2023 CESM Land Model Working Group Meetings

The Effect of Forest in Dampening the Diurnal Cycle on Land-Atmosphere Interaction

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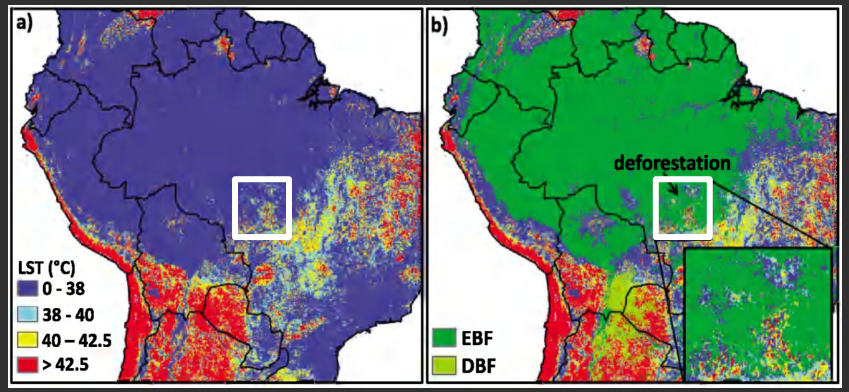
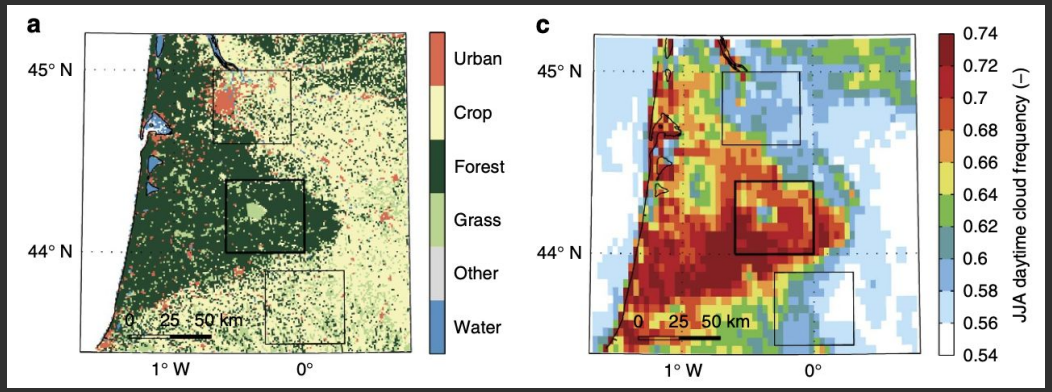
The critical role of forest in land-atmosphere interaction

- Due to evapotranspiration, forest significantly decreases the surface temperature.
- Cloud cover increases over large forest regions through radiative, moistening, dynamic, and biogeochemical processes.



(Mildrexler, et al,2011)

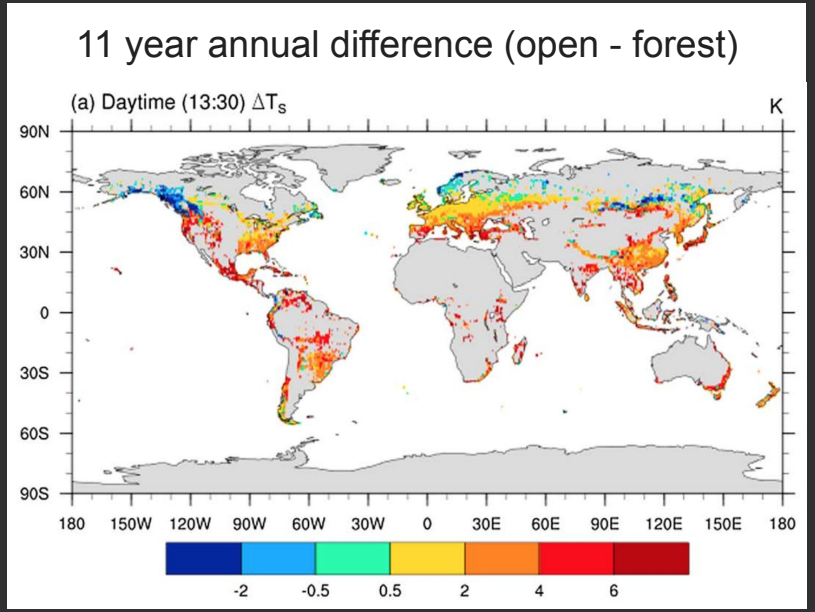


(Teuling et al., 2017)

Cooling effect in the daytime

- The competition effect between evapotranspiration and albedo dominates the spatial changes of the cooling effect by forest.

