Terms for Projections

Azimuthal Projections

Same as Planar Projections. A family of projections where a plane is placed tangent or almost tangent to the world and the earth locations projected on it.

Circle, Great

A great circle is a circle on the earth whose center is the center of the earth. Alternately, it is the intersection of a plane and a sphere when the center of the sphere is on the plane. Shortest distance between two points on the earth in spherical model is a great circle. Meridians are great circles.

Circle, Small

A small circle is a circle on the earth whose center is not the center of the earth. Alternately, it is the intersection of a plane and a sphere when the center of the sphere is not on the plane. Parallels of latitude are small circles.

Conformal

The property of a map projection that implies that angles are preserved. Useful for navigation. A map is conformal if $h = k$ at each point (the latitude scale distortion parameter is equal to the longitude scale distortion parameter). A map cannot be both conformal and equal area.

Conic Projections

A family of projections based on a cone being placed over the world and the earth locations projected on it. It is cut from the base to the apex and unrolled to form a map.

Cylindrical Projections

A family of projections based on placing the world in a cylinder (without ends) and projecting the earth locations onto it. It is cut lengthwise an unrolled to form a map.

Developable Surface

A surface that can be unrolled and lay flat without distortion used as the basis of a projection. The three developable surfaces are a cylinder, a cone, and a plane.

Easting

Distance east or west of a reference line in meters or feet. Commonly used term with UTM projection. An offset (false easting) is added to the UTM values to ensure all values are positive.

Equal Area

The area measured on the map will be correct. A map is equal area if $h\,k = 1$ everywhere. (See scale distortion parameters.) A map cannot be both equal area and conformal.

Equidistant

A projection where lines and/or circles of latitude are equally spaced.

Interrupted Projection

A projection that has sections or lobes. The most common example is the "orange peel" type projection. Along cut lines points on the map a separated by blank areas.

Northing

Distance north or south of a reference line. Used in UTM projection where the equator is the reference line. Values south of the equator have an offset (false northing) of 10,000 added to them to keep the values positive.

Planar Projections / Azimuthal Projections

Two terms are identical. A family of projections where a plane is placed tangent or almost tangent to the world and the earth locations projected on it.

Perspective Projection

A view that would be seen from some point is a perspective projection. Sometimes the view is inverted. These projections can be formed by the shadow on the projection surface from a light source at a point. (Sometimes the point is at infinity as in the orthographic projection.)

Projection Families

These are Groups of projects that share a developable surface. Major families are Cylindrical, Conic, and Azimuthal (or planar). Projections that use mathematical formulae that are close to a cylinder are called pseudo-cylindrical. Projections with no easy geometric interpretation are called irregular.

Rhumb line

Line followed by keeping at the same true azimuth. A line of constant azimuth. On a conformal map, Rhumb lines are straight lines.

Scale

The ratio between the physical distance on the map sheet and the distance on the ground. Maps all have a scale. It is usually approximately correct over the whole map, but precisely true only at a point, a few lines, or a family of lines. Scale is expressed as a fraction such as 1:24,000 . This is read as "1 to 24 thousand". (This case is 1 inch map distance equals 2000 feet.)

Small values, such as 1:5,000,000 are used for large area maps and large values, such as 1:50,000 are used for small area maps.

Scale Distortion Parameters

The ratio between the true scale value and the nominal scale of a map. These are a function of the location on the map. The scale is true if the value is one. There are two values usually defined, that in the North-South direction called “h”, and that in the East-West direction called “k”. The formulae for h and k are often quoted in map projection manuals. Specifying h and k is not sufficient to specify the distortion in an arbitrary direction.

Standard Line

A line on a projection where the scale is true. This is often the line(s) where a developable surface cuts through the earth.

Tissot’s Indicatrix

This is a diagram showing the scale distortion value at a point on a map. It is usually an ellipse with the radius of the ellipse is the value of the distortion parameter. Diagrams with small ellipses giving Tissot’s Indicatrix at a series of points are sometimes shown to give and idea of the variation of the distortion over a map. The value in the N-S direction is h and the value in the East-West direction is k. For a conformal map Tissot’s Indicatrix is a circle, but not necessarily of radius 1.

Windowed Projection

A map that is part of a much larger projection. The map is a "window" into a much larger map. The UTM projection is one example of this. The full projection is a longitude strip 6 degrees wide from 84 N to 80 S. Individual maps are windows into this. This allows the edges of adjacent maps to line up.

Projection Examples

A few common examples are listed. There are hundreds of projects, and only a few can be listed here.

Mercator

Conformal, cylindrical projection. Mercator 1569. Useful for large scale navigation. Common for world maps.

UTM (Universal Transverse Mercator)

Mercator projection where cylinder is oriented with the center circle along a meridian. There are 60 zones where the central meridian is moved 6 degrees in longitude between each zone. The cylinder is depressed into the earth for error control. Adopted for military maps. Coordinates are in meters and called Northing and Easting. UPS and UTM form the basis of the military maps used by the US (The military grid reference system, or MGRS).

Orthographic

A planar (azimuthal) projection where the projecting lines are all parallel and perpendicular to the plane. (Come from a projecting point, "light source location", at infinity.) Matches orthorectified aerial photographs.

Stereographic

A planar projection with the surface tangent to the earth and the projecting point ("light source location") is on the other side of the earth from the tangent point. A northern polar stereographic projection is tangent to the north pole and the projecting point is at the south pole.

