UNITED NATIONS GLOBAL GEODETIC CENTRE OF EXCELLENCE

MODERNISING GEOSPATIAL REFERENCE SYSTEM CAPACITY DEVELOPMENT WORKSHOP

National geodetic adjustments

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HOW

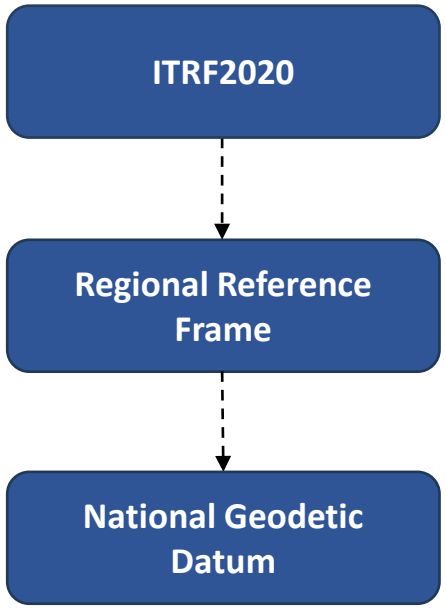
Day 2, Session 2 [2_2_1]

Acknowledgements: Phil Collier (AUS); Nic Donnelly (NZ); Roger Fraser (AUS); Craig Harrison (AUS); Anna Riddell (AUS).

When to consider performing a national geodetic adjustment

- Datum not aligned with current version of ITRF
- Distortion in datum due to geophysical reasons
- Increase in accuracy of datum is needed for emerging technologies
- GNSS CORS network has been densified (improved resolution)

How to aligning NGD with ITRF



1. Choose an ITRF realisation and epoch to align to (e.g. ITRF2020@2024)

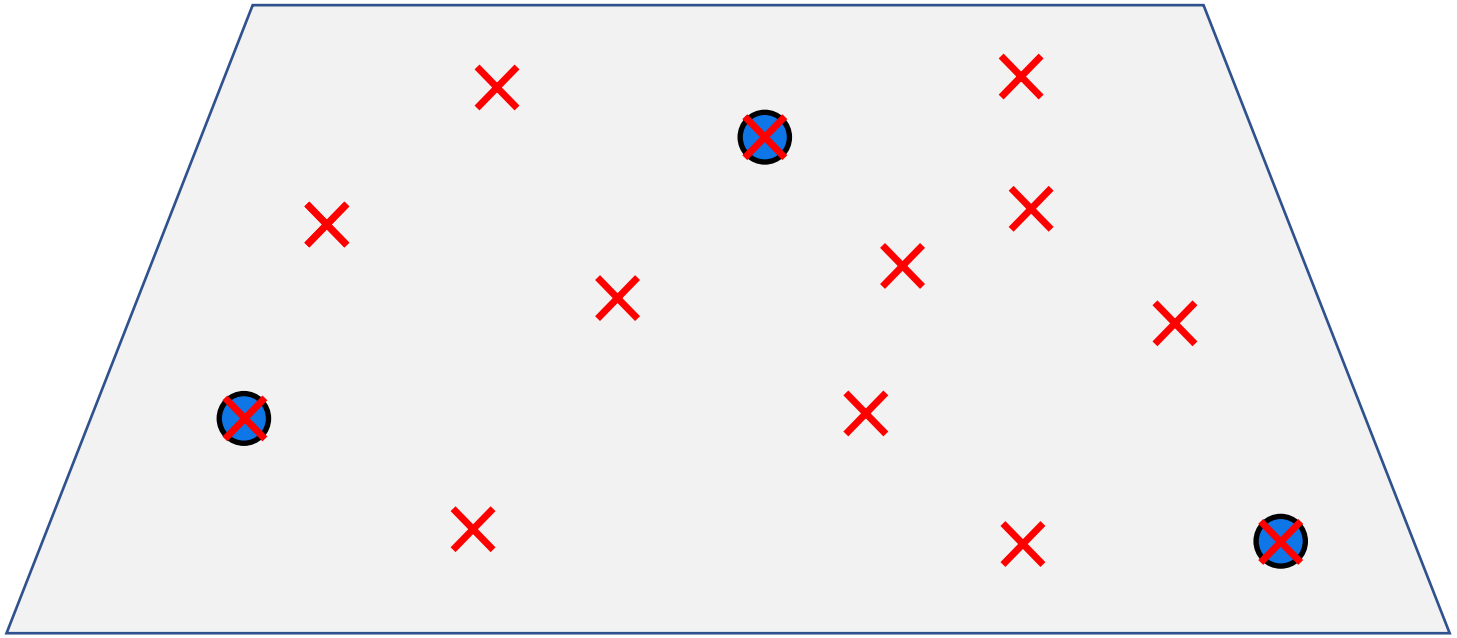
2. Include the GNSS CORS from your country in the regional reference frame (e.g EUREF)

