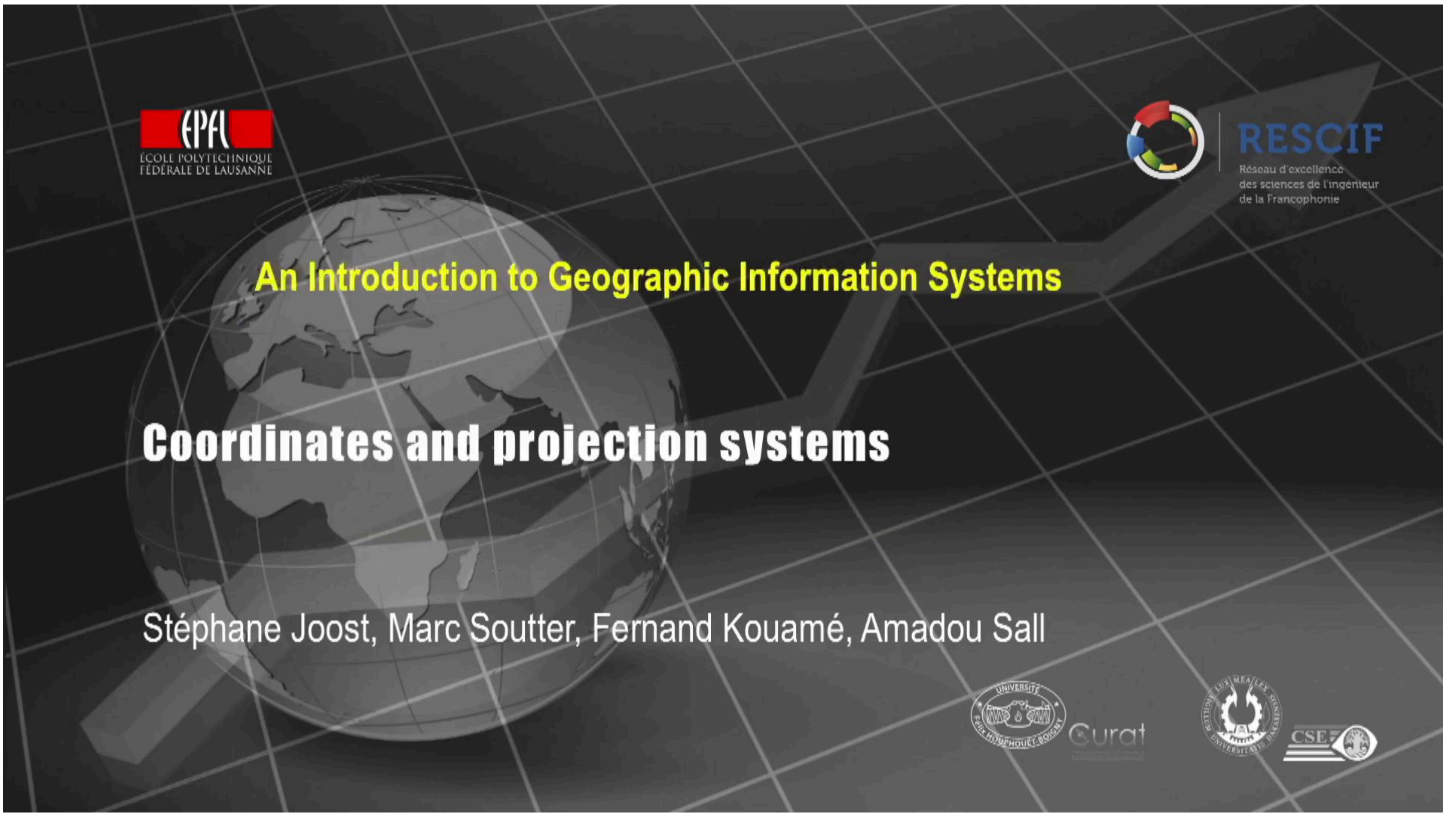
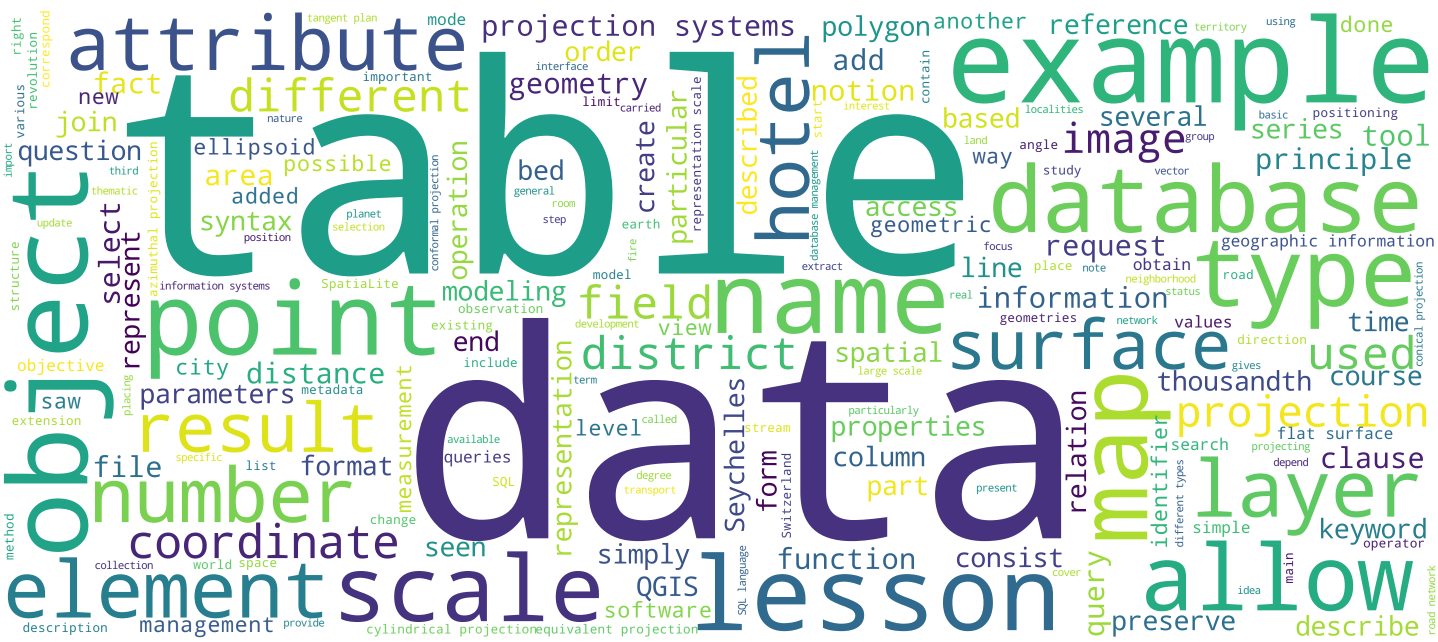
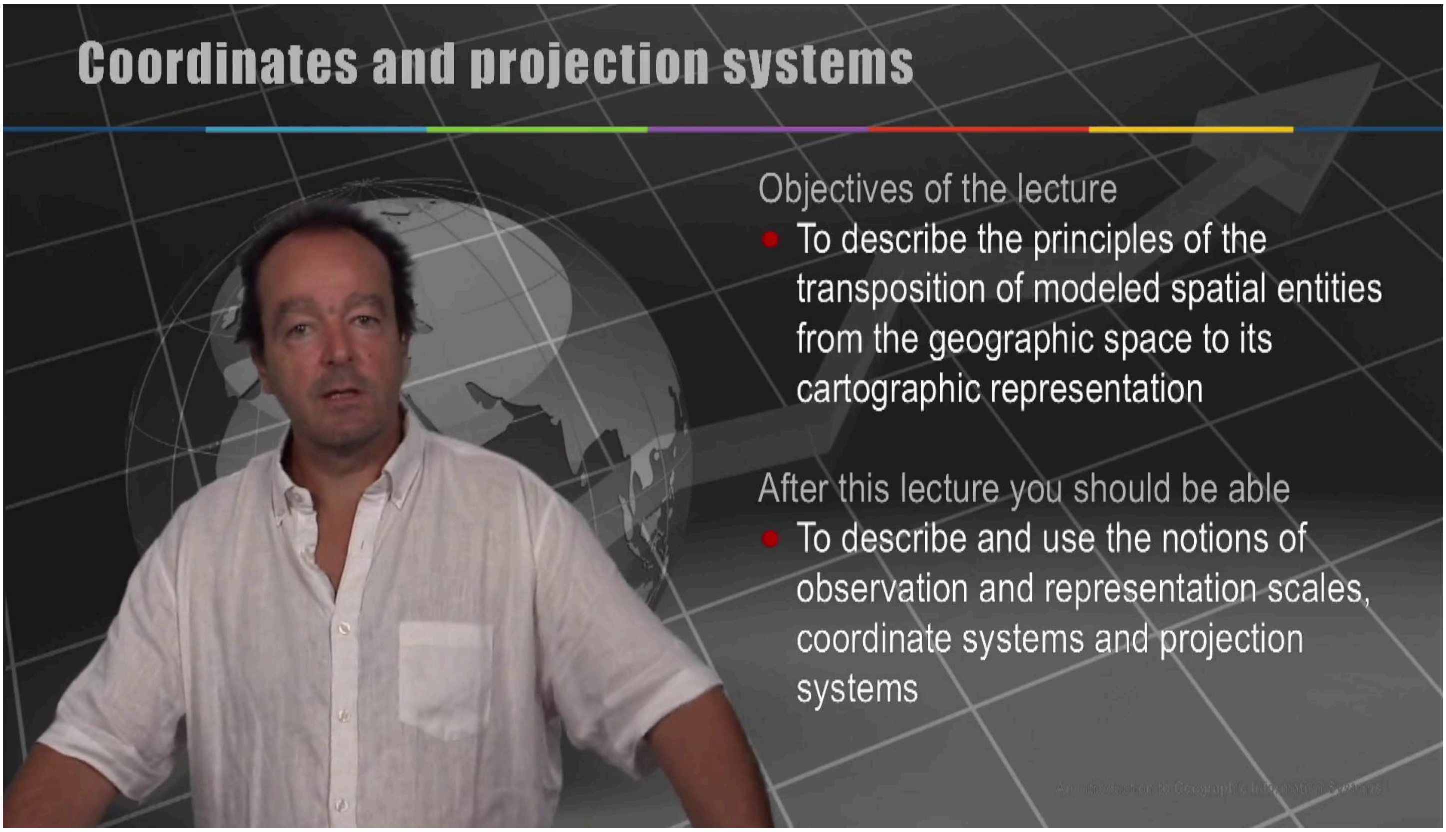




