Department of Applied Geomatics, Chien-Hsin University, Taiwan

大地測量課程

大地測量概述
(Introduction to Geodesy)

張嘉強

健行科技大學

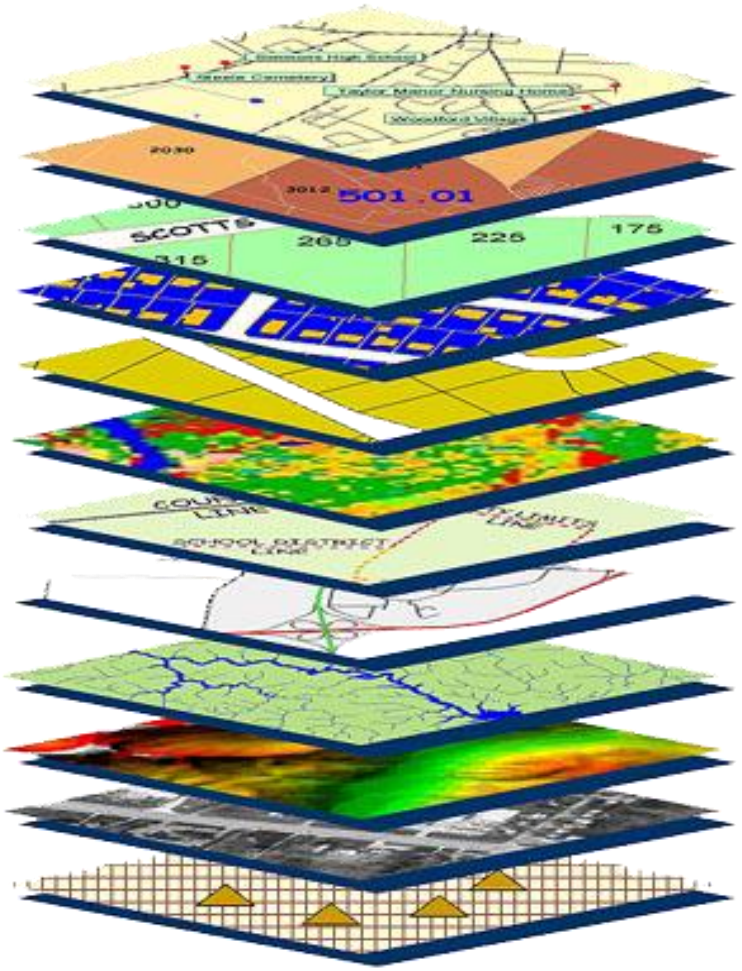
應用空間資訊系

大地測量的工作內容

- 參考框架
- 重力場
- 地球旋轉與地球動力
- 定位及應用

依照國際大地測量學會
(International Association of Geodesy, IAG)
的定義

大地控制-測量成果的基石



Satellite Observations

Environmental Modeling

Obstructions in Air & Sea

Water Levels and Flow

Sea Surface Topography

Habitat Mapping

