Developing and testing the Dynamic Habitat Indices from Terra and Aqua MODIS data for biodiversity and conservation science

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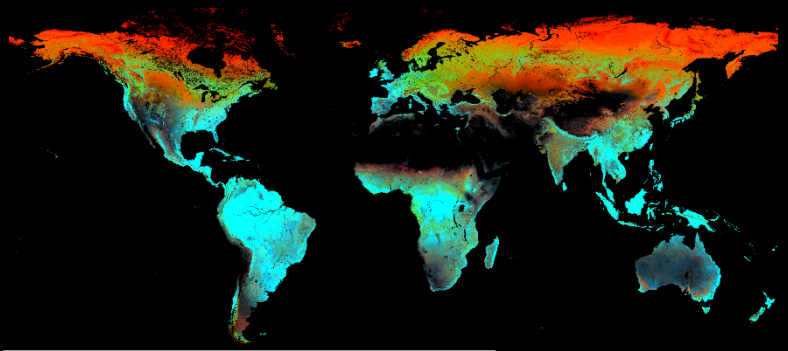
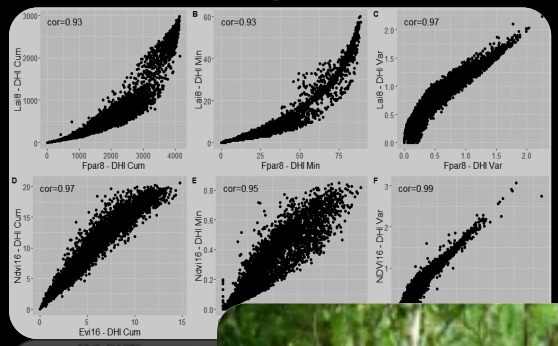
Outline

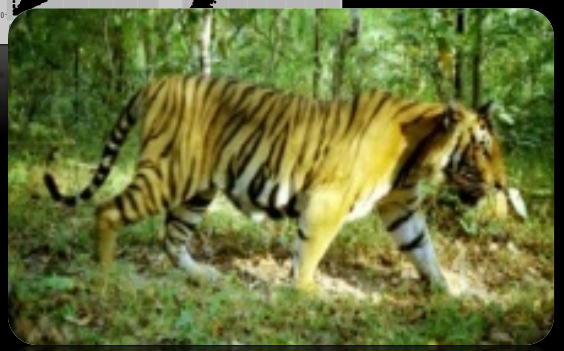
I. Background: the Dynamic Habitat Indices

II. Datasets: Composite and annual DHIs

III. Case studies: DHIs and biodiversity

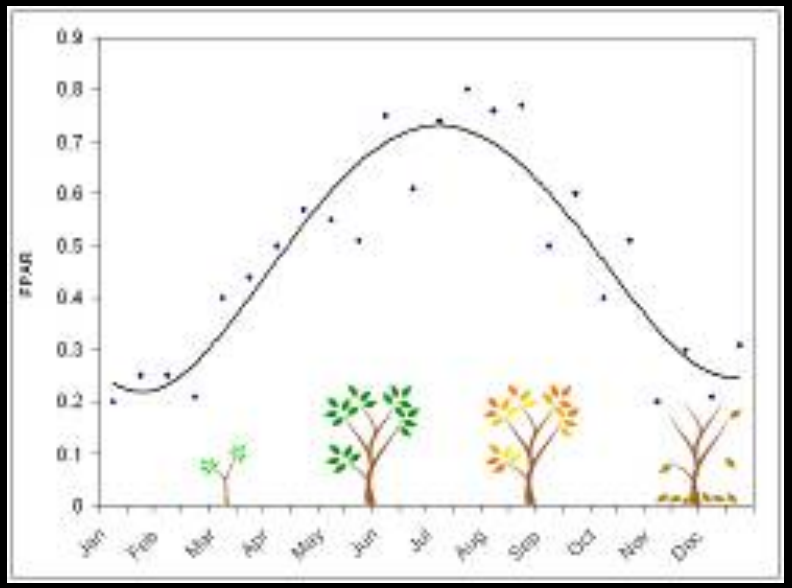




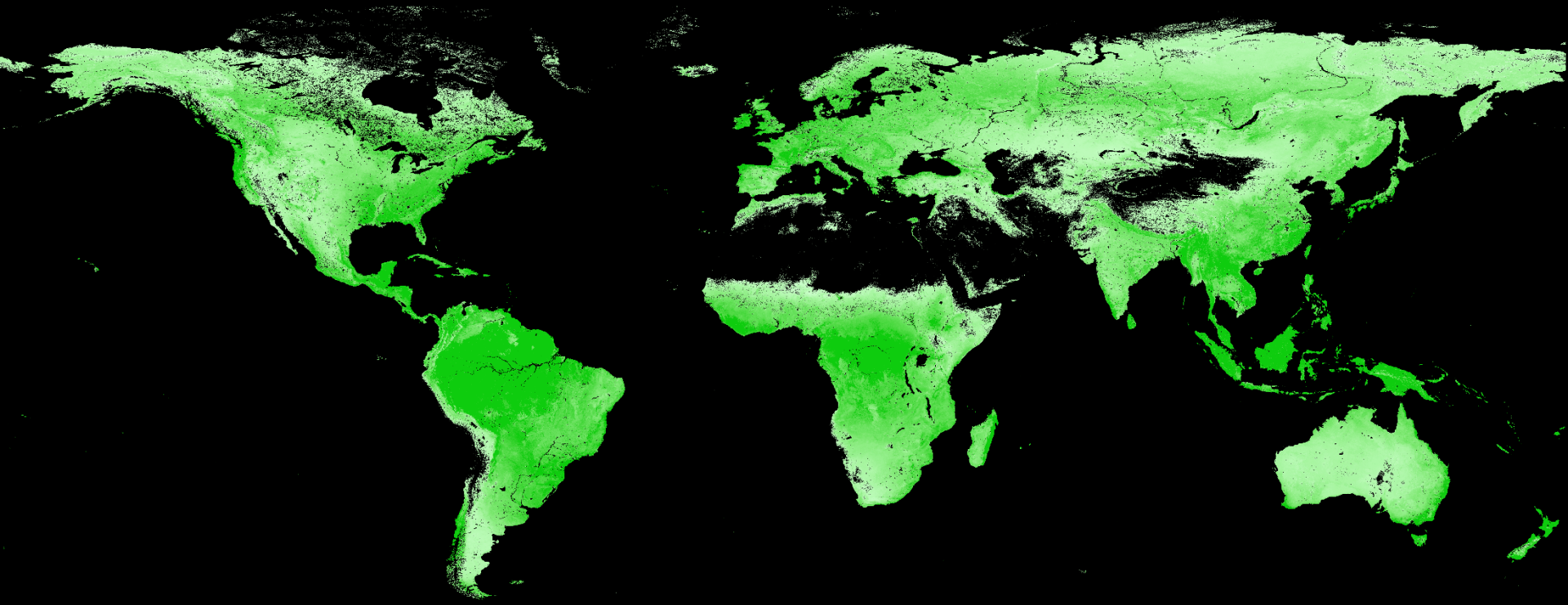


The Dynamic Habitat Indices

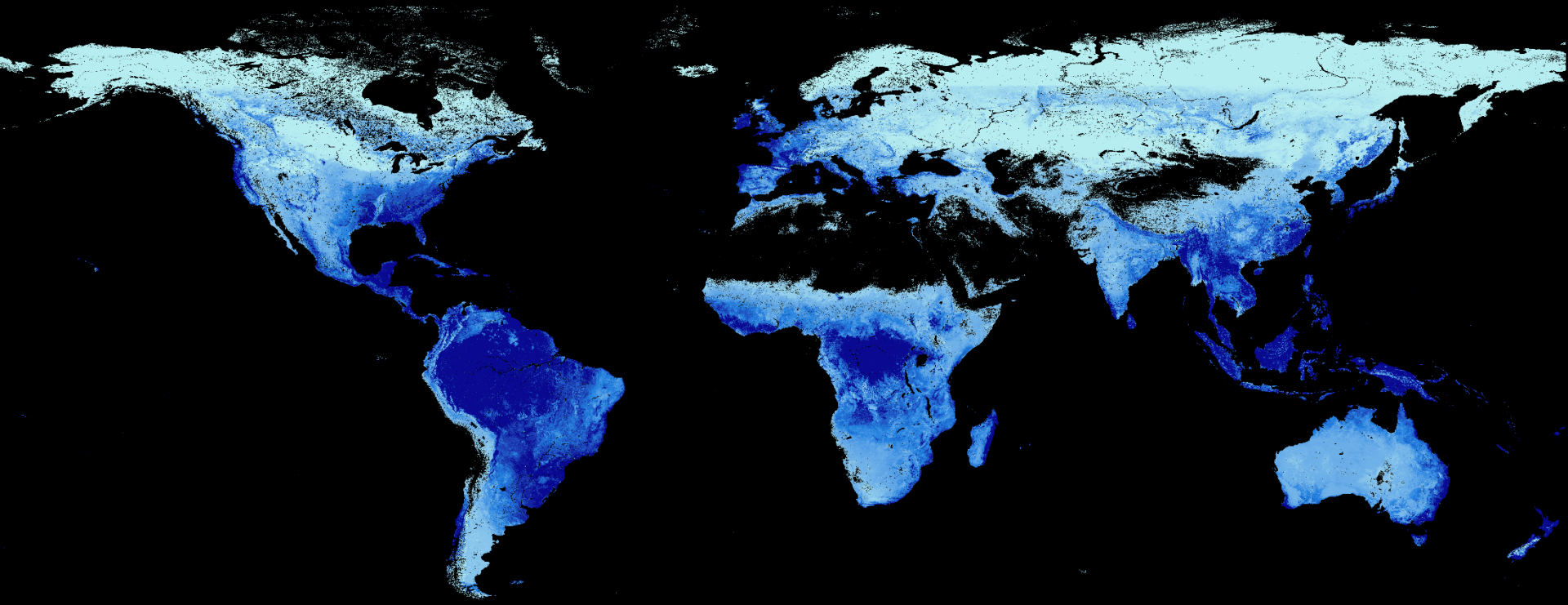
- Plant productivity is a proxy for the energy available for biotic communities
- The DHIs capture three key attributes of annual productivity
  - Cumulative
  - Minimum
  - Variability (CV)



