



THE **GLOBE** PROGRAM

# Tracking the Vernal Window using GLOBE protocols



An introduction to the winter-spring seasonal transition



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# How to use this PowerPoint



## Slides 3-22:

Climate and weather basics, introduction to the vernal window

## Slides 23-25:

Vernal Window Timeline Activity

## Slides 26-37:

Description of protocols

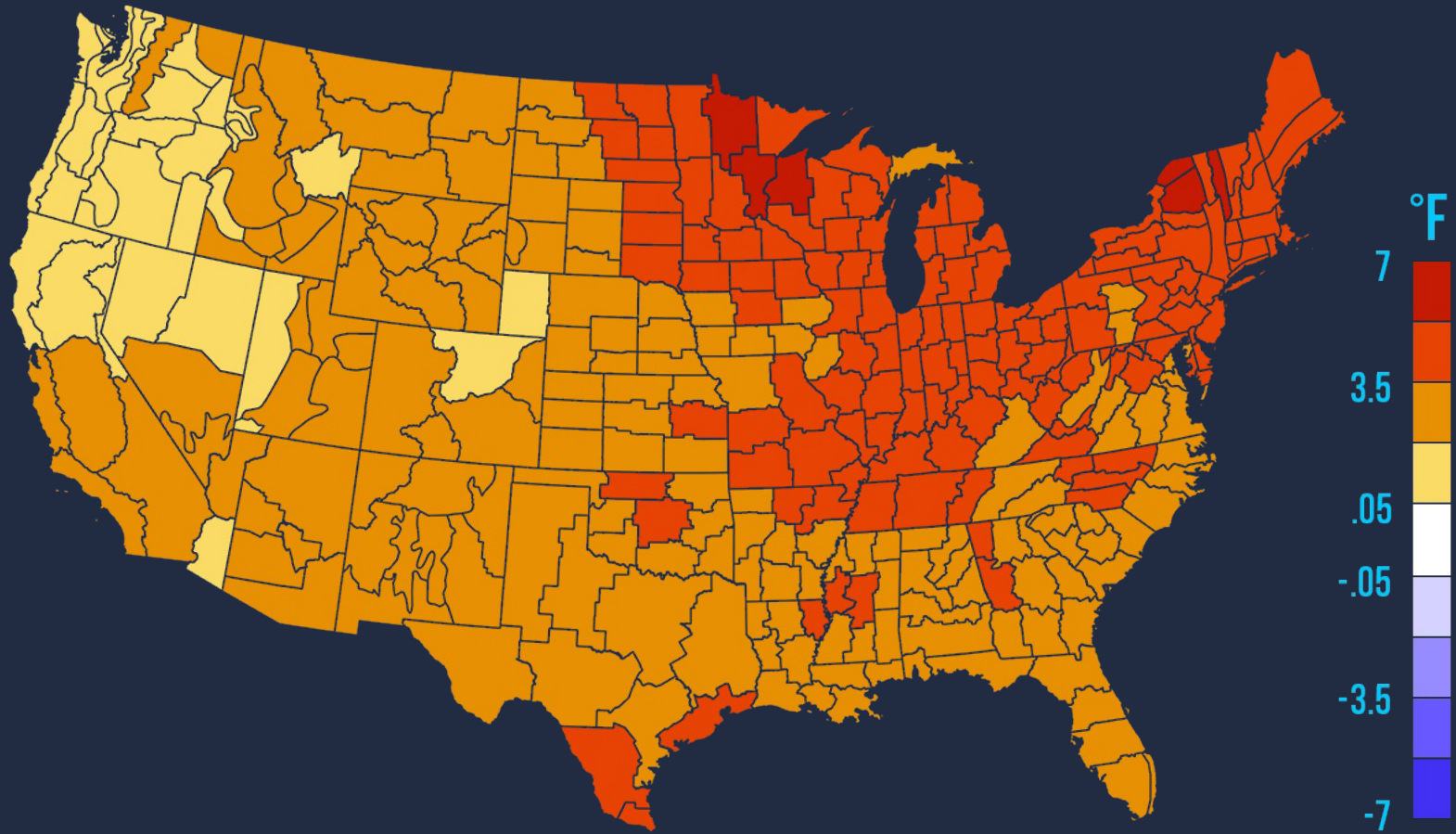
## Slides 38-46:

Explore and Evaluate Data



# WINTER WARMING

Since 1970

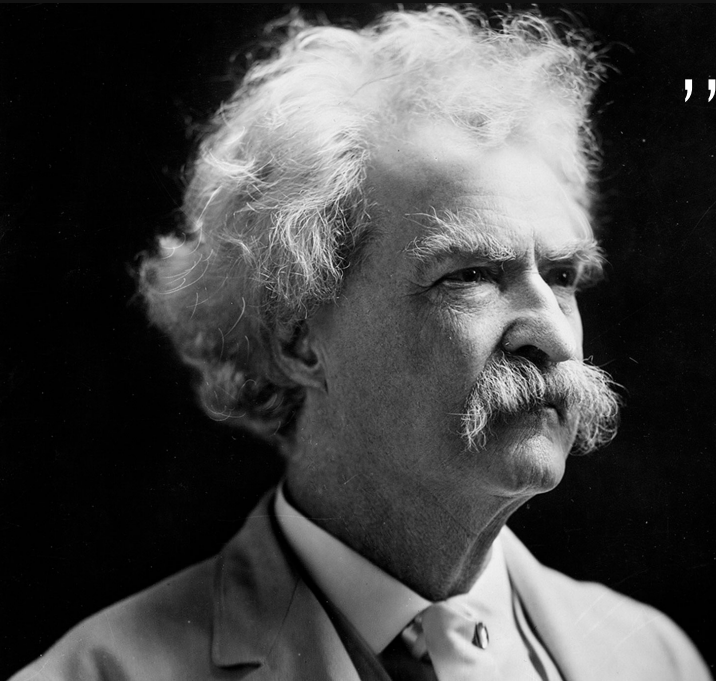


Source: NOAA/NCEI Climate at a Glance. Average winter temperature (Dec-Feb). Produced 11/26/2019

What is the difference  
between climate and  
weather?



What's the difference  
between climate and  
weather?



"Climate is what we expect,  
weather is what we get."

Mark Twain

# Climate or Weather?

*Weather* is the actual state of the atmosphere at a particular time and location.

*Climate* is the statistical description of weather over a long period of time, usually 30 years or more.

# Additional winter *climate* indicators



Fewer days  
with  
snow cover

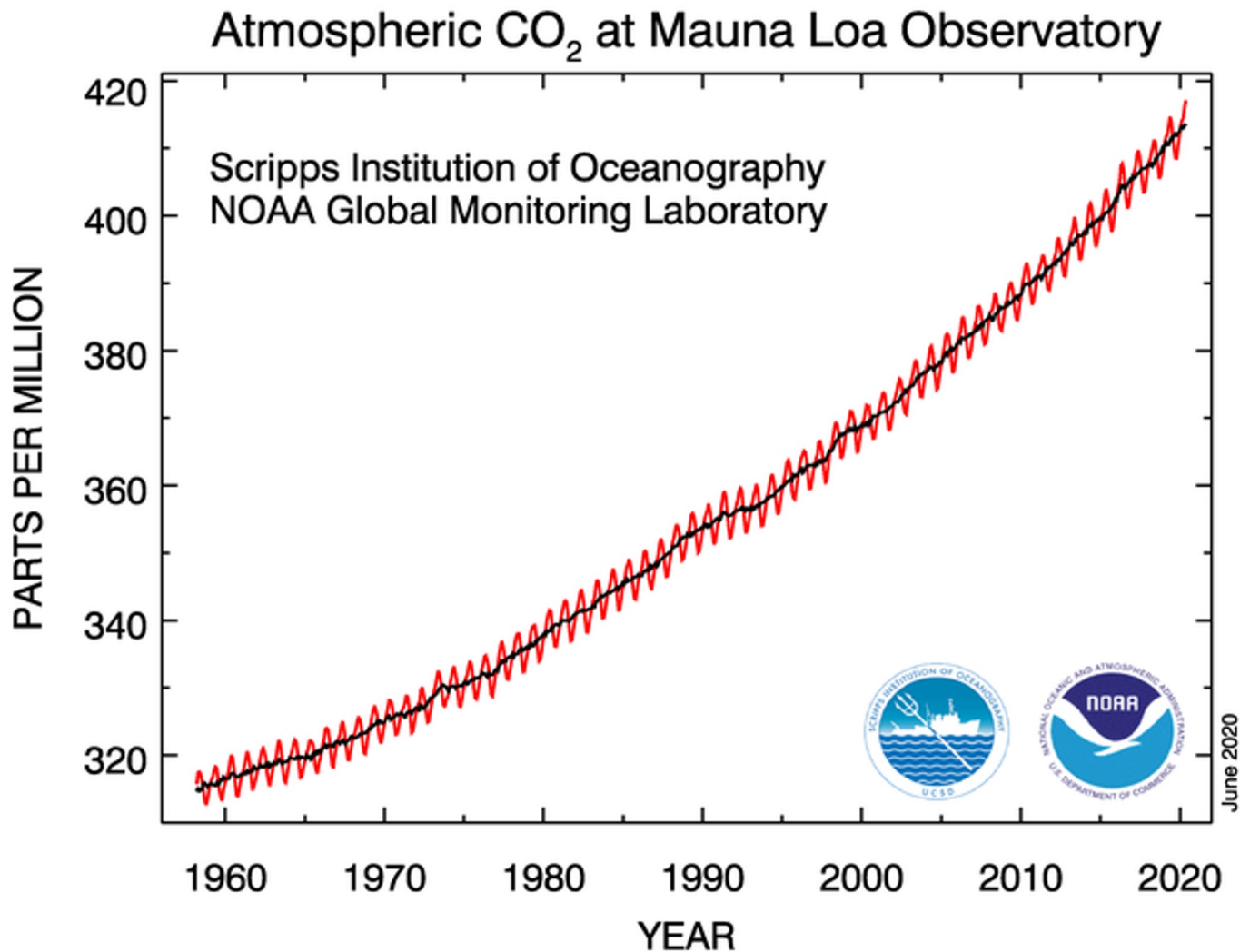
Earlier spring  
melt

Less snow,  
more rain.



