



Tracking changes in the timing and duration of the Vertical Window



Elizabeth Burakowski, Danielle Grogan, Alix Contosta
University of New Hampshire
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What is the Vernal Window?



Burakowski – LMWG 2019 - Tracking the "Vernal Window"

Snowmelt to Canopy Closure

Groffman et al. 2012

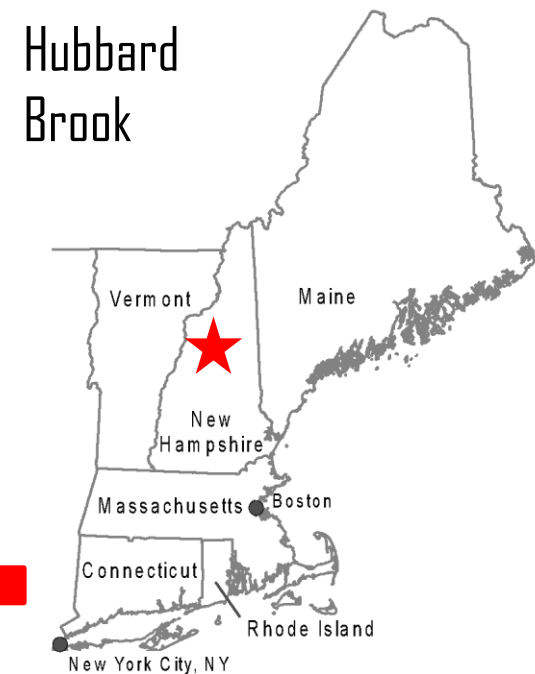
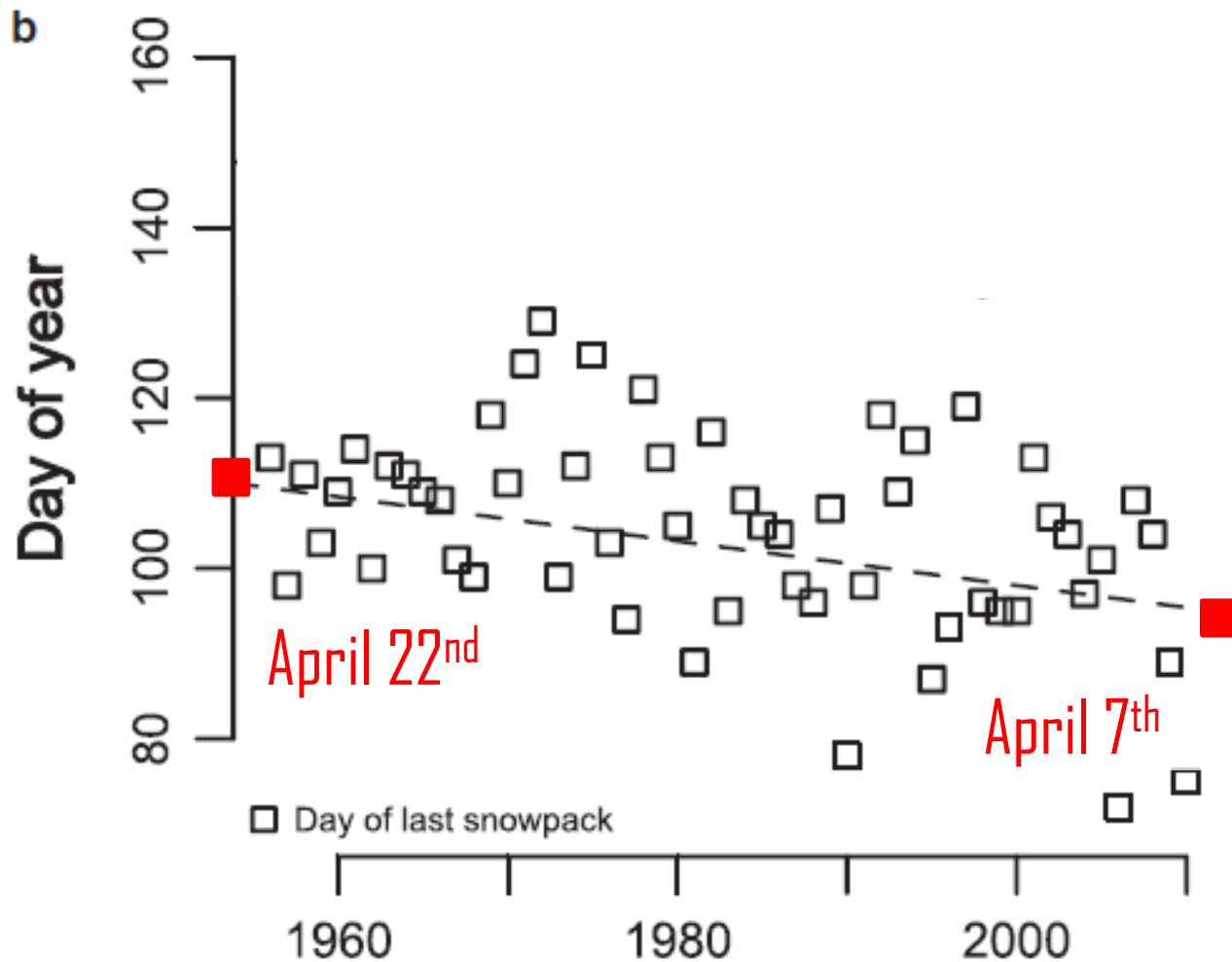
Creed et al. 2015

Contosta et al. 2017



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Hubbard Brook snowpack disappears ~ 15 days earlier.



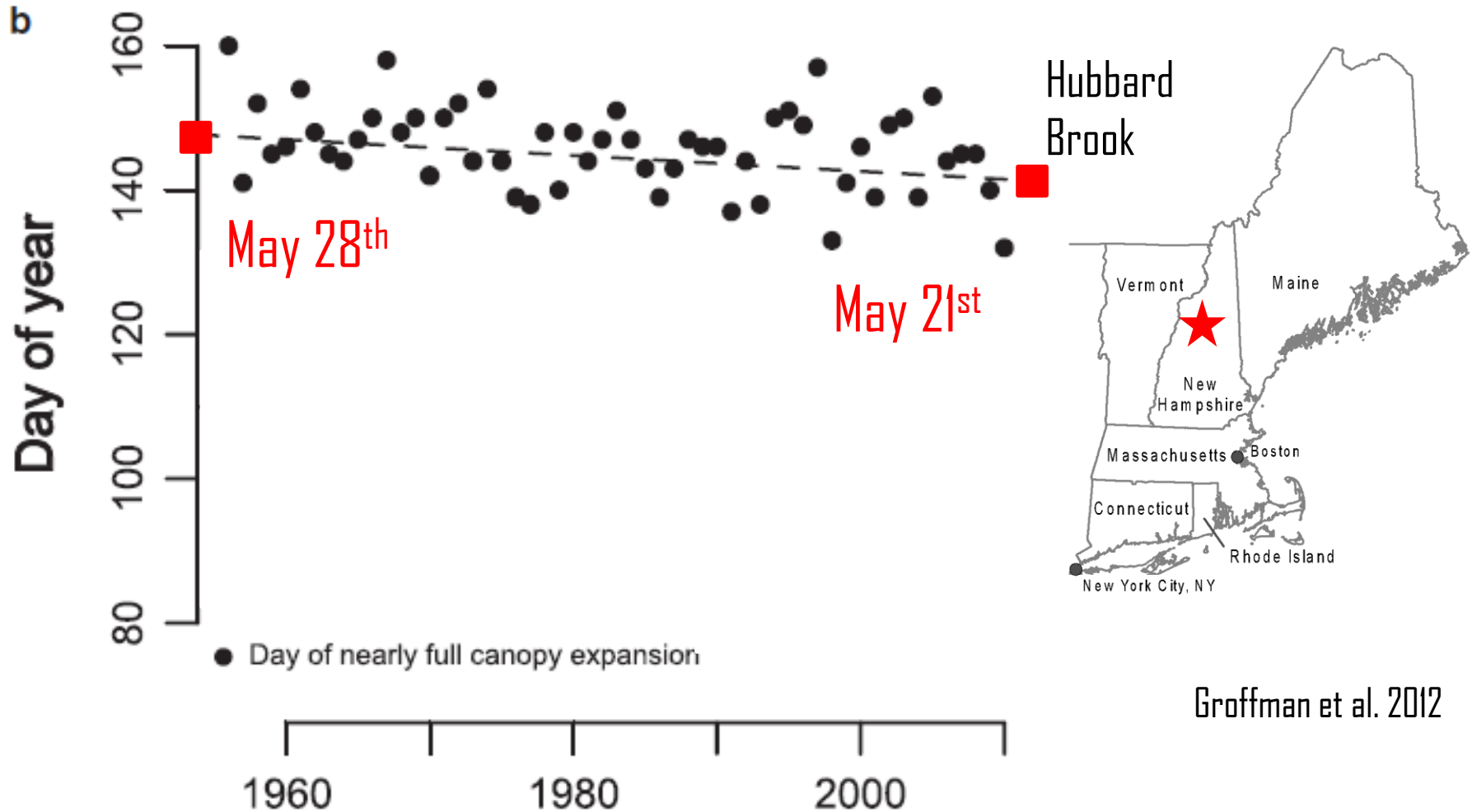
Groffman et al. 2012

Earlier snowmelt lengthens the vernal window.



