ANZLIC COMMITTEE ON SURVEYING & MAPPING

GDA2020 Update Process Guidelines

Version 6.3

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1 Document History

Date	Version	Amendments	Author/s
2014-06-02	1.0	- Initial version	Craig Harrison
2014-07-15	1.1	- Change to the data submission folder and emphasis placed on the iterative nature of the process	Craig Harrison
2014-07-23	1.2	- Previous version amendments corrected - Translation table file extension corrected to .csv - Guidelines name corrected to include the version	Craig Harrison
2014-08-27	1.3	- Suggested that RINEX files be verified with *verifySub.pl* instead of with *teqc* and AUSPOS	Craig Harrison
2014-10-12	2.0	- Mistakenly sent out as Guidelines-v1.4.docx - Expanded the scope to include a discussion of all three data streams for the national adjustment - Added a discussion of co-factor scaling - Added a description of the clustering algorithm and details on how to customise clusters - Modified the items returned from the national GNSS campaign data processing - Added a description of the format required for the submission of the jurisdictional data	Craig Harrison
2015-01-30	2.1	- Clarified that only APREF CORS data should not be submitted - Noted that *verifySub.pl* requires the DateTime::Precise library - Suggested that the translation table be included in the submission folder if it has been updated from last submission	Craig Harrison
2015-02-23	2.2	- Specified that RINEX files should have 30-second sampling - Added more details on installing and running *verifySub.pl* on Windows	Craig Harrison

		- Updated the products returned section - Provided the URL version of the ftp command - Clarified that we require spirit-levelled AHD heights not derived heights - Added information on the station coordinates file use to calculate the distortion grid.	
2015-03-13	2.3	- Corrected an error in the *teqc* command used to decimate data - Mentioned the adjustmentData folder - Added dome type to the information required in the antenna information file - Clarified that it is acceptable to submit a station that has an AHD height but no AHD height uncertainty - Clarified what is required in the station coordinate file.	Craig Harrison
2015-04-23	2.4	- Minor changes made to the following sections: 'Jurisdictional Data Archives', 'Directory Structure', 'Antenna Information File', 'Station Coordinate File', and 'Uploading the Data'. - Correction of minor typos.	Craig Harrison
2016-01-13	3.0	- Complete refresh of the entire document - Structure of the document modified to better describe the entire national adjustment process - Added details on APREF processing - Removed reference to *verifySub.pl* - Updated data submission instructions - Added details on the jurisdictional adjustment	Craig Harrison
2018-07-03	4.0	- Major re-write to make the guidelines more prescriptive - Moved some existing information to appendices	Craig Harrison
2018-07-17	4.1	- Corrected Step 2 in Section 6 - Varied the dates in the JADJ example to make things more clear	Craig Harrison
2018-08-16	4.2	- Made changes based on feedback - Corrected example *delete.txt*	Craig Harrison

		- Added NADJ flow process chart	
2019-10-25	5.0	- Post-GDA2020 refresh with the focus now on ATRF	Craig Harrison
2022-07-04	6.0	- Title changed to 'GDA2020 Update Process Guidelines' - Incorporated some feedback - Added information about measurement IDs	Craig Harrison
2022-10-03	6.1	Amend instructions for using DynAdjust for discontinuities rather than fixDisconts_v0.3.py	Kent Wheeler
2022-11-10	6.2	- Assigned letter "C" to NSW in Table 2	Alistair Deane
2024-08-DD	6.3	- Reflect changes in data transfer method (SFTP). - Remove reference to fixDisconts.py when using DynAdjust 1.2.2 or earlier. - Highlight code statements with textboxes for clarity. - Assigned letter "B" to QLD in Table 2 - Add file format examples in section 7.5	Alistair Deane
2025-04-07	6.4	-- Added letter "I" to NSW	Umma Zannat

2 Introduction

To modernise the Australian Geospatial Reference System, the GWG proposed a two-datum solution that was approved by both the ICSM and ANZLIC. The first stage of modernisation involved the production of Geocentric Datum of Australia 2020 (GDA2020), an updated GDA coordinate set that replaces Geocentric Datum of Australia 1994 (GDA94). This update removes the offset to the ITRF, removes the distortion that affected portions of GDA94 and, for the first time, provides rigorous uncertainties. Like GDA94, GDA2020 is a plate-fixed datum meaning the coordinates of a feature are constant with time. This also means that, after the GDA2020 epoch of 1 January 2020 has passed, the offset to the ITRF will return and will increase at 7cm/year. This provides the rationale for the second stage of modernisation, which will focus on a time-dependent reference frame that will remain aligned with the ITRF. This Earth-fixed reference frame is called the Australian Terrestrial Reference Frame 2014 (ATRF2014) and it will coexist with GDA2020. In both GDA2020 and ATRF2014, users' coordinates will be the products of a robust national adjustment (NADJ).

