Global Consensus Land Cover Data

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Goal

- To generate a standardized set of 1-km resolution land cover product that provides scale-integrated and accuracy-weighted consensus land cover information on a continuous scale
  - Accounting for classification errors of individual products
  - Containing information on sub-pixel land cover heterogeneity

Four Global Land Cover Products

	DISCover	GLC2000	MODIS2005	GlobCover
Sensor	AVHRR	VEGETATION	MODIS	MERIS
Satellite	NOAA	SPOT	Aqua, Terra	ENVISAT
Image Acquisition Time	Apr 1992 - Mar 1993	Nov 1999 - Dec 2000	2005	Dec 2004 - Jun 2006
Input Data	Monthly NDVI composites	Diverse composites of reflectance in four spectral bands, NDVI and/or derived metrics	32-day composites and annual metrics of nadir BRDF-adjusted reflectance in bands 1 - 7, EVI and LST	Bi-monthly surface reflectance composites of 13 spectral bands
Classification Technique	Unsupervised classification	Flexible classification depending on the responsible institutions	Supervised classification decision tree	Per-pixel supervised and unsupervised classification; Per-cluster unsupervised classification
Processing Sequence	Continent-by-continent	Region-by-region	Global	Region-by-region
Classification Scheme	IGBP; 17 classes	LCCS-based; 22 classes	IGBP; 17 classes	LCCS-based; 22 classes
Spatial Resolution	1 km	1 km	500 m	300 m
Overall Accuracy	66.9% (Scepan, 1999)	68.8% (Mayaux etal., 2006)	75% (Friedl et al., 2010)	73.1% (Bicheron et al., 2008)

Generalized Land Cover Classes

Generalized Land Cover Class	DISCover/ MODIS2005	GLC2000	GlobCover
1. Evergreen/ Deciduous Needleleaf Trees	1. Evergreen Needleleaf Forest 3. Deciduous Needleleaf Forest	4. Tree Cover, Needle-leaved, Evergreen 5. Tree Cover, Needle-leaved, Deciduous	70. Closed Needleleaved Evergreen Forest 90. Open Needleleaved Deciduous or Evergreen Forest
2. Evergreen Broadleaf Trees	2. Evergreen Broadleaf Forest	1. Tree Cover, Broadleaved, Evergreen 7. Tree Cover, Regularly Flooded, Fresh and Brackish Water 8. Tree Cover, Regularly Flooded, saline Water	40. Closed to Open Broadleaved Evergreen and/or Semi-deciduous Forest 160. Closed Broadleaved Forest Regularly Flooded – Fresh Water 170. Closed Broadleaved Semi-deciduous and/or Evergreen Forest Regularly Flooded – Saline water
3. Deciduous Broadleaf Trees	4. Deciduous Broadleaf Forest	2. Tree Cover, Broadleaved, Deciduous, Closed 3. Tree Cover, Broadleaved, Deciduous, Open	50. Closed Broadleaved Deciduous Forest 60. Open Broadleaved Deciduous Forest
4. Mixed/Other Trees	5. Mixed Forest 8. Woody Savanna 9. Savanna	6. Tree Cover, Mixed Leaf Type 9. Mosaic: Tree Cover/Other Natural Vegetation 10. Tree Cover, Burnt	100. Closed to Open Mixed Broadleaved and Needleleaved Forest 110. Mosaic Forest/Shrubland (50-70%) / Grassland (20-50%) 120. Mosaic Grassland (50-70%) / Forest/Shrubland (20-50%)
5. Shrubs	6. Closed Shrubland 7. Open Shrubland	11. Shrub Cover, Closed – Open, Evergreen 12. Shrub Cover, Closed – Open, Deciduous	130. Closed to Open Shrubland