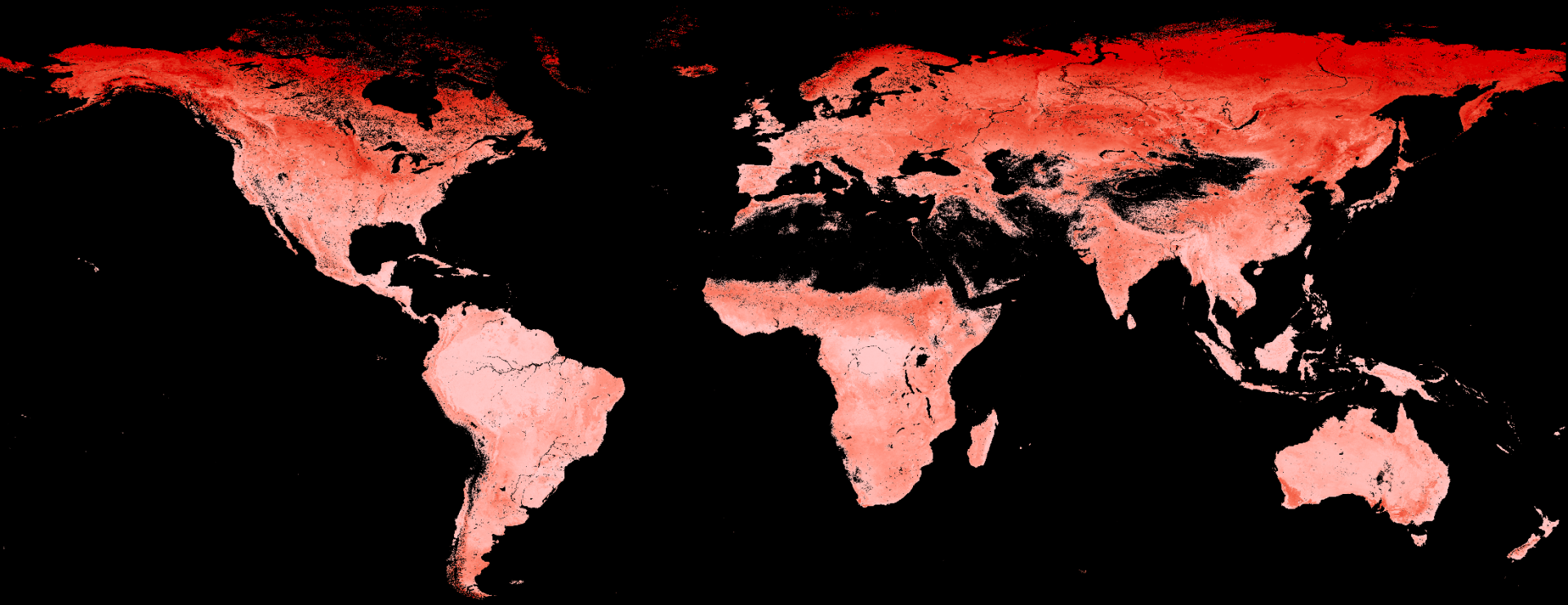
Fpar – Cumulative



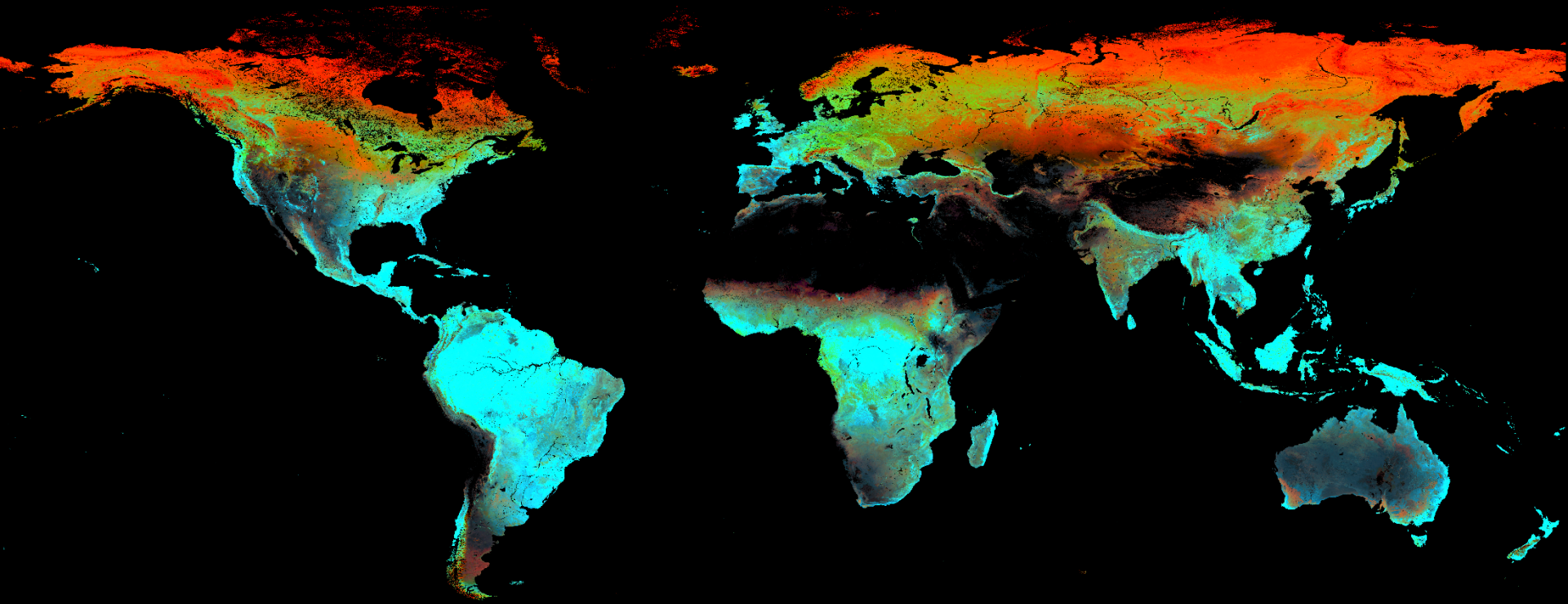
Fpar – Minimum



Fpar – Variability



Fpar DHIs



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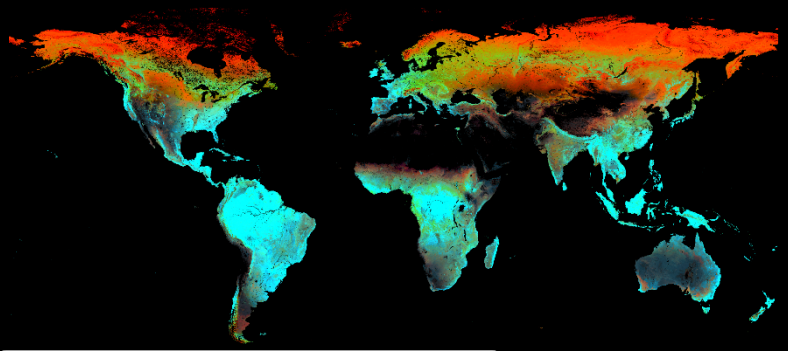
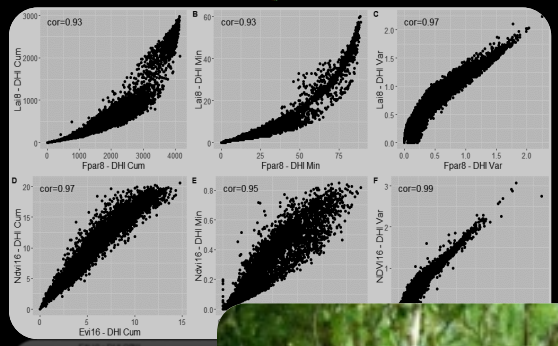
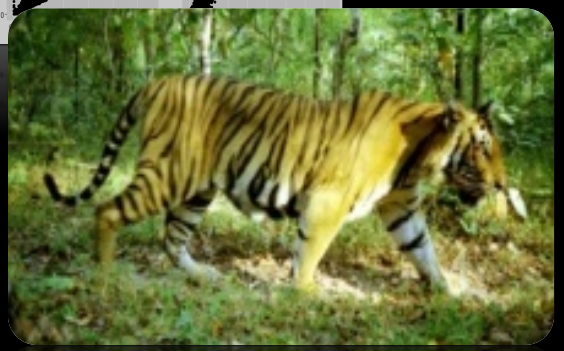


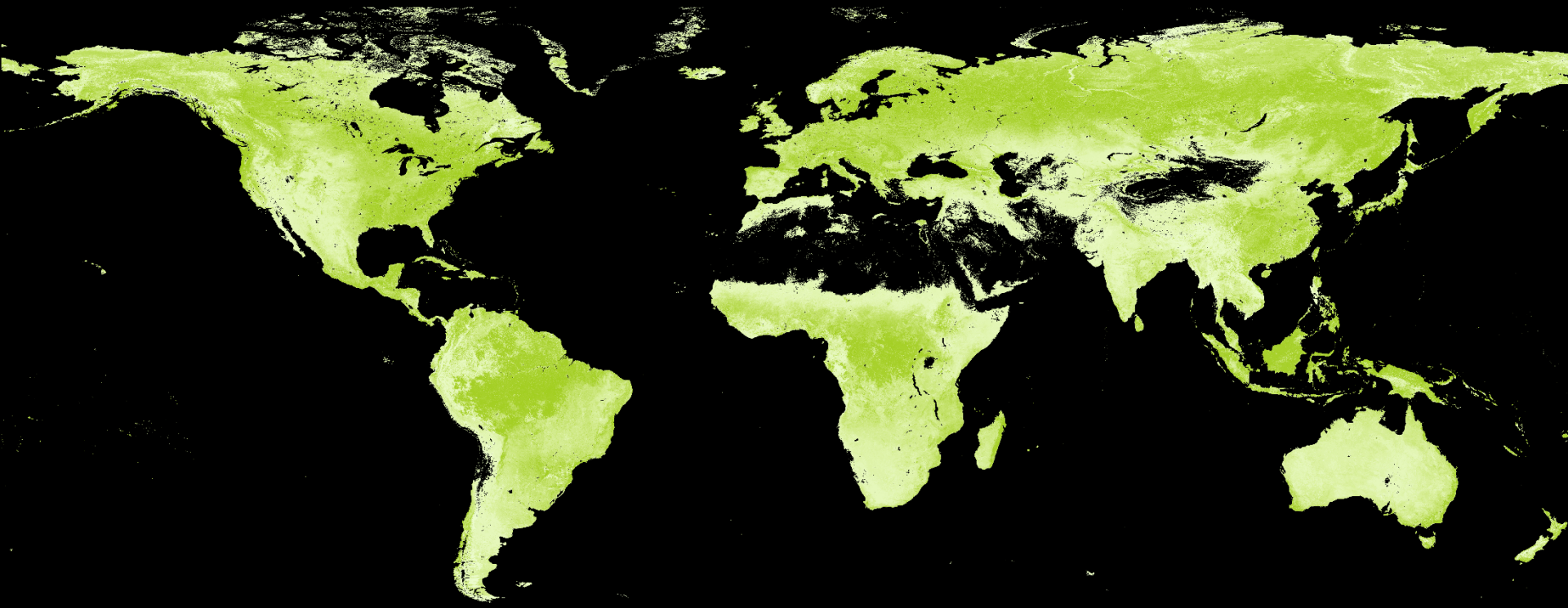




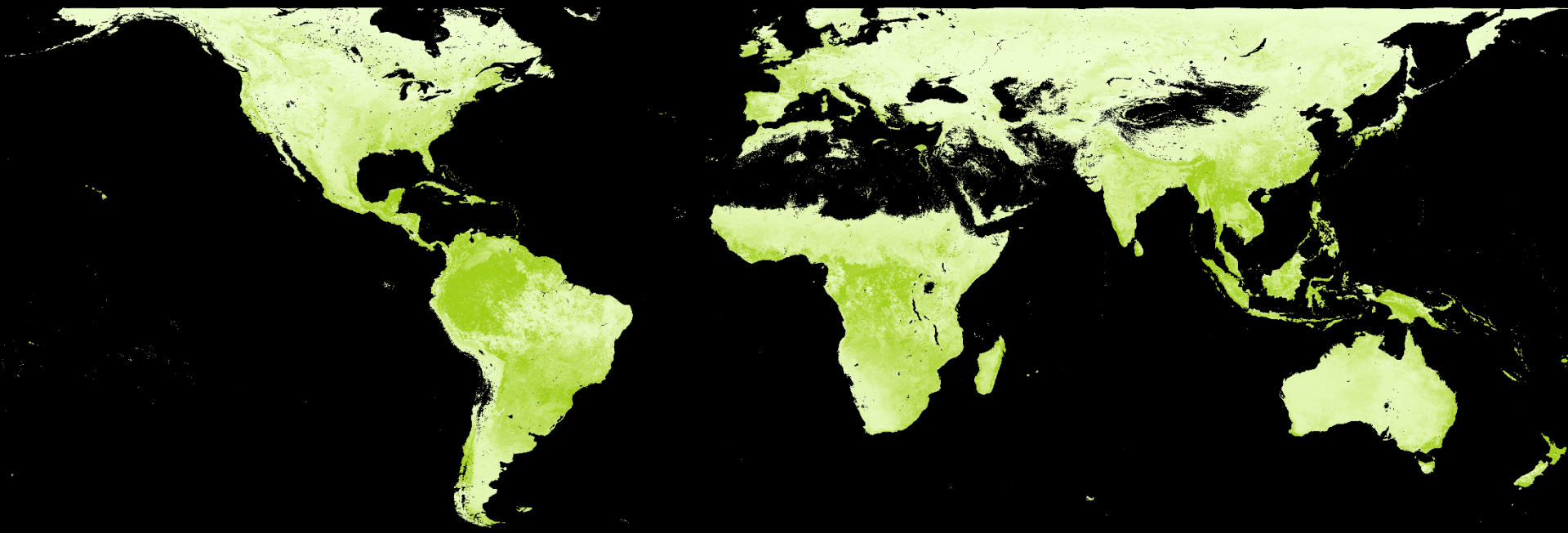
Datasets

- MODIS Composite DHIs for 2003-2014
  - Why: MODIS vegetation data are noisy and phenology varies among years
  - How: calculate the median of all observations for a given date
  - How: only good MODIS QA flags
  - How: set no-data to functional zeros
    - Northern Latitudes
    - Snow and deserts

