

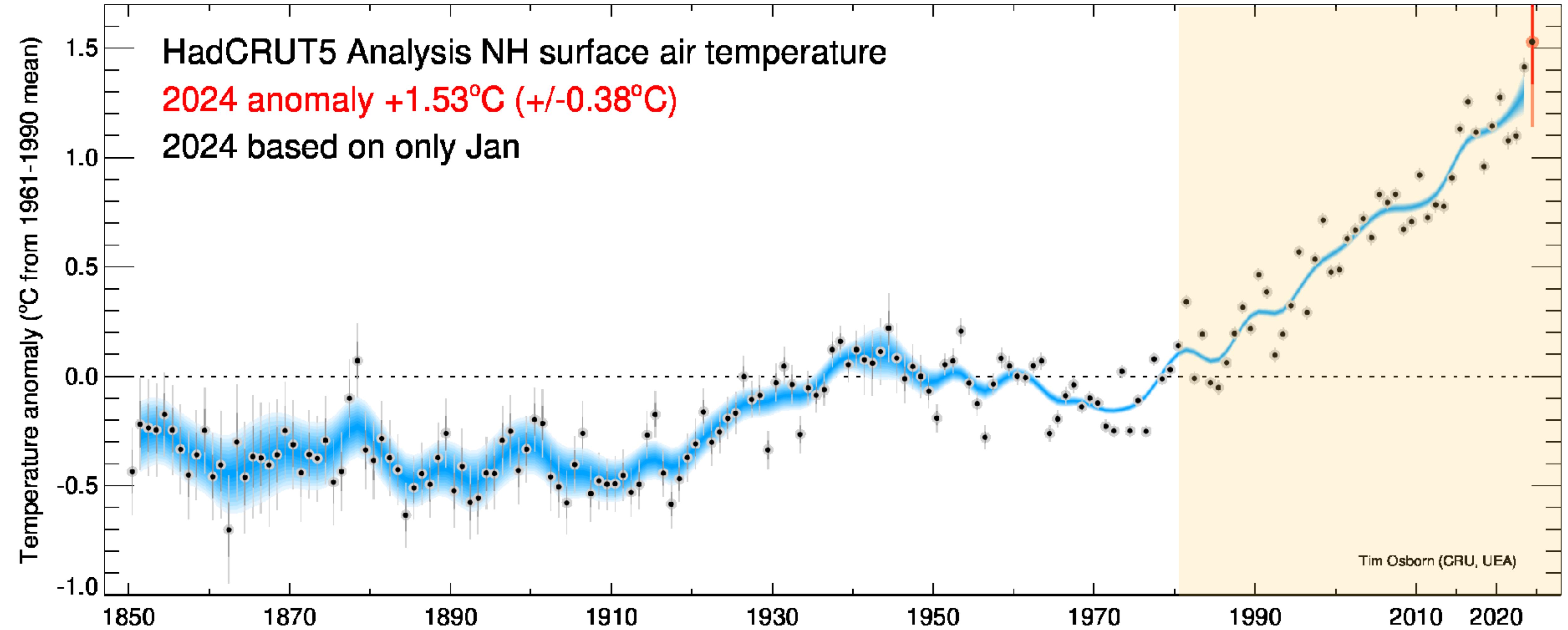
Modeling biological processes as stopped random walks (Background)

E M Wolkovich
Temporal Ecology Lab at UBC
2 December 2024

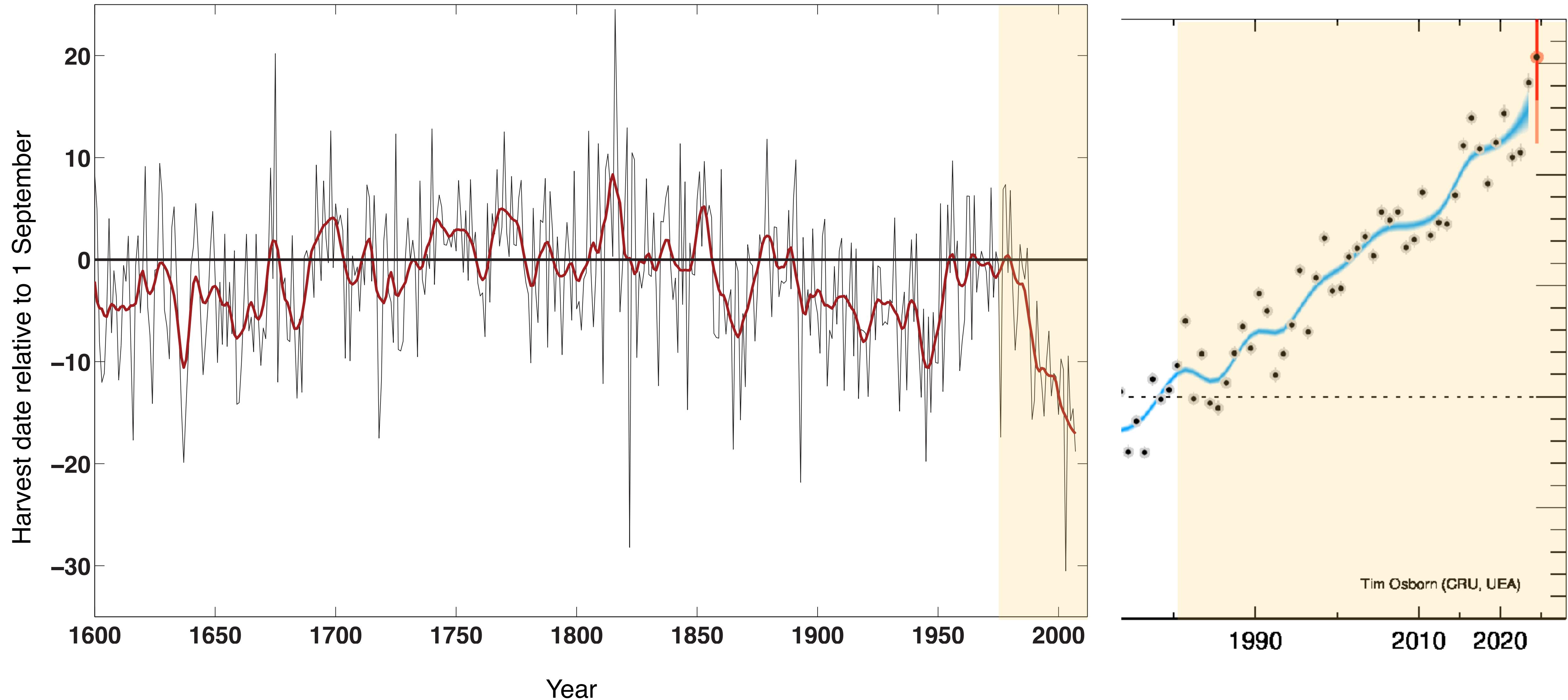
EFI and Statistical Ecology Section webinar