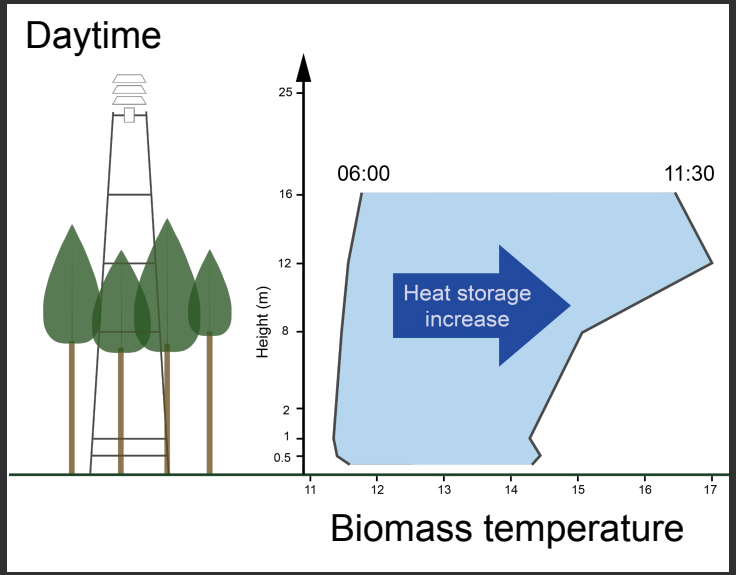
- Constrained by the observed method, the cooling effect of the forest could not be evaluated in dense forest regions.



(Schultz, et al,2017)

Warming effect in the nighttime

- The roughness of the forest encourages turbulence in the stable atmosphere.
- Biomass heat storage in the forest is released at night.



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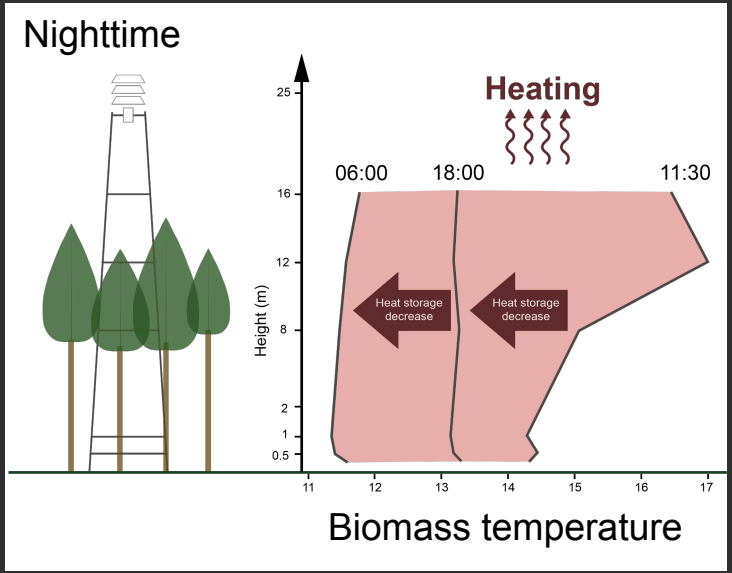

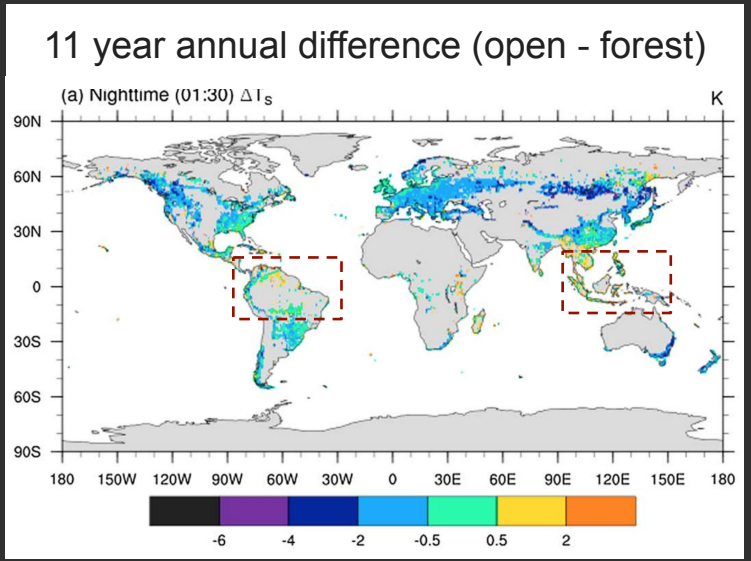

(Schultz, et al,2017)

