

Mountain Research Centre School of Surveying, University of Otago

Pascal Sirguey, Associate Professor

The University of Otago is Aotearoa New Zealand's oldest university, with its School of Surveying offering various qualifications in surveying and geospatial sciences.

I teach and research in remote sensing, photogrammetry, and spatial analysis. As part of the Mountain Research Centre (MRC), I develop methods and techniques to map complex topography and characterise dynamic landscapes and natural resources.



USE CASE

Pushing the boundaries of 3D-Change Detection with Pléiades Neo to monitor landscape change in New Zealand's Southern Alps



Kawarau/The Remarkables, Queenstown, Aotearoa/New Zealand (credit: Pascal Sirguey)

Application: Satellite Photogrammetric Mapping, 3D Change Detection, snow mapping

Location: The Remarkable, New Zealand

Products: PHR/PNEO tri-stereo



Challenge

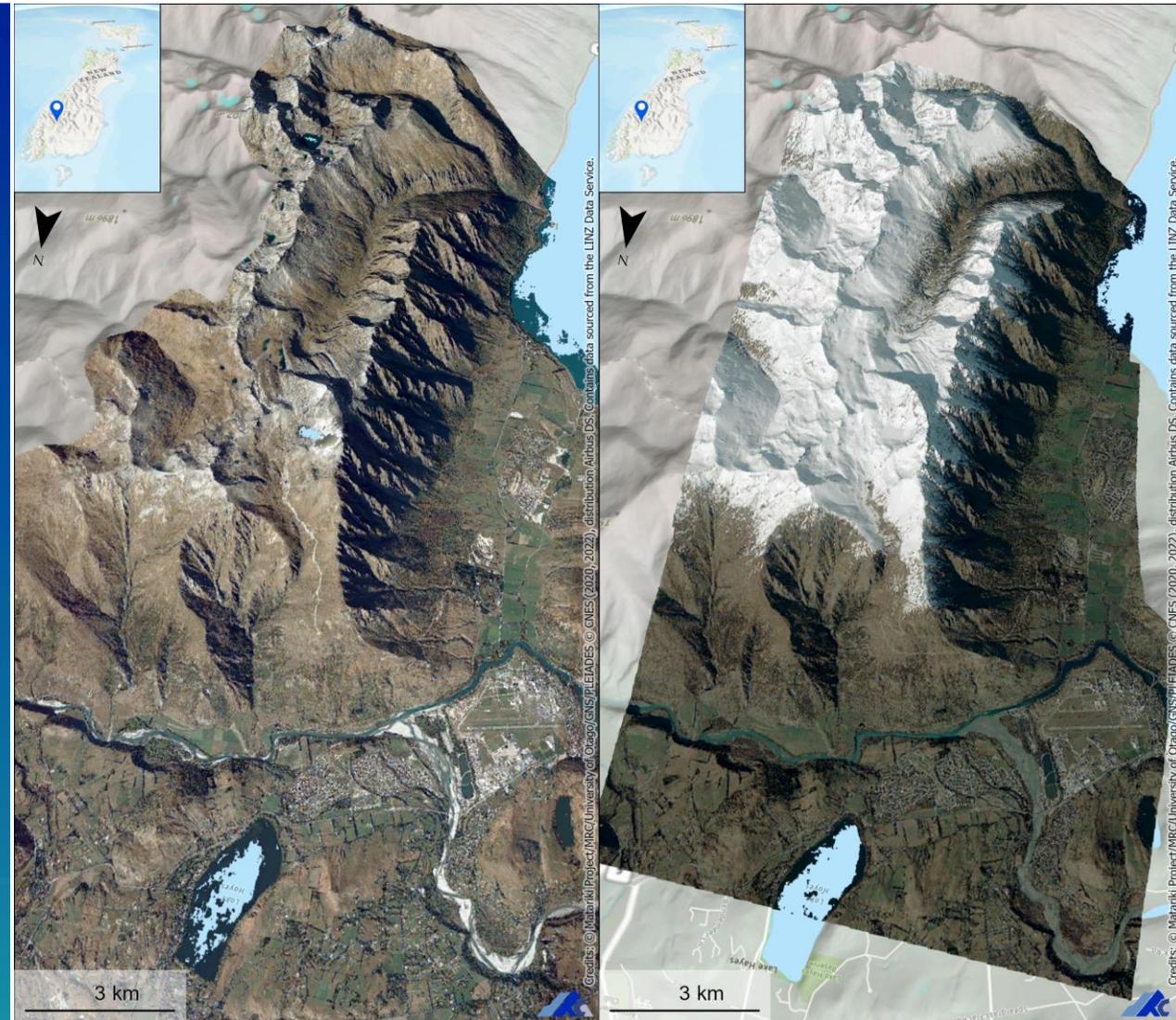
We have automated Satellite Photogrammetric Mapping (SPM) with Pléiades HR to produce accurate and coherent DSMs that enable sensitive 3D-Change Detection (3D-CD) in challenging terrain.

How does Pléiades Neo compare to PHR for 3D-CD?

- Photogrammetric mapping in snow-covered terrain is complicated by steep topography and challenging low-contrast environments
- Repeat coherent mapping at a sub-pixel level is necessary to obtain sensitive detection of surface elevation change
- Mapping the highly variable spatial distribution of snow depth is an **unforgiving** but **rewarding** application to develop robust 3D-CD with SPM.

Kawarau/The Remarkables is an iconic mountain range, and home of one of New Zealand's largest ski fields.