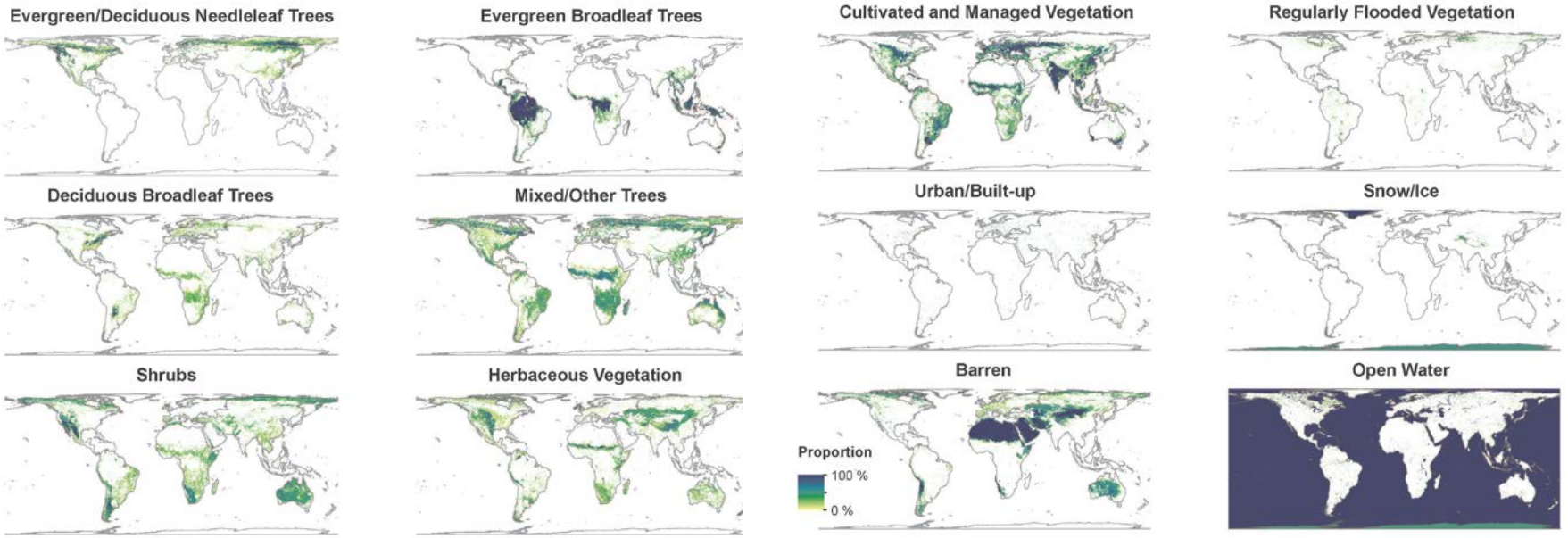
Modified from Herold et al., 2008

Generalized Land Cover Classes

Generalized Land Cover Class	DISCover/ MODIS2005	GLC2000	GlobCover
6. Herbaceous Vegetation	10. Grasslands	13. Herbaceous Cover, Closed – Open	140. Closed to Open Grassland
7. Cultivated and Managed Vegetation (including a mixture with natural vegetation)	12. Cropland 14. Cropland/ Natural Vegetation	16. Cultivated and Managed Areas 17. Mosaic: Cropland/Tree Cover/Other Natural Vegetation 18. Mosaic: Cropland/Shrub or Grass Cover	11. Post-flooding or Irrigated Croplands 14. Rainfed Croplands 20. Mosaic Cropland (50-70%) / Vegetation (Grassland, Shrubland, Forst) (20-50%) 30. Mosaic Vegetation (Grassland, Shrubland, Forest) (50-70%) / Cropland (20-50%)
8. Regularly Flooded Vegetation	11. Permanent Wetlands	15. Regularly Flooded Shrub and/or Herbaceous Cover	180. Closed to Open Vegetation (Grassland, Shrubland, Woody Vegetation) on Regularly Flooded or Waterlogged Soil – Fresh, Brackish or Saline Water
9. Urban/Built-up	13. Urban and Built Up	22. Urban and Built-up Areas	190. Artificial Surfaces and Associated Areas
10. Snow/Ice	15. Snow and Ice	21. Snow and Ice	220. Permanent Snow and Ice
11. Barren	16. Barren	14. Sparse Herbaceous or Sparse Shrub Cover 19. Bare Areas	150. Sparse Vegetation (Woody Vegetation, Shrubs, Grassland) 200. Bare Areas
12. Open Water	17. Water	20. Water Bodies	210. Water Bodies

