Federal Agency for
Cartography and Geodesy

Session 6.2:

Learning to localize the data with GPS

V1

Pier-Giorgio Zaccheddu

Federal Agency for Cartography and
Geodesy (BKG)

Richard-Strauss-Allee 11
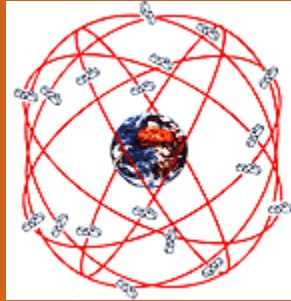
60598 Frankfurt am Main

Tel.: +49 69 6333 305

Fax: +49 69 6333 441

Email: pier.zaccheddu@bkg.bund.de

Federal Agency for
Cartography and Geodesy

Content

- What is a Satellite Positioning System?

- Positioning – direct and differential

- Coordinate Systems, Geodetic Datum, Map projections

- Coordinate Transformation

Federal Agency for
Cartography and Geodesy

GPS: Global Positioning System
USA, 24 satellites

GLONASS:
Global Navigation Satellite System
Russia, about 12 satellites

GALILEO
Europe, planned, 30 satellites
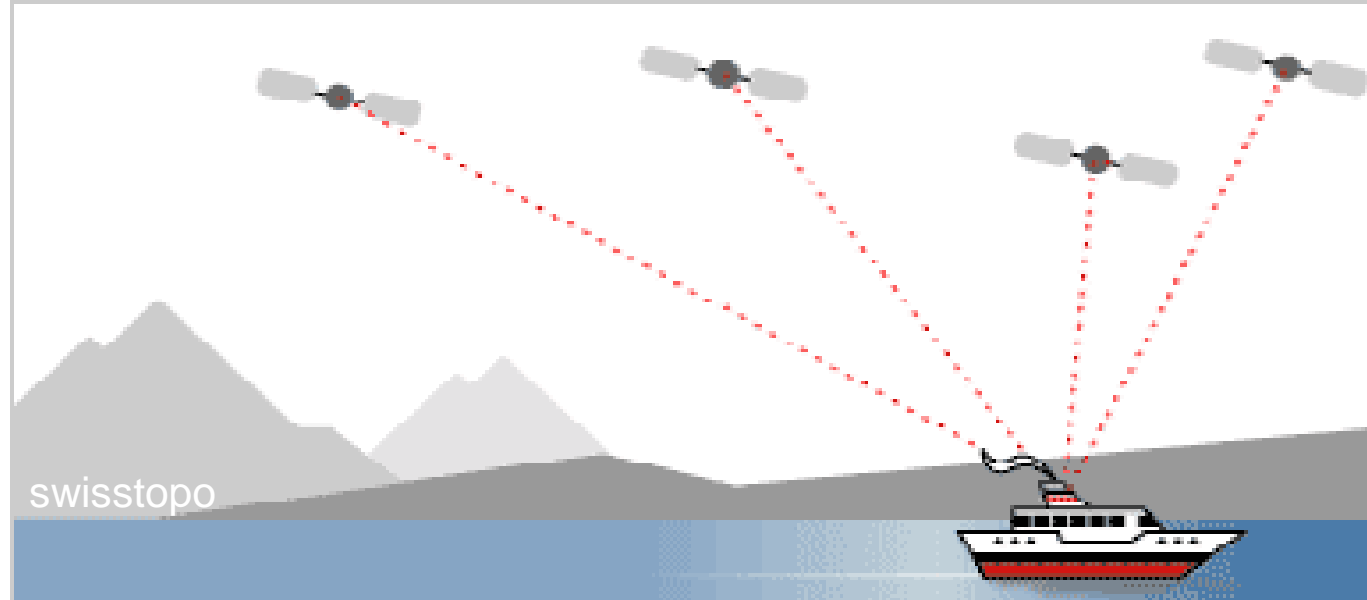
Simultaneous observation of 4 satellites

provides 3-dimensional coordinates

Accuracy: 5 – 10 meters

In a nutshell:

- Satellite ranging - calculating the distances between the receiver and the position of 3 or more satellites.

- "Triangulation" of an additional position.

