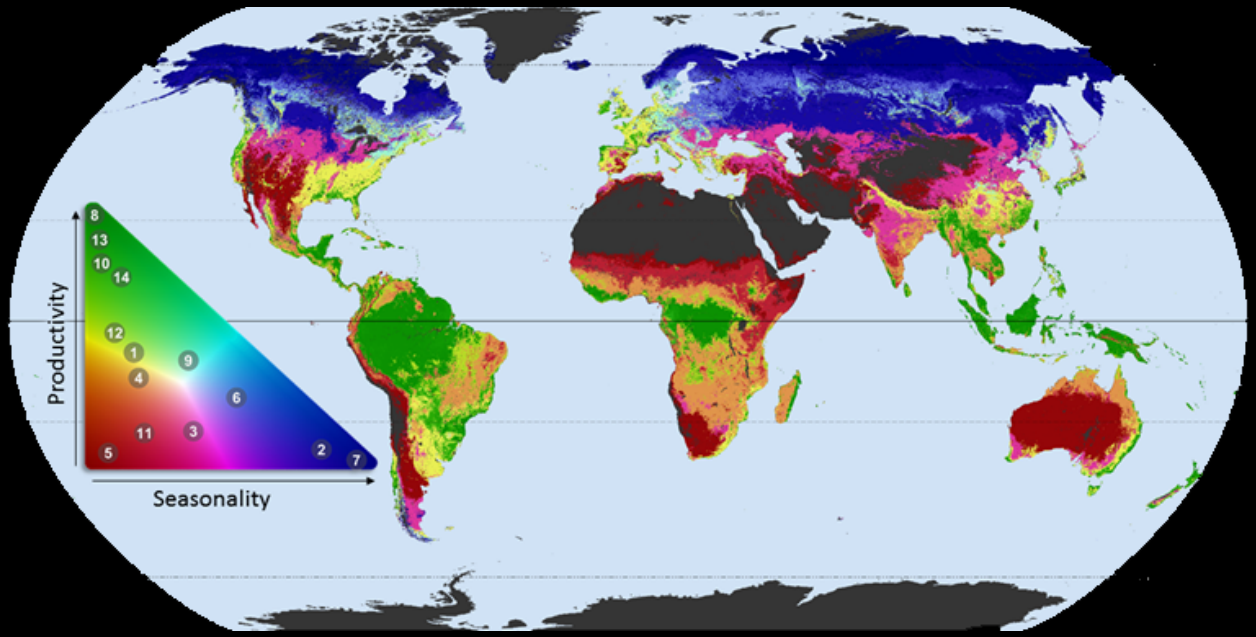
Developing and testing the Dynamic Habitat Indices from MODIS for biodiversity and conservation



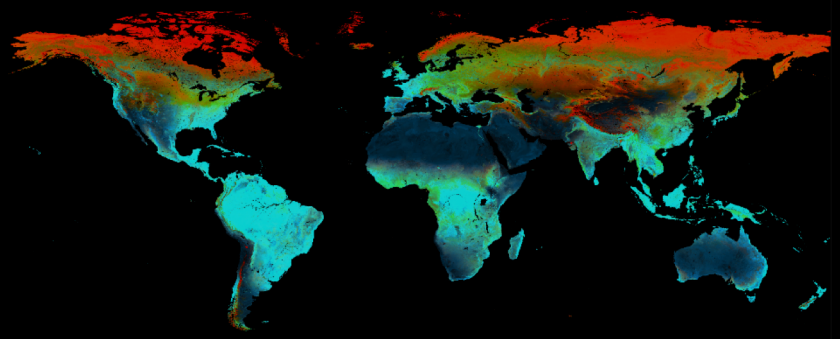
V. C. Radeloff, M. Dubinin, M. Hobi, A. Ives, A. Pidgeon, E. Razenkova, N. Suttidate, L. Zhu, University of Wisconsin-Madison

A. Allen, B. Borisov, T. Brooks, N. Coops, C. Graham, D. Koselov, J. Marin, G. Rapacciuolo

NASA Biodiversity and Ecological Forecasting Science Team Meeting, 5/24/2018

Outline

I. The Dynamic Habitat Indices



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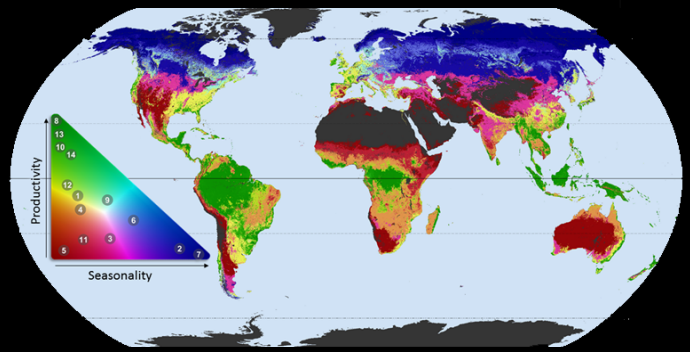

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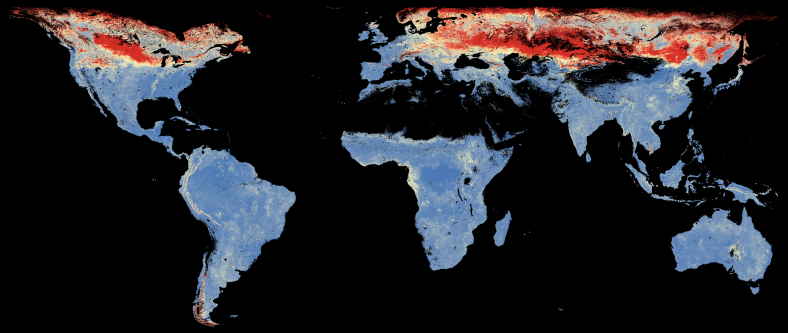
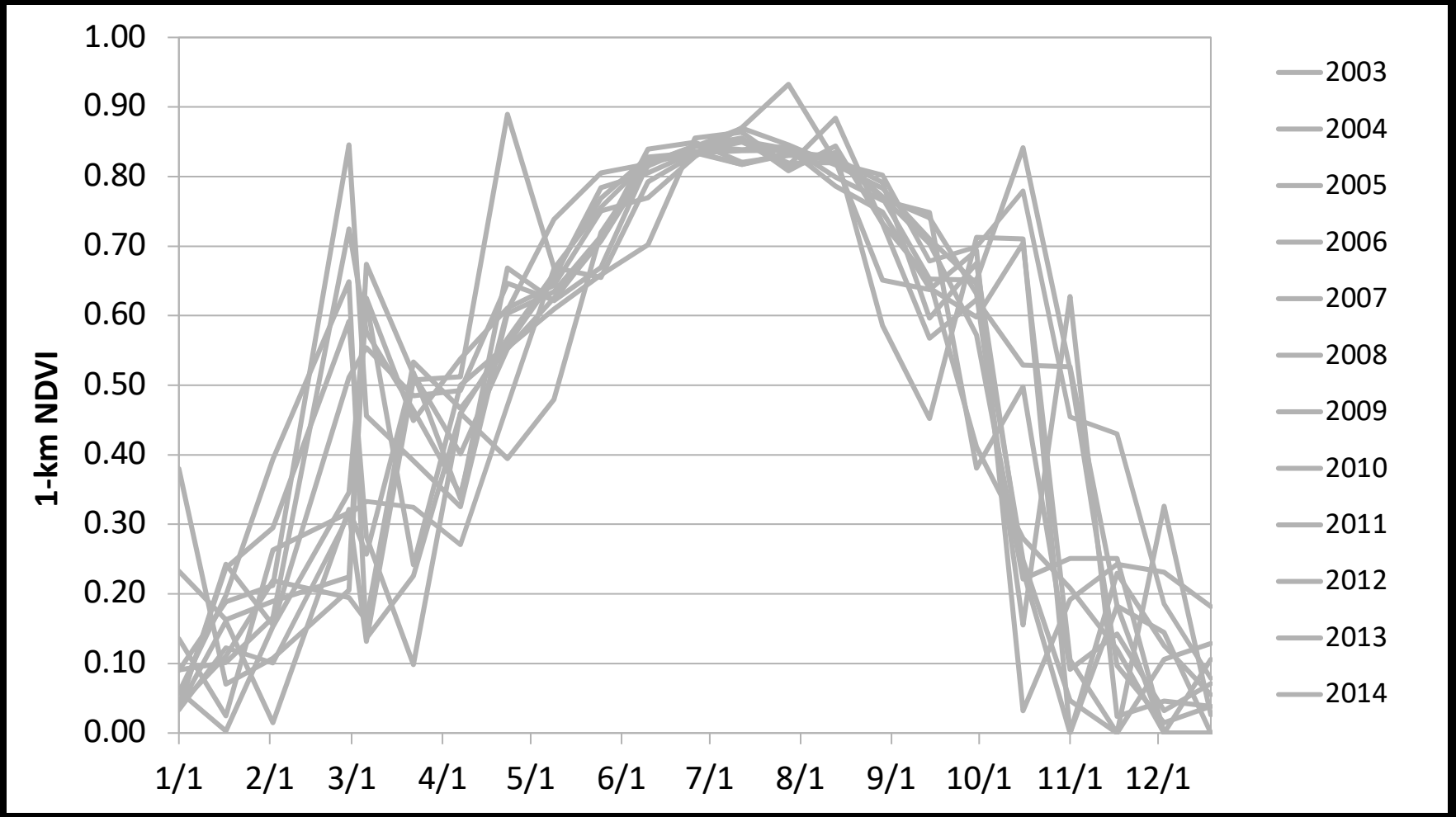


The Dynamic Habitat Indices

Ecology		DHIs
Available energy hypothesis	→	Cumulative productivity
Environmental stress hypothesis	→	Minimum productivity
Environmental variability hypothesis	→	Coefficient of variation

The Dynamic Habitat Indices



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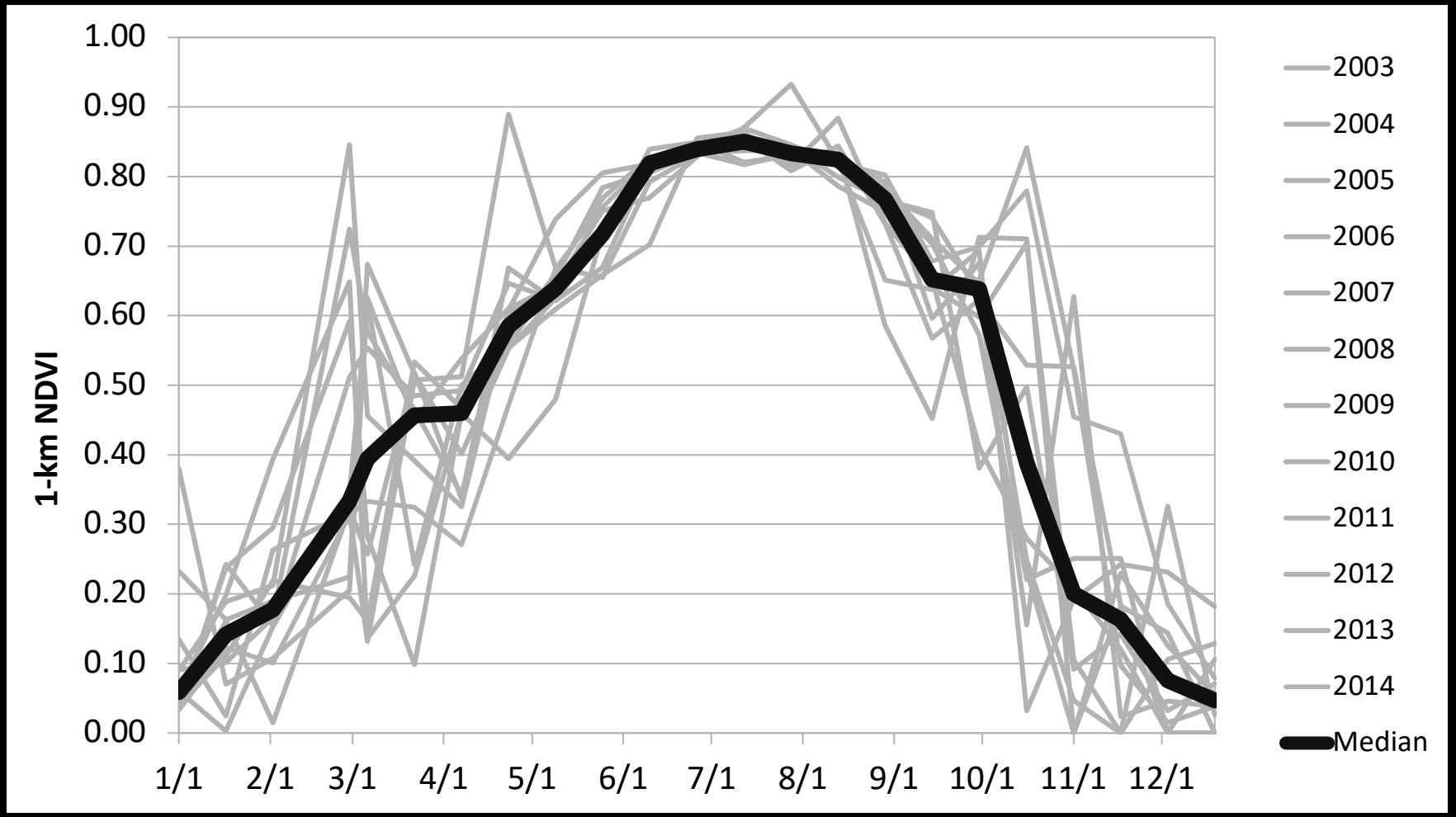

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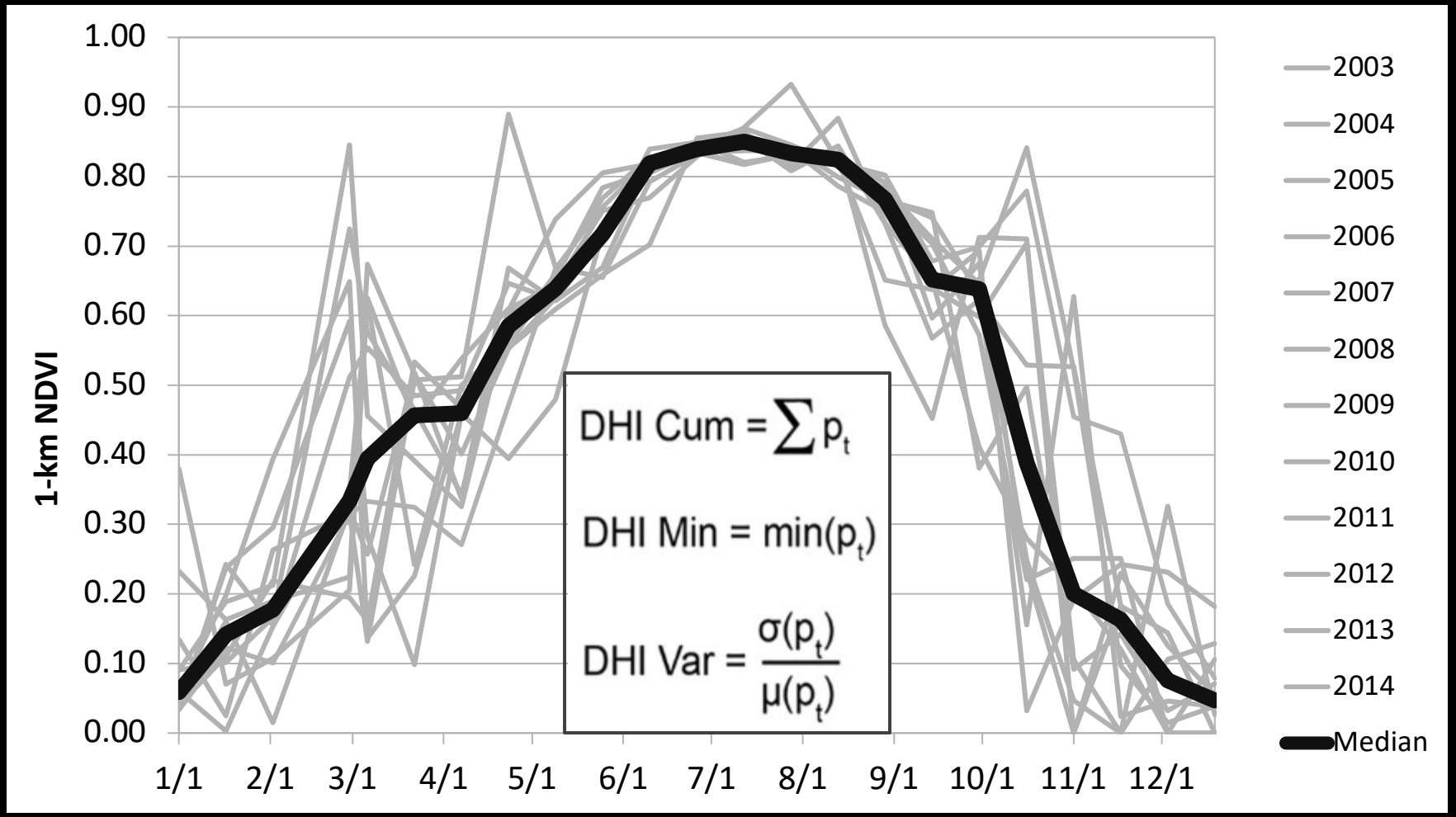