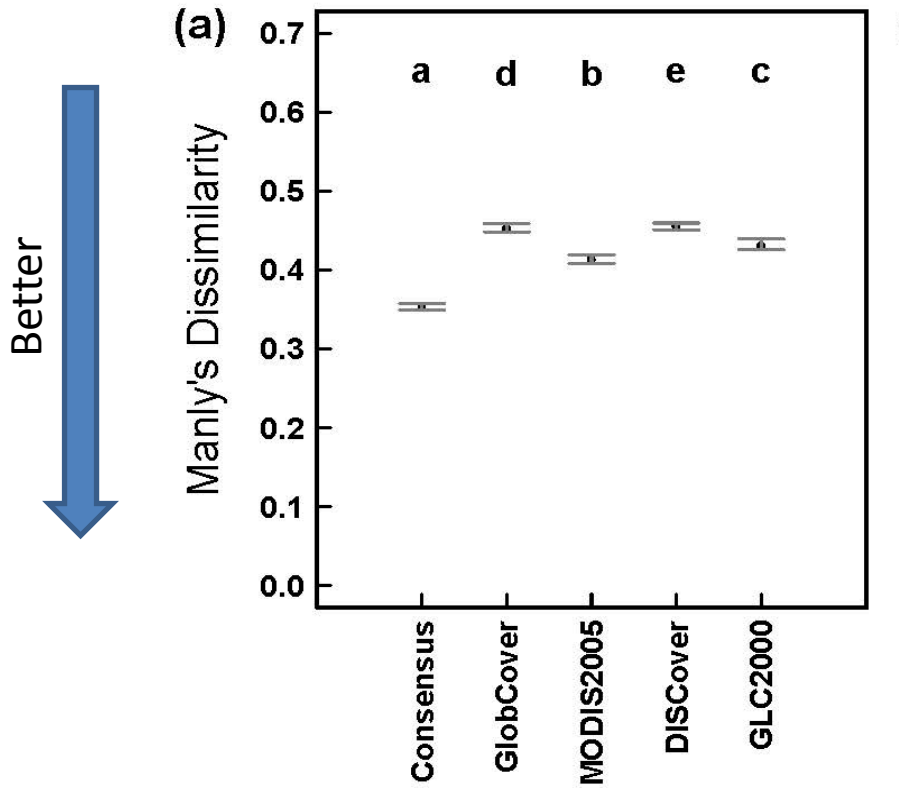
Modified from Herold et al., 2008

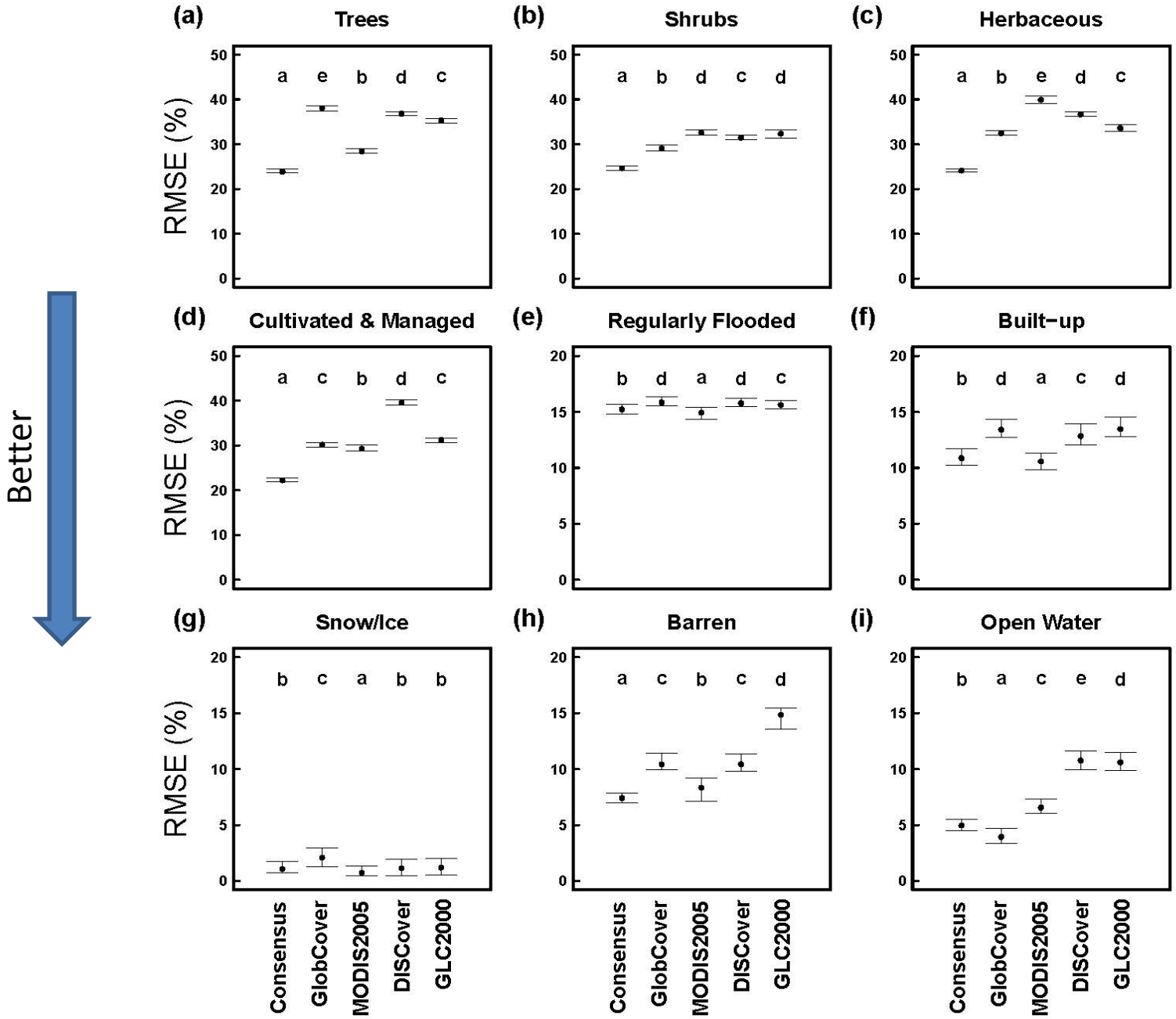
