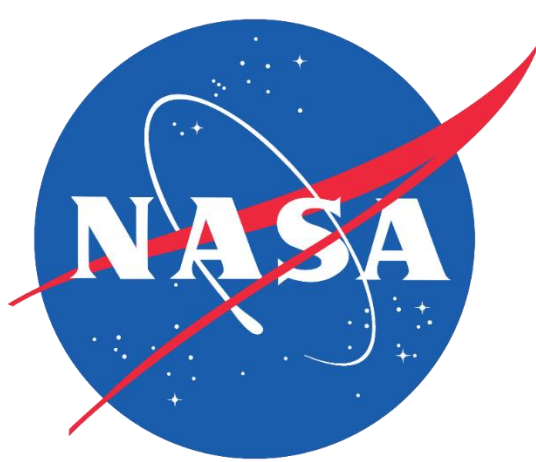




Enhancing Crop Classification Mapping Using Optical and Radar Satellite Sensors to Inform Agricultural Management and Policymaking in Mato Grosso, Brazil



Abstract

Ranked as the fourth largest food producer in the world, Brazil is an agricultural powerhouse. Agricultural production at this scale warrants accurate crop monitoring and classification, however, this tropical area is frequently concealed by dense cloud cover in standard optical imagery. To improve the accuracy and spatial coverage of current crop monitoring operations, the team incorporated radar data capable of penetrating cloud coverage to classify second season corn and cotton fields. Utilizing optical imagery from Landsat 8 Operational Land Imager (OLI) as well as radar imagery from Sentinel-1 C-band Synthetic Aperture Radar (C-SAR), and topographic imagery from Shuttle Radar Topography Mission (SRTM), the NASA DEVELOP team worked with the United States Department of Agriculture (USDA) Foreign Agricultural Service (FAS) and World Agricultural Outlook Board to generate a crop classification procedure using a random forest model for accurate mapping and crop area estimates. Additionally, accuracy assessments were performed to ensure confidence in classification accuracy and to allow for comparison with previous classification maps of the area. Classification maps and area estimates produced will be used by the USDA FAS to generate accurate estimates of available commodities as well as assist in agricultural policy decision making.