- Use of information from the *almanac* in conjunction with the *ephemeris error data*

- The clocks in GPS receivers are not as accurate as the very precise atomic clocks in the satellites:
  -> determine a fourth variable (in addition to x, y, z), time, in order to calculate a precise location
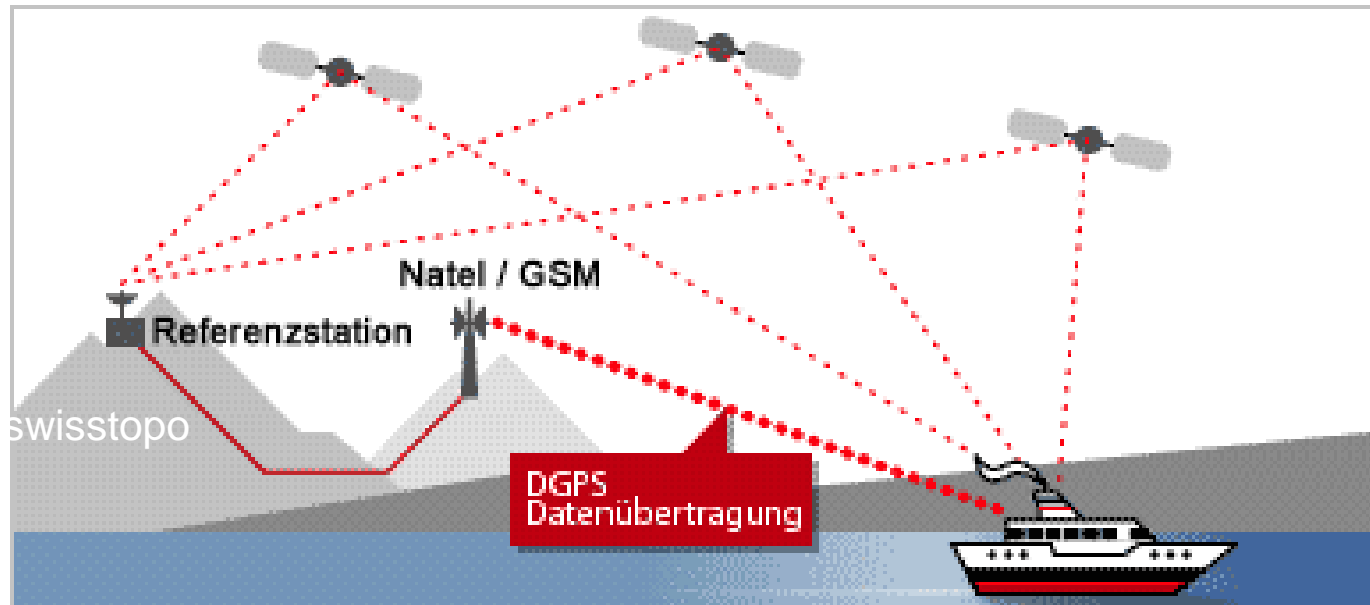
Requires in addition: reference station and communication link

