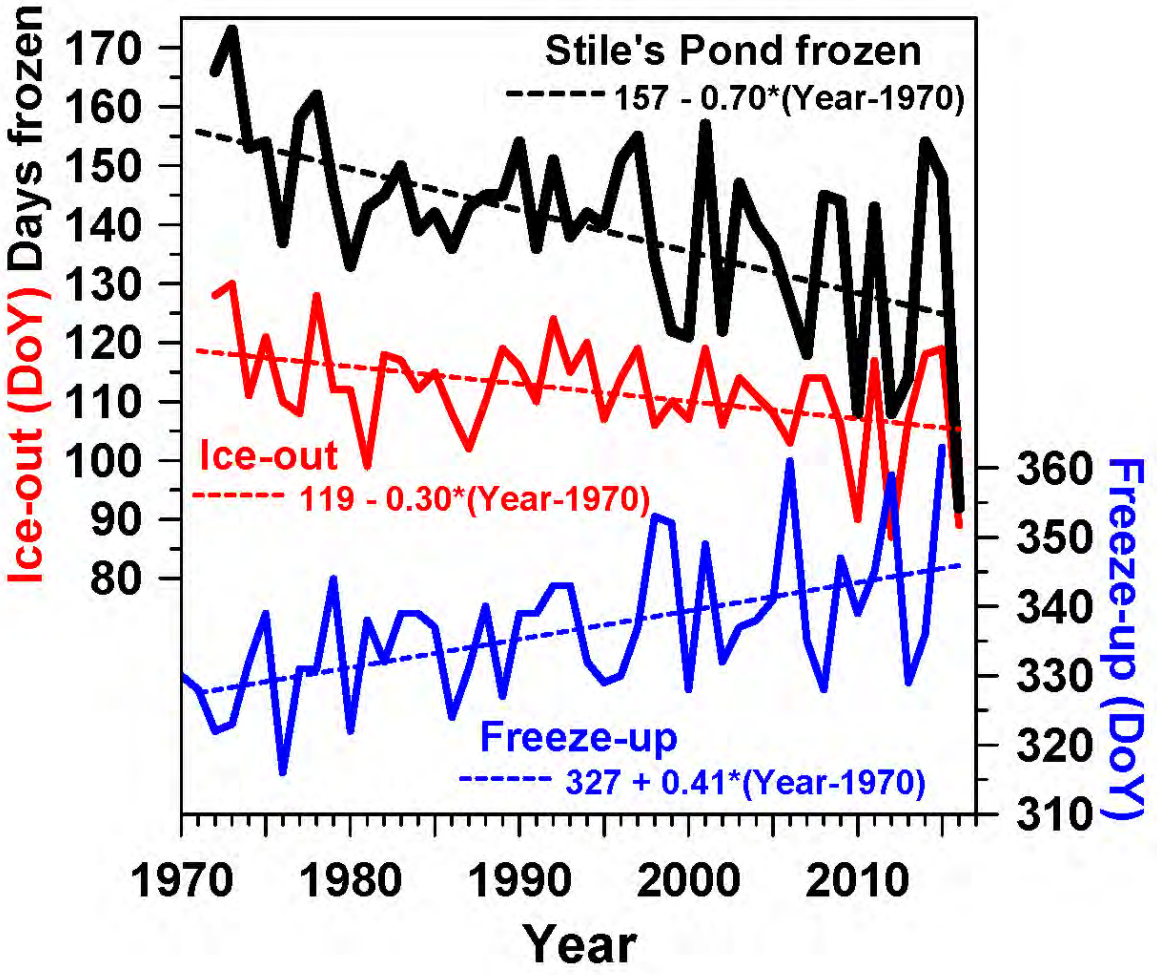


Lake Freeze-up & Ice-out Changing

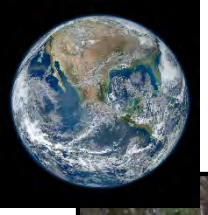
Frozen Period Shrinking: variability huge