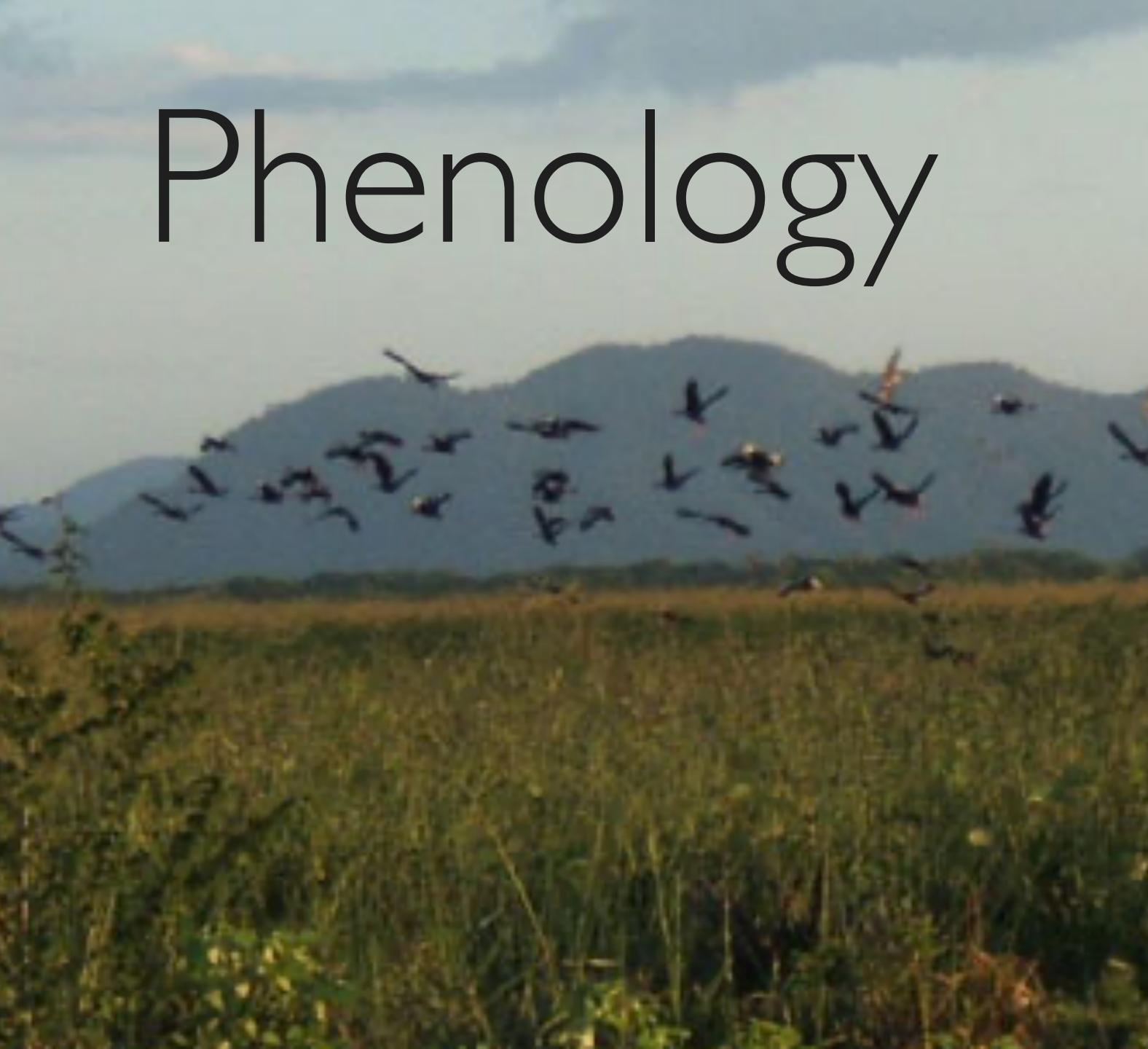
Climate change in the Northern hemisphere



Impacts of climate change on biological processes



Phenology





Declining sensitivity to temperature

LETTER

doi:10.1038/nature15402

Declining global warming effects on the phenology of spring leaf unfolding

Yongshuo H. Fu^{1,2}, Hongfang Zhao¹, Shi Mengtian Huang¹, Annette Menzel^{7,8}, Jo