Fpar July 2002



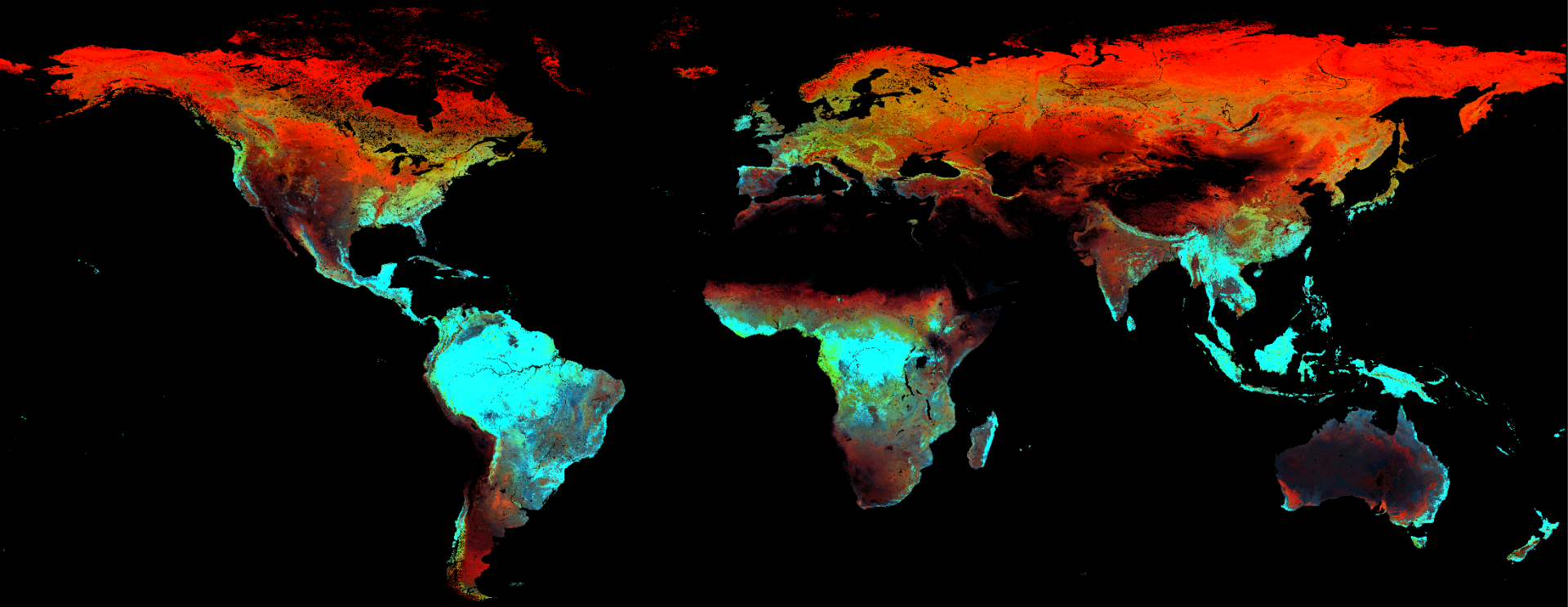
Fpar January 2002



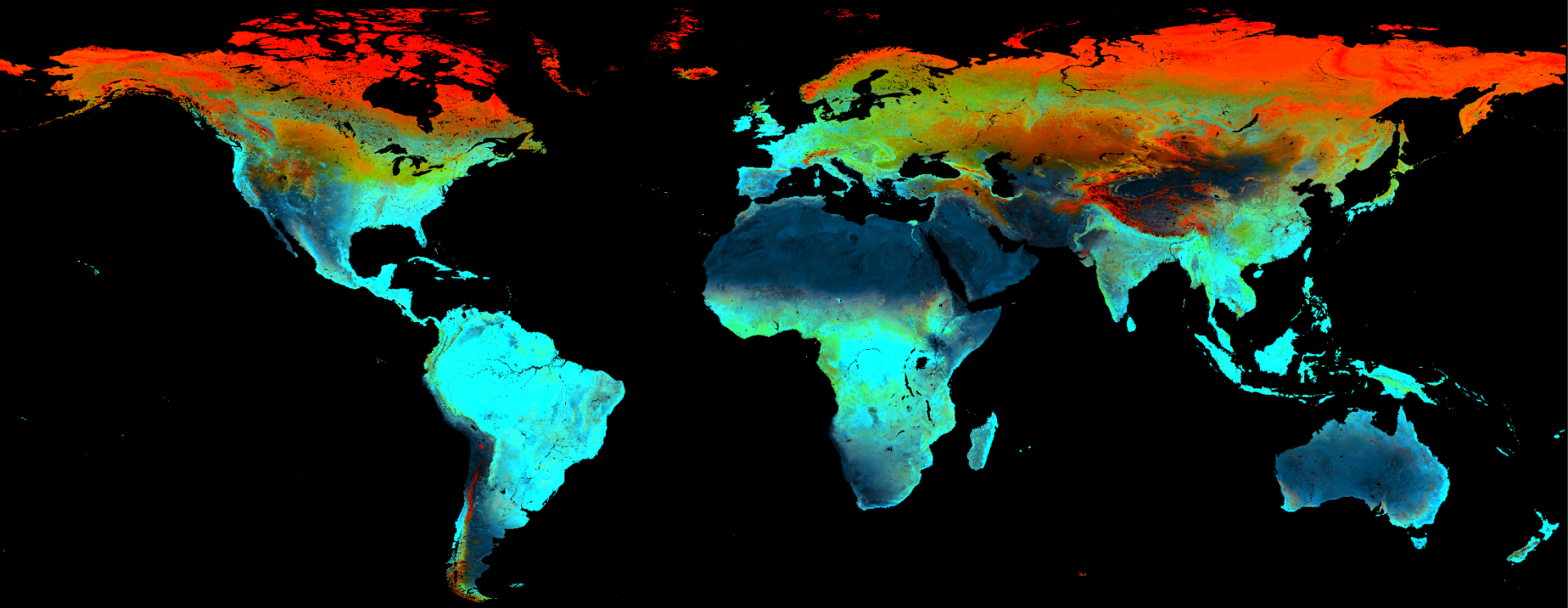
Datasets

Index	Product	Platform	Temporal resolution	Spatial resolution	Composite DHI
NDVI	MOD13A2	Terra	16-day	1000 m	Yes
NDVI	MOD13A1	Terra	16-day	500 m	In progress
EVI	MOD13A2	Terra	16-day	1000 m	Yes
EVI	MOD13A1	Terra	16-day	500 m	In progress
FPAR	MCD15A2	Terra/Aqua	8-day	1000 m	Yes
FPAR	MCD15A3	Terra/Aqua	4-day	1000 m	Yes
LAI	MCD15A2	Terra/Aqua	8-day	1000 m	Yes
LAI	MCD15A3	Terra/Aqua	4-day	1000 m	Yes
GPP	MOD17A2	Terra	8-day	1000 m	Yes

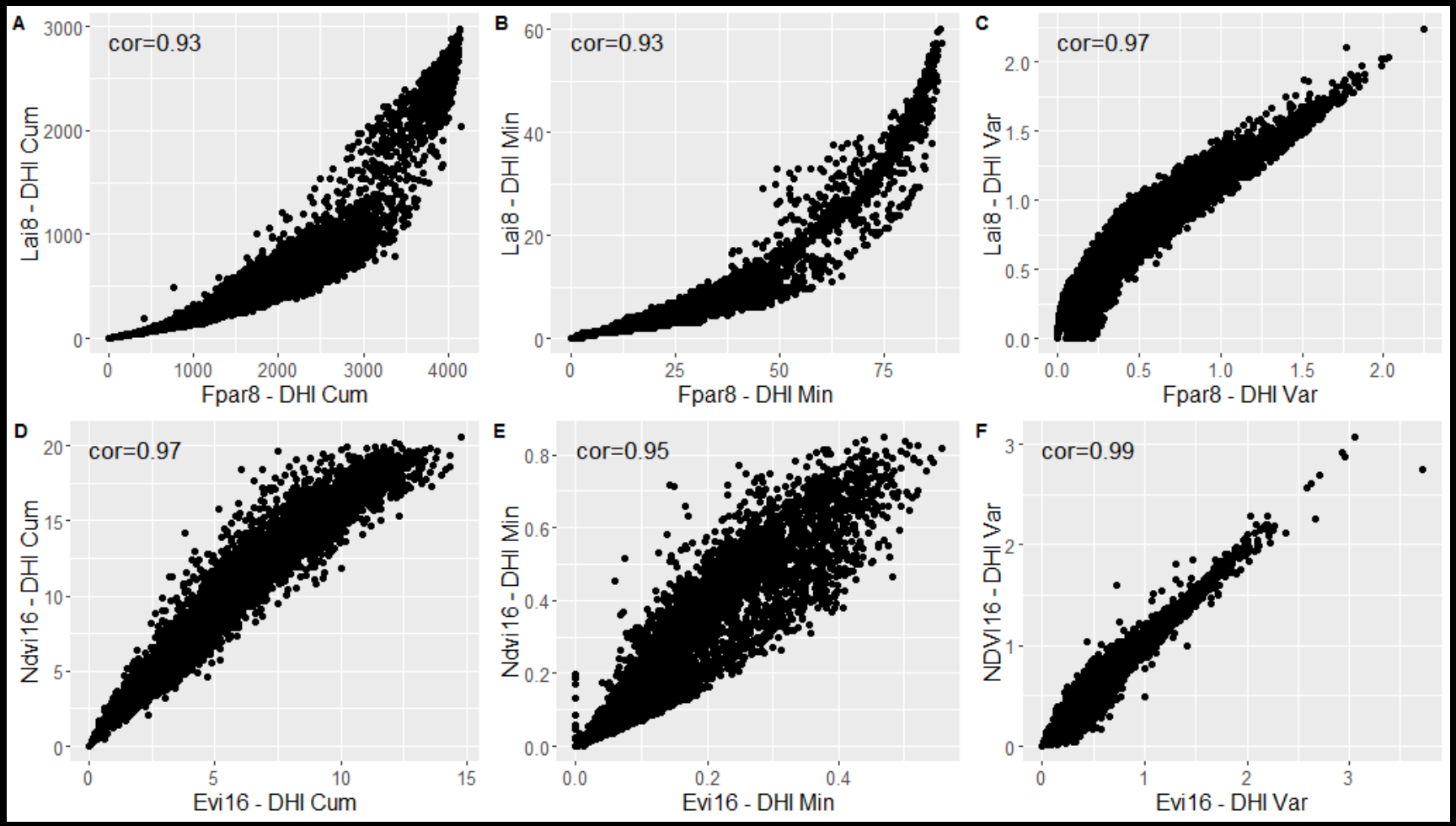
Composite LAI DHIs



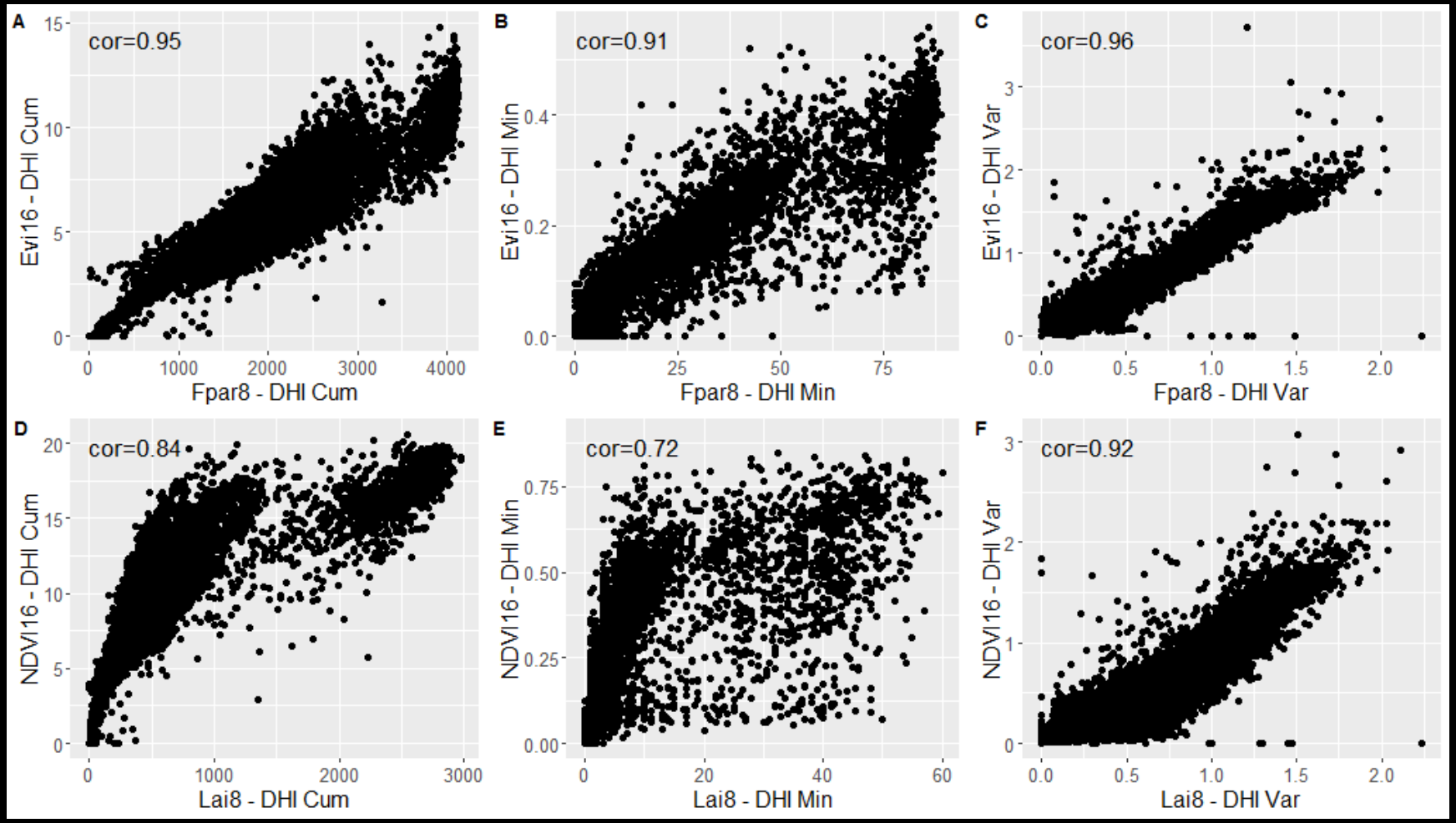
Composite EVI DHIs



Datasets


A
cor=0.93
Lai8 - DHI Cum
Fpar8 - DHI Cum
B
cor=0.93
Lai8 - DHI Min
Fpar8 - DHI Min
C
cor=0.97
Lai8 - DHI Var
Fpar8 - DHI Var
D
cor=0.97
Ndvi16 - DHI Cum
Evi16 - DHI Cum
E
cor=0.95
Ndvi16 - DHI Min
Evi16 - DHI Min
F
cor=0.99
NDVI16 - DHI Var
Evi16 - DHI Var

Datasets


A
cor=0.95
Evi16 - DHI Cum
Fpar8 - DHI Cum
B
cor=0.91
Evi16 - DHI Min
Fpar8 - DHI Min
C
cor=0.96
Evi16 - DHI Var
Fpar8 - DHI Var
D
cor=0.84
NDVI16 - DHI Cum
Lai8 - DHI Cum
E
cor=0.72
NDVI16 - DHI Min
Lai8 - DHI Min
F
cor=0.92
NDVI16 - DHI Var
Lai8 - DHI Var

Datasets

- Annual DHIs
  - Why: One person's noise is another's data
  - How: Smoothing annual phenology
    - Median
    - Something else

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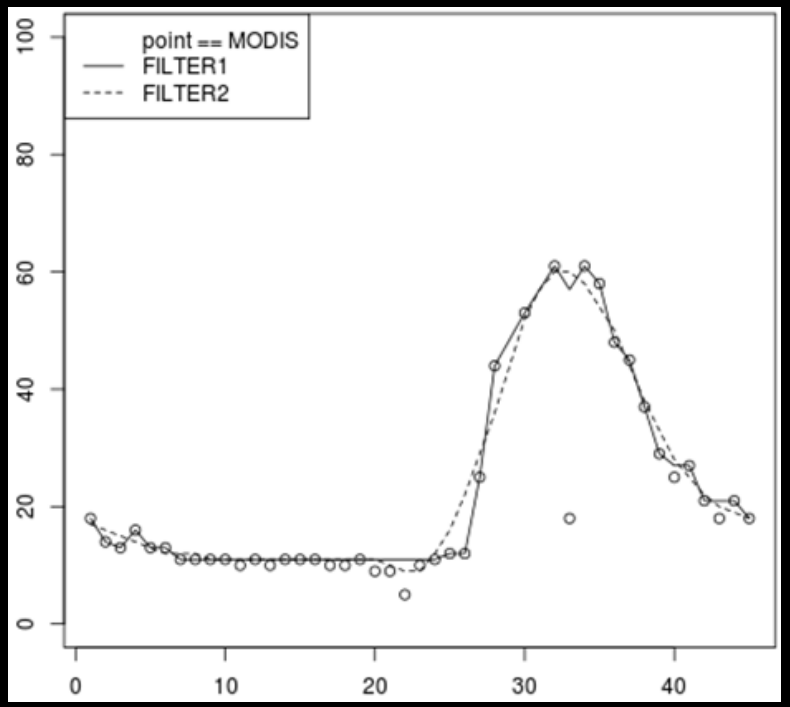