STILES POND

- **Ice-out earlier**
  - **by -3 days / decade**
- **Freeze-up later**
  - **by +4 days / decade**
- **Lake frozen trend**
  - **- 7 days/decade**



Steve Maleski: "Eye on the Sky"



January 2, 2012

March 11, 2012

October 2011– March 2012

- **Warmest 6 months on record**
- **My garden frozen only 67 days**

- **January 15, 2013**

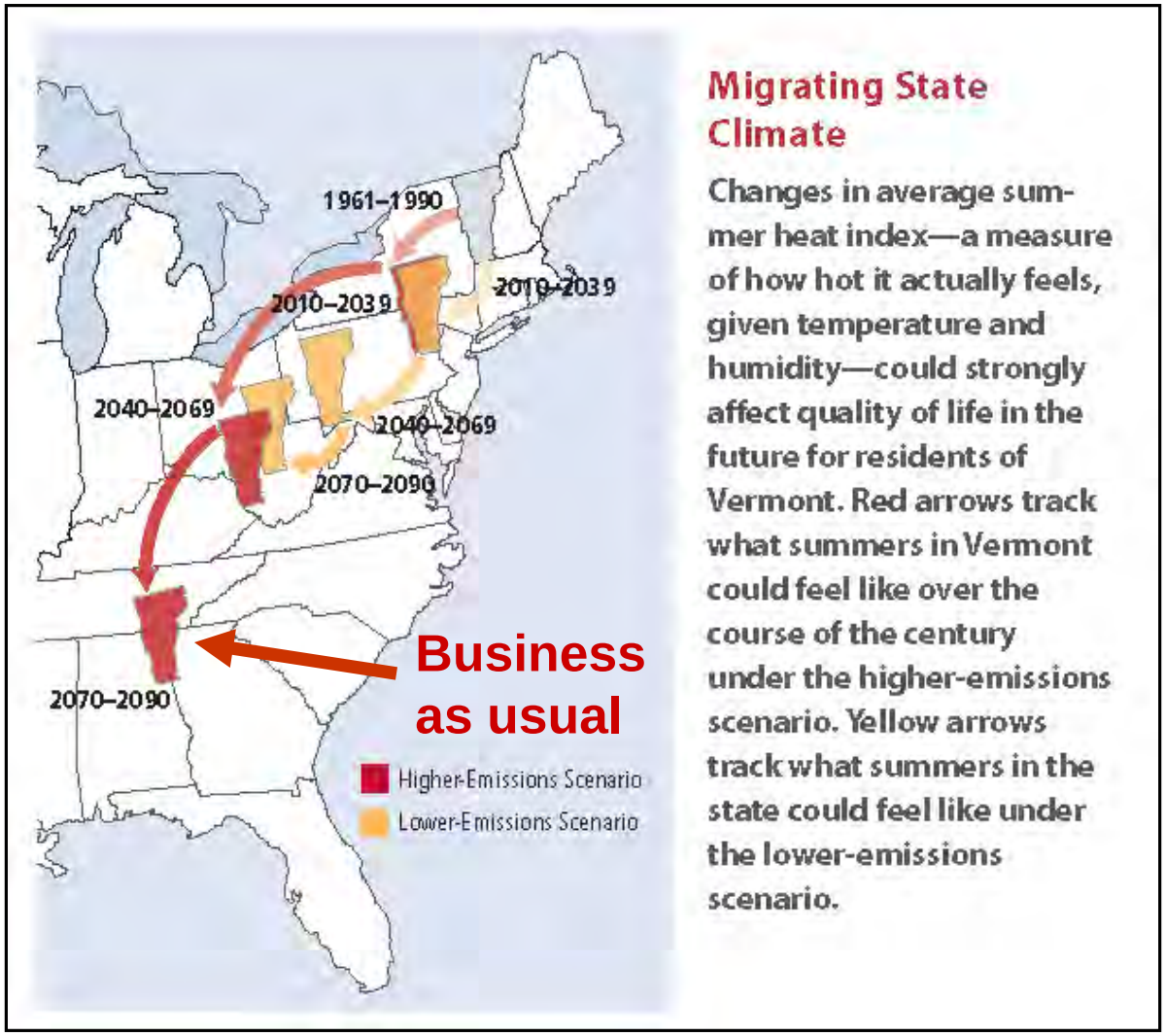
February 5, 2016
(Digging in Feb. first time ever)

March 3, 2017

Vermont's Future with High and Low GHG Emissions

What about VT forests?

