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Crop Monitoring and Nutrient Prediction Using Satellite Imagery and Soil Data

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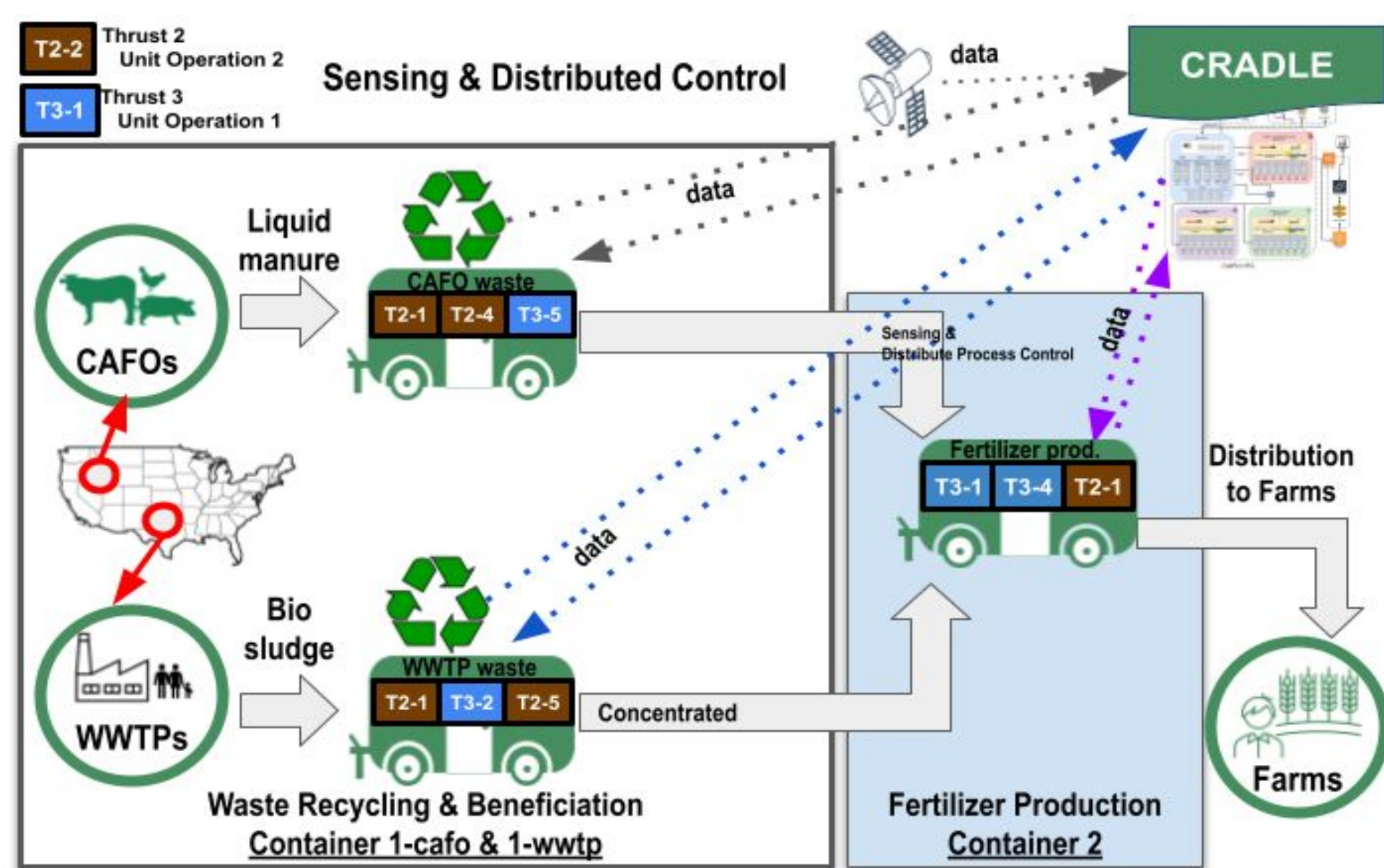[4] Center for Advancing sustainable and Distributed Fertilizer Production (CASFER