Accuracy: 1 meter, up to a few centimeters

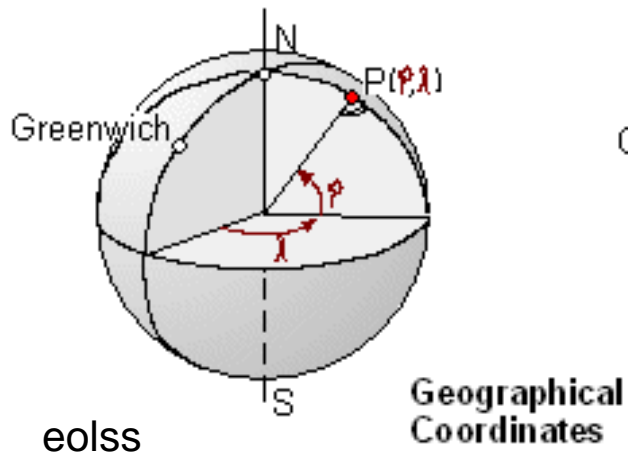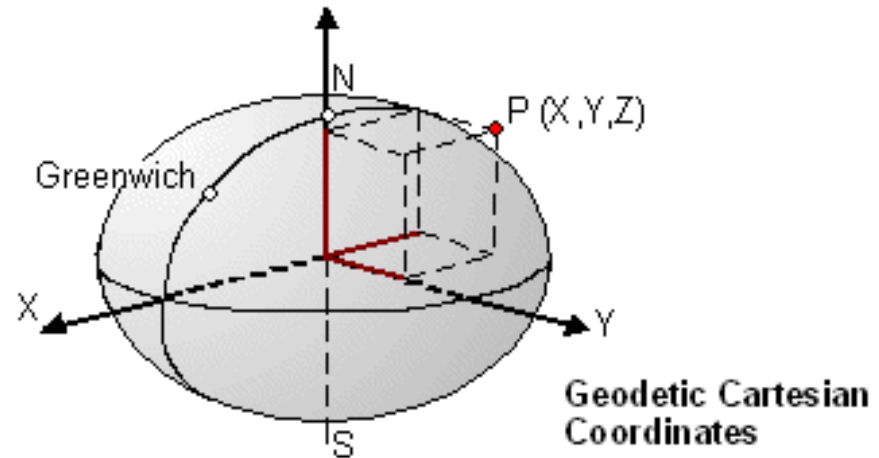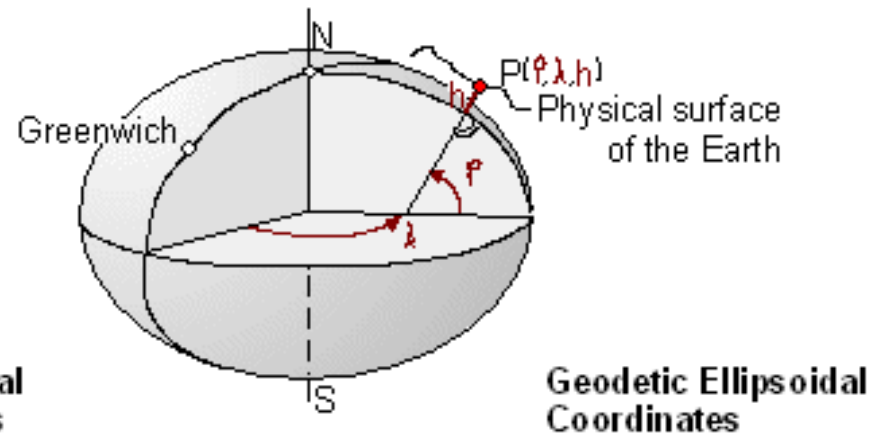There are many different coordinate systems, based on a variety of *geodetic datums*, *projections*, and *reference systems* in use today…
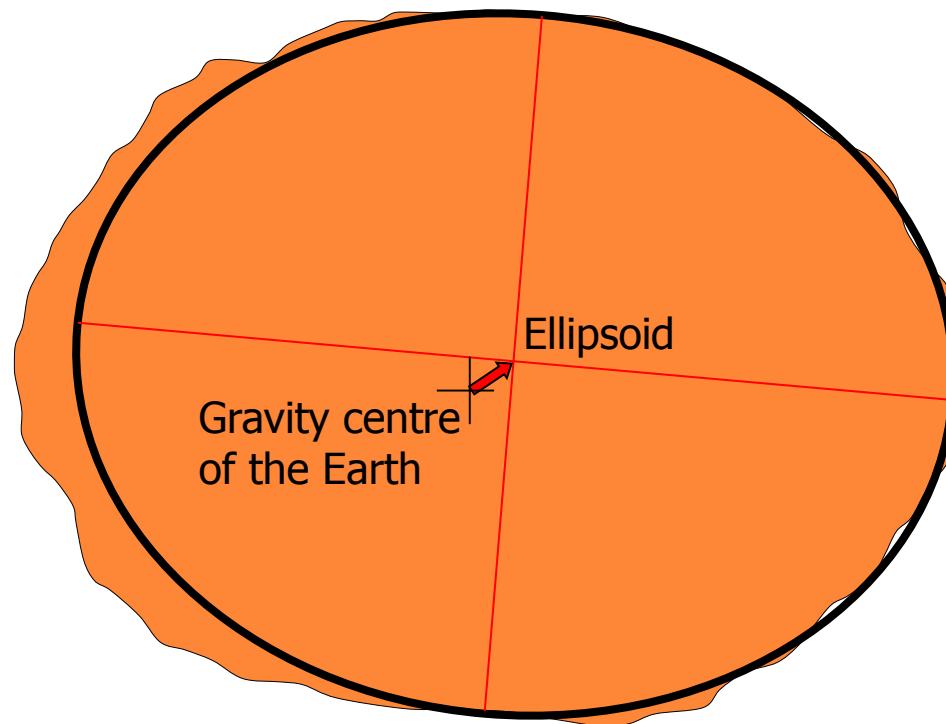
describe a 3-D position
on the surface of the
Earth

Geodetic Cartesian Coordinates

Geographical Coordinates

Geodetic Ellipsoidal Coordinates

eolss

defines shape of ellipsoid and its position to the gravity centre of the Earth

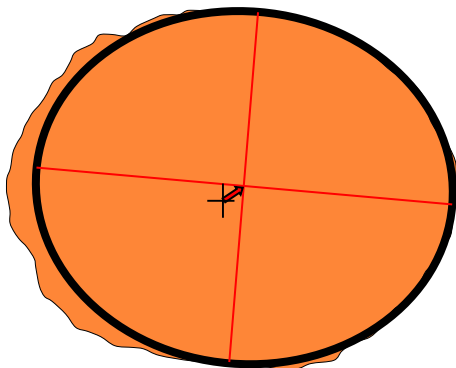Ellipsoid

Gravity centre
of the Earth

National or regional ellipsoids: best fit locally

now: global ellipsoid GRS80 (best fit for whole planet)
  Global Geodetic Datum WGS84, uses GRS80

