EUREF Symposium 2005
Vienna
June 1st-4th, 2005

Gravity measurements on the French geodetic network: toward an integrated network

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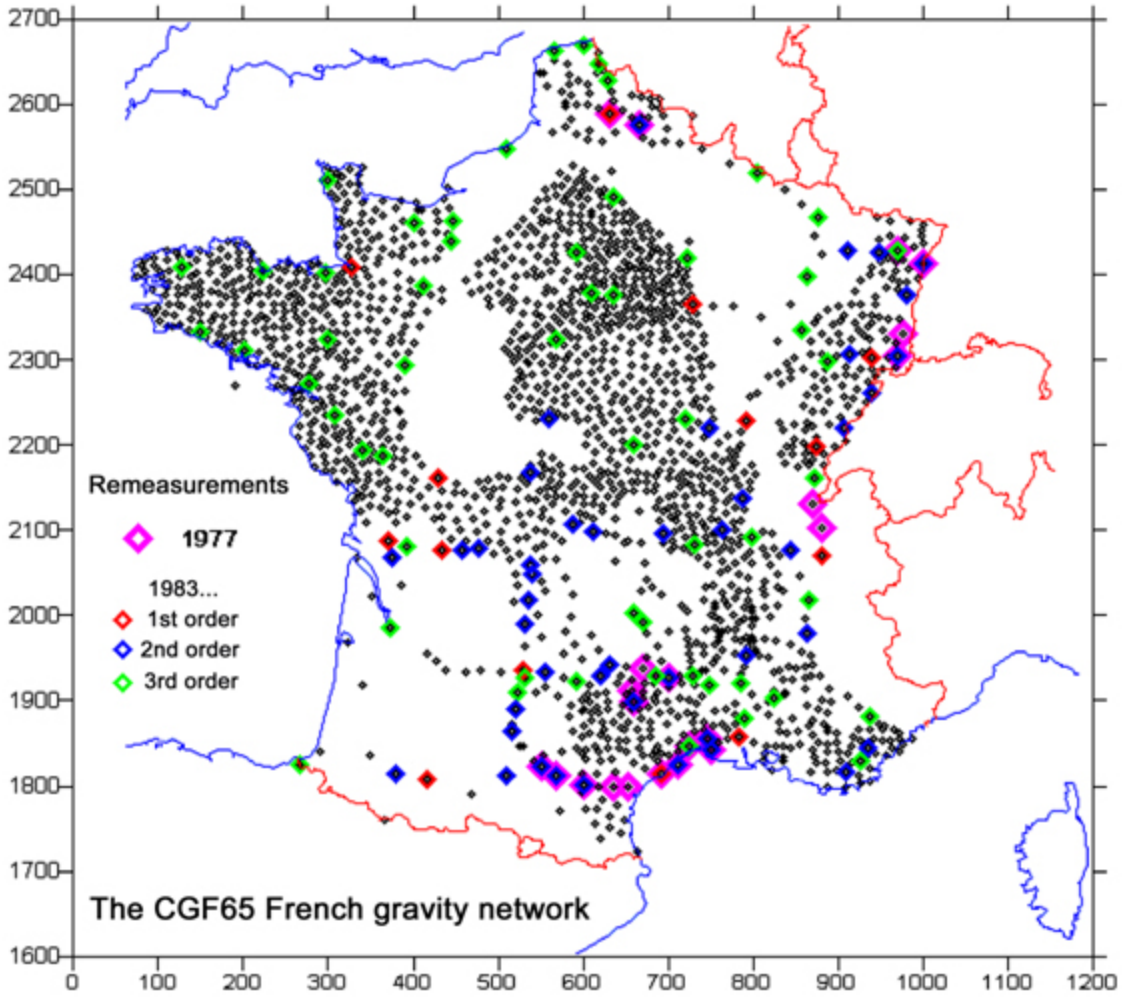
Summary

- **A brief history of the French gravimetric networks**
- **The new gravity network**
  - Present measurement
  - Comparisons with old data
  - Future plans

