# Product Generation and Future: IGFS

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*Unified Analysis Workshop*
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# Precise gravity observations as contribution to GGOS

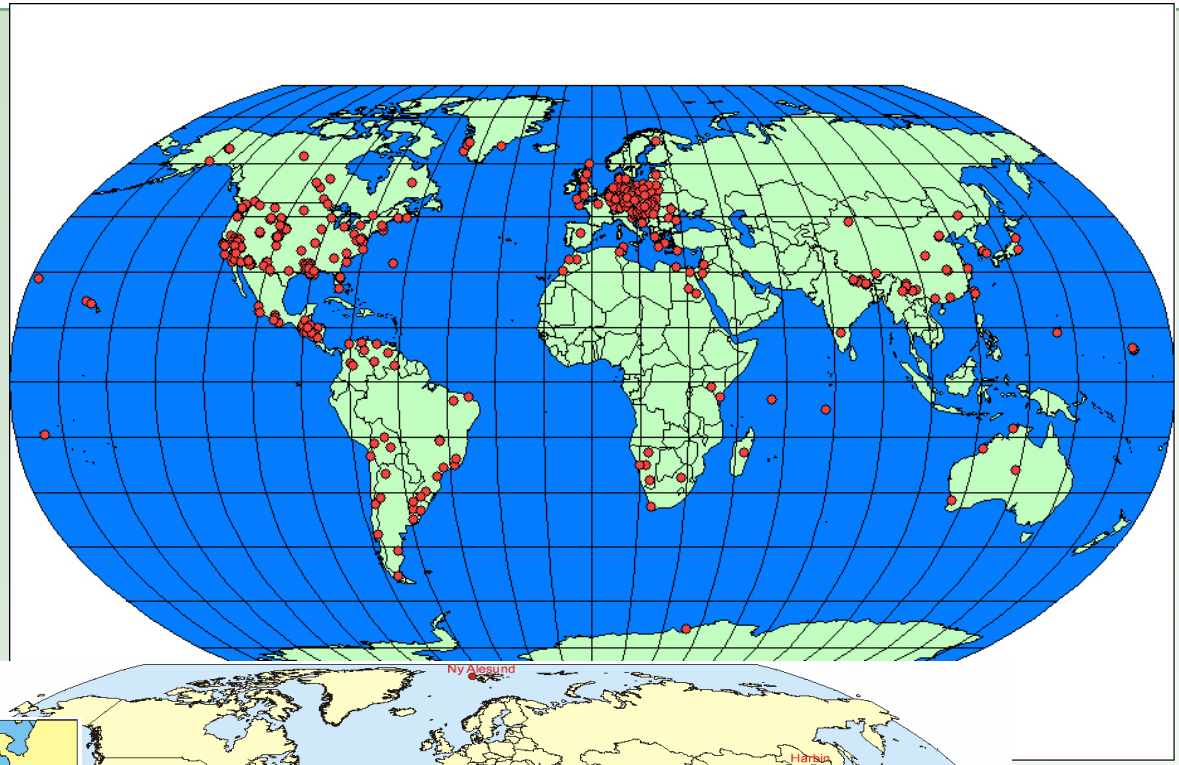
- **Development of the sensitivities**
  - **Absolute gravity measurements (AG) (at 1 - 2 µGal-level / 1 - 2 parts in $10^{-9}$)**
  - **High sensitivity in time-dependent observations (SG) (sub-µGal level)**

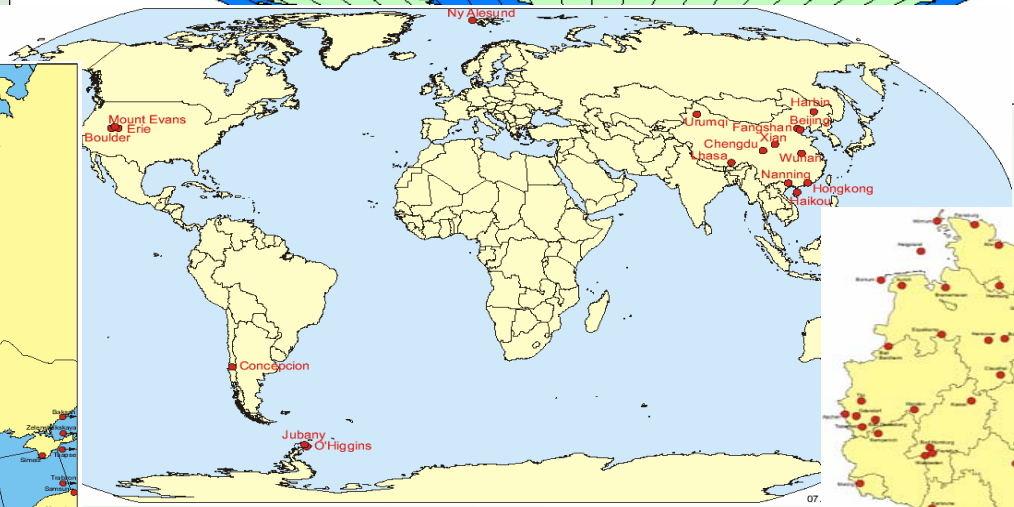
# Precise gravity observations as contribution to GGOS

