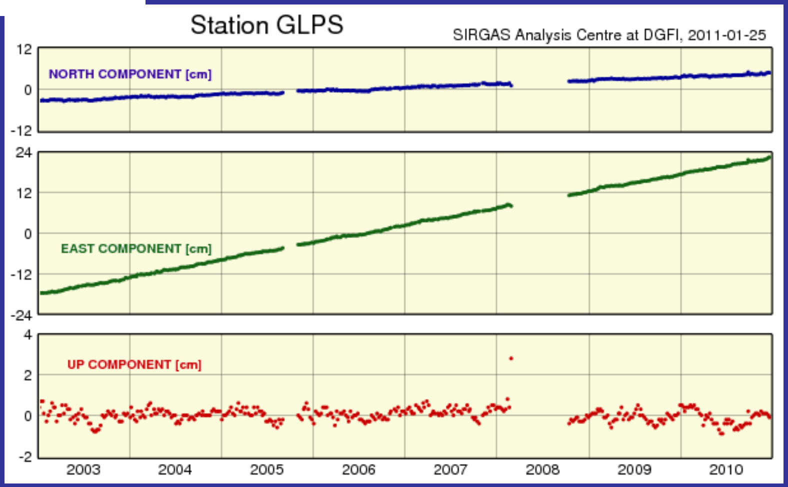
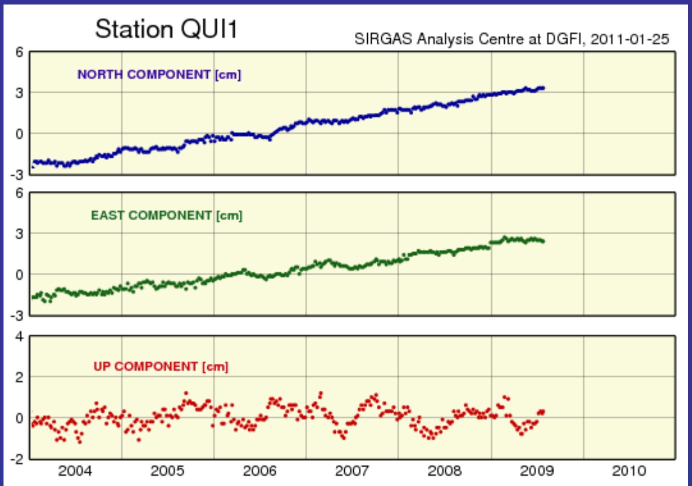
Sistema de Referência Vertical para Ecuador

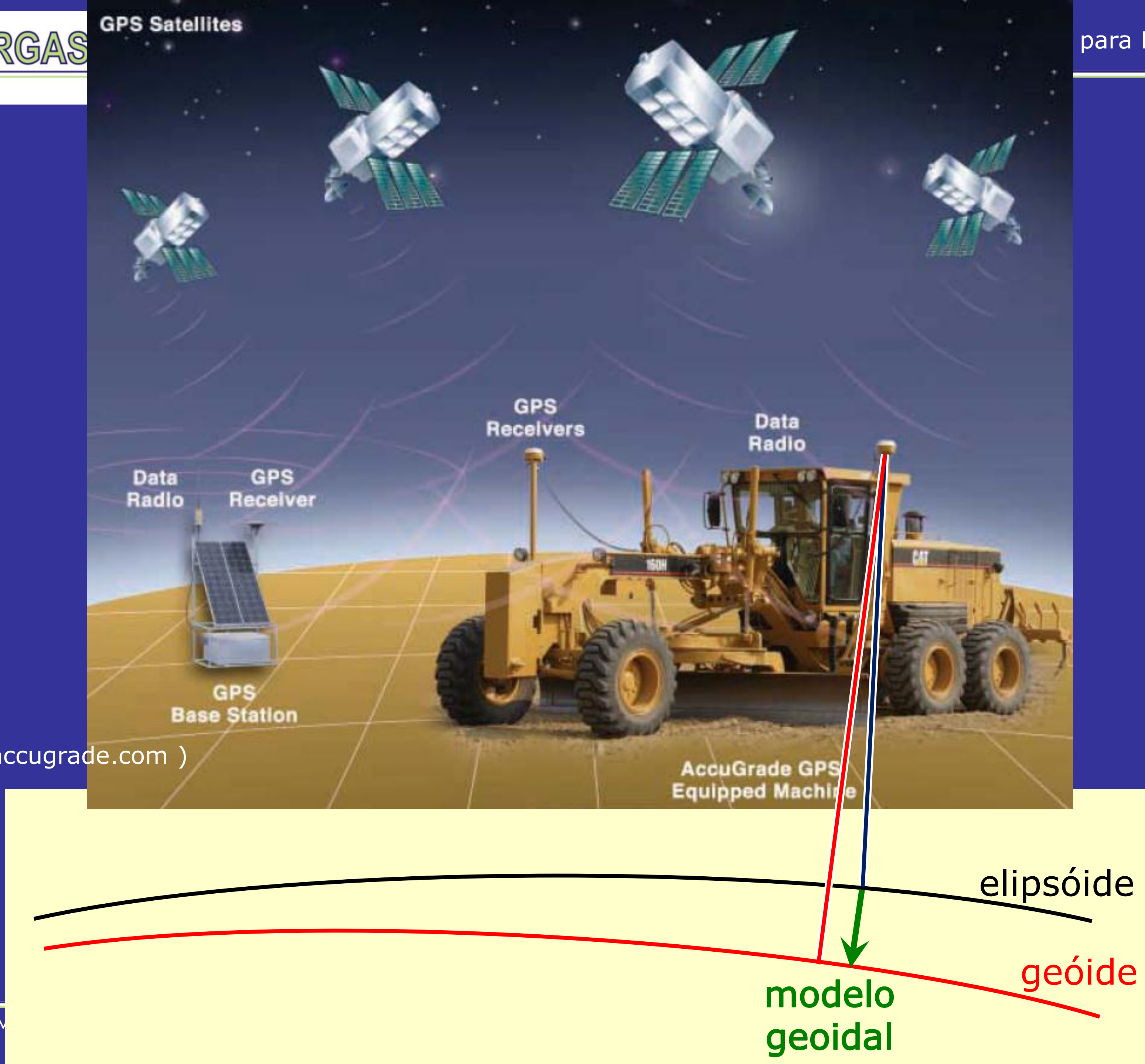
Roberto Teixeira Luz
Grupo de Trabalho “Datum Vertical” (GT-III), Projeto SIRGAS

