GEODESY

2020
V0.5
C. Champollion
P. Vernant
M. Ferry

Organisation

- Terrain: 12h
- TP/TD: 18h
- CM: 6h

- Evaluation:
  - TP/TD for field experiment set-up
  - Field experiment report (including data processing and interpretation)
  - QCM for global knowledge in geodesy evaluation

Teaching methods

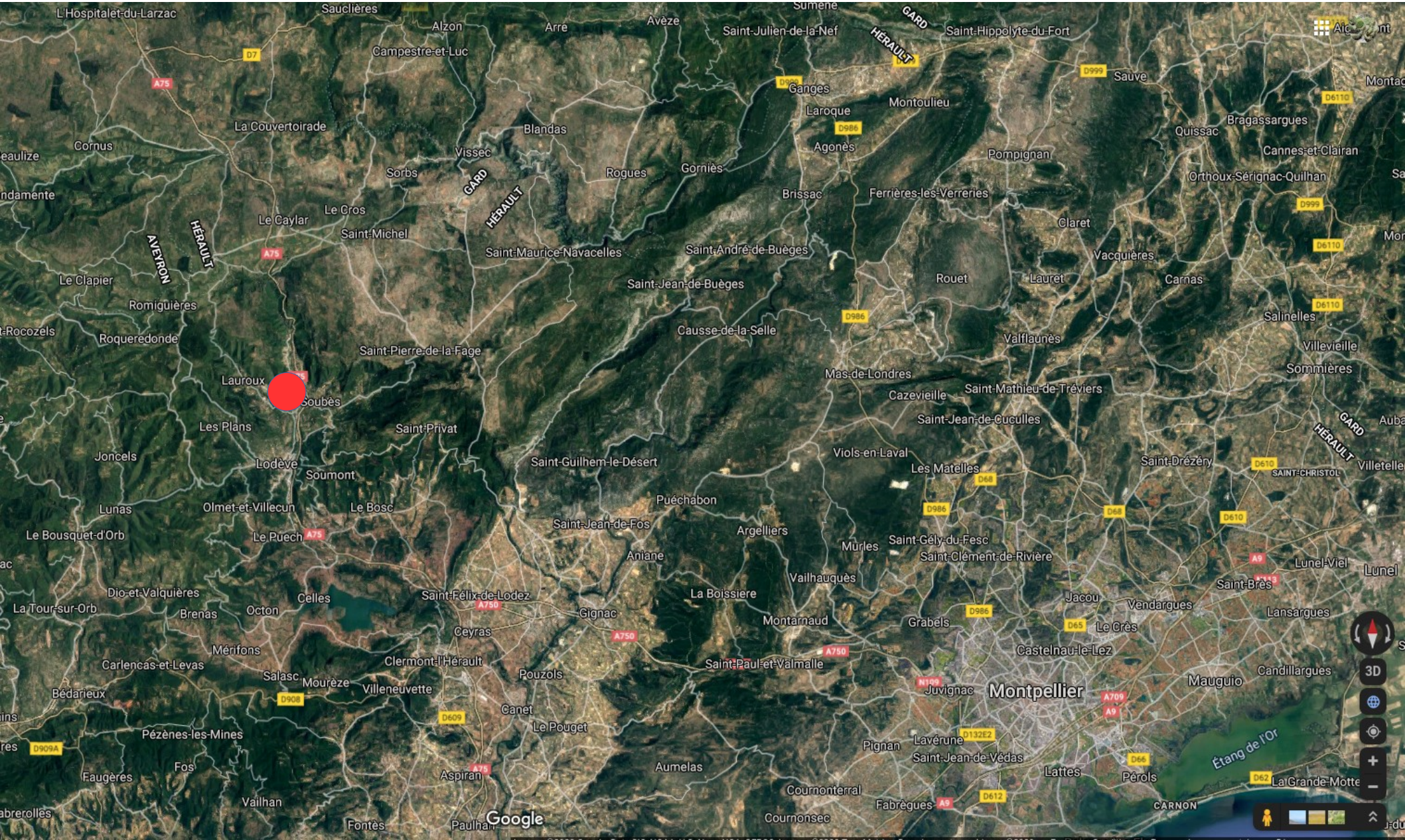
- CM: basic knowledge (GNSS / levelling / laser / reference frame / vertical displacement)
- Project teaching:
  - Large part of TP/TD
  - Python code learning
  - Participation / self-governement

