

Climate Change and the Future of Vermont

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Pawlet Energy Fair

Earth Day

April 22, 2017



Climate Science is Critical

- **Climate change is accelerating**
 - *Shifting energy system away from fossil fuel is only way to slow down changes*
 - **Science and technology are critical**
 - Social issues go far beyond science
 - **Honesty is critical**
 - Remember Earth wins not us!



Fundamentals

- **Burning fossil fuels: transforming climate**
 - *Many water cycle amplifying feedbacks*
 - *Heading for high CO₂ “Carboniferous era climate”*
 - *Climate extremes increasing*
 - *Decadal to centennial - long timescales*
- **Avoidance of responsibility for decades**
 - Politicians, professionals, public
 - Climate change: Incompatible with business-as-usual
- **Linked to unmanaged technology**
 - Soluble by changing system guidelines
 - Create efficient society, based on renewable energy
- **Choices are value based**
 - Science and economics need guiding
 - Resilience incompatible with exploitative model

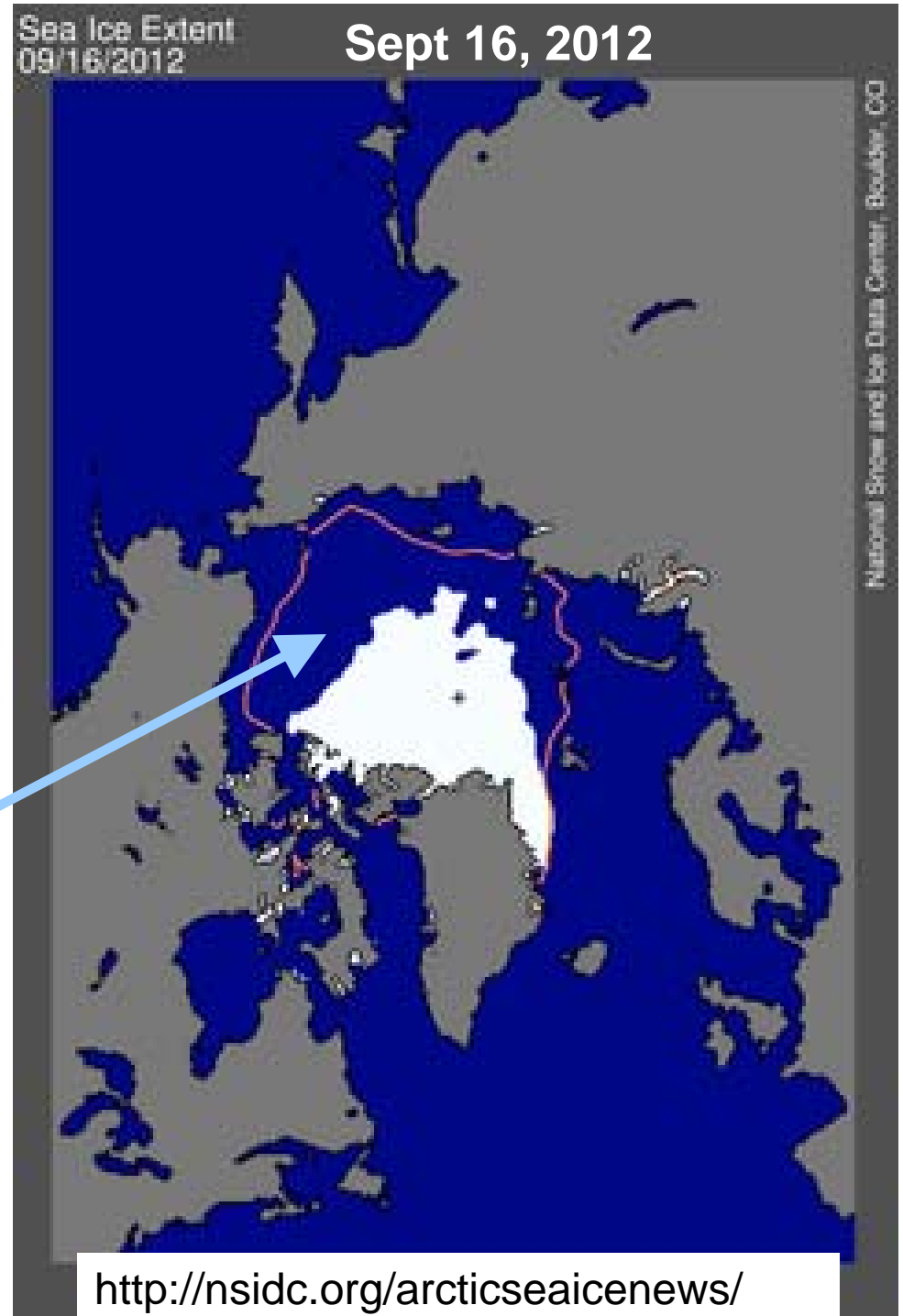
Our Present Challenge

- **How to reintegrate
all that we know and understand**
 - *given the deep interconnectedness
of life & climate on Earth*
 - *given immense opposition to change*

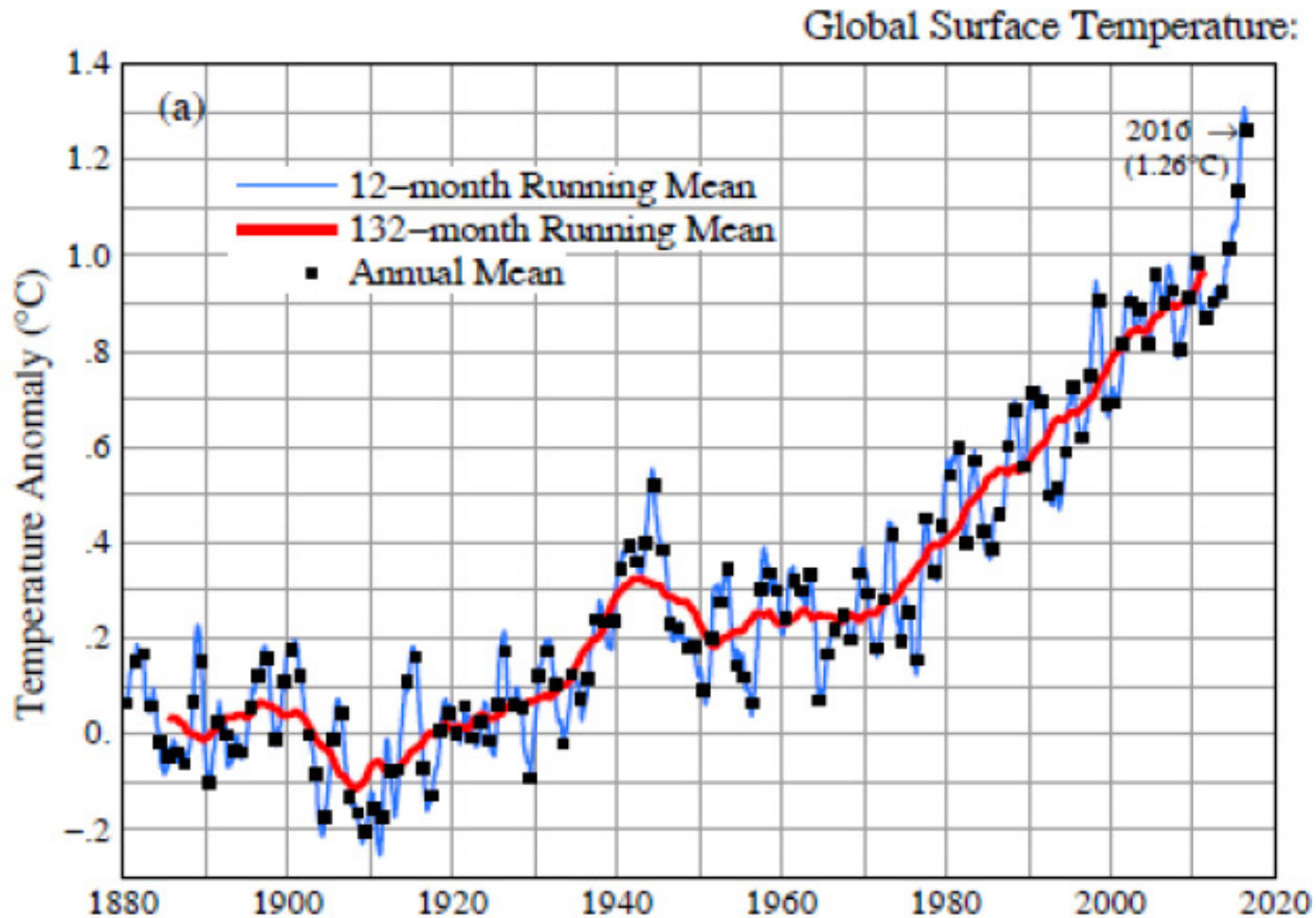
- **Half the Arctic Sea Ice Melted in 2012**
- **Open water in Oct. Nov. gives warmer Fall in Northeast**

