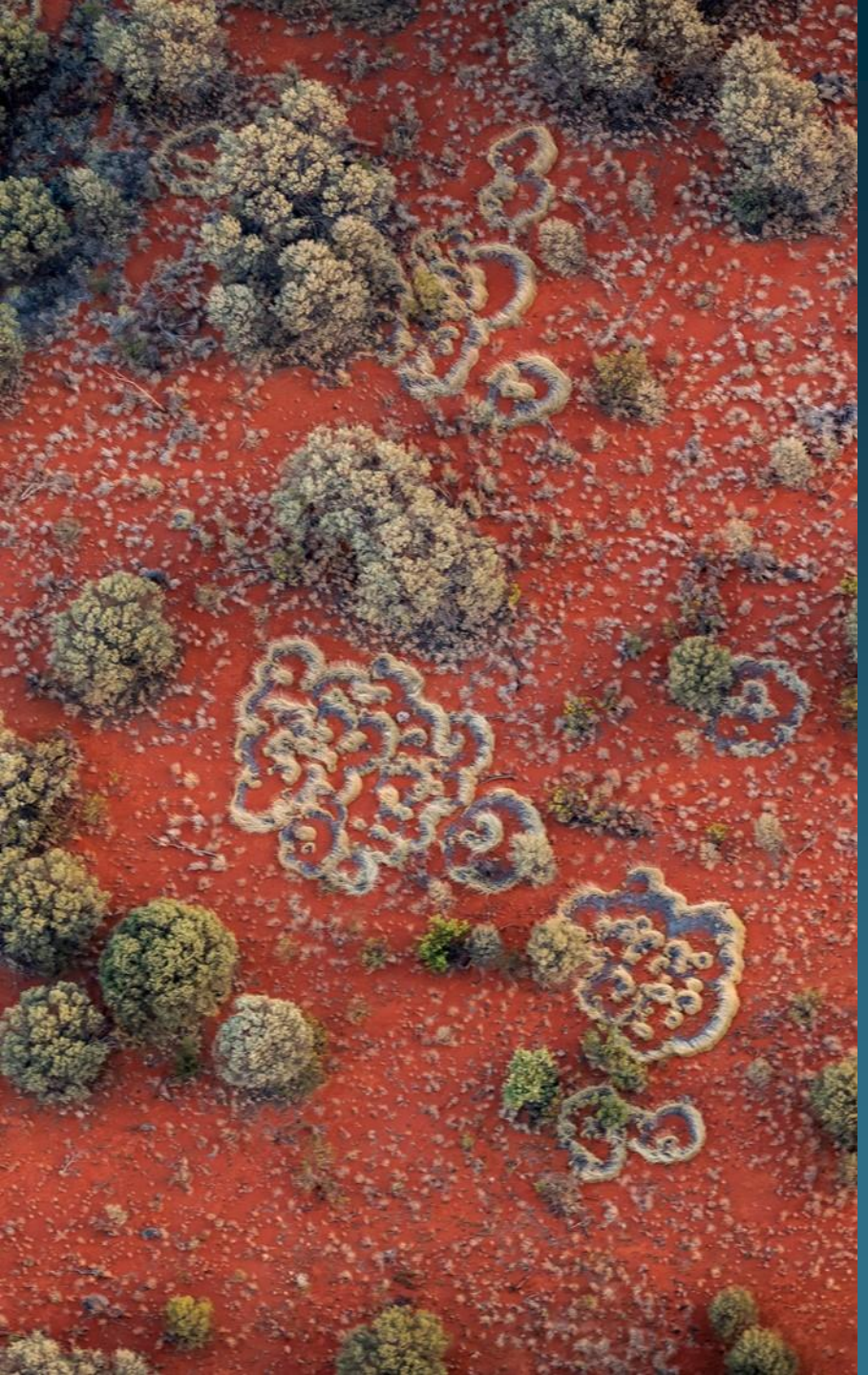


Australian Government
Geoscience Australia

Positioning Australia

APREF applications: case study in Australia

Dr Guorong Hu, Geodetic Scientist, Positioning Australia, Geoscience Australia

12th Plenary Meeting of UN-GGIM-AP WG1, 6-10 November 2023, Bali, Indonesia

UN-GGIM-AP

Applications Example 1:
APREF products contributions to the Australian National Datums

Geospatial Reference System

Legal and Documentation

- Business Case
- Legislation
- Technical Manuals and Implementation Guidelines

Geometric

- Global Reference Frame — ITRF
- Regional Reference Frame — APREF
- National Geodetic Datum — GDA2020
- Previous National Geodetic Datums — GDA94

Physical

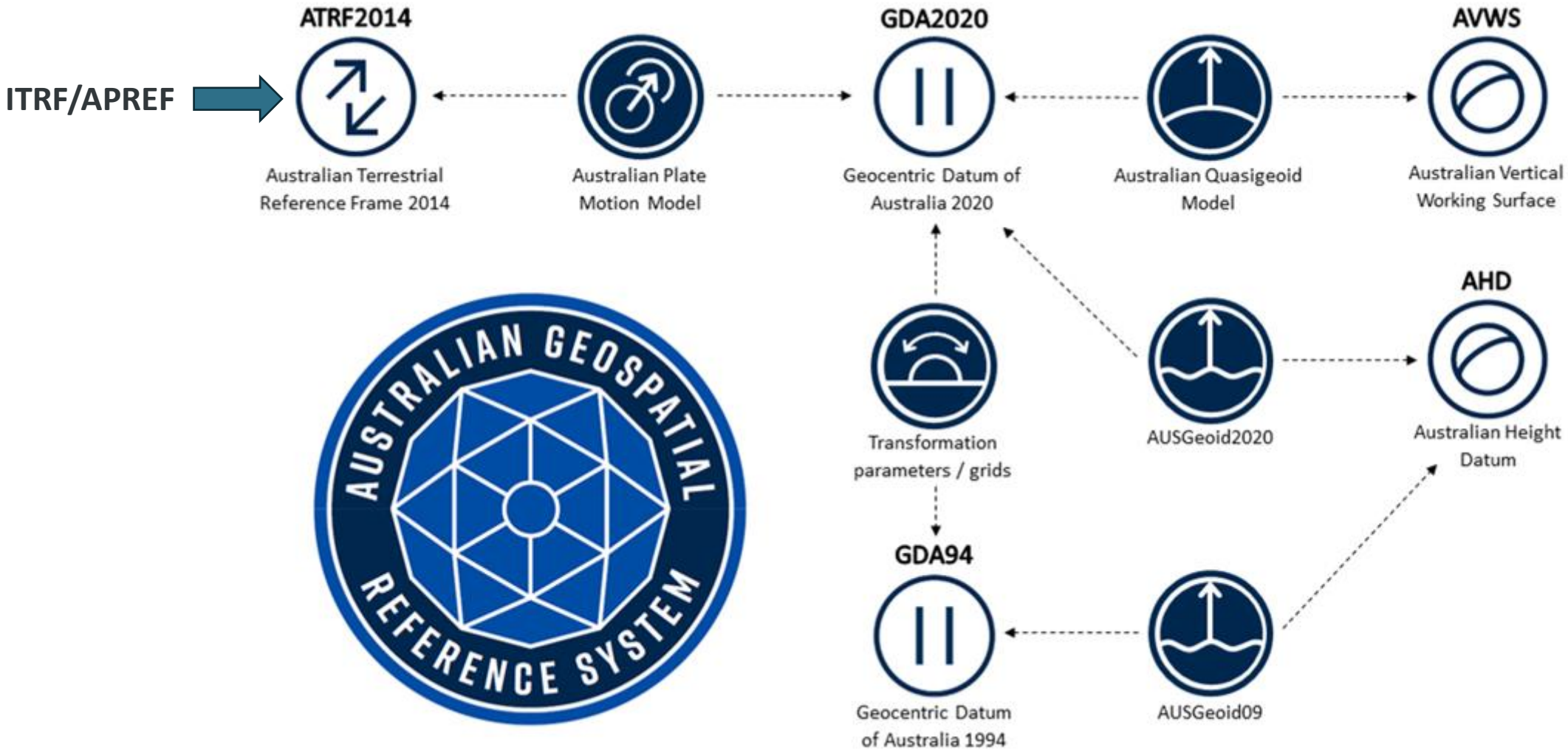
- International Height Reference System
- National Height Datum

Models

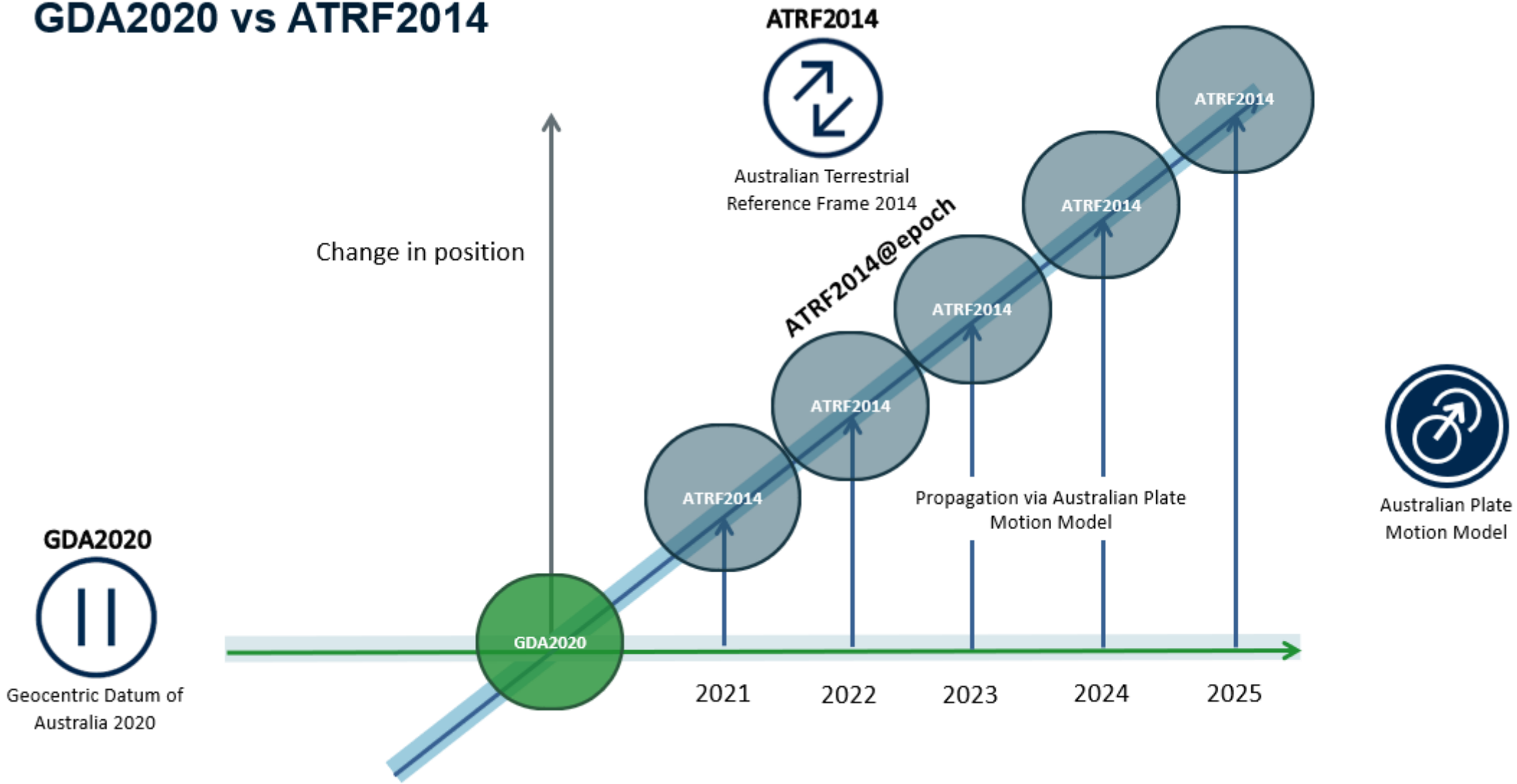
- Plate motion
- Deformation
- Geoid
- Transformations

