
F S G L O B A L 2 0 1 0

Digital Elevation Mesh Scenery
For Microsoft Flight Simulator X / 2004

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1. INTRODUCTION

It started back in 1996. One day I received a letter which contained a floppy disc (one of those little magnetic things, back then…). It was sent to me by a german student, who offered PILOT'S to participate in his project. He said, he was about to digitize the whole world and prepare it for use in the (then current) FS5. I must say, that in these days it was common to receive sceneries offered for marketing. In most cases it was „my grandmother's backyard on January 30th. There you can see the shadow of her cat's tail. It has stripes". And so the floppy stayed where it was. Within its envelope. But this young man insisted. So I was forced to deal with him.

Today I am grateful for his convincing me. His visions have altered the world in Flight Simulator, infected me and tempted me even to take financial risks. Far regions got real and realistic. When in 1998 it was flat polygons, changing depending on season and region, today we have 3D meshes drawing our FS world. 2004 still in resolution of 76m and SRTM data only covering from 60° North to 60° South. They were supplemented with regions outside this area and within with resolutions of up to 19m in 2007. With this version FS Global for the first time reaches complete world coverage of up 9m. Small parts of it can not be released at this time due to a technical problem within FS. But we will make up for that. SRTM data however deliver only a third of all altitude points. The remaining areas have been conceived using higher quality data.

The student of back then today drives a Jumbo in real world. His views may have changed. But not his visions.

And now, have fun exploring the world in FS Global 2010!

We look forward seeing you again when we release a possible FS Global 2013 or so, then possibly being the first FS Add-On delivered on Blueray! ☺

Stefan Schäfer, Vienna, October 2009

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2. THE PROJECT

We have assembled the currently best available data in reasonable resolution. It does not make sense to deliver the “Great Plains” in the USA in a resolution of LOD12 (9m). Flat is flat. There is no benefit for you and FS 2004 can’t even display it! And the amount of data gets extremely huge. Nevertheless some of our competitors do offer it! Resolution itself is not the only thing responsible for the looks of your world in FS. At least as much important are algorithms and error correction when converting data into FS readable scenery files. Our experience helped us to improve these (compared to previous versions of FS Global) in a way everyone can notice. But see yourself and compare …

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3. INSTALLATION

PLEASE NOTE: This setup will take a long time! We have to copy about 25 GB of data per version. Depending on your system this may take several hours. Expect about 3 hours!

1) Deinstall any previous version of FS Global. Do not forget to also remove the appropriate scenery layers in scenery library within FS. Exit FS, if running.

2) Insert DVD1 into your DVD-ROM drive. **Please note**: IT WILL NOT WORK IN A CD-ROM drive! If AUTORUN does not start, please manually start “autorun.exe” on DVD 1 for easy installation.

Please make sure you read and understand what is written on the screen! First you will be prompted for your FS directory. Usually this is already written in the appropriate field (taken from the registry). If not, please fill in the correct path to the directory where your Flight Simulator was installed to. You can use the BROWSE button to browse there.

If your Flight Simulator was identified you will be prompted for the drive where you want to install FS Global 2010 files onto. This drive MUST have 26GB of free space.

At this time we do not support to install just sections of FS Global 2010. If you really want that, you can disable continents via the scenery library and even delete the files manually.

Follow the instructions on your screen!

You will be asked to insert the other DVDs during the process of setup. The last one will be DVD1 again.

PLEASE HANDLE THE DVDs WITH CARE! TOUCH THEM ON THE EDGES ONLY! DO NOT TOUCH THEM ON THE DATA SURFACE!

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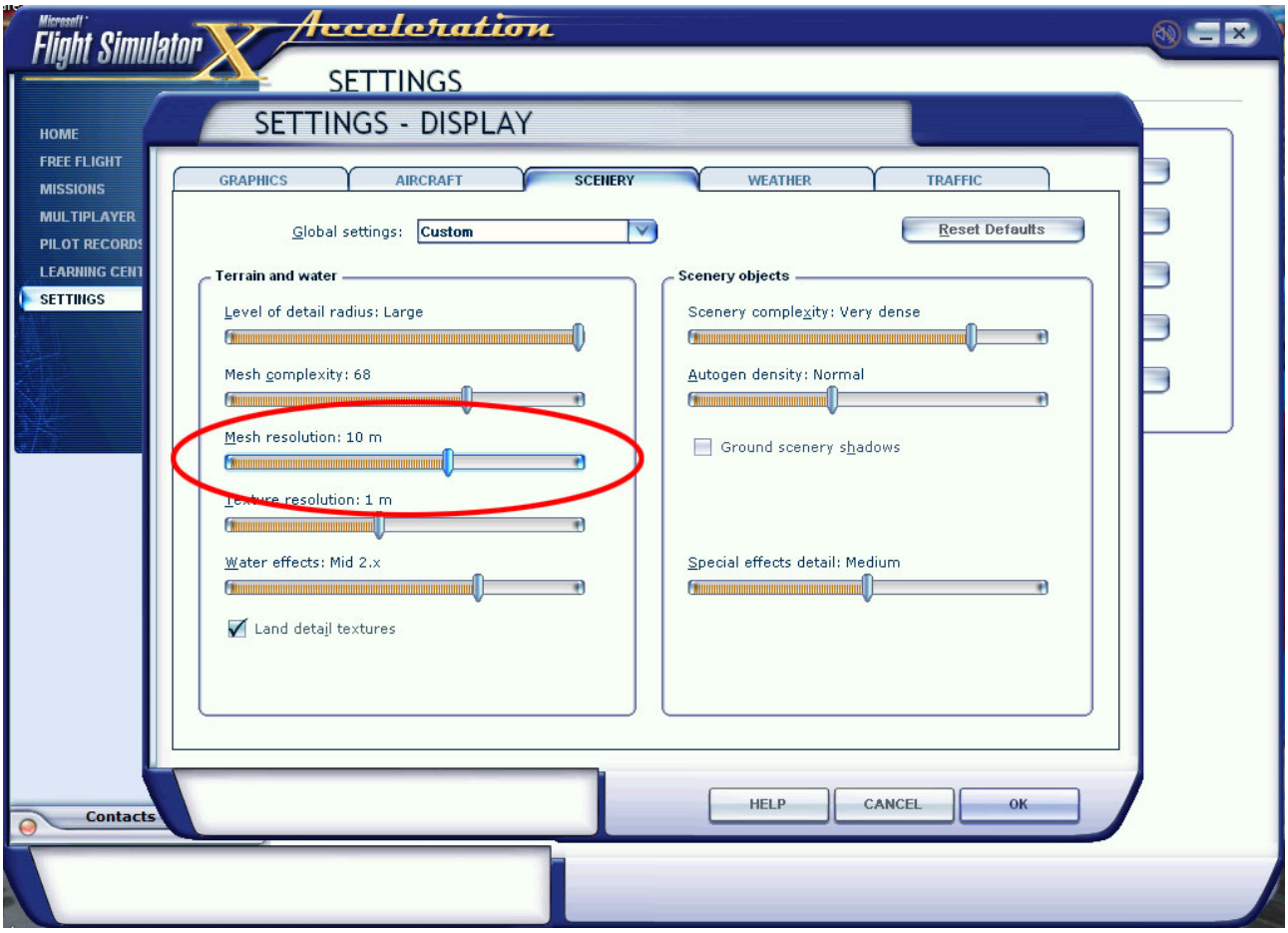
4. SETTINGS IN FS

After installation you should control settings within FS and maybe change it, so that advantages FS Global 2010 comes with do show up in your FS environment. We have on purpose set aside to do this automatically. We think our users should decide themselves which setting they want to have and which not.

In FSX it is easy. The only thing you need to do is to set mesh resolution to 10m in your settings for scenery display. Then you will always see the best available resolution in FS Global 2010. If the setting there already is below 10m, leave it as is. You can also start experimenting with this value to optimize framerate, if necessary. All other settings in this screenshot below are by coincidence and have no relevance for FS Global.



In FS2004 there is no way to enter these settings via a GUI. You must find the current version of the file FS9.cfg. It would make sense to use the Windows-Search-Function, as given the current number of Operating Systems in different language versions it is not possible to exactly guide you to the file. It is in different locations in pretty much each version of OS. When you have located the file, please open it with a Text-Editor and look for the string „TERRAIN_MAX_VERTEX_LEVEL“. If the value written there is lower than 21, amend it to 21 and save the file. So you will see the best available resolution of FS Global 2010 in FS2004 as well.

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5. TECHNICAL DETAILS

Please read the document „INSIDE FSGLOBAL 2010“. You can find it on DVD1 (folder MANUAL) or via the link from the programgroup PILOT’S Software.

This document is work in progress!

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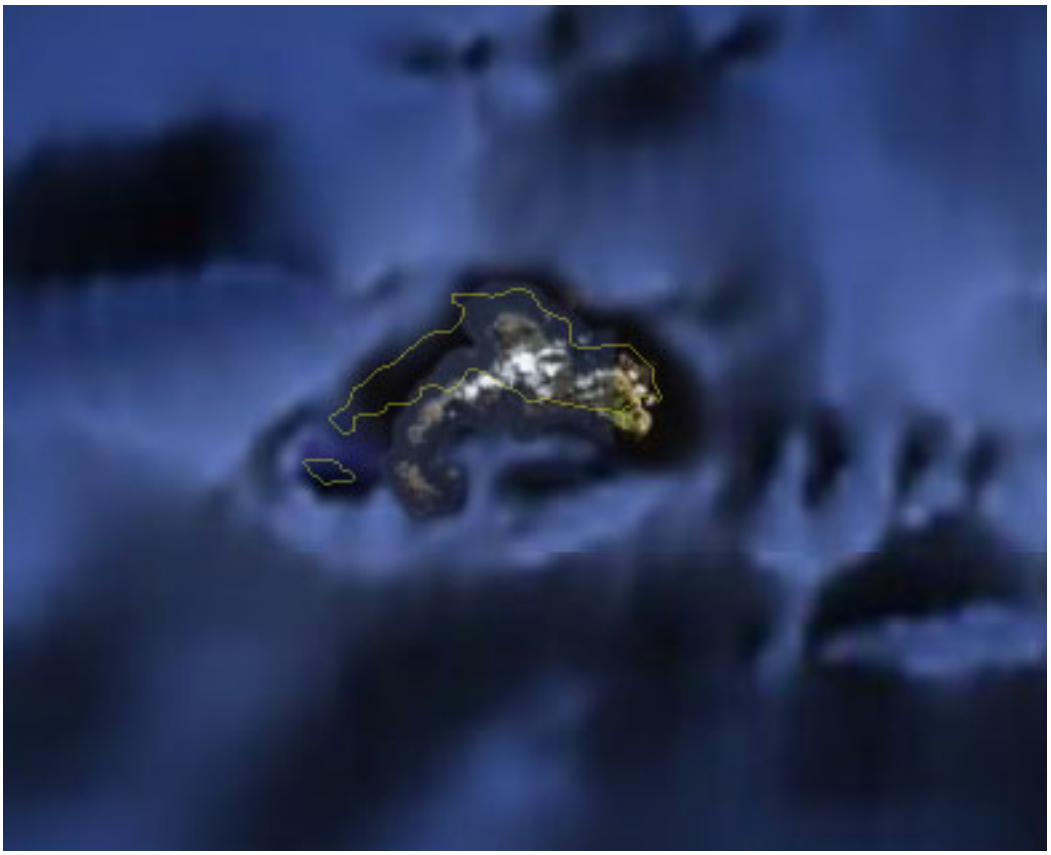
5. COMPATIBILITY & KNOWN PROBLEMS / AFX

Again we point to our documentation „INSIDE FSGLOBAL 2010“ (see above). Further we want to draw attention to the fact, that we do nothing else than to replace already existing things. The default 3D mesh of FSX/FS2004 is replaced by one with much better resolution and quality. You can count on the fact that the FS Global world in that area looks as you see it in FS (besides possibly still existing small data errors). Unfortunately we have (at this time) to live with the fact, that FSX as well as FS2004 have been dispatched with horribly inaccurate coastlines. These mercilessly cut through 3D meshes (such as FS Global). This leads to the fact, that FS Global, though being fully correct in that area, is forced to show what the coastlines force. Please see yourself on the following example (Robinson Crusoe Island; thanks to Google Earth).



Our correct 3D data is cut by the coastlines, which are drawn too much to the north thus drawing ugly steep costs, which are not even there.

The only possibility to remedy this is, to have correct coastlines. We are already considering the possibility to get that done on a worldwide base …

Another annoyance are wrong altitudes of airports. An airport in FS has to be flat. Bottom line. As per definition of Microsoft. Therfore all objects, including runway ends are at the same defined altitude. As we all know, airports are mostly not flat. Well, maybe Sylt … ☺ In most cases this can be ignored, because differences are small. But not always. There are differences in the altitude of runway ends, which are considerable. See Lukla for example. This runway has a length of 527m with an inclination of 12°! If you are interested to read more, may I draw your attention to the book „Ein Schrank fliegt nach Lukla“ by Urs Wildermuth. (Contakt: www.danur.com). Or see Cairo, the difference in altitude of runway ends is 191ft at this airport! When you approach CAT III in FS you may crash even before you hear “Minimums”. This is a problem in concept and can not be changed by us. We have to accept that the airport and its polygon cut into the correct terrain. One runway end may stick in terrain and the other ends in a jump. Depending on actual differences in altitude this may be more or less prominently visible. The only possibility to optically ease that would be to create a micromesh, which needs to be placed in X:\FSGX2010\LocalMeshes\Scenery (FSX) or X:\FSG2010\LocalMeshes\Scenery (FS2004). But mind, this is just an optical ease and has nothing to do with reality.