However,

- The diurnal dampening effect of forests is hard to reveal by satellite observation with only maximum and minimum temperatures, especially in the dense and giant rain forest regions.

How does the asymmetric impact of forest on diurnal temperature cycle affect L-A interaction?

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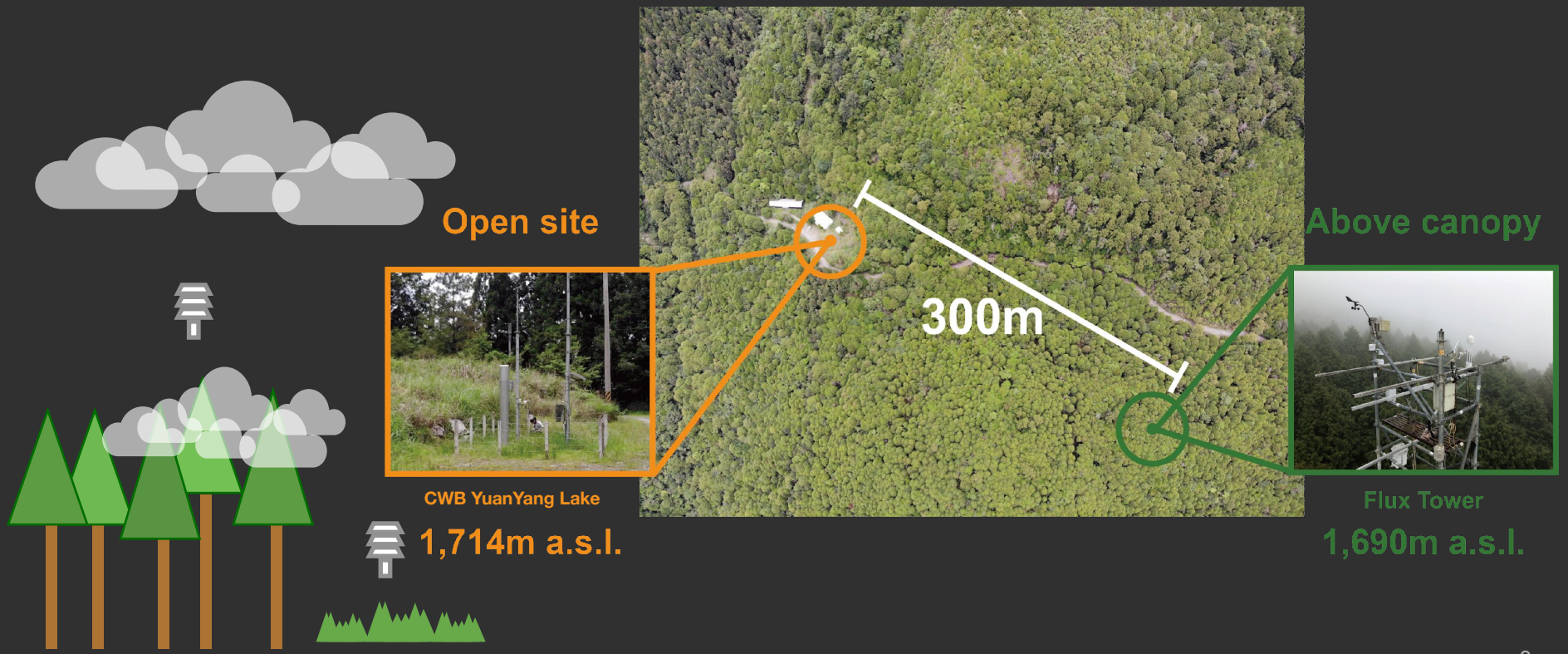
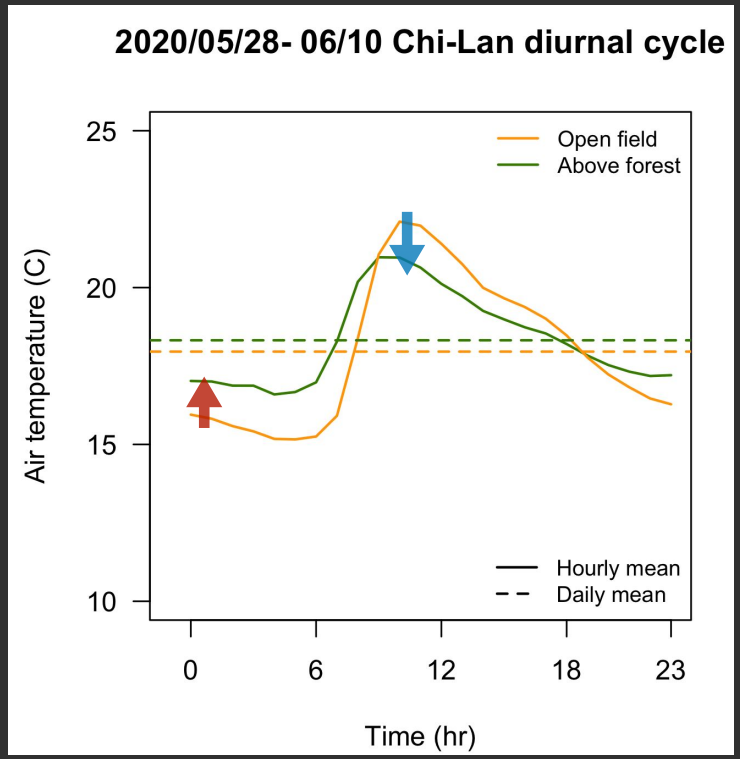
Continuous observation by in situ paired weather station



