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science for a changing world

Land Change Monitoring, Assessment and Projection (LCMAP)

Jesslyn Brown

(contributions by T. Sohl, S. Labahn, J. Rover, C. Barber, R. Auch, H. Tollerud, B. Pengra, G. Xian….and entire LCMAP team!)

U.S. Department of the Interior
U.S. Geological Survey

CESAS Space Science Week
3/24/2021

What is LCMAP?

Monitoring

- Monitoring Product Suite
  - Methods
- Production Collection 1.x strategy, status, schedule
- Applications and use cases
- Data distribution and users
- Plans: Collection 2, transition to Cloud

Assessment

- Accuracy assessment/validation
- Land change science assessments: what, when, where of land change

Projection

- Modeling land surface/land cover beyond the satellite record

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LCMAP

Land Change Monitoring, Assessment, and Projection

Monitoring: Continuous tracking of land surface change using Landsat Analysis Ready Data

Assessment: Knowledge about landscape change, its causes, and consequences

Projection: Forecasting past and future landscapes

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LCMAP Monitoring Methods: Video

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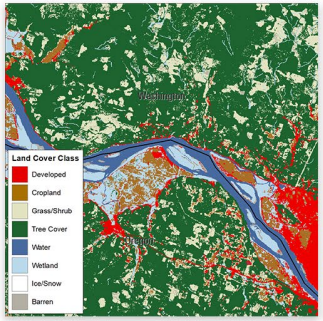
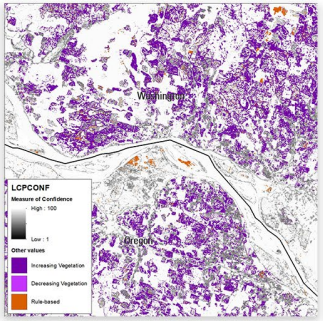
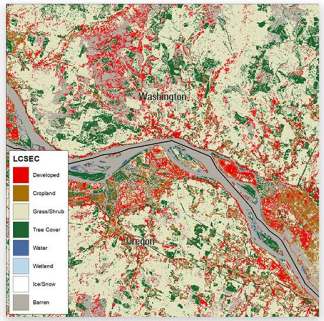
Ten LCMAP Monitoring Products:
Annual Land Surface Change and Land Cover



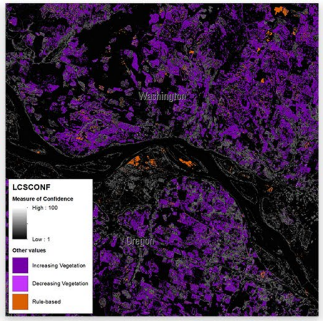
Primary Land Cover



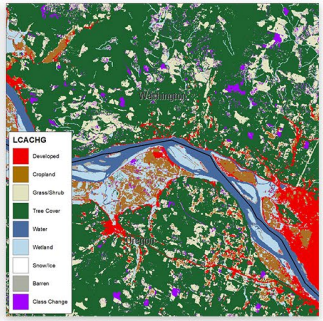
Primary Land Cover Confidence



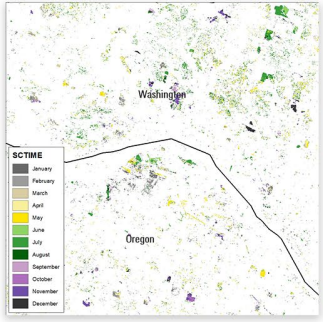
Secondary Land Cover



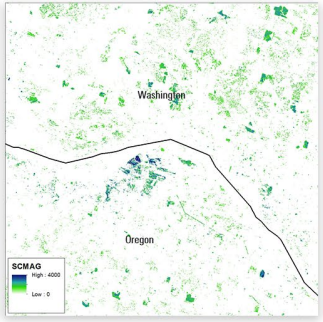
Secondary Land Cover Confidence



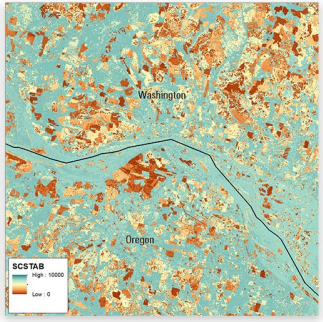
Annual Land Cover Change



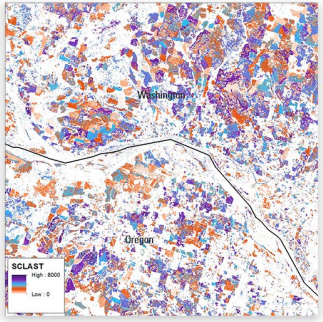
Time of Spectral Change



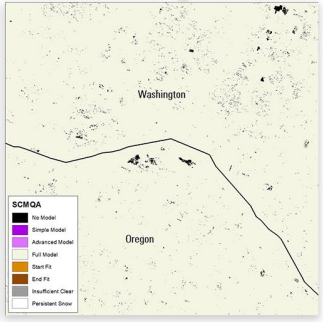
Change Magnitude



Spectral Stability Period



Time Since Last Change



Spectral Model Quality

USGS **Collection 1: Conterminous U.S. 1985 – 2017, 422 ARD Tiles at 30 m spatial res.**

LCMAP Methodology

CCDC: Continuous Change Detection and Classification

Zhu and Woodcock (2014) Continuous change detection and classification of land cover using all available Landsat data. *Remote Sensing of Environment*

Brown, J.F., Tollerud, H.J., Barber, C.P., et al (2020) Lessons learned implementing an operational continuous U.S. national land change monitoring capability: The LCMAP approach. *Remote Sensing of Environment*

