



Global Land Cover Facility: Global Tree and Water Cover Product Globbiomass Meeting, UN FAO, Rome Italy

Saurabh Channan
Min Feng
Joe Sexton
John Townshend (PI)

2010 2015 Forest Cover Change

Outline

- Background of the project and products
- Current status
- Future activities
- Questions/Discussion

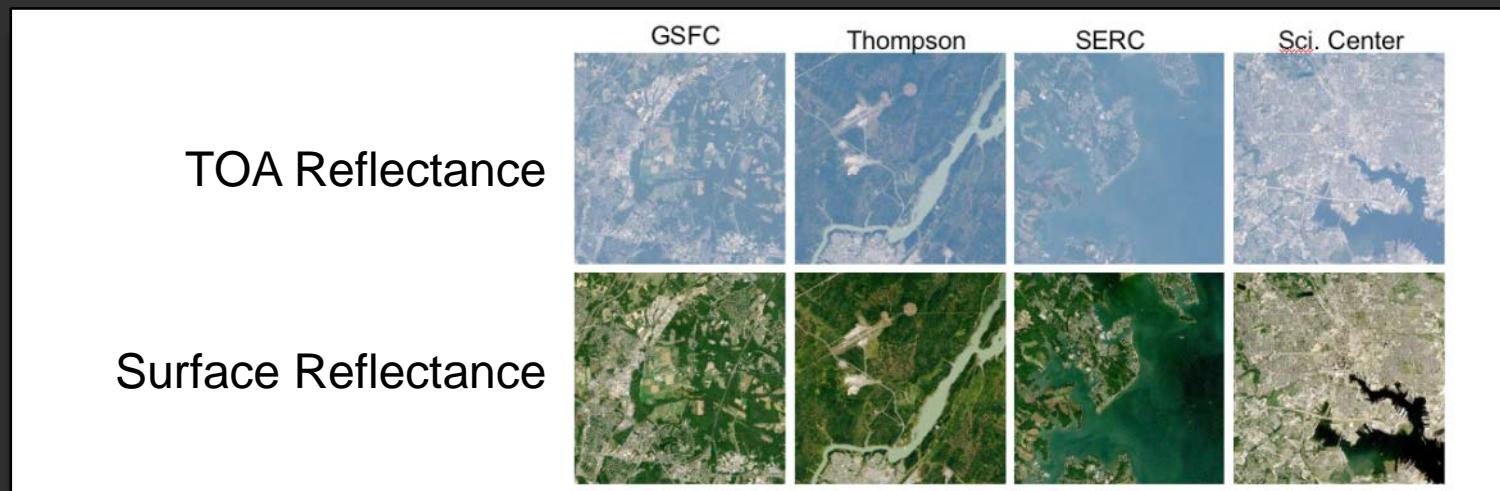
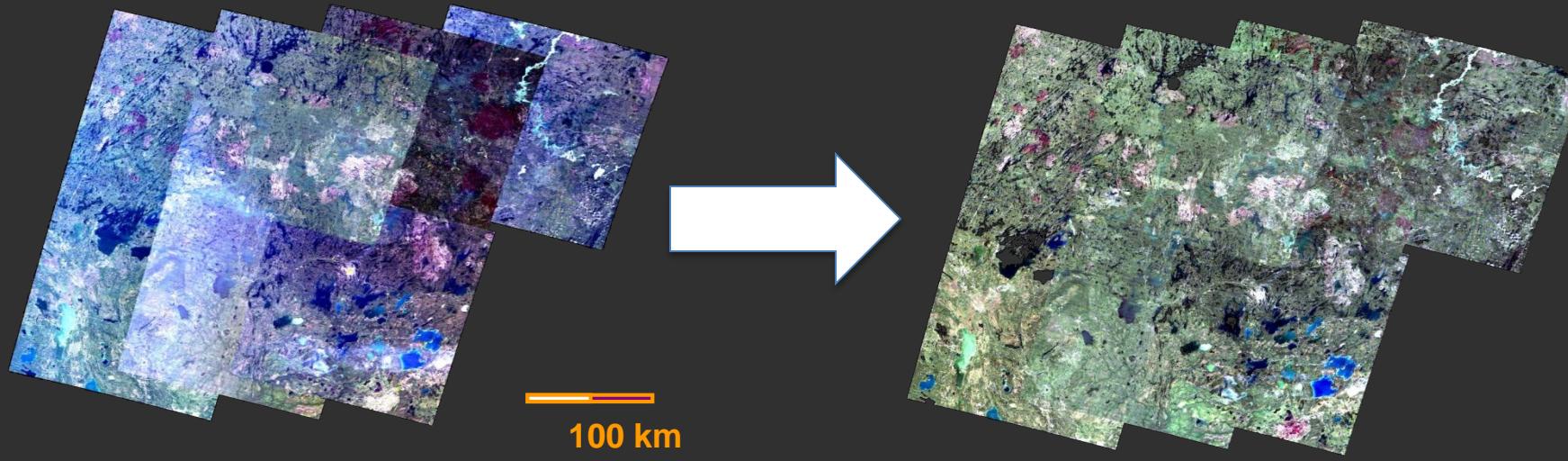
Outline

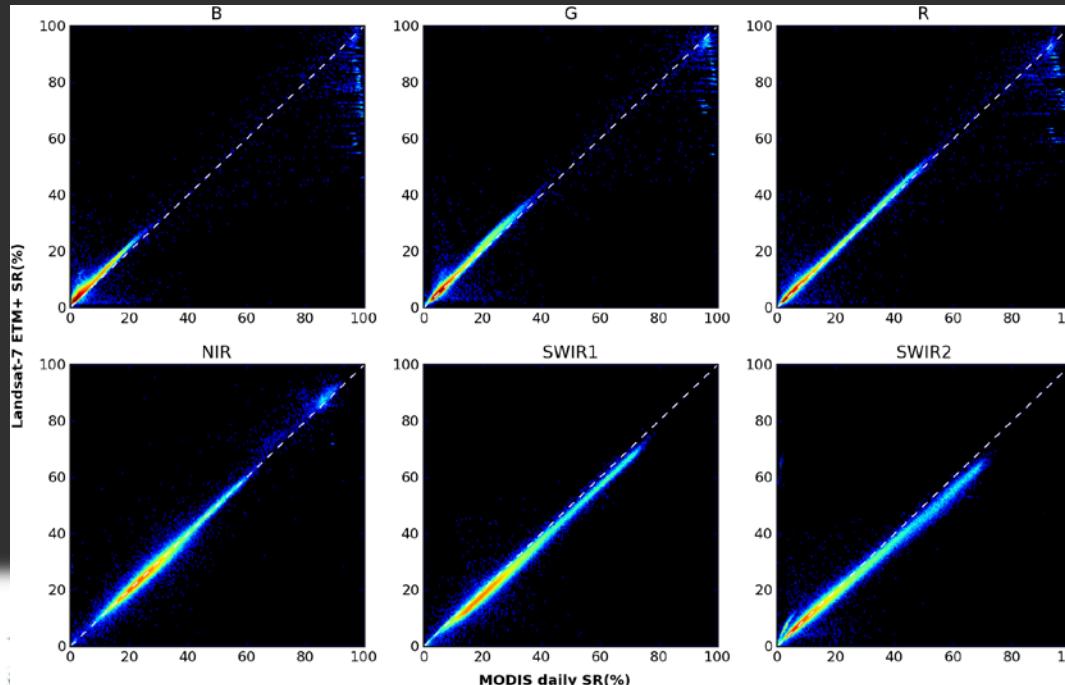
- Background of the project and products
- Current status
- Future activities
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NASA LCLUC: Multi-source Land Imaging

- Funded July 2015
- Objective:
 - fuse multiple sensors from NASA, ESA, etc. platforms
 - develop tree and water cover product
 - Global 2000, 2005, 2010 and 2015
 - Annual 2010 – 2015 for North and South America
- ESA Collaborator: Chris Schmullius.

Surface reflectance: LEDAPS





Landsat- and MODIS-based SR estimates are highly consistent at a collection of globally distributed sample locations.



ELSEVIER

Remote Sensing of Environment

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



Global surface reflectance products from Landsat: Assessment using coincident MODIS observations

Min Feng ^{a,*}, Joseph O. Sexton ^a, Chengquan Huang ^a, Jeffrey G. Masek ^b, Eric F. Vermote ^c, Feng Gao ^d,
Raghuram Narasimhan ^a, Saurabh Channan ^a, Robert E. Wolfe ^c, John R. Townshend ^a

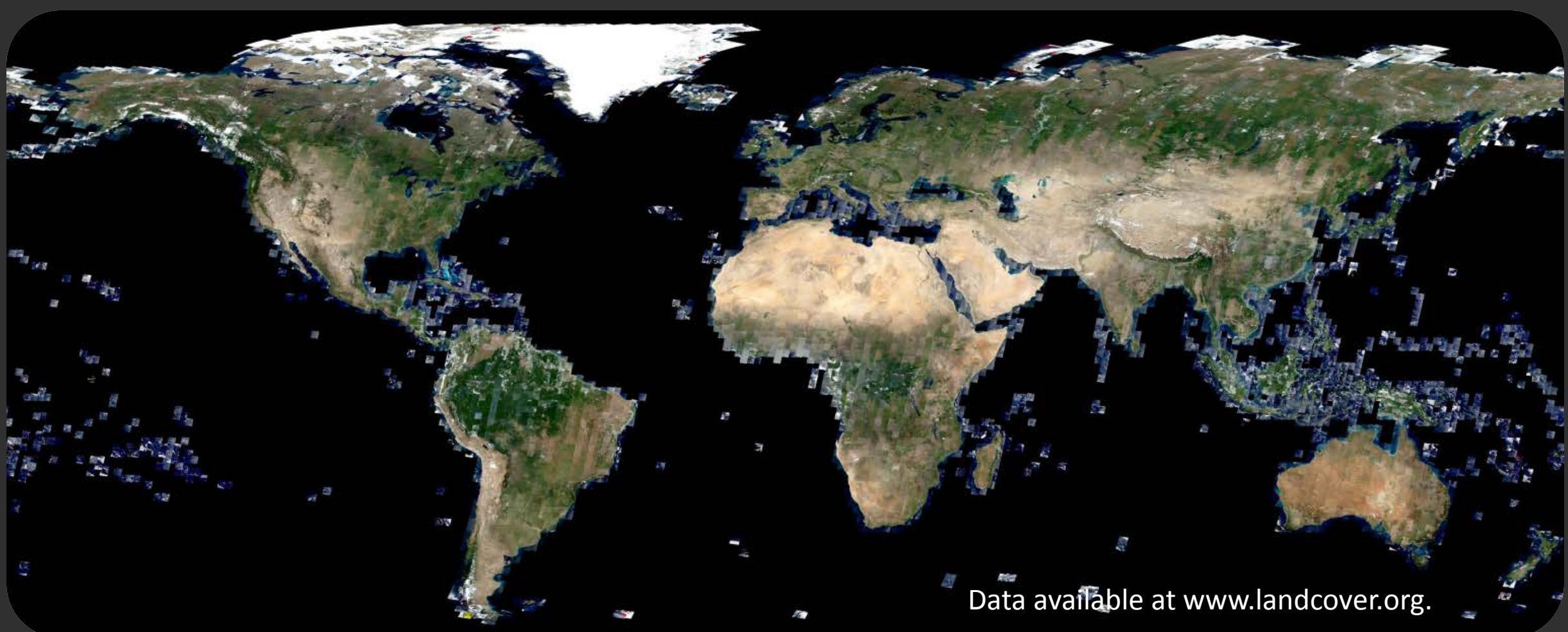
^a Global Land Cover Facility, Department of Geography, University of Maryland, College Park, MD 20742, USA

