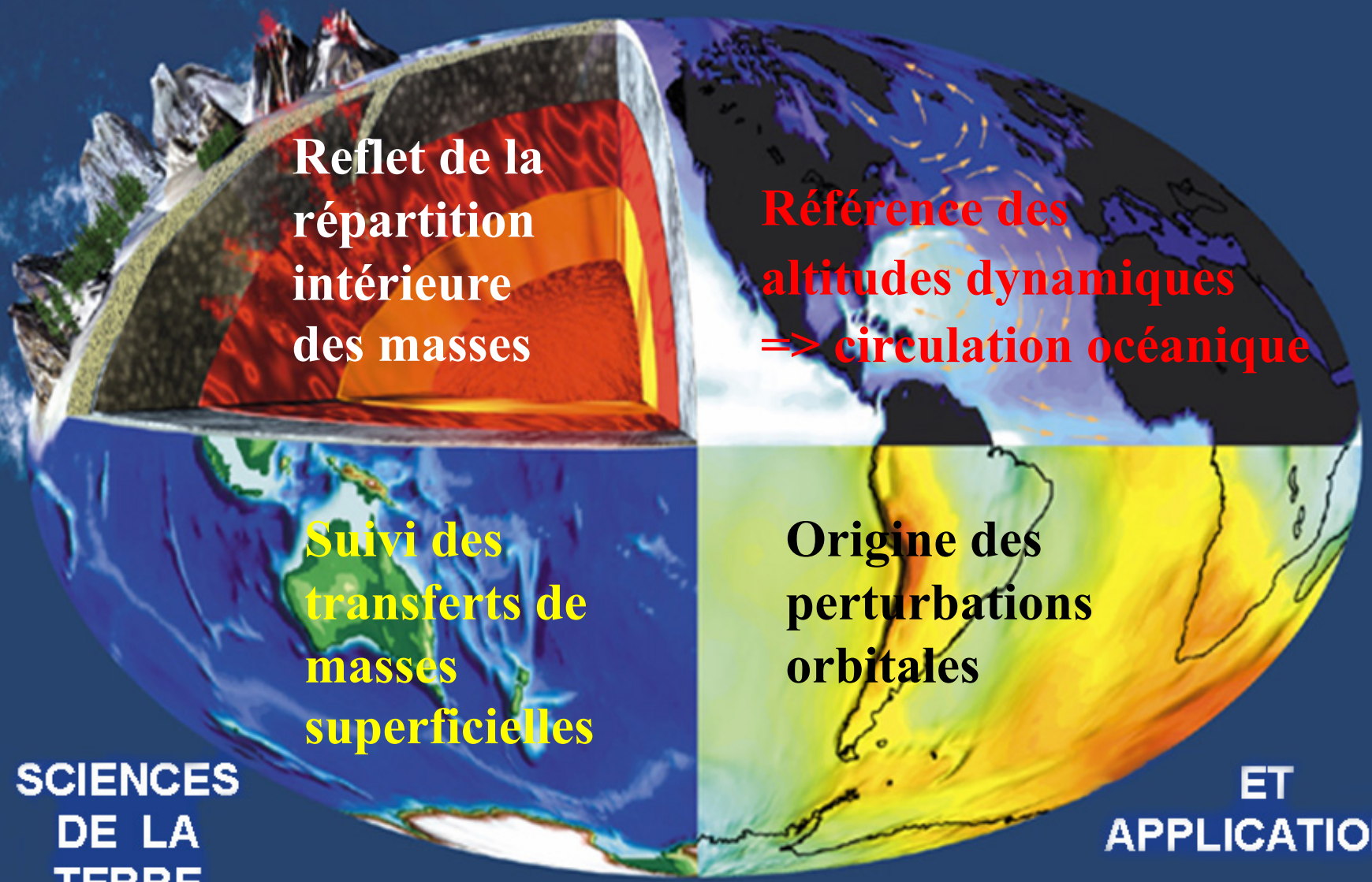
CHAMP DE GRAVITE



Reflet de la répartition intérieure des masses

Référence des altitudes dynamiques => circulation océanique

Suivi des transferts de masses superficielles

Origine des perturbations orbitales

SCIENCES DE LA TERRE

ET APPLICATIONS

La modélisation et les manifestations de la gravité

Potentiel de gravité:

±1000 m² s⁻²

$$U = \frac{GM}{a_e}\sum_{l=0}^{L}\left(\frac{a_e}{r}\right)^{l+1}\sum_{m=0}^{l}\overline{P}_{l,m}(\sin\varphi)\left(\overline{C}_{l,m}\cos m\lambda + \overline{S}_{l,m}\sin m\lambda\right)$$

$$U_0 = 62\,494\,812.4\ m^2 s^{-2}$$

Perturbation d'orbite:

±1000 m

(10 km /C_{20})

$$\ddot{\bar{x}} = \frac{\partial U}{\partial \bar{x}} \quad \textit{intégré numériquement ou analytiquement (équations de Lagrange)}$$

$$U = \frac{GM}{a_e}\sum_{l=o}^{L}\left(\frac{a_e}{a}\right)^{l+1}\sum_{m=o}^{l}\sum_{p=o}^{l}\sum_{q=-Q}^{+Q}F_{lmp}(i)\,G_{lpq}(e)\,S_{lmpq}(C_{l,m},S_{l,m},\omega,\Omega,M,\theta)$$

Anomalie de gravité:

-500/+1000 mgal

(10^{-5} m s^{-2})

$$\Delta g = \frac{\partial T}{\partial r} + 2\frac{T}{r} \quad \textit{avec} \quad T = U - V, \quad V \textit{ potentiel de l'ellipsoïde}$$

$$\Delta g = \frac{GM}{a_e^{\,2}}\sum_{l=0}^{L}(l-1)\sum_{m=0}^{n}\overline{P}_{l,m}(\sin\varphi)\left(\overline{C}^{*}_{l,m}\cos m\lambda + \overline{S}^{*}_{l,m}\sin m\lambda\right)$$

Hauteur de géoïde:

±100 m

$$N = \frac{T}{\gamma} \quad \textit{où } \gamma \textit{ est l'accélération de la gravité}$$

$$N = a_e\sum_{l=0}^{L}\sum_{m=0}^{n}\overline{P}_{l,m}(\sin\varphi)\left(\overline{C}^{*}_{l,m}\cos m\lambda + \overline{S}^{*}_{l,m}\sin m\lambda\right)$$

Déviation de la verticale:

±100 "

$$\xi = -\frac{1}{r\gamma}\frac{\partial T}{\partial \theta}; \quad \eta = -\frac{1}{r\gamma\cos\varphi}\frac{\partial T}{\partial \lambda}$$