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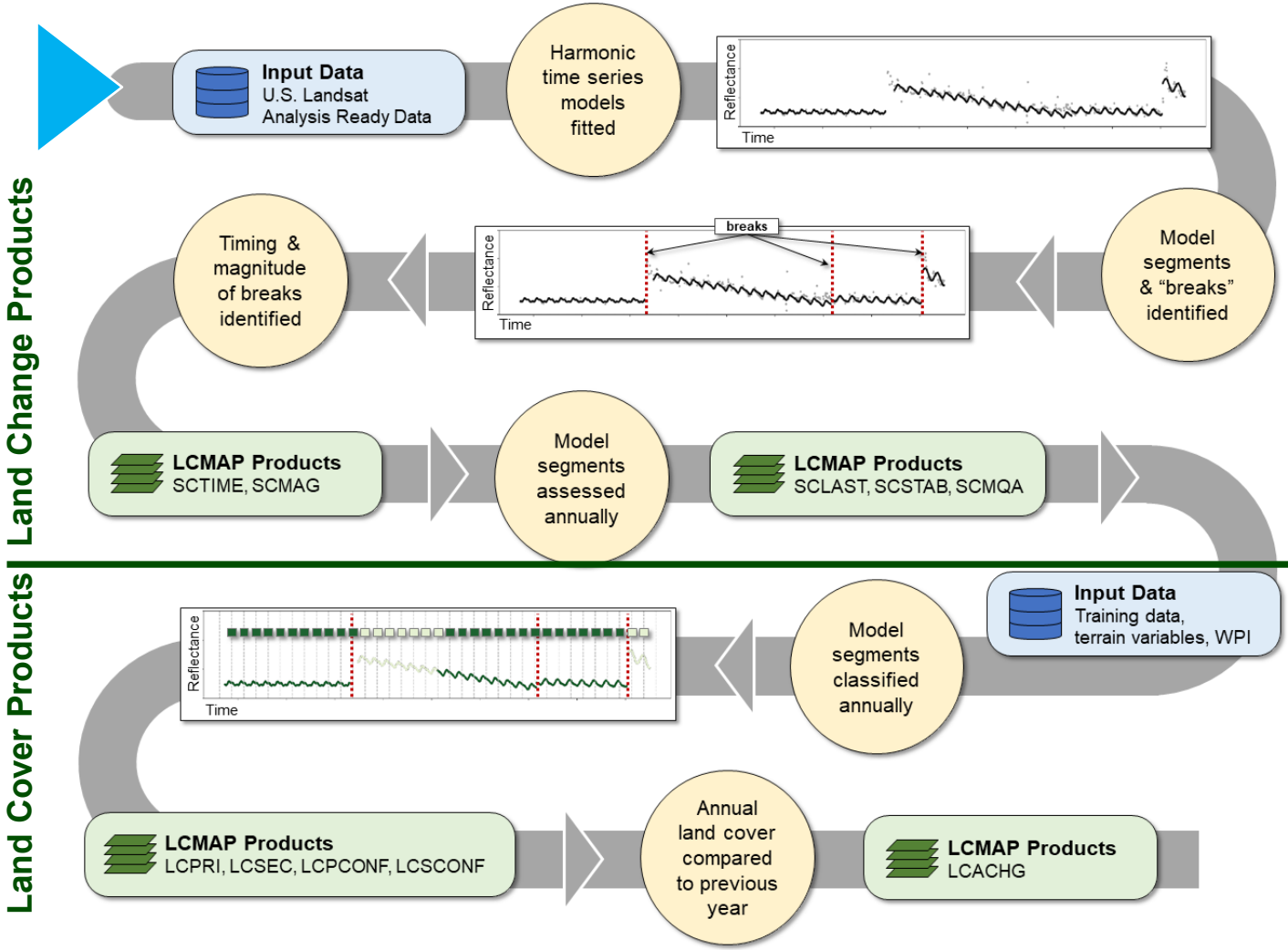

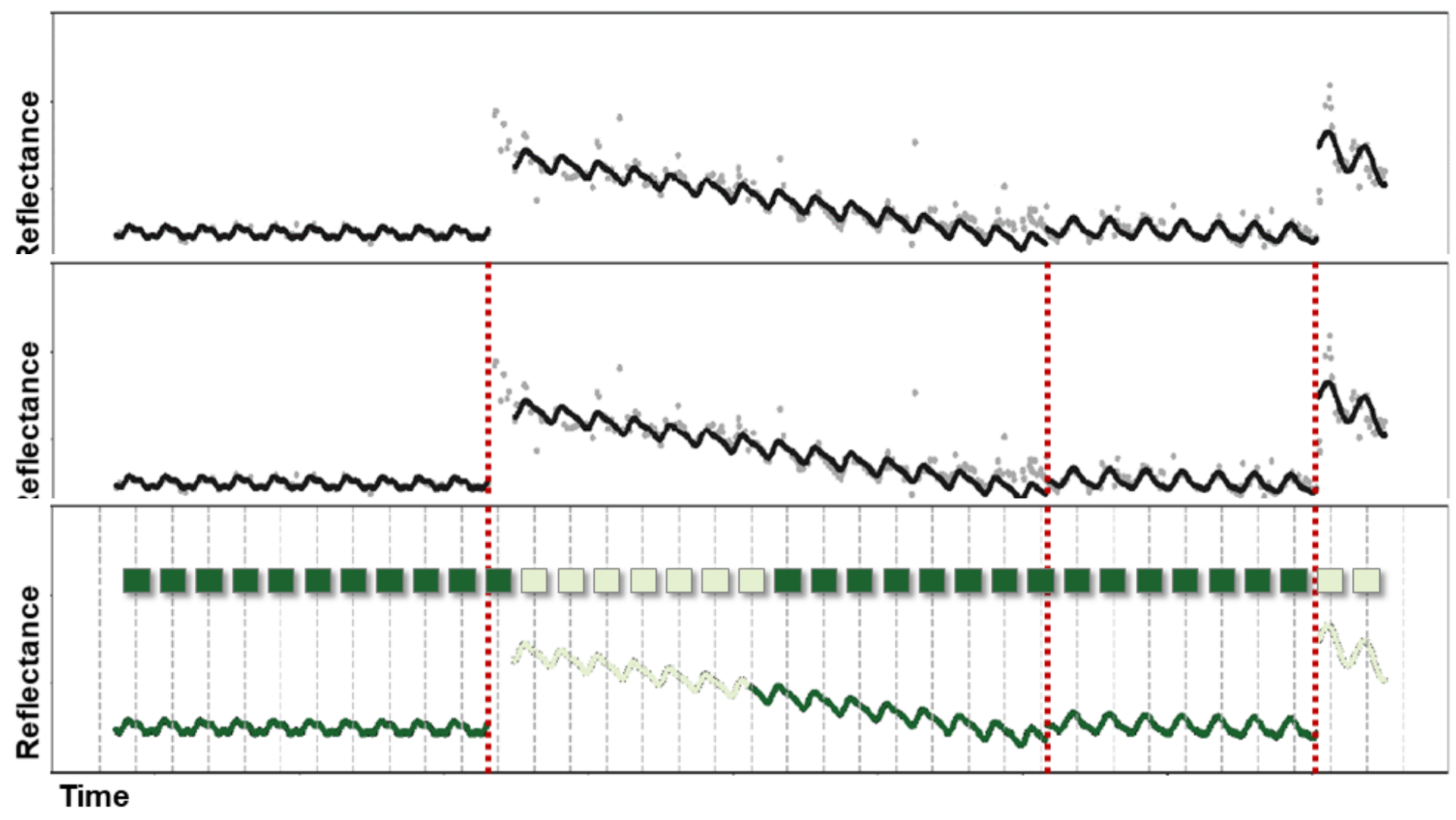
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Time

