Decision Support Tools: Modeling Plant X Environment Interactions For Improved Management

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SmartPath USDA *Meeting Nov 14, 2018*
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Reduce Crop Losses by using Crop Models to Improve (Genetic) Environment X Management–

"Unseasonably warm temperatures deprived the crop of needed "chill hours," followed by freezing temperatures in mid-March that stretched across the Southeast."

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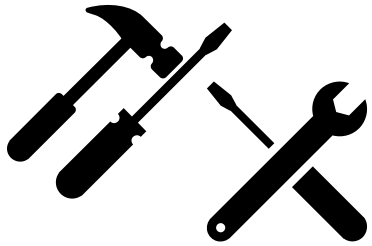

Plant Breeders and Farmers Need Decision Support Tools

- It takes approximately 10 years for a new genotype of a crop to make it to market.
- As climates change, new crop cultivars (genotypes) need to be created that are adapted to these changes (i.e., the targeted environments).
- Plant breeders need computational tools to design and test new genotypes in targeted environments without running costly experiments.
- Tools to characterize the **environment** are necessary to tease out the plant – environment- soil ecosystem interactions for better management (farm management).

  ❑*Improved Sensor Technology*

  ❑*Network Models of water-soil-microbe-plant systems*

  ❑*Decision Support Models to better manage crops*

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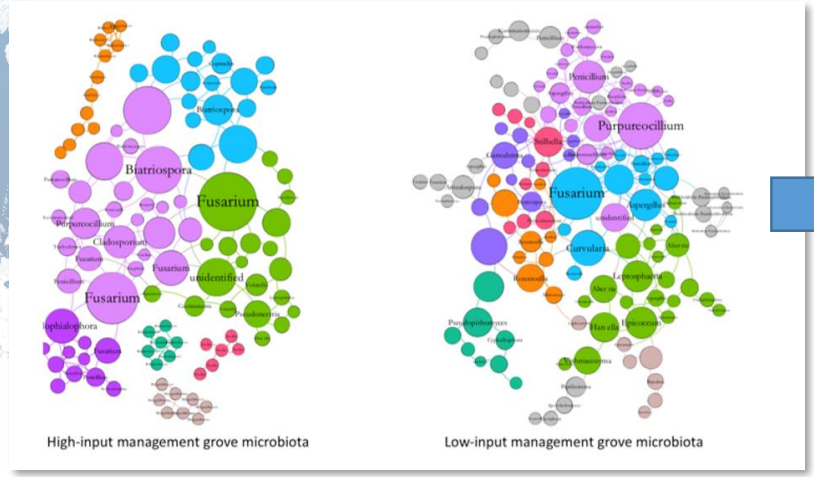
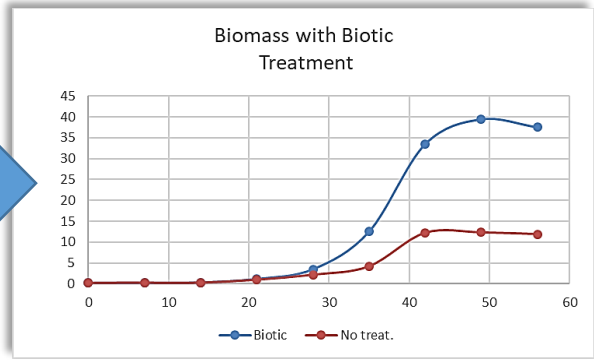
Hydroponics (lettuce) – Test Bed for Pathogen Detection and Biotic Controls (with Drs. Sarah Strauss (UF), McLamore (UF), Gomes (IA), Stutte(SyNRGE LLc))



Microbial Community (+/- treatment)
Image Provided Dr. Strauss



Predictive Model of Plant Growth

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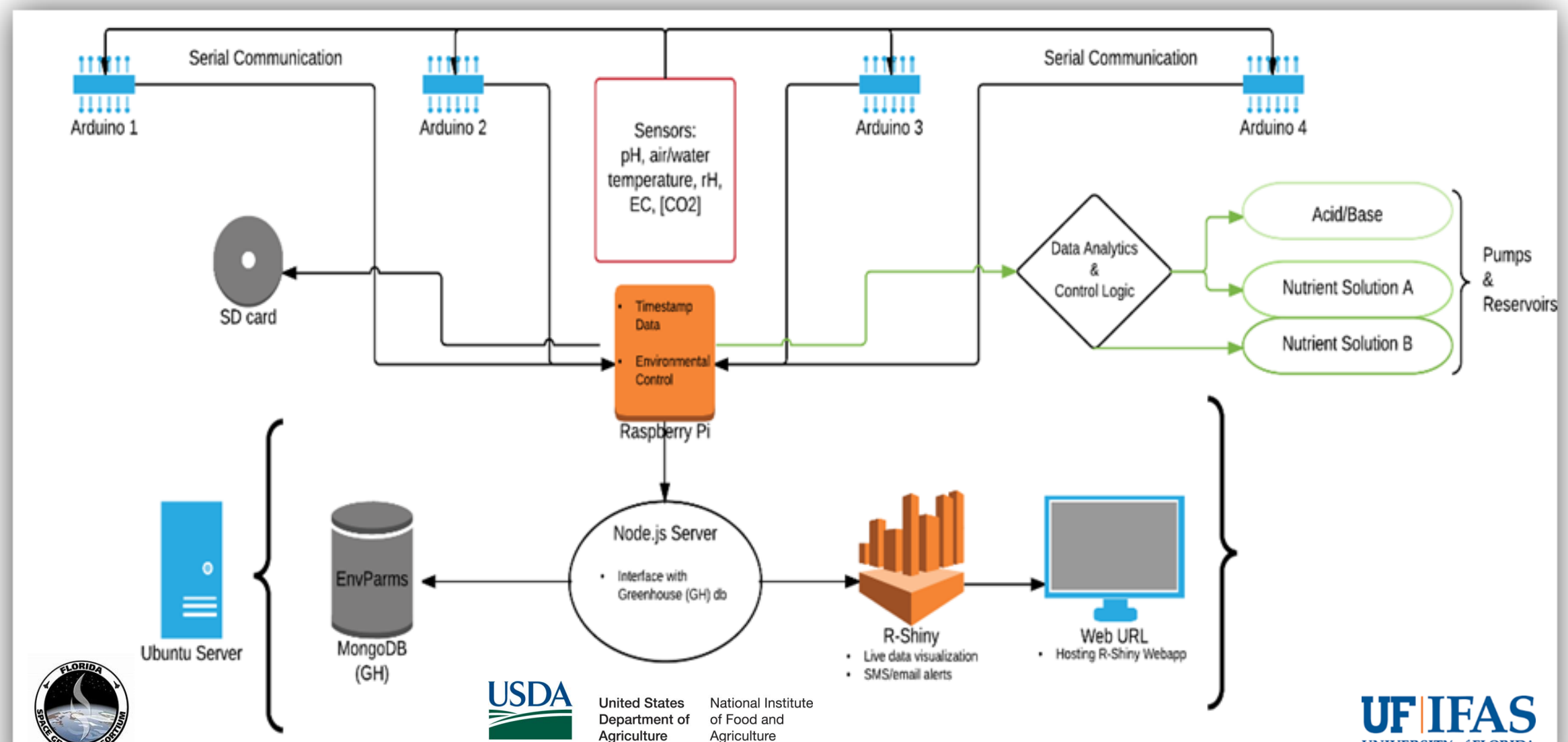
Ph.D. student: Emerick Larkin