Search MOOC

Video

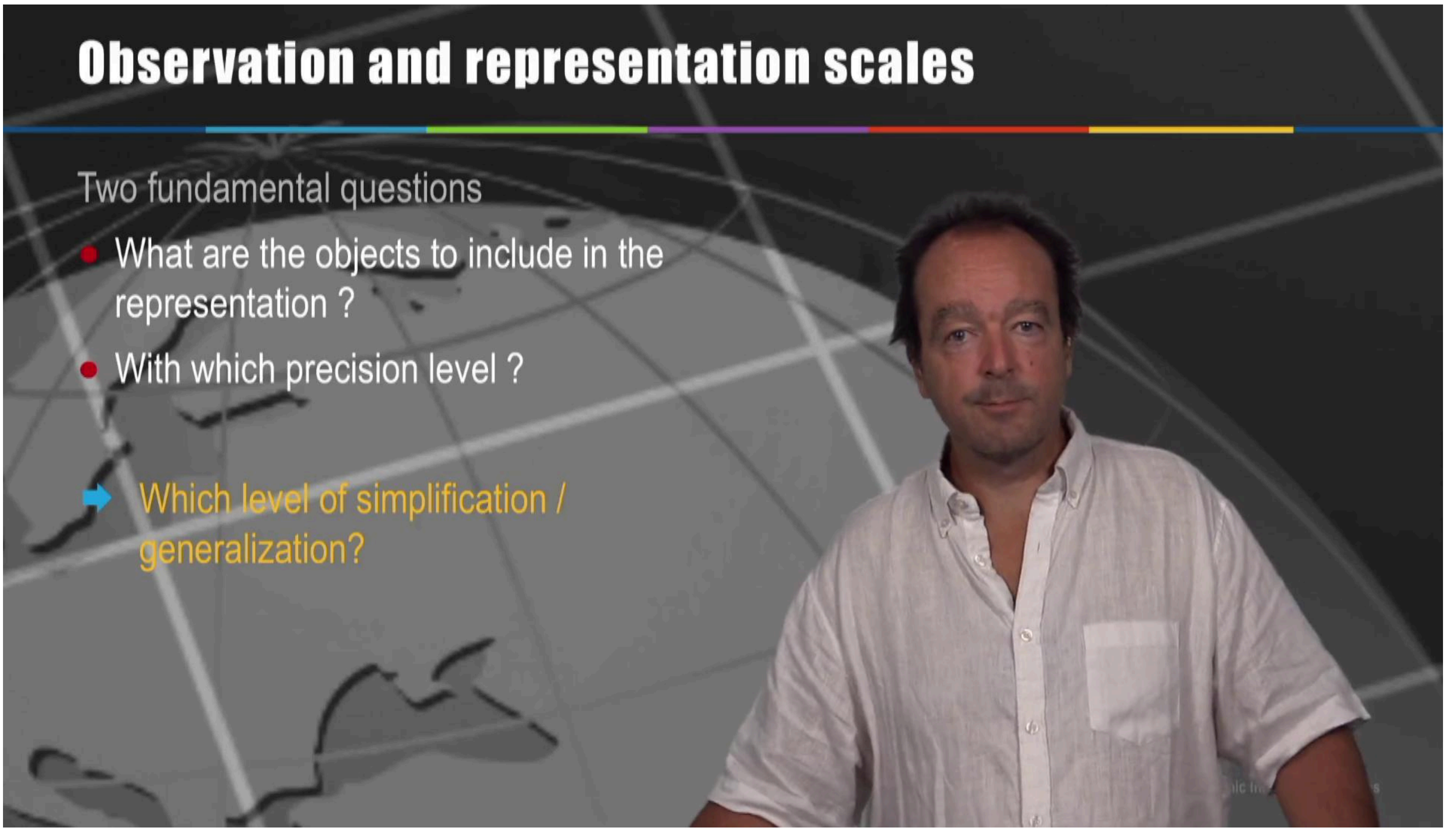


Welcome to this course which will focus on geographic coordinates and projection systems. Geographic coordinates allow to locate objects on the surface of the hearth. The projection systems allow objects to be projected onto a flat surface. In the first lesson we discussed the question of the modeling of the territory and we have seen that this implies, at least in object mode, to identify and describe the elements that make up the model. We will now see how to describe the geometric of these elements and how this geometric can be transposed into a cartographic representation. This second lesson will therefore deal with the metric of the description of the elements of the territory so on questions of scale, of coordinate systems and projection systems. The objective of this lesson is to explain the principles of this geographical space transposition to the cartographic representation. At the end of the lesson, you will be able to describe and use these notions of coordinates and projection scales.

Notes

Summary

0m 25s

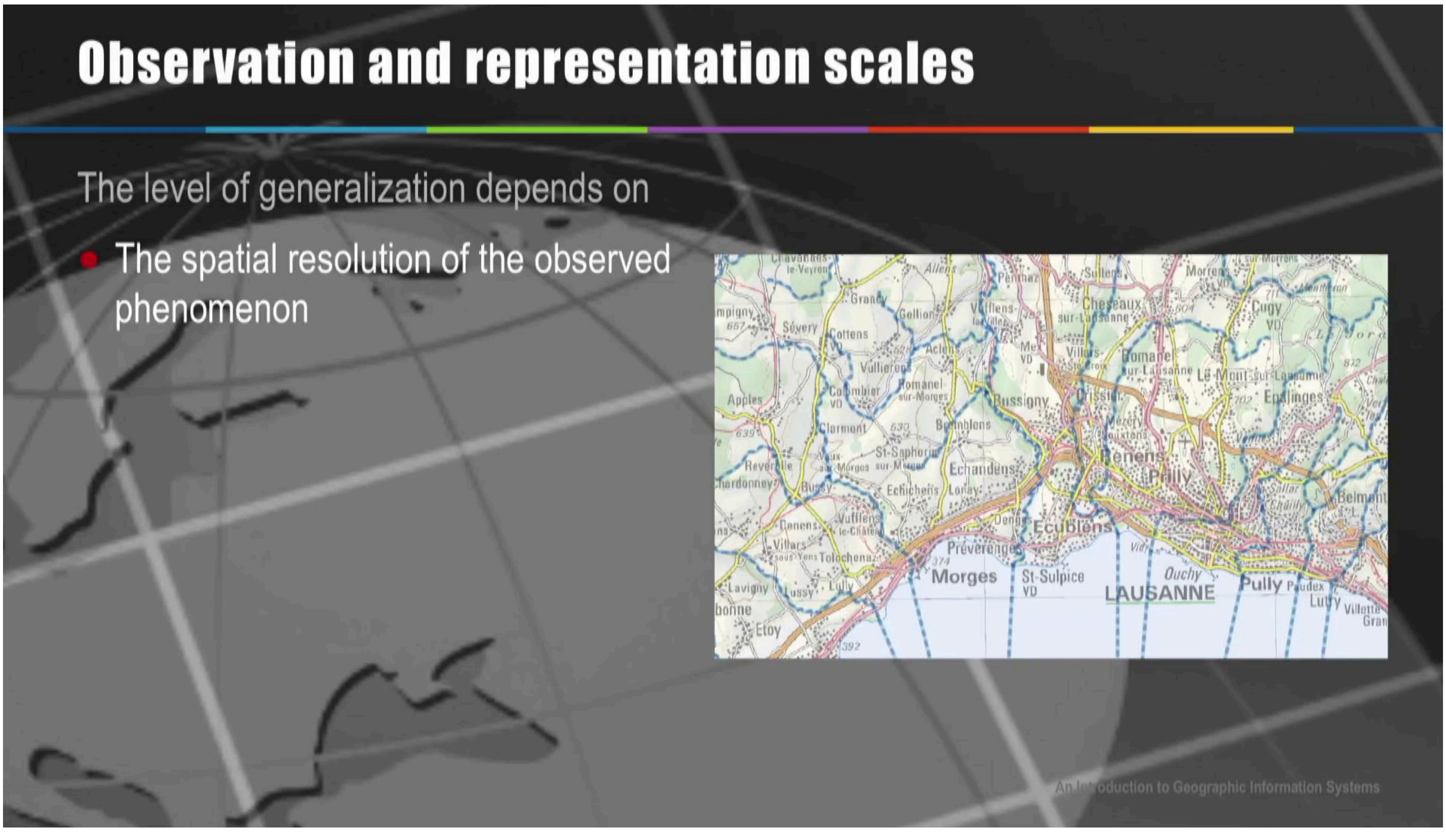


In this lesson, we will therefore discuss successively the notions of observation and representation scales the notions of coordinates and positioning, the principles of projection systems and finally the EPSG codes. The scale of representation is the ratio between the distance measured on the map or on the screen and the actual distance. So, for example, on the scale of 10 thousandth 1 cm on the map is 100 meters on the field, whereas at the scale of 50,000, this centimeter represents 500 m and on the scale of 100,000 it will represent 1,000 m. The choice of the scale is dictated by technical constraints, by graphical constraints or by physiological constraints, what the human eye is capable of perceiving. What objects to represent and with what precision ? Beyond the thematic aspects, these two fundamental questions of the modeling of the territory refer to the questions of the observation and representation scales, in other words to the degree of schematization of the real that the modeling of the territory implies.

