

# Contrasting Effects of a Warm Winter on Carbon Fluxes Across Land Cover Types in NH, USA

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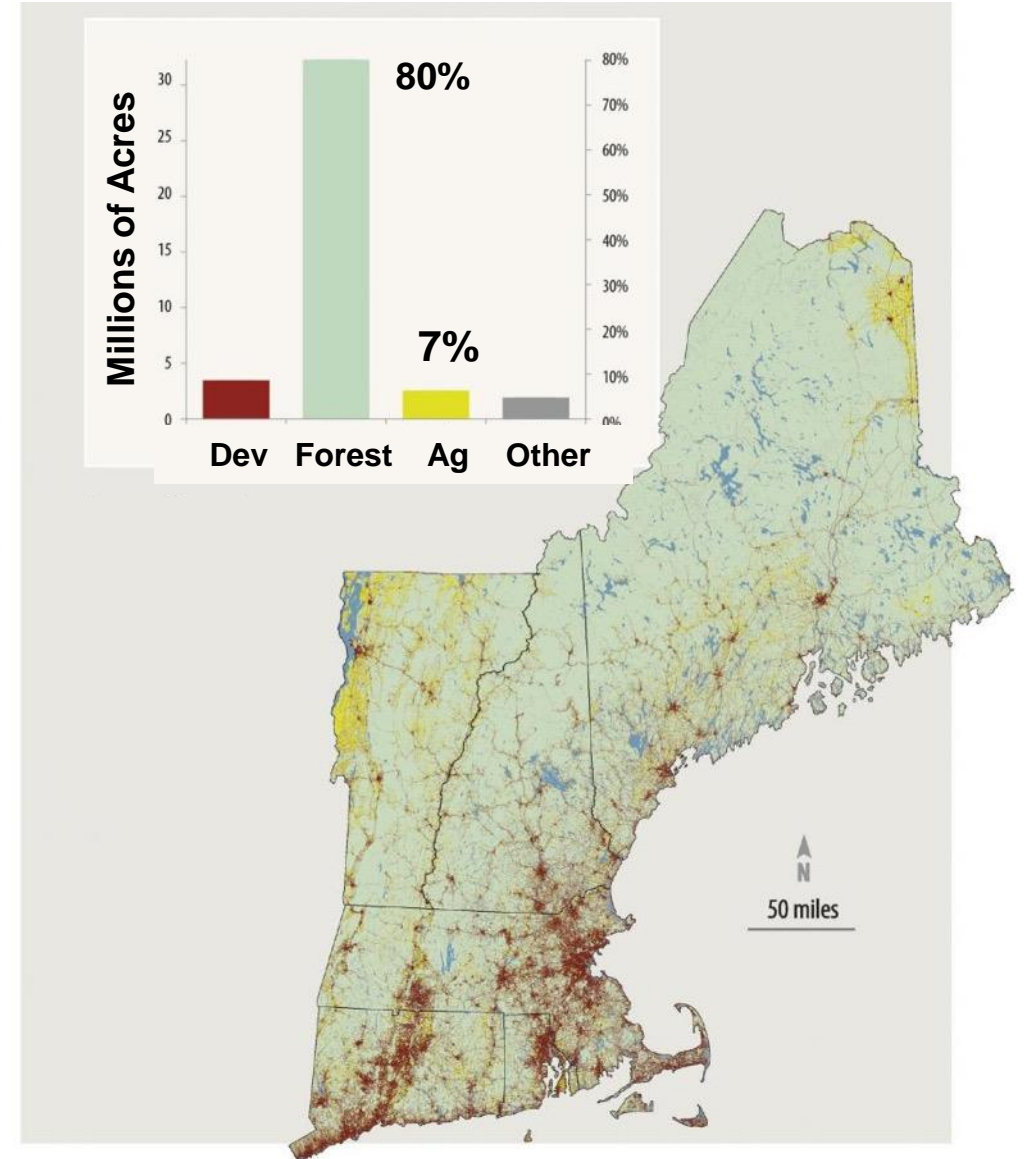


Lamprey River  
Symposium  
January 8, 2018  
Durham, NH

# New England consists of dynamic mixed landscape



- New England dominated by forests
- Forest land declining: development and suburbanization
- Potential for agricultural expansion?
- Future land cover change uncertain

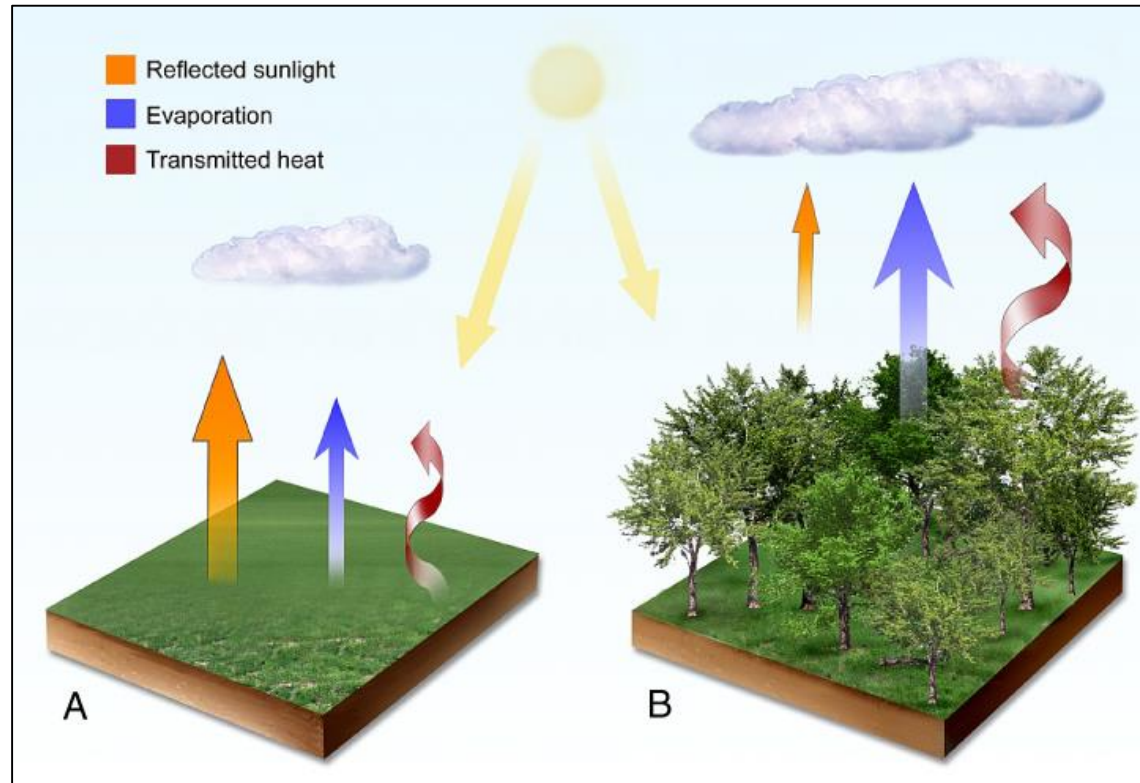


# Land cover feeds back to climate

## Grassland

## Forest

Carbon uptake  
Surface roughness  
Heat dissipation  
Albedo



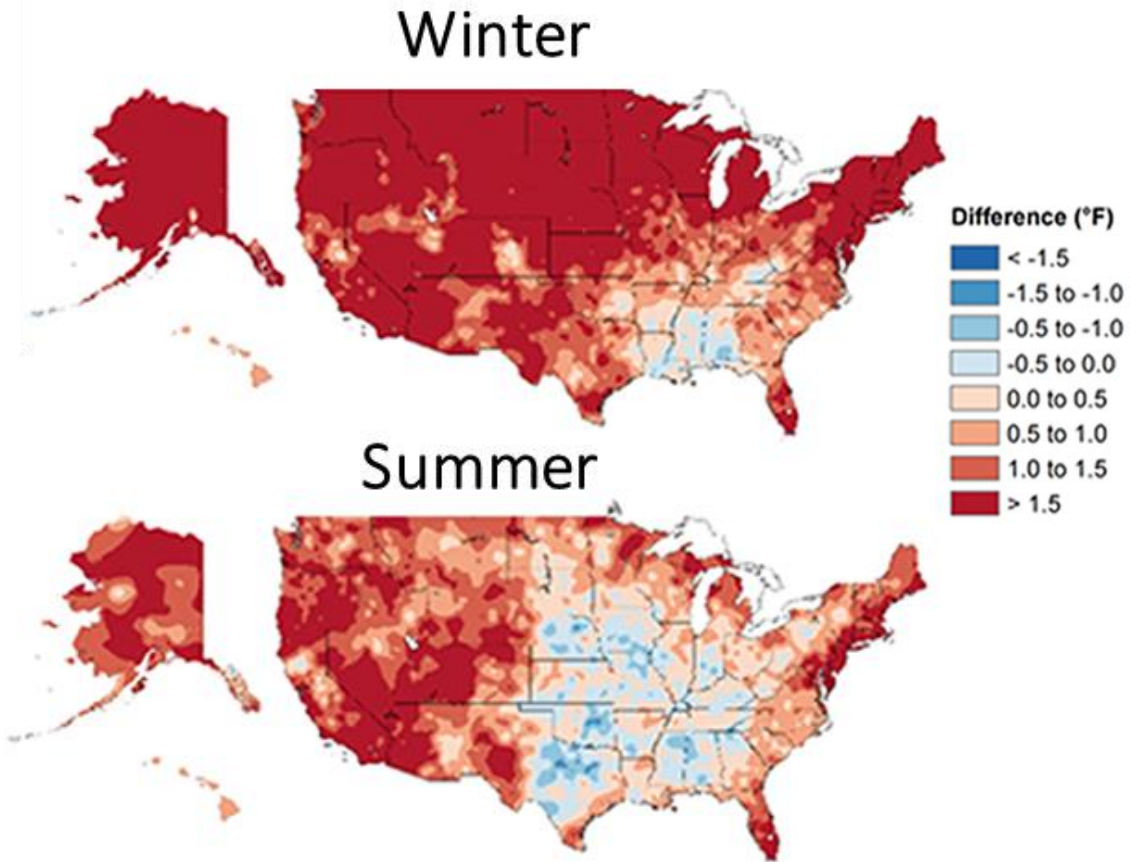
Carbon uptake  
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Jackson et al. 2008

Bonan et al. 2008; Burakowski et al 2018

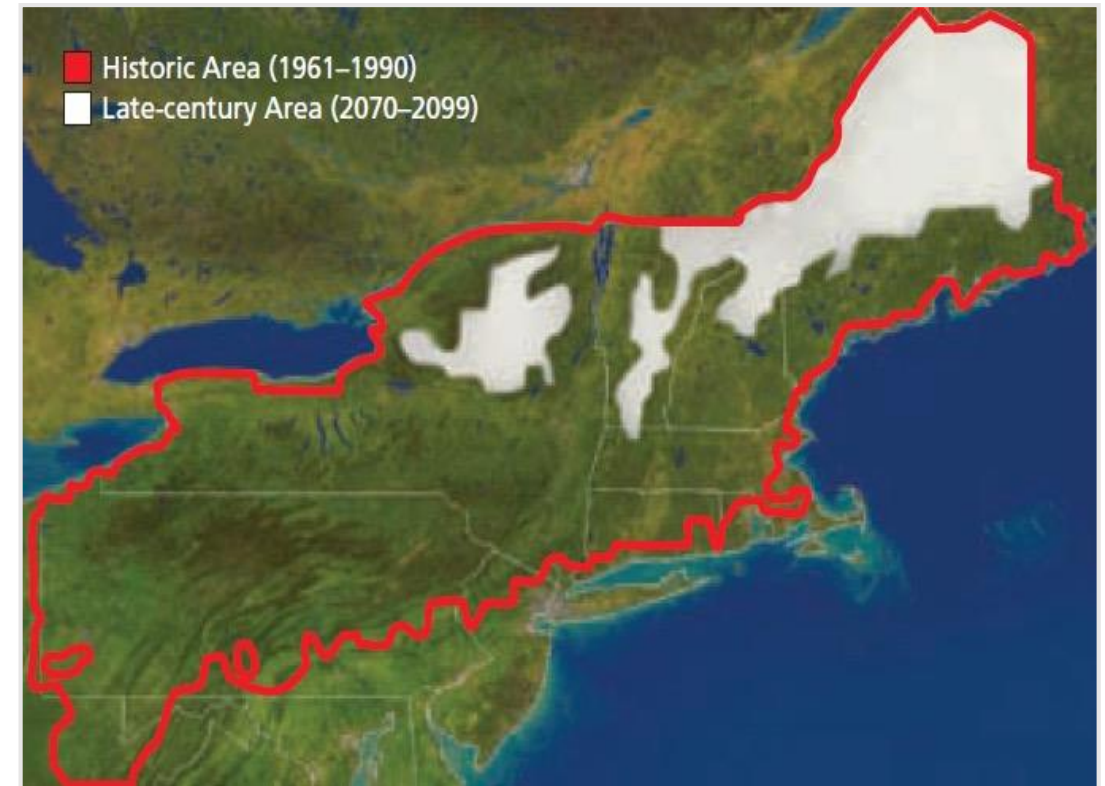
# Warming is changing winters in New England

Warming more pronounced in winter



National Climate Assessment 2017

Projected declines in snow cover



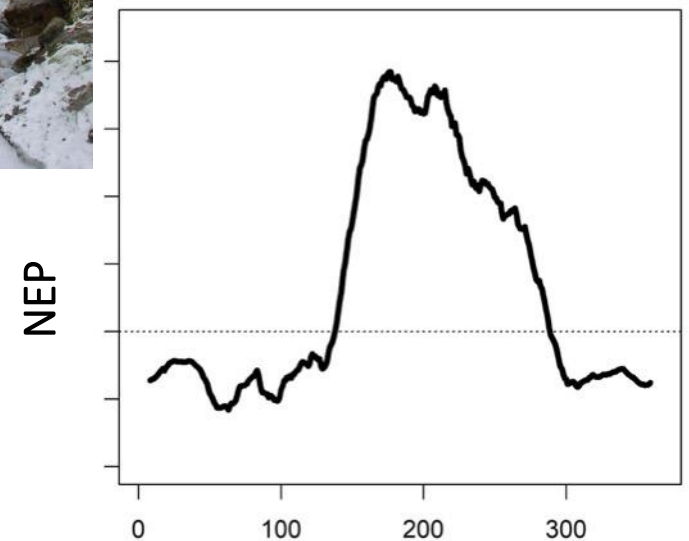
Northeast Climate Impacts Assessment 2007

