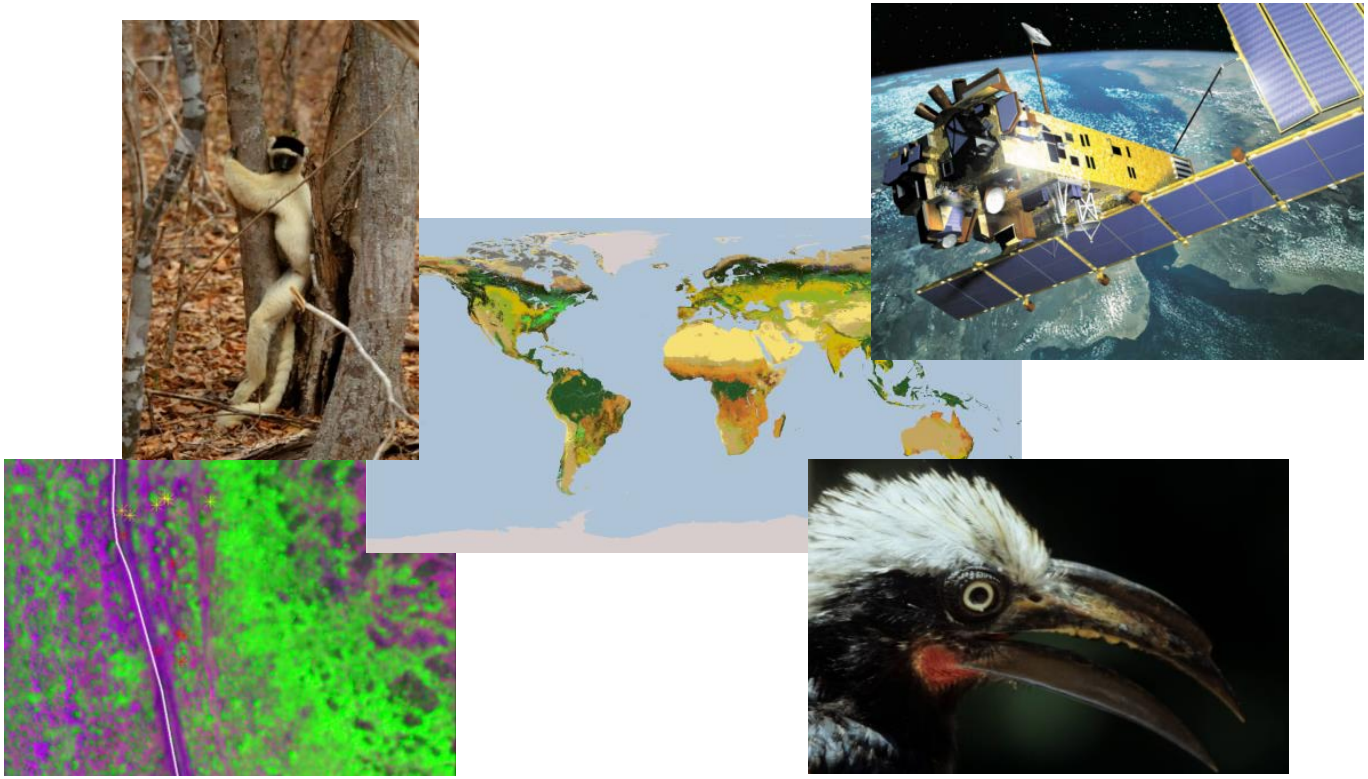
Tracking changes to habitats and biodiversity for global assessments and monitoring



Walter Jetz
Yale University

Habitat

Latin *habitare* - 'possess, inhabit'

The natural or environment of an animal, plant, or other organism

Global science-policy activities

Convention on Biological Diversity

Rio 1992: Develop national strategies for the **conservation and sustainable use of biological diversity**. **Aichi 2020 targets** to monitor progress.

futurearth
research for global sustainability

1980/2013: A global **research platform** aiming to provide the knowledge and support to accelerate our transformations to a sustainable world.

GEO BON

2008: Group on Earth Observations **Biodiversity Observation Network**: link and leverage efforts to collect, manage, share and analyze biodiversity status and trend observations

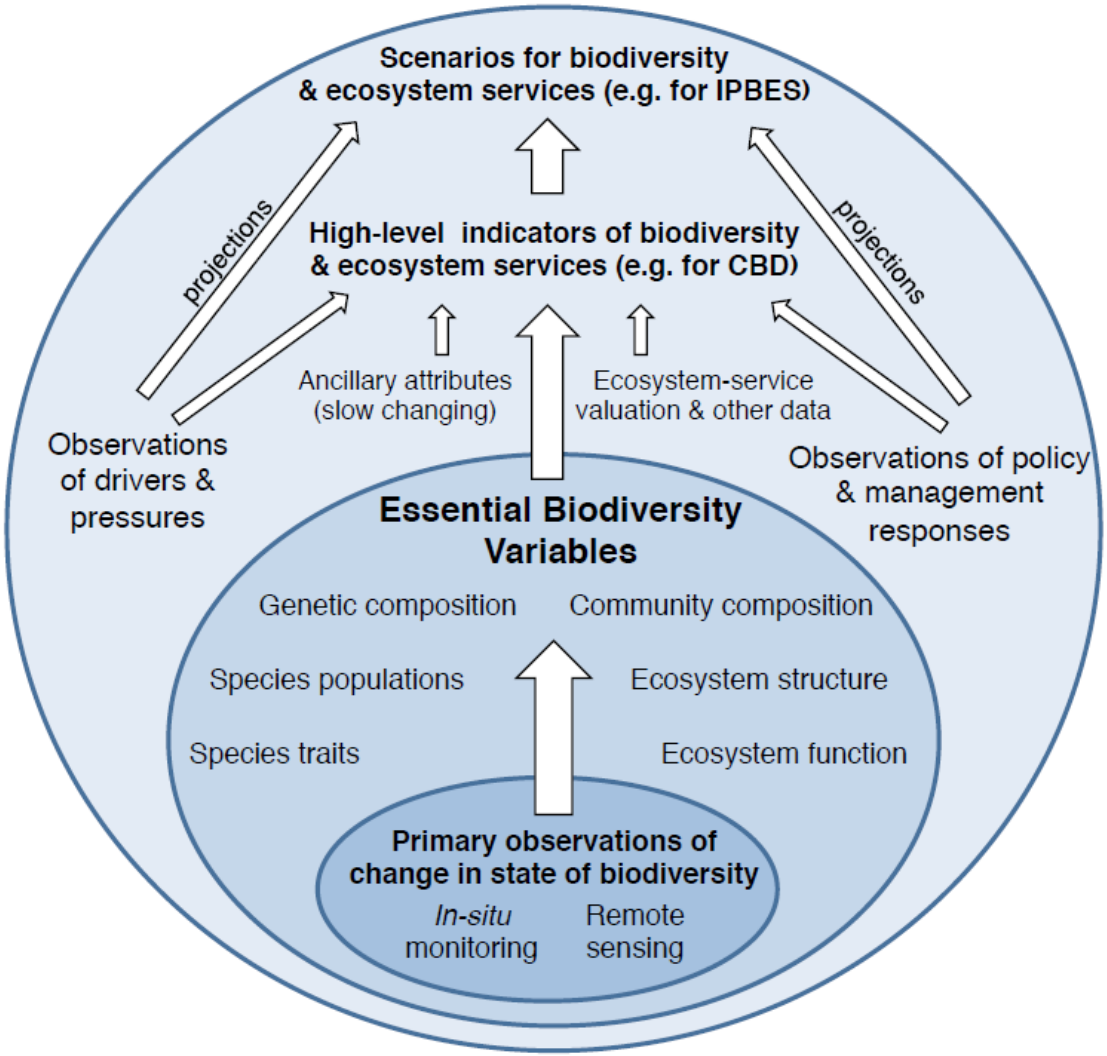
ipbes

2012: **Intergovernmental Platform on Biodiversity & Ecosystem Services:** an IPCC style assessment process. Carries out assessments of existing knowledge in response to governments' and other stakeholders' requests

