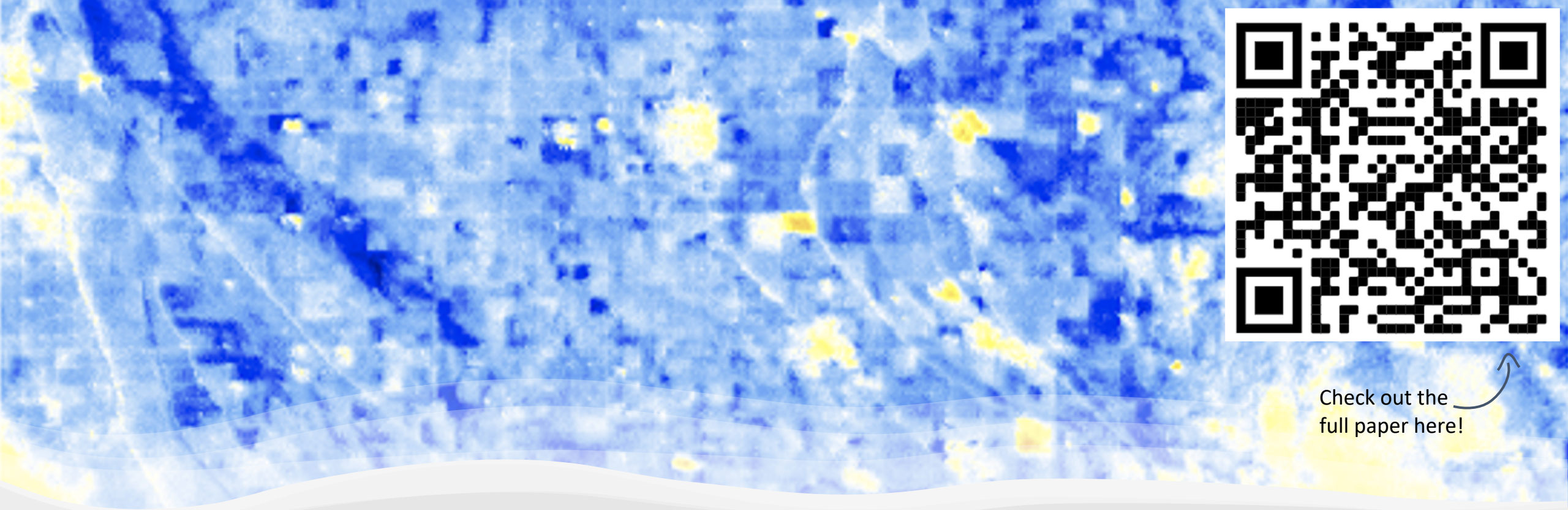

Check out the full paper here!

Micro-climate to macro-risk

Mapping fine scale differences in mosquito-borne disease risk

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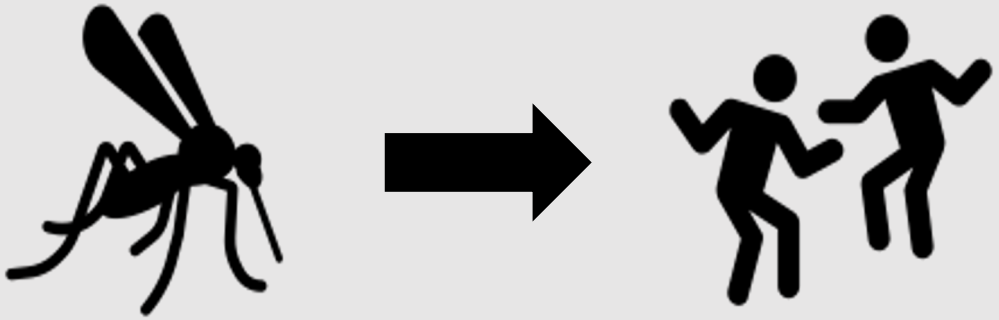
[3]Earth Research Institute, UC Santa Barbara, Santa Barbara, CA, USA

Mosquito-borne disease

- Mosquito-borne diseases (MBDs) threaten 80%+ of the world's population[1]
  - Malaria
  - Zika
  - Dengue