Bathymetry

Shoreline

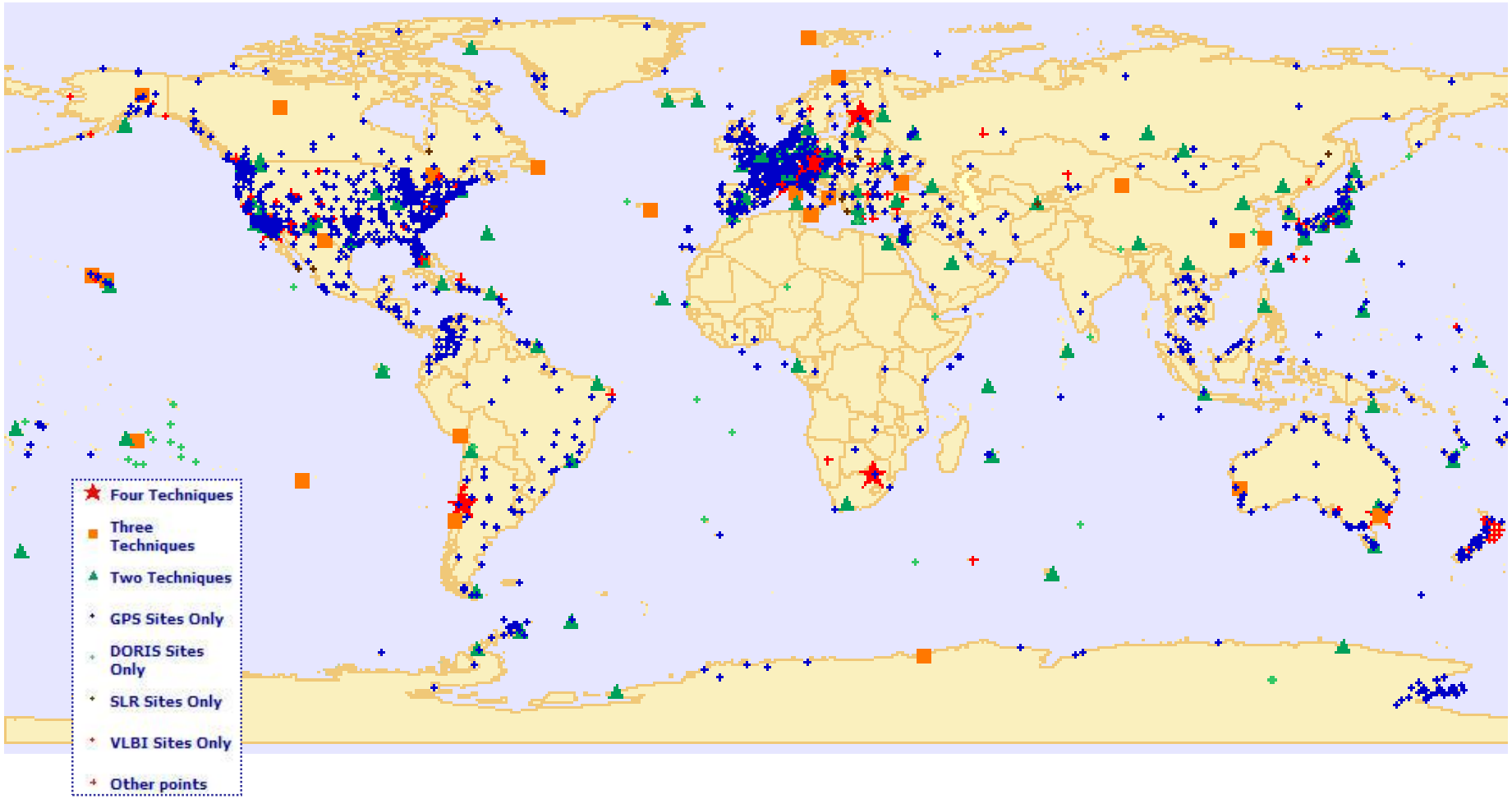
Land Elevations

Aerial Imagery

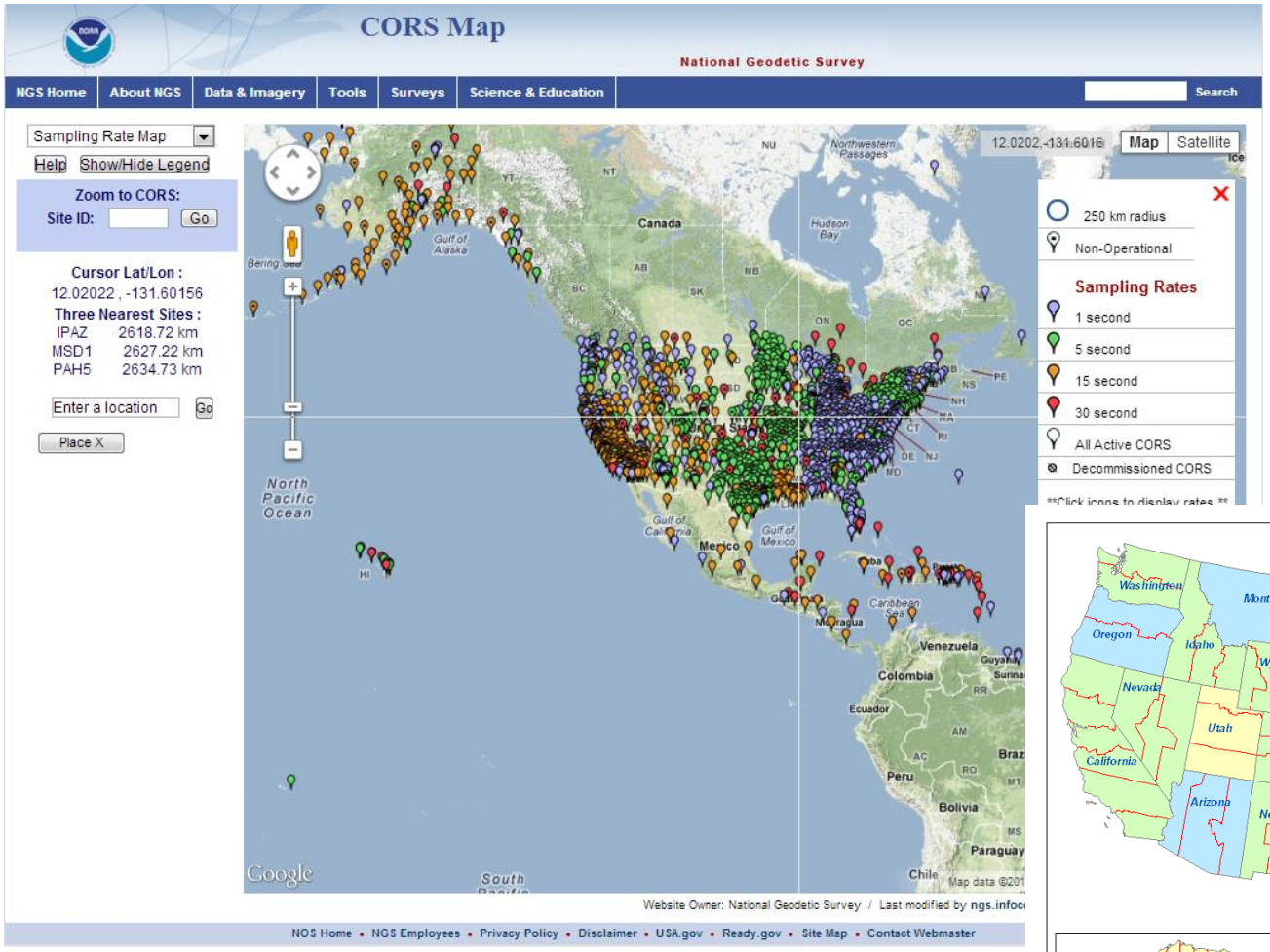
Geodetic Control

全球地型參考框架

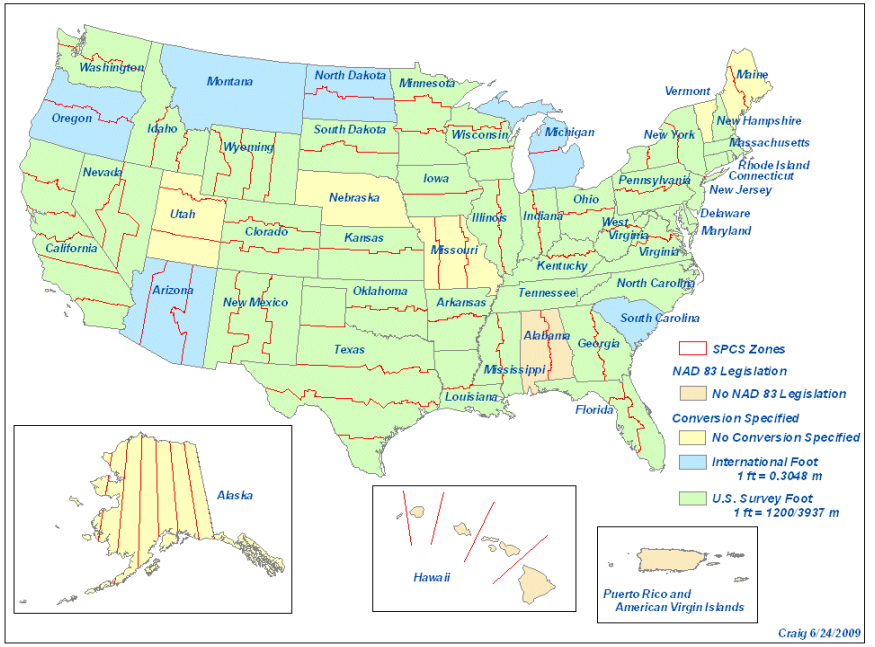
International Terrestrial Reference Frame (ITRF 2020)



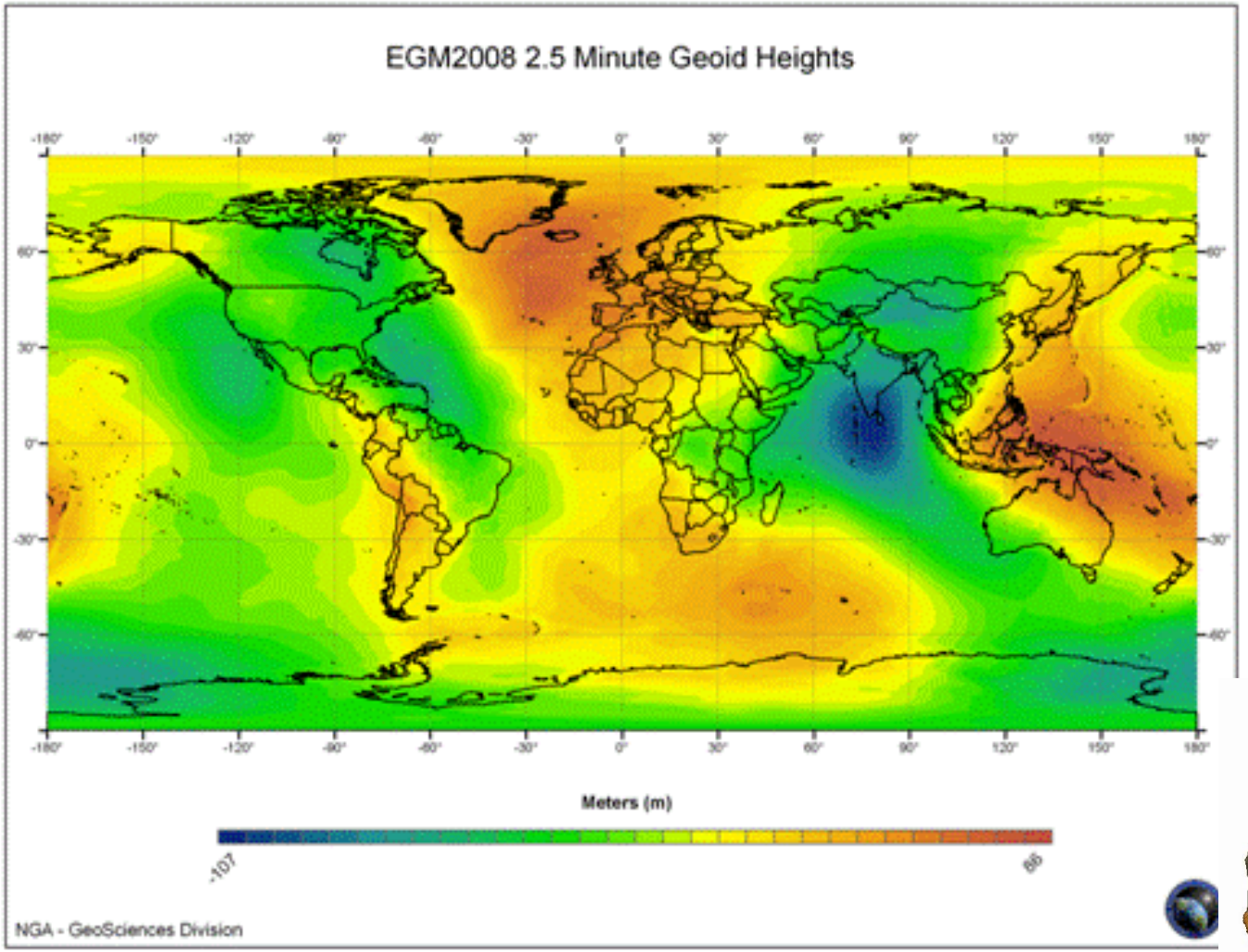
區域性坐標系統

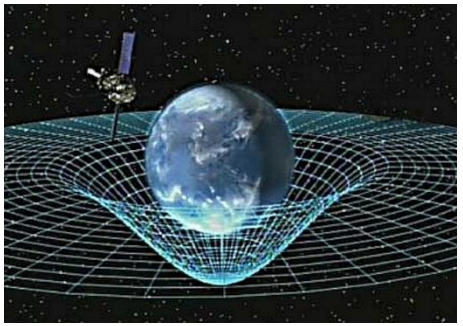


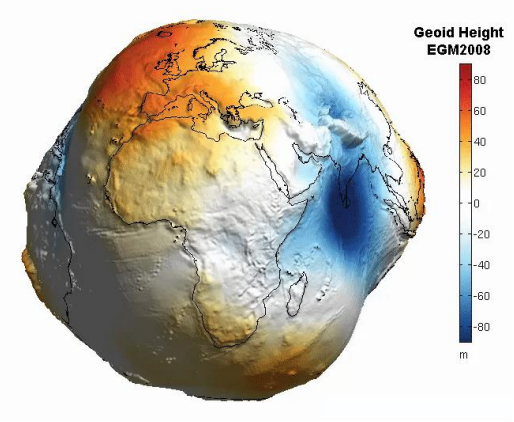
美國 NAD83 (2011)
我國 TWD97 (2010)