Why is winter warming?

# Carbon Dioxide (CO<sub>2</sub>) levels increasing



# What is the Vernal Window?



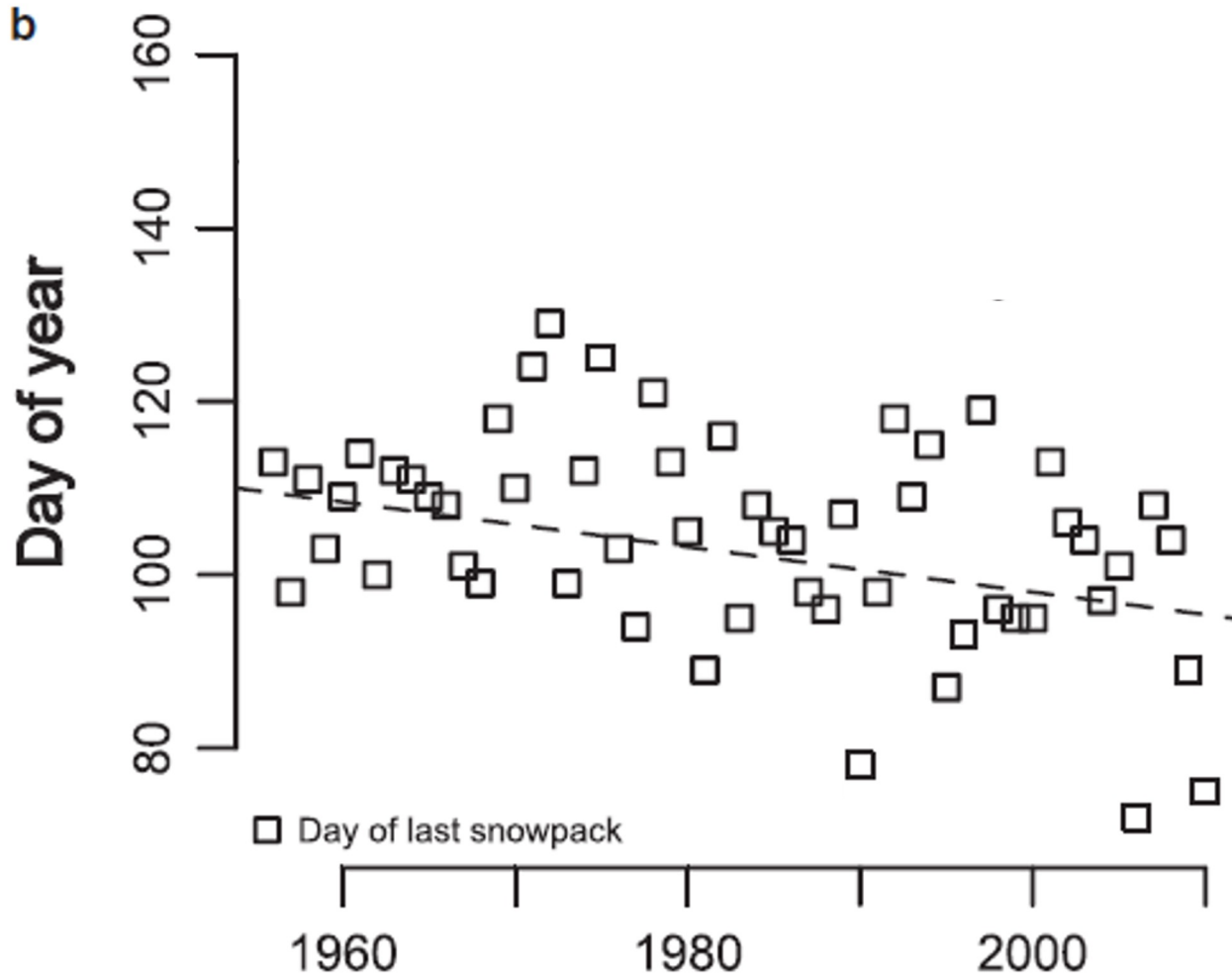


# Snowmelt to Canopy Closure

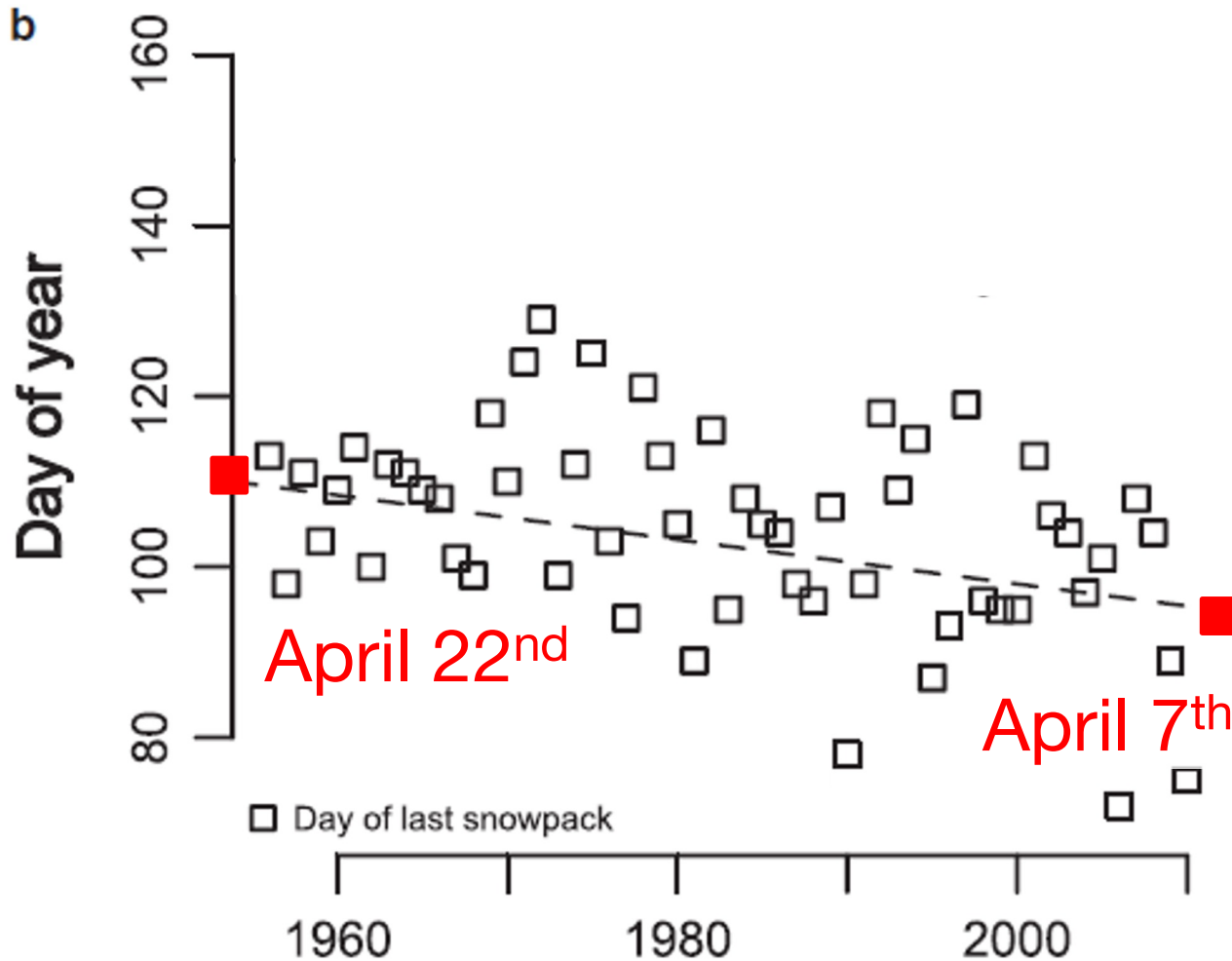
Creed et al. 2015  
Contosta et al. 2017



