Geopotential Value at NAVD88 and IGN69 refined

Milan Bursa[1], Steve Kenyon[2], Radomir Kopecky[3], Jan Kouba[4], Zdislav Sima[1], Viliam Vatrt[3], Marie Vojtiskova[3]

[1]Astronomical Institute, Academy of Sciences of the Czech Republic, Prague, CR, e-mail: bursa@ig.cas.cz, sima@ig.cas.cz
[2] National Geospatial-Intelligence Agency, MO 63010-6238, U.S.A.; e-mail: Kenyons@nga.mil
[3]Geographical Service of the Czech Armed Forces, Military Geography and Hydrometeorology Office, Dobruska, CR, e-mail: vatrt@vghur.army.cz, marie.vojtiskova@vghur.army.cz
[4] Geodetic Survey Division, Natural Resources Canada, Ottawa, Canada, e-mail: kouba@geod.nrcan.gc.ca

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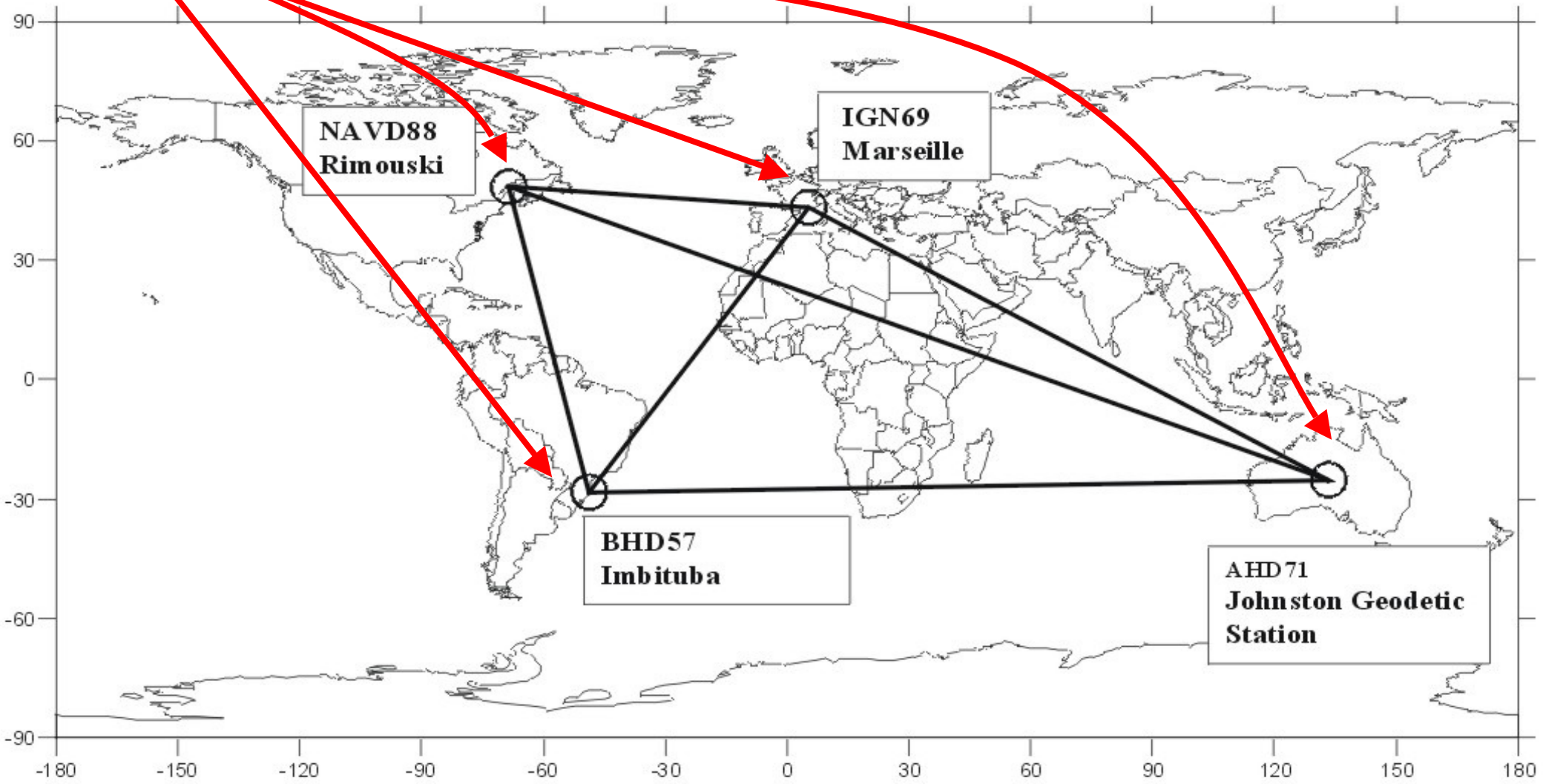
-Our group takes part in the IAG Inter-Commission Project Vertical Reference Frames (chairman Johannes Ihde) ICP1.2