HydroPatrol – Low Cost ($500), Online Monitoring and Control System -Sensors (https://github.com/EmerickL/HydroPatrol/),

Ph.D. student:
Emerick Larkin



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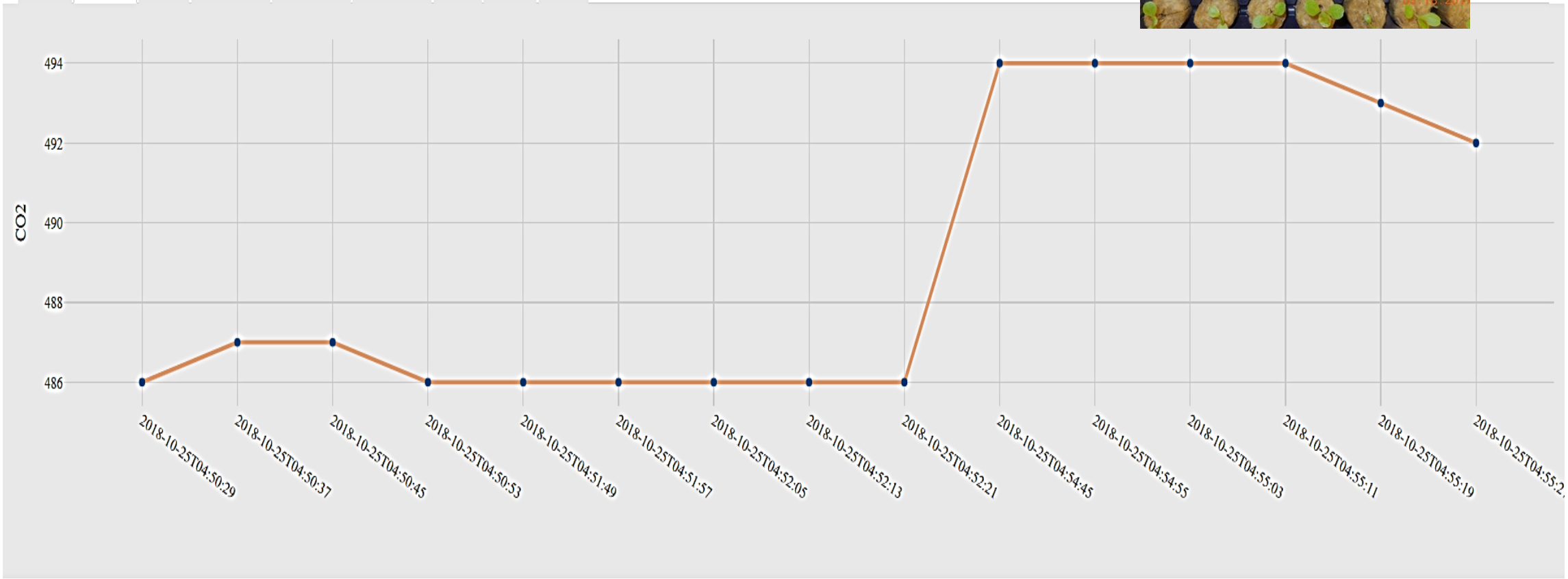
SmartPath - HydroPatrol

Select System

B4E62D2726AF

dO | CO2 | EC | temp3 | temp2 | temp1 | lvl | pH | rH



Resolution:

10

Minutes Back:

60

Ph.D. student:
Emerick Larkin

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SmartPath - HydroPatrol

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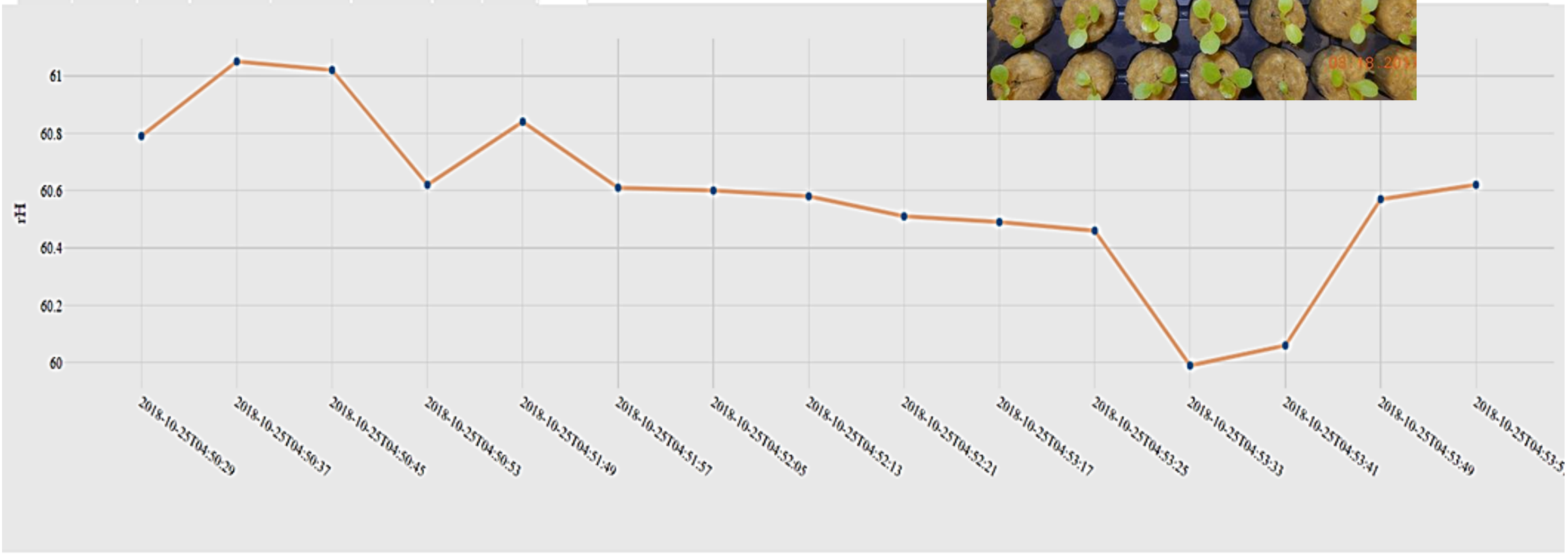