- PHR tri-stereo, control surveys and lidar are available for *snow-off* reference
- We acquired 2022 *snow-on* winter tri-stereo imagery (1× PHR, 2× PNEO) and surveyed *in-situ* snow profiling for comparison



PHR 20200401 *snow-off* orthoimage draped onto 2m DSM derived from SPM

PHR 20220826 *snow-on* orthoimage draped onto 2m DSM derived from SPM



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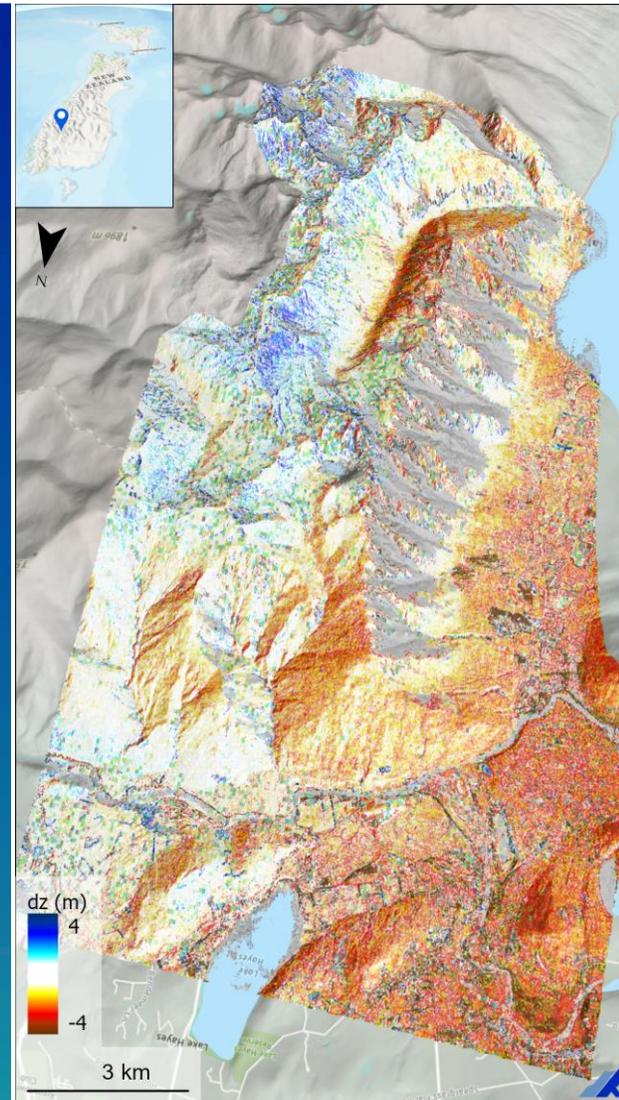
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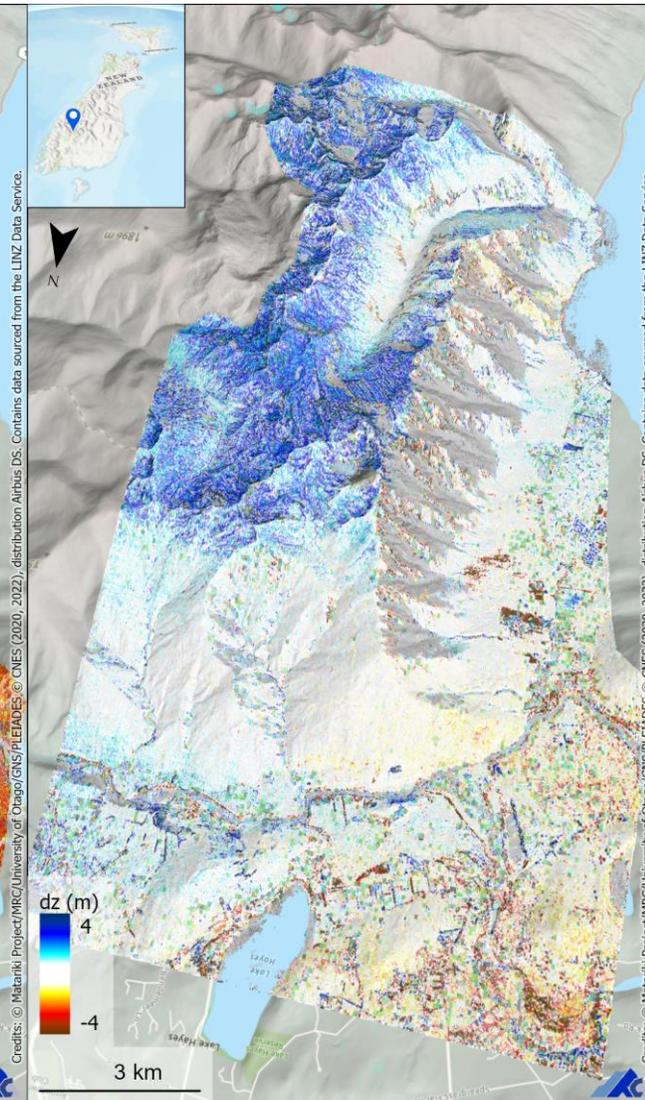
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PHR20220826-2020 elevation change using 2022 initial geometric model from Airbus. It reveals how the systematic nature of spatial incoherence between DSMs defeats change detection despite a planimetric offset <2m.



