Initial results from a re-processed global network solution for New Zealand CORS

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Toitū te whenua

New Zealand's unique position straddling the Australian and Pacific plate boundary means it experiences both secular tectonic plate motion and non-secular motions associated with earthquakes. The 39 PositioNZ network CORS sites, jointly operated by Land Information New Zealand (LINZ) and GeoNet, monitor land deformation and maintain the national datum as these sporadic and ongoing events occur. Positions and velocities from these sites are integrated into the national deformation model which translates between the present ITRF coordinates and the New Zealand Geodetic Datum 2000 (NZGD2000).

Monitoring deformation in the dynamic landscape of New Zealand is a technical challenge and is carried out through a combination of continuous GNSS, InSAR, LiDAR, and campaign surveying. This poster describes the current GNSS reprocessing activities at LINZ in the face of ongoing earthquake events.

Long term monitoring using GNSS

The operational products created by the IGS and its associated Analysis Centres (ACs) are state of the art when they are produced and are incrementally improved over time as new methods and models are adopted and incorporated into the routine processing. However, these incremental changes cause coordinate jumps and changes in the noise characteristics of the time series, which ultimately affect the long term derived positions and velocities.

Long term monitoring requires a temporally homogeneous processing strategy to ensure the time series estimated from long term GNSS data contain only real physical movements and minimise day to day scatter (Steigenberger et al, 2006). In response, the IGS have coordinated two iterations of the reprocessing effort which seeks to reprocess historical data using the latest strategies and models to produce orbits, clocks and earth orientation parameters in a consistent way (https://acc.igs.org/reprocess2.html).

Aims

The aim of reprocessing New Zealand's 39 CORS sites is to identify and model different types of earthquake events, and analyse deformation of the country in three dimensions in order to link present position data to the NZGD2000 datum. This link is created through the generation of a deformation model which is derived in part from GNSS (Crook et al, 2016). This newest solution is the result of changing the processing strategy to reflect the requirements of long term monitoring.

Method

The long term monitoring of land movements is carried out through a 'homogeneous' reprocessing using a double difference strategy with Bernese 5.2 GNSS software and CODE's reprocessed CO2 products and final orbits and earth rotation parameters. The major changes from the original to the reprocessed strategy are outlined in Table 1.

Figure 1. Global IGb08 core reference network used to align the New Zealand reprocessed solution to the IGb08 reference frame.

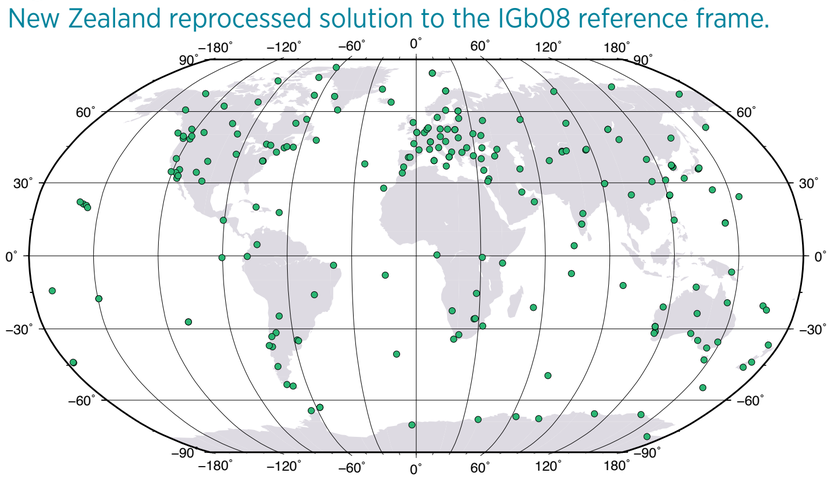


Figure 2. LINZ PositioNZ network of 39 CORS sites.

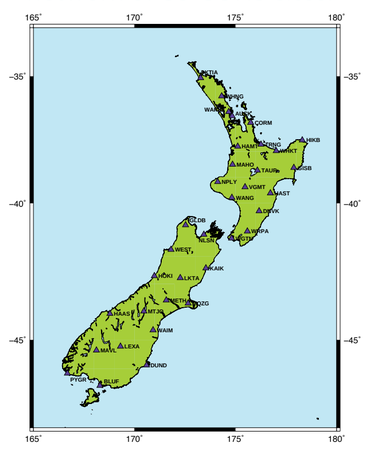


Table 1. Major processing strategy changes between legacy processing and new processing strategy.

Solution	Extent	IGB08 reference sites	Clusters	Products	Tropo
Original	Regional	15	1	IGS Final	GMF
Reprocessed	Global	194	4 regional + 1 redundant	CO2/CODE Final	VMF1

Other parameters common to both solutions are: Absolute antenna phase centre variation calibrations applied, FES2004 ocean tide loading models are applied, atmospheric tidal loading models are applied, baseline length based ambiguity resolution strategies are applied, reference site outlier rejections are enabled at a level of 15mm, 15mm, and 35mm in north, east, and up respectively.

Preliminary results

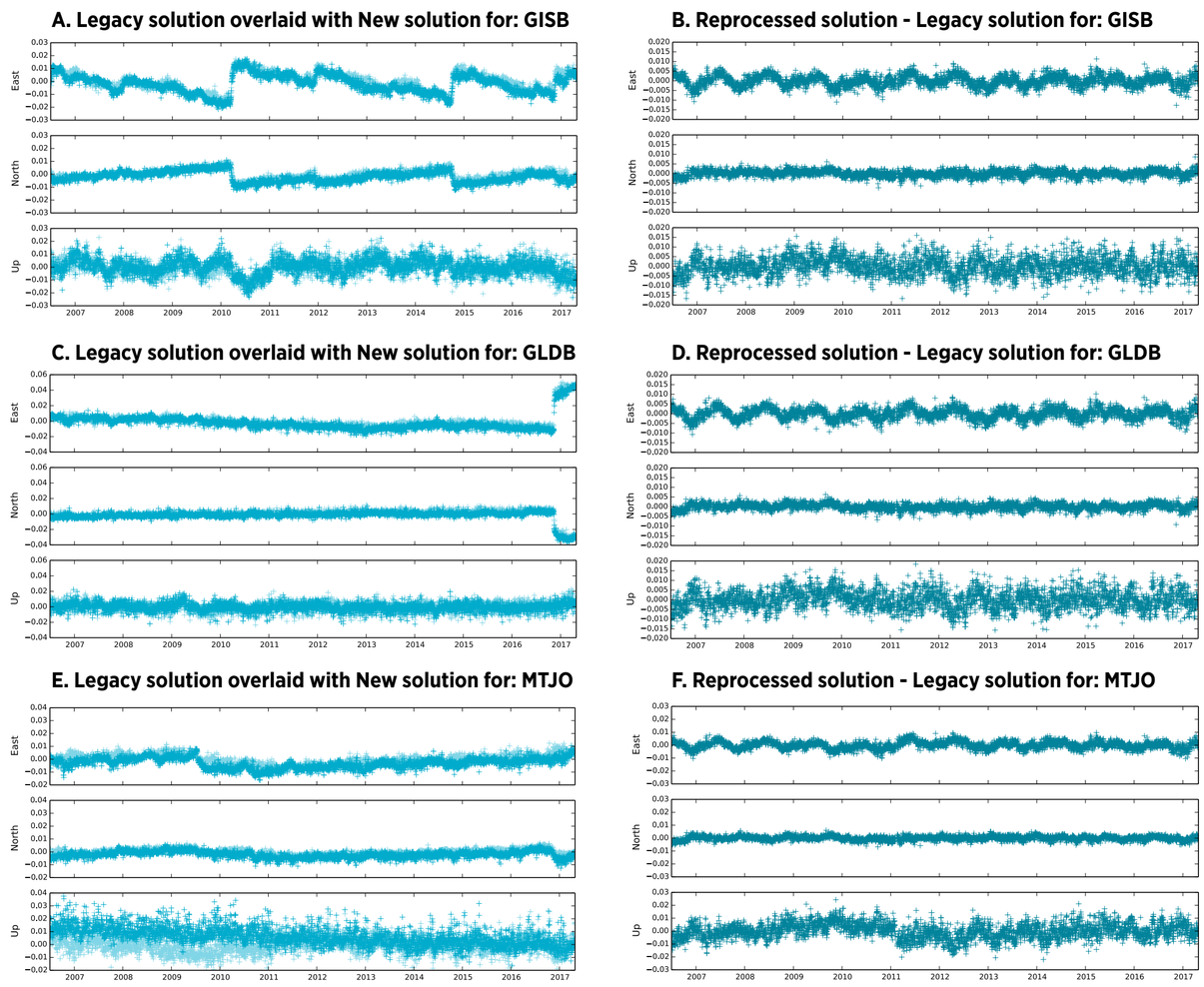
LINZ is currently processing historical data for all PositioNZ stations. The preliminary results from a subset of sites are listed in Table 2 and displayed in Figure 3. These results indicate the effect of the strategy changes including:

1. A systematic coordinate offsets for each site between the original and reprocessed solutions. For the selected sites in Table 2, the east and north components have differences that range from -1.5 to -3mm of difference.
2. Increased standard error introduced by the global network in East and North components, and some decreases in the up component.
3. Velocity differences in the east component have all decreased, while there appears to be no pattern to the changes in the north and up components.
4. The daily coordinate difference plots in Figure 3 show that there is a change in the seasonal signals with the introduction of the global network.

Selected results from Gisborne (GISB), Golden Bay (GLDB), and Mount John (MTJO)

The time series displayed show the original time series overlaid with the reprocessed time series. Daily coordinate differences between these are also shown as reprocessed-original. These plots show the differences in the seasonal signals present in the two solutions and systematic coordinate offsets between the two solutions.

Figure 3. Comparison of reprocessed and original results for Gisborne (GISB), Golden Bay (GLDB), and Mount John (MTJO)



Note. *Figures a, c, and e show the original solution overlaid with the reprocessed solution, while figures b, d, and f show a daily coordinate difference between solutions as reprocessed - original.*

Table 2. Summary of the differences between the reprocessed solution and the original solution for selected sites.

	Mean coordinate difference [mm]			Robust Standard Error difference [mm]			Velocity difference [mm/yr]		
	e	n	u	e	n	u	e	n	u
AUCK	-1.965	-1.943	0.506	0.229	0.484	0.368	-0.416	-0.129	0.313
BLUF	-2.072	-1.565	0.940	0.238	0.472	-0.640	-3.261	0.271	2.674
DNVK	-1.919	-1.839	0.644	0.134	0.352	0.069	-0.465	-0.093	0.928
DUND	-2.191	-1.819	-0.431	0.245	0.411	-0.669	-0.331	-0.014	0.245
GISB	-1.993	-2.006	-0.019	0.146	0.430	-0.058	-0.570	0.018	0.805
GLDB	-2.063	-1.833	-0.338	0.208	0.216	-0.153	-0.861	0.033	-0.105
MTJO	-3.072	-2.112	6.212	0.271	0.400	-0.065	-0.355	-0.032	-0.071
PYGR	-2.312	-1.809	-0.502	0.277	0.214	0.048	-0.229	-0.368	1.707
WANG	-2.045	-1.918	0.025	0.213	0.481	-0.138	-0.321	-0.112	1.174
WGTN	-2.292	-2.023	0.075	0.083	0.317	-0.424	-0.061	0.840	1.327
WHKT	-2.473	-2.389	0.199	0.146	0.491	-0.070	-0.339	-0.104	-0.243

Note. *Differences are computed as reprocessed - original.*

Conclusions

The plots and table of differences show some seemingly systematic changes to the mean coordinates and east velocities, but more investigation will be carried out on the remaining CORS sites. Also of interest, is the differing shape and position computed for the sites after the 14 November 2016 earthquake.

Once the full time series is computed, the solution will be incorporated into the new 3 dimensional New Zealand deformation model.

Future developments to the solution include: shifting from IGB08 to IGS2014, and processing using the CODE EGIESM products, shifting to cloud processing.

References
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Steigenberger P, Rothacher M, Dietrich R, Fritsche M, Rulke A, and Vey S. "Reprocessing a global GPS network", Journal of Geophysical Research – Solid Earth, vol. 111, 2006.

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