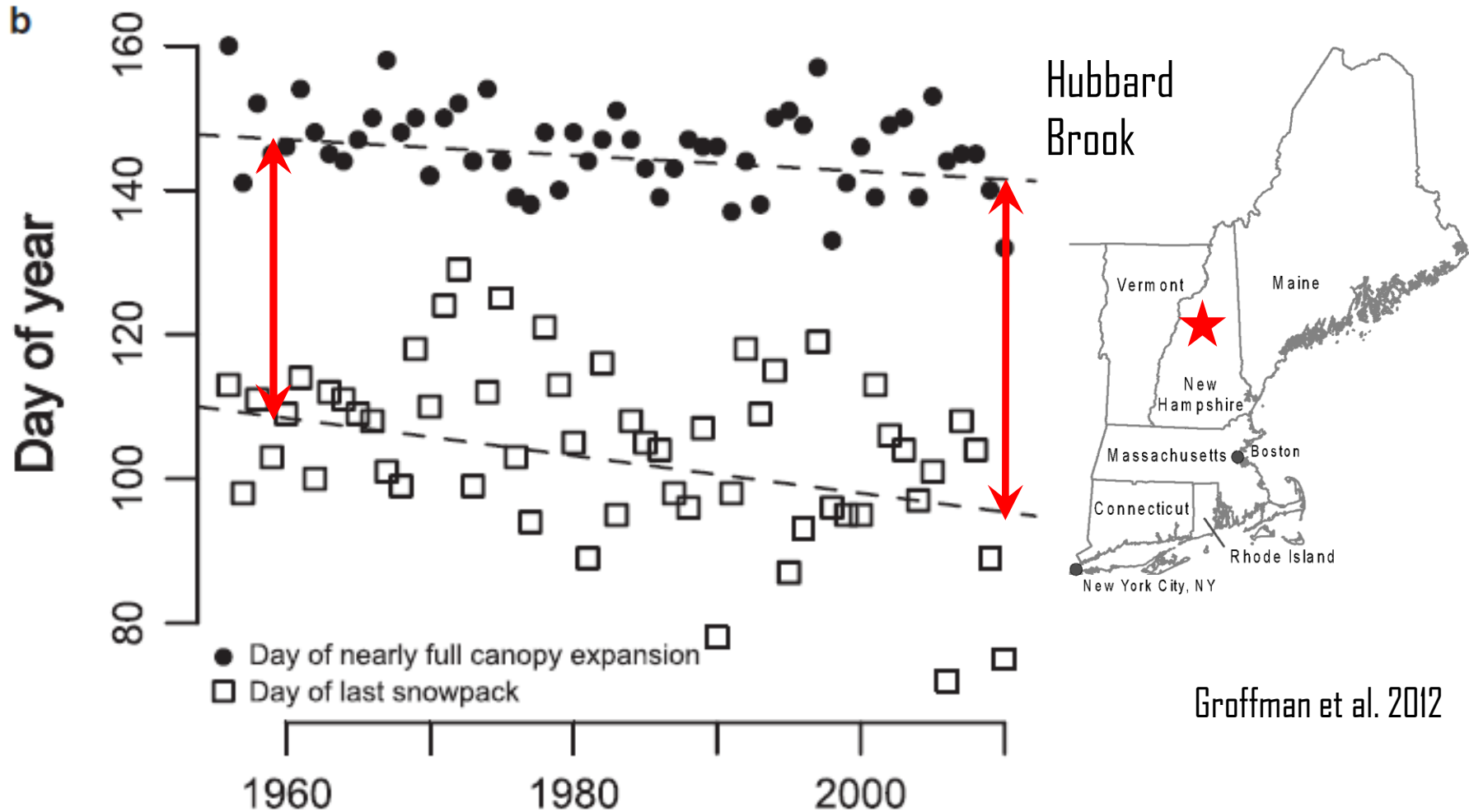
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Hubbard Brook canopy closes ~ 7 days earlier.



Groffman et al. 2012

An overall lengthening of the vernal window, by ~ 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



 picture post
picturepost.unh.edu

Carbon: Snow-free → Budburst

During the snow-free period, soils thaw/warm up and heterotrophic respiration increases.



Carbon: Snow-free → Budburst

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



Water:
Snowmelt → Peak streamflow



What will the vernal window look like in the future?

February 26, 2017 Kingman Farm, Durham, NH



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What will the vernal window look like in the future?

February 26, 2017
Kingman Farm, Durham, NH

This is the warmest February day ever recorded in Boston. Boston Globe



Model Workflow

LOCA

Localized Constructed Analogs

Pierce et al. 2014

- Daily minimum & maximum temperature, precipitation
- 29 CMIP5 models
- 1980-2005 historical
- 2006-2099 RCP4.5, RCP8.5

WBM

UNH Water Balance Model

Vörösmarty et al. 2014

- Snow water equivalent
- Runoff
- Soil moisture

Phenor R

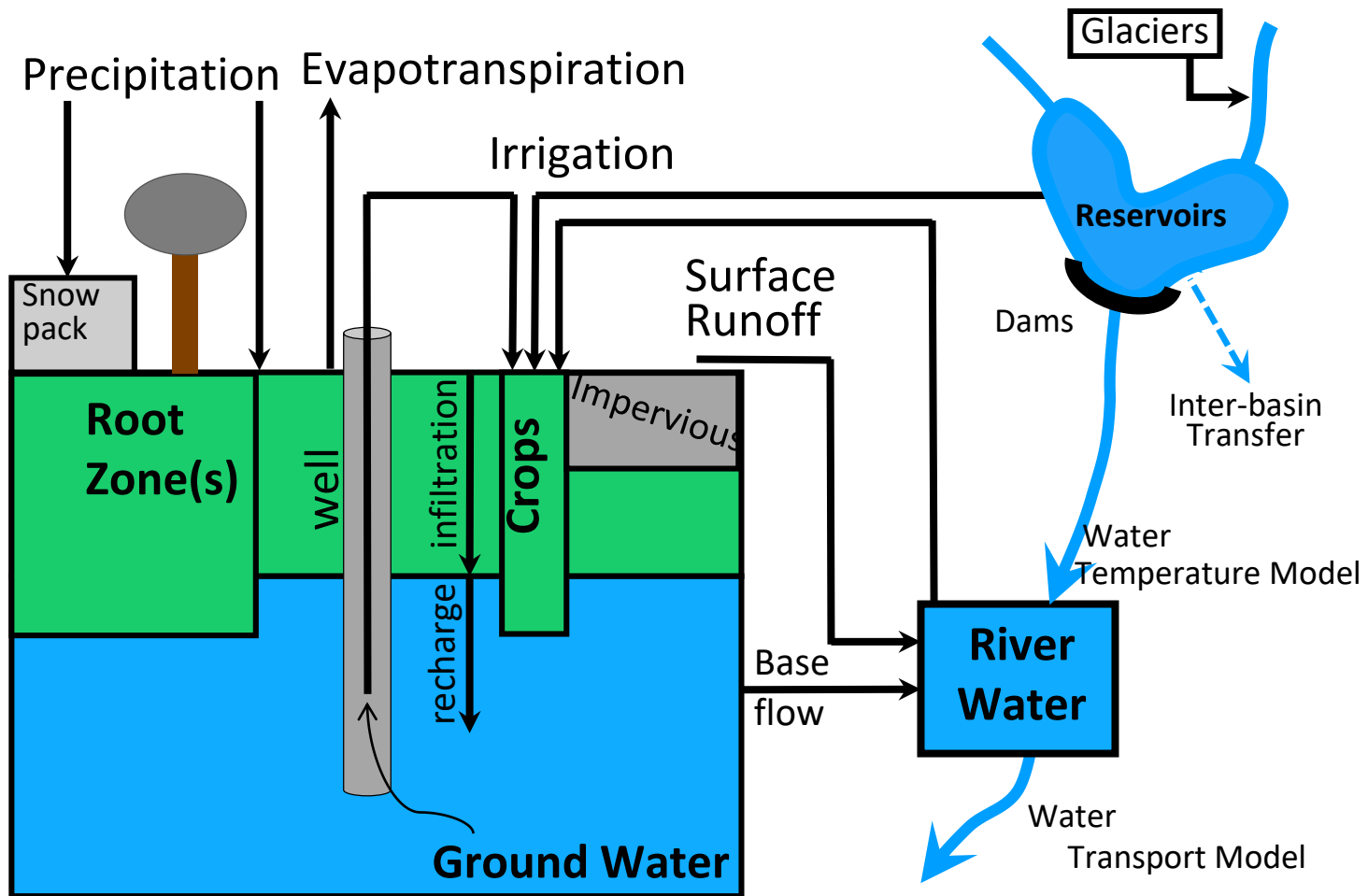
Phenology Model

Hufkens et al. 2018

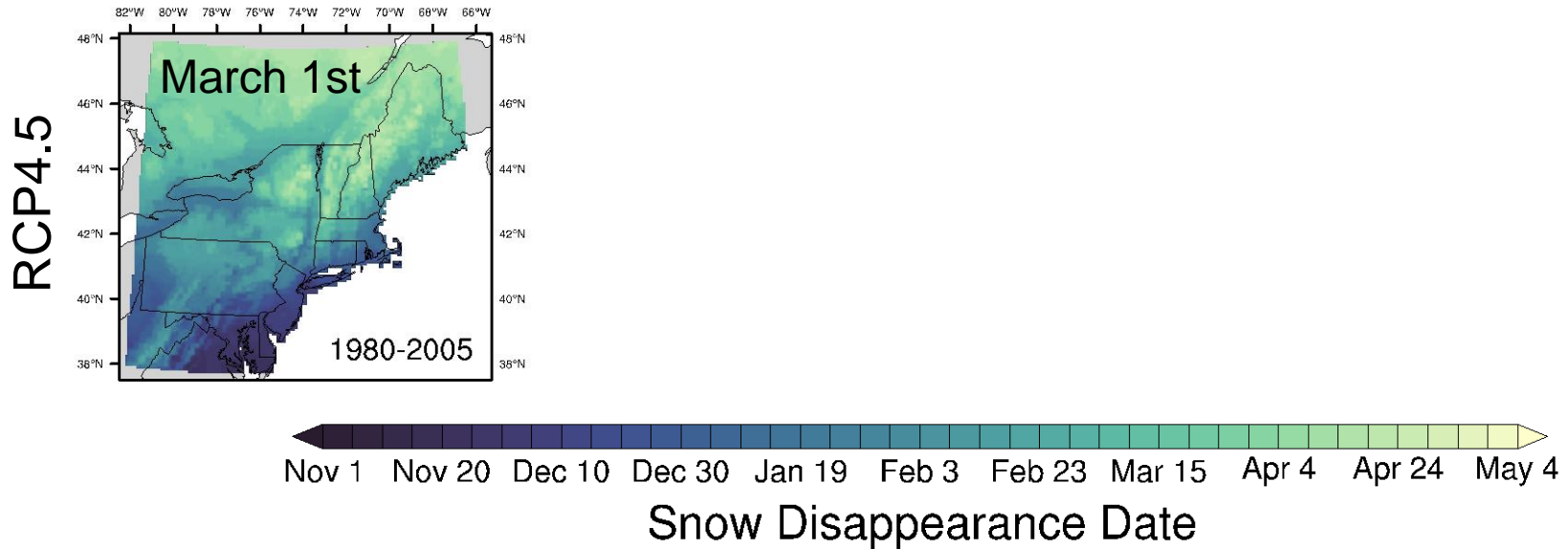
- Thermal Time (TT)
- Canopy green-up date