The data that will be used in the NADJ will come from three sources: the Asia Pacific Reference Frame cumulative solution (the APREF solution); the National GNSS Campaign Archive (NGCA); and the jurisdictional data archives (JDA). GA computes the APREF solution, and it will be used to constrain the NADJ. The NGCA is a high-quality data set that consists of RINEX files submitted to GA by each jurisdiction for processing. These files are non-CORS RINEX files that contain 6 hours or more of continuous observations over survey control ground marks. Eventually, all CORS will be included in APREF and their data will be included in the NADJ via the APREF solution. The JDA will consist of all other jurisdictional data, including GNSS observations of >6 hours but of poor quality.

Before a jurisdiction submits their data for inclusion in the NADJ, it must perform a jurisdictional adjustment (JADJ). This involves performing a least-squares adjustment of its data using the latest APREF solution as the constraint. This provides a relatively quick check of a jurisdiction's data before inclusion in the much larger NADJ. A flow process chart for the NADJ is provided in Figure 1.

The NADJ is just one part of the bimonthly GDA2020 Update Process. The process starts on the 10th of each month with the preparation of the updated APREF solution, which is used in all the remaining parts of the process. The NGCA is processed on the 15th of every second month and the NADJ adjustment is run on the 1st of the following month.

These guidelines cover the NGCA, the JADJ, and the NADJ. They will only briefly touch on the APREF solution and the JDA. The reason for this is that the APREF solution will be the responsibility of GA and the JDA need only be submitted as part of the JADJ to be included in the NADJ, while the NGCA involves a more complex process. Guidelines are provided for the submission of data to the NGCA, and information is given on their subsequent processing and the products that will be returned after processing. Details are also given on the JADJ, which will be performed as a means of data quality assurance prior to final data submission.

Ultimately, both GDA2020 and ATRF2014 will be dynamic in the sense that the network will not be static, it will be improved and will change in size as new data are incorporated and poor-quality data are removed. This will require an iterative approach to data submission and therefore it is important that submissions are correctly date stamped.