Sub-tropical drought areas moving into southern US

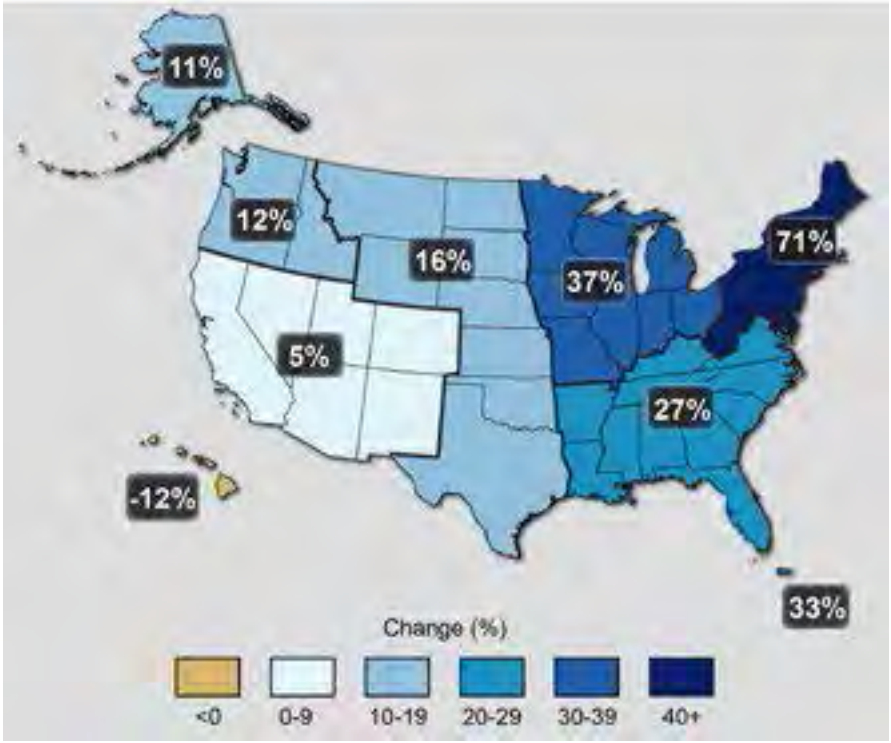


NECIA, 2007

Very Heavy Precipitation Is Increasing

- **Precipitation Extremes**

- **Most of the observed precipitation increase during the last 50 years has come from the increasing frequency & intensity of heavy downpours.**