   Even if the GNSS CORS are not in the IGS network, they will be linked to the ITRF through the regional reference frame,

3. The positions from the GNSS CORS in your country which are analysed in the regional reference frame are used as the constraint in the national adjustment.

How to align NGD with ITRF

- National GNSS CORS
- GNSS CORS included in International or regional reference frame



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Site selection process

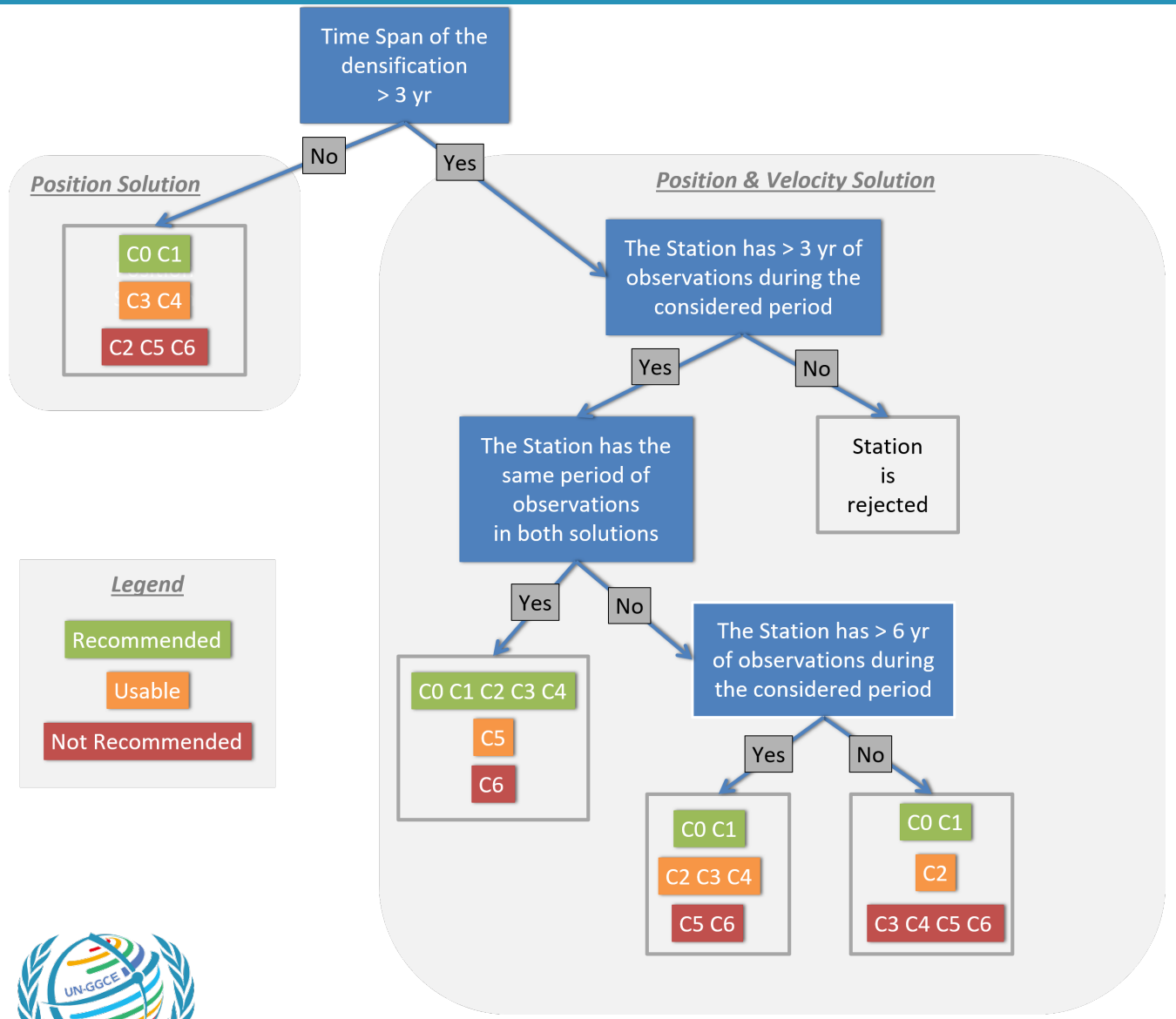

Table2: the rules applied to define the 8 station classes C0, C1, C2, C3, C4, C5, C6, Short