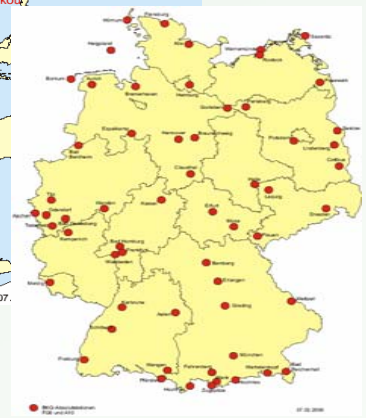
- AG – Absolute Gravity
  - Increasing number of worldwide AG instruments (> 50) and observations
  - Field observations not coordinated (yet)
  - Worldwide occupations with “random” repetitions
  - Four-yearly comparisons coordinated by IAG and BIPM
  - New Inter-Commission Working Group on Absolute Gravimetry
    - Design and promote global AG network
    - Standardise models, parameters and procedures for homogenous evaluation
    - Establish an AG database

# Examples of AG station distribution

## NGA absolute gravity stations





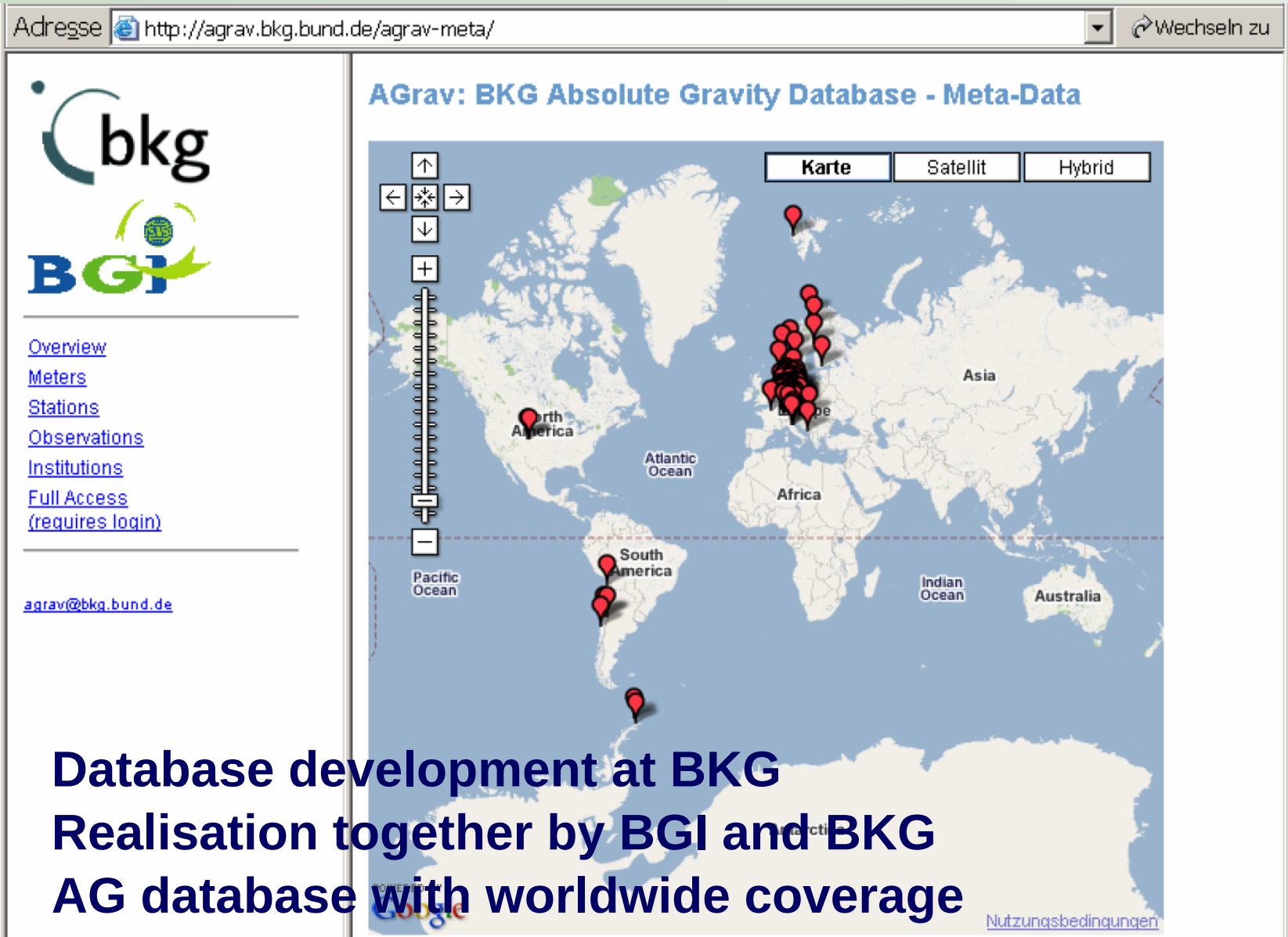



## BKG absolute gravity sites

# Applications

- **Sensitivity of terrestrial gravity observations due to**
  - **Height changes**
  - **Mass changes / mass transports**
- **Specific aspects of terrestrial gravity observations**
  - **Gravity data can be co-located to geometric observations**
  - **Long-term stability of absolute gravity reference values**
  - **High resolution of gravity variations**
  - **Distinction between masses above and below the Earth surface possible**
  - **Emphasis upon local and regional mass effects**

