



# **Climate Crisis is Here** **How do we *plan creatively*?**



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***UVM CDAE 260***

***Smart Resilient Communities***

***Feb 8, 2021***



# Outline

- **Science of climate change**
  - Global and local
  - What is happening in the Northeast?
- **The catastrophe we face**
  - **How soon can we stabilize the climate?**
    - **And slow the extinction of species?**
  - **What are our responsibilities?**
    - To our children & to the Earth
  - *Will we listen to the webs of deceit*
    - *and sacrifice all to “Business as Usual”?*
  - *Or will we creatively transform society?*
    - *Solve issues with a new mindset!*

# Strategies for Resilience

- Understand technical/ecological issues
  - And place great value on future of the Earth
- Engineer for efficiency and resilience
  - Reject: “cost effective for today’s bottom line”
- Spend \$1 trillion on climate resilience
  - Saves \$60 trillion later this century
- If we ignore the climate crisis
  - Existential crisis for human civilization and Earth’s ecosystem
  - Community resilience & resistance!
  - Needs imagination and creativity - which inspire!

# Different Mindsets

- ***Technology will save us***
  - ***We are in charge (need small changes in behavior)***
    - ***Economics based on consumerism produces 'wealth'***
    - ***Oil has made us (& the fossil fuel industry) rich***
    - ***Inventions will power the future***
    - ***[Yes - if renewable tech!]***
- **Climate, life & humanity interwoven**
  - **Environmental intelligence crucial**
  - **Community imagination & creativity essential**
  - **Intergenerational time-frame**
  - **Sustainability & Justice interwoven**

# Different Mindsets-2

- ***Western capitalist mindset***
  - Anthropocentric, egocentric & dualistic
  - Power: Exploit & subdue natural world
  - Maximize quarterly profits
  - ***[Driving climate crisis & ecosystem loss]***
- ***“Indigenous mindset”***
  - Ecocentric: respecting life and nature
  - Shared resources, holistic, long-term view
  - ***Not part of our education: yet critical since Earth wins hands-down!***

# Economic doctrine vs Reality

- “Free market” promotes material growth
  - = Freedom to exploit Earth’s resources & poor
  - “Regulation” interferes with growth/profits
  - The assets and interests of the wealthy must be protected (*they fund politicians and public deceit*)
  - Choices must be “cost-effective” now: *future costs are discounted or paid for later (by you!)*
- Current economics driving climate change
  - *since Earth does not discount the future - accumulates energy imbalance in oceans*
  - *Crises ahead for our children and all life*
  - *Grasping indigenous worldview critical*

# Powerful interests fighting

- **Fossil fuels reserves are worth \$20-30T**
  - Big money: “of course we will burn them”
  - Regulating or taxing emissions of CO<sub>2</sub> is an ‘unfair cost to the free market’
  - [Too bad if the Earth’s ecosystems are destroyed: ‘others’ can pay the price]
- *US controlled global oil supply/price for 80yrs*
  - Fueled ‘fossil’ capitalism and exploitation of the Earth and the poor
  - Webs of skillful deceit shifting issue from legislating industrial change to “individual behavioral changes”

*Oil, Power and War: Matthieu Auzanneau*  
*The New Climate War: Michael Mann*

# Climate Fundamentals

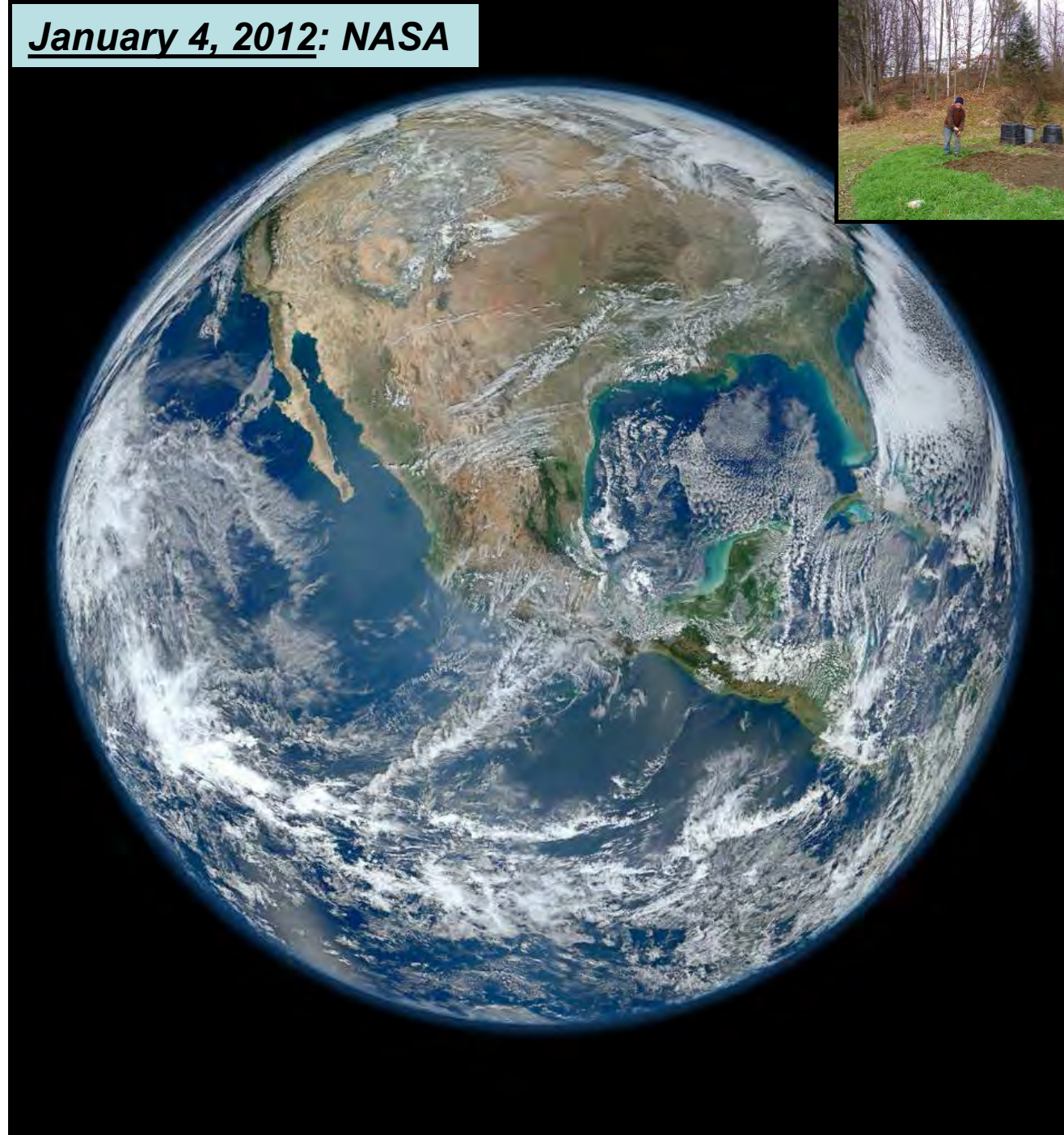
- ***Burning fossil fuels: transforming climate***
  - *Many water cycle amplifying feedbacks*
  - *Heading for high CO<sub>2</sub> “Hot-house climate”*
  - *Climate extremes increasing*
  - *Severe weather costs: \$300B in US in 2017*
  - *Long memory: decades to centuries*
- **Avoidance of responsibility for decades**
  - Politicians, professionals, public
  - Stable Climate is incompatible with business-as-usual
- **Linked to unmanaged technology/economics**
  - Soluble by changing system guidelines
  - Create efficient society, based on renewable energy
- **Choices are value based: moral issue**
  - Beyond science and economics
  - Must value the future of life on Earth



# Earth's climate sustains life

- **Greenhouse gases keep Earth warm**
  - Increase of CO<sub>2</sub> warms further
  - Evaporation of more water vapor triples warming
- **Ice & snow melt; less reflection of sun**
  - Arctic warms
  - Winters warm
- **Oceans store heat & get warmer**
- ***Extreme weather is increasing as Arctic warms; westerlies slow down***

January 4, 2012: NASA



# Hurricane seasons

- Earth is warming as greenhouse gases increase and reflective ice cover falls
- *Oceans are storing 93% of heat*
  - Warmer Atlantic, Caribbean, Gulf of Mexico and Gulf Stream means stronger hurricanes; when vertical shear is low
- *2017: Harvey, Irma, Maria*
- *2018: Florence, Michael*
- *2019: Barry, Dorian*
- *2020: Goni 195 mph (Philippines)*





## Major Hurricane Harvey - August 25-29, 2017

[Weather.gov](#) > [Corpus Christi, TX](#) > Major Hurricane Harvey - August 25-29, 2017

Corpus Christi, TX

Weather Forecast Office

[Current Hazards](#) [Current Conditions](#) [Radar](#) [Forecasts](#) [Rivers and Lakes](#) [Climate and Past Weather](#) [Local Programs](#)

### Category 4 Hurricane Harvey: South Texas Landfall & Impacts from August 25<sup>th</sup> to 29<sup>th</sup>, 2017

[Overview](#) [Stats](#) [Radar](#) [Satellite](#) [Winds](#) [Storm Surge](#) [Rainfall](#) [Rivers](#) [Seadrift](#) [Tornado](#) [Storm Reports](#) [Photos](#) [One Year Later](#)

#### Hurricane Harvey Summary PDF

...Hurricane Harvey is the first major hurricane to make landfall along the Middle TX Coast since Celia in 1970...

...Hurricane Harvey is the first Category 4 hurricane to make landfall along the TX Coast since Carla in 1961...



NHC Final Best Track of Harvey (Click points above to view additional information.)

# Why was Harvey so Damaging?

- Huge evaporation off warm ocean
- Category 4 hurricane developed fast
- Very heavy rain-rate: 10-12 inches per day
- Two stationary high pressure systems to the north **trapped** Harvey for 4 days over Houston
- Result **40+ inches** of rain & massive flooding





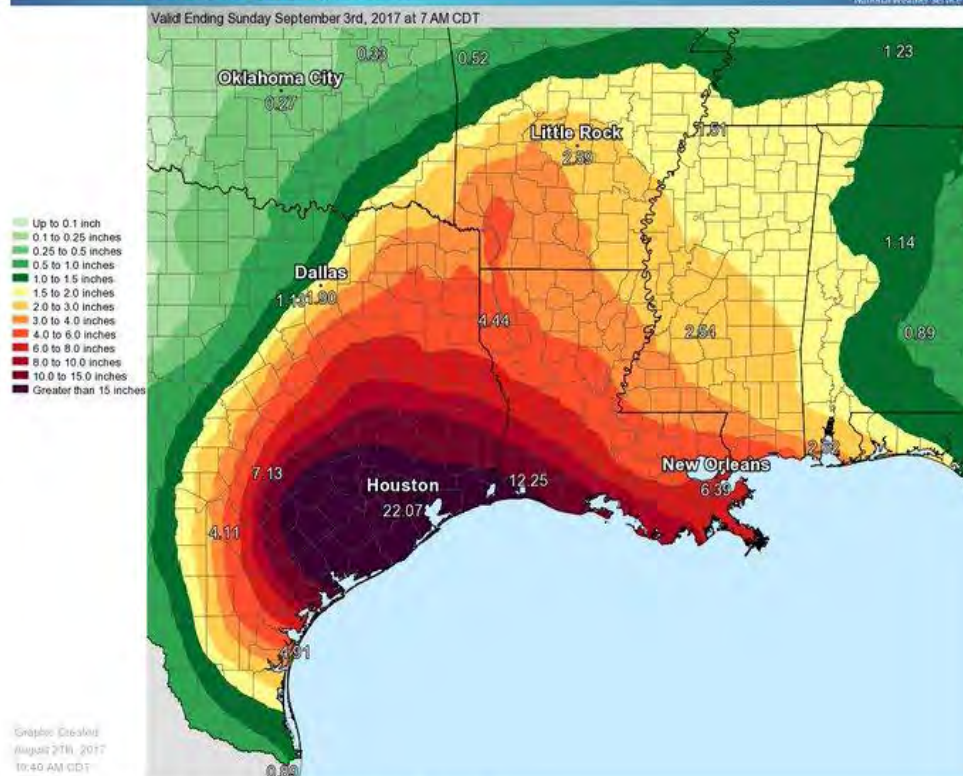
# Challenge to Forecast & Emergency Services