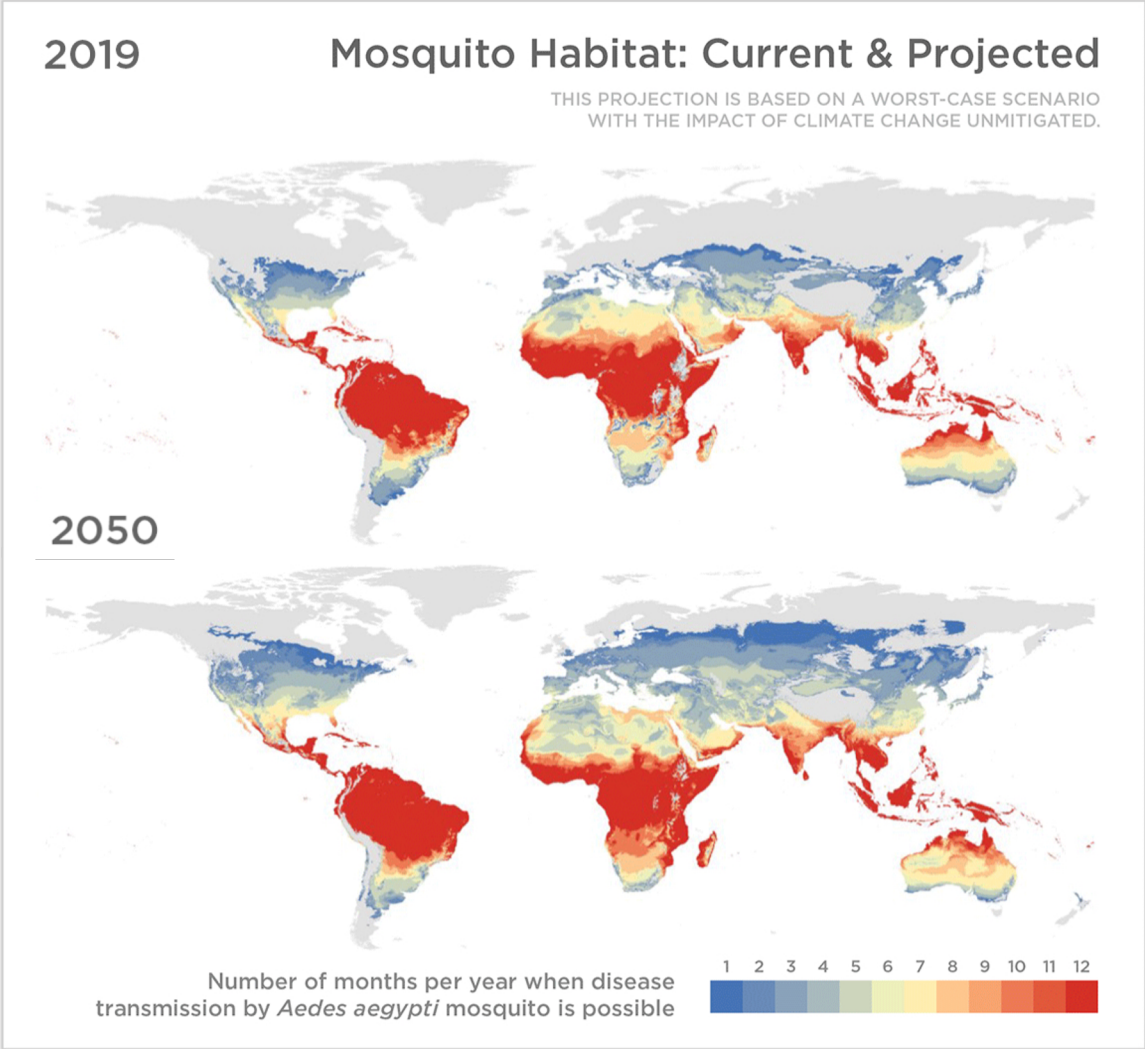


[1]Ebi, K. L., Boyer, C., Ogden, N., Paz, S., Berry, P., Campbell-Lendrum, D., Hess, J. J., & Woodward, A. (2021). Burning embers: Synthesis of the health risks of climate change. Environmental Research Letters.