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

(This past winter, Arctic sea-ice reached new record lows)



Long-term Global Mean Trend 1880-2016



Gardening in Pittsford, Vermont in January



January 7, 2007

December 2006:

- Warmest on record



January 10, 2008

Warm Fall:

- Record Arctic sea-ice melt
- Snow cover in December,
ground unfrozen



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)

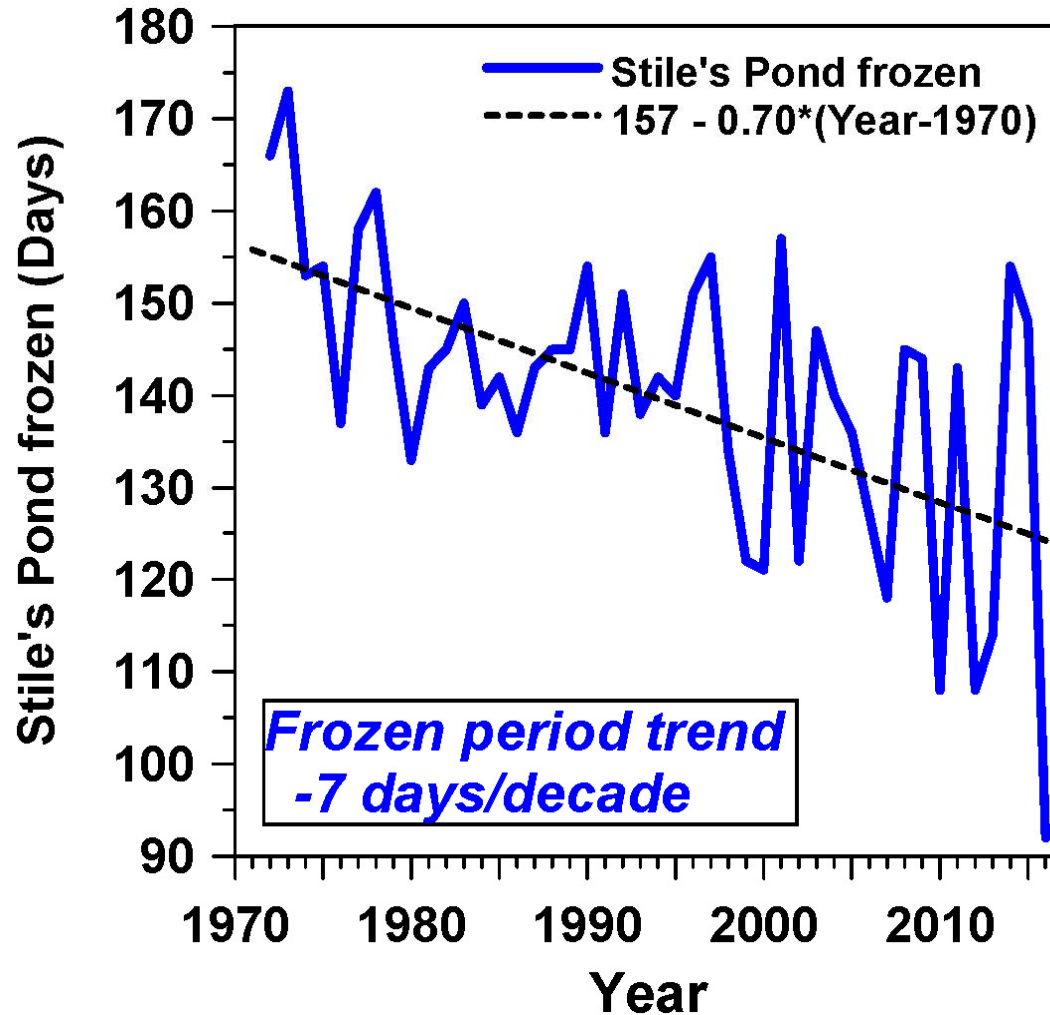


March 3, 2017



Vermont's Reference Lake

Frozen Period Shrinking: variability huge



Steve Maleski: "Eye on the Sky"

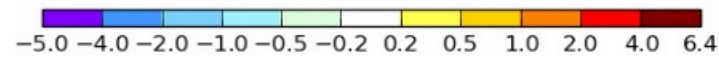
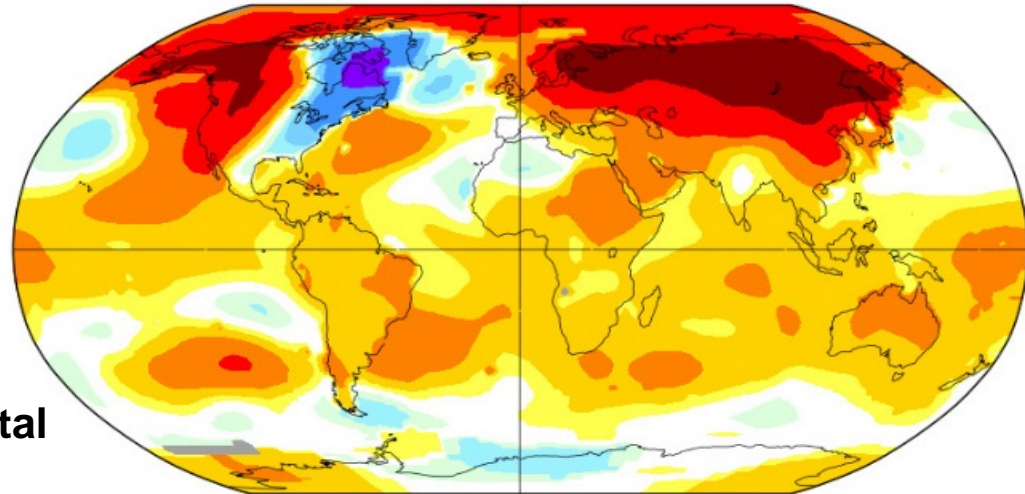
Jan-Feb-Mar 2015