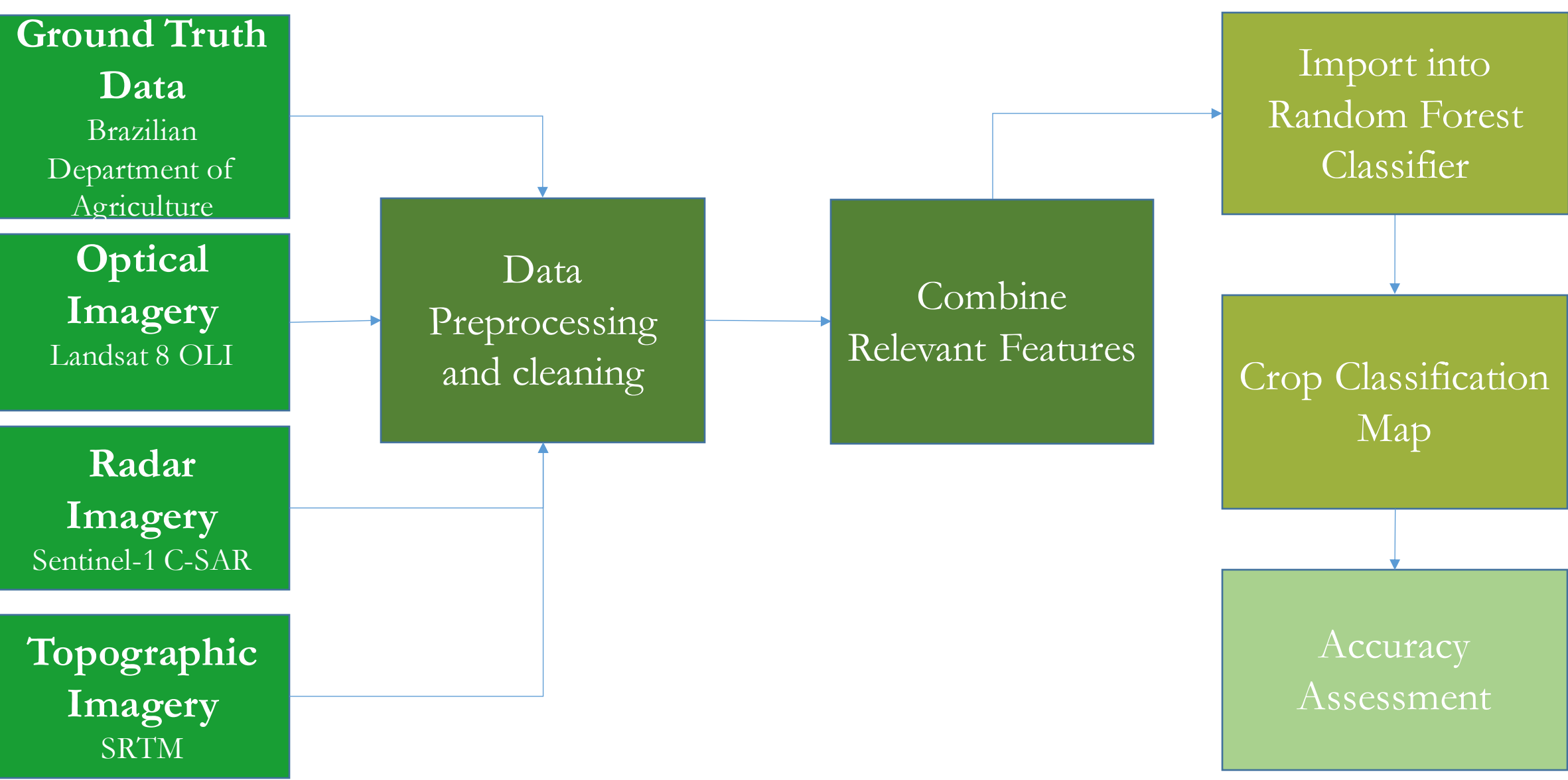
Study Area

Mato Grosso, Brazil

- ▶ Main agricultural region in Brazil
- ▶ Tropical savanna to the south and tropical monsoon to the north
- ▶ Hosts two agricultural seasons
- ▶ Primary Crops Include
 - ▶ Soybean (*Glycine max*)
 - ▶ Corn (*Zea mays*)
 - ▶ Cotton (*Gossypium*)



Methodology



Project Partners

United States Department of Agriculture (USDA)

USDA Dr. Sunita Yadav-Paulitti, Foreign Agricultural Service, International Production Assessment Division for Brazil
Mark Brusberg, Office of the Chief Economist and World Agricultural Outlook Board

The team partnered with the United States Department of Agriculture (USDA) Foreign Agricultural Service (FAS) to develop these crop classification maps. The USDA FAS for Brazil supports the United States in decisions regarding agricultural imports, exports, and foreign policy by producing crop commodity and yield estimates in Brazil.

Team Members



Max Rock
Project Lead



Elijah Dalton



Aidan Harvey

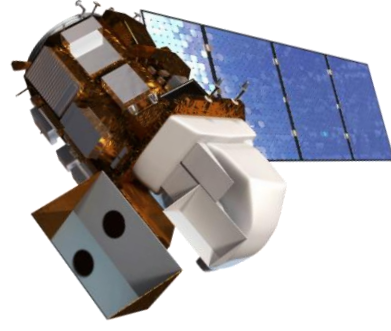


Kate Reynolds

Objectives

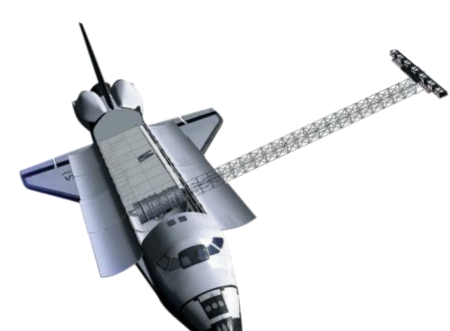
- ▶ **Create** crop classification maps for corn and cotton to enhance map inventories limited by cloud cover
- ▶ **Assess** the accuracy of the optical and radar fused data approach through a crop confusion matrix to increase partner confidence
- ▶ **Generate** a sensitivity analysis to improve partner understanding of factors contributing to accurate crop identification

