



United States Department of Agriculture
Forest Service

Landscape Change Monitoring System (LCMS)

CONAFOR Seminario

Resumen de los Métodos LandTrendr y CCDC

Josh Heyer

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Redcastle Resources, contractor to

USDA Forest Service

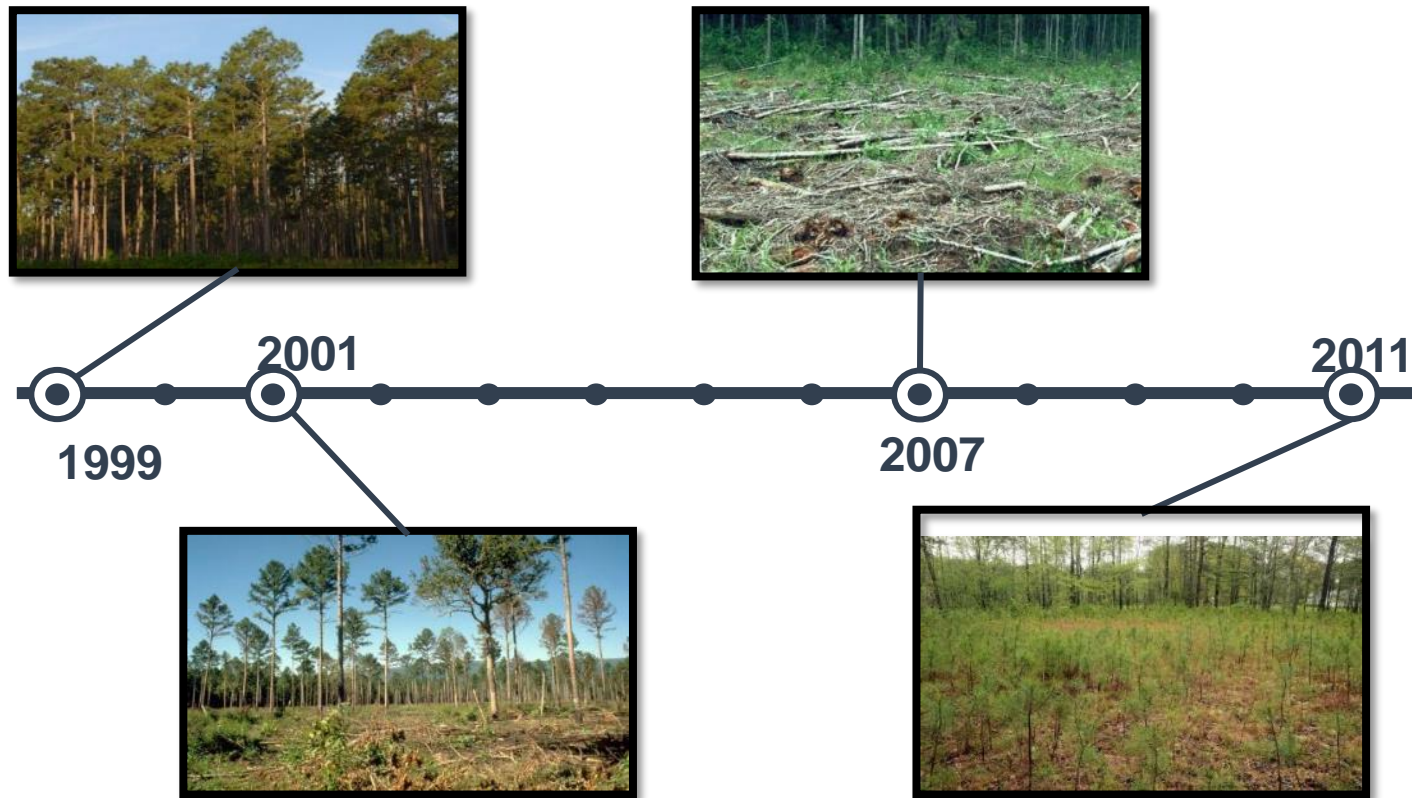
Geospatial Technology & Applications Center