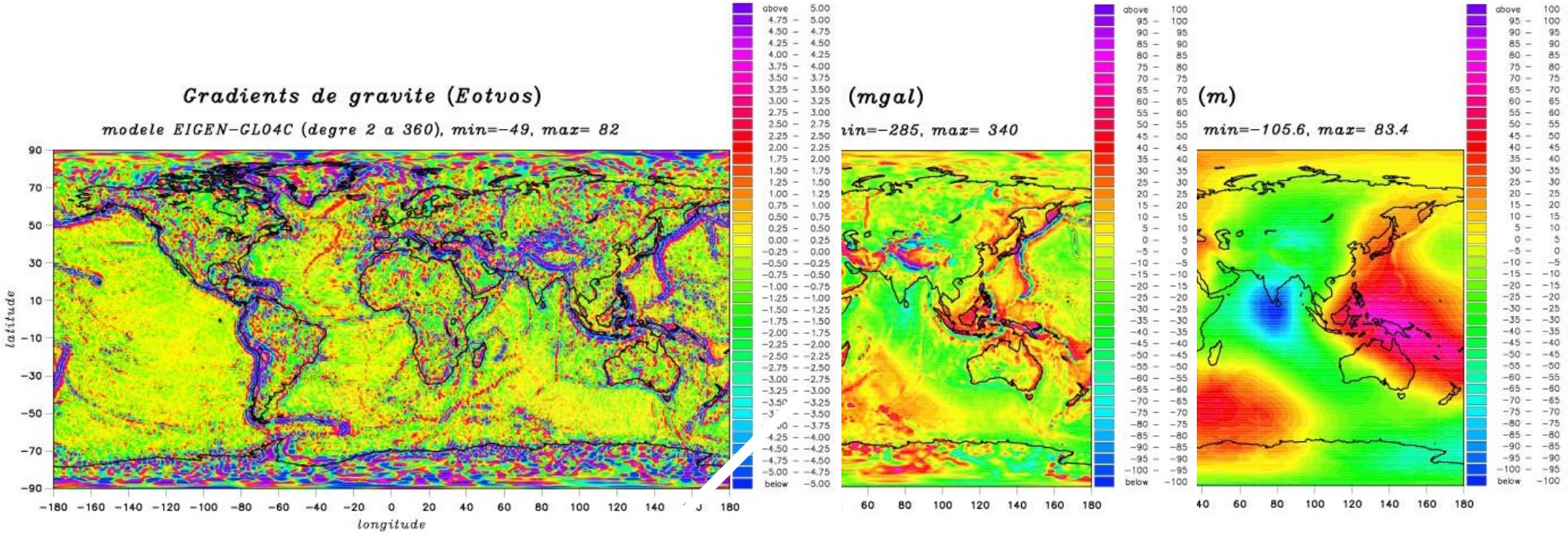
Gradient de gravité:

-50/+100 Eötvös

(10^{-9} s^{-2})

$$\frac{\partial^2 U}{\partial x\,\partial y}$$

$$\frac{\partial^2 U}{\partial r^2} = \frac{GM}{a_e}\sum_{l=0}^{L}(l+1)(l+2)\left(\frac{a_e}{r}\right)^{l+3}\sum_{m=0}^{l}\overline{P}_{l,m}(\sin\varphi)\left(\overline{C}_{l,m}\cos m\lambda + \overline{S}_{l,m}\sin m\lambda\right)$$



dériv

sensi

d^2/dt^2

GOCE

$(R/r)^{l+3}$	$(R/r)^{l+2}$	$(R/r)^{l+1}$
$\begin{pmatrix} \frac{\partial^2 U}{\partial x^2}, & \frac{\partial^2 U}{\partial x \partial y}, & \frac{\partial^2 U}{\partial x \partial z} \\ \frac{\partial^2 U}{\partial y \partial x}, & \frac{\partial^2 U}{\partial y^2}, & \frac{\partial^2 U}{\partial y \partial z} \\ \frac{\partial^2 U}{\partial z \partial x}, & \frac{\partial^2 U}{\partial z \partial y}, & \frac{\partial^2 U}{\partial z^2} \end{pmatrix}$	$\ddot{r} = \left(\frac{\partial U}{\partial x}, \frac{\partial U}{\partial y}, \frac{\partial U}{\partial z} \right)$	$U = \int \ddot{r}\, d\vec{s}$
Gradient radial :	Anomalie de gravité :	Hauteur de géoïde :
$\partial^2 U/\partial r^2 = R_l^2 \sum (l+1)(l+2)\, H_l$	$\Delta g = -\partial T/\partial r - 2T/r$	$N = T/\gamma = (U-V)/\gamma$
	$= \gamma \sum (l-1)\, H_l^*$	$= R \sum H_l^*$

Equation de Laplace :