Notes

Summary

1m 37s



As we have already seen in the first lesson the degree of generalization depends of the spatial resolution of the observed phenomenon. For exemple, constructions are ideally represented by their hold on the ground but they can be also represented by some dots which would be the gravity centres of these polygons or by these arbitrary polygons which do not have much signification on a large scale but which make sense on smaller scales. In this other example, we can see that the course of a stream can be described with great precision on a large scale but on smaller scales, this precision becomes superfluous and it is preferable to simplify the geometric for a more accessible representation.

Notes

Summary

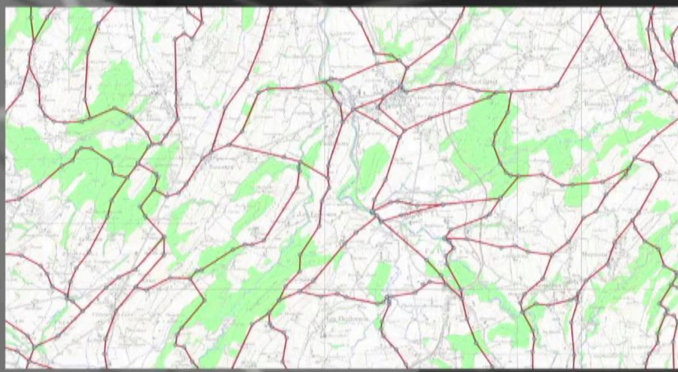
2m 53s

Observation and representation scales

The level of generalization depends on

- The spatial resolution of the observed phenomenon
- The seeked thematic richness

Digitization of sub-watershed (1:25'000)



In fine

- Choice driven by the scope of modeling
- Coexistence of different scales

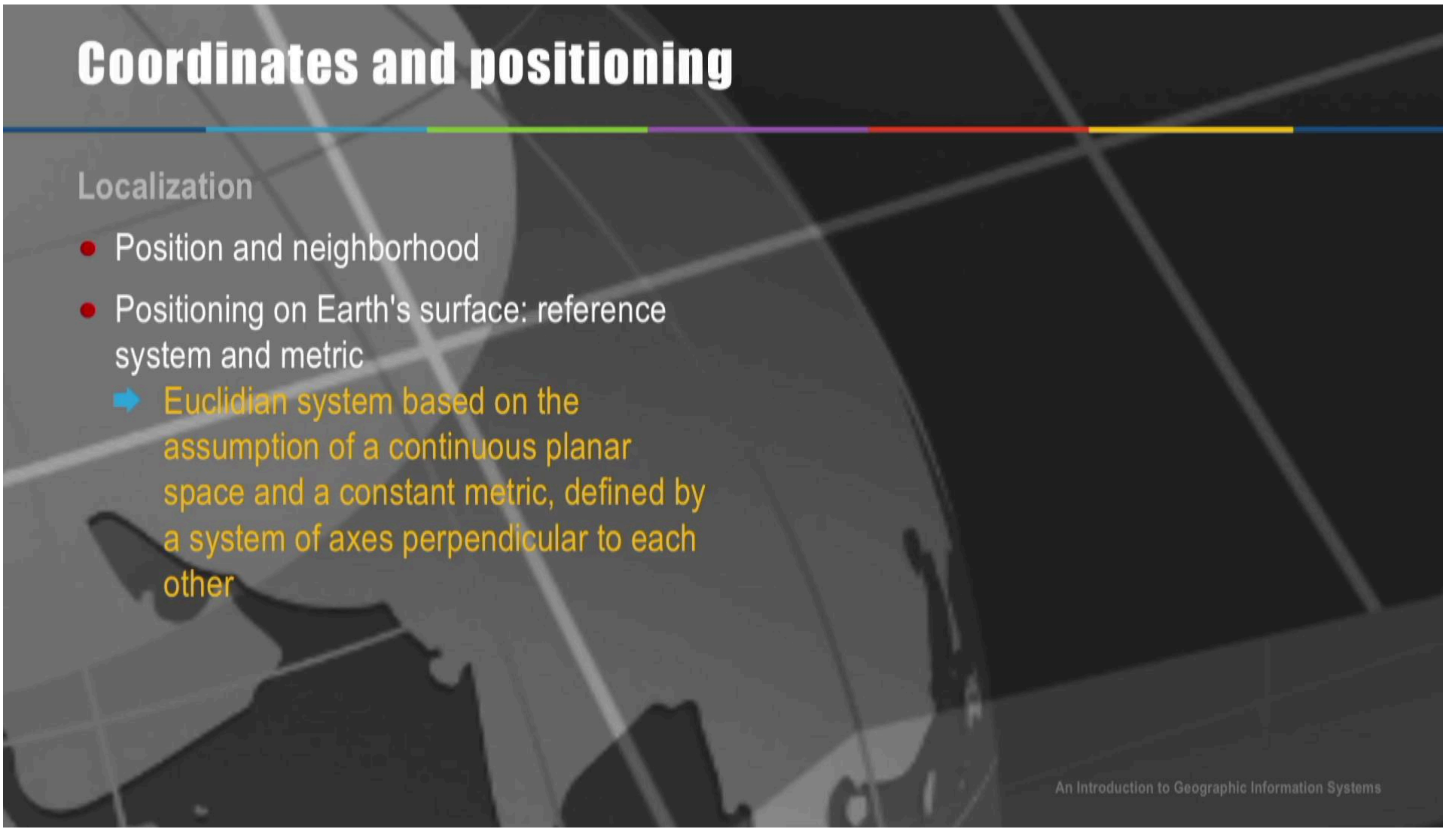
An Introduction to Geographic Information Systems

The degree of generalization also depends on the richness in thematic details sought, like this example of the road network, which essential components are represented in priority but for which we see that on a larger scale there is a whole series of more detailed elements that can be taken into consideration. In the end, the choice is dictated by the purpose of the modeling. For example, if the customer is an agency that deals with the management of a motorway network, the communal roads will be of no interest. As a result, we can have situations that see the coexistence of different scales. That is the case, for example, of streams and catchment basins with streams that can be described or represented on a very large scale in 10 thousandth for maximum accuracy and topographic catchment basins which are by nature much more difficult to define and which may be described on a scale of 25 thousandth.