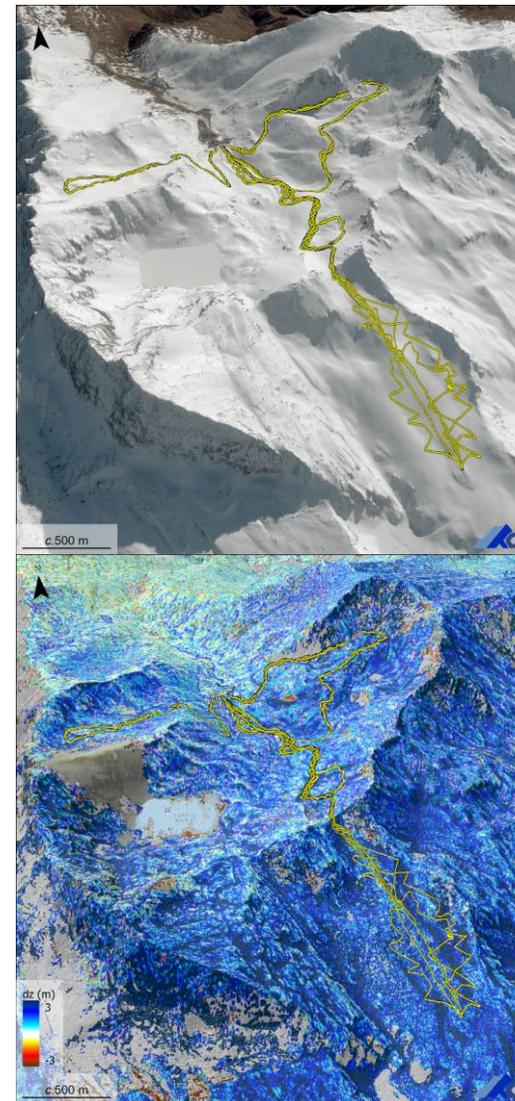
PHR20220826-2020 elevation change using the *Matariki photogrammetric mapping workflow* cross-matching method. Spatial coherence between DSMs at sub-pixel level reveals a rich and realistic variability in the spatial distribution of snow depth.



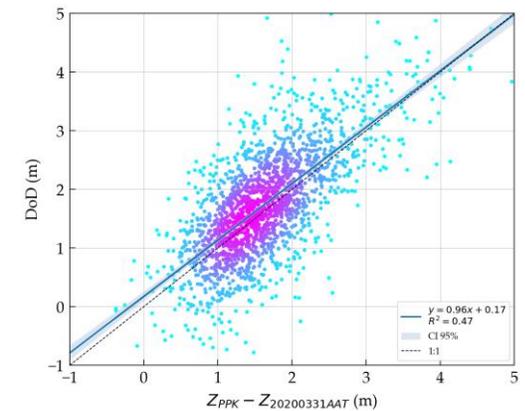
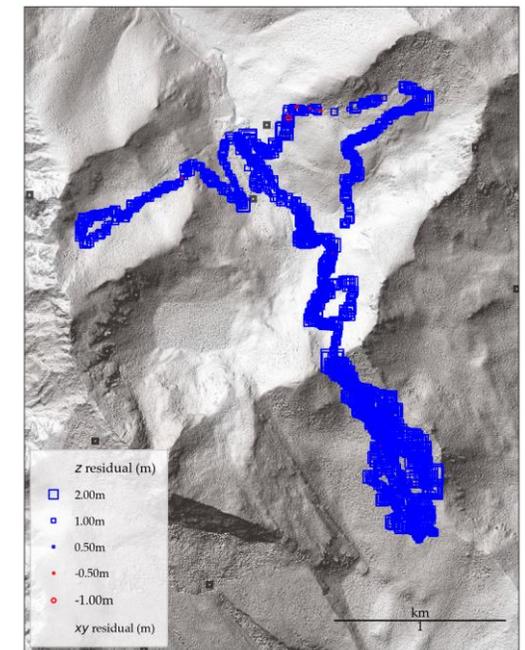
Solution & Results

How does Pléiades Neo compare to PHR for 3D-CD?

- Processing of PHR20220826 winter tri-stereo automatically with the Matariki photogrammetric mapping workflow achieves **spatial coherence at sub-pixel level** required for sensitive 3D-CD
- PHR maps the spatial distribution of snow depth across the range with **sub-meter accuracy (NMAD = 0.63m)**
- 3D-CD between PHR20200401 and 2016 lidar reveals **landslide** in Owen Creek.



2022-2020 elevation change with PHR over the Remarkable skifield and Wye Creek



Comparison with GNSS measurements of snowdepth from fieldwork



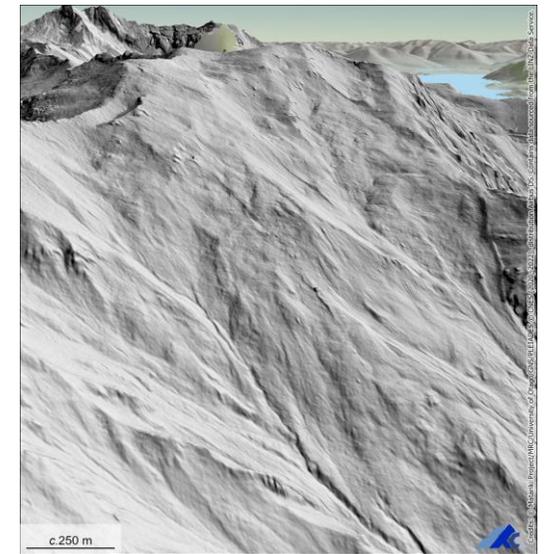
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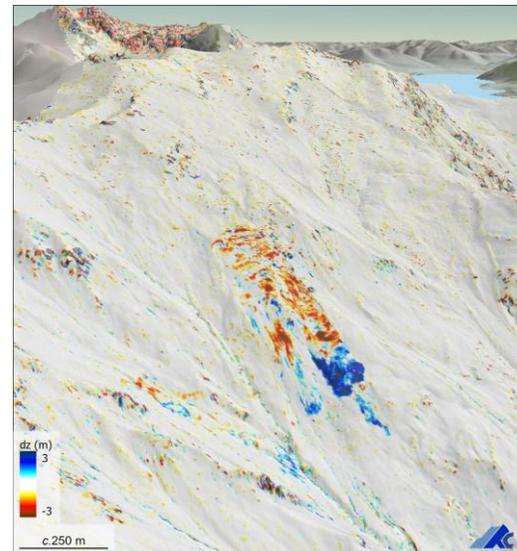
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- 3D-CD between PHR20200401 and 2016 lidar reveals **landslide** in Owen Creek.