nature
climate change

LETTERS

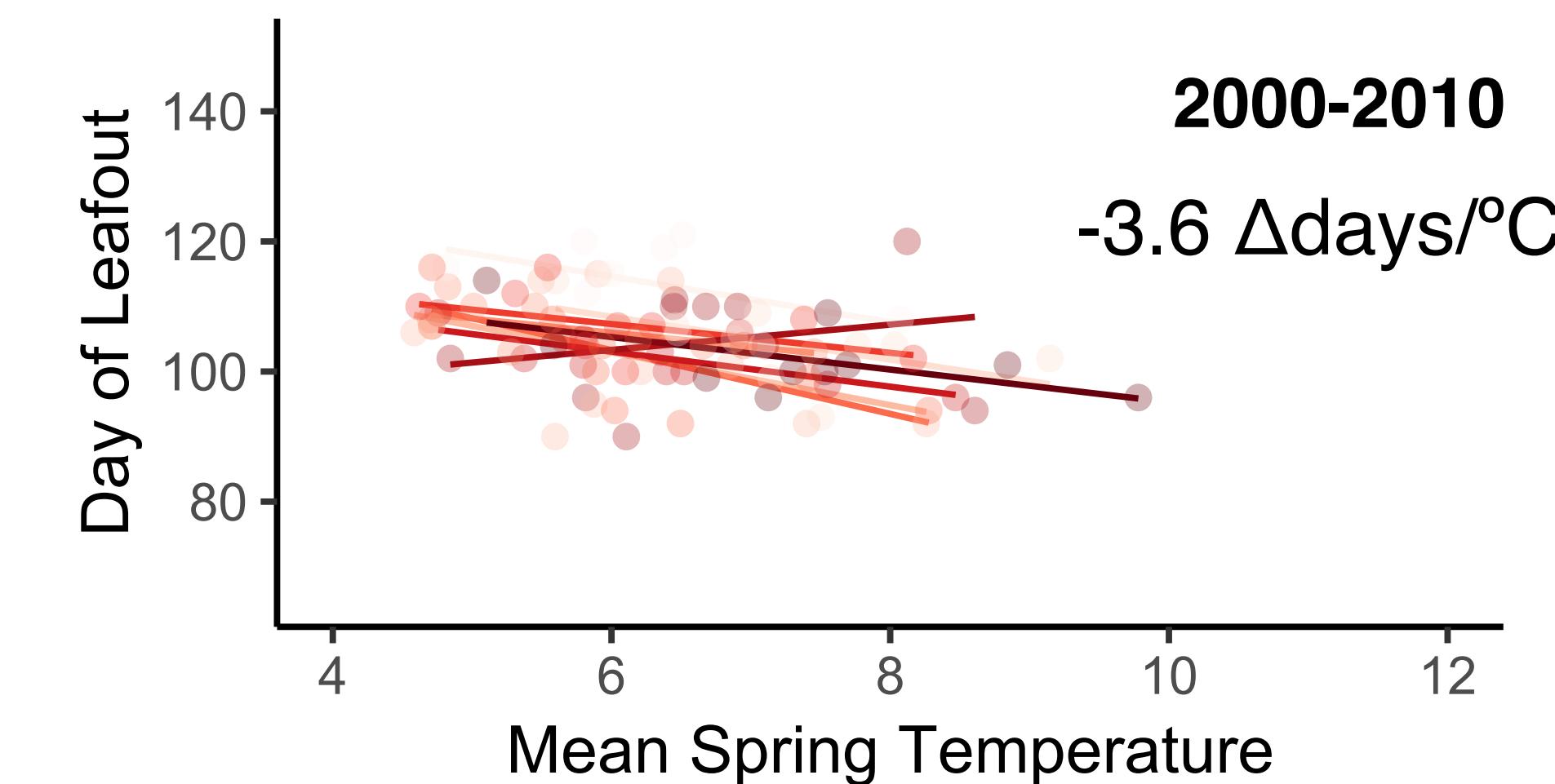
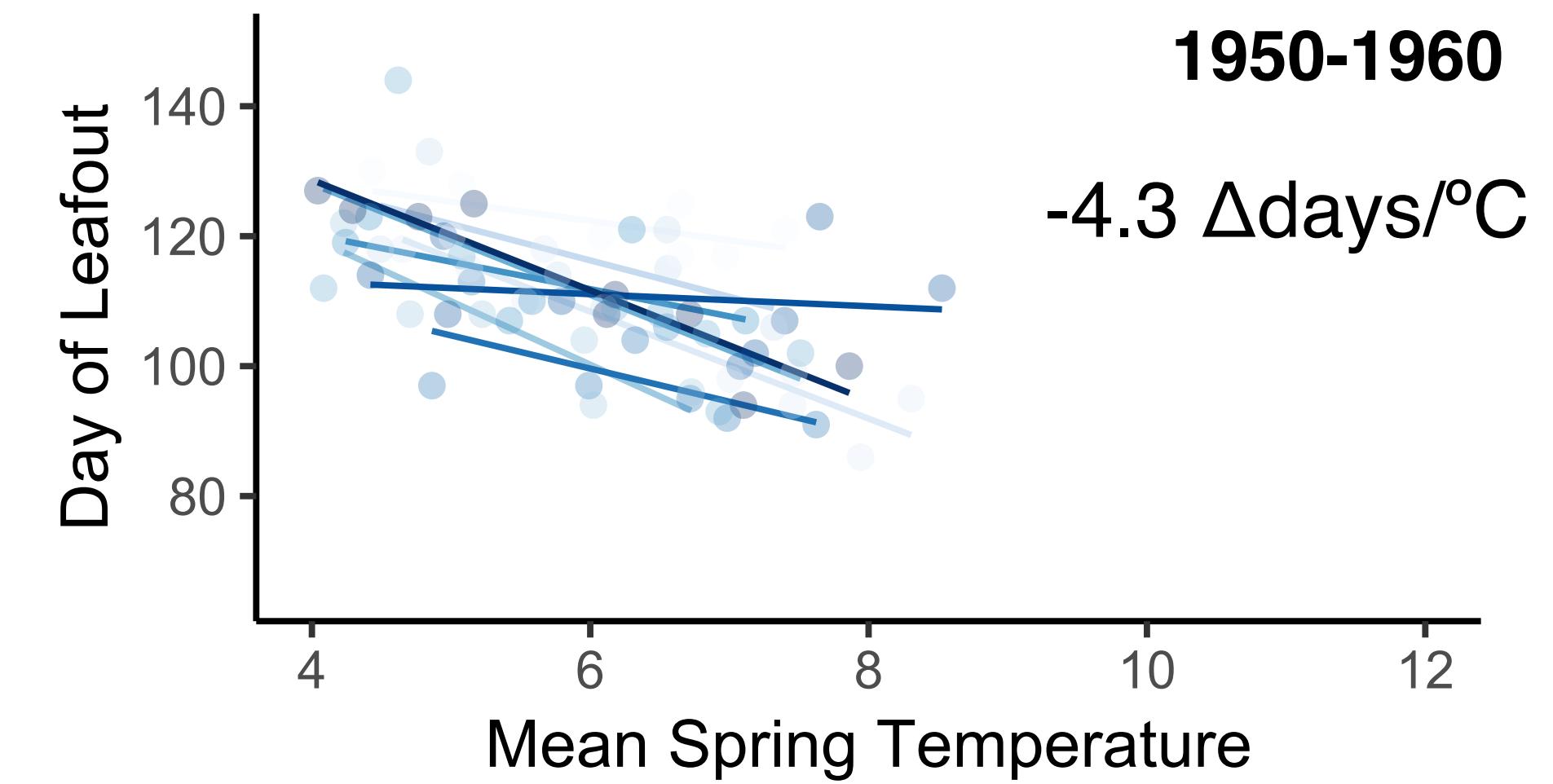
PUBLISHED ONLINE: 24 APRIL 2017 | DOI: 10.1038/NCLIMATE3277

Weakening temperature control on the interannual variations of spring carbon uptake across northern lands

