

Guide- Using GLEAMviz

Introduction

At first glance, the GLEAMviz program may seem a bit daunting for the first-time user. This guide is meant to help you through the process of installation and set-up and to introduce you to the components of the program. After you are familiar with how the interfaces work and the options built into the program, you will be ready to set up an infectious disease model and run a simulation. You should use this guide for reference while working through the GLEAMviz program for the first time.

The GLEAMviz (Global Epidemic and Mobility Model) visualization program is a computational model that integrates high resolution demographic and mobility data to allow a user to define characteristics of an infectious disease. The demographic information and mobility data are built into the program; you simply have to choose the options and define how you want the infectious disease simulation to “run”.

Using the GLEAMviz program allows visualization of the progress of the disease as defined by user input.

There are three major components of the GLEAMviz program:

- 1) The Simulation Builder
- 2) The Simulation Manager
- 3) Visualization

Each component is described below so that you can be familiar with what each component allows you to do.

Getting Started

Downloading the GLEAMviz program

- GLEAMviz is a standalone desktop program that can be installed on Windows (Vista, Windows 7, or later), Mac OSX (10.8 or later), or Linux (64 bit).
- You must have 200 MB free available disk space on your computer; additional space is needed if you want to store the simulations you create and run locally.
- Download the GLEAMviz epidemic modeling program at <http://www.gleamvis.org/simulator/client/>

User Registration and Log In

After GLEAMviz has installed, the login screen will appear.

Log in by creating a user name and password.

The login screen also allows you to register with a new user profile, proceed offline (takes you to the Simulation Manager without logging in), and retrieve or reset a forgotten password. This is a standard login process and is quick and easy.

Once you have logged in, if you choose for GLEAMviz to remember your login and password, the screen to enter the program will appear automatically when you open the program. You can then click directly into the Simulation Manager interface.

You're then ready to start building an infectious disease model!

The Simulation Manager

The Simulation Manager's menu bar contains two important simulation options:

- 1) New simulation—use this option to design a new simulation.
- 2) Import simulation—use this to open a window to load a simulation definition from the file system.

The Simulation Manager lists the simulations the user can access.

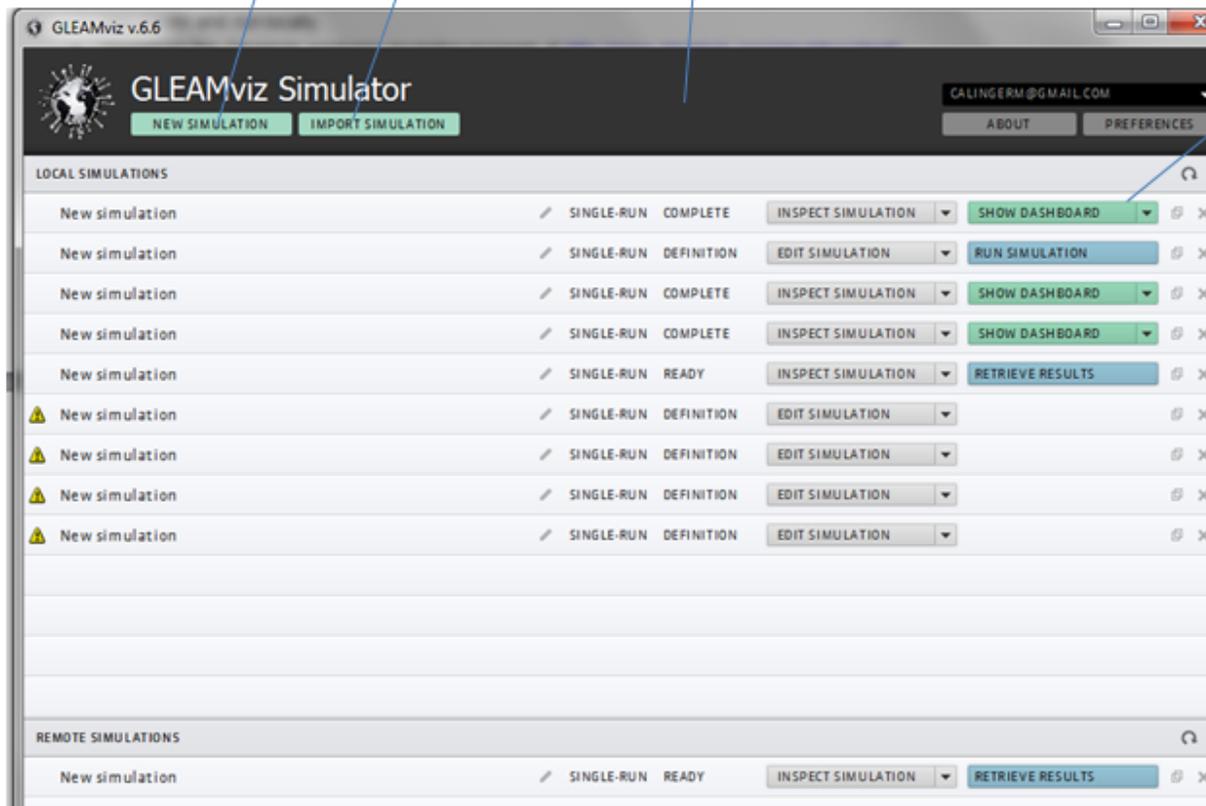
The screen below shows the GLEAMviz Simulator and several important features that you access from this page to build an infectious disease simulation.

Click **"New Simulation"** to start a new sim.

Click **"Import Simulation"** to load a sim from the file system.

Access all sims from the columns on the right side of the screen. You can choose to inspect the sim details, edit the sim, show the sim dashboard, run the sim, or retrieve results.

If the sims have been uploaded to the GLEAMviz server, you can access sims from multiple machines.



Simulation Results

Local sims are available on this site, meaning either the user has created them or imported them from other sources.

Functions in the Simulation Manager

More options and tasks that you can perform from the Simulation Manager screen are described below.

Title

- To change the title, double click on the title or click the “edit” icon next to the title (near the “single-run” status choice).
- Hover the cursor on the edit icon to display the ID # of the simulation.

Type

This displays the type of simulation: either single-run or multi-run. Single-run executes the model once; multi-run adds averages of multiple runs to sim results.

Execution Status

Displays the execution status.

Status of a sim can be one of the following, depending on availability of results:

definition—a sim has been created and defined, but has not been submitted for execution. If a sim has not been fully and accurately defined, if some parameters are missing, or there are inconsistencies present, an **alert icon** is shown at the left of the title. The sim cannot be run until all inconsistencies are corrected.



running—the execution request has been issued and accepted by the GLEAMviz server.

ready—the execution has been completed and output data can be retrieved.

retrieving—the sim data are being downloaded from the GLEAMviz server.

paused—the retrieval of the sim’s data has been stopped by the user.

complete—the sim is complete and the output data are locally available.

failed—the execution failed for some reason.

aborted—the sim execution has been interrupted by the user.

Sim definition menu

Choices include:

Edit/Inspect sim—allows editing of sim. Click on this to open the Sim Builder and change the compartmental model of the sim.

Inspect Sim—once a sim has been submitted, it cannot be modified. This button allows you to view a (read-only) version of the sim, but not change it. You can also save the sim model from this button.

Export simulation definition—exports the sim details to an XML file.

Sim results menu

Provides access to actions related to execution and results of simulation.

Clone sim button

Opens the Simulation Builder with new clone of the currently selected simulation.

Remove simulation button

Deletes selected simulation; results will be deleted and the action cannot be undone.

The last column on the Simulation Manager screen is the Simulation Results Menu. It gives you access to tasks related to the execution of the sim. Options include:

Run Simulation—submits the sim to the GLEAMviz server.

Stop simulation (multi-run)—allows the user to stop the sim run while it is running. Using the drop-down menu allows you to access the Visualization Dashboard.

Retrieve results—for completed sims. You can download the results from the server from this button.