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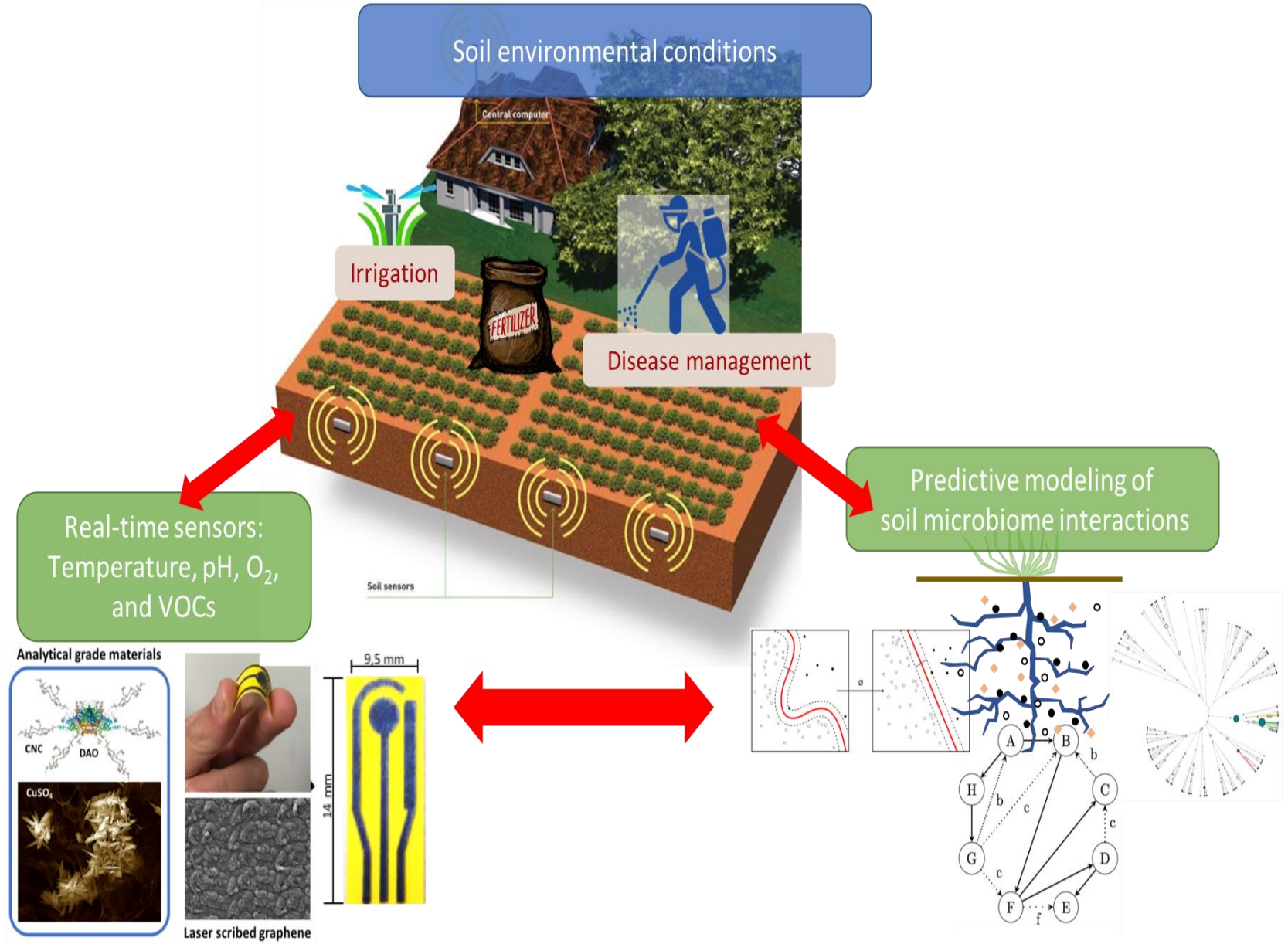
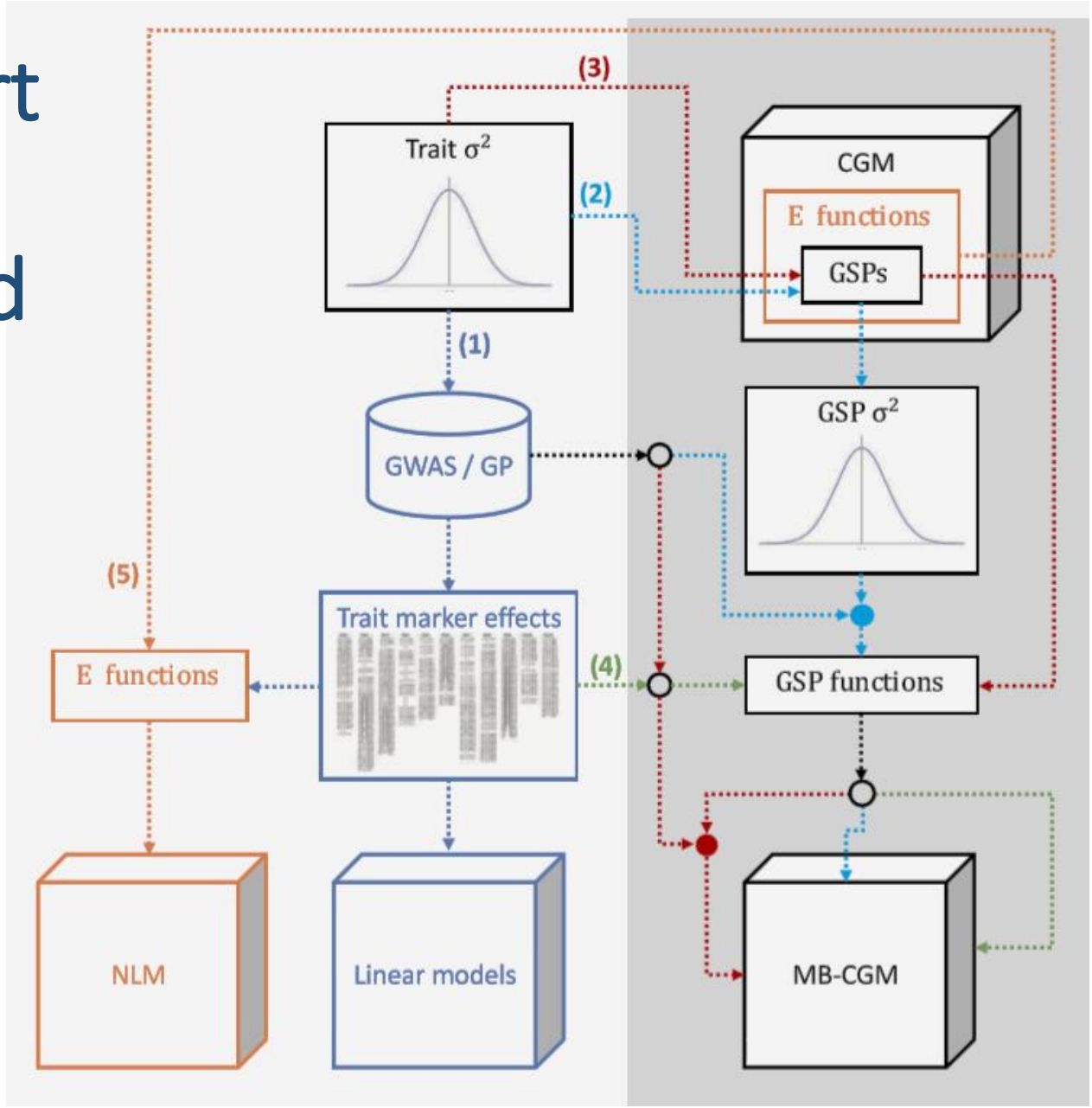


