



RoadSnow™ - User Manual

Simulation and forecast of road conditions in North America

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1. Introduction

Being able to predict road conditions is critical for successful road maintenance. Recognizing when to prepare for an icing event or a winter storm can save money, resources, and most importantly, is necessary for public safety.

RoadSnow™ is a complete thermal and physical model of the road that can be used for road maintenance and management in cold weather conditions. It predicts the onset of freezing on the road surface, calculates the temperature profile below the road surface and predicts the surface snow, ice, and water thickness (as it melts or freezes) over a period of time. RoadSnow accounts for the effects of solar radiation, latent heat transfer, sensible heat transfer, precipitation, ambient temperature, the presence of road salt, wind speed as well as the effect of particulates (soot) on surface snow and ice.

1.1. Quick Start Guide

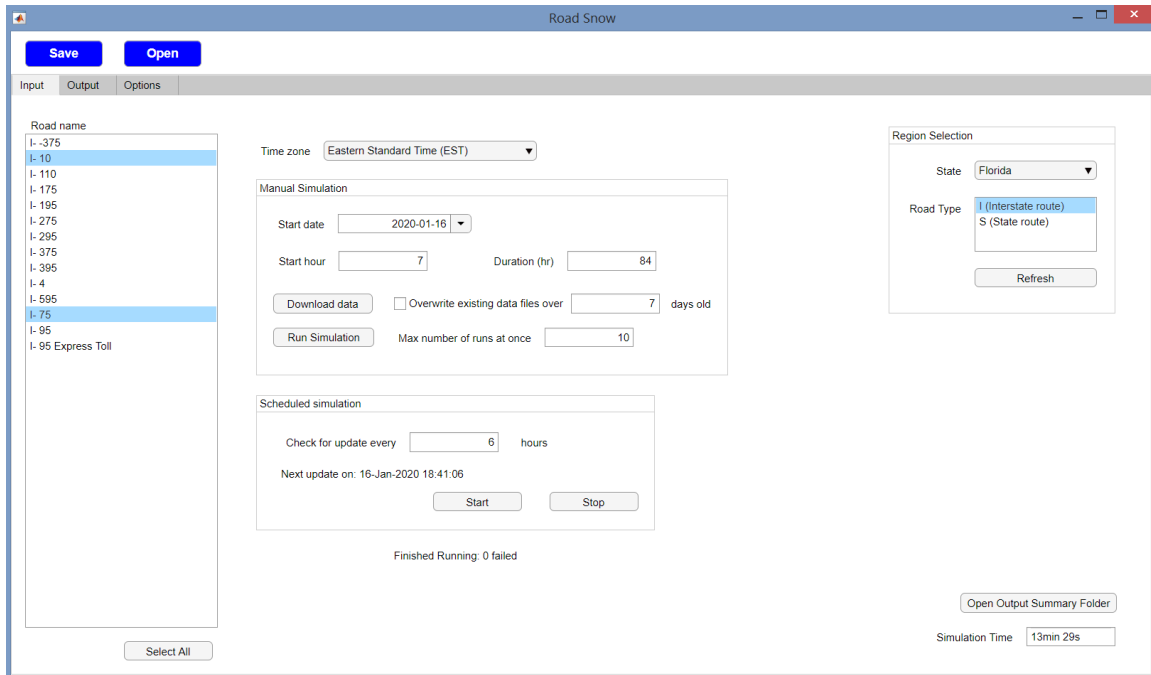


Figure 1 – User Interface

The interface shown in Figure 1 can be viewed when RoadSnow is opened. On the left of the interface, a list of road names is shown, those are the major roads in Georgia, US. To get quickly started, select the roads that you wish to simulate (hold the Ctrl key on the keyboard to select multiple items), then click on “**Start**” in the **Scheduled Simulation** panel.

Once the button is clicked, a progress bar will pop up as shown in Figure 2, checking for the latest files available and download the required files. Internet connection is required, and the size of the data files are quite large (50 MB ~ 60MB per file), if a simulation period of 84 hours is requested, then the total size of the files will be around 5.4 GB.

