PNG08 - A new geoid model for Papua New Guinea

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Quickclose

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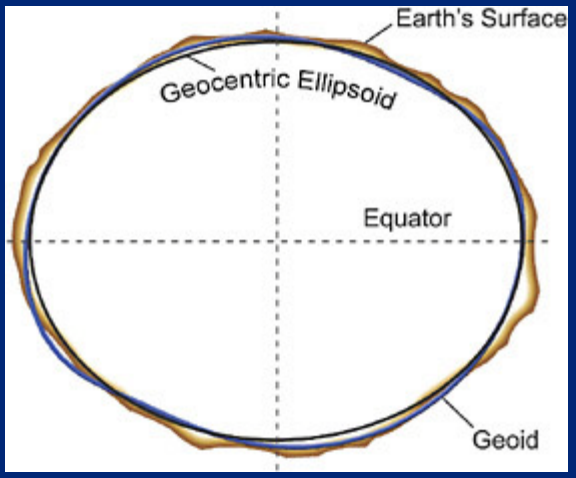
What is a geoid?



The geoid is a surface approximating Mean Sea Level (MSL)

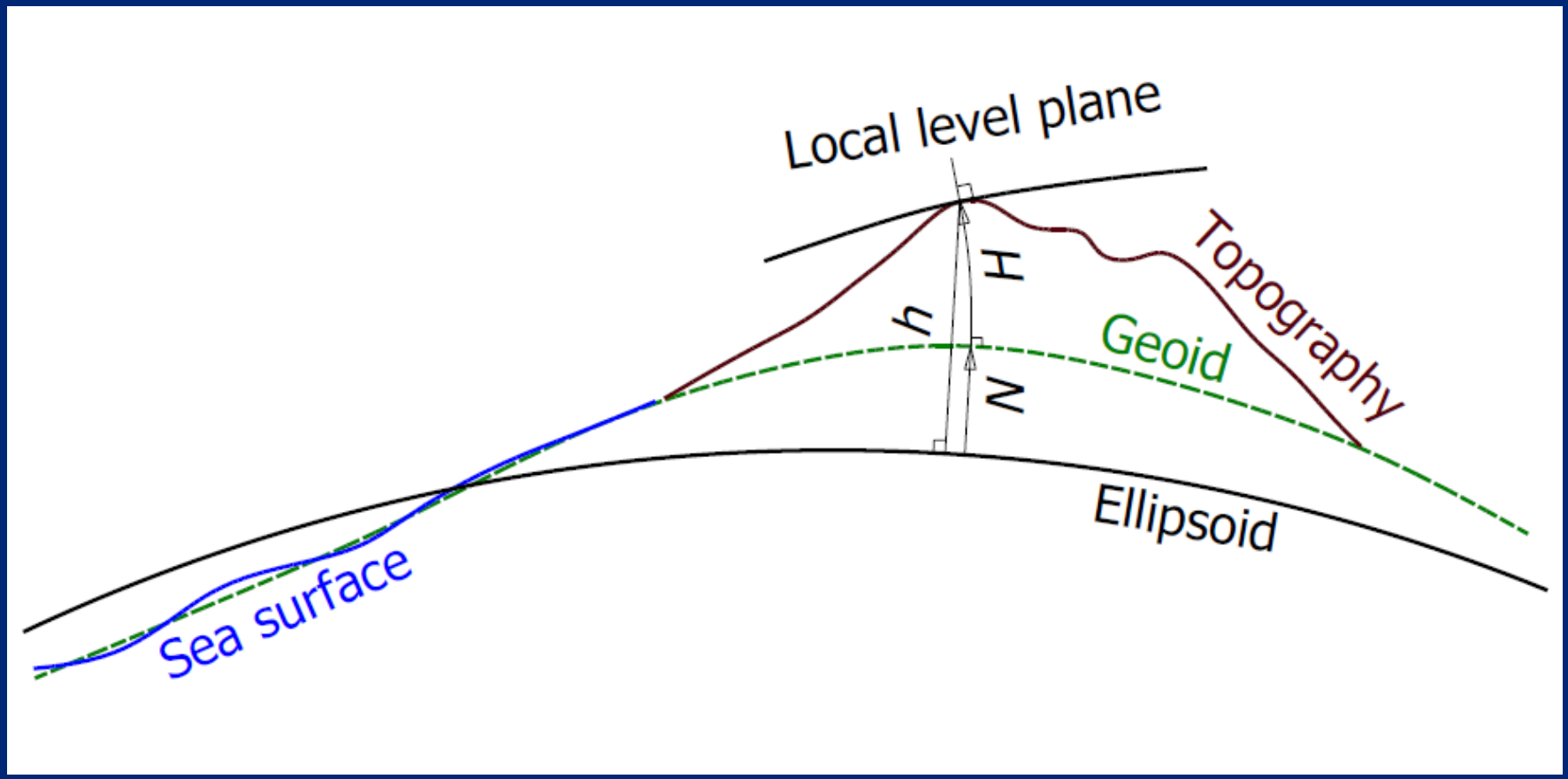
Universität Stuttgart

What does a geoid model do?