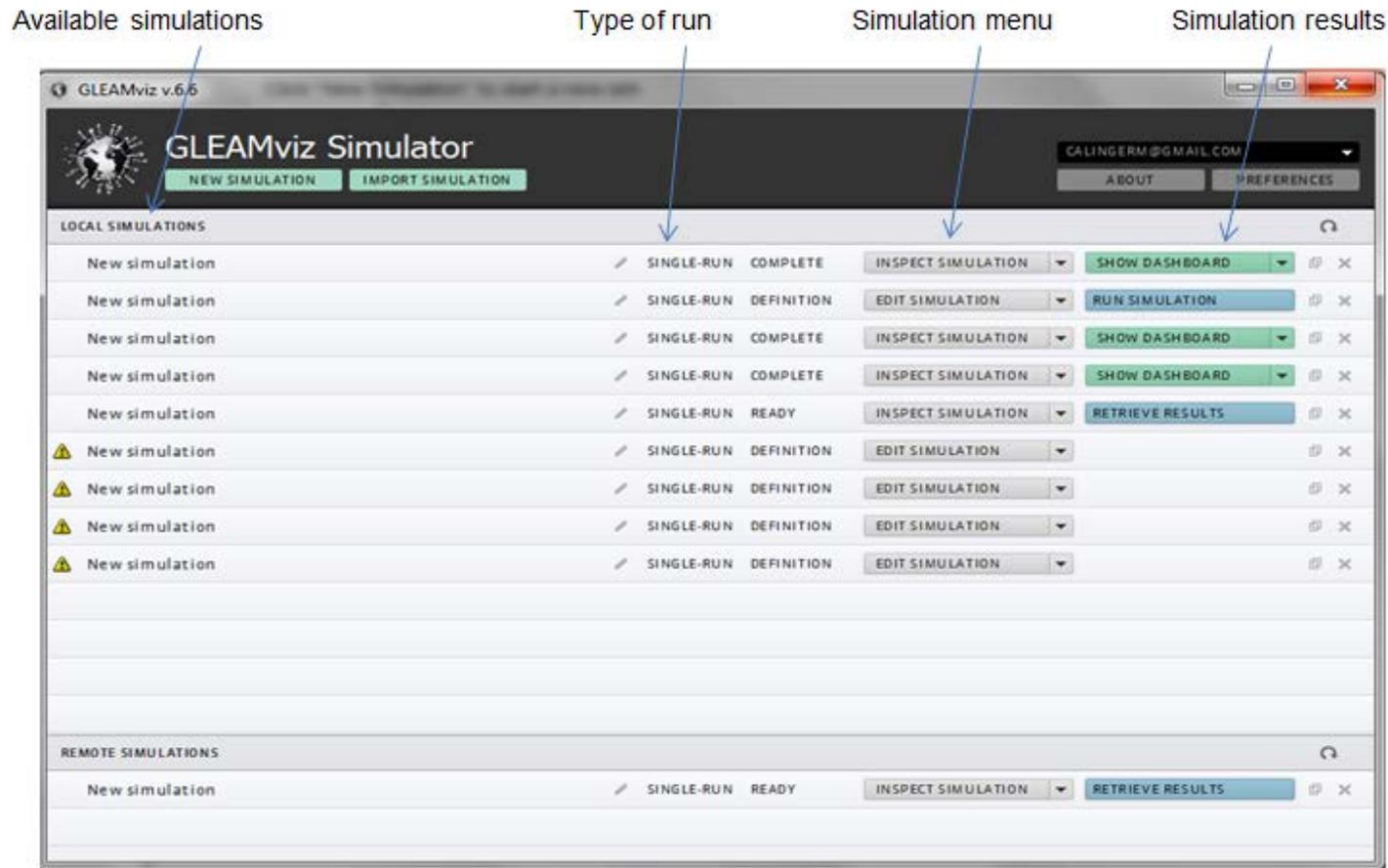
Retrieving—shown when sim results are being downloaded. You can also access the Visualization Dashboard by using the drop down menu on this option.

Resume retrieving—If you have stopped sim retrieval, this allows you to continue.

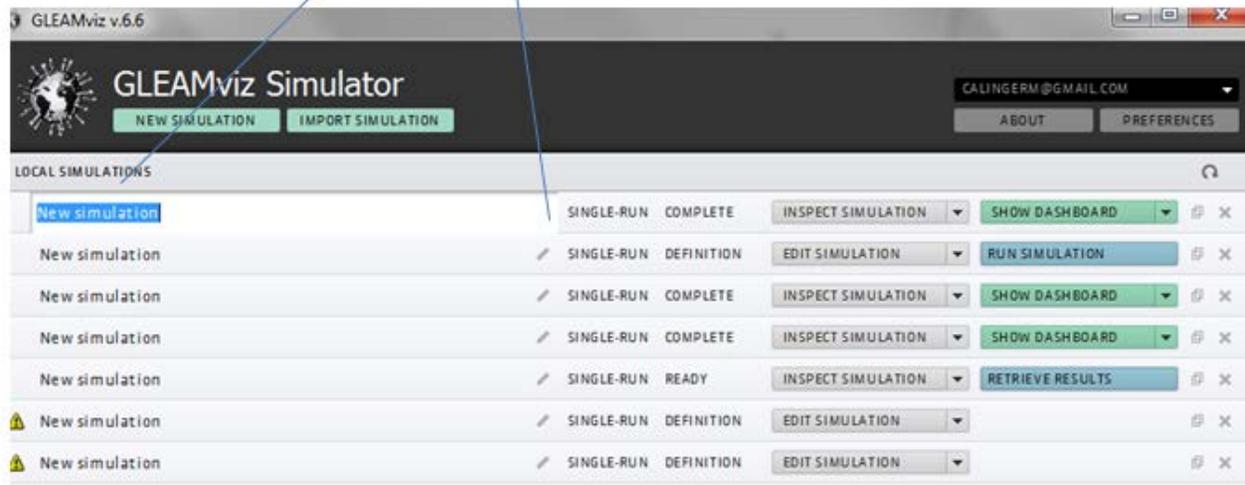
Show Dashboard—Shown only when results are present, you can access output results here.

Export results—Allows you to export the data to a folder.

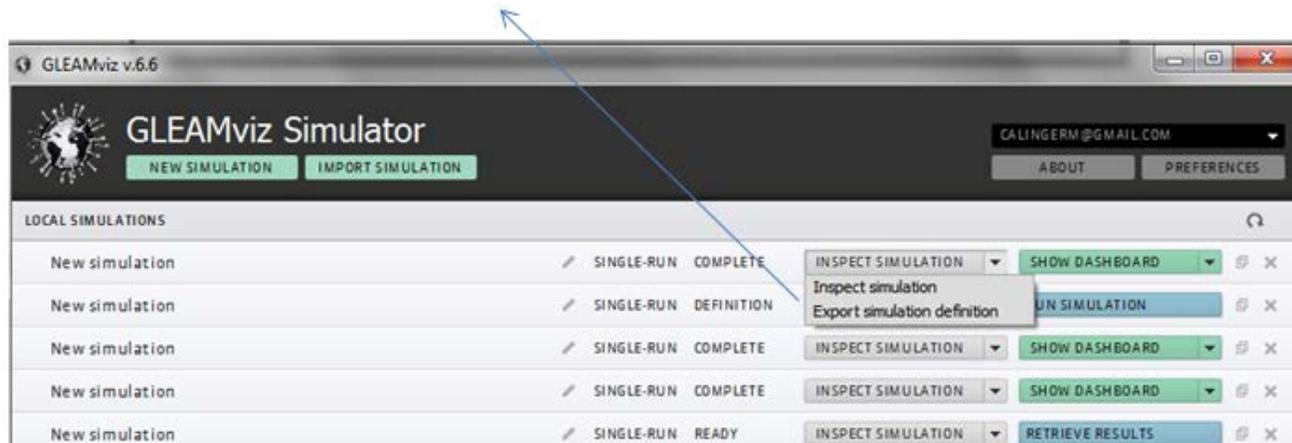
Clear results—If the sim is no longer available on the server, this option resets the sim to definition status and cannot be undone.