Name	Number	Criteria					Comment
		Velocity variability	Timeseries RMS	Amplitude 1Y signal	$DV_{Catref-Hector}$	σ_{Hector}	
C0	64	< Percentile 75	< Percentile 75				Most Stable Stations
C1	38	< Percentile 75	< Percentile 85				
C2	47	< Percentile 75	No threshold		< Percentile 85		Stable but Noisy or with Seasonal Signals
C3	19	< Percentile 85	< Percentile 85				Less Stable
C4	11	Not Available - Short time series	< Percentile 85				
C5	72	< Percentile 85	No criteria > Percentile 95				Even Less Stable
C6	146	velocity variability > Percentile 85 and/or 1 or more other criteria > Percentile 95 or Short time series with 1 or more criteria > Percentile 85					Less Reliable
Short	74	< 3yr - not applicable					No velocity published

https://epncb.oma.be/_productsservices/ReferenceFrame/Tool.php

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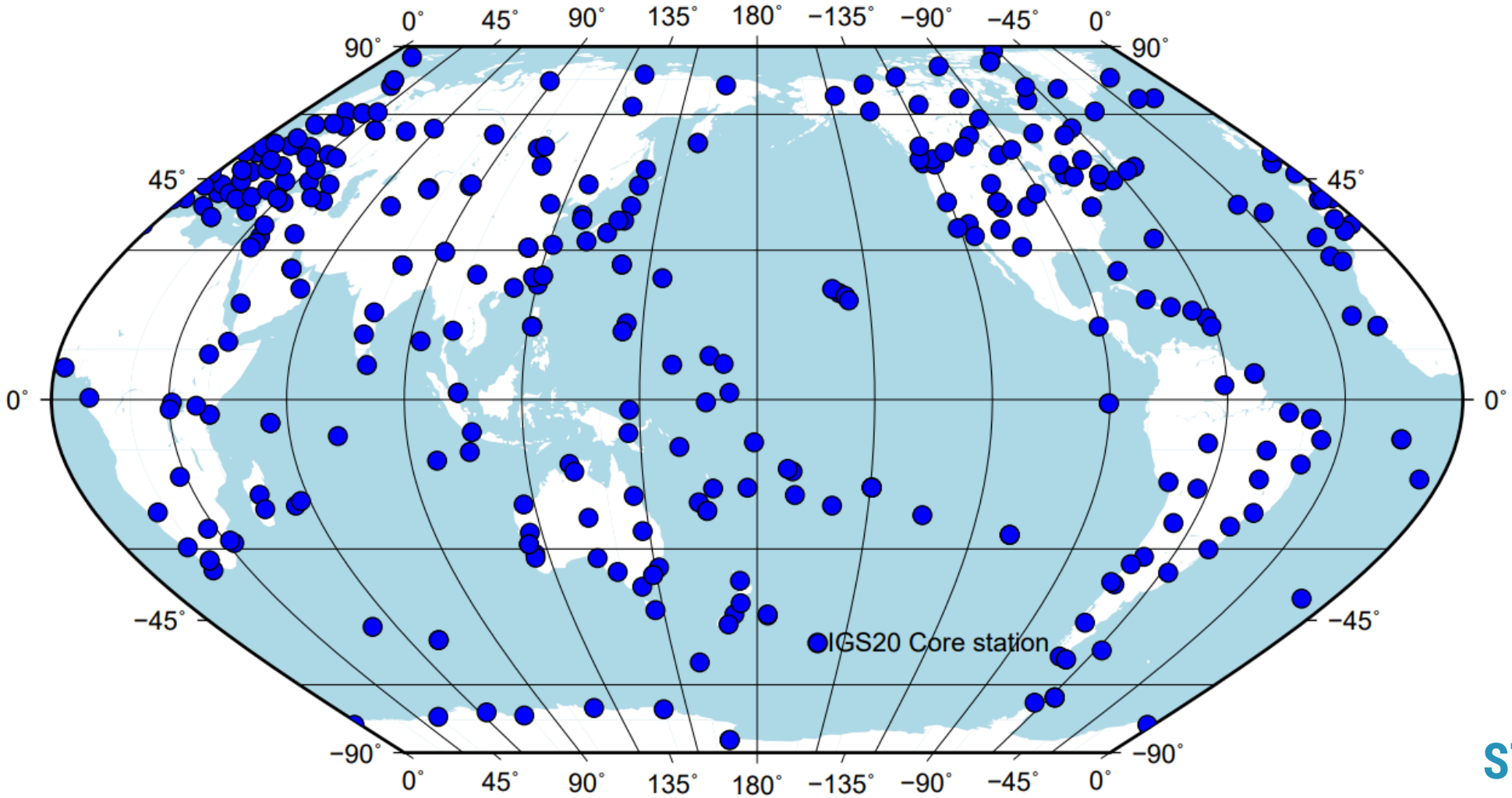
IGS20 sites