Land Cover Proportions



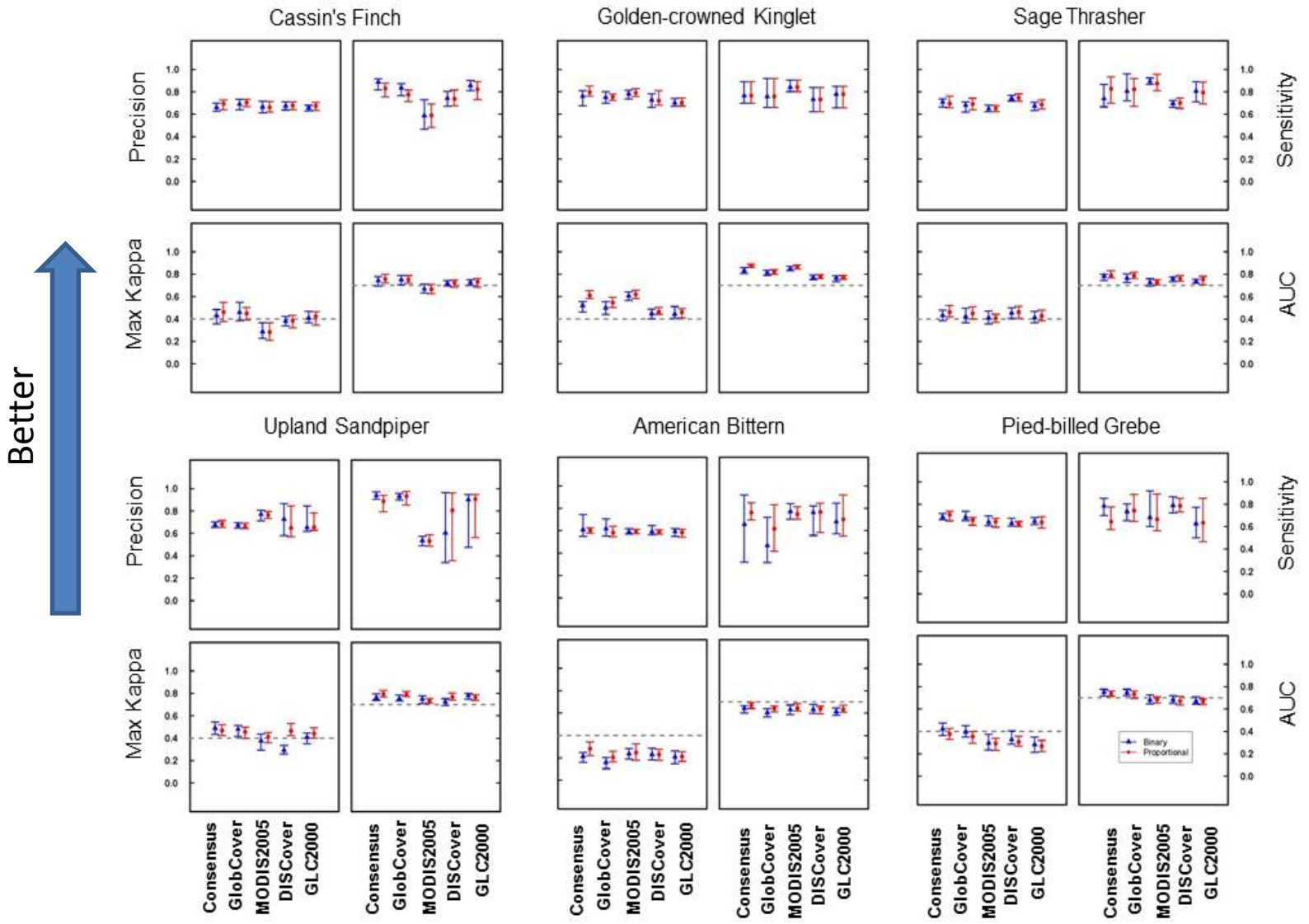
Ability to Capture Sub-pixel Information