全球重力位模型

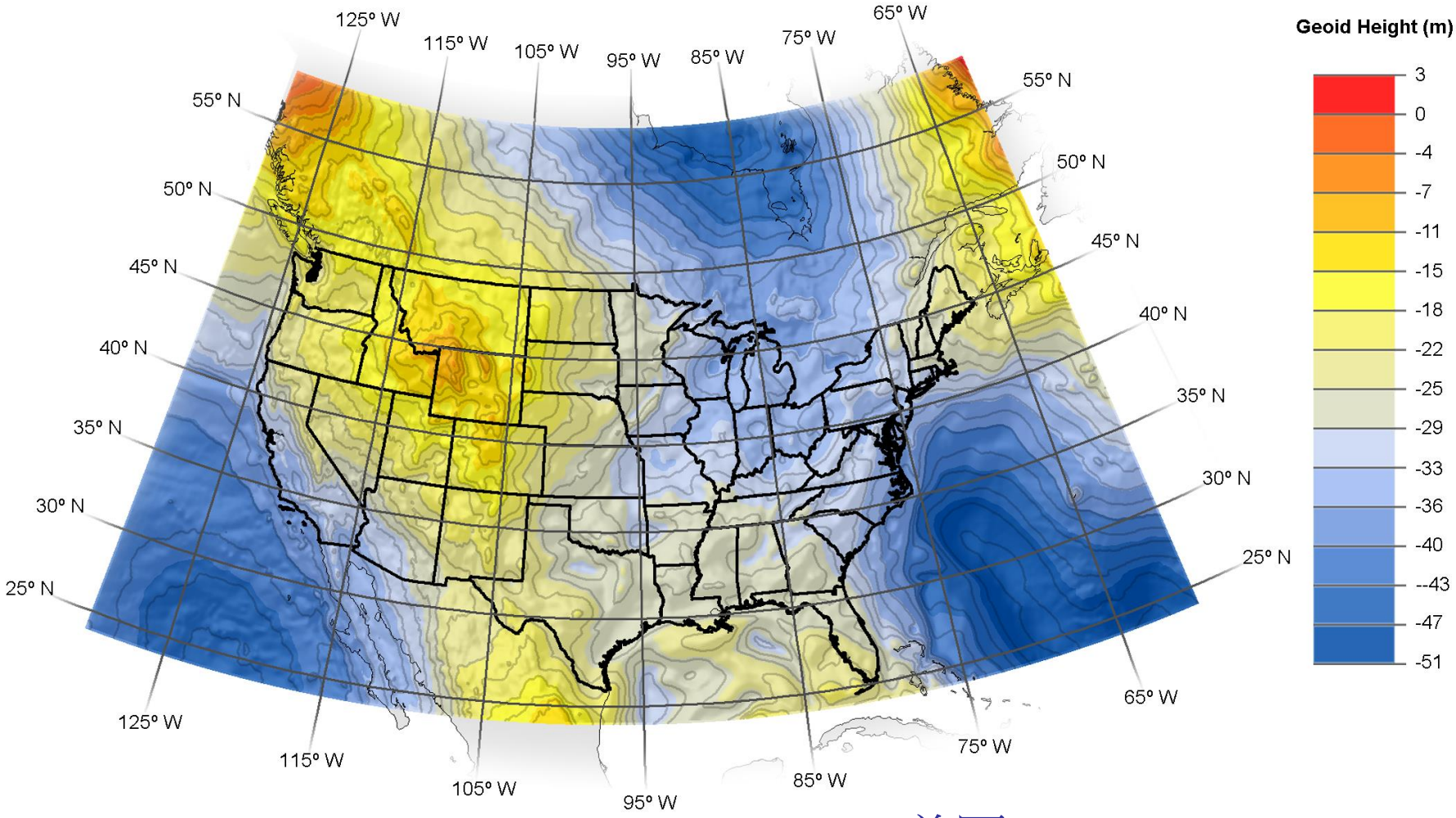






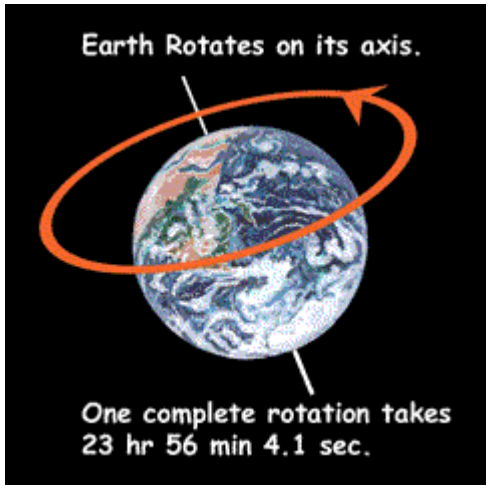
EGM 2008

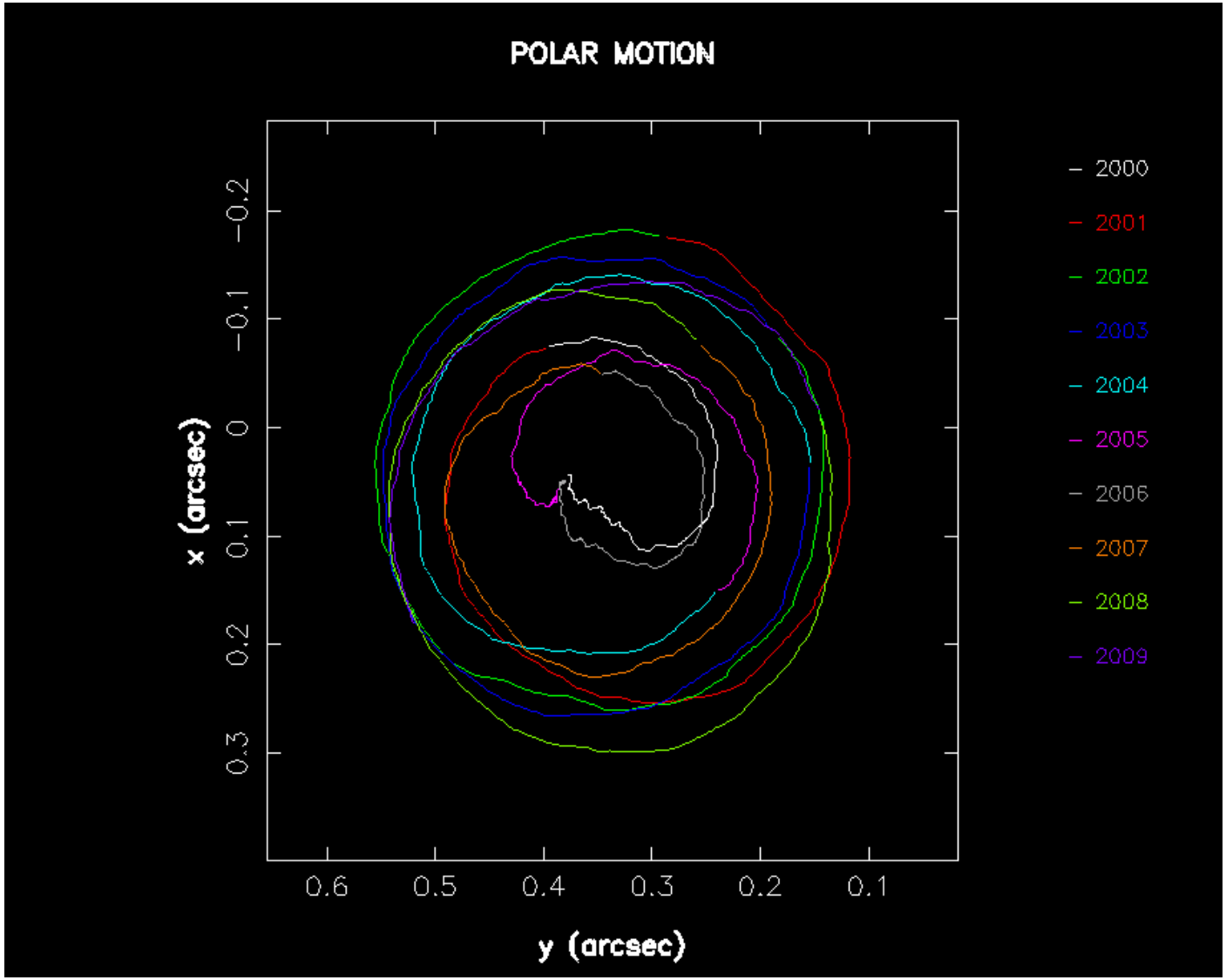
區域性大地起伏模型



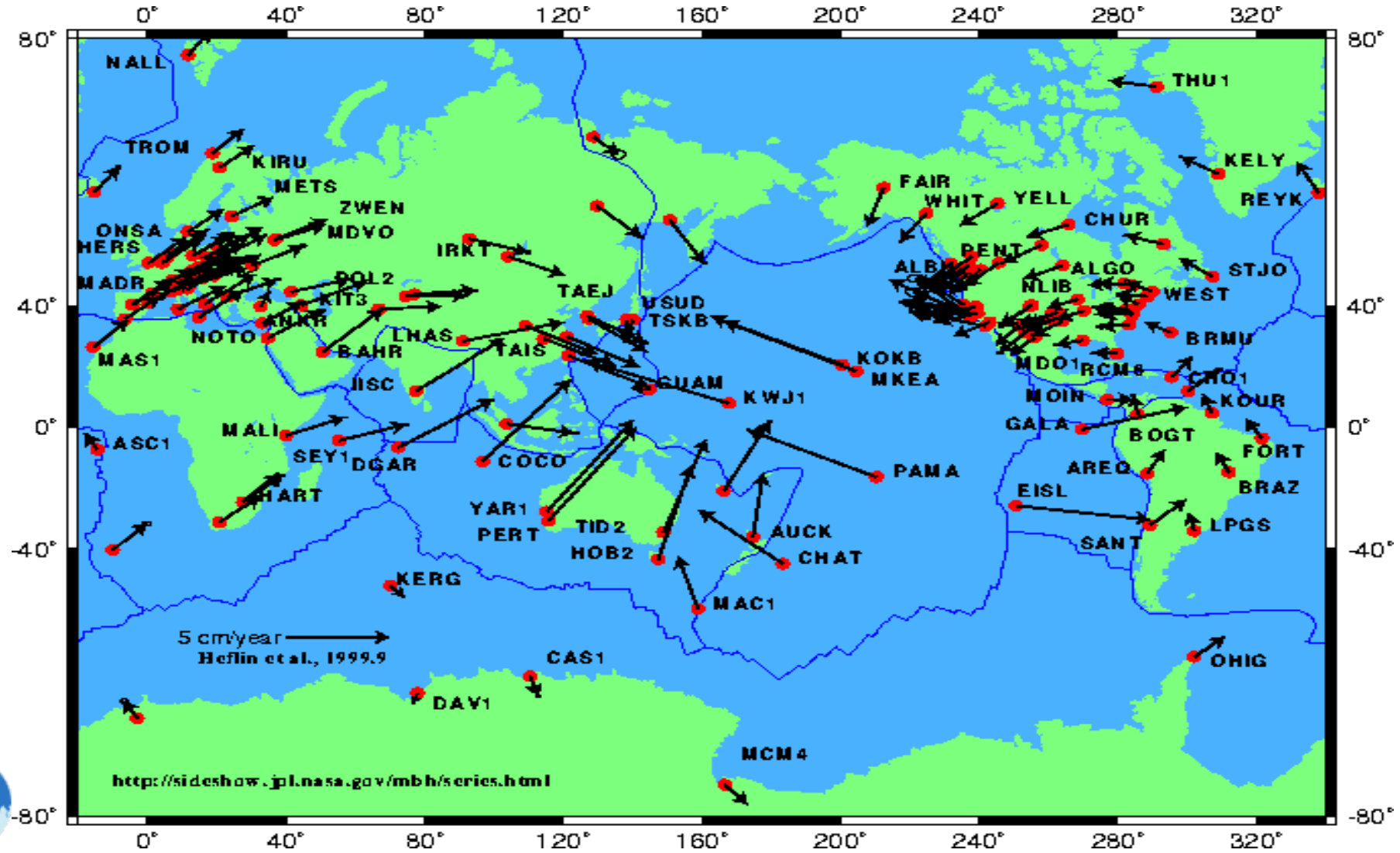
美國GEOID 12A

地球旋轉

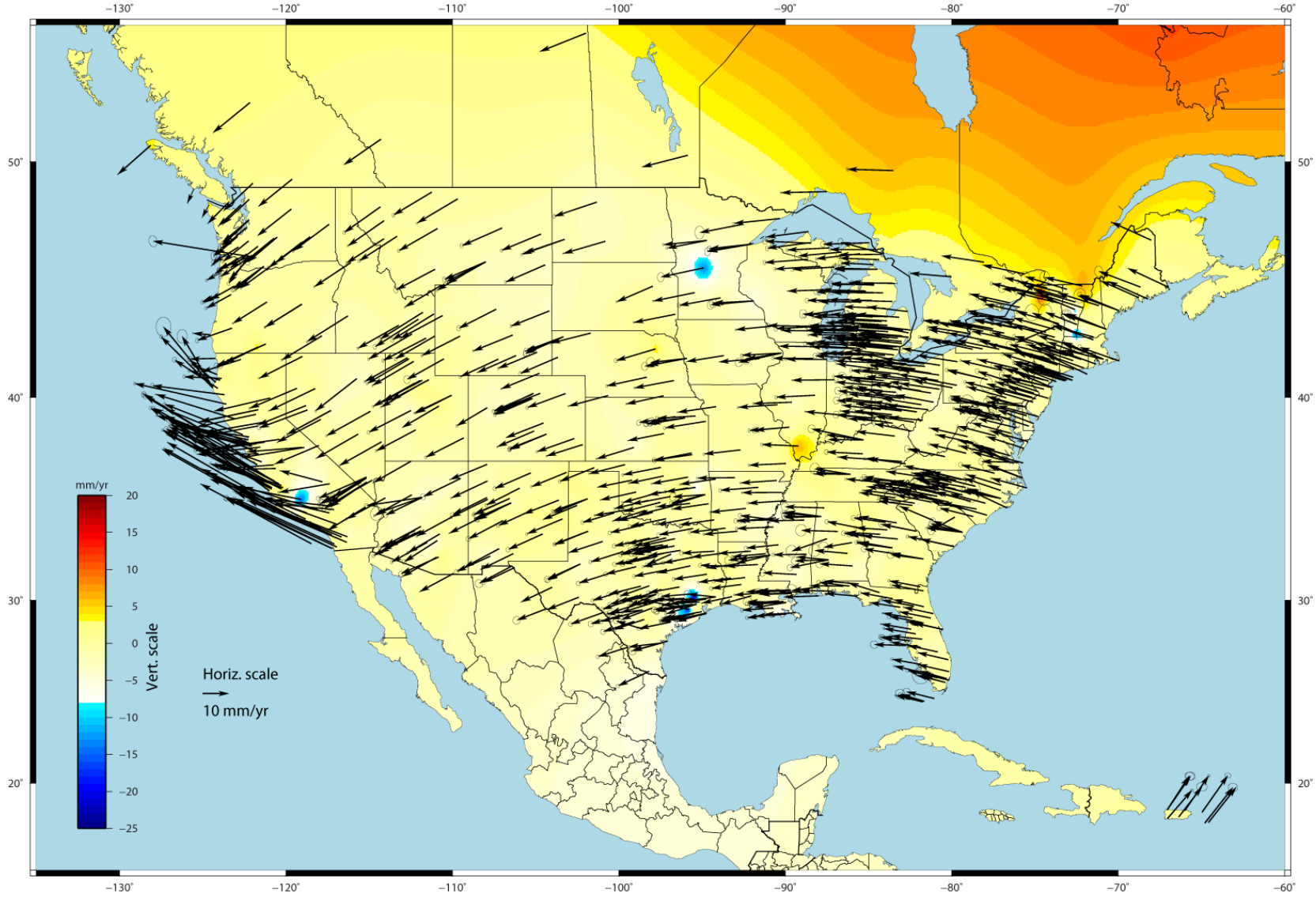

Earth Rotates on its axis.
One complete rotation takes
23 hr 56 min 4.1 sec.


POLAR MOTION
x (arcsec)
y (arcsec)
0.6
0.5
0.4
0.3
0.2
0.1
0.3
0.2
0.1
0
−0.1
−0.2
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

全球板塊運動


0°
40°
80°
120°
160°
200°
240°
280°
320°
80°
40°
0°
-40°
-80°
NALL
TROM
KIRU
METS
ZWEN
MDVO
ONSA
HERS
MADR
POL2
KIT3
NKLG
NOTO
MAS1
BAHR
IRKT
LHAS
TAIS
TAEJ
USUD
TSKB
GUAM
KWJ1
IISC
ASC1
MALI
SEY1
DGAR
COCO
HART
YAR1
PERT
TID2
HOB2
KERG
MAC1
AUCK
CHAT
PAMA
