MILDOS 4.21 release notes

The information provided in this document covers updates to the MILDOS4 computer program since the release of version 4.1 as documented in NUREG/CR-7258 (*Technical Manual and User's Guide for MILDOS, Version 4.1)*. Version 4.2 introduced a population wheel generator and custom user output graphics. Limited parallel programing and other changes were incorporated into version 4.21 to shorten problem run time.

<u>**Installation**</u>

The size of the installation file for version 4.21 is approximately 554 MB. It includes the U.S. Census population data for generating population distributions. The census data is contained in the US_blocks.xxx set of files (shapefile implementation) that are installed in the \MILDOS4\MapData directory. These files require a total of approximately 1.4 GB of disk storage.

<u>**Population Data**</u>

A population wheel generator is now available in MILDOS4. Based on U.S. Census estimates for 2016, users can generate an 80-km population distribution for any location within the United States. The map setup in the user file must be using a UTM projection (not local coordinates) to use this feature. In keeping with the current practice, the population distribution is centered at the location of the first emission source listed in the user file. If the 80-km radius extends into either Canada, Mexico, or offshore, only persons within the U.S. are considered. The US_blocks shapefile does not have to be loaded in the user file map to generate a population distribution.

Note that low population areas often contain large census blocks. In such cases, the estimated population in the same size grid segments (i.e. in the same ring) will have the same population numbers if they are both entirely within the same census block. With low population counts (e.g., single- or double-digit population counts per population grid segment), the user may need to manually adjust these numbers based on their knowledge of the local area.

Age group distributions are also developed for children under the age of 5, ages 5 to 9, ages 10 to 17, and ages 18 plus. These age groupings are based on the available Census tables and do not directly match those used in MILDOS (Infant – 0 to 1 yr; Child – 1 to 11 years; Teenager – 11 to 17 years; Adult – 17 and older) but can provide a basis for adjusting the fraction of population in each age group if desired. These distributions are found in the pop-up window at the completion of the population wheel generation routine and in the PopSum.txt file in the application directory immediately after a run of the generator. The PopSum.txt file is overwritten each time a new population distribution is generated.
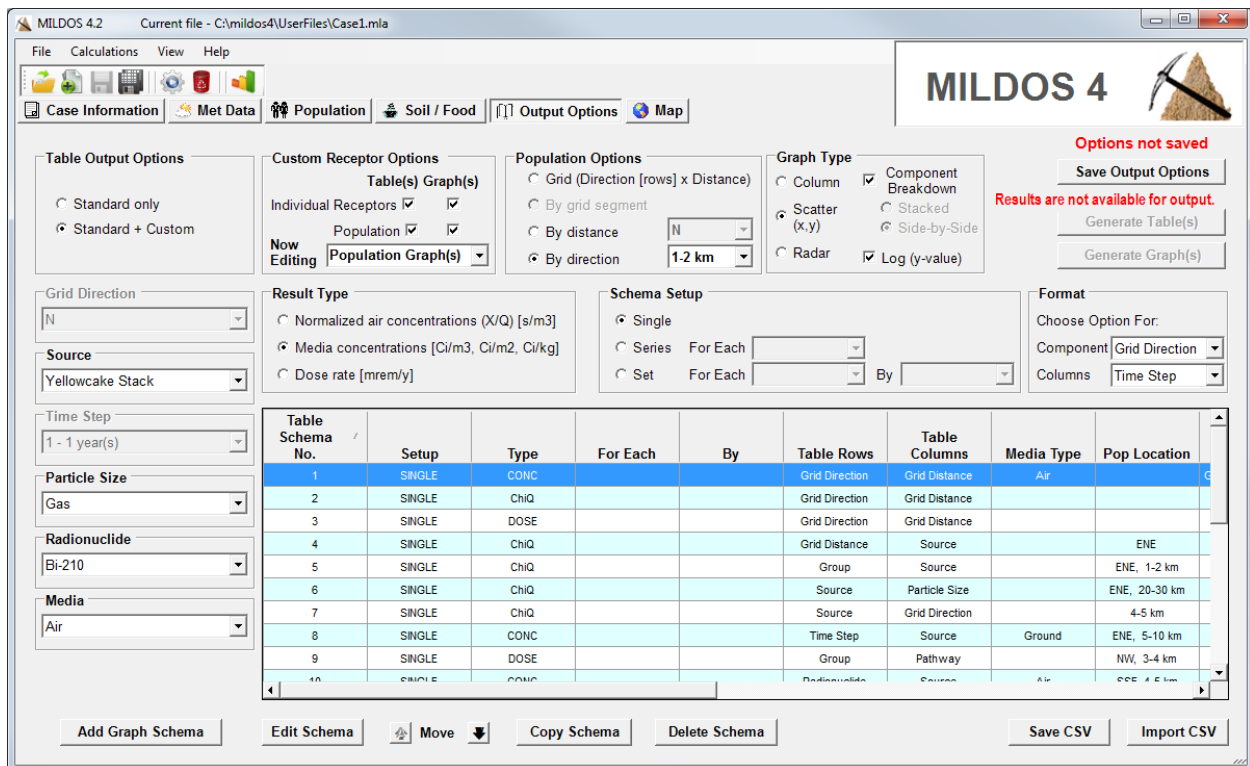
<u>**Graphics**</u>