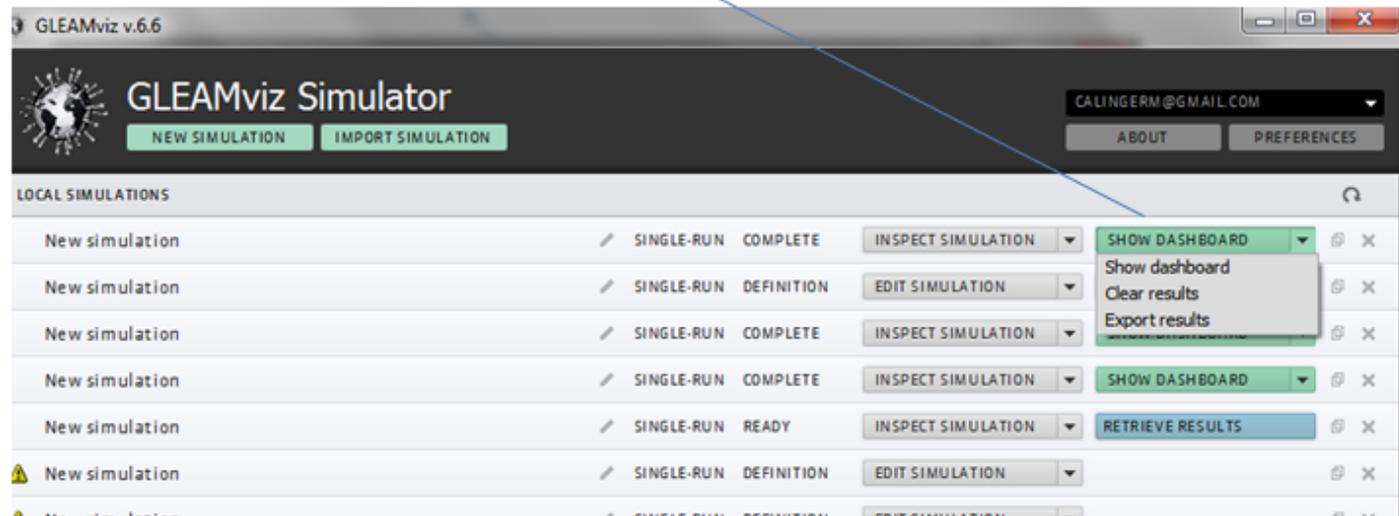
Partial Simulation Manager screen showing title edit icon clicked and option for changing the sim title.



Partial Simulation Manager screen showing Simulation Definition Menu and options.



Partial Simulation Manager screen with Simulation Results menu shown with options.



Now, you're ready to build an infectious disease model using the Simulation Builder.

The Simulation Builder

You will use the Simulation Builder for all aspects of simulation design, including identifying infectious disease compartments, choosing global settings and time options, and solving any inconsistencies in your design.

This area is the **Menu Header**. It contains the simulation name and the “Run Simulation” button. When the sim is built and error free (as shown by the absence of inconsistencies), clicking the Run Simulation button sends the simulation to the GLEAMviz server for execution.

The screenshot shows the Simulation Builder application window. The title bar reads "Simulation Builder". The interface is divided into several sections:

- Menu Header:** Located at the top left, it contains a "New simulation" button, a text field for "Simulation description and notes", and a "RUN SIMULATION" button.
- Menu Bar:** A horizontal bar below the menu header containing buttons for "ADD COMPARTMENT", "CLEAR MODEL", "LOAD MODEL", and "EXPORT XML".
- Settings:** A tabbed interface on the right with three tabs: "MODEL", "SETTINGS", and "EXCEPTIONS". The "SETTINGS" tab is currently active.
- Canvas:** The main workspace area, currently empty.
- Inconsistencies:** A panel on the right side of the canvas showing two error messages:
 - At least two compartments must be defined
 - At least one compartment must be marked as clinical case

Annotations in the image include:

- A blue arrow pointing from the text "Settings" to the "SETTINGS" tab.
- A white box labeled "Menu Header" pointing to the top-left area.
- A white box labeled "Menu Bar" pointing to the horizontal bar with buttons.
- A white box labeled "Canvas" containing the text: "Canvas-contains the editable compartmental model. Add or remove compartments, set parameters, transition rates, and change infection source compartments here."
- A white box labeled "Inconsistencies-all inconsistencies must be solved before the sim can run." pointing to the error messages.

Build an infectious disease model by first adding **compartments** to your disease model diagram. In this infectious disease modeling program, a compartment is a group of people identified as a component of the infectious disease. For example, a compartment or group of people may be “Susceptible”, “Infected”, “Exposed”, or “Recovered”, .

Add a compartment by clicking on the ADD COMPARTMENT button in the Menu Bar. The compartment box will appear in the Canvas.

Change the name of the compartment by clicking on the name and entering the new name.

Move the compartment around the canvas by dragging it by the gray area.

Change the color of the compartment by clicking on the color change button—the round circle button on the top right of the compartment, next to the delete “X”.



The screenshot shows the Simulation Builder interface. A new compartment box labeled "default_1" is visible on the canvas. The interface includes a menu bar with "ADD COMPARTMENT", "CLEAR MODEL", "LOAD MODEL", and "EXPORT XML". A right-hand panel displays "VARIABLES" and "INCONSISTENCIES". The "INCONSISTENCIES" section lists three warnings: "At least two compartments must be defined", "At least one compartment must be marked as clinical case", and "At least one infection transition must be defined".

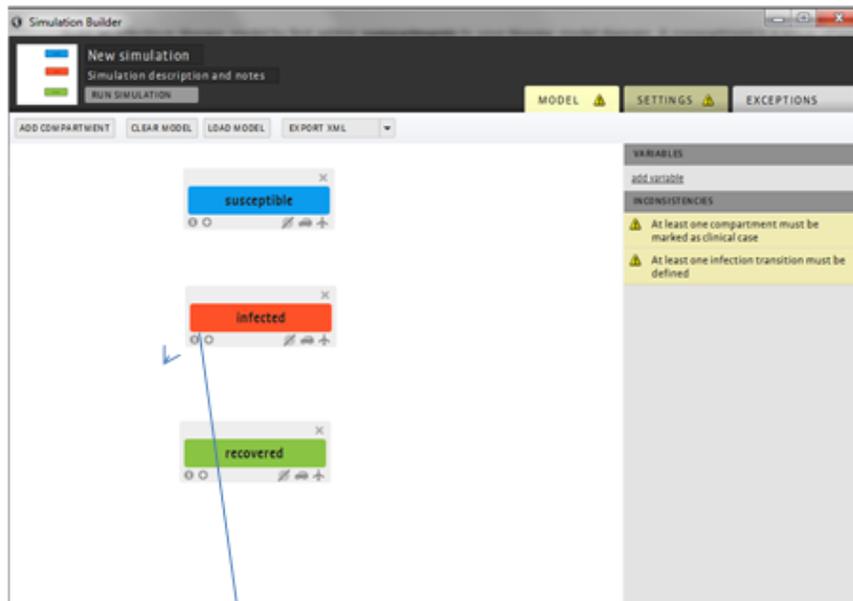
Add compartment (points to the ADD COMPARTMENT button)

Compartment (points to the default_1 compartment box)

Inconsistencies appear automatically (points to the INCONSISTENCIES panel)

Here, a new compartment has been added. The circle for the color change shows when you scroll over it. Click on the circle and color choices appear. Click on your choice to change the color.

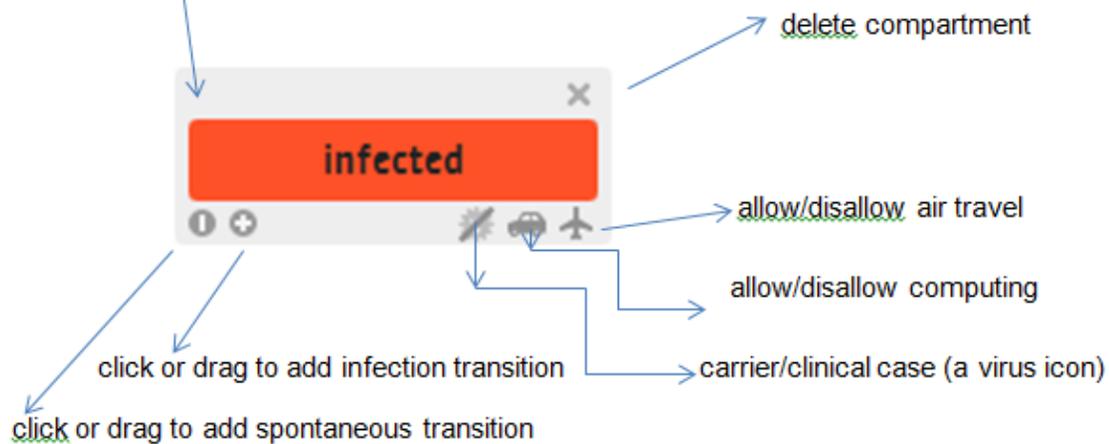
Now begin building your model by adding compartments and identifying the groups you want in the infectious disease model.