Infrastructure | Analysis capability | Standards | People | Governance | Consultation and Communication

Australian Geospatial Reference System



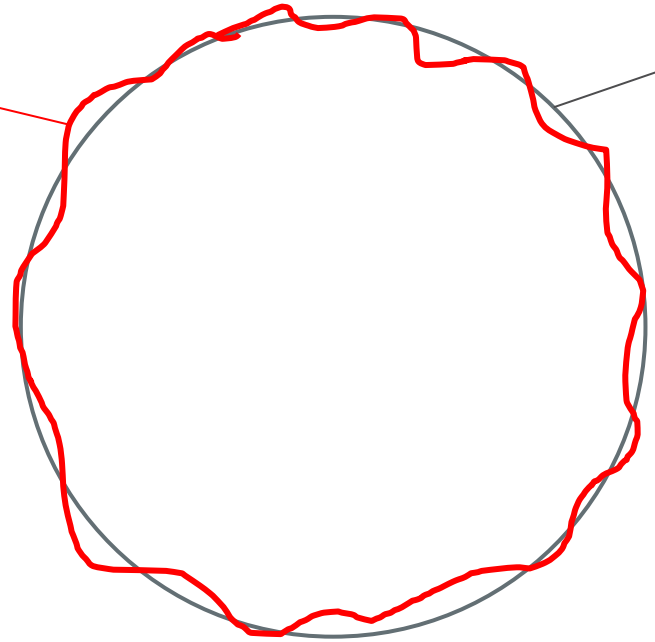
GDA2020 vs ATRF2014



Geometric vs Gravitational Potential

Gravity

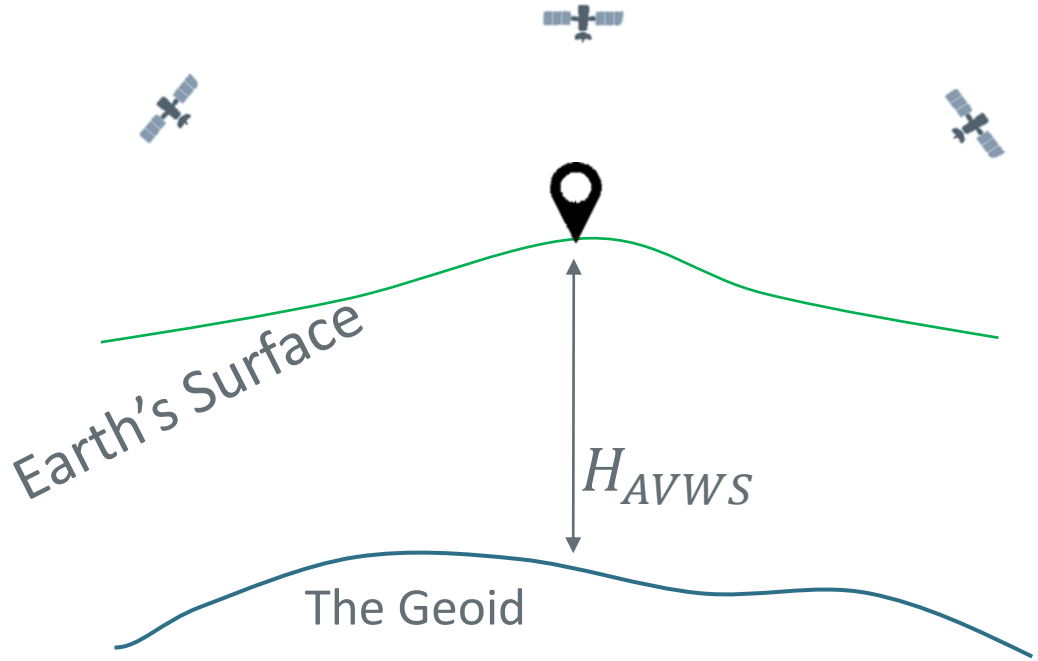
- Complex
- Harder to define
- Precise
- Gravitational Potential
- Need a model to use with GNSS
- Water **always** flows downhill



Geometric

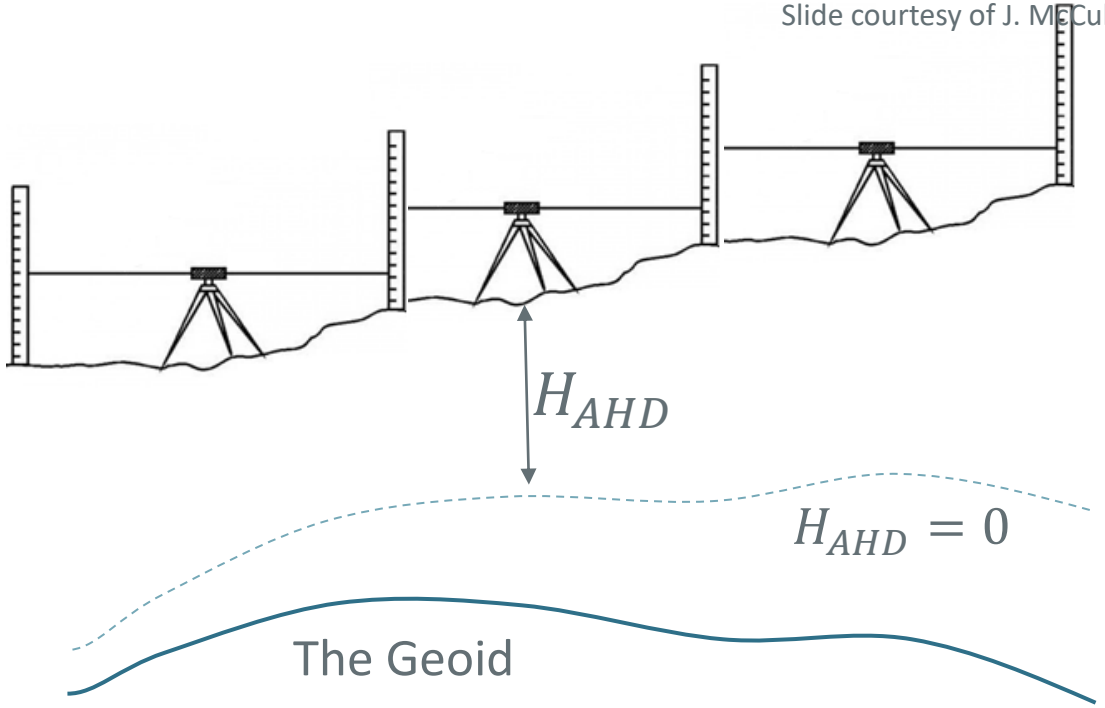
- Simple
- Precise
- Geometric **(APREF products)**
- Useful for GNSS **(APREF GNSS network)**
- Water doesn't always flow downhill

Slide courtesy of J. McCubbine



Australian Vertical Working Surface

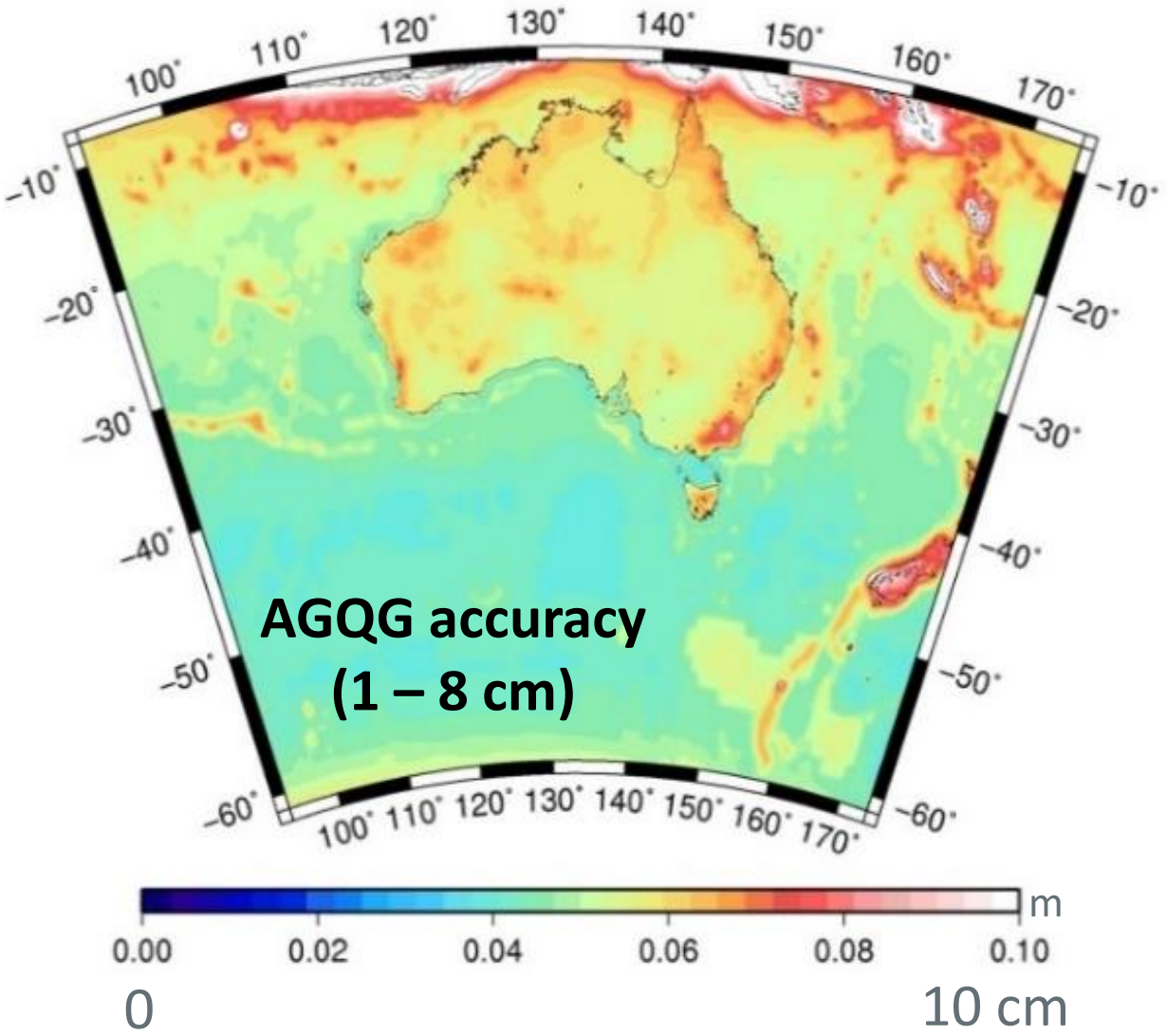
- Based on a gravimetric quasigeoid model, AGQGYYYY - directly compatible with GPS.
- Doesn't depend on physical infrastructure
- Heights referenced to a smooth, flat and level surface in the Earth's gravity field.