Warm Atlantic, cold NE, strong coastal storms - Boston record snow

Jan-Mar 2015

L-OTI(°C) Anomaly vs 1951-1980

0.86



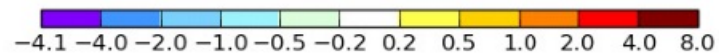
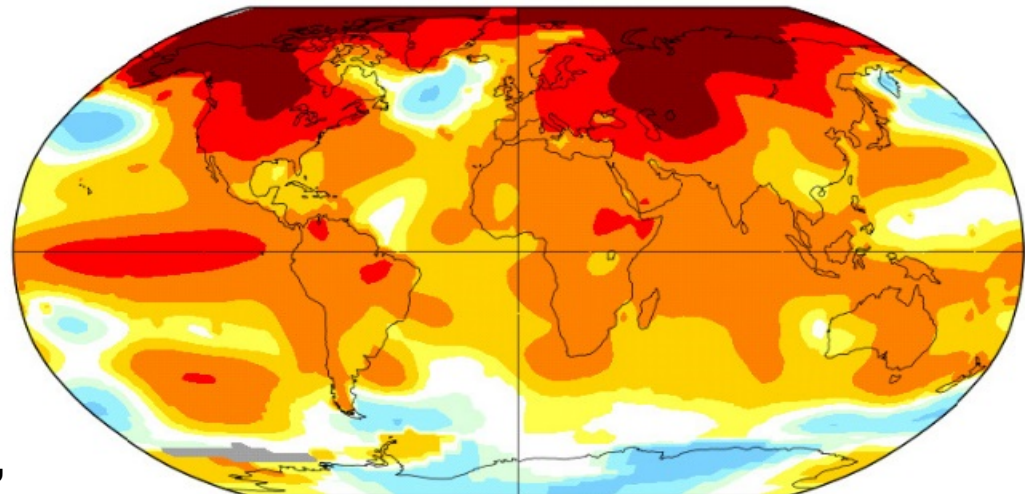
Jan-Feb-Mar 2016