^b Biospheric Sciences Branch, NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA

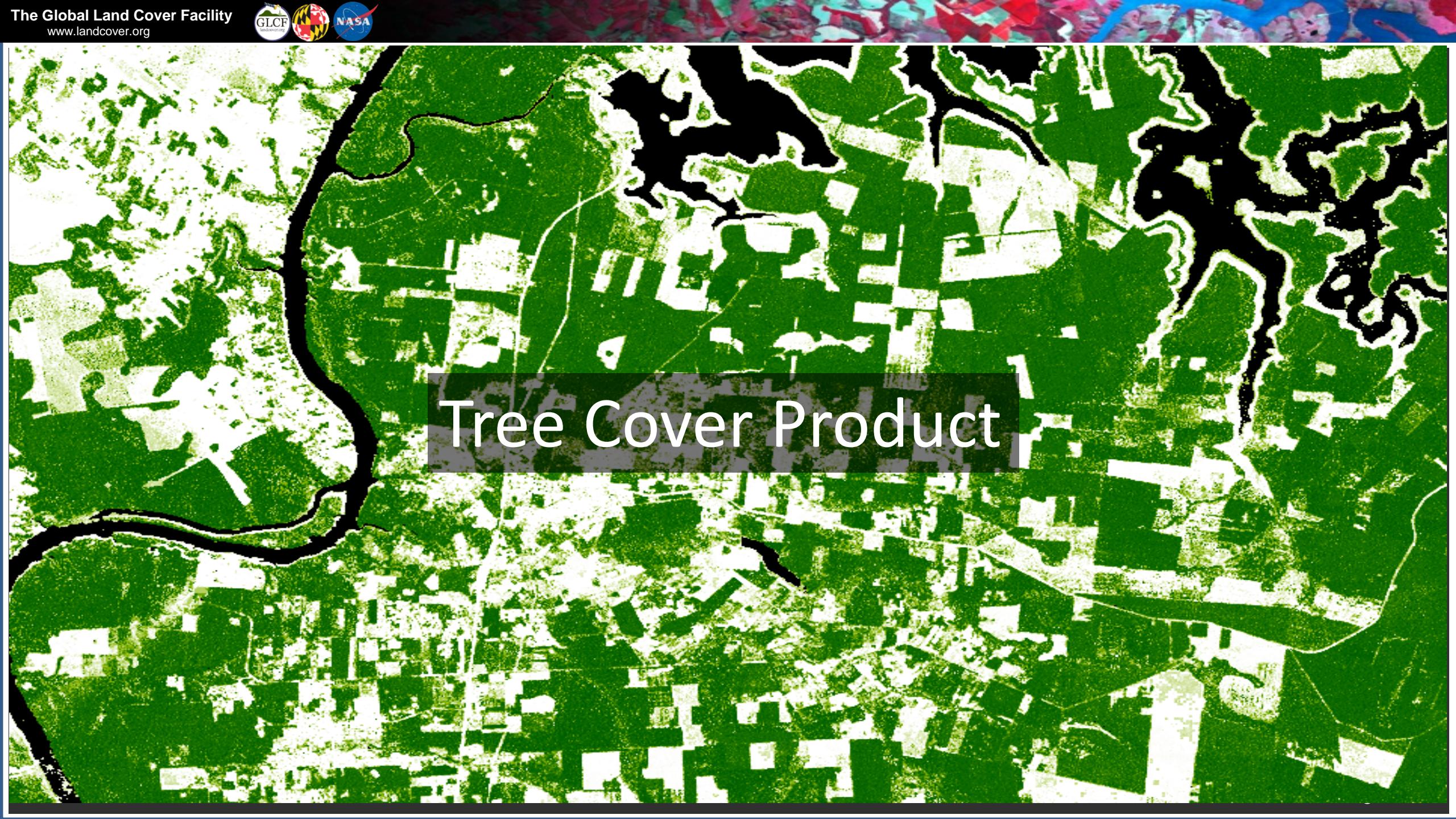
^c Laboratory for Terrestrial Physics, NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA

^d Hydrology and Remote Sensing Lab, USDA Agricultural Research Service, Beltsville, MD 20705, USA

Global Surface Reflectance Product



Feng, M., Sexton, J. O., Huang, C., Masek, J. G., Vermote, E. F., Gao, F., Narasimhan, R., Channan, S., Wolfe, R. E., & Townshend, J. R. (2013). Global surface reflectance products from Landsat: Assessment using coincident MODIS observations. *Remote Sensing of Environment*, 134, 276–293.
<http://doi.org/10.1016/j.rse.2013.02.031>



Tree Cover Product

International Journal of Digital Earth, 2013
Vol. 6, No. 5, 427–448, <http://dx.doi.org/10.1080/17538947.2013.786146>



Global, 30-m resolution continuous fields of tree cover: Landsat-based rescaling of MODIS vegetation continuous fields with lidar-based estimates of error

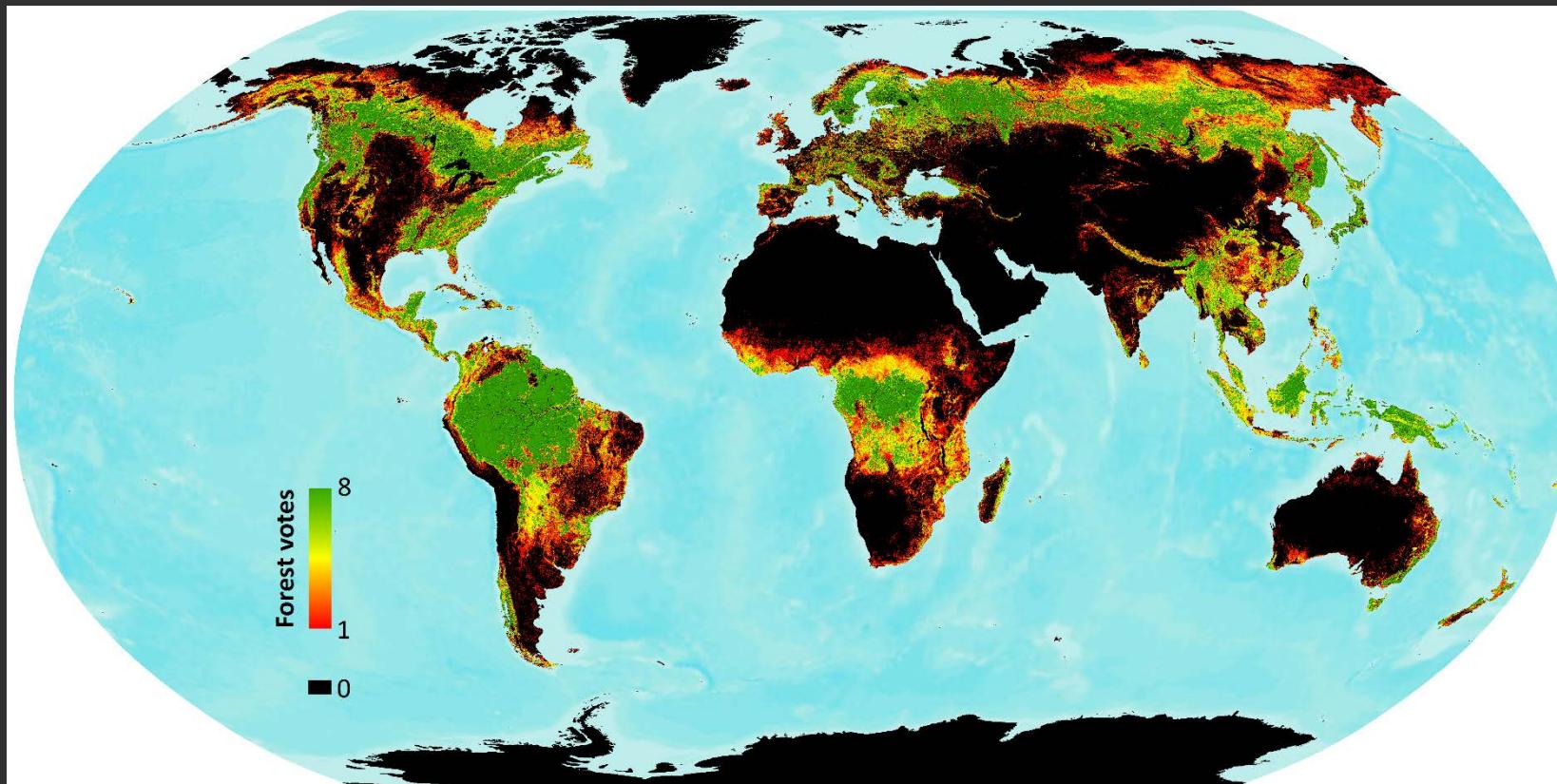
Joseph O. Sexton^{a*}, Xiao-Peng Song^a, Min Feng^a, Praveen Noojipady^a,
Anupam Anand^a, Chengquan Huang^a, Do-Hyung Kim^a, Kathrine M. Collins^a,
Saurabh Channan^a, Charlene DiMiceli^b and John R. Townshend^a

^a*Global Land Cover Facility, Department of Geographical Sciences, University of Maryland,
College Park, MD, USA;* ^b*Department of Geographical Sciences, University of Maryland,
College Park, MD, USA*

Rationality

Global forest cover?