The dampening effect of forest on diurnal temperature range

- A tiny open field in a comparatively large and uniform forest could create substantial spatial variation of diurnal cycle.
- Forest moderates diurnal temperature range.

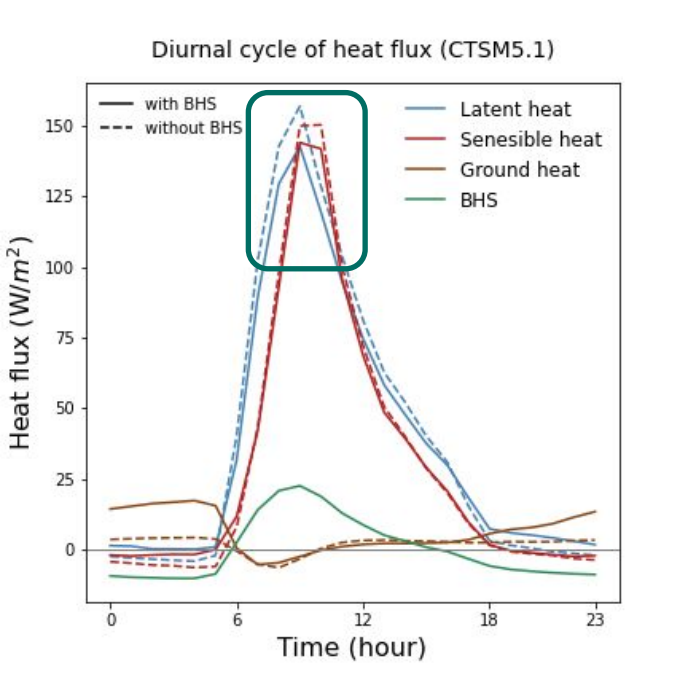


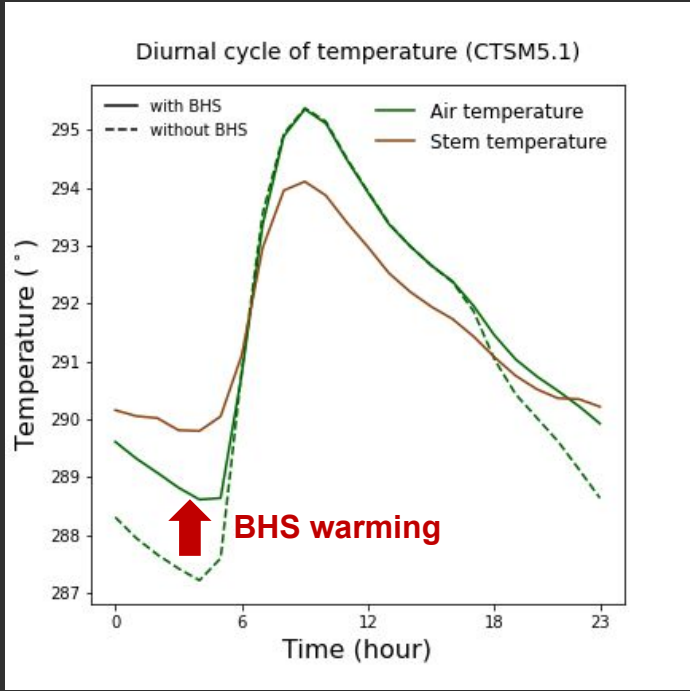
Determine the dampening effect of forest on heat flux

