Mapping the world

ST PAUL'S GEOMETRY MASTERCLASS III

Who are we?

Mairi Walker

- Final year maths PhD student at The Open University
- Studying links between geometry and numbers
- Also interested in the history of maths

David Martí Pete

- Second year PhD student at The Open University
- Studying complex dynamics

What are we doing?

We have organised a series of workshops to show you what it's like to study maths at university. We've based the themes on aspects of our own research, and some of our favourite topics!

The workshops are:

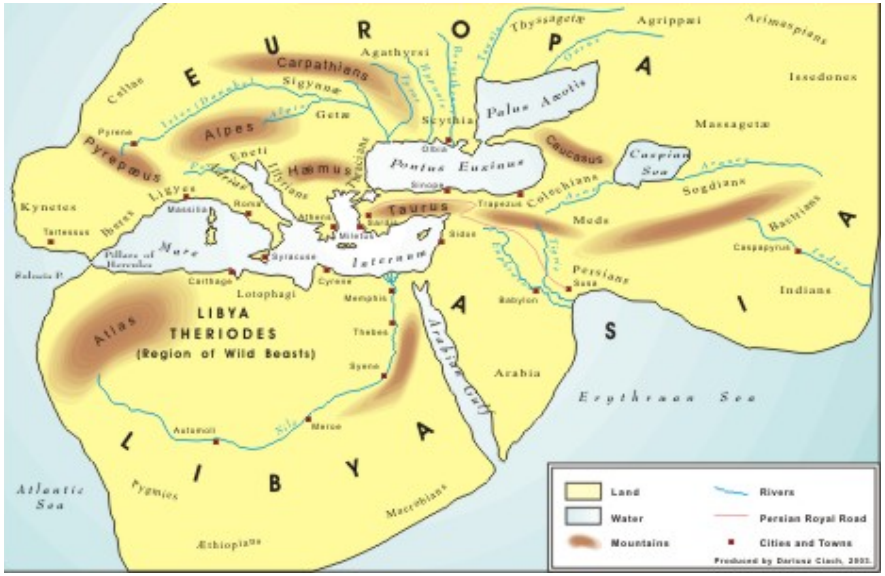
- From polygons to polyhedra and beyond
- Fractals everywhere
- Mapping the world

Our world

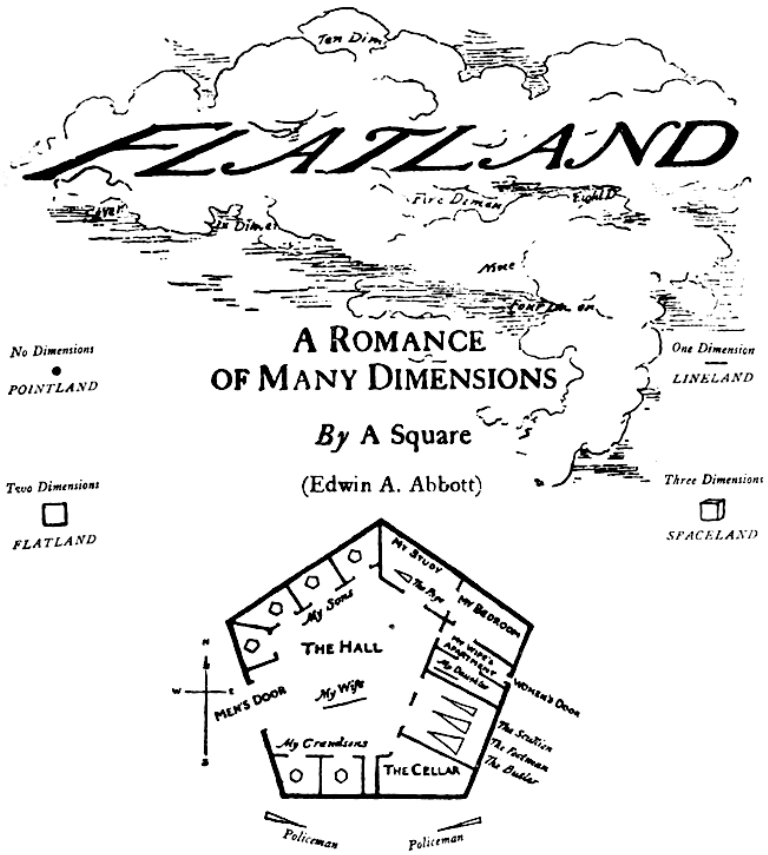
Today we are going to be looking at how can we make maps of the world from the mathematical point of view!

