

The Geoid Geopotential Value for Unification of Vertical Datums

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The Geoid

- The geoid: An equipotential surface which represents MSL in its ideal case.

- Defined by
 - The geoid ellipsoid separation (N)
 - The geoid geopotential value (W_0)

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W_0

- The geopotential value on the geoid

$$W_0(\varphi, \lambda, N) = V(\varphi, \lambda, N) + \Phi(\varphi, N)$$

- V : The gravitational potential
- Φ : The centrifugal potential
- φ, λ : The geodetic coordinates
- N : The geoid height

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Aims

- To investigate offsets between regional datums
- To estimate W_0 from regional and global dataset
- To connect vertical datums within geopotential space

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Regional Datum

- Nine TGs in the UK, two in France and one in Germany
- Co-located CGPS
- 1999.0-2009.5
- Precise levelling to connect GPS and TG datums

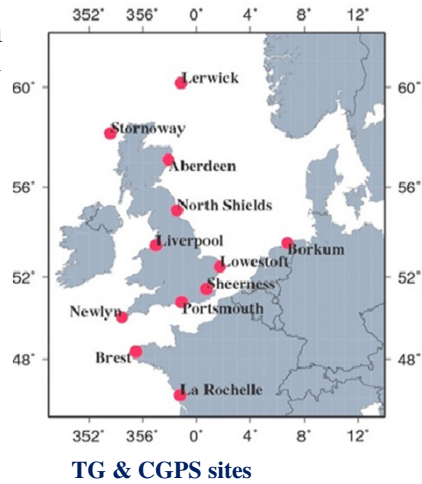
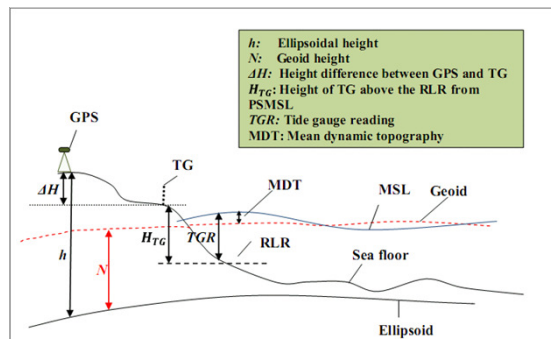


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The Geoid Coordinates

- φ, λ from GPS
 - N from
- $$N = h + TGR - (\Delta H + H_{TG} + MDT)$$



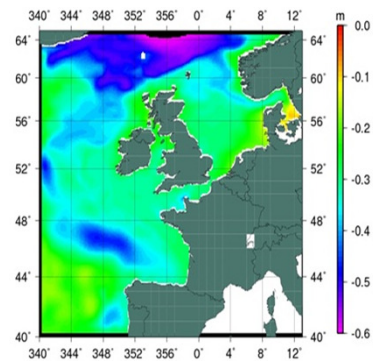
N from TG & GPS

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Results: Regional W_0

Station	$W_0 - 62636850 \text{ (m}^2\text{s}^{-2}\text{)}$	
	MSL	Geoid
Aberdeen	6.95*	4.48*
Liverpool	8.64*	5.44
Lowestoft	8.15	5.30
Newlyn	8.61	5.72*
North Shields	7.48	4.85
Portsmouth	7.61	4.66
Sheerness	7.51	4.74
Lerwick	8.28	5.06
Stornoway	7.13	4.74
Brest	8.35	5.39
La Rochelle	8.33	5.55
Borkum	7.57	5.59
Average	7.88±0.33	5.13±0.24

- TG+Levelling+GPS → MSL
- MSL+MDT(POLCOMS) → geoid
- EGM2008 to degree/order 2160



The POLCOMS model

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Global Datum

- $1^\circ \times 1^\circ$ MSL from CLS01 for $70^\circ/70^\circ$ N/S
- MDT from ECCO-2
- EGM2008 limited to degree/order 360/360
- Global averaging with $\cos \theta$ as a weighting function

Model	Degree	$W_0 \text{ (m}^2\text{s}^{-2}\text{)}$ MSL	$W_0 \text{ (m}^2\text{s}^{-2}\text{)}$ Geoid
EGM2008	360	62636854.25±0.06	62636854.29±0.02

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Datum connection

- Global datum defined by

$$W_0 = 62636854.29 \text{ m}^2\text{s}^{-2}$$

- Mean geopotential value for each region W_{0LVD}

- Datum offset

Datum	$(\text{m}^2\text{s}^{-2})$	(cm)
UK (mainland)	-0.74	-7.5
Lerwick	-0.77	-7.8
Stornoway	-0.45	-4.6
France	-1.18	-12.0
Germany	-1.30	-13.2

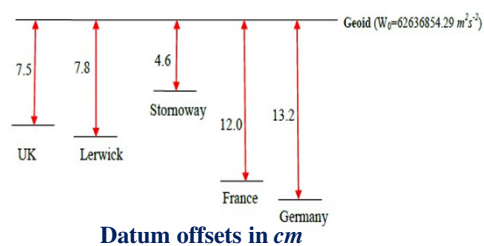


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Conclusions

- W_0 has been estimated from regional and global datasets
- Based on CLS01, ECCO-2 and EGM2008, the global datum has been defined by $W_0=62636854.29 \text{ m}^2\text{s}^{-2}$
- The UK, French and German datums have been connected within geopotential space
- MDT plays a major role in unification of vertical datum

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Acknowledgement

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