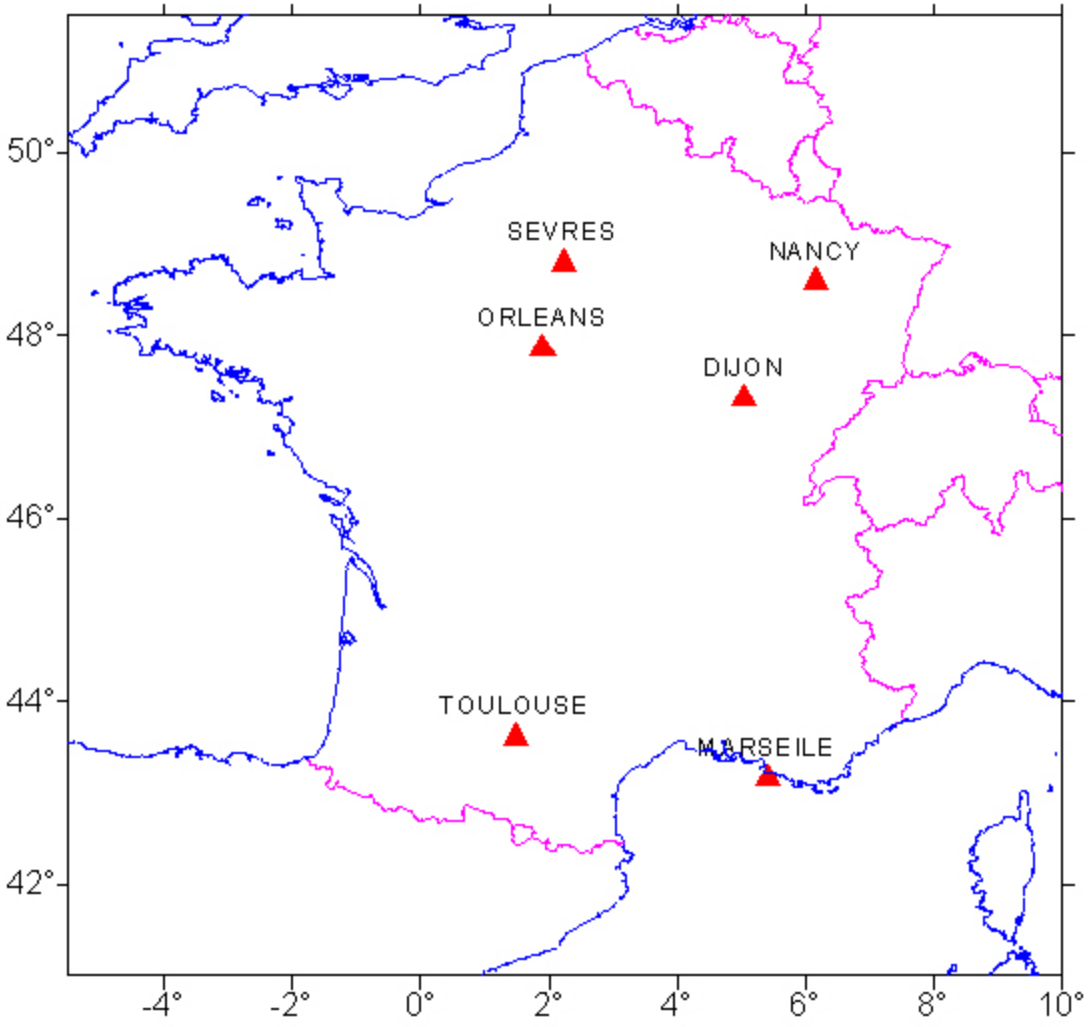
The first French gravity network CGF65

- Based on 2 “fundamental” stations
- Referred to Potsdam
- Precision 0.1 mGal
- Never completed