Notes

Summary

3m 34s

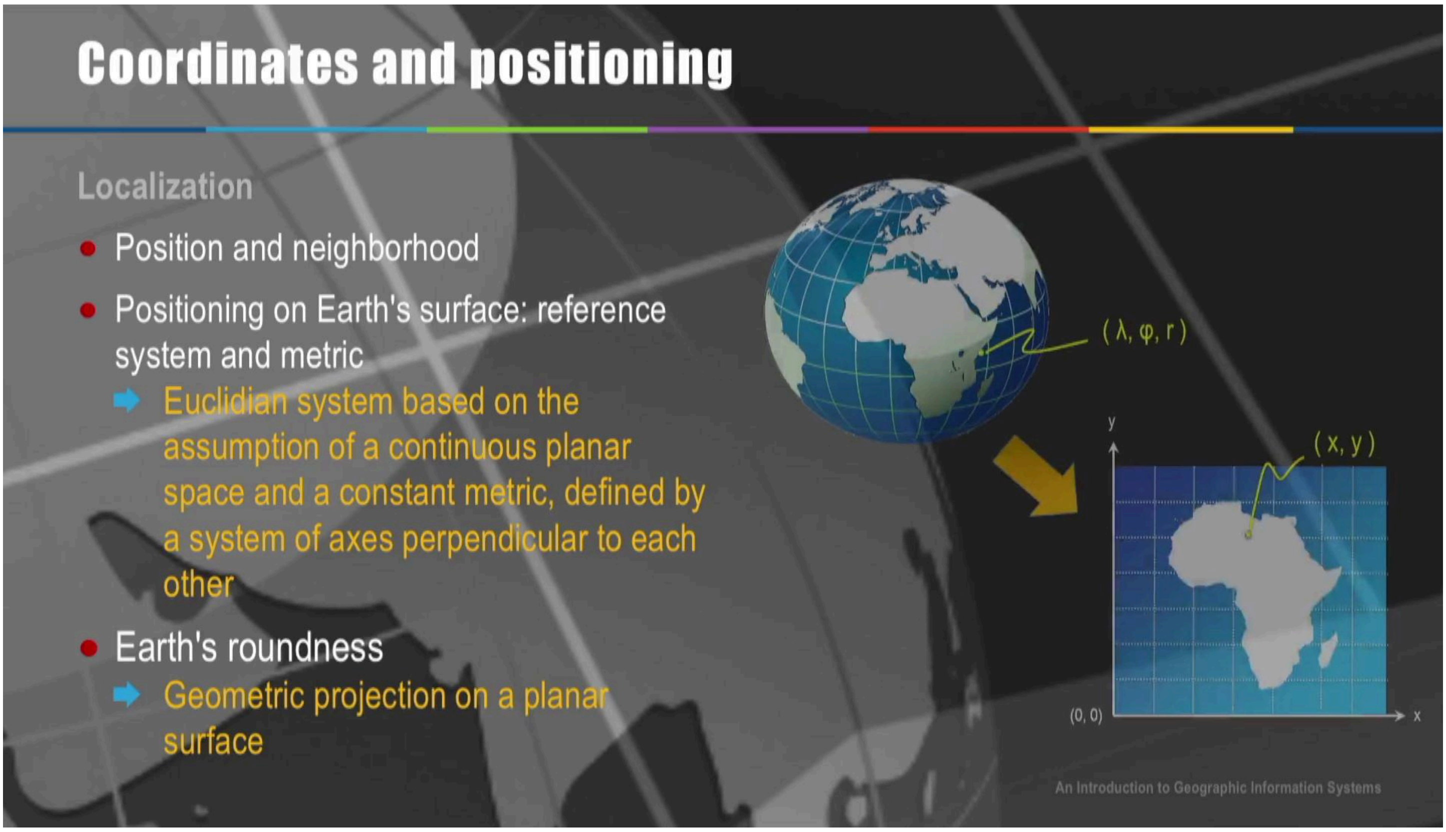


The observation and representation scales are closely linked because the map is both a source of information on space elements and a vector of representation. The scale of representation should thus correspond roughly to the threshold at which an object becomes non-discernible, which corresponds to a square of about 1 mm. In this example, we have drawn 4 squares of 10, 25, 50 and 100 m on the scale of one thousand. The representation size of these objects decreases when the scale is reduced, first at 2,500th then to 5 thousandth. From the 10 thousandth, the 10 m square reaches its perception limit and at the next stage, we no longer see it and it is the 25 m square which is at the limit and so on. We can rely on empirical rules which would say for example that for objects of a medium size about ten meters, it should not be a representation scale of less than 10 thousandth. The location of an object in space is based on the notions of position and neighborhood so its location in space on one hand and its relation to others objects on the other. The notions of neighborhood like "the grocery store is near the church" are very effective in everyday life but do not provide a frame of description which is suitable for complex objects such as those exploited in geographic information systems.

Notes

Summary

4m 31s

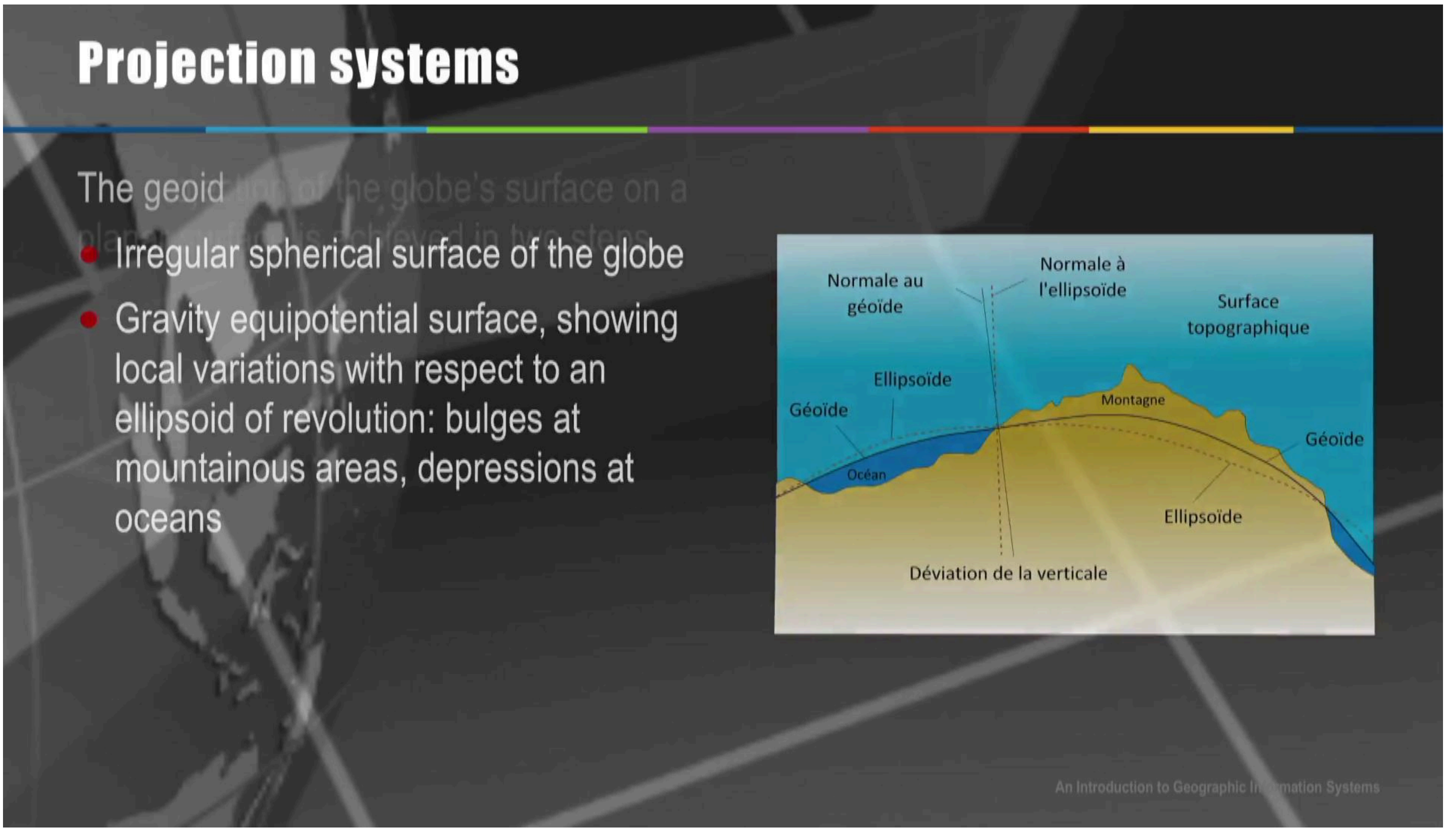


This requires a positioning method on the earth's surface which involves a reference system and a metric, two conditions verified by a Euclidean system. This system is based on the hypothesis of a continuous space plan and of a constant metric defined by a system of perpendicular axis between them.