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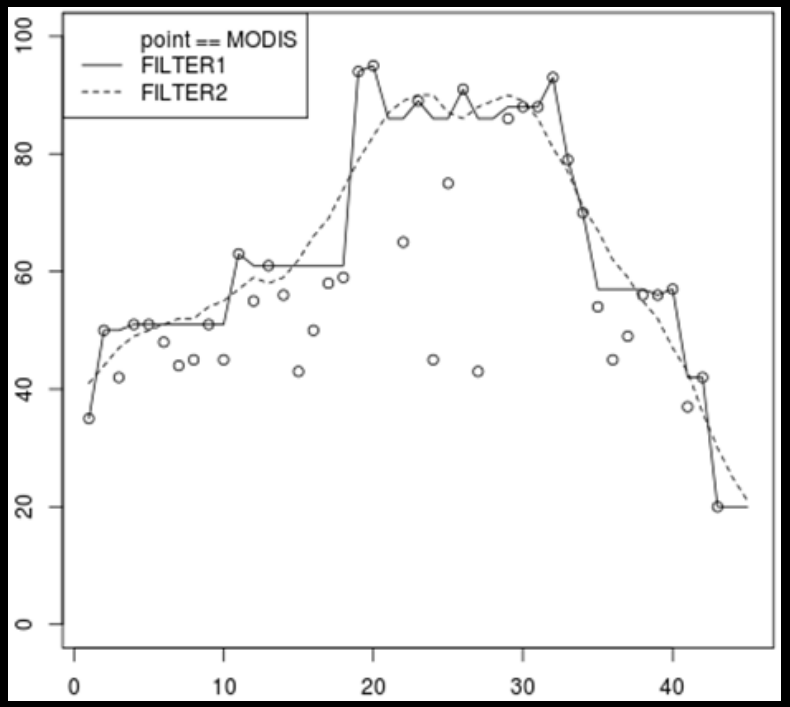
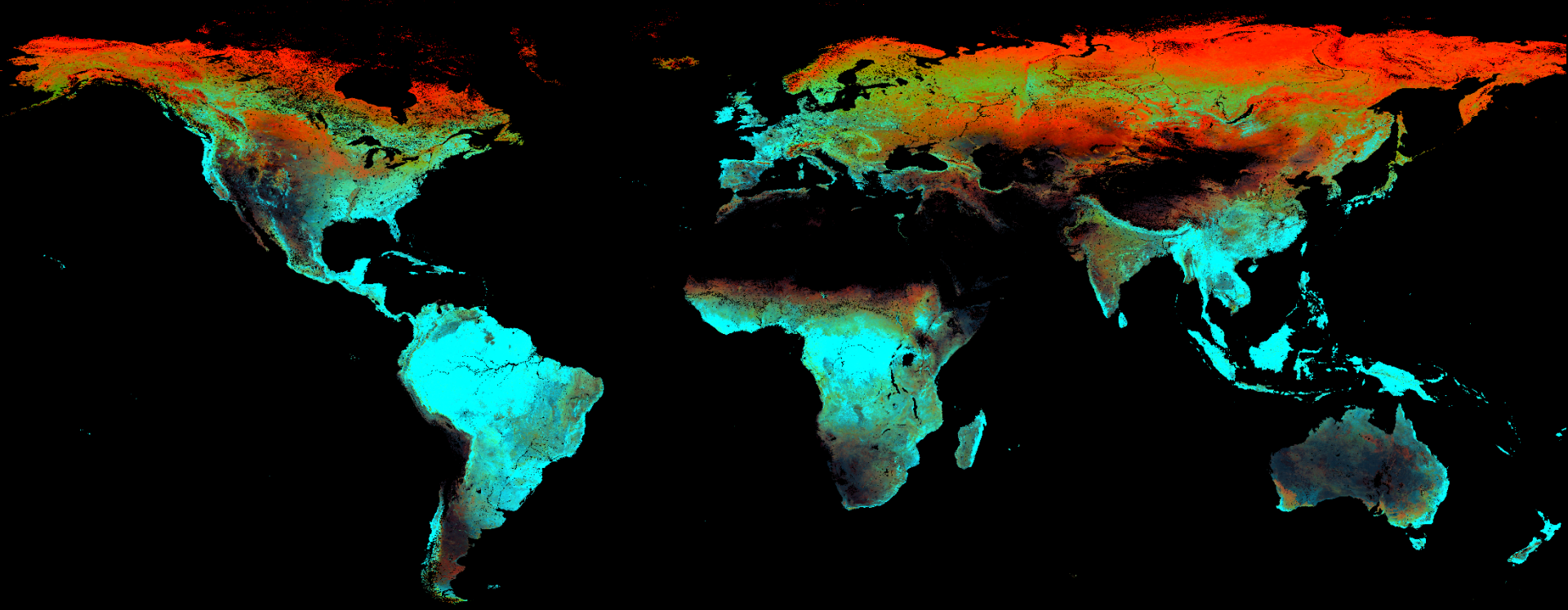


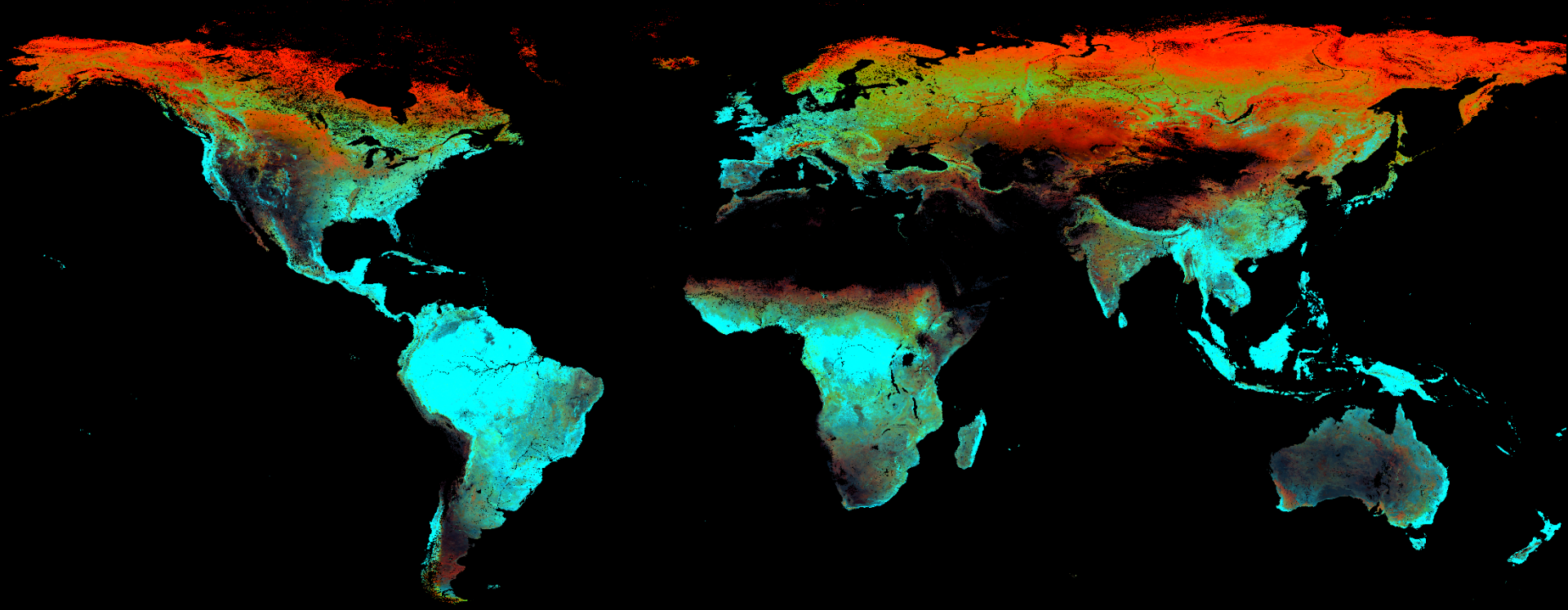
Datasets

Index	Product	Platform	Temporal resolution	Spatial resolution	DHIs yearly	DHIs smoothed
NDVI	MOD13A2	Terra	16-day	1000 m	Yes	I.P.
EVI	MOD13A2	Terra	16-day	1000 m	I.P.	I.P.
FPAR	MCD15A2	Terra/Aqua	8-day	1000 m	Yes	Yes
FPAR	MCD15A3	Terra/Aqua	4-day	1000 m	Yes	N.A.
LAI	MCD15A2	Terra/Aqua	8-day	1000 m	Yes	I.P.
LAI	MCD15A3	Terra/Aqua	4-day	1000 m	Yes	N.A.
GPP	MOD17A2	Terra	8-day	1000 m	Yes	I.P.

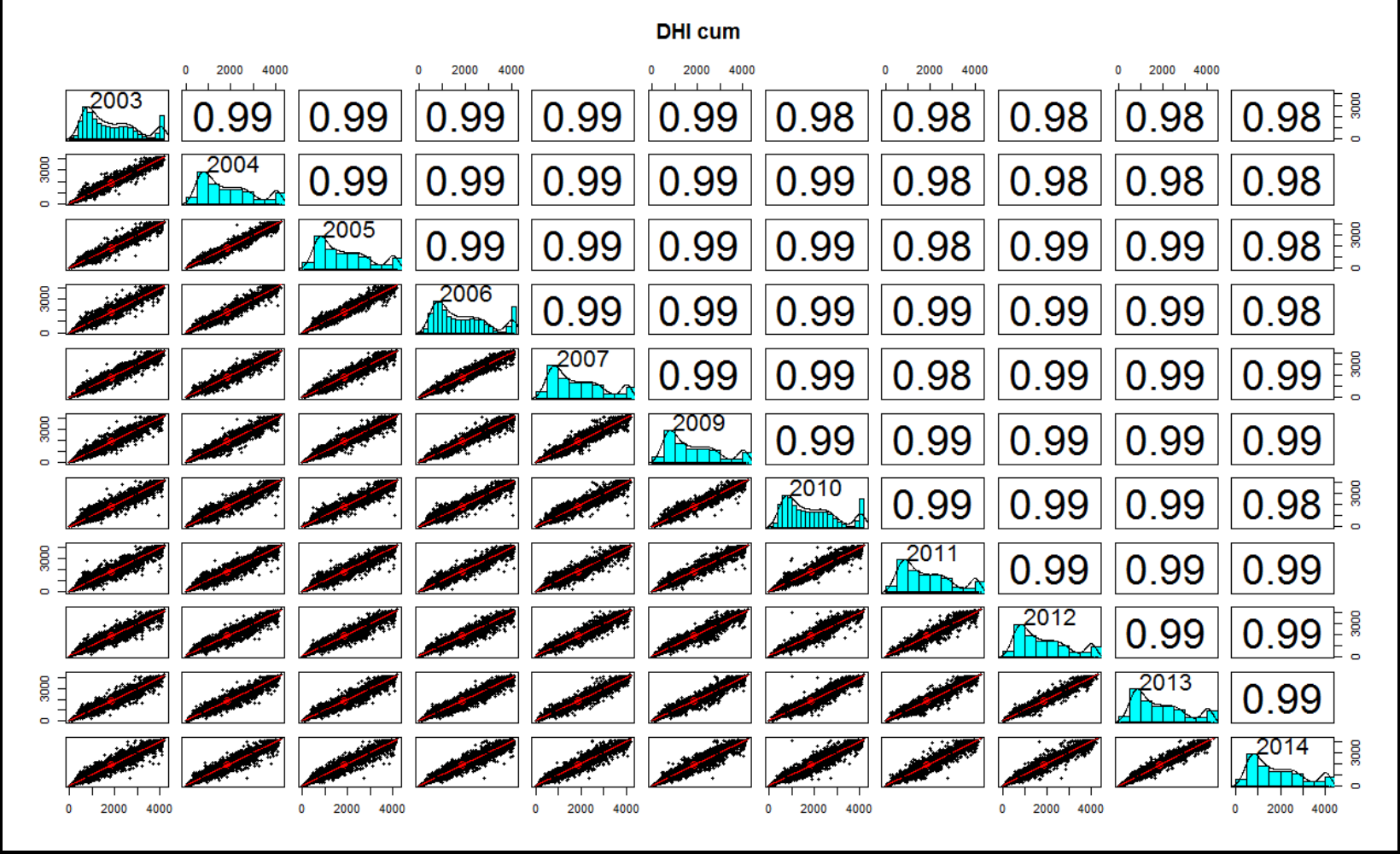
Fpar DHIs 2003



Fpar DHIs 2012



Datasets


DHI cum
2003
2004
2005
2006
2007
2009
2010
2011
2012
2013
2014
0.99
0.98
0 2000 4000
0 3000