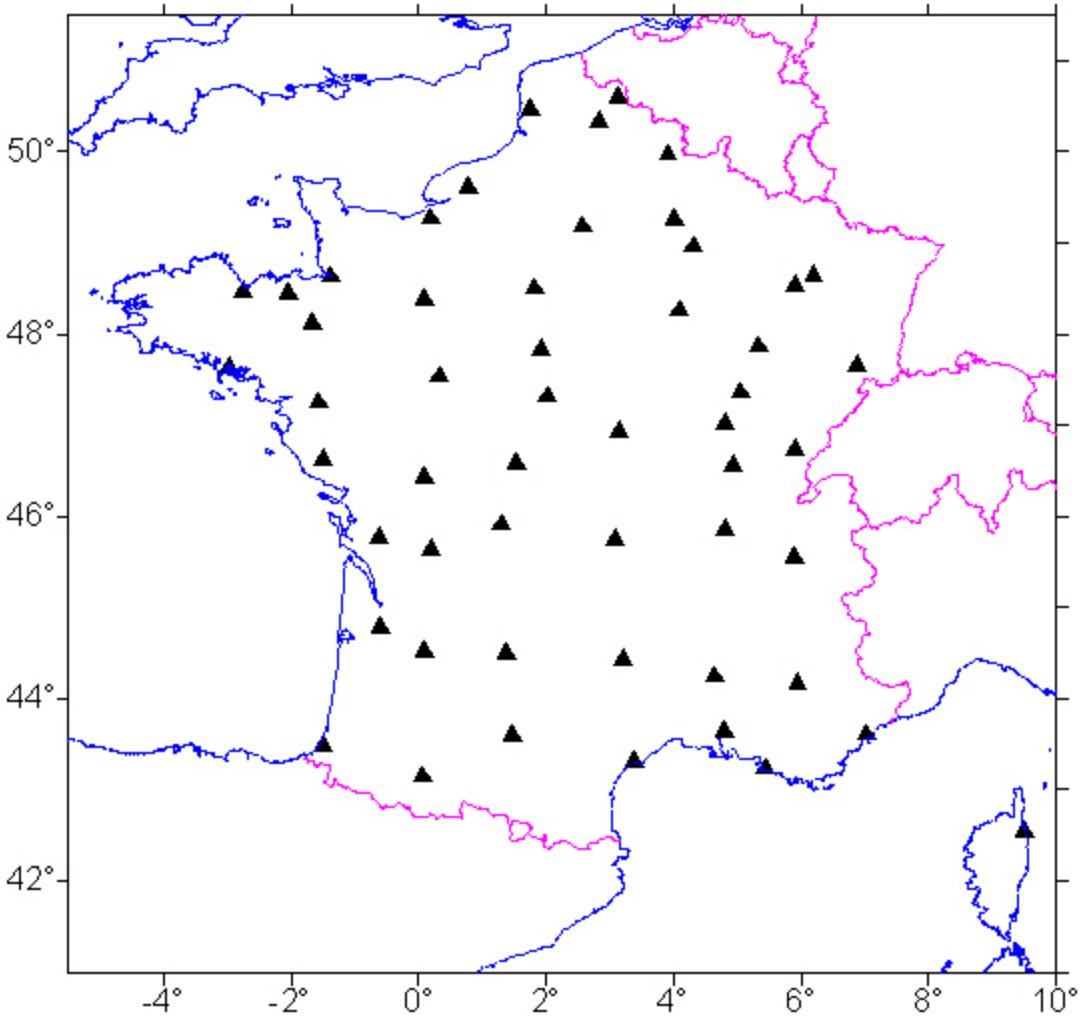
The second French gravity network RGF83

- **Fundamental stations**
  - BRGM, BIPM, BNM
  - 6 stations
  - Rise and fall absolute gravimeter Jaeger GA60
  - Max error: 15 to 24 μGal