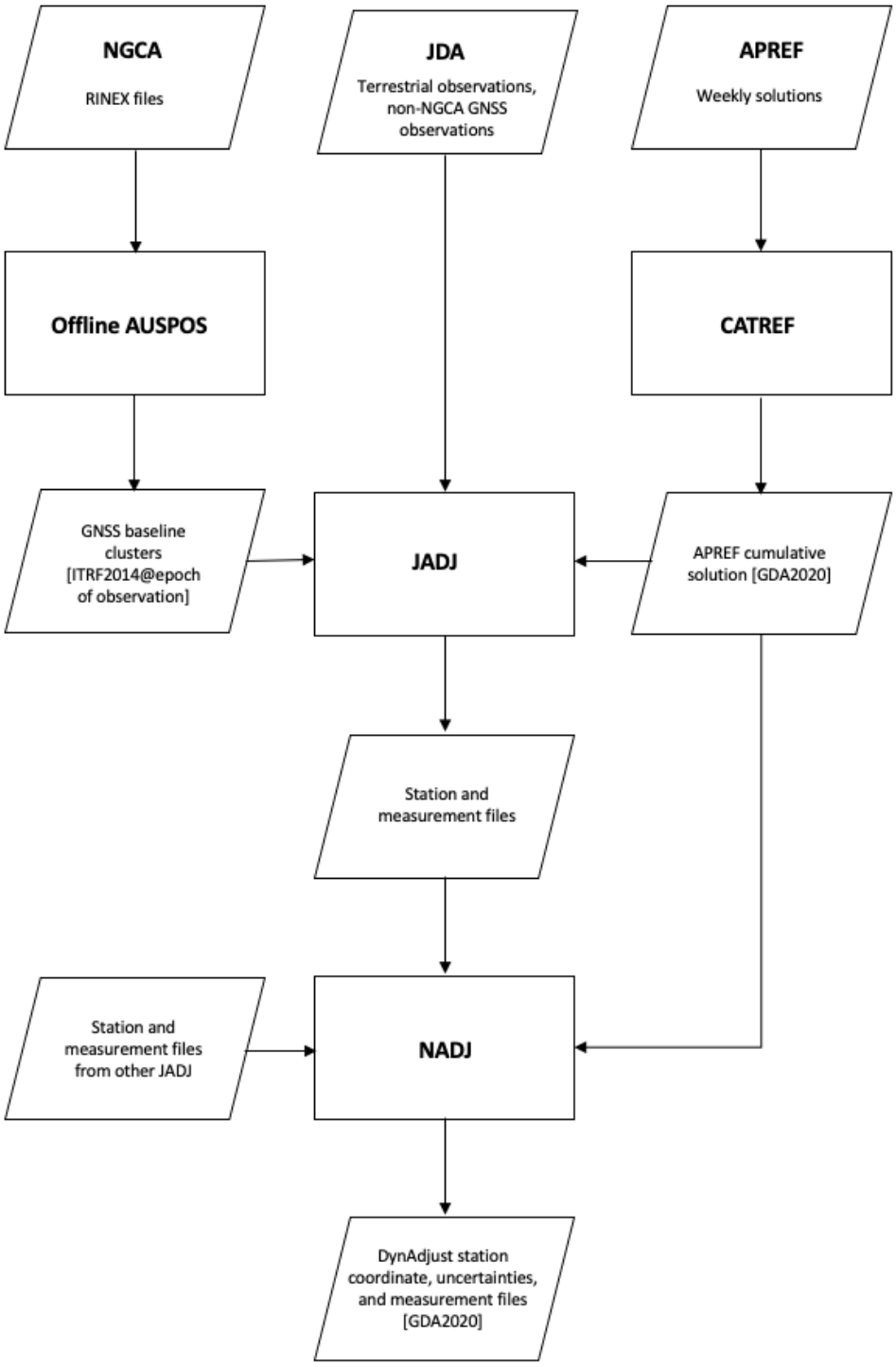

Figure 1: National Adjustment flow process chart. Rectangles represent processes and parallelograms represent data.

3 Asia Pacific Reference Frame

The Asia Pacific Reference Frame (APREF) network is a densification of the ITRF in the Asia Pacific region. For GPS week 2192 (week ending 15 January 2022), there were 1,239 CORS in the APREF cumulative solution. GA computes a weekly ITRF2020 solution for this network, with a two-week delay caused by the time required for IGS to release their final orbits. These weekly solutions are then combined into a cumulative solution (the APREF solution), which, for some stations, stretches back to the start of 1996. The epoch of these solutions is the default ITRF2020 epoch of 01.01.2015. Discontinuities are accounted for in this solution.

For the purposes of the NADJ, the APREF solution is modified as follows for use in jurisdiction and national adjustments.

- A three-month delay has been introduced before an APREF solution is used in the GDA2020 Update Process to allow time for new discontinuities and other potential problems to be found and corrected
- stations outside the extent of GDA2020 (Figure 2) are removed, reducing the number of stations to 767. Note, not all these stations are still operational.
- The solution is transformed to GDA2020@01.01.2020 using the GDA2020 plate motion model
- Type B measurement uncertainties are added.
    - For the 109 Recognized-Value Standard (RVS) stations these uncertainties are 3mm, 3mm, and 6mm (east, north, and up). The 4-character IDs of the RVS stations are shown in Table 1.
    - For all other stations the Type B measurement uncertainties are 6mm, 6mm, and 12mm.
- Stations with less than 2 years' worth of data are removed from the cumulative solution SINEX file and are included in the NADJ as a pair of DynaML GNSS baseline cluster files. Only stations in the SINEX file are used for scaling the NGCA.
- The SINEX file, baseline cluster files, and discontinuity files are uploaded to the GA SFTP server.

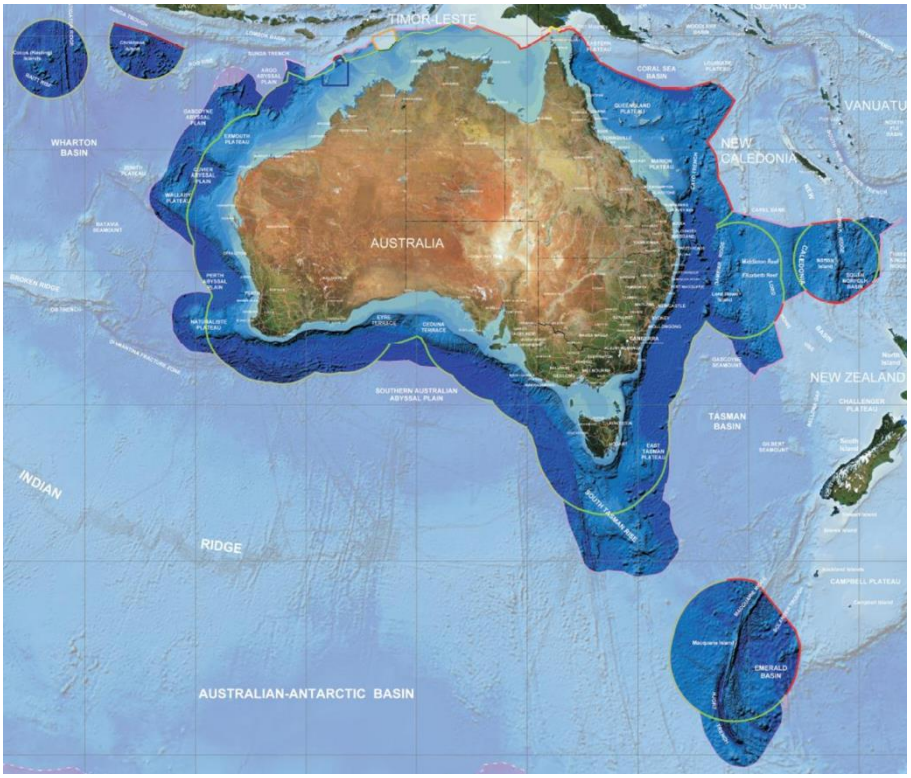

Figure 2: The extent of GDA2020.

