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Should we use climate analogs to predict climate impacts? A contemporary validation.

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Validating climate impacts forecasts. Are climate analogs any good?

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Grad Con 2021

Motivating Question: How will agriculture, cities, forests respond to climate change?

1900s

Source: RMRS

2100?

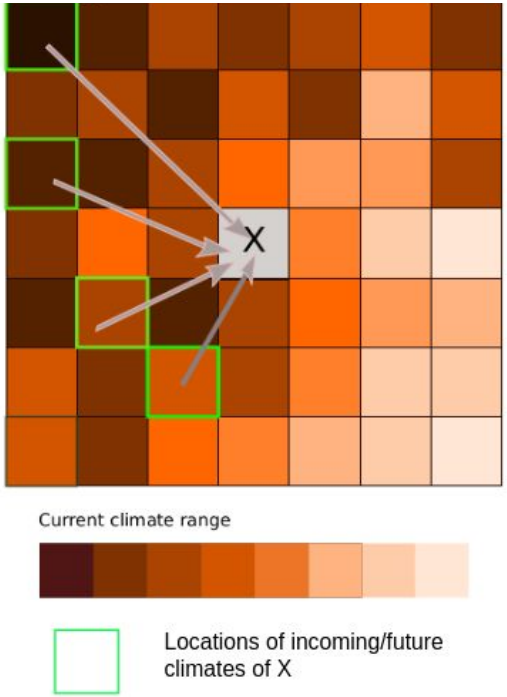
Source: MTNHP

?

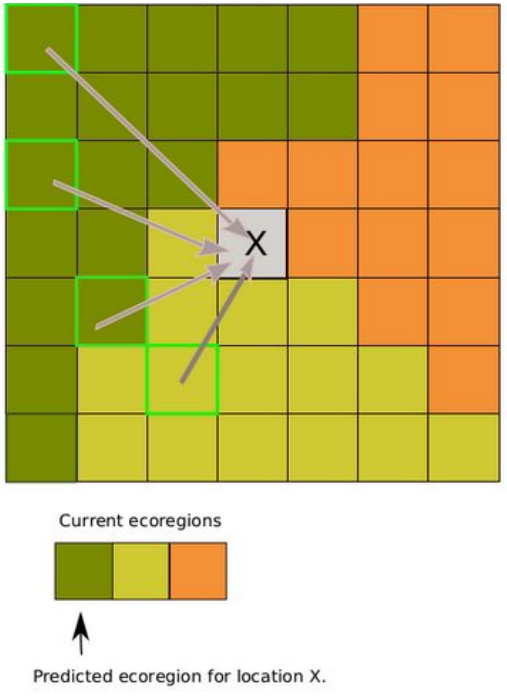
https://www.bloomberg.com/news/articles/2020-12-16/bp-acquires-majority-stake-in-u-s-forest-carbon-offsets-company

Climate analogs: locations that share a similar climate

Where is the future climate of X located today?



What are the ecoregions associated with the incoming climates?



Examples of Applications:

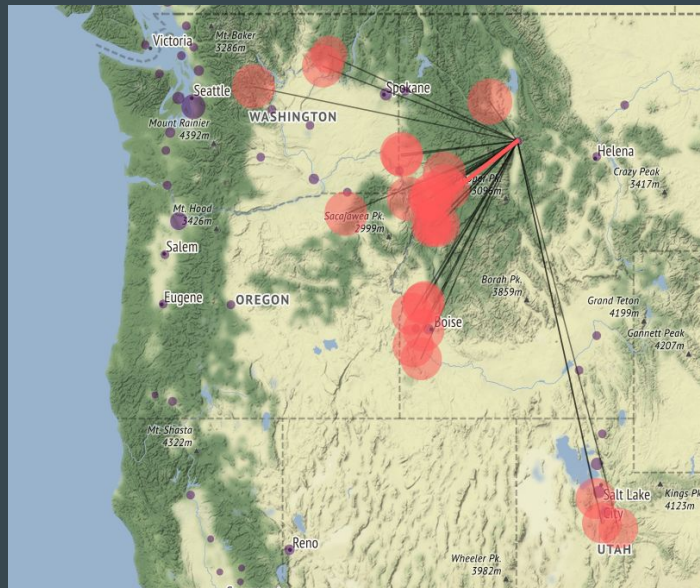
- City adaptation costs (Hallegatte et al 2007) and climate communication (Fitzpatrick and Dunn 2019)