- 30-m NLCD land cover dataset for the conterminous US (reference dataset)




(a) Trees
a e b d c
(b) Shrubs
a b d c d
(c) Herbaceous
a b e d c
(d) Cultivated & Managed
a c b d c
(e) Regularly Flooded
b d a d c
(f) Built−up
b d a c d
(g) Snow/Ice
b c a b b
(h) Barren
a c b c d
(i) Open Water
b a c e d
RMSE (%)
Better
Consensus
GlobCover
MODIS2005
DISCover
GLC2000

Utility for Modeling Species Distributions



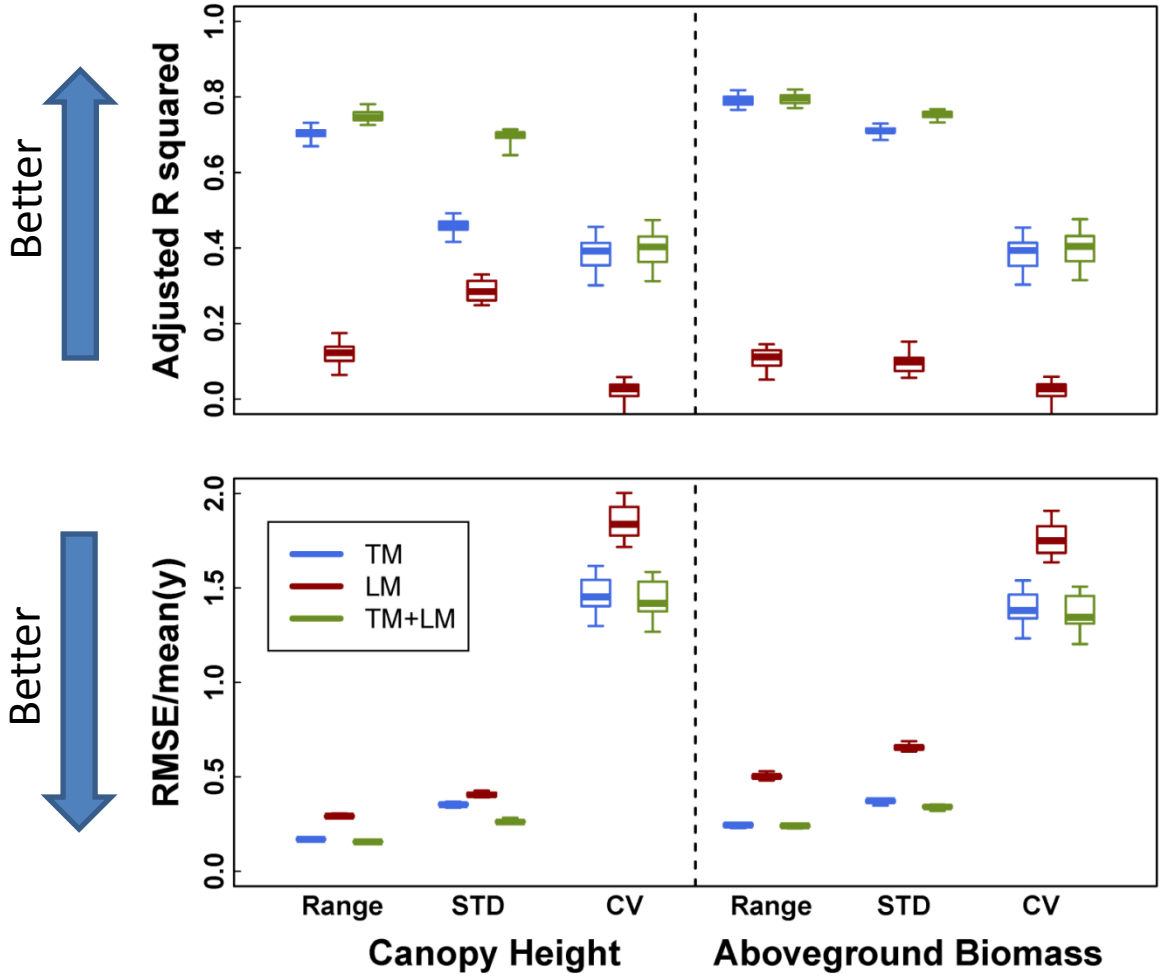
Remotely Sensed Habitat Heterogeneity

Oregon

Texture Measure (TM)
First-order
Coefficient of Variation (cv)
Range (range)
Skewness (skew)
Standard Deviation (std)
Second-order
Angular Second Moment (ASM)
Contrast (CON)
Correlation (COR)
Dissimilarity (DIS)
Entropy (ENT)
Homogeneity (HOM)
Maximum (GLCMMAX)
Mean (GLCMMEAN)
Variance (GLCMVAR)

Landscape Metric (LM)
Area-Edge
Edge Density (ED)
Large Patch Index (LPI)
Core Area
Core Area Index (CAI_AM, CAI_CV)
Diversity
Patch Richness (PR)
Simpson’s Diversity Index (SIDI)
Shape
Fractal Dimension Index (FRAC_AM, FRAC_CV)
Perimeter-Area Ratio (PARA_AM, PARA_CV)
Aggregation
Euclidean Nearest Neighbor Distance (ENN_MN, ENN_CV)
Interspersion Juxtaposition Index (IJI)
Landscape Division Index (DIVISION)
Proximity Index (PROX_MN, PROX_CV