ALBY	BKNL	COOL	HIL1	KAT1	LURA	NCLF	PTHL	SYDN	WALH
ALIC	BNDY	DARW	HNIS	KELN	MAIN	NEBO	PTKL	TBOB	WARA
ANDA	BRO1	DODA	HOB2	KGIS	MEDO	NHIL	PTLD	THEV	WILU
ARMC	BROC	EDSV	HUGH	KILK	MOBS	NMTN	RAVN	TID1	WLAL
ARUB	BULA	ESPA	HYDN	KMAN	MRO1	NNOR	RKLD	TMBO	WMGA
BALA	BUR2	EXMT	IHOE	LAMB	MTCV	NORF	RNSP	TOMP	WWLG
BBOO	BURA	FLND	JAB2	LARR	MTDN	NORS	RSBY	TOOW	XMIS
BDLE	CEDU	FROY	JERV	LIAW	MTEM	NSTA	SA45	TOW2	YAR2
BDVL	CNBN	GABO	JLCK	LKYA	MTMA	NTJN	SPBY	TURO	YEEL
BEEC	COEN	GASC	KALG	LONA	MULG	PARK	STNY	UCLA	YELO

BING	COOB	HERN	KARR	LORD	NBRK	PERT	STR1	WAGN	

Table 1: The 109 Recognized-Value Standard stations that are used to constrain the national adjustment.

4 Jurisdictional Data Archives

Each jurisdiction will maintain a jurisdictional data archive (JDA) that should contain all data that they want included in the NADJ but which are not suitable for inclusion in the NGCA, because they are <6 hours in duration, >6 hours but of poor quality, or they are terrestrial measurements. Stations outside the extent of GDA2020 are not to be included. All GNSS observations must be included as baselines (Type G or X measurements in DynAdjust) rather than point clusters (Type Y). The reason for this is that the APREF solution, which is included as a SINEX file, will provide the constraints for the NADJ and therefore all other measurements should be relative measurements that can be aligned with the APREF network. As noted in Section 3, APREF stations with less than two years' data are not used as constraints but rather are introduced to the NADJ separately as a GNSS baseline cluster.

The addition of Type B measurement uncertainties for the JDAs is left to the jurisdictions.

There is no need for jurisdictions to submit this archive directly to GA. It will be supplied to GA after it has been successfully included in the JADJ, which is an important quality assurance measure that will ensure all jurisdictions' data sets combine correctly in the NADJ.

5 National GNSS Campaign Archive

The National GNSS Campaign Archive (NGCA) is a key component of the Australian Geospatial Reference System. This archive will be a high-quality, national-scale data set that will enable science requiring accurate positioning to be conducted. The NGCA will, as GNSS observation modelling and data analysis strategies improve with time, facilitate the maintenance of a state-of-the-art national geodetic adjustment by supporting the automated processing and inclusion of GNSS observations into the NADJ.

This section provides an outline of the process for submitting data for inclusion in the NGCA. It includes how to upload the data to the GA SFTP server, some details on the processing, and a description of the files that are returned after processing.

5.1 Accessing the GA SFTP Server

An SFTP server has been setup to act as an end point to transfer data. This works in a similar way to the previous FTP server, but the physical location of the data is now in an AWS s3 bucket instead of an on-premises server at GA. This can be accessed programmatically or with a file transfer program (e.g. FileZilla). To access the server, a user name and key file is needed. In the future, for more security, GA may slightly change the method of access to not rely on a key, but for now this is the access method. Contact gda2020@ga.gov.au if a username or key file is not known, or if other assistance is needed.

Host (endpoint): s-a54bcbfb140c4154b.server.transfer.ap-southeast-2.amazonaws.com

5.1.1 Data to be submitted

The only files that should be submitted to the NGCA are RINEX files, which need to satisfy the following conditions:

- their names are in the form expected by Bernese v5.2;
- the station names follow the agreed GWG naming convention;
- they are of high-quality;(See Note 1 below)
- the observations were made after 1 June 1994;
- they contain between 6 and 48 hours of observations sampled at 30 second epochs; and
- the station is within the extent of GDA2020;
- RINEX version 2 or 3 will be accepted. Note that any RINEX-3 will be converted to RINEX 2 during AUSPOS processing.
- decimated to 30 seconds

A description of the Bernese v5.2 file name format is given Section 7.1 and the GWG naming convention is detailed in Section 7.2.

Explanatory Notes

1) The NGCA is an archive for high-quality GNSS observations. Even if the file contains more than 6 hours of observations, if the observation quality is low then the data should not be submitted but rather included in the JDA. See Section 7.3. for some suggestions on how to determine the quality of your data. The criteria for inclusion / exclusion are not strictly defined here and will be subject to review of specific datasets by GA and the submitting jurisdiction.