Resource Mapping, Inventory & Monitoring Program



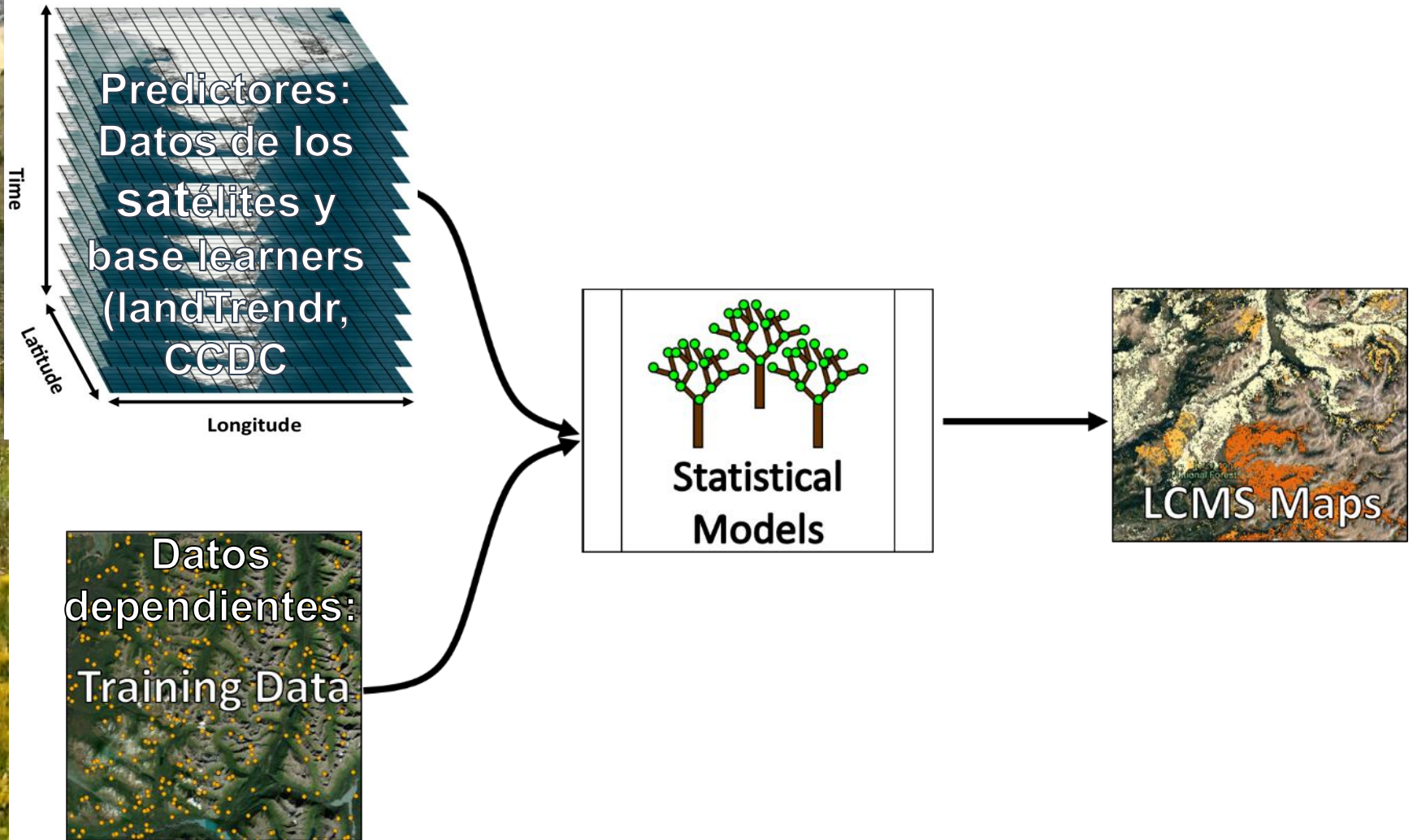
Mapping Our Future Together

LCMS: Una Sistema de detección de las variaciones de la tierra

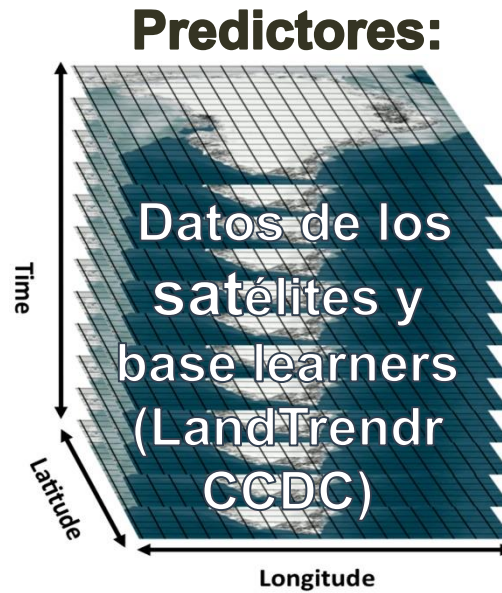


Landscape Change Monitoring System

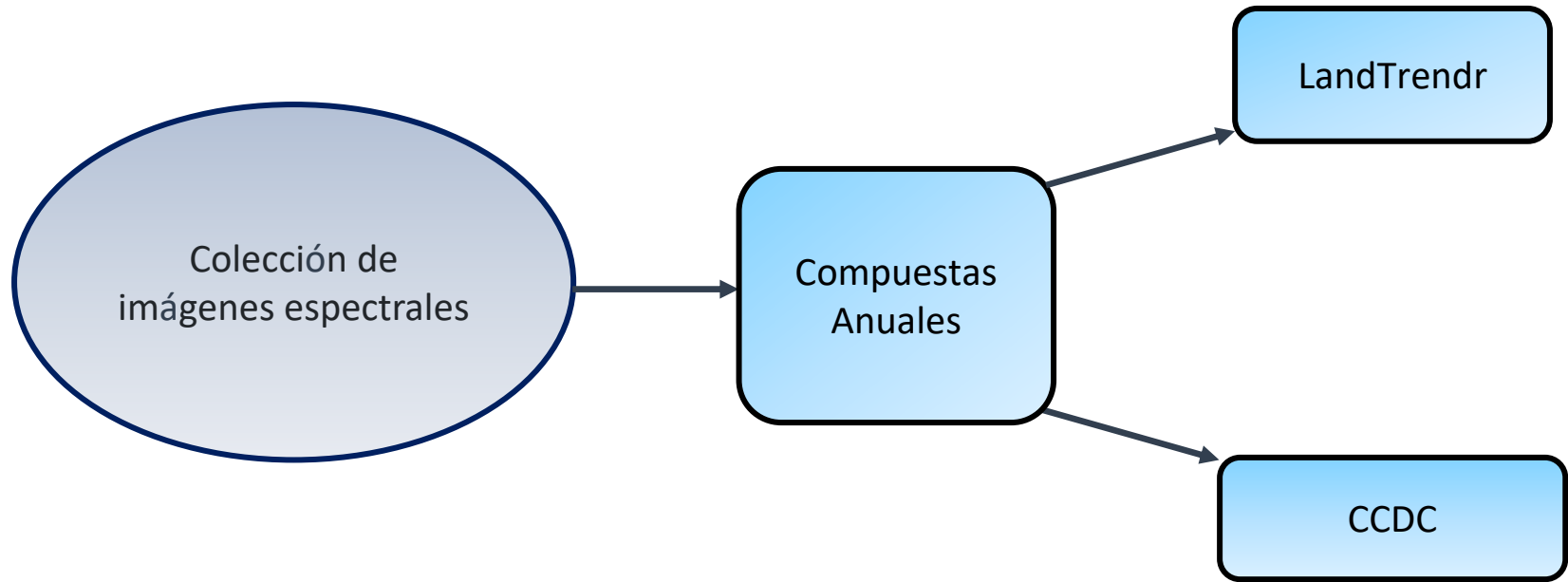
LCMS Proceso



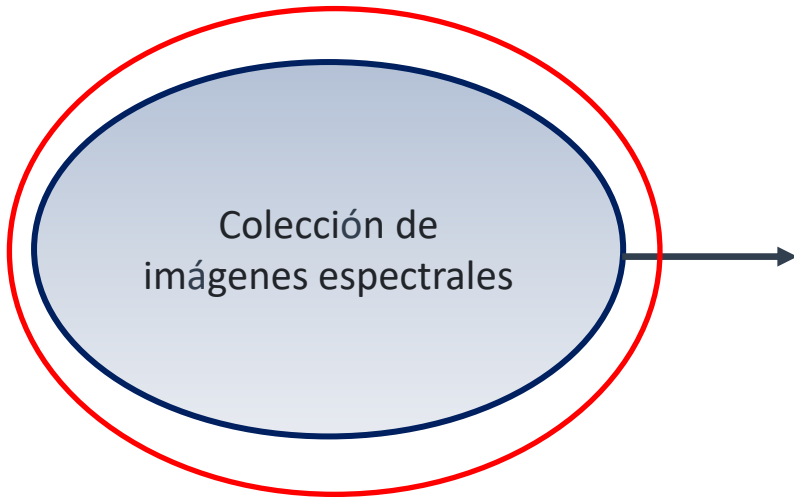
Los Predictores



Los Predictores

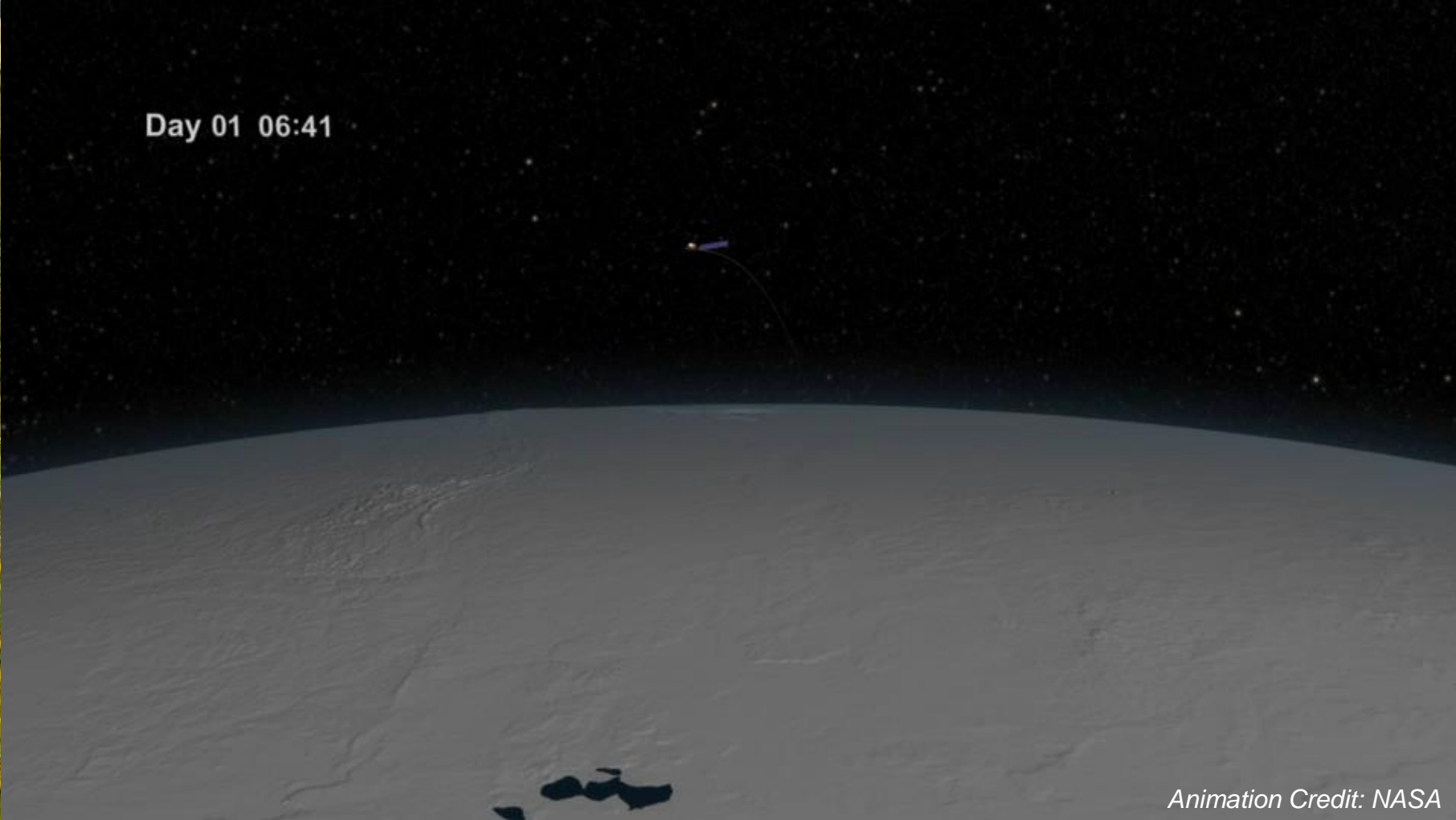


Los Predictores



Satélites que observan la tierra

Day 01 06:41



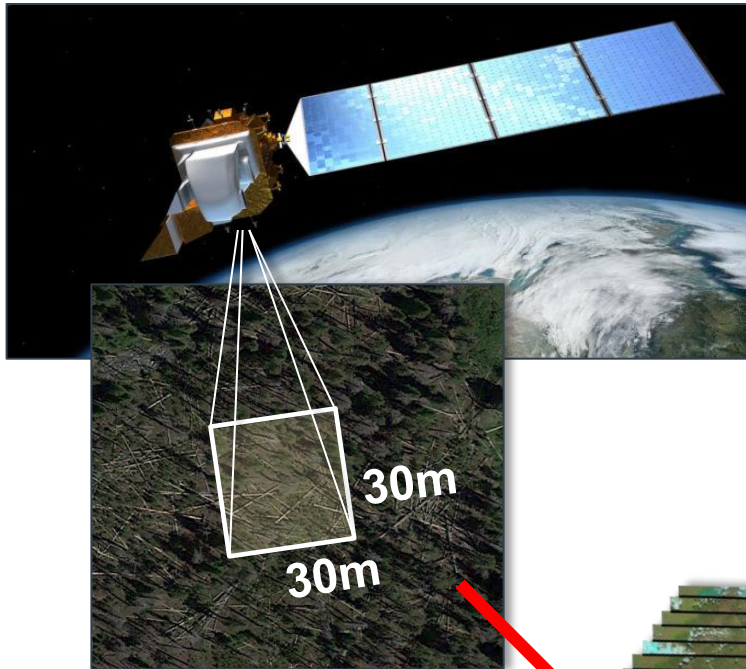
Animation Credit: NASA

Much of the information inaccessible until recently

Registro de Satélites

Landsat

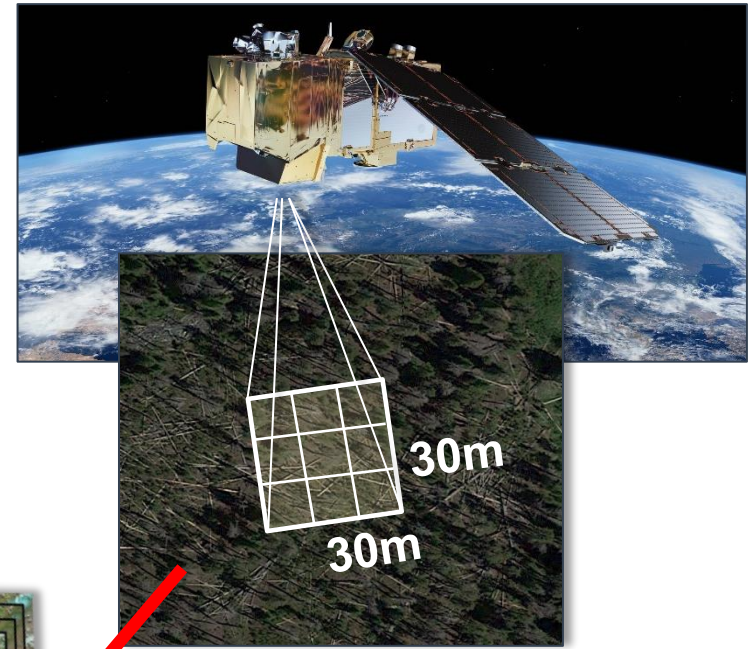
REGISTRO: 1984-Present
FRECUENCIA: ~ 8 Days
RESOLUCIÓN : 30m x 30m



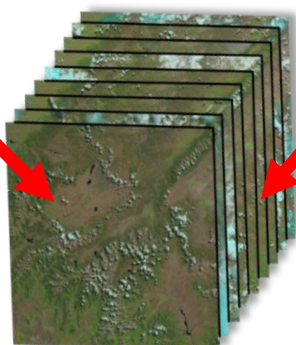
Landsat 4 TM
Landsat 5 TM
Landsat 7 ETM+
Landsat 8 OLI

Sentinel 2

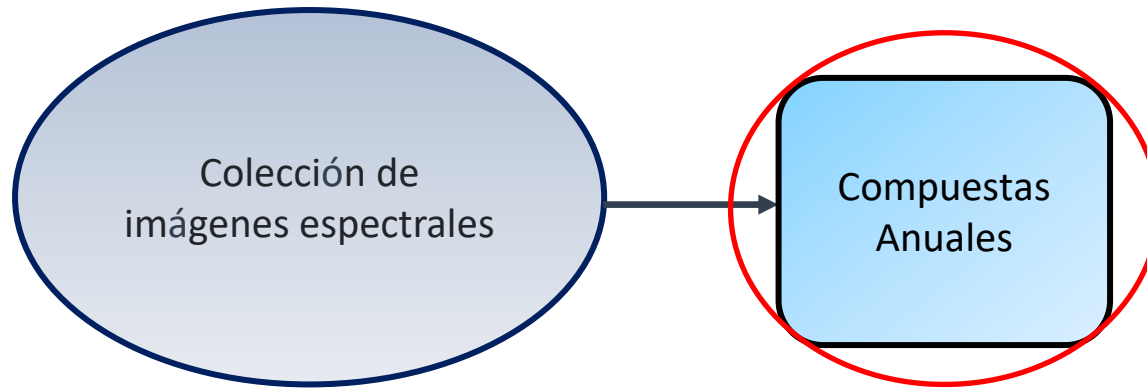
REGISTRO: 2016-Present
FRECUENCIA: ~ 5 Days
RESOLUCIÓN: 10m x 10m



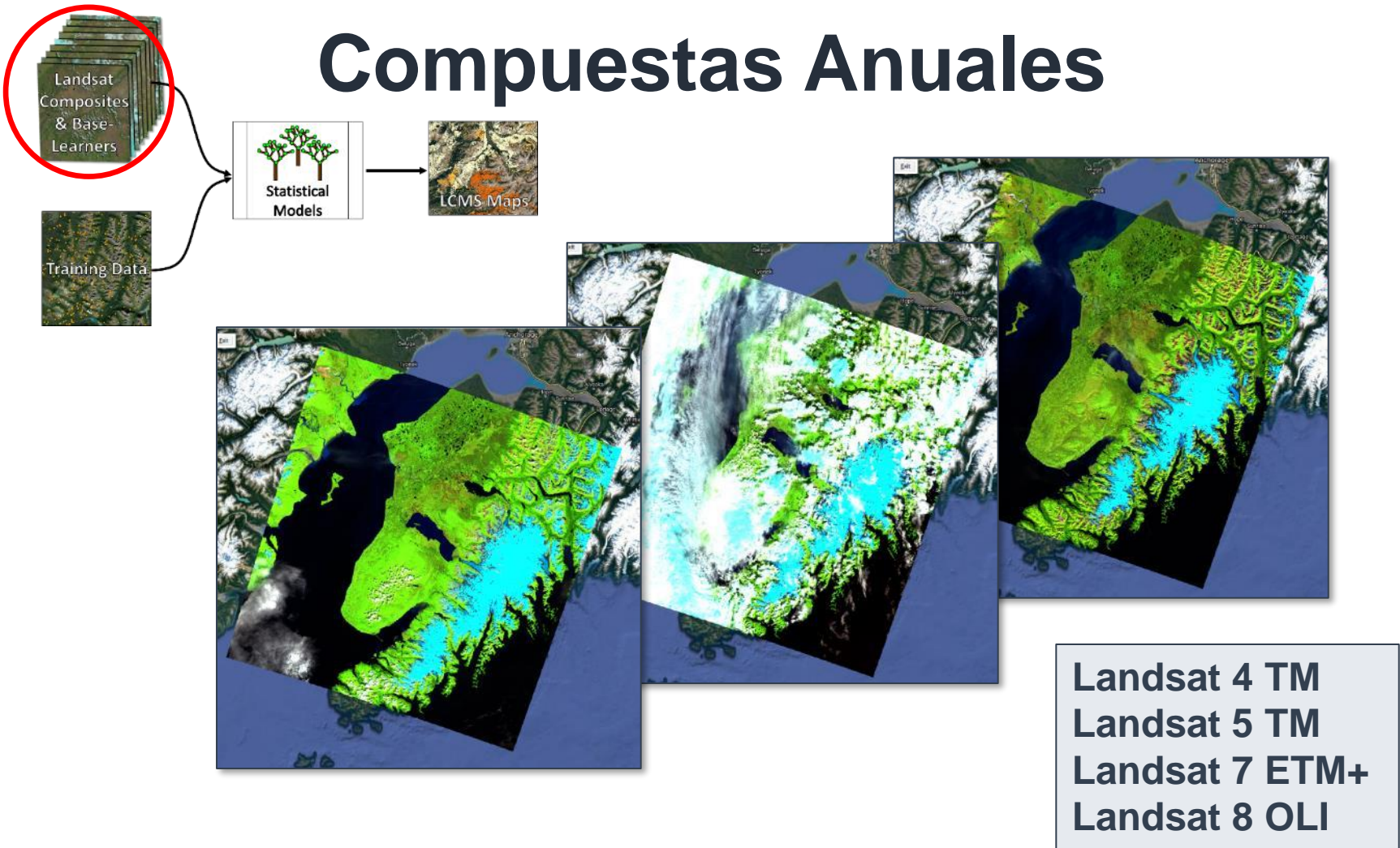
Sentinel 2 is resampled to 30m x 30m and included in the Landsat data record



Los Predictores



Compuestas Anuales



- Juntar todas las escenas del medio del verano
- Esconde (mask) las nubes y sombras de las nubes
- Usa el medoid para hacer compuestas anuales