# Winter climate influences ecosystems

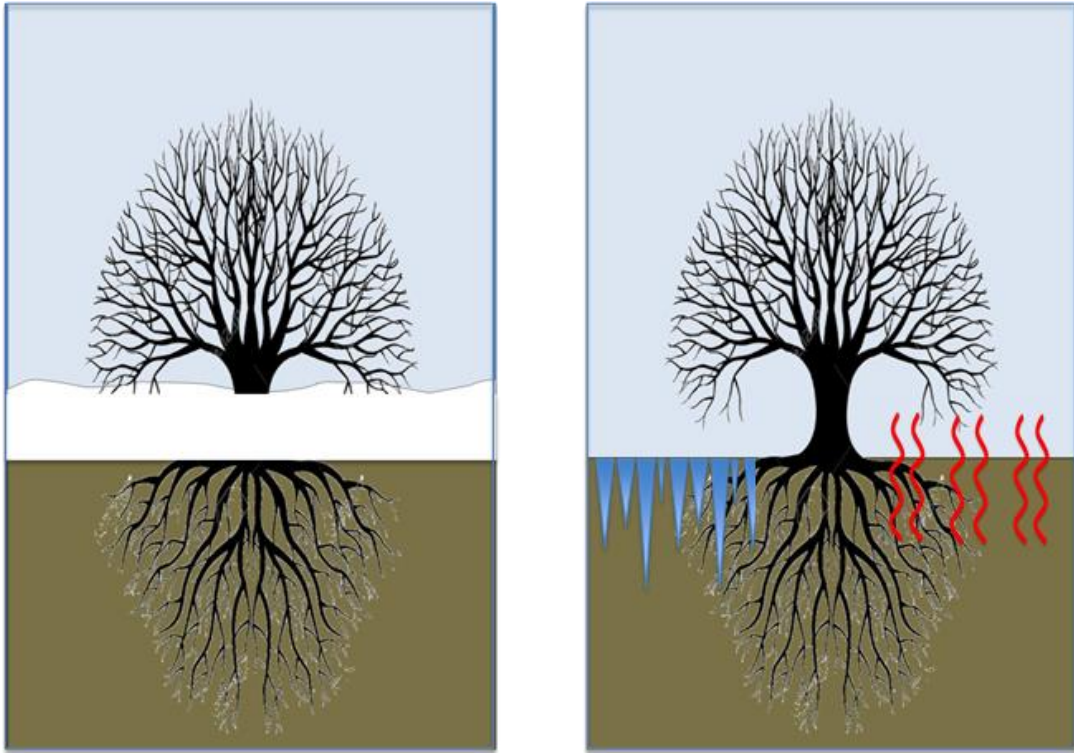
Winter C losses account for

- 5-12% of annual respiration

Temperature sensitivity of respiration varies between growing season and winter



# Winter climate influences ecosystems



Winter warming is complex:

- reduced snowpack depth
- earlier snowmelt
- variable soil temperatures

Observed to

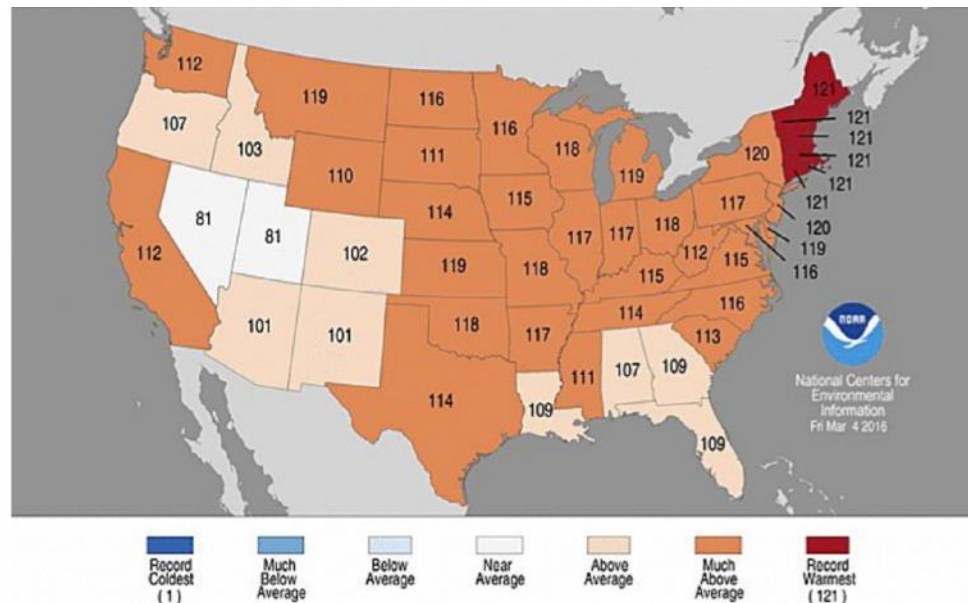
- **decrease** (Hu et al 2010)
- **increase** (Yu et al 2016)
- **not affect C flux** (Galvagno et al 2013)

# A Natural Experiment: Record-Breaking Winter 2015-2016

*The Washington Post*

## America's year without a winter: The 2015-2016 season was the warmest on record

By Jason Samenow March 8, 2016



8.6 °F (4.7 °C) above  
long term average

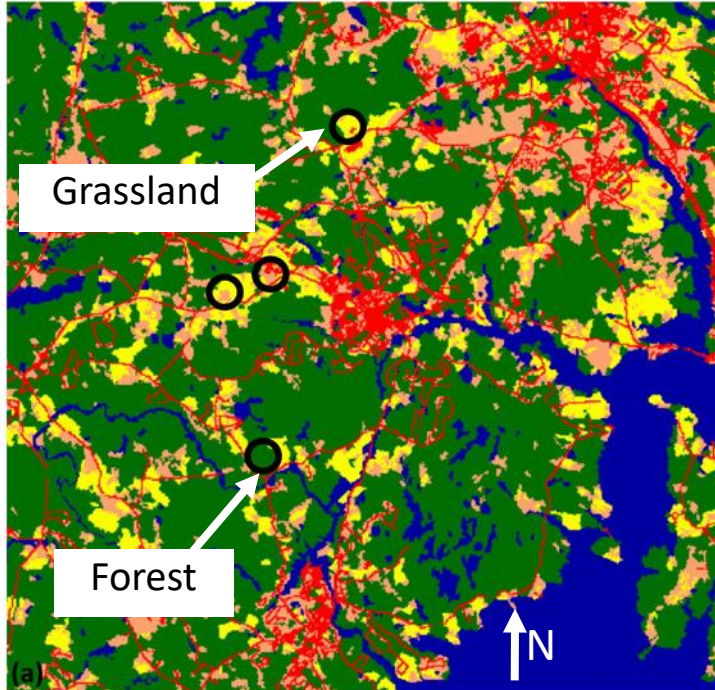
How does land cover type affect response of to a very warm winter with little snow?

- winter-spring cumulative C fluxes
- timing of spring transitions



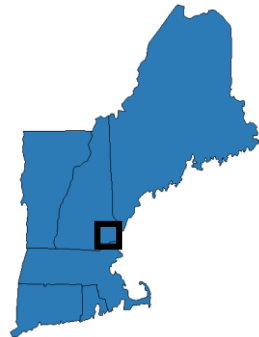


# Site Description



## Land Cover

- Developed
- Agriculture
- Forest
- Water/wetland
- Non-vegetated



0 1 2 3 4 km

## Grassland

managed hayfield for feed  
C3 non-artic grasses  
switchgrass, cordgrass, alfalfa



## Forest

mature mixed temperate  
50-50 conifer/deciduous  
red maple, red oak, white pine



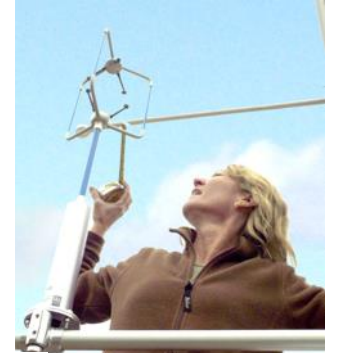
# Carbon Fluxes: Eddy Covariance

February-April Flux Data - 3 years

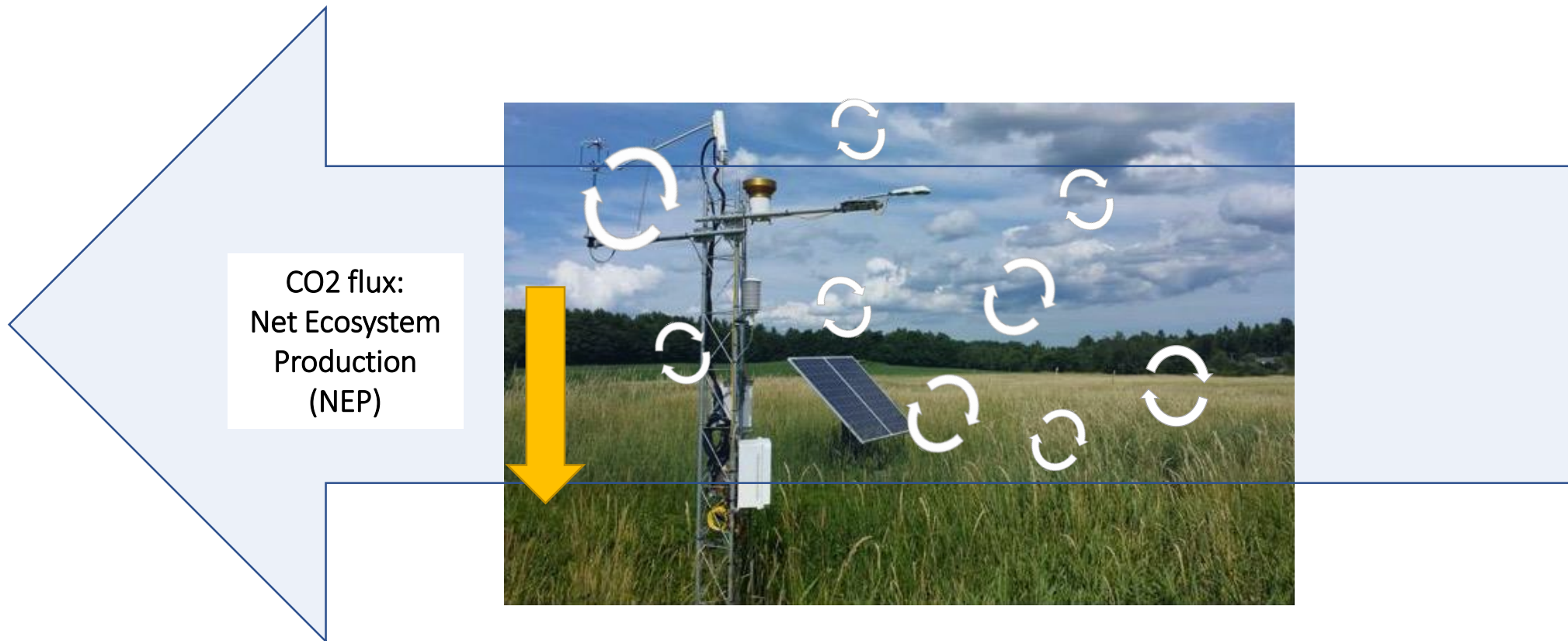
- Grassland: 2014, 2016-2017
- Forest: 2015-2017