  → If additional knowledge are needed, do not hesitate to use professor, books, articles

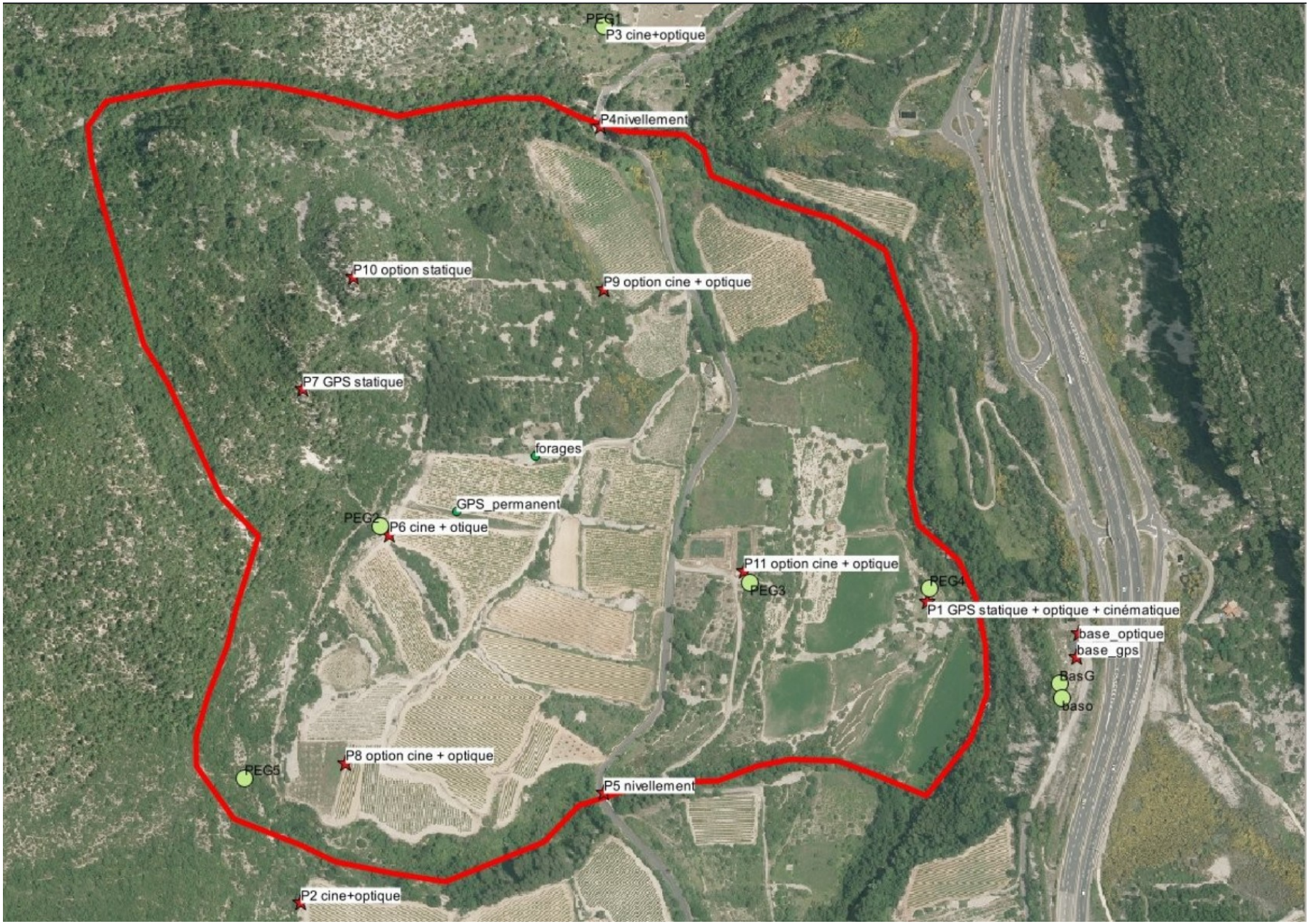
The 2023 project: Monitoring slow landslide

- Set-up of a field experiment (including preparation and formation) : starting now !
- **Step 1** : Preparation
  - Technical skills (including processing and calibration) for each instruments and for the combination of the instruments on the field
  - Organization of the field experiment (planning, strategy, instruments)
- **Step 2** : field experiment (29/09)
- **Step 3** : Data processing, numerical models, interpretation and presentation of the results

Geographical area



Geographical area



What do we know ?