-Our presentation contains an example of our contribution to the project

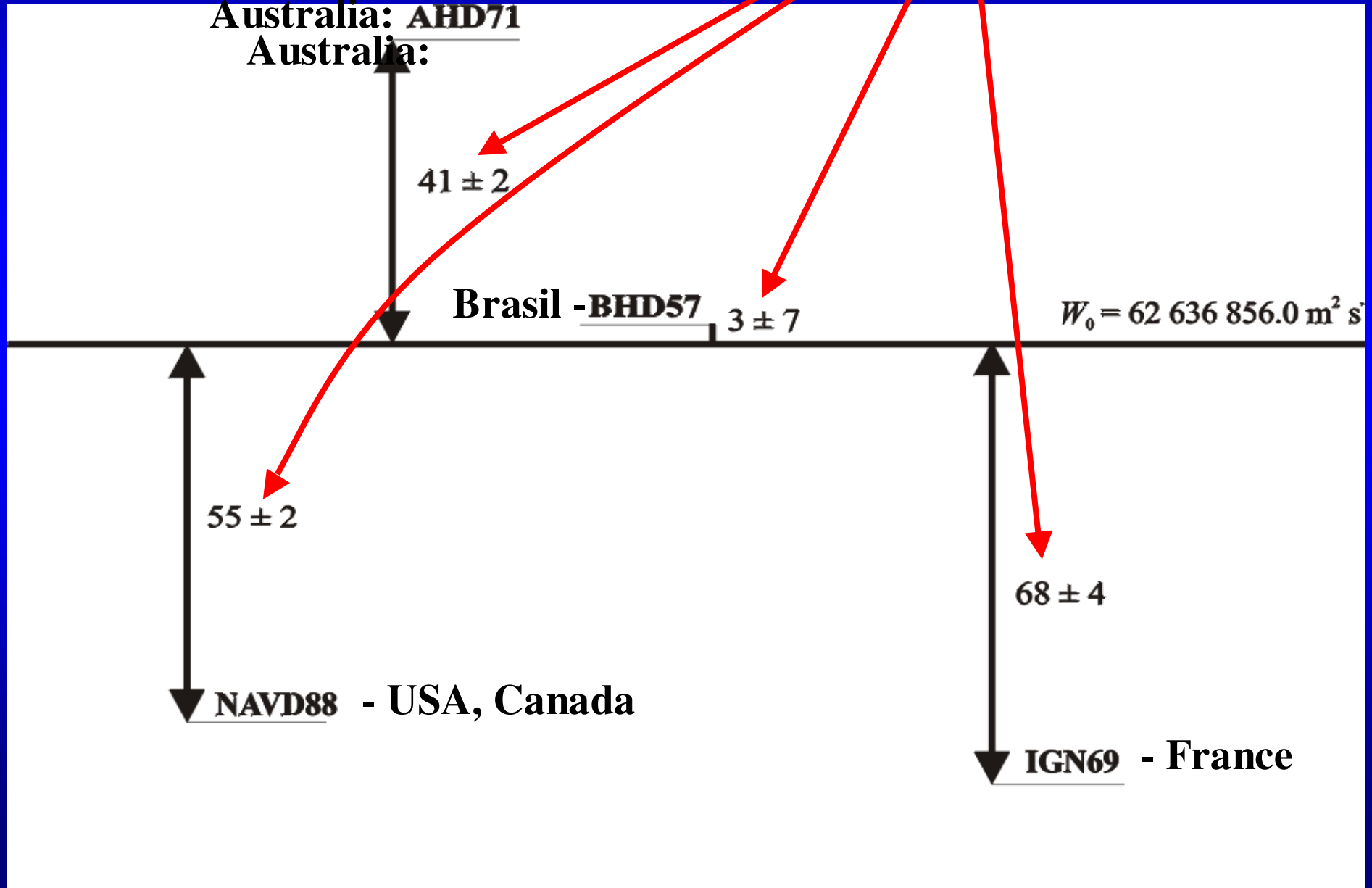
- We mention a refined geopotential value at NAVD88 and IGN69 LVDs developed by EGM08

- The methodology can be used for other territories

In the past we introduced a project of Global Vertical Reference Frame based on four LVDs



Previous result of four LVDs vertical shift to the W_0 value (by EGM96 geopotential model)



