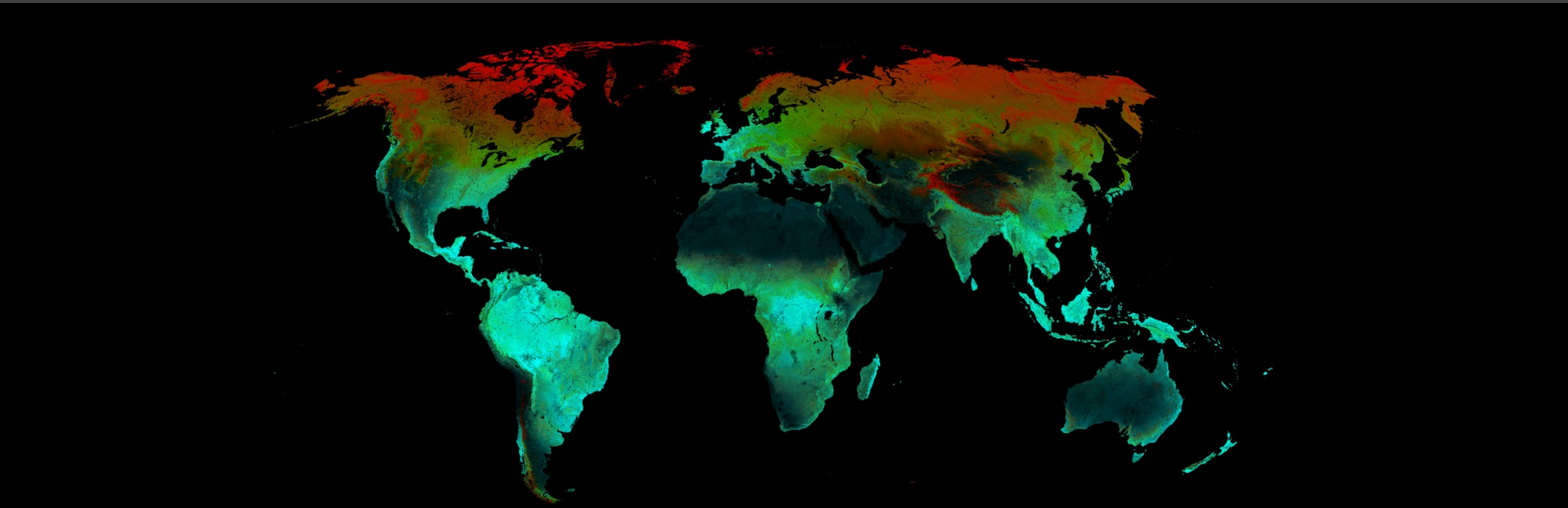
The Dynamic Habitat Indices from Terra, Aqua, Suomi NPP and JPSS data for biodiversity science and conservation



Volker C. Radeloff, Duanyang Liu, University of Wisconsin-Madison
E. Silveira, E. Razenkova, A. M. Pidgeon, N. Coops, D. Gudex-Cross, M. Hobi, and A. Ives

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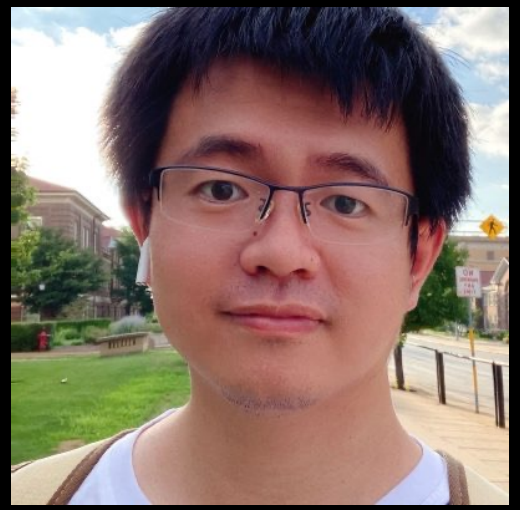

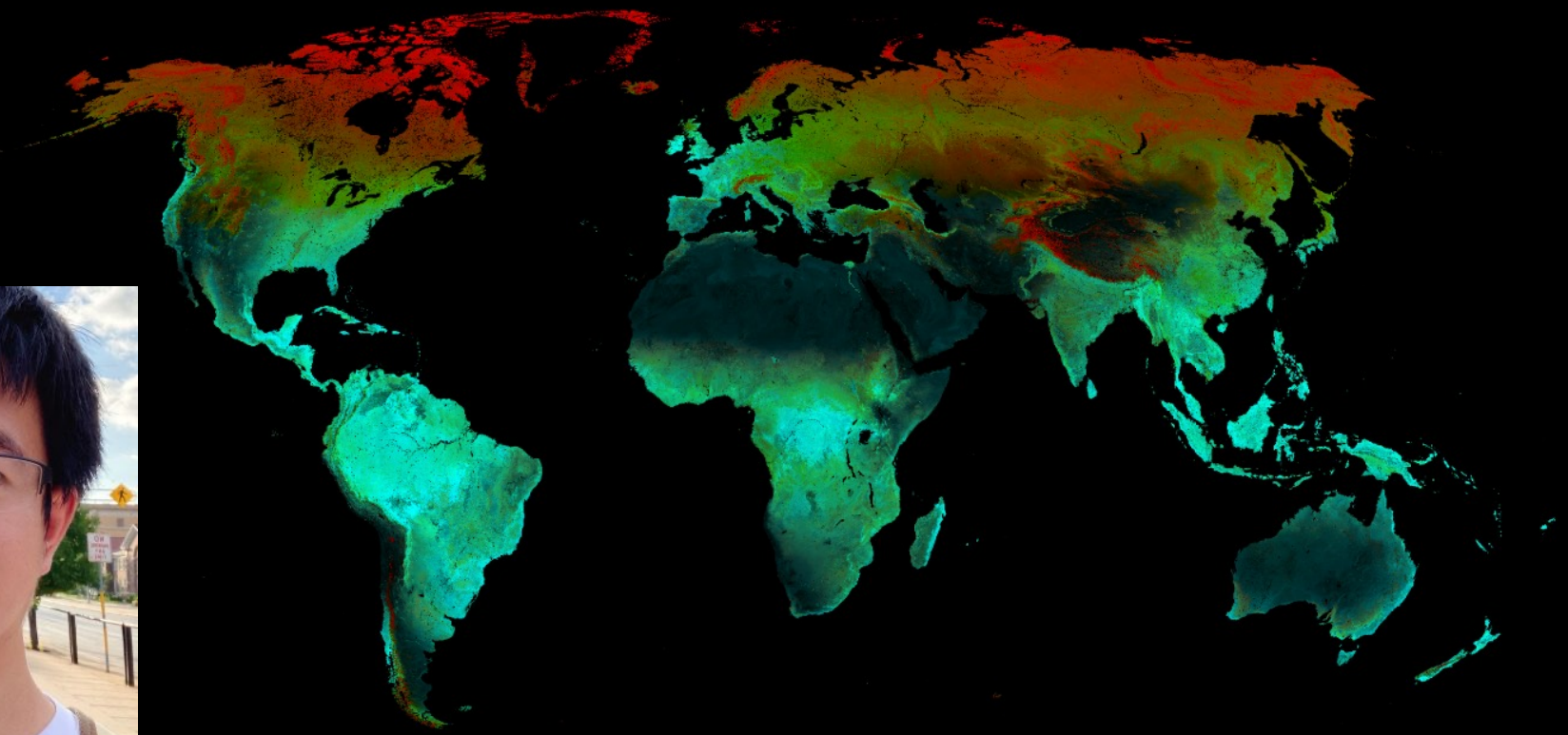

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Outline

1. Introducing the DHIs
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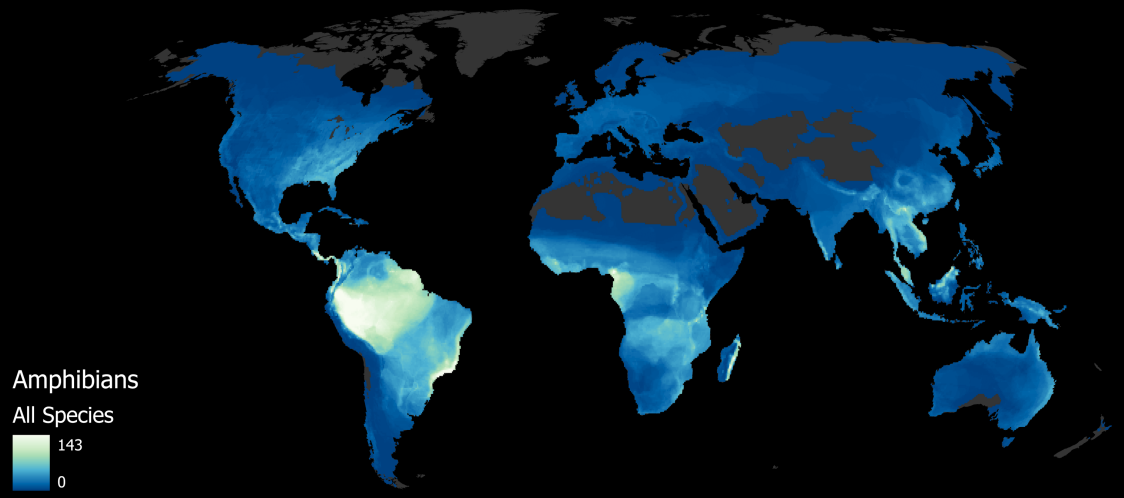
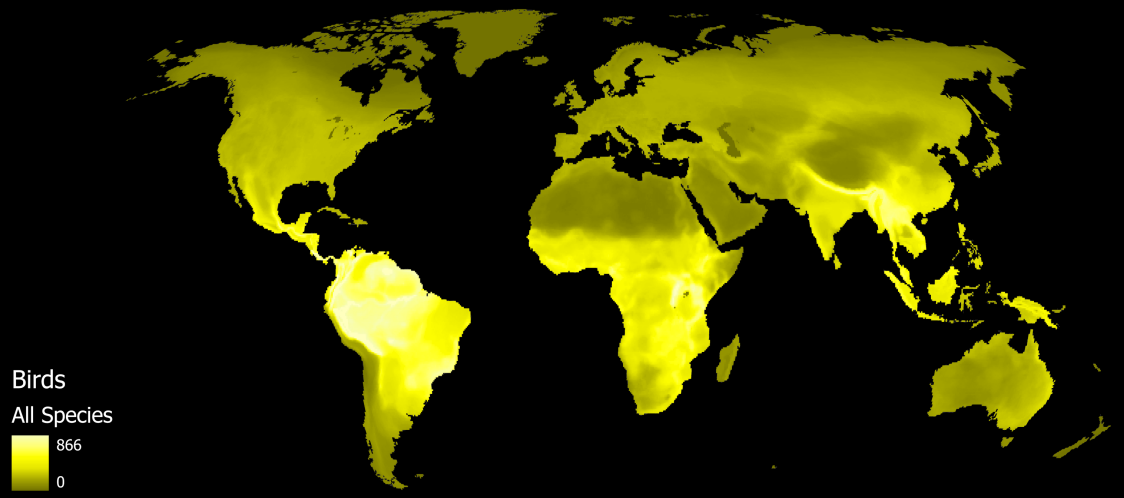
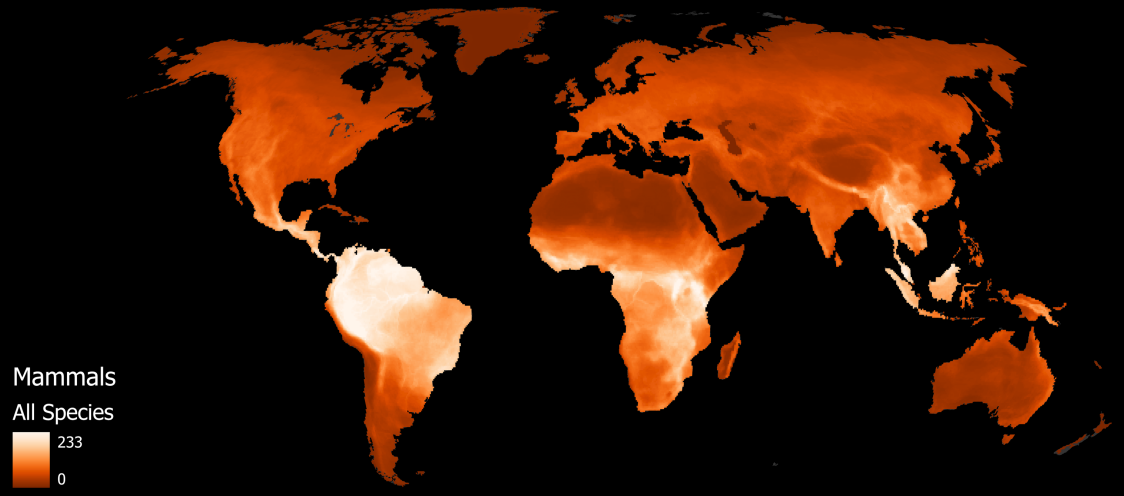
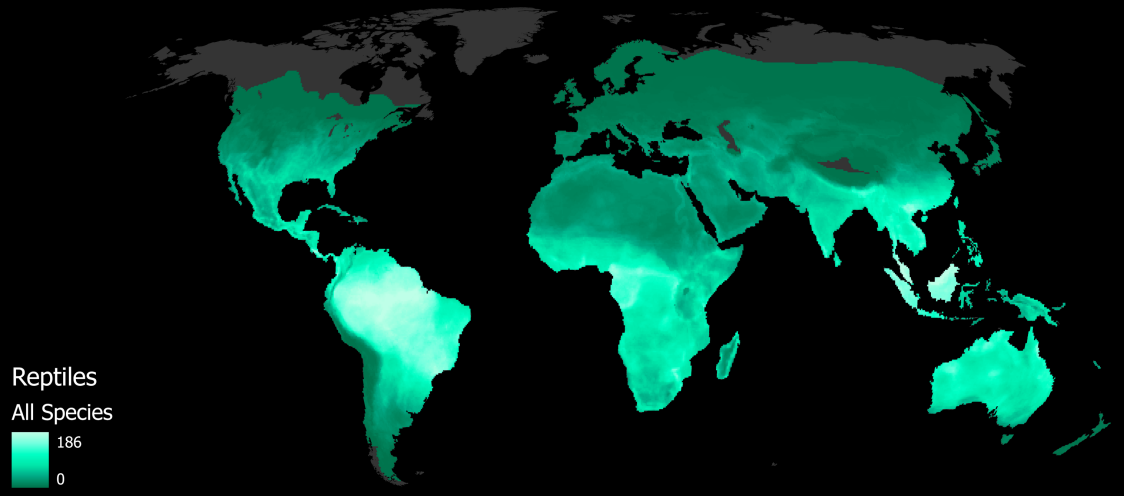
3. Uncertainty estimation
4. DHIs versus species richness and human settlements

Introduction



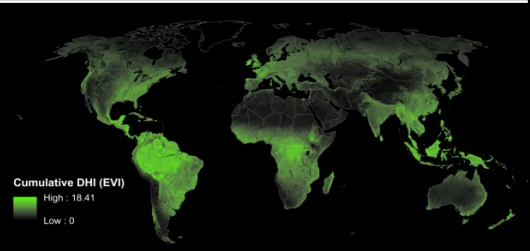
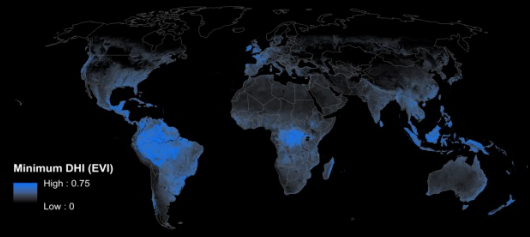
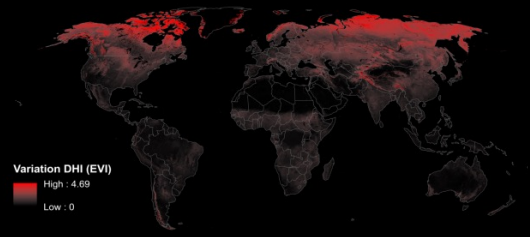






Cox, Young, Bowles, *et al. Nature* (2022)