Sometimes airports have wrong altitudes in default FS. This may have several reasons. One is wrong coordinates in airport databases. The most nasty are those, which altitude has been amended by Microsoft to fit their own wrong 3D mesh in this area. Once you install a correct 3D mesh these airports become “aircraft carriers” or sink into a bath tub.

It is important to us to show our users, that not FS Global is the source of these problems. It just unmasks them. They are present already in your default FSX/FS2004. We do not amend correct data to wrong ones in order to satisfy optical demands. The correct and scientific way is to always correct the wrong data! However, currently in FS this is not possible on a global base.

We have corrected some of the known problems with this release of FS Global. They are installed with the FS Global files. Unfortunately it is impossible to control all areas. That you do not have to live with possibly undetected errors of that kind, we teamed up with Konstantin Kukushkin and Flight1 and present a tool (called AFX). You can correct wrong altitudes yourself with this tool. If you want to build your own airport, you can buy the full version from their website. The version here is a DEMO, but enabled to change airport altitude and save these changes for use in FSX.

The following pages you can find a short description on a prominent problem of how to use the program for the purpose of changing airport altitudes.

See below pictures of the airport of Bata (FGBT) in Africa.

That is the way it looks in default FSX (without FS Global):

And that is the way it looks in reality (thanks to Google Earth):

Or so (thanks to Horatio Hornblower):

Do you see a steep coast somewhere? We do not!

Consequently the airport looks that way in FS Global 2010:

We should do something here….

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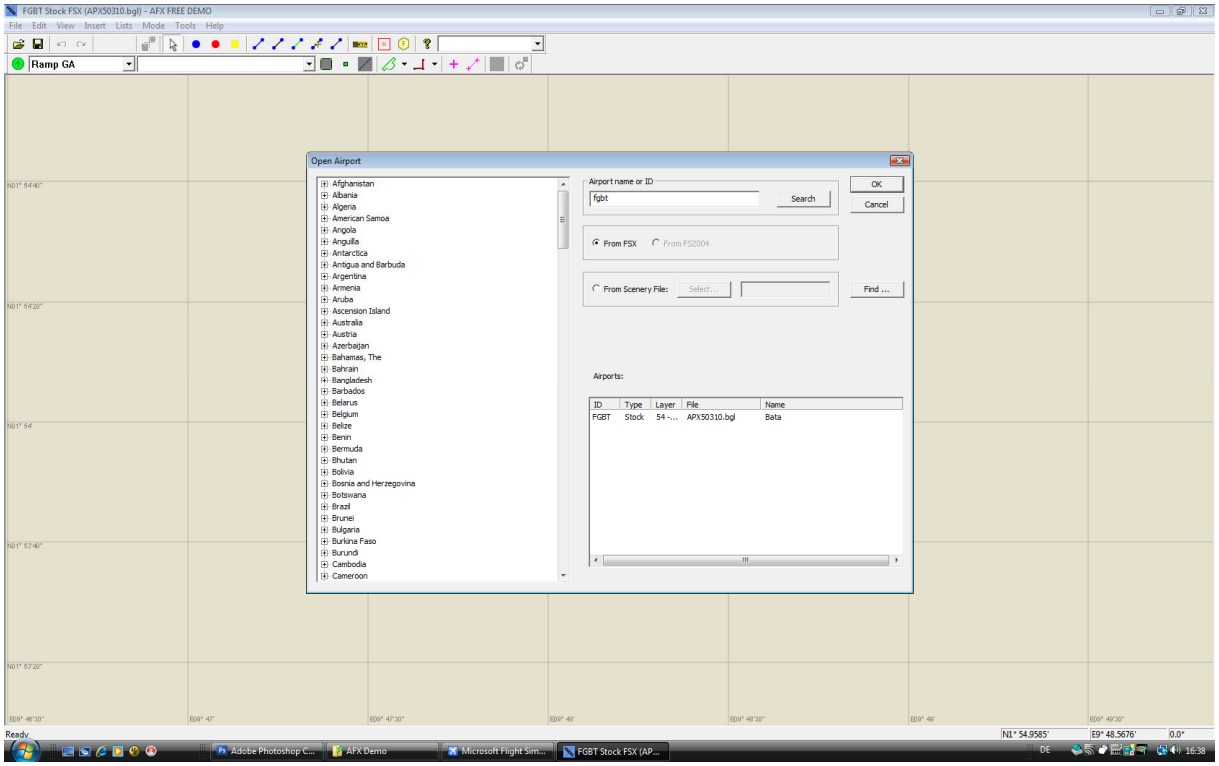
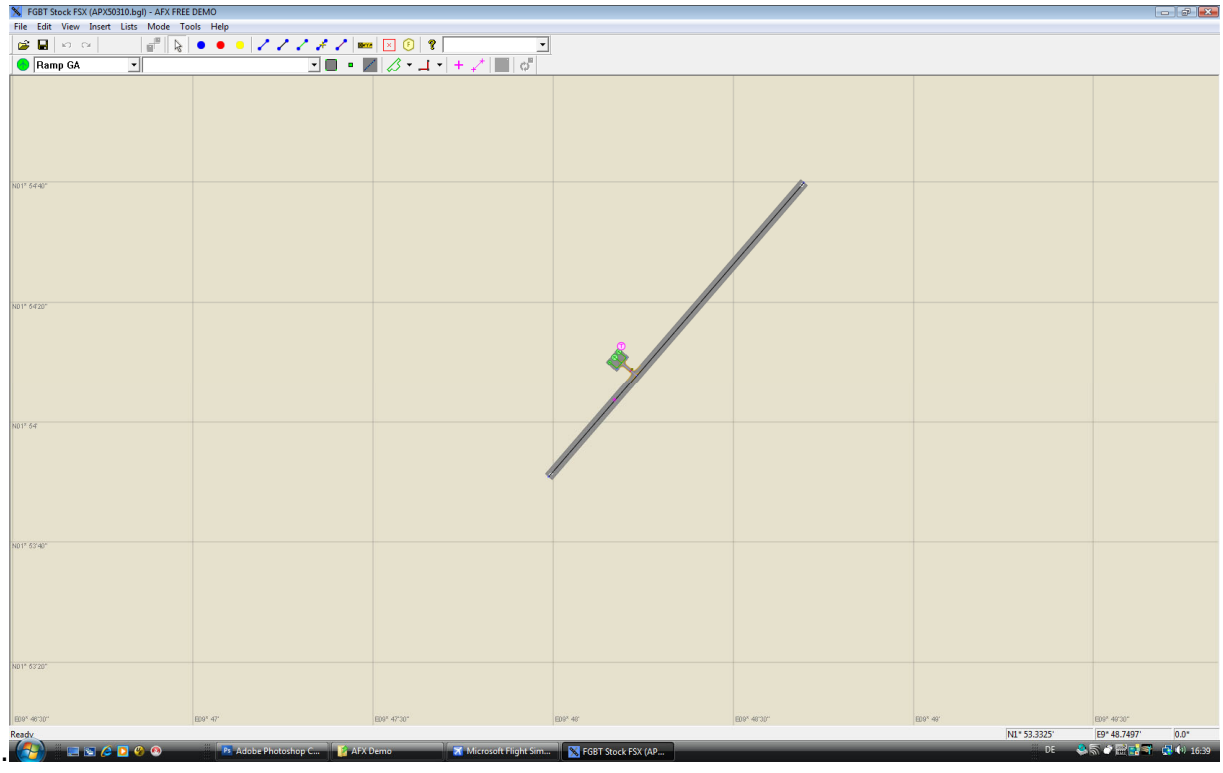
OK, let us install AFX DEMO. You can find it on DVD1 in the folder AFX or you just click the link „Airport Elevation Tool (AFX)" in the PILOT'S Software programgroup.

Then please start AFX and click „File open". In the opening window select „from FSX" (AFX now reads all files!), enter fgbt (the airportcode of Bata) in the search area and click „Search".

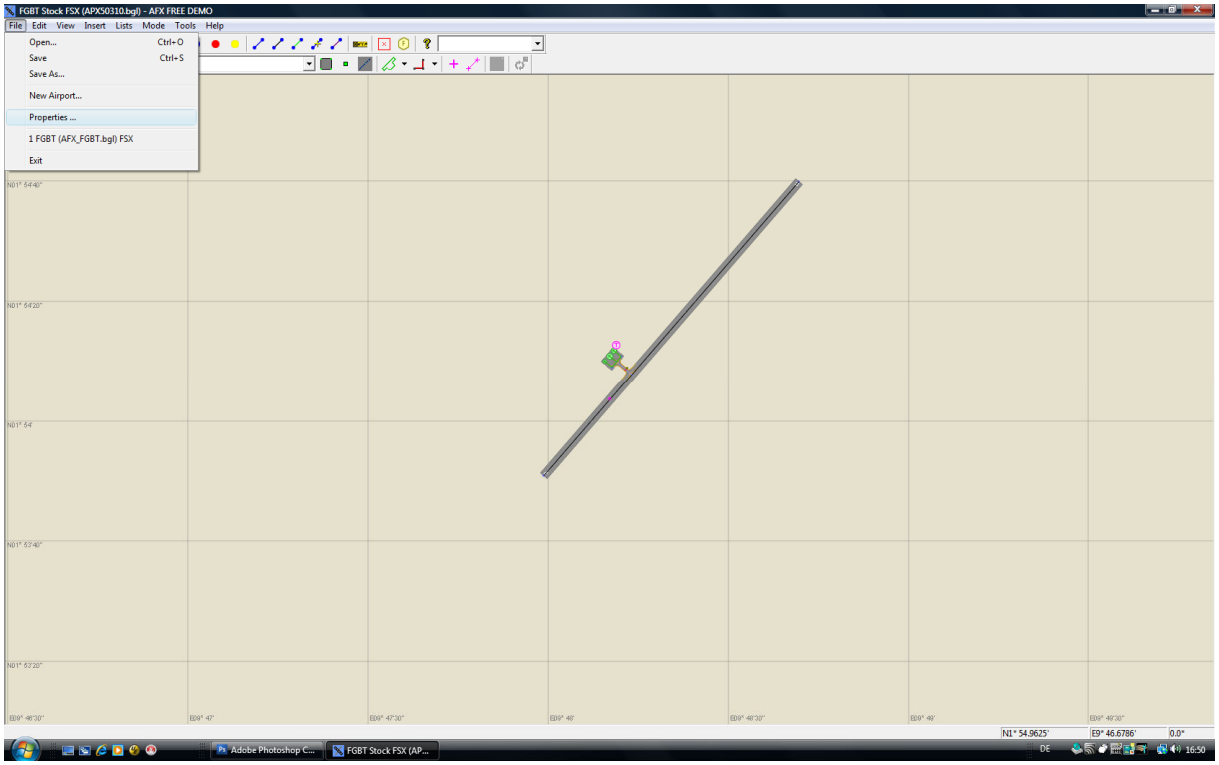


Once the airport has been found, you can see it listed in the area where results are shown. Click it and it will open for further processing in AFX

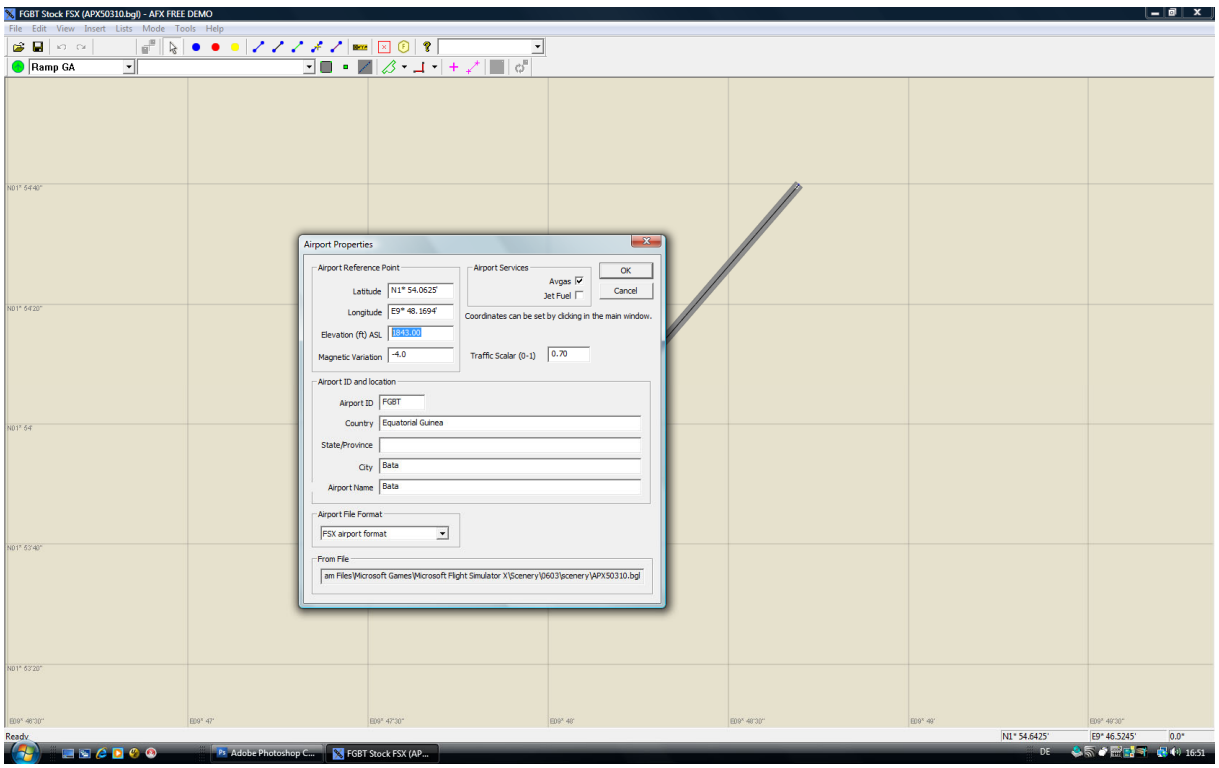


Now you can change the altitude. Either you know the altitude or you find it out in FS itself.