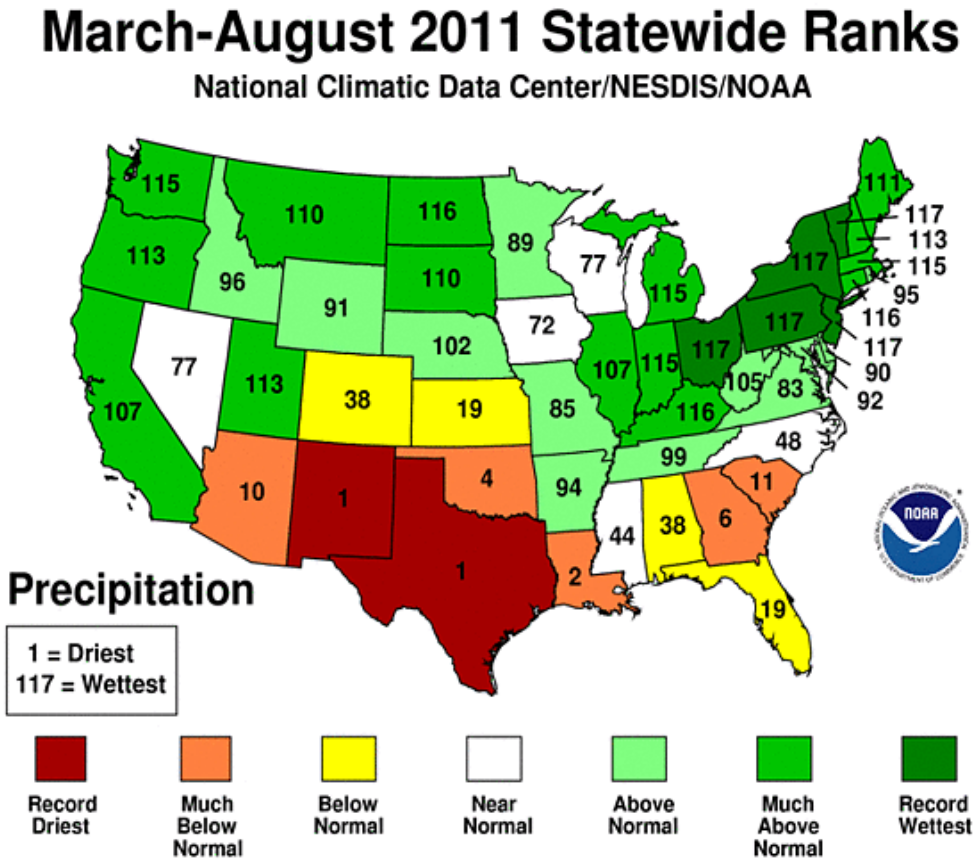


(Walsh et al., 2014)

- **71% increase in Northeast**
- ***Recent study: abrupt shift in 1996***

2011 Floods: VT and NY

- **Record spring flood: Lake Champlain**
- **Record flood with tropical storm Irene**



March-August, 2011

- **Record wet : OH to VT**
- **Record drought: TX & NM**
- **'Quasi-stationary' pattern**

