

# The climate adaptation potential of reforestation, and how it changes during heat waves



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EGU22-2056

Session CL4.1 – Land–atmosphere interactions and climate extremes

# Informing nature-based climate solutions with the best-available science

Strategies like reforestation, cover crops, biochar, enhanced mineral weathering

Received: 10 December 2021 | Accepted: 4 February 2022

DOI: 10.1111/gcb.16156

OPINION

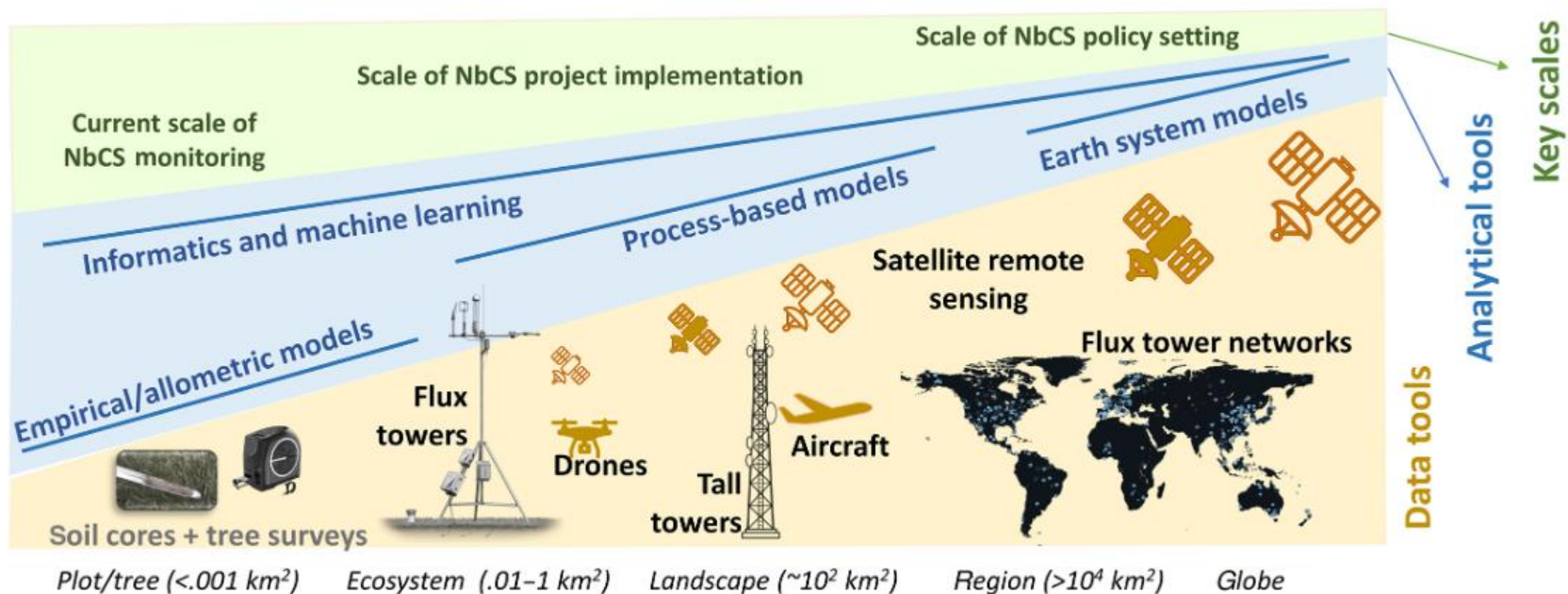
Global Change Biology WILEY

## Informing Nature-based Climate Solutions for the United States with the best-available science

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## Big uncertainties!

