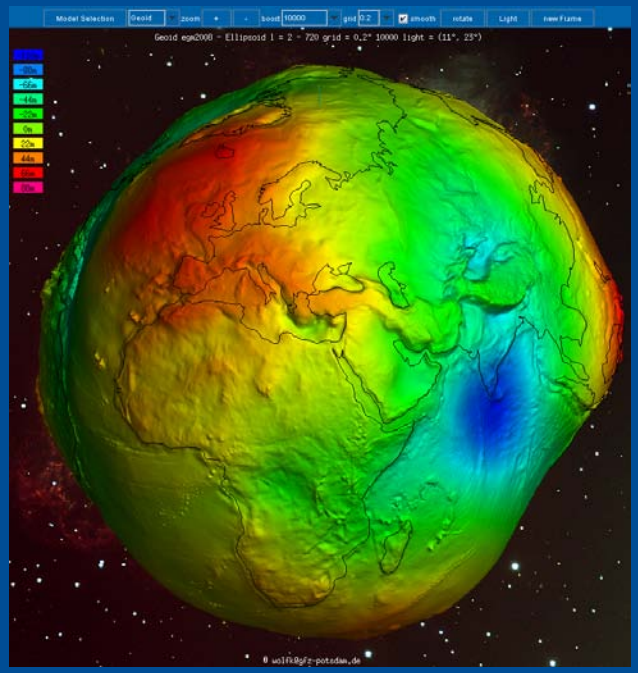
ICGEM

The International Centre for Global Earth Models

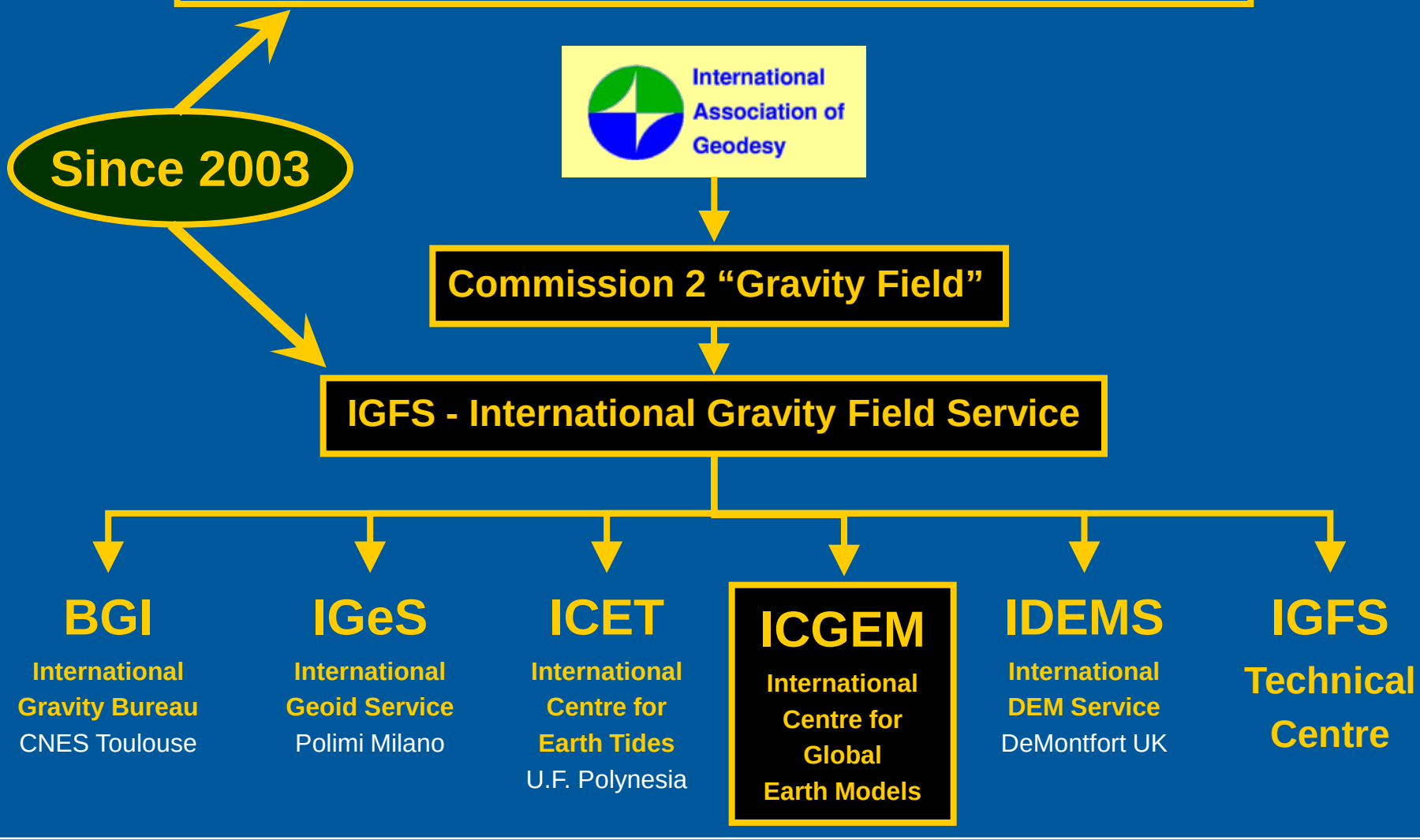
Franz Barthelmes
Wolfgang Köhler



Unified Analysis Workshop 2009

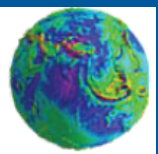
GFZ Helmholtz Centre Potsdam
HELMHOLTZ ASSOCIATION