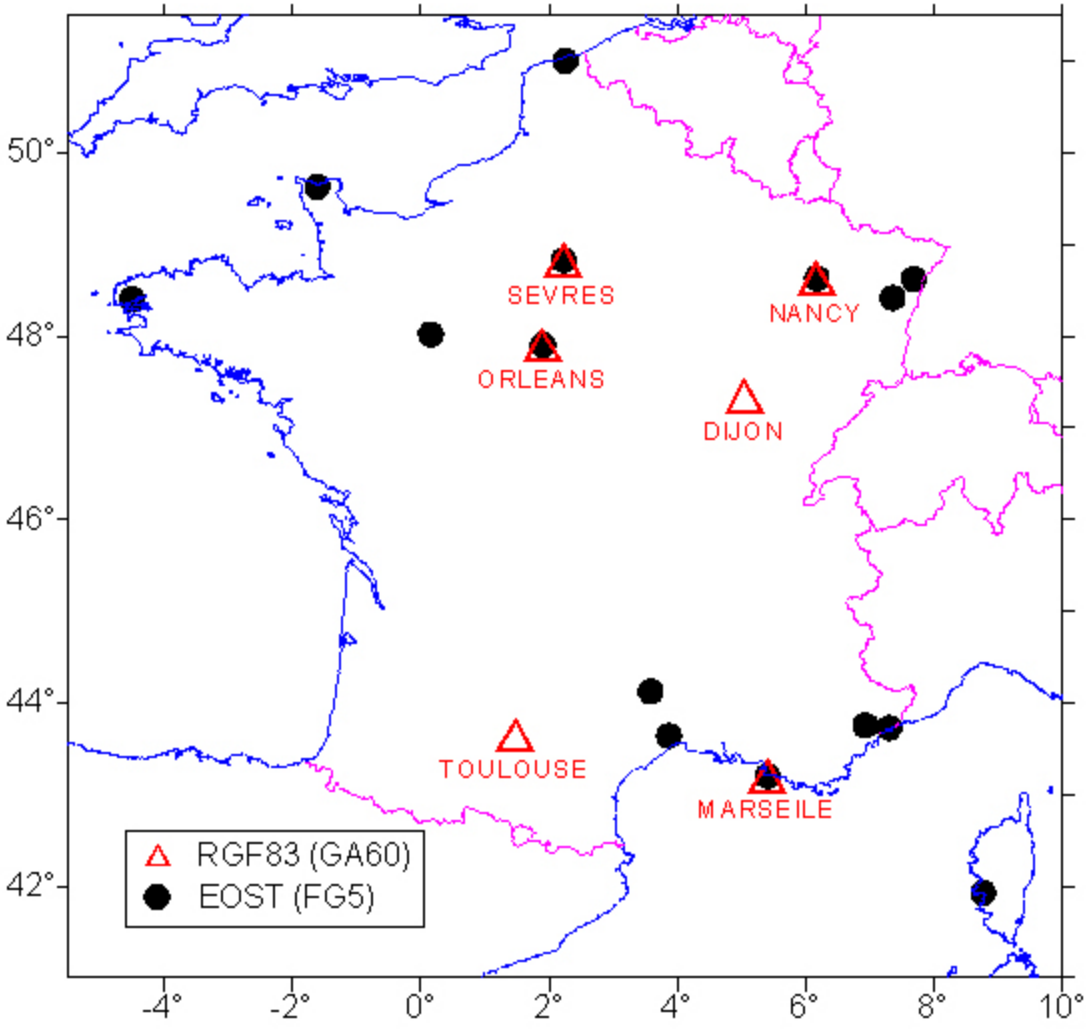
The second French gravity network RGF83

- **First order network**
  - BRGM and BNM
  - 53 main stations + calibration lines + frontier stations
  - 4 Lacoste model G gravimeters
  - Max error: 63 µGal
- **2nd order network**
  - 280 stations
  - 1 Lacoste model G gravimeter
- **Destruction rate > 30%**



Recent absolute measurements

- **Measurements by EOST**
  - Since 1998
  - 15 stations
    (4 calibration lines)
  - Absolute gravimeter:
    FG5 # 206
  - Accuracy ~3 μGal



Present gravity campaigns by IGN : motivations

- **Improvement of the French gravimetric reference network :**
  - Toward a dense, accurate, precise, protected network, with possible reiterations
  - Integrated geodetic and gravimetric networks
    - For scientific and practical applications
    - Reduce the cost of monumentation and maintenance
    - Participation to EUREF, ECGN and EGGP
- **Improvement of the French quasigeoid model and the height conversion grid**
  - Better gravimetric reference of the old gravity coverage
  - Recovering of inaccurate values in that coverage.

Present gravity campaigns : specifications

- **Consistency**
  - About 1020 points of the RBF (GPS levelling points) and RGP
  - Nodes of the 1st order levelling network
  - Old RGF83 gravity points
  - Tide gauges
- **Absolute measurements**
  - About 200 points
  - Micro-g A10 gravimeter
- **Relative measurements**
  - Scintrex CG3M gravimeters

A standard RBF point, suitable for GPS and gravity measurements: 1 m^3 slab. The benchmark is protected by law and periodically visited.

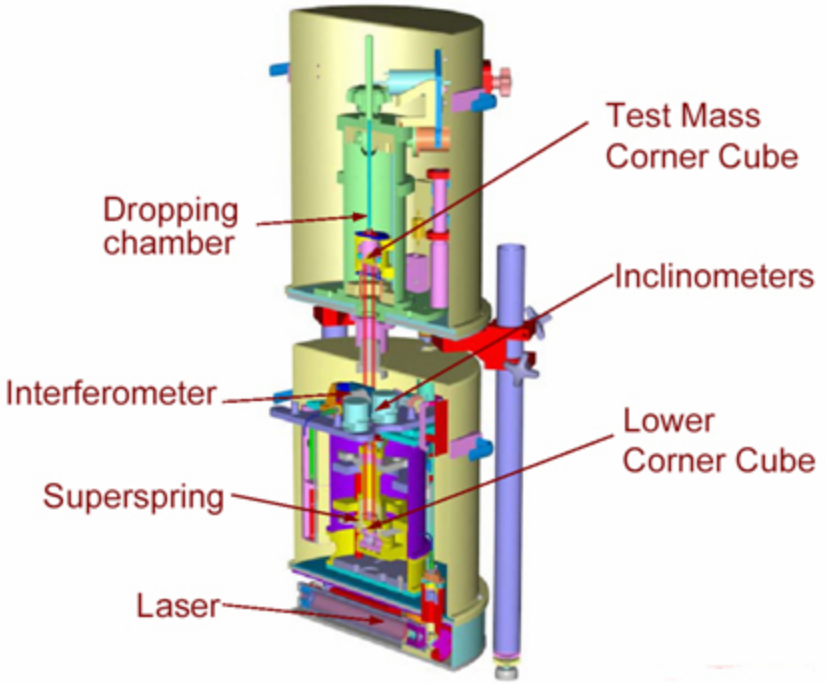
Absolute measurements

- **Gravimeter: A10 purchased by IGN, IPGP, IRD in January 2005**
- **Experienced repeatability: 5 μGal**