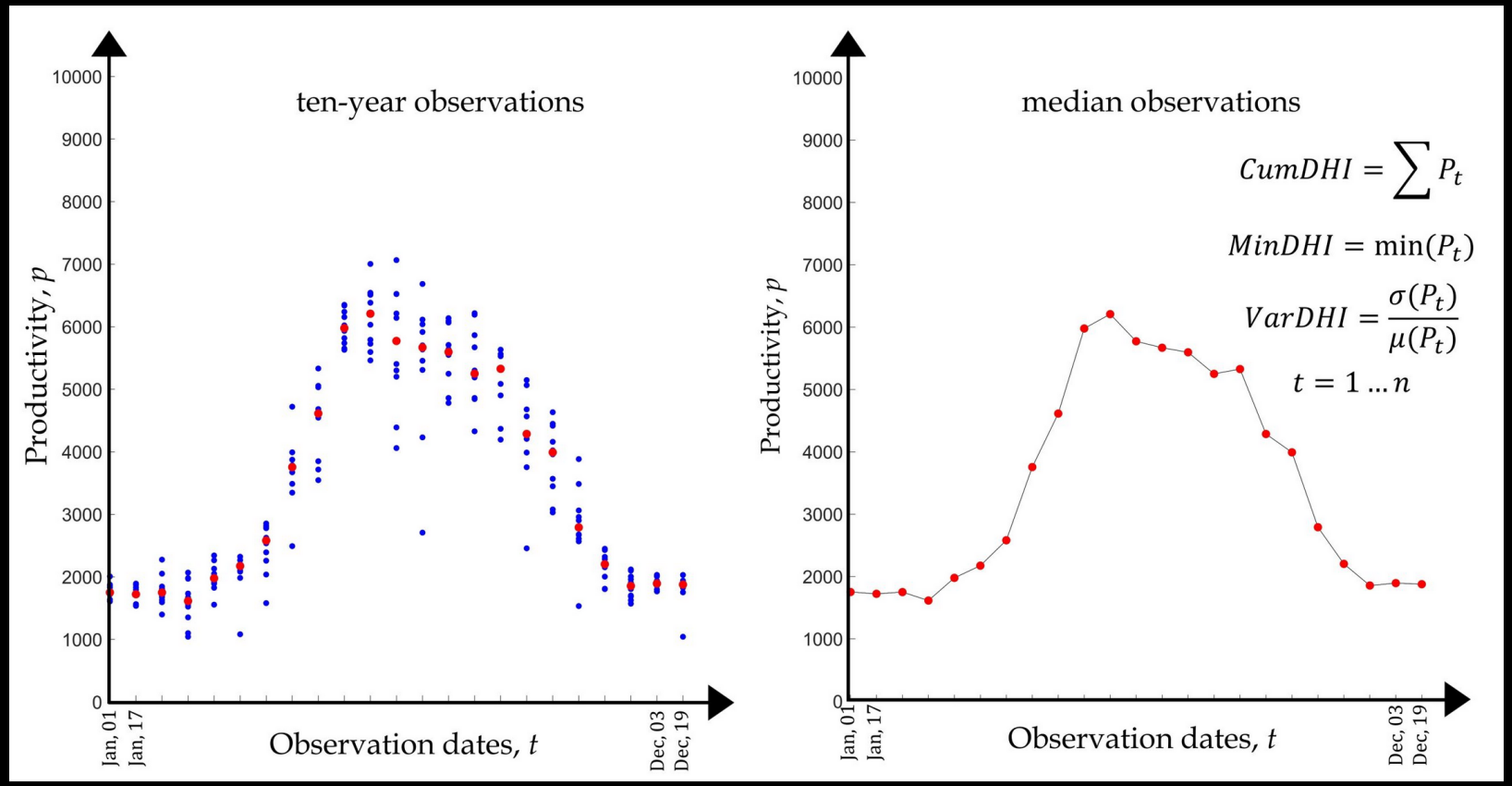
Introduction

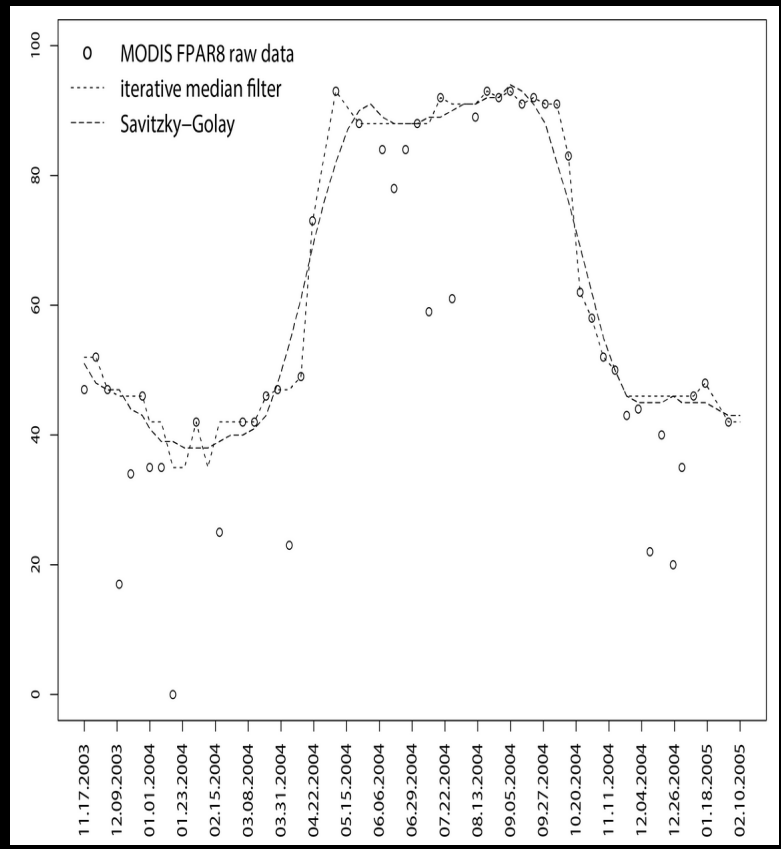
Ecology	DHIs
Available energy hypothesis	
Environmental stress hypothesis	
Environmental variability hypothesis	

Radeloff, et al., 2019, RSE

Introduction

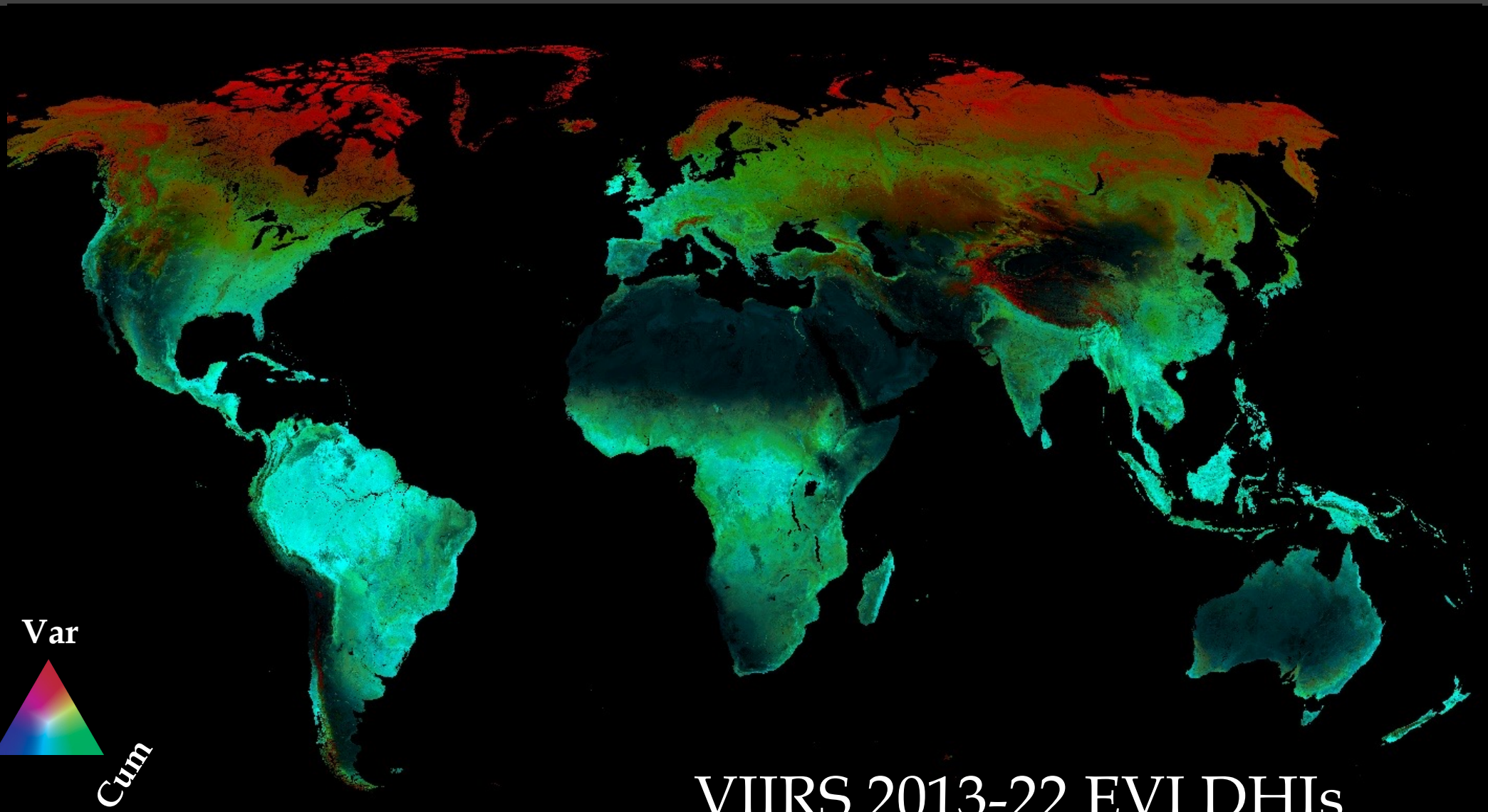
Composite & annual DHIs from MODIS and VIIRS



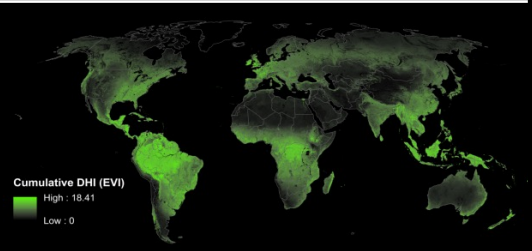
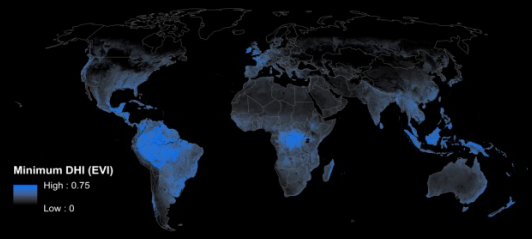
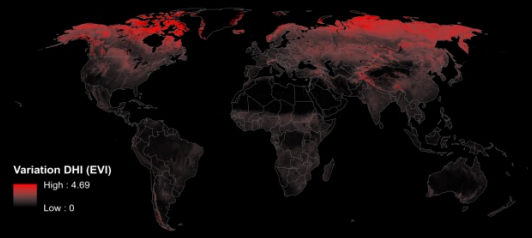


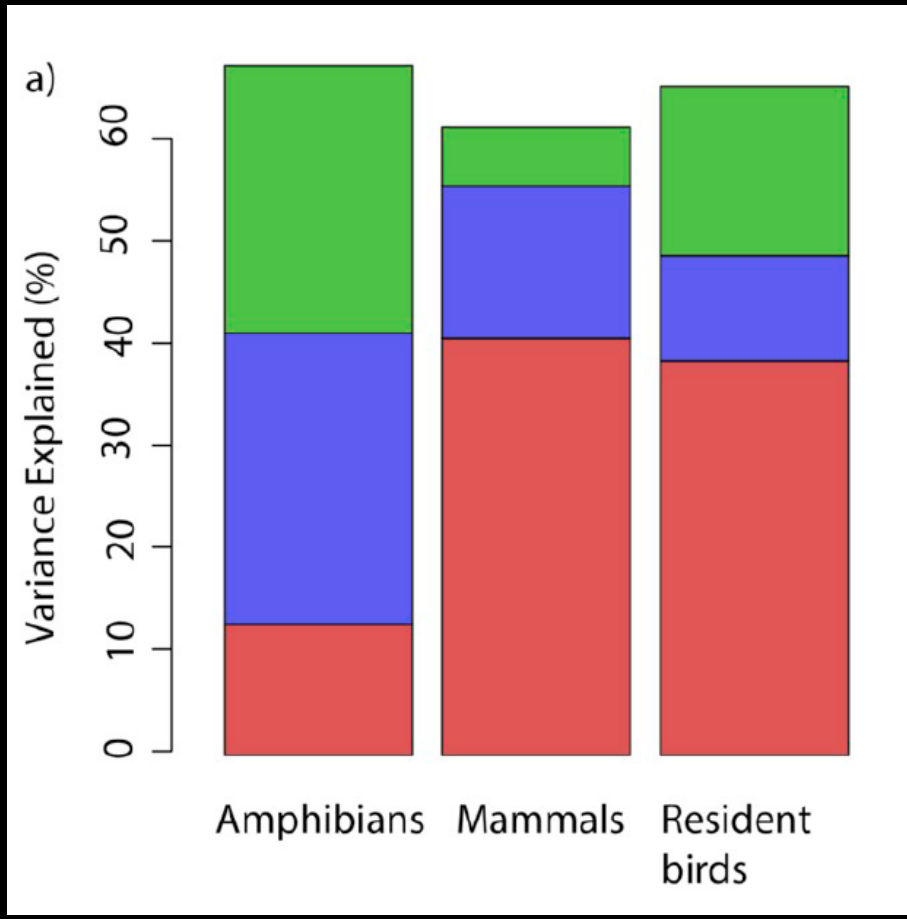
Radeloff, et al., 2019, RSE

Introduction



Introduction

Ecology	DHIs
Available energy hypothesis	
Environmental stress hypothesis	
Environmental variability hypothesis	



Radeloff, et al., 2019, RSE

Outline

1. Introducing the DHIs
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DHIs Product Status

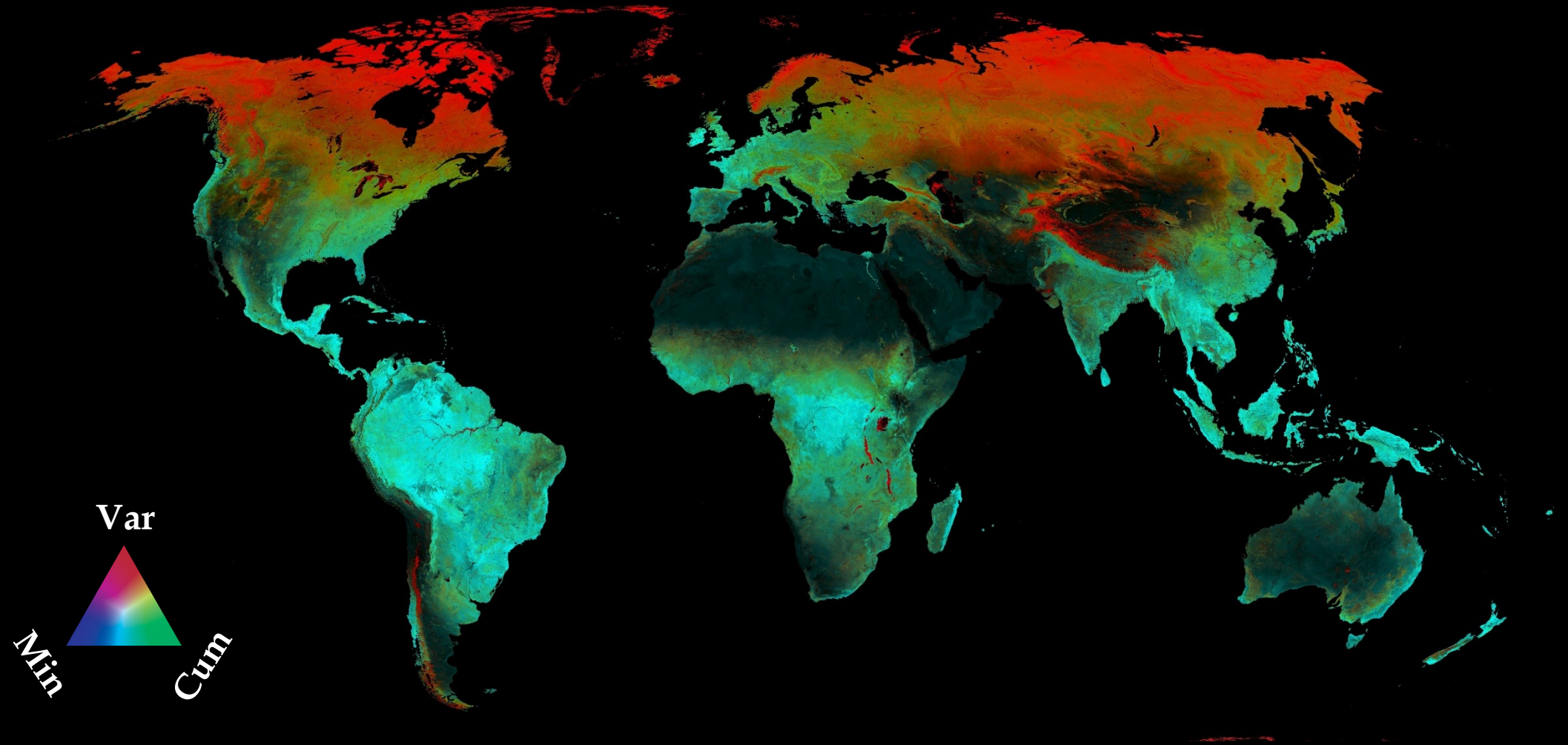
Composite & annual DHIs from MODIS and VIIRS

