Lecturer: Jhonathan Ephrath

The student will read, present and discuss with the lecturer, research papers dealing with the subjects mentioned below. The student will be guided as to possible papers to choose so that a comprehensive picture is built of how plants synthesis and regulate metabolites and what techniques are used for this topic.

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentations</td>
<td>80%</td>
</tr>
<tr>
<td>Class discussions</td>
<td>20%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>

Course Description:
During the first 4 classes, Students will learn concepts involved in developing models of the soil-plant-atmosphere system with a focus primarily on plant growth and development. Course will provide an in-depth survey on different approaches used in explanatory crop models to simulate crop gas exchange (photosynthesis and transpiration), organ expansion rates, carbon allocation, and crop phenology. The course will include 4 lectures of the teacher of the course and 9 lectures of the student according to reading assignments.

Course Objectives:
To give to the students the ability to understand the concepts of using models that describe agricultural activities (irrigation, fertilization) together with physiological processes taking place in plants.
The course does not deal with programing and the participants do not need to have any experience in computer science.

Course Structure:
i) Why do we need models for agriculture - Introduction
   Student - examples of computerized decision support as used in irrigation management, yield-gap analyses, and geospatial food security
ii) Modeling theory / Systems analysis
    Student - Models as abstraction of reality; Descriptor variables and system behavior;
    Conceptual overview of model building / testing / validation
iii) The soil-plant-atmosphere system
    Student - Basic concepts involving soil physics, plant physiology, and meteorology;
    Plant as the central component of the system
iv) Crop modeling overview
    Lecture (Teacher) - Why are more complicated models needed?
v) Crop growth 1: Radiation Use Efficiency (RUE) – reading and student assignment
    Student - concept of LAI, light extinction through the canopy, leaf angles

Vi Photosynthesis, transpiration, and energy balances –
**reading and student assignment:**

i) Student - Crop growth and Photosynthesis

ii) Stomatal conductance and water use
   Student  - Overview of transpiration, stomatal conductance, water use efficiency

iii) Coupling energy balance to gas exchange
Lecture (Teacher)  - Concepts involved in scaling up from leaf-level to canopy

Viii **Phenology, organ growth, and carbon demand. reading and student assignment**

i) Plant Development versus Phenology
   Student  - Difference between modeling particular developmental stages versus predicting progression among developmental stages; Identification of developmental stages for particular crops; Correlations with temperature
   **Lecture (Teacher): Thermal time. Students will be given data for spreadsheet and asked to construct thermal time model. In-class assignment will include study of sensitivity analyses of development response using their thermal time model in which different growing seasons (with different temperatures) are provided.**

IX **Plant Stresses**

i) Nitrogen stress
   Student  - When does a plant experience nitrogen stress?; how is nitrogen demand quantified? what is nitrogen used for?

ii) Water stress
   Student  - When does a plant experience water stress; how to quantify water demand?; what happens to the plant when water stressed?; Discuss impacts on leaf expansion, stomatal conductance, root: shoot ratios
References:

Other References (only from 1990 and onward)


Mathematical / Modeling Concepts


(soil)-Plant-Atmosphere Overview


Chapter 11: Radiation Fluxes in Natural Environments, pp. 167-184 [energy balance]


Light Interception / Attenuation


Chapter 15: The light environment of plant canopies, pp. 247 – 275 [in depth light interception, sunlit / shaded approaches]

**Crop Growth Rates – Modeling leaf level photosynthesis**


**Soil x Plant Overview**
Soil Resources 164 – 192.

**Water Demand**

Chapter 14: Plants and Plant Communities, pp 223-246 [review of energy balance for leaf and canopy; examples of sunlit / shaded photosynthesis]

Chapter: 9 Water Relations, pp. 224-256. [brief overview of transpiration, crop coefficients]

**Soil Water Balance**

**Growth, Respiration, Partitioning**
Chapter 11: Respiration and Partitioning

**N balance – soil**
Chapter 8: Nitrogen Processes

**N balance – plant**


**N transformation, movement, and uptake**


**N stress**

**Biotic stress**

**Climate change**
