第二讲

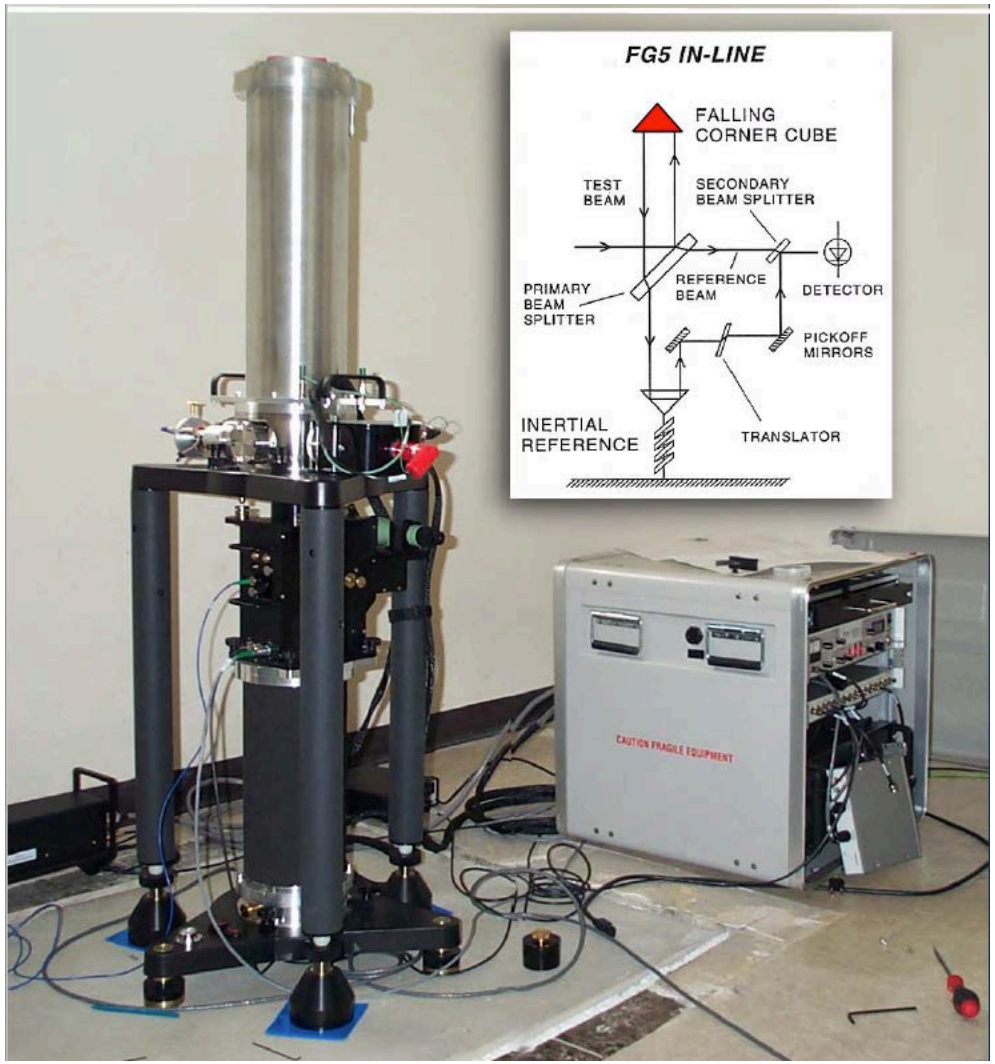
来自地球，去往火星

2.3

行星重力学

- 重力加速度和重力异常
- 海平面和海平面变化
- 卫星重力学

1. 重力加速度测量（绝对测量）



Credit: Reiner Rummel, IAS, Technische Universität München
5th ESA Observation Summer School, 2010

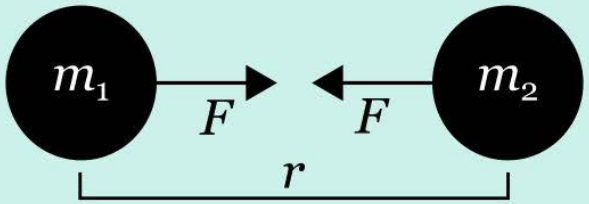
重力加速度

stationary	10^{0}	spherical Earth
	10^{-3}	flattening & centrifugal acceleration
	10^{-4}	mountains, valleys, ocean ridges, subduction
	10^{-5}	density variations in crust and mantle
	10^{-6}	salt domes, sediment basins, ores
variable	10^{-7}	tides, atmospheric pressure
	10^{-8}	temporal variations: oceans, hydrology
	10^{-9}	ocean topography, polar motion
	10^{-10}	general relativity

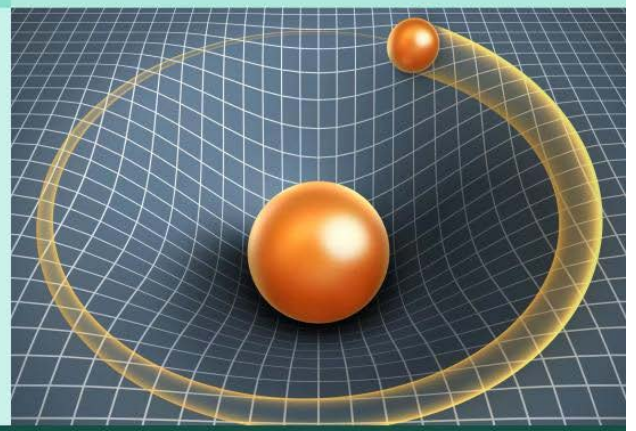
广义相对论中的重力

Gravity is a natural phenomenon where things with mass or energy are brought toward each other. It is explained by the **law of universal gravitation** and **general relativity**.

Newton's law of universal gravitation describes gravity as a **force**.



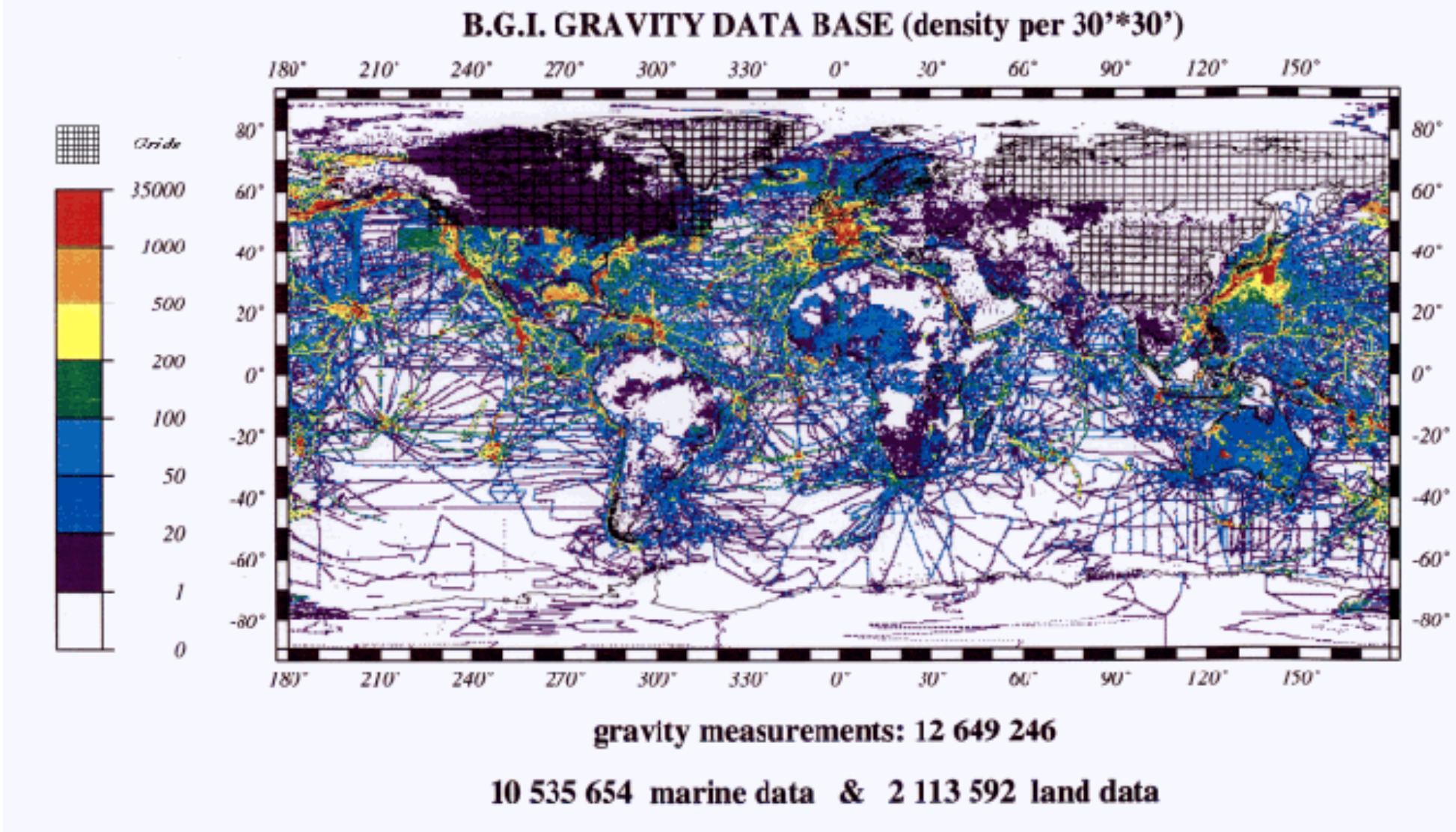
Einstein's general relativity describes gravity as a result of **space time curvature**