GROUP ON EARTH OBSERVATIONS | GEO BON

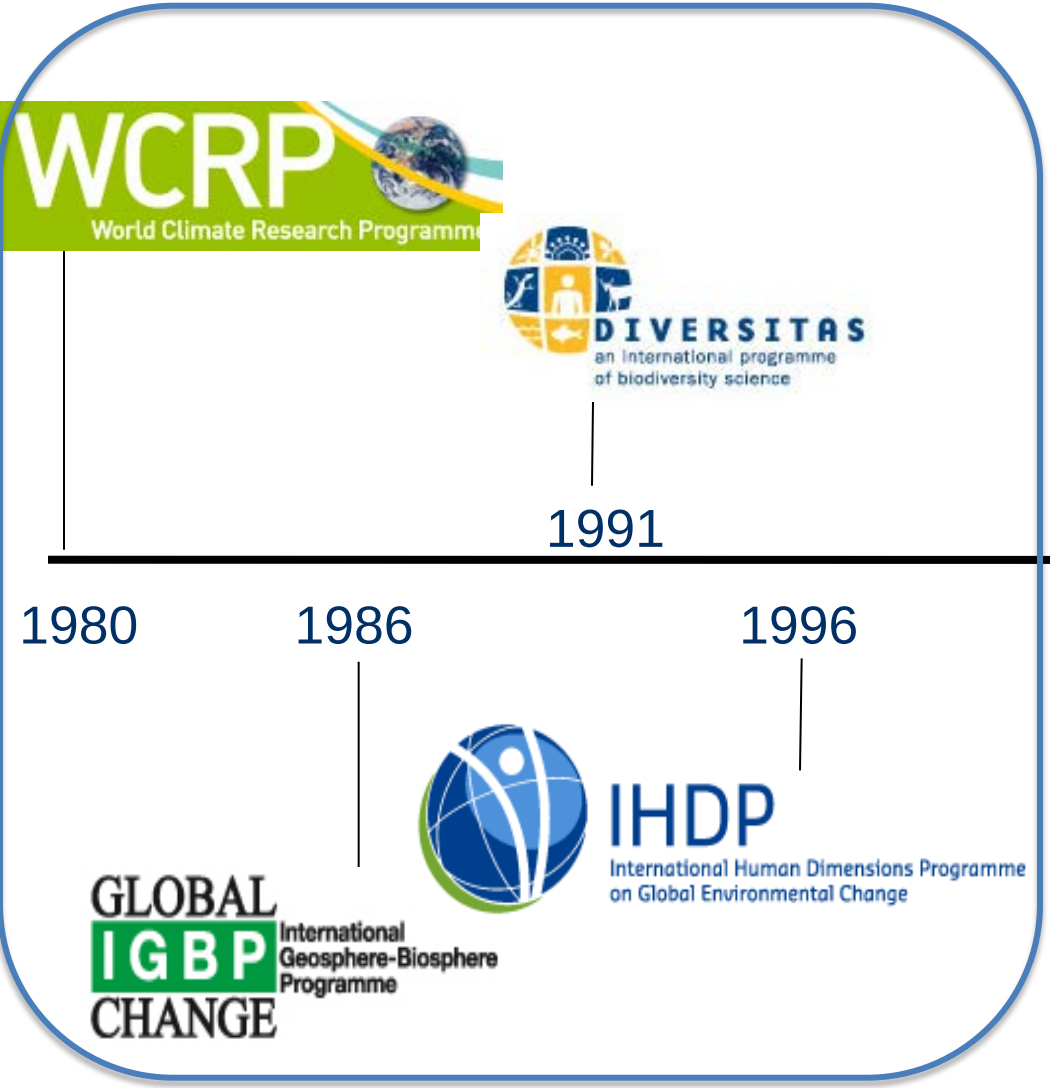
- Coordinate the gathering and delivery of biodiversity change information globally

- Provide a set of innovative and relevant products based on the integration of key data set



Essential Biodiversity Variables

Pereira et al. (2013)

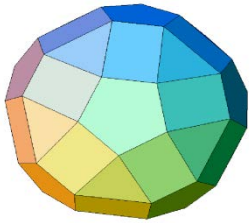


2001

2013

Cluster on Global Biodiversity Monitoring, Prediction & Reporting

(Launch: Yale, 4 May 2015)



Provide the knowledge required for societies in the world to face risks posed by global environmental change and to seize opportunities in a transition to global sustainability

Platform work programme 2014–2018: Objectives and associated deliverables

Objective 1: Strengthen the capacity and knowledge foundations of the science-policy interface to implement key functions of the Platform:

(a) Priority capacity-building needs to implement the Platform's work programme matched with resources through catalysing financial and in-kind support
(b) Capacities needed to implement the Platform work programme developed
(c) Procedures, approaches for participatory processes for working with indigenous and local knowledge systems developed
(d) Priority knowledge and data needs for policymaking addressed through catalyzing efforts to generate new knowledge and networking

Objective 2: Strengthen the science-policy interface on biodiversity and ecosystem services at and across subregional, regional and global levels:

(a) Guide on production and integration of assessments from and across all scales
(b) Regional/subregional assessments on biodiversity, ecosystem services
(c) Global assessment on biodiversity and ecosystem services

Objective 3: Strengthen the science-policy interface on biodiversity and ecosystem services with regard to thematic and methodological issues:

(a) One fast track thematic assessment of pollinators, pollination and food production
(b) Three thematic assessments: land degradation and restoration; invasive alien species; and sustainable use and conservation of biodiversity and strengthening capacities/tools
(c) Policy support tools and methodologies for scenario analysis and modelling of biodiversity and ecosystem services based on a fast track assessment and a guide
(d) Policy support tools and methodologies regarding the diverse conceptualization of values of biodiversity and nature's benefits to people including ecosystem services based on an assessment and a guide

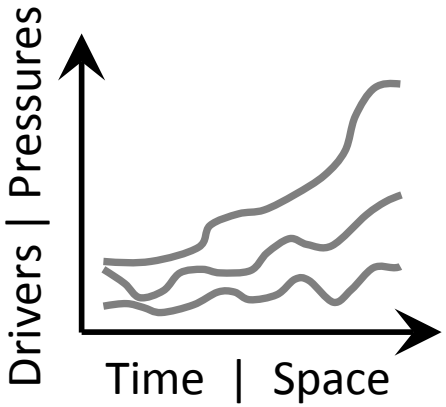
Objective 4: Communicate and evaluate Platform activities, deliverables and findings:

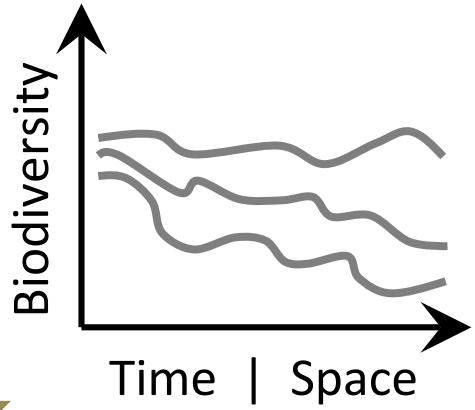
(a) Catalogue of relevant assessments
(b) Development of an information and data management plan
(c) Catalogue of policy support tools and methodologies
(d) Set of communication, outreach and engagement strategies, products and processes
(e) Reviews of the effectiveness of guidance, procedures, methods and approaches to inform future development of the Platform

Intergovernmental Platform for Biodiversity & Ecosystem Services

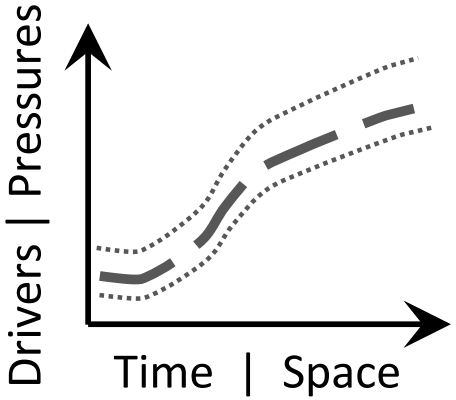
Task Force on Knowledge & Data

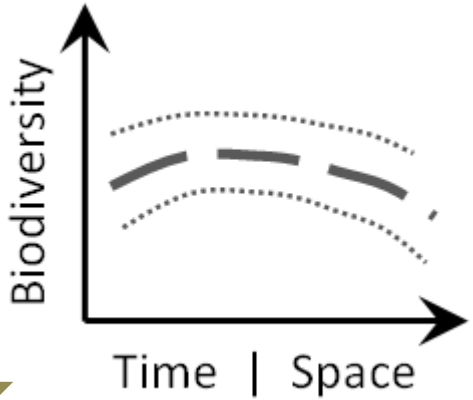
Data Monitoring





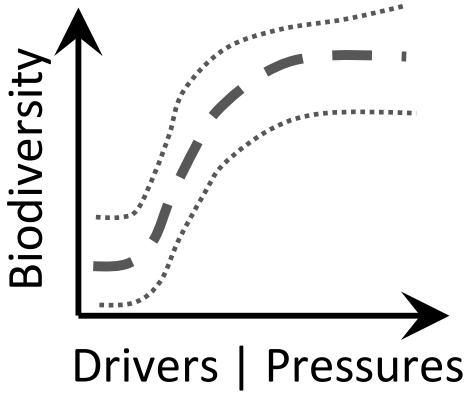
Indicators Metrics

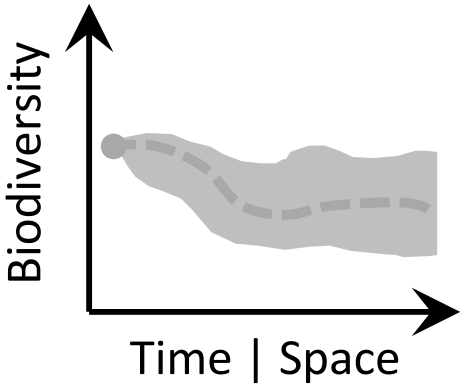




Response

Projection (Future)





From: IPBES Guide on Assessments, Chapter 4 (Walter Jetz, Belinda Reyers, Sheila Vergara, et al. 2015)

