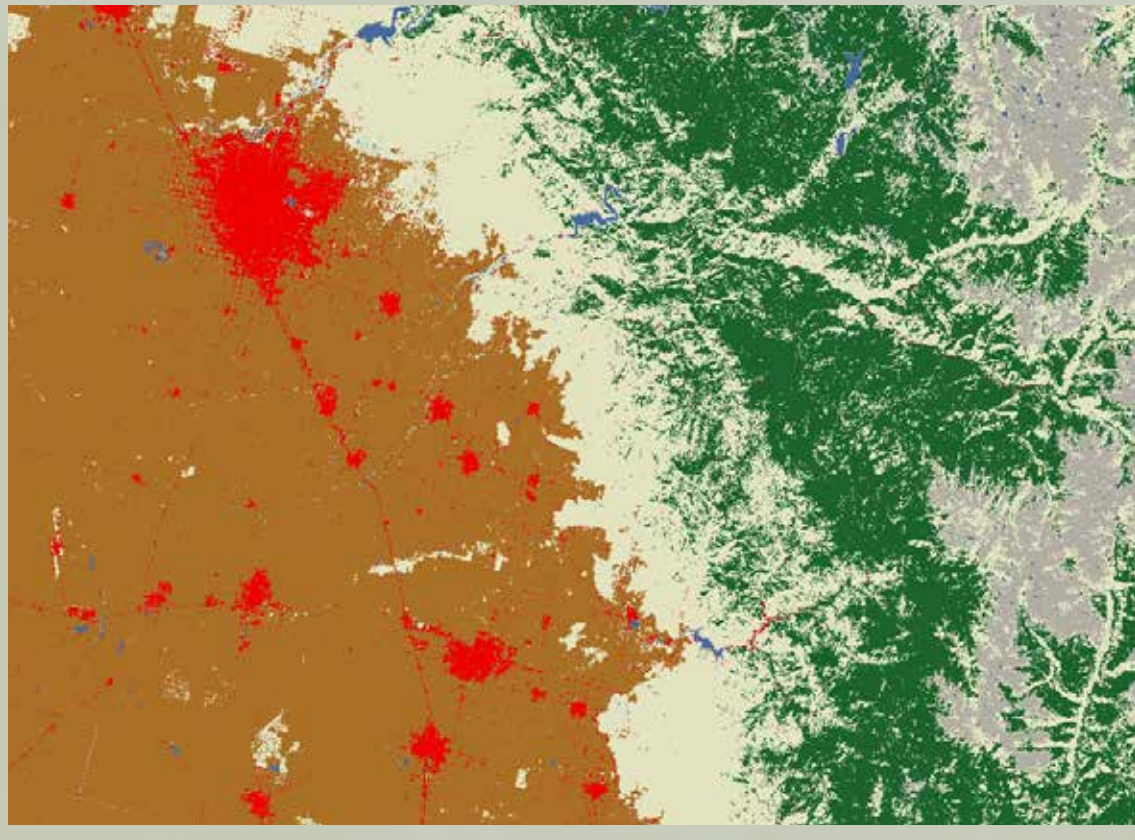


NEW CAPABILITIES IN CONTINUOUS MONITORING OF U.S. LAND COVER AND LAND COVER CHANGE

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Sample LCMAP data products are now available to the public for USA Landsat ARD tile h003v010 in southern California, with annual data for the years 1985 to 2017 through this website (<https://www.usgs.gov/land-resources/eros/lcmap/lcmap-sample-products>).