Custom User Output

Users can specify custom output graphs in a variety of formats (column charts, scatter plots, radar plots) to review results (normalized air concentrations [χ/Q], media concentrations, and dose) for individual receptors and population segments. Development of the schema for each graph is done by the user with an expanded version of the interface implemented for custom

output table generation under the 'Output Option' tab. Each schema denotes the specifications for generating a single, series, or set of graphs.

Selected schema can be added, edited, or deleted by the user. Tables of schema can be saved in CSV format for later use with other user files, but are specific to the type of receptor and output (i.e., individual tables, individual graphs, population tables, or population graphs). The table of schema for a given receptor option is displayed for reference purposes only. Editing of a selected schema is done using the option selections available on the 'Output Options' tab, not through direct editing of the schema table.

Schema may reference specific receptors, sources, or time steps. If the user deletes a receptor (individual receptors only) or source that is referenced in a table or graph schema, that schema entry will be removed automatically. If the name of a receptor or source is changed, it will be changed in the schema. Also, if a time step is removed, any time step number greater than the maximum number of remaining time steps will cause a schema entry to be removed. Similarly, if a schema table is imported from a CSV file, schema entries that refer to receptors, sources, or time steps that are not present in the current user file will not be imported. If the user decides that custom output is no longer desired by clicking on the 'Standard only' radiobutton, custom output will be deleted if present, but any existing schema will remain in the user file and will be available for use if the custom option is enabled again.
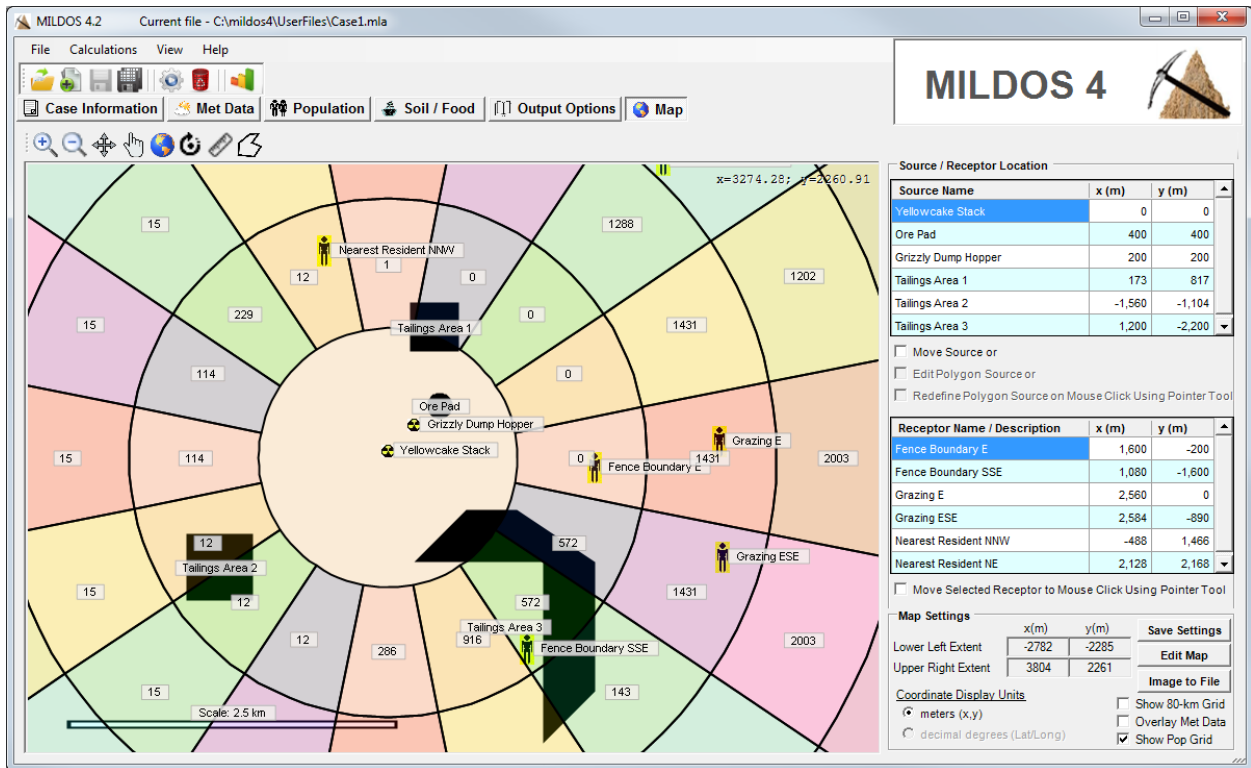

Custom tables and/or graphs are generated automatically at the end of a calculation run. They may also be modified and generated at any time that results are available. Since generation of custom output does not affect the calculated results, a calculation run is not required after the modification of custom output options.