   Note: It is anticipated that in future RINEX files may automatically be submitted to AUSPOS to determine if they are of sufficient quality or not (pending development).

2) RINEX files from before 1 June 1994 cannot be processed because there are no IGS products available prior to this date.

3) RINEX files that contain more than 48 hours of observations must be split into files of 48 hours (or less).

4) RINEX files should be decimated to 30 seconds to minimise file sizes. Data at higher frequency is not generally of benefit for geodetic applications It is possible to lose an epoch when decimating data. It is also possible that some receivers may drop the first and last epoch of an observation. For technical reasons such as these, RINEX files with 5:59:00 of observations will be accepted into the archive. For data being collected specifically for inclusion in the NGCA, it is a good idea to set up the receiver to observe for slightly longer than 6 hours to avoid these sorts of problems.

NGCA processing starts on the 15th of every 2nd month. Jurisdictions should keep their uploaded NGCA archive up-to-date to ensure their contents are processed as soon as possible. Station translation table

To make the NGCA processing as automated as possible there are a few other files that may be needed. Not all file types will be required by all jurisdictions. Each file should have a name that contains the jurisdiction and the date the file was uploaded. These files should be placed in the files/ directory on the GA SFTP server, with older versions being deleted after newer versions have been uploaded. See Section 5.1 for details on accessing the ftp server.

There are four different file types, but only one, is relevant to the NGCA processing. This file, the translation table, should be named in the following format *jur*TransTableYYYYMMDD.csv, where *jur* is one of act, nsw, nt, qld, sa, tas, vic, or wa. This file translates the 4-character site codes back to the common jurisdictional names. It consists of lines containing the 4-character site code and the jurisdictional name separated by a comma.

We will describe the other files in more detail in Section 7.5.

5.2 Processing

Before processing, the RINEX files in an NGCA are divided up into ‘clusters’. All the files contained in a single cluster are processed together. Clusters are created by grouping RINEX files that overlap temporally, with every file in the cluster having at least 2 hours of overlap with every other file in the cluster.

Cluster files are named with the following format

YYDOY_ls

where DOY is the day of year, YY, that the earliest file in the cluster starts on. If there is more than one cluster that starts on a particular day then the second cluster file will have a '1' added after the DOY and before the '_ls'. A third cluster will have a '2', etc.

The NGCA is processed using the offline version of AUSPOS. The nearest 7 IGS CORS and the nearest 8 non-IGS CORS are selected for use as reference stations. The former provides a good connection to the ITRF and the latter provides a good local solution.

Two SINEX files are produced for each cluster:

- A 'full' SINEX file with the station coordinates given in ITRF2014 at the epoch of observation.
- A second 'cutback' version of each SINEX file is created with all reference stations removed, except the two closest to the centroid of the cluster.

A pair of DynaML GNSS baseline cluster files is created containing the stations and the non-trivial baselines between the stations in each SINEX file, both the full and the cutback versions. One GNSS baseline cluster, using the full VCV, is produced for each SINEX file. These baselines are formed between one station and all other stations, i.e., they radiate out from a single station. Generally, this station will be one of the stations from the jurisdiction's archive rather than one of the APREF sites. The 4-character site codes will be translated back to the common jurisdictional names using the translation tables supplied (see Section 0).

Type B uncertainties are determined as per SP1 (v2.2) by scaling each cluster's a-priori uncertainties. For each full GNSS baseline cluster in an NGCA, a minimally-constrained adjustment is performed, with the 15 reference stations held fixed, and the resulting μ_0 is adopted as the scaling value for that particular baseline cluster. The cutback baseline clusters are then scaled, combined into a single pair of msr and stn files, and a fully-constrained adjustment is performed with the APREF solution as the constraint. The purpose of the scaling is to ensure that NGCA measurements are consistent with, and do not introduce tension between, the APREF constraints. The final adjustment provides a final check that all clusters fit well together and with the APREF solution.

5.3 Processing Results

NGCA processing results are uploaded to the ngcaResults/ directory on the GA SFTP server and the relevant jurisdiction notified. The archive name will contain the jurisdiction and the date that processing started, e.g., GA_NGCA_20220704.zip. Any existing archive is deleted. Downloading this archive and unzipping it will create a directory called GA_NGCA_20220704/, which contains the following:

[JUR]_NGCA_[YYYYMMDD]_EoO_msr.xml [**Adopt this file for JADJ]**
[JUR]_NGCA_[YYYYMMDD]_EoO_stn.xml [**Adopt either stn file for JADJ]**

- the combined GNSS baseline cluster file, fully scaled and expressed in ITRF2014 at the epoch of observation (EoO)
- the station file associated with the ITRF@EoO msr file.

        - WARNING: As of v6.4 of this guideline, this EoO station file currently expresses coordinates for each station at the EoO, but must nominate a single 'epoch' in the file header. DynAdjust will read station coordinates from this file as if they have already been transformed to the header epoch. Since this can result in metre-level differences, the GDA2020 transformed version below is advised for use in JADJ for the time being.