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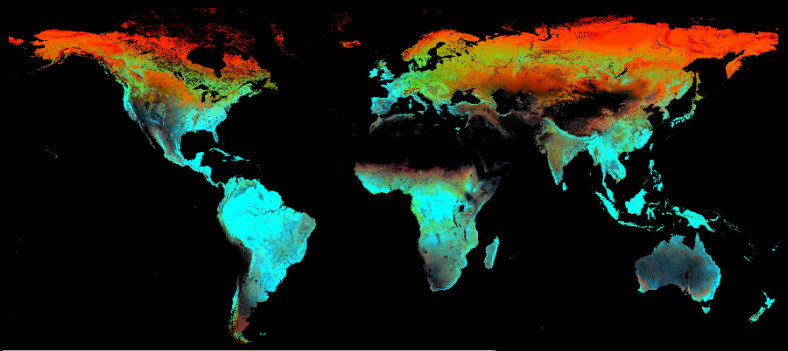
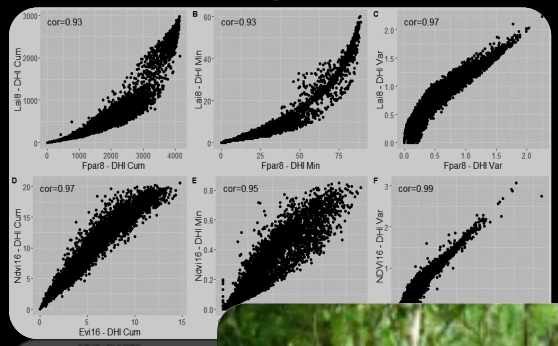
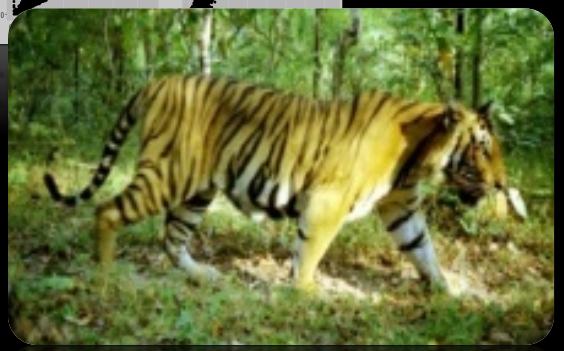
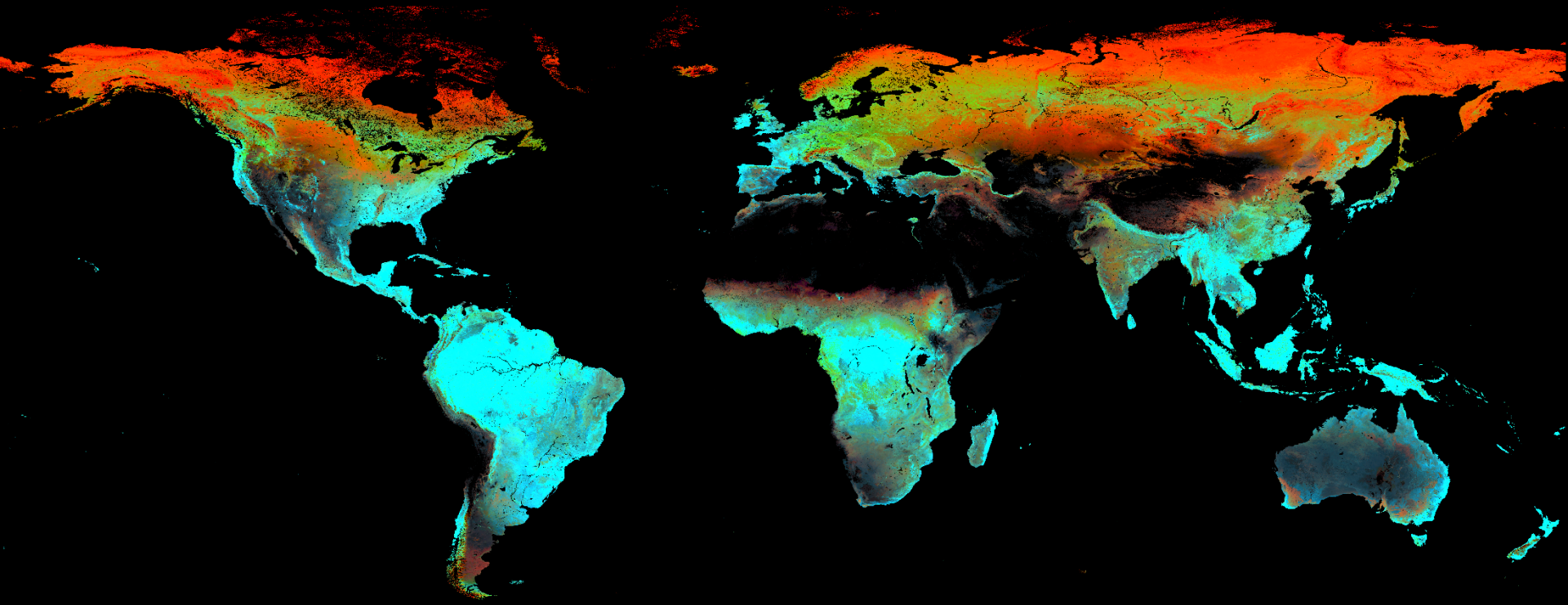






Composite Fpar DHIs



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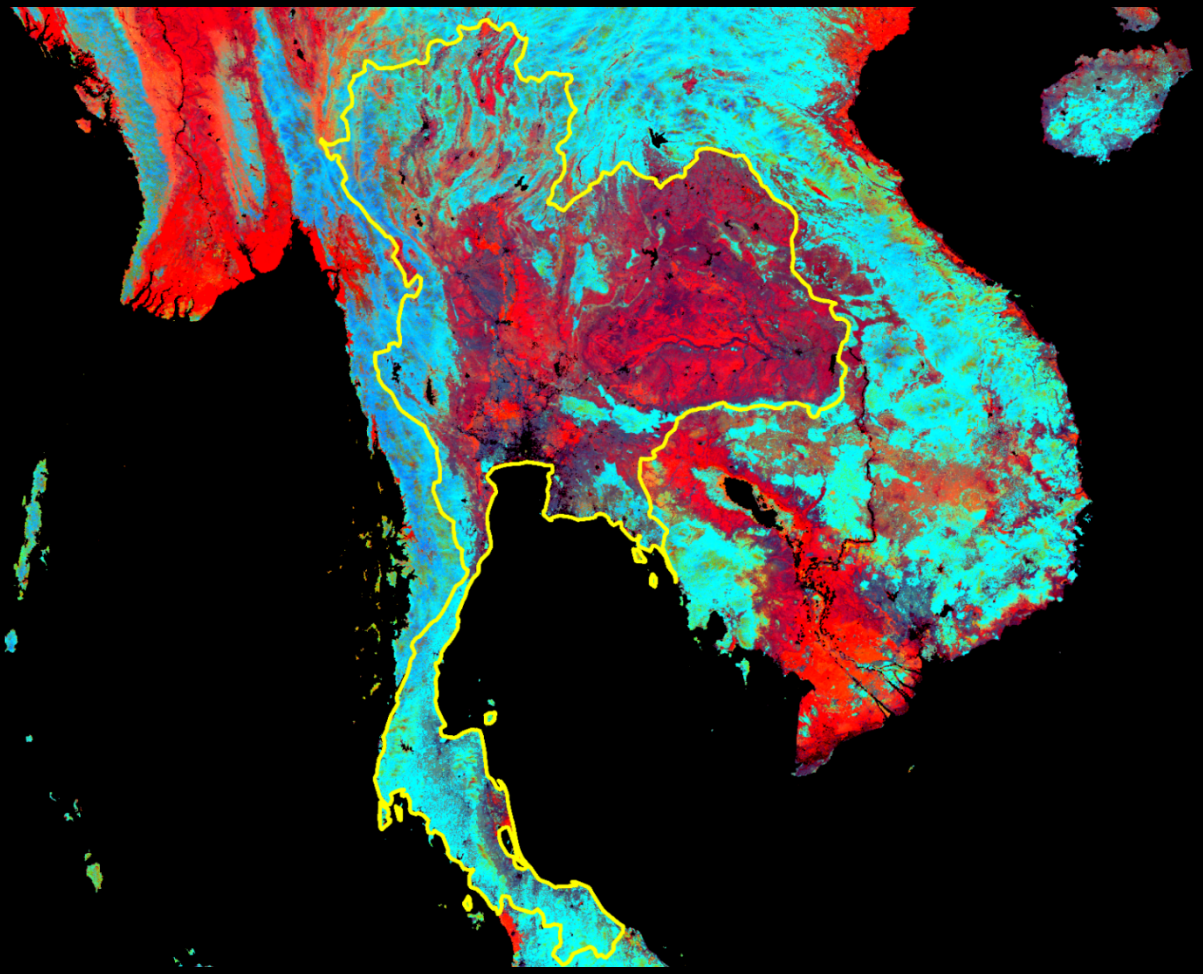
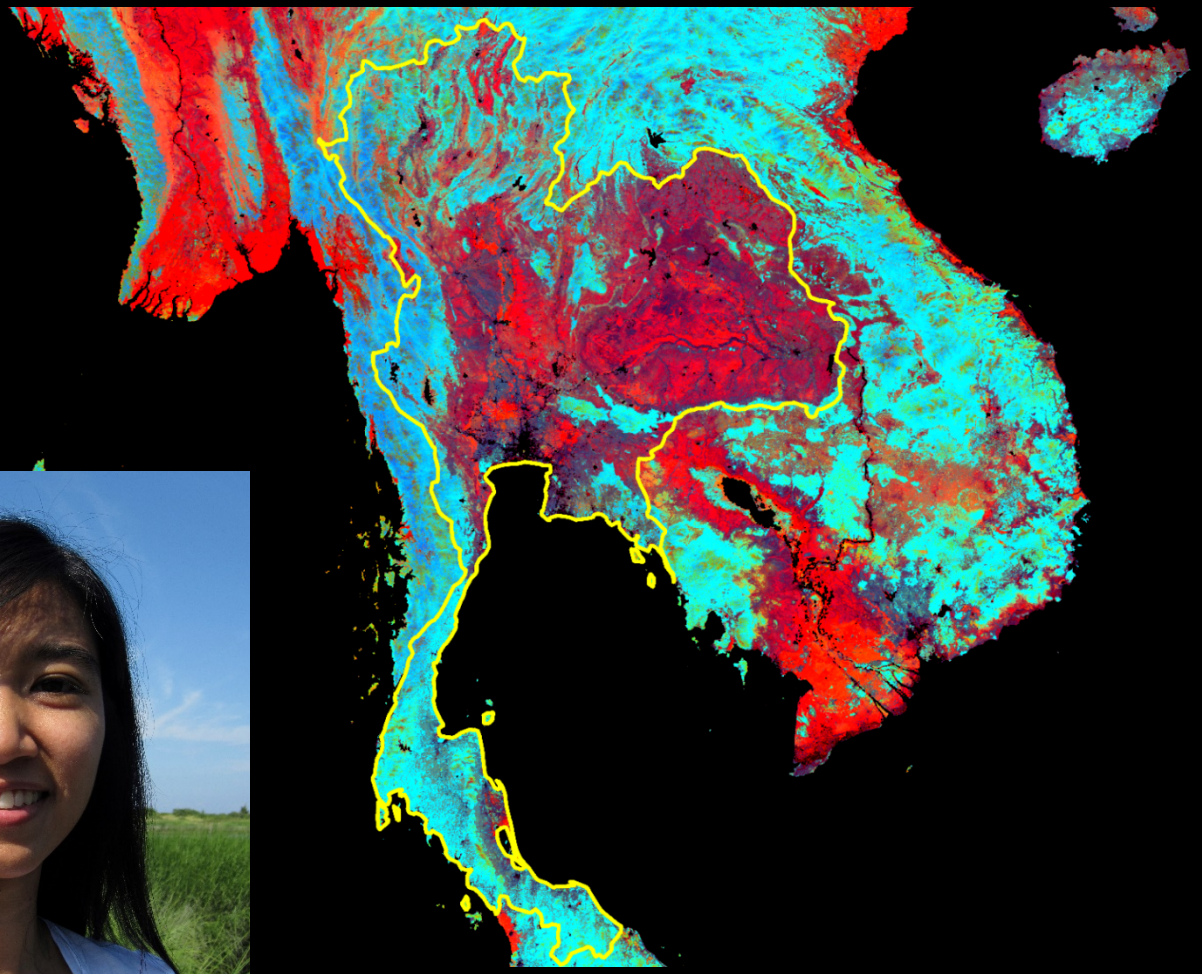
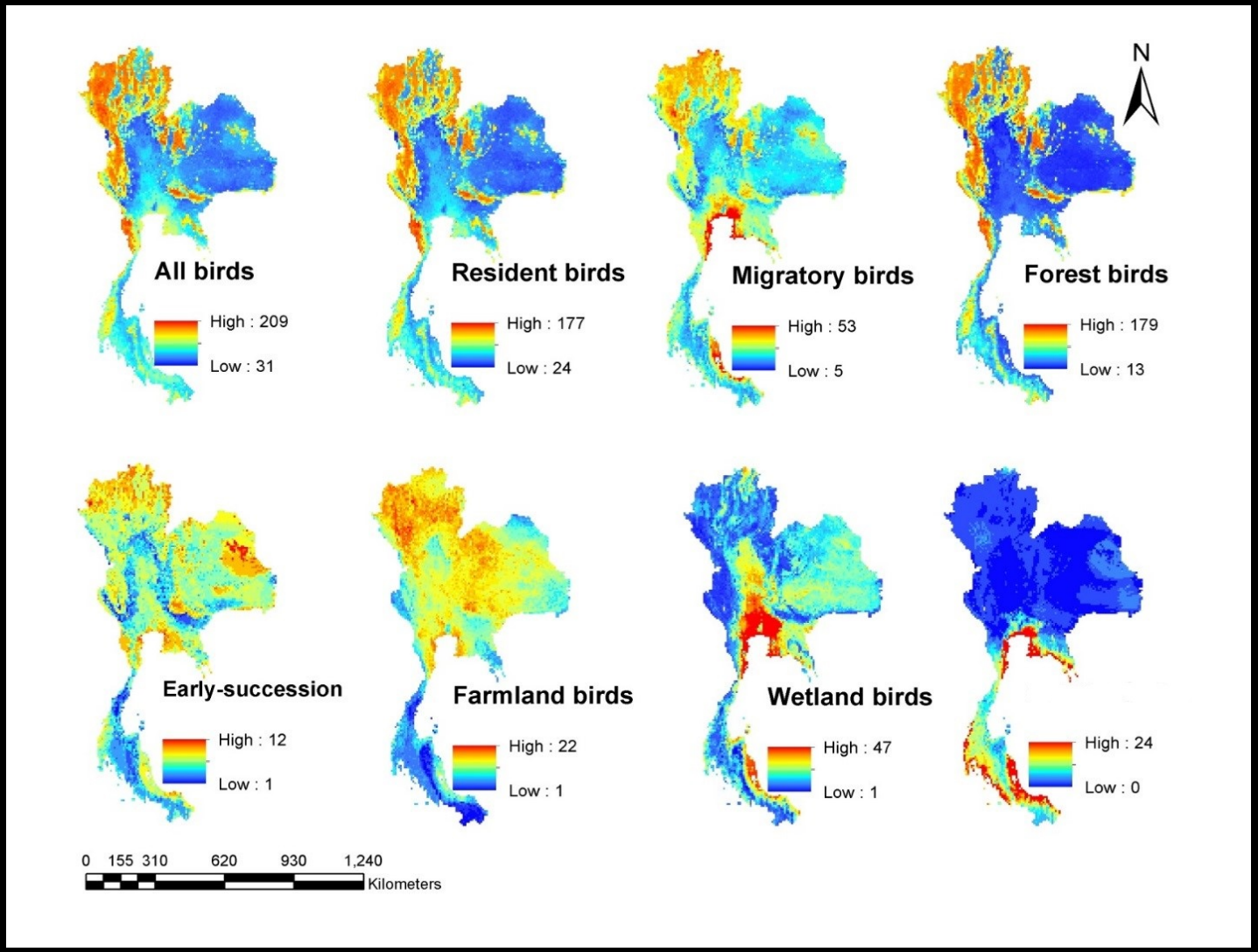