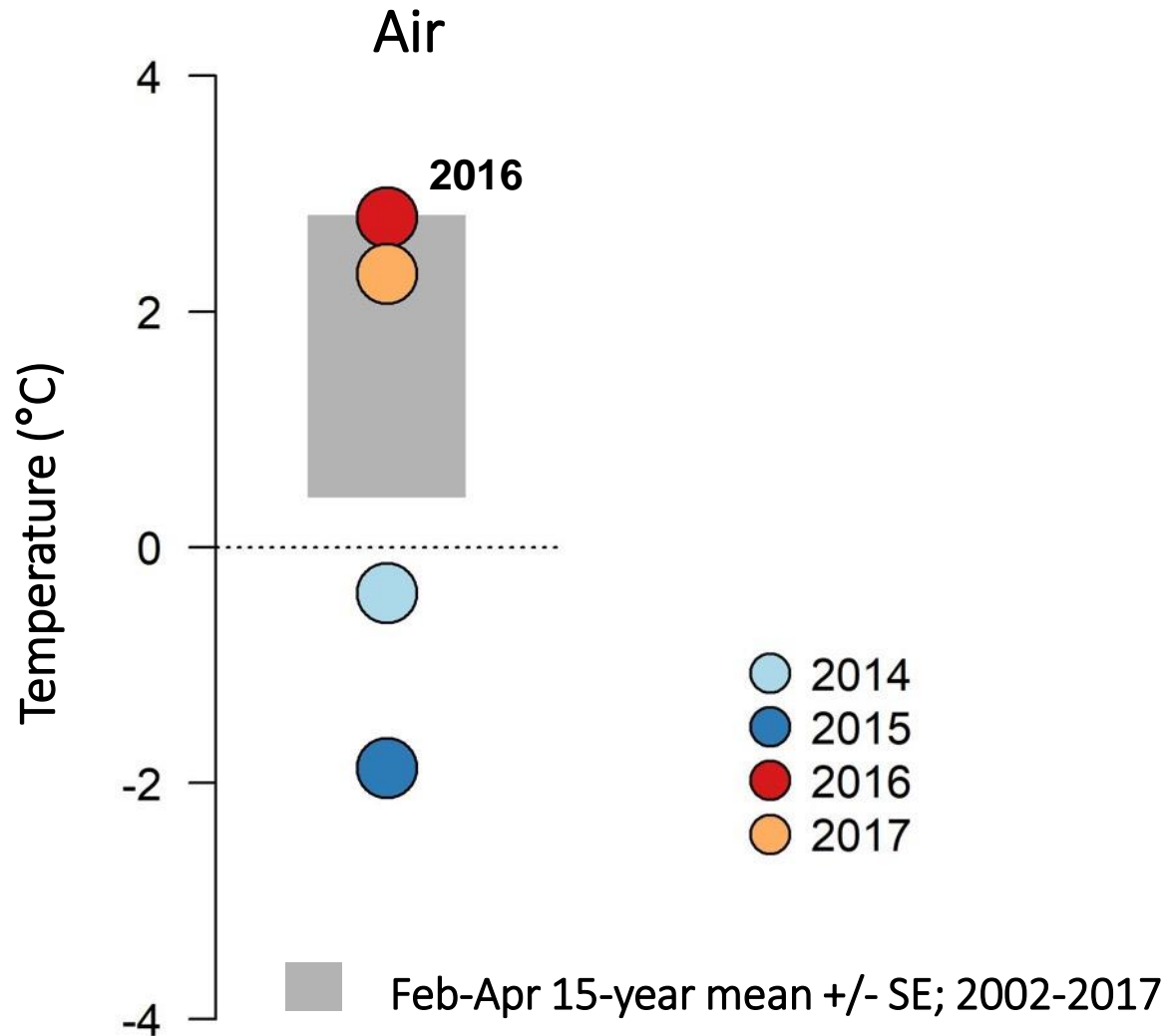
Andy Ouimette



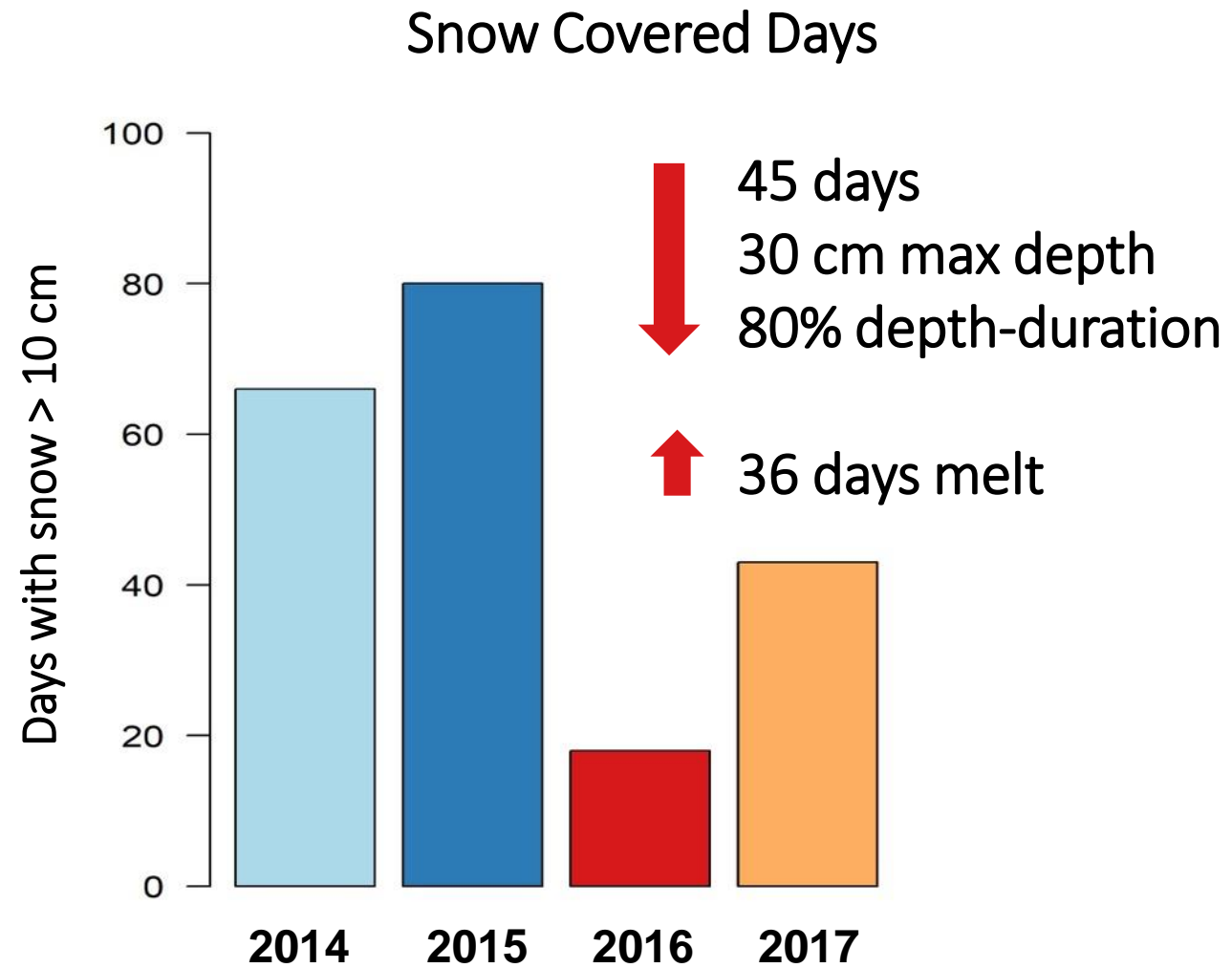
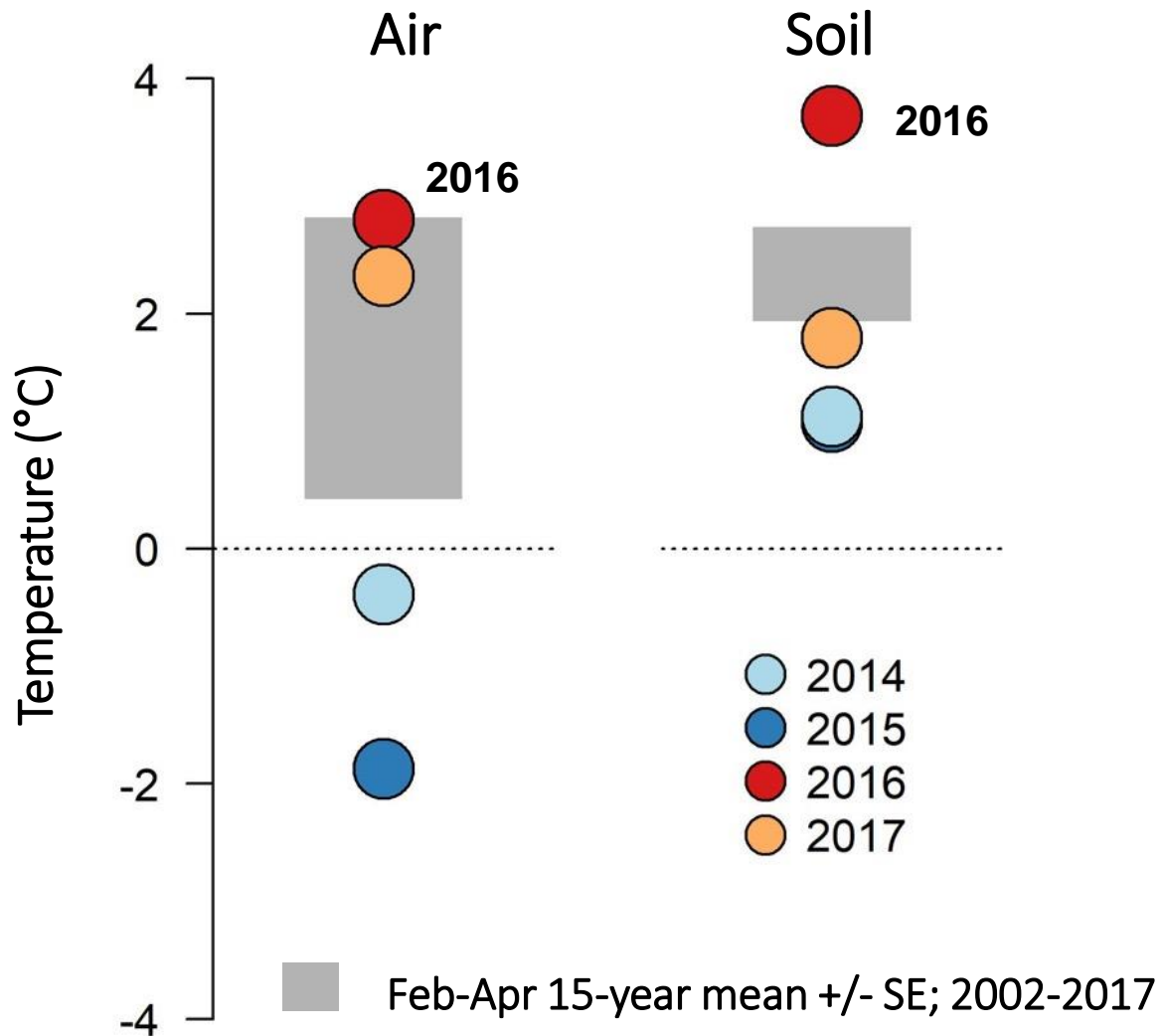
Lucie Lepine



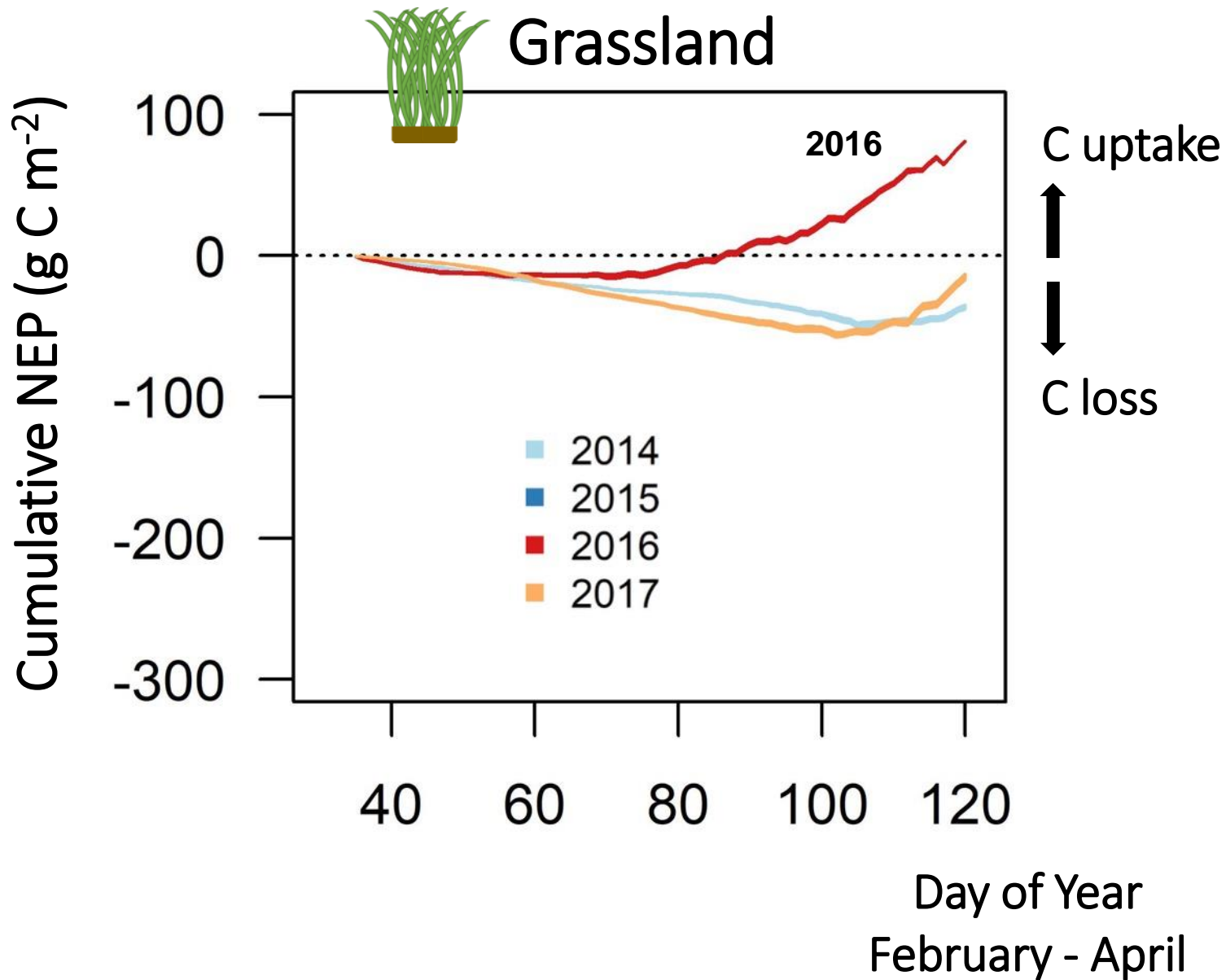
# Winter-Spring 2016 warm with little snowpack