- [JUR]_NGCA_[YYYYMMDD]_msr.xml **[SUPERSEDED by EoO file]**
  [JUR]_NGCA_[YYYYMMDD]_stn.xml **[SUPERSEDED by EoO file]**
    - the same combined GNSS baselines cluster results transformed to GDA2020

- Notes on NGCA station and measurement files and epoch:
    - 'epoch' in DnaXML format files refers to the epoch of the reference frame (for the whole file, or optionally per individual measurement). Currently, dynadjust is not capable of reading or writing metadata which separately describes the epoch at which the measurement was actually taken, i.e. the 'epoch of observation' (EoO). To maintain a record of the EoO therefore requires a file (or measurement) to express an 'epoch' of reference frame equal to the EoO.
    - The EoO of a measurement is useful when comparing multiple observations at the same station over time. Consider a station which is suspected of moving due to surface deformation. Expressing all measurements at EoO allows the user to identify which measurements apply to a mark before or after the movement.
    - For this reason measurements in EoO are adopted for review and inclusion in the JADJ, and eventually in the NADJ for additional cross-jurisdictional review.
    - Station files in contrast, can (currently) only express a single 'epoch' in the file header.
    - All stations in a file must be expressed at the same 'epoch' of reference frame. For this reason, stations (and the stations referred to in measurements) must eventually be identified as unique nodes, Two formats commonly in use are s*tationname_YYYYdoy (as in APREF disconts) and stationname_YYYYMMDD*

- clusters/: the files in this directory show what RINEX files were included in each cluster.
- dynaML/: the individual GNSS baseline cluster files are contained in this directory. [Expressed in ITRF2014 at the epoch of observation]
- snx/: this directory contains the SINEX files that were created during the NGCA processing. Files ending in .AUS contain all the references stations used in processing while those ending in .NGCA have all reference stations except the two nearest removed. Expressed in ITRF2014 at the epoch of observation]
- feedback/: this directory contains some of the files produced during the processing. Some may document problems that need to be corrected:

- *checkNgca.log*: this file lists, after the minimally-constrained adjustments, the measurements that have large residuals (20mm or more in XYZ) and stations that have large positional uncertainties (20mm or more in east and north, and 40mm or more in up);
- *selectRef.log*: this file lists RINEX files that were submitted that failed processing. This file is only created if there are RINEX files that failed processing.
- *sigma0.dat*: the file lists the μ_0 that was obtained from the minimally-constrained adjustment.
- *verifySub.log*: this file lists any problems with any of the RINEX files that may prevent them from being processed. This includes:
  - that the RINEX file is not compliant:
    - less than 6 hours of observations or more than 48 hours
    - data not sampled at 30 second intervals;
  - that the RINEX file name does not conform to the *Bernese* standard (see Section 7.2);
  - that the file is from before 1 June, 1994;
  - that the day of year in the file name does not match the day that the observations began; and
  - that the antenna type is not supported.
- *log_4_submit.txt*: this file lists what the AUSPOS job number is for each cluster. The job number is the first item on each line (no need to provide all the zeros) and the cluster name is the fourth data column. If you have problems with a cluster the job number will help to track down what went wrong.

These feedback files should be checked to ensure that problems are fixed.

6 Jurisdictional Adjustments

An important quality check is the jurisdictional adjustment (JADJ). Below are the steps necessary to complete a JADJ and ensure the data will fit with the NADJ without issue.

There are four steps:

1. Rename the APREF stations that have a discontinuity in your JDA;
2. Use your renaming file to rename all cross-border stations in your data set;
3. Adjust your data; and
4. Upload the combined measurement file (Step 2) and the adjusted station file (Step 3)

The examples below will use the following data sets:

- APREF: apref20220115.snx, apref20220115_stn.xml, apref20220115_msr.xml & disconts20220115.snx
- NGCA: GA_NGCA_20220415_stn.xml & GA_NGCA_20220415_msr.xml
- JDA: GA_JDA_20220423_stn.xml & GA_JDA_20220423_msr.xml
- Seismic Zone Survey: GA_SZS_20171111_stn.xml & GA_SZS_20171111_msr.xml
- Renaming file: ga_20220424.renaming

Not all jurisdictions will have all data sets, so modify where necessary. To be safe, you should always back up all your data files before running through these steps.

When performing a JADJ, please do not change the scaling of the APREF solution, the NGCA, nor the Seismic Zone Survey data. Only the scaling in the JDA can be changed in order for the JADJ to pass the statistical tests.

Step 1

The first step is to rename the APREF stations that have a discontinuity in your JDA.This step can be done using DynAdjust with the following command and flags.

```
import -n GA_JDA_20220423_ GDA_JDA_20220423_stn.xml
GDA_JDA_20220423_msr.xml --export-xml --discontinuity-file
disconts20220115.snx
```

Warning: DynAdjust will remove comments from the files during the above step!