# The date of snowpack disappearance at Hubbard Brook NH, 1956-2010.



# Snowpack disappears ~ 15 days earlier.

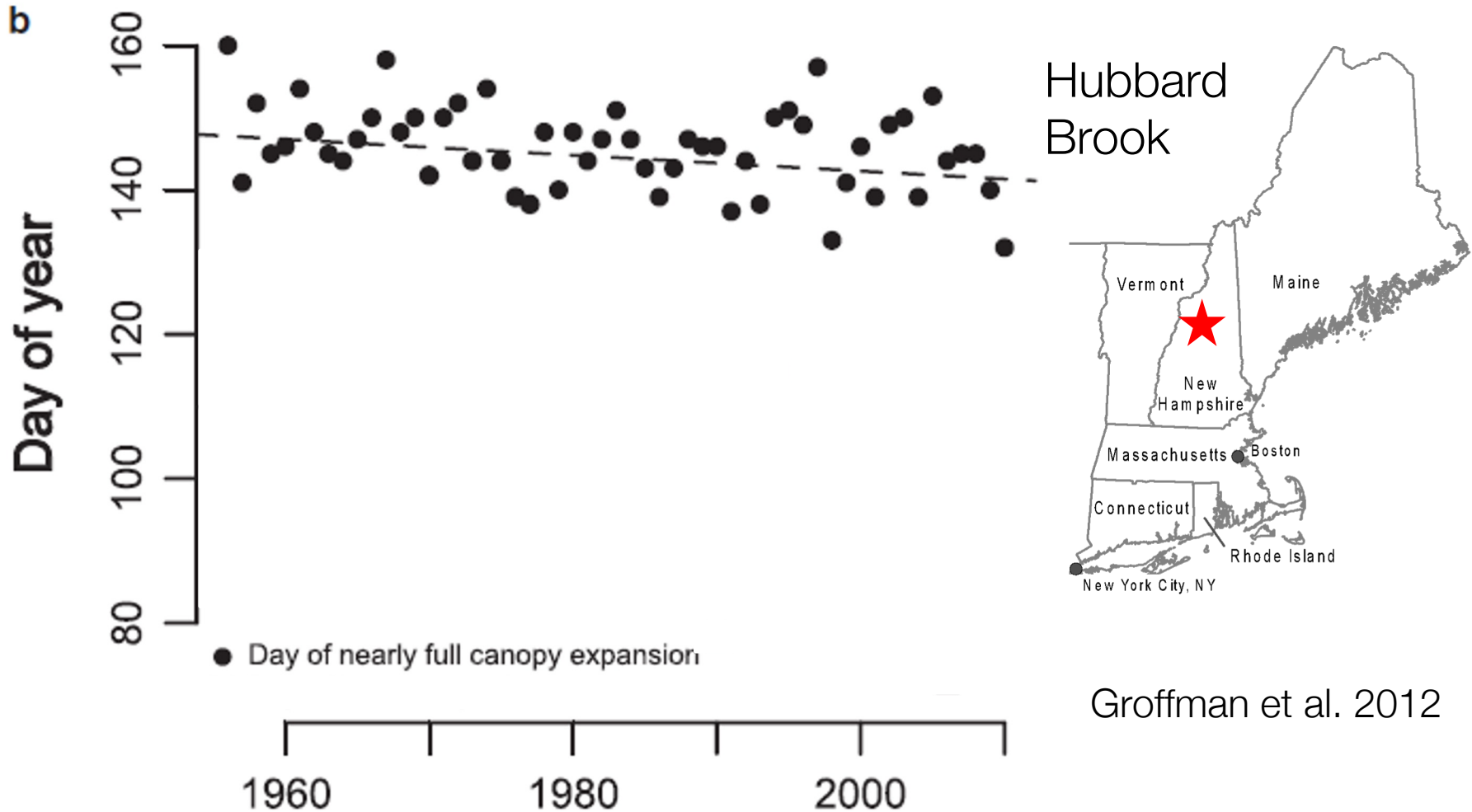




Earlier snowmelt lengthens the vernal window.