- Model simulation
  - NCAR Community Terrestrial Systems Model 5.1 (CTSM5.1)
  - Single-point offline model with satellite observed phenology
  - Atmosphere forcing: 2020/5/28- 6/9 (13 days) observed hourly data (T, P, WS, q, precip., $SW_{downward}$ and $LW_{downward}$)
  - Run 1 year, and analyze the DOY 131-143
  - 100% needleleaf evergreen trees
  - With or without considering biomass heat storage (BHS)

Considering BHS,

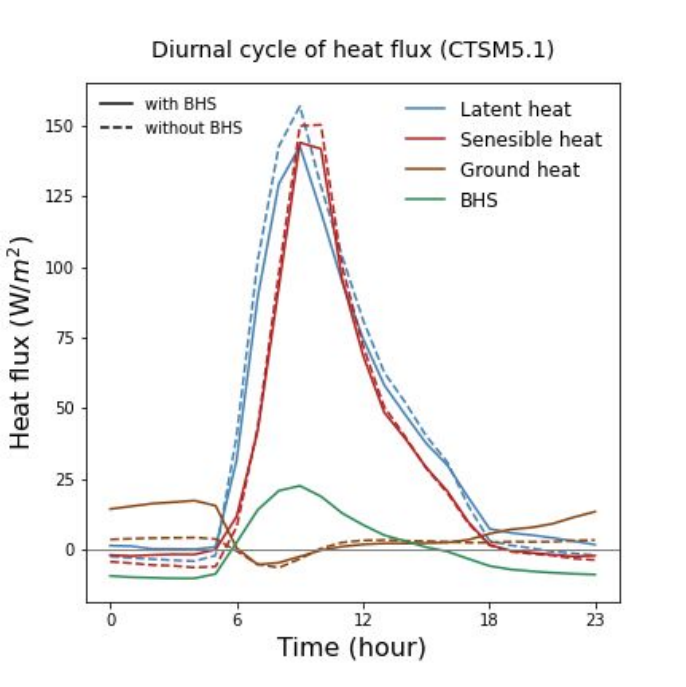
- Latent heat and sensible heat flux decrease in the daytime.
- Ground heat warming / sensible heat cooling become stronger / weaker at night.

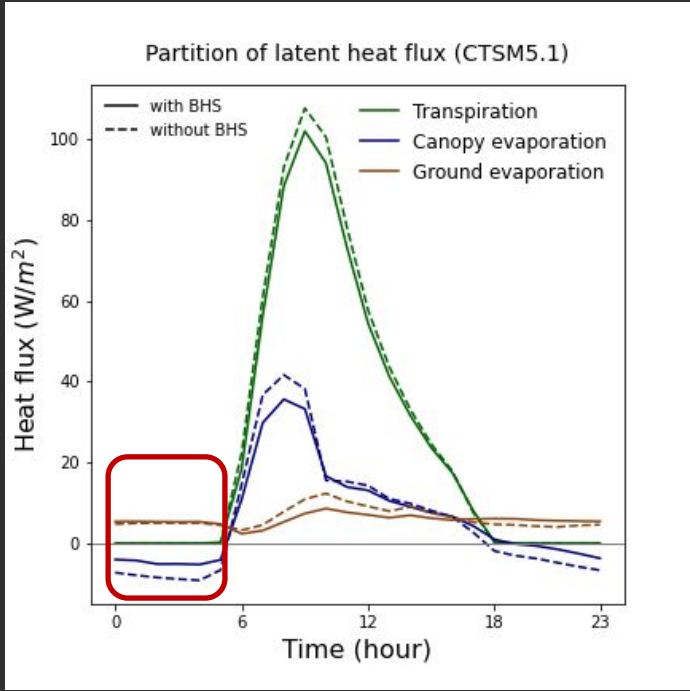




Considering BHS,

- Every component of latent heat flux decreases in the daytime.

