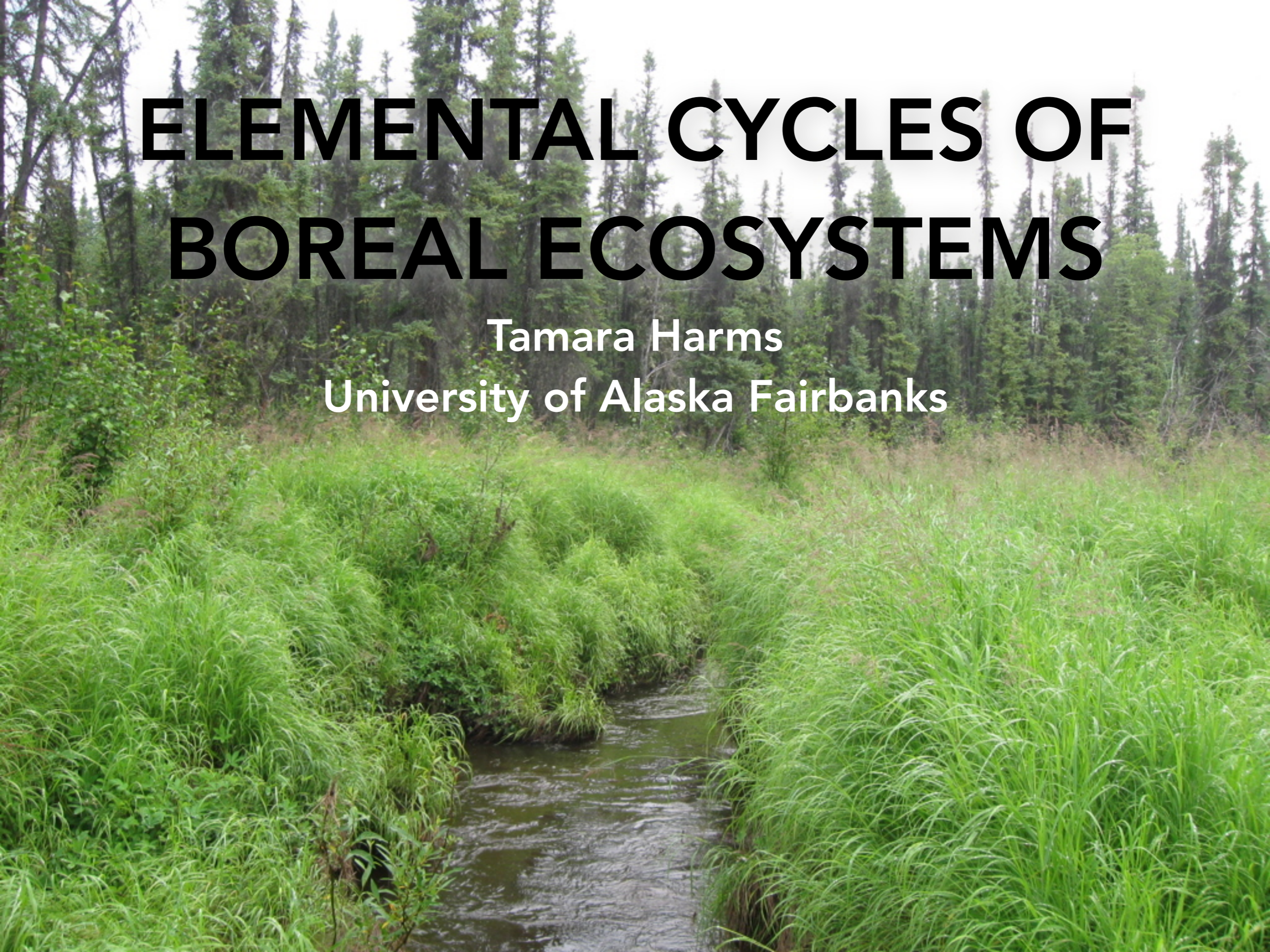


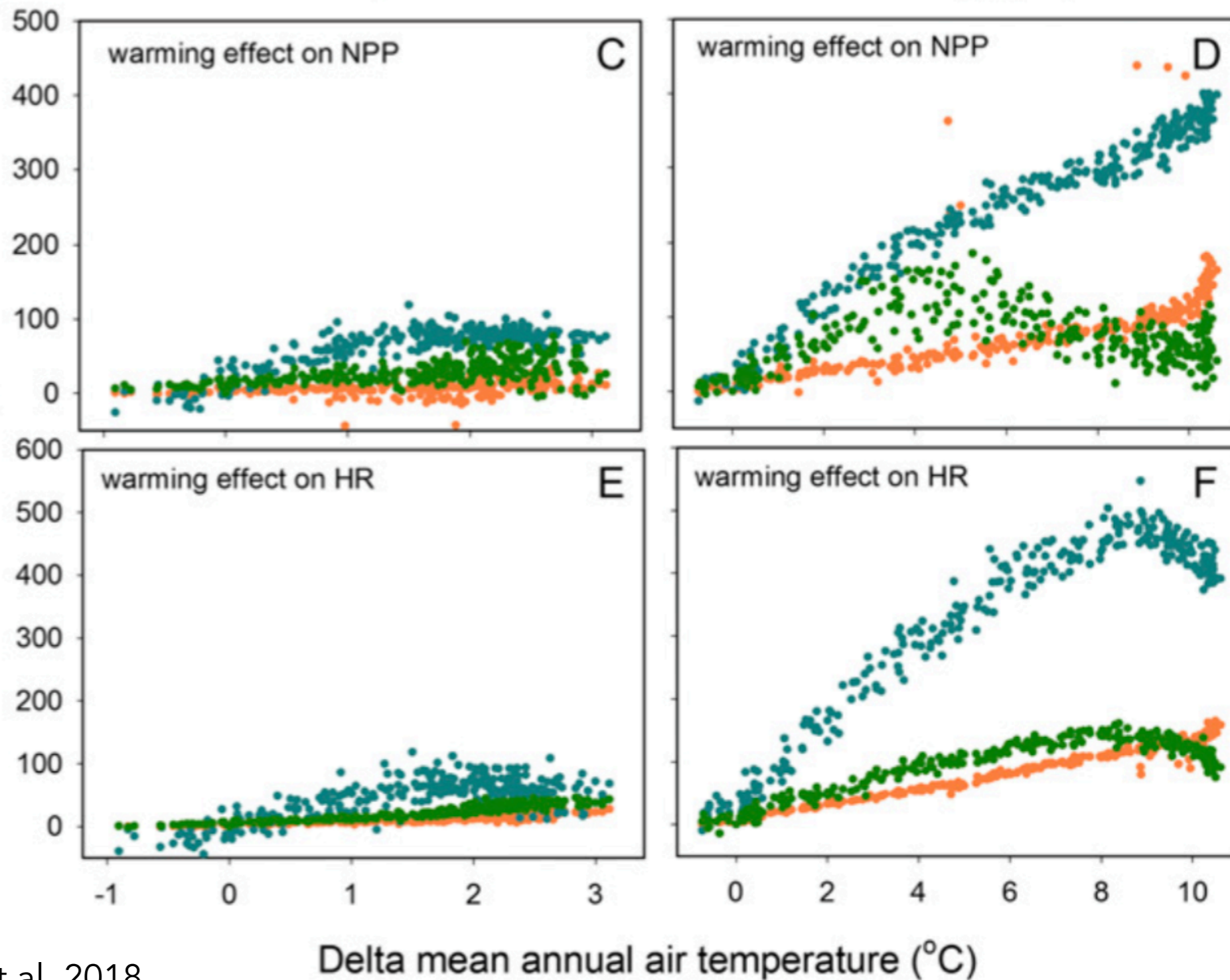
# ELEMENTAL CYCLES OF BOREAL ECOSYSTEMS

Tamara Harms  
University of Alaska Fairbanks