Composite Fpar DHIs



Thailand – bird species richness



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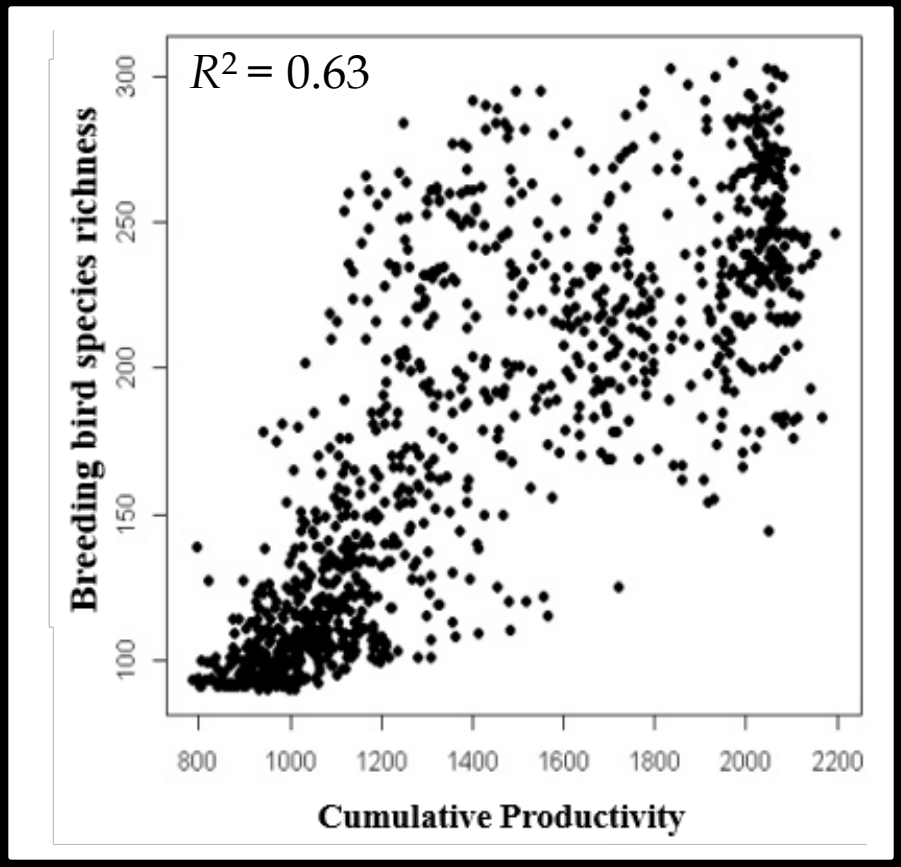

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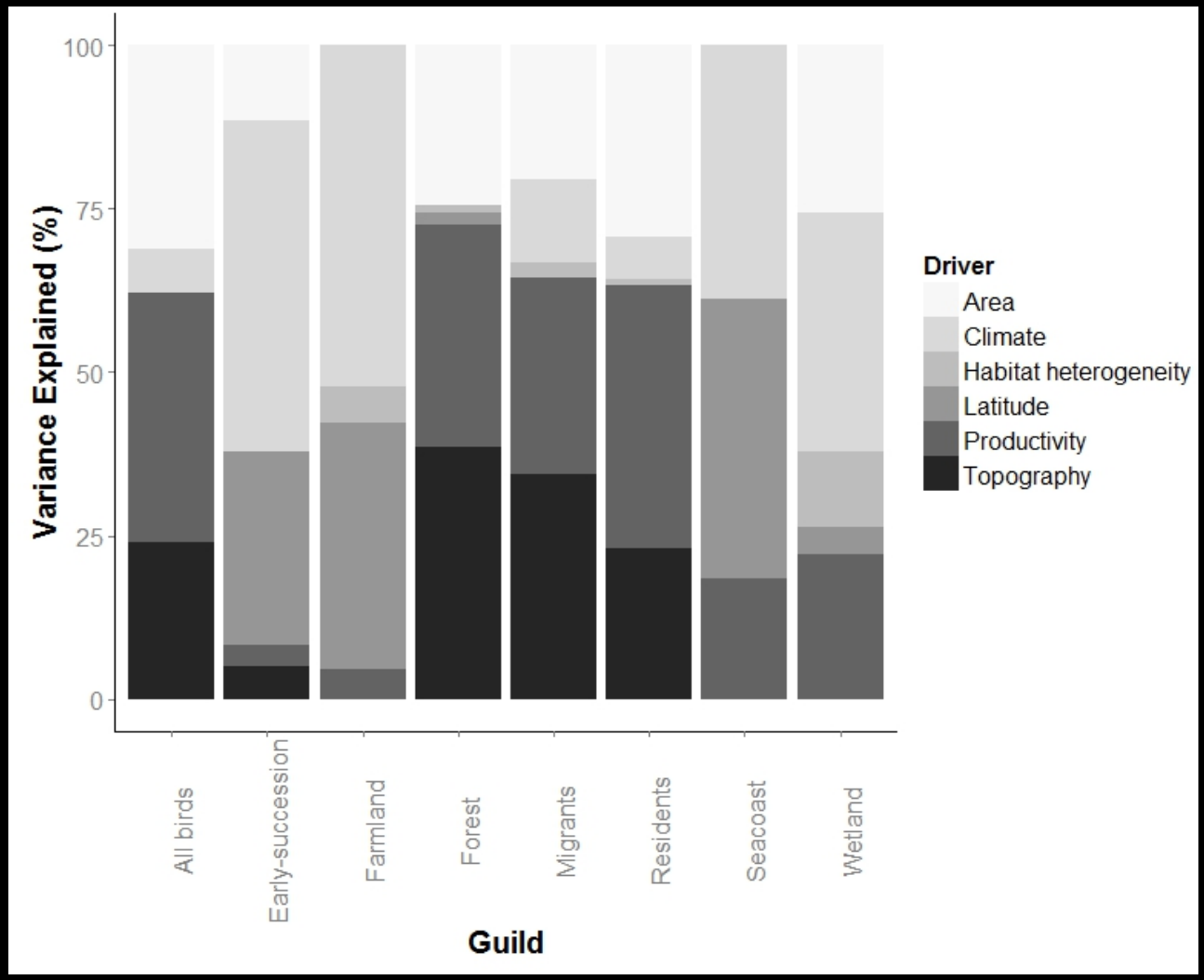
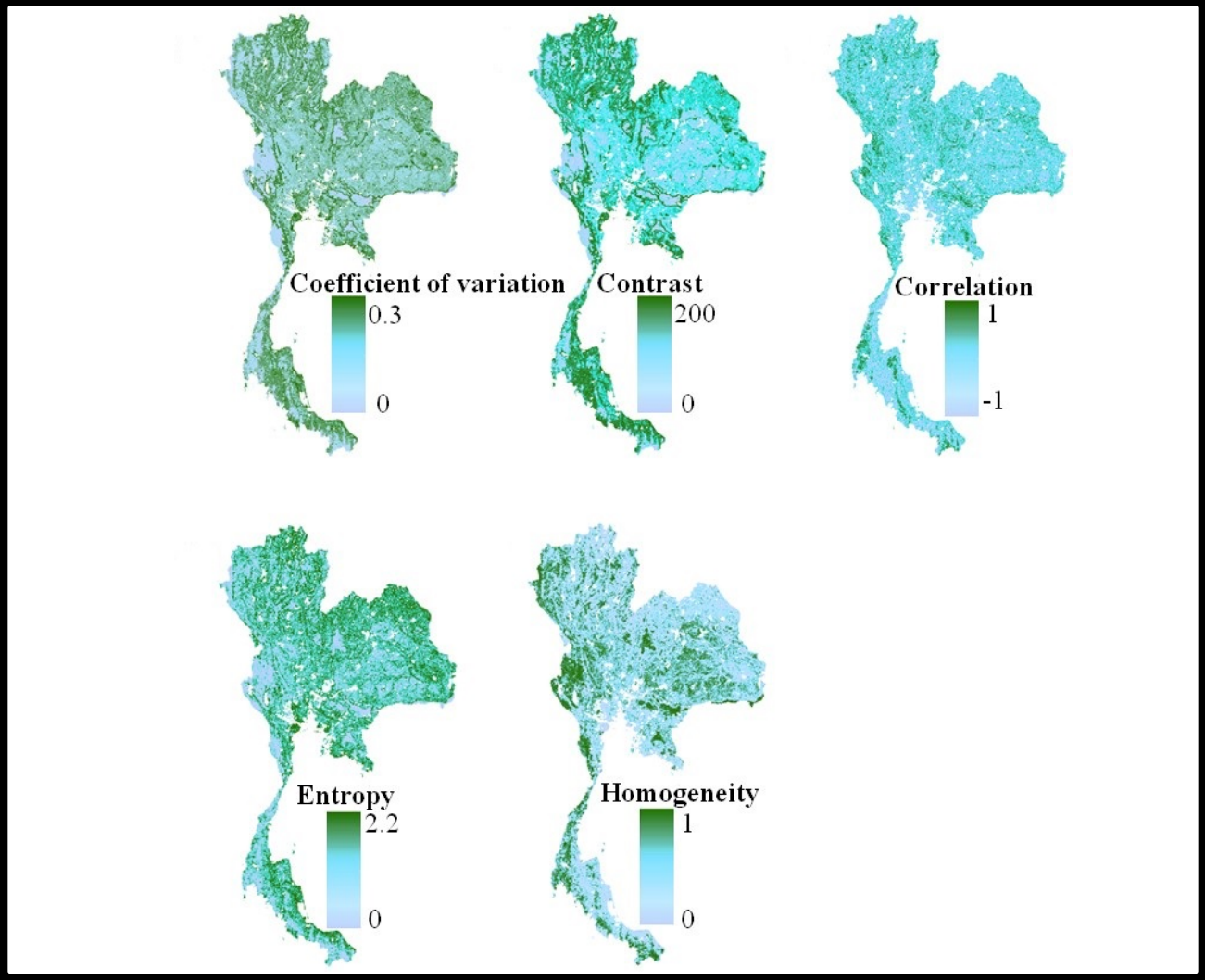


Thailand – DHI-1 texture



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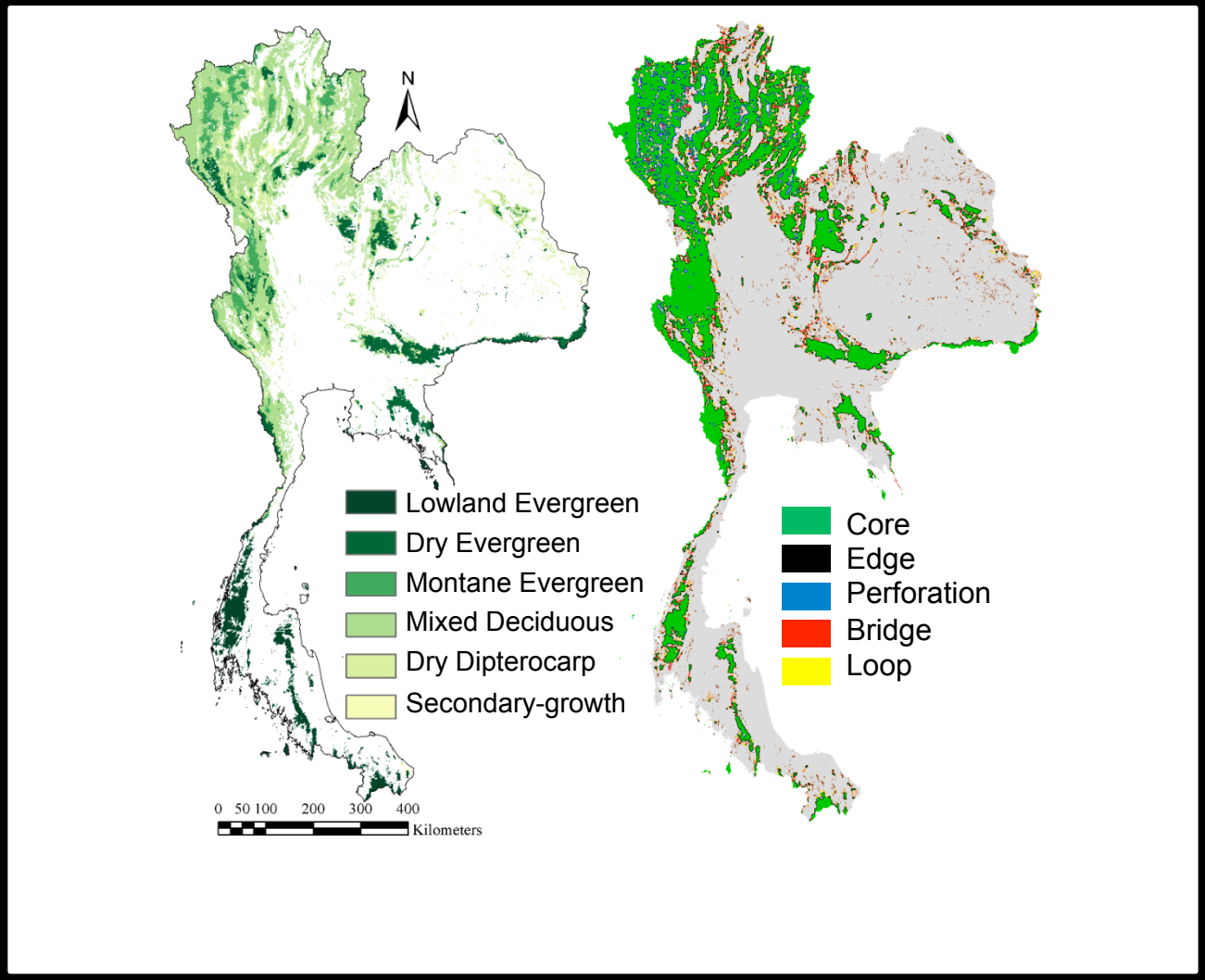