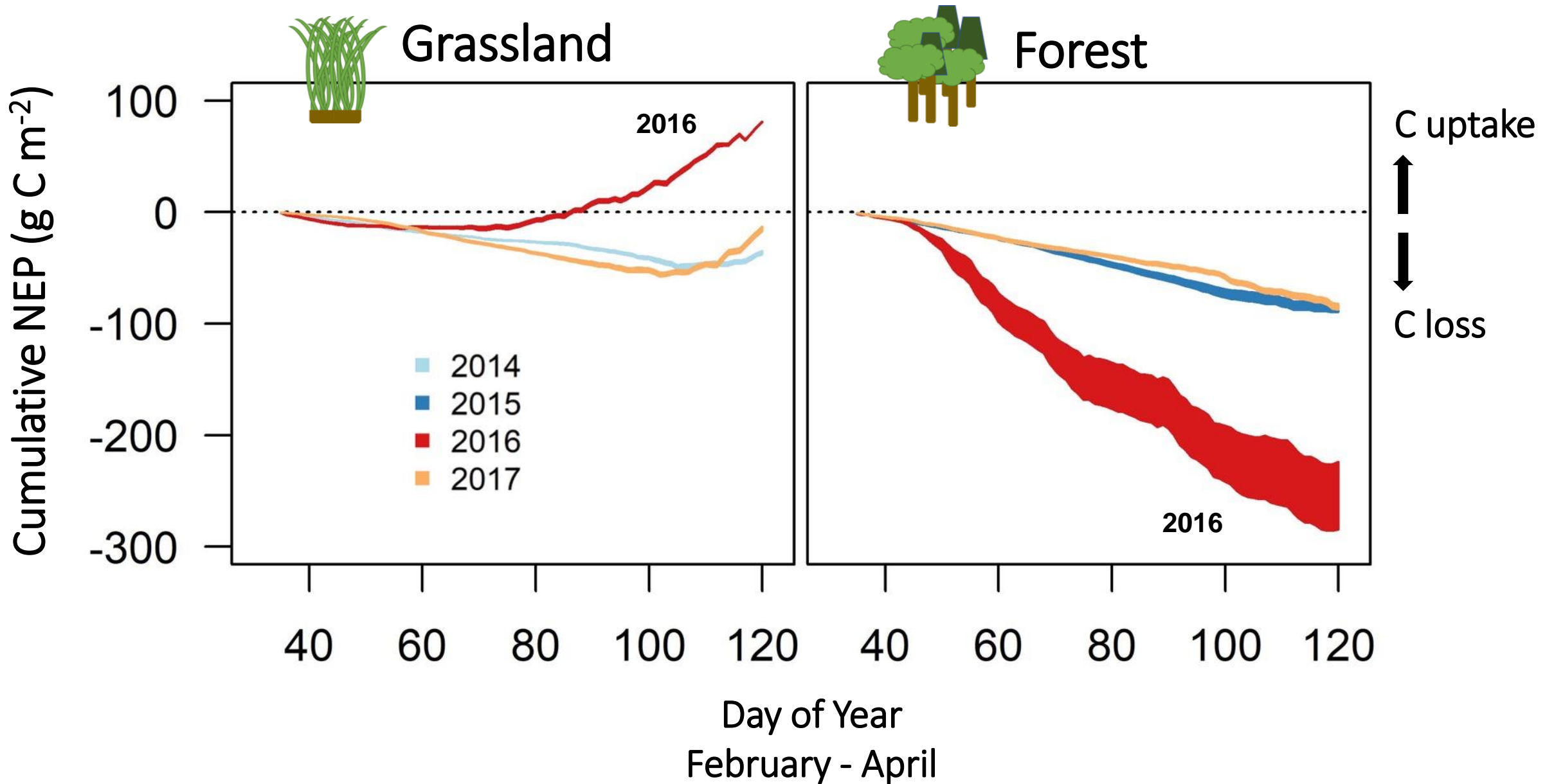
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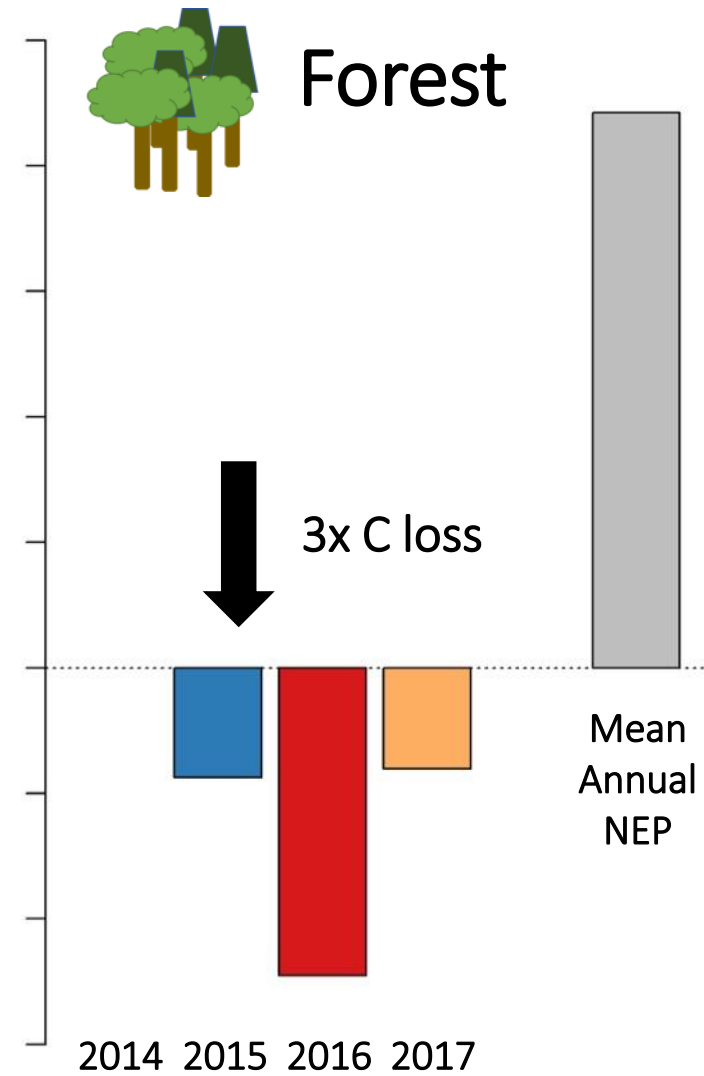
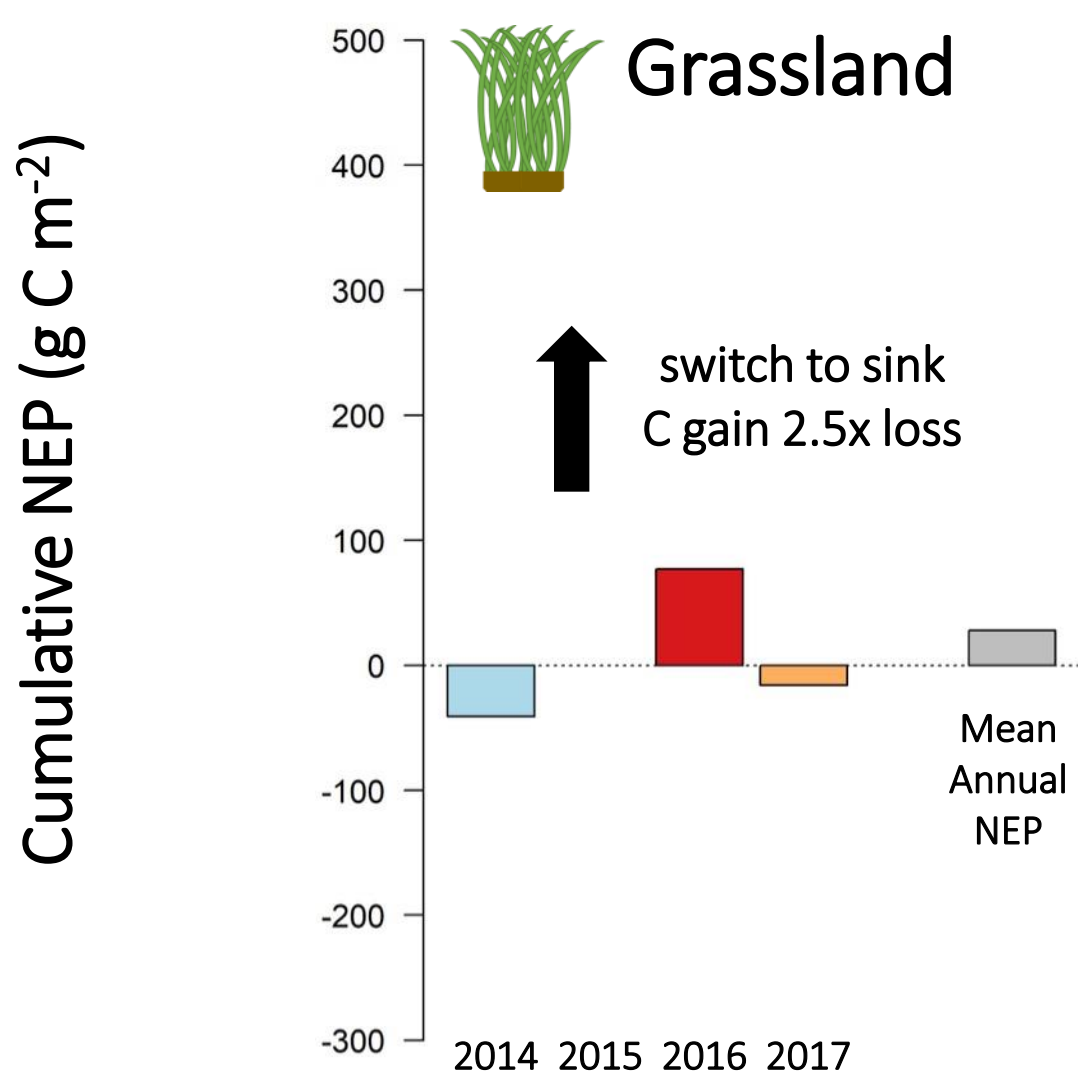
# Contrasting Response of Cumulative C Flux

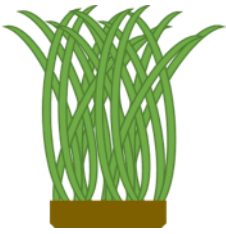


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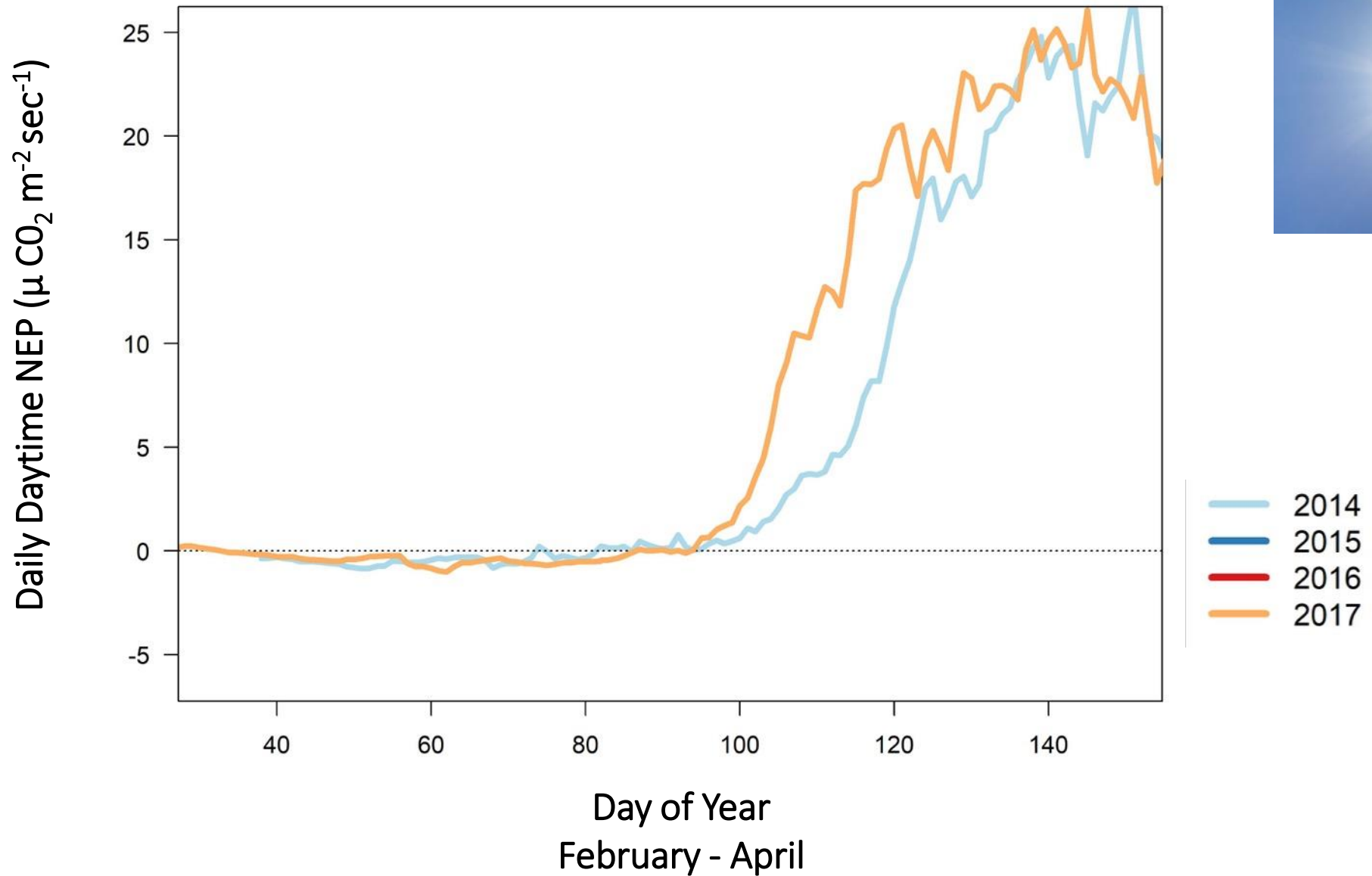
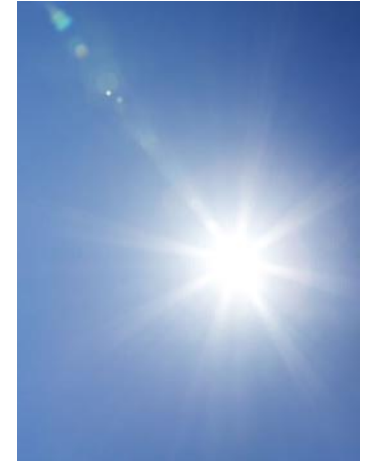


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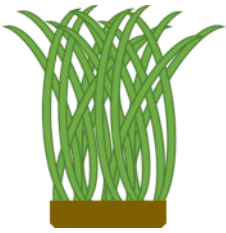


