



# **Caring for the Earth**

***The Climate Emergency is here***



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***Rochester & Stockbridge  
Communities  
Feb 17, 2020***



# Outline

- **Science of climate change**
  - Global and local
  - What is happening in the Northeast?
- **The catastrophe we face**
  - How can we stabilize the climate?
  - What are our responsibilities?
    - To our children
    - To the Earth
  - *Will we sacrifice them to “Business as Usual”?*
  - *Or will we creatively transform society?*
    - *With a new mindset!*

# Strategies for Resilience

- Understand technical/ecological issues
  - And place great value on future
- 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 climate change
  - Catastrophic costs for humanity and Earth’s ecosystems
  - Community resilience & resistance!
  - Needs imagination and creativity - which inspire!

# Different Mindsets

- ***Technology will save us***
  - ***We are in charge: no need to change behavior***
  - ***Economics based on individual consumerism produces 'wealth'***
  - ***Oil has made us rich***
  - ***Inventions will power the future***
- **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
  - Exploit & subdue natural world
  - Maximize quarterly profits
  - *[Driving climate change & ecosystem loss]*
- **Indigenous mindset**
  - Ecocentric: respecting life and nature
  - Shared resources, holistic
  - Long-term view
  - *[Not part of our education]*

# 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, since they fund politicians
  - Choices must be “cost-effective” now: future costs can be discounted or paid for later
- Climate change and current economics are incompatible
  - since Earth does not discount the future - accumulates energy imbalance in oceans
  - Catastrophe ahead for our children and all life
  - Embracing indigenous worldview essential

# Fundamentals

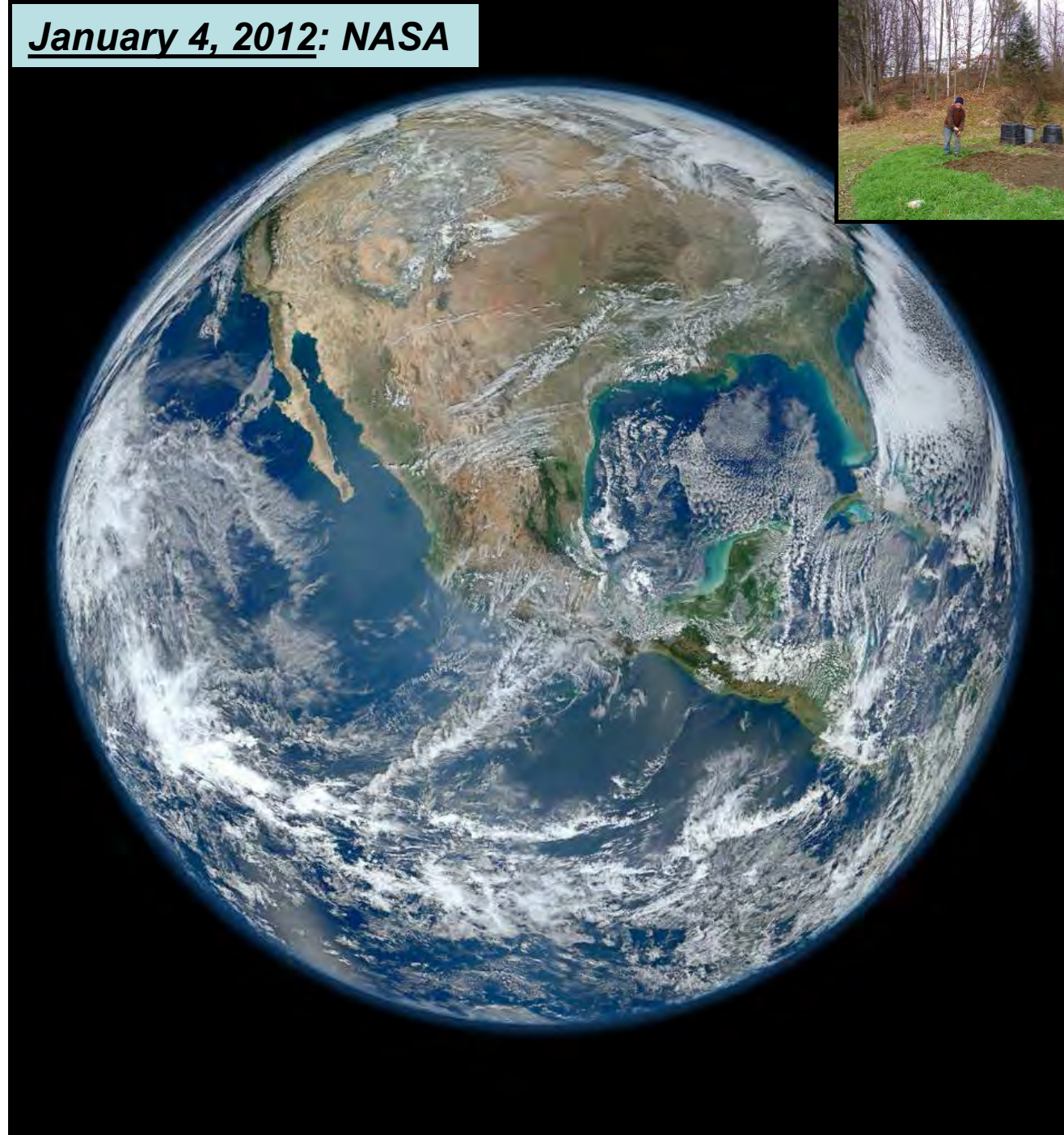
- ***Burning fossil fuels: transforming climate***
  - *Many water cycle amplifying feedbacks*
  - *Heading for high CO<sub>2</sub> “Hot-house climate”*
  - *Climate extremes increasing*
  - *Severe weather costs: \$300B in US in 2017*
  - *Long memory: decades to centuries*
- **Avoidance of responsibility for decades**
  - Politicians, professionals, public
  - Climate change 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, economics and financial system
  - 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*



## 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





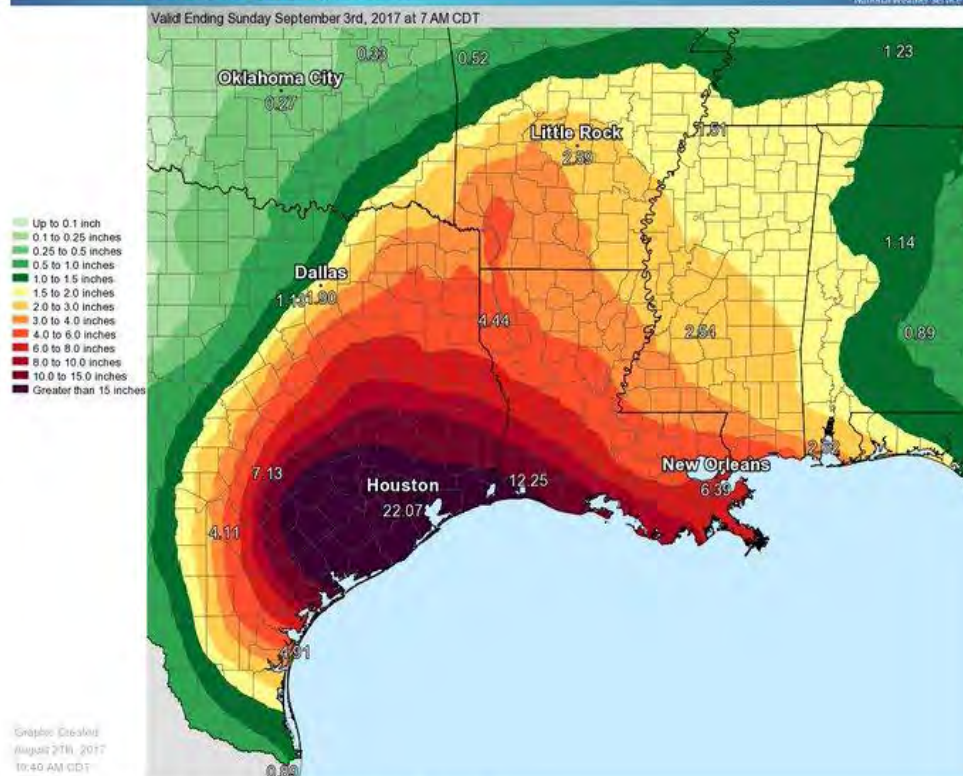
# Challenge to Forecast & Emergency Services