Opportunities to leverage existing infrastructure for more robust assessments that consider **biophysical impacts on water and energy cycles**



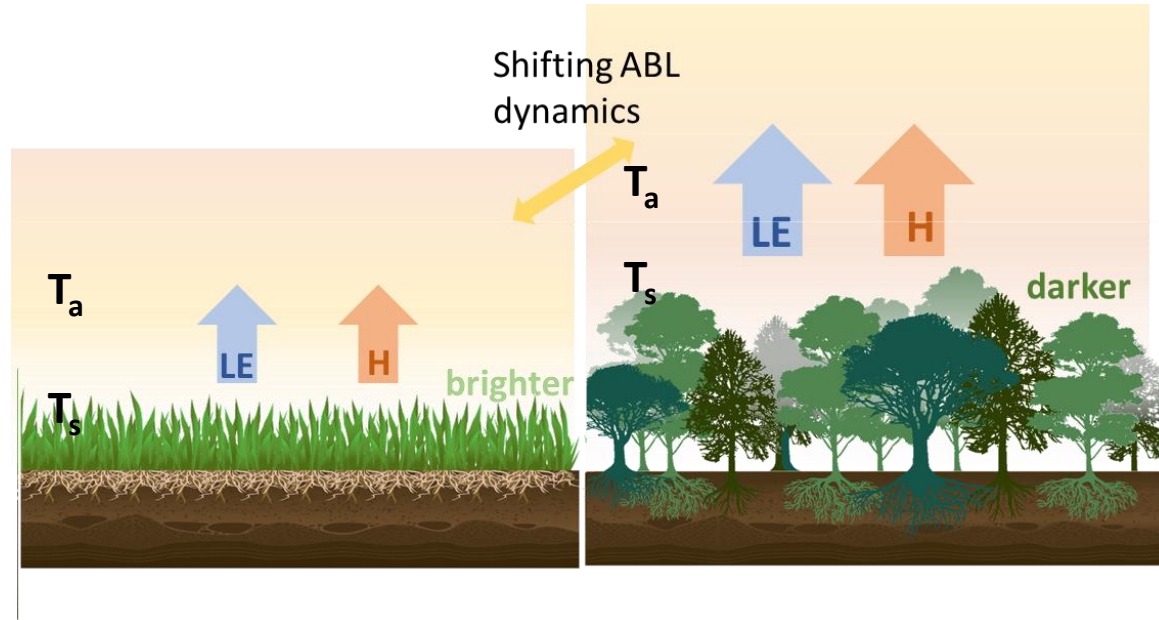
# Biophysical impacts on water and energy cycles:

If they are beneficial → Local climate adaptation

For example, reforestation usually:

- Decreases albedo (warming)
- Increases LE (cooling)
- Increases H (surface cooling)

In tropical and temperate zones, forests surfaces are relatively cool



## Some unanswered questions:

Does the cooling benefit of forests persist when it's really hot?  
depends in part on physiological function (LE dynamics)

Does the cooling benefit extend to the near-surface air temperature?  
depends in part on boundary layer processes (H dynamics)

## Approach:

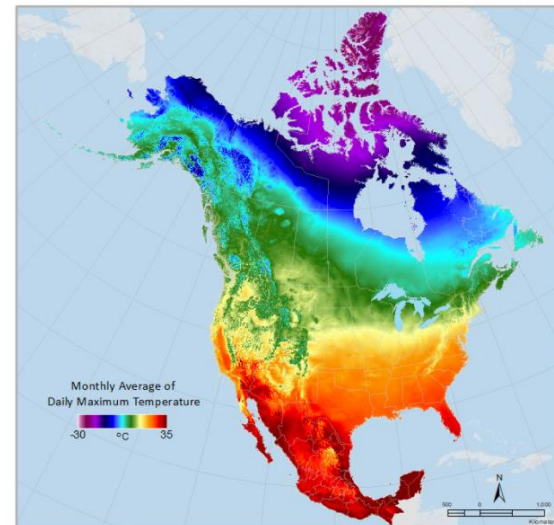
- Synthesis of energy cycle information from 139 AmeriFlux towers in the U.S. (all CC-BY-4.0). Focus on mid-day conditions during summer (JJA).