# Grassland C Uptake Phenology

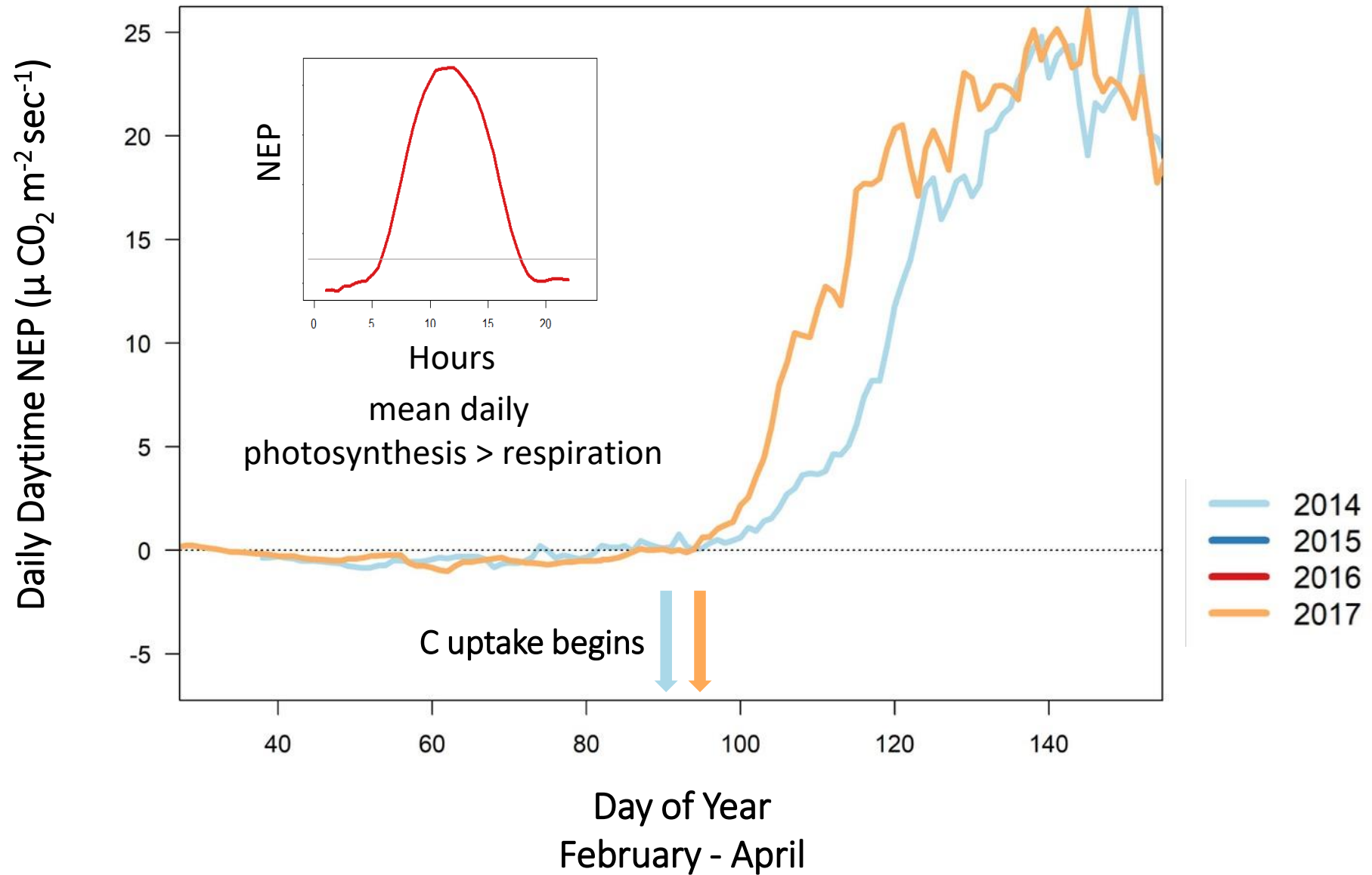


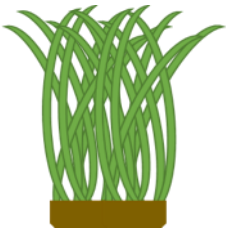
- 2014
- 2015
- 2016
- 2017



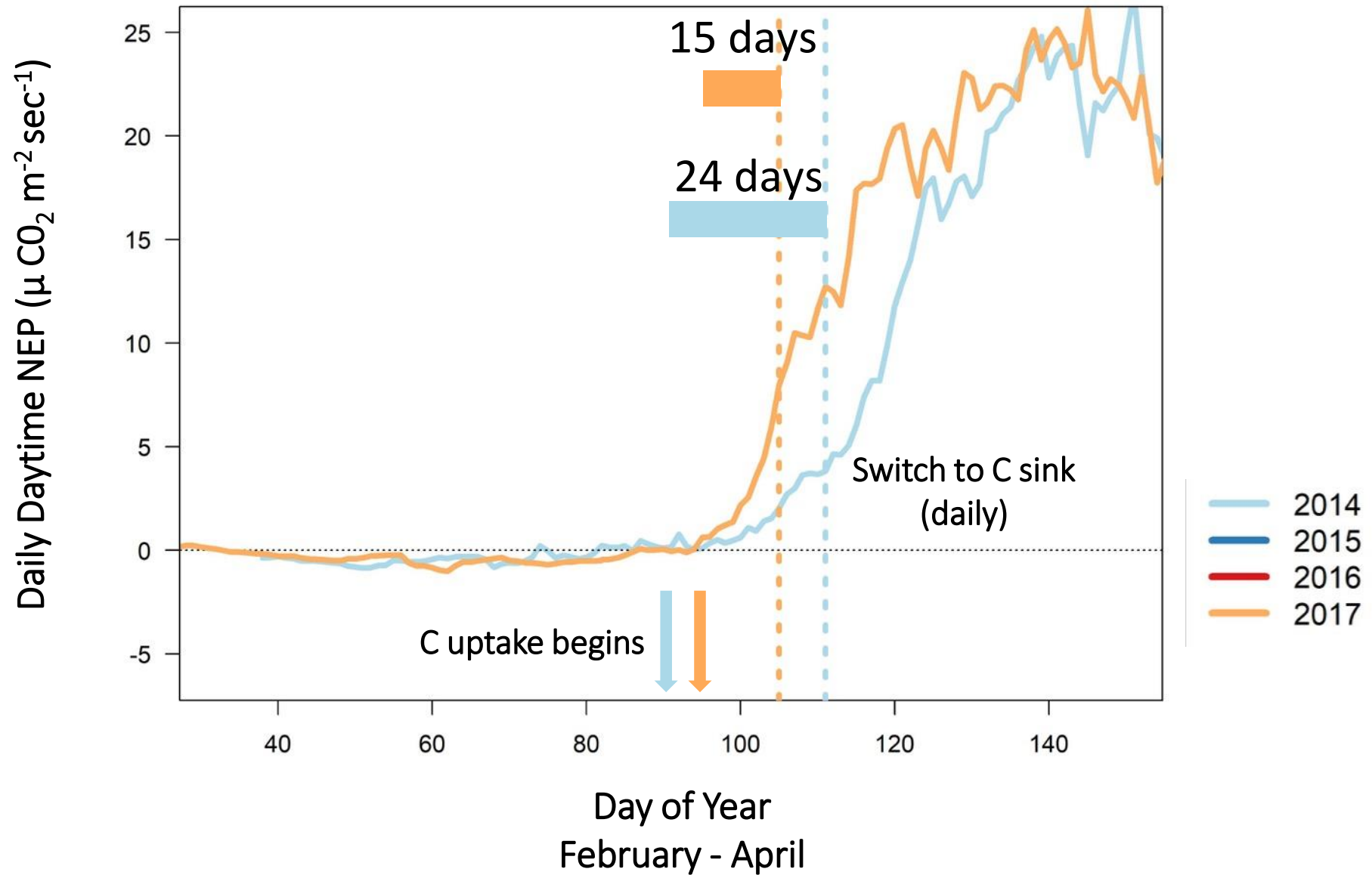


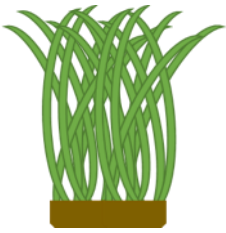
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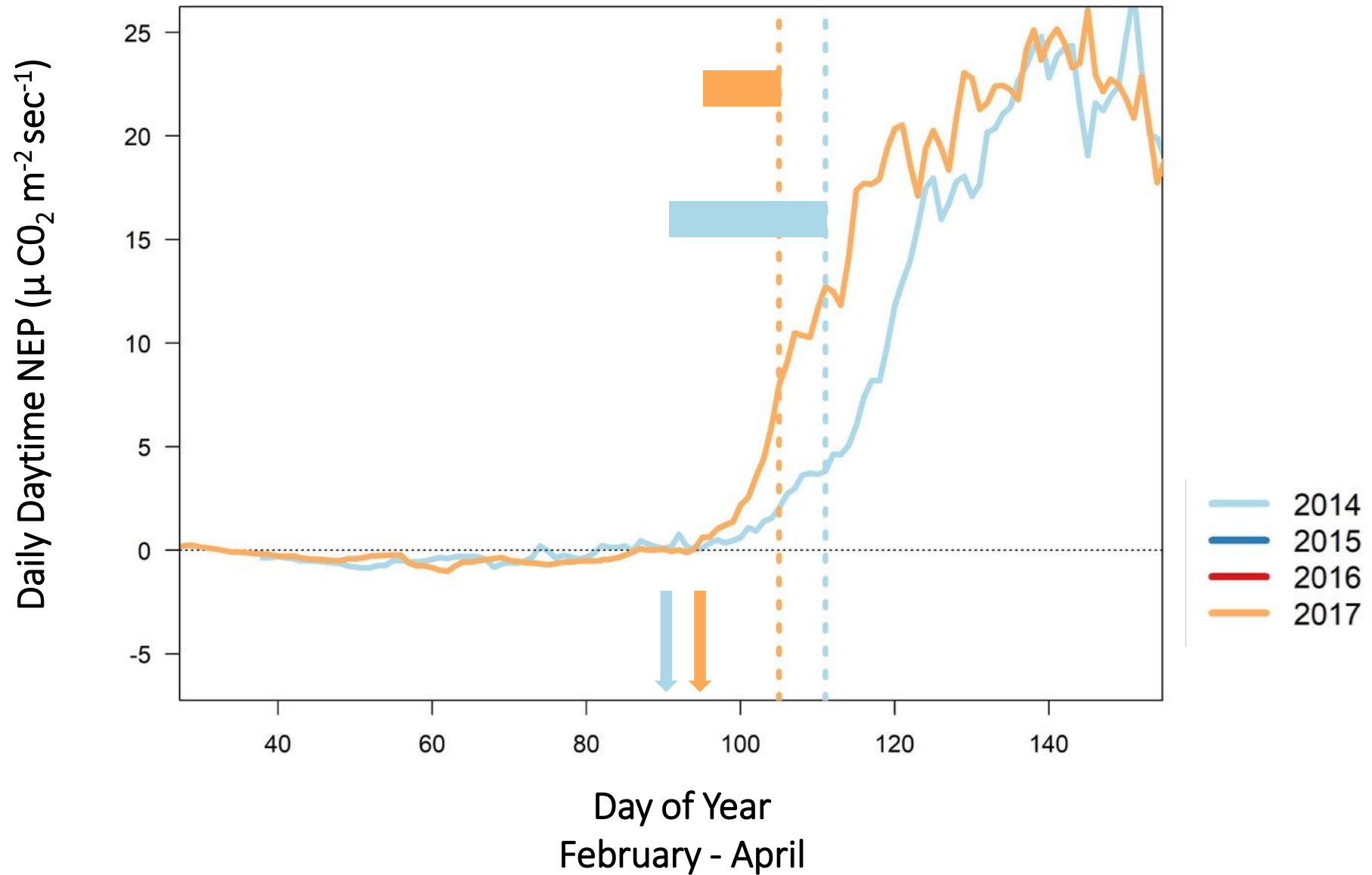


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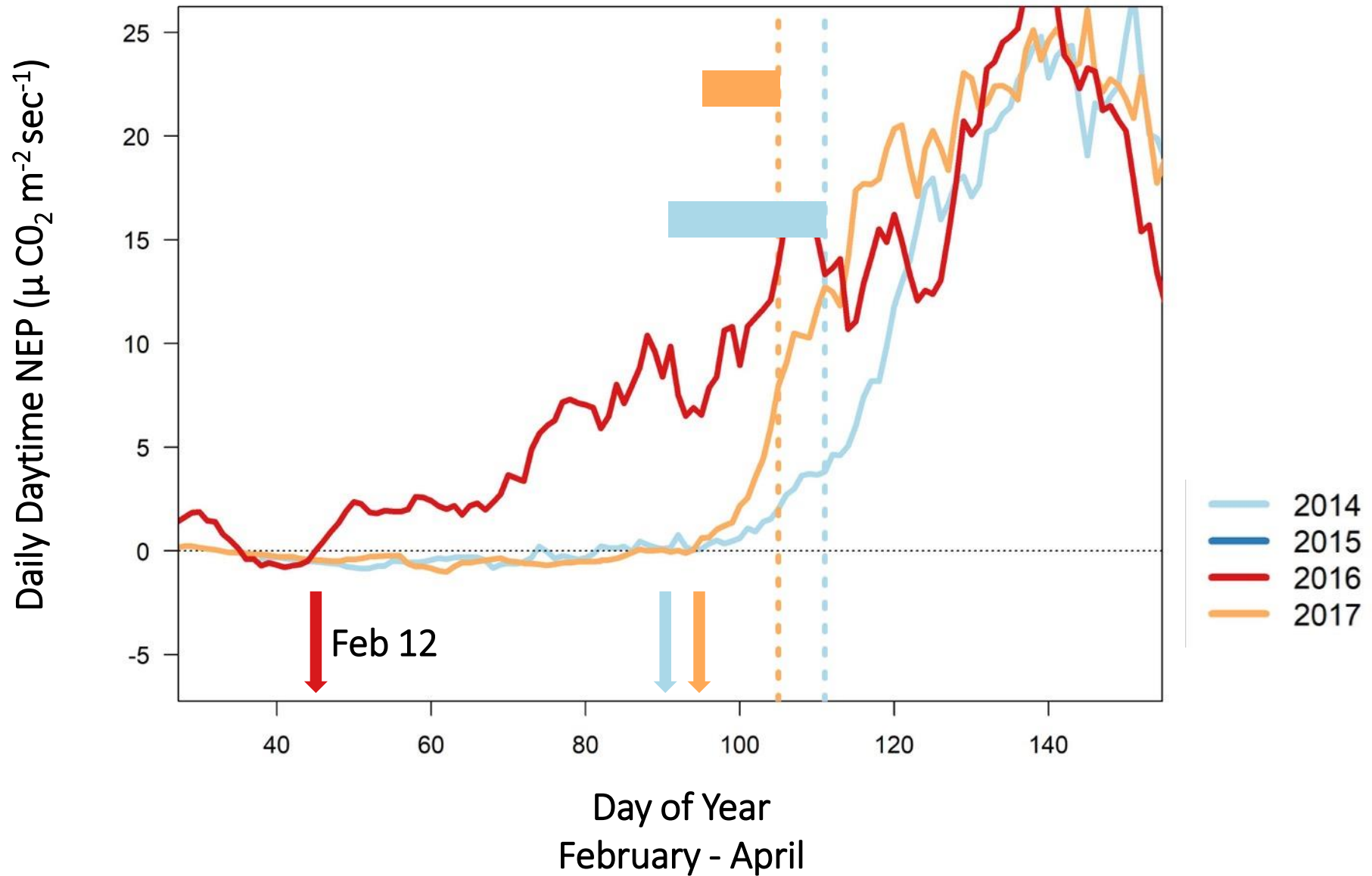


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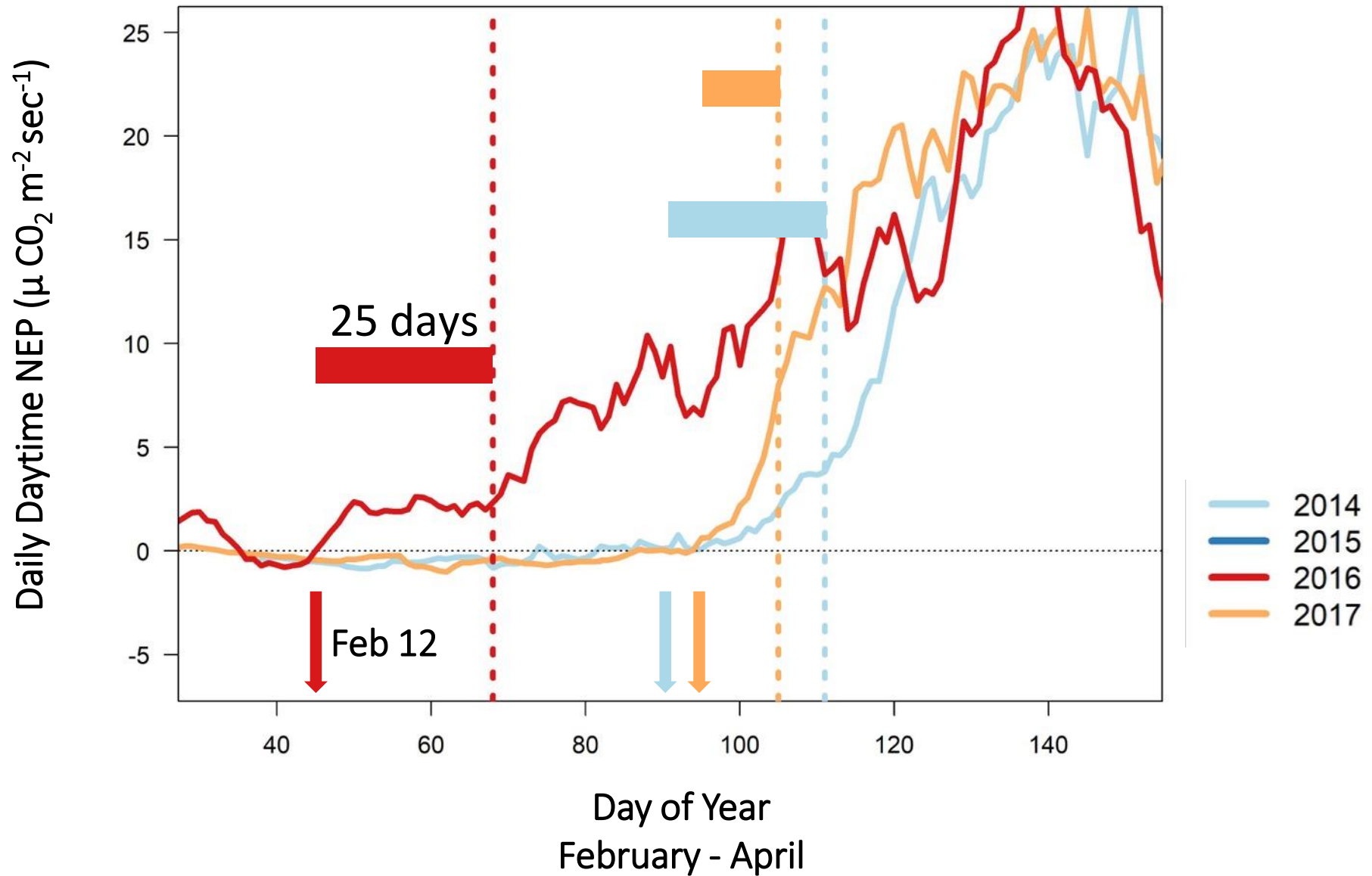