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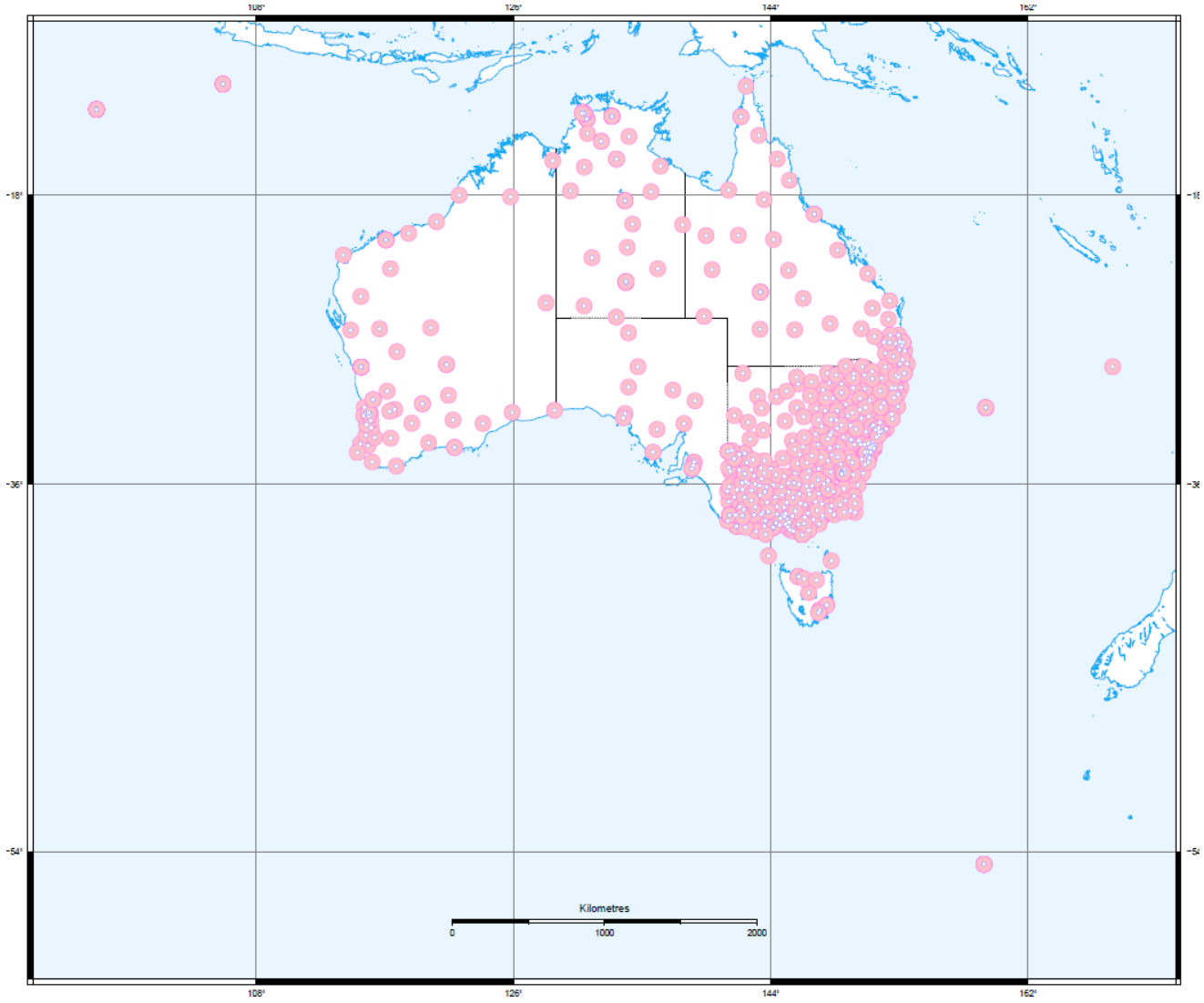