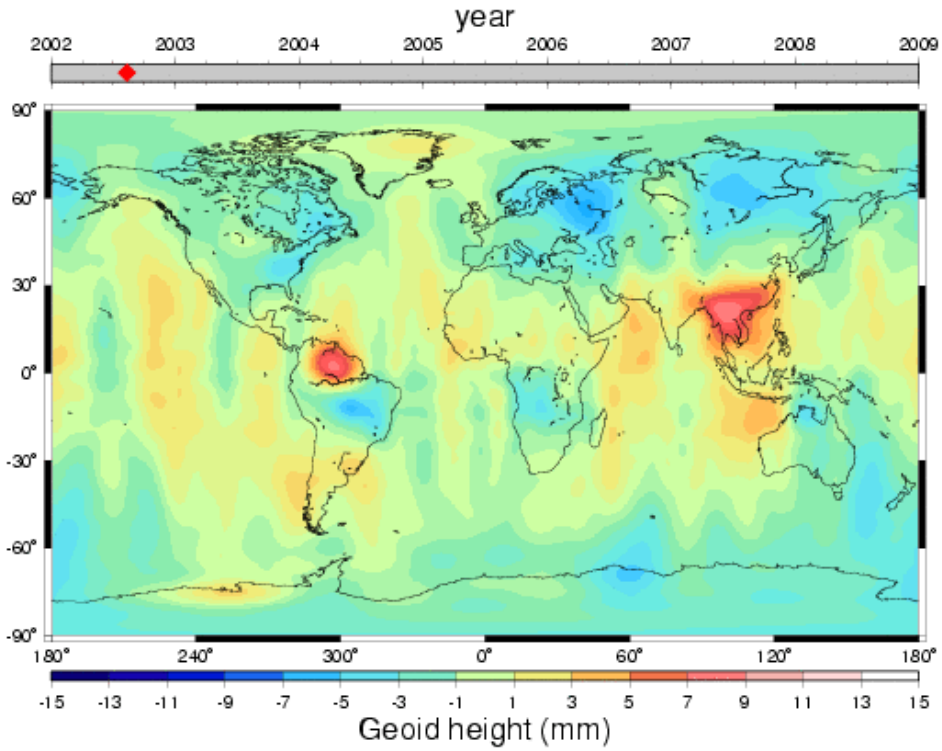
$\partial^2 U/\partial x^2 + \partial^2 U/\partial y^2 + \partial^2 U/\partial z^2 = 0$

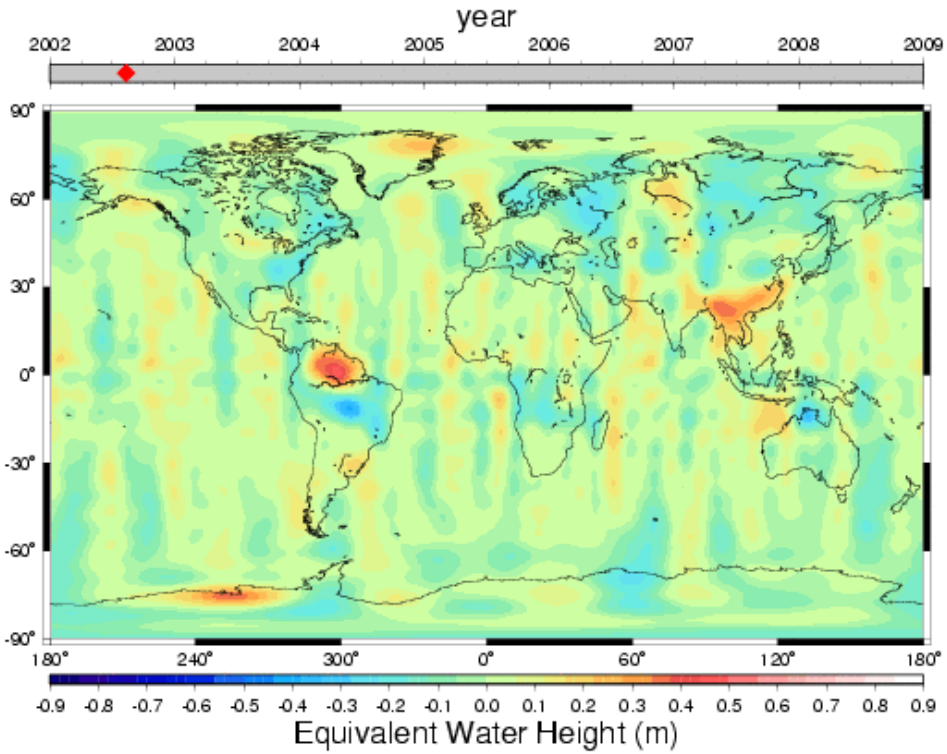
$\partial^2/\partial s^2$ $\partial/\partial s$ s **espace**

différentiation

longueur d'onde

Modèles décadaires CNES/GRGS à partir des données GRACE et LAGEOS





$$\Delta h^{water} = \frac{g}{4\pi G R \rho_w} \sum_{l=2}^{50} \frac{2l+1}{1+k'_l} \Delta h_l^{geoid}$$