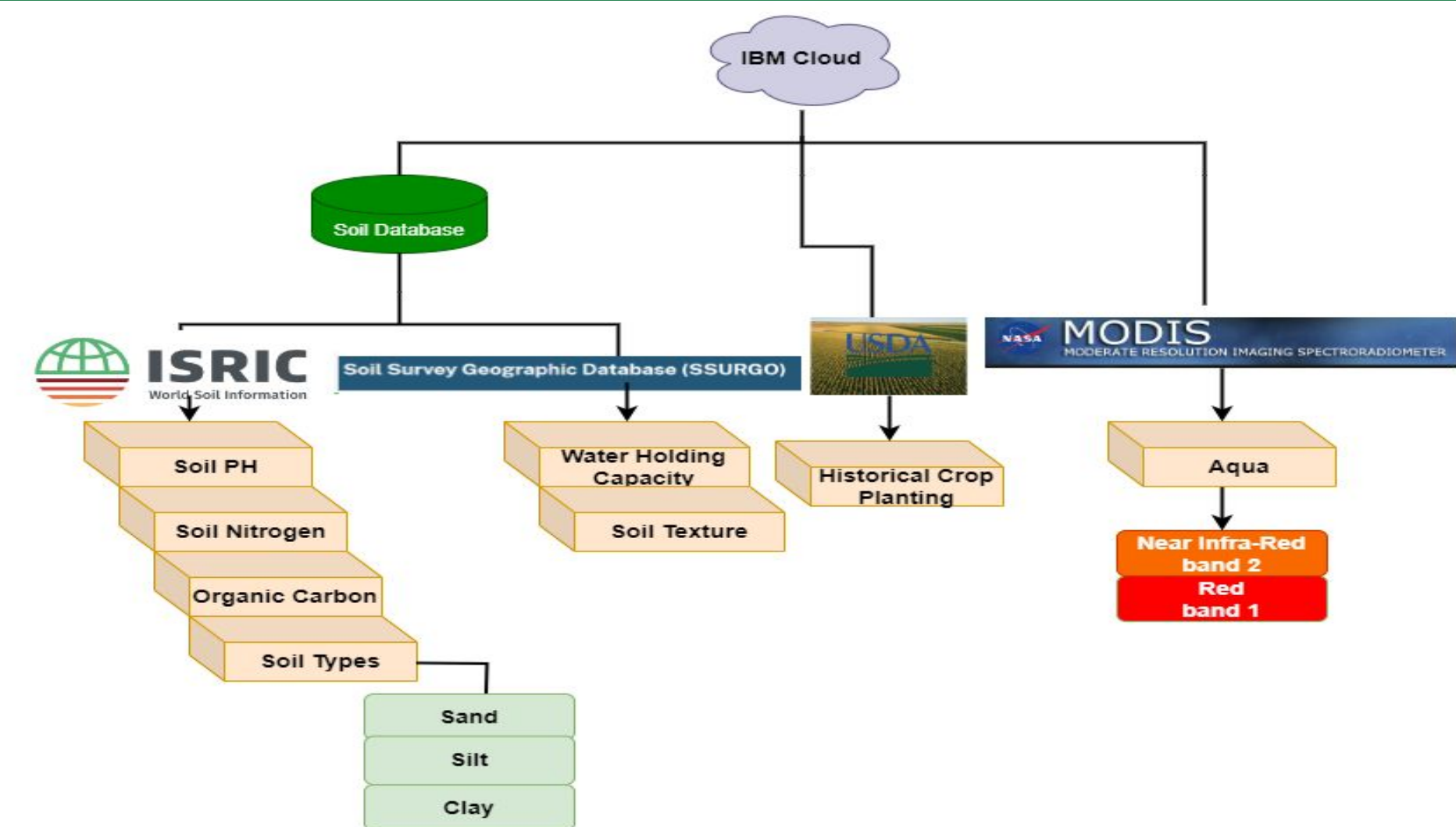Corresponding Author: Roger