Notes

Summary

6m 01s

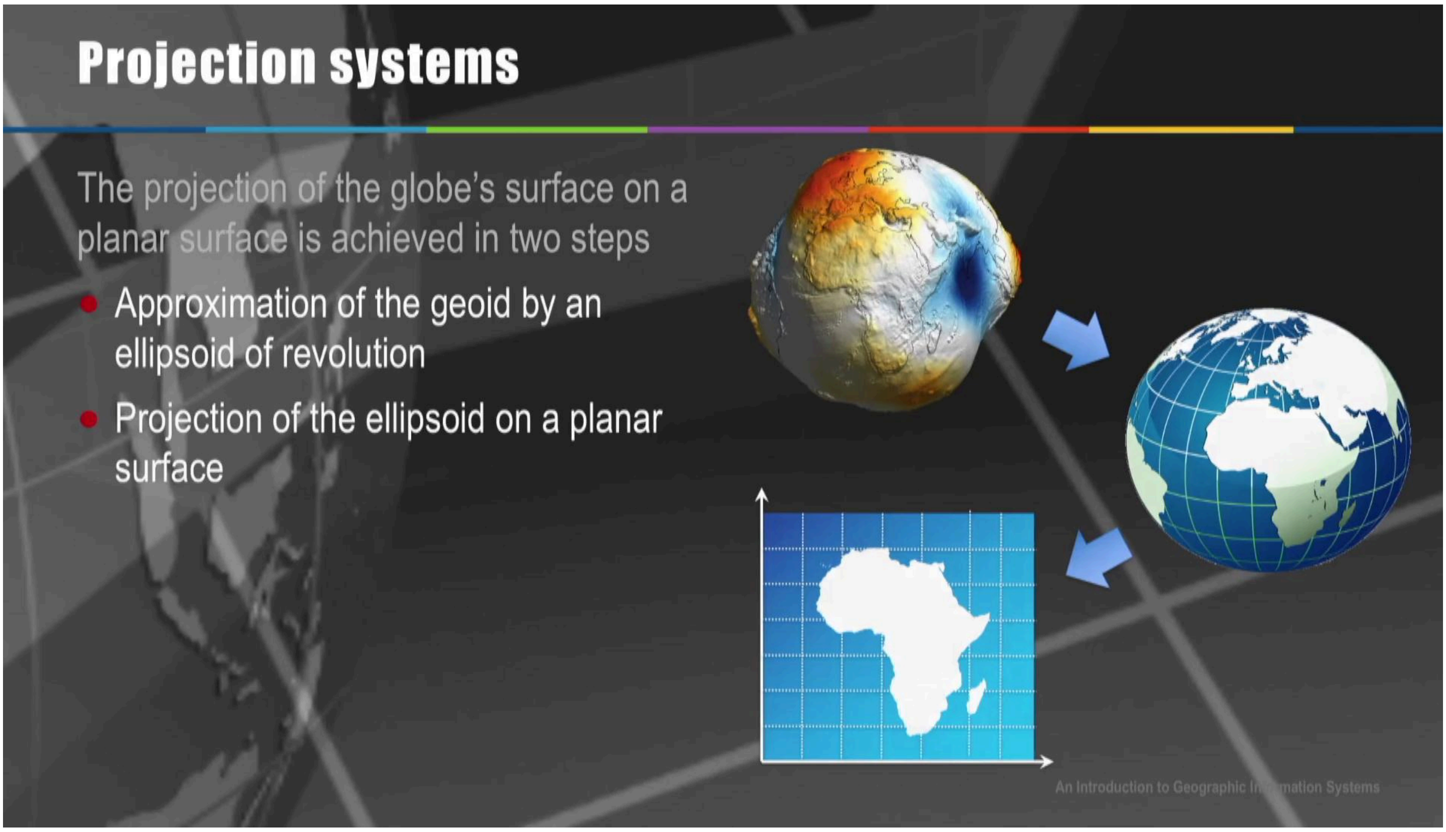


The surface of the earth is curved and it is desirable, for obvious convenience reasons, to represent it on a flat surface. This involves a geometric projection to go from a spherical positioning system with 3 coordinates to a 2-coordinate plan positioning system. The projection systems allow to establish a univocal punctual relationship between the surface of the earth and its flat representation. From a geometric point of view, the earth constitutes an irregular spherical tri-dimensional object called "geoide". It is an equipotential surface in gravity adjusted to an average level of the surface of the sea which presents swellings at the level of continents and depressions at the level of oceans. These gravimetric variations explain that the terrestrial form deviates locally from an ellipsoid of regular revolution.

Notes

Summary

6m 19s

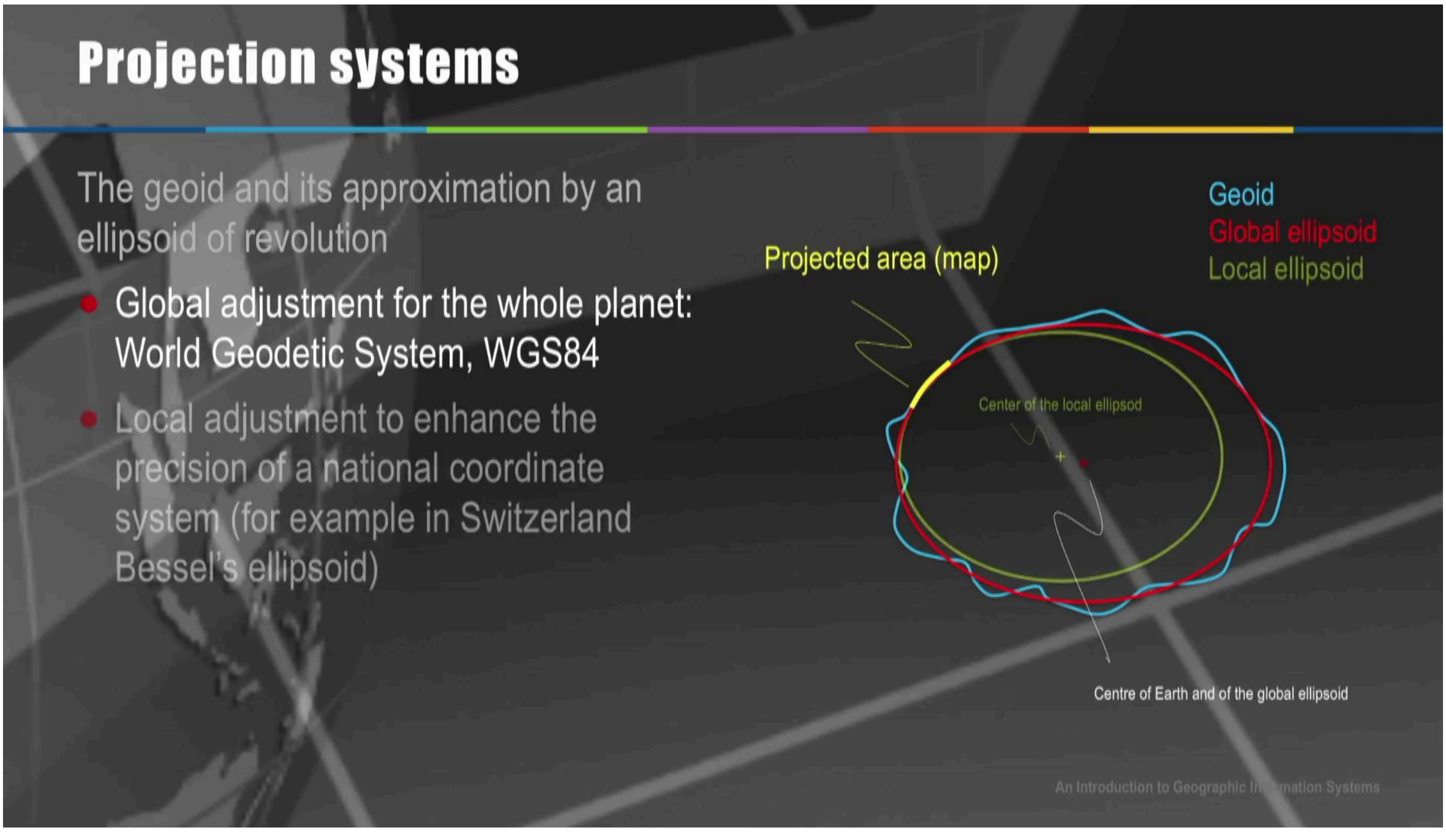


The projection of the coordinates of an object situated on the surface of the globe towards flat coordinates is carried out in 2 steps: First, approximation of the geoid by an ellipsoid of revolution. Then, secondly, projection of coordinates on this ellipsoid towards a flat surface.

Notes

Summary

7m 15s

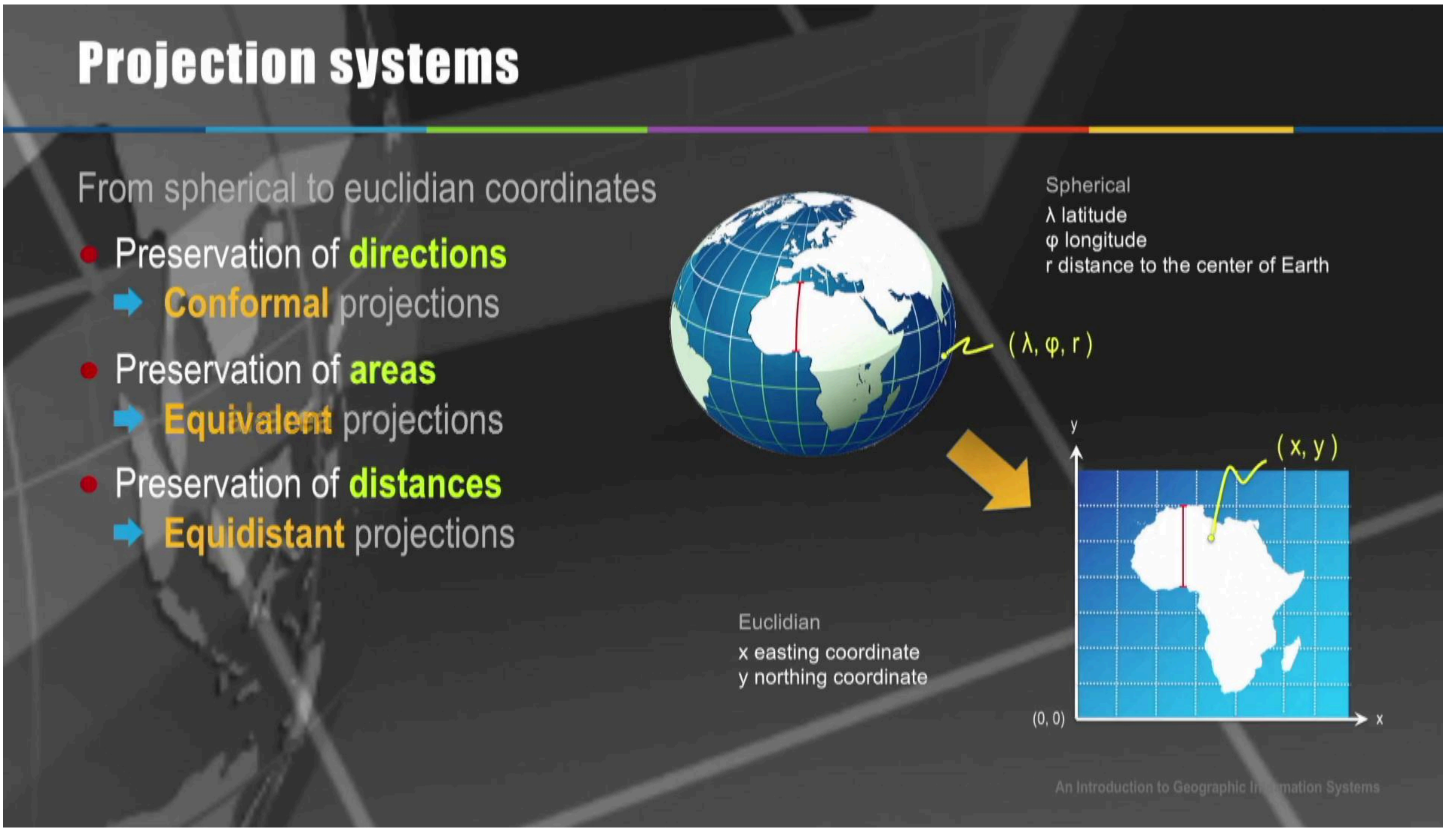


The approximation of the geoid by an ellipsoid of revolution can be done globally for all the planet, it is the principle of the World Geodetic System which latest version dates back to 1984, which is why this ellipsoid is known as WGS84.