- **Availability of new geopotential model EGM08 offered us the opportunity to use again our methodology for determination of geopotential $W_{0,IGN69}$, $W_{0,NAVD88}$ and its connection to W_0**

1st STEP of our methodology:

The Helmert orthometric heights on the territory of the USA and Canada were transformed into the Molodensky's normal heights, the tidal corrections were applied, i.e. tide-free model was used

2nd STEP of our methodology :

The following constants have been adopted:

$GM = (398\ 600\ 441.8 \pm 0.8) \times 10^6\ m^3 \cdot s^{-2}$

$\omega = 7\ 292\ 115 \times 10^{-11}\ rad \cdot s^{-1}$

$W_0 = 62\ 636\ 856.0\ m^2 \cdot s^{-2}$

- our group is developing a new value of W_0 from Jason 1 and EGM08 (ICP - 1.2 project)

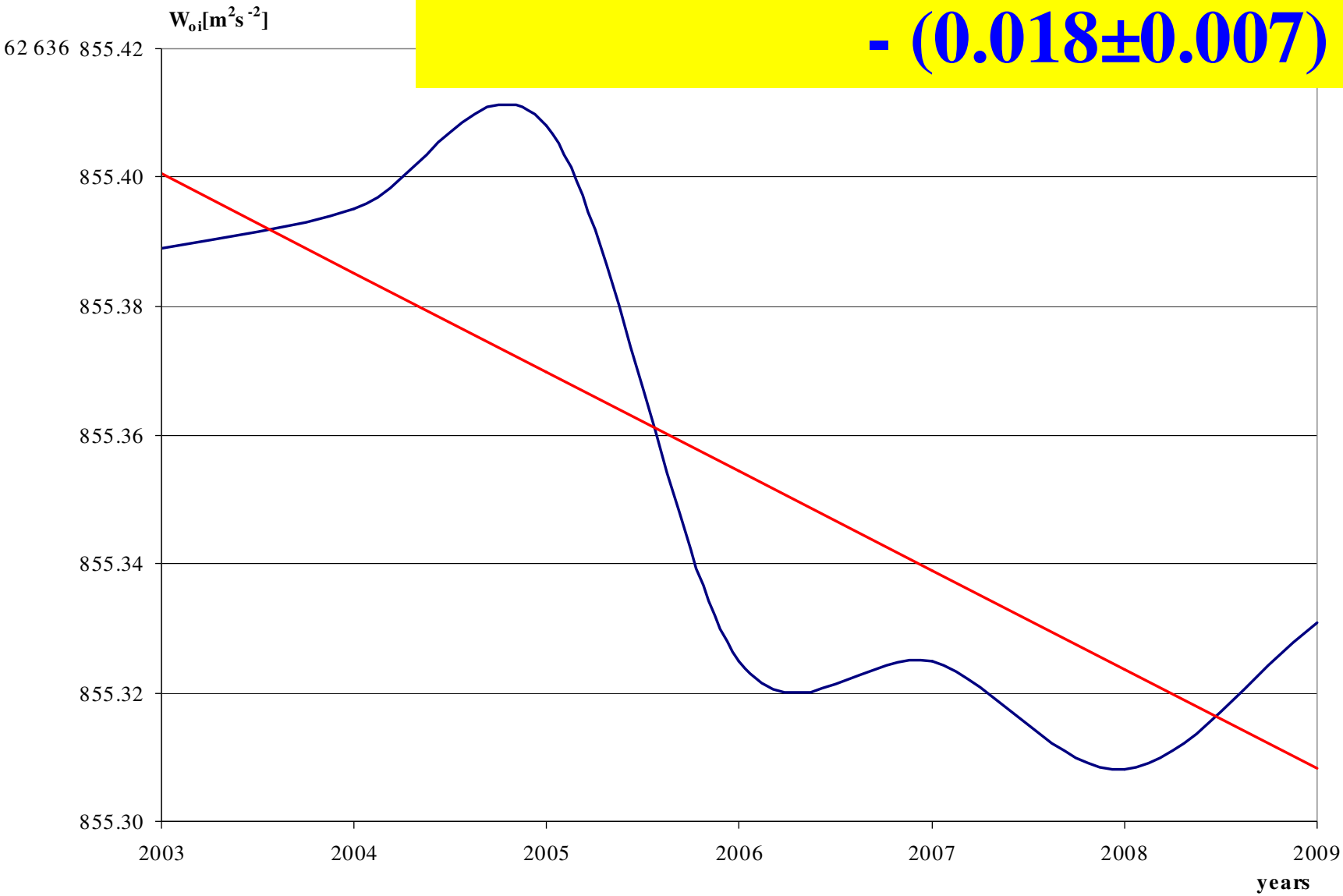
The geopotential W_{0i} value at the mean ocean surface, Jason-1 2003-2009