French, roger.french@case.edu
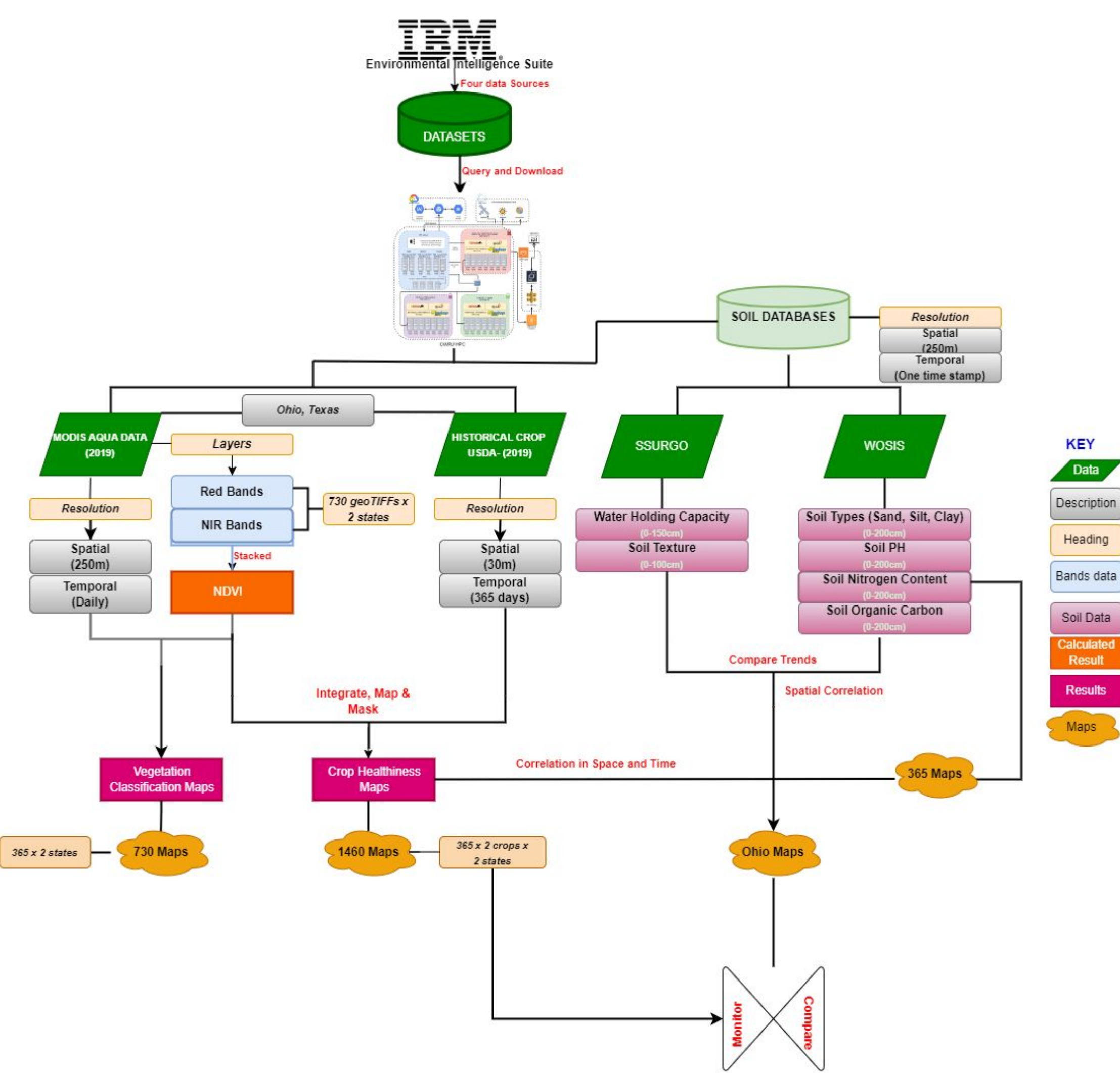
Introduction