KOKB
MKEA
FAIR
WHIT
YELL
CHUR
KELY
REYK
THU1
PENT
ALBH
ALGO
NLIB
STJO
WEST
BRMU
MDO1
RCM6
CHO1
KOUR
MOIN
GALA
BOGT
FORT
AREQ
BRAZ
EISL
LPGS
SANT
OHIG
CAS1
DAV1
MCM4
5 cm/year
Heflin et al., 1999.9
http://sideshow.jpl.nasa.gov/mbh/series.html

區域性地殼變形


−130°
−120°
−110°
−100°
−90°
−80°
−70°
−60°
50°
40°
30°
20°
mm/yr
20
15
10
5
0
−5
−10
−15
−20
−25
Vert. scale
Horiz. scale
10 mm/yr

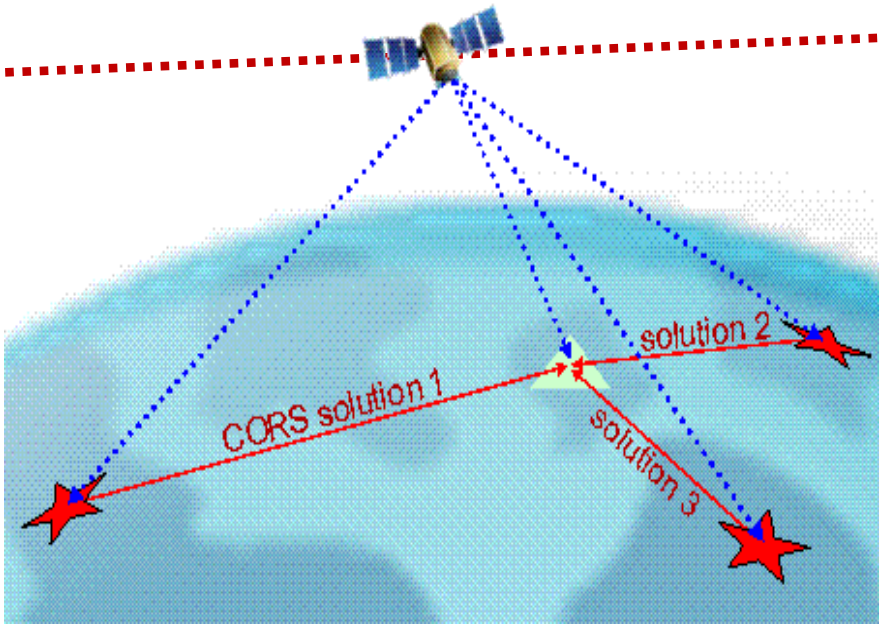
地層下陷

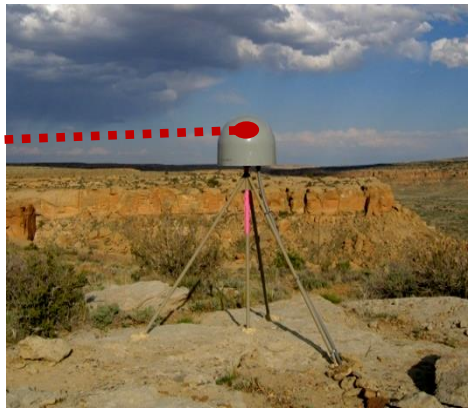

8.5 meters
50 years
1925
1955
1977
SAN JOAQUIN VALLEY
CALIFORNIA
BM S681
SUBSIDENCE 8M
1925-1977


1988
16 Years: 2.3 feet
2004
4 Years: 0.6 feet
2008
5 Years: 1.9 feet
2013
25 Years: 4.8 feet
USGS
SAN JOAQUIN VALLEY
CALIFORNIA
BM H 1235 R
SUBSIDENCE 4.8FT
1988-2013