Celebração do 83º Aniversário do IGM de Ecuador
08 . 04 . 2011





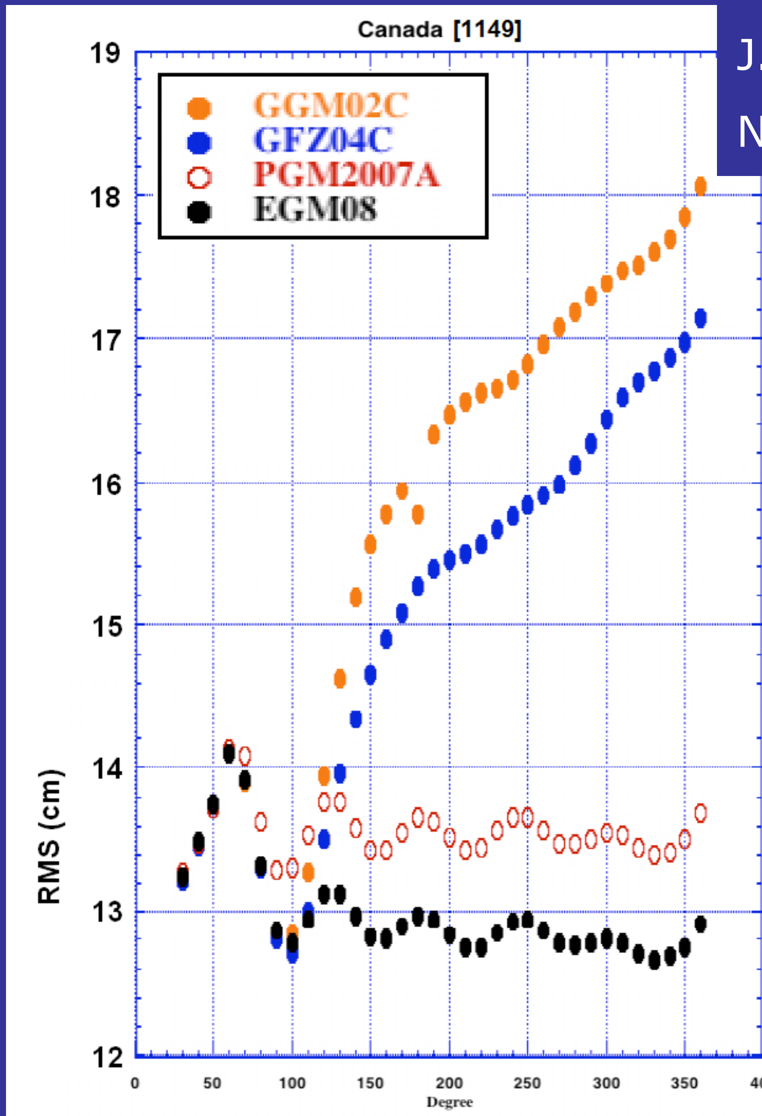
(http://www.sirgas.org/index.php?id=148)

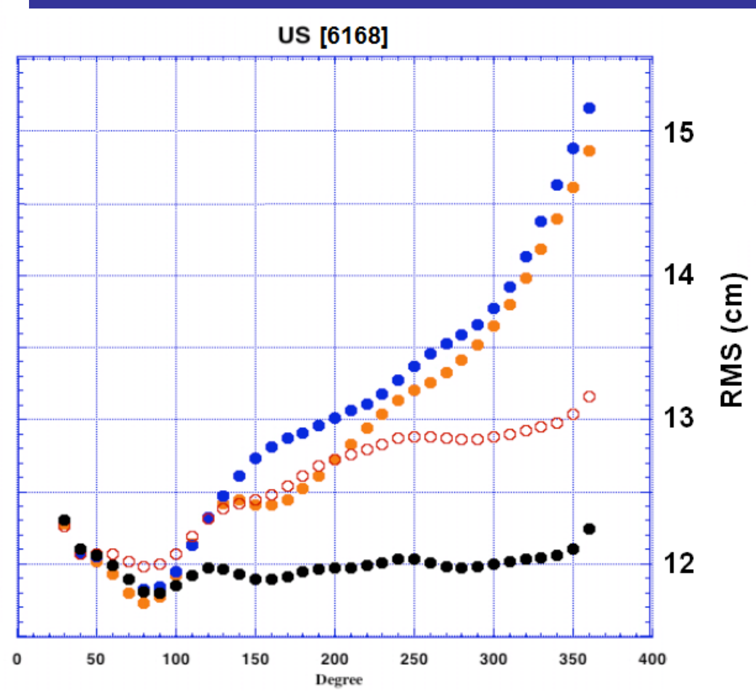


(www.cataccugrade.com)

	SR530, SR520, SR510
Coordinate (position), baseline, stakeout displays	Identical for SR530, SR520, SR510
All displays apply to:	Real-time RTK, DGPS, and navigation positions
Real-time RTK	SR530 standard
DGPS	SR530 standard, SR520/SR510 optional
Navigation	SR530, SR520, SR510
Coordinate (position) displays:	
Ellipsoidal	Latitude, longitude, height.
Cartesian	X, Y, Z
Grid	Easting, Northing, Height
Height	Ellipsoidal, Orthometric
Coordinate systems	Management of ellipsoids, projections, geoidal models, transformation parameters
Ellipsoids	All common ellipsoids User-definable ellipsoids
Map projections User definable and country specific	Transverse Mercator UTM Oblique Mercator Lambert (1 and 2 standard parallels) Soldner Cassini Polar Stereographic Other country-specific projections
Geoidal model ???	Upload geoidal model from SKI-Pro
Transformation in receiver	Classical 7-parameter 3-D Helmert One step and two step (direct WGS84 to grid)