Click „File“ and „Properties“.

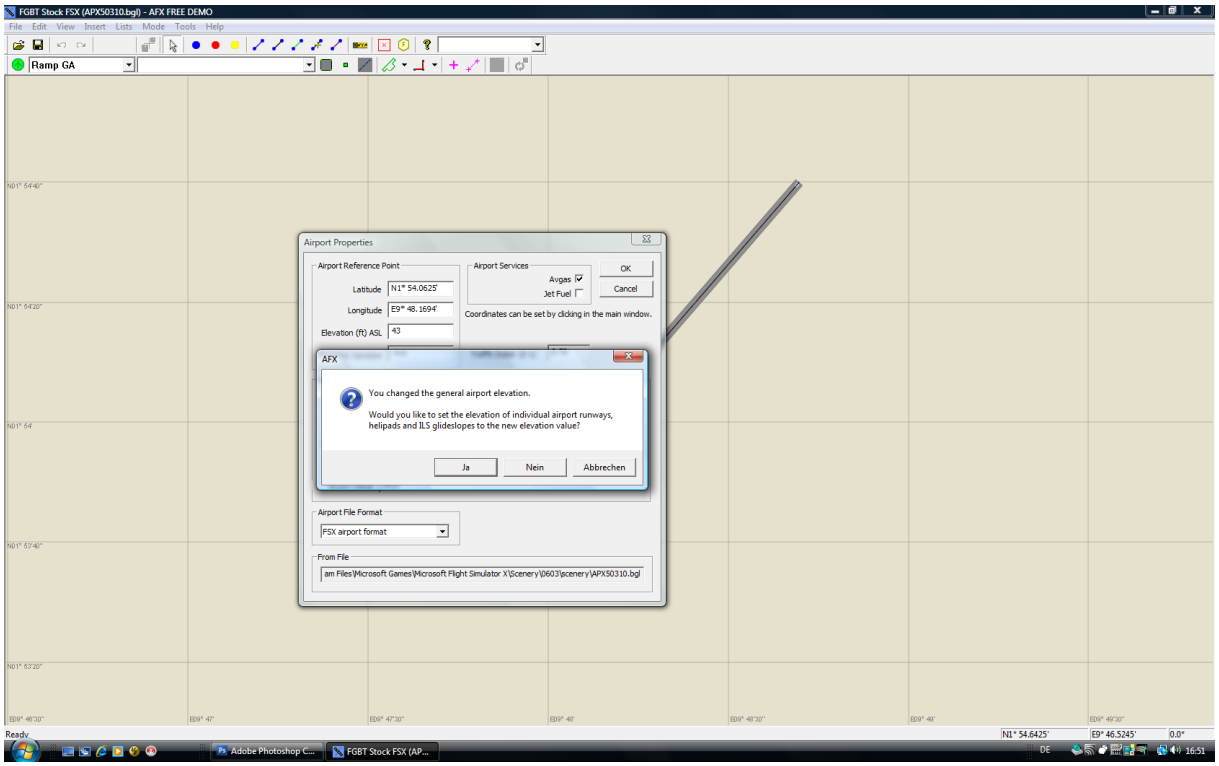


In this window you can change the altitude.

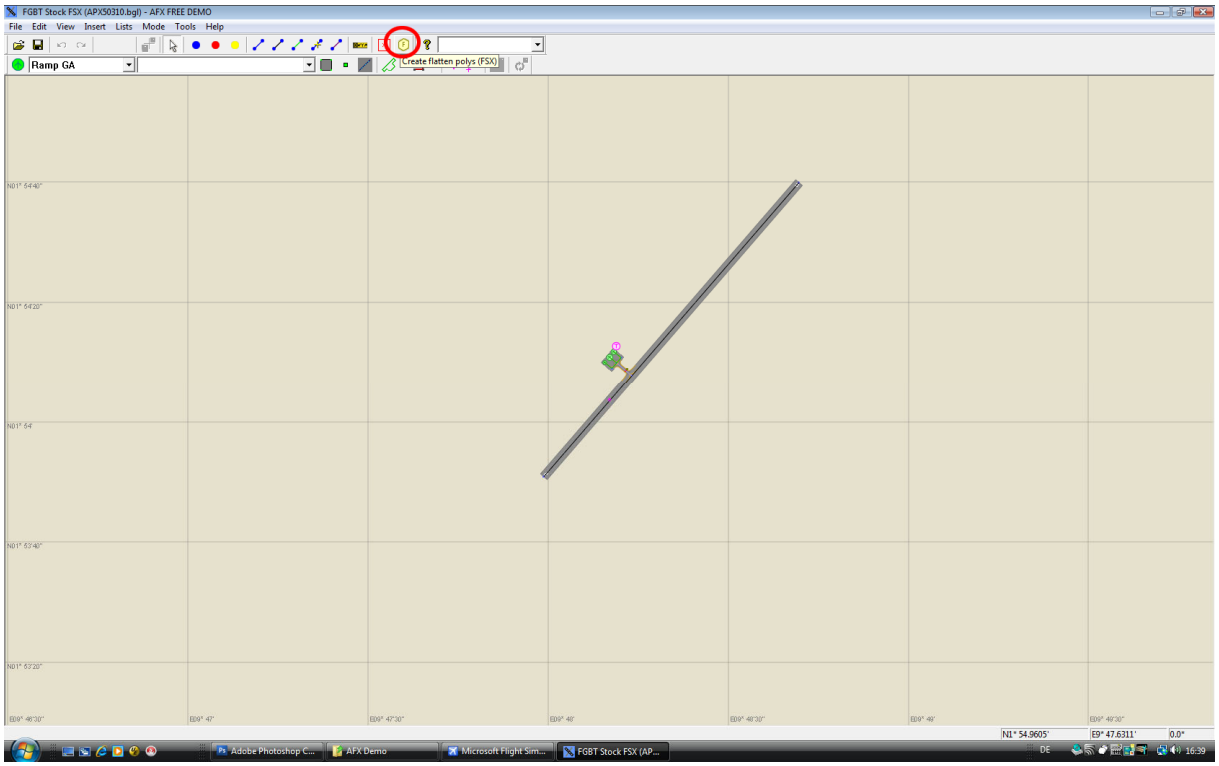


Then click „OK“.

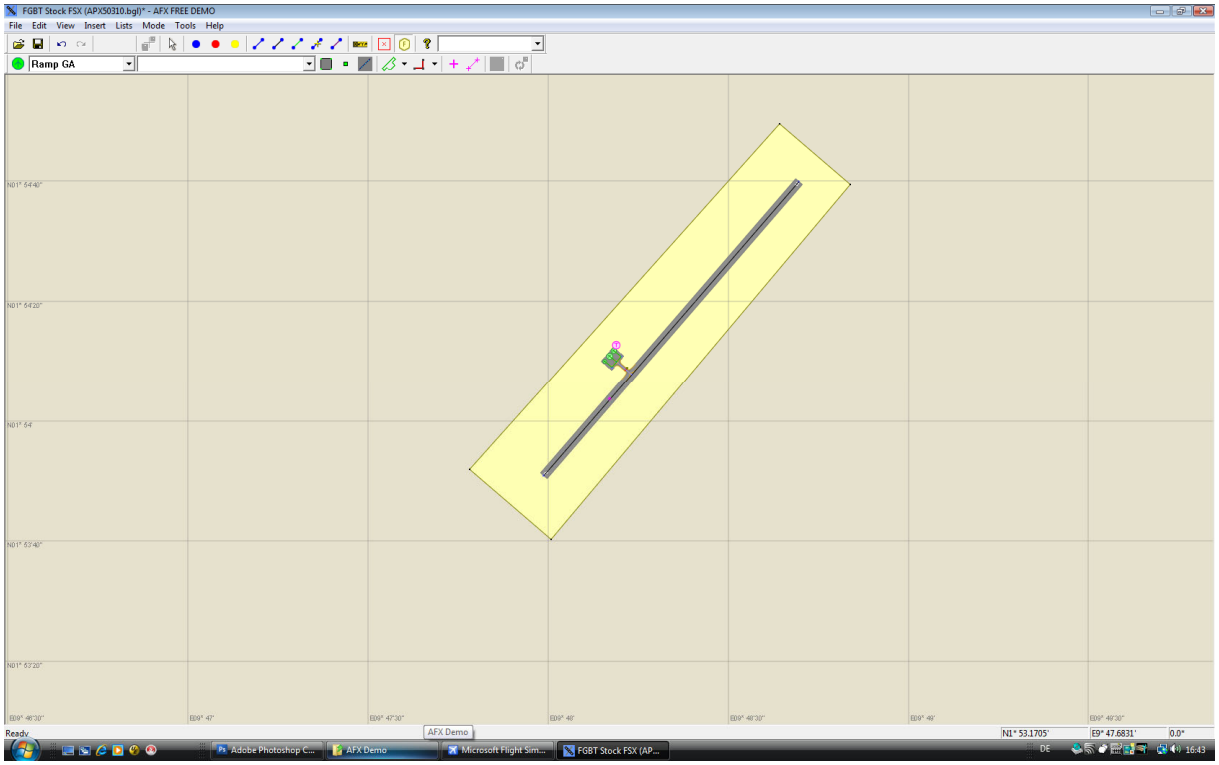
Now you are asked by AFX if you wish to amend connected values (such as ILS, etc) as well. Of course you want to do that!



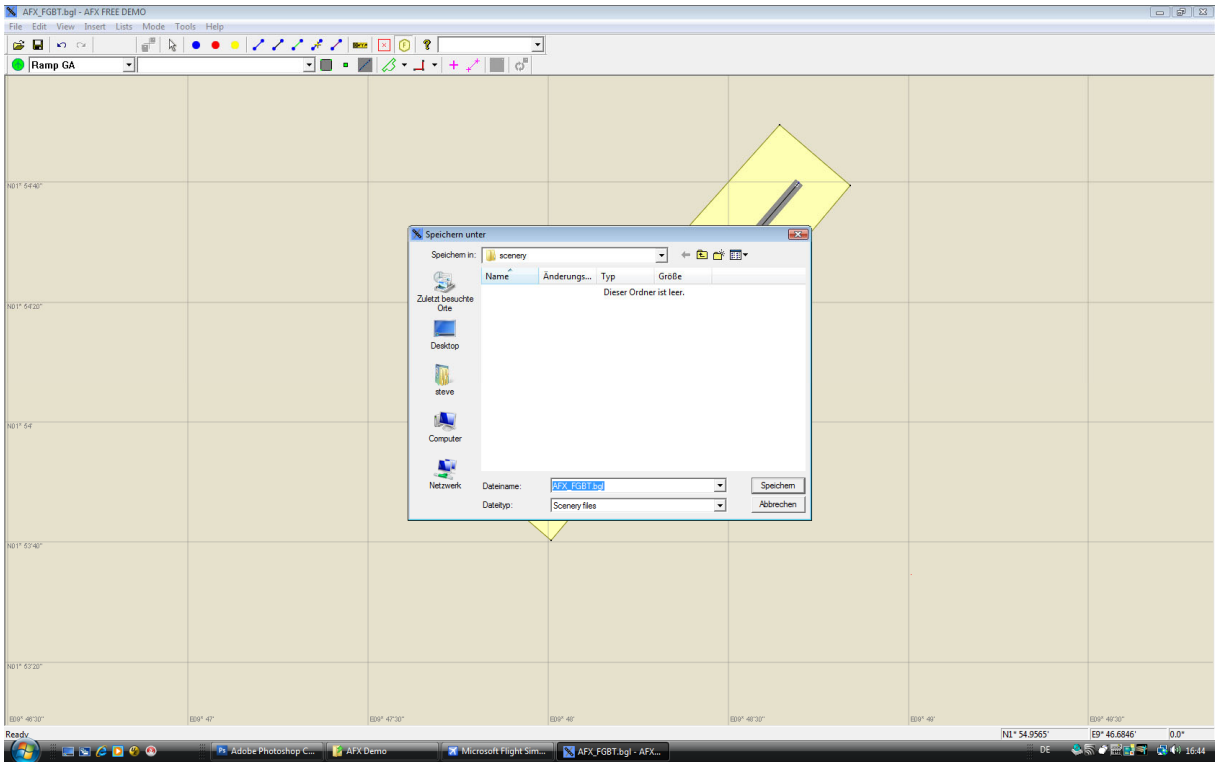
Now we need to redraw the airport polygon(s), since these can not be amended by AFX. Therefore we have to create a new one (or more than one), which overwrites the existing within FS. Click the icon „Create Flatten Polys“.



Now you can draw this polygon. You should draw it a bit larger and in the same shape as the existing “wrong” one. For help you can connect AFX and FSX and see what you draw in a preview mode within FS. Please check the AFX manual for help on this.



Now you just have to save your work. The correct folder is already preselected. If you wish to remove the amendments one day, you find the airportfile in the folder \FSX\Addon Scenery\Scenery and the altitudefile in the folder \FSX\scenery\world\scenery. FSX stands for the folder your FSX was originally installed to.



If all went well, Bata looks like that now:

Goooooood!

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7. IMPORTANT INFORMATION

If you experience any problems, please FIRST read the manual THEN check our FS Global 2010 product website at SUPPORT/GERENAL. You can reach the FS Global 2010 product website via our company website www.fsim.net.

If your problem is not addressed by then, please send us a request via the contact form on the website.

Once you have removed FS Global 2010 from your system, do not forget to also remove the appropriate scenery layers in scenery library within FS

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8. DISCLAIMER

And again we want to thank Konstantin Kukushkin. He has amended his AFX in a way, so that we are able to amend airport altitude and, even more, opened his DEMO version of AFX for us and you to save these changes.

Your PILOT'S FS Global 2010 Team

October 2009

INSIDE FS GLOBAL 2010

Technical background and detailed product information

This document is work in progress!

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CONTENTS

1. INTRODUCTION

This document provides some information on how the FS Global dataset was compiled and how it works in FSX. Understanding how the scenery works helps to get most of it, because the behaviour of scenery objects can be adjusted according to user preferences.

The concept of FS Global is to make the best geographic data available for Flight Simulation and to provide a near-global coverage. Huge areas of fantastic landscape remain unexploited or far less detailed than it could be even with the newest edition of the Microsoft Flight Simulator – the FSX. FS Global allows to explore millions of square kilometers of landscape in South America, Africa and Asia, or to see the Alps in Europe in far greater detail than with the default scenery. It is a base scenery that exclusively contains elevation data, and will combine seamlessly with highly detailed local airport scenery.

FS Global 2010 is based on SRTM data in the first place. Microsoft used SRTM data for parts of the FSX default scenery as well, so why do we need FS Global? Maybe this gives a first impression: The highly compressed FS Global terrain files have a total size of about 25 GB, while the terrain files of FSX (Professional Edition) add up to 1.26 GB, barely more than a twentieth of the size. Apart from the far greater coverage FS Global aims for a better quality. While we find every error of the SRTM dataset in the FSX default scenery, enormous efforts have been made to correct these errors in FS Global. Looking at many billion elevation points for this global scenery, such work will never be complete, but there is a great improvement over earlier editions of FS Global. Additionally, the resolution has been increased and reaches 9 m now in some areas.

FS Global 2010 goes beyond SRTM and its limited coverage between about 60°N and 60°S. See appendix for coverage charts.

Here are some of the improvements:

- LOD12 (FS-Mesh- and sourcedata in 9m resolution!) for Hawaii (complete) and the southwest of the US, south of 38°N and west of 108°W (ca. Mesa Verde -> Point Reyes)
- High Quality Coverage of Northamerica (and p.Canada!): nationwide LOD11 (19m).
- Greenland, Iceland and Scandinavia in LOD 9 (76m; standard SRTM resolution)
- additional high resolution areas in Europe in LOD11 (19m): High Tatra, Scottland, Hardangervidda (Norway)
- Russia / Sibiria in LOD9.
- Antarctica in LOD8
- sophisticated new algorithm for correct views of ridges and peaks (most of them should have been higher and will now be nearer to actual value)
- new algorithm for reducing irrelevant data for higher data compression
- new algorithm for finding and correcting errors
- Airport-Patches for prominent problem areas
- a tool for the user to correct wrong airport elevations (AFX)

2. SRTM

In February 2000 NASA in cooperation with ESA and NASDA conducted a Space Shuttle flight (STS-99) to acquire the most complete high-resolution topographic database of Earth. The Orbiter Endeavour was equipped with a special interferometric radar system, consisting of two antennas: one was located in the payload bay, the other one extended on a mast 60m into space. During the 11-day mission the complete landmass between 60° north latitude and 54° south latitude was mapped.

SRTM delivered an elevation model covering almost 120 million square kilometers of terrain in a lateral resolution of 1 arc second (approx. 30m). However, for political reasons, the full resolution dataset was only released for the U.S. territory. Global coverage is available in 3 arc second resolution. The dataset as it has been released to public consists of 35,9 billion elevation points or 67 GB (uncompressed). Further information can be obtained from the SRTM websites:

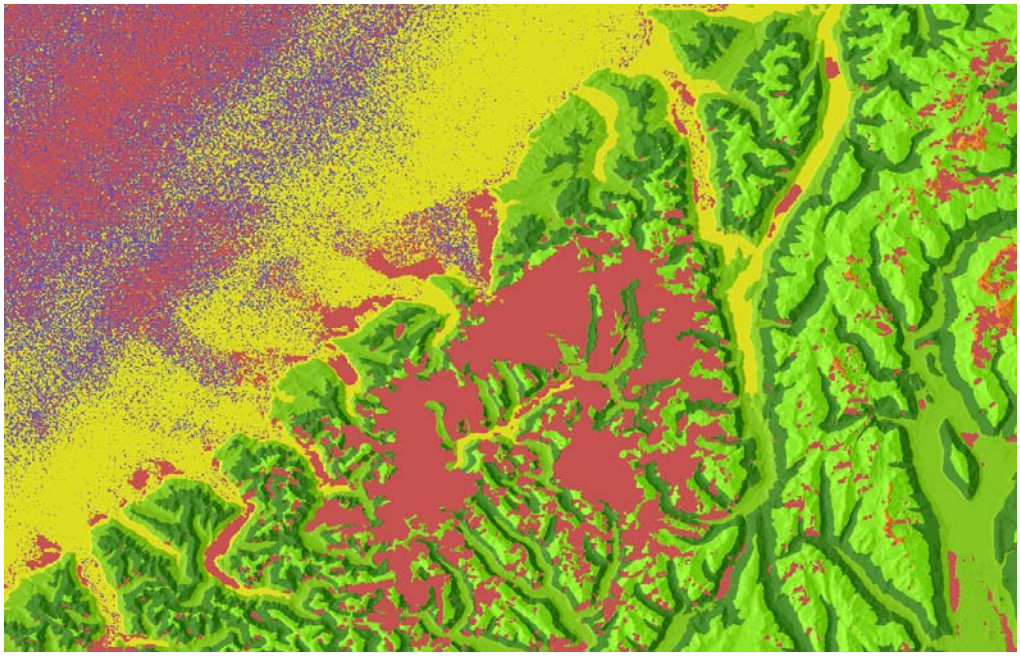
http://www2.jpl.nasa.gov/srtm/ and http://www.dlr.de/srtm/

Due to the principle of measurement SRTM data contain errors and voids, areas were no valid data are available. The reason is poor reflection of the radar signal on certain surfaces like sand or snow. Also shadowing effects play an important role: the radar often looked in a certain angle at the surface, so that the terrain behind steep slopes remained invisible for any measurement. The goal was to obtain the surface elevation of the Earth, not the elevation of tree-top or roof-top level. However, due to similar shadowing effects, in some very dense built-up areas measurements were distorted towards a higher elevation.

Although these errors affect less than 0,2% of the total landmass surveyed, they do affect the most prominent landmarks, especially mountain summits. This makes SRTM unsuitable for use in Flight Simulation without further processing.

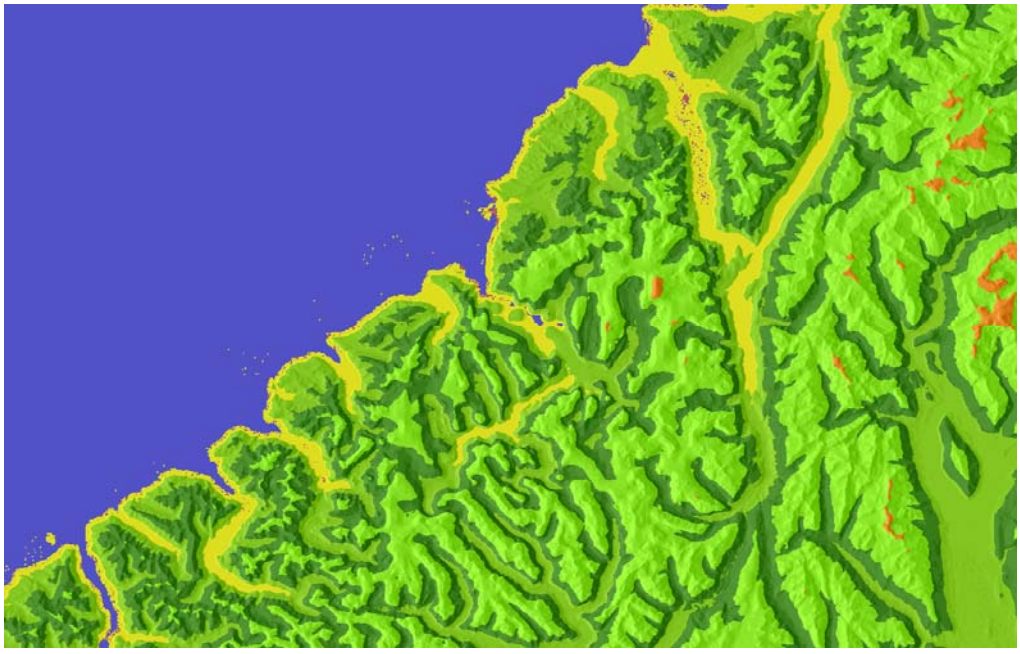
3. IMPROVING SRTM

Here is an image that shows elevation data for a part of New Zealand – voids are indicated by the red colour:



To cover small areas of data voids a simple spline interpolation can give good results. We have specialized in adapting more sophisticated algorithms for this problem using statistic and empiric approaches. By analyzing the slopes around a data void and the surrounding terrain characteristics, the algorithm can provide a good guess on how the missing data should look like. For example, the interpolation at the slopes of the table mountains in south-eastern Venezuela uses totally different parameters than in the rolling hills of the Black Forest in Germany. While reprocessing the data, we have further improved and corrected this approach by manual adjustments.

Here you can see the image of the above section after such initial reprocessing has been done:



This approach works well for certain, small areas or specific problems like shadowing of mountain slopes. But the void areas in the image above are too big already. Interpolation can not recover features that are definitely lost, like characteristic mountain summits or ridges where not even the ridge crest is available in the dataset.

So there is need for other sources. Unfortunately there is no digital dataset of global coverage available that can be compared to SRTM. In the FSX default scenery, terrain elevation in South America, Africa and most of Asia is based on the older GTOPO30 mesh. At many locations in high mountains the GTOPO30 elevation is wrong by more than 1.000 m due to combined vertical and lateral error. Using this source to amend SRTM data in void areas would rather worsen the result than improve it. For many countries local elevation meshes are available, that are even better than SRTM. They are used for military and industry applications like telecommunication, and they cost much more than a product like FS Global would generate as total sales volume. Moreover, the owner of the data usually doesn't allow any release to the public.

The only country with excellent data coverage available for free is the United States, thanks to the Freedom of Information Act. For the rest of the world, we have collected all mesh data that we were allowed to use. For very prominent Summits we've acquired local maps and generated a digital elevation mesh manually. This is the "hard way", the most time-consuming approach, but it was necessary to provide a significant improvement over the elevation data of the previous version, FS Global 2008.

There is one man who has specialized in this kind of work and who allowed us to build on his work for further improvement of FS Global: Jonathan de Ferranti. Most of our new, high-quality rendition of the Alps is based on his data, as well as Scandinavia beyond 60° N. He also provided several summits in the Andes and in the Himalaya. You may find more interesting information on his website:

http://www.viewfinderpanoramas.org/

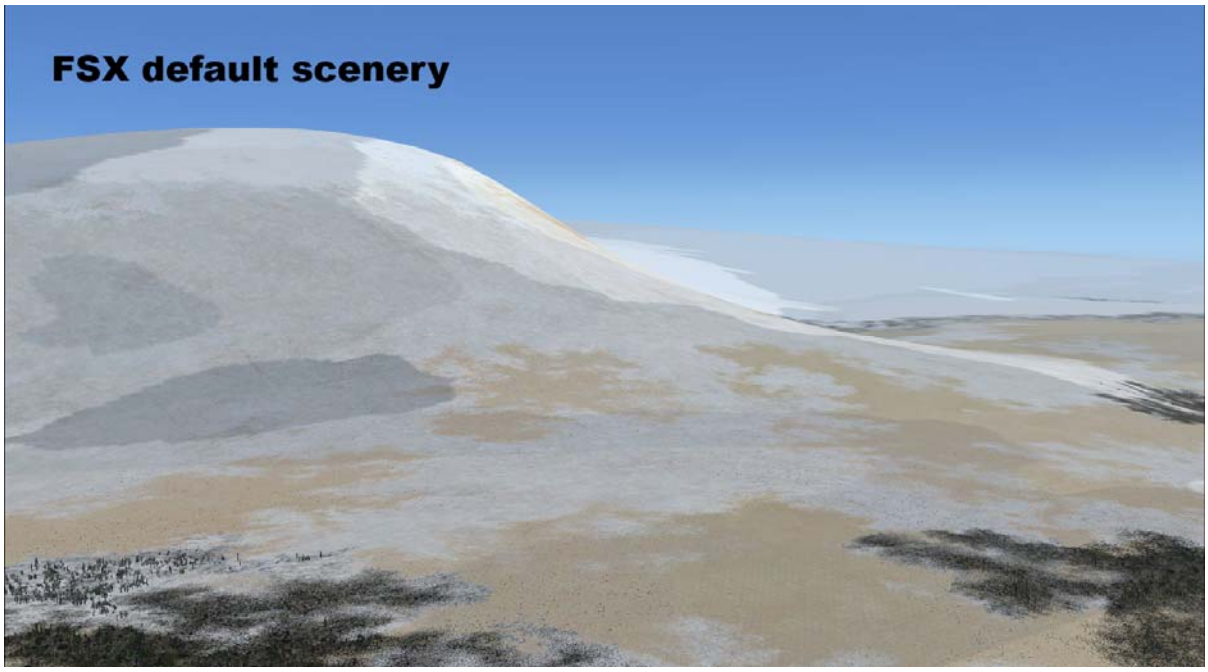
4. DATA COVERAGE IN FSX DEFAULT SCENERY

The FSX default scenery covers U.S. territory and a few very small areas in 38 m resolution (LOD10) and several developed regions in 76 m (LOD9) resolution, based on barely corrected SRTM data. A coverage map of the default scenery elevation mesh can be found in the appendix. Here is a list of the LOD10 meshes of the FSX Professional Edition – the file naming convention is explained in a separate section below:

Region	Scenery area filename (xxyy)
USA & Carribean	0101, 0102, 0201, 0202, 0301, 0302
Alaska	0000, 0001, 0100, 0101
Hawaii	0003
Samoa	0004
Puerto Rico	0303
Pazifik	1002, 1003, 1103
Rio de Janeiro	0405
Cliffs of Dover	0601
Athen	0602

Things don't look so good in Europe, although FSX offers high resolution data there as well. The probably most prominent mountain of Switzerland, 4478 m high Matterhorn, does practically not exist in FSX, only the lower third of the Hörnli ridge is visible. Even SRTM errors that are easier to catch, like spikes and holes, have been transferred to the FSX default scenery. Here is a hole in the Moselle River in Germany near Koblenz, where the highway A61 crosses the valley – "Highway to Hell":

The terrain quality outside the detailed scenery areas in Europe, North America and parts of Asia is very poor. The direct comparison with FS Global shows a dramatic difference. The following two screenshots have been taken in exactly the same position in Patagonia, the coordinates are S49° 19,68' W072° 57,80', Altitude 7105 ft, magnetic heading 296, it is a view to the Mount Fitzroy massif.


FSX default scenery


FSX with FS Global 2008

5. DATA COVERAGE IN FS GLOBAL 2010

Here are the facts:

- Global coverage generally according to SRTM availability between 54° southern latitude and 60° northern latitude in approx. 76 m resolution (LOD9). Corrected SRTM data using local meshes, manual data acquisition and contributions from Jonathan de Ferranti.
- Coverage of the European Alps in a resolution of 19 m (LOD11), adjacent areas in 38 m resolution (LOD10).
- LOD12 (FS-Mesh- and sourcedata in 9m resolution!) for Hawaii (complete) and the southwest of the US, south of 38°N and west of 108°W (ca. Mesa Verde -> Point Reyes)
- High Quality Coverage of Northamerica (and p.Canada!): nationwide LOD11 (19m).
- Greenland, Iceland and Scandinavia in LOD 9 (76m; standard SRTM resolution)
- additional high resolution areas in Europe in LOD11 (19m): High Tatra, Scottland, Hardangervidda (Norway)
- o Russia / Sibiria in LOD9.
- o Antarctica in LOD8
- Using the new “quad mesh” technology introduced with FSX, intermediate meshes for far-distance views are included with each BGL starting with LOD4. For that reason, we need two versions o FS Global 2010 to ensure it is compatible with FS2004 / FS9.

It is important to understand how elevation data of different sceneries interact. Generally, a scenery layer that stands higher in the scenery library and has a lower number under “Priority” supersedes any scenery that stands below. That is why it is important to install FS Global correctly. In some early versions of Microsoft Flight Simulator there have been special rules for elevation data, this is not the case for FSX.

There is one exception: Independent from their order in the scenery library, higher *resolution* elevation data always supersede lower resolution data.

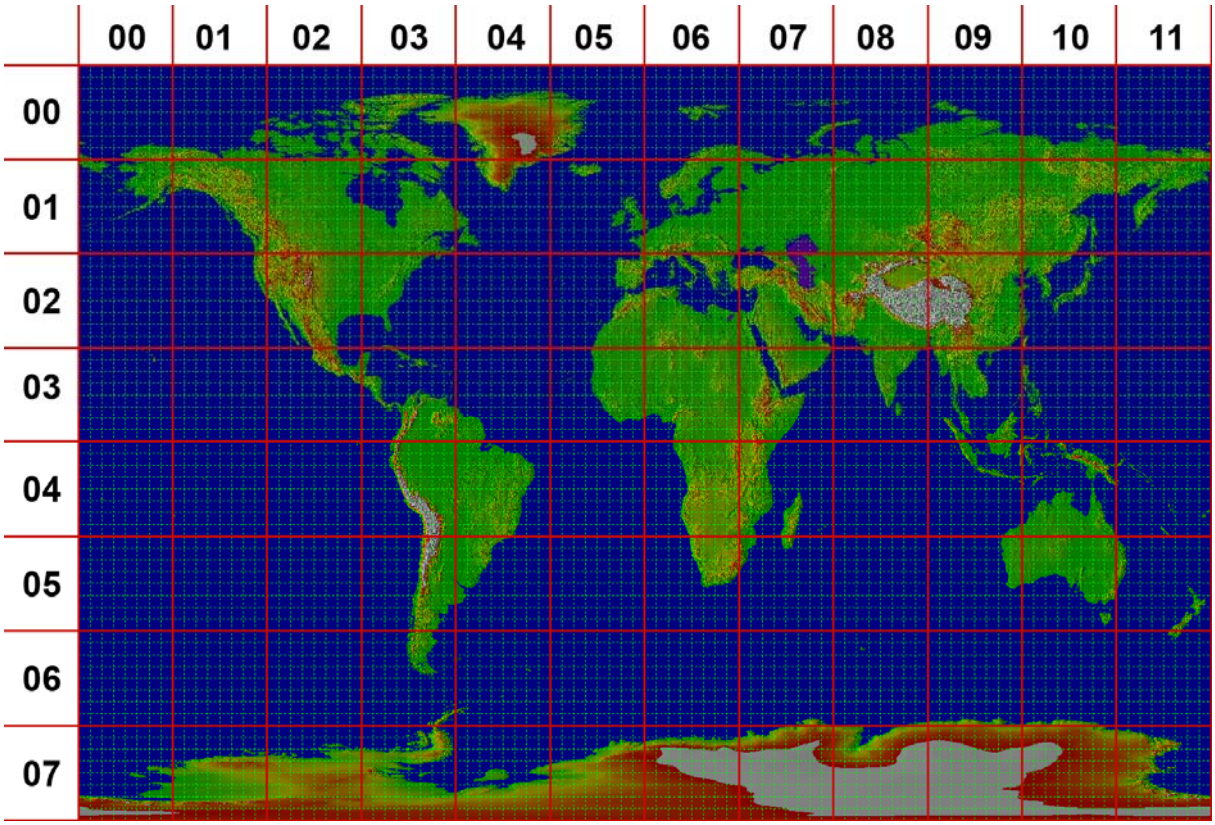
Example: In the previous section we’ve seen that the file DEM0601.BGL of the default scenery contains a small LOD10 mesh for the Dover Cliffs. FS Global installs in a higher level than the base scenery and generally overwrites the base scenery, as both sceneries offer an LOD9 resolution in Europe. Except in the area of Dover, where the LOD10 mesh of the default scenery has higher priority. So what you see in Flight Simulator is the best combination of both: the LOD10 Mesh of the default scenery at the Cliffs, and the FS Global mesh everywhere else.

This concept usually makes sense, as it protects the higher quality data. However, if you want to deactivate the default scenery completely, it is the best to rename the file {FSX main directory}\Scenery\0601\scenery\dem0601.bgl with a different file ending. Doing so will prevent FSX from loading these data, and it even reduces the loading time slightly. The Cliffs of Dover will still be present, although not quite as steep due to the lower resolution of the mesh.

6. FILENAMES IN FSX AND FS GLOBAL

6.1 Default scenery directory tiles

The FSX base scenery is strictly organized in a tiling system. The earth is divided into 12 columns of 30° of longitude and 8 rows of 22,5° of latitude each:



Directory names and filenames are derived from this system by naming the column first and the row next. The base scenery for Germany, for example, is completely contained in the Folder “0601 Base”. And there we find a file named “DEM0601.BGL” that contains the elevation data (DEM for Digital Elevation Model). So the complete elevation data of FSX are distributed over 96 files named DEMxxyy.BGL.

6.2 Scenery data files and FS Global

There also is a second file naming system: you see the finer green grid in the image above. Each “red” cell is segmented into 8 x 8 “green” cells. Again, they are numbered from left-top to right-bottom, running from “0000” to “9563”. This file naming system is used by other scenery data (e.g. APXxxyy0.BGL) as well as FS Global. Except that FS Global uses three digits for each number, resulting in filenames like DX0xx0yy.BGL. The additional “0” doesn’t really make sense here, but was introduced by the original Microsoft SDK tools that we used for compilation.

Of course it would have been easier for us, and for the user as well, to use another file naming system than the one explained above. But certain concepts, especially the inclusion of lower resolution intermediate meshes made it necessary to adhere to the FSX conventions and internal boundaries. And it’s not too difficult to calculate the coverage area when you see the filename, here are the formulas:

Longitude coverage:	-180 + 3.75 * x	to	-180 + 3.75 * (x+1)
Latitude coverage:	90 – 2.8125 * (y+1)	to	90 – 2.8125 * y

X and Y the indices as described above, referring to the filename scheme DX0xx0yy.BGL. And vice versa – to calculate the file that covers a certain point that is defined by (Latitude, Longitude):

XX: truncate ((Longitude + 180°) / 3.75)
YY: truncate ((90 – Latitude) / 2.8125)

Example:

The Matterhorn summit is at E007° 39.5' (= 7.65833°), N45° 58.6' (= 45.97667°). Inserting these values to our formula leads to:

XX = truncate ((7.65833+180) / 3.75) = truncate (50.04) = 50
YY = truncate ((90-45.97667) / 2.8125) = truncate (15.65) = 15

So the Matterhorn summit is contained in the FS Global file DX050015.BGL.

Just take care that western longitudes and southern latitudes are represented by negative values for longitude respective latitude. The FS Global files are distributed in directories covering one continent or area each. Here are the directory names:

Local Meshes	Meshes for local adaptation of SRTM and airport terrain
AFR	Africa
ASI	Asia
CSA	Central and South America
EUR	Europe
OCE	Oceania

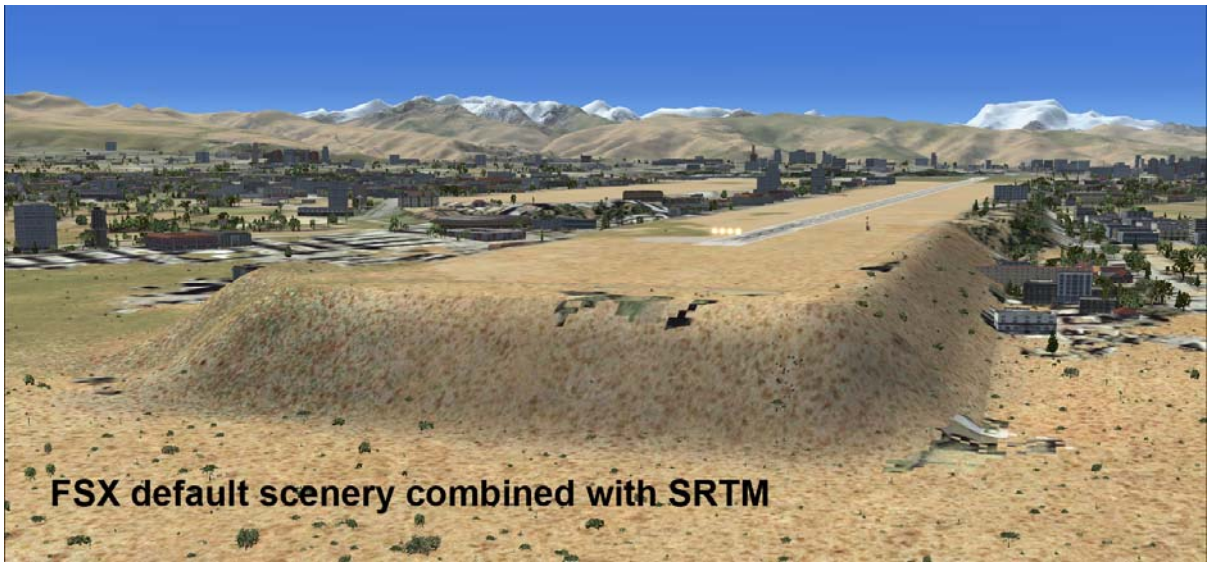
Please refer to the appendix to see where the boundaries for these areas are.

7. FS GLOBAL AND AIRPORTS: INTRODUCING LOCAL MESHES

FS Global changes the elevation of the Flight Simulator terrain, and nothing else. For that reason there are very few compatibility problems with other add-ons or the default scenery. There are however problems, when scenery objects introduce their own elevation data and that value differs too much from SRTM data. In flat and clear areas where airports usually can be found, the reliability of SRTM data is very high and their vertical accuracy is mostly within 2 m. In all cases where we have analyzed conflicts, the SRTM data were correct.

One typical reason for a conflict lies in a very old concept that is used in scenery design for Flight Simulator. FSX airports usually have to be totally flat at one unique elevation. The surrounding terrain is forced to that elevation and flattened. Now Microsoft, as well as developers of add-on scenery, uses the official aerodrome elevation to build the airport upon. Unfortunately that aerodrome elevation *always* represents the highest of all runway thresholds; it is an extreme value, *not* an average value or the elevation of the airport reference point.

And real world airports are everything but flat, even rather large and popular airports have a significant slope. In Madrid, for example, threshold elevations differ by 123 feet, in Cairo it's a difference of 192 feet – almost the height of a regular CAT I minimum. What happens when the misplaced airport enforces such a wrong elevation can be seen here:



This is the western end of the airport of La Paz, Bolivia. The runway 10 threshold has a real world elevation of 13.112 ft, Microsoft places it at 13.313 ft – that is an error of 201 ft. The higher elevation is true for the other end, runway 28, and the real world airport has a significant slope. The slope can be seen in the SRTM data, which are very precise and deliver the correct picture. So the runway *should* be at the level of the surrounding terrain. The problem is not so obvious with the elevation mesh of the default scenery, because due to its coarse resolution, it adapts smoother to the airport elevation.

So the problem is that the airport enforces a wrong elevation. We cannot solve the problem, as it is impossible for a project like FS Global to redesign so many airports, but we can improve the looks. We just added a little file to FS Global named SLLP.BGL (SLLP is the ICAO code for La Paz) which adapts the terrain to the wrong airport elevation in a smooth way. It is not correct, but it looks better:

This file is installed in the scenery area “local meshes”, which is registered in the scenery library with a higher priority than FS Global and therefore supersedes the default FS Global terrain. Placing this local mesh in a separate file allows us to provide the correct elevation data with the default FS Global mesh. So if ever add-on scenery with a correctly sloped runway becomes available, it will fit perfectly into FS Global after just removing the local mesh file.

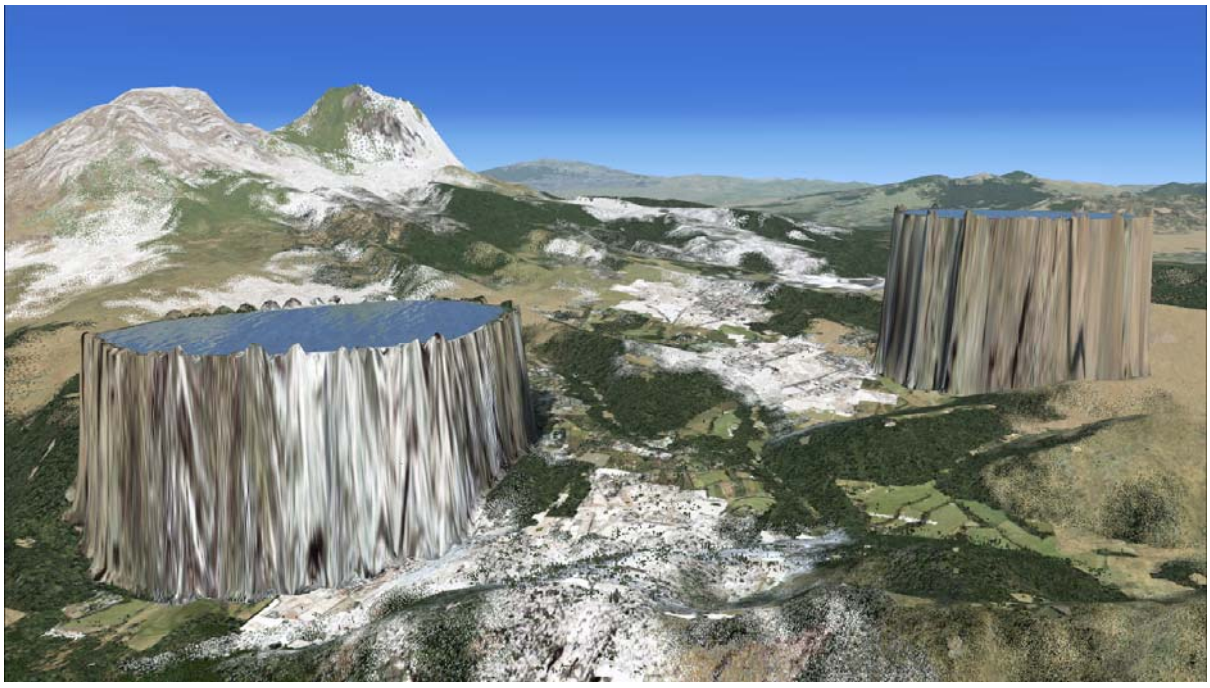
FS Global is developed by people who have a regular job and just spend their spare time with Flight Simulation. It exceeds our capacity to provide such a local mesh for every airport or add-on scenery in the world. So if you are a developer and intend to place an airport at a locally wrong elevation, we ask you to provide such a local mesh.

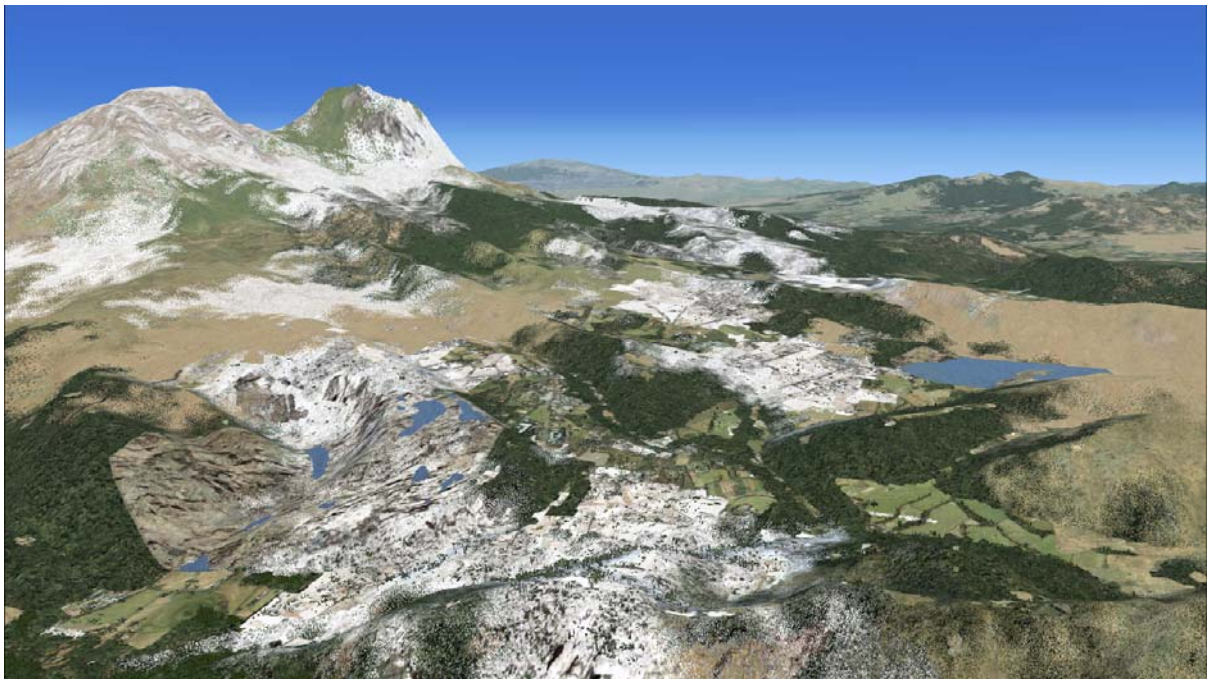
Finally, here is another famous airport, as seen when combining with high-resolution terrain data. It is the island of Madeira in the Atlantic Ocean. Microsoft has placed the aerodrome at an elevation of 711 ft, while the real world elevation is 147 ft for runway 05, and 192 ft for runway 23. That is an elevation error of more than 500 ft. Not the only one, but probably the most prominent one. We are asking you to understand that it makes no sense to adopt any precise elevation mesh to such nonsense data.

8. FS GLOBAL AND VECTOR DATA

It's not only the airports that enforce their own elevation. Every water body, road or railroad in FSX is carrying its own elevation data, which was simply derived from the default scenery elevation mesh and therefore is consistent with the default scenery. This kind of scenery data is called vector data, because it is defined by discrete coordinates (vectors) and not by a grid as a bitmap or mesh.

Here are two images from the north slopes of the huge Cayambe volcano in northern Ecuador. The first image shows the potential conflict, the second how it is solved with FS Global.



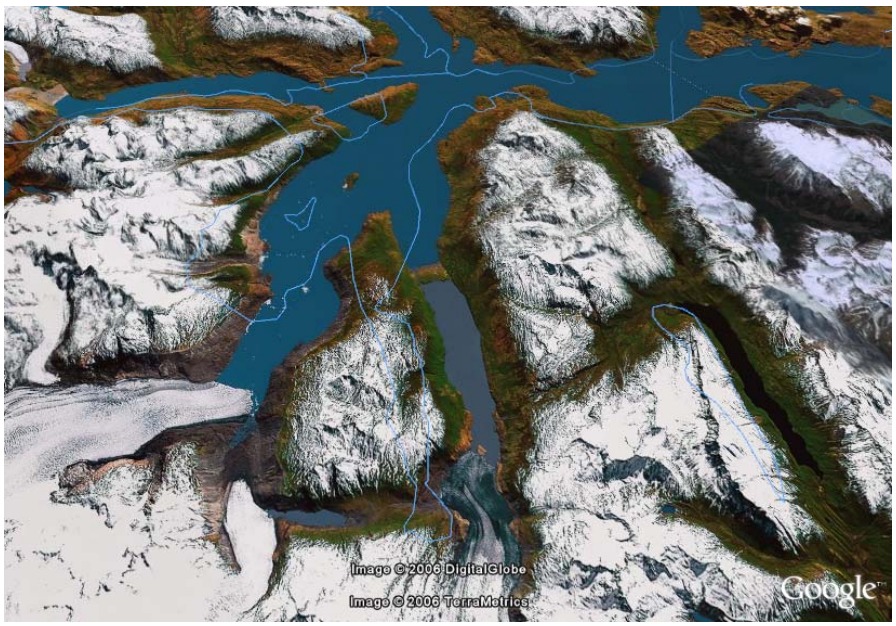


The large pools in the first image are defined in the FSX default scenery. Based on very bad GTOPO30 data they have been placed at an elevation that is more than 1000 m to high. To understand the conflict, we can use Google Earth as a tool, because it is capable to display precisely georeferenced satellite images overlayed with the same

vector data that are used in FSX default scenery. Here it is obvious that the left lake doesn't exist in the satellite imagery at all, and the right one is misplaced:

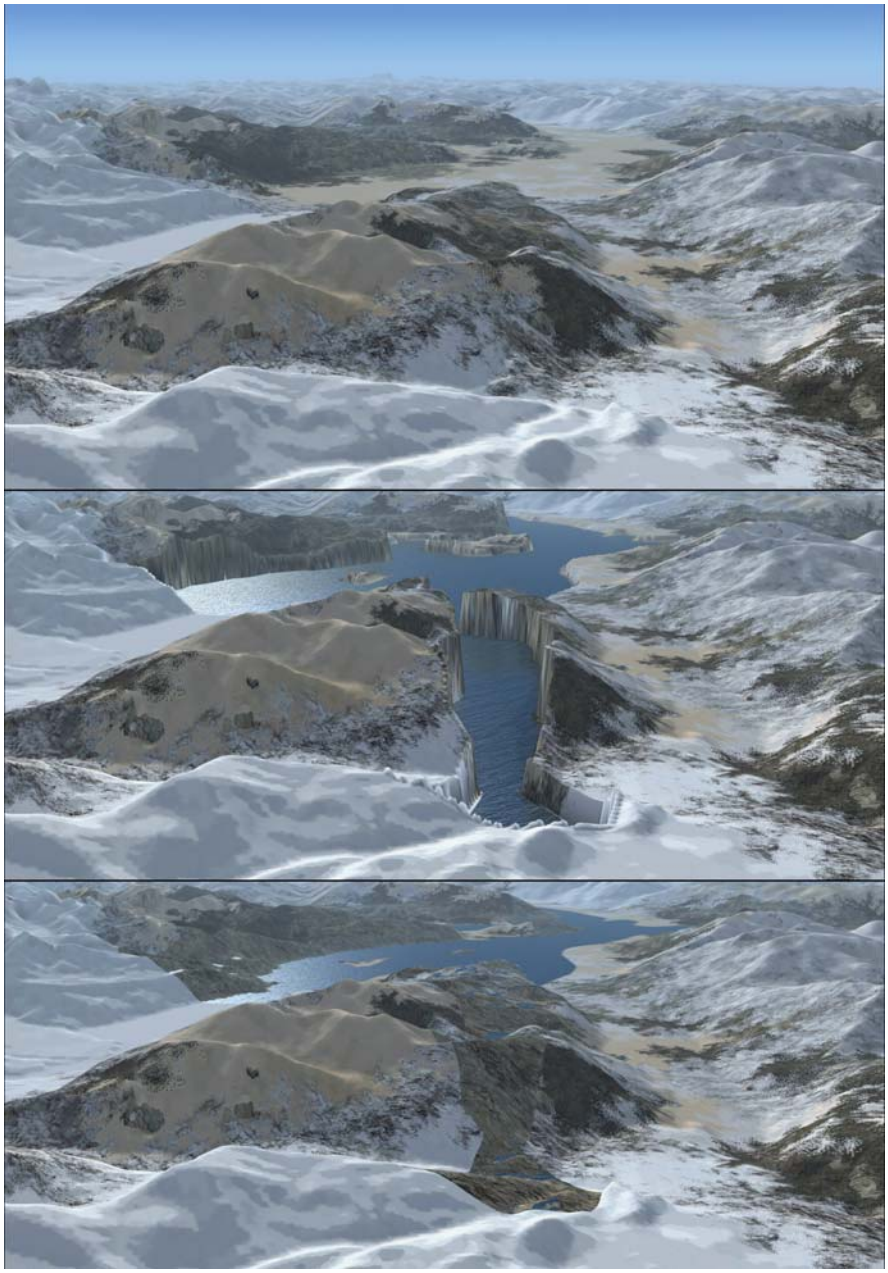
In Google Earth the lakes don't have any elevation information, they are just drawn onto the surface provided by the elevation mesh. FSX can be configured to do it the same way, as the second image above shows. There is a function in the graphic engine, that automatically replaces the water texture with a rock texture whenever the slope exceeds a certain steepness. This makes sense when combined with a good elevation mesh, as only those places where the presence of water is likely are displaced as water.

Here is another example that shows the conflict between an inaccurate shoreline and precise terrain/satellite data. First the Google Earth image, it's Lago Chico in southern Chile:



The southern arm of the lake is misplaced to the southwest by more than two miles. The same can be observed with Flight Simulator. Of the following three images, the

first one shows the naked elevation data of FS Global with the vector scenery deactivated. The second one shows the combination with default vector scenery without further adjustments and the third image shows FS Global with the terrain flattening function deactivated for certain scenery objects.

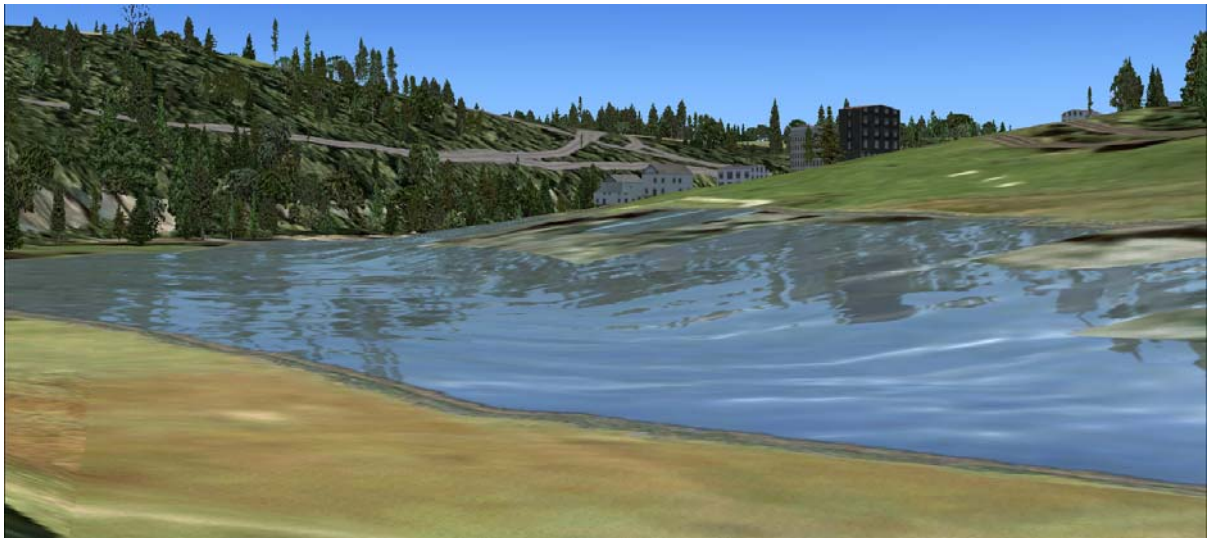


Due to the lack of better data sources we have to live with the default vector scenery for now. After a lot of testing we think that the solution demonstrated above is currently the best way to combine FS Global with the default vector scenery.

We provided a tool named FSG_No_Flatten.exe that configures your FSX easily as shown above, or to return it to its original state. Details about how it is working come with the next section.

9. TERRAIN.CFG

The FS Global 2010 installation routine recommends to deactivate the flatten function of several scenery objects. It is the default setting to do this, but it is optional and it may have disadvantages, like water texture on uneven surfaces:



After a lot of testing, we found that the negative side effect of not having even water bodies is usually barely noticeable from any reasonably flying altitude. Also, the default scenery contains a lot of water bodies that are not flat due to erroneous elevation information in them. Overall, there are much more advantages than disadvantages. However, if you find that the default settings suit your preferred places in the Flight Simulator world better, you can easily return to the defaults or change the settings manually.

The configuration tool FSG_No_Flatten.exe edits the file TERRAIN.CFG that can be found in the FSX default directory. This file must be dealt carefully with and it is to be expected that many scenery add-ons will make changes to that file without appropriate notification to the user.

The TERRAIN.CFG defines the settings for several hundred generic scenery objects like water bodies, roads or airport polygons. Each section begins with an entry [Texture.NNN], where NNN is a number. FSG_No_Flatten.exe looks up a couple of sections and exclusively changes the “FlattenMode” setting to “none” – or back to the default value.

Here are the settings in the TERRAIN.CFG that are changed by default:

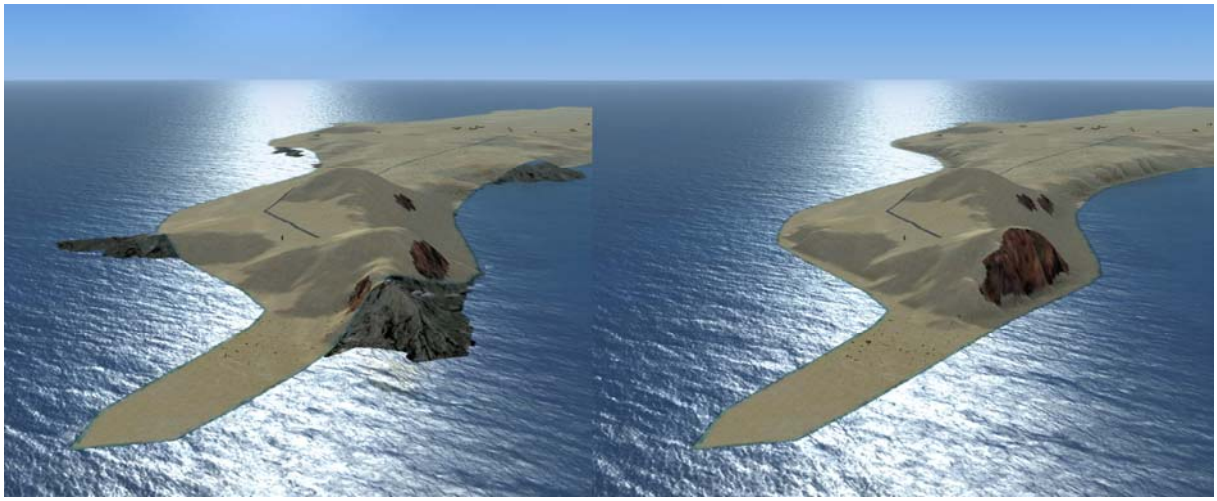
Texture-number [Texture.###]	**Object type**	**Default FlattenMode (old)**	**FlattenMode for FS Global (new)**
0, 1	Water bodies	FlattenMode=offset	FlattenMode=none
116 – 163 (48 x)	Roads	FlattenMode=flat	FlattenMode=none
195	Bay, Harbor	FlattenMode=slope	FlattenMode=none
196, 197, 198	Water bodies	FlattenMode=slope	FlattenMode=none
200	Railroads	FlattenMode=flat	FlattenMode=none

Unfortunately, it is not sufficient only to change the flatten mode for water bodies. When you go back to the section “DATA COVERAGE IN FSX DEFAULT SCENERY” in this document, you will find a picture with a “hole” in the Moselle River. The wrong

elevation of the hole is coded in the elevation mesh (that is fixed by installing FS Global), but also in the river polygon, the highway, three roads and the railroad. So the flatten function for all these object types has to be deactivated to fix the hole.

We did not dare to change the flatten mode setting for “default ocean” ([TEXTURE.194] and [TEXTURE.199]) objects, because we expected possible interference with other scenery. You might want to try changing this manually. Here is an example that shows Cape of Good Hope near Cape Town, South Africa. The default scenery coastline is very inaccurate at this prominent location. The left image shows the FS Global elevation data combined with the default coastline and the flatten mode for all water bodies switched off. You can imagine real shape of the Cape and see that the long arm of the coastline doesn’t belong there.

The right image shows what you currently get with FS Global and the default setting. The (truly) southernmost point of the Cape is clipped of by the inaccurate shoreline, and the terrain flattened to sea level.



Of course, the best solution will always be to acquire more accurate coastlines. We are working on future solutions, but cannot offer a solution on a global scale as quickly as a small local scenery can. Quite shortly after release of FSX we already found detailed coastline add-ons on the internet. In such areas with good vector data coverage the flattening problem becomes partly obsolete.

Also on the internet we found a modified version of the TERRAIN.CFG file by Richard Ludowise and Luis Féliz-Tirado (fsx_modified_terrain_cfg.zip on www.avsim.com). This file turns off the function that displays rock instead of water on greater slopes. However, that problem becomes obsolete when you turn off the flatten mode as described above, and have an underlying mesh that provides a rather even surface. FS Global offers a great improvement in that field, the demonstrated problem with the River Thames in London is not existent anymore with FS Global!

So we do not recommend using that file, but if are annoyed by too much rock instead of water in the area where you prefer to fly, you may do so. Just remember: By simply **overwriting the TERRAIN.CFG** with another version you **will delete all settings** that FS Global and other add-ons might have applied to that file. To recover the settings for FS Global, you just need to execute the configuration tool “FSG_No_Flatten.exe” once again. Same applies if another add-on has overwritten the TERRAIN.CFG after installation of FS Global.

10. ACKNOWLEDGEMENT

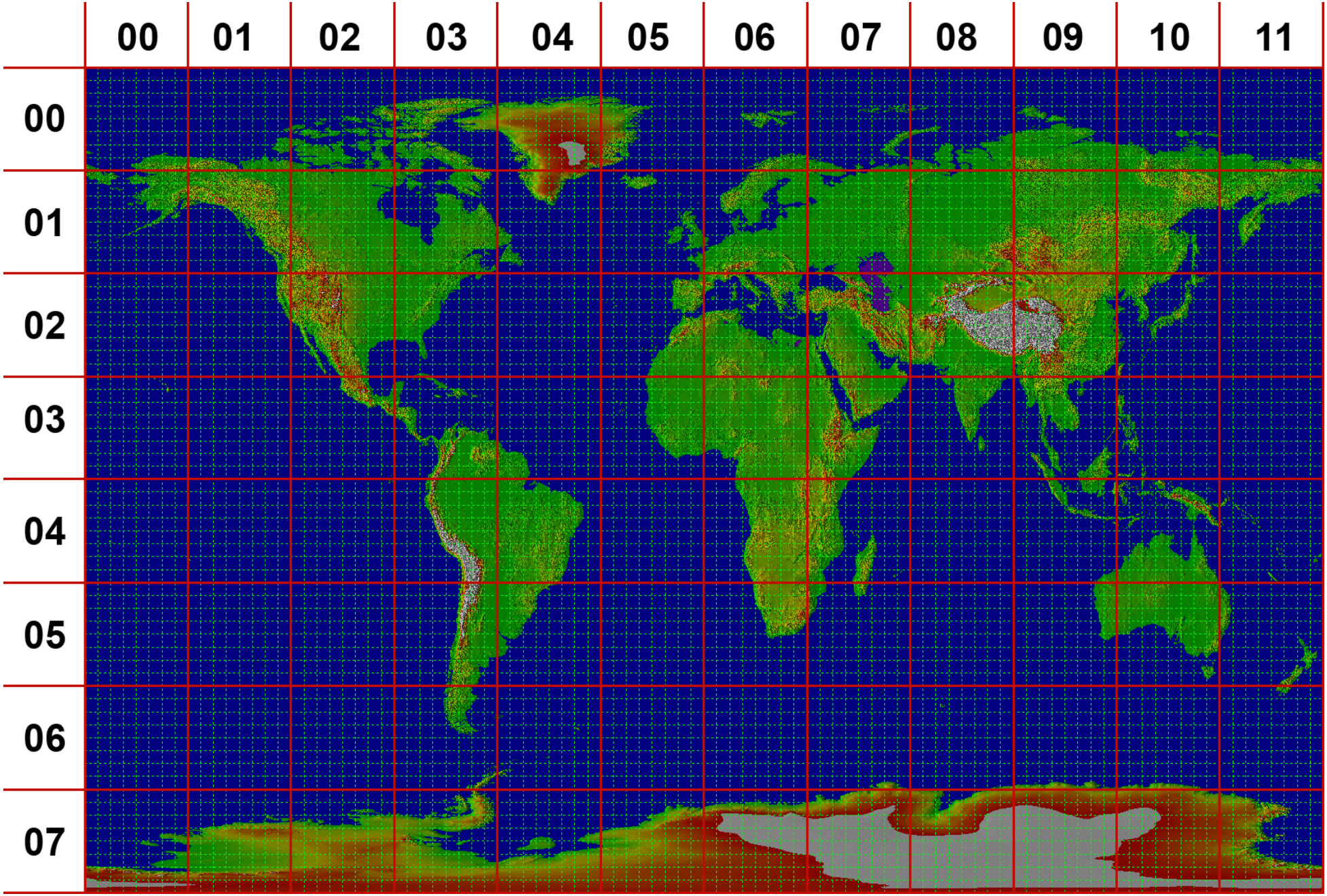
Special thanks to

- **Jonathan de Ferranti**
- **NASA and USGS for SRTM**

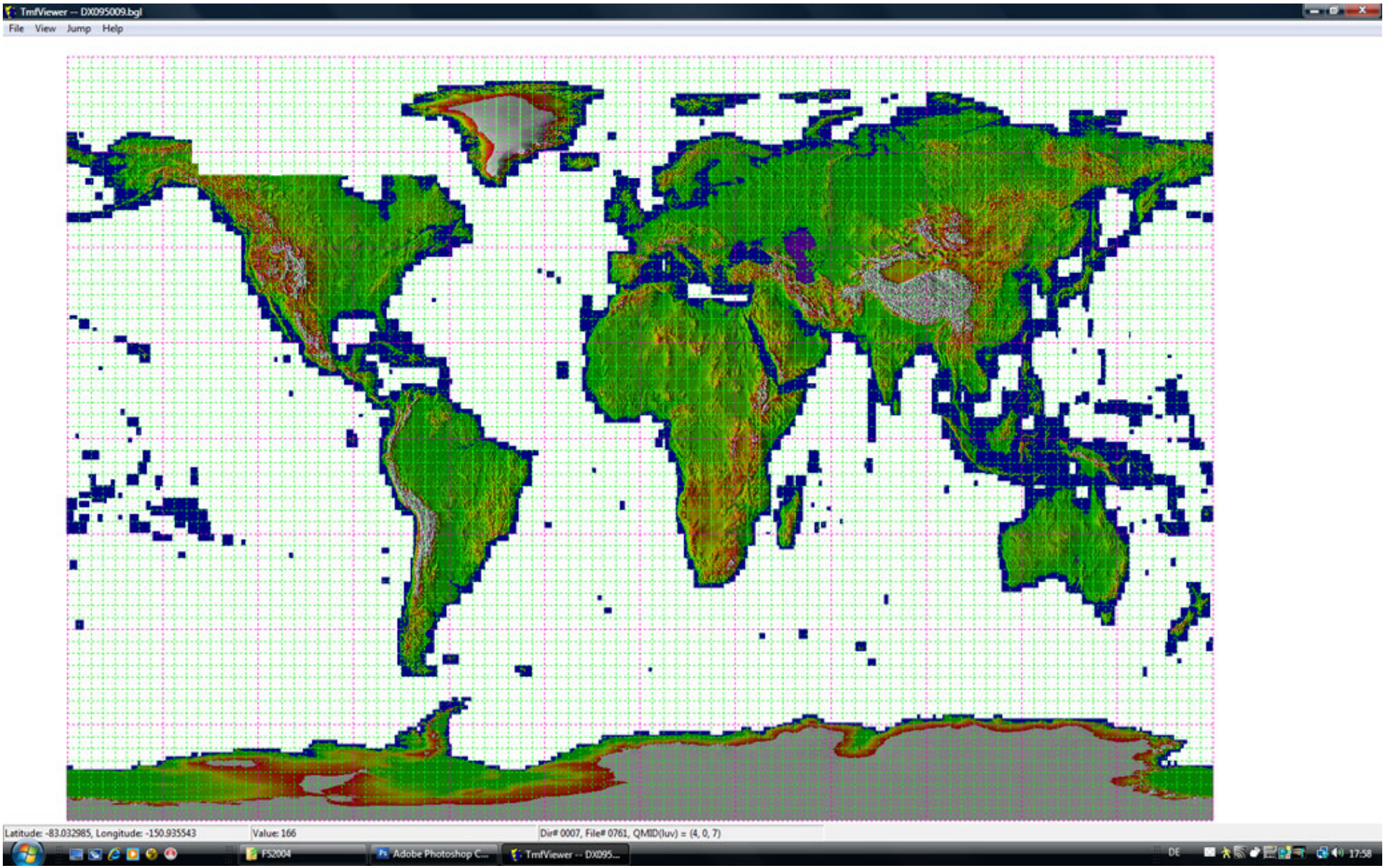
11. APPENDIX

The following pages display the coverage of FSX and FS Global data.

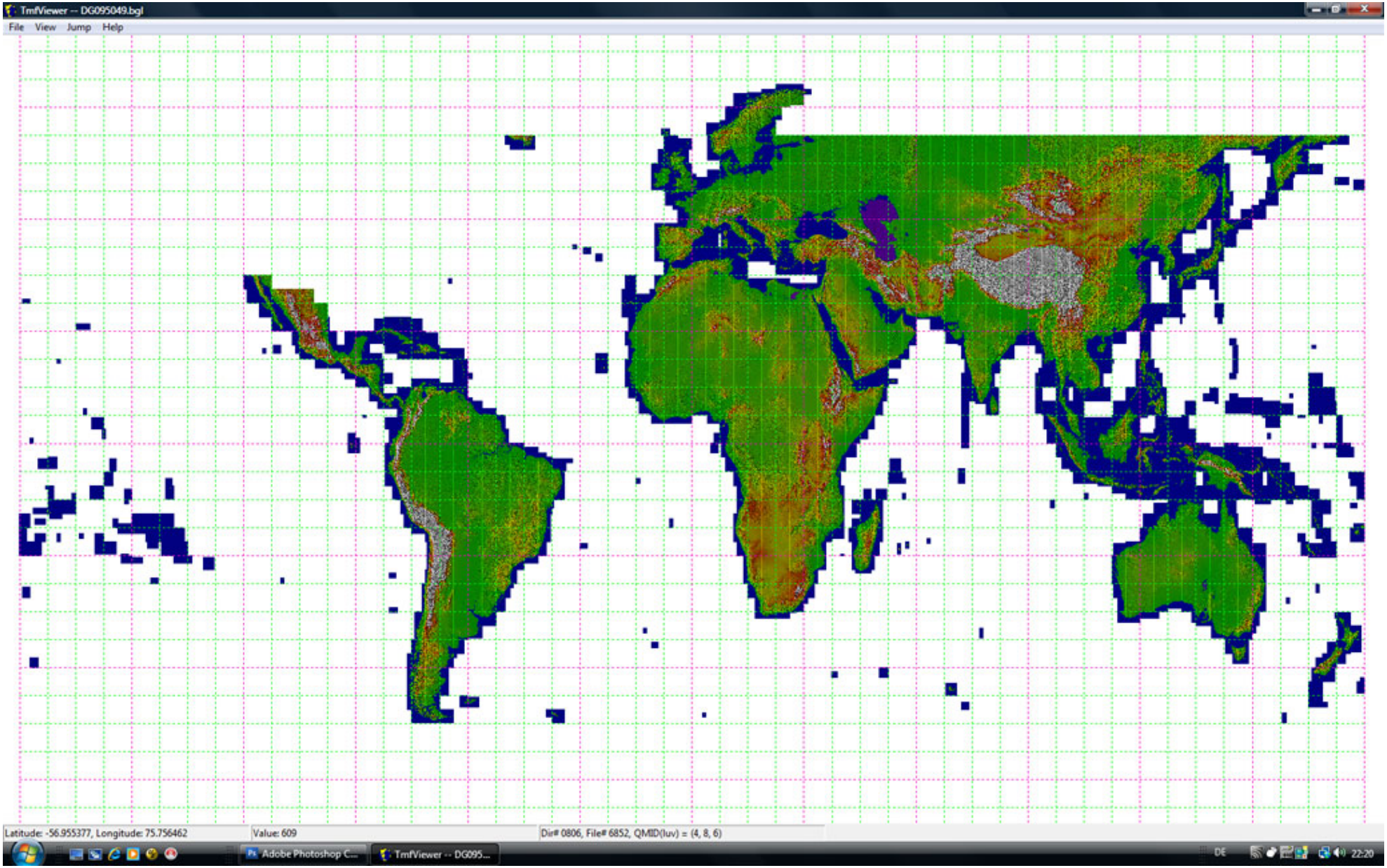
Base Scenery Areas in FSX



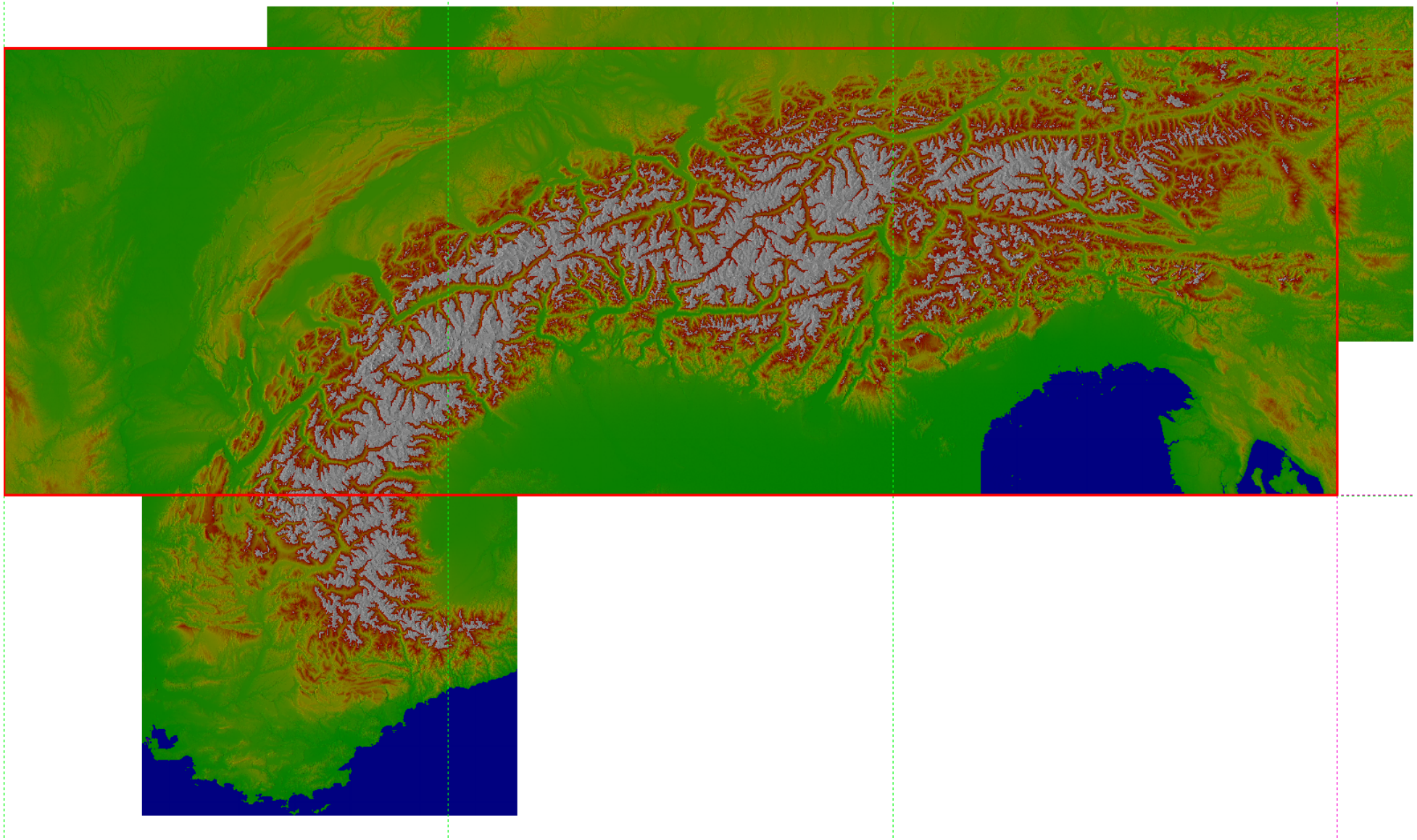
NEW FS Global 2010 Coverage (LOD 9, 10, 11, 12)



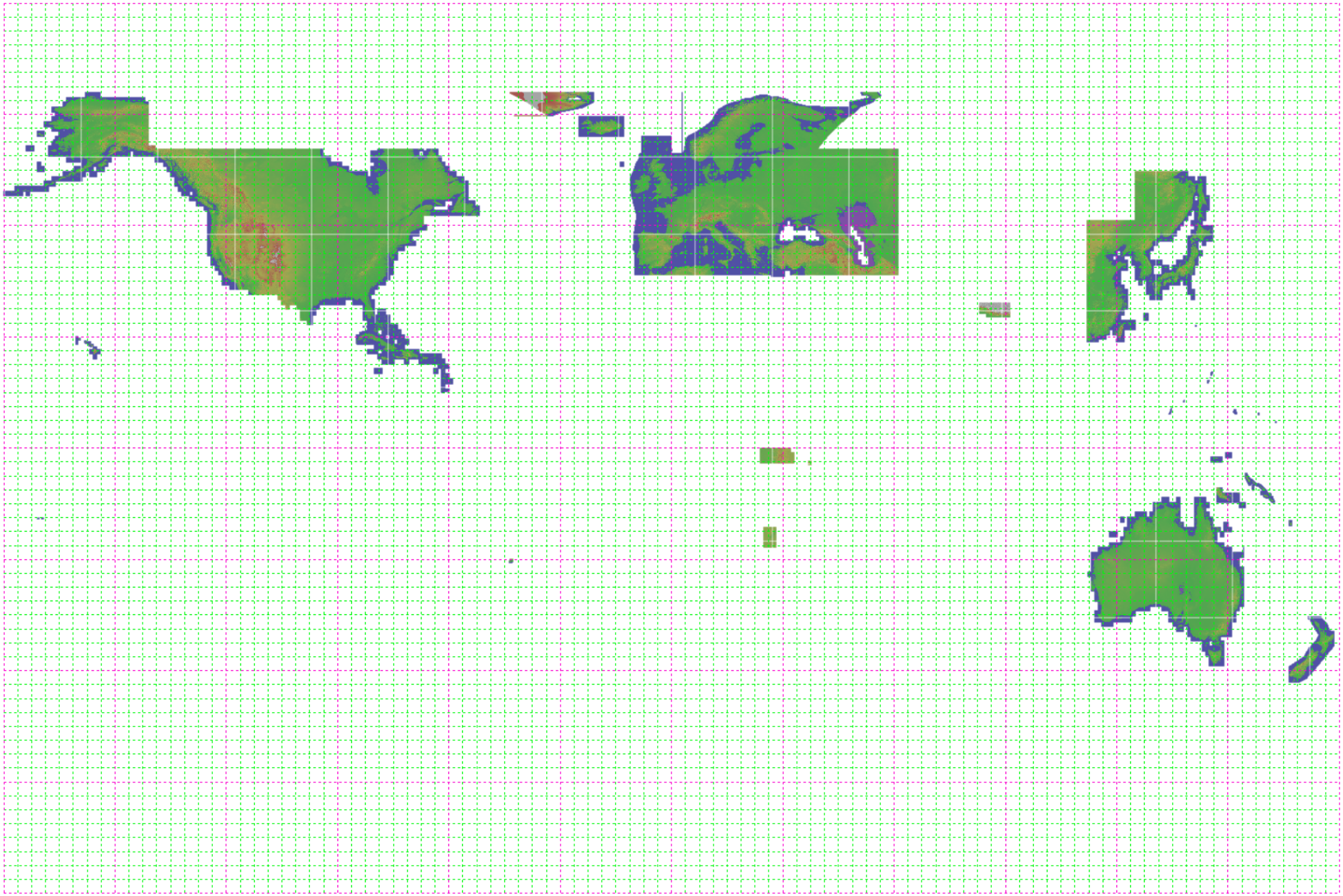
OLD FS Global 2008 Coverage (LOD 9, 10, 11) (USA disabled! See text above)



FS GLOBAL ALPS: LOD 10 (all visible) AND LOD 11 (red rectangle)



FSX Deluxe Edition: default scenery coverage in LOD 9



FSX Deluxe Edition: default scenery coverage in LOD 10