The International Gravity Field Service (IGFS) and its components

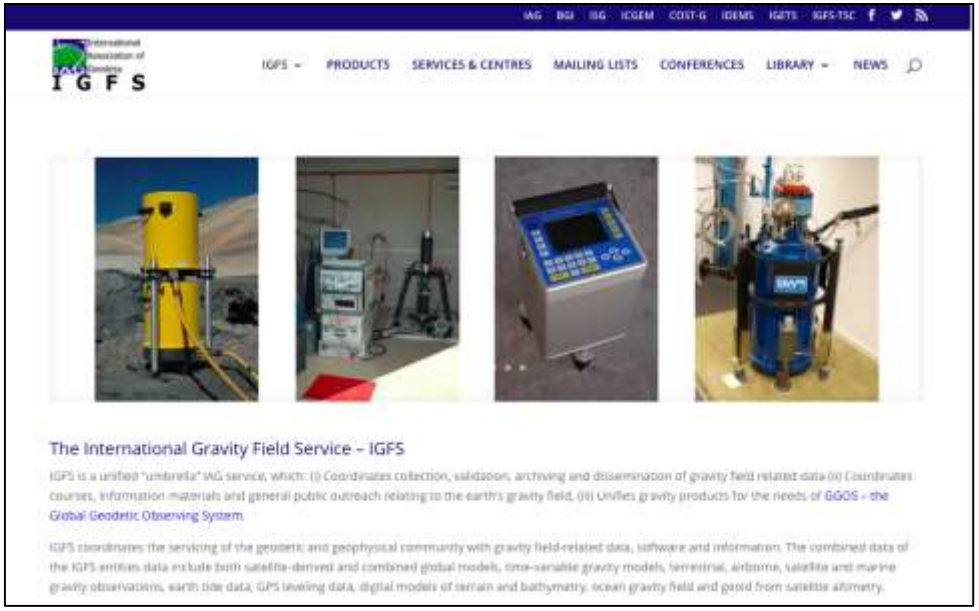
Riccardo Barzaghi
IGFS c/o DICA-Politecnico di Milano

Implementation of the Global Geodetic Reference Frame (GGRF) in Latin America
Buenos Aires, Argentina, 16th-20th September, 2019

The International Gravity Field Service (IGFS)

(http://igfs.topo.auth.gr/)

Director : Riccardo Barzaghi - CB Director: Georgios Vergos

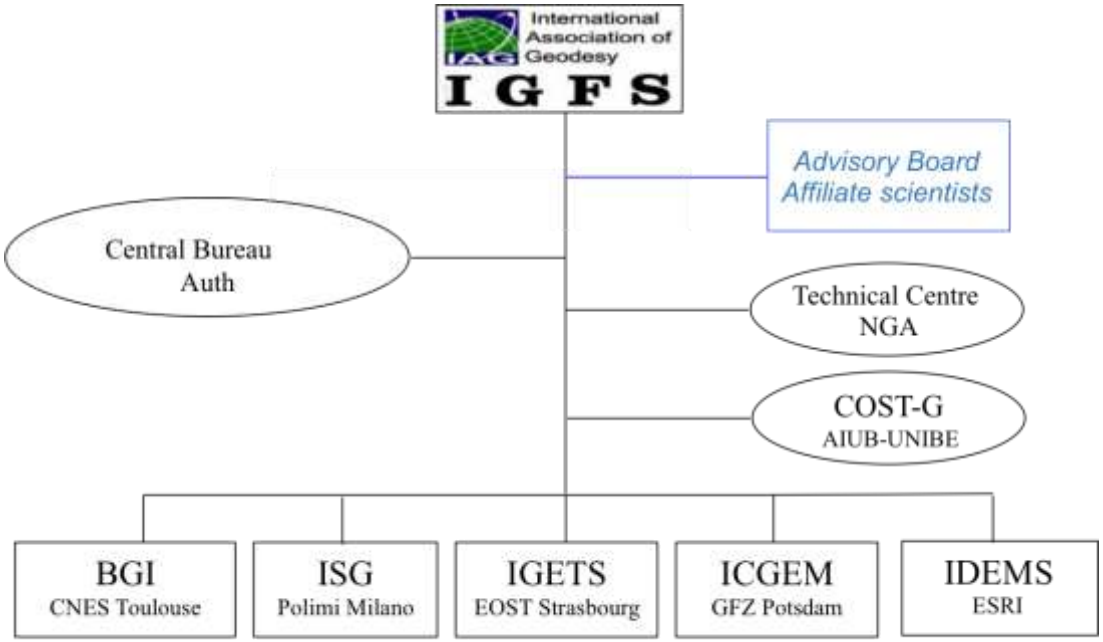


Main IGFS tasks

IGFS is an “umbrella” IAG Service which :

- Coodinates collection, validation, archiving and dissemination of gravity field related data
- Coordinates courses, information materials and general public outreach relating to the Earth’s gravity field
- Unifies gravity products for the needs of GGOS

The IGFS structure



International Gravity Field Service (IGFS) – Director: R. Barzaghi

Central Bureau – Director: G. Vergos

International Gravimetric Bureau (BGI) – Director: S. Bonvalot

International Center for Global Earth Models (ICGEM) – Director: E. S. Ince

International Service for the Geoid (ISG) – President: M. Reguzzoni; Director: D. Carrion

International Geodynamics and Earth Tide Service (IGETS) – Director: H. Wziontek

International DEM Service (IDEMS) – K.Kelly

International Combination Service for Time-variable Gravity field solutions (COST-G) – A. Jäggi

The IGFS Central Bureau

The new Central Bureau was established on April 1st, 2016 (call at the beginning of 2016)

Director: Georgios S. Vergos

Scientific Cosultants**: Ilias N. Tziavos, Dimitrios Tsoulis, Christopher Kotsakis**

Scientific Staff: **Vassilios N. Grigoriadis, Dimitrios A. Natsiopoulos**

Secretary: **Dimitrios A. Natsiopoulos**

IGFS-CB Department of Geodesy and Surveying, AUTh
Univ. Box 440, GR-54124, Thessaloniki (GREECE)

Tel: +30 2310 994366 Fax: +30 2310 995948 Mail: igfs@topo.auth.gr
Web: http://igfs.topo.auth.gr/

The IGFS web page

The IGFS applications front-end (g-μeta, N-μeta and μeta-Locator @ IGFS web page)