GPS uses WGS84
But: many coordinates still in local systems
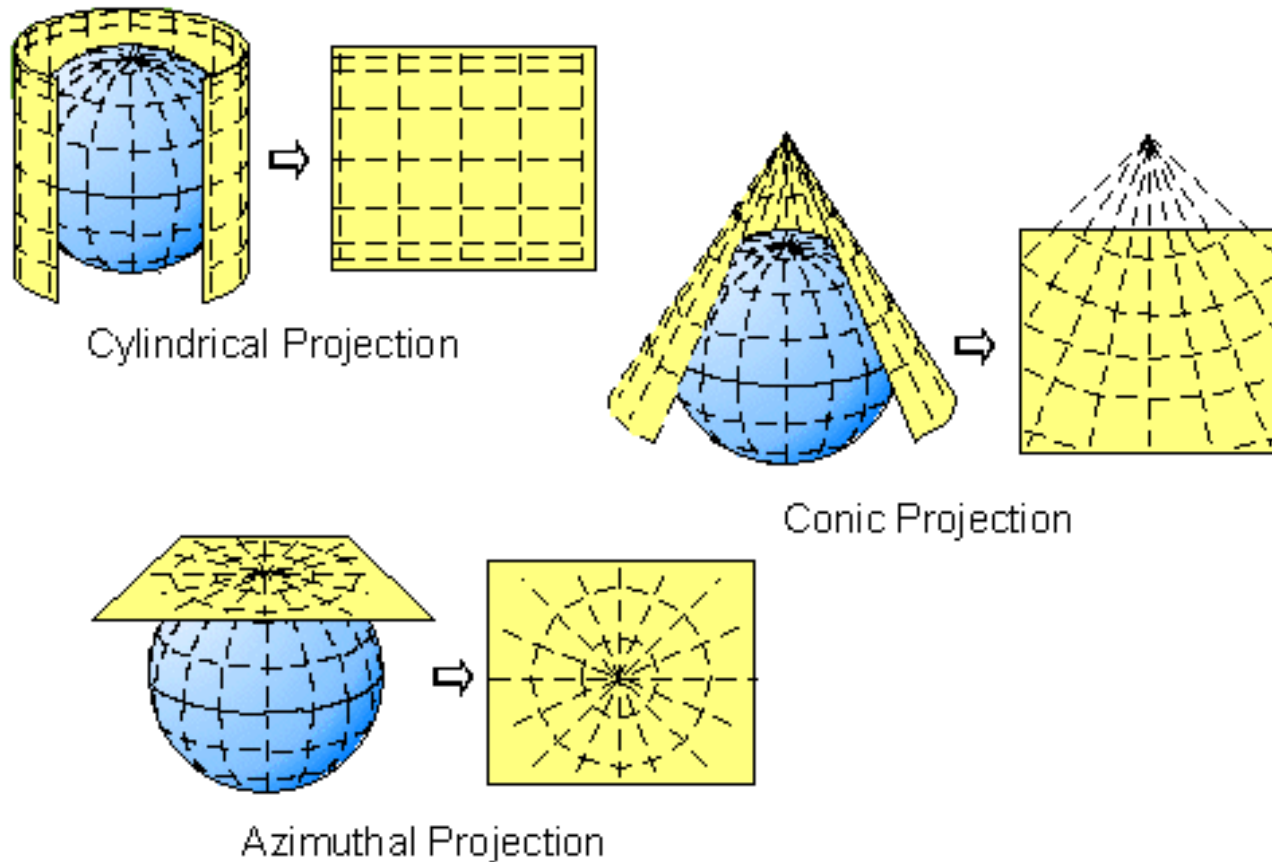> you might need to apply datum conversion

- A map projection is used to portray all or part of the round Earth on a flat surface. This cannot be done without some **distortion**. Every projection has its own set of advantages and disadvantages.

- **There is no "best" projection**. The mapmaker must select the one best suited to the needs, reducing distortion of the most important features.

- Mapmakers and mathematicians have devised almost limitless ways to project the image of the globe onto paper (*conformal, equal area, equidistant*).

Federal Agency for
Cartography and Geodesy

Convert positions from 3-D to 2-D

Cylindrical Projection

Conic Projection

Azimuthal Projection

from GPS:
P (X,Y,Z) Geodetic Cartesian, in WGS84

Datum conversion

P (X,Y,Z) Geodetic Cartesian, in national system

P (φ,λ,h) Geodetic ellipsoidal, in national system

Map projection

Federal Agency for Cartography and Geodesy

Garmin

Take care that you use the correct parameters!