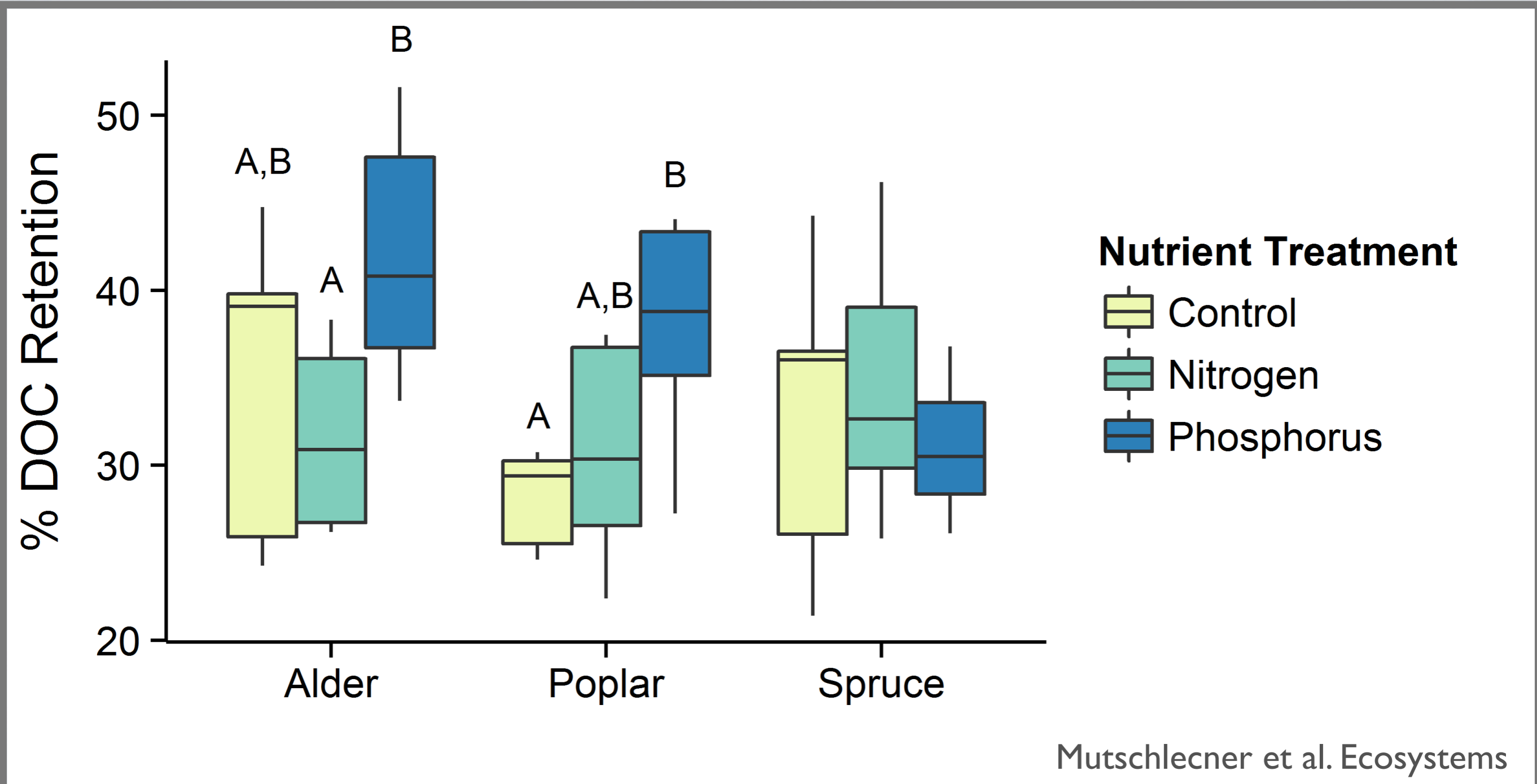


# How (and why) are elemental cycles coupled?

Change from 2010 baseline  
( $\text{g C m}^{-2} \text{ y}^{-1}$ )