- Short state of the art
  - Slow landslide (~ 1-2 mm/year) from continuous GNSS measurements
  - Probably seasonal part (intense rainfall) of the deformation
  - Explicit indication of landslide (geomorphology, bridge deformation, ..)

Field experiment

- Preparation of the field experiment in class
- On the field, split by groups
  - → 3 GNSS RTK
  - → Layer for SWMaps on moodle

The plan ?

- First we learn theoretical knowledge !
  - 3 CM (lectures) on GNSS / Leveling / Optical measurements

- Then we practice and evaluate the accuracy
- Then we prepare the field experiment
- At the end we process the data
- And present (report) the results

Field experiment

- To Be Done:
- Available instruments:
  - ~~Leveling (accurate, relative, expert, slow)~~
  - GPS static (accurate, absolute, easy, slow)
  - GPS cinematic (accurate, relative, easy, fast)
  - INSAR (accurate, relative, easy, fast)
  - ~~Laser (accurate, relative, expert, fast, measure of inaccessible point)~~
  - ~~Scanner 3D et/ou photogrammetry~~

Pratical constrains

- Field experiment the XXXX ?.
- Less than one hour driving
- **(With your car ?)**
- In the (french) bush with a lunch and water
- Meeting point at 9 AM bat 22 (coffee)

Introduction Geodesy

Definition *(du grec ancien geo «Earth» et daion «slice»)*

Geodesy is defined as the study (theoretical) and

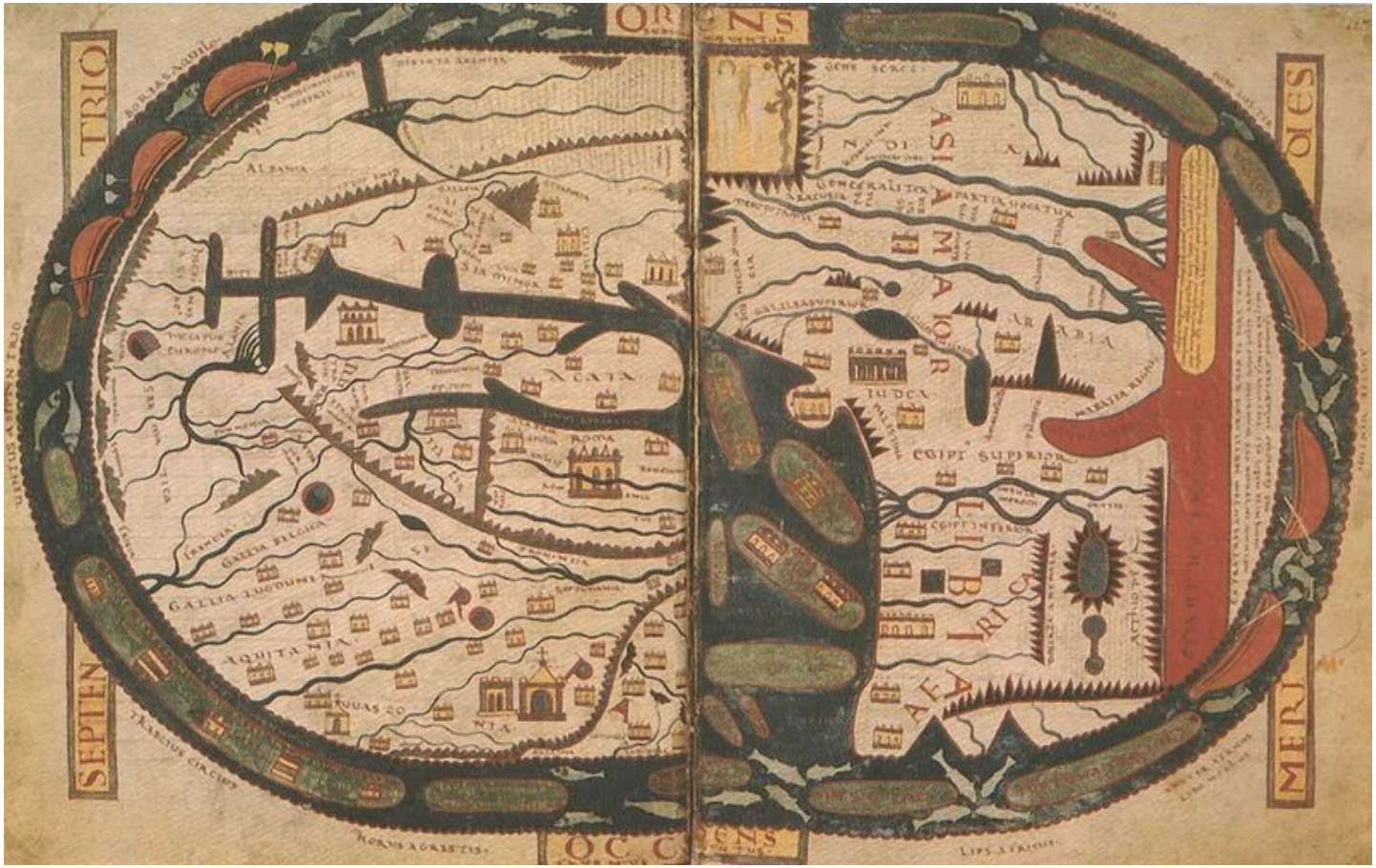
the observation of the shape and the size of the Earth,