**National Weather Service**  
@NWS

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

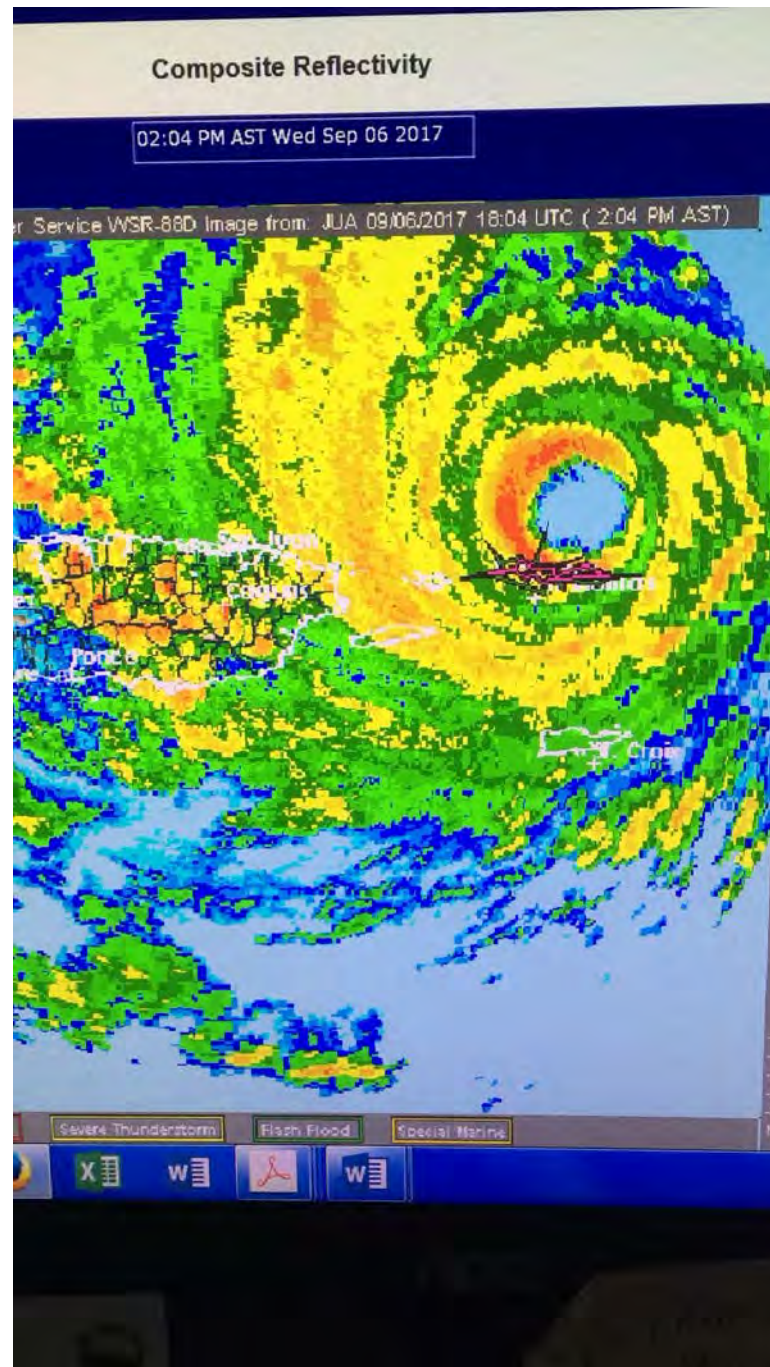
## Forecast Precipitation



21.8K 11:44 AM - Aug 27, 2017

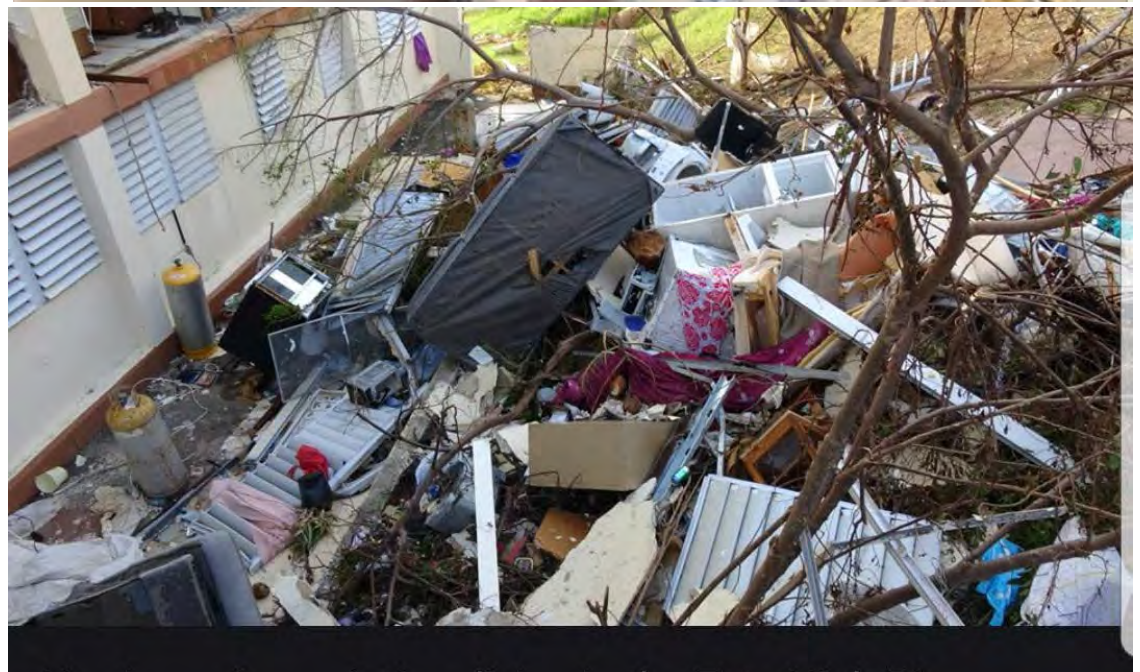
**2pm Sept. 6**  
***Category 5\****  
***IRMA***  
**grazing**  
**St Thomas**