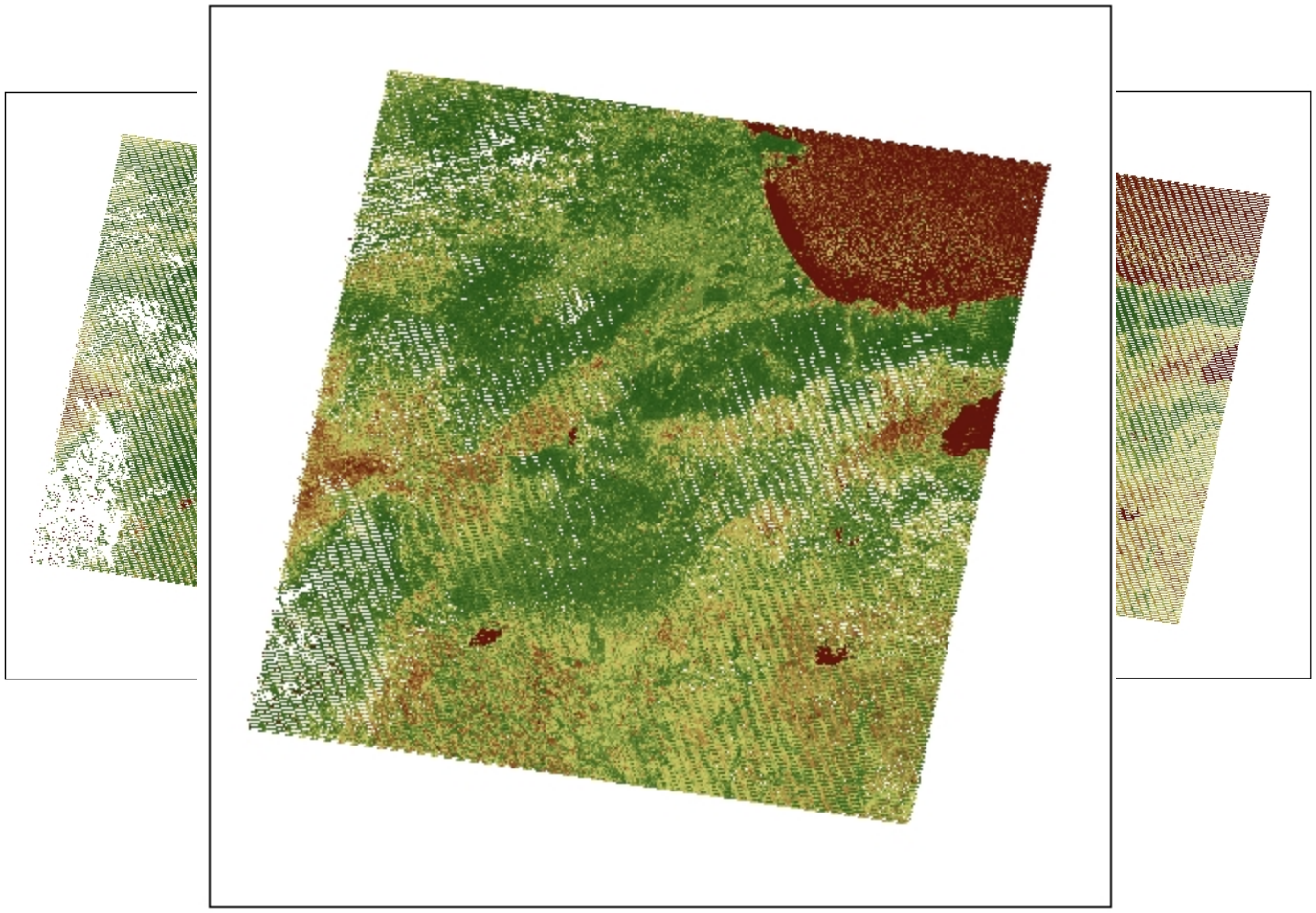
Spatial Heterogeneity of Vegetation Structure



Bird Species Richness

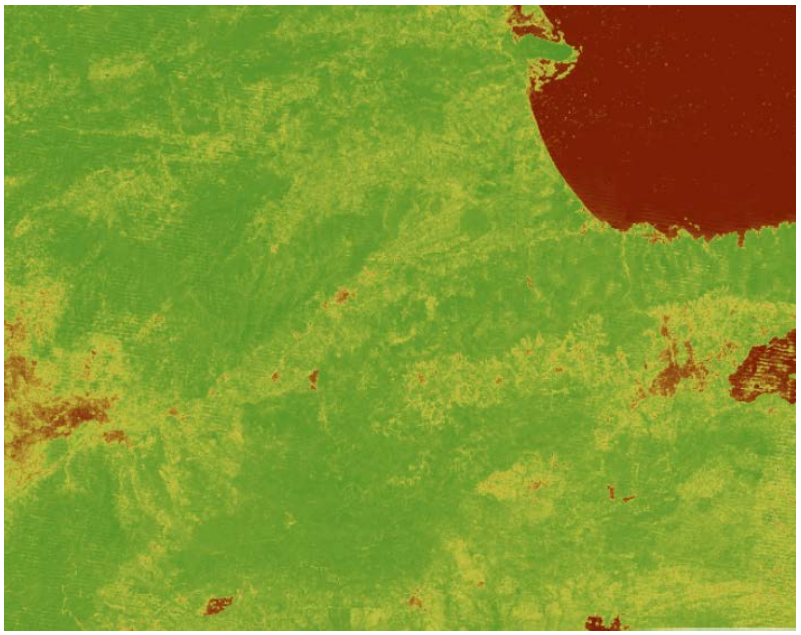
Prediction		Model					
		TM (1990)	*LM (1992)*	*TM +LM (1990)*	*TM (2000)*	*LM (2001)*	*TM +LM (2000)*
BBS (1986-1995)	*Adjusted R^2*	0.60	0.60	0.51	0.48	**0.08**	0.54
	RMSE/mean(y)	0.15	0.15	0.14	0.18	**0.23**	0.16
BBS (1996-2005)	*Adjusted R^2*	0.28	**0.02**	0.38	0.39	0.35	0.50
	RMSE/mean(y)	0.18	**0.22**	0.16	0.17	0.17	0.14

