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The Crop Sequence Boundaries (CSB) Project

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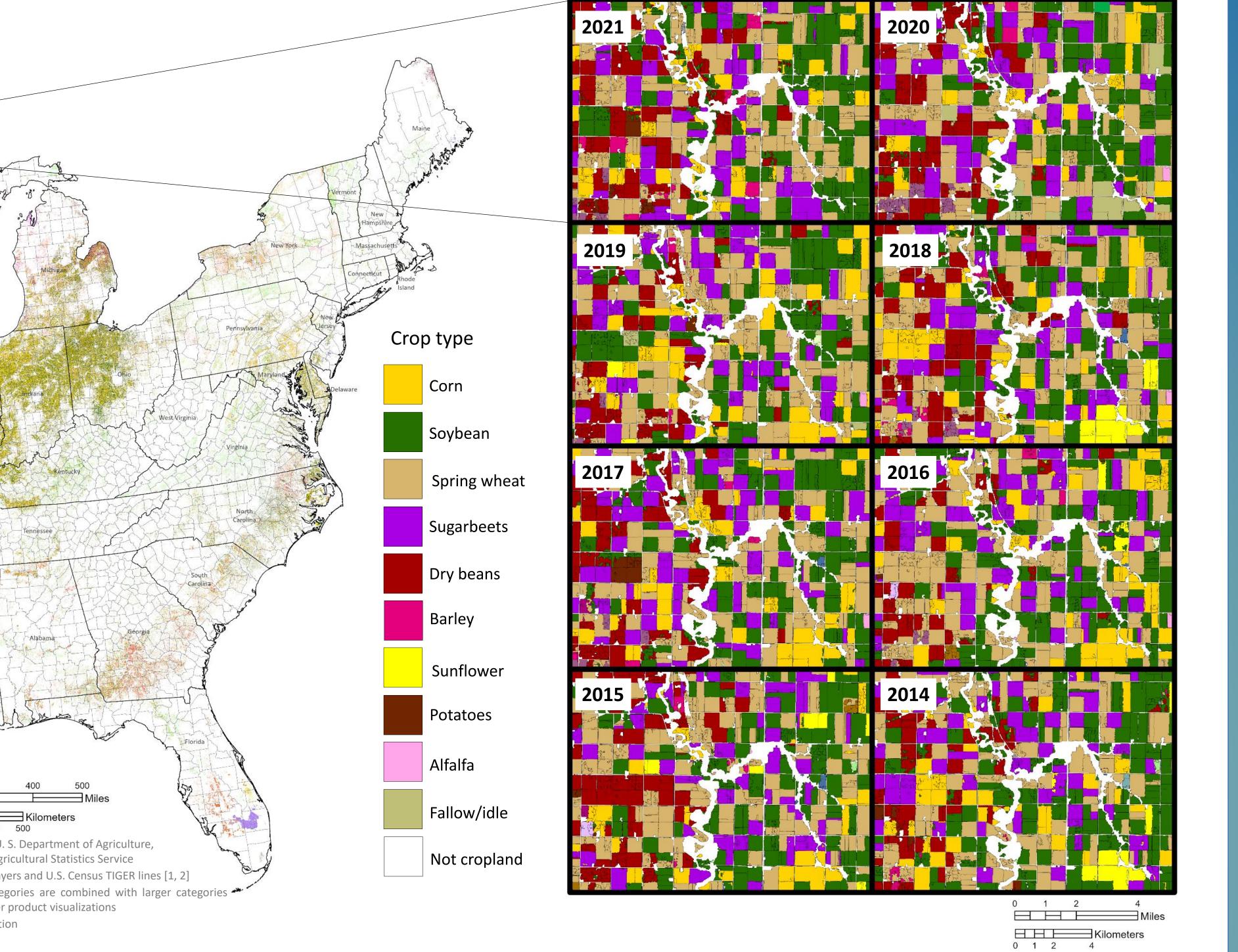* Correspondence: kevin.a.hunt@usda.gov

U.S. Crop Sequence Boundaries for 2021

This map is showing CSB using an 8-year time frame displaying crop types from 2021 for the conterminous United States

Acknowledgments

This project has relied on the essential support of many including Maria Bowman[3], Claire Boryan[1], Rachael Jennings[1], David Johnson[1], Eileen O'Brien[1], Warner Rose[5], Luca Sartore[4], Jessica Spencer[5], Patrick Willis[1], and Ying Zhang[5]
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Crop Sequence Boundaries produced by: U. S. Department of Agriculture, Economic Research Service and National Agricultural Statistics Service
Data Sources: 2014-2021 Cropland Data Layers and U.S. Census TIGER lines [1, 2]
Cartographic Generalization: Smaller categories are combined with larger categories and colors match other Cropland Data Layer product visualizations
Projection: Albers Equal Area Conic Projection
Map Production: Esri ArcGIS Pro 2.9.2