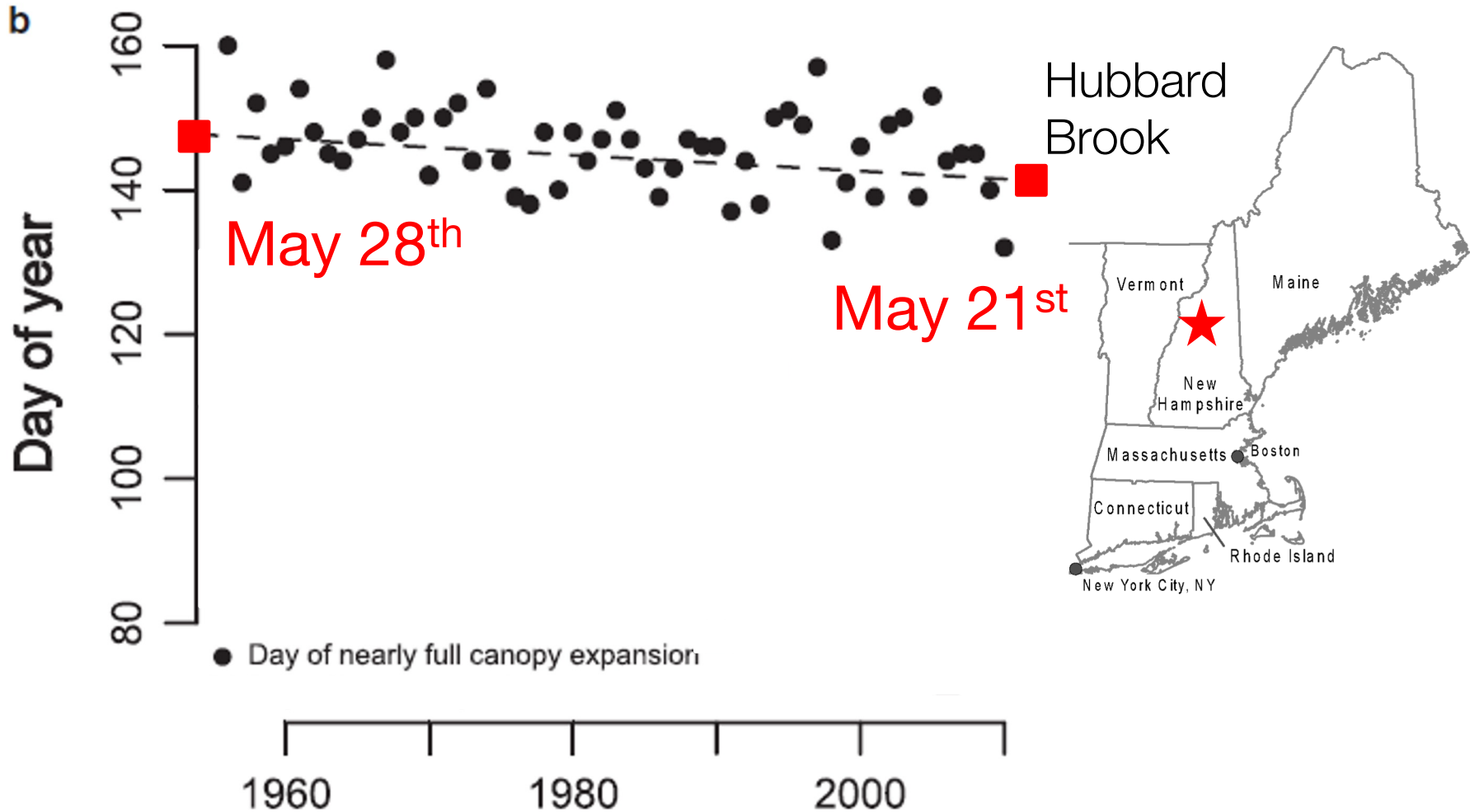


# The date of canopy closure at Hubbard Brook NH, 1956-2010.



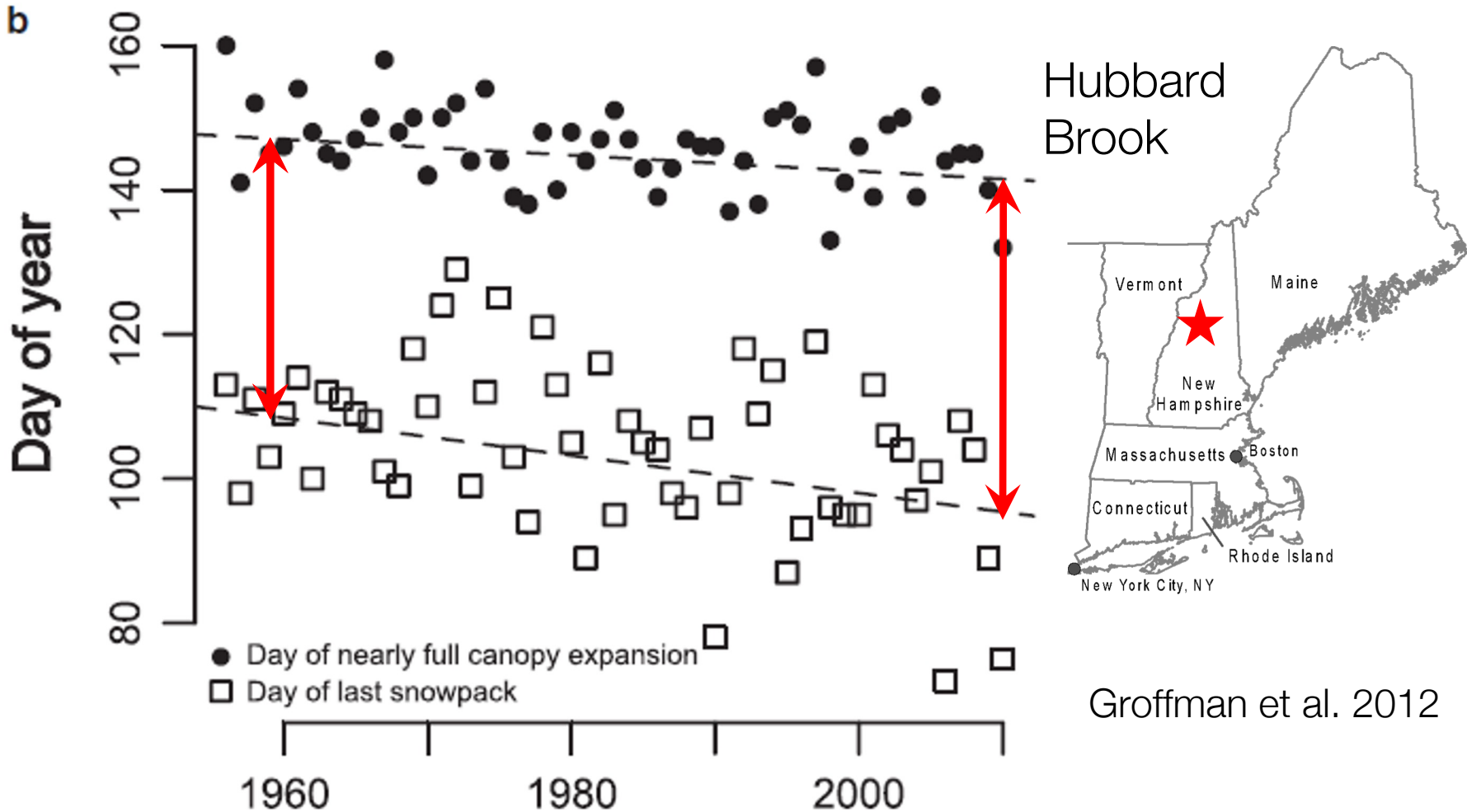
Groffman et al. 2012

# Canopy closes ~ 7 days earlier.





An overall lengthening of the vernal window, by  $\sim 8$  days.





A longer vernal window could lead to phenological mismatches in timing of key energy, carbon, and water related ecosystem processes.



# Energy: Snowmelt → Snow-free

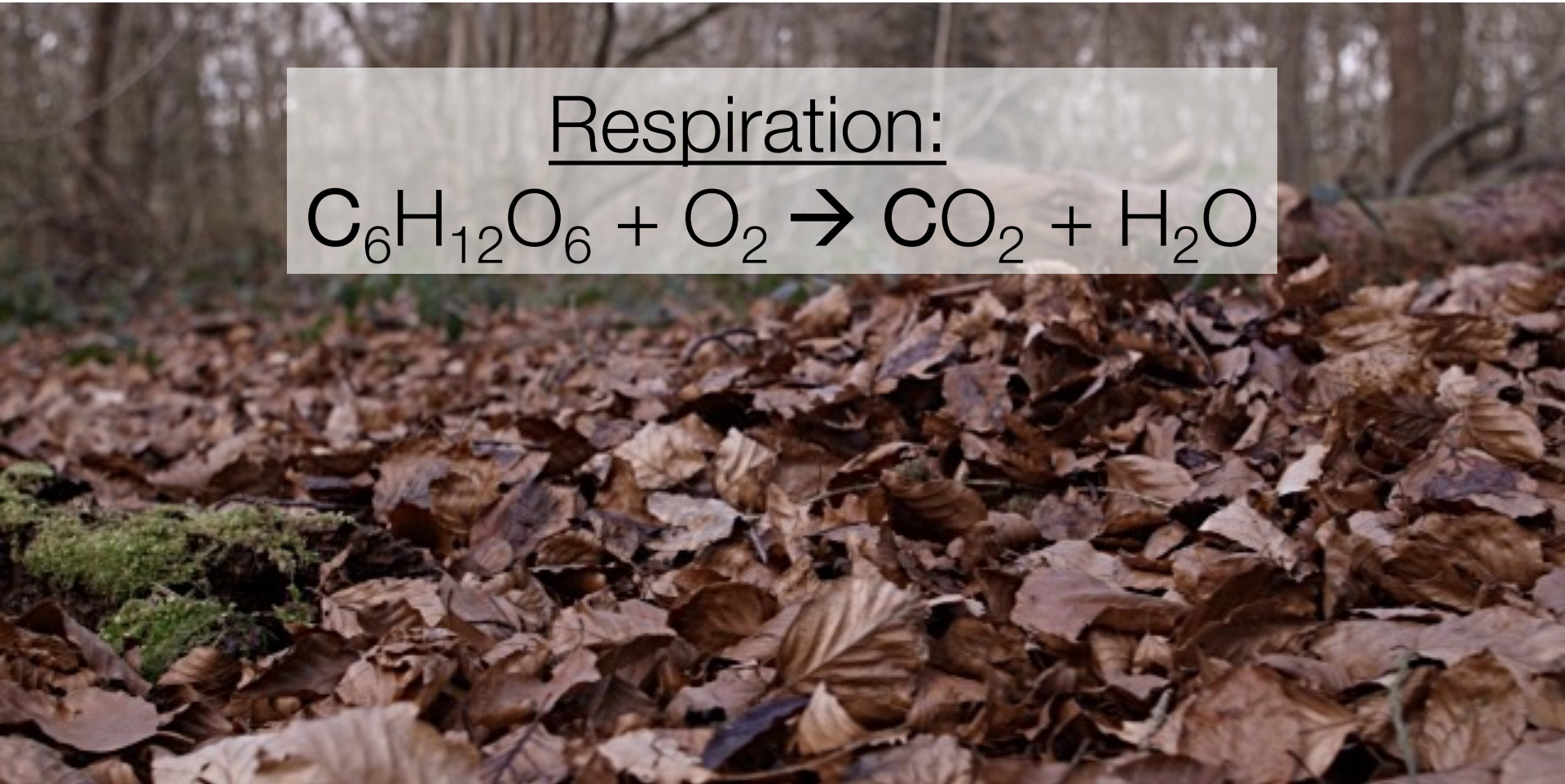
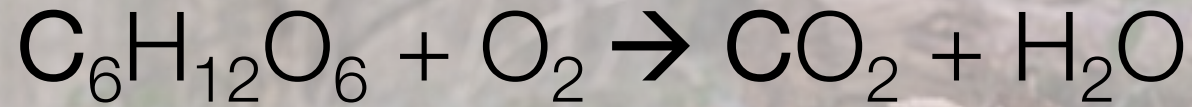




# Carbon: Snow-free → Budburst

During the snow-free period until budburst, soils warm up and microbes start respiring organic matter.