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





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



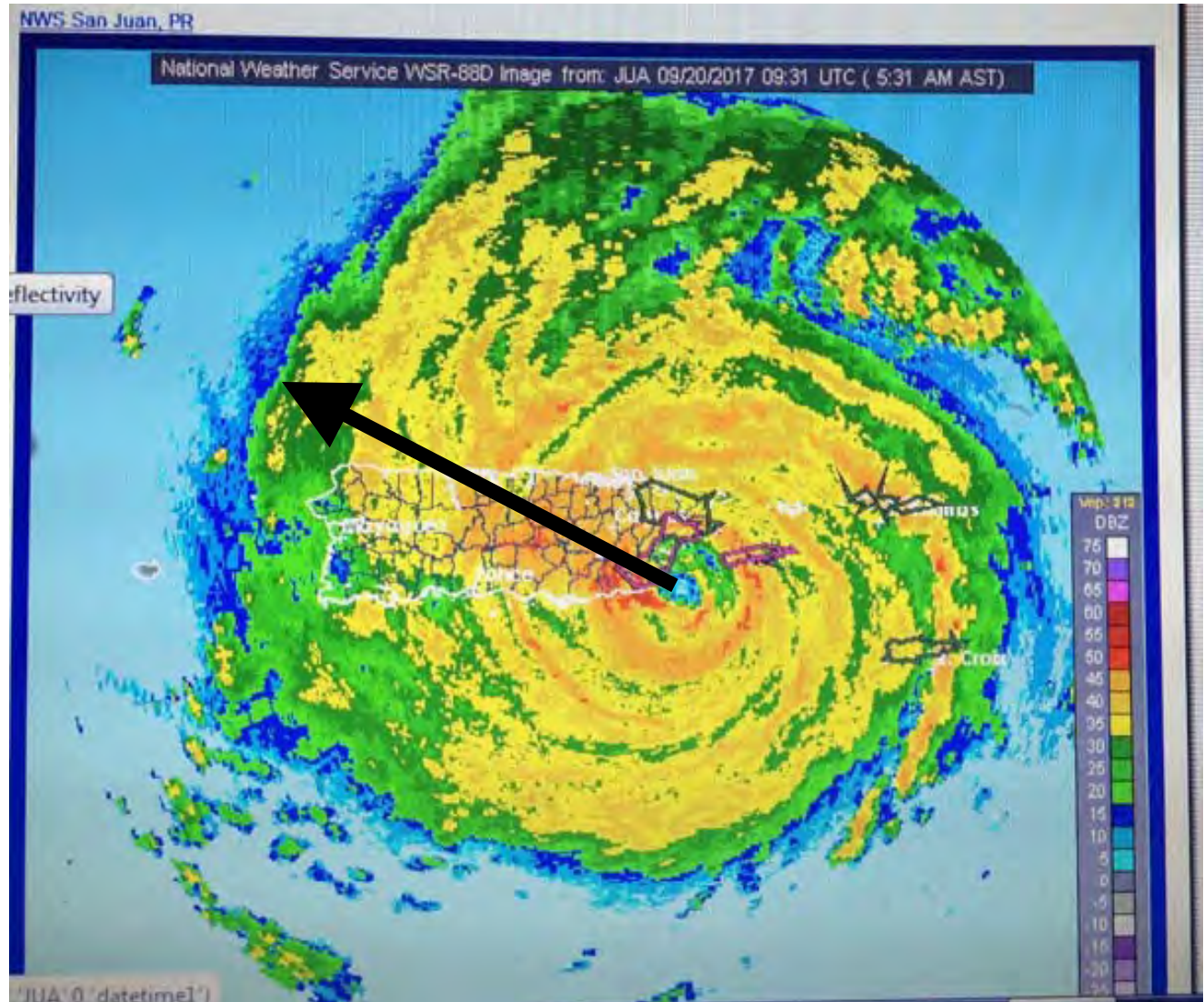
# ***Maria: 5:30am Sept. 20, 2017***

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

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

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

***Narratives:  
[alanbetts.com](http://alanbetts.com)***





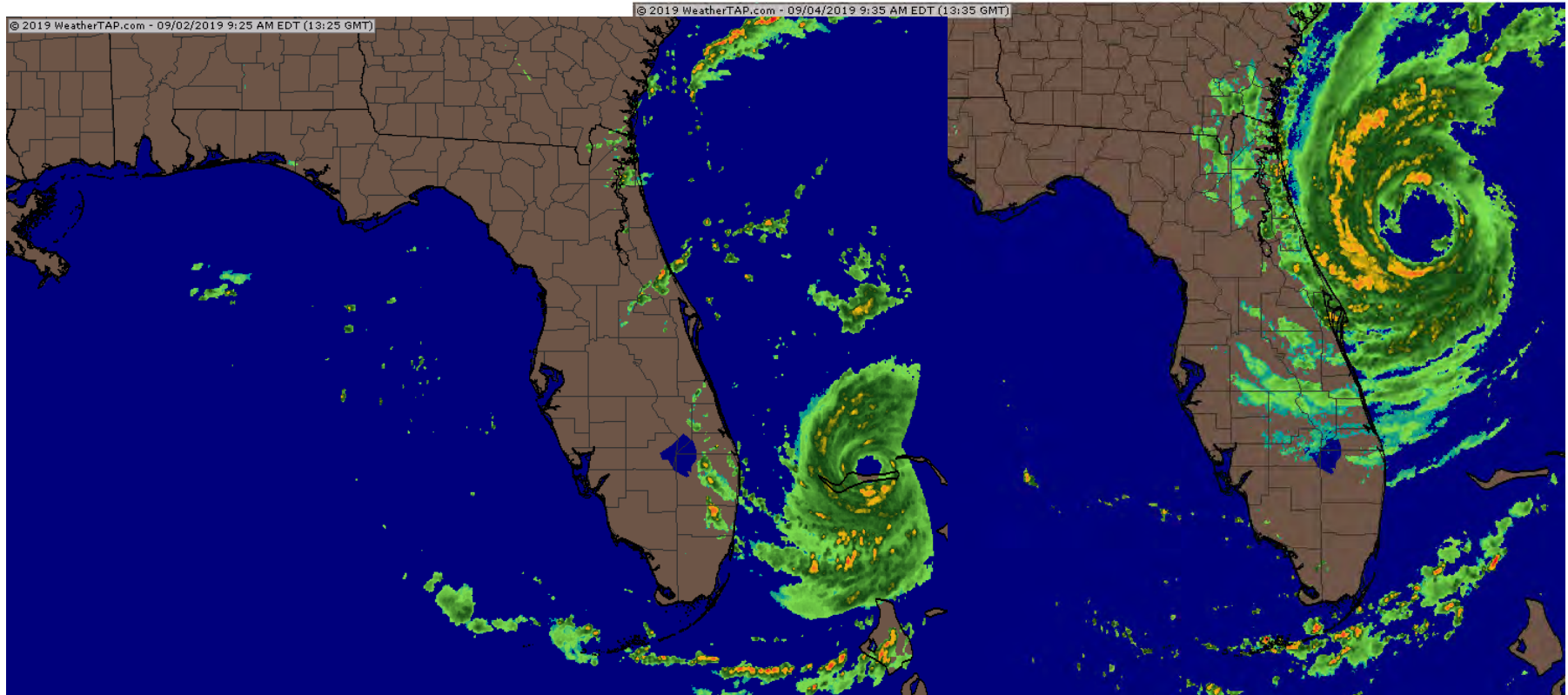
# July 2019: track of Barry



**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

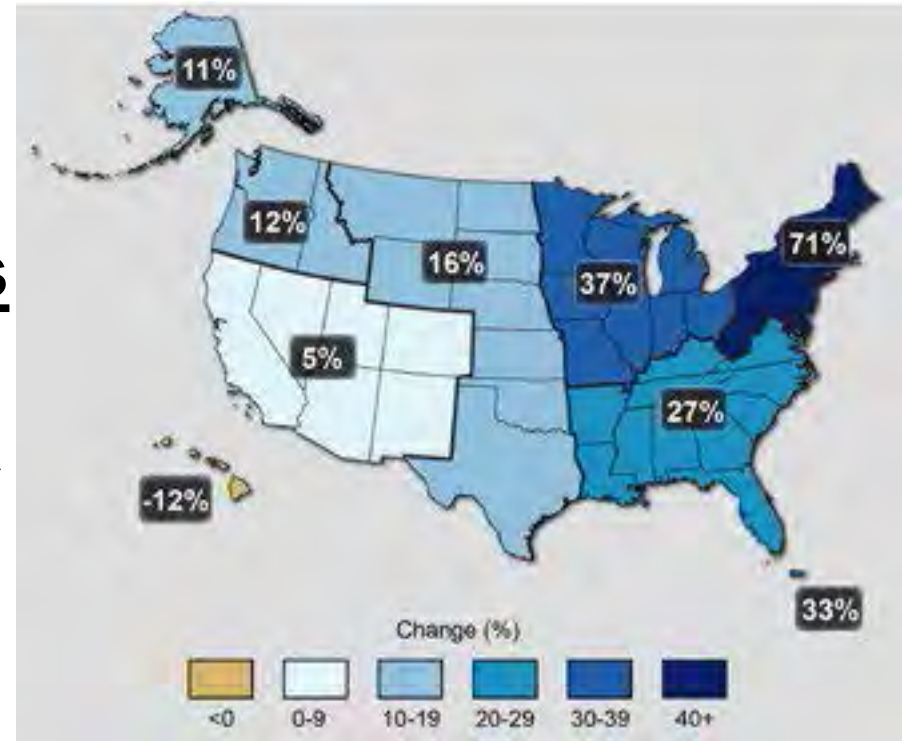
- Southeast Africa cyclones *were very rare*
- *Idai* in March left 1000 dead from flooding
- Cat 4 *Kenneth* in April, 2019
  - 60 in of rain





# 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.
- **71% increase in Northeast**



(Walsh et al., 2014)

# TS Irene

*Rte 131,  
Cavendish  
Sept, 2011*

**Roads in valleys**

**Massive damage**

**Some roads took  
months to repair**

**Wake-up call**



# 2011 Classic Flood Situations

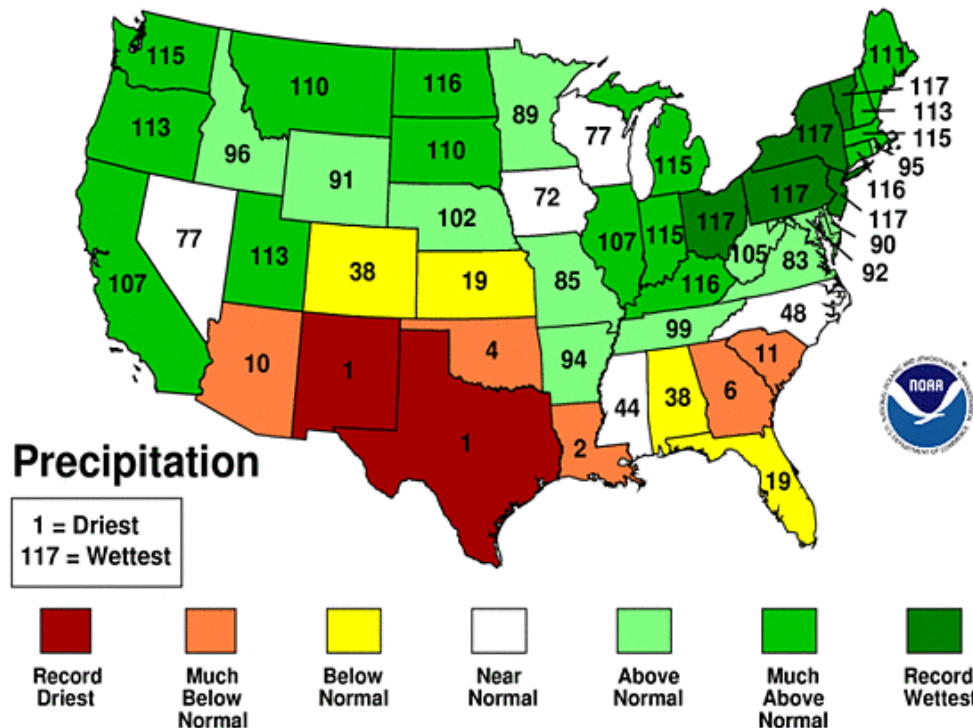
- **Spring flood:** heavy rain and warm weather, melting large snowpack from 2010-11 winter
  - 70F (April 11) and 80F(May 27) + heavy rain
  - record April, May rainfall: 3X at BTV
  - Severe floods on Winooski and Adirondack rivers
  - Lake Champlain record flood stage of 103ft
- **Irene flood: tropical 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**
  - Including Rochester & Stockbridge
- **State emergency systems flooded**
- **FEMA: 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 rescue services across mountains
  - *Communication networks critical*

# Flooding increasing

- Warmer temps = higher rain-rate (4%/°F)
- As Arctic warms 2X 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
- As extremes of flood and drought increase
  - Need to store water in ground for summer use
- Summer water extraction by roots from ground storage damps 60% of precipitation anomalies: 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”
  - Missing as we exploit the environment to support corporate profits; dumping the costs on the poor, the indigenous, our children and all life
- 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)***