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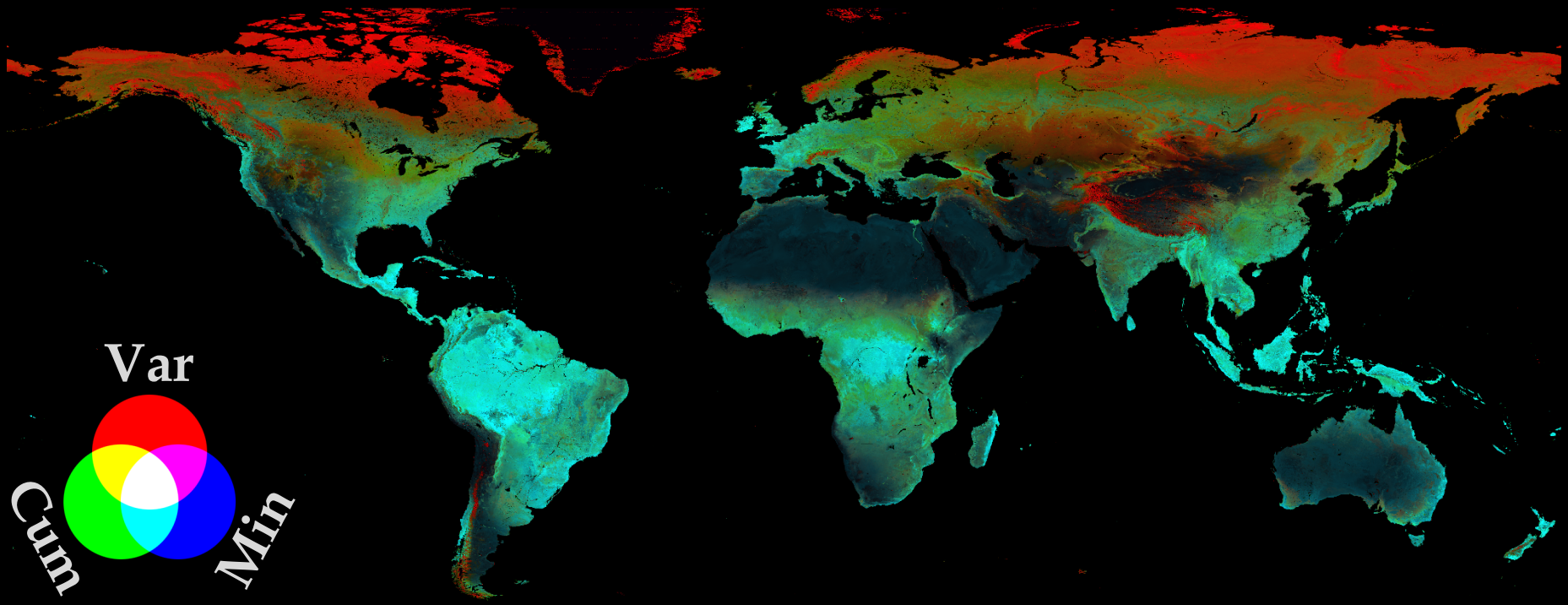
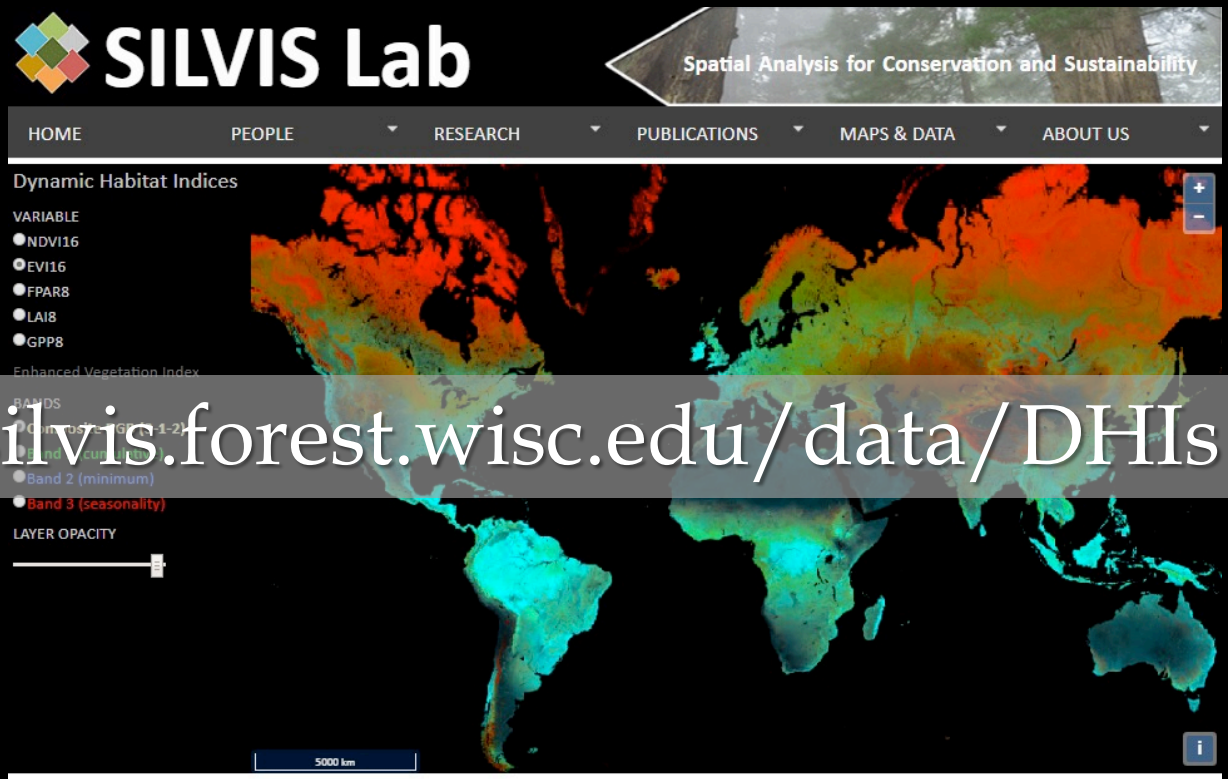


Composite EVI DHIs (2003-'14)

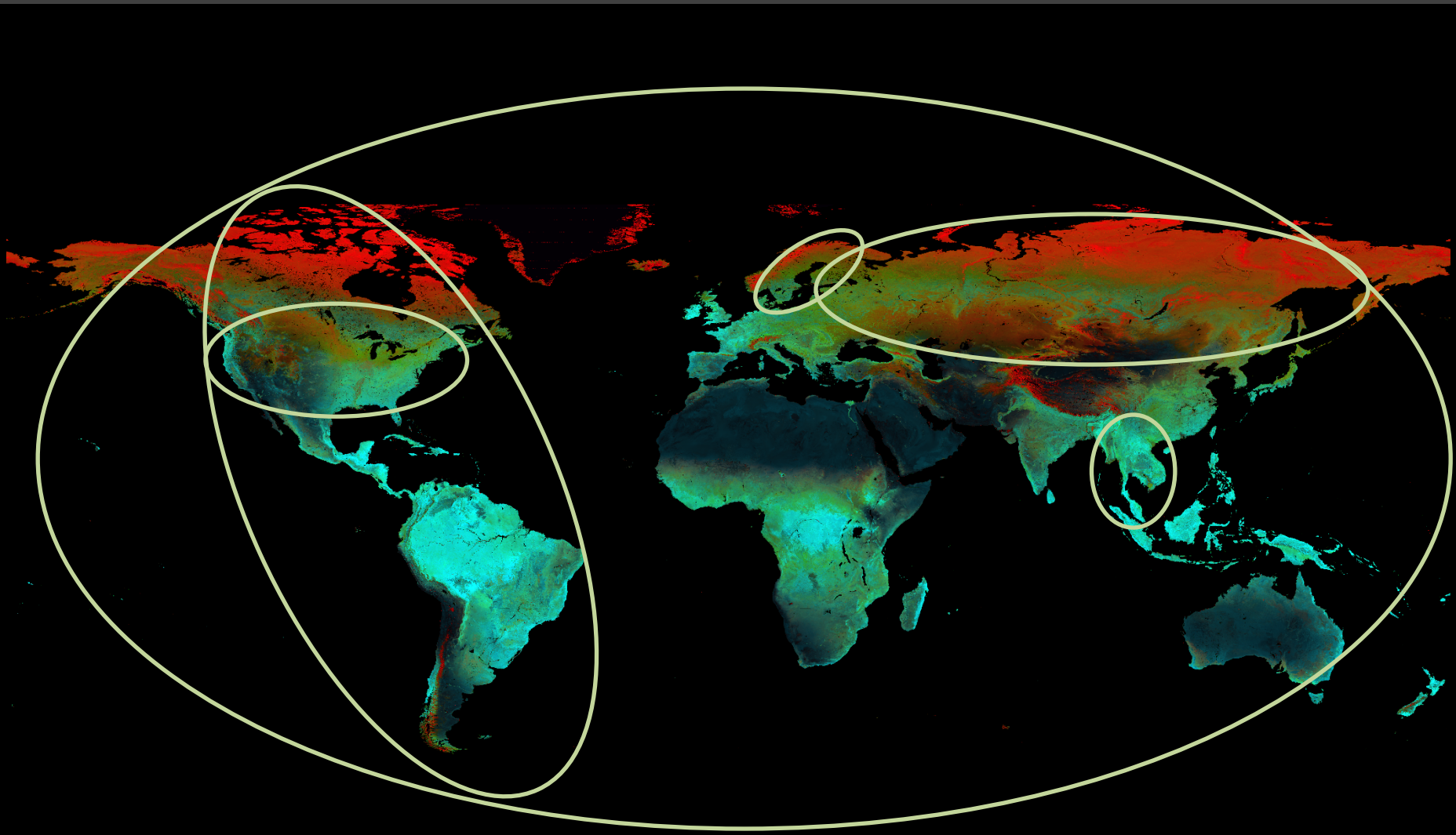
The Dynamic Habitat Indices



silvis.forest.wisc.edu/data/DHIs

Vegetation Index	Composite DHIs from 2003 -2014 MODIS data	Smoothed annual DHIs												
NDVI16 Normalized Difference Vegetation Index	NDVI16 Composite DHIs	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
EVI16 Enhanced Vegetation Index	EVI16 Composite DHIs	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
FPAR8 Fraction absorbed Photosynthetically Active Radiation	FPAR8 Composite DHIs	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
LAI8 Leaf Area Index	LAI8 Composite DHIs	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
GPP8 Gross Primary Production	GPP8 Composite DHIs	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015

The Dynamic Habitat Indices



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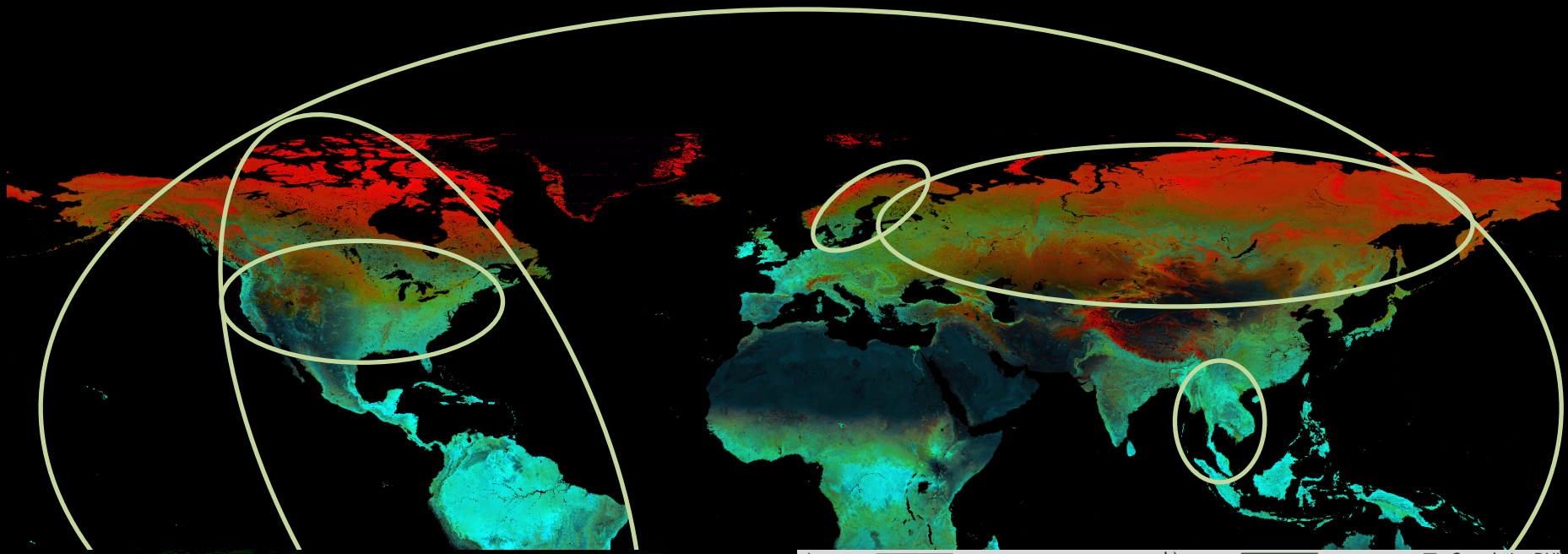

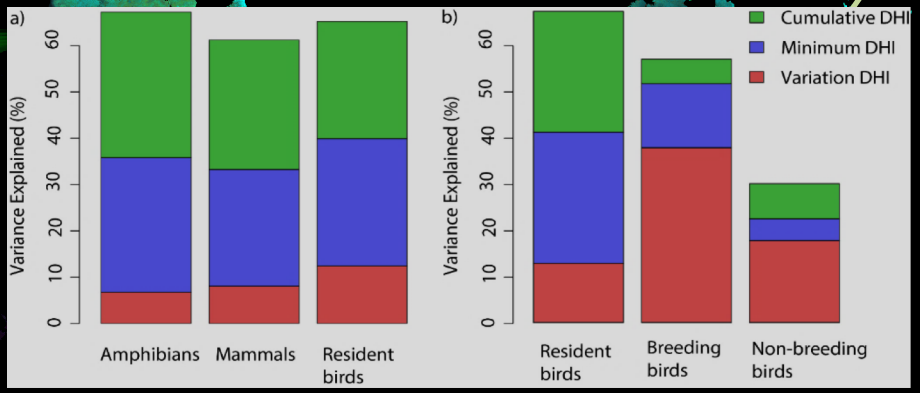

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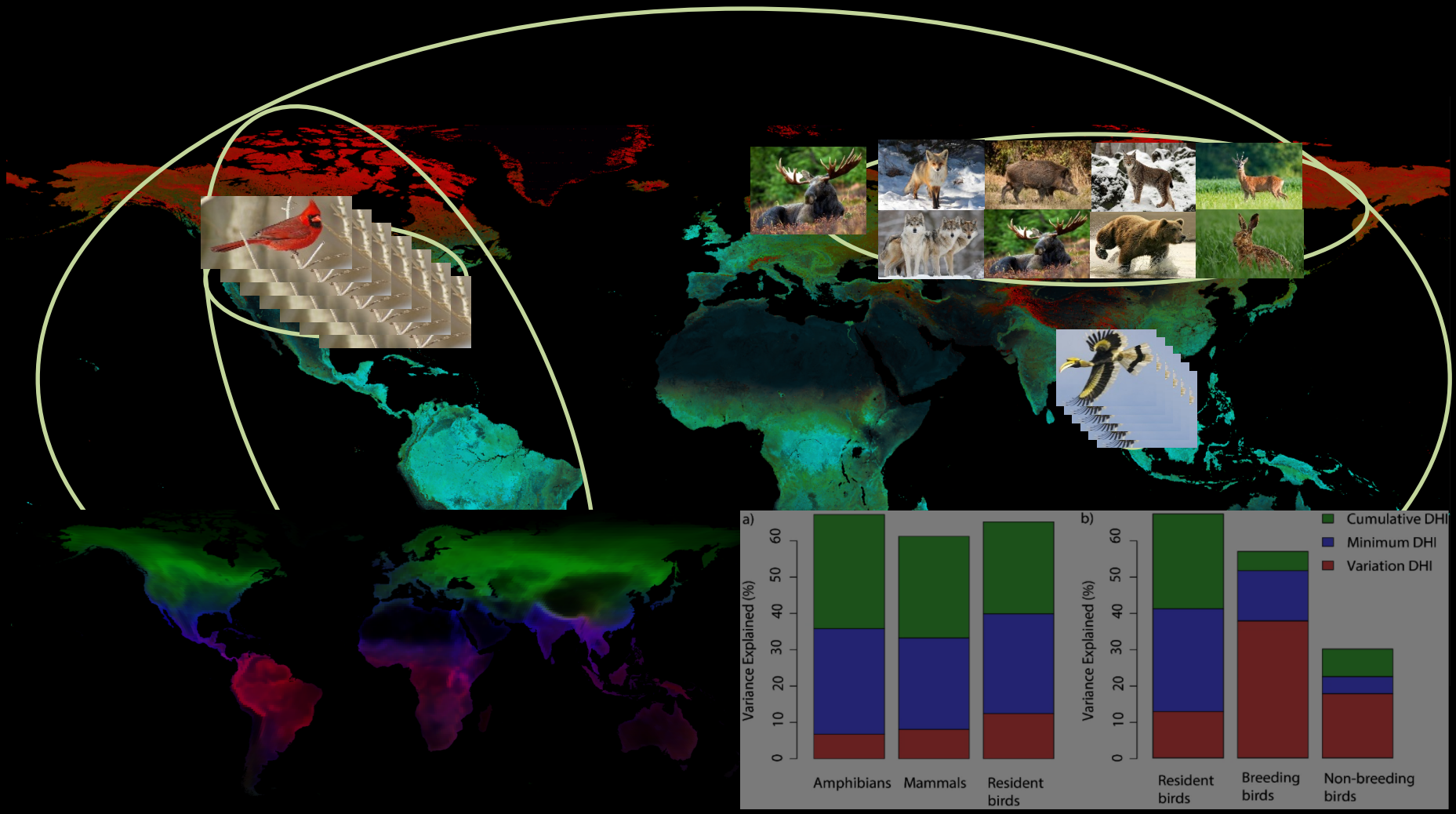