8 datasets.... 8 estimates.



Loveland et al. (2000)
Hansen et al. (2000)

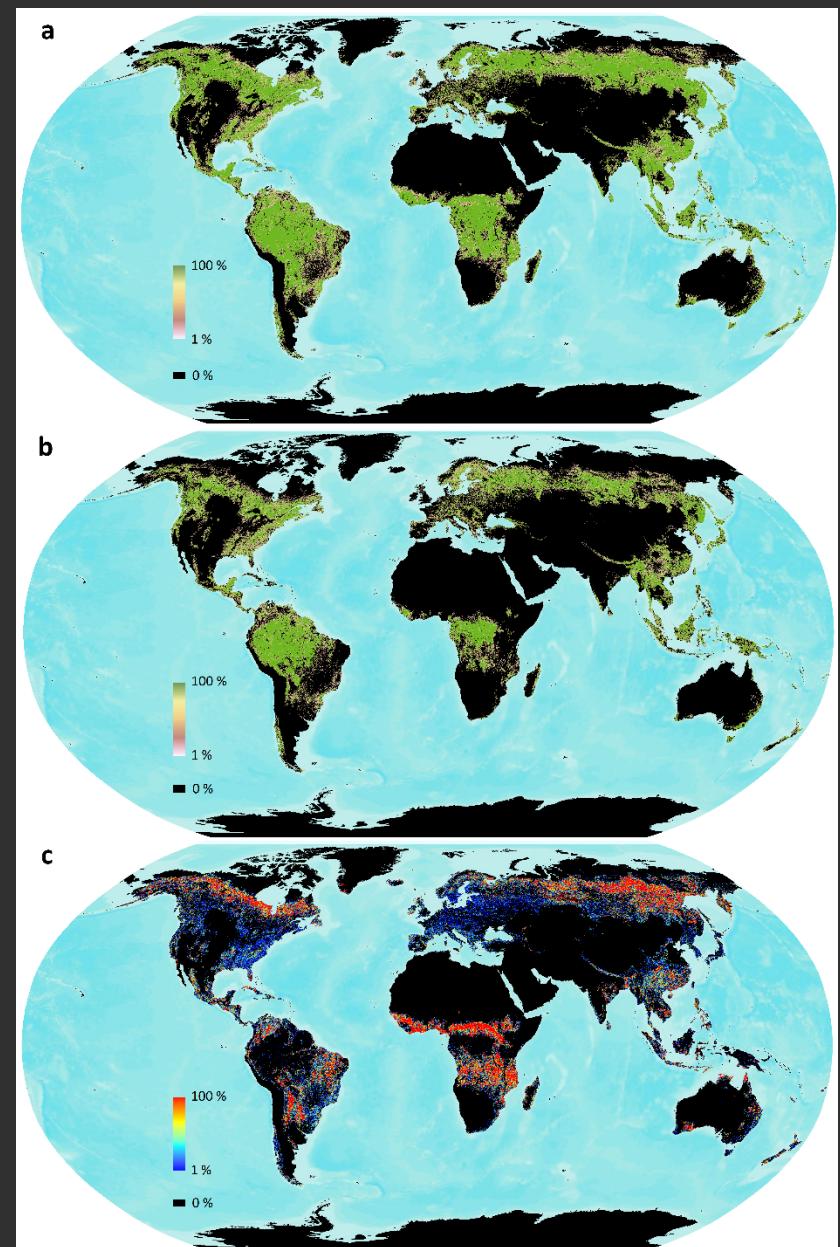
Bartholomé & Belward (2005)
Hansen et al. (2003, 2005)

Bicheron et al. (2008)
Friedl et al. (2002)

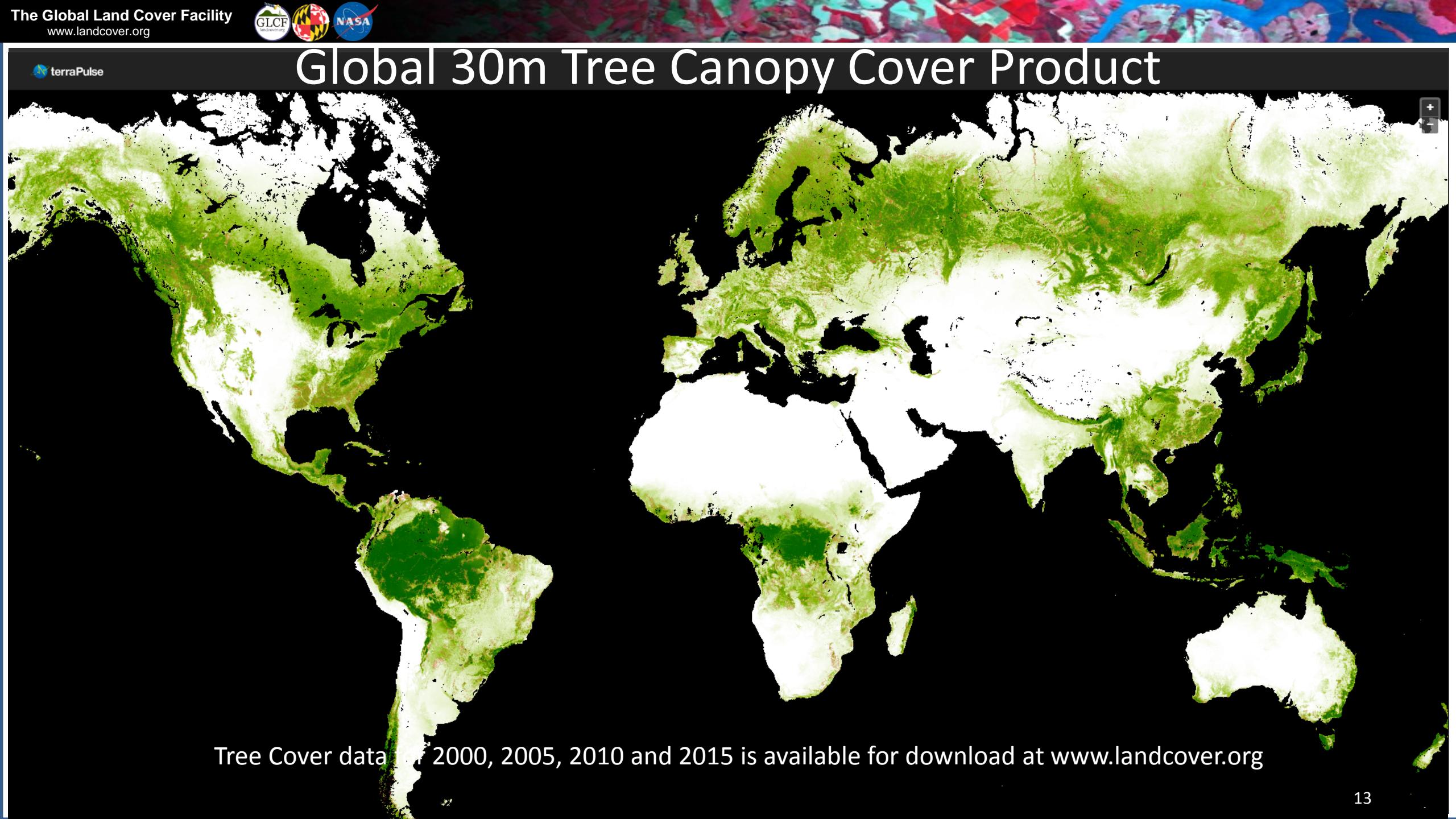
Hansen et al. (2013)
Sexton et al. (2013)

How much forest is there?

- UNFCCC allows countries to define “forest” based on a criterion of tree cover, from >10 to >30% cover.
 - Defined as 10% cover $\rightarrow 51.5 \times 10^6 \text{ km}^2$
 - Defined as 30% cover $\rightarrow 32.2 \times 10^6 \text{ km}^2$
- Difference = $17.9 \times 10^6 \text{ km}^2 \approx 13\%$ of Earth’s land area.
- Greatest uncertainty in tropical savannahs & boreal forests.
- The discrepancy within the tropics alone involves a difference of 43.5 Gt C of biomass valued at >US\$ 1 trillion.