Warm Atlantic, warm NE, little snow, warm Arctic

Jan-Mar 2016

L-OTI(°C) Anomaly vs 1951-1980

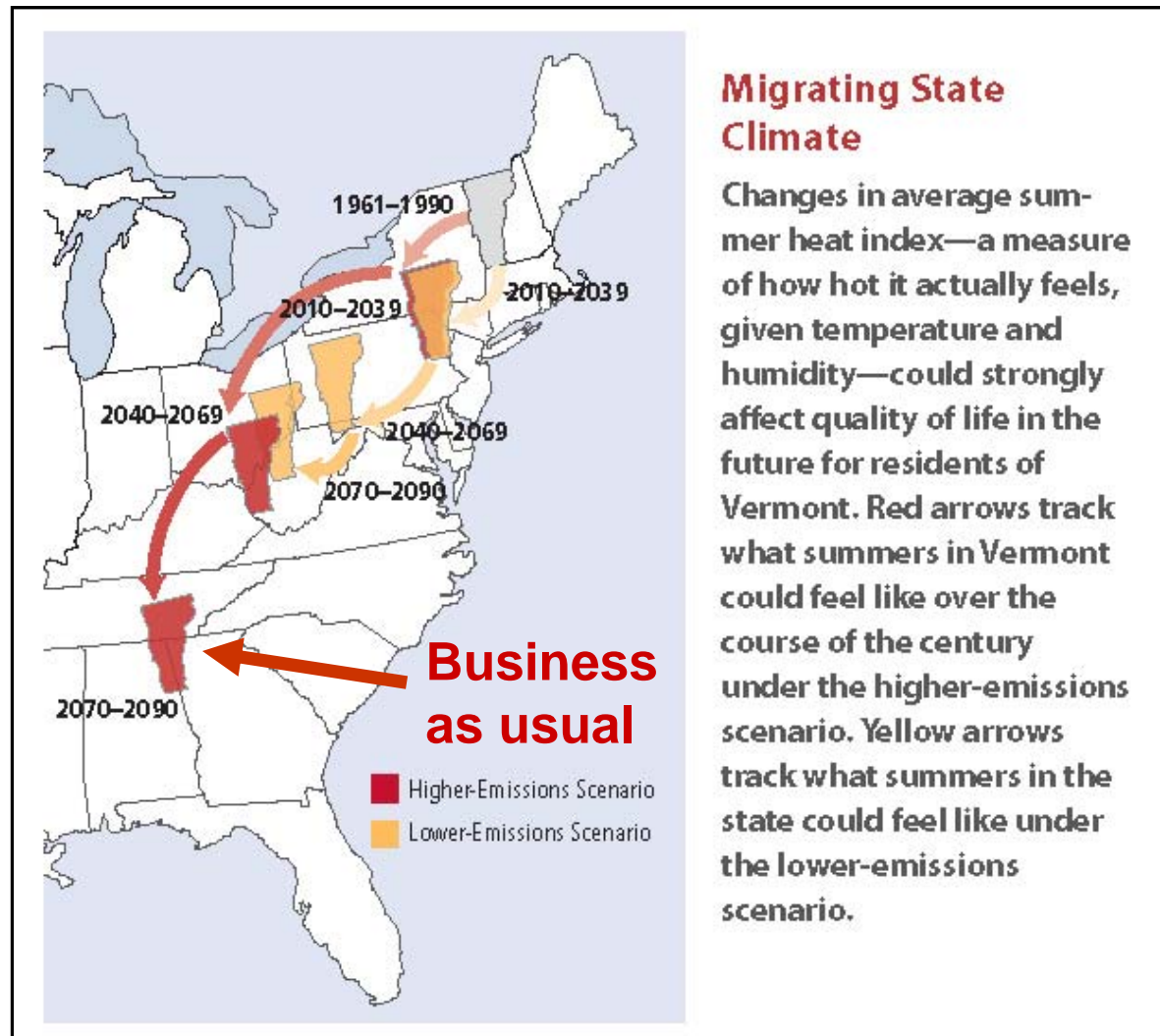
1.24



Vermont's Future with High and Low GHG Emissions

What
about VT
forests?

