

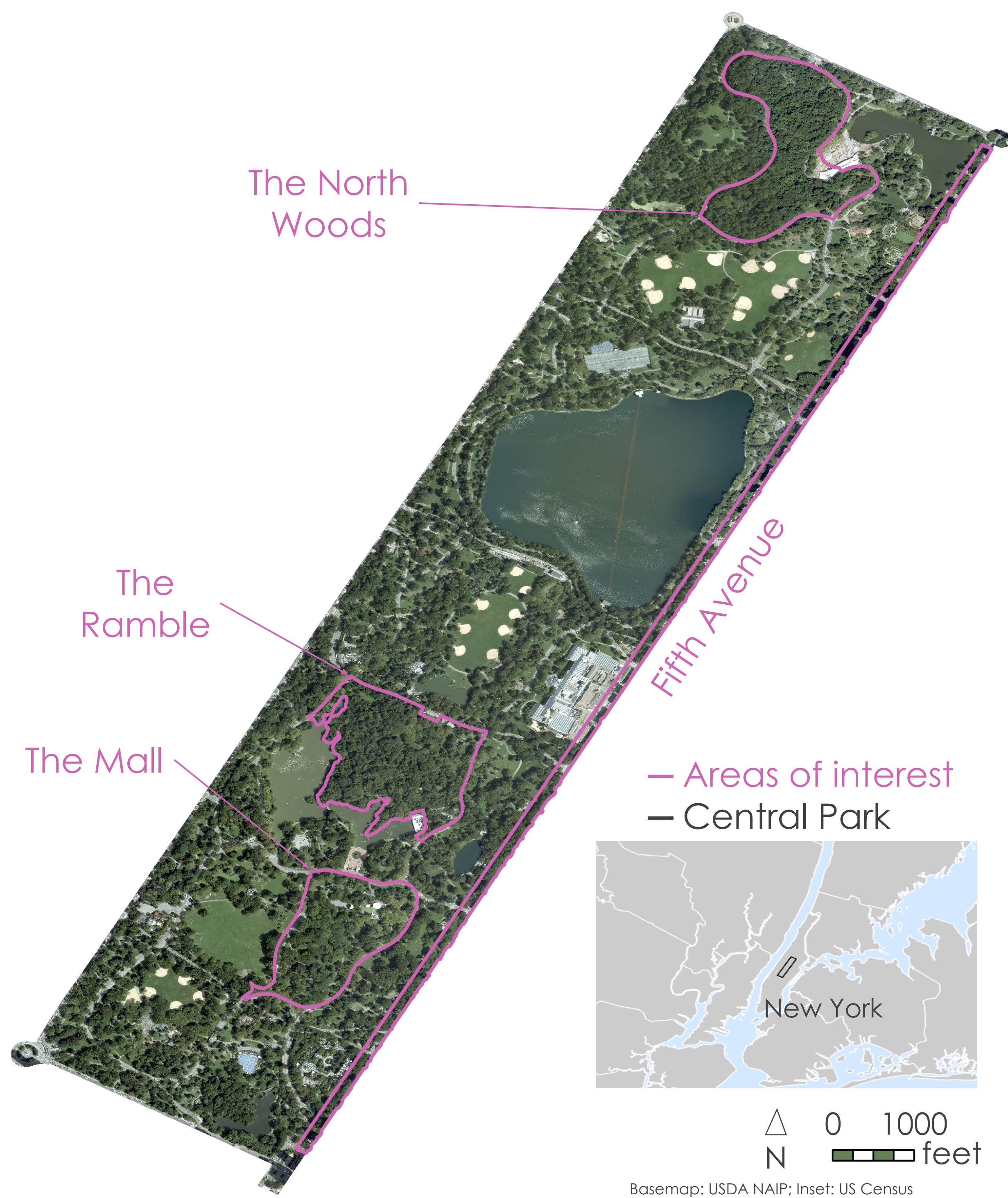
# Assessing Tree Health Conditions in New York City's Central Park with Earth Observation Data