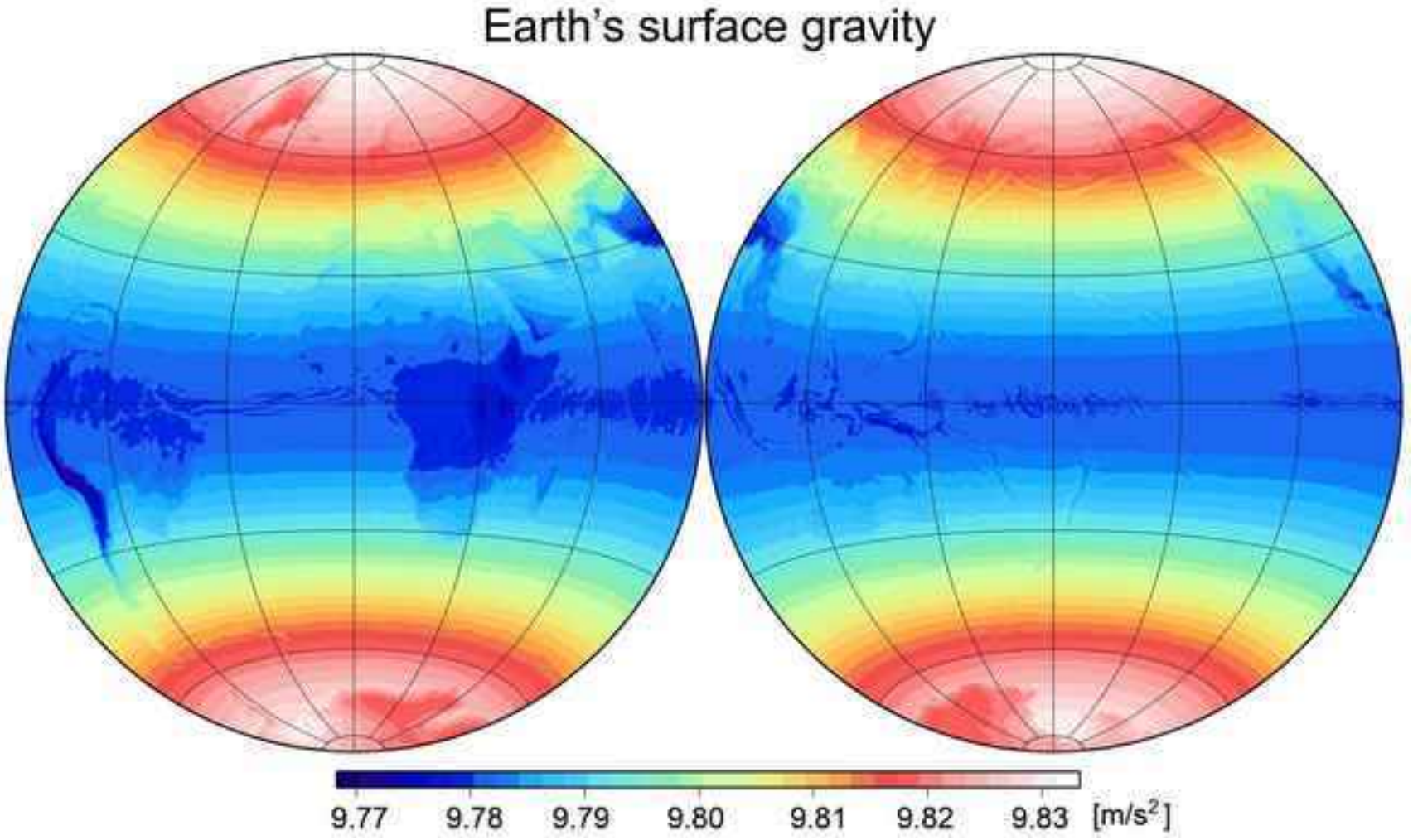
Gravity is the name of the **phenomenon**. Newton's **law of universal gravitation** & Einstein's **general relativity** explain the phenomenon. Einstein's is **more accurate**. Newton's is **simpler** and gives **sufficiently accurate results** for most usage. These are two separate **theories of gravity.** Both are correct, only with **different complexity and accuracy**.

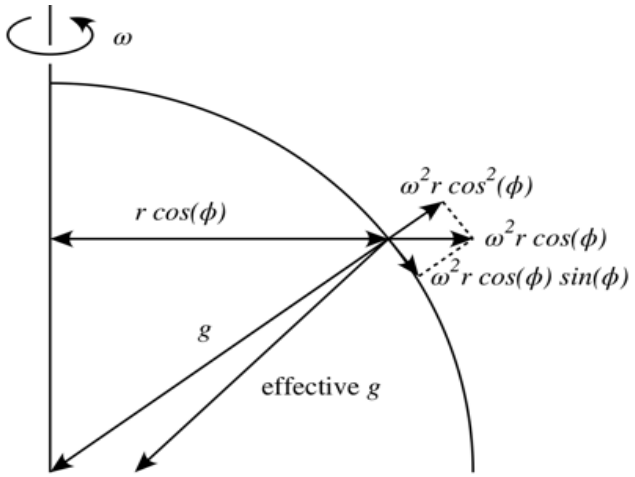
FlatEarth.ws/gravity-theory
Debunking Flat Earth Misconceptions

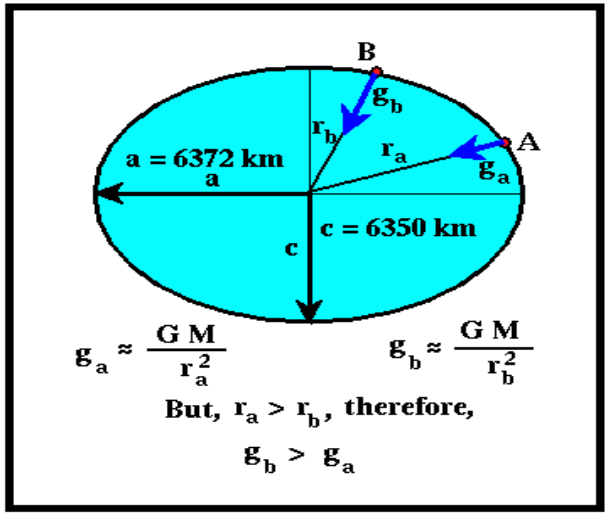
地球绝对重力测量


B.G.I. GRAVITY DATA BASE (density per 30'*30')
Grids
35000
1000
500
200
100
50
20
1
0
180° 210° 240° 270° 300° 330° 0° 30° 60° 90° 120° 150°
80° 60° 40° 20° 0° -20° -40° -60° -80°
gravity measurements: 12 649 246
10 535 654 marine data & 2 113 592 land data