Figure 1 – Overview of autonomous soil sensor system, including long-lasting, ultra-low powered, sensor development, their validation in greenhouse experiments and in-field testbeds, and biophysical model development for healthy soil microbiome.

Improve Decision Support Tools→ Crop Modeling Environment (abiotic and biotic)







Ph.D. student: Christopher Hwang

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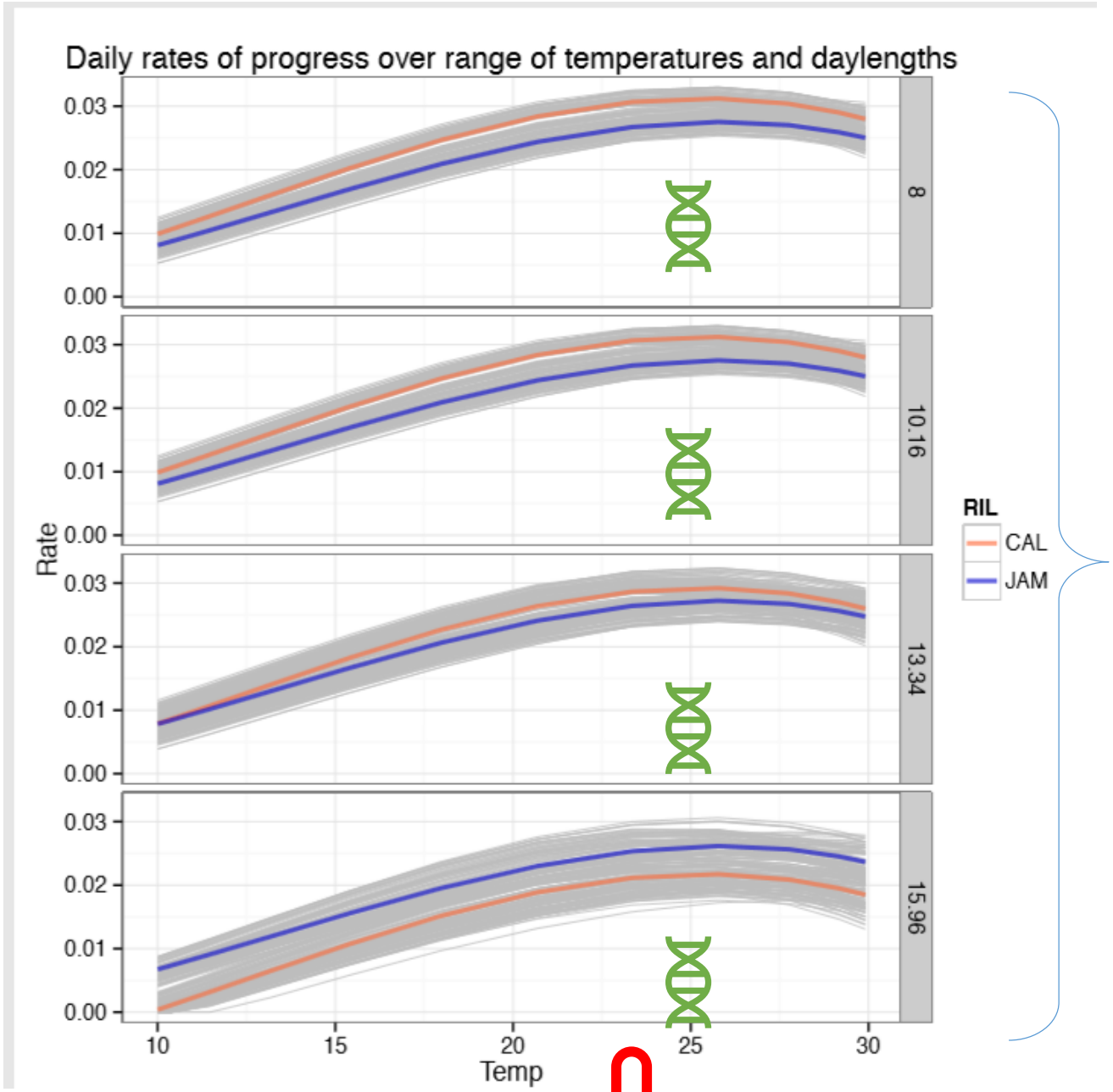
Rate Towards Flowering (per hour)



