PennState Extension

# Cycles Agroecosystem Model Online Interface Tutorial

Prepared by Charlie White, Plant Science Department, Penn State

The Cycles Agroecosystem Model is a computer simulation of cropping systems that takes into account site-specific weather and soil data and user-input management information. Based on these inputs, the model can simulate crop growth and yields, soil water dynamics, and soil carbon and nitrogen cycling. Given these capabilities, the model can be used to explore a wide range of questions about how crop yields respond to climatic variations and management, how nitrogen fertilizer, manure management or cover cropping affects crop yields and N losses to the environment, and how crop management may change soil carbon levels over long-time periods. Models provide a complimentary methodology to field experiments because simulations can be run quickly in many locations and over many weather years. Simulations can also be developed to evaluate the effects of a management practice over long time periods. This can be useful when you need an answer today about how a practice might affect things over the course of the next 40 years.

In this tutorial, we will be using the online interface of the Cycles model to evaluate how crop rotations (corn – corn vs. soy – corn) and fertilization affect nitrogen cycling dynamics. This tutorial is intended to be a brief introduction to the operational use of a cropping system model and will give you some familiarity with the Cycles online interface.

Step 1. Create a user login.
Navigate to the Cycles website at https://cycles-model.psu.edu and then follow the instructions in the call out boxes below to create an account. Make sure you use a password that is NOT important to you, because the process of password recovery is done manually by the site administrator.
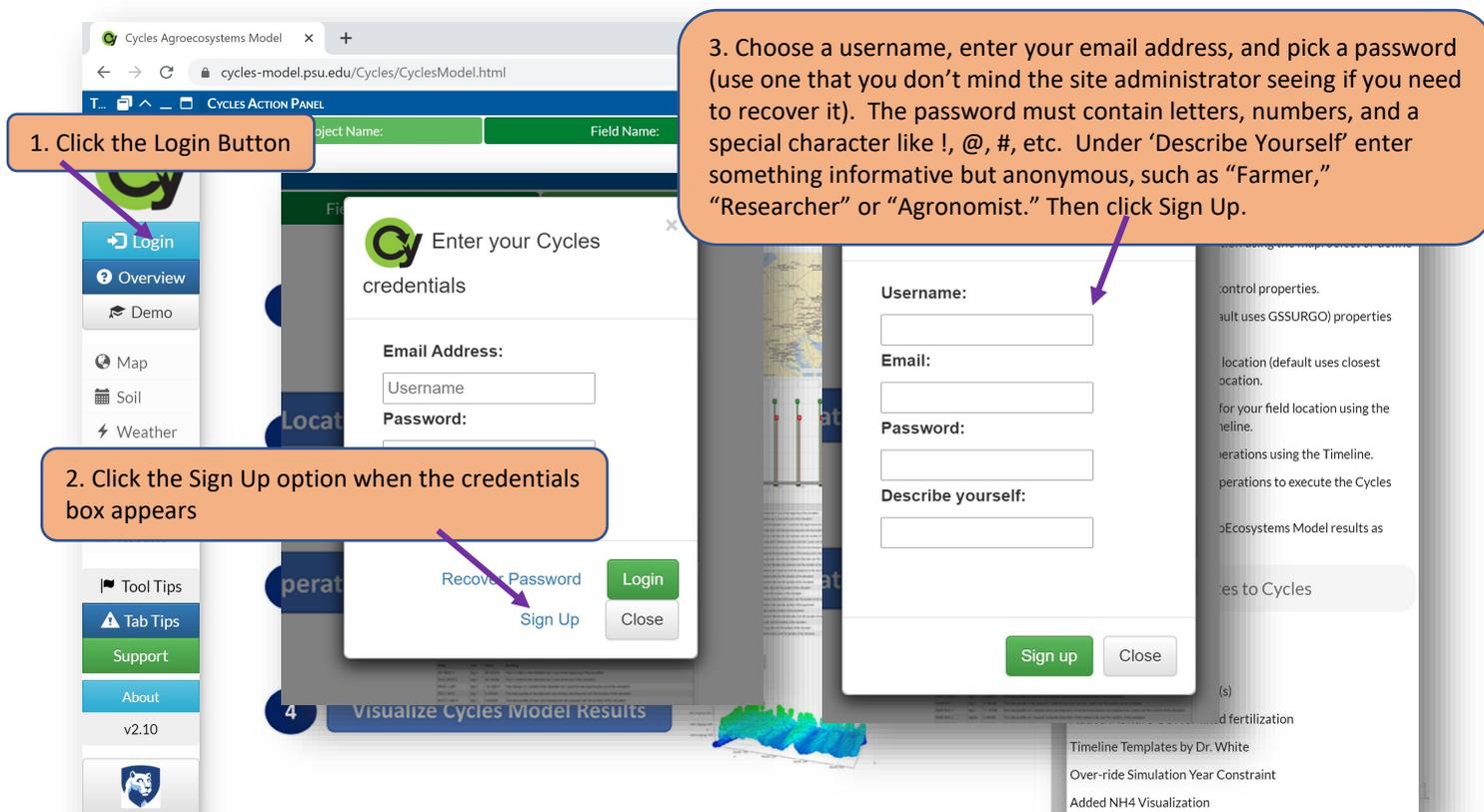
1. Click the Login Button

2. Click the Sign Up option when the credentials box appears

3. Choose a username, enter your email address, and pick a password (use one that you don't mind the site administrator seeing if you need to recover it). The password must contain letters, numbers, and a special character like !, @, #, etc. Under 'Describe Yourself' enter something informative but anonymous, such as "Farmer," "Researcher" or "Agronomist." Then click Sign Up.