Many combinations of Individual and Population Options and Graph Types are available with some exceptions that are enforced by the user interface. Radar graphs are only available to display population "Grid" or "By direction" results where the selected output is plotted by compass direction. Scatter plots for individual receptor results are only permitted for graphs with time (time step) on the x-axis. Scatter plots for population results are permitted for graphs with time (time step), distance, or direction on the x-axis. Note that the 'Columns' entry in the 'Format' group specifies the x-axis parameter. Column charts are available for most combinations.
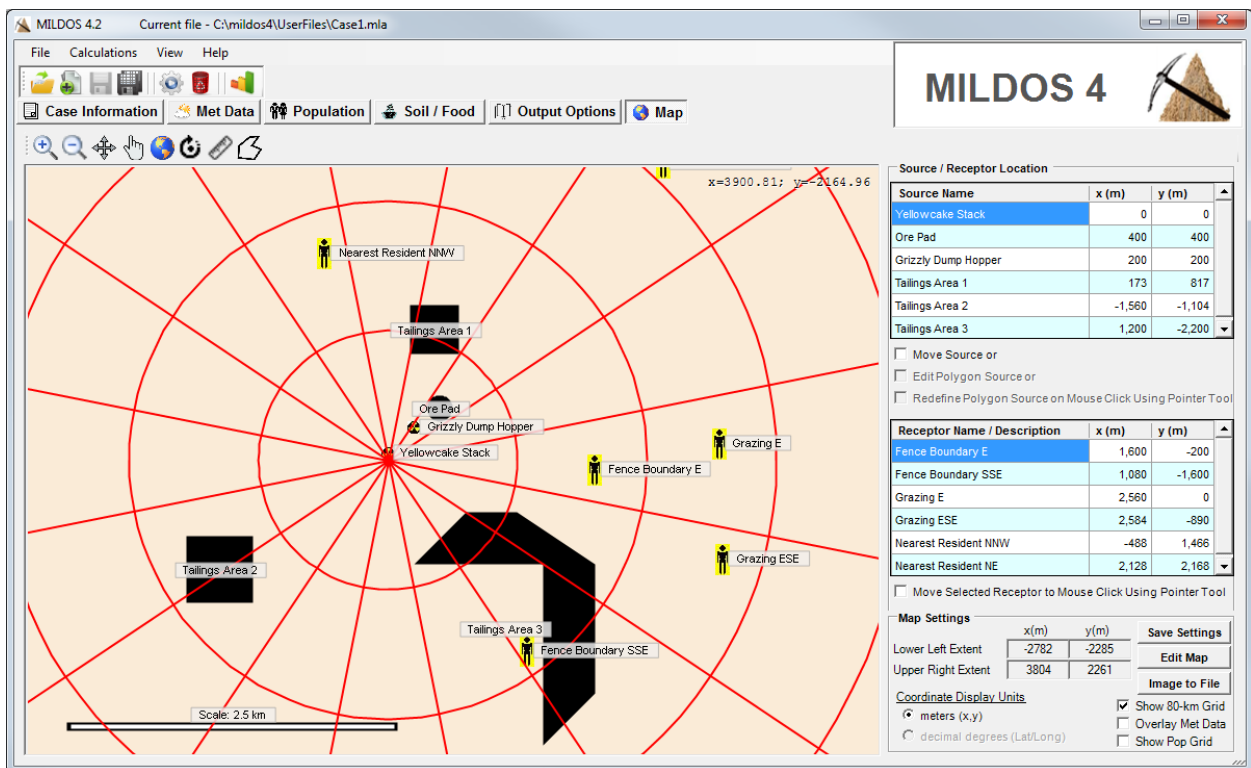
For column charts and scatter plots, a component breakdown may be available. For example, if a concentration or dose is presented on the y-axis, the total concentration or total dose may be displayed as a set of single bars or a curve in the column chart or scatter plot, respectively (no component breakdown). If the component breakdown option is selected, the concentration or dose will be broken down by the option specified in the 'Component' droplist in the 'Format' group. If the selected component option was 'Source', a bar chart could present these results as side-by-side bars (one for each source) at each x-value (column position) or as a stacked column at each column position. However, if the log option for y-values is selected, a stacked column chart is not allowed. For scatter plots, the Stacked / Side-by-Side options are not available, and a set of lines (one for each source in this example) would be drawn for the specified concentration or dose if the component breakdown was selected.