Applied SCIENCE

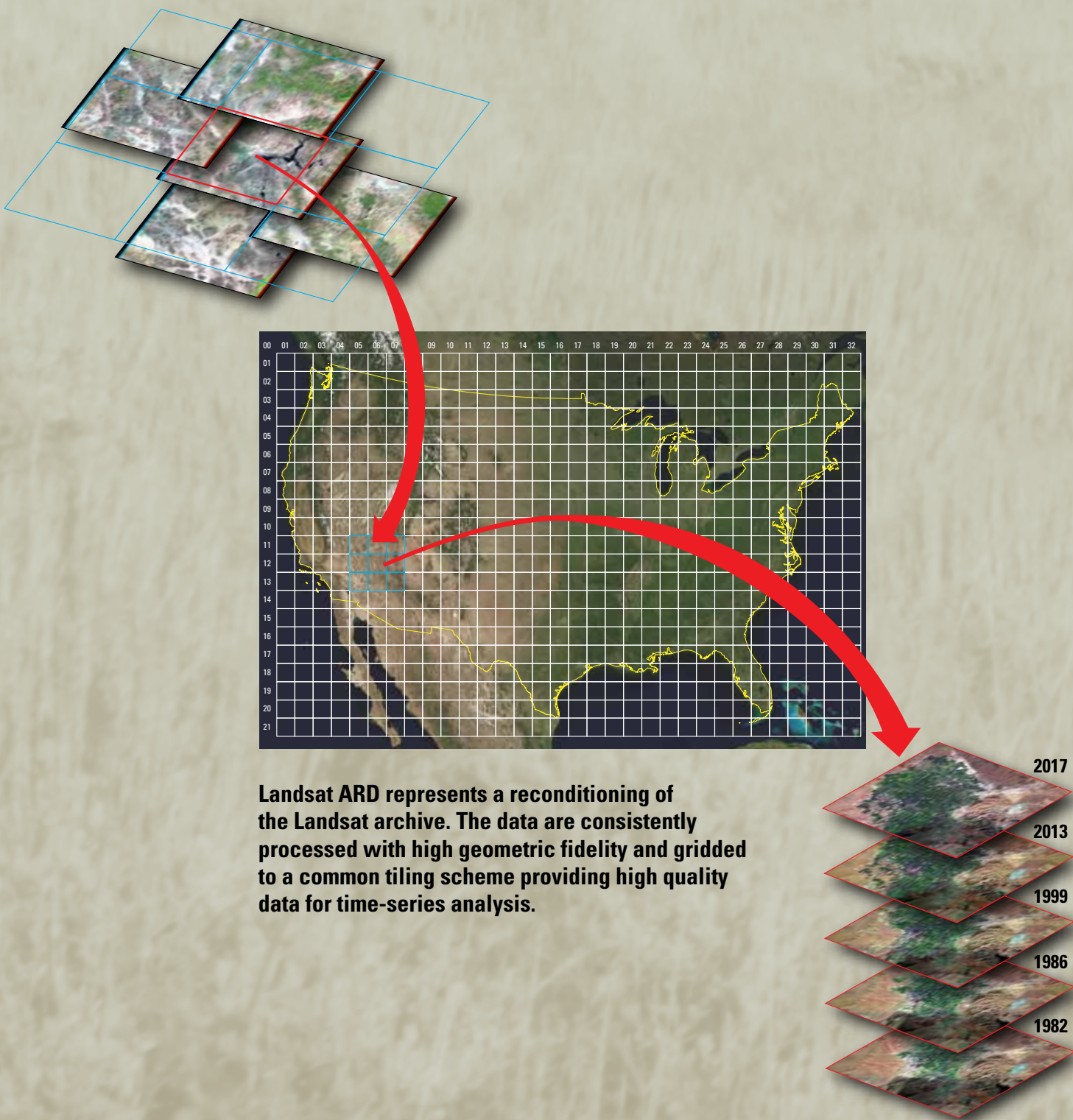
The new monitoring capability of the Land Change Monitoring Assessment and Projection (LCMAP) initiative supports evolving science applications. We are developing innovative applications with time-series land cover data and products that are relevant to partner and stakeholder needs and provide opportunities to collect user feedback to be incorporated into future research. LCMAP supports the science community by developing tools and web-based applications to improve data access for research and to support user requirements including tools, data visualization, data exploration, and processing. We employ various mechanisms for community engagement, such as workshops and seminars.