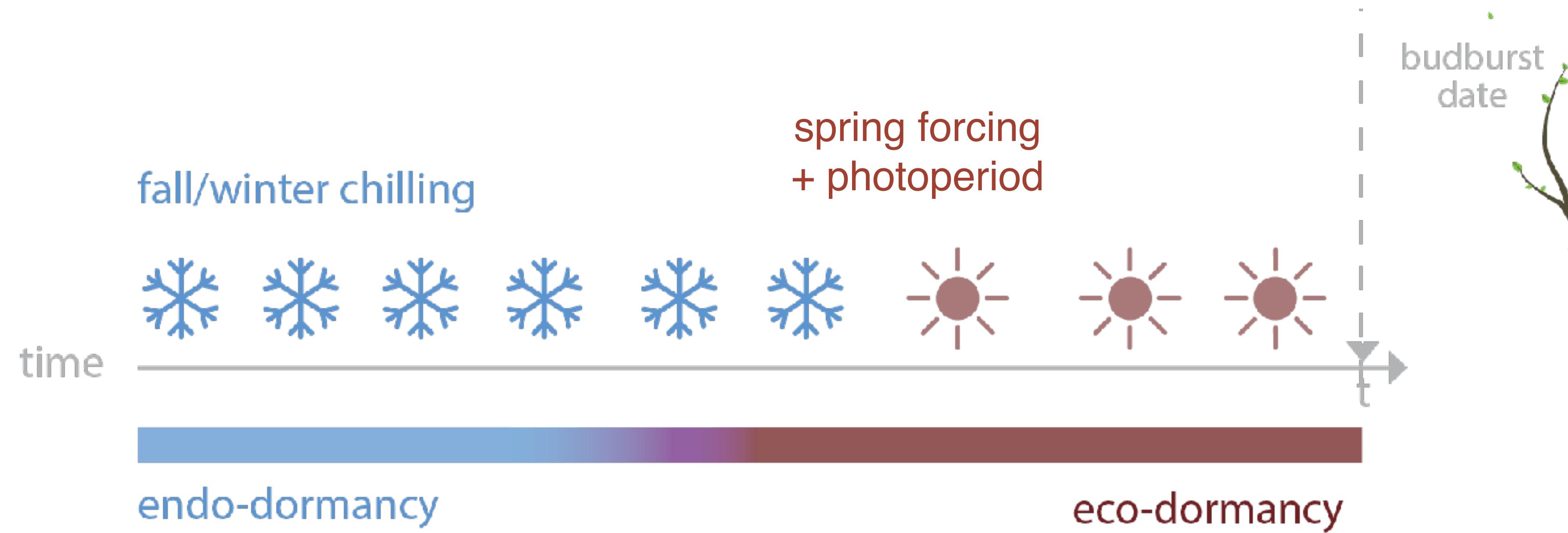
Shilong Piao^{1,2,3*}, Zhuo Liu², Tao Wang^{1,3}, Shushi Peng², Philippe Ciais⁴, Mengtian Huang², Anders Ahlstrom⁵, John F. Burkhardt⁶, Frédéric Chevallier⁴, Ivan A. Janssens⁷, Su-Jong Jeong⁸, Xin Lin⁴, Jiafu Mao⁹, John Miller^{10,11}, Anwar Mohammat¹², Ranga B. Myneni¹³, Josep Peñuelas^{14,15}, Xiaoying Shi⁹, Andreas Stohl¹⁶, Yitong Yao², Zaichun Zhu² and Pieter P. Tans¹⁰

Declining sensitivity to temperature

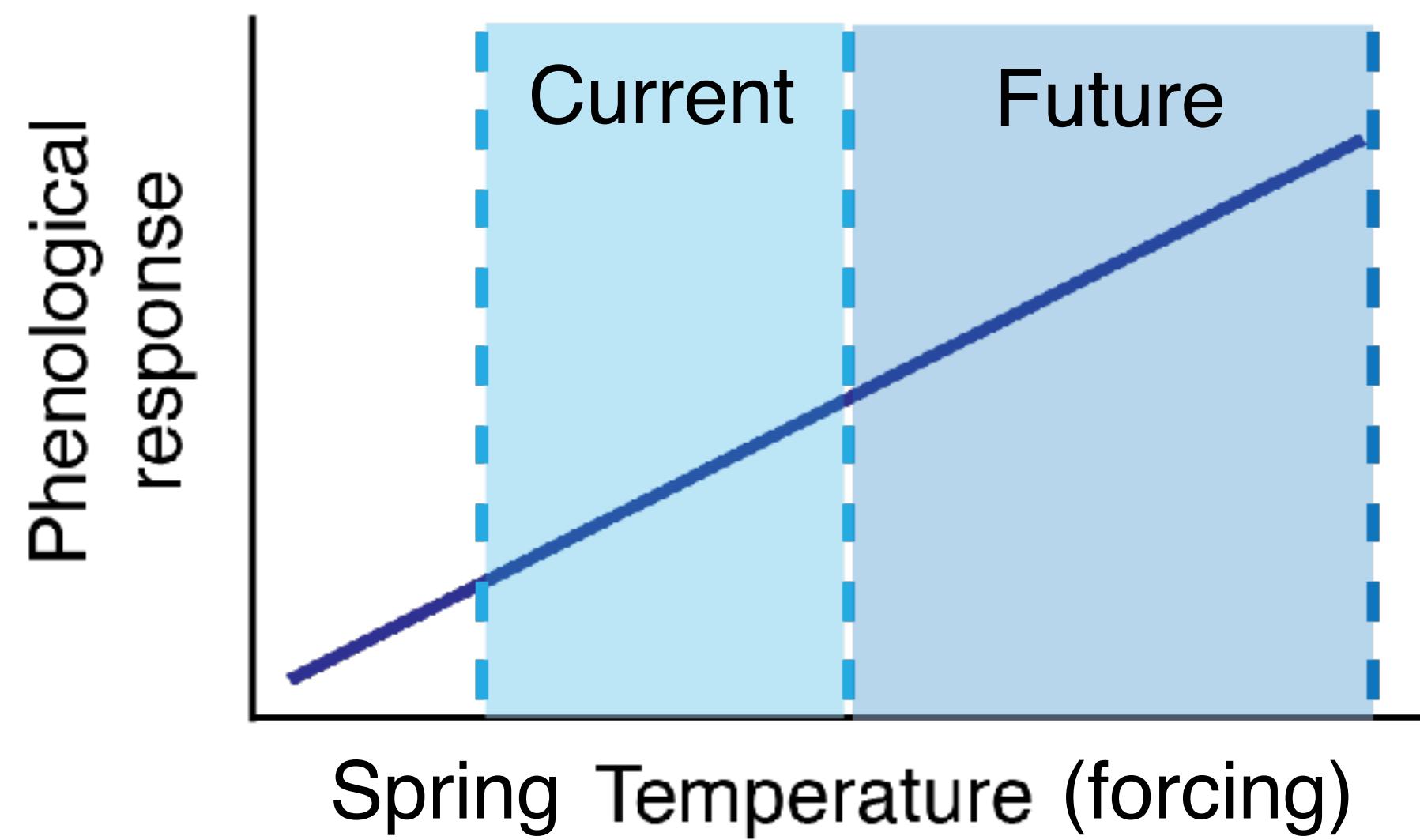
- Silver birch
(*Betula pendula*)
- 45 sites from Europe
- Sensitivity measured as slope: $\Delta\text{days}/^\circ\text{C}$