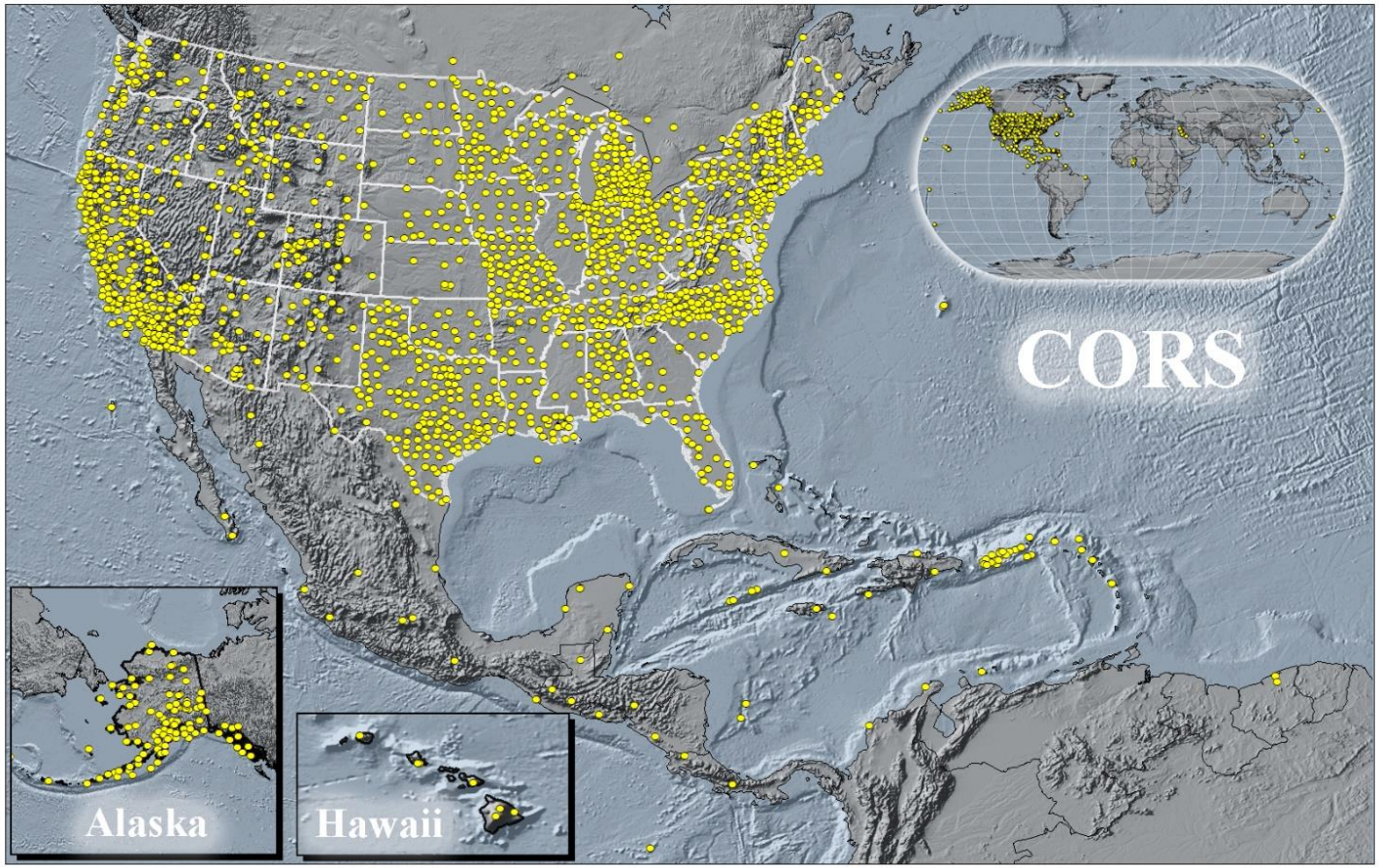
全球導航衛星系統

Global Navigation Satellite System (GNSS)

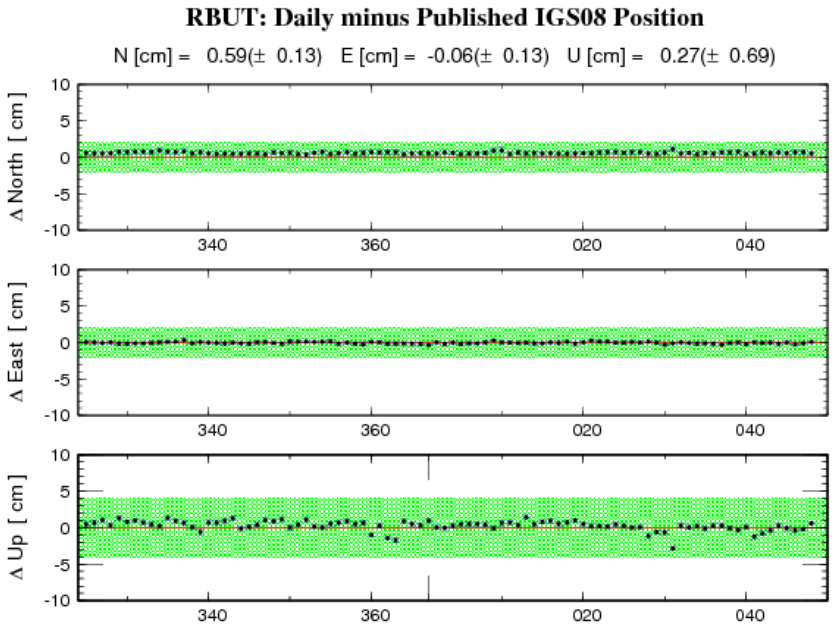


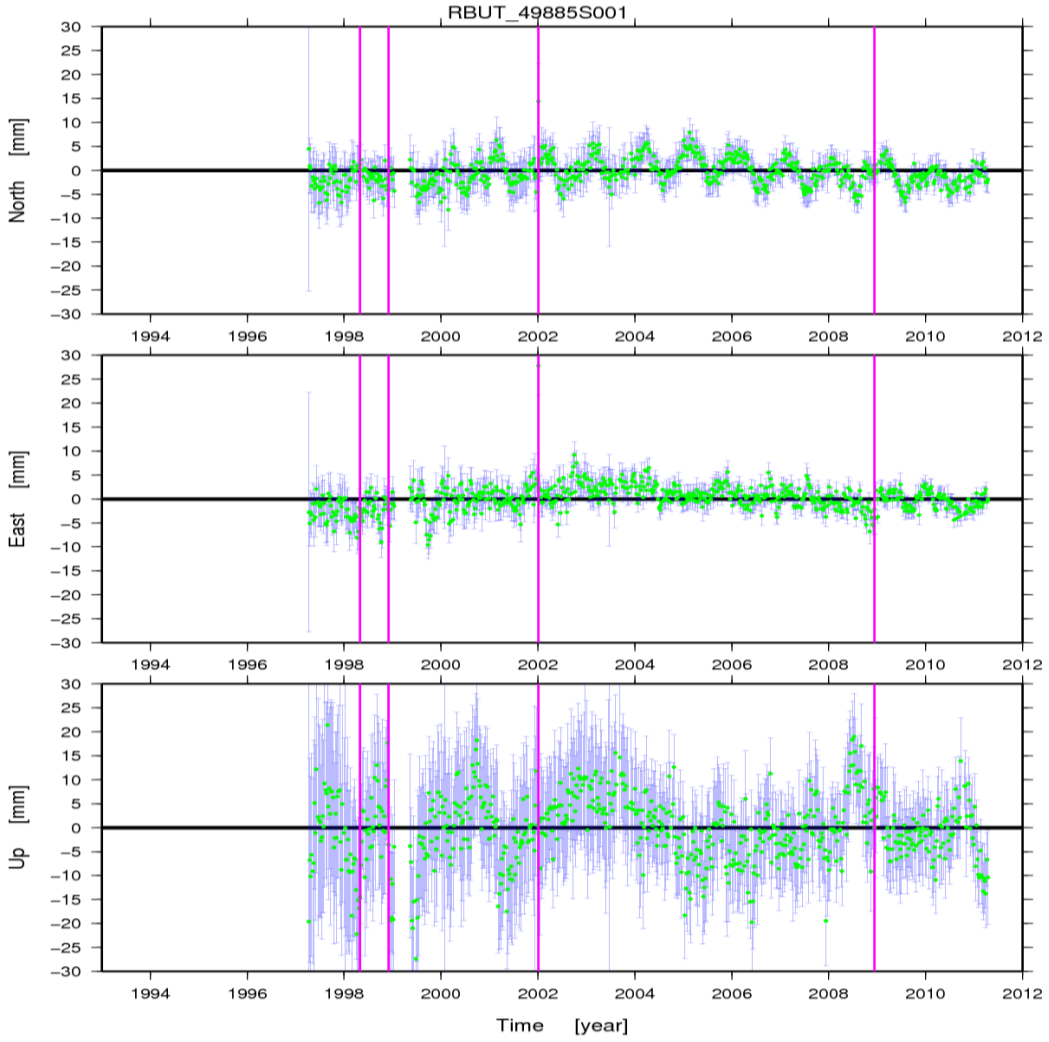


GNSS追蹤站(CORS)