- Aiming to resolve the problem of land application and proper crop planting among farmers
- Mitigate continual runoff from CAFOS/WWTPs into streams.
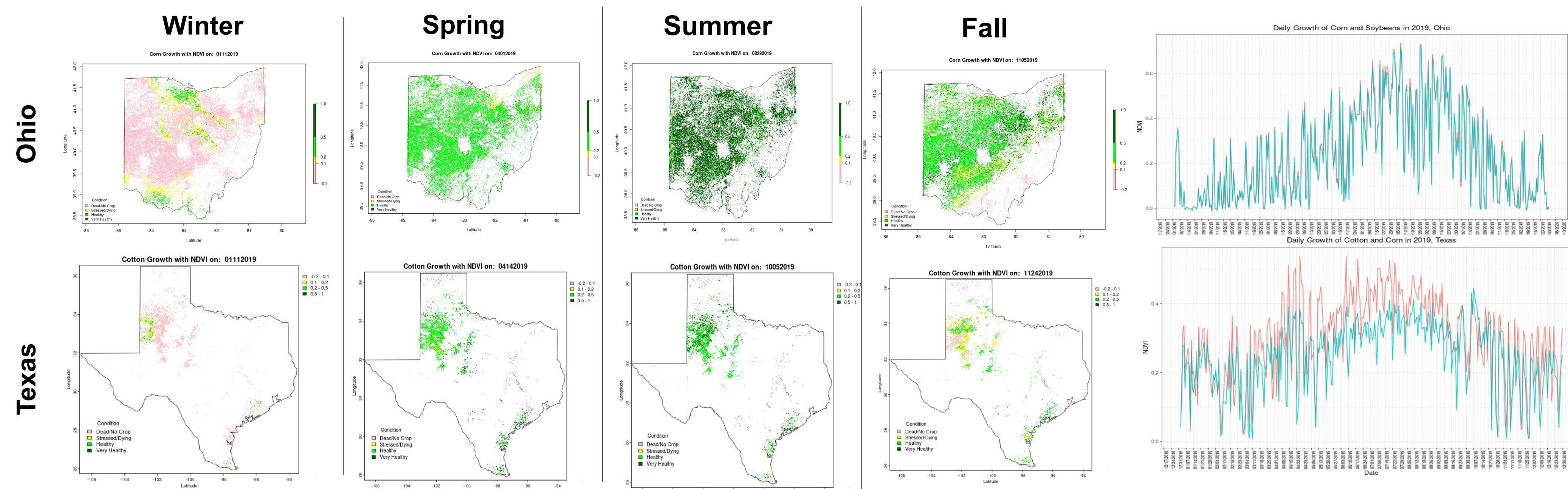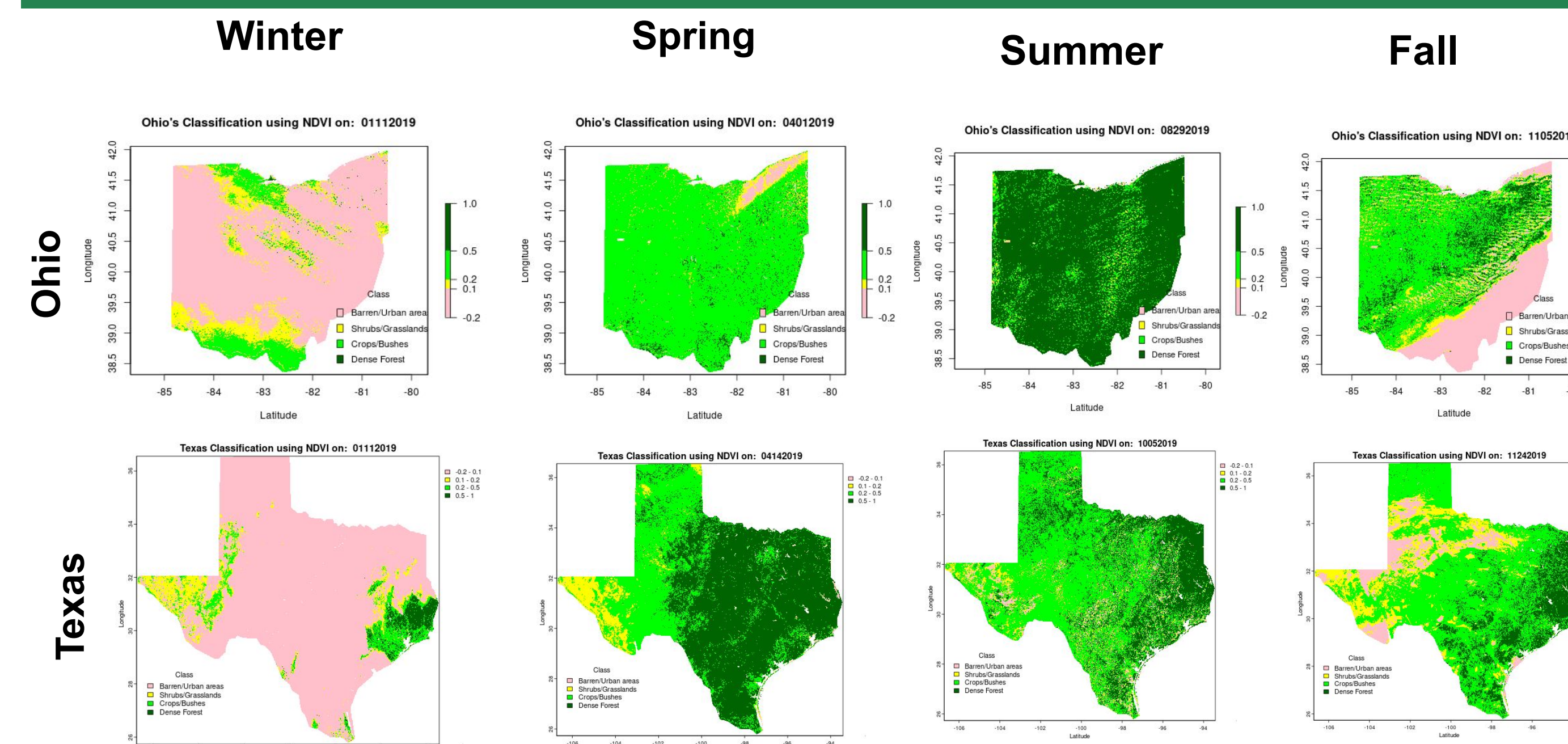- Geospatially locate where to position CASFER trailers