# 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 much 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



# 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



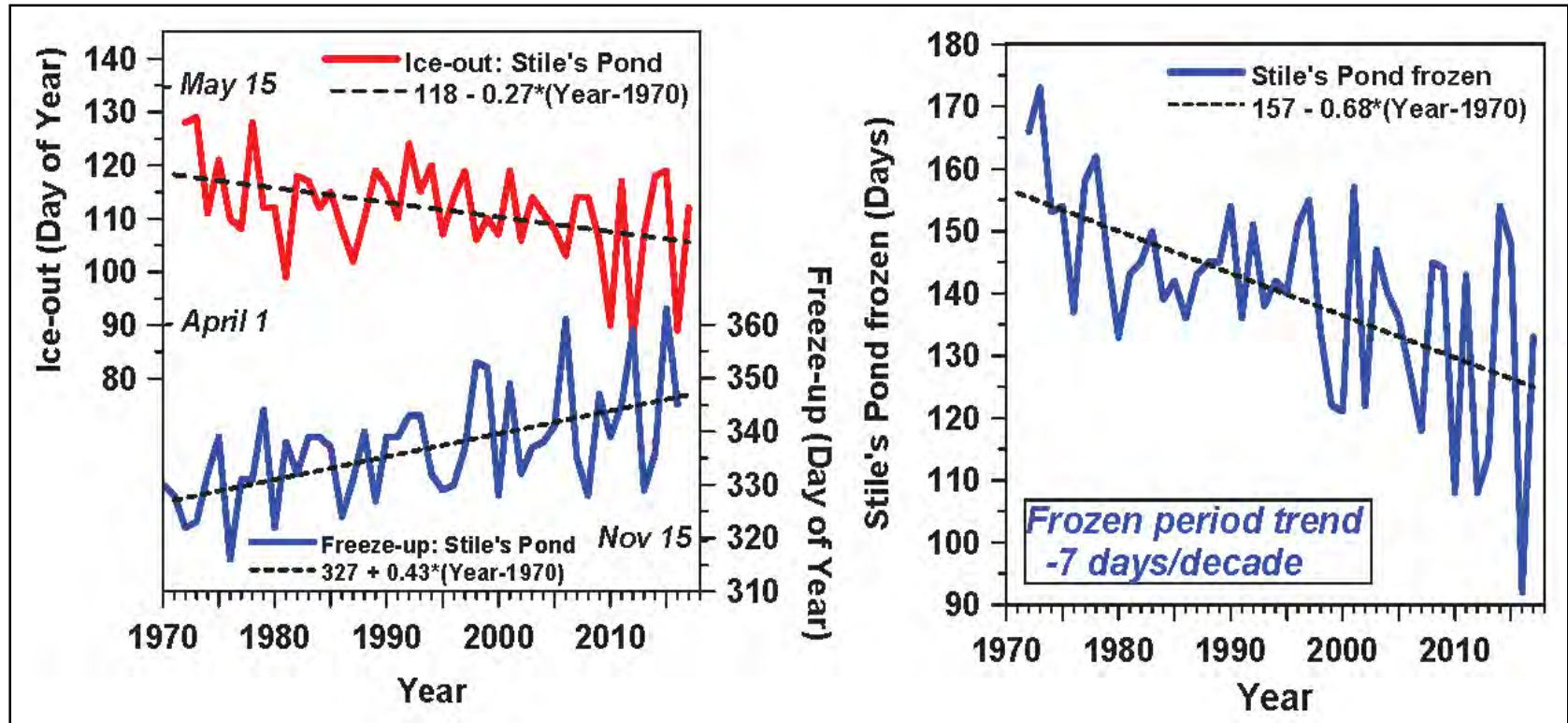
**January 3, 2020**  
**Digging cover crop**  
**(smart resilience)**



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

# Marker: Lake Freeze-up & Ice-out

## Frozen Period Shrinking: variability huge

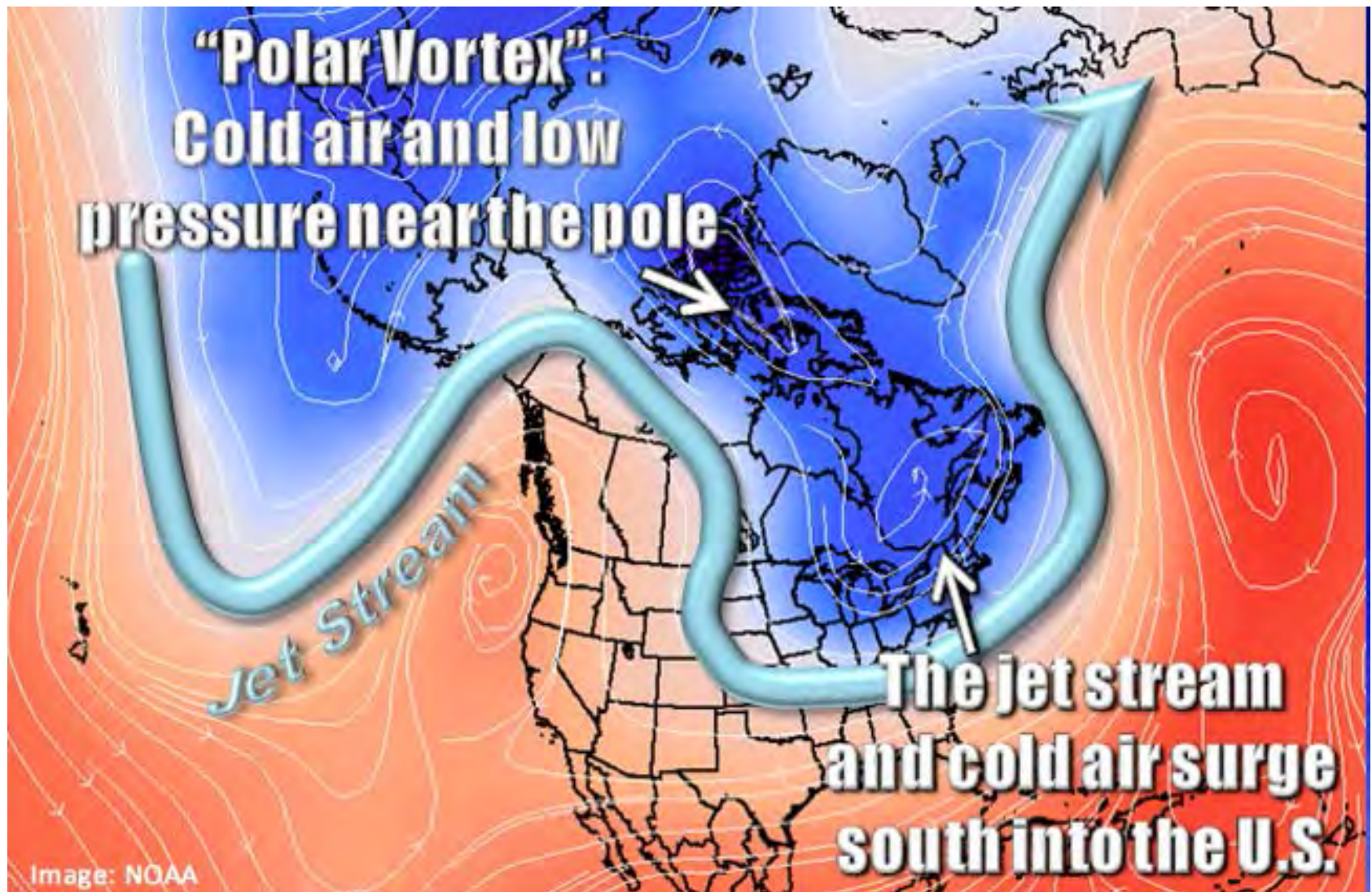


- Freeze-up later by **+4 days / decade**
- Ice-out earlier by **-3 days / decade**
- Lake frozen period trend **-7 days/decade**
- Interannual variability  $\approx$  40 yr trend