Global 30m Tree Canopy Cover Product



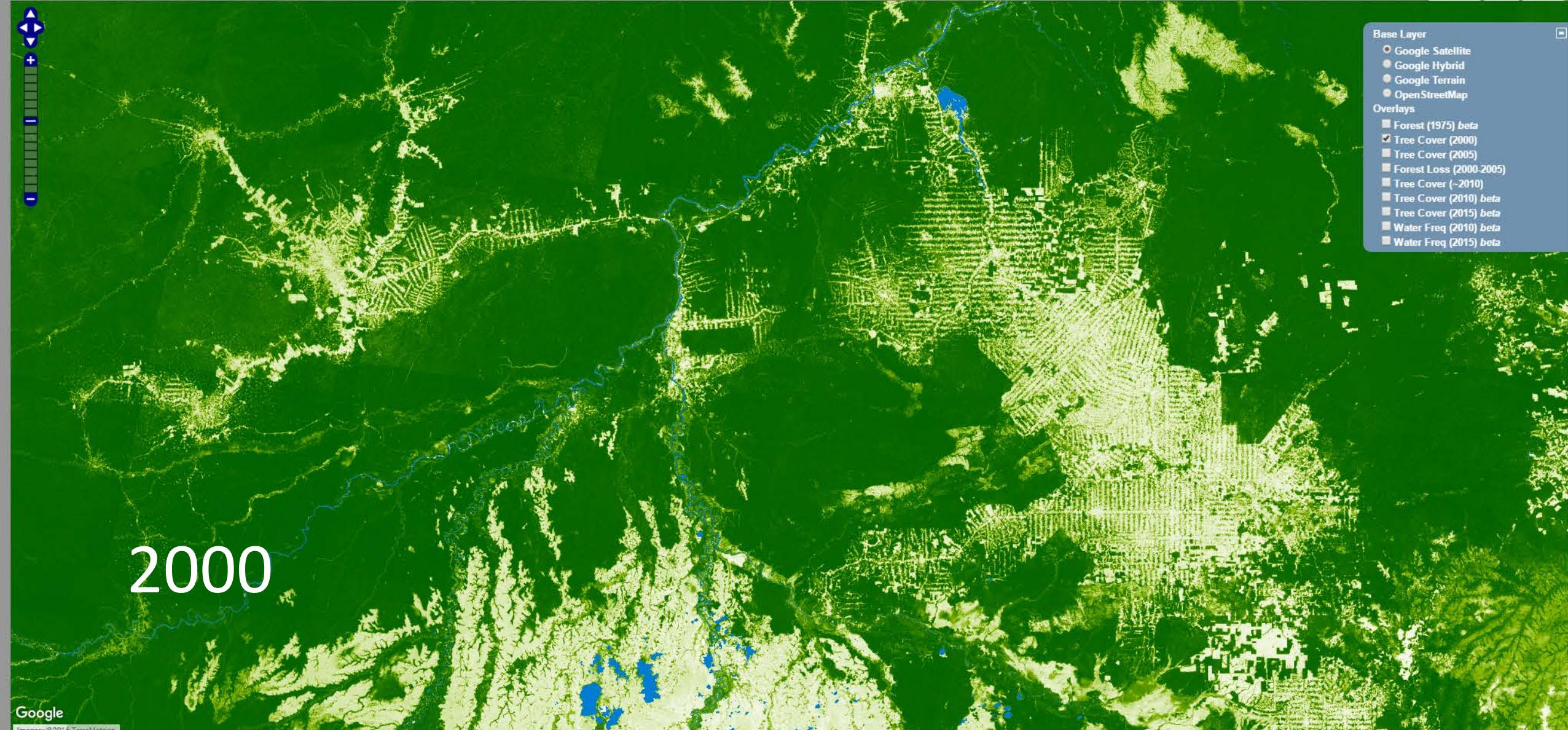
Tree Cover data for 2000, 2005, 2010 and 2015 is available for download at www.landcover.org

terraPulse

Legend Tile NDVI

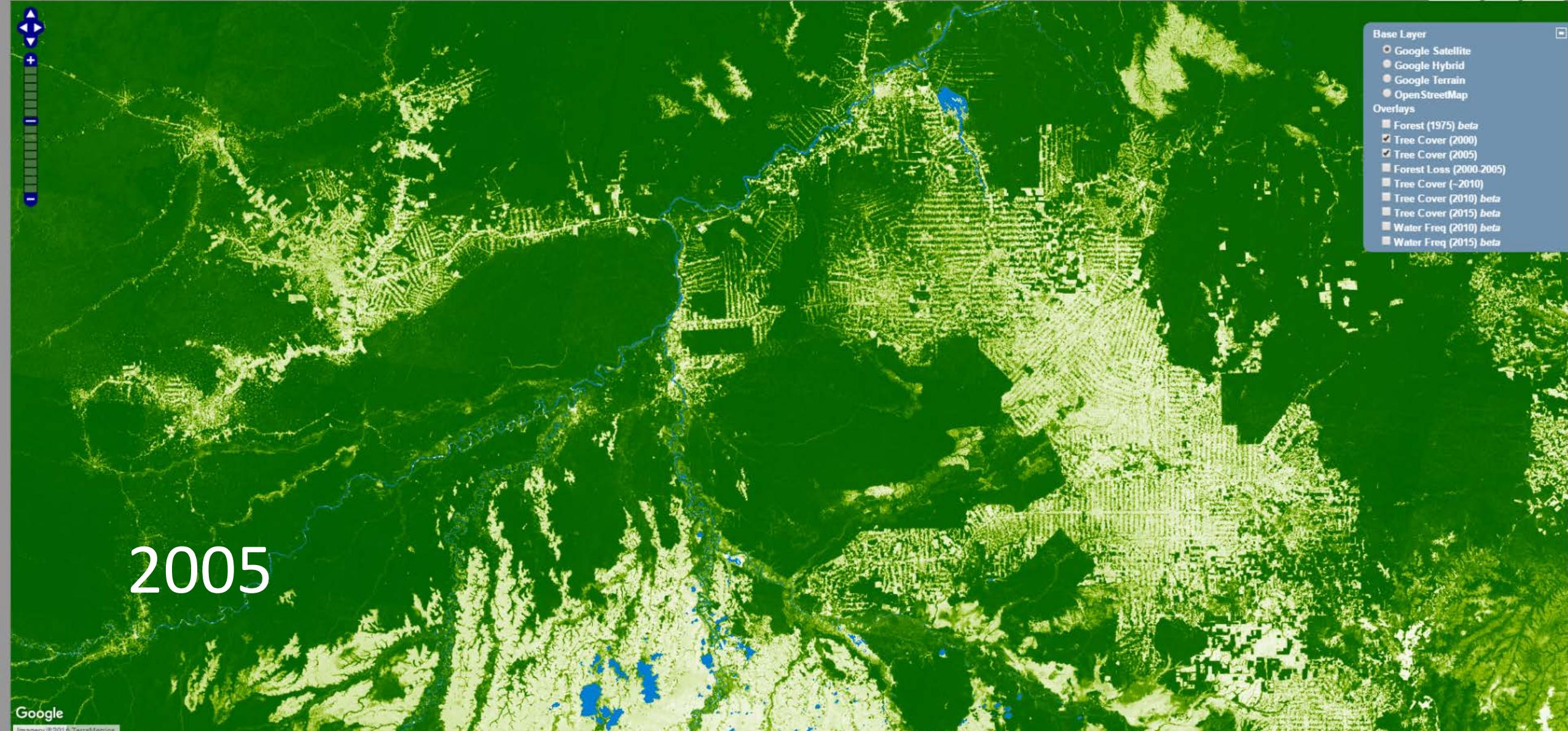
- Base Layer
- Google Satellite
 - Google Hybrid
 - Google Terrain
 - OpenStreetMap
- Overlays
- Forest (1975) beta
 - Tree Cover (2000)
 - Tree Cover (2005)
 - Forest Loss (2000-2005)
 - Tree Cover (~2010)
 - Tree Cover (2010) beta
 - Tree Cover (2015) beta
 - Water Freq (2010) beta
 - Water Freq (2015) beta

2000



terraPulse

Legend Tile NDVI



terraPulse

Legend Tile NDVI

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 - Tree Cover (2015) beta
 - Water Freq (2010) beta
 - Water Freq (2015) beta

2010

Google

Imagery ©2016 TerraMetrics



Ask me anything



16 10/2/2016

21

terraPulse

Legend Tile NDVI

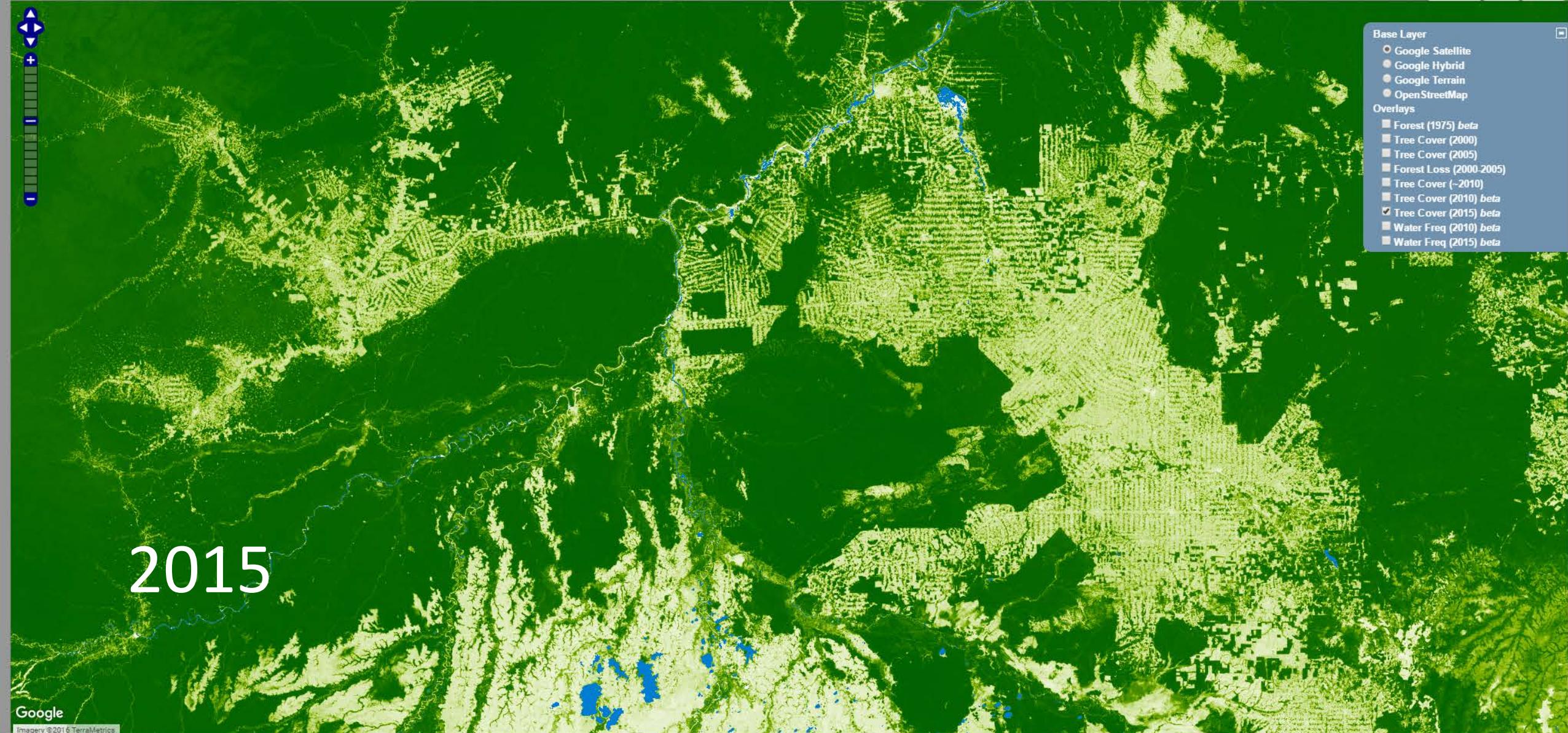
Base Layer

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Overlays

- Forest (1975) beta
- Tree Cover (2000)
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- Forest Loss (2000-2005)
- Tree Cover (~2010)
- Tree Cover (2010) beta
- Tree Cover (2015) beta
- Water Freq (2010) beta
- Water Freq (2015) beta