- δH_{0i} the height of surface $W = W_{0i}$ related to $W = W_0$
- $W_0 = 62\ 636\ 856\ m^2s^{-2}$

Years	Number of testing sites	W_{0i} [m^2s^{-2}]	$W_{0i} - W_0$ [m^2s^{-2}]	δH_{0i} [m]
2003	189 475	62 636 855.389±0.010	-0.611±0.010	+0.0621±0.0011
2004	276 446	62 636 855.395±0.010	-0.605±0.010	+0.0615±0.0011
2005	268 658	62 636 855.408±0.010	-0.592±0.010	+0.0602±0.0010
2006	296 050	62 636 855.325±0.010	-0.675±0.010	+0.0686±0.0010
2007	321 433	62 636 855.325±0.010	-0.675±0.010	+0.0686±0.0010
2008	285 000	62 636 855.308±0.010	-0.692±0.010	+0.0703±0.0010
2009	250 706	62 636 855.331±0.010	-0.669±0.010	+0.0680±0.0010

Long-term variation in W_{0i}, Jason-1 2003-2009

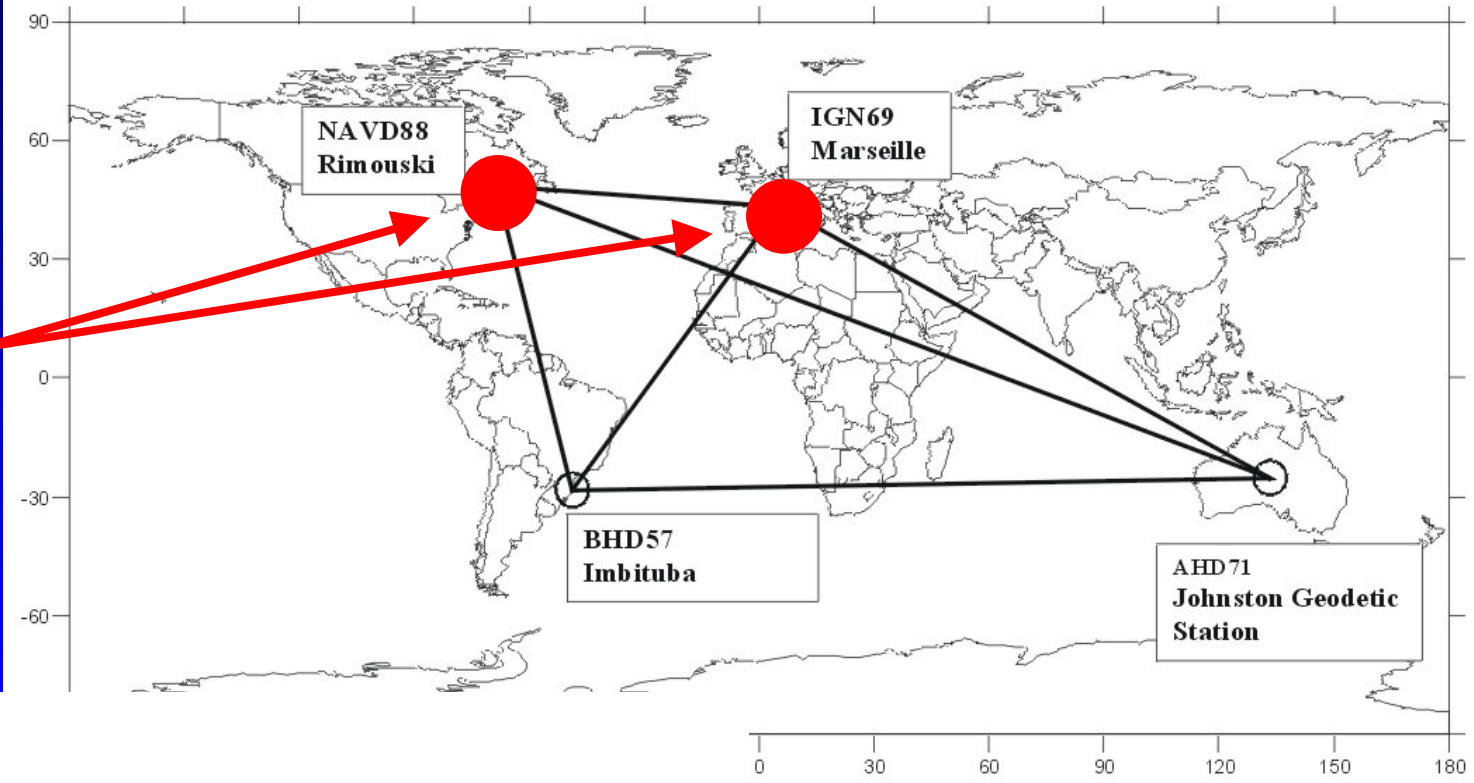
$$W_{0i} = (62\,636\,855.410 \pm 0.027)\ m^2s^{-2} - (0.018 \pm 0.007)\ m^2s^{-2}y^{-1}$$