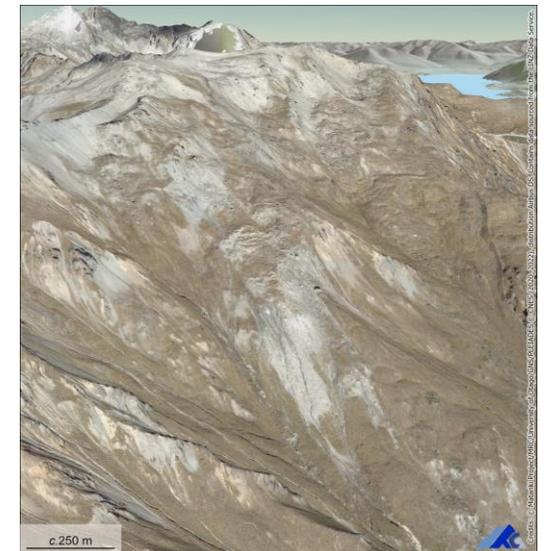
Hillshade from 2016 lidar DSM in Owen Creek



Hillshade from PHR20200401 DSM in Owen Creek



PHR20200401-2016 elevation change revealing landslide in Owen Creek



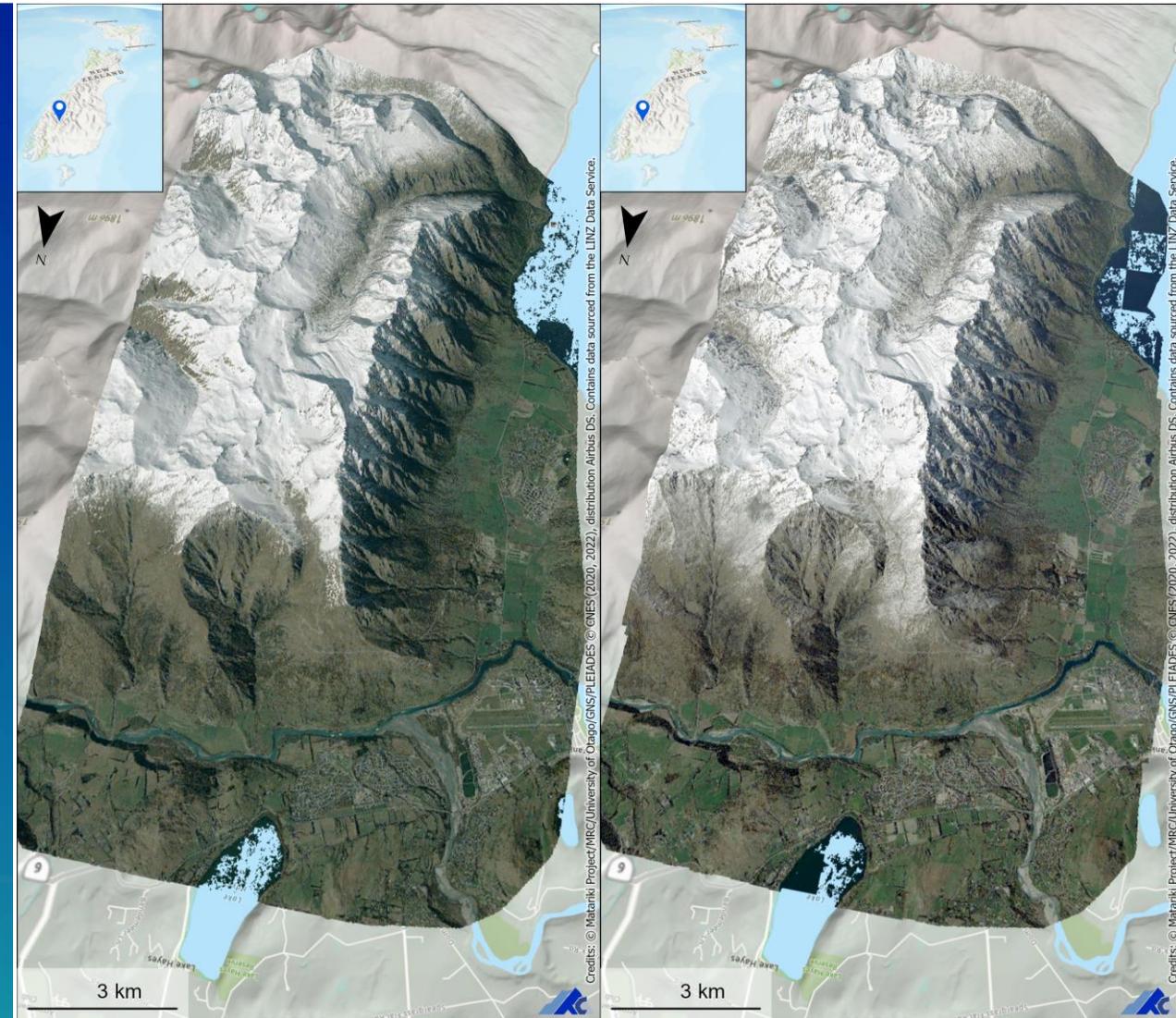
PHR20200401 othoimage in Owen Creek



Solution & Results

How does Pléiades Neo compare to PHR for 3D-CD?