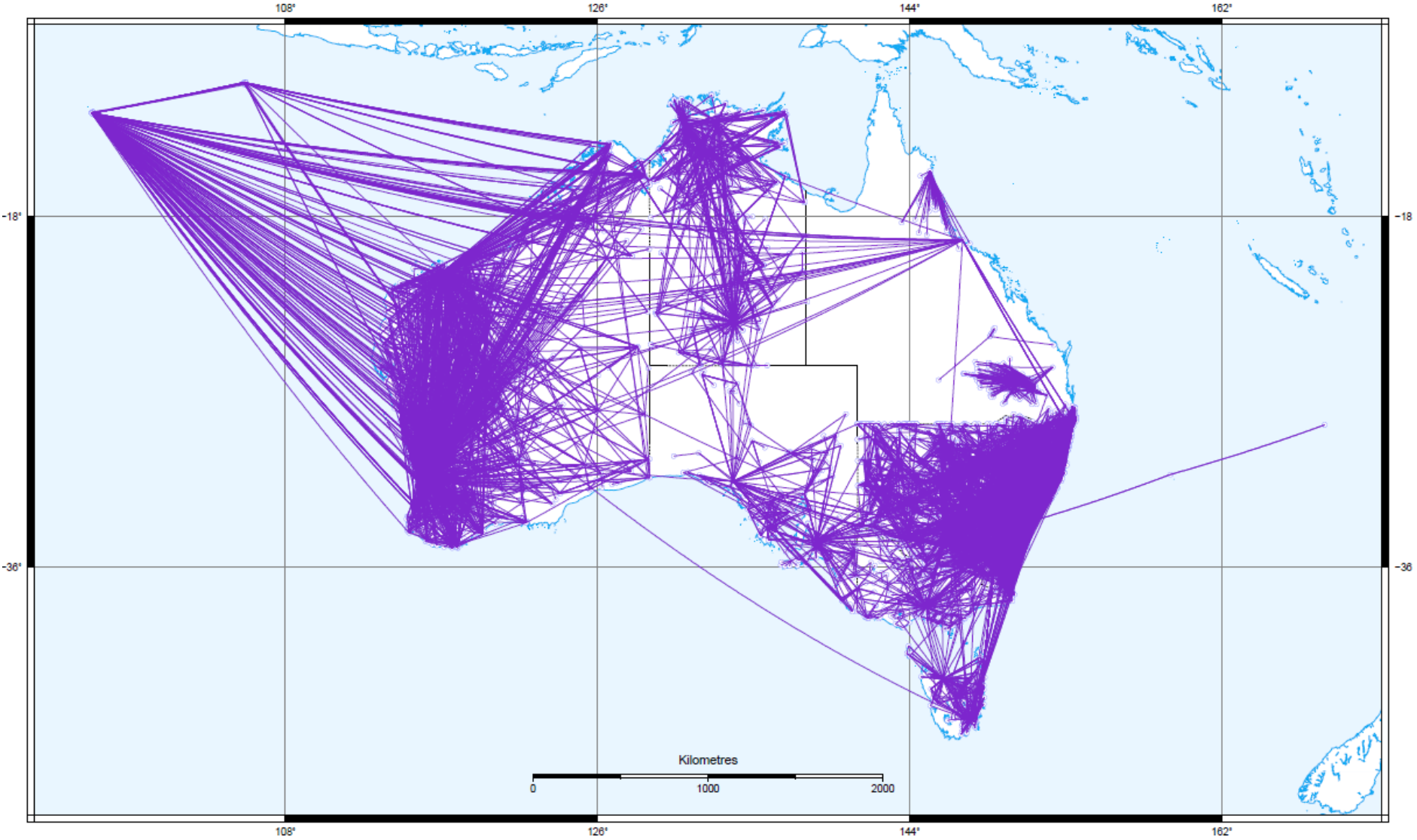
Regional Reference Frame (e.g. APREF)