  (laboratory)
- **Expected accuracy and precision:**

  $\sqrt{100 + 100/N}$ μGal

  (from manufacturer)
- **3×100 falls per point**
- **1st campaign : 2005**

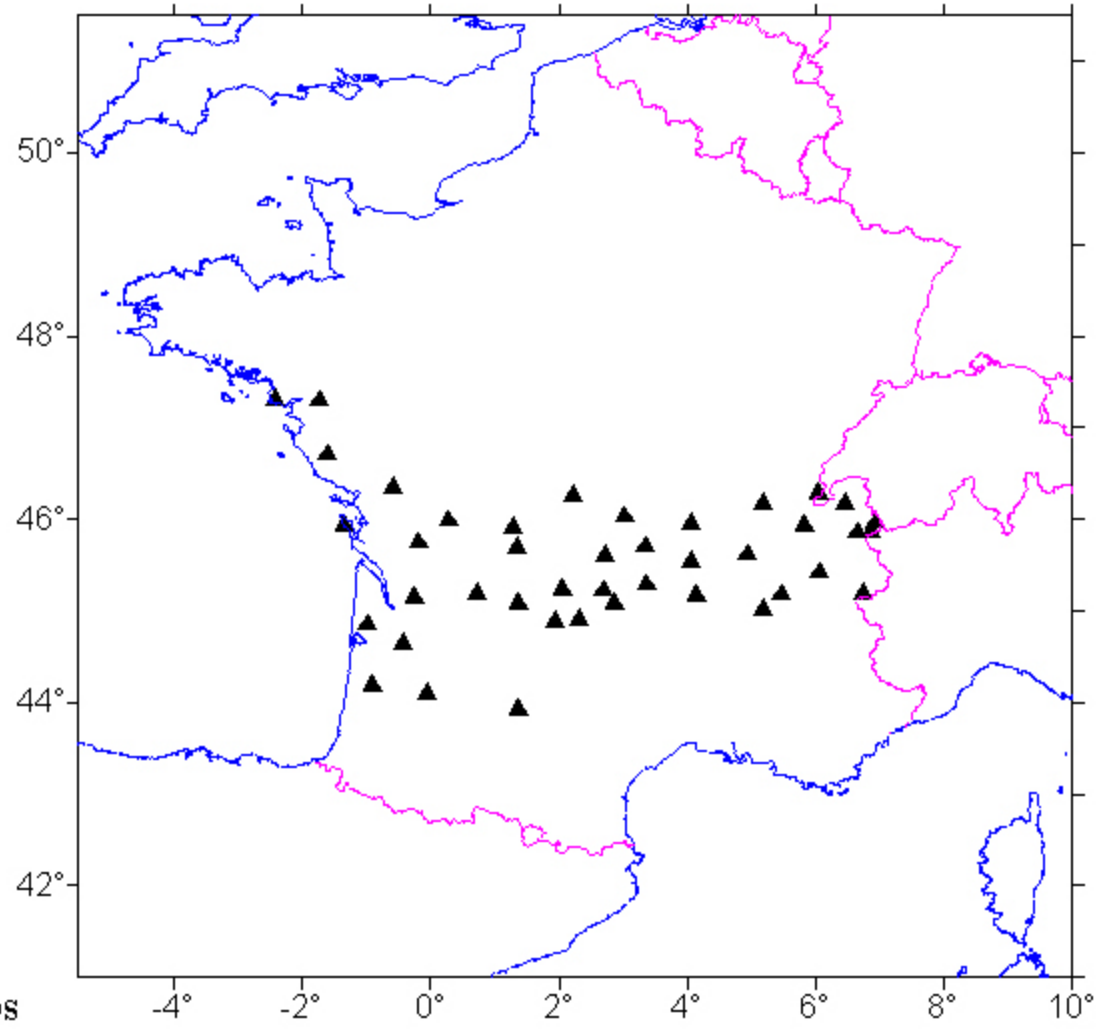


A10 shematic (© Micro-g Solutions)

Progress in absolute measurements

- **2005 campaign**
  - 1.5~2 points per day
  - 50 points measured
  - Minor problems with rain and wind
  - 1st minor failure after 50 points