	Vegetation index	Resolutions	Time span
MODIS Collection 6.1 Aqua & MODIS Collection 6.1 Terra	NDVI	250/500/100m, 16-day	2003-2017
			2018-2022
			2013-2022
			2003-2022
	EVI	250/500/100m, 16-day	2003-2017
			2018-2022
			2013-2022
			2003-2022
	LAI	500m, 8-day	2003-2017
			2018-2022
			2013-2022
			2003-2022
	fPAR	500m, 8-day	2003-2017
			2018-2022
			2013-2022
			2003-2022
	GPP	500m, 8-day	2003-2017
			2018-2022
			2013-2022
			2003-2022

	Vegetation index	Resolutions	Time span
VIIRS	NDVI	500m, 16-day	2018-2022
			2013-2022
	EVI	500m, 16-day	2018-2022
			2013-2022
	EVI2	500m, 16-day	2018-2022
			2013-2022
	LAI	500m, 16-day	2018-2022
			2013-2022
	fPAR	500m, 16-day	2018-2022
			2013-2022

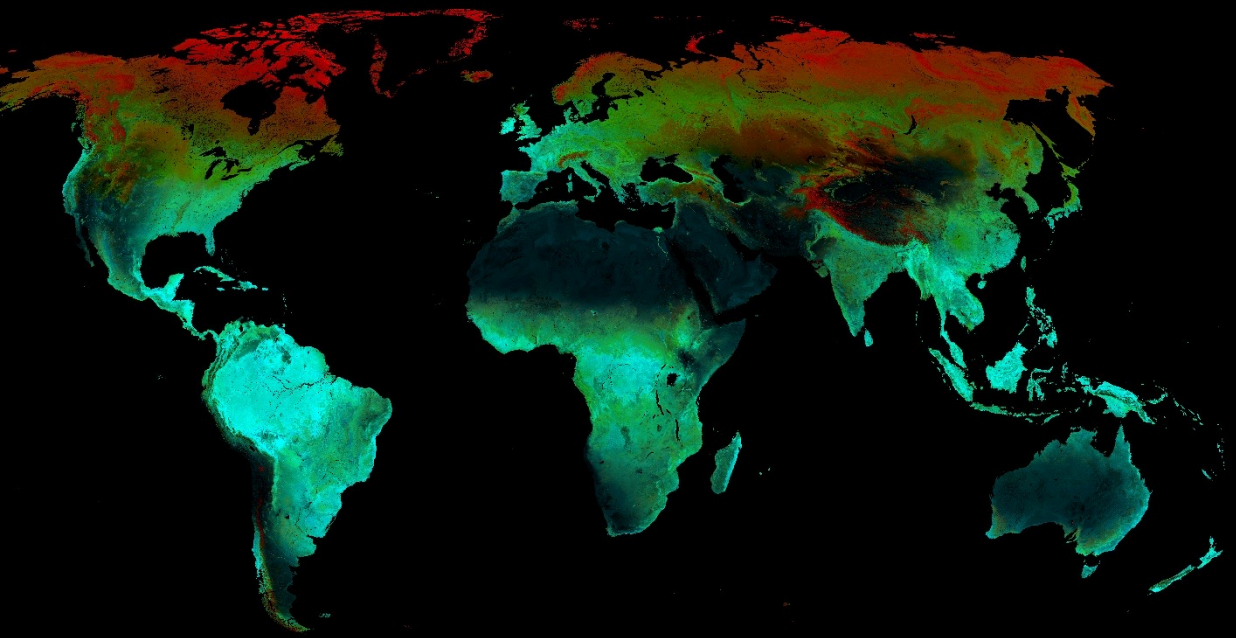
DHIs Product Status

2020 Annual DHIs based on MODIS Terra C6.1 EVI

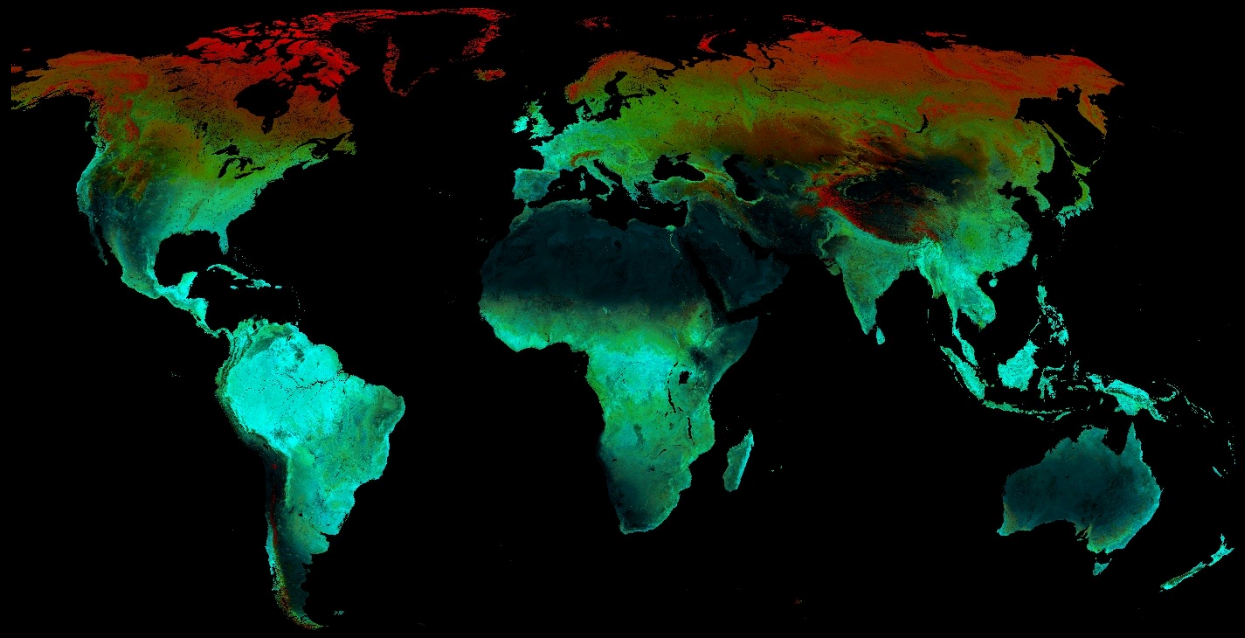


DHIs Product Status

MODIS 2013-2022 C6.1 EVI Aqua

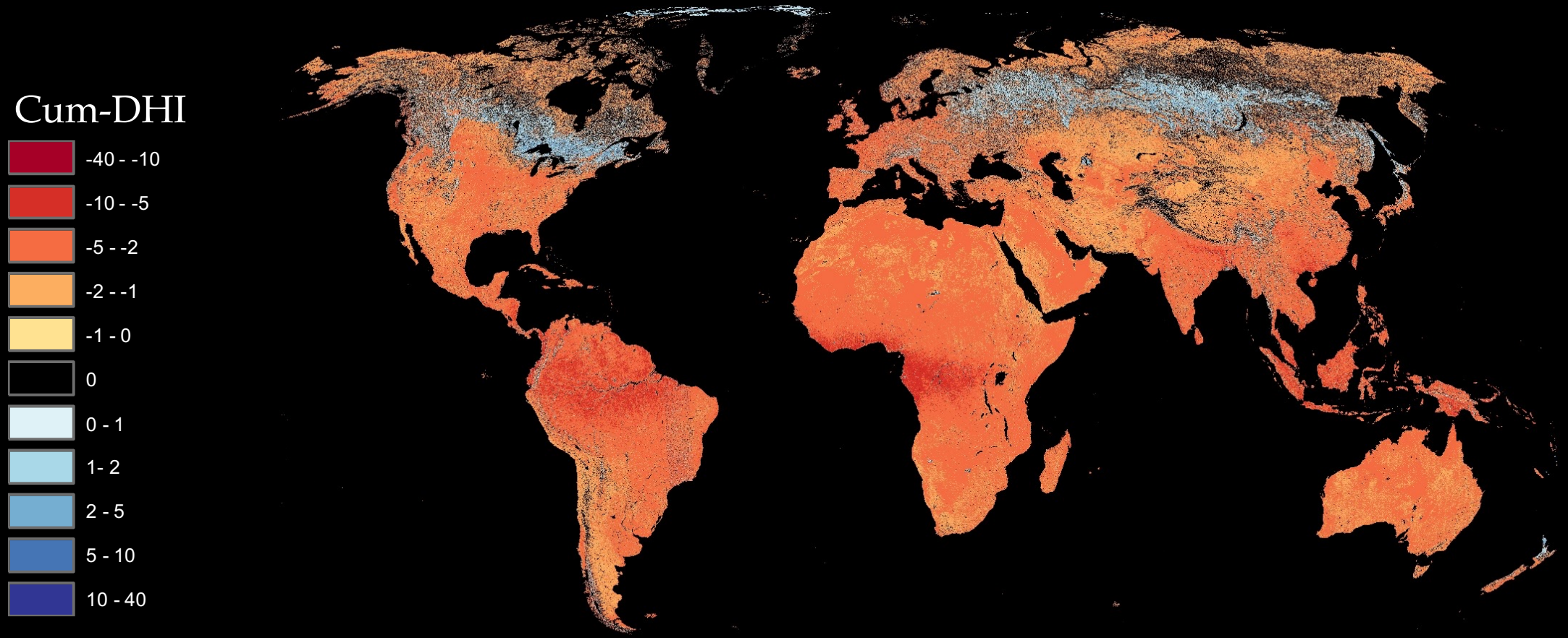


VIIRS 2013-2022 EVI version 1



DHIs Product Status

Cum-DHI EVI 2013-22: MODIS Aqua C6.1 minus VIIRS version 1



DHIs Product Status

Cum-DHI

- -40 - -10
- -10 - -5
- -5 - -2
- -2 - -1
- -1 - 0
- 0
- 0 - 1
- 1- 2
- 2 - 5
- 5 - 10
- 10 - 40

VIIRS version 2 !!!

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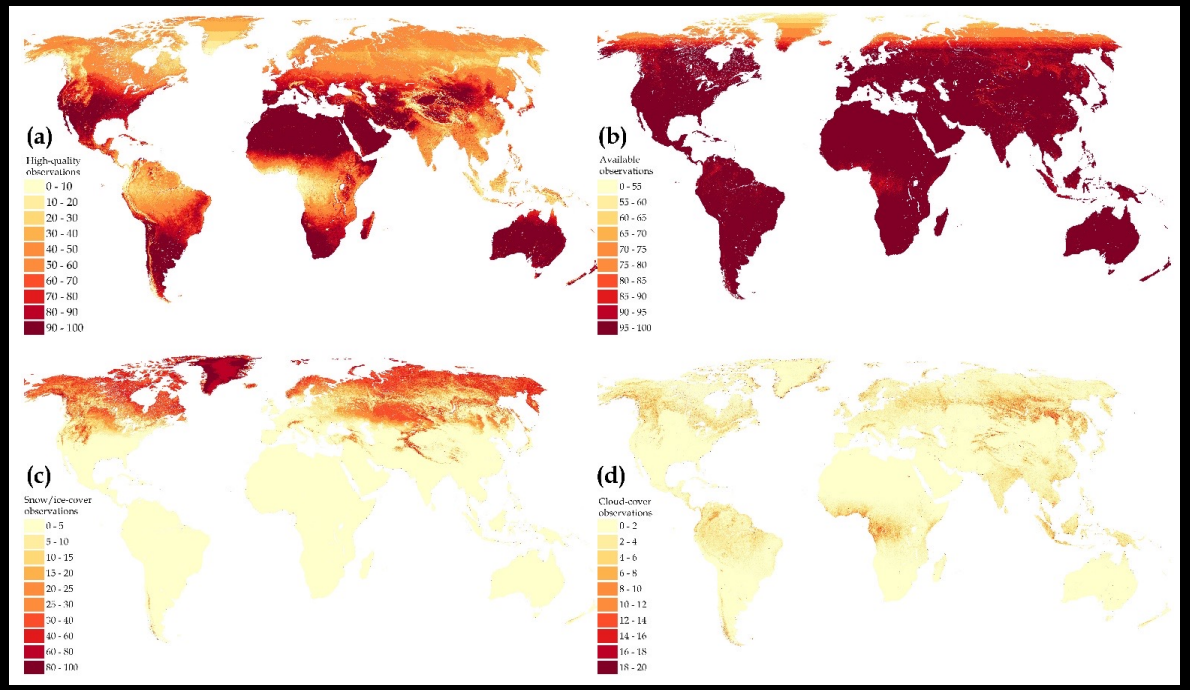
DHIs Uncertainty Estimation