Example applications for the LCMAP annual product suite

Landsat ANALYSIS READY DATA

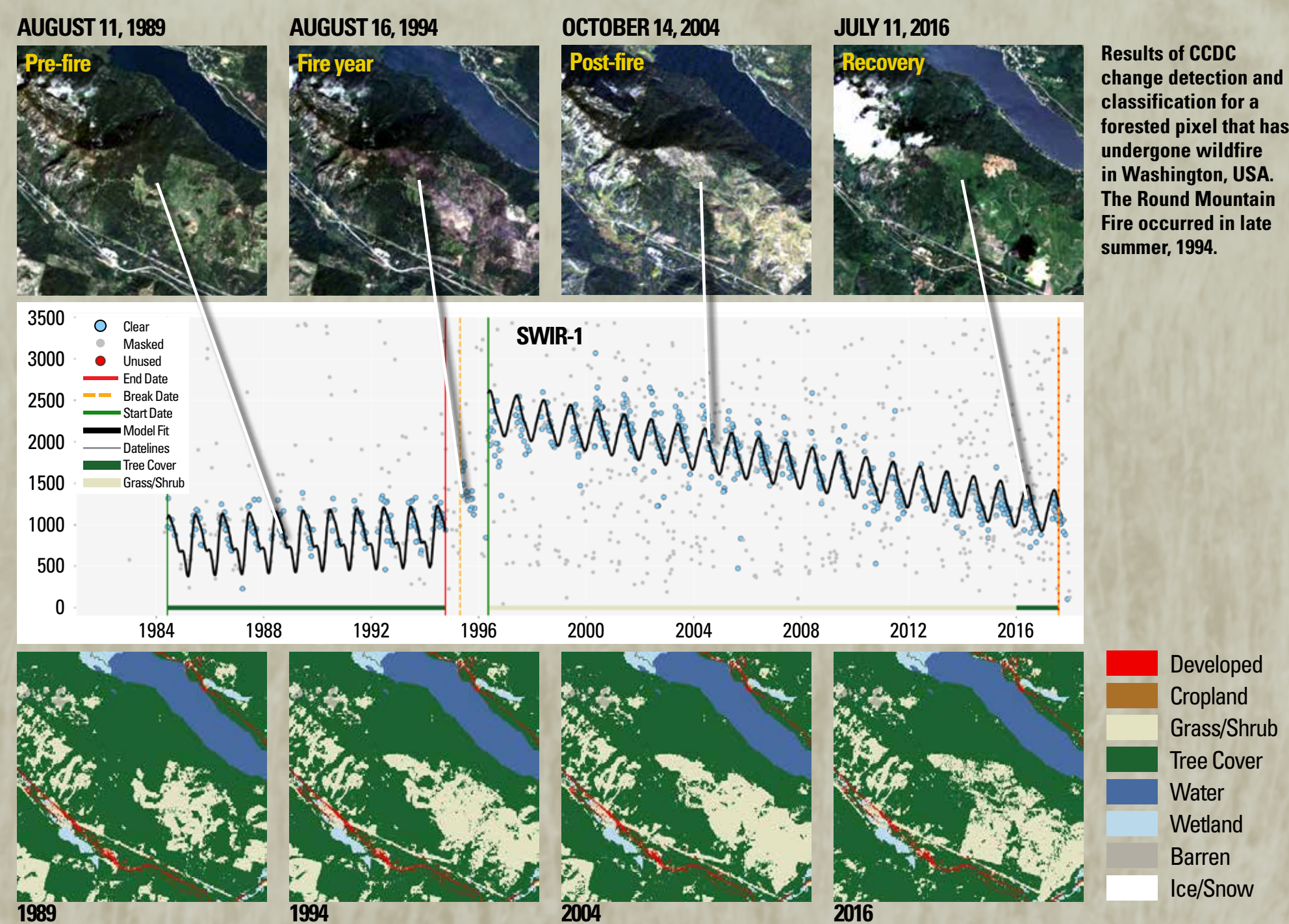
The Landsat Analysis Ready Data (ARD) are foundational to LCMAP. For LCMAP, the standard Landsat Level 1 Terrain Corrected products from Landsat 4-5 Thematic Mapper (TM), Landsat 7 Enhanced Thematic Mapper Plus (ETM+), and Landsat 8 Operational Line Imager (OLI) serve as the input for ARD. The ARD data suite for the USA consists of Top of Atmosphere Reflectance, Surface Reflectance, Brightness Temperature, and Pixel Quality data that are consistently processed, gridded to the Albers Equal Area Conic projection, and processed to a common tiling scheme. This processing produces a time series based on the Landsat archive with great geometric uniformity, ideal for continuous monitoring.