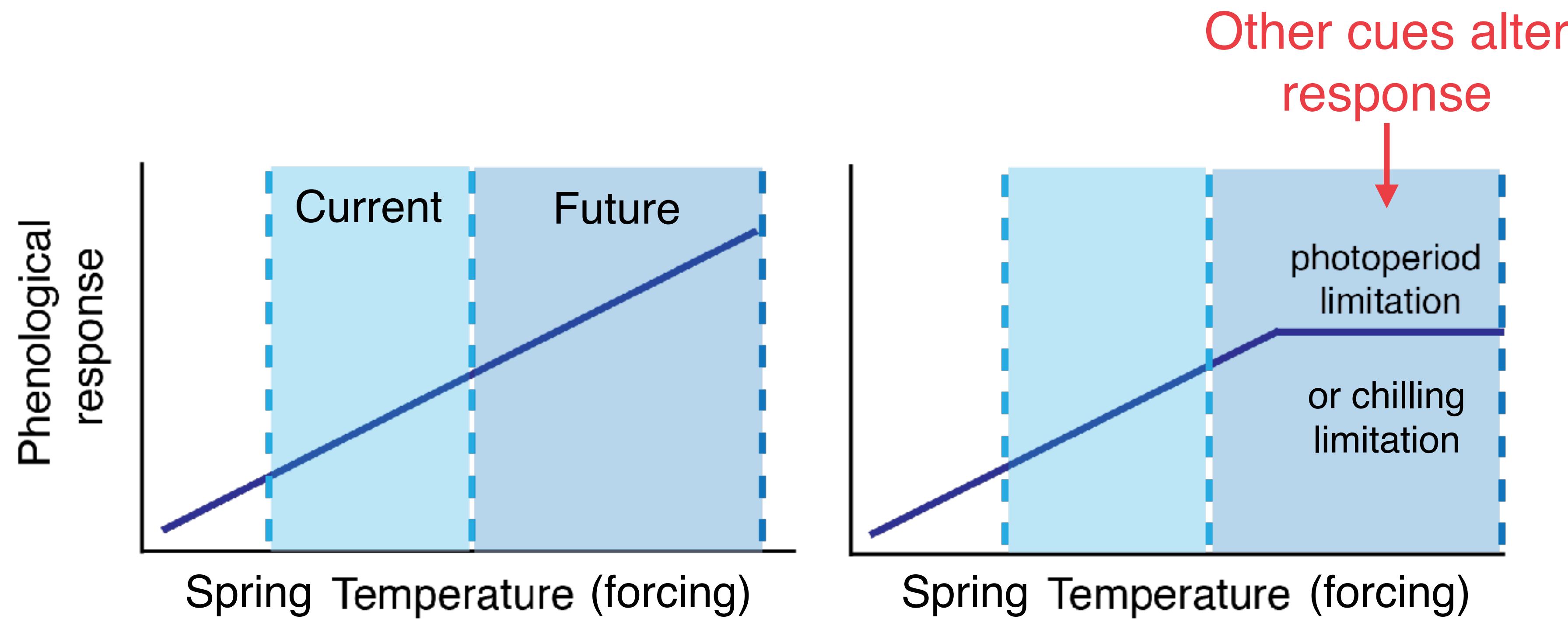
Phenology uses multiple cues



Other cues may become increasingly important to forecasting



Other cues may become increasingly important to forecasting



Declining sensitivity to temperature

LETTER

**Declining global warming
causing leaf unfolding
lagging behind warming**

Global Change Biology (2014) 20, 170–182, doi: 10.1111/gcb.12731

**Chilling outweighs photoperiod in
spring development**

JULIA LAUBE^{*†}, TIM H.
DONNA P. ANKERST[§] and
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[†]Institute for Advanced Study, Technische Universität München,
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Plant, Cell &
Environment

Plant, Cell and Environment (2015) **38**, 1725–1736

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&
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doi: 10.1111/pce.12431