of the gravity field

Geodesy is at the frontier between two large scientific fields: the astronomy and the Earth sciences

General knowledge and epistemology of geodesy

- Geodesy and politic:
  - Religion: first maps



Mapa Mundi de Beatus de Liébana (780)

General knowledge and epistemology of geodesy

- Geodesy and politic:
  - Military (Napoléon)



Part (Languedoc-Roussillon) of the Cassini french map (~1756)

General knowledge and epistemology of geodesy

- Geodesy et politic:
  - Military control (GPS)



GPS



The Global Positioning System is the world's only global utility.

Operated by the dedicated men and women of the 2nd Space Operations Squadron at Schriever Air Force Base, Colo., GPS is also the world's largest military satellite constellation. The 2nd SOPS has three missions: global navigation, time transfer and nuclear detection. Uses of GPS include precise timing for financial transactions, search and rescue, communications, farming, recreation and both military and commercial aviation.

GPS Operations Center

The Global Positioning System Operations Center provides a single center of excellence for user support and GPS constellation operations. The GPSOC, located at Schriever Air Force Base, Colo., provides Department of Defense and allied GPS users worldwide with anomaly reports and other information 24 hours a day, seven days a week.

Military users who need to request information or report an anomaly or outage may contact the GPSOC using the phone number or e-mail address provided in the contact information below. Non-military users should contact the U.S. Coast Guard's Navigation Center at 703-313-5900.

GPSOC RESOURCES

- U.S. Strategic Command
- NOAA Space Environment Center
- Air Force Space Command
- USCG Navigation Center
- GPS Joint Program Office
- International GNSS Service

CONTACTS

Military Users: Contact the GPS Operations Center at 719-567-2541, DSN 560-2541.

Civilian Users: Contact the U.S. Coast Guard Navigation Center at 703-313-5900 or visit www.navcen.uscg.gov.

For Web site questions or comments click here.

GPSOC CONTACT INFORMATION

GPS OPERATIONS CENTER
300 O'Malley Avenue Suite 41
Colorado Springs, CO 80912-3041