TS Irene

Roads in valleys

Massive damage

Some roads took months to repair

Rte 131, Cavendish

Sept, 2011

Lake Champlain, Spring 2011, Courtesy LCBP

Mouth of Connecticut River from Irene 2011

Value of Flood Plains

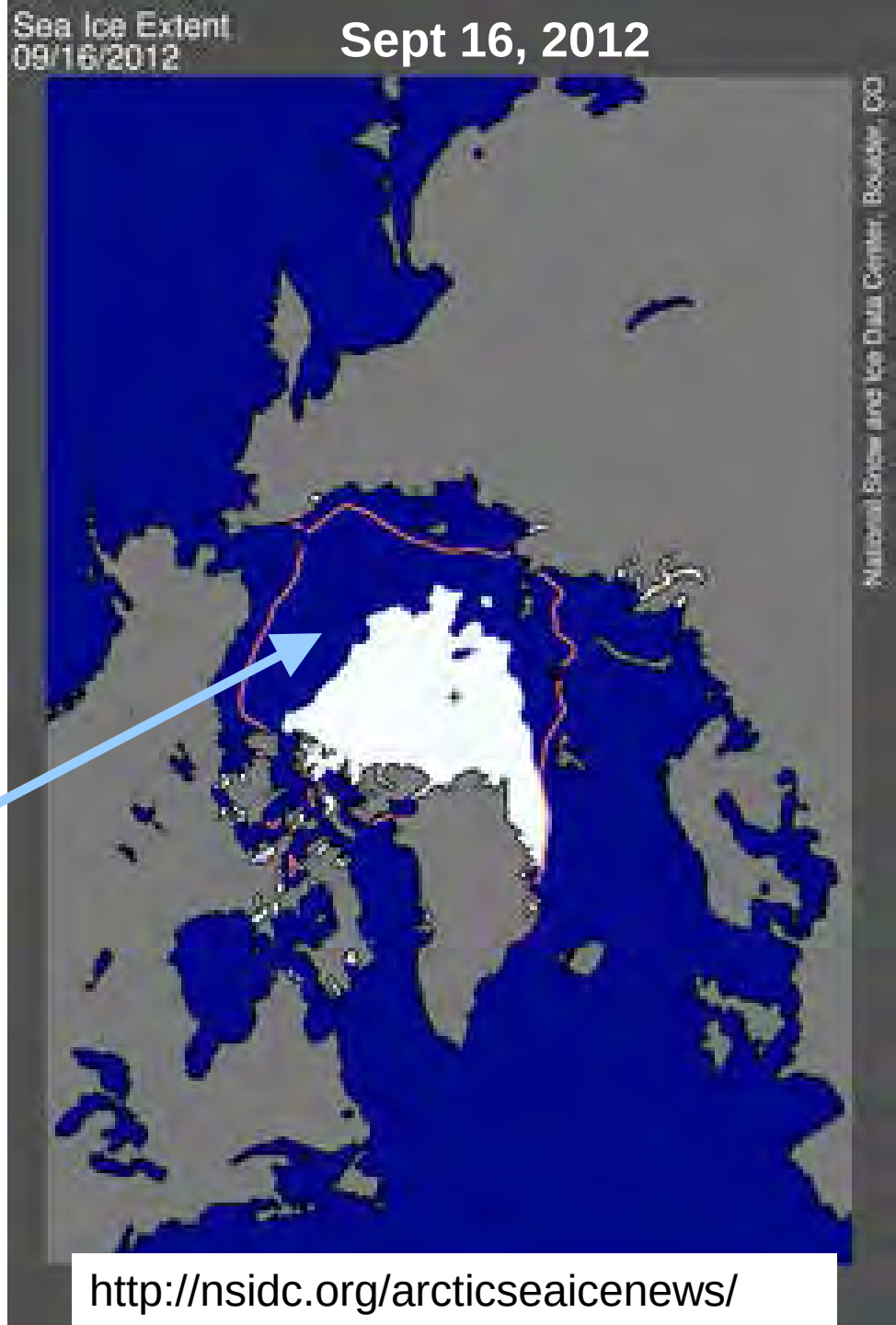
- **Otter Creek after Irene on August 30, 2011**
  - **River rose ten feet: flood plain saved Middlebury**