- Continuously estimated from:
  - Weekly solutions combined from daily GNSS analysis
  - Aligned to IGb14
  - Cumulative solution combines weekly solutions from 1994
  - Full variance matrix
  - Provides datum constraint for jurisdiction and national adjustments
- Densification of ITRF in the Asia Pacific region:
- 726 GNSS CORS total;
- 488 on AU plate.
- **Only 15 in ITRF2014**

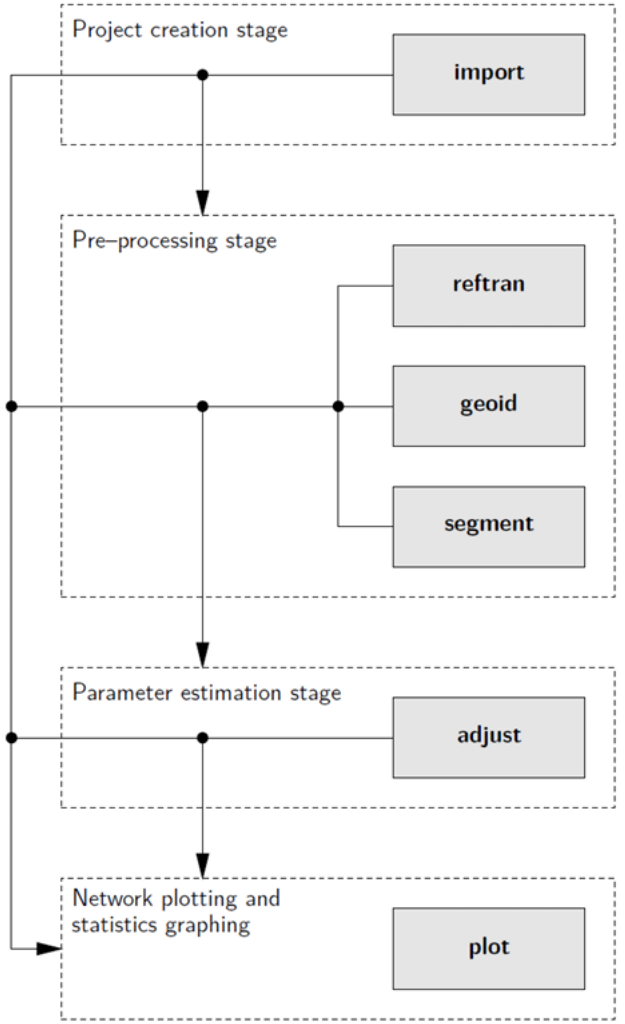
Campaign archive



- Network backbone
- 6+ hour GNSS observations
- Processed by GA
- 6,092 stations with 11,578 baselines in 3,206 clusters

