



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



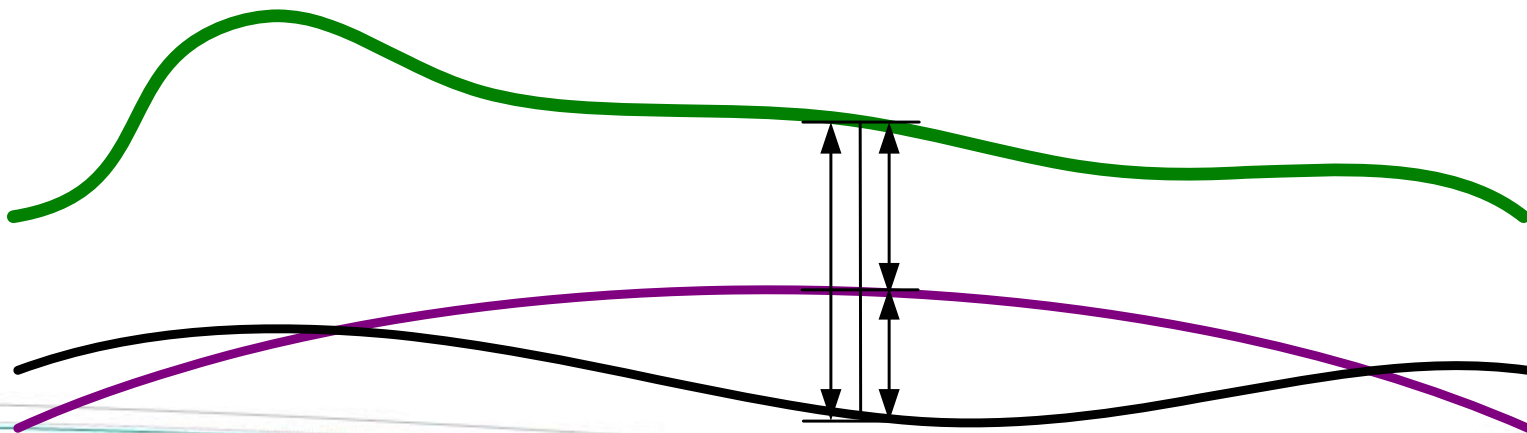
Types of Height

- 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



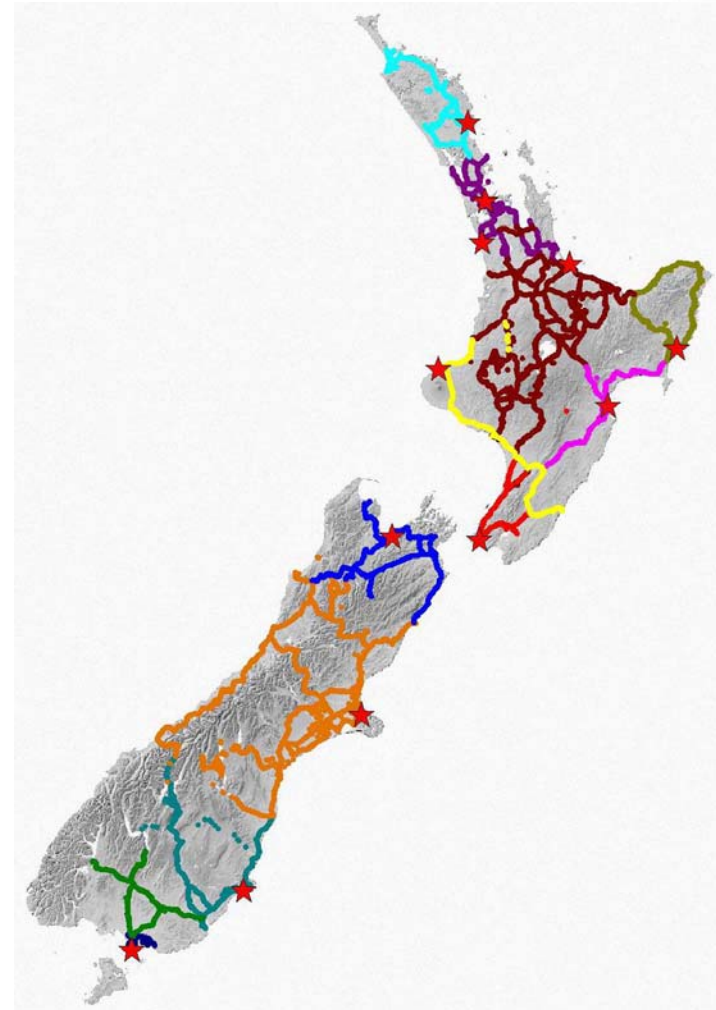
Height Relationships

- 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