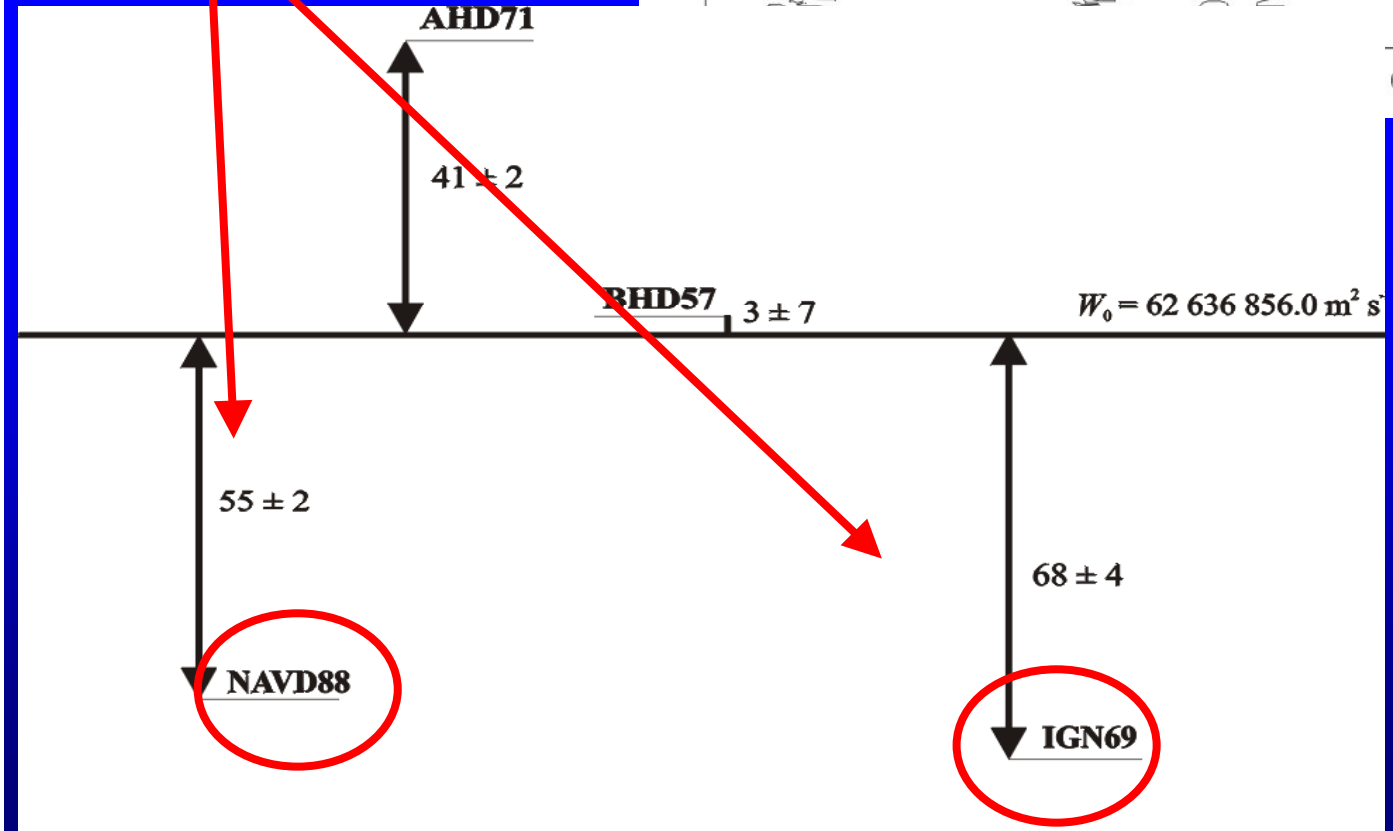


The following gravity models have been adopted:

EGM96 (for solution in the past)
EGM08 (for refining solution)