Mosquito-borne disease risk

Risk = f
- mosquito habitat suitability
- biting rate
- transmission probability

- Risk is heavily dependent on temperature
- Risk maps are useful for:
  - Prediction
  - Mitigation



Source: Sadie J. Ryan, Colin J. Carlson, Erin A. Mordecai, and Leah R. Johnson
Credit: Koko Nakajima/NPR

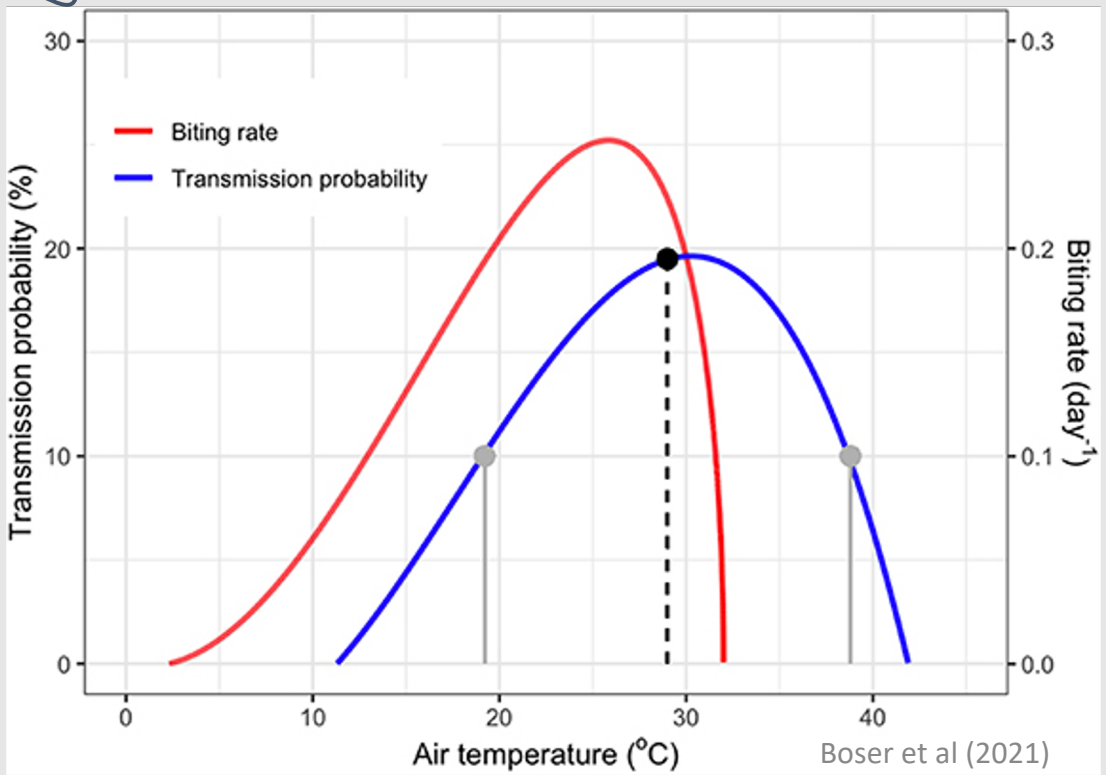
Risk maps from temperature-trait relationships