Sub-tropical
drought areas
moving into
southern US



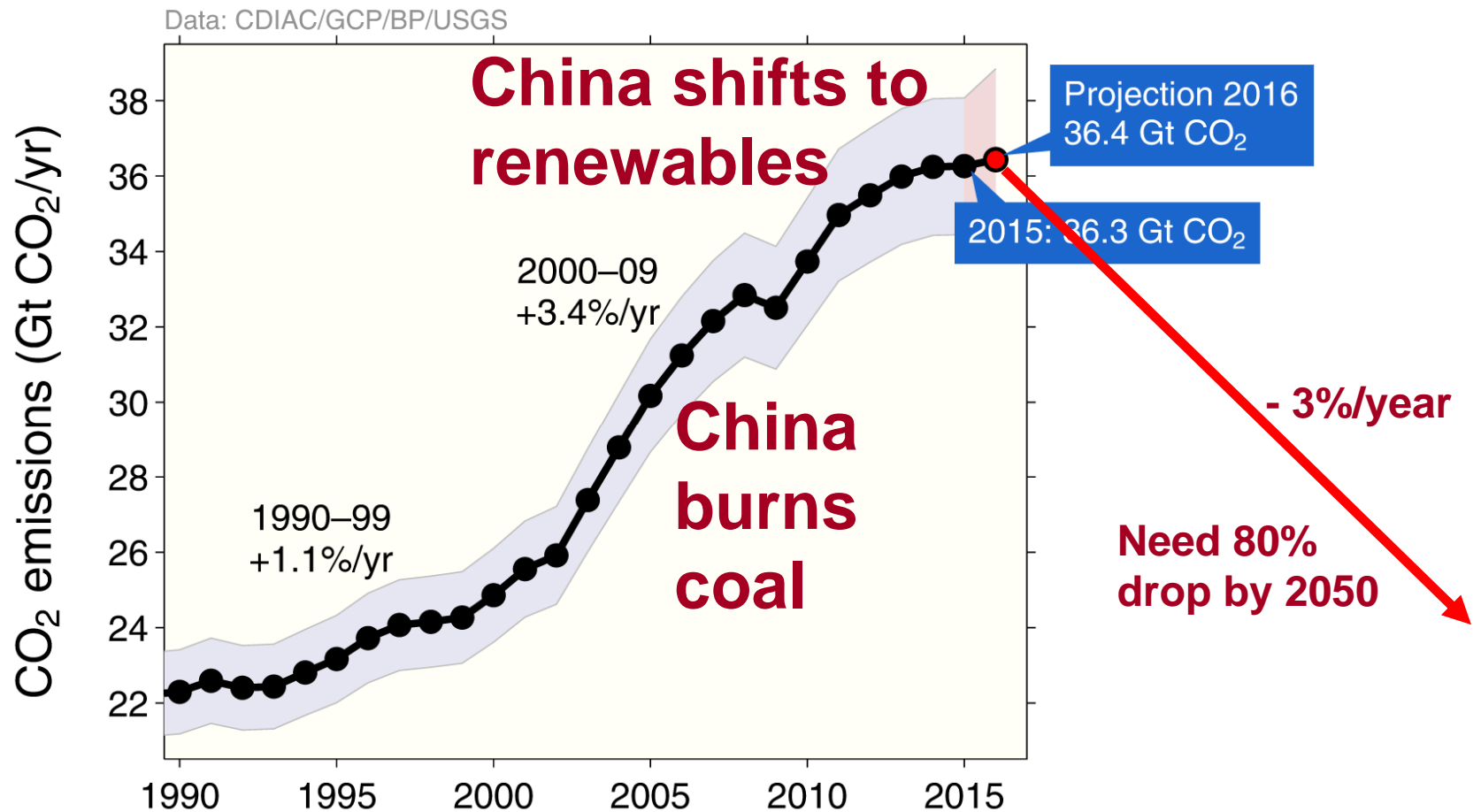
**NECIA,
2007**

Can We Stop “Dangerous Climate Change”?

(UNFCCC 1992)

- **Yes:** Quickly stabilize atmospheric CO₂
- This means an 80% drop in CO₂ emissions!
- **Technically 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

Growth of CO₂ Emissions Flat for 3 years



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 CO₂ to 1,000 ppm**
 - *Radically change climate/wipe out species*
 - *In time melt icecaps, raise sea-level 150ft*

System Guidelines

- **Reeducation of society and its 'systems'**
 - The transition we face is huge
 - What will raise awareness/change paradigm?
 - How can we better manage our relation to Earth?
- *Develop renewable energy*
 - *Maximize energy efficiency: housing, transport, power*
 - *Add and monitor renewable power*
- **Examine all waste-streams**
 - Aim to recycle/remanufacture everything
 - Fully cost all waste streams
- **Relocalize food system**
 - Compost all organic waste
- **Understand water and the landscape**
 - Limit phosphorus loads on streams/lakes
 - Growth of algae in lakes, big issue in VT (and elsewhere)
- **Reconnect with natural world**
 - Fundamental if we are to accept transition

Value of science

- **Great value of science is its honesty, integrity and its cooperative global vision**
 - It deals with the measurable world
 - It communicates openly
 - Priceless to a society lost in corruption & deceit
- **Greatest challenge is that humanity is embedded in a deeply interconnected living Earth's system**
 - That cannot be separated and objectified
 - In fact the separation of our social frames from the Earth's ecosystem is driving climate change

Practical Local Solutions

