

# Координатные системы и картографические проекции (в Open Source QGIS)

Екатерина Подольская, к. т. н., ГИС-аналитик

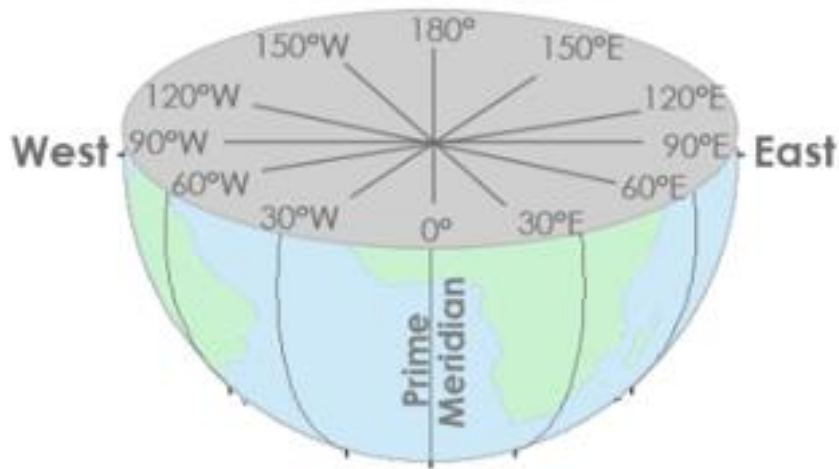
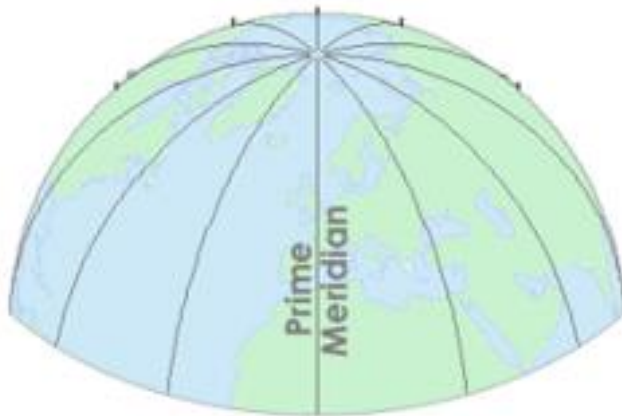
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- Сетки меридианов и параллелей
- Набор инструментов для обработки

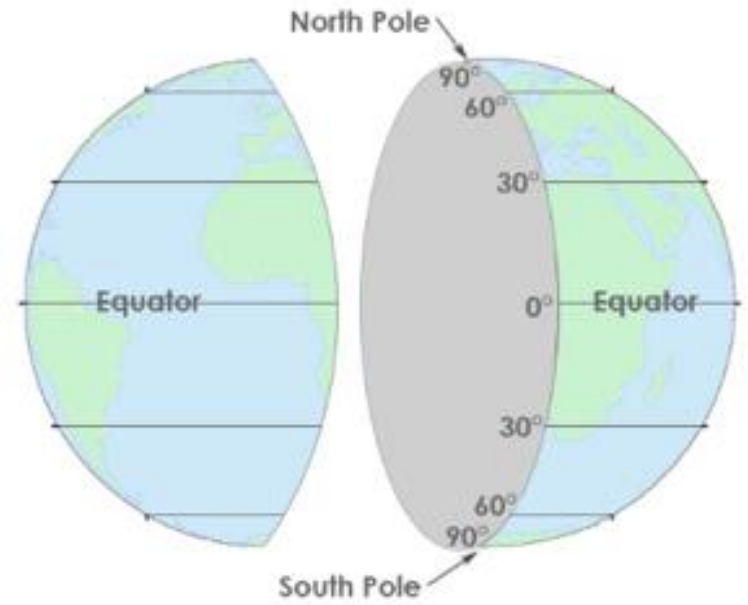
Таблица для преобразования вида географических координат

Ссылки

# Координатная система



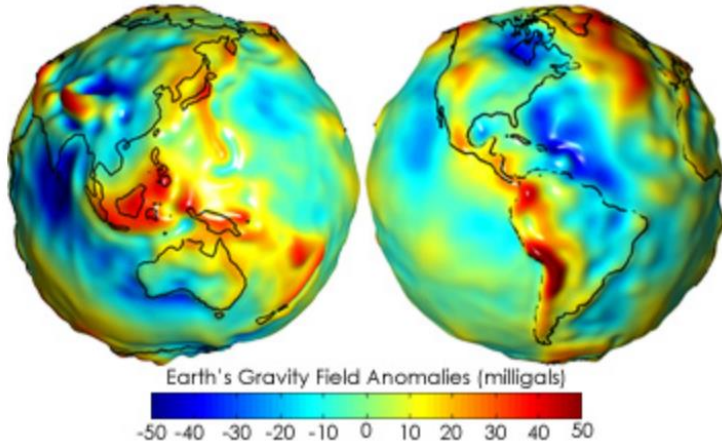
Longitude Coordinates



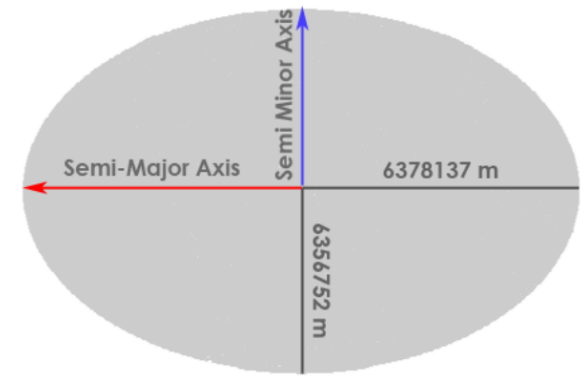
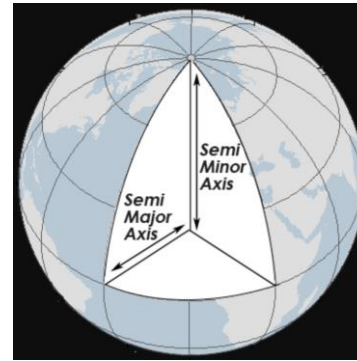
Latitude Coordinates

<https://gisgeography.com/latitude-longitude-coordinates/>

# Датум



Geoid (Image courtesy of NASA/JPL)



Главная ось эллипса – это экваториальный радиус;  
другая ось – от центра к полюсам

Name	Year	Semi-Major Axis (Equator Radius)	Semi-Minor Axis (Polar Radius)	Users
Clarke	1866	6,378,206.4 m	6,356,583.8 m	North America
International (Hayford) Ellipsoid	1924	6,378,388.0 m	6,356,911.9 m	Most of the World
WGS72	1972	6,378,135.0 m	6,356,750.5 m	NASA
GRS80	1980	6,378,137.0 m	6,356,752.3 m	Worldwide
WGS84	1984	6,378,137.0 m	6,356,752.3 m	Current Worldwide

<https://gisgeography.com/ellipsoid-oblate-spheroid-earth/>  
<https://gisgeography.com/geodesy/>

# ГИС-определение картографической проекции

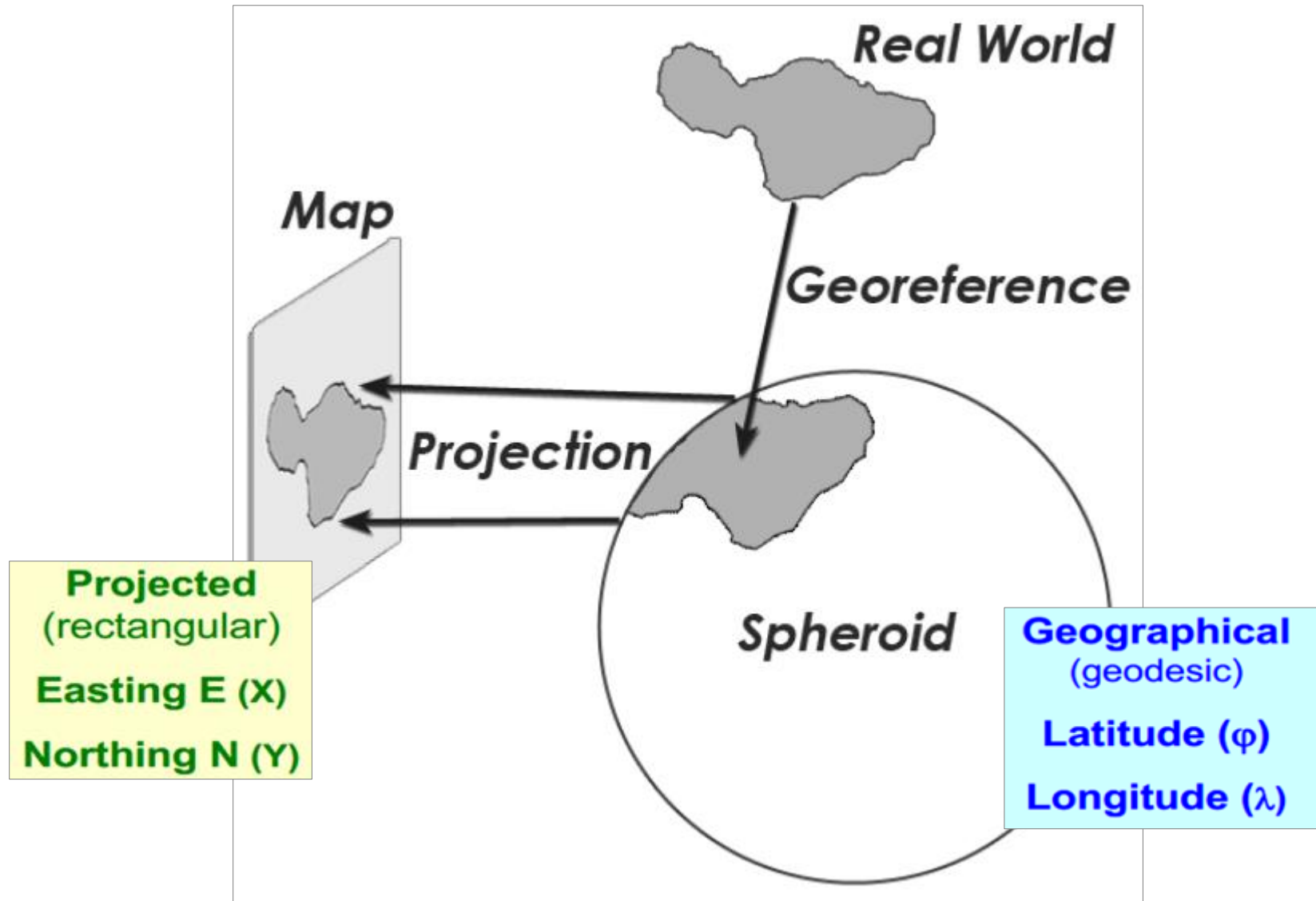
Картографическая проекция – это метод, при помощи которого картографы представляют сферу или глобус на плоскости

<https://gisgeography.com/map-projections/>

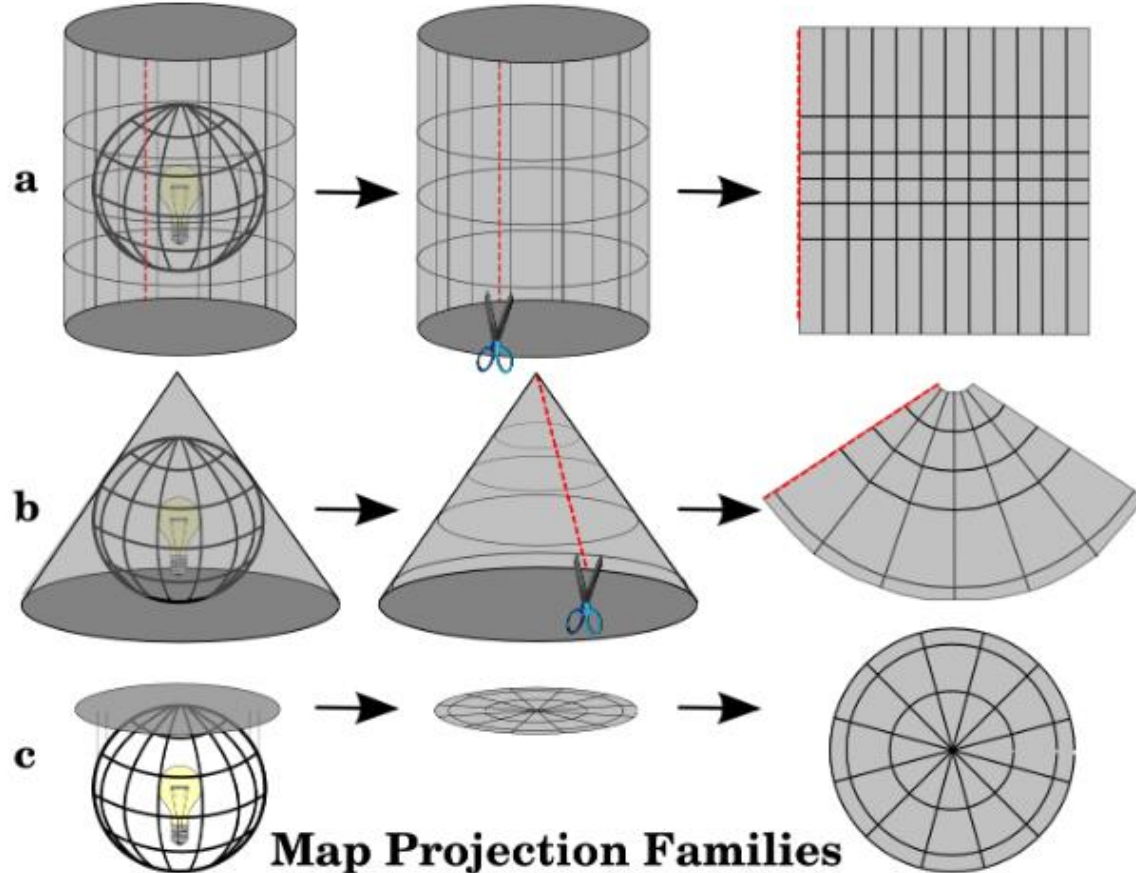
- Любая картографическая проекция обладает рядом искажений (углы, расстояния, площади)
- Координатная референцная система (CRS) определяет при помощи координат каким образом спроектированная карта связана с реальным положением объектов на местности
- ***On the Fly*** перепроектирование – ГИС-функция, которая позволяет осуществить наложение слоев в разных координатных системах или проекциях

[https://docs.qgis.org/testing/en/docs/gentle\\_gis\\_introduction/coordinate\\_reference\\_systems.html](https://docs.qgis.org/testing/en/docs/gentle_gis_introduction/coordinate_reference_systems.html)

# Картографическая проекция: преобразование в прямоугольные координаты



# Типы картографических проекций



The three families of map projections. They can be represented by a) cylindrical projections, b) conical projections or c) planar projections.

[https://docs.qgis.org/testing/en/docs/gentle\\_gis\\_introduction/coordinate\\_reference\\_systems.html](https://docs.qgis.org/testing/en/docs/gentle_gis_introduction/coordinate_reference_systems.html)

# Международные каталоги пространственных ссылок

Spatial Reference welcome

Home | Upload Your Own | List user-contributed references | List all references

Find your references in any number of formats!

- See Existing EPSG Codes
  - Upload your own Project
  - Browse a list:
    - 4362 EPSG references
    - 447 ESRI references
    - 2380 IAU2000 references
    - 2717 spatialreference.org references
- Recently Viewed
- NAD83(NSRS2007) / Modified
  - NAD83(HARN) / New Mexico
  - 3857 Pseudo MER WGS84
  - WGS 84, 1509108 views
  - Phobos Oblique Cylindrical

## EPSG:4326

WGS 84 ([Google it](#))

- **WGS84 Bounds:** -180.0000, -90.0000, 180.0000, 90.0000
- **Projected Bounds:** -180.0000, -90.0000, 180.0000, 90.0000
- **Scope:** Horizontal component of 3D system. Used by the GPS satellite navigation system and for NATO military geodetic surveying.
- **Last Revised:** Aug. 27, 2007
- **Area:** World

- [Well Known Text as HTML](#)
- [Human-Readable OGC WKT](#)
- [Proj4](#)
- [OGC WKT](#)
- [JSON](#)
- [GML](#)
- [ESRI WKT](#)
- [.PRJ File](#)

Spatial Reference List - Spatial Ref

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Search References: [Search]

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• SR-ORG:1: First test	• SR-ORG:19: lambert azimuthal equal area
• SR-ORG:2: abc	• SR-ORG:20: WRF Lambert Conformal Conic
• SR-ORG:3: copy of 4326	• SR-ORG:21: Test
• SR-ORG:4: another 4326 copy	• SR-ORG:22: met no spherical mercator
• SR-ORG:5: wgs copy 3	• SR-ORG:23: met no spherical mercator
• SR-ORG:6: Google Projection	• SR-ORG:24: EPSG
• SR-ORG:7: Mollweide on Greenwich	• SR-ORG:25: EPSG
• SR-ORG:8: Upload test via OGC WKT	• SR-ORG:26: IAU National Datum 1997
• SR-ORG:9: try an ESRI WKT	• SR-ORG:27: Czech S-JTSK
• SR-ORG:10: California Teale Albers, NAD83 projection	• SR-ORG:28: I can't find the projection to use for my sharp file data
• SR-ORG:11: California Teale Albers, NAD27 projection	• SR-ORG:29: Mexico Albers Equal Area Conic
• SR-ORG:12: NC State Plane Coordinate System	• SR-ORG:30: Mexico Lambert Conformal Conic
• SR-ORG:13: WGS 1984 UTM Zone 37N	• SR-ORG:31: Yukon Albers (NAD83)
• SR-ORG:14: WGS 1984	• SR-ORG:32: Lambert I Nord Maroc
• SR-ORG:15: North American Datum 1983	• SR-ORG:33: North Pacific Albers Conic Equal Area
• SR-ORG:16: Mercator (world)	• SR-ORG:34: Warszawa 75
• SR-ORG:17: Testing	• SR-ORG:35: Albers_Equal_area
• SR-ORG:18: Sphere, Robinson	• SR-ORG:36: WGS 1984 Web Mercator
• SR-ORG:19: alughes_australian_mercator	• SR-ORG:37: Test wkt
• SR-ORG:20: Gall-Peters Orthographic Projection	• SR-ORG:38: Test another wkt
• SR-ORG:21: NAD_1983_Oregon_Washington_Albers	• SR-ORG:39: Test
• SR-ORG:22: NAD_1983_Oregon_Washington_Albers	• SR-ORG:40: Test
• SR-ORG:23: NAD_1983_Oregon_Washington_Albers	• SR-ORG:41: test3
• SR-ORG:24: test_evs	• SR-ORG:42: test4
• SR-ORG:25: Ramsey County, MN Coordinates Feet	• SR-ORG:43: test7

## World Geodetic System 1984 (WGS84)

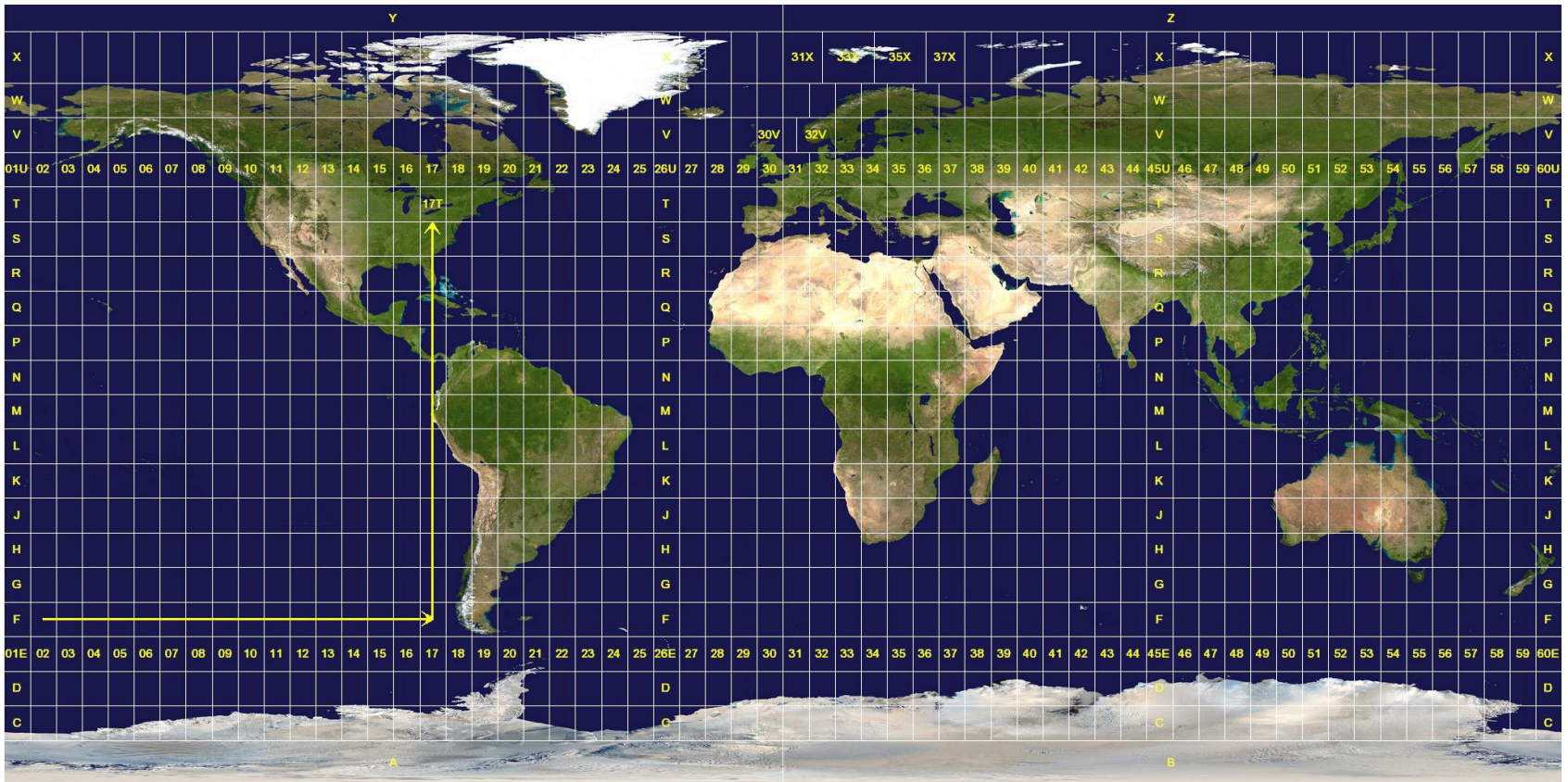
<https://spatialreference.org/>

[https://georepository.com/crs\\_4327/WGS-84-geographic-3D.html](https://georepository.com/crs_4327/WGS-84-geographic-3D.html)

<https://gisgeography.com/wgs84-world-geodetic-system/>



# Universal Transverse Mercator: пример картографической проекции

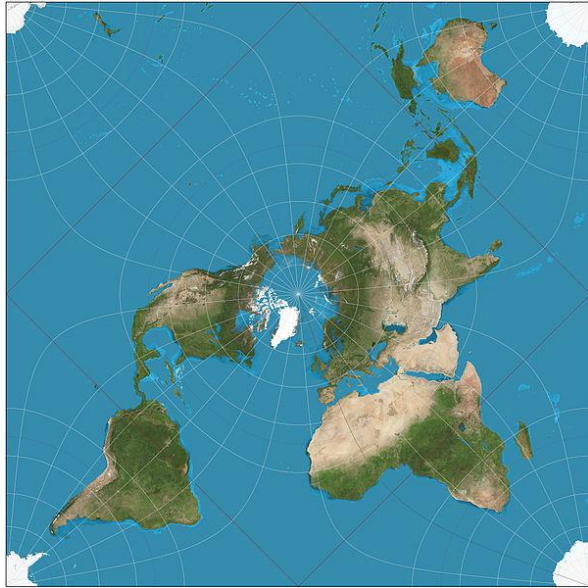


[https://en.wikipedia.org/wiki/Universal\\_Transverse\\_Mercator\\_coordinate\\_system#/media/File:Utm-zones.jpg](https://en.wikipedia.org/wiki/Universal_Transverse_Mercator_coordinate_system#/media/File:Utm-zones.jpg)

Проекция Меркатора была предложена в 1569 фламандским картографом [Gerardus Mercator](#)

<https://www.gislounge.com/look-mercator-projection/>

# Картографические проекции и сетки меридианов и параллелей



Peirce Quincuncial projection SW 20W

[https://en.wikipedia.org/wiki/File:Peirce\\_quincuncial\\_projection\\_SW\\_20W.JPG](https://en.wikipedia.org/wiki/File:Peirce_quincuncial_projection_SW_20W.JPG)

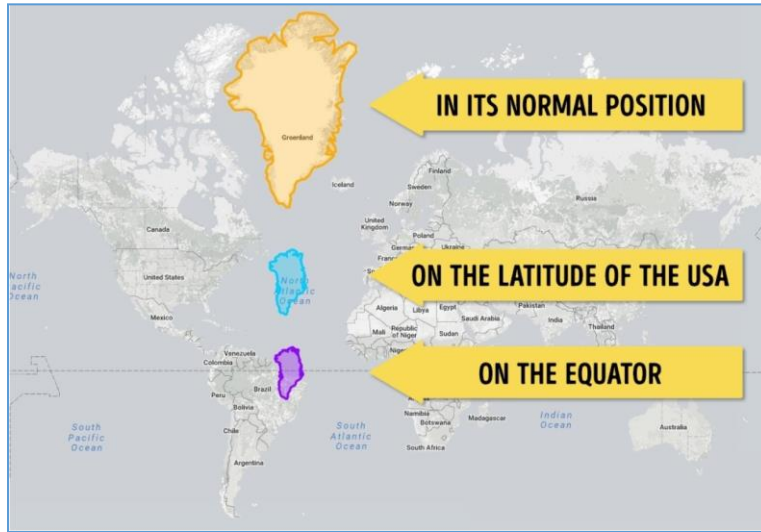


AuthaGraph World Map

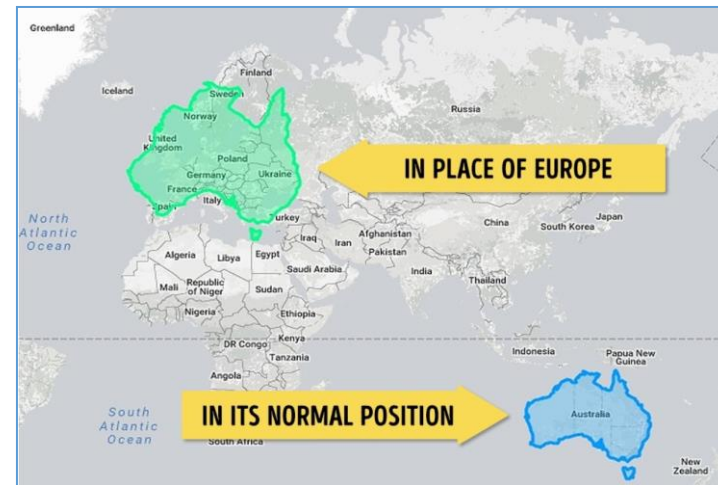
<http://www.authagraph.com/top/?lang=ja>  
<https://interestingengineering.com/not-new-earth-authagraph-map-accurate-real-view>

# Искажения картографических проекций

## Гренландия



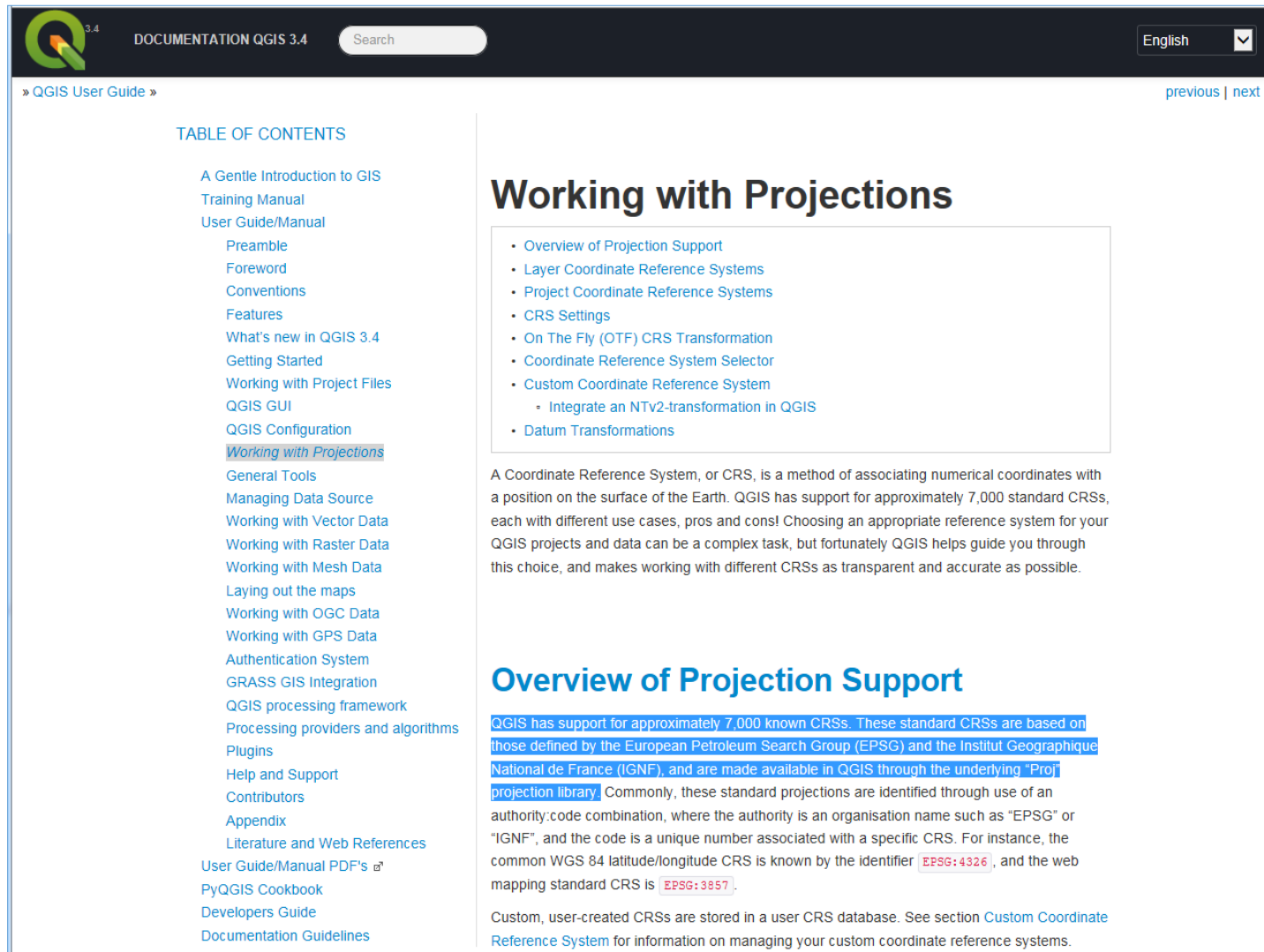
## Австралия



[https://thetruesize.com/#?borders=1~!MTY2NjkzNDg.NjlxNDM5\\*MzYwMDAwMDA\(MA~!GL\\*MTAyMzA5NTg.MTUyNjUwNA\)Mw](https://thetruesize.com/#?borders=1~!MTY2NjkzNDg.NjlxNDM5*MzYwMDAwMDA(MA~!GL*MTAyMzA5NTg.MTUyNjUwNA)Mw)

<http://monde-geospatial.com/12-maps-that-will-change-your-understanding-of-the-world-forever/>

# Принципы работы с координатами в QGIS



The screenshot shows the QGIS 3.4 documentation interface. At the top, there is a search bar and a language dropdown set to 'English'. The main content area is titled 'Working with Projections' and includes a table of contents on the left and a list of topics in the main body. The table of contents lists various sections, with 'Working with Projections' highlighted. The main body contains a list of topics, a paragraph about Coordinate Reference Systems (CRS), and a section titled 'Overview of Projection Support' with a detailed explanation of CRS and examples of identifiers like EPSG:4326 and EPSG:3857.

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- A Gentle Introduction to GIS
- Training Manual
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  - QGIS Configuration
  - Working with Projections**
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- PyQGIS Cookbook
- Developers Guide
- Documentation Guidelines

## Working with Projections

- Overview of Projection Support
- Layer Coordinate Reference Systems
- Project Coordinate Reference Systems
- CRS Settings
- On The Fly (OTF) CRS Transformation
- Coordinate Reference System Selector
- Custom Coordinate Reference System
  - Integrate an NTV2-transformation in QGIS
- Datum Transformations

A Coordinate Reference System, or CRS, is a method of associating numerical coordinates with a position on the surface of the Earth. QGIS has support for approximately 7,000 standard CRSs, each with different use cases, pros and cons! Choosing an appropriate reference system for your QGIS projects and data can be a complex task, but fortunately QGIS helps guide you through this choice, and makes working with different CRSs as transparent and accurate as possible.

## Overview of Projection Support

QGIS has support for approximately 7,000 known CRSs. These standard CRSs are based on those defined by the European Petroleum Search Group (EPSG) and the Institut Geographique National de France (IGNF), and are made available in QGIS through the underlying "Proj" projection library. Commonly, these standard projections are identified through use of an authority:code combination, where the authority is an organisation name such as "EPSG" or "IGNF", and the code is a unique number associated with a specific CRS. For instance, the common WGS 84 latitude/longitude CRS is known by the identifier `EPSG:4326`, and the web mapping standard CRS is `EPSG:3857`.

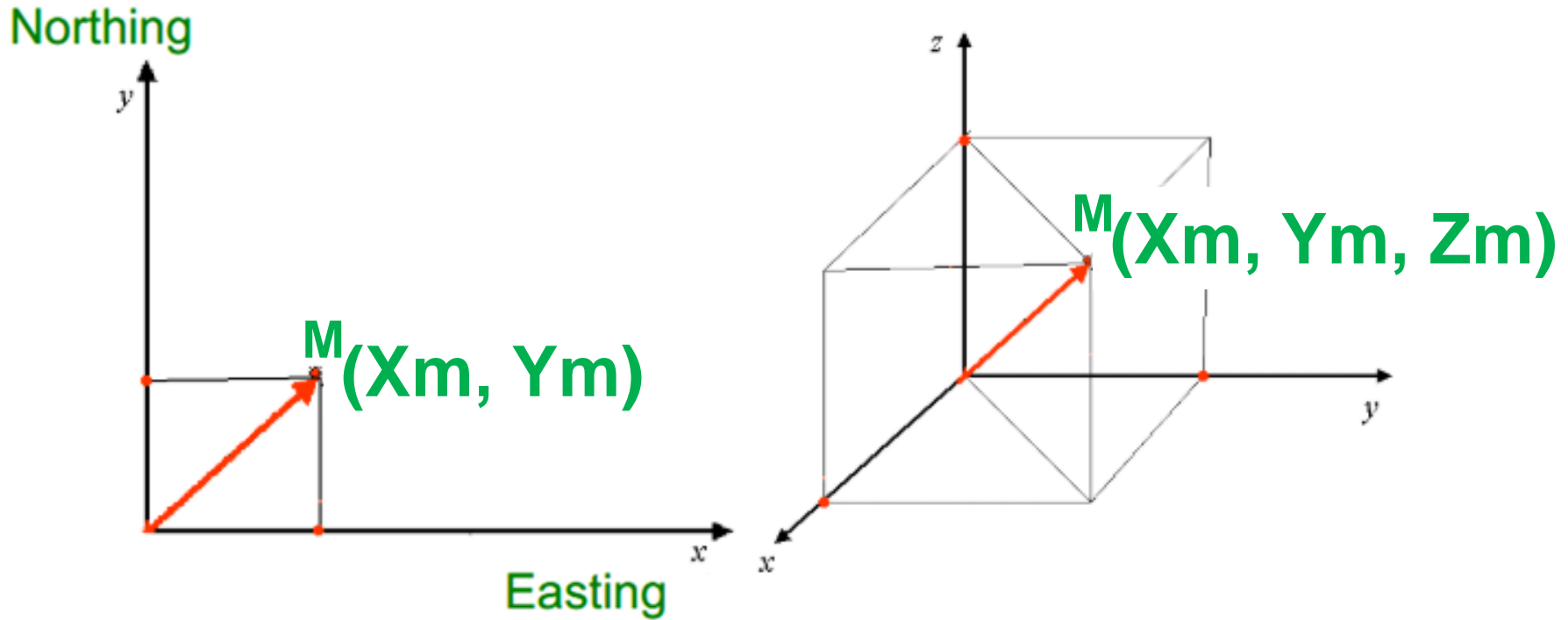
Custom, user-created CRSs are stored in a user CRS database. See section [Custom Coordinate Reference System](#) for information on managing your custom coordinate reference systems.

[https://docs.qgis.org/3.4/en/docs/user\\_manual/working\\_with\\_projections/working\\_with\\_projections.html](https://docs.qgis.org/3.4/en/docs/user_manual/working_with_projections/working_with_projections.html)

<https://www.gislounge.com/working-with-coordinate-reference-systems-mastering-qgis/>

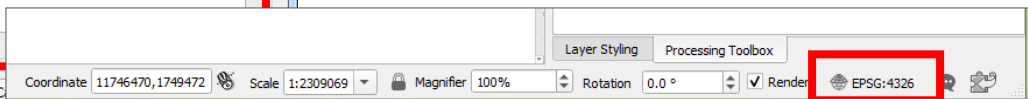
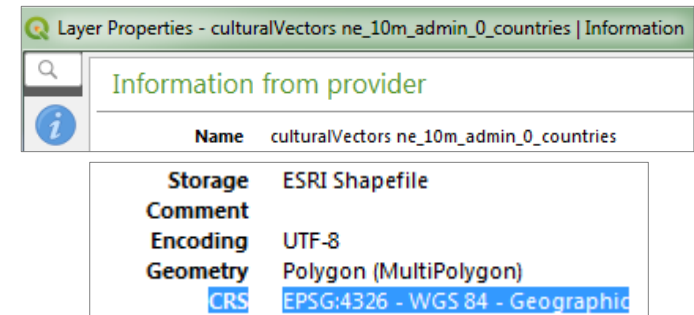
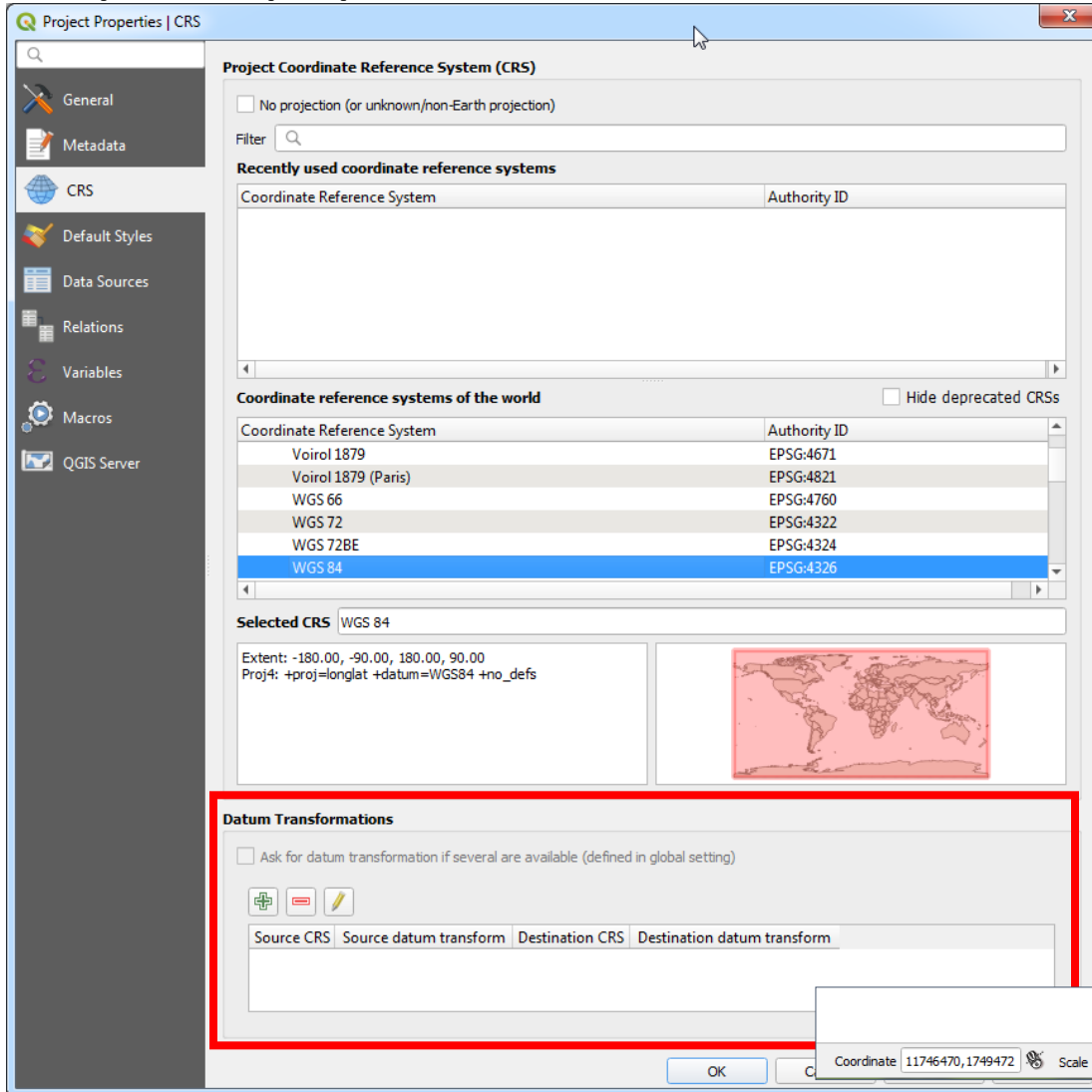
[https://www.qgistutorials.com/en/docs/working\\_with\\_projections.html](https://www.qgistutorials.com/en/docs/working_with_projections.html)

# Каким образом QGIS определяет положение объекта



Two and three dimensional coordinate reference systems

# Информация о проекции/координатной системе и трансформациях

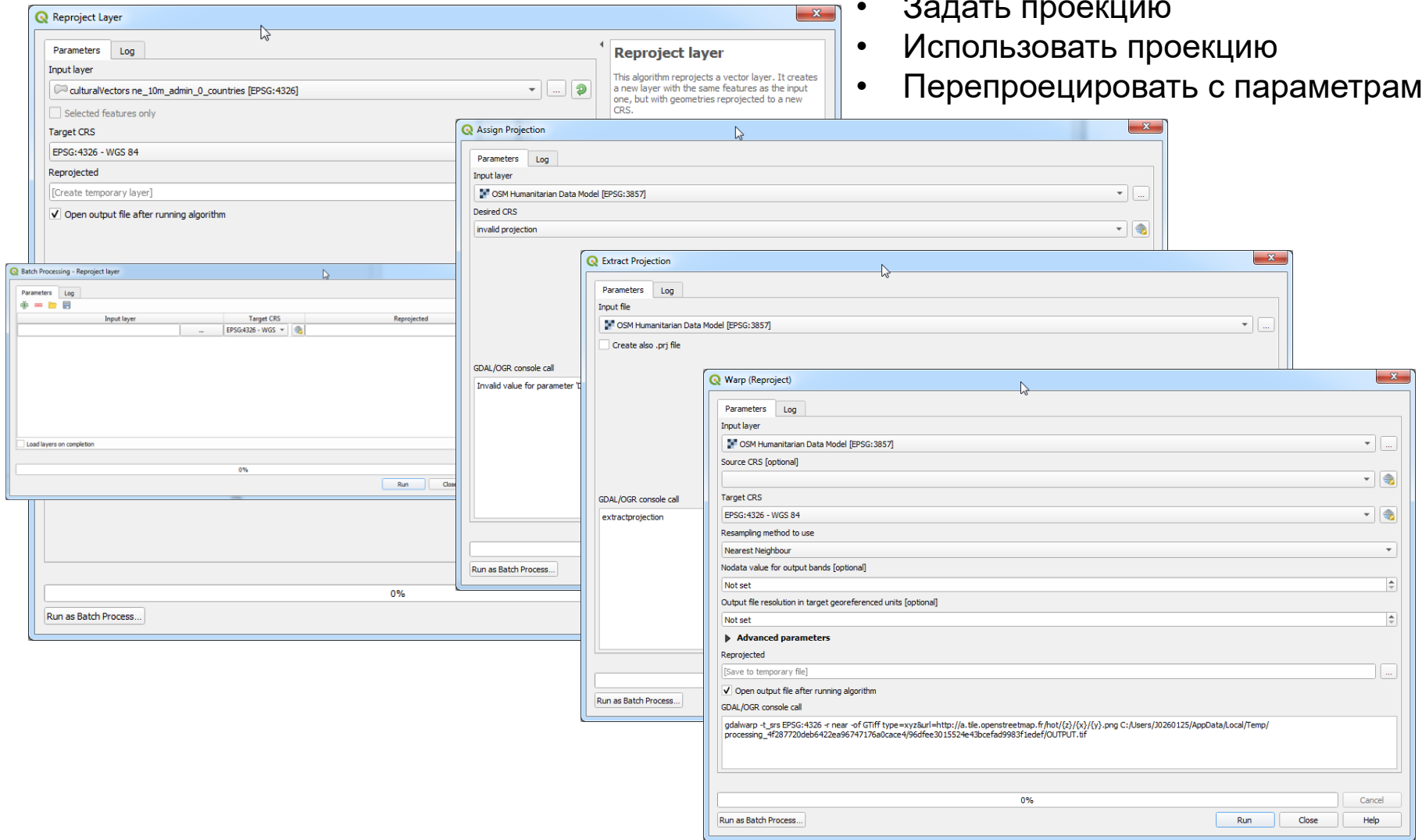


[https://docs.qgis.org/3.4/en/docs/user\\_manual/working\\_with\\_projections/working\\_with\\_projections.html](https://docs.qgis.org/3.4/en/docs/user_manual/working_with_projections/working_with_projections.html)

[https://docs.qgis.org/3.4/en/docs/user\\_manual/working\\_with\\_projections/working\\_with\\_projections.html#datum-transformations](https://docs.qgis.org/3.4/en/docs/user_manual/working_with_projections/working_with_projections.html#datum-transformations)

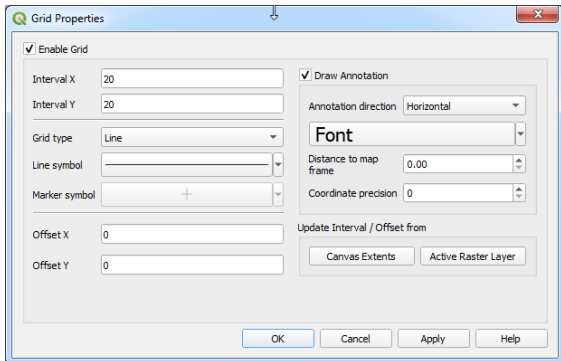
# Изменение картографической проекции/ координатной системы

- Перепроецировать слой
- Задать проекцию
- Использовать проекцию
- Перепроецировать с параметрами



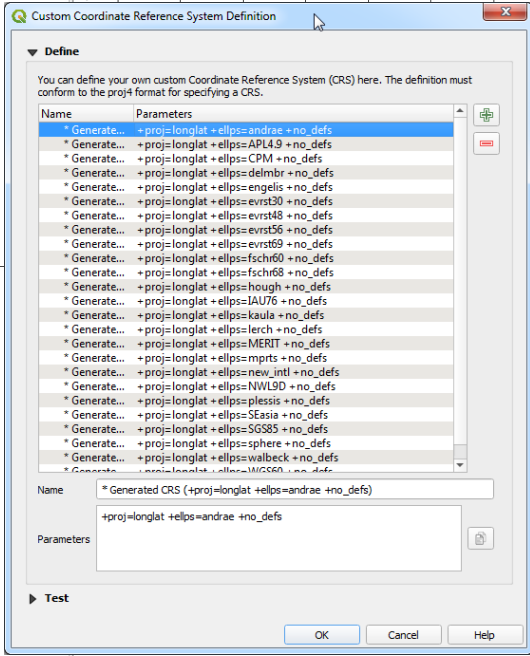
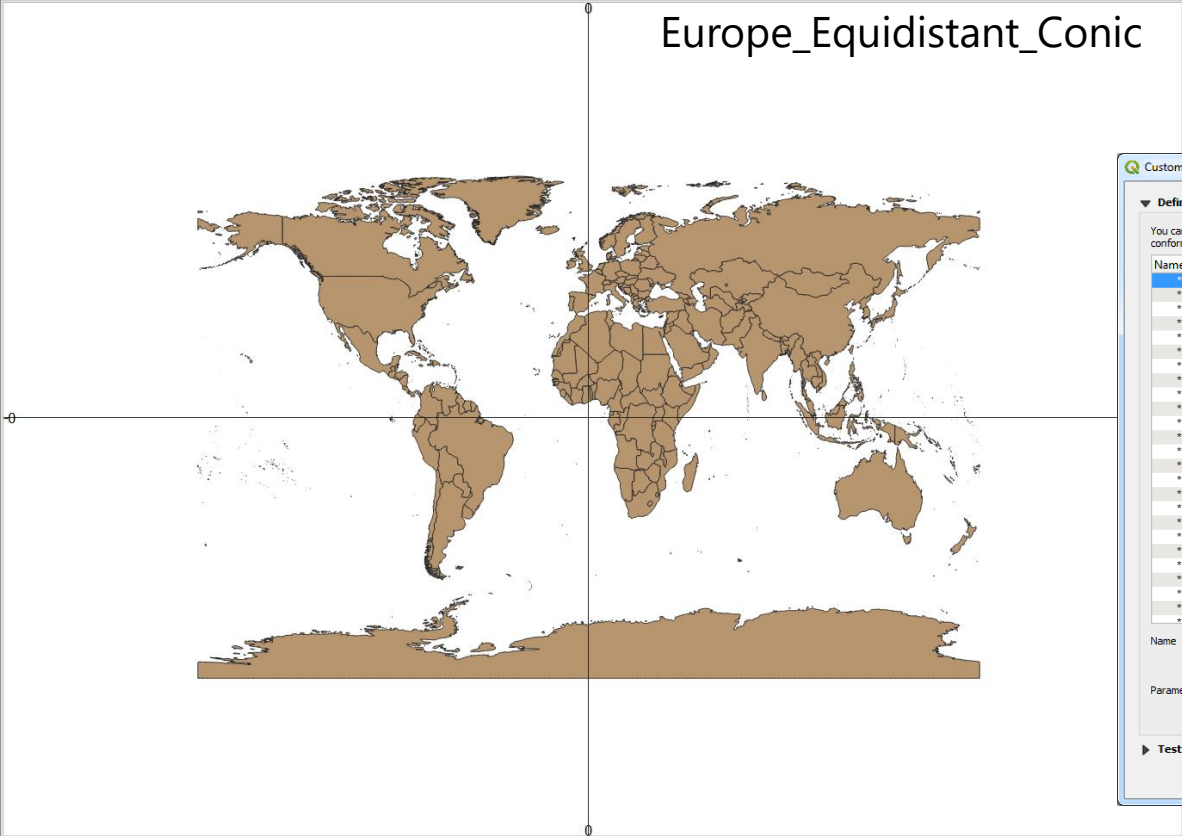
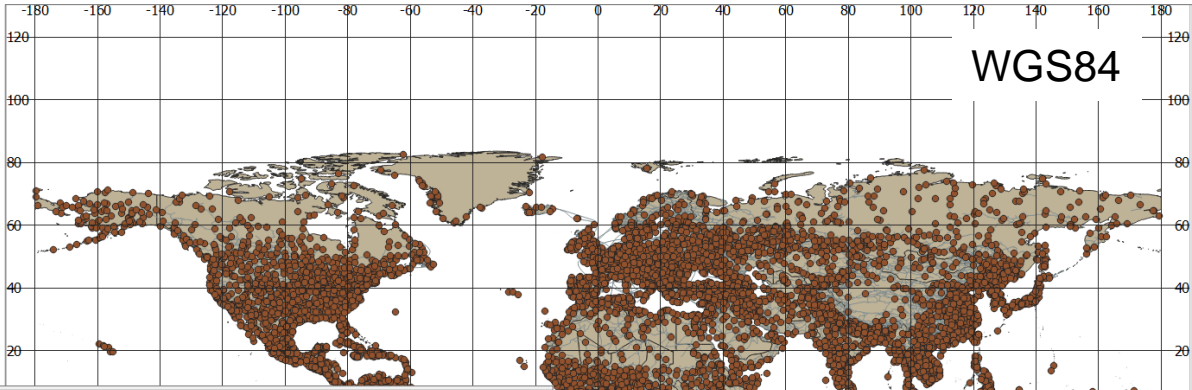
<https://www.gislounge.com/how-to-change-the-projection-of-a-shapefile-using-qgis/>

# Сетки меридианов и параллелей в QGIS



Grid Properties dialog box with the following settings:

- Enable Grid:
- Interval X: 20
- Interval Y: 20
- Grid type: Line
- Line symbol: [dropdown]
- Marker symbol: [dropdown]
- Offset X: 0
- Offset Y: 0
- Draw Annotation:
- Annotation direction: Horizontal
- Font: [dropdown]
- Distance to map frame: 0.00
- Coordinate precision: 0
- Update Interval / Offset from: Canvas Extents



Custom Coordinate Reference System Definition dialog box. The "Define" tab is active, showing a list of CRS definitions. The "Name" field contains: `* Generated CRS (+proj=longlat +ellps=andreae +no_defs)` and the "Parameters" field contains: `+proj=longlat +ellps=andreae +no_defs`.



# Набор инструментов для обработки

**Add Coordinates to Points**

Parameters Log

Points

culturalVectors ne\_10m\_populated\_places [EPSG:4326]

Select

Points with

[Save to

Open

Run as Ba

**Swap X and Y Coordinates**

Parameters Log

Input layer

culturalVectors ne\_10m\_admin\_0\_countries [EPSG:4326]

Selected features only

Swapped

[Create temporary layer]

Open output file after running algorithm

0%

Run as Batch Process...

Processing Toolbox

coordinates

- Vector analysis
  - Mean coordinate(s)
- Vector geometry
  - Swap X and Y coordinates**
- GRASS
  - Imagery (i.\*)
    - i.eb.hsebal01.coords
  - Miscellaneous (m.\*)
    - m.cogo
  - Raster (r.\*)
    - r.walk.coords
  - Vector (v.\*)
    - v.in.lines
- SAGA
  - Raster calculus
    - Gradient vector from cartesian to polar coordinates
    - Gradient vector from polar to cartesian coordinates
  - Vector general
    - Polar to cartesian coordinates
  - Vector point tools
    - Add coordinates to points

# Таблица для преобразования вида географических координат “decimal degrees” – “degrees minutes seconds”

CoordinatesTransformation\_table.xls [Compatibility Mode]

A	B	C	D	E	F	G	H	I	J	K
	DD MM SS.SS				DD MM SS.SS				DD.DDDDD	
	Longitude				Latitude				Longitude	Latitude
	Grad	Minute	Second		Grad	Minute	Second			
	168.00	5.00	40.41		54.00	30.00	18.52		168.0946	54.50514
	82.00	24.00	8.00		54.00	41.00	14.80		82.40222	54.68744
	82.00	18.00	20.50		54.00	36.00	26.70		82.30569	54.60742

	DD MM SS.SS				DD MM SS.SS				DD.DDDDD	
	Longitude				Latitude				Longitude	Latitude
TEXT	Grad	Minute	Second	TEXT	Grad	Minute	Second			
166°14'32.29"	166	14	32.29	55°13'39.80"	55	13	39.80		166.2423	55.22772
166°14'33.75"	166				DD MM.MMMM				DD.DDDDD	
166°14'33.63"	166				Longitude				Latitude	
166°14'31.98"	166				Grad	Minute			Longitude Latitude	
166°17'12.49"	166			37.00	21.00			3.00	4.00	37.35 3.066667 1986

16	DD.DDDDD		DD MM SS.SS			DD MM SS.SS			DD MM.MMMM		DD MM.MMMM	
16	Longitude	Latitude	Latitude			Longitude			Latitude		Longitude	
16			Grad	Minute	Second	Grad	Minute	Second	Grad	Minute	Grad	Minute
16	37.35333	3.075833	3	4	33.00	37	21	12.00	3	4.5500	37	21.2000
	82.40222	54.68744	54	41	14.80	82	24	8.00	54	41.2467	82	24.1333
	82.30569	54.60742	54	36	26.70	82	18	20.50	54	36.4450	82	18.3417
	82.29314	54.58078	54	34	50.80	82	17	35.30	54	34.8467	82	17.5883
	82.28822	54.58039	54	34	49.40	82	17	17.60	54	34.8233	82	17.2933
	82.19694	54.51758	54	31	3.30	82	11	49.00	54	31.0550	82	11.8167
	82.18239	54.49156	54	29	29.60	82	10	56.60	54	29.4933	82	10.9433
	82.18006	54.49058	54	29	26.10	82	10	48.20	54	29.4350	82	10.8033
	82.17386	54.47558	54	28	32.10	82	10	25.90	54	28.5350	82	10.4317
	81.75208	54.33836	54	20	18.10	81	45	7.50	54	20.3017	81	45.1250

	81.00	37.00		81.00	33.00		54.00	30.00		81.55	54.5
	81.00	22.00	20.00	81.00	23.00	22.00	54.00	12.00	81.51667	54.21667	

DDMMSS-DD.DDDD    DDMMSS-DD.DDDD-parse    DDMMMM-DD.DDDD    DD.DDDD-DDMMSS

<http://gis-lab.info/qa/dms2dd.html>  
<https://www.fcc.gov/media/radio/dms-decimal>

# Ссылки

- <http://gis-lab.info/qa/proj-sk-faq.html>
- <https://www.gislounge.com/map-single-coordinate-using-qgis/>
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