Development of a land deformation model from InSAR: combination with heterogeneous geodetic measurements in the Latrobe Valley (Australia) test site

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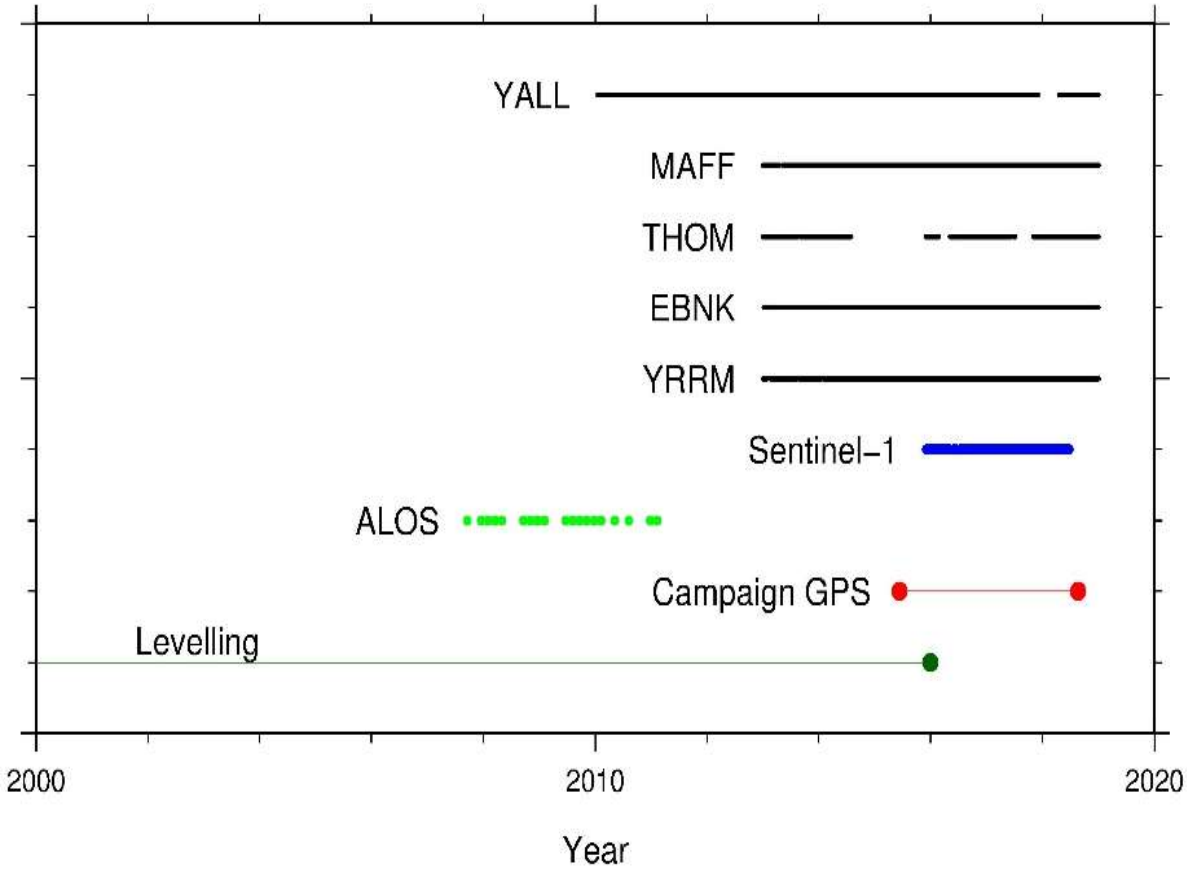
Introduction

- Deformation of the Earth's surface impacts geodetic reference frames – as the land deforms, the 3D coordinates of each position will change within the reference frame.
- Monitoring local deformation occurring between GNSS continuously operating reference stations (CORS) is challenging, as it is not directly measured.
- This project is investigating the use of radar interferometry (InSAR), combined with other geodetic data to develop a deformation model to support maintenance of the geodetic reference frame.

Data available

- Study area in Latrobe Valley, Australia.
- Test a combination of InSAR, GNSS and levelling from different time periods.



- Figure: Black lines are GNSS stations, blue and green are SAR, red are repeat GPS observations, dark green is repeat levelling.

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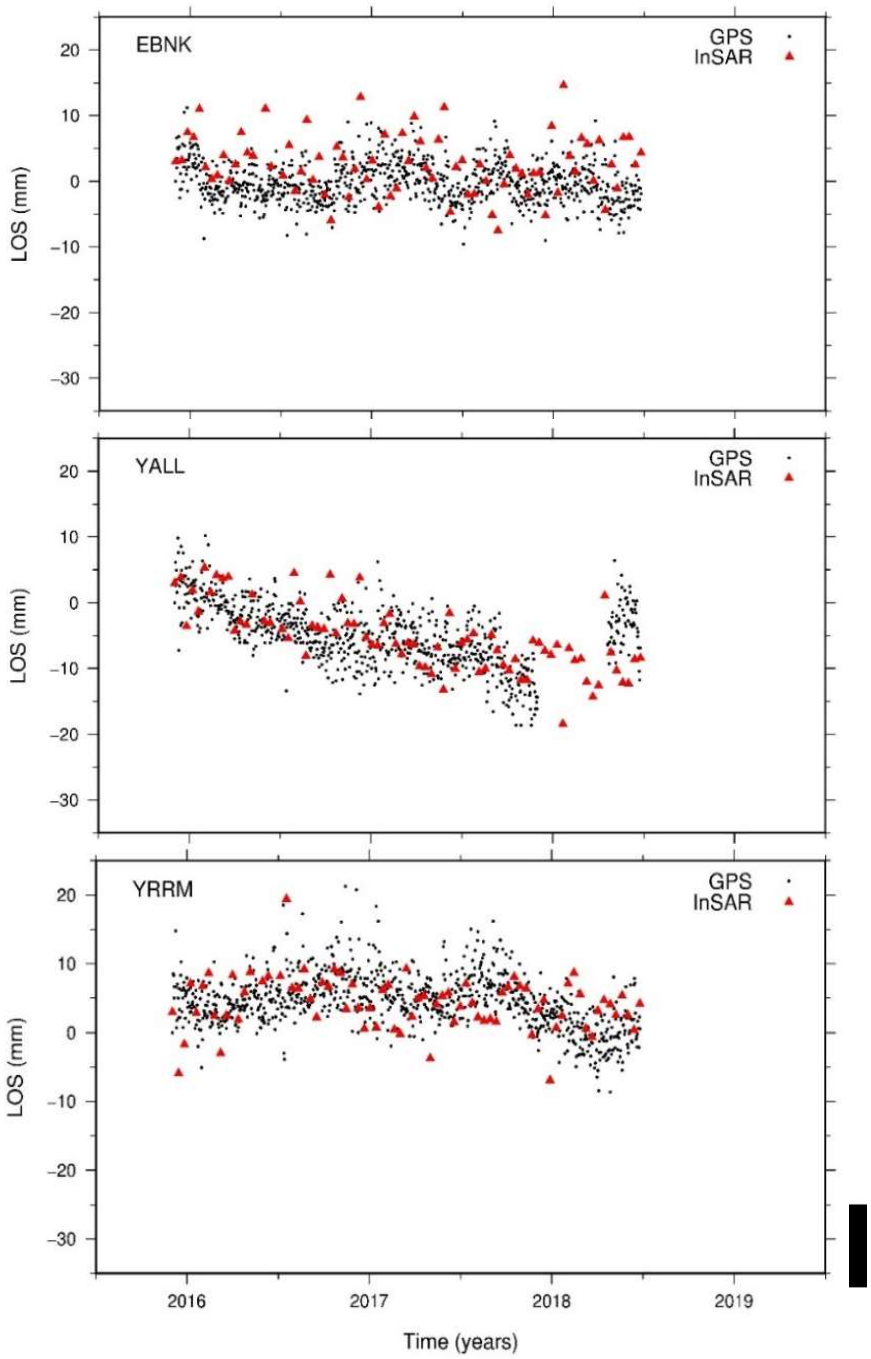
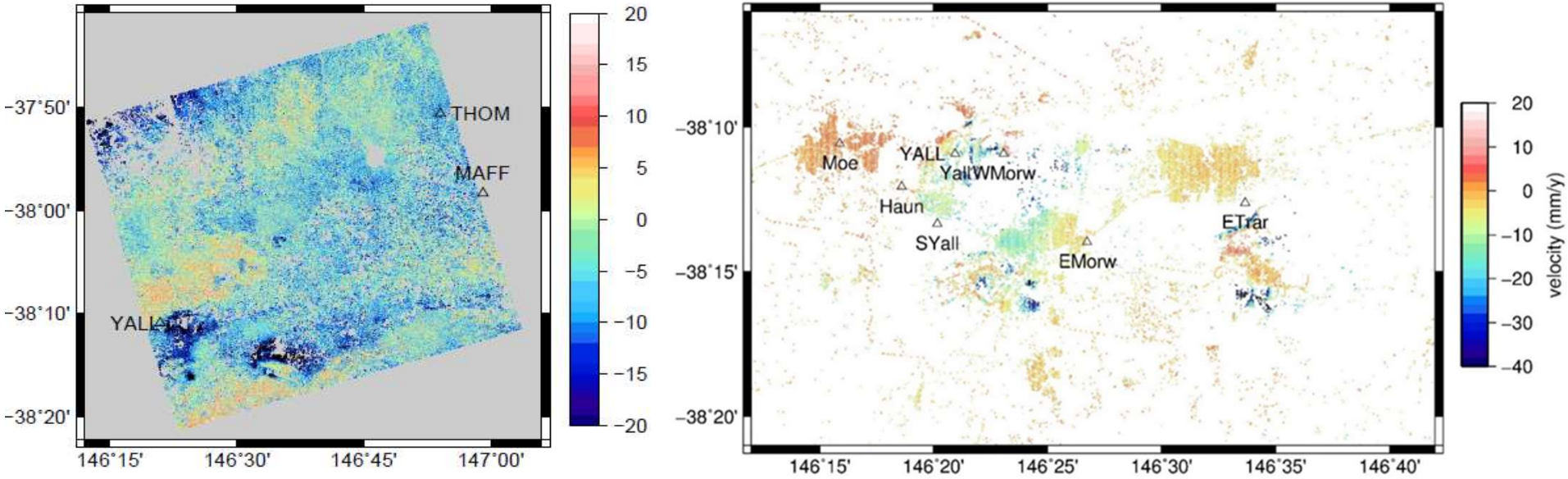
GNSS constraints

- LOS Sentinel-1 time series (red triangles) are transformed to GNSS station at EBNK (top right, black dots).
- Sentinel-1 time series validated at GNSS stations YALL and YRRM (middle and bottom right respectively)



ALOS rates 2007 – 2011 (left)
Sentinel-1 rates 2015.9 – 2018.5 (right)



- Processed using PS-SBAS algorithms
- L-band ALOS provides coherent coverage over rural areas.
- C-band Sentinel-1 decorrelates over rural areas.
- ALOS/Sentinel-1 time series not coincident in time or space – note different scale; Sentinel-1 is enlargement of bottom left corner of the ALOS extent.

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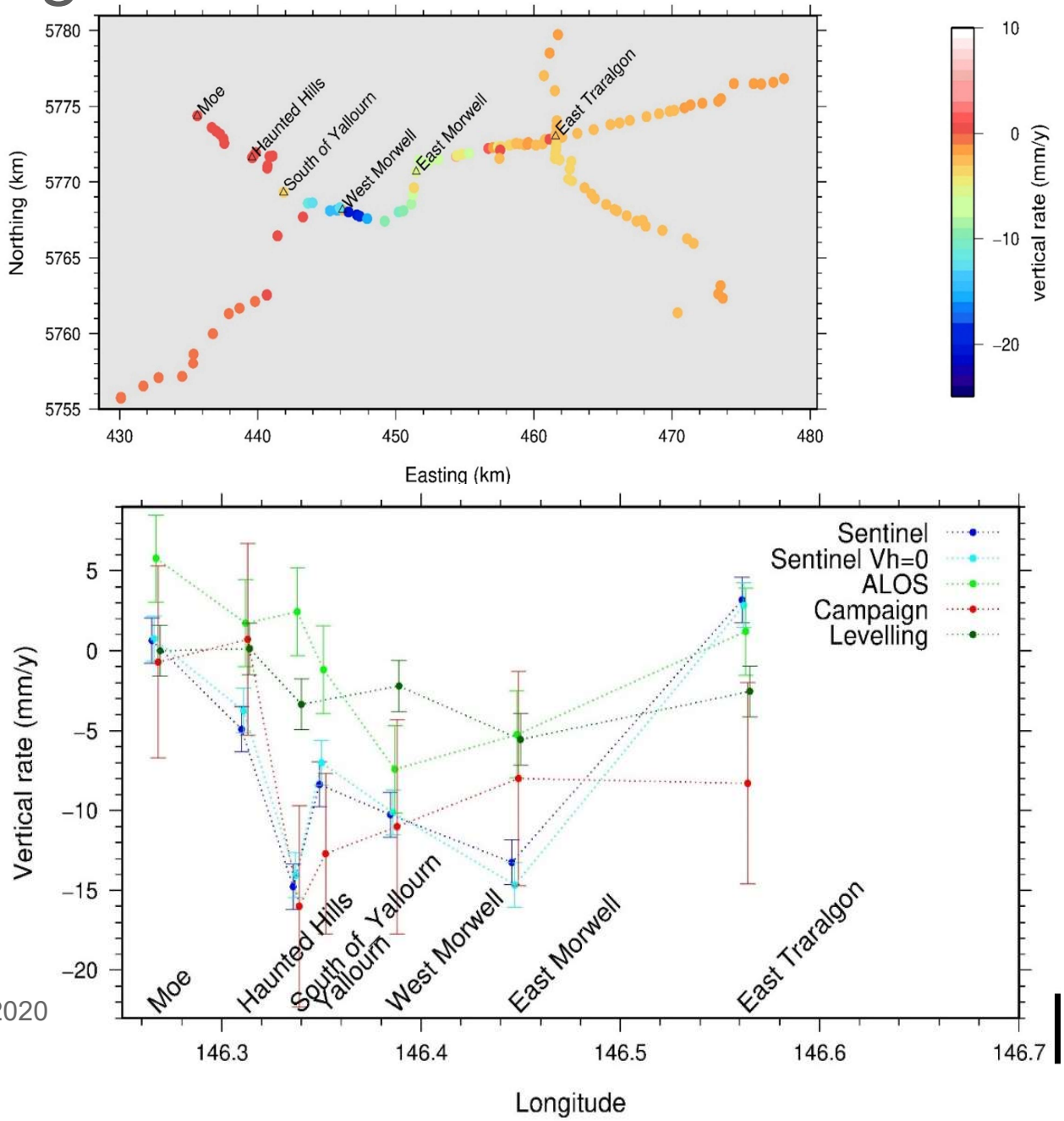
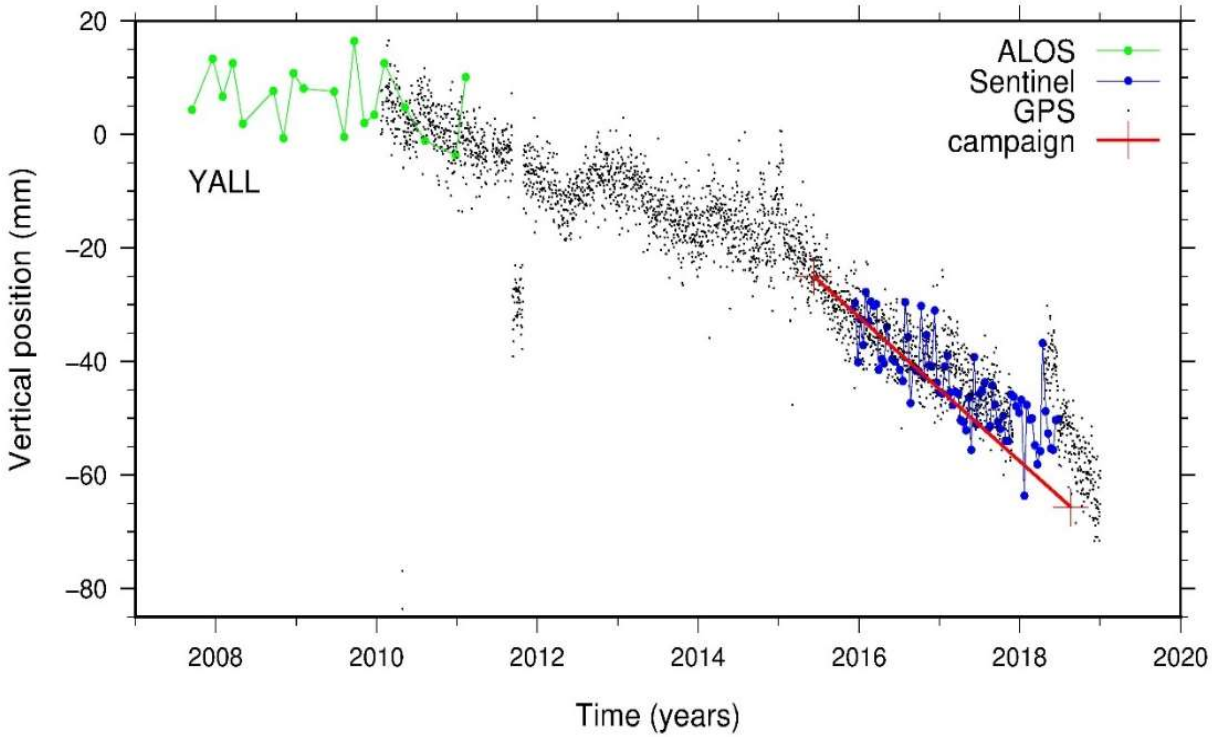
Compare heterogeneous measurements

- Top: levelling rates at benchmarks near YALL CORS (top)
- Bottom: comparison at benchmarks for:
  - Sentinel-1 2015.92-2018.57
  - ALOS 2007-2011
  - Campaign (periodic) GNSS at 2015 and 2018
  - Repeat levelling at 1980 and 2015



Combined time series at GNSS station YALL

- Combine time series:
  - ALOS
  - Sentinel-1
  - Continuous GNSS (YALL)
  - Campaign GPS



- Continuous GNSS stations needed to constrain InSAR
- Additional SAR data (multiple geometry) at common time period and spatial extent needed for rigorous combination.

Summary

- Preliminary results indicate localised large magnitude deformation around mining areas.
- Combining InSAR with other geodetic measurements that do not coincide in time and space requires assumptions of linear motion that may not be realistic.
- Additional (multi-geometry) SAR acquisitions in common time periods and spatial extent are required to develop a deformation model.

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