Step 2. Familiarize yourself with the user interface.
The user interface of the Cycles Web Application has three panels. On the left are the main navigation tabs. The tabs for Map, Control, Soil, to Results help you move through the stages of developing a simulation in logical order. The center panel gives you the main visual interface relevant to each step of the simulation development. The right panel provides different tools that are needed in each stage of simulation development. Note that each panel can be resized by dragging its edges and can be minimized, maximized, or made to float over other panels by using the panel controls at the top of each panel. On the left navigation panel, the "Tool Tips" and "Tab Tips" buttons will turn on or turn off dialog boxes that give helpful hints on navigating the model for new users.

Navigation Panel

Visual Interface Panel

Tools Panel

Use the panel control buttons to hide, minimize or maximize a panel. Clicking the first control button will reset the view of all three panels. You can also resize the width of each panel by dragging the edges.

Step 3. Select the location of your simulation.
Click the magnifying glass in the upper right corner of the map window in the center panel. A search box will then appear in the lower right corner. Search for the address: 1794 W Pine Grove Rd, Pennsylvania Furnace, PA 16865. This is the address of the Penn State Agronomy Research Farm. If you type the address in slowly, you should see it pop-up as a pre-populated option in the search.

Step 3, cont'd. Select the location of your simulation.

Click the X on the dialog box that shows you the search location result on the map to clear it. You should see an aerial image of the Agronomy farm and a NRCS soil map unit boundaries indicated by the dashed lines. If you want to know the name of each soil map unit, you can click on the icon that looks like a ribbon in the upper right of the map window, then click anywhere on the map and the soil unit will become highlighted and you can see the name and some basic information. We are going to develop a simulation for a Hagerstown soil in the field just to the north of the Agronomy Farm headquarters. Follow the directions in the numbered dialog boxes below to set the simulation location.

Soil Map Unit boundaries

1. Click the 'Select field using Point' tool. Then use the crosshairs to click a point in the Hagerstown soil map unit approximately where the plus sign is below.

Inspect soil type button

2. A dialog box will appear to create a simulation at the point you selected. Give the simulation the name 'Corn – Corn, ' the parcel name 'Agronomy Farm Hagerstown' and set the Start Year to 2017 and the End Year to 2018. Then Click the Options Tab to select the simulation options.

3. In the Options tab, add a check box next to Automatic Nitrogen. Finally, click Add Simulation. You should see the simulation name get added to the menu of simulations on the right-side menu bar.

Step 3, Recap and Context. Select the location of your simulation.

Let's recap and provide some context to the steps that were just completed. You added a simulation named 'Corn – Corn' to be run in the Hagerstown map unit of a specific field. Choosing this location on the map links the simulation to a soil profile description of the Hagerstown soil, including the texture and typical organic matter levels of each soil horizon based on an NRCS database. This location on the map also links the simulation to a database of daily weather records for this location which is available from 1980 to 2019, including temperature, humidity, rainfall, solar radiation and windspeed. We named the simulation 'Corn – Corn' and set the years to 2017 through 2018 because the first simulation we develop will be for a rotation of corn grown after corn using the weather in 2017 and 2018.

In the Options dialog window we checked the box for **Automatic Nitrogen**. This will allow the model to grow a crop with no nitrogen limitation. If the crop experiences a nitrogen limitation due to lack of available N in the soil, the model will automatically add just enough N to the crop biomass to maintain optimal growth. The important thing here is to recognize that the N is added directly to the biomass, it never enters the soil or interacts with N cycling processes. This feature of the model allows us to isolate and evaluate the N cycling from just soil organic matter and crop residues without the influence of fertilizers.

At this point, the Web Interface should look like the image below. Depending on how far you are zoomed in, you may or may not see aerial imagery on the map. Read the dialog boxes to learn a little bit more about how to navigate within the interface. Note, at this point you will just have one simulation in your Cycles Simulation menu. The number of simulations will grow as you progress through this tutorial.

The 'Map' navigation tab will allow you to browse and select from simulations stored in your account.

The simulation you just created will be at the top of the 'Cycles Simulations' menu. To change the active simulation, click any of the other simulations in the menu.

The toolbar allows you to do several useful things with the simulation, including edit the properties, such as the simulation name and dates, and delete simulations that are not needed.

The location of the active simulation will be shown with an icon.

Step 4. Review and set simulation options.

Using the tabs on the left navigation bar allows you to move through the steps of developing a simulation. On the Control Tab, you see the basic simulation options that were established in a previous step. This is a good time to double check that the "Automatic Nitrogen" feature is activated with a green check mark. If it's not, double click on the red X to turn it on.

The next tab will show you the soil profile description for the soil map unit where the simulation point was located. This data is looked up automatically from the NRCS soil survey database. The model divides the soil profile into layers of different depths in order to be able to simulate how water and nutrients move through the soil, and how plant roots and organic inputs interact with different layers of the soil. You can customize any of the information in the default soil profile description, for instance if you have field specific information about the soil texture or organic matter. To change a value, click the cell and enter a new number.

Step 4, Cont'd. Review and set simulation options.