Phone: 719-567-2541
719-567-5081

Https link: https://gps.afspc.af.mil/gpsoc/Default.aspx
E-mail: click here

GPS LINKS

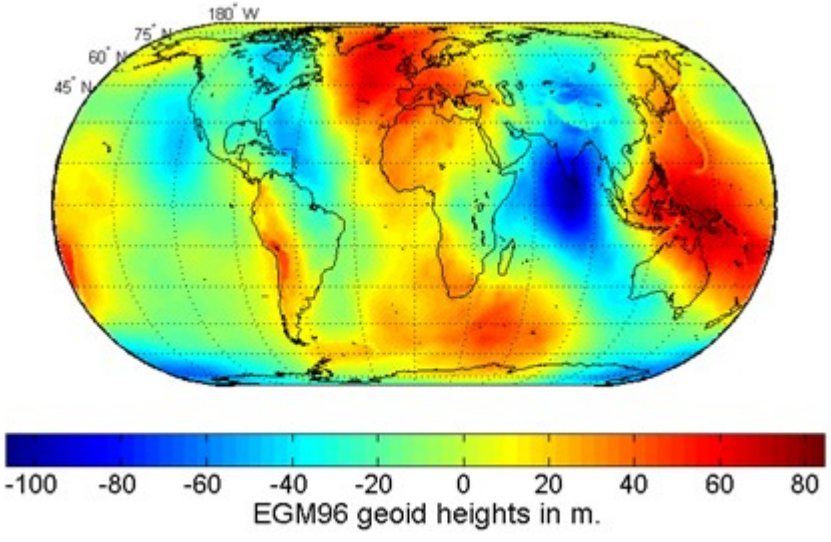
- Home
- Automatic NANUs
- Report an Anomaly
- Request Information

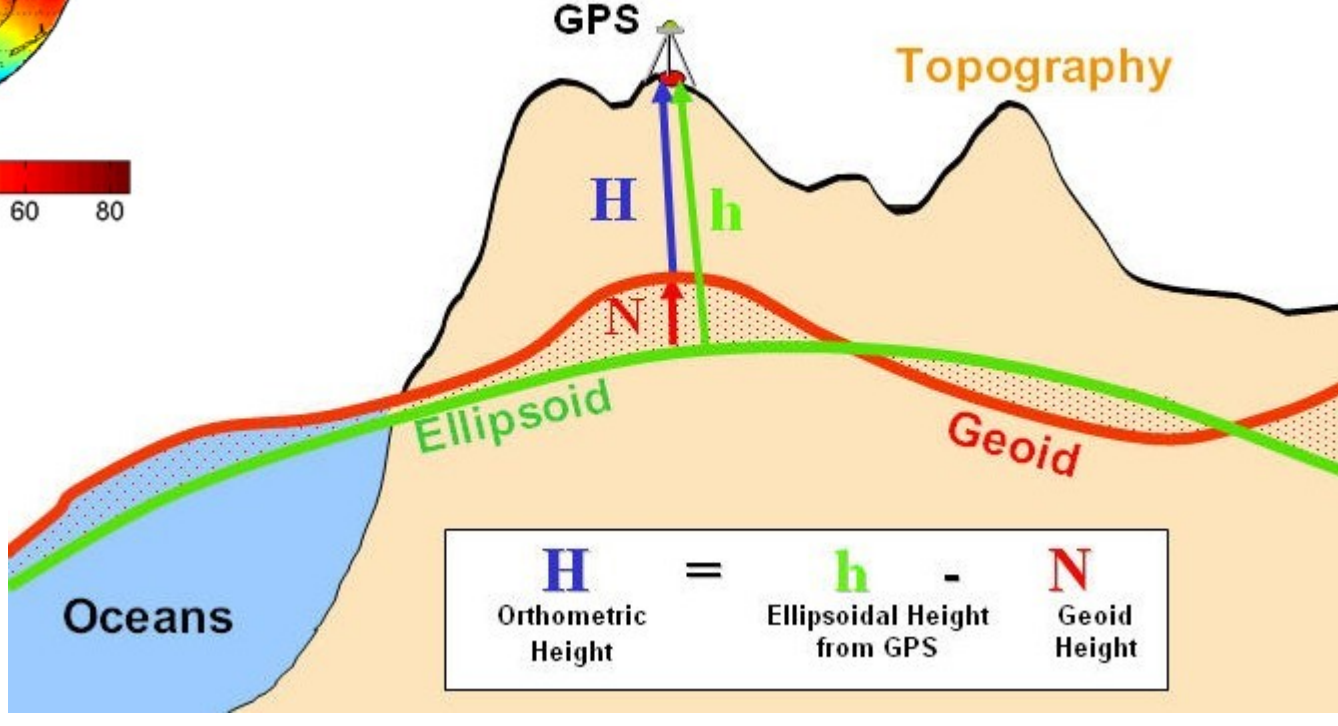
SCHRIEVER LINKS

- Contracting
- GPS
- Inspector General
- Voting Assistance Program
- FOIA
- Letters
- AirForce.com
- Environmental Office
- A&FRC
- Commander's Hotline
- Guide to Social Media Security
- Air Force Social Media Guide
- 50th Space Wing Heritage Pamphlet
- SAFB EMS Commitment Statement