- *Technically, we know what to do!*
- **Vermont is well on its way**
 - Large solar development
 - Battery storage on its way
 - California installing 100MWh storage units
 - Energy efficiency for homes and businesses underway
 - **Need net-zero building codes**
 - **Need transportation shift**
 - **Efficient networked vehicles**

Efficient transport

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



>3000lbs and 120 mpg
Payload: 750 lbs at 55 mph



180lbs gets "1800 mpg" or 100 mp(1000Cals)
Payload: 350lbs at 25mph

How do we plan/adapt?

- **Future needs creative approaches**
 - **Shift to efficient society**
 - **Community support**
 - **People reconnected to landscape**
- **We need to work with the Earth**
 - **Manage water on landscape**
 - **Manage forest diversity for a warmer climate**
 - **Manage diversified year-round agriculture**
 - **Manage energy crops and solar farms**

Voice the Ethical Issues

- **Do we just exploit the Earth's wealth**
 - For greater 'economic growth'
 - To maximize profit for a wealthy few?
 - What will be left for our children?
 - What happens to the ecosystems we depend on?
- **Fundamental practical moral issue**
 - Don't we need to co-operate with the Earth?
 - *Shift in understanding and mind-set needed*

Vermont Newspaper Columns

2008-2017: 93 articles: “They blend science with a systems perspective, and encourage the reader to explore alternative and hopeful paths for themselves, their families and society”

(Rutland Herald and the Barre-Montpelier Times Argus)

(alanbetts.com/writings)

Today’s communities must understand the connections between energy use, climate and food to make the transition to an efficient, resilient and sustainable society.