Respiration:

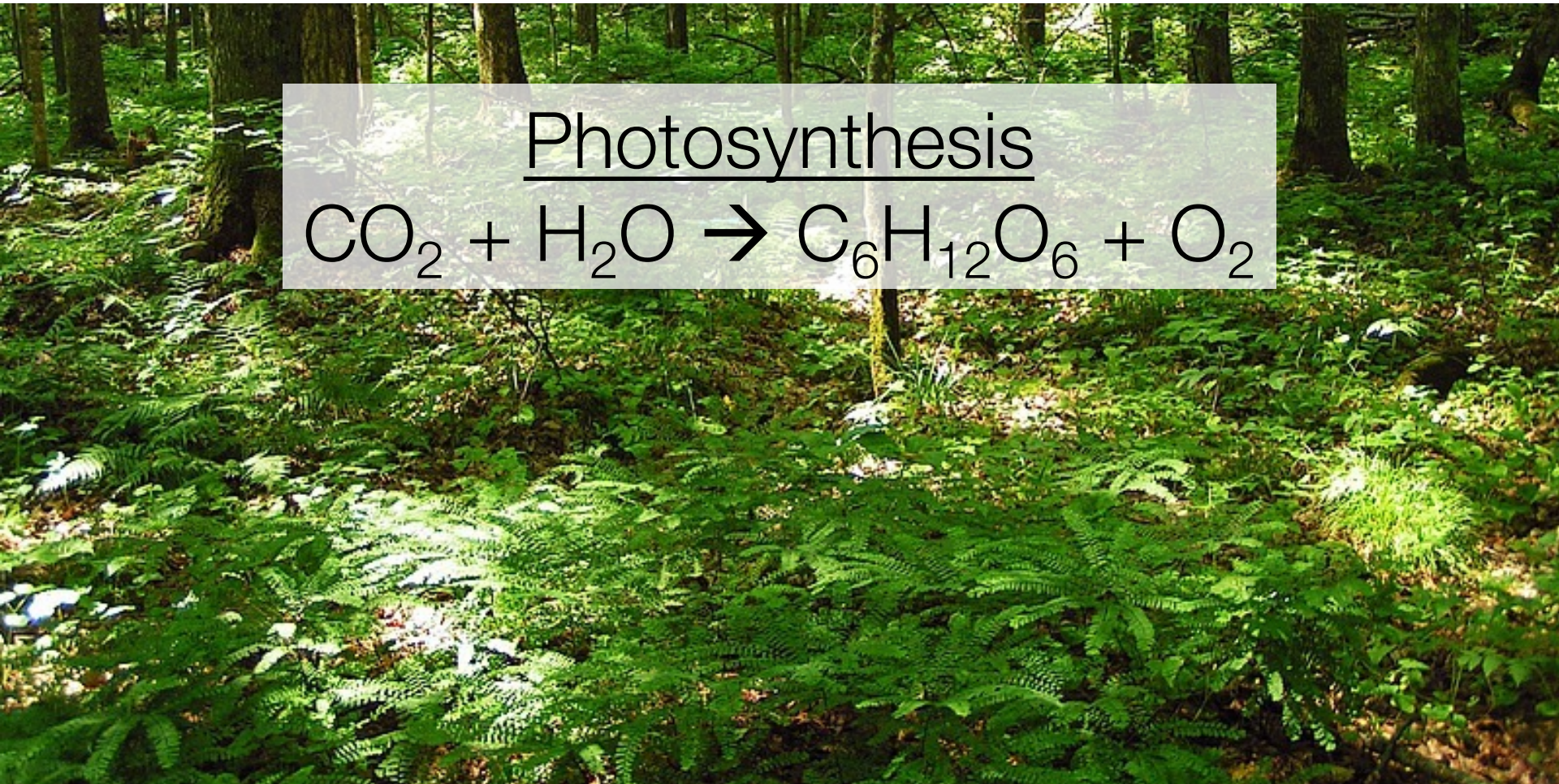




# Carbon: Budburst → Canopy Closure

Once budburst begins, ecosystem begins to take up carbon through photosynthesis.

Photosynthesis





Water:  
Snowmelt → Peak streamflow



# Hypothesize a vernal window timeline

## ACTIVITY:

Organize the cards provided into a *hypothesized* sequence of events that occur in spring. Cards are color coded by their importance to ecosystem...

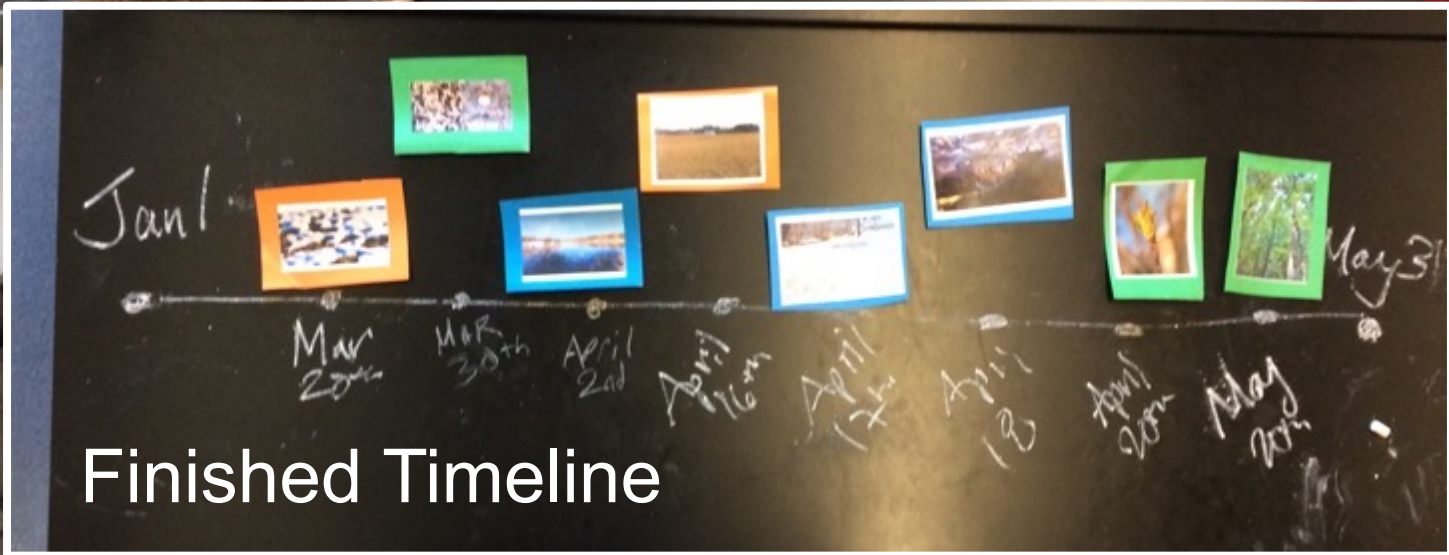
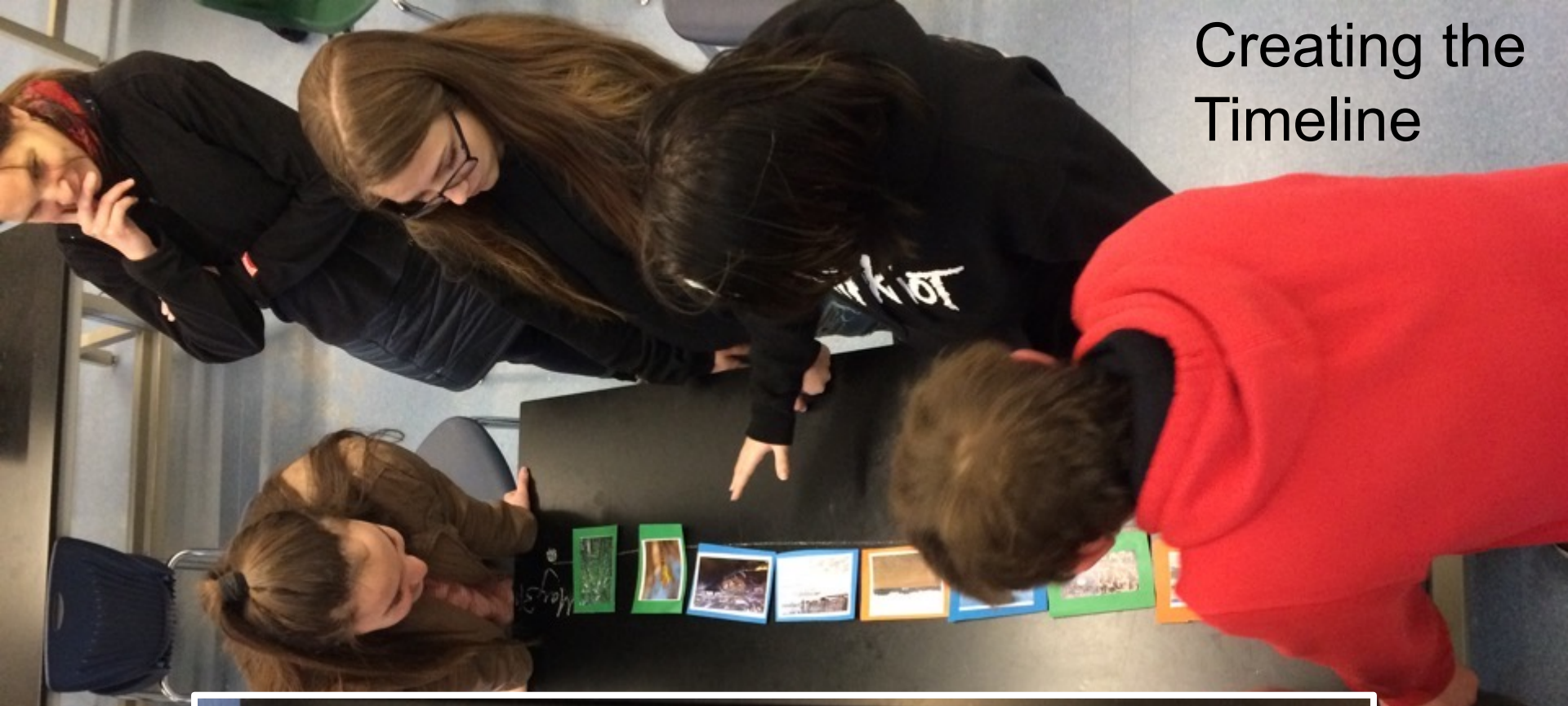
- energy (**orange**)
- carbon (**green**)
- water (**blue**)







# Creating the Timeline



Finished Timeline



# What will the vernal window look like in the future?



February 26, 2017 Kingman Farm, Durham, NH

# Tracking the vernal window using GLOBE Protocols.

Snowpack  
depth



Soil frost  
depth



Canopy  
Green-Up



Soil  
respiration





# Old Town High Field Sites

Hemlock Neighborhood



Beech Neighborhood



# Snowpack Depth



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[www.globe.gov](http://www.globe.gov)

- measures how deep the insulative snow pack is.



Photo: Elizabeth Burakowski

## Materials:

- Meter stick (measure in cm)
- Data sheet or field notebook
- Pencil

## Protocol:

- Insert meter stick vertically into snowpack, about a foot away from soil frost tube
- Report snow depth to nearest 0.1 cm
- Repeat for all frost tubes (1-3)\*

# Soil Frost Depth



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[www.globe.gov](http://www.globe.gov)

- measures frozen soil throughout the winter.

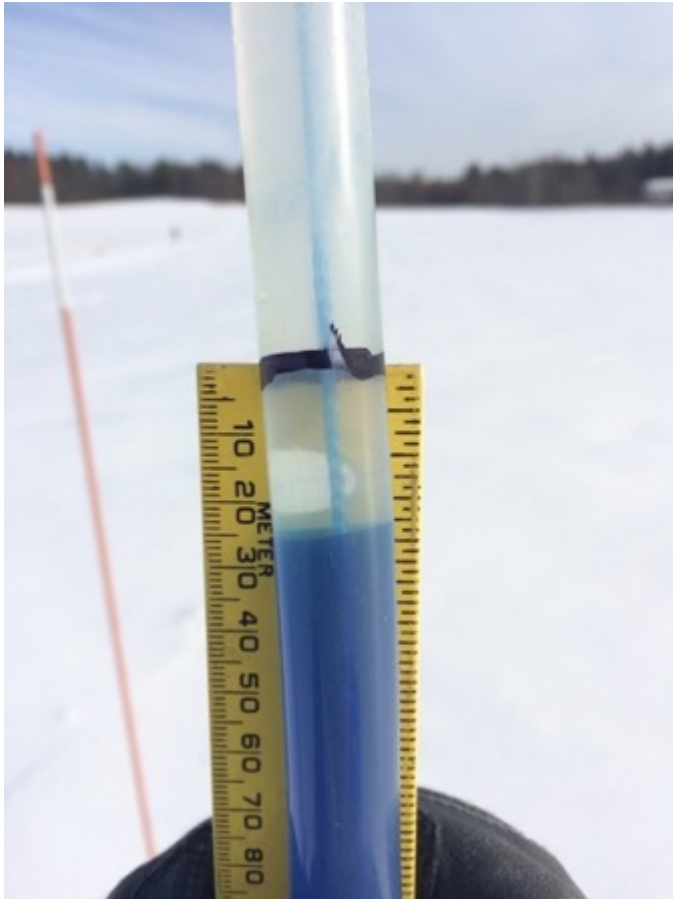


Photo: Elizabeth Burakowski

## Materials\*:

- PVC pipe,
- Clear aquarium tubing,
- Rubber stoppers
- Methylene blue or food coloring
- String
- Data sheet or field notebook
- Pencil

\*detailed assembly instructions on [globe.gov](http://globe.gov)





## Protocol:

- Approach tube and minimize disturbance of snow pack
- Pull rubber stopper and inner tube out of PVC casing
- Measure soil frost depth (clear) from black line downward to blue liquid.
- Place tube back in PVC pipe.
- Measure daily to weekly, or whenever there is a major weather shift (cold snap, snow storm, rapid melt).

# Canopy Green-Up



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[www.globe.gov](http://www.globe.gov)

- measures canopy phenophases



## Materials:

- Ribbon
- Permanent marker
- Data sheet

## Protocol:

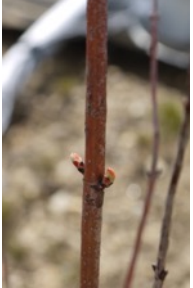
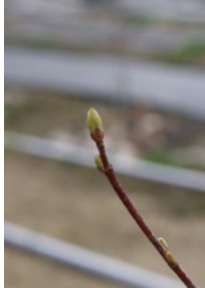


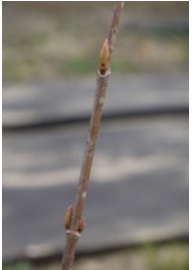
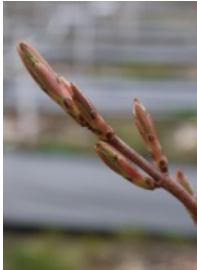
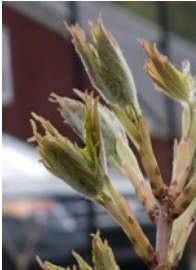

- Select a tree, identify the species. Tie ribbon to branch.
- Mark buds on branch with 1-4 dots.
- Examine buds and record: dormant, swelling, budburst, or lost.
- If budburst, measure length of leaf from base to tip until fully grown.



# Canopy Green-Up



- examples of the four phenophases.

	1 Dormant	2 Bud Swelling	3 Bud Burst	4 Expansion
Red Maple				
Sugar Maple				

# Soda Lime Base Trap



- measures dormant season soil respiration.



Photo: Elizabeth Burakowski

## Materials:

- 5 gallon bucket
- Glass mason jar
- Small plant stand
- Trowel or serrated knife
- Graduated cylinder
- Drying oven or toaster oven
- Precise digital scale
- 400 grams of soda lime
- 50 ml distilled water

# Soda Lime Base Traps



## Protocol:

- Dry and weigh ~400 g soda lime. Keep sealed in jar.
- At field site, invert bucket over soil
- Use serrated knife to cut 1-3" deep trench around bucket perimeter.
- Add 50 ml of distilled water to the soda lime, making sure not to breath your CO<sub>2</sub> rich air into the jar!



# Soda Lime Base Trap



Photo: Elizabeth Burakowski

## Protocol:

- Place soda lime jar on plant stand.
- Invert bucket over sample and place a large rock or piece of wood on top of the bucket to keep it sealed over the winter.
- Set it and forget it! You will not need to disturb the soda lime base traps until the spring.

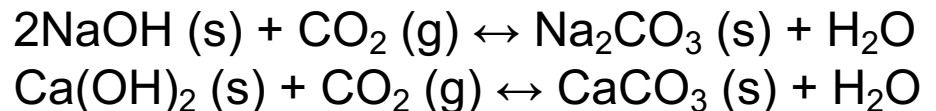
# Soda Lime Base Trap



Photo: Elizabeth Burakowski

## Protocol:

- After the canopy leafs out, remove the bucket and seal the jar.
- Dry the sample in a drying oven and re-weigh.
- Respiring soils will 'gain weight' over the winter.
- From the sample weight gain, we calculate CO<sub>2</sub> flux.



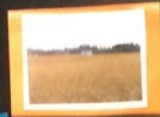
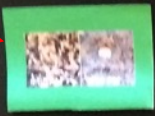
# Opportunity for additional GLOBE protocols



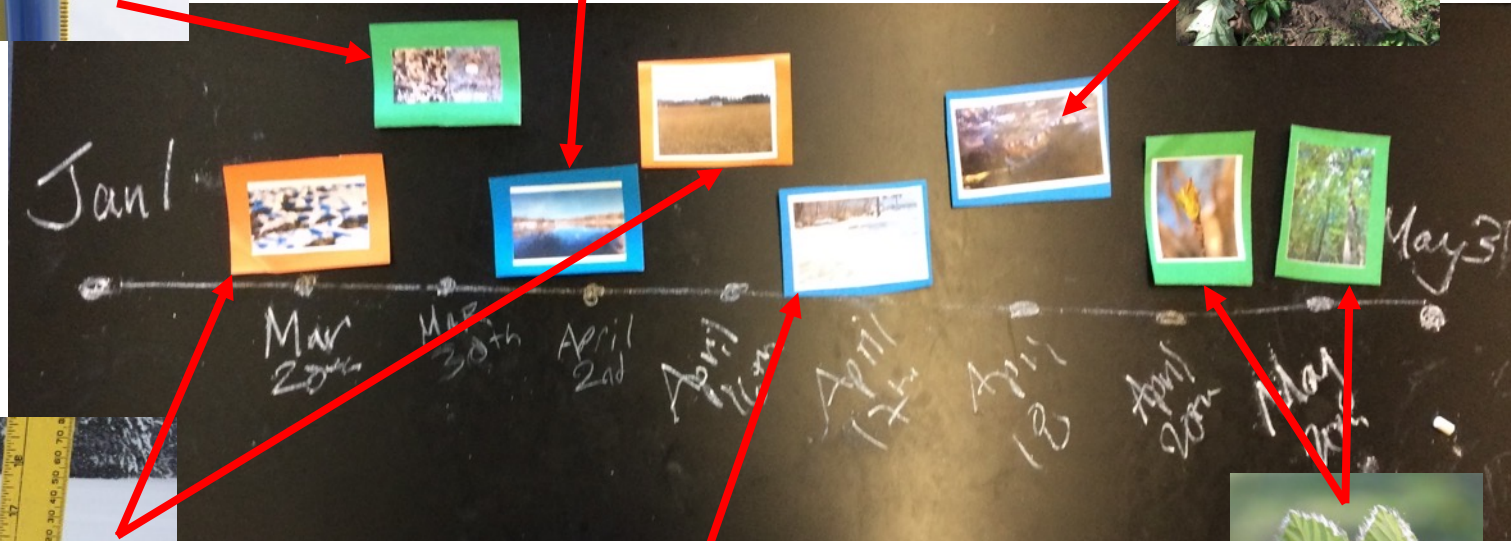
Soil frost



Stream  
Flow



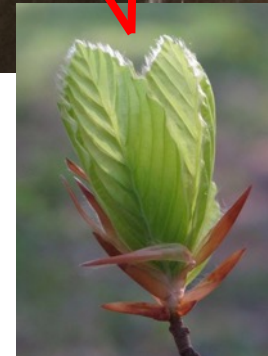
Soil  
Temperature



Snow  
depth



Water  
temperature



Canopy  
Green-Up

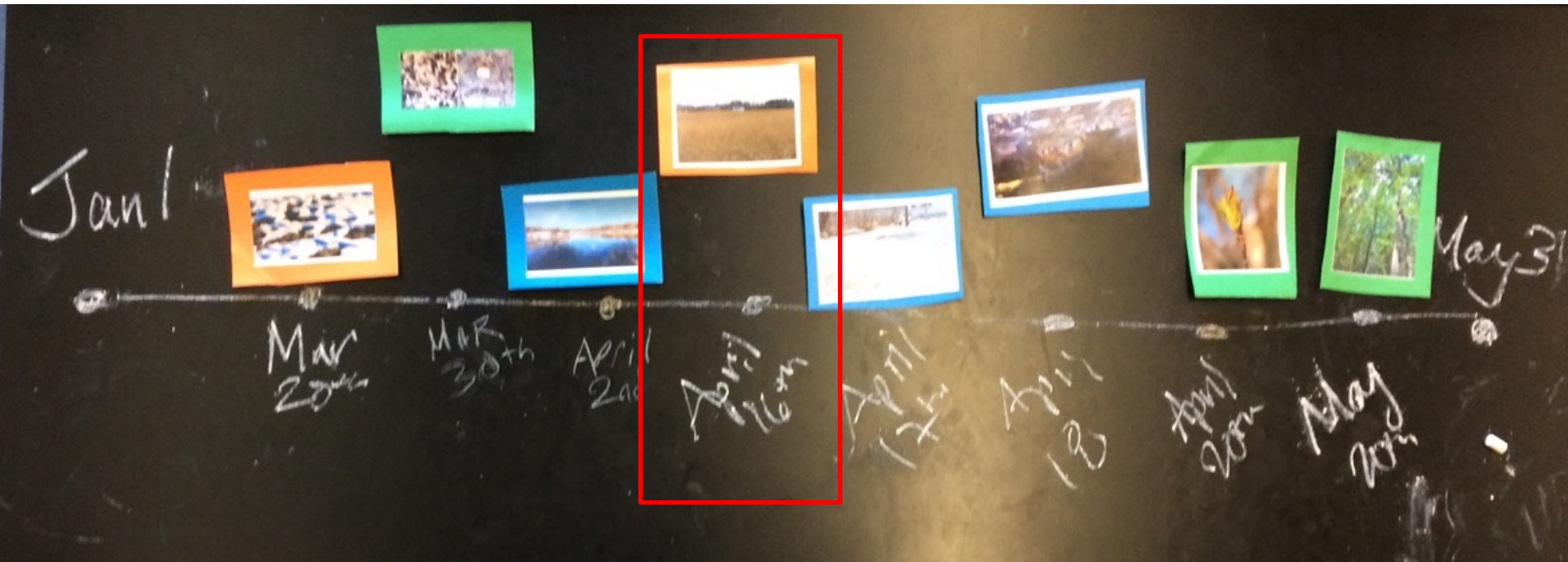


# Revisit the hypothesis

## Snow disappearance:

- Hypothesis – April 16th
- Observed – April 18th

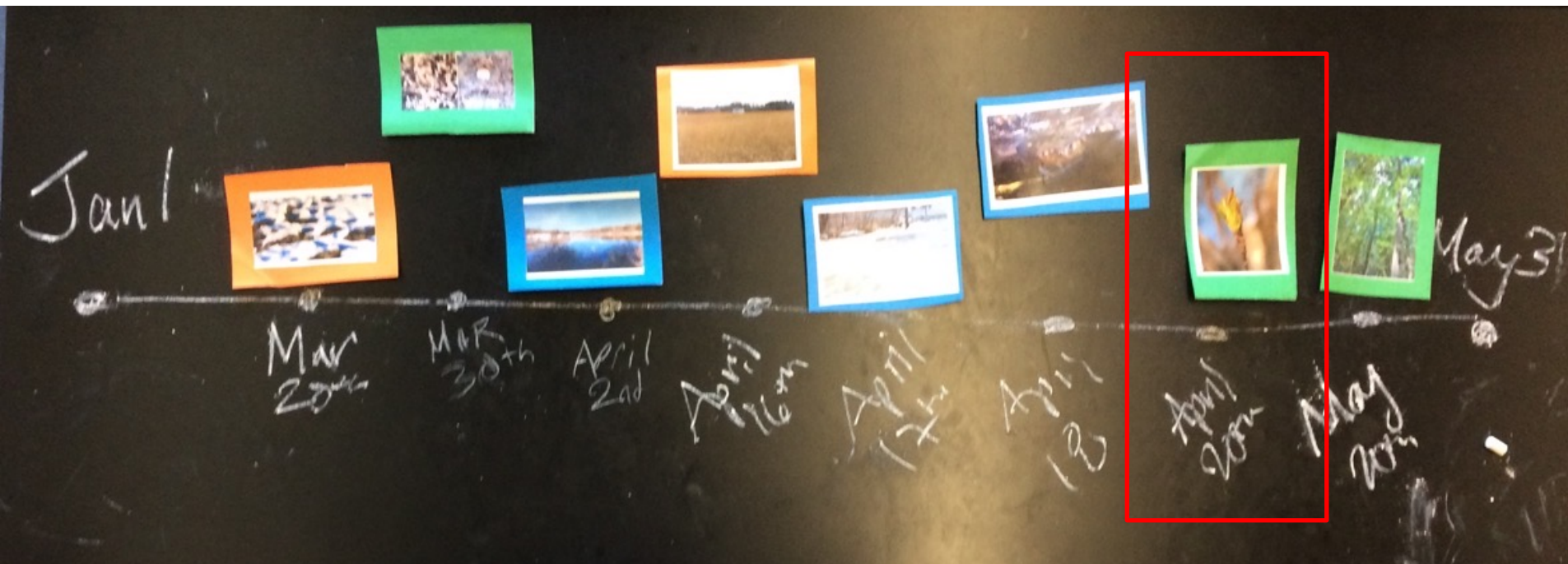
100



# Let's revisit the hypothesis

## Budburst

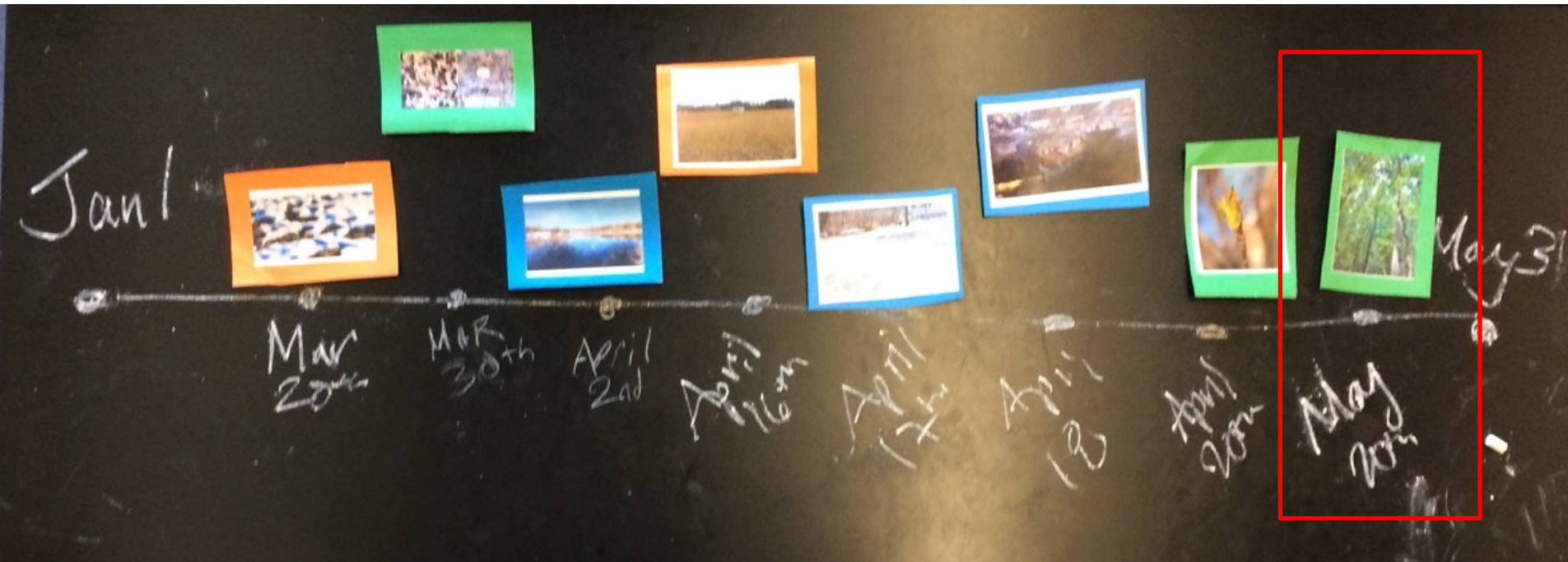
- Hypothesis – April 20
- Observed – May 22



# Let's revisit the hypothesis

## Canopy closure

- Hypothesis – May 20
- Observed – June 2





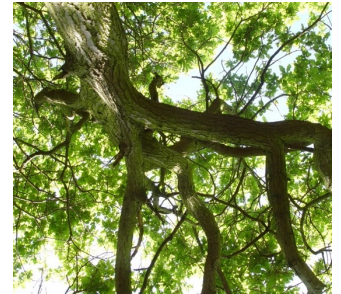
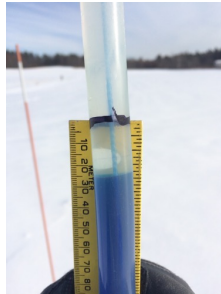
# Same sequence, different timing

2019