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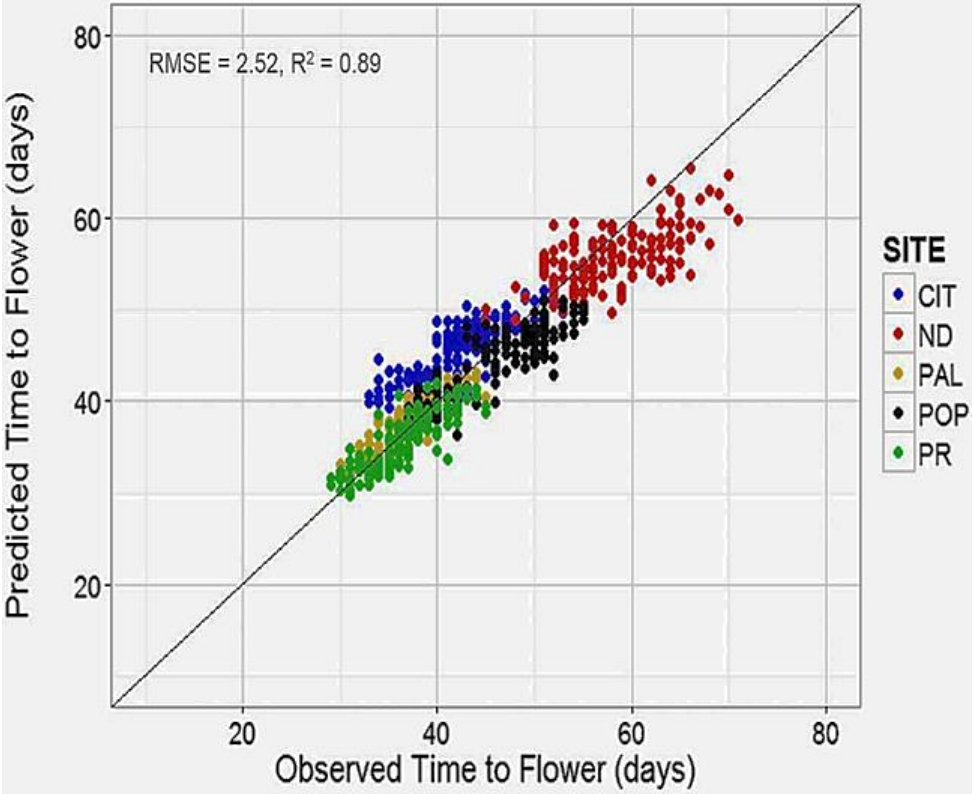
Christopher Hwang

Predicting Flowering Based on Genetic, Environment and G X E



Bahkta et al. G3: Genes, Genomes, Genetics December 1, 2017 vol. 7 no. 12 3901-3912; https://doi.org/10.1534/g3.117.300229

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PSU, Pennsylvania

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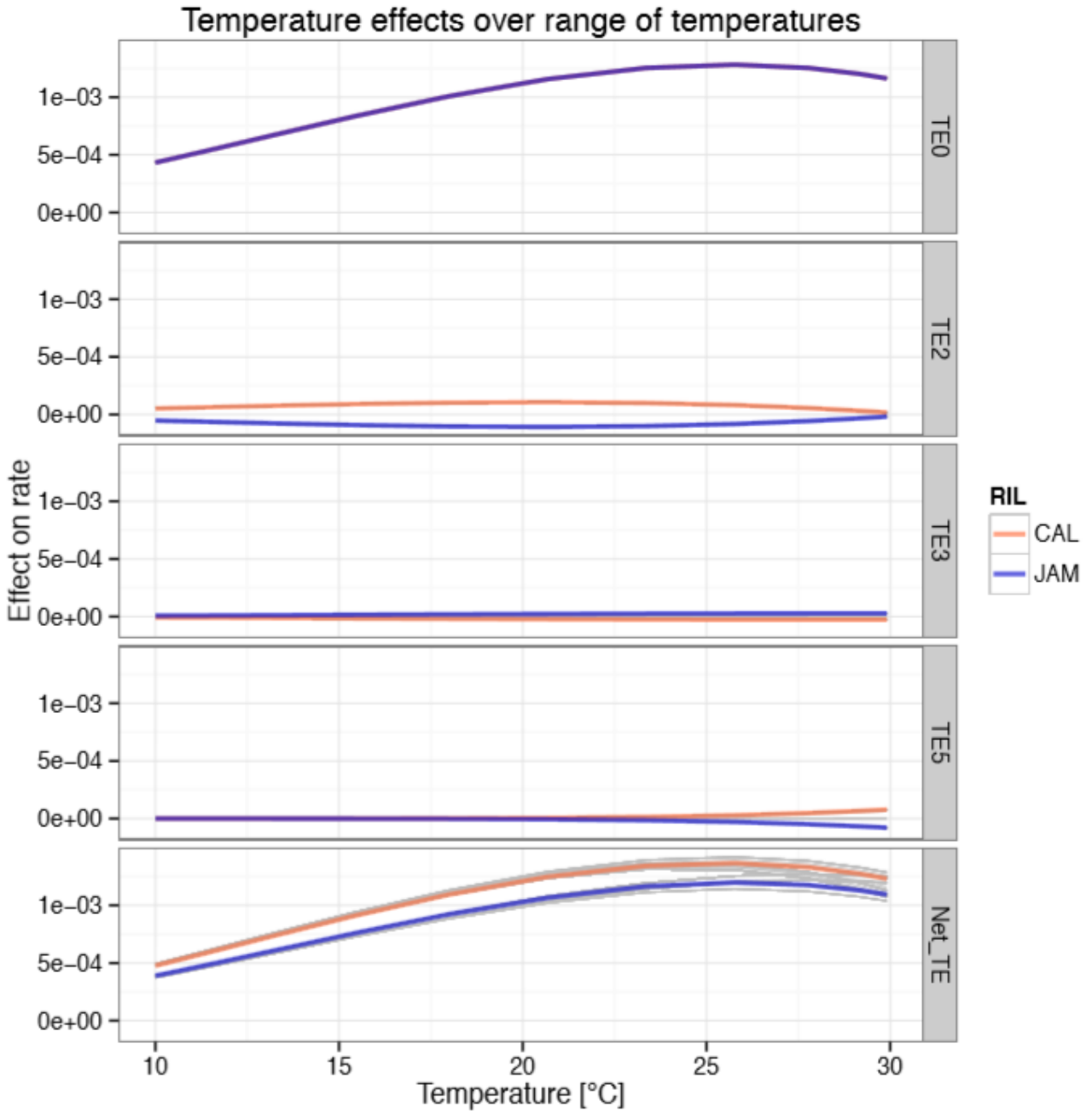