IGFS-CB Online Apps

The on-line application for gravity and geoid metadata

Overall Goals

- Online application for creating metadata for gravity measurements

g-μeta

- Online application for creating metadata for geoid models

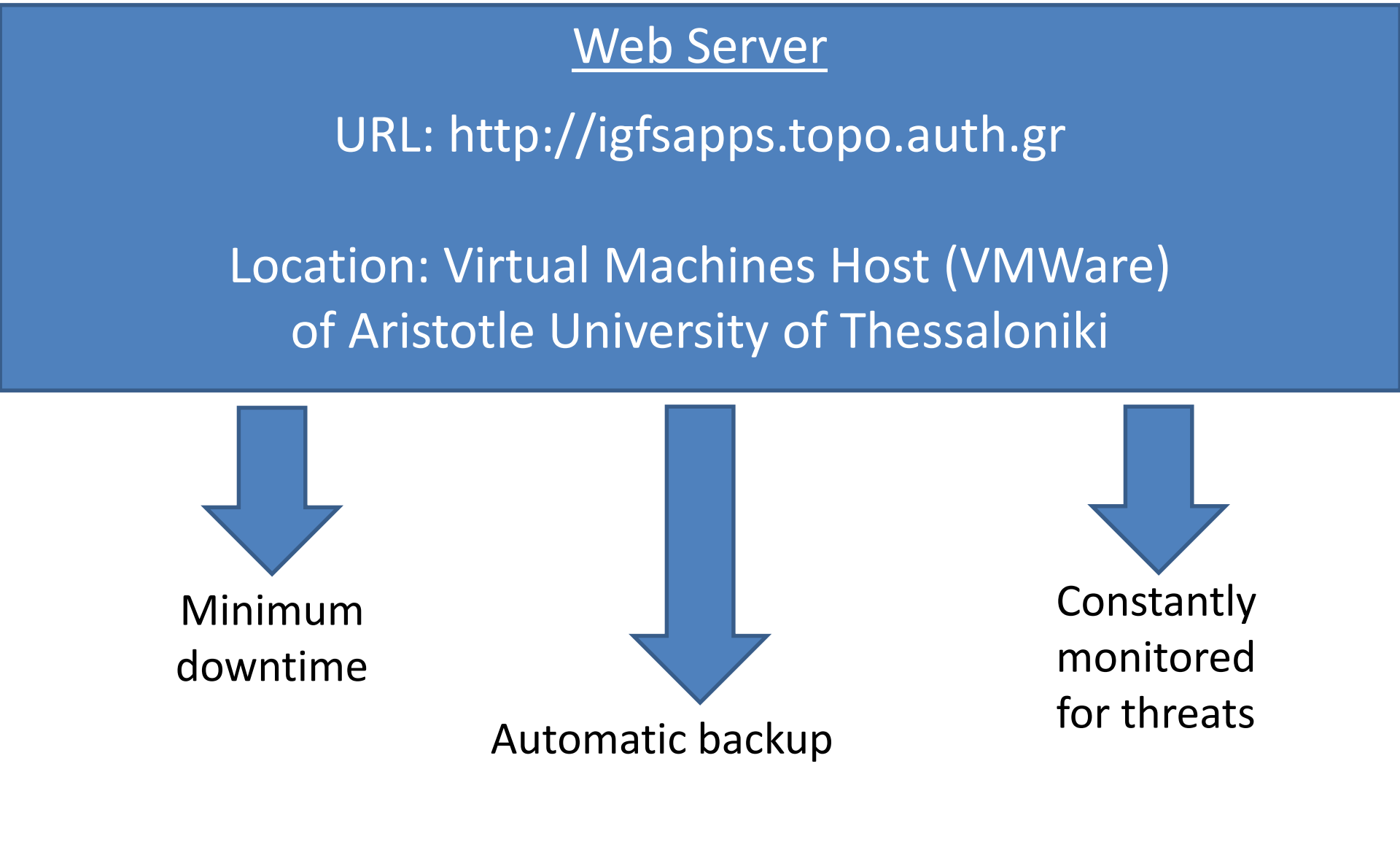
N-μeta

- Online application for discovering different type of information

μeta-Locator

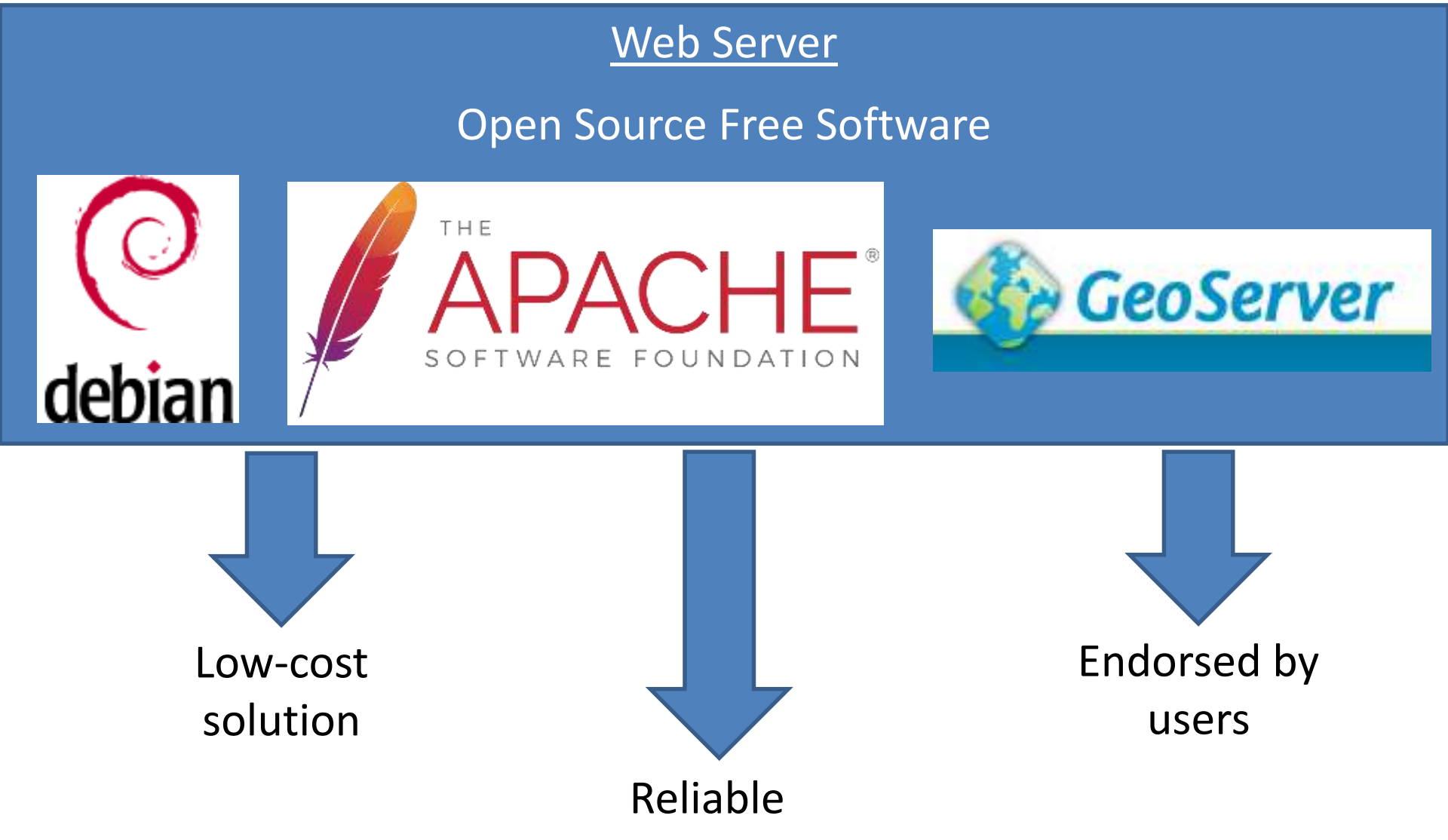
IGFS-CB Online Apps

General Setup



IGFS-CB Online Apps

General Setup



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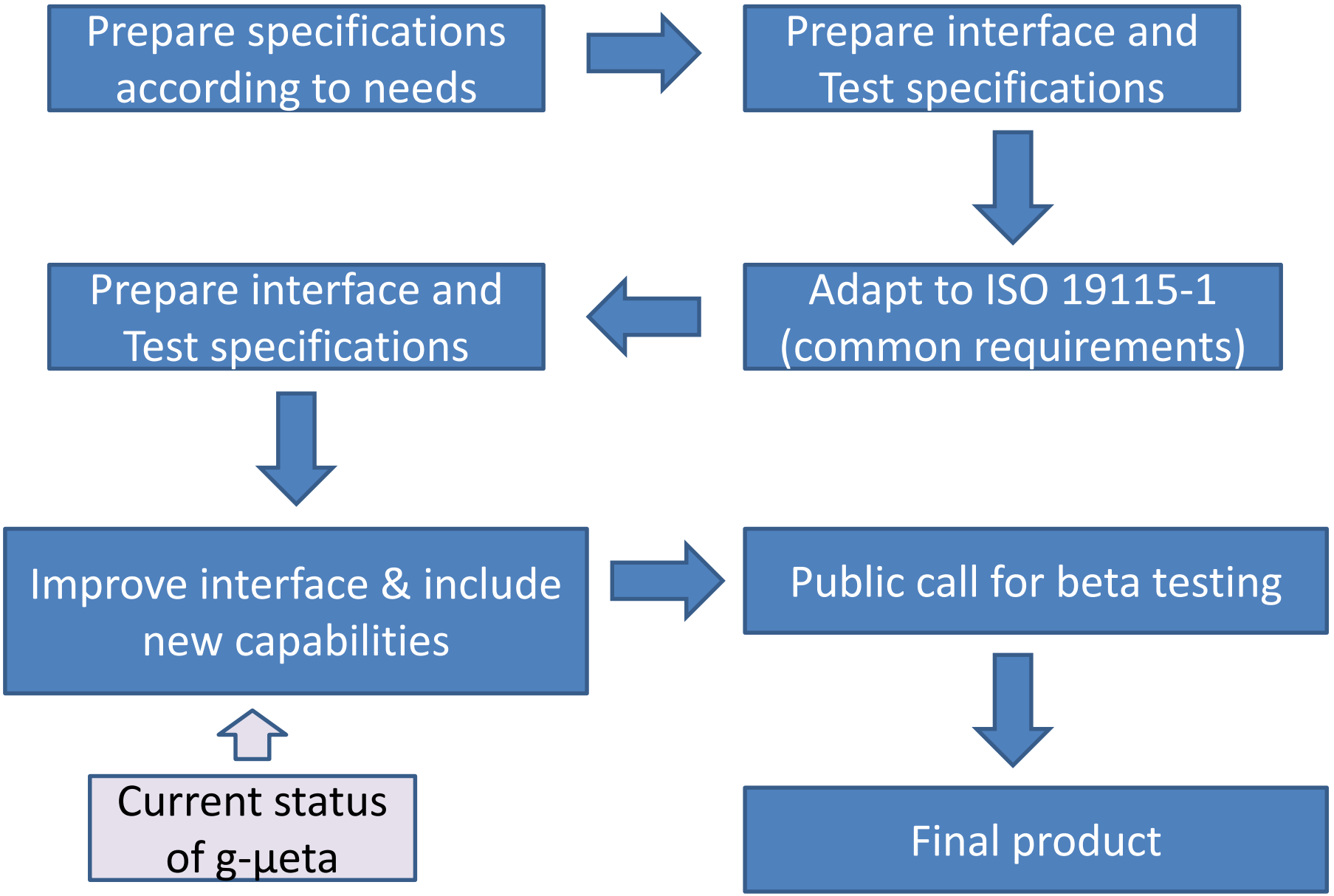