**National Weather Service**  
**@NWS**

This event is unprecedented & all impacts are unknown & beyond anything experienced. Follow orders from officials to ensure safety. [#Harvey](#)

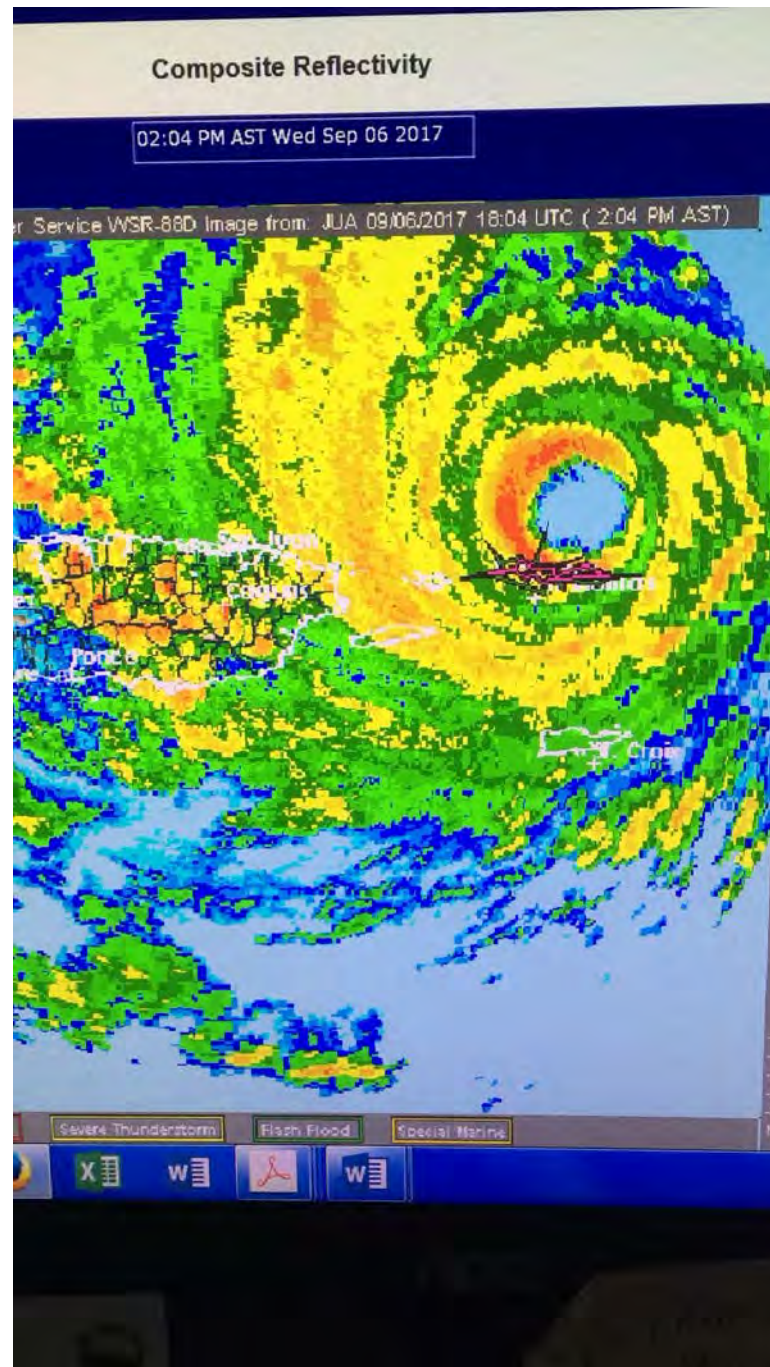
## Forecast Precipitation



21.8K 11:44 AM - Aug 27, 2017

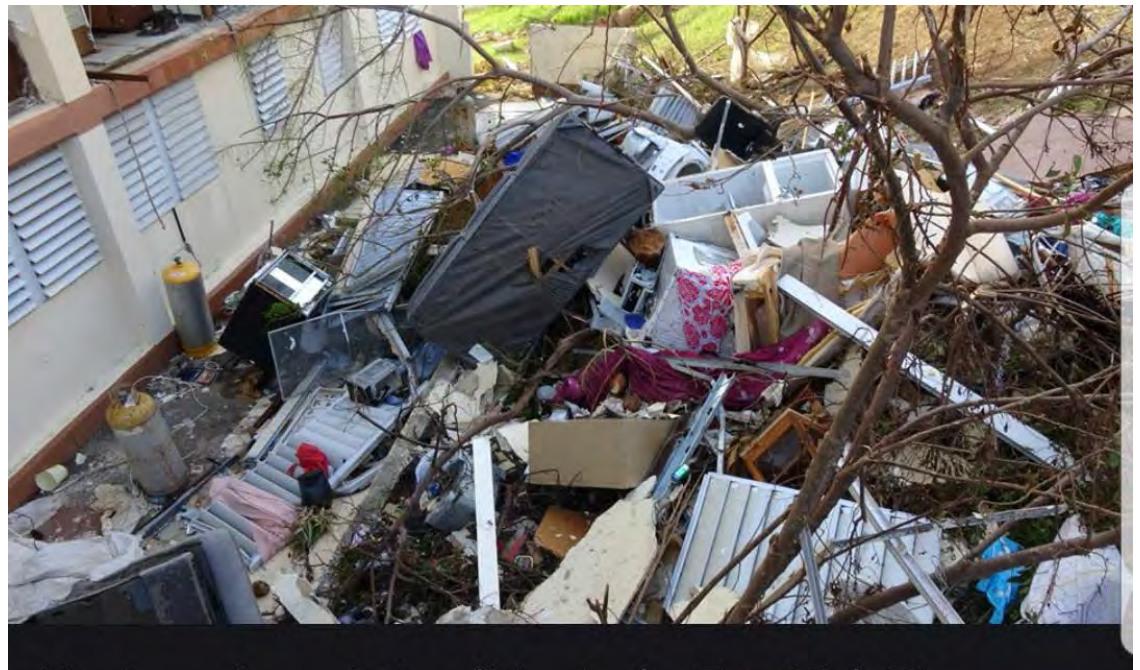
**2pm Sept. 6**  
***Category 5\****  
***IRMA***  
**grazing**  
**St Thomas**