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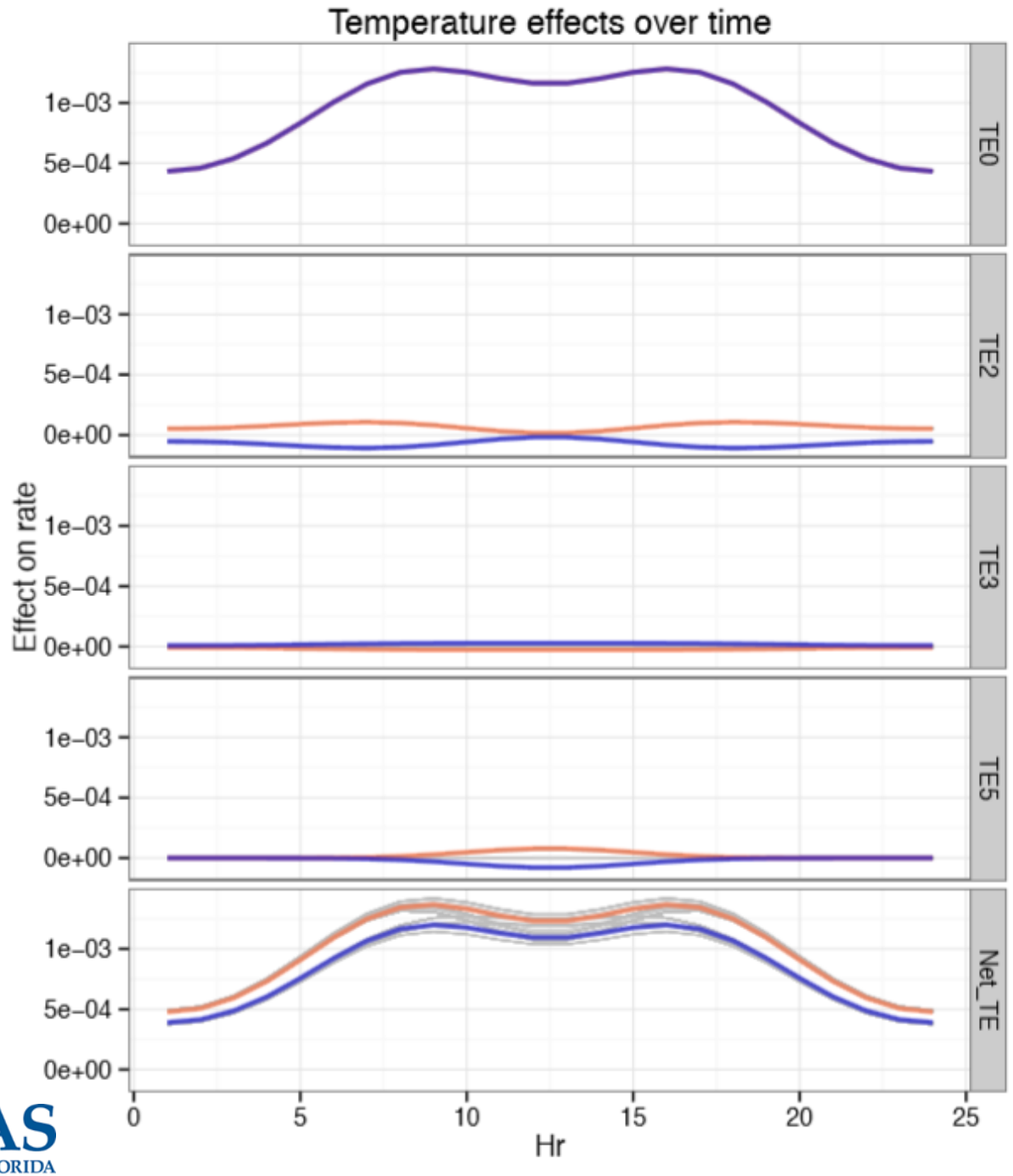