Note that the original compartment has been renamed “susceptible” and two new compartments have been added: infected and recovered.

Also note that one inconsistency has been resolved after the addition of the compartments.

Each compartment has icons which you use to make important settings for your disease model.



Carrier/clinical case—Use this button to identify the compartments that are carrying the pathogen and may eventually have the disease.

Mark all compartments as carriers if they can introduce the pathogen into the population, even if they have not yet transmitted the infection (as identified by transition choices).

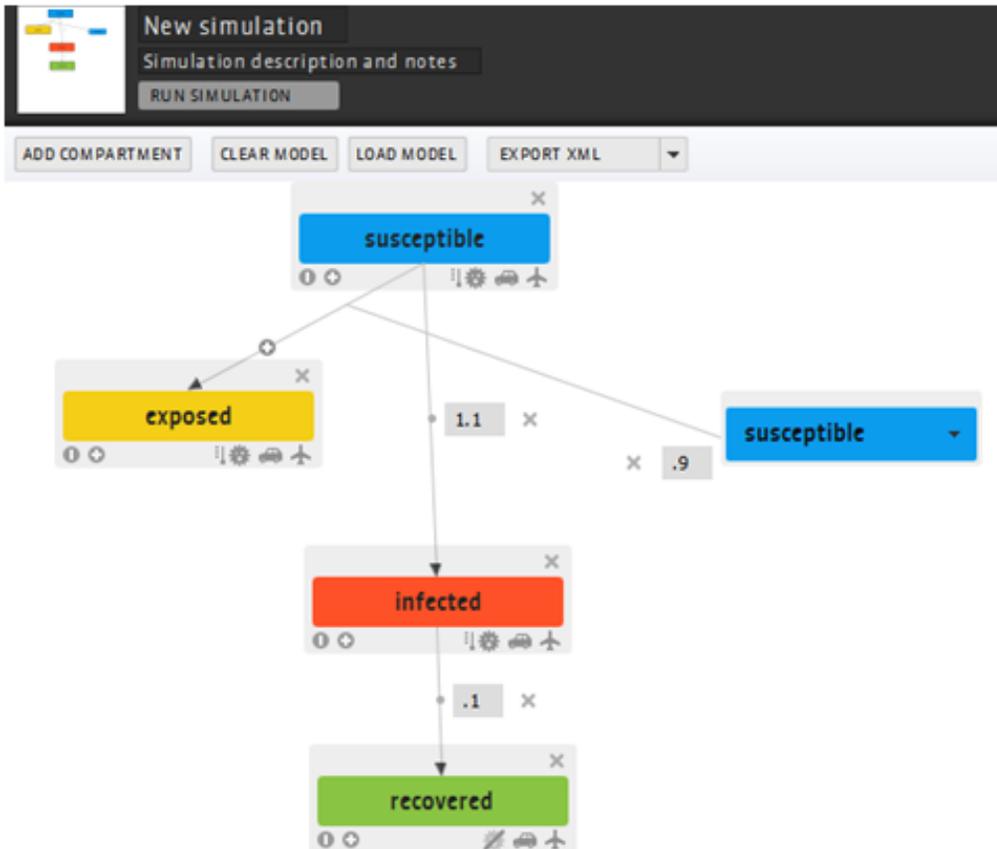
If the **virus icon** is not barred, the compartment or group of people is considered to be a carrier.

Double-click to make the compartment include clinical cases with disease (infection transition). A thermometer will appear beside the virus icon.

Add **transitions** to compartments by dragging a **transition icon** from the source compartment to a target compartment. Dragging a transition icon to an empty space on the canvas will create a new compartment.

Individuals can also spontaneously transition. For example, an individual can transition from having a latent infection to being infected or from being infected to being recovered. Transition rates need to be identified in the model. This can be done through the “Variables” menu or by entering a numerical value in small text “boxes” that appear next to the arrow that go between compartments.

The **variable** name must begin with a letter and contain only alphabetic, numerical, or underscore characters. Variable names that do not follow these guidelines are marked in yellow and must be corrected before the sim will run.



Using the guidelines listed above, note the changes made to the model:

The virus icon was double-clicked to make the susceptible, infected, and exposed compartments having clinical cases with the disease.

The infection transition button was dragged to create 2 new compartments: an exposed compartment and a susceptible without clinical disease compartment.

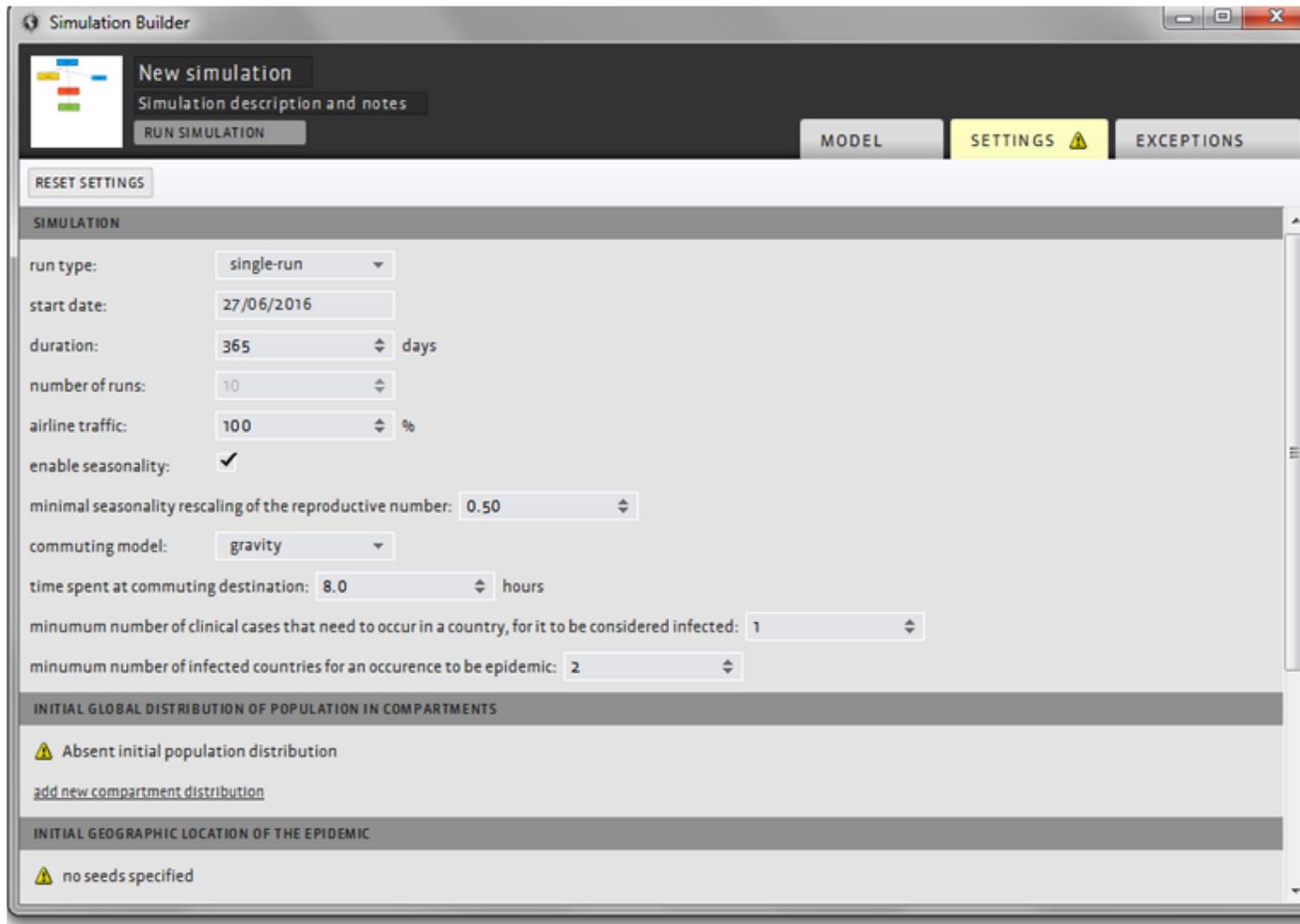
The susceptible compartment was connected to the infected compartment and the infected compartment was connected to the recovered compartment to represent the natural flow being diagrammed in this infectious disease.