Environmental journalism revisited (Betts and Gibson 2012)

As Climate Changes

Everything is interconnected

- *Accept our responsibility for the Earth's future*
- Human society & energy use; people's choices
- Precipitation, streams, forests; habitat and wildlife
- Look for the big picture and draw connections
- Talk to your neighbors and ask what you can do
- Stay connected to Vermont's natural environment
- *Insist on honesty and accuracy*
 - *not "alternative facts" – "lies with a political agenda"*

Discussion

alanbetts.com

(articles and talks)

TS Irene

Roads in valleys

Massive damage

Some roads took
months to repair

*Rte 131,
Cavendish
Sept, 2011*



2011 Classic Flood Situations

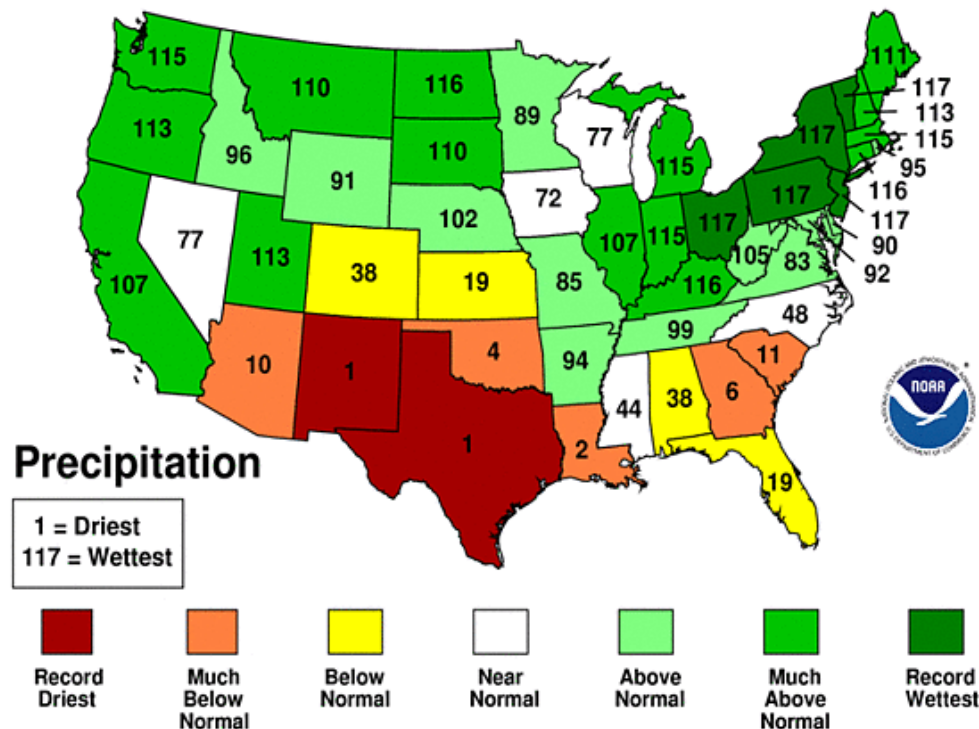
- **Spring flood:** heavy rain and warm weather, melting large snowpack from 2010 winter
 - 70F (4/11) and 80F(5/27) + heavy rain
 - record April, May rainfall: 3X at BTV
 - Severe floods on Winooski and Adirondack rivers
 - Lake Champlain record flood stage of 103ft
- **Irene flood: tropical storm** moved up east of Green Mountains and Catskills
 - dumped 6-8 ins rain on wet soils
 - Extreme flooding

2011 Floods: VT and NY

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

March-August 2011 Statewide Ranks

National Climatic Data Center/NESDIS/NOAA



March-August, 2011

- Record wet : OH to VT
- Record drought: TX & NM
- Pattern nearly stationary

Value of Flood Plains



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