*See Novick & Katul (2020, JGR-B)  
for details on methodology.*

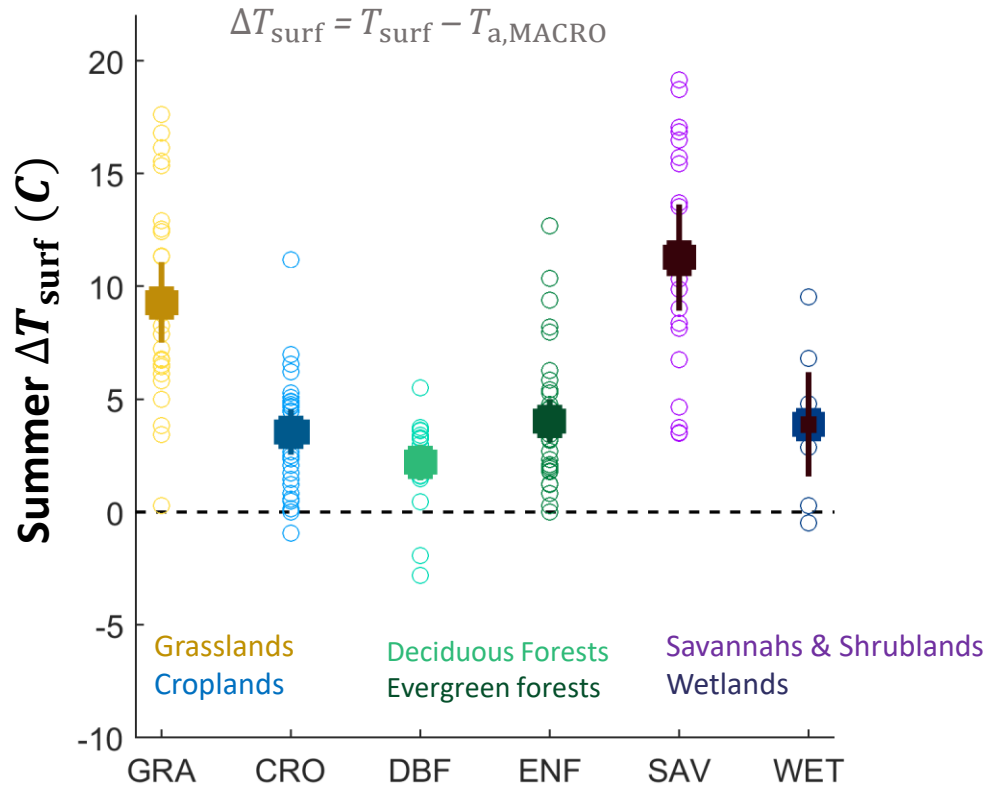


- Used **DAYMET** interpolated weather station data as a proxy for macro-scale climate variability



Begin by looking at land cover impacts on  $T_{\text{surf}}$  during summer, at mid-day

Croplands, forests & wetlands have relatively cool surfaces.  
Grasslands, savannahs and shrublands are relatively hot.