UNH Water Balance Model (WBM)

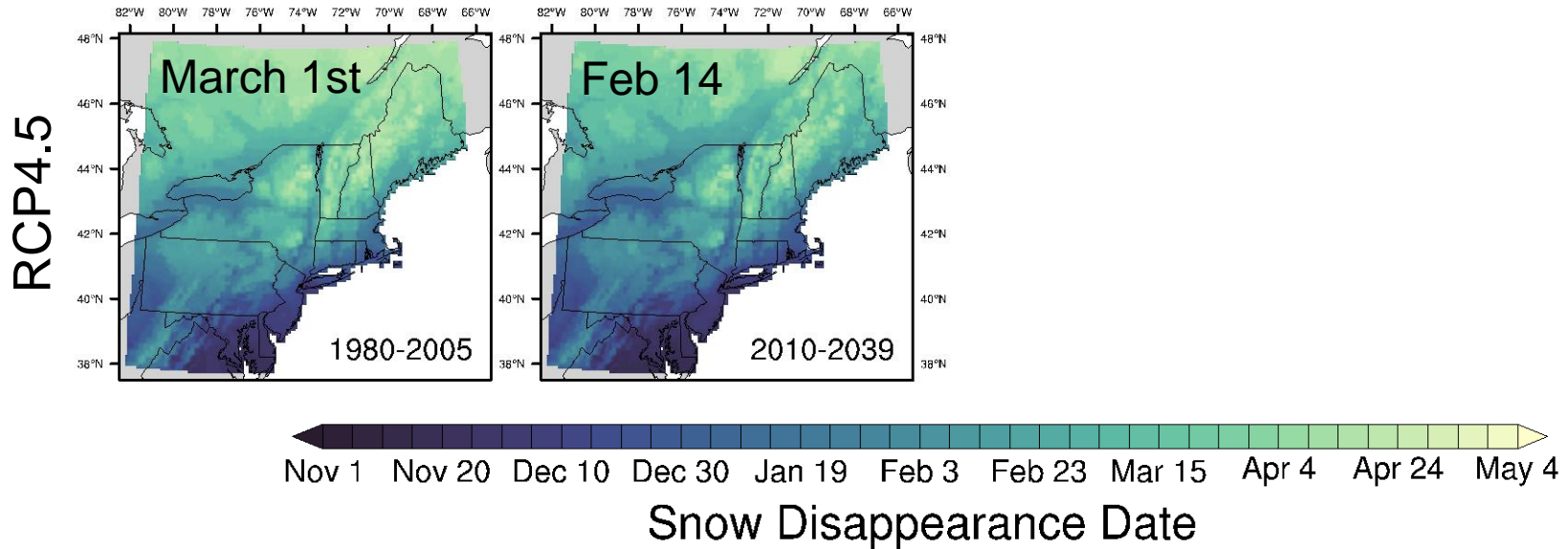
Wisser et al 2010; Grogan 2016



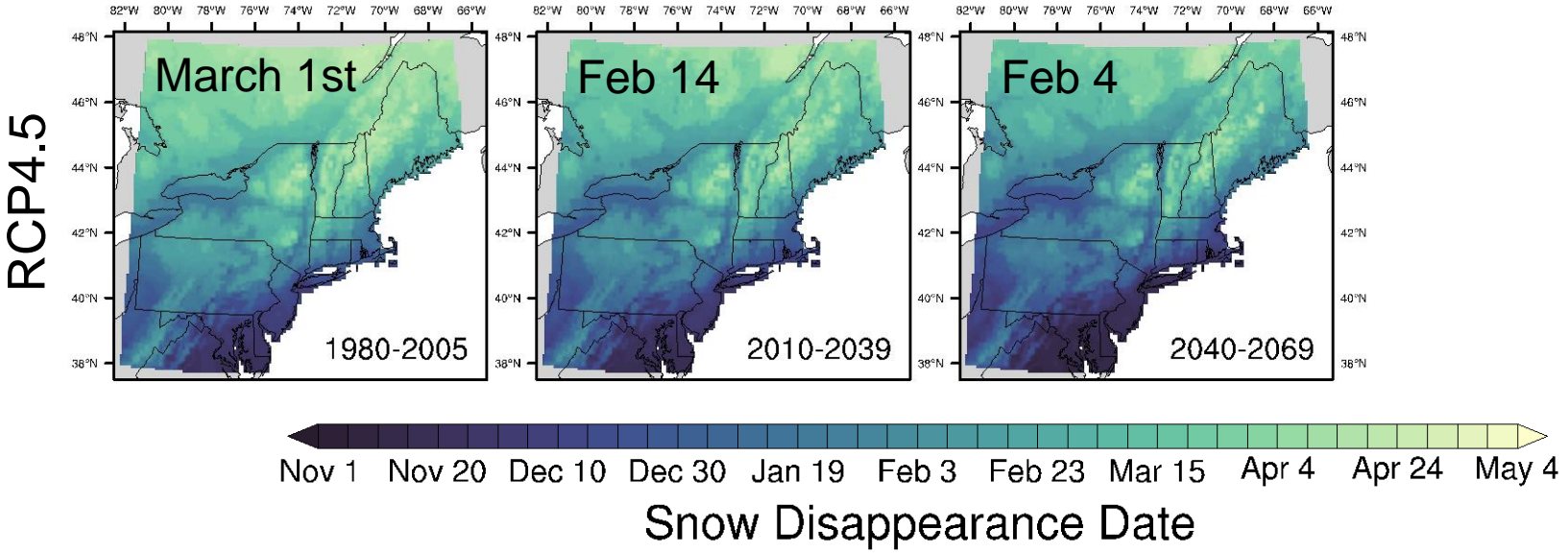
Historical (1981-2005) Northeastern US snow disappearance date: March 1st



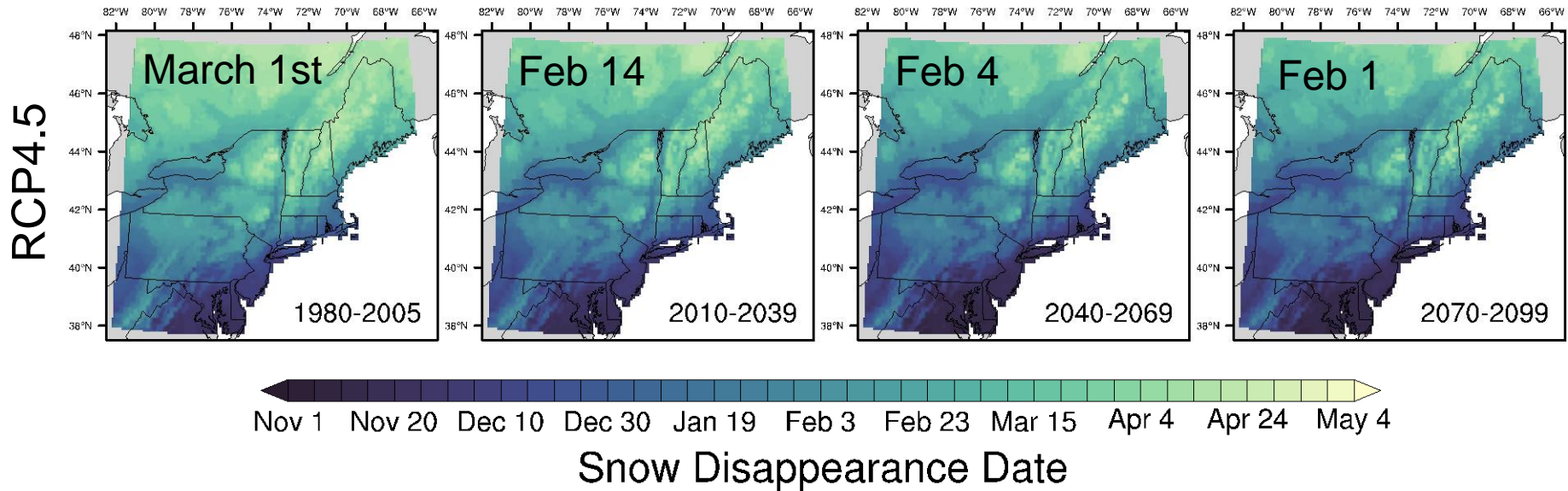
Under RCP4.5, snow disappearance data advances two weeks earlier by 2010-2039.