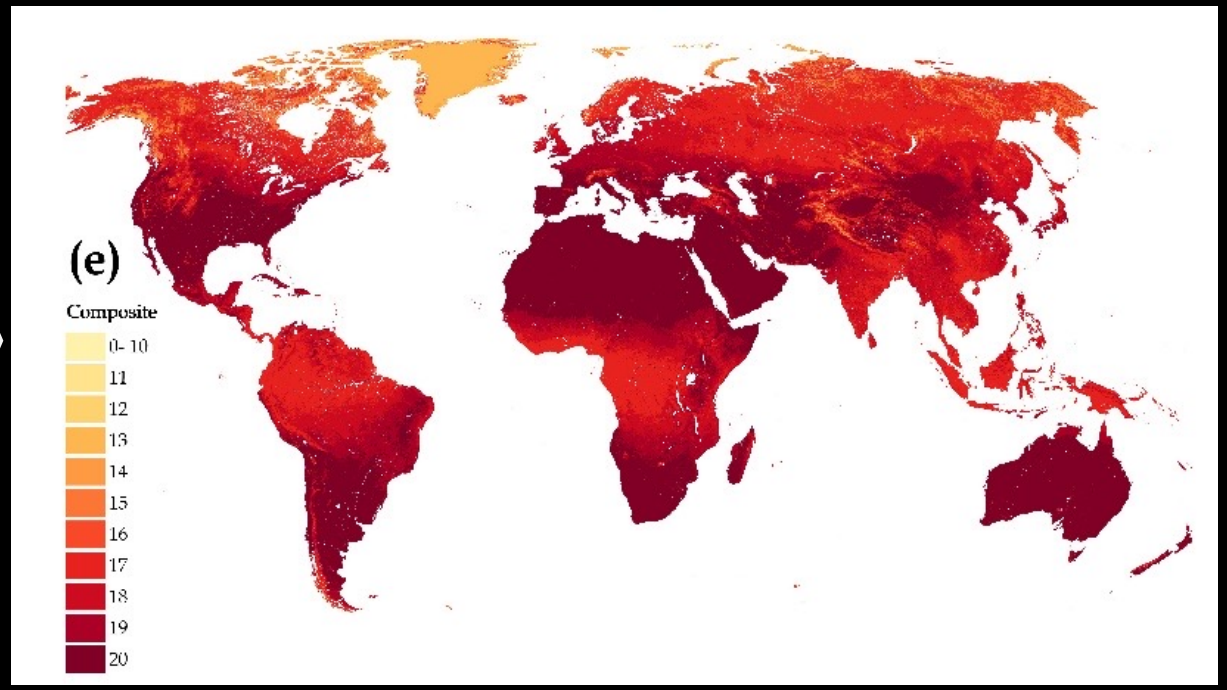
MODIS Aqua EVI DHIs Quality Flags

% High-quality

% Available



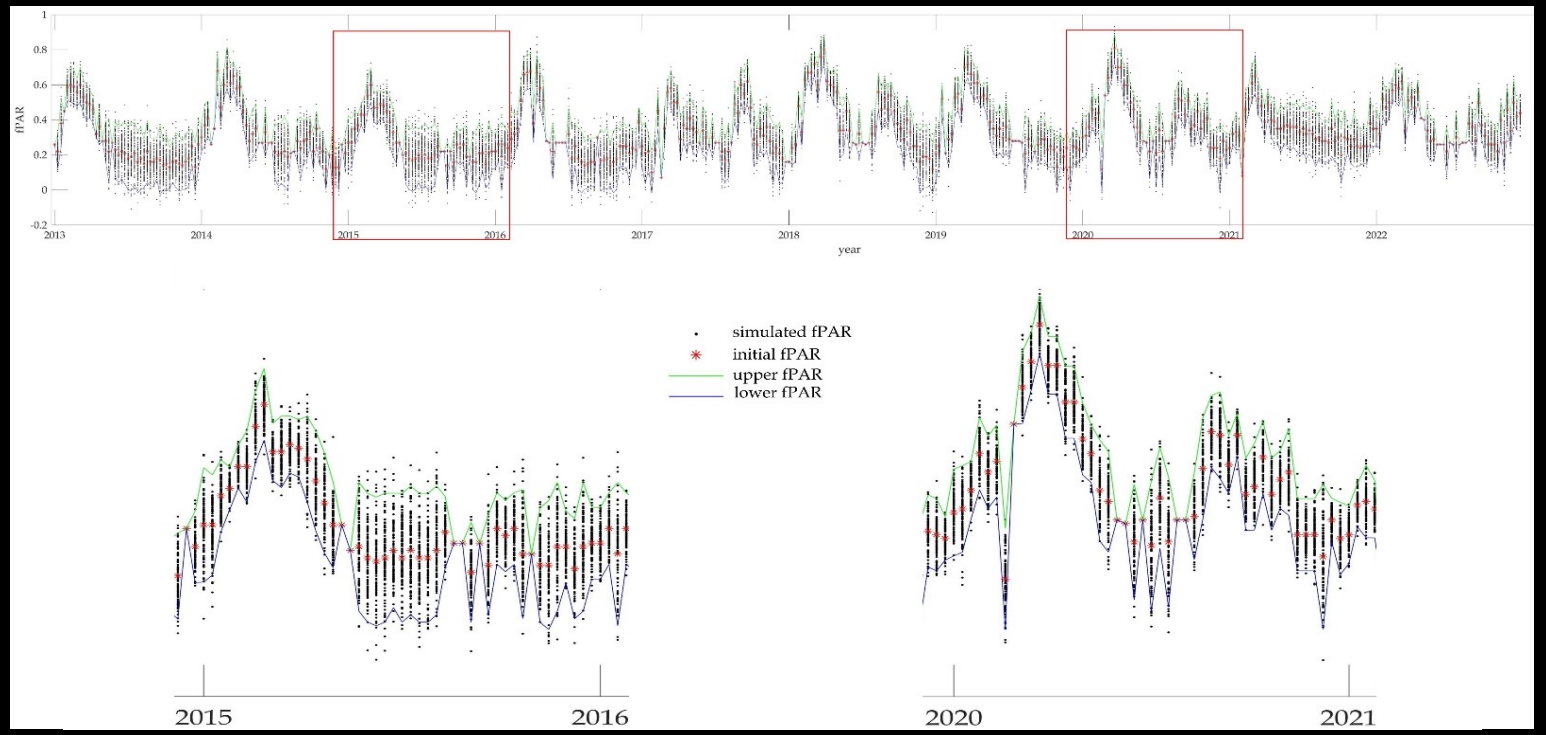
Composite quality flag

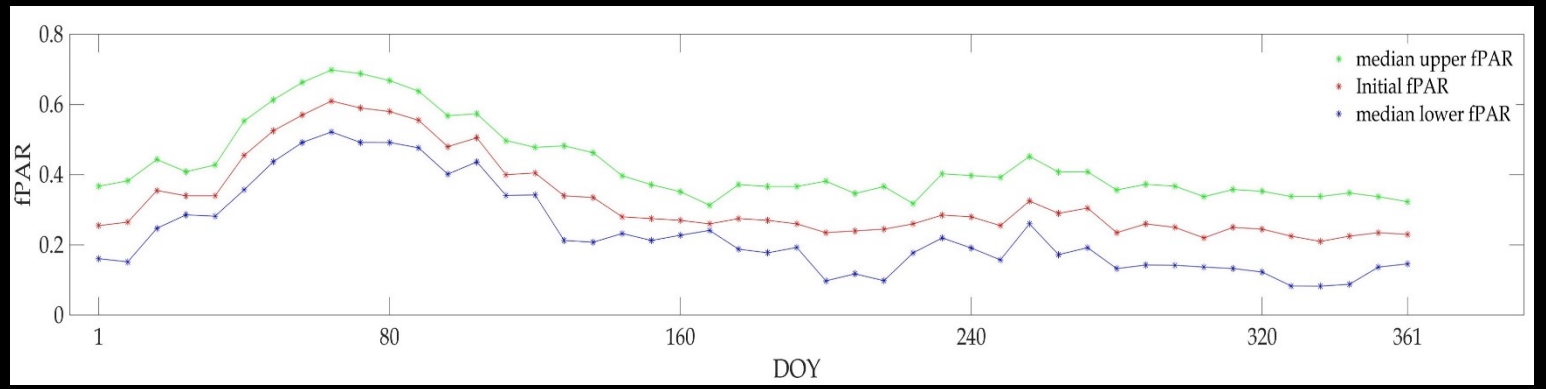


% Snow

% Cloud

DHIs Uncertainty Estimation





95% Confidence Interval

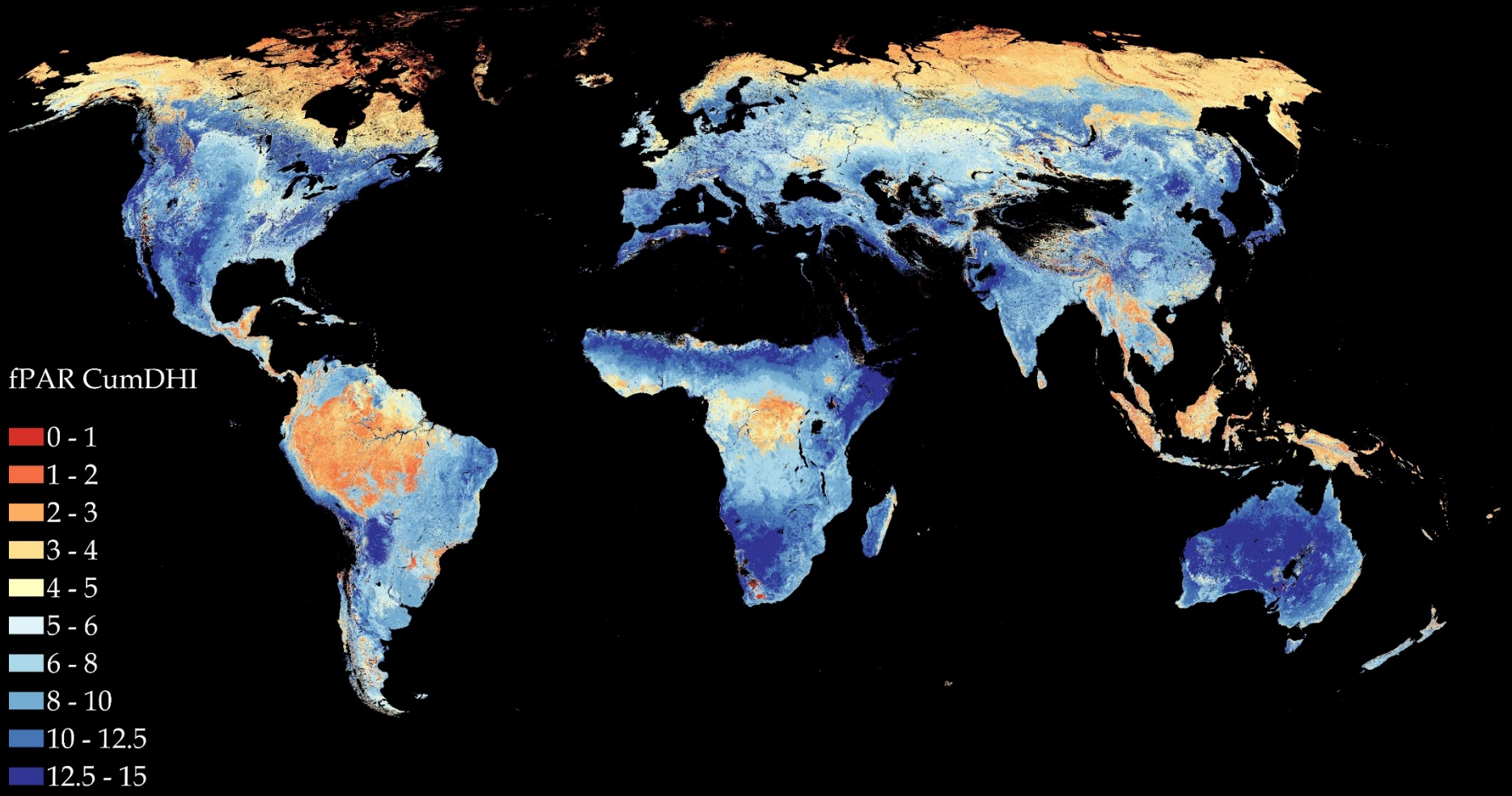
$$lower\colon X - Z_{\alpha/2} * \frac{\sigma}{\sqrt{n}}$$

$$upper\colon X + Z_{\alpha/2} * \frac{\sigma}{\sqrt{n}}$$

	Cum. DHI	Min. DHI	Var. DHI
upper fPAR	43.1	31.3	3.9
estimated fPAR	32.8	21.0	2.8
lower fPAR	23.5	8.2	1.8

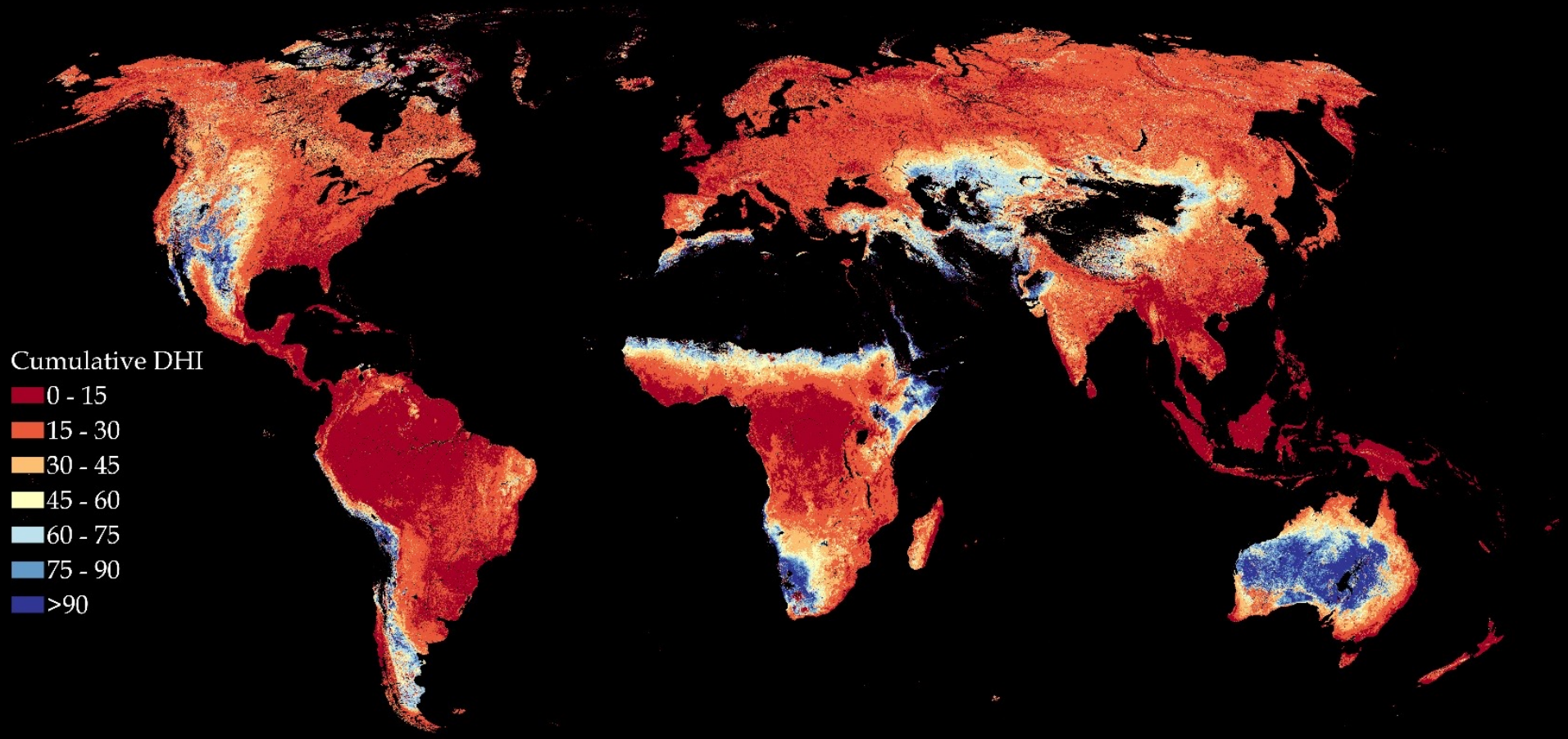
DHIs Uncertainty Estimation

fPAR Cumulative DHI: Upper minus Lower CI



DHIs Uncertainty Estimation

fPAR Cumulative DHI: ±CI(%)



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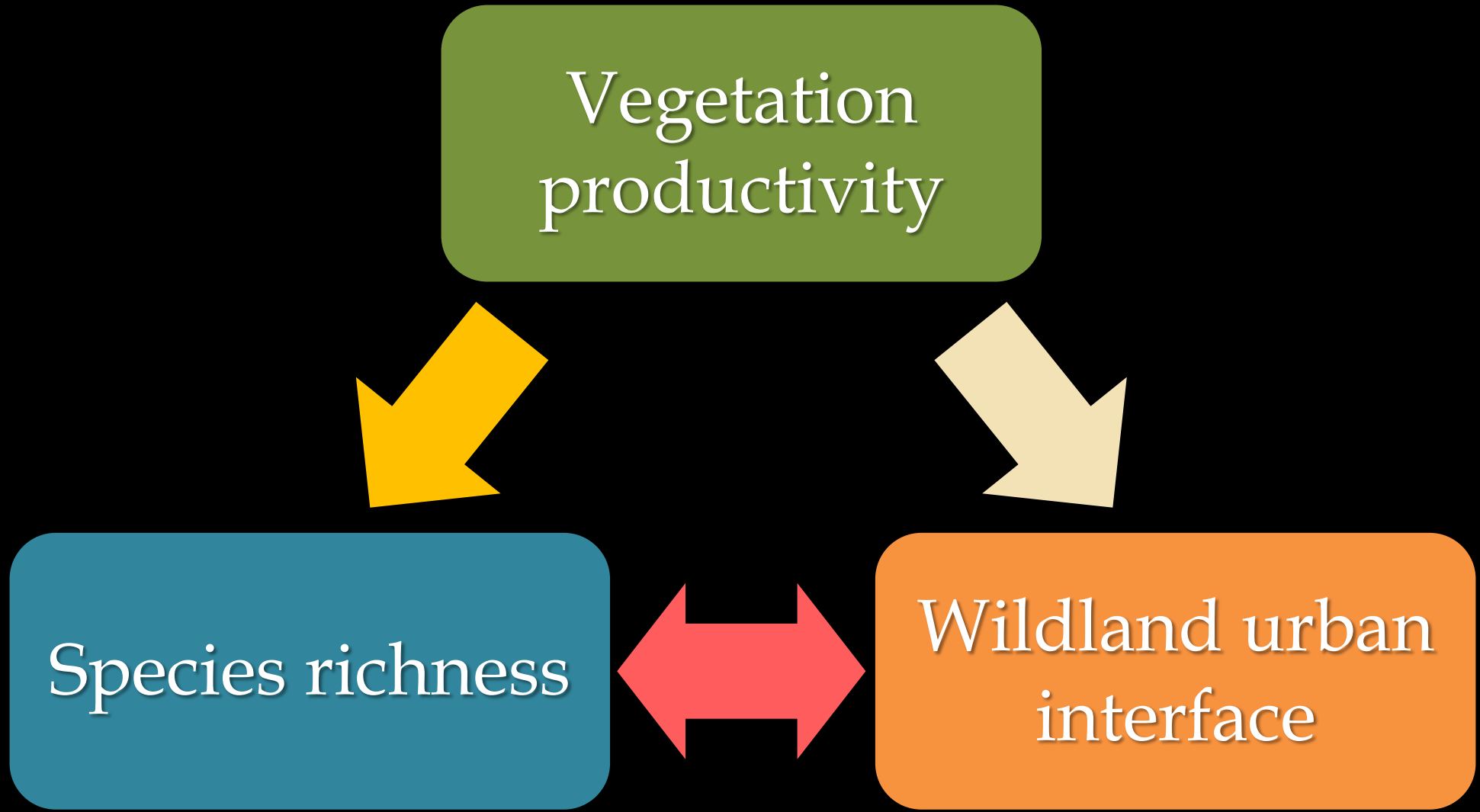
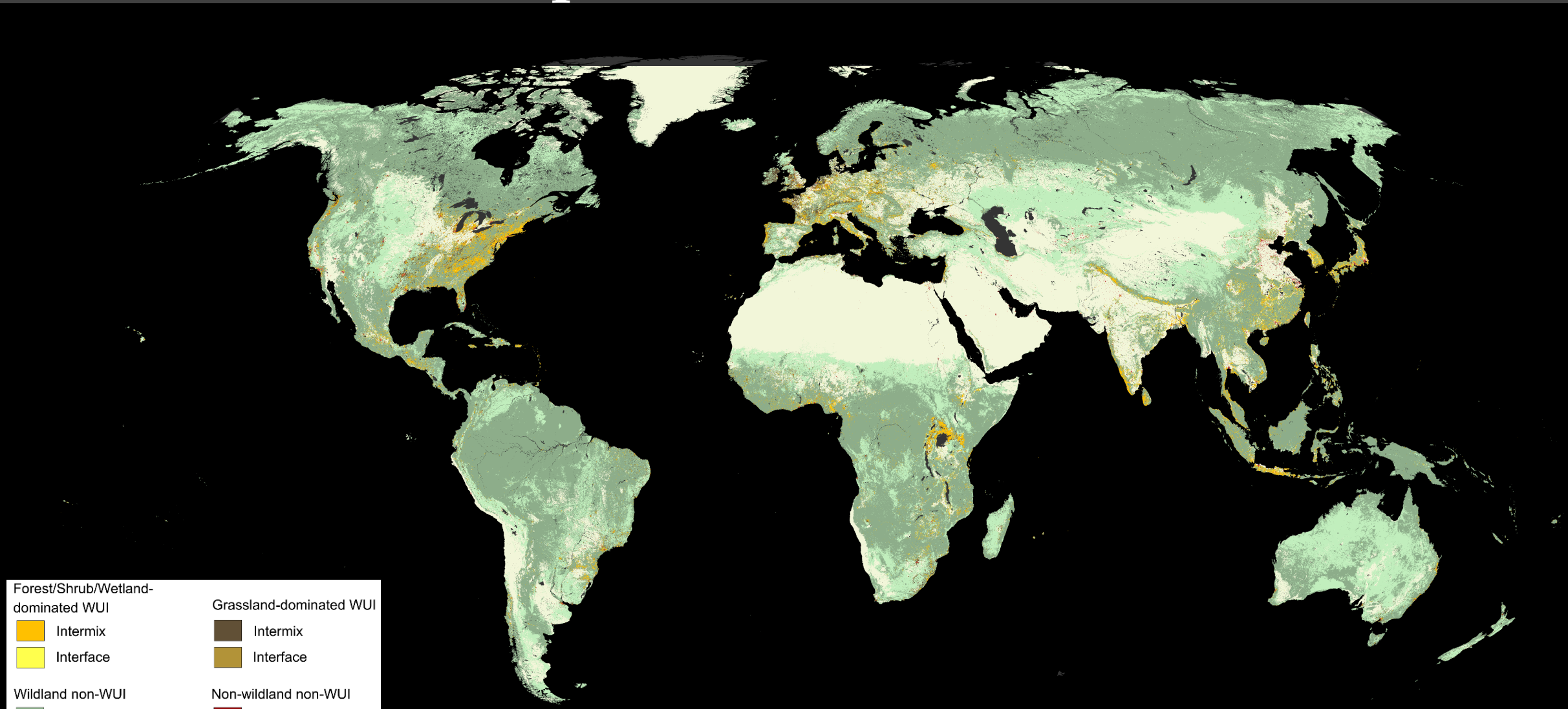
DHIs, species richness, and WUI