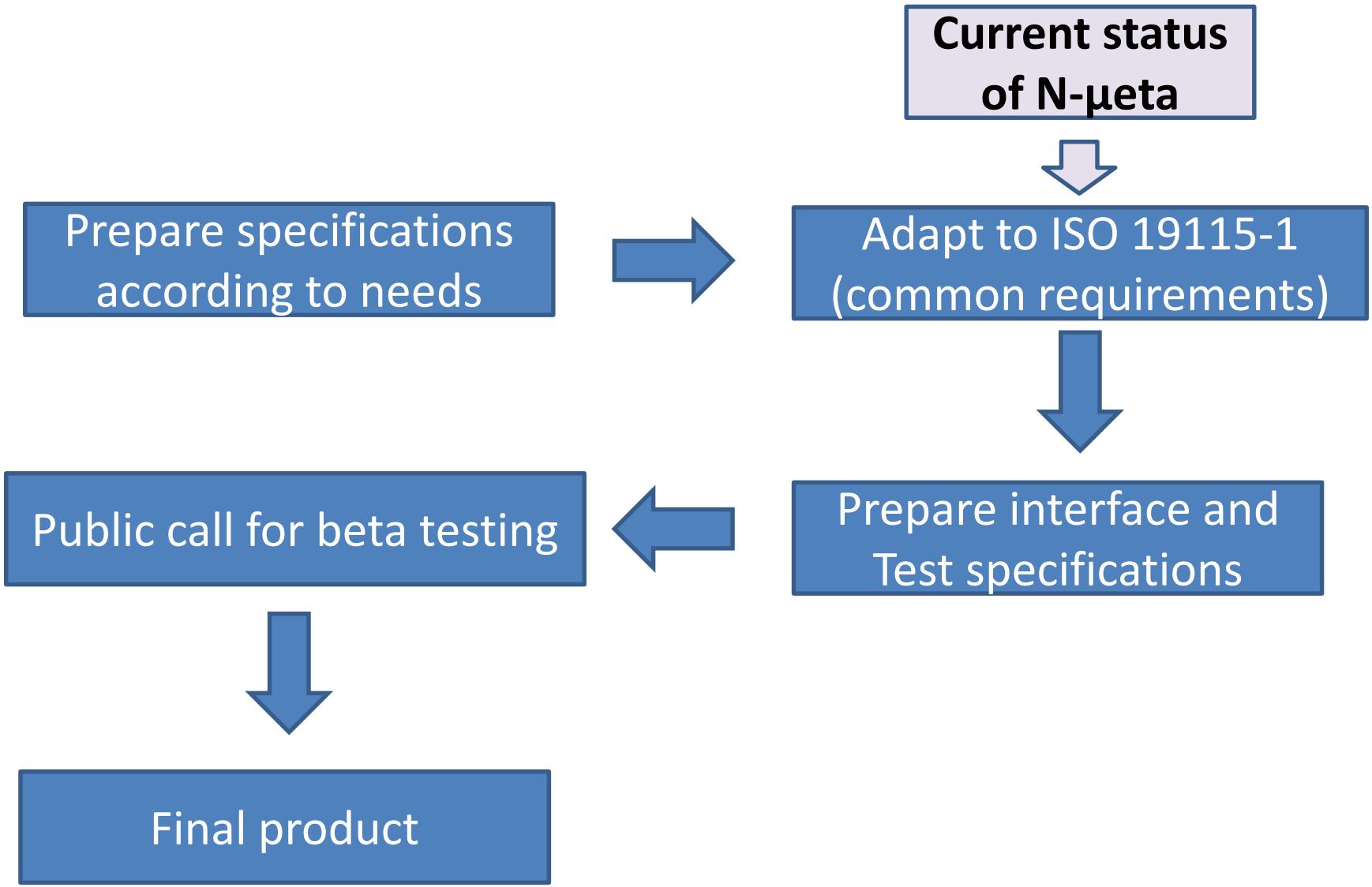
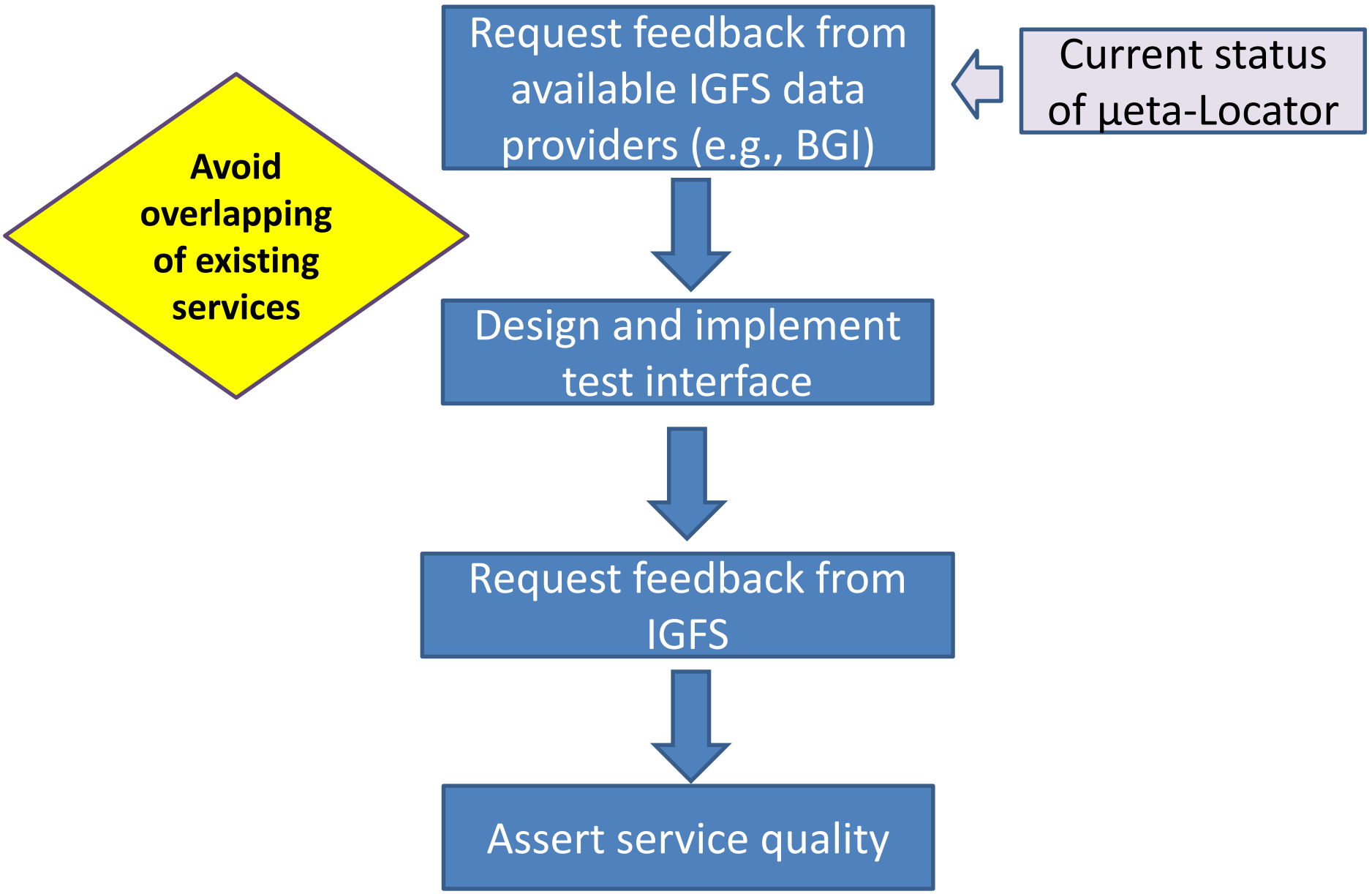
Development roadmap (g-µeta)



Development roadmap (N-µeta)



Development roadmap (µeta Locator)



Current progress (g-μeta) – Available Categories (1/3)

1.Metadata Reference Information
Metadata Creation Date and Creator Information
Metadata Constraints
Metadata Prototype Information

2.Identification Information	
Citation	Description
Status	Points of Contact
Keywords	Spatial Domain
Constraints and Security Information	

Current progress (g-μeta) – Available Categories (2/3)