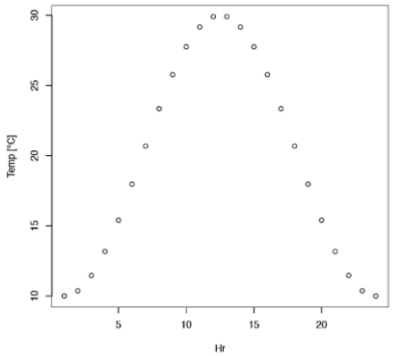

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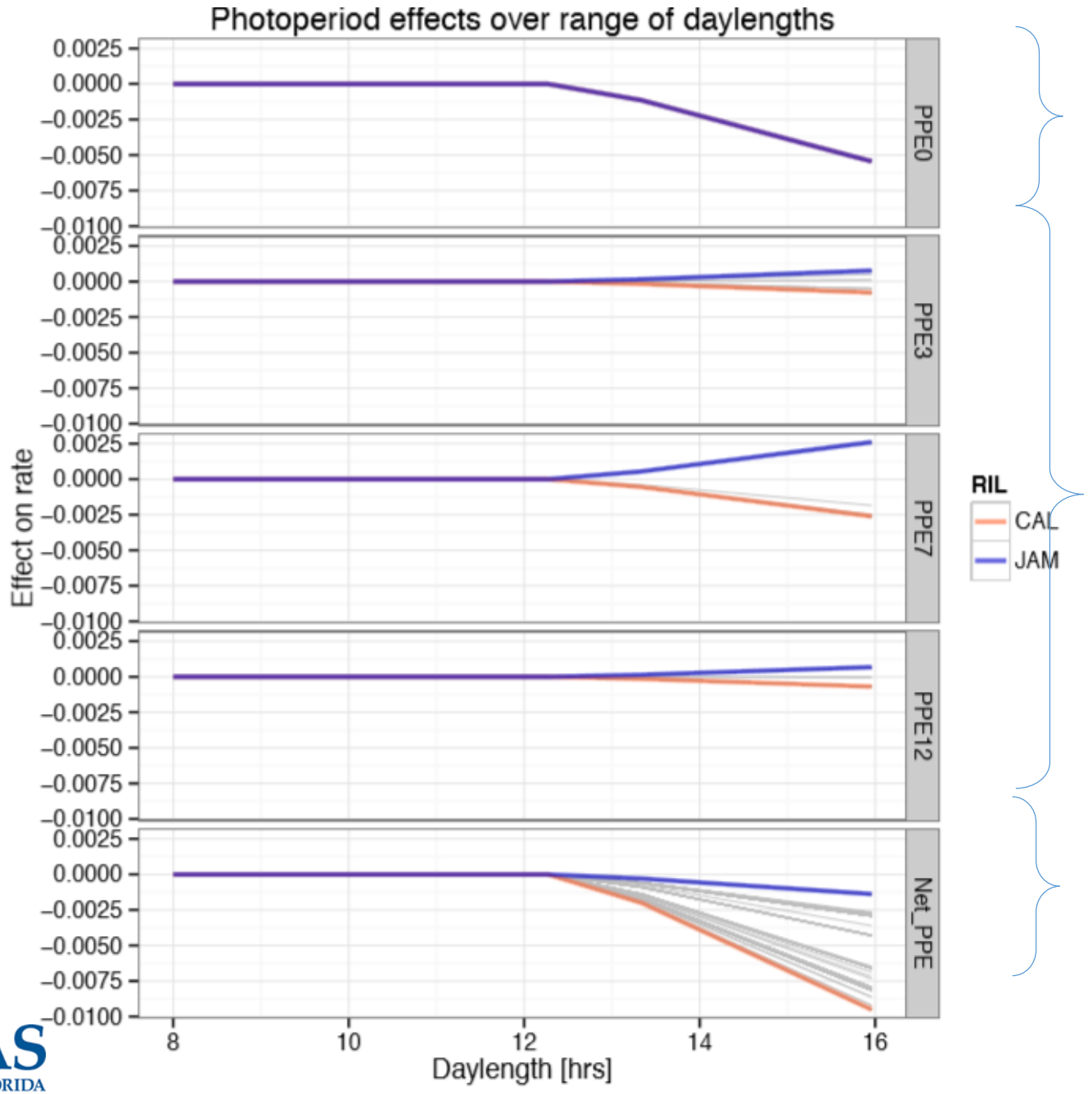

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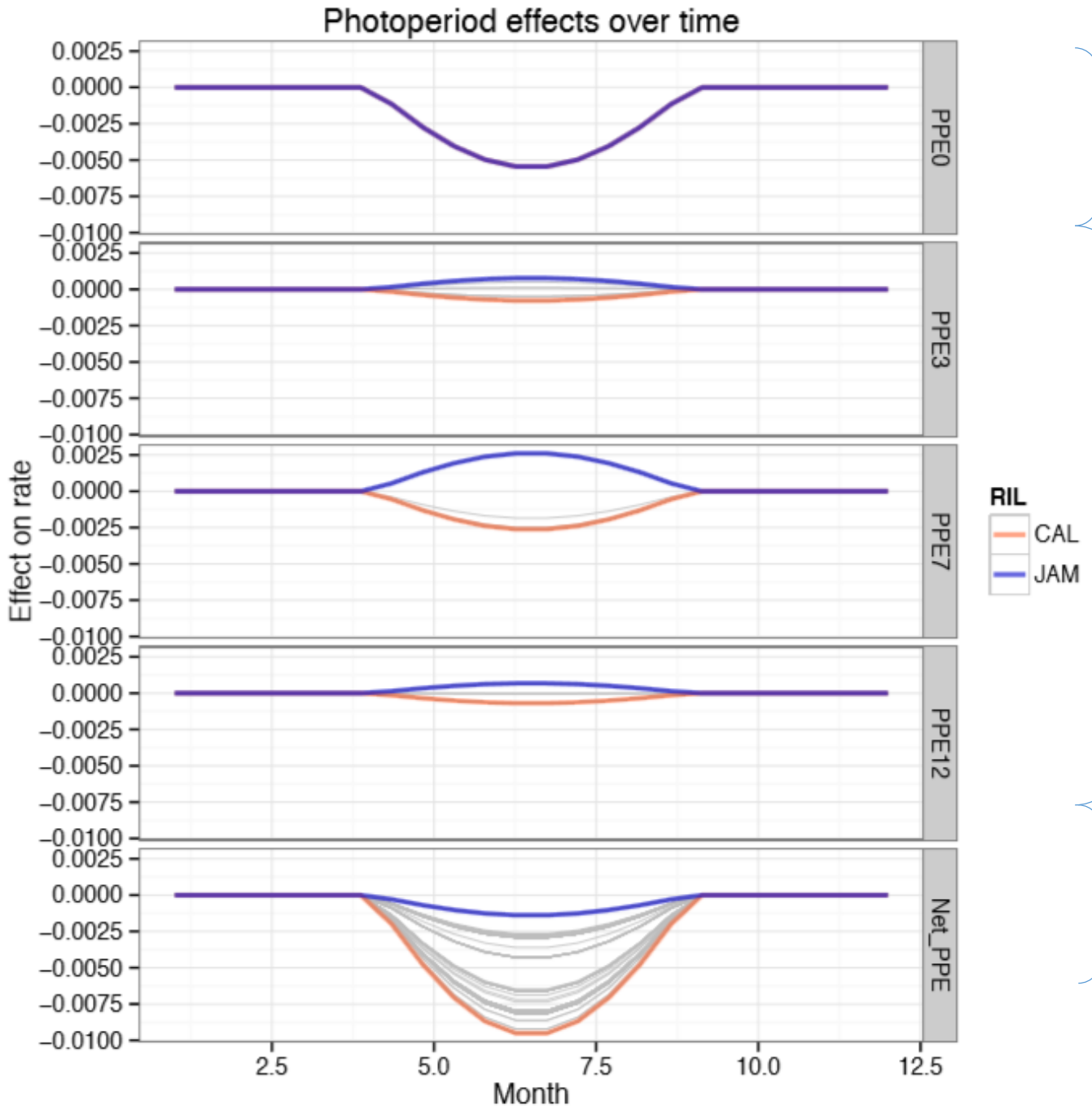