ICGEM – A Service of the IAG



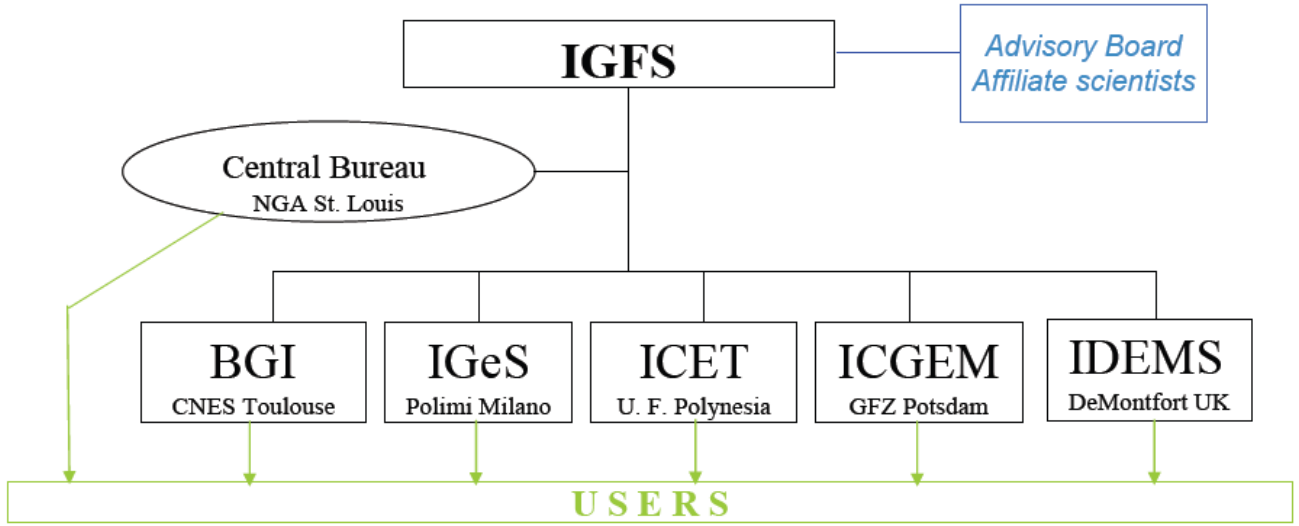
→ from R. Forsberg, Buenos Aires, 2009

International Association of Geodesy
I G F S



Structure of the IGFS

International Gravimetric Bureau (BGI) – *Director S. Bonvalot, Toulouse*
International Geoid Service (IGeS) – *Director R. Bazarghi, Milano*
International Center for Earth Tides (ICET) – *Director J. P. Barriot, Papeete*
International Center for Global Earth Models (ICGEM) – *Director J.Kusche, GFZ*
International DEM Service (IDEMS) – *Director P. Berry, De Mont Fort, UK*
Technical Centre of the IGFS – chief geodesist S. Kenyon, NGA, USA
Upcoming: Global Gravity Project (supercunducting gravimeter net) – new service?
IAS – International Altimetry Service (link / coordination)



Objectives / Status of ICGEM

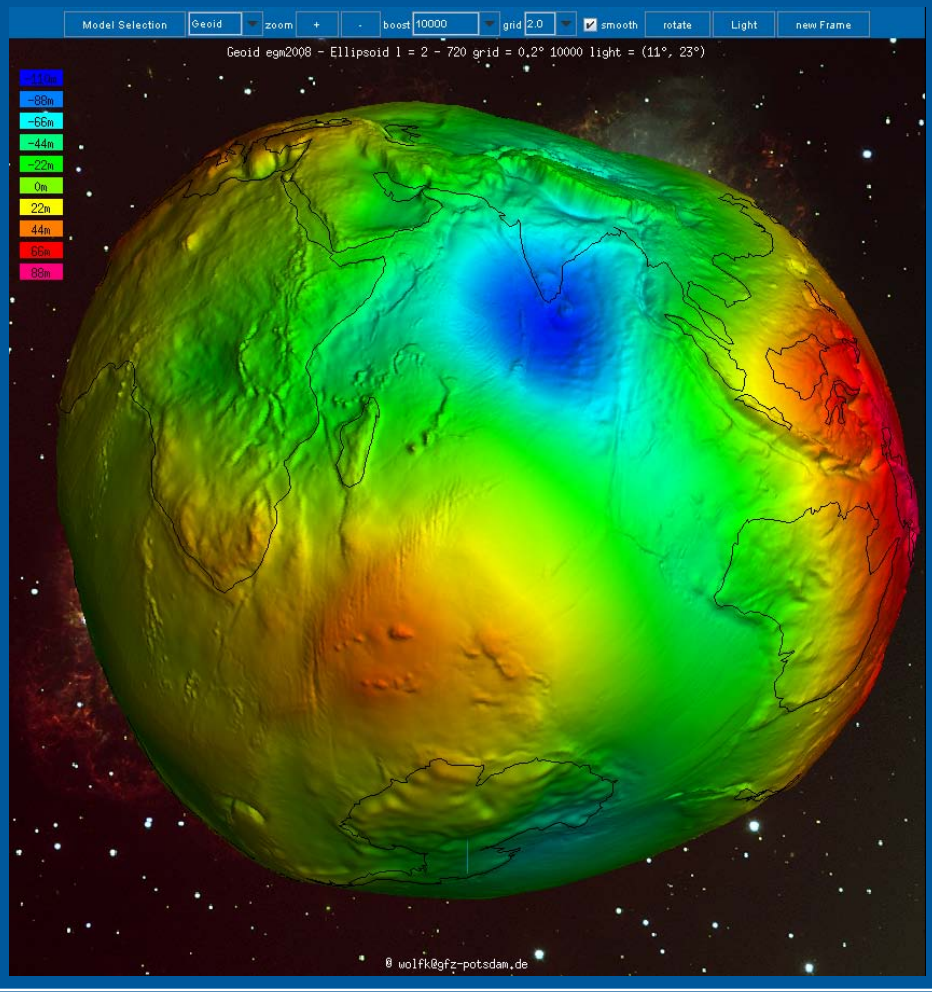
- collecting and archiving of all existing global gravity field models
- making them available on the web **107 listed** **90 downloadable**
- use of standardised format (self-explanatory)
- interactive visualisation of the models their differences and their time variation
- web-interface to calculate gravity functionals from the spherical harmonic models on freely selectable grids (filtering)
- evaluation of the models ←→ ??
- recommendations ←→ ??