地球的重力

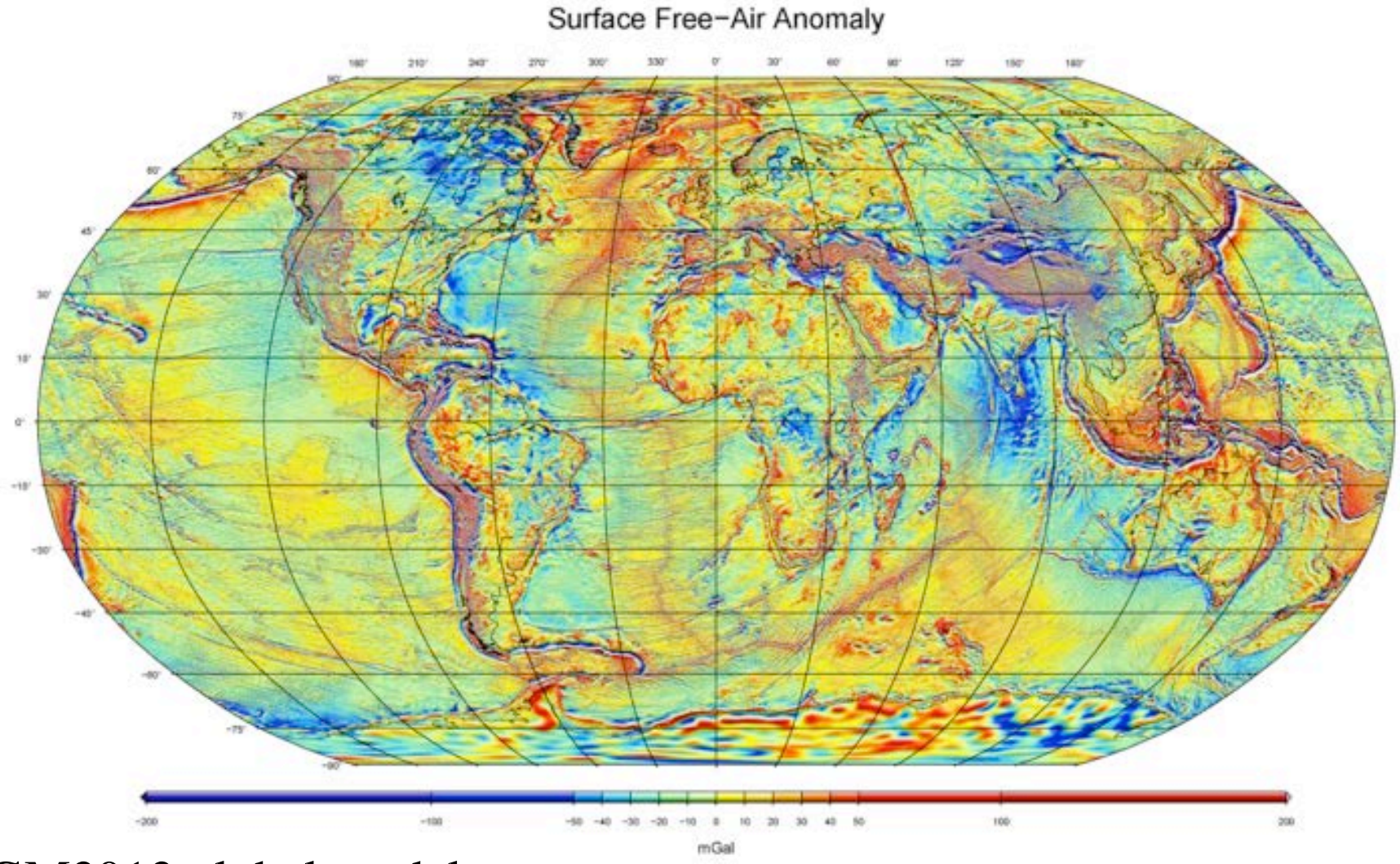






- 实测重力和纬度非常相关：地球是椭圆 + 自转的离心力

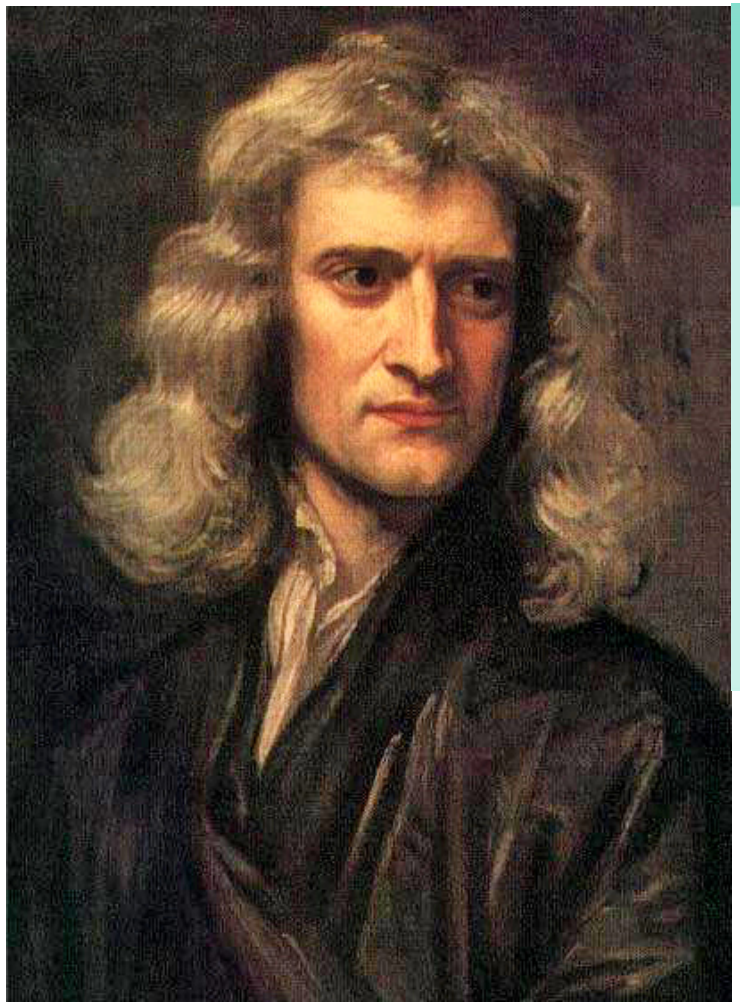
After Subtracting Latitude-Dependence



WGM2012 global model

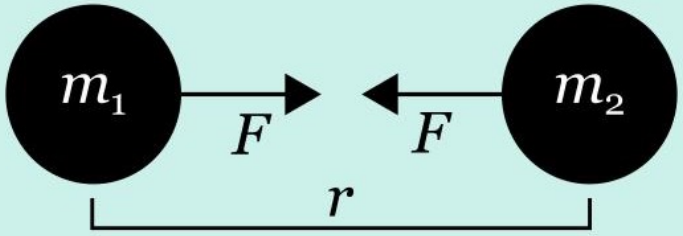
1 mGal = 10^{-5} m/s^2

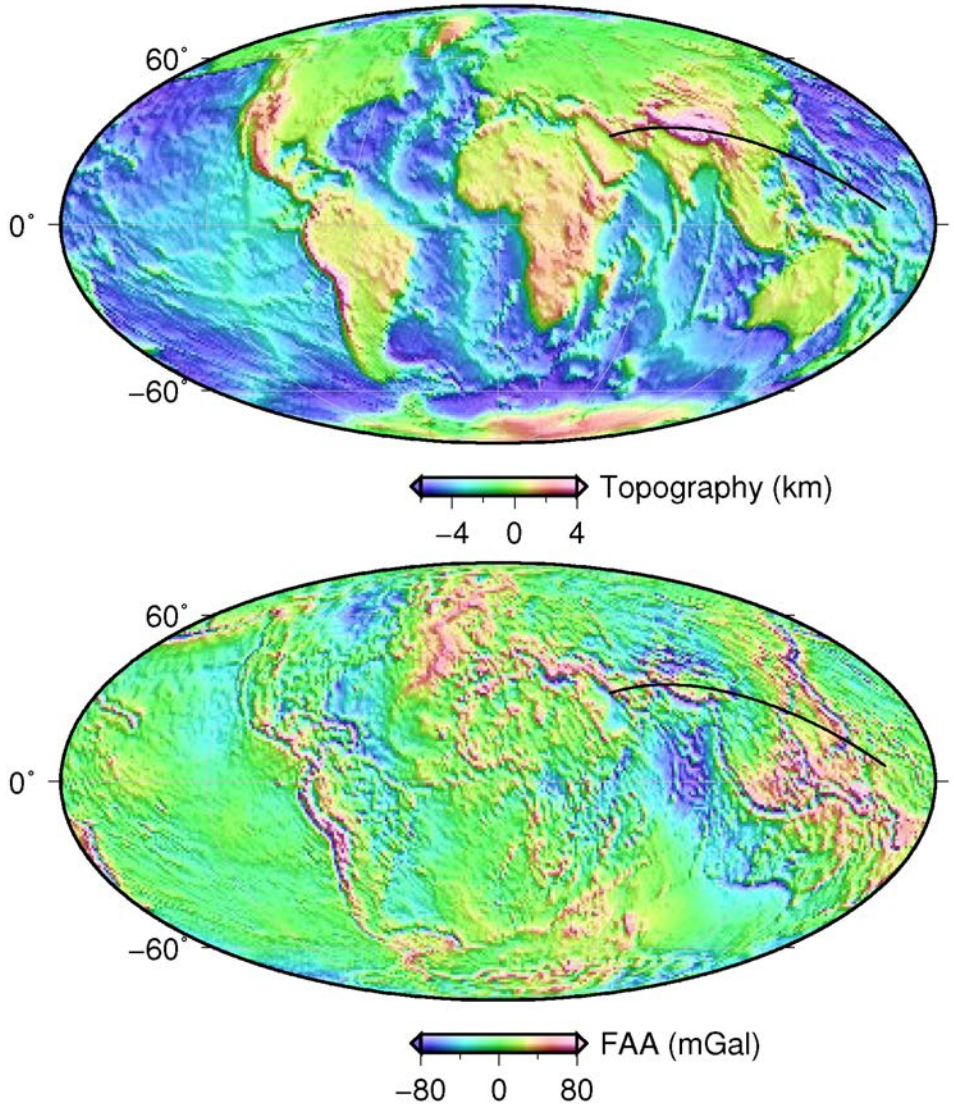
How to Explain the Variations?



Newton's law of universal gravitation describes gravity as a **force**.

$$F = Gm_1m_2/r^2$$





Discovery of Mountain Root