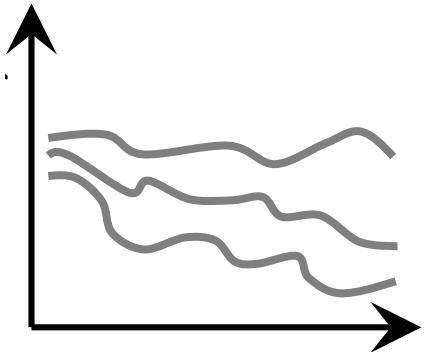
Data suited for monitoring is …

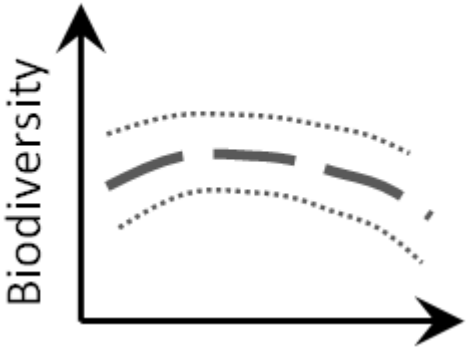
Not mobilized

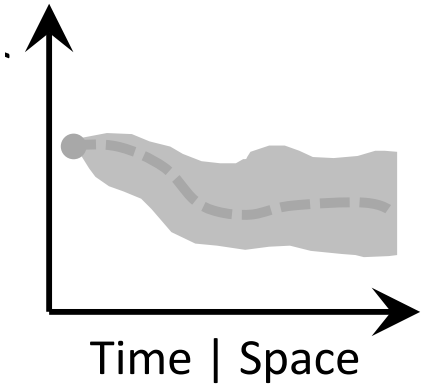
Spatially, temporally coarse

Limited to only certain attributes

Geographically, environmentally, taxonomically biased





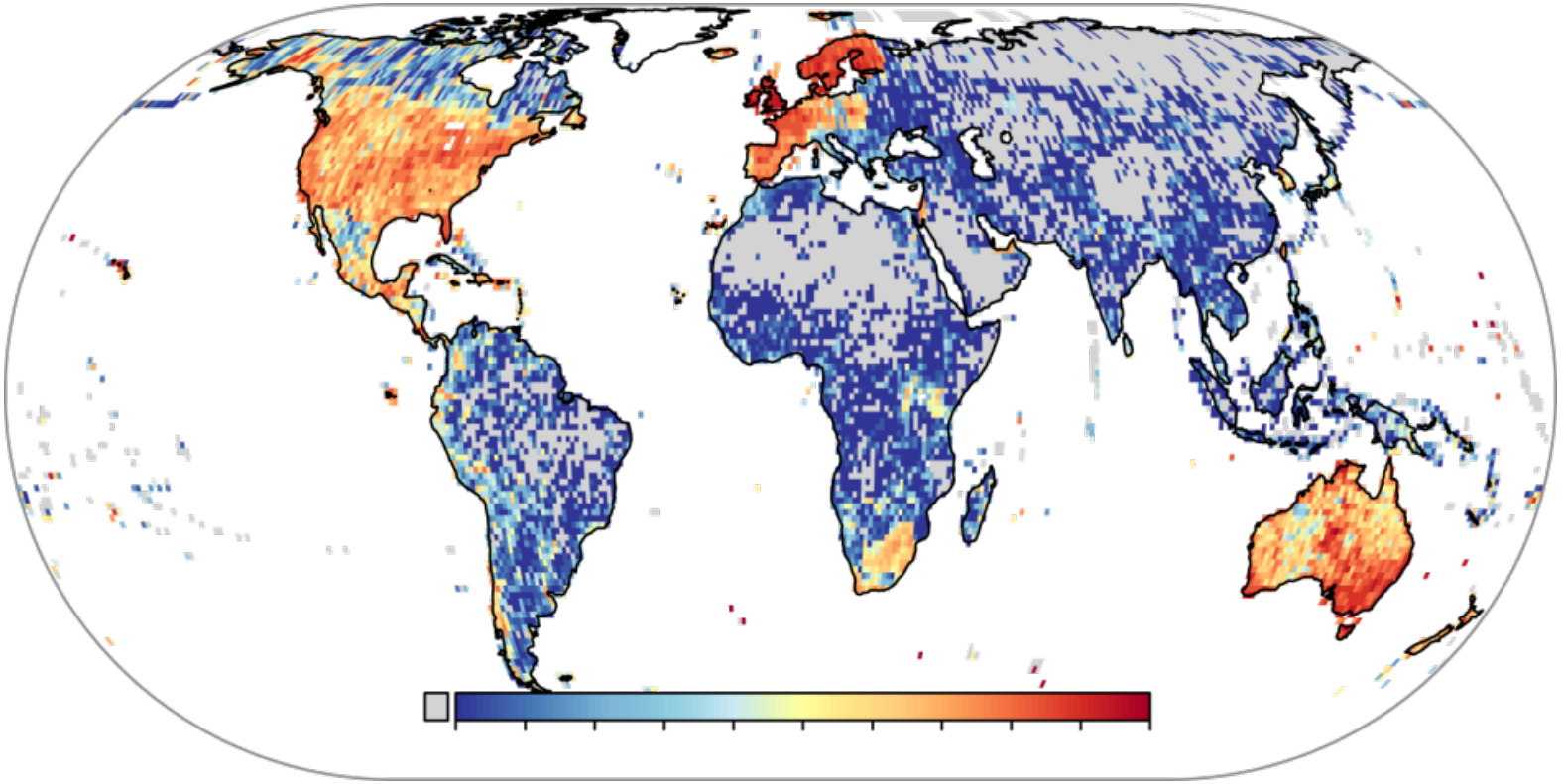


Sparse and biased:
Population trend data

The “Living Planet Index”

Collen et al 2009

Sparse and biased:
Species Distributions



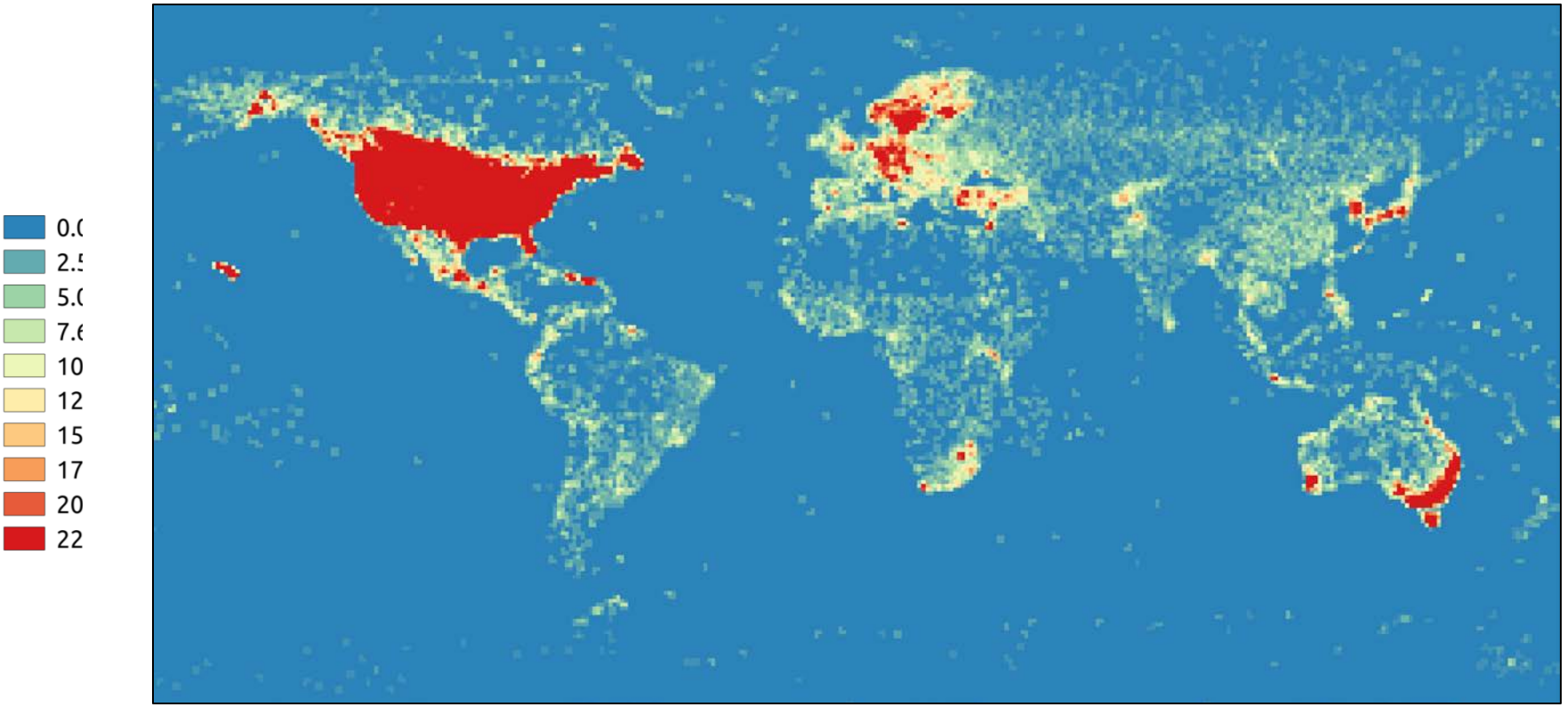
Inventory completeness (%)
Terrestrial vertebrates