The first maps

Until around 500 BC
the Earth was believed to be **flat**!



Flatland



How would it be
to live in a
2-dimensional world?

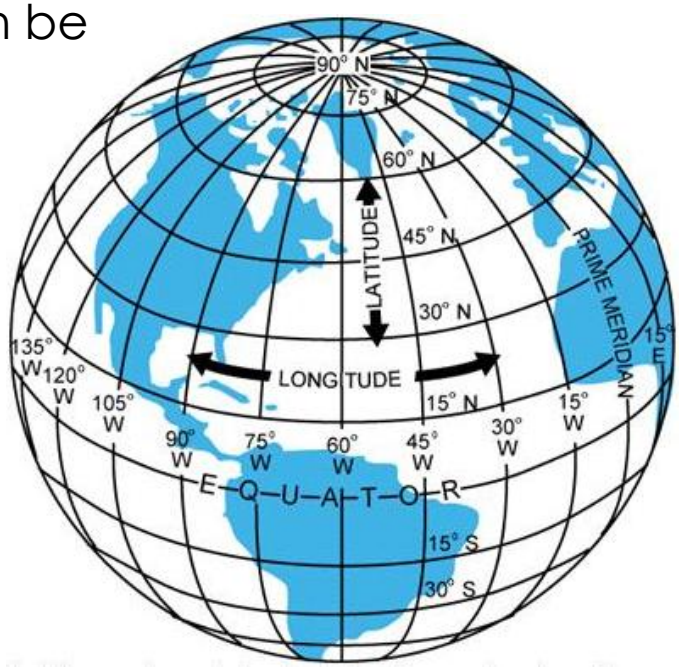
Book
"Flatland: A Romance
of Many Dimensions"
by Edwin A. Abbott

Further developments…

Coordinates

A point on the surface of the Earth can be determined by two numbers (angles):