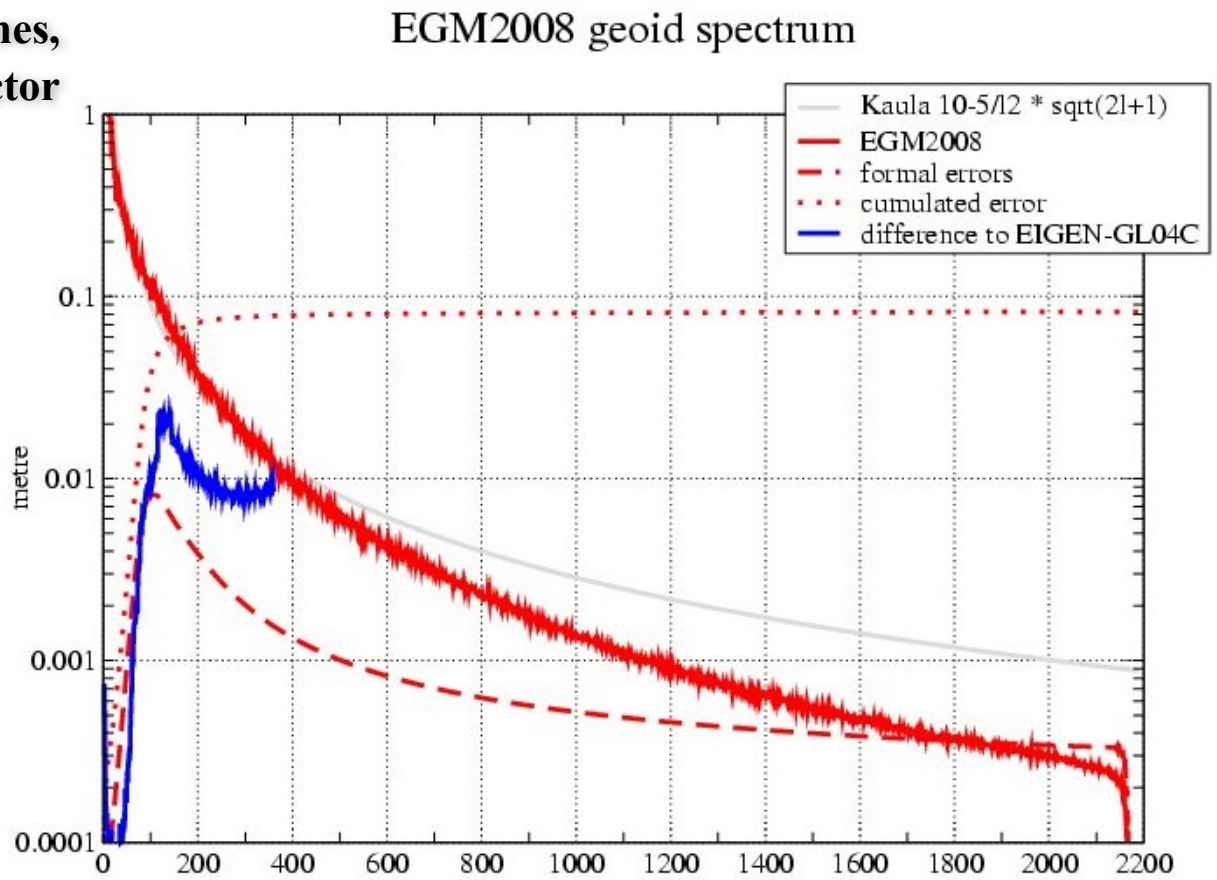
Disponible sur le site: http://bgi.cnes.fr

An Earth Gravitational Model to Degree 2160: EGM2008

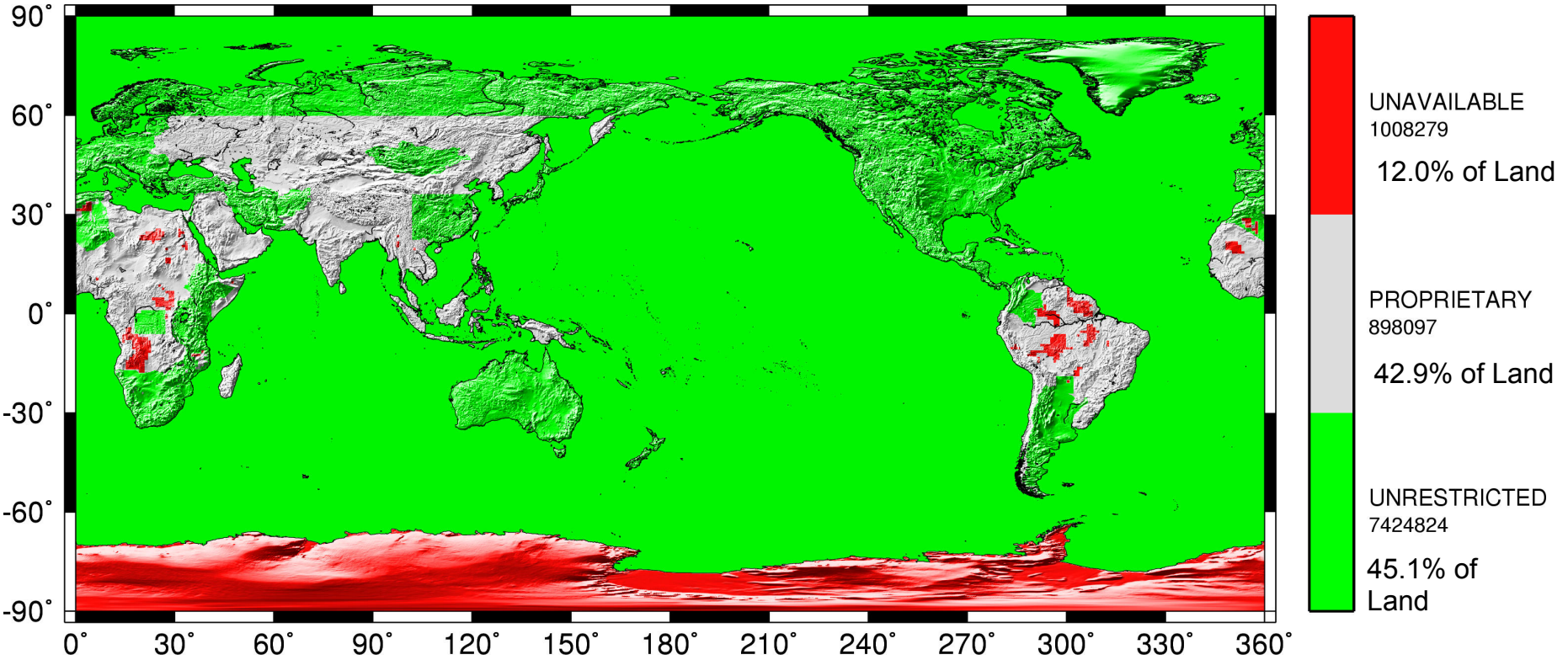
Nikolaos K. Pavlis, Simon A. Holmes, Steve C. Kenyon, and John K. Factor

Presented at:
EGU General Assembly 2008
Vienna, Austria, April 13-18, 2008
Nikolaos.K.Pavlis@nga.mil

From GRACE data + gravity data (measured or derived from altimetry over the oceans)



5′×5′ Δg Data Sources



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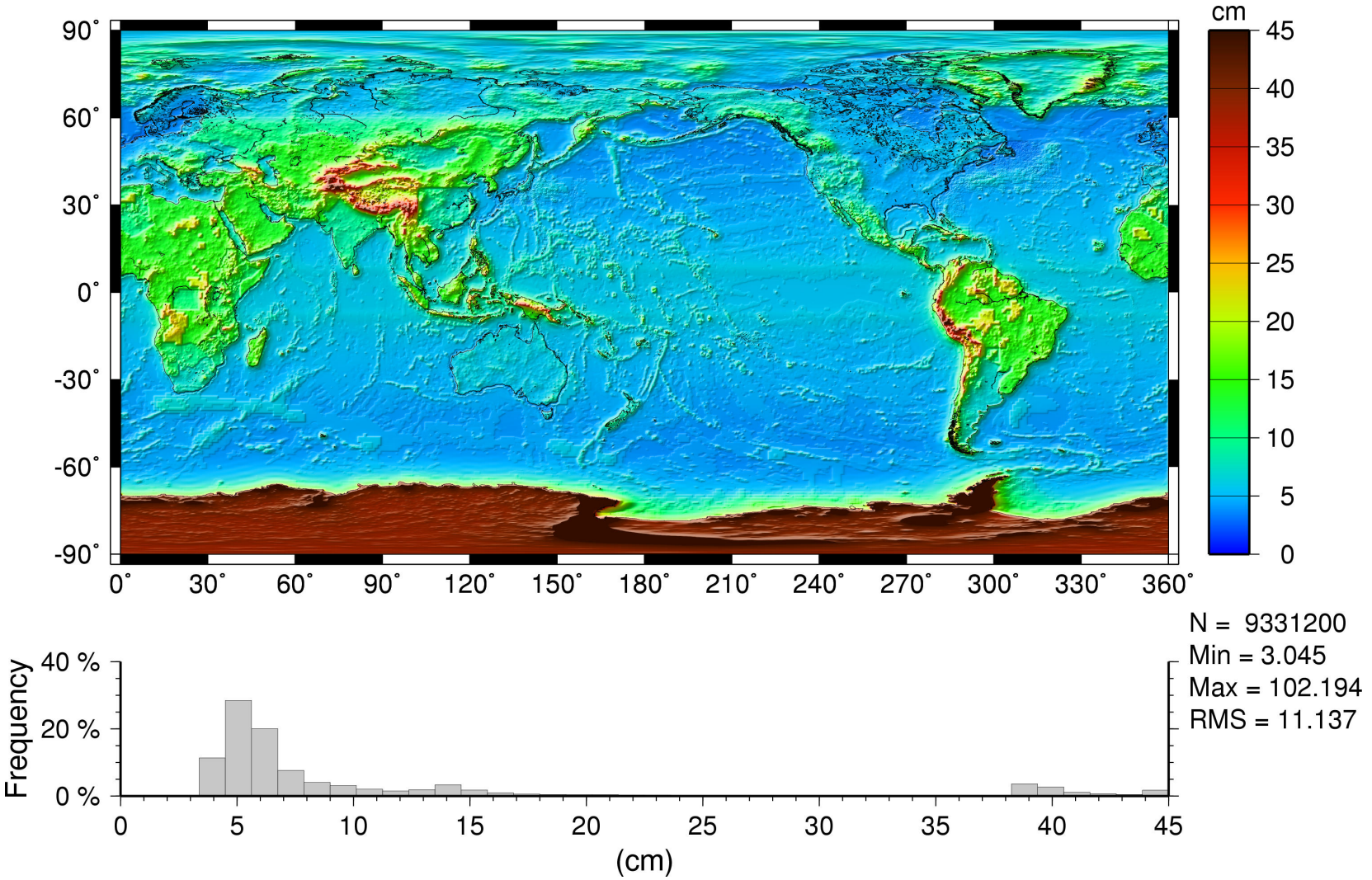
5′×5′ Commission Error (Nmax=2159)



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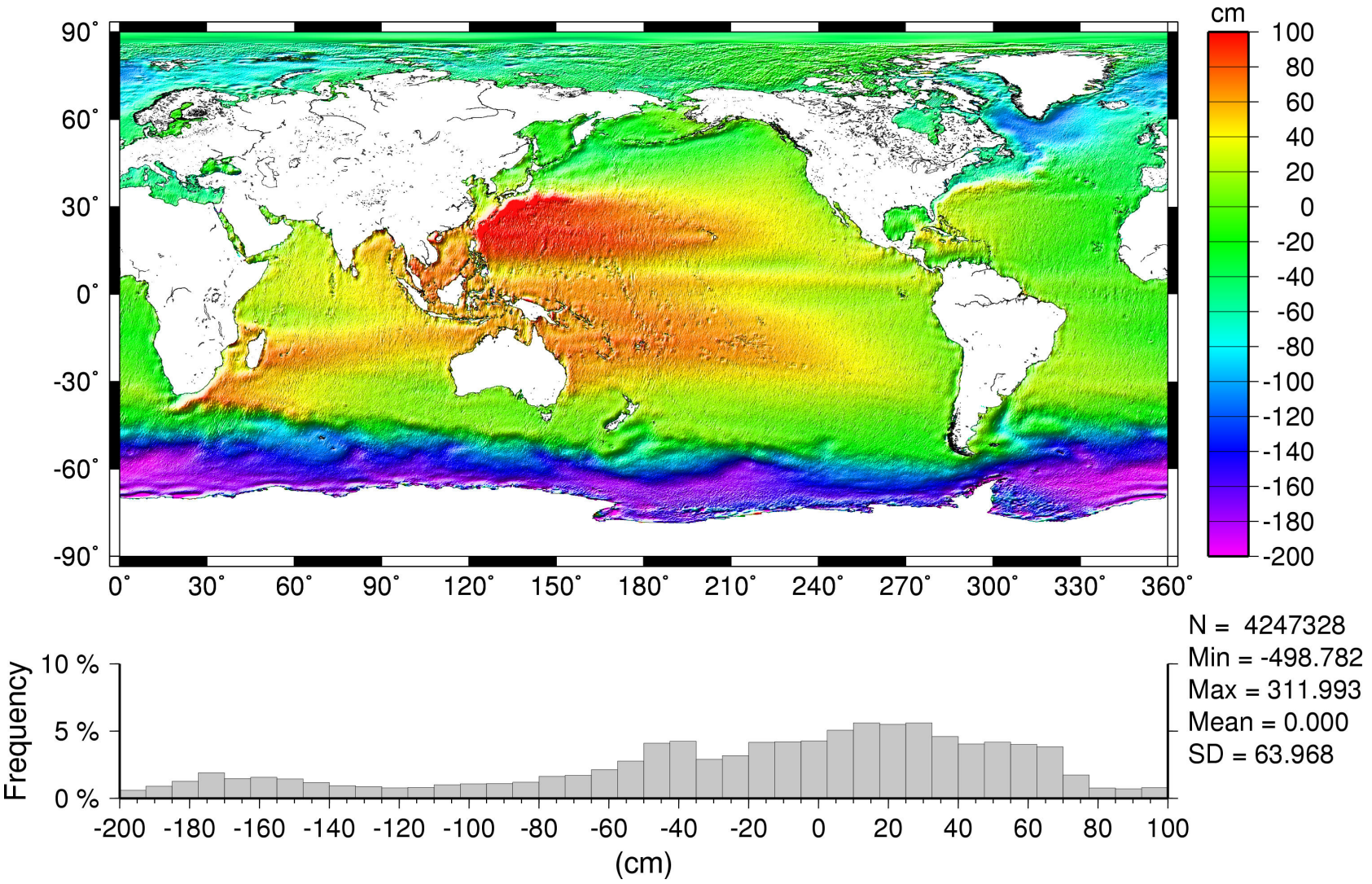
6’×6’ ΔSSH DNSC08B – EGM2008 (Nmax = 2190)



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Evolution des orbites de CHAMP/GRACE/GOCE