El Seria Cronológica Método

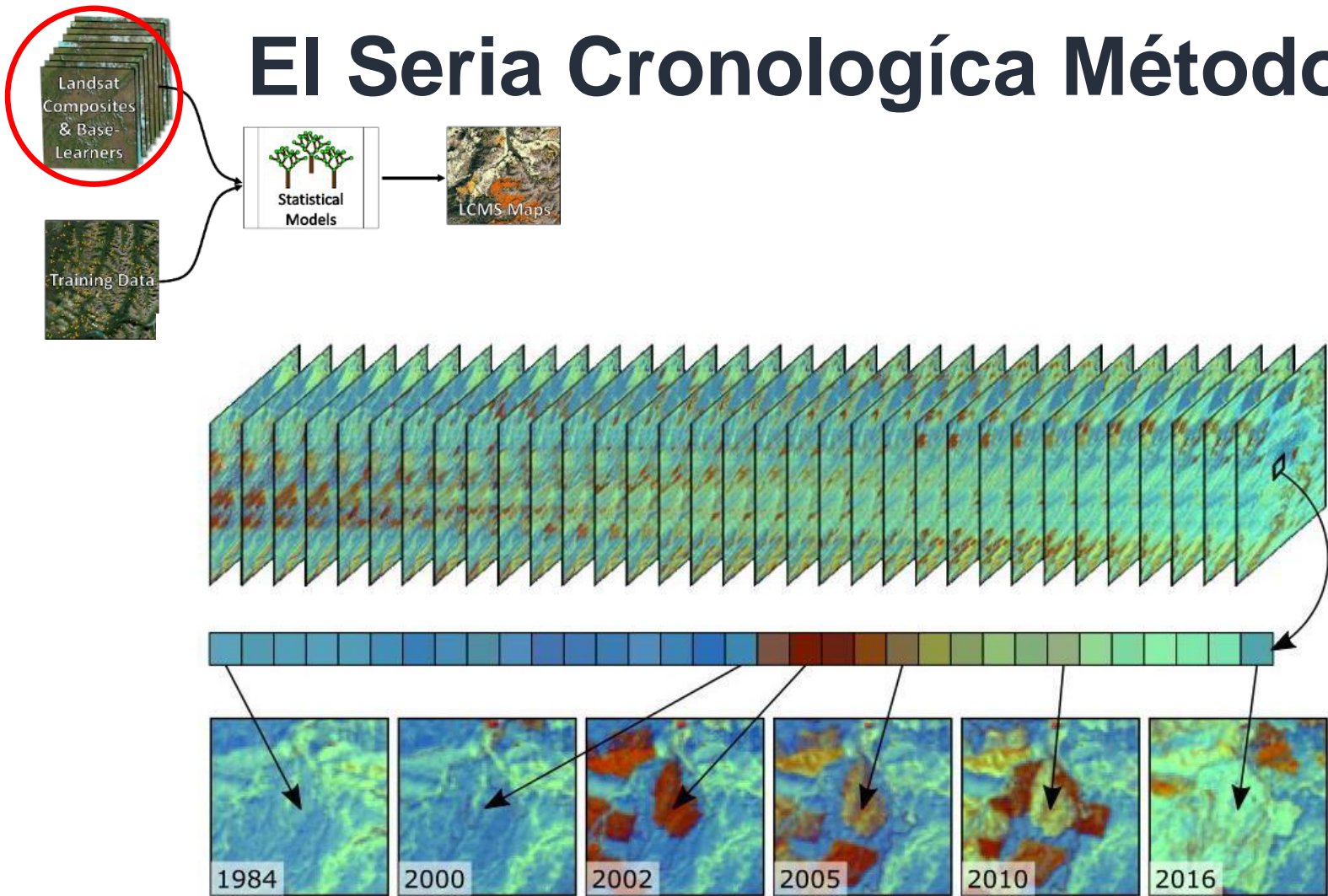
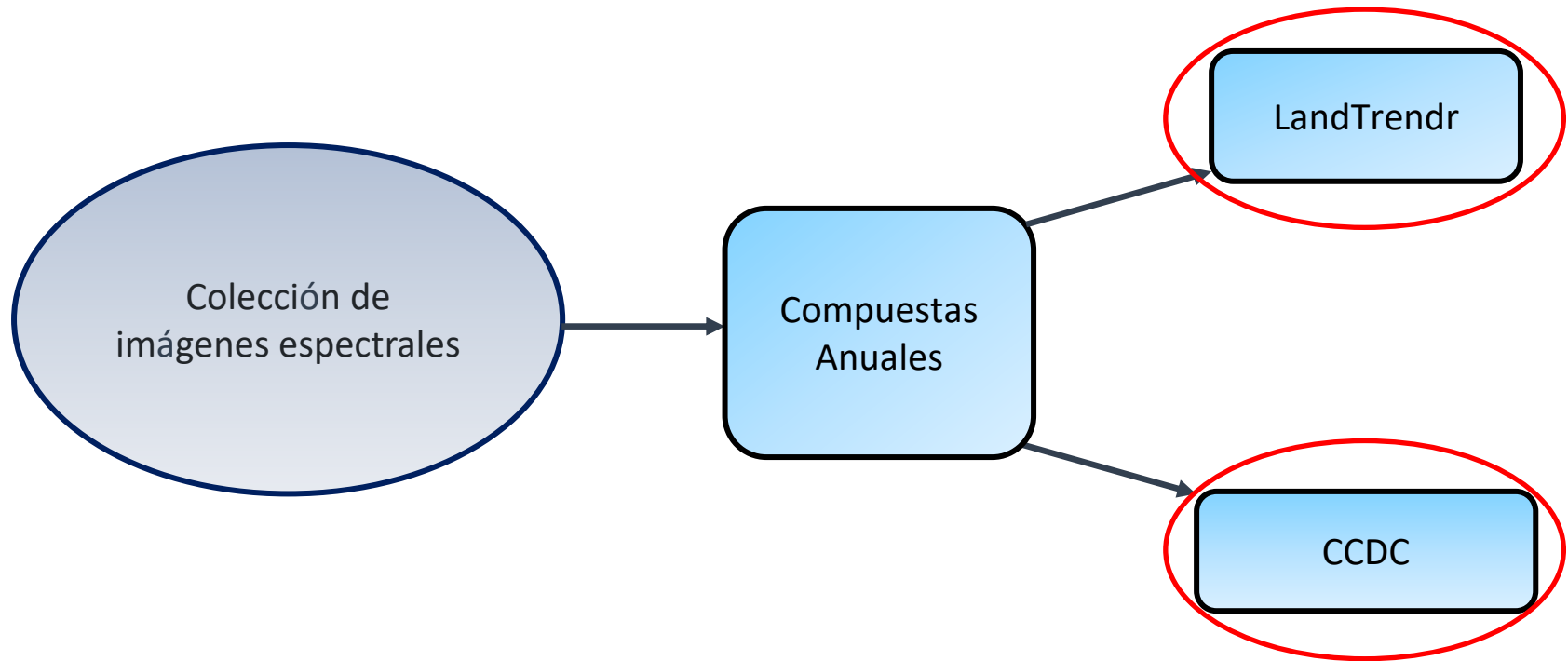


Figure from Braaten & Kennedy's eMapR Lab LT-GEE Guide (<https://emapr.github.io/LT-GEE/landtrendr.html>)

Los Predictores



Los algoritmos hacen una serie cronológica de segmentos temporales

LandTrendr

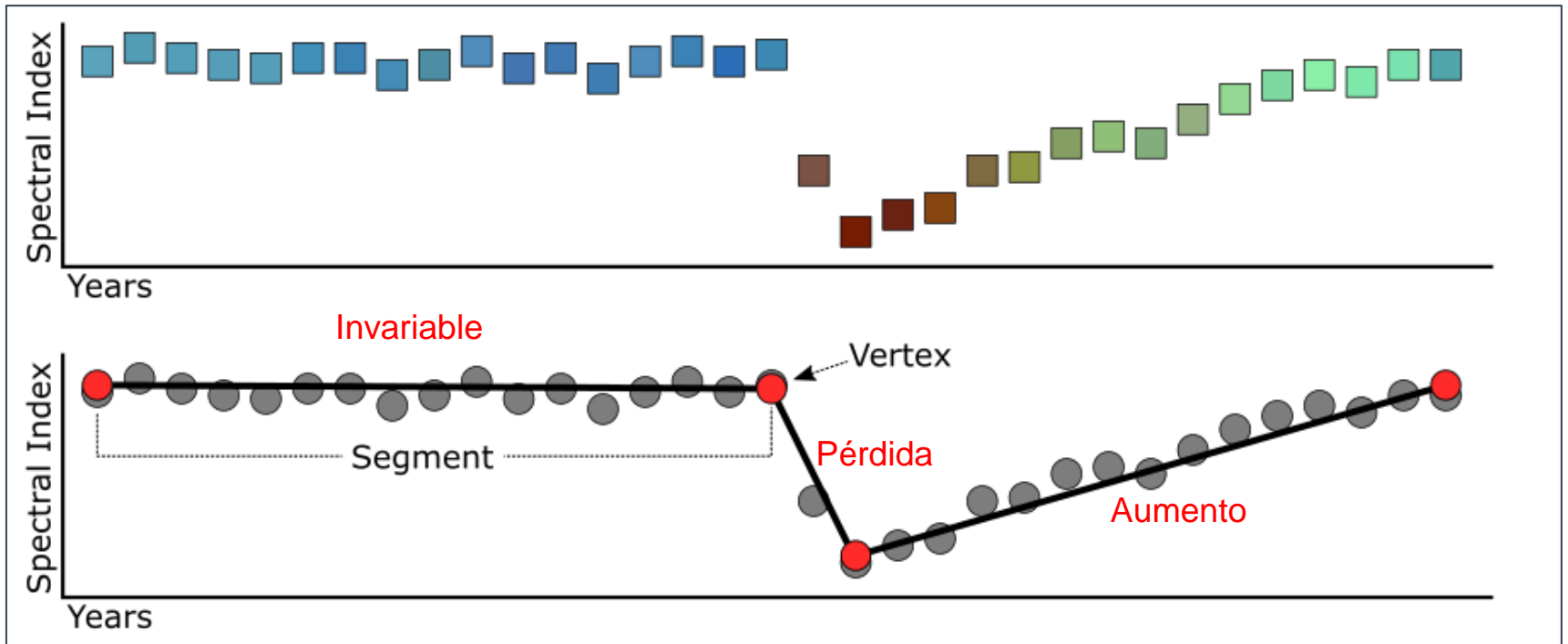
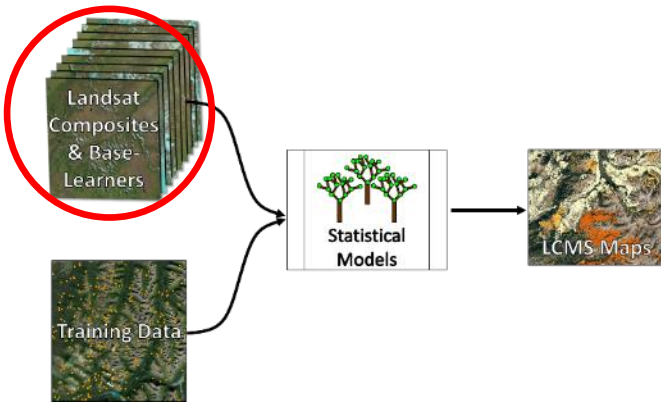


Figure from Braaten & Kennedy's eMapR Lab LT-GEE Guide (<https://emapr.github.io/LT-GEE/landtrendr.html>)

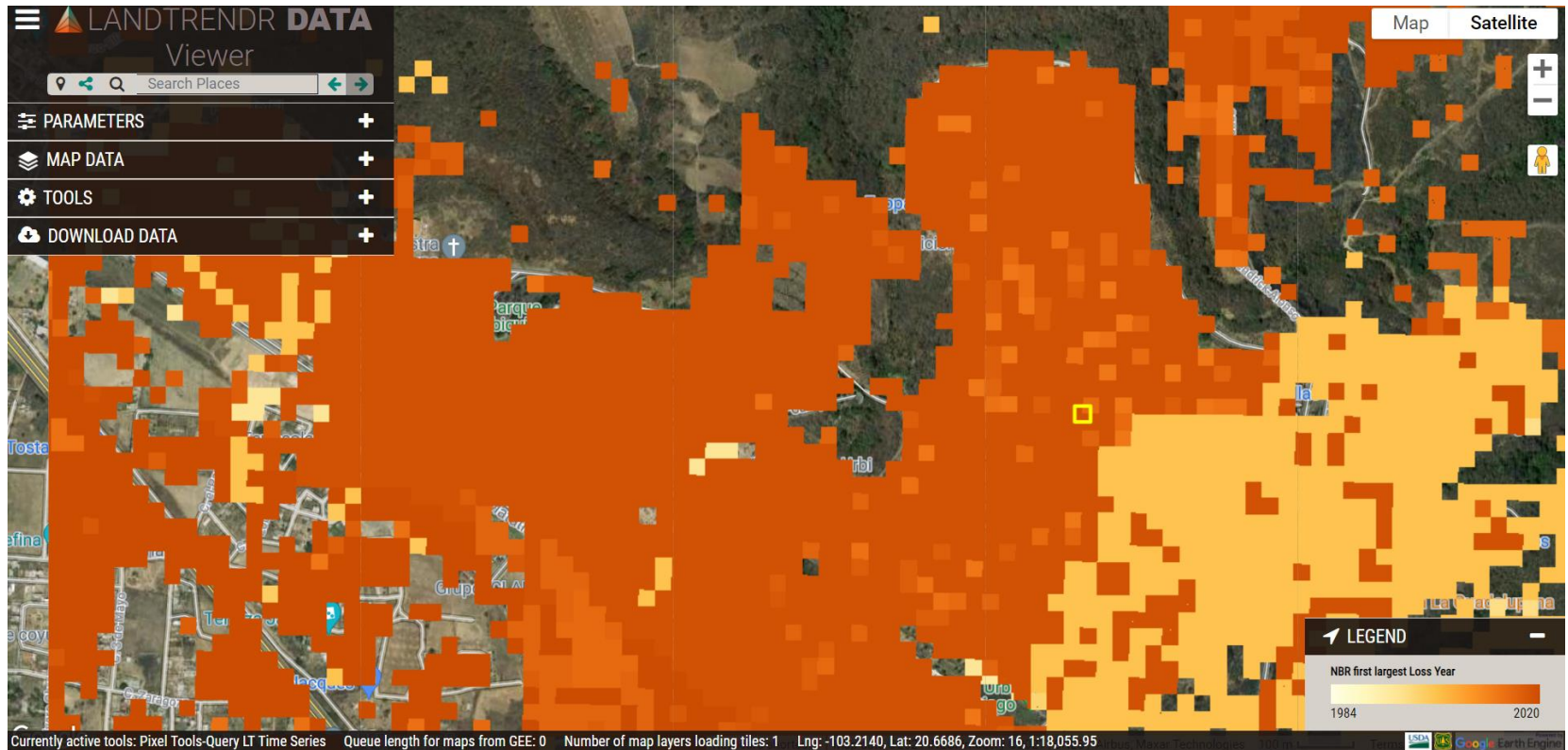
LandTrendr ejemplo - Urbanización



LandTrendr ejemplo - Urbanización

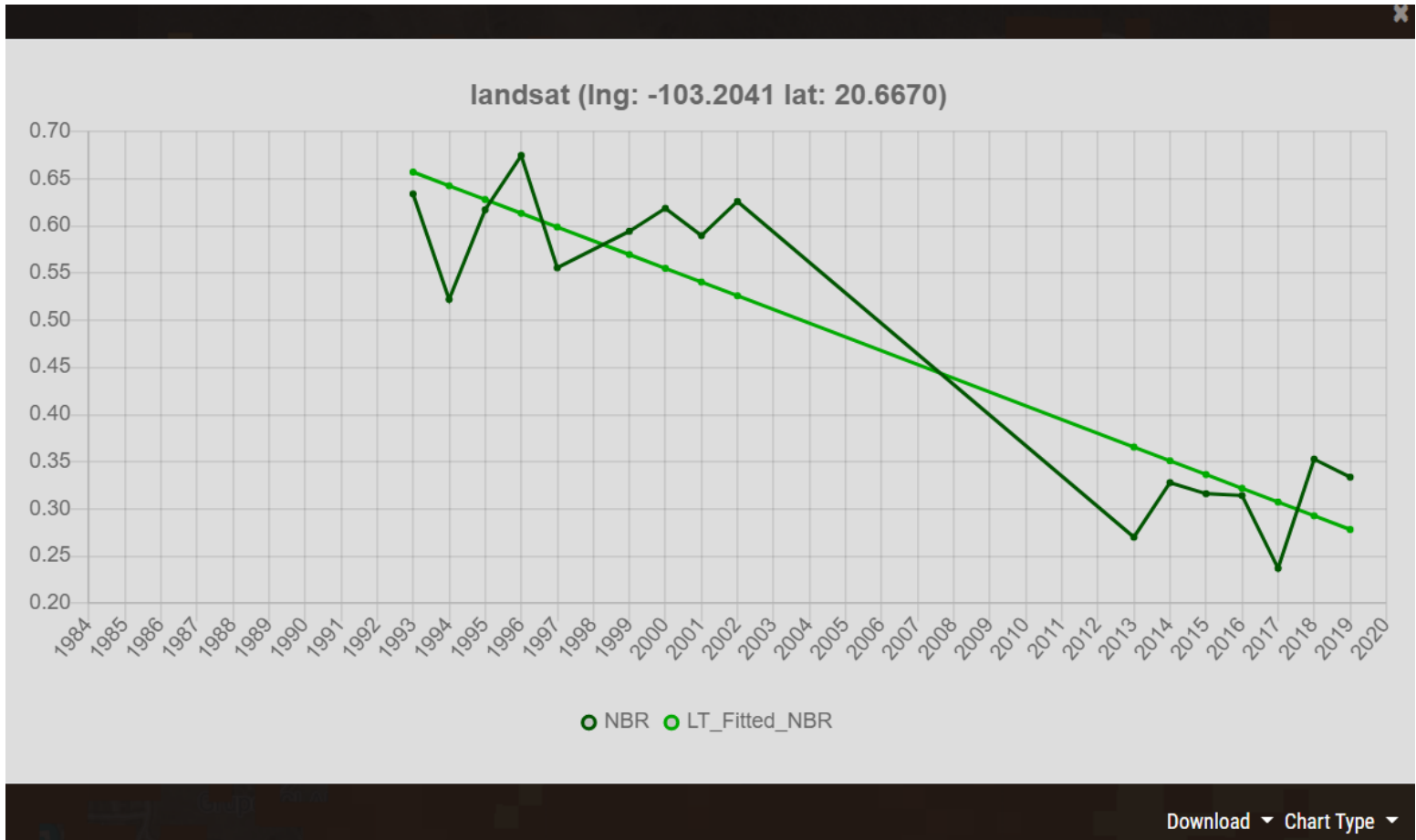


LandTrendr detecta pérdida



<https://apps.fs.usda.gov/lcms-viewer/landtrendr.html?id=yj48wma>

LandTrendr ejemplo - Urbanización



LandTrendr ejemplo - Conversión a Agricultura



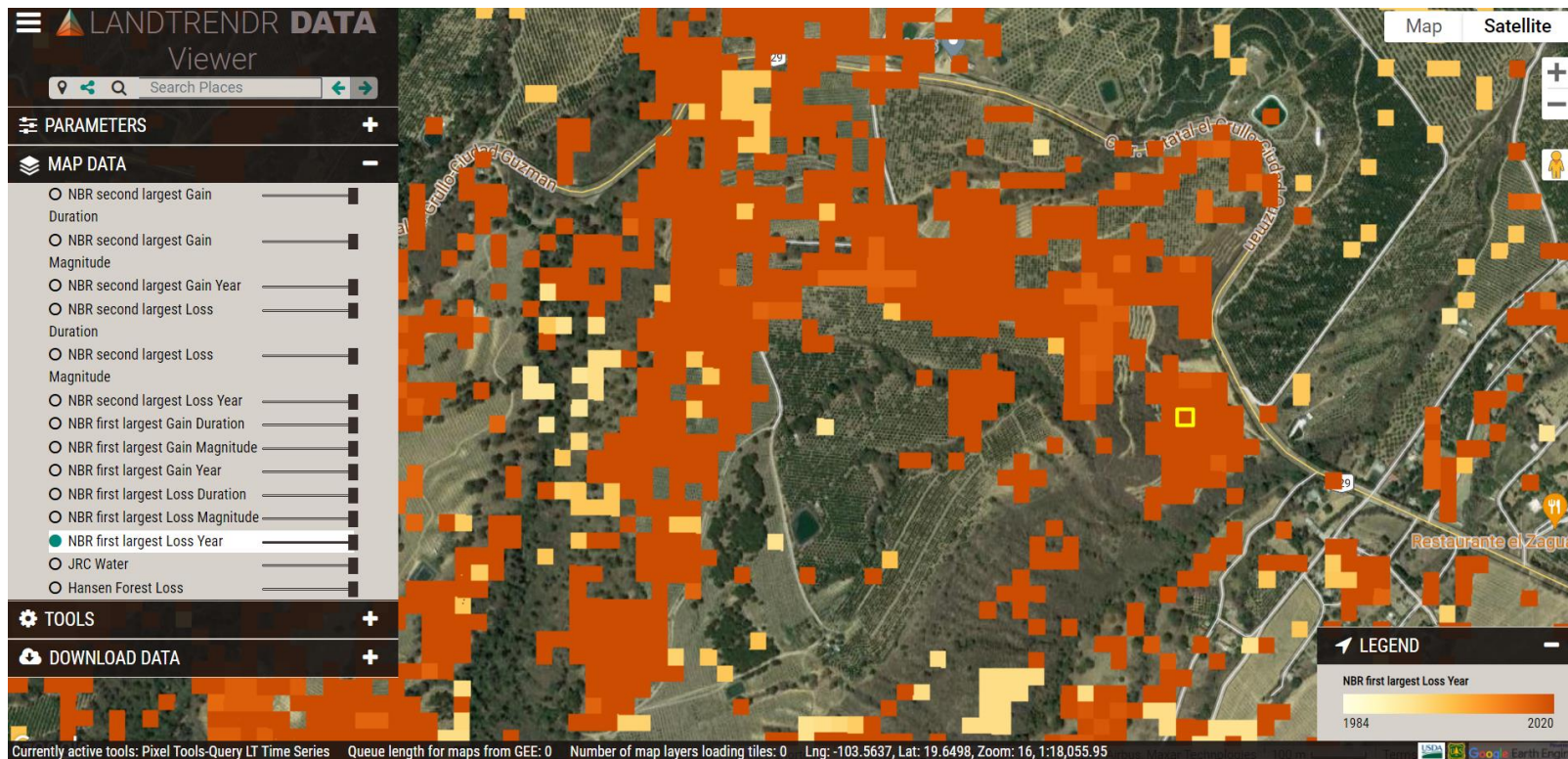
LandTrendr ejemplo - Conversión a Agricultura



LandTrendr ejemplo - Conversión a Agricultura

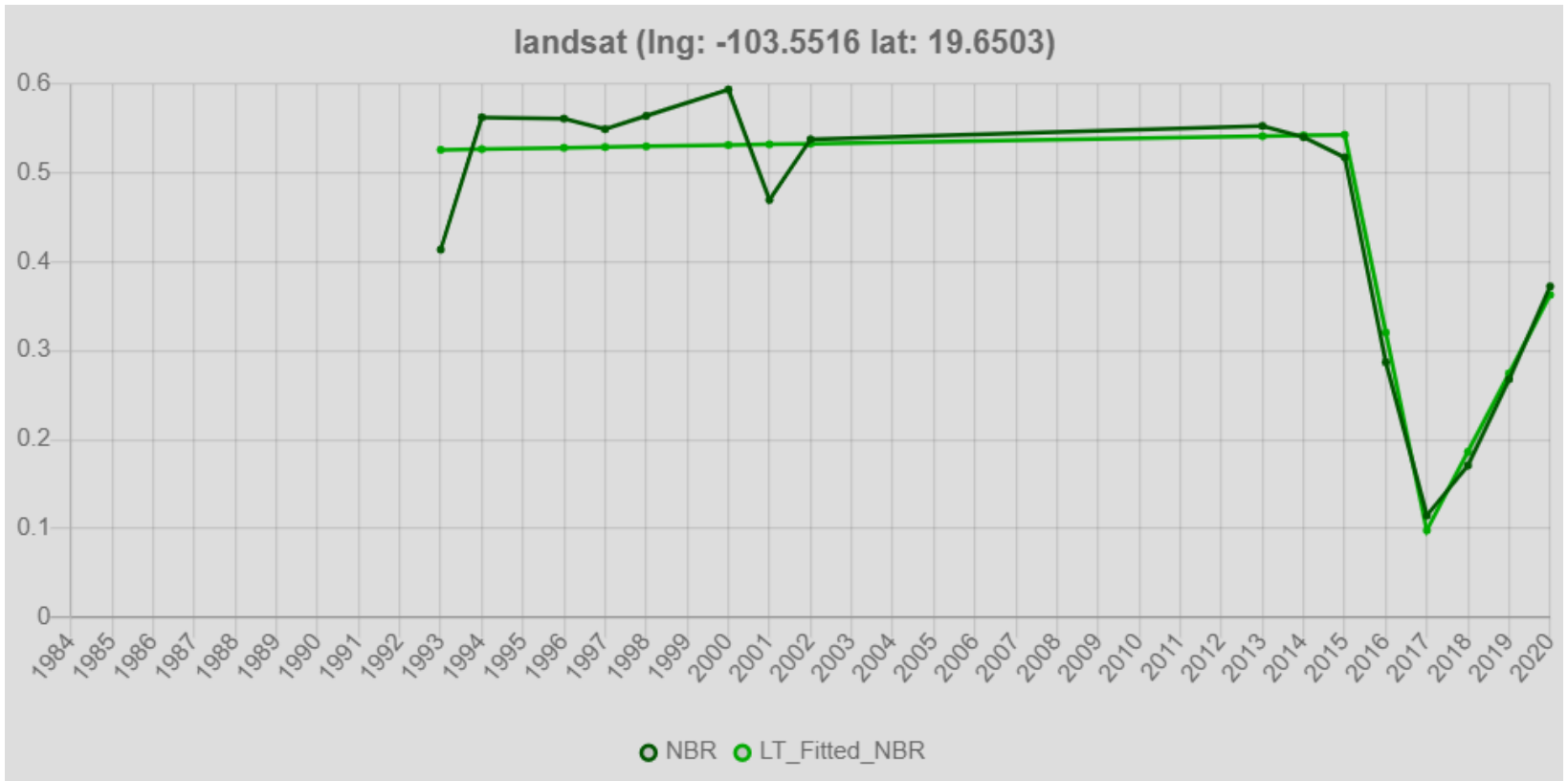


LandTrendr detecta pérdida

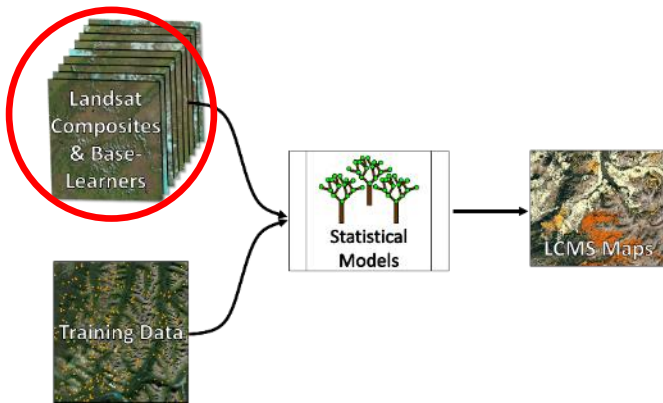


<https://apps.fs.usda.gov/lcms-viewer/landtrendr.html?id=yjzqt499>

LandTrendr ejemplo - Conversión a Agricultura



LandTrendr



Kennedy, R. E., Yang, Z., & Cohen, W. B. (2010). Detecting trends in forest disturbance and recovery using yearly Landsat time series: 1. LandTrendr—Temporal segmentation algorithms. *Remote Sensing of Environment*, 114(12), 2897-2910.

Kennedy, R. E., Yang, Z., Gorelick, N., Braaten, J., Cavalcante, L., Cohen, W. B., & Healey, S. (2018). Implementation of the LandTrendr algorithm on google earth engine. *Remote Sensing*, 10(5), 691.

Continuous Change Detection and Classification - CCDC

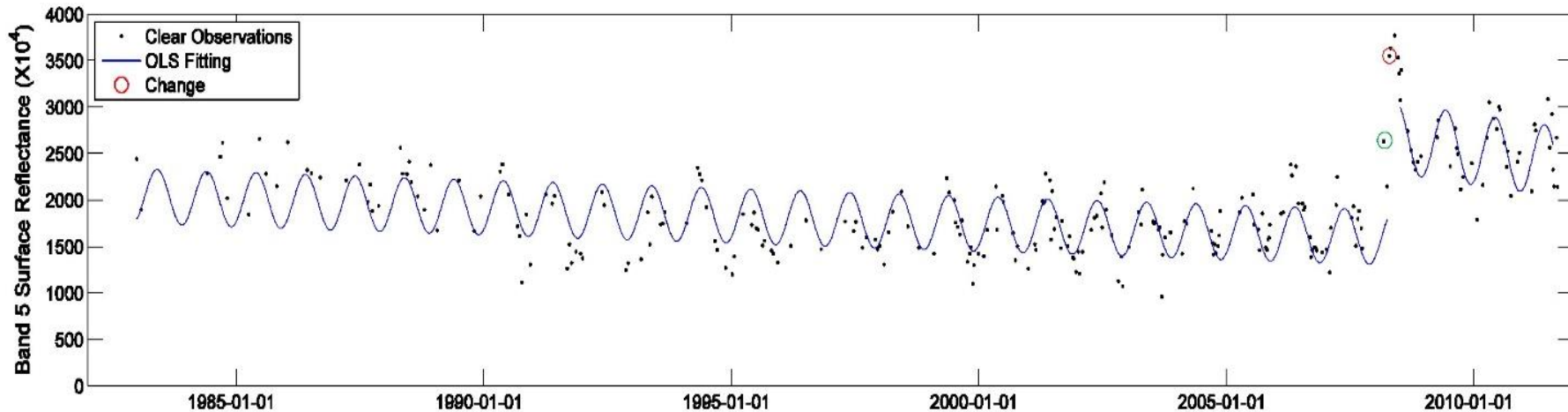
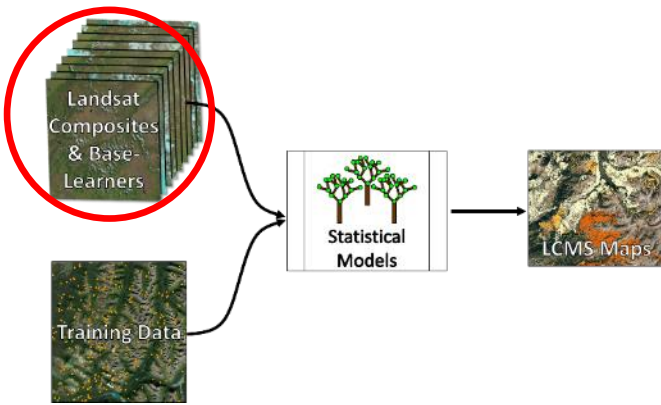
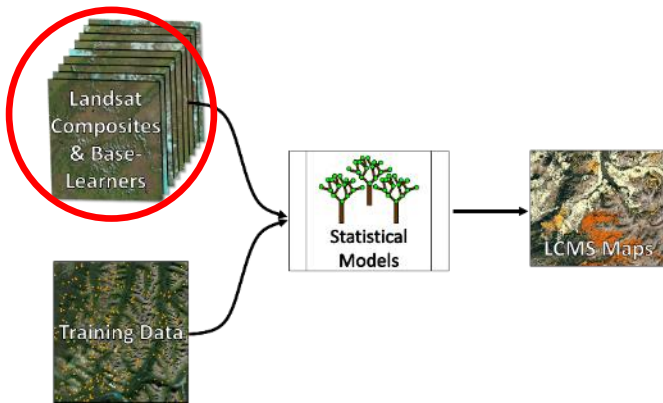


Figure from Zhu & Woodcock 2014, Fig. 21



CCDC

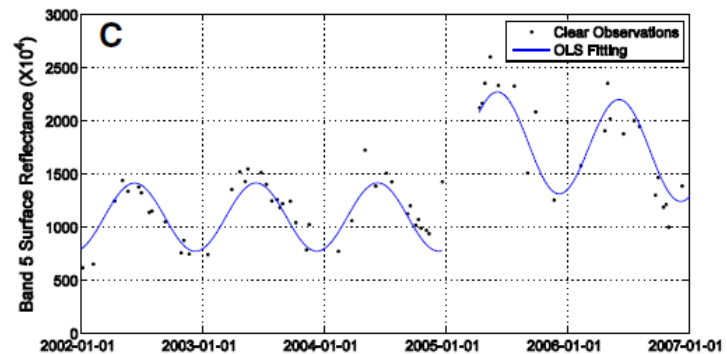
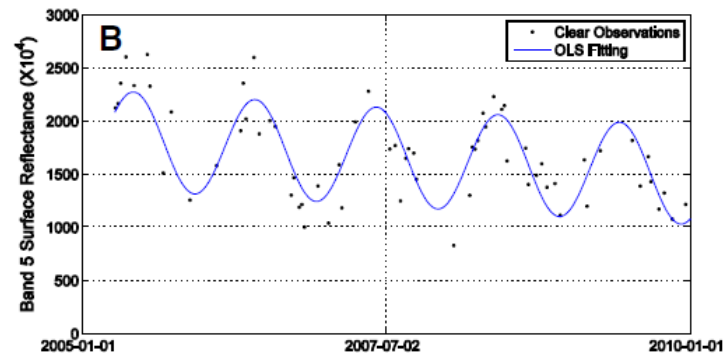
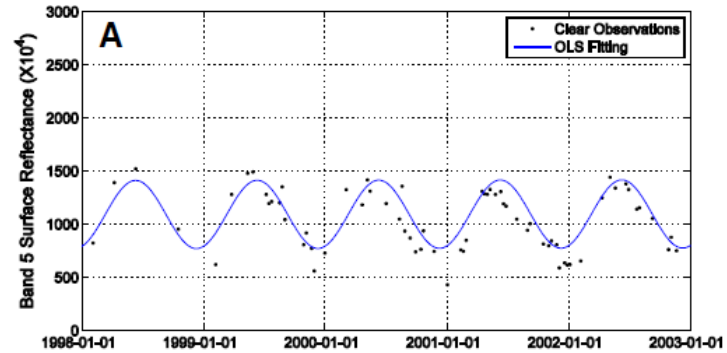


Figure from Zhu & Woodcock 2014, Fig. 21

CCDC

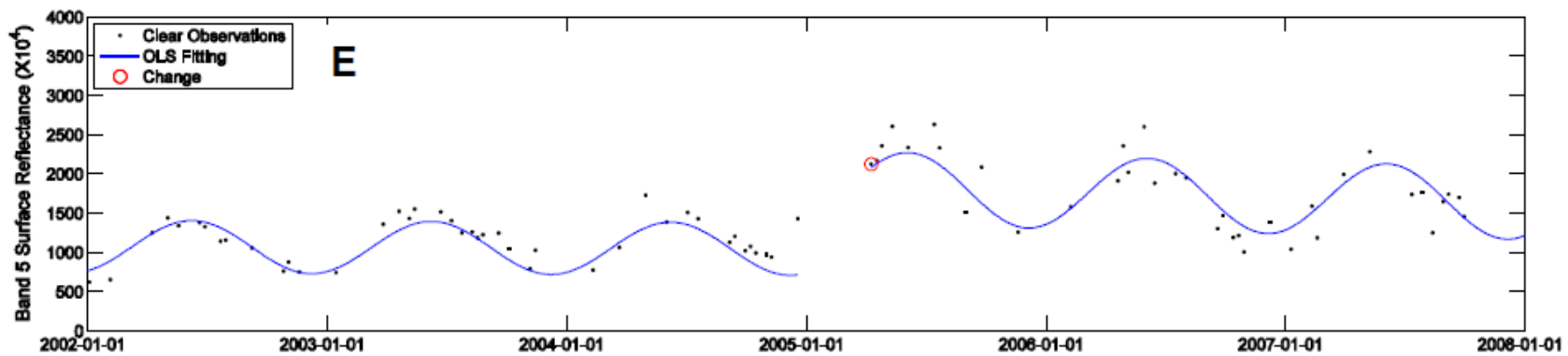
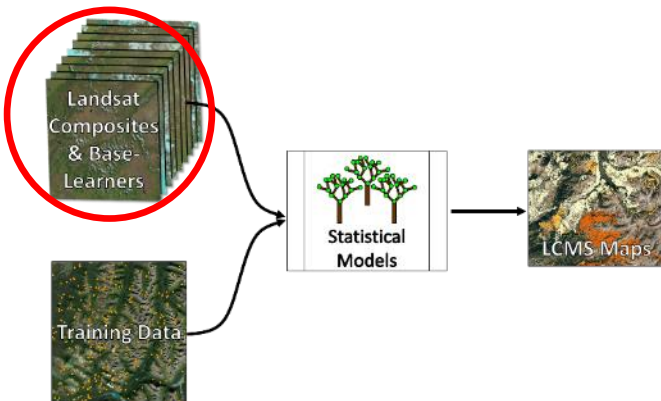


Figure from Zhu & Woodcock 2014, Fig. 21

CCDC

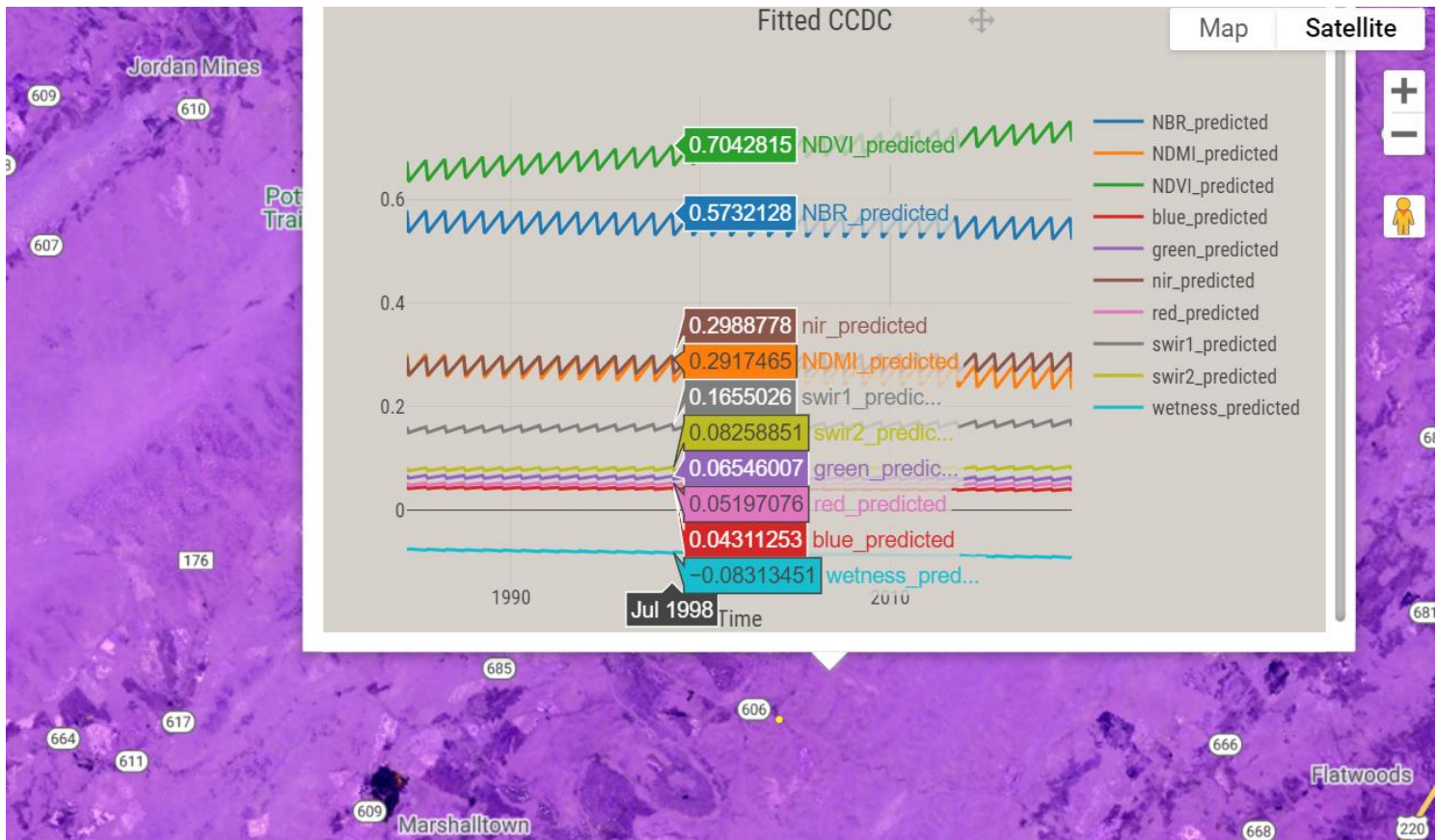
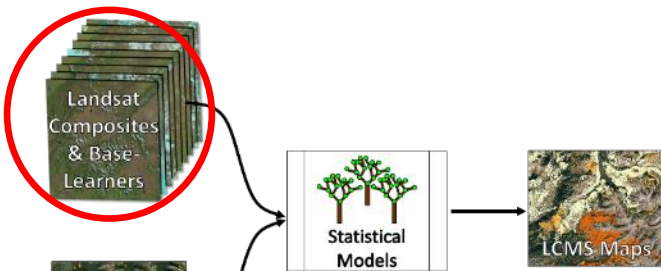
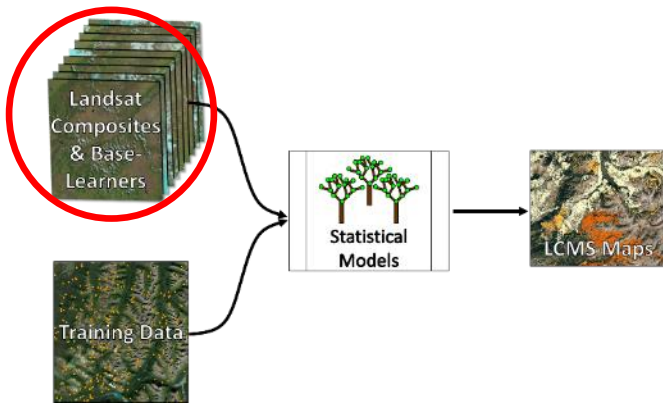


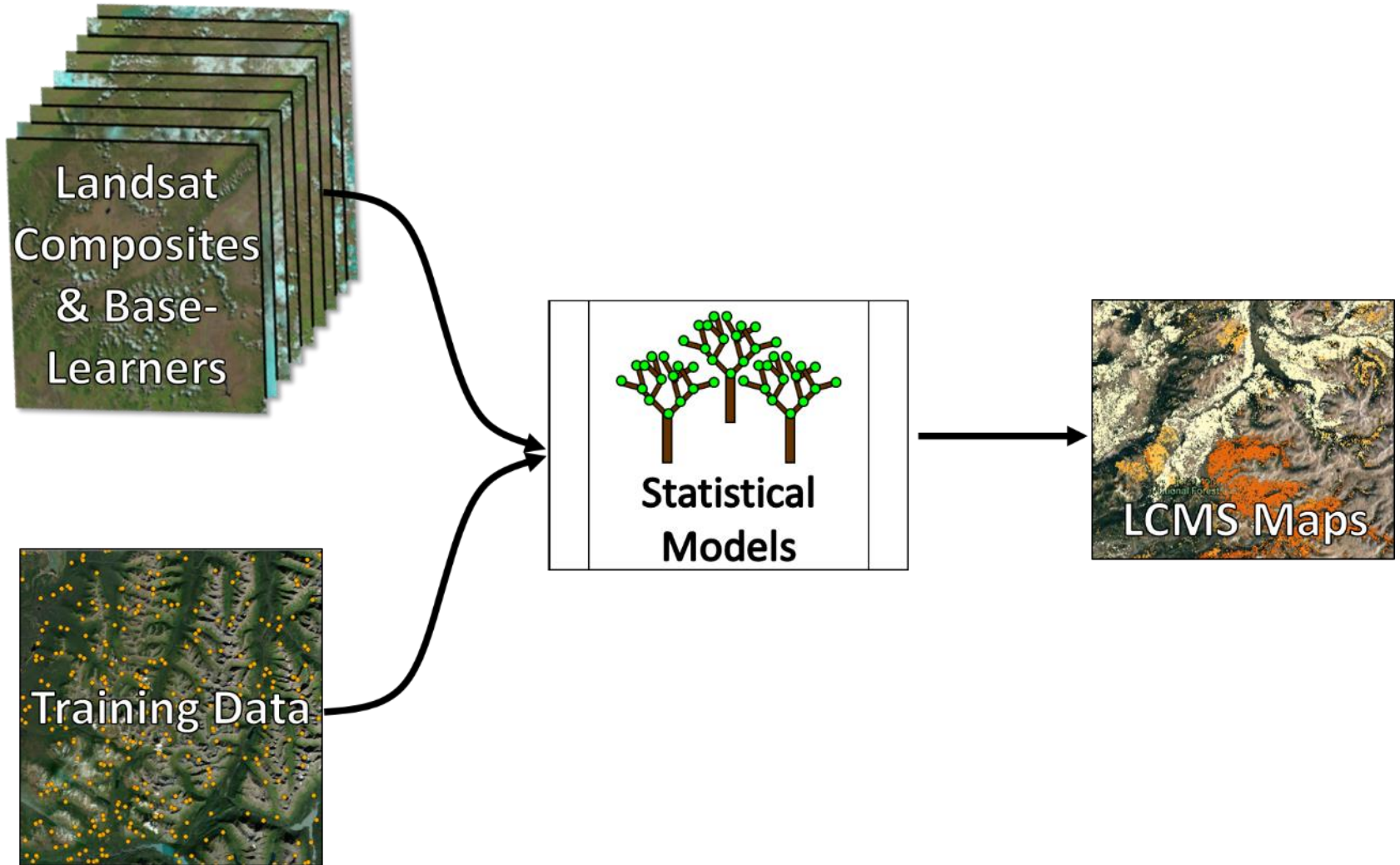
Figure from Zhu & Woodcock 2014, Fig. 21



Continuous Change Detection and Classification - CCDC

Zhu, Z., & Woodcock, C. E. (2014). Continuous change detection and classification of land cover using all available Landsat data. *Remote sensing of Environment*, 144, 152-171.

LCMS Proceso





Conversamos sobre LandTrendr y CCDC y LCMS

- Ideas como LandTrendr y CCDC pueden ayudar investigaciones del grupo CONAFOR
- Preguntas sobre LandTrendr y CCDC o LCMS



Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Gracias y Preguntas?



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Geospatial Technology and Applications Center | GTAC
USDA Forest Service

GTAC

Mapping Our Future Together

Remote Sensing, Geographic Information Systems, Cartography, Photogrammetry, Training, and Information Services

Geospatial Technology and Applications Center | GTAC  USDA is an equal opportunity employer

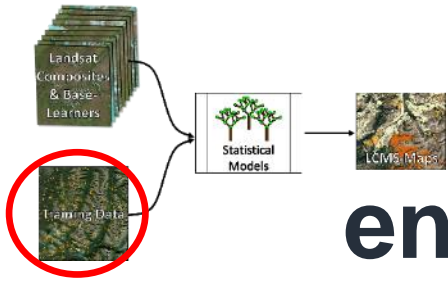


Diapositivas Suplementarias

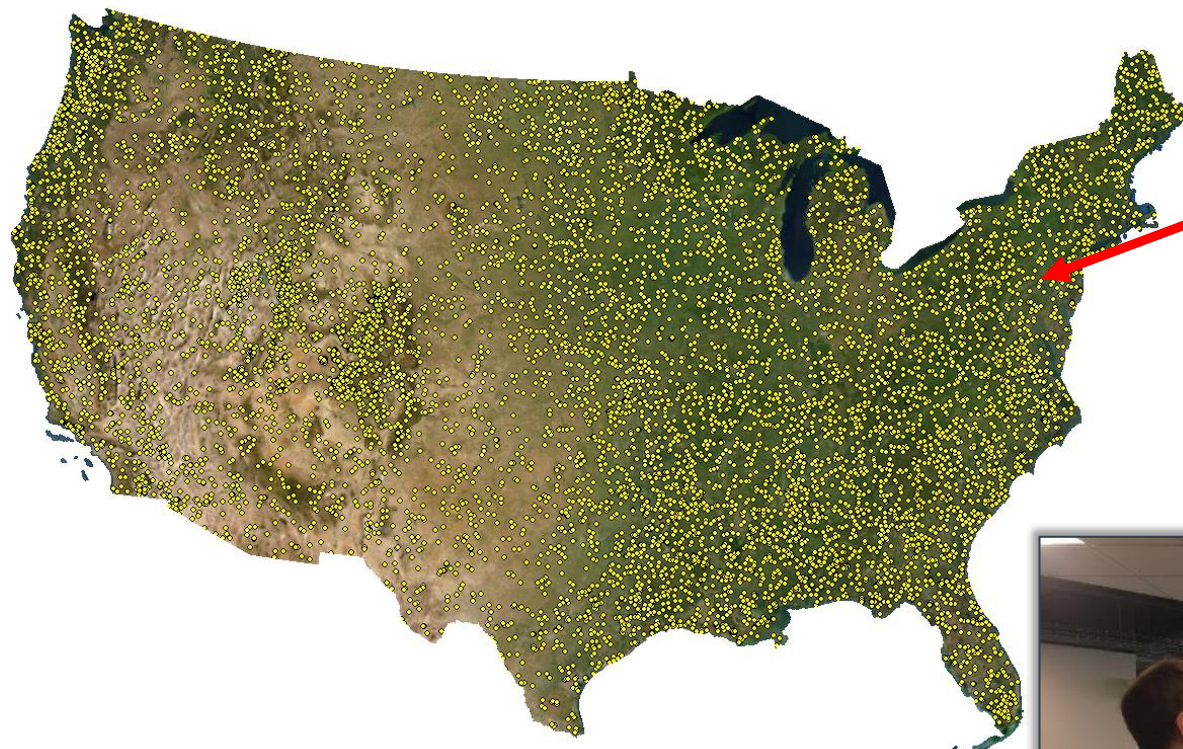
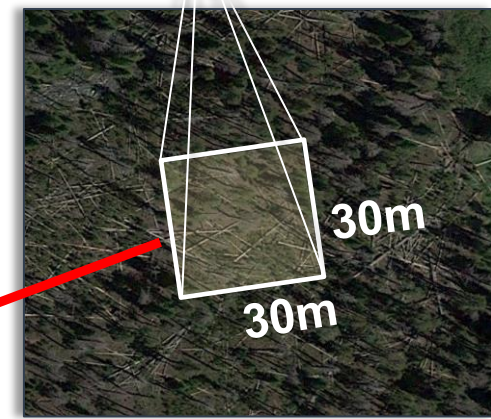
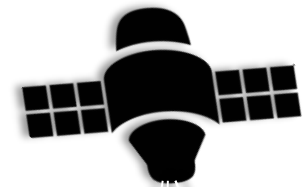
LCMS Proceso

**Datos
dependientes:**



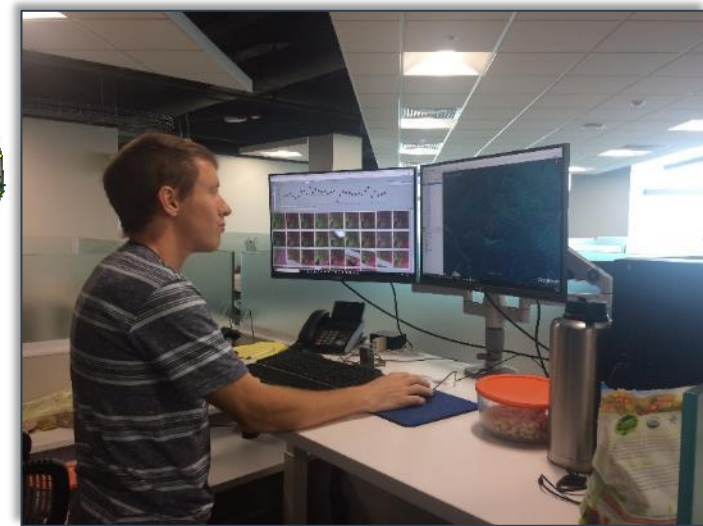


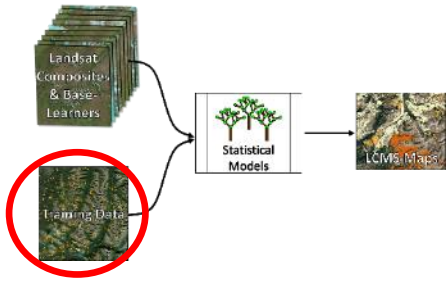
Datos para enseñar los modelos



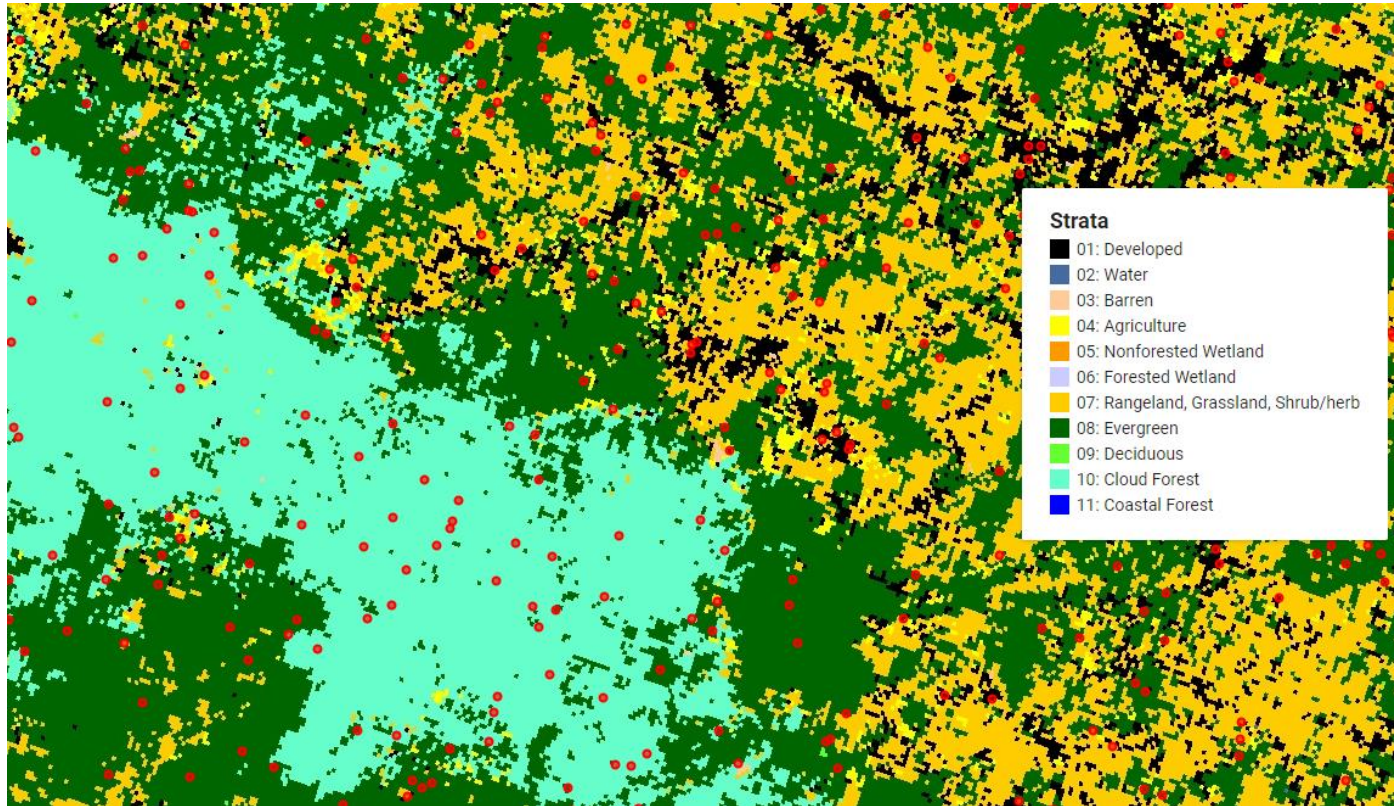
10,010 sitios

- La ubicación de sitios están determinados a través de una muestra aleatoria estratificada para representar toda la cobertura de la tierra y presta atención a zonas de pérdida.

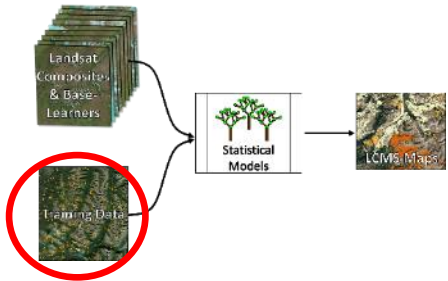




Datos para enseñar los modelos



La ubicación de sitios están eligidos de una estratificación de la tierra que representa todas las coberturas de la tierra.



Clasificación

(Primary & Secondary)

Variaciones

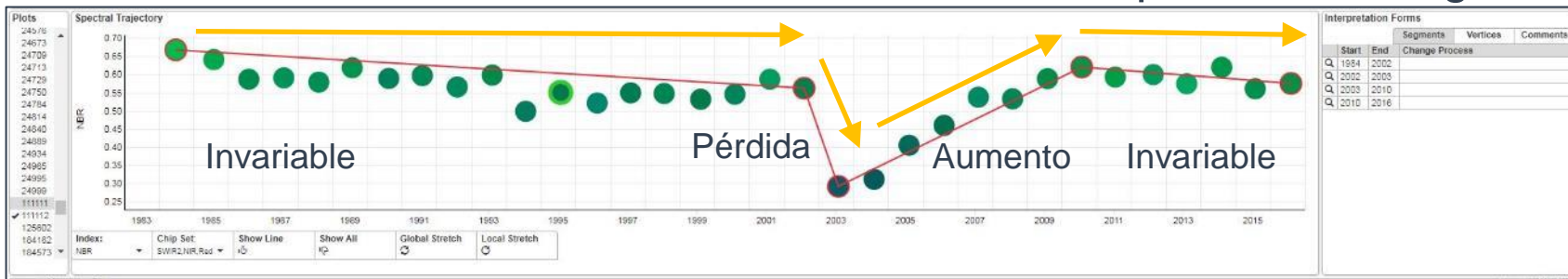
Invariable
Pérdida
Aumento

Usos de la tierra

Bosque
Urbanizado
Agricultura
Pantano sin bosque
Pastizal/Campo
Otro uso

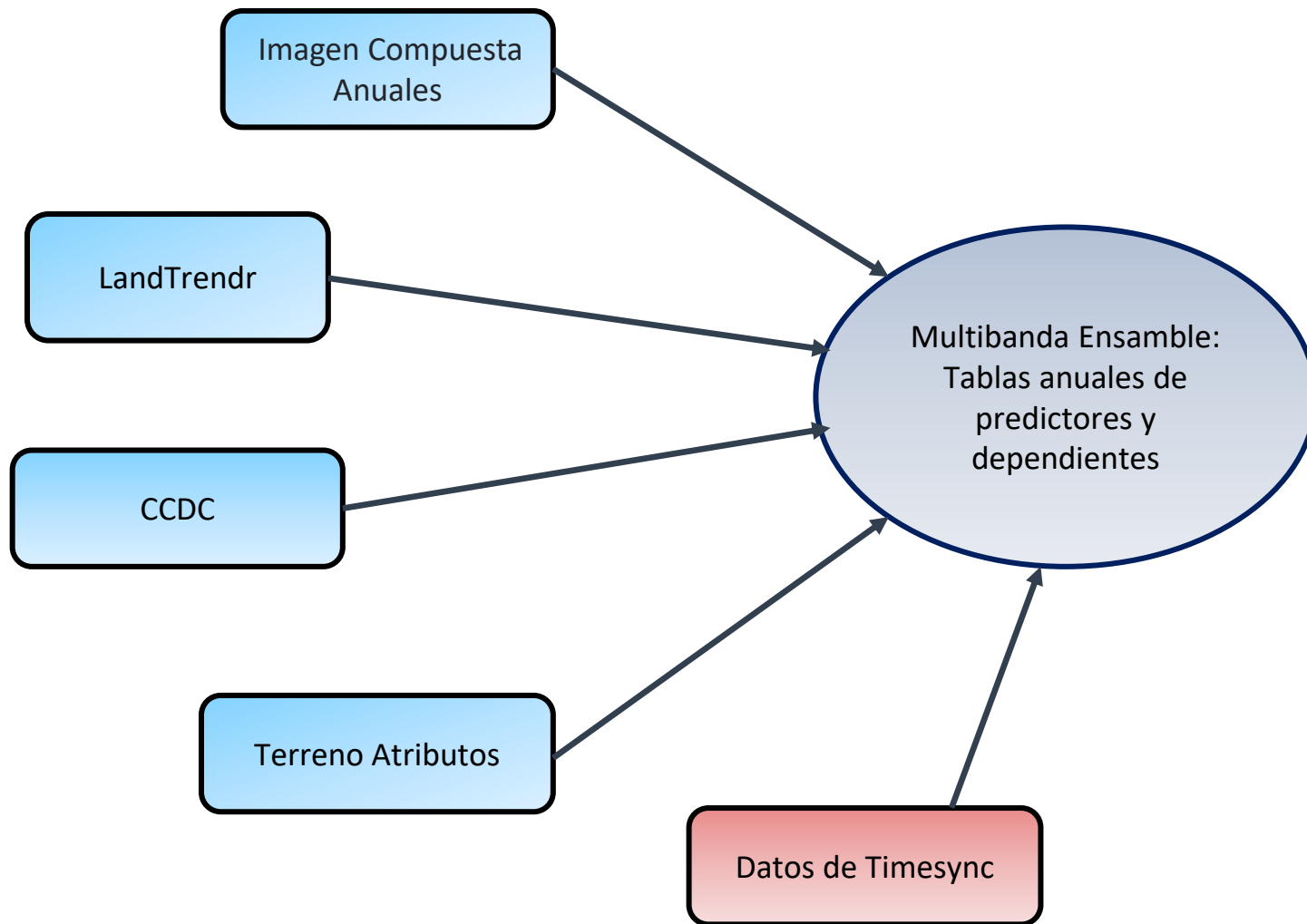
Cobertura de la tierra

Árbol
Matorral
Pasto
Superficies Impermeables
Páramo
Nieve/Hielo
Superficies del agua

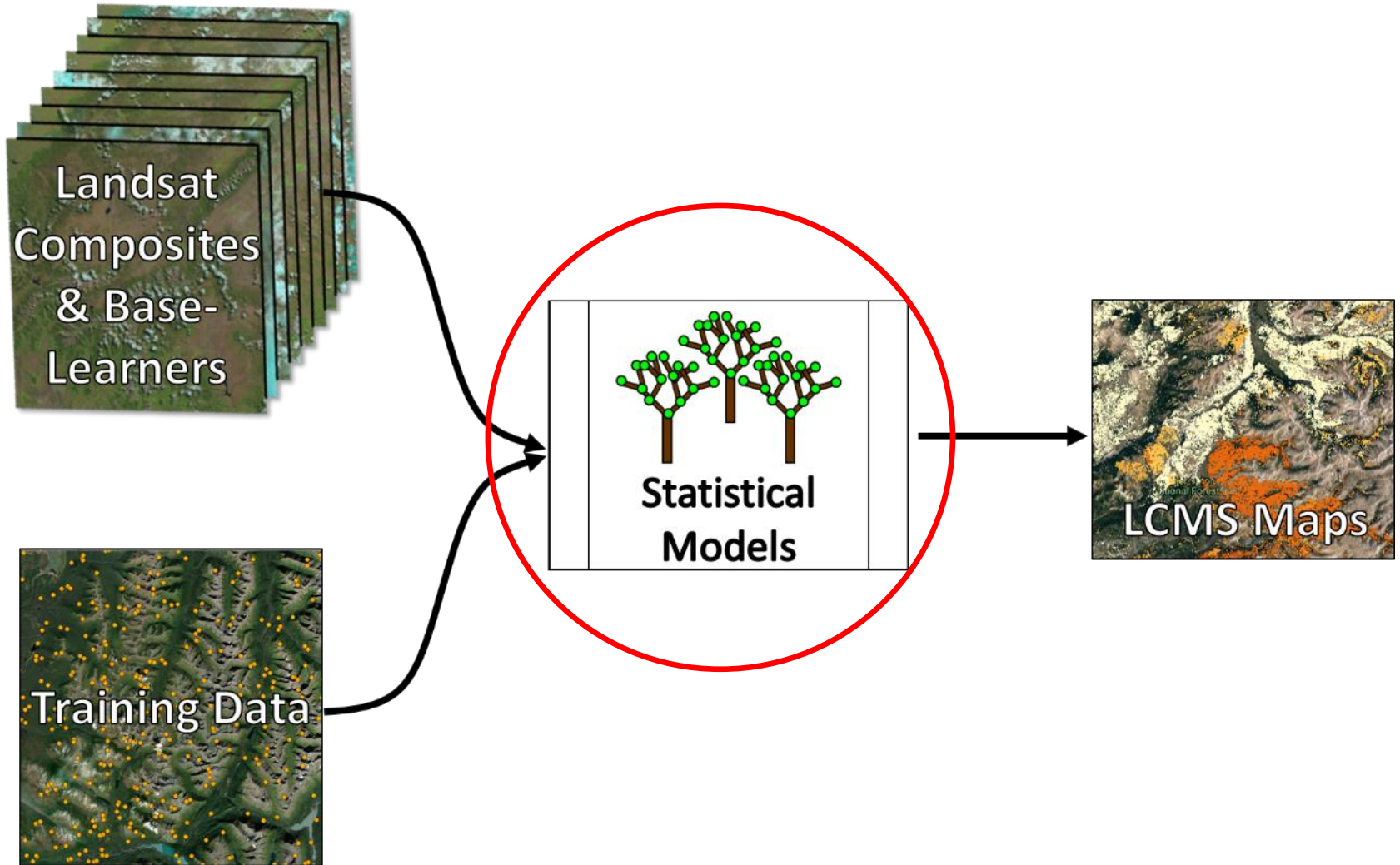


Para cada sitio de clasificación, cada año hacemos clasificaciones de variaciones de la tierra, usos de la tierra y cobertura de la tierra

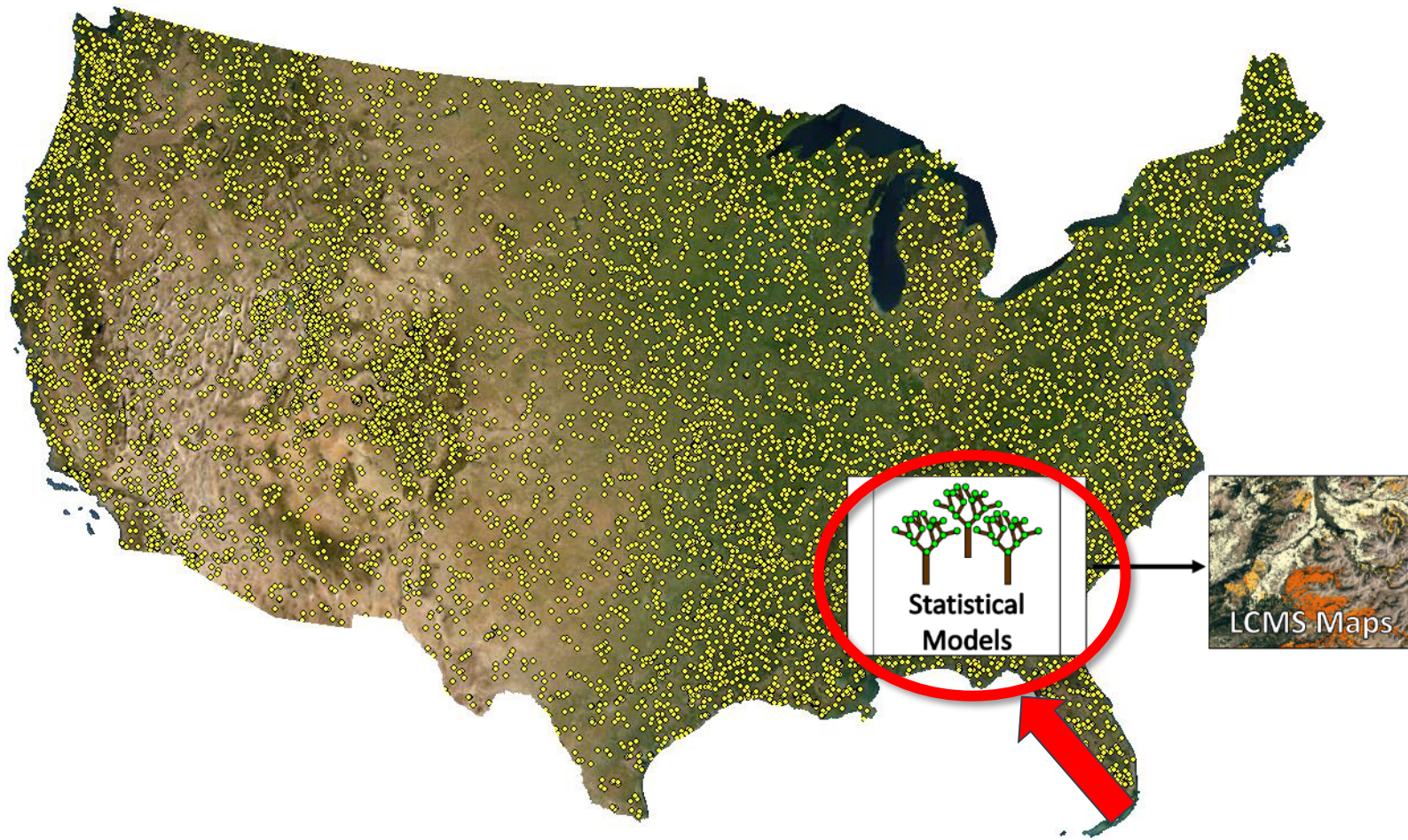
Ensamble de los Predictores y Dependientes



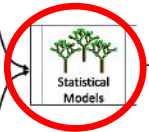
LCMS Proceso: Modelo Estadístico



Random Forest Modelo

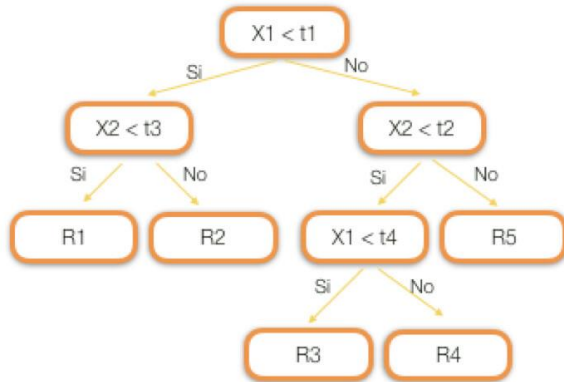


**Random
Forest Modelo**



Random Forest Modelo

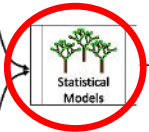
Compuesto de muchas clasificaciones y árboles de regresión



Pérdida



No Pérdida



Random Forest Modelo



Pérdida



Pérdida



Pérdida



No Pérdida

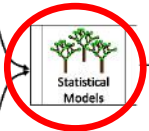


Pérdida

El resultado es la probabilidad que una píxel pertenece a una clase



Probability of Loss:
0.8 (80%)
(for this pixel, for this year)



Dos-Clase Caso: *Umbrales (Variaciones solamente)*

Umbral = 35%

Umbral = 51%

Píxel 1



72 % Pérdida



72 % Pérdida

Píxel 2



50 % Pérdida



50 % Pérdida

Píxel 3



28 % Pérdida



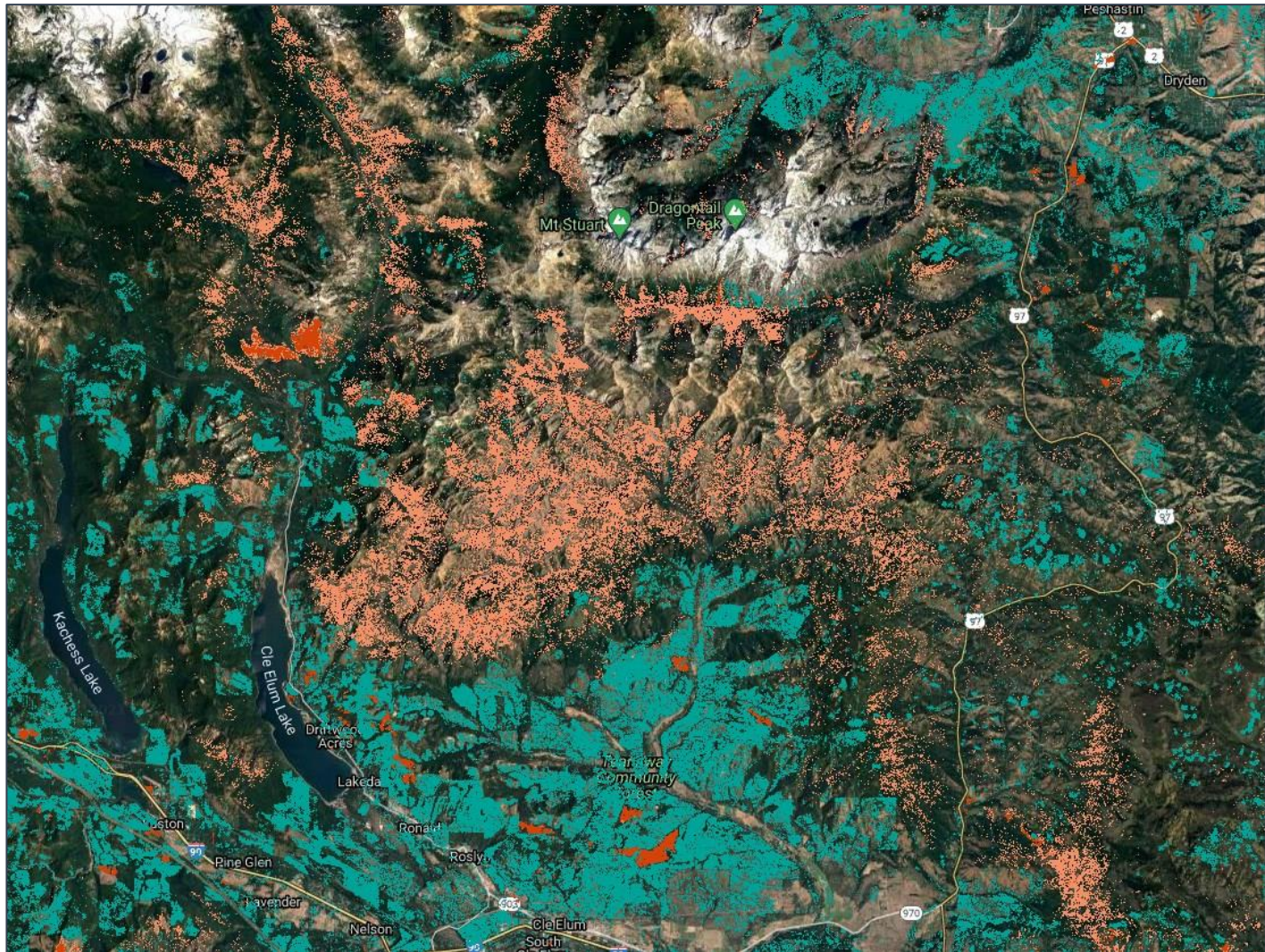
28 % Pérdida

**2 Pérdida
1 No Pérdida**

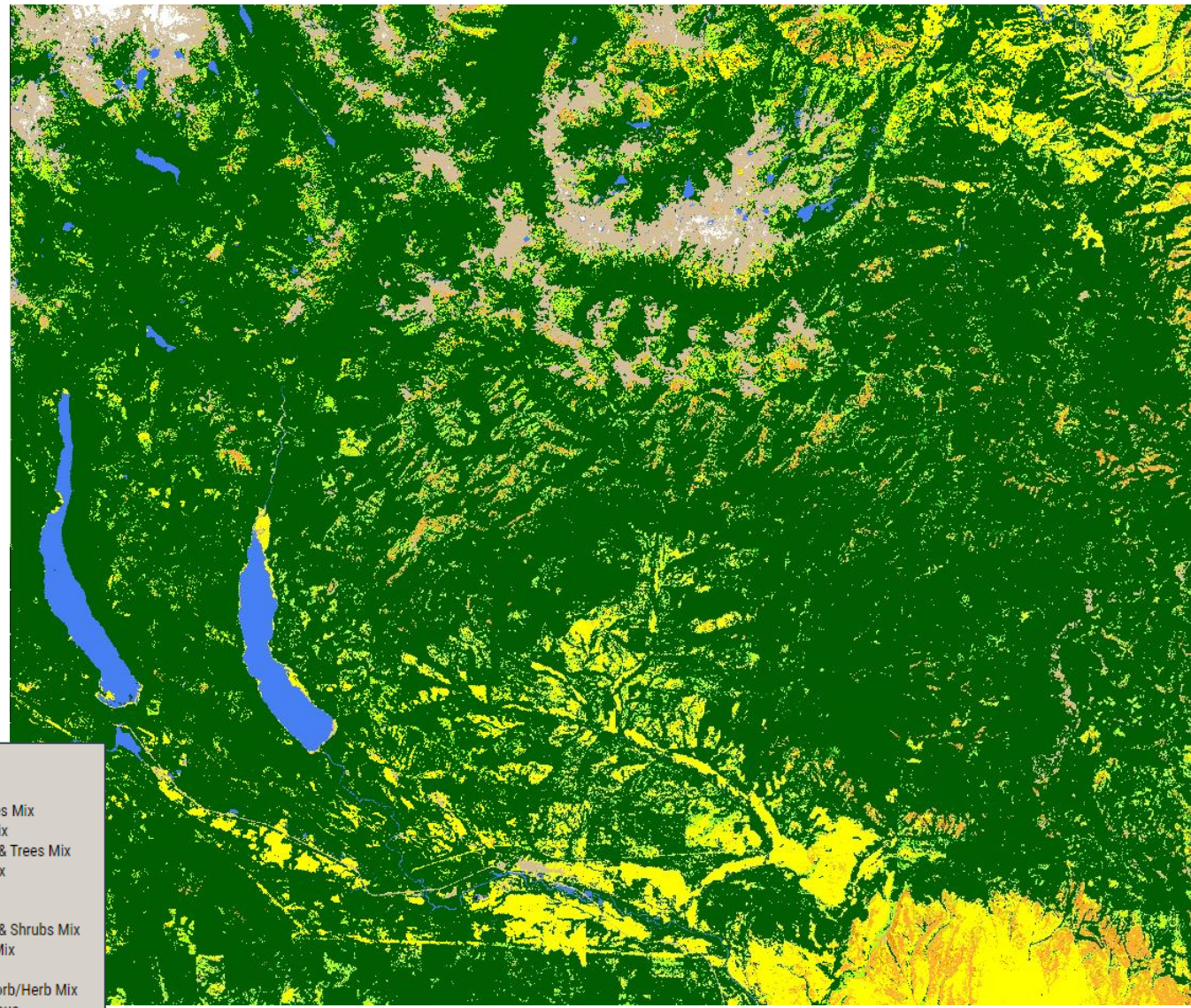
**1 Pérdida
2 No Pérdida**

- Consideramos cada umbral posible (1-100)
- Usamos estadísticas para determinar umbrales de variaciones de la tierra
- Default Thresholds:
 - 29% (Fast Loss)
 - 18% (Slow Loss)
 - 29% (Gain)
- Cubierto y usos de la Tierra no tienen un umbral

Mapas de Variaciones



Mapas de Cobertura y Usos de la Tierra



Land Cover

- Trees
- Tall Shrubs & Trees Mix
- Shrubs & Trees Mix
- Grass/Forb/Herb & Trees Mix
- Barren & Trees Mix
- Tall Shrubs
- Shrubs
- Grass/Forb/Herb & Shrubs Mix
- Barren & Shrubs Mix
- Grass/Forb/Herb
- Barren & Grass/Forb/Herb Mix
- Barren or Impervious
- Snow or Ice
- Water

LCMS Products

Google Earth Engine LCMS

Scripts Docs Assets New Script * Get Lin

Filter scripts... NEW ↕ ↻

- Owner (4)
 - users/joshuaheyer/Coastal_Alaska
 - users/joshuaheyer/image-processing
 - users/joshuaheyer/LCMS
 - users/joshuaheyer/TCC
- Writer (3)
- Reader (1)
- Archive
 - No accessible repositories. Click Refresh to check again.
- Examples

USFS Landscape Change Monitoring System v2020.5

DESCRIPTION BANDS TERMS OF USE CITATIONS

This product is part of the Landscape Change Monitoring System (LCMS) data suite. It shows LCMS-modeled change, land cover, and/or land use classes for each year.

LCMS is a remote sensing-based system for mapping and monitoring landscape change across the United States. Its objective is to develop a consistent approach using the latest technology and advancements in change detection to produce a "best available" map of landscape change.

Outputs include three annual products: change, land cover, and land use. Change relates specifically to vegetation cover and includes slow loss, fast loss (which also includes hydrologic changes such as inundation or desiccation), and gain. These values are predicted for each year of the Landsat time series and serve as the foundational products for LCMS. Land cover and land use maps depict life-form level land cover and broad-level land use for each year.

Because no algorithm performs best in all situations, LCMS uses an ensemble of models as predictors, which improves map accuracy across a range of ecosystems and change processes (Healey et al., 2018). The resulting suite of LCMS change, land cover, and land use maps offer a holistic depiction of landscape change across the United States over the past four decades.

Predictor layers for the LCMS model include annual Landsat and Sentinel 2 composites, outputs from the LandTrendr and CCDC change detection algorithms, and terrain information. These components are all accessed and processed using Google

Dataset Availability
1985-06-01T00:00:00 - 2020-09-30T00:00:00

Dataset Provider
[USDA Forest Service \(USFS\) Geospatial Technology and Applications Center \(GTAC\)](#)

Collection Snippet

```
ee.ImageCollection("USFS/GTAC/LCMS/v2020-5")
```

[See example](#)

Tags

- redcastle-resources change
- change-detection landcover
- landuse forest time-series

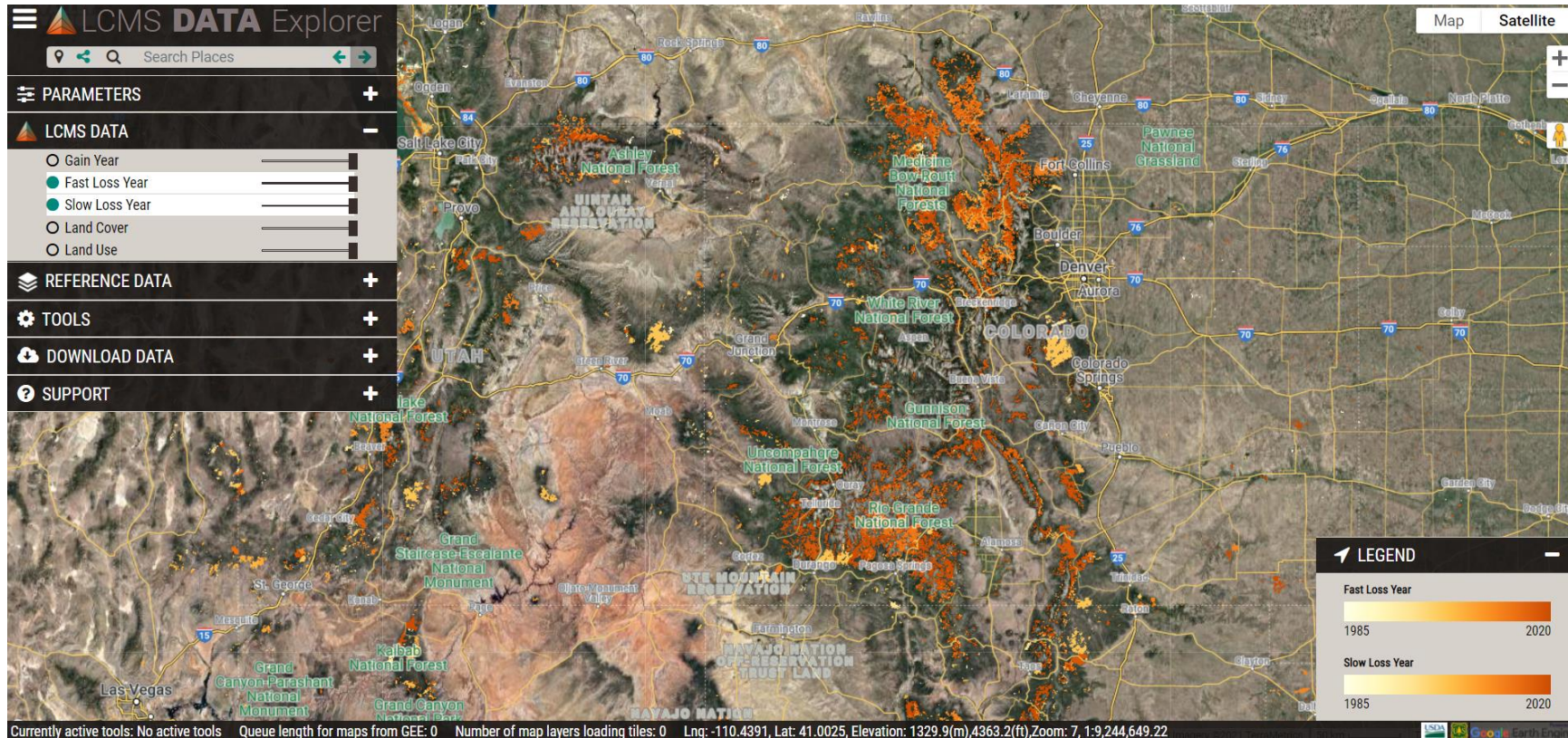
North Pacific

CLOSE IMPORT

Landscape Change Monitoring System

LCMS Data Explorer

<https://apps.fs.usda.gov/lcms-viewer/>



Landscape Change Monitoring System


geeViz GitHub








<https://github.com/gee-community/geeViz>

gee-community / geeViz Public 🔔

<> Code 🔍 Issues 1 🔗 Pull requests ▶ Actions 📁 Projects 📖 Wiki 🛡 Security 📈 Insights

🔑 master 🌿 1 branch 🏷 0 tags Go to file Code

 rcr-usfs Update release-notes.md 4537e6e 19 days ago 🕒 2,667 commits

 examples	2021.8.1 release	19 days ago
 geeView	2021.8.1 release	19 days ago
 .gitignore	2021.5.2 updates	4 months ago
 README.md	2021.8.1 release	19 days ago
 __init__.py	2021.8.1 release	19 days ago
 assetManagerLib.py	Google load error debug	2 months ago
 changeDetectionLib.py	Added ability to change year start day for annualizeCCDC()	2 months ago

Base de los Predictores

- Guardamos los predictors y otros datos en Google Earth Engine assets

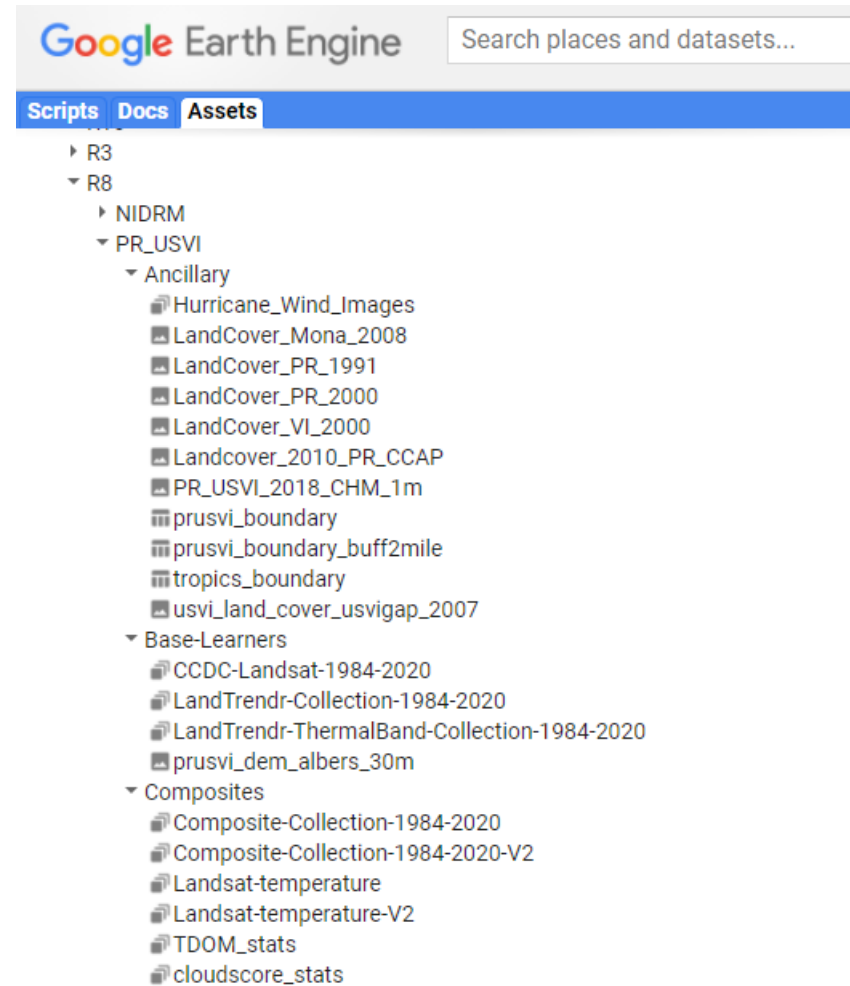


Figure from Zhu & Woodcock 2014, Fig. 21