- **Longitude**: from 0° to 180° E/W
- **Latitude**: from 0° to 90° N/S

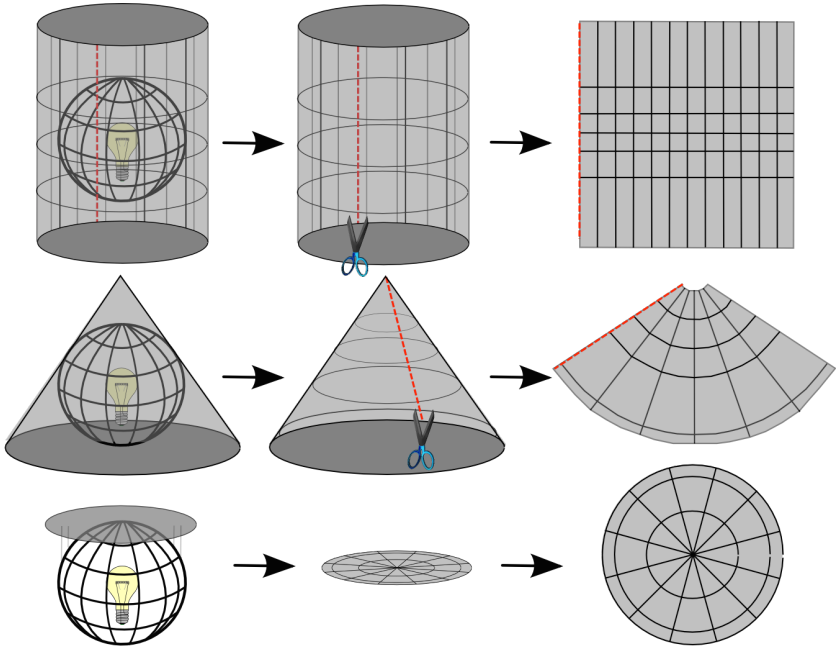


Parallels have constant latitude
The 0° parallel is the equator

Meridians have constant longitude
The 0° meridian passes through Greenwich

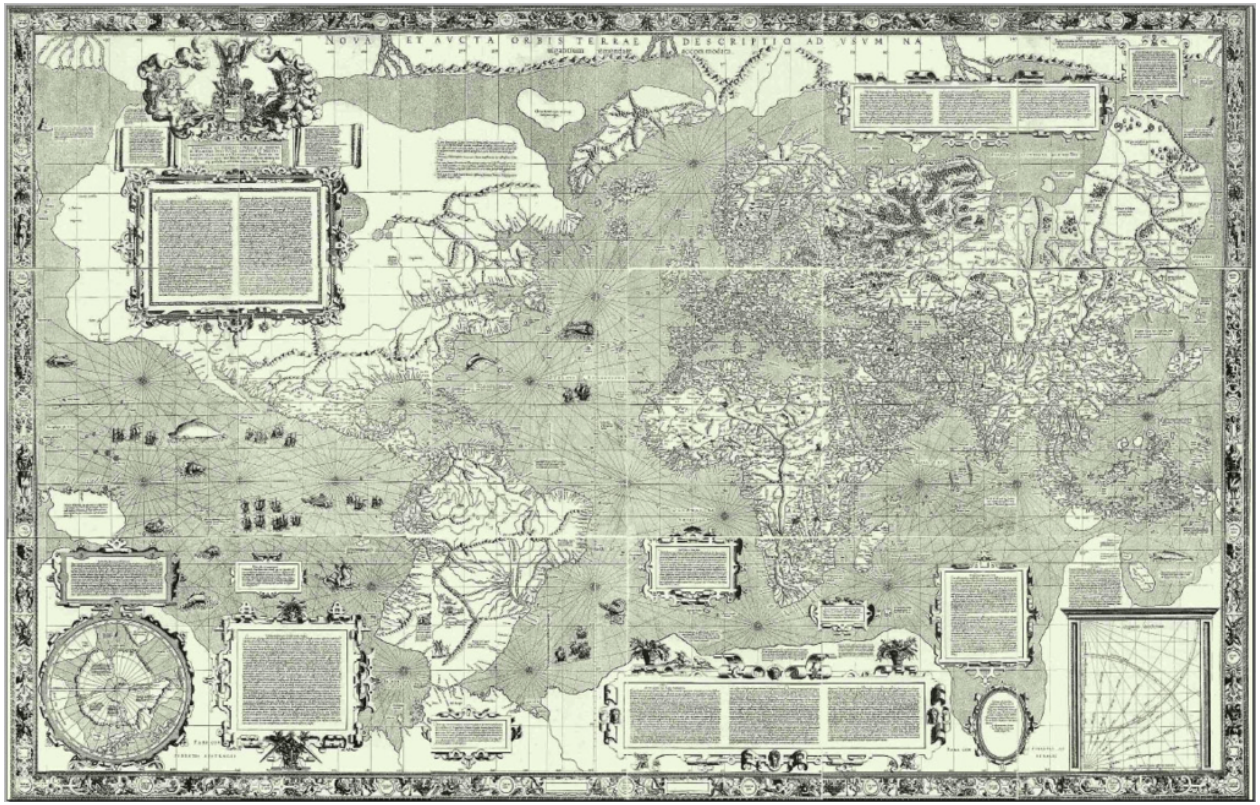
Maps are projections

A **projection** is any mathematical function transforming coordinates from the curved surface (our sphere) to the plane.