2015



What makes our product different

Remote Sensing of Environment 156 (2015) 418–425

 ELSEVIER

Contents lists available at [ScienceDirect](#)

Remote Sensing of Environment

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

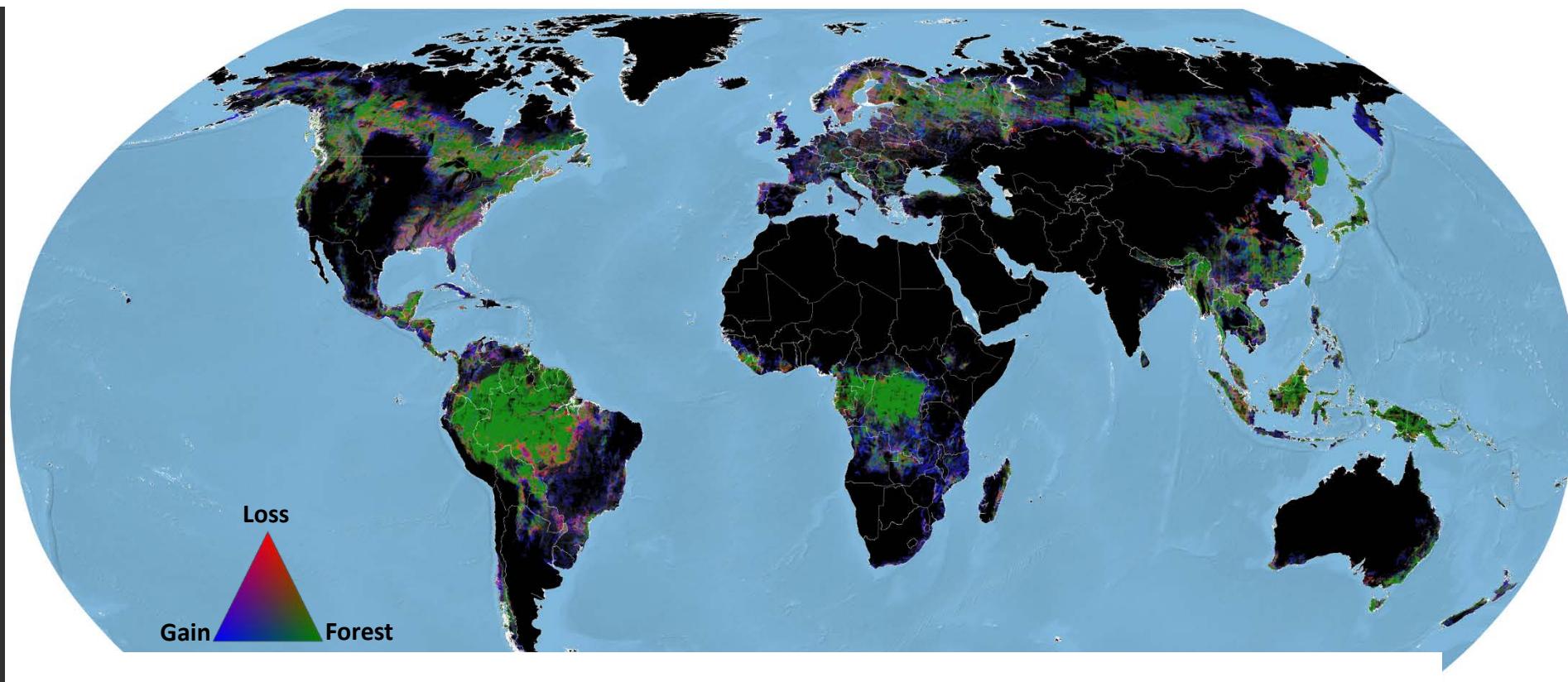


A model for the propagation of uncertainty from continuous estimates of tree cover to categorical forest cover and change

Joseph O. Sexton ^{a,*}, Praveen Noojipady ^{a,b}, Anupam Anand ^{a,c}, Xiao-Peng Song ^a, Sean McMahon ^d, Chengquan Huang ^a, Min Feng ^a, Saurabh Channan ^a, John R. Townshend ^a

^a *Global Land Cover Facility, Department of Geographical Sciences, University of Maryland, College Park, MD 20742, USA*
^b *National Wildlife Federation, National Advocacy Center, Washington, DC 20004, USA*
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 CrossMark



[Remote Sensing of Environment 155 \(2014\) 178–193](#)



Contents lists available at [ScienceDirect](#)

Remote Sensing of Environment

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



Global, Landsat-based forest-cover change from 1990 to 2000

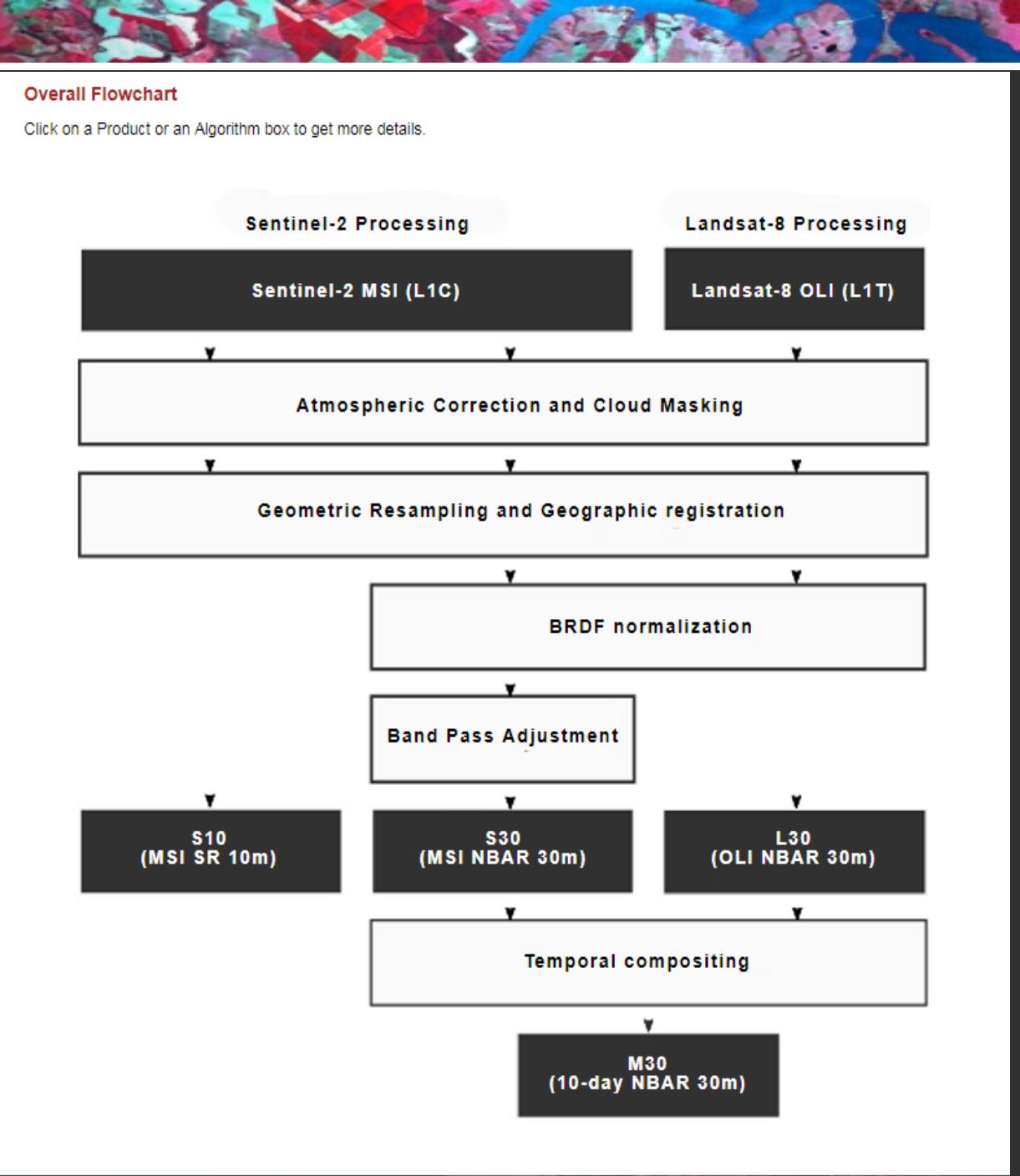
Do-Hyung Kim ^{*}, Joseph O. Sexton, Praveen Noojipady, Chengquan Huang, Anupam Anand, Saurabh Channan, Min Feng, John R. Townshend