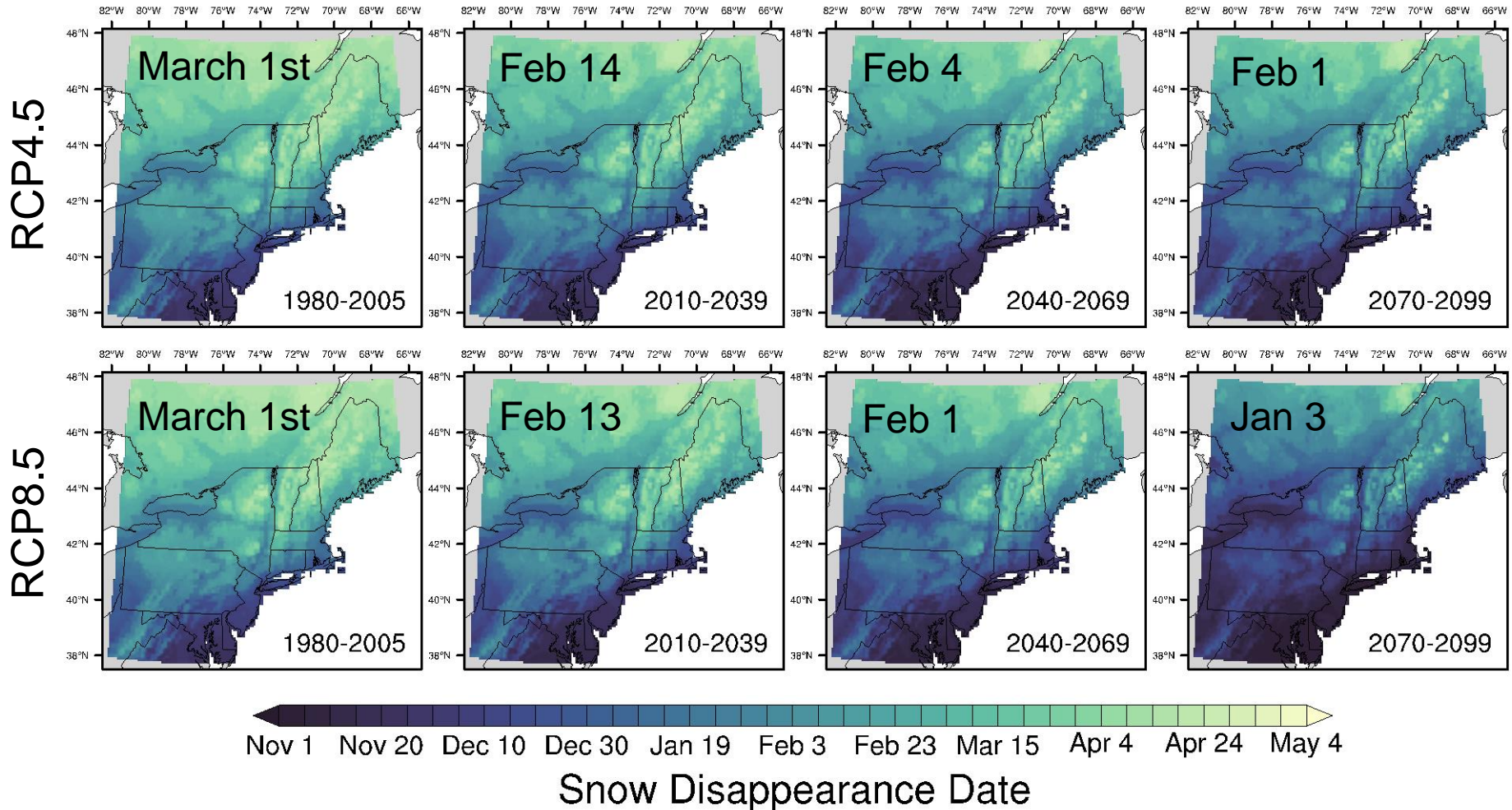
By mid-century, snow disappearance date is early February under RCP4.5.



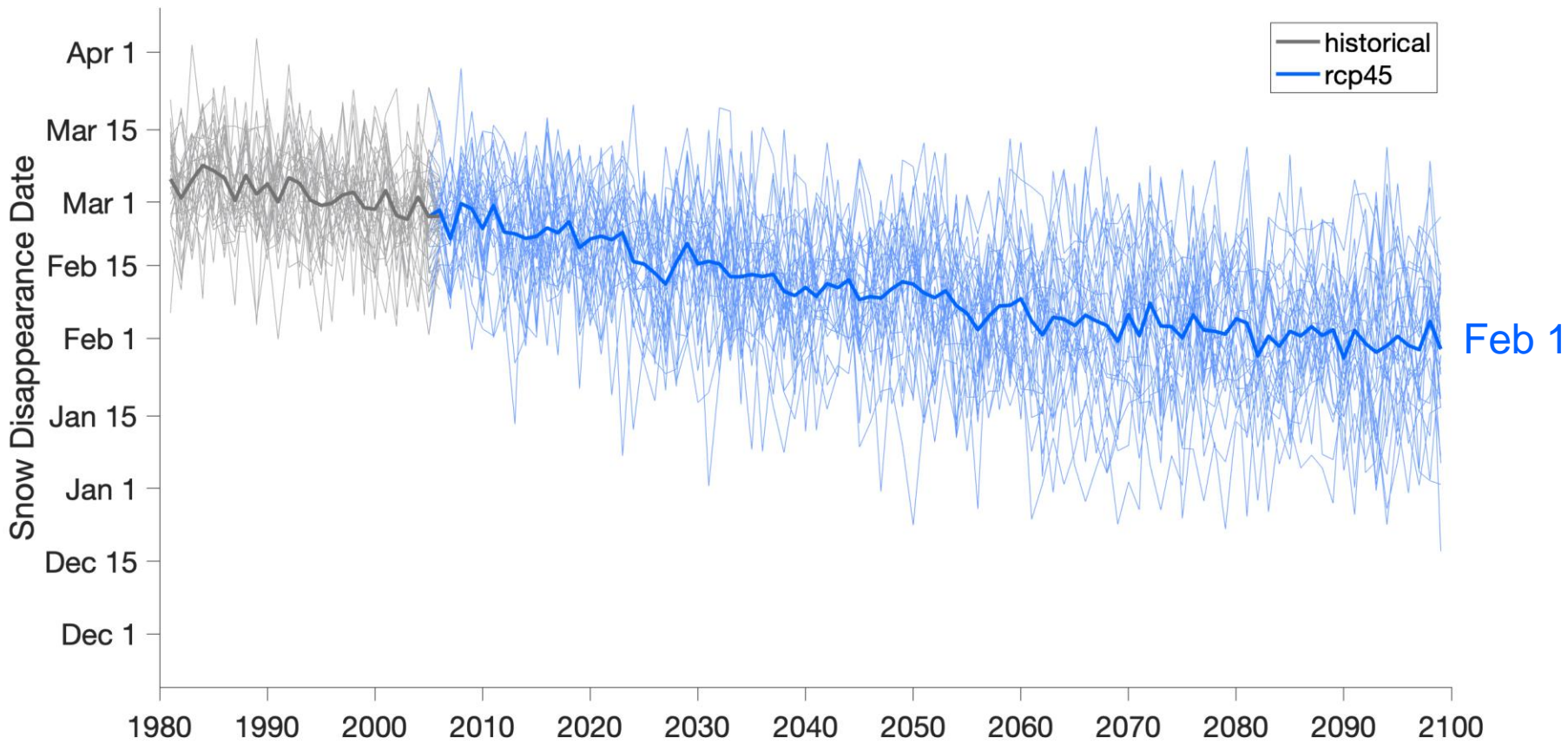
Snow disappears a month earlier by end of century under RCP4.5 compared to historical.



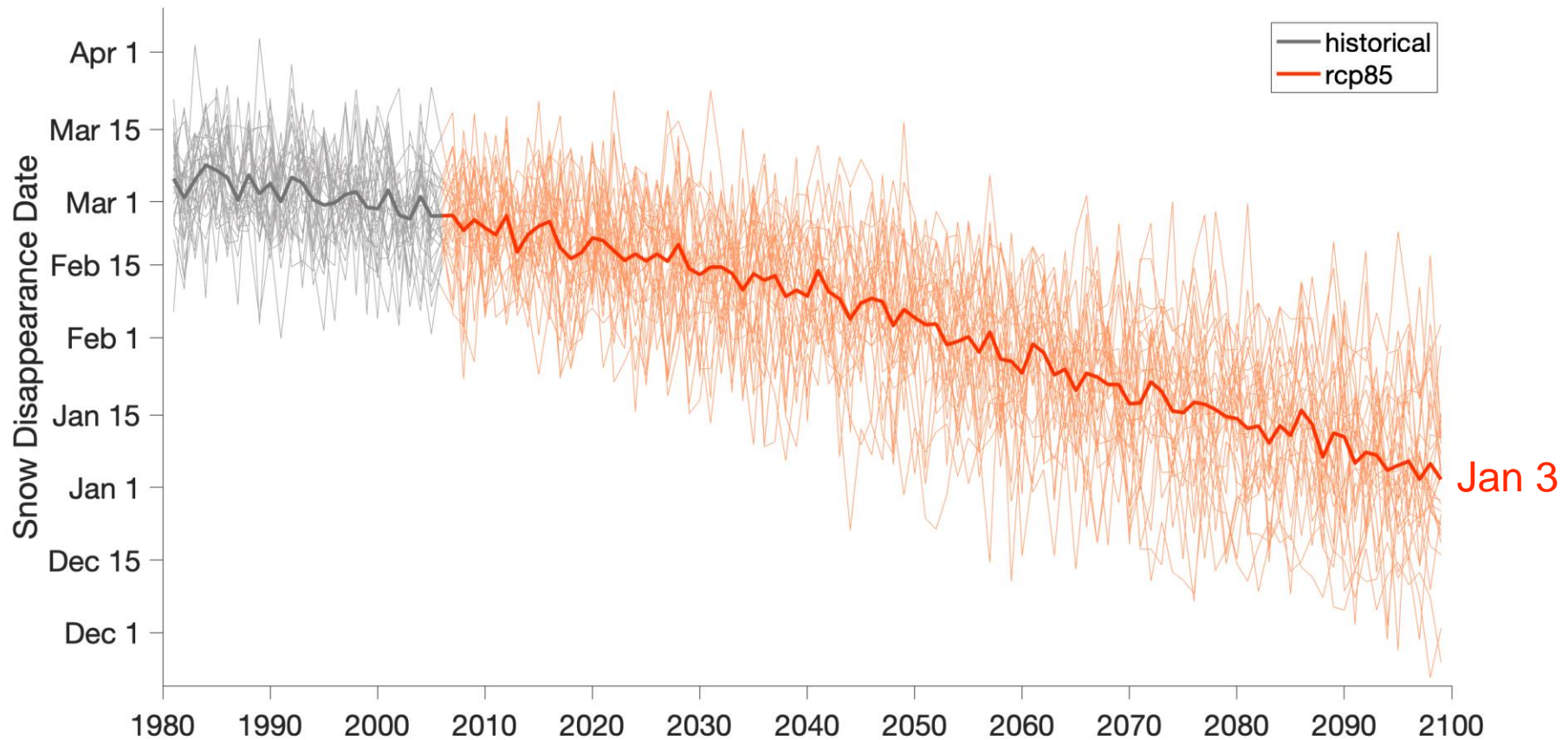
Under RCP8.5, January is the new March for snow disappearance date.