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## ABSTRACT

The Central Park Conservancy stewards New York City's iconic Central Park with a mission to preserve the park for all. This mission is complicated by the spread of Dutch elm disease (DED) which has threatened the culturally and ecologically significant American elm tree (*Ulmus americana*). Central Park is home to one of the largest and last remaining urban concentrations of American elm and the Conservancy currently protects them through integrated pest management. This project is an interdisciplinary feasibility study that assessed the application of NASA Earth observations from 2014 to 2023 to detect changes in forest phenology possibly related to DED. Landsat 8 and 9 imagery was used to calculate a multiyear time series of the Normalized Difference Vegetation Index (NDVI) and quantify changes in land surface phenology. A pixel-based logistic regression analysis was performed using changes in NDVI, tree site locations, and recorded occurrences of trees infected with DED as inputs. The results of this analysis show that changes in NDVI derived from Landsat data are capable of detecting unhealthy tree canopies with 71% precision and healthy tree canopies with 41% precision. The study had uncertainties and limitations due to the spatial and temporal resolutions of Landsat, the natural variability in land surface phenology and NDVI, and the attempt to detect disease impacts while disease prevention and mitigation are occurring. As is, the findings of this study and its methods provide managers with an approach for integrating Earth observations to make more informed decisions in the application and timing of urban forest management activities.

