1.0 OVERVIEW

The NSRS Align Database is designed to monitor the long term stability of GNSS stations by managing and visualizing coordinate residuals over time. It supports the final stage of an automated alignment workflow focused on time series generation and monitoring.

The system ingests standardized XML files that contain coordinate solutions from daily OPUS Static processing, weekly OPUS Projects session adjustments, and fully constrained network solutions. These solutions are compared against published station coordinates to compute residuals in the East, North, and Up directions.

Residuals are assessed using fixed thresholds. Two centimeters (2 cm) is used for East and North components, and four centimeters (4 cm) is used for the Up component. These values help identify when positional changes have occurred. Results are presented through interactive time series plots that allow users to observe patterns, detect deviations, and determine if station coordinates need to be updated.

The database ensures continuous tracking of GNSS station alignment within the National Spatial Reference System through an automated and consistent monitoring process.

2.0 DATA STRUCTURE AND SCHEMA

2.1 STATION RECORDS

Each record in the database begins with a GNSS station. A station represents a physical location equipped with a GNSS receiver. These stations serve as fixed geodetic reference points used for continuous monitoring and coordinate evaluation over time.

The database stores essential identifying information for each station, including a unique station ID, an optional reference ID, a textual location description, and a field indicating the type of GNSS equipment or designation. This metadata is used to manage, organize, and interpret the positional data linked to each station.

The station record forms the foundational unit in the database. All coordinate estimates, published positions, residuals, and time series records are linked directly to a specific station. While positional estimates may vary over time, the station identity and associated metadata remain constant, enabling long-term tracking and analysis.

Field Name	**Description**
station_id	Unique identifier for the station
ref_id	Optional secondary identifier or alias
location	Textual description of the station’s physical or operational location
gnss_type	Type or designation of the GNSS installation or equipment

2.2 PUBLISHED COORDINATES

The database stores published coordinates for each GNSS station. These coordinates represent the official reference positions that form the operational basis of a real time GNSS network. They are defined and maintained by the network operator and are used to configure correction streams and ensure the positional consistency of real time services.

Published coordinates are expressed in a stable geodetic reference frame aligned with the National Spatial Reference System. They are considered fixed unless long term positional changes are observed. These coordinates serve as the baseline for evaluating incoming coordinate solutions derived from automated OPUS processing.

To monitor station alignment, the database computes positional residuals by comparing each solution to the corresponding published coordinates in the east, north, and up directions. This allows the system to detect offsets, drift, or other deviations that may affect network integrity.

If coordinate differences exceeding two centimeters in either horizontal component or four centimeters in ellipsoidal height persist over a period of several consecutive days, this may indicate that the station's actual position has shifted relative to its reference coordinates. In such cases, it may be necessary to review and update the station's published position to maintain alignment with the National Spatial Reference System and ensure continued accuracy in real time network operations.

When published coordinates are updated, the system generates a complete backup of the existing values before any changes are applied. It also logs each update in a structured record that includes the station identifier, the original and updated coordinates, and the timestamp of the change. These logs are saved externally to maintain a full and auditable history of all modifications.

Field Name	**Description**
station	Foreign key linking the coordinate to the corresponding station
published_lat	Geodetic latitude of the published position
published_long	Geodetic longitude of the published position
published_ellipsoidal_height	Height above ellipsoid of the published position
published_reference_frame	Geodetic reference frame used for the published coordinates
published_epoch	Reference epoch associated with the published coordinates

2.3 SOLUTIONS

The database stores multiple types of coordinate solutions for each GNSS station, corresponding to distinct stages in the alignment workflow. These include positions derived from OPUS Static processing, OPUS Projects session adjustments, and horizontally constrained network adjustments. Each solution is stored with its associated station, reference frame, and epoch.

These coordinate records serve as the primary input for computing residuals, generating time series, and monitoring the alignment of each station with respect to its published position in the National Spatial Reference System.

1. OPUS Static Solutions

These solutions represent daily coordinate estimates generated from OPUS Static processing. For each GNSS station, a RINEX file is submitted to the Online Positioning User Service (OPUS), which computes a static position based on three independent baselines to nearby reference stations. The result is a position expressed in both Earth-Centered Earth

Fixed (ECEF) and geodetic coordinates, stored alongside metadata describing the processing configuration. Each solution is tagged with the reference frame, epoch, and type of ephemeris used during processing. The coordinate fields capture both the raw Cartesian values and the converted geodetic representation. These solutions provide the most granular view of daily station positions and serve as the foundation for subsequent weekly and network-level adjustments.

Field Name	Description
station	Associated GNSS station
reference_frame	Geodetic reference frame used in the OPUS Static solution
epoch	Reference epoch corresponding to the coordinate estimate
ephemeris	Type of satellite ephemeris used during processing
ecef_x, ecef_y, ecef_z	Earth-Centered Earth-Fixed Cartesian coordinates (in meters)
lat, long	Geodetic latitude and longitude (in decimal degrees)
ellipsoidal_height	Height above the ellipsoid (in meters)

2. **OPUS Projects Session Solutions**

Session solutions represent weekly coordinate estimates for each GNSS station, computed from a group of daily static solutions. These sessions reflect a broader positional context by incorporating multiple observations over time and aligning them through a minimally constrained network adjustment. Each session solution includes an adjusted position expressed in both Earth-Centered Earth-Fixed (ECEF) and geodetic coordinates. The solution is tagged with the associated station, session identifier, epoch, reference frame, and type of satellite ephemeris used. These records offer a more stable representation of a station's position over a defined interval and help reduce the impact of day-to-day variations. These solutions are used to evaluate alignment consistency and serve as input for later stages of network processing and residual analysis.

Field Name	Description
station	Associated GNSS station
session_id	Unique identifier for the session
reference_frame	Reference frame used in the session adjustment
epoch	Reference epoch for the session solution
ephemeris	Type of satellite ephemeris used
ecef_x, ecef_y, ecef_z	Earth-Centered Earth-Fixed Cartesian coordinates (in meters)
lat, long	Geodetic latitude and longitude (in decimal degrees)
ellipsoidal_height	Height above the ellipsoid (in meters)

3. **Horizontally Constrained Network Solutions**

Network solutions represent the final stage in a multi-step adjustment process designed to align station positions with the National Spatial Reference System. This stage follows session processing and is preceded by two intermediate steps known as the preliminary adjustment and the horizontal free adjustment. The database captures the result of the final horizontal constrained adjustment. In this stage, selected control stations are fixed to their published coordinates, and the adjustment propagates that reference to all remaining stations in the network. This ensures consistency with the National Spatial Reference System and provides the most stable positional estimates available for each station. Each solution is linked to its corresponding station and includes the computed coordinates in both Earth-Centered Earth-Fixed and geodetic formats. Additional metadata such as the epoch, reference frame, and satellite ephemeris used are also recorded.

These solutions are used to evaluate long-term positional consistency and serve as a key input for residual analysis and time series monitoring. When persistent deviations are observed or realignment to the National Spatial Reference System is required, these final adjusted coordinates are the recommended candidates to be adopted as updated published positions.

Field Name	**Description**
station	Associated GNSS station
network_id	Identifier for the network adjustment run
reference_frame	Reference frame used in the network solution
epoch	Epoch corresponding to the adjustment
ephemeris	Type of satellite ephemeris used
ecef_x, ecef_y, ecef_z	Earth-Centered Earth-Fixed Cartesian coordinates in meters
lat, long	Geodetic latitude and longitude in decimal degrees
ellipsoidal_height	Height above the ellipsoid in meters

2.4 RESIDUALS

The residuals section of the database stores the positional differences between computed coordinate solutions and the corresponding published coordinates for each station. These differences are expressed in the east, north, and up components and serve as indicators of how closely a given solution aligns with the station’s reference position as maintained by the real time GNSS network.

To ensure meaningful comparisons across all coordinate solutions, a common geodetic reference frame and epoch must be used. If a coordinate solution is expressed in a different reference frame or epoch than that of the station's published coordinates, the solution is transformed before residuals are computed. This transformation is performed using the Horizontal Time Dependent Positioning tool, which adjusts the coordinate solution to the same frame and epoch by accounting for tectonic motion and reference frame evolution. This guarantees that residuals reflect true positional differences and are not influenced by inconsistent reference definitions.

Residuals are stored separately for each type of coordinate solution. These include residuals computed from OPUS Static solutions, OPUS Projects session processing solutions, and final horizontally constrained network adjustments solutions. Each residual record includes the associated coordinate solution, the station involved, the computed residual components, the reference frame and epoch used, and the published coordinates against which the residual was evaluated.

Each residual is stored alongside the exact published position that was used during the comparison. This ensures traceability and provides an audit trail for all residual computations. The database also timestamps the residual computation, allowing analysts to track when each residual was derived and under what conditions.

When residuals consistently exceed established monitoring thresholds of two centimeters in either horizontal component or four centimeters in ellipsoidal height over multiple consecutive days, this may indicate a positional shift. Such cases warrant further evaluation and may require updates to the station's published coordinates.

1. OPUS Static Residuals

Residuals from OPUS Static solutions are derived from daily coordinate estimates. Each residual is tied to a specific OPUS Static solution and includes metadata such as the ephemeris type, reference frame, epoch, and the published coordinates used for the comparison. These residuals provide the highest temporal resolution.

Field Name	Description
station	GNSS station associated with the residual
opus_solution	OPUS Static solution used to compute the residual
residual_e	East component of positional difference in meters
residual_n	North component of positional difference in meters
residual_u	Up component of positional difference in meters
reference_frame	Reference frame of the coordinate solution
epoch	Reference epoch of the coordinate solution
ephemeris_type	Ephemeris model used in OPUS processing

published_lat_used	Latitude of the published coordinate used
published_long_used	Longitude of the published coordinate used
published_ellipsoidal_height_used	Ellipsoidal height of the published coordinate used
doy	Day of year associated with the solution
year	Year of the solution
computed_at	Timestamp when the residual was calculated

2. **OPUS Projects Session Residuals**

These residuals capture the positional differences between session-based coordinate solutions and the published reference coordinates of each station. Each record contains the residual values in the east, north, and up directions along with the exact published coordinates used in the computation. Metadata such as the reference frame, epoch, ephemeris type, and processing day are preserved to support traceability.

Field Name	Description
station	GNSS station associated with the residual
session_solution	Linked OPUS Projects session solution used to compute the residual
residual_e	East component of the positional difference in meters
residual_n	North component of the positional difference in meters
residual_u	Up component of the positional difference in meters
reference_frame	Reference frame of the session solution
epoch	Reference epoch of the session solution
ephemeris_type	Ephemeris model used in processing
published_lat_used	Latitude of the published coordinate used
published_long_used	Longitude of the published coordinate used
published_ellipsoidal_height_used	Ellipsoidal height of the published coordinate used
doy	Day of year associated with the session
year	Year of the session
computed_at	Timestamp when the residual was calculated

3. **OPUS Projects Network Residuals**

These residuals represent the positional differences between the final horizontally constrained network solutions and the published coordinates of each station. Each residual is tied to a network-level solution that spans multiple days and reflects the final alignment of the station with respect to the National Spatial Reference System. The residual values in the east, north, and up directions are stored together with the reference frame, epoch, ephemeris type, and the specific published coordinates used during computation. The residual also includes the day-of-year range covered by the network adjustment and is timestamped to record when it was generated.