- Forests expected to shift into non-forested conditions (Parks et al 2019)

- Changes in global agricultural yield (Pugh et al 2016)

Cities that have Missoula's 2060 climate:

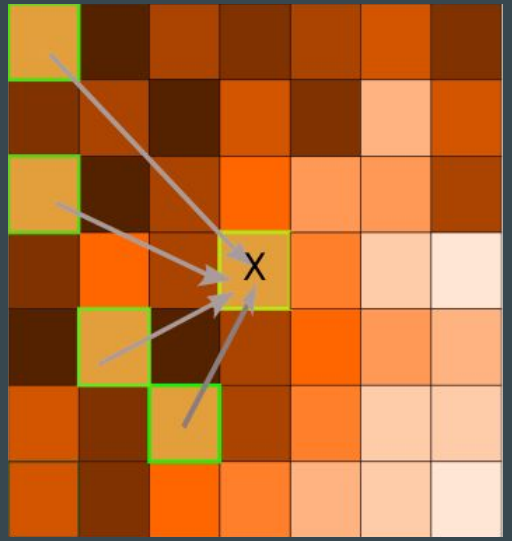
from Fitzpatrick and Dunn 2019



We need to evaluate the reliability of climate analog predictions

- Usually, we validate by comparing predictions to observed values. But predicted impacts haven't occurred yet, so we do not have observations to validate our prediction.
- Contemporary validation as an alternative.

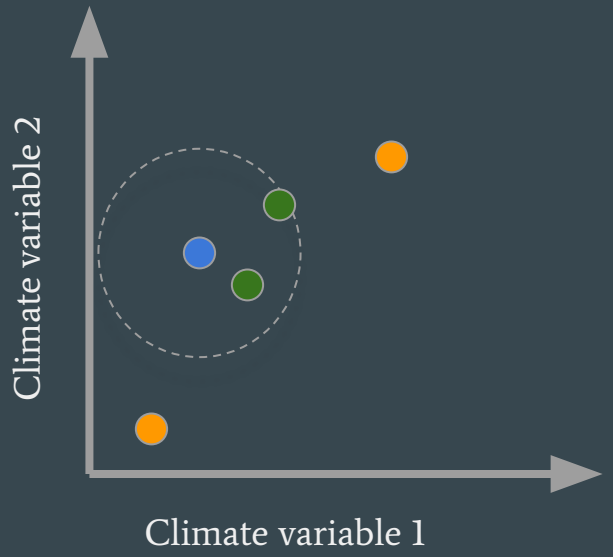
Contemporary climate analogs of X



Research questions:

- Do contemporary climate analogs of location X model the tree cover of X well?
- Does tree cover prediction improve with greater climate similarity of analog?

Methods: what climate is analogous & data



Climate variables used:

T_{min} = Average minimum temp of the coldest month

T_{max} = Average maximum temperature of warmest month

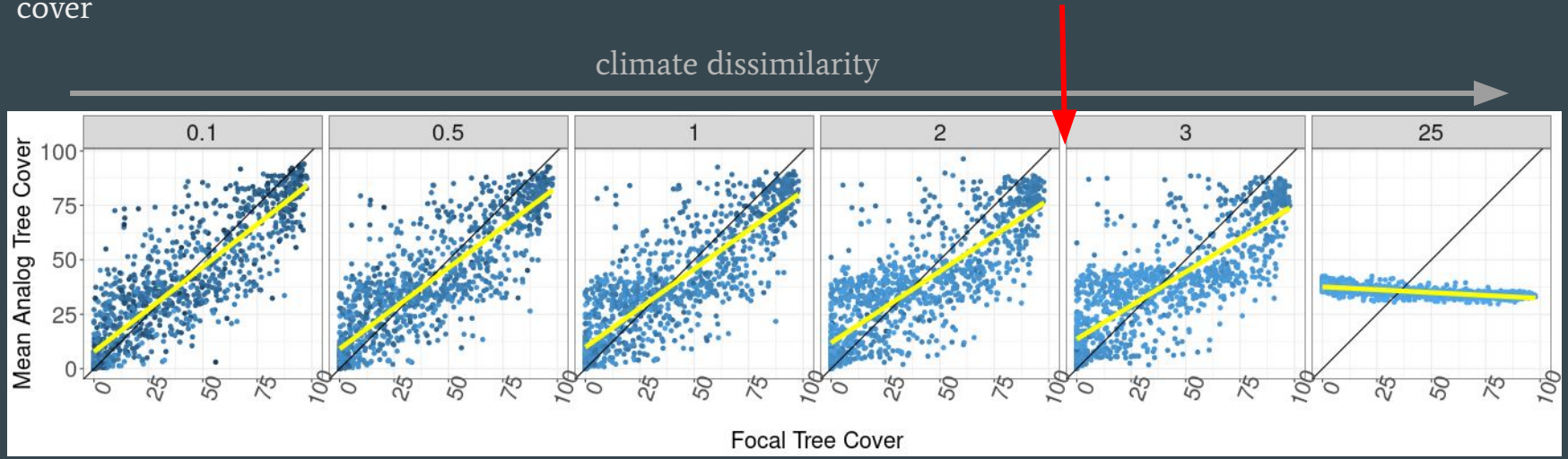
Actual evapotranspiration

Climatic water deficit

Landsat tree cover, 4 km

Results: Climate analogs predict focal locations' tree cover!

More climatically similar analogs have less biased and more accurate predictions of the focal location's tree cover



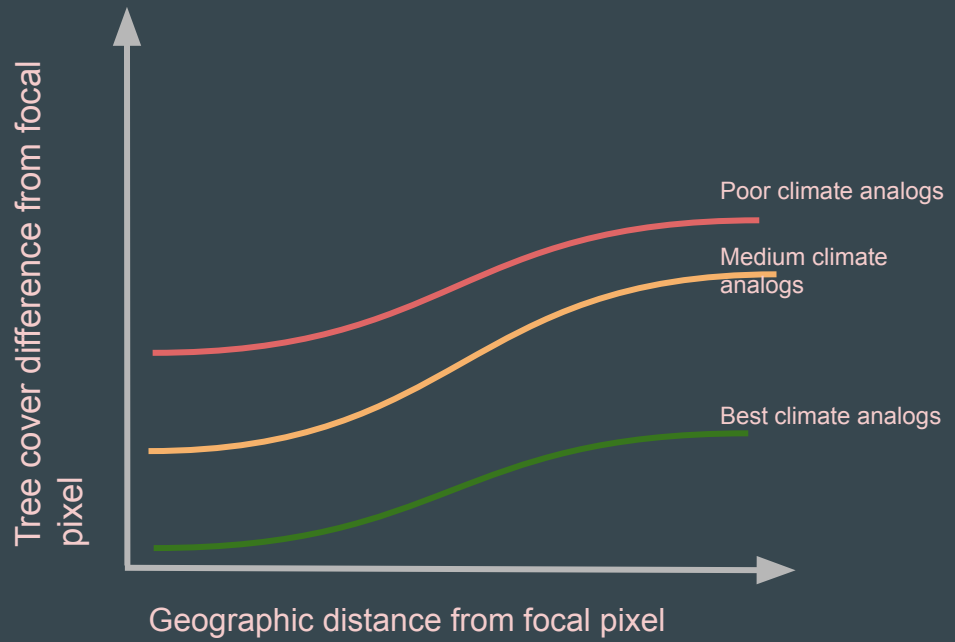
Climate dissimilarity	0.1	0.5	1	2	3	25
Slope	0.78	0.74	0.71	0.65	0.62	-0.05
R^2	0.78	0.75	0.73	0.68	0.66	0.46

Can we use the spatial nature of analogs to our advantage?

Do closer analogs provide a better prediction of the focal tree cover compared to farther analogs?

http://jasss.soc.surrey.ac.uk/11/4/4.html

Are analogs that are nearby provide better predictions than those far away? Hypothesized relationship:



Review and Conclusions

- Climate analogs share similar climate and have been used to predict climate impacts.
- Are analogs any good at estimating climate impacts?
- **Yes! Contemporary climate analogs can be used to predict tree cover.**
- Can we take advantage of the spatial nature of climate analogs to improve climate impact predictions? Do not know yet.

So what? This research makes a step toward improving our ability to forecast climate impacts and therefore adapt to climate change.