3.Distribution Information
Distributor
Standard Order Process

4.Standards and Conventions
General Standards and Conventions
Earth’s Gravity Field Permanent Tide System
Earth Orientation Parameters Specifications
Tidal Conventions
Station Coordinates and Corrections (for absolute gravity)

Current progress (g-μeta) – Available Categories (3/3)

5.Data and Data Quality Information	
Attribute Accuracy	Logical Consistency
Completeness Report	Data Distribution
Gravity Data (type&accuracy)	Time Period of Content
Position and Height Accuracy	

Current elements comply with ISO 19115-1

Vergos GS, Grigoriadis VN, Barzaghi R, Carrion D (2017) IGFS metadata for gravity. Structure, build-up and application module. IAG Symposia. DOI*: https://doi.org/10.1007/1345_2018_38*

IGFS&GGOS

- *IGFS representatives attended GGOS meetings*:

✓ GGOS Days Meetings, Frankfurt, Germany (October 21st-23rd, 2015)
✓ GGOS Days Meetings, Cambridge, USA (October 24th-27th, 2016)
✓ GGOS Bureaus meetings held in San Francisco (during AGU 2015, 2016)
✓ GGOS Bureaus meetings held in Vienna (during EGU 2016, 2017)

- IGFS participates into the activities of the GGOS Focus area on "Unified Height System" for establishing the IHRS/IHRF

- IGFS is participating in the definition of the Essential Geodetic Variables (gravity)

Joint IGFS&IAG-Commission2 scientific meetings

The 1st Joint IGFS and IAG-Commission 2 meeting GGHS2016
Thessaloniki, Greece, September 19-23, 2016
(LoC: Aristotle University of Thessaloniki)

The 2nd Joint IGFS and IAG-Commission 2 meeting GGHS2018
Copenhagen, Denmark, September 17-21, 2018
(LoC: DTU Space)

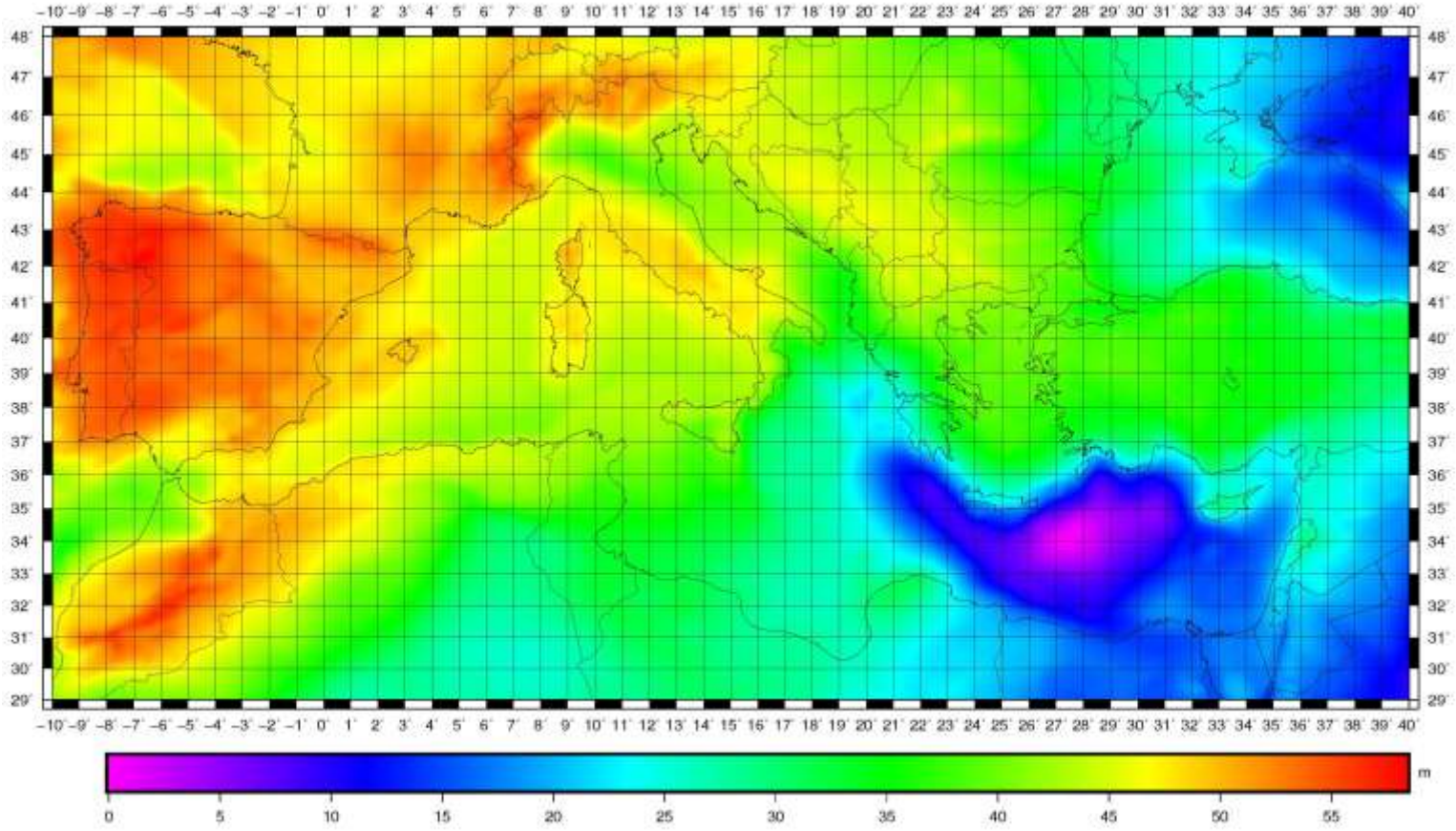
The 3rd Joint IGFS and IAG-Commission 2 meeting GGHS2020
Austin, Texas, September 2020
(LoC: UT)

GGHS scientific topics

1) Current and future satellite gravity missions
2) Global gravity field modelling
3) Local/regional gravity field modelling
4) Absolute, Relative and Airborne Gravity - observations and methods
5) Height systems and vertical datum unification
6) Satellite altimetry and applications
7) Mass transport and climate-relevant processes

The IGFS GEOMED2 project

IGFS has proposed and managed the GEOMED2 Project that started in 2015 and will close at the end of 2019. The project is based on the cooperation between IGFS related Services (BGI, ICGEM, ISG) and other scientific institutions in the Mediterranean area



Main activities of the Gravity Services

Bureau Gravimetrique International (BGI)

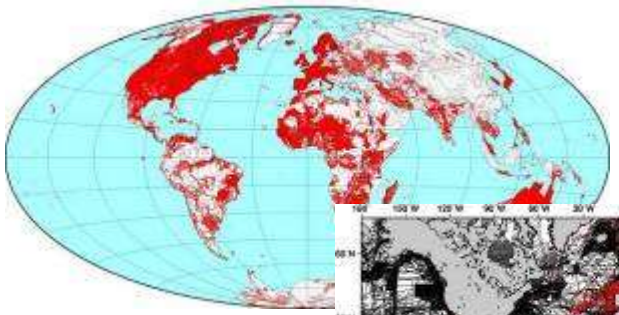
(http://bgi.obs-mip.fr)

Director : Sylvain Bonvalot

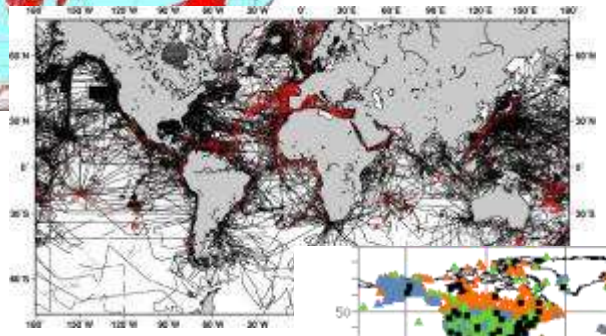
Main BGI tasks

- To collect, on a world-wide basis, all gravity measurements and pertinent information about the gravity field of the Earth
- To compile and store them in a computerized data base
- To redistribute them on request to a large variety of users for scientific purposes.