Rate "boxes" automatically appear next to those compartments that need a rate of infection or recovery.

In this model, no restrictions on air travel or commuting were made.

All inconsistencies were resolved by these actions.

The next step is to use the Settings panel to choose other parameters for the infectious disease. The Settings panel is accessed by clicking on the Settings tab in the Menu Header.



There are 4 sections to the Setting panel and each section offers descriptors of the infectious disease that you want to model. Choices are made in each case by simply clicking on the parameter you wish to use.

1) Simulation panel

Set the global settings of the sim model using the options in the simulation panel.

Type: single-run (SR) or multi-Run (MR)

Single-run—performs the simulation once and does not include averages or confidence levels. Single-run does show data on transmission of infected individuals between cities.

Multi-run—performs multiple runs on the same simulation. Averages and confidence intervals are calculated over the set of runs.

Start date—the date the epidemic begins.

Duration—the length of the simulation in days.

Number of runs—only given if multi-run has been chosen.

Airline traffic—Default value is 100%. This value is the average percentage of passengers with respect to the number of bookings; derived from flight data.

Enable seasonality—considers the seasonality effect on the infection transmission.

Minimal seasonality rescaling of the reproductive number—only available if Seasonality has been enabled. This value is calculated to derive the minimal of the reproductive number due to seasonality.

Commuting model—chooses the model that will be used to compute the number on commuters between neighboring regions.

2 options:

Gravity model—the number of commuters with estimated parameters based on commuting data from more than 30 countries. The number of commuters is an increasing function of the populations at the origin and destination and a decreasing function of the distance between them.

Radiation model—the number of commuters estimated from data from over 30 countries with the numbers being calculated as an increasing function of populations at the origin and destination and a decreasing function to the total population of the surrounding regions.

Time spent at commuting destination (in hours)—the average number of hours spent at the destination by a commuter. (Default value is 8 hours, a work day.)

Minimum number of clinical cases that need to occur in a country for it to be considered infected—This sets the condition for the outbreak. Default value is 2.

Minimum number of infected countries for a global epidemic to be considered to occur—Default value is 2.

2) Initial assignment of population

This allows the user to set the population for each compartment in the sim model. Populations are expressed in percentages of the total population in the city, region, or country.

Click the “Add New Compartment” distribution link to add new compartments to the list.

The total of all compartments must equal 100%.

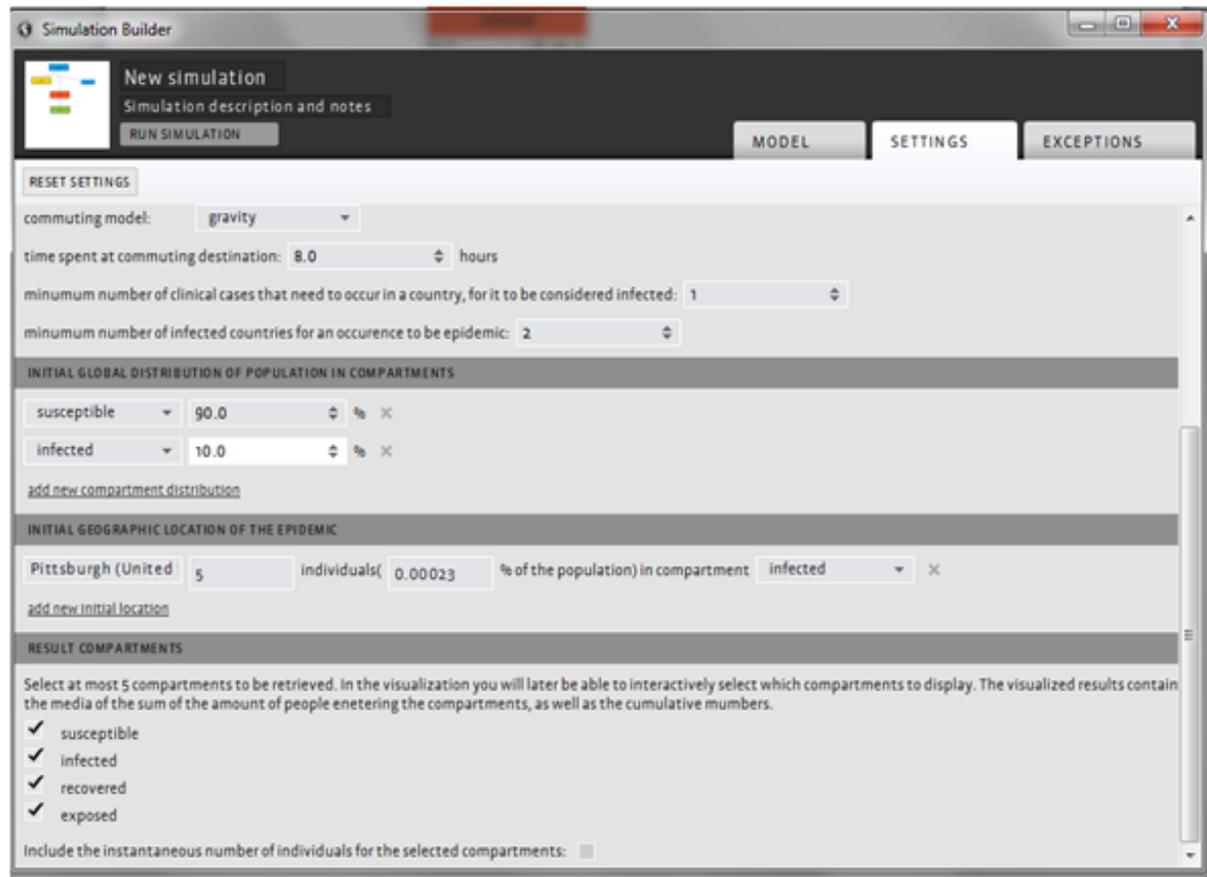
3) Initial geographic location of the epidemic

This allows the user to define the initial location of the outbreak and the quantity of infectious individuals.

Click on add new initial location to add a new line in the list.

Click on the X button to remove a location.

4) **Result compartments**—Select the compartments that will be shown in the Visualization Window. Select up to five.