Notes

Summary

7m 30s

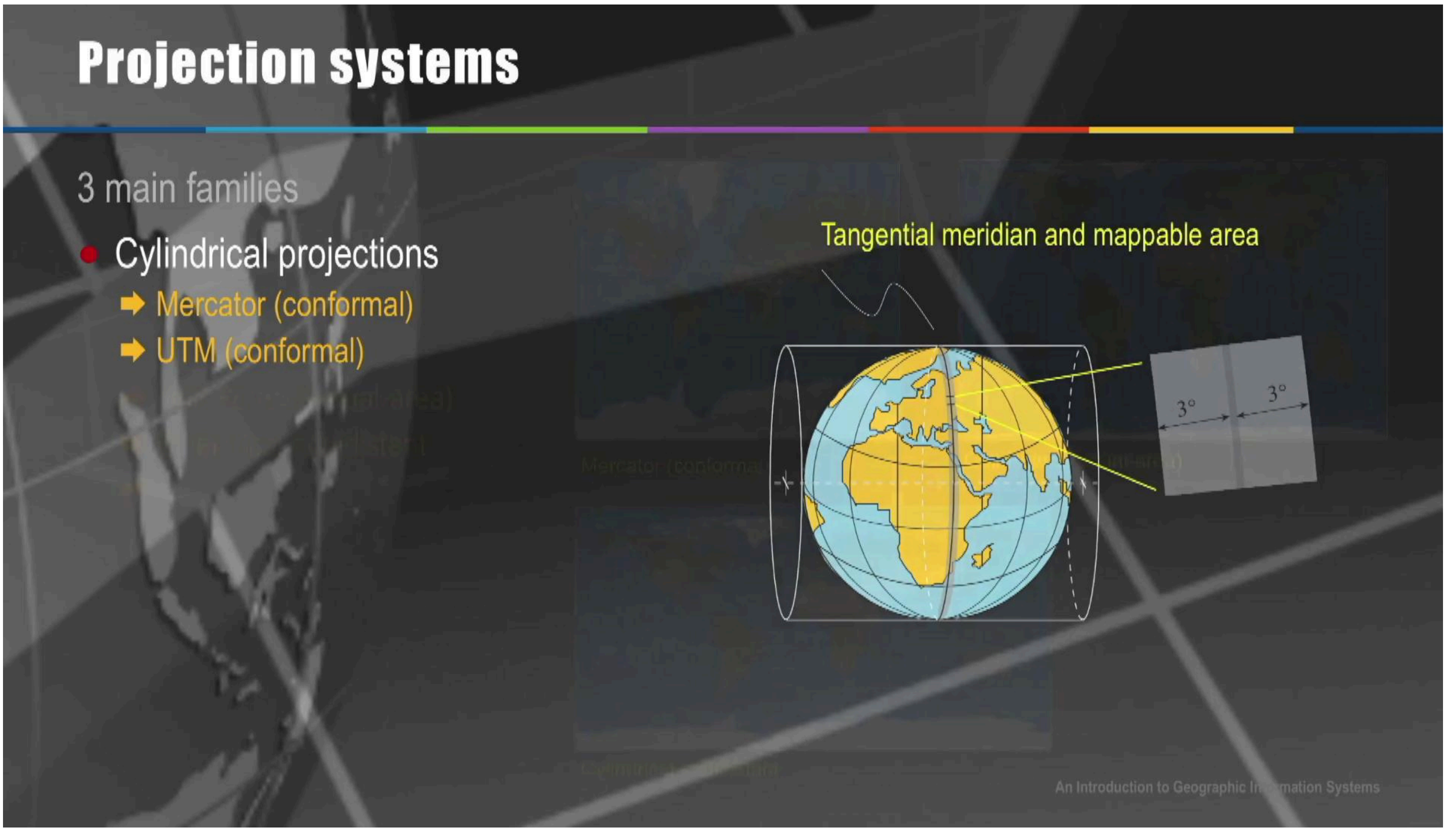


This adjustment can also be done locally to obtain a better accuracy on an area of particular interest, which is the case for example of Bessel's ellipsoid used in Switzerland. As we saw, going from an ellipsoid of revolution to a flat surface involves going from a 3 spherical coordinates system - latitude, longitude and distance at the center - to a system of 2 Euclidean coordinates: - the East coordinate and the North coordinate. The spherical and euclidean geometric laws show that this operation can't be carried out without a loss of information. So there are 3 types of projection systems that favour the conservation of a property to the detriment of the others. These properties are the orientation or direction, the surface and the distance. The projections which preserve directions or angles are called certified projections, the projections which preserve the surfaces are called equivalent projections and the projections which preserve the distances are called equidistant projections.

Notes

Summary

7m 52s

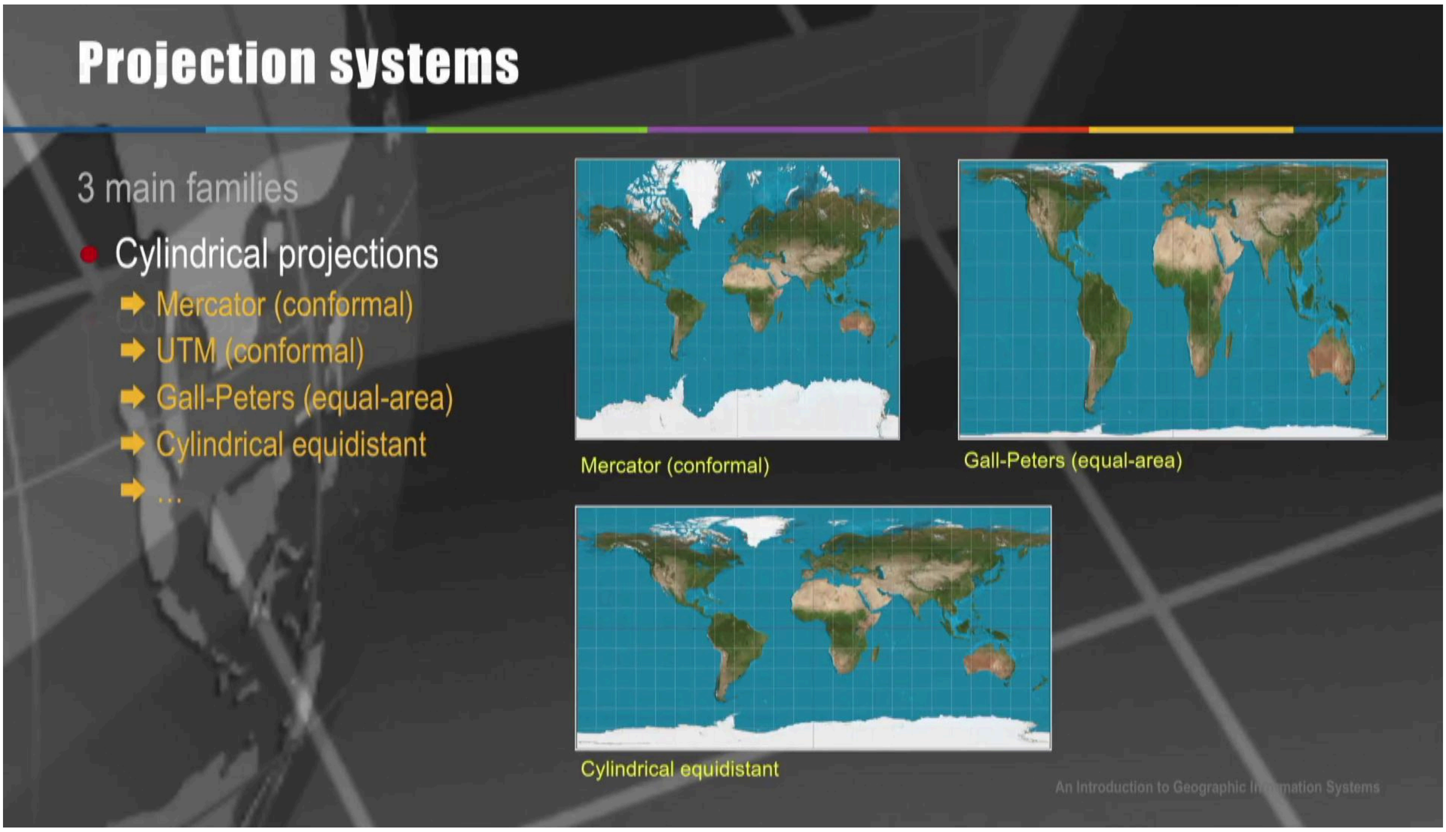


Beyond these properties, the projection systems are subdivided into 3 large families to which a number of more or less exotic projection systems are added. The first of these large families is constituted by cylindrical projections. It consists in placing the terrestrial globe inside a generally tangent cylinder, even if the one represented here is not, then projecting the points of the surface of the globe onto the walls of the cylinder, cutting the cylinder and unfolding it to get the map. The most common form of cylindrical projection is the Mercator projection which is a conformal projection which preserves the angles and directions. As we can see on this illustration this projection shows a 3 degree zone on either side of the great circle of tangency where the other properties, the surface and the distance, are sufficiently little altered so that the mapping is reliable. The UTM projection is very widely used With declinations of the parameters which depend on the longitude of the place. For example, UTM28 is used in Senegal or UTM40 in the Seychelles.

