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PlanetX. Manual

Русская версия

Version 0.18.0

PlanetX is a 3D globe inside QGIS. The globe opens in its own window and shows the whole Earth with terrain and atmosphere, from space down to single streets. Layers of the current project, your own placemarks, paths and polygons lie on the globe. Tours fly over the places, and a tour recording gives frames for a video.

Plugin page - www.informpp.ru.

Installation

The plugin runs in QGIS 3.36 and newer, including QGIS 4. It is tested on QGIS 3.36 with Qt 5 and on QGIS 4.0 with Qt 6. It needs a graphics card with OpenGL 3.3 and the Python module PyOpenGL. QGIS builds for Windows include PyOpenGL.

Open **Plugins** → **Manage and Install Plugins**, search for PlanetX and install it. QGIS does not need a restart.

The globe opens with the button on the PlanetX toolbar or from **Web** → **PlanetX**. The same menu holds About PlanetX. If the QGIS build has no PyOpenGL, the plugin says so and does not open the window.

Interface language

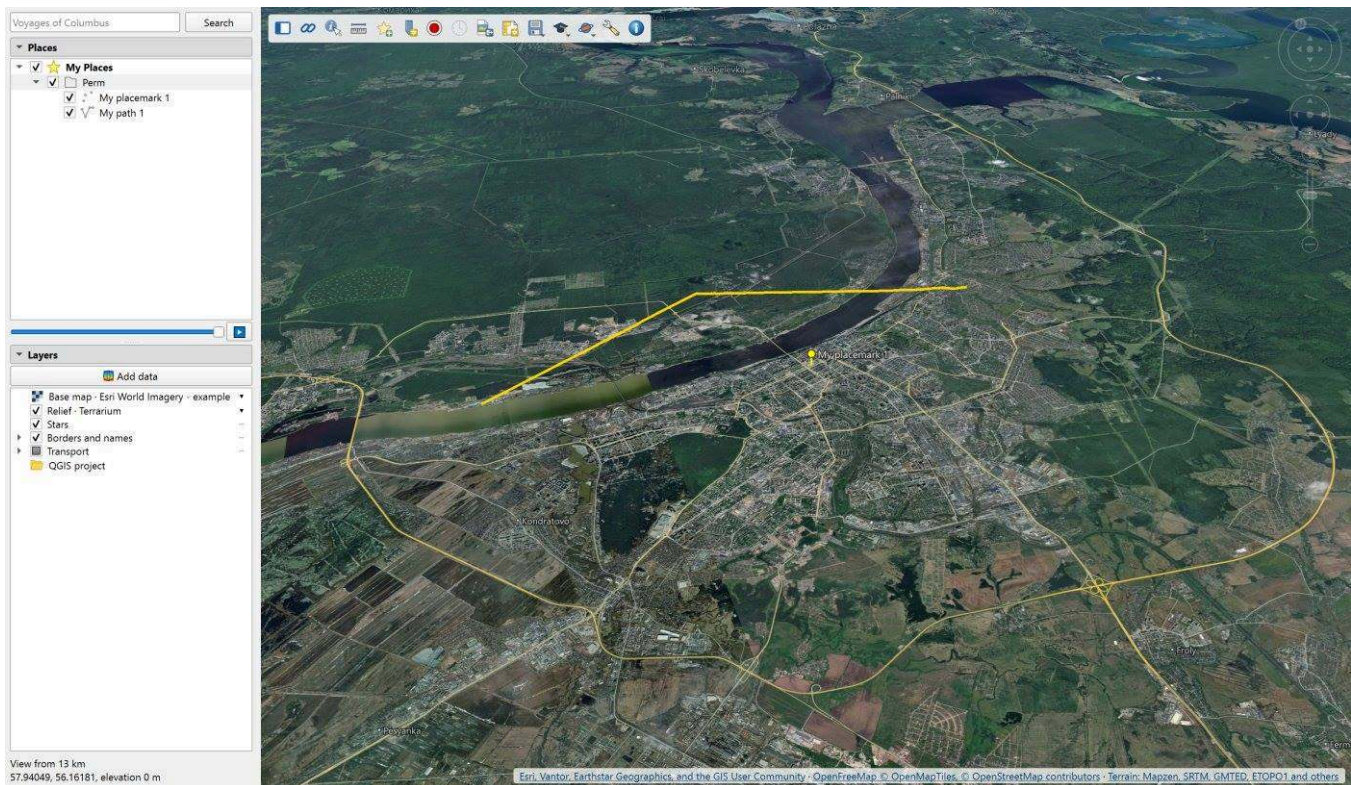
The language follows the QGIS settings, not the system. With Russian in QGIS the plugin is in Russian, with any other language it is in English. The label language on the globe is set separately, in the view properties.

The globe window

The panel is on the left, the globe view on the right. The icon bar sits in the top left corner of the view, the data source credits in the bottom right corner. The border between the panel and the view is dragged with the mouse.

The properties of a placemark, folder, image, water body bathymetry and layer extrusion open in the panel to the right of the view. The view narrows by its width, the panel width is changed with the splitter and remembered. The panel holds one properties window. A new one closes the previous one with its Cancel - changes of the previous one without OK are not saved. The × button in the panel header works as Cancel.

When the window opens for the first time in a QGIS profile, an introduction to the plugin runs - five hints over the window. They show the globe under the mouse, the Search field, the Layers section, the right-click menu and the time slider. A hint shades the window except its place, and the globe under it can be tried. The Back and Next buttons turn the hints, Close and Escape end the introduction. It is repeated from the Search field with the action Getting to know the plugin.



Icon bar

Icon	What it does
Sidebar	Hides and shows the left panel, the view takes its place
Refresh	Shows new settings and layers. The icon is visible only when automatic update is off in the View properties window. It turns orange when there is something to show
Synchronization	Links the globe with the QGIS map window
Identify features	Turns on identify by a click on the globe
Ruler	Opens the Ruler window
New placemark	Opens the New placemark window
Save view	Puts a placemark at the look-at point with height, heading and tilt
Record a flight	Records the camera movement as a tour into My Places. The ● button of the tour bar records a tour to video
Time slider	Opens and closes the time slider. The slider is shared by placemarks, tracks, project layers, events, maps and the globe clock. It is available when visible data has a time
View snapshot	Saves the view to a PNG or JPEG file
View to layout	Puts the view into a QGIS layout as a picture
Scene	The menu Save Scene... and Open Scene...
Demo	Ready scenes by body, see Demo
Body	The menu of planets, moons, asteroids and Sky, see Other bodies and Starry sky
View properties	Base map and data sources, terrain, labels, link with the map, update, coordinate format, subsurface mode, assistant
About	Controls, data sources, links

Status line

The status line sits under the left panel. It usually shows the camera height, for example "Overview from 2 000 km". The second line shows the coordinates and elevation of the point under the cursor. The coordinate format is chosen in the view properties.

The line also reports loading:

- "loading 12" - this many tiles, layer pictures and labels still wait for loading.
- "loading has stalled for 7 s" - data waits and nothing has arrived for 5 seconds or longer.
- "places are heavy, 250 thousand vertices" - your own objects exceed 200 thousand vertices, turning may become slow.
- "The base map did not load" and "The vector base did not load" - the source answered with an error.

While loading goes on, a blue icon spins to the right of the icon bar. A short load does not light it, it appears after half a second. When loading stalls, the icon turns orange. Its tooltip tells how much still waits.

Messages of search, scenes, tours and recording stay for 5 seconds.

Navigation

Navigation uses the mouse, the keys and the navigation controls.

Mouse

Action	What happens
Left button drag	The Earth follows the cursor. After release it spins on by inertia
Wheel	Zooms in and out. The point under the cursor stays in place
Left double click	Flies to the point under the cursor and zooms in 2.5 times
Right double click	Zooms out 2.5 times
Right button drag	Up - closer, down - farther, toward the press point
Right click	The menu of the point under the cursor
Middle button or left with Shift	Turn and tilt around the look-at point
Left button with Ctrl	Looks around, the eye stays in place

The camera does not go lower than 50 m above the terrain. The tilt is limited to 85°. While the ruler, drawing or identify is on, a double click stays two plain clicks and places points.

Keys

Keys work when the globe view has focus. A click on the globe gives it focus.

Key	What happens
Arrows	Move the view by a twentieth of the window width
Shift and arrows	Turn and tilt by 3°
Ctrl and arrows	Look around by 3°
PageUp, plus	Zoom in by a wheel step
PageDown, minus	Zoom out by a wheel step

Key	What happens
N	North up
U	Look straight down
R	North up and look straight down
Space	Stop inertia and flight

On-screen controls

The navigation controls stand in the top right corner of the view.



Control	What it does
Compass ring	Dragging turns the view. The letter N shows north
Letter N	A click puts north up
Stick inside the ring	While the button is held, the view looks toward the press
Lower stick	While the button is held, the view moves toward the press
Plus and minus	While the button is held, the camera zooms in or out smoothly
Slider	The thumb stands at the camera height, dragging sets a new one

The speed of the sticks grows with the distance from the middle. The controls are always shown. While the cursor is far away, they stand as a faint outline and do not cover the view. When the cursor comes near the corner of the view, they are drawn in full.

Place search

Type a place name into the Search field at the top of the panel, for example Perm, coordinates or a topic, for example "Voyages of Columbus" - this example stands grey in the empty field. Enter or the Search button starts the search. A topic without a place on the map becomes placemarks, see Places from a description.

Format	Example
Decimal degrees	58.0105, 56.2294
Degrees, minutes, seconds	58°00′37.8″ N, 56°13′45.8″ E or 58 00 37.8 N 56 13 45.8 E
UTM	40V 454464 6430139
MGRS	40V DK 54464 30138

Search also understands the coordinates copied from the status line of the globe together with the elevation.

- Coordinates start a flight at once. The camera lands no higher than 2 km from the point.
- A name goes to the Nominatim service in the label language. The camera flies to the first place found and frames it whole.
- When several places are found, they are listed under the field. A click on a row starts a flight.
- The found place carries a red pin. Clearing the field removes the pin and closes the list.

Suggestions of four kinds appear below the field while typing:

- Placemarks of My Places on the body on the screen with a matching name.
- Actions of the plugin - layers, catalogue maps, windows, icon bar tools, demos and globe bodies. The suggestion names the action and what it will do, for example "Currents - turn on" or "Ruler - open the window". An action is also found by a related word - "power lines", "power plants", "imagery", "contours", "iss".
- Earlier queries.
- Stars and constellations when the sky view is open.

A click on a suggestion or Enter on it starts a flight to the placemark or the sky object or runs the action, an earlier query is searched again. Ctrl+K from anywhere in the globe window puts the cursor into the field and shows the layers that are on and the earlier queries. The Down key moves into the list of suggestions, in an empty field it shows the earlier queries. Escape closes the list. Place names from the network are not suggested while typing. The Nominatim service takes a query only on Enter.

Enter in the field handles the query in this order:

1. Coordinates start a flight.
2. The exact name of an own placemark starts a flight to it with no network request. In the sky view the name of a star or a constellation works the same way.
3. The exact name of an action or its word runs the action. Demos do not open on Enter, "Perm" stays a place search.
4. A request in words goes to the assistant, the Assistant section describes it.
5. Anything else is searched as a place name.

Queries entered with Enter are kept in the QGIS profile, 30 at most. The Clear search history button of the Assistant group in the View properties window erases them.

Over a long distance the camera rises and lands smoothly. The mouse interrupts a flight.

Left panel

The panel has two sections - Places and Layers. A click on a header collapses the section, and the open section takes its place. The globe remembers which sections are collapsed.

Layers section

The section shows in one list what is on the globe now. Its check boxes take effect at once, without the Refresh button. The rows go like this:

Rows	What they hold
Base map	The base map - imagery or a map. A click on the row opens a menu - Esri World Imagery, OpenStreetMap, the QGIS XYZ Tiles connections and Add tile source...

Rows	What they hold
Relief	The check box turns heights and hill shading on. A click on the name opens a menu - land heights Terrarium, Copernicus DEM 30 m or GEDTM30, Sea and ocean depths and Data sources...
Layers that are on	Layers and the map of the catalogue, the coordinate grid, 3D buildings, contours - everything that is switched on
Vector base groups	Borders and names, Transport, Nature, while something in them is on
QGIS project	Layers of the current project, see QGIS project group

A row takes one line. The ... on the right of a row opens its menu, the right button opens the same menu. Clearing the check box switches the layer off, the row stays, and the same check box switches the layer on again. The Remove from the globe item of the menu removes the row too. The Opacity slider of the menu changes the opacity of the layer - points, surface colouring or lines, the value is remembered. For mineral deposits, power plants, mines, earthquakes, fires, plate boundaries, mining areas, power lines and cables the menu also saves what is in view to the QGIS project. The To QGIS project... item asks for a GeoPackage file and writes the objects inside the view frame with the record fields into it. The layer goes into the PlanetX - globe layers group at the top of the project tree. Points keep the globe colour and size, lines and outlines keep their style. Colourings go to the project too. A weather forecast field and currents go as a raster of values inside the view frame (degrees, mm/h, m/s, for wind and currents also bands of the eastward and northward speeds) with the globe legend. A NASA theme, clouds and surface temperature go as a NASA GIBS image of the same date, the temperature as two rasters - sea and land.

The Add data button at the top of the section puts the catalogue in place of the list, see Add data catalogue. The vector base groups hold rows. Borders and names holds Borders, Places and Water names. Transport holds Roads, Road numbers, Railways and Airports. Nature holds Rivers, Lakes and reservoirs, Peaks, Reserves and national parks.

The vector base comes from OpenFreeMap tiles. On the first opening borders, places, terrain and stars are on. The tooltip of each row tells how the feature is drawn and from what height it is visible.

The grid step follows the camera height, from 30° from space to seconds near the ground. The stars stand where they stand over the Earth at this minute and fade when the camera goes below 150 km. The Milky Way image, about 10 MB, is downloaded when the stars are first shown and comes from the QGIS cache afterwards. Clouds lie as a veil over the imagery. Snow and ice get into the clouds too, they have the same colour.

The Surface temperature map of the catalogue colours land and sea with their own scales. The scales in degrees Celsius are in the bottom left corner of the view. Land shows the temperature of the surface itself by day, not of the air, over 8 days. Land may have gaps under clouds. Sea shows the water temperature near the surface over a day.

The Sun layer lights the terrain and buildings from the side of the sun. The night side of the Earth is dark, the air over it does not glow. City lights shine on it - the NASA Black Marble image of 2016, pixel about 600 m. In the twilight the lights fade together with the night, under clouds they are weaker. The sun time is the end of the interval of the open time slider, so the light of the hour of a placemark shows. Without the slider the sun follows the computer clock. Without the Sun layer the light falls from the north-west at 45°, as on a relief map. The position of the sun is computed to about 0.01°, there are no shadows.

Labels stay level at any turn and tilt and do not overlap. A place behind a mountain or beyond the horizon has no label.

The Slope and Aspect layers colour the surface by the terrain heights. Slope is the angle of the surface to the horizontal, in classes 0-2°, 2-5°, 5-10°, 10-15°, 15-25°, 25-35° and steeper than 35°, from green to purple. Aspect is the compass direction a slope faces downhill, each of the eight directions has its colour, ground flatter than 0.5° is grey. The scale is in the bottom left corner of the view. The slope is computed from the true heights, without the vertical exaggeration of the view. The layer exists on the Earth, Mars and the Moon, other bodies have no heights. The accuracy is limited by the height pixel. It is about 5 m at the equator on the most detailed level on the Earth, 2.6 km on Mars, 1.3 km on the Moon.

Slope and contours are drawn no farther than three distances from the camera to the look-at point. In a view tilted to the horizon the far terrain stays without them. So the computation does not hold the view on hundreds of far tiles.

The Contours layer of the Map category of the catalogue draws lines of equal height on the surface, as on a topographic map. The contour interval depends on the zoom. It is 1, 2, 2.5 or 5 metres times a power of ten. Close up at middle latitudes it is 5 m, from tens of kilometres up it is 20-50 m. Every fifth contour is thicker. Below sea level the lines are blue, these are depth contours. Where contours merge on a steep slope, they fade. Contours are built from the same heights as the slope and have the same accuracy. The layer exists on the Earth, Mars and the Moon.

The interval is never finer than 5 m. The open Earth heights were surveyed with a 20-90 m spacing, detailed tiles are their resampling. Close up the contours are therefore built from smoothed heights with about a 20 m spacing, resampled smoothly. The lines have no steps, small terrain forms do not show on them. Open sea depths exist in these data only on overview levels, so depth contours in the open sea are built from them close up too. Own terrain from a project raster and an own height source give contours at full detail.

Thicker contours are labelled with their height, as on a topographic map. The number stands in a gap of the line, the top of the digits faces uphill. There is no label at a tile edge, on a sharp bend of the line and where the neighbouring contours are closer than the height of the digits. A flat lake surface at a contour height does not count as a line and is not filled.

On satellite imagery contours are yellow and depth contours light blue, on a map they are brown and blue. Imagery means Esri World Imagery and the imagery of other bodies. Basemaps with imagery, satellite, aerial, ortho and similar words in the name or address count as imagery too.

While the layer is on, its scale stands in the bottom left corner of the view. It shows the line colour, the interval in the middle of the view and the step of thicker contours. The cross of the scale switches the contours off.

The To the QGIS project... link of the scale exports the contours of an area around the view point as a GeoPackage layer. The View contours to the QGIS project... item of the globe menu does the same. Export exists only on the Earth. The area is the view strip at the view point with the width and height of the window, the interval is as on the screen. Heights are loaded for up to 30 s. The layer goes to the PlanetX - contours group at the top of the layer tree. The `elev` field is the height, thicker lines are wider and labelled.

Sea and ocean depths are part of the terrain. The floor lies at its depths, and semi-transparent water lies above it at sea level. Water shallower than 200 m is more transparent, the floor shows near the shore. Below sea level the status bar shows the depth under the cursor. The depths come from the same Terrarium tiles as the land heights, in the ocean these are ETOPO1 data. Sea names stay at sea level. The elevation profile, the ruler and the slope use the floor, the viewshed and insolation use the water surface. A profile below sea level shows the water and a dashed sea level line. Dry depressions below zero, for example the Dead Sea, are not told apart from the sea by the heights and are filled on the profile too. The Sea and ocean depths box in the Terrain group of the view properties switches them off, then heights below sea level count as zero and the sea is flat. Depths exist only on the Earth.

The Paleogeography layer shows the Earth in the past, up to 540 million years ago, after the PALEOMAP PaleoDEM maps (Scotese and Wright, 2018). The map of an age holds land heights and sea depths on a 0.1° grid, about 11 km, coloured by height with hill shading. A slider in the bottom left corner of the view sets the age in millions of years in steps of 5 million years, the geological period is named next to it. The ► button shows the ages one after another towards the present. Today's imagery, borders, labels and relief are removed for that time, the relief setting itself does not change. The maps lie as tiles in the planetx-terrain repository, the first showing of an age needs the internet. A new age appears at once in a coarse form and sharpens as it loads. When the window opens, the row is off.

Add data catalogue

The Add data button of the Layers section puts the catalogue in place of the list, the panel grows wider for that time, the globe stays visible. The ← arrow brings the list back. The categories stand on the left: Map (the vector base, coordinate grid, 3D buildings, contours), Weather, NASA themes by groups, Sky and light (Stars, Clouds, Sun, Satellites), Inside the Earth (Earthquakes, Plate boundaries, Mineral deposits, Mining areas, OSM mines and quarries, Earth cutaway, Paleogeography), Energy (Power plants, Power lines and pipelines, Submarine cables), Terrain analysis (Slope, Aspect) and Satellites - the satellite groups. The search field looks for a name and a description across the whole catalogue.

The rows are split into One map on the globe and Layers - switched on together. A row has a check box, a preview, the name and the source and day of the map on a second line. The preview of a map is its tile over Eurasia on the latest ready day over the base map, forecast fields and fires show a strip of the scale colours. The check box shows a map or a layer on the globe. A click on a row shows its description under the list with the Show on the globe or Remove from the globe and To QGIS project... buttons. The globe shows one map of the catalogue, the cross on its scale in the lower left corner of the view also removes it. A satellite group card shows or removes the group. The first group switches the Satellites layer on, the last removed one switches it off.

Voyages of Columbus
Search

Places

☐
☒
My Places

☐
☐
Perm

☐
☐
My placemark 1

☐
☐
My path 1

Layers

←
snow, mines, wind

All
Map
Weather
Planet of Fire
Planet of Water
Planet of Air
Land and Life
Sky and light
Inside the Earth
Energy
Terrain analysis
Satellites

One map on the globe

☐

Precipitation
NASA GIBS, 10.10.2026

☐

Soil moisture
NASA GIBS, 07.10.2026

☐

Snow cover
NASA GIBS, 10.10.2026

☐

Snow over 8 days
NASA GIBS, 22.09.2026

☐

Snow mass
NASA GIBS, 08.10.2026

☐

Sea ice
NASA GIBS, 10.10.2026

☐

Water vapour
NASA GIBS, 10.10.2026

☐

Chlorophyll
NASA GIBS, 10.10.2026

☐

Sea salinity
NASA GIBS, 07.10.2026

Currents
NOAA CoastWatch
Ocean surface currents as white running streaks over a speed colouring. Geostrophic currents of NOAA CoastWatch from satellite altimetry for the latest ready day, 0.5° grid. The first switch-on in a session downloads about 4 MB.

Show on the globe

View from 2869 m

NASA themes are rasters by days, months or years from the NASA GIBS service. A day of a series counts as ready a day later, before that its image is empty. The NASA theme groups of the catalogue hold:

- Planet of Fire - fire spots, smoke, aerosol optical depth, carbon monoxide and its emission.
- Planet of Water - precipitation, soil moisture, daily snow, snow over 8 days, snow mass, sea ice, water vapour, chlorophyll, sea salinity and floods.
- Planet of Air - nitrogen dioxide, sulphur dioxide, methane, carbon dioxide and ozone.
- Land and Life - vegetation, dust, night lights and land cover.

The theme lies as semi-transparent colouring over the imagery, where there is no data the imagery shows. A legend with the name, units and date stands in the bottom left corner of the view. The day of the theme is set by the right handle of the time slider, see Placemark time and the time slider. A chosen theme opens the slider on the last day of its series. The handle gives the nearest day of the series that is not later, missing days of the series are skipped. A new theme takes the same moment while the slider is open. Some series lag behind today by months, the tooltip of the theme says so. Themes exist only on the Earth.

Daily snow from MODIS imagery shows only where the day had no clouds and was light. On 15 January 2026 over West Siberia clouds and the polar night hid snow on 78 % of the area. The 8-day summary is hidden on 40 %. Snow mass is a SMAP model calculation from satellite data, it has no gaps under clouds. The snow themes show land only. Lake ice is in the 8-day summary, sea ice is the Sea ice theme.

Comparison swipe

The ⇌ button of the time slider splits the view with a swipe. Right of the swipe the theme is shown for the day of the slider, left of it for a day of its own. By default this is the same day a year ago, for a series shorter than a year its first day. Tags with the days of both sides stand above the swipe. The < and > buttons of the left tag move its day along the theme series, the cross removes the swipe. The swipe is dragged with the mouse by the strip with a circle.

The white line along the border is also on a view snapshot and in a tour recording. The swipe works with NASA themes. GFS forecast fields, fires and surface temperature have no swipe. A change of theme keeps the swipe, its day is looked up in the series of the new theme. Switching the theme off removes the swipe.

Weather

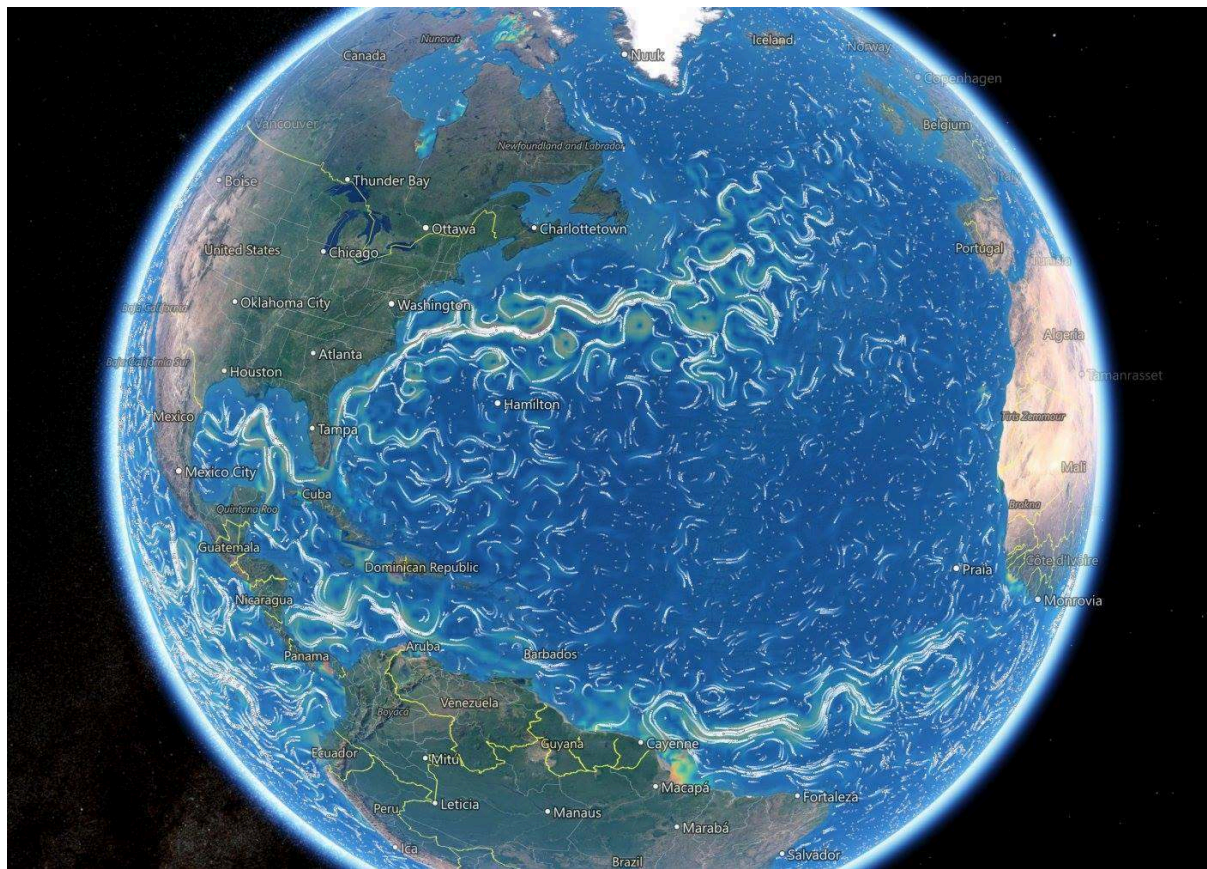
The Weather category stands in the catalogue before the NASA themes. Its first map is Surface temperature of land and sea from NASA. The others are Air temperature at 2 m, Precipitation in mm/h, Wind at 10 m in m/s and Clouds in percent. The fields come from the NOAA GFS forecast model with a 0.25° grid, about 28 km. A field is chosen in the catalogue, as a NASA theme.

The Aurora map shows the probability of a visible aurora in percent by the OVATION forecast of the NOAA Space Weather Prediction Center for the next 30-90 minutes, 1° grid. Below 3 % the field is transparent, a weak aurora is green, a strong one yellow and red. There is one forecast, for now, the time slider does not change it. The map asks for a new forecast at most once in 10 minutes. City lights on the night side come with the Sun layer, they can be on together with the aurora.

White streaks run over the Wind colouring - particles that float with the wind and drag a trail. A streak of a weak wind is paler. The streaks are sped up - in a second a wind of typical strength passes about an eighth of the view width, so they are visible both from afar and close up. They are born within the view and follow it.

The Currents layer of the Planet of water group of the catalogue shows ocean surface currents with the same white streaks over a speed colouring from dark blue for slow ones to red for 2.5 m/s. Slow water is almost not coloured, the streak of a slow current is paler. From afar the particles are born within the visible circle of the Earth and pass no more than a third of a grid cell per frame, so the trail does not loop through the eddies. The currents are geostrophic, NOAA CoastWatch calculates them from satellite altimetry for a day,

the data lag two to three weeks. The series starts on 13 February 2017, the day of the currents is set by the right handle of the time slider, without the slider it is the latest ready day. The 0.25° grid is taken at every other node, 0.5°. The first switch-on in a QGIS session downloads about 4 MB. The Gulf Stream, Kuroshio, the current around Antarctica and eddies tens of kilometres across are visible. Near the coasts and under ice there is no data.



The time slider sets the moment of the field. A chosen field opens the slider at the present moment. The slider spans 10 days before the latest model run and 16 days of forecast after it. The future is the forecast of the latest run, hourly for the first 5 days, then every 3 hours. The past is the model analysis for the nearest hour. The < and > buttons of the slider move the moment by an hour, ► shows the hours one after another and waits for each to load. The model runs 4 times a day, a new run is published 4-5 hours later.

A field for the whole world weighs 0.5-0.8 MB and arrives in a few seconds. The legend in the bottom left corner shows the units and the valid time of the field in UTC. It is a model calculation. Model clouds are not a cloud image, the Clouds layer gives the image.

The values of the field stand over its colours. Temperature is in degrees, precipitation in mm/h, wind in m/s, clouds in percent. The values stand at the nodes of a latitude and longitude grid, about six across the view. The node step changes with the eye height, from 30° from space to 0.25° close up. The values come from the same field, there are no new network requests. Where precipitation is below 0.1 mm/h, there are no precipitation values.

The first map of the Planet of Fire is Fires. It shows fire spots over the last 24 hours from VIIRS images of the NOAA-20 satellite from the NASA FIRMS feed, about 78 thousand spots. A dot stands at the fire, its colour and size show the radiative power from 1 to 1000 MW, the legend stands in the bottom left corner of the view. The feed, about 6 MB, is loaded each time the row is switched on. The spots stand on the time slider by the image time. A click on a spot in the Identify mode shows its power, image time and confidence.

The Plate boundaries layer shows the lithospheric plate boundaries after the PB2002 model (Bird, 2003). Red lines are plates moving apart at oceanic ridges and continental rifts, green - plates sliding along transform faults, blue - plates converging in subduction and collision zones. Plate names show as labels. A click near a boundary in the Identify mode shows the boundary type, the plate pair and the speed of their relative motion in mm/yr. In the plate pair a slash in Bird's notation shows which plate goes under which: "PA\OK" is the Pacific plate under the Okhotsk plate.

The Mineral deposits layer shows mineral deposits, mines and occurrences of the U.S. Geological Survey (USGS) from three datasets. The MRDS database is about 300 thousand points, about 267 thousand of them in the USA and about 1400 in Russia, USGS has not updated it since 2011. Major mineral deposits of the world (USGS OFR 2005-1294) is 3161 deposits, 300 of them in Russia, they show as large points. World mines and plants (USGS Mineral operations outside the United States) is 6478 mines, processing and metallurgical plants outside the USA for 2006-2010 with the operator and capacity, among them the Verkhnekamsk deposit, the North Urals bauxite and the Saranovsky chromite complex. For some records the place is given by district, the information window then says approximate, by district. The point colour is the group of the first commodity, the group scale is in the lower left corner of the view. The size of an MRDS point is the development status, a producing mine is larger than an occurrence. A click on a point shows the name, commodities, type, status, operator, capacity, country and a link to the USGS record, the Identify mode is not needed for it. Earthquake foci, fires and satellites open the same way. The first switch-on downloads the USGS archives, about 25 MB, and parses them in a background thread, which takes 15-20 s. The result is kept as a file in the QGIS profile, later switch-ons read it in 1-2 s. Over a large area, for example the whole USA, no more than 80 thousand points show. The major deposits, world mines and plants come first, then the rest. Large points are drawn over small ones.

The Mining areas layer shows outlines of open pits, waste dumps, tailings and industrial sites of the world - about 45 thousand areas outlined on Sentinel-2 images of 2019 (Maus et al., 2022, CC BY-SA 4.0). The outlines lie as an orange fill in the tile image. A click on an outline shows the country and area. The first switch-on downloads a file of about 25 MB into the QGIS profile.

The OSM mines and quarries layer shows mines, shafts and quarries from OpenStreetMap with their names. They load for the place of the view when the camera is below 150 km - an area of about 100 km around the look point in one request to an Overpass server. The point colour is the commodity group from the resource tag, without it the point is white, Other. A click on a point shows the name, kind, operator and a link to the OpenStreetMap object. In busy hours the Overpass server answers with a delay or a refusal. The request then repeats by itself on another Overpass server or on the same one after a pause.

The Energy category of the catalogue holds the Power plants, OSM power lines, cables and pipelines and Submarine cables layers.

The Submarine cables layer shows submarine communication lines in turquoise and submarine power cables in purple from any altitude. The data is OpenStreetMap, extracted on 11 October 2026 - 909 communication lines and 1040 power cables longer than 5 km. OSM holds part of the world's cables, most of them in the Atlantic and near Europe. A click on a line shows the name, kind, owner and a link to the OpenStreetMap object.

The Power plants layer shows about 35 thousand power plants of the world from the WRI Global Power Plant Database, data as of 2021 (CC BY 4.0). The point colour is the fuel, the size is the capacity. The points are visible from any altitude, a click on a point shows the name, capacity, commissioning year, owner and a link to the source of the record. Some plants are placed wrongly in the database. The first switch-on downloads an archive of about 4 MB, the result is kept as a file in the QGIS profile.

The OSM power lines, cables and pipelines layer shows power lines, substations, cables and pipelines from OpenStreetMap. A power cable, underground or under water, is a purple dashed line, a communication line is turquoise. The line colour and width show the voltage class - 500 kV and above, 220-330 kV, 110-150 kV or below. A pipeline is dashed, its colour shows the substance - gas, oil and products, water and heat. A substation is a square in the colour of its voltage. The objects load for the place of the view when the camera is below 150 km, the same way as the OSM mines. A click on a line or substation shows the kind, voltage, substance, owner and a link to the OpenStreetMap object.

The Earthquakes layer shows earthquakes of magnitude 4.5 and above over the last 30 days from the feed of the U.S. Geological Survey (USGS). The feed is loaded each time the row is switched on. A circle marks the focus at its depth, and a thin line leads from it to the epicentre on the surface. The colour of the circle shows the focus depth, from red near the surface to purple at 700 km, the scale is in the bottom left corner of the view. The circle grows with the magnitude. Foci show through the surface, foci on the far side of the Earth are hidden. The depth is stretched by the vertical exaggeration of the terrain, like the heights. Each event has a time. With the row on, the time slider becomes available, and it shows the events of the chosen interval. The row exists only on the Earth.

The Earth cutaway layer removes a sector of the Earth under the look-at point. The sector is a quarter of a hemisphere 90° wide in longitude, from the equator to the pole of the hemisphere of the look-at point. Its three faces are coloured by shells after the radii of the PREM model. These are the crust to 24.4 km, the upper mantle to 400 km, the transition zone to 670 km, the lower mantle to 2891 km, the outer core to 5149.5 km and the inner core. The shell scale is in the bottom left corner of the view. The edge of the faces lies on the ellipsoid, the depths are not stretched by the vertical exaggeration. The crust on the faces comes from the CRUST1.0 model in 1° cells. These are water, ice, upper, middle and lower sediments, upper, middle and lower crust, below the Moho the mantle begins. The crust is 6-7 km thick under the ocean and about 70 km under Tibet. Where a face crosses a subduction zone, the subducting slab from the Slab2 model of the U.S. Geological Survey shows on it as a band from the upper surface of the slab down by its thickness. Slabs exist in 27 zones. The file of a zone is requested when a face touches it, the loading icon shows this. The model is downloaded from the site of its authors when the row is first switched on, until then the crust is the 24.4 km PREM layer. The crust layers can be told apart up close, where the depths on the faces are true. As the camera moves away, depths to 400 km are stretched so that the crust stays visible. At the surface the stretch reaches 8 times, towards 400 km it fades out, below the scale is true. The shell scale shows the factor, earthquake foci are stretched the same way. Labels of places in the removed sector are not shown. The sector is placed anew each time the row is switched on. The corners of the sector are marked with points showing their latitude and longitude, and they can be dragged with the mouse. A corner changes its own longitude and its own latitude. If the latitude is neither 0° nor a pole, the lower or upper face becomes a cone towards the centre of the Earth. The row exists only on the Earth.

The Section down... item in the menu of a path in My Places opens the Section window. It shows a section of the Earth down along the path. The distance from the start of the path runs across, the depth runs down. The section shows the CRUST1.0 crust layers, the PREM shells, the Slab2 slabs and earthquake foci from a band along the path. The colours are those of the Earth cutaway faces, the layer scale is to the right of the chart. The Depth list sets the depth of the section, from 100 km to the centre of the Earth. The Foci band field sets the width of the band. A focus is moved onto the section at the nearest point of the path. The cursor over the chart marks the point on the globe and shows the Moho and slab depths there. The crust, the slabs and the earthquake feed are loaded when the window opens, if they are not there yet, the line under the chart tells what is still loading. While the window is open, a wall of the same section hangs along the path on the globe. It shows through the surface, its depths are true. When the window closes, the wall disappears.

Base map and a tile source of your own

The menu of the Base map row lists Esri World Imagery, OpenStreetMap and the XYZ Tiles connections of the QGIS browser, the chosen base map is checked. A choice changes the base map on the globe at once. On other bodies the row shows the imagery of the body, there is no choice.

The Add tile source... item of the menu opens the new source window. The Address field takes an address in any of these forms:

- a template with {z}, {x}, {y}, for example <https://{s}.tile.opentopomap.org/{z}/{x}/{y}.png>
- the address of one tile copied from a browser, for example https://server.arcgisonline.com/ArcGIS/rest/services/World_Topo_Map/MapServer/tile/5/10/17
- an address with the level, column and row in the query

The window turns the address into a template and suggests a name from the server name. Below it builds a mosaic of the whole world from four level 1 tiles. If north is at the bottom of the mosaic, the server rows go from the bottom up, the box Rows from the bottom up (TMS) fixes this. The window finds the most detailed level itself by asking for tiles at the look point of the globe. No-data placeholders do not count. The source credit is in the corner of the view and on snapshots, for known servers it is filled in by itself.

The source is saved as a QGIS XYZ Tiles connection and becomes the base map at once. It is also visible in the QGIS browser, where it can be edited or removed. The owner of the tiles sets their terms of use.

3D buildings

The 3D buildings row of the Layers section puts OpenStreetMap buildings on the globe as blocks. Outlines and heights come from the same OpenFreeMap vector tiles as the vector base. The row is off by default.



Buildings show when the camera is closer than 6 km to the ground. The globe keeps up to 32 building tiles around the camera, the nearest first. Tiles behind the camera are not loaded.

The height of a building is its height in OpenStreetMap, otherwise the number of floors times 3.66 m. A building without either gets a height of 5 m. In the centre of Perm two thirds of the buildings have a height of their own, in the centre of Moscow almost all. In the outskirts many houses have the same height. The colour of a building comes from OpenStreetMap, otherwise the building is light grey. Roofs are flat.

The bottom of a building stands at the lowest point of the terrain under its outline. A view snapshot waits until all buildings of the frame are loaded. A scene remembers whether buildings are on.

View properties

Base map

Esri World Imagery - exampleData sources...

Terrain

Vertical exaggeration1.0

☒ Sea and ocean depths

Labels

LanguageAs in QGIS

QGIS map

SynchronizationBoth ways

☐ Layers as on the QGIS map

☐ New layers straight to the globe

Update

☒ Update automatically

Coordinates

FormatDecimal degrees

Inside the Earth

Subsurface mode...

Assistant

Conversation...Settings...Clear search history

Заккрыть

The View properties icon on the icon bar opens the View properties window. The window does not block work with the globe.

Group	Field	What it sets
Base map	List	Source of imagery or map
Terrain	Vertical exaggeration	Height multiplier from 0.5 to 10
Terrain	Sea and ocean depths	The floor at its depths with water above it, on by default
Labels	Language	Language of labels and search
QGIS map	Synchronization	Direction of the link with the map
QGIS map	Layers as on the QGIS map	The globe shows the layers switched on in the QGIS legend
QGIS map	New layers straight to the globe	A new project layer is checked on the globe at once

Group	Field	What it sets
Update	Update automatically	The globe refreshes after every change without the Refresh button, on by default
Coordinates	Format	Decimal degrees, degrees-minutes-seconds, UTM or MGRS in the status line and the Features window. North of 84° and south of 80° UTM and MGRS are replaced with decimal degrees
Inside the Earth	Subsurface mode...	Opens the Subsurface mode window, see Subsurface mode

The default base map is Esri World Imagery, listed as an example. Esri sets its terms of use. OpenStreetMap comes next, then the XYZ Tiles connections from the QGIS browser. Terrain connections are not listed. A new connection appears in the list the next time the window opens.

The Data sources... button next to the base map list opens a window with all globe sources. Its table lists by groups the base maps, terrain, vector base, NASA data and Earth science data. Each source shows what it gives and an open link to its terms of use. The Check button requests one tile or file from each source bypassing the cache and writes the answer time and size or an error. Large files, the star sky image, are not requested.

The same window sets own terrain - a height tile template with {z}, {x}, {y} in Terrarium or Mapbox Terrain-RGB encoding - and an own vector base - a TileJSON address in the OpenMapTiles schema. Each has a credit for the view corner. Apply takes the data from the new address, Reset returns the default source. The Add base map..., Edit... and Remove buttons work with the QGIS XYZ Tiles connections, a removed connection disappears from the QGIS browser too.

The Terrain - where the heights come from group of the same window explains that the heights are built from three layers - the world height tiles, the 30 m land refinement and an own raster of the project. The 30 m land refinement list puts a 30 m terrain model over the height tiles:

- No - height tiles only - the Mapzen Terrain Tiles relief, as before. It loads the fastest. North of 60° on land its data is about 250 m.
- Copernicus DEM 30 m - the Copernicus GLO-30 surface model, files per degree on the open AWS storage. Forest and buildings are part of the height.
- GEDTM30 30 m - the model of the bare ground without forest and buildings, OpenGeoHub, CC BY 4.0. It is one large file, its pieces take longer to read.

The height tiles still give the sea floor and the view from afar. From level 9 the model gives the land heights, deeper than level 12 the model pieces are not read again but resampled from the ones already read. The model credit stands in the view corner. The model is read from the network for every new area, without the network the height tiles remain. At Mount Narodnaya the height tiles give 1816 m, Copernicus and GEDTM30 give 1888 m, the summit is 1895 m.

The label language is chosen from a list. As in QGIS takes the QGIS interface language, Local names keep the names in the language of the country. Fifteen languages follow. When there is no name in the chosen language, Latin-script languages get the Latin name, the others the local one.

Without automatic update a change of base map, terrain exaggeration or project layers shows after the Refresh button on the icon bar. The status line reminds about it. The label language changes at once.

QGIS project group

The group of the Layers section lists the layers of the current project in the order of the QGIS map, each with its type - raster, points, lines, polygons or table. The check box of a layer shows it on the globe and does not change its visibility on the map. In a new project the boxes are clear. The checks are stored in the project.

Layers lie on the globe as a picture drawn by QGIS, with the styles of the map. The picture lies on the terrain, it cannot be raised or extruded.

Labels of vector layers come separately, like city names. They stay level at any turn and tilt, do not overlap and hide behind mountains and the horizon. The text, colour and size come from the layer labels in QGIS, rule-based labels too. A point label stands to the right of the point, a line label at its middle, a polygon label inside it. Features around the view point are labelled, at most 500 per layer. The scale visibility of QGIS labels is not used on the globe.

A double click on a layer flies to its extent, looking straight down. The right-click menu:

- Fly to - a flight to the extent of the layer.
- Transparency slider - the transparency of the QGIS layer itself, it changes on the map too.
- Track... - for point layers, see [Tracks](#).
- Globe terrain - for rasters, see [Own terrain](#).
- Extrusion... - for vector layers, see [Extrusion by field](#).
- Layer Properties... - the standard QGIS layer properties window.

Extrusion by field

Features of a project vector layer rise above the terrain to a height from a numeric field. A polygon becomes a prism, a point an octagonal column, a line a wall. The Extrusion... item of the layer menu opens a window with the height field and a factor. The height in metres is the field value times the factor. For a field of storeys the factor is about 3. A feature with an empty, zero or negative value is not extruded. The No extrusion row removes the extrusion.

The colour of a feature is its symbol in the QGIS layer style, as on the map. The bottom of a prism and a column lies at the lowest terrain point under the feature, the roof is flat. A line wall follows the terrain. The column radius is 1/150 of the layer span, from 2 m to 2 km. The layer is extruded while it is checked on the globe. The settings are kept in the project. Up to 20 000 features of a layer are read.

Own terrain

A height raster of the QGIS project becomes the globe terrain within its extent. An example is a quarry with a mine survey. The Globe terrain item of the raster menu in the QGIS project group turns the inset on and off. The raster can be in any coordinate system, it needs a file that GDAL reads. The checkbox that shows the layer on the globe is not needed for the inset.

Where the raster has data, its heights replace the common terrain. Along a band at the edge of the data the heights change smoothly to the common terrain, the band is 5 % of the smaller side of the extent. Within the extent the terrain is more detailed than the common one, down to the raster pixel, but not finer than the pixel of level 17 (about 0.6 m at latitude 60°). The raster heights are taken as they are. If the survey has its own height system, the band at the edge smooths the difference with the common terrain.

The inset is seen by the surface mesh, the height under the cursor, the ruler, the elevation profile, the viewshed, the insolation, the slope and the aspect. With several insets the one higher in the project lies on top. The choice is kept in the project and in the scene.

On the first switch-on the raster is converted into a file of the QGIS profile. For a survey of 2400 × 2400 pixels this takes about 2 s.

Cut and fill

Two surveys of one site, for example a quarry with dumps, give the cut and fill volumes. The Cut and fill... item of the menu of the new survey raster in the QGIS project group opens a window:

- Earlier survey - a raster of the same site at an earlier date.
- Site - polygons outside which the difference is not computed, or the whole extent of the new survey.
- Threshold - a difference smaller than the threshold in absolute value does not enter the volumes, it is survey noise. The default is 0.1 m.

The earlier survey is resampled to the grid of the new one. The computation goes in metres, in the coordinate system of the new survey or in the UTM zone if it is in degrees. The summary window shows the cut and fill volumes, their areas, the greatest cut depth and fill height and the difference of the volumes. The difference raster goes into the project in the PlanetX - cut and fill group and is shown on the globe, the cut in red, the fill in blue.

Own bathymetry

A raster of depths or bed elevations of a lake, sea or reservoir goes into the globe terrain like own terrain, and semi-transparent water at the water body level is drawn above it. The Water body bathymetry... item of the raster menu in the QGIS project group opens a window with three fields:

- Values are depths - the depth below the water surface, with a plus or minus sign. The bed elevation is the water level minus the absolute depth.
- Values are bed elevations - the bed height above sea level.
- Water level - the height of the water surface. The default is the terrain height in the middle of the raster, for a lake it is usually the water surface.

The water is drawn over all raster points where the bed is below the level, the bed is seen through it. Without terrain no water is drawn - the bed and the water would lie in one plane. Remove bathymetry turns off both the inset and the water. The choice is kept in the project. The elevation profile across the water body shows the water above the bed and a dashed line of the water body level with a label.

The Lake Brienz, own bathymetry demo of the Demo icon is the bed of Lake Brienz in Switzerland from swisstopo swissBATHY3D data with a 10 m step, water at 564 m. The deepest point is 308 m, 256 m below the water. The elevation profile across the lake shows the basin.

Bathymetry from soundings

Echo sounder soundings are a point layer of the project with the depth in a field or in the point Z, for example a CSV with latitude, longitude and depth opened in QGIS as a delimited text layer. The Bathymetry from soundings... item of the point layer menu builds a depth raster from them and makes it own bathymetry. The window sets:

- Depth - the field with the depth or the point Z. The sign of the depth does not matter.
- Cell - the raster cell size. The default is the square root of the sounding area per point. For tracks 20 m apart with a point every metre it is 5 m.
- Limit from sounding - a cell farther than this distance from the nearest sounding stays empty. The default is 10 cells. The limit has to be larger than the distance between tracks.
- Water level - the water height on the day of the soundings.
- File - the GeoTIFF of the depth raster, by default in the QGIS profile.

The raster is built by triangulation in metres of the UTM zone of the middle of the soundings and goes into the project in the PlanetX - bathymetry group.

Places section

The section holds the My Places folder, described in the chapter [My Places](#).

Link with the QGIS map

Synchronization

The synchronization icon on the icon bar links the globe with the QGIS map window. The direction is chosen in the view properties:

- Both ways - the default.
- Map leads the globe - the globe moves to the map extent and keeps its tilt and heading.
- Globe leads the map - the map centers on the look-at point of the globe once the globe stops.

Any map coordinate system works. The map width on the ground equals the width of the globe view.

Selection

Features selected on the QGIS map are highlighted on the globe.

Identify features

The Identify features icon turns identify on, the cursor becomes a cross. A click on the globe puts a pin with the coordinates and opens the Features window.

- The top of the window shows the coordinates and elevation of the point.
 - Below are the project layers checked on the globe, their features under the point and the feature fields. A raster shows its values at the point.
 - The Select on map button selects the found features in the QGIS layers. The selection shows on the map, in the attribute table and on the globe.
 - The My Places group lists the visible placemarks, paths and polygons under the point. Each shows its type, coordinates or length, measurement and description.
 - The Earthquakes group lists the foci near the click point on the screen. Each shows its magnitude, depth, UTC time, place and the USGS event page.
 - The Site group shows the elevation or sea depth, the Moho depth, the crust and sediment thickness after CRUST1.0 and the Slab2 slab under the point. The crust model and the slab zone file load on the first click, the window updates when they arrive.
-

My Places

My Places is the folder at the top of the Places section, marked with a star. It holds placemarks, paths, polygons, saved views and measurements. The places are kept in one file `PlanetX/myplaces.gpkg` in the QGIS profile folder and are visible in any project.

List rows

The row icon shows the kind of object - placemark, path, polygon, saved view or folder. A check box shows and hides the object on the globe, a folder check box does it for the whole folder. A double click on a place flies there.

Places and folders are rearranged by dragging, including from folder to folder. The tour follows the list order.

Several rows are selected with Ctrl and Shift. The selection is dragged together, and the Del key deletes it after a question.

The slider under the list changes the opacity of the selection - placemarks, paths, polygons, images and the whole contents of selected folders. It stands at the opacity of the selection, to the left is more transparent. A polygon fill stays more transparent than its line in the same share. The value is kept in My Places and in KML as the colour alpha, Google Earth sees it too.

Menus

Where	Items
My Places	Add, Play tour, Sort A-Z, Open KML or KMZ..., Save as KML..., Copy, Paste, Add the places layers to the project, Clear My Places...
Folder	Fly to, Add, Cut, Copy, Paste, Delete, Open KML or KMZ..., Save as KML..., Snapshot folder view, Sort A-Z, Play tour, Properties...
Place	Fly to, Tour along the path, Snapshot view, Properties..., New Folder, Cut, Copy, Paste, Delete
Several rows	Copy, Show selected, Hide selected, Delete selected
Empty space	New Folder, Open KML or KMZ..., Paste

Only paths have Tour along the path. The Add submenu creates a folder, placemark, path, polygon or recorded tour in the folder. The placemark, path and polygon are drawn in the New place window, the tour is recorded with the record button. Cut copies the row to the clipboard and removes it from the list, Paste puts it in a new place. Sort A-Z orders places and folders by name.

Folder properties

The Folder properties window opens from the folder menu:

Field	What it sets
Name	The folder name in the list
Allow the folder to be expanded	Without the box the folder does not expand in the list, the folder box shows and hides all its contents
Show contents as option buttons	One row of the folder shows on the globe, checking one clears the others
Hide beyond	All placemarks of the folder are visible only while the eye is closer than this distance. In KML the field is written as the Region of the folder
Description	Text about the folder, the tooltip of its row
View	Look point, range, heading and tilt, buttons Snapshot current view and Reset

A double click on a folder and Fly to in its menu fly to the folder view. Without a view of its own the flight frames all places of the folder. The view is set by hand with numbers on the View tab or by a snapshot. Snapshot folder view sets the folder view to the view of the globe. The description, the view and the way contents show go to KML and back.

A new folder appears at once with the name New Folder, the name is changed in the Properties... window. On a folder it is created inside, on a place right below it. A folder is deleted with its contents after a question.

Add the places layers to the project adds the three layers of the places file to the project - points, lines and polygons. Their attributes and undo are the standard ones.

New placemark

The New placemark icon opens a window with the tabs Placemark, Path, Polygon and Circle.

- A placemark is put with a click on the globe, a new click moves it.
- Path points and polygon vertices are put with clicks on the globe.
- A circle is set by two clicks - the centre and a point of the circle. Both points can be dragged with the mouse. The circle is saved as a polygon of 128 vertices along the circle on the ellipsoid.
- The Name field is filled at once with a numbered name - My placemark 1, My path 1, My polygon 1, My circle 1. Each kind counts on its own. The name can be changed in the same field.
- Color sets the color of the line and outline, the polygon fill has the same color, half transparent. Width is set in screen pixels.

The Save button writes the object to the selected folder of My Places. The window stays open for the next object. The Clear button removes the points put so far.

Vertices are shown as circles and are dragged with the mouse. The circle in the middle of a segment adds a new vertex there. A click on the first point closes the shape, and a path becomes a polygon. A click on the last point finishes the path. A hint stands at the cursor. After finishing, clicks add no points, and the vertices can still be edited.

Right-click menu on the globe

A right click on the globe opens a menu.

Item	What it does
Point coordinates, the first line	A click copies them to the clipboard in the format of the status line
Delete vertex	Removes the vertex of the drawn object under the cursor
Finish drawing, Continue drawing	Stops and resumes adding points with clicks
Properties...	Opens the properties of the placemark under the cursor
Add placemark here	Opens the New placemark window with the point under the cursor
Fly here	Flies to the point with the same altitude and tilt
Orbit around	Flies to the point and circles it slowly, one turn a minute. Any mouse or key movement stops it
Directions from here, Directions to here	The start and the end of a route, see Route
What's here?	The Identify window for the point under the cursor without the Identify features mode. The Site group holds the address from Nominatim, the OpenStreetMap geocoder
Map sheet designation	A submenu with map sheet numbers at the point. The International Map of the World 1:1,000,000 (IMW), the Russian designation at 1:1,000,000, 1:500,000 and 1:200,000, the NATO JOG 1:250,000 sheet and the MGRS 100 km square. A click on a row copies the number. The All numbers in a window... item opens a window with the same numbers

Item	What it does
Sentinel-2 and Landsat images here...	The Sentinel-2 and Landsat images window for an area around the point under the cursor, see Sentinel-2 and Landsat images
Early Landsat images 1972-1993 here...	The same window right on the Landsat 1-5 MSS images
ASTER images here...	The same window right on the ASTER images of 2000-2006. Images after 2006 are the ASTER since 2007 line of the Satellite list, see NASA Earthdata key
Measure distance	Opens the Ruler with its first point here
Copy link to place	A link to the point on the OpenStreetMap map to the clipboard, the scale follows the view. Any browser opens the link
Open in browser	A submenu of custom items. An item opens in the browser an address with the point under the cursor, for example the weather forecast at the point on windy.com. The Custom items... item opens the list window. In the address {lat} and {lon} are the latitude and longitude in degrees, {zoom} is the map scale by the view. The address starts with https:// or http://, the list is kept in the QGIS settings
Paste	KML placemarks from the clipboard into My Places

The shape of a 3D path, a 3D polygon and a tour is not edited this way. A placemark with a saved measurement loses the measurement text after its shape is edited.

Sentinel-2 and Landsat images

The Sentinel-2 and Landsat images window looks for scenes of the Sentinel-2 or Landsat satellites over an area and adds the chosen bands and indices to the QGIS project. The scenes are L2A, that is surface reflectance, 10-20 m per pixel. Two items open the window:

- Sentinel-2 and Landsat images here... of the globe menu takes a square around the point. The square side equals the width of the visible strip of the globe, from 1 to 100 km. The Area side field changes it.
- Sentinel-2 and Landsat images... of the My Places menu takes the area from the placemark. A polygon gives its outline, a path gives its bounding box, a point gives a square around it.

The Acquired from and to fields set the date range. Scene cloud cover up to limits the cloud cover of the whole 110 × 110 km scene by the catalogue. Over the area up to limits clouds and shadows over the area itself. The window computes it from the SCL scene class mask after the search and hides scenes above the limit. The Find button fills the list, newest first. The columns are the acquisition date and time in UTC, the cloud cover over the area, the scene cloud cover, the Sun elevation and the MGRS tile. The chosen row shows a natural colour preview of the area.

The checkboxes of the product list choose what goes to the project:

Product	Bands	What it shows
Natural colour	B4 B3 B2	as the eye sees
False colour, near infrared	B8 B4 B3	vegetation in red
Agriculture	B11 B8 B2	crops and ploughland
Shortwave infrared	B12 B8A B4	moisture and burns, haze is almost transparent
Geology	B12 B11 B2	rocks and outcrops
Urban	B12 B11 B4	built-up areas and bare soil

Product	Bands	What it shows
NDVI - vegetation	$(B8 - B4) / (B8 + B4)$	green biomass
NDWI - open water	$(B3 - B8) / (B3 + B8)$	water above zero
NDMI - vegetation moisture	$(B8A - B11) / (B8A + B11)$	moisture in foliage
NBR - burned areas	$(B8 - B12) / (B8 + B12)$	burns lower, the difference of two dates gives burn severity
NDSI - snow	$(B3 - B11) / (B3 + B11)$	snow and ice above 0.4
All scene bands	B1-B12 and B8A	12 bands in one file for own computations

All scene bands is one GeoTIFF with all bands in the order of their numbers, each band in the file carries a name like "B8A nir08", it is seen in the QGIS layer properties. For Sentinel-2 these are the 12 bands of the L2A product (band B10 is not in it), the 20 and 60 m bands are resampled to a 10 m step. Landsat 8-9 has 8 bands, Landsat 4-7 has 7, the thermal band in the file is the surface temperature in kelvins. The layer shows natural colours, another combination is chosen in the layer properties without a new download. The file is large - for Sentinel-2 an area of 3 km takes about 1.5 MB, 20 km about 190 MB, so an area with a side over 20 km goes at a 20 m step with All scene bands.

The list at the bottom of the window chooses the method:

- Clip to the area, GeoTIFF writes float32 reflectance files to the folder set by the Folder... button. Pixels outside the polygon are empty. With the Clouds and shadows empty checkbox the pixels of clouds, shadows and snow by the SCL mask are empty too. The pixel size is 10 m, for a large area 20 or 60 m, so that a side stays within 4000 pixels.
- Whole scene by link, no download writes a VRT file, links to the scene bands on the network. Only band combinations go by link, indices go by clipping to the area. The method exists only for Sentinel-2.
- Whole scene, source files writes the scene files as they are, in the source values and resolution, to a scene folder inside the Folder... folder. These are all bands, the cloud mask and for Landsat the MTL metadata file. One VRT layer set of all bands goes to the project, it shows natural colours, for MSS and ASTER false colours, for MODIS the first layer of the product in grey. The checked products are not built then. A Sentinel-2 scene weighs about 1 GB, Landsat about 0.8 GB, ASTER 50-200 MB, MSS about 30 MB. For MODIS the files of all tiles of the day are downloaded. The status line shows how many files are downloaded. A file already downloaded is not downloaded again on a repeat. The method exists for all satellites of the list.

The To QGIS project button puts the layers into a group of the day inside the Sentinel-2 group. Band combinations are stretched by 2-98 % of the values, indices are coloured with their own scale. The layers are checked on the globe, their metadata carry the notice «Contains modified Copernicus Sentinel data» with the acquisition year. Loading a 3 km area takes 10-20 s.

The scene catalogue is Earth Search (Element 84), the images are Copernicus Sentinel-2 (ESA), Element 84 files on the open AWS storage. No key or account is needed.

The Satellite list at the top of the window switches to Landsat 4-9 - images since 1982, 30 m per pixel, surface reflectance and surface temperature of the Collection 2 Level-2 processing of the U.S. Geological Survey (USGS). The catalogue and the files are Microsoft Planetary Computer. The files are read with a temporary access key, the window gets it from Planetary Computer by itself, without an account, and asks again every 45 minutes. When the key service has not answered three times, the line at the bottom of the window says so. Over the area, Landsat cloud cover is computed from the qa_pixel mask - clouds, cirrus and shadows. The tile column shows the satellite, the WRS path and row, for example "L9 167/020". The products

are those of Sentinel-2 without band numbers, as Landsat 4-7 and 8-9 number them differently, plus Surface temperature, °C from the thermal band. This is the surface temperature of the USGS Level-2 product (ST_B10 of Landsat 8-9, ST_B6 of Landsat 4-7), not brightness temperature. USGS has already converted the radiance with the surface emissivity from the ASTER GED database and the atmosphere. The plugin converts the file value to kelvins by the scale and offset of the product and subtracts 273.15. Where the ASTER GED database has no emissivity, USGS does not compute the temperature. Over most of Russia that is half of the area or more, at Yakutsk in summer 2024 it is 86-100 %. The Temperature gaps by formula check box, on by default, computes such pixels by the same USGS formula from the radiance and atmosphere of the scene (the ST_TRAD, ST_ATRAN, ST_URAD, ST_DRAD layers), the emissivity comes from NDVI. It is 0.991 for water, 0.973 for bare soil and 0.986-0.99 for vegetation. Where USGS computed the value itself, the mean difference is below 0.5 °C, for 95 % of the pixels not above 1.9 °C. The layer description tells what share of the pixels the formula computed. The layers go to the Landsat group with the credit "Landsat N image courtesy of the U.S. Geological Survey". The Whole scene by link method is not available for Landsat - the key lives an hour, and a layer of a saved project would not open later. Landsat 7 images after May 2003 have empty stripes from an instrument failure. Over water, the near infrared reflectance of Landsat 4-5 can be above red, and the NDVI of water comes out about +0.1.

The ASTER images here... item of the globe menu and the same action of the Search line - by the words ASTER, minerals, kaolinite - open the window right on these images. The ASTER line of the same list gives ASTER images of the Terra satellite of 2000-2006 - 14 bands, visible and near infrared at 15 m, six shortwave infrared at 30 m, five thermal at 90 m. The catalogue and files are Microsoft Planetary Computer, no sign-in is needed. ASTER imaged on request, there are few scenes - 5 near Perm, 24 at Cuprite in Nevada. The VNIR and TIR bands work after 2006 too, but in the open copy imaging ends in 2006, later scenes exist only at NASA and in Earth Engine with a sign-in. If the search dates are later than 2006, the window sets 2000-2006 when this line is chosen. Products:

Product	Bands	What is seen
False colours (3N 2 1)	3N 2 1	vegetation is red, 15 m
Shortwave infrared (4 6 8)	4 6 8	rocks and minerals
Kaolinite, alunite	(4 + 6) / 5	argillic alteration
Sericite, muscovite	(5 + 7) / 6	sericitic alteration
Mg-OH and carbonates	(7 + 9) / 8	carbonates, chlorite, epidote
Iron oxides	2 / 1	hematite, goethite
Quartz	11 ² / (10 × 12)	quartz from the thermal bands
All scene bands	1-14	14 bands in one file

The band ratios are those used in ore exploration (Rowan, Mars 2003, Ninomiya 2003), the scale is stretched over the area, warm colours mean more of the mineral. At Cuprite the kaolinite and alunite index shows both known zones of altered rocks. The values are top of atmosphere reflectance and brightness temperature in K, computed for the normal band gain. The gain mode of a scene is not recorded in the open copy, with another gain the reflectance of a band differs by a constant factor, so ASTER gives no NDVI. ASTER L1T has no cloud mask, the cloud cover over the area is the cloud cover of the scene, the Clouds and shadows empty check box is not available. Some scenes have no shortwave bands, products from them are not built then. The layers go to the ASTER group with the credit "ASTER data courtesy of NASA/METI/AIST/Japan Spacesystems and U.S./Japan ASTER Science Team".

The ASTER since 2007 - NASA, an Earthdata key is needed line gives ASTER images after 2006 from the NASA LP DAAC archive. The search in the NASA CMR catalogue goes without sign-in, the preview is the open picture of the whole scene. NASA gives the files only by an Earthdata key. The key is free, how to get and enter it is told in the NASA Earthdata key section. If NASA does not accept the key, the window erases it and asks for a new one at the next load. The files are read by temporary addresses that NASA gives. The ASTER shortwave bands failed in 2008, so these scenes have only the VNIR and TIR bands - false colours, iron oxides, quartz and 8 bands in All scene bands, the tile column says ASTER VNIR TIR. The 2026 scenes at Cuprite have no thermal bands either, then All scene bands holds the three VNIR bands, and quartz is not built. Night scenes with only thermal bands are not listed. The NASA catalogue knows only the scene frame, and the ASTER imaged strip is turned inside it. An area near the frame edge may lie beyond the edge of the image. Then the window adds no layers and says that the bands hold no data.

The Early Landsat images 1972-1993 here... item of the globe menu and the same action of the Search line - by the words MSS, early images, old images - open the window right on these images. The Landsat 1-5 MSS line of the same list gives the oldest Landsat images - the MSS scanner, 1972-1993, 60 m per pixel, USGS Collection 2 Level-1 processing from the same Planetary Computer catalogue. Near Perm there are 778 scenes of 1973-1993. There are four bands - green, red and two near infrared, without blue and thermal. So the products differ - False colour, near infrared, All four MSS bands in one file, NDVI and NDWI. The values are top of atmosphere reflectance by the multipliers of the scene metadata file and the sun elevation, without atmospheric correction. NDVI from them is not directly comparable with NDVI of Landsat 4-9. Cloud cover over the area comes from the qa_pixel mask, for MSS it holds only clouds. If the search dates are later than 2013, the window sets the summer of 1975 when this line is chosen and returns the former dates when another satellite is chosen. Many MSS scenes have slanted stripes of failed lines - saturated pixels of one band and dips next to them. The window finds them by the qa_radsat saturation mask, by the ratio of a band to the others along the stripe and by spikes of one band and replaces them with the mean of the neighbouring sound pixels. Wide saturated areas - clouds and snow - stay as they are. The geolocation of all MSS scenes near Perm is class T2, coarser than that of Landsat 4-9. MSS images were added after a discussion with Nadezhda (<https://github.com/nadiopt-cell>), the author of QGIS plugins for loading satellite images.

The same Satellite list gives the ready MODIS products of the Terra and Aqua satellites, version 061, since 2000. The catalogue and the files are Planetary Computer, the window gets the access key itself:

- Temperature per day, 1 km and over 8 days - the daytime and nighttime surface temperature in °C (MOD11A1 and MOD11A2, MYD for Aqua).
- NDVI and EVI over 16 days, 250 m - the MOD13Q1 vegetation indices.
- Snow per day, 500 m - the snow share of a pixel in percent, MOD10A1, over 8 days - the classes no snow, snow and lake ice, MOD10A2.
- Burned areas by month, 500 m - the day of year of burning, MCD64A1.

A MODIS scene is a day or a period of one satellite. The MODIS tiles that the area touches are read together, the layers come in the UTM system of the area centre with the product step. The Over the area column of MODIS is the cloud share by the product quality band, for temperature the share of pixels without a value. MODIS has no cloud cover of the whole scene, its field is disabled. In winter at the latitude of Perm the daily products are often fully cloudy, the 8- and 16-day composites have fewer gaps. The layers go to the MODIS group with the credit of the product and the NASA archive, for example "MOD11A1 v061, NASA EOSDIS LP DAAC".

NASA Earthdata key

NASA gives ASTER images after 2006 only by an Earthdata key. The key is free, each user has a key of their own.

1. Account. Open <https://urs.earthdata.nasa.gov/users/new> and fill in the form - user name, password, email address, country, occupation. Confirm the email by the link in the NASA letter. If you already have an account, sign in at <https://urs.earthdata.nasa.gov>.
2. Key. On the profile page open the Generate Token tab at the top and press the Generate Token button. A long string of Latin letters, digits and dots appears - this is the key. Copy it whole.
3. Key in PlanetX. Right-click the globe at the place you need and choose ASTER images here.... In the Satellite list choose ASTER since 2007 - NASA, an Earthdata key is needed. Press Find, choose a scene and press To QGIS project. The window asks for the key. Paste the copied string and press OK. The window keeps the key and does not ask for it again.

The key is valid for 60 days. When it expires, the line The Earthdata key was not accepted appears at the bottom of the window, and the window asks for a new one at the next load. The same Generate Token button makes a new key. The key is kept in the QGIS settings of this computer and goes only to the NASA server. Whoever knows the key loads data on behalf of its owner, so the key is not sent to anyone. A key that got into other hands is revoked by the Revoke button next to it on the same tab. The scene search and the preview work without a key too.

Route

A route by roads is built between two points on the Earth. The Directions from here item of the globe menu sets the start, Directions to here sets the end. With a point placemark under the cursor the route takes its point and name. When both points are set, the route is built by itself and goes into My Places as a path named Route N. The camera flies to it. The length and the travel time stand under the search line. The By car, By bike and On foot links build the route the other way, Clear removes the points.

The OSRM service on the FOSSGIS server builds the route from OpenStreetMap data, at any distance. The route from Perm to Sochi, 2664 km, arrives in 1 s. The route points go to the service server. The service updates its data every two days. The Map error link opens the OpenStreetMap page where errors in roads are reported. Requests to the server go no more often than once per second, a FOSSGIS condition. The Build routes with the service box and the address of an own OSRM server are the Routes group of the Data sources window.

Without the box or when the service did not answer, the plugin builds the route itself. It uses the roads of the vector base, that is OpenStreetMap data in OpenFreeMap tiles. A car drives on roads from motorways to tracks, keeps one-way traffic and does not go on paths. A walker goes on all roads and paths except motorways, in both directions. A bike goes where a walker goes, except trunk roads. The travel time follows the road class, from 90 km/h on a motorway to 15 km/h on a track, by bike 15 km/h, on foot 5 km/h. The data hold no traffic, speed limits or turn restrictions.

Over tiles the route points lie no more than 50 km apart in a straight line. A point goes to the nearest road of the connected network, an island of roads without an exit, for example inside the Kremlin, is skipped. Road tiles load in a strip along the straight line between the points, the line under the search shows the loading. Without a way in the strip the strip widens. A route from the centre of Perm to Motovilikha, 5 km, is built in 3 s together with loading. The ready path is an ordinary placemark, it has an elevation profile, a tour and a KML record.

Saved view

The Save view icon puts a placemark at the look-at point. The name is offered with a number - View 1, View 2. The placemark keeps the camera distance, heading and tilt. A flight to such a placemark brings the whole view back.

Place properties

Name

My path 1

Description

Color

Width

3.00

Height above ground

0.0 m

Ground

Space

☐

Extend to ground

Time

None

2026-10-12 01:59

Hide beyond

do not hide

☐

Place view

Latitude

58.035000°

Longitude

56.210000°

Range

3000 m

Heading

0.0°

Tilt

0.0°

Date/time

None

2026-10-12 01:59

Snapshot current view

Reset

OK

Отмена

The Properties... item opens the properties window. The window does not block the globe, the view can be turned and zoomed. Each change shows on the globe at once. While the window is open, the vertices of the placemark, path or polygon show on the globe as circles and can be dragged, a circle in the middle of a

segment adds a vertex. OK writes the changes to the place together with the shape, Cancel brings the previous look and shape back.

Field	What it sets
Name	Name in the list and label on the globe
Description	Text of the placemark, it goes into KML too
Icon	Point icon from the QGIS set, in KML a standard icon of the same theme
Color, Width	Color of the point icon, color and width of the line and outline
Fill	Fill color of the polygon and of the wall
Height above ground	Lift of the object above the terrain in metres. The Ground - Space slider under the field sets it from the ground to 100 km
Extend to ground	A wall from the object to the ground, a post for a placemark
Time	Moment or interval of the placemark for the time slider
Hide beyond	The placemark is visible only while the eye is closer than this distance. 0 - always visible. In KML the field is written as Region
Place view	Look point, range, heading, tilt of the camera at the place and the view date

Extending works with a height above zero. A path becomes a wall, a polygon becomes a block.

Place view

Any place can have a view of its own. A view is the point the camera looks at, the range to it, the heading and the tilt. The look point may differ from the place. Fly to, a double click on the place and a tour stop follow the view.

Snapshot view in the place menu makes the current globe view the view of the place. The properties window has the same values in the Place view section. The Snapshot current view button takes the globe view, Reset brings back the view the place had when the window opened. Clearing the section check box removes the view, then the camera frames the whole place. The view goes into KML as a LookAt element and is read from it.

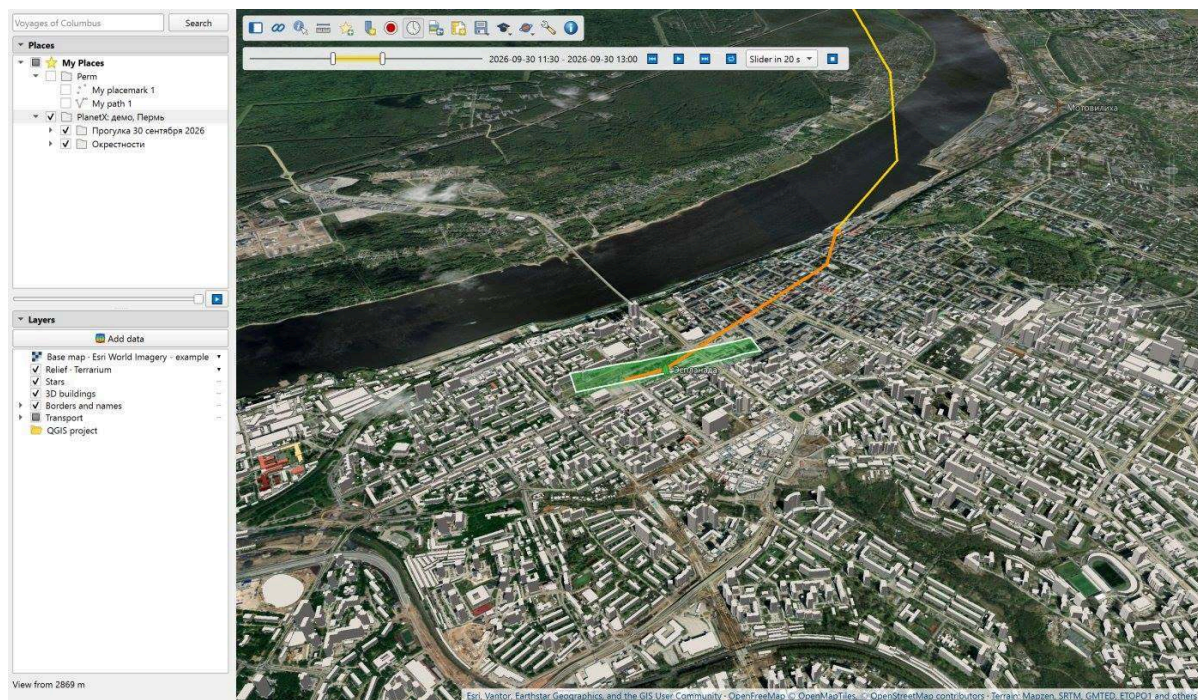
Copy and paste

Copy or Ctrl+C puts the selected places and folders into the clipboard as KML text. The text can be pasted into a text editor, edited and copied back. Paste or Ctrl+V puts the places from the clipboard into a folder. On a place it is the folder of that place, on empty space the root of My Places. Folders from the clipboard come in as folders. KML copied in Google Earth pastes the same way.

Placemark time and the time slider

The time slider is one time of the whole view. Coverages - NASA themes - take the moment, the right handle. Events - placemarks with time and earthquakes - take the range between the handles. When a theme is on and there are no events, the slider has one handle. The < and > buttons move the moment by a step of the theme series, ► shows the days of the series one after another and waits until each day has loaded. The legends of the layers - theme, foci, cutaway, beds, insolation, slope and temperature - stand as one panel in the bottom left corner of the view.

A placemark can have a time of its own. It is a moment or an interval, the Time field of the placemark properties. In KML the time is written as TimeStamp and TimeSpan. The view of a placemark has its own time, the Date/time field of the Place view section.



The time slider opens with the Time slider button on the icon bar. The button is available when visible placemarks have a time. The slider spans the placemark times from the earliest to the latest. A closed slider hides no placemarks, all of them show.

Part	What it does
Handles	Set the interval. Placemarks outside it are hidden, placemarks without a time always show
Bar between the handles	Dragging moves the whole interval, a click on the bar centres it on the click
⏮, ⏭	The interval of the same width moves to the start or the end of the slider
▶,	Playback and pause, the interval moves along the slider
🔄	Playback in a loop, after the end of the slider the interval starts from the beginning
Speed	Slider in 20 s crosses the whole slider in 20 seconds. $\times 1$ - time runs as on a clock, $\times 60$ - a minute per second, $\times 3600$ - an hour, $\times 86400$ - a day
Now	The moment goes to the computer clock, time runs at $\times 1$. The button is there when the Sun, satellites or the sky are on
■	Closes the slider

A flight to a placemark and a tour set the slider to the time of the placemark view, without it to the time of the placemark itself. A closed slider opens then. The slider is its own and does not depend on the QGIS Temporal Controller.

The Sun and Satellites layers and the sky view depend on the moment, not on data. With them the slider opens without timed placemarks too, on the computer clock, with one handle. The slider spans a day before the moment and a day after it. Playback at a clock speed does not stop at the edge of the span, the span moves after the moment. So at $\times 3600$ the line between day and night runs over the Earth, and the satellites pass their revolutions. A closed slider returns the Sun and the satellites to the computer clock.

KML and KMZ

Open KML or KMZ... puts a KML or KMZ file, including one from Google Earth, into My Places as a new folder named after the file. Folders, styles, icons, times and placemark views are kept. `gx:Tour` becomes a recorded tour. The Region of placemarks and folders is kept too. A placemark is visible while its box on the screen is not smaller than `minLodPixels` and not larger than `maxLodPixels`. The box size is counted for a window 1000 pixels high with a 60° field of view. A placemark therefore hides at the same distance in any globe window. The camera flies to the contents of the file.

Save as KML... saves a folder or the whole My Places to KMZ or KML. The file extension chooses the format.

Network links

A network link is a My Places folder with the contents of a KML or KMZ document at an address, as `NetworkLink` in KML. The address is a web page (http, https) or a file on disk. The Add - Network link... item of a folder menu opens a window with the name, the address and the refresh interval. A network link from an opened KML file goes into My Places as the same kind of folder.

The document is loaded while the folder and its parents are checked. Without an interval it is loaded once per session, with an interval it is loaded again after it, but not more often than every 10 s. A file on disk is read again when another program changes it. A new document replaces the folder contents, edits inside the folder are lost then. Addresses inside the document count from the address of the document itself. Nested network links are loaded the same way, down to the third level. The Reload item of the link menu loads the document at once, Properties... change the name, the address and the interval. On a loading error the status bar shows its reason, the old contents stay. In KML a link is saved as `NetworkLink`, without contents.

An example lies in the plugin repository, folder `examples/network_link`. The `link.kml` file opens with Open KML or KMZ.... It holds two links. The first is the `planetx_demos.kml` file with demo places from the same repository on GitHub, it is loaded again once an hour. The second is the USGS feed of earthquakes of magnitude 2.5 and above for a week, it is loaded again every 5 minutes. USGS gives ready link files for its feeds with the `_link.kml` ending, for example

`https://earthquake.usgs.gov/earthquakes/feed/v1.0/summary/4.5\_week\_depth\_link.kml`.

Image overlays

The Add submenu of a folder adds an image from a PNG, JPEG or GIF file in three ways:

- Ground overlay - the image lies on the terrain by four corners, in the middle of the view at half of its width. It lies under the borders and project layers.
- Photo - the image stands as a plane in 3D in front of the current camera. Fly to puts the eye at the camera point of the photo, and the photo covers the view.
- Screen overlay - the image stands in a corner of the view and does not move with the globe, for example a logo or a legend.

The overlay opens in a properties window. It changes the name, description, image and opacity, for a screen overlay also the corner of the view and the width. OK saves the changes, Cancel brings back the previous state.

A ground overlay is placed in one of two ways, as in KML:

- Box - north, south, east, west and rotation, fields of the properties window. While the window is open, handles stand on the globe. The centre moves the image, the handle above the north side rotates it,

the corners and the middles of the sides stretch it from the opposite corner or side, with Shift from the centre. A new image is placed as a box.

- Four corners - the Convert to four corners button. Each corner is dragged with the mouse on its own, the image can become an irregular quadrilateral. It does not convert back to a box.

The image is kept in one of two ways, the Storage field:

- In the places file - a copy inside My Places, shown without the source file.
- Link to a file or address - a file path or an http(s) address. The image is read when shown, an edit of the file shows on the globe.

The Refresh field sets the interval after which a linked image is read again while it is shown. A web address is requested past the cache, so the globe shows a fresh image or map that the server updates by itself. An interval shorter than 10 s is raised to 10 s. In KML this is `refreshMode onInterval` and `refreshInterval` of `Icon`.

KML and KMZ with Google Earth overlays - GroundOverlay, ScreenOverlay and PhotoOverlay - open the same way. The image of a KMZ goes into the places file, the image of a plain KML stays a link to a file next to it or to a web address. Save as KML... to KMZ puts into the archive the images from the places file and the ones linked to files. To KML the images from the places file go into a folder next to it, links stay links.

Image to the QGIS project... in the menu of a ground overlay writes it to a GeoTIFF file in WGS84 by the corners of the image. The file is added to the project as a raster layer in the PlanetX - images group, with the opacity of the overlay. Ground overlays to the QGIS project... in the folder menu does the same for all ground overlays of the folder, into a chosen directory.

Clear My Places... removes all placemarks and folders after a confirmation. The removal cannot be undone, so the places needed are better saved to KML first.

Ruler

The Ruler icon opens a window with the tabs Line, Path, Polygon, Circle, 3D path and 3D polygon. Points are put with clicks on the globe, a rubber band follows the cursor.

Tab	Values
Line	Map length, ground length, heading. The third click starts a new line
Path	Map length, ground length
Polygon	Perimeter, area
Circle	Radius, perimeter, area. The first click is the center, the second sets the radius
3D path	Length by straight segments in space

Tab	Values
3D polygon	Perimeter, area in the plane of the polygon, tilt of the plane

Map length, perimeter and area are computed on the WGS84 ellipsoid. Ground length runs along the surface with its rises and falls. Heading is the azimuth of the start of the line clockwise from north. Each value has its own units - metres, kilometres, miles, nautical miles, and for the area square metres, hectares, square kilometres, square miles.

Heights for the ground length come from Mapzen Terrain Tiles. Missing height tiles along the line are loaded, even when terrain is off. While they load, the ground length is preceded by «≈».

A ruler point can be grabbed with the mouse and dragged, Backspace removes the last point. Each segment on the globe is labelled with its length.

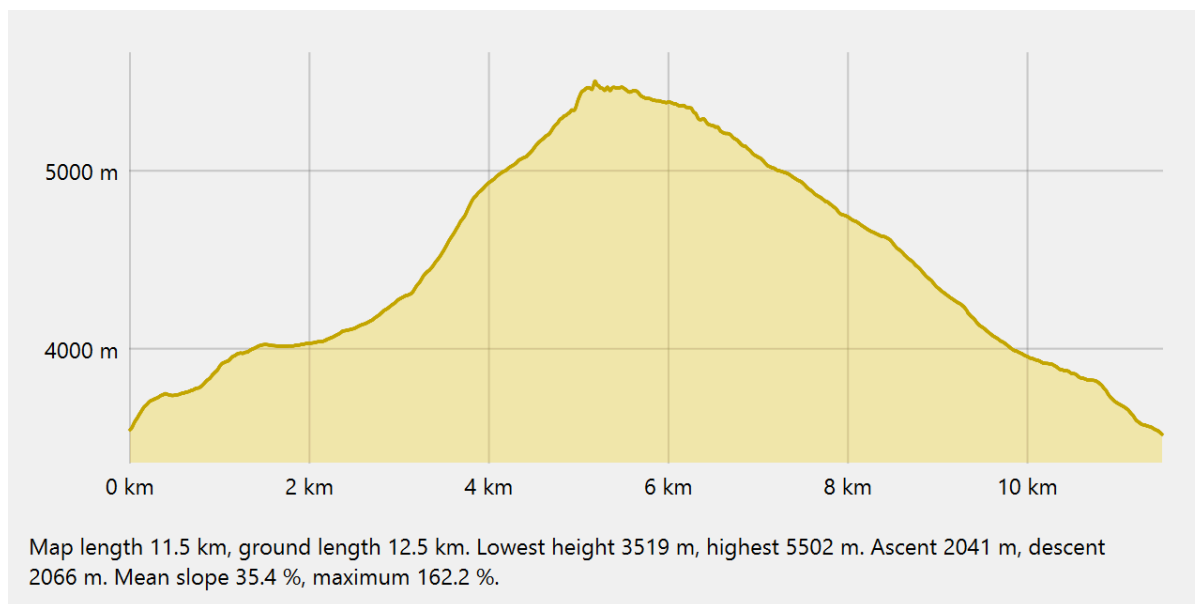
The Save button puts the shape into My Places together with the measurement. The name is offered with a number, for example Line 1. The measurement shows in the row tooltip.

The 3D path and 3D polygon tabs put a point on the roof or wall of a 3D building when the ray from the eye meets it before the terrain. They keep the height of the point. Segments run straight between the points and do not follow the terrain. The area of a 3D polygon is measured in its plane, so for a roof slope or a wall it is the real one. Tilt is the angle of the plane to the horizon, 0 is a flat roof, 90 a wall. A saved 3D shape goes to KML with altitudeMode absolute.

The Ruler and New placemark windows are open one at a time. Opening one closes the other.

Elevation profile

The Elevation profile button of the ruler opens a chart of height along the line. The Elevation profile item in the menu of a path in My Places does the same.



Under the chart are the map and ground length, the lowest and highest height, ascent and descent, the mean and maximum slope. The cursor over the chart shows the distance, height and slope at that place, and a mark with the height shows the point on the globe. The profile of the ruler follows its points.

Heights are taken as for the ground length. The slope is measured over a stretch not shorter than three pixels of height data, so roughness of the data does not pass for a cliff. On steep mountains the maximum slope may exceed 100 %, that is 45°.

Viewshed from a point

The Viewshed from here... item in the menu of a point placemark opens the Viewshed from a point window. The window sets the observer height above the terrain, the target height and the circle radius. The Build button loads the heights under the circle and colours it. Visible places are green, places hidden by the terrain are red. The Remove button removes the colouring.

Rays leave the point with an equal azimuth step. The step along a ray is one five-hundredth of the radius, 20 m for a radius of 10 km. A place is visible if the ray from the eye to it does not touch the terrain on the way. The computation takes the curvature of the body into account, and on the Earth the refraction with the coefficient 0.13. Buildings and forest are not taken into account. The window shows the visible share of the circle area. If the heights are not loaded within 30 s, the computation uses less detailed ones, and the window says so. The viewshed is computed on the Earth, Mars and the Moon.

Insolation

The Insolation... item in the menu of a point placemark opens the Insolation window. The window sets the first and the last day of the period and the circle radius. The Build button loads the heights and colours the circle by the mean number of hours of direct sunlight per day. Blue means little light, red means much light. The scale in the bottom left corner of the view runs from zero to the largest value in the circle. The Remove button removes the colouring.

The position of the Sun is computed every 10 minutes of the UTC day. A place is lit if the Sun is above the mountain horizon at its azimuth and falls on the front side of the slope. The horizon is taken in 32 directions at a distance of at least the radius and at least 5 km. A period longer than 15 days is computed over 15 evenly spaced days. Clouds, refraction, buildings and forest are not taken into account. The height grid has 800 nodes per side, the step is 25 m for a radius of 5 km. The computation runs in parts, and the globe responds to the mouse meanwhile. The line under the fields shows the share done. Insolation is computed only for the Earth.

Subsurface mode

The Subsurface mode... button of the View properties window and the ... button of the Ground above grids row of the Layers section open the Subsurface mode window. The mode shows drill holes, bed roofs, section walls and a block cut under the surface.

Data

The data are tables in the same layout as in Isoliner.

Table	Fields	What it sets
collar	hole_id, z, eoh, point geometry	Hole collar, collar elevation, end-of-hole depth along the hole
interval	hole_id, from, to, code	Intervals along the hole, positive downward, code is the bed or lithology
survey	hole_id, depth, azimuth, dip or zenith	Survey. Without it the hole is vertical
beds	code, ord, color, surface	Order of beds from top to bottom, colour "#rrggbb", roof raster file
sections	line geometry	Section lines
cut	polygon geometry	Block cut

Table	Fields	What it sets
images	name, image, top, bottom, line geometry	Image section: a PNG or JPG file relative to the folder of the GeoPackage file, elevations of the top and bottom of the image in metres
tunnels	name, depth, depth_end, diameter, color, line geometry	Tunnel: depth of the axis below the surface at the start and the end of the line, diameter in metres, colour "#rrggbb"

Fields are also found by other common names, for example bhid, elev, td, from_m, to_m, litho. A dip angle with negative values is counted from the horizontal, -90 is straight down. A bed roof is a raster of elevations in metres in any coordinate system, GDAL reads it.

Geological project layers show in 3D as ordinary globe layers. A layer is recognised by a table name from the list above or by its fields, for example a point layer with the fields hole_id and eoh is collars. A layer checked in QGIS project goes under the surface, an unchecked box removes it. Such layers are not drawn as a flat image on the surface. A roof is a raster whose file is named in the surface field of the beds table. The interval, survey and beds tables are taken from the project by themselves, first from the same layer group.

The path to a section image is relative to the folder of the file of its layer. When the project has several layers of one role, the top one in the layer tree is taken.

The style comes from QGIS, as with ordinary layers:

- a roof whose raster is coloured with a pseudocolour ramp, a palette or RGB takes this colouring. A grey raster without settings takes the bed colour from the beds table.
- a hole without intervals and a tunnel take the colour of the feature symbol when the layer style is categorized, graduated or rule-based. With a single symbol the colour comes from the color field, without it the mode uses its own colour.
- the opacity of a QGIS layer is the opacity of its objects under the surface.
- the labels above the collars are the labels of the QGIS collar layer, from a field or an expression. With the layer labels off there are no labels.

After the style or data of a layer is edited, the globe rebuilds the model as with ordinary layers. The Create template... button of the Subsurface mode window writes a GeoPackage file with all tables of the mode and an example at the view point - a drill hole with two intervals, a section, a tunnel and a cut - and adds it to the project as the Subsurface template group. The template tables are filled with your own data.

Grids by elevations

A project raster whose values are absolute elevations in metres lies under the ground as a surface. For this the Surface by elevations item is checked in the raster menu of the QGIS project group. The layer box shows and hides the surface. The raster coordinate system comes from the QGIS layer, so an ASCII Grid without a .prj file also fits.

The surface colour is the QGIS raster colouring. A grey raster without settings takes the bed colour. Grids whose names end with _top and _bottom, for example B_top and B_bottom, are the top and the base of one bed. They take one colour, end walls stand between them along the data edge, and the bed looks like a slab. The endings roof, base and their Russian words also fit.

Contour lines lie on a grid surface, about 12 lines over the range of elevations, with an interval from the same series as the terrain contours. Every fifth line is thicker and darker.

The Contours to the QGIS project... item of the raster menu exports contours of the raster values as a GeoPackage layer to the PlanetX - contours group. The interval is the same as on the globe grid, every fifth line is thicker and labelled.

A block is built under the grids. Walls with beds stand along the data edge from the terrain to the model bottom, a floor lies at the model bottom. The walls darken with depth. A wall facing the camera from outside is not drawn, so the block is seen from inside from any side. Above the block the ground is transparent by the Ground above grids slider of the Layers section, outside the data outline it is opaque. The slider row appears together with the underground model.

Thin beds are easier to see with the vertical terrain scale of the View properties window. The scale stretches depths too.

Display

The model is built when at least one geological layer is checked. The globe loads the terrain heights under the model and puts it under the surface.

- A drill hole follows the survey by the minimum curvature method. Intervals take the colour of their bed, the layer label stands above the collar.
- A bed roof is a surface in the colour of the bed.
- A tunnel is a tube of its diameter along the line below the terrain. The depth changes from depth at the start of the line to depth_end at its end, this sets a ramp to a portal. Without depth_end the depth is constant, without diameter it is 3.7 m.
- A section is a set of walls along the line from the terrain to the model bottom, beds between the roofs have their own colours.
- An image section is a vertical wall along the line from the top elevation to the bottom elevation with the image stretched on it. The left edge of the image is the start of the line, its top is the top elevation. An image larger than 4096 pixels on the longer side is scaled down.
- The model bottom is the end of the deepest hole, without holes it is 20 m below the deepest roof.

Depth is stretched by the terrain scale, like the surface. With the terrain off, elevations are counted from the surface.

The Surface opacity slider makes the terrain inside the model frame transparent, the drill holes and roofs show through it. Outside the frame the surface stays opaque, with grids - outside their data outline. The Block cut checkbox removes the surface and the roofs inside the cut polygon. Walls with beds stand along the cut edge, a plane at the model bottom lies at its floor. The Camera under ground checkbox lets the camera go below the terrain down to the model bottom. Inside the model frame the camera then moves along its bottom. The window settings are kept in the project.

A polygon of My Places cuts the model with the Model cut item of its menu, a path puts a wall with beds with the Model section wall item. Choosing the item again removes the cut or the wall. Editing the shape of the place changes the model at once. So a cut and a section are drawn on the globe with the New placemark tool.

The Beds legend in the bottom left corner of the view shows the beds of the model from top to bottom in their colours and the tunnels.

In the Identify mode a click on a drill hole shows its number, the bed, the depth along the hole and below the collar, the elevation and the end of hole at the point under the cursor. A click on a tunnel shows its name, the depth and elevation of the axis and the diameter.

The Model section... item of the path menu in My Places opens the window of the same name. The horizontal axis is the distance along the path, the vertical axis is the elevation in metres. The section shows the terrain, the beds between the roofs, the drill holes in the colours of their intervals and the tunnels at their diameter from a band along the path. The Band of holes and tunnels field sets the band width. The cursor over the chart marks the point on the globe.

The subsurface demos put their data into the QGIS project as a group of ordinary layers and check them on the globe. The Permian deposits demo in the Demo icon opens a synthetic site near Berezniki, on the Verkhnekamsk deposit. It has 24 drill holes, 9 bed roofs of the Verkhnekamsk section, two sections, a cut of the north-east quarter and the image section 3-3. The data are made up for the example, they are not a survey.

The Vegas Loop tunnels demo opens the tunnels of The Boring Company under Las Vegas with their stations, about 8 km of lines. The routes and stations come from OpenStreetMap. OpenStreetMap has no depth, the tunnel axis is 12 m below the surface, about 40 feet after public information on the Las Vegas Convention Center tunnels, and ramps to the stations go from the surface down to this depth.

Tours

A tour flies over the checked places of a folder in the list order, including nested folders. The description of the stop place shows below the buttons of the tour bar.

- A place with a view of its own brings back its look point, range, heading and tilt.
- Along a path the camera travels the line.
- Other places are framed whole.

A tour starts with Play tour in the menu of My Places or a folder. A path has Tour along the path in its menu. The ► button under the places list starts a tour too. It tours the selected folder or path, and with a place selected it tours the folder holding the place. A tour goes through the places of the body now on the globe. When no places are checked, the status line says so.

The tour bar appears at the top of the view as a second row under the time slider, and without the slider in its place:

Button	What it does
Slider	Shows how much of the tour has passed and winds the tour. The camera moves to the chosen point at once, after release the tour goes on from it
⏮, ⏭	Previous and next stop
⏸, ▶	Pause and continue
Pause	How many seconds the camera stays at a stop
🔄	Loops the tour. After the last stop the tour starts again from the first. The button state is kept between sessions
●	Records the tour to an MP4 video or PNG frames
■	Ends the tour

Moving the camera with the mouse pauses the tour.

Recording a tour from the screen

The record button ● on the icon bar records the camera movement. The camera can be moved with the mouse, keys, flights and the navigation controls. A second click ends the recording and asks for a name. The tour goes into My Places with a film icon and is not drawn on the globe.

Play tour in the menu of such a tour plays the recording. The camera first flies to the start of the recording. The slider of the tour bar and tour recording work as for a tour over places. In KML a recorded tour is saved as `gx:Tour`, and Google Earth plays it.

The path of a recorded fly-around is edited in the Properties... window of the tour. While the window is open, the path of the view point is shown on the globe as a line with twenty key points. A key point is dragged with the mouse, the poses between key points follow it smoothly. The Fly-around height slider lowers the camera in all poses down to a quarter of the recorded height or raises it up to four heights. Time, heading and tilt of the poses do not change. OK saves the edit, Cancel discards it.

How to make a video

1. Put the stop places into one folder of My Places. Snapshot view in the menu of a place sets its view.
2. Check the places you need and drag them into the flight order.
3. Switch on the layers of the video - a NASA theme, the sun, clouds or the time slider at the day you need.
4. Play tour in the folder menu plays the tour. The pause at a stop is set on the tour bar.
5. The ● button of the tour bar opens the Tour recording window. The MP4 video at the window size mode gives the video at once. The video size equals the size of the globe window, so stretch the window beforehand.

Instead of places, the ● button on the icon bar can record the camera movement, see Recording a tour from the screen. A tour along a My Places path leads the camera along the line.

Recording a tour for a video

The ● button opens the Tour recording window with two modes. Both write 25 frames per second of the tour, the source credits stand in the corner of each frame.

- MP4 video at the window size is the quick mode. The window asks for a file name, at the end of recording an H.264 clip is ready. Windows itself encodes it, no other programs are needed. The mode exists only on Windows. A tour of two stops, 71 frames of 2592×1860 , is written in about 45 s and takes 10 MB.
- PNG frames to a folder is the professional mode. The window asks for a folder and a size: as the window, 1920×1080 , 2560×1440 or 3840×2160 . A frame larger than the window is drawn anew at this size, labels and lines grow in the same proportion. The files are named `frame_00000.png`, `frame_00001.png` and on, frames with the same numbers in the folder are replaced.

Each frame waits for the tiles, so recording takes longer than the tour and the frames have no blurred spots. A frame that waits longer than 20 seconds is taken as it is. Recording always starts at the first stop, so a repeated recording gives the same frames.

A file `frames.json` lies next to the PNG frames - frame rate, size, camera pose and data time of each frame, numbers of frames that did not fully load.

The bar shows the frame number. The cross on the bar stops the recording. A stopped video stays a valid file of the frames already written.

Making a video from the frames

Any program that opens an image sequence assembles a video from the PNG frames.

The free program ffmpeg (ffmpeg.org) makes an MP4 with one command in the folder with the frames:

```
ffmpeg -framerate 25 -i frame_%05d.png -vf "pad=ceil(iw/2)*2:ceil(ih/2)*2" -c:v libx264 -pix_fmt yuv420p -crf 18 tour.mp4
```

The rate 25 matches the recording rate, so the video runs at the pace of the tour. The `pad` filter adds a pixel when a frame side is odd, the H.264 codec needs even sides. A smaller `-crf` value gives better quality and a larger file.

The video editors Shotcut and DaVinci Resolve open numbered frames as one clip. Music, captions and several tours joined together can be added there.

Tracks

A track shows the path of moving objects over time. The source is a point layer of the project with a time field, and the time slider of the globe sets the time. The QGIS Temporal Controller does not act on the globe.

The Track... item in the menu of a point layer opens the settings window:

Field	What it sets
Time	A field with date and time, ISO 8601 text or seconds since 1970
Object	A field that tells the objects apart. One object - all points form one path
Color	Color of the travelled path
Camera follows	The camera keeps the first object in the middle of the view along the motion

The time of a track enters the extent of the time slider. Each object grows its travelled path up to the right handle of the slider, and a label with its name marks the current point. With the slider closed, whole tracks are shown. The Remove track button returns the layer to its usual look. Track settings are stored in the project.

During a tour recording the tracks grow along the tour over the range of the open slider, with the slider closed over the whole track time.

Project layers with time

A project layer with time switched on in its QGIS temporal properties is shown on the globe within the range of the time slider. The time of the layer enters the extent of the slider. The picture of the layer and its labels are redrawn after the handles stop. With the slider closed, the layer is shown in full.

Historical maps

A historical map is a raster, XYZ tiles or a ground image with a year. Maps of one group replace each other on the time slider. The last map not later than the slider moment is shown, before the year of the first map of the group none is shown. The ◀ ▶ steps of the slider go by the map years. With the slider closed, all maps are shown.

The Map year... item of the layer menu in the QGIS project group sets the year of a project raster or tiles. Maps of one QGIS layer group replace each other. The years are kept in the project.

The year of a ground image is the Time field of its properties window, for example «1890». Maps of one My places folder replace each other. In KML the map year is a `TimeStamp` of a `GroundOverlay`. An image with a span, for example «1890/1910», is shown within its span, like a place.

The ⇌ button of the slider opens the swipe of two years. Left of the swipe is the map of the previous map year, right of it is the map of the slider moment. The swipe is dragged with the mouse, the arrows on the left label change its year. A step before the first map leaves the imagery without maps on the left.

The Moscow, historical maps demo puts maps of Moscow of 1813, 1860, 1900, 1917 and 1935 from Wikimedia Commons into the project. The maps are in the public domain, members of the Wikimaps Warper project georeferenced them, the tiles come from its server.

The Rumsey historical maps here... item of the globe menu opens the Rumsey maps window - maps of the David Rumsey collection at the view. The collection holds about 57 thousand georeferenced maps from the 13th to the 21st century. The list goes by year, a click on a column header sorts by title or scale. The list holds 400 maps closest to the place by extent. The search line picks maps by year or title, the Whole catalogue check box searches among all maps of the collection. Frames of the listed maps are shown on the globe, the frame of the chosen map is brighter, the Show on the globe button flies to it. The To QGIS project button builds the chosen map from the collection image and georeferences it by the collection control points. The map goes into the Rumsey maps group at the top of the project with the map year and takes its place on the time slider, with maps changing by year and the swipe of two years. Building takes 5-15 s, a ready map is kept in the QGIS profile and is not downloaded again. The Map page button opens the page of the map on the collection site.

The collection images are published under CC BY-NC-SA 3.0, it allows only non-commercial use with credit to the source. The georeferencing was done by members of the collection, for some maps it is rough or wrong.

Satellites

The Satellites layer of the Add data catalogue shows artificial satellites of the Earth as dots at their height. The Satellites tab of the catalogue chooses the groups, any of them can be on:

Group	What it holds
Space stations	the ISS, Tiangong and the docked spacecraft
Bright satellites	about a hundred satellites and stages visible without binoculars
Navigation	GPS, GLONASS, Galileo, BeiDou
Weather satellites	weather satellites
Earth observation	imaging satellites, Landsat and Sentinel among them
Science	science satellites and observatories
Geostationary	active satellites at about 36 000 km
Starlink, OneWeb	communication satellites, thousands of dots

CelesTrak gives the orbital elements of the groups. The position is calculated by the SGP4 model for the right handle of the time slider. With the slider closed, the satellites follow the computer clock. A satellite whose elements are older than 30 days at that moment is not shown.

CelesTrak updates the elements once in 2 hours and asks to download a group no more often. A downloaded group is kept in the QGIS profile, and a new request goes no earlier than 2 hours later. After a refusal of CelesTrak the group is not requested for 2 hours.

A click on a satellite dot with identification on opens the Identify window with the name, the NORAD number, the group, the height, the speed and the age of the elements. The satellite becomes the selected one.

The selected satellite shows its orbit loop at its height and its ground track. The loop shows one revolution ahead of the moment, the track shows the path of the point under the satellite half a revolution back and ahead. A right click on a satellite dot opens a menu with its name and two items:

- Orbit and ground track shows or removes the loop and the track.
- Camera follows puts the look point under the satellite, the view turned along its motion. The distance and the tilt of the view change with the wheel and the mouse as usual. Choosing the item again releases the camera.

Scenes

A scene saves the whole view and can be passed to other people. The Scene icon opens the menu Save Scene... and Open Scene.... A scene file has the extension `.planetx`.

A scene holds:

- the camera pose.
- the range of the open time slider.
- the project layers checked on the globe, as a link to their source.
- the base map, terrain, terrain exaggeration, groups of the Layers section and the label language.
- the rows of the Layers section, the grid, stars, clouds, temperature and 3D buildings.
- the selected folder of My Places with its tour.

A database password does not go into the file, a link to a QGIS connection setting stays. When the whole My Places folder or nothing is selected, no places go into the scene.

When a scene opens, a layer is looked up in the project by its source and added if missing. The other project layers are unchecked on the globe. The places of the scene come in as a new folder, and the camera flies to the scene pose. The status line lists the layers that were not found and did not open.

Share view

The Share View... item of the Scene icon menu writes an HTML page. It opens in a browser without QGIS and PlanetX, it can be sent as a file or published on a site. After writing the page opens in the system browser.

The page holds:

- the globe with the camera of this view - the look-at point, distance, heading and tilt.
- the OpenStreetMap base in the OpenFreeMap style and Terrarium terrain with the terrain exaggeration of the view. Without terrain on the globe the page has no terrain either.
- the placemarks, paths and polygons selected in My Places, with their colours and labels. A click on a placemark shows its name and description.
- the Initial view button and the ► Tour button. The tour is the recorded tour from the selection. Without it the camera flies to the views of the placemarks in turn, to a point without its own view - from above at 3 km with a tilt of 45°.

The Esri base map, QGIS project layers, overlay pictures, placemark times and rows of the Layers section do not go to the page. The camera tilt on the page is not more than 85°. The page is built for the Earth only. The globe of the page is drawn by the MapLibre GL JS library, the browser loads it from unpkg.com, the tiles from the OpenFreeMap and Amazon servers. Without internet access the page is empty.

Demo

The Demo icon with an academic cap on the icon bar opens prepared scenes. Each scene puts its places into My Places as a new folder, the ► button under the list plays a tour over them. The folder can be deleted.