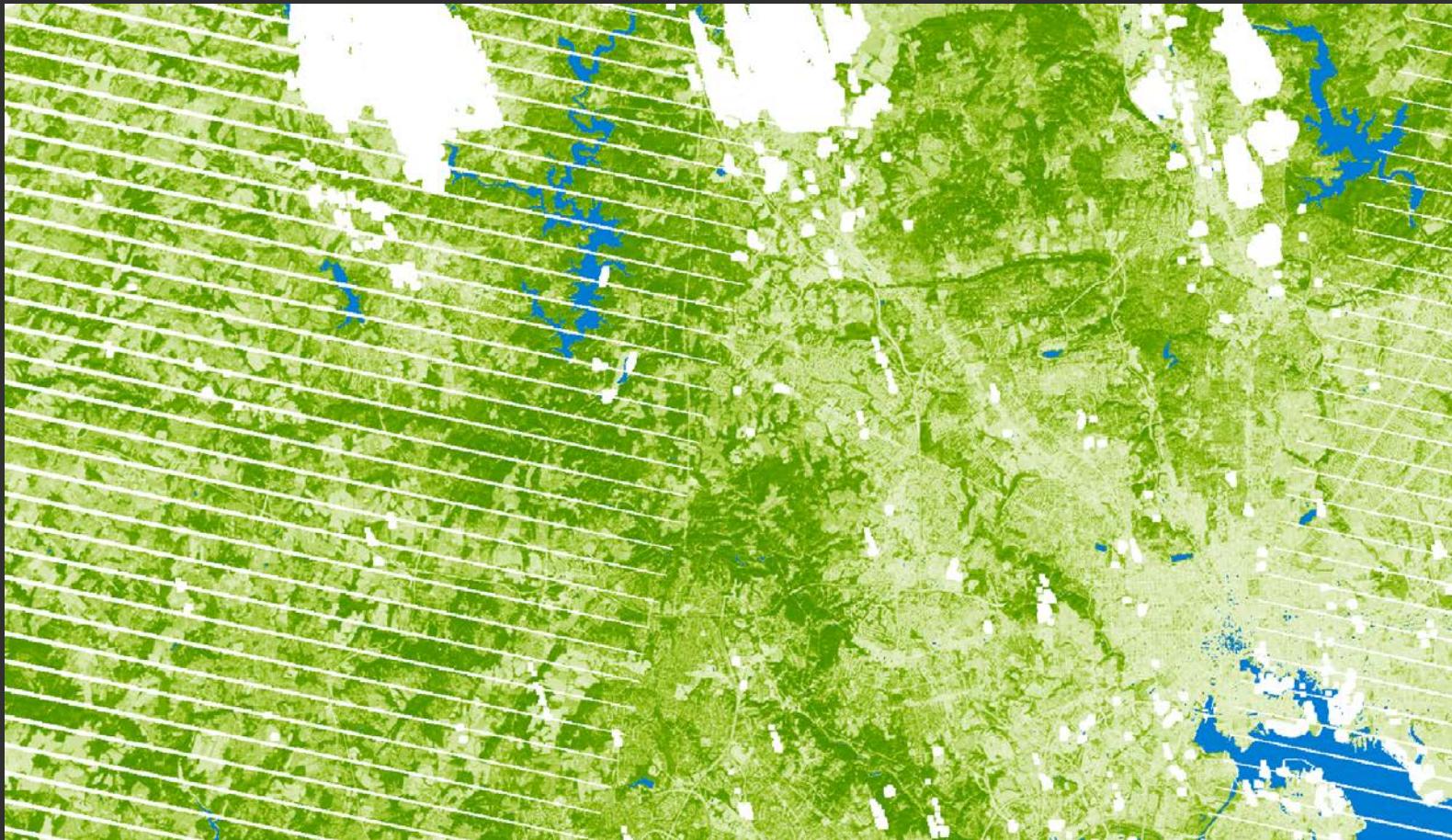
Global Land Cover Facility, Department of Geographical Sciences, University of Maryland, College Park, MD, USA

Fusing Landsat, Sentinel 1 & 2

- NASA HLS v1.3
 - Masek et. al.
 - <https://hls.gsfc.nasa.gov/algorithms/>



TCC estimated from Landsat ETM+ SR



Gaps caused by SLC off, cloud, cloud shadow in the ETM+ scene.

TCC estimated from Landsat ETM+ & OLI SR



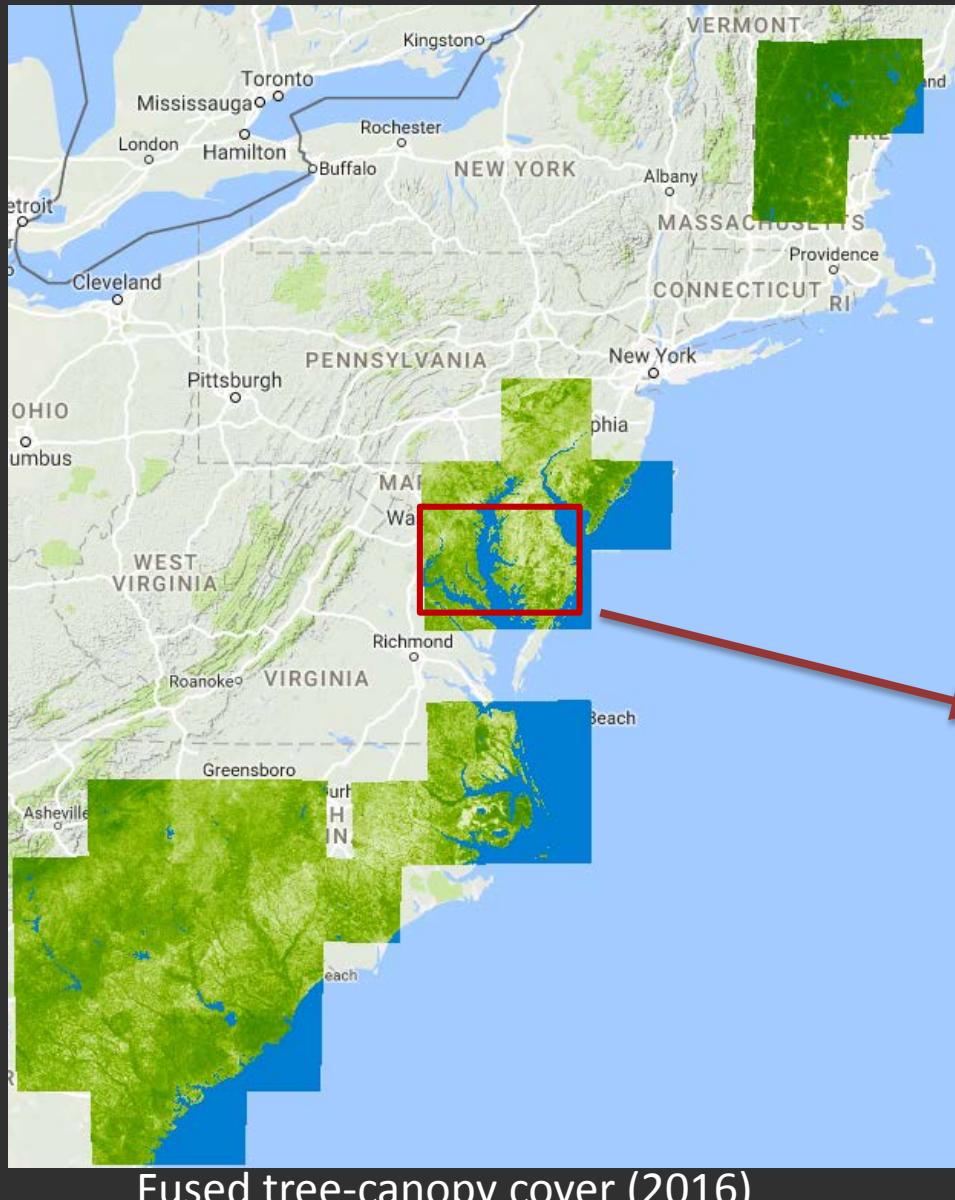
Filled most of the gaps caused by SLC off, cloud, cloud shadow.

Combined ETM+, OLI, S1, and S2 derived TCC



All gaps were filled after combining TCC derived from Landsat ETM+, OLI, Sentinel 1, and Sentinel 2
The predictions from Landsat and Sentinel appear to be consistent.

Optical fusion: Landsat and Sentinel-2



1,974 HLS Landsat and Sentinel-2 images were applied to estimate tree cover over the U.S. east coast



Geophysical Research Letters

RESEARCH LETTER

10.1002/2014GL062777

Key Points:

- Sixty-two percent increase in net deforestation in the tropics from the 1990s to the 2000s

Accelerated deforestation in the humid tropics from the 1990s to the 2000s

Do-Hyung Kim¹, Joseph O. Sexton¹, and John R. Townshend¹

¹Global Land Cover Facility, Department of Geographical Sciences, University of Maryland, College Park, Maryland, USA



RESEARCH ARTICLE

APPLIED ECOLOGY

Habitat fragmentation and its lasting impact on Earth's ecosystems

Nick M. Haddad,^{1*} Lars A. Brudvig,² Jean Clobert,³ Kendi F. Davies,⁴ Andrew Gonzalez,⁵ Robert D. Holt,⁶ Thomas E. Lovejoy,⁷ Joseph O. Sexton,⁸ Mike P. Austin,⁹ Cathy D. Collins,¹⁰ William M. Cook,¹¹ Ellen I. Damschen,¹² Robert M. Ewers,¹³ Bryan L. Foster,¹⁴ Clinton N. Jenkins,¹⁵ Andrew J. King,⁹ William F. Laurance,¹⁶ Douglas J. Levey,¹⁷ Chris R. Margules,^{18,19} Brett A. Melbourne,⁴ A. O. Nicholls,^{9,20} John L. Orrock,¹² Dan-Xia Song,⁸ John R. Townshend⁸

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10.1126/sciadv.1500052

Science 30 May 2014:
Vol. 344 no. 6187
DOI: 10.1126/science.1246752

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REVIEW

The biodiversity of species and their rates of extinction, distribution, and protection