Flooding Issues

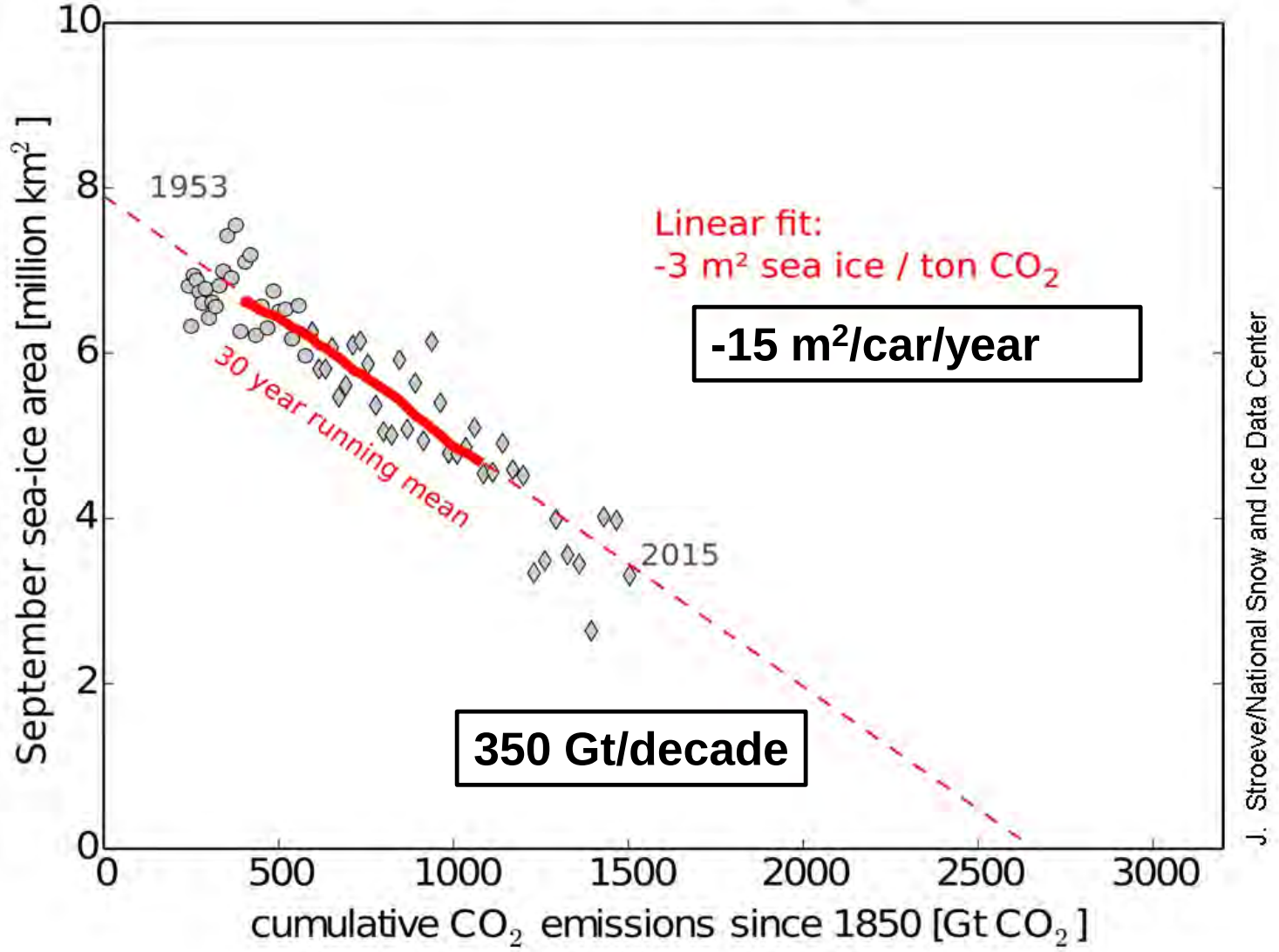
- **Maintain mountain forest cover**
  - **Devastating floods in 1920's, 30's with reduced forest cover**
- **Manage water/pollutants on landscape**
  - **Maximize infiltration: urban and on farms**
  - **Don't wall-in rivers**
- **Preserve flood plains**
  - **Saves downstream towns (Middlebury)**
  - **Stop building houses and trailer parks in flood plains**

- **Half the Arctic Sea Ice Melted in 2012**
- **Open water in Oct. Nov. gives warmer Fall in Northeast**

- ***Positive feedbacks:***
- ***Less ice, less reflection of sunlight***
- ***More evaporation, larger vapor greenhouse effect***
- ***Same feedbacks as in our winters***



September Arctic Sea Ice Loss



Water, Snow & Ice Give Positive Radiative Feedbacks

- As Earth warms, evaporation and water vapor increase and this is 3X amplifier on CO_2 rise
- As Earth warms, snow & ice decrease and reduced SW reflection amplifies warming in Arctic in summer and mid-latitudes in winter
- Doubling CO_2 will warm globe about 5°F (3°C)
  - Much more in the cold regions and over land, which responds faster than oceans
  - Change the global circulation

Can We Stop "Dangerous Climate Change"?

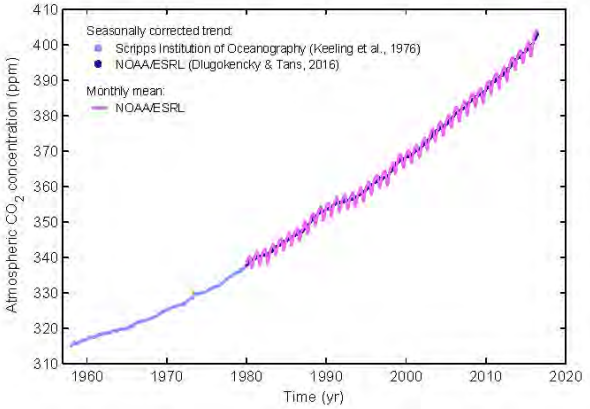
(UNFCCC 1992)