- Enables conversion of GNSS/GPS heights (which use the WGS84 or other closely aligned ellipsoid) to approximate Mean Sea Level (MSL)
- The geoid model is the difference between the WGS84 ellipsoid and a geoid approximating MSL (the N value)
- MSL ≈ ellipsoid height – N value
  (H ≈ h – N)

Different geoid models result in different MSL values

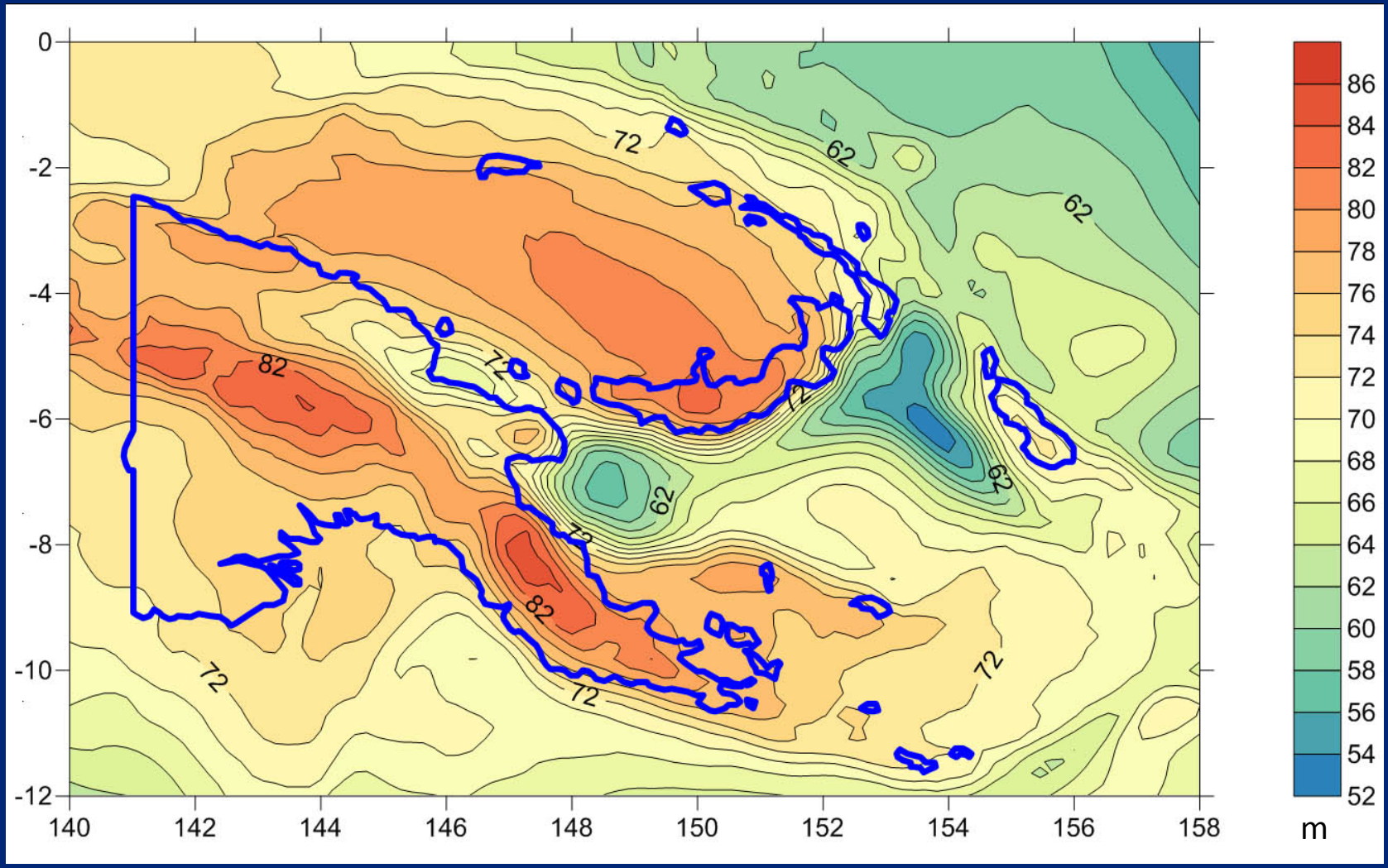
The Geoid in PNG – old assumptions



Assumption that the geoid in PNG is coincident to MSL.

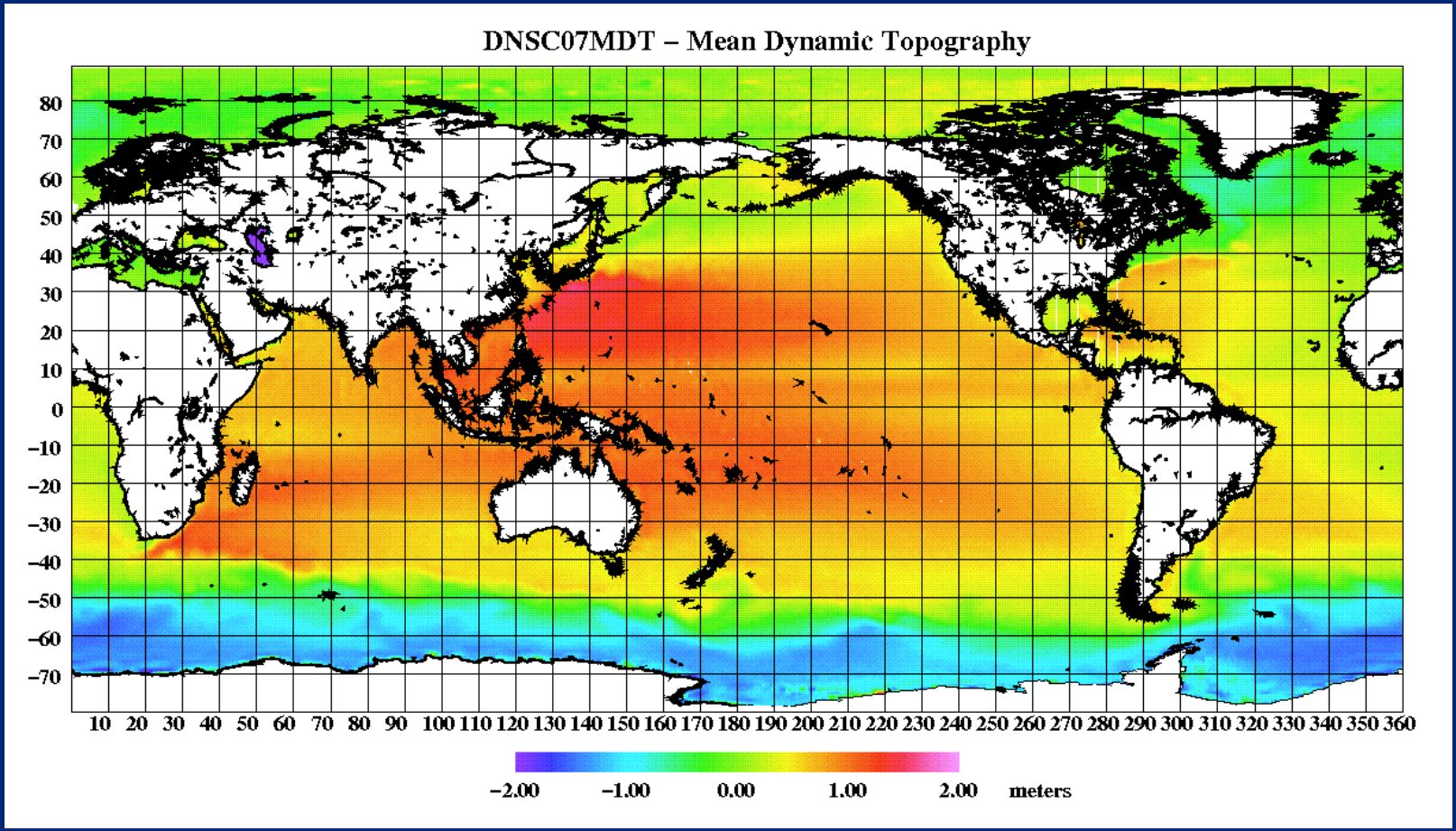
We know now that this isn't true.