Earth Observations



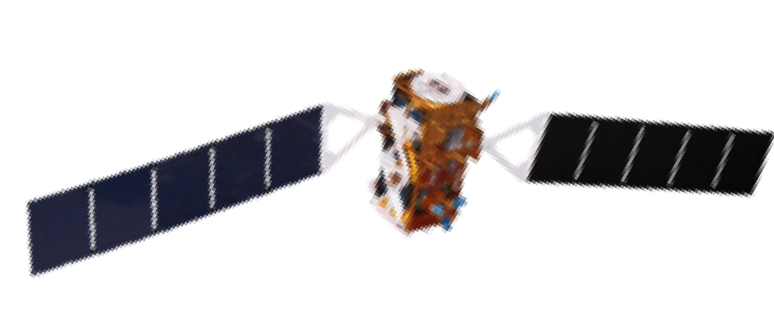
Landsat 8 OLI

Parameters: Surface Reflectance, NDVI, NDRE, GCVI, EVI2



SRTM

Parameters: Elevation, Slope, Aspect

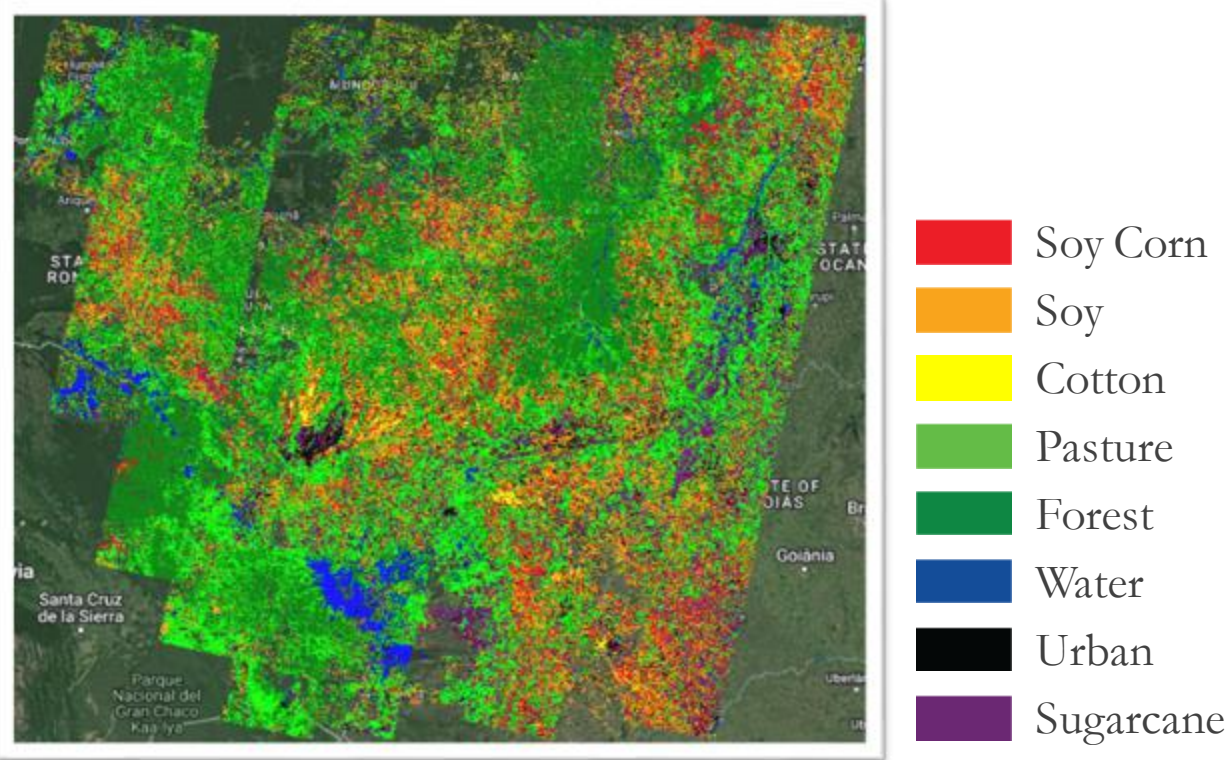


Sentinel-1 C-SAR

Parameters: Backscatter values, vertical polarization (VV), horizontal polarization (VH)