Isostasy: The Initial Discovery

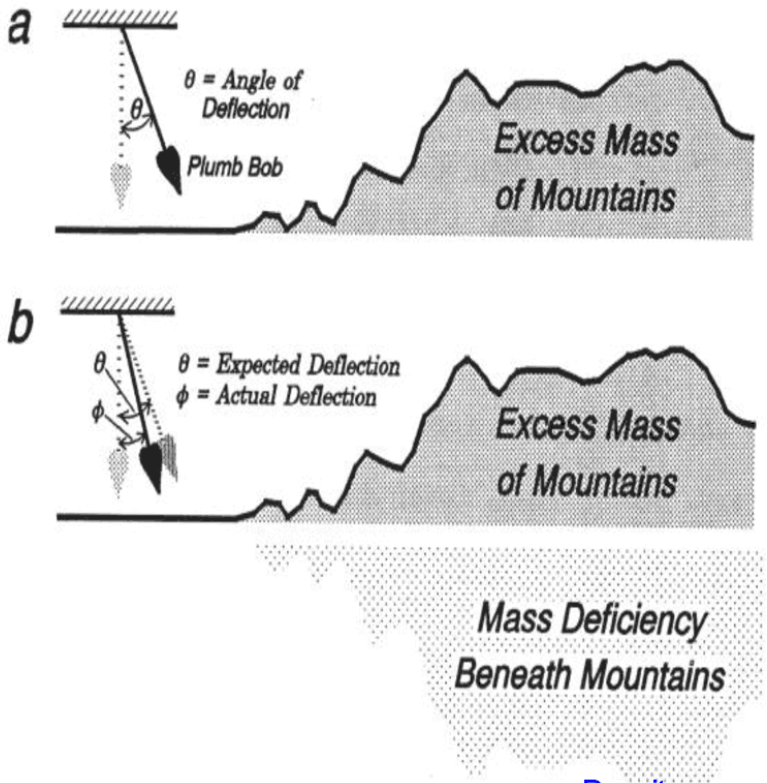
- The hypothesis that large mountains have low density roots was first proposed during topographic surveys of India and the Himalayan Mountains

Questions:

- How does this low density root form?
- As a mountain range becomes eroded why are there not large negative anomalies due to the low density roots?

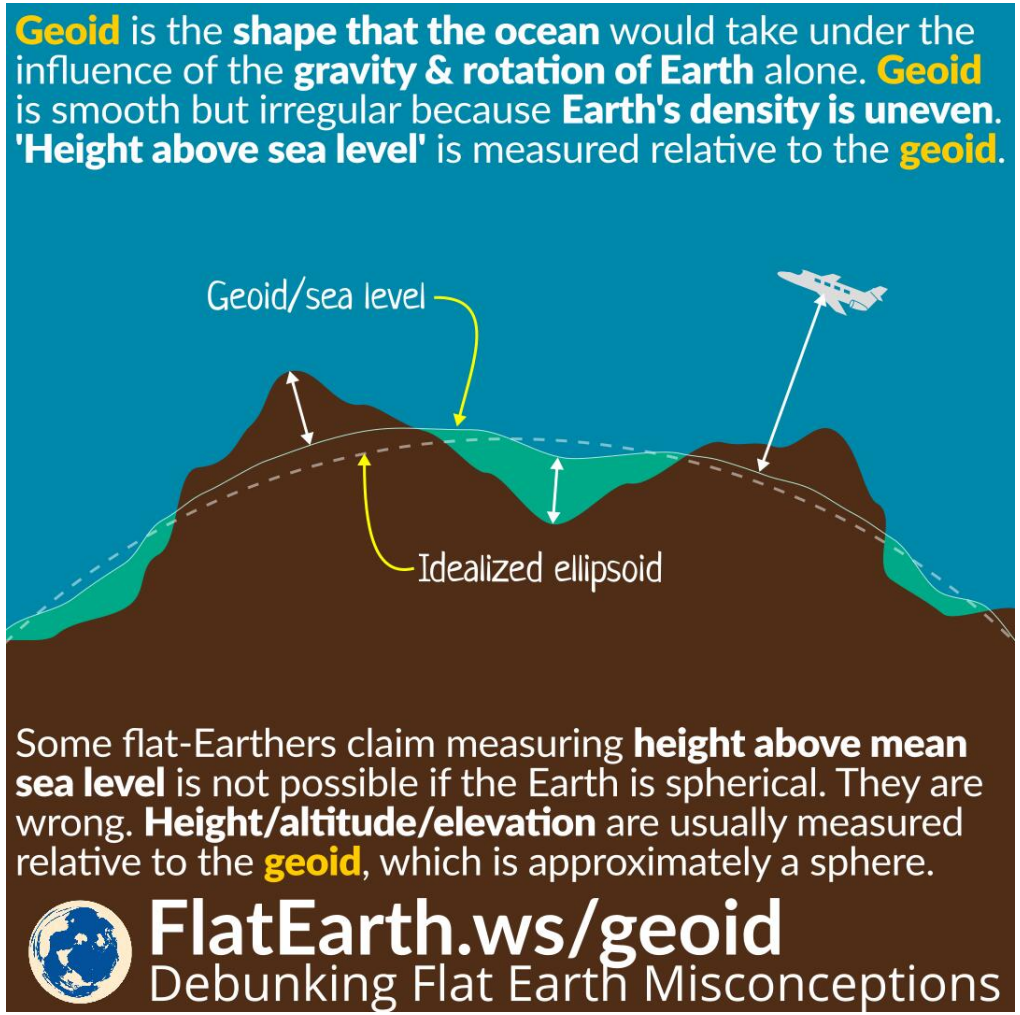
Explanation:

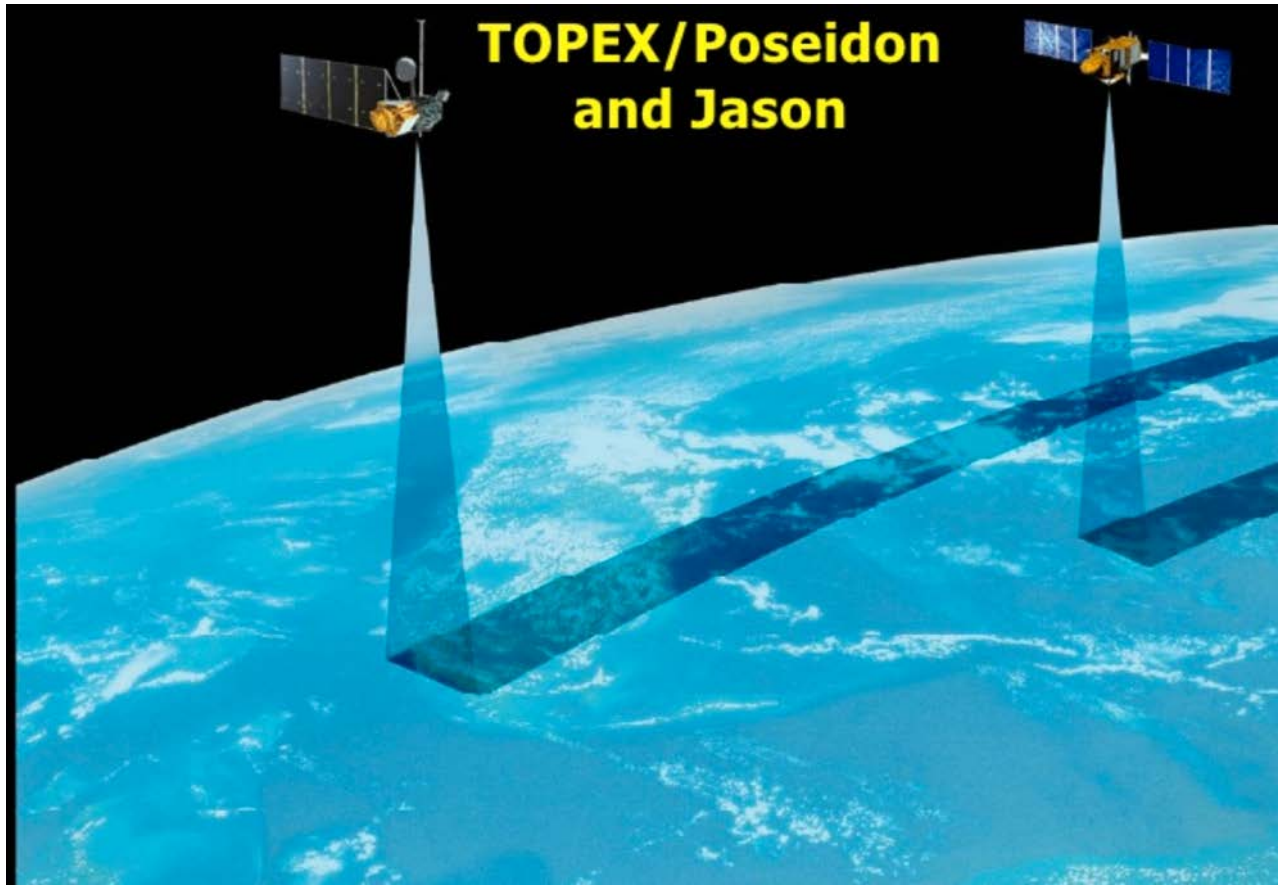
- Large topographic features effectively 'float' on the
  enosphere
  ws Archimedes principle