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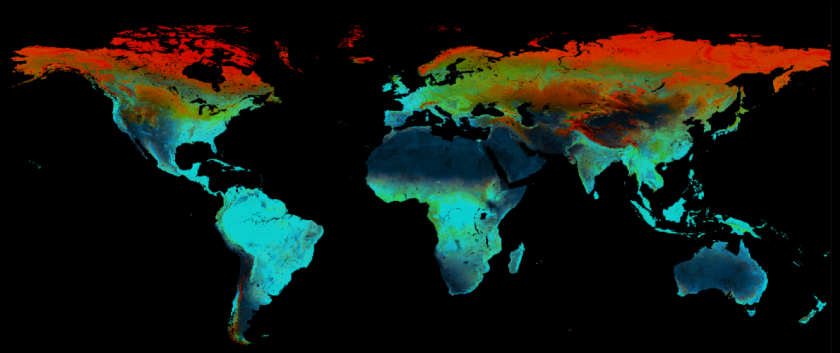

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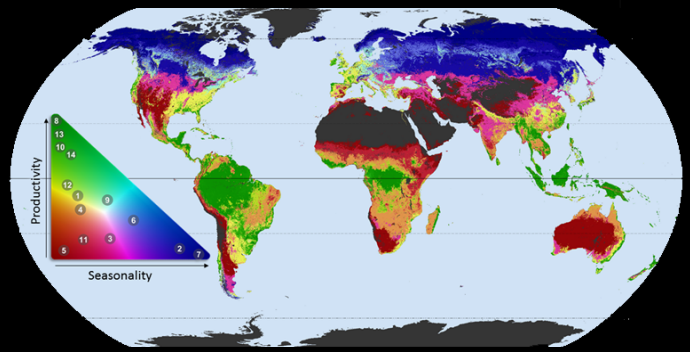

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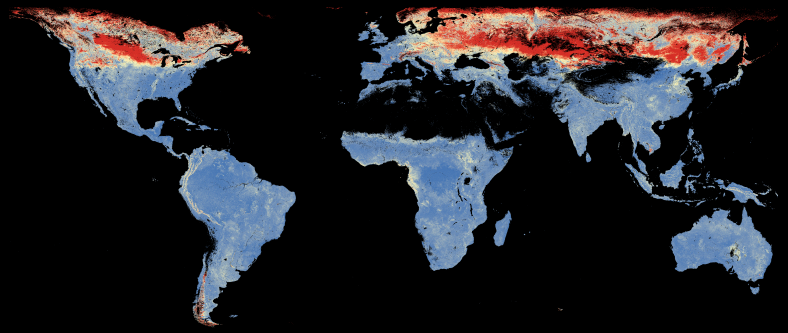

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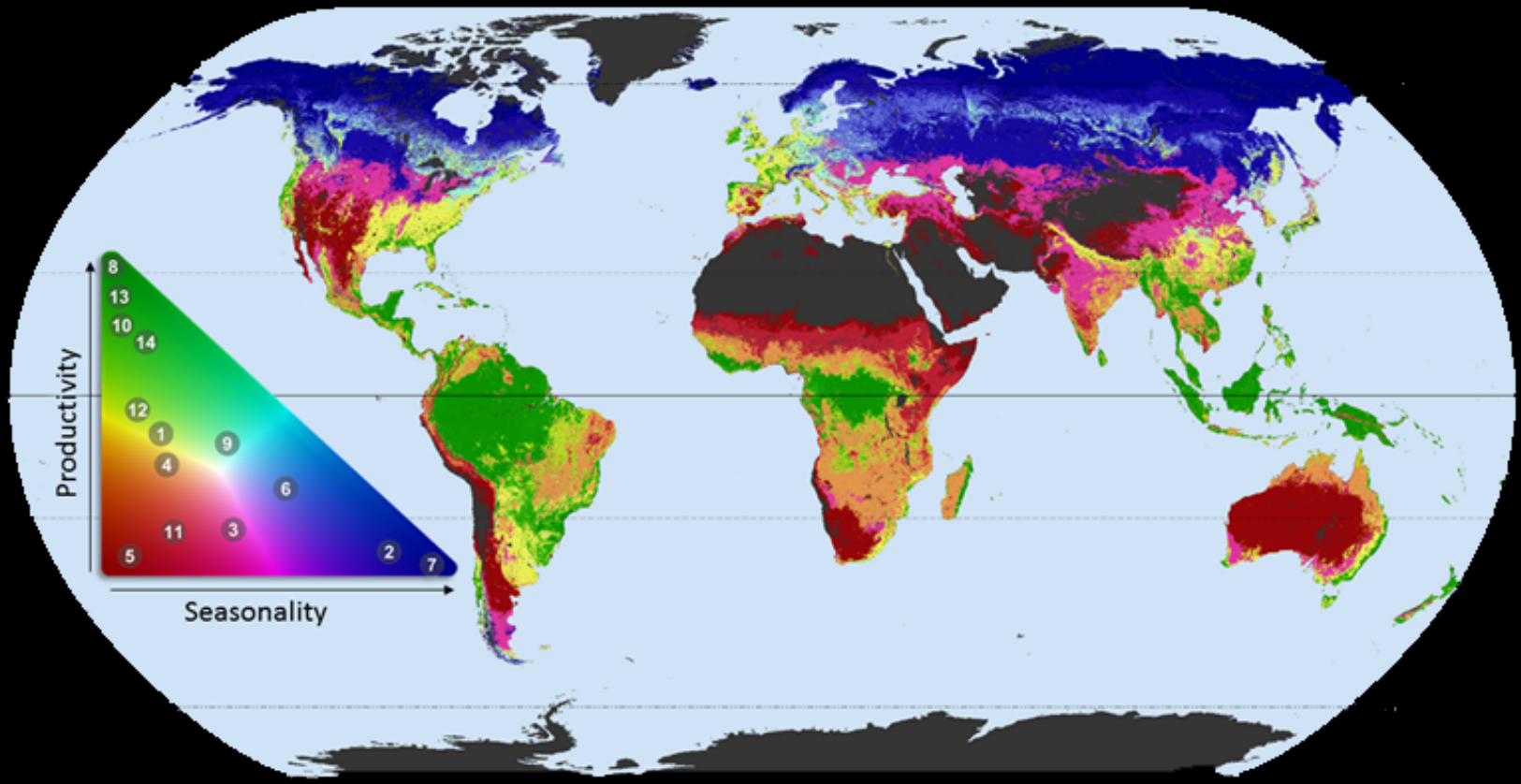

Coops et al.

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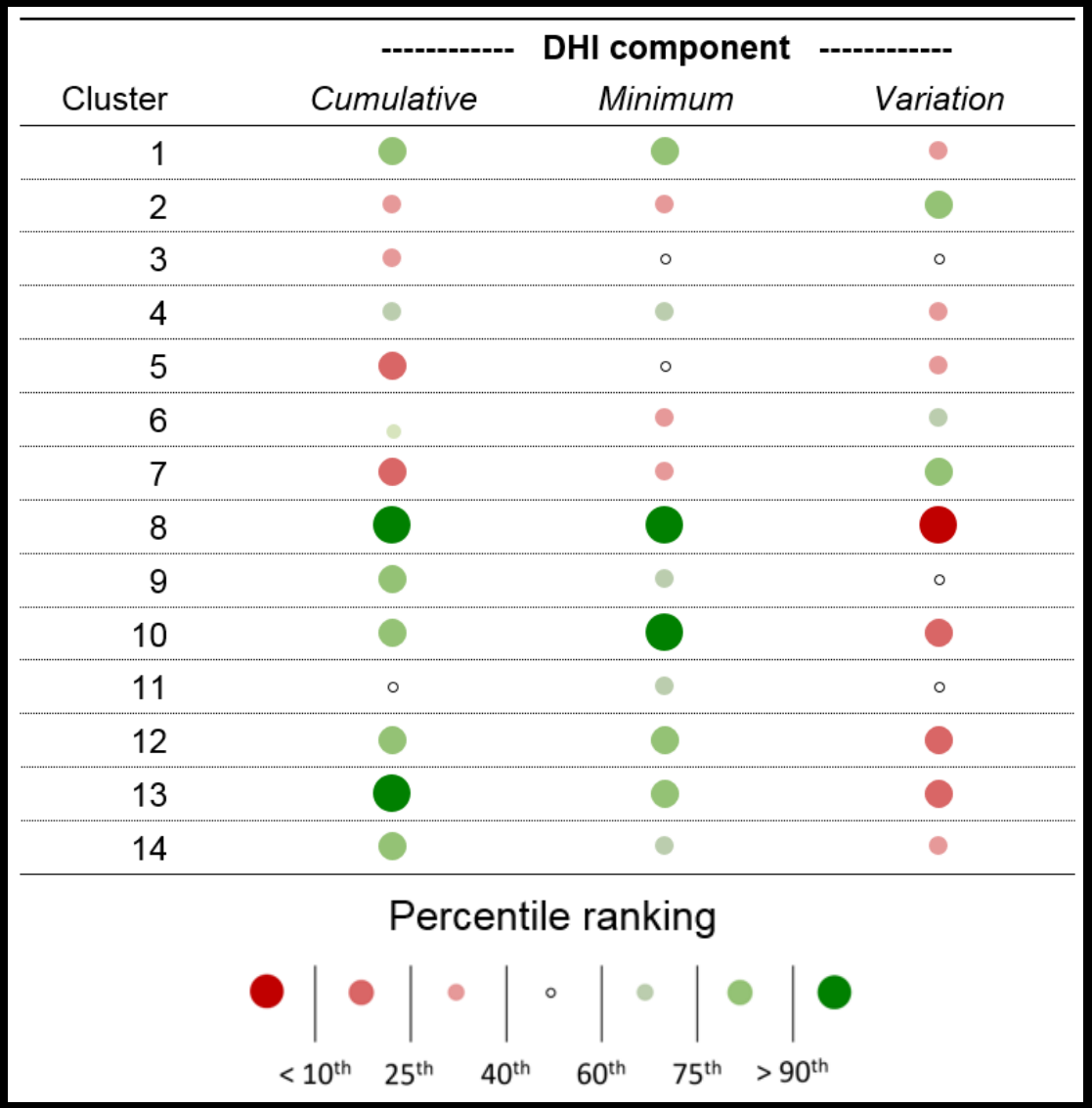

Coops et al.

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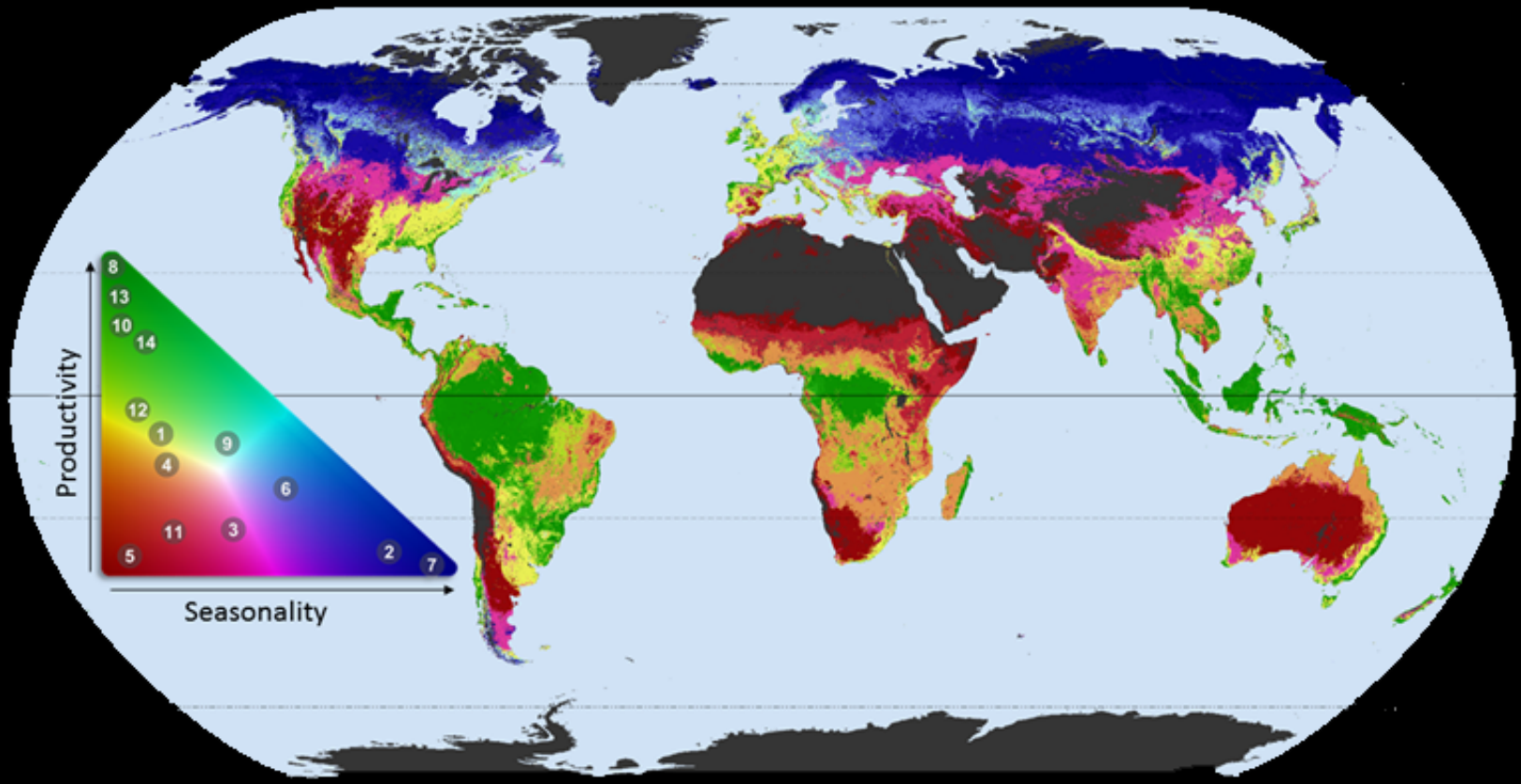

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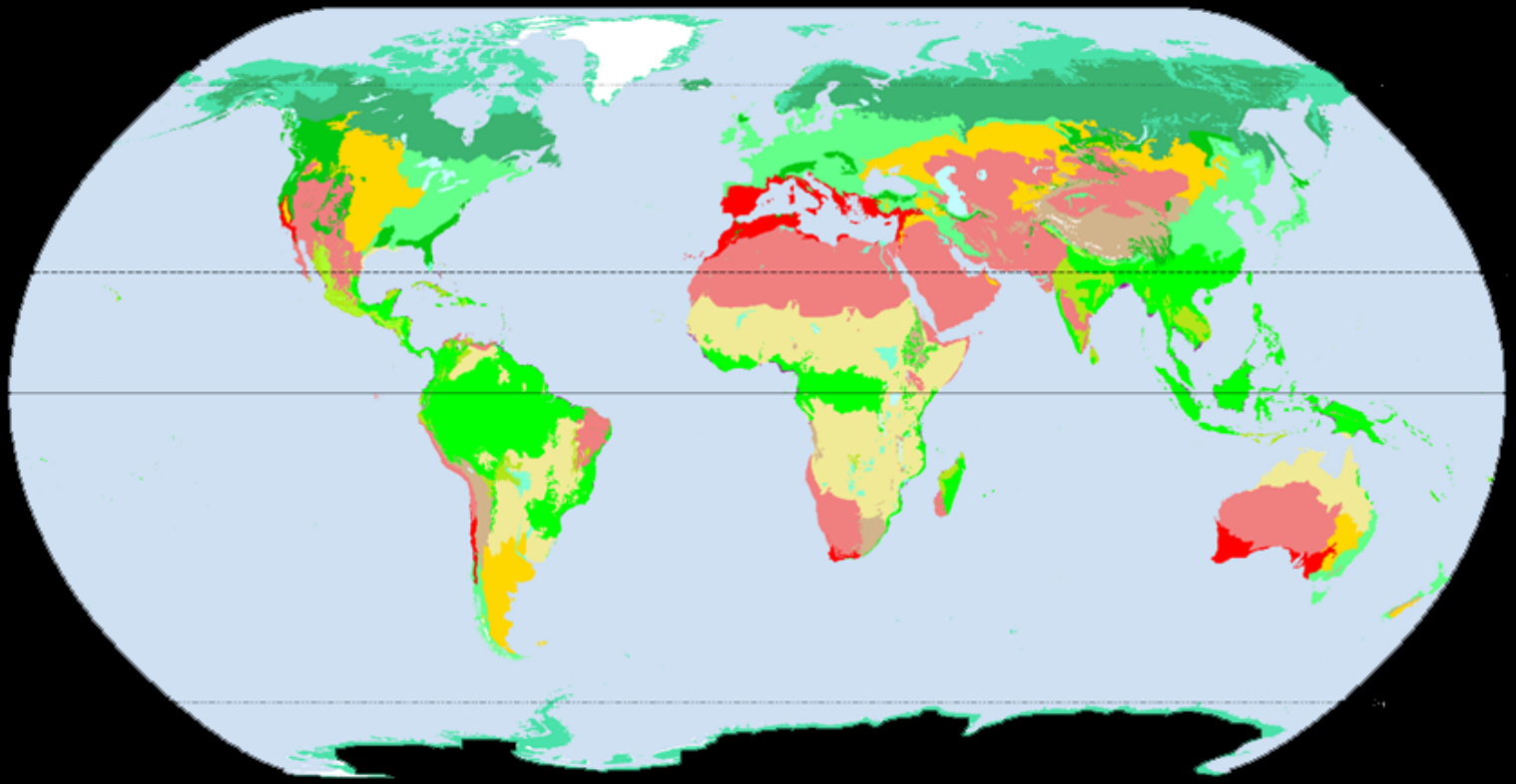