Table of available Models

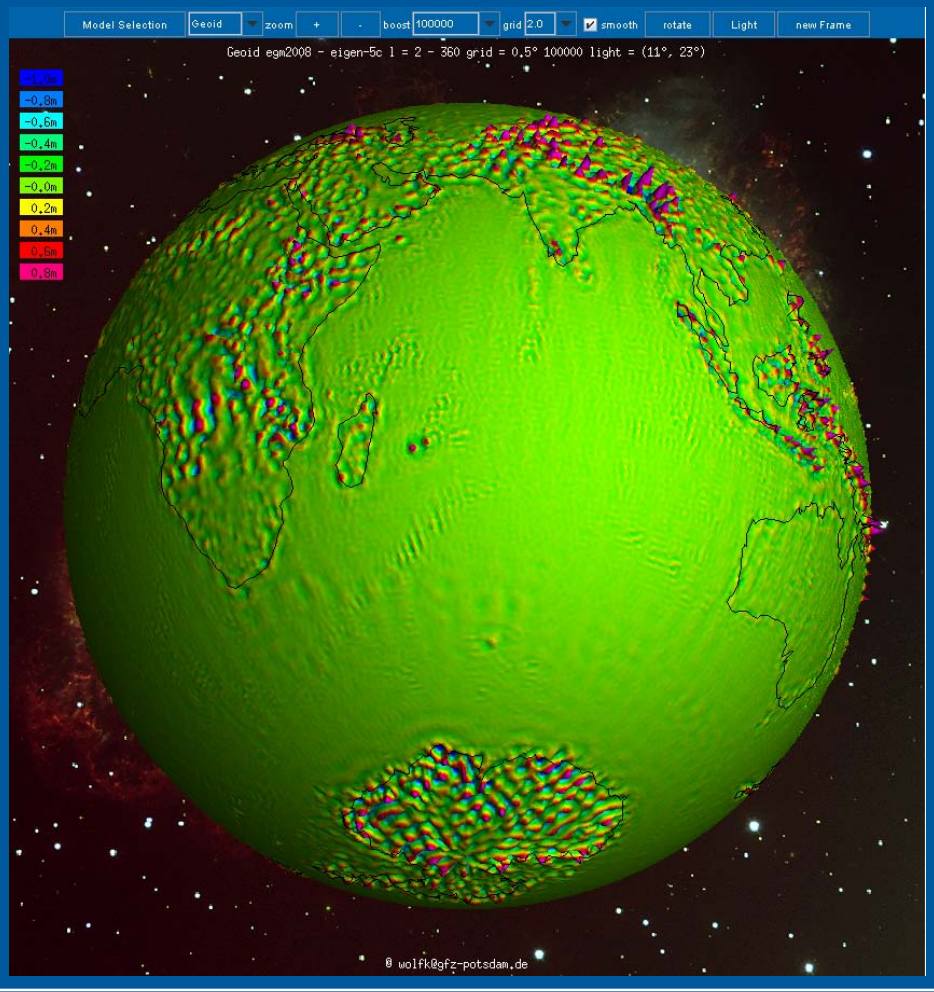
Model	Year	Degree	Data	Reference	download
AIUB-GRACE02S	2009	150	S(Grace)	Jäggi et al, 2009	X
GGM03C	2009	360	S(Grace),G,A	Tapley et al, 2007	X
GGM03S	2008	180	S(Grace)	Tapley et al, 2007	X
AIUB-GRACE01S	2008	120	S(Grace)	Jäggi et al, 2008	X
EIGEN-5S	2008	150	S(Grace,Lageos)	Förste et al, 2008	X
EIGEN-5C	2008	360	S(Grace,Lageos),G,A	Förste et al, 2008	X
EGM2008	2008	2190	S(Grace),G,A	Pavlis et al, 2008	X
ITG-Grace03	2007	180	S(Grace)	Mayer-Gürr et al, 2007	X
AIUB-CHAMP01S	2007	90	S(Champ)	Prange, L. et al, 2007	X
ITG-Grace02s	2006	170	S(Grace)	Mayer-Gürr et al, 2006	X
EIGEN-GL04S1	2006	150	S(Grace,Lageos)	Förste et al, 2006	X
EIGEN-GL04C	2006	360	S(Grace,Lageos),G,A	Förste et al, 2006	X
EIGEN-CG03C	2005	360	S(Champ,Grace),G,A	Förste et al, 2005c	X
GGM02C	2004	200	S(Grace),G,A	UTEX CSR, 2004	X
GGM02S	2004	160	S(Grace)	UTEX CSR, 2004	X
EIGEN-CG01C	2004	360	S(Champ,Grace),G,A	Reigber et al, 2006	X
EIGEN-CHAMP03S	2004	140	S(Champ)	Reigber et al, 2005b	X
EIGEN-GRACE02S	2004	150	S(Grace)	Reigber et al, 2005a	X

Interactive Visualisation Service

Geoid

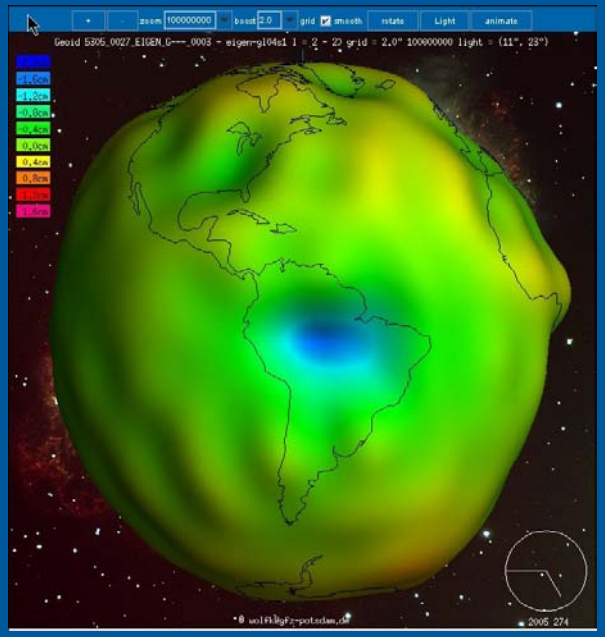


Differences of 2 Models

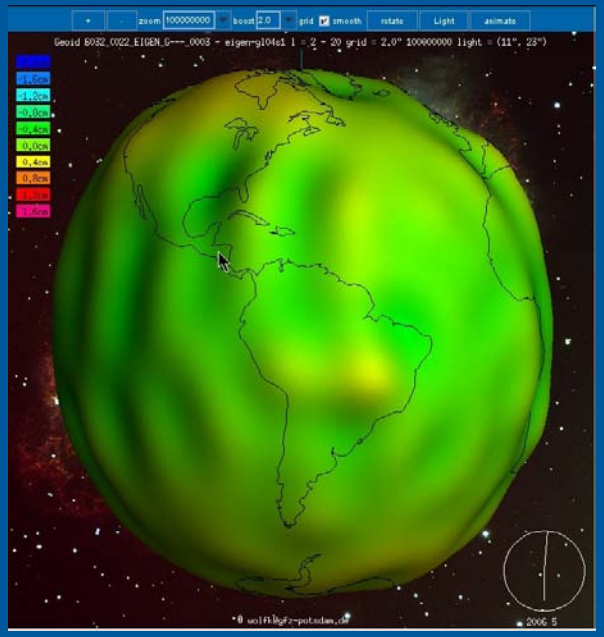


Interactive Visualisation Service

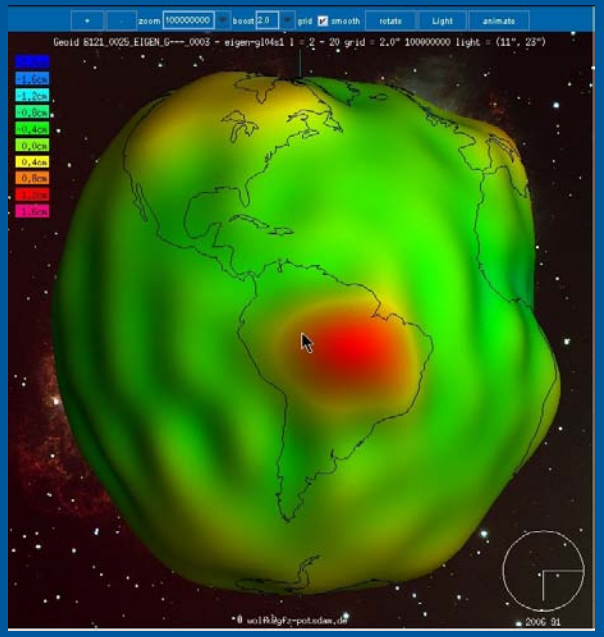
Animated Visualisation of Monthly Solutions



