DEMEX Tutorial

By Lawrence Kellie

Purpose and Introduction

Creating the "perfect" prototypical route is a dream of many MSTS users. Part of that "perfect" route means that a mountain, valley, plateau, mesa are formed correctly so they look like the corresponding feature in real life.

Early on in the MSTS community, John Stanford and others worked hard to decipher MSTS's tile file format in order to be able to write elevational information directly to that tile.

It has been my privilege to use nearly every version of DEMEX, from the earliest beta to the current public release. (DEMEX can be obtained from John's Website at http://www.demex.vcn.com/) And I can tell you that the product that John Stanford has provided to the MSTS community is one of the most valuable.

This tutorial is aimed at first-time users who have not registered DEMEX, but there are useful tips here for experienced registered users too.

## *Method Used in this Tutorial*

In this tutorial, we will be actually creating a route from idea to terraforming the terrain. So hang on to your hats!

Choose Route Area

We are going to create portion of the Boston and Maine railroad route in New Hampshire, United States. Specifically, we will be terraforming between Concord and Laconia, New Hampshire—an extremely scenic area of New England.

So let's start with starting the Route Geometry Extractor, also known as Route Geography Creator. For the purposes of this tutorial, I'll refer to it by RGE.

If you do not know how to generate a route using the RGE, please follow the help file that comes with it. We will, however, be working in the following region of North America:
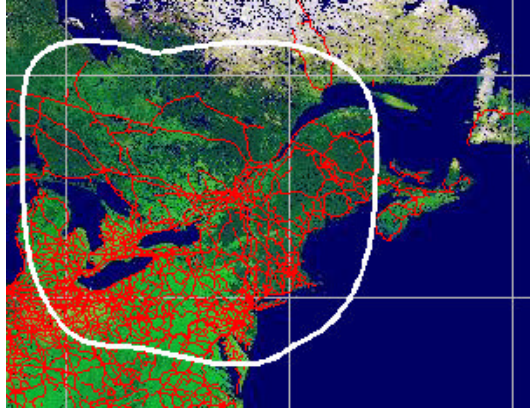
Zoom in that region to its largest, and scroll all the way to the eastern edge. Scroll about ¾ the way down to find this formation of terrain and red lines:
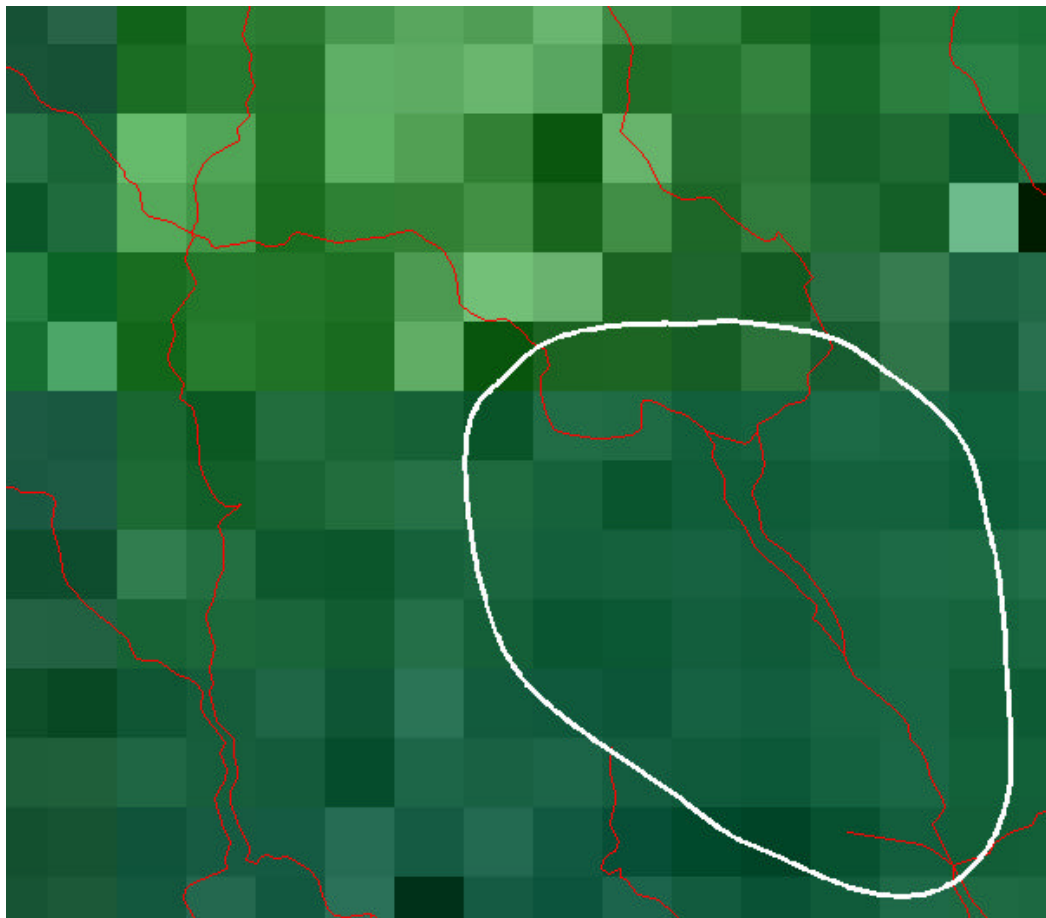
The circled area is the most distinctive part, and what we will be modeling.

The red lines are supposed to represent rail trackage, and whereas it may not be 100% accurate, it does give a general idea.

When you are done selecting the tiles, your display should some something similar to this:
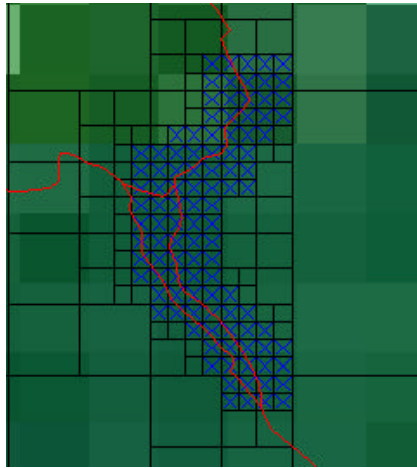
We are going to be terraforming for the eastern red line.

Generate Route Tiles

Now that the route has been selected, go ahead and generate the tiles. If you have exactly the same tiles selected that I do, you will be generating 106 tiles. Not a bad start for a first route! And the route will be approximately 50 km, or about 30 miles.

Do NOT exit the RGE at this time.

Determine Long/Lat Coverage

What we need to do at this time is to determine the longitude and latitude of the area covered by your route. Specifically, for this route, we will be making a box and seeing where two of the corners are.

Imagine a box around your route, something like in the below graphic:
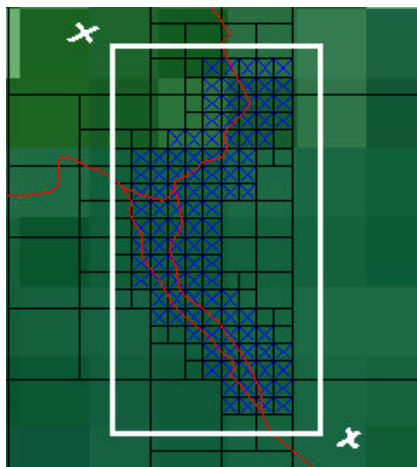
Now, let's get the long/lat for the northwest and southeast corners, where the "x"s are. You do that by hovering your mouse pointer over the spot in the RGE, then read the status bar for the lat/long.

The northwest corner is `Lon: -71.6515 Lat: 43.5903`

And the southeast corner is `Lon: -71.4460 Lat: 43.1792`

Write those two sets of numbers down.

Now be sure to set the Route Editor Start Tile for your route. Set it at the tile the arrow points to in the below graphic:
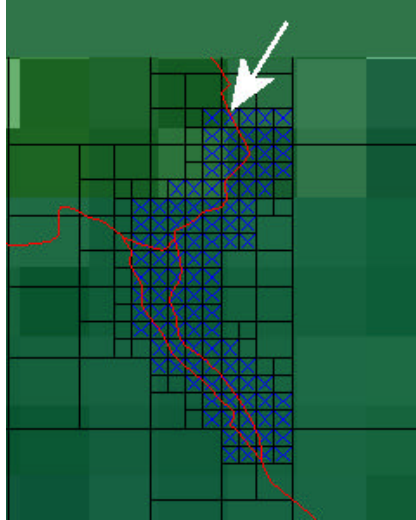
You can now exit the RGE, making sure that you have created the tiles and set your starting point. Don't foget to save your tile quadtree before you exit.

If you were to open your route in the Route Editor (RE), you would see nice flat green nothingness.

Download DEMs

Now, let's go get some DEM data.

There are two main sites where you can obtain *free* DEM data: http://www.gisdatadepot.com and http://www.mapmart.com.

For me, I always use Mapmart. So, that is what we will use for our route.

Go to http://www.mapmart.com. Select the link for Digital Elevation Models (which is what DEM stands for). Select High Detail 7.5-Minute.

You will see a map of the United States.

Click on the state of New Hampshire, and it will zoom in to New Hampshire.

The area is pretty easy to find, as we are going to be terraforming the route between Concord (south) and Laconia (north)—both of which show up on the map. However, let's practice another method, one to use when you do not have any landmarks on the MapMart map.

Move your mouse around the picture of New Hampshire, look down to the status bar. You will see that the long/lat values are being shown. What we want to do is

to draw a box from the upper right corner which is the northwest corner values above down to the lower left corner which is the southeast corner values above.

When you are done, the map on your screen should look something like this:
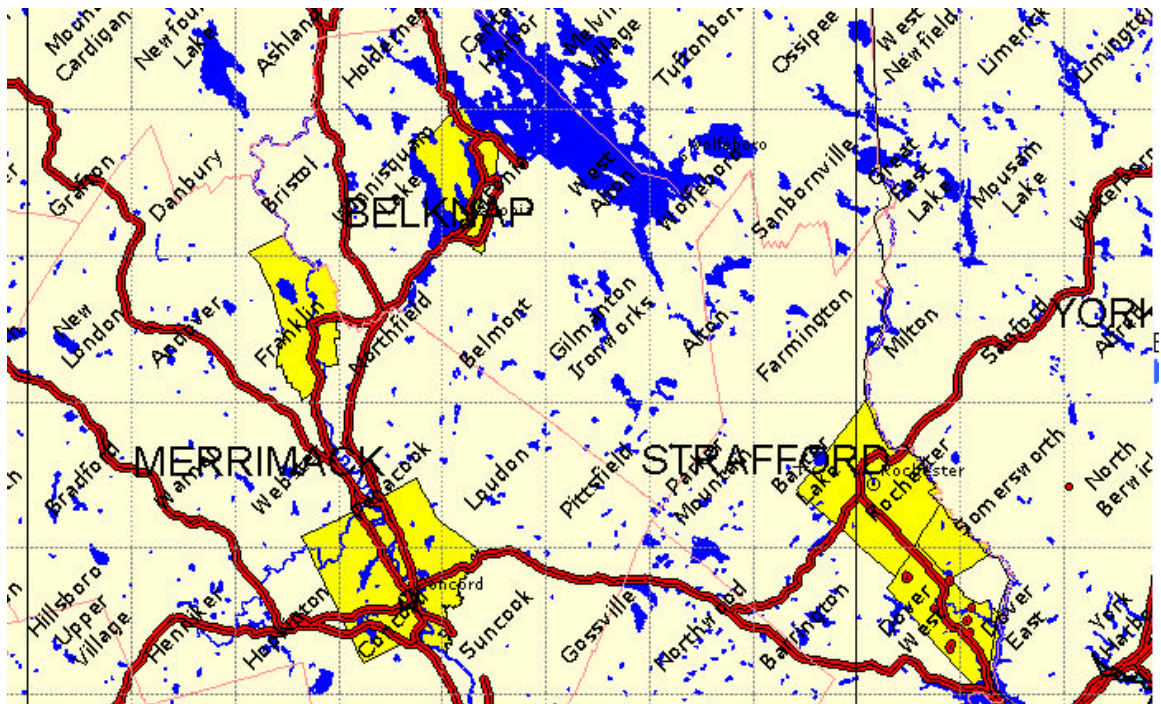

Obviously if you compare the area you outline to the area you had shown, the two do not match. What you outlined is tall and skinny, and what you see is short and wide. However, that is okay. Don't worry.

Now click the Begin Ordering button.

The same map appears, but now when you select the area, you will get the DEMs you need. Oh, each one of the boxes above represents one DEM file.

So again drag the mouse as you did before to select the area you want.

You should end up with your map looking something like this:
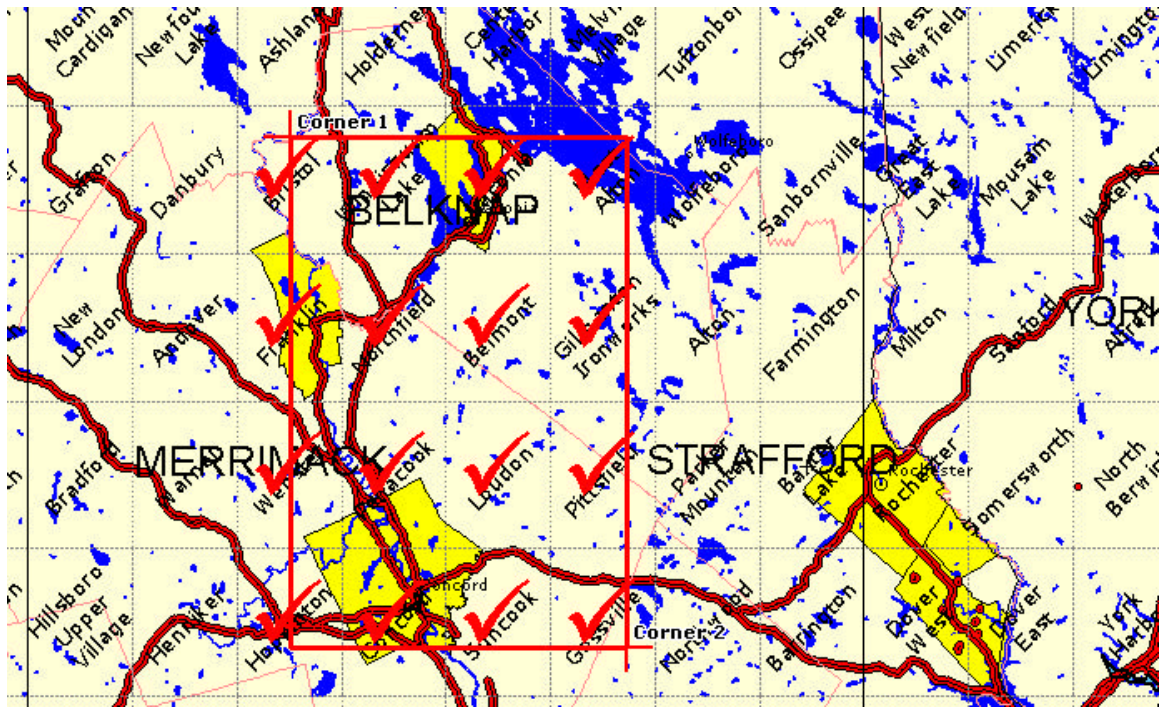
Each of those checkmarked squares is one DEM file—and we are going to get 16. Be sure that you have those 16 rectangles selected.

Notice to the left of the map. See the following:

If you have a choice, and the computer power to handle it, 10 meter DEM is better than 30 meter DEM. The number (10 or 30) represents distance between measurement points; therefore the 10 has a finer resolution than the 30.

In our case, only 30 meter DEM is available.

Scroll to the bottom of the screen, and you will see the Check Out button. Click it.

You will come to a very confusing appearing page. But it isn't as daunting as it first seems.

All you have to worry about is the lower section. Fill in your name, etc., and make sure that for the Shipping Method, you choose FTP Download. By making that choice, the entire process is free.

When you are ready to start downloading, click Submit Order. It takes a little while to process the order, so just click in once and wait.

Now, if you scroll down this next page, you will see that you are told you can only order 10 files at a time. Don't worry, we have a way to work around that.

Download each of the 10 files by clicking on the Download link for each file. Wait until the downloading is completed.

Now after the downloading is completed, just click the Back button.

Now, remove the check mark for each DEM you just downloaded, see graphic:

| 10 Meter DEM	30 Meter DEM	Order Contour File	Quad Name	State	Cost
Not Yet Available	☐ Available	☐ Custom 30	BELMONT	NH	$0
Not Yet Available	☐ Available	☐ Custom 30	BRISTOL	NH	$0
Not Yet Available	☐ Available	☐ Custom 30	CONCORD	NH	$0
Not Yet Available	☐ Available	☐ Custom 30	FRANKLIN	NH	$0
Not Yet Available	☐ Available	☐ Custom 30	GILMANTON IRONWORKS	NH	$0
Not Yet Available	☐ Available	☐ Custom 30	GOSSVILLE	NH	$0
Not Yet Available	☐ Available	☐ Custom 30	HOPKINTON	NH	$0
Not Yet Available	☐ Available	☐ Custom 30	LACONIA	NH	$0
Not Yet Available	☐ Available	☐ Custom 30	LOUDON	NH	$0
Not Yet Available	☐ Available	☐ Custom 30	NORTHFIELD	NH	$0
Not Yet Available	☑ Available	☐ Custom 30	PENACOOK	NH	$0
Not Yet Available	☑ Available	☐ Custom 30	PITTSFIELD	NH	$0
Not Yet Available	☑ Available	☐ Custom 30	SUNCOOK	NH	$0

Now scroll to the bottom again, and click on Submit Order.

Continue that until you have downloaded all the DEM files.

You can now exit from the Web site.

DEMEX

When you first start DEMEX, the following window appears.
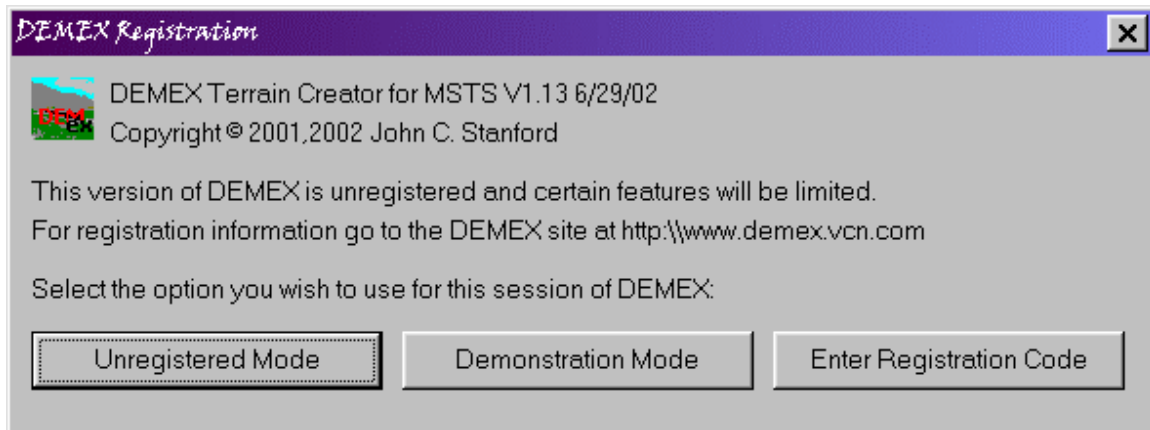
The three choices are explained very well by the DEMEX documentation:

Unregistered Mode

The Unregistered mode provides full access to the basic features of DEMEX. All features of the original freeware DEMEX are supported, and the new graphical tile selection tools are available. The following options are disabled in UNREGISTERED mode: File Save, DEMEX Options, and Distant Mountains. All DEMEX Options are set to their default unselected setting with the exception of Terrain Buffer deletion, which is always on.

Demonstration Mode

The demo mode provides limited access to all of DEMEX's features except File Saving. All of the DEMEX options may be selected and used, however only one standard terrain tile may be updated during a session (if more than one tile is selected the generated tile will be chosen at random). DEMEX must be exited and restarted to generate additional terrain. Distant Mountain terrain can be generated on multiple tiles, however only the South half of each Distant Mountain tile will be generated.

Registered Mode

Clearly, this needs no explanation. You can do everything to as many tiles as you can.

Starting

To start Demex is very simple. Double click on the icon. When you do, the following window will appear (if you are using Unregistered or Demonstration modes, this follows the above window.) We want to start in Unregistered mode.
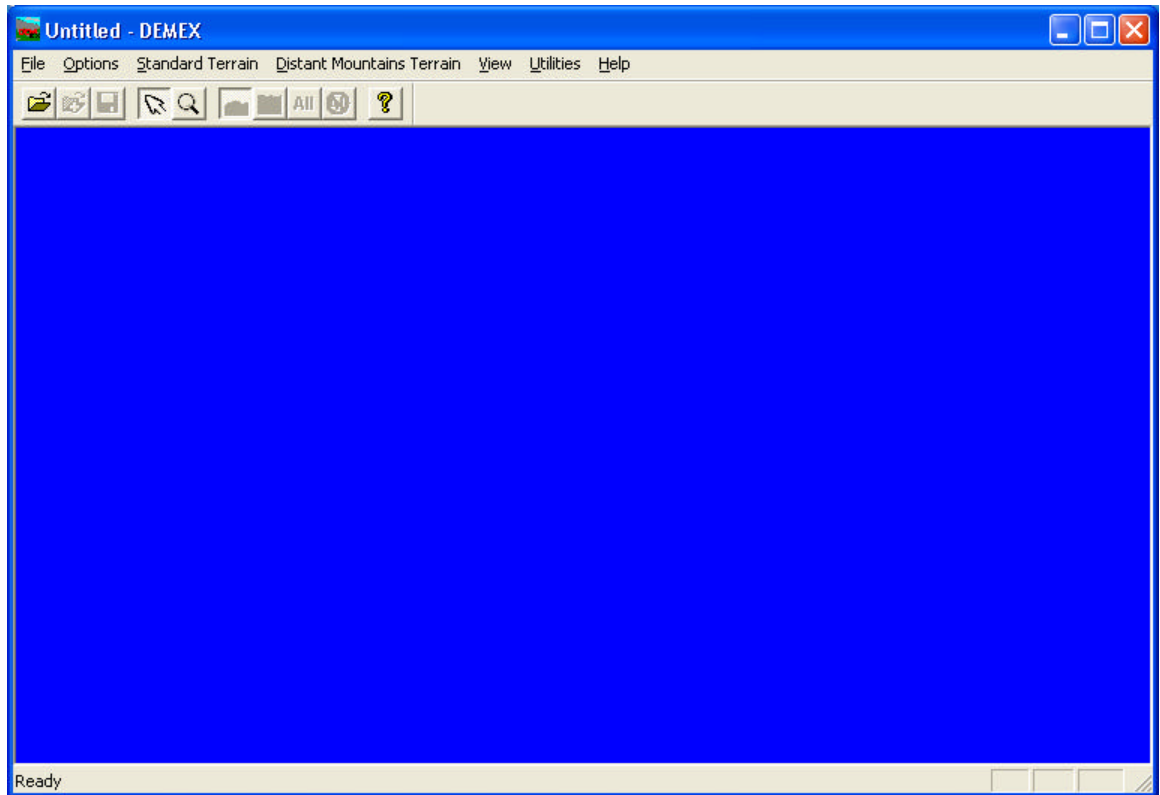
You can find the menu choices and options described in appendices at the end of this document.

Merging

You can work with one file of DEM or you can merge several. We are going to merge all our DEM that we downloaded above into one giant file.

To do this, we start with selecting File, Open (ctrl-o or the open file on the tool bar). In order to merge DEM, you must "open" the first one.

Select any one of the 16 files…the first would probably be the most logical.

After opening the first one, the screen will look something like the below.
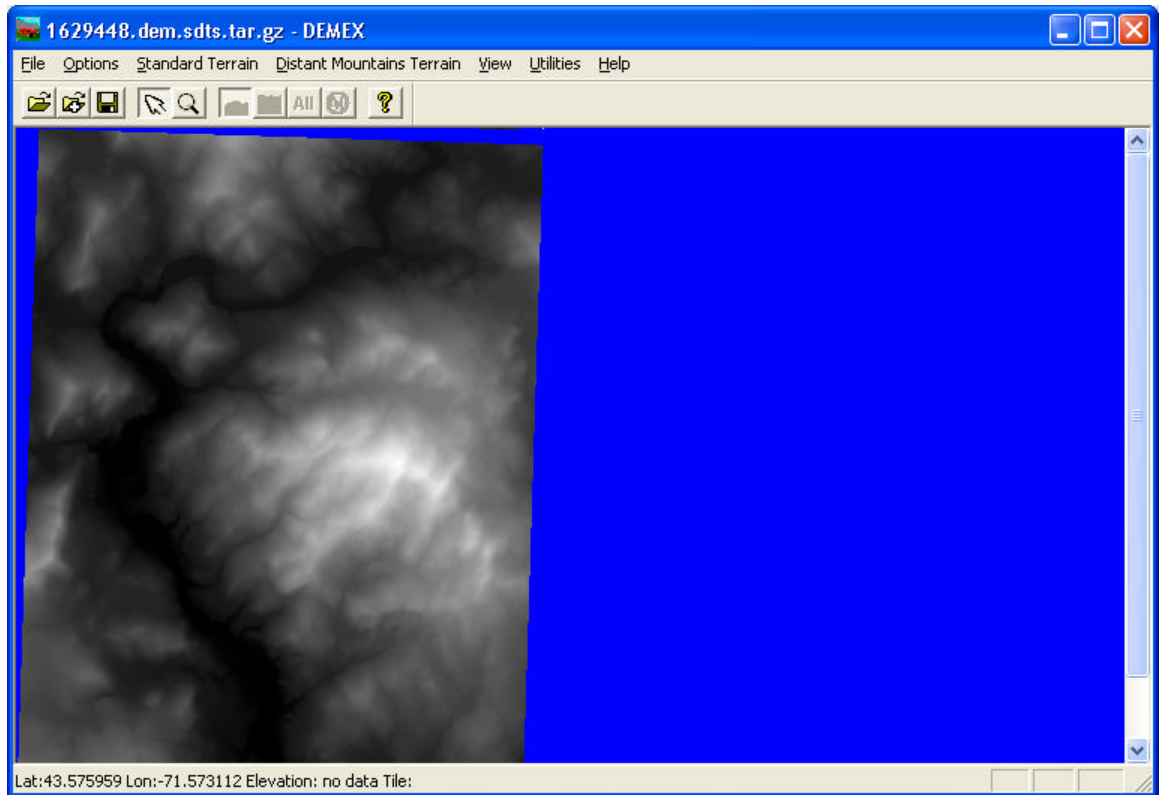
Now comes the fun part. I have purposely not Maximized the window, because I want to show you what can happen here. See the magnifying glass icon? Click on it. When you do, the mouse pointer changes to a magnifying glass. When you left click on the gray-scale map, it will zoom larger, when you right mouse click on it, it will zoom smaller. Do that a couple of times, and then leave it so it the map is one zoom smaller than you started with, like this.
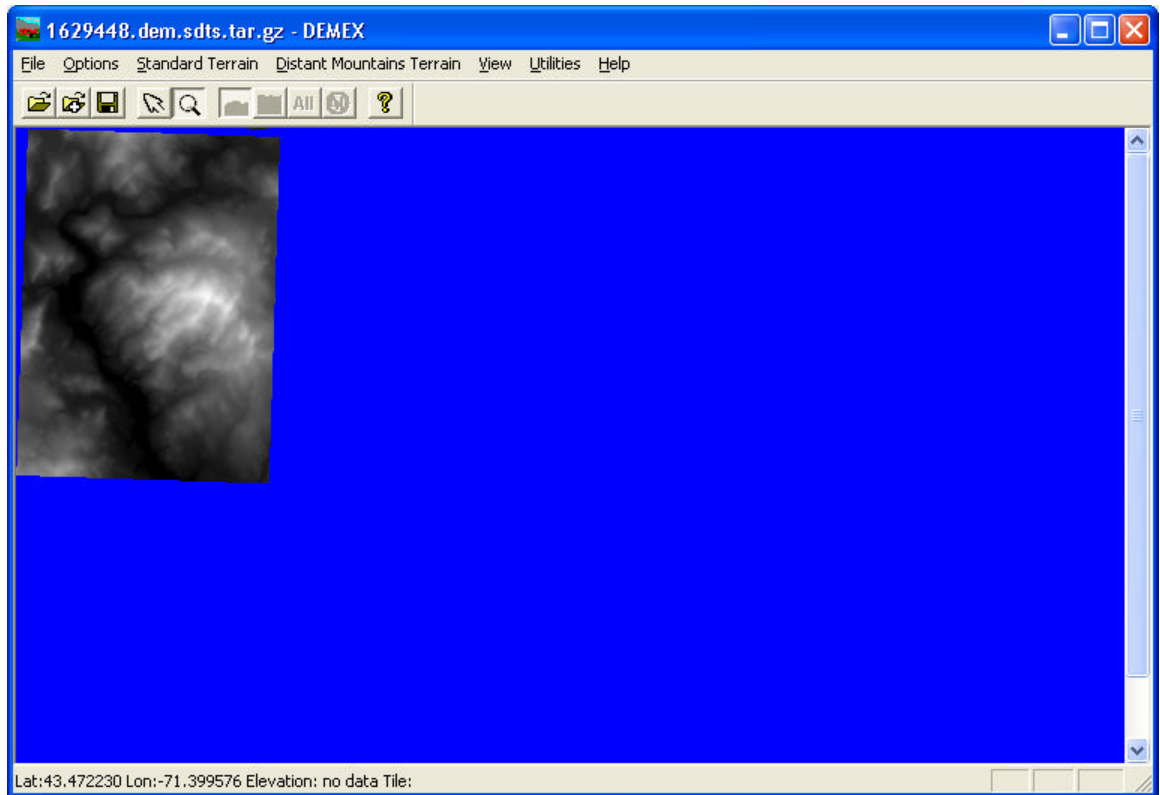
Now let's select File, Merge DEM (or click on the file open with a plus sign button on the toolbar). When you see the window with all the files listed, you can select them all by using the shift key or control key in conjunction with the mouse clicks. So, select the other 15 DEM files. Depending on the speed of your computer, this may merge quickly or not. When you are done, right mouse click zoom to a smaller size until it all fits in the window as shown below. (I made the Demex window a little larger, to keep the map a little larger.)
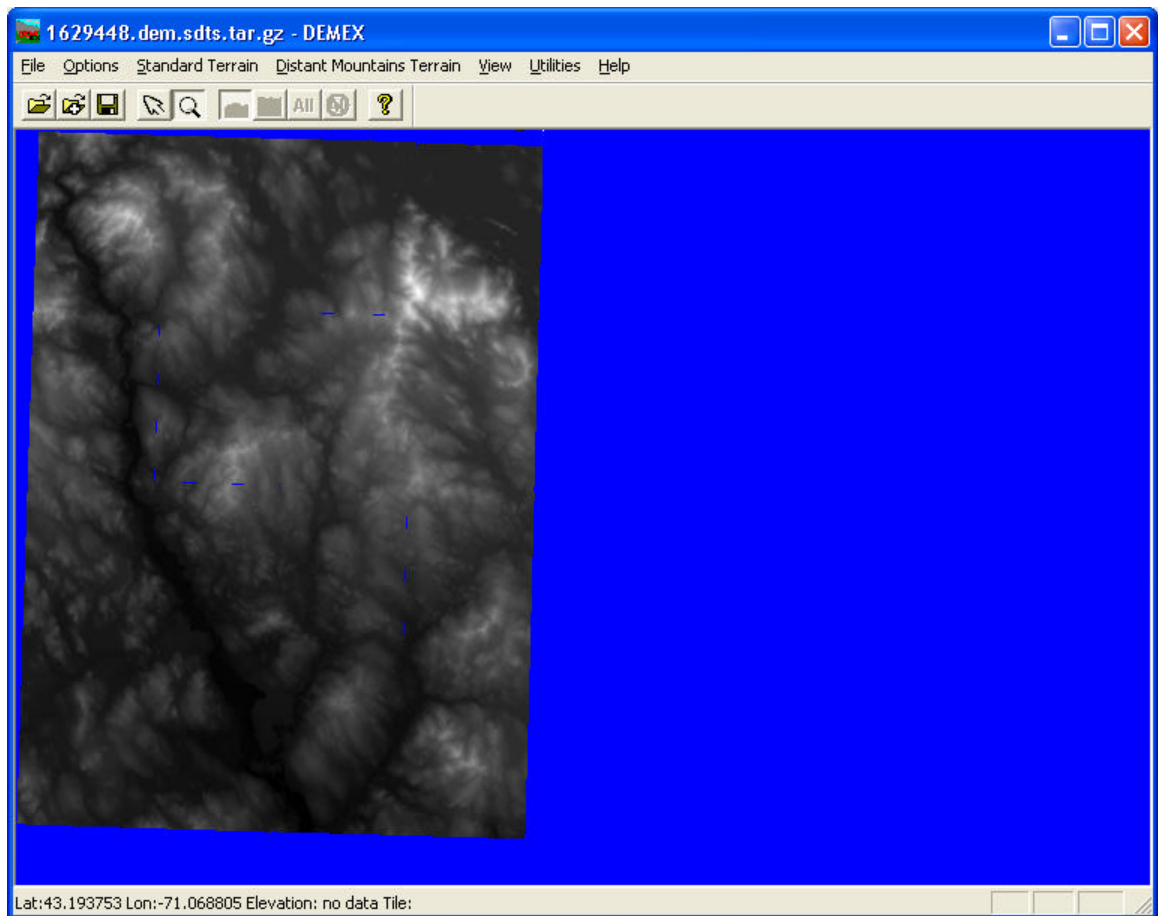
Notice some blue lines "leaking" through the map. These are areas where data is missing from the merged DEM. In Appendix 6 – Another Useful Program, the program MicroDem is mentioned. With that program, you could also merge the DEM and fill in the gaps, but later I'll show a way to handle this within DEMEX.

Selecting Route

This part I always find quite interesting, because it is great to see how the route configures to the map.

Now we are going to select the route. So, select File, Select Route. When you do, the following window will be shown.
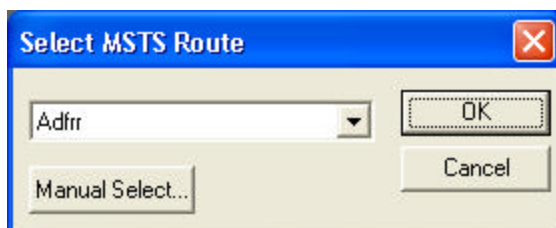
Click the drop down arrow just to the left of the OK button, and select the route. For me, I named this route Laconia.
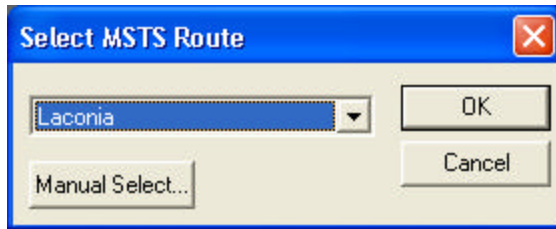
Then click OK.

Alternatively, you can select Manual Select… which will then give you a window where you can select any route on your computer. The drop down list contains the routes *only* in the Train Simulator Routes directory.

When you click OK, this is what you will see.
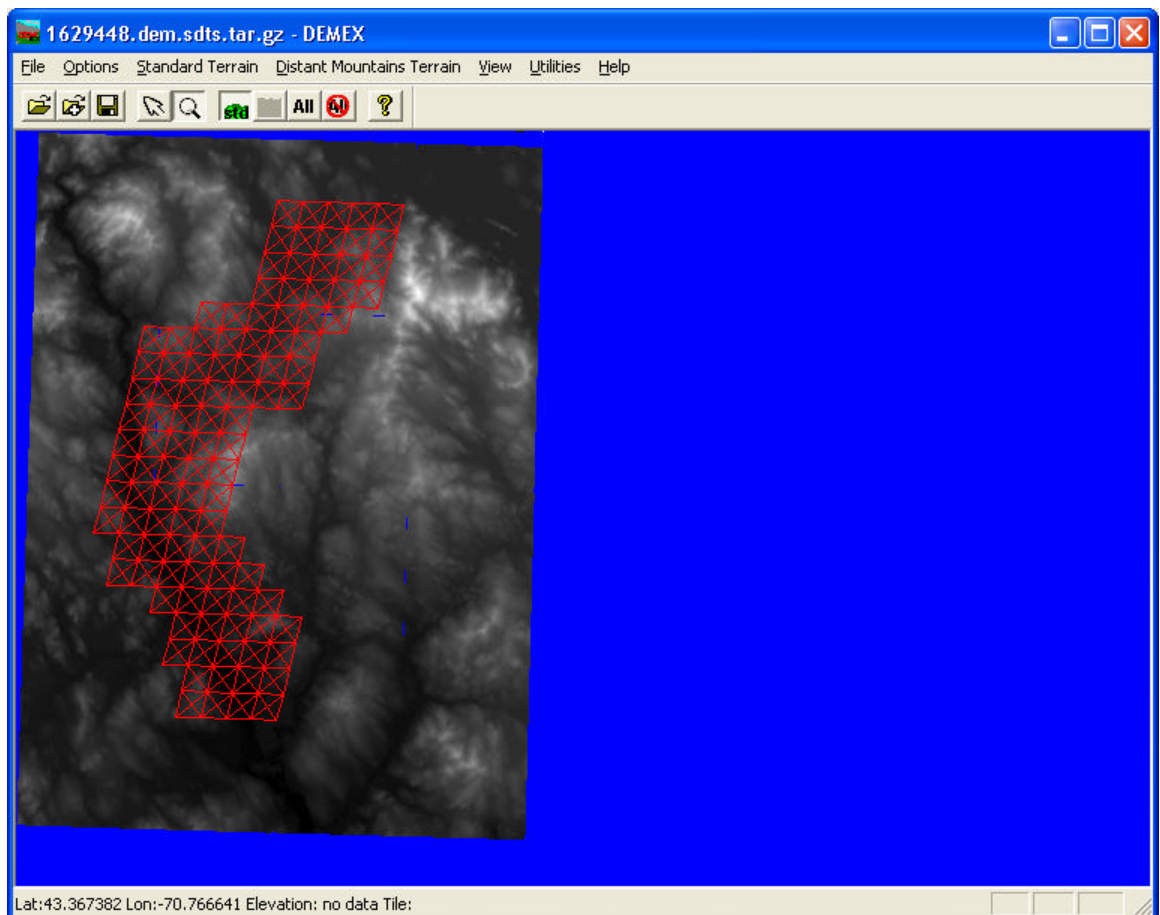
Each red square with an "x" in it represents one of the tiles we created.

Compare the above picture with the one up a page or two that is like it but without the route being shown. You can see that the route follows a valley. This is quite normal.

Okay, we have our DEM loaded, we have the route selected. What's next?

Generating Tiles

First, notice that all of the tiles are selected, that is, they have an "x" in them. This is the default behavior of Demex. If, however, you don't want to model all the tiles, you can click on them one by one to turn them off.

Alternatively, you can also select Standard Terrain, Deselect All Route Tiles. Or, finally, you can click on the Deselect all Route Tiles button on the toolbar. This button has the word All overlaid with the internationally recognized Do Not Do This circle and slash.

You can then select the tile(s) you want to model by clicking on them.

However, for this exercise, we will be modeling all the tiles.

Therefore, select Standard Terrain, Create Route Terrain. That's it. Go ahead and load your route in the Route Editor and do a little sight-seeing.

Seam Filling

Remember those blue lines "leaking" through the map after we merged the DEMs in DEMEX? One of them started at 43.5 degrees latitude, -71.5 degrees longitude. These gaps where the DEM files didn't merge tightly now show up as 'trenches' in our route terrain. Jump there in the Route Editor (press the 'home' key and enter the latitude/longitude coordinates) and this is what you'll see:
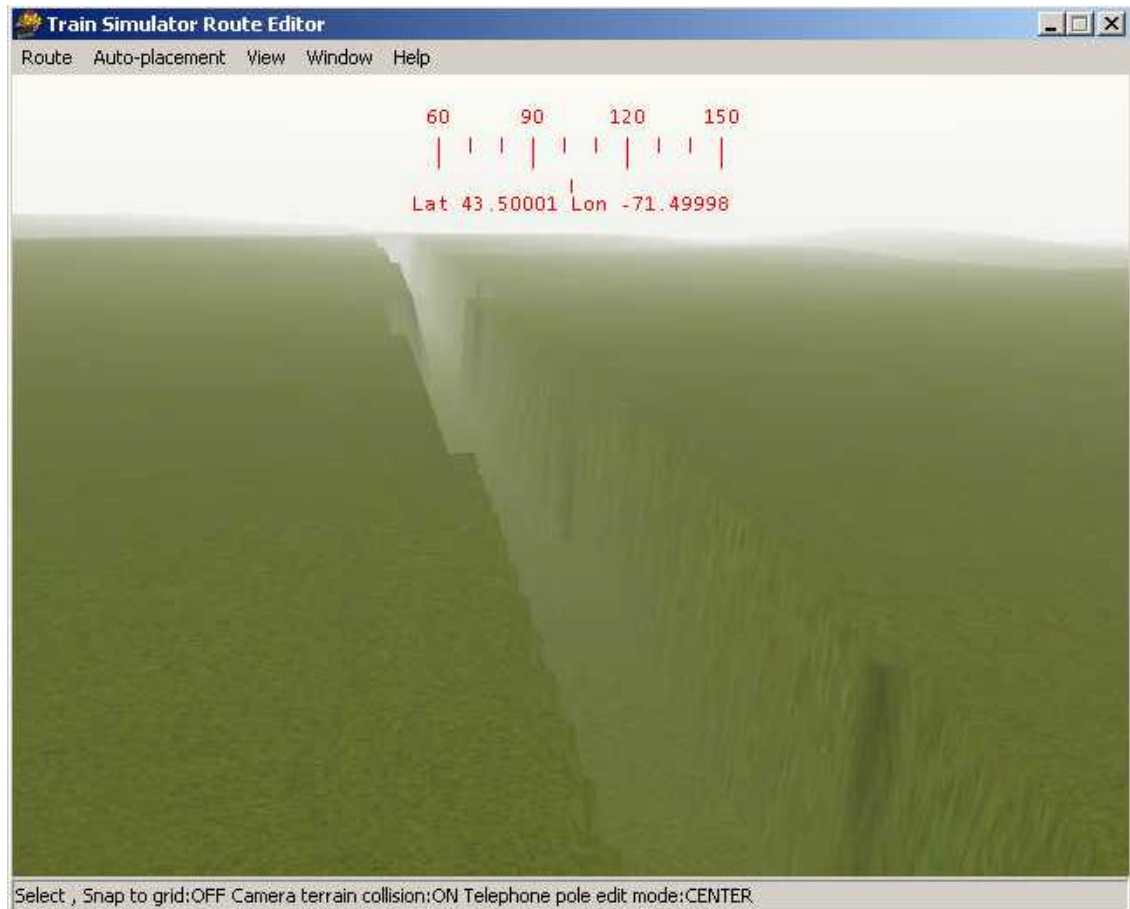
Now we could have used a different program such as Microdem (see Appendix 6) to merge our DEMs without gaps, but we can also use DEMEX to solve the problem.

Start Demex, but start it in Demonstration mode, not Unregistered mode! In Demonstration mode, you have all the options available to you which are not available in Unregistered mode, but you can only use them on one tile at a time.

That's just fine, as we only want to work on three tiles!

So, choose Options to set some options. The following dialog box will appear:
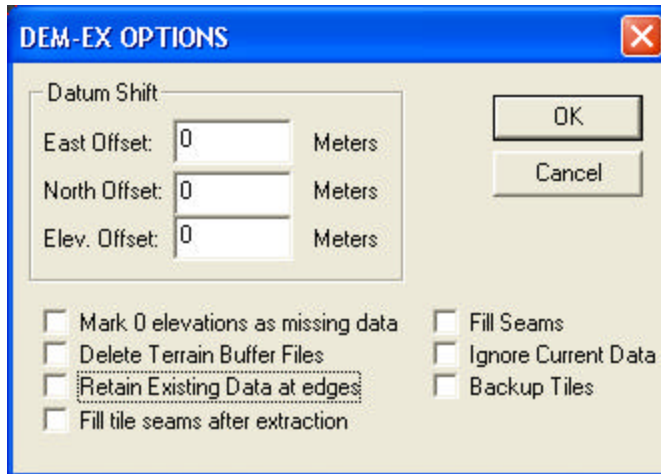
Place a check mark in the Fill Seams option (always leave Delete Terrain Buffer Files selected).

Click OK. (For more on the options, see Appendix 1 – Portions of the Help File.)

Now merge the 16 DEM files together again. Because Demo mode will only work on one tile at a time - deselect all the terrain tiles, and select only one of the tiles covering the trench:
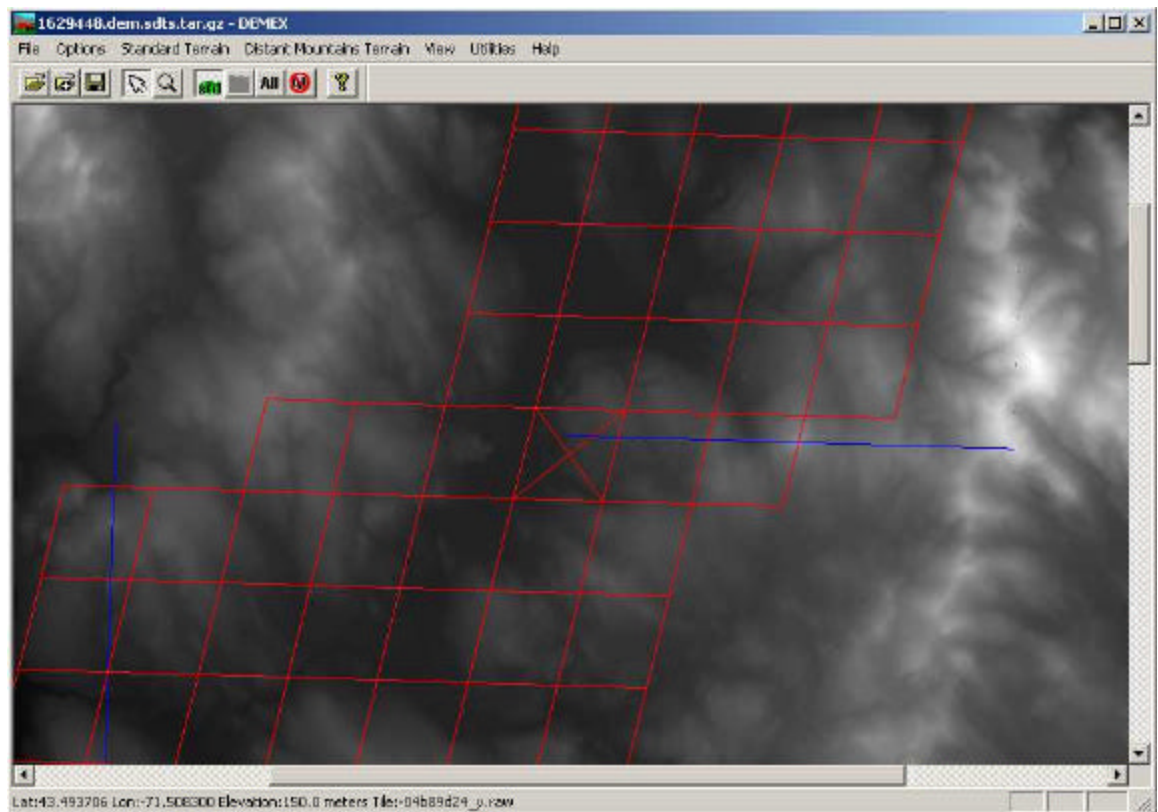
Select Standard Terrain, Create Route Terrain. That one tile will be modeled. Now exit Demex and restart it. Follow the above procedure only choose a

different tile. This is the way you can use all the options available, making some pretty nice modeling choices, only one tile at a time.

Now to Get Tricky!

Now, what if? What if you decide to expand your route later? In this example we'll decide to expand our route southward after we initially created the terrain. Load your B&M route in the RGE and add additional tiles on the south end so the route looks like this:
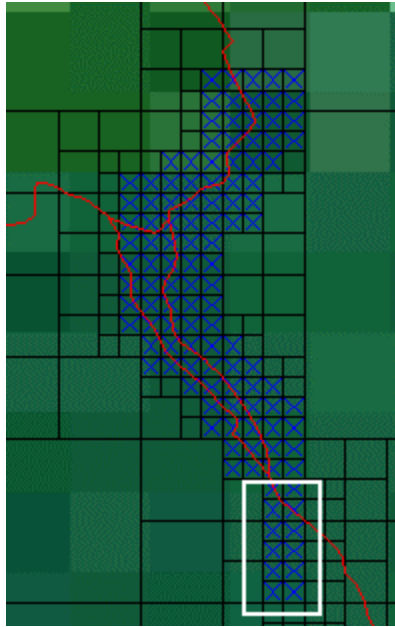
Generate the flagged tiles in the RGE to create the new tiles (don't worry – the previously created tiles won't be overwritten).

Start DEMEX in Unregistered mode again and merge all your DEMs together as you did previously. Select your B&M route and deselect all the route tiles – we don't want to overwrite the route terrain you've already created – especially if you've added track and sculpted the grades already. Now individually select the 12 tiles we just added so that DEMEX looks like this:
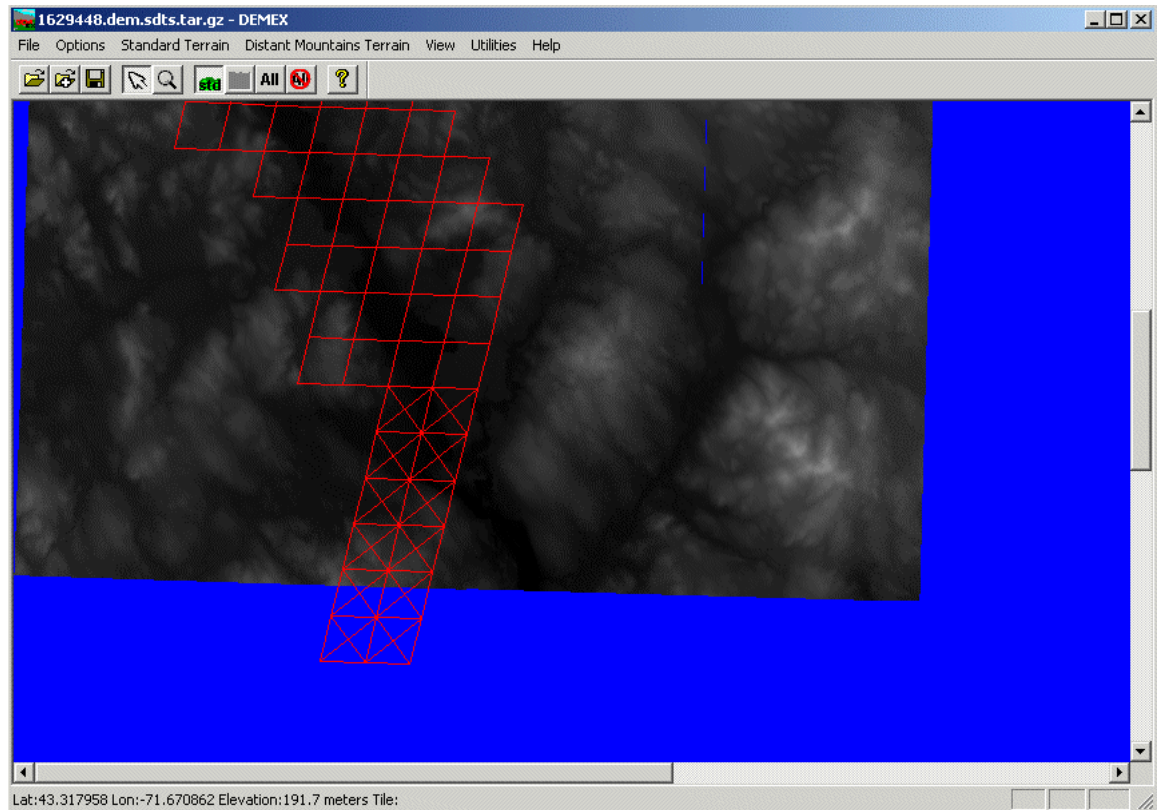
Select Standard Terrain, Create Route Terrain. Only the new tiles that you selected will be modeled.

Oops! Now our DEMs don't cover the entire route! In the Route Editor we can see the terrain drop off where our DEM data ends:
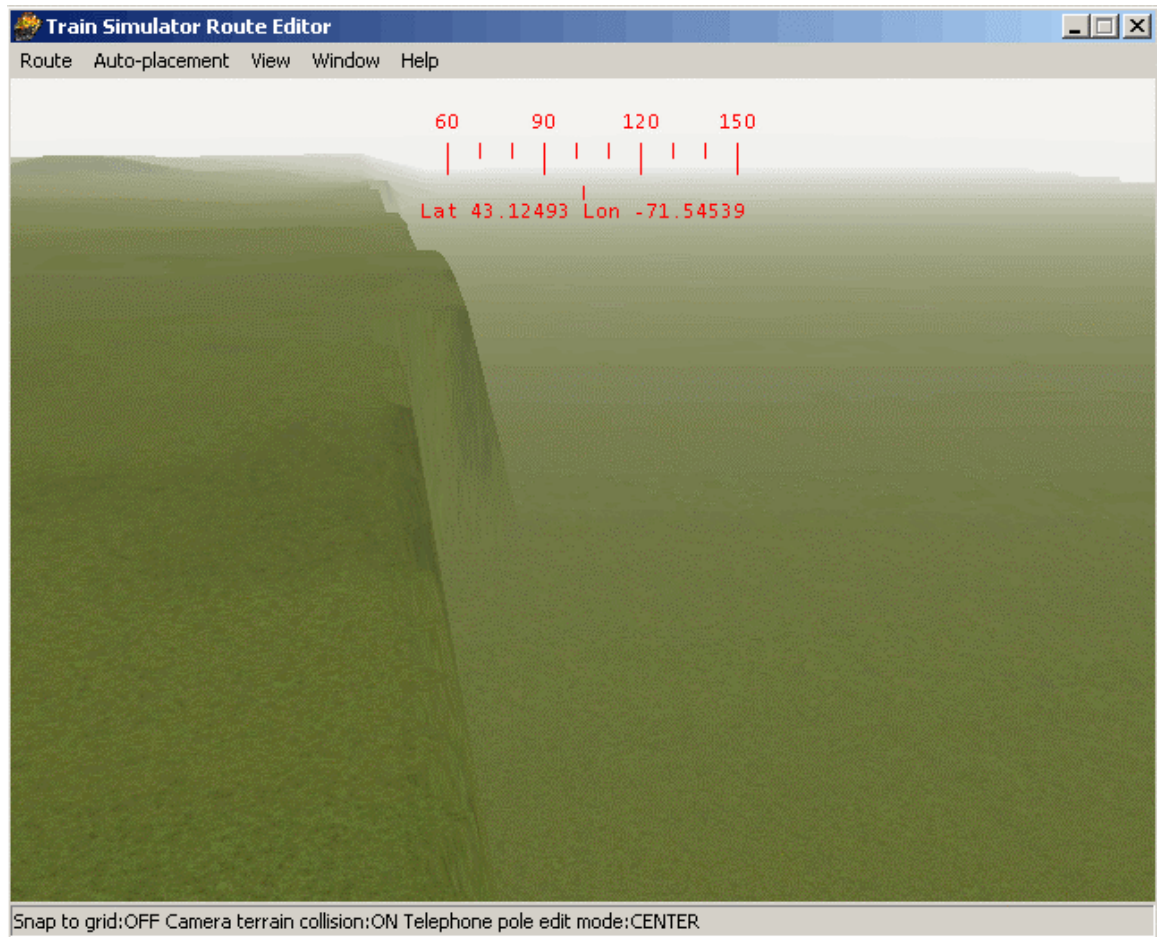
Time to get some more DEMs! Checking the coordinates of our new route tiles in either the RGE or DEMEX and going back to www.mapmart.com we see we need one more DEM quad: Goffstown. Go ahead and download that DEM.
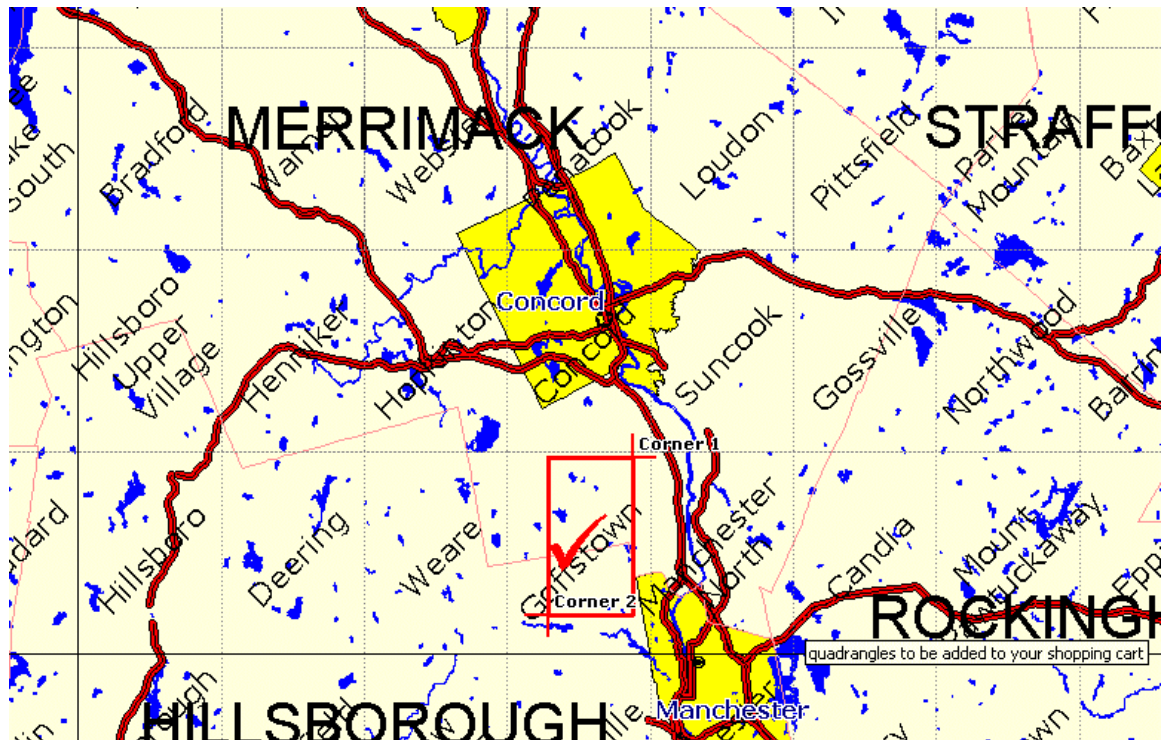
Now we could simply merge the new DEM with the ones we already have and regenerate the terrain on all the tiles – wiping out any modifications we've made to the terrain in the process. Instead we're going to learn how to use another one of DEMEX's features – and keep any existing terrain modifications we've made in the process.

Start DEMEX in Demo mode again and load the Goffstown DEM we just downloaded. (Its filename is 1629479.dem.sdts.tar.gz in case you haven't been keeping track.) Select your B&M route and you'll see the tiles covered by the new DEM:
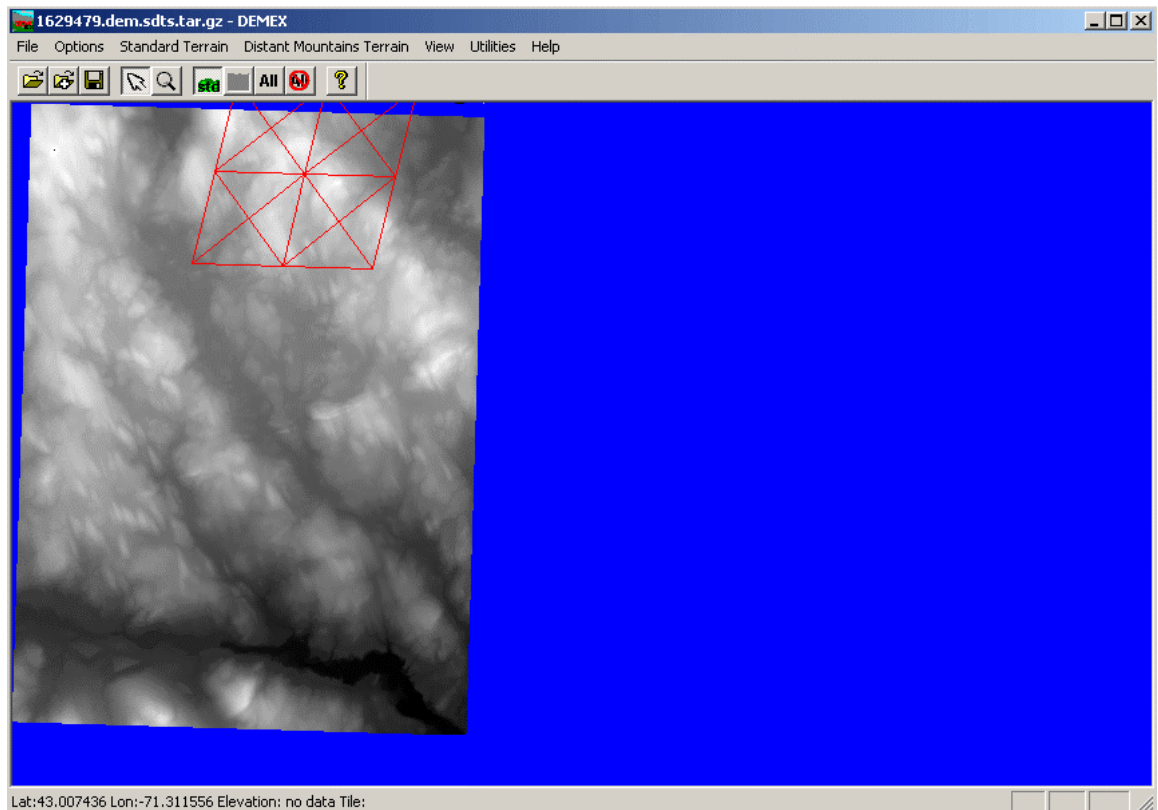
Now normally, if we just went ahead and modeled the terrain on the tiles we'd get another "trench" in our terrain in the blue area - where the new DEM doesn't cover the tiles. This is because in Unregistered Mode DEMEX completely reforms the entire area of any tile being updated – wiping out any existing terrain on the tile. To get around that we'll use some more of the options available in Demo mode.

Bring up the DEMEX Options Dialog:
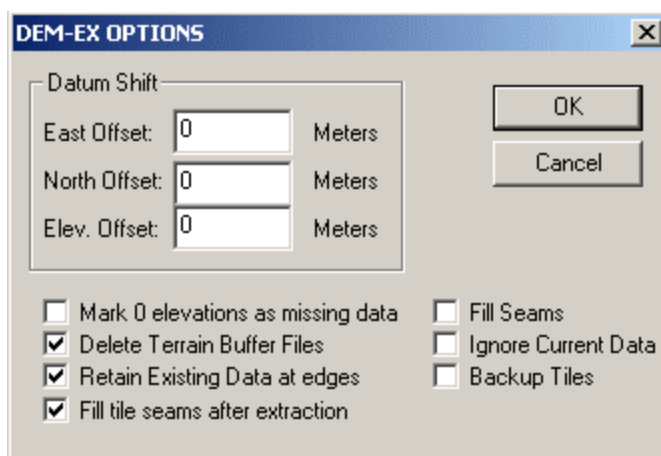
Place a check mark in Retain Existing Data at edges and Fill tile seams after extraction.

The Retain Existing Data at edges option will prevent DEMEX from overwriting any previously created terrain on a tile – only terrain covering the flat, previously untouched areas will be modeled.

The Fill Tile Seams After Extraction option will fill in the terrain in the small gap between where the existing terrain on the tile ends and the newly created terrain from the DEM begins. This is different from the Fill Seams option we used earlier because that one fills the gaps by looking at surrounding data in the DEM before creating terrain – in this case the adjoining DEM data isn't loaded and is not available.

Now go ahead and click OK to exit the Options Dialog.

Remember – Demonstration Mode only lets you do one tile per session, so we need to deselect all the tiles except the one we want to work with. Make sure you use the Deselect All Route Tiles option, since even though you can only see 4 tiles in the display all the route tiles are actually selected. Select one of the two edge tiles so DEMEX looks like this:
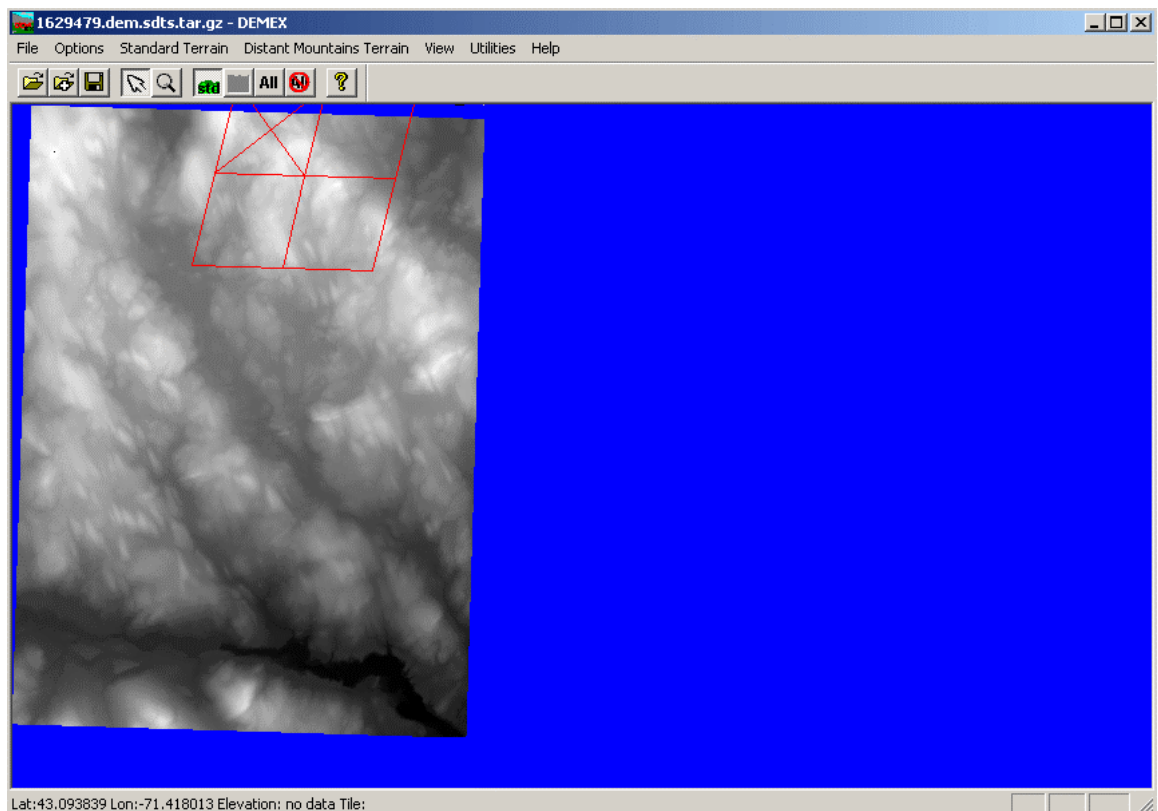
Select Standard Terrain, Create Route Terrain. The one tile you selected will be modeled.

Now we get to exit DEMEX and do it all over again! Repeat these steps but this time select the other edge tile to model it.

The remaining two tiles are completely covered by the DEM so you can model them using Unregistered mode instead.

The above techniques give you a lot of power to correct problems with individual tiles. These "tricks" let you use all the DEMEX features without registering (except Distant Mountains of course!), with just a little more work. As John puts it:

> Demo mode is more useful than it sounds - it lets you combine terrain from two separate dems in different sessions, add a new dem to existing terrain, fill seams, etc. Where this really matters is along the tiles which interface the two - usually only a few. It isn't too hard to do them one tile at a time.

Troubleshooting

Below you will find some troubleshooting type questions that have been send to John or that have been asked in the forum at train-sim.com.

Q: I'm doing [an area where lots of water was prevalent] and in the old DEMEX I could see the piers sticking up out of the water, and now with the new version I can't.

A: The old demex figured everything with an elevation of 0 was bad data and ignored it - setting those areas to a negative elevation. The DEM formats used now can identify valid data at elevation 0 and DEMEX uses that - so the seabed is now an elevation of 0 and the 'piers' are at an elevation of 0.3, rendering them unnoticeable to the naked eye. In the DEMEX options menu select the 'mark 0 elevations as missing data' option before loading the dem. This will set the water areas as missing (blue in the dem view), and generate their terrain at the tile floor (around -11 meters) - making the coastline much more visible. Obviously, this only works for water that is marked in the DEM data with a height of 0, this won't work for lakes and rivers at higher elevations.

Q. Is there a tutorial that explains loading up DEMs in DEMEX. I have searched the forum and have come up dry. I have created my tiles with the RGE (with the proper LAT and LON) and I have then loaded the DEM data

into DEMEX. The route terrain is created. The problem I am having is adding new tiles and updating the DEM for the those tiles. The route terrain in the original section changes. If any track is there it jumps up about 2m off the ground. Is there a process that I am missing when I create the route? I thought I could add tiles and update the terrain at any time.

A. DEMEX will update the terrain on all selected tiles which cover the area of the DEM loaded. All tiles in the route default to selected. Simply deselect the tiles you don't want to modify (or if easier pick the 'deselect all' option then add in the ones you want). There unfortunately isn't an option to automatically determine which ones are 'new' vs. old.

Q. How come USGS topo maps and terrain that Demex creates are not the same? In other words, the lat/long of a specific point in a river does not line up between the Demex created terrain and USGS topo maps.

A. Part of your problem is probably due to a datum shift. Most USGS topo maps use the NAD 1927 datum, while DEMEX creates all terrain using the WGS1984 datum (basically, under different reference datums the same coordinates can refer to different points)

Microdem has a waypoint creation utility which works fairly well when the waypoints are converted to markers. There is a tutorial in the file library at http://www.train-sim.com (search on waypoint or marker). This has the advantage that when using georeferenced Geotiffs Microdem will do the datum conversion for you.

Alternatively, you can shift all the terrain in Demex using the offset options.

Answer from Dr. Guth, programmer of Microdem: "The magnitude of the datum shift depends on whether you are shifting UTM or Lat/Long coordinates. With NAD27 and either NAD83 or WGS84, in the US: The lat/long shift varies by 0-100 m, with the low in Michigan and the max on the West Coast.

The UTM shift is everywhere about 200 m, with a small dependence on latitude.

MICRODEM can calculate this for you, if you turn on the Cartography options."

Q. White Tile that appears and disappears.

A. This is an MSTS bug. I have not seen any solutions for it. It has nothing to do with UTM zones - that is a DEM / DEMEX issue.

If you look in your TD directory, you will see multiple td files for your route. The RGE splits the tile definitions into multiple files at certain boundaries in the quadtree. When crossing one of the boundaries is when all hell breaks loose in MSTS.

If a route crosses a boundary, you'll have more than one td file. The starting point of an activity seems to decide how they load. Apparently, due to a glitch, they will

all load correctly in one order but not the other, so it matters which one you start in. It seems so far in my case that they will load properly from East to West, but not West to East.

Q. I laid out DM tiles that cover my entire current "normal" tile area plus a lot of additional area beyond that. Then I extracted lo tiles from the same DEM I used for the regular tiles.

I'm getting some weird results though, in a lot of areas it looks like the regular and lo tiles are "competing" to show themselves, resulting in a big mess.

A. What you are doing is looking through the 'gaps' between the distant mountains and the standard terrain. The way MSTS works is it draws standard terrain up to the 'terrain visibility threshold'. At that point it quits drawing standard terrain, and starts drawing lo_tile terrain. If the lo_tile terrain is at or below the level of the standard terrain everything looks fine, however if it is above the standard terrain you can look through the resulting 'crack' and either see sky or the next ridgeline back.

So why don't they line up? Obviously any modification you do to the standard terrain won't be reflected in the lo_tiles. Track cuts and other terrain modifications will lower the standard terrain. The other primary reason is the differing resolutions of the two terrain types. At it's highest resolution lo_tile points are ~200 meters apart, vs 8 meters apart for standard terrain. This means narrow dips, valleys and slopes less than 400 meters wide may not show in the lo_tile terrain. This also means that a hilside slope may be 'apparently' shifted by up to 100 meters from its actual position. This can make the distant mountain terrain appear 'above' the normal terrain at threshold boundary.

There are several steps you can take to mitigate this problem. Most importantly make sure the terrain visibility slider in MSTS options is set at its maximum of 2000 meters. You can also lower the Distant Mountain terrain in DEMEX. In the DEMEX options set the elevation offset to -10 or -20 meters and regenerate the distant mountain terrain. Try different values until you get something that looks good to you. The third recourse is to 'mask' the gap with viewblocks. This can be seen in the stock MSTS routes which include distant mountains. In many cases Kuju placed treelines and other objects strategically to disguise these gaps. They're there, you just have to look hard for them.

Q. I have been trying to use XYZ data files. They don't work. What's wrong?

XYZ data files DO work, but don't, don't, don't use XYZ data files with DEMEX unless there is a good reason for it (which in your case there isn't). In your case you have selected the wrong height scale.

Use the original STDS files, or save it from Microdem in MD DEM format.

Q. I have the DEMEX registered version, and am trying to put DEM terrain on a mountain route, all of which is over a mile high. All 298 tiles are in place, and I have the 10 meter DEM files for all 20 quads that impact the tiles. I have tried to get started by entering DEM data from 3 adjacent DEM files.

Three problems have occurred so far:

1. At each of the 2 joints of the 3 DEM files, there is a massive flat section of ground with 90 degree cliffs surrounding the flat area, and I have been unable to get DEMEX to do anything to fill in those flat areas.

2. Regardless of which options I choose, if I select the "Fill tile seams after extraction" option, I get the classic closing message with "report" or "don't report" options.

3. Although not a DEMEX issue I suppose, with my Windows XP I have to select DEM files one at a time. It is not possible to multi-select DEM files from the box using shift or control keys.

This is what I am doing: Elevation offset is set at -1525 (negative). The problems are the same at either that setting or at 0 setting. I have ALWAYS selected the option "Delete terrain buffer files". I have NEVER selected "Ignore current data" or "Backup tiles" or "Retain existing data at edges". That leaves just 2 options, which are "Mark 0 elevations as missing data" and "Fill seams". The flat sections are the same whether I use neither or both or either one of those 2 options.

Then I use the file menu to select my route, and then click file, then open, then a DEM file. When it's done loading I go to standard terrain and click select all route tiles (is that required?) and then create route terrain. This is repeated for subsequent DEM files, using open rather than merge DEM. What is the merge DEM for, when it can not even be selected for the first DEM file?

A. 1-Load 1 dem in DEMEX

2-Merge the other 19 dems in DEMEX. You can multi-select only when using the merge option. This will combine all the dem files together to cover your whole area.

3-Select the following options: 'delete terrain buffers' and 'fill seams'

4-create the terrain on all tiles

Basically whats happening is by default DEMEX when creating terrain will wipe out the complete terrain on any tile which overlaps the DEM. So when you load your second DEM and generate terrain from it the adjoining terrain on the edge tiles is wiped out and is why you see those flat areas. To do what you're doing 1 DEM at a time can be done, however you need to have the 'ignore current data'

and 'fill tile seams after extraction' selected, and ensure you have 'fill seams' and 'retain existing data at edges' options unselected.

The problem you are having with XP can be solved by not having both "fill" options selected at the same time. In other words, see the below graphic for what options NOT to have selected together.
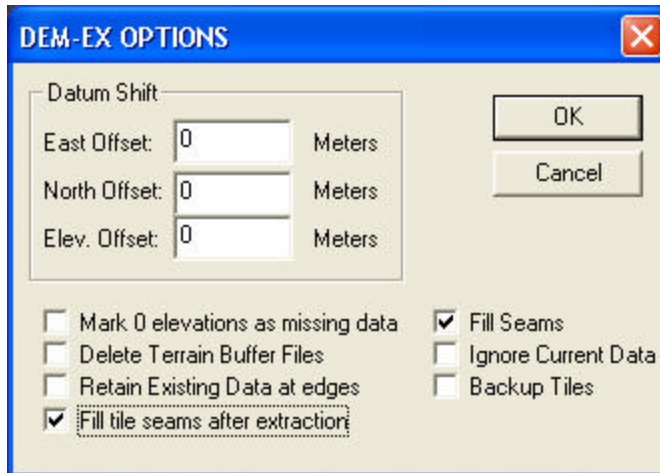
Do NOT have Fill tile seams after extraction and Fill seams both selected.

Conclusion

Demex is a great program, and actually quite easy to use. However, following the above instructions should make it a little easier.

Enjoy.

Appendix 1 – Portions of the Help File

FILE menu

DEMEX can read DEM files in the following formats:

DEMEX created DMX files

Microdem DEM binary files

Microdem XYZ ASCII files

USGS SDTS in archived tar.gz format

USGS DEM ASCII files

DEMEX performs a geodetic datum conversion of any loaded DEM to the WGS84 datum. If using marker files ensure the marker file data is also in the WGS84 datum or the markers will be mis-aligned. XYZ data is not datum shifted, and is created by Microdem using Microdem's default datum (usually WGS84 unless changed by the user).

The **OPEN** menu item will load a DEM file, replacing the DEM data currently in memory.

The **MERGE DEM** menu item will display the file selector to merge a new DEM with the DEM currently in memory. Merge will support merging a higher resolution DEM (ie 10meter) with a previously loaded lower resolution DEM (ie 30 meter), however the DEM will be sampled to the lower resolution. You cannot merge a lower resolution DEM with a previously loaded higher resolution DEM. You also cannot merge DEMs with differing coordinate systems together (ie UTM and Lat/Long). You can merge multiple DEMs at one time by multiselecting the desired files in the file selector (hold the shift or control keys while clicking on successive file names).

 The **SAVE AS** menu item will save the currently loaded DEM data as a DEMEX DMX file (this format is unique to DEMEX and cannot be loaded by other programs).

The **SELECT ROUTE** menu displays a drop-down list of the current routes in the MSTS Routes directory, listed by the route's folder name. Selecting a route enables display and selection of route tiles for generation.

The **REFRESH ROUTE TILES** menu will update DEMEX's list of tiles for the selected route in the event tiles are added or removed from the route (ie from the RGE) after the route has been selected.

The DEMEX DISPLAY

The main window will display the loaded DEM as a gray-scale relief image with the highest points shaded white and the lowest points shaded black. Any points marked as missing data are shaded blue.

Moving the mouse over the DEM will display the latitude, longitude and elevation of the point under the mouse cursor. If a Microdem XYZ file was loaded the latitude & longitude coordinates will not display until a route is selected. (XYZ data does not include the UTM zone information to specifically locate the data). If the mouse pointer is moved over a loaded MSTS tile then the tile's filename will also be displayed in the bottom of the frame.

The view scale can be changed by selecting the magnifying glass icon on the toolbar and clicking on the image. Left clicking will zoom the image in, right clicking will zoom the image out. Select the arrow cursor icon in the tool bar to exit zoom mode.

If a route has been selected the route tiles will be drawn as red boxes. Each tile will initially have a red X inside of it - indicating the tile is selected for terrain generation. Tiles may be toggled on or off by left clicking the mouse within the tile when not in zoom mode. The red X will be removed if the tile is not selected. Tiles which cross a UTM zone boundary will be drawn in green to denote the boundary edge.

If a marker file has been created for the selected route each marker will be plotted on the display with a green dot.

The DEM & tile display may be disabled by selecting the **SHOW DEM** menu item under the **VIEW** menu.

OPTIONS menu

Selecting the DEMEX options menu allows the selection of DEMEX terrain loading and generation options.

DATUM SHIFT - You can horizontally offset the generated terrain by a set distance to improve alignment with markers or existing track by setting the North and East offset distances. A North offset of 32 will shift a given terrain feature 32 meters to the North, while an offset of -32 would shift it 32 meters to the South. Horizontal offsets are done within DEMEX at 8 meter increments. The Elevation offset will shift each generated terrain point vertically the specified distance. Setting the Elev. Offset to -100 will lower the terrain by 100 meters. This is particularly useful if creating terrain at very high elevations because MSTS will not support terrain hights above approximately 3500 meters.

MARK 0 ELEVATIONS AS MISSING DATA - Some DEM formats indicate void areas or missing data as having an elevation of 0. Selecting this option before loading a DEM will mark all points with 0 elevation as missing data areas when the DEM is loaded. This will allow DEMEX to fill the seams at the missing terrain points. This option should not be selected however if the DEM contains valid sea-level data at elevation 0 (ie around coastlines). The option only applies when the DEM is loaded.

DELETE TERRAIN BUFFER FILES - When this option is selected DEMEX will delete the terrain buffer files for each tile when generating terrain. This allows MSTS to automatically rebuild these files with the proper normal shading and error bias information. If this option is not selected then the *_e.raw and *_n.raw tile files must be

manually deleted, or each tile's floor & ceiling must be manually updated in the MSTS Route Editor.

RETAIN EXISTING DATA AT EDGES - When DEMEX generates terrain by default any tile areas covered by 'missing data' portions of the DEM will be set to the floor elevation of the tile. Selecting this option will retain the pre-existing tile data covered by 'missing data' areas of the DEM when terrain is created.

IGNORE CURRENT DATA - When DEMEX generates terrain by default any existing terrain on the tiles is overwritten. Selecting this option will retain any existing tile terrain data and DEMEX will only create terrain on un-modified areas of the tiles. An un-modified area of the tile is defined as any existing point with an elevation of 1 meter or with an elevation equal to the tile's floor elevation.

FILL SEAMS - Selecting this option will cause DEMEX to attempt to fill in any gaps in the terrain containing 'missing data' in the DEM.

FILL TILE SEAMS AFTER EXTRACTION - When this option is selected DEMEX will attempt to fill any remaining seams on the tile after terrain is generated. DEMEX will only use the data on the current tile as a basis to fill the seam. This can be useful when the tile is updated at separate times with 2 adjoining DEMS. This option should not be selected if the tile contains valid sea-level data at 0 elevation.

BACKUP TILES - When this option is selected DEMEX will create a backup of each tile before generating terrain. Standard tiles will be copied into the 'tiles_backup' directory of the Route if a route has been selected, or into a 'tiles_backup' directory within the selected tiles directory is no route is selected. Distant Mountain tiles will be backed up into directories entitled 'lo_tiles_backup'.

Standard Terrain Menu

The normal terrain tiles used my MSTS are refered to as Standard Terrain. This menu contains commands to select and create terrain on Standard Terrain tiles.

The **SHOW STANDARD TERRAIN TILES** item will switch the display of route tiles from Distant Mountain tiles (if any exist) to Standard Terrain tiles. A route must be selected for this to have effect.

The **SELECT ALL ROUTE TILES** item will select all the Standard Terrain route tiles for terrain generation. Each tile will be shown with a red X on the display.

The **DESELECT ALL ROUTE TILES** item will deselect all the Standard Terrain route tiles. The tiles will be displayed without the red X's in them - indicating they will not be updated with terrain.

The **CREATE ROUTE TERRAIN** item will generate terrain on all selected route tiles (displayed with a red X) covered by the current DEM data. A route must have been selected for this option to be available.

The **CREATE TERRAIN TO SPECIFIED DIRECTORY** item allows creating terrain on tiles not located within the normal route directory. Selecting this menu item displays the file selector for choosing the tile directory to be modified. Select any file within the directory to begin terrain creation. ALL tiles within the directory will be updated irregardless of which tiles may be selected from the route display.

Distant Mountain Terrain Menu

DEMEX supports creation of Distant Mountain terrain for MSTS. Many more steps are required to create working Distant Mountain terrain than for standard terrain, although DEMEX automates many of these steps. This menu contains commands to select and create terrain on Distant Mountain tiles.

The **SHOW DISTANT MOUNTAIN TERRAIN TILES** item will switch the display of route tiles from Standard Terrain tiles to Distant Mountain Terrain tiles (if any exist). A route must be selected and have Distant Mountain tiles for this to have effect.

The **SELECT ALL ROUTE TILES** item will select all the Distant Mountain route tiles for terrain generation. Each tile will be shown with a red X on the display.

The **DESELECT ALL ROUTE TILES** item will deselect all the Distant Mountain route tiles. The tiles will be displayed without the red X's in them - indicating they will not be updated with terrain.

Appendix 2 – Creating Distant Mountains—from the Help File

This is a 5 step process to create Distant Mountains on a specific route. DEMEX will aid you to walk through the process.

Before you begin however you must create a temporary route for DEMEX to place the Distant Mountain Tiles in to allow MSTS to create the terrain buffers. You only need one temporary route regardless of the number of routes you create Distant Mountains for. The temporary route must be an empty route without any terrain tiles. Run the MSTS Route Geometry Extractor (RGE) and select the **New Route** menu item from the **File** menu. You may give the route any name you wish, however it is recommended you name it TEMPORARY so you know what it is for. Select OK to create the route, then exit the RGE. Do not create a quad-tree or any tiles for the route. You only need one temporary route regardless of the number of routes you create Distant Mountains for.

STEP 1- PREPARE THE ROUTE FOR DISTANT MOUNTAINS - Select the **PREPARE ROUTE - STEP 1** menu item in DEMEX to prepare the files of the route. You must have previously selected a route from the **File** menu. DEMEX will copy several files from the USA2-Marias Pass route to your route. You must have the Marias Pass route installed for this process to function properly. This step only needs to be performed once for each route.

STEP 2 - CREATE THE LO_TILES FOR ROUTE - Run the MSTS Route Geometry Extractor (RGE), load your route & quadtree, and zoom in on your tiles. The right most icon on the icon-bar (it has a DM and a down arrow on it) will now be enabled. Click this button to bring up the lo_tile quadtree. Note that your existing quadtree will dissapear.

Define terrain tiles for the lo_tiles quadtree to cover your route just as you would normally by dragging a range, right click to 'add all selection tiles' and right click to 'toggle populated state'. Note that the minimum sized tile is 8 times larger than the smallest standard route tile (covering 64 standard route tiles). You should cover an area larger than that encompassed by your route, though there's no point in going larger than what your DEM data covers. Don't generate the tiles yet. From the **file** menu select the 'save quad-tree' option to save your distant-mountain (DM) quadtree. Note you can swap back and forth between your DM quadtree and the normal quadtree by selecting 'load quad-tree' again from the **File** menu.

In DM quadtree mode go back to the **North America View** window in the RGE. You will see that the quad-tree covering the Marias Pass route still exists. Zoom in on that area and de-select all the tiles for the Marias Pass route. (There's no real harm done if you skip this part, but you'll end up with alot of tiles you'll never use if you do).

Now save your quad-tree again, make sure you are in DM mode by selecting the DM icon, and then from the **Edit** menu select 'generate flagged tiles' to create the lo_tiles. You may now exit the RGE.

If you didn't exit DEMEX when running the RGE then select the **Refresh Route Tiles** menu item from the DEMEX **File** menu to update DEMEX with your new Distant Mountain tiles. Otherwise load the desired DEM and select your route.

STEP 3 - CREATE DISTANT MOUNTAIN TERRAIN - Select the **Create Distant Mountain Terrain** menu item in DEMEX. A dropdown box will appear to select the temporary route to be used for terrain creation. Select the temporary route you created for terrain buffer creation. Distant Mountain terrain will be generated on all selected route tiles (displayed with a red X) covered by the current DEM data. When complete DEMEX will copy the tiles into your temporary route for creating terrain buffers.

STEP 4 - CREATE TERRAIN BUFFERS - Run the MSTS Route Editor (RE) and open the temporary route you specified in step 3. The RE will generate all the needed terrain buffers for your Distant Mountain tiles. Once the temporary route has completed loading (you'll just see a blank white screen in the display) you can exit the RE.

STEP 5- COPY DISTANT MOUNTAIN TILES BACK TO ROUTE - Select the **Copy DM Tiles Back To Route** menu item to move your route tiles and their new terrain buffers back to your route. In the drop-down box select the temporary route you choose in step 3 again. When complete your Distant Mountains are ready for viewing in MSTS (note they won't be visible in the Route Editor). Make sure you turn the **Distant Mountains** option in the MSTS Advanced Display Options on.

You can also bypass all the DEMEX automated steps and generate terrain on Distant Mountain tiles in any directory by selecting the **Create Distant Mountain Terrain to Specified Directory** . The file selector for choosing the tile directory to be modified will be displayed. Select any file within the directory to begin terrain creation. ALL tiles within the directory will be updated irregardless of which tiles may be selected from the route display. DEMEX will not copy the Distant Mountain tiles to the temporary route or perform any of perparatory steps.

Appendix 3 – Notes on Distant Mountains

To make updates to previously generated Distant Mountains tiles you only need to repeat steps 3 through 5.

Distant Mountain tiles are currently limited to a single terrain texture, which must be called **terrain.ace**. You must ensure that you have a terrain.ace file in the TERRTEX and TERRTEX\SNOW folders of your route. If you wish to use a different texture you will need to copy the desired texture ACE file and rename it to **terrain.ace**. A future update to DEMEX will allow selecting multiple texture for Distant Mountain tiles.

It may appear that the terrain doesn't line up between the regular tiles & the lo_tiles, however this is an artifact of the sampling level. The smallest lo_tile has 24 times greater spacing between elevation points than a standard tile, or almost 200m between points. This results in some terrain features being missed or appearing shifted on the lo_tiles depending on where the elevation points fall. Seeing some hills fade in from the fog is unavoidable, and does occur on the Marias pass route also, although they did a good job of limiting the player's sight distance with vegetation to minimize the effect.

Due to this aliasing process you can occasionally see 'sky' between the regular terrain and the DM's where MSTS cuts in the DM terrain but its level is higher than the standard tiles. This can be seen in the stock Kuju routes which use DM's also, though they try to hide it with view blocks. You can try using the **Elev Datum Shift** option in DEMEX to lower your distant mountain terrain to minimize these seams. Of course if you don't have 2km worth of tiles on each side of the tracks this will happen also.

Appendix 4 – Notes on Creating Terrain Across UTM Zone Boundaries

UTM coordinates change at each 6 degree longitude zone boundary (ie 0 degrees, +6 degrees, +12 degrees, etc.). This creates discontinuities in the terrain data at each boundary edge. When merging DEMs on opposite sides of a zone boundary DEMEX will reproject the DEMs to make them continuous (Seamless UTM projection does not work with XYZ data files). Although this makes the zone boundaries seamless, this reprojection results in terrain distortion on points further away from the boundary. To obtain the best results the following process should be followed:

Merge and generate terrain from DEMs on either side of the zone boundary separately. The boundary can be easily seen in DEMEX from the green colored tiles which overlap the boundary. Next merge the DEMs in DEMEX from opposite sides of the boundary, merging only dems that lie on the boundary. Deselect all the route tiles except the green colored tiles which overlap the boundary, and generate the terrain for these boundary tiles only.

Appendix 5 – Definition of Terms

What is a DEM?

DEM stands for Digital Elevation Model, a generic term refering to any dataset containing digital representations of cartographic information in a raster form. DEMs consist of a sampled array of elevations for a number of ground positions at regularly spaced intervals.(USGS)

DEM files in the United States are produced by the U.S. Geological Survey (USGS) as part of the National Mapping Program, and 7.5 minute DEMS are freely available. DEM data for other areas of the world are available from a number of sources in varying formats at varying prices and data resolutions.

DEMEX directly supports USGS DEMs in the UTM coordinate system in either USGS ASCII DEM format or the SDTS (Spatial Data Transfer Standard) format. A number of free data translators are available on the internet to convert other data formats to formats DEMEX can read. DEMEX now also supports DEMs containing data in the geographic (latitude/longitude) coordinate system.

What is UTM?

UTM (Universal Transverse Mercator) is a widely used map projection that employs a series of identical projections around the world in the mid-latitude areas, each spanning six degrees of longitude and oriented to a meridian. This projection is characterized by its conformality; that is, it preserves angular relationships and scale plus it easily allows a rectangular grid to be superimposed on it. Many worldwide topographic and planimetric maps at scales ranging between 1:24,000 and 1:250,000 use this projection.(USGS) Discontinuities in the data exist at the border between each 6 degree of longitude zone boundary.

Appendix 6 – Another Useful Program

If you are working with USGS data then DEMEX (and of course MSTS) are the only programs you need, however there are a number of freely available DEM data translators and manipulators which can simplify the process of merging DEM files. One such program is Microdem, written by Dr. Peter Guth of the Oceanography Department, U.S. Naval Academy. DEMEX can directly read DEM files created by Microdem. Microdem is available at: http://www.usna.edu/Users/oceano/pguth/website/microdem.htm

If you are working with other DEM formats (such as DTED), you will need to first convert them to the UTM coordinate system in a format DEMEX can read using a DEM data translator. One such translator is Microdem as described above.