Field Name	Description
station	GNSS station associated with the residual
network_solution	Linked network-level solution used to compute the residual
residual_e	East component of the positional difference in meters
residual_n	North component of the positional difference in meters
residual_u	Up component of the positional difference in meters
reference_frame	Reference frame of the network solution
epoch	Reference epoch of the network solution
ephemeris_type	Ephemeris model used in network processing
published_lat_used	Latitude of the published coordinate used
published_long_used	Longitude of the published coordinate used
published_ellipsoidal_height_used	Ellipsoidal height of the published coordinate used
start_doy	Start of the day-of-year interval covered by the solution
end_doy	End of the day-of-year interval covered by the solution
year	Year corresponding to the network adjustment
computed_at	Timestamp when the residual was calculated

2.5 TIME SERIES RECORDS

The database supports residual time series tracking for each GNSS station. These records are based on residuals computed from OPUS Static solutions, OPUS Projects session solutions, and final horizontally constrained network adjustments. The time series allow analysts to monitor positional consistency by visualizing residuals in the east, north, and up components over time.

Each residual is transformed into a visual point and grouped into an interactive time series chart. These charts are updated automatically whenever new residuals are computed and are accessible directly through the database interface. The database links each station to a single residual time series visualization that spans all solution types and epochs.

To maintain consistency in monitoring, all residual values are converted from meters to centimeters and plotted against calendar dates. For OPUS Static and session solutions, each point corresponds to a specific day of year. For network solutions, which span multiple days, the plot reflects the midpoint date of the corresponding interval and includes metadata for both the start and end dates.

Each residual point is assigned a distinct visual style depending on the type of solution and the ephemeris model used. OPUS Static residuals are shown as black circles, session residuals as black squares, and network residuals as blue diamonds. Points that exceed the monitoring thresholds of two centimeters in either east or north or four centimeters in up are automatically highlighted in red. This visual differentiation allows users to identify and interpret anomalies quickly.

The interactive chart presents three vertically stacked panels. Each panel corresponds to one residual component. The top panel shows the up residuals, the middle panel displays north residuals, and the bottom panel contains east residuals. Each axis is scaled automatically to include a buffer beyond the minimum and maximum residual values, ensuring clarity in visualization.

Users can filter the time series view by solution type and ephemeris model. This allows selective visibility of OPUS Static, session, or network residuals, as well as comparisons between precise and broadcast ephemerides. Tooltips appear when hovering over each point, providing contextual metadata including solution type, date, day of year, residual value, ephemeris model, and interval duration for network solutions.

The chart includes a range selector to control the visible time window. Users can switch between predefined periods such as one week, one month, three months, or the full dataset. A timeline slider is also available to refine the visible window manually.

Each time a residual plot is updated, the chart is regenerated and saved as a self-contained file. The database keeps track of the location of this file for each station, allowing for seamless retrieval through the interface.

Field Name	**Description**
station	GNSS station associated with the time series
residual_plot_html	Relative path to the stored time series visualization
solution_types_included	Types of solutions included in the chart (OPUS Static, session, network)
residual_components_tracked	Residual components plotted (east, north, up)
ephemeris_models	Ephemeris types distinguished in the chart (precise, broadcast)
highlight_thresholds	Thresholds used for visual highlighting (2 cm horizontal, 4 cm vertical)

symbol_mapping	Circle for OPUS Static, square for session, diamond for network
color_scheme	Black for normal values, red for threshold exceedance, blue for network residuals
hover_metadata	Displayed metadata includes component, solution type, ephemeris model, date, day of year, and interval
last_updated	Timestamp of the most recent chart generation

These time series visualizations provide an immediate and intuitive view of station performance over time. They support early detection of deviations and help identify patterns or periods of instability. By centralizing and standardizing these plots, the database enables consistent long term monitoring across the entire network.

3.0 AUTOMATED WORKFLOW INTEGRATION

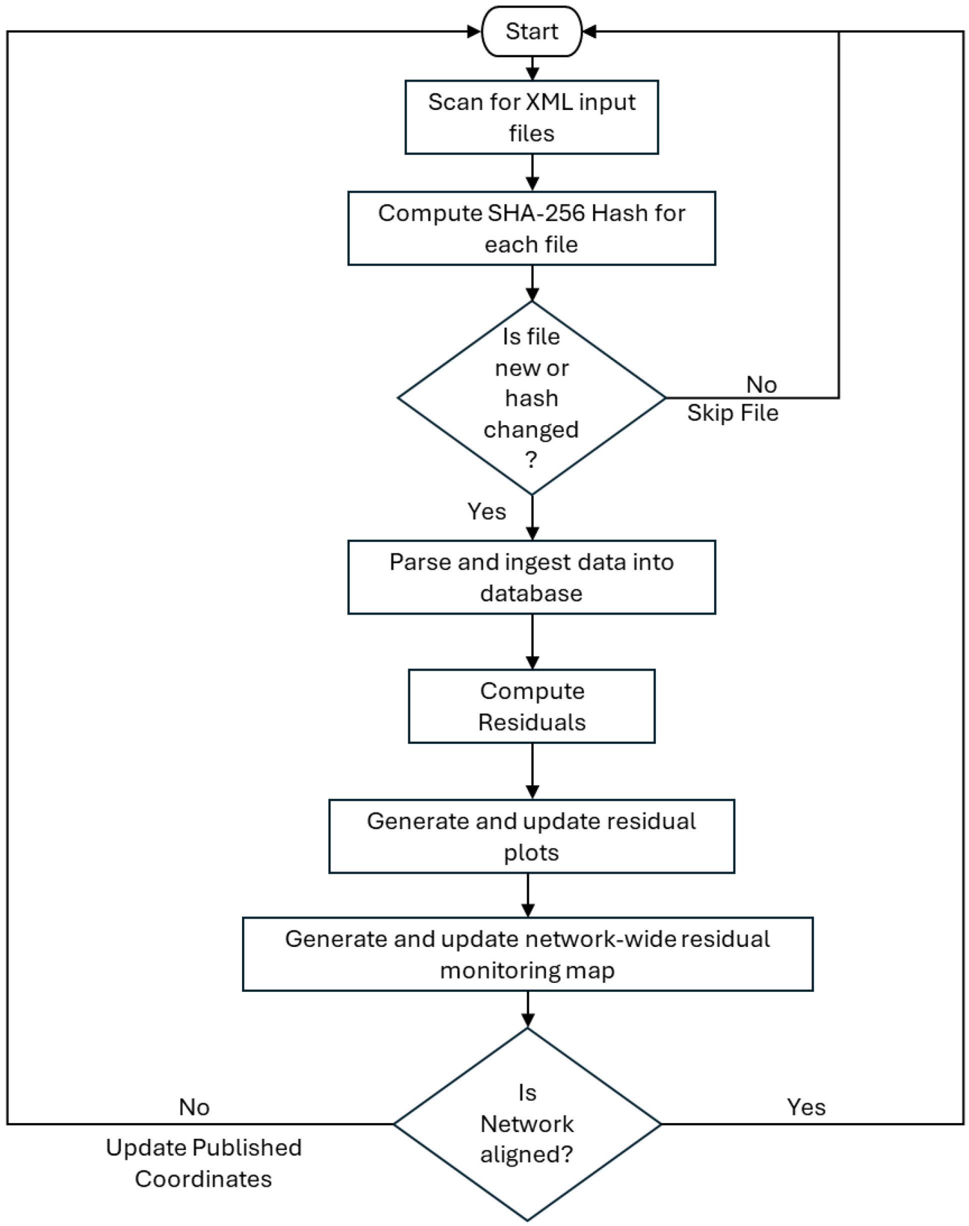
The NSRS monitoring database operates within a fully automated workflow designed for scheduled execution. This workflow ingests structured XML input, updates the database with new positional solutions, evaluates differences from reference positions, and generates updated visualizations for each station. It is architected to support both manual runs and continuous cloud-based deployments.

The process is driven by a central script that checks for incoming project files and detects changes by computing and comparing file-level hash values. Only new or modified files are processed, ensuring efficiency while maintaining a complete log of activity. Each valid input file is parsed, and its contents are used to update the database with recent positional data across all stages of the alignment process.

Once the coordinate records are inserted, the workflow initiates a residual computation step. Solutions that differ in reference frame or epoch are adjusted to match the reference configuration prior to comparison. The resulting residuals are recorded and time-stamped to support traceable monitoring. All necessary geodetic transformations are automatically applied during this stage.

After residuals are stored, the final step generates updated visual summaries. These summaries are produced as static HTML files that present residuals over time and are linked directly to the corresponding station records. The plots are replaced if newer data are available, ensuring that each station's chart always reflects the most current results.

The entire workflow is designed for cloud-native execution and is scheduled to run at regular intervals using external orchestration tools. Logs are generated on each run to capture processing actions and file outcomes. This supports scalable and fault-tolerant deployment and ensures consistent monitoring without manual oversight.



3.1 INPUT FILE MONITORING AND VALIDATION

To ensure efficient and repeatable execution, the automated workflow incorporates a file monitoring mechanism that processes only newly added or modified XML files. Cryptographic hashing is used to detect changes in file contents since the last execution.

Input files are stored in a designated root directory and must follow a standardized XML schema. These contain coordinate solutions generated from different stages of automated OPUS processing.

Each file is evaluated using the following steps:

a) A SHA-256 hash is computed from the file's content to generate a unique fingerprint representing its current state.
b) A JSON-based registry stores previously computed hash values, indexed by full file path.
c) The current hash is compared against the stored value. If it differs or is absent from the registry, the file is considered new or modified.
d) Only such files are selected for ingestion into the database.
e) After processing, the registry is updated with the new hash.

This method ensures that unchanged files are skipped, minimizing redundant computation and database writes. The use of a cryptographic hash guarantees that even minor alterations are detected. After each execution, the updated registry is saved to disk. A separate CSV log records all processed files, including their paths and timestamps, providing a complete audit trail of database updates. The validation process functions reliably in both manual and scheduled execution contexts, ensuring that all updates are based on actual data changes and that results are never duplicated.

3.2 DATABASE INGESTION AND POPULATION

After validated XML files are identified, the monitoring process proceeds by extracting coordinate solutions and associated metadata and inserting them into the database. These XML files follow a structured schema and contain positional estimates derived from multiple OPUS processing stages, including daily static solutions, session adjustments, and final network alignments.

Each file is parsed systematically to extract relevant fields. These include:

a) Station identifiers and associated metadata.
b) Coordinate estimates expressed in both Cartesian and geodetic formats.
c) Processing attributes such as the reference frame, epoch, and satellite ephemeris model.
d) Solution type classification to determine whether the entry corresponds to a static, session, or network solution.

Parsed values are validated for internal consistency and completeness. Once verified, the extracted data are mapped to corresponding database models and written to permanent storage. Each solution is linked to its respective station, allowing the system to maintain temporal continuity and spatial traceability across all records. To maintain a record of processing events, all files successfully ingested into the database are logged with a timestamp. This log is written to a separate file that enables full auditing of historical data imports. Additionally, metadata related to each ingestion event is stored internally to support provenance tracking. By centralizing all positional inputs into a structured relational schema, this ingestion step ensures that downstream processes such as residual computation and chart generation operate on a consistent and normalized data foundation.

3.3 RESIDUAL COMPUTATION

After coordinate solutions are populated into the database, each solution is evaluated to determine its positional offset from the published coordinates of the corresponding station. These offsets are computed in the east, north, and up components and reflect the true deviation from the station's reference position.

To ensure valid comparison, the reference frame and epoch of the coordinate solution must match those of the published coordinates. If they differ, the solution is first transformed to match the frame and epoch of the published coordinates. This ensures that any differences observed are due to actual positional changes and not mismatches in coordinate definitions. Once aligned, the difference in each component is recorded as the residual. Each residual entry is linked to the original solution and includes metadata such as the reference frame, epoch, and processing day. The published coordinates used in the comparison are also stored alongside the residual to ensure traceability.

Residuals are recorded separately for each solution type. This allows the database to distinguish between residuals derived from daily static solutions, session adjustments, and network-level adjustments. Only residuals that have not previously been computed are processed, ensuring data integrity and preventing duplication. These records serve as the foundation for subsequent monitoring and visualization tasks.

3.4 PLOT GENERATION AND UPDATE

Once new residuals are present in the database, updated visualizations are created for all affected stations. This update reflects the latest residual values and replaces any existing plots to ensure each station's visualization remains current. The output is saved as a self-contained HTML file, structured for standalone display and directly linked to the corresponding station record. Only stations with newly computed residuals are selected for update, minimizing redundant operations and preserving efficiency. The database tracks the relative path to each generated file along with the timestamp of its most recent update. This ensures consistent retrieval of the correct visualization through the interface. Plot generation occurs during each run of the time series pipeline. This guarantees that visual outputs remain aligned with the underlying data while allowing updates to be scheduled or triggered as needed.

3.5 NETWORK-WIDE RESIDUAL MONITORING (MAP TOOLS)

To complement the station-level time series plots, the monitoring workflow includes a network-wide visualization tool designed to assess overall station alignment. This component generates a geospatial map interface that summarizes the frequency of residual threshold exceedance for each station, based on their OPUS Static residuals.

The map enables efficient identification of stations that may have deviated from their published coordinates using a color-coded indicator system. It is automatically updated following each residual computation cycle, ensuring that the displayed status reflects the most recent alignment performance across the network.

Each station is shown as a colored point on the map. This classification is based on comparisons between OPUS-derived coordinate solutions and each station's current published position. Thresholds are defined as 2 cm for the horizontal components and 4 cm for the vertical component. Any residual exceeding these limits is flagged as an exceedance.

The system ensures that only residuals linked to the latest published coordinates are evaluated. Outdated offsets are excluded from the exceedance count. When a station's published position is updated, all previously computed residuals are excluded from future map calculations. This reset mechanism ensures that monitoring accurately reflects the current coordinate definition.

For example, if a station previously exhibited exceedance events but its published coordinates are subsequently updated to reflect its actual position, those earlier residuals are no longer considered. Only new residuals, computed after the update and directly associated with the latest published coordinates, contribute to the map display. This approach guarantees that station health assessments are current and based on the most accurate reference data.

Stations that appear on the map with flagged exceedance counts can be further evaluated using the corresponding time series plots. These provide detailed historical insights across all solution types. This layered visualization strategy supports both network-level assessments and station-specific investigations.

3.6 LOGGING AND AUDIT TRAILS

All monitoring operations are accompanied by structured logging to ensure transparency, traceability, and reproducibility. Every significant step in the automated process generates a corresponding log entry that is either written to disk or persisted in the database. This provides a reliable audit trail of processing activity over time and enables verification of results and workflow integrity.

Ingested XML inputs are recorded in a CSV log file, which stores the file path and timestamp of each processed entry. This allows users to confirm which input contributed to the current state of the database and when they were processed.

To detect file changes, a JSON-based hash registry is maintained. This registry maps each input file to its most recently observed SHA-256 hash. It prevents the reprocessing of static files and serves as a persistent record of input state across executions. If an input file is modified or newly added, its hash changes, and the updated state is recorded after successful ingestion.

Residual computation events are timestamped and linked to the corresponding coordinate solutions. Each residual entry includes metadata such as the reference frame, epoch, and published coordinates used in the comparison. This ensures that the computation context for each residual is preserved in the database.

Visual residual summaries are tracked by recording the relative path to each generated file and noting the timestamp of its most recent update. This information is stored alongside the station record, enabling retrieval of the most current time series visualization and confirming its alignment with the underlying residual data.

Logs are also produced for processing errors. When an XML file cannot be ingested or a residual computation fails, an error message is written to standard error without halting the overall run. This ensures that other files in the queue continue to be processed and that failure contexts are preserved for review.

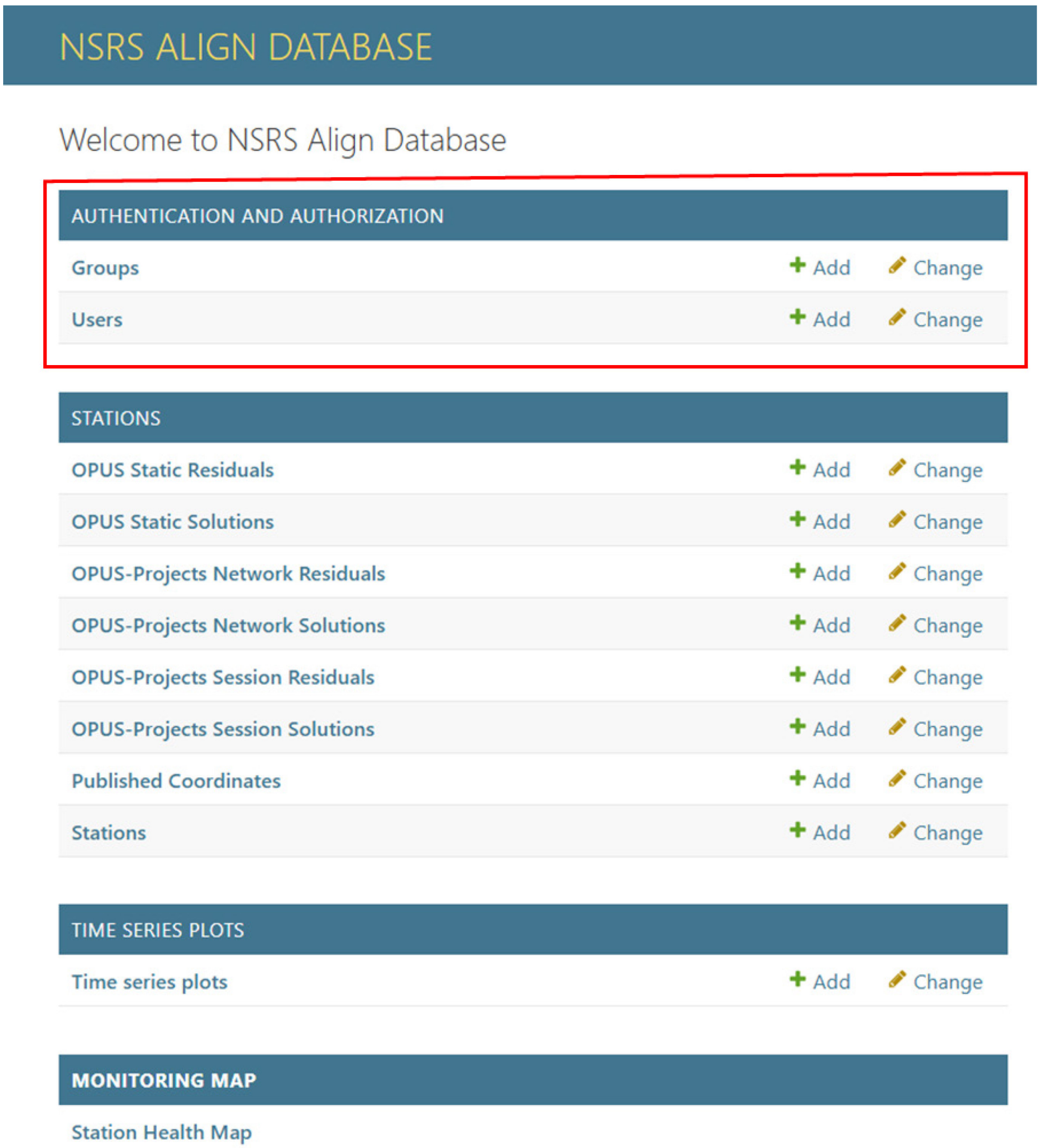
The following table summarizes the structure and purpose of each log artifact:

File Type	Format	Contents	Purpose
Processed Input Log	CSV	File paths and timestamps of successfully ingested XML files	Tracks each input that resulted in a database update
Hash Registry	JSON	SHA-256 hash values indexed by full file path	Detects changes to input content and prevents duplicate processing
Residual Computation Log	Internal (DB)	Timestamps and metadata for residuals added	Ensures residuals are timestamped and traceable
Plot Update Log	Internal (DB)	File paths and update times for generated residual plots	Confirms when each station's visual summary was last refreshed
Error Output	Stdout / Stderr	Descriptive error messages during processing	Identifies failures without interrupting the entire monitoring cycle

4.0 Administrative Interface (Django)

4.1 AUTHENTICATION AND AUTHORIZATION : ADMIN INTERFACE GUIDE

This section provides a clear and easy-to-follow guide for using the Django admin interface to manage users, groups, and permissions. These tools help control who can log into the system and what actions they are allowed to perform. No technical background is required to follow this guide—each step is explained in simple terms.

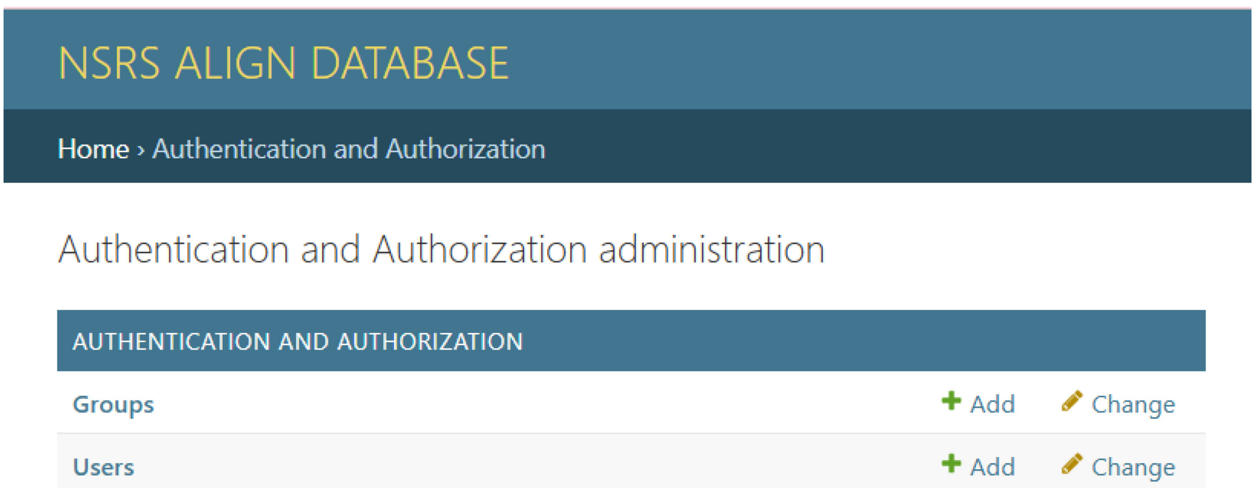


1. **Overview Of Access Control**

Django uses two main tools to manage access:

- **Users:** These are individual accounts for people who need to log in. Each user has a username and password.
- **Groups:** These are collections of users who have the same set of permissions. Groups make it easy to give many users the same type of access.

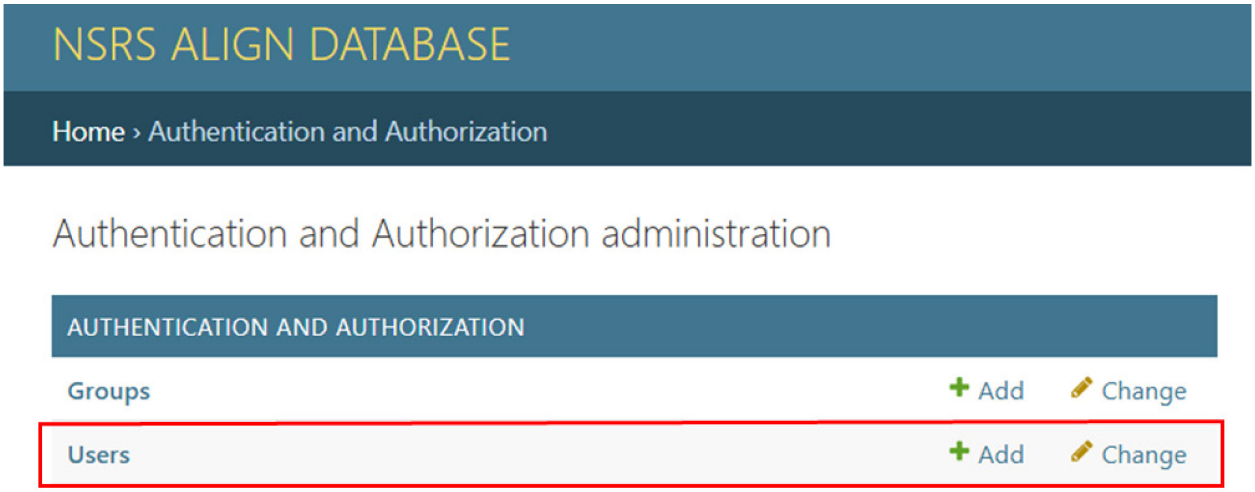
Each user or group can be assigned permissions that determine what they can see and do inside the admin system.



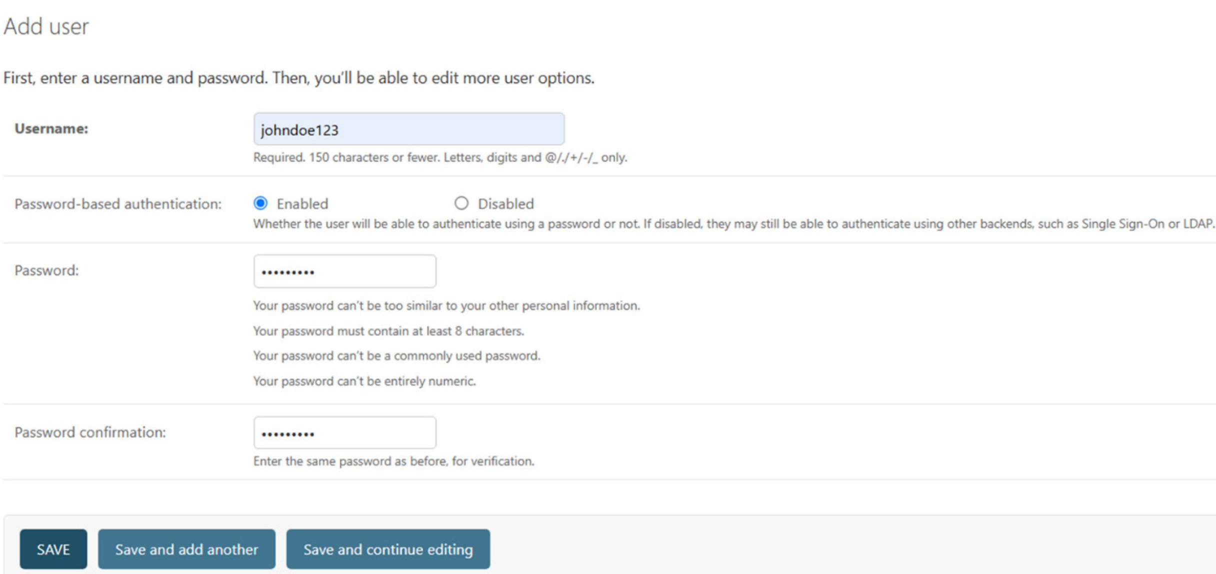
2. **<u>Managing Users</u>**

To view or add users:

1. In the admin menu, click on Users to view users.
2. To add a new user, click Add.



Step 1: Create a New User



You will first be asked to enter:

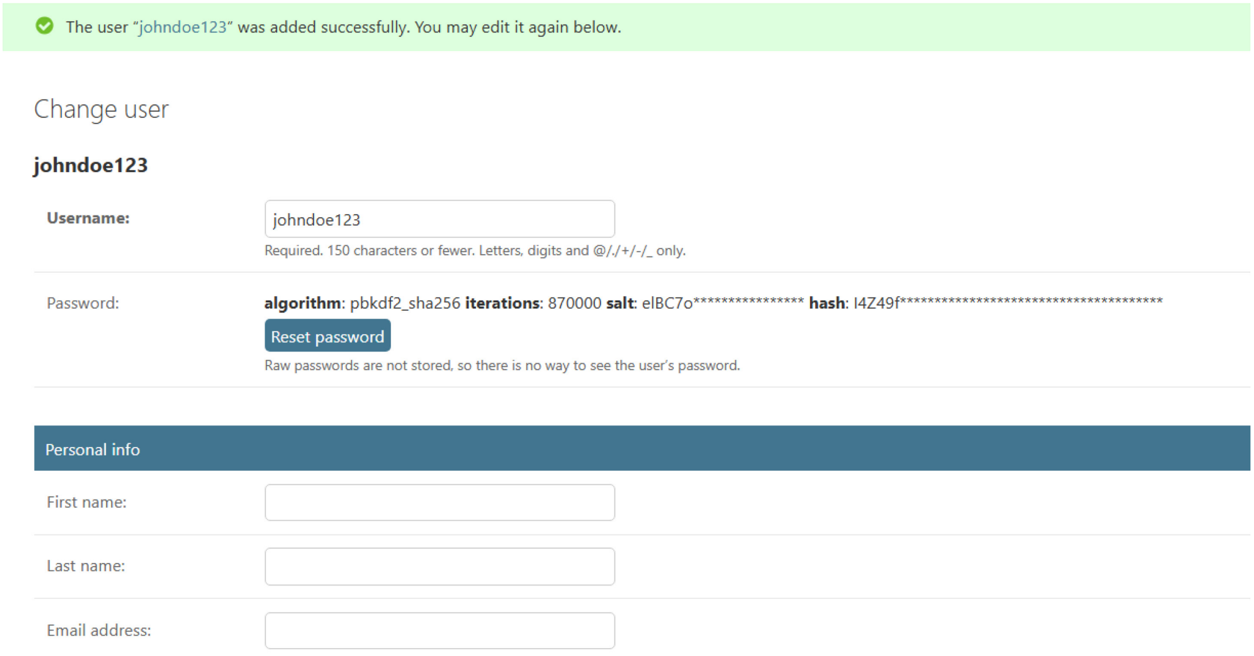
Field	What It Means
Username	A unique name the user will use to log in. Example: johndoe123. It must not be used by another account.
Password	A secret word or phrase the user must enter to log in. It must be at least 8 characters long and cannot be too simple.

Confirm Password	Type the password again to make sure it was entered correctly.
Password-based Authentication	This lets the user log in using their password. Leave this on (enabled) unless your system uses other login systems like "Single Sign-On".

After completing this page, click “Save and continue editing.”

Step 2: Fill Out User Details

You can now provide more information and set permissions.

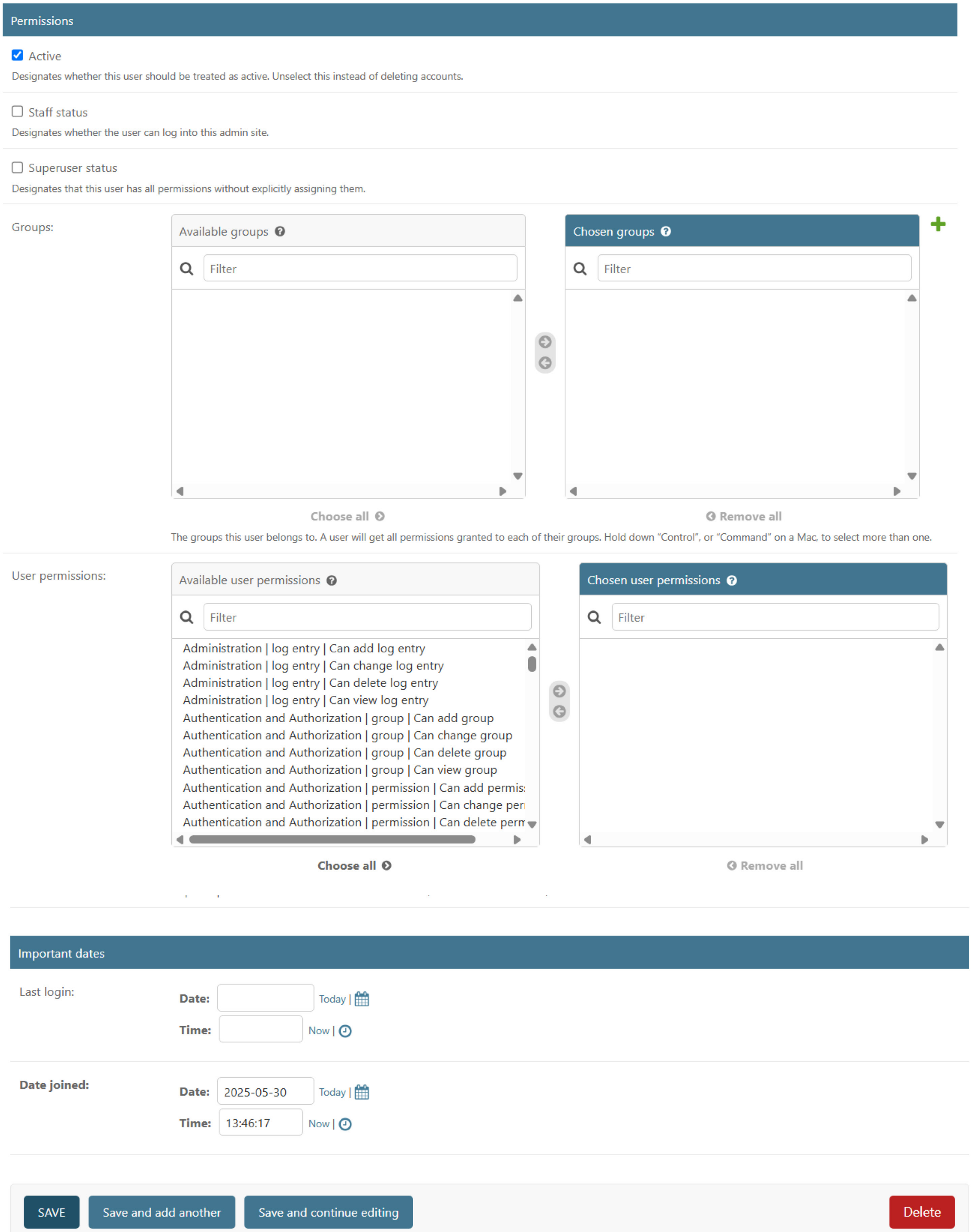


Personal Info:

You can add the user's first name, last name, and email address. These fields are optional.

Permissions:

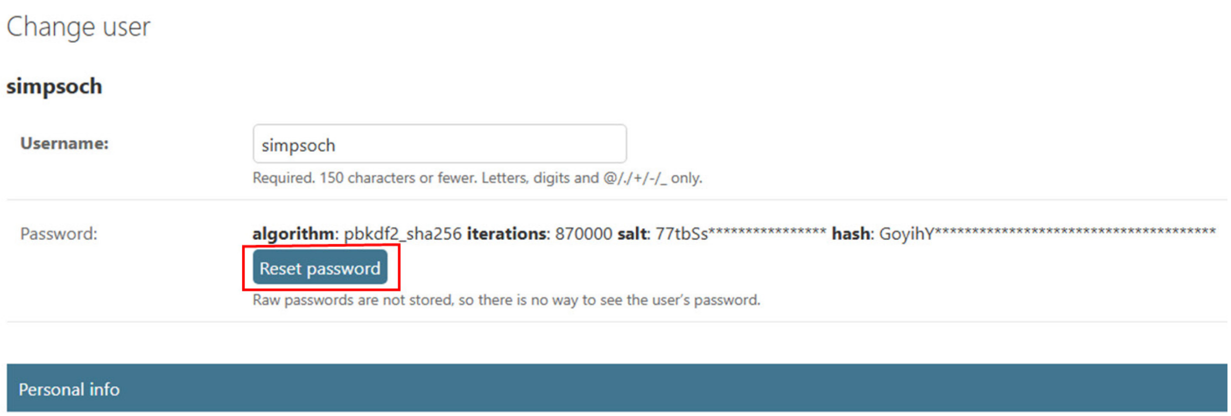
- Active: Leave this checked so the account is usable.
- Staff status: Check this if the person needs to access the admin dashboard.
- Superuser status: Only for developers or managers who should have full access to everything.
- Groups: Add the user to one or more groups if applicable (e.g., Reviewers, Editors).
- User permissions: Optional – gives this user extra permissions individually, instead of through groups.
- Important Dates : Automatically shows when the account was created and last used.

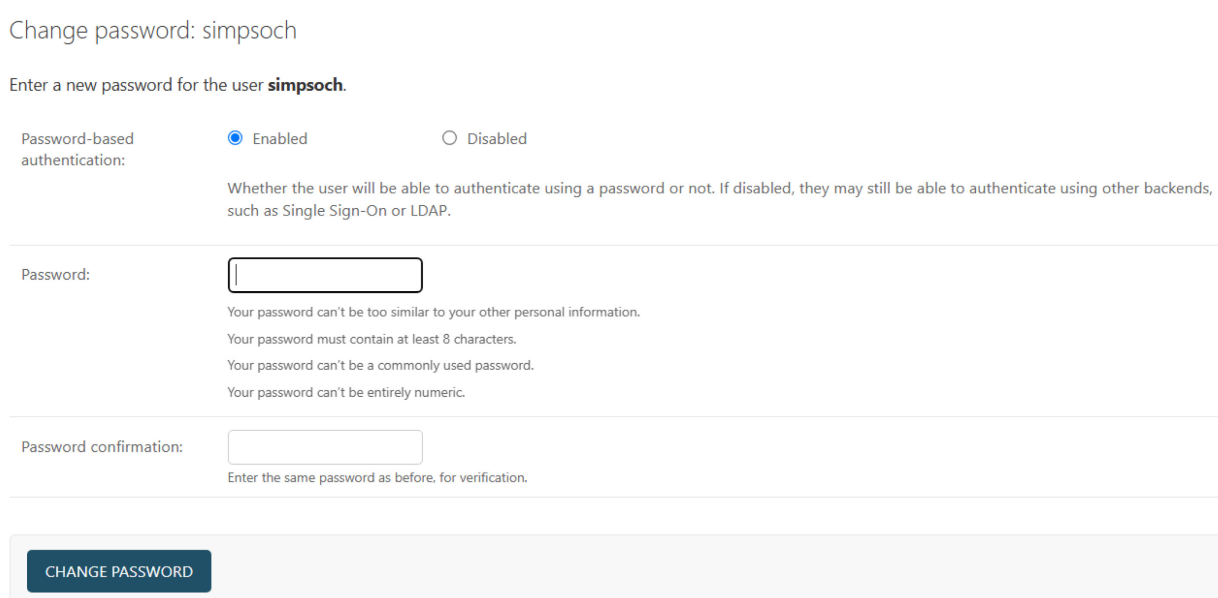

Permissions
Active
Designates whether this user should be treated as active. Unselect this instead of deleting accounts.
Staff status
Designates whether the user can log into this admin site.
Superuser status
Designates that this user has all permissions without explicitly assigning them.
Groups:
Available groups
Filter
Chosen groups
Filter
Choose all
Remove all
The groups this user belongs to. A user will get all permissions granted to each of their groups. Hold down "Control", or "Command" on a Mac, to select more than one.
User permissions:
Available user permissions
Filter
Administration | log entry | Can add log entry
Administration | log entry | Can change log entry
Administration | log entry | Can delete log entry
Administration | log entry | Can view log entry
Authentication and Authorization | group | Can add group
Authentication and Authorization | group | Can change group
Authentication and Authorization | group | Can delete group
Authentication and Authorization | group | Can view group
Authentication and Authorization | permission | Can add permis
Authentication and Authorization | permission | Can change per
Authentication and Authorization | permission | Can delete perm
Chosen user permissions
Filter
Choose all
Remove all
Important dates
Last login:
Date:
Today |
Time:
Now |
Date joined:
Date:
2025-05-30
Today |
Time:
13:46:17
Now |
SAVE
Save and add another
Save and continue editing
Delete

Changing a Password Later

To reset a user's password:

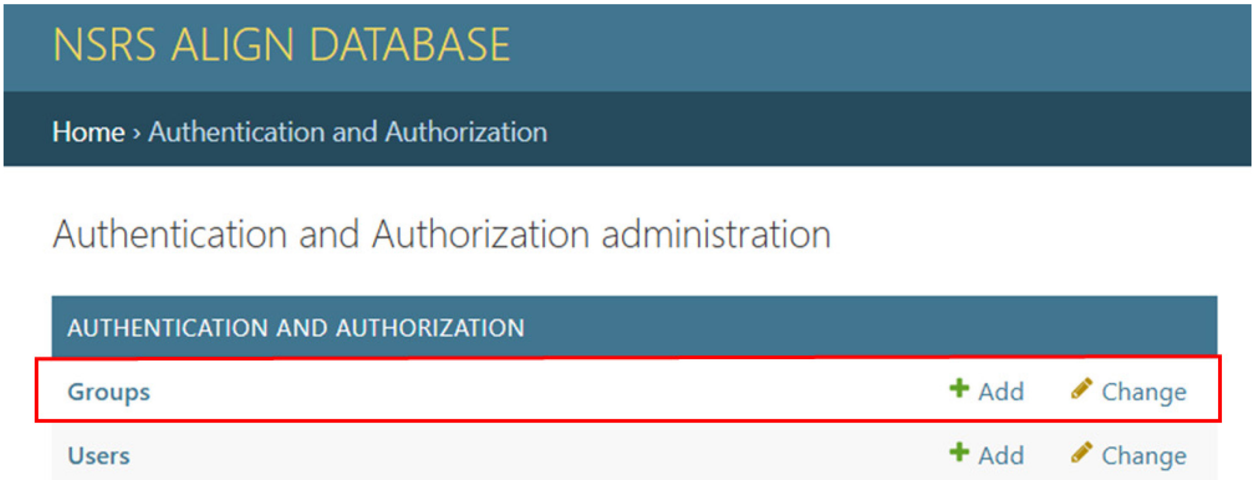
- Open their account from the Users list.
- Click Reset password.
- Enter the new password twice and "CHANGE PASSWORD".





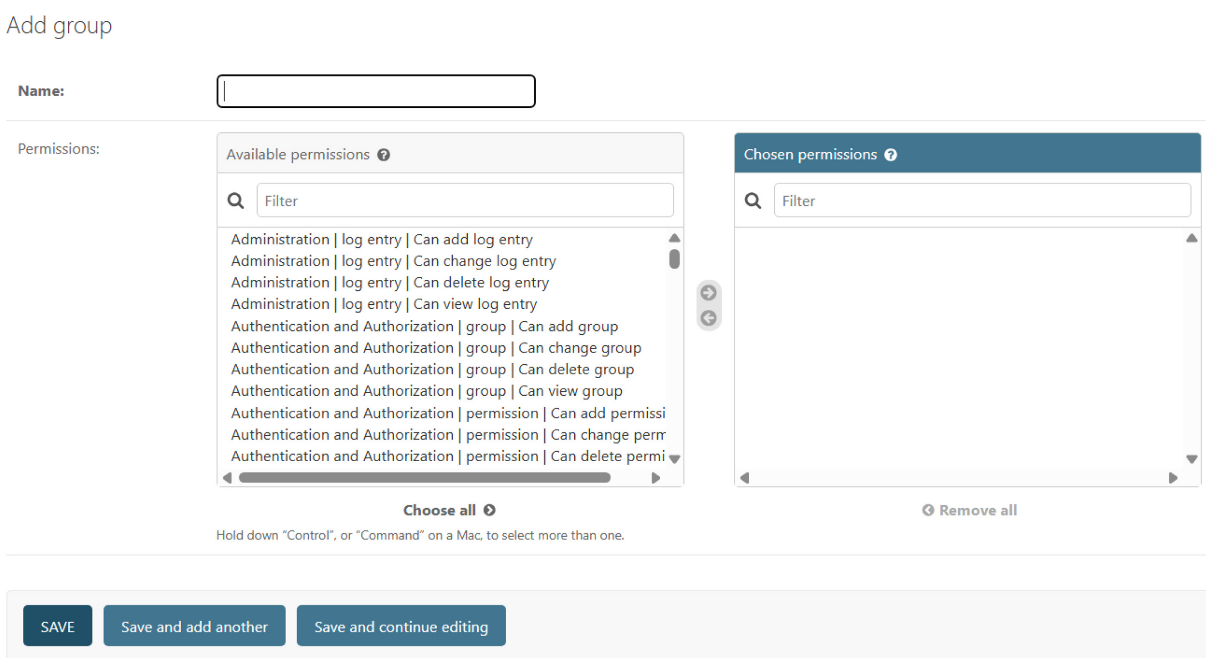
3. Managing Groups

Groups are helpful when multiple users should have the same type of access.



How to Create a Group

1. In the admin menu, click on Groups.
2. Click Add group.
3. Enter a name for the group (e.g., "Data Editors").
4. Assign permissions from the list. These control what the group can do.
5. Click Save.



Understanding the Permission Format

Permissions are shown as:

```
App | Model | Can <Action> <Model>
```

Example: Stations | station | Can view station

This means users in the group can view station data.

Sample Group Permissions Table

App Area	Model	Typical Group Actions
Authentication	User, Group	Add, Change, View
Stations	Station, Solutions	View or Edit station data
Time Series Plots	Time series plot	View charts, add plots
Residuals (various)	Opus, Session, Network	View only (for reviewers)

4. **Best Practices**

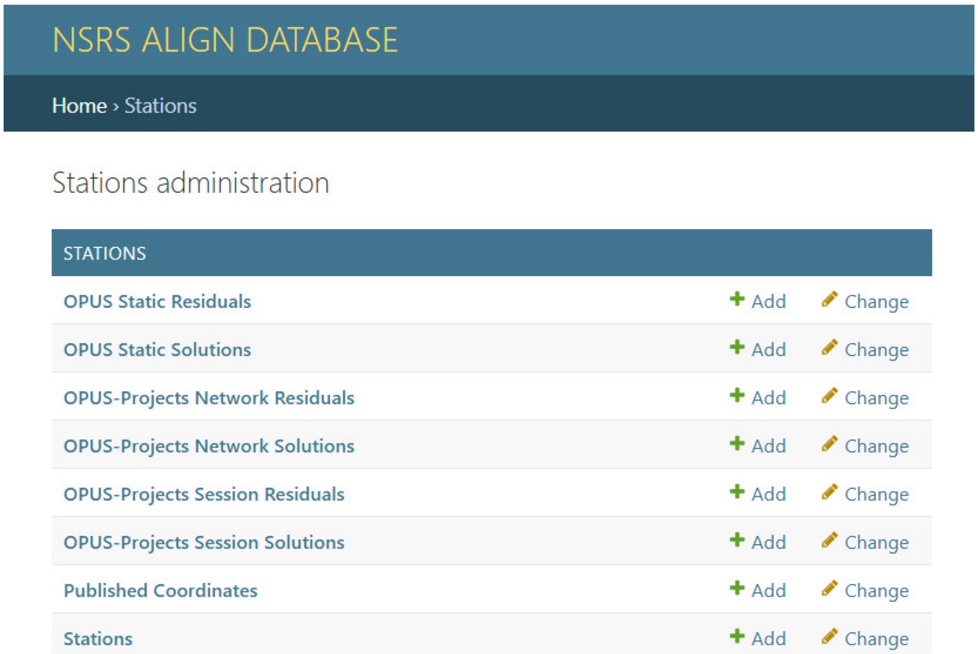
- Use Groups instead of setting permissions for each user.
- Only check Staff status for users who need admin access.
- Give Superuser rights only to highly trusted staff.
- Review user accounts regularly. Remove old or unused users.
- Start with View only access when unsure.
- Use clear and meaningful names for groups.

5. **Troubleshooting Login or Access Issues**

Problem	**Cause**	**Solution**
Can’t log into admin	Staff status not enabled	Edit user and check "Staff status"
Can’t see data in admin	No view permissions assigned	Add the right "view" permissions
User can see too much	They are marked as a superuser	Remove superuser status
Permissions aren’t working	Group was not saved properly	Reopen group and reassign permissions
Shared accounts between people	Poor practice	Give each person their own account

4.2 STATIONS : ADMIN INTERFACE GUIDE

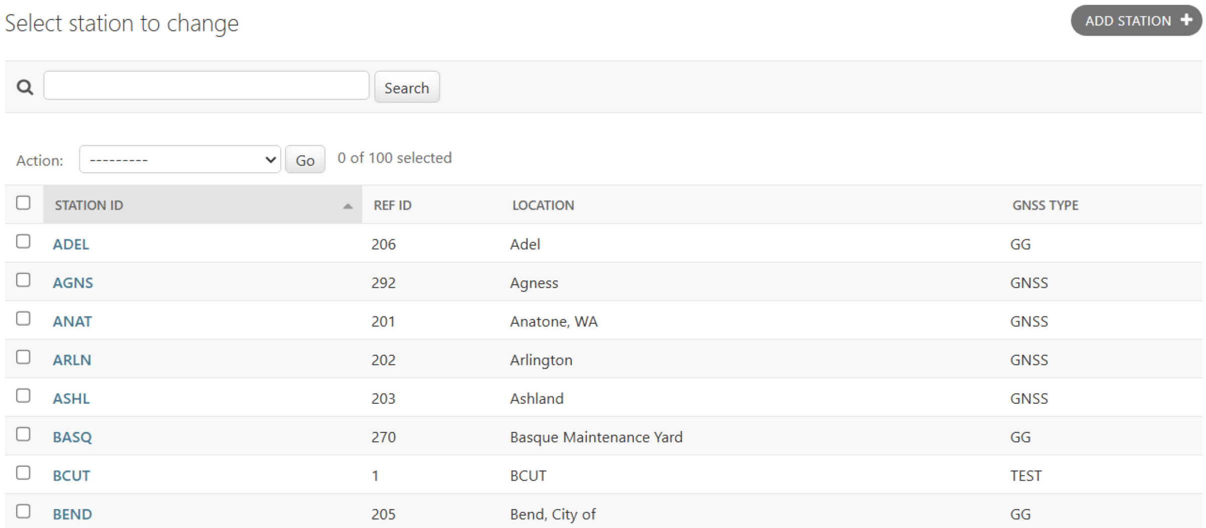
The Stations app provides tools to manage GNSS station records and their associated coordinate data. Through the Django admin interface, users can easily view, add, edit, or remove station records, along with related information such as published coordinates and GNSS-derived solutions. This guide explains the key features available in the admin interface.



1. **Managing Station Records**

View Stations

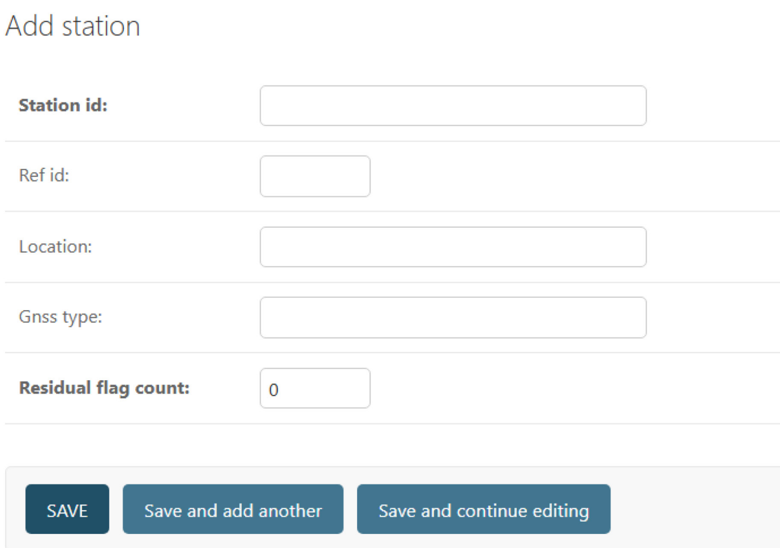
- From the Django admin dashboard, click “Stations”.
- You’ll see a list of all known stations, showing their Station ID, location, GNSS type.



STATION ID	REF ID	LOCATION	GNSS TYPE
ADEL	206	Adel	GG
AGNS	292	Agness	GNSS
ANAT	201	Anatone, WA	GNSS
ARLN	202	Arlington	GNSS
ASHL	203	Ashland	GNSS
BASQ	270	Basque Maintenance Yard	GG
BCUT	1	BCUT	TEST
BEND	205	Bend, City of	GG

Add a New Station

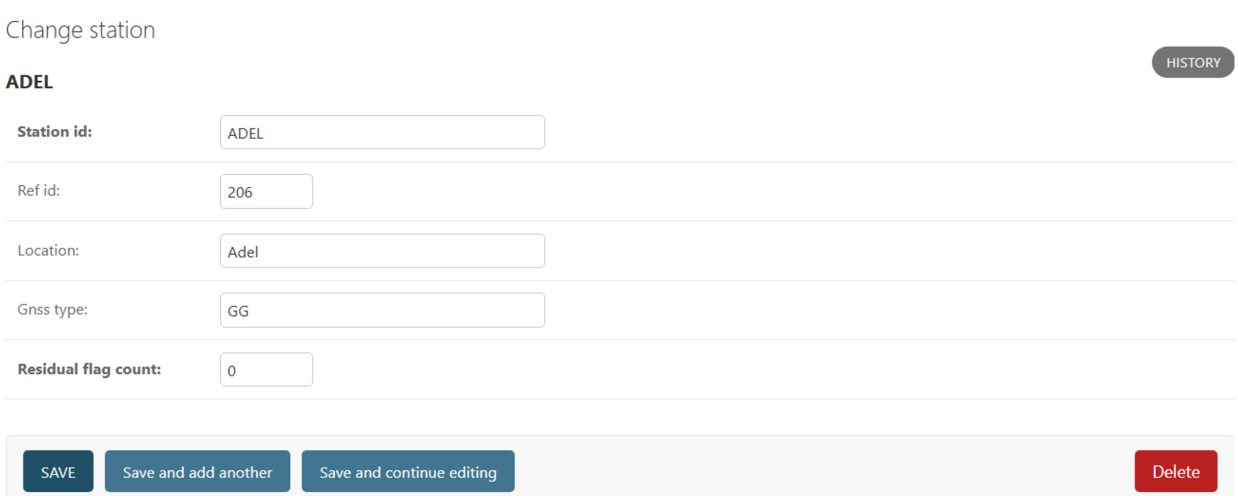
1. Click “Add station”
2. Enter the Station ID (this must be unique).
3. Optionally enter:
4. Reference ID – used for internal linking.
5. Location – general name or description.
6. GNSS type – equipment used.
7. Leave Residual flag count as is “0”.
8. Click Save.



Edit or Delete a Station

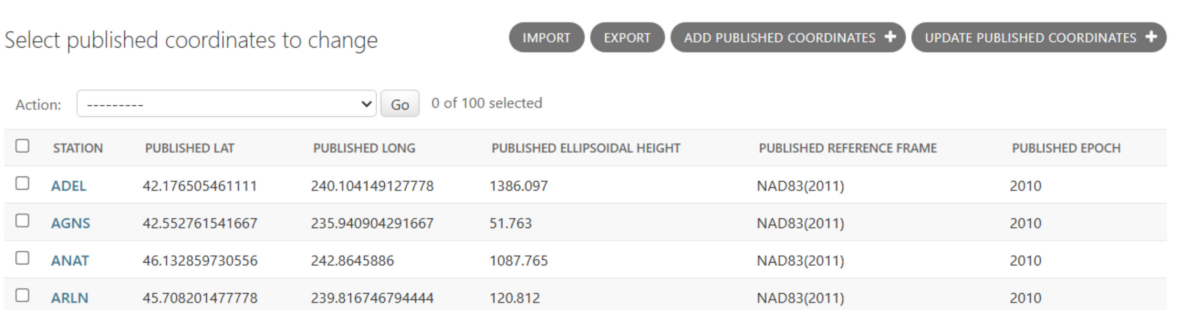
1. Click on a station's name to open and update its fields.
2. To remove it completely, use the Delete button at the top right of the station's detail page.

⚠️ Deleting a station also removes any related coordinate or residual records.



2. **Managing Published Coordinates**

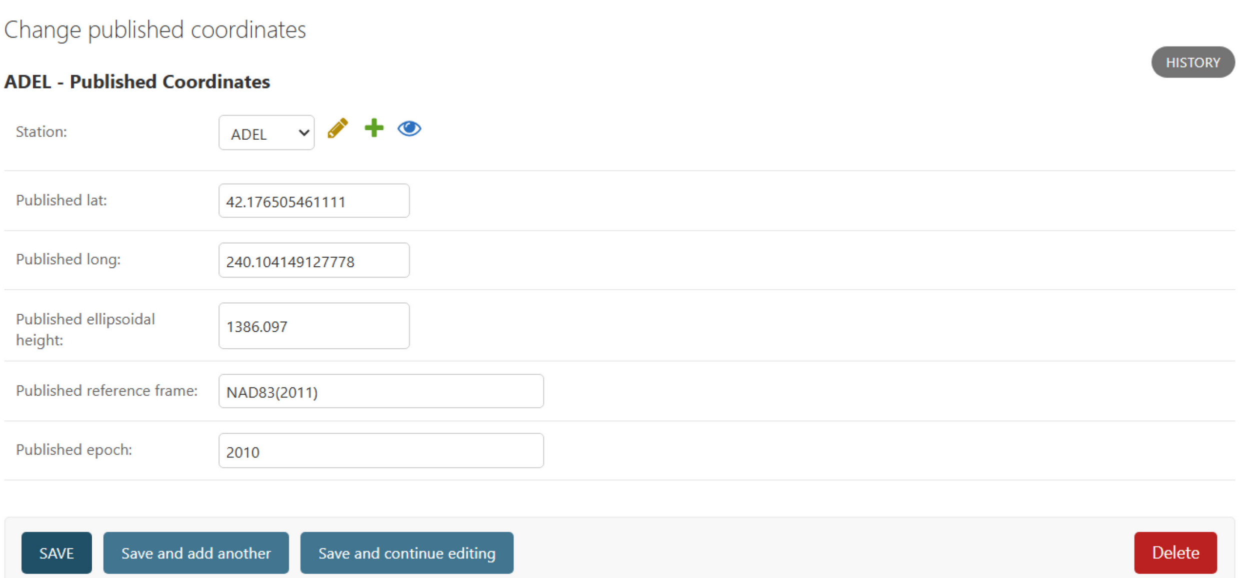
Each station has one set of Published Coordinates, which define its official position within the network. These coordinates are the authoritative reference used to evaluate station stability and configure real-time corrections. Maintained by the network operator, they are expressed in a stable reference frame aligned with the National Spatial Reference System and are considered fixed unless updated due to confirmed long-term positional shifts.

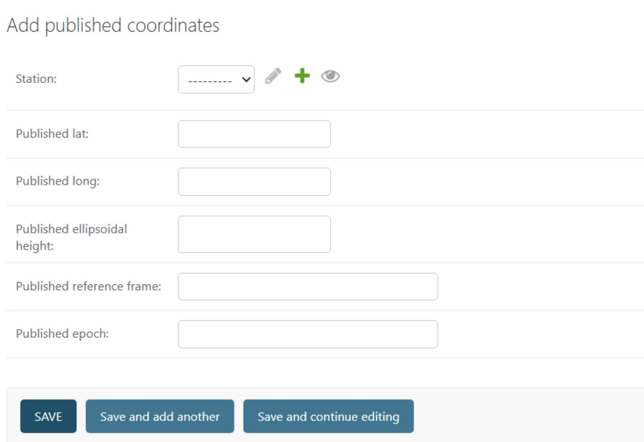


STATION	PUBLISHED LAT	PUBLISHED LONG	PUBLISHED ELLIPSOIDAL HEIGHT	PUBLISHED REFERENCE FRAME	PUBLISHED EPOCH
ADEL	42.176505461111	240.104149127778	1386.097	NAD83(2011)	2010
AGNS	42.552761541667	235.940904291667	51.763	NAD83(2011)	2010
ANAT	46.132859730556	242.8645886	1087.765	NAD83(2011)	2010
ARLN	45.708201477778	239.816746794444	120.812	NAD83(2011)	2010

View or Update Coordinates

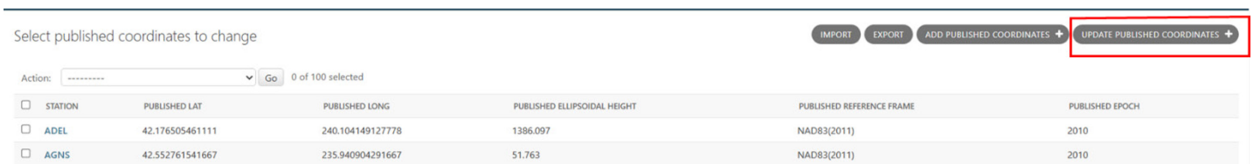
- In the admin menu, go to Published Coordinates.
- Click on a row to view or update coordinate values (latitude, longitude, ellipsoid height, reference frame, and epoch).
- You can also use the Add Published Coordinate button to manually add a new set of coordinates for a station if it does not already exist. This is useful for adding new stations individually outside of the bulk update process.





Importing Updated Coordinates in Bulk

To keep the database up to date, you can replace all published coordinates at once using a spreadsheet.



Important Notes:

- This method overwrites all existing published coordinates.
- The input spreadsheet must include exactly the same stations as currently stored in the database.
- If any station is missing, the update will fail.
- If extra stations are present, the update will also fail.
- The process is designed to prevent accidental changes. It checks for mismatches before making updates.

Why use this method?

This is the recommended approach for updating official published coordinates , especially after a full network adjustment. Typically, coordinate updates come from adjusted results (network solutions) that were computed using a least squares adjustment process in

OPUS Projects. This ensures that all stations are aligned consistently and accurately within the National Spatial Reference System.

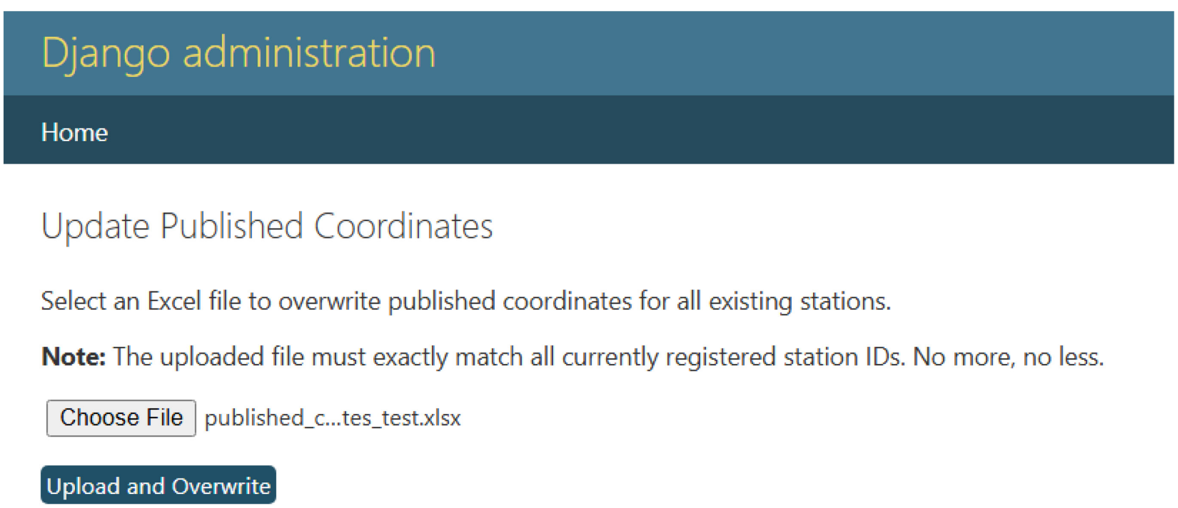
What the system does:

- Compares station lists from the input file and database.
- If they match exactly, it updates all coordinates.
- Before changes are applied, a full backup of the old coordinates is saved.
- A log file is generated, recording each change (old values, new values, and timestamps).

This process ensures accuracy and traceability for official coordinate updates.

How to Use the Bulk Update Tool

- Navigate to the Update Published Coordinates page.
- Click Choose File to select your Excel file.
    - The file must contain exactly the same station IDs as are currently registered in the database. No more, no less.
- Click Upload and Overwrite.



- A preview page will appear (Step 2: Map Columns), showing a sample of your data.

- Match each required system field to the appropriate column from your file:
  - Station
  - Published Latitude
  - Published Longitude
  - Published Ellipsoidal Height
  - Reference Frame
  - Epoch
- Once matched, click Confirm and Overwrite to apply the updates.
- If the update is successful:
  - All coordinates will be updated.
  - A full backup and log of changes will be saved.
- If the station IDs do not match exactly:
  - You will see an error message.
  - The update will be cancelled automatically to prevent partial changes.

Django administration

Home

Step 2: Map Columns

File Preview:

STATION ID	LOCATION	LATITUDE	LONGITUDE	ELLIPSOID HEIGHT	REFERENCE FRAME	EPOCH	UNNAMED: 7	REF ID	GNSS
adel	Adel	42.176509	119.895869	1385.621	NAD83(2011)	2010	NaN	206	GG
arln	Arlington	45.708205	120.183272	120.393	NAD83(2011)	2010	NaN	202	GNSS
basq	Basque Maintenance Yard	42.411604	117.863032	1348.608	NAD83(2011)	2010	NaN	270	GG
bend	Bend, City of	44.057158	121.315189	1095.837	NAD83(2011)	2010	NaN	205	GPS
bly1	Bly	42.406844	121.049067	1313.419	NAD83(2011)	2010	NaN	204	GG

Match each required field to your file's column:

Required Field	Your File's Columns
Station	Station ID
Published lat	Latitude
Published long	Longitude
Published ellipsoidal height	Ellipsoid Height
Published reference frame	Reference Frame
Published epoch	Epoch

Confirm and Overwrite

3. Managing Coordinate Solutions

Users can view and review GNSS-derived coordinate solutions that have been automatically calculated and stored in the system.

These include:

- OPUS Static Solutions
- Session Solutions (OPUS-Projects)
- Network Solutions (Combined Session Results)

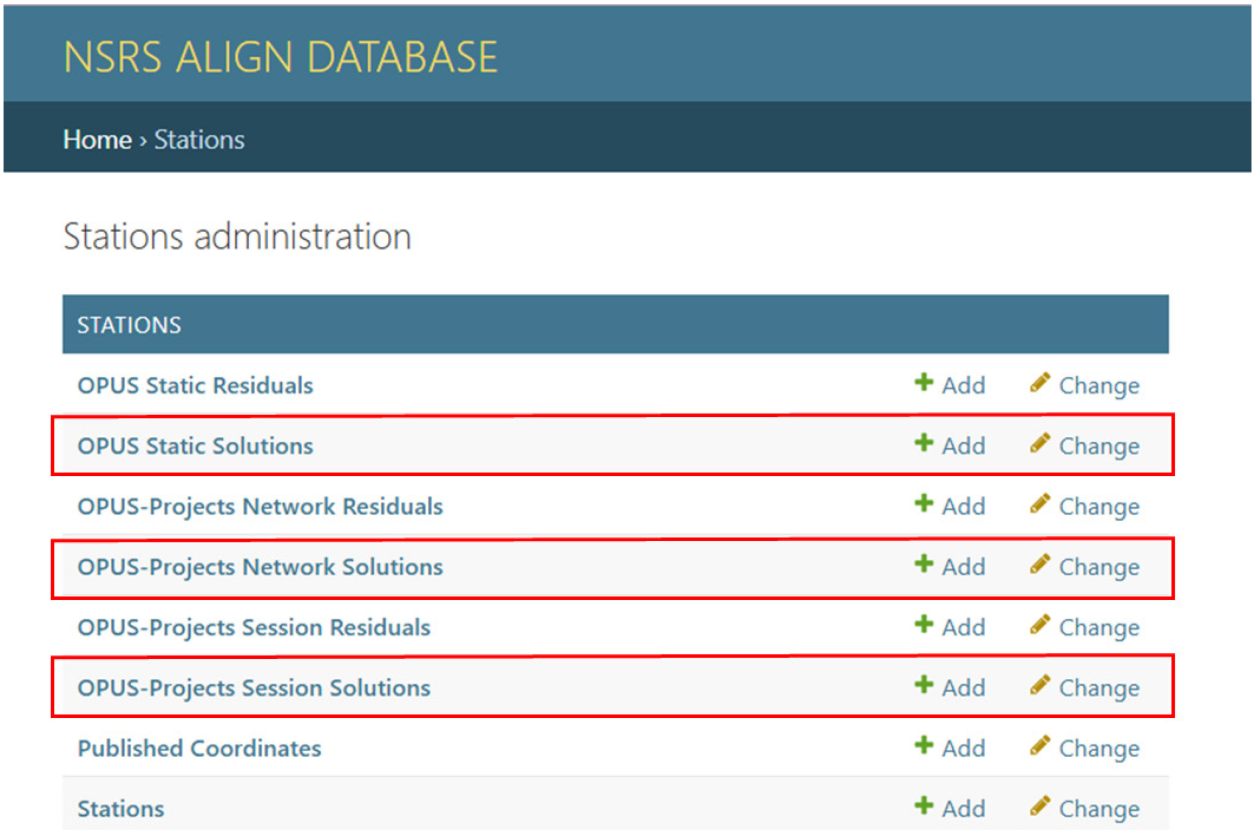
Each solution:

- Is linked to a specific station
- Contains the coordinates computed for a specific day (or date range)
- May include uncertainty and peak-to-peak error fields

These records are typically generated by automated scripts and not entered manually.

You can view them in the following sections:

- OPUS Static Solutions
- OPUS-Projects Session Solutions
- OPUS-Projects Network Solutions



4. Reviewing Residuals

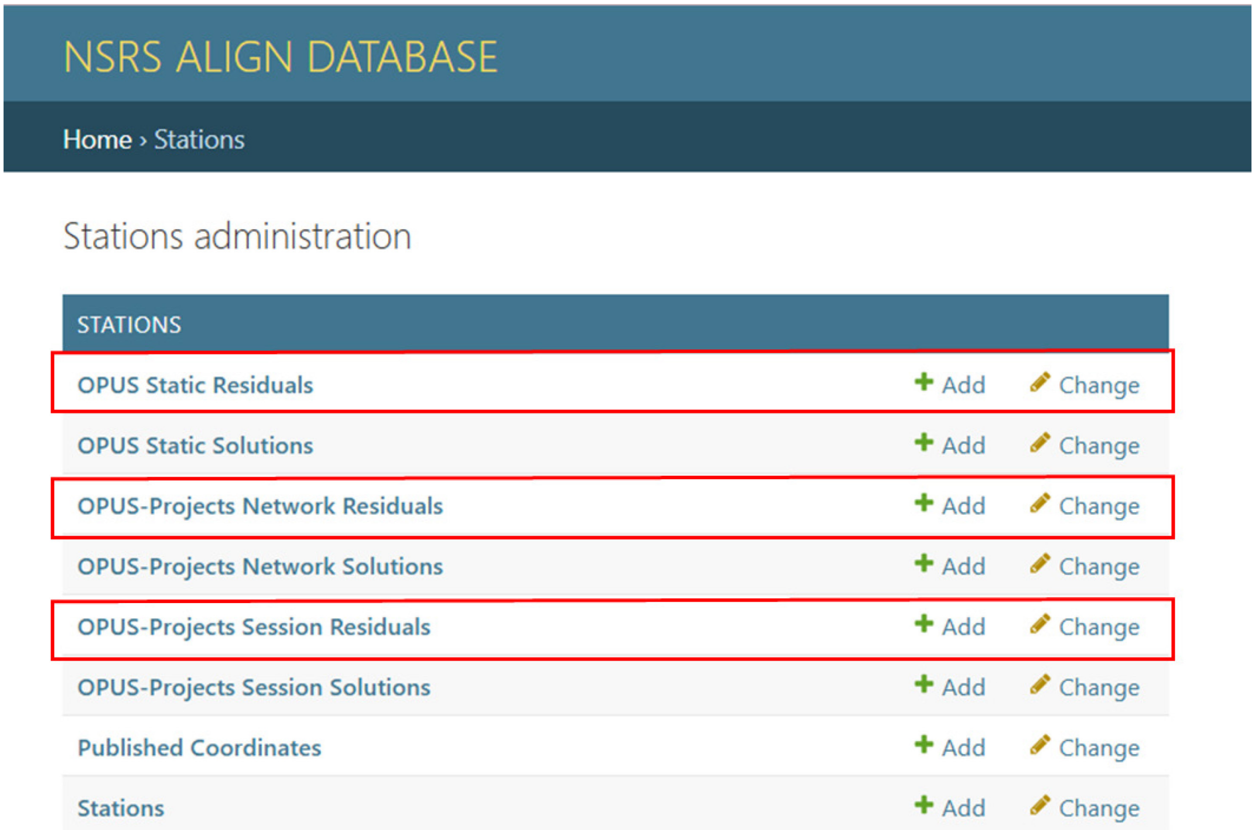
Residuals show how much each computed solution differs from the published coordinates. They are stored separately for each solution type:

- OPUS Static Residuals
- Session Residuals
- Network Residuals

Each includes:

- East, North, Up residuals (in meters)
- Reference frame and epoch used
- Ephemeris type (precise or broadcast)
- Published Coordinates used for computation
- Time of computation

These are read-only for review. You don't need to edit or create residuals manually.



Common Actions

The following actions are available across all sections of the Stations app, including Station records, Published Coordinates, Coordinate Solutions, and Residuals:

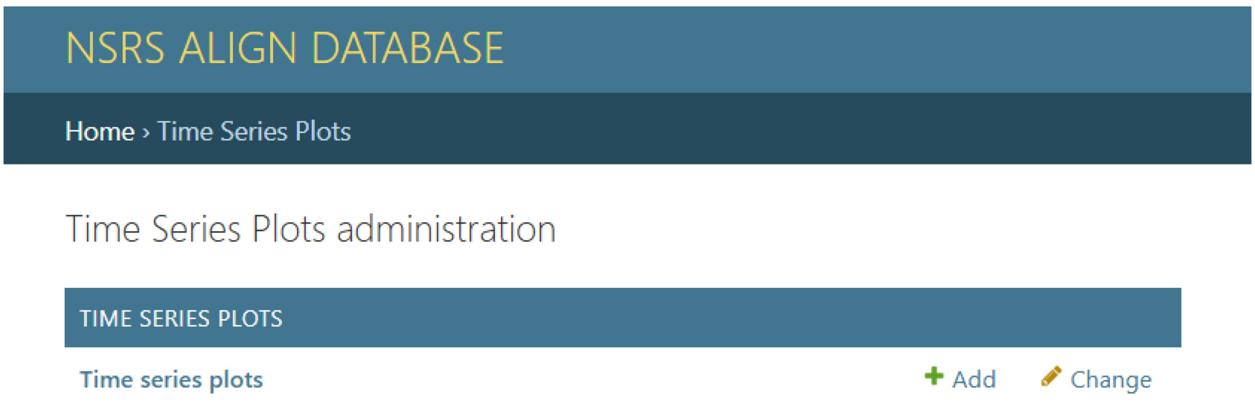
Action	Description
Add	Create a new record, such as a new station or a published coordinate.
Edit	Click a row to open and update the record's details.
Delete	Remove a record permanently. Use with caution, especially when deleting stations, as related records will also be removed.

Search	Use the search bar at the top to locate records by station ID or related fields.
Filter	Narrow down results using filters (e.g., by year, ephemeris type, reference frame).
Import	Upload new or updated records across all model types using built-in admin import tools. This includes support for spreadsheet-based imports across solutions, residuals, and coordinates.
Export	Export any data table to a structured file format for backup, audit, or external processing. All models support exporting directly from the admin interface.

4.3 TIME SERIES PLOTS : ADMIN INTERFACE GUIDE

The Time Series Plots app provides an interactive interface to visualize station coordinate residuals over time. These residuals represent the differences between computed GNSS solutions and the station's published coordinates, plotted in East, North, and Up components.

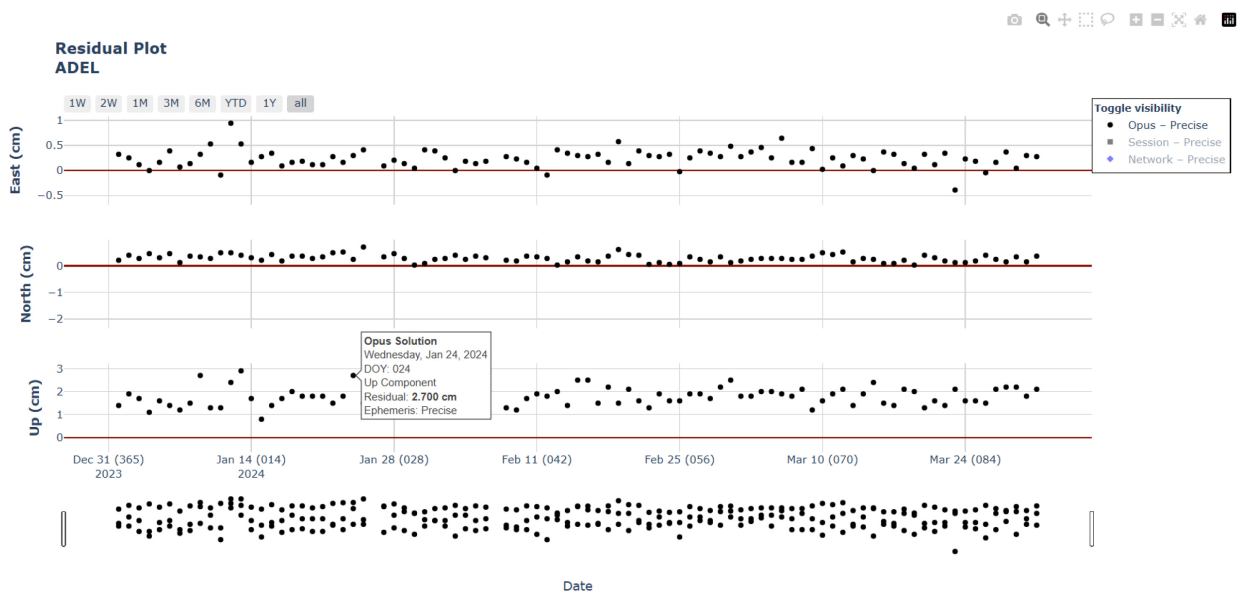
The plots help monitor the alignment of stations with the National Spatial Reference System (NSRS) and are automatically generated (no manual data entry is required).



1. Key Features