The weather tab will let you select historical weather files from nearby locations. Weather files are available on one-eighth degree latitude and longitude intervals. The closest weather station to the point your simulation is located will automatically be highlighted and used. To choose a different weather location, click a different row.
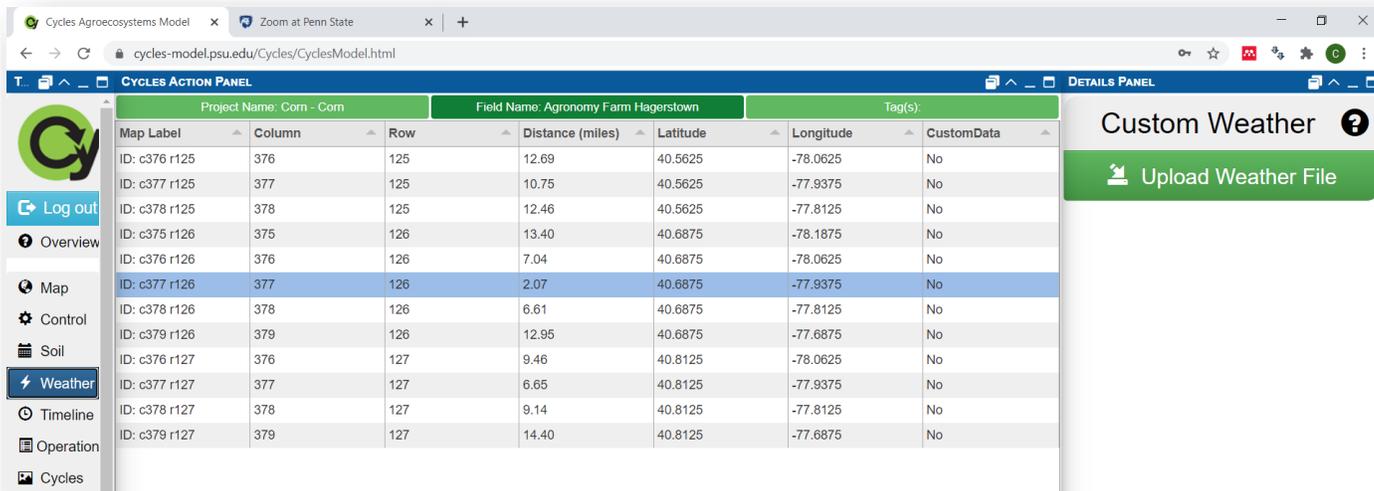
Step 5. Create a Rotation Group.

The Timeline tab is where you do the work of creating the management practices used in the simulation, including the crop rotation, tillage practices, and fertilizer applications. When you first click on the Timeline tab, you will have a blank timeline. The first step in adding operations is to create a "Rotation Group." The rotation group is essentially a modular unit of associated practices. If you want to create a long-term rotation, you can replicate a rotation group over many years. Here we are just developing a simulation for two years, so you will not be replicating your rotation group, rather you will just create it once and run the simulation for 2017 and 2018. Follow the text bubbles below to create a Rotation Group.

1. Click on the Rotation Group button.

2. The Create Rotation Group dialog box will appear. Since we are creating a two-year simulation, make sure the Start Year is 2017 and the End Year is 2018. Then click Create and you should see a little gray bar has been added to the Timeline window.

3. Click the 'Fit' button on the timeline control and the window should Zoom in to the time period of the Rotation Group that was just created. See the next page for a picture of what the timeline should look like now.

Step 6. Add Crop Plantings.

Your timeline should now look like the image below. If it's not zoomed in on the Rotation Group you just created, click the Fit button in the bottom of the right-hand panel. In the timeline window, you can click on the blue line and drag it to different dates on the timeline. When you add an operation to the timeline, it will be added on the date where the blue line is located. Move the blue line to May 7, 2017, like you see below.   Then follow the text bubbles to plant a corn crop on May 7, 2017.

Step 6, Cont'd.

Repeat the process above to plant another corn crop on May 7, 2018. Use the CornRM.100 crop type and select Automatic Fertilization as above. Your timeline should now look like image below with two corn crops planted. Depending on you screen setting, you may not be able to see both the top of the planting operation "flagpole" and the crop icon at the bottom of the flagpole. It's helpful to be able to see both of these, so if you can't see them on your current view, click the minus icon on the timeline toolbar to shrink the height of the rows in the timeline.