Monitoring Production Schedule

- **CONUS**
  - Collection 1 (1985-2017): June 6, 2020
  - Collection 1.1 (1985-2019): ~April 15, 2021 (target)
  - Collection 1.2 (1985-2020): ~October 2021 (target)
  - Collection 1.3 (1985-2021): ~May 2022 (target)
  - Collection 2.0 (1985-2022): ~April 2023 (target) **in the Cloud**
- **Hawaii**
  - Collection 1.x (2000-2020): ~December 2021 (target)
- **Alaska**
  - Collection 1.x (2000-2022): ~mid 2023 (target)

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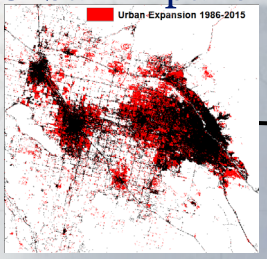
Plans: Collection 2 Landsat and Cloud

Migration of LCMAP to the Cloud (2021-2022)

- Enables access to LCMAP data/resources by users (esp. outside EROS)
- Allows LCMAP to take advantage of cloud-accessible resources/datasets
- Realization of the LCMAP science products roadmap for Collection 2 and CCDC Version 2.0 and beyond
- Faster CCDC processing, more frequent releases, addition of new products
- Simplifies implementation of low-latency products
- Allows R&D users to bring their analytics to the data (tools: CHS Pangeo, Jupyter Notebooks, Open Data Cube, AWS SageMaker, et al.)
- Supports a “pay only for what you use” operating model
- Reduces/eliminates hardware investment, maintenance, obsolescence and replacement

LCMAP: Land Change Monitoring, Assessment, and Projection

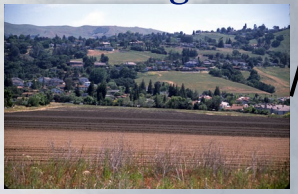
Urban Expansion



Surface Water

Forest Harvest

Agricultural Change



Hurricane Damage

Wildfire

Satellite-based Remote Sensing

Climate-sensitive Modeling

Urban growth application

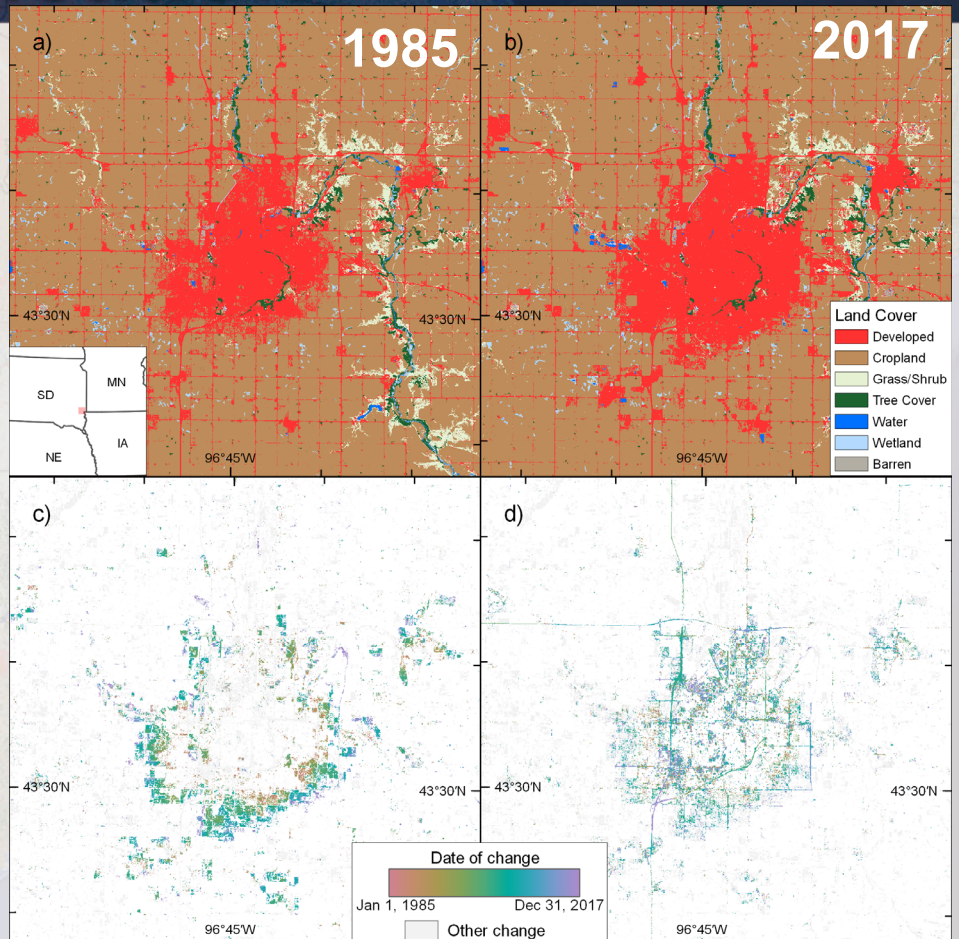
Developed land change for Sioux Falls, SD

a) Primary land cover (1985)

b) Primary land cover (2017)

c) the timing for Land Surface Change (SCTIME) that occurred between 1985 and 2017 and switched into Developed land cover from a different prior land cover type in Annual land cover change (LCACHG)

d) land surface change within the Developed class in Primary land cover representing a change in condition.