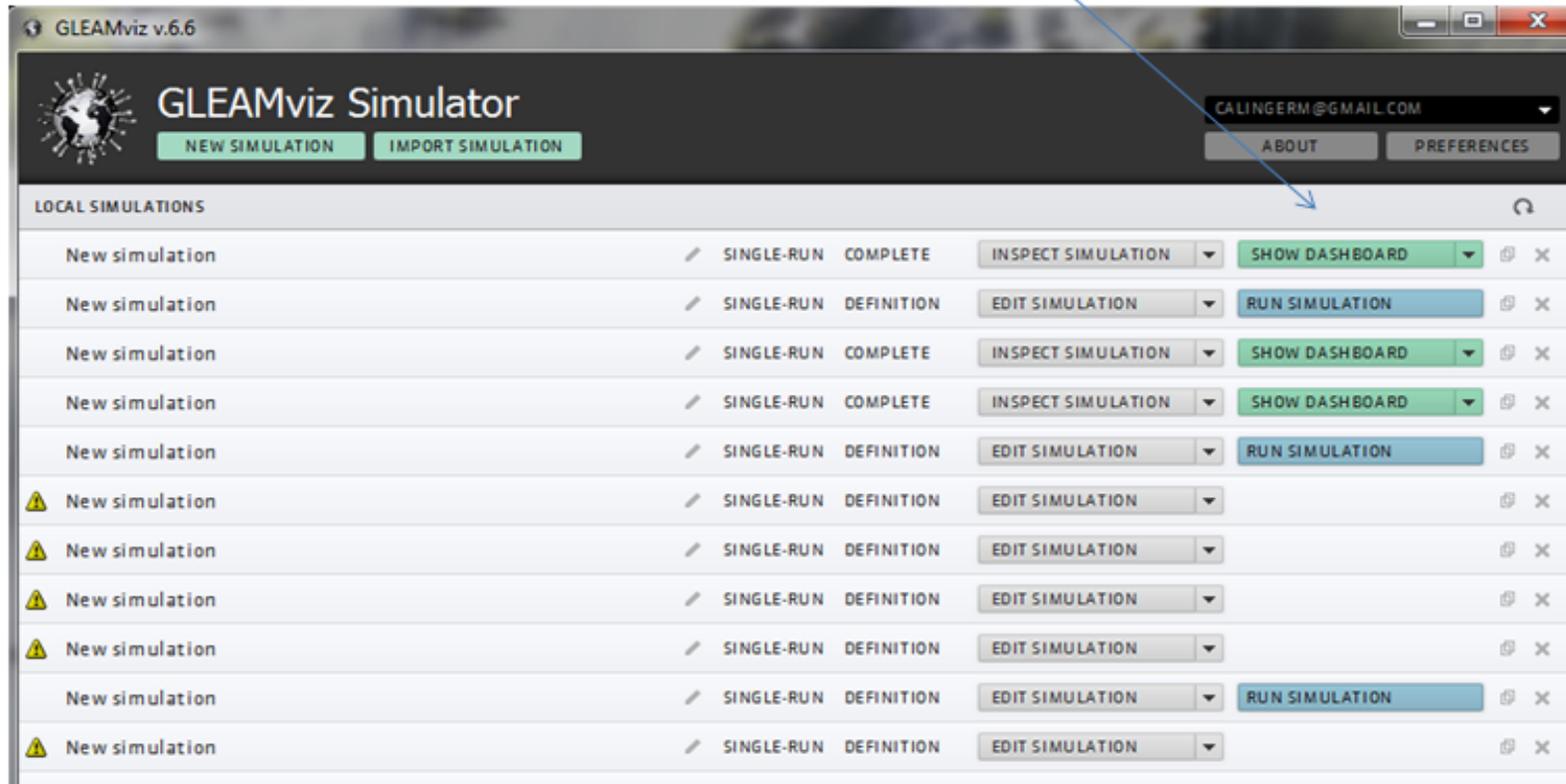
Result compartment choices

The Exceptions panel (accessed by clicking the Exceptions tab in the Menu Header) allows the user to define exceptions to compartments such as alternative variable values.

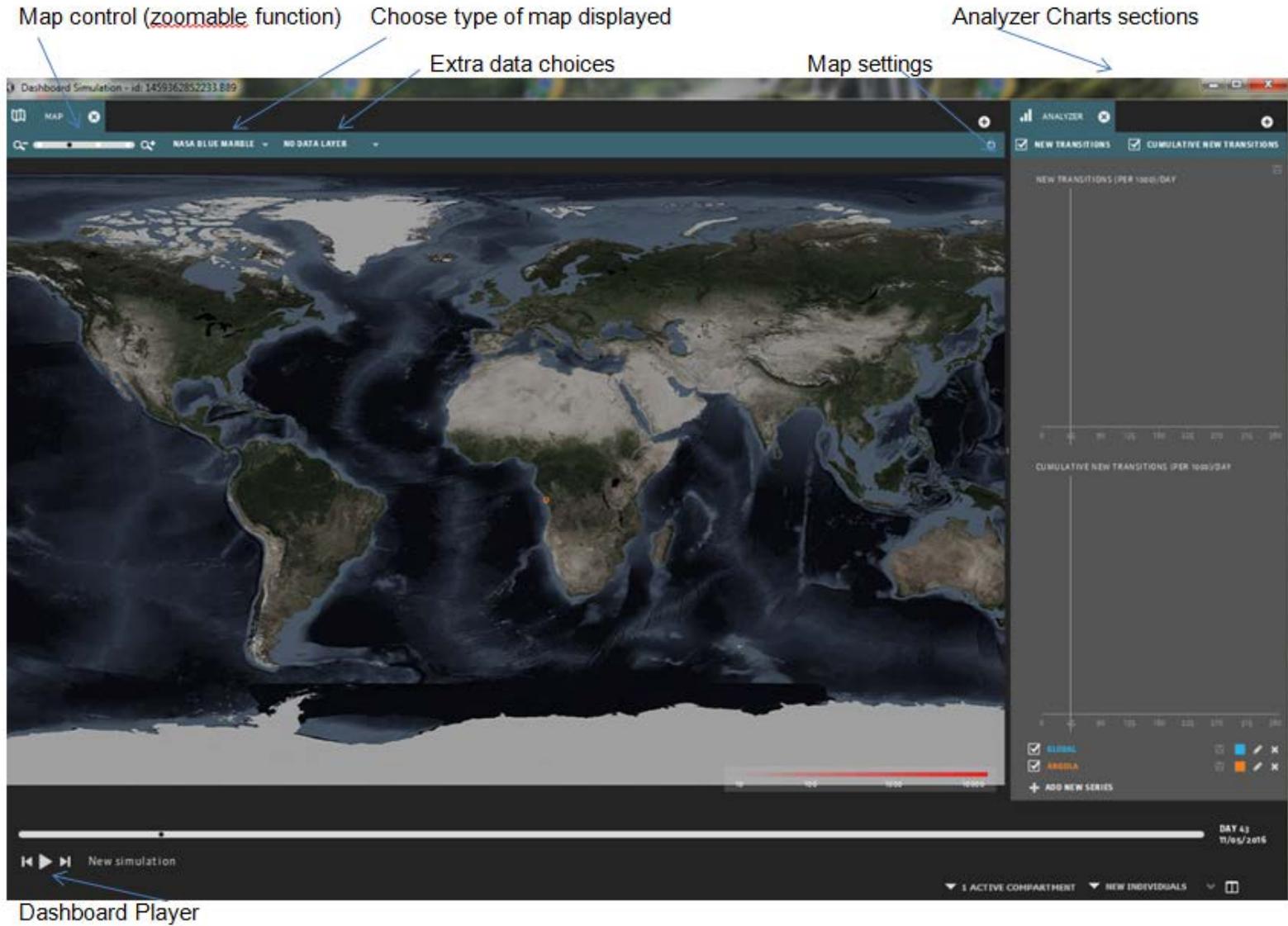
Visualization Components

After building the infectious disease simulation and choosing and setting the parameters to place the disease in the global environment, the user can view the progress of the disease by using the **Visualization Dashboard**.

Access this part of the modeling program by clicking on the **Show Dashboard** tab in the Simulation Manager.

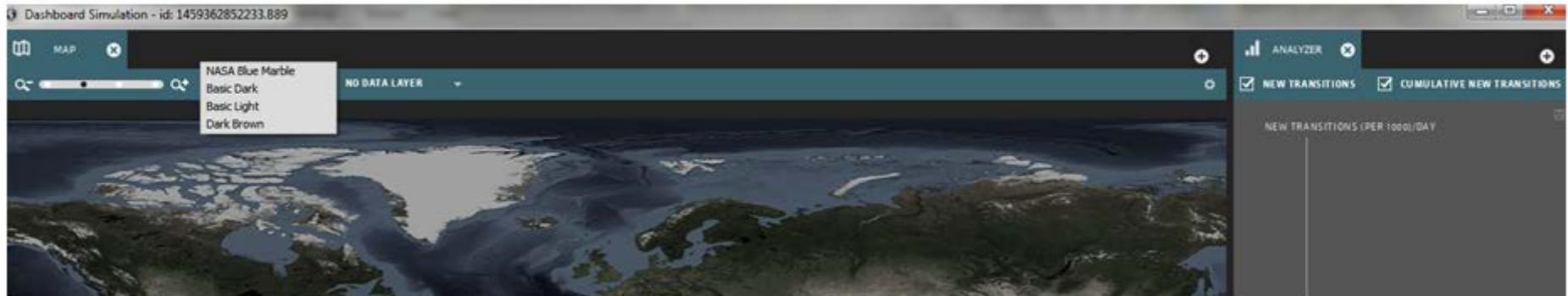


The Dashboard consists of a map of the globe and several widget options that allow visualization of different characteristics of the infectious disease. Features of the widgets are selected by clicking the “+” icon at the top right-hand corner of each widget section.