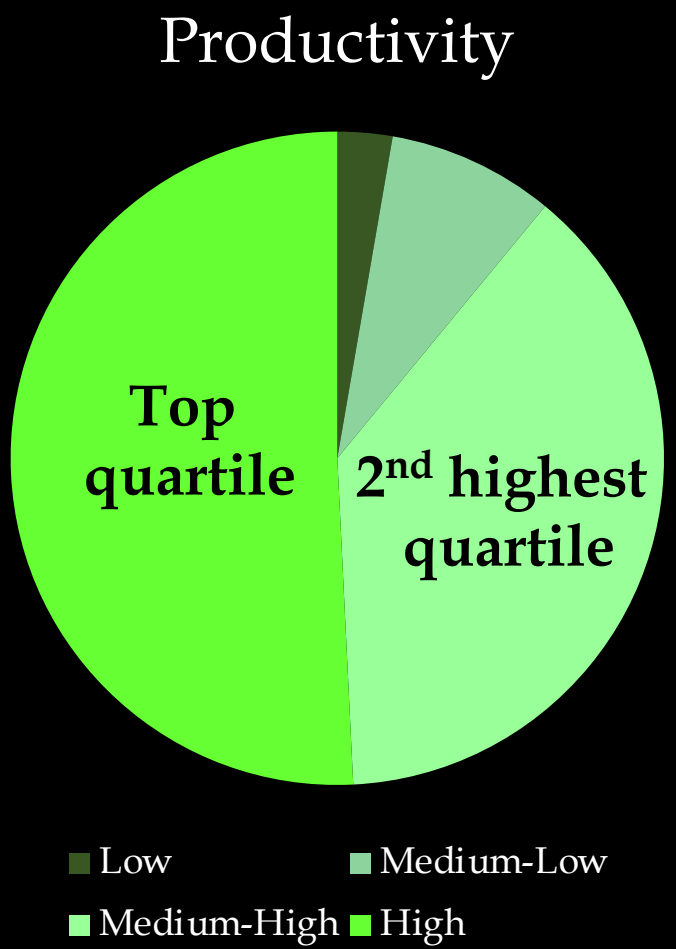


DHIs, species richness, and WUI



Schug, Radeloff, et al., 2023. *Nature*

DHIs, species richness, and WUI



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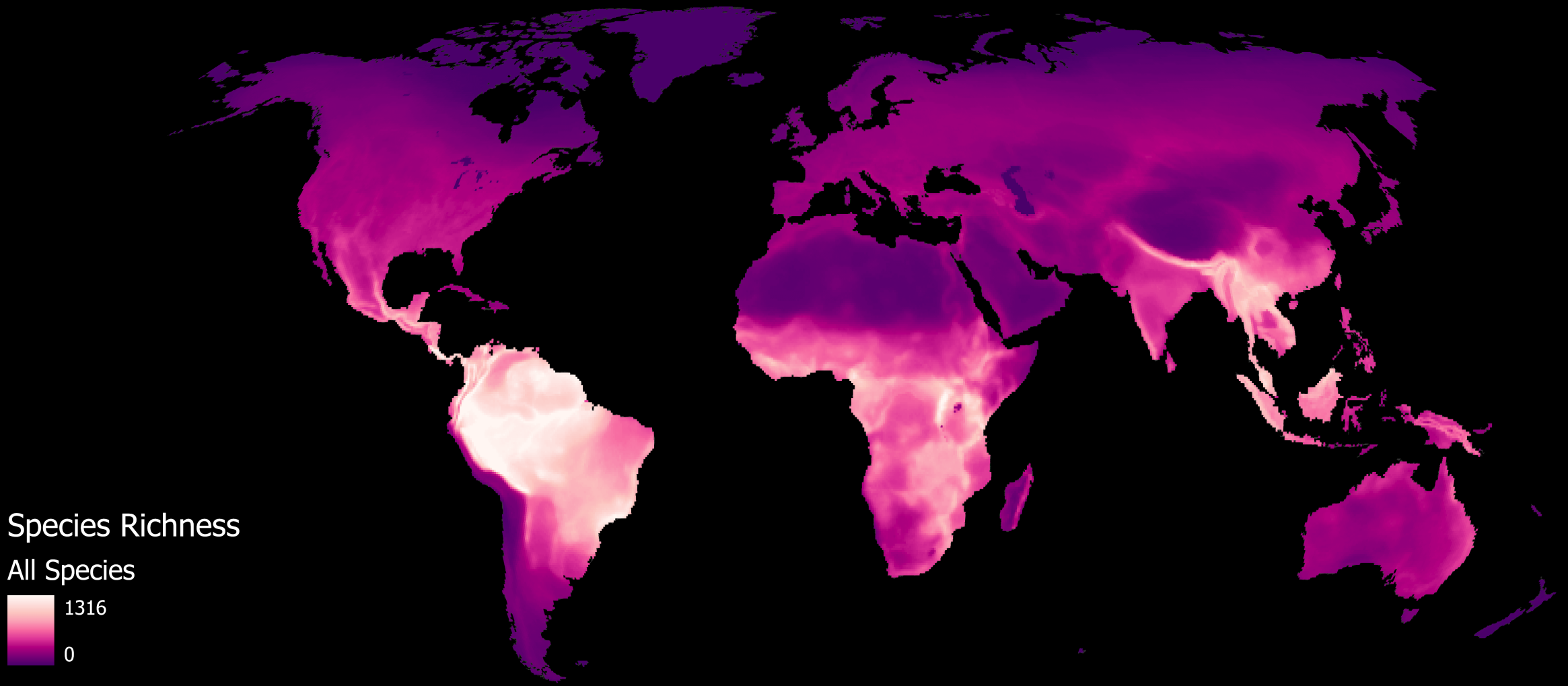
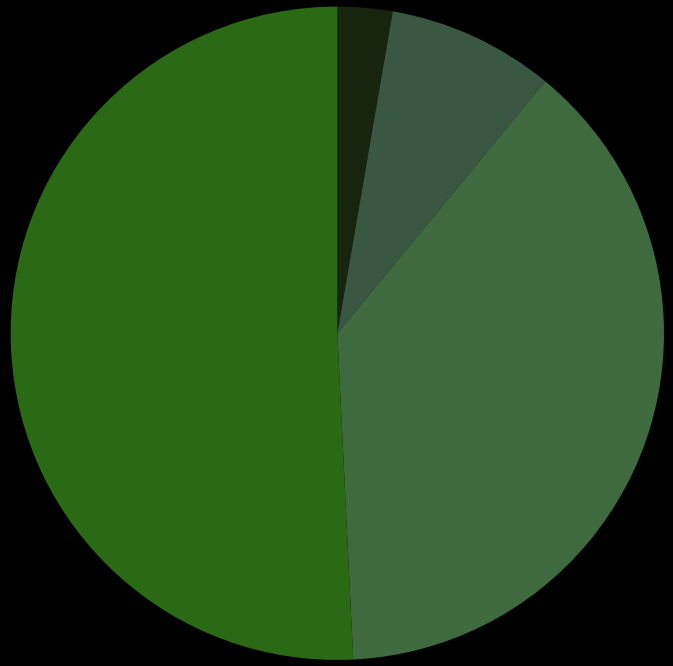
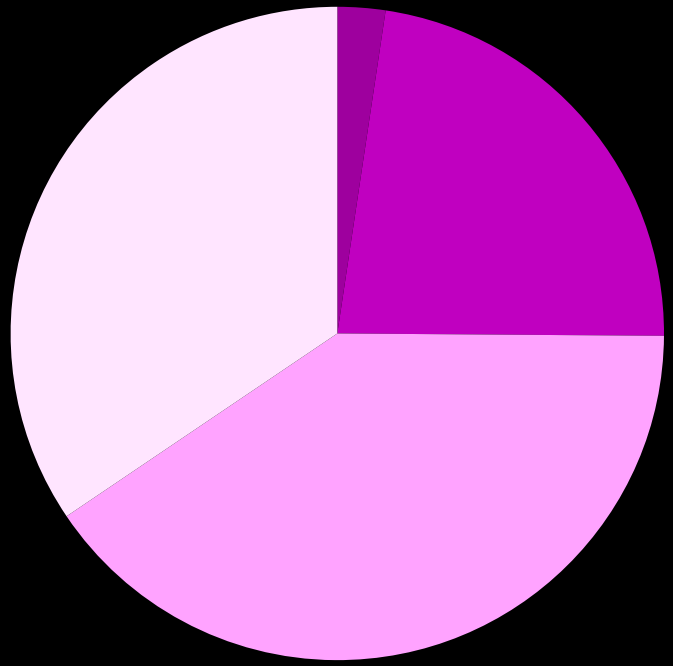


DHIs, species richness, and WUI

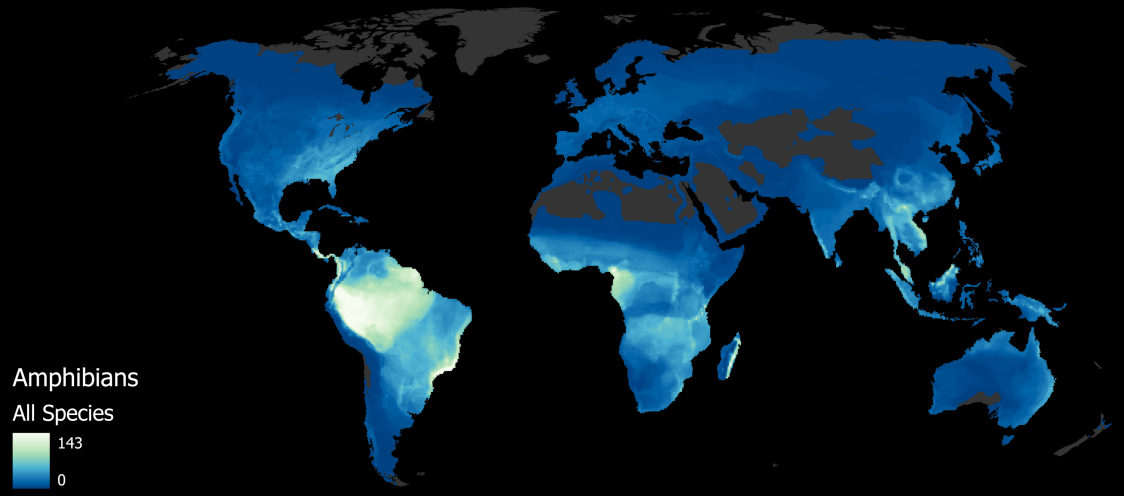
Productivity

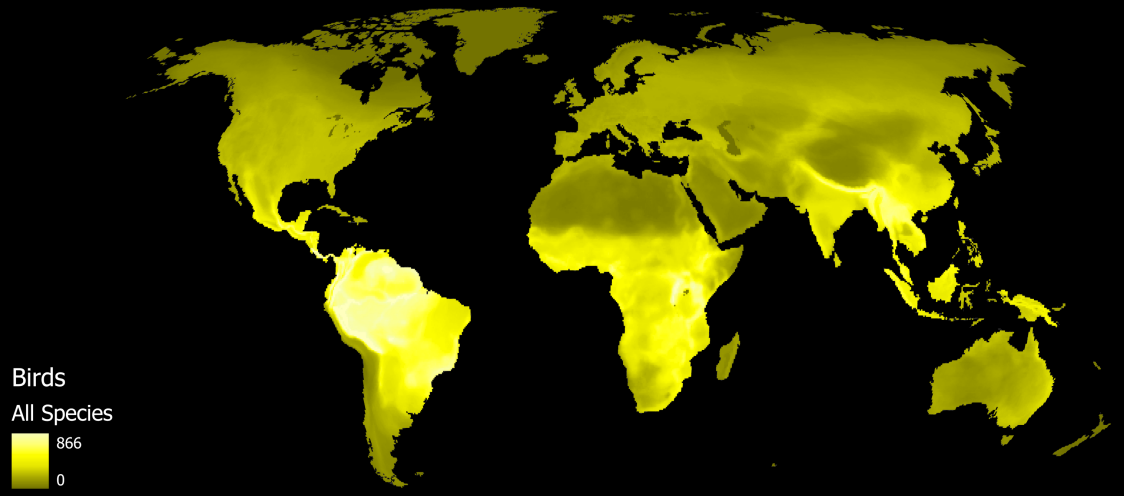


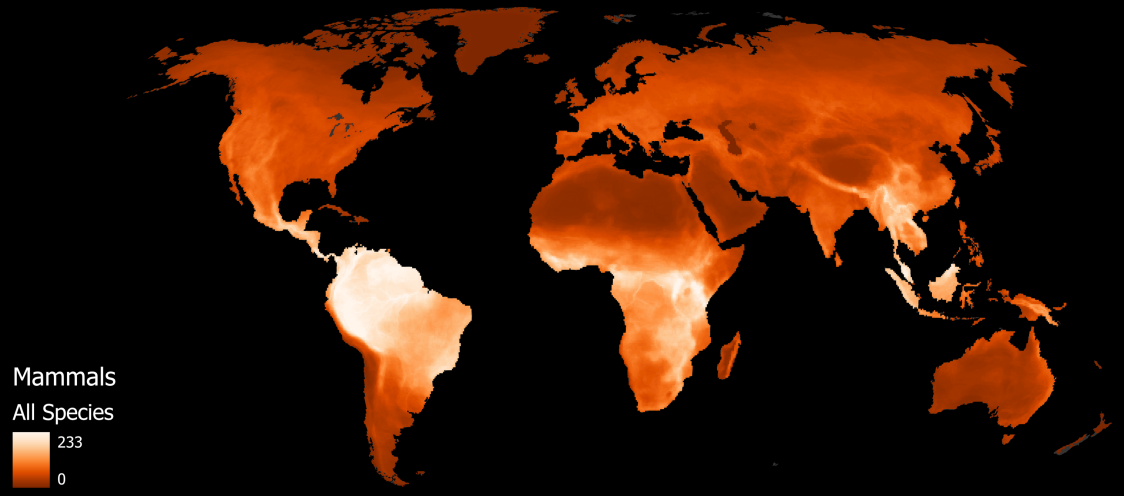
All Tetrapods

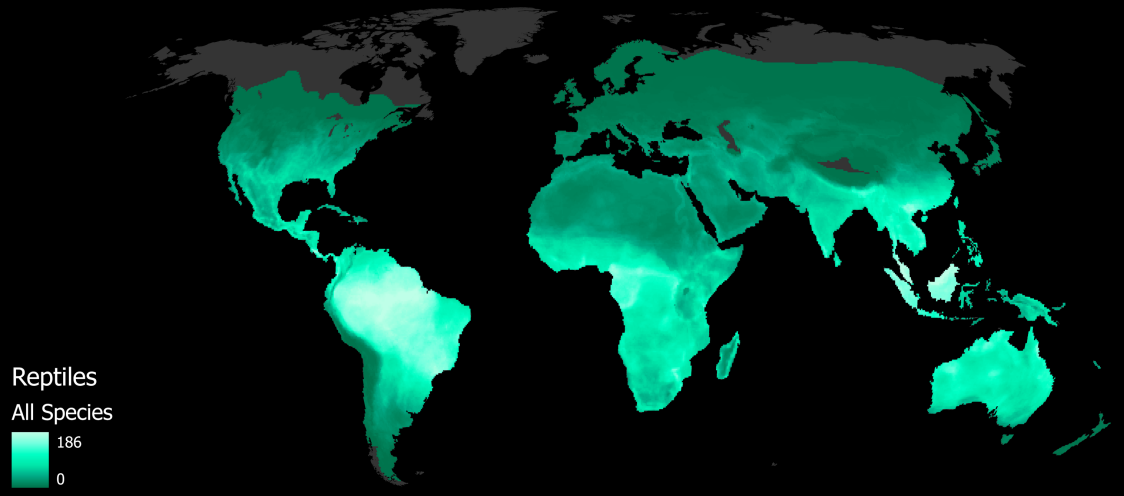


DHIs, species richness, and WUI









Cox, Young, Bowles, *et al. Nature* (2022)