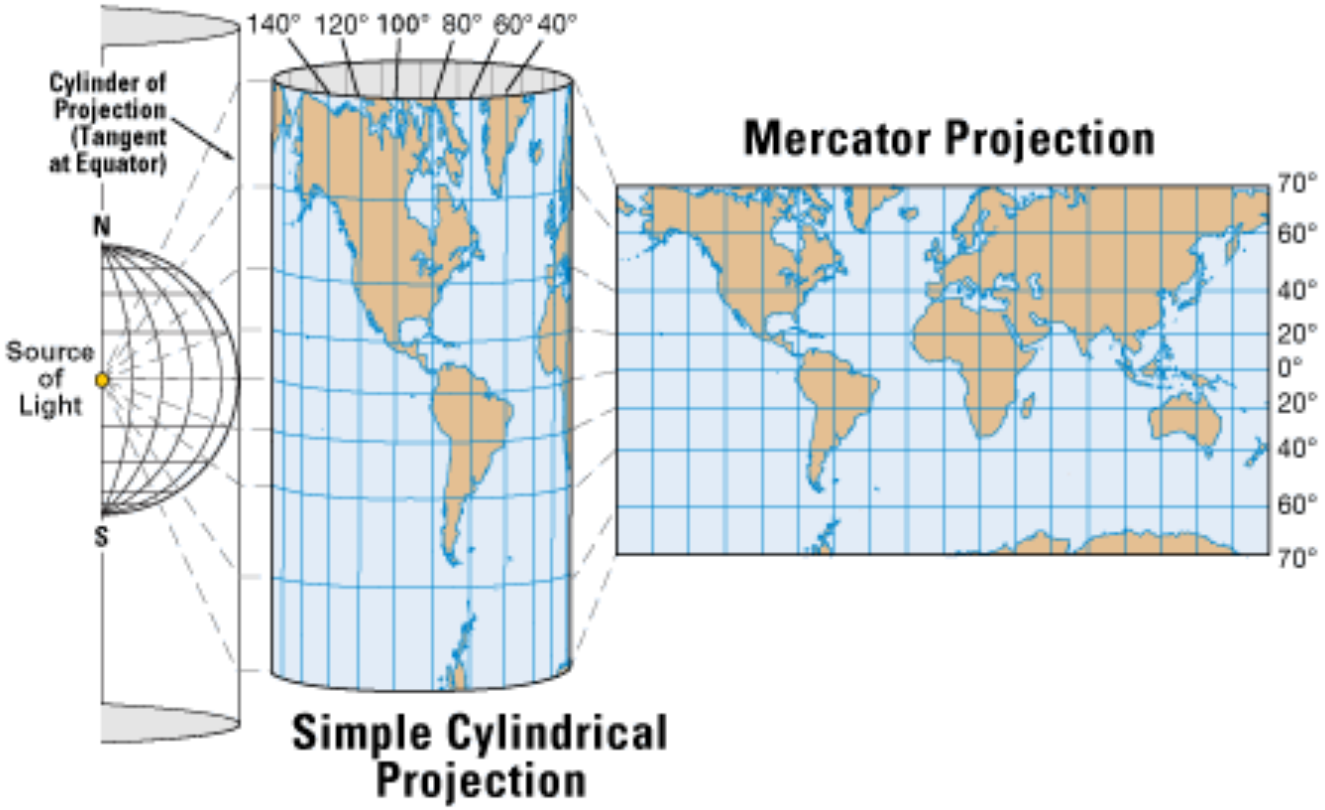


How can we achieve this?

Mercator's world map (1569)



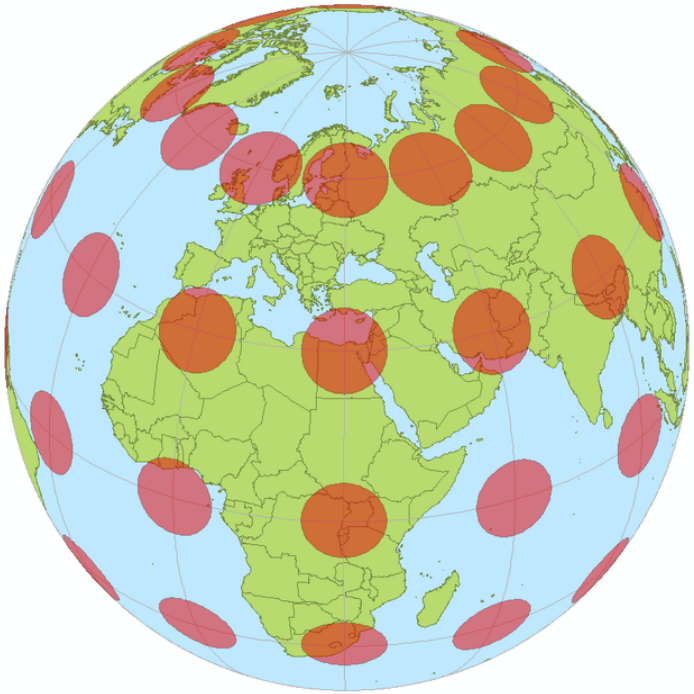
How is it made?