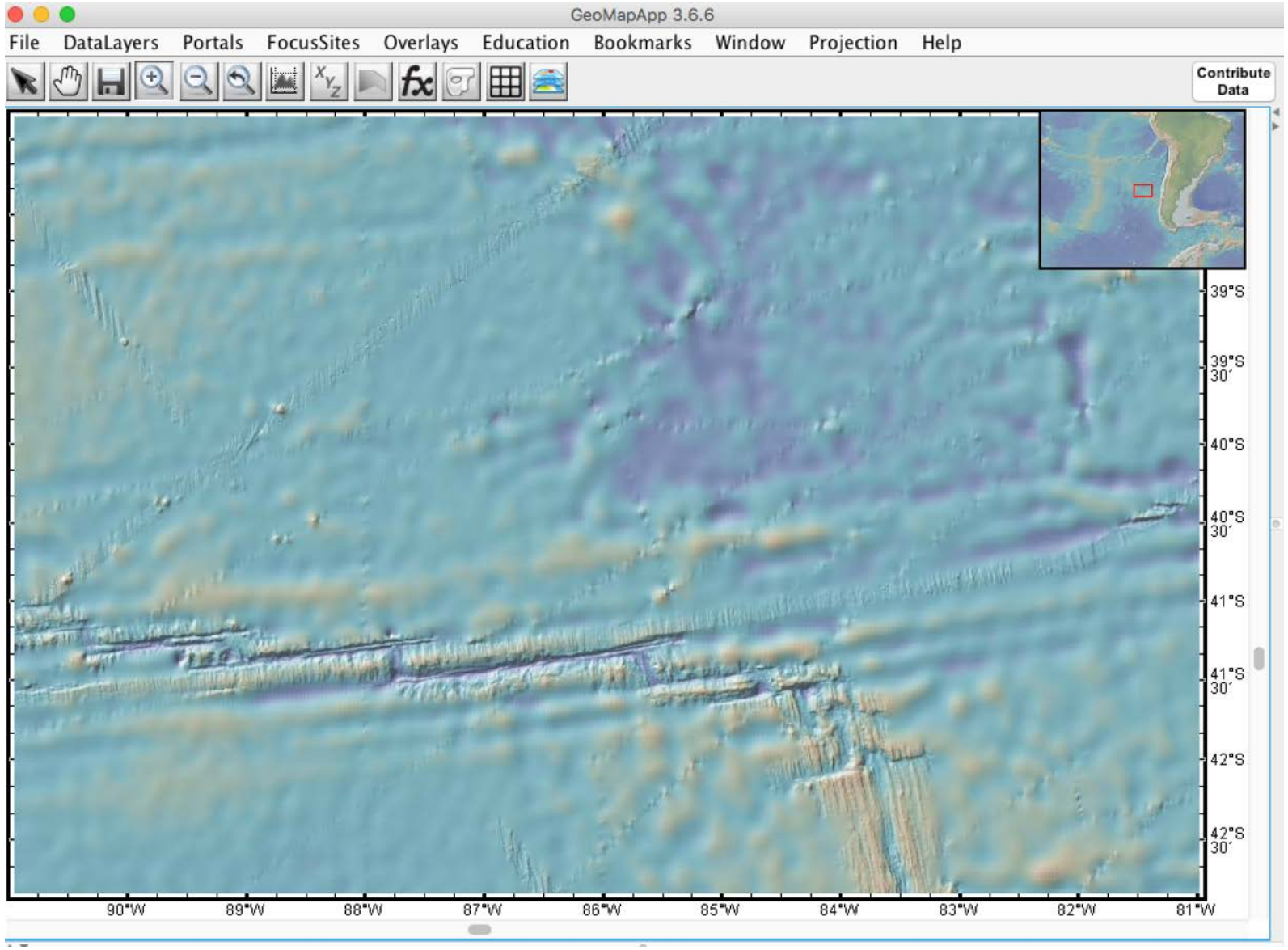
Docsity.com

2. Geoid 大地水准面和海平面

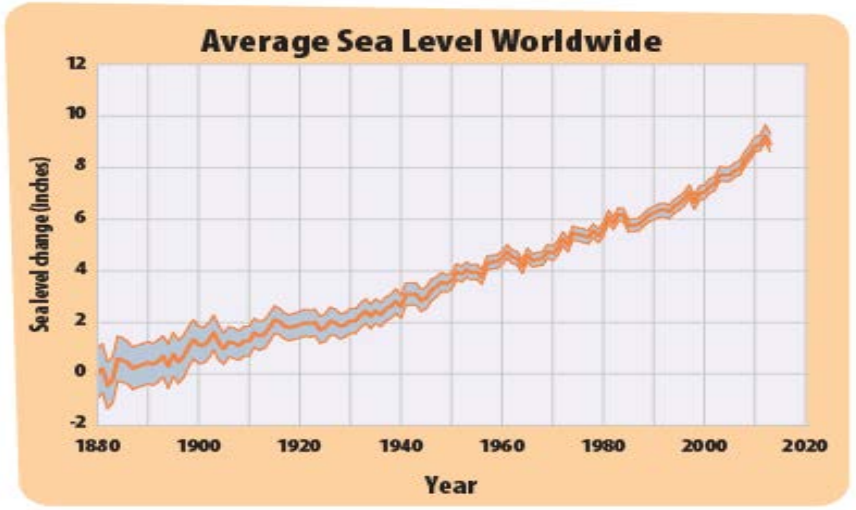


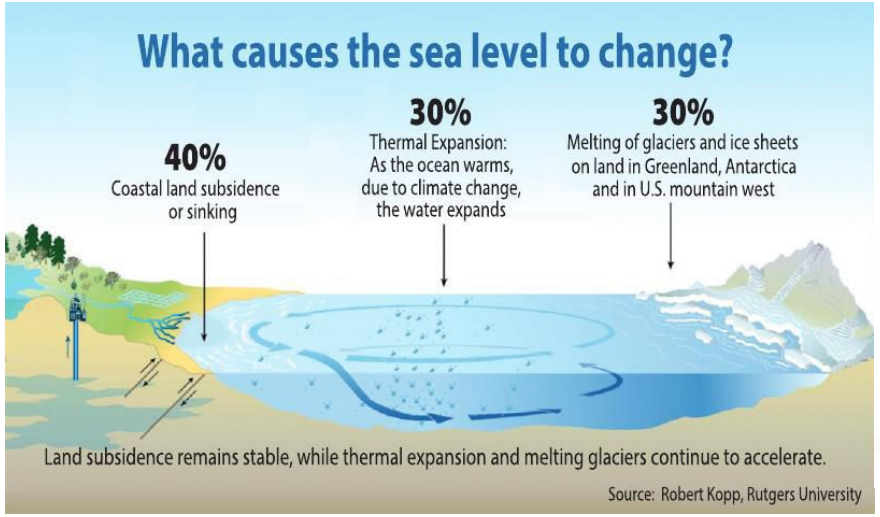


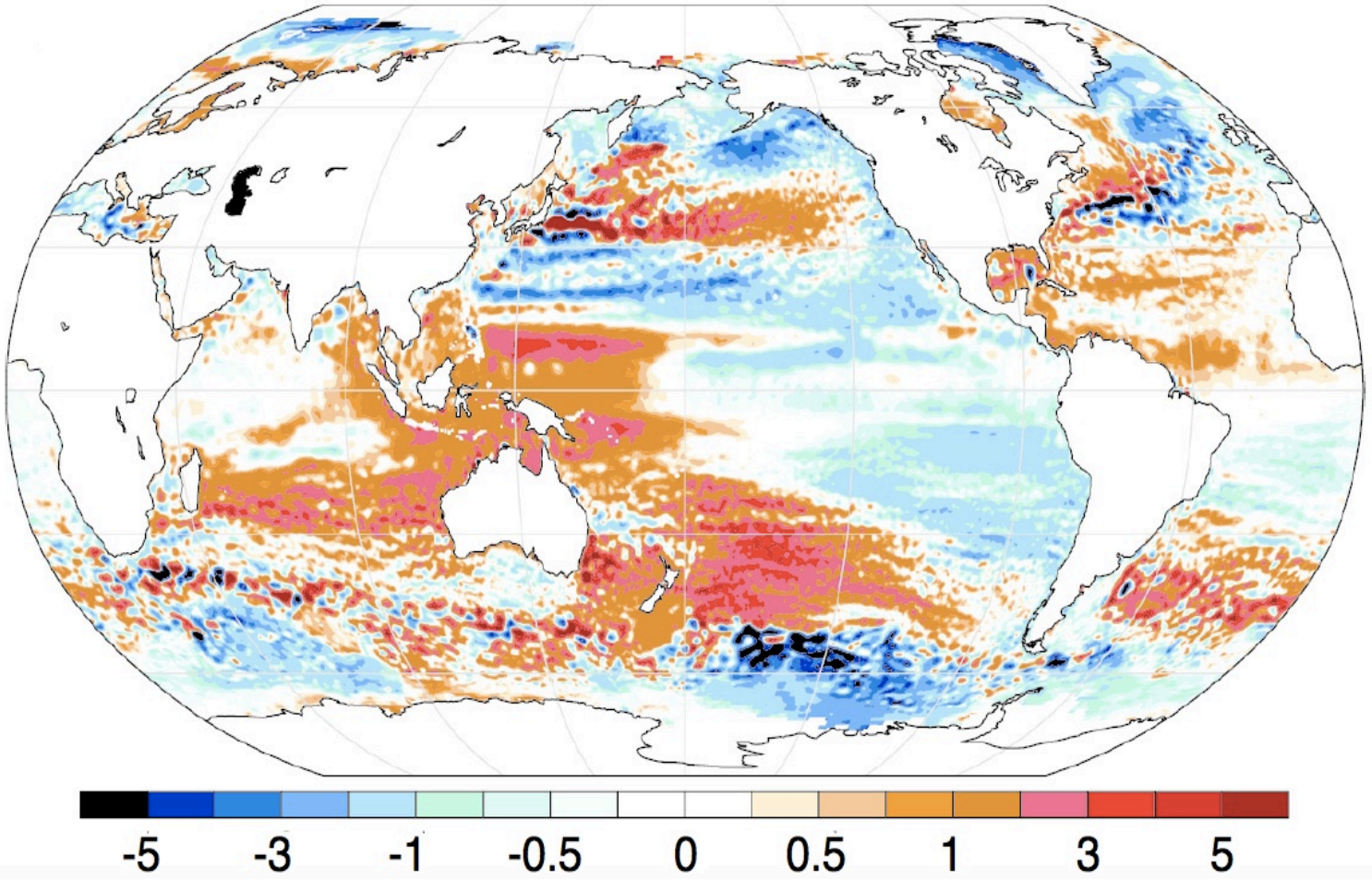
用海平面数据求得海底地形：我们并不了解海底



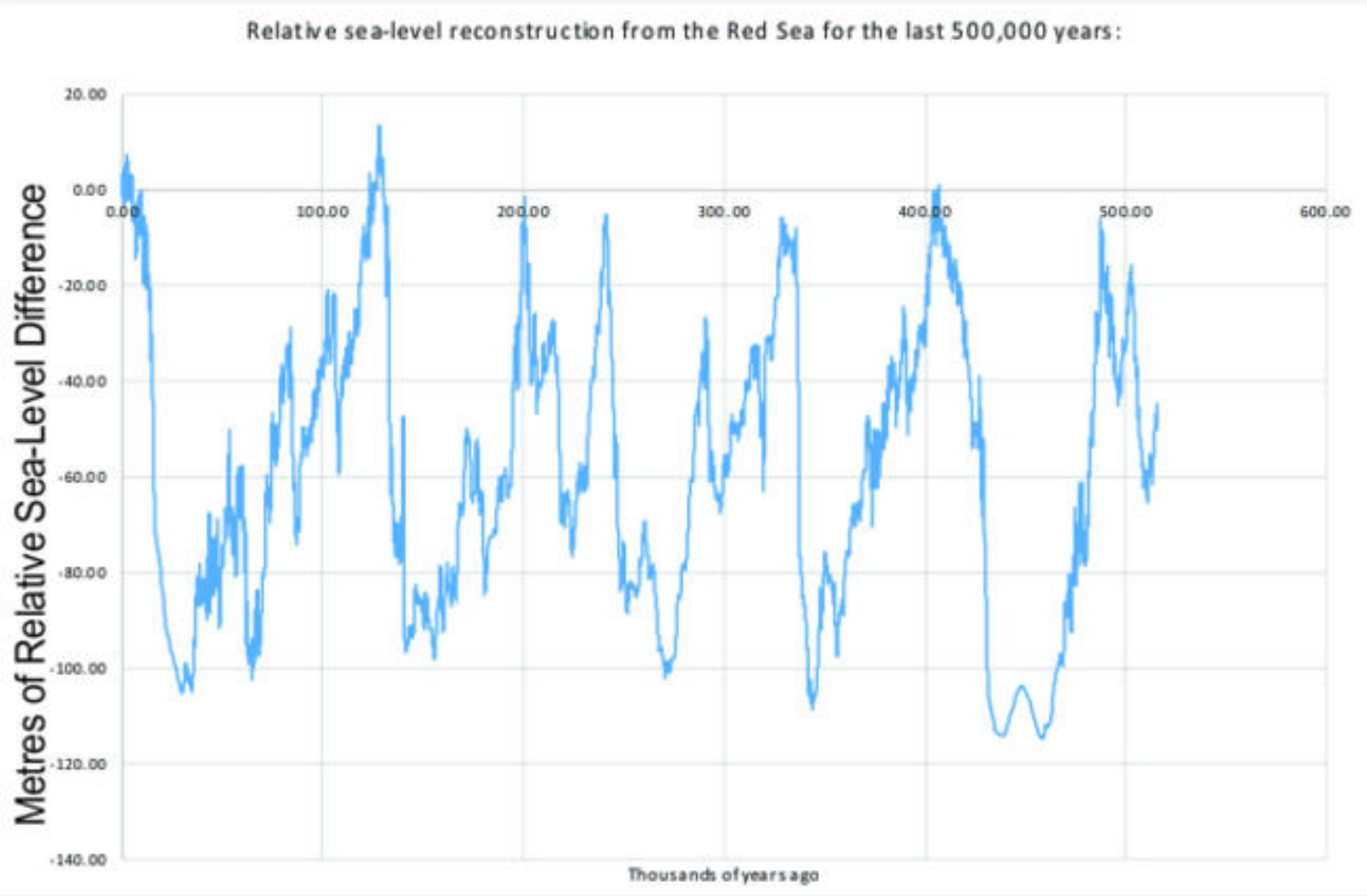
Sea Level Change & Climate Change