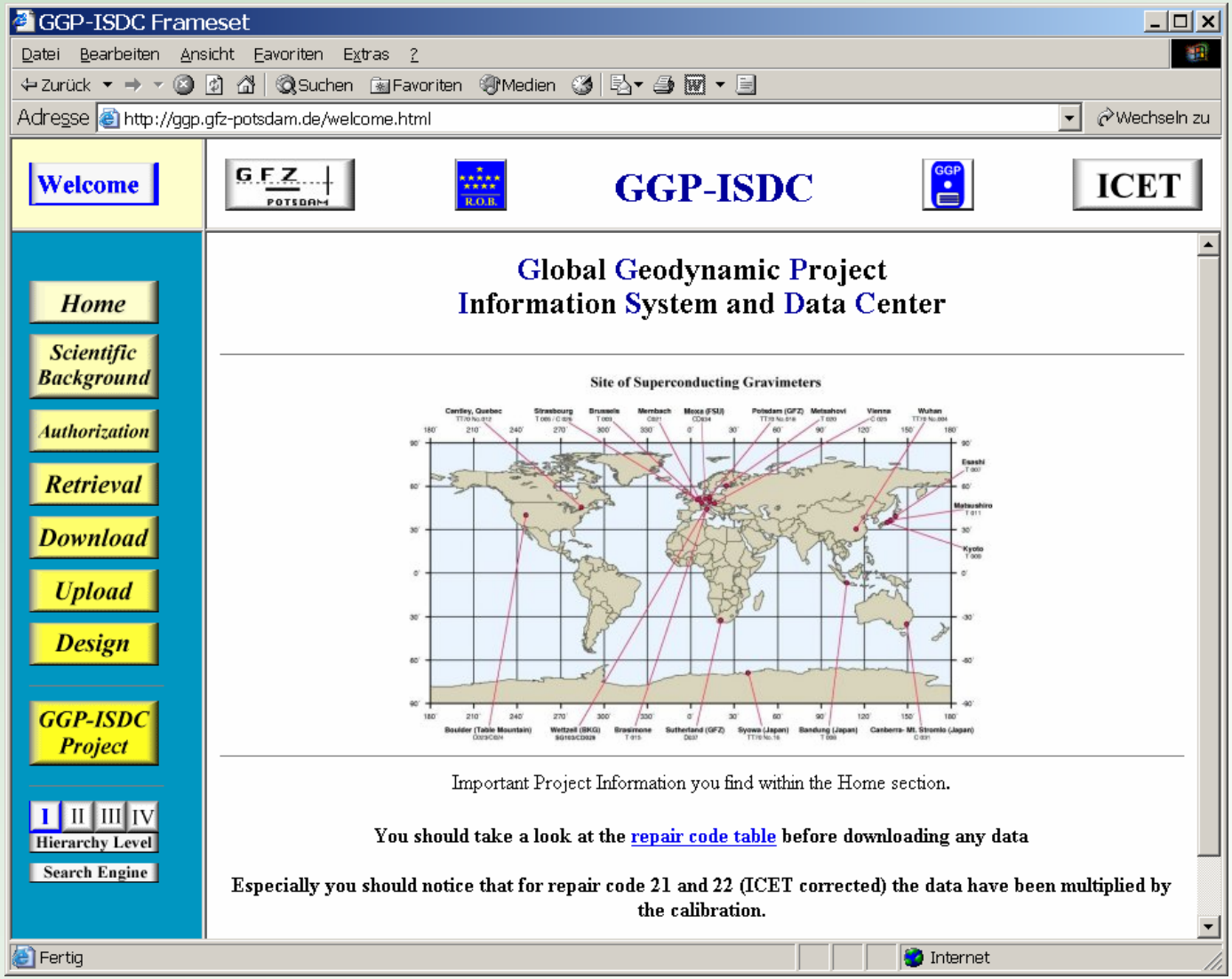
# Graphical interface of AG database




**Database development at BKG**
**Realisation together by BGI and BKG**
**AG database with worldwide coverage**

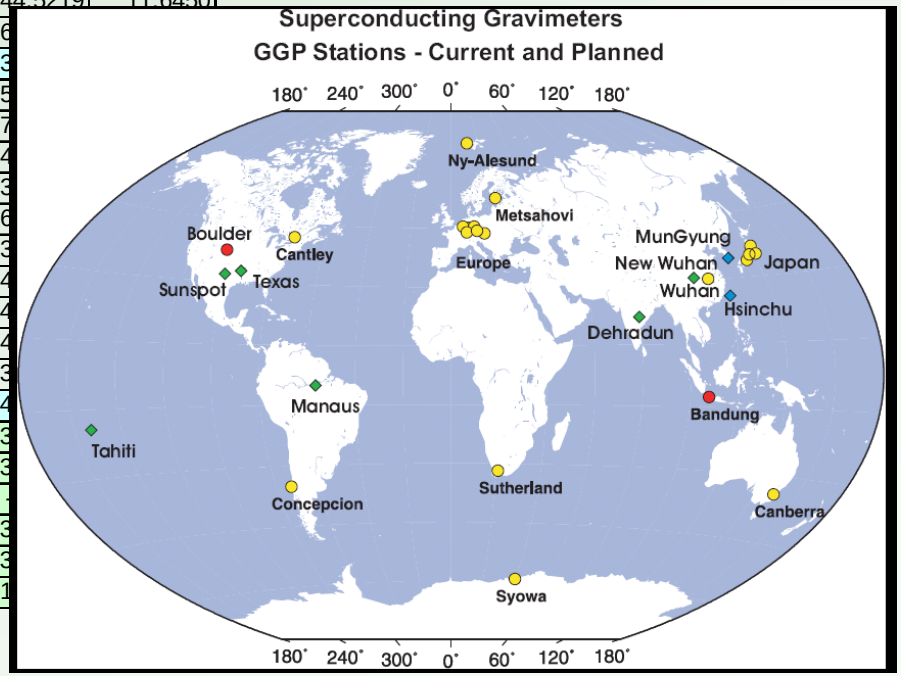
- **SG – Superconducting Gravity**
  - **Global Geodynamics Project - GGP**
  - **Coordinated in IAG Inter-Commission Project IC-P 3.1**
  - **GGP Network (~25 stations)**
  - **Combination of AG and SG observations**
    - **SG drift determination and calibration**
    - **AG comparison and verification of accuracy**