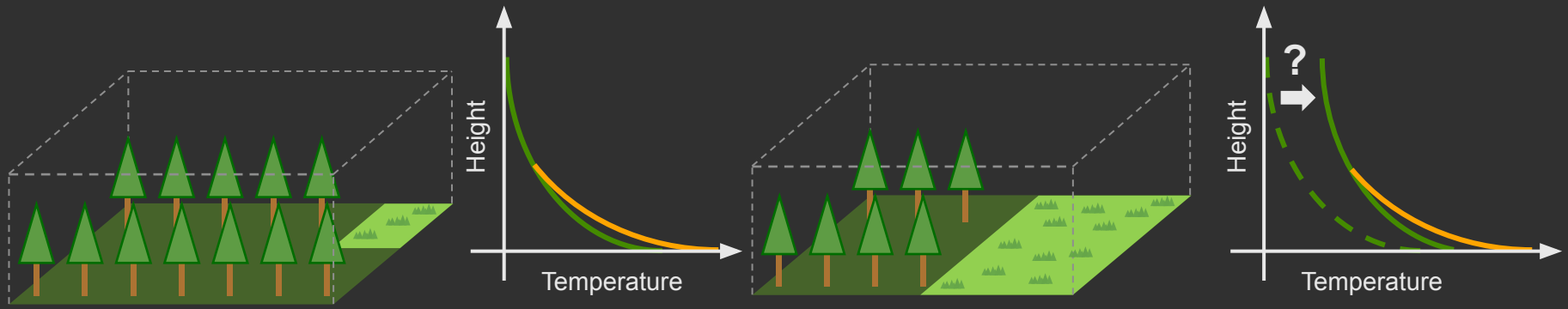




Take-home messages & Ongoing work

I. Tiny deforestation in the relatively large forest can generate local near-surface microclimate variation from the original environment.

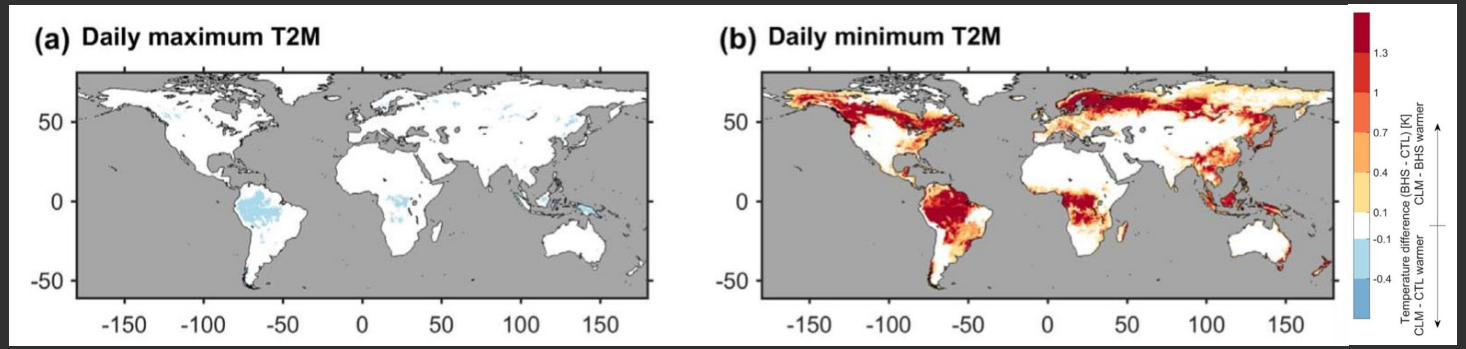
How does the temperature of the atmospheric bottom layer change as the area of deforestation increases?



Using a single-column couple model and air drone observation

Take-home messages & Ongoing work

I. Tiny deforestation in the relatively large forest can generate dramatic variation from the original environment.
II. Without considering BHS, latent heat and sensible heat might be overestimated in the daytime.
III. The changes in the diurnal temperature range after deforestation might be larger than the previous simulated estimation.



(Meier et al., 2019)

Thanks for listening and
I will take any questions here.

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