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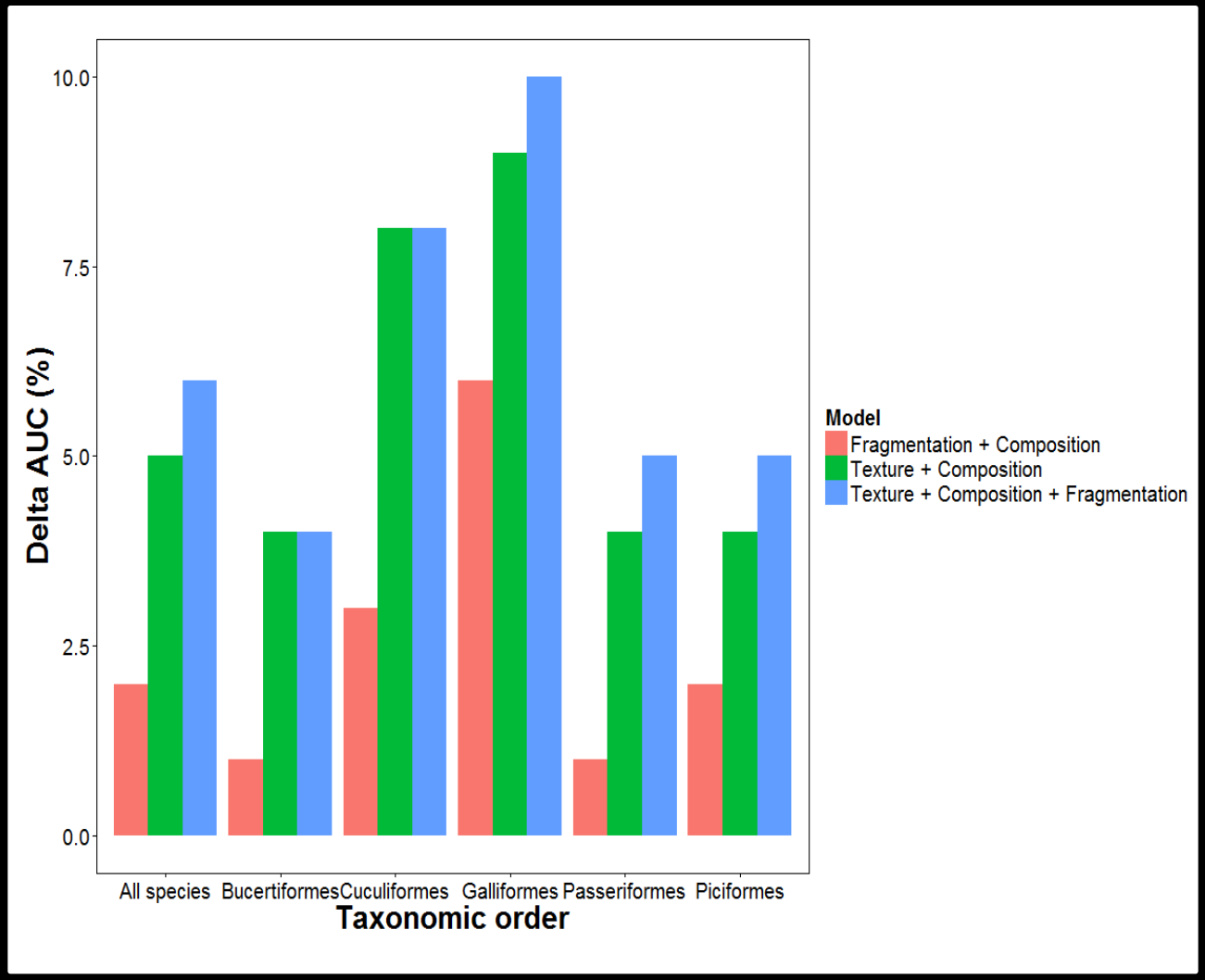
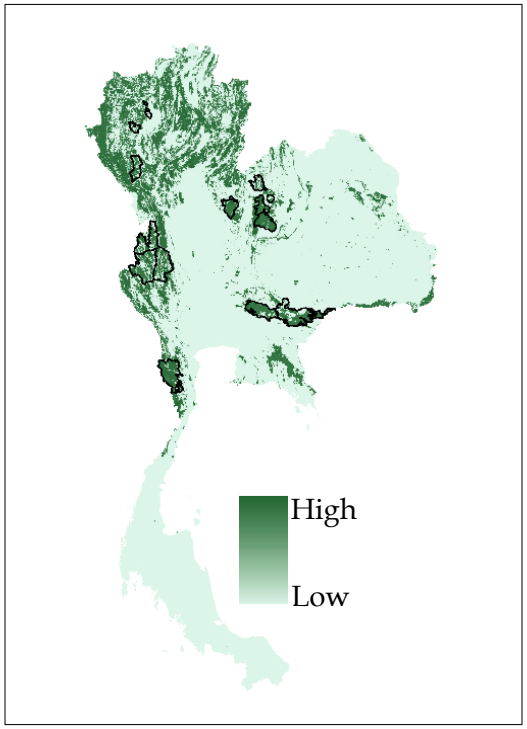


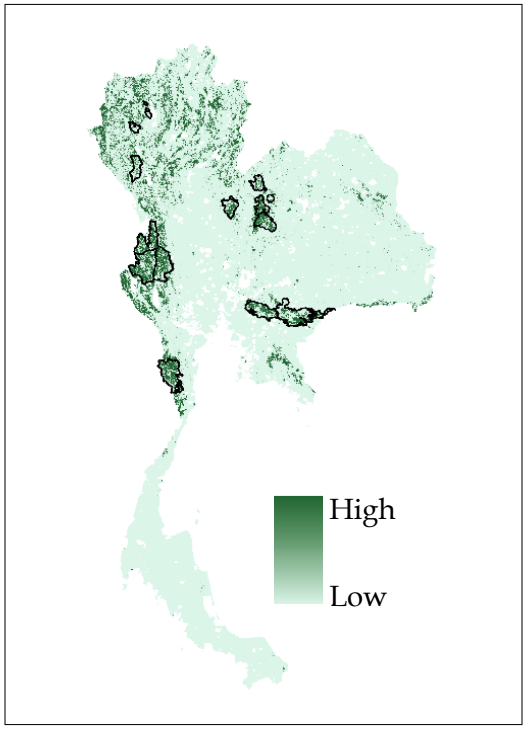
Thailand – DHI-1 texture

Anorrhinus tickelli

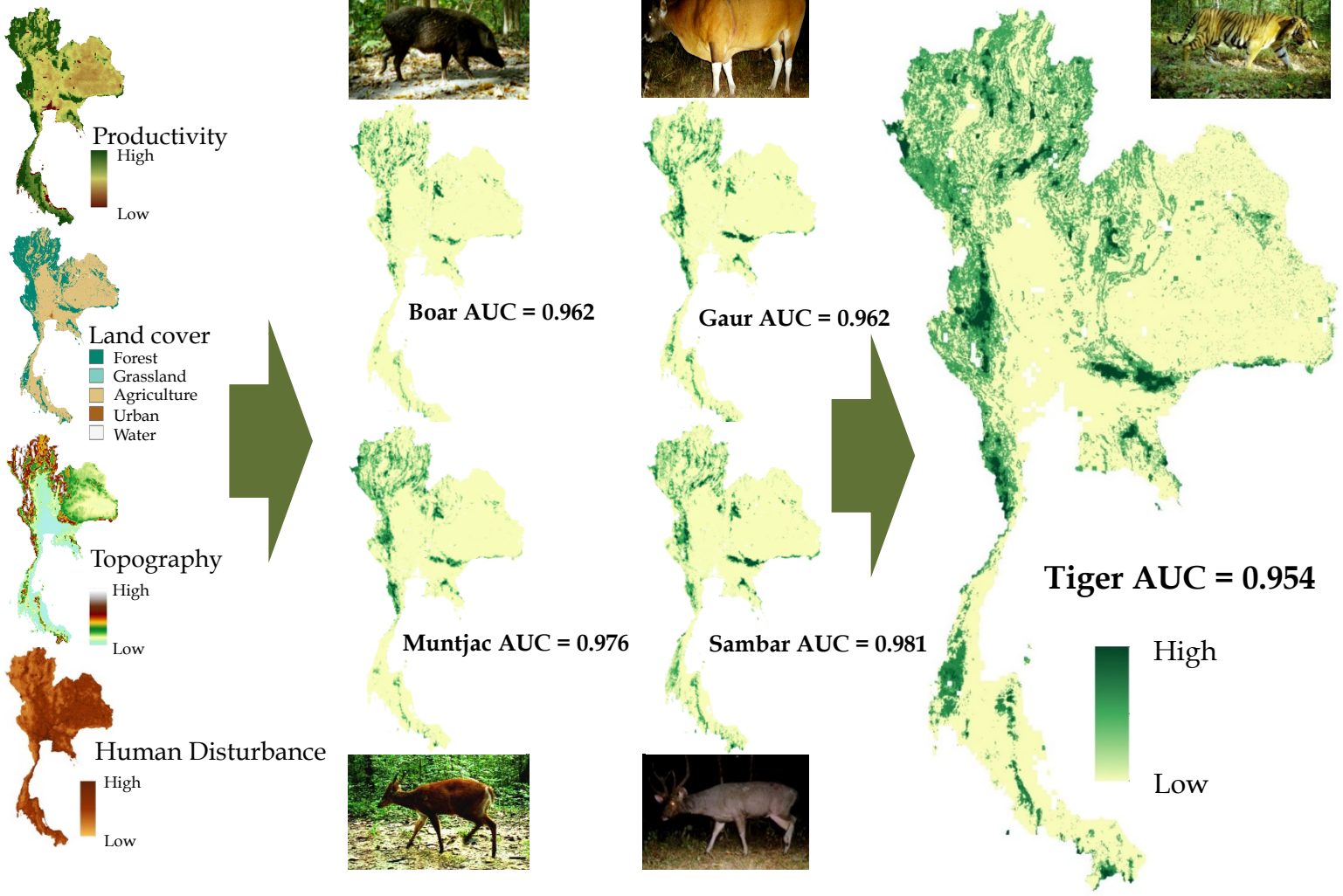
Habitat composition model



Habitat + texture model



Thailand - Tigers



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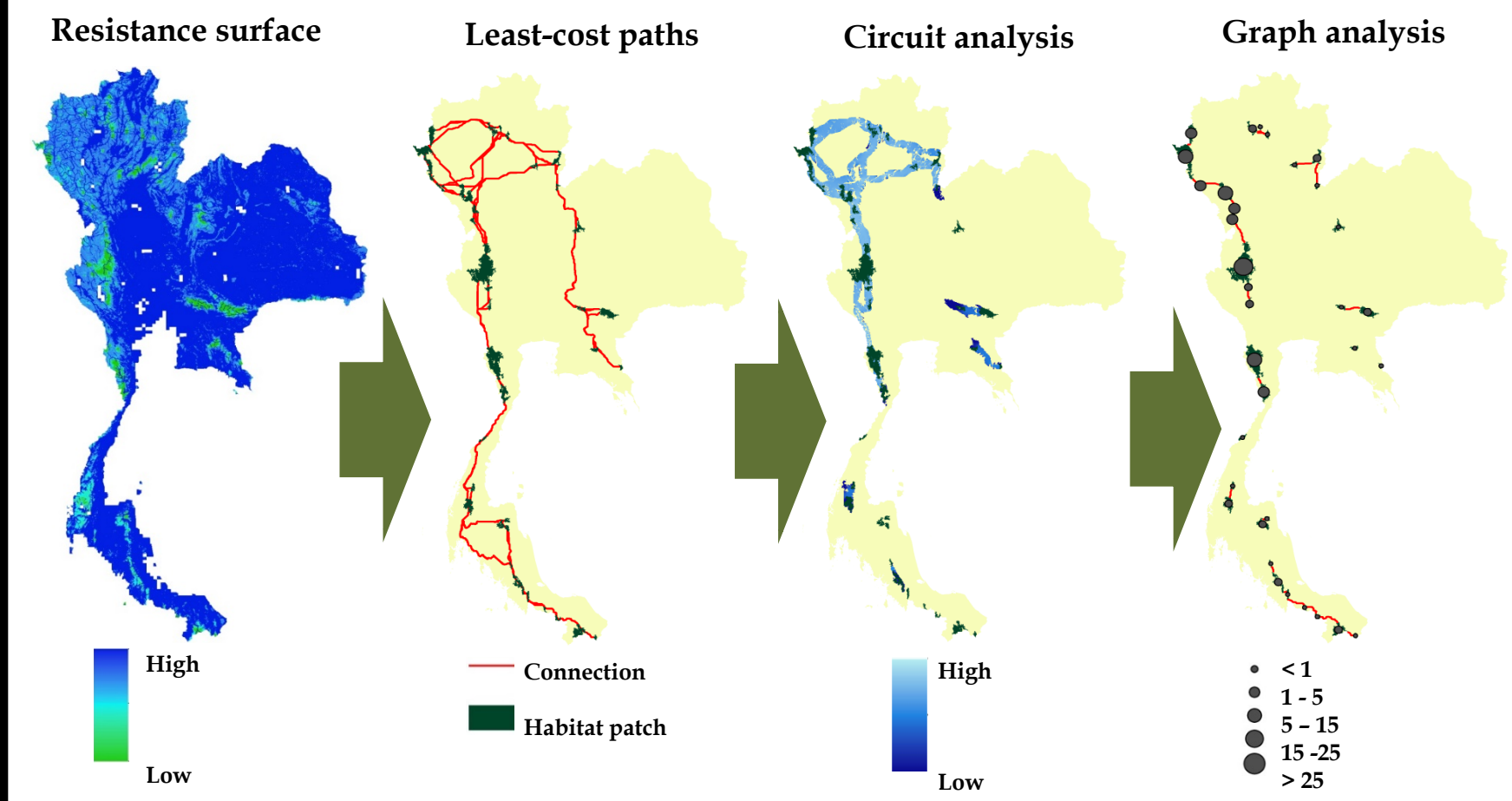