MOL
MAP OF LIFE

Meyer et al., 2015

Sparse and biased:

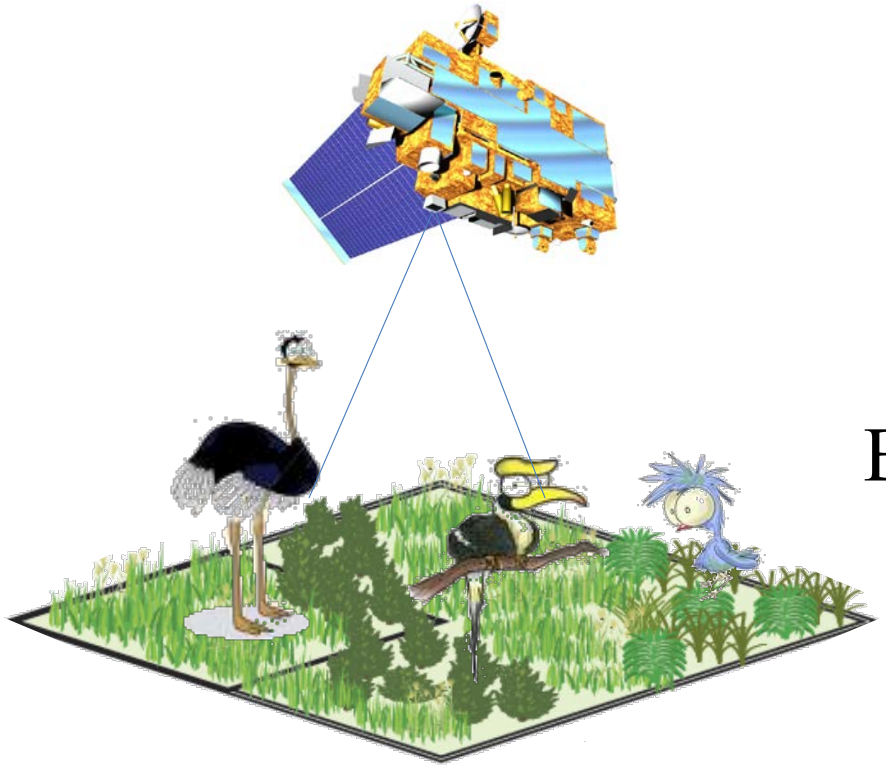
Climate data



Monthly GHCN+GLSD
Total station count

Remote Sensing

Habitats



Biodiversity and its functions

Fine spatial resolution

Consistent temporal sampling

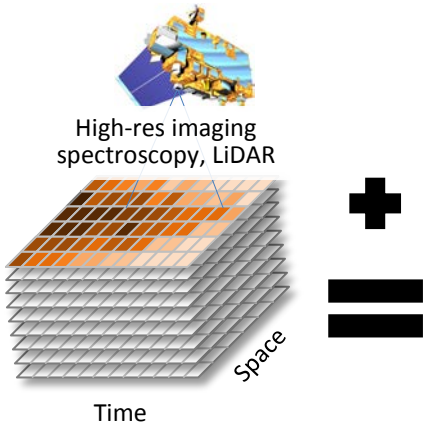
Ecological characteristics: habitats

Global extent

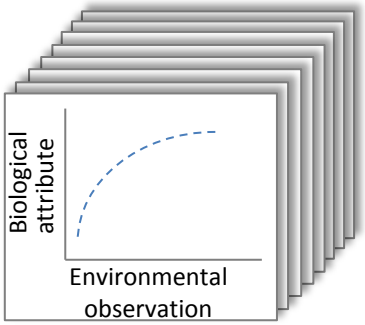
Spatial observations, not interpolations

I.

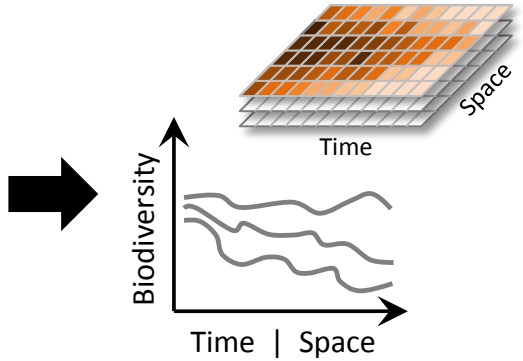
Observation

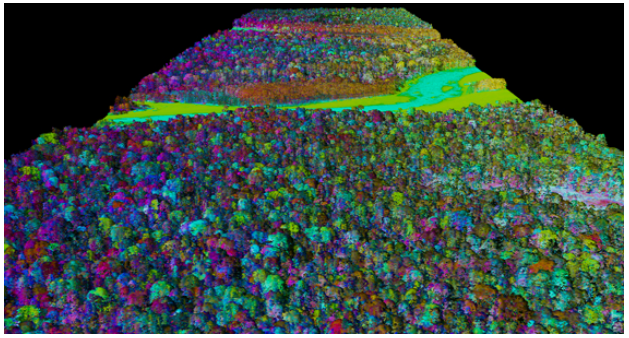


Biochemical relationships



Observed|Predicted Change

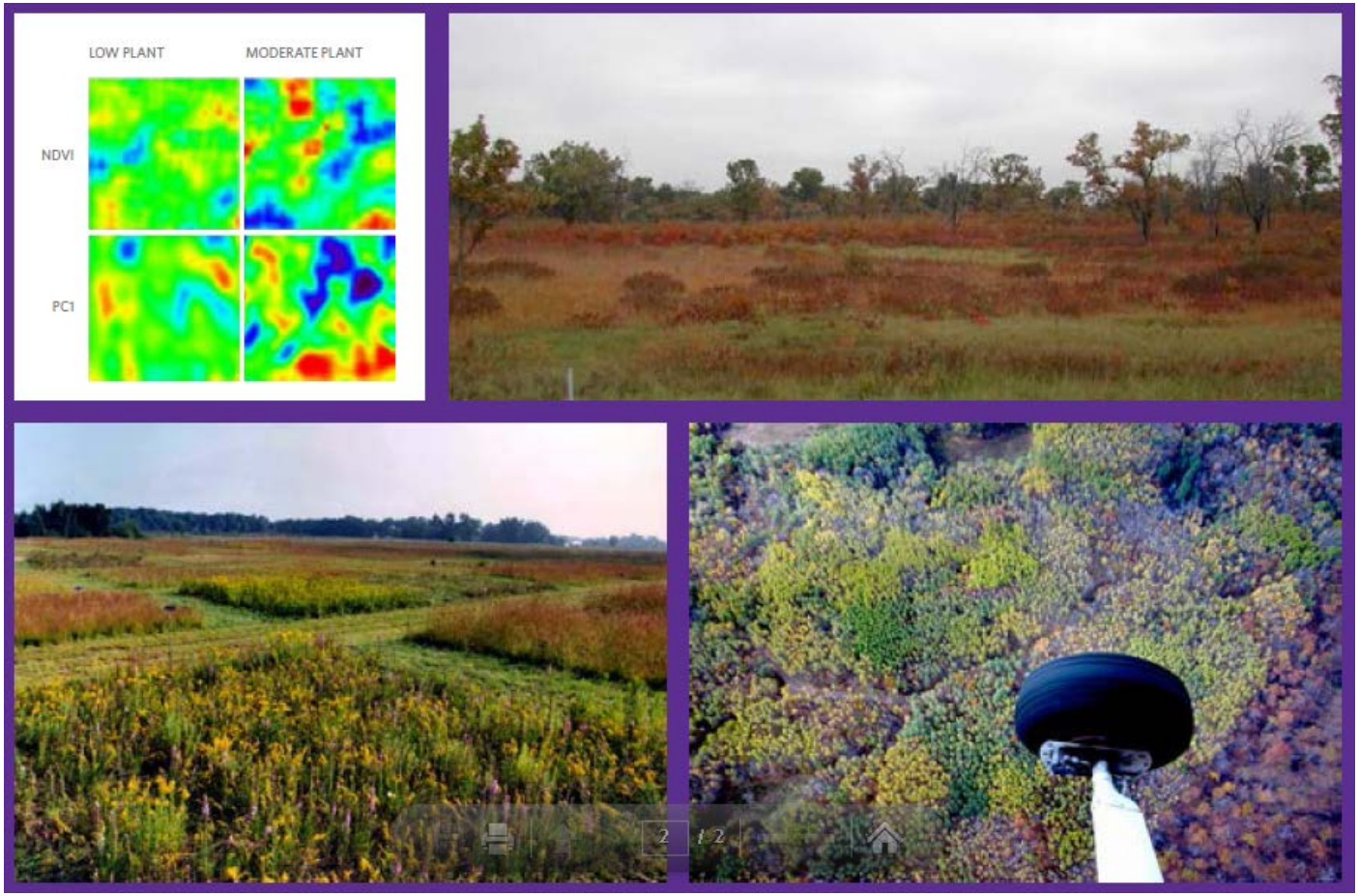




Asner et al. (2011)
Schimel et al. (2014)

HyspIRI … ?