Step 2

```
import -n GA_RENAME_20220704 GA_NGCA_20220415_stn.xml
GA_SZS_20171111_stn.xml GA_JDA_20220423_stn.xml GA_NGCA_20220415_msr.xml
GA_SZS_20171111_msr.xml GA_JDA_20220423_msr.xml --stn-renaming-file
'ga_20220424.renaming' --flag-unused-stations --remove-ignored-msr --
export-xml-files
```

```
import -n GA_RENAME_20220704 GA_RENAME_20220704stn.xml
GA_RENAME_20220704msr.xml
```

```
reftran GA_RENAME_20220704 -r GDA2020 --export-xml-files
```

The first import command will produce two XML files, GA_RENAME_20220704stn.xml & GA_RENAME_20220704msr.xml. We will ignore the station file as it will have a mixture of reference frames and epochs, which in many instances will not match the defaults written to the header. This will cause undue shifts in your adjustment and may cause other problem besides. Make a copy of the measurement file, GA_RENAME_20220704msr.xml, named GA_GDA2020_20220704_msr.xml. This file will contain all your measurements in the reference frame and at the epoch they were observed, and it is the measurement file that you will submit to the NADJ.

The second import command is necessary to remove any unused stations from your JADJ.

The reftran command will produce two files GA_RENAME_20220704.GDA2020.1.1.2020stn.xml and GA_RENAME_20220704.GDA2020.1.1.2020msr.xml. All the measurements and station coordinates in these two files will be in GDA2020 and at epoch 01.01.2020, which will match the defaults listed in the header. These are the files you will input into Step 3.

These files will have all cross-border stations correctly renamed and both ignored measurements and unused stations removed.

Step 3

```
import -n GA_GDA2020_20220704_ apref20220115.snx apref20220115_stn.xml
apref20220115_msr.xml GA_RENAME_20220704.GDA2020.1.1.2020stn.xml
GA_RENAME_20220704.GDA2020.1.1.2020msr.xml -r GDA2020 –flag-unused-stns
--discontinuity-file disconts20220115.snx
```

```
geoid -n GA_GDA2020_20220704_ -g AUSGeoid2020_20180201.gsb --convert
```

```
segment GA_GDA2020_20220704_ --min 800 --max 800
```

```
adjust GA_GDA2020_20220704_ --multi --export-xml-files
```

The adjust step will produce GA_GDA2020_20220704_.phased-mt.adj.xml, which you should rename to GA_GDA2020_20220704.adj.xml. These are the adjusted station coordinates that you will submit.

Step 4

Log onto the GA SFTP server and go to the directory adjustmentData/. Upload GA_GDA2020_20220704.adj.xml (Step 3) & GA_GDA2020_20220704_msr.xml (Step 2) here and delete the old versions of these two files.

6.1 Measurement IDs

The DynaML schema allows for measurements to be assigned an ID. To avoid duplicating IDs, each jurisdiction is assigned a number to start their 9-digit IDs. These numbers are: 0 GA, 1 NSW, 2 Victoria, 3 Queensland, 4 South Australia, 5 Western Australia, 6 Tasmania, 7 NT, 8 ACT, and 9 Other.

7 Appendices

7.1 RINEX File Compliance

The NGCA processing involves the use of Bernese v5.2 and so the RINEX file names must conform to the Bernese standard of STATDOY0.YYO, where:

STAT	is the 4-character station name, i.e., the site code (see Section 7.2)
DOY	is the three-digit day of the year
0	is the number ‘0’
YY	is the last two digits of the year in which the RINEX file was created
O	is the capital letter ‘O’

7.2 RINEX File Naming Convention

GA will process the RINEX files prior to inclusion in the NADJ. Since the IGS standard is to assign 4-character IDs to stations and since Bernese only accepts 4-character station names this restricts the range of possible names jurisdictions can use. This restriction increases the chances of two distinct stations using the same name and adversely affecting the national adjustment.

Therefore, to prevent station name conflicts, a naming convention has been adopted. The 4-character station name (site code) will conform to the following specification:

nnAB

where

nn	is a two-digit number drawn from 00 to 99
A	is the letter assigned to a particular jurisdiction (see Table 2)
B	is a letter drawn from A to Z

Jurisdiction	Letter
ACT Government	A
NSW Government	C D E F G and I
NT Government	M and N
QLD Government	B P and Q
SA Government	R and S
TAS Government	T
VIC Government	U and V
WA Government	W and X
Hydro (Defence)	H
GA	Z
Letters reserved for future assignment	J K L O Y

Table 2: The letters assigned to each jurisdiction for use as the first character in their site codes.

The total number of site codes available to ACT, TAS, Defence, Hydro, and GA is 2600. The total number of site codes available to all other jurisdictions is 5200. NSW has exceeded this number and so has been assigned another two letters and has 10400 codes available.