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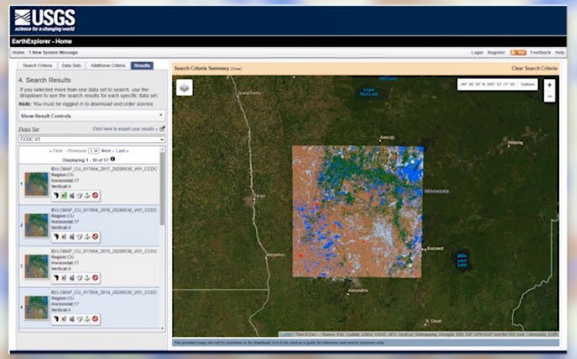
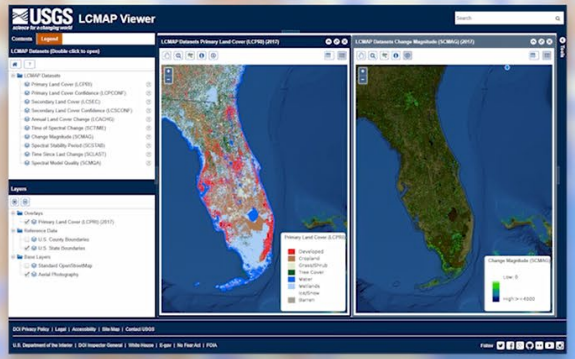


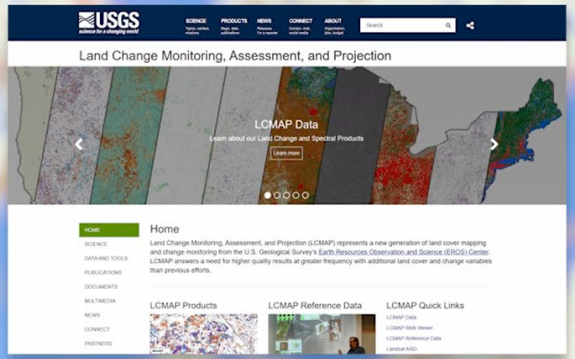
Earth Explorer

earthexplorer.usgs.gov



LCMAP Viewer

eros.usgs.gov/lcmap/viewer



LCMAP Website

usgs.gov/land-resources/eros/lcmap

USGS EROS Customer Service

custserv@usgs.gov | 800-252-4547

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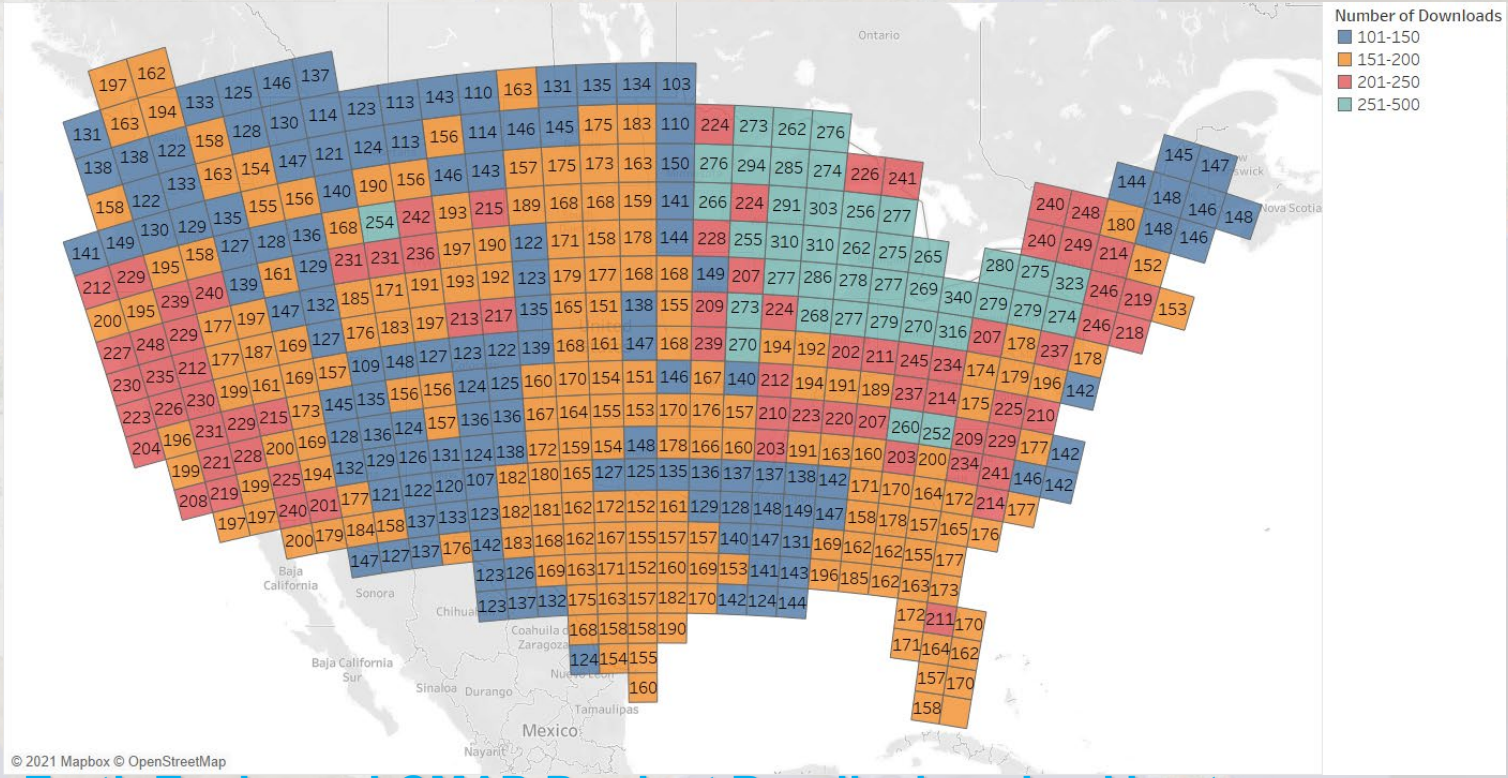
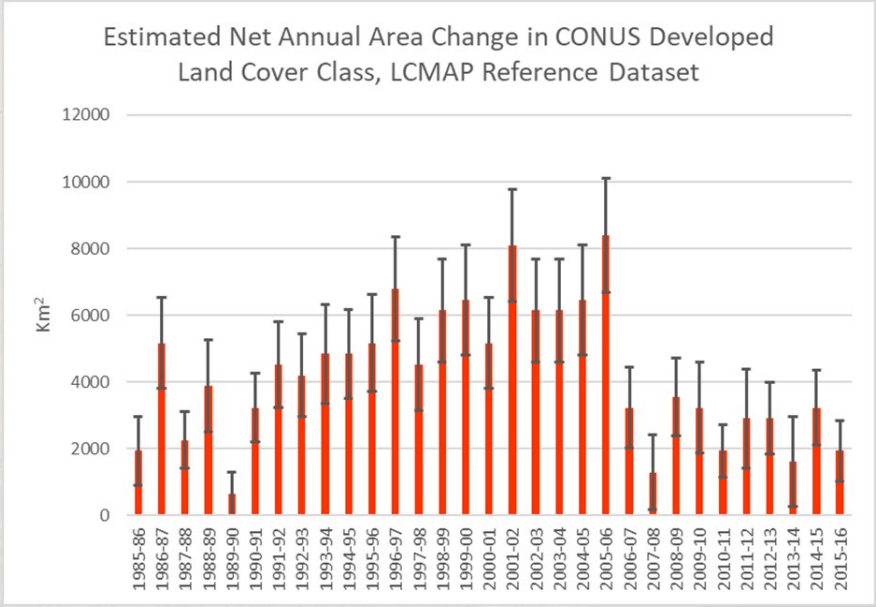
LCMAP Product Downloads