定位應用

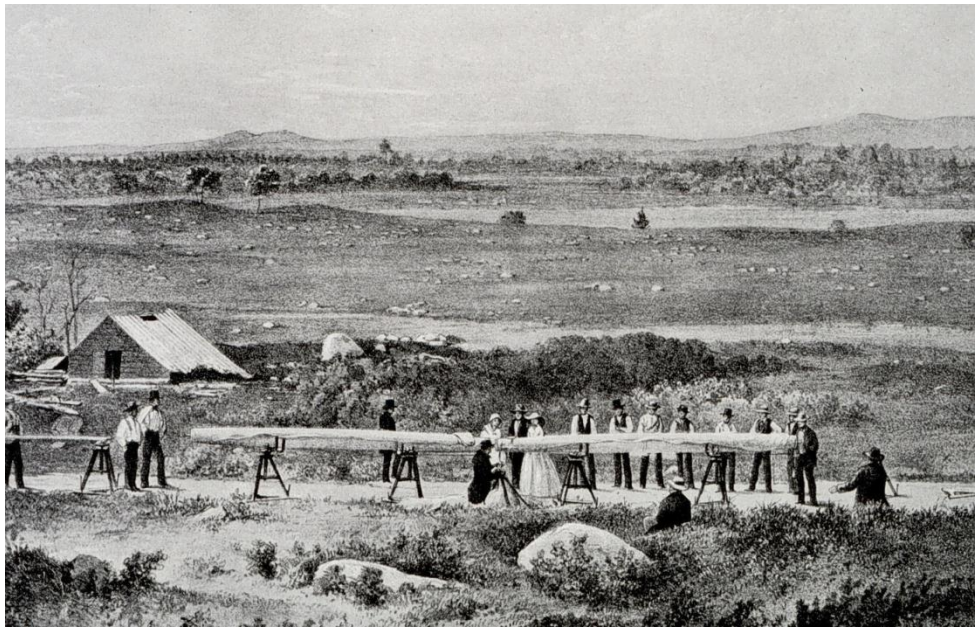

RBUT: Daily minus Published IGS08 Position
N [cm] = 0.59(± 0.13) E [cm] = -0.06(± 0.13) U [cm] = 0.27(± 0.69)
Δ North [cm]
Δ East [cm]
Δ Up [cm]
10
5
0
-5
-10
340
360
020
040


RBUT_49885S001
North [mm]
East [mm]
Up [mm]
30
25
20
15
10
5
0
−5
−10
−15
−20
−25
−30
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Time [year]

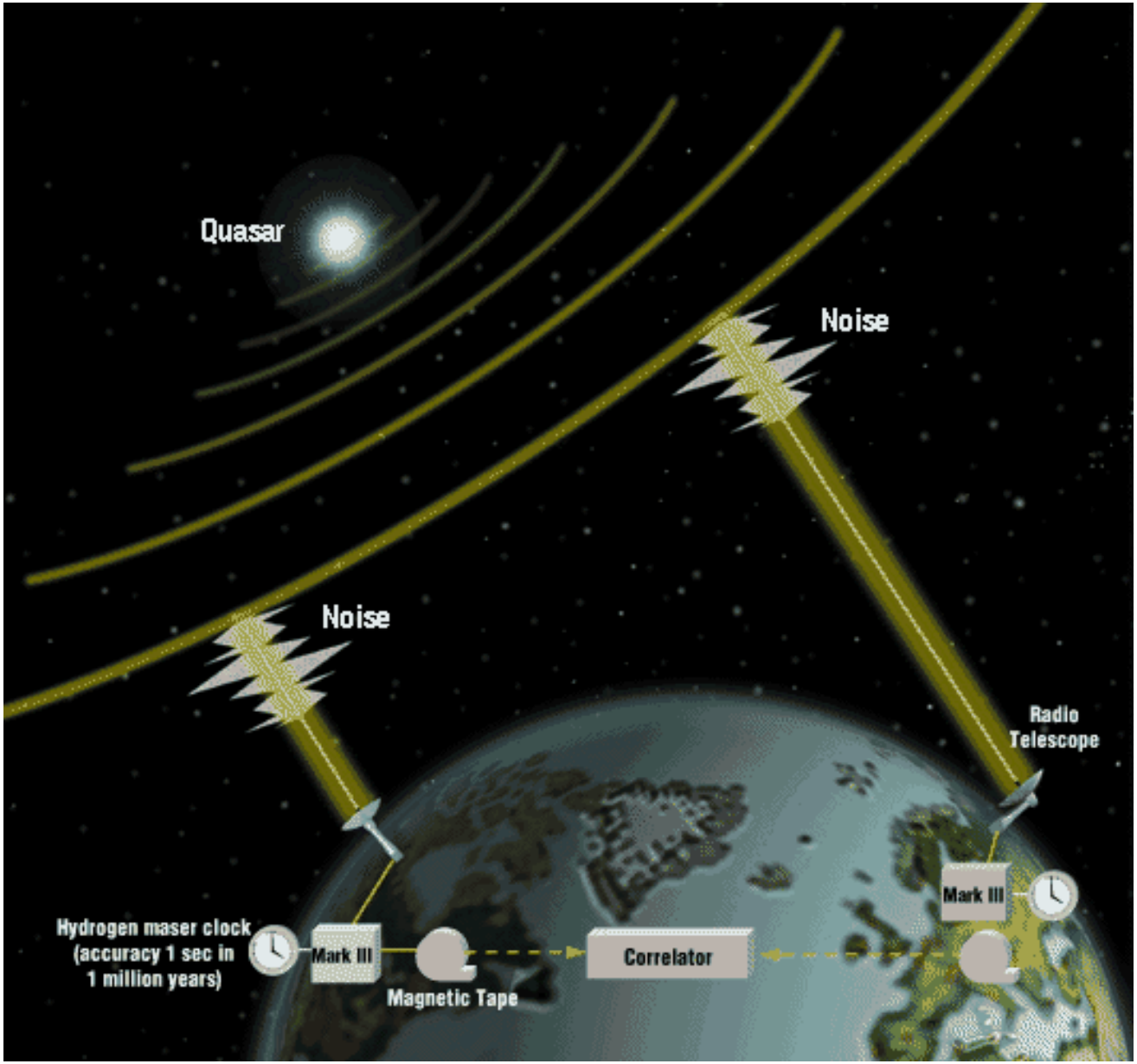
大地測量涵蓋的學科

- 大地控制測量
- 天文測量
- 重力測量
- 幾何大地測量
- 物理大地測量
- 衛星定位測量
- 太空大地測量

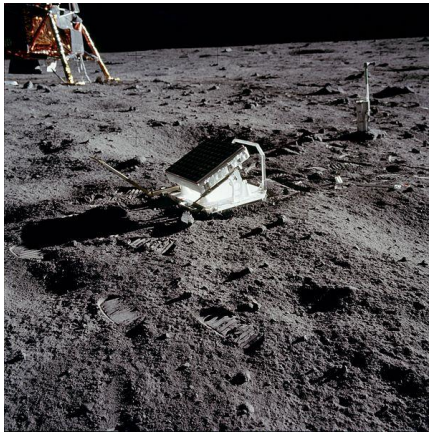
1816年基線測量



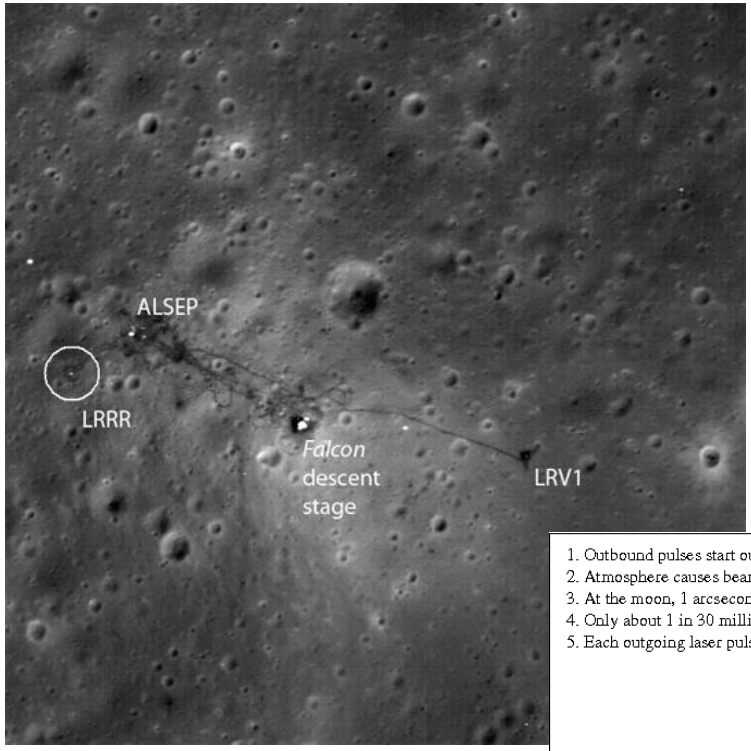
Very Long Baseline Interferometry (VLBI)



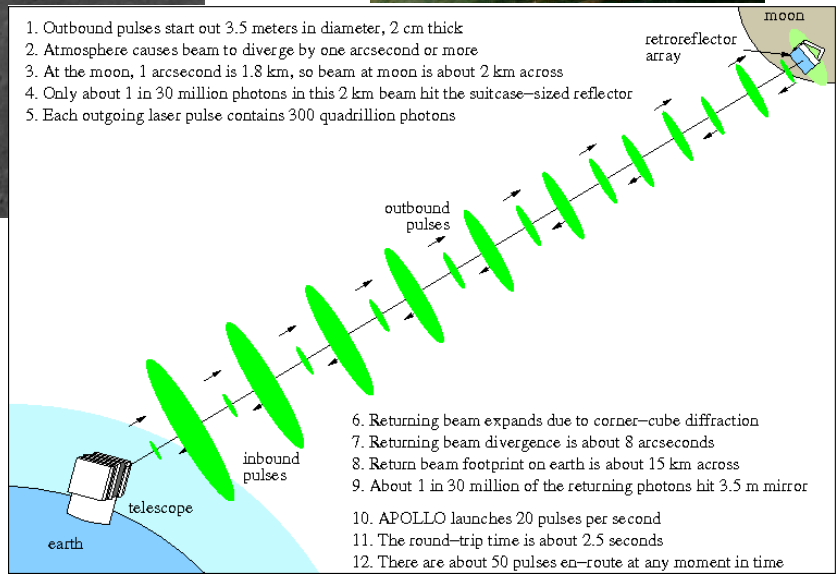
Lunar Laser Ranging (LLR)