EGM2008 Geoid height in PNG



Plot showing EGM2008 N values over PNG. The geoid in PNG is up to 85 m above the WGS84 ellipsoid .

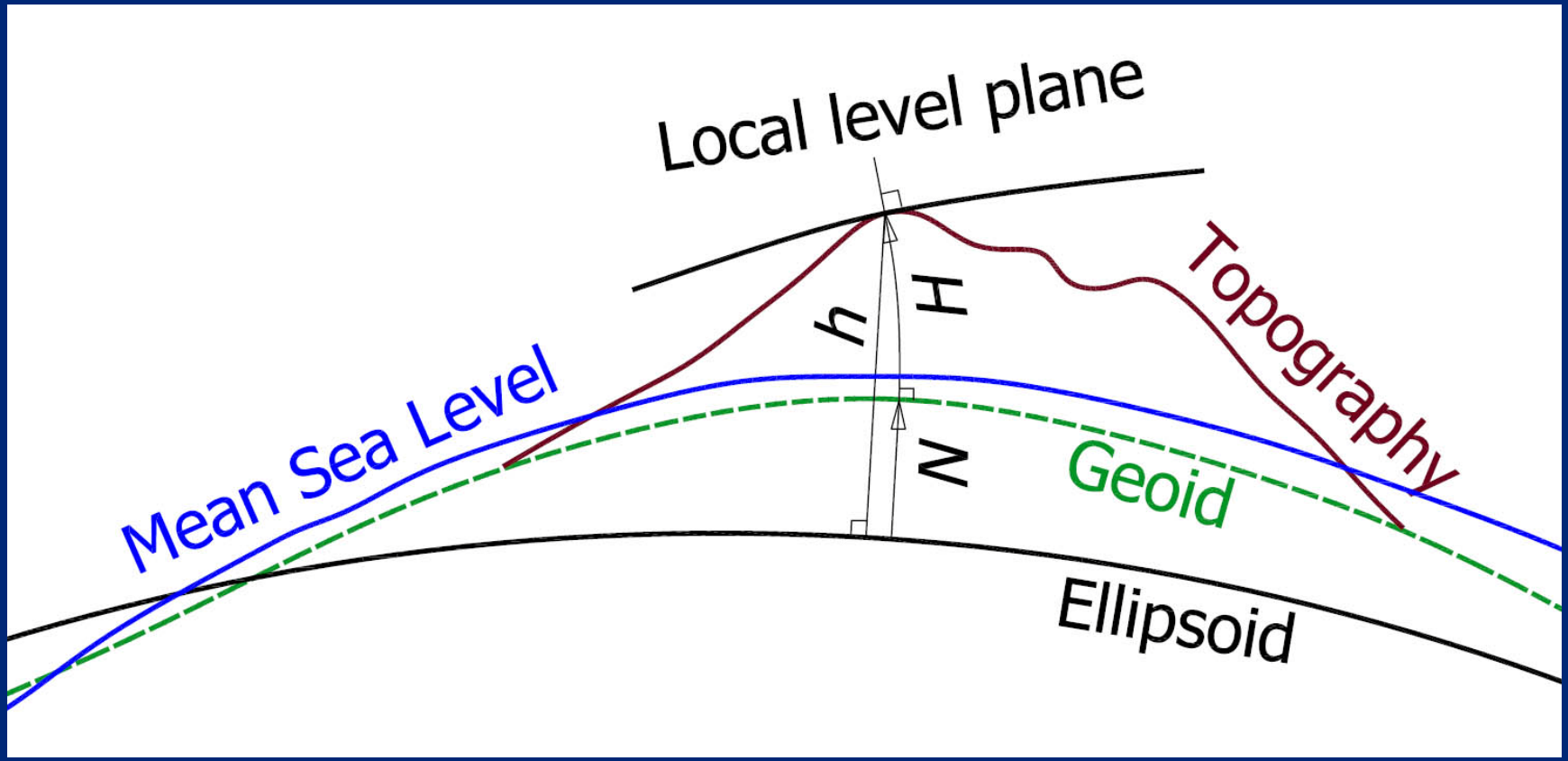
Height of MSL above the geoid



Technical University of Denmark – National Space Institute

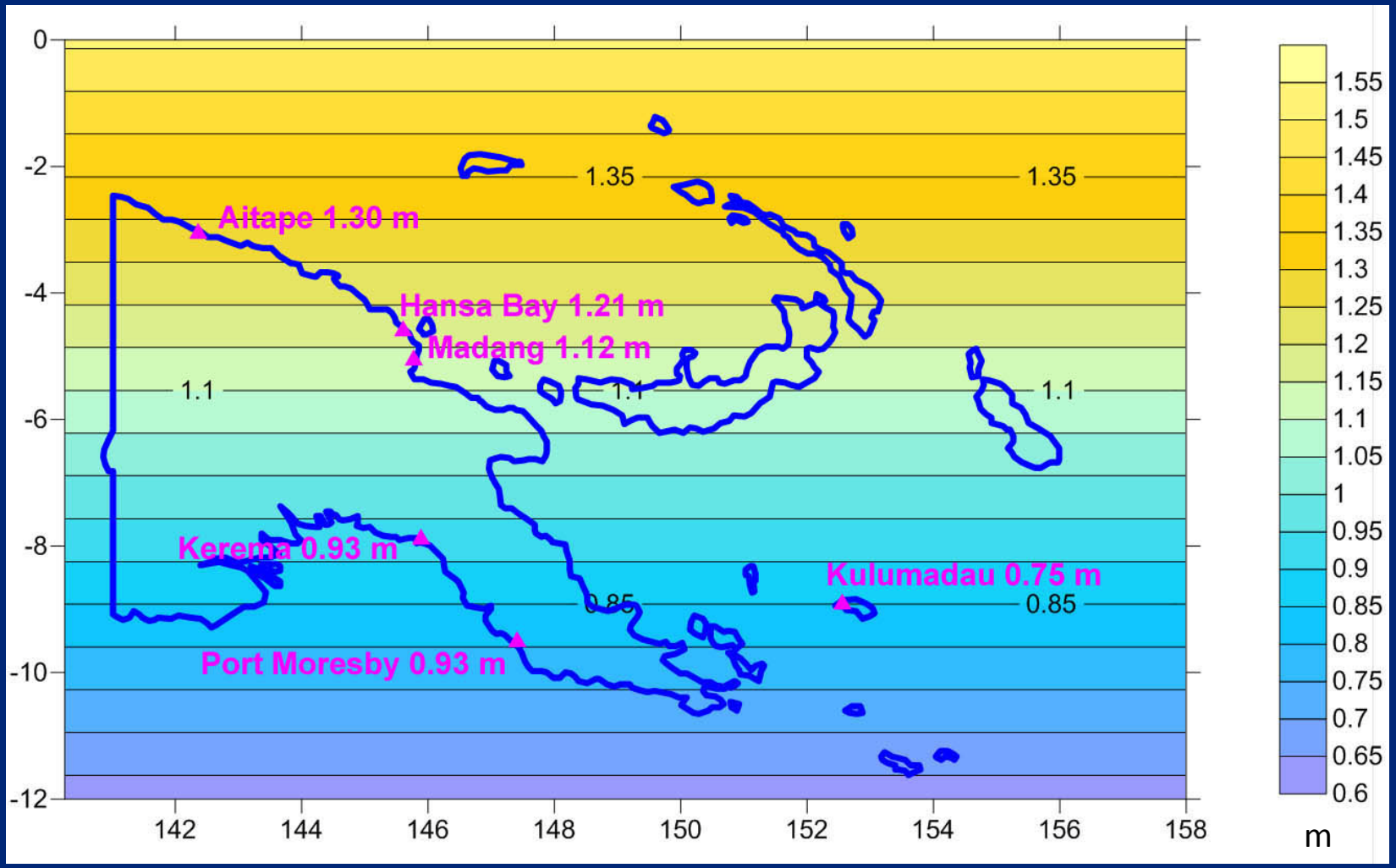