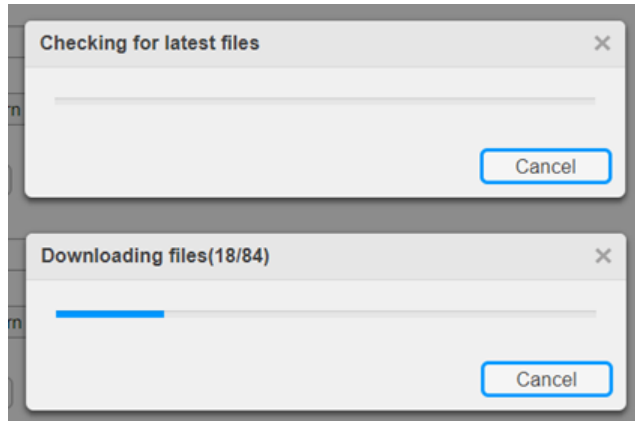


Figure 2 – Progress bars

Once the downloads complete, the program will start to simulate for the latest available time period. The length of this period is specified in the **Duration** input box. Beside the **Max number of runs at once** input box, the current simulation progress is shown (Figure 3). This program calls a separate executable to compute multiple simulations at the same time. The maximum number of simulations can be run at the same time is limited by the number specified in the **Max number of runs at once** input box. Depending on the spec of the machine, this number can be adjusted to ensure smooth performance.

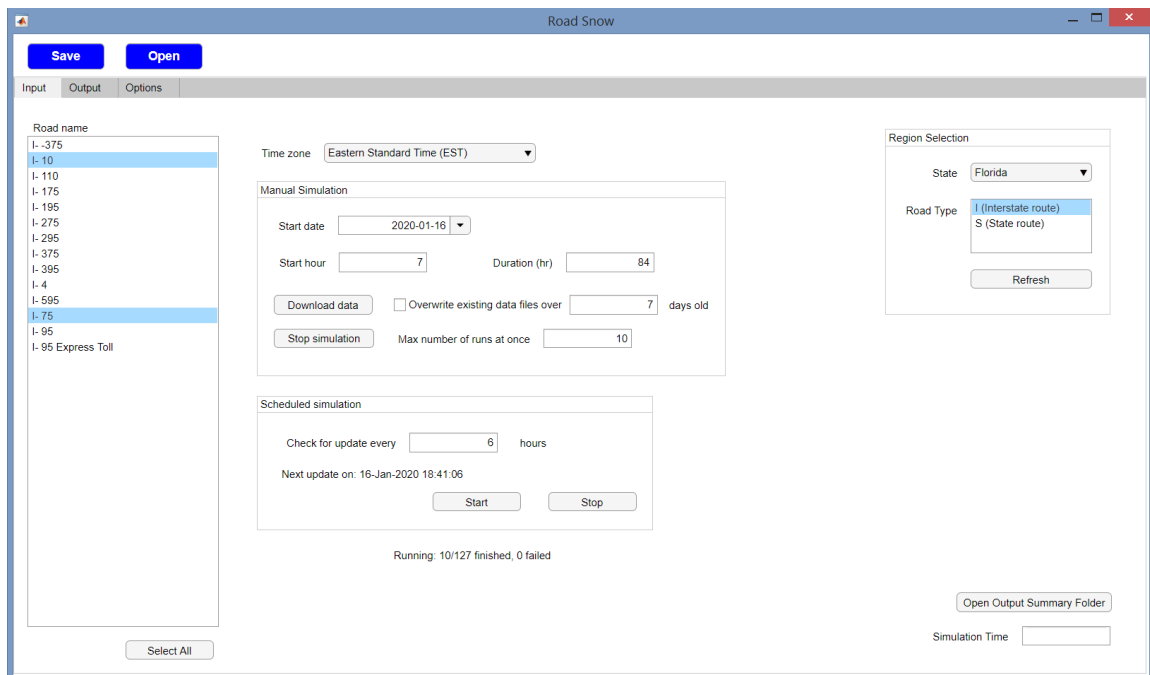


Figure 3 – Simulation Currently Running

As soon as some of the simulations are completed, the user could view the results under the **Output** tab as shown in Figure 4. Slide the timeline located at the bottom of the GUI to refresh the map display. The map and the map legend can be zoomed in or out by using the scroll on the mouse. The thick black line represents road locations that are being simulated but have not yet completed, or in cases where the simulation did not complete successfully. Thin black lines represent unselected roads but available in the shape file.

When the simulation is running, the **Run Simulation** button will be changed to a **Stop Simulation** button as shown in Figure 4. Click on stop simulation will stop the current simulation, and force closes any running executables, these executables could be seen in the taskbar as RoadSnowCoreDeployed.exe in Figure 5.

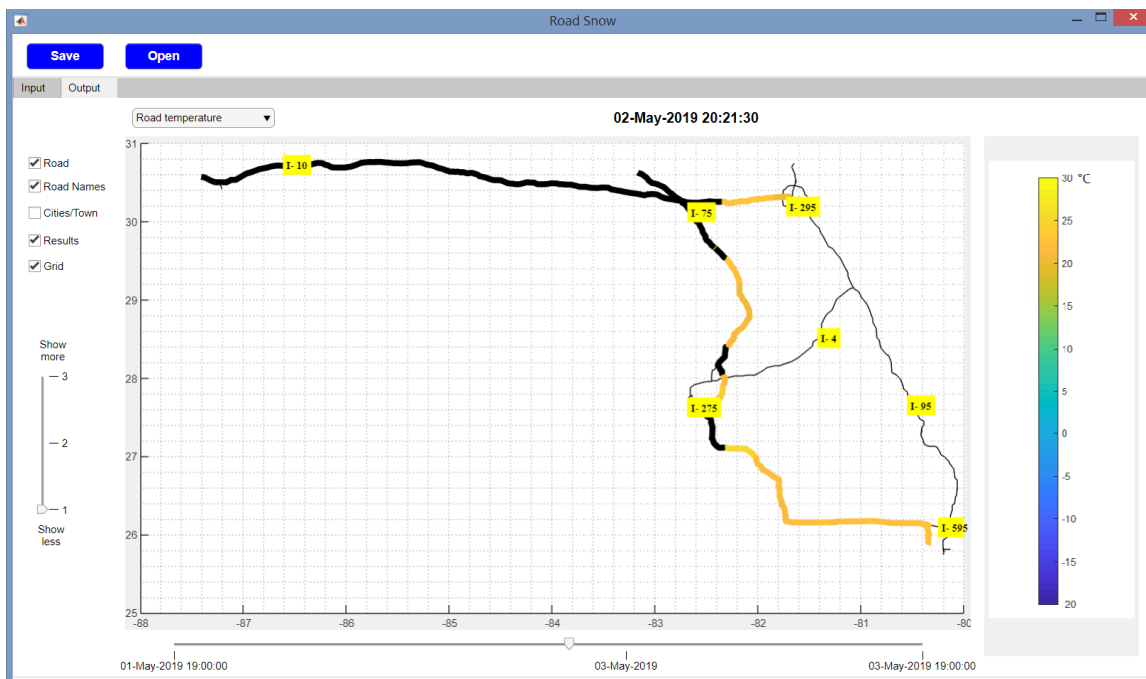


Figure 4 – Output Tab

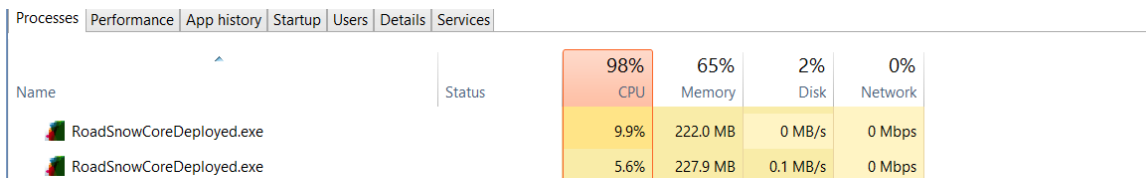


Figure 5 – RoadSnow executable for simulation of individual locations

2. Input

The screenshot shows the 'Road Snow' software interface. The window title is 'Road Snow'. At the top, there are 'Save' and 'Open' buttons. Below are tabs for 'Input', 'Output', and 'Options'. The 'Input' tab is active, showing a list of road names on the left (labeled 1), a 'Time zone' dropdown set to 'Eastern Standard Time (EST)' (labeled 2), a 'Manual Simulation' section with fields for 'Start date' (2020-01-16), 'Start hour' (7), and 'Duration (hr)' (84), and a 'Scheduled simulation' section with a 'Check for update every' field set to 6 hours (labeled 3). On the right, a 'Region Selection' panel shows 'State' as 'Florida' and 'Road Type' as 'I (Interstate route)' (labeled 4). At the bottom, there are buttons for 'Download data', 'Overwrite existing data files over 7 days old', 'Stop simulation', 'Max number of runs at once' (10), 'Open Output Summary Folder', and 'Simulation Time'.

Figure 6 – Input Interface

1. Road name list box

- Select the roads to simulate, only roads in the currently selected State will be shown.

2. Input parameters

- **Time Zone:** The time zone of the location being simulated. Only North American time zones are available. The selected roads and locations must be in the same time zone.
- **Start Date, Start Hour:** The simulation start time, must be the local time of the location being simulated. It is recommended to start a little earlier than the interested time period, to ensure the model converge properly. For example, if the user wishes to know the road condition at 5 pm, it is best to start the simulation at least 5 am.
- **Duration:** The length of the simulation in hours. The default value is set at 84 hours, because the data sets usually come with an 84 hour predictions period.
- **Download Data:** Download the *.grb or *.grb2 files to the data folder selected in ②. For the time interval defined by Start Date, Start Hour, Time Zone and Duration.
- **Run Simulation:** Run the simulations based on the time interval defined by the input boxes above, Start Date, Start Hour, Time Zone and Duration. At the locations selected in ①. The number of simulations will be greater than the number of roads selected, because for each road, there could be multiple

locations to simulate. Each simulation has a unique longitude and latitude coordinate, and the longer the load, the more simulations are required to compute the conditions over the length of the road.

- **Overwrite existing data files over X days old:** The data file from National Weather Services may be updated. The user can check this option to automatically update data files over a certain day old (from the time of the data files were downloaded).
- **Max number of runs at once:** Default is set at 10, too many executables computing at the same time could slow down the machine or even cause the machine to crash. For lower end machines, consider reducing this number

3. Scheduled Simulation

- **Check for an update every X hours:** Program will schedule a check for the latest data files every X hours. Internet connection is required. If a simulation is running at the scheduled time, the check will be delayed.
- **Next update on:** Displays the time to check for update. This time is based on the time on the machine, not based on the time specified by the time zone.
- **Start/Stop:** Start or stop the schedule; the program will not look for updates or automatically run simulations until the user clicks on the Start button. The time interval simulated by the scheduled simulation does not depend on Start Date, Start Hour in ②. Because the program will always try to simulate the latest data available. However, the duration and the time zone for the scheduled simulations is still defined in ②. If the duration is 24 hours, and the latest forecast is up until Jan 25, 5 pm. Then the program will simulate from Jan 24, 5 pm to Jan 25, 5 pm. Clicking on stop will clear the schedule.

4. Region Selection

- **State:** Program will schedule a check for the latest data files every
- **Road Type:** Select the type of roads to simulate, I – Interstate roads, S – State recognized roads.

3. Output

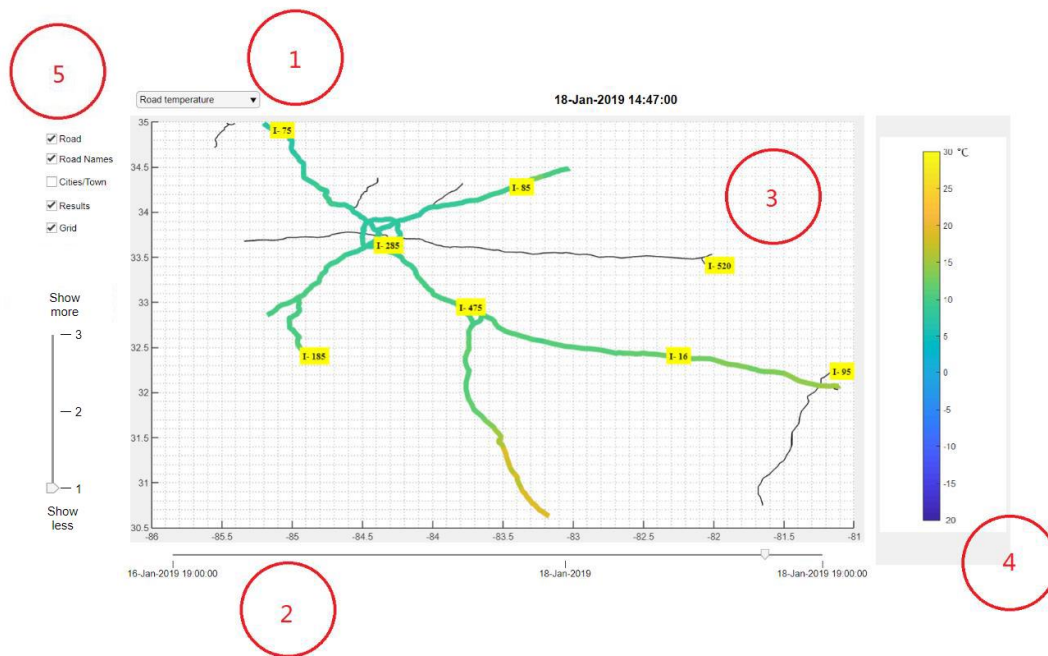


Figure 7 – Output interface

1. Output selection

- **Road Temperature:** Change the map display to show a heat map the of the surface temperature of the road
- **Road Condition:** Change the map display to show the expected road condition.

2. Map display

- Locations with available results are shown using thick colored lines, Locations with results unavailable are shown with thick black lines, and available locations not selected are shown with thin black lines. If data is not available at certain locations, it could be due to i) simulation not yet completed, ii) error in the simulation.
- The map can be moved or zoomed using a mouse.

3. Timeline

- Slide the timeline to display the result at the corresponding time. The time is the local time defined by the selected time zone in ③. The current time on the timeline is also shown above the top right corner of the map display.

4. Legend

- Show the value represented by the colors on the map display. This legend can also be moved or zoomed using a mouse.

5. Layer Display

- Show or hide labels or plots on the map. "Show more" will show more city names/ road names. "Show less" will show less city names/ road names.

Output files

The data of the simulation runs are automatically saved in the output folder, the user can navigate to the output summary folder by clicking on the Open Output Summary Folder button.

Name	Date modified	Type	Size
I- 695_Nov-14	11/14/2019 10:16 ...	Microsoft Excel Co...	6 KB
I- 787_Nov-13	11/13/2019 11:23 ...	Microsoft Excel Co...	6 KB
I- 787_Nov-14	11/14/2019 10:16 ...	Microsoft Excel Co...	6 KB
I- 790_Nov-13	11/13/2019 11:23 ...	Microsoft Excel Co...	3 KB
I- 790_Nov-14	11/14/2019 10:16 ...	Microsoft Excel Co...	3 KB
I- 890_Nov-13	11/13/2019 11:23 ...	Microsoft Excel Co...	9 KB
I- 890_Nov-14	11/14/2019 10:16 ...	Microsoft Excel Co...	9 KB
I- 895_Nov-13	11/13/2019 11:23 ...	Microsoft Excel Co...	6 KB
I- 895_Nov-14	11/14/2019 10:16 ...	Microsoft Excel Co...	6 KB
I- 985_Jan-06	1/6/2020 9:54 PM	Microsoft Excel Co...	11 KB
I- 985_Jan-13	1/13/2020 7:20 PM	Microsoft Excel Co...	12 KB
I- 985_Jan-14	1/14/2020 9:11 PM	Microsoft Excel Co...	12 KB
I- 985_Jan-15	1/15/2020 9:12 PM	Microsoft Excel Co...	12 KB
I- 985_Jan-16	1/16/2020 6:47 PM	Microsoft Excel Co...	11 KB
I- 990_Nov-13	11/13/2019 11:24 ...	Microsoft Excel Co...	9 KB
I- 990_Nov-14	11/14/2019 10:17 ...	Microsoft Excel Co...	9 KB
RoadCondition	1/17/2020 2:52 PM	MP4 Video	7,288 KB
RoadTemperature	1/17/2020 2:53 PM	MP4 Video	7,098 KB

Figure 8 – Output folder

1. Numerical Data Outputs

In the output folder, there are many csv files, each file contains the simulation data for a road at the specified start date.

In each csv file, there are multiple tables containing the hourly data for road temperature, road condition, and snow/water/ice thickness. Each of these table correspond to a certain latitude and longitude.

An example csv file is shown in Figure 9. Note that some of the rows are hidden to show that the file contains multiple tables

	A	B	C	D	E	F
1	73.601560N 41.388090W					
2	Time	Road Tem	Road Conc	Snow Thic	Water Thic	Ice Thickne
3	s	deg C	1~4=bes	cm	cm	cm
4	Nov-14 7/	-2.6	4	0	0	0
5	Nov-14 8/	-5.4	4	0	0	0
6	Nov-14 9/	-5.4	4	0	0	0
7	Nov-14 10	-4.3	4	0	0	0
89						
90	73.623540N 41.284410W					
91	Time	Road Tem	Road Conc	Snow Thic	Water Thic	Ice Thickne
92	s	deg C	1~4=bes	cm	cm	cm
93	Nov-14 7/	-2	4	0	0	0
94	Nov-14 8/	-4.5	4	0	0	0
95	Nov-14 9/	-4.5	4	0	0	0
178						
179	73.645450N 41.180670W					
180	Time	Road Tem	Road Conc	Snow Thic	Water Thic	Ice Thickne
181	s	deg C	1~4=bes	cm	cm	cm
182	Nov-14 7/	-2.1	4	0	0	0
183	Nov-14 8/	-3.9	4	0	0	0
184	Nov-14 9/	-3.8	4	0	0	0
185	Nov-14 10	-2.8	4	0	0	0
186	Nov-14 11	-0.9	4	0	0	0
187	Nov-14 12	-1.1	4	0	0	0
188	Nov-14 1F	-0.8	4	0	0	0
189	Nov-14 2F	0.8	4	0	0	0
190	Nov-14 3F	0.4	4	0	0	0

Figure 9 – CSV output

2. Video Generation

Videos are generated showing the road temperature or road condition over time. These videos are can also be found in the output folder. The video shows hourly condition/temperature of the road.



Figure 10 – Video output

4. Options

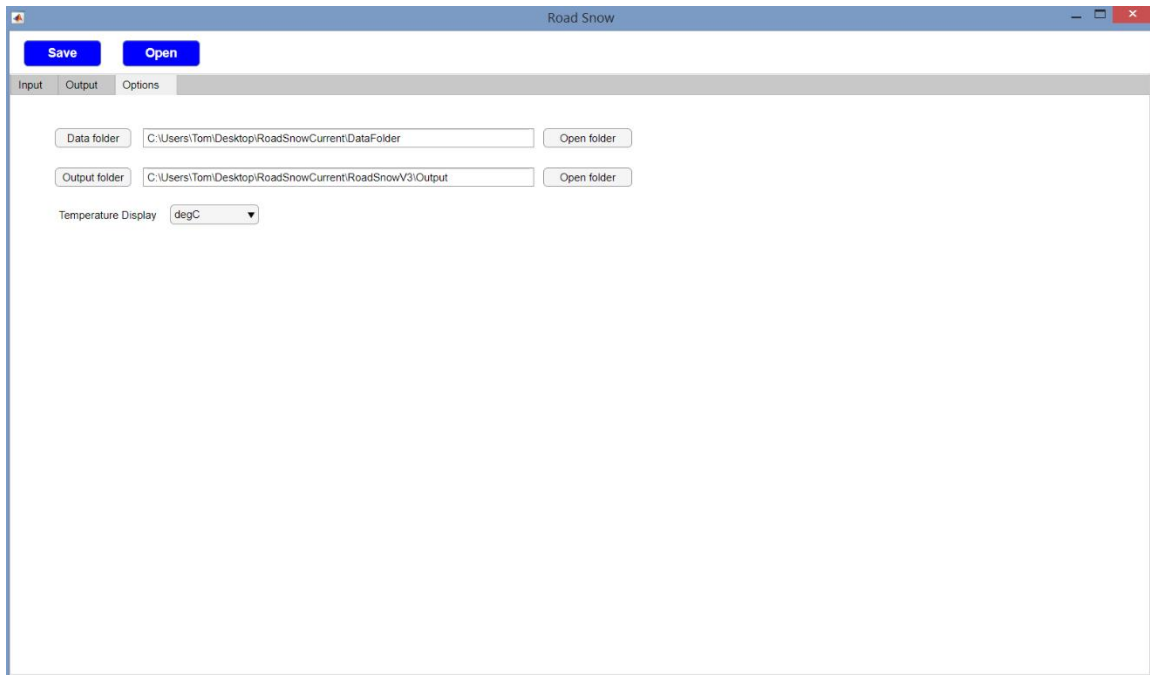


Figure 11 – Options Interface

- **Data Folder:** The *.grb or *.grb2 files will be downloaded to and read from this directory. The program will always download data specified in this directory, so make sure that there is plenty of space in the corresponding disc.
- **Output Folder:** The location to write the results for individual runs. At the start of computation, the results from previous runs will be discarded, and a new set of folders will be generated. In each of the subfolder automatically generated, there will be a *.ini file which contains all the simulation information for that run. After the simulation is completed, a result *.mat file will be generated. The main program will look for this file and update the results.
The user usually does not need to access these folders, unless an error occurred, the error log will be saved to these folders.
- **Temperature Display:** Select the unit of temperature to be displayed in the GUI