Eight-year Crop Rotations with Boundaries

2021 | 2020 | 2019 | 2018 | 2017 | 2016 | 2015 | 2014

Crop type
- Corn
- Soybean
- Spring wheat
- Sugarbeets
- Dry beans
- Barley
- Sunflower
- Potatoes
- Alfalfa
- Fallow/idle
- Not cropland
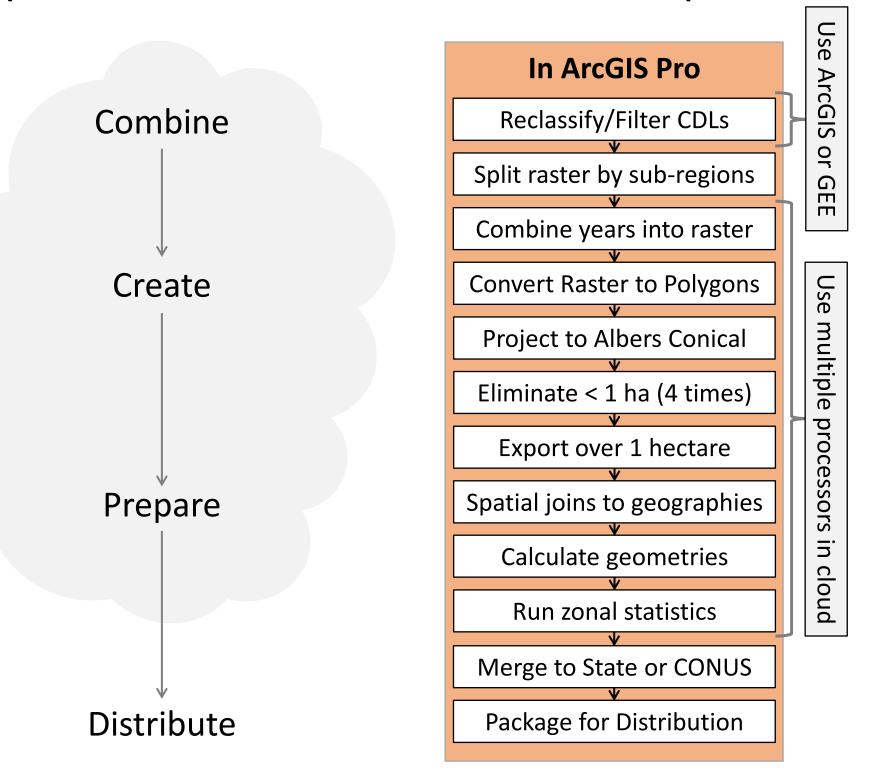
Learn more about this beta vector-based dataset:

What are Crop Sequence Boundaries (CSB)?

Crop Sequence Boundaries (CSB) are geospatial algorithm-based field polygons. The growth of gridded datasets, such as the NASS Cropland Data Layer (CDL) (3), has fostered applications that require field boundaries for aggregating the data to an analysis unit (4). Most efforts to build algorithm-based field polygons have focused on limited geographies or on individual years. CSBs are created to provide full coverage for the 48 conterminous United States (CONUS) and to be accurate and repeatable across years. CSBs use a specified time frame of historic CDLs together with road and rail networks to capture the crop sequence in these synthetic fields.

- Combine Cropland Data Layer histories
- Create synthetic field boundaries based on crop rotations
- Utilize vector-based synthetic fields for analysis