Earth Explorer: LCMAP Product Bundle download heatmap (Jun 2020 – Feb 2021)

LCMAP: Monitoring, Assessment, and Projection

- Built on analysis of Monitoring products and data
- Built on the reference data
- Perform analysis and publish regional-to-national scale assessments
- Characterizing land change 1985-present
- Increase understanding of landscape-scale processes and drivers



Eg. Annual net change in developed lands shows a dramatic drop off in 2006-2007 concurrent with a large economic recession. Level of new developed land has stayed fairly flat since that time.

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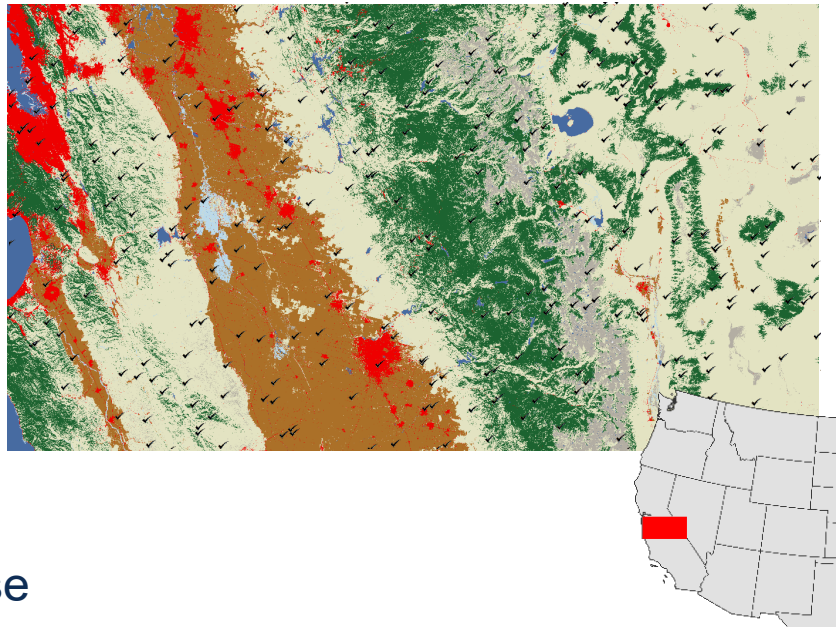
Land Cover/Change Validation: Reference Data

- 25,000 random points across CONUS
- 34 years (1985-2019)
- Photo Interpretation
  - Landsat ARD
  - High resolution imagery
    - Google Earth, NAPP, NHAP
  - Ancillary data (MTBS, Soils, NWI)
- Validation of 2 LCMAP Products
  - Primary Land Cover (OA=82.5%)
  - Annual Land Cover Change (OA=82.1%)
- Reference & Validation dataset(s) release
  - ScienceBase



OA = overall accuracy

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First Geographic Assessment of CONUS Land Change

Land-cover change from 1985 to 2016.

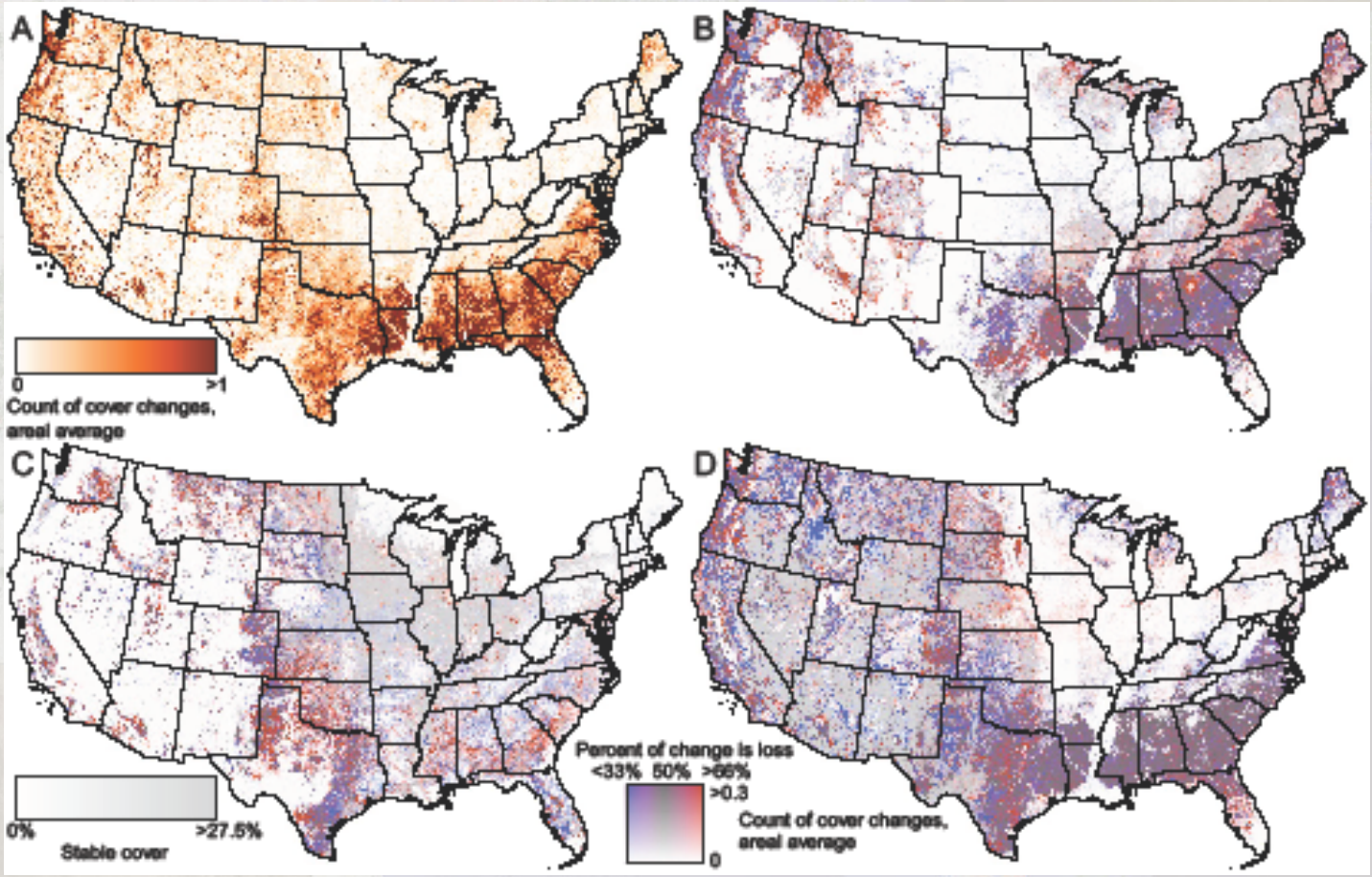
a) Total Land-cover change.