DHIs, species richness, and WUI

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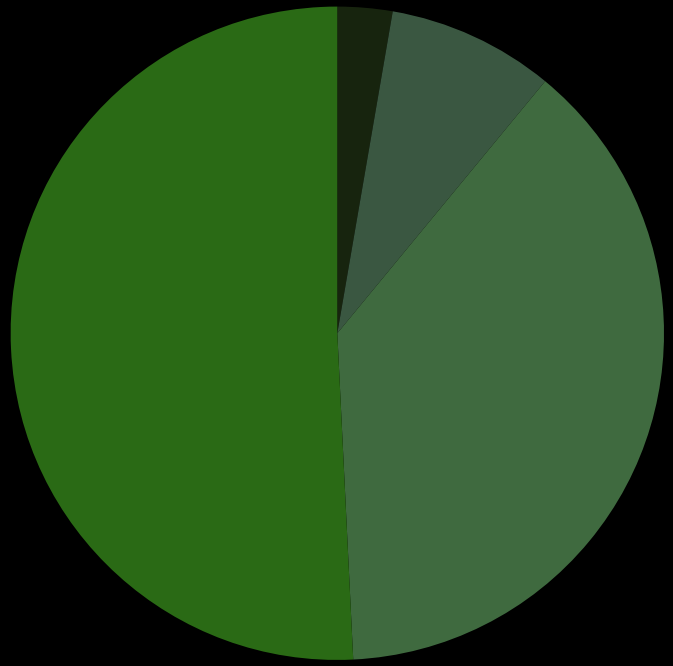
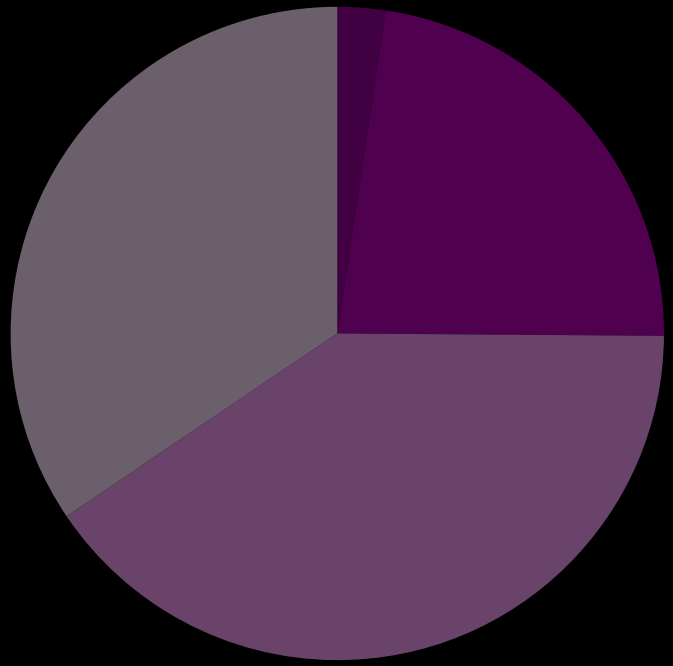


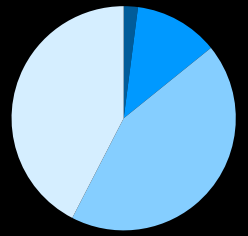
Low | Medium-Low | Medium-High | High

All Tetrapods



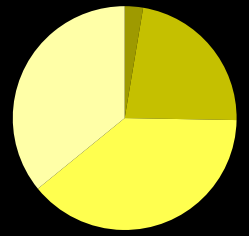
Low | Medium-Low | Medium-High | High

Amphibians



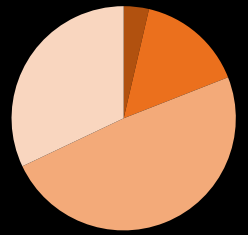
Low | Medium-Low | Medium-High | High

Birds



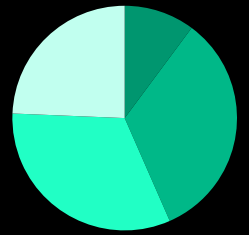
Low | Medium-Low | Medium-High | High

Mammals



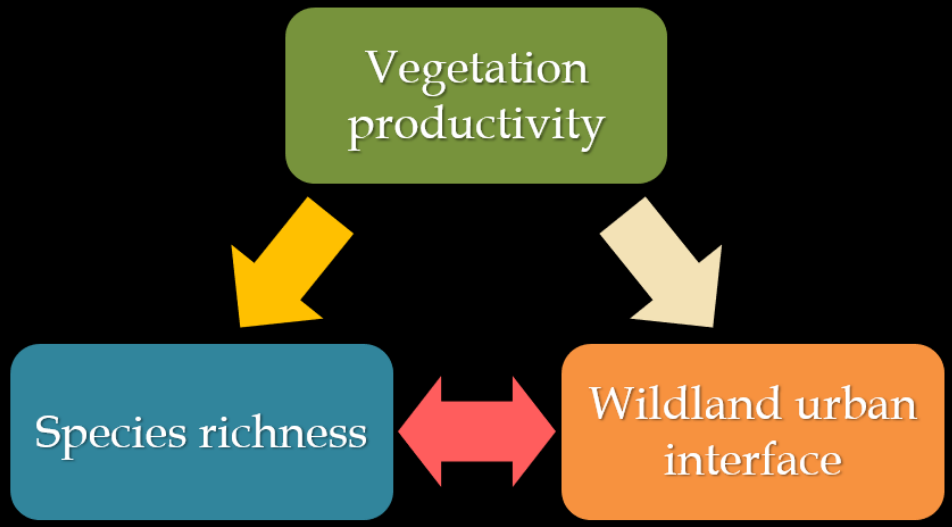
Low | Medium-Low | Medium-High | High

Reptiles

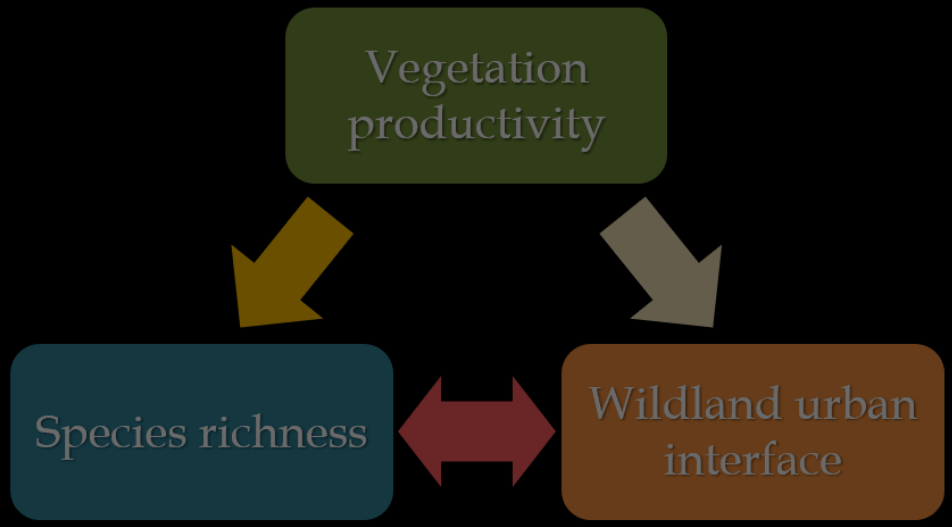


Low | Medium-Low | Medium-High | High

DHIs, species richness, and WUI



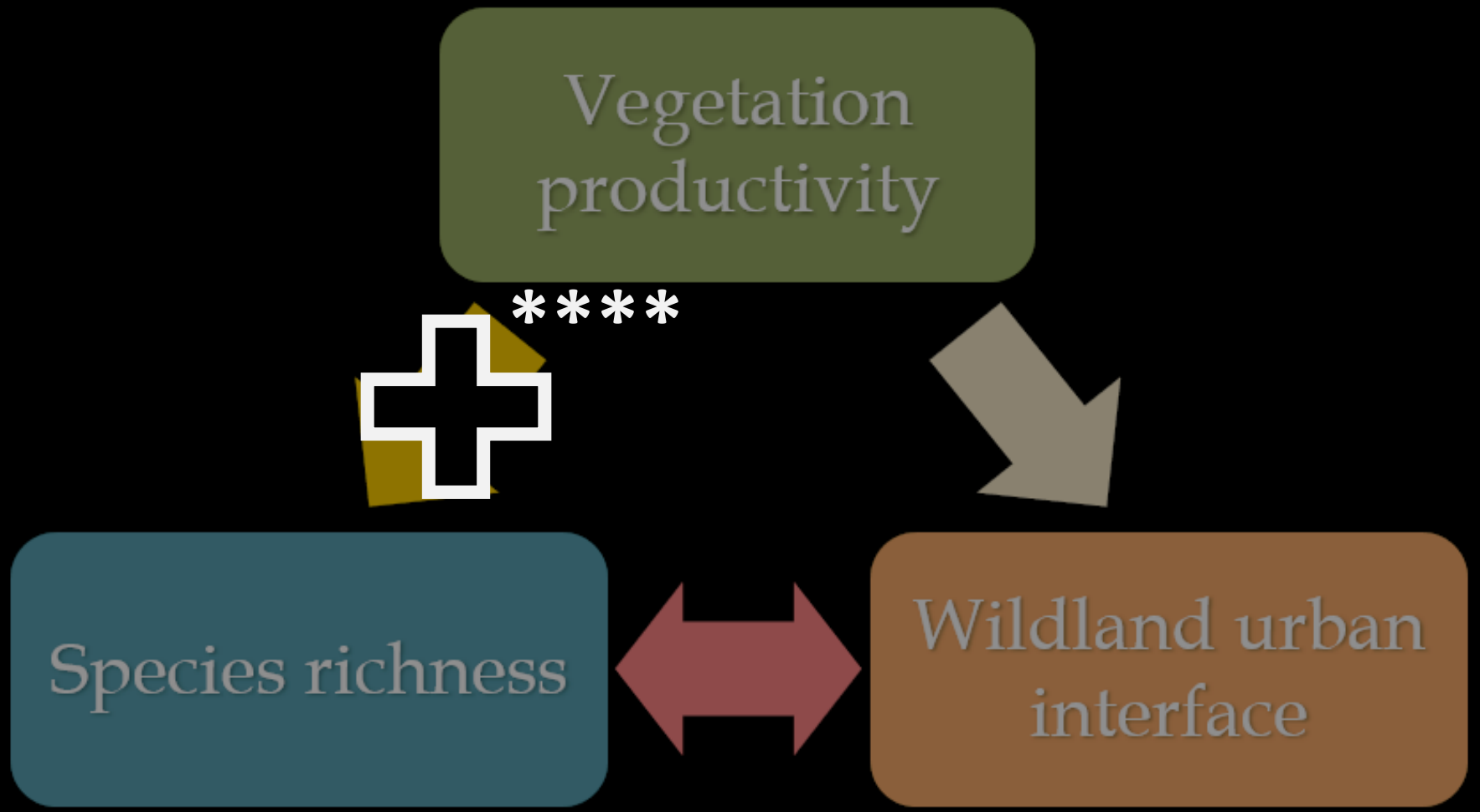
DHIs, species richness, and WUI



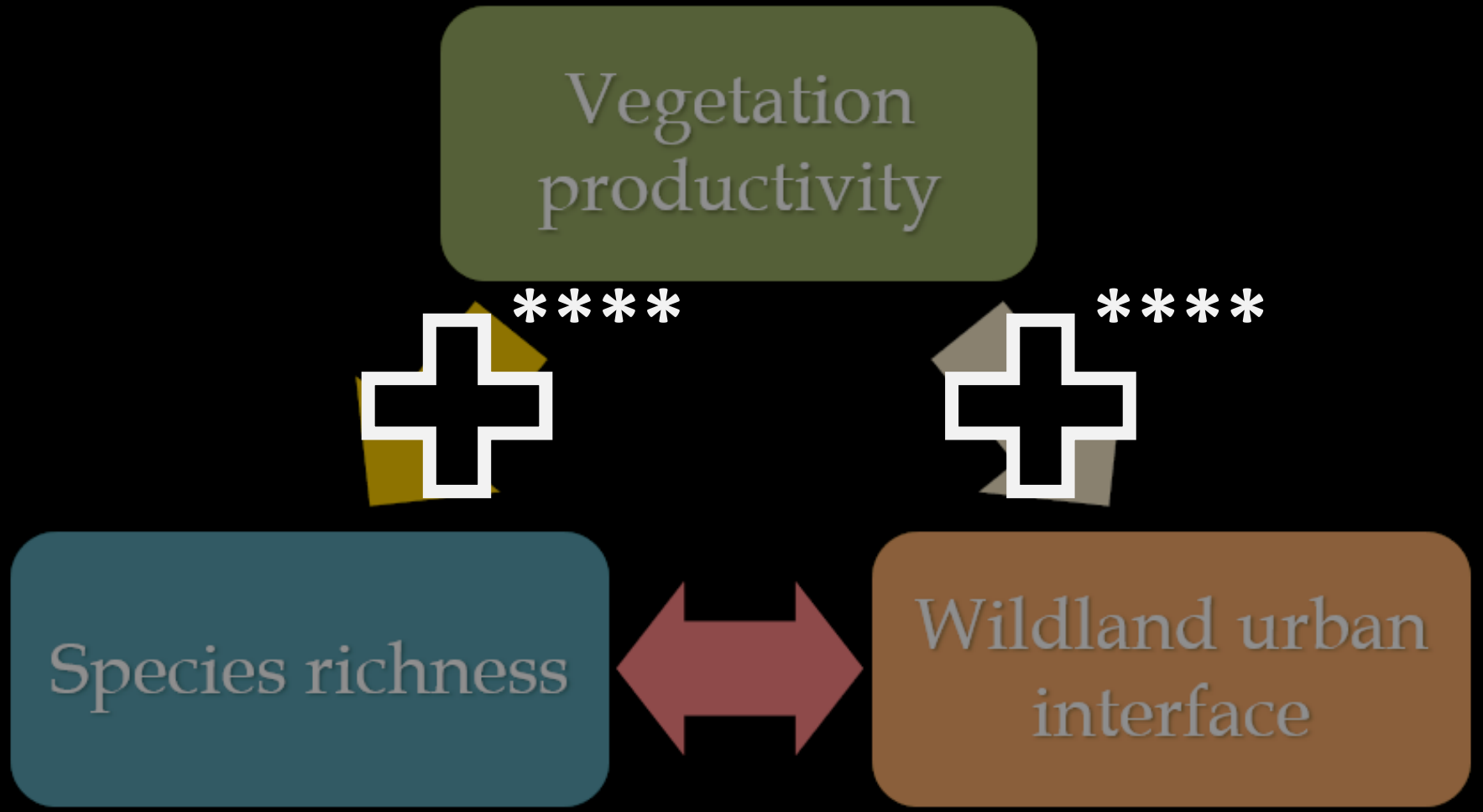
SpeciesRichness ^ WUI ~ CumDHI

remotePARTS: multivariate regression, global dataset, accounting for spatial autocorrelation