*Stiles Pond:  
"Eye on the Sky"*



# Arctic Warming: Polar Vortex Unstable





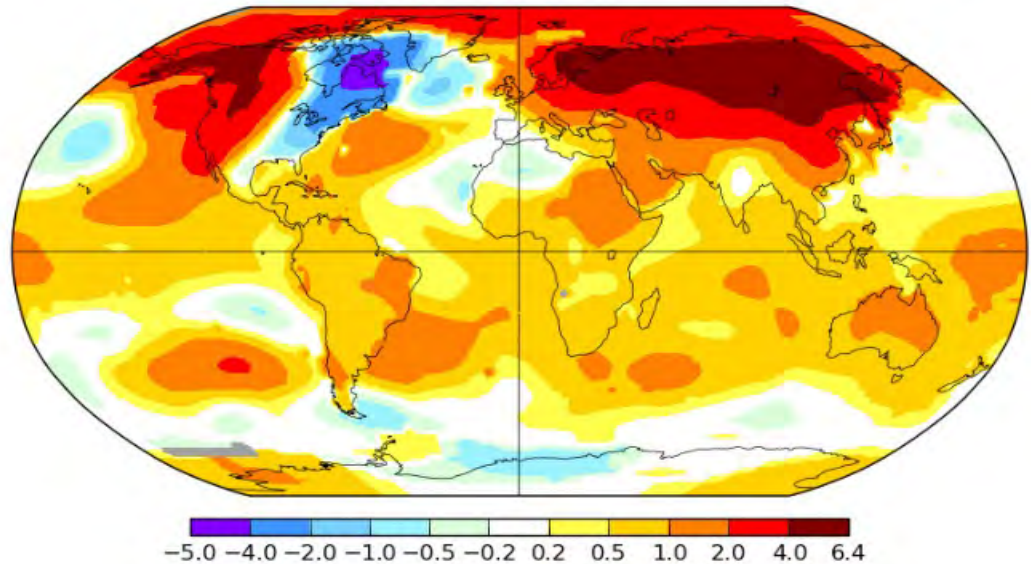
# *Jan-Feb-Mar 2015*

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



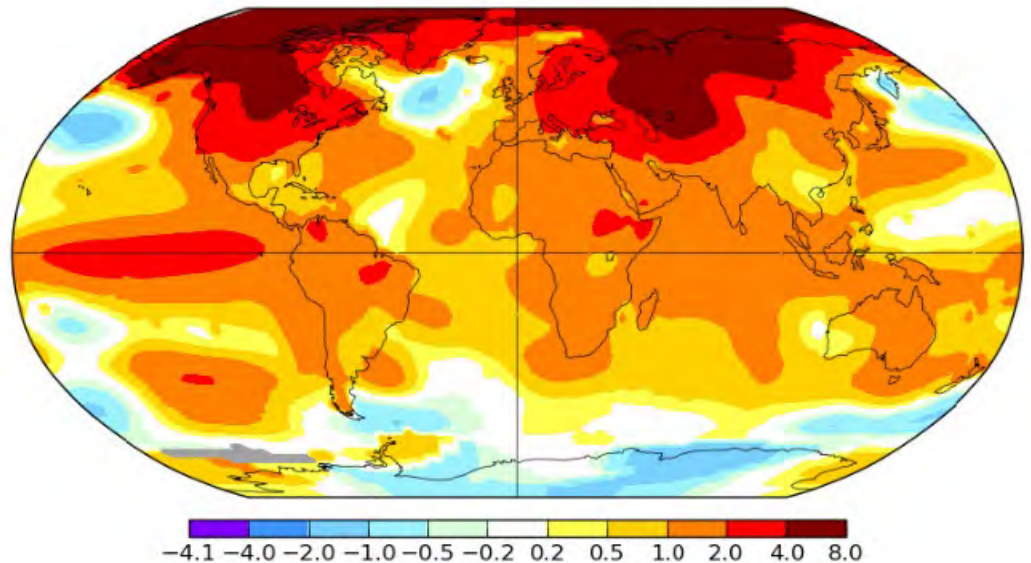
# *Jan-Feb-Mar 2016*

Warm Atlantic, warm NE, little  
snow, warm Arctic

Jan-Mar 2016

L-OTI(°C) Anomaly vs 1951-1980

1.24



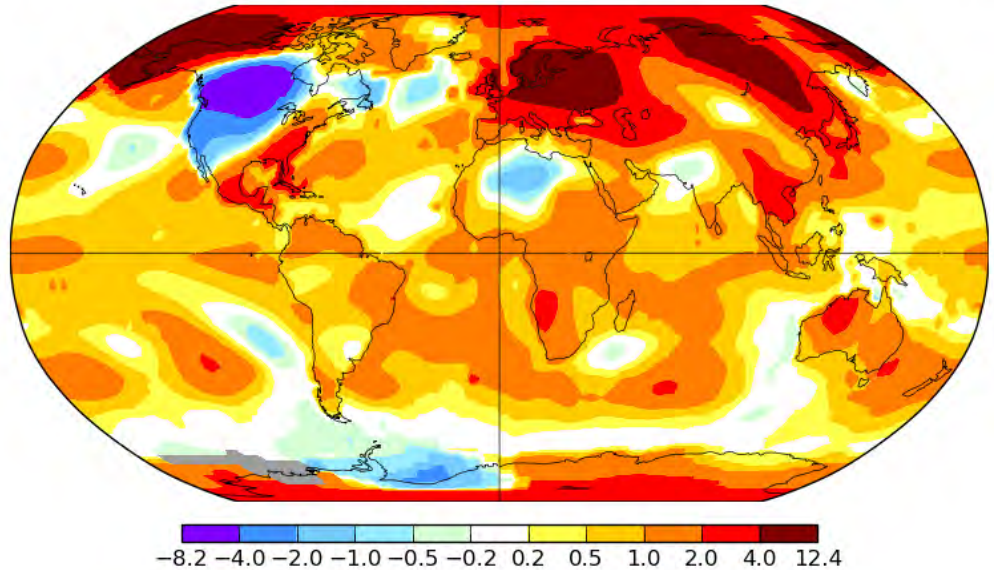
# Feb-2019

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

February 2019

L-OTI(°C) Anomaly vs 1951-1980

0.94



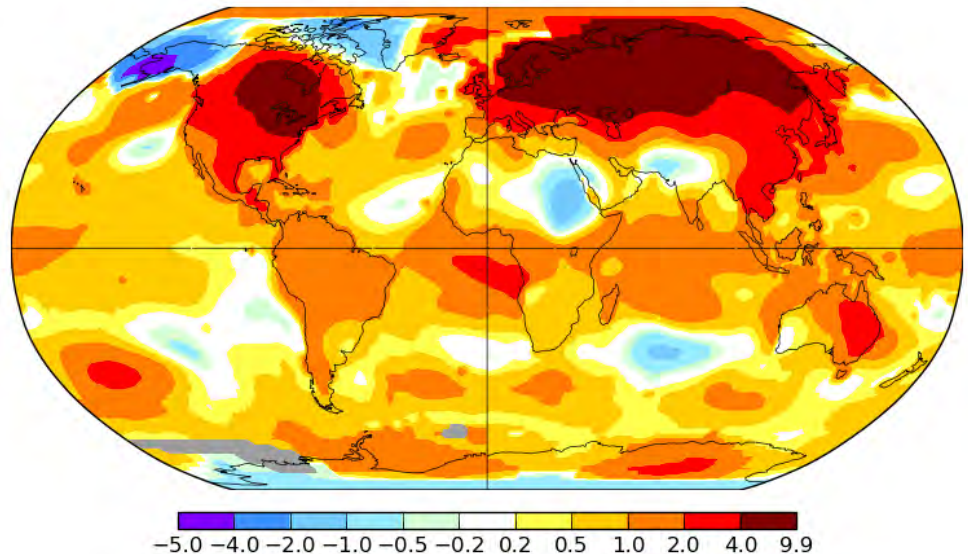
# Jan-2020

Warm US and Canada, Cold  
Alaska. Extreme warmth in Asia  
Record Global temperature