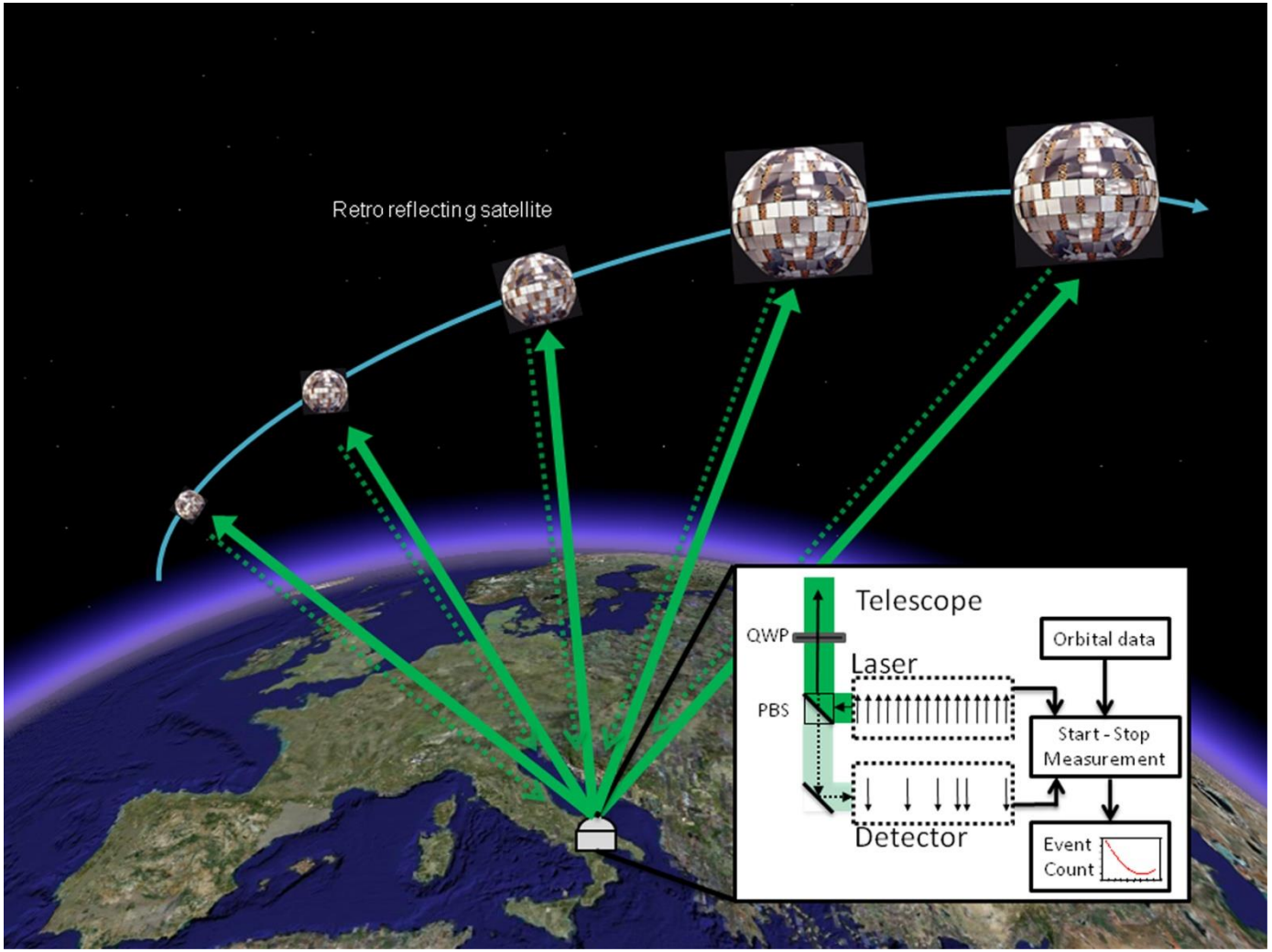
Apollo 11



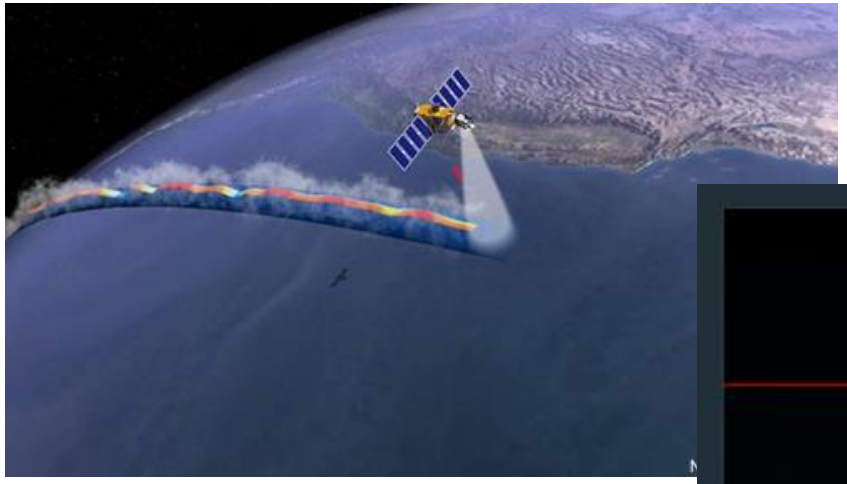
Apollo 15

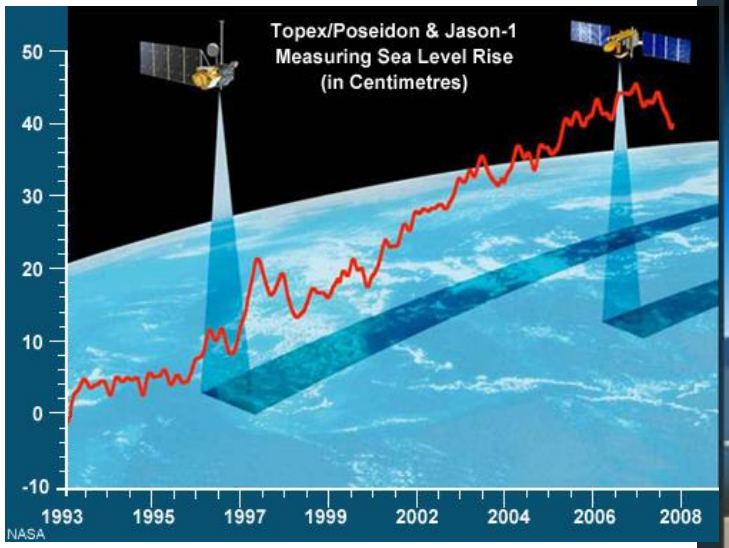


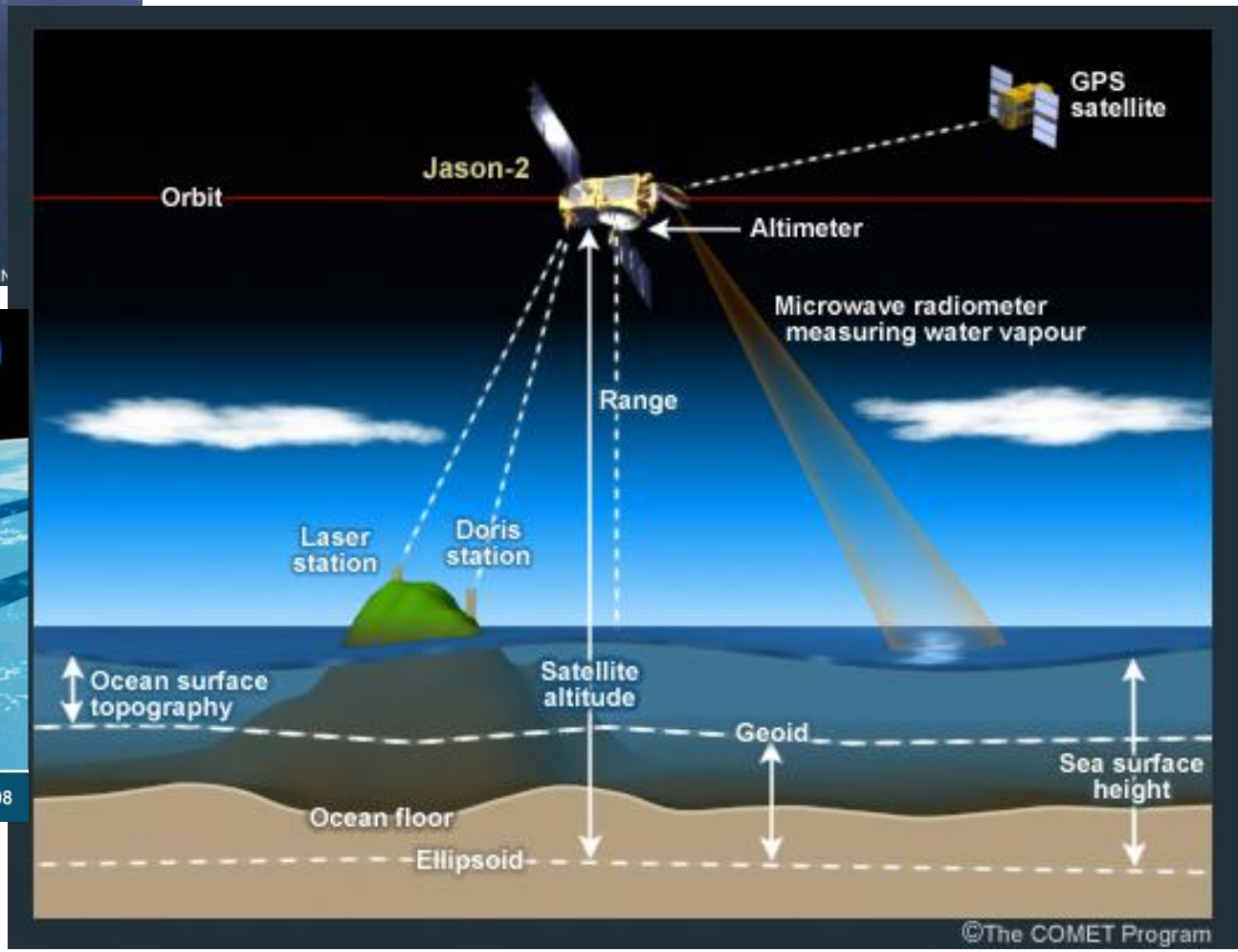
Satellite Laser Ranging (SLR)