S. L. Pimm^{1,*}, C. N. Jenkins², R. Abell^{3,†}, T. M. Brooks⁴, J. L. Gittleman⁵, L. N. Joppa⁶, P. H. Raven⁷, C. M. Roberts⁸, J. O. Sexton⁹

gef IEO Independent Evaluation Office
GLOBAL ENVIRONMENT FACILITY



Impact Evaluation of GEF Support to Protected Areas and Protected Area Systems

Juha I. Uitto (Director of GEF)
COP12, Pyeongchang, Oct 2014

GLOBAL ANALYSIS

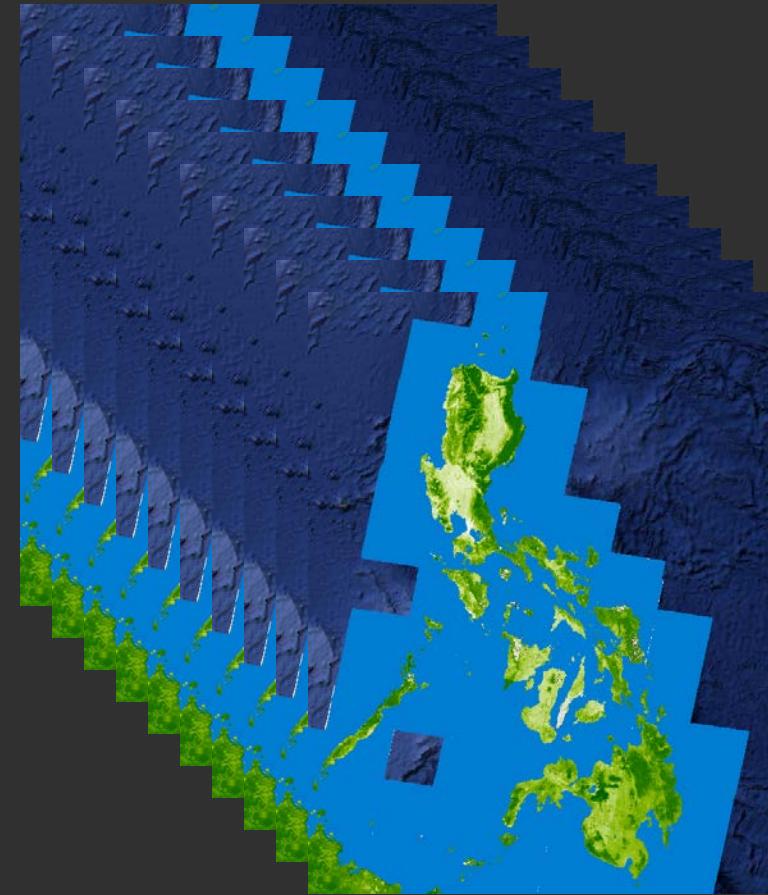


This is the **MOST COMPREHENSIVE**
global evaluation undertaken on the impact of PAs
on biodiversity in terms of the diversity of methods
used and the scope of inquiry.

tions. It is so far the most comprehen-

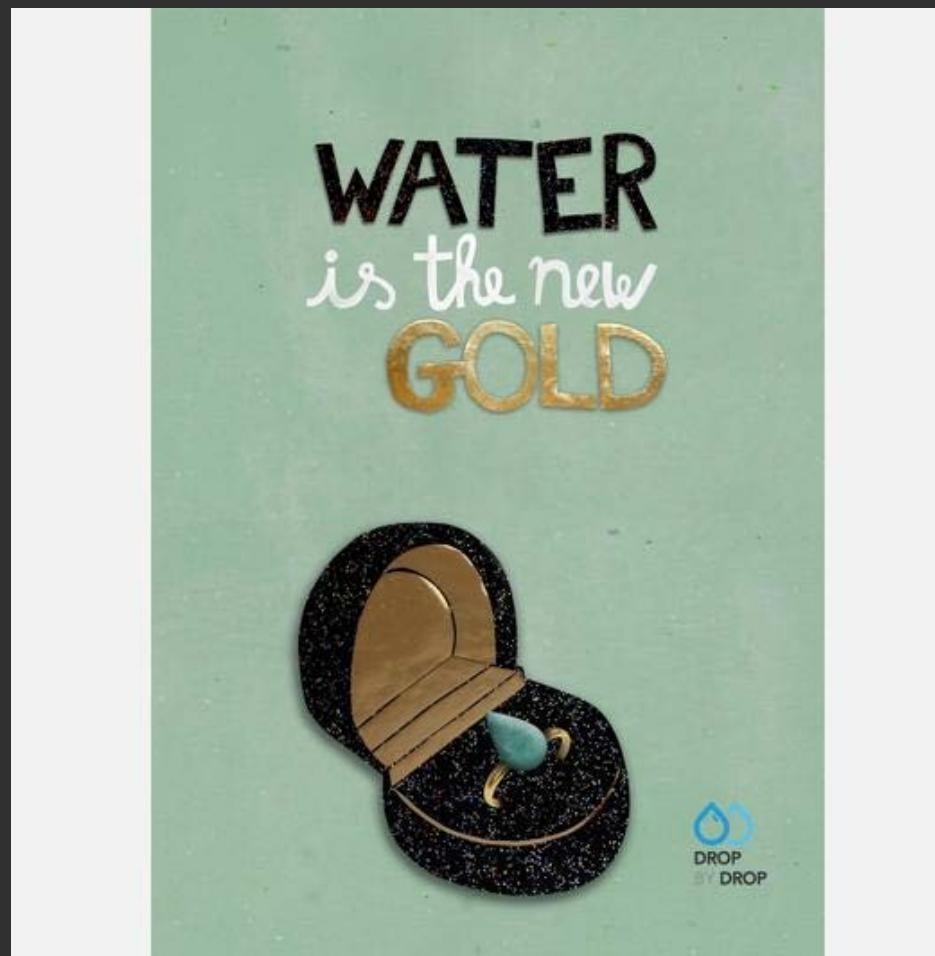
Application: Philippines Forest Monitoring

- Time serial canopy cover product from 2000 – 2015
- Improving estimation of tree canopy cover using Philippines airborne LiDAR data



Funded via USFS IP Program

Water Cover



Maria Figueiredo - Portugal

Source : <http://www.dropbydrop.eu/36916>

Water

“As climate changes, is water the new oil? WASHINGTON” [Deborah Zabarenko](#),
Environment Correspondent, 2012, Reuters

“Water is the new gold, a big commodity bet” Published: July 24, 2012, [Paul B. Farrell](#), MarketWatch

“Where Water Is Gold”, By [THE EDITORIAL BOARD](#) SEPT. 19, 2013. New York Times

“Water becoming more valuable than gold”, Patrick M. Sheridan, April 24, 2014, CNNMoney (New York)

International Journal of Digital Earth, 2015
<http://dx.doi.org/10.1080/17538947.2015.1026420>

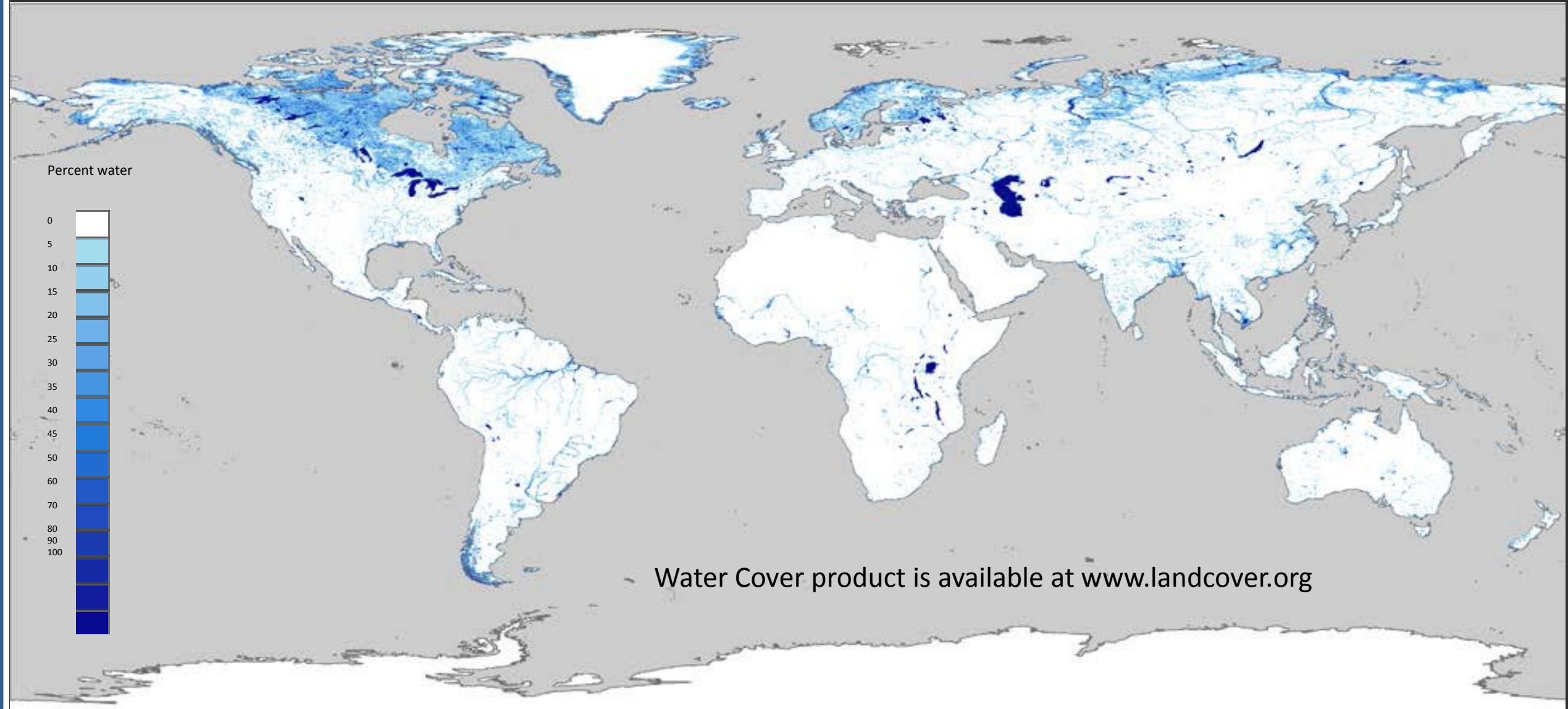


A global, high-resolution (30-m) inland water body dataset for 2000: first results of a topographic–spectral classification algorithm