J. Cheng, C. Ries, D. P. Chambers (2009): Newton's Bulletin, v. 4, p. 24





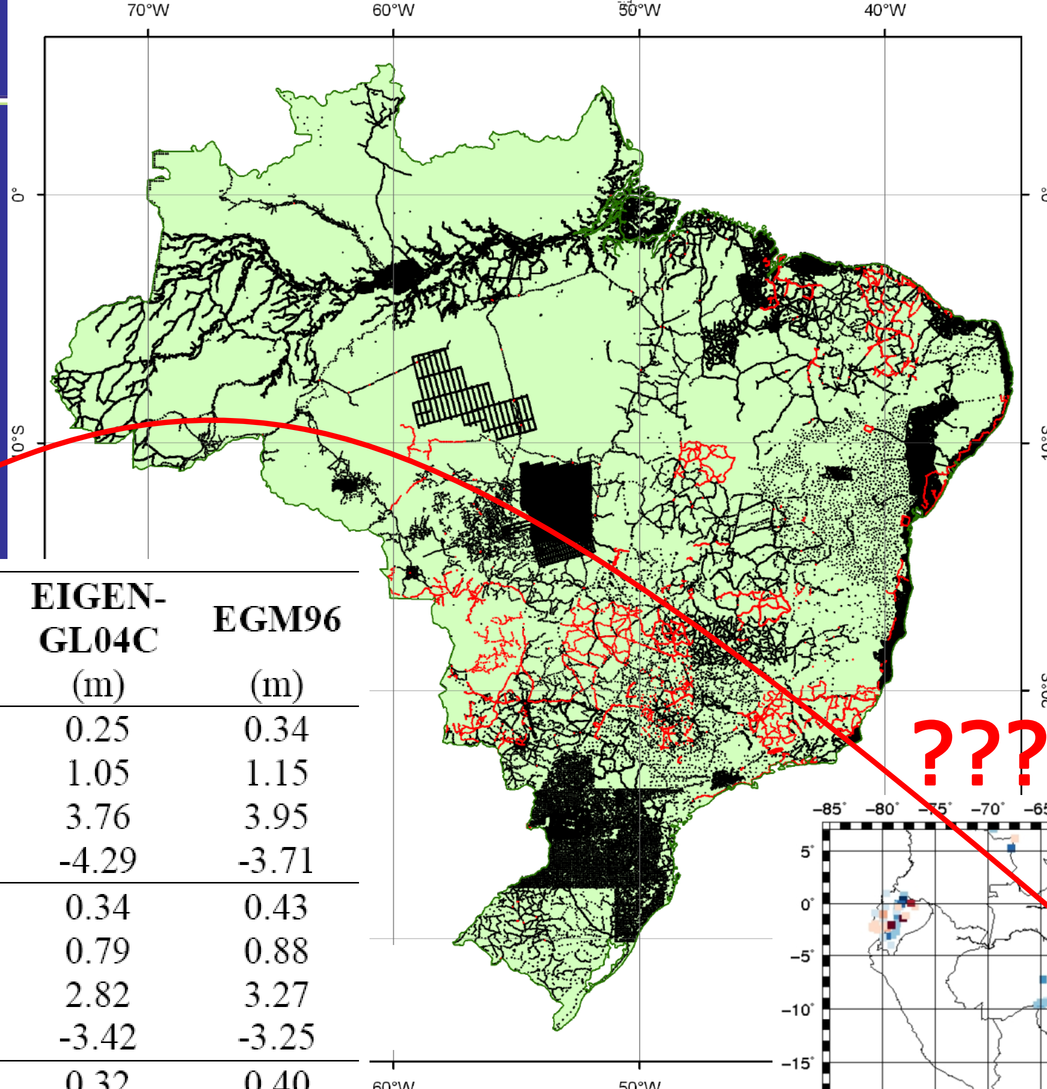
SIRGAS

…ertical para Ecuador

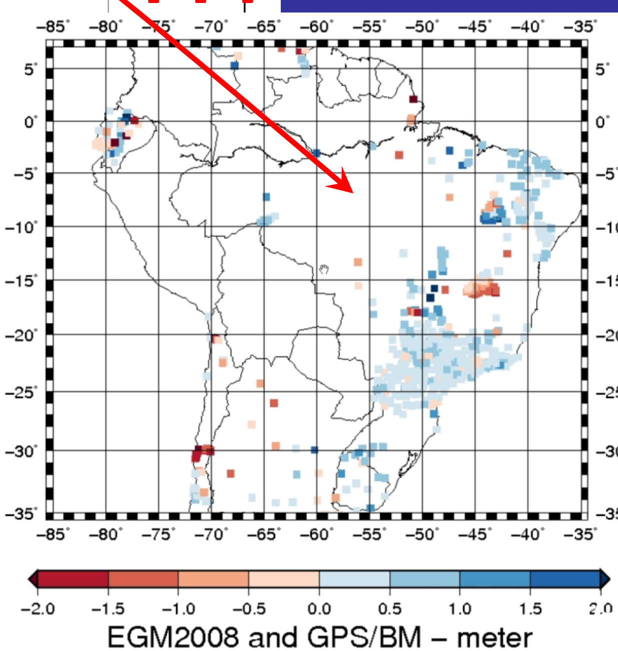
Kenyon (2009):

www.iag2009.com.ar

n=m	Dataset [696]	EGM2008 (m)	EIGEN-GL04C (m)	EGM96 (m)
60	Mean	0.26	0.25	0.34
	RMS dif.	1.06	1.05	1.15
	Max.	3.85	3.76	3.95
	Min.	-4.30	-4.29	-3.71
120	Mean	0.34	0.34	0.43
	RMS dif.	0.79	0.79	0.88
	Max.	2.95	2.82	3.27
	Min.	-3.38	-3.42	-3.25
360	Mean	0.31	0.32	0.40
	RMS dif.	0.58	0.62	0.75
	Max.	2.81	3.12	3.73
	Min.	-3.05	-2.85	-3.03
2160	Mean	0.29		
	RMS dif.	0.56		
	Max.	2.78		
	Min.	-3.05		



???



D. Blitzkow, A. C. O. C. Matos (2009):

Newton's Bulletin, v. 4, p. 81-82

RESUMO

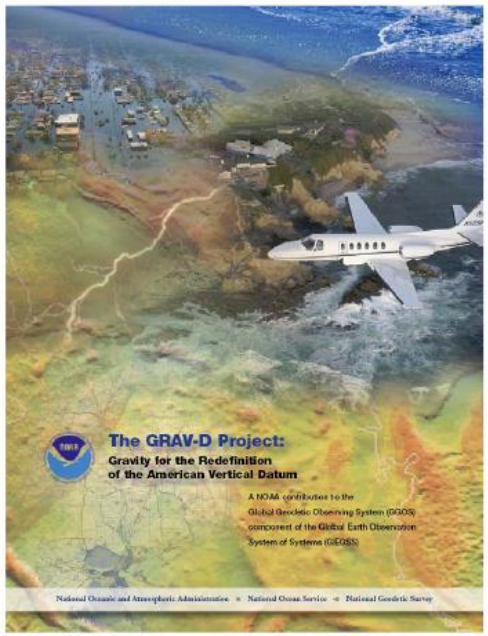
país	núm.pontos	RMS (cm)
BRASIL	696	53~58
Argentina	715	44~48
Alemanha	675	4
Austrália	197	24
Japão	837	10
Canadá	1149	13
EUA	6168	12

>>> GOCE ???

Fonte: Newton's Bulletin, v. 4 (2009)
(http://bgi.omp.obs-mip.fr/index.php/eng/ Publications/Newton-s-bulletin)

