Three-Dimensional Modeling of Almond Orchards

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Aims and Objectives:

The overall objective of this project is to develop a simulation platform that serves as a tool to perform virtual experiments in almond orchards in order to better understand the effects of various design and management decisions.

Specific objectives are listed below:

1. Adapt the Cronus simulation system to almond orchards in order to develop an efficient, three-dimensional modeling system that can accurately predict water transport, microclimate, radiation interception, and photosynthesis in almonds.

2. Perform model calibration, verification, and validation.

3. Use the model to examine a wide range of canopy architectures and quantify trade-offs between water usage and photosynthesis.

Computer-aided Design and Management:

The last several decades have seen revolutionary improvements in product design and development across many industries as a result of computer design and modeling (i.e., CAD) tools. However, the agricultural industry is largely lacking such technology.

This project focuses on developing detailed modeling tools to be used to accelerate innovation in almond orchard systems by allowing for virtual testing of design and management strategies.

computer-aided innovation process
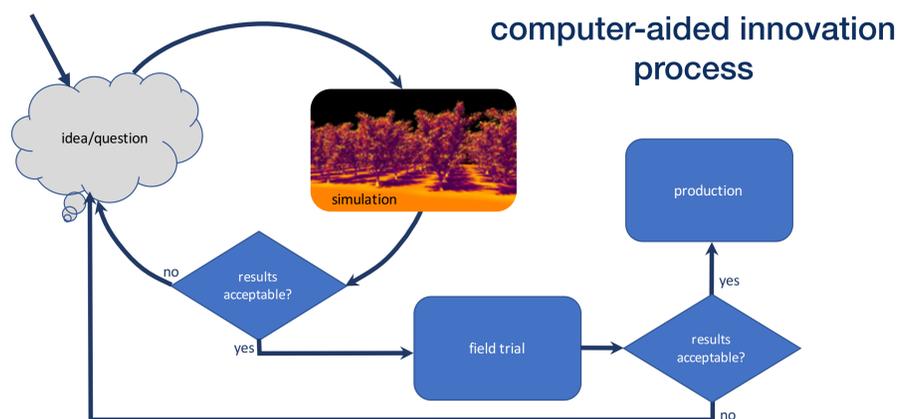
Inputs   Models   Outputs

LiDAR Reconstructions

High-resolution laser scanning (LiDAR) is used to reconstruct the almond canopy leaf-by-leaf.
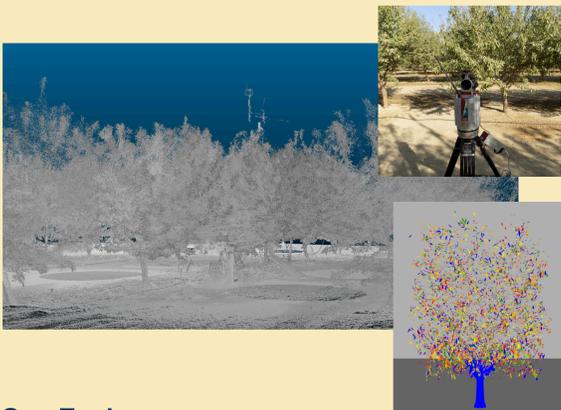
Gas Exchange

Gas exchange measurements are performed to measure the response of photosynthesis and transpiration to environmental conditions.

Canopy Representation

Every leaf and branch is explicitly represented by the model based on the LiDAR reconstruction.

Three-dimensional Models

- Sunlight (radiation) interception
- Temperature (microclimate)
- Water evaporation
- Photosynthesis

Model Acceleration

3D models require a lot of computer power to run. We accelerate the models using graphics processing units (GPUs).

Three-dimensional Visualizations
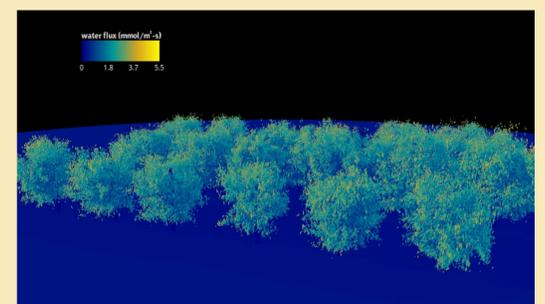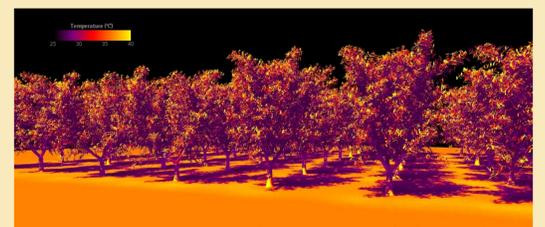
Other Outputs of Interest (future work)

- Crop coefficients
- Light interception
- Water use efficiency
- Potential yield

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california almonds