Step 7. Review Planting Operation Details and Crop Type properties.
If you want to edit any details about operations on the timeline, you can double click the top of the "flagpole". Depending on the layout of your screen, you may not see the top of the flagpole at first. If not, click on the timeline background and drag down to reveal the top row for planting operations. You do not need to make any changes unless you made a mistake on the previous section. Click cancel to exit without changes.
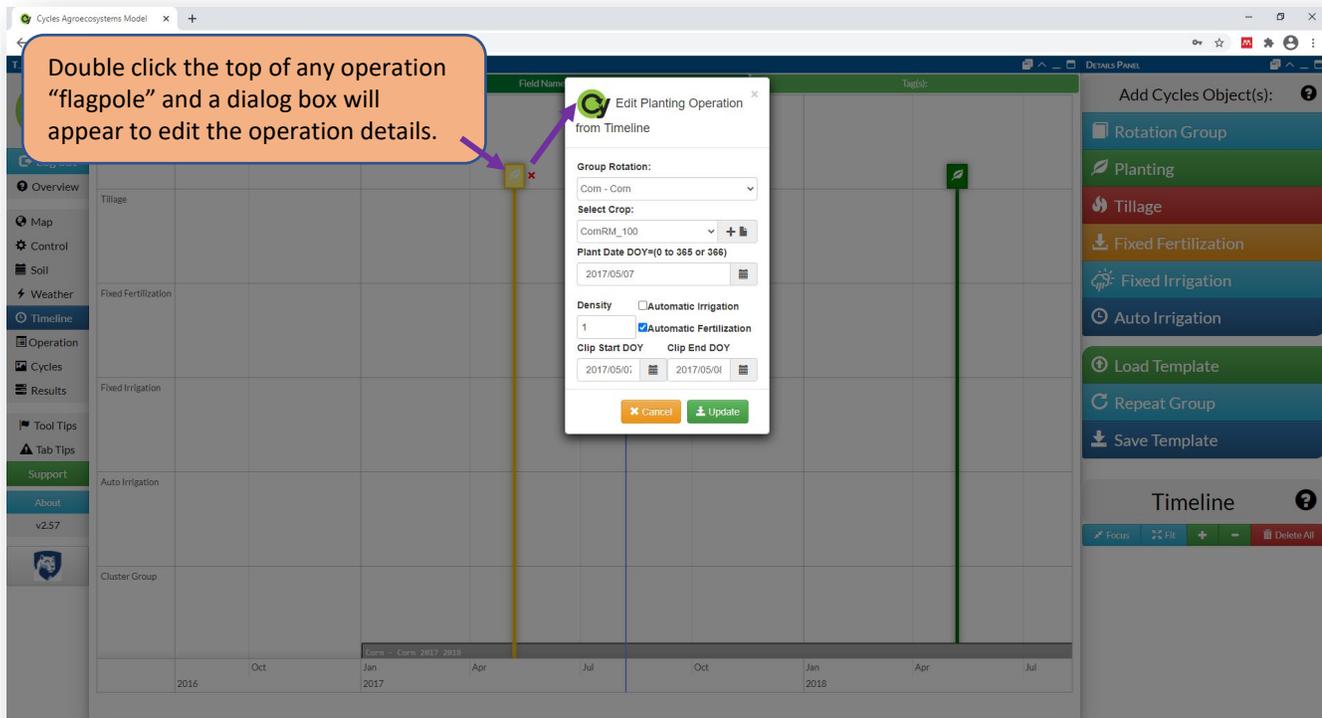
You can also review and update properties about the crop types by double clicking on the crop icon at the bottom of the timeline. The various properties of the crop type control the physiological response of the crop to the environment, such as growing degree days to maturity, growth in response to solar radiation interception, response to temperature and water stress, etc. In this tutorial, we need to review these crop properties because there may be a bug in the version of the interface that we need to correct. Follow the instructions below to verify the crop properties are set properly. Do this for both of the corn crops that were planted.
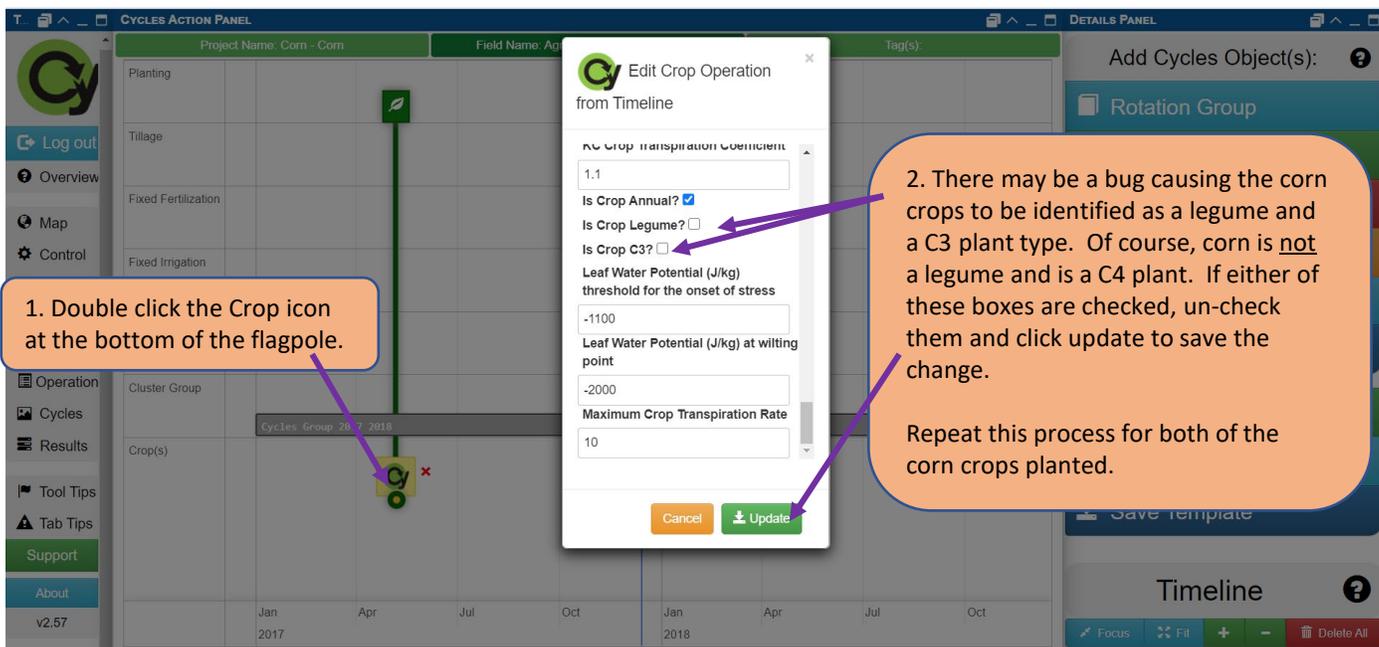
Step 8. Run the simulation, download the full results, and view some results summary figures.