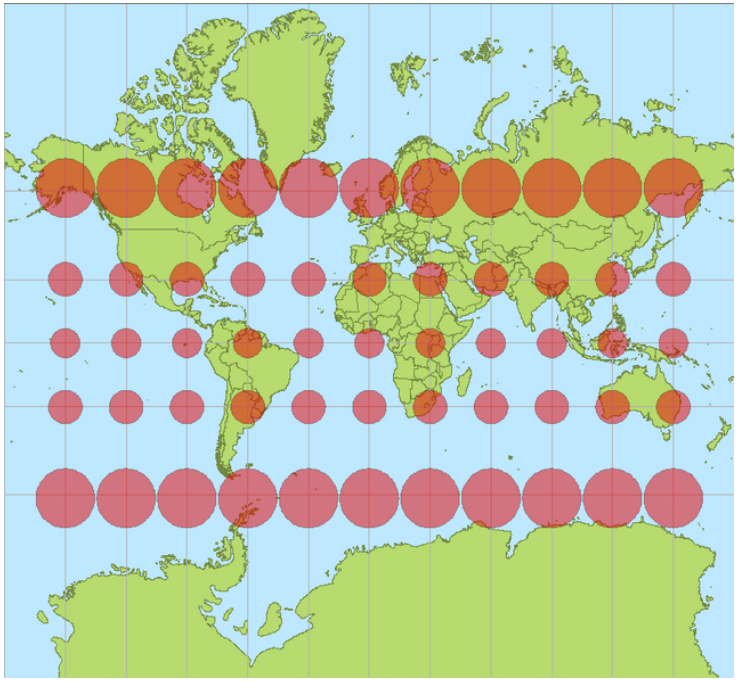


Mercator's projection

How to measure the distortion?

Mathematicians use a tool called **Tissot's indicatrix**!



