



Heights and Vertical Datums in New Zealand

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Overview



- Heights in New Zealand
- Precise levelling datums
- Vertical datum relationships
- Geoids
- Proposed national vertical datum
- Summary

Heights



- Different data sets use different heights
- Topographic maps
 - Mean sea level derived from zero contour
- Hydrographic charts
 - Lowest Astronomic Tide (LAT)
- GPS, LiDAR
 - WGS84 ellipsoid
- Surveying & engineering
 - MSL from sea level observations

Types of Height

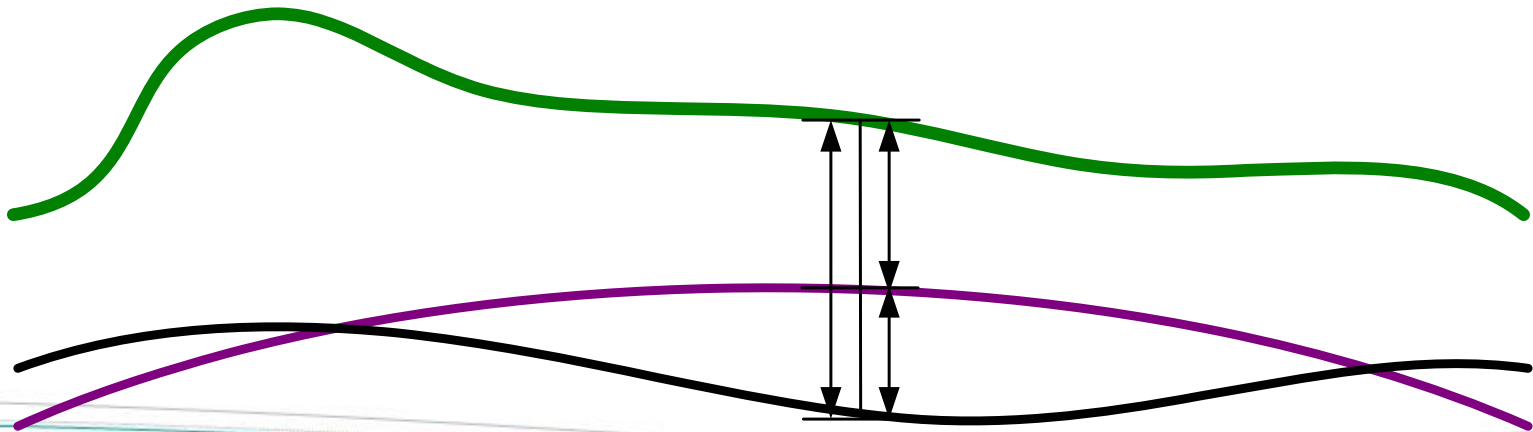


- Two main types of height used in New Zealand
- Ellipsoidal
 - NZGD2000 and GPS heights
 - Refer to ellipsoid (independent of gravity field)
 - Zero height varies from sea level by up to 35m
- Normal-orthometric
 - Established by precise levelling
 - Relate to Earth's gravity field
 - Zero height coincident with sea level