National Geodetic Survey

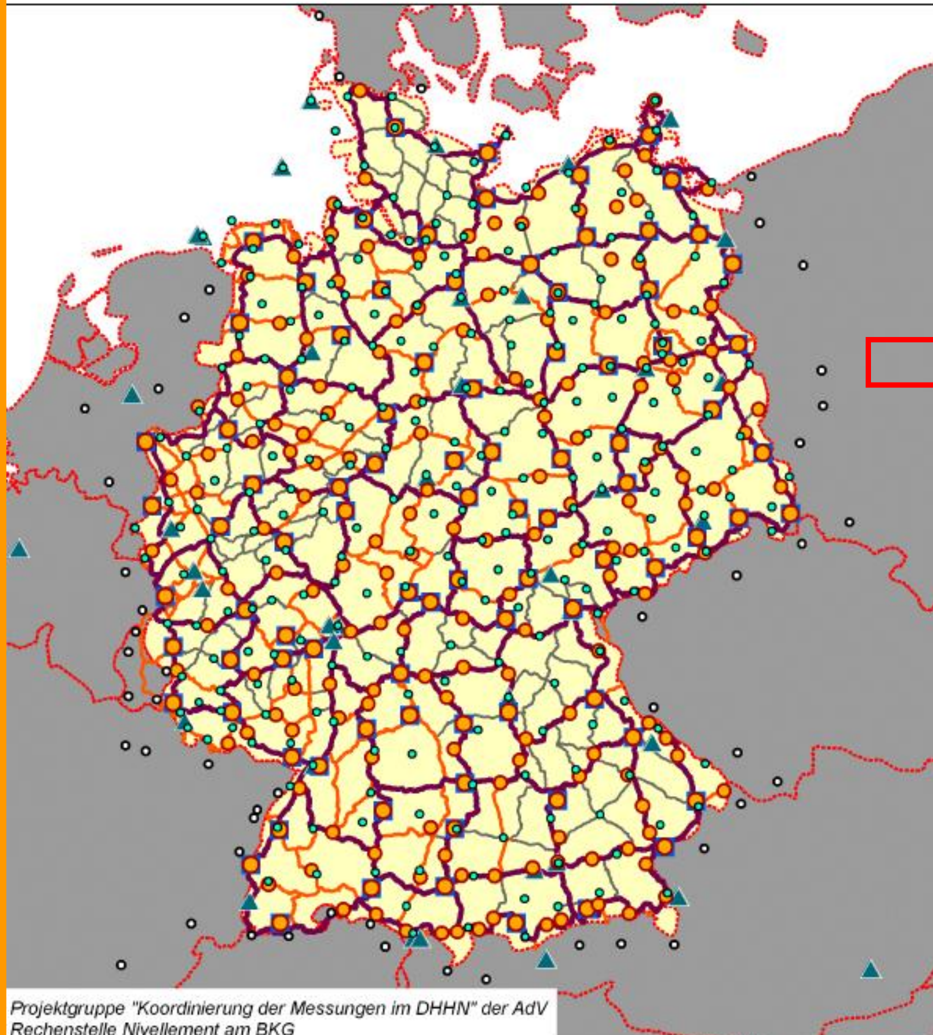
NGS' Plan: GRAV-D



- Official NGS policy:
  - *Re-define the US Vertical Datum by creating a new gravimetric geoid*
  - *10 year program*
- Two Major Program Elements
  - *Airborne Gravity "Snapshot" for Baseline*
  - *Long Term Monitoring of Temporal Changes*
- *Projected program cost: $38.5M over 10 years*

National Oceanic and Atmospheric Administration

Childers et al. (2009): www.iag2009.com.ar



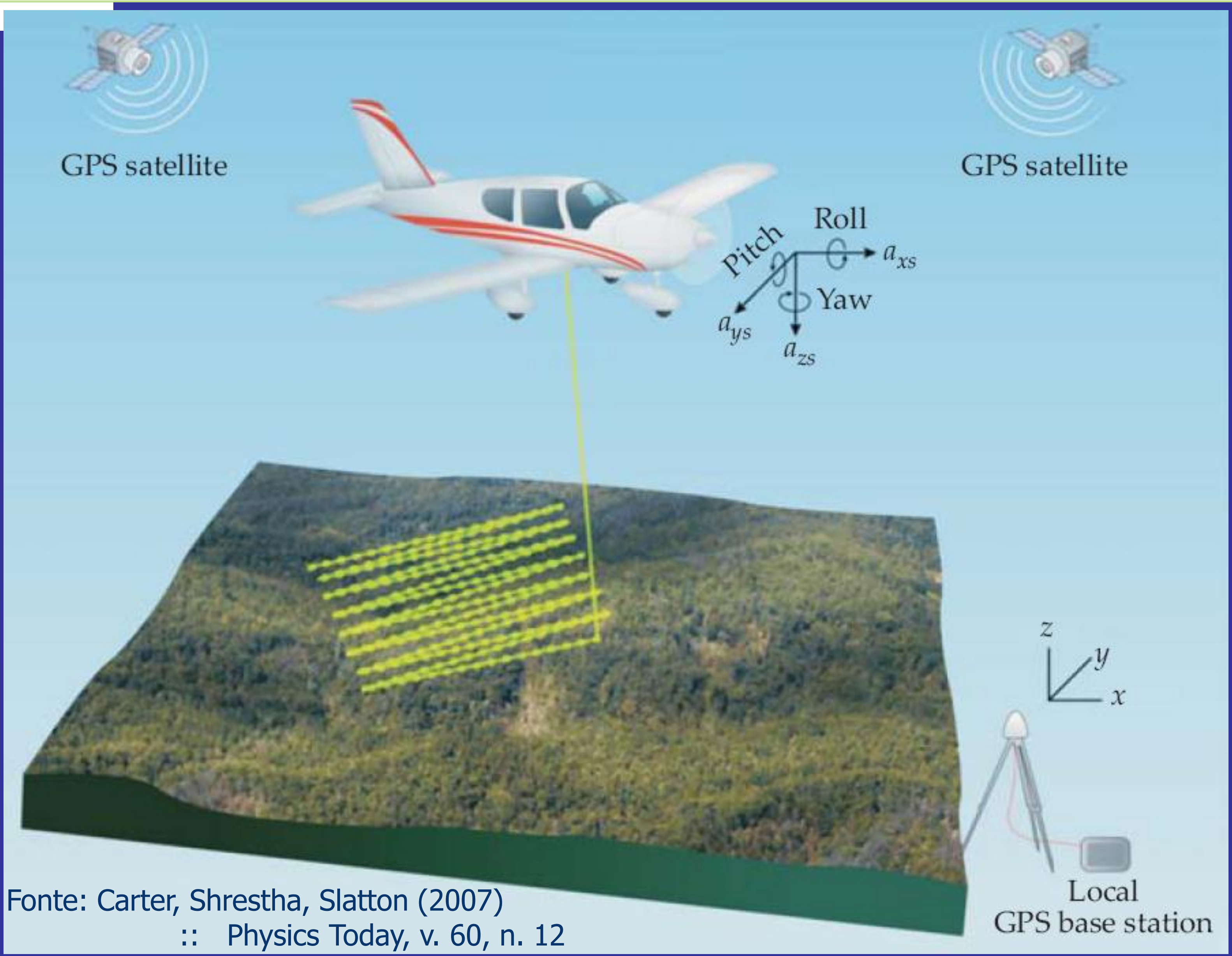
DHHN2010 combined with GNSS and absolute gravity

Releveling 2006 - 2011
GNSS campaign 2x24h
May/June 2008
Absolut Gravity 2009 - 2011