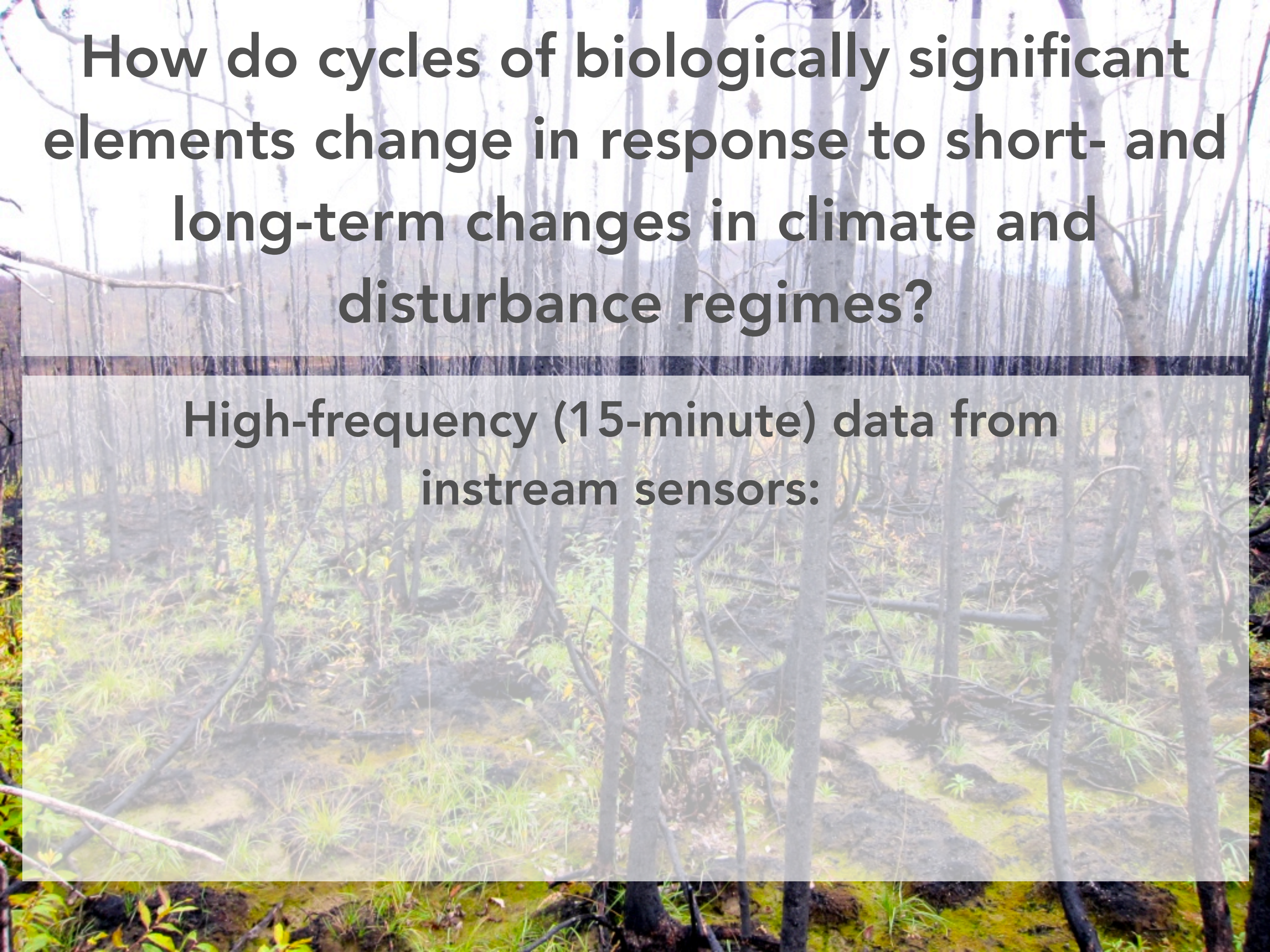


# How (and why) are elemental cycles coupled?



**How do cycles of biologically significant elements change in response to short- and long-term changes in climate and disturbance regimes?**