General knowledge and epistemology of geodesy

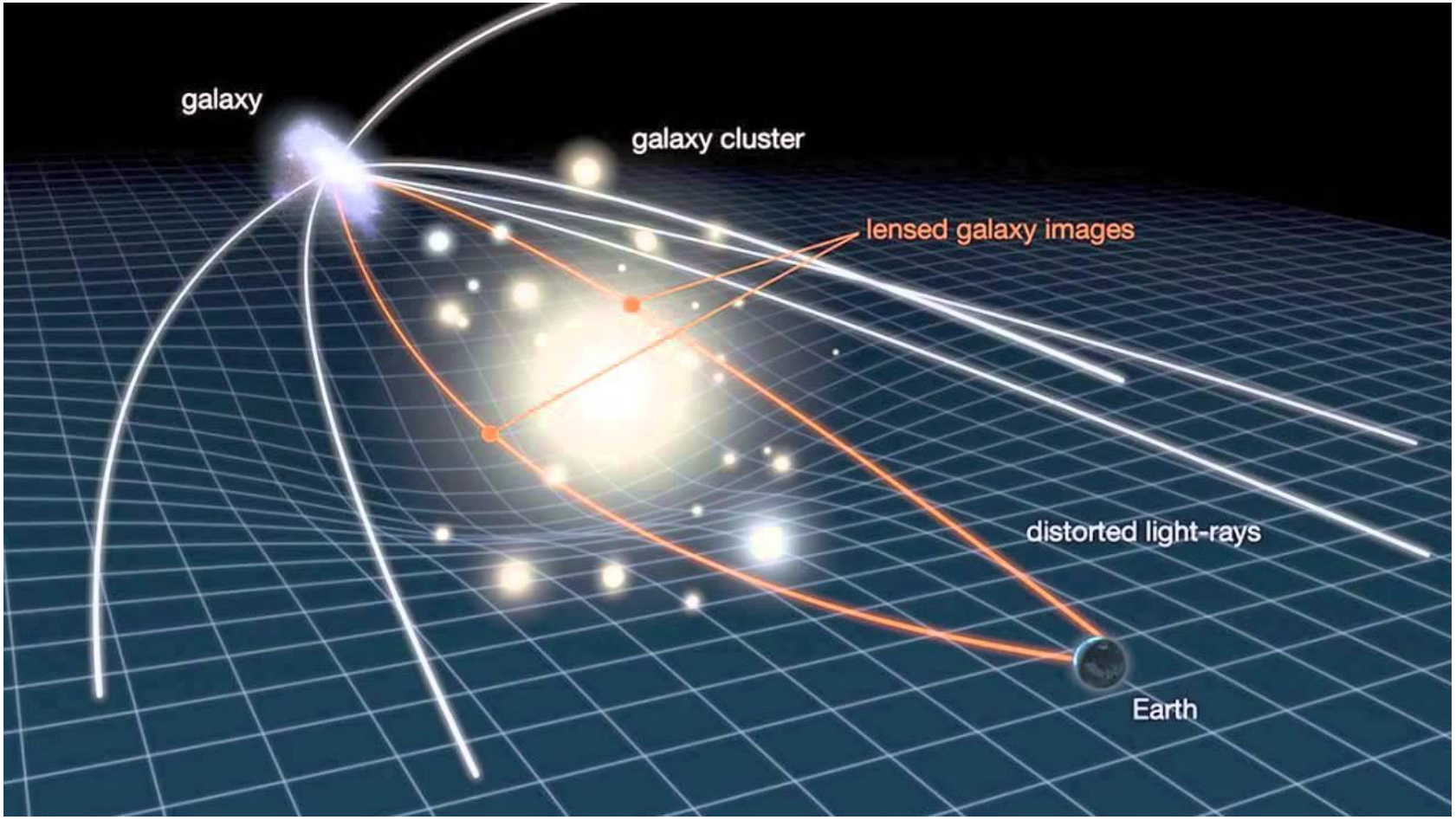
- Geodesy and gravity





General knowledge and epistemology of geodesy

- Geodesy and gravity



General knowledge and epistemology of geodesy

- Geodesy and units definition
  - in 1799, the french “Académie des sciences” define the meter as the unit of measure of distance: 1 meter = 10 000 000 part of the Earth meridian. Now the meter unit is defined by light speed velocity and the second.
  - Controversy about the shape of the Earth (North-south or East-West flattening) between Newton (physician) and Cassini (topographer)
  - Definition of the unit of mass: kilogram (gravity value needed)