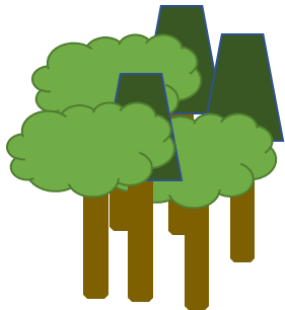
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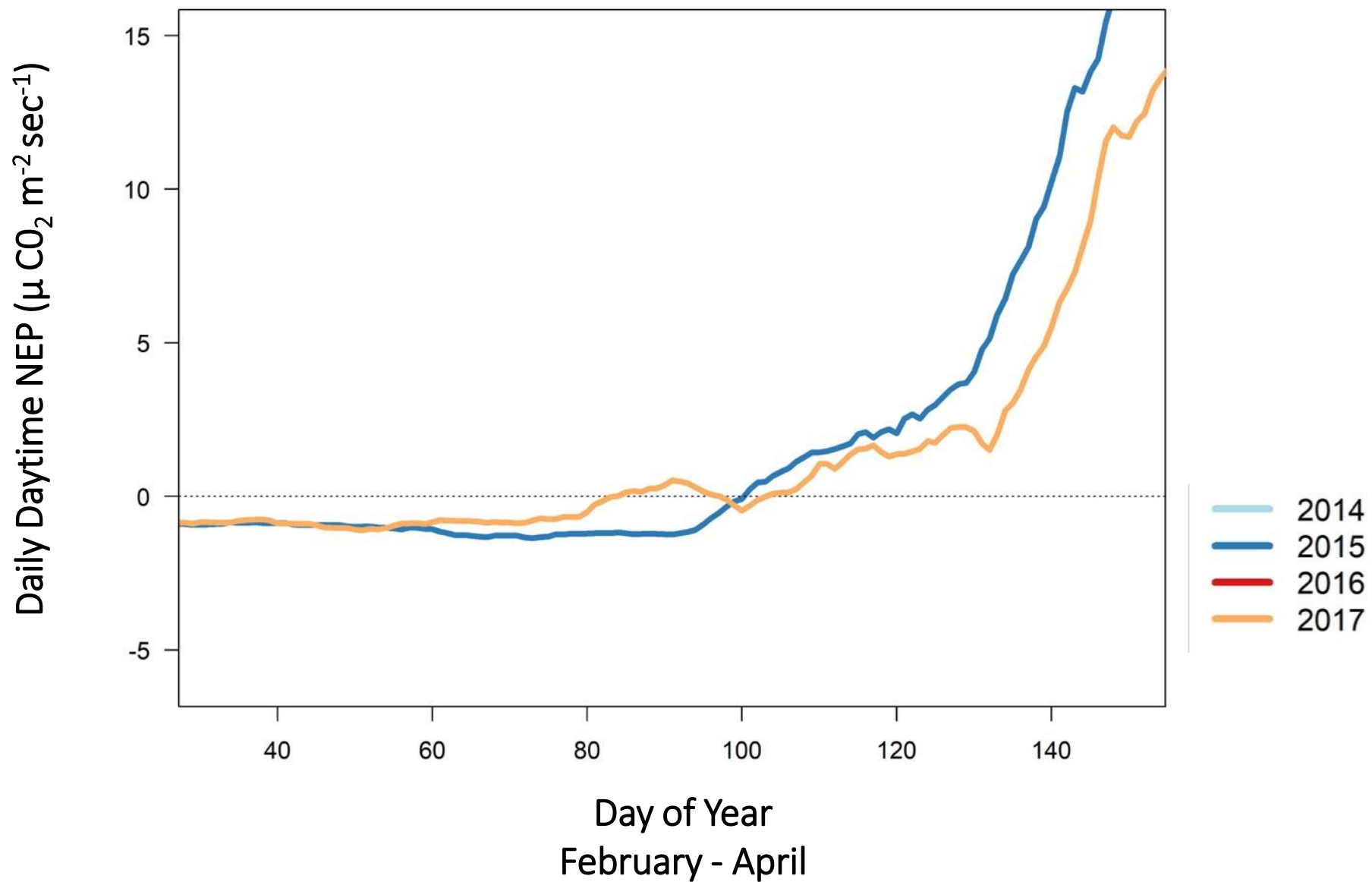


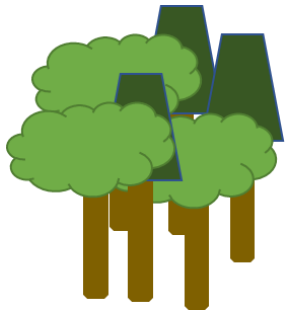
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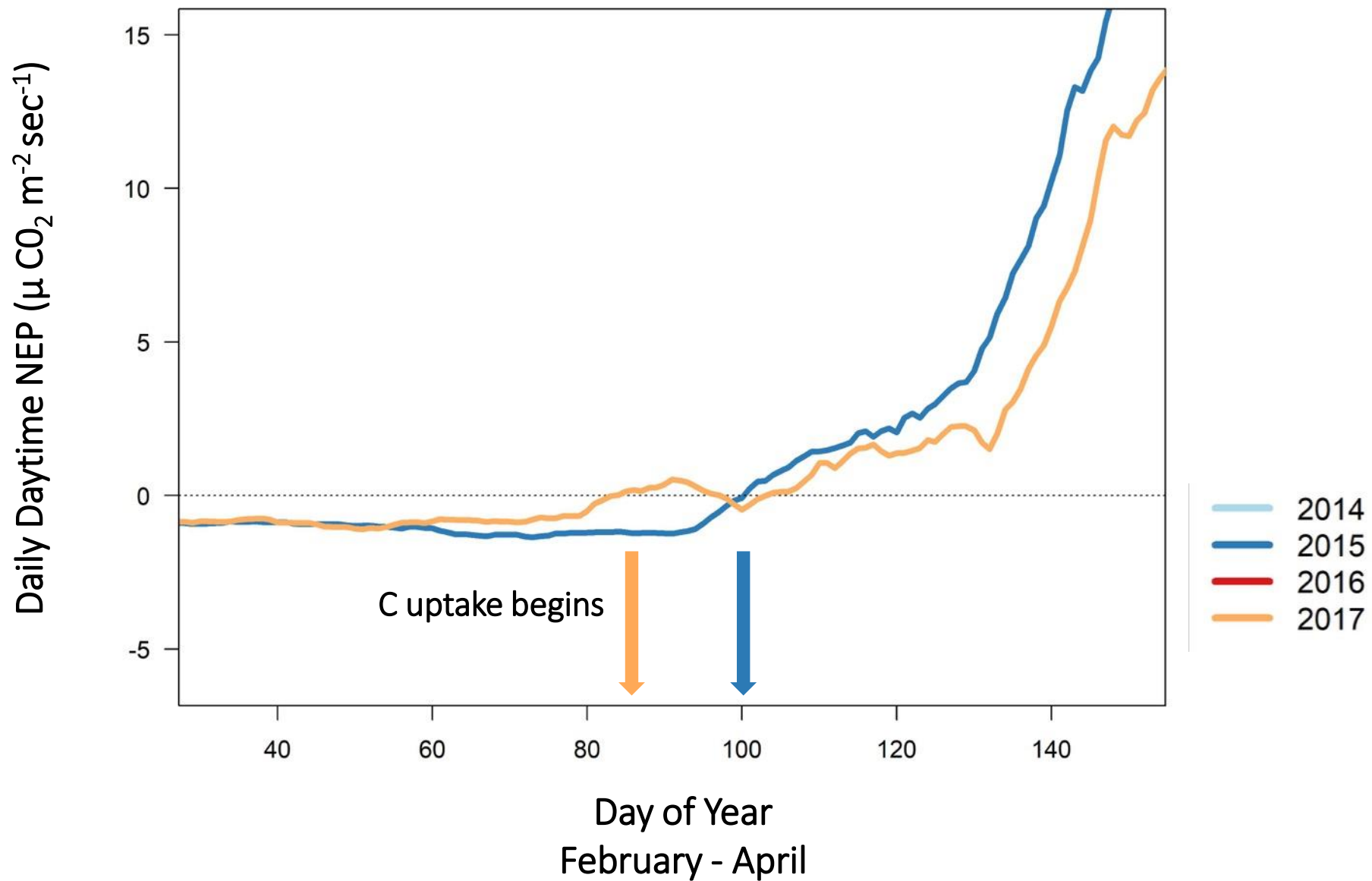


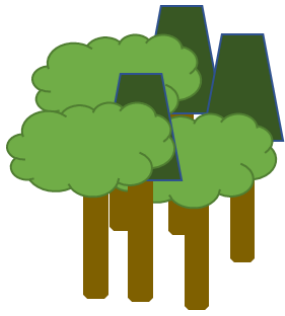
# Forest C Uptake Phenology



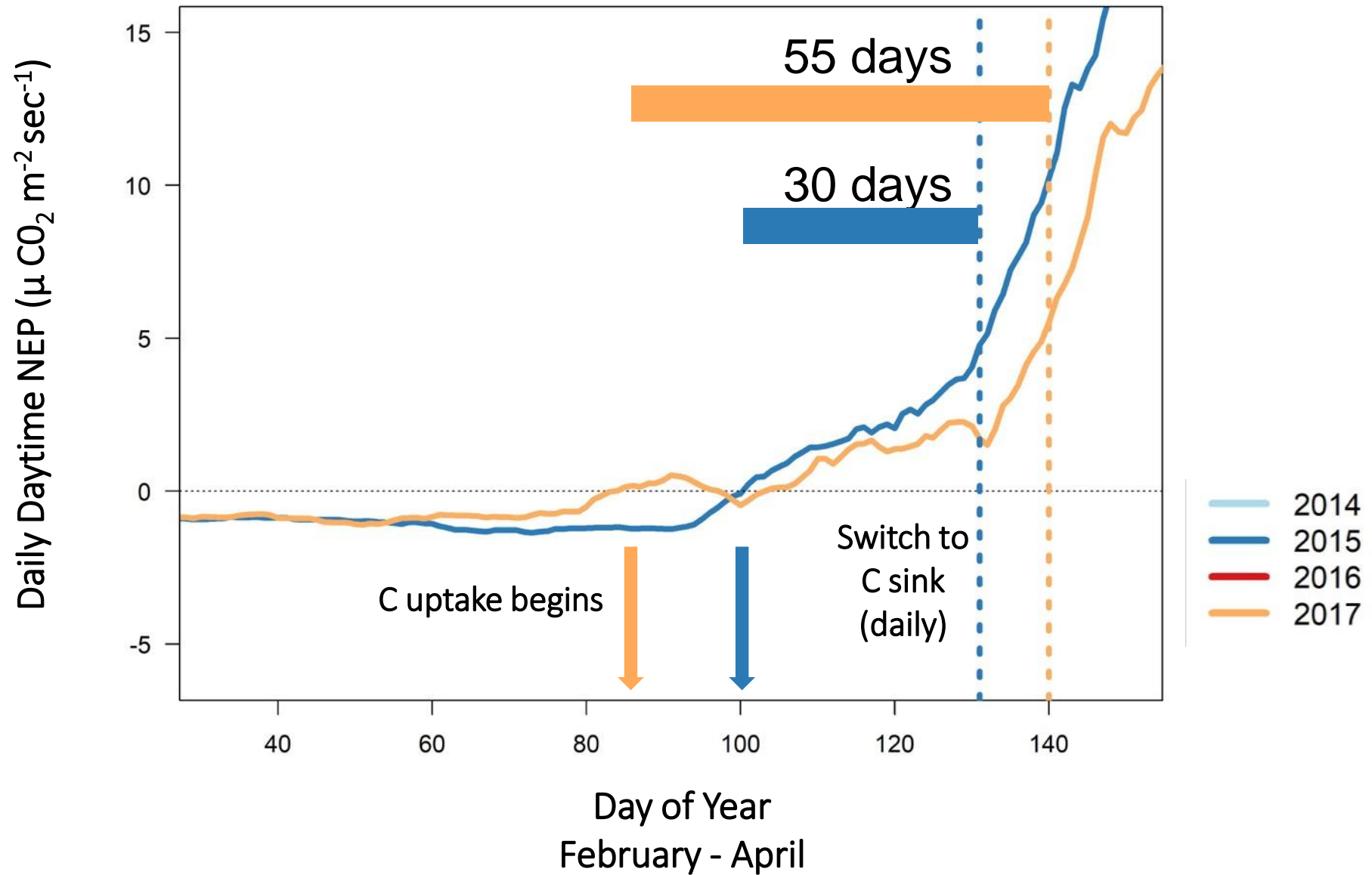


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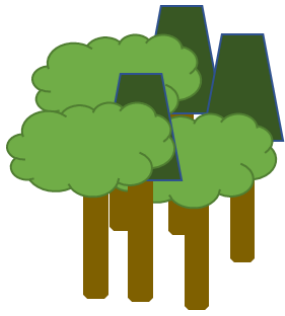