***\*Cat 5 >155mph***  
***IRMA >180mph***





***Irma(Cat.5)***  
**Sept. 6**  
**St Thomas**



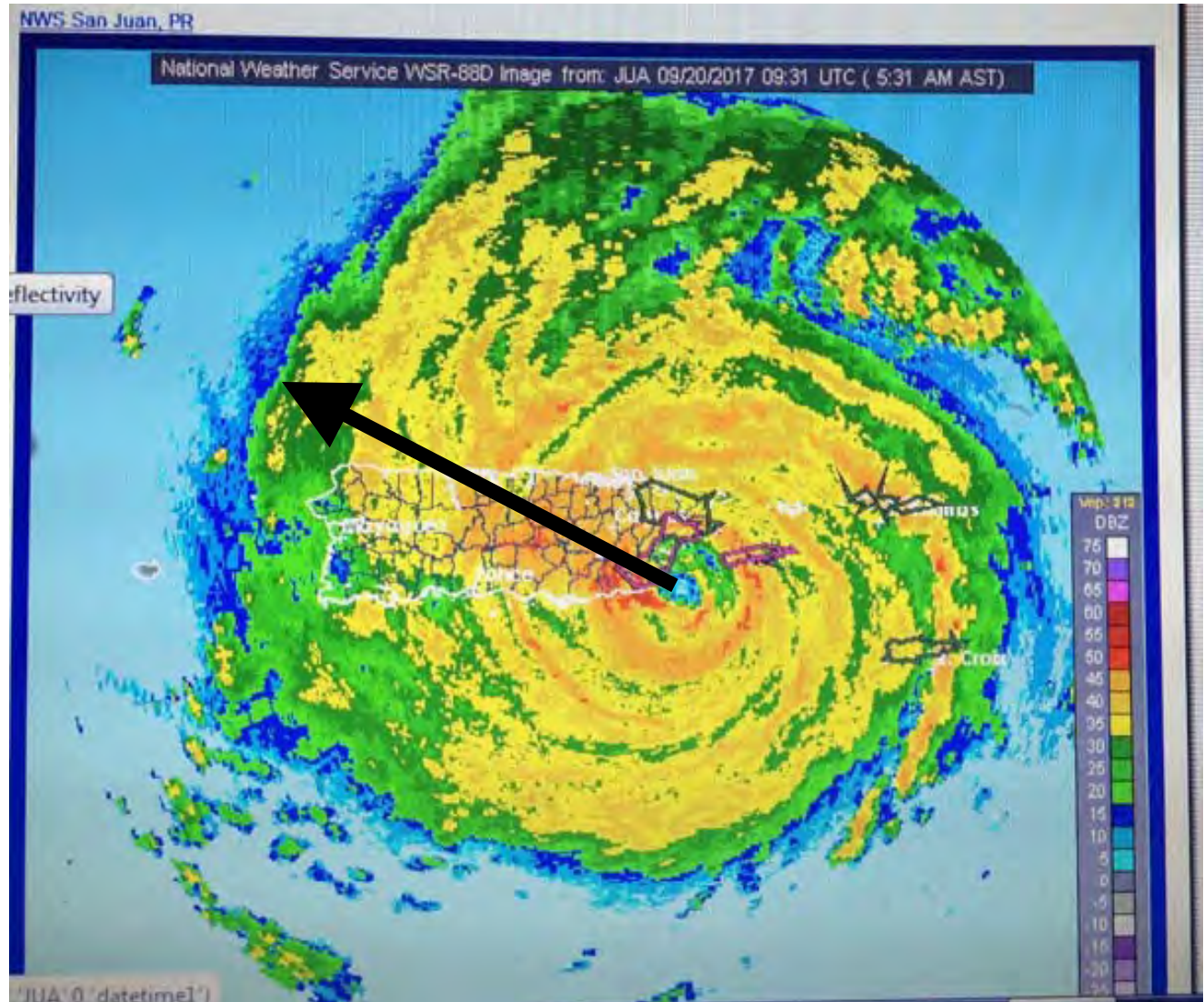
# ***Maria: 5:30am Sept. 20, 2017***

## ***Category 4 hits Puerto Rico***

**Cat 4**  
**>130mph**  
***Maria***  
**>150mph**

***Wiped cell  
towers and  
power grid  
(90% back  
after 6 mos!)***

**2 Narratives:**  
**alanbetts.com**





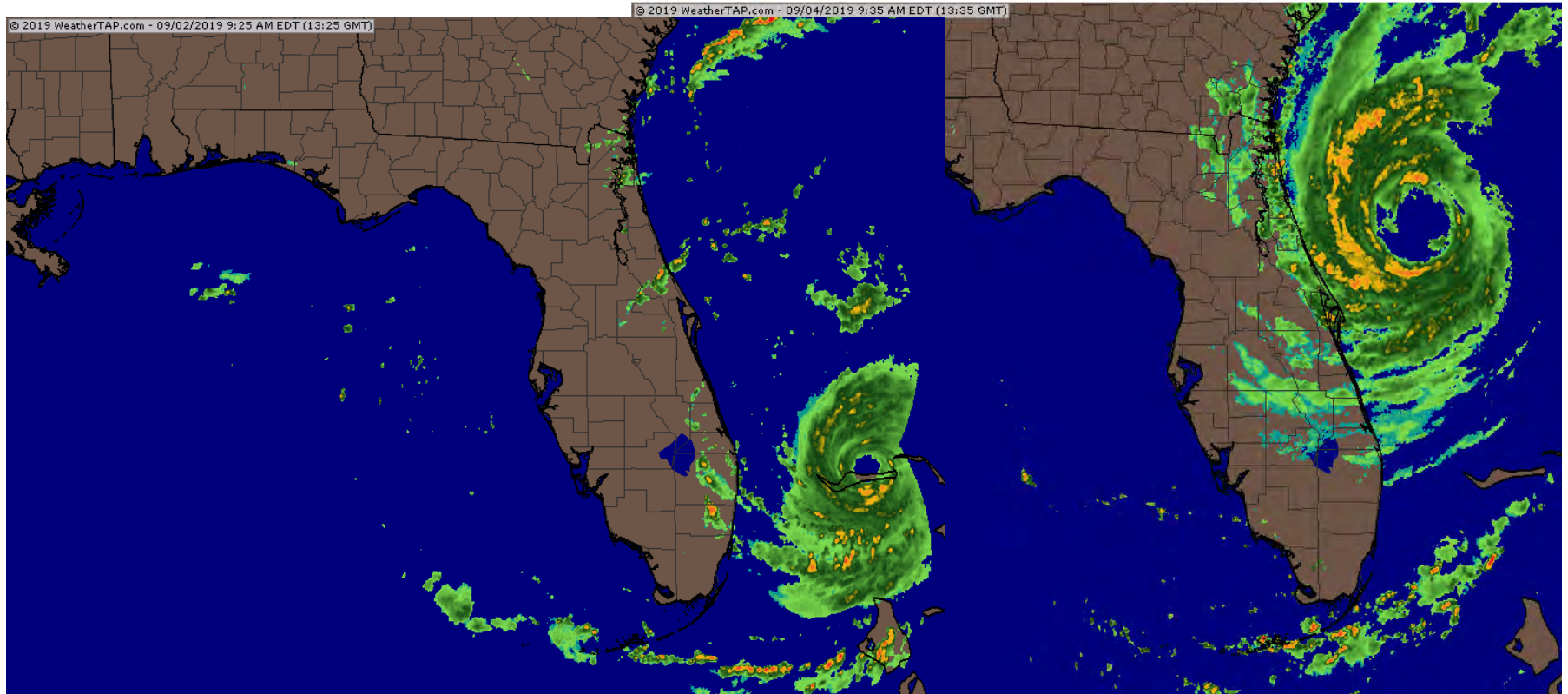
# July 2019: track of Barry



**Started as band of thunderstorms in Kansas, traveled in slow circle, intensified over warm water of Gulf to weak hurricane, rained on wet Louisiana [Cost: \$1 billion]**

# ***Dorian: Cat 5***

# ***Cat 2/3***



**Sept 2, 2019  
Stationary over  
Grand Bahama**

**Sept 4, 2019  
Off Florida  
Coast**

# Two Severe Tropical Cyclones hit Mozambique: 2019

- Southeast Africa cyclones *were very rare*
- *Idai* in March left 1000 dead from flooding
- Cat 4 *Kenneth* in April, 2019
  - 60 in of rain





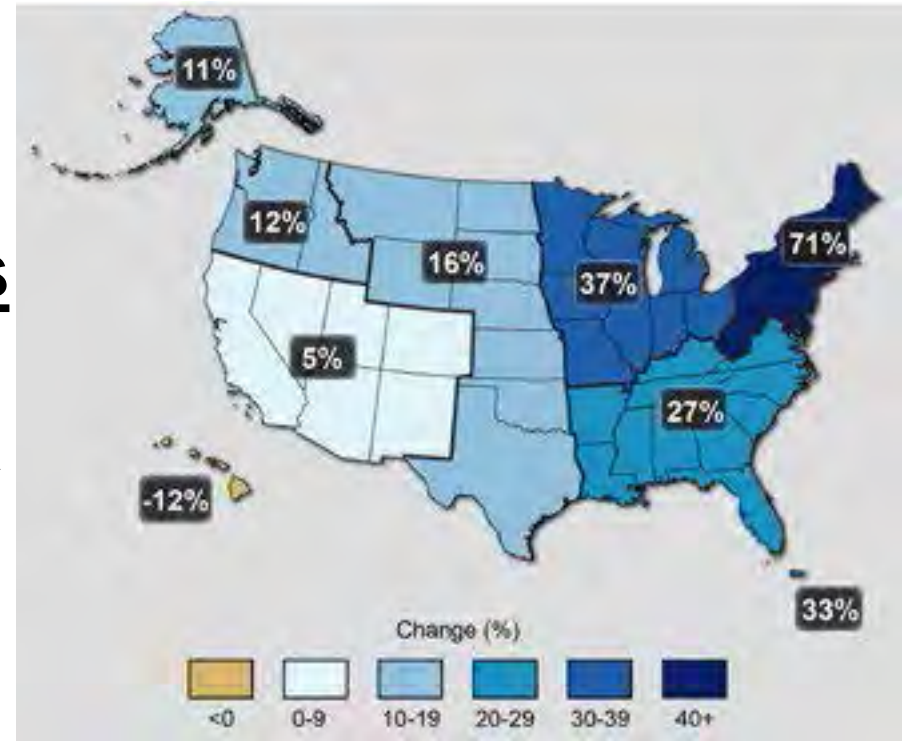
# Some Climate Disasters: 2020

- **2020 Record global temperature matched 2016**
  - Record fires raging in the western US (and Australia)
  - Record temperatures melting the Arctic and the **permafrost in northern Siberia**: town on Arctic circle: 100F in June
  - Record 30 tropical storms in Atlantic
- **Gulf coast hit by storm after storm**
- **Nicaragua devastated by **Cat-4 hurricane Eta** and **Cat-5 Iota** just two weeks apart in Nov.**
- **Nov. 1 strongest **super-typhoon (Goni Cat-5+)** ever to hit the Philippines with 195 mph winds**
- **Late Nov. northern Somalia, struck by the strongest cyclone (**Gati Cat-3**) of the satellite era: a year's rainfall in 48 hrs.**

# 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**

# TS Irene

*Rte 131,  
Cavendish  
Sept, 2011*

**Roads in valleys**

**Massive damage**

**Some roads took  
months to repair**

**Wake-up call**







**Mouth of Connecticut River from Irene  
2011**

**Lake Champlain, Spring 2011, Courtesy LCBP**

# 2011 Classic Flood Situations

- **Spring flood:** heavy rain and warm weather, melting large snowpack from 2010-11 winter
  - 70F (April 11) and 80F(May 27) + heavy rain
  - record April, May rainfall: 3X at BTV
  - Severe floods on Winooski and Adirondack rivers
  - Lake Champlain record flood stage of 103ft
    - **Wet summer**
- **Irene flood: tropical storm** moved up east of Green Mountains and Catskills
  - dumped 6-10 ins rain
  - Extreme flooding

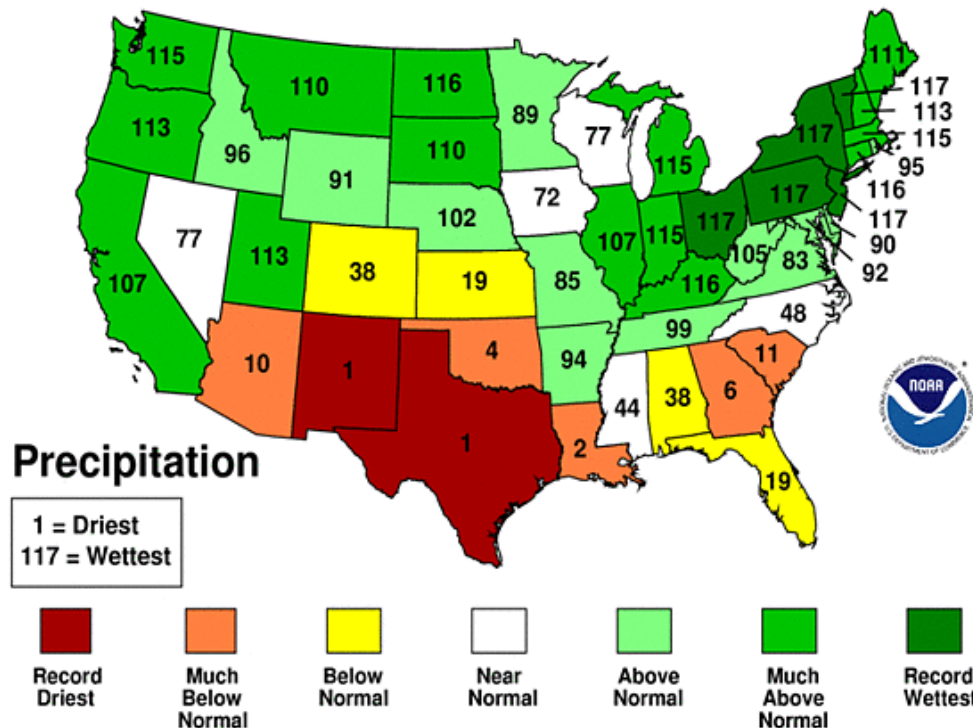


# 2011 Floods: VT and NY

- 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**

# Irene: Resilience

- 13 towns cut off overnight
- State emergency systems flooded
- FEMA had no road access
- Communities reorganized overnight
- Those with equipment stepped in
  - “Can fix this in 72 hrs”: will need engineer to check bridge (Brandon)
  - “We worked 120hrs last week...” (Wardsboro)
  - Social networks collected supplies; and ran rescue services across mountains
  - Communication networks critical

# Flooding increasing

- Warmer temps = higher rain-rate (4%/°F)
- As Arctic warms faster than equator
  - N-S temperature gradient decreasing
  - Westerly jet-stream slowing & meandering
  - Patterns stationary for longer
- *Slower moving storms mean more rain over one place - more flooding*
- Harvey stayed 4 days over Houston, raining 10 in/day [*Florence 3 days; NC*]

# Management of water

- Engineering approach was to get it off the land into streams & rivers (“manage it”)
  - Must now oversize all culverts/ bridges
- Poor policy as extremes of flood and drought increase
  - Need to store in ground for summer use
- Summer water extraction by roots from ground storage damps precipitation anomalies by 60%: maintains evaporation in dry years

# Environmental Intelligence

- “Blend of natural science, social science and indigenous knowledge that helps humans interact constructively and creatively with the living natural world” (Betts, 2018)
- **Blue River Declaration (October 2011)**
  - “A truly adaptive civilization will align its ethics with the ways of the Earth
    - *A civilization that ignores the deep constraints of its world will find itself in exactly the situation we face now, on the threshold of making the planet inhospitable to humankind and other species”*
- **Huge conscious challenge for society**
  - Key to smart community resilience

# Community Resilience

- Shared local infrastructure, resources, knowledge and awareness
  - Designed to maximize efficiency and renewable energy use
  - Localized shared food supply
  - Shared efficient transport system
  - Support ecosystems long-term
  - *Needs imaginative community*
  - ***Contrast to 'happy isolated individuals addicted to consumerism, escapism and the media'***

***(Joanna Macy)***

- ***Once kept population under control: now failing!***

# Gardening in Vermont for 40 years

- How long was growing season in 1970s?
  - About 125 days: now 155 days
- How long was the ground frozen?
  - About 155 days: now 125 (*or less*)
  - No longer hard freeze in November
- Winter climate zones in 1970's were?
  - Zones 4-5: now zones 5-6 (10F warmer)
- BUT winter variability increasing (2021)