Click the Cycles tab on the left navigation panel. This is where you can submit the simulation to be run and download detailed files of all the results. Initially the center panel will be blank. Once you click the Submit button, you will get messages from the server indicating the progress. If the simulation runs correctly, you should get a message at the bottom that says "Finished processing Cycles results." Follow the instructions in the text bubbles to submit the simulation to the server and download the results.
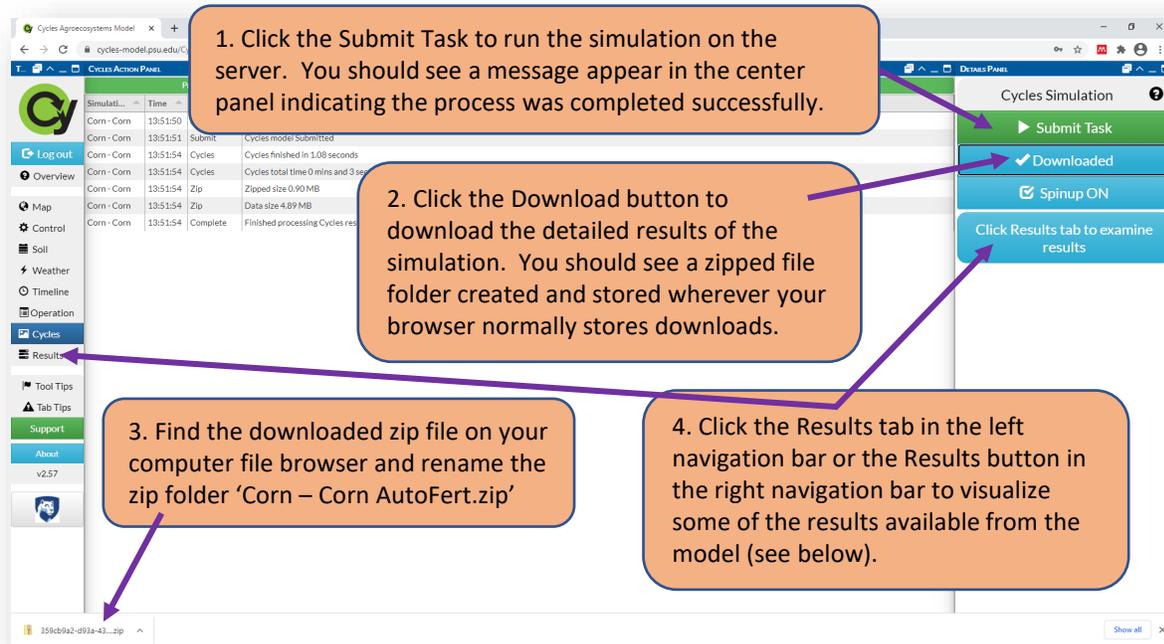
In the results view, you will first see some a summary text output from the model in the center panel. You can ignore this, as it's not very helpful for our purposes. On the right side toolbar, there are buttons to create graphs from some of the simulation outputs. Click on the 'NO3 Results' button and a figure will be generated that shows the monthly average soil nitrate levels during the simulation. You can add lines from different layers of the soil (remember the soil profile description is divided into layers of 5cm, 5cm, 10cm, and continuing with 10cm layers to the bottom of the profile (2 meters depth or until bedrock, whichever is shallower). Follow the text bubbles below to create a figure of the results.
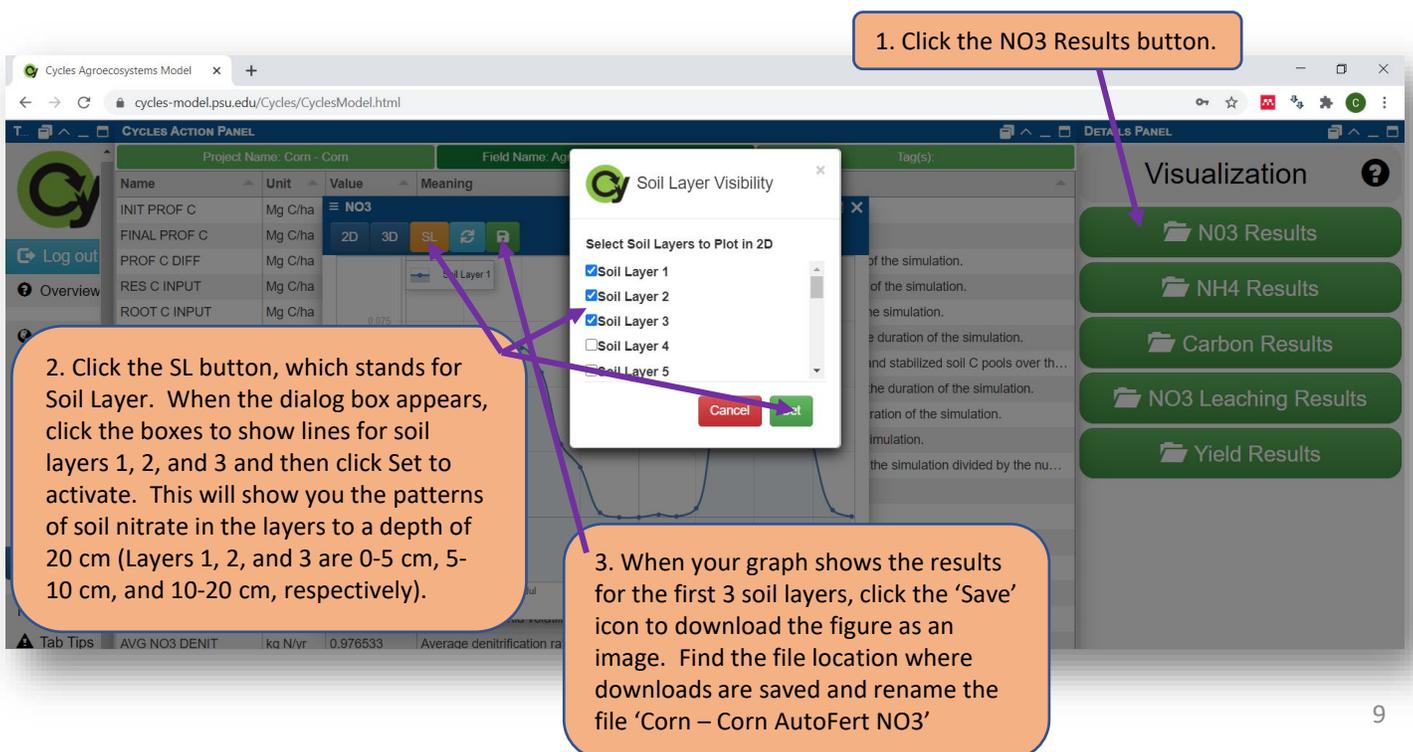
Step 9. Create and run the simulation for a Soy – Corn rotation.