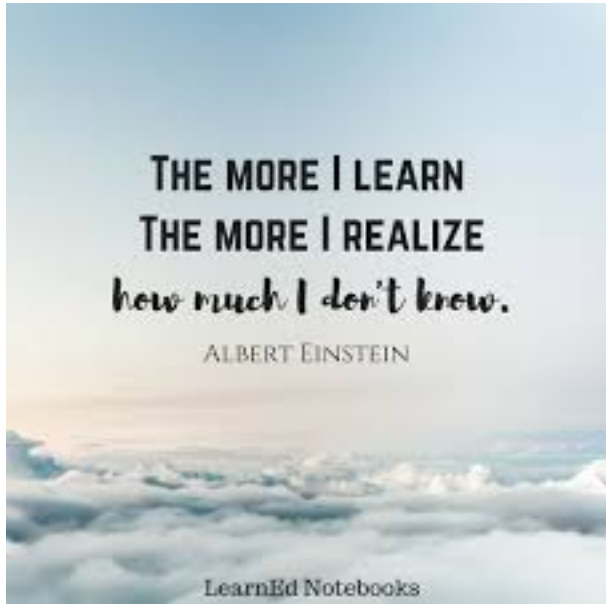


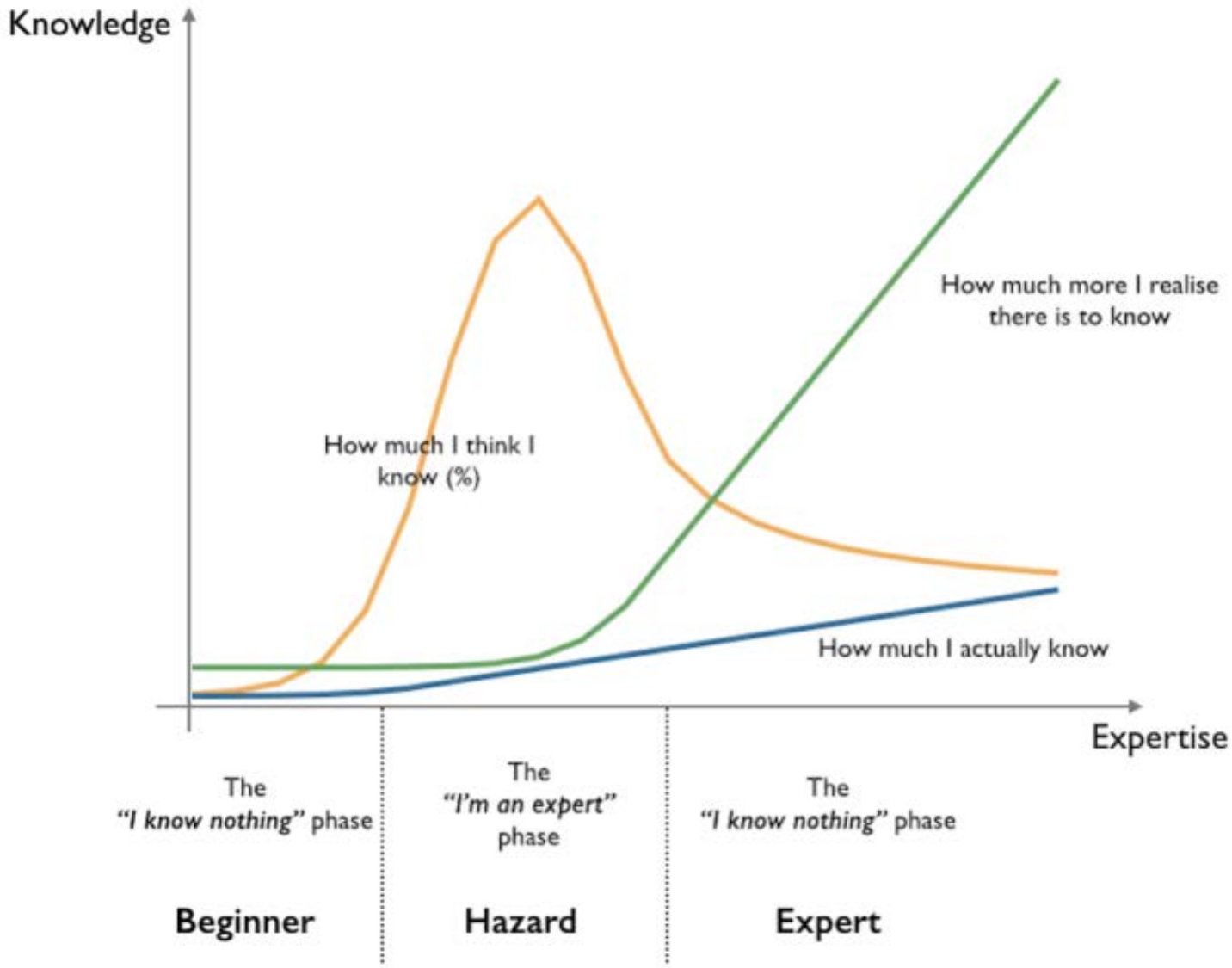


Longer Timescale

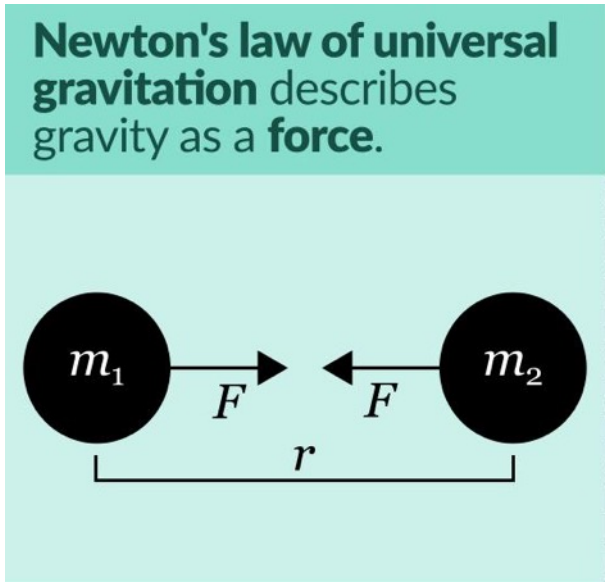


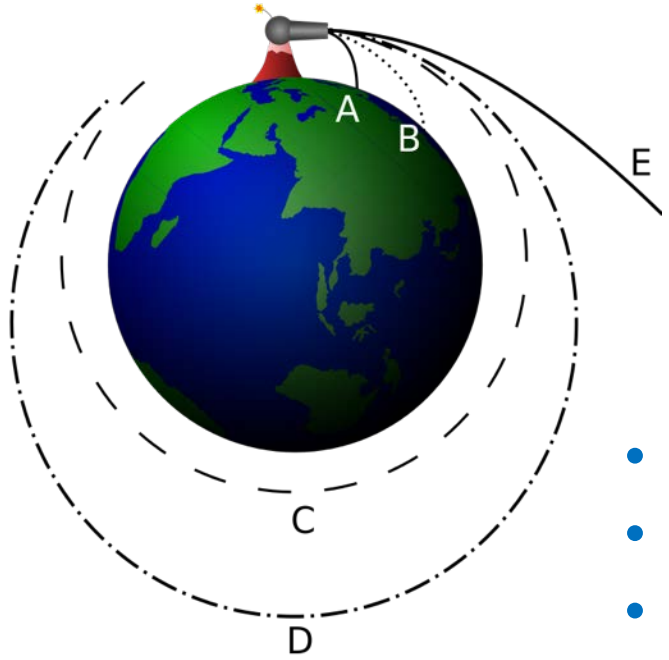
A Learning Paradox

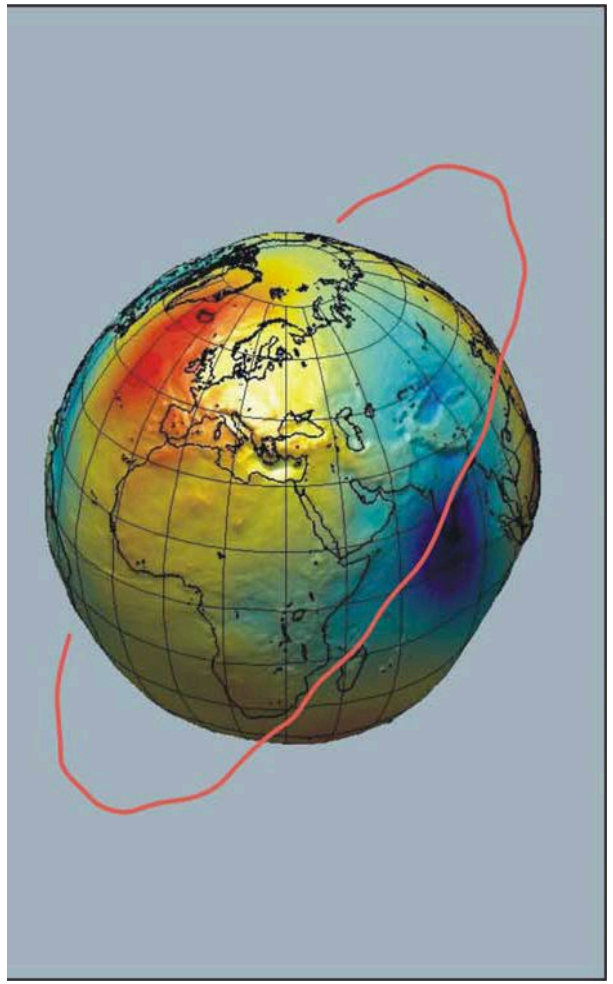




Newton’s Brilliant Idea