Imaging spectroscopy



Linking remotely sensed optical diversity to genetic, phylogenetic and functional diversity to predict ecosystem processes

NSF – NASA Dimensions Team: Jeannine Cavender-Bares, Sarah Hobbie, Rebecca Montgomery (University of Minnesota, Twin Cities). Michael Madritch (Appalachian State University) Philip Townsend, Richard Lindroth (University of Wisconsin, Madison). Arthur Zygielbaum, John Gamon (University of Nebraska, Lincoln)

Observation

Observed|Predicted Change

I.

High-res imaging spectroscopy, LiDAR

Time

Space

Biochemical relationships

Biological attribute

Environmental observation

Time

Space

Biodiversity

Time | Space

I.

Biological attribute

Time

Space

Environment

Time

Space

Inductive model

Biological attribute

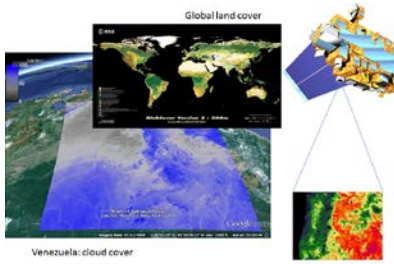
Environmental drivers

Time

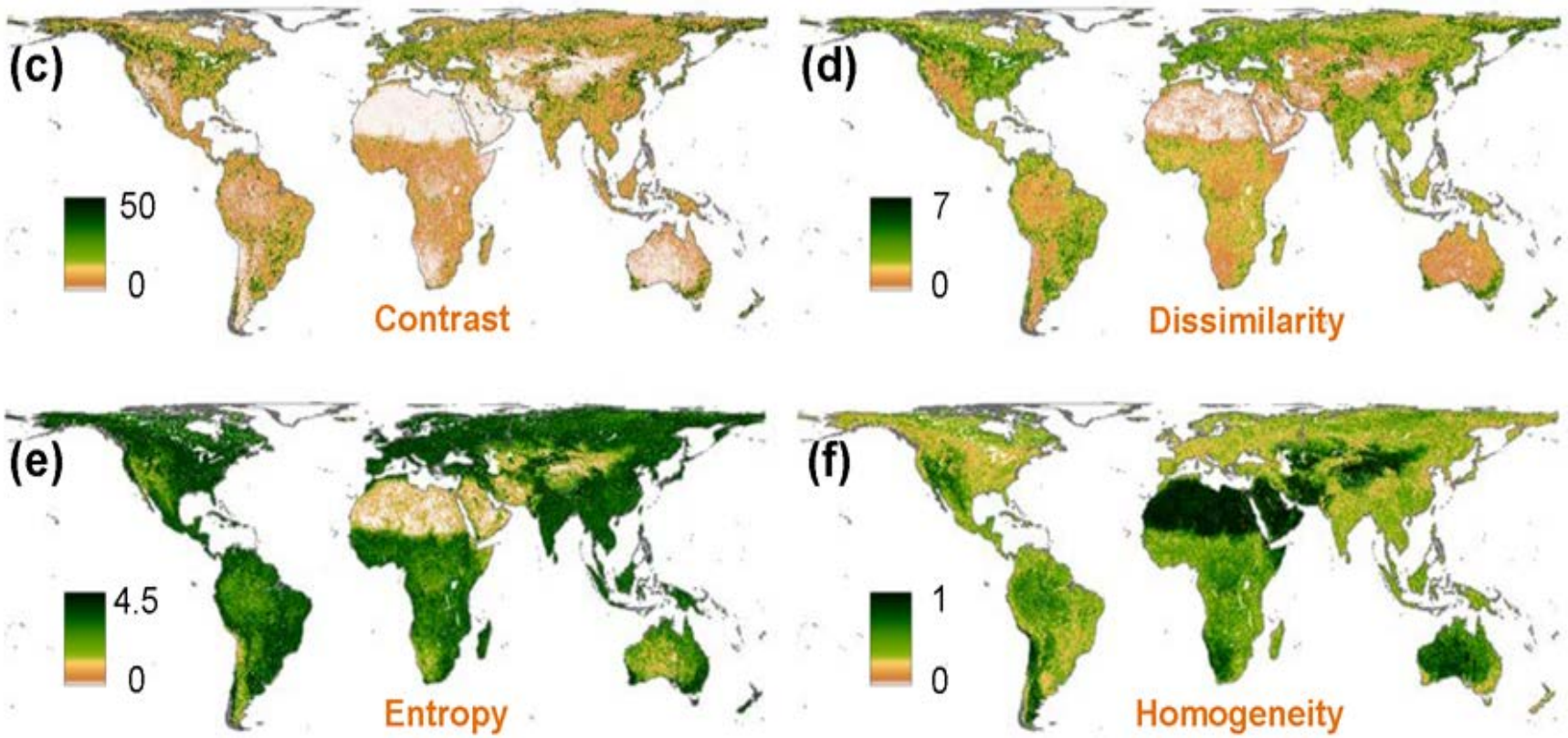
Space

Biodiversity

Time | Space



Habitat Heterogeneity



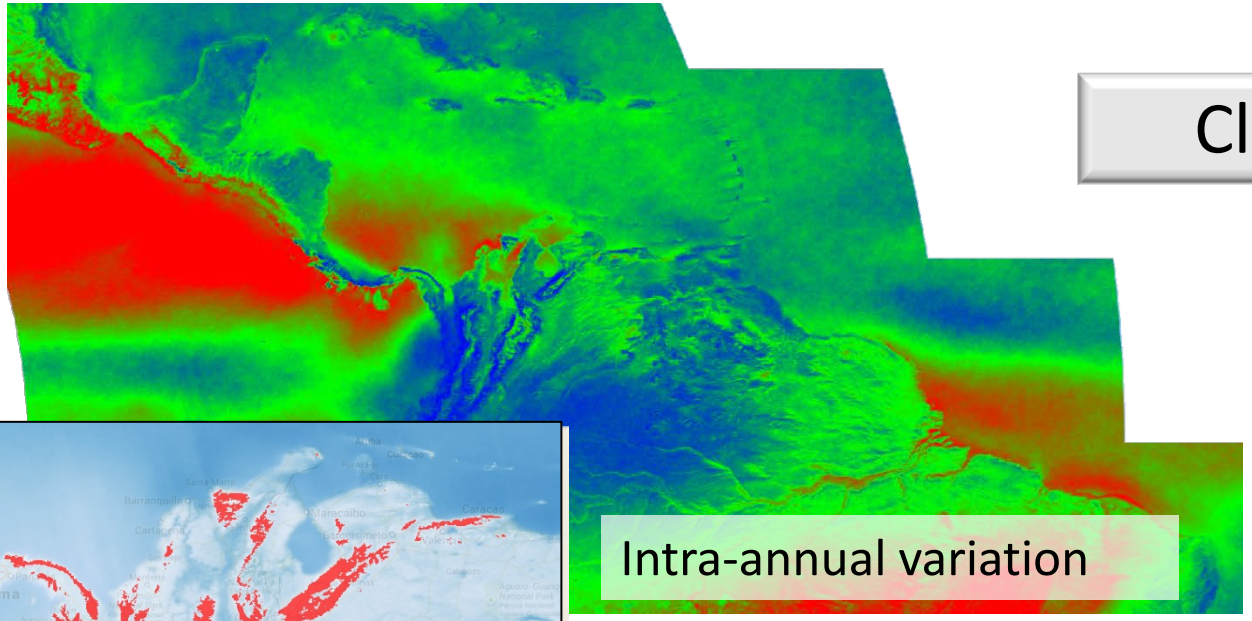
MODIS EVI-based **texture metrics** explain bird species richness and functional diversity better than traditional heterogeneity predictors

NASA EarthEnv project: W. Jetz (Yale U), F. Melton (Ames), B. McGill (U Maine)R. Guralnick (U Florida)

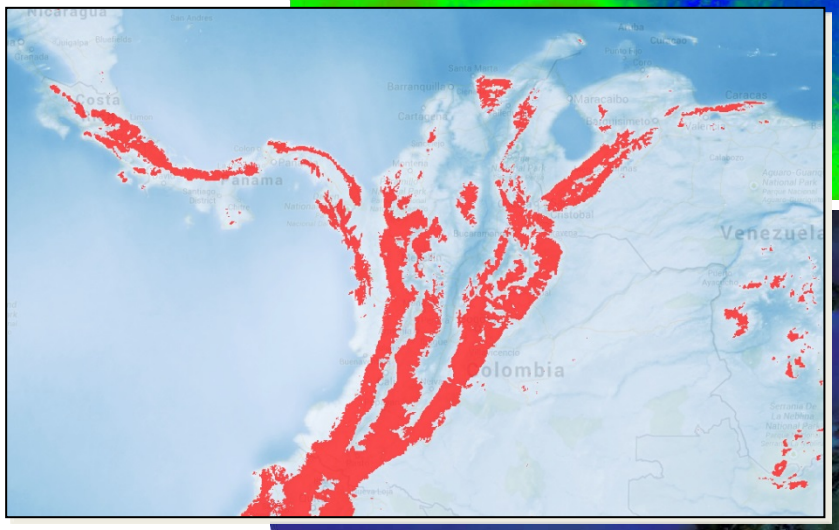
Tuanmu & Jetz (in review)