Review

**Photoperiod constraints on tree phenology, performance
and migration in a warming world**

LETTERS

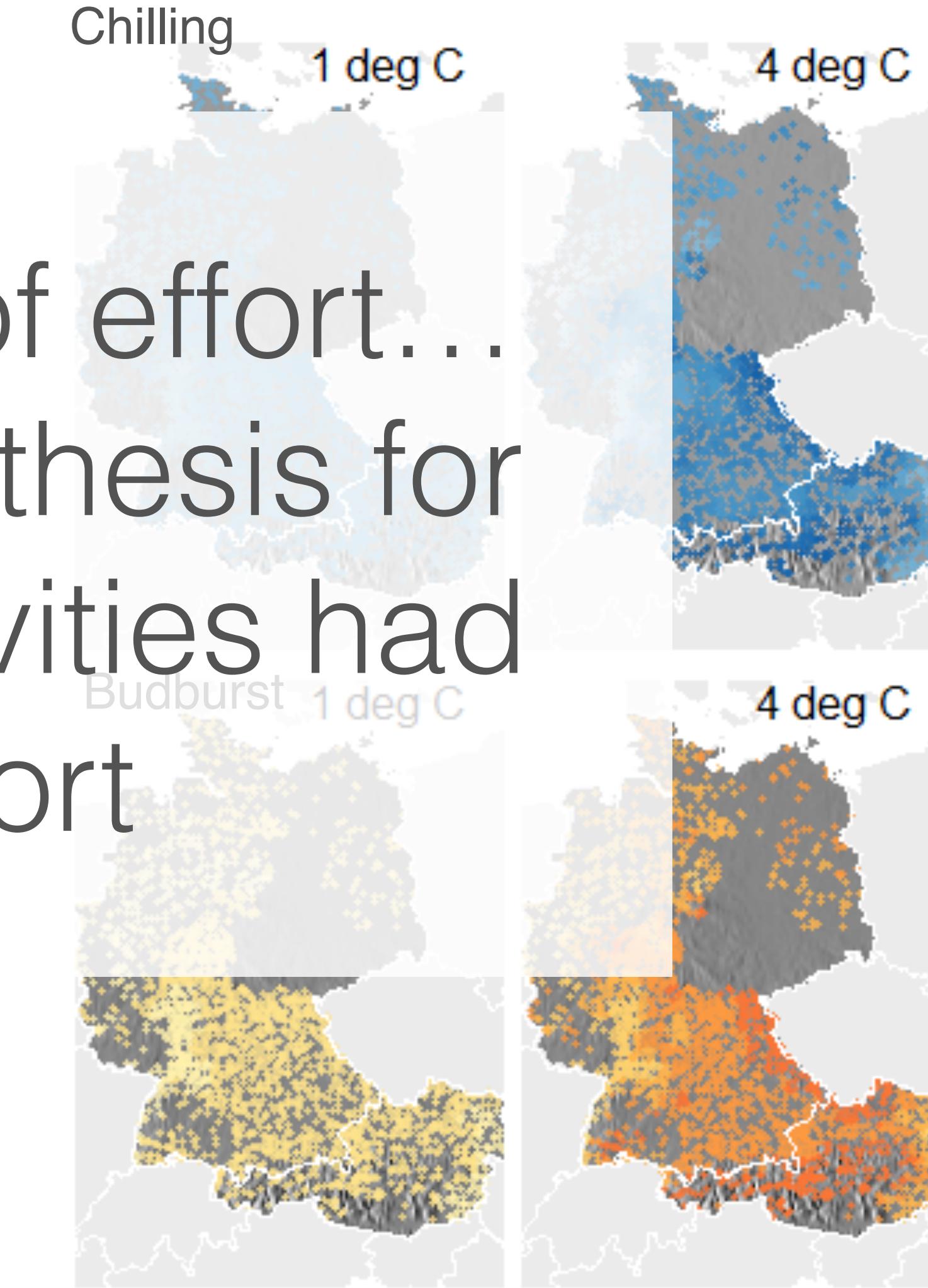
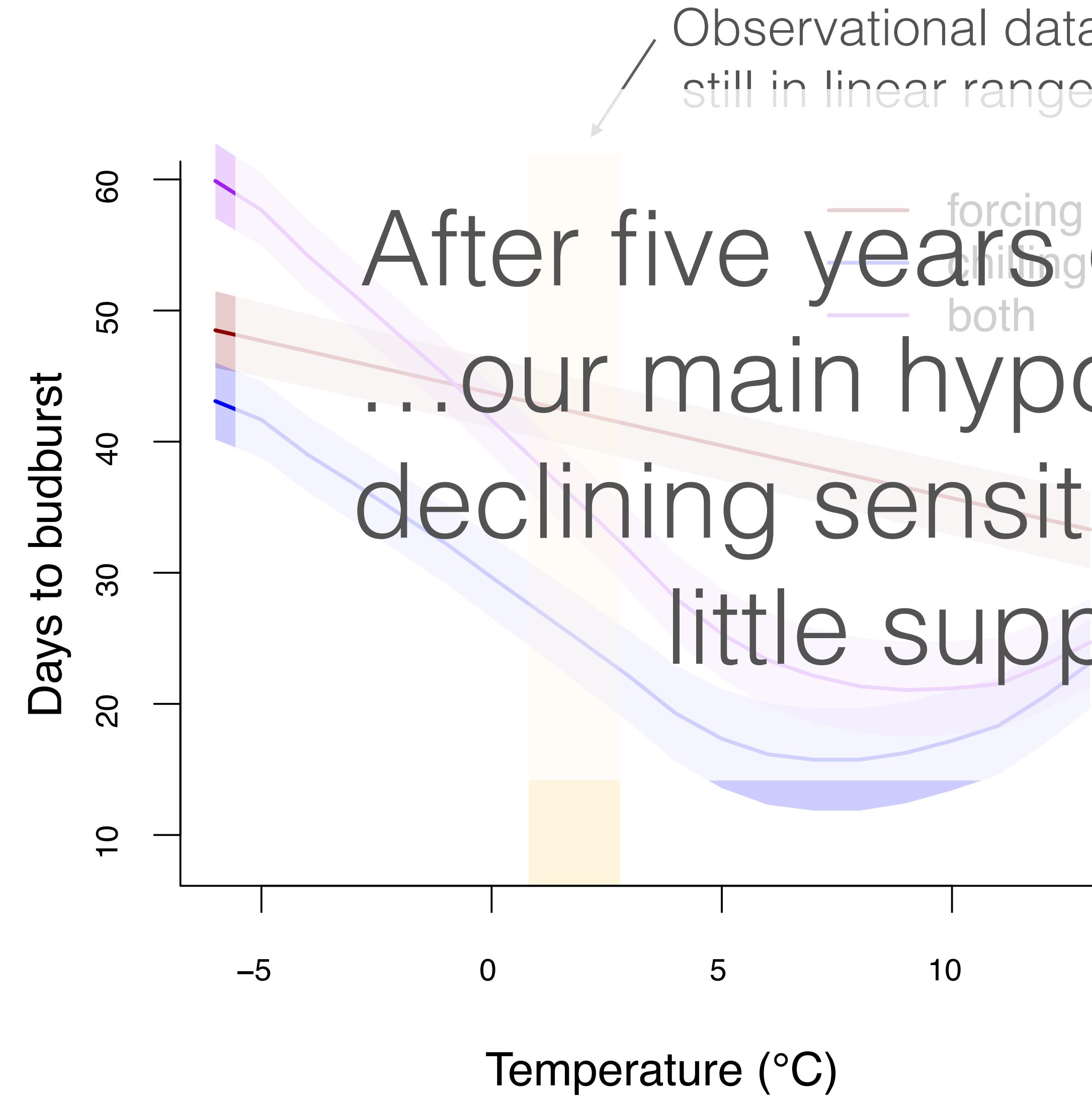
PUBLISHED ONLINE: 17 OCTOBER 2016 | DOI: 10.1038/NCLIMATE3138