Notes

Summary

8m 52s

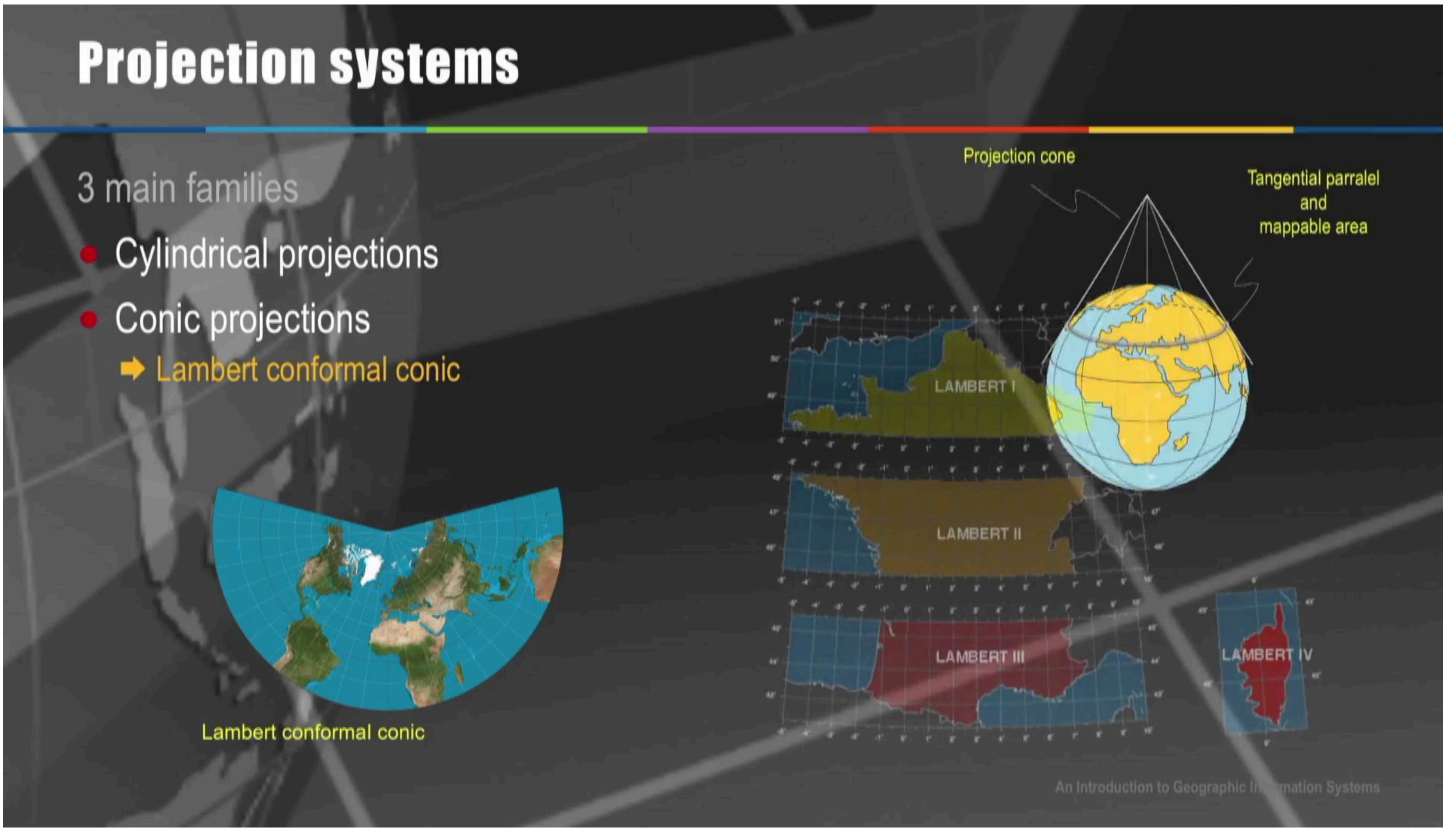


Among the other cylindrical projections we can note the Gall-Peters' projection which is an equivalent projection which preserves the surfaces and which gives a vision somewhat different from the planet than that of which we are accustomed. There is also an equidistant cylindrical projection illustrated here.

Notes

Summary

10m 02s

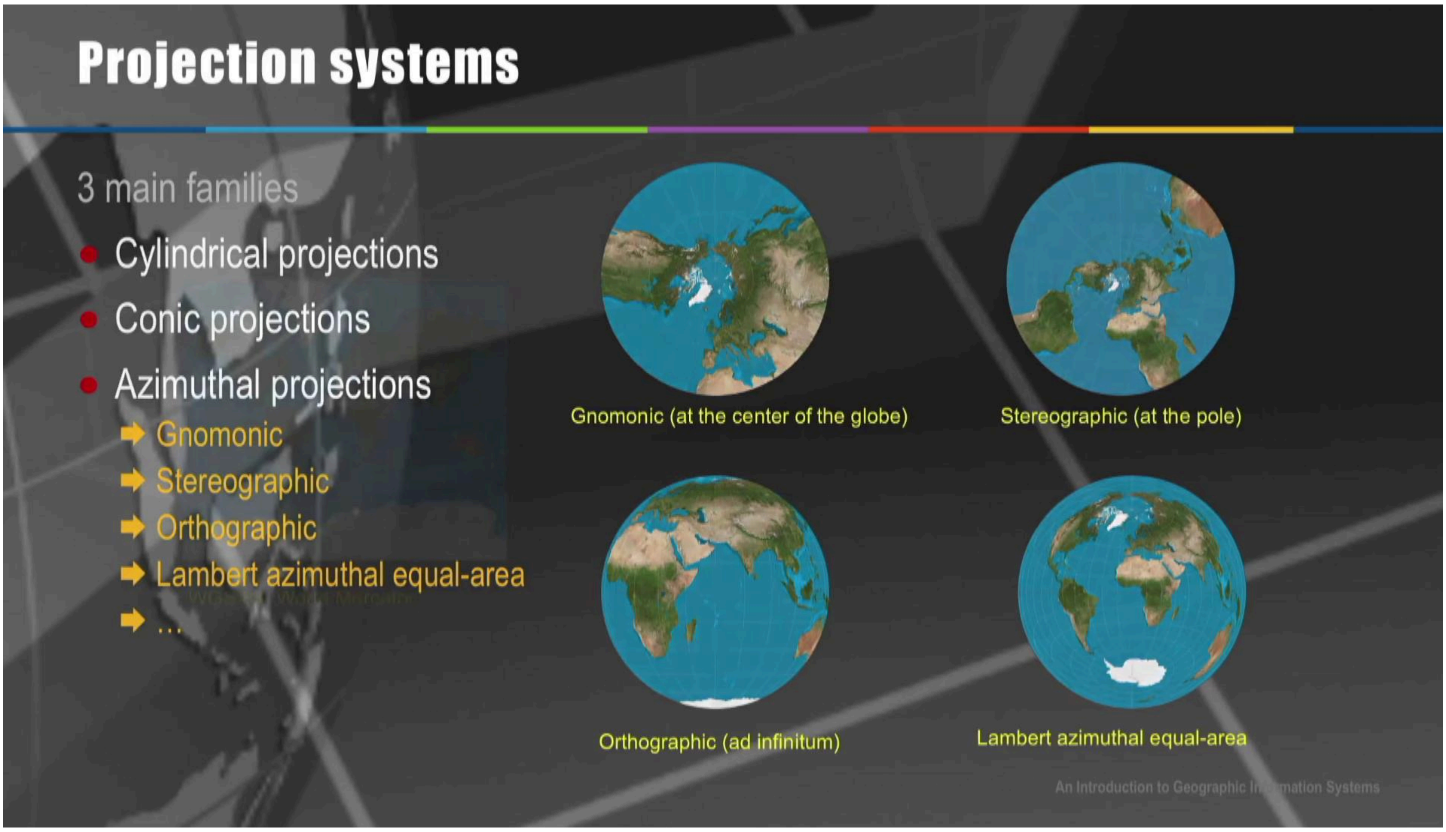


The second large projection family consists of conical projections. It consist of placing a cone on the terrestrial globe and then projecting the points of the surface of the globe on the cone, cutting the cone and unfolding it to obtain the map. The most common form of conical projection is Lambert's conformal projection which is also a projection that preserves the directions or the angles. This projection also has a tangential parallel which defines a mapping area where surfaces and distances are little altered by projection. This Lambert's conformal projection is used by our french friends with 4 tangency parallels to cover the whole territory.