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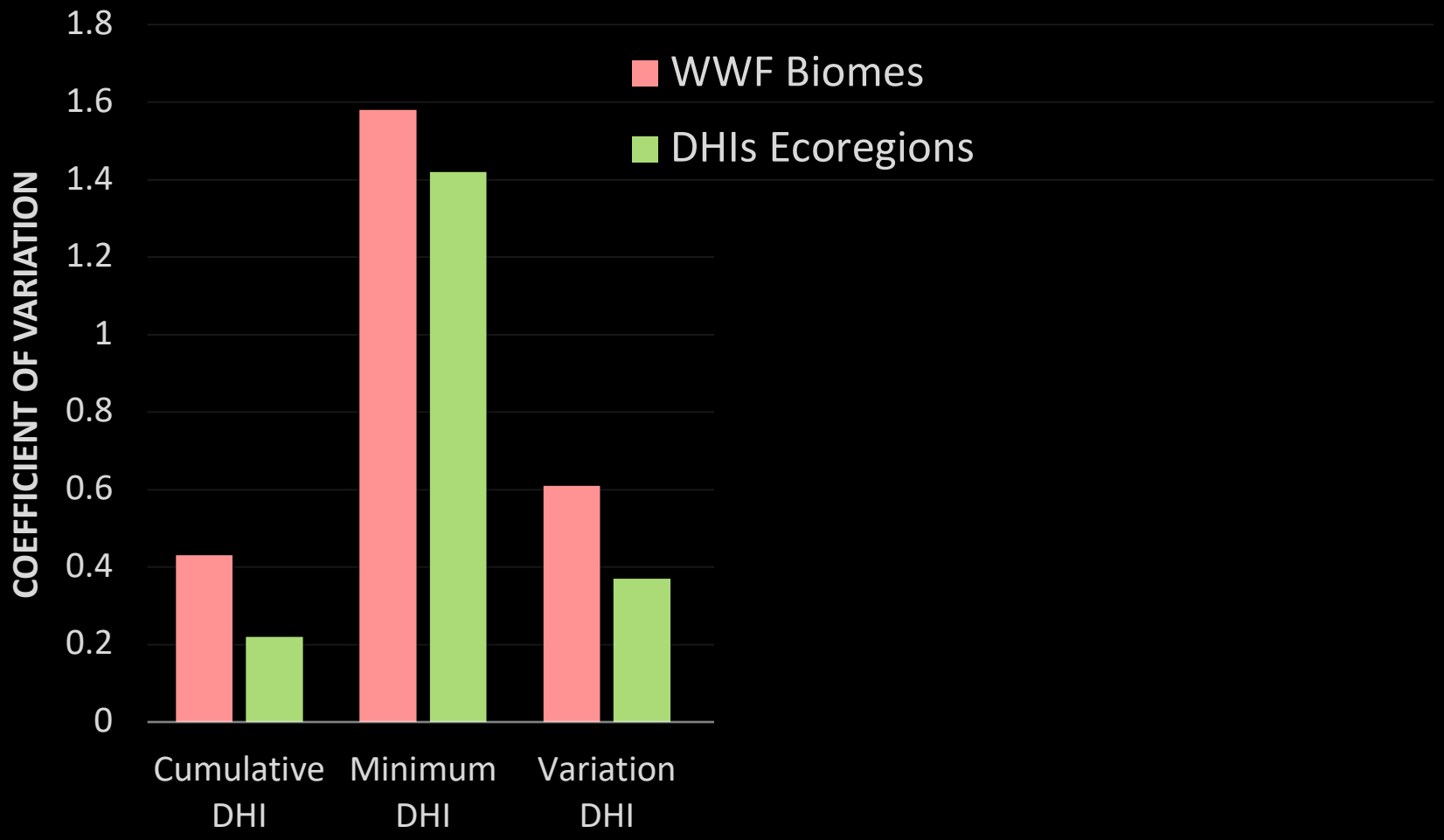

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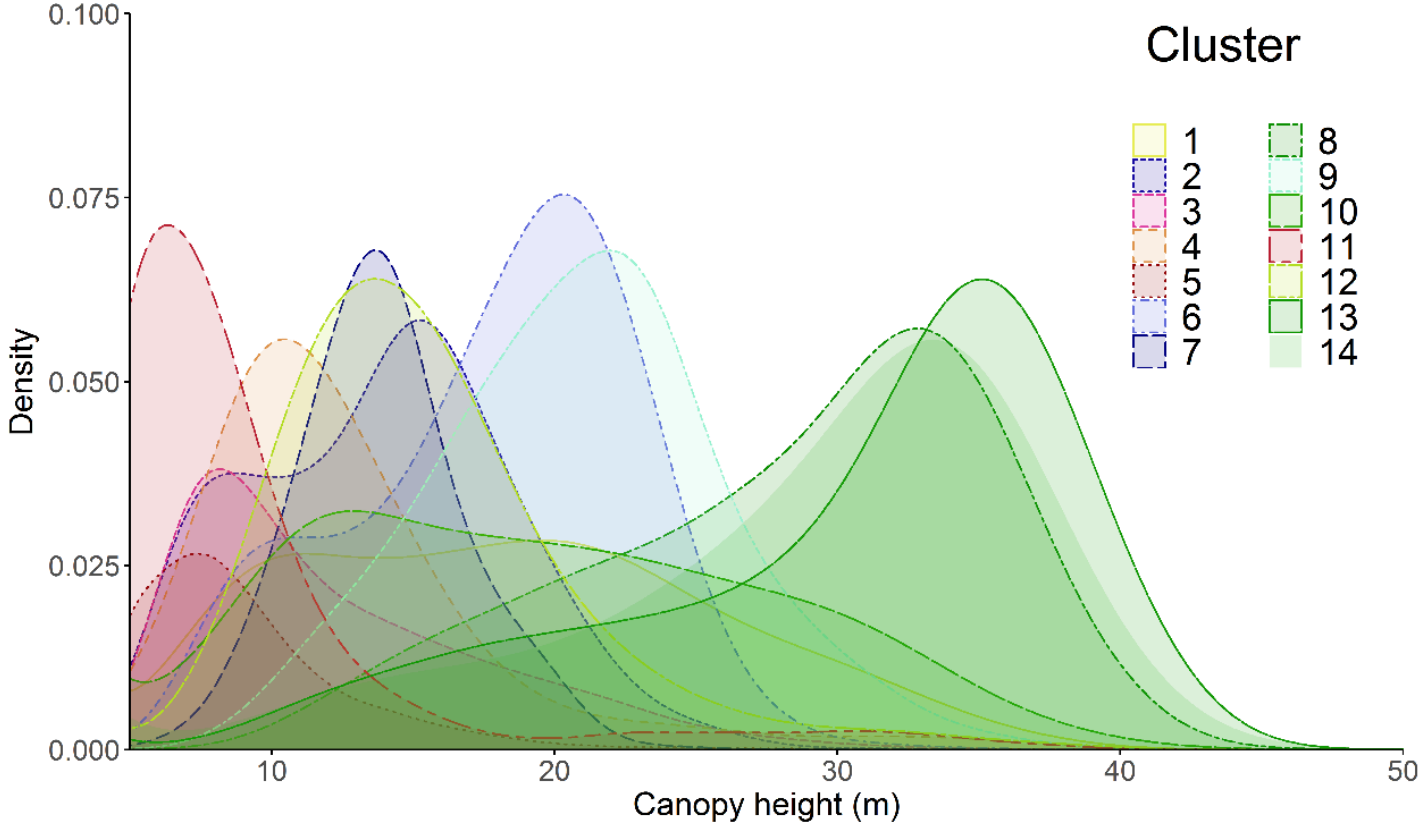

Based on GLAS/ICESat waveform Lidar data plus climate, topography etc. (Simard et al., 2011)

Coops et al.

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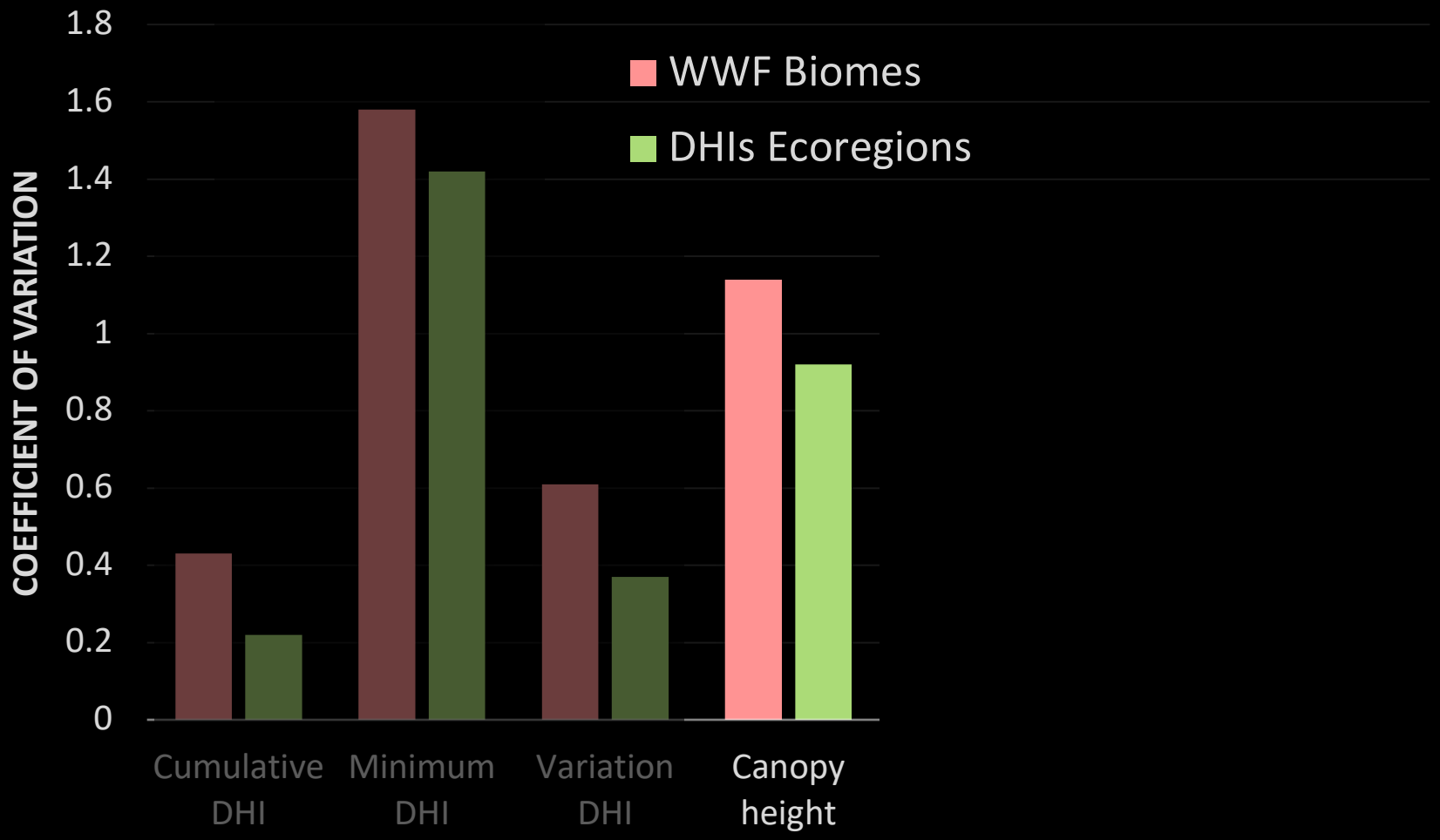

Coops et al.

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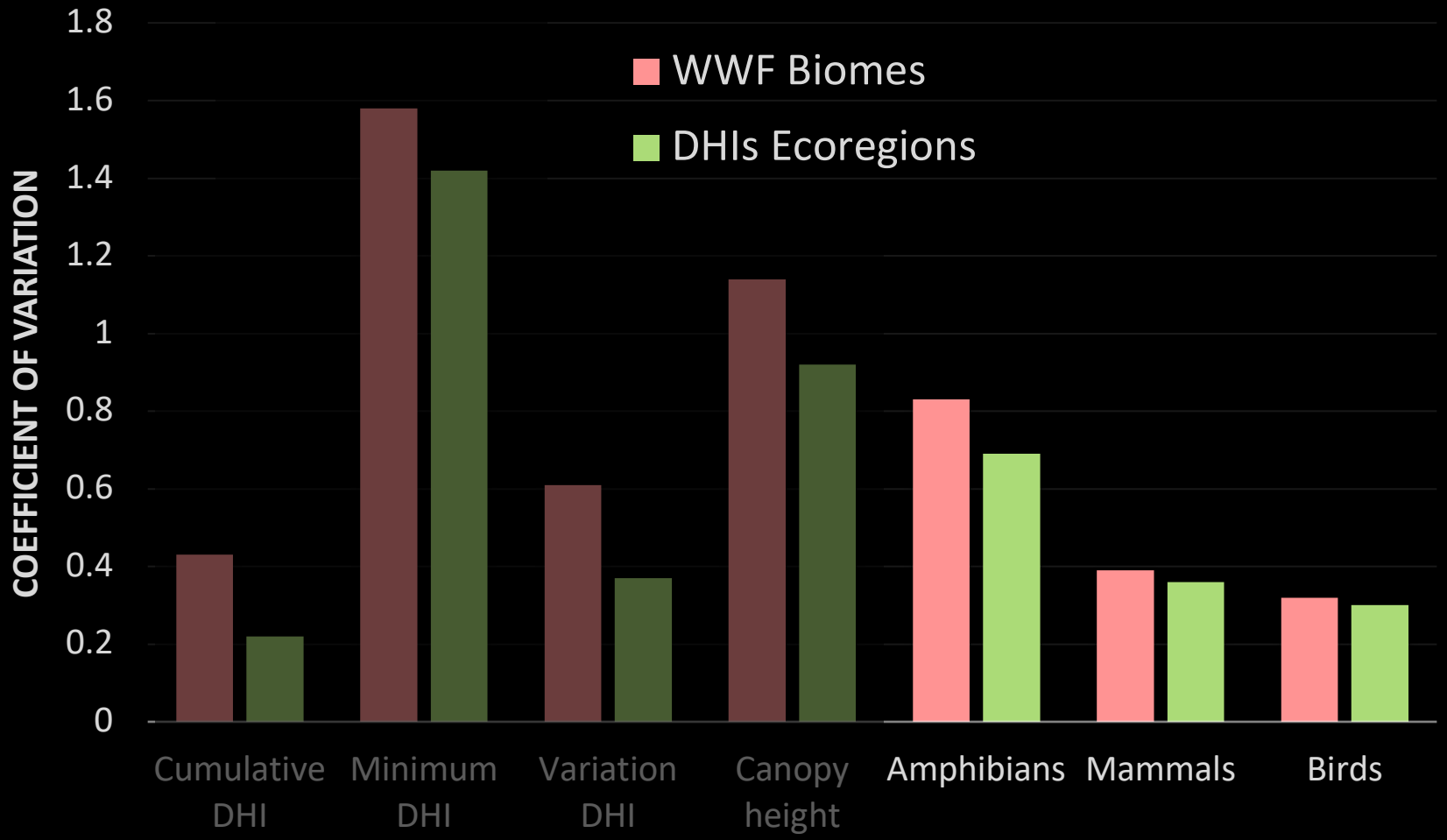