In steps 1 through 8 you became familiar with the Cycles online interface and ran a simulation for a Corn – Corn rotation with automatic fertilization. In the remainder of this tutorial, you will create new simulations for a Soy – Corn rotation with automatic fertilization, and a Soy – Corn rotation with sidedressed Urea Ammonium Nitrate solution. Follow the directions below to create the second simulation for a Soy – Corn rotation with Automatic Fertilization.
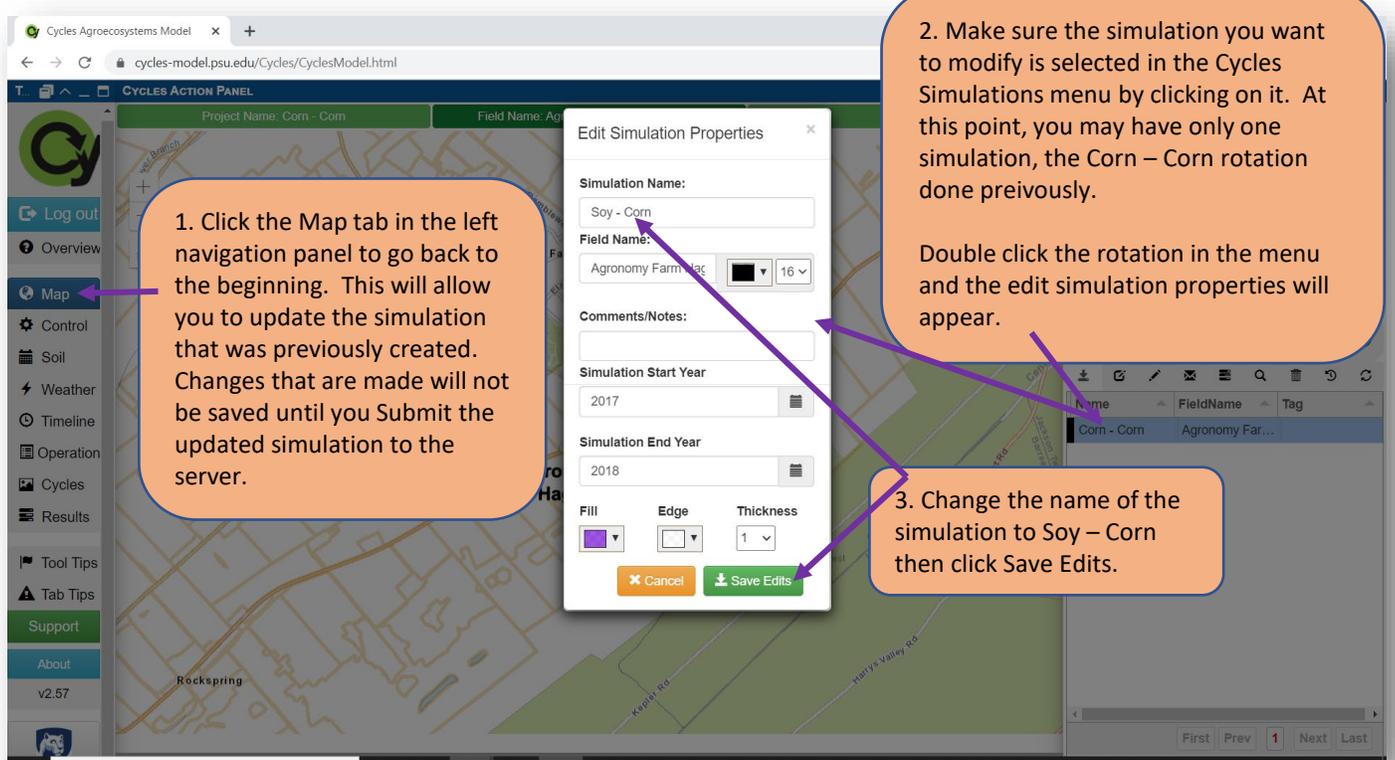
1. Click the Map tab in the left navigation panel to go back to the beginning. This will allow you to update the simulation that was previously created. Changes that are made will not be saved until you Submit the updated simulation to the server.