January 2020

L-OTI(°C) Anomaly vs 1951-1980

1.17

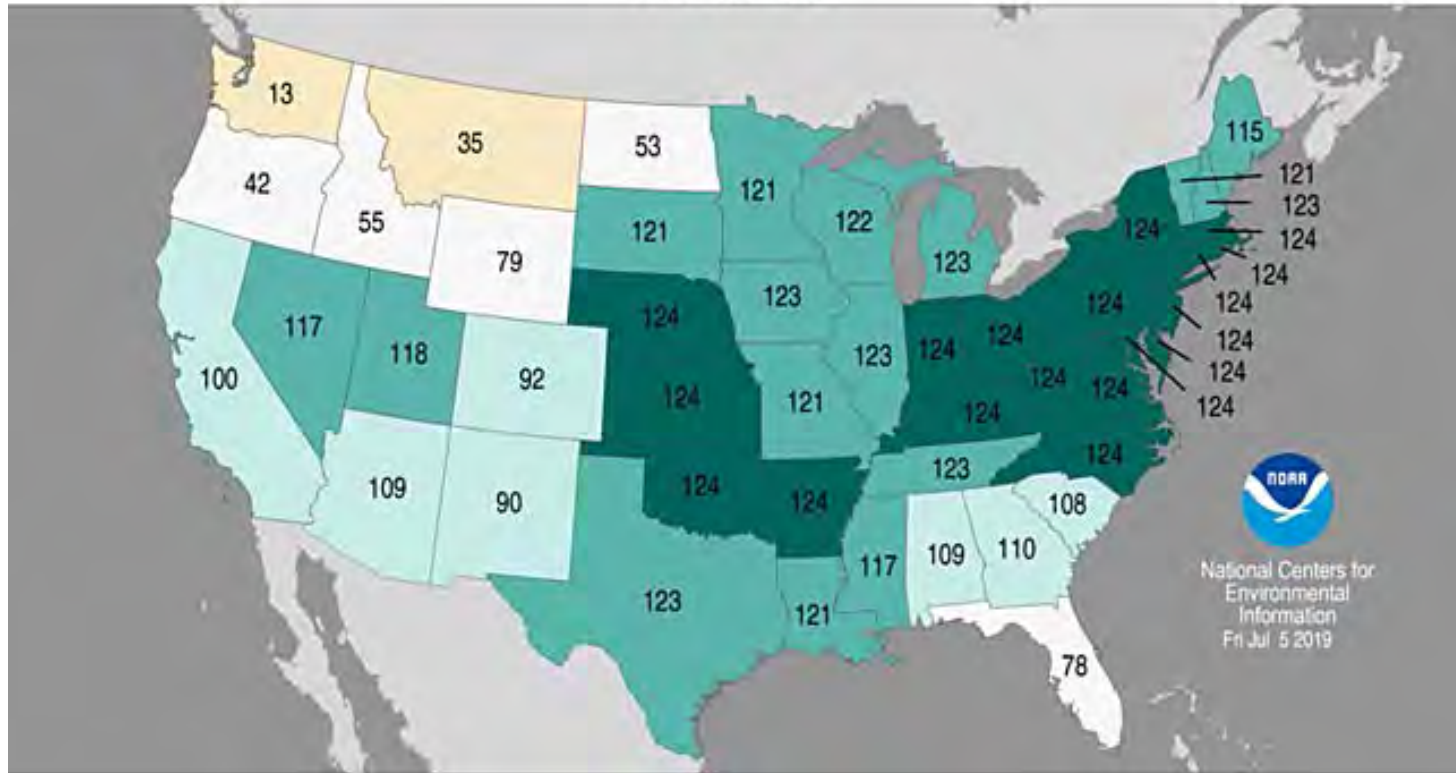


# ***July 2018 to June 2019***

## Statewide Precipitation Ranks

July 2018–June 2019

Period: 1895–2019

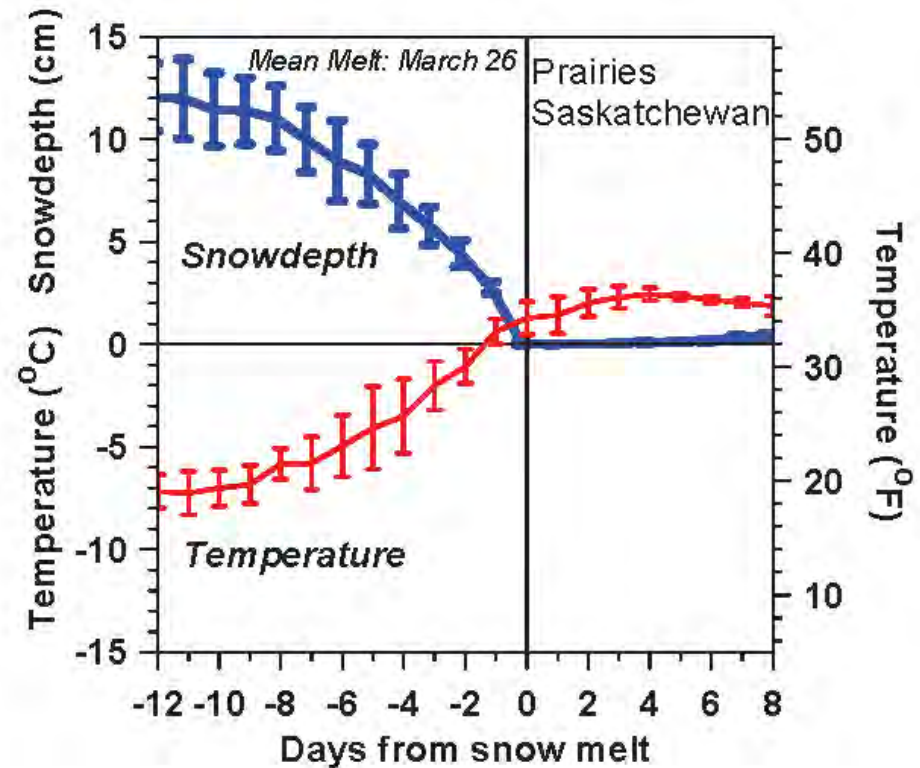
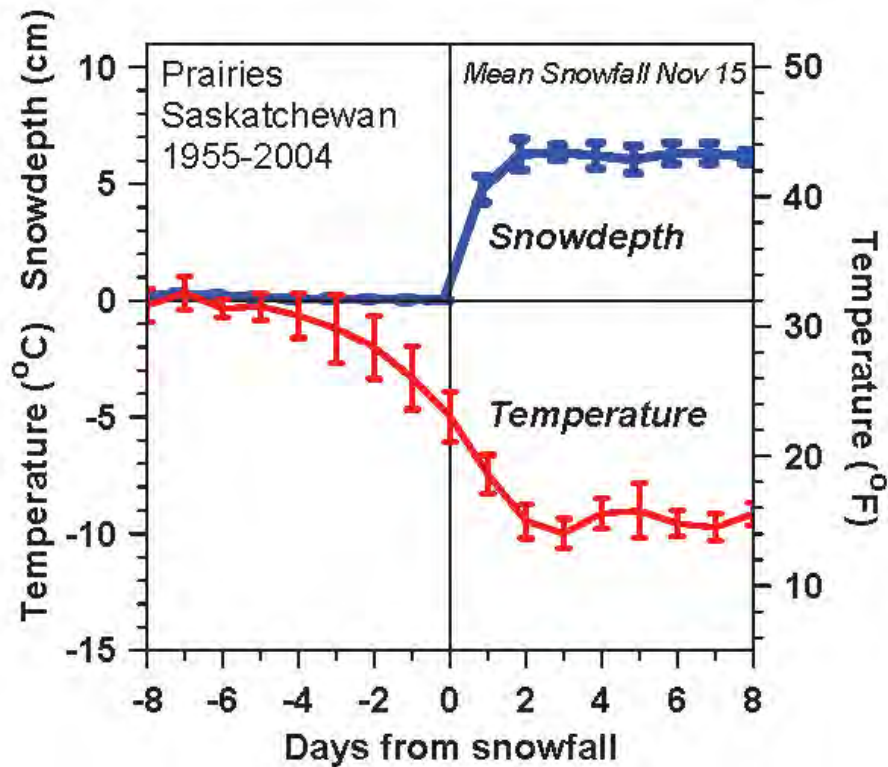