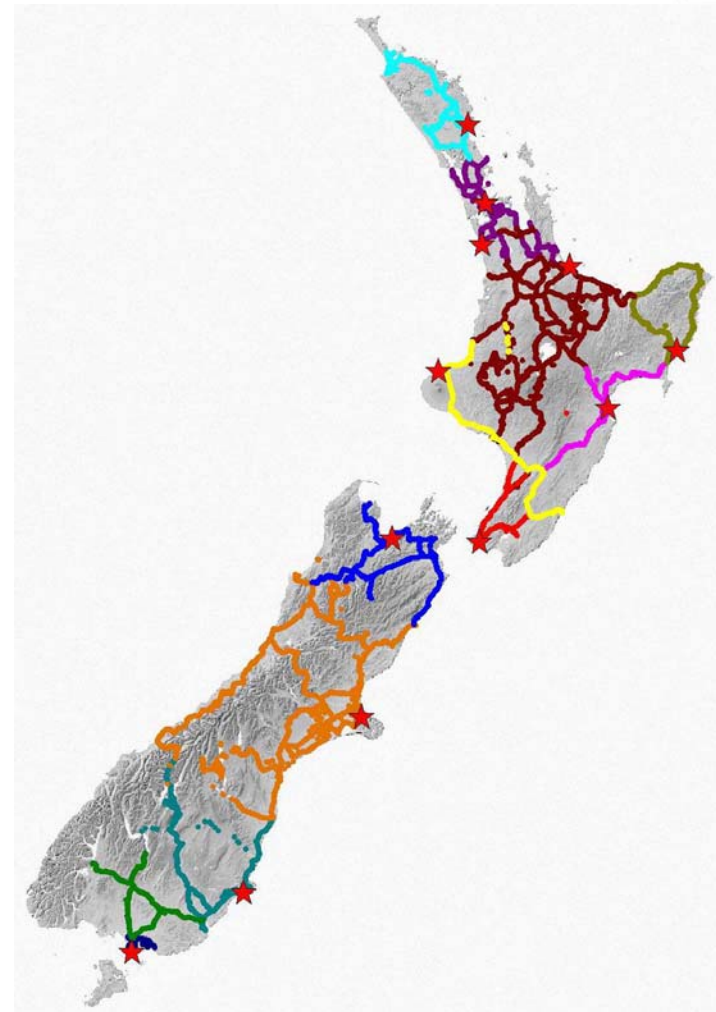
Height Relationships

- Ellipsoidal heights (h) are not always representative of fluid flows
- Normal-orthometric heights (H) measured above an equipotential surface
- The geoid is an equipotential surface approximating global MSL
- Geoid height (N) is the distance of the geoid above the ellipsoid
- Heights are related by: $H = h + N$



NZ Levelling Datums

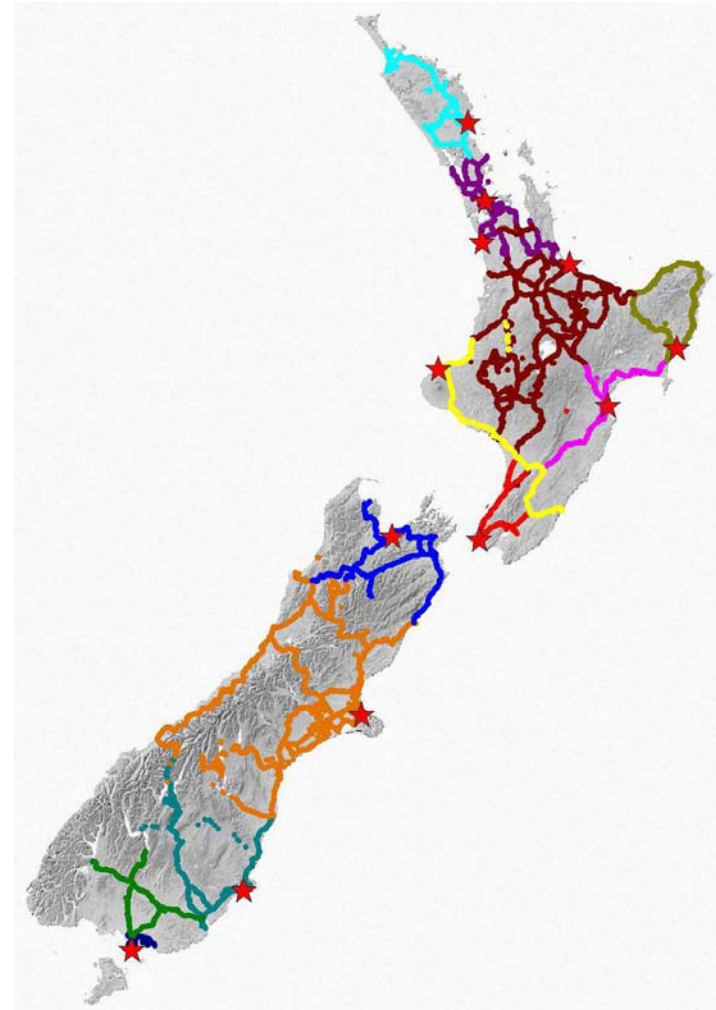
- New Zealand does not have a national vertical datum
- 13 major datums (and many local datums) are used
- Most normal-orthometric heights are in terms of these datums
- Datums include:
 - Wellington 1953
 - Moturiki 1953
 - Auckland 1946