MSL surface is above the geoid in tropical zones due to thermal expansion of the ocean.

MSL geoid difference in PNG



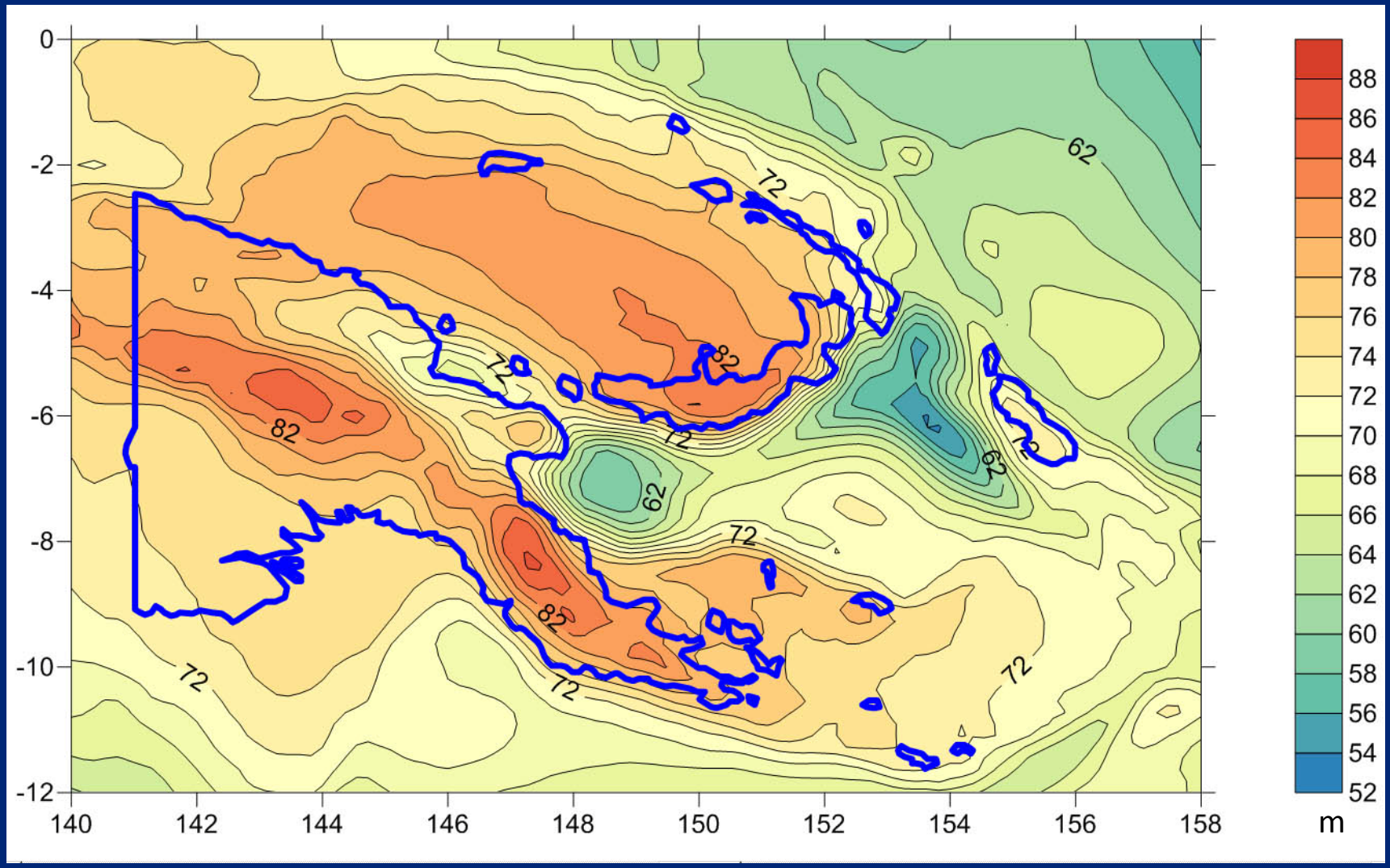
MSL surface is between 0.7 m (Milne Bay Province) & 1.4 m (Manus) above the most recent geoid (e.g. EGM2008).