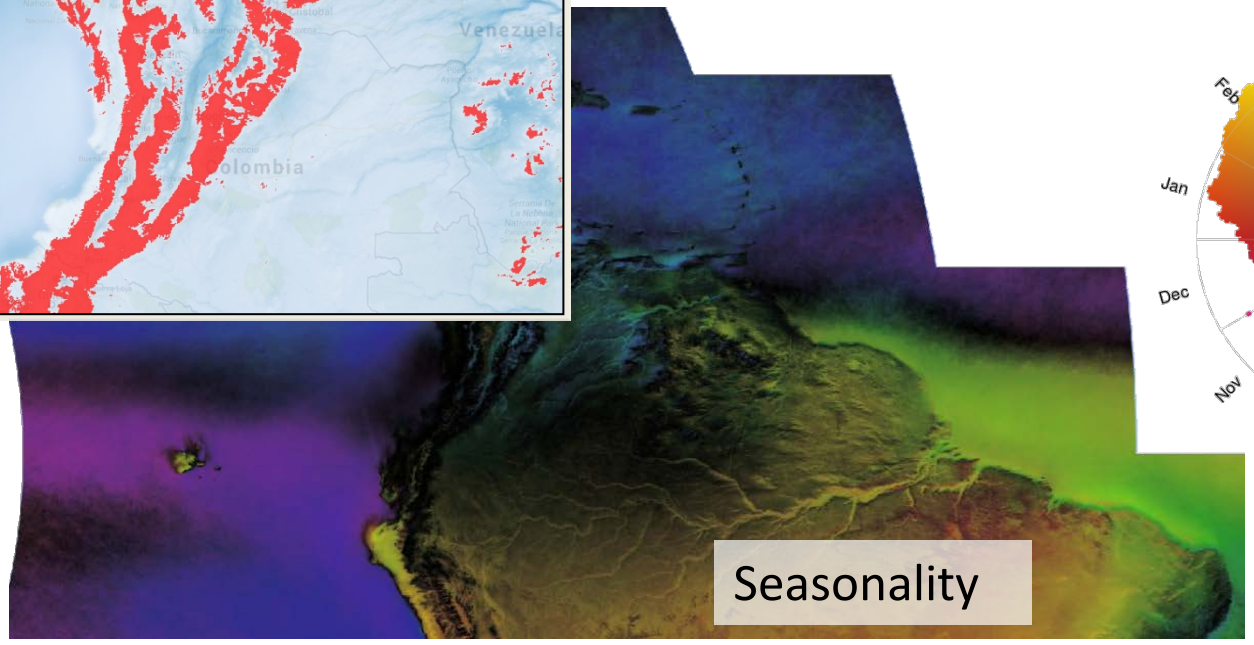
Climate: Spatial accuracy, structure

Clouds

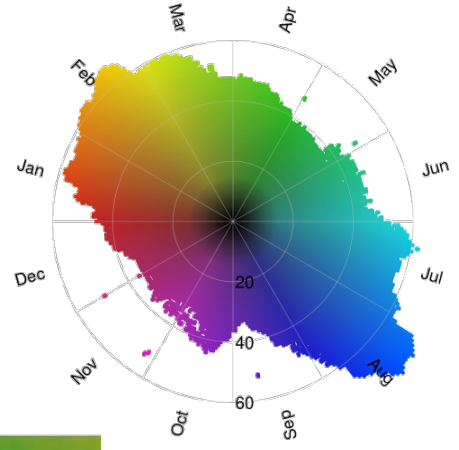


Intra-annual variation





Seasonality

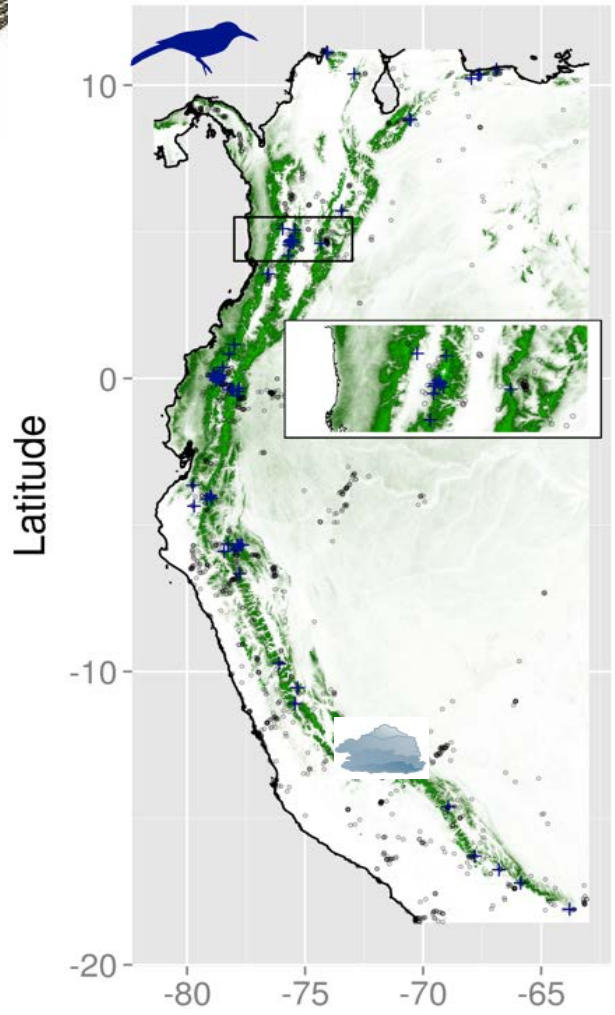


Based on MOD09

Wilson & Jetz (in revision)