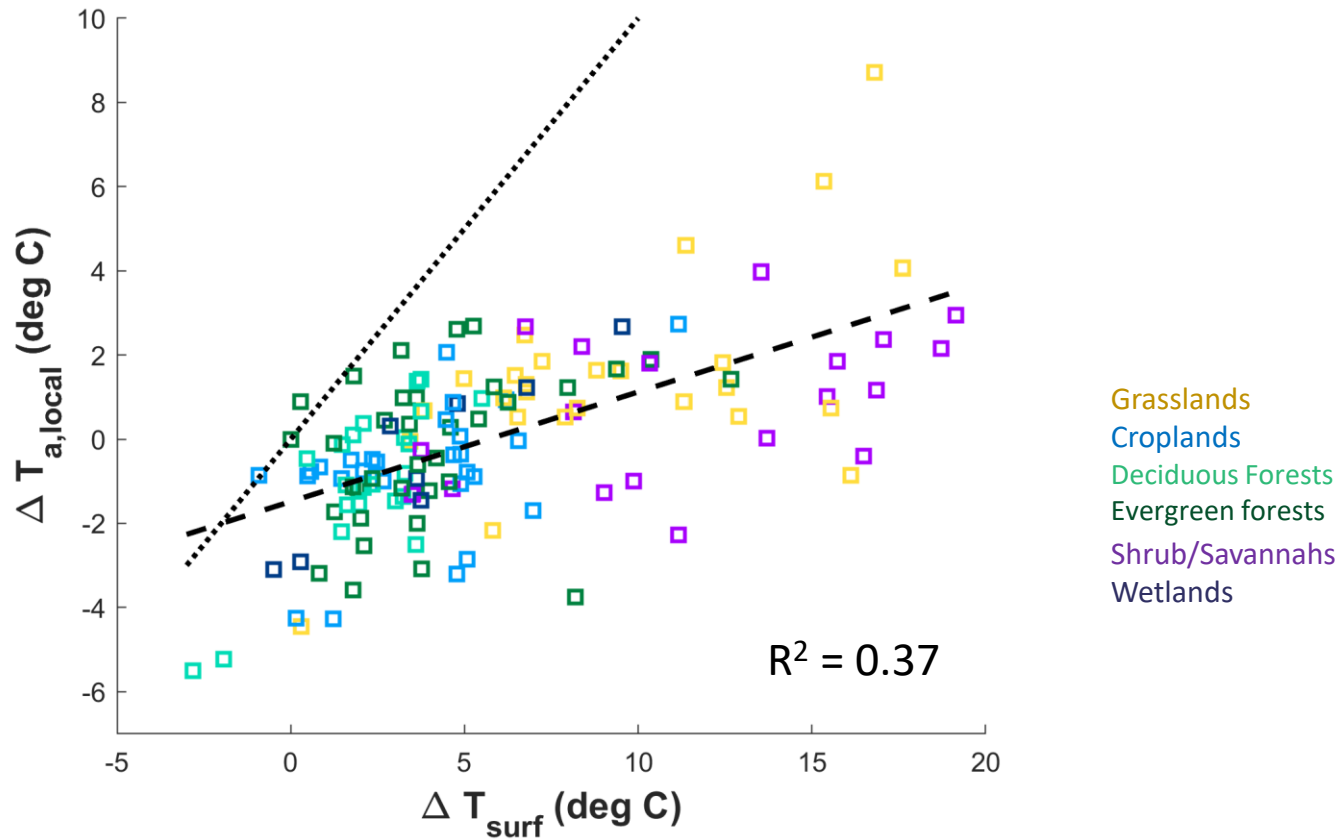


*Cross-site variability linked to growing-season LE, canopy height (results not shown)*

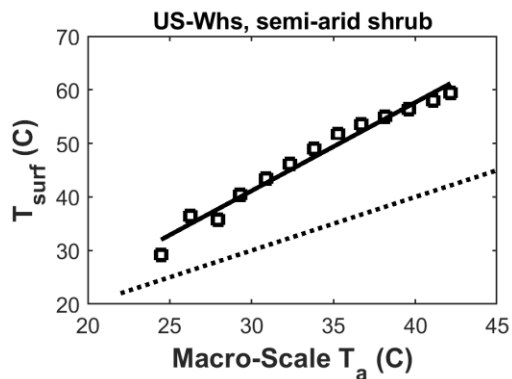
# Does the surface cooling benefit extend to the air?

Averaging across mid-day summer periods:

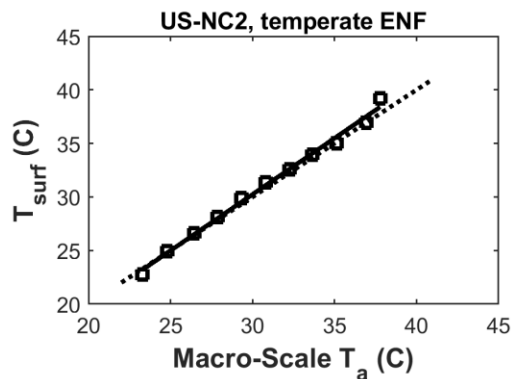
- Land cover impacts on air temperature are smaller overall
- The relationship between the two is not particularly strong.