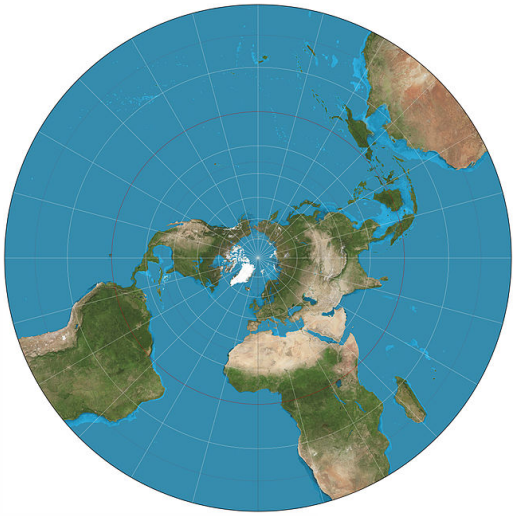


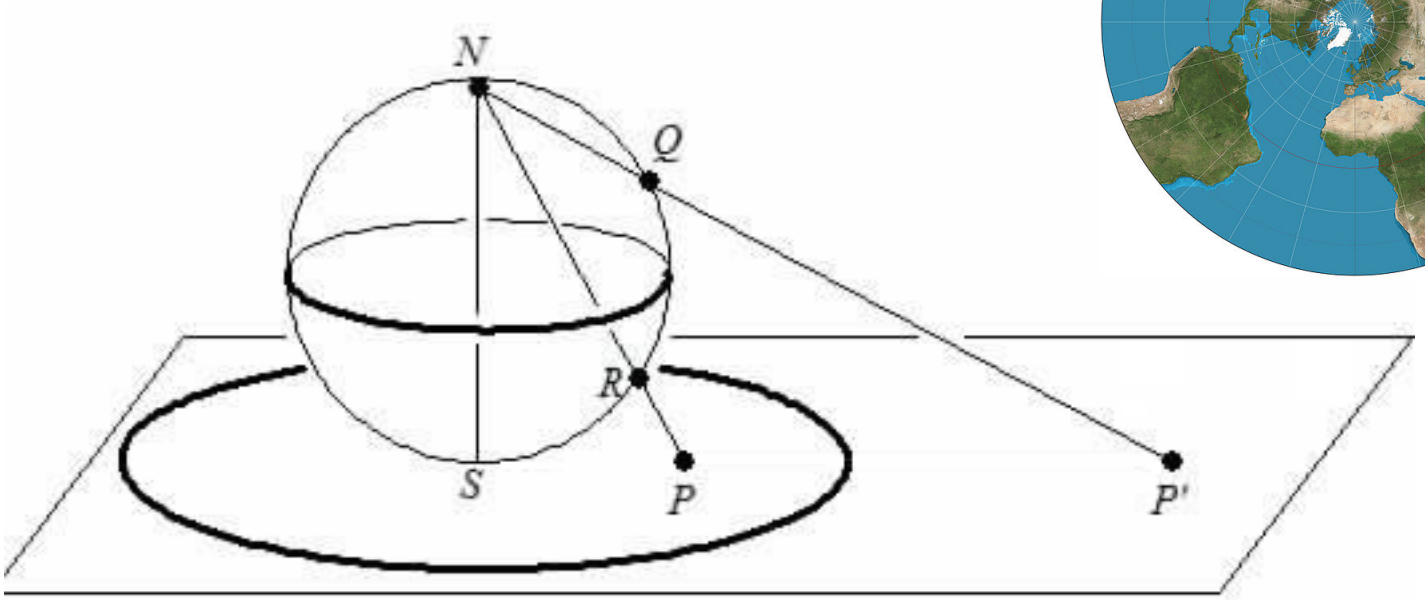
Stereographic projection

This is an example of another **conformal** projection,

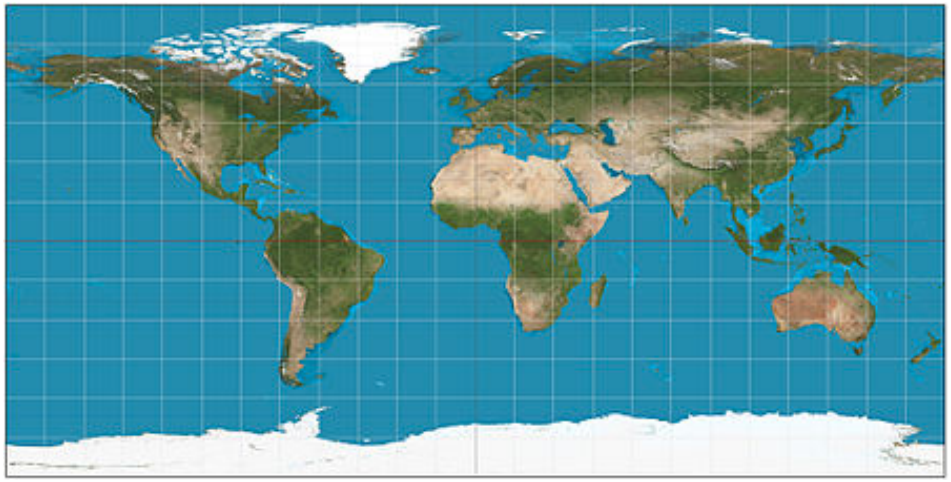
this means that it maps circles to circles