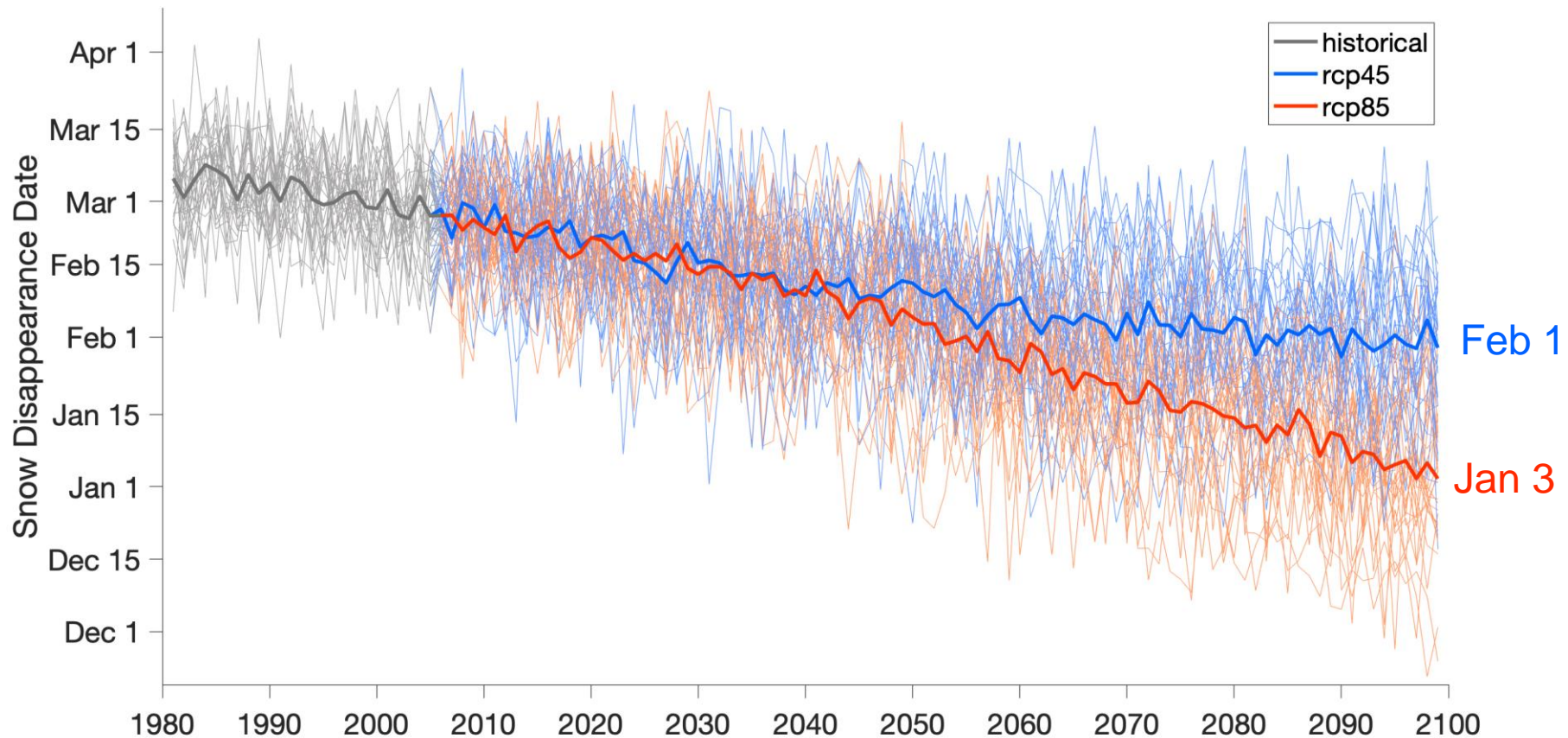
Stabilization of snow disappearance date by end of century under RCP4.5.



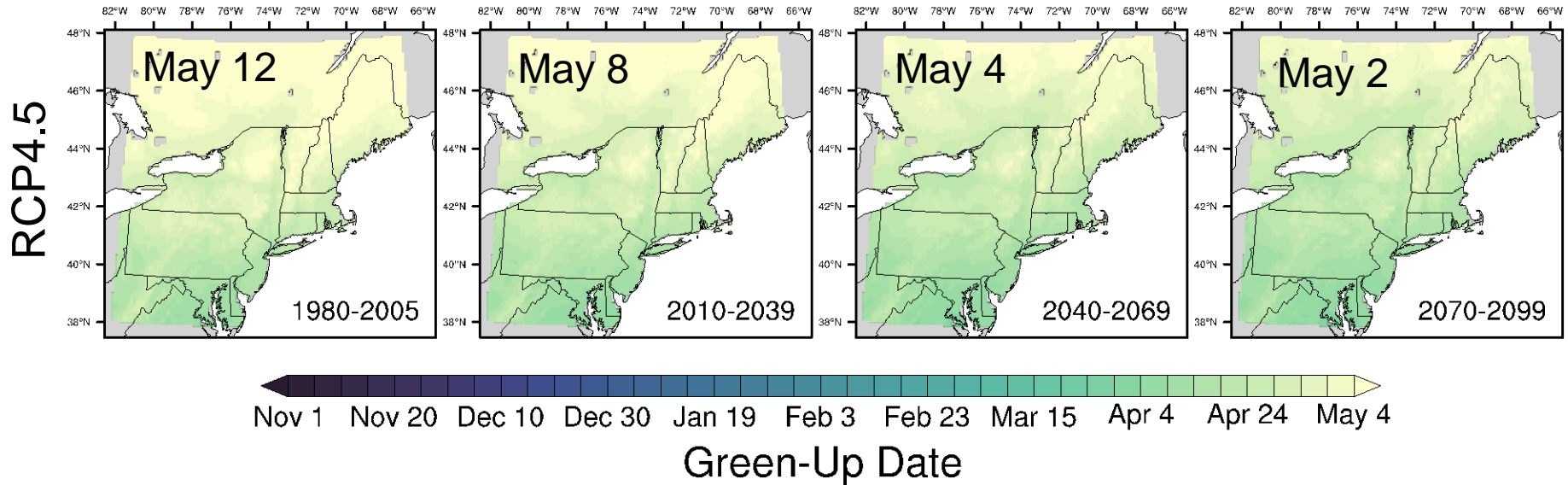
Individual ensemble members demonstrate wide spread for each scenario.



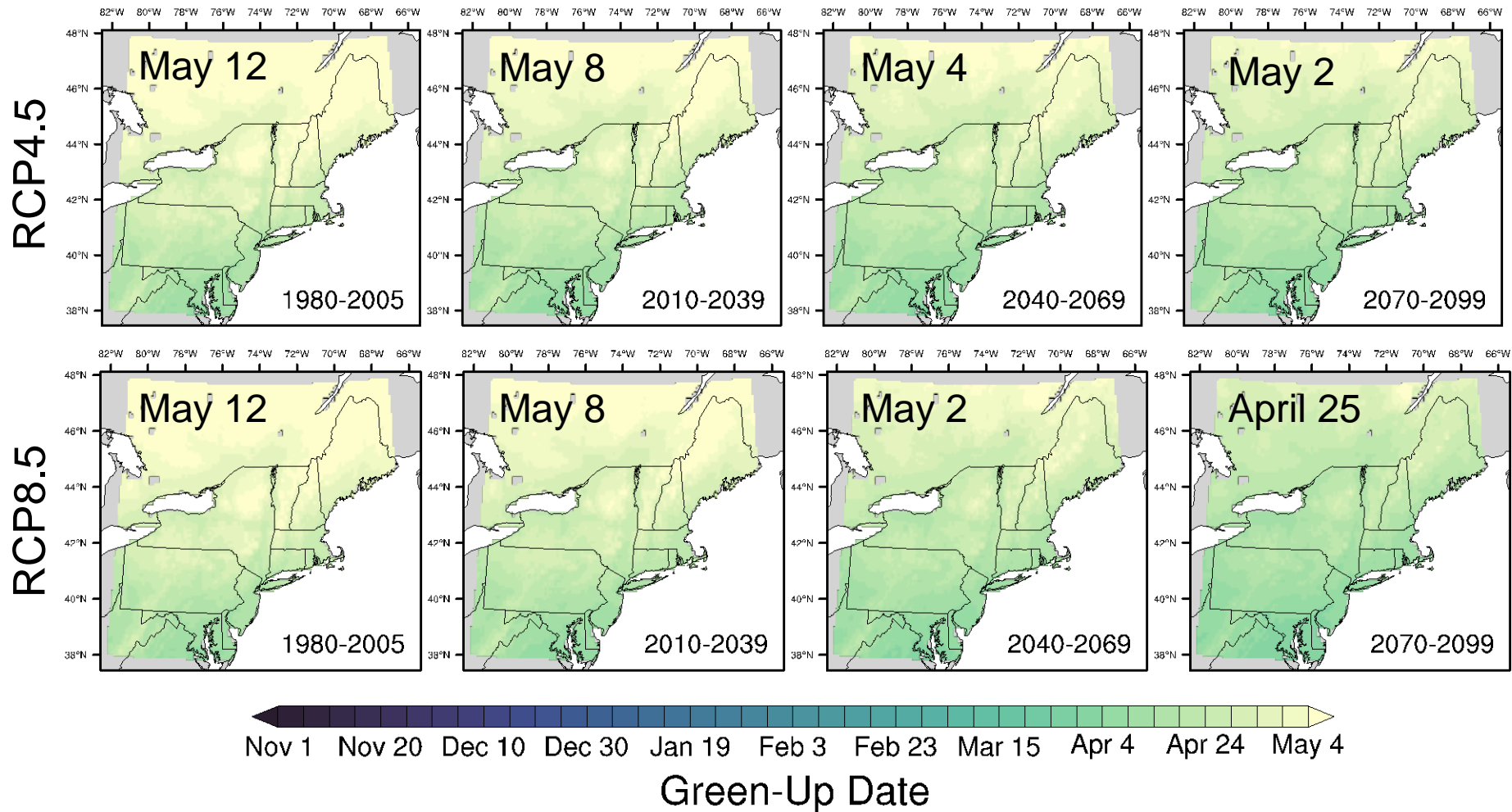
Snow season ends about one month earlier under higher scenario.