Australian Height Datum

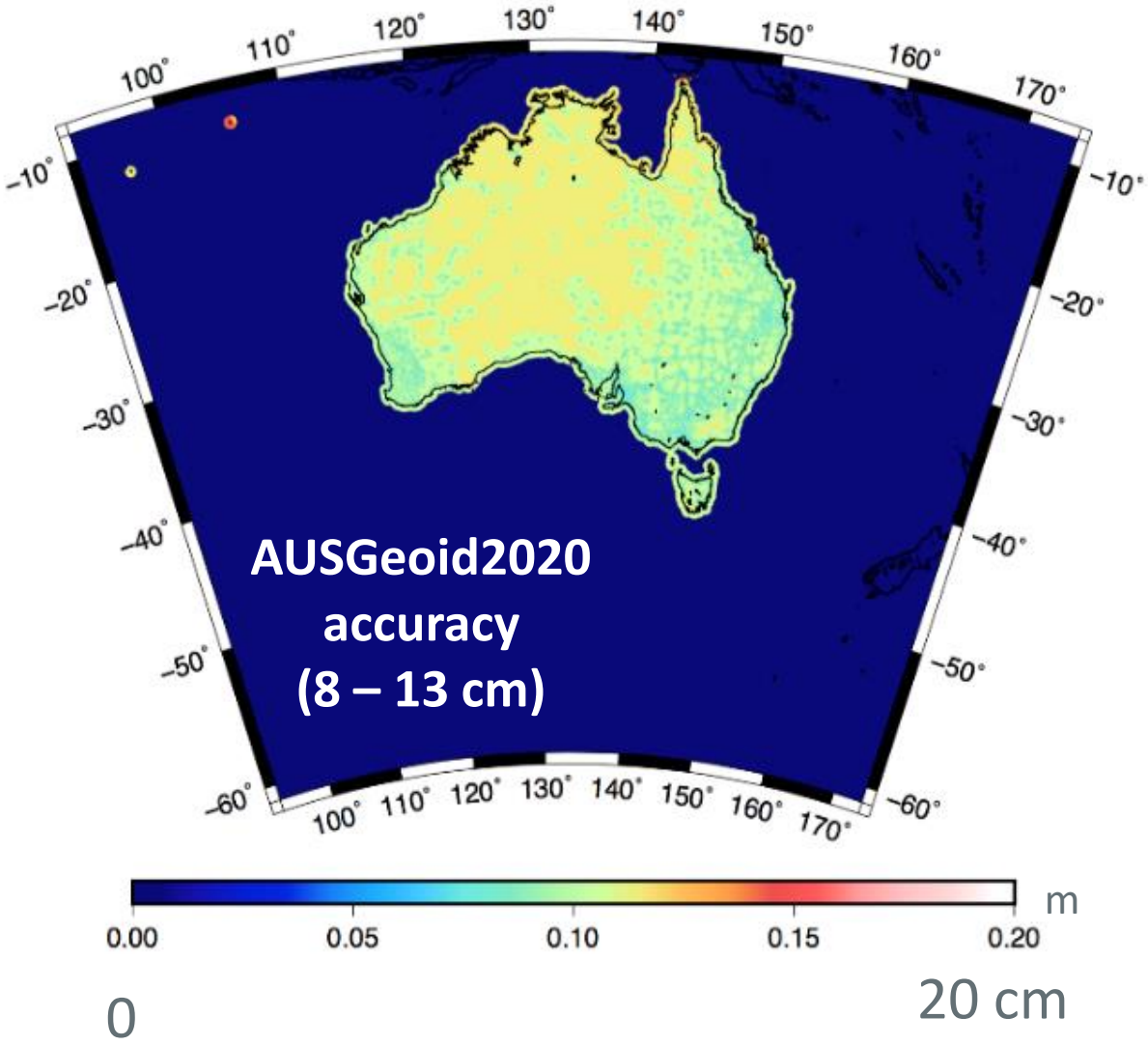
- Based on a 50 years old levelling network- indirectly compatible with GPS via e.g. AUSGeoid2020
- Depends on physical infrastructure and historic measurements of sea level
- Has known errors and distortions

AGQG2017 - Error



Featherstone et al. (2017), Journal of Geodesy

AUSGeoid2020 - Error



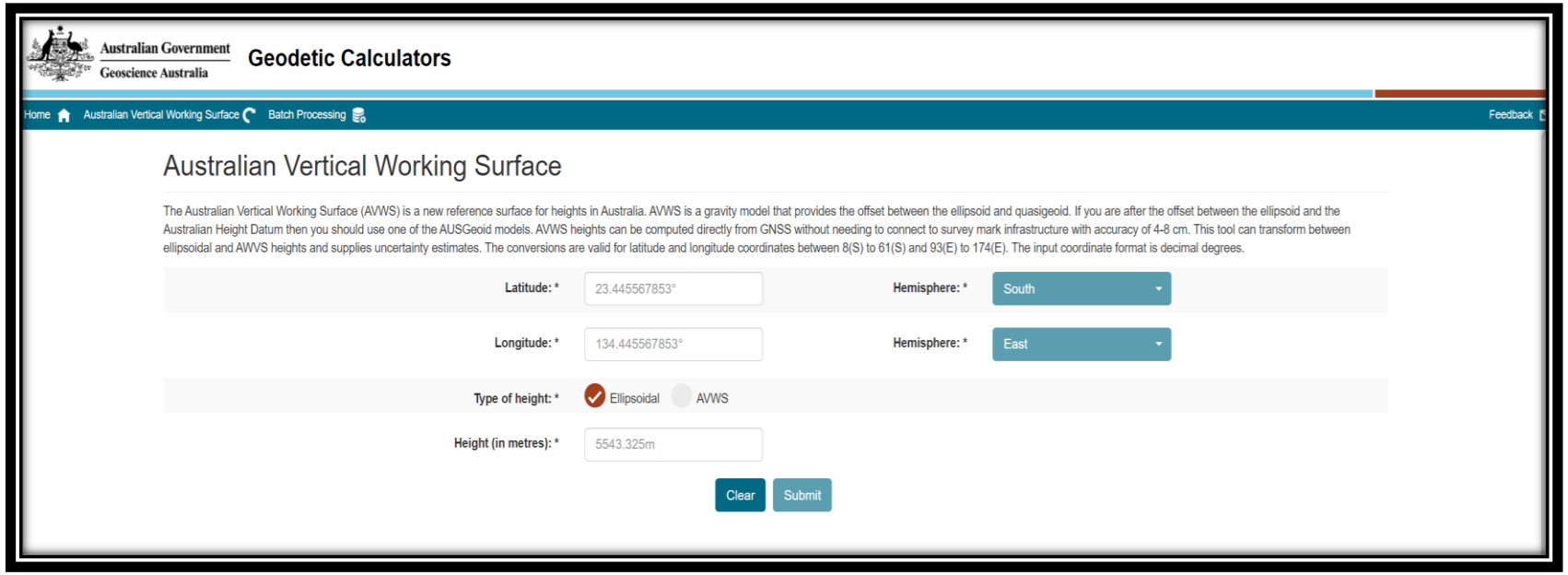
Brown et al. (2018), Journal of Geodesy

Tools and Models

GitHub:
https://github.com/GeoscienceAustralia/GeodePy

GeodePy

AGRS online tools:
https://geodesyapps.ga.gov.au/avws



Applications Example 2:
Modernisation of the Australian National Datums – linking to the ITRF2020/IGS20

Introduction

- Since 27 November 2022, GPS week 2238, the reference frame of IGS products has moved to ITRF2020

- IGS20 is the IGS GNSS realization of ITRF2020, including:
  - A set of **coordinates and velocities** of 332 IGS20 core stations at reference epoch 2015.0 (IGS20.snx: ftp://igs-rf.ign.fr/pub/IGS20)

  - Updated GNSS satellites and ground antennas PCV models (IGS20.atx: https://files.igs.org/pub/station/general/igs20.atx)

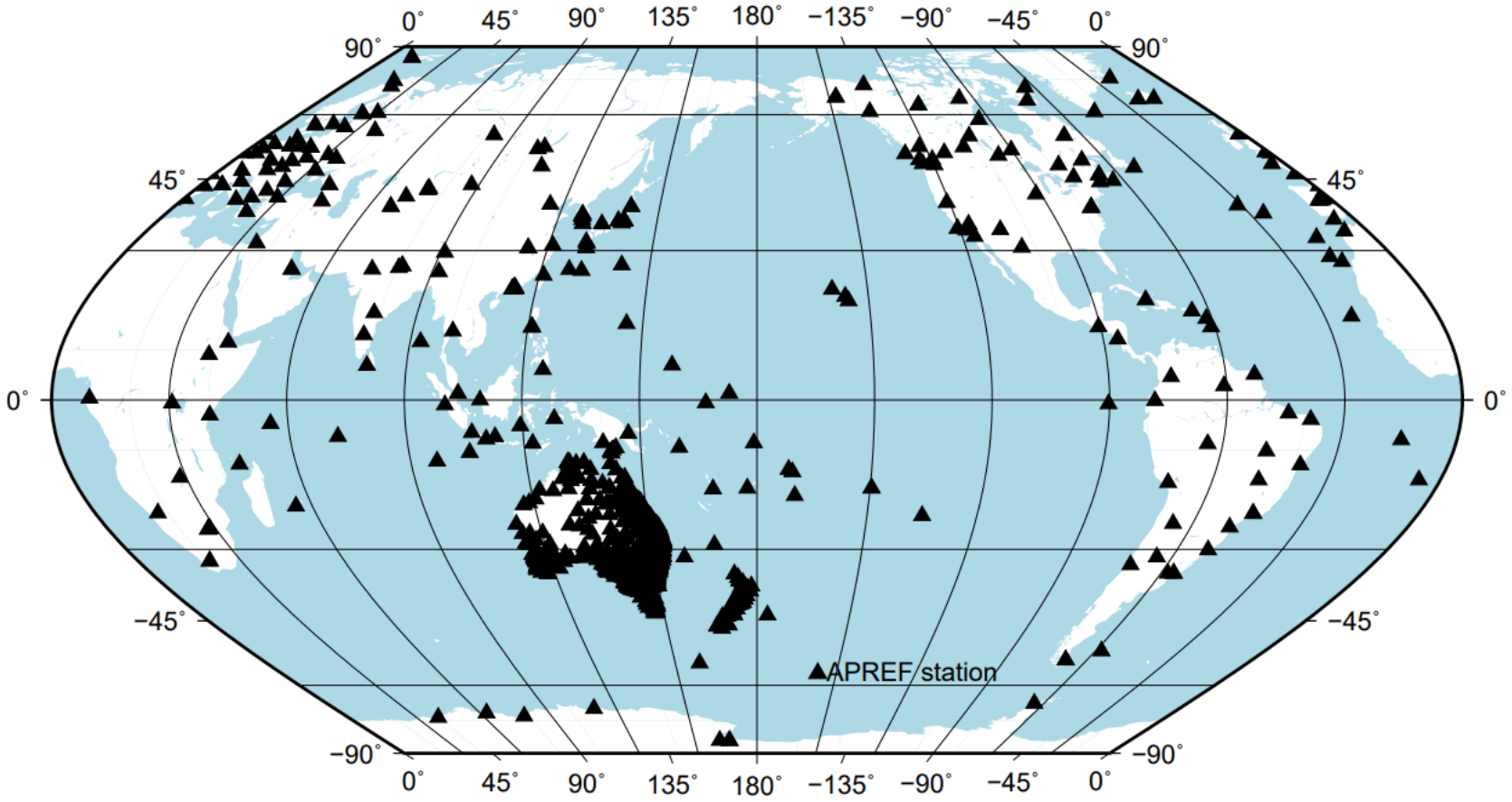
  - Updated post-seismic deformation models to be used with IGS20.snx for 37 IGS20 core stations (IGS20.psd: ftp://igs-rf.ign.fr/pub/IGS20)