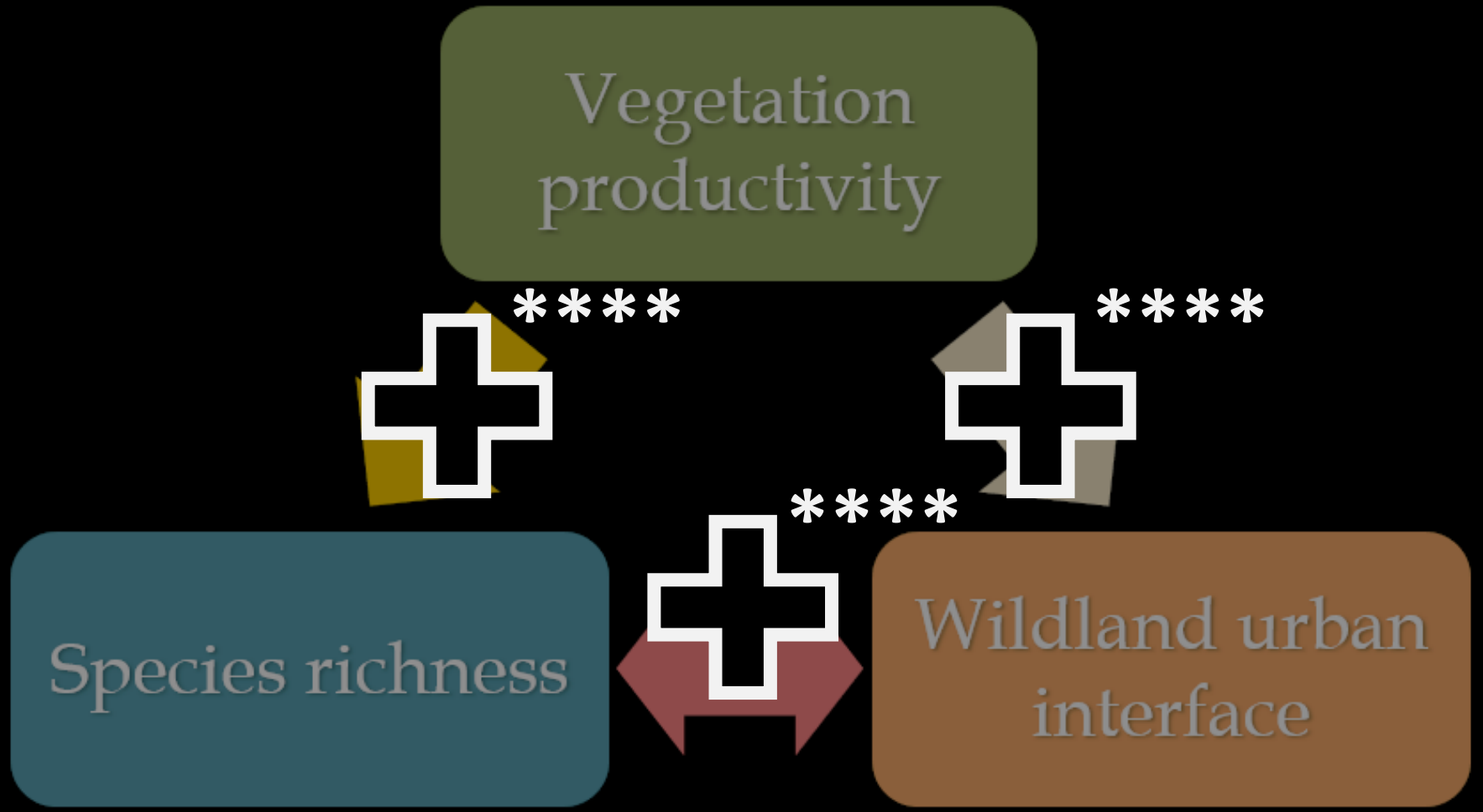
DHIs, species richness, and WUI



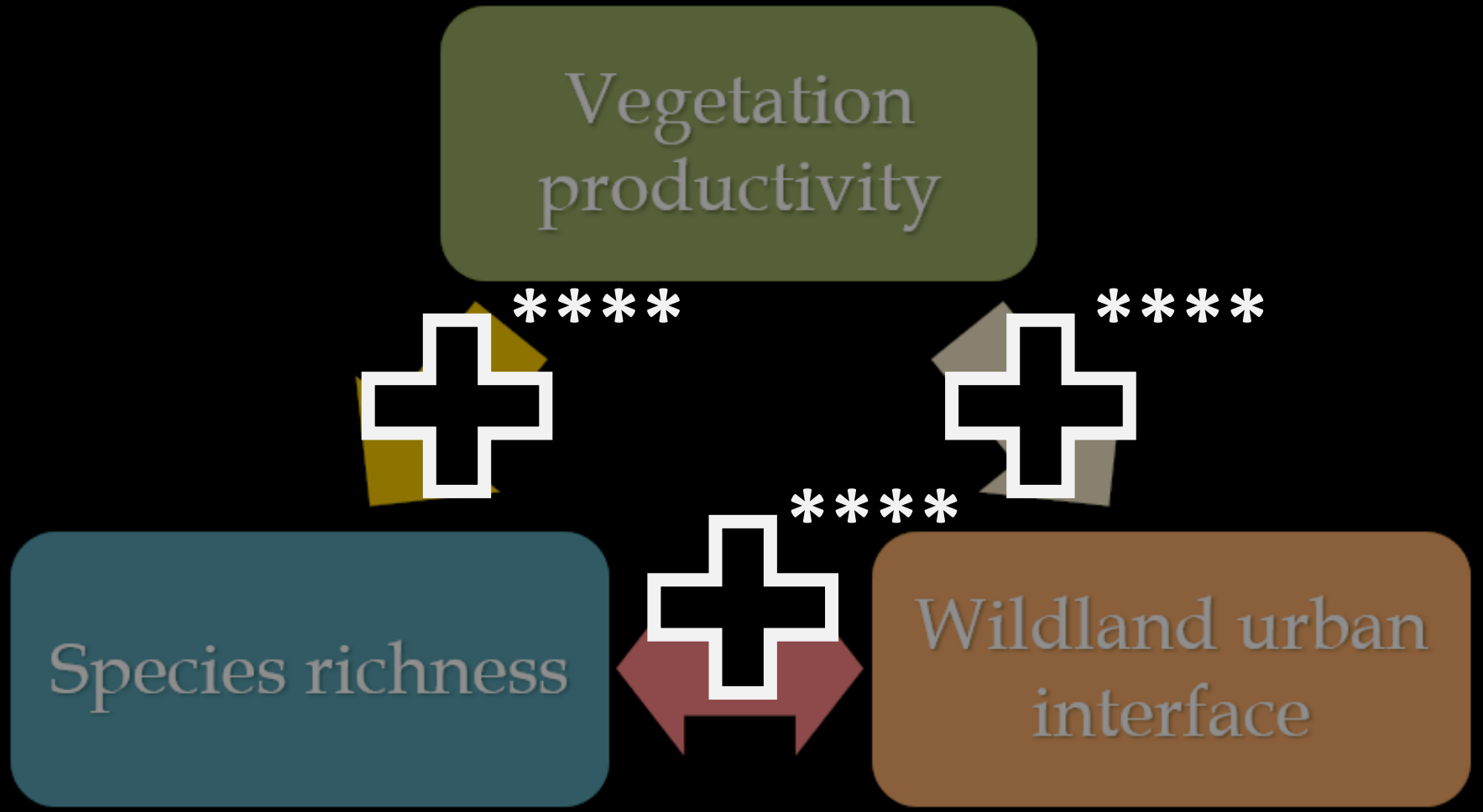
DHIs, species richness, and WUI



DHIs, species richness, and WUI



DHIs, species richness, and WUI

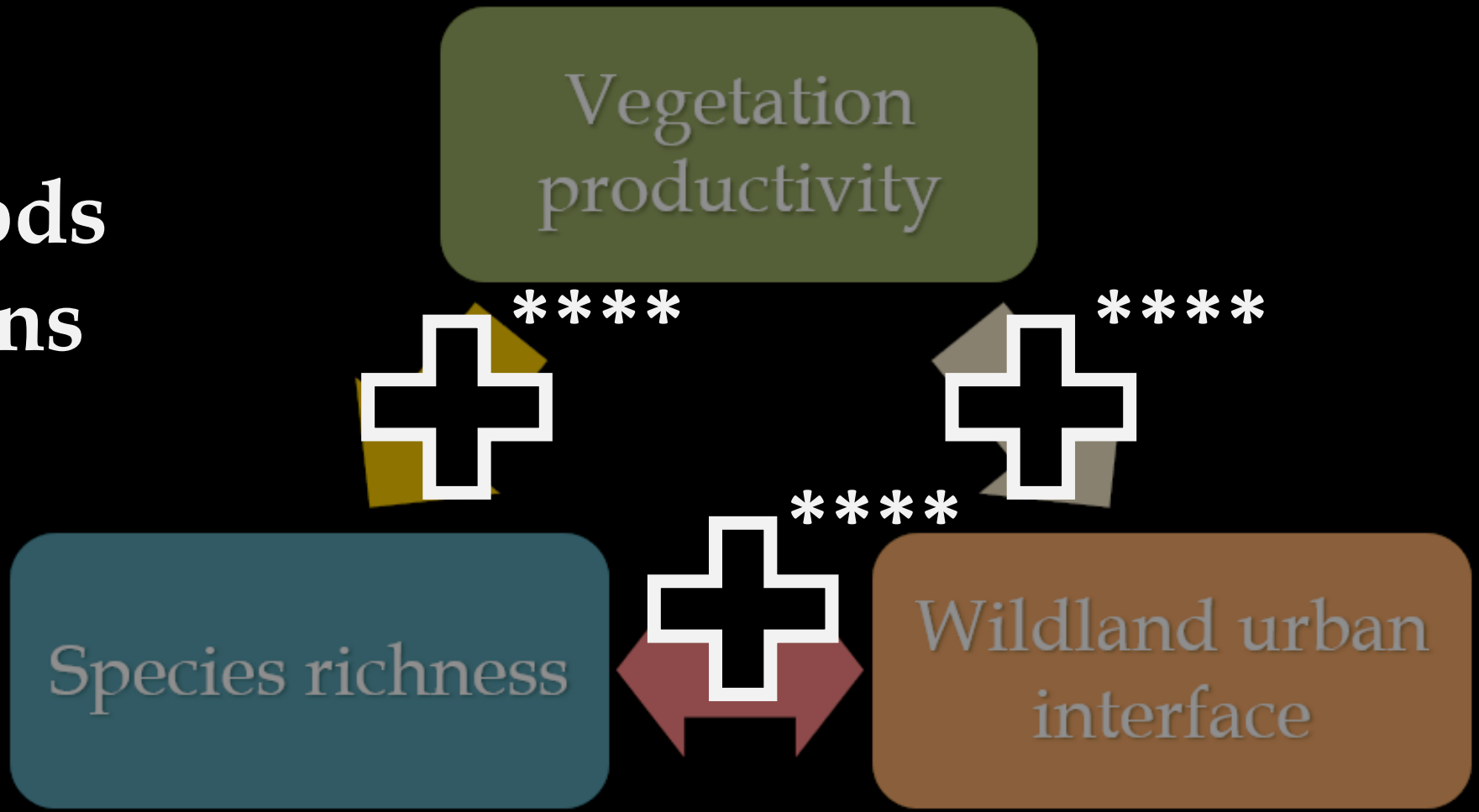


additional $r = 0.3$

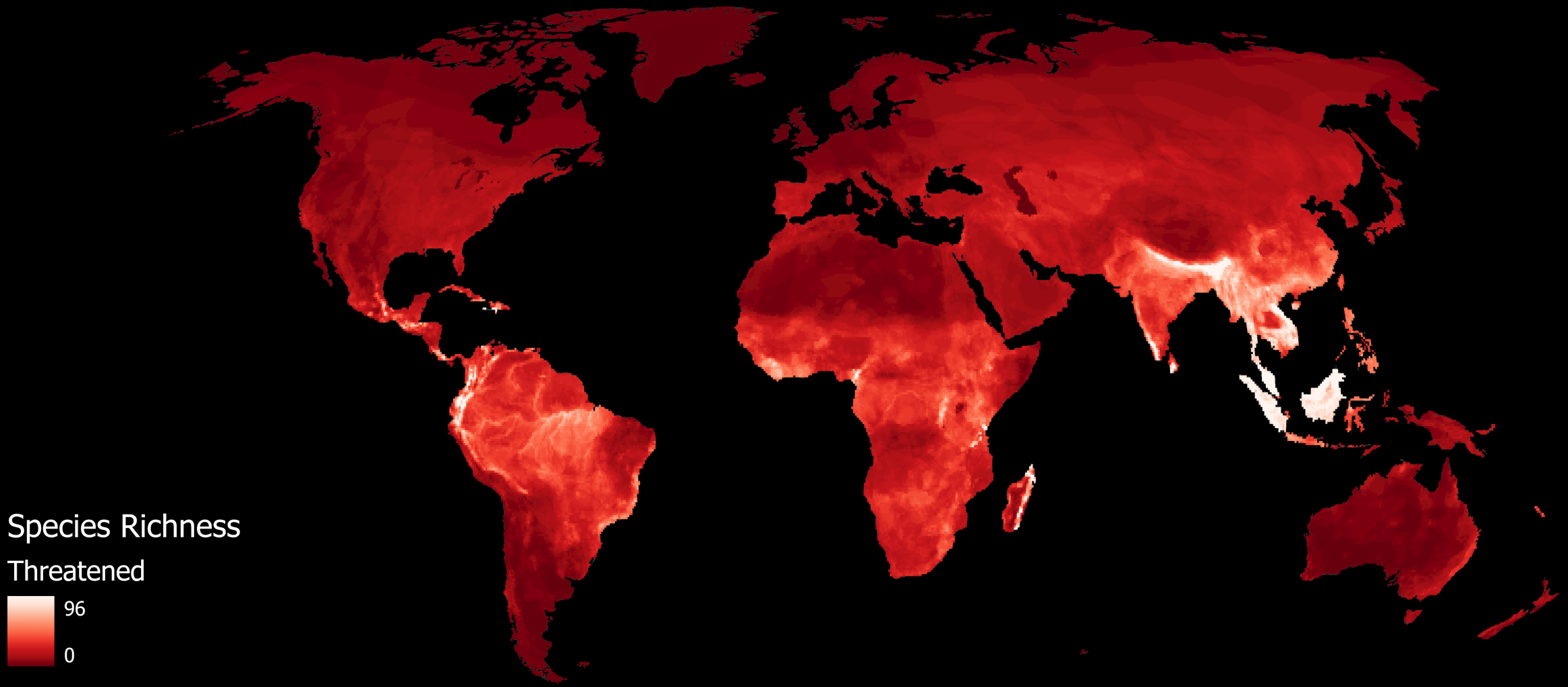
DHIs, species richness, and WUI

Richness of:

- All tetrapods
- Amphibians
- Birds
- Mammals
- Reptiles



DHIs, species richness, and WUI

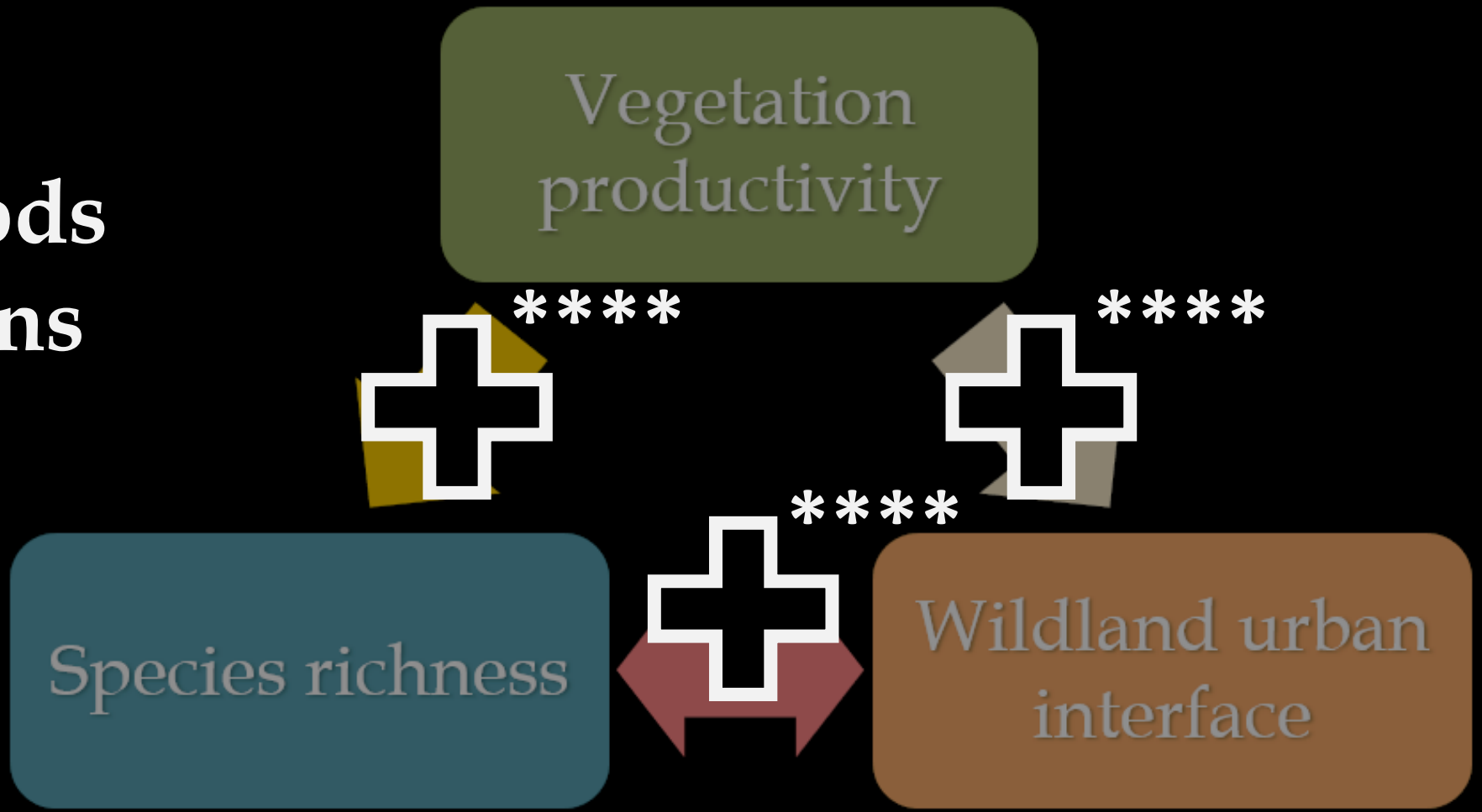


DHIs, species richness, and WUI

Richness of:

- All tetrapods
- Amphibians
- Birds
- Mammals
- Reptiles

- Threatened species



Outline

1. Introducing the DHIs
2. Product status updates
3. Uncertainty estimation
4. DHIs versus species richness and human settlements

Conclusions

Contents lists available at ScienceDirect

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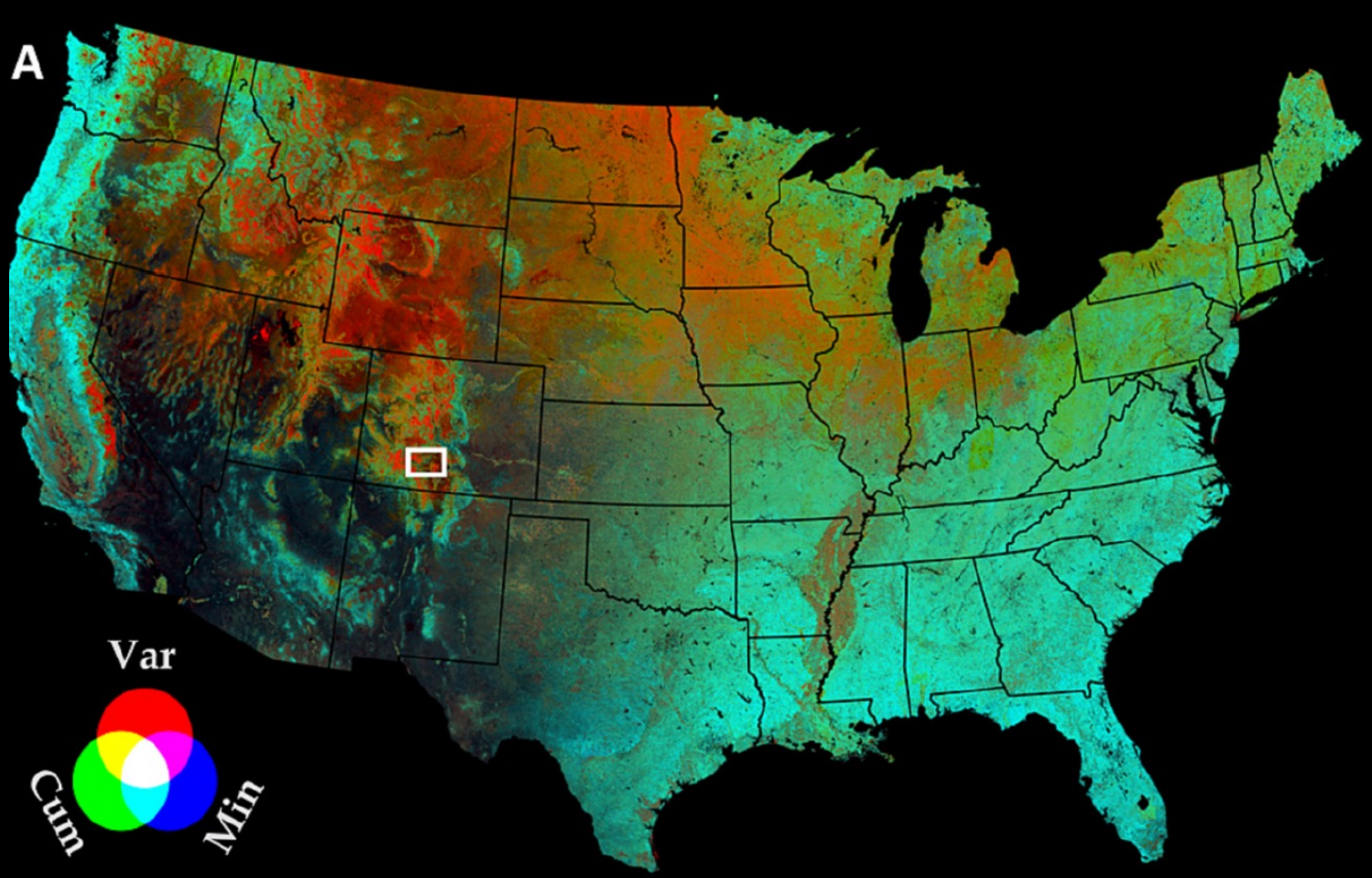
journal homepage: www.elsevier.com/locate/rse

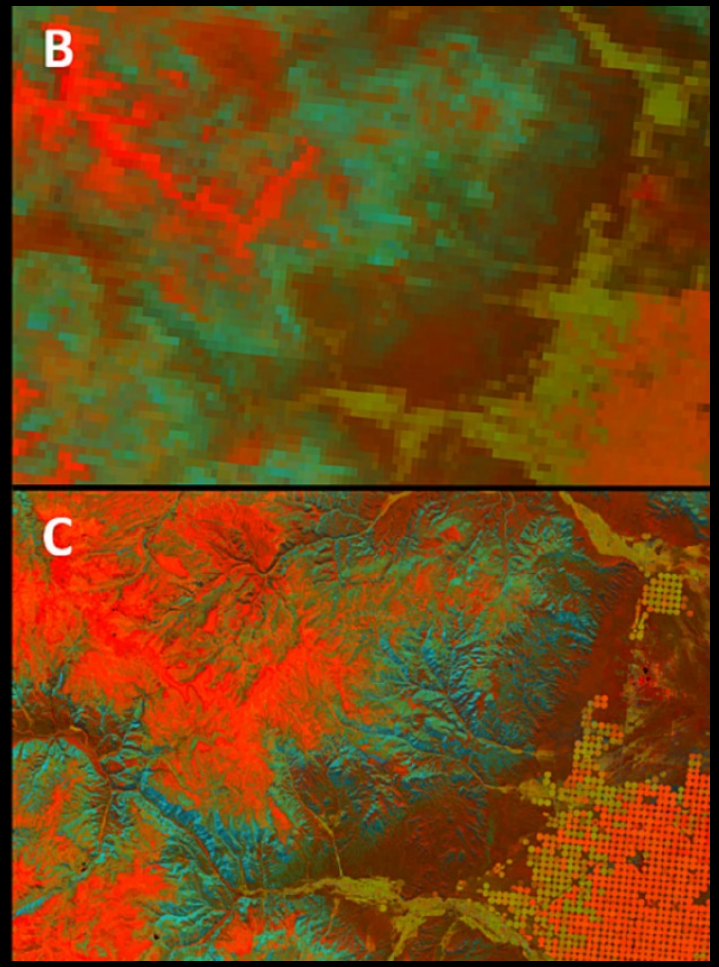
Review

Need and vision for global medium-resolution Landsat and Sentinel-2 data products

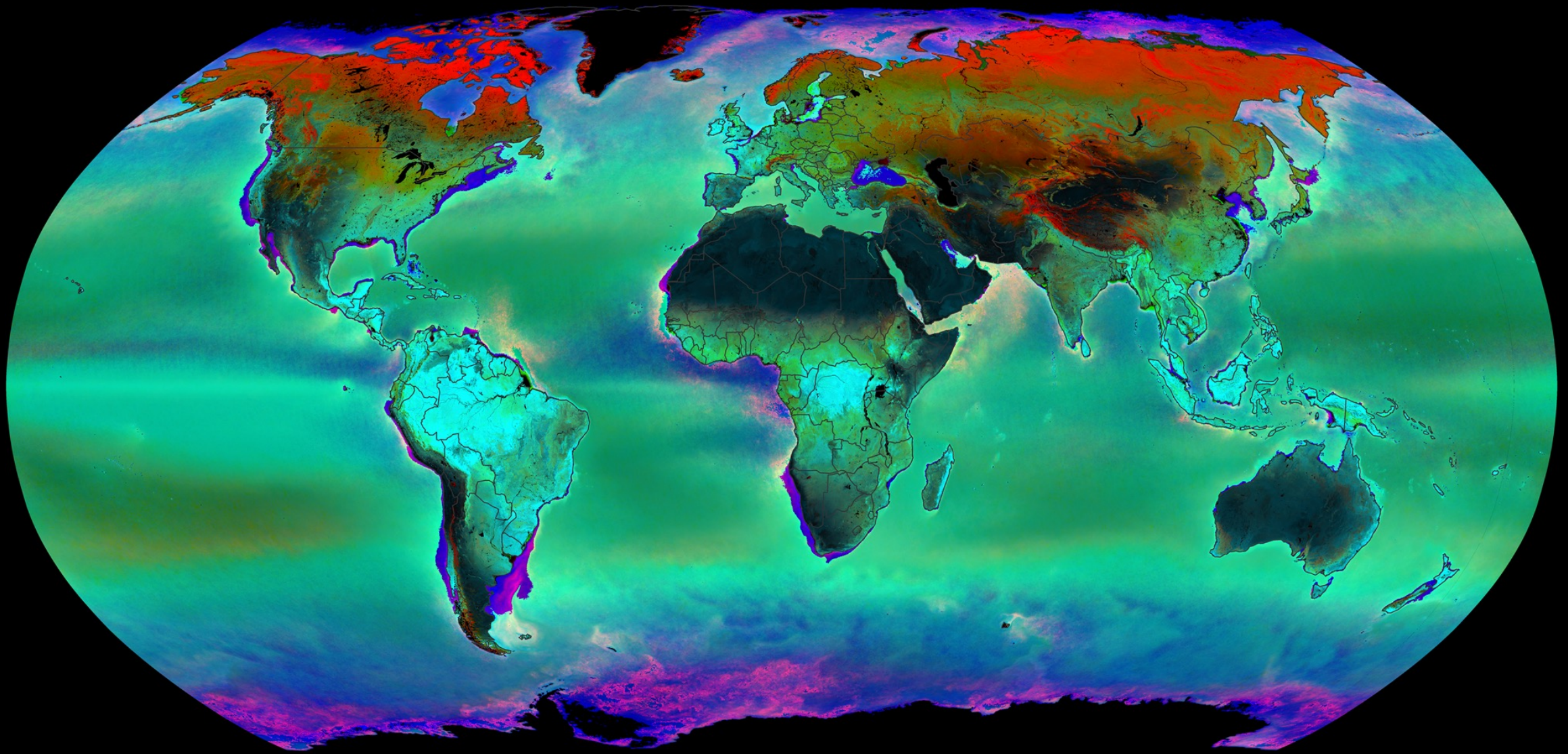
Volker C. Radeloff [a,*], David P. Roy [b], Michael A. Wulder [c], Martha Anderson [d], Bruce Cook [e], Christopher J. Crawford [f], Mark Friedl [g], Feng Gao [d], Noel Gorelick [h], Matthew Hansen [i], Sean Healey [j], Patrick Hostert [k,l], Glynn Hulley [m], Justin L. Huntington [n], David M. Johnson [o], Chris Neigh [e], Alexei Lyapustin [e], Leo Lymburner [p], Nima Pahlevan [e], Jean-Francois Pekel [q], Theodore A. Scambos [r], Crystal Schaaf [s], Peter Strobl [q], Curtis E. Woodcock [g], Hankui K. Zhang [t], Zhe Zhu [u]

Conclusions





Conclusions



Conclusions

SILVIS Lab

- Hobi, 2017, ***RSE***
- Radeloff, 2019, ***RSE***
- Hobi, 2021, ***Ecol Ind***
- Rapacciuolo, 2017, ***GEB***
- Coops, 2018, ***Sci Rep***
- Marin, 2018, ***Proc R Soc B***
- Coops, 2019, ***Ecol Ind***
- Rapacciulo, 2019, ***Nature E&E***
- Suttidate, 2019, ***RSE***
- Razenkova, 2020, ***Sci Rep***
- Silveira, 2021, ***RSE***
- Silveira, 2022, ***EcoApps***
- Suttidate, 2021, ***GECCO***
- Carroll, 2022, ***EcoApps***
- Razenkova, 2023, ***J. BioG***
- Silveira, 2023, ***RSE***
- Suttidate, 2023, ***Bio Cons***
- Carroll, 2023, ***EcoApps***
- Carroll, 2024, ***EcoApps***
- Radeloff, 2024, ***RSE***

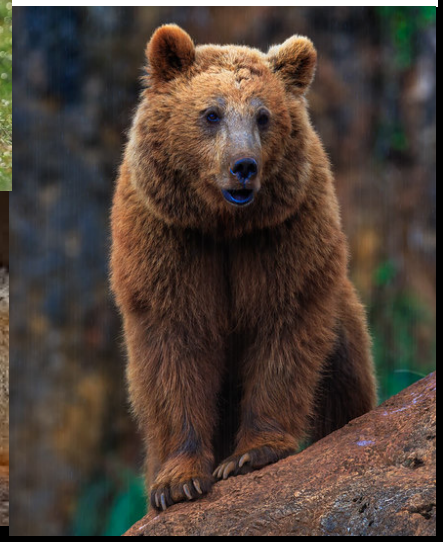
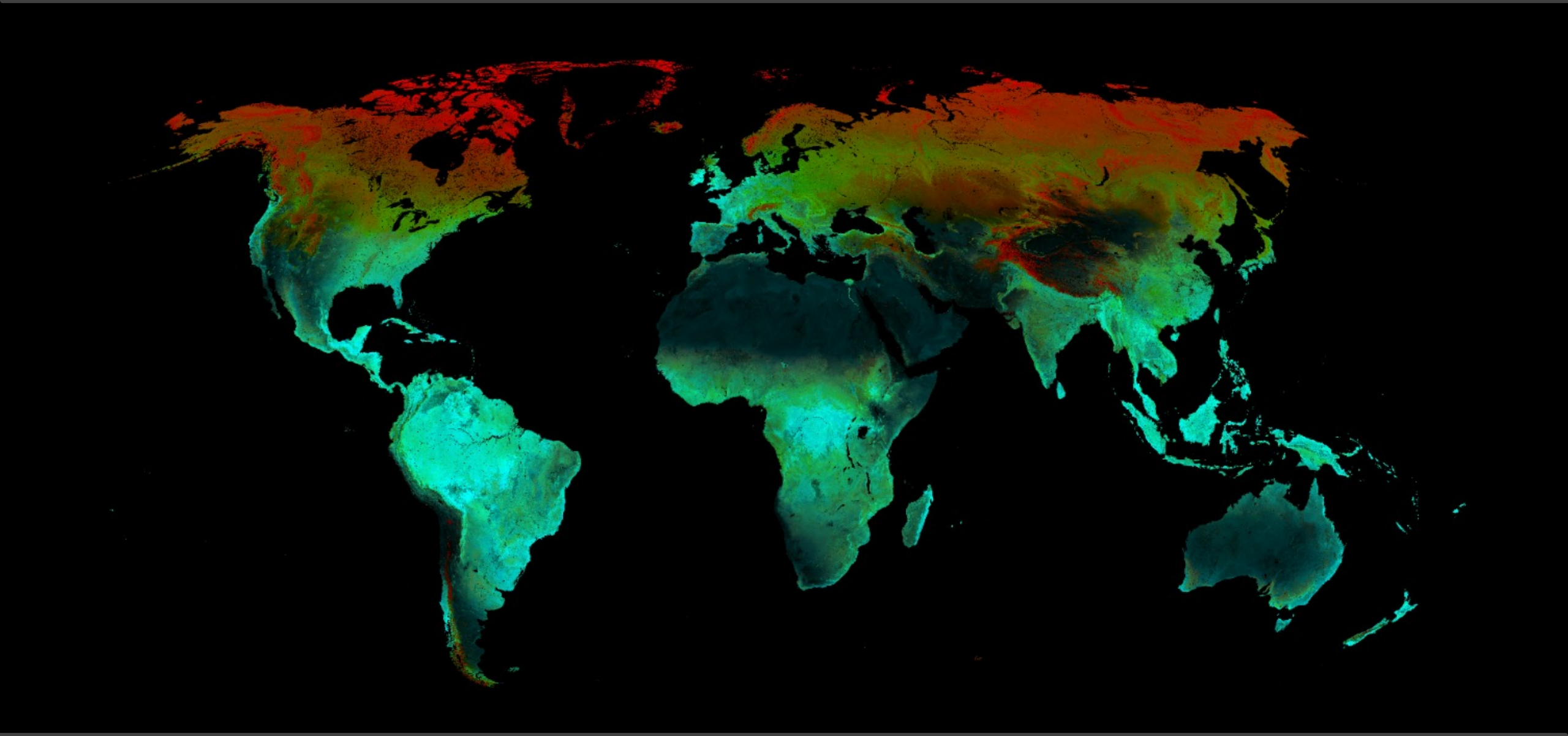
Other Users

Richness

- Algal species richness / Siberia
- Plant diversity / India
- Mammal richness / Xinjang
- Mammals & Birds / Pamir
- Bird diversity / France
- Raptor richness / Americas
- …

Species distributions

- Dwarf honeybee / Iran
- Sandhill crane / US
- Brown bear / Cantabria
- Caribou / US
- Moose / China
- Andean Condor / Argentina
- Grey Foxes / US
- Philippine Eagle / Philippines
- Grizzly bear / Canada
- White-tailed deer / US
- Purple-winged Ground Dove
- Mountain Tapir / Peru
- Serpent Eagle / Madagascar
- …



Thank you!!!