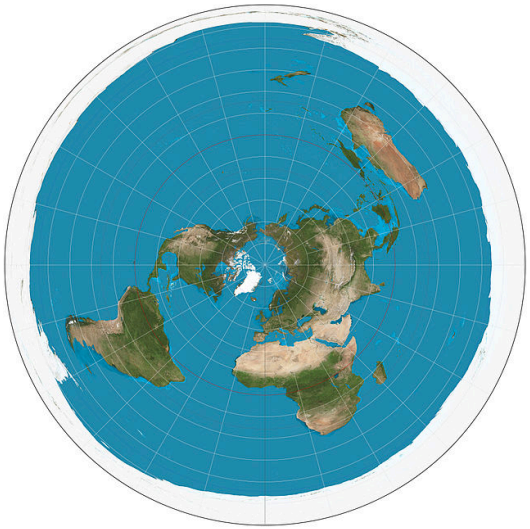
or, in other words, it preserves angles

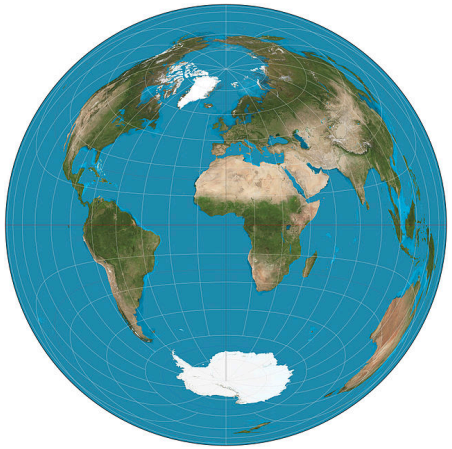


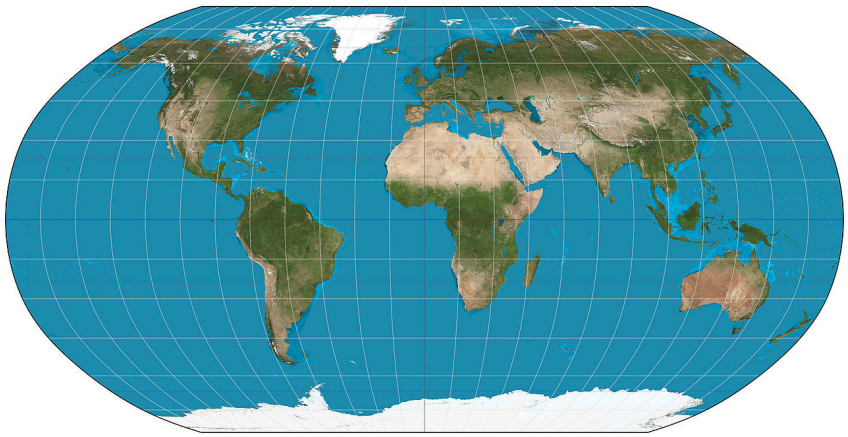


Other projections









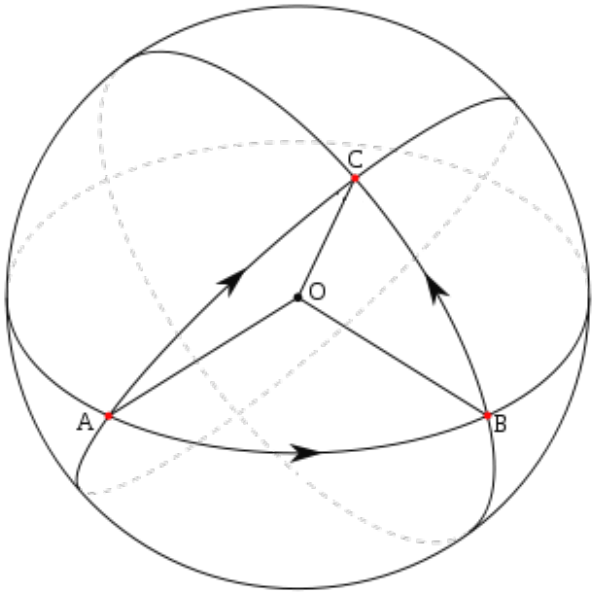
Gauss's *Theorema Egregium*

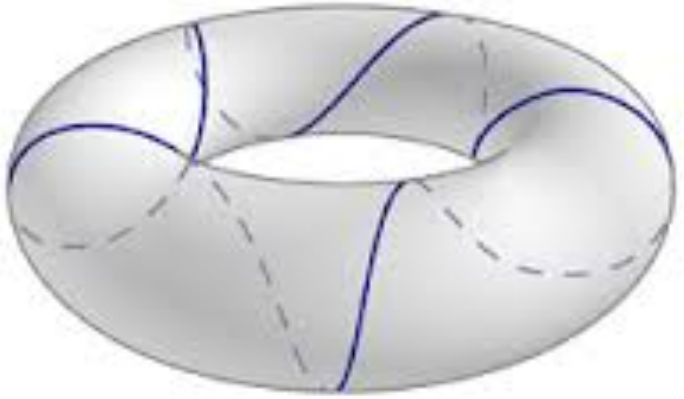
If a surface is developed upon any other surface whatever, the measure of curvature at each point remains unchanged!

This implies that maps cannot preserve both area and angles at the same time!

Geodesics

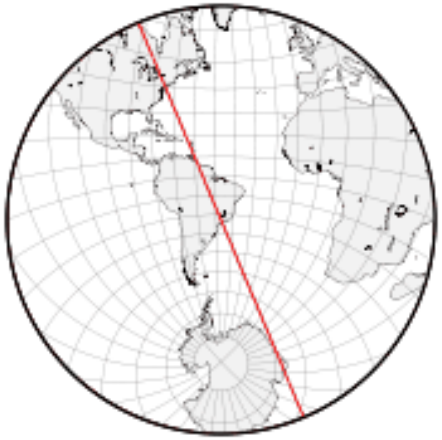
A geodesic is the **shortest path** to go from a point A to a point B on a mathematical surface!

