

Rotated earth or when your fantasy world goes up side down

A couple of weeks ago there was a discussion started if Fractal Terrain 3 (FT3) can rotate our earth.

<http://forum.profantasy.com/comments.php?DiscussionID=4709&page=1>

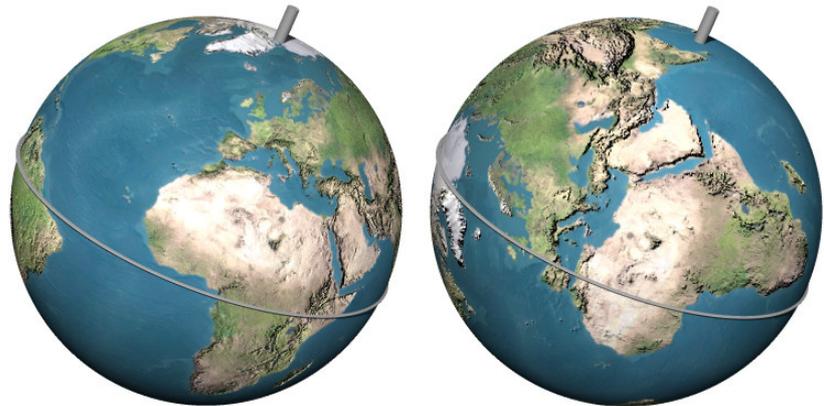
The answer was no – if you e.g. want to rotate real world data or imported data. A generated world in FT3 though can be rotated in FT3 directly.

But now there is a way to even manipulate real world data or imported worlds from binary files.

The question was related to an article found here <http://what-if.xkcd.com/10/>

What would happen if the rotation axis of the world (the earth in this case) would be rotated by 90 degrees?

This picture shows our known world with its rotation axis and the equator to the left. To the right you see what it would be like when the rotation axis was moved towards the Indic Ocean.



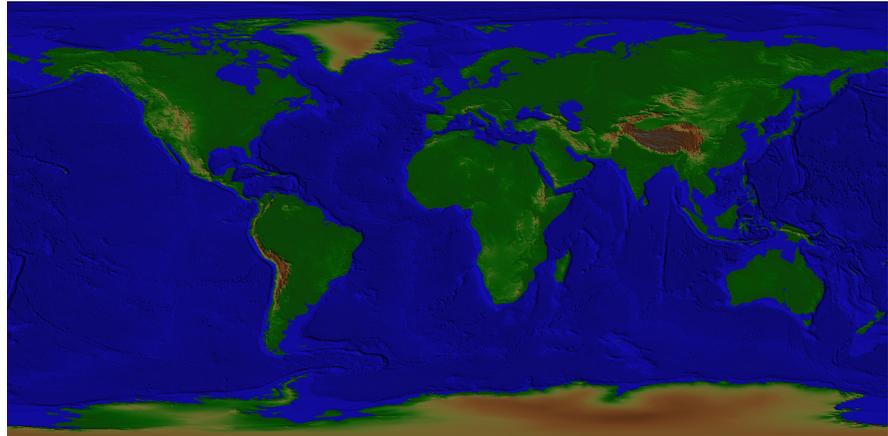
You see also a little problem with our texture – it does not fit the new world because Antarctica, which now is situated at the equator, is still covered by ice while India near the North Pole still has a climate of southern latitudes (seen from the northern hemisphere).

This is where Fractal Terrain can do a great job. It can recalculate the climate of all regions of the planet once we have a correct rotated earth to get a picture similar to this (after a bit of temperature and rain painting):

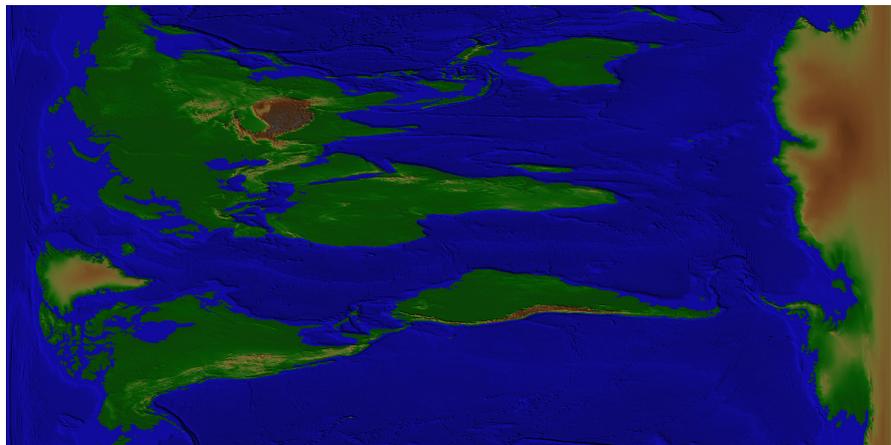


How do we get there?

Many maps are drawn in a so called equirectangular projection. You are able to see all features of the world at the same time with big distortions towards the poles.



My first guess was that the map only should be rotated by 90 degrees.

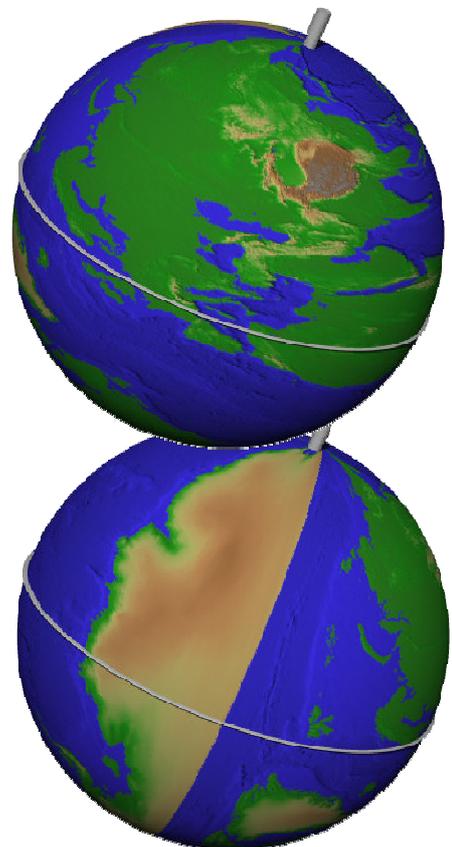


See now what happens when we wrap the map around a sphere:

This looks quite ok and we might think – that was an easy solution – but wait – see what happens if you take a look at our new world from a slightly different angle?

Oh no, what's this? You might already have guessed what kind of problem we got. The right and the left corner of our equirectangular projection map must be kind of a seamless texture, which means there must not be a discontinuity. In case in our original world there is no discontinuity from 180 degrees east (to the right) and 180 degrees west (to the left) – both values at the same latitudes have the same value or the same altitude (height).

This is not the case in our simply rotated map. Here the high mountains of Antarctica meet the rather deep Arctic Ocean.



So this way is not the proper way to rotate our planet or our fantasy world.

But how do we do it?

The answer did I find in astronomy or spherical trigonometry. In astronomy you have many coordinate systems that are rotated against each other.

The new world coordinates are rotated against our old ones as well.

So I wrote a tiny program that recalculates all those coordinates and so we can get our correct rotated world.

If you want to rotate the real world do the following steps:

1. Download the ETOPO2 earth altitude dataset from <http://www.ngdc.noaa.gov/mgg/global/relief/ETOPO2/ETOPO2-2001/ETOPO2.dos.bin> and save it into a folder. For those with a slow internet connection: This file is rather large, about 110 Mb.

2. Rename the filename into ETOPO2.bin

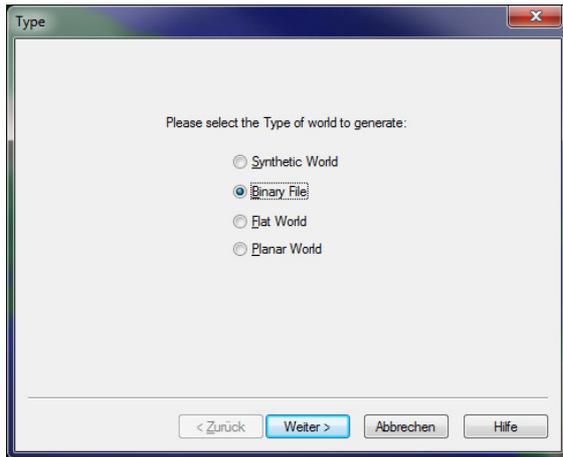
3. Download the belonging header file that works with FT3. I have placed one on my website – you can download it here: <http://www.andre-franke.se/ft3/ETOPO2.hdr> and save it in the same folder where you saved the ETOPO2.bin file.

4. Start FT3

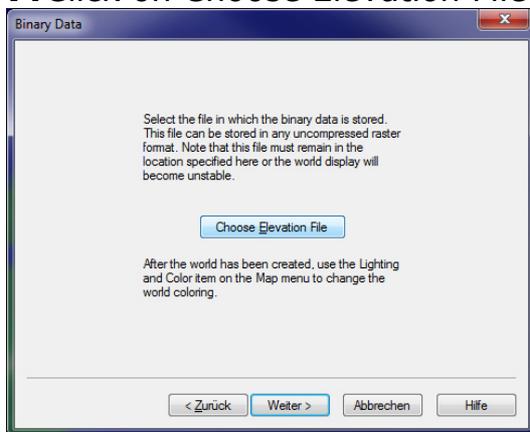
5. Choose New



6. Check Binary File -> click on continue

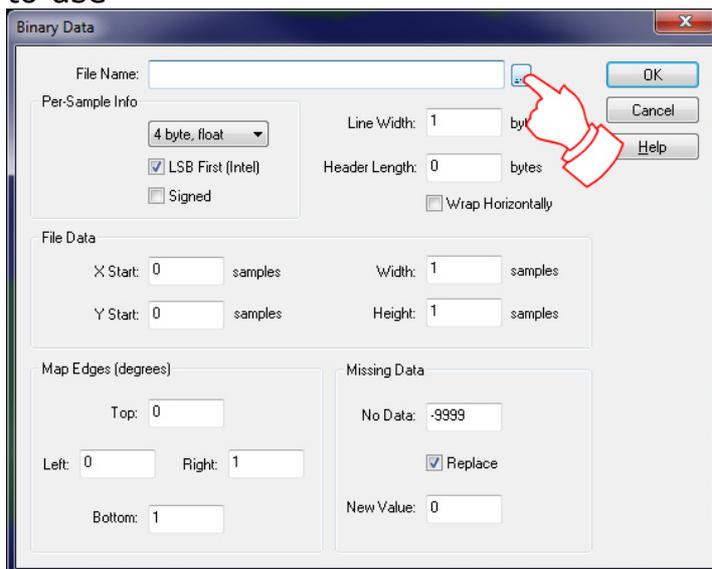


7. Click on Choose Elevation File

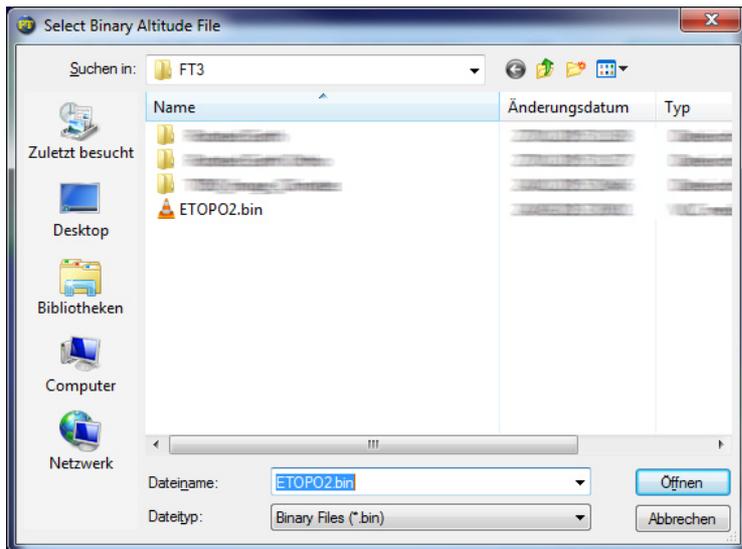


and the Binary Data dialog box will open.

8. Click on the button with the three dots to select the data file you want to use

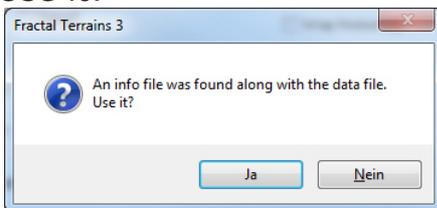


9. Choose the file ETOPO2.bin in the File name selection dialog.



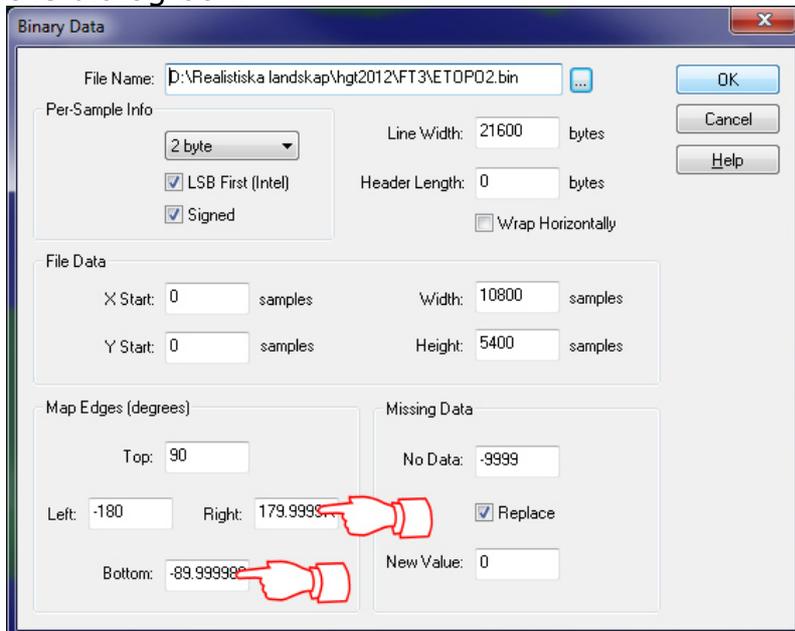
Make sure that *.bin files are shown – in case your file does not show up.

10. You will be told that “An info file was found along with the data file. Use it?”



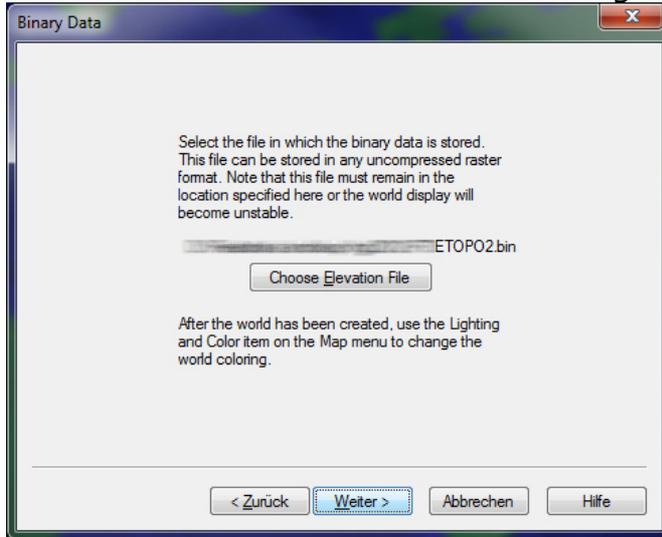
Click yes

11. FT3 will use the header file ETOPO2.hdr and place all its values into the dialog box.

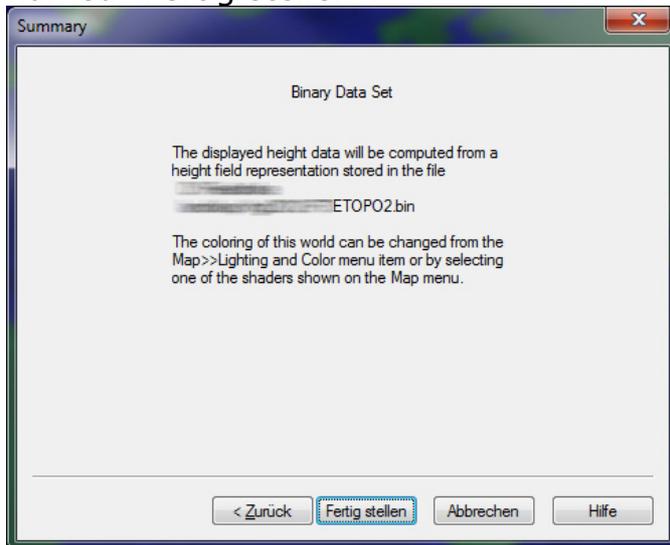


Correct the two values for Right and Bottom in the section for Map Edges (degrees). Right value should be 180 and Bottom value -90. The errors are due to rounding. Press Ok to continue.

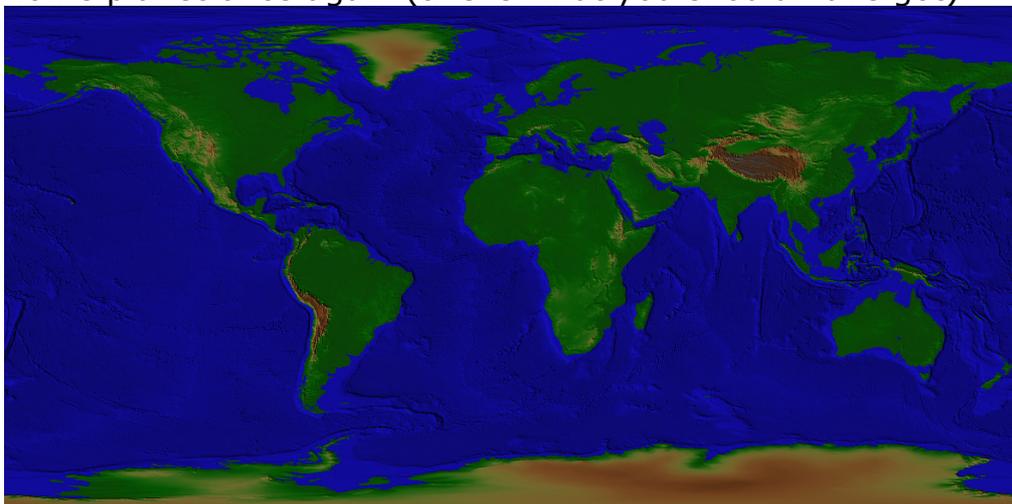
12. Press continue in the next dialog box



13. Click here on the button to finish (in the German version the Button named "Fertig stellen").



14. Now you get a highly detailed map of the whole earth. The graphic shows the equirectangular version of the altitude map of our home planet once again (this is what you should have got):



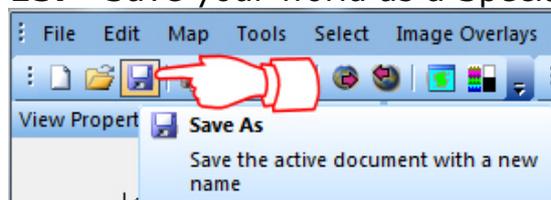
But what happened, if our world got an impulse that the rotation axis moved by 90 degrees towards the equator and the new north pole of the earth world would be positioned in the Indic ocean on the equator (also the new coordinates of the north pole being 90 degrees east and 0 degrees (north or south).

If you take a spherical earth model this would simply be a turn of our globe by 90 degrees. But belonging maps are often shown equirectangular projection as shown above.

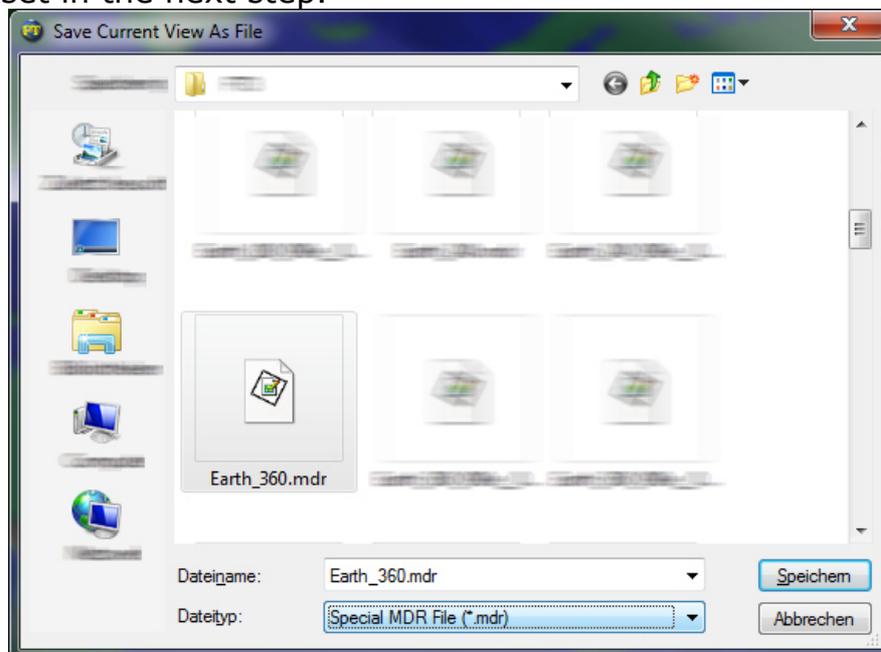
While in 3d space nothing will be disturbed – all continents do still lie exact the same way relatively to each other – in the equirectangular projection the disturbance will be amazingly.

This part can not be done directly in FT3. But here is the solution to do it.

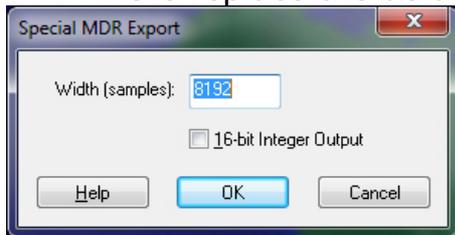
15. Save your world as a Special MDR File from FT3. Choose Save as



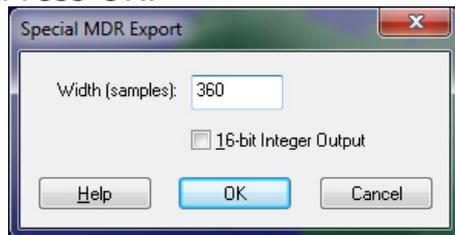
16. In the Save Current View As File dialog box select Special MDR File (*.mdr) in the file extension drop down box and give your file a useful name. I call my file in this example "Earth" and I recommend adding e.g. "360" to the file name – the resolution of your exported file that you will set in the next step.



17. Here replace the default Width (samples)



that I use to call resolution (8192 in my case, the number may vary) with the number you chose for your file name e.g. 360. Leave the 16-bit Integer Output unchecked! Press OK.



FT3 exports now the MDR file.
This is the file we can work with.

18. At this step we can repeat from step 15 a couple of times to save different resolutions from FT3, e.g. 360, 3600 and maybe even full resolution of 10800 – it is up to you. The export times from FT3 are rather short compared with the much longer transformation progress.

The little converter program

I have developed a little application that reads from a given mdr file and saves transformed data into a new file.

19. You can download it from my website

http://www.andre-franke.se/ft3/FT3_MDR_fileconverter.exe

I have scanned it with my anti-virus program – do so with yours for own security.

Place it in the same folder where you saved your mdr files.

It is a compiled GFA32-Basic program for those who are interested. The programming language was popular for about 20 years ago on Atari and survived even in Windows (at least on my PC).

The compiled program needs a kind of runtime library called GfaWin23.Ocx (like compiled VB-programs)

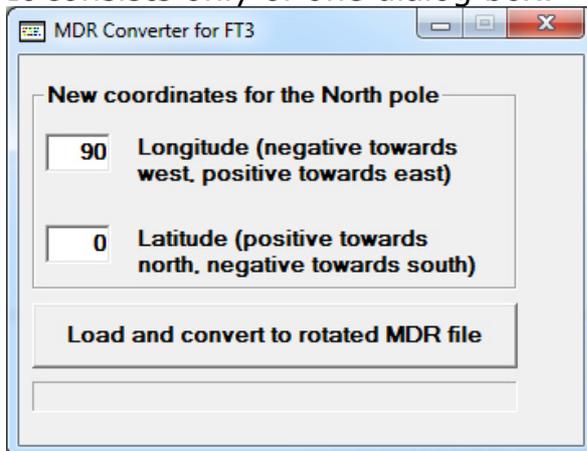
20. Download it also from my site

<http://www.andre-franke.se/ft3/GfaWin23.Ocx>

and place it in the same folder as the exe.

I have scanned it with my anti-virus program – do so with yours for own security.

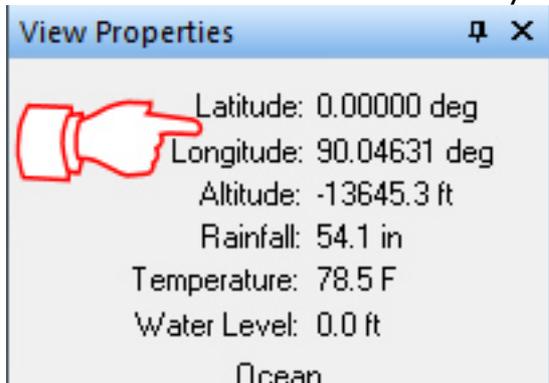
21. Now start the fileconverter – the Exe file you downloaded. It consists only of one dialog box.



Choose here your new coordinates for the North Pole.

Where to get the new coordinates from?

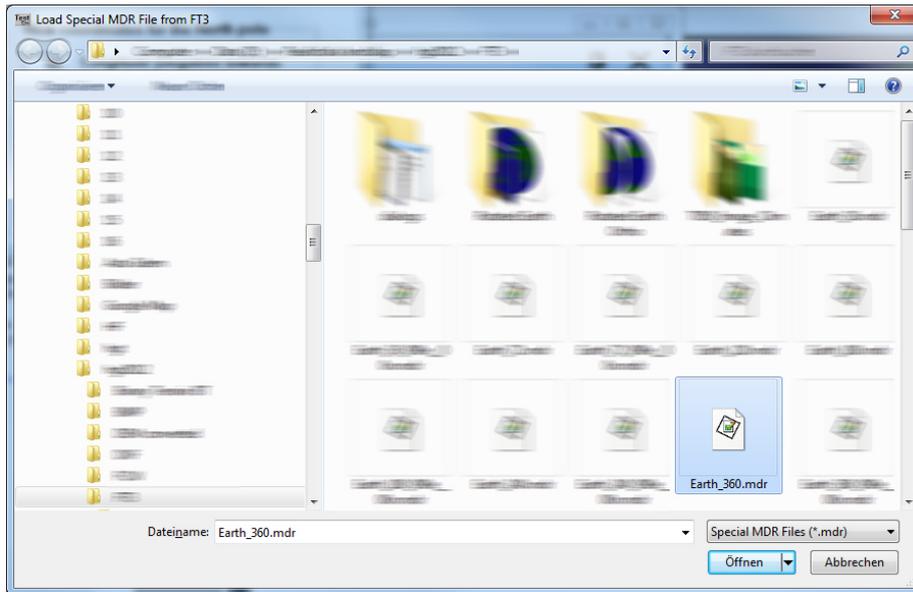
If you select in FT3 View -> Toolbars and Docking Windows -> View Properties you can see longitudes and latitudes while moving your cursor over the map. Move your mouse cursor to a position you want to be placed at the North Pole on your rotated planet. This will be the coordinates to be entered in my application.



Write down the coordinates and enter it into my application – **enter only integer numbers between -180 and 180 for the longitude and between -90 and 90 for the latitude.** The program does not do many security checks – so do not enter other values or letters then it may crash. **I have tested the program thoroughly but programs may always contain errors and therefore you use this program at your own risk.**

22. After entering the new coordinates press the button “Load and convert to rotated mdr file.”

23. A file selection dialog will appear and you can now select your exported mdr file from FT3.



The new file will be named exactly as the old one but with the coordinates of the North Pole in the file name, so you will get a second file of exact the same file size as your original file.

E.g. if your old file was named "Earth_360.mdr" and your new north pole is situated at 90 degrees east and 0 degrees north/south (as in the default values in my application) then the new file name will be "Eart_360_090e_00n.mdr" in the same folder.

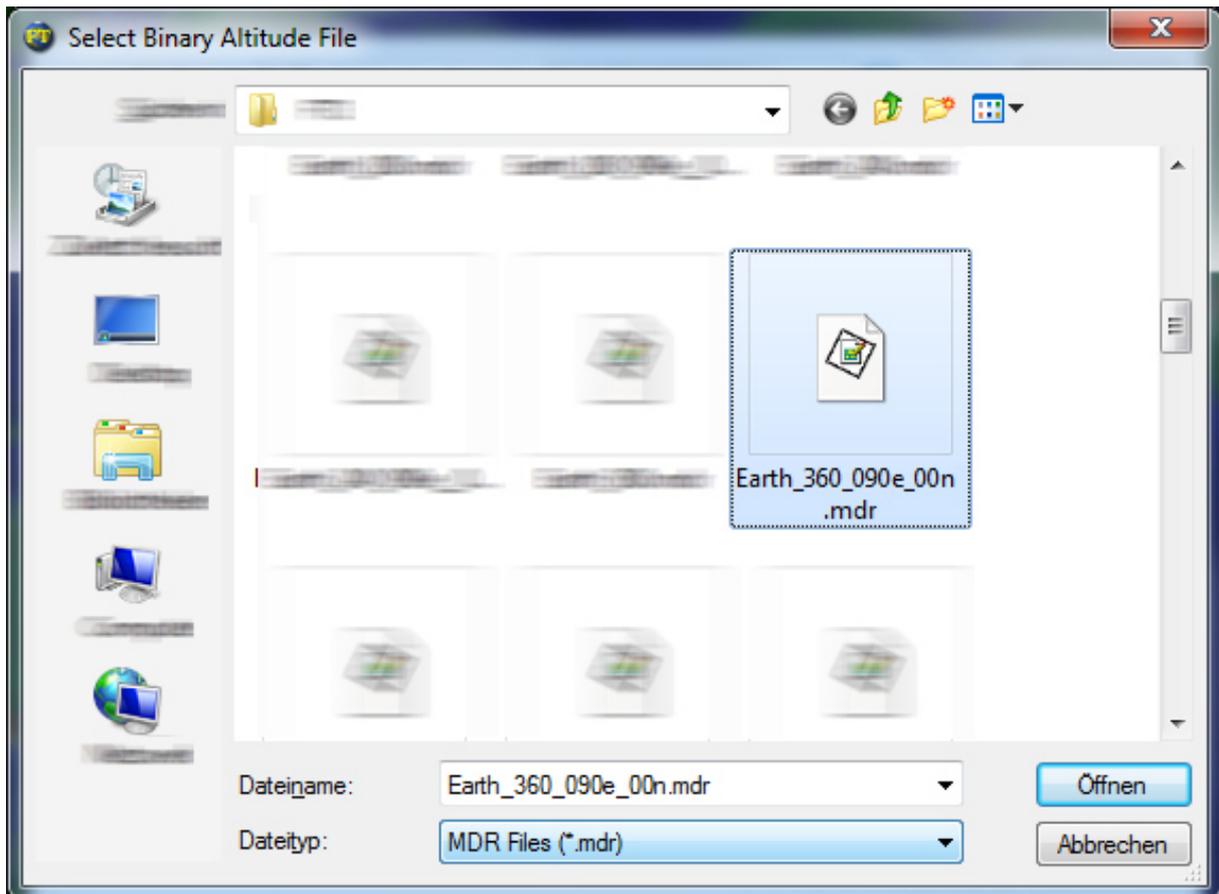
The progress bar in the dialog box shows you if the program is working – the new file is ready when the progress bar status changes from full to empty again. (In case of small resolutions this happens very fast – so check the folder of your file has been generated)

If the program does not do anything with your chosen file than it may have no access to the file – this happens if the file still is opened by FT3 or has been opened earlier by FT3. This is no bug in my program. Close in this case FT3 and press the "Load and Conversion" button in my application once again.

Start best with a 360 sample resolution. In this case my little program works in a few seconds (time varies depending on your machine). If you choose a sample resolution of 3600, calculation time increases by factor 100, because of 360x360 points now 3600x3600 points have to be transformed (that are 12960000 points)!

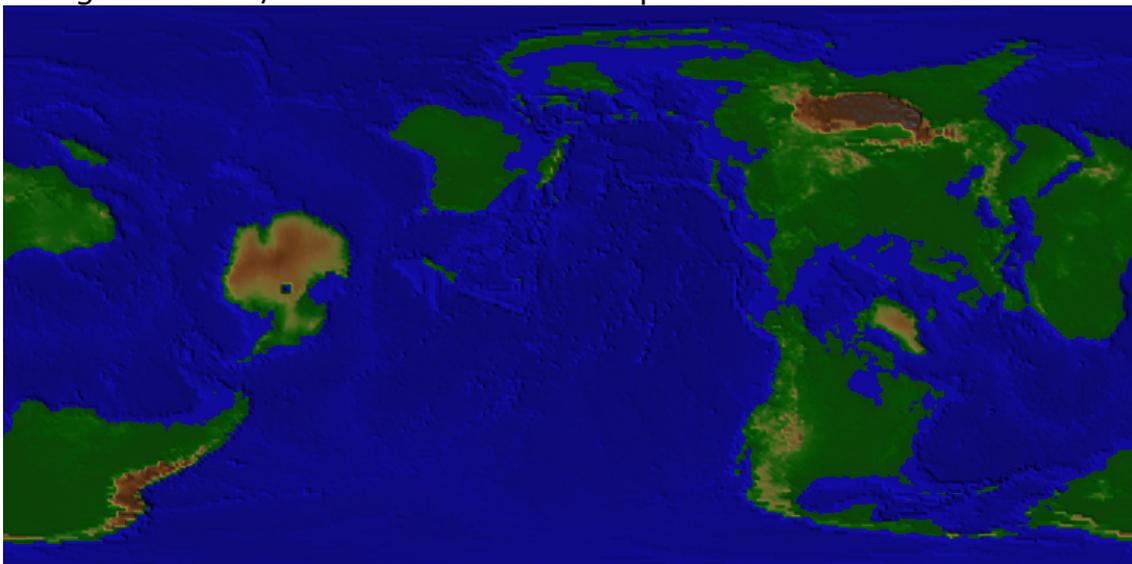
Because you newer or barely know in advance what your rotated map of your planet will look like in a equirectangular projection it is a good idea to start with a smaller resolution to get fast results an if you are satisfied you can do the same process with a higher resolution file.

24. Open the new converted file into FT3 as described in steps 5 to 13, but in step 9



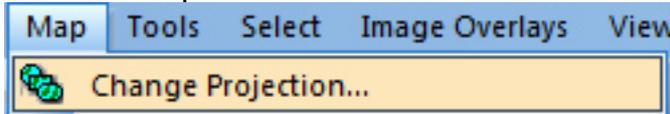
choose this time "MDR Files (*.mdr)" in the file extension drop down box instead of "Binary Files (*.bin)" and select your newly created file. Step 10 will be skipped because the mdr files have all necessary information inside them, so you do not need a header file.

This is the result with the new North Pole situated at 90 degrees east and 0 degrees north/south with a 360 sample resolution.

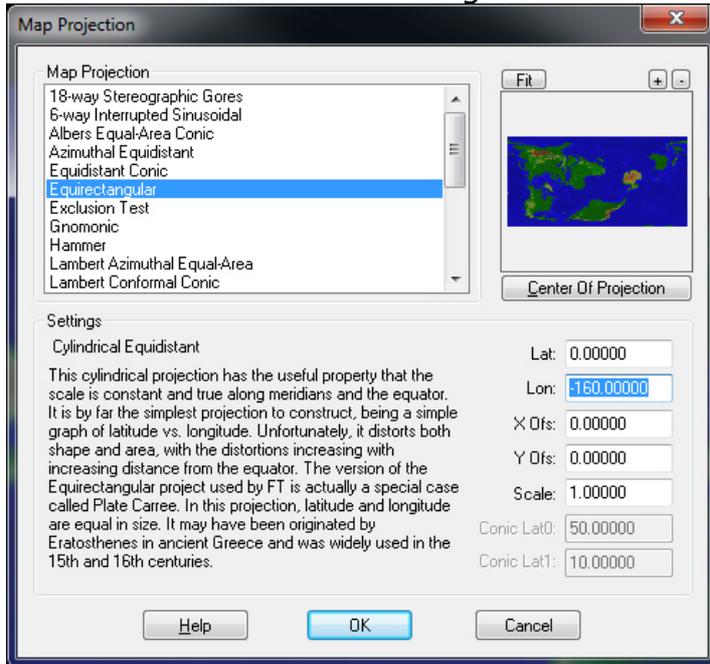


The old North Pole features have been moved to place where on our earth the Indic Ocean near India was situated and that part of the world has been pushed up to the upper edge of the map which represents the North Pole.

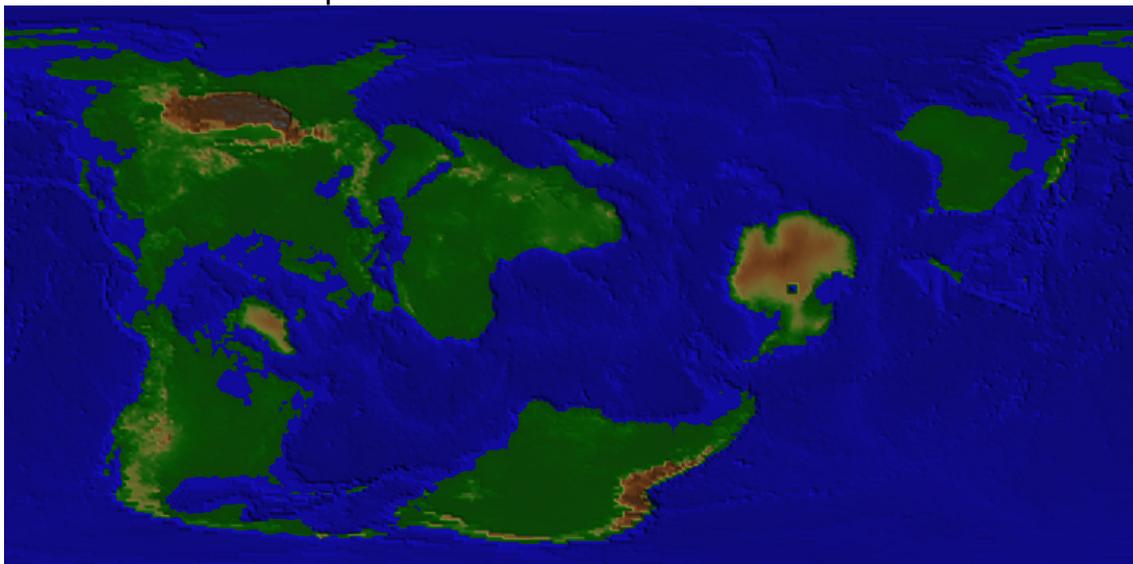
You may find the projection a little bit unfortunate. You can change that by changing the map projection directly in FT3:
Choose Map in the menu bar and thereafter Change Projection:



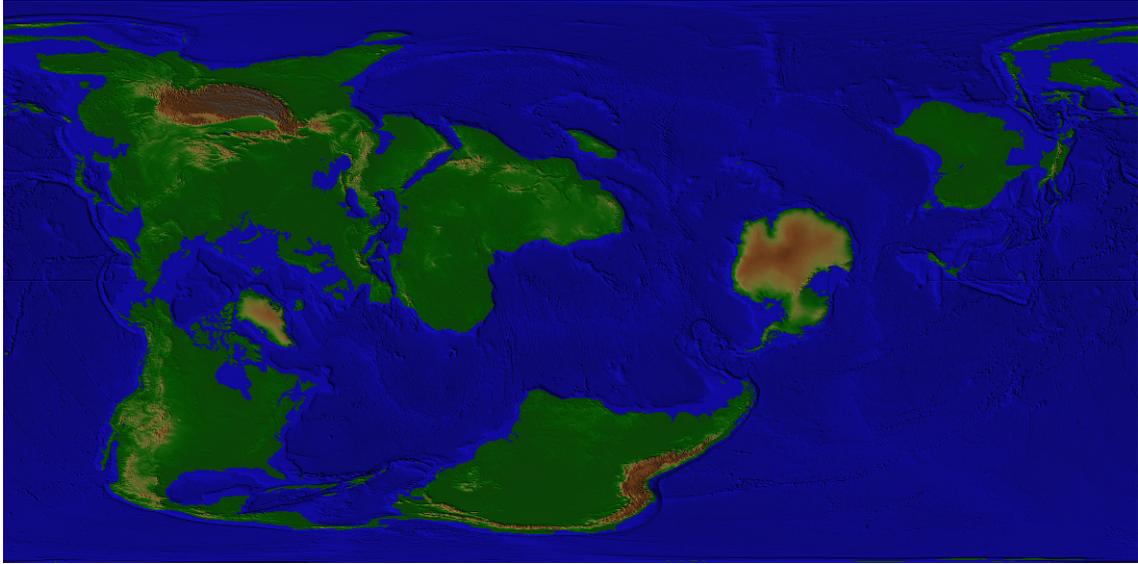
Now insert a new longitude for the North Pole. Changing its latitude will not do change the map!
In this case I chose -160 degrees as the new longitude.



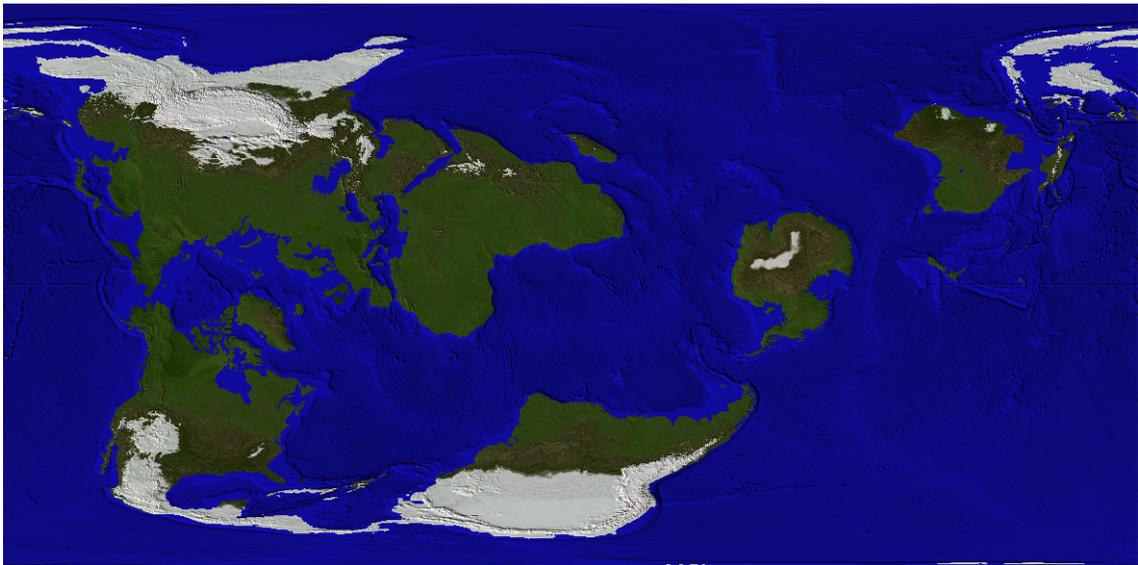
The result will be a map like this:



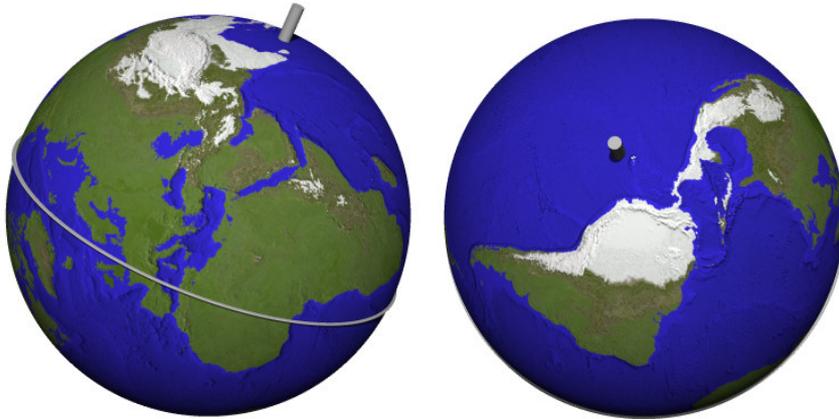
You can do the same with a higher resolution file and in case of a full resolution of 10800 samples the map will look like this:



Now you can for example choose another climate texture and your new world will look like this:



Keep in mind – even when you take this heavy disturbed map and wrap it around a sphere – you will have our earth again with all it well known features – but rotated – as in my example by 90 degrees.



The rotated world seen from slightly above the equator and from near the South Pole.

You are of course free to choose any angle you like within the boundaries mentioned in step 21.