b) Tree Cover change

c) Cropland change

d) Grass/Shrub change

Light gray shading shows stable land cover for the respective LC class.



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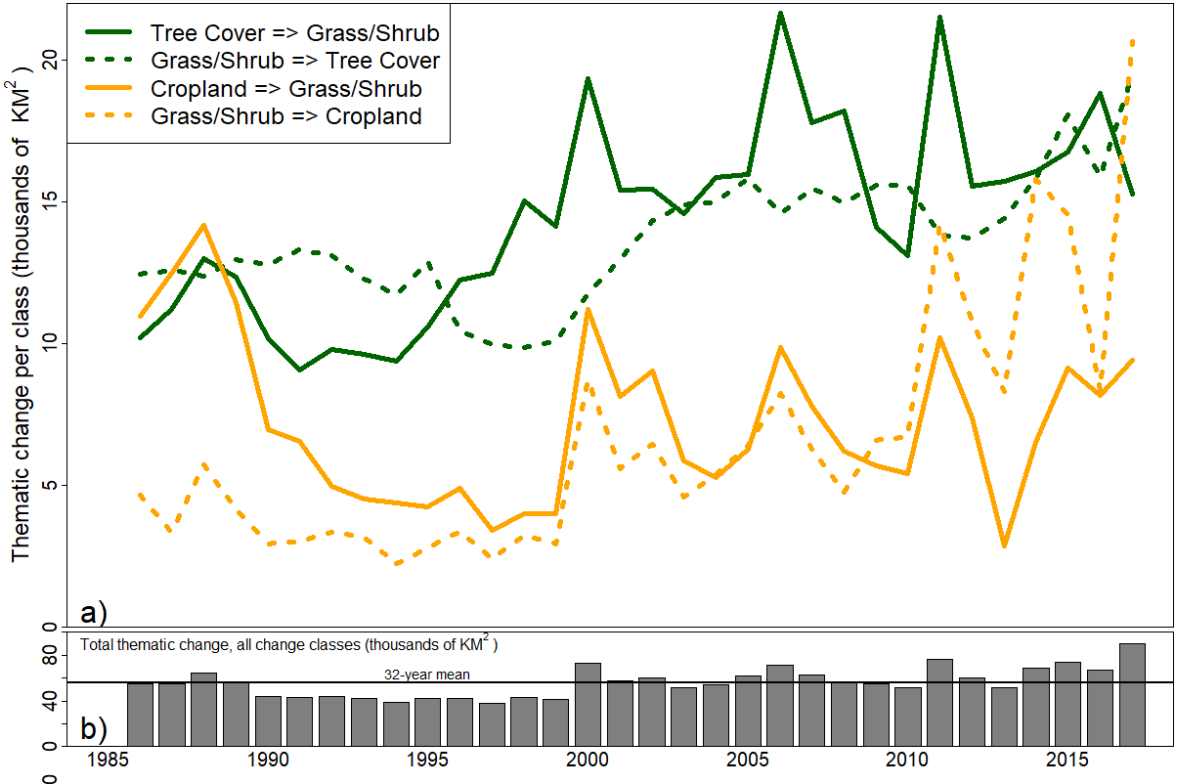
U.S. Land cover change over time