Continuous MONITORING

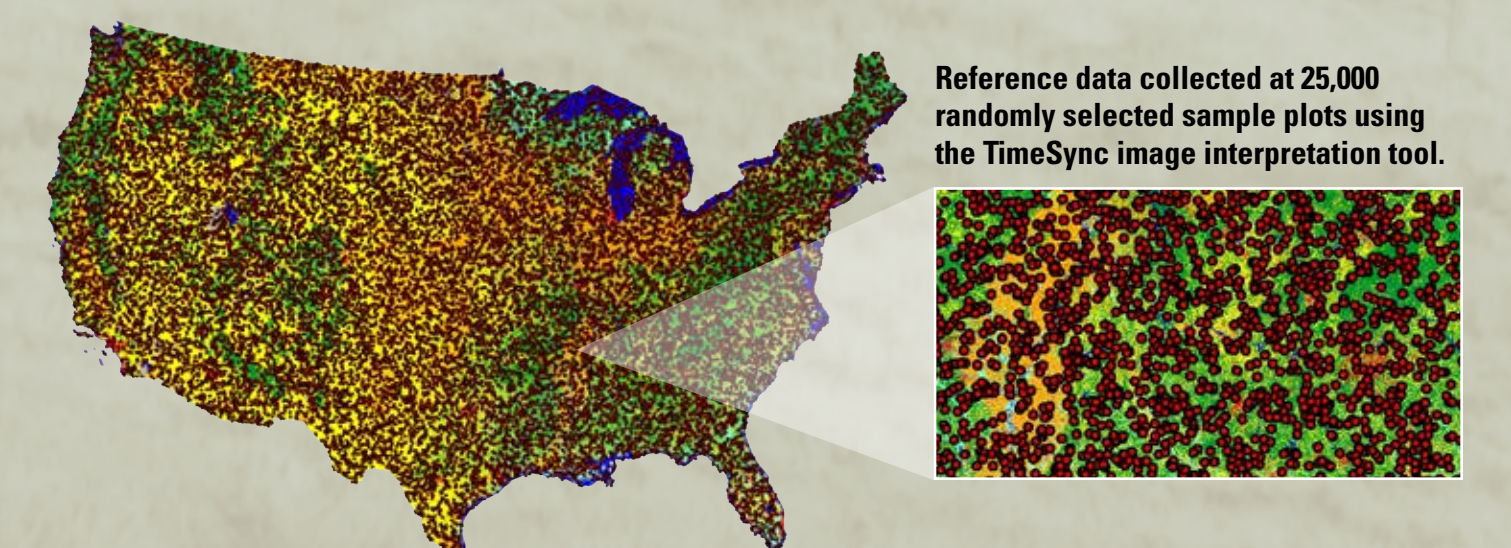
LCMAP monitoring methods involve using every clear Landsat observation to determine if current land conditions diverge from those observed in the past. An automated time-series modeling approach is used to identify different forms of change and to characterize the large variety of land cover types, uses, and conditions. By using the full historical depth of the Landsat archive from the Landsat ARD, LCMAP monitoring reveals trajectories of land change from the mid 1980s to the present day at 30m spatial resolution.