Notes

Summary

10m 22s

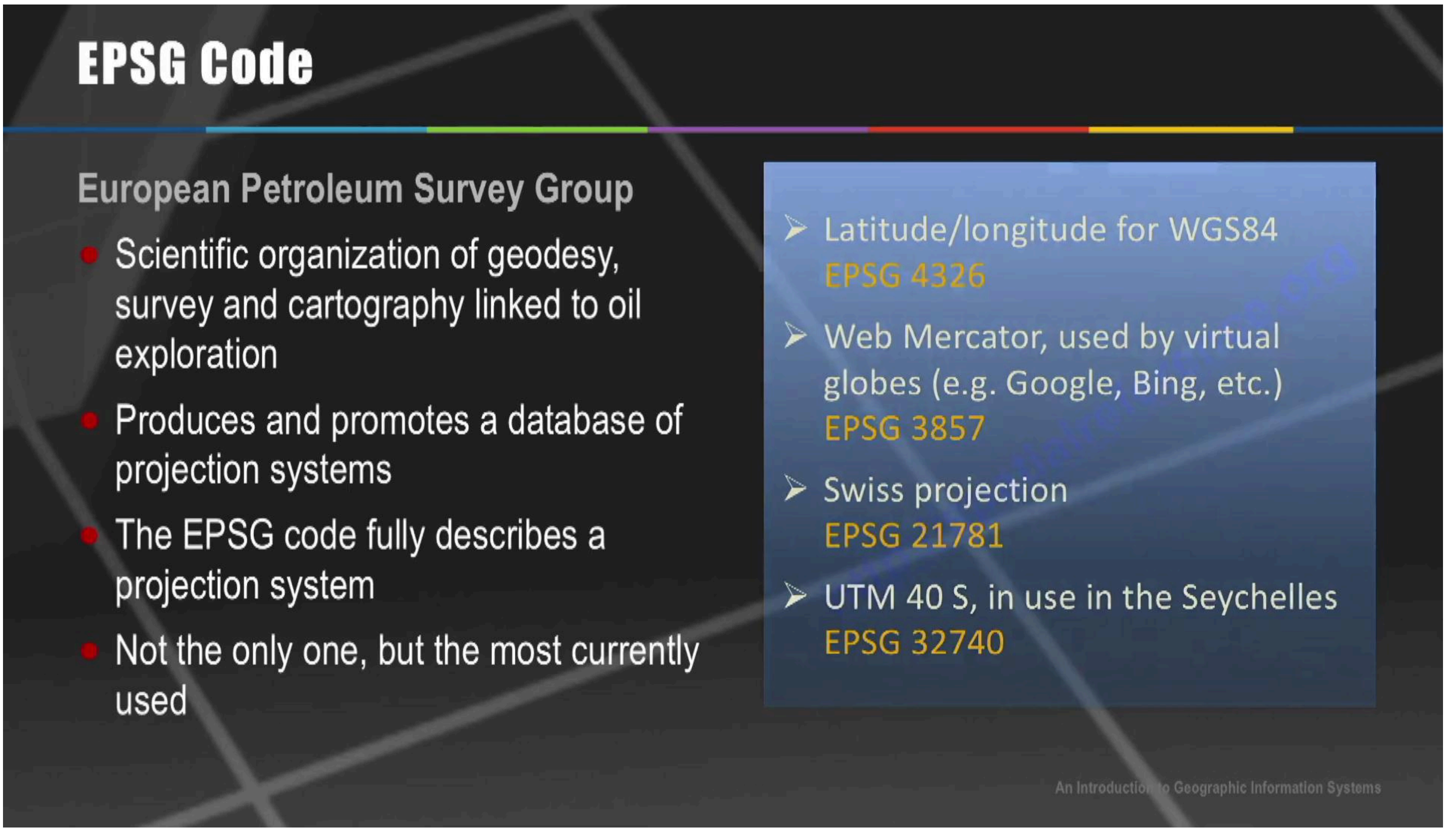


Among the other conical projections let's note the Albers' projection which is an equivalent projection and the equidistant conic projection. The third and last large family of the projection systems consists of azimuthal projections. The principle of azimuthal projection consists of placing a tangent plan in a point of the revolution ellipsoid then projecting the points of the ellipsoid surface on this tangent plan which finally becomes the map. The different types of azimuthal projections are distinguished by the position of the projection centre which can be at the centre of the earth for the gnomonic projections, at the poles for the stereographic projections, located in infinity for the orthographic projections which are projections where each point is projecting othogonally on the tangent plan. There is also a form of equivalent projection: Lambert's equivalent azimuthal projection.

Notes

Summary

11m 06s

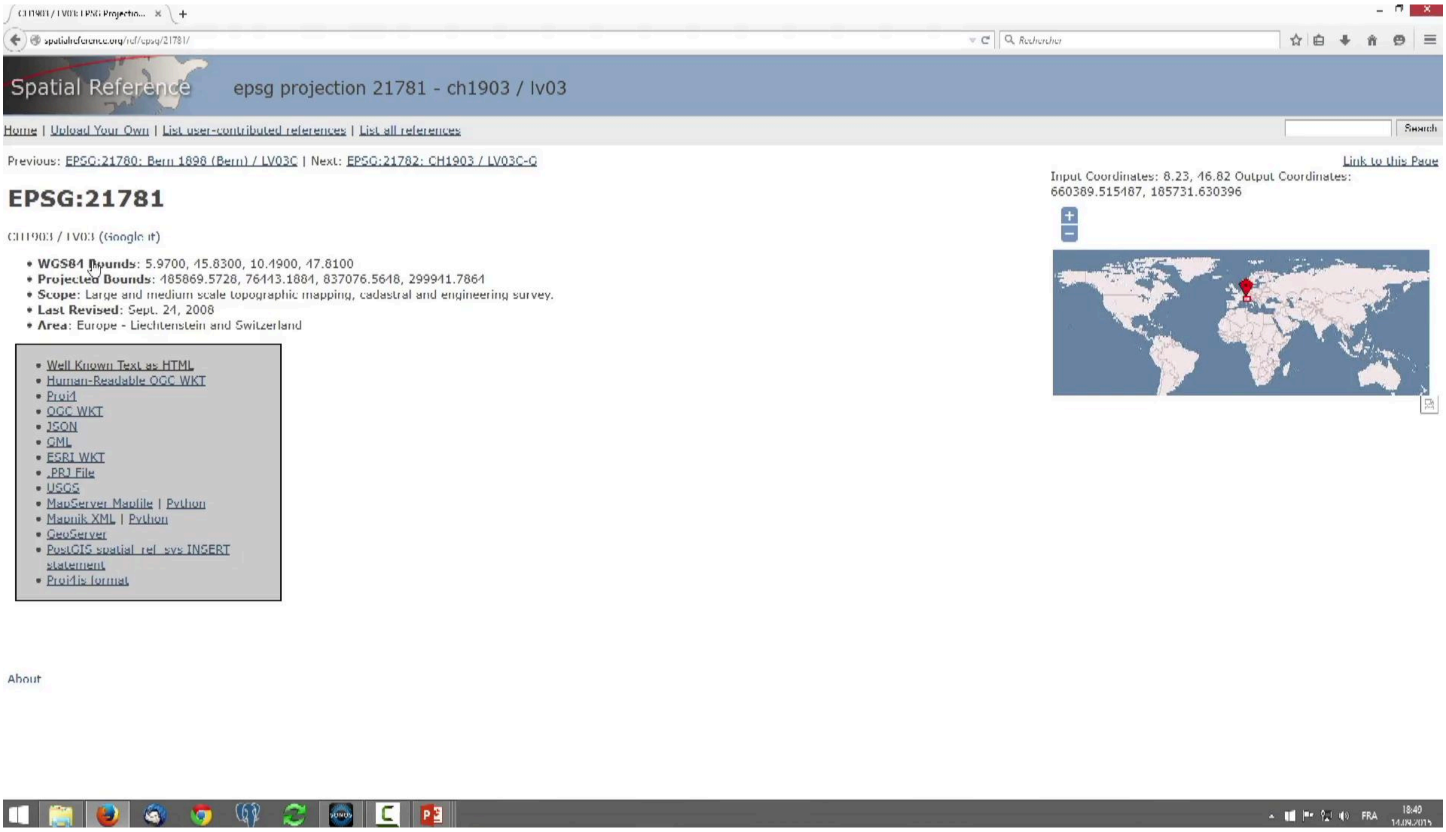


These different legal references of positioning have been numbered, they are therefore characterized by a code,the EPSG code. The numerous projection systems used throughout the world have at some point been surveyed by a geodesy, measurement and mapping organization linked to oil exploration: The European Petroleum Survey Group, EPSG in an abbreviated form. This databases, even if it is not the only one of its kind has become a factual reference. This is why the longitude latitude coordinates system for the WGS84 ellipsoid of reference bears the code EPSG 4326. The Web Mercator coordinates system used by the virtual globes, for example Google maps,etc..

Notes

Summary

12m 09s



bears the number 3857, the projection used in Switzerland, the 21781, and the UMT 40 South projection used in the Seychelles number 32740. These various references can be consulted on the following website: spatialereference.org We can search for example the EPSG 4326 reference which corresponds to the longitude latitude coordinates system for the WGS84. And we find all the parameters in different formats for this coordinates sytem for example here the Well Known Text in HTML format. We can also search the 32740, the UTM40 South used in the Seychelles. And we see that... in fact the use area of this coordinates system on the right is restricted to a small part of the planet and also we have access to the parameters of this projection in a file. The reference 21781, the coordinates system used in Switzerland, we can see that in fact it covers a very small area of validity. We can also access all the parameters of this projection in various formats: the Well Known Text in HTML form the Proj4, the JSON, the GML, etc.

Notes

Summary

13m 23s