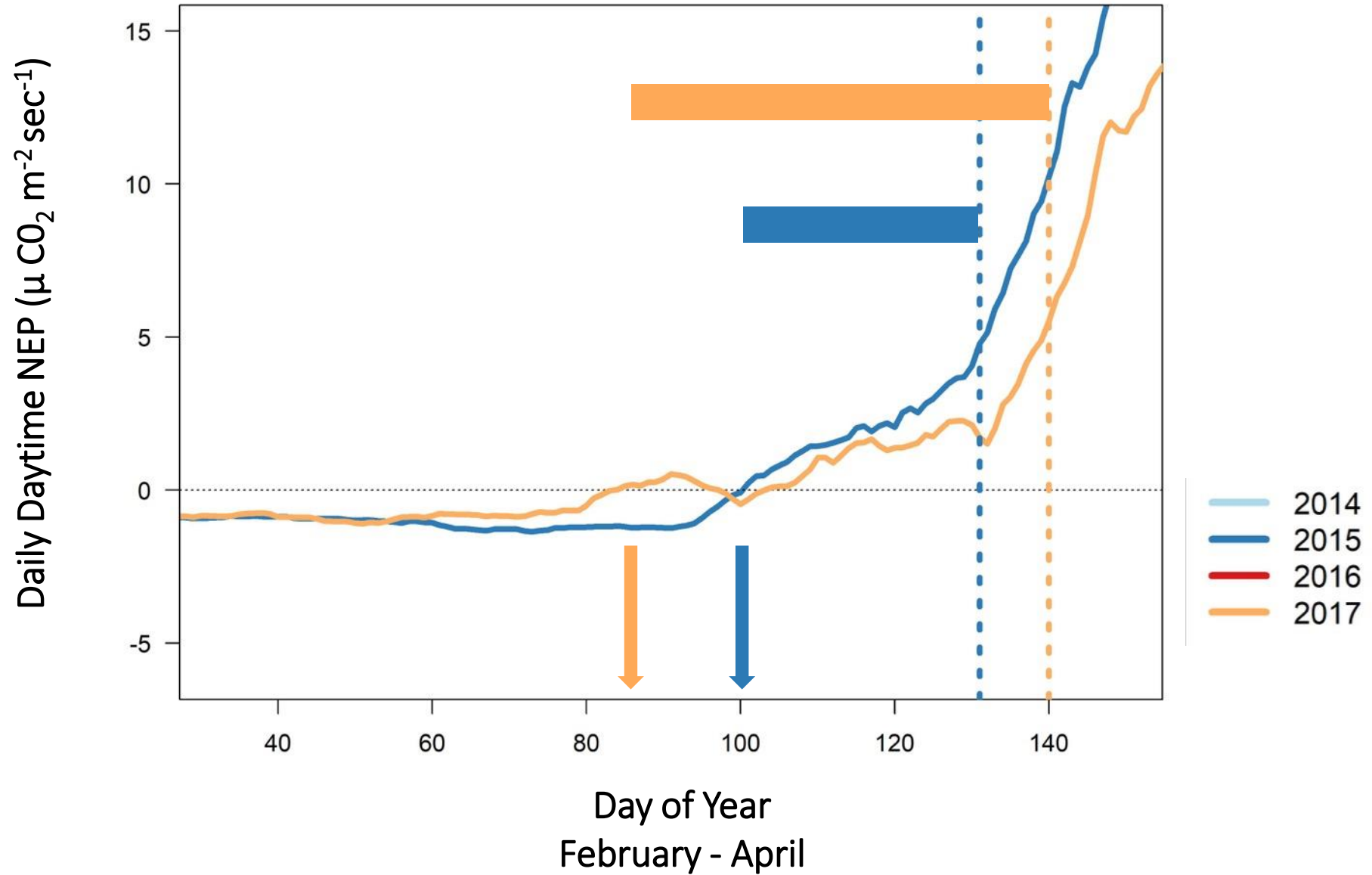
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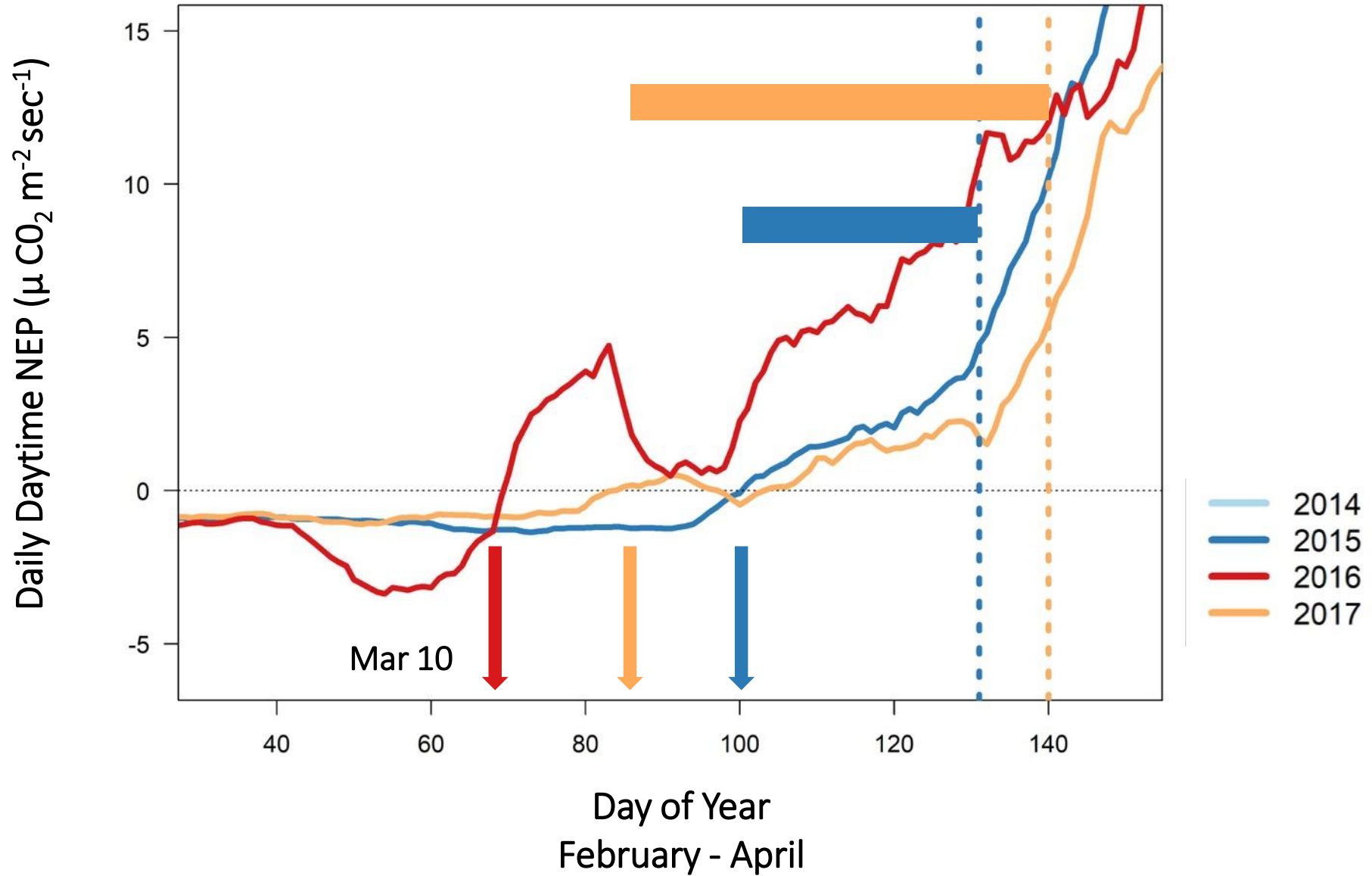


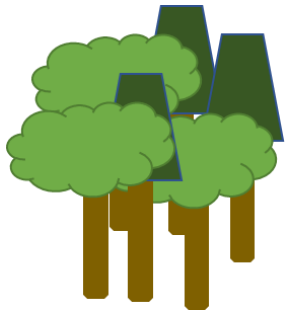
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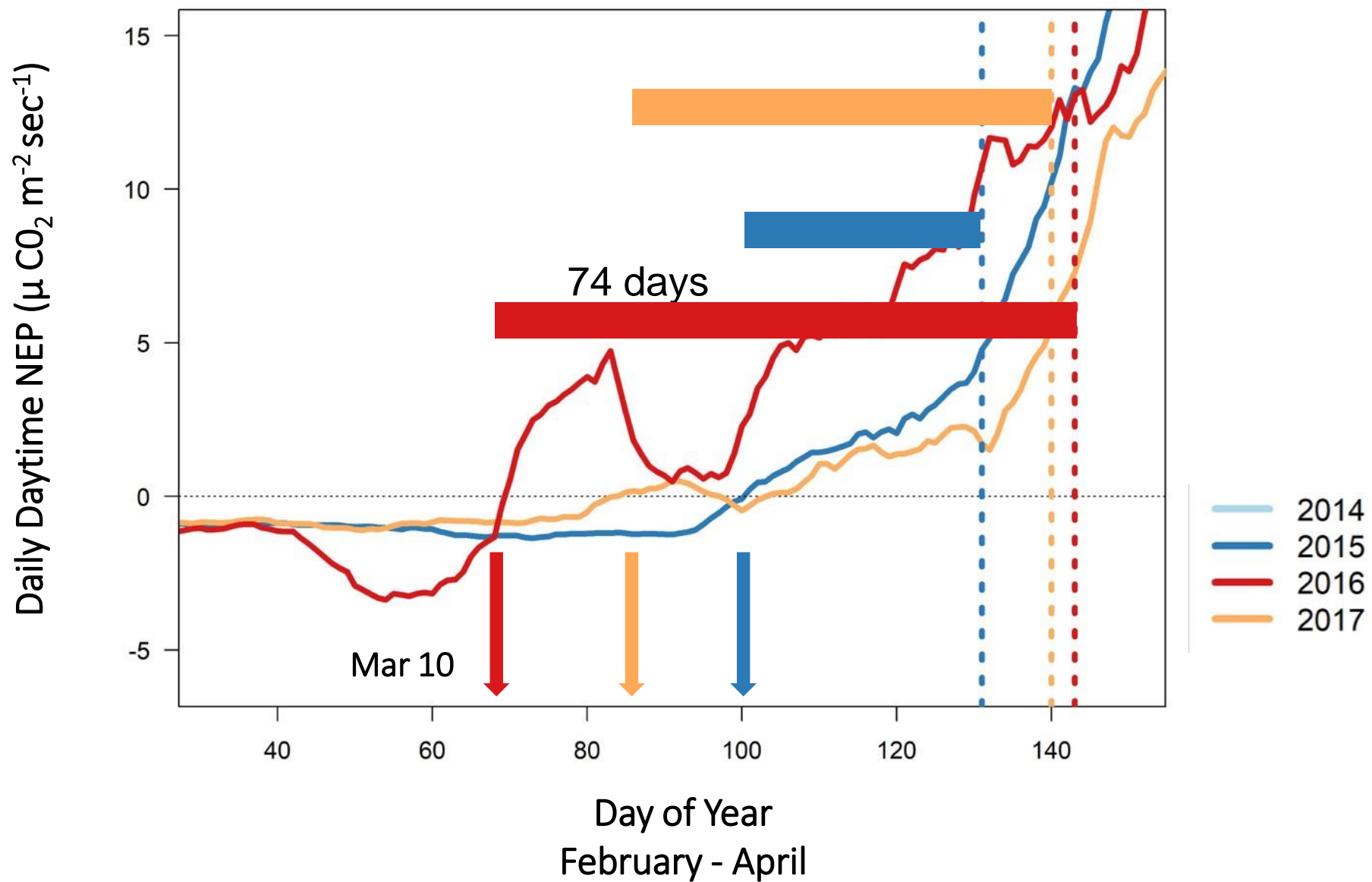


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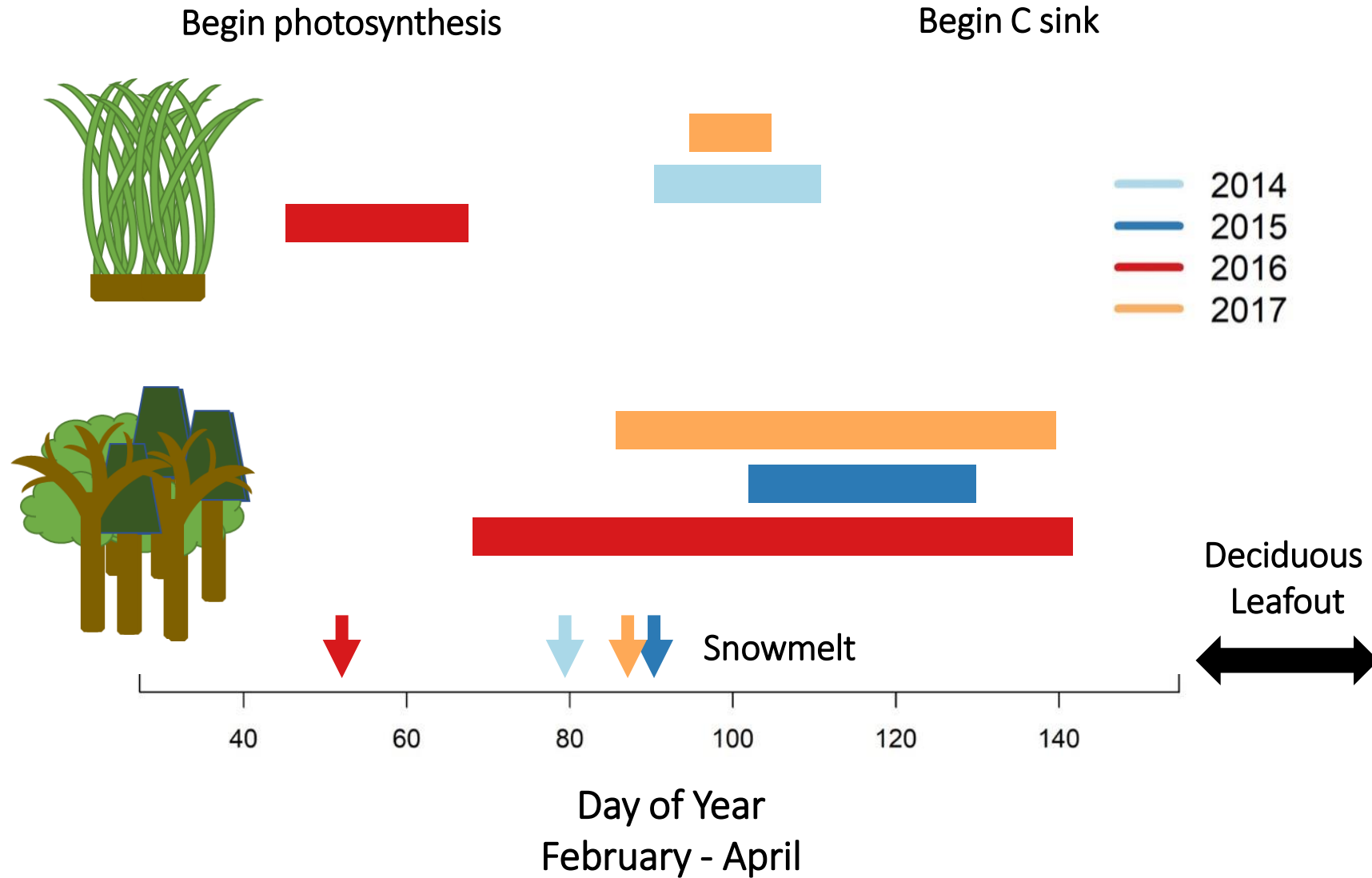




# Forest C Uptake Phenology



# Flexibility in C uptake timing varies by vegetation

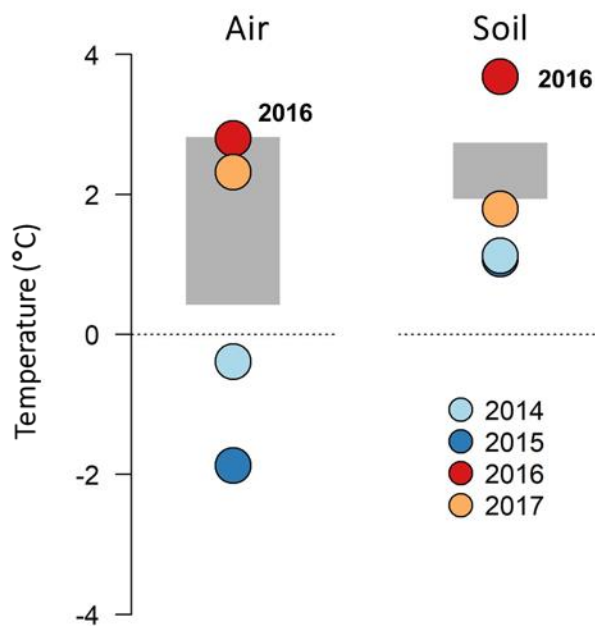


# Summary

Warm winter had contrasting effects on C fluxes during winter-spring transition

- Grassland C sink
- Forest C source

Driven by snow and soil temperature rather than air



# Implications

- Grasses activate C uptake in winter if air is warm and ground is snow-free
- Forests begin C loss early, but C uptake is constrained by phenology
- Contrasting responses could shift timing of C uptake across dynamic landscapes
- Future directions: explore mechanisms, new data sources and modeling