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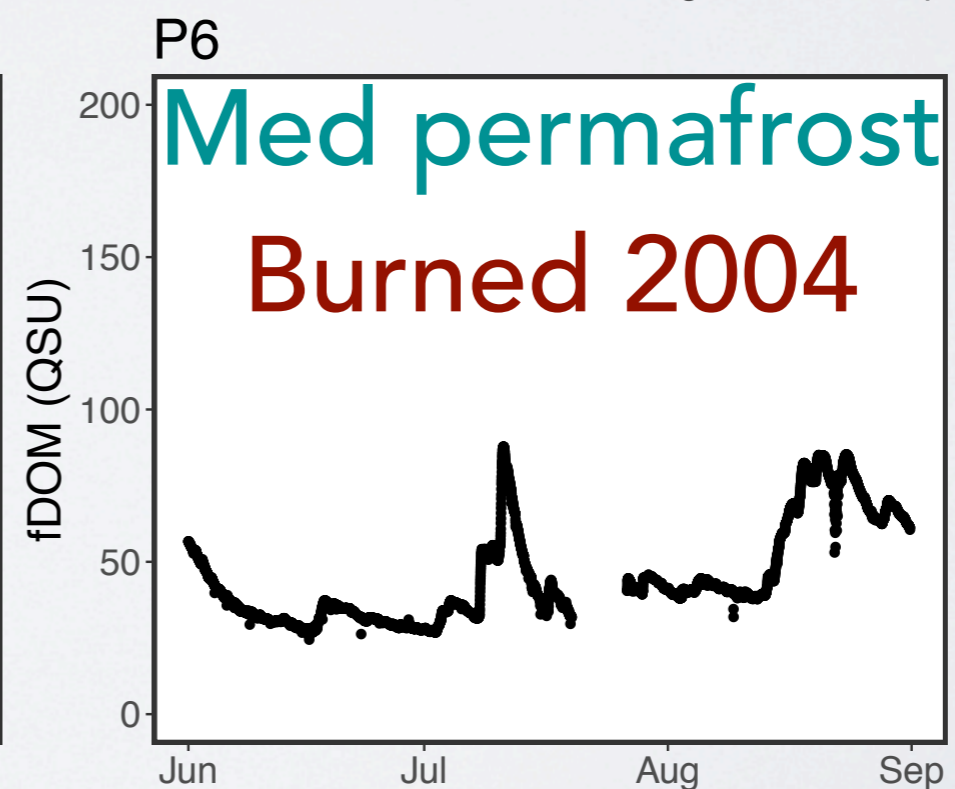
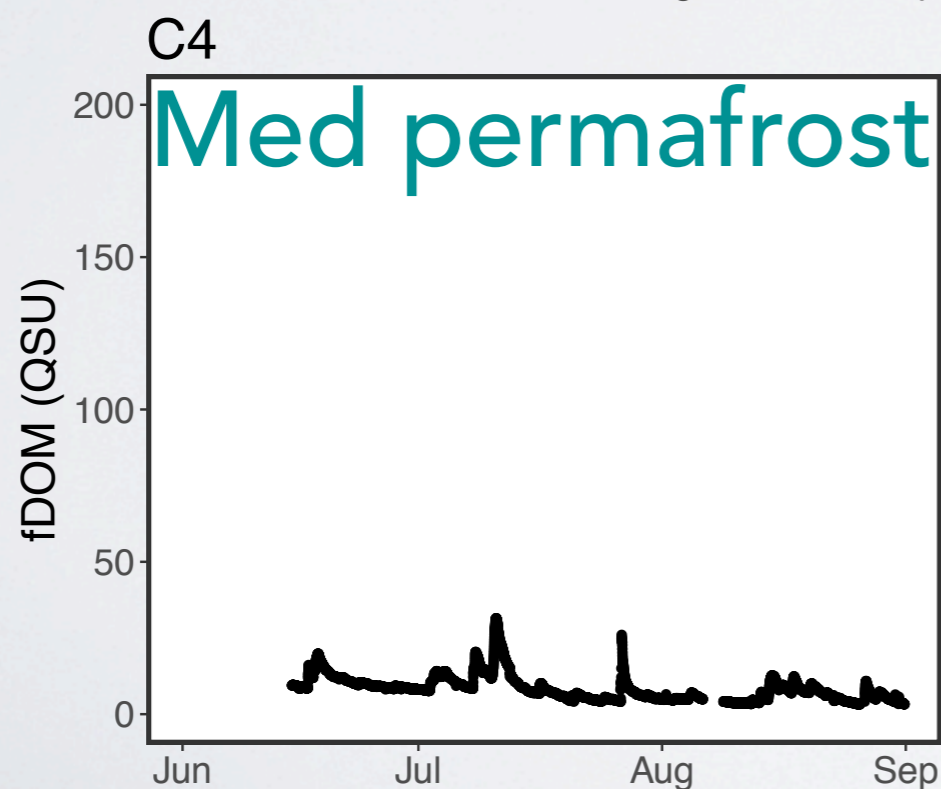
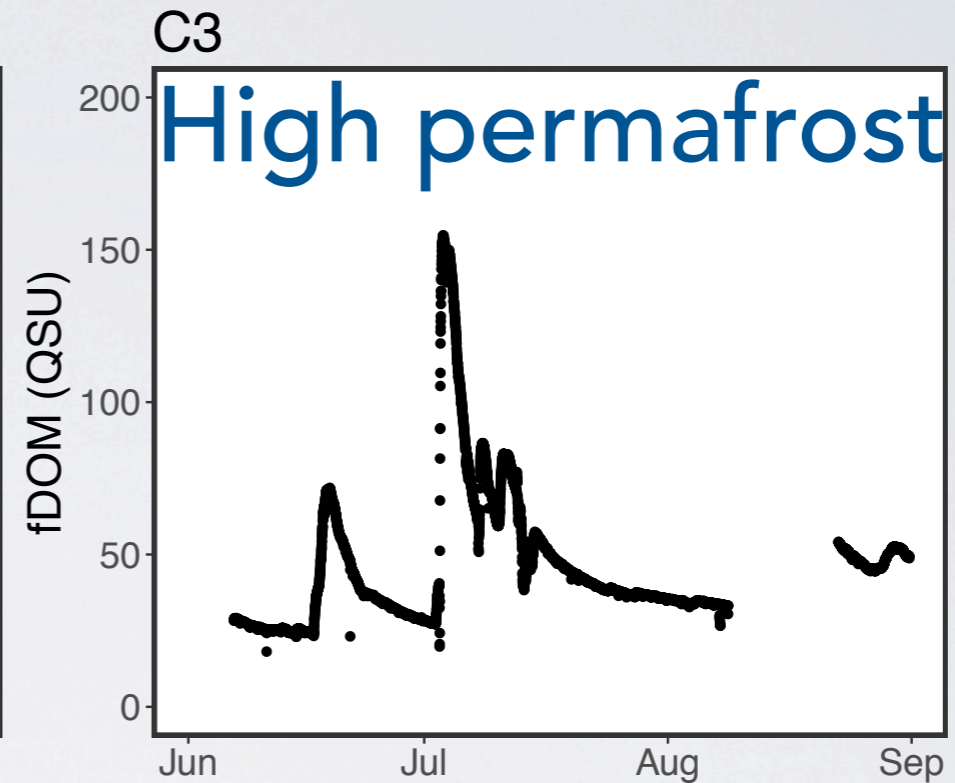
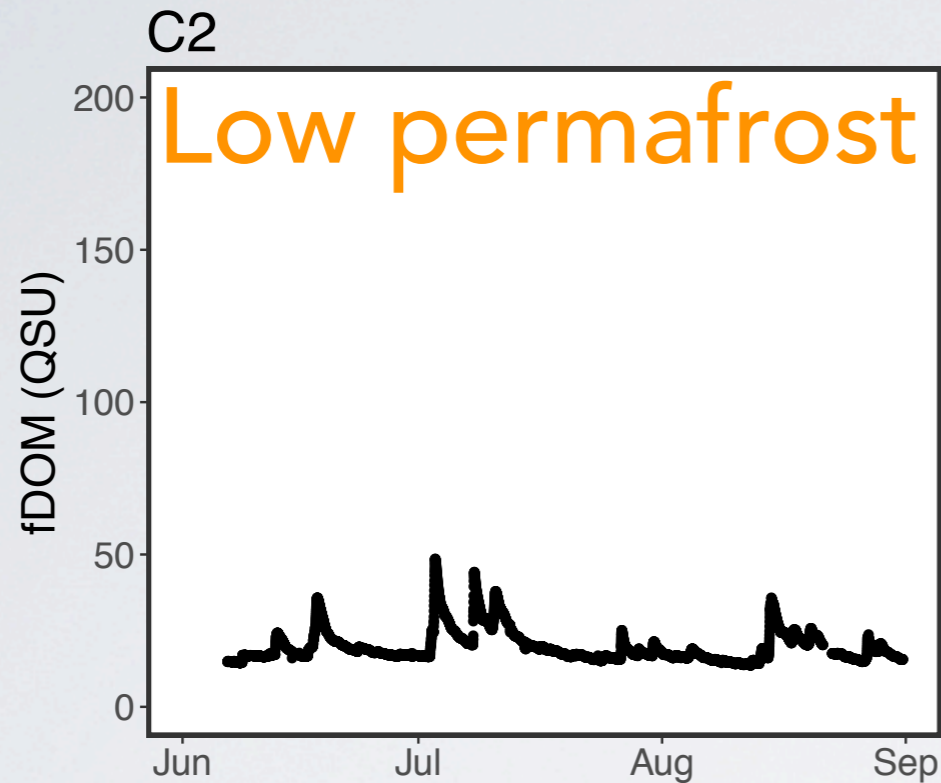
**High-frequency (15-minute) data from instream sensors:**

# How do cycles of biologically significant elements change in response to short- and long-term changes in climate and disturbance regimes?