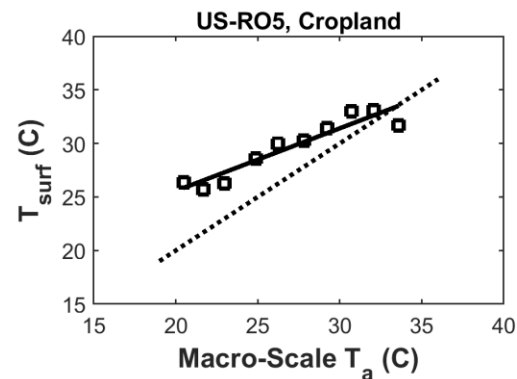
# Does the cooling benefit persist when its really hot?



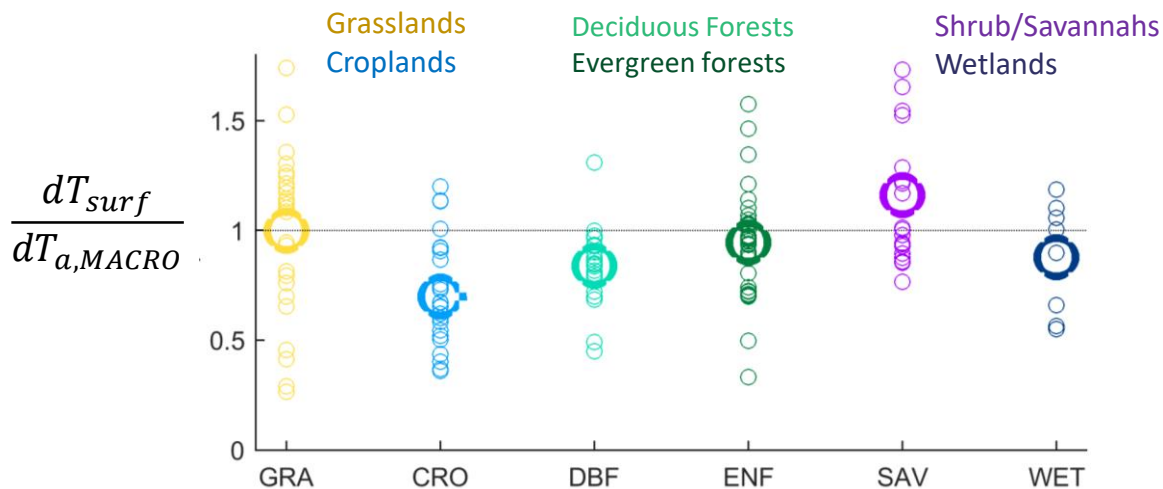
Slope > 1. Surface warming faster than the macro-scale air



Slope ~ 1. "lockstep"