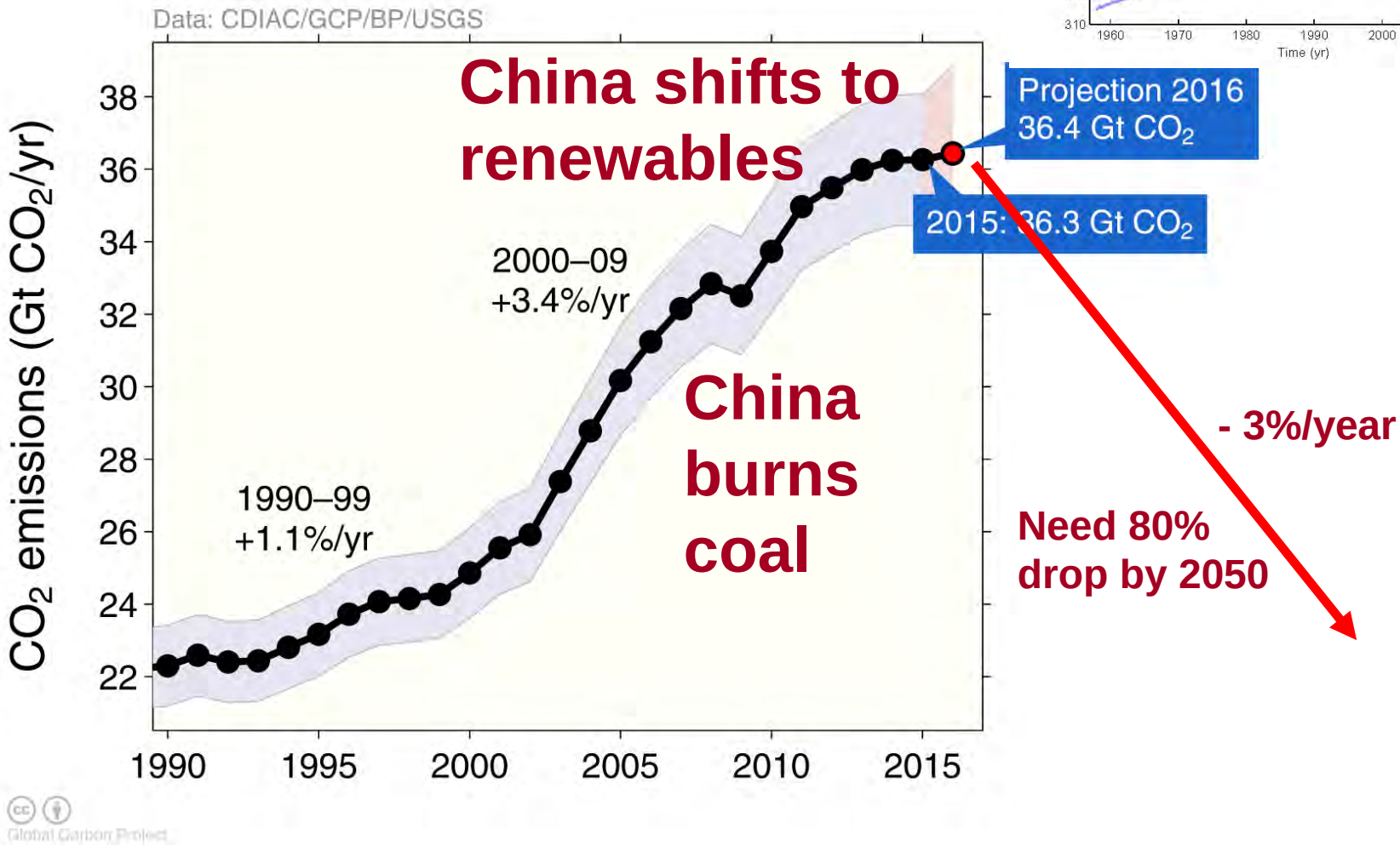
- **Yes: Quickly stabilize atmospheric CO_2**
- **This means an 80% drop in CO_2 emissions!**
- **This is possible but very difficult**
  - **Fossil fuels have driven our industrial growth and population growth for 200 years**
  - **"Lifestyle" has become dependent on fossil fuels**
  - **Powerful vested interests: trillions $ at stake**