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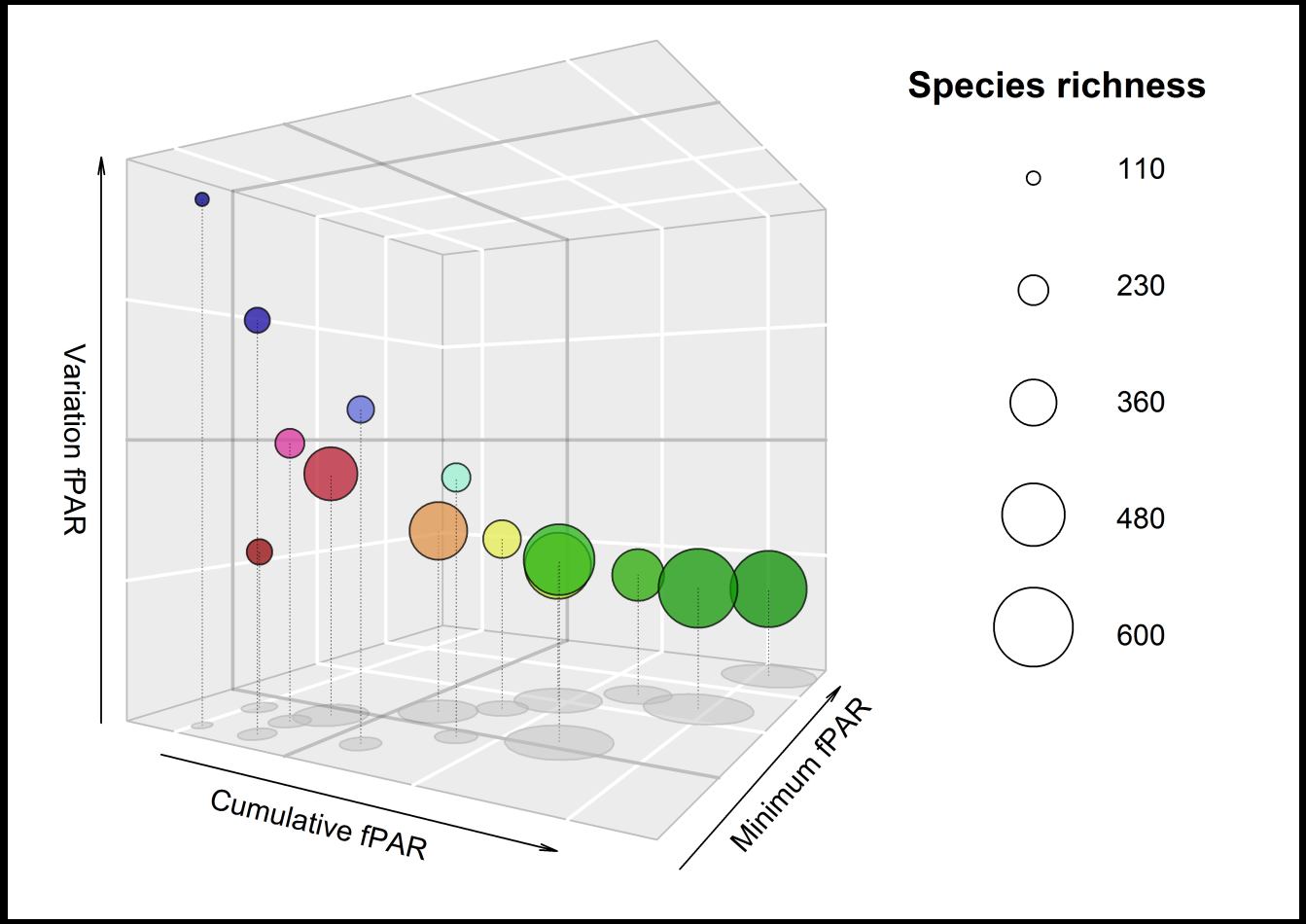

Coops et al.

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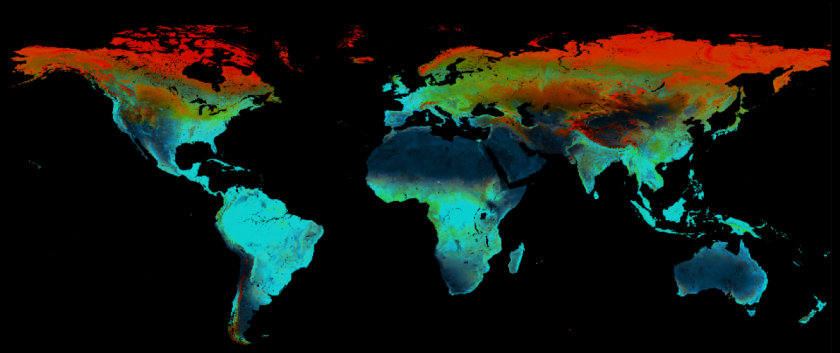

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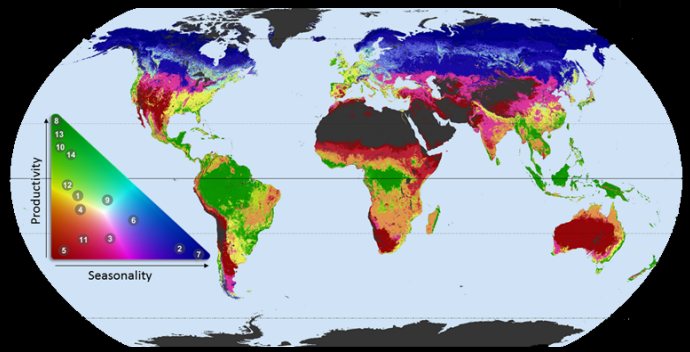

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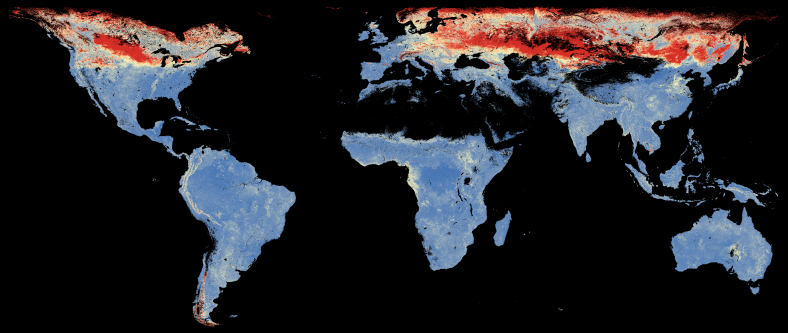
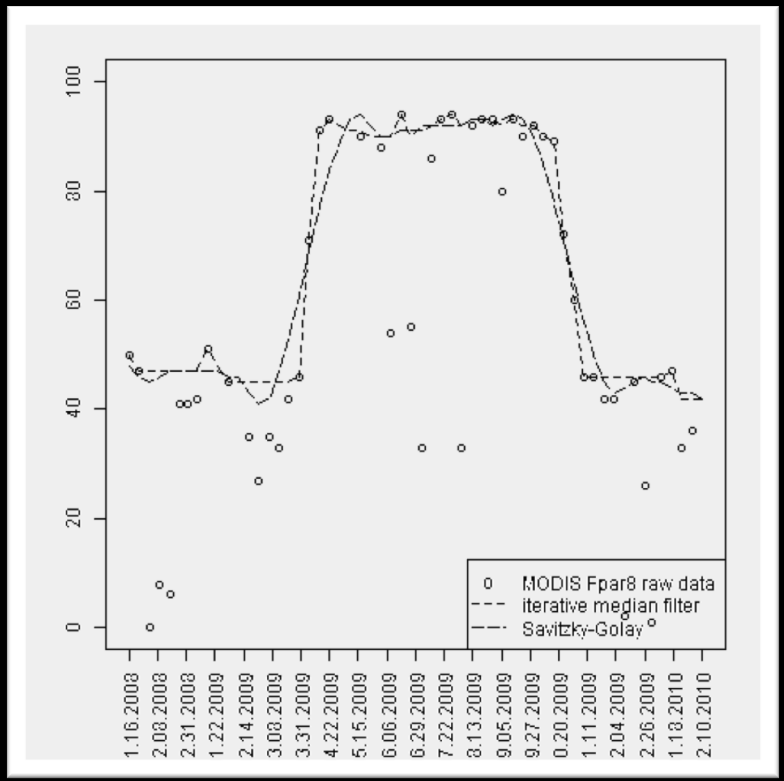


Annual DHIs

- Annual DHIs
  - Smoothed annual phenology
    - Iterative median
    - Savitzky-Golay



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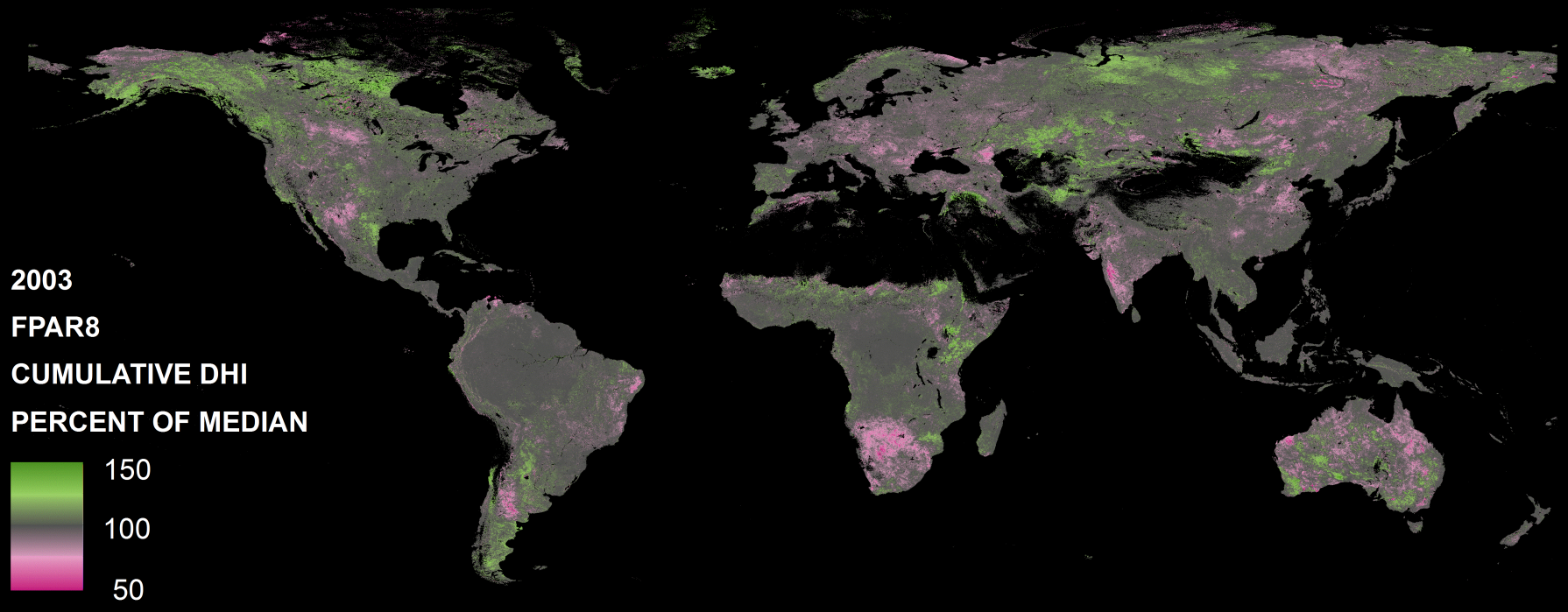

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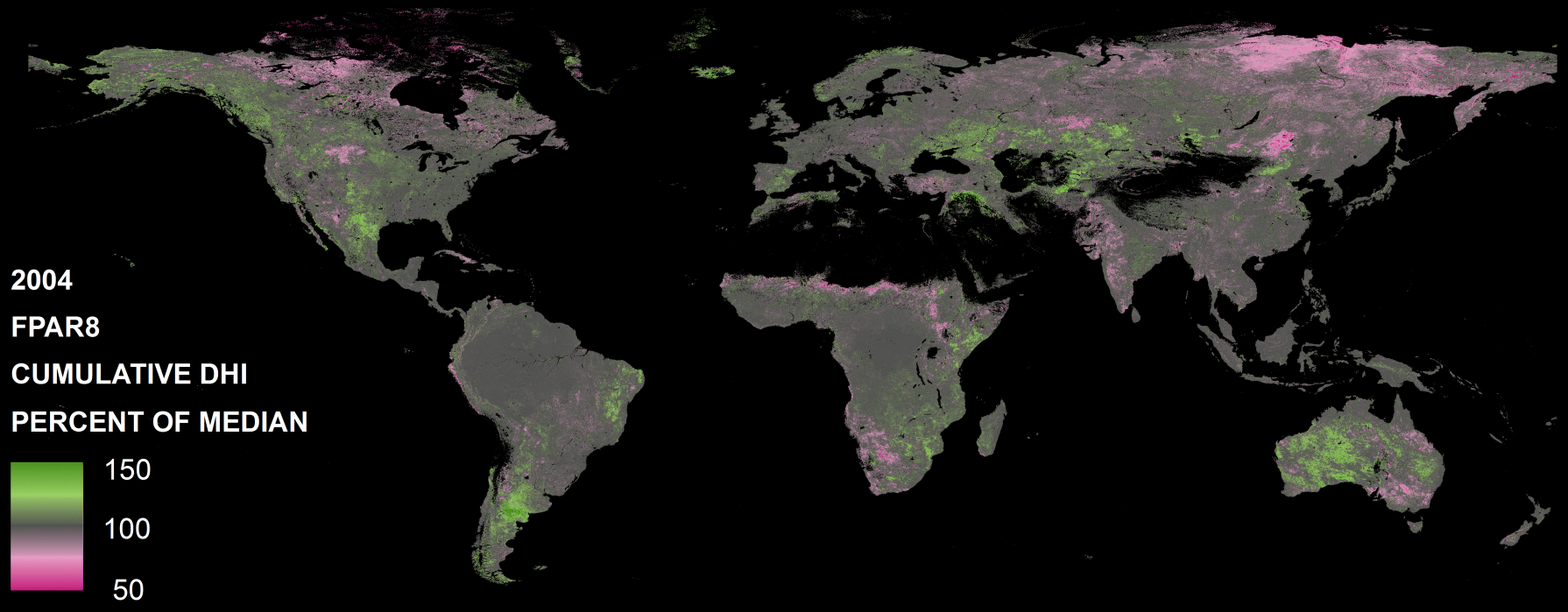

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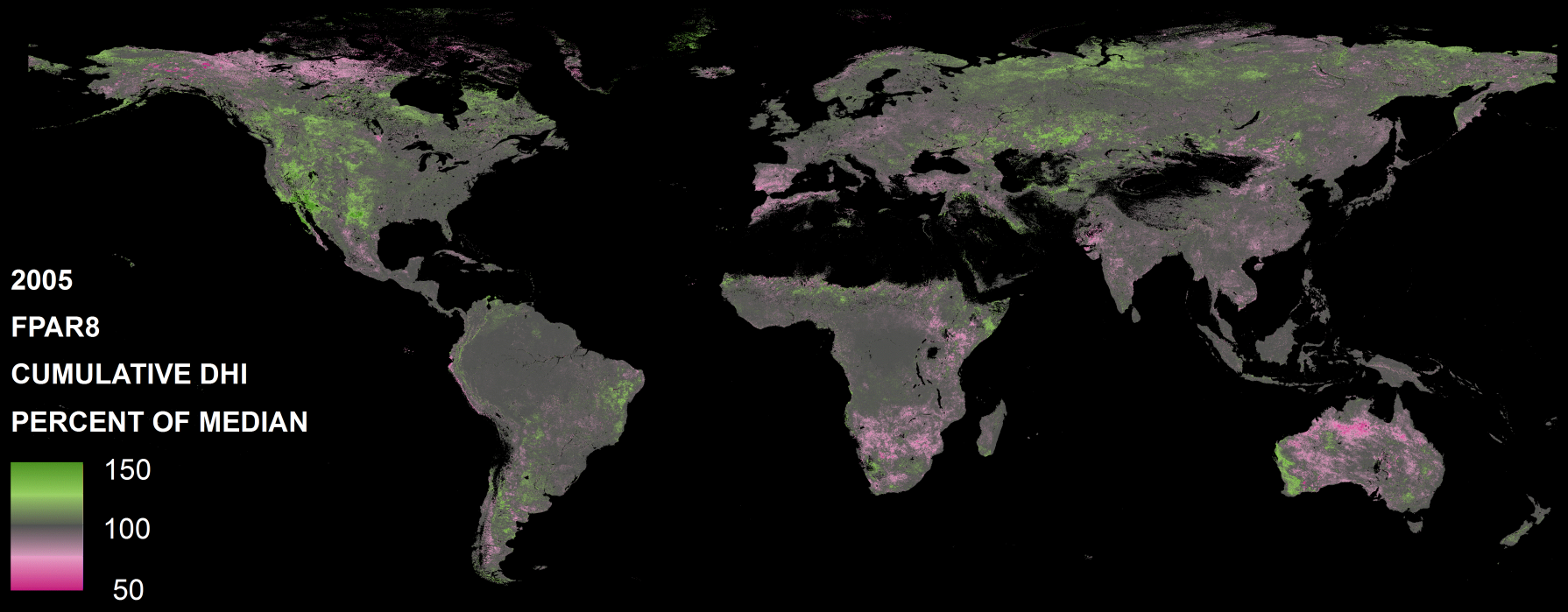