## STUDY AREA

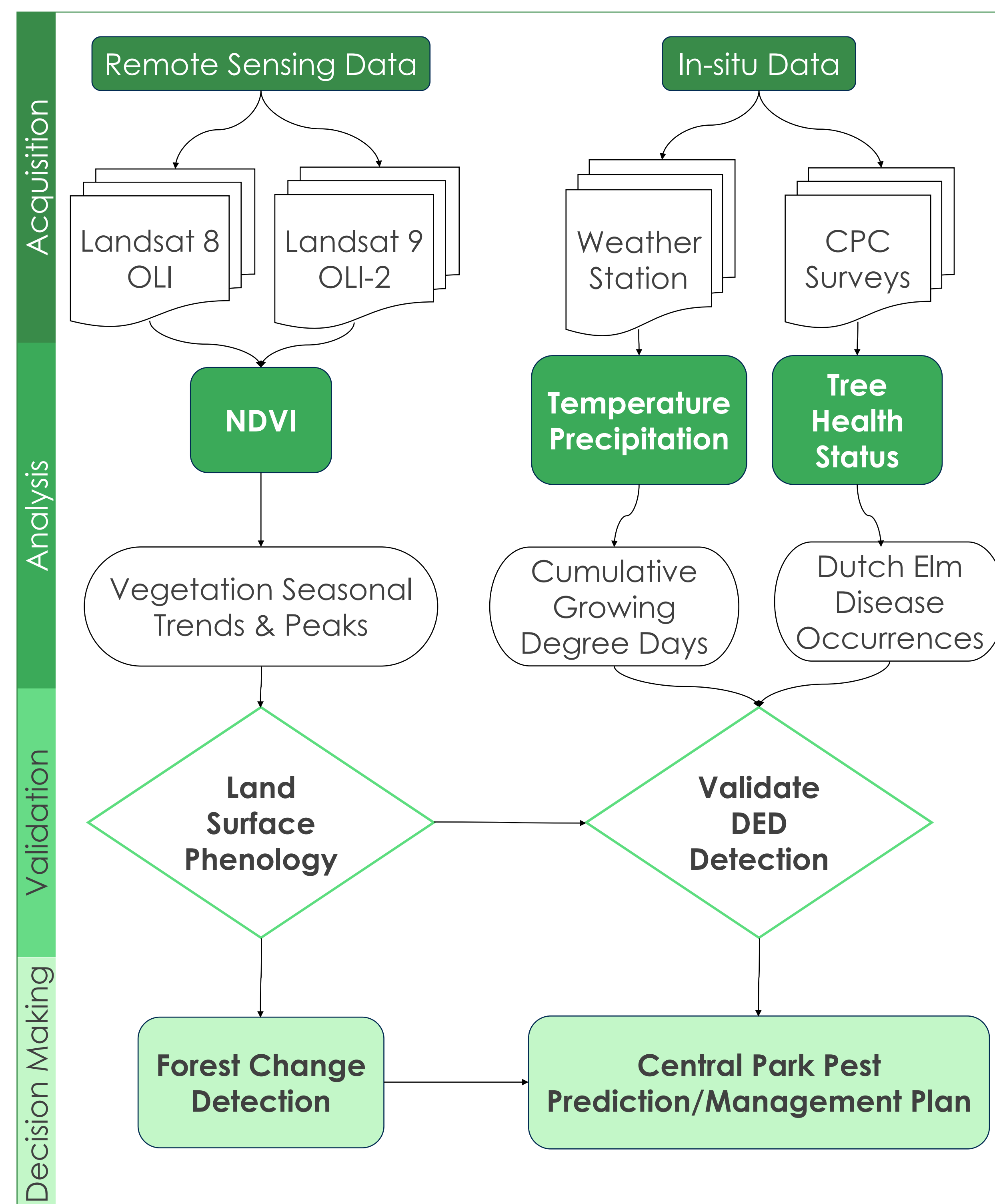


## OBJECTIVES

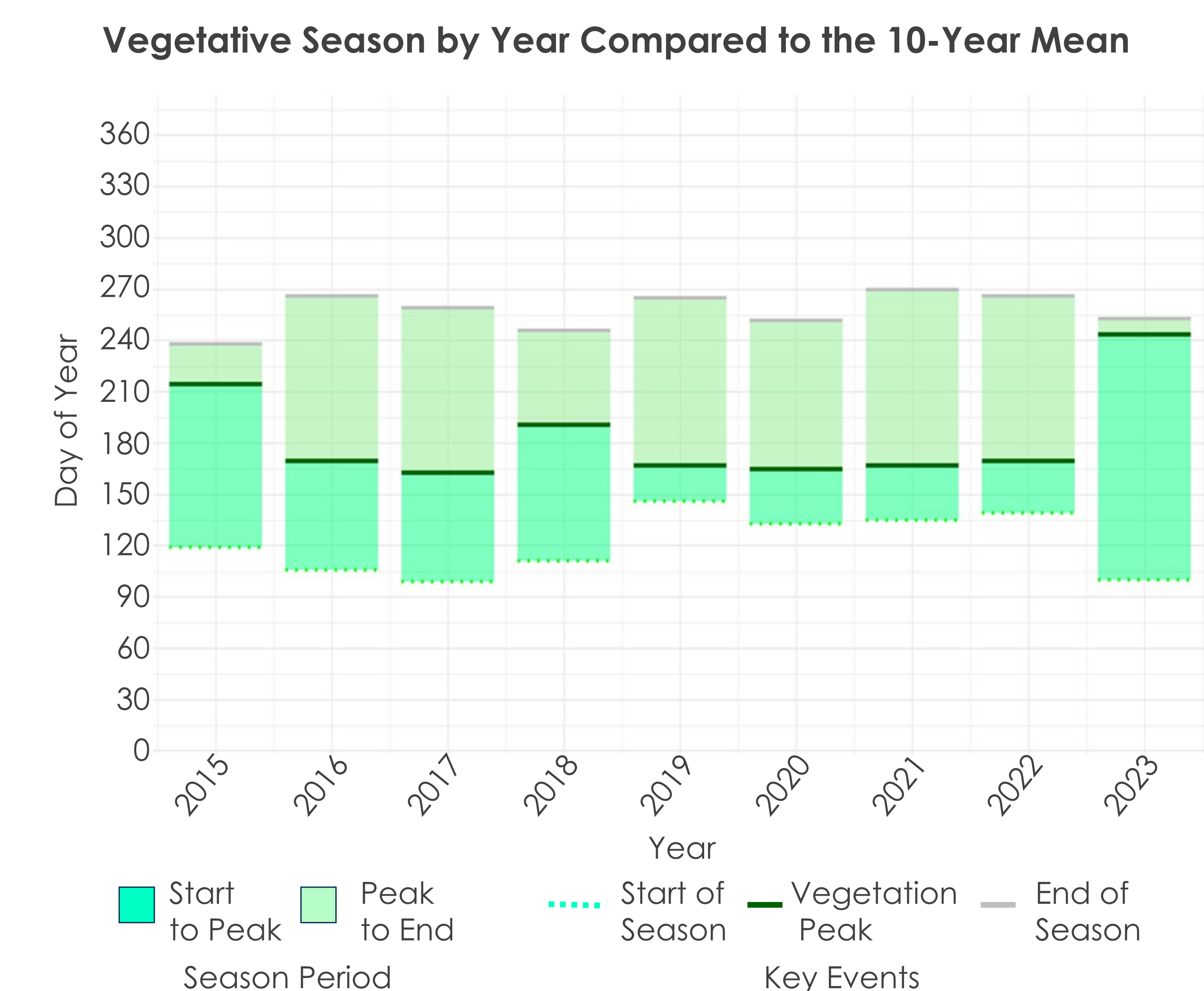
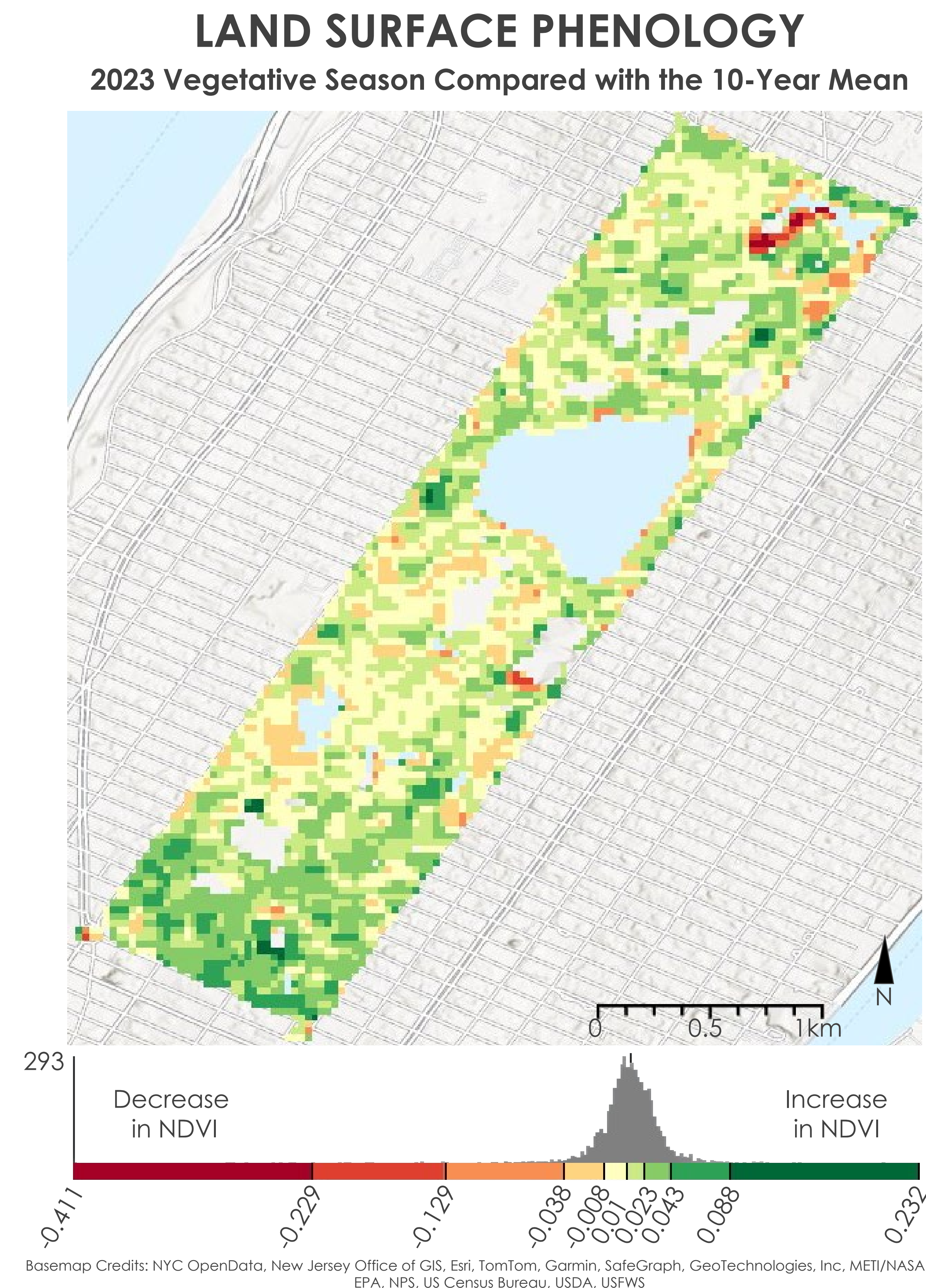
- ▶ **Monitor** land surface phenology in Central Park, with a focus on areas of interest with high concentrations of elm, and determine tree canopy change using Landsat imagery
- ▶ **Understand** the spread factors of Dutch elm disease such as temperature and precipitation
- ▶ **Validate** the detection of tree health and DED occurrences using NASA Earth observations