2015 was Transition Year

- **Climate meeting in Paris in December**
  - **188 Nations made ‘national commitments’**
- **Pope Francis encyclical on the environment, climate change and our responsibilities to the Earth**
  - **Exploitation of the Earth and the poor are inseparable**
  - **Short-term profit as primary motive is immoral**
- ***2017: US wants to avoid the commitments it made; China and Europe are taking lead***

Growth of CO_2 Emissions Flat for 3 years





What can we “safely” burn?

- **Only 750 Gt more for an even chance of keeping warming below 2°C**
  Requires leaving 2/3 of remaining fossil fuels in ground
- **Only 21 years left at 36 Gt/year**
- ***Rapid phase-down extends period***

System Issues

- **Human waste streams are transforming the Earth's climate, and human and natural ecosystems**
- **How will this affect landscape, water supplies, food system and human health?**
- **What strategies and mindset are needed to mitigate, adapt and build resilience**
  - **Can we better manage our relation to the Earth?**
  - **Is this an efficient way of doing this?**
  - **Can we manage our waste streams better?**
  - **How can we adapt?**

Efficiency Comes First

- **We need to double or triple our energy efficiency because…**
  - **We cannot replace current fossil fuel use with biofuels & renewable energy**
  - **Fossil fuel reserves are enough to push CO_2 to 1,000 ppm**
    - ***Radically change climate/wipe out many species***
    - ***In time melt icecaps, raise sea-level >100ft***

Why Is It Difficult for Us?

- **The "American dream" is crumbling**
  - **"Economic growth" based on fossil fuels, debt, and consumerism is unsustainable — and a disaster for the planet!**
- ***Individual "rights" and the needs of humanity must be balanced against the needs of the earth's ecosystem***
- **We don't know how to guide and manage technology — so the result is tremendous successes and catastrophic failures**

Powerful interests are threatened

- **Fossil fuels reserves are worth $20-30T**
  - **Big money: ‘of course we will burn them’**
  - **Regulating or taxing emissions of CO_2 is an ‘unfair cost to the free market’**
  - **(Too bad if the Earth’s ecosystems are destroyed: ‘others’ can pay the price)**
- ***Our politics are facing collapse:***

  fantasy disconnected from real world
  - ***We are all deeply embedded in system!***

Step back from dark side

- **Cannot be solved with mindset that created it**
  - **Oppose new fossil fuel ‘solutions’**
  - ***But stand for the Earth and ‘reality’***
- **Push practical solutions**
  - **Efficiency and renewables**
  - **And a fossil-carbon tax**
- **Social, moral, spiritual shift needed**
  - **Your personal role**
  - **Role of community**

Discussion

(http://alanbetts.com)

Technical solutions

- **Electrical power**
  - **Renewable: solar, wind, hydro**
  - **Storage: lithium batteries down to $150/kWh**
  - **Electric car industry generating massive storage**
- **New technologies: electricity to liquid fuels**
- **Net-zero housing**
- **Rethink transport**

Efficient transport

- **Gasoline to hybrid: 50% gain to 50mpg**
- **Hybrid to plug-in hybrid: now 120mpg**
- **Electricity from community solar array**

>3000lbs and 120 mpg
Payload: 750 lbs at 60 mph

180lbs gets “1800 mpg”
Payload: 350lbs at 25mph

What is a pollutant?

- **First it was the obvious hazards to health**
  - **Smoke/smog from burning coal and exhausts**
  - **Toxic contaminants dumped in drinking water**
  - **These were regulated by the Clean Air and Clean Water legislation in 1980's & 1990's**
- **But many of our waste products that look harmless to humans are hazards to life on Earth!**
  - **CFCs that destroy the ozone layer that protects life**
  - **CO_2 from burning fossil fuels, driving climate change**
  - **Plastics dumped into the oceans**
- ***In our disconnected human world, these are harder for us to deal with***