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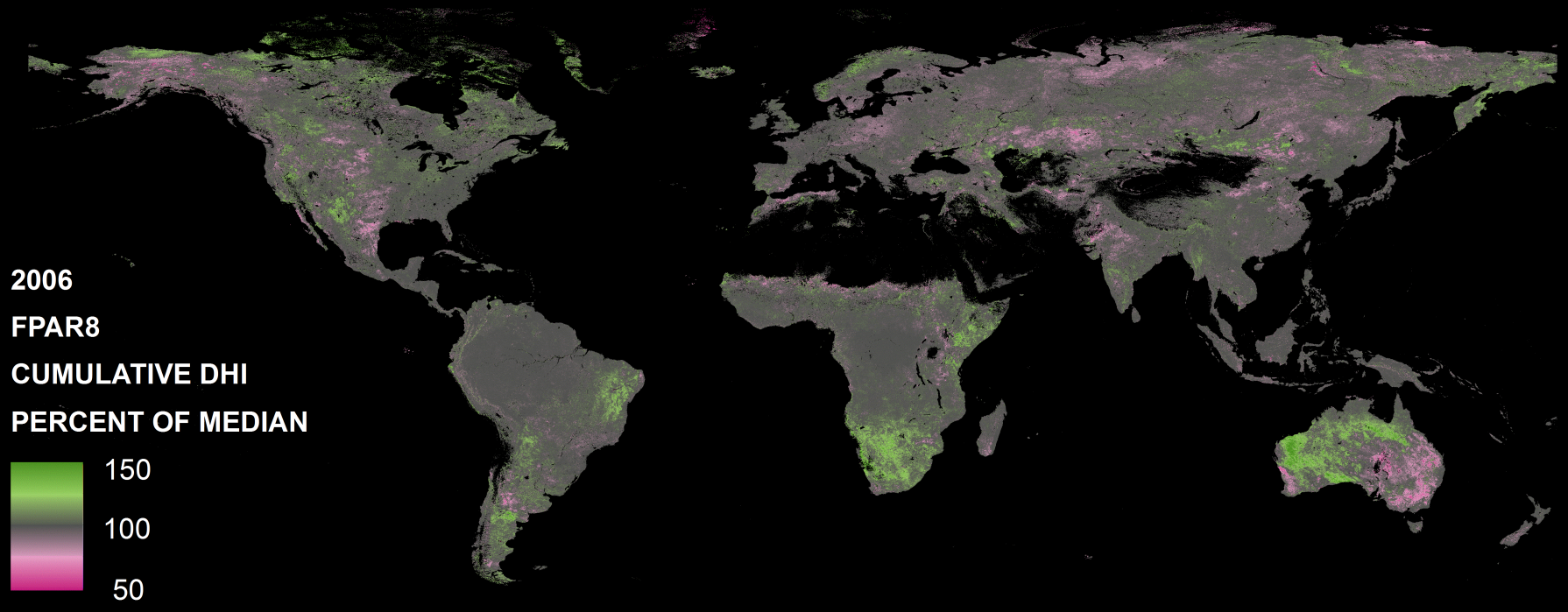

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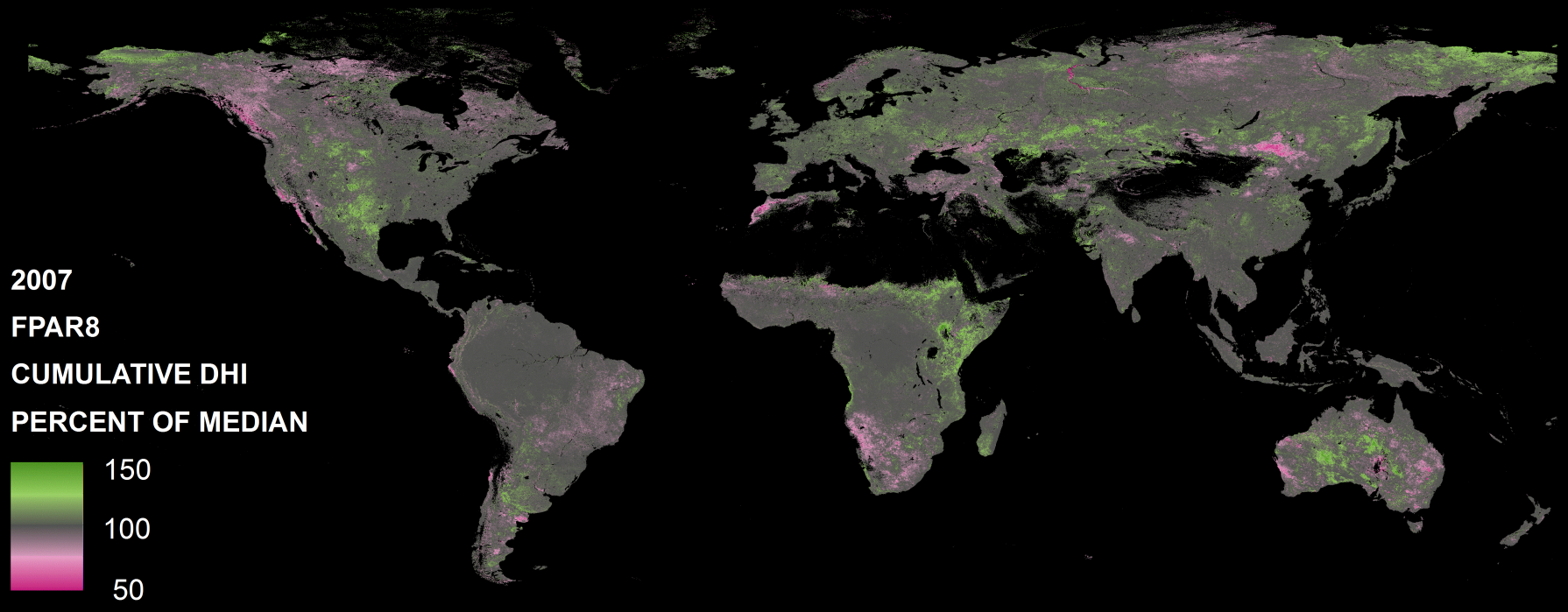

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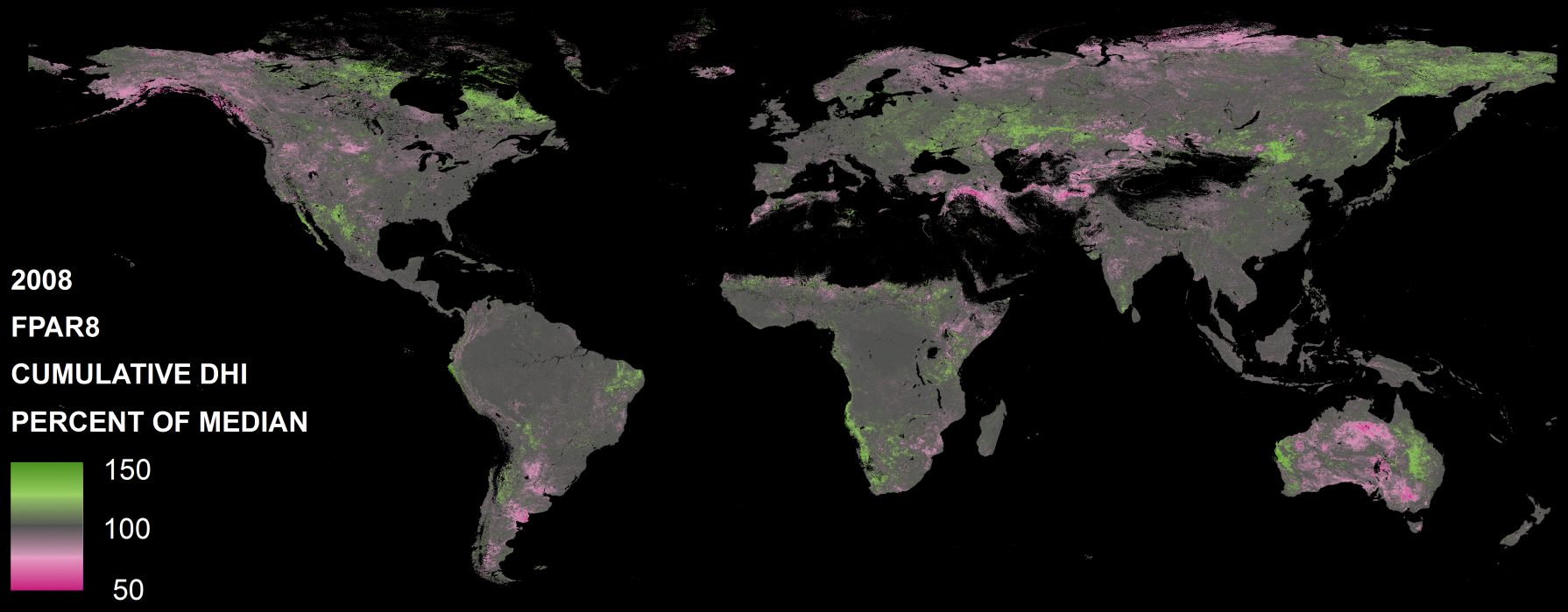

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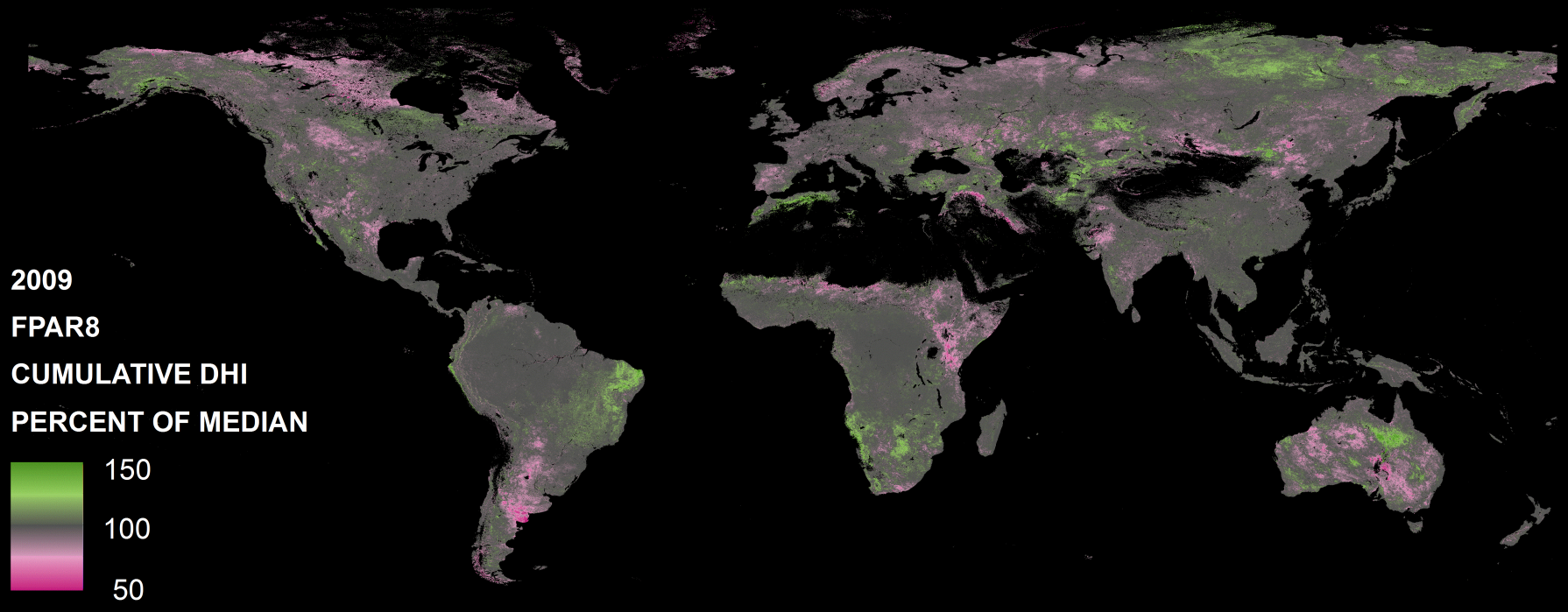

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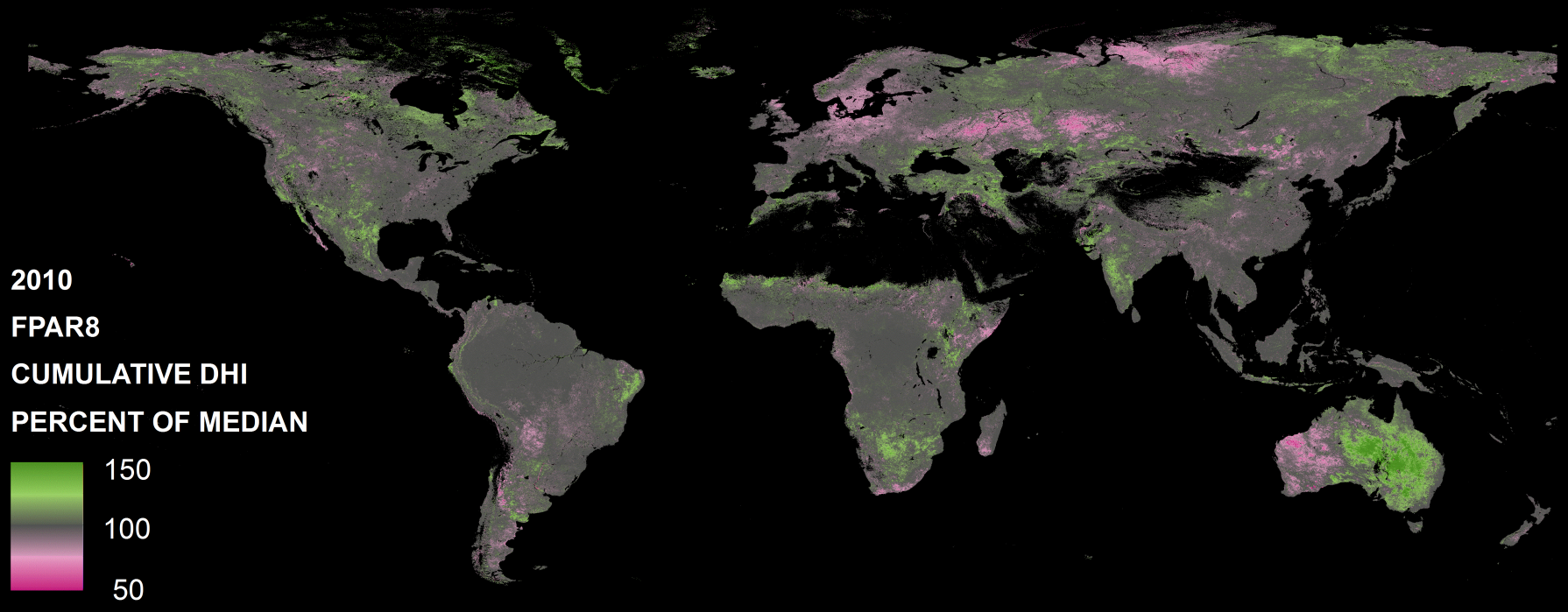

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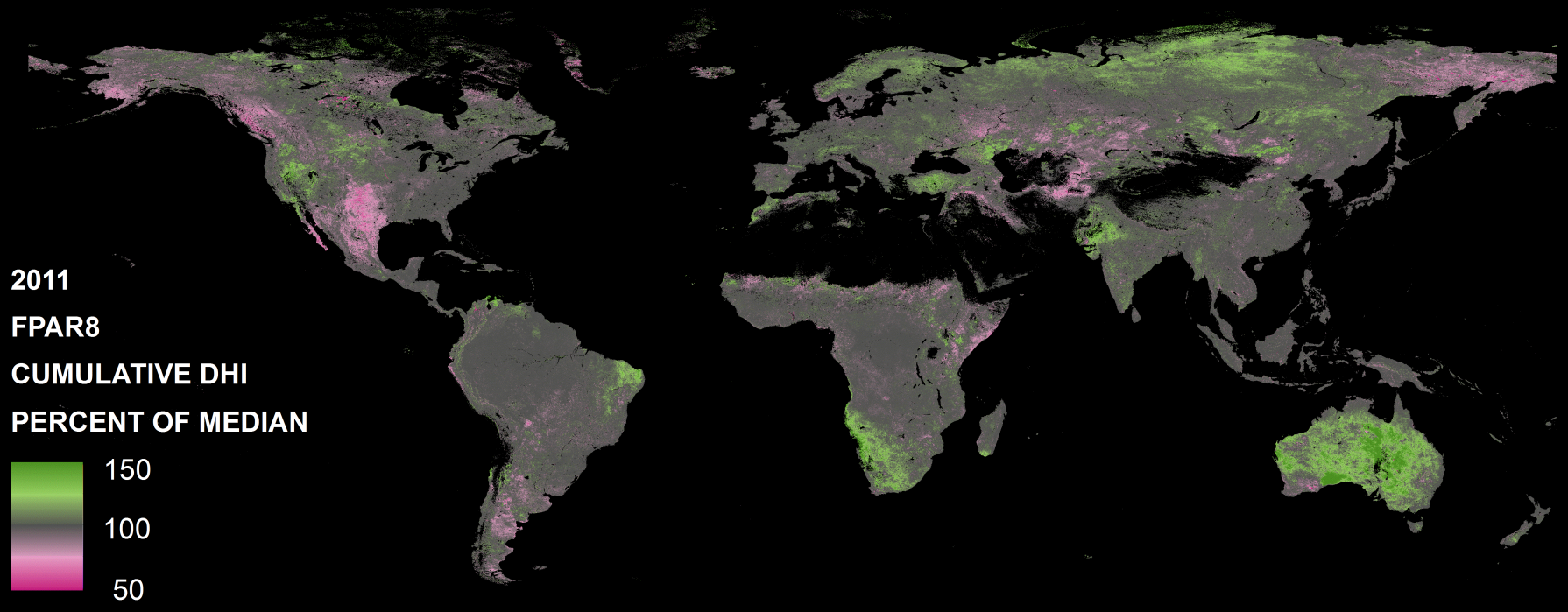