# My Wake-up Call: Gardening in January, Pittsford, VT



**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**





# January 3 and Feb 5, 2020



**January 3, 2020**  
**Digging cover crop**  
**(smart resilience)**



**February 5, 2020**  
**Soil still unfrozen**  
**(despite  $T_{\min}$  to -5F)**

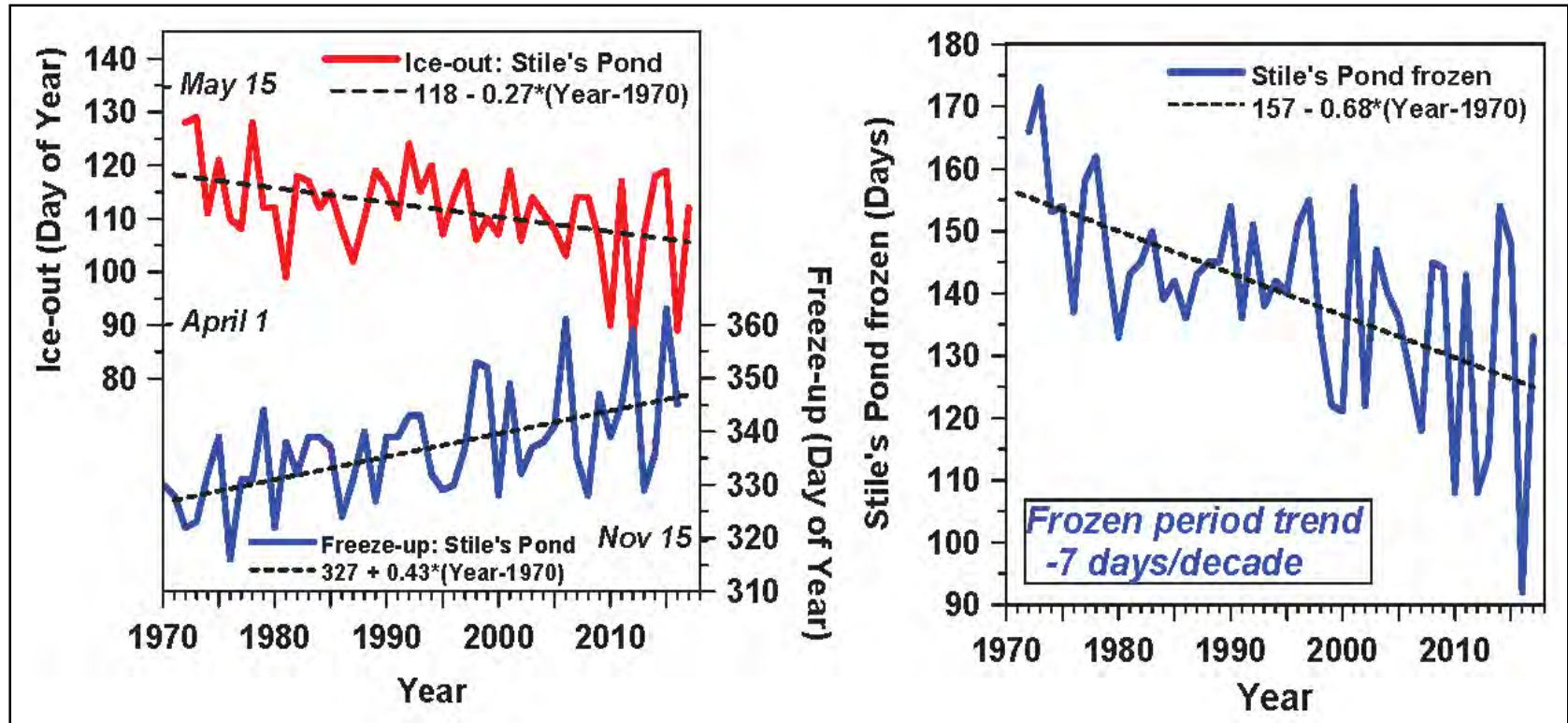


**January 31, 2020**



# Marker: Lake Freeze-up & Ice-out

## Frozen Period Shrinking: variability huge

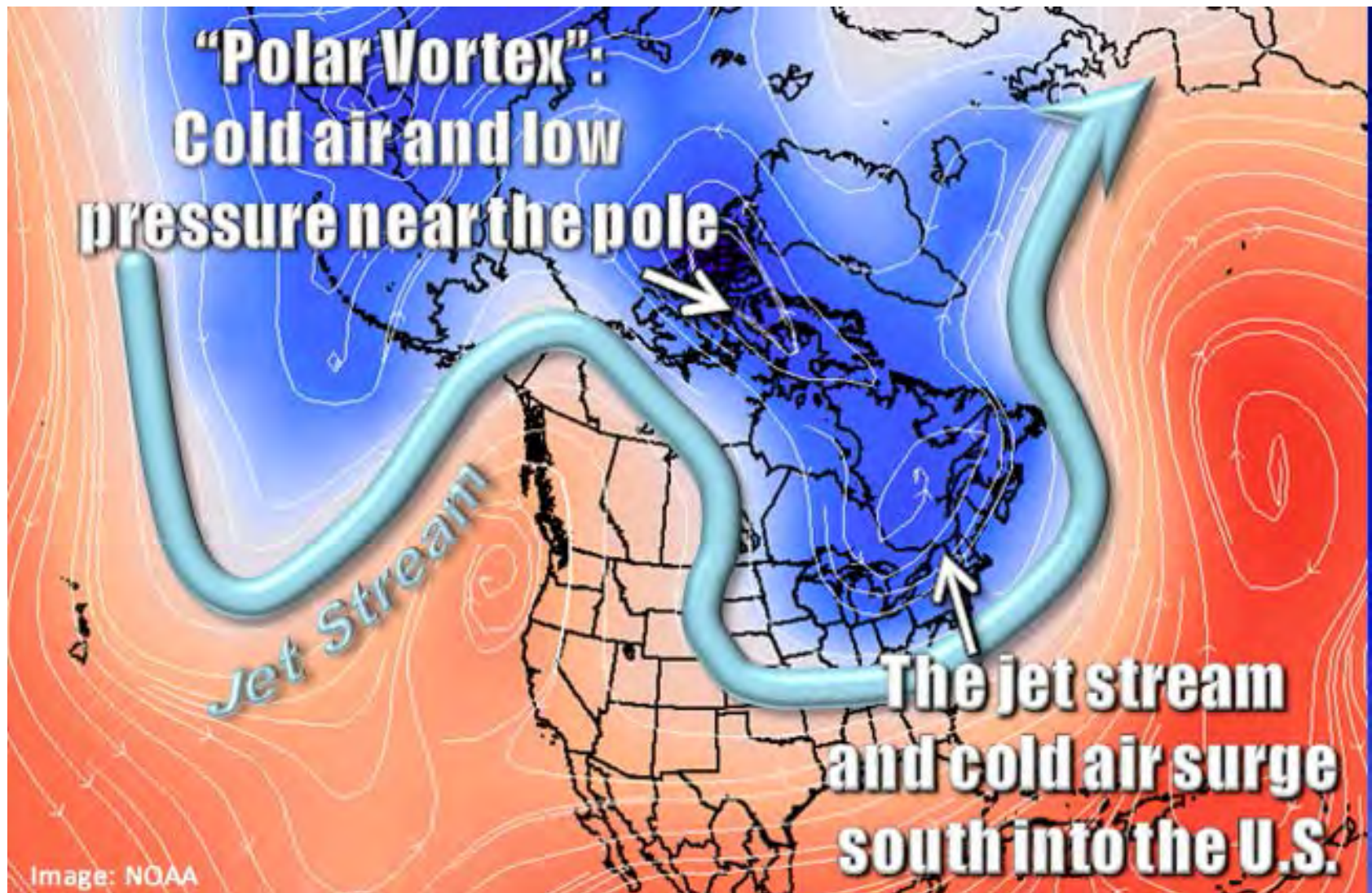


- Freeze-up later by +4 days / decade
- Ice-out earlier by -3 days / decade
- Lake frozen period trend - 7 days/decade
- Interannual variability  $\approx$  40 yr trend

*Stiles Pond:  
"Eye on the Sky"*



# Arctic Warming: Polar Vortex Unstable





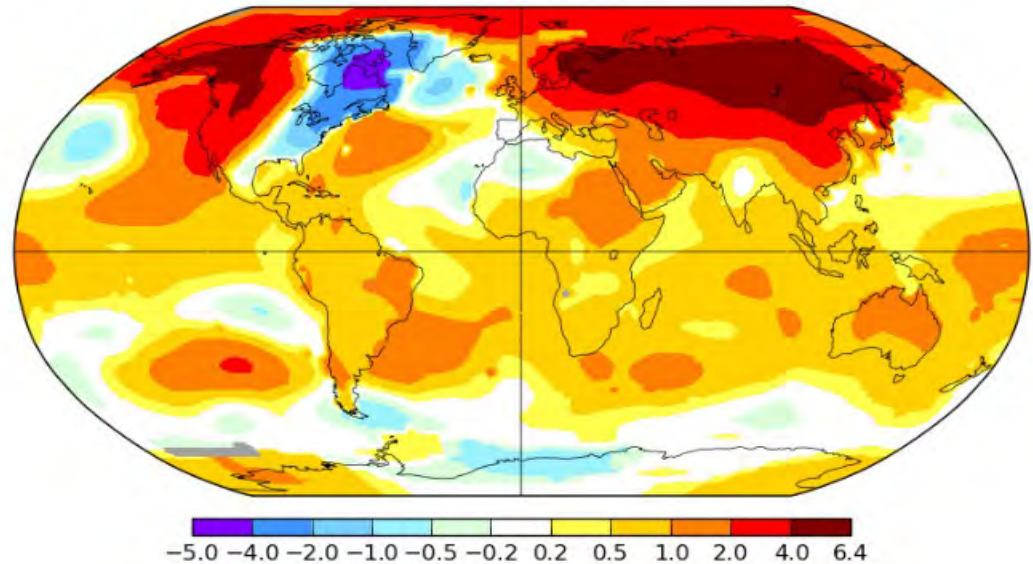
# Jan-Feb-Mar 2015

Warm Atlantic, record temp in  
west; cold NE, strong coastal  
storms - Boston record snow

Jan-Mar 2015

L-OTI(°C) Anomaly vs 1951-1980

0.86



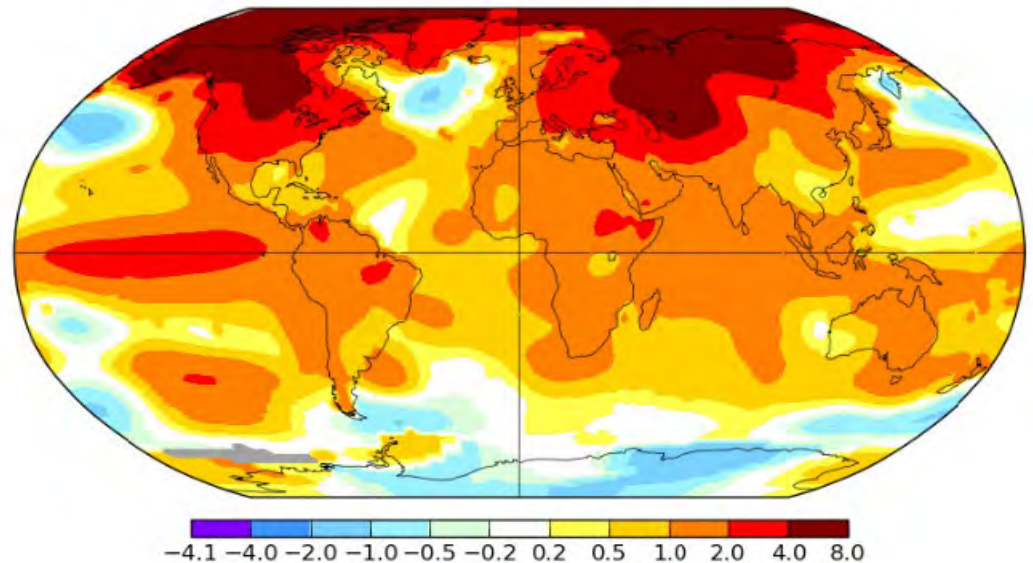
# Jan-Feb-Mar 2016

Warm Atlantic, warm NE, little  
snow, warm Arctic

Jan-Mar 2016

L-OTI(°C) Anomaly vs 1951-1980

1.24



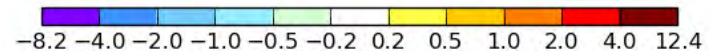
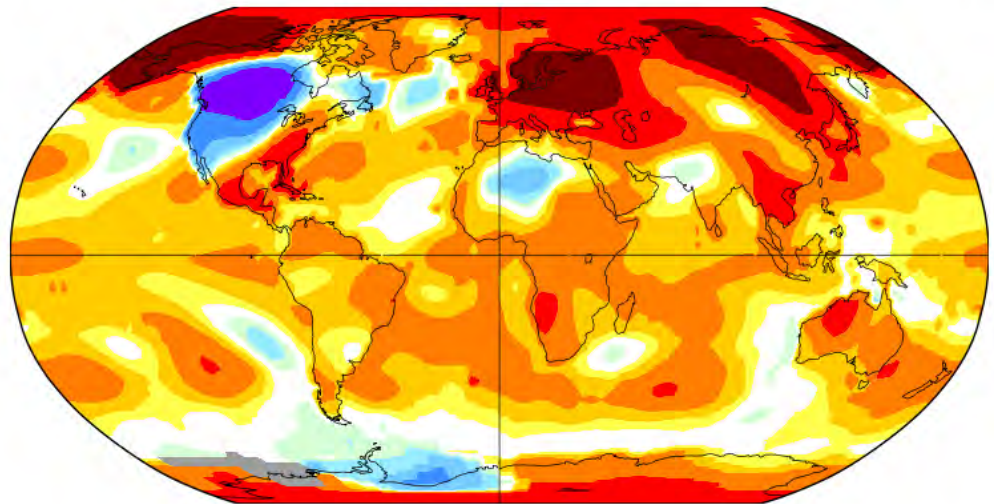
# Feb-2019