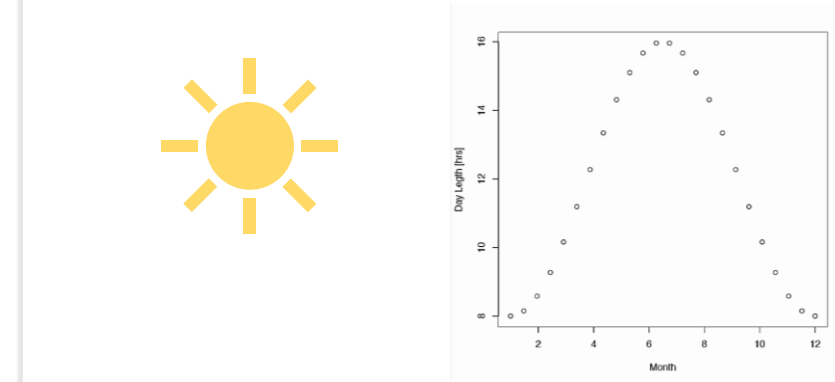

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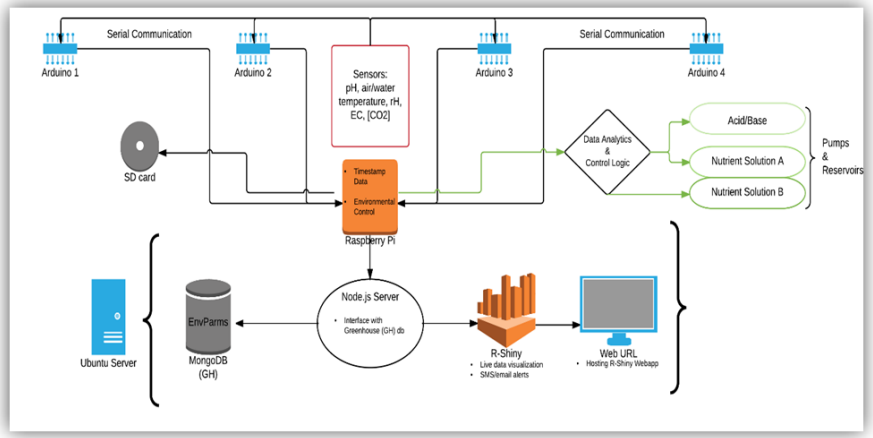
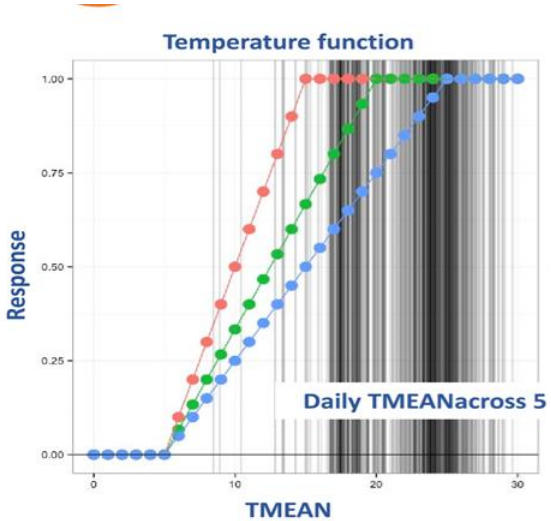
Contributions to SmartAg, Farm of the Future





$$Ft_i = 44.18 + 4.026(Day_i - Day_m) + 0.1895(Srad_i - Srad_m) - 1.363(Tmax_i - Tmax_m) - 0.6091(Tmin_i - Tmin_m) - 1.31(TF1_i) - 2.279(TF2_i) + 1.59(TF3_i) - 0.5576(TF4_i) + 0.04971(TF5_i) - 0.8937(TF6_i) + 0.8774(TF7_i) + 0.3658(TF8_i) + 0.6629(TF9_i) + 0.3565(TF10_i) - 0.5583(TF11_i) + 0.326(TF12_i) - 0.3337(TF1_i * TF2_i) + 0.3031([Tmin_i - Tmin_m] * TF2_i) + 1.808([Day_i - Day_m] * TF3_i) + 0.1974([Tmin_i - Tmin_m] * TF3_i) - 0.1495([Tmax_i - Tmax_m] * TF5_i) + 0.4997([Day_i - Day_m] * TF7_i) + 0.0266([Srad_i - Srad_m] * TF12_i) - 0.2764([Day_i - Day_m] * TF12_i)$$

General structure of the HydroPatrol full-stack

Bahkta et al. G3: Genes, Genomes, Genetics December 1, 2017 vol. 7 no. 12 3901-3912; https://doi.org/10.1534/g3.117.300229

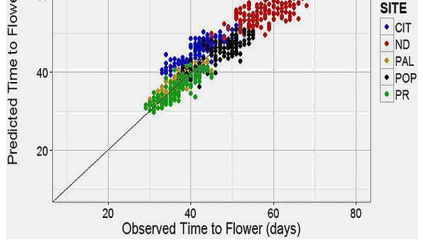
Melanie Correll @G2EPlants

Topic: → Genotype to Phenotype based on Environment

- **Research (60%):** Developing tools to unravel the Genotype to Phenotype Grand Challenge
  - *Integrating Genetic Information into Crop Models (tools for plant breeders)*
  - *Biotic/Abiotic factors affecting plant growth and development (network analyses-microbiomes)*
  - *Using controlled environment agriculture (CEA agriculture) to understand the Genotype to Phenotype relationships*
- **Teaching (40%):** ABE 3000c (Applications in Biological Engineering): ABE 4662 (Quantification of Biological Processes); ABE 4905 (Industrial Hygiene); ABET Coordinator, *New Agroecology Course with Wageningen?;* iGEM faculty advisor (2017, reviewer 2018)
- **Current funding interest**: Crop Models, Genotype to Phenotype studies, hydroponics, digital ag, sensor technologies
- **Industry partners or interest in industry partners:** (SyNRGE, LLC via Dr. Gary Stutte, Florida Space Grant Partner), CEA companies, Monsanto/Climate Corp.







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