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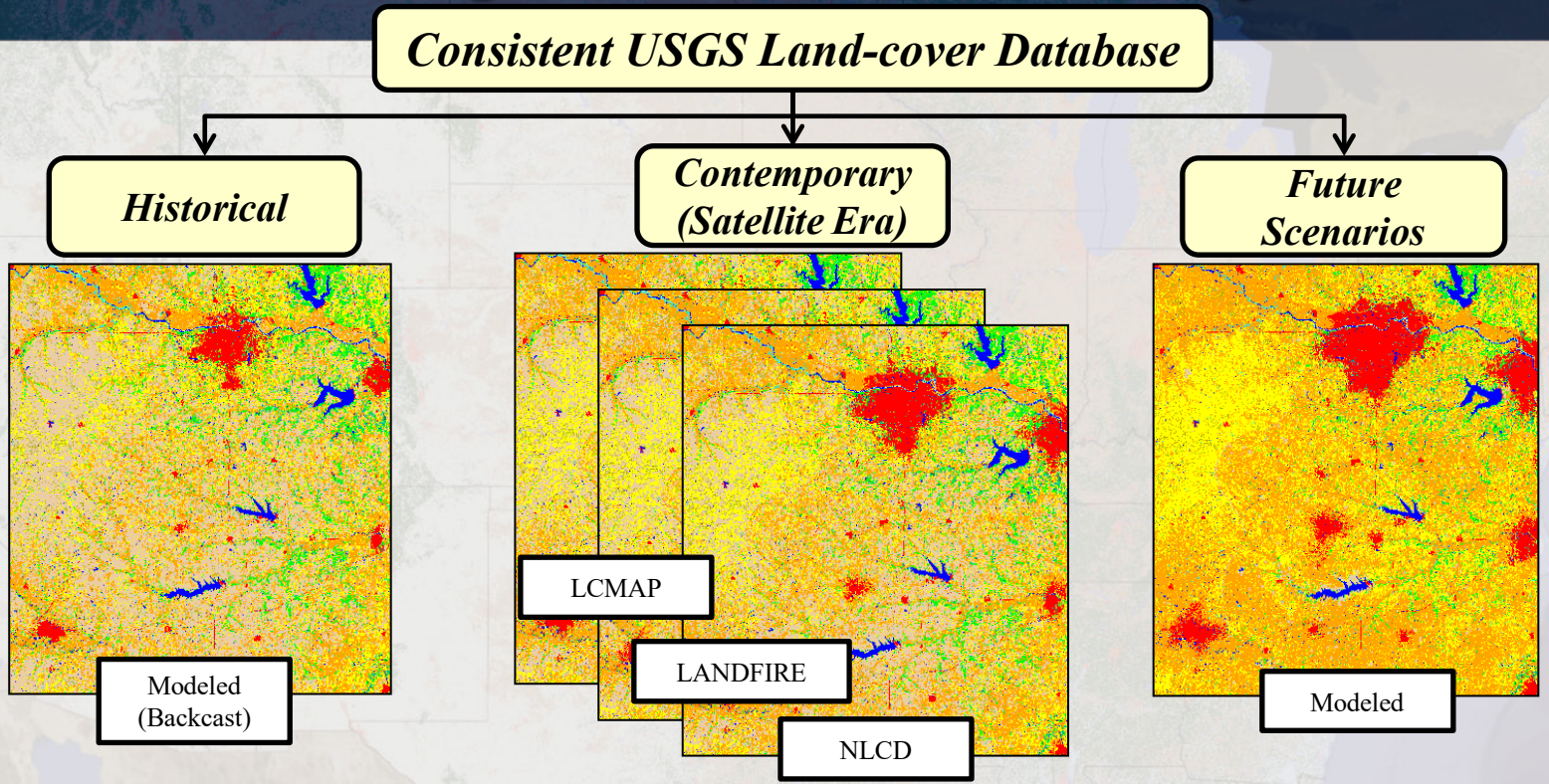
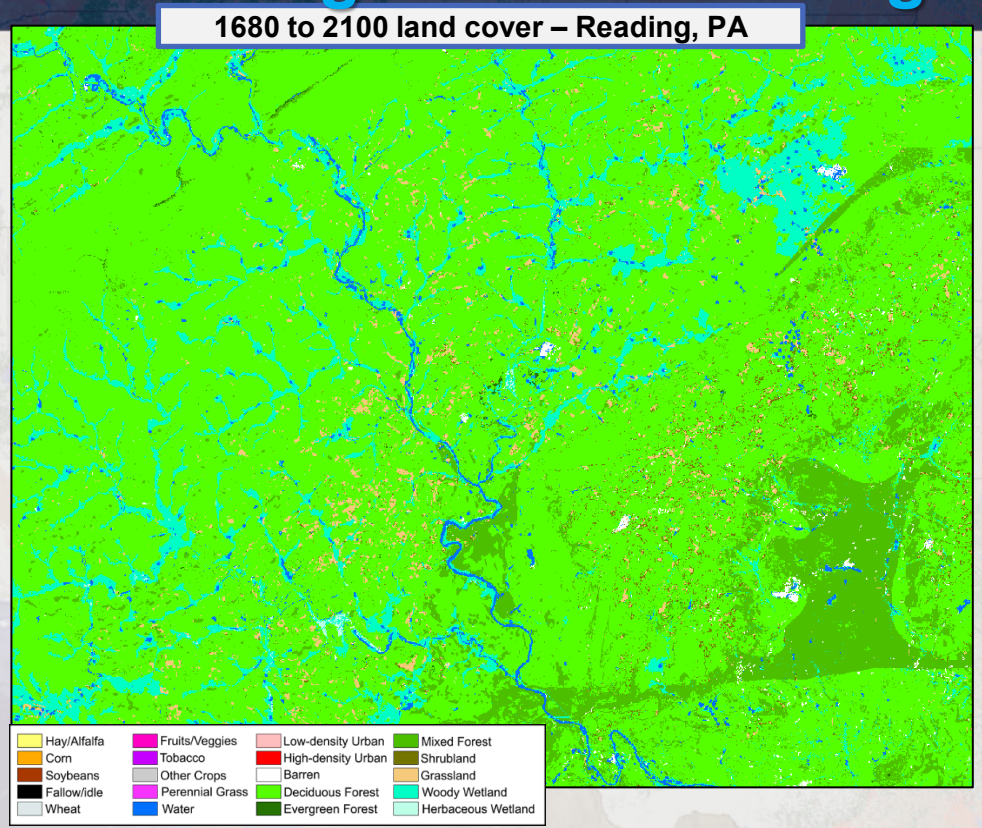
LCMAP: Monitoring, Assessment, and Projection



Use of modeling for "Temporally extending" land cover to provide long-term time series data; using information from the past to predict the future

Modeling Land Use Change – Historical and Future



USGS landscape models leverage landscape monitoring data

- Driven by both socioeconomic and biophysical input data
- Scenario-based modeling
- Consistency with USGS land cover data, facilitating seamless time series analyses
- Parcel-based modeling using real land ownership/management boundaries
- Model responds to climate change and water availability
- Can be applied both historically and for future scenarios