Our approach involves Continuous Change Detection and Classification (CCDC) which has two major elements, change detection and classification. The change detection element utilizes all available surface reflectance ARD measurements to fit a time-series model for the spectral response of every pixel and to estimate dates at which the spectral time-series data diverge from past responses or patterns. "Divergence" (or model "break") is generally the result of an abrupt change (e.g. wildfire, logging, and land use conversions), but can also result from a gradual shift (e.g., forest regrowth, insect infestation, disease, drought) in the spectral signal. Results of CCDC change detection for a forested pixel that has undergone wildfire are illustrated below.



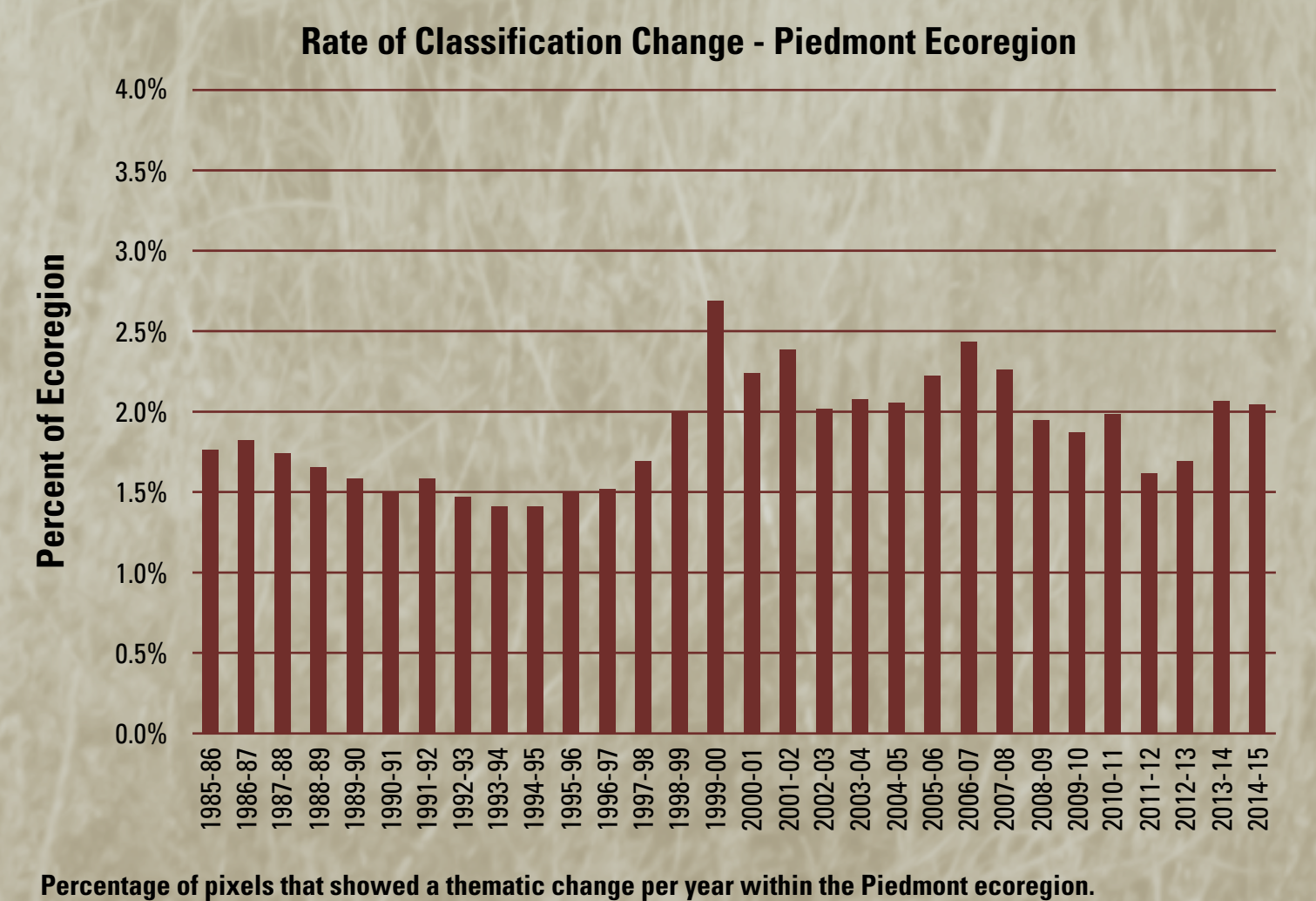
Accuracy & REFERENCE DATA