# GGP database for superconducting gravity data



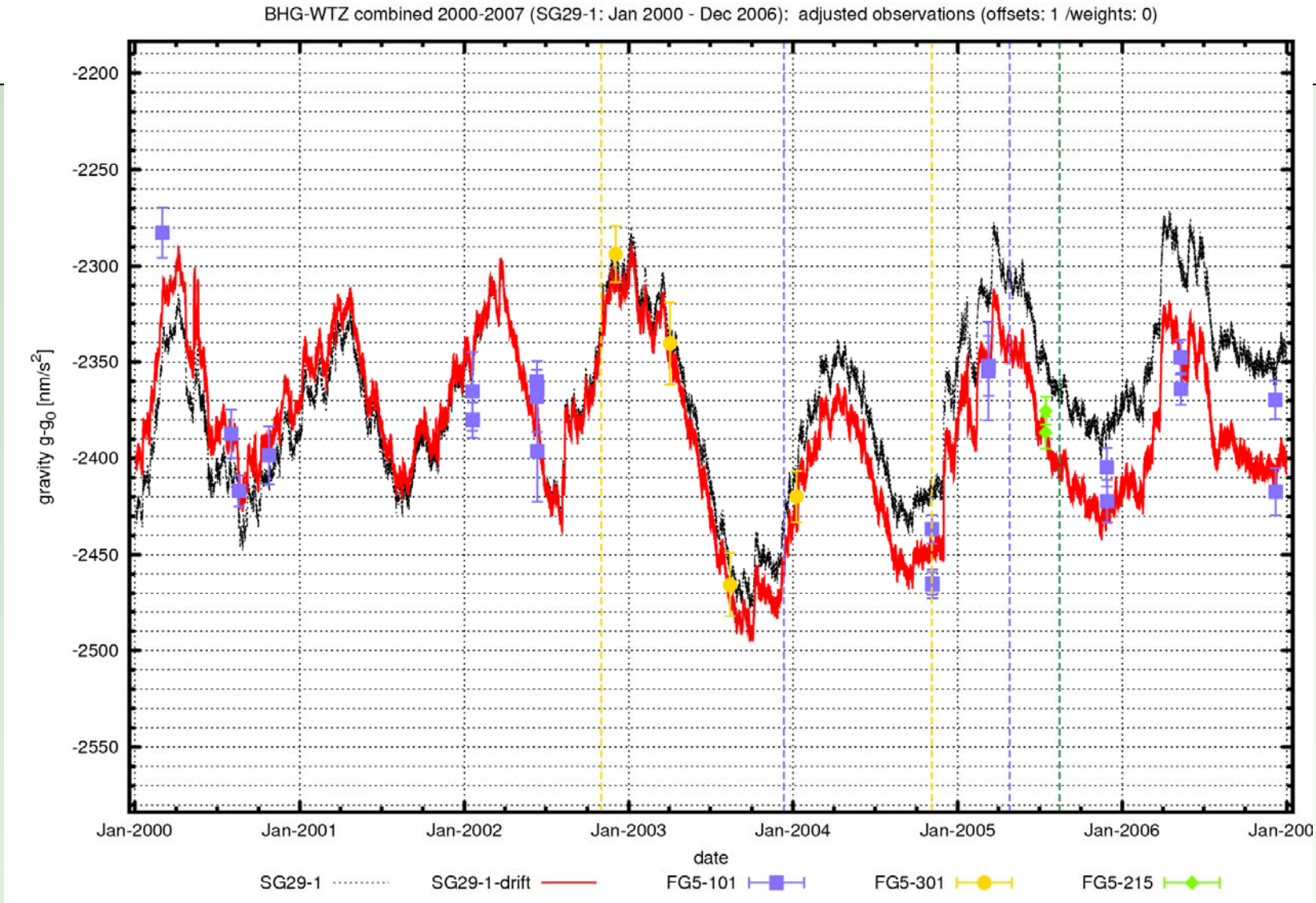
# GGP stations

| Table 1. SG stations of the GGP Network, as of 5 March 2007 | | | | | | installed | |
|---|---|---|---|---|---|---|---|
| Most recent coordinates are given | | | | | | 2006 | 2007 |
| # | Code | Location | Country | Responsible | Institute | Latitude | Long |
| | | | | | | +N, -S | +E, -W |
| 1 | BA | Bandung | Indonesia | Y. Fukuda | Kyoto U. | -6,8964 | 107,6317 |
| 2 | BH | Bad Homburg | Germany | H. Wilmes | BKG Frankfurt | 50,2285 | 8,6113 |
| 3 | CA | Cantley | Canada | J. Liard | GSC Ottawa | 45,5850 | 284,1929 |
| 4 | CB | Canberra | Australia | T. Sato | NAO Mizusawa | -35,3206 | 149,0077 |
| 5 | ES | Esashi | Japan | T. Sato | NAO Mizusawa | 39,1511 | 141,3318 |
| 6 | HS | Hsinchu | Taiwan | C. Hwang | Nat. Chiao Tung U. | 24,7890 | 120,9710 |
| 7 | KA | Kamioka | Japan | T. Sato | NAO Mizusawa | 36,4250 | 137,3100 |
| 8 | KY | Kyoto | Japan | Y. Fukuda | Kyoto U. | 35,0278 | 135,7858 |
| 9 | MA | Matsuchiro | Japan | Y. Imanishi | U. Tokyo | 36,5430 | 138,2070 |
| 10 | MB | Membach | Belgium | M. van Camp | ROB Brussels | 50,6093 | 6,0066 |
| 11 | MC | Medicina | Italy | H. Wilmes | BKG Frankfurt | 44,5219 | 11,6450 |
| 12 | ME | Metsahovi | Finland | H. Virtanen | FGI Masala | 6 | |
| 13 | MG | MunGyung | S. Korea | J.-W. Kim | Sejong U. | 3 | |
| 14 | MO | Moxa | Germany | C. Kroner | FSU Jena | 5 | |
| 15 | NY | Ny-Alesund | Norway | T. Sato | NAO Mizusawa | 7 | |
| 16 | ST | Strasbourg | France | J. Hinderer | EOST Strasbourg | 4 | |
| 17 | SU | Sutherland | S. Africa | J. Neumeyer | GFZ Potsdam | -3 | |
| 18 | SY | Syowa | Antarctica | K. Shibuya | NIPR Tokyo | -6 | |
| 19 | TC | Concepcion | Chile | H. Wilmes | BKG Frankfurt | -3 | |
| 20 | VI | Vienna | Austria | B. Meurers | U. Vienna | 4 | |
| 21 | WA | Walferdange | Luxembourg | O. Francis | MNH Walferdange | 4 | |
| 22 | WE | Wettzell | Germany | H. Wilmes | BKG Frankfurt | 4 | |
| 23 | WU | Wuhan | China | H.-P. Sun | IGG Wuhan | 3 | |
| 24 | PE? | Pecny | Czech Rep. | | Geodetic Obs. Pecny | 4 | |
| 26 | | Derhadun | India | | Wadia Inst. Himal. Geol. | 3 | |
| 25 | | Wuhan | China | | China Earthquake Admin. | 3 | |
| 27 | | Manaus? | Brazil | | GFZ Potsdam | 1 | |
| 28 | | Austin | USA | C. Wilson | U. Texas at Austin | 3 | |