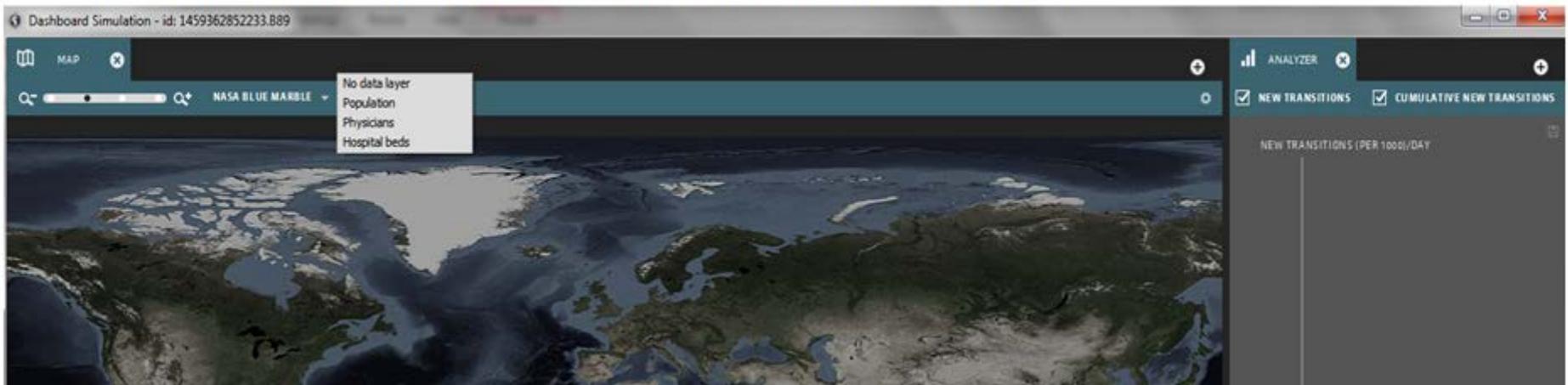


Examples of choices shown when options are opened:

This option allows you to choose the look of the map:



The data layer provides extra data choices not built into the compartments, but available here.



Examples of types of widget options when the + icon in the widget taskbar is clicked and widgets are chosen.



Player Bar options:



Forward one day
Play/Pause
Back one day

Compartment Selector
Data Selector
Layout Selector

The **Compartment Selector** allows the user to select which compartments of the simulation will be shown.



Compartment Selector

The **Data Selector** lets the user choose data of New Individuals (those people entering the compartment on the current day) or Cumulative New Individuals (the cumulative number of people that entered the compartments until the current day).

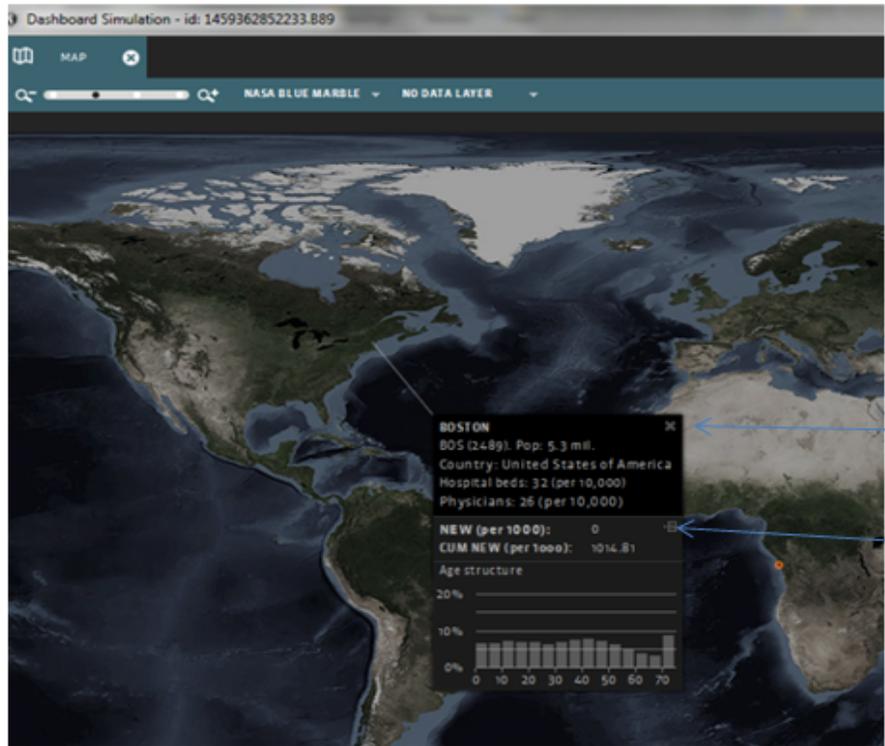


Data Selector

The **Layout Selector** allows the user to change the appearance of the screen.



Layout Selector

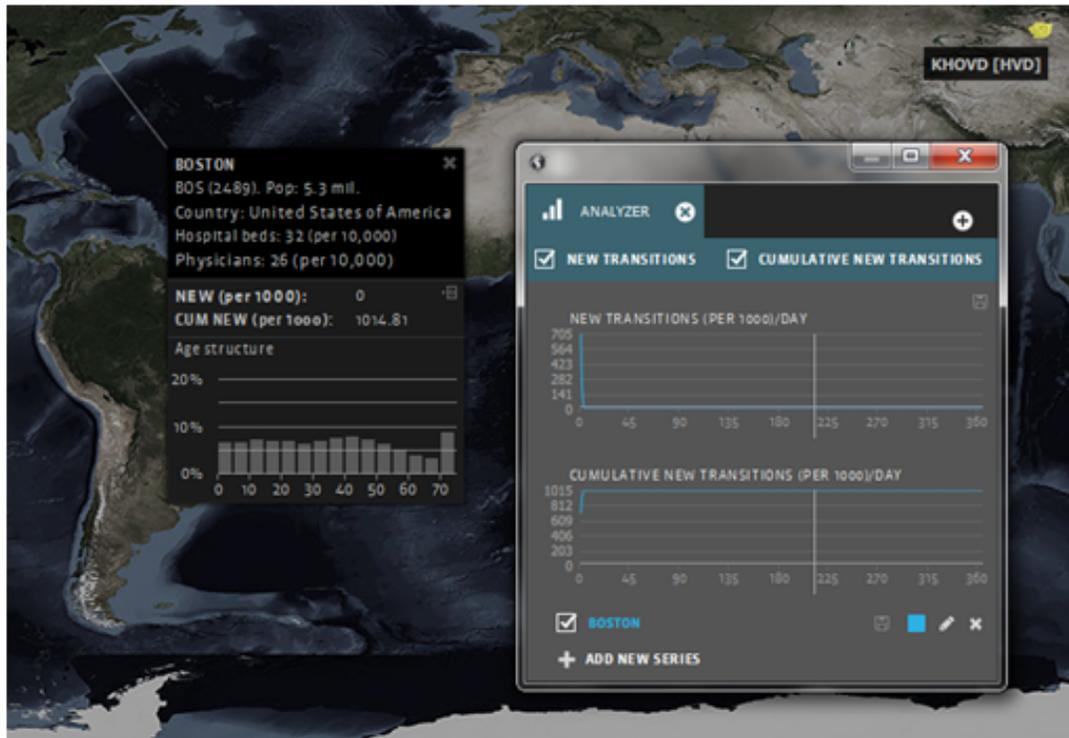


When the cursor moves over the map, names of cities will appear. Hovering over the city will display city information in the database of the GLEAMvis modeling program. Population, number of hospital beds and physicians, the airport code, the new and cumulative number of people in the focus compartments on the current day, and the age distribution structure of the population is shown.

Example: Information for Boston, Massachusetts

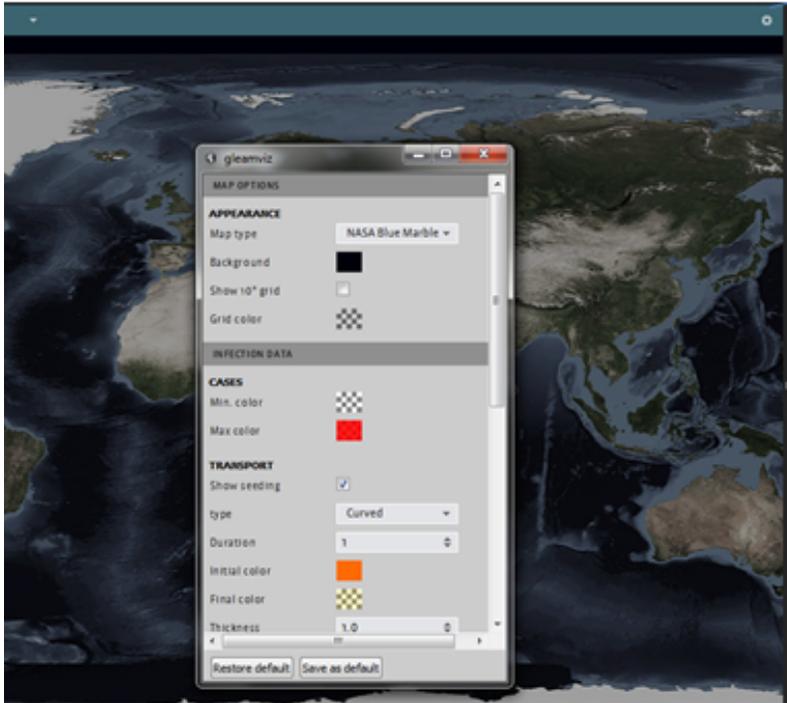
Close button for population information

Show in new Analyzer opens an analyzer chart for this city. See an example below.