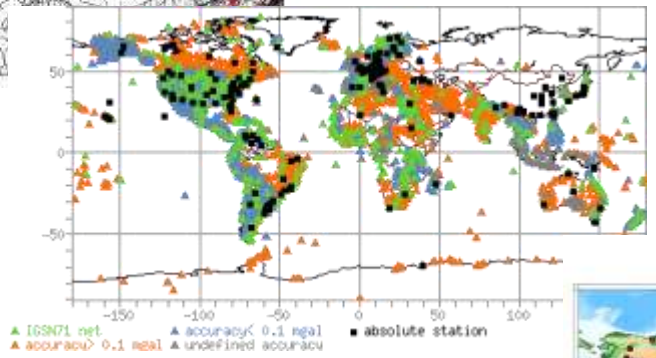
The gravity database at BGI



Relative land gravity measurements
(2,3 millions of data)



Relative marine gravity measurements
(10,5 millions of data)



Reference stations
(>4500 stations)

Absolute gravity measurements

The new International Gravity Reference System

BGI & IGETS Services
(existing databases in cooperation with BKG)

Providing a **long term & precise absolute gravity reference** at given stations (time variable gravity field)

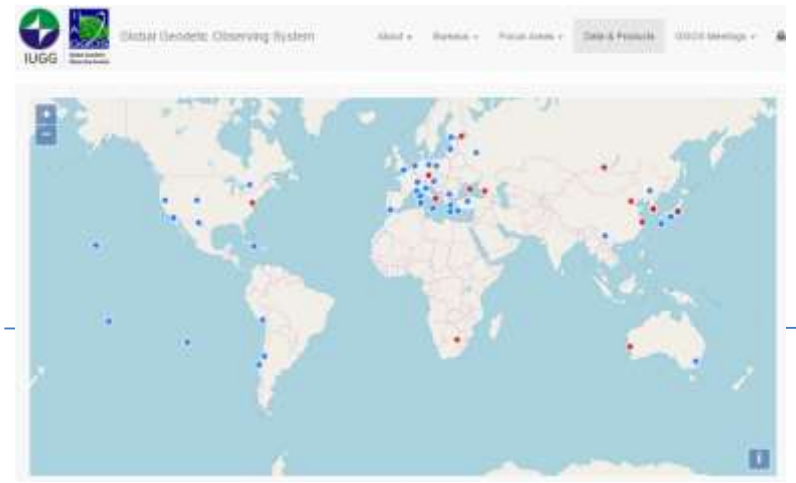
- **Reference stations** with continuous monitoring (Superconducting or Quantum Gravimeter) preferred but no exclusive
- Should also includes
- ✓ **GGOS Core stations :** Link to space geodetic techniques (GNSS, SLR; VLBI)
- ✓ **Comparison sites**: with extended facilities for instrumental comparisons (meter traceability)

Providing a **worldwide infrastructure of absolute gravity values** (static gravity field)

- **Global dense network of AG stations** needs for referencing relative land & marine surveys
- **Progressive replacement of the IGSN71** (mostly based on relative measurements)
- Advantage of **increasing facilities for field AG measurements** (Ex: A10, Quantum ?)
- Expected support and collaboration from National agencies

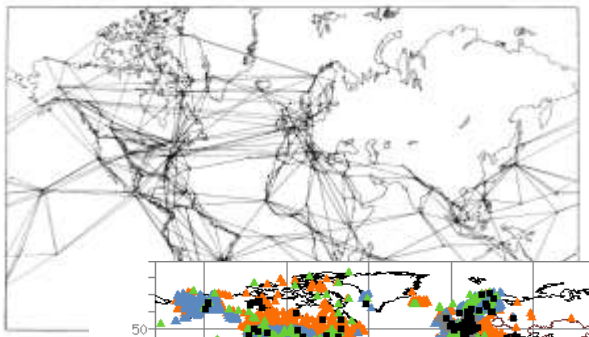
Absolute gravity monitoring : where ?

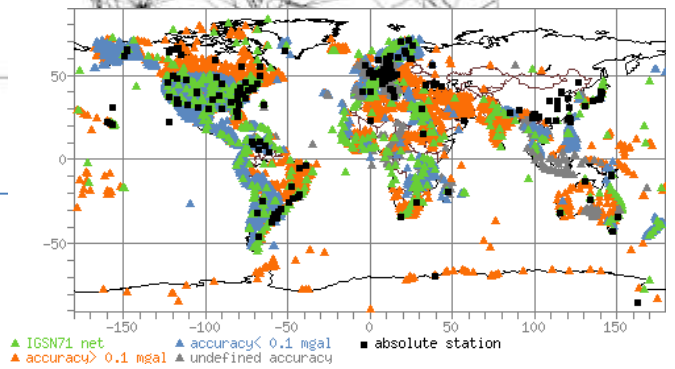
- ✓ AG/SG stations (cf. IGETS/GGP)
- ✓ Selected “Core” stations (cf. GGOS)



Absolute gravity values : where ?

- ✓ Increasing number of field measurements (cf. BGI/BKG Agrav database)
- ✓ Increasing accuracy and accessibility w.r.t. IGSN71 network





International Centre for Global Earth Models (ICGEM)

(http://icgem.gfz-potsdam.de/home)

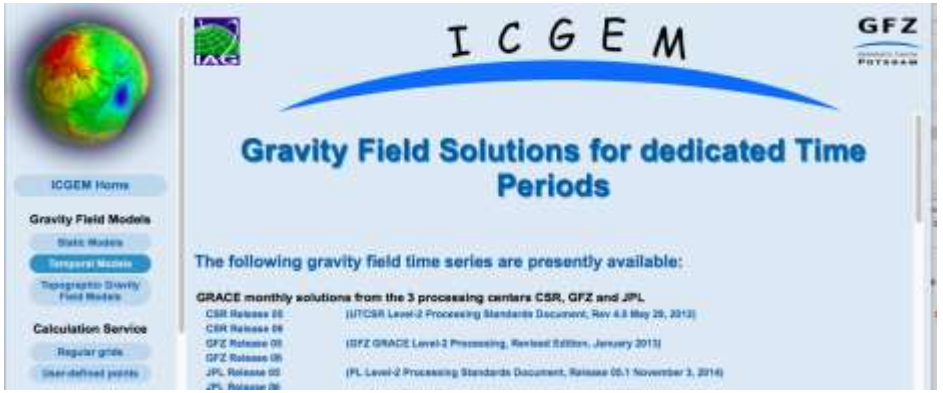
Director : Elmas Sinem Ince

Main ICGEM tasks

- To collect and long-term archiving of existing global gravity field models
- To use standardized format in storing the models
- To develop tools for the visualization of the models
- To compute solutions from dedicated time periods (e.g. monthly GRACE models)
- To develop web-interface to calculate gravity functionals from the spherical harmonic models on selectable grids/user defined points
- To evaluate the global geopotential models

The available GGM at the ICGEM database

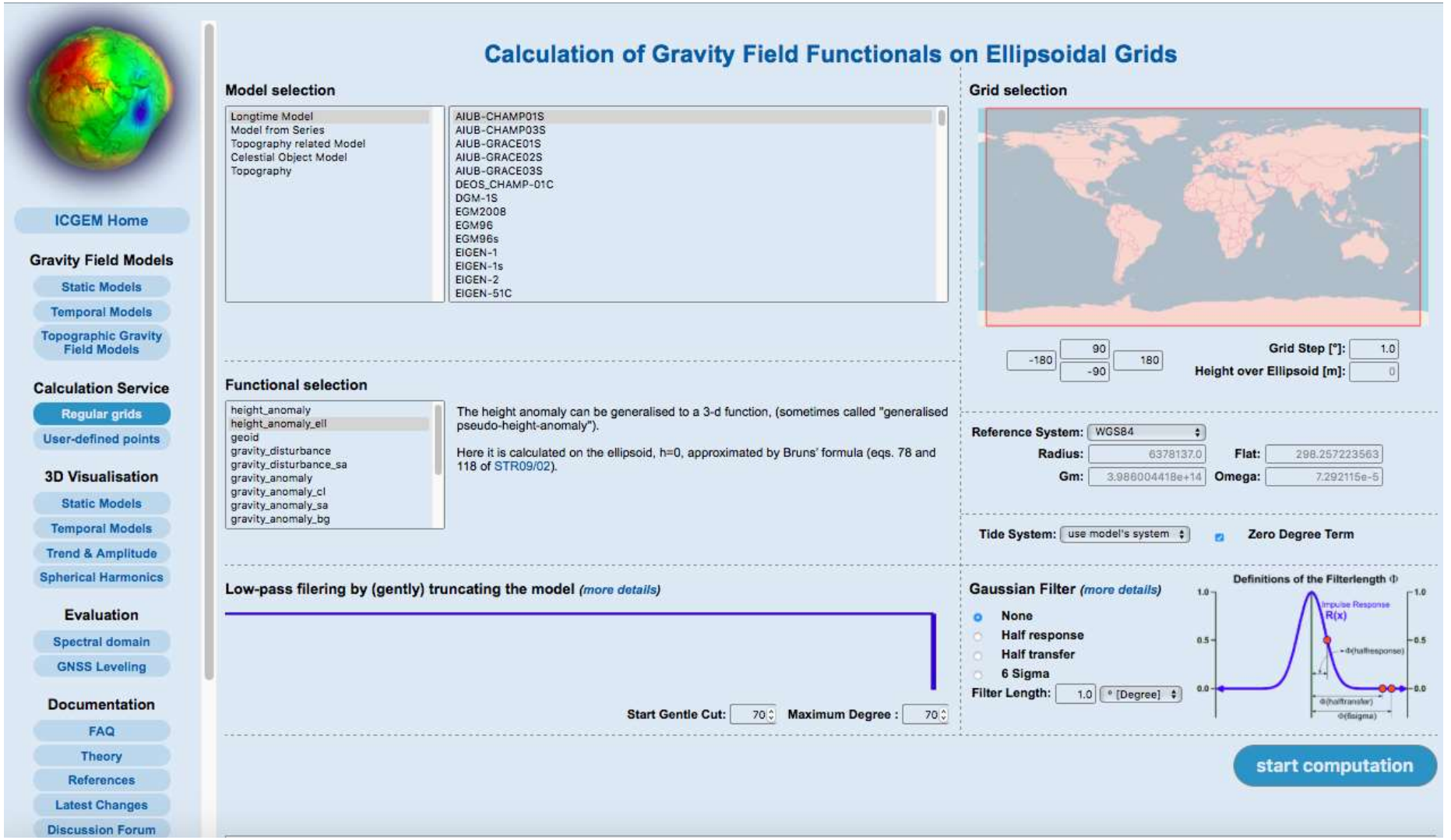
A screenshot of the list of available static gravity fields (175 models)