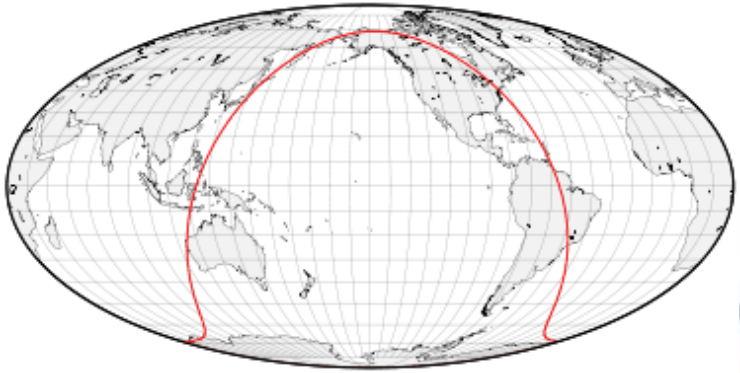


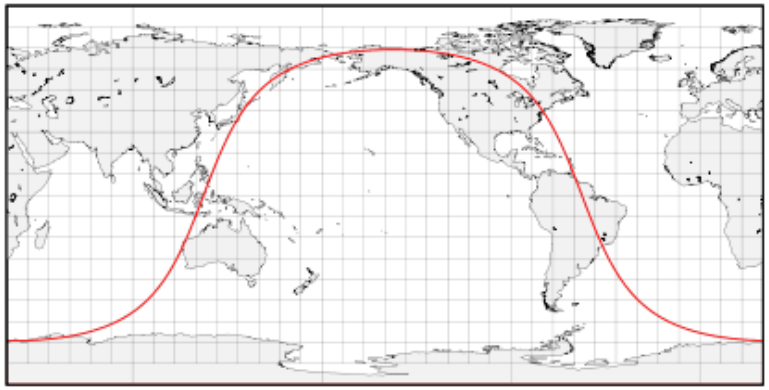


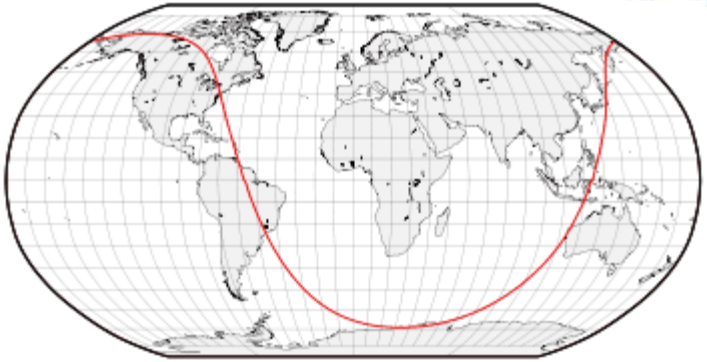
In the case of a sphere,
geodesics correspond to **great circles**
(those who have maximum diameter)

How do they look on a map?





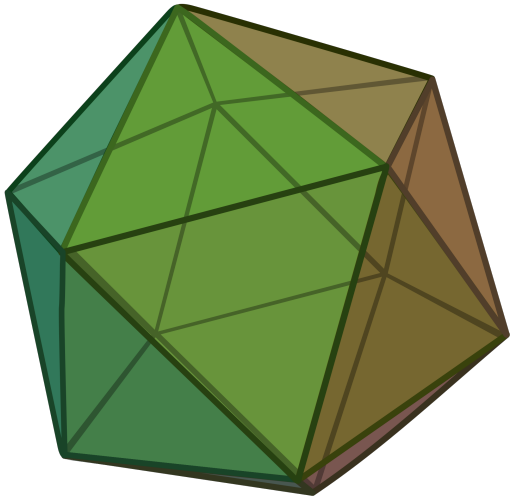


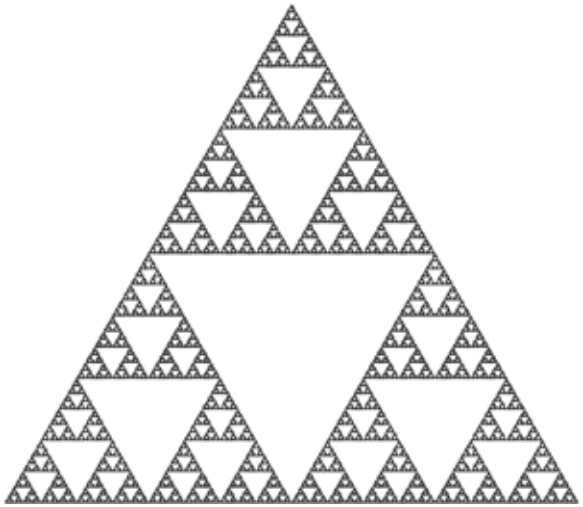


That's all folks!

You will find all the material and more links to related things in our websites:

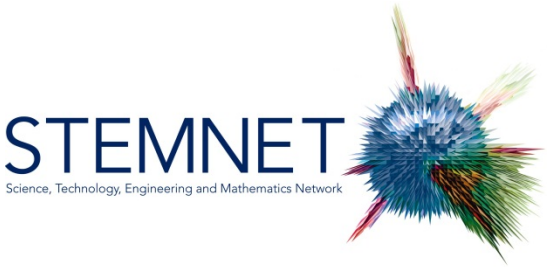
http://users.mct.open.ac.uk/dmp387/eng/outreach.html
http://www.mairiwalker.co.uk





Thanks to

The Open University



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