Nov. 2005



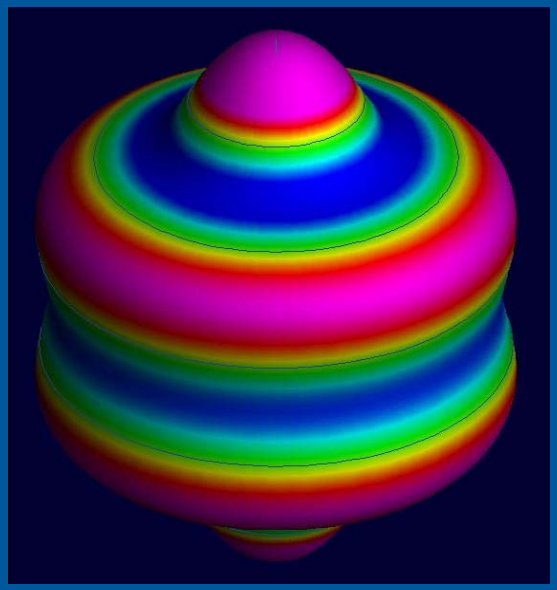
Jan. 2006



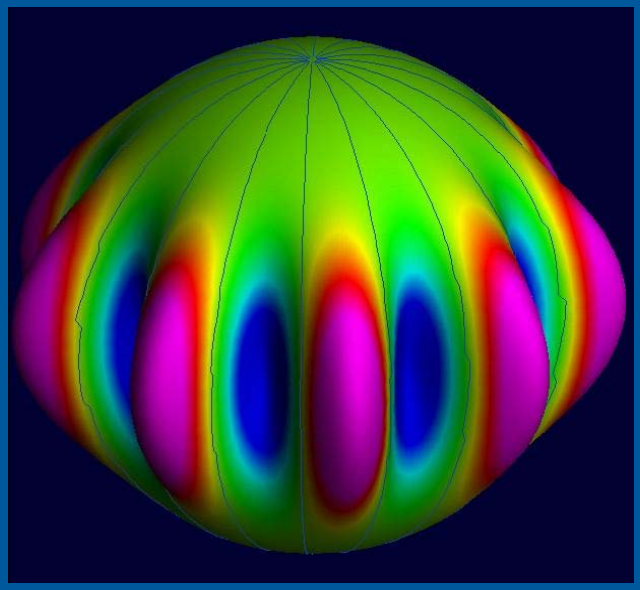
Apr. 2006

Interactive Visualisation Service

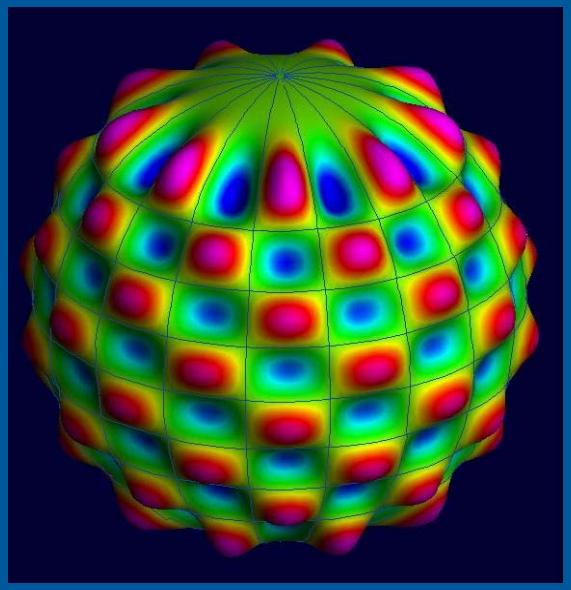
Spherical Harmonics as Tutorial



zonal: $\ell = 6$, m = 0

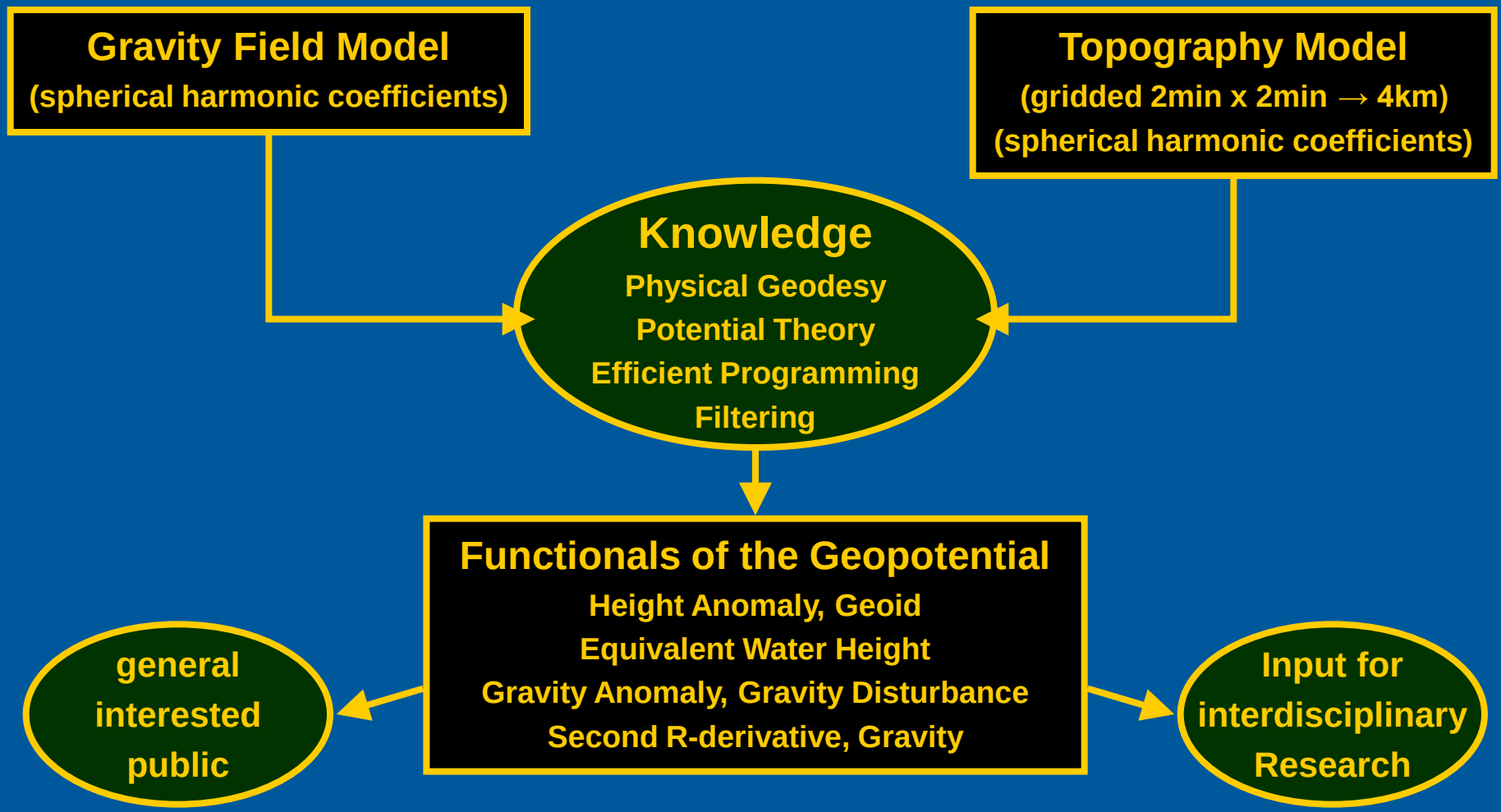


sectorial: $\ell = 9$, m = 9



tesseral: $\ell = 16$, m = 9

Calculation Service



Calculation Service

Web-Interface

Reference System

Model

Functional

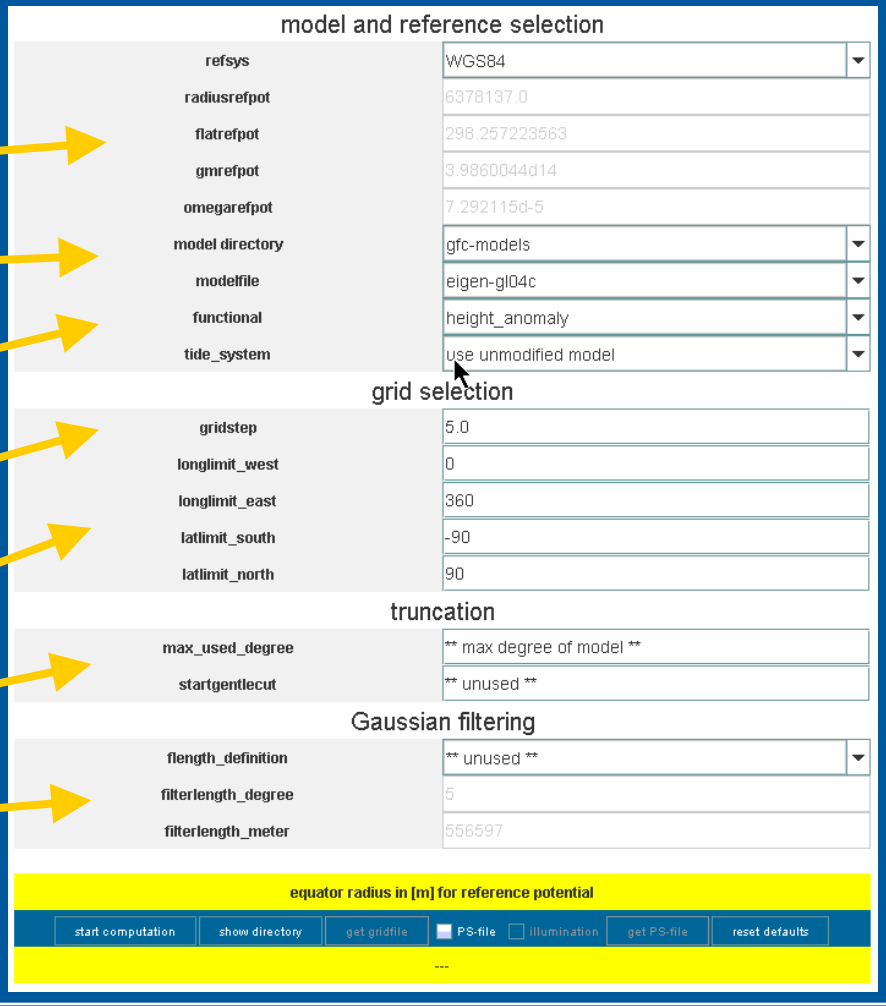
Grid Density

Grid Area

Truncation

Filtering

Grids and Plots

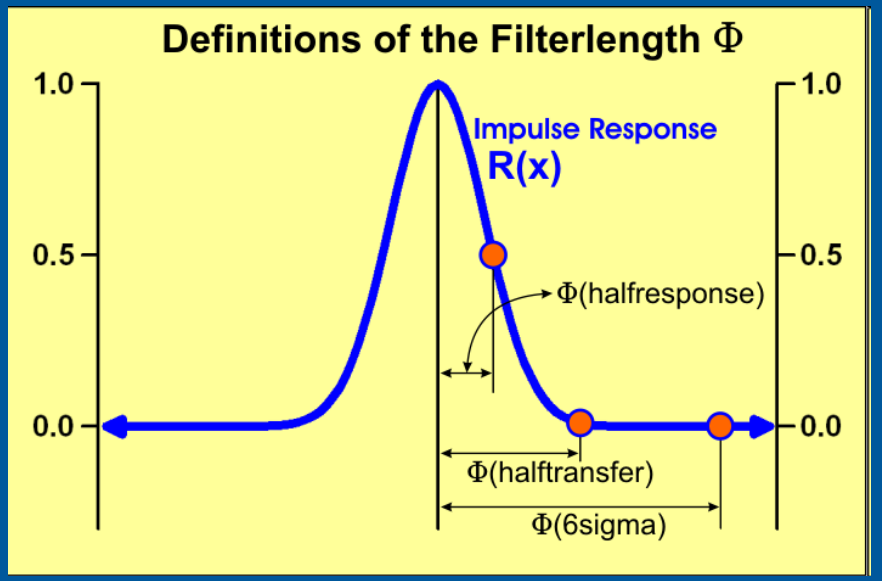


Calculation Service

Explanation of the Functionals

keyword	explanation
height_anomaly	The so called "height anomaly" is an approximation of the geoid according to Molodensky's theory. It is equal to the geoid over sea. Here it will be calculated, as defined, on the Earth's surface approximated by Bruns' formula on the ellipsoid plus a first order correction (eqs. 81 and 119 of STR09/02).
height_anomaly_ell	The height anomaly can be generalised to a 3-d function, (sometimes called "generalised pseudo-height-anomaly"). Here it can be calculated on (h=0) or above (h>0) the ellipsoid, approximated by Bruns' formula (eqs. 78 and 118 of STR09/02).
geoid	The Geoid is one particular equipotential surface of the gravity potential of the Earth. Among all equipotential surfaces, the geoid is those which is equal to the undisturbed sea surface and its continuation below the continents. Here it will be approximated by the height anomaly plus a topography dependent correction term (eqs. 71 and 117 of STR09/02).
gravity_disturbance	The gravity disturbance is defined as the magnitude of the gradient of the potential at a given point minus the magnitude of the gradient of the normal potential at the same point. Here it will be calculated on the Earth's surface (eqs. 87 and 121 – 124 of STR09/02).
gravity_disturbance_sa	The gravity disturbance calculated by spherical approximation (eqs. 92 and 125 of STR09/02) on (h=0) or above (h>0) the ellipsoid.
gravity_anomaly	The gravity anomaly (according to Molodensky's theory) is defined as the magnitude of the gradient of the potential on the Earth's surface minus the magnitude of the gradient of the normal potential on the Telluroid (Earth's surface minus height anomaly) (eqs. 101 and 121 – 124 of STR09/02).
gravity_anomaly_cl	The classical gravity anomaly is defined as the magnitude of the gradient of the downward continued potential on the geoid minus the magnitude of the gradient

Explanation of the Filtering



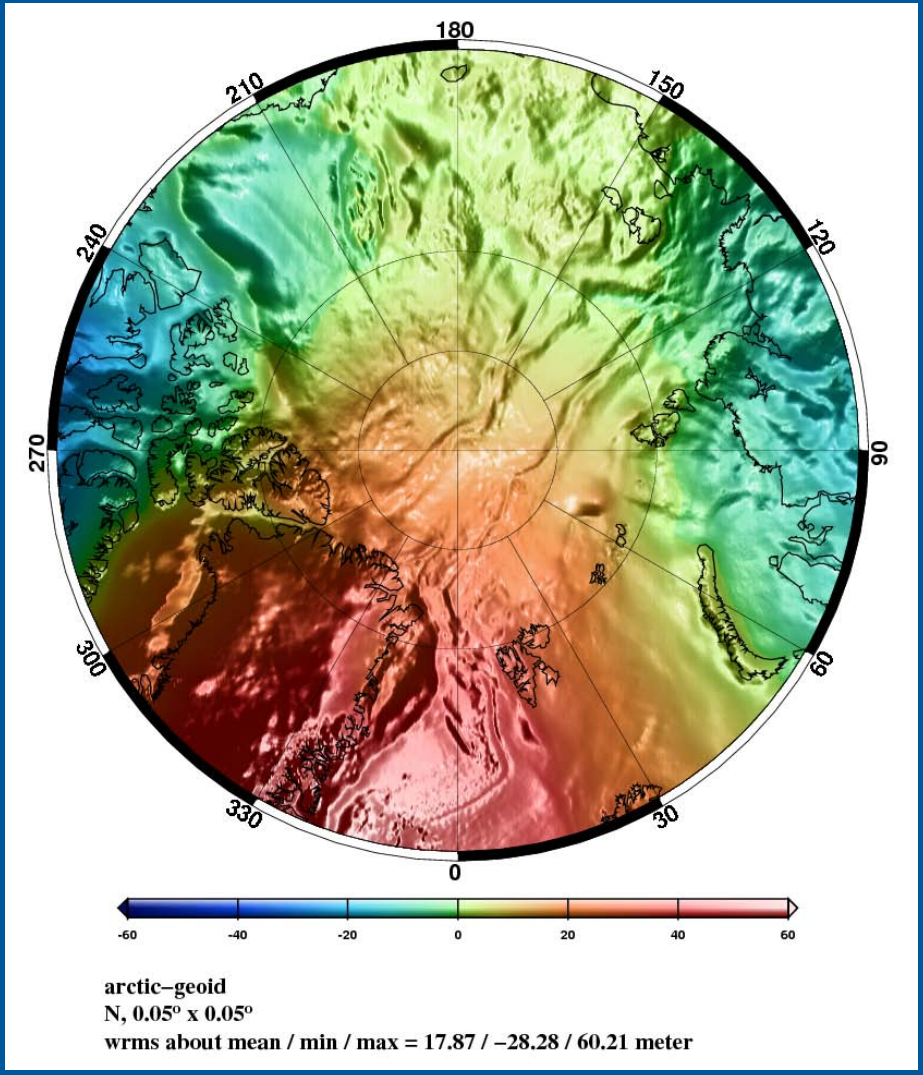
Theory and Formulas

➔ Link to: Report STR09/02

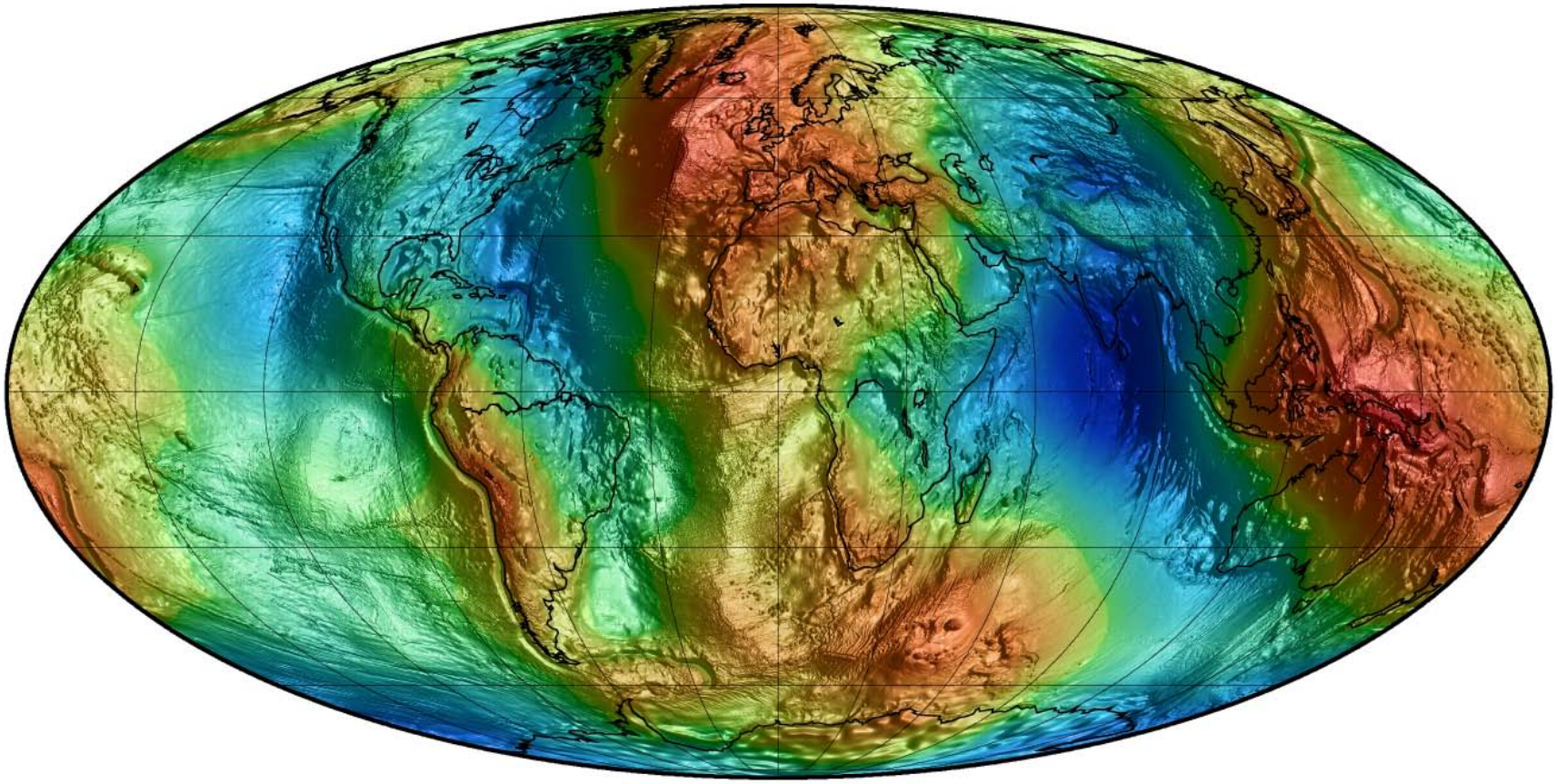
Calculation Service

Calculation of downloadable Grids

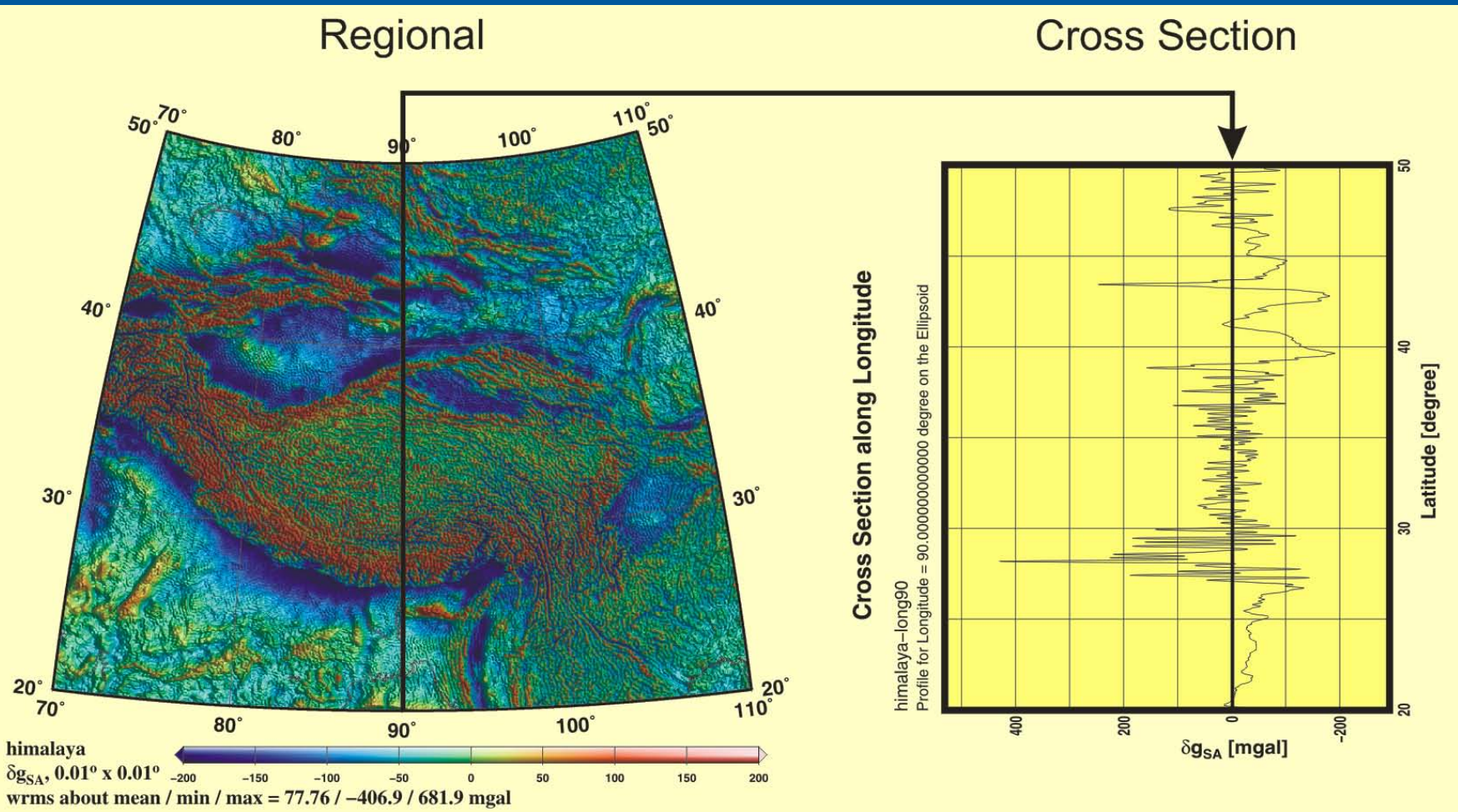
- **freely selectable grid areas**
- **automatic generation of plots**



Calculation Service



Calculation Service



Evaluation of the Models

Comparisons in the spectral domain

AIUB–GRACE02S

spectral comparison with the model EIGEN–5C

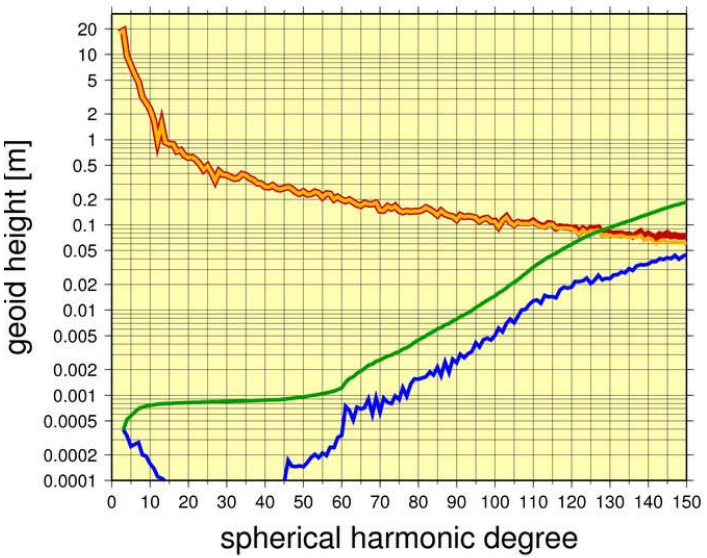
The graphs show:

Signal amplitudes per degree of AIUB–GRACE02S

Signal amplitudes per degree of EIGEN–5C

Difference amplitudes per degree of AIUB–GRACE02S vs. EIGEN–5C

Difference amplitudes as a function of maximum degree of AIUB–GRACE02S vs. EIGEN–5C



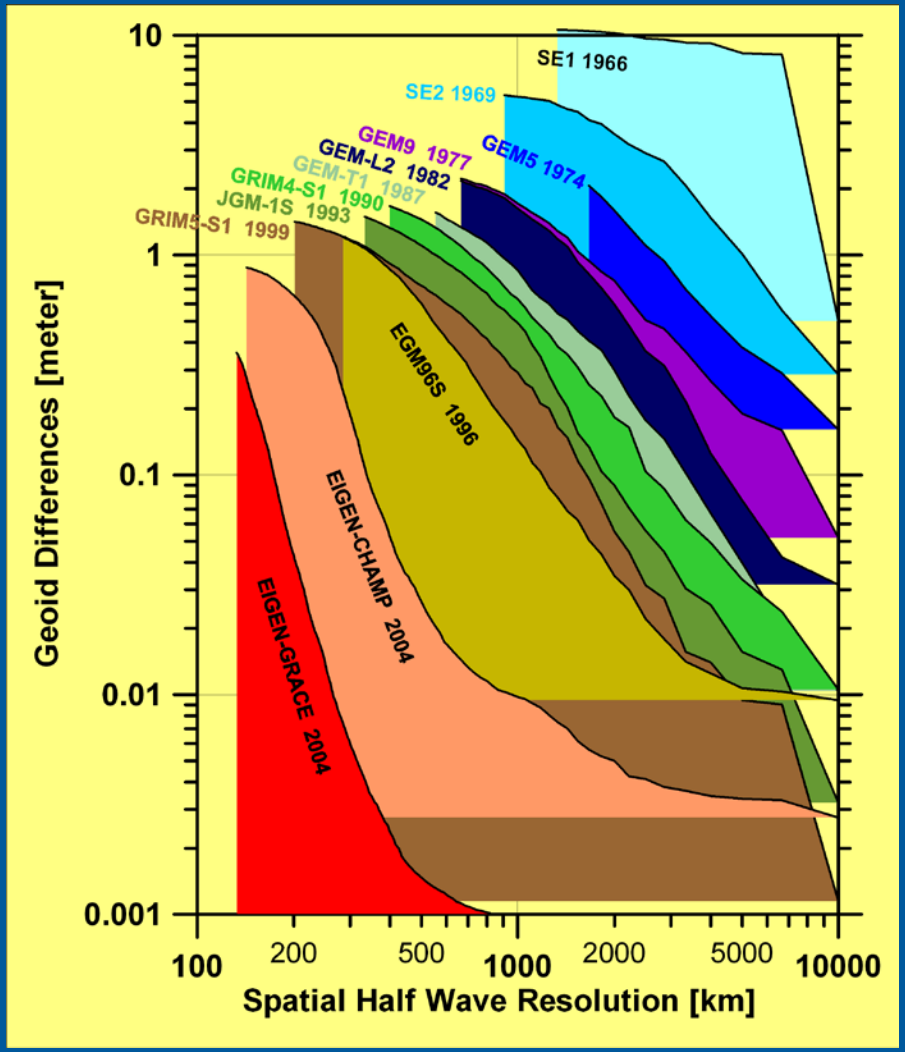
Evaluation of the Models

Comparisons with GPS-levelling data

Model	Nmax	USA 6169 points	Canada 1930 points	Europe 1235 points	Australia 201 points
AIUB-GRACE02S	150	0.630 m	0.571 m	0.701 m	0.495 m
GGM03C	360	0.346 m	0.279 m	0.334 m	0.259 m
EIGEN-5C	360	0.341 m	0.251 m	0.303 m	0.244 m
GGM03S-UPTO150	150	0.641 m	0.521 m	0.710 m	0.494 m
AIUB-GRACE01S	120	0.724 m	0.628 m	0.930 m	0.563 m
EGM2008	2190	0.248 m	0.126 m	0.208 m	0.217 m
EIGEN-5S	150	0.630 m	0.547 m	0.737 m	0.475 m
ITG-GRACE03	180	0.633 m	0.557 m	0.658 m	0.603 m
AIUB-CHAMP01S	70	0.843 m	0.906 m	1.513 m	0.893 m
ITG-GRACE02S	170	0.623 m	0.511 m	0.639 m	0.489 m
EIGEN-GL04C	360	0.339 m	0.253 m	0.336 m	0.244 m
EIGEN-GL04S1	150	0.630 m	0.576 m	0.748 m	0.464 m
EIGEN-CG03C	360	0.346 m	0.306 m	0.355 m	0.260 m
GGM02C	200	0.473 m	0.378 m	0.515 m	0.376 m
GGM02S	160	0.977 m	1.116 m	1.416 m	1.356 m
EIGEN-CG01C	360	0.351 m	0.270 m	0.370 m	0.263 m
EIGEN-CHAMP03S	140	0.816 m	0.842 m	1.451 m	0.849 m
EIGEN-GRACE02S	150	0.739 m	0.643 m	0.828 m	0.538 m
TUM2S	60	0.864 m	0.963 m	1.639 m	1.101 m
DEOS_CHAMP-01C	70	0.813 m	0.887 m	1.499 m	0.886 m
ITG_CHAMP01K	70	0.841 m	0.881 m	1.574 m	0.944 m
ITG_CHAMP01S	70	0.908 m	0.941 m	1.529 m	0.979 m
ITG_CHAMP01E	75	0.802 m	0.839 m	1.470 m	0.806 m
TUM2SP	60	0.866 m	0.973 m	1.641 m	1.089 m
TUM1S	60	0.860 m	1.004 m	1.636 m	1.165 m
GGM01C	200	0.477 m	0.381 m	0.555 m	0.398 m
GGM01S	120	0.748 m	0.719 m	0.964 m	0.636 m
EIGEN-GRACE01S	140	0.765 m	0.705 m	0.936 m	0.553 m

Accuracy – Improvement in History

Geoid differences of satellite-only models of the past to recent ("best") combination solution as a function of spatial resolution



Thank You