A screenshot of the list of the computed time varying solutions (e.g monthly solutions)

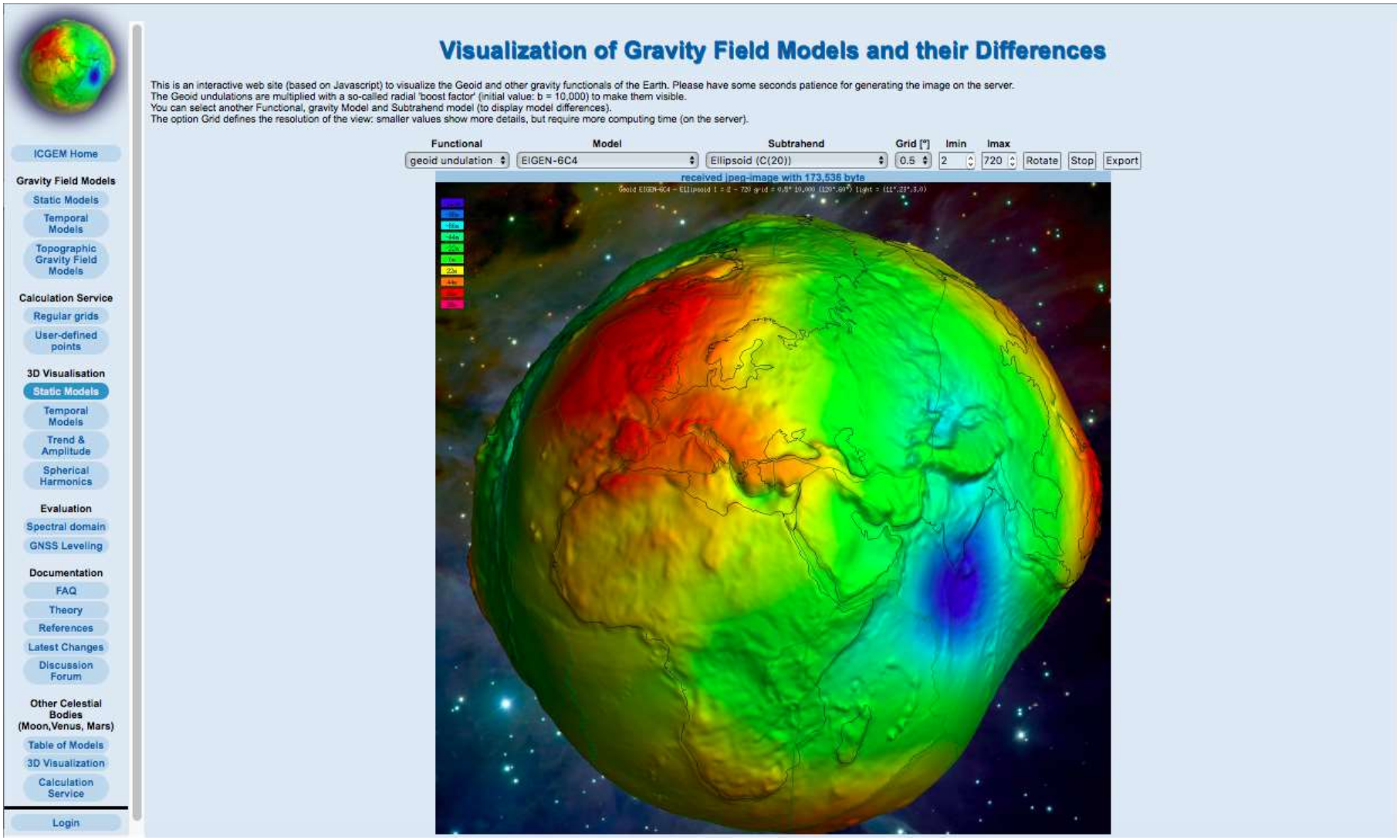
A screenshot from the table of topographic gravity fields in the website (18 models)

The Calculation Service



GGM computation on a given grid

The 3D visualization tool



EIGEN-6c4 model undulation (m)

International Service for the Geoid (ISG)

(http://www.isgeoid.polimi.it)

President : Mirko Reguzzoni Director: Daniela Carrion

Main ISG tasks

- To collect geoid estimates worldwide and to disseminate them among the scientific community
- To collect, test and, when allowed, to distribute software for the geoid determination
- To conduct researches on methods for the geoid determination
- To organize schools on geoid determination
- To disseminate special publications on geoid computations (e.g. lecture notes of the schools)
- To support Agencies or scientists in computing regional geoids

The local/regional geoid repository

- Almost 200 models are currently available in the ISG repository
- Each model has a dedicated webpage with some information

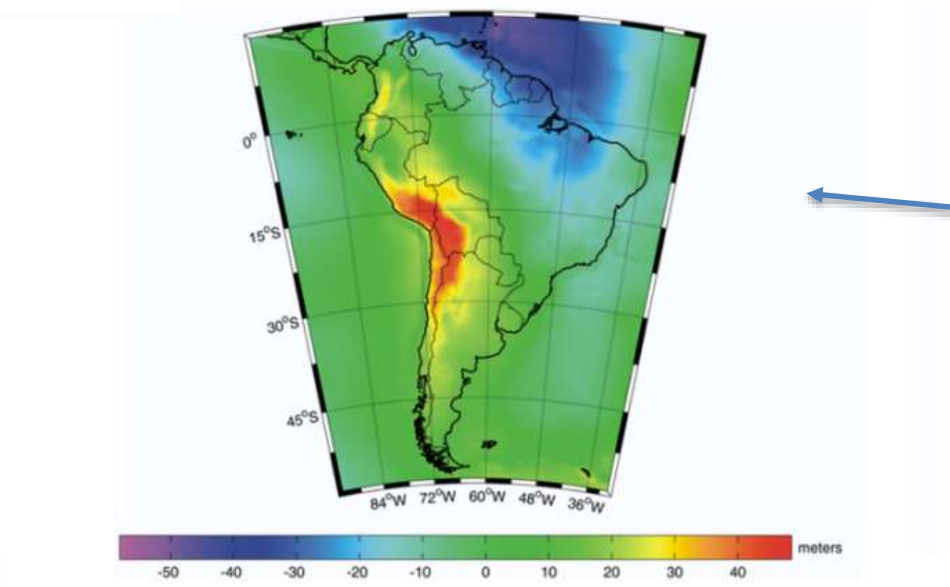
Authors, year, distr. policy

Short description

Bibliographic reference

Web of Science index

Download and email links



Model visualization

Geoid models for South America

Continental

South America	Blitzkow et al.	2010
South America (GEOID2015)	Blitzkow et al.	2015

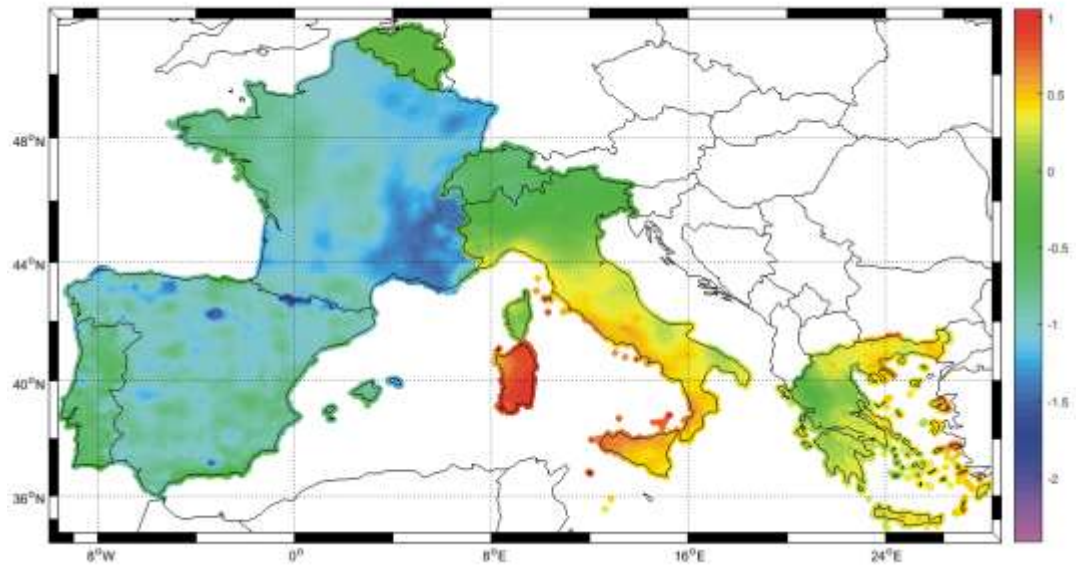
National

Argentina (GAR)	Corchete & Pacino	2007
Argentina (GEOIDEAR16)	Pinon et al.	2016
Bolivia (BOLGEO)	Corchete et al.	2006
Brazil (MAPGEO2004)	Blitzkow et al.	2004
Brazil (MAPGEO2010)	Blitzkow et al.	2010
Brazil (MAPGEO2015)	Blitzkow et al.	2015
Colombia (GEOCOL2004)	Sanchéz	2004
Uruguay (URUGEOIDE2000)	Subiza Piña	2000
Uruguay (URUGEOIDE2007)	Subiza Piña	2007

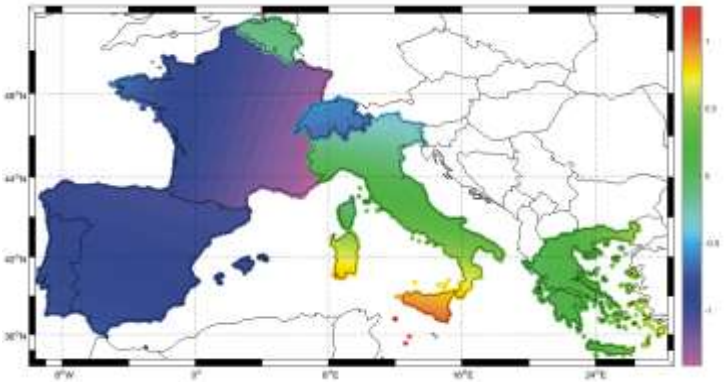
Regional

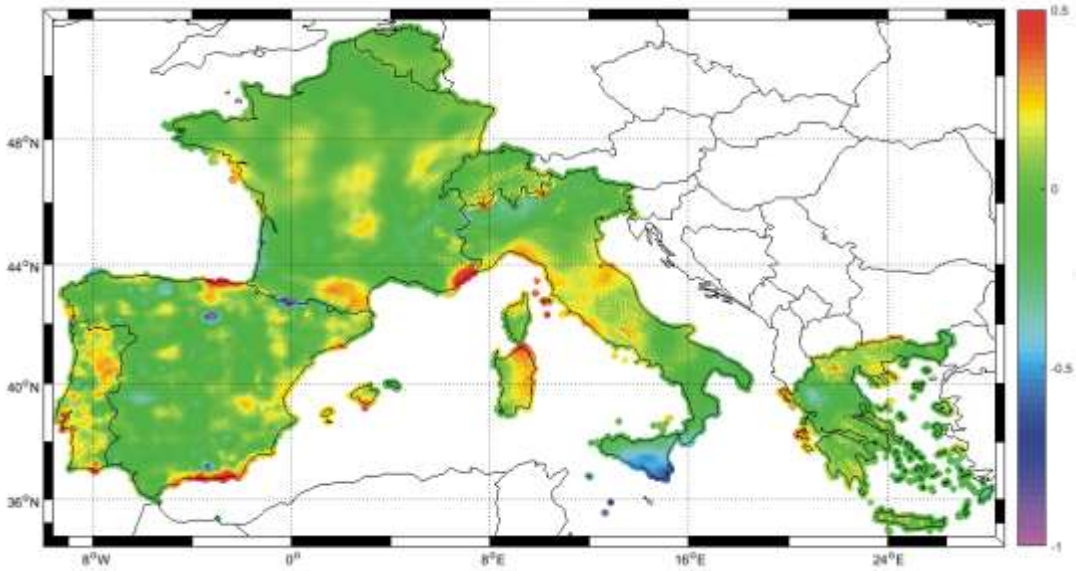
Santa Fe Province - Argentina	Cornero et al.	2018
Sao Paulo State - Brazil (GEOID-SP)	Guimarães et al.	2014
Tierra del Fuego	Gomez et al.	2014

Merging national geoid estimations



national geoid models residuals w.r.t. a global satellite-only model before applying the de-trending procedure, i.e. as they are stored in the ISG archive (units in m).





residuals after the de-trending procedure (units in m).

The geoid schools and the training courses

- The First International School for the determination and use of the Geoid was organized in Milan (Italy) in 1994. Since then many other editions of the School followed

- The last one was organized in Ulaanbaatar (Mongolia) in 2016.

Year	1994	1997	1999	2000	2002	2005	2006	2008	2009	2010	2013	2016
Location	Italy	Brazil	Italy	Malaysia	Greece	Hungary	Denmark	Italy	Argentina	Russia	Ecuador	Mongolia
N°Students	34	31	23	41	30	49	24	25	23	15	15	30
N°Countries	17	13	12	13	13	19	15	12	5	5	9	10

Milan, Italy, 1994

Ulaanbaatar, Mongolia, 2016

- In addition to the International Geoid School, ISG gives support to institutions and scientists by organizing, on request, specific training courses on geoid computation held at Politecnico di Milano

International Geodynamics and Earth Tide Service (IGETS)

(http://igets.u-strasbg.fr)

Director: Hartmut Wziontek

Main ICET tasks

- To monitor temporal variations of the Earth gravity field through long-term records from ground gravimeters, tiltmeters, strainmeters and other geodynamic sensors
- To continue the activities of the Global Geodynamic Project, to provide support to geodetic and geophysical research activities using superconducting gravimeter data within the context of an international network for field gravimetry, absolute gravity measurements and for tilt measurements
- To continue the activities of the International Center for Earth Tides

Data and products at IGETS

i) Several SG data are available at ISDC at GFZ:

- Raw gravity and local pressure records sampled at 1 or 2 seconds, in addition to the same records decimated at 1-minute samples
(*Level 1 products*)
- Gravity and pressure data corrected for instrumental perturbations, ready for tidal analysis
(*Level 2 products*)
- Gravity residuals after particular geophysical corrections (including solid Earth tides, polar motion, tidal and non-tidal loading effects)
(*Level 3 products*)
- Corrected gravity data (Level 2) can also be found at Univ. of French Polynesia, along with the Bulletin d'Information des Marees Terrestres at **http://www.bim-icet.org/.**

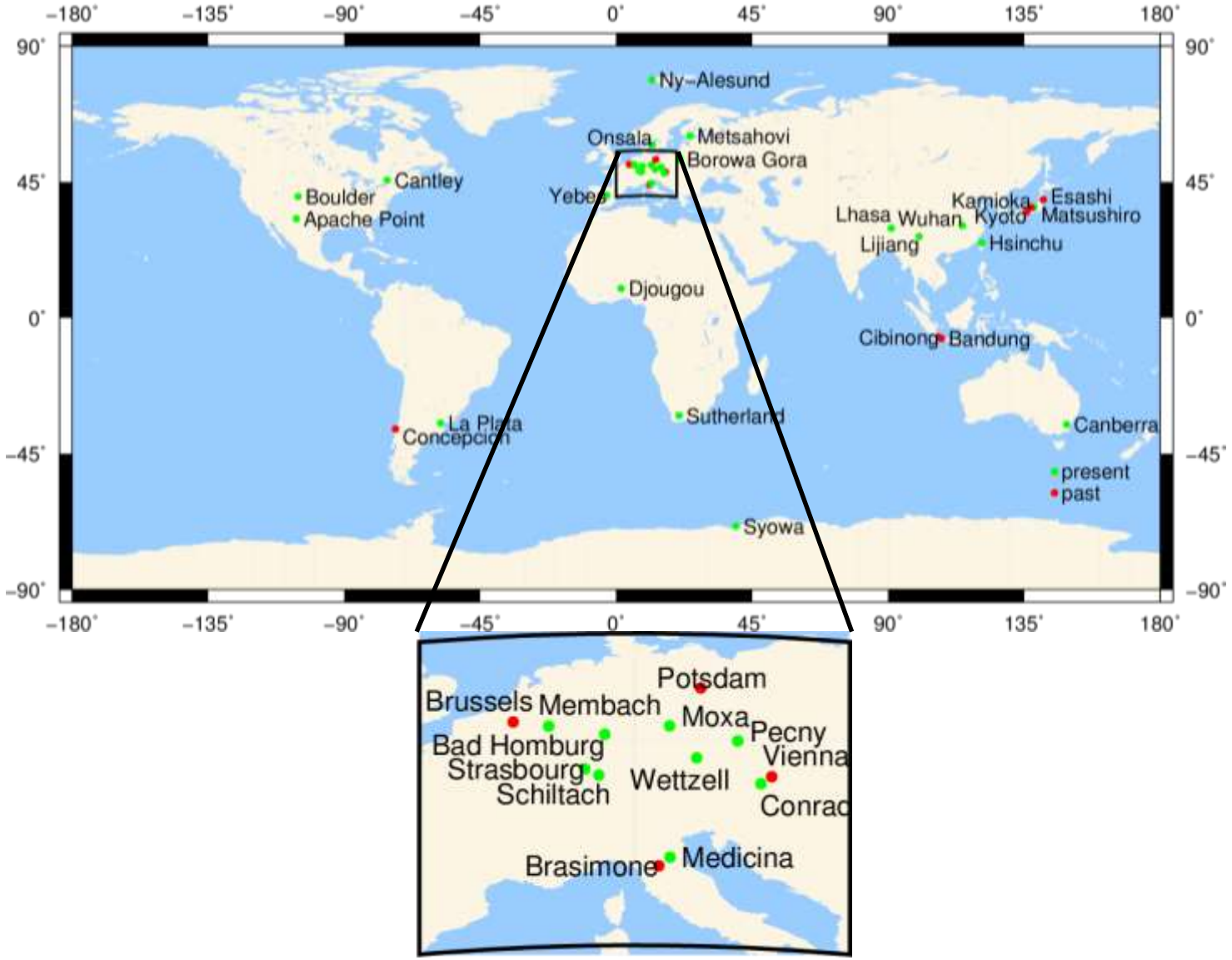
ii) SG data for major Earthquakes (minute and second sampling)

iii) ATMACS, Atmospheric Attraction Computation Servics at BKG

iv) mGlobe Matlab/Octave toolbox for computation of global hydrological, atmospheric and non-tidal ocean loading effects

v) EOST loading service (displacements, gravity, tilts)

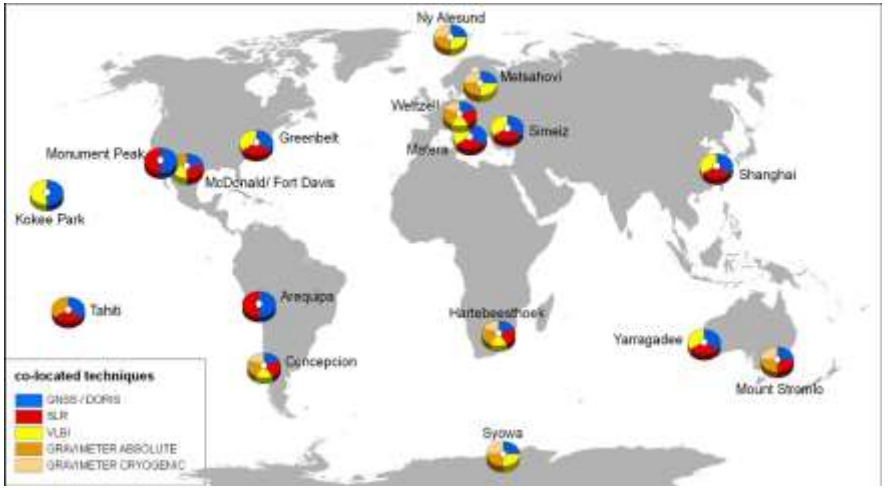
IGETS SG data base containing data from 37 stations

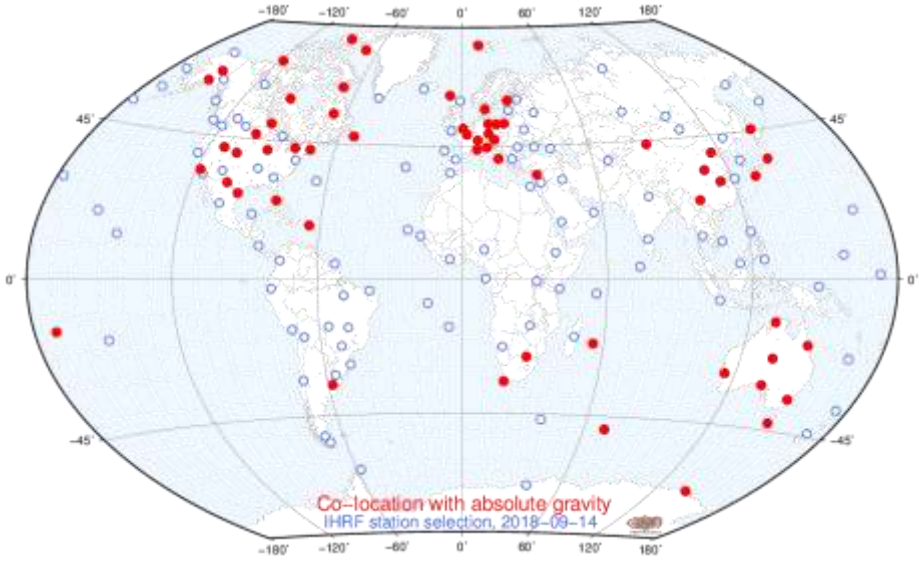


Links of Reference Stations with IGETS, GGOS and IHRF

IGETS: links to stations with AG

GGOS: links to space geodetic techniques





IHRF: links with the height system

International Digital Elevation Model Service (IDEMS)
(https://idems.maps.arcgis.com/home/index.html)

Director: Kevin Kelly

Main IDEMS tasks

- To provide a focus for distribution of data and metadata about digital elevation models (DEMs)
- To provide spherical-harmonic models of Earth's global topography
- To provide lunar and planetary DEM
- To provide relevant software for managing DEMs and related datasets.

Data and products at IDEMS

- Compilation of available national elevation data sets with information on data resolution, methods used for DEM generation and links to providers

- Generation and dissemination of spherical-harmonic models of Earth's global topography and bathymetry

- Compilation of geodesy relevant DEMs studies

- Extension of the focus from Earth to Moon and terrestrial planets through compilation of information on available planetary topography models.

- Website managing in order to separate regional DEMs and global DEMs

- Ongoing updates of existing DEMs

Data and products at IDEMS

Geodesy Relevant DEM and BTM Studies

Panoramica | Contenuto | Membri

Cerca contenuti del gruppo

Elenco | Titolo | Filtro

Filtri

Tipo Argomento

- Mappe
- Layer
- Scene
- Applicazioni
- Strumenti
- File

Posizione

Data di modifica

Tag

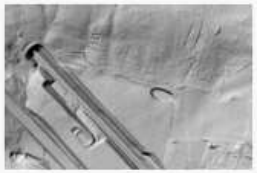
1 - 6, totale: 6

DEM and BTM Research Papers

PDF di chirt_IDEMS2

Compilation of selected DEM and BTM (bathymetry) research papers relevant to geodesy. The list include papers on SRTM, ASTER, TanDEM-X and ALOS DEM and BTM with focus on the model generation, performance, accuracy and pitfalls.

Data creazione: 21 set 2016 Aggiornamento: 15 mag 2019 Conteggio visualizzazioni: 112



Digital Terrain Models, C. Hirt (2015)

PDF di chirt_IDEMS2

Digital terrain models reference work entry in the Encyclopedia of Geodesy.

Data creazione: 26 ott 2016 Aggiornamento: 26 ott 2017 Conteggio visualizzazioni: 56

Global Geospatial Data from Earth Observation (2016)

Document Link di kkelly_IDEMS

Overview paper on the status of global topography models.

Data creazione: 26 ott 2016 Aggiornamento: 12 set 2017 Numero di download: 19

International Combination Service for Time-variable Gravity Field Solutions (COST-G)

(https://cost-g.org)

Chair: Adrian Jäggi

Main COST-G tasks

The International Combination Service for Time-variable Gravity Fields (COST-G) is the Product Center of the International Gravity Field Service (IGFS) for time-variable gravity fields. COST-G provides consolidated monthly global gravity models in terms of spherical harmonic (SH) coefficients and thereof derived grids by combining solutions from individual Analysis Centers (ACs).

Recent Activities

- COST-G is currently working on the extension of combined GRACE monthly gravity field solutions (and also on combined Swarm monthly gravity field solutions)

- In January 2019 COST-G met in Bern at ISSI to further coordinate its upcoming activities.

- Preliminary combined solution presented at IAG/IUGG, Montreal (G03, July 14th)