## DATA & METHODS

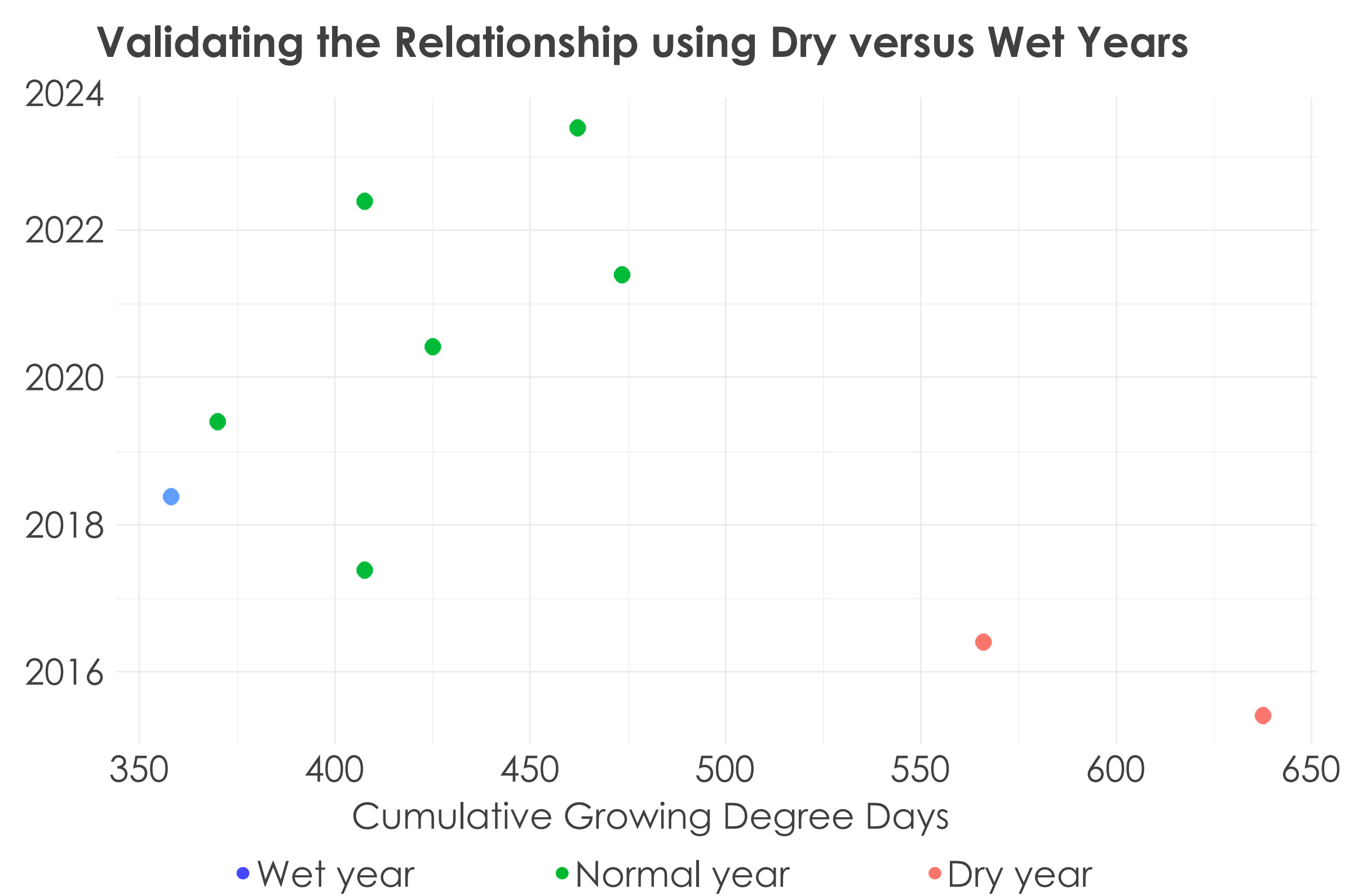
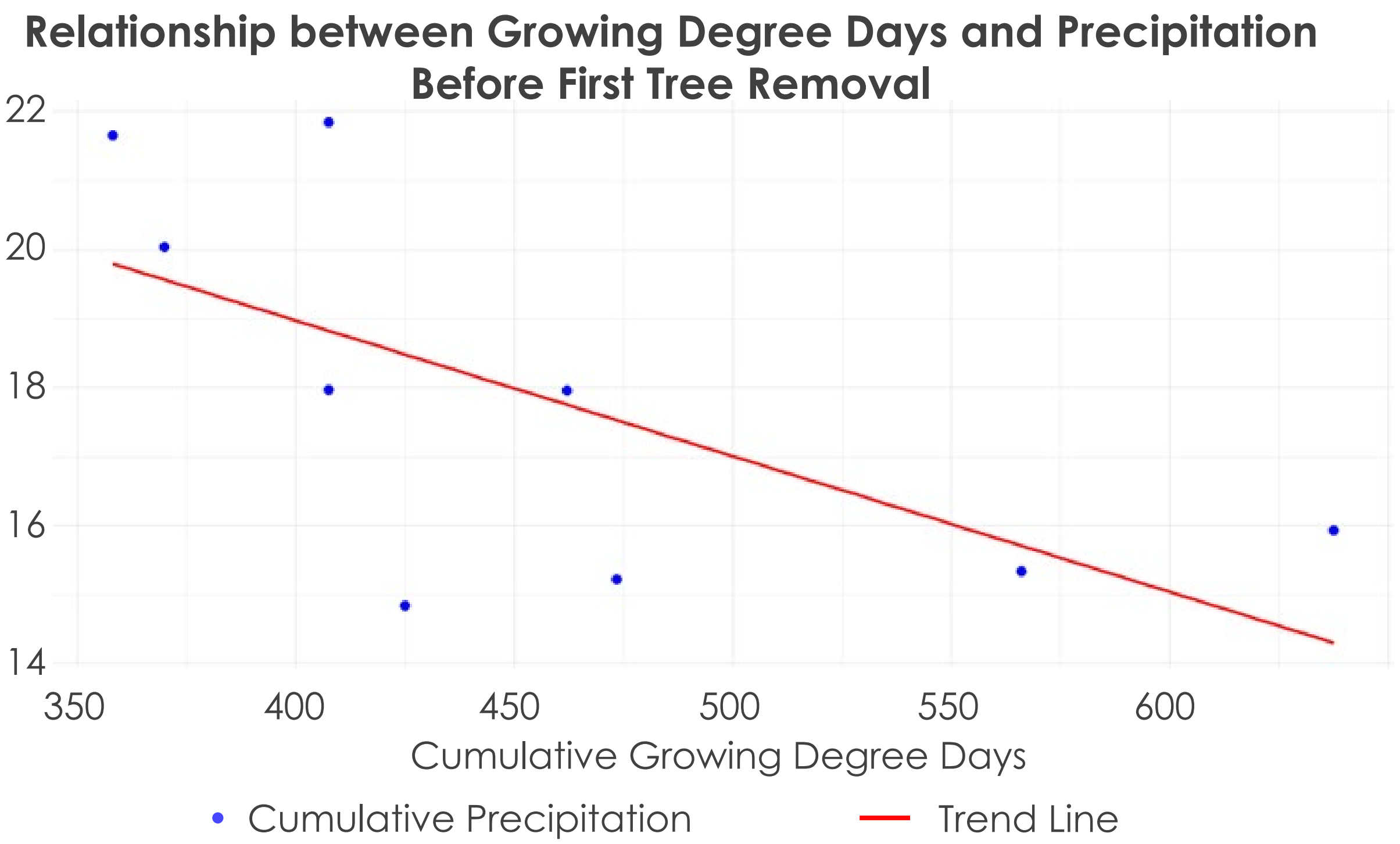
- ▶ Landsat 8 OLI and Landsat 9 OLI-2 imagery from 2014 to 2023 was used to create an NDVI time series analysis.
- ▶ A general additive model (GAM) analysis of NDVI was performed to estimate the start and end of seasons for each year.
- ▶ In situ data used for validation include:
  - ▶ Central Park weather station Global Historical Climatology Network-Daily temperature and precipitation from 2000 to 2023 to calculate cumulative growing degree days and precipitation
  - ▶ Tree locations, species types, diameters at breast height and canopy, and Dutch elm disease occurrences from the Central Park Conservancy
- ▶ An elm tree mask to select pixels with elm trees was created by calculating a linear regression to estimate elm trees with an unknown canopy diameter.
- ▶ A spatial join was performed between Landsat and in situ data to track the pixels at which an occurrence of DED was recorded, allowing a logistic regression model to be run to validate the ability to detect DED using NDVI derived from Landsat.