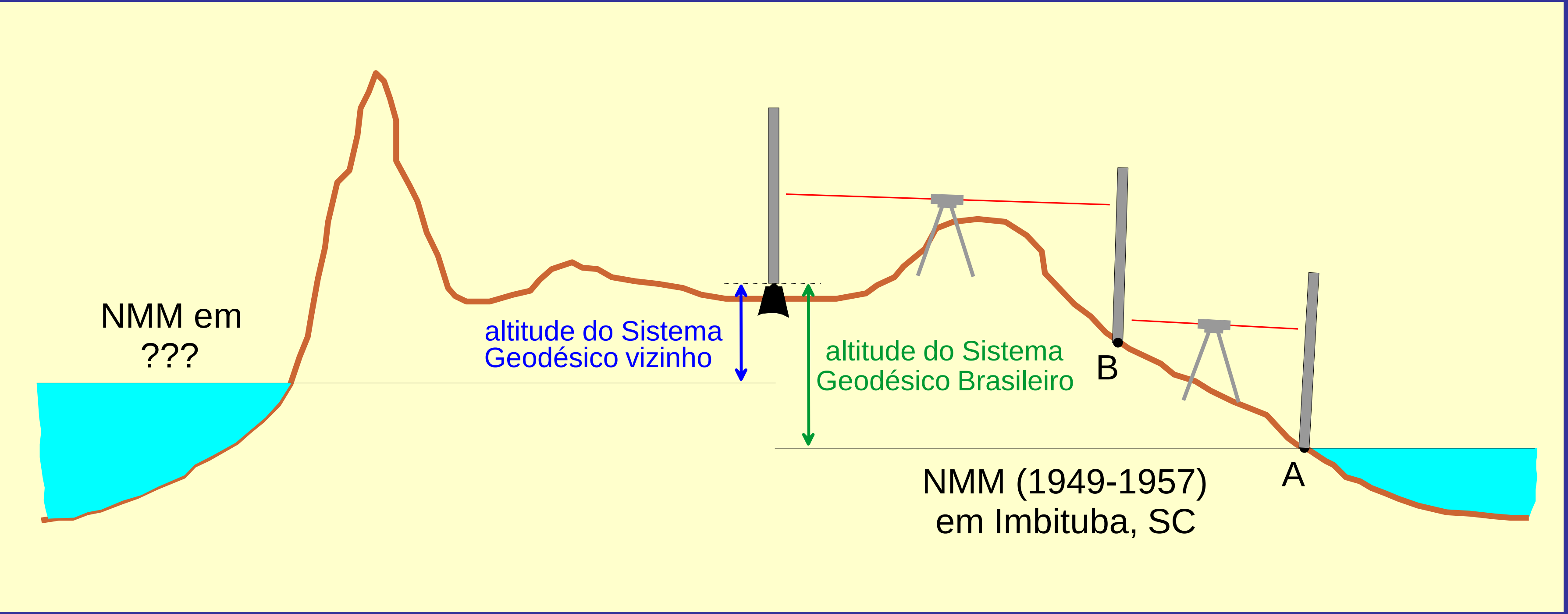
Stand September 2008

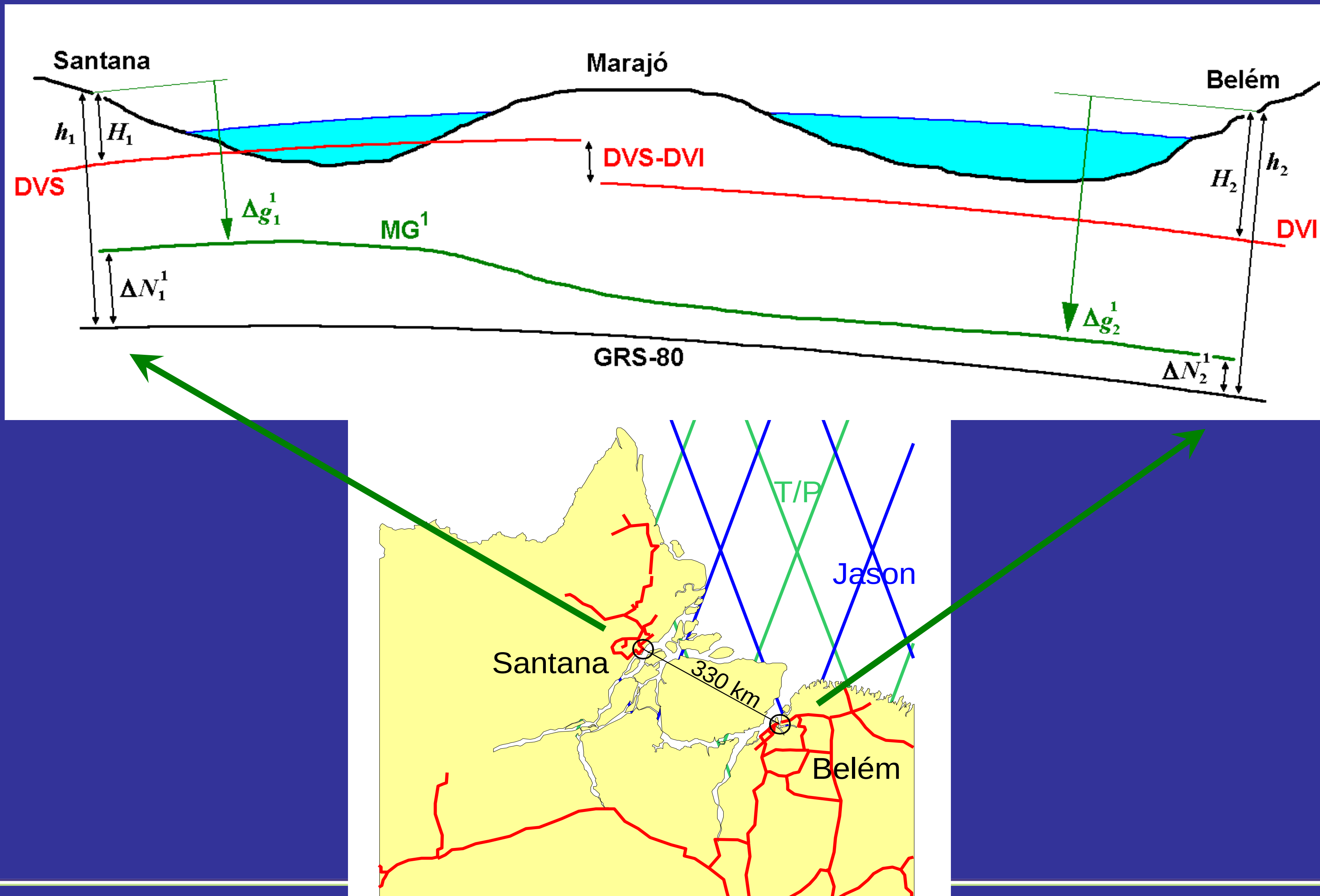
●	GNSS-Station	250
■	GNSS+Absolutschwere	100
•	SAPOS-Station	250
○	Station benachbarter Positionierungsdienste	
▲	IGS/EPN/GREF-Station	
—	Pflichtlinien	
—	optionale Linien	
—	restliche Linien des DHHN92	

Ihde et al. (2009): www.iag2009.com.ar



Fonte: Carter, Shrestha, Slatton (2007)
:: Physics Today, v. 60, n. 12


NMM em
???
altitude do Sistema
Geodésico vizinho
altitude do Sistema
Geodésico Brasileiro
B
A
NMM (1949-1957)
em Imbituba, SC


Santana
Marajó
Belém
h_1
H_1
DVS
DVS-DVI
Δg_1^1
MG[1]
ΔN_1^1
GRS-80
H_2
h_2
DVI
Δg_2^1
ΔN_2^1
T/P
Jason
Santana
330 km
Belém

Strategies for the vertical datum unification

Oceanic approach
(SStop around gauges)
Satellite altimetry and satellite-only GGM, SSTop at coast lines including also tide gauge records.

$$T_P^j - T_0 = \delta W^j$$

Coastal approach
(reference tide gauges)
GPS positioning at tide gauges, (geopotential numbers), terrestrial gravity and satellite-only GGM.

$$\frac{1}{2}T_P^j - \frac{1}{2}h_P\gamma_P = \delta W^j$$

Terrestrial approach
(geometrical reference stations)
GPS positioning at reference stations (including border points), geopotential numbers, terrestrial gravity and satellite-only GGM.

$$\frac{1}{2}\left(T_P^j + \Delta C_P^j\right) - \frac{1}{2}h_P\gamma_P = \delta W^j$$

$$\frac{1}{2}\left(T_P^j + \Delta C_P^j\right) - \frac{1}{2}\left(T_P^{j+1} + \Delta C_P^{j+1}\right) = \delta W^{j+1} - \delta W^j$$

Solution of observation equations by a combined adjustment !

Height datum unification within a global vertical reference system
IAG Scientific Assembly, 2009-09-02, Buenos Aires, Argentina

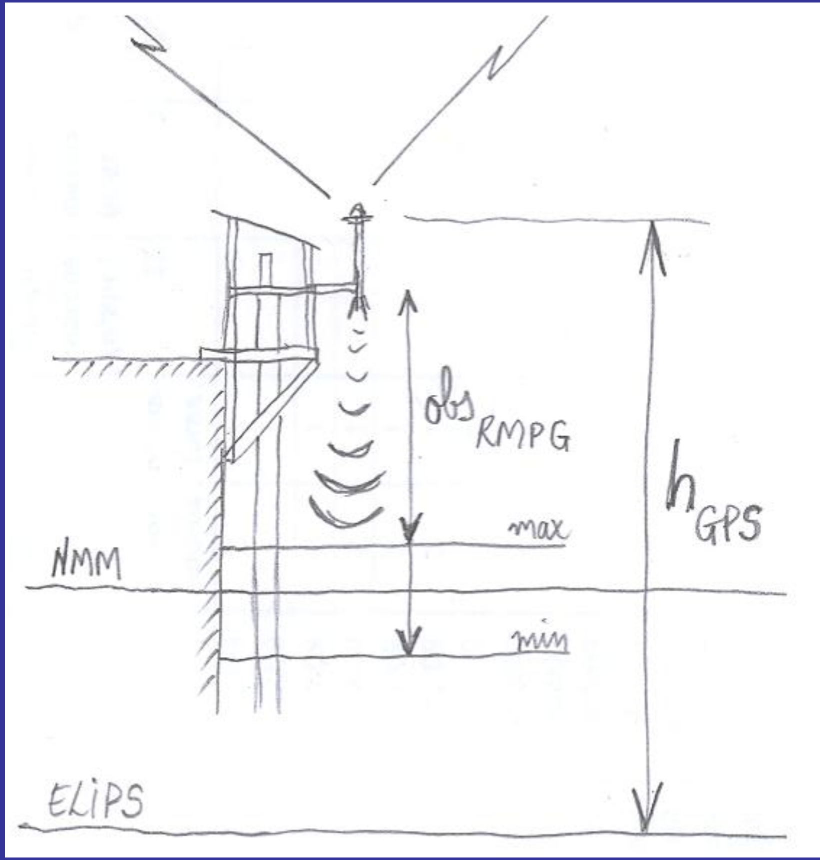
SIRGAS DGFI

Fonte: Sánchez (2009) :: www.iag2009.com.ar

Situação ideal

Table 4.1 Accuracy of geodetic fixing of TGBMs.

Technique	Accuracy
GPS from TGBM to SLR/VLBI Reference Frame	<1 cm
Absolute Gravity near Tide Gauges and at SLR/VLBI Station	<2 µgal (approx. 1 cm)



Situação real

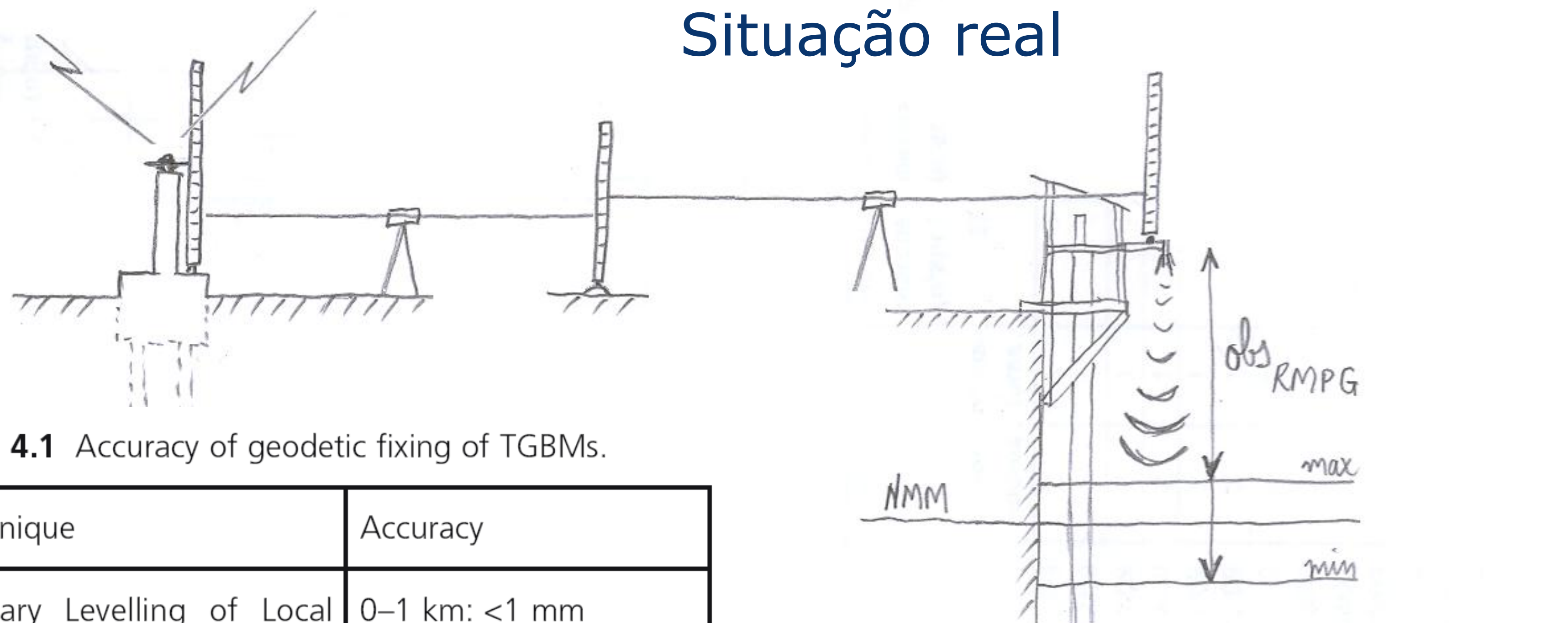


Table 4.1 Accuracy of geodetic fixing of TGBMs.

Technique	Accuracy
Primary Levelling of Local Benchmarks	0–1 km: <1 mm 1–10 km: <1 cm
GPS from TGBM to SLR/VLBI Reference Frame	<1 cm
Absolute Gravity near Tide Gauges and at SLR/VLBI Station	<2 µgal (approx. 1 cm)

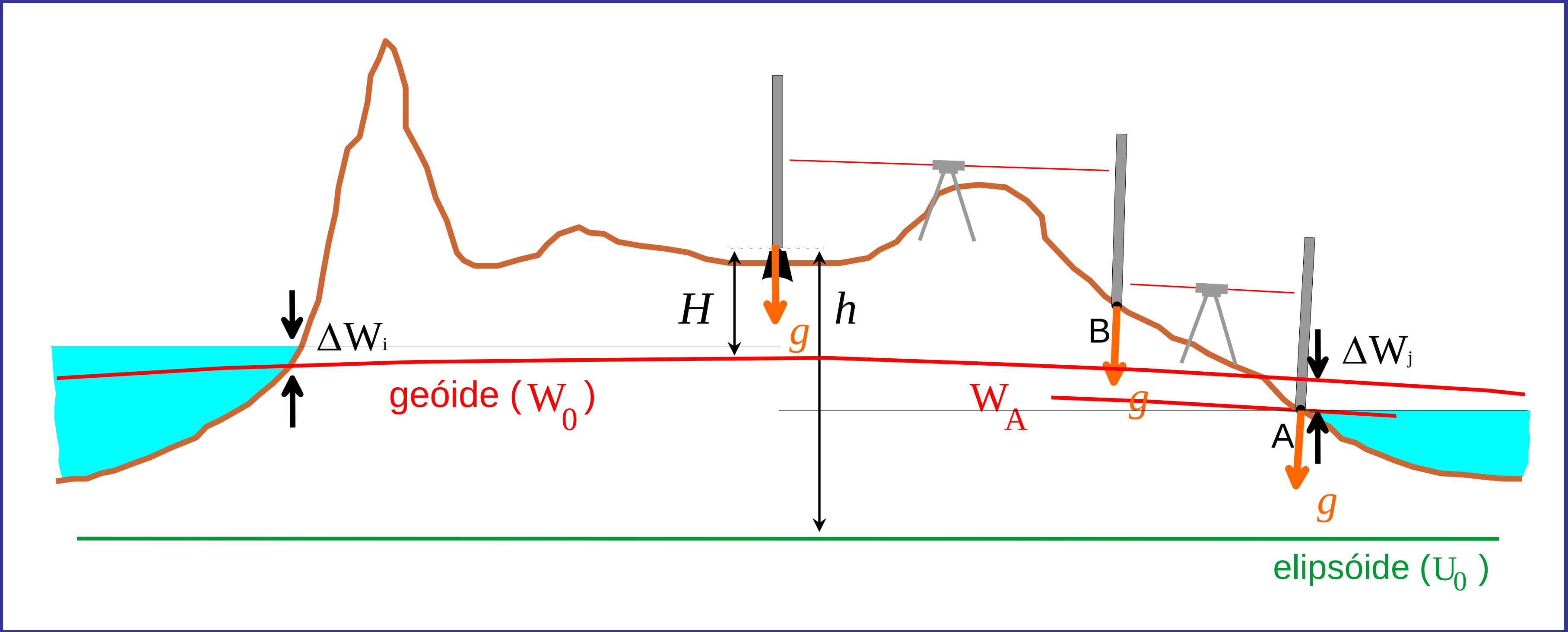
Fonte: *Manual on Sea Level Measurement and Interpretation*
(http:// www.pol.ac.uk / psmsl / manuals)
vol. II (1994): p. 26
vol. III (2002): p. 37
vol. IV (2006): p. 31

Sistema Vertical SIRGAS

- estações SIRGAS CON
- estações nos *data* verticais
- estações nas fronteiras

a. altitudes geométricas

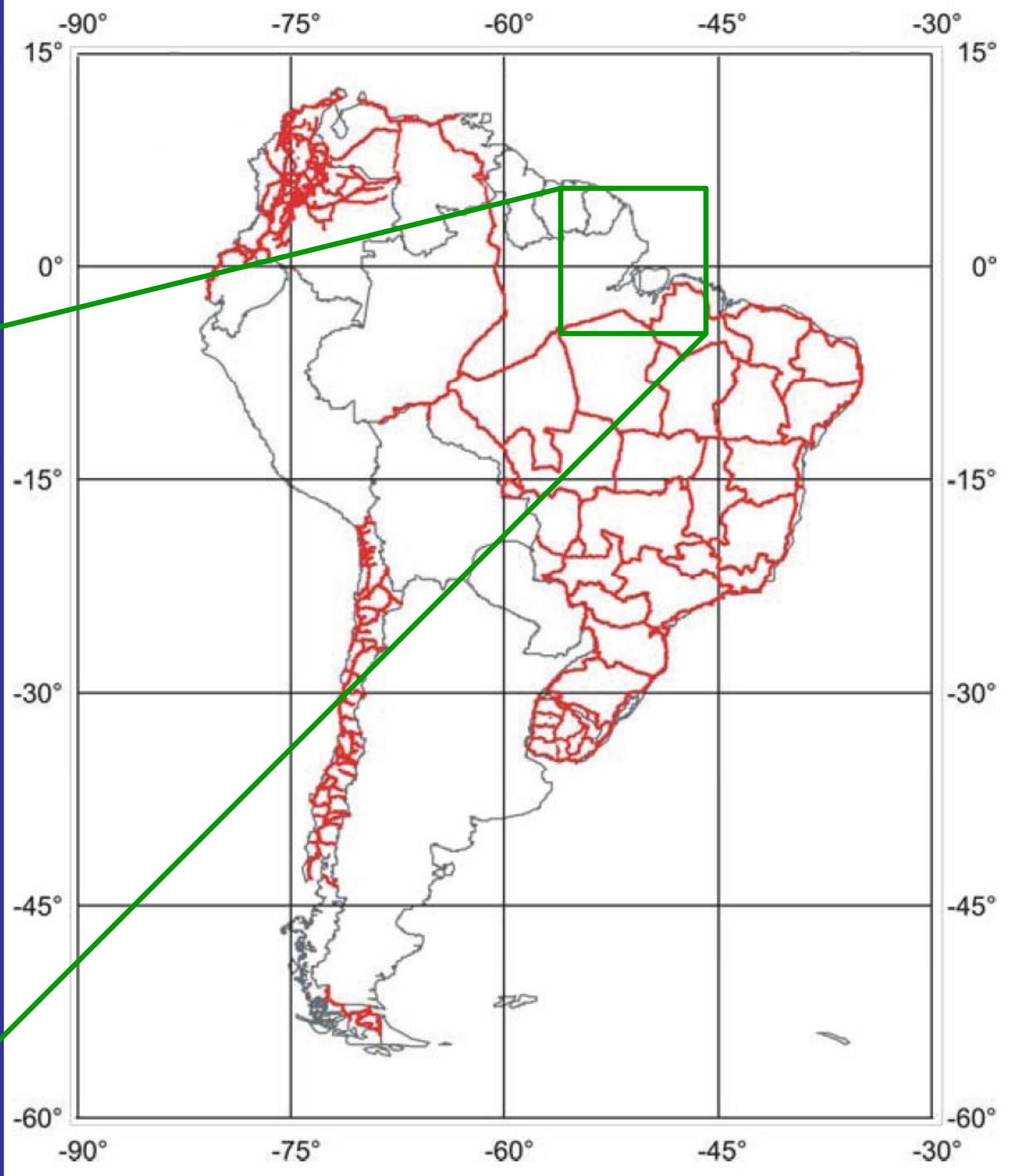
b. altitudes físicas (números geopotenciais)



Dificuldades para uma rede de nivelamento "continental" interligando as estações SIRGAS

- os Andes

- a Amazônia (rios e floresta)



Dificuldades para uma rede de nivelamento "continental" (cont.)

- os Andes

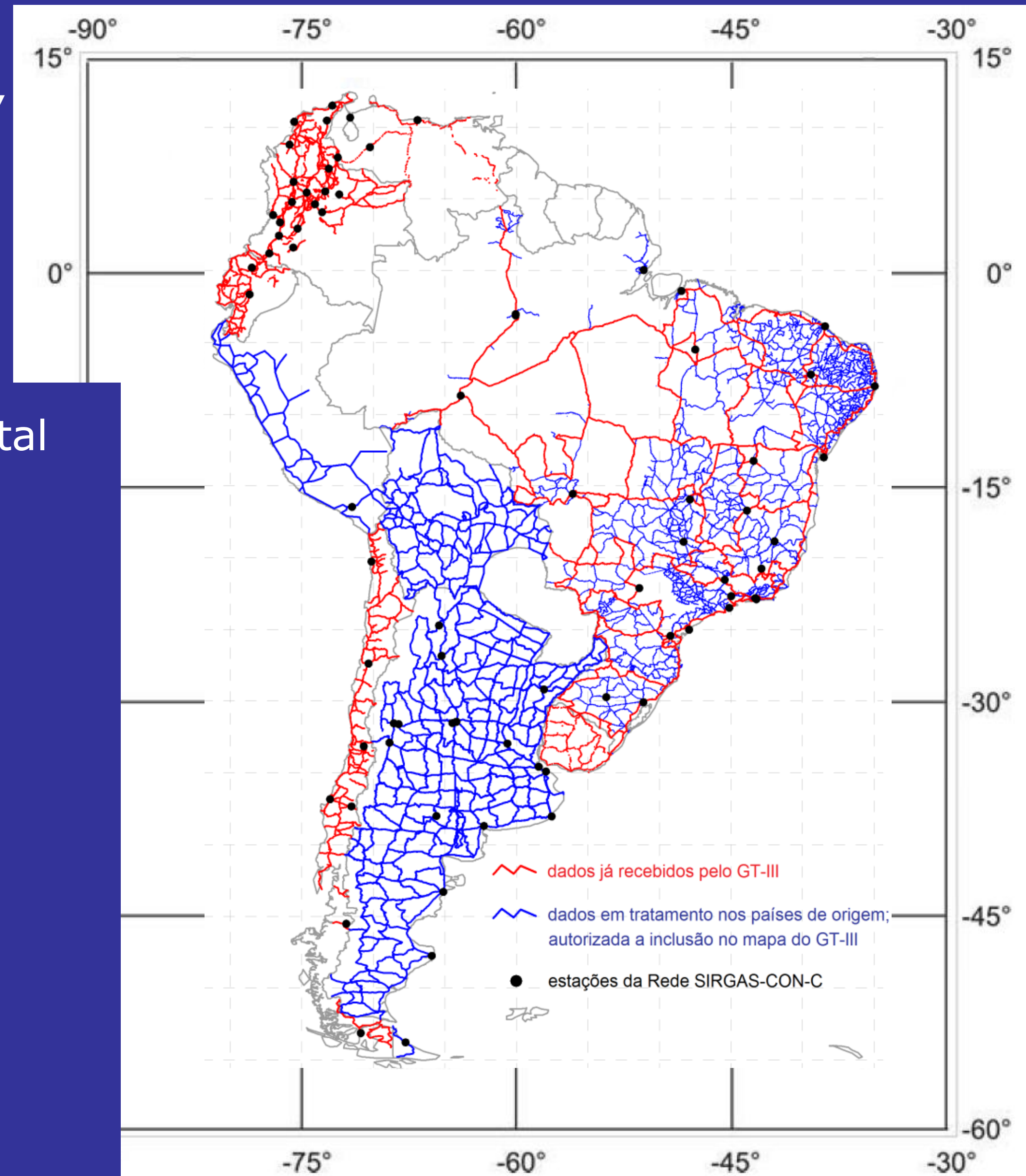
- a Amazônia (rios e floresta)

- a ausência de dados em meio digital

- o problema (3,5m +/- ?) na longa linha aberta que liga Venezuela e Brasil

- a heterogeneidade espacial e temporal dos dados enviados ao GT-III do SIRGAS

- a ausência de gravidade nas estações de nivelamento



Comentários finais

- nivelar e gravimetrar a rede de estações GNSS ativas
- ampliar esta rede, incluindo também os principais marégrafos
- vincular a rede gravimétrica básica às estações absolutas
- ampliar as redes gravimétricas (básica e de densificação)
- discutir a viabilidade da aerogravimetria
- discutir alternativas para a densificação da rede de nivelamento e o cálculo de modelos geoidais (local e regional)
- dados de nivelamento e gravidade já enviados a SIRGAS (2007; 2009)
- IGM continuou a refinar esses dados depois desses envios
- continuar o magnífico esforço de capacitação e organização!!!

Muchas Gracias!