Temperature maps

Temperature and mosquito-borne disease trait relationships

Risk maps

- Coarse
- Biased due to Jensen's inequality



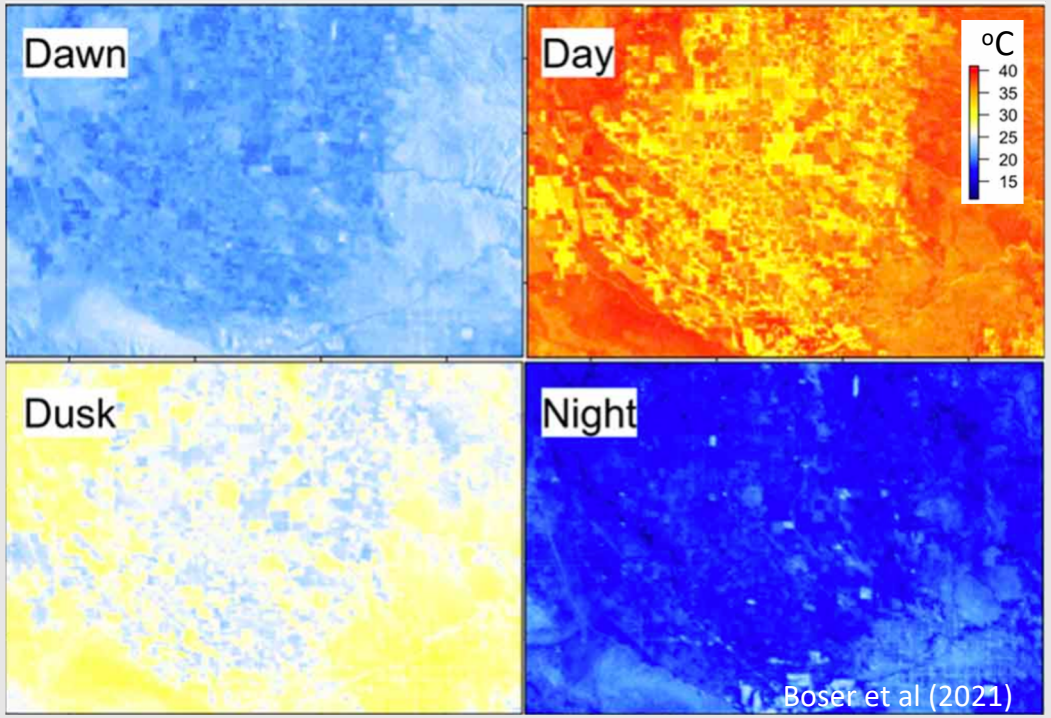
***Culex tarsalis* biting and WNV transmission rates** as a function of temperature as described in Shocket et al (2020). The vertical lines represent an example of Jensen's inequality.

We use **ECOSTRESS LST** images to generate **high resolution, unbiased mosquito-borne disease risk maps**.

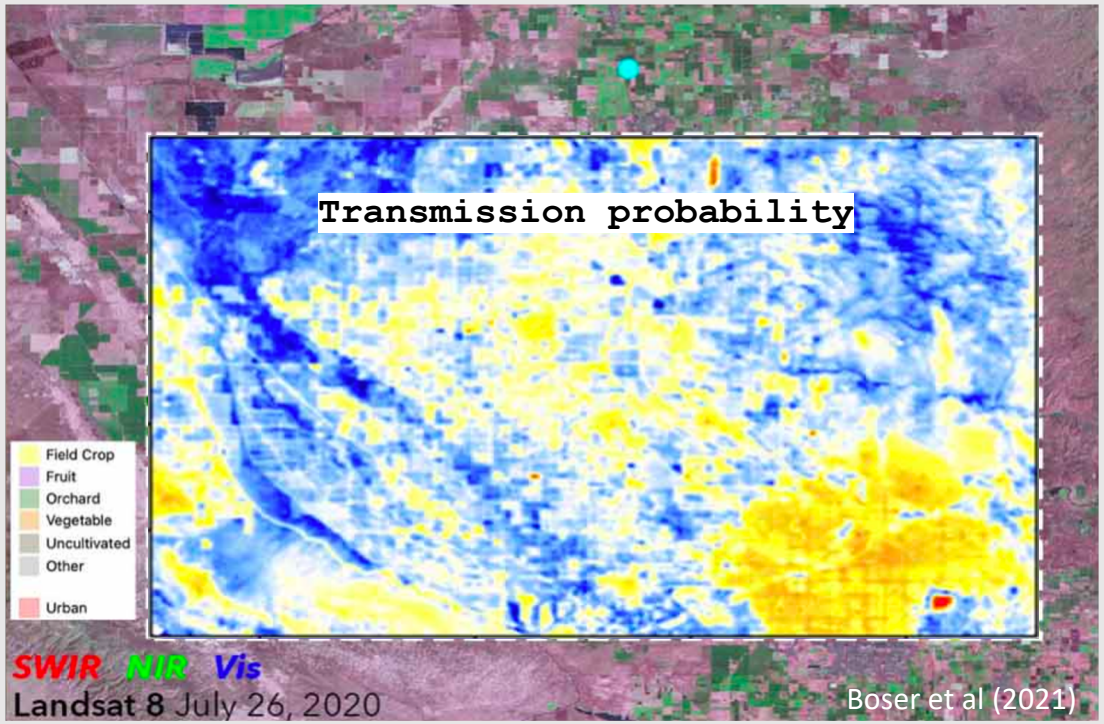
- *Differences in risk by land cover/crop type?*
- *Differences between using low and high resolution data for unbiased average risk?*