## Datasets

Methodology

Daily Crop Heathiness

Winter | Spring | Summer | Fall

Ohio

Texas

Daily Vegetation Classification

Winter | Spring | Summer | Fall

Ohio

Texas

Vegetation Index

- **MODIS Aqua(red and NIR bands)** were used to classify **Ohio and Texas**
- Classification is done with the calculated NDVI.

Normalized Difference Vegetation Index $NDVI = \frac{NIR - Red}{NIR + Red}$

- **Ohio**: **Corn** and **Soybeans** we
- **Texas**: **Cotton** and **Corn**
- The greenness of the crops vary with **seasons**, **location** and **crop type**.

Nutrient Distribution

Correlations Maps

Chemical Properties
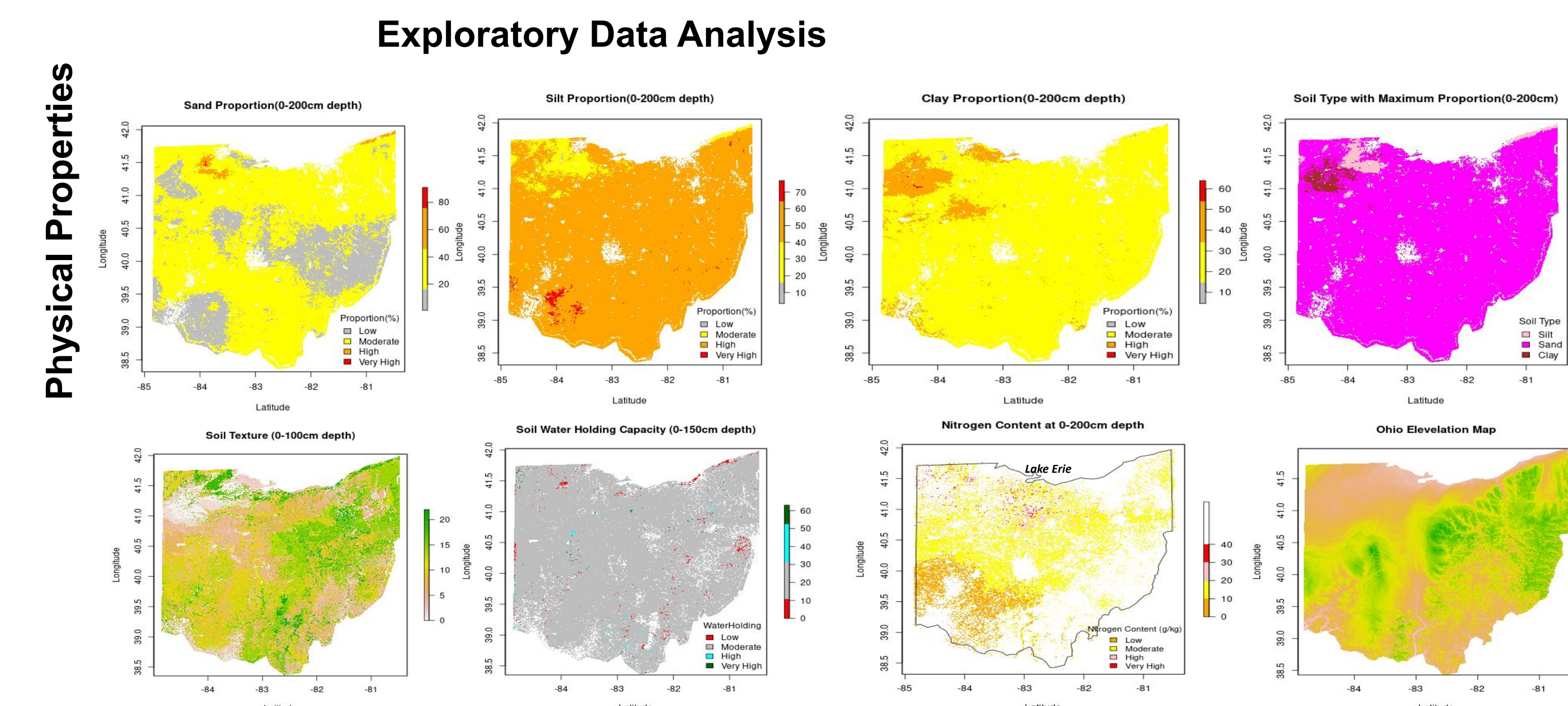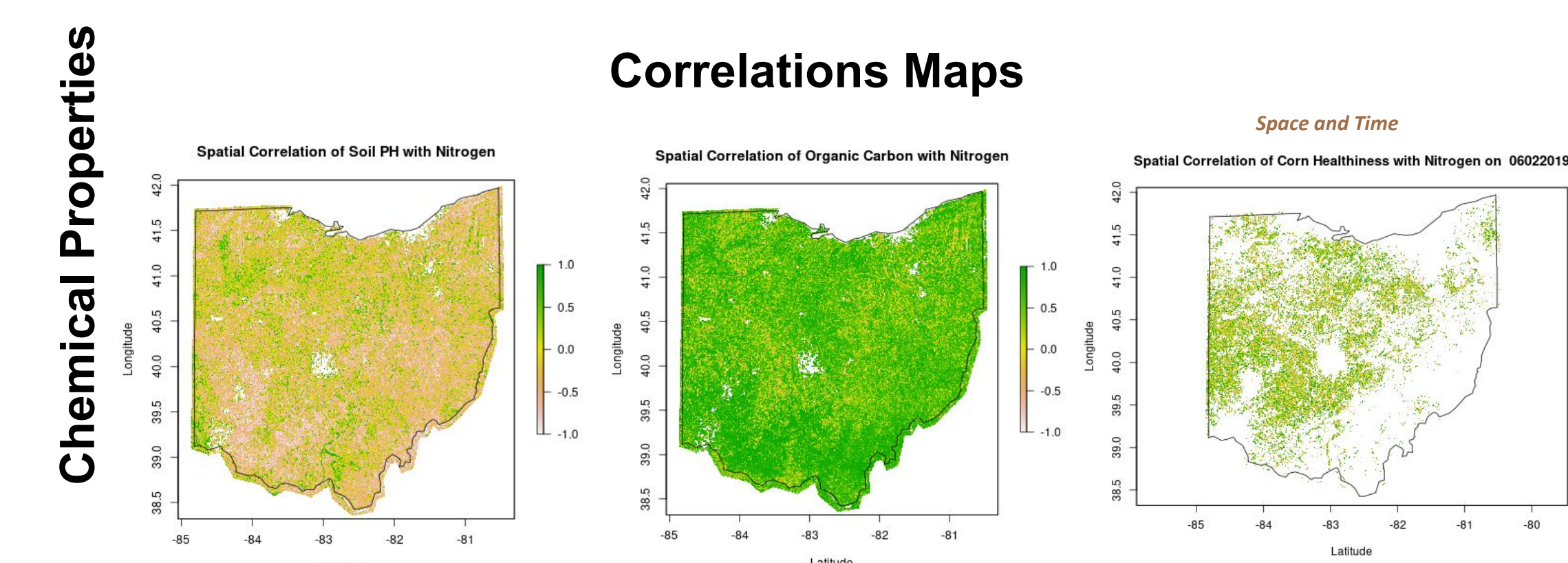
Discoveries