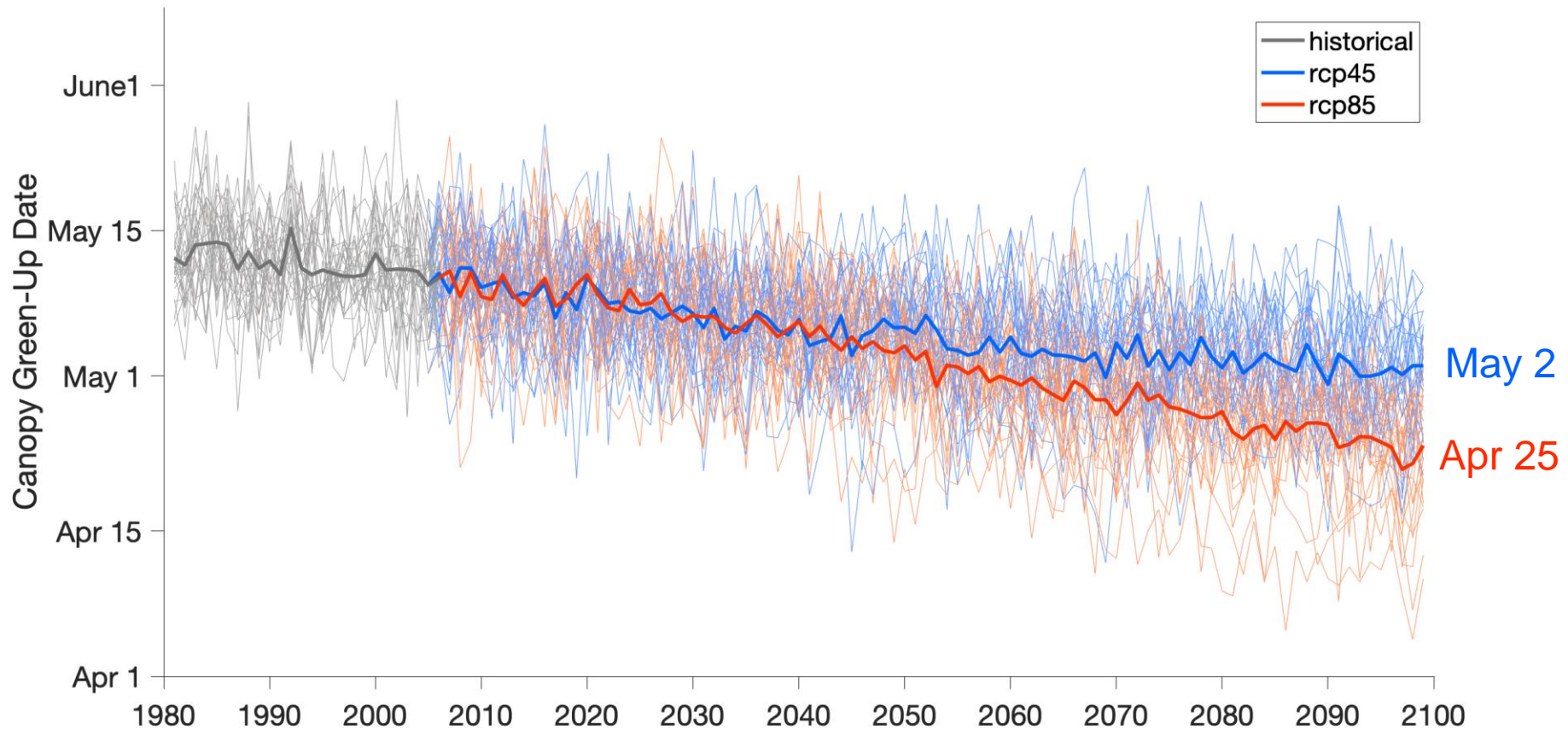
Canopy green-up date advances 10 days under RCP4.5, relative to historical.



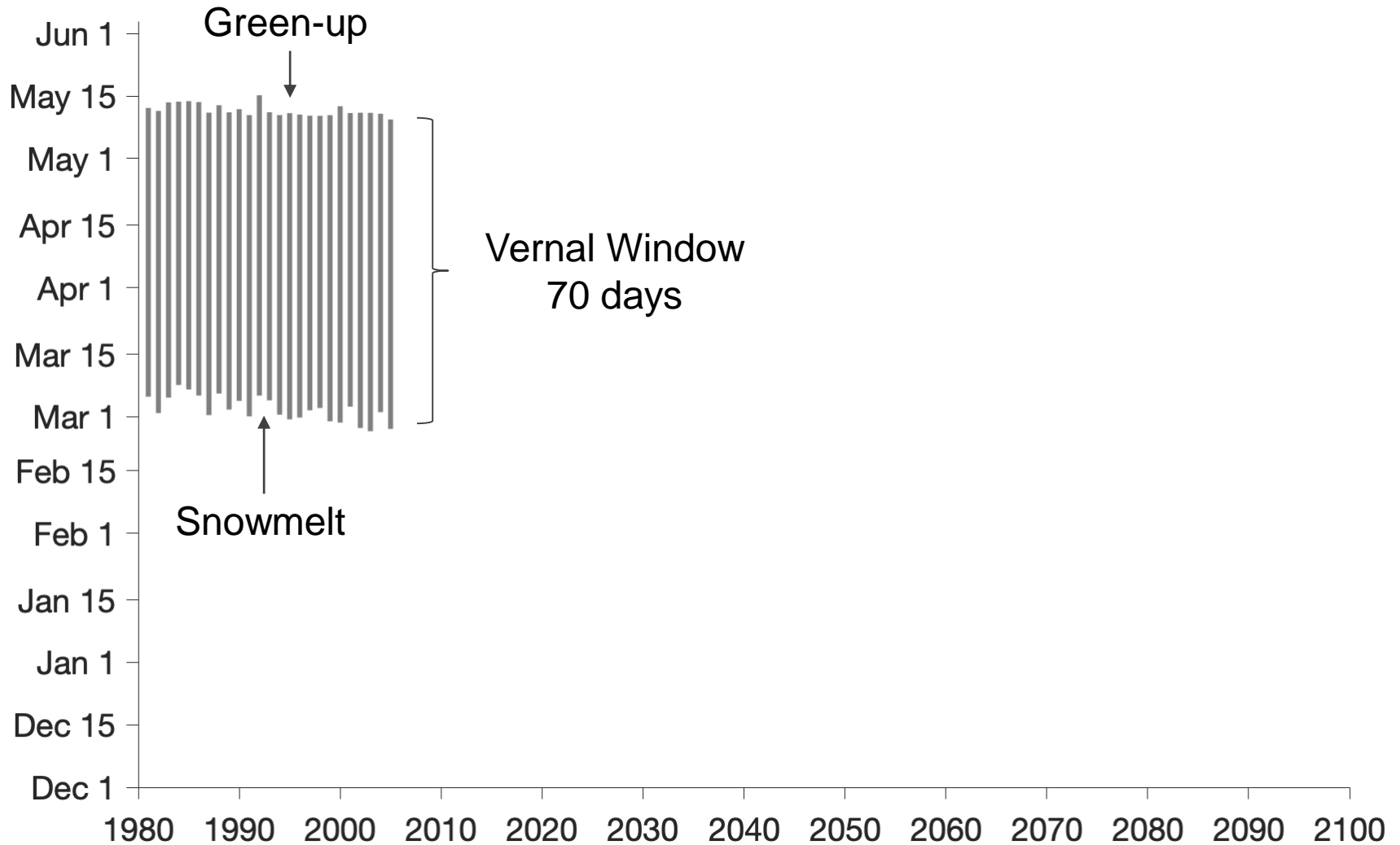
Under RCP8.5, green-up date advances 15 days earlier, relative to historical.



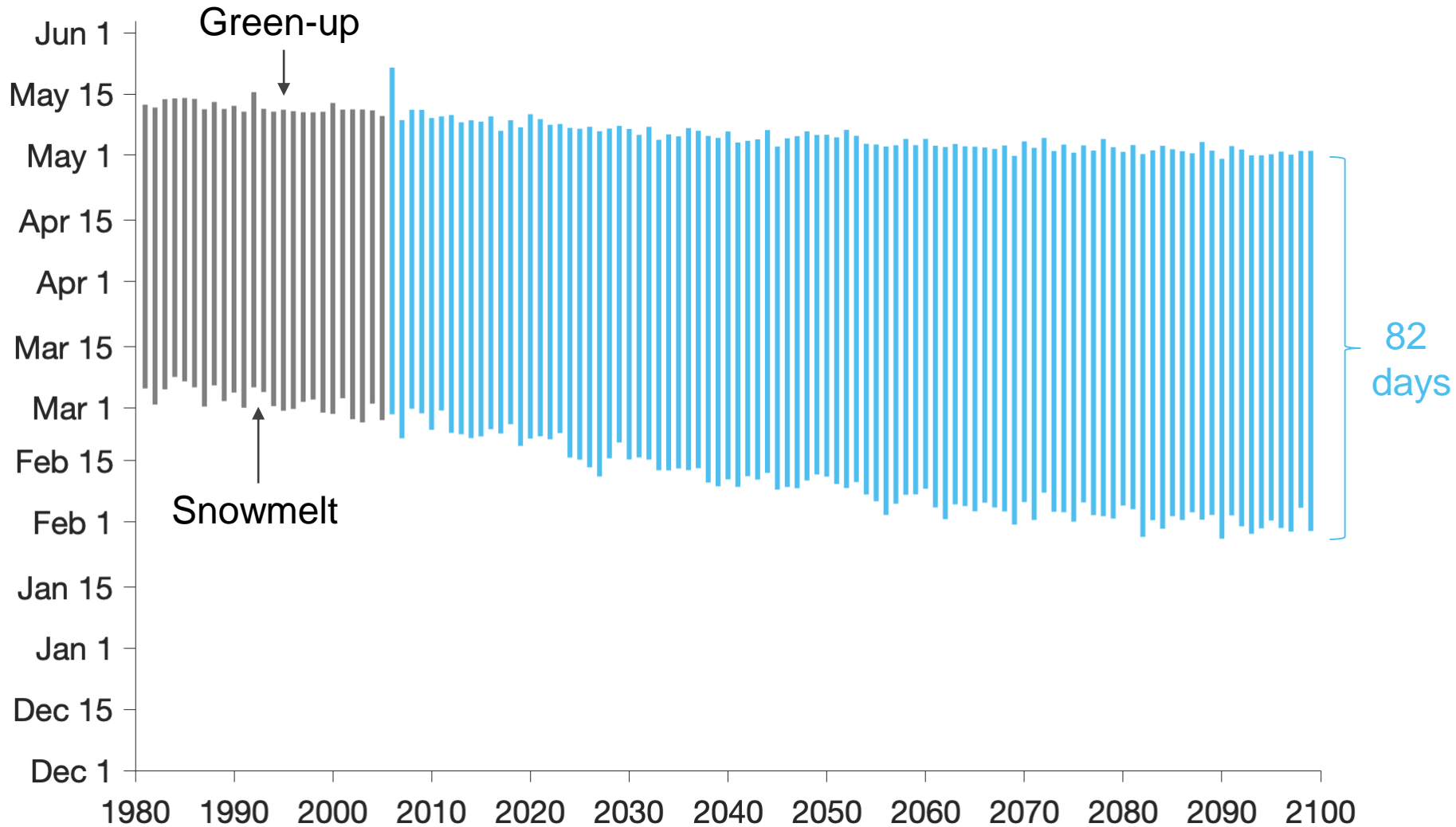
Canopy green-up occurs about a week earlier under RCP8.5 compared to RCP4.5



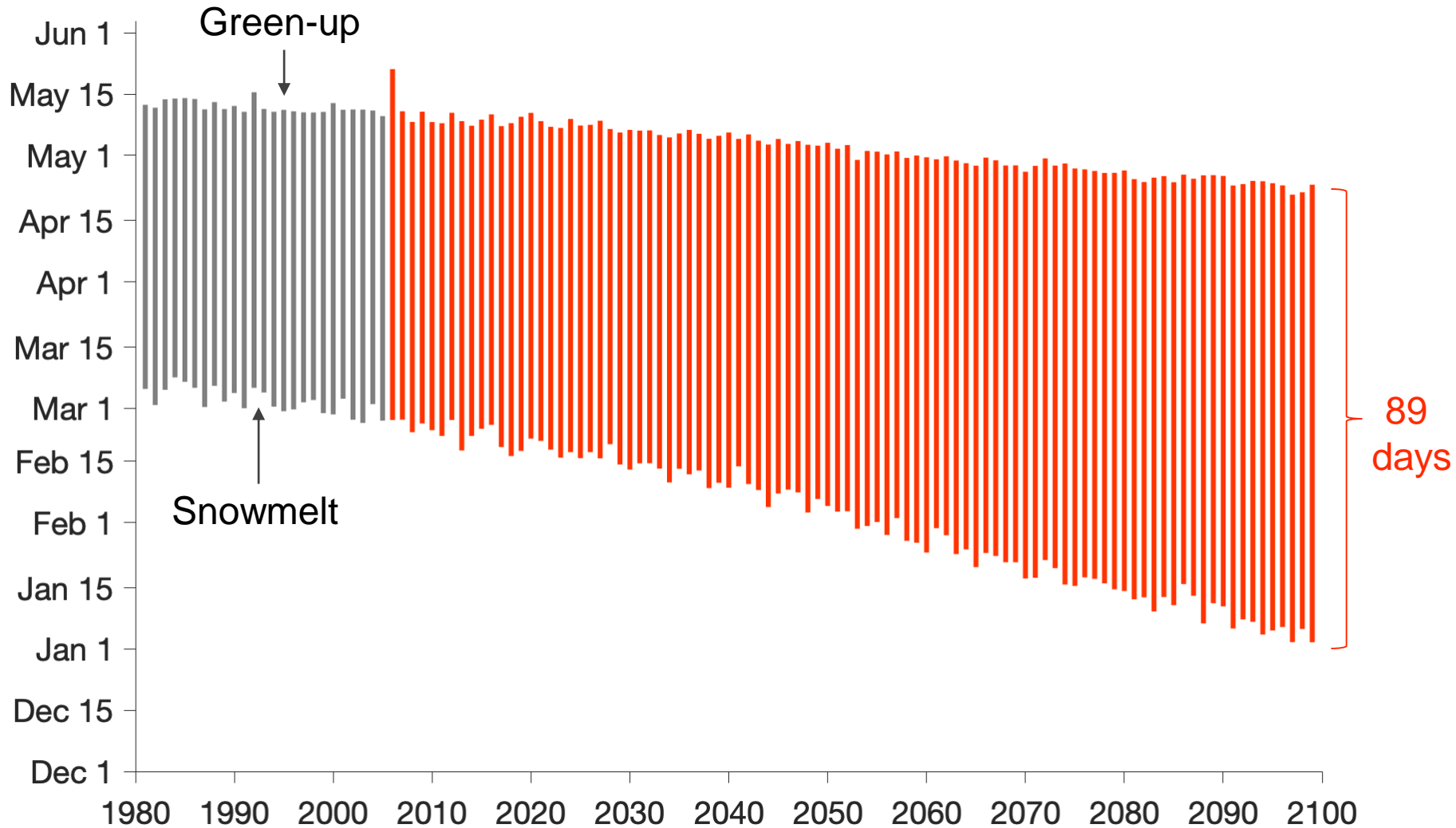
Vernal window lengthens three weeks under RCP4.5.



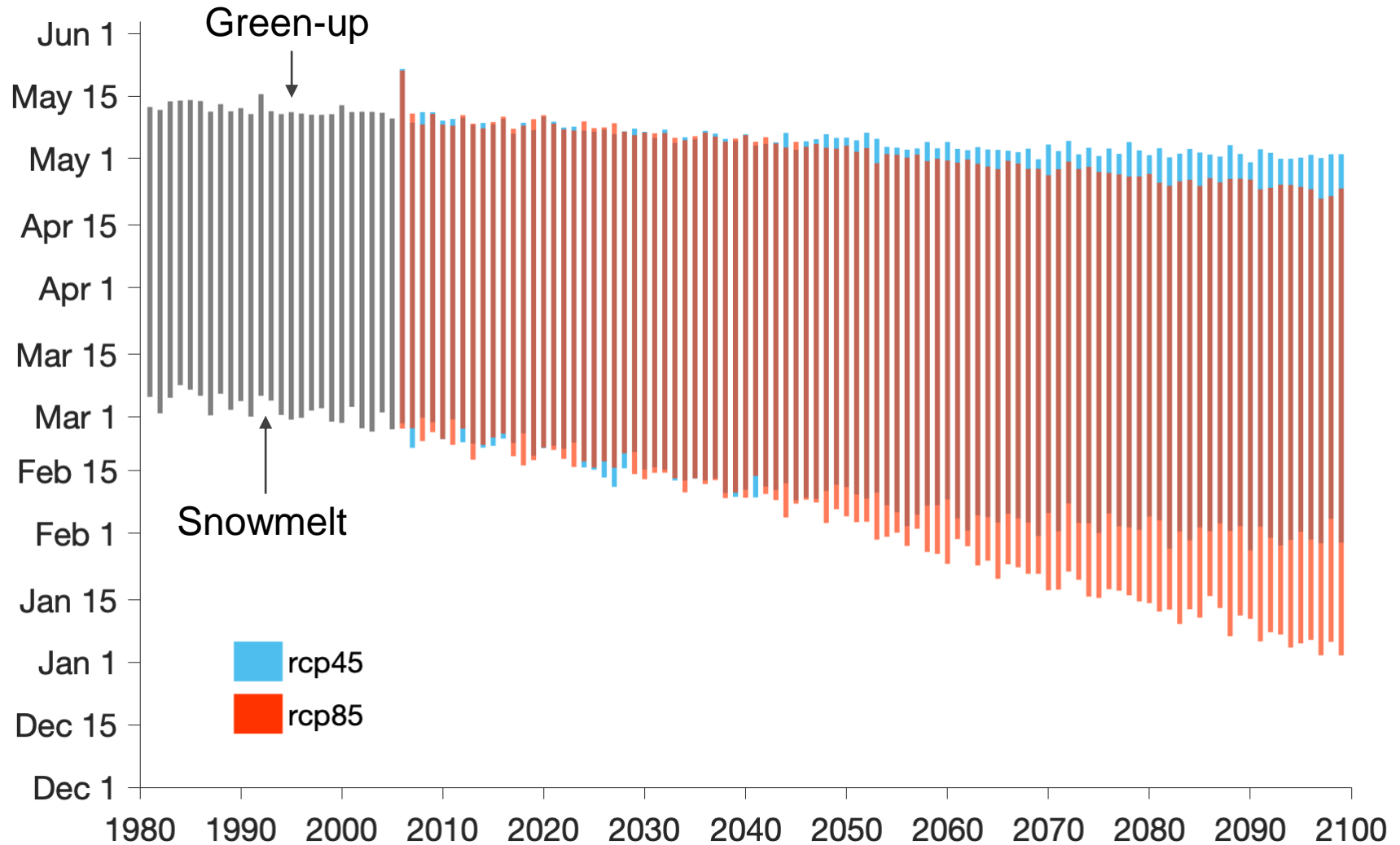
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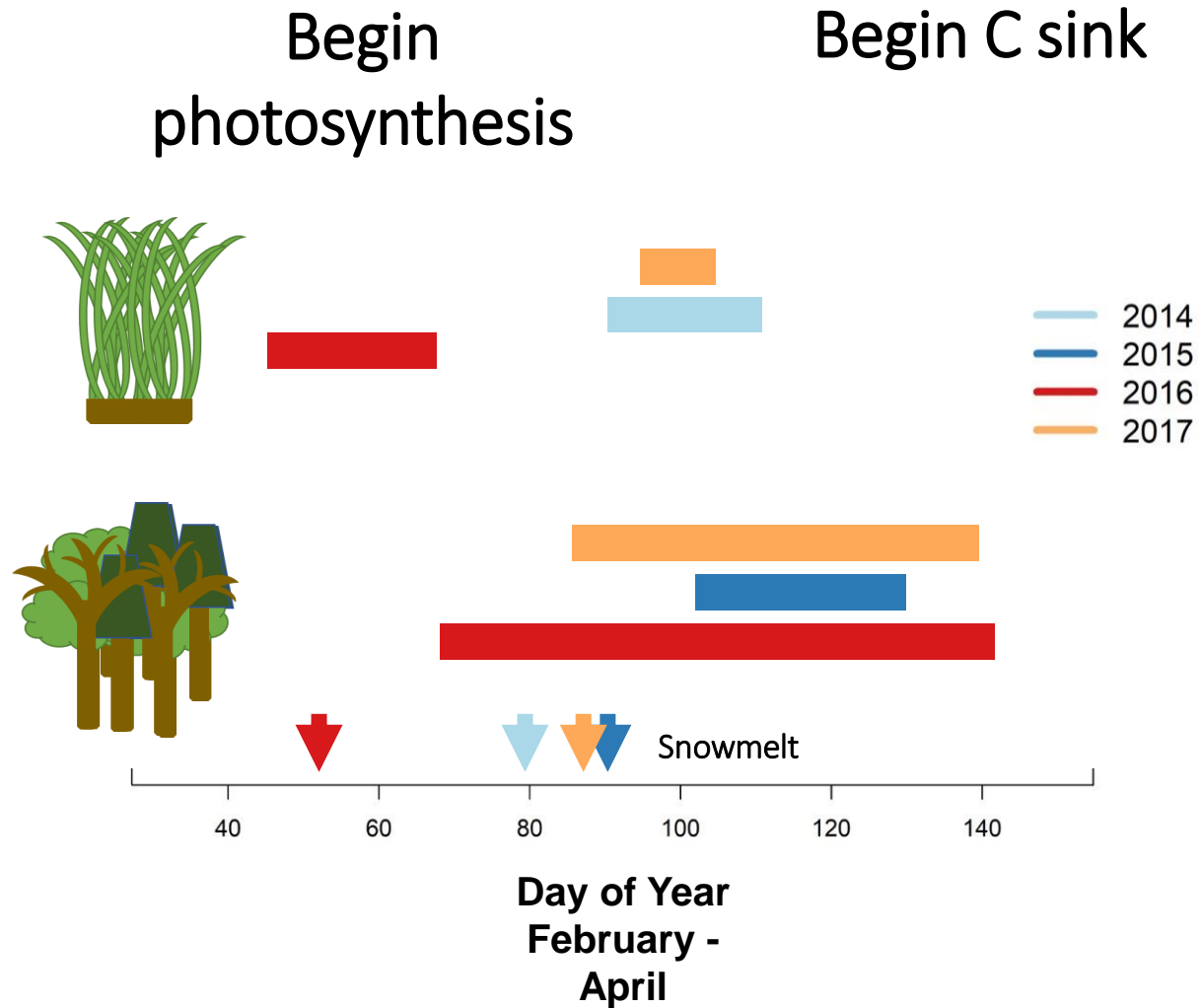
Vernal window lengthens three weeks under RCP4.5.



Vernal window lengthens almost five weeks under RCP8.5.



Flexibility in C uptake timing varies by vegetation



Key Points

Using ensemble of simple models, we find:

- Snow melts **one month earlier** under RCP4.5, and **two months earlier** under RCP8.5.

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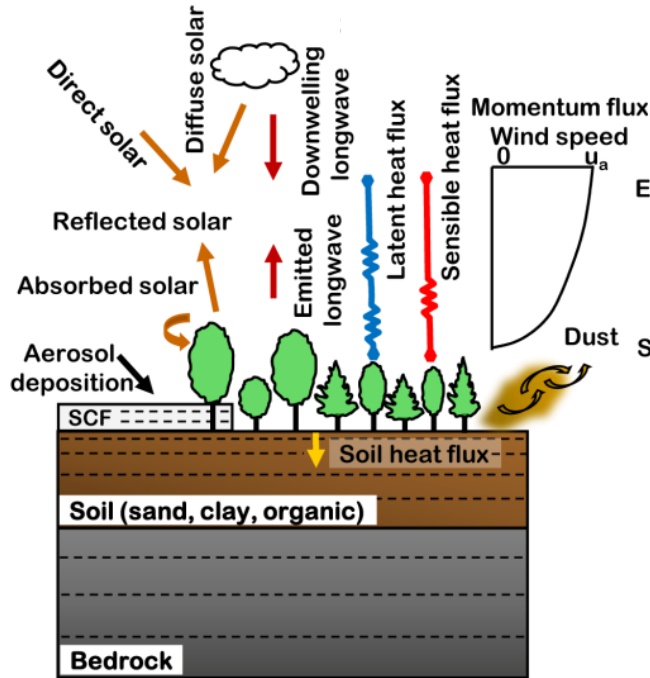
Using ensemble of simple models, we find:

- Snow melts **one month earlier** under RCP4.5, and **two months earlier** under RCP8.5.
- Canopy green-up occurs **ten days earlier** under RCP4.5, and **three weeks earlier** under RCP8.5
- Vernal window is **12 days** under RCP4.5, and **19 days longer** under RCP8.5

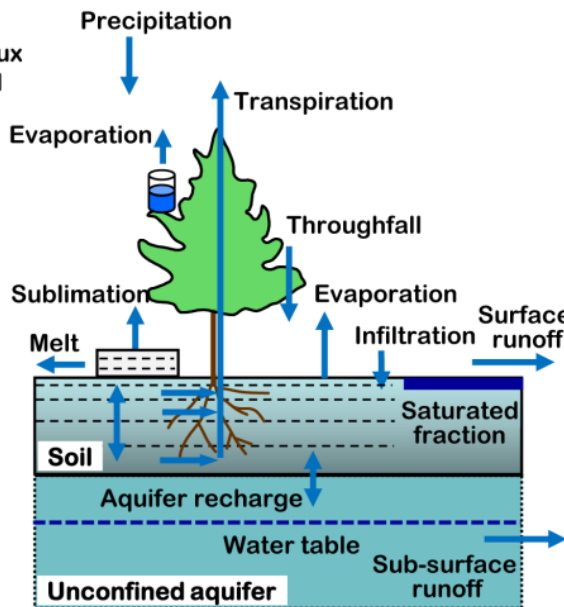
Next Steps

Repeat analysis with CLM5 simulations

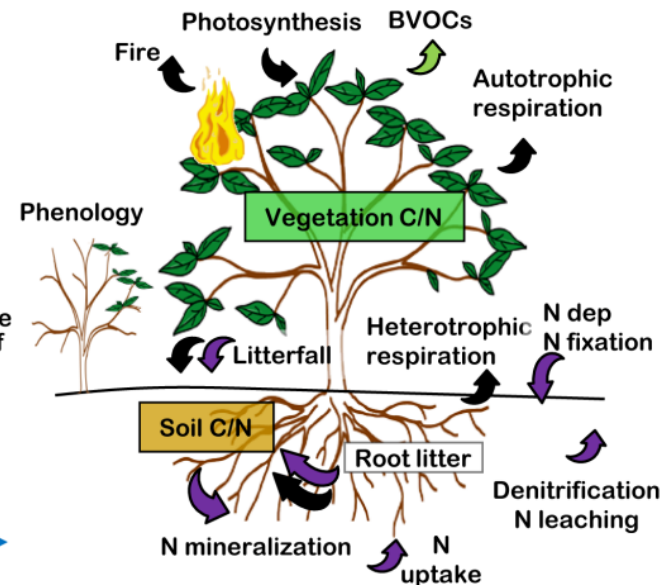
Surface energy fluxes



Hydrology



Biogeochemistry





Vernal Window Projects



THE **GLOBE** PROGRAM

NSF Macrosystems Biology

Lead PI:

Elizabeth Burakowski
Earth Systems Research Center (ESRC), Institute for
Study of Earth, Oceans, and Space (EOS), University of
New Hampshire (UNH)

Co-PIs:

Alexandra Contosta, ESRC, EOS-UNH
Danielle Grogan, Water Systems Analysis Group, EOS-UNH

US Forest Service CitSci Fund

Institutional Lead PI:

Elizabeth Burakowski, EOS-UNH

Forest Service Lead PI:

John L. Campbell, Northern Research Station, US
Forest Service

Co-PIs:

Alix Contosta, EOS-UNH
Rebecca Sanders-DeMott, EOS-UNH

NSF EPSCoR Track 4 Fellowship Elizabeth Burakowski

Thanks and Questions
elizabeth.burakowski@unh.edu



@LizBurakowski