# Acknowledgements

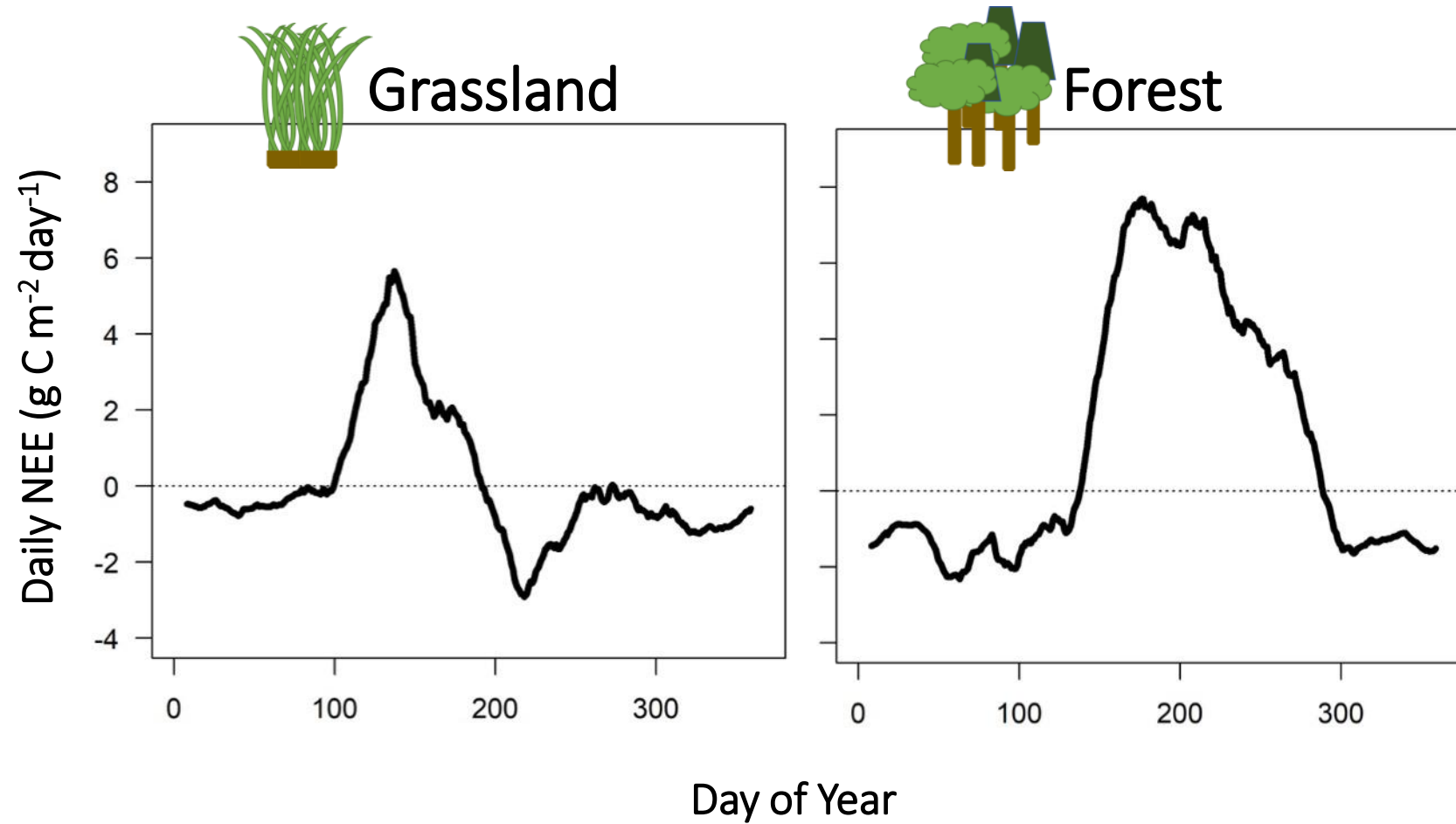


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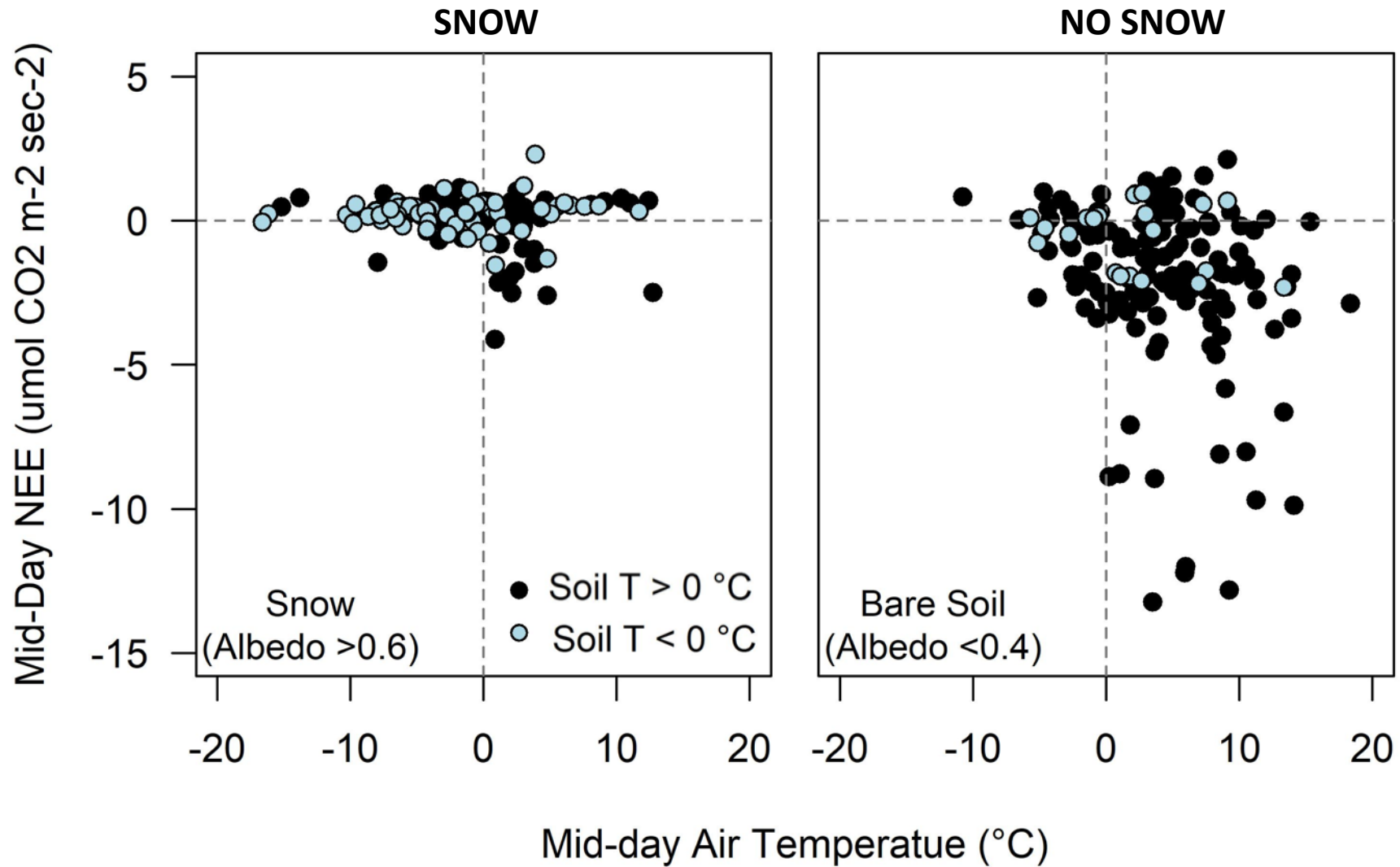


# Mean annual C cycles (2014-2017)

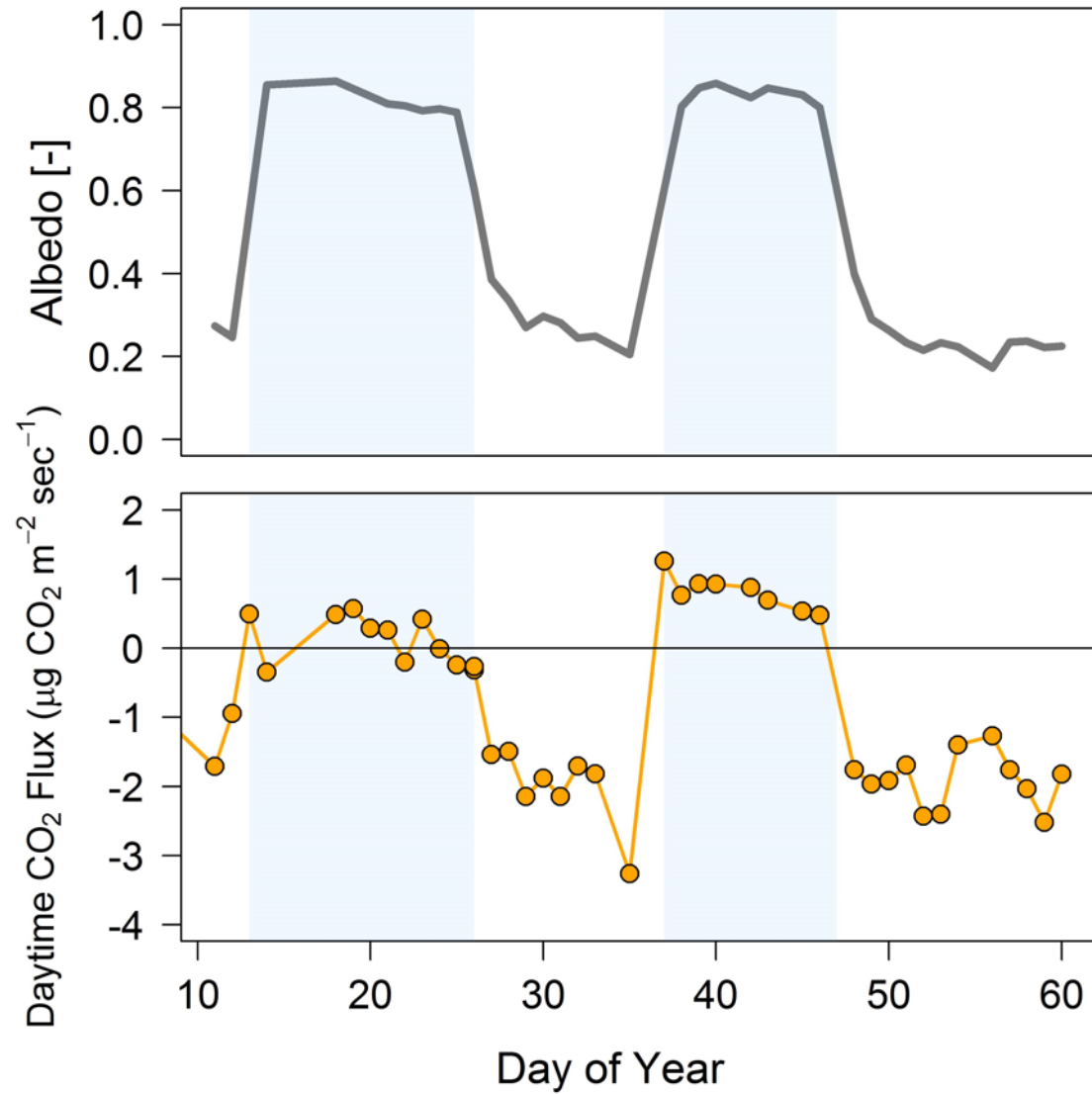




# Grassland: Photosynthesis in the absence of snow

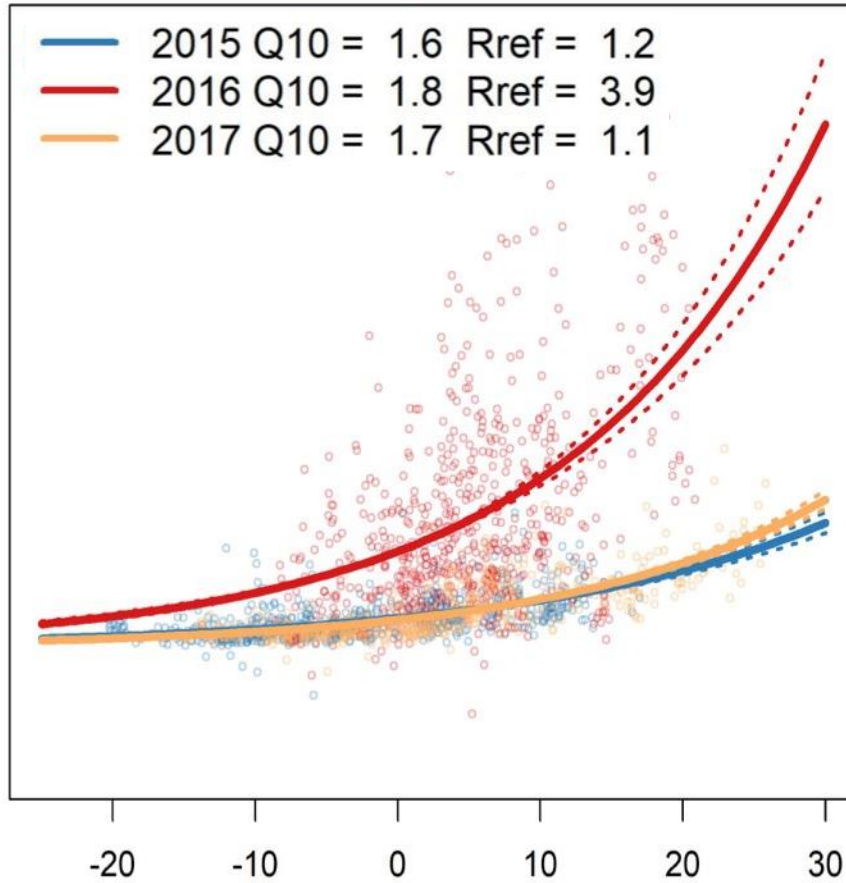


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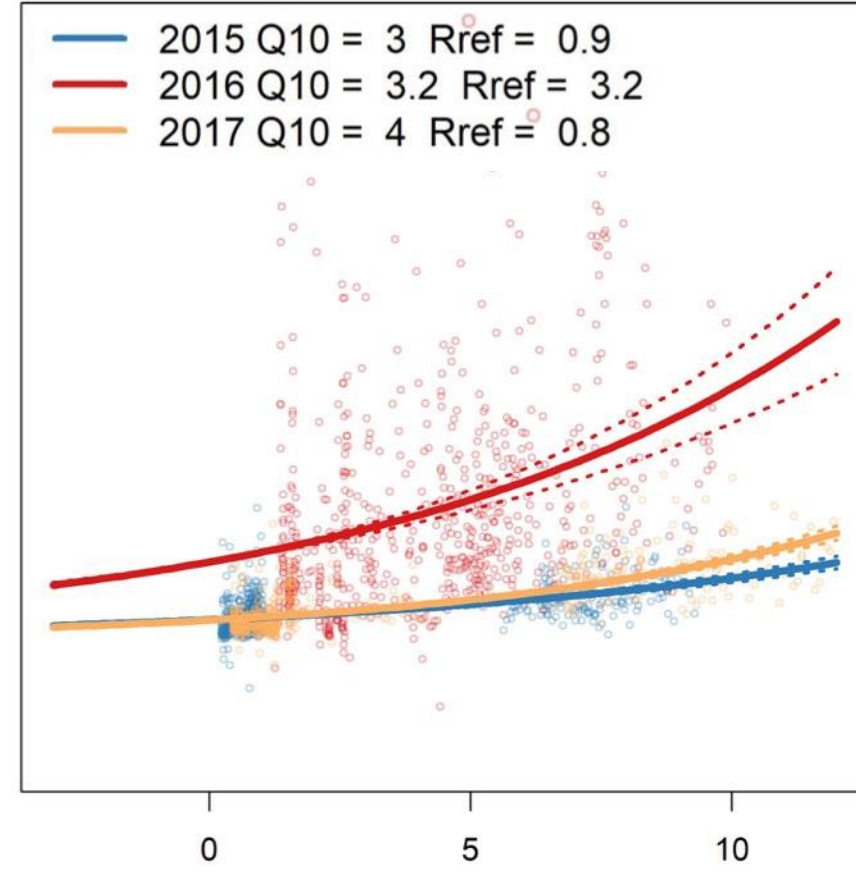


# Forest: Temperature sensitivity of respiration

Half-Hourly Nighttime NEE ( $\mu\text{CO}_2\text{ m}^{-2}\text{ sec}^{-1}$ )



Air Temperature ( $^{\circ}\text{C}$ )



Soil Temperature ( $^{\circ}\text{C}$ )