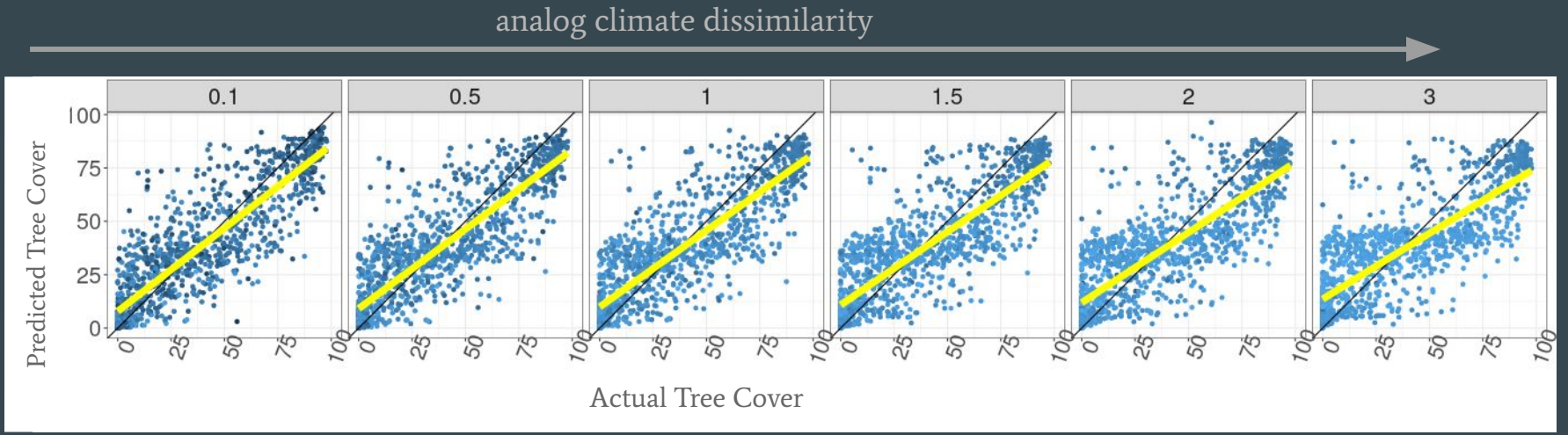
Acknowledgements:

Solomon Dobrowski

Sean Parks

Extra Slides

Results: Actual and Predicted tree covers



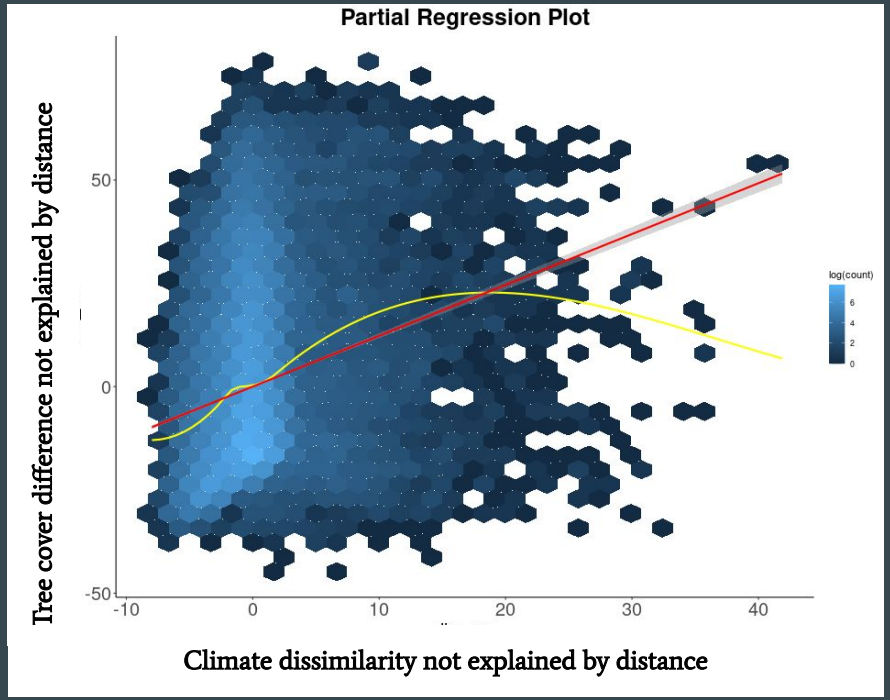
Climate dissimilarity	0.1	0.5	1	1.5	2	3	>3
Slope	0.78	0.74	0.71	0.68	0.65	0.62	-0.05
R^2	0.78	0.75	0.73	0.71	0.68	0.66	0.46

Research Question: Can contemporary climate analogs be used to predict focal location's tree cover?