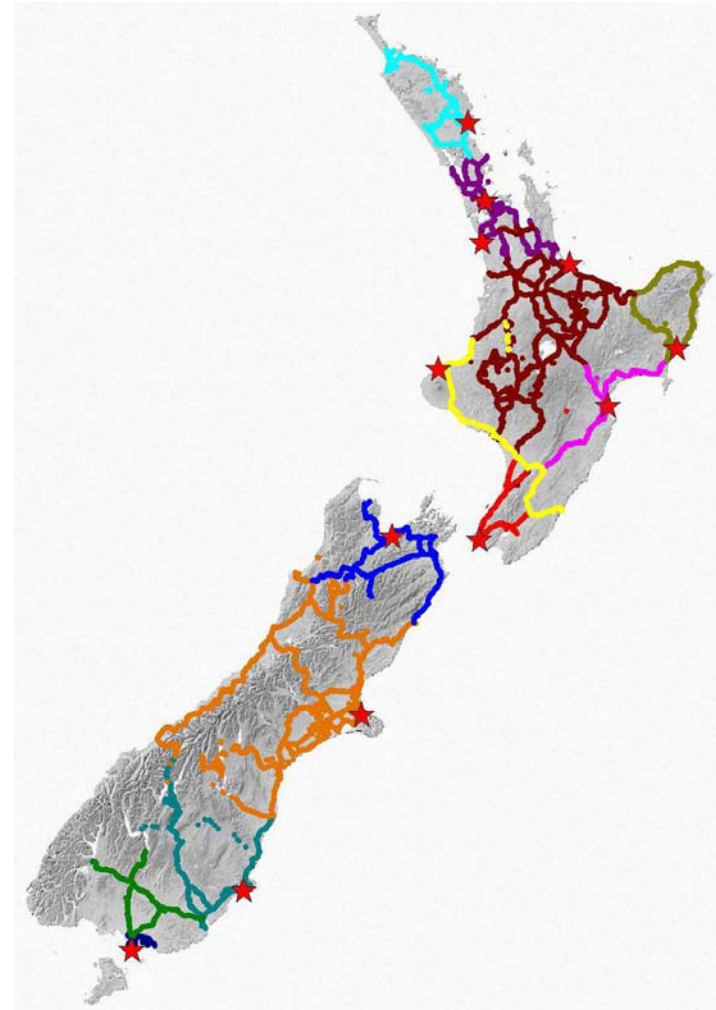
- New Zealand does not have a national vertical datum
- 13 major datums (and many local datums) are used
- Most normal-orthometric heights are in terms of these datums
- Datums include:
 - Wellington 1953
 - Moturiki 1953
 - Auckland 1946