A10 gavimeter operated in the French Alps

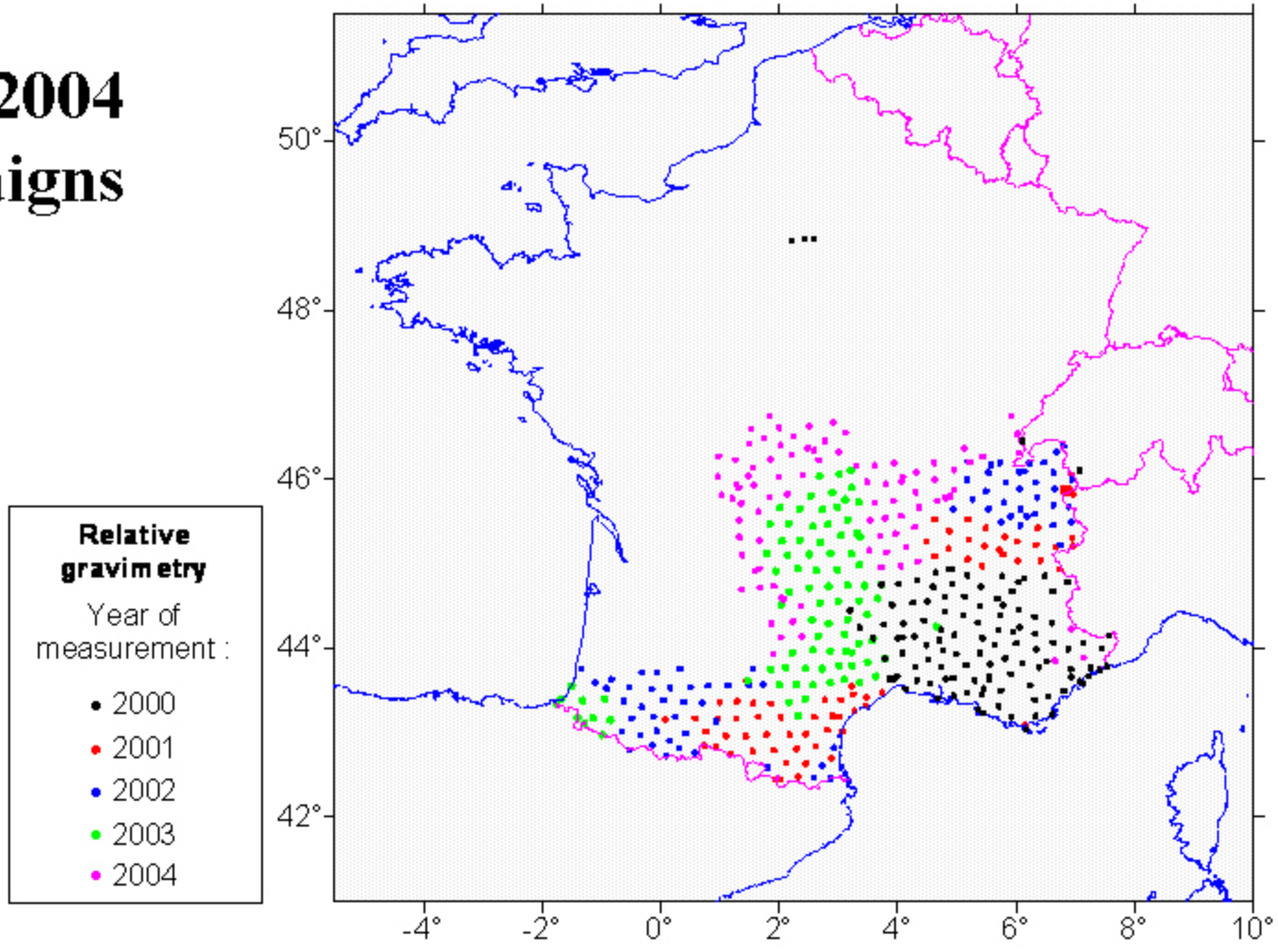


Relative measurements

- **Gravimeters: Scintrex CG3M (provided by INSU/IPGP, ORB)**
- **Expected precision: 25 μGal (diff. of *g* and *g*)**
- **Method of measurements:**
  - 2000~2004:
    - Main loops of 3~4 points, spacing 100 km, with re-occupation, 2 gravimeters
    - Lines between points of the loops, 2 gravimeters
  - Since 2005: lines of 2~3 points between absolute points, with re-occupation, 1 gravimeter