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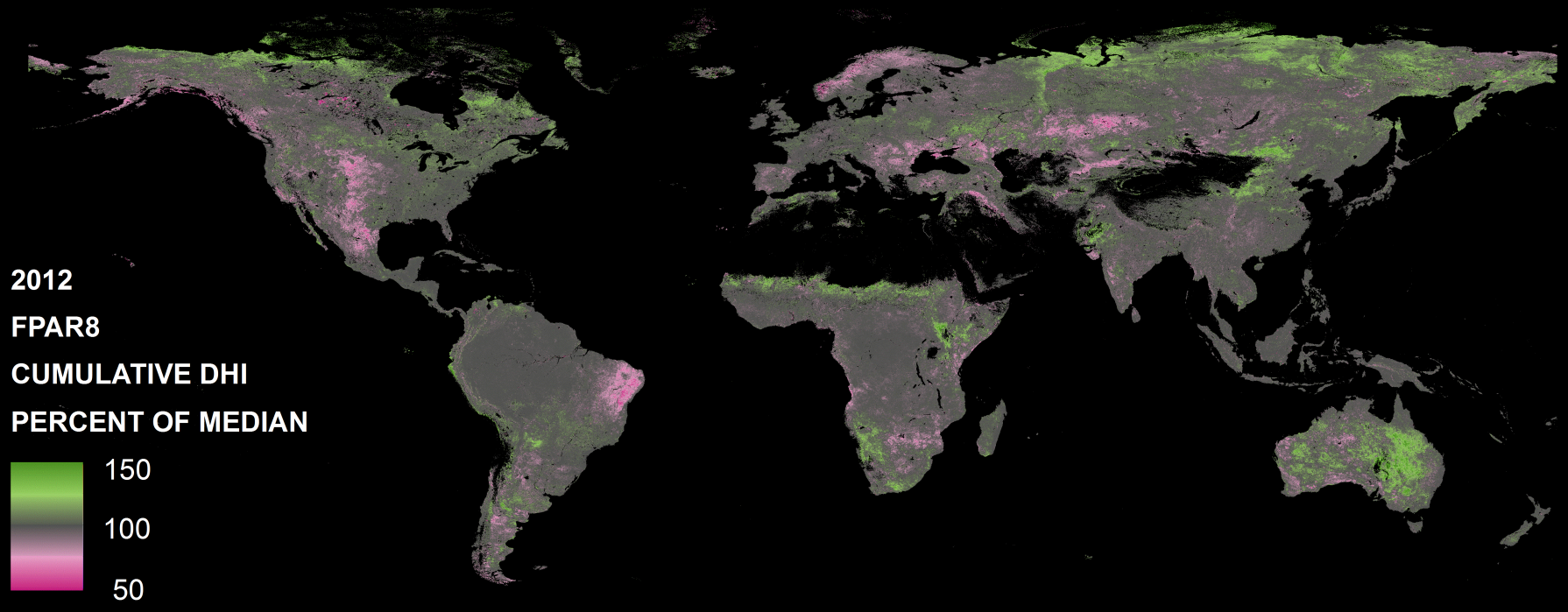

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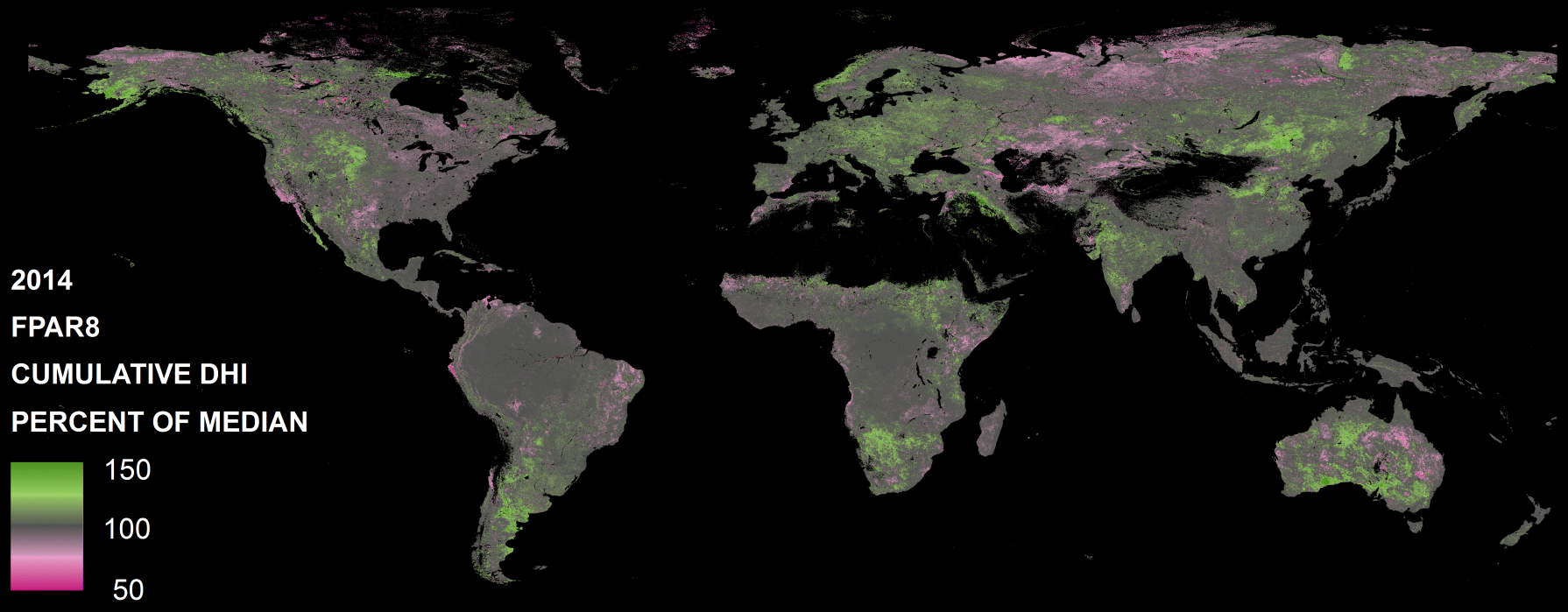

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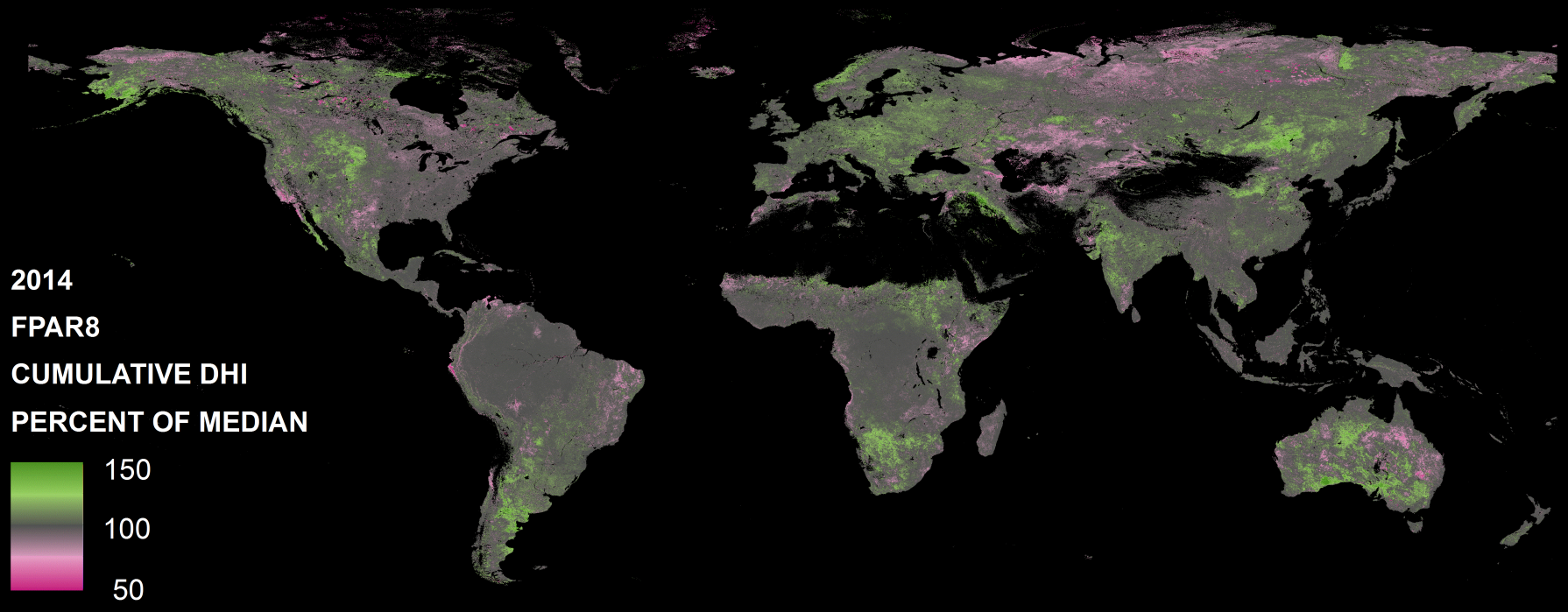

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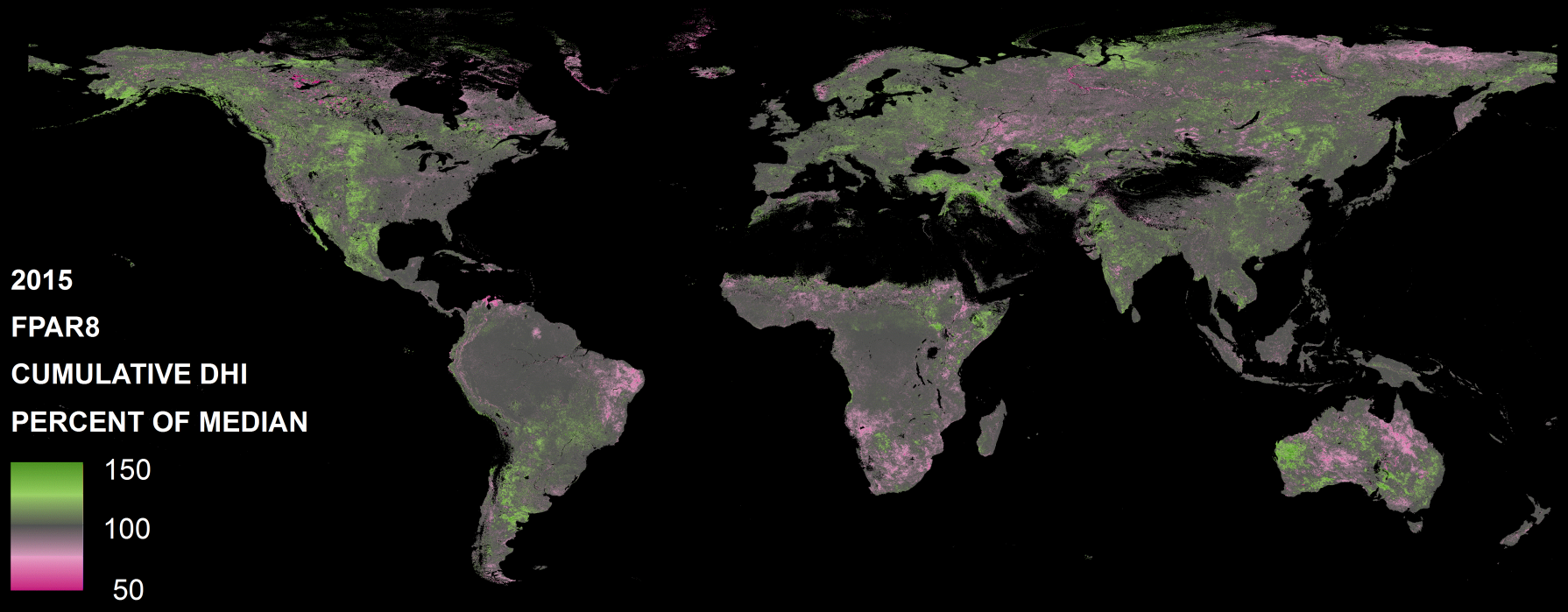

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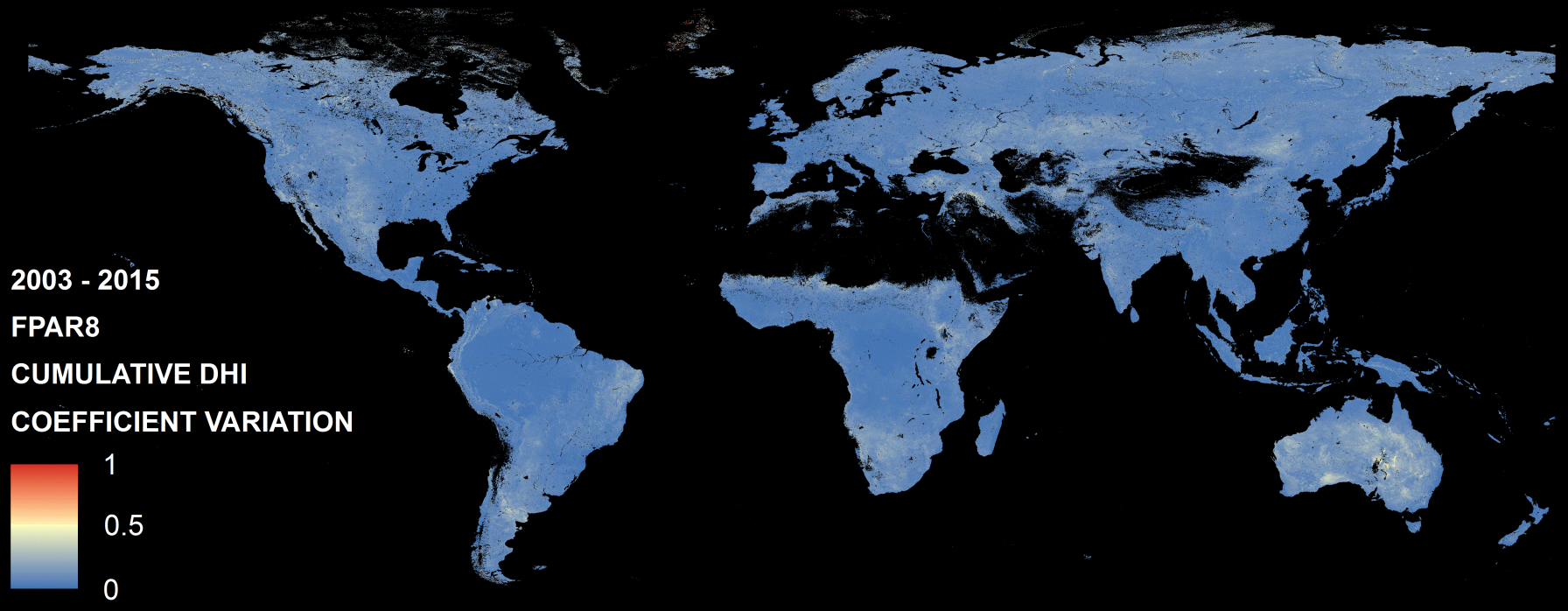
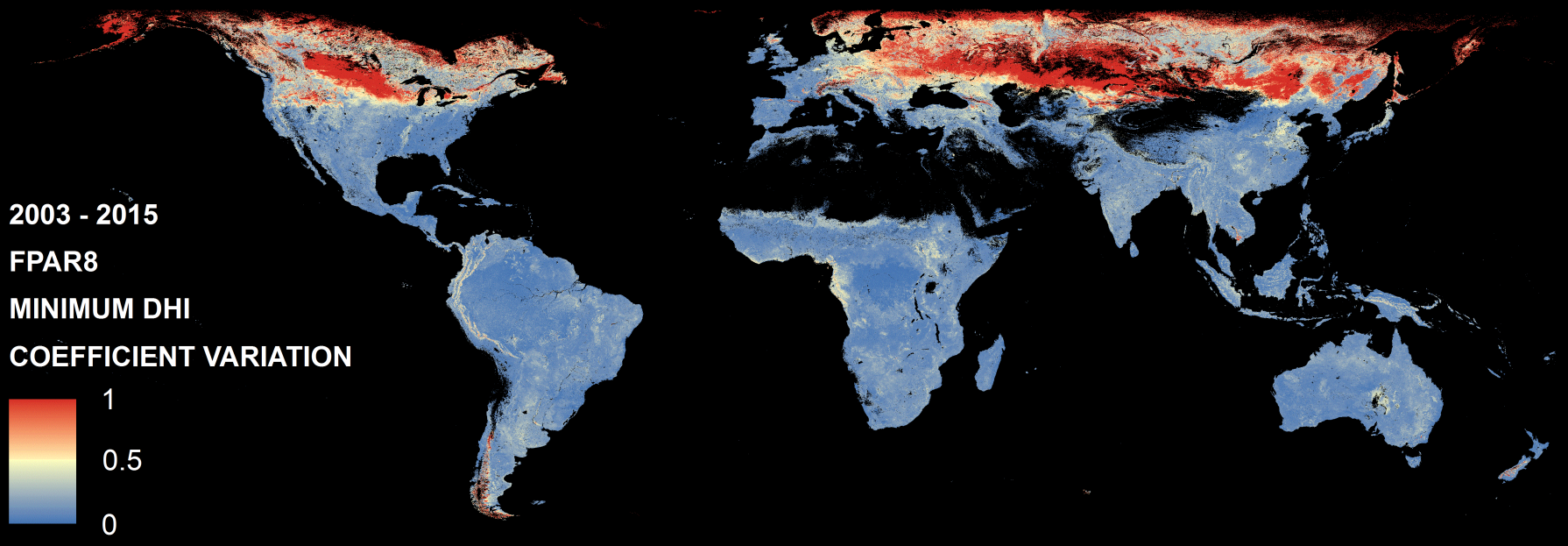