High-frequency (15-minute) data from instream sensors:

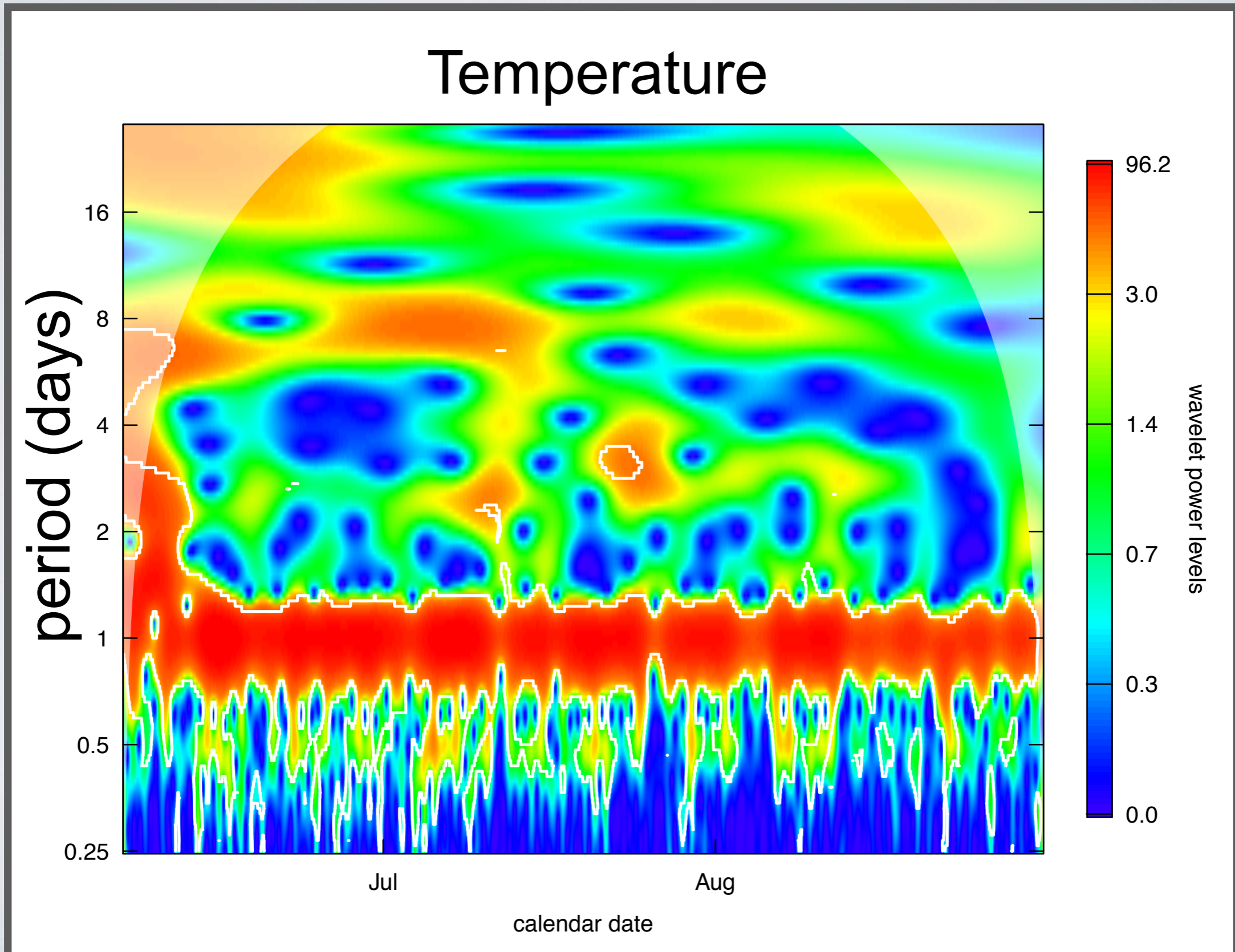
- ▶ temperature
- ▶ conductivity
- ▶ dissolved oxygen
- ▶ turbidity
- ▶ nitrate
- ▶ dissolved organic matter