Progress in relative measurements

- **2000~2004 campaigns**

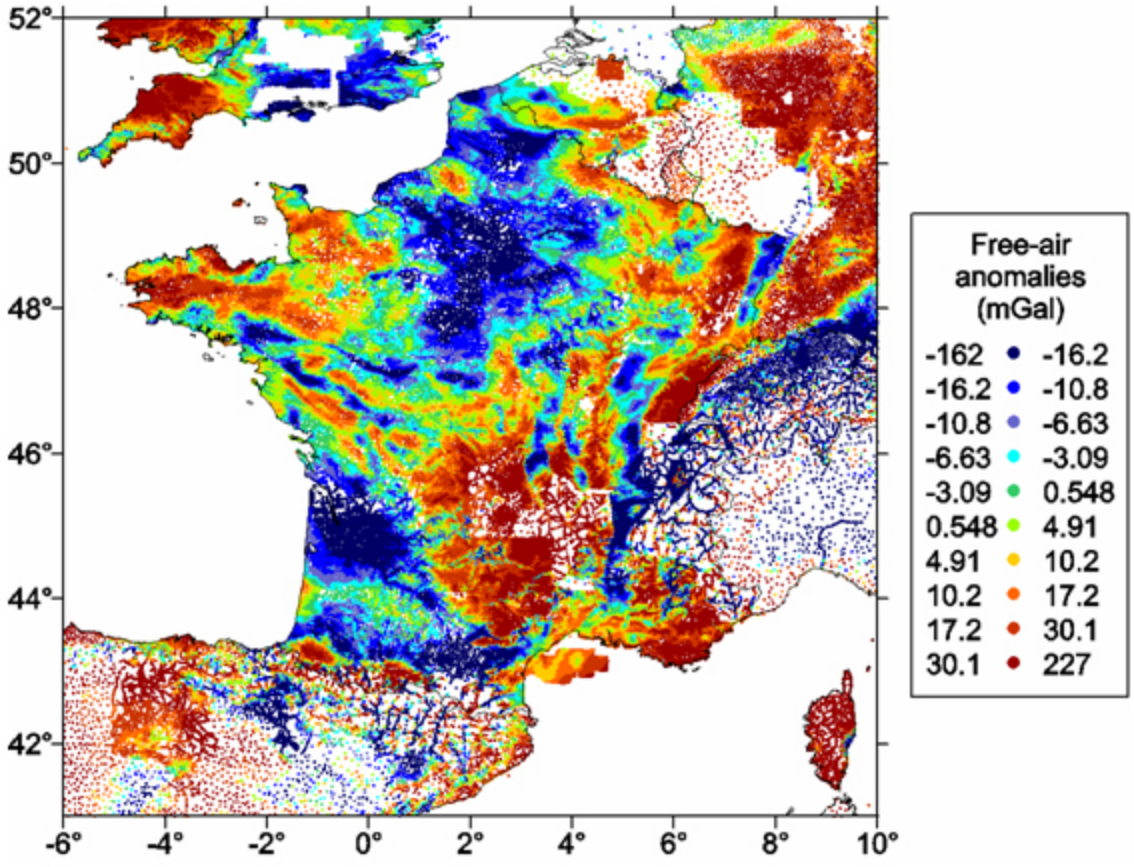


Computation and evaluation of the 2000~2004 campaigns

- **Corrections**
  - CG3TOOL software (IRD)
  - Tide, calibration, Drift
- **Provisional adjustement**
  - Geolab software
  - 481 points
  - 2 Fixed points : Sèvres, Montpellier (quasi-free adjustment)
  - 1065 observations
  - A posteriori standard deviation of observations : 24.4 µGal
  - Mean standard deviation of gravity values : 23 µGal
- **Comparison with RGF83 values on 17 points (absolute or relative)**
  - 2 abnormal points (Agde, Chambéry)
  - Standard deviation of differences on 15 points : 26.6 µGal

The dense gravity coverage of France

- 410000 points (marine surveys not included)
- Initial reference CGF65 (Potsdam)
- Converted into RGF83
- Precision on Bouguer anomalies :
  - 0.5 mGal (flat areas)
  - 2 to 3 mGal (mountainous areas)
- Positioning sometimes doubtful, some surveys erroneous
- Used for the computation of the QGF96, EGG97 and QGF98 quasigeoid models