2. Make sure the simulation you want to modify is selected in the Cycles Simulations menu by clicking on it. At this point, you may have only one simulation, the Corn – Corn rotation done preivously.

Double click the rotation in the menu and the edit simulation properties will appear.

3. Change the name of the simulation to Soy – Corn then click Save Edits.

To modify the rotation and management practices of the previous simulation, jump straight to the Timeline tab on the left navigation. All the other properties of the simulation, including automatic nitrogen and the location for the weather history and soil profile will stay the same. When you click on the Timeline tab, you may need to click the "Fit" button to Zoom in on your rotation group. Follow the text bubbles below to modify the rotation by making the first crop a soybean crop instead of corn.
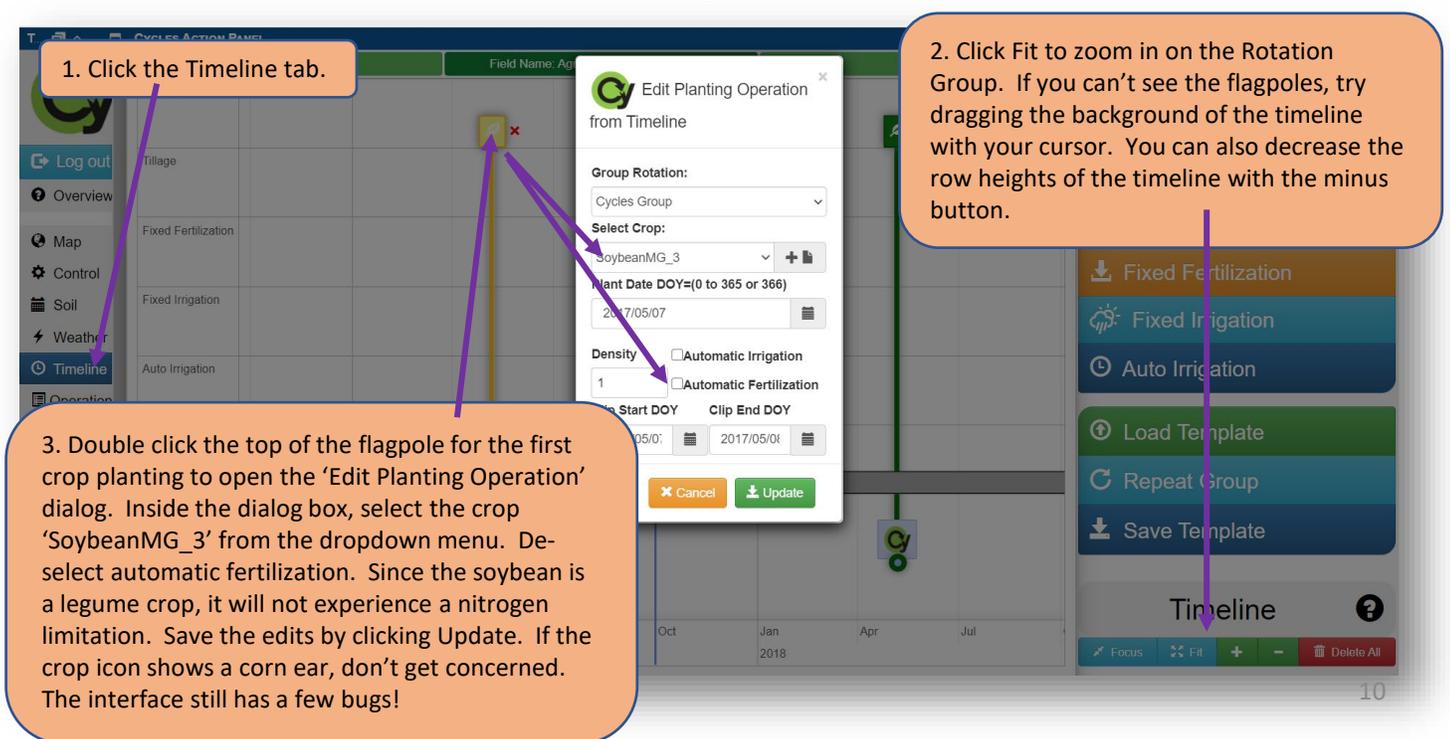
1. Click the Timeline tab.

2. Click Fit to zoom in on the Rotation Group. If you can't see the flagpoles, try dragging the background of the timeline with your cursor. You can also decrease the row heights of the timeline with the minus button.

3. Double click the top of the flagpole for the first crop planting to open the 'Edit Planting Operation' dialog. Inside the dialog box, select the crop 'SoybeanMG_3' from the dropdown menu. De-select automatic fertilization. Since the soybean is a legume crop, it will not experience a nitrogen limitation. Save the edits by clicking Update. If the crop icon shows a corn ear, don't get concerned. The interface still has a few bugs!

Step 9, Cont'd. Create and run the simulation for a Soy – Corn rotation.
Now go to the Cycles tab in the left navigation panel and click the Submit Task button. This will save the changes you made in the timeline to the server and will run the model for the updated management practices. You can now download the detailed ouputs to a zipped folder, like you did last time. Also create a figure of the soil nitrate levels in the top 3 soil layers for the Soy – Corn rotation. Follow the text bubbles below for assistance.

1. Click the Cycles tab.

2. Click Submit Task to save the modified management practices to the server and run the model.

3. Click Download to save a copy of the detailed outputs. Find this file on your computer and rename the zipped folder 'Soy – Corn AutoFert.zip'

4. Click the Results button to view the results and make a figure of the soil NO3 levels for the top 3 layers (see below).