Extreme cold, central US, Canada  
Extreme warmth UK, Europe, Asia,  
NW Alaska

February 2019

L-OTI(°C) Anomaly vs 1951-1980

0.94



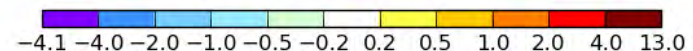
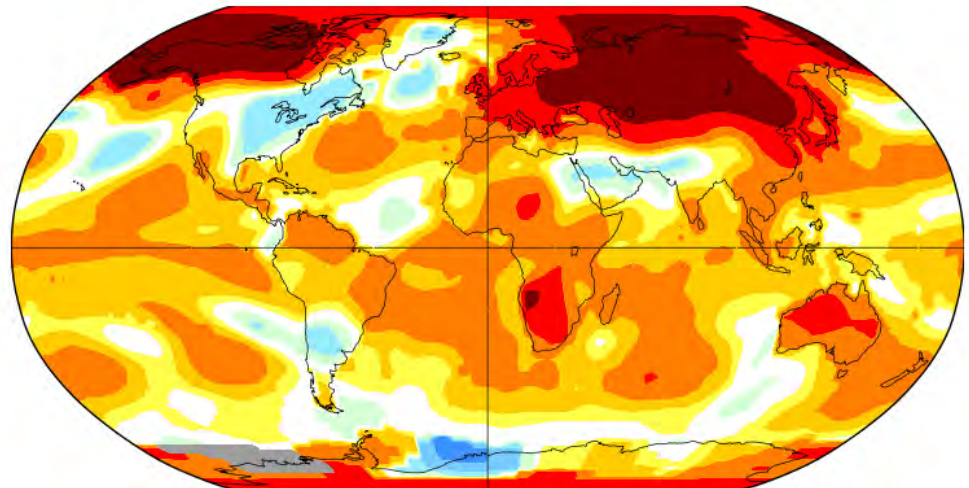
# March-2019

Cold eastern US, Canada  
Extreme warmth UK, Europe, Asia,  
Alaska

March 2019

L-OTI(°C) Anomaly vs 1951-1980

1.18



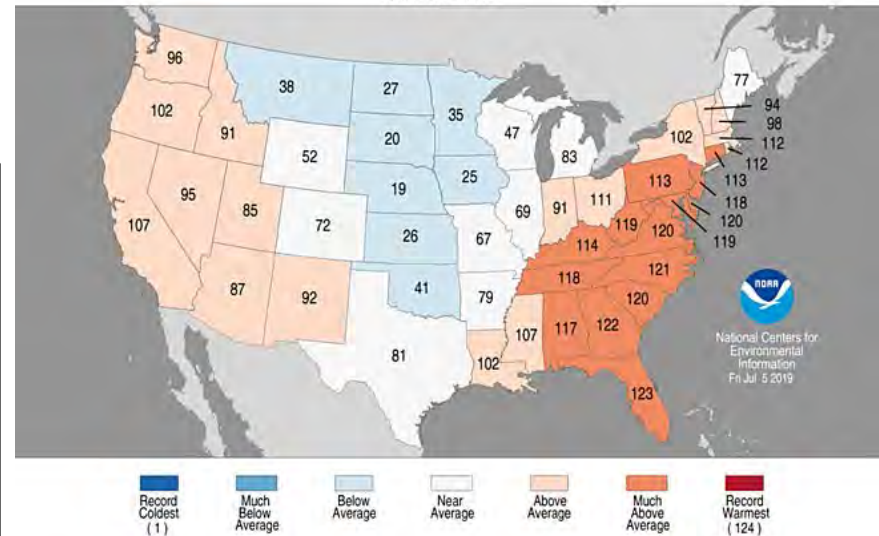
***July 2018  
- June 2019***

***Warm in South-east  
Cold in north-central***

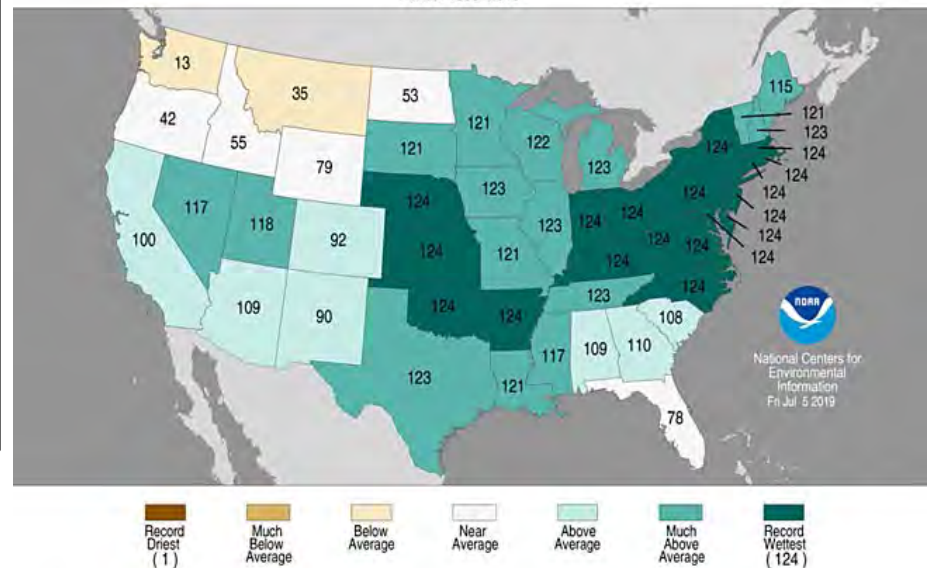
***Very wet across eastern &  
central US***

***2019 Mississippi flooding  
longest on record***

Statewide Average Temperature Ranks  
July 2018–June 2019  
Period: 1895–2019

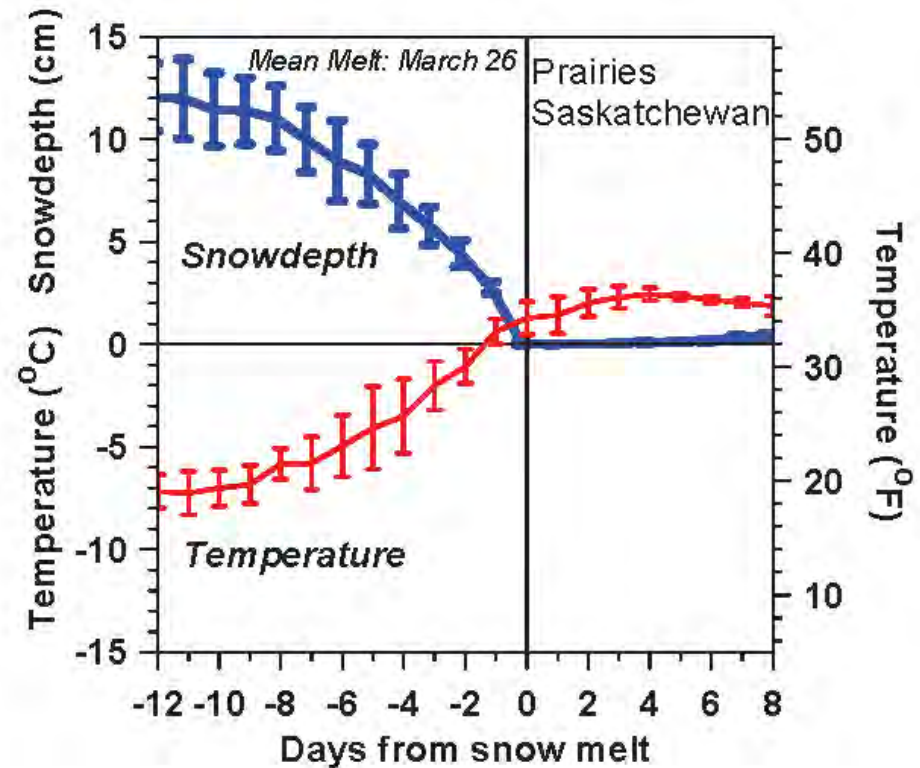
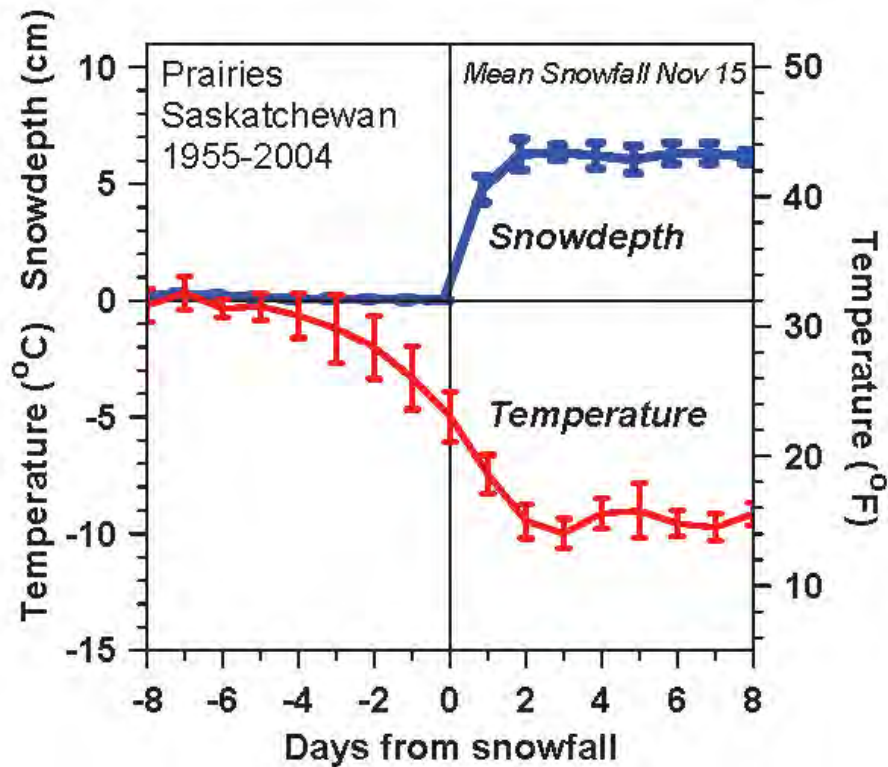