MSL EGM2008 correction plane to derive PNG08



Sites in purple are tide gauges used to compute the MSL / ellipsoid / EGM2008 offset. The MSL / EGM2008 offsets are shown.

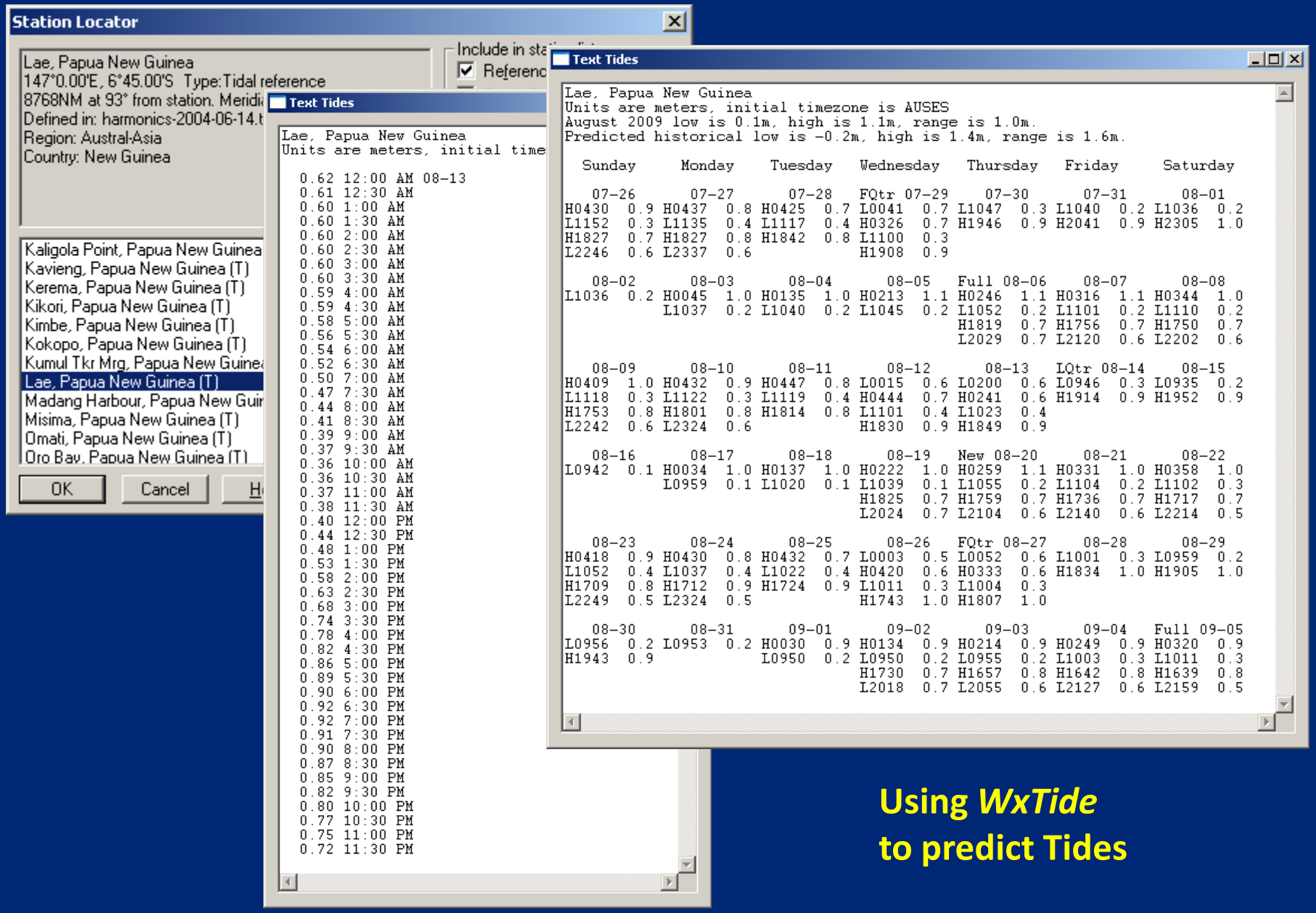
PNG08 Geoid model



PNG08 geoid model accuracy is 0.2 m at 2σ

PNG08 is an interim model until more tidal monitoring is completed

- Requires tidal monitoring at all PNG ports
- Requires cm precise ellipsoidal heights of Tide Gauges
- Stability monitoring of Tide Gauge is required
- Tide Gauges sited away from river mouths
- Lower precision sea surface measurements are still useful especially if made over the full tidal cycle
  (e.g. by lowering levelling staff or tape from jetty edge)
- Updated MDT model from satellite altimetry can also be used



Using *WxTide* to predict Tides

Computing Ellipsoid Height at Tide Gauges

Static baseline from PNG94 control

or, AUSPOS or NRCan

AUSPOS **www.ga.gov.au/bin/gps.pl**

NRCan www.geod.nrcan.gc.ca/online_data_e.php

Computing MSL and geoid correction

Compute RL on Prediction Datum

$$RL_{PRED} = RL_{EGM} + D$$

Compute LAT

$$RL_{LAT} = RL_{PRED} - low$$

Compute HAT

$$RL_{HAT} = RL_{PRED} - high$$

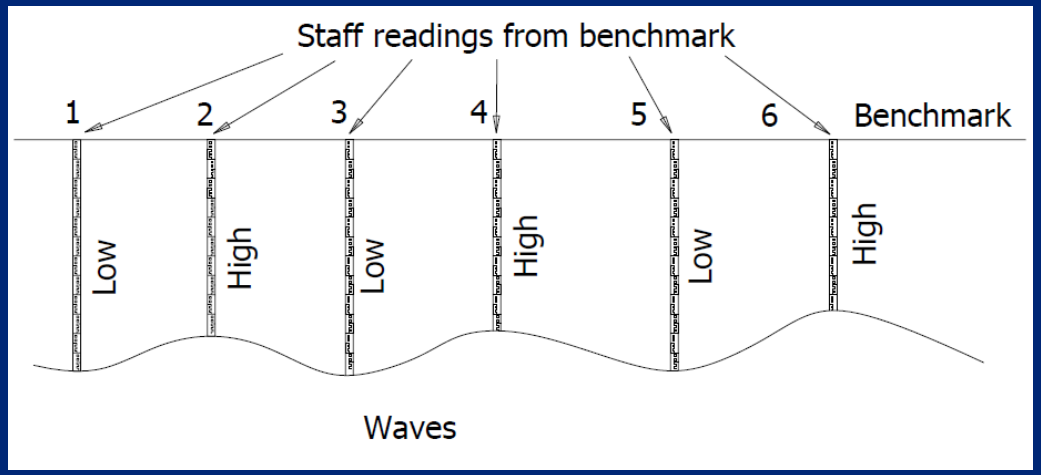
Compute MSL

$$RL_{MSL} = (RL_{HAT} + RL_{LAT})/2$$

Compute correction to Geoid model (zero order term)

$$c = RL_{MSL} - RL_{EGM}$$

Direct measurements of sea level from a BM



Measurement is average of 3 wave tips and 3 wave troughs within 3-4 minutes

Worked Example

$RL_{EGM2008}$ of BM4 = 3.766 m

PNG Date (2009)	PNG Time (UT +10 hr)	Predicted Height (from WXTide)	Staff Reading (from BM4)	EGM08 RL (3.766 - staff reading)	Predicted minus EGM2008 (D)
May-20	03:00 PM	0.87	2.30	1.47	-0.60
May-20	04:00 PM	0.91	2.28	1.49	-0.58
May-21	09:00 AM	0.57	2.53	1.24	-0.67
May-21	12:00 PM	0.44	2.68	1.09	-0.65
May-21	01:00 PM	0.53	2.67	1.10	-0.57
May-21	05:00 PM	0.95	2.16	1.61	-0.66
May-21	06:00 PM	0.96	2.13	1.64	-0.68
May-21	10:30 PM	0.74	2.34	1.43	-0.69
May-22	04:30 AM	1.21	1.98	1.79	-0.58
May-22	08:00 AM	0.79	2.41	1.36	-0.57
May-22	10:00 AM	0.42	2.78	0.99	-0.57

Mean D = -0.62

$RL_{PRED} = RL_{EGM} + D$

RL_{PRED} = 3.766 + -0.62 = 3.15

Low = -0.20 (from *WxTide*)

High = 1.80 (from *WxTide*)

$RL_{LAT} = RL_{PRED} - low$

RL_{LAT} = 3.15 - -0.20 = 3.35

$RL_{HAT} = RL_{PRED} - hat$

RL_{HAT} = 3.15 - 1.80 = 1.35

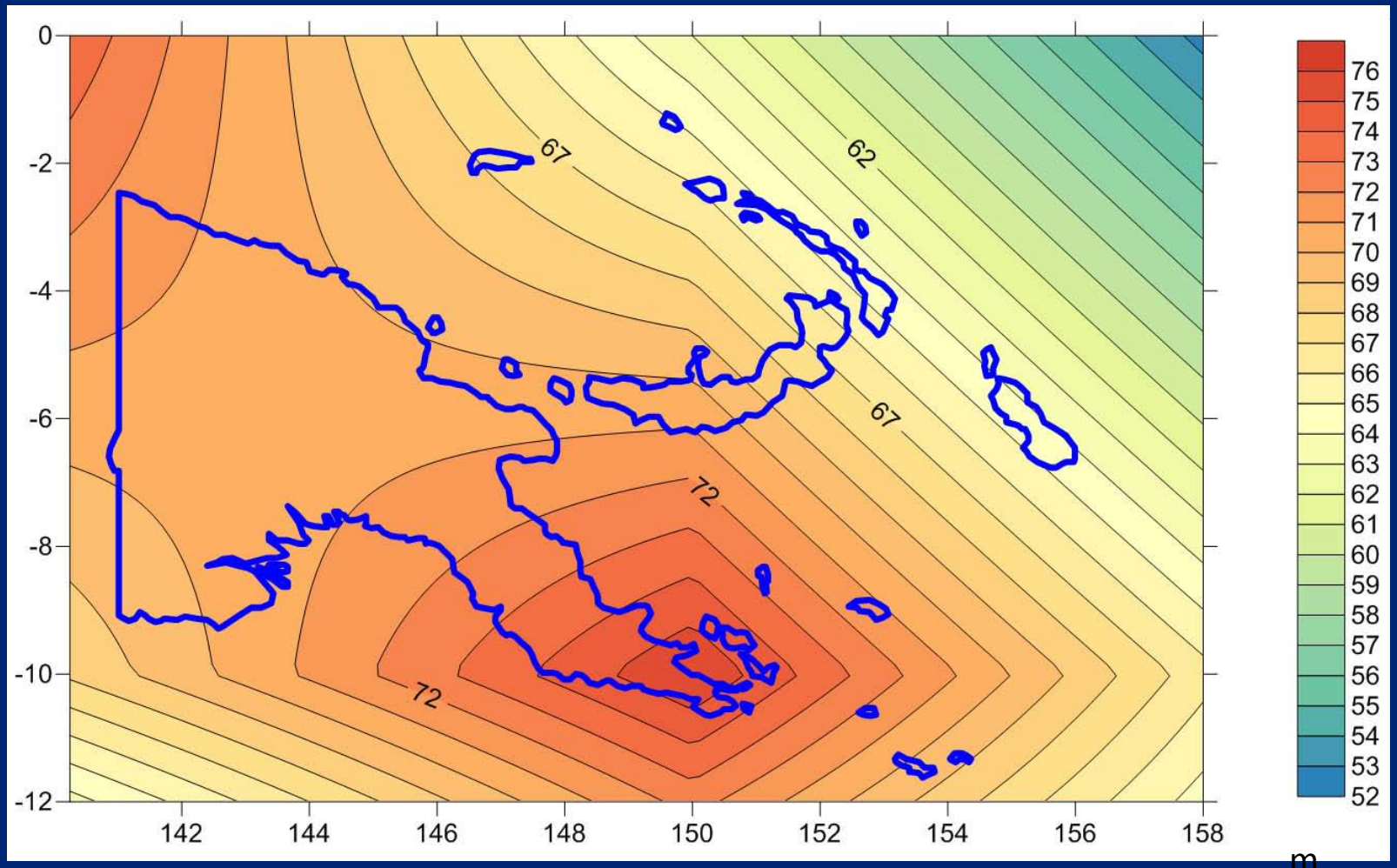
$RL_{MSL} = (RL_{HAT} + RL_{LAT})/2$

RL_{MSL} = (3.35 + 1.35)/2 = 2.35

$c = RL_{MSL} - RL_{EGM}$

$c = 2.35 - 3.766 = -1.42$

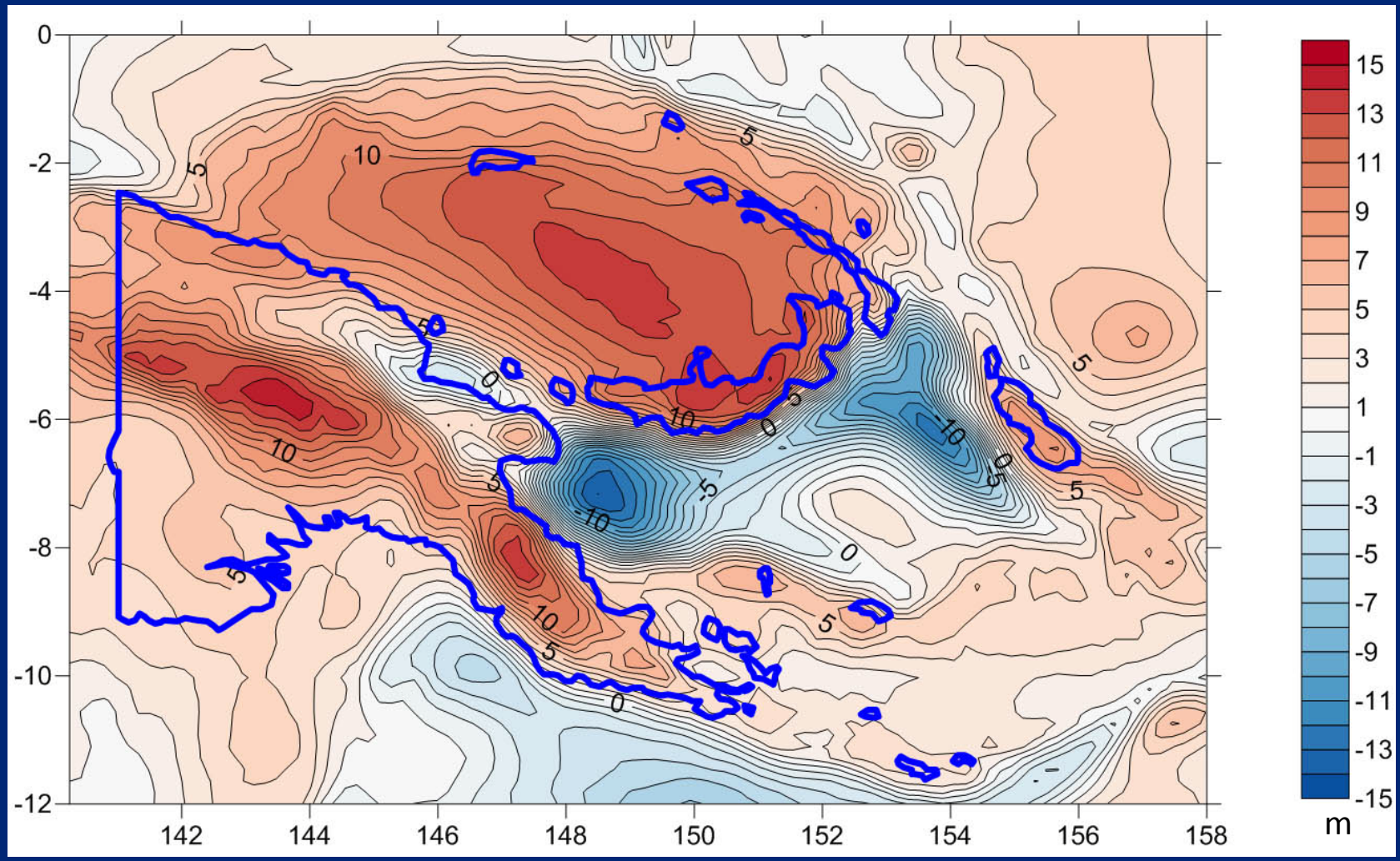
DMA 10˚x10 ˚ Model – UGLY!



This very inaccurate model is still used in many software packages and GPS receivers – e.g. Trimble, Hemisphere, OmniSTAR.

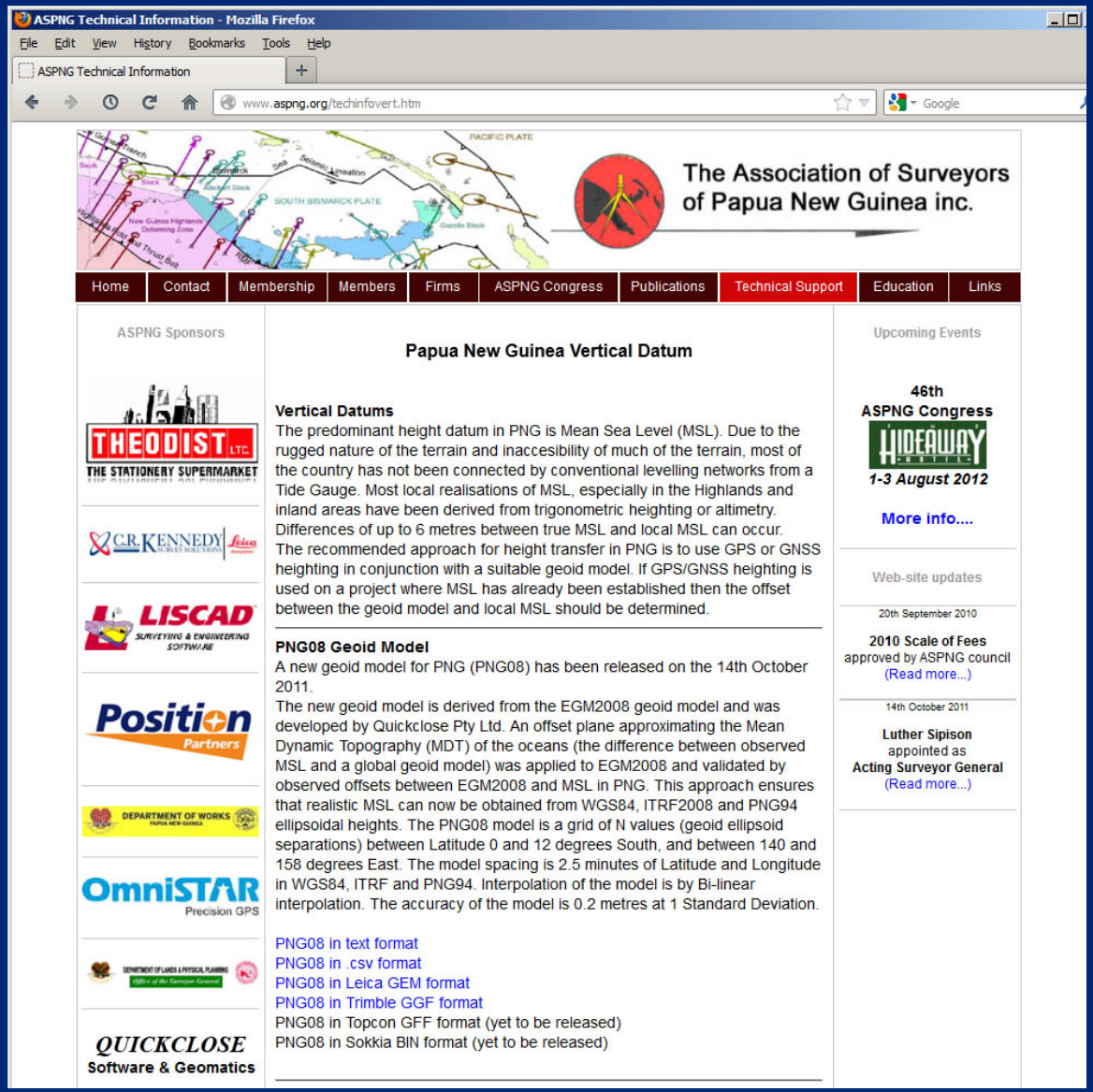
Results in many significant errors in bathymetry and hydrography!

DMA 10˚x10 ˚ Model Error (compared to PNG08)



Errors in heighting of up to 14 metres!! & false gradient of up to 0.2 m / km!!

PNG08 geoid model – where to find it



- ✓ Text format
- ✓ csv format
- ✓ Leica GEM
- ✓ Trimble GGF
- ✓ Topcon/Sokkia GFF format

PNG08 work flow

- Use PNG08 model with GNSS / GPS processing software RTK controller and AUSPOS or NRCan ellipsoid heights.
- MSL(PNG08) = PNG94 ellipsoid height – PNG08 N value ($H \approx h - N$)
- PNG Geodetic database being converted to PNG08 PNG08 update could become gazetted vertical datum
- PNG08 Reduced Levels (RLs) may differ from existing RLs by several metres (e.g. in Highlands, CDW datum, LAT) (difference should be consistent over local area)
- PNG08 values are within 0.2 m of MSL

What can happen if the geoid model is wrong!

Thank you