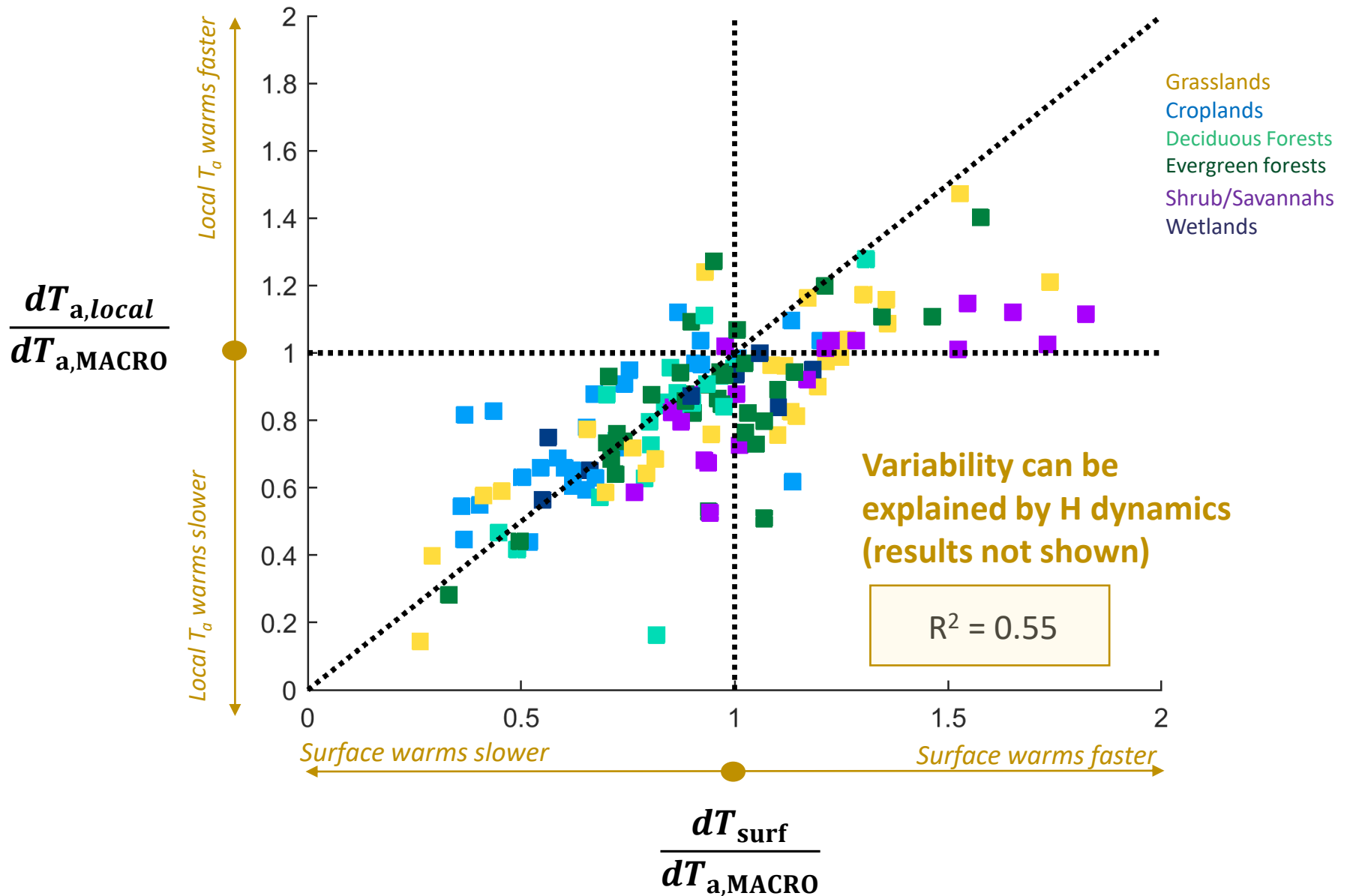
Slope < 1. Surface warming slower than the macro-scale air