Statewide Precipitation Ranks  
July 2018–June 2019  
Period: 1895–2019



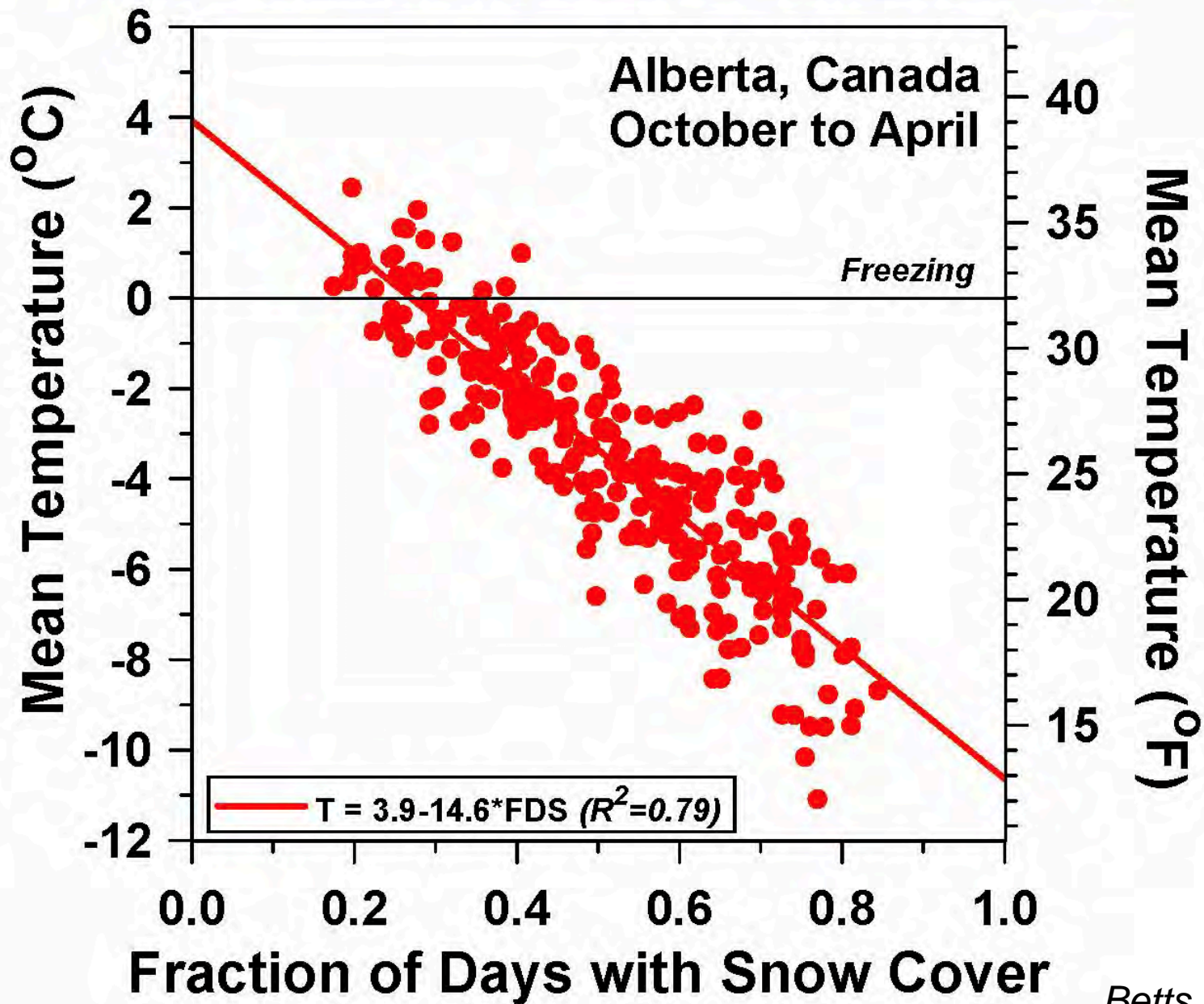


# Snowfall and Snowmelt

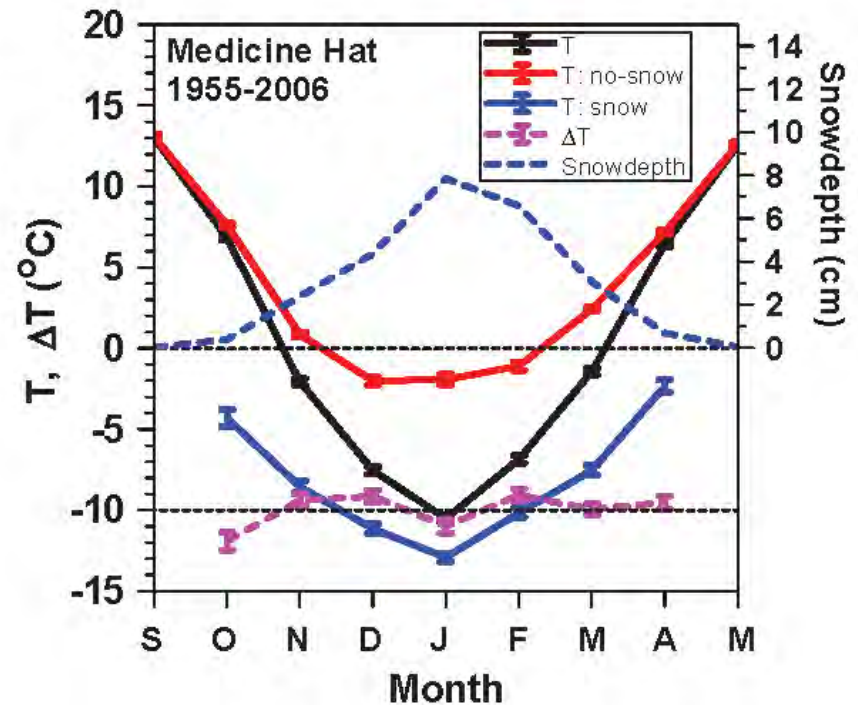
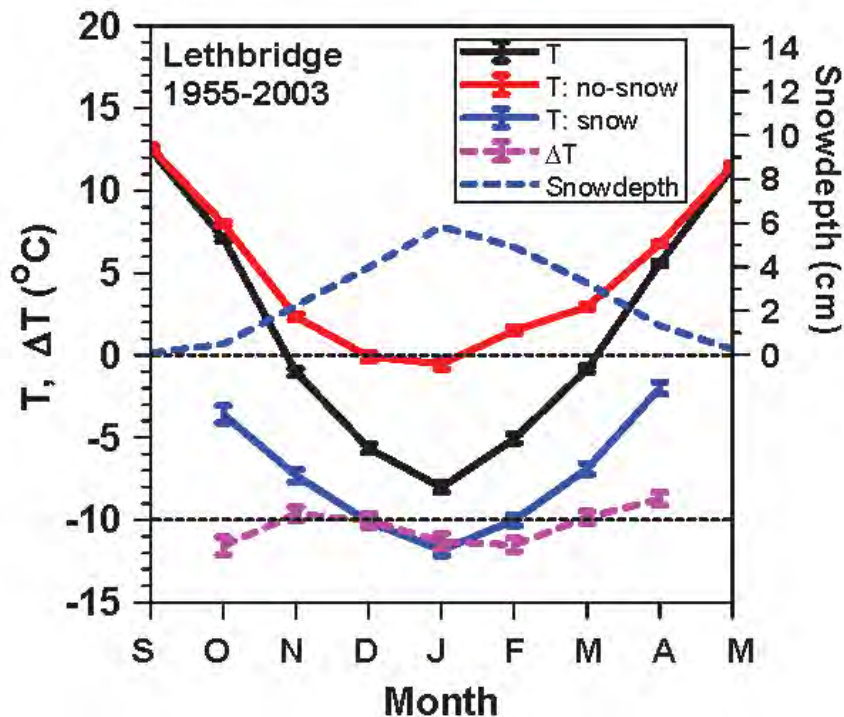


- Temperature changes 10°C with snow cover
- Snow cover is a 'climate switch'
- *Fast transitions in 'local climate'*
  - *Snow reflects sunlight*
  - *Reduces evaporation and water vapor greenhouse*

## More snow cover - Colder temperatures



# Impact of Snow on Climate



Separate mean climatology into days  
with no-snow and snowdepth >0

$$\Delta T = T:\text{no-snow} - T:\text{snow} = -10.2(\pm 1.1)^{\circ}\text{C}$$

# Impact of Snow

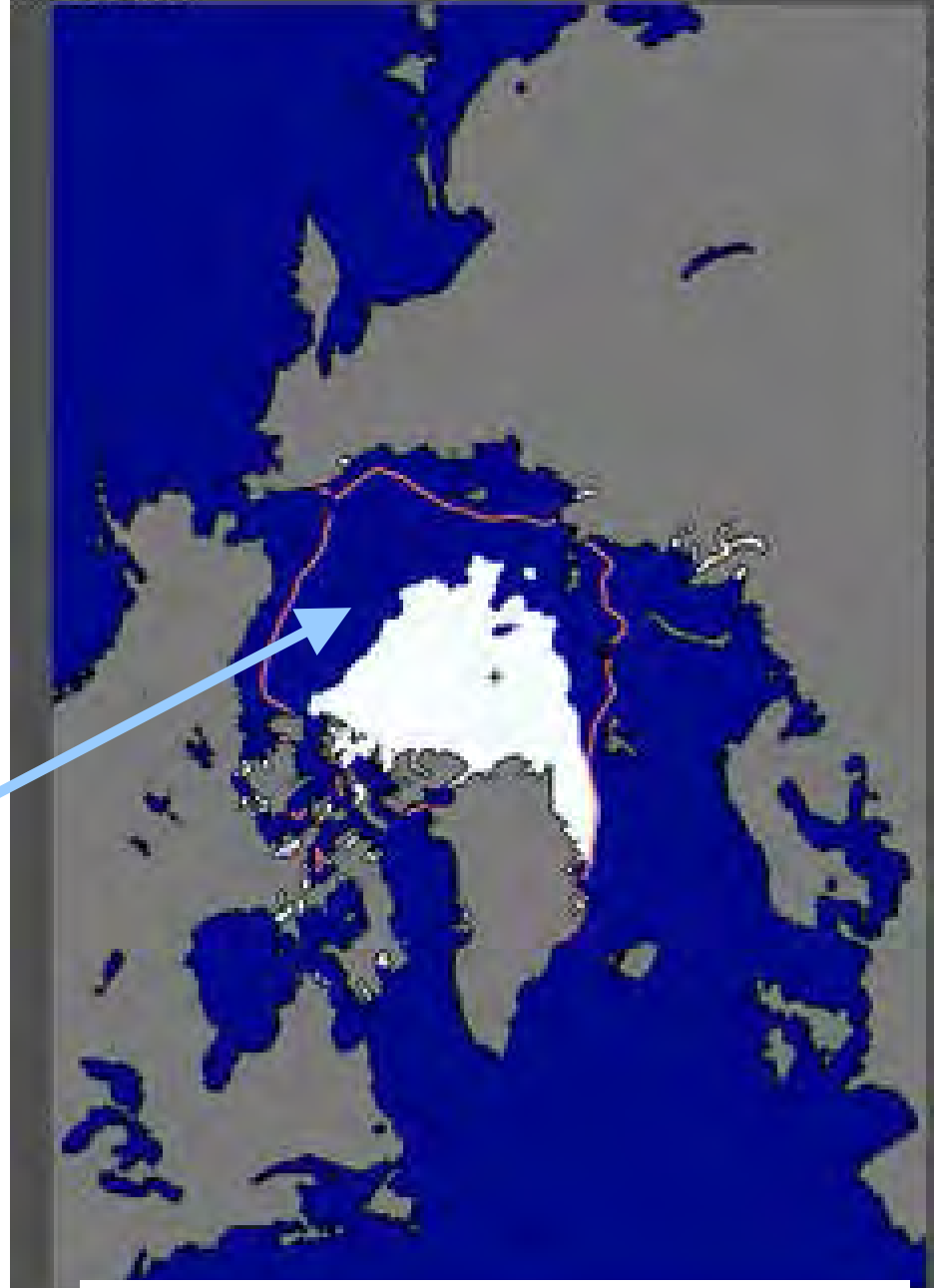
- **Distinct warm and cold season states**
- **Snow cover is the “climate switch”**

## With snow

- **Prairies: Temperature falls 10°C (18°F)**
  - **snow reflects 70%**
- **Vermont: Temperature falls 6°C (10°F)**
  - **snow reflects 35% (because more forest)**