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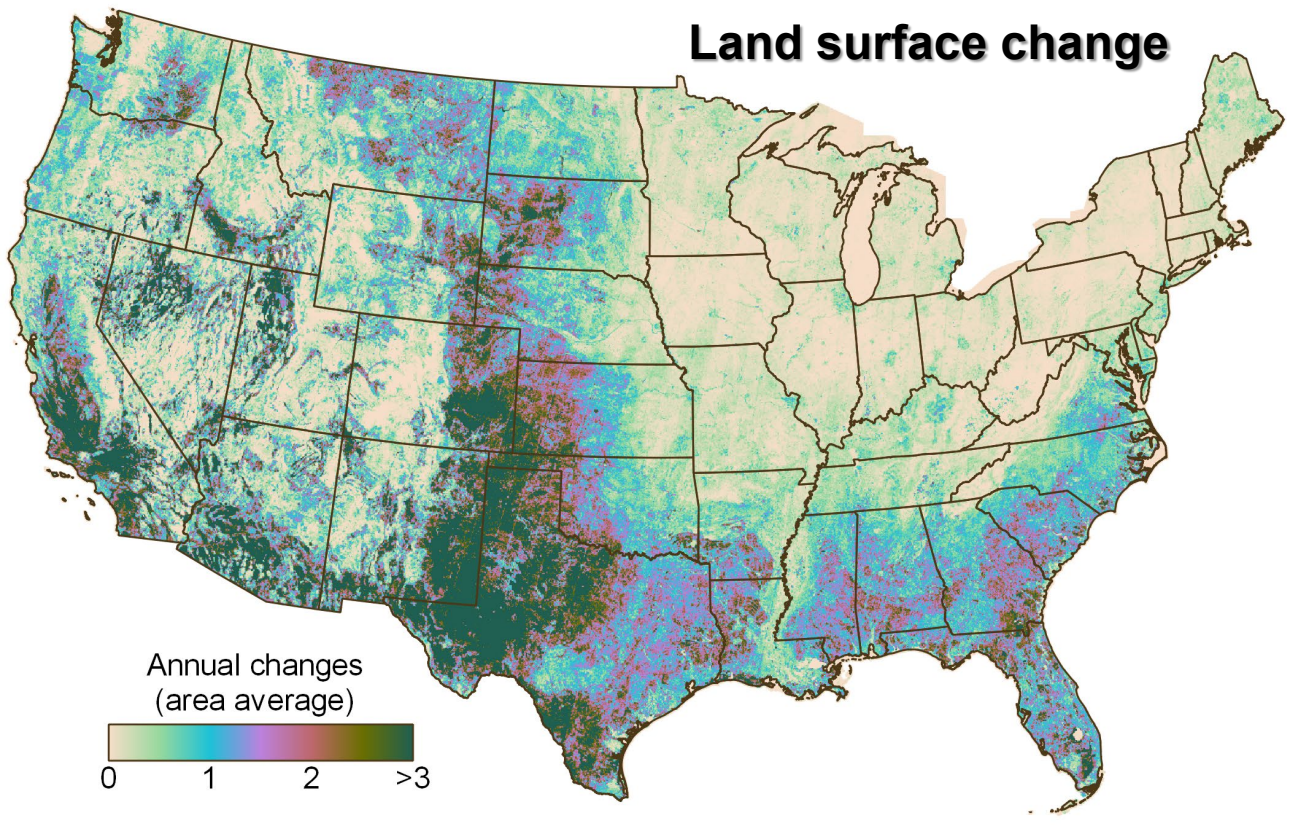
Footprint of change from LCMAP



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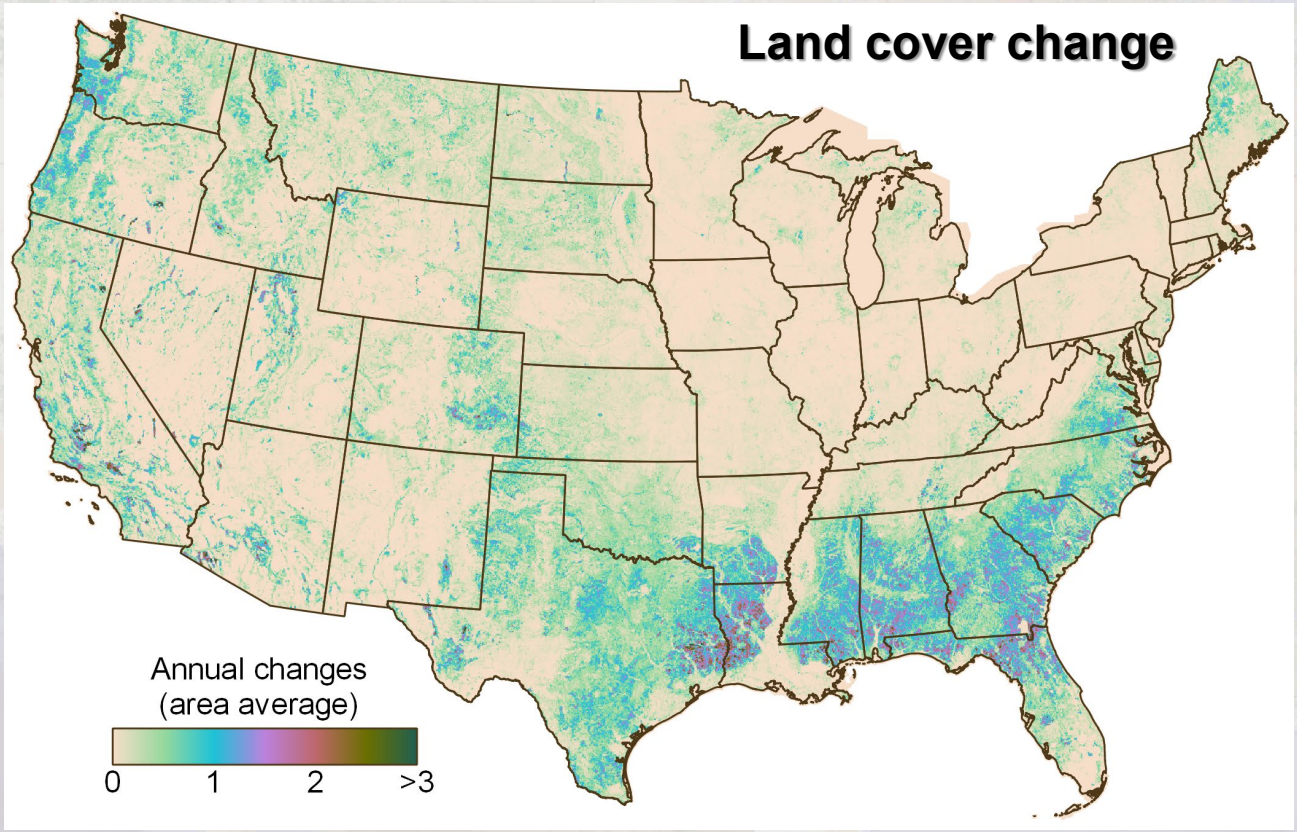

Thank you!
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