Validation provides a measure of map accuracy for use in evaluating the appropriateness of a map for a particular application. We have collected reference data for the LCMAP land-cover annual products at 25,000 randomly selected sample plots using the TimeSync image interpretation tool.



Land Cover ASSESSMENTS

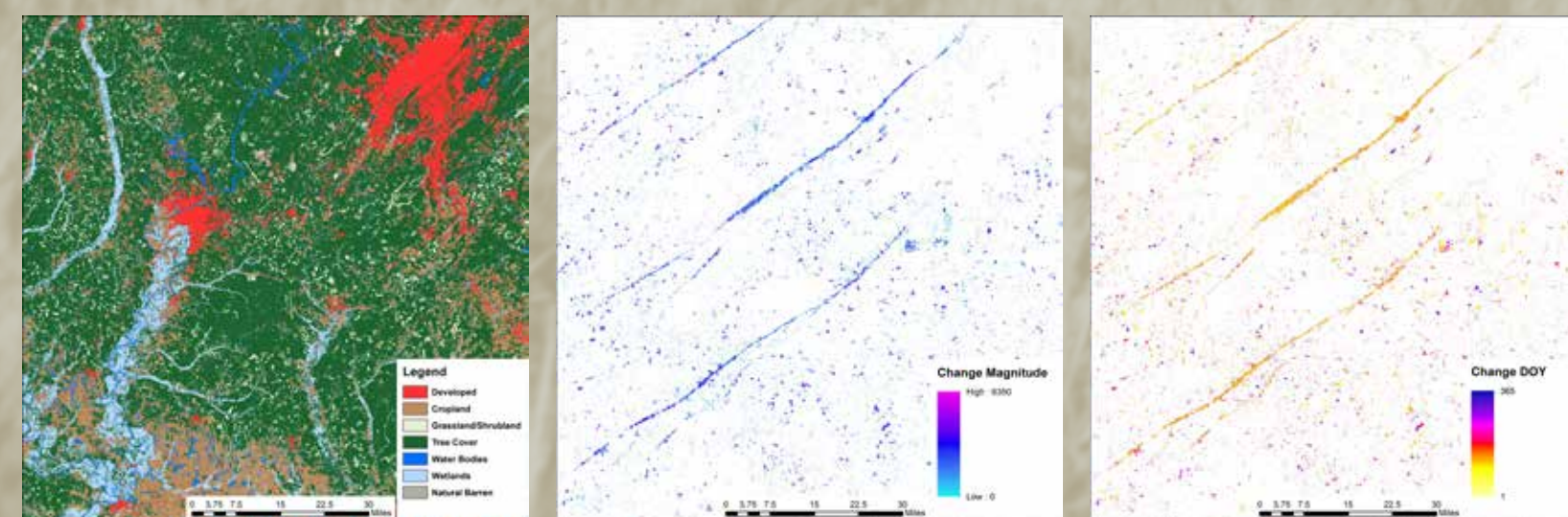
Mapping at an annual frequency offers an opportunity to better understand USA land cover and land use change processes. Assessments will help us grasp the complexity of land dynamics and address basic change questions. The baseline LCMAP regional-to-national scale assessment will first address the building block questions of what has changed, where has it changed, how much of it has changed, what are the rates of change, and what caused the change.