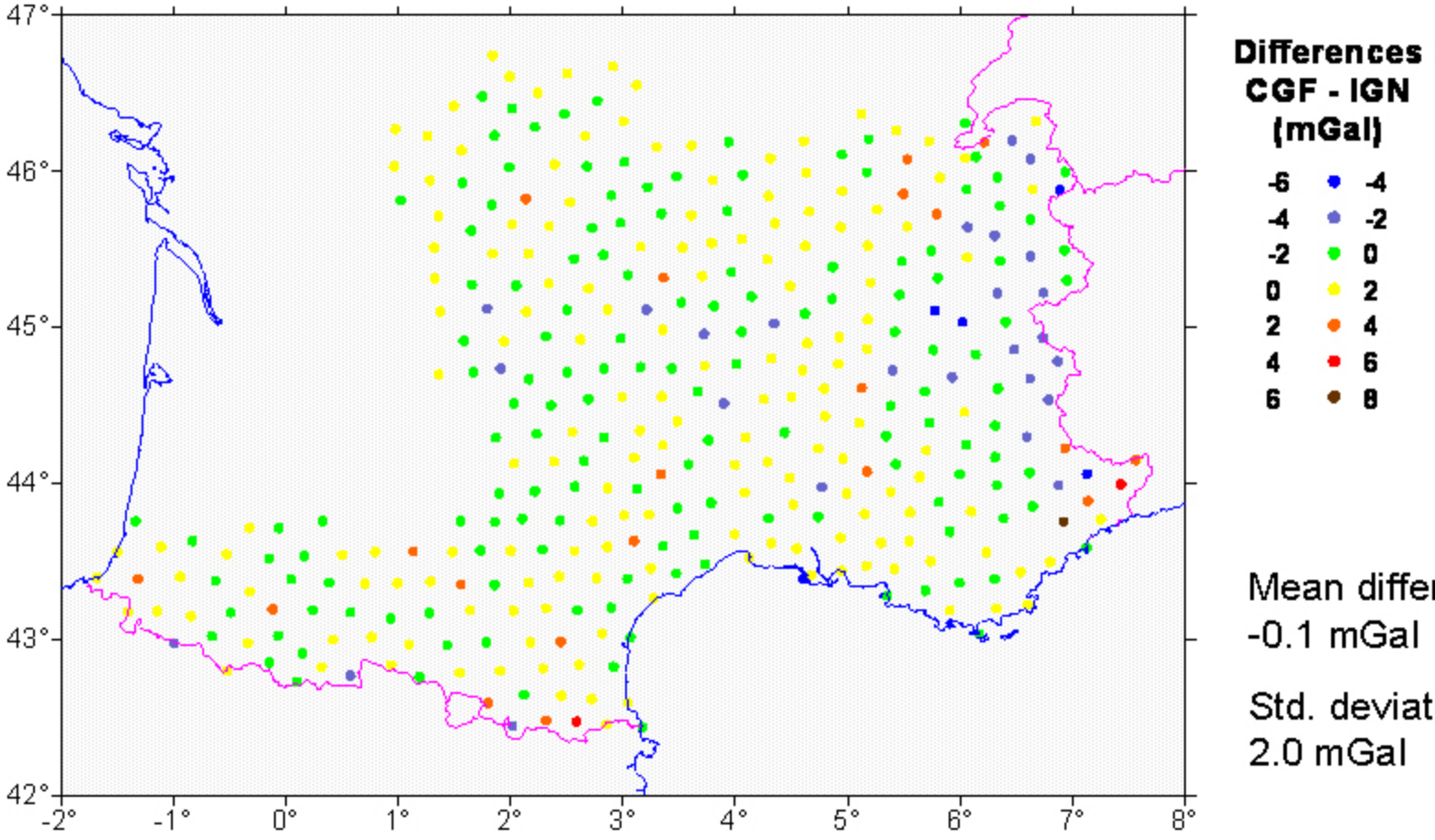


Gravity free-air anomalies CGF + neighbouring countries.
Data sources : BRGM and BGI

Evaluation of the dense gravity coverage of France

Comparison CGF / IGN (Bouguer anomalies) on RBF points

DTM : IGN (140 m) + SHOM - CT radius 167 km – Software: TC (Gravsoft)



Mean difference :
-0.1 mGal

Std. deviation :
2.0 mGal

Future plans

- **End of gravimetric measurements : 2007**
- **Final adjustment**
- **Improvement of the dense coverage CGF**

  Modelling the differences between the dense gravity coverage and the new gravimetric network
- **Computation of a new model of the geoid**

  Including: a new global field model, the improved dense gravity coverage, a new DTM
- **Computation of a new grid to transform ellipsoidal heights into normal heights**

  Using: the new geoid and the levelled GPS (RBF) points
- **Participation in the European Gravimetric Geoid Project**

The geodetic and gravimetric data of the integrated network will be available for EUREF and related activities.