UPS Universal Polar Stereographic

A stereographic projection with tangent point at the pole. The plane is depressed into the earth for error control. UPS and UTM form the basis of the military maps used by the US (The military grid reference system, or MGRS).

Lambert Conic Conformal

A common conic projection used in air navigation charts. It is conformal. Also used for areas (like the US), which have a longer east-west extent than north-south. The cone is depressed into the earth and goes through the surface along two parallels of latitude. These are standard lines.

Polyconic

A conic projection where the apex of the cone is a function of latitude. Used by USGS for topographic maps. Invented by Hassler 1820. Used in most USGS large scale topographic maps.

Adlers Equal-Area

A conic projection introduced by Adlers in 1805. Used mainly for small scale (large area) maps with predominate east-west extent (such as the US).

Gnomonic

A planar projection with the projecting point (light source location) at the center of the earth. Has property that straight lines are great circles (least distance paths on a sphere).

Robinson

An irregular projection. Is “Mercator” like but has no closed form formulae for converting latitude and longitude to map locations. Invented in 1962 for Rand McNally map company to make “nice looking” maps. A table of points is used for the definition. There are computer algorithms that interpolate this table to perform this projection. Used for some National Geographic Society maps.

Platte Carree / Simple Cylindrical / (latitude-longitude)

Linear plotting of latitude and longitude. What you get if you use longitude for x and latitude for y in a computer plotting program.

Miller

A cylindrical projection introduced in 1942. Has less distortion at high latitudes than Mercator. Neither conformal or equal area. Common in computer generated data plots.

Goodie

An interrupted projection, usually of the whole world in three lobes. Published by Goodie in 1916. The cuts are in ocean areas giving a “nice looking” map. It is a type of sinusoidal projection. It is common for thematic maps of the world. Sometimes called Homolosine projection. Used by Rand McNally for 1925 atlas of the world.

Mollweide

A pseudocylindrical projection introduced in 1805, and used world maps. The outline of the world looks line an ellipse. The center meridians have only moderate distortion.

Properties

● = Yes
○ = Partly

Projection	Type	Conformal	Equal Area	Equidistant	True Direction	Perspective	Compromise	Straight Rhumbs
Globe	Sphere	●	●	●	●			
Mercator	Cylindrical	●			○			●
Transverse Mercator	Cylindrical	●						
Oblique Mercator	Cylindrical	●						
Space Oblique Mercator	Cylindrical	●						
Miller Cylindrical	Cylindrical						●	
Robinson	Pseudocylindrical						●	
Sinusoidal Equal Area	Pseudocylindrical		●	○				
Orthographic	Azimuthal (Planar)				○			
Stereographic	Azimuthal (Planar)	●			○			
Gnomonic	Azimuthal (Planar)				○			
Azimuthal Equidistant	Azimuthal (Planar)				○			
Lambert Azimuthal Equal Area	Azimuthal (Planar)		●		○			
Albers Equal Area Conic	Conic		●					
Lambert Conformal Conic	Conic	●			○			
Equidistant Conic (Simple Conic)	Conic			○				
Polyconic	Conic			○			●	
Bipolar Oblique conic Conformal	Conic	●						

Suitable for Mapping

● = Yes
○ = Partly

Projection	Type	World	Hemisphere	Continent / Ocean	Region / Sea	Medium Scale	Large Scale
Globe	Sphere	●					
Mercator	Cylindrical	○				●	
Transverse Mercator	Cylindrical			●	●	●	●
Oblique Mercator	Cylindrical			●	●	●	●
Space Oblique Mercator	Cylindrical						●
Miller Cylindrical	Cylindrical	●					
Robinson	Pseudocylindrical	●					
Sinusoidal Equal Area	Pseudocylindrical	●		●			
Orthographic	Azimuthal (Planar)						
Stereographic	Azimuthal (Planar)		●	●	●	●	●
Gnomonic	Azimuthal (Planar)				○		
Azimuthal Equidistant	Azimuthal (Planar)	○	●	●	●		○
Lambert Azimuthal Equal Area	Azimuthal (Planar)		●	●	●		
Albers Equal Area Conic	Conic			●	●	●	
Lambert Conformal Conic	Conic			●	●	●	●
Equidistant Conic (Simple Conic)	Conic			●	●		
Polyconic	Conic					○	○
Bipolar Oblique conic Conformal	Conic			●			

● = Yes

○ = Partly

General Use

Projection	Type	Topographic Maps	Geological Maps	Thematic Maps	Presentations	Navigation	USGS Maps	
Globe	Sphere			●	●			
Mercator	Cylindrical	●	●			●	●	
Transverse Mercator	Cylindrical	●	●				●	
Oblique Mercator	Cylindrical	●					●	
Space Oblique Mercator	Cylindrical	●					●	
Miller Cylindrical	Cylindrical			●			●	
Robinson	Pseudocylindrical			●	●			
Sinusoidal Equal Area	Pseudocylindrical			●			●	
Orthographic	Azimuthal (Planar)						●	
Stereographic	Azimuthal (Planar)	●	●			●	●	
Gnomonic	Azimuthal (Planar)				●	●		
Azimuthal Equidistant	Azimuthal (Planar)	●					●	
Lambert Azimuthal Equal Area	Azimuthal (Planar)			●	●		●	
Albers Equal Area Conic	Conic			●	●		●	
Lambert Conformal Conic	Conic	●	●		●	●	●	
Equidistant Conic (Simple Conic)	Conic							
Polyconic	Conic	●					●	
Bipolar Oblique conic Conformal	Conic		●				●	