- 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



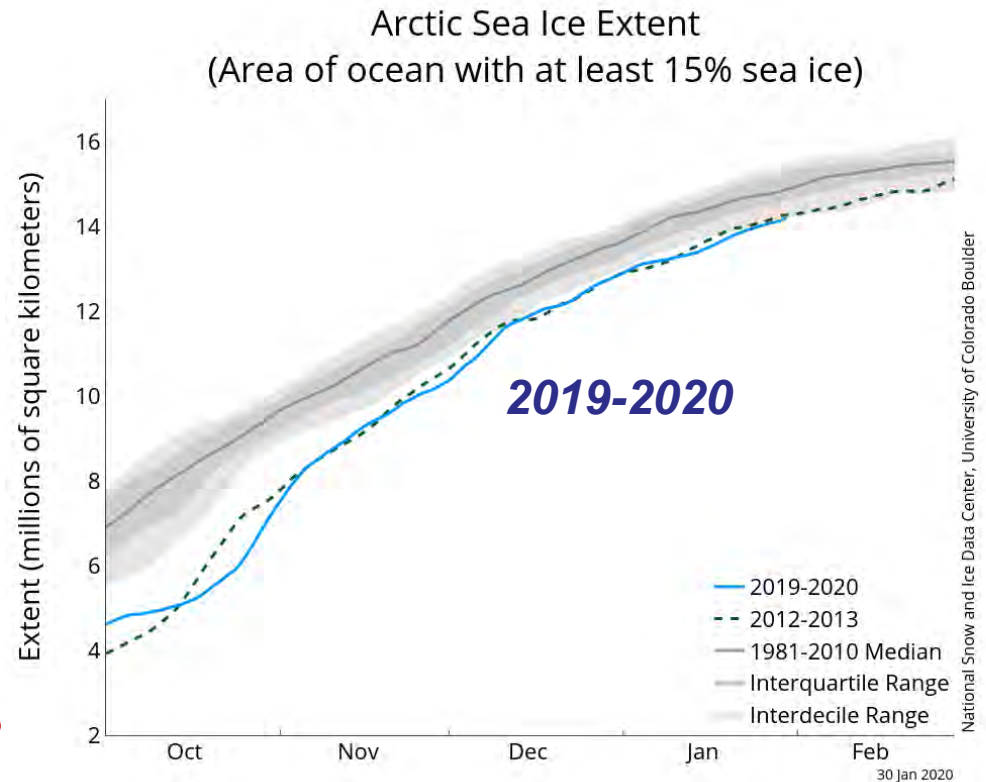


# Winters are changing

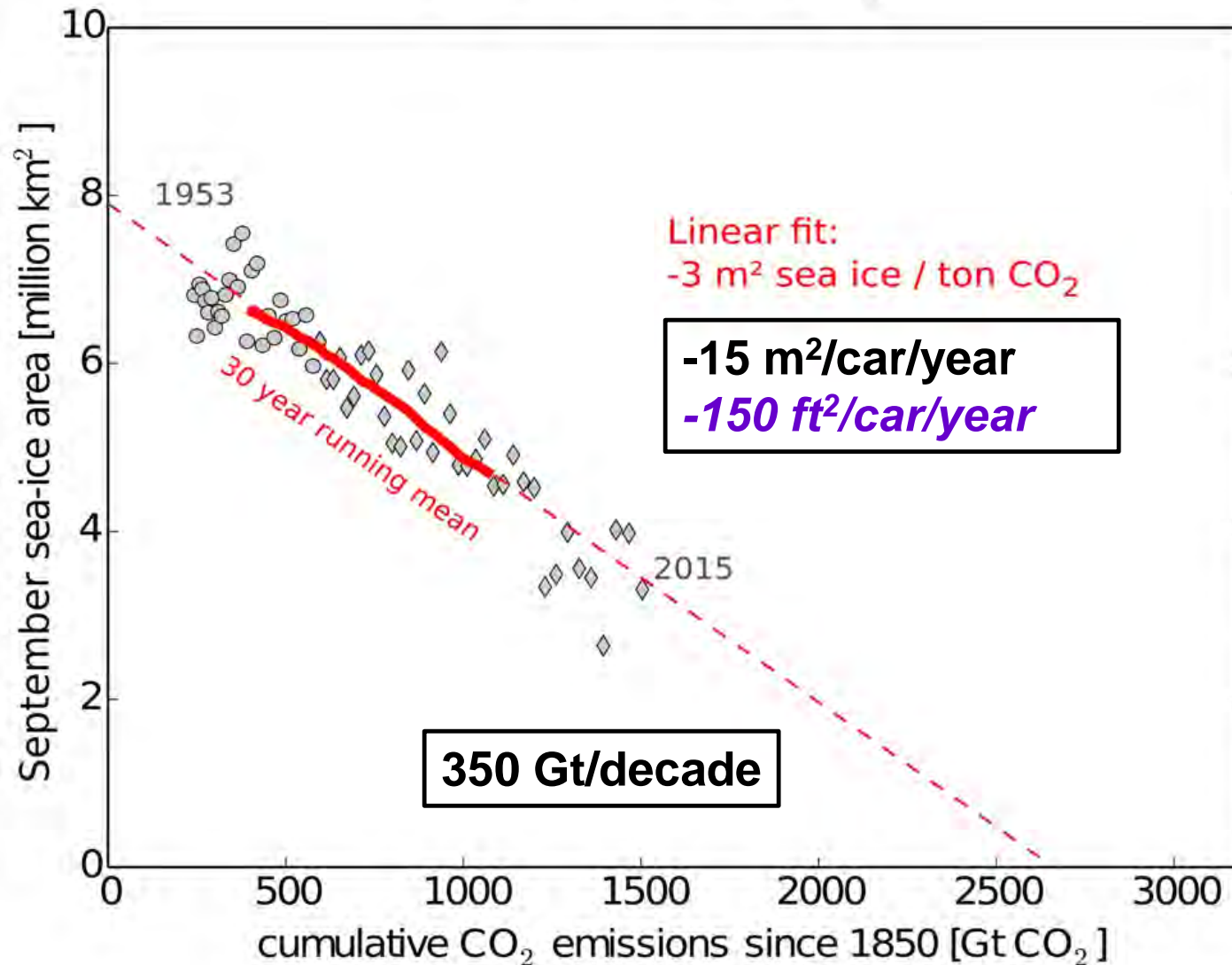
## - as Arctic warms and melts

- **Sea-ice minimum mid-September**

- **Winter sea-ice coverage falling**
- **Sea-ice thinning**
- **Polar vortex weakening**
- **Winter extremes**



# September Arctic Sea Ice Loss



# Efficient transport

- Gasoline to hybrid: 50% gain to 50mpg
- Hybrid to plug-in hybrid: now 140mpg
- Electricity from community solar array



>3000lbs and 140 mpg (44000 miles)  
Payload: 750 lbs at 60 mph (Prius Prime)



180lbs: solar panel on roof  
Payload: 350lbs at 20 mph

73lb Cargo bike;  
300 lbs at 20 mph



# **We promised to stop “Dangerous Climate Change”?**

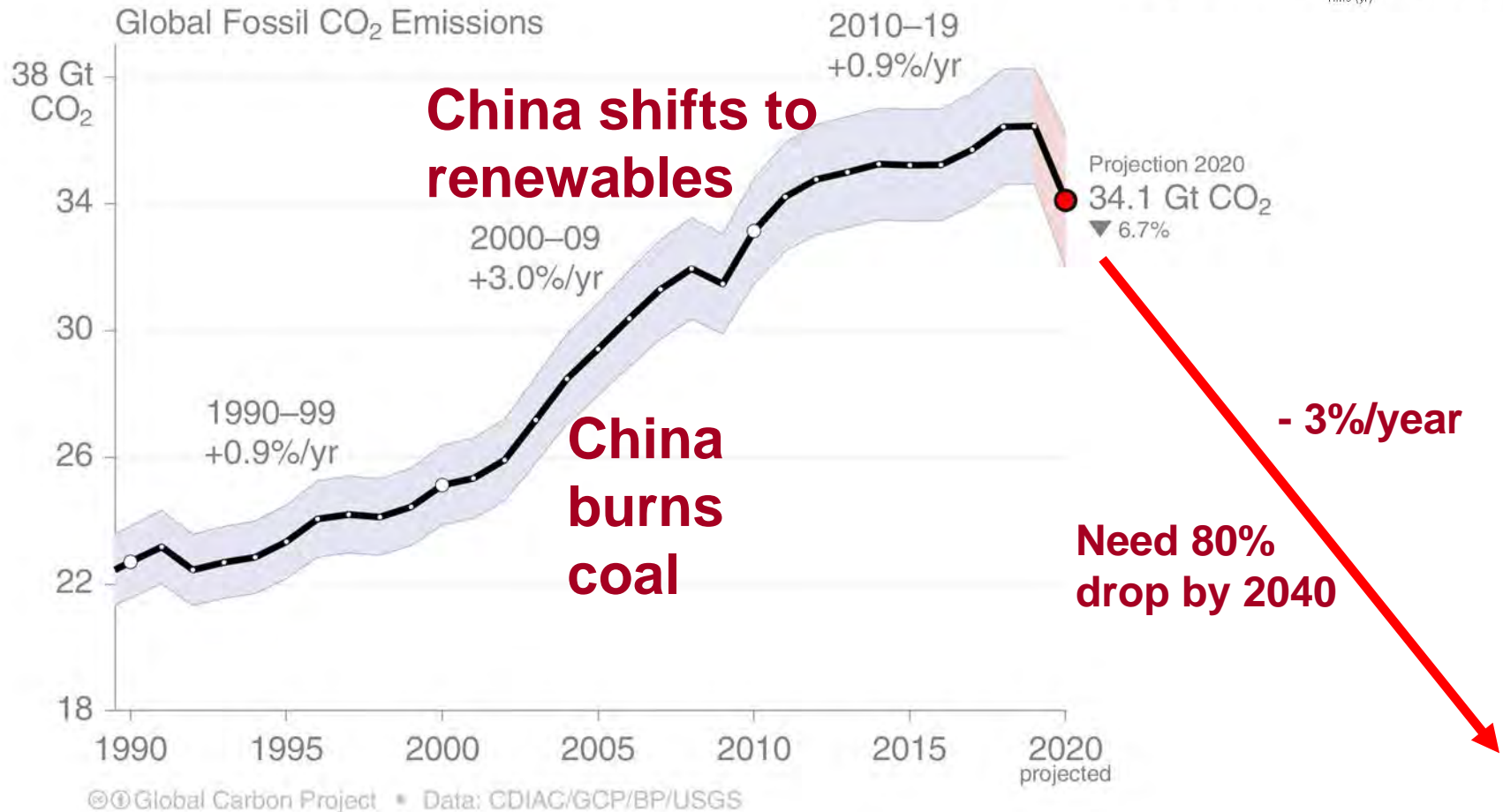
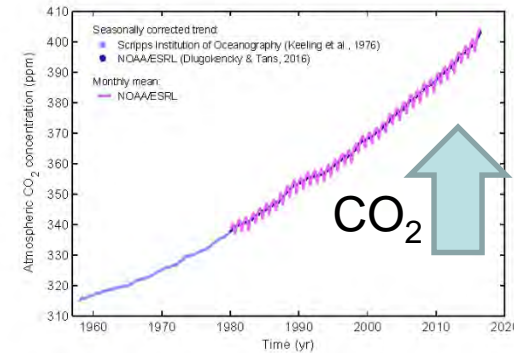
*(UNFCCC 1992)*

- **How?** Quickly stabilize atmospheric CO<sub>2</sub>
- This means an 80+% drop in CO<sub>2</sub> emissions!
- **Possible but difficult for industrial societies**
  - 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
  - **Need Fossil Carbon pricing !**
  - No ‘smart’ moral guidance; *just webs of deceit*

# 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
  - Told Catholic Church to act: *institutional resistance*
- **2017/20: US cancels the commitments it made**
  - 2019 UN report says one million species will be gone in the next decade or two from habitat loss and climate change

# Growth of CO<sub>2</sub> Emissions slowed – COVID decrease





# 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 22 years left at 34 Gt/year
- *Rapid phase-down extends period*
- *Rapid shift to renewables + storage*
  - *Needs systems engineering*

# Efficiency Comes First

- We need to double or triple our energy efficiency – *needs strong legislation*
- We cannot replace current fossil fuel use with biofuels & renewable energy
  - Fossil fuel reserves are enough to push CO<sub>2</sub> to 1,000 ppm
    - *Radically change climate/wipe out many species*
    - *In time melt icecaps, raise sea-level 100ft*

# How do we plan/adapt?

- **Future needs creative approaches**
  - **Efficient society run on renewable energy...**
  - **But it needs vision and deep change**
- **We need to work with the Earth's biosphere**
  - **People reconnected to landscape; to Earth**
  - **Manage water on landscape**
  - **Manage forest diversity for a warmer climate**
  - **Manage diversified year-round agriculture**
  - **Manage energy crops and solar farms**

# Why Is It Difficult for Us?

- The “American dream” is crumbling
  - “Economic growth” based on **fossil fuels, debt, consumerism and dumping waste streams is unsustainable** — and a disaster for the planet
- We have failed to **guide and manage technology**
  - Resulting in tremendous successes and catastrophic failures (*Climate, possibly COVID: BSL-4 labs*)
- *Climate change is existential challenge to corporate capitalism*
- *So massive hidden propaganda to deceive, deflect and encourage ‘inactivism’ (Michael Mann)*