West Nile virus (WNV) in Bakersfield, CA

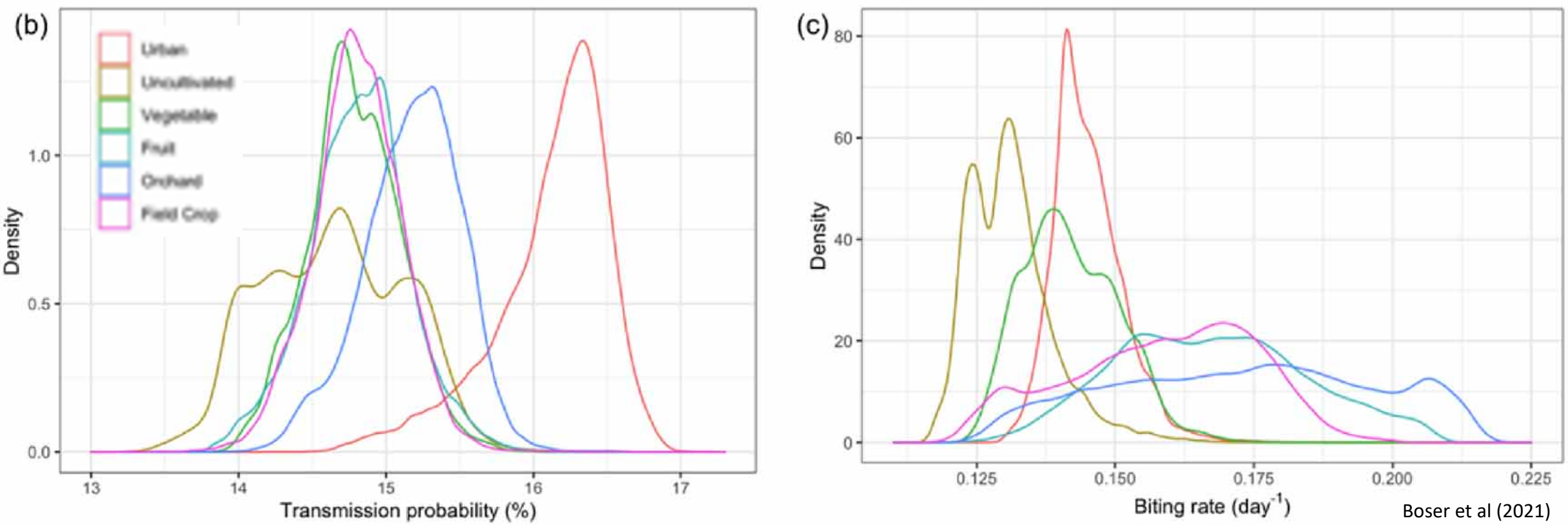
1. Retrieve 65 cloud-free ECOSTRESS LST images and convert to air temperature maps (R^2 = 0.86)



2. Predict *Culex Tarsalis* biting rate and WNV transmission probability in the greater Bakersfield area



High resolution maps reveal differences in risk by land cover type (p<0.05)



Boser et al (2021)

High spatial and temporal resolution avoid significant bias due to Jensen's inequality[1]

	Bias from spatial averaging	Bias from temporal averaging	Bias from both
Biting rate (day-1) (range 0–0.252)	−0.006 (2.4%)*	0.099 (39.3%)*	0.102 (40.5%)*
Transmission probability (%) (range 0–19.634)	0.246 (1.3%)*	3.069 (15.6%)*	3.166 (16.2%)*

If we didn't have the high spatial resolution

If we didn't have the high temporal resolution

[1]*Jensen's inequality: When relationships are nonlinear, aggregation bias can arise*

Conclusion

- ECOSTRESS can be used to make high resolution mosquito-borne disease risk maps that
  - Can help target mitigation efforts and further research on land cover effects on risk
  - Mitigate biases caused by Jensen's inequality

Check out the full paper here!