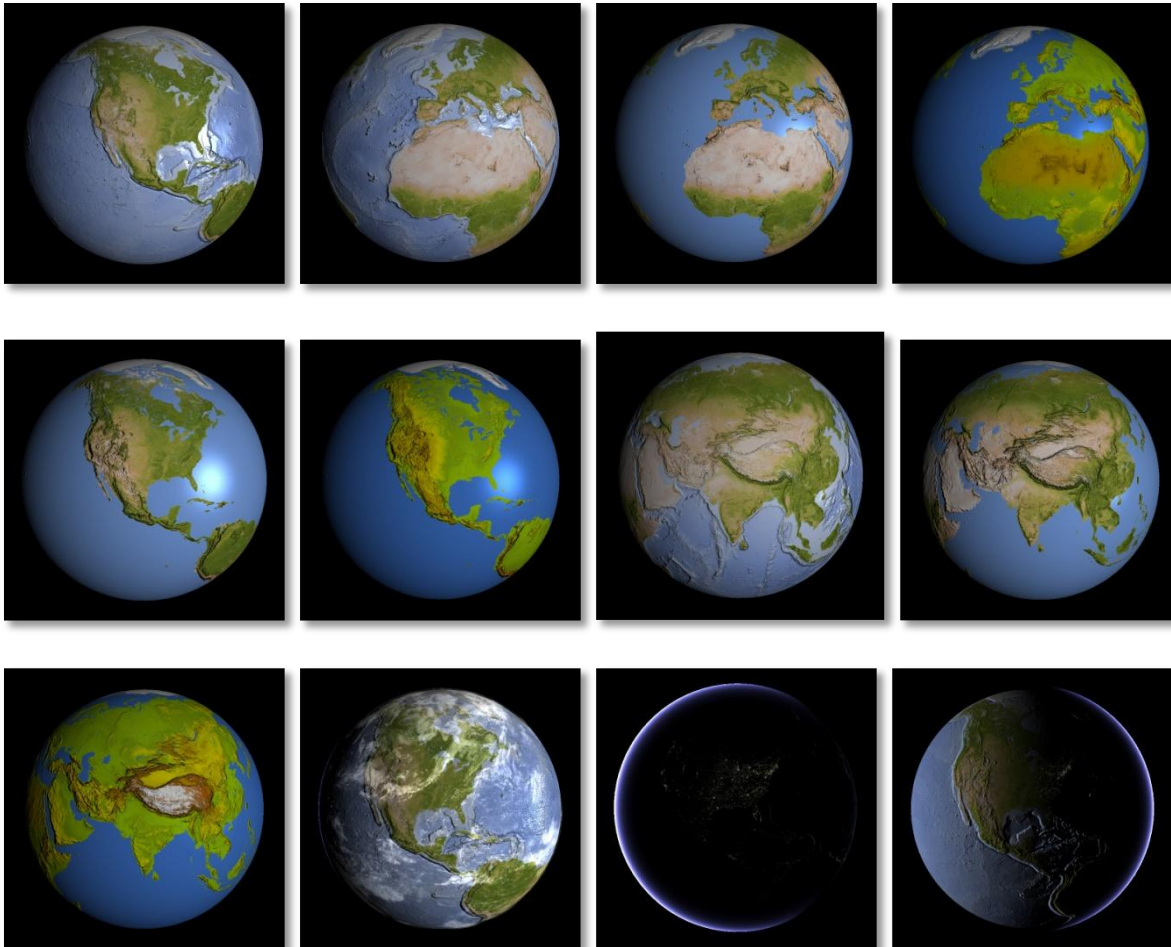


UltimaEarth for Unity 3D

General description

UltimaEarth includes three different representations of the Earth:

1. Natural colors with land and sea floor relief
2. Natural colors using bright tints with land relief and plain ocean
3. Colors according to terrain height (so-called hypsometric tints) with land relief and plain ocean



Up to 243 cities can be displayed with their placement on the globe and their name.



All versions can be combined with polar ice around the north pole, with land or sea floor relief, and with different cloud textures and atmospheric glow.

The night side of the earth can show illuminated city lights.

There are numerous parameters that let you change the appearance.

The Models

There are three 3D models included:

- Earth-Sphere.obj
- Earth-Clouds
- Earth-Atmosphere

They are simple smooth sphere models with 9024 tris and 4751 vertices each. The earth is treated as an ideal sphere (instead of an ellipsoid). The radius of the earth sphere is 6.37 (approximately corresponding to the real earth radius of 6371 km).

Prefabs

The installation package contains 6 prefab GameObjects, one with polar ice and one without polar ice for each of the three representations.

Each prefab GameObject consists of the earth sphere and 2 spheres for clouds and atmosphere attached as child objects. The cloud and atmosphere spheres are scaled, making them a bit larger than the earth sphere.

In addition there are 2 prefabs for city markers and city labels and 6 prefabs for ui elements which are used in the demo scene.

Textures

The following textures are linked with the prefabs:

- Cities.tif City night lights
- Clouds-Dense.tif Cloud texture (fractal)
- Clouds-Dense-Bump.tif Cloud bump map
- Elevation-Land-4k.tif Height map for land areas
- Elevation-Sea-4k.tif Height map for land and sea, without polar ice
- Elevation_Sea_PolarIce.tif Height map for land and sea, with polar ice
- World-Ocean-4k.tif Color texture for Earth model 1, without polar ice
- World-Ocean-PolarIce-4k.tif Color texture for Earth model 1, with polar ice
- World-Simple-4k.tif Color texture for Earth model 2, without polar ice
- World-Simple-PolarIce-4k.tif Color texture for Earth model 2, with polar ice
- World-Hypsometric-4k.tif Color texture for Earth model 3, without polar ice
- World-Hypsometric-PolarIce-4k.tif Color texture for Earth model 3, with polar ice

The color textures contain the diffuse color in the RGB channels and the specular gloss in an alpha channel. (The specular gloss is set to 0 (black) for all land areas, such that gloss only applies to water areas.)

The height maps are converted by Unity to normal maps. You can adjust the bump strength by changing the 'bumpiness' parameter in the texture's Inspector panel.

All textures have a resolution of 4096 x 4096 pixels. This corresponds to 9.78 km per pixel at the equator. (This can give you an idea about the maximal possible detail you can expect when zooming in.)

Shaders

Included are 3 shaders:

- EarthAtmosphere.shader
- EarthClouds.shader
- EarthSurface.shader

EarthAtmosphere shader

The atmosphere shader is attached to the atmosphere sphere. It is a transparency shader and responsible for the atmospheric glow around the earth.

Parameters:

- Glow Color the color of the glow effect

- Glow Intensity the strength of the glow effect
- Glow Power the sharpness of the glow effect

EarthClouds shader

The cloud shader is attached to the cloud sphere. It is a transparency shader and renders the cloud texture.

Parameters:

- Clouds the cloud texture (b/w)
- Cloud Bumpmap the normal (bump) map for the clouds
- Cloud Intensity the strength of the clouds
- Cloud Intensity at Night strength of clouds on the night side of the earth
- Cloud Color specifies the color of the clouds

'Cloud Intensity at Night' lets you show some remaining clouds on the unlit side of the earth.

For the bump map you can simply use the cloud texture and convert it to a normal map.

EarthSurface shader

The surface shader is attached to the earth sphere. It renders the diffuse color, the specular gloss and the city lights at night.

Parameters:

- World Texture the color texture with diffuse and specular channels
- Elevation Bumpmap the normal (bump) map for land and sea floor relief
- City Lights the city lights texture
- City Light Intensity specifies the strength of city lights on the night side
- City Light Time specifies how long city lights will be shown during the night

- City Light Color specifies the color of city lights
- Ocean Shininess Power specifies the sharpness of the specular gloss
- Ocean Gloss specifies the intensity of gloss on water areas

'City Light Time' restricts city light to the unlit side of the earth. A low value shows some remaining city lights during morning and evening, a high value shows city lights only during very dark times.

City data

Geographic data for 243 cities is included. The data is obtained from the Natural Earthdata site (all data in the public domain):

<http://www.naturalearthdata.com>

The direct download link for the city data (in ESRI shapefile format) is:

<http://www.naturalearthdata.com/downloads/110m-cultural-vectors>

For a description of the data see the README file included in the download.

The data was exported to a .csv file which is located in the folder Resources/Data/populated_places_110m.csv.

In the demo scene the file is referenced in the demoscene.cs script, which is attached to the GUI Canvas.

Scripts

Included are 20 scripts, all written in C#. 10 of these are used for displaying gui elements in the demo scene. They encapsulate prefabs for the ui elements and are used in the demo scene. They do not represent a full implementation of a GUI, but can be used as a starting point for a more sophisticated GUI. The remaining scripts are:

- CloudRotation.cs
- EarthRotation.cs
- SunRotation.cs
- Earth.cs
- Sun.cs
- CityMarker.cs
- CityLabel.cs
- DemoScene.cs

CloudRotation.cs script

The script is attached to the cloud sphere. Cloud movement is achieved by animating the offset parameter of the clouds texture.

Parameters:

- cloudSpeedH speed of clouds in horizontal (east-west) direction
- cloudSpeedV speed of clouds in vertical (north-south) direction

The parameters accept positive and negative values to let clouds move forward or backwards.

EarthRotation.cs script

The script is attached to the earth sphere. It performs a simple animation of the earth rotation.

Parameters:

- earthSpeed speed of earth rotation

SunRotation.cs script

This script is used in the demo scene to animate the sun rotation.

It is attached to the sun light. It rotates the sun light around the earth (yikes, yes!) to simulate day and night cycles.

Parameters:

- sunSpeed speed of sun rotation

Earth.cs script

The script encapsulates the earth and clouds. It is used in the demo scene.

Parameters:

- rotationSpeed speed of earth rotation
- tilt tilt of earth

- cloudIntensity strength of cloud cover
- cloudSpeed speed of cloud cover movement

CityMarker.cs script

The script encapsulates a marker for a city position on the globe and the associated name label.

CityLabel.cs script

The script is attached to 2D text elements representing city labels. It places the label at its appropriate position on the screen.

DemoScene.cs script

The script is attached to the GUI Canvas and is executed automatically when the scene is run. The script loads ui elements from prefabs display a demo GUI which allows to check out the most important features of UltimaEarth.

The city display is intended as an example. A more sophisticated application will probably implement more functionality.

Supplemental Textures

The 'supplemental.zip' files contains some additional cloud textures and a layered Photoshop file with sources for the color textures, which you can use to make color adjustments or combine representations differently. See below for a description of the layers.

- Clouds-Dense-2.tif Alternate cloud texture (real-world)
- Clouds-Very-Dense.tif Alternate cloud texture (fractal render)
- Clouds-Fair.tif Alternate cloud texture (real-world)
- Clouds-Storm.tif Alternate cloud texture (real-world)
- World-Ocean-4k.psd See 'Source Textures' below

Render Settings

The demo scene uses a zero (black) ambient light in Edit -> Render Settings to make the night side of the earth very dark.

The black background is set in the Main Camera's Inspector Panel.

Performance Considerations

The project uses high resolution textures with a resolution of 4096 x 4096 pixels. To conserve memory you can resize them to 1024 x 1024 at the expense of detail. In Photoshop the option 'Bicubic sharper' is recommended for downsizing.

I set the Aniso Level for all color textures and normal maps to a higher value for better rendering quality. If performance is a consideration you can lower these values to 1.

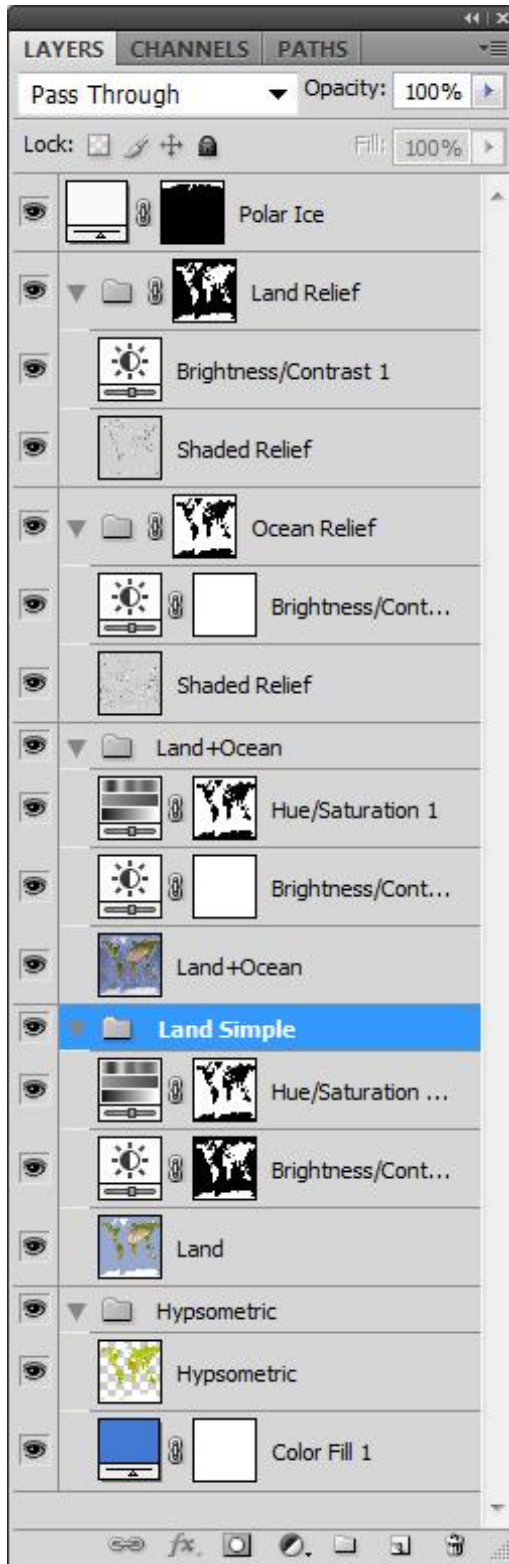
The spheres for the earth surface, the clouds and the atmosphere have a high poly count in order to look smooth. You can reduce the poly count by using Unity's built-in sphere or by omitting the atmosphere or cloud spheres altogether.

Another optimization would be to remove the bump map from the cloud shader.

Source Textures

This is a description of the layers in the supplemental Photoshop file 'World-Ocean-4k.psd'.

Here is a screenshot of the layers panel in Adobe Photoshop CS4:



Layer 'Polar Ice'

A fill layer with a layer mask for the polar ice around the North Pole. You can combine this with the other layers.

Layer Group 'Land Relief'

This group contains a grayscale shaded relief of land areas. A brightness adjustment layer allows to fine tune the relief strength. The group's blend mode is set to 'multiply'.

This relief is 'baked' into the color texture *in addition* to the real-time displacement effect from the bump shader to make the relief stand out more. You can disable this layer group if you find the relief too strong.

Layer Group 'Ocean Relief'

This group contains a grayscale shaded relief of the sea floor. A brightness adjustment layer allows to fine tune the relief strength. The group's blend mode is set to 'multiply'.

This relief is 'baked' into the color texture *in addition* to the real-time displacement effect from the bump shader to make the relief stand out more. You can disable this layer group if you find the relief too strong.

Layer Group 'Land+Ocean'

This group contains an earth texture in natural colors made from satellite images, using a proprietary color adjustment process. Ocean areas are colored according to ocean depth.

A brightness and a hue/saturation adjustment layer allow extensive color customizations.

This texture is used in the first earth representation.

Layer Group 'Land Simple'

This group contains an earth texture in natural colors made from satellite images, using a proprietary color adjustment process. Ocean areas are colored in plain blue.

A brightness and a hue/saturation adjustment layer allow extensive color customizations.

This texture is used in the second earth representation.

Layer Group 'Hypsometric'

This group contains a land texture colored according to terrain height (so-called 'hypsometric tints').

Parts of North Africa (Sahara) and the interior of Australia have been colored in more natural colors, however, because a strict hypsometric color would have shown these areas quite inappropriately in bright green.

A fill layer is used to set the ocean color for this layer group.

This texture is used in the third earth representation.

Alpha Channels

The file contains two alpha channels (accessible from the channels panel or via Select -> Load Selection).

The 'Specular' channel contains a specular mask. The land areas are set to black (no gloss), and the water areas are set to a low gloss value (which can be further adjusted in the shader, see above). This channel is copied to all the color textures in .tif format.

The 'Wet' channel contains a mask for all water areas (ocean, lakes and rivers). It can be used for customizations of the textures.

The two relief groups and the polar ice layer can be combined with any of the other color textures for different shading effects.

Acknowledgements

The real-world cloud textures are taken from

<http://www.shadedrelief.com/natural3/pages/clouds.html>

(you can find more clouds textures there)

and from NASA

<http://visibleearth.nasa.gov/view.php?id=57747>

They are in the public domain.

The city data was obtained from the Natural Earthdata site:

<http://www.naturalearthdata.com>

The data is in the public domain.

The color textures were made by me in a proprietary process from NASA satellite images.

They are copyrighted by me.

The fractal cloud textures were made by me and are copyrighted.

The elevation maps and shaded relief layers were made by me with data from the NASA Shuttle Radar Topography Mission and from NASA bathymetry data. They are copyrighted by me.

The city lights texture was made by me using data from the US National Geospatial Intelligence Agency. It is copyrighted by me.

Contact

Don't hesitate to contact me if you find any problems with the product or if you have any questions.

Email: sales@aridocean.com