- Geodesy and reference
  - Reference level of the altitude: the geoid surface

General knowledge and epistemology of geodesy

- Geodesy and time:
  - Eratosthène: pourquoi il a choisi deux villes alignées Nord-Sud.
  - Temps et gravité: Transfert du temps en guyane à la révolution française (pendule) et maintenant (GPS).
  - Relativity (restreinte et general):

Einstein …

La meilleure idée de sa vie !

« Nous allons faire l'hypothèse de la complète équivalence physique entre un champ de gravitation et l'accélération correspondante du système de référence » (1907)

$$t = \frac{t'}{\sqrt{1-(v^2/c^2)}}$$

Résumé

- Géodésie → science du pouvoir (religieux puis militaire)
- Géodésie = position (vitesse) + gravité + temps
- Référence: unité de distance (actuellement le kilogramme).

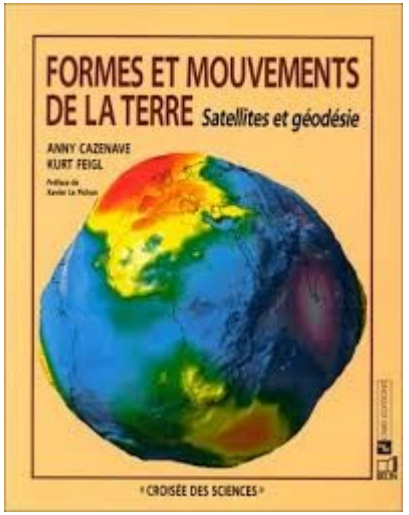
Applications

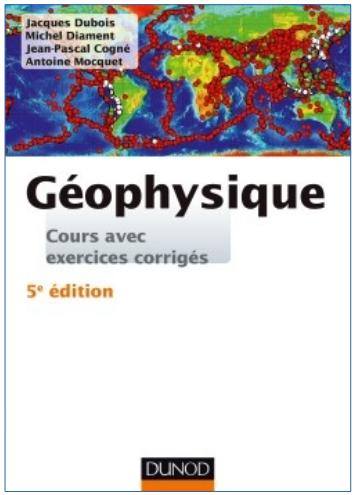
- Volcanologie
- Subsidence et suivi de réservoir
- Cycle sismique
- Météorologie
- Tectonique
- Navigation (voiture, bateau, avion, satellite)
- Agriculture
- Cadastre (topographe)
- Aménagement (construction)
- Transfert de temps

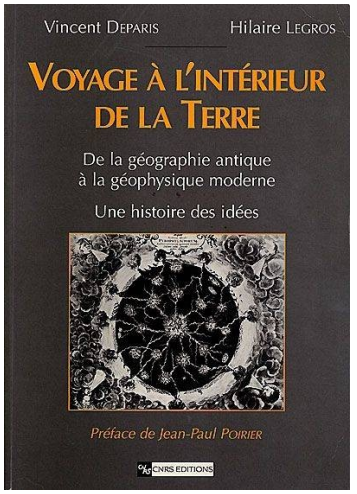
A lire

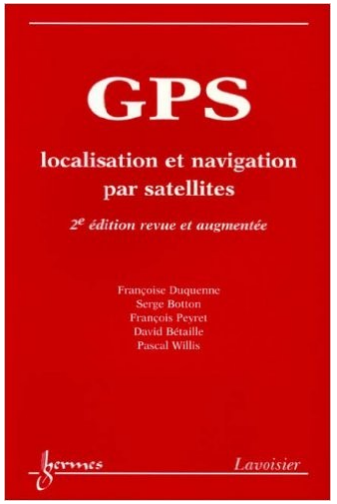
- Sur l'ENT:
  - Cours / cours 2020 → les CM de cette année
  - Cours / cours Erik Doerflinger
    - **Lire géodésie 1 et géodésie 2 et géodésie 8 : important pour QCM !**