nature
climate change

**Day length unlikely to constrain climate-driven
shifts in leaf-out times of northern woody plants**

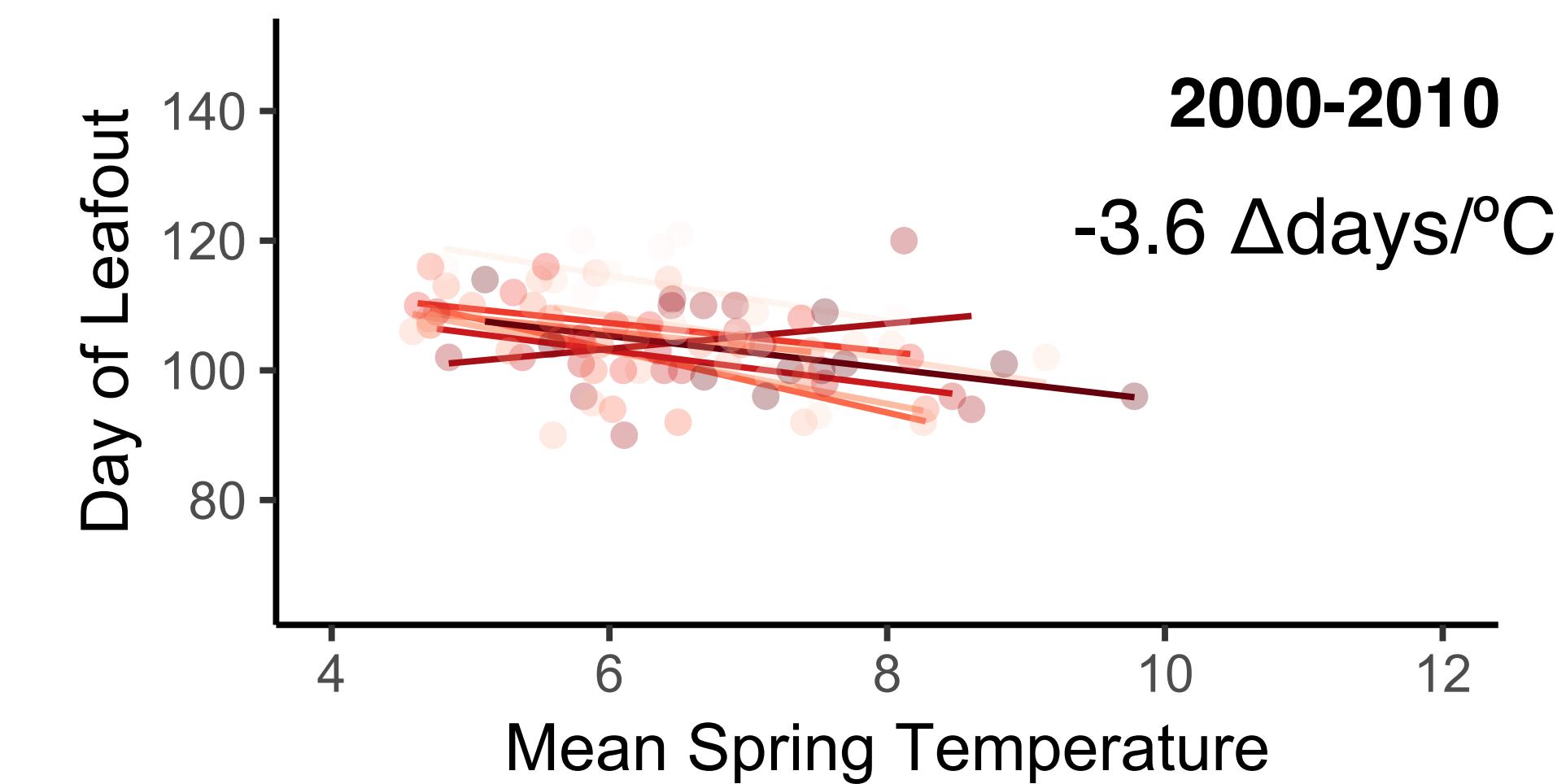
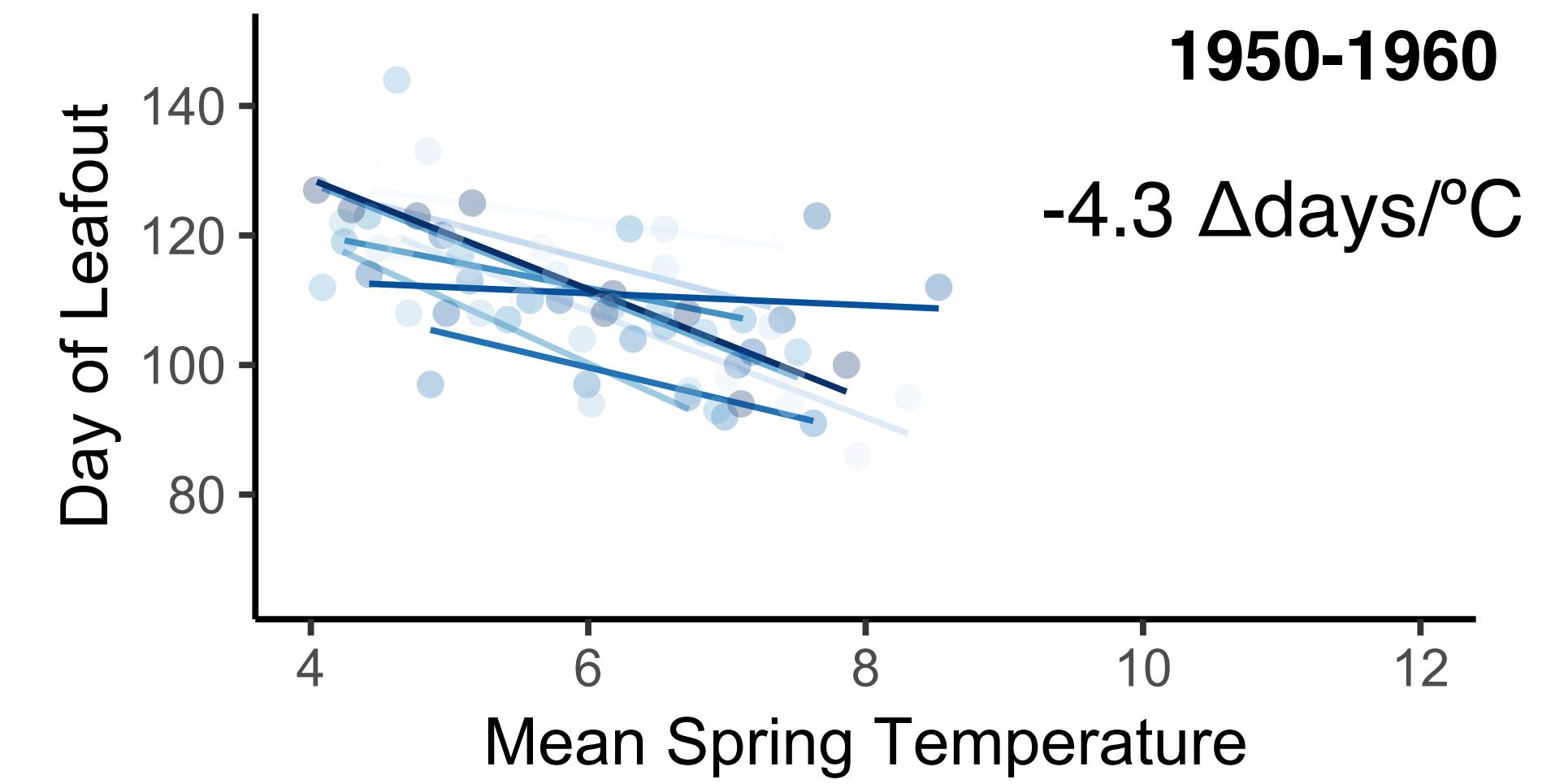
Constantin M. Zohner^{1*}, Blas M. Benito², Jens-Christian Svensson² and Susanne S. Renner¹