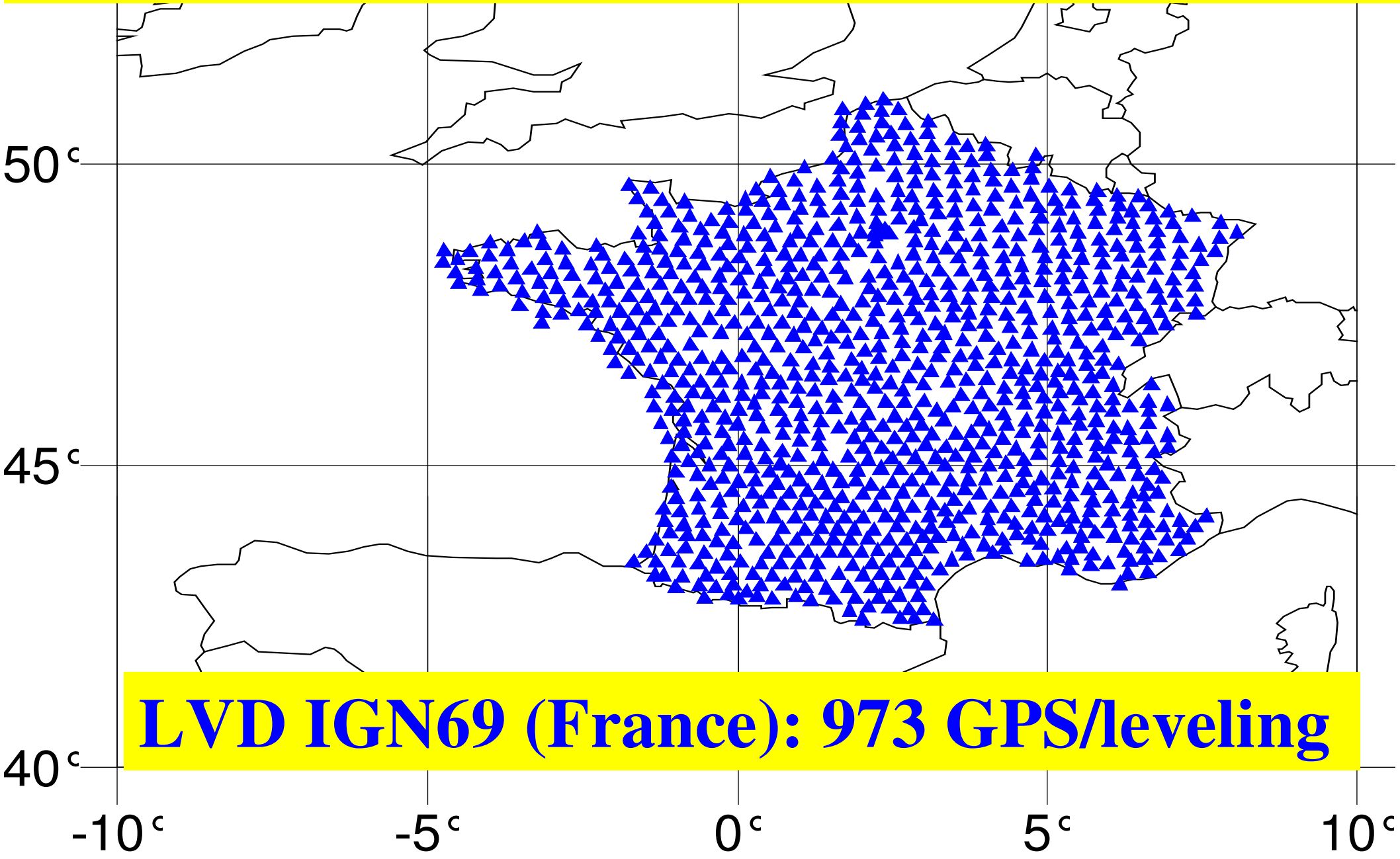
Refinement concerns <u>two</u> of four LVDs in the very moment