April 18  
April 21

May 22

June 2



2020

April 3  
April 4

May 18

June 1



# Deciduous vs. Coniferous

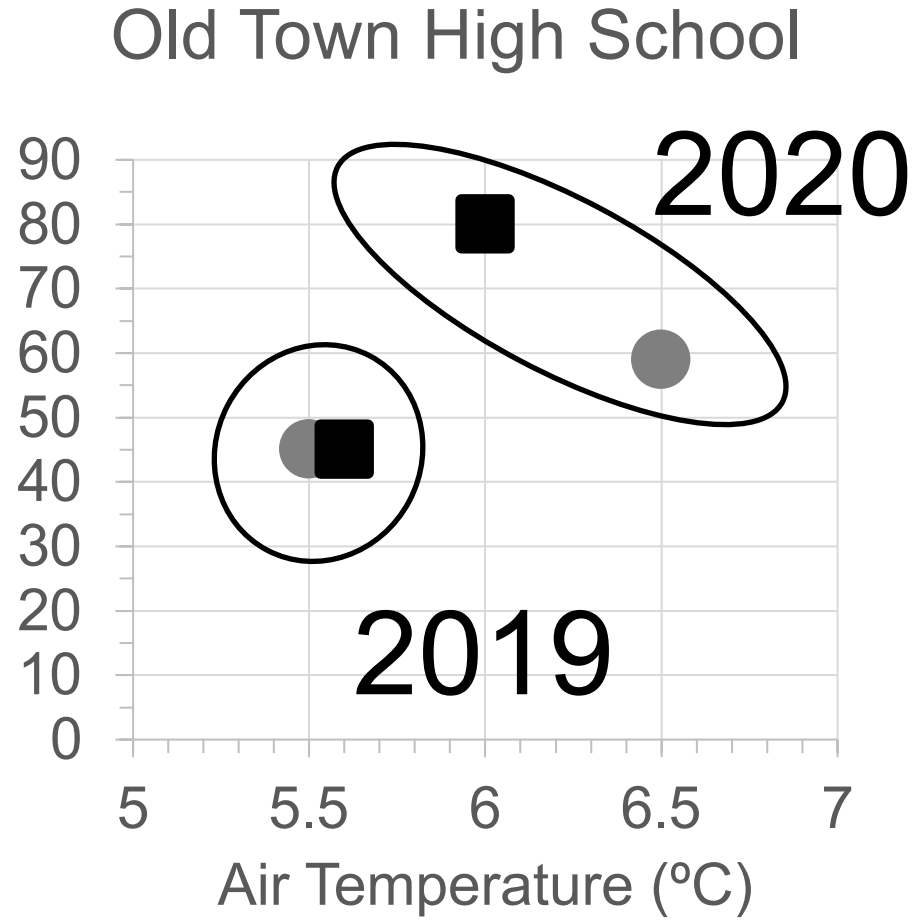
## ● Deciduous



## ■ Coniferous

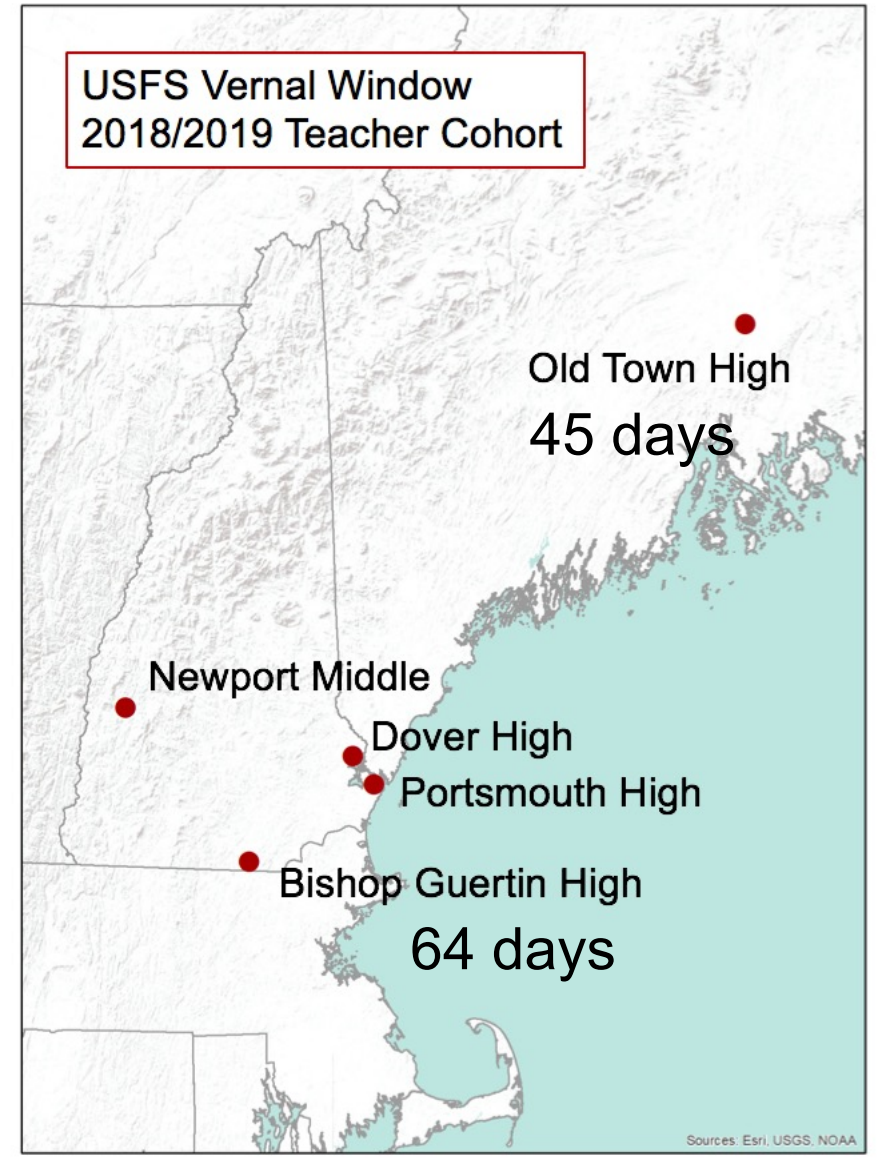


Vernal Window Length  
(days)





# Snow Disappearance to Canopy Closure:





What research questions can your class answer about the vernal window using GLOBE protocols?





Thanks and Questions  
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This project supported by



US Department of Agriculture Forest Service  
CitSci Fund  
#18-CS-11242307-044



National Science Foundation Macrosystems  
Biology #1802726  
National Science Foundation EPSCoR –  
INSPIRES #1920908