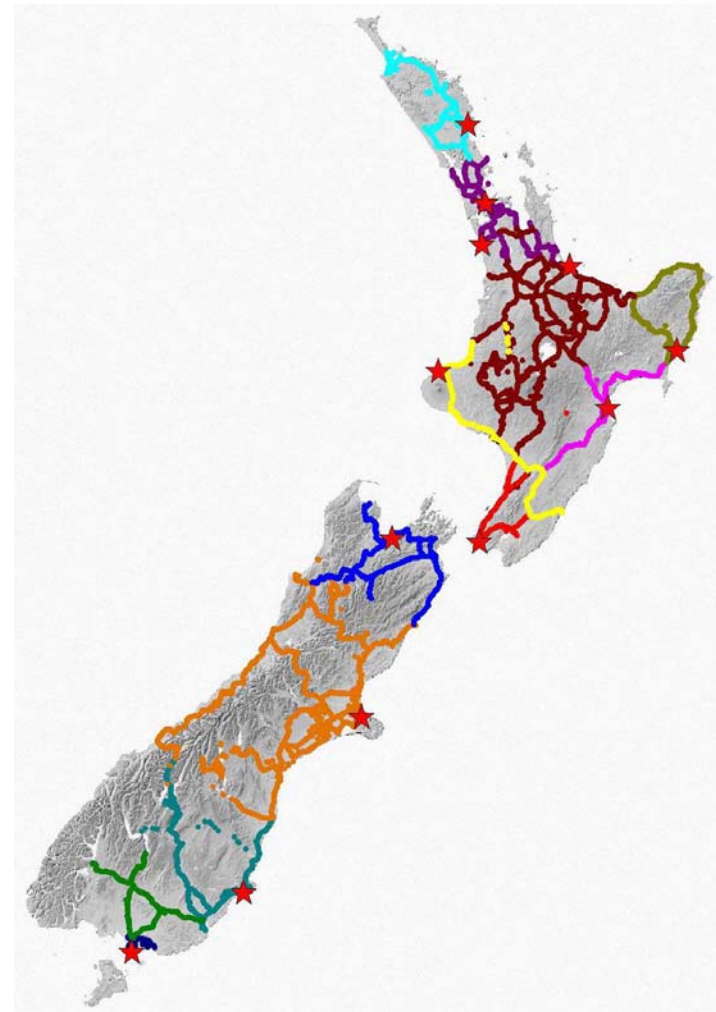
Levelling Datum Origins

- Datums in terms of MSL at 12 different tide-gauges
- MSL not determined consistently
 - Length of observations (6 months – 4 years)
 - Time of observation
 - Gauge location
- Datums are not in terms of each other