2003 - 2015
FPAR8
CUMULATIVE DHI
COEFFICIENT VARIATION
1
0.5
0

Annual DHIs



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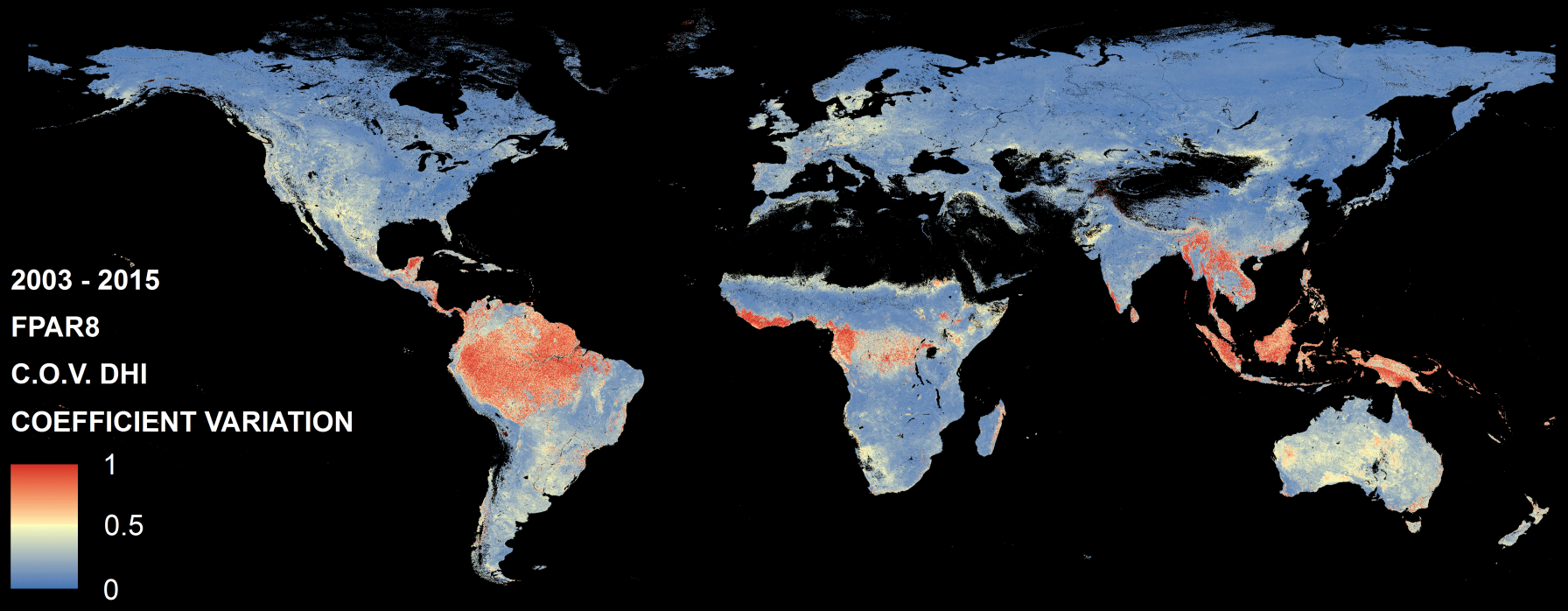


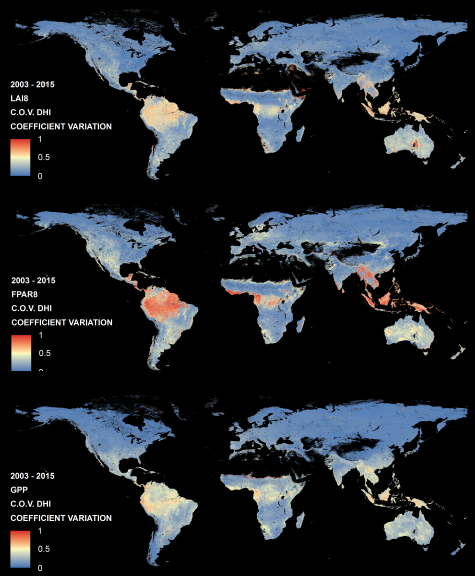
Annual DHIs

Variation DHI

LAI

FPAR

GPP



Annual DHIs

NDVI

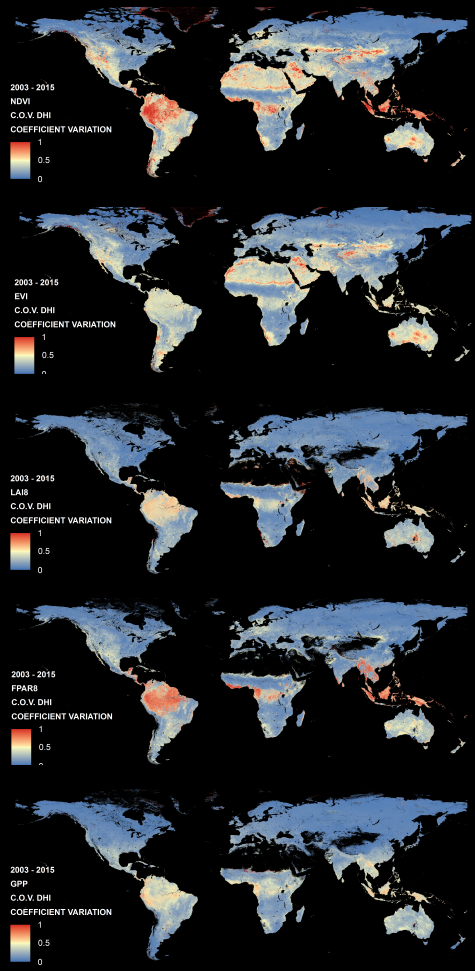
EVI

LAI

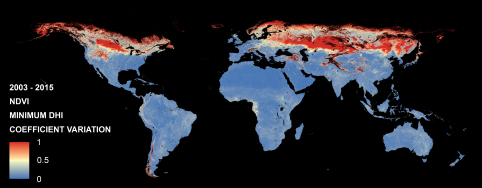
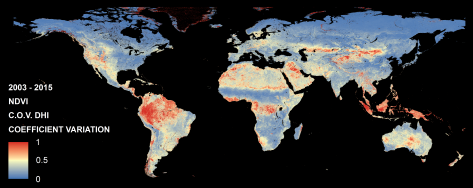
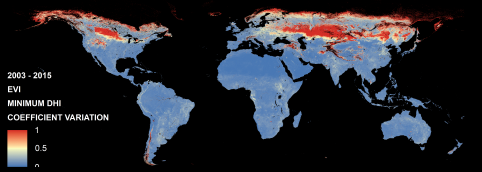
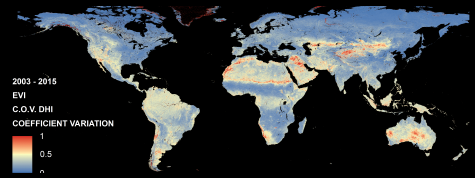
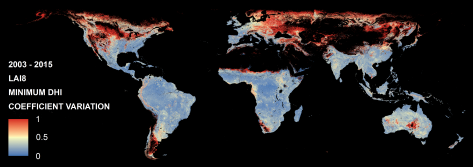
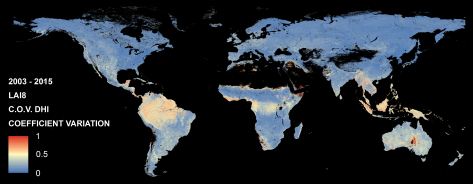
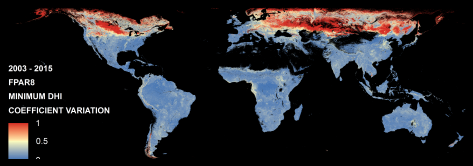
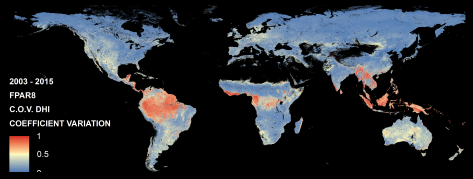
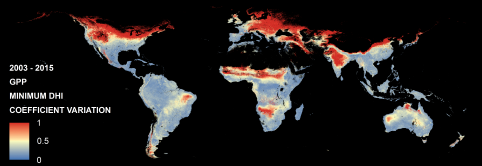
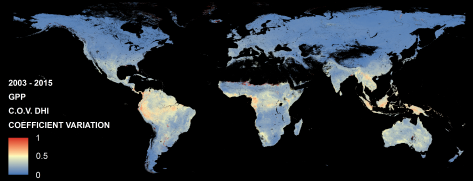
FPAR

GPP

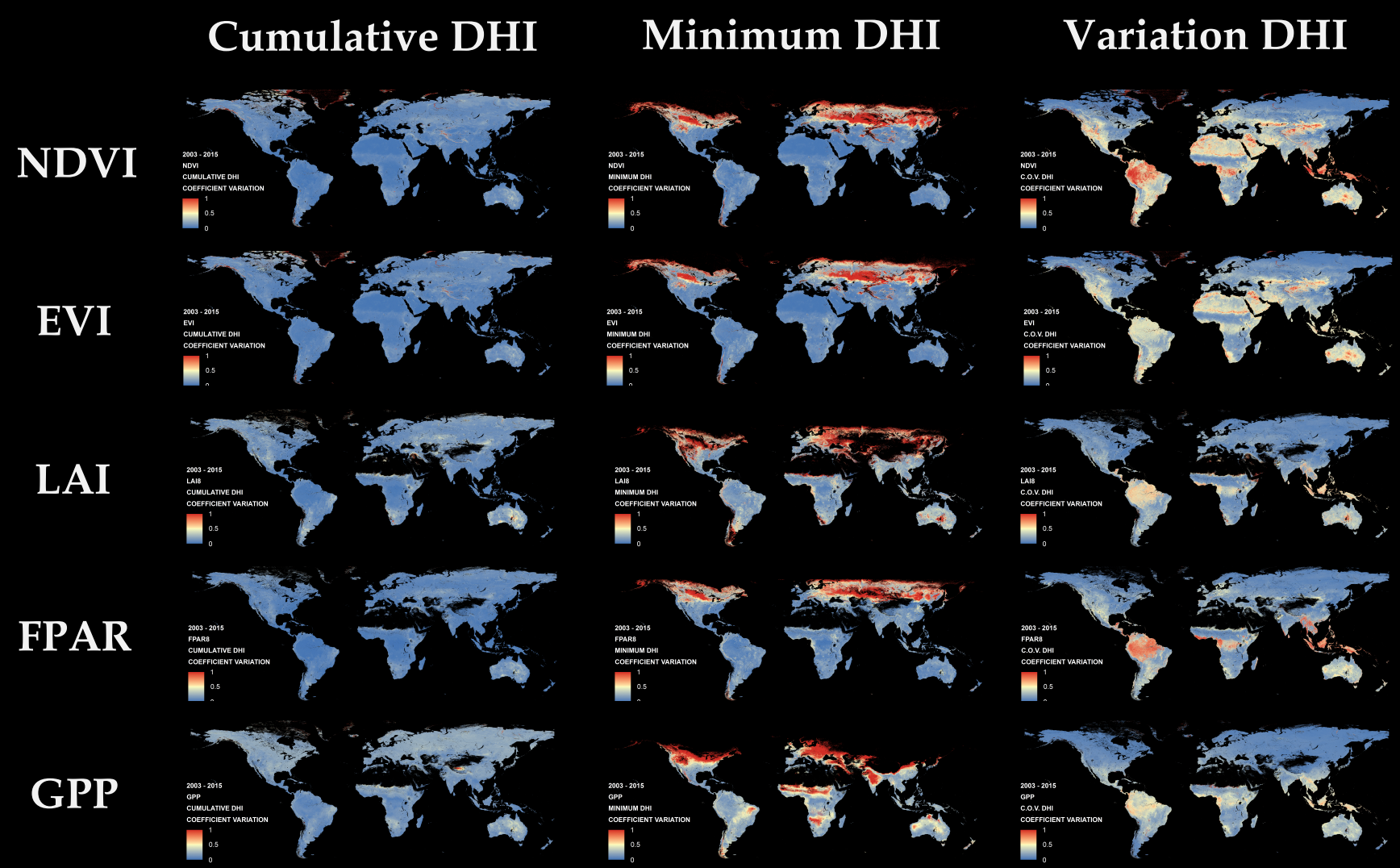
Variation DHI



Annual DHIs

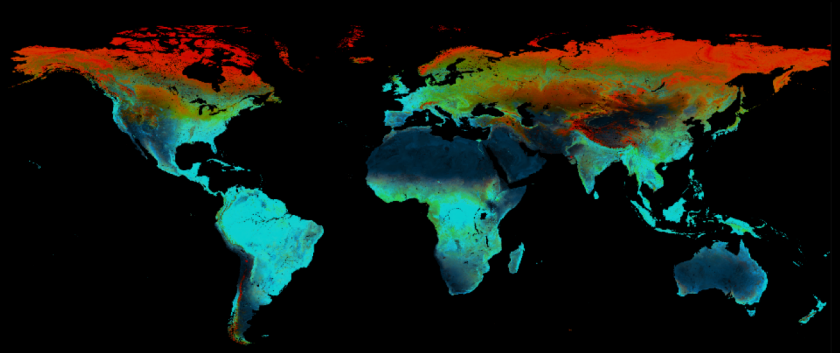
	Minimum DHI	Variation DHI
NDVI		
EVI		
LAI		
FPAR		
GPP		

Annual DHIs

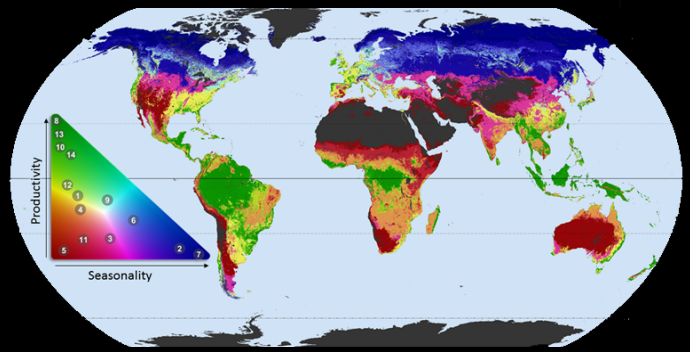

Cumulative DHI
Minimum DHI
Variation DHI
NDVI
EVI
LAI
FPAR
GPP
2003 - 2015
NDVI
CUMULATIVE DHI
COEFFICIENT VARIATION
MINIMUM DHI
C.O.V. DHI
EVI
LAI8
FPAR8
GPP
1
0.5
0

Outline

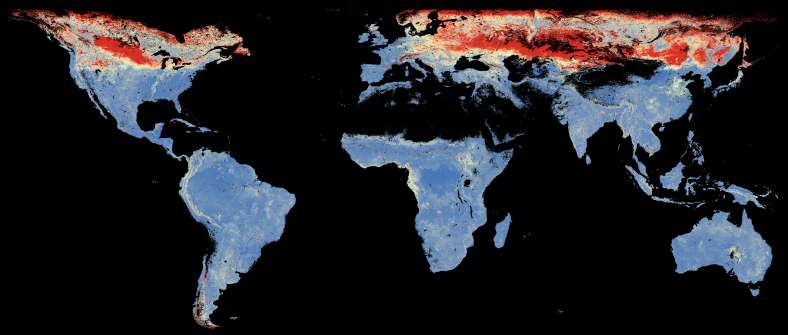
I. The Dynamic Habitat Indices



II. DHIs Ecoregions



III. Annual DHIs



Conclusions

The DHIs work well

- Successful tests with various biodiversity datasets
- Based on ecological theory
- Make sense and are straightforward

The DHIs capture annual productivity patterns

- Important for communities (Species richness)
- Important for species' habitat (SDMs)

Conclusions

Relative importance of the three DHIs makes sense

- Cumulative DHI generally most important
- Variation DHI generally comes 2nd
- Minimum DHI generally comes 3rd

Deviations from that ranking make also sense, e.g.,

- Variation DHI more important in temperate systems
- Minimum DHI not important in tropical systems
- Variation DHI most important for migratory species

Conclusions

The DHIs play nice with others

- Climate data (BIOCLIM)
- Land Cover (MODIS, NLCD)
- Topography (SRTM)
- Snow and frozen ground (in-house)
- Human threats (misc. population, roads)
- …

Conclusions

MODIS vegetation data are amazing!!!

Conclusions

MODIS vegetation data are amazing!!!

But also noisier and more variable than we had expected

- High variability among years
- Surprising differences among products

"Thou shall chose wisely"

Conclusions

When including productivity in models of biodiversity:

- Use composite DHIs based on 10+ years of MODIS data whenever possible
- Use annual DHIs (only) when interannual changes in productivity are important (e.g., drought)
- Avoid using single dates of MODIS vegetation data

Conclusions

When analyzing biodiversity data without dates (e.g., Range maps, atlas data, species lists):

- Use composite DHIs
- In drylands: NDVI- or EVI-based DHIs
- Everywhere else: FPAR- or GPP-based DHIs

Conclusions

When analyzing biodiversity data with dates (e.g., Point counts, GPS collars, airplane surveys):

- Consider averaging years, and use composite DHIs
- If difference among years is the research question:
  - NDVI- and FPAR-based DHIs most sensitive
  - EVI-, LAI-, and GPP-based DHIs more robust

Conclusions

We hope the DHIs will be useful for you

Please let us know what you find

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Thanks so much!