Artificial light at night: an underappreciated effect on plant phenology

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Introduction

1.Artificial light at night (ALAN) has rapidly increased by 1.8% per year worldwide from 2012 to 2016, due to urbanization, electrification, population growth and socio-economic development.

2. Circadian rhythm of plants may be affected by ALAN, which affect physiology and phenology.

3.Plant phenology refers to the timing of life cycle events, such as flowering, fruiting, and leaf senescence.

4.Understanding the effects of ALAN on plant phenology provides insight into the ecological consequences of human activities and informs strategies for mitigating urbanization impact on natural systems.

5. NASA Black Marble ALAN products provide a unique opportunity to explore the effect of ALAN on plant phenology at a national scale.

Method

Goal: Investigate the influence of ALAN on phenology of deciduous woody plants in the conterminous U.S.

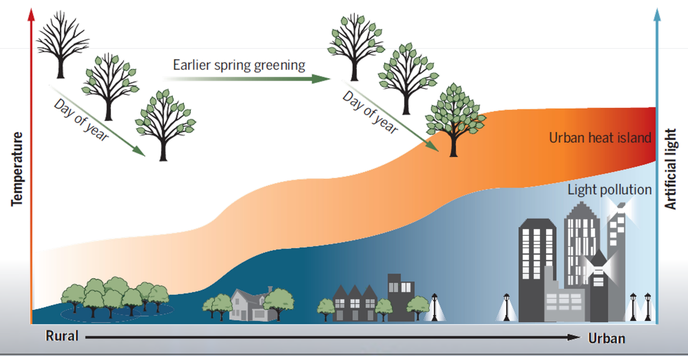
Research questions:

(1) Whether and to what extent ALAN affects spring and autumn phenology, respectively?

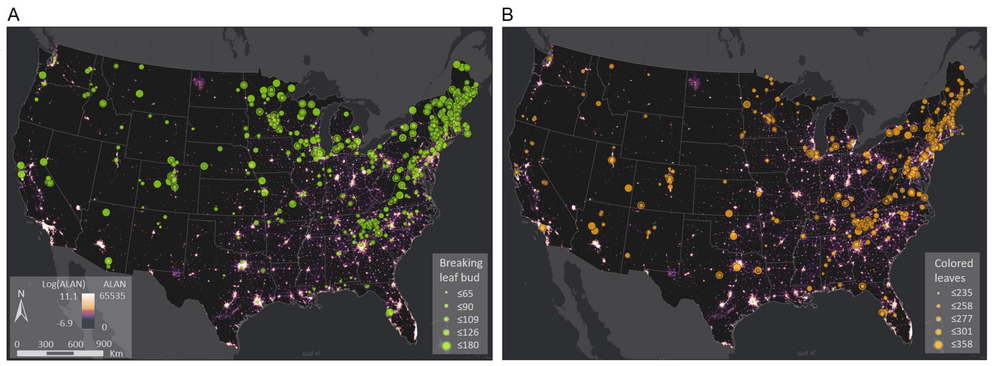
(2) Are there interactions between ALAN and temperature effects on the phenology?

(3) How will phenology change in a warmer and brighter night future?

Data: NASA Black Marble ALAN product, Nature's notebook phenology dataset, TopoWx climate data, and temperature projection from CMIP6