Venezuela

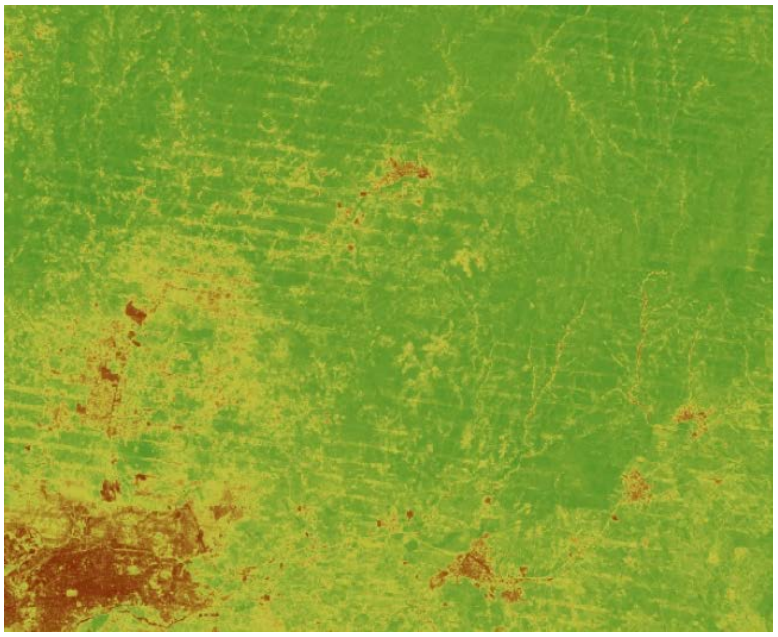


Google Earth Engine

- All Landsat images in the past 40 years from USGS
- Annual maximum NDVI

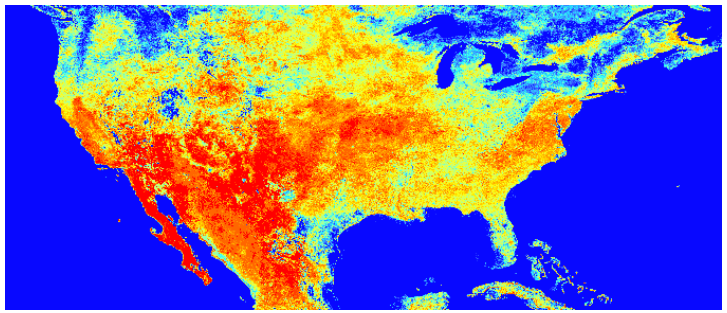


2005

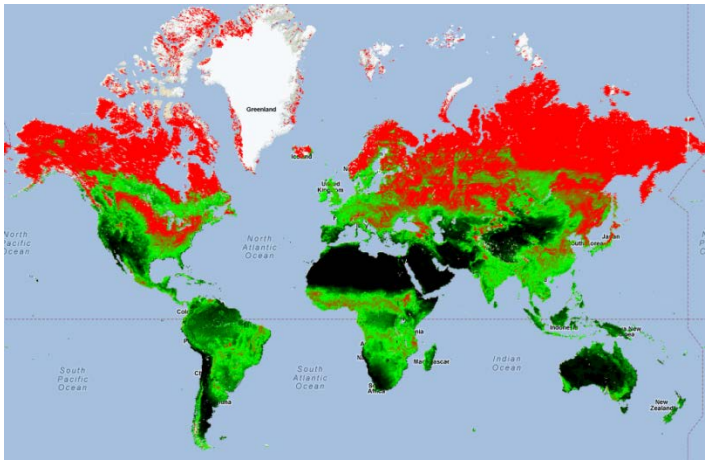


Temporal Heterogeneity

- MODIS time series data
- Intra- and inter-annual variability of NDVI, EVI…



Inter-annual SD of annual MAX



Inter-annual mean of intra-annual SD
(by Adam)