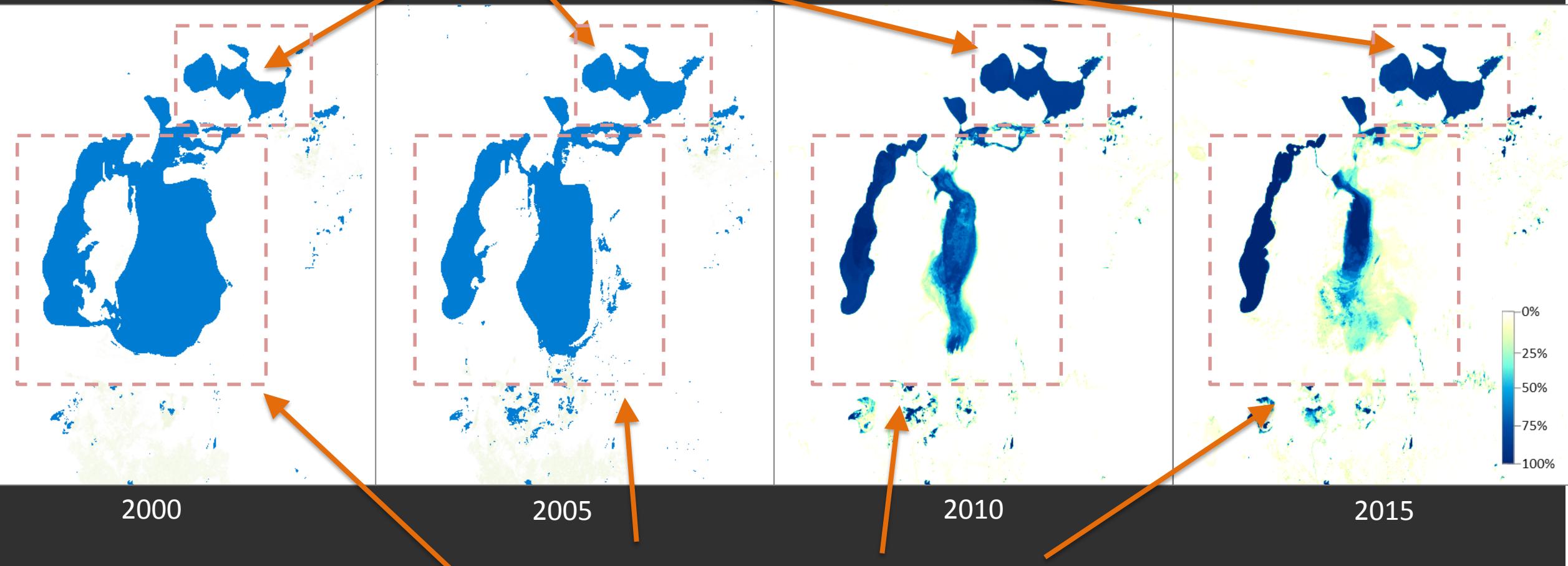
Min Feng*, Joseph O. Sexton, Saurabh Channan and John R. Townshend

*Global Land Cover Facility, Department of Geographical Sciences, University of Maryland,
College Park, MD, USA*

Water Cover Product



Water extent increased from 2000 and has been stable after 2005, after the dam was built

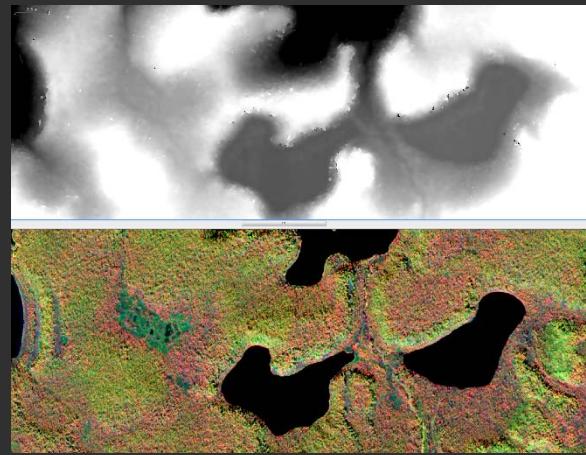
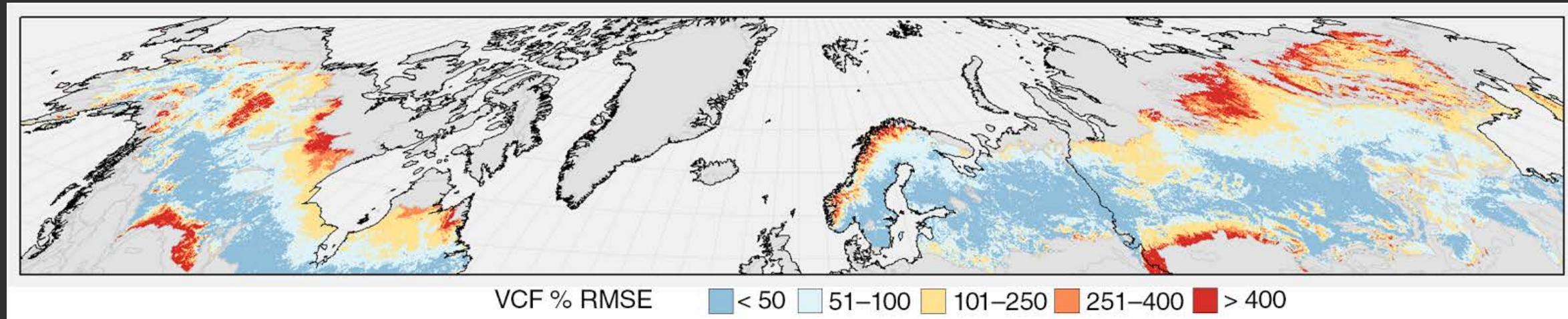


The South Aral has been on a constant shrinking trend in the past decades

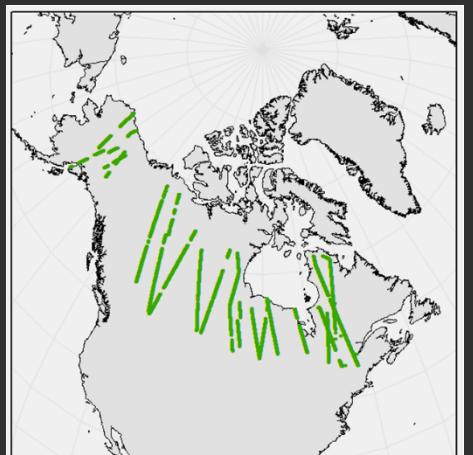
Outline

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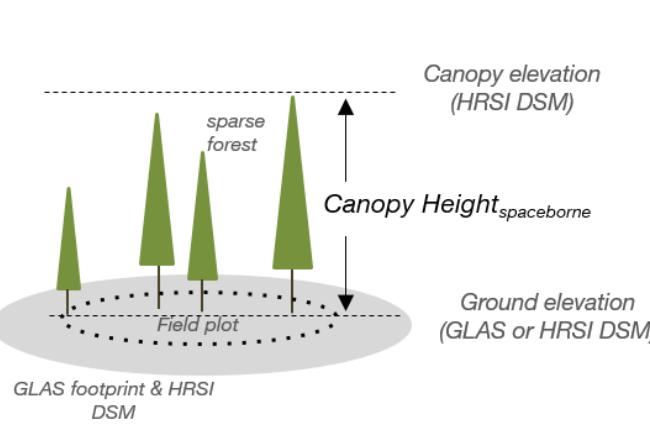
Tree Canopy Cover Validation & Calibration (Taiga Tundra Ecotone)



HRSI estimation of canopy height & cover



airborne LiDAR estimates of tree canopy closure



- RMSE from 8-20% in temperate and tropical biomes
- Highest uncertainty in sparse, short forests
- Often dominated by systematic errors—amenable to calibration

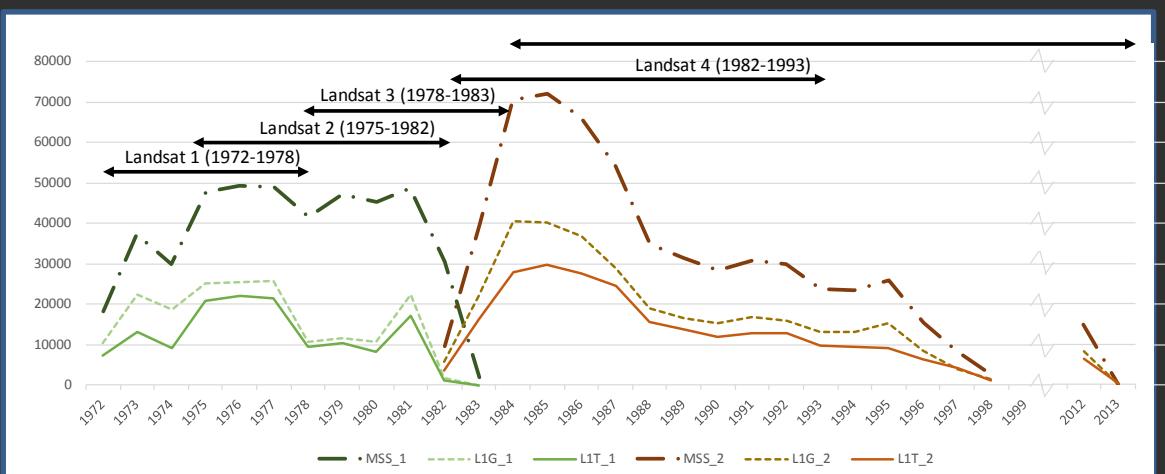
Calibrated TCC for Boreal in North America (2010)



First forest cover map in the 1970s

Long-term records of forest cover are needed across a broad range of investigation, including climate and carbon-cycle modeling, hydrological studies, habitat analyses, biological conservation, and land-use planning.

Starting in 1972, the Multispectral Scanner (MSS) was the first generation of sensors aboard the Landsat satellites. We developed an automated approach to detect forests using MSS archive by leveraging the multispectral and phenological characteristics of forests observed in MSS time-series. More than 70,449 Landsat MSS scenes were processed to provide a 120-meter resolution forest cover for North America.



Questions/Discussion

Saurabh Channan

Email: schannan@umd.edu

Visualize our data at www.terrapulse.com/terraView

Download the data at www.landcover.org

Publications

2015

- Rastogi, A., Hickey, G. M., Anand, A., Badola, R., & Hussain, S. A. (2015). [Wildlife-tourism, local communities and tiger conservation: A village-level study in Corbett Tiger Reserve, India.](#) Forest Policy and Economics.
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- Song, D., C. Huang, J.O. Sexton, S. Channan, M. Feng, and J.R. Townshend. 2014. [Use of Landsat and Corona data for mapping forest cover change from the mid-1960s to 2000s: Case studies from the Eastern United States and Central Brazil](#). ISPRS J. of Photogrammetry and Remote Sens. DOI: 10.1016/j.isprsjprs.2014.09.005
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