- Photogrammetric restitution of Pléiades Neo stereo imagery yielded successful **robust surface modeling**
- The improved spatial resolution allows to map **significantly finer structures in the snow spatial distribution**
- Pléiades Neo achieved **significantly improved precision**
($NMAD_{20220915} = 0.21m$; $NMAD_{20221008} = 0.32$) compared to PHR ($NMAD_{20220826} = 0.63m$)
- 3D-CD between Pléiades Neo and 2016 lidar maps existing **landslide in Owen Creek with substantially finer details, while also revealing new landslide.**



PNEO202200915 snow-on orthoimage draped onto 2m DSM derived from SPM

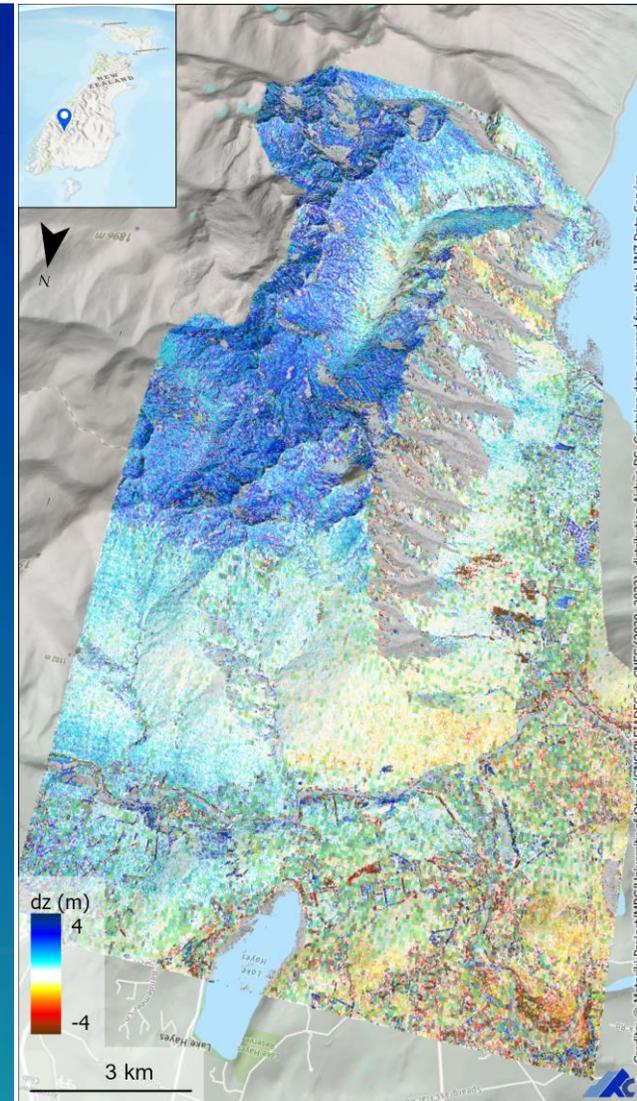
PNEO20221008 snow-on orthoimage draped onto 2m DSM derived from SPM



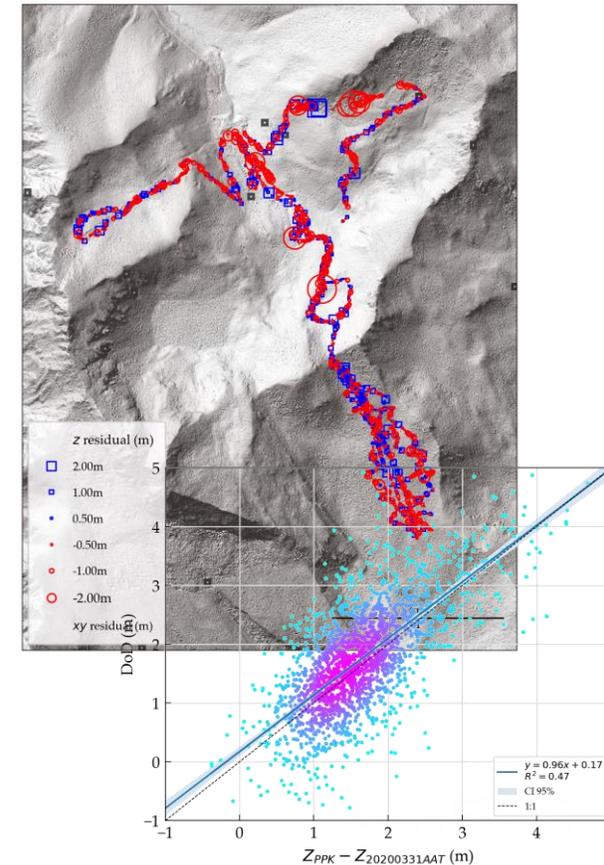
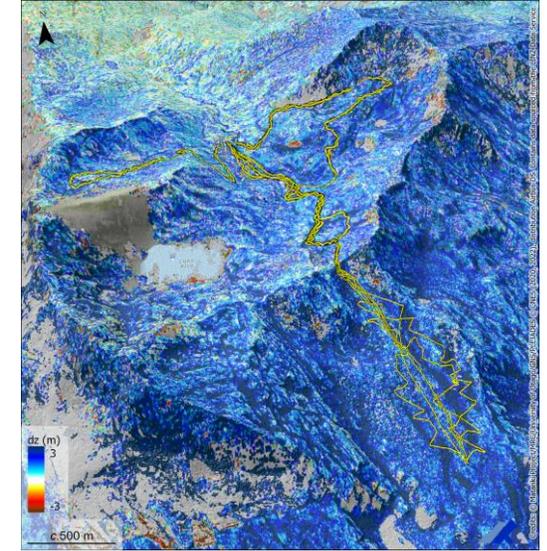
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PHR20220826-2020 elevation change using the *Matariki* photogrammetric mapping workflow cross-matching method

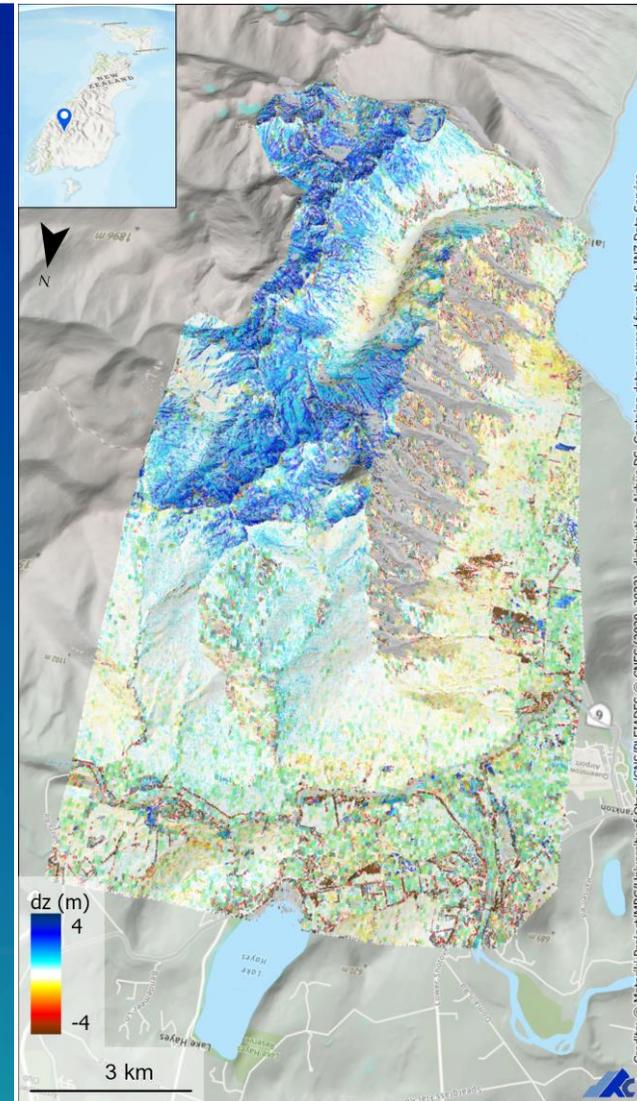




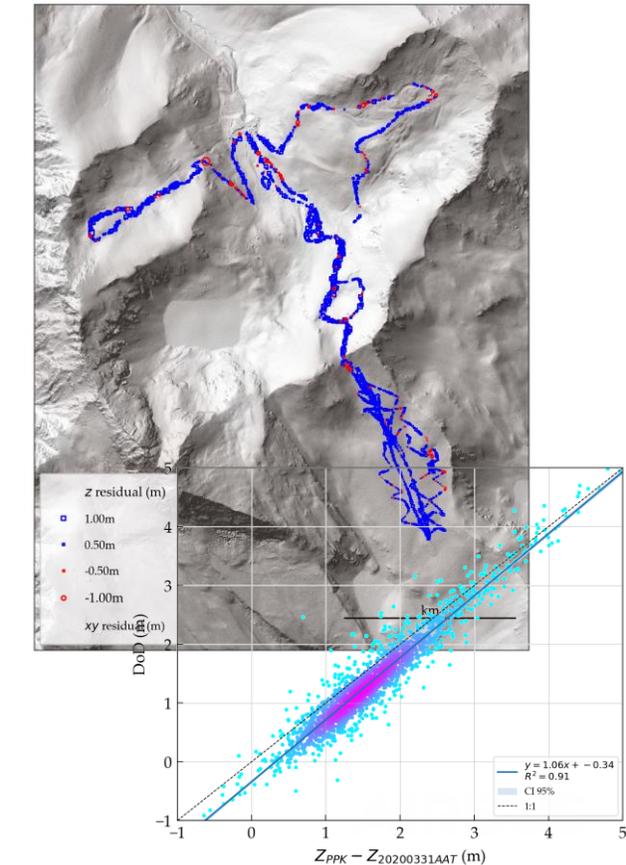
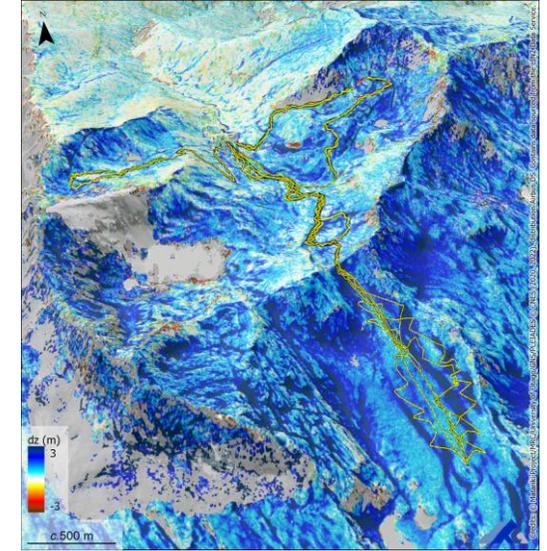
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PNEO20220915-2020 elevation change using the *Matariki* photogrammetric mapping workflow cross-matching method

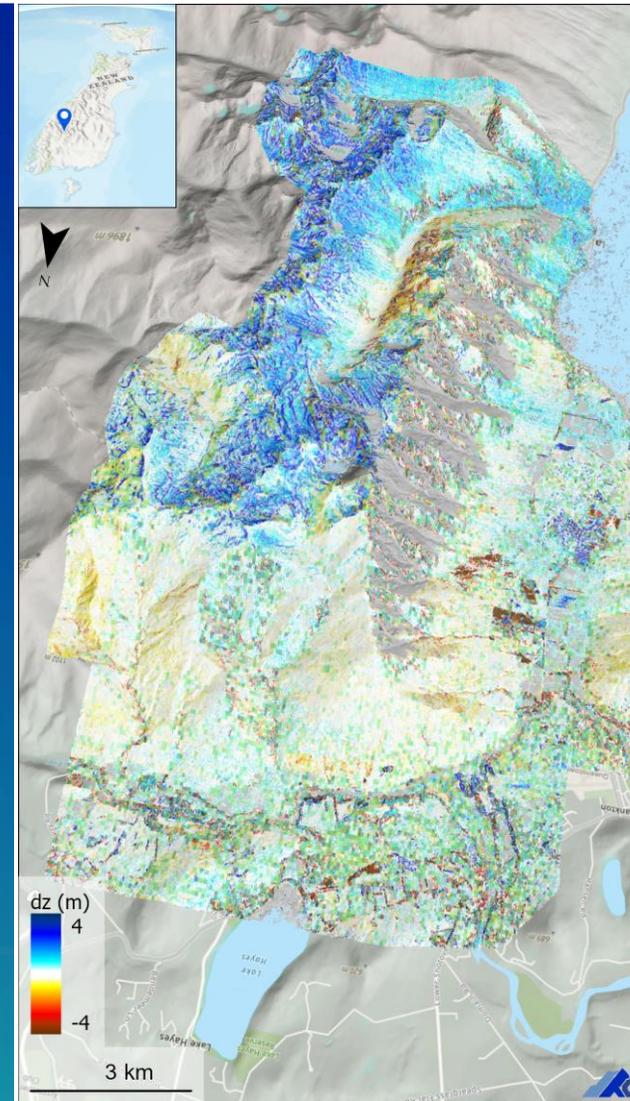




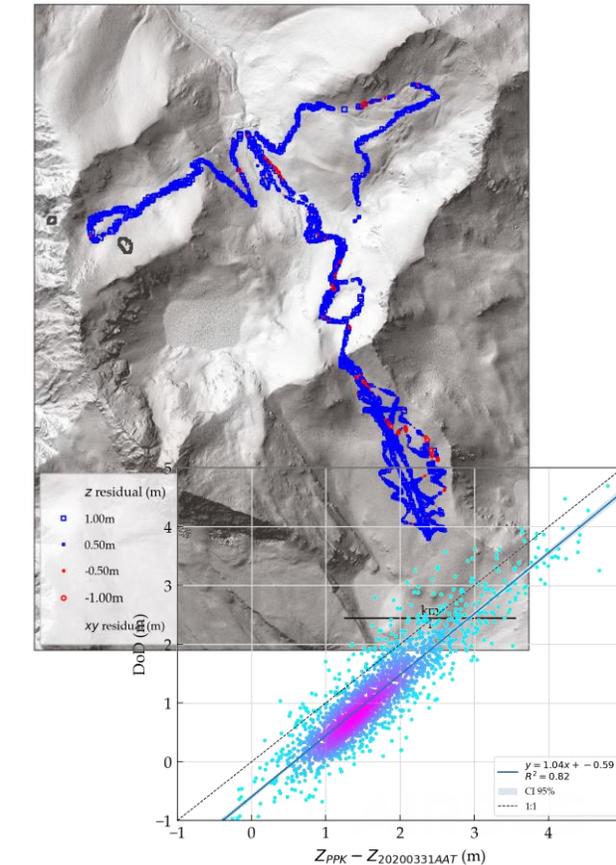
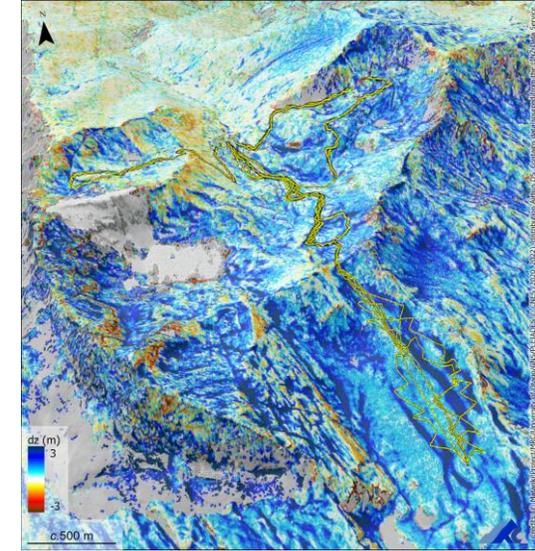
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- 3D-CD between Pléiades Neo and 2016 lidar maps existing **landslide** in Owen Creek with **substantially finer details**, while also revealing **new landslide**.



PNEO20221008-2020 elevation change using the *Matariki* photogrammetric mapping workflow cross-matching method





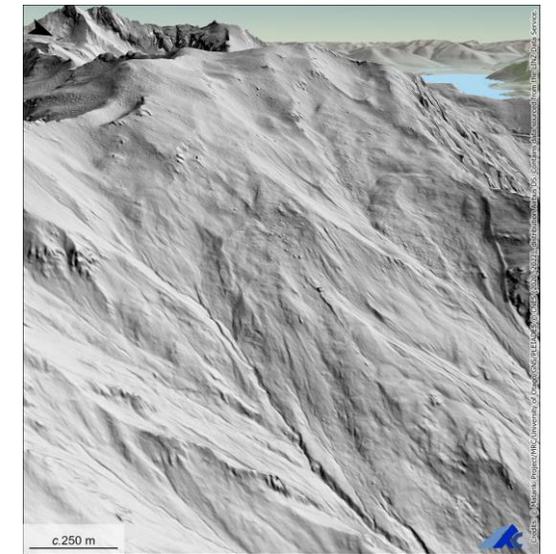
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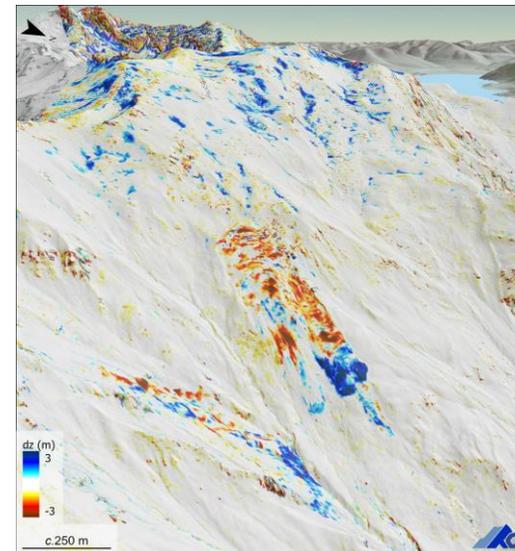
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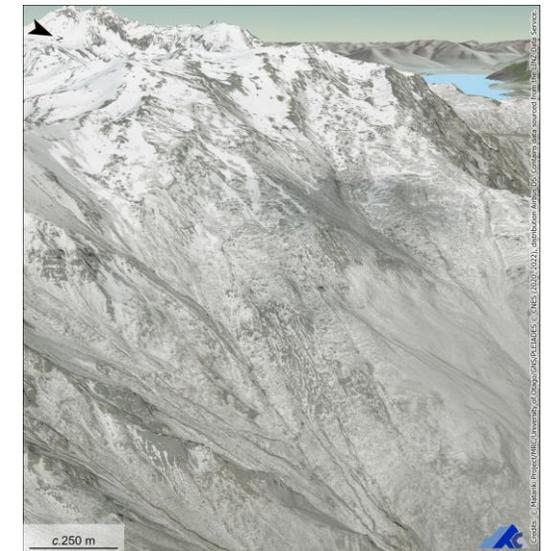
Hillshade from 2016 lidar DSM in Owen Creek



Hillshade from PNEO20221008 DSM in Owen Creek



PNEO20221008 -2016 elevation change revealing landslide in Owen Creek



PNEO20221008 othoimage in Owen Creek



Benefits

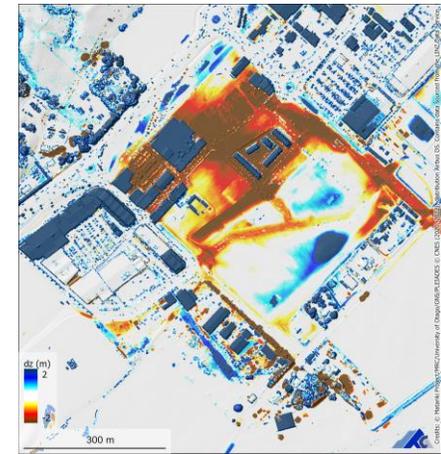
- Tests on the Five Mile shopping centre development area with repeated lidar surveys available for benchmarking demonstrates the **significant improvement of Pléiades Neo** over **PHR**, resolving much finer details of surface elevation changes.
- **Pléiades Neo** offer a competitive platform for sensitive applications of 3D-CD at sub-metre level.

Organisations Involved:

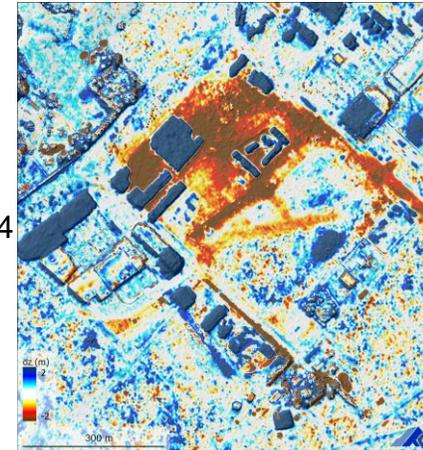


Comparison of 3D-Change Detection on Five Mile shopping centre in Frankton

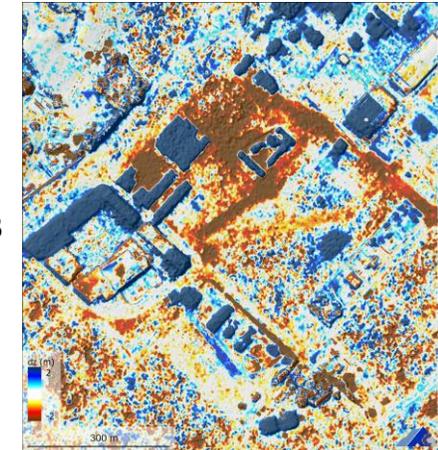
2021 lidar – 2016 lidar (benchmark)



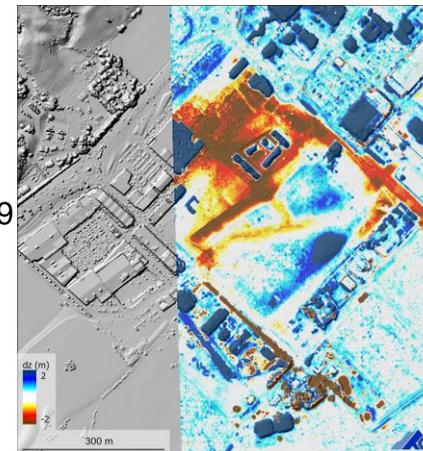
PHR202004



PHR202208



PNEO202209



PNEO202210