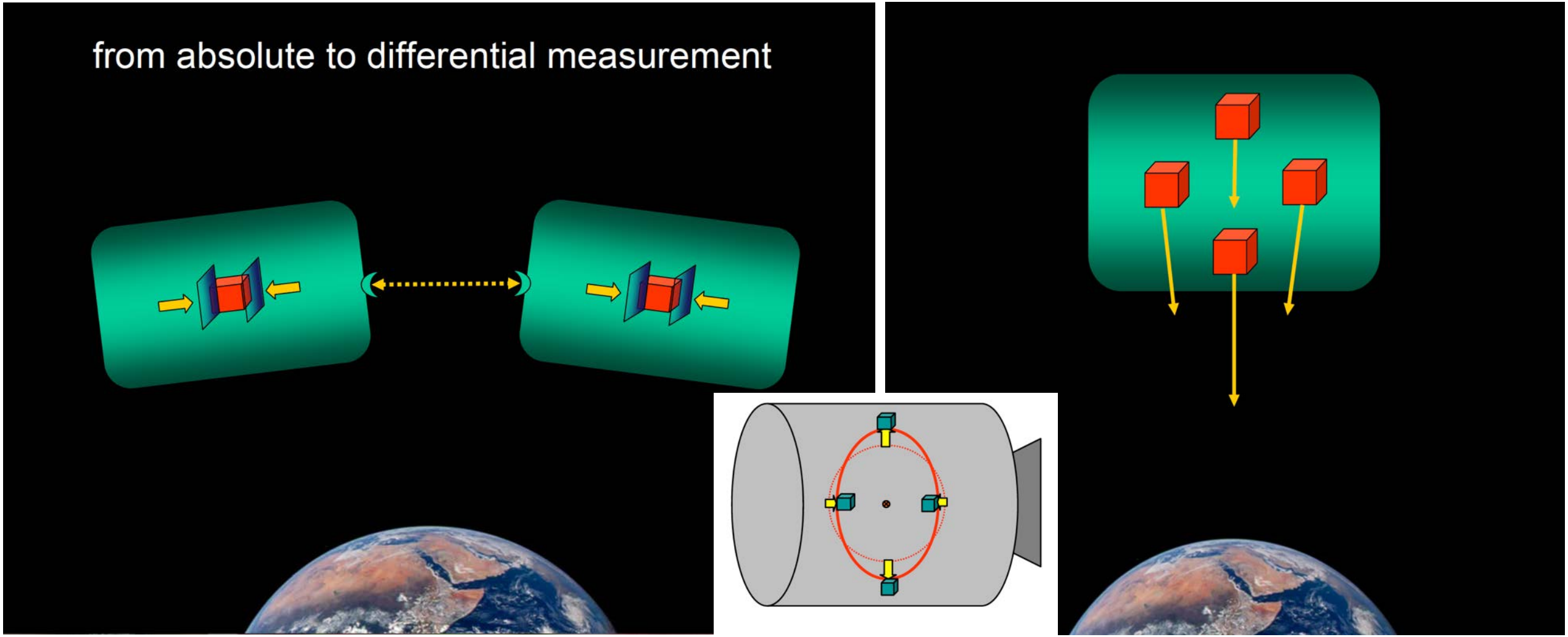






- 苹果 = 行星 = 卫星
- 卫星其轨道的变化反映了重力场的变化
- 从而反映了地球的内部的结构

3. 卫星重力学



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5th ESA Observation Summer School, 2010

通过卫星轨道变化得到的类地行星重力异常
卫星重力异常 (FAA) 反映岩石圈弹性厚度

地球和金星:

重力变化小 –> 岩石圈弹性厚度较小

火星和月球：

重力变化大 –> 岩石圈弹性厚度较大