| 29 | | Sunspot NM | USA | | Lunar Laser Ranging | 3 | |
| 30 | | Tahiti | France | J. Hinderer | EOST Strasbourg | -1 | |




Reference: D. Crossley, 2007

# AG and SG combination for station Wettzell



# Aims to be achieved:

(1) Build up a global network of gravity reference sites which are regularly observed. Basis could be the regional AG comparison sites and/or GGP sites.

(2) Complete AG database with international contributions at BGI under IGFS umbrella

(3) Intensify AG contribution to GGP: combination of AG and SG observation at all GGP sites in regular intervals

(4) Standardise models, parameters and procedures for homogeneous evaluation

(5) Improve IGNS71 gravity reference system

# Gravity Modelling

## Gravity Field “products” for GGOS: Globally relevant quantities

- Global gravity models (satellite L…200, combination L…360…?)
- Precise regional geoid models around key stations
- Global vertical datum
- Global networks of superconducting gravimeters (SCG) and absolute gravimeters (SG)

Forsberg & Kenyon, The IGFS and GGOS

# Standards for low-degree coefficients

- IERS conventions (2003)
- GRACE centers
  - GFZ (TVG RL04) A-priori secular rate terms $C_{20}$, $C_{30}$, $C_{40}$ and $C_{21}$, $S_{21}$ (IERS Conventions 2003), $a_e$=6378136.46, ref. epoch = 01.01.2000, conventional tide-free, non-tidal A+O removed from ECMWF+OMCT
  - CSR
  - JPL
  - GRGS
- GOCE
  - HPF $a_e$=6378136.46, non-tidal A+O to be removed from ECMWF+OMCT referred to multi-year mean

See
http://icgem.gfz-potsdam.de/ICGEM/ICGEM.html

R. Forsberg (IGFS Status Report):

There seems to be a need for some more formalised cooperation for the upcoming period 2007-11, not least from a general user and GGOS point of use, to truly let the gravity field take the role of a “third pillar” of geodesy, looking into the success of the cooperation of the geometric services (IERS, IGS, ILRS, IVS etc.).

Developments in satellite geodesy should, however, make a case for improved cooperation and coordination of gravity field service in the near future, given the need for combining models, into a single unified “GGOS product”.

Other new developments, such as the adaption of a global vertical datum ($W_0$), and the increased absolute accuracy of satellite-derived geoid models, would also enforce a need for much closer cooperation on standardisation of corrections to gravity field data.