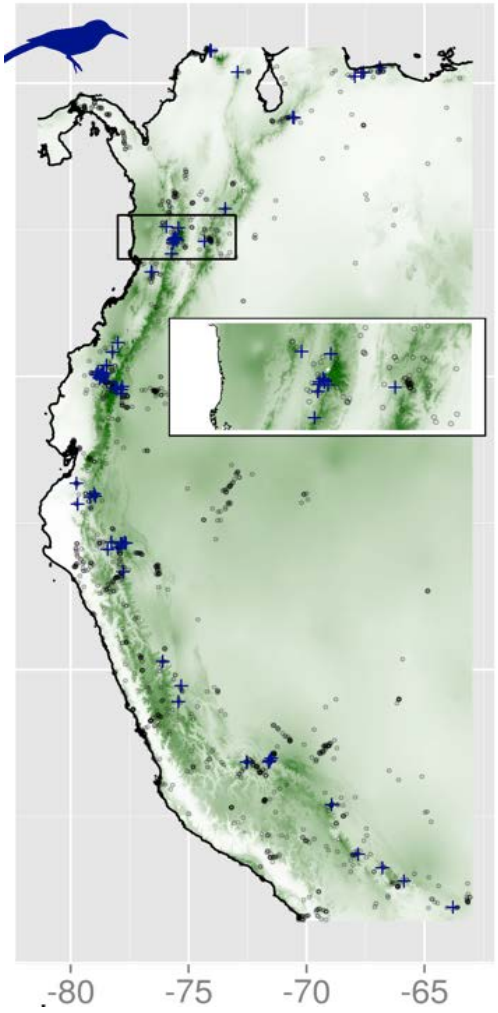
Climate: Spatial accuracy, structure

MODIS – observed



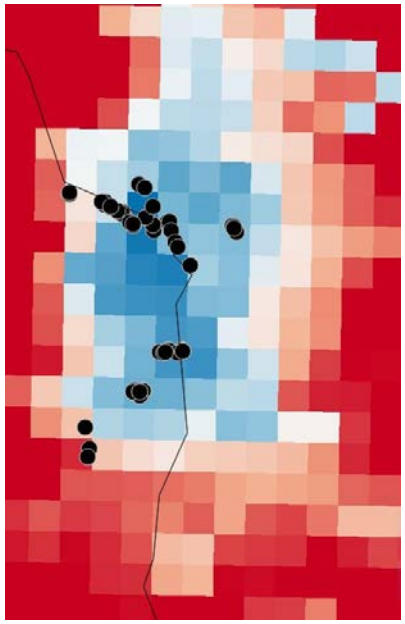
AUC	COR	DIC
0.87	*0.35*	*1,861*

Interpolated

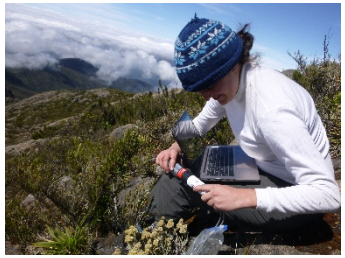


AUC	COR	DIC
0.68	*0.10*	*2,176*

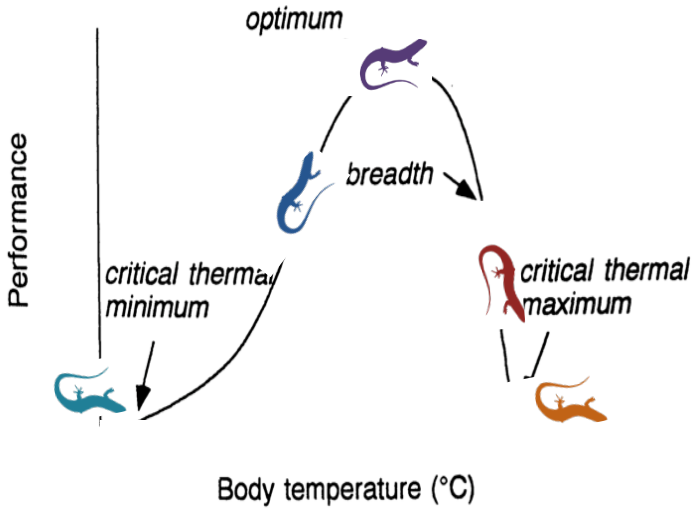
Climate: Spatial & Temporal Detail



Estimates of surface temperature based on MODIS LST

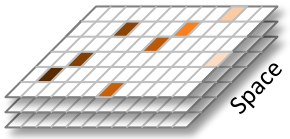


Thermal Performance Curve



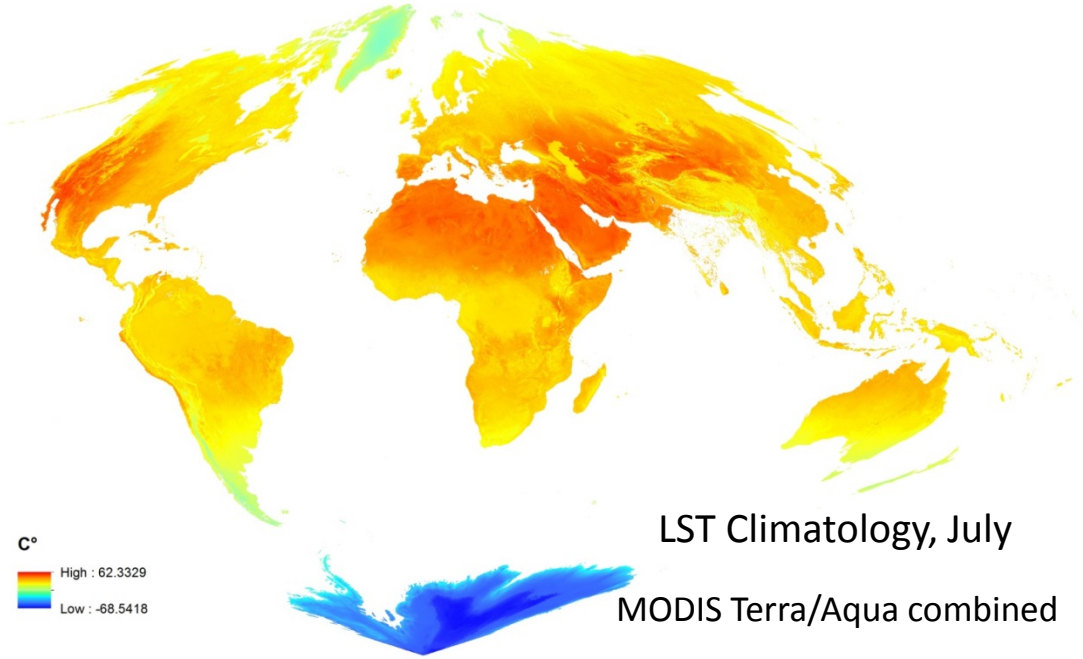
Performance curves based on experiments.

Atlantic Forest Dimensions of Biodiversity team : Ana Carnaval, Kyle McDonald and Mike Hickerson (all from City College of CUNY) plus Fabian Michelangeli and Wayt Thomas (both from New York Botanical Garden).



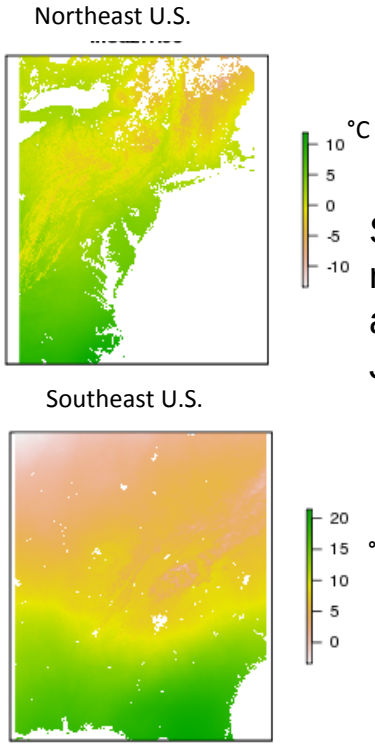
Climate: Spatial & Temporal Detail

- MODIS Land Surface Temperature + met station data
- **Daily, global , 1km ambient temperature layers** 2001-14
- RMSE: ~2°C
- Watch **earthenv.org** (contact us for earlier use)



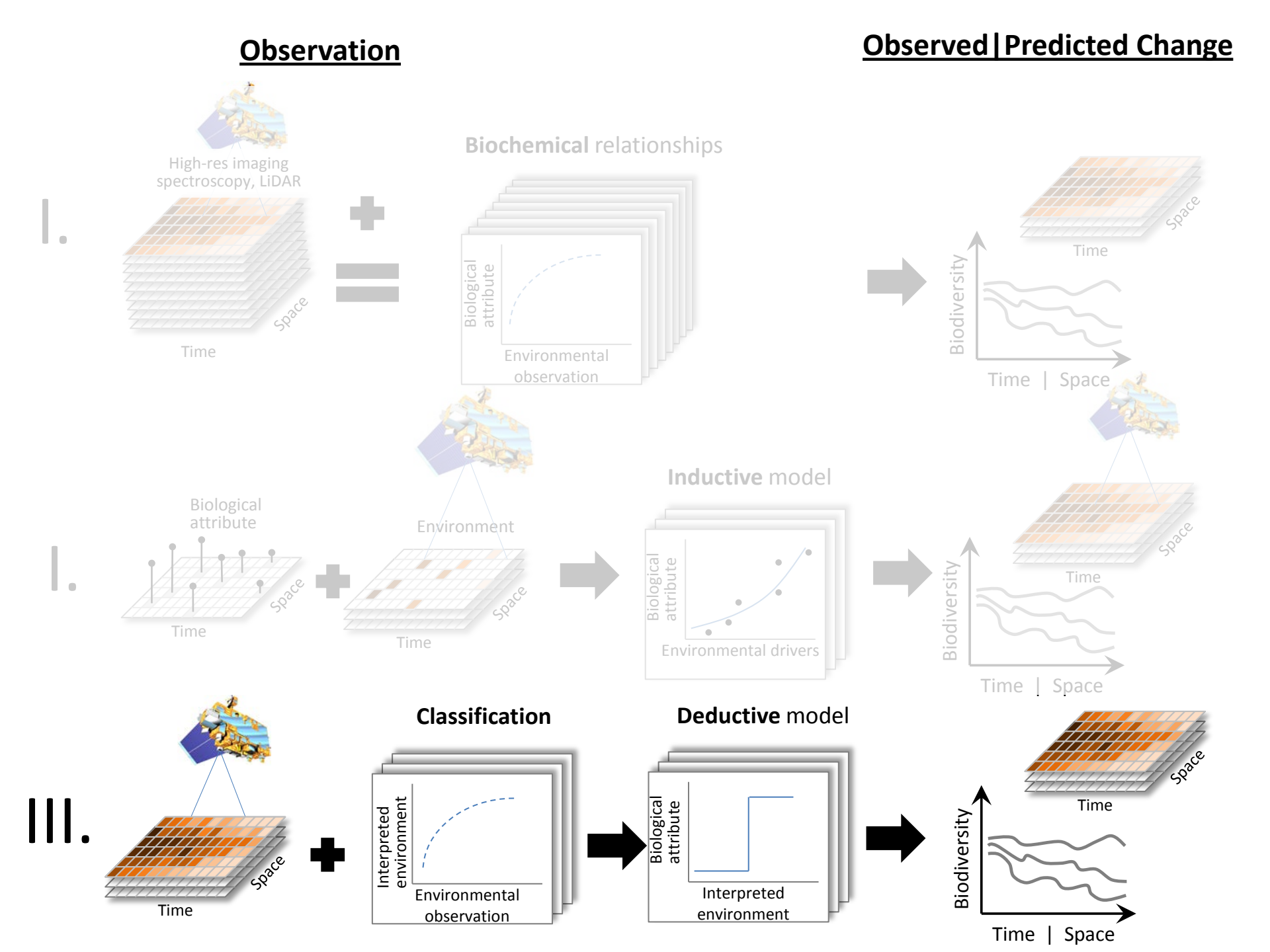
LST Climatology, July

MODIS Terra/Aqua combined



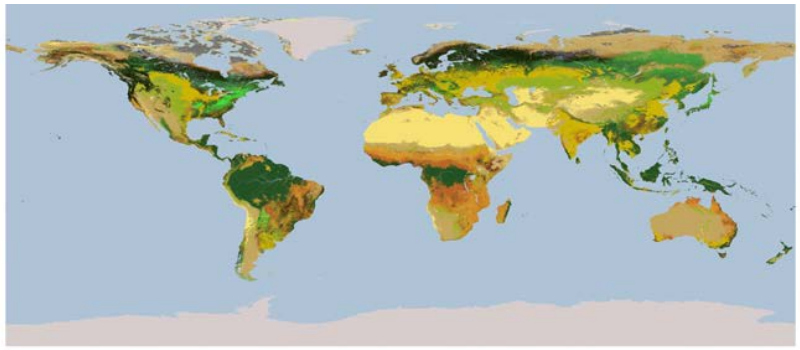
Sample results, air temp., Jan 1., 2010,