As an example, the site codes available to the Victorian Government are:

00VA to 99VA

00VB to 99VB

:

00VZ to 99VZ

00UA to 99UA

:

00UZ to 99UZ

7.3 Assessing RINEX data quality

There are a number of reasons why a RINEX file can contain poor quality data, e.g., multi-pathing or overhanging trees. This can result in some files missing some observations, from some satellites, in many epochs. The SINEX file produced by processing a low-quality RINEX file can exhibit some issues when it is included in an adjustment, such as large uncertainties on a station position (~4m) or large measurement residuals (>5cm). The file *checkNgca.log* that is returned as part of the processing results contains this information. See Section 5.3 for more details.

In a RINEX file, all lines are limited to 80 characters. If a line exceeds that length it is continued on the next line. The RINEX header line(s) listing the number observation types and their names contain the header label "# / TYPES OF OBSERV". The observation types required by AUSPOS depend on whether RINEX v2 or v3 are submitted. For RINEX 2, two carrier phases (L1 & L2) and two pseudoranges (C1 & P2, or P1 & P2, or C1 & C2) are required. For RINEX 3, two carrier phases (L1 & L2) and two pseudoranges for each carrier phase are required. For L1, C1P & L1P, or C1W & L1W, or C1C & L1C, or C1X & L1X. For L2, C2P & L2P, or C2W & L2W, or C2C & L2C, or C2D & L2D, or C2X & L2X. A file that is missing too many of these observations can result in a poor solution. Whether this is the case or not can be seen by examining the epoch data.

Each epoch in a file begins with the date and time (YY MM DD hh mm ss.sssssss). The next number is the epoch flag and a flag of 0 means this epoch is OK. Anything other than this may mean there is a problem with that epoch. The rest of this line lists the total number of satellites observed followed by the satellite numbers with G being a GPS satellite, R being a GLONASS satellite, and E being a Galileo satellite. Note, single digit satellite numbers may or may not be padded with a 0.

Each epoch then contains a line for each satellite observed with the observations being listed in the same order as they are given in the header line labelled "# / TYPES OF OBSERV". If these lines exceed 80 characters then they are continued on the next line. For a file to be of high-quality, a very large fraction of all satellites in all epochs must have a recorded observation for each of the four types listed above.

7.4 Splitting and Decimating RINEX Files With teqc

teqc can be used to split large files and to decimate any data that is sampled at a higher than 30-second frequency. The latter can be achieved with the following command:

teqc –O.dec 30 [infile] > [outfile]

To batch process a large number of files the Windows FORFILES command can be utilised. For instance, the following will use *teqc* to decimate all RINEX files in the current directory and export the decimated output to a file with the same name in a subdirectory:

FORFILES /m *.??O /c "CMD /c teqc -O.dec 30 @file > c:\teqc\decimate\@file

7.5 Other files required in GDA2020 Update Process

To make the GDA2020 Update Process as automated as possible there are a few other files that may be needed. Not all file types will be required by all jurisdictions.

Station Renaming File

Name format: ga_20220704.renaming

Often, stations from another jurisdiction will be included in a JDA, and often with a different name to that used by the jurisdiction that operates the station. This can lead to a station having multiple names in the NADJ. This file is used by DynAdjust to rename stations on import so that each station has a single, unique name before the adjustment. The file is fixed format with station 1 in columns 1-20 and station 2 in columns 21-40, such that any instance of station 2 will be renamed to station 1. There should be only one renaming pair per line. The actual renaming is done by the jurisdiction during the JADJ, but they are still required for QA before running the NADJ.

Here is an example of the expected format for the .renaming file. The '*' indicates a comment line. Comments are not required. This is from section 3.3.2 of the DynAdjust manual.

```
!#=DNA 3.01 REN
* Station renaming file
* List the preferred name first, and then all other aliases a mark may have
* NEWNAME (20 chars) ALIAS (20 chars) ALIAS (20 chars) ALIAS (20 chars)
302513640            1364
302509800            980
302508300            830
261907650            765
```

Station Ignore File

Name format: ga_20220704.ignore

Some jurisdictions prefer to permanently rename stations from other jurisdictions so that the name matches that used by the jurisdiction operating the station. This will cause DynAdjust to flag these station names as duplicates. This file helps to filter out these types of duplicates so that real duplicates can be easily identified. This file should contain one station per line.

Here is an example of the .ignore file. It is single column with no header. One station per line.

```
302513640
302509800
302508300
261907650
```

Near Station File

Name format: ga_20220704.near

To help with identifying stations that may have multiple names, DynAdjust flags stations that are closer than 30cm horizontally. Often there will be stations that are genuinely this close and so this file is used to filter out these stations, making it easier to identify stations with multiple names that need to be dealt with. Like the station renaming file this file is fixed format with station 1 in columns 1-20 and station 2 in columns 21-40, with one pair per line. The order of the stations is unimportant. Please do not put pairs of APREF stations in this file. An APREF station paired with a non-APREF station is fine.

Here is an example of the .near file. It is two columns with no header.

```
302513640           3640
302509800           9800
302508300           8300
261907650           7650
```