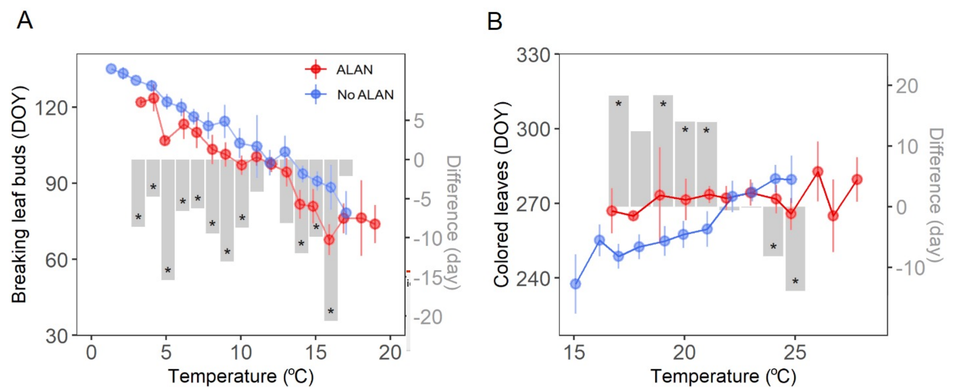


Results



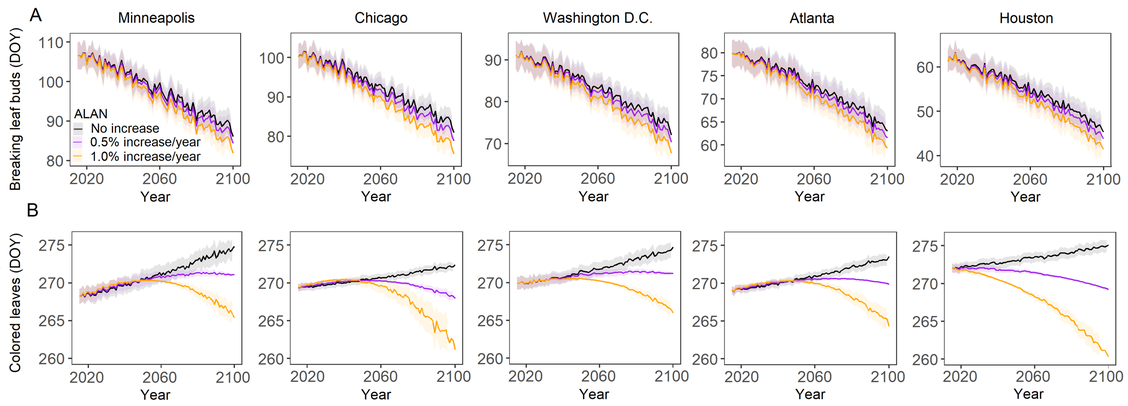
Spatial patterns of the breaking leaf buds (A) and colored leaves dates (B) under ALAN.

The breaking leaf buds and colored leaves (day of year) are shown by the size of colored points. The background color represents ALAN intensity (nW/cm²/sr).



ALAN advanced the date of breaking leaf buds by 8.9 ± 6.9 days (mean ± SD) (A) and delayed the coloring of leaves by 6.0 ± 11.9 days (B) on average.

Points and error bars represent the mean and 95% confidence interval of phenology (day of year) for each 1 ºC temperature increment. Gray bars represent the differences in phenology (days) by subtracting phenology at sites without ALAN from sites with ALAN.

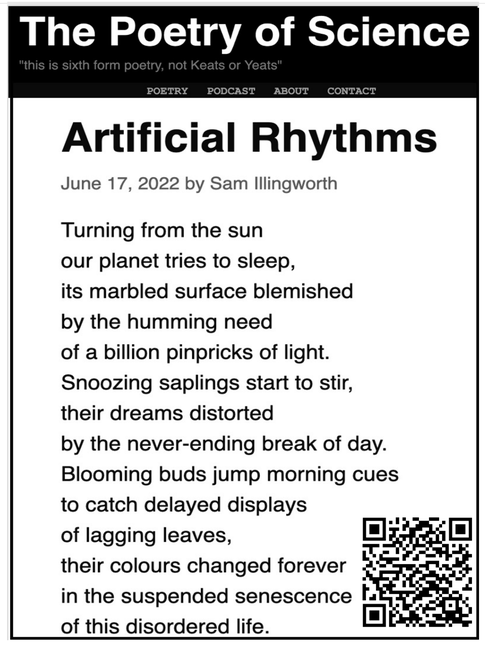


ALAN will accelerate the advance in breaking leaf buds but exert a more complex effect on the coloring of leaves under future climate warming scenarios.

Lines and shadow area represent the mean and standard deviation, respectively, of estimated phenology using temperatures from 24 climate model simulations for CMIP6 under SSP 5-8.5 scenario.

Impact

Did you know our paper inspired the creation of a science poem and was featured in podcast? Scan the below QR code to listen!