5. When you first get to the Results window, you may still be seeing the figure created for the previous simulation. Update the figure with the new simulation results by clicking the NO3 Results button.

6. Click the SL button and add the lines for layers 1, 2, and 3.

7. When your graph shows the results for the first 3 soil layers, click the 'Save' icon to download the figure as an image. Find the file location where downloads are saved and rename the file 'Soy – Corn AutoFert NO3'

Step 10. Create and run the simulation for a Soy – Corn rotation with sidedressed UAN solution.
Follow the directions below to create the third simulation for a Soy – Corn rotation with sidedressed UAN fertilizer.

1. Click the Map tab in the left navigation panel to go back to the beginning. This will allow you to update the Soy - Corn simulation that was previously created.

2. Make sure the simulation you want to modify is selected in the Cycles Simulations menu by clicking on it. The most recent simulation you submitted will be at the top of the list. It will probably be the Soy – Corn rotation from the previous step.

Double click the rotation in the menu and the edit simulation properties will appear.

3. Change the name of the simulation to 'Soy – Corn Sidedressed' then click Save Edits.

Now that we are developing a simulation where we want to evaluate the effects of fertilizer management, we should turn off the Automatic Nitrogen setting in the simulation control tab. Follow the text bubbles below to complete this.

1. Click the Control tab.

2. Double click the checkmark on the Automatic Nitrogen setting to disable it. You should see a red X.

Step 10, Cont'd. Create and run the simulation for a Soy – Corn rotation with sidedressed UAN solution.

In the timeline, we need to add the sidedressed UAN application. The nitrogen fertilizer that we add here will be based on our traditional Penn State Agronomy Guide N recommendation system, which uses 1 lb N fertilizer for every bushel of corn yield expected, minus credits for previous legume crops. In a good year, corn can yield 200 bu/ac at the Agronomy Farm, and a previous soybean crop typically provides a 50 lb/ac N credit. Therefore, the N fertilizer recommendation is 200 bu/ac x 1 lb N/bu – 50 lb/ac N soybean credit = 150 lbs N/ac fertilizer. Because Cycles is a research tool, it operates in metric units. 150 lbs/ac N is equivalent to 168 kg/ha N. Add the sidedressed fertilizer application to the timeline by following the text bubbles below.

1. Click the Timeline tab.

2. Click Fit to zoom in on the Rotation Group. If you can't see the flagpoles, try dragging the background of the timeline with your cursor. You can also decrease the row heights of the timeline with the minus button.

4. When the Fertilization Operation dialog box opens, give the fertilizer source a name by typing in the box. Here we put UAN. The name you put in this box is not important, its just a label. (Do not click the gear or the list icon, those are advanced features not needed here.)

Add Fertilization Operation from Timeline

Group Rotation:
Cycles Group
Date DOY=(166)
2018/06/15
Source
UAN
Mass (kg/ha): 168   Soil Layer: 1
C Organic: 0   N Organic: 0
N NH4: 0.75   N NO3: 0.25

Close   Save

- Tillage
- Fixed Fertilization
- Fixed Irrigation
- Auto Irrigation
- Load Template
- Repeat Group
- Save Template

Timeline

Focus   Fit   +   –   Delete All

5. In the Mass box, type 168 kg/ha. Here we are entering the mass in units of N.

In the N-NH4 box, type 0.75. This tells the model that 75% of the N in UAN solution is in the ammonium form. You should know that UAN is actually 50% urea, 25% ammonium, and 25% nitrate. However, the model does not simulate the breakdown of urea into ammonium, so instead we specify that the urea component is ammonium. In the N-NO3 box type 0.25 to indicate that 25% of the N is in the nitrate form.

C Organic and N Organic should be set to zero.

Then click Save to add the fertilizer application.

3. Drag the blue line to June 15, 2018. Sidedressed nitrogen applications are usually applied about 5 to 6 weeks after corn is planted. Then click the Fixed Fertilization button to add a fertilizer application event.

Now that the fertilizer application is added to the timeline, go to the Cycles tab and submit the simulation. Download the detailed results file and create a figure of the soil nitrate levels in the soil during rotation, just as you did the previous two times. The text bubbles below provide a reminder of how to do this.

CYCLES ACTION PANEL

1. Click the Cycles tab.

2. Click Submit Task to save the modified management practices to the server and run the model.

3. Click Download to save a copy of the detailed outputs. Find this file on your computer and rename the zipped folder 'Soy – Corn Sidedressed.zip'

4. Click the Results button to view the results and make a figure of the soil NO3 levels for the top 3 soil layers.

Cycles Simulation

- Submit Task
- Download
- Spinup ON
- Click Results tab to examine results

Rotation	Time	Status	Message
Corn - Corn	09:59:39	Start	Creating Cycles Inputs
Corn - Corn	09:59:40	Submit	Cycles model Submitted
Corn - Corn	09:59:43	Cycles	
Corn - Corn	09:59:43	Cycles	
Corn - Corn	09:59:43	Zip	
Corn - Corn	09:59:43	Zip	
Corn - Corn	09:59:43	Complete	
Soy - Corn	10:51:22	Start	Creating Cycles Inputs
Soy - Corn	10:51:22	Submit	
Soy - Corn	10:51:26	Cycles	
Soy - Corn	10:51:26	Cycles	
Soy - Corn	10:51:26	Zip	
Soy - Corn	10:51:26	Zip	Data size 4.89 MB
Soy - Corn	10:51:26	Complete	Finished processing Cycles results

- Log out
- Overview
- Map
- Control
- Soil
- Weather
- Timeline
- Operation
- Cycles
- Results