Comparison of IGb14 (ITRF2014) and IGS20 (ITRF2020)

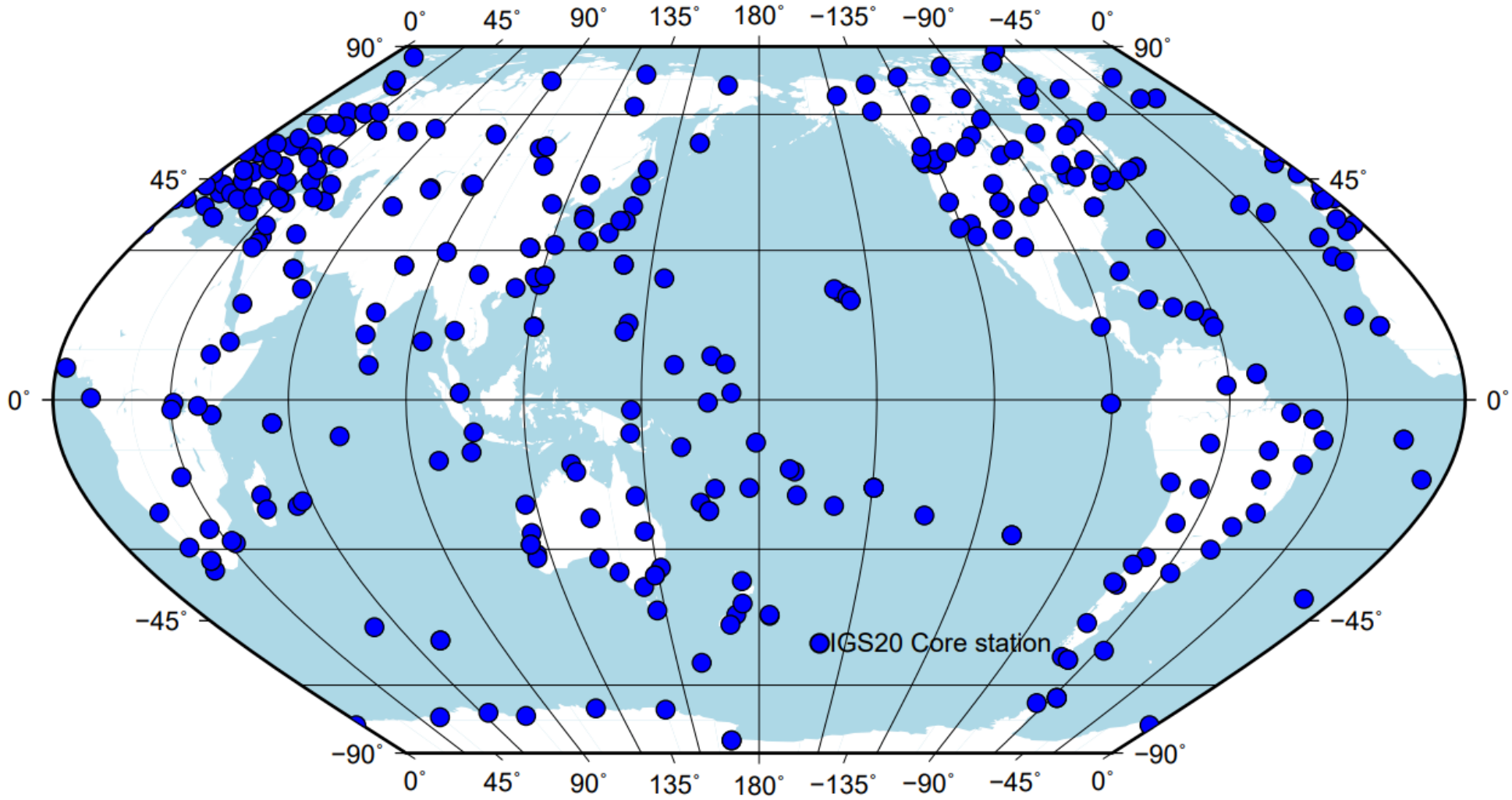
	IGb14	IGS20
Number of core station	242	332
Reference epoch	2010.0	2015.0
PCV models	IGS14.atx	IGS20.atx
IGS recommended Ocean loading model	FES2004	FES2014b

APREF CORS Network including IGS20 Core stations

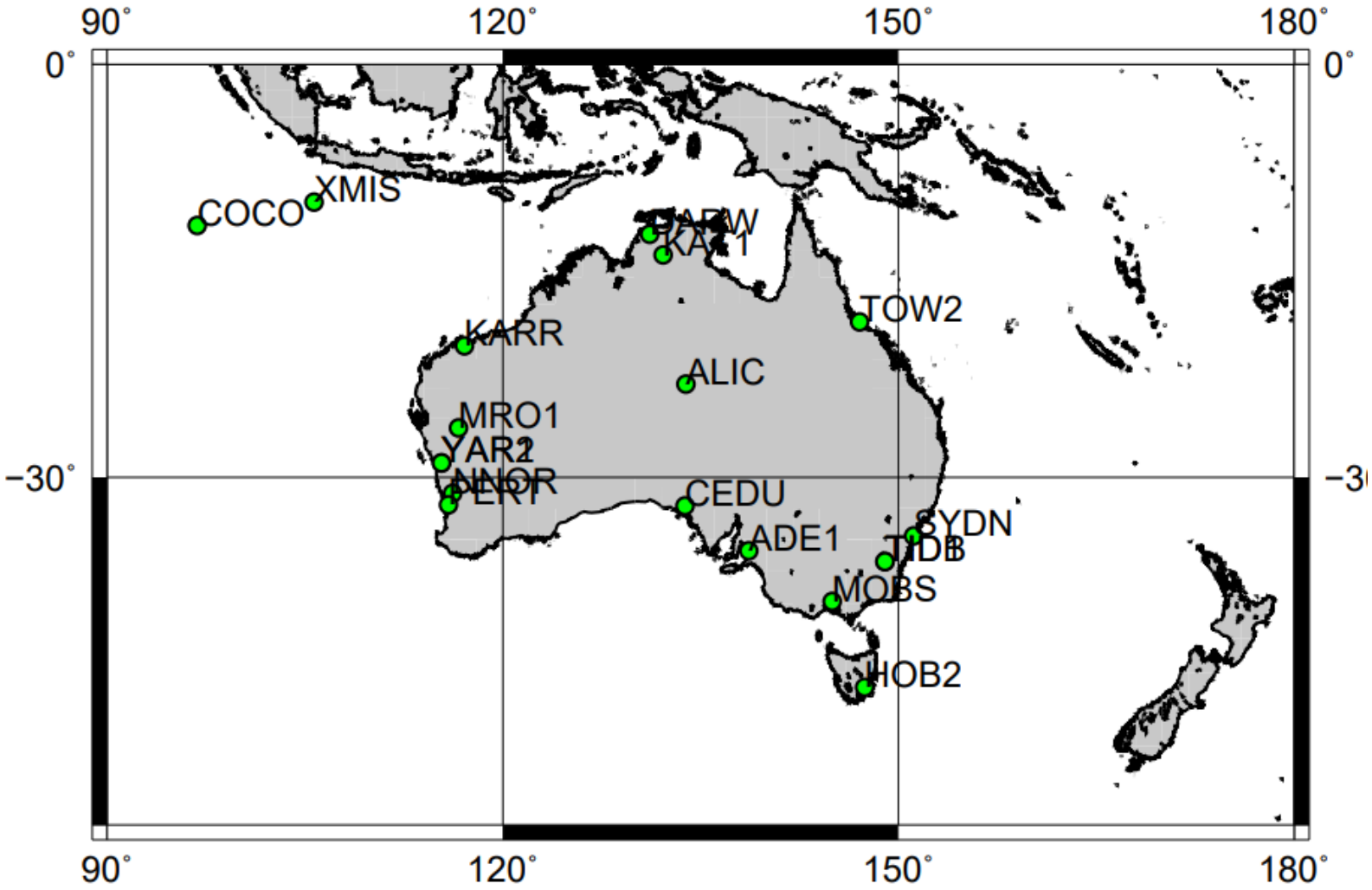
As of Oct 2023, total 1053 stations including 332 IGS20 core stations



ITRF2020/IGS20 core sites



ITRF2020/IGS20 core sites in Australia



ITRF2020

Transformation Parameters from ITRF2020 to ITRF2014

14 transformation parameters from ITRF2020 to ITRF2014 have been estimated using 131 stations listed in the core network list and located at 105 sites shown on *fig.2*.

	T1 mm	T2 mm	T3 mm	D 10-9	R1 mas
	-1.4	-0.9	1.4	-0.42	0.00
±	0.2	0.2	0.2	0.03	0.00
Rates	0.0	-0.1	0.2	0.00	0.00
±	0.2	0.2	0.2	0.03	0.00