Forecasted model to European data

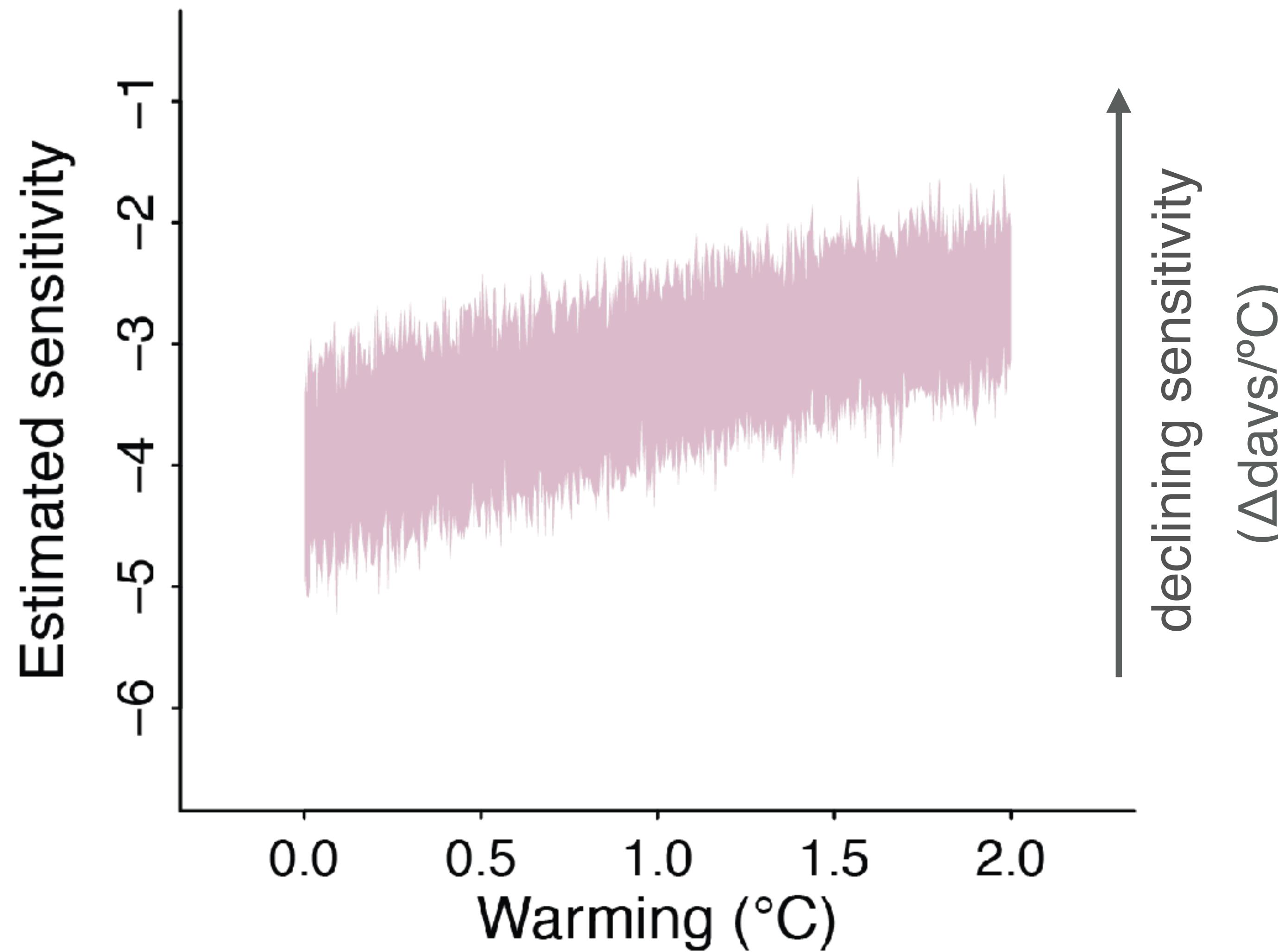


What underlies declining sensitivities?

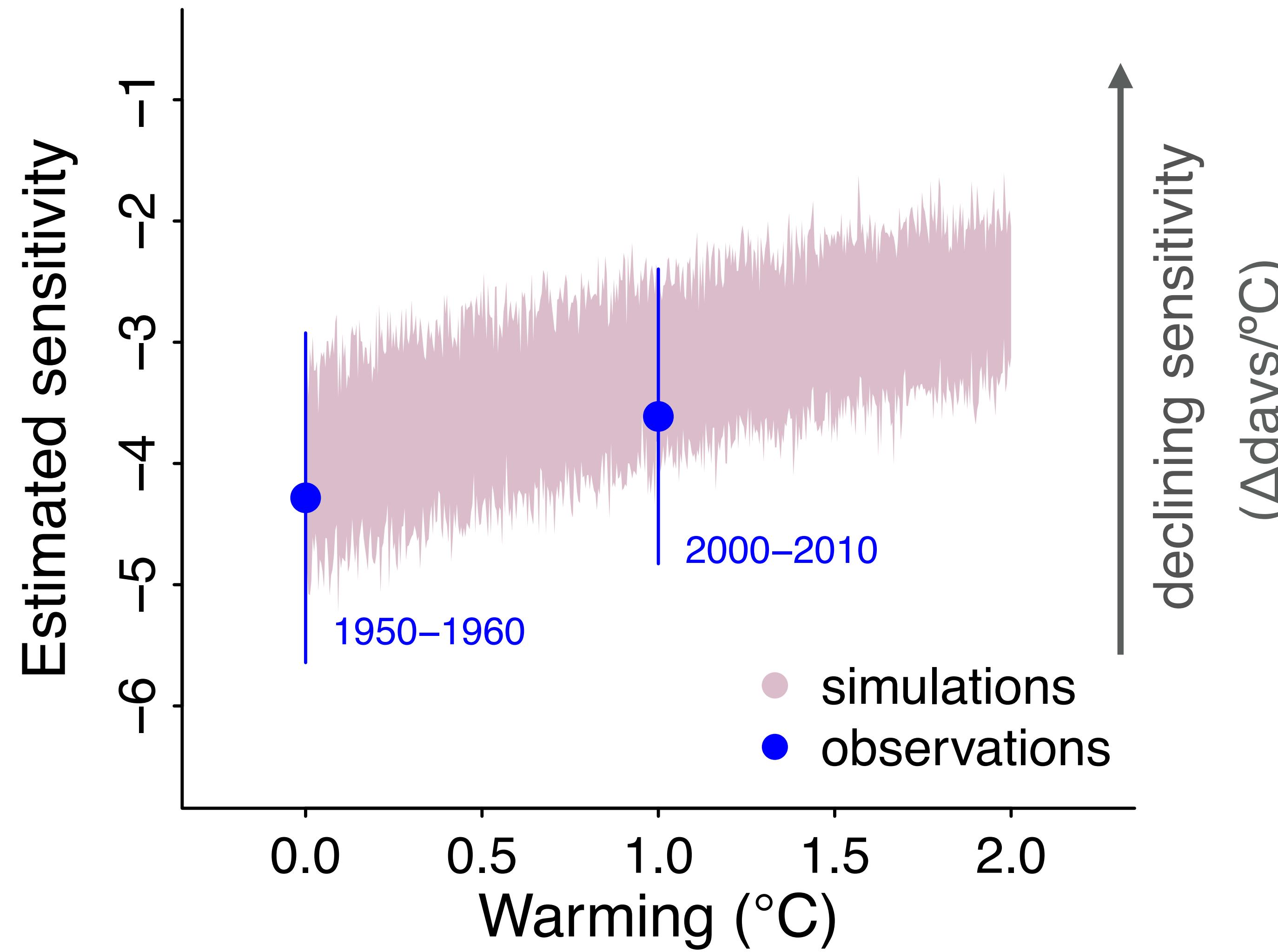
- I simulated a simple model ...
- Leafout occurs after a certain thermal sum (no chilling or photoperiod)
- Simulated across different temperatures



Simulations predict observed decline



Simulations predict observed decline



And this is the problem I brought to Jonathan Auerbach some years ago ...

Modeling biological processes as stopped
random walks