Results

Optical Only



Corn F-1 Score: 0.58
Cotton F-1 Score: 0.76

Training

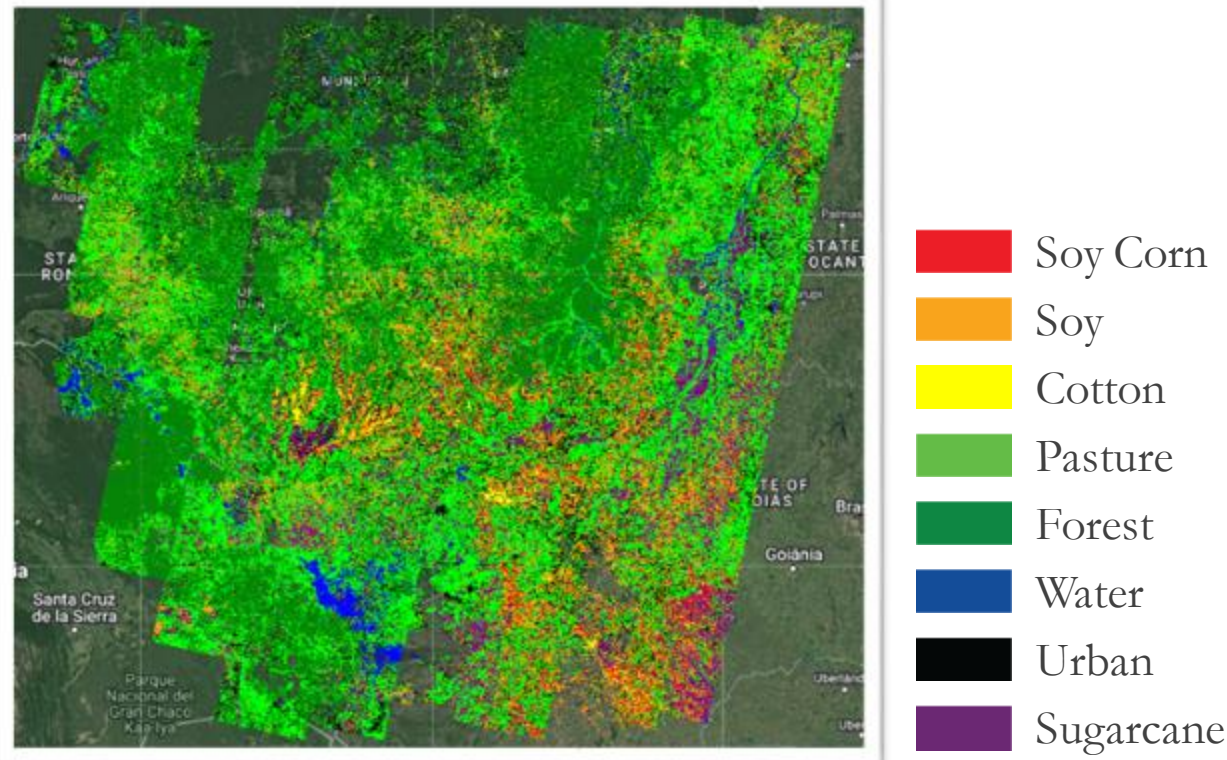
	Corn	Cotton	Soy
Corn	0.93	0.03	0.02
Cotton	0.02	0.96	0.02
Soy	0.03	0.03	0.88