## RESULTS



## DUTCH ELM DISEASE SPREAD FACTORS



## LOGISTIC REGRESSION RESULTS

- ▶ **Healthy Trees:** The model's precision is 0.37, recall is 0.47, and F1-score is 0.41, indicating a moderate performance with a tendency to produce incorrect predictions for healthy trees.
- ▶ **Unhealthy Trees:** The model demonstrates higher accuracy with a precision of 0.76, recall of 0.67, and F1-score of 0.71, showing stronger detection capability for unhealthy trees.

## CONCLUSIONS

- ▶ NASA Earth observations successfully identified tree canopy seasonality, change, and anomalies in Central Park, but validation from in situ data could enhance precision.
- ▶ Adequate precipitation is key for elm bark beetles' spread.
- ▶ The logistic regression model performed better in identifying unhealthy trees than healthy ones, reflected in the higher F1-score for unhealthy trees.
- ▶ While remote sensing shows promise for detecting Dutch elm disease, the following challenges contribute to uncertainties: (1) moderate spatial and temporal resolution, (2) natural variability in land surface phenology, and (3) attempting to detect disease while prevention and mitigation is occurring.

## ACKNOWLEDGEMENTS

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### WHAT IS DEVELOP?

Since 1998, DEVELOP has fostered the use of Earth observation data and geospatial information to better inform environmental decision making. As a dual capacity building program, DEVELOP builds skills to access and apply satellite data in both its participants (students, recent graduates, and transitioning career professionals) and project partners (federal, state, and local governments; non-profits and for-profits; and international organizations). Projects are conducted in rapid, 10-week terms (spring, summer, & fall), by small teams of participants under the guidance of NASA and partner Science Advisors.