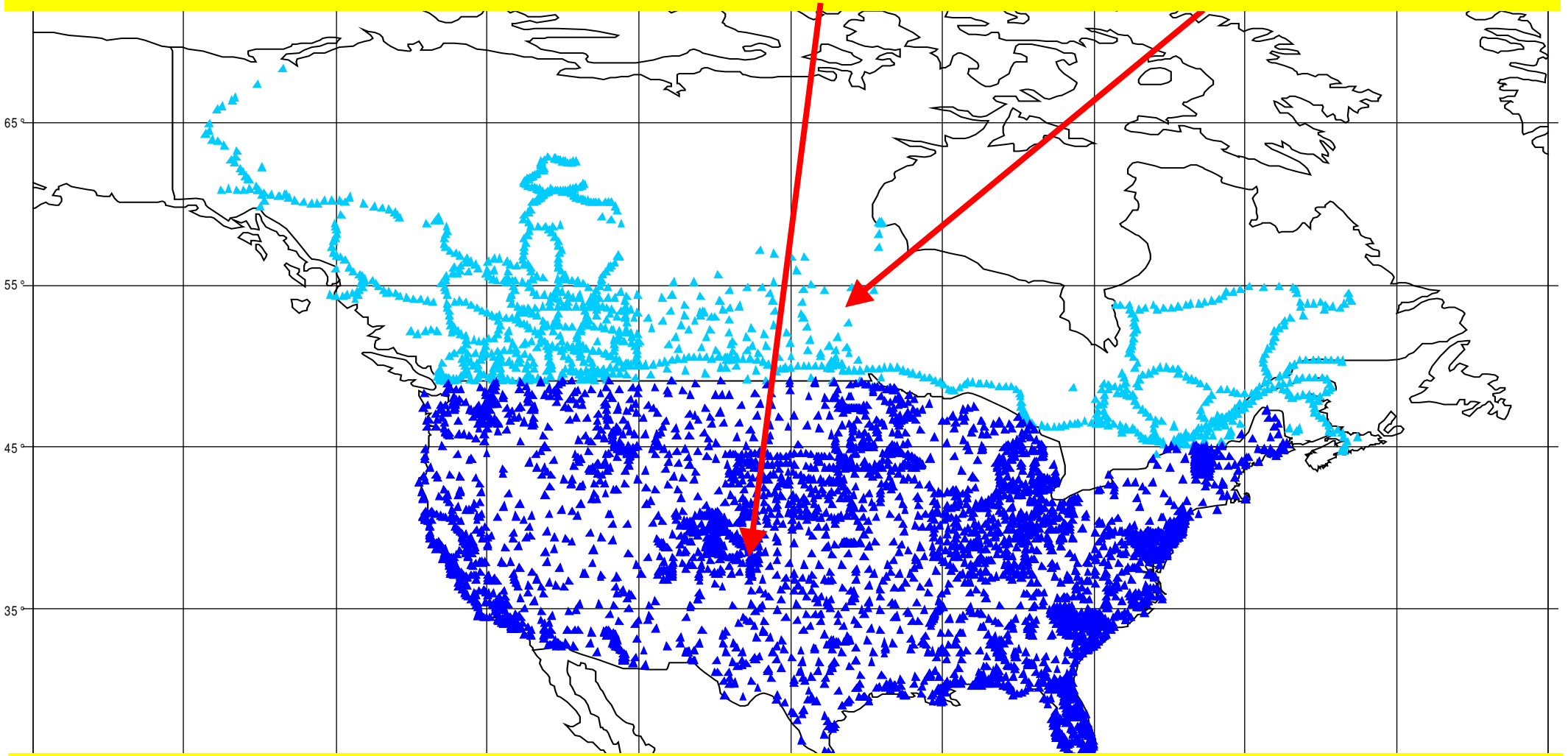
Solution for other territories will follow

a) Current GPS/leveling sites from territory of France were available and used:



LVD IGN69 (France): 973 GPS/leveling

a) Current GPS/leveling sites from territory of USA and Canada were available and used:



LVD NAVD88 (USA, Canada): 5168 and 2579 GPS/leveling

Geopotential values W_{0i} at the LVDs NAVD88 and IGN69

- δH_{0i} vertical shift of the LVD origin, related to the reference surface $W=W_0$
- EGM96R, i.e. the estimated resolution of EGM96 (error)