***Record Precipitation Eastern & Central US***

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

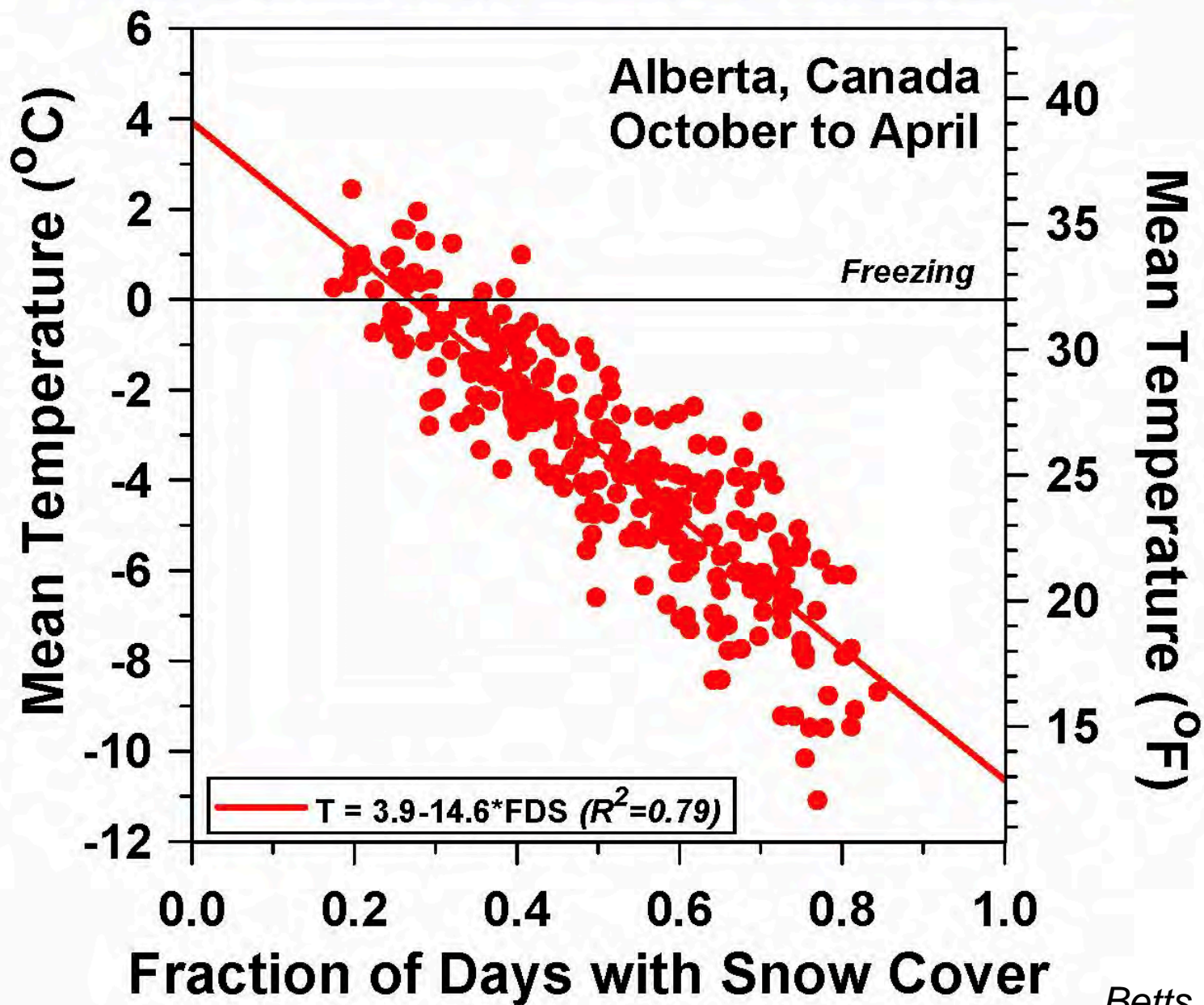


# Snowfall and Snowmelt

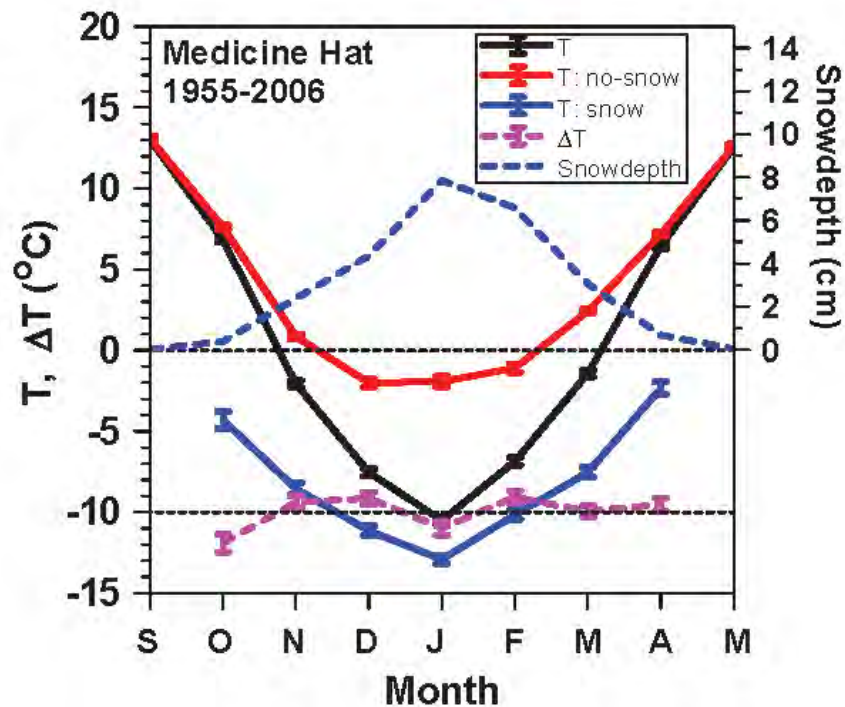
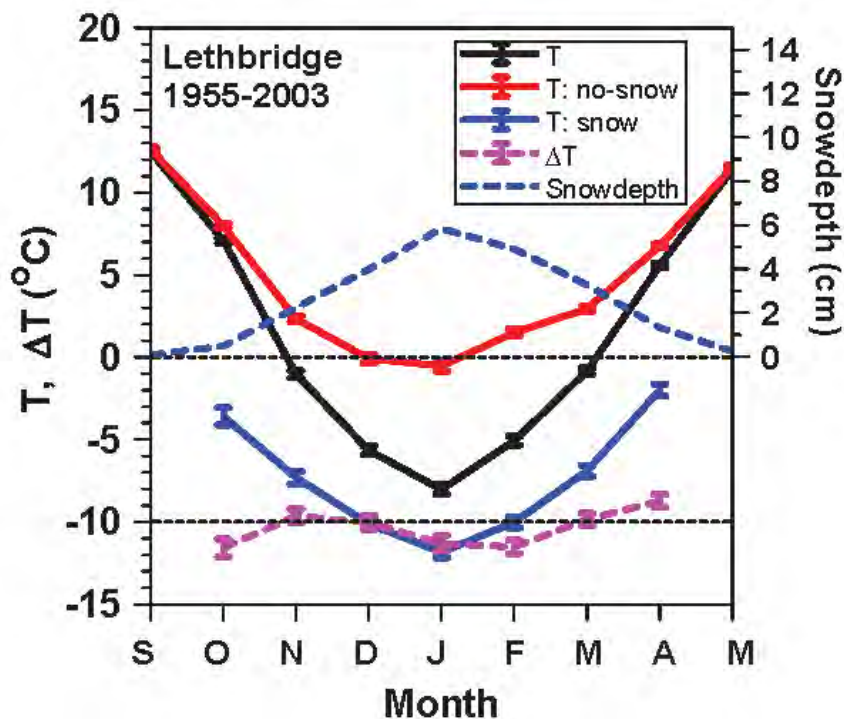


- Temperature changes 10°C with snow cover
- Snow cover is a 'climate switch'
- *Fast transitions in 'local climate'*
  - *Snow reflects sunlight*
  - *Reduces evaporation and water vapor greenhouse*

## 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

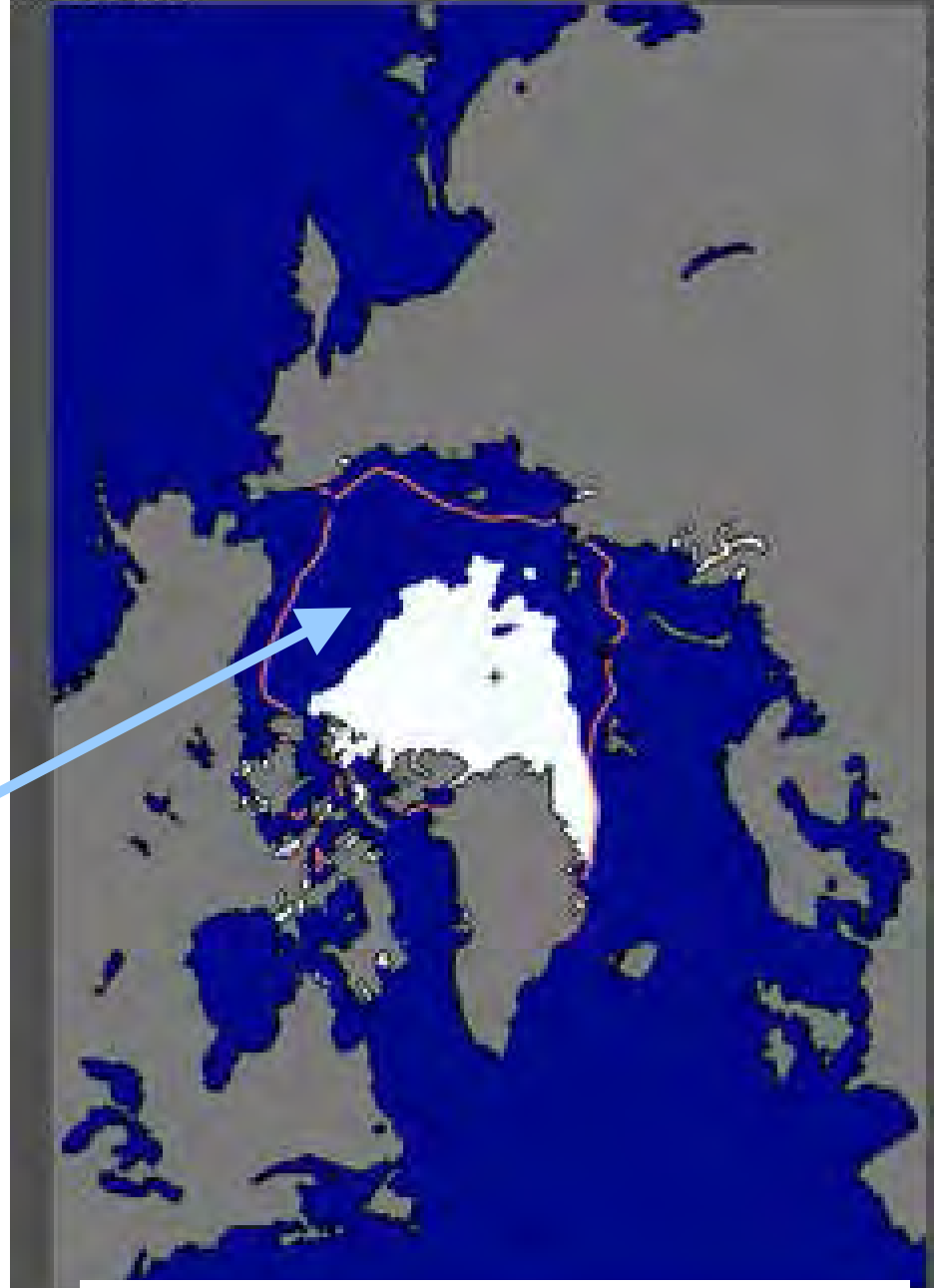
- **Distinct warm and cold season states**
- **Snow cover is the “climate switch”**

## 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)**

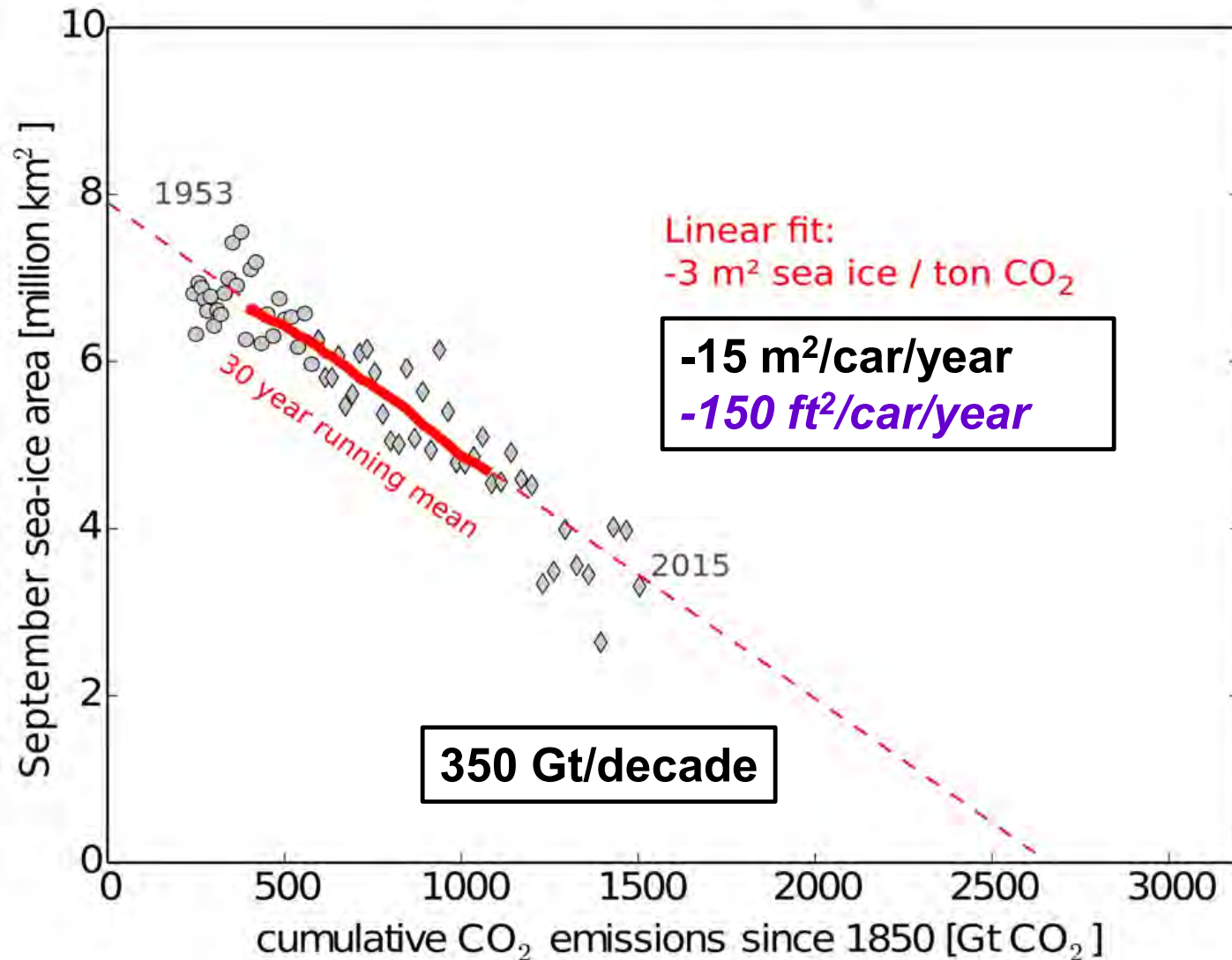
- Half the Arctic Sea Ice Melted in 2012
- Open water in Oct. Nov. gives warmer Fall in Northeast