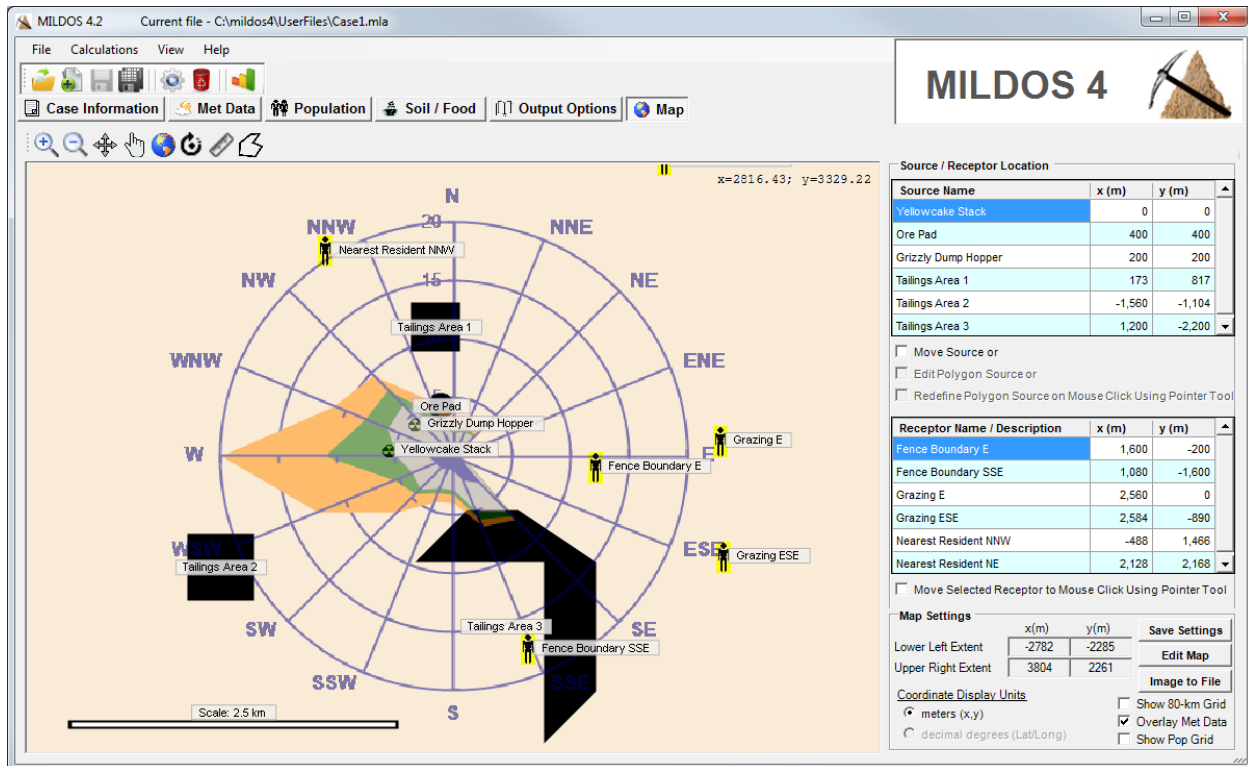*Map (examples of the 3 overlay options are shown below)*

1. The population wheel can be overlaid on the map showing the number of persons in each population segment ('Show Pop Grid' checkbox option). This option is available for all cases with the population option turned on.

2. An overlay of the 80-km grid remains available ('Show 80-km Grid' checkbox option).

3. An overlay of the wind rose on the map is available using the 'Overlay Met Data' checkbox option. This is the same figure shown on the left hand side of the met data graphics display form (Percent of time wind is blowing from a specific direction for each stability class). The figure overlays any map elements. This overlay is not geo-referenced to the map, but provides a visual reference as to the major wind directions relative to receptors and sources for perspective.

Population overlay option

80-km grid overlay option

Met data overlay option

Calculation Time Reduction

Reduction in calculation times was realized to a small extent through the use of parallel programming algorithms in the area source dispersion calculations and the population dose calculations. To take advantage of parallel computing, there must be enough repetitive calculations to offset the overhead of implementing and coordinating 2 or more parallel sets of calculations. The extent of the reduction in calculation times will be dependent on the executing machine's CPU and memory configuration as well as the problem under study. The χ/Q calculation for an area source in the area source dispersion calculations is used for both individual and population calculations. Compared to the single-thread version of the code, the relative computational time (v. 4.21 versus v. 4.2) will decrease with an increase in the size of the area source (larger benefit with larger sources). Problems with larger area sources will benefit more when the full area source calculation is performed (the receptor is within the 'Max. Distance for Area Source' setting under the Met Data tab). Execution of the Case 1 example file should be reduced approximately 15 to 20%, with a further reduction on the order of a minute due to a revised routine for output of the population results to the standard report.

Bug Fixes

Some minor user interface issues were resolved.

A calculation error in versions prior to 4.2 was corrected. User files with area sources listed in sequence that had different associated particle distribution sets may have resulted in higher estimated doses for the second source.