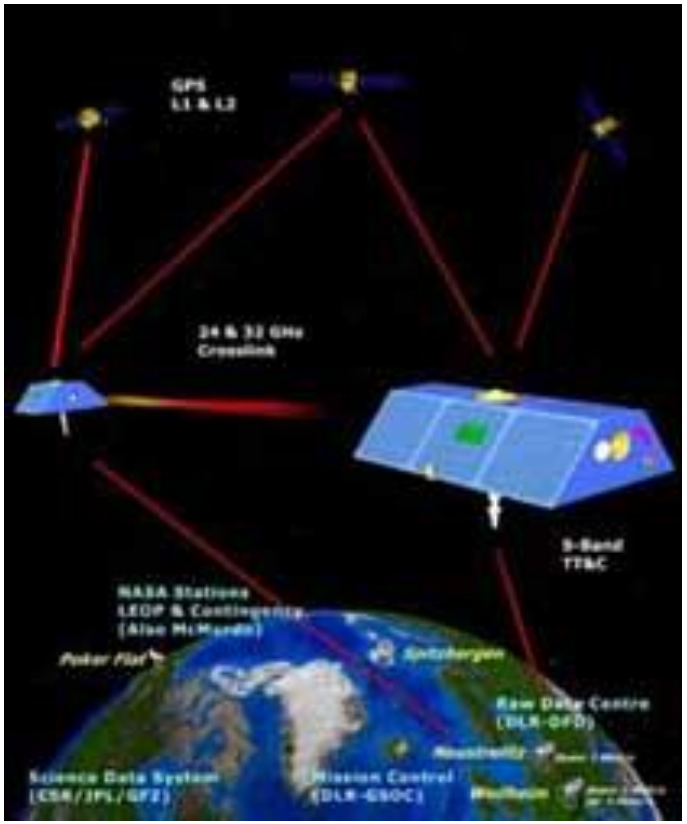
Satellite Altimetry

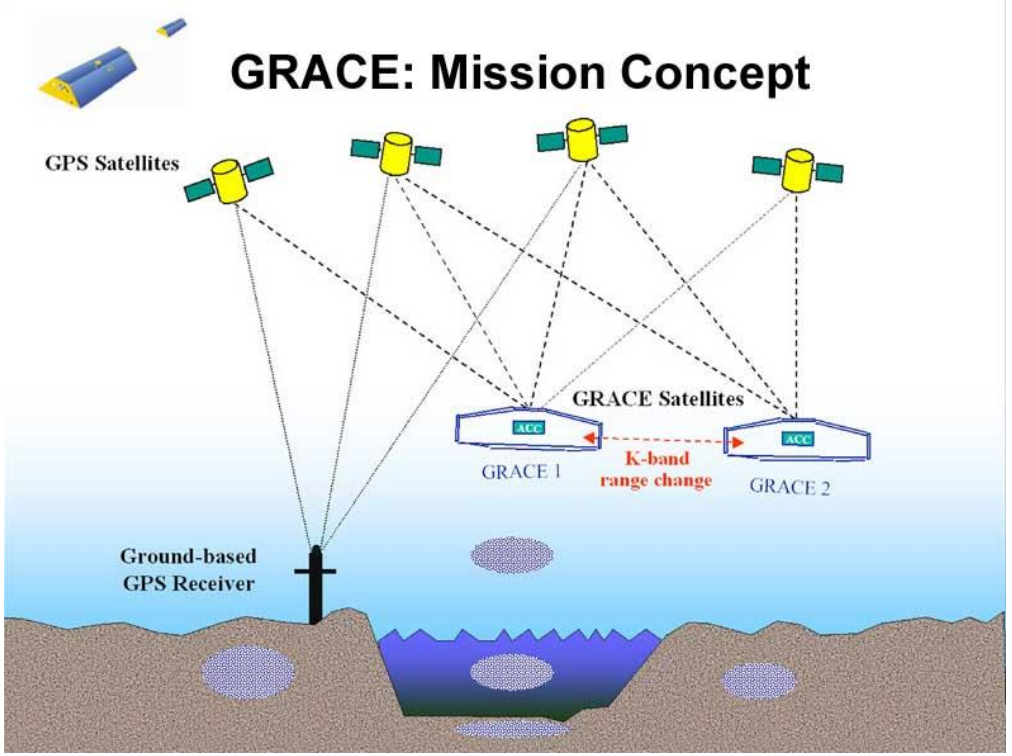


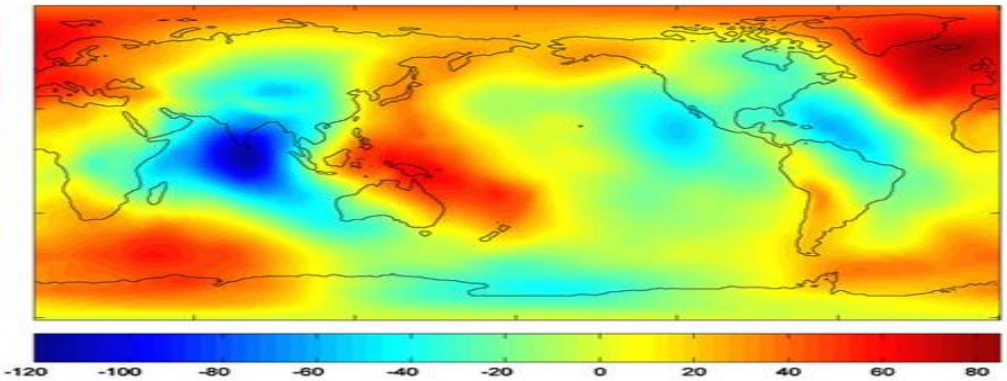




Satellite Gravimetry







GRACE (Gravity Recovery and Climate Experiment)

與平面測量比較

- 施測的範圍大小不同
- 使用的儀器精度不同
- 施加的改正模式不同
- 要求的成果精度不同
- 運用的領域範疇不同

大地應用的重要性

美國大地測量局教學影片


What are Geodetic Datums?


How Were Geodetic Datums Established?

What Is the Status of Today's Geodetic Datums?


Geospatial Infrastructure for Coastal Communities: Informing Adaptation to Sea Level Rise


Best Practices for Minimizing Errors during GNSS Data Collection


The Importance of Accurate Coastal Elevation and Shoreline Data

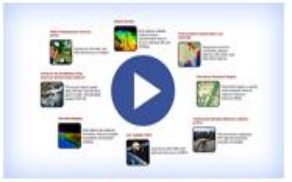

What's Next for Geodetic Datums?


Precision and Accuracy in Geodetic Surveying


Two Right Feet? U.S. Survey Feet vs. International Survey Feet

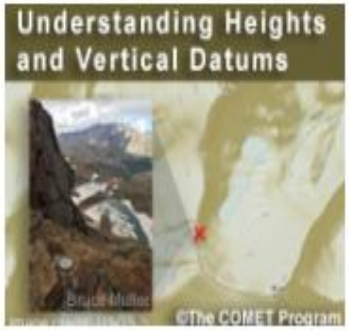

NOAA's VDatum Tool: Transforming Heights Between Vertical Datums


Geodetic Control in Land Surveying: Active vs. Passive


Location Science Improves Everyday Life

https://geodesy.noaa.gov/datums/newdatums/WatchVideos.shtml

美國大地測量局線上課程

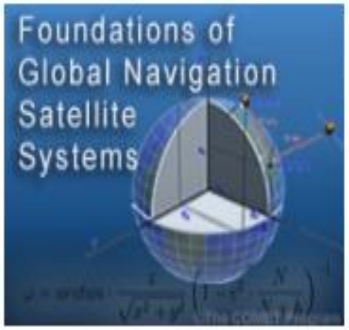


Understanding Heights and Vertical Datums

Skill Level: 0

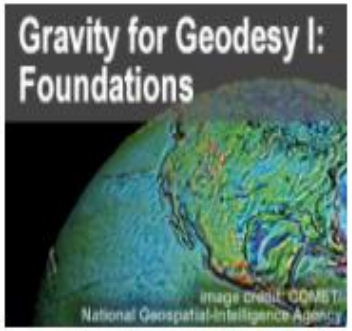
GNSS Positioning: Survey Planning and Data Acquisition

Skill Level: 1



Foundations of Global Navigation Satellite Systems

Skill Level: 2



Gravity for Geodesy I: Foundations

Skill Level: 2

Gravity for Geodesy II: Applications

Skill Level: 2

https://geodesy.noaa.gov/web/science_edu/online_lessons/index.shtml