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





# September Arctic Sea Ice Loss



# Efficient transport

- Gasoline to hybrid: 50% gain to 50mpg
- Hybrid to plug-in hybrid: now 135mpg
- Electricity from community solar array



**>3000lbs and 135 mpg**  
**Payload: 750 lbs at 60 mph**



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

**73lb Cargo bike;**  
**300 lbs at 20 mph**



# World promised to stop “Dangerous Climate Change”? (UNFCCC 1992)

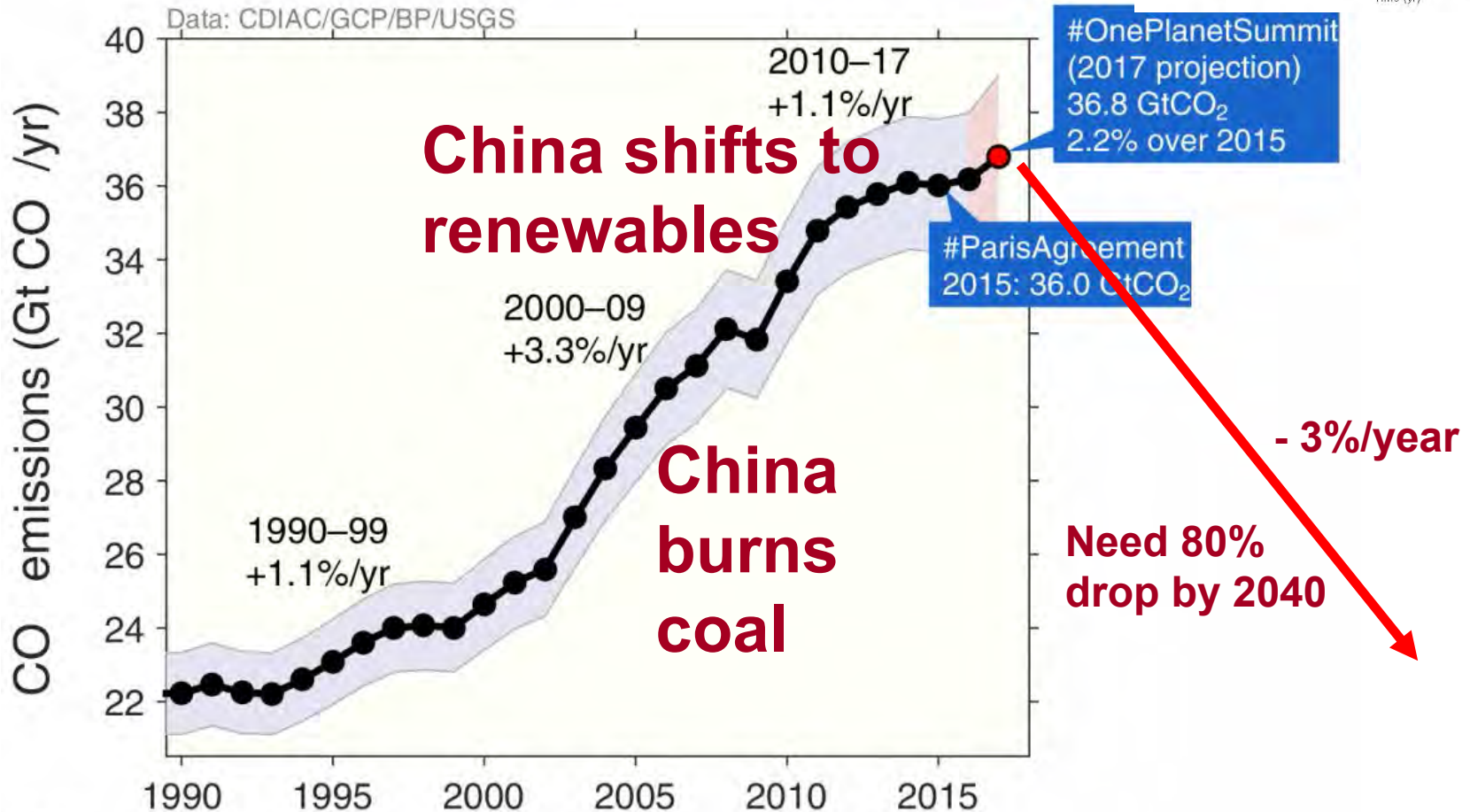
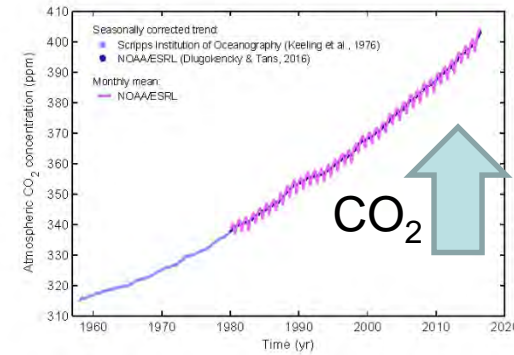
- **How?** Quickly stabilize atmospheric CO<sub>2</sub>
- This means an 80% drop in CO<sub>2</sub> emissions!
- **Possible but difficult for industrial societies**
  - Fossil fuels have driven our industrial growth and population growth for 200 years
  - “Lifestyle” has become dependent on fossil fuels
  - **Powerful vested interests**: trillions \$ at stake
  - No ‘smart’ moral guidance

# 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 – now increasing



# 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 20 years left at 37 Gt/year
- *Rapid phase-down extends period*
- *Double/triple our energy efficiency*

# What do we need?

- **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**

# Financial Interests Amoral

- **Fossil fuels reserves are worth \$20-30T**
  - Big money: “of course we will burn them”
- **Banking: JP Morgan Chase is leading US bank investing in new fossil fuel development**
  - CEO chairs business roundtable and talks soothingly about improving capitalism to create a healthier society with affordable health care and better climate policies (*Time*:2/3/20)
- **World's largest asset manager is BlackRock; also the world's largest investor in fossil fuel companies and utilities**
  - Web-site talks about “integrating environmental, social and governance practices into our investment processes to creating positive social impact”
- **Insurance industry routinely invests enormous sums in the fossil-fuel industry**



# The Coming Catastrophe

- **What are the challenges ahead?**
  - Complex living systems: nearing collapse
  - Fossil capitalism incompatible with livable Earth
  - Financial, political & social resistance to change
  - Corruption in the system at many levels
- **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 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)*



# Climate Emergency is here

- ***Last decade to avoid the worst***
  - Citizens/communities must demand action
  - Governments paralyzed by corporate \$
  - US particularly helpless
- ***Glimpse of action: 12/29/2019***
  - ***Netherlands Supreme Court ordered the government to meet 2015 climate commitments for 2020 and 2025***
  - ***Legal actions in many other countries***

# What matters in Vermont?

- **Of course we cannot fix global challenge alone**
  - Don't wait for Montpelier: partial solutions by 2050 (*'while growing economy'*), veto threats....
  - Redoing capitalism critical but a huge challenge
  - Redoing financial system critical, also huge
  - Drive change in energy and transport systems
- **Relocalize as much as we can**
  - Localize food supply: year round
  - Vermont should have enough water if we plan
  - Big changes across US; southern and western drought, fires & floods - will impact migration

# Discussion

**“Power concedes nothing without a demand”** (*Frederick Douglass, 1857*)

***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)

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





# 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
- *Earth strikes back – Earth wins easily*
  - *Climate change and species extinction are existential challenges to corporate capitalism*

# How do we do it?

## Systems Engineering

- ***Change the rule-book from maximizing profit***
  - *Ask: Is this cost-effective for our children?*
- ***Minimize human waste products dumped into the Earth's atmosphere and ocean***
  - *Shift from fossil fuel ASAP*
- **Maximize the efficiency with which our society uses energy and fresh water**
- **Maximize the use of renewable energy**

# 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*



# **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