Clicking on the Show in New Analyzer icon displays modeling information for the specific chosen city.

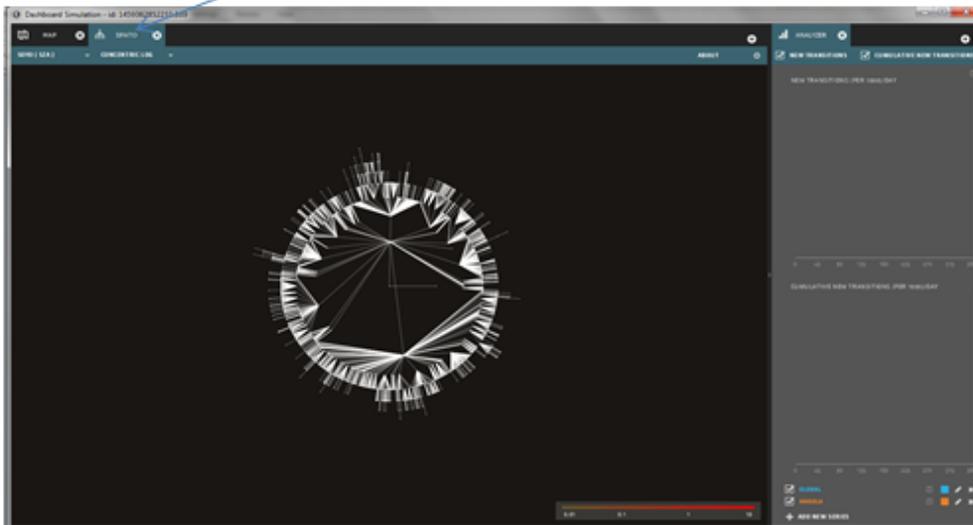
Note: The transportation of individuals carrying the infectious disease can be shown on the map, but only for compartments which carry the pathogen, only for those compartments if they have been selected for focus, and only in single-run simulations.



Map Settings

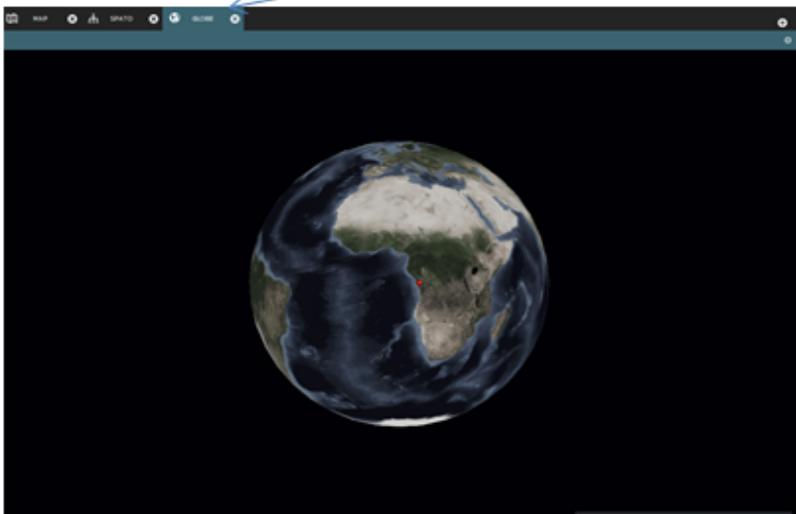
Select different options for map features by clicking on the Map Settings icon. Customizable options include differences in appearance, infection data, data layers, and city appearance.

Spato



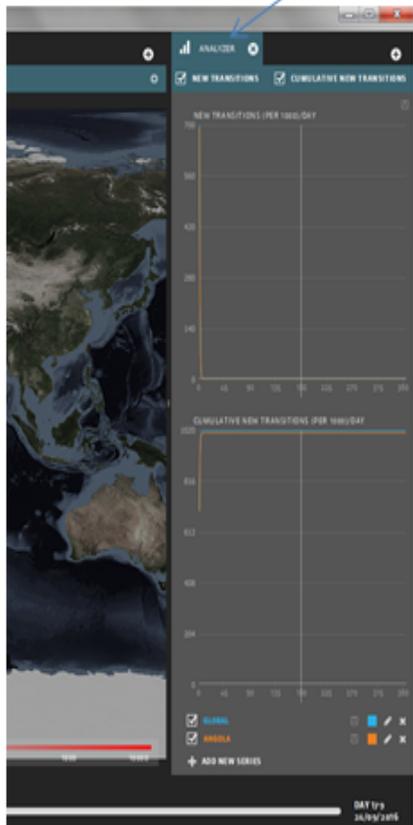
The Spato widget is an interactive software tool that provides a visualization of the shortest path-tree of the infection. It shows a concentric mapping of the local centers of infection. Hovering over the peaks of the hubs shows the location of the data given. (Students may understand the mapping functions of the visualization better and find them more useful than the Spato widget visualization.)

Globe



The widgets also include a 3-D globe that displays the infection spread. The globe can be manipulated by clicking and dragging the mouse.

Analyzer



The Analyzer widget contains two graphical areas. The top graph shows the number of new individuals per 1000 in the selected compartments.

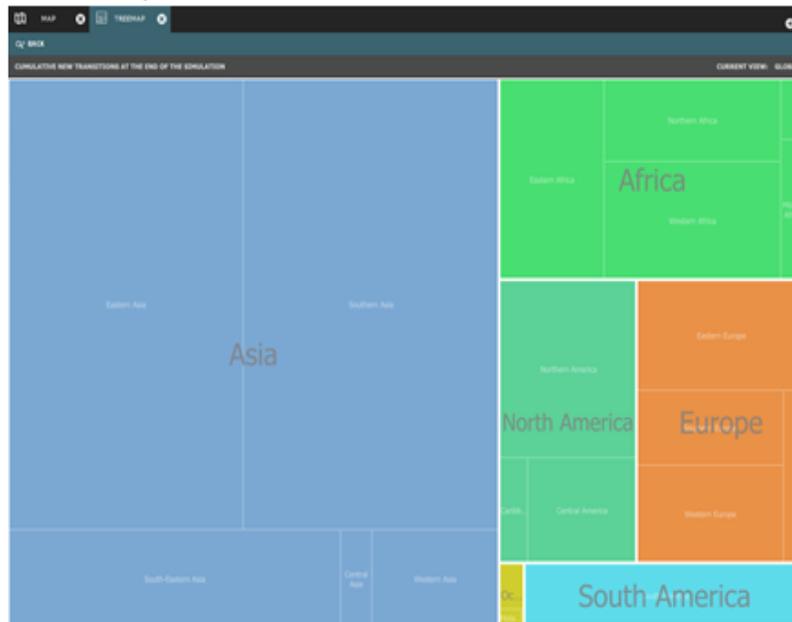
The bottom chart shows the cumulative number of new individuals per 1000 over time.

Remember: Choose the compartments for display by using the **Active Compartment** button at the bottom right of the interface.

You can also select other options for display using the **Context Selection** menu at the bottom of the Analyzer section.

Clicking on the graph displays the status of the epidemic on the dashboard for the day selected.

Tree Map



The **Tree Map** widget shows the final size of the infectious disease epidemic by rectangles with sizes proportional to the cumulative number of affected individuals at the end of the simulation for each region.

Hovering over the regions displays information about the number of transitions within the epidemic for both higher and lower levels.

Clicking on the regions shows specific information within sections of the regions.

Clicking again on the regions displays country information.

Another click shows city information.

Simply click the "Back" button near the top left portion of the screen to return to a larger geographical area.