Section	Scene	What it holds
Earth	Perm	Places with icons and the moments of a walk, place views with a date, a route, an extruded polygon, a path along the Kama, a recorded flight over the centre, 3D buildings
Earth	Boca Chica, Starbase	The Starbase launch site and factory, the beach, nearby towns, the highway from Brownsville, a recorded flight around the launch site
Earth	Permian deposits	A synthetic site near Berezniki with drill holes, roofs, sections and a cut. A tour of five stops explains the subsurface mode, see Subsurface mode
Earth	Vegas Loop tunnels	The Boring Company tunnels under Las Vegas with their stations, see Subsurface mode
Earth	Aral Sea	MODIS images of 2000, 2014 and 2023 as a group of radio buttons, a photo of the ships at Moynaq and a basin map on the screen. All images are links to web addresses, see Image overlays
Earth	Quarry, own terrain	A synthetic 1 m survey of a quarry near Berezniki as the globe terrain: 10 benches of 15 m, a waste dump, a path for the elevation profile. The raster goes into the QGIS project, see Own terrain
Earth	Moscow, historical maps	Maps of Moscow of 1813, 1860, 1900, 1917 and 1935 as tiles in the QGIS project with map years, the Kremlin and the Cathedral of Christ the Saviour. See Historical maps
Earth	Japan Trench	Earthquakes, the Earth cutaway with a sector from the equator to 38.5° N, the Slab2 slab under Japan, the epicentre of the 2011 Tohoku earthquake, Mount Fuji. The Section window along 38.5° N opens with the demo, the foci band is 300 km
Mars	Rover landing sites	Olympus Mons, Valles Marineris, the landing sites of Curiosity, Perseverance, Zhurong, Spirit and Opportunity
Mars	Jezero crater	The Perseverance landing site, the surroundings of the crater, an elevation profile across the crater, a point on the rim for the viewshed, a flight around the crater, the Slope layer and terrain with scale 3
Moon	Apollo and Lunokhod sites	The landing sites of six Apollo missions, Lunokhod 1 and Lunokhod 2
Sky	Constellations and bright sky objects	Orion, the Pleiades, the Andromeda Galaxy (M31), Cassiopeia, Ursa Major, Lyra with Vega, the Southern Cross

The Perm walk time is fictional. Landing coordinates are rounded to hundredths of a degree.

View snapshot and view to layout

View snapshot

The View snapshot icon opens a window with the snapshot width and height in pixels. A snapshot can be larger than the window, the globe loads detailed tiles for it. The Window proportions check box keeps the height in step with the width.

The Save... button asks for a PNG or JPEG file and starts the snapshot. The camera stands still meanwhile. The Take now button does not wait for the remaining tiles. The source credits stand in the bottom right corner of the snapshot.

View to layout

The View to layout icon puts the view as a fixed picture into a QGIS layout, an existing one or a new one.

Field	What it sets
Layout	An existing layout or New layout
Width, Height	Size of the picture on the page in millimetres
Resolution	Output resolution of the layout, it sets the snapshot size in pixels

The picture is kept inside the project. The layout window opens after the insertion.

Other bodies

The Body icon on the icon bar opens the menu of bodies. The Earth is at the top, the Moon and Mars are below a separator, then come submenus:

Submenu	Bodies
Planets	Mercury, Venus, Jupiter
Moons of Jupiter	Io, Europa, Ganymede, Callisto
Moons of Saturn	Mimas, Enceladus, Tethys, Dione, Rhea, Titan, Iapetus
Asteroids	Ceres, Vesta

The menu holds only bodies imaged by spacecraft in full. On Pluto, Charon and Triton 24 to 33 % of the globe is not imaged, they are not in the menu.

The chosen body replaces the Earth. The size of the globe, the imagery and the atmosphere change, and the camera flies to the start point of the body. On Mars it is Olympus Mons, on the Moon it is the Sea of Tranquility, the Apollo 11 landing site, on Mercury the Caloris basin, on Venus Maxwell Montes. On other bodies it is a point on the equator and the prime meridian.

Imagery of the bodies other than Mars and the Moon comes from global mosaics of USGS Astrogeology and NASA, made from MESSENGER, Magellan, Galileo, Voyager, Cassini and Dawn data. A tile pixel at the equator ranges from 100 m on Enceladus and Vesta to 120 km on Jupiter. Some imagery does not look as the eye would see it:

- Venus is shown by the Magellan radar, the colour shows the height
- Jupiter is a Cassini cloud map of December 2000, its clouds do not move
- Titan is imaged in near infrared light through the haze
- Mercury, Io and Ganymede are in colour, other bodies are grey

The globe of each body is a sphere, Jupiter is an oblate ellipsoid. Vesta, Ceres and small moons are not spherical in reality, their imagery is slightly distorted on the sphere.

Mars imagery is the Viking MDIM2.1 colour mosaic, about 650 m per pixel. Moon imagery is the LOLA albedo map with hill shading, about 670 m per pixel. Mars has a thin, dusty atmosphere, the Moon has none.

Mars terrain is built from the MOLA MEGDR heights, Moon terrain from the LOLA GDR heights. Heights are rounded to 10 m on Mars and to 20 m on the Moon. A height pixel at the equator is 2.6 km on Mars and 1.3 km on the Moon. The terrain is switched on with the same Terrain row of the Layers section, the vertical scale is set in the view properties. Mars heights refer to the areoid, Moon heights refer to a sphere of radius 1737.4 km. Depressions below zero are kept, the floor of the Hellas plain lies 7-8 km below zero.

On other bodies the navigation, grid, stars, ruler, My Places, tours, view snapshot and scenes work, on Mars and the Moon terrain works too. Functions with Earth-only data are off:

- vector base, clouds, temperature, 3D buildings and sunlight
- project layers and their labels, tracks
- synchronization with the QGIS map and feature identification
- place search by name. Coordinates in the search field work

Each place remembers its body. My Places lists the places of all bodies, the globe shows only the places of the current one. A flight to a place on another body switches the body first. A tour goes through the stops of the current body. A scene keeps its body and opens on it.

Assistant

The assistant answers topics and requests from the Search field. Its buttons stand in the Assistant group of the View properties window. Conversation... opens the Assistant window, Settings... the Assistant settings window. The conversation window with an AI model is Assistant. The model controls the globe on a request in words, for example "show a section across the Japan Trench" or "where are the deepest earthquakes near Japan this month". An API key of your own for the chosen service is needed.

The conversation goes in the Assistant window. The line at the top names the service and the model, the Settings button opens the Assistant settings window. There the service, address and model are chosen, the key is entered and the check boxes are set. By default OpenRouter with a free model is chosen.

- **Service.** Each service has its own key, address and model.
 - Claude (Anthropic) - Claude models, by default `claude-sonnet-5-5`.
 - Grok (xAI) - Grok models, by default `grok-4.7`.
 - DeepSeek - DeepSeek models, by default `deepseek-flash`.
 - OpenRouter (free models available) - models of many developers with one key. Models with `:free` in the name are free, the number of requests per day is limited. By default `openrouter/free`, it picks a free model that is available itself. If the chosen `:free` model is busy, the request goes to `openrouter/free`.
 - Own service, for example Ollama - any service of the OpenAI Chat format. A service on this computer needs no key. By default the Ollama address `http://localhost:11434/v1` and the model `qwen3`. The model must be able to call tools, otherwise the assistant only answers with text.
- **Key.** The key is entered in the Key field of the Assistant settings window and saved with the Save key button. The Keep the key without the master password box is checked by default. With it the key is saved as plain text in the QGIS profile settings, the master password is not asked. Anyone with access to the profile folder can read such a key. Without the box the key goes to the QGIS password manager, and QGIS may ask for the master password.
- **What the assistant does.** Flight to a point and place search, body change, rows of the Layers section and the time slider, the Earth cutaway and a section down along points, point information and an earthquake summary in a box. All actions of the Search field are available to the assistant as well - catalog layers and maps, windows and tools, demos and bodies. It also changes the opacity of a shown layer. The assistant does not open file choice windows and does not start tour recording, the user opens them.
- **Placemarks in KML.** The assistant proposes placemarks, paths, polygons, folders and tours as a KML document. Below the conversation a proposal appears with the Write to My Places and Cancel

buttons. Nothing is written without the button. Placemarks selected in My Places can be read by the assistant as KML and returned corrected.

- **What goes to the model server.** The request text, the look-at point, the body and the rows switched on in the Layers section. Names of project layers and My Places do not go, except placemarks selected by the user.

The assistant's actions show in the conversation as Action lines. It makes no more than six rounds of actions in a row, then it stops.

Places from a description

A topic in the Search field, for example "voyages of Columbus" or "battles of the Hundred Years' War", becomes placemarks if no place with that name is found. Ctrl+Enter in the field and the Make places button of the Assistant window make placemarks at once, without a place search. The model answers with one KML document, it is written to My Places as a new folder at once, the camera flies to the places.

The model receives the rules of the document. They list everything the globe shows in space and in time:

- Places and events come as points, routes, fronts and borders - as lines along the real path, territories - as polygons.
- Time stands on every placemark with at least a known date or year. An event gets a moment, a campaign, a siege or a reign - an interval.
- A route is split into legs. Each leg is a line with its own time interval, on the time slider it grows from start to end.
- A change of a territory or a front line comes as several shapes with intervals in a row, on the time slider they replace one another.
- The document holds 100 placemarks at most.

The answer comes as a stream. While it comes, the line below the field shows the count of placemarks received and the Stop link. Stopping keeps the placemarks received whole. The plugin does the same when the answer breaks off or hits the length limit. The answer time grows with the size of the document.

The finished answer below the field names the folder, the number of placemarks and the number of placemarks with time. The time slider opens on the interval from the first to the last date. The Cancel link removes the made folder.

A topic like "World War I" searched with Enter finds places with these words in the name. Then the link Make places on the topic stands below the field, it does the same as the button.

The coordinates and dates come from the model, they need checking.

Requests from the Search field

A request can also be typed in the Search field of the left panel. The assistant receives a request with a question mark, a request of six words or more and a request that starts with a request or question word, for example "show", "where", "how many". A topic for which Nominatim finds no places, for example "Voyages of Columbus", turns into placemarks at once, as with the button next to the field. A question for which no places are found goes to the conversation. Outside the Earth any request except coordinates goes to the assistant. The answer appears below the field, the Conversation link opens the Assistant window with the history. Placemarks that the assistant proposes in the conversation are shown below the field with the Write to My Places link. The Answer requests from the Search field box of the Assistant settings window switches this off, then the field finds only places and coordinates. Without a saved API key the field also finds only places.

Starry sky

The Sky item of the Body menu shows the sky from the centre of the celestial sphere. It holds the Milky Way, 5080 stars down to magnitude 6, lines and names of 88 constellations and names of bright stars. The Sun, the Moon and the planets from Mercury to Neptune are there too. The north celestial pole is up and east is on the left, as on a star chart.

Action	What it does
Drag with the left button	The sky follows the cursor
Wheel, PageUp, PageDown, plus, minus	Changes the field of view from 2° to 110°
Double click with the left button	The point moves to the centre, the field of view halves
Double click with the right button	The field of view doubles
Arrows	The view moves by a tenth of the window height

The status bar shows the field of view, the right ascension and the declination of the point under the cursor. Equatorial coordinates refer to the epoch J2000.0. The Sun, the Moon and the planets are placed at the end of the open time slider range, otherwise at the computer clock time. Planet positions differ from the JPL Horizons ephemerides by at most 0.2° in the years 1800-2050, the Moon position by at most 0.3°.

The Constellations item of the same menu hides and shows the constellation lines and names. Stars, their names, the Sun, the Moon and the planets stay.

Places and tours work in the sky. Save view puts a place with the view direction and the field of view. New place puts a point with a click on the sky. Record a flight records the motion over the sky. Sky places are kept in My Places with the others and are shown in the sky as yellow circles with a label. A tour and the ► button in the sky go through the sky places, between distant points the field of view widens on the way. A flight to a sky place from the list opens the sky.

The ruler, synchronization and feature identification are off in the sky. A view snapshot saves the sky with its labels. A scene keeps the view direction and the field of view. To return to a body, choose it in the same menu.

Log

The plugin keeps a log in the file `PlanetX/planetx.log` of the QGIS profile folder. The Log button of the About window opens it in the system program. The log records the versions of the plugin, QGIS, Qt and Python, the graphics card, the opening and closing of the globe window, the choice of maps and layers, the base map, the body and the demo, the SSL errors of QGIS network requests with the certificate owner. The log receives all unhandled Python errors in QGIS, including those in worker threads. An error of another plugin is marked with its name. Every 15 minutes the log records the memory of QGIS and the count of Windows GDI and USER objects.

When QGIS does not respond for more than 30 s, a separate watch process of the plugin writes next to the log a process dump `hang-<process number>-<time>.dmp` with the stacks of all threads, about 300 KB without memory contents, and writes its analysis at once - for every thread the QGIS and Qt functions it stands in. It shows which thread waits for what. The watch runs outside QGIS and writes the dump even when QGIS hangs completely. The last three dumps are kept.

The log records a QGIS crash at the next start. The log gets the process number and the start time of the crashed session, the Python stacks at the crash and the path to the Windows dump, if there is one. While the Windows error window keeps the crashed QGIS open, the session counts as alive. A normal QGIS exit is marked with the line "QGIS is closed".

When QGIS does not respond for more than 10 s, the log receives the stacks of all Python threads. When QGIS responds again, the log gets a line with the length of the pause. This shows where QGIS hung even when it had to be closed. A log larger than 1 MB is renamed to `p1anetx.1.log`, and a new one starts. The log file helps with an error report.

Limitations

- Project layers lie on the terrain as a picture, a layer cannot be raised or extruded by a field. Your own places have lift and extrusion.
- A layer with time from an expression does not enter the extent of the time slider, its range is set with the handles manually.
- Above latitude 85° the poles are covered with the ocean color, the Web Mercator tile grid ends there.
- Recording a tour takes longer than the tour itself.
- Buildings are blocks with flat roofs, roof shapes and facades are not shown.
- Mars and Moon heights are coarser than Earth heights, a height pixel at the equator is 2.6 km and 1.3 km. Craters smaller than 5-10 km do not show in the heights.
- KML does not store the body of a place, places from a KML file go to the current body.
- The sky is shown from the centre of the Earth, without the horizon of an observing site. Coordinates are not reduced to the date, by 2026 precession shifts them by about 0.36°.

Data sources

Imagery - Esri World Imagery, Esri sets the terms. Map data © OpenStreetMap contributors. Vector tiles and 3D buildings - OpenFreeMap. Terrain - Mapzen Terrain Tiles, SRTM, GMTED, ETOPO1 and other data. Clouds - NASA GIBS, VIIRS imagery. Temperature - NASA GIBS, MODIS and GHRSSST MUR. Stars - the Yale Bright Star Catalogue. Milky Way - NASA/Goddard Space Flight Center Scientific Visualization Studio, Gaia DR2: ESA/Gaia/DPAC. Place search - Nominatim. Mars - NASA, USGS, Viking MDIM2.1, the Moon - USGS, LRO LOLA, tiles of both bodies - OpenPlanetaryMap. Mars heights - NASA MGS MOLA MEGDR, Moon heights - NASA LRO LOLA GDR. Imagery of other bodies - global mosaics of USGS Astrogeology and NASA Photojournal from data of NASA, JPL, DLR and mission institutes, the credit of each body is in the corner of the view. Constellation lines, names and star names - d3-celestial, © Olaf Frohn. Planet positions are computed from JPL orbital elements, the Moon position from the formulae of the Astronomical Almanac.

The terms of all sources are described in [SOURCES.md](#). Tiles go through the QGIS network settings and cache, the plugin keeps no cache of its own.

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