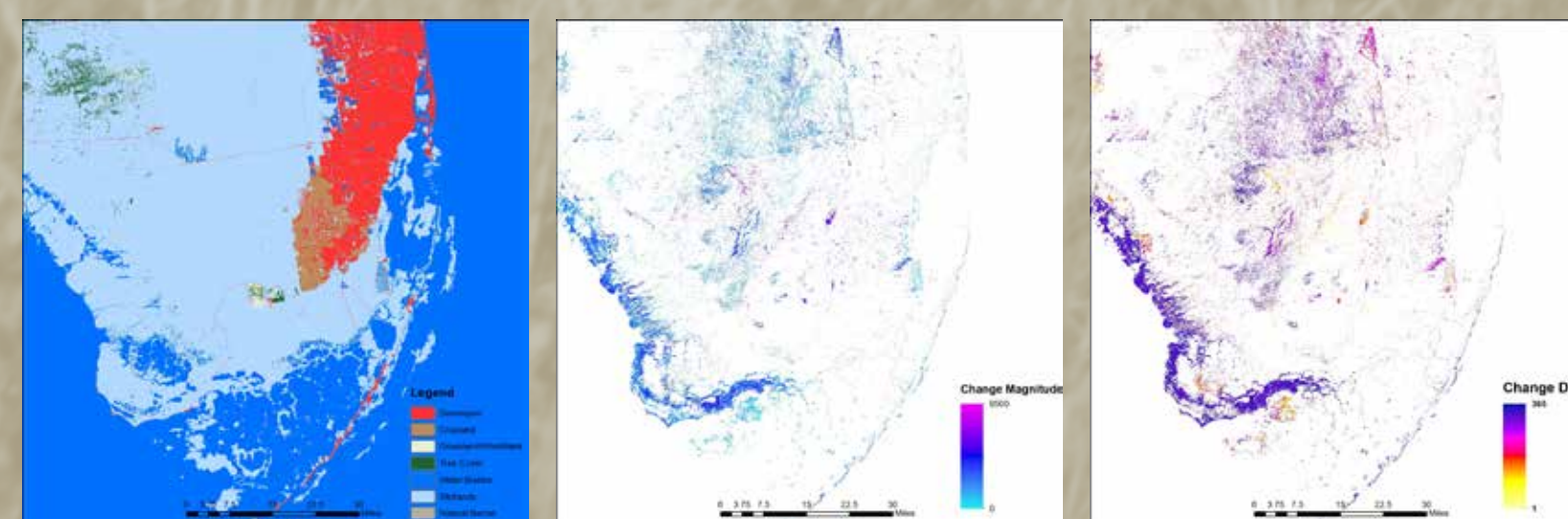
Land Change STORIES

The power of the LCMAP approach to detecting and monitoring change on the land surface is in the temporal domain. The USGS Landsat series of satellites, the world's longest continuously-collected record of moderate resolution land surface imagery, have long offered the capability of looking backward in time for the entire earth. Studies of change in the past have used approaches that generally target snapshots at discrete times versus a more continuous approach. Instead of comparing data for one date to another, the CCDC algorithm synthesizes across time and performs change detection automatically.

TORNADOES

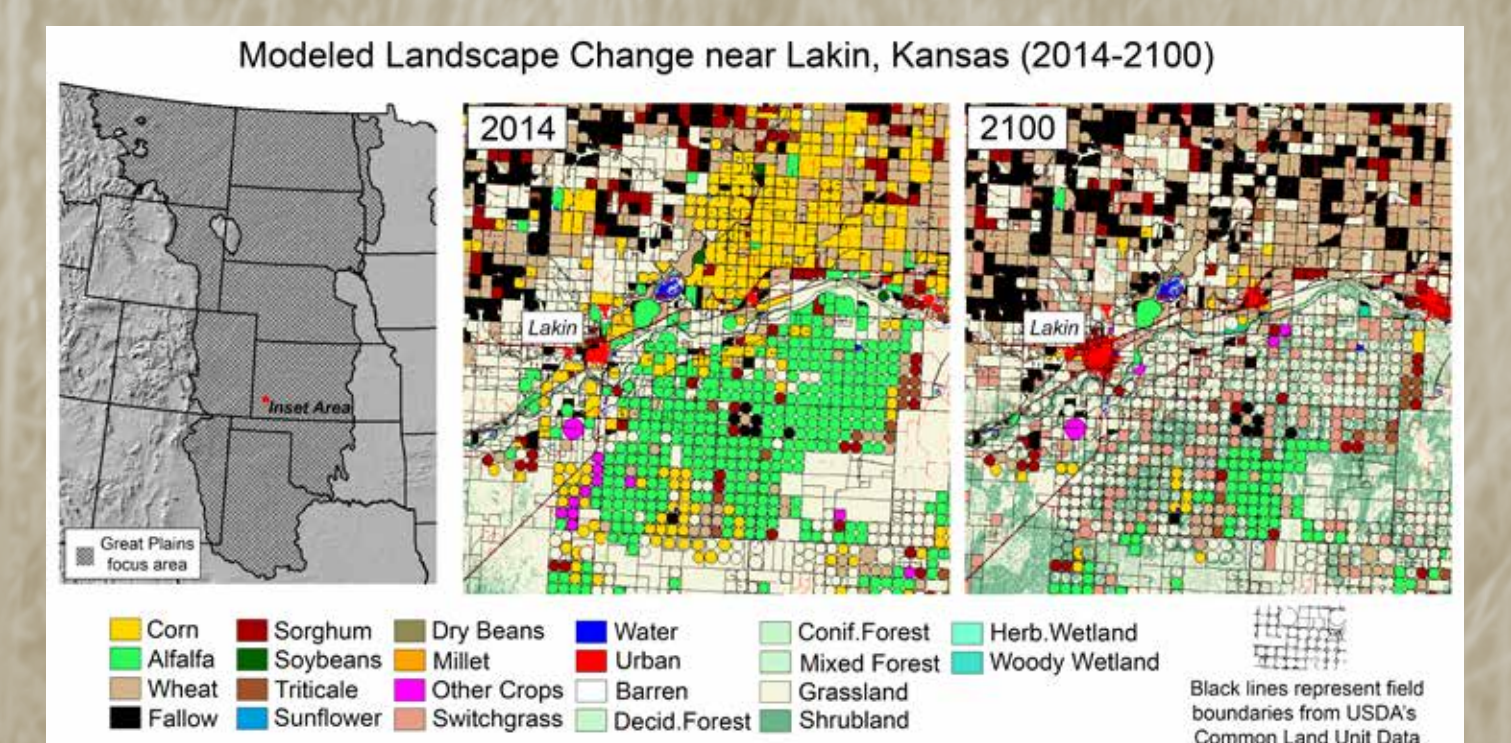


HURRICANES



Future PROJECTIONS

Land use and land cover (LULC) modeling components include: 1) to "project" or temporally extend land cover into future and historical time periods (when remote sensing data are not available), and 2) to facilitate the application of modeled landscape data. A LULC model called Forecasting Scenarios (FORE-SCE) produces landscape projections that match the spatial, temporal, and thematic characteristics of LCMAP land cover. FORE-SCE employs actual land management parcels for spatial modeling to ensure a realistic representation of landscape pattern.



LULC projections created from LCMAP can be used seamlessly, enabling analyses of past, current, and future landscape impacts on biodiversity, hydrology, climate and weather, and other relevant processes.

LCMAP PRODUCTS

The classification element of CCDC produces a land cover classification that is applied to every pixel. Unlike traditional land cover approaches, CCDC classifications are based on data from the time-series models (e.g. model coefficients). In LCMAP, we generate land cover products on an annual basis for the study period, instead of for just a few selected time periods.

The monitoring product suite includes ten annual land cover and spectral change maps that provide land change science information for understanding dynamics in the cover type, condition, location, timing and intensity of change. Version 1 for the conterminous USA is planned to be released in 2019.