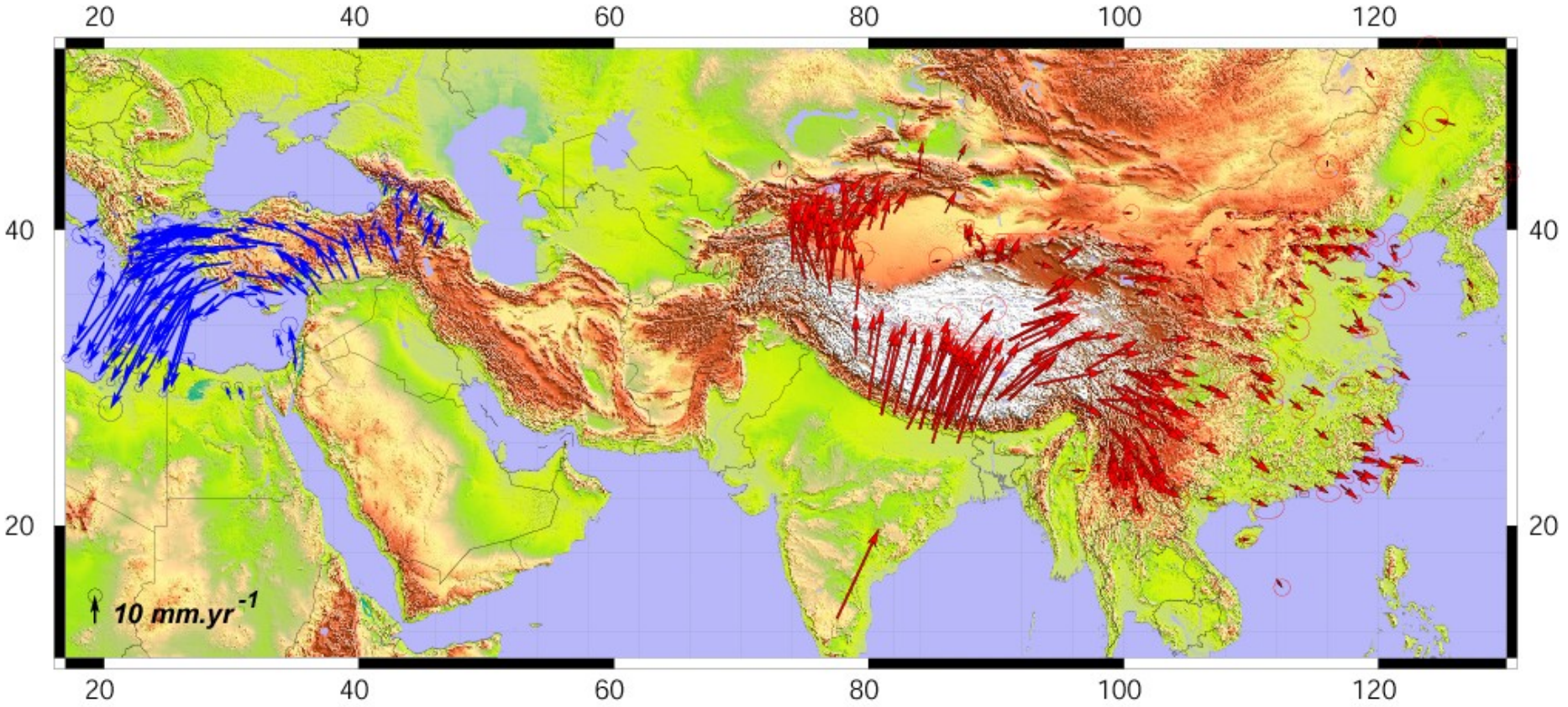
- Références:
  - Formes et mouvements de la terre (Anny cazenave et Kurt Feigl chez Belin)
  - Géophysique (Jacques Dubois et Michel Diament chez Masson puis Dunod)
  - Voyage à l'intérieur de la terre (Hilaire Legros chez CNRS édition)
  - GPS localisation et navigation (Serge Botton chez Hermes)











Blue arrows : McClusky et al. (2000)
Red arrows : Wang et al. (2001)