Thailand - Conclusions

- DHIs and species richness
  - DHI-1 mattered most
  - Forest birds well correlated
- Texture of DHI-1 improves bird species distribution models
- DHI-1 improves mammal distribution models and connectivity analyses

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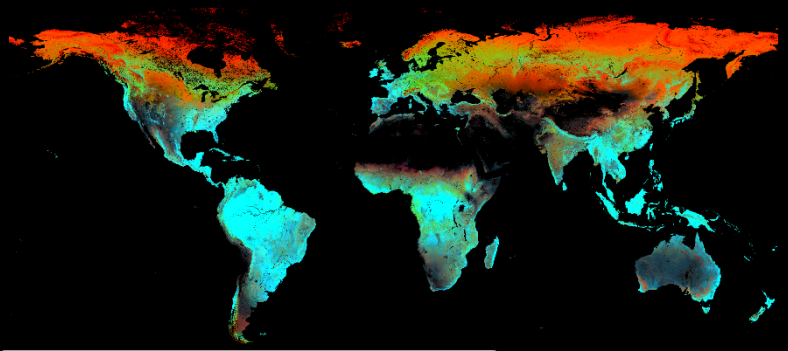
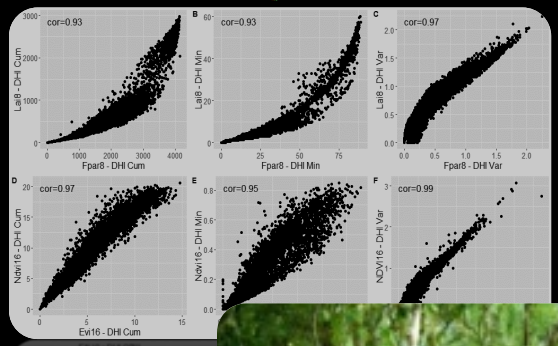
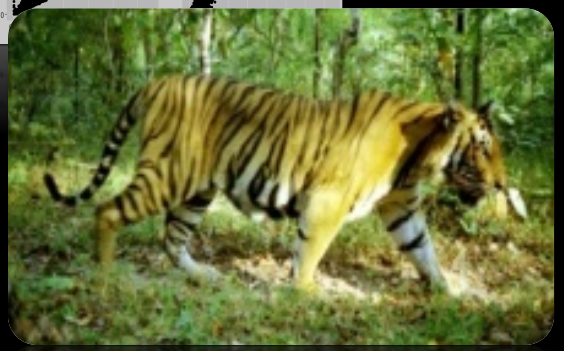
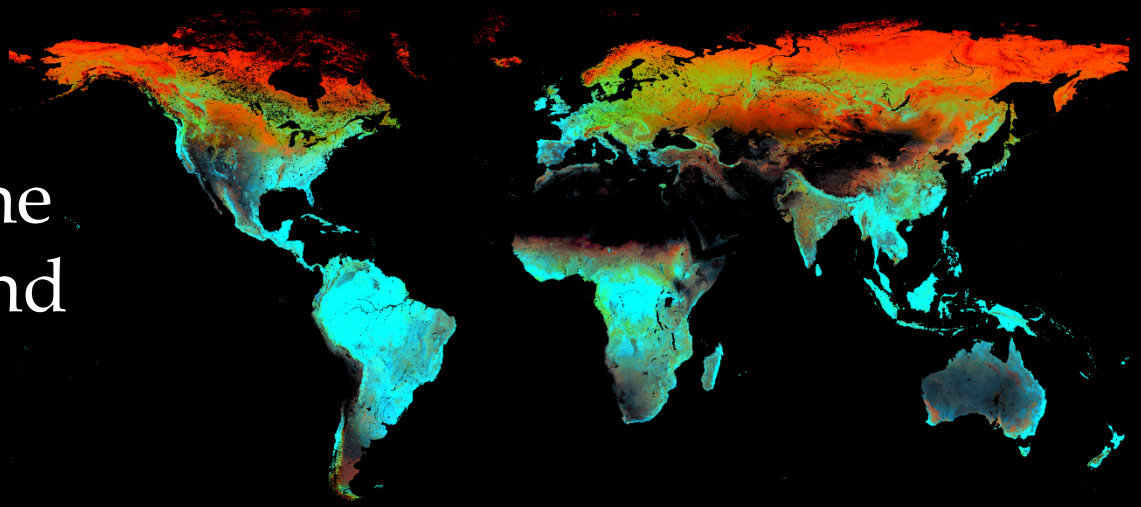






Conclusions

- Datasets: largely completed
  - Composite DHIs
  - Annual DHIs
  - Next step: online data viewing and downloading



Conclusions

- DHIs and biodiversity
  - Promising results from Thailand
    - DHIs and bird species richness
    - Cumulative DHI texture and birds
    - Cumulative DHI and tiger habitat connectivity
  - DHIs and global biodiversity patterns
    - Alpha of mammals, birds and amphibian
    - Beta with C. Graham, T. Brooks, et al.
  - DHIs and Breeding Bird Survey data
    - Comparison of DHIs depending on Veg. Product

The Dynamic Habitat Indices based on MODIS as predictors of avian species richness

SILVIS Lab
Spatial Analysis for Conservation and Sustainability

Martina L. Hobi[1], Maxim Dubinin[1], Anna M. Pidgeon[1], Anthony R. Ives[1], Nicholas C. Coops[2], Catherine H. Graham[3] & Volker C. Radeloff[1]

[1]University of Wisconsin-Madison, USA; [2]University of British Columbia, Canada; [3]Stony Brook University, USA

Introduction

- Numerous studies suggest an association of available energy with species richness. The ***Species-Energy Theory*** relates high species richness with high vegetation productivity over the time of a year.
- We present the **MODIS** based **Dynamic Habitat Indices** as productivity mea
  (1) **DHI Cum** – cu
  (2) **DHI Min** – mi
  (3) **DHI Var** – coe

Test the predictive p
productivity data ve

Da

Study site

The 48 conterminou
85 ecoregions based

Data

- A range of MODI
  spatial resolutio
- Bird species richn

Calculation of DHI's

- Global calculatio
  thresholds for th
- Correction for nc
  and end of the g
- Masking of urba

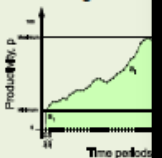


Fig 1 Yearly calculation c
based on productivity p

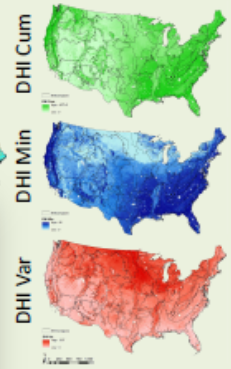
Methods

- Correlation of the productivity data sets averaged over Ecoregions
- Testing the relation between the DHI's and bird species richness of different functional guilds using linear regression

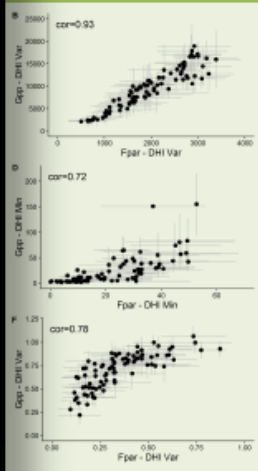
Results: Dynamic Habitat Indices

DHI products (Example FPAR, Fig 3):

- FPAR based DHI, MOD15A2, 8-day
- LAI based DHI, MOD15A2, 8-day
- NDVI based DHI, MOD13A2, 16-day



lations of DHIs



ctivity data sets between the mean
e standard deviations of ecoregions.

- Correlation coefficients (Fig 4) between the input data sets vary in a range of 0.72 to 0.99, with DHI Cum being best correlated

Results: Explaining bird richness

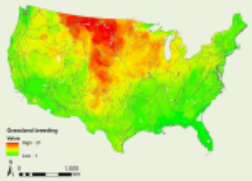


Fig 5 Grassland breeding bird richness.

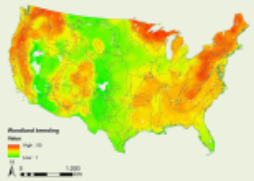


Fig 6 Woodland breeding bird richness.

Bird species richness maps based on BBS abundance maps, here two examples grassland and woodland breeding birds (Fig 5, Fig 6)

Tab 1 Linear regression models using the mean of the five different DHI data sets within an ecoregion to explain woodland and grassland breeding species richness. All DHI refers to the multivariate model. R^2 indicates predictive power.

Bird guilds	R^2 - All DHIs	R^2 - DHI Cum	R^2 - DHI Min	R^2 - DHI Var
WOODLAND				
Fpar	0.60***	0.44***	0.09**	NS
Lai	0.58***	0.44***	0.07**	0.07*
Ndvi	0.50***	0.35***	0.07*	NS
Evi	0.32***	0.30***	0.08*	NS
Gpp	0.48***	0.31***	NS	NS
GRASSLAND				
Fpar	0.70***	0.26***	0.57***	0.58***
Lai	0.67***	0.26***	0.48***	0.32***
Ndvi	0.62***	0.26***	0.52***	0.32***
Evi	0.64***	0.21***	0.57***	0.43***
Gpp	0.62***	0.23***	0.33***	0.43***

- Overall similar predictive power of the DHIs based on the five productivity data sets (Tab 1)
- DHI Cum most important for woodland breeding species and DHI Min and Var for grassland breeding species.

Discussion and conclusions

- The type of MODIS vegetation productivity data as input data for DHI calculation did matter leading to different results.
- Correlation between the vegetation productivity data sets varies.
- Generally the DHIs have a high explanatory power in predicting breeding bird species richness. The strength of the relationship is dependent of the birds breeding habitat.
- The results hold potential for similar biodiversity assessments for mammals or amphibians and to use the maps of bird biodiversity for conservation planning.

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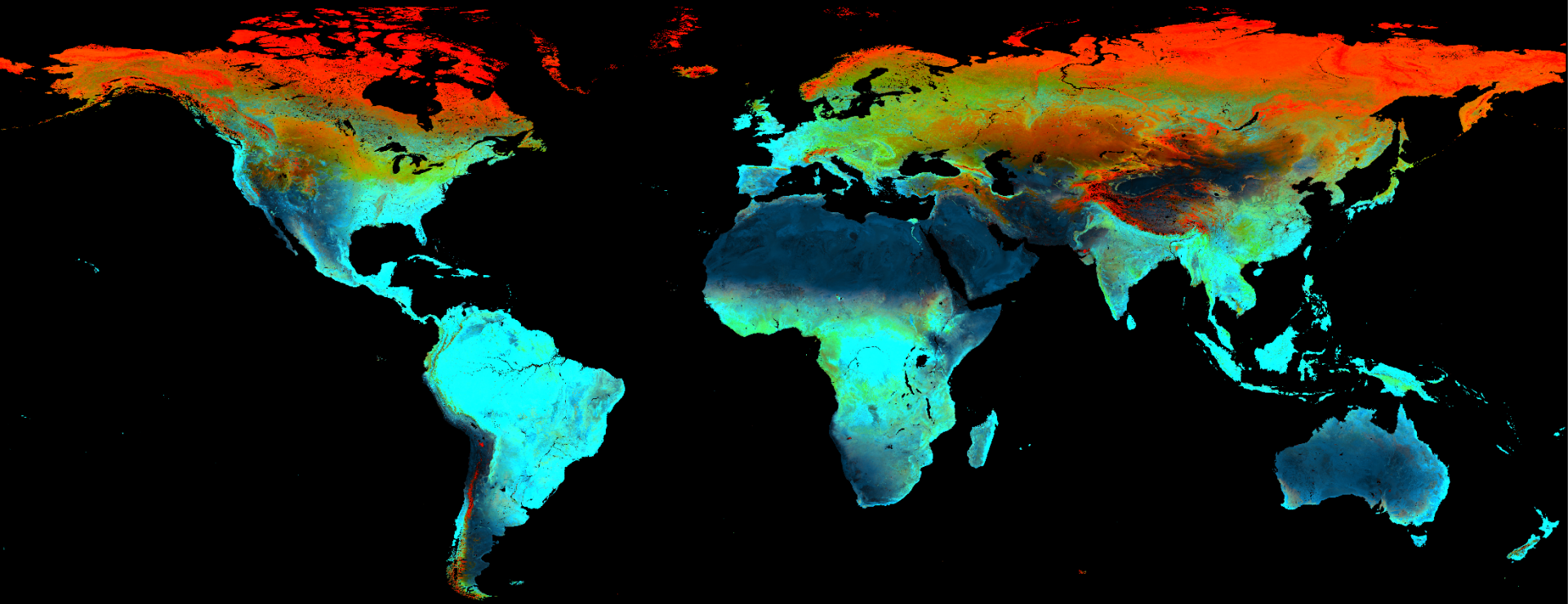

Thank you!