Validation

Corn F-1 Score: 0.56
Cotton F-1 Score: 0.82

	Corn	Cotton	Soy
Corn	0.50	0.13	0.22
Cotton	0.27	0.50	0
Soy	0.17	0.04	0.67

Optical & Radar



Corn F-1 Score: 0.91
Cotton F-1 Score: 0.98

Training

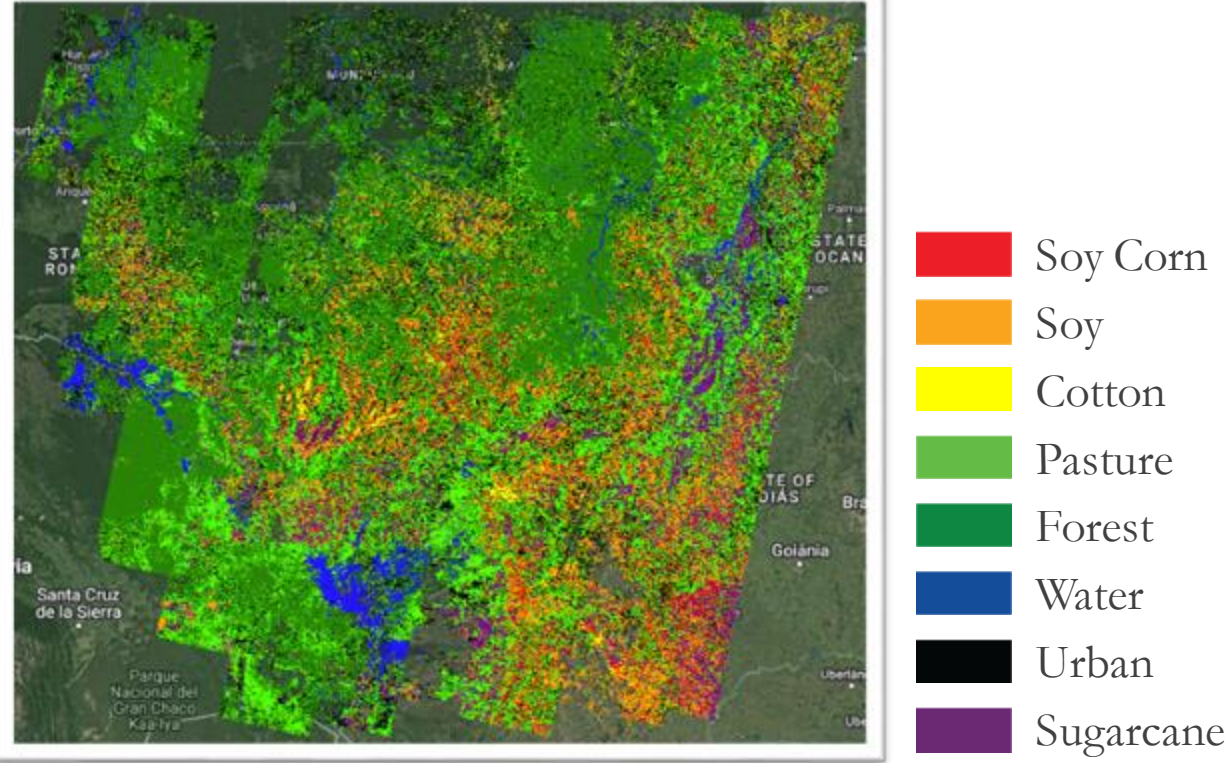
	Corn	Cotton	Soy
Corn	0.89	0	0.07
Cotton	0	0.98	0.02
Soy	0.04	0.02	0.89

Validation

Corn F-1 Score: 0.58
Cotton F-1 Score: 0.76

	Corn	Cotton	Soy
Corn	0.52	0.28	0.09
Cotton	0.05	0.84	0.11
Soy	0.09	0.09	0.64

Optical, Radar, & Topographic



Corn F-1 Score: 0.85
Cotton F-1 Score: 0.97

Training

	Corn	Cotton	Soy
Corn	0.78	0.03	0.15
Cotton	0.01	0.97	0.01
Soy	0.03	0.09	0.95

Validation

Corn F-1 Score: 0.58
Cotton F-1 Score: 0.76

	Corn	Cotton	Soy
Corn	0.52	0.22	0.09
Cotton	0.05	0.84	0.10
Soy	0.09	0.09	0.64

Conclusions

- ▶ **Data fused** classification can provide greater overall accuracy than optical imagery alone.
- ▶ The fusion of radar and optical data in crop classification **increases cotton accuracy**, but not necessarily corn.
- ▶ **Topographic data** does not make a significant impact for classification accuracy in Mato Grosso.

Acknowledgements

- ▶ Kathleen Lange, Fellow, NASA DEVELOP North Carolina – NCEI
- ▶ Dr. Garrett Graham, NOAA National Centers for Environmental Information, North Carolina Institute for Climate Studies
- ▶ Molly Woloszyn, NOAA National Centers for Environmental Information, National Integrated Drought Information System
- ▶ Dr. Sunita Yadav-Paulitti, USDA Foreign Agricultural Service
- ▶ Mark Brusberg, USDA Office of Chief Economist
- ▶ This material contains modified Copernicus Sentinel data (2015), processed by ESA.