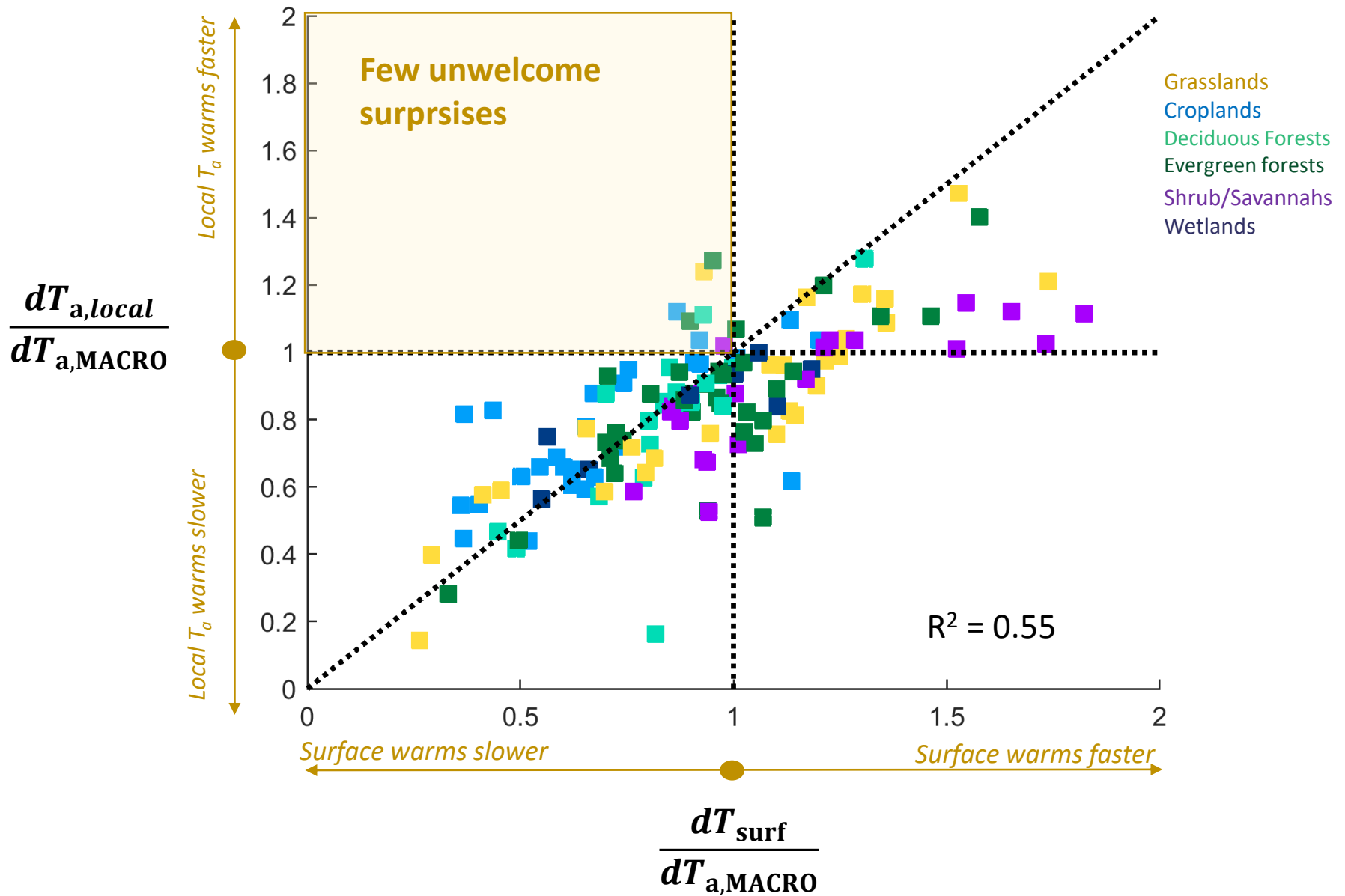
Slope is <1 for most croplands and deciduous forests.

Incident radiation and LE dynamics explain some of this variability (results not shown)

# Does the cooling benefit persist when it's really hot?



# Does the cooling benefit persist when it's really hot?



## Summary:

Does the cooling benefit persist when its really hot?

For deciduous forests and croplands, yes.

For evergreen forests, not necessarily.

Does the cooling benefit extend to the near-surface air temperature?

For deciduous forests & croplands, generally yes.

For evergreen forests and wetlands, not necessarily.

Sensible heat flux predicts the decoupling between local surface and air temperature dynamics.

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**Thanks to collaborators**, including: Gabriel Katul, Mallory Barnes, Quan Zhang.

**Thanks to the flux tower community** for sharing their data, and **thanks to networks like AmeriFlux** for standardizing and redistributing these data.

**Thanks to U.S. Department of Energy and NSF** for funding.

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