Levelling Datum Origins

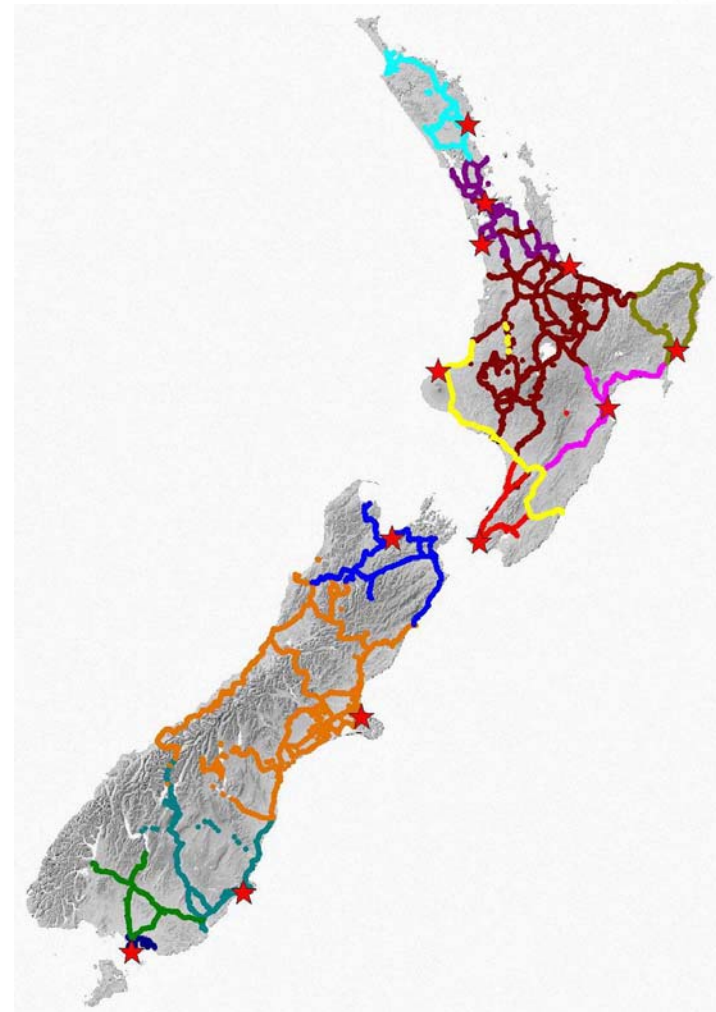
- Datums in terms of MSL at 12 different tide-gauges
- MSL not determined consistently
 - Length of observations (6 months – 4 years)
 - Time of observation
 - Gauge location
- Datums are not in terms of each other





Levelling Datum Extents

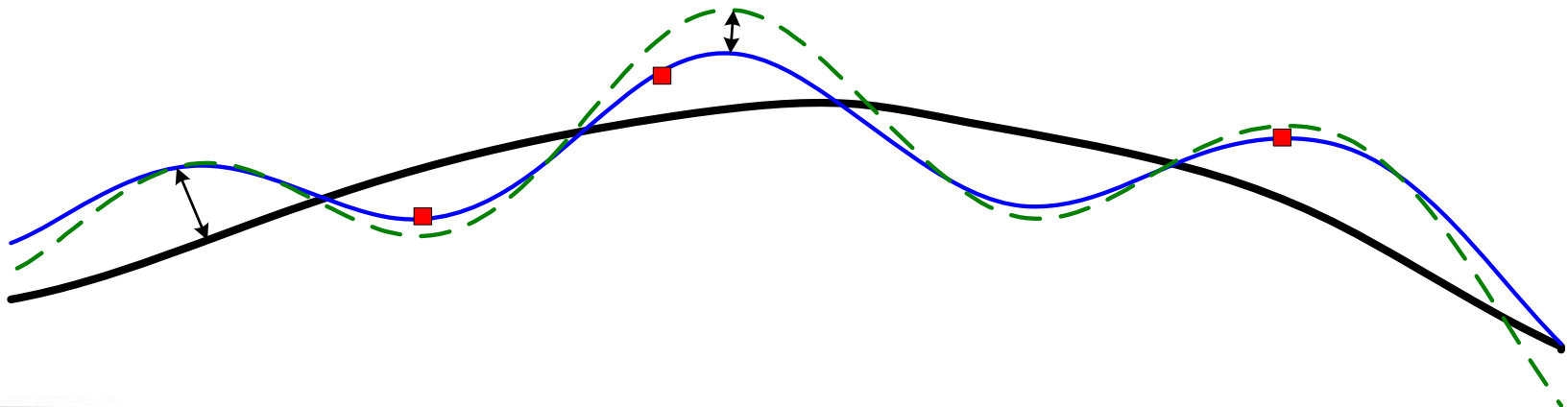
- Datums follow main roads from tide gauges
 - 40 years so far
 - Some loops are closed, others are hanging
 - Movement of marks ignored in adjustments
- Benchmarks can have multiple heights





Vertical Datum Relationships

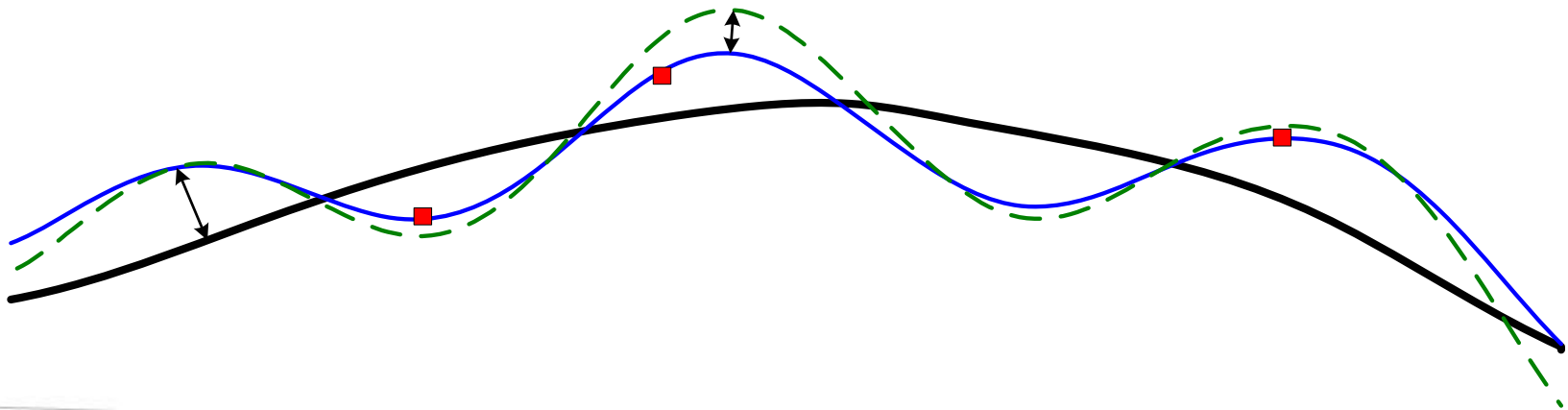
- The NZ vertical datums do not refer to the same reference surface
- Datum origins relate to MSL at specific tide gauges
- Local MSL affected by:
 - Quasi-stationary sea surface topography
 - Dynamic effects such as tides, river flows etc





Vertical Datum Relationships

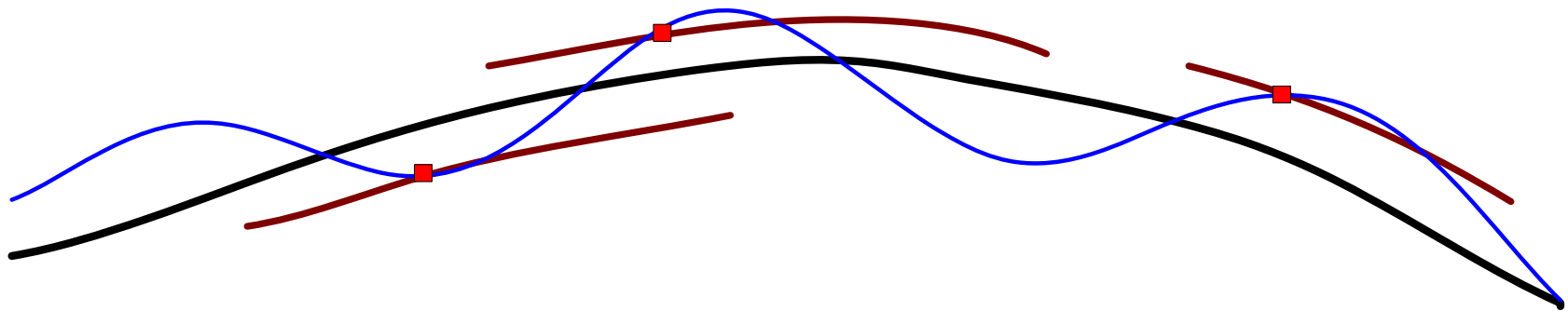
- Tidal effects can be modelled with long term sea level measurements (~18.6 years)
- Most NZ datums
 - Defined over short time frames (1-2 years)
 - In non-ideal locations





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



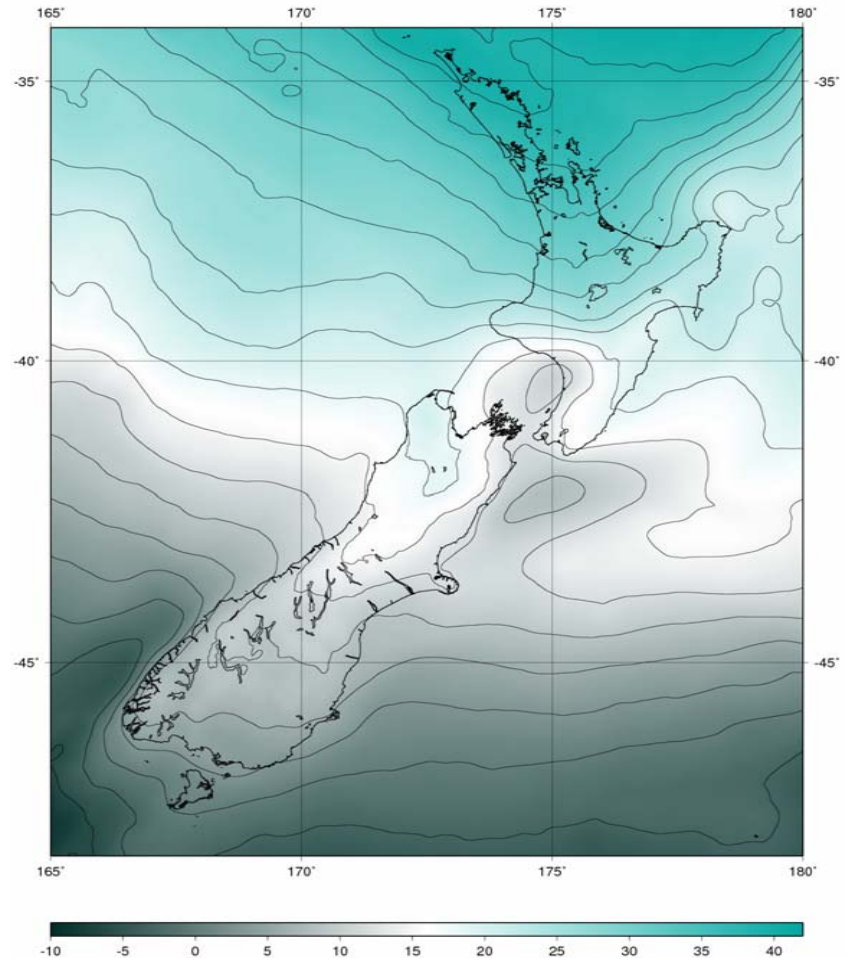


Geoids in New Zealand

- 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

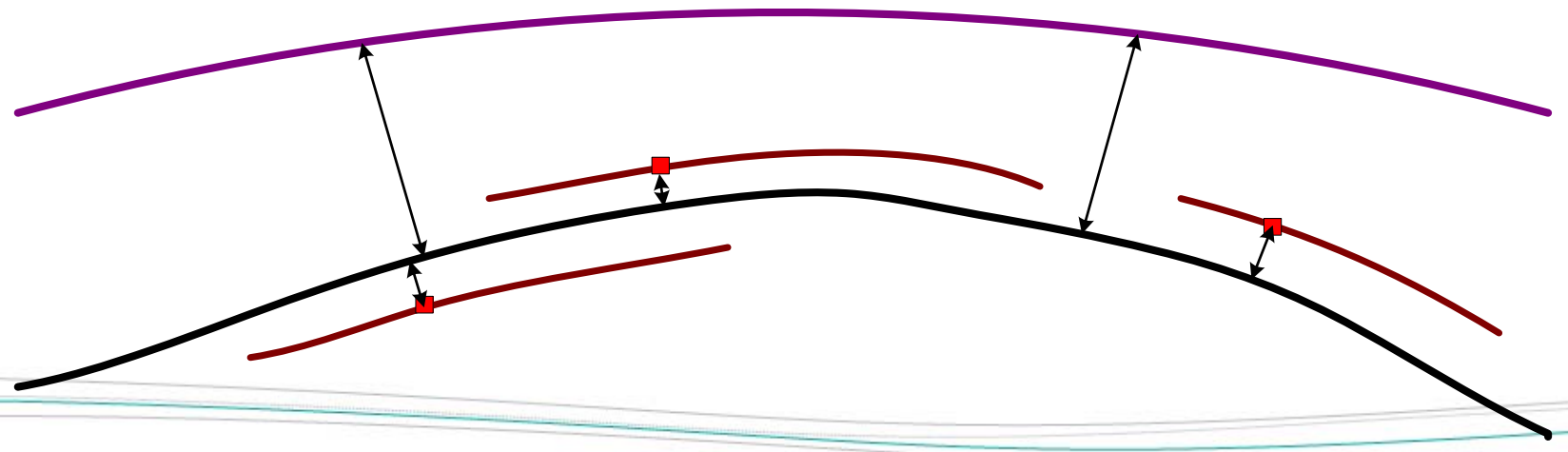
- Heights from 0 to 35 m over NZ
- Provided on a 2 arc-minute (3.7 km) grid
- Calculated from 12 km spaced gravity observations
- Accuracy:
 - ± 10 cm nationally
 - $\pm 4 - 16$ cm on local datum
 - Must be verified by user





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

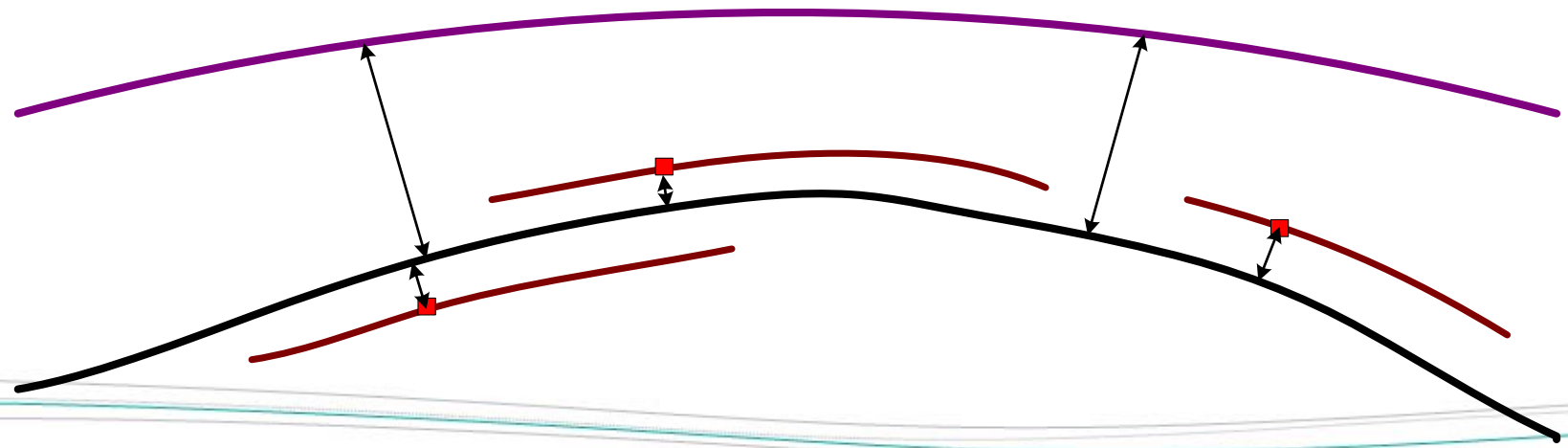
| Datum | Offset | Std |
|---------------------|--------|------|
| One Tree Point 1964 | 0.26 | 0.06 |
| Auckland 1946 | 0.50 | 0.07 |
| Moturiki 1953 | 0.32 | 0.07 |
| Gisborne 1926 | 0.59 | 0.09 |
| Taranaki 1970 | 0.45 | 0.07 |
| Napier 1962 | 0.32 | 0.05 |
| Wellington 1953 | 0.51 | 0.04 |
| Nelson 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