# Biogeochemical responses to climate and disturbance



# Biogeochemical responses to climate and disturbance

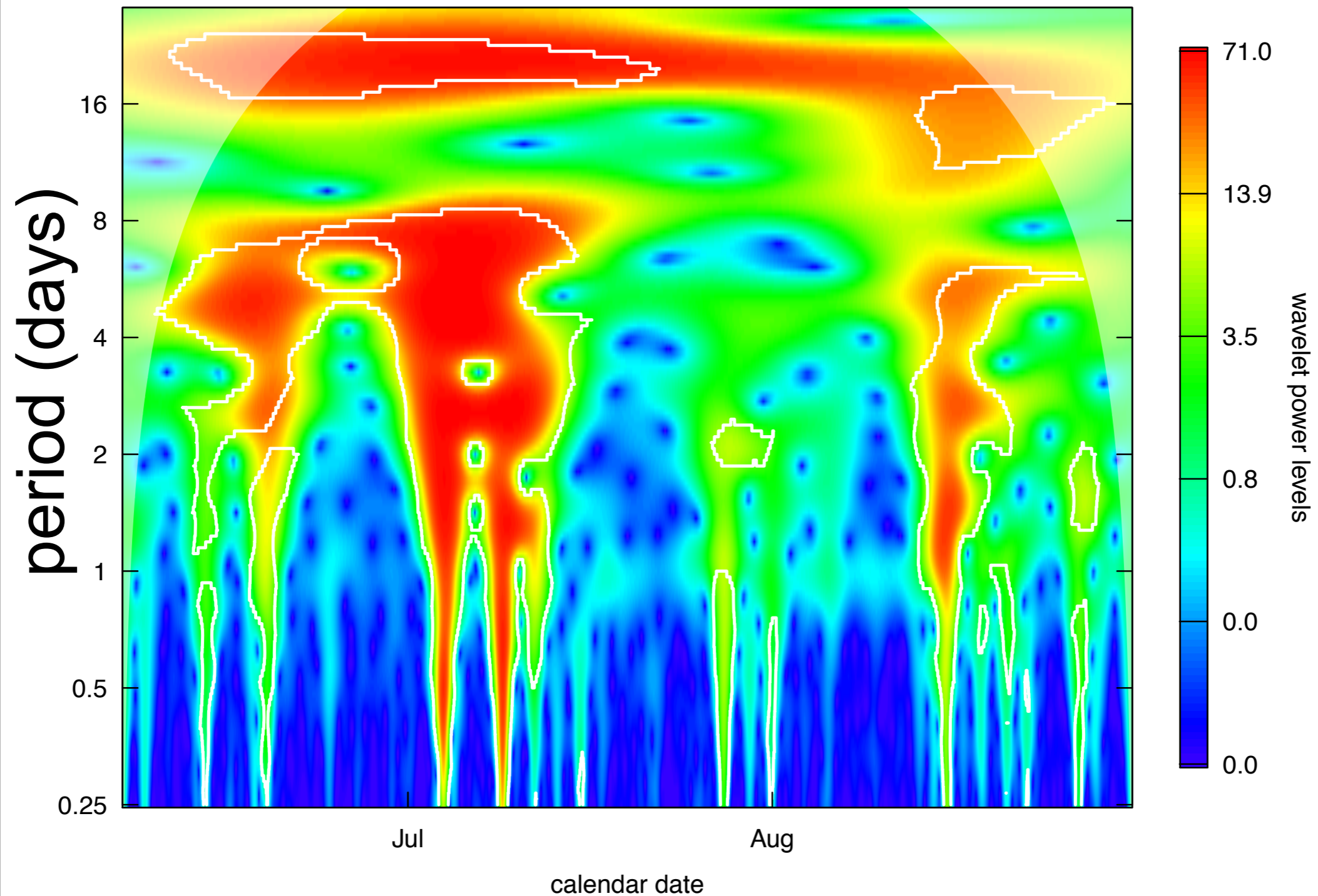
## Temperature



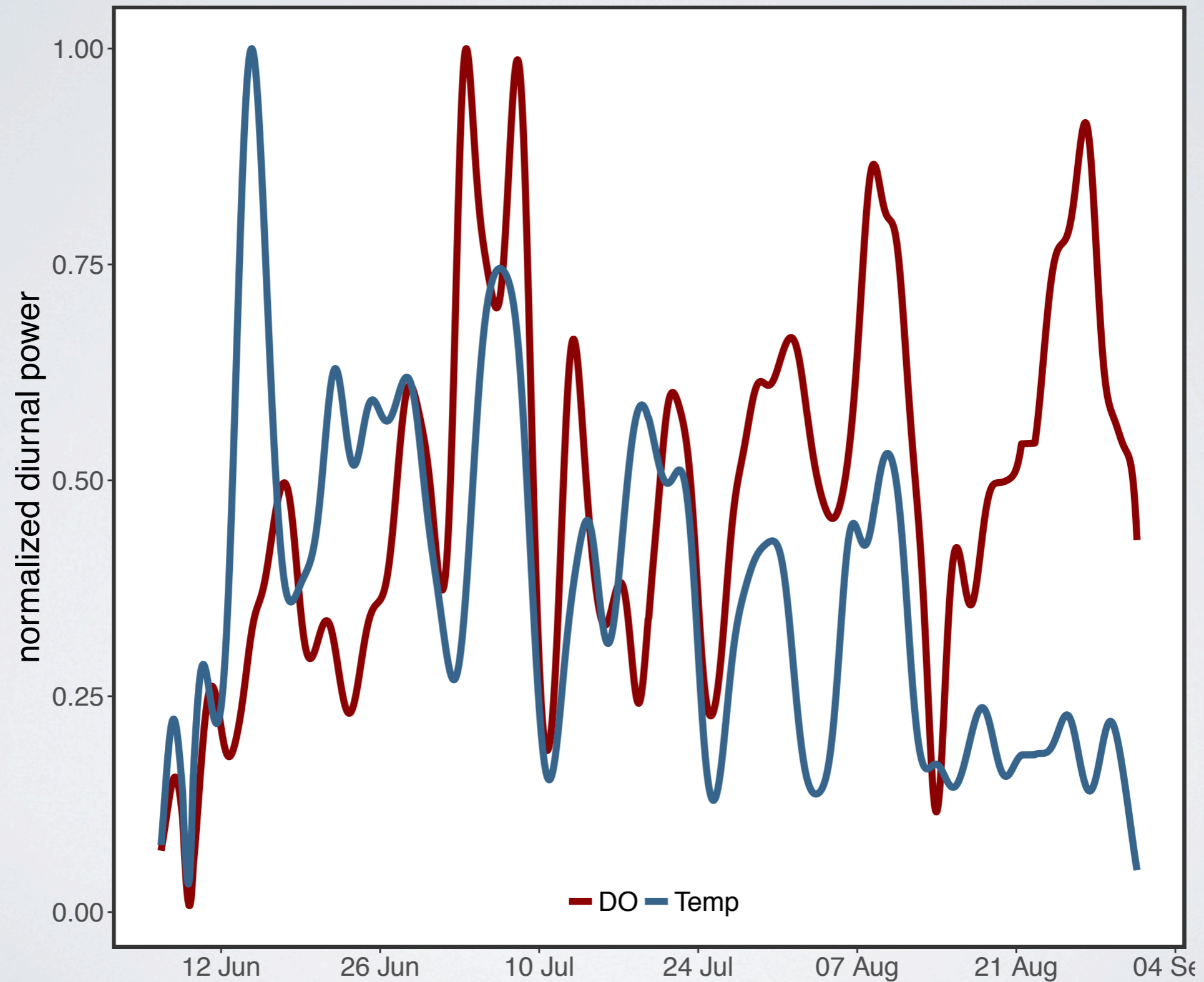


# Biogeochemical responses to climate and disturbance

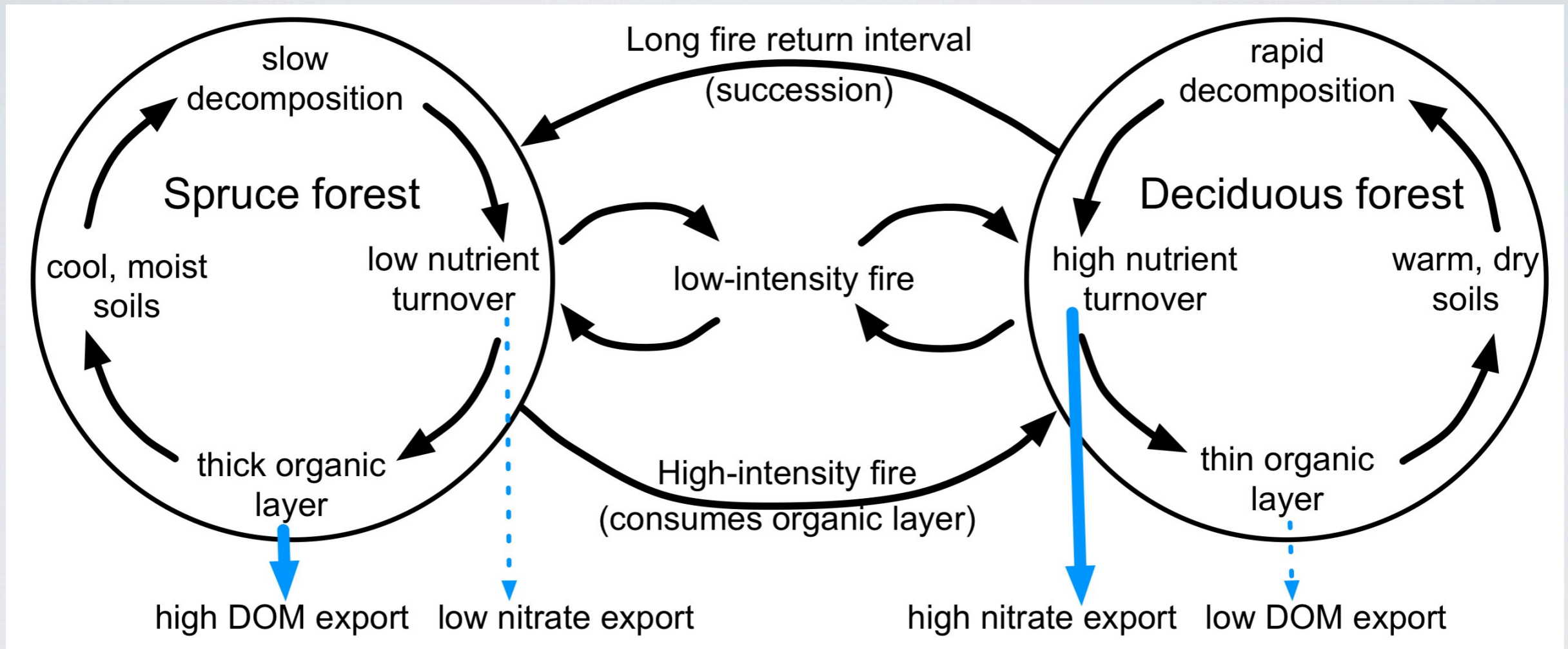
## Dissolved organic matter



# Biogeochemical responses to climate and disturbance

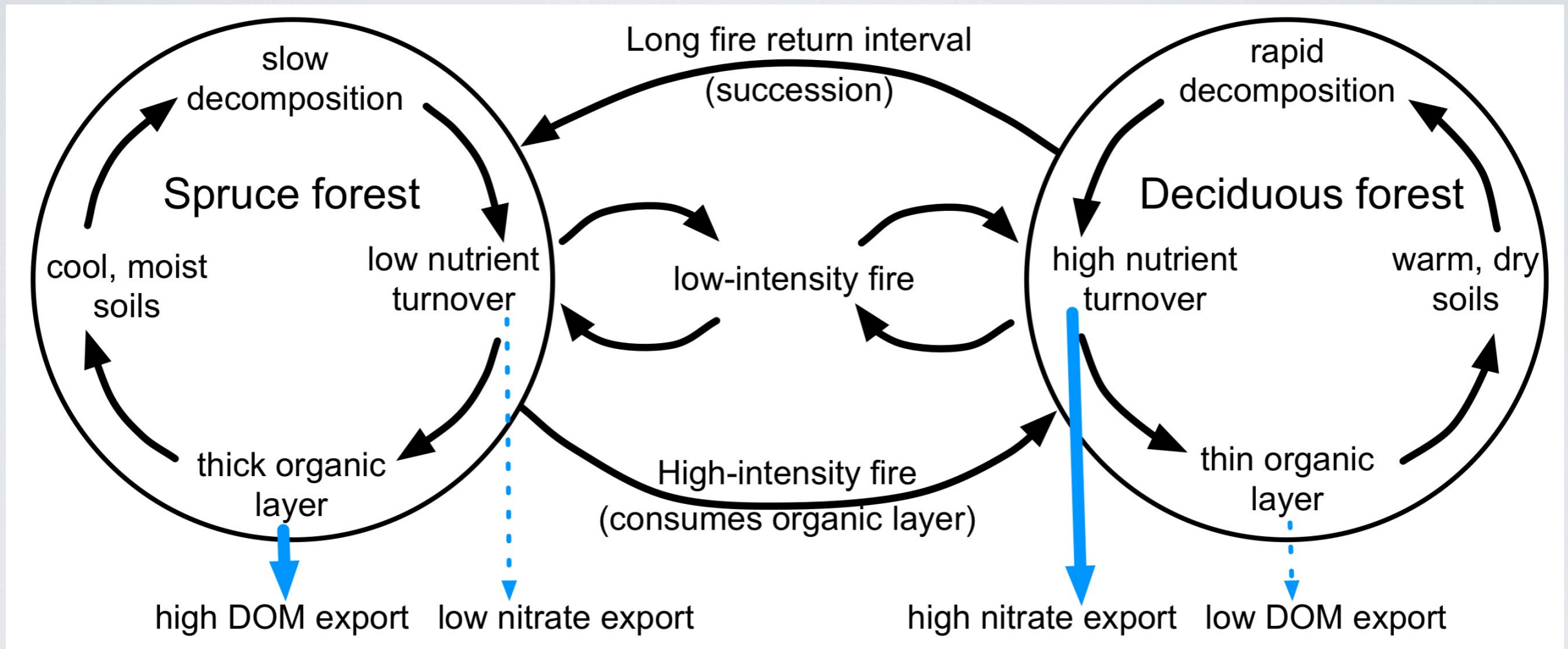


# How can we detect and predict ecological regime changes in the boreal forest?



Johnstone et al. 2010

# How can we detect and predict ecological regime changes in the boreal forest?



Johnstone et al. 2010

## Stream chemistry as indicator of ecological state of catchment?

# Ecological regime shifts

- ▶ Quantify the stability of ecosystems in response to fire, permafrost thaw, & climate
- ▶ Evaluate proximity of catchments to a change in ecological state due to intensification of the disturbance regime



# Ecological regime shifts

## Early warnings of state change

Increased:

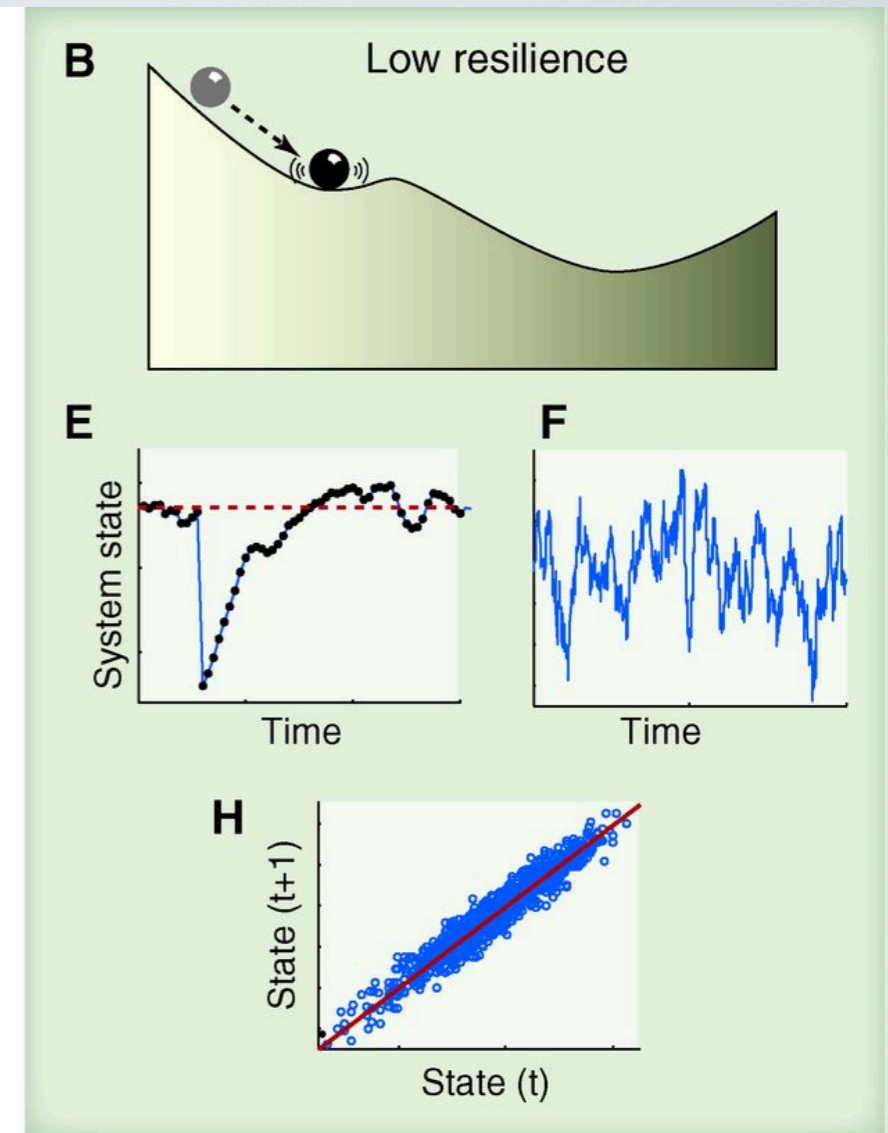
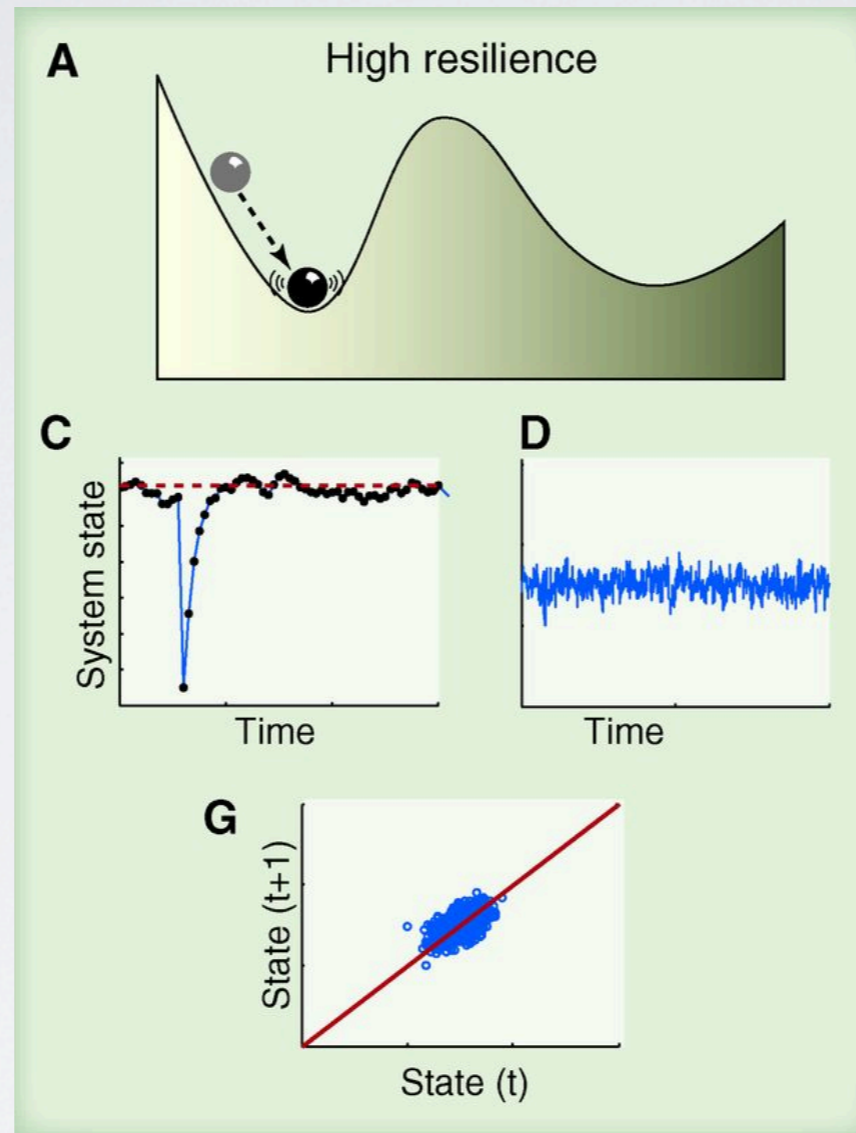
Variance

Autocorrelation

Skewness

Kurtosis

Biomodality





▶ How (and why) are elemental cycles coupled ?





- ▶ How (and why) are elemental cycles coupled ?
- ▶ How do cycles of biologically significant elements change in response to short- and long-term changes in climate and disturbance regimes?



- ▶ How (and why) are elemental cycles coupled ?
- ▶ How do cycles of biologically significant elements change in response to short- and long-term changes in climate and disturbance regimes?
- ▶ How can we detect and predict ecological regime changes in the boreal forest?