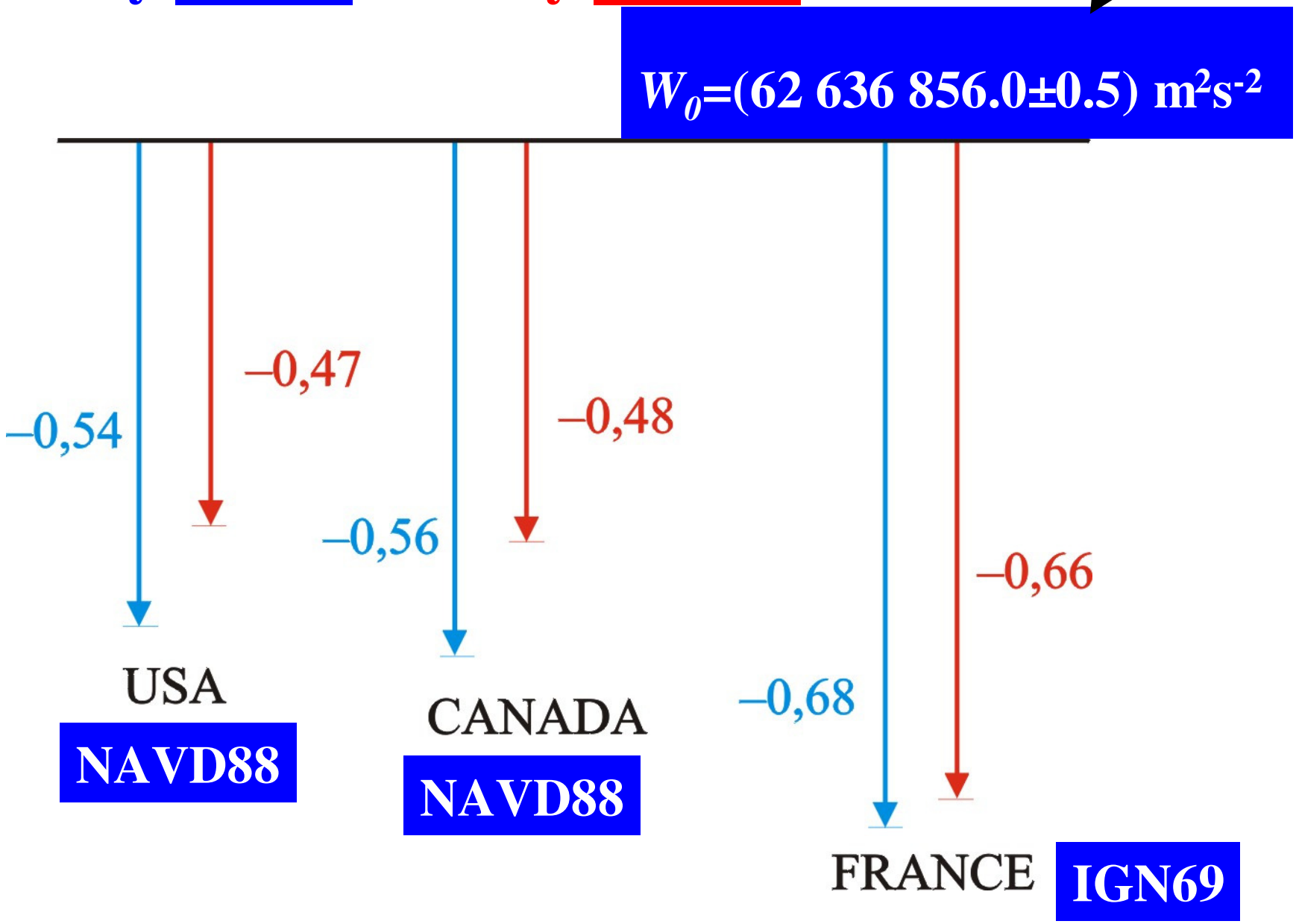
Previous solution by EGM96

Territory	LVD_i	Number of testing sites	EGM96R [cm]	W_{0i} [m^2s^{-2}]	$W_{0i} - W_0$ [m^2s^{-2}]	δH_{0i} [m]
USA	NAVD88	5168	1.0	62 636 861.27 ± 0.51	+5.27 ± 0.11	-0.54± 0.01
CANADA	NAVD88	1311	1.4	62 636 861.54 ± 0.53	+5.54 ± 0.17	-0.56 ± 0.02
FRANCE	IGN69	973	3.3	62 636 862.68 ± 0.61	+6.68 ± 0.34	-0.68 ± 0.04

Actual solution by EGM08

Territory	LVD_i	Number of testing sites	EGM96R [cm]	W_{0i} [m^2s^{-2}]	$W_{0i} - W_0$ [m^2s^{-2}]	δH_{0i} [m]
USA	NAVD88	5168	1.0	62 636 860.66 ± 0.51	+4.66 ± 0.10	-0.47 ± 0.01
CANADA	NAVD88	2482	1.4	62 636 860.75 ± 0.52	+4.75 ± 0.14	-0.48 ± 0.01
FRANCE	IGN69	973	3.3	62 636 862.50 ± 0.60	+6.50 ± 0.33	-0.66 ± 0.03

Vertical shift δH_{0i} in cm of the NAVD88 and IGN69 LVDs origin, related to the reference surface $W=W_0$ by EGM96 and by EGM08



CONCLUSION

By this process the following could be developed:

- **mutual vertical shifts of all LVDs´**
- **vertical shifts of all LVDs´ to the geopotential value W_0**
- **World Height System**

All of these questions are discussed in IAG, ICP 1.2

Our papers on WHS, GVRS, GVRF, and W_0

Burša M., Kouba J., Raděj K., True S. A., Vatrt V., Vojtíšková M., 1999a: Determination of the geopotential at the tide gauge defining the North American Vertical Datum 1988 (NAVD88). *Geomatica*, 53, 459-466.

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