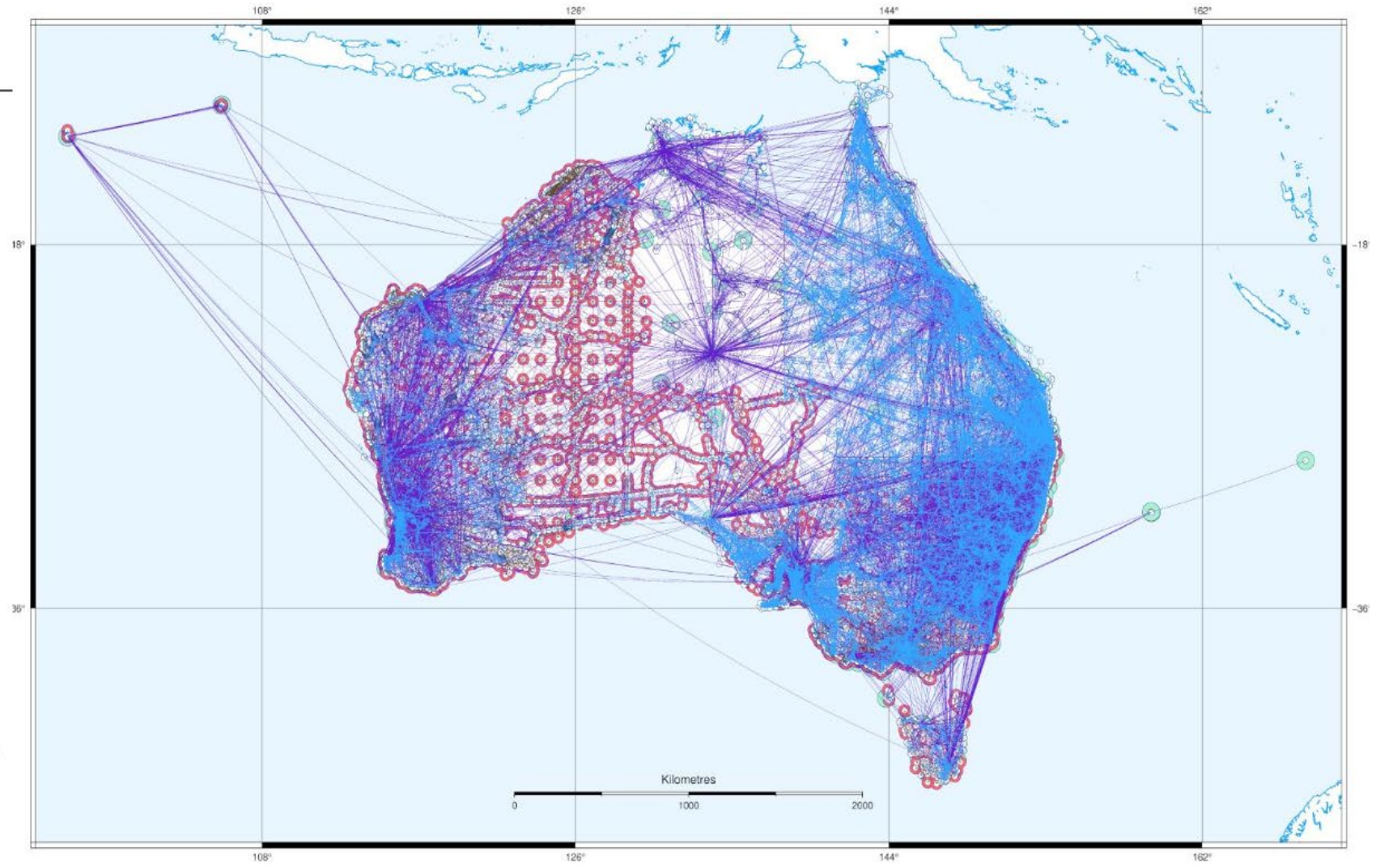
Fully automated adjustment approach

- Import all data
  - SINEX, GNSS baselines, terrestrial measurements, levelling
- Align stations and measurements to an epoch (e.g. 2020)
  - Datum/frame transformation (ITRF2000,2005,2008,2014)
  - Apply plate motion model if no direct parameters are available
- Apply geoid model to convert orthometric data to ellipsoidal
  - (Gravity) deflections of the vertical
  - Ellipsoid-geoid separations
- Automatic network segmentation
- Parallel or sequential phased adjustment
- Export uncertainties



National adjustment

333,164	Stations
2,400,419	Measurements
1,542	Geodetic azimuth
132	Astronomic azimuth
215	Zenith angle
484,696	Direction set
201,213	MLS arc
186,479	Ellipsoid arc
46,464	Slope distance
1,171,545	GNSS baseline
89,175	GNSS baseline cluster
2,178	GNSS point cluster
230	Ellipsoid height
204,178	Orthometric height
12,372	Level difference