1. Do climate analogs work? What is the relationship between actual and predicted tree cover? Does this relationship change with climate dissimilarity of considered analogs?

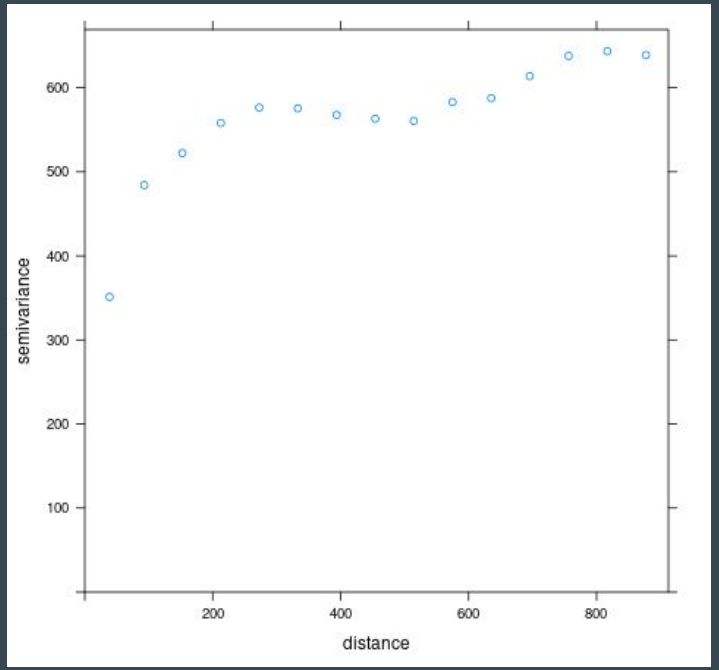
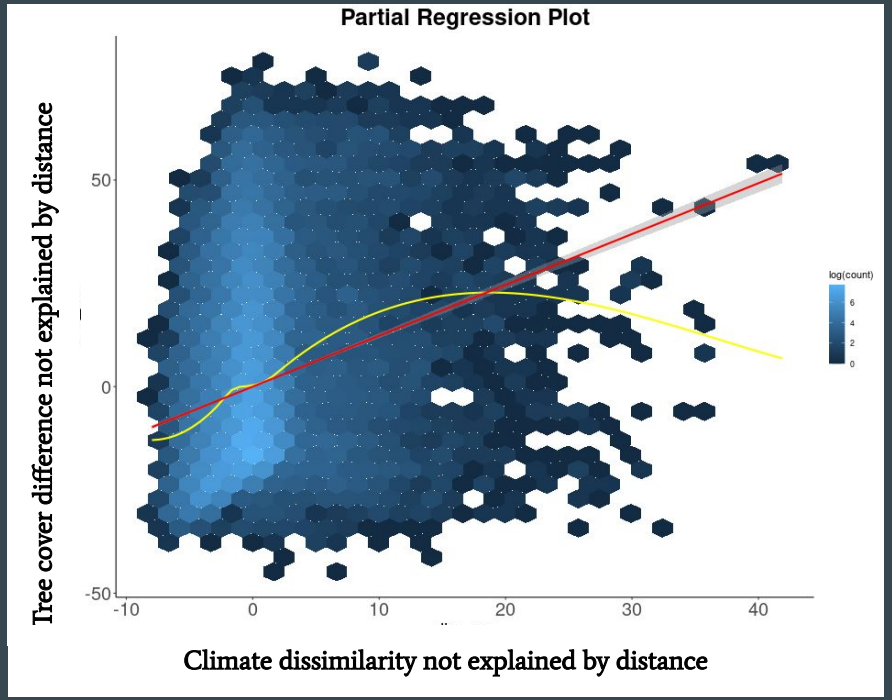
Is climate a better predictor of tree cover than distance from the focal pixel? Preliminary results.

Climate carries information not captured by distance alone:



Is climate a better predictor of tree cover than distance from the focal pixel? Preliminary results.

Tree cover data is spatially structured (and so is climate data, but not shown).



Climate carries information not captured by distance alone: