Map projections are mathematical procedures which enable the mapping of the earth's or other celestial bodies' curved surface to a plane. The curved surface is usually a sphere or a rotational ellipsoid. The theory of map projections is often referred to as the mathematic cartography. The goal of studying map projections is the creation of mathematical basis for making maps and solving theoretic and practical problems in cartography, geodesy, geography, astronomy, navigation and other related sciences.

The points on the surface of an ellipsoid or sphere are determined by the intersection of meridians and parallels. The image of the network of meridians and parallels in the plane of projection is called the *basic graticule*. The *normal graticule* is the one with the simplest shape in the observed map projection.

The goal of a map projection is to establish the dependence between the point coordinates on the earth's ellipsoid or sphere and the coordinates of their images in the plane of projection. The dependency is commonly written in terms of equations

$$x = f_1(\varphi,\lambda), \quad y = f_2(\varphi,\lambda)$$

where φ is the geographic latitude, λ the geographic longitude, and x and y are rectangular coordinates in the plane of projection.

The beginnings of map projections are approximately 2000 years old, when the Greek scientists first introduced the mathematical principals into the foundations of mapping the earth and the sky, and started to apply the graticule. The works of Anaximander, Eratosthenes, Apolonious and Hipparchus played an important role in the development of cartography. Thales from Milet is considered the creator of the first map in a projection in 600 B.C. It was a map of the celestial sphere in *gnomonic* projection. The *stereographic* and *ortographic* projections are among the oldest projections which were used by famous Greek astronomer and mathematician Hipparchus, also for making maps of the celestial sphere about 150 B.C. Several hundred map projections have been invented up to the present days.

Map projection classification had to be made in order to facilitate their studying. Map projections can be divided according to the position and the shape of the normal graticule, but also according to the distortions which are present.

According to the position of the normal graticule, projections can be divided into *normal*, *transversal* and *oblique*, and according to its shape into *conical*, *cylindrical*, *azimuthal*, *pseudoconical*, *pseudocylindrical*, *polyconical*, *circular* and other.

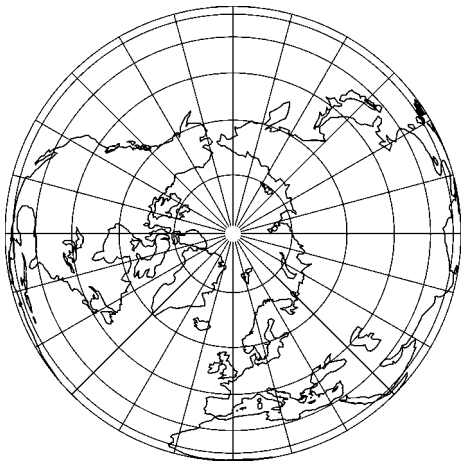
Map projections are used for representing one part or whole surface of the earth with as few distortions as possible. The smaller the represented area, the smaller the expected deformations. According to kinds of deformations, map projections are divided into *conformal* (angles remain the same), *equal-area* or *equivalent* (area remains the same), *equidistant* (lengths in certain direction remain the same) and *conditional*.

Some projections were named after their inventors. Some of them are the *Mercator* projection (usually normal or transversal conformal), the *Lambert* projection (azimuthal equal-area, but also conical conformal), the *Bonne* projection (pseudoconical equal-area), the *Mollweide* projection (pseudocylindrical equal-area), and a series of pseudocylindrical projections by *Eckert*, *Kavrayskiy* and others. Miscellaneous projections are projections created by combining two or more projections. The most famous miscellaneous projection is the *Winkel* (triple) projection.

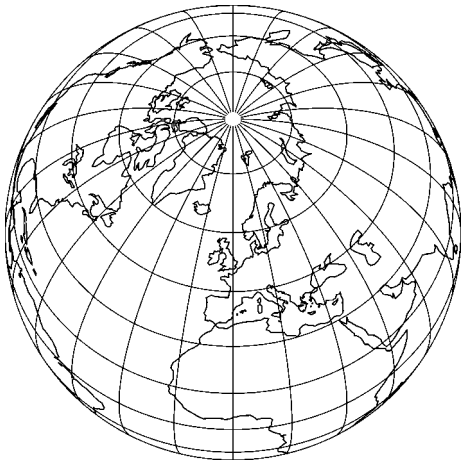
Geodetic projections form a special group of projections; these projections are intended for the state survey and the making of official topographic maps. The most commonly used projections in this group are the Universal Transversal Mercator projection (UTM), the transversal Mercator projection or the Gauß-Krüger projection, the polyconical and the Lambert conformal conical projection. The official projection in Croatia is the Gauß-Krüger (transversal cylindrical conformal) projection of the rotational ellipsoid.