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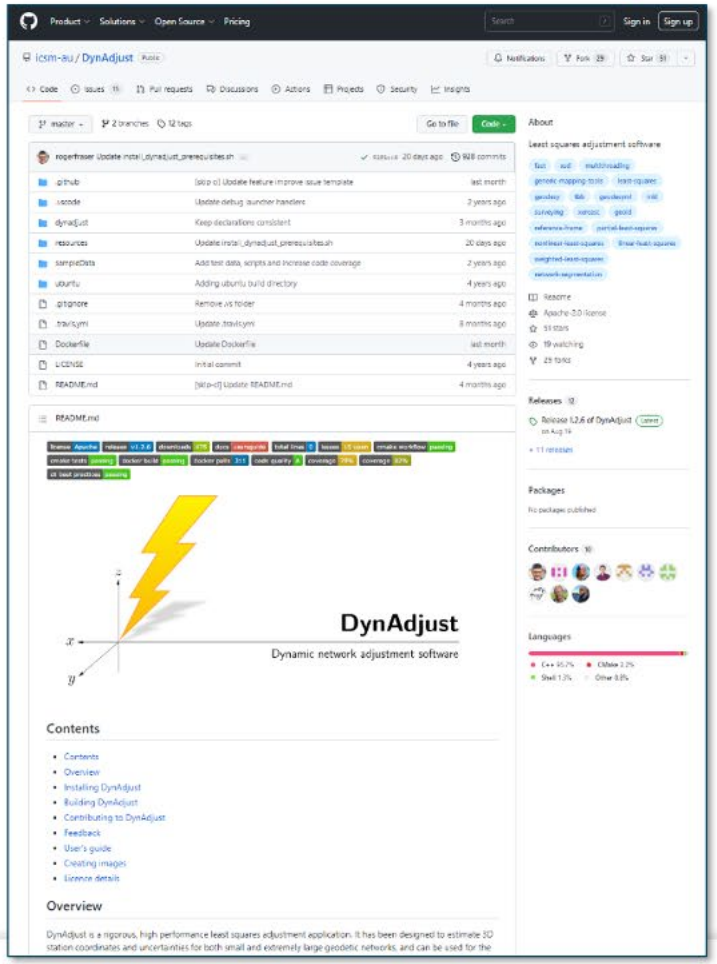
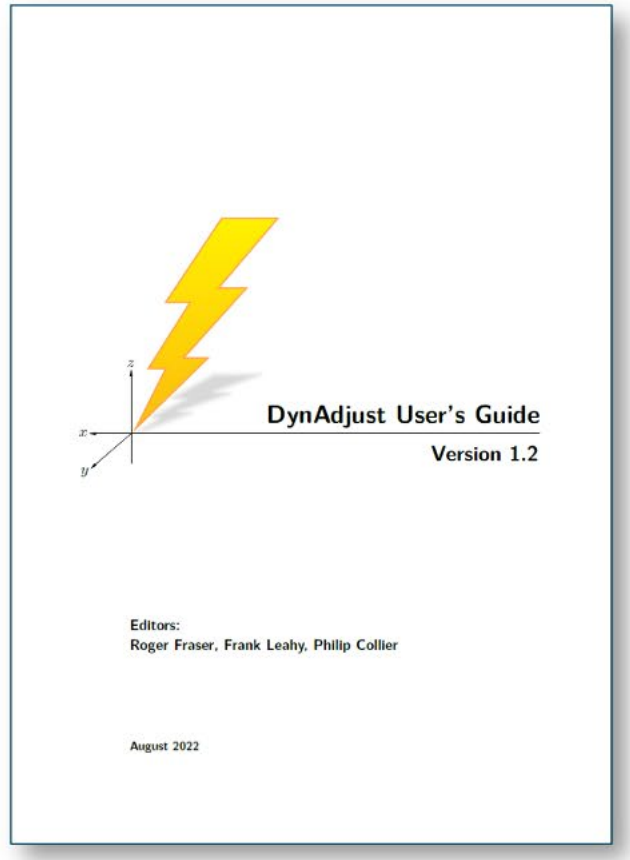
DynAdjust

DynAdjust: open source adjustment package

Generic Mapping Tools





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https://github.com/icsm-au/dynadjust

Resources

- GNSS analysis
  - BERNESE – network GNSS analysis
  - AUSPOS – GPS site analysis https://www.ga.gov.au/scientific-topics/positioning-navigation/geodesy/auspos
  - OPUS – GNSS site analysis https://geodesy.noaa.gov/OPUS/
- CATREF – combination software
- Geodetic Adjustment
  - DynAdjust (https://github.com/icsm-au/DynAdjust)
- Least Squares training presentation
  - Full presentation – https://www.youtube.com/watch?v=T5YB_1Jpjp0 (1hr 42 mins)
  - Chapter 1 – What is Least Squares and why are we using it in DCM? https://youtu.be/0YkjHsVgGMk (26 mins)
  - Chapter 2 – Why do we iterate? https://youtu.be/_iFg3Ho_cRI (18 mins)
  - Chapter 3 – Weighting Observations https://youtu.be/2yQCWblrQGs (10 mins)
  - Chapter 4 – Constraints https://youtu.be/WcwKv-vWUtk (7 mins)
  - DynAdjust Q&A https://youtu.be/WZN38NrPBeY