NASA EarthEnv project: W. Jetz (Yale U), F. Melton (Ames), B. McGill (U Maine)R. Guralnick (U Florida)

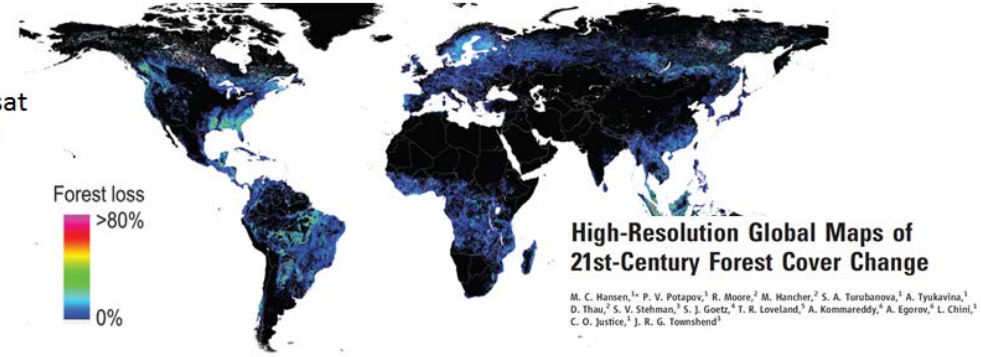

Observation
Observed|Predicted Change
I.
High-res imaging spectroscopy, LiDAR
Time
Space
Biochemical relationships
Biological attribute
Environmental observation
Biodiversity
Time | Space
I.
Biological attribute
Time
Space
Environment
Inductive model
Biological attribute
Environmental drivers
III.
Classification
Deductive model
Interpreted environment
Environmental observation
Biological attribute
Interpreted environment

The special role of habitat monitoring

1km MODIS
Land cover



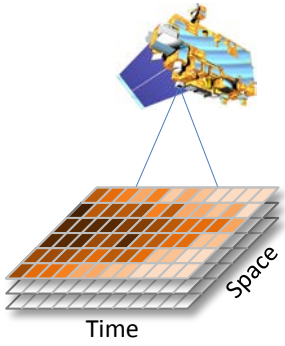
30m Landsat
Tree cover



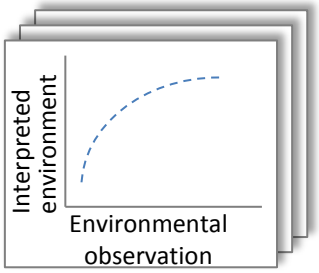
High-Resolution Global Maps of 21st-Century Forest Cover Change

M. C. Hansen,[1]* P. V. Potapov,[1] R. Moore,[2] M. Hancher,[2] S. A. Turubanova,[1] A. Tyukavina,[1] D. Thau,[2] S. V. Stehman,[3] S. J. Goetz,[4] T. R. Loveland,[5] A. Kommareddy,[6] A. Egorov,[6] L. Chini,[1] C. O. Justice,[1] J. R. G. Townshend[1]

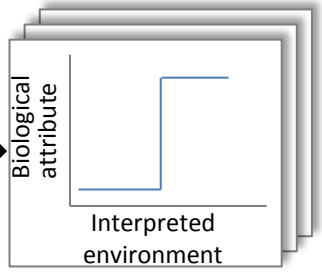
III.

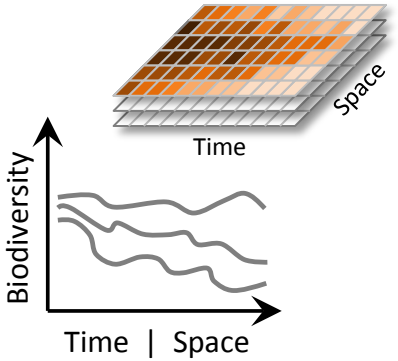


Classification



Deductive model





MOL
MAP OF LIFE

Species Info | Map a Species | Species Lists by Location | About MOL | News | Help

Overview | Habitat Distribution | Habitat Change | Reserve Coverage | Info

Select a species | Pick random | Birds

Büttikofer's Babbler
Trichastoma buettikoferi

Learn more | Update

Habitat Associations ON OFF

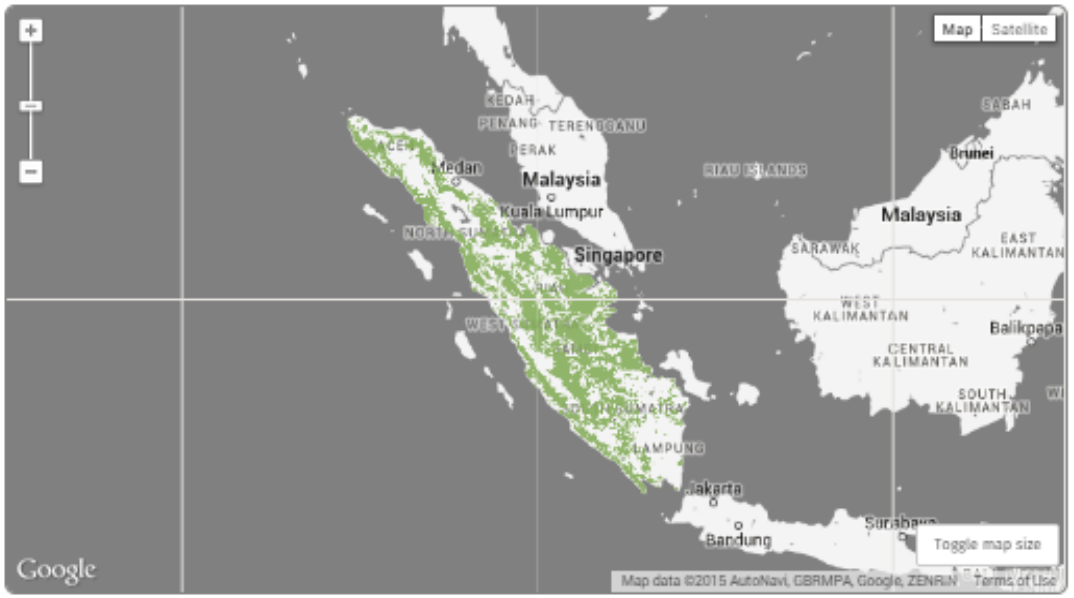
Elevation ON OFF
0 - 900 meters

Tree cover: ON OFF
75 - 100%

Landcover ON OFF

Woodlands: Forests | Woody Savannas
Cultivated: Cropland | Cropland Mosaics
Shrublands: Open | Closed
Barren | Urban: Barren | Urban
Herbaceous: Savannas | Grasslands
Water: Wetlands | Water Bodies

Records outside suitable range | Records in suitable range | Suitable range



Geographic distribution

Range size	216,074 km² Suitable	374,925 km² Total

With support from Google Earth Engine

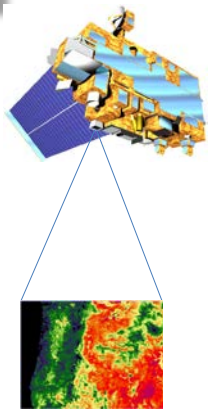
Explore at MOL.org

2015 NASA Carbon Cycle & Ecosystems JOINT SCIENCE WORKSHOP

- How can CC&E community best tackle the next generation of cutting-edge science questions to help assess global change in habitats and biodiversity?

- Can we develop more effective and integrated global products to capture habitat change?

- Which larger research questions and observation needs emerge, how can they inform NASA priorities?



ipbes

GEO BON

Global Monitoring of Habitats and Biodiversity

Convention on Biological Diversity

futureearth
research for global sustainability

Remote-sensing based biodiversity monitoring

I.

II.

III.

Observation

Biological attribute

Environment

observation

Inductive model

Biological

elation

Space

Space

Time | Space

Observed|Predicted Change

Space

Time

Classification

Interpreted environment

Environmental observation

Thanks!

Deductive model

Biologi attribu

Interpreted environment

Space

Time

Biodiversity

Time | Space