When making a map, the first thing one should do is to choose the appropriate projection and to construct the graticule. Today, a number of programs, which enable the automatic calculating and making graticules for any part of the earth's sphere or ellipsoid in any projection and in any scale, can be used for that procedure. These programs also enable the drawing of other map contents. The use of the computer and the plotter in cartography has greatly facilitated the research and the invention of completely new or variations of already existing projections.

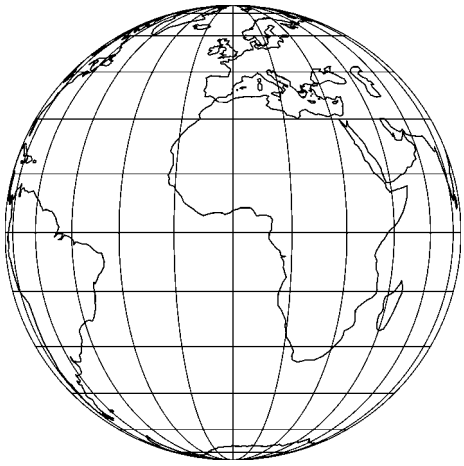
In Croatia, map projections have been getting special attention since the end of the 19th century. The authors concerned with that thematics in Croatia are Dr. David Segen, Dr. Marije Kiseljak, Dr. Vladimir Vranić, Tomo Jakić, Dr. Artur Franović-Gavazzi, Dr. Anton Fasching and Prof. Stjepan Horvat. PhD theses in the field of map projections were defended by the following professors of the Faculty of Geodesy, University of Zagreb: Dr. Branko Borčić (*Matematička podloga karte svijeta u mjerilu 1:1 000 000*), Dr. Nedjeljko Frančula (*Die vorteilhaftesten Abbildungen in der Atlaskartographie*) and Dr. Miljenko Lapaine (*Preslikavanja u teoriji kartografskih projekcija*).



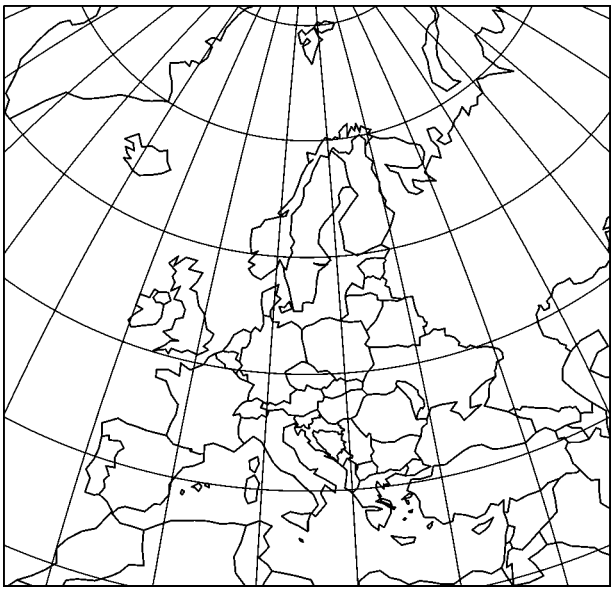
Orthographic projection, normal aspect



Orthographic projection, oblique aspect

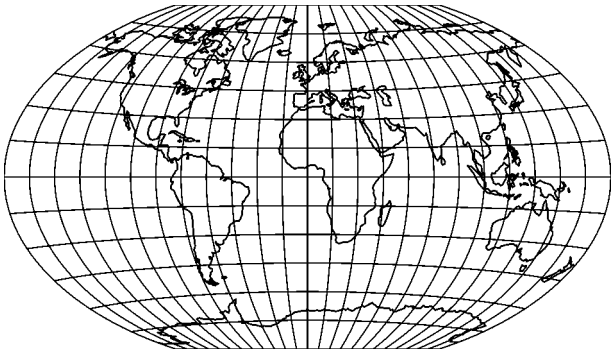


Orthographic projection, transversal aspect



Europe in the azimuthal equal-area projection

Europe in the conical conformal projection



Winkel projection