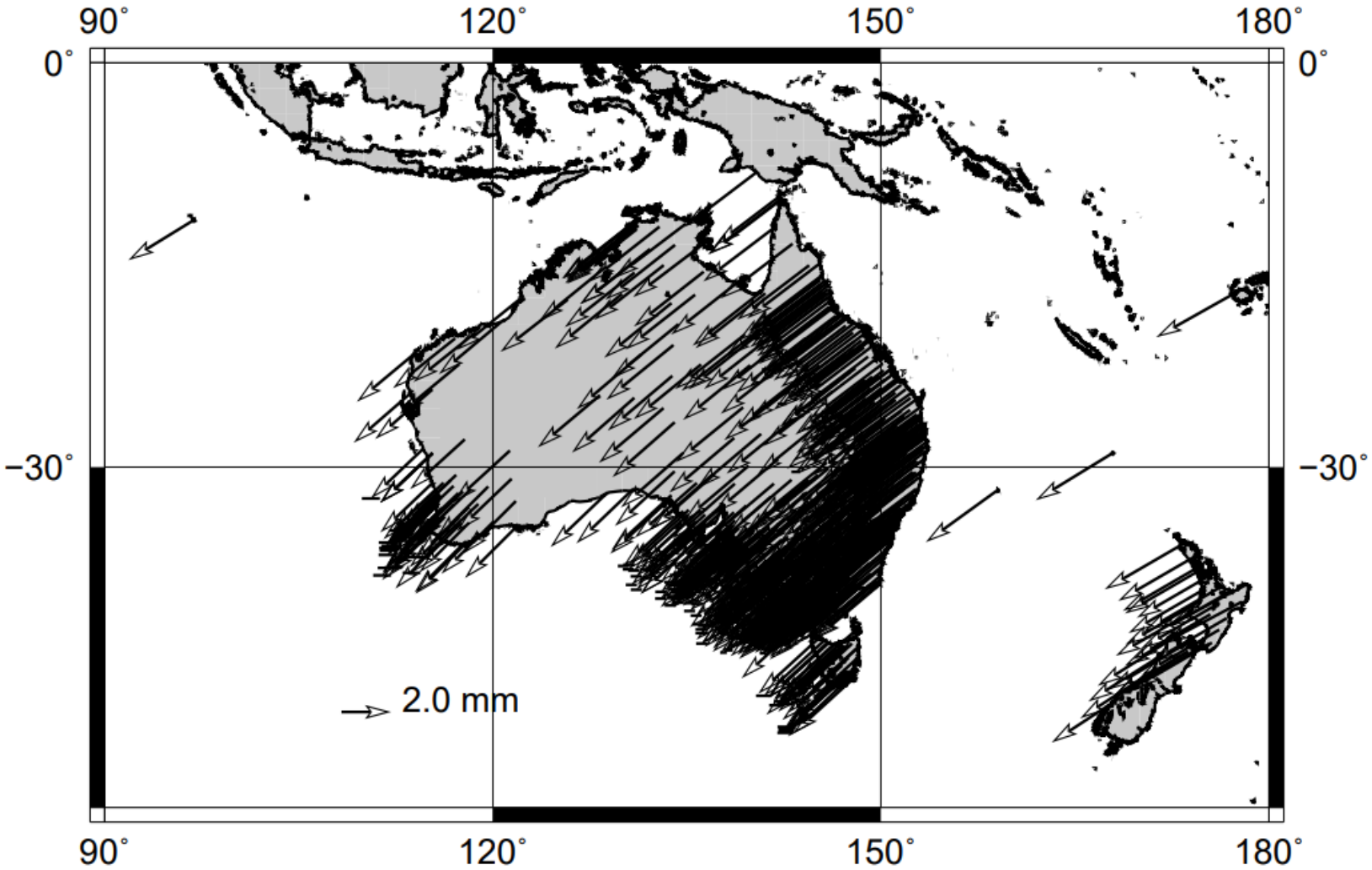
ITRF2014

Transformation Parameters from ITRF2014 to ITRF2008

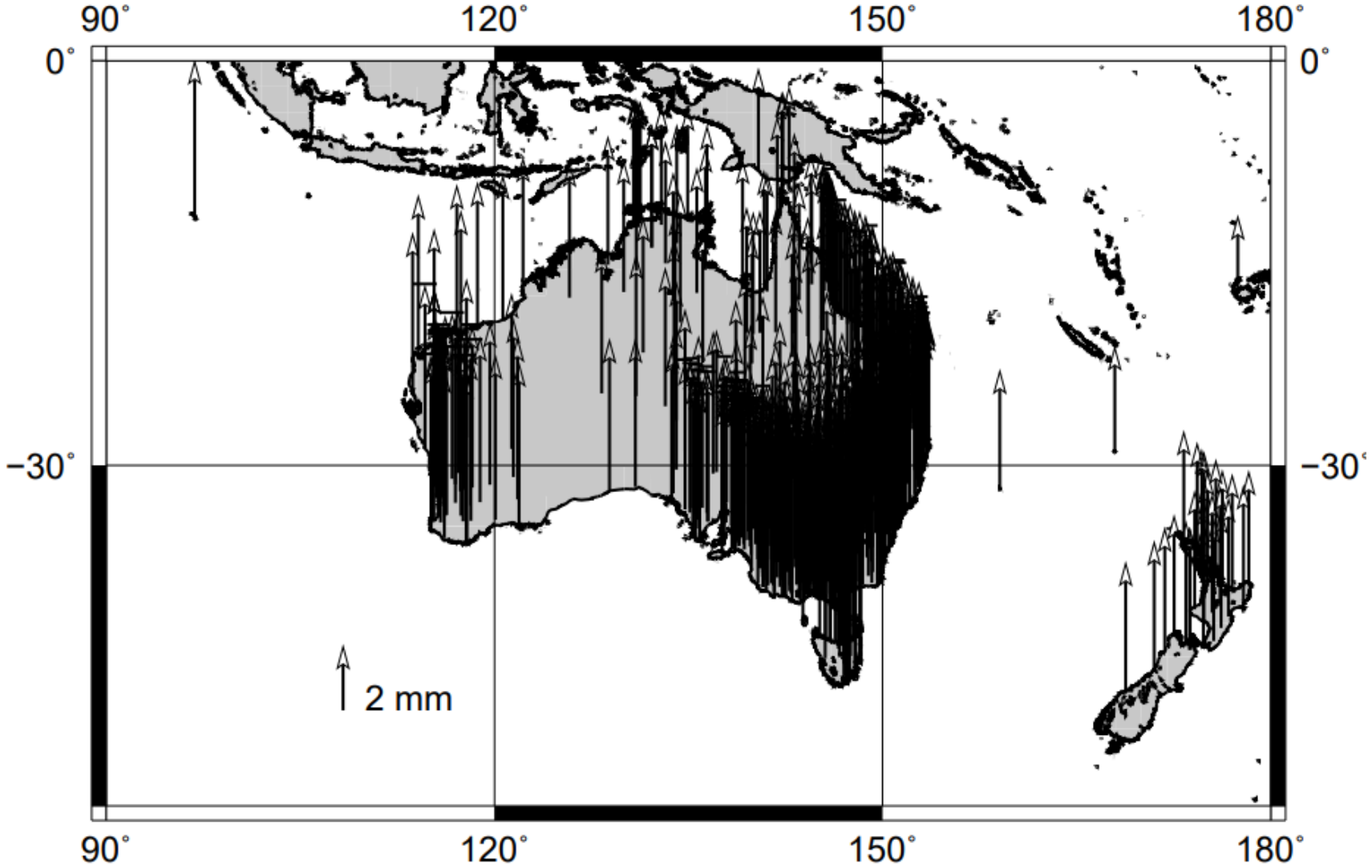
14 transformation parameters from ITRF2014 to ITRF2008 have been estimated using 127 stations listed in the core network list and located at 125 sites shown on the map below (*fig.2*).

	T1 mm	T2 mm	T3 mm	D 10-9	R1 mas	R2 mas	R3 mas
	1.6	1.9	2.4	-0.02	0.000	0.000	0.000
±	0.2	0.1	0.1	0.02	0.006	0.006	0.006
Rates	0.0	0.0	-0.1	0.03	0.000	0.000	0.000

Horizontal position difference between ITRF2020/IGS20 and ITRF2014/IGb14 when using the transformation parameters from IERS (taking GPS week 2238 of APREF solutions as an example)



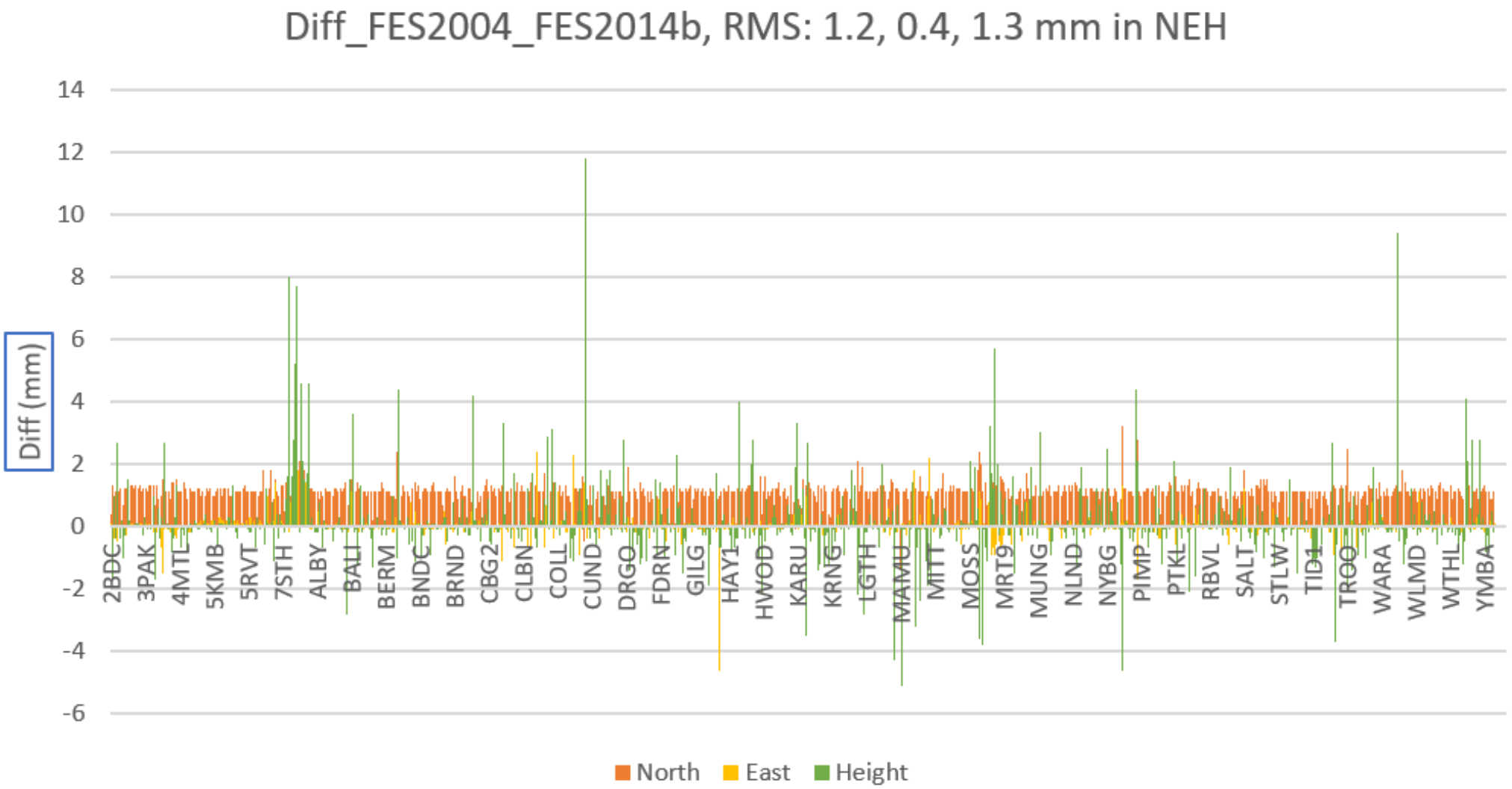
Vertical component difference between ITRF2020/IGS20 and ITRF2014/IGb14 when using the transformation parameters from IERS (taking GPS week 2238 of APREF solutions as an example)



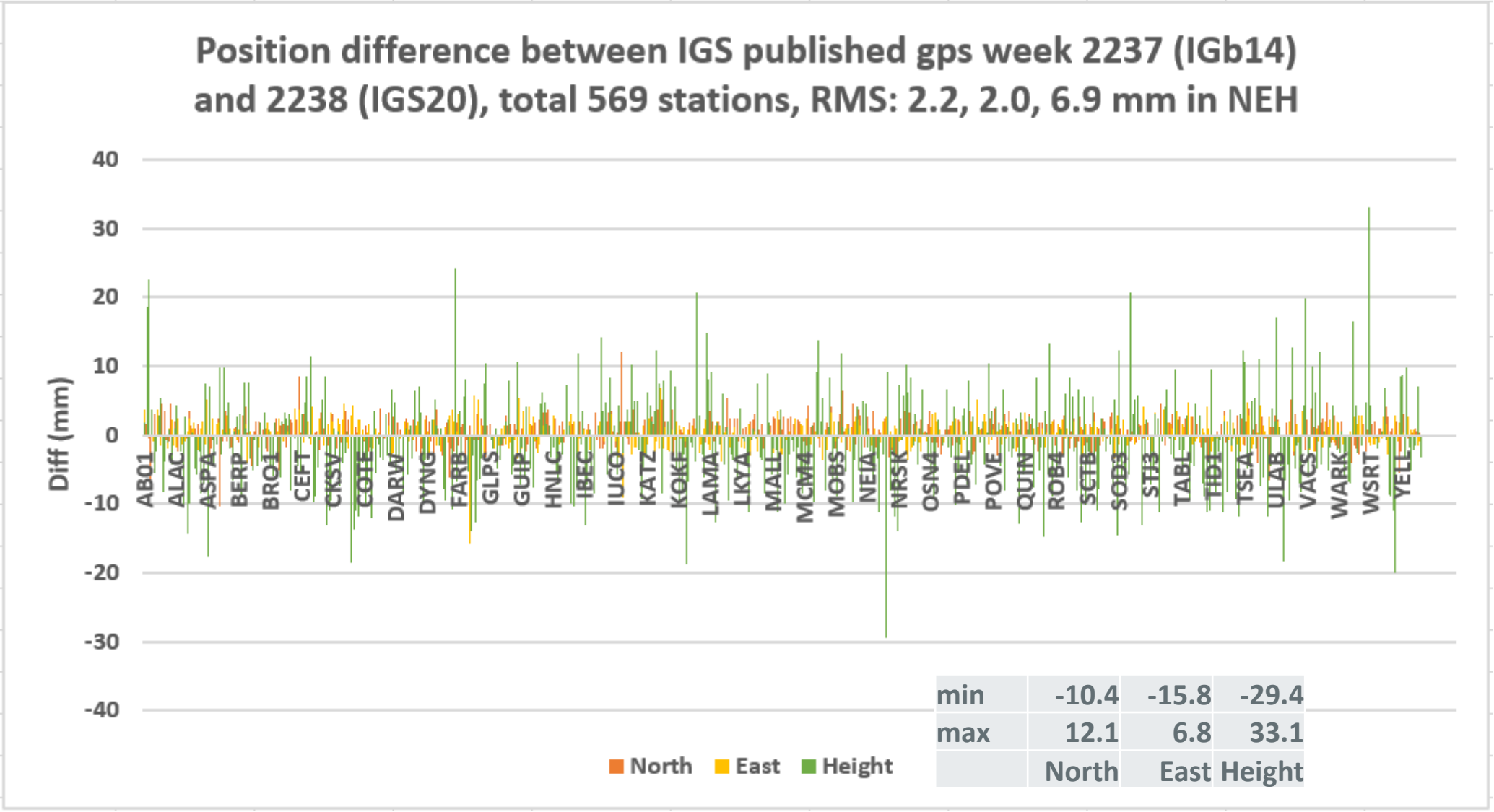
Transition to ITRF2020/IGS20 for APREF routine analysis

- IGS20 core sites where data available included in APREF routine analysis
- Minimum constraint of IGS20 core sites to allow the alignment solutions to IGS20 reference frame
- Follow IGS repro3 standards, such as Ocean loading model changed from FES2004 to FES2014b

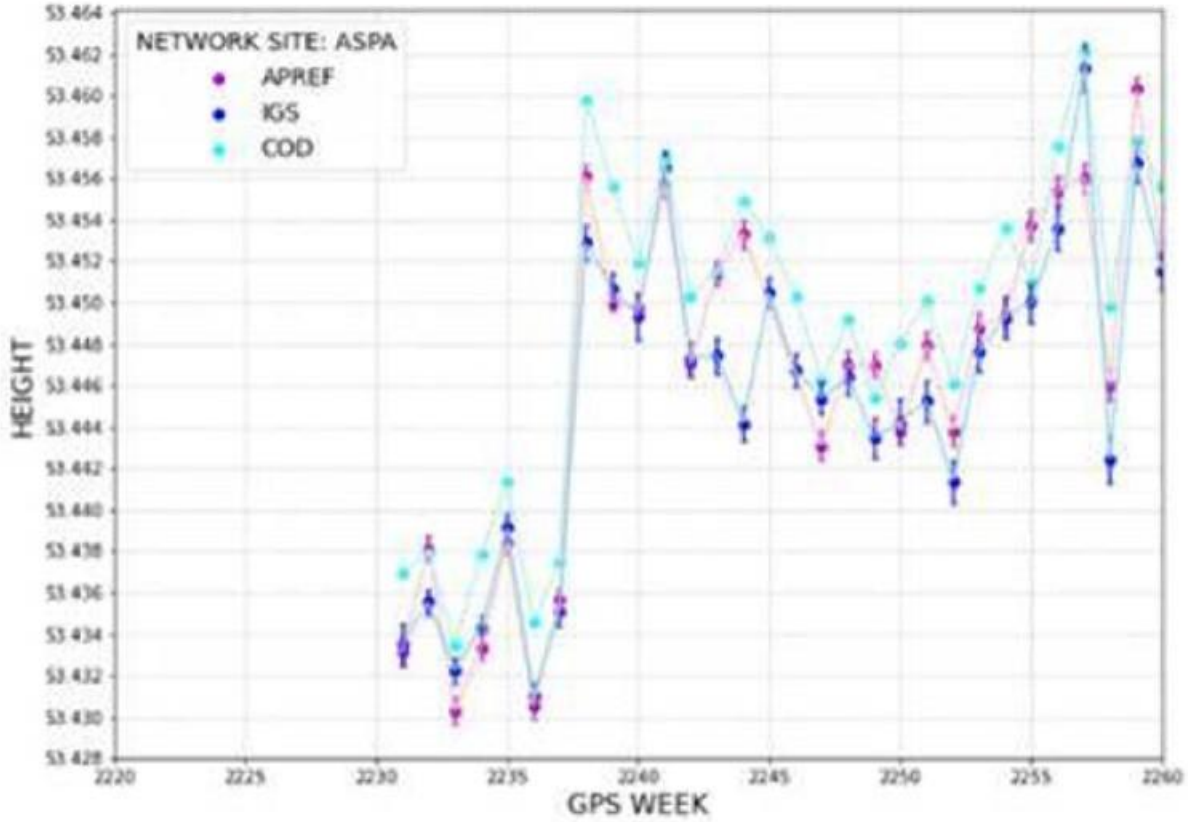
Any position impact of changing FES2004 to FES2014b?

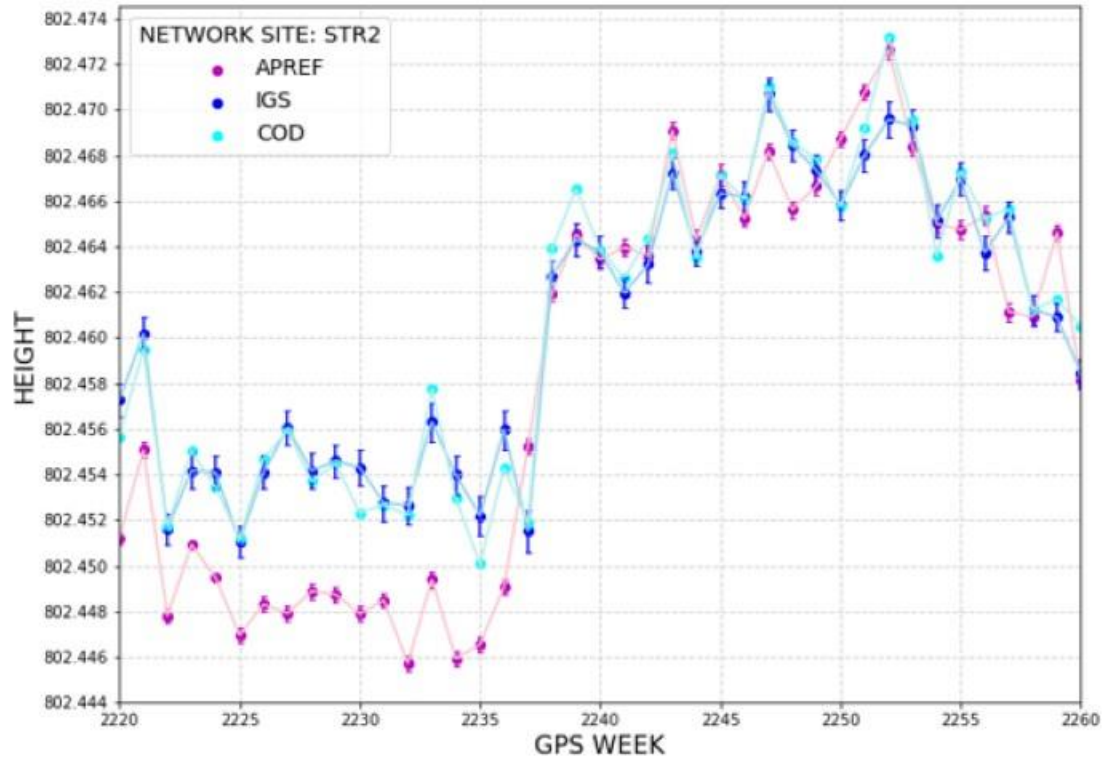


IGS published weekly solutions difference between gps week 2237 (IGb14) and 2238 (IGS20)

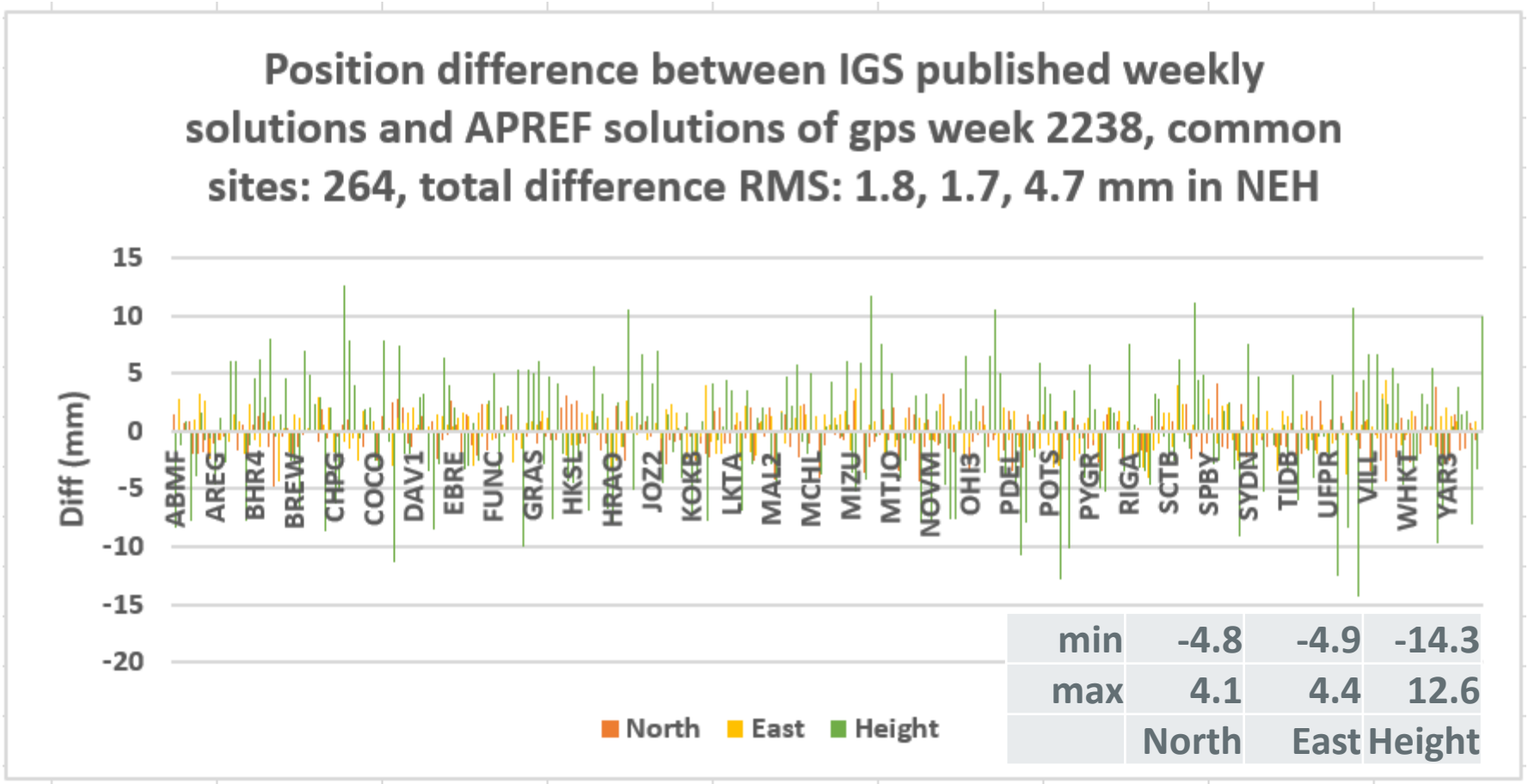


A jump of heights in the IGS core sites



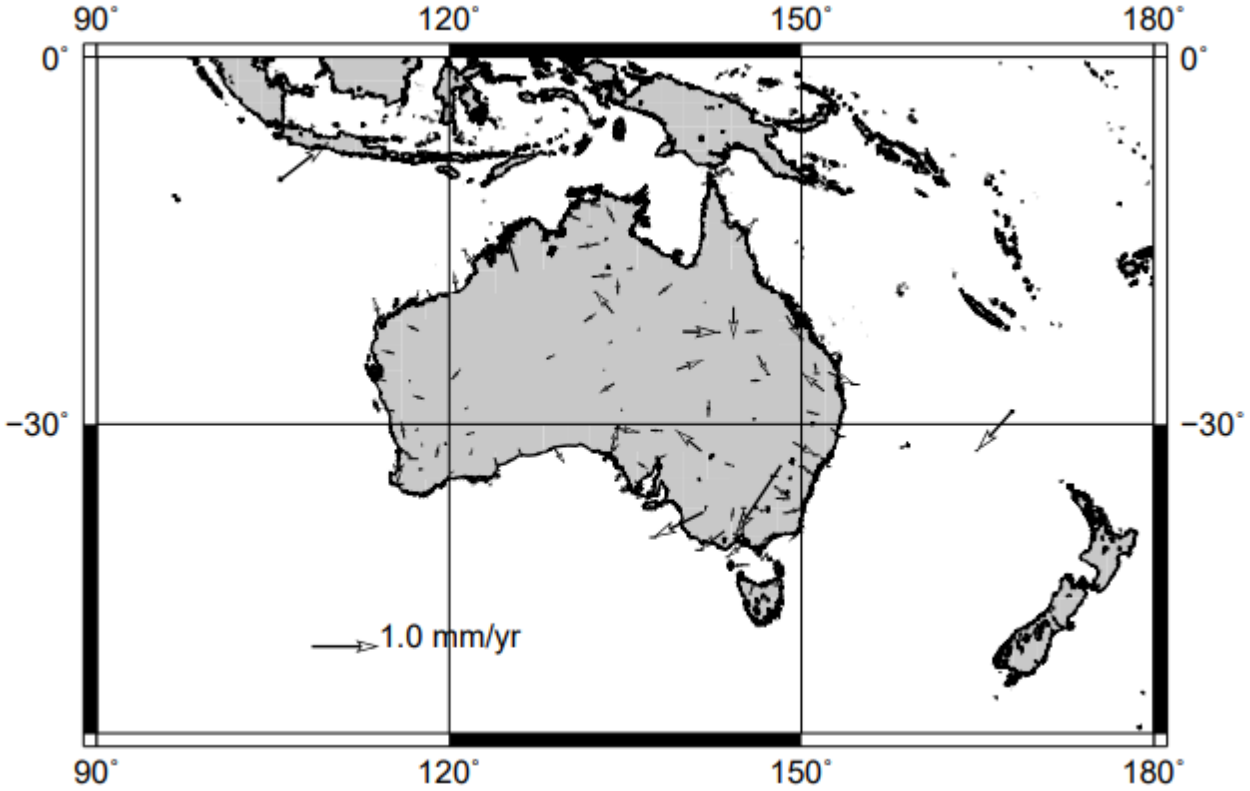


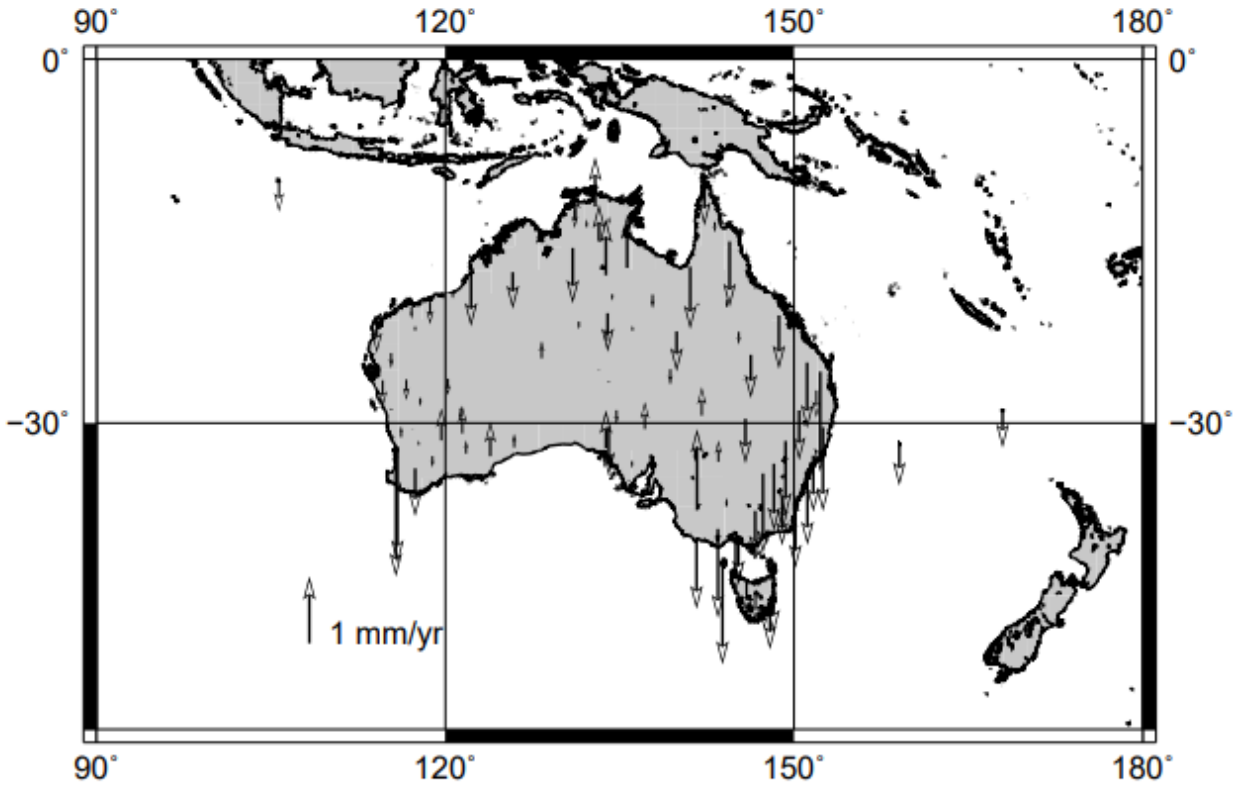
How well APREF solutions matching with IGS published weekly solutions, taking GPS week 2238 as an example



Applications Example 3:
Monitoring the Australian National Datums

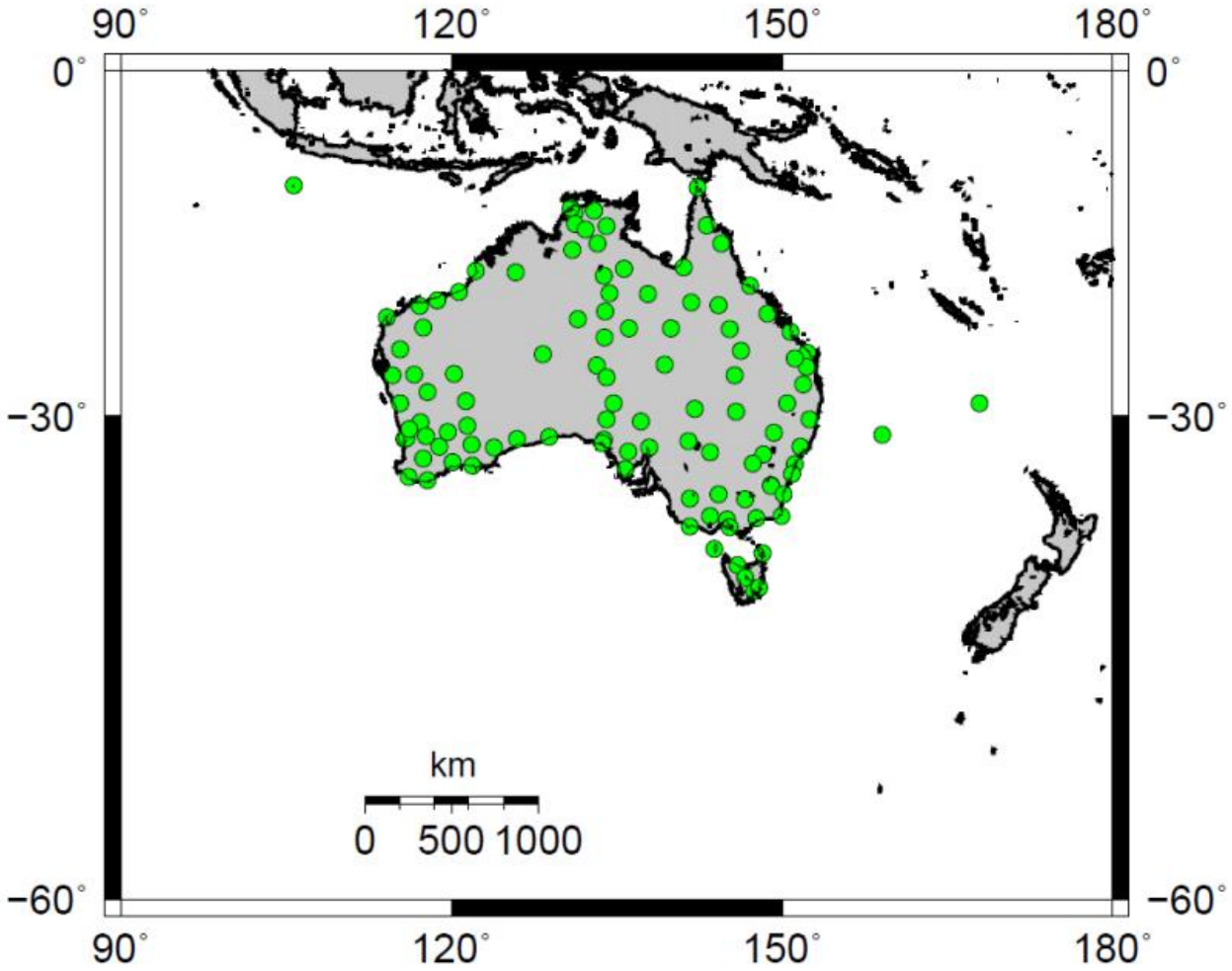
Rigid Australian plate after removing plate velocity model derived from APREF solutions





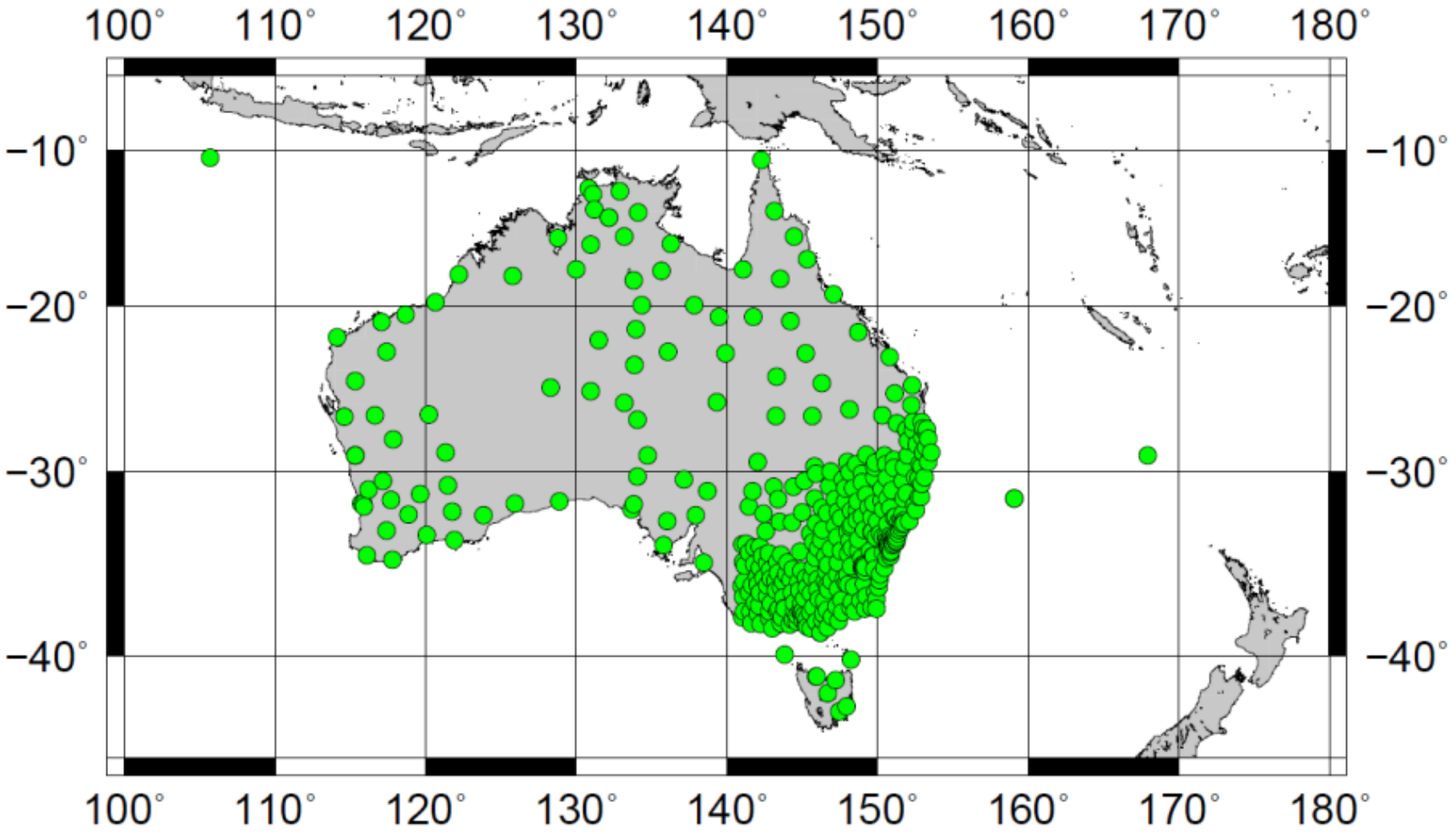
Australia national datum: GDA2020@2020.0

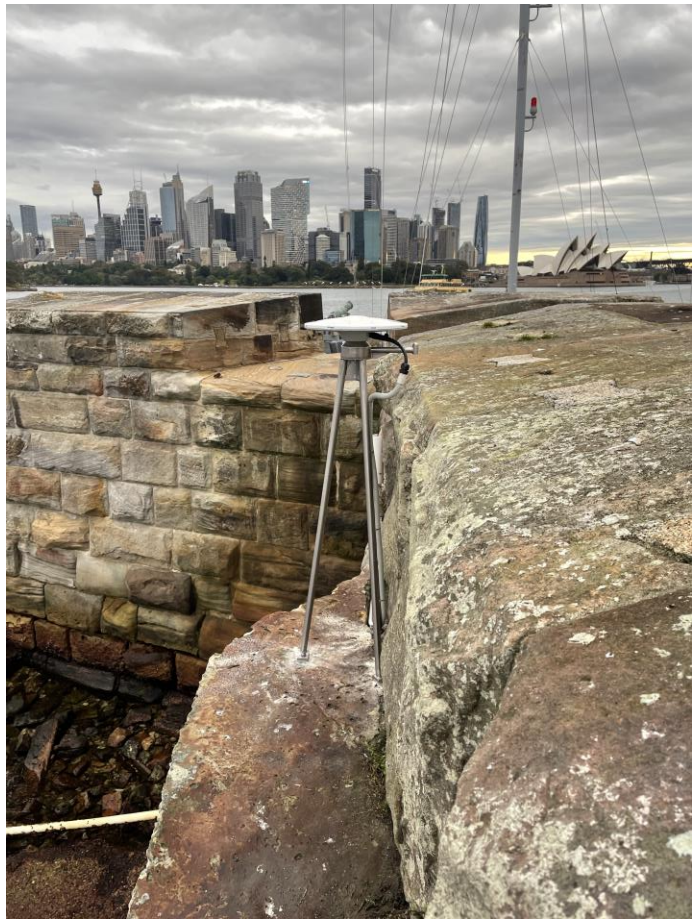
The distribution of the extended 109 AFN stations of GDA2020



Legal Traceability of GPS Positioning in Australia

The locations of all CORS on the Australian plate that have a Regulation 13 position verification certificate

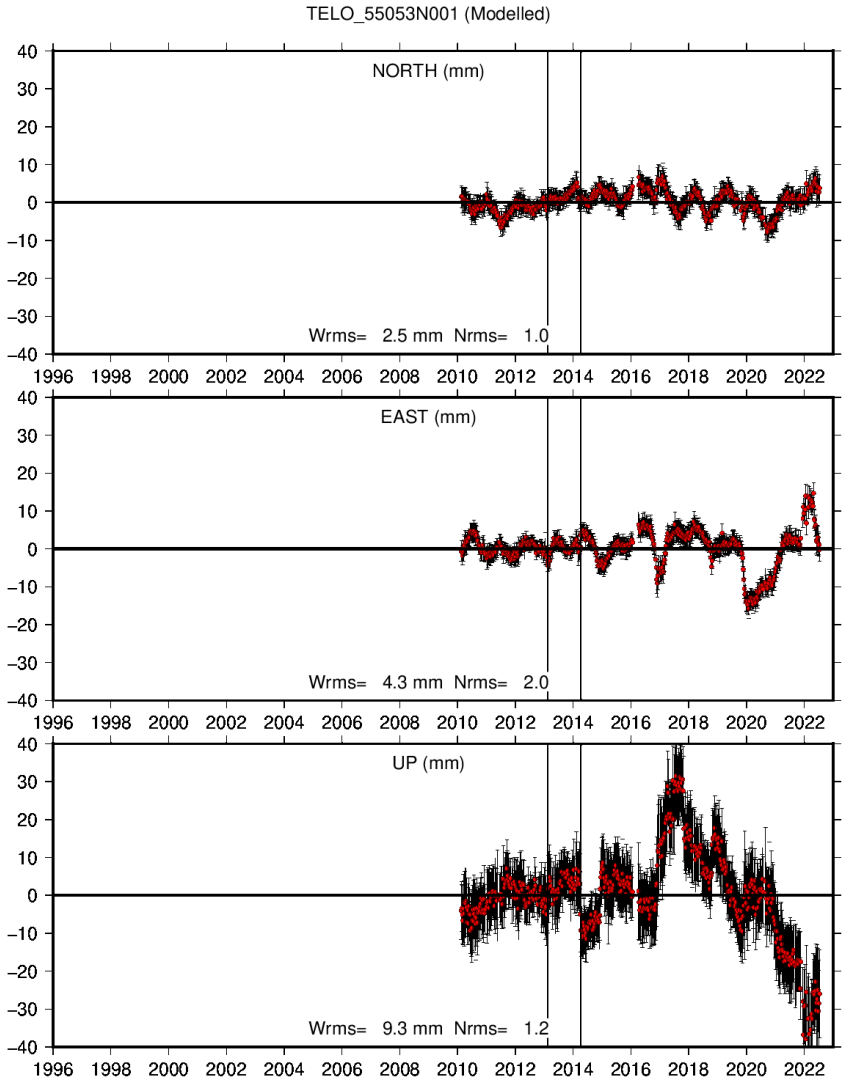




FTD2 at Sydney Harbour

CORS site stability monitoring: not suitable for reg 13 certificate

- Anomaly behaviour in the east and vertical components of the position timeseries at station TELO in Victoria, Australia



Questions/comments?

Further information

Guorong.hu@ga.gov.au

References:

Hu G., Dawson J. (2020) Overview of Legal Traceability of GPS Positioning in Australia. Satellite Navigation, 1, 25, https://doi.org/10.1186/s43020-020-00026-8.

Hu G., Jia M., Dawson J. (2019). *Report on the Asia Pacific Reference Frame (APREF) Project*. Record 2019/17. Geoscience Australia, Canberra. http://dx.doi.org/10.11636/Record.2019.017.