- **PH** has **negative correlation** with **Organic carbon**, **Crop Healthiness** and **Nitrogen**
- Maximum **Silt** and **Clay** towards the Maumee Watershed
- **More Nitrogen accumulation towards Lake Erie and Maumee Watersheds**

Exploratory Data Analysis

Physical Properties

Nutrients Flow

- Relatively **low texture towards Lake Erie** correlates with silt and clay available in that area
- Moderate Holding of water/nutrient across the state
- **High Nitrogen accumulation in low elevation area**

Predictive Model
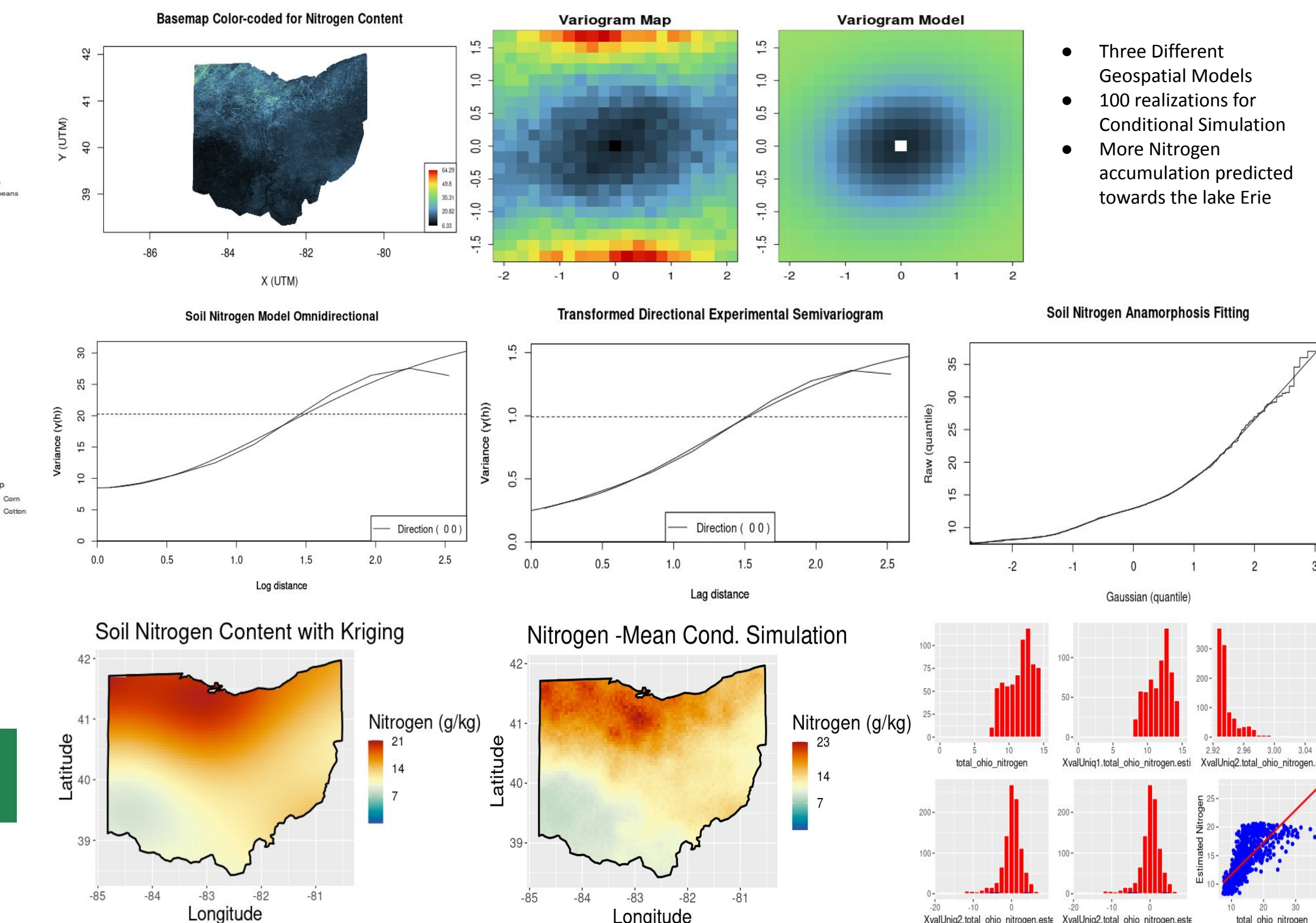
- Three Different Geospatial Models
- 100 realizations for Conditional Simulation
- More Nitrogen accumulation predicted towards the lake Erie

Takeaways

- **Gains**
  - Recommendation for farmers on crops planting and getting the locations where crops are planted.
  - Monitoring metrics is needed in land application in pursuit of the nitrogen circular economy
  - More nitrogen accumulation/contamination in known areas (help to know where to position CASFER trailers)
  - Soil Nutrient Distribution:
    - Useful on when land application is appropriate
    - Knowing right crop, best soil and time to plant
    - Soil properties correlate with nutrient flow
- **Next**
  - Integrate weather, CAFOS, water and elevation data
  - Explore other soil properties

Acknowledgement

References

- Lu, Siyuan & Shao, Xiaoyan & Freitag, Marcus & Klein, Levente & Renwick, Jason & Marianno, Fernando & Albrecht, Conrad & Hamann, Hendrik. (2016). IBM PAIRS curated big data service for accelerated geospatial data analytics and discovery. 2672-2675. 10.1109/BigData.2016.7840910.
- Zhan, X., Sohlberg, R. A., Townshend, J. R. G., DiMiceli, C., Carroll, M. L., Eastman, J. C., et al. (2002). Detection of land cover changes using MODIS 250 m data. Remote Sensing of Environment, 83, 336–350.

Thrust Interactions

Thrust 1

Thrust 2   Thrust 3

Animations