Levelling Datum Extents

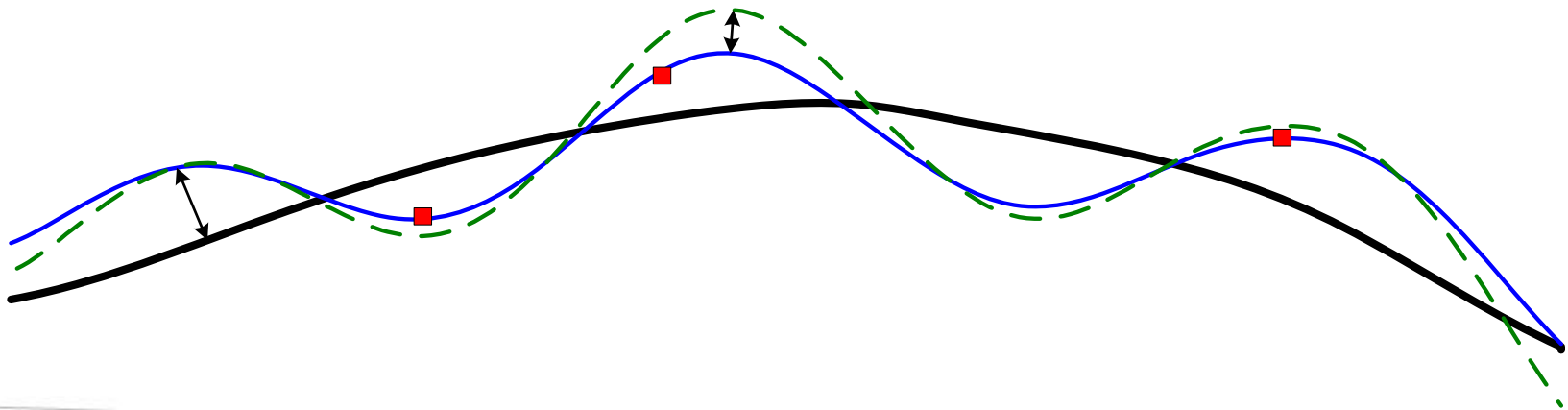
- Datums follow main roads from tide gauges
 - 40 years so far
 - Some loops are closed, others are hanging
 - Movement of marks ignored in adjustments
- Benchmarks can have multiple heights





Vertical Datum Relationships

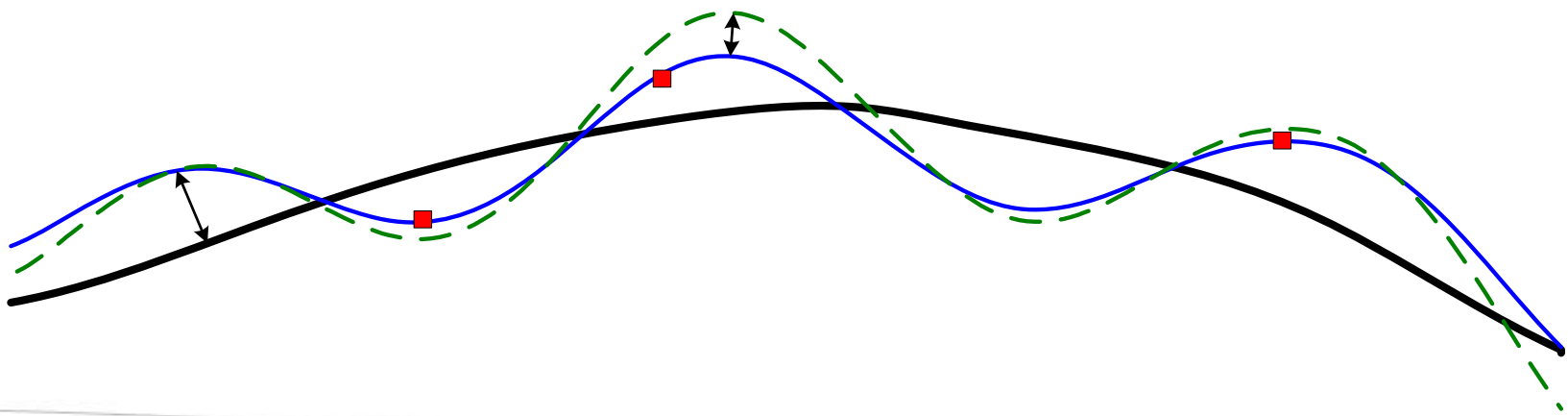
- The NZ vertical datums do not refer to the same reference surface
- Datum origins relate to MSL at specific tide gauges
- Local MSL affected by:
 - Quasi-stationary sea surface topography
 - Dynamic effects such as tides, river flows etc





Vertical Datum Relationships

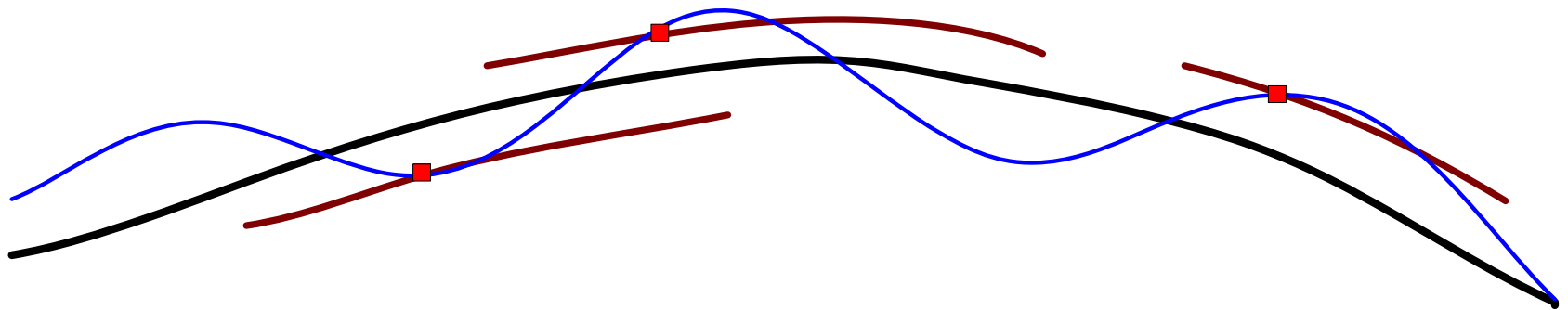
- Tidal effects can be modelled with long term sea level measurements (~18.6 years)
- Most NZ datums
 - Defined over short time frames (1-2 years)
 - In non-ideal locations





Vertical Datum Relationships

- Each levelling datum based on local MSL at origin
- Each datum is offset from each other
- If the datums do not overlap it is difficult to determine this offset



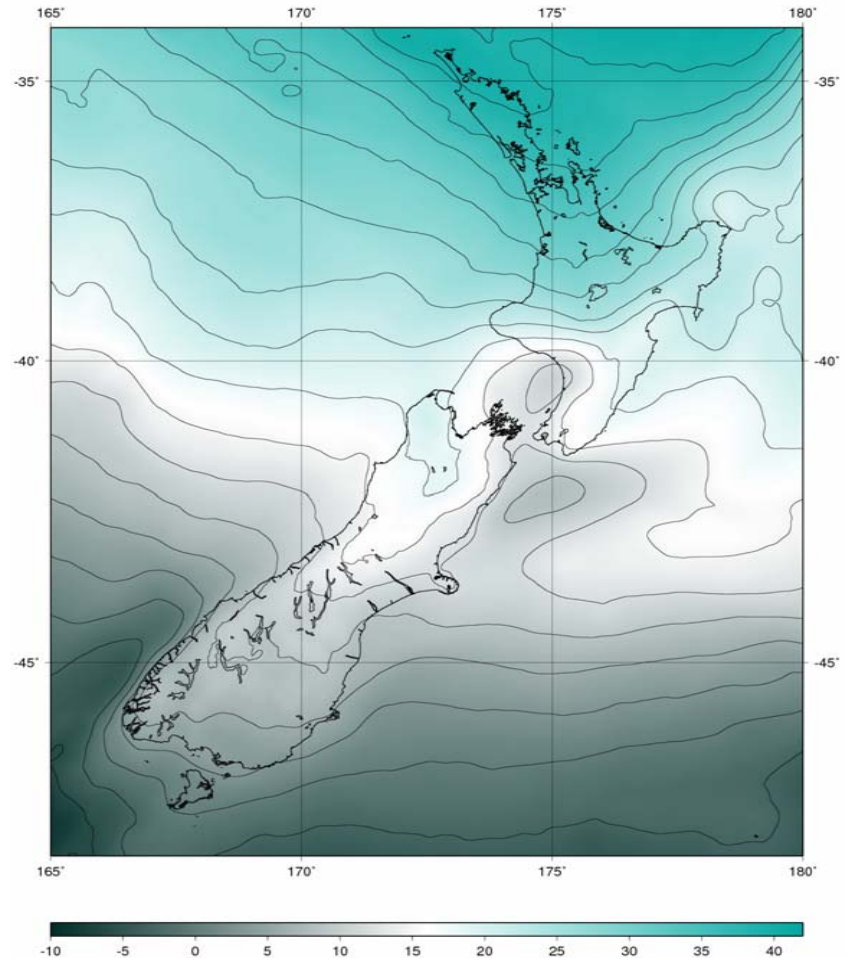


Geoids in New Zealand

- Geoid computed using global gravity observations
 - Not practical to evaluate new model for each application
- Available models
 - EGM96
 - ± 2 m, 39 kilometre resolution
 - Global
 - EGM2008
 - ± 20 cm, 7 km resolution
 - Global
 - NZGeoid05
 - ± 8 cm, 3.7 km resolution
 - NZ continental shelf

NZGeoid05

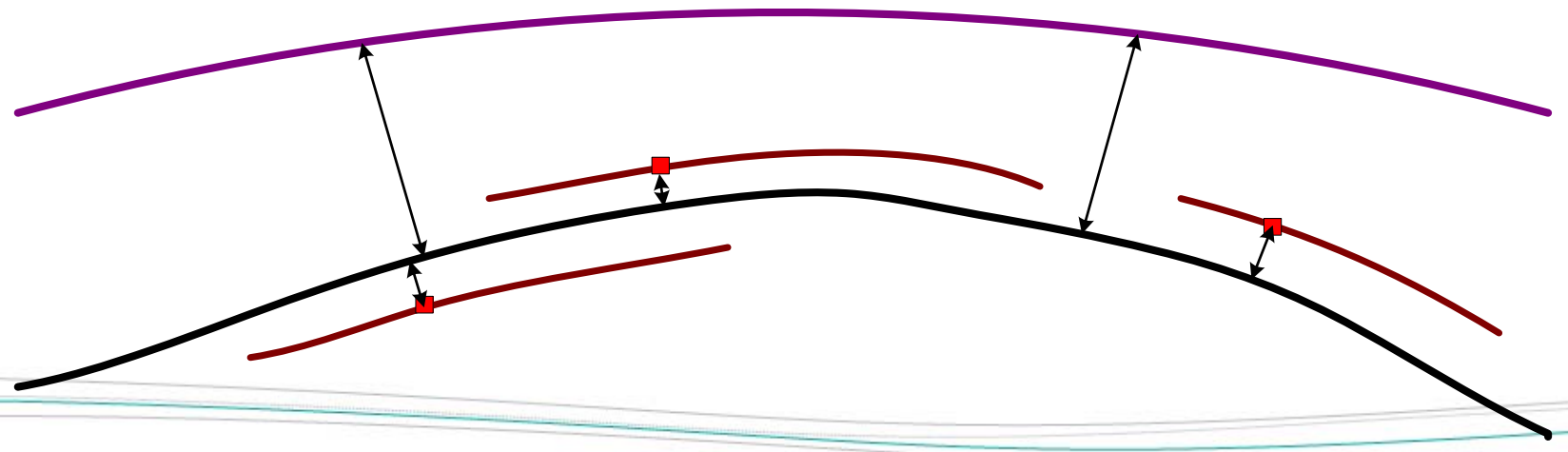
- Heights from 0 to 35 m over NZ
- Provided on a 2 arc-minute (3.7 km) grid
- Calculated from 12 km spaced gravity observations
- Accuracy:
 - ± 10 cm nationally
 - $\pm 4 - 16$ cm on local datum
 - Must be verified by user





Proposed National Vertical Datum

- New datum proposal will be consulted on later this year
- Normal-orthometric heights in relation to NZGeoid05
- Official transformation to NZGD2000/GRS80 heights
- Official offsets to existing vertical datum N-O heights



Datum Offsets

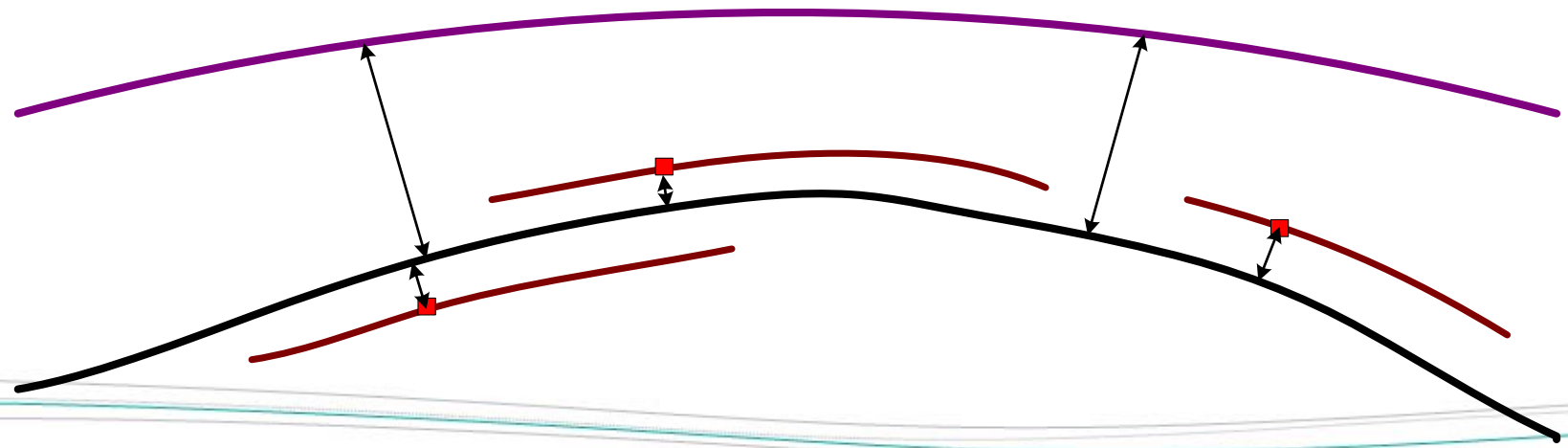
Datum	Offset	Std
One Tree Point 1964	0.26	0.06
Auckland 1946	0.50	0.07
Moturiki 1953	0.32	0.07
Gisborne 1926	0.59	0.09
Taranaki 1970	0.45	0.07
Napier 1962	0.32	0.05
Wellington 1953	0.51	0.04
Nelson 1955	0.26	0.08
Lyttelton 1937	0.35	0.10
Dunedin 1958	0.48	0.16
Dunedin-Bluff 1960	0.26	0.08
Bluff 1955	0.37	0.05
Stewart Island 1977	0.40	0.12





Proposed National Vertical Datum

- Existing normal-orthometric heights retained
- Compatible with both new and existing technology
 - GPS derived ellipsoidal heights can be easily converted to normal-orthometric heights (and vice versa)



Summary



- Heights can be transformed between datums
 - Be aware of errors in transformation
 - Know how transformations have been done
 - Check transformations on known points
- Essential to know:
 - The type of height being used
 - The datum the height refers to