# The Coming Crisis

- What are the challenges ahead?
  - Complex living systems: some nearing collapse
  - Fossil capitalism incompatible with livable Earth
    - *Funds webs of deception rather than change*
    - *So social, corporate & political resistance to change*
  - *Refusal to price Fossil Carbon*
- Moral issues surfacing at last
  - Sacrificing our children
  - Extinction of species & stable biosphere
- *Global Rebellion has started*

# Greta Thunberg (born Jan 2, 2003)

[Fridaysforfuture.org](https://fridaysforfuture.org)



*Swedish parliament: Fall, 2018*

*Crossing Atlantic in August, 2019*





# September 20-27, 2019

- 7.6 million, 185 countries: School strikes demanding climate action (*Ongoing*)



# Extinction Rebellion

- Destruction of Earth now a Civil Rights issue
  - Can only be checked by civil disobedience
  - To defend the rights of our children
  - To defend the rights of the Earth
- Shut down London 4/15 to 4/17/19 till UK and Scottish governments declared “Climate Emergency”
- October 7-14: actions in 60 cities around the world
  - *Motto: Compassion; awareness; courage*
  - *Visionary and creative* [\*\*\*https://rebellion.earth\*\*\*](https://rebellion.earth)
  - Force large reductions in C-emissions this decade
  - *XR-Newsletter 34\_ Hell and High Water (weekly)*



# Are Science & Policy 'separate'?

- *Separation was the traditional frame*
  - How scientists are trained
  - It protects the integrity of science
  - Invaluable for global cooperation
  - *Final collapse under Trump/ fantasy realities*
- *We cannot solve global challenges with this dualist mindset*
  - *Dates back to Greek and Roman period*
  - *Drove the rise of science, but also driving destruction of the Earth*
- *Fifty years ago, I realized science was not enough: needs wisdom – direct insight*

# What are Your Responsibilities?

- Just do what society expects?
  - Be docile servants; leave policy to ‘others’
  - Avoid public engagement and politics?
  - *Let politicians/media fabricate fictitious science?*
- Or recognize
  - Climate change is existential issue for humanity, the future of the Earth and its ecosystems
  - Understanding brings responsibility
  - *Your skills essential to create livable future*
  - *Support yourself by going deeper...so that your patterns of thought shift*

# Discussion

***Real info:*** [climatecentral.org](http://climatecentral.org), [cleanet.org](http://cleanet.org)  
[www.realclimate.org](http://www.realclimate.org), [skepticalscience.com](http://skepticalscience.com)

***Rebellion:*** [350.org](http://350.org), [Fridaysforfuture.org](http://Fridaysforfuture.org),  
[Rebellion.earth](http://Rebellion.earth)

***(<https://alanbetts.com>)***





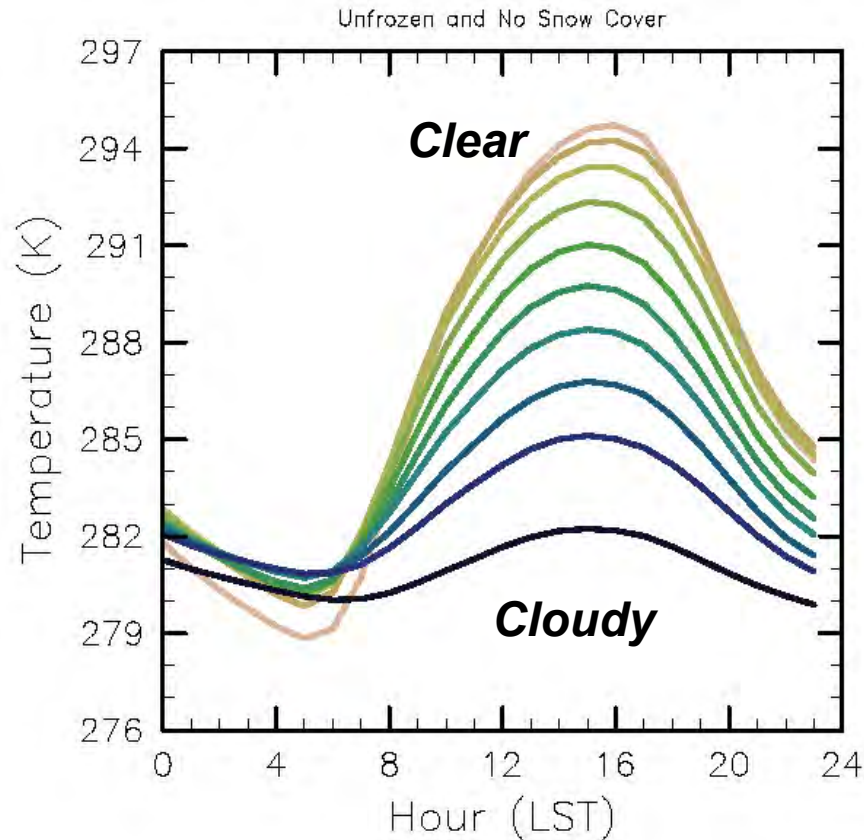
# What is a pollutant?

- **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<sub>2</sub> 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*

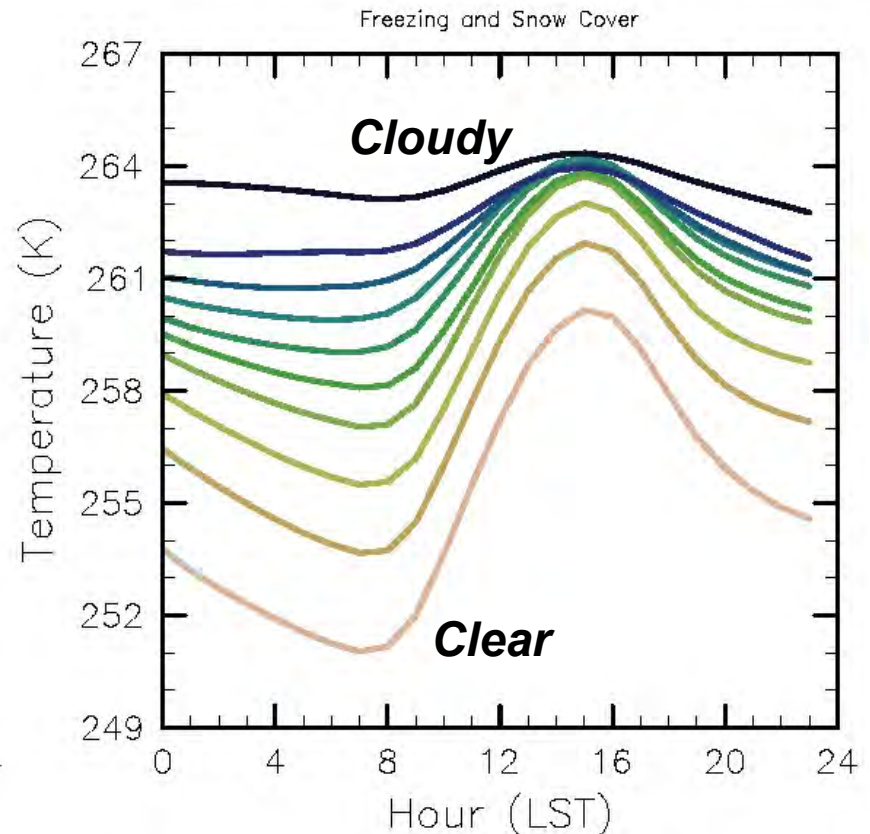
# Warm & Cold Climates: $T > < 0^{\circ}\text{C}$

## *Effect of Clouds 'Reversed'*

$T_m > 0^{\circ}\text{C}$ : no snow: 150,000 days



$T_m < 0^{\circ}\text{C}$ : snow: 75,000 days

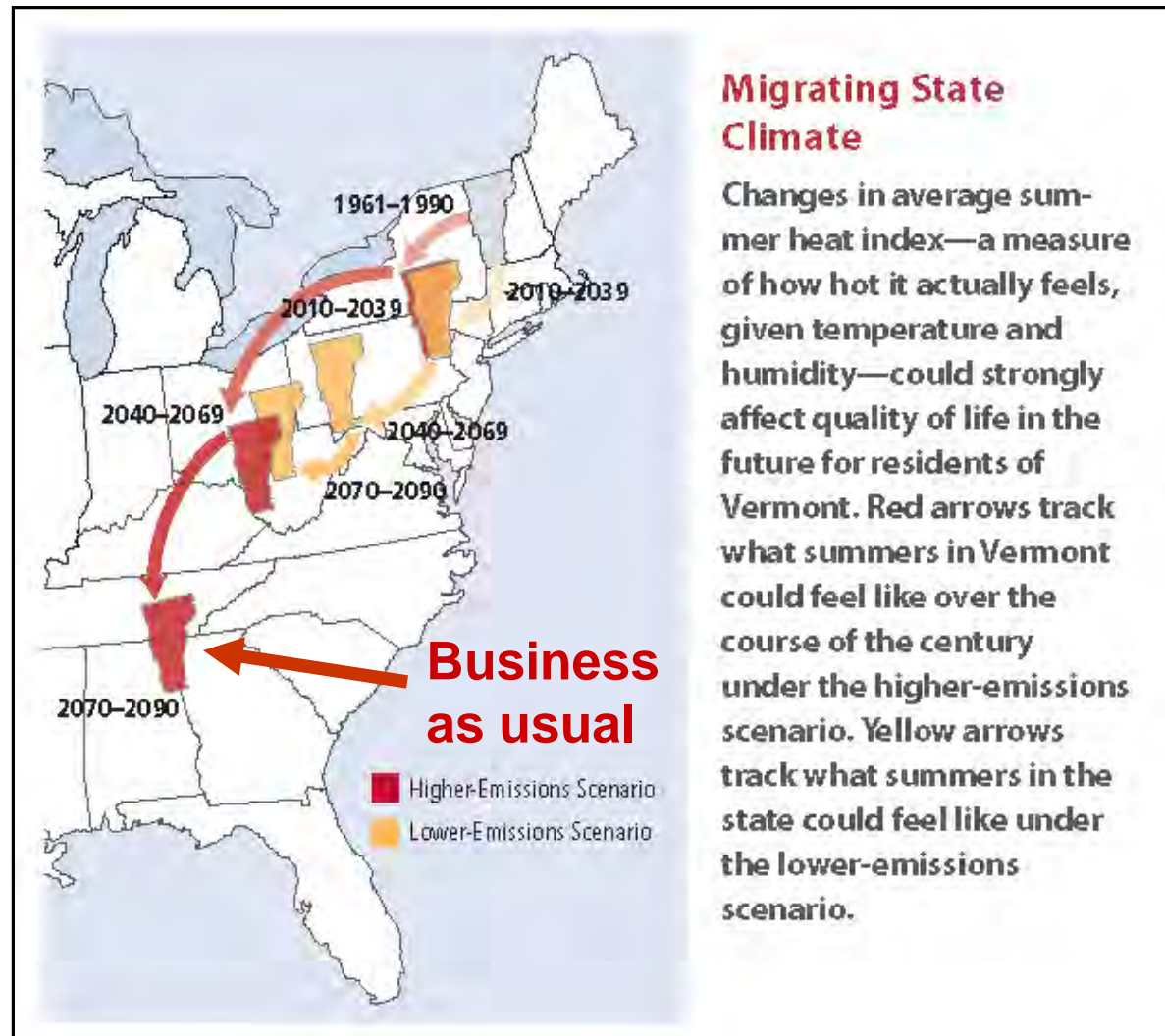


- **Warm  $> 0^{\circ}\text{C}$ : Clouds reflect sunlight**
- **Cold  $< 0^{\circ}\text{C}$ : Clouds are greenhouse & snow reflects sun**

# Vermont's Future with High and Low GHG Emissions

What  
about VT  
forests?

Sub-tropical  
drought areas  
moving into  
southern US



**NECIA,  
2007**



# January 10 and 12, 2018



**January 10, 2018**

**After cold snowy period  
 $T_{\min}$  down to -10 to -20F**



**January 12, 2018**

**After  $T_{\max}$  up to 50F**