The Poetry of Science

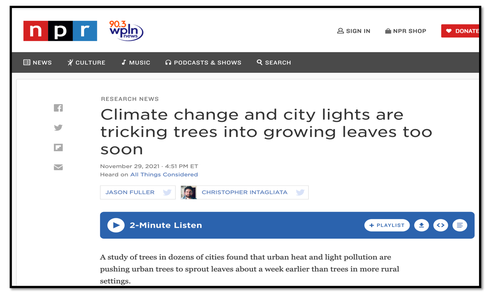
"this is sixth form poetry, not Keats or Yeats"

POETRY PODCAST ABOUT CONTACT

Artificial Rhythms

June 17, 2022 by Sam Illingworth

Turning from the sun
our planet tries to sleep,
its marbled surface blemished
by the humming need
of a billion pinpricks of light.
Snoozing saplings start to stir,
their dreams distorted
by the never-ending break of day.
Blooming buds jump morning cues
to catch delayed displays
of lagging leaves,
their colours changed forever
in the suspended senescence
of this disordered life.


npr

Climate change and city lights are tricking trees into growing leaves too soon

November 29, 2021 · 4:51 PM ET
Heard on All Things Considered

JASON FULLER CHRISTOPHER INTAGLIATA

2-Minute Listen

A study of trees in dozens of cities found that urban heat and light pollution are pushing urban trees to sprout leaves about a week earlier than trees in more rural settings.


AAAS

HOME | NEWS

Warmer, Brighter Cities Alter Urban Tree Leafing

25 November 2021

by: Meagan Phelan

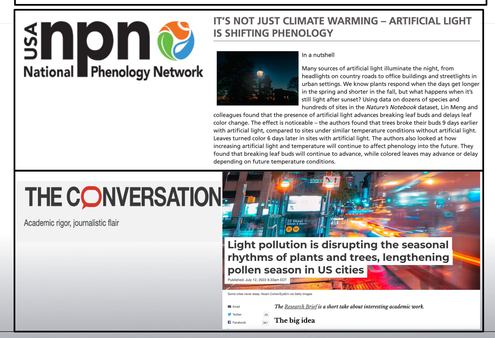

azcentral.

ENVIRONMENT

Sneezing more? City lights and warming temperatures are leading to longer pollen seasons

Joan Meiners
Arizona Republic

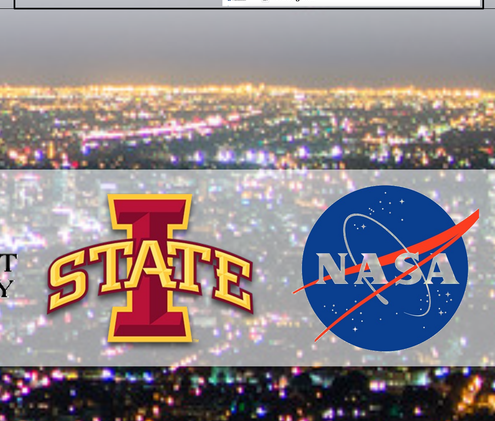
Published 6:01 a.m. MT April 12, 2023 | Updated 11:06 a.m. MT April 12, 2023


USA npn National Phenology Network

IT'S NOT JUST CLIMATE WARMING – ARTIFICIAL LIGHT IS SHIFTING PHENOLOGY

In a nutshell

Many sources of artificial light illuminate the night, from headlights on country roads to office buildings and streetlights in urban settings. We know plants respond when the days get longer in the spring and shorter in the fall, but what happens when it's still light after sunset? Using data on dozens of species and hundreds of sites in the *Nature's Notebook* dataset, Lin Meng and colleagues found that the presence of artificial light advances breaking leaf buds and delays leaf color change. The effect is noticeable – the authors found that trees broke their buds 9 days earlier with artificial light, compared to sites under similar temperature conditions without artificial light. Leaves turned color 6 days later in sites with artificial light. The authors also looked at how increasing artificial light and temperature will continue to affect phenology into the future. They found that breaking leaf buds will continue to advance, while colored leaves may advance or delay depending on future temperature conditions.


THE CONVERSATION

Academic rigor, journalistic flair

Light pollution is disrupting the seasonal rhythms of plants and trees, lengthening pollen season in US cities

The Research Brief is a short take about interesting academic work.

The big idea

Every Day Needs a Night. Turn off the light to preserve natural rhythms.

Check out our papers:

Meng, Lin. "Green with phenology." Science 374.6571 (2021): 1065-1066.

Meng, Lin, et al. Artificial light at night: an underappreciated effect on phenology of deciduous woody plants. PNAS Nexus 1.2 (2022): pgac046.

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