Example 3-year crop sequence boundaries

Time Frame
Year 1
Year 2
Year 3
Boundaries

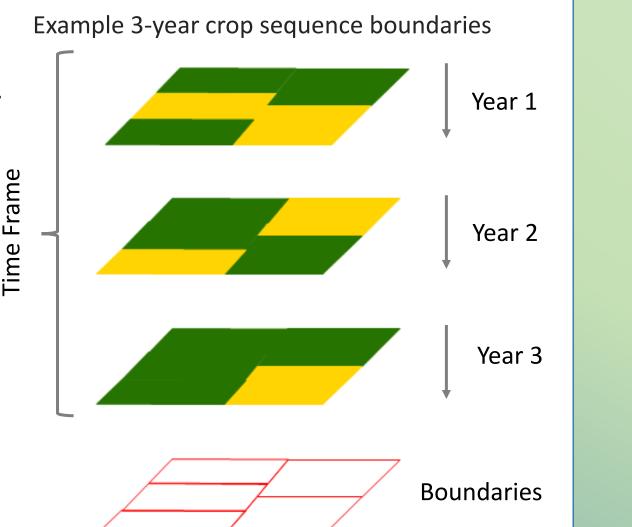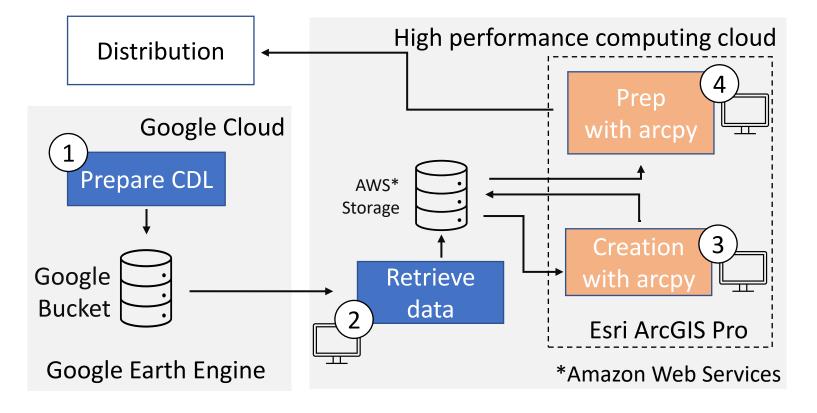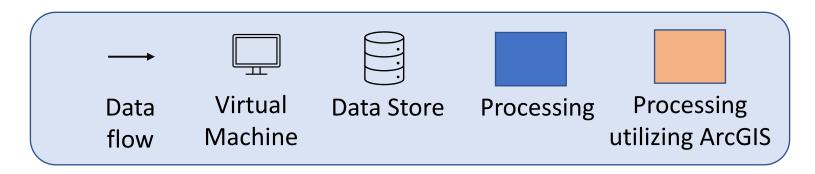### Utilizing cloud computing for large vector datasets

To identify and map agricultural fields by their boundaries for the entire conterminous United States (CONUS) has previously presented computationally large challenges. Leveraging decades of the remotely sensed Cropland Data Layer (CDL) history by utilizing cloud computing capabilities has expanded the scale of crop field mapping. The CSB approach is constructed using only public datasets using an algorithm of geospatial functions accessing clouds by both Google Earth Engine (GEE) and Amazon Web Services (AWS) and maximizing ArcGIS Pro application and its functions. These GIS functions can be run in parallel by sub-dividing CONUS into 2,844 county sized regions based on road boundaries. These regions are merged after parallel processing utilization is complete.

1. Prepare raster Cropland Data Layer histories by filtering and combining in Google Earth Engine utilizing cloud processing
2. Retrieve data from Google Cloud Buckets via gsutil into Amazon Web Services storage to be utilized for parallel processing at the sub-region level
3. Run arcpy utilizing ArcGIS Pro in parallel to create CSB
4. Run arcpy utilizing ArcGIS Pro in parallel to prep CSB by adding attributes

Distribution — High performance computing cloud
Google Cloud
1 Prepare CDL
Google Bucket
Google Earth Engine
2 Retrieve data
AWS* Storage
Esri ArcGIS Pro
4 Prep with arcpy
3 Creation with arcpy
*Amazon Web Services

Data flow | Virtual Machine | Data Store | Processing | Processing utilizing ArcGIS

Geospatial functions used in CSB development

Combine
Create
Prepare
Distribute

In ArcGIS Pro
- Reclassify/Filter CDLs
- Split raster by sub-regions
- Combine years into raster
- Convert Raster to Polygons
- Project to Albers Conical
- Eliminate < 1 ha (4 times)
- Export over 1 hectare
- Spatial joins to geographies
- Calculate geometries
- Run zonal statistics
- Merge to State or CONUS
- Package for Distribution

Use ArcGIS or GEE
Use multiple processors in cloud

Impacts of this project

The CSB will be utilized as an algorithm-based geospatially delineated field that can contain supplemental information and improve methods for area summaries for major crops. The CSB has utility as a new standard agricultural field proxy that can incorporate available time frames. The cloud-based methods of development are enhancing large scale crop mapping with vector-based data. Many applications are being researched including crop modeling and georeferencing agricultural fields.

Citations

1. USDA National Agricultural Statistics Service Cropland Data Layer. 2021. Published crop-specific data layer [Online]. Available at https://nassgeodata.gmu.edu/CropScape/ (accessed on May 16, 2022; verified on February 14, 2022). USDA-NASS, Washington, DC.
2. 2019 TIGER/Line Shapefiles (machine-readable data files) / prepared by the U.S. Census Bureau, 2019
3. Johnson, D.M.; Mueller, R. The 2009 cropland data layer. Photogramm. Eng. Remote Sens. 2010, 76, 1201–1205.
4. Beeson, P.C.; Daughtry, C.S.T.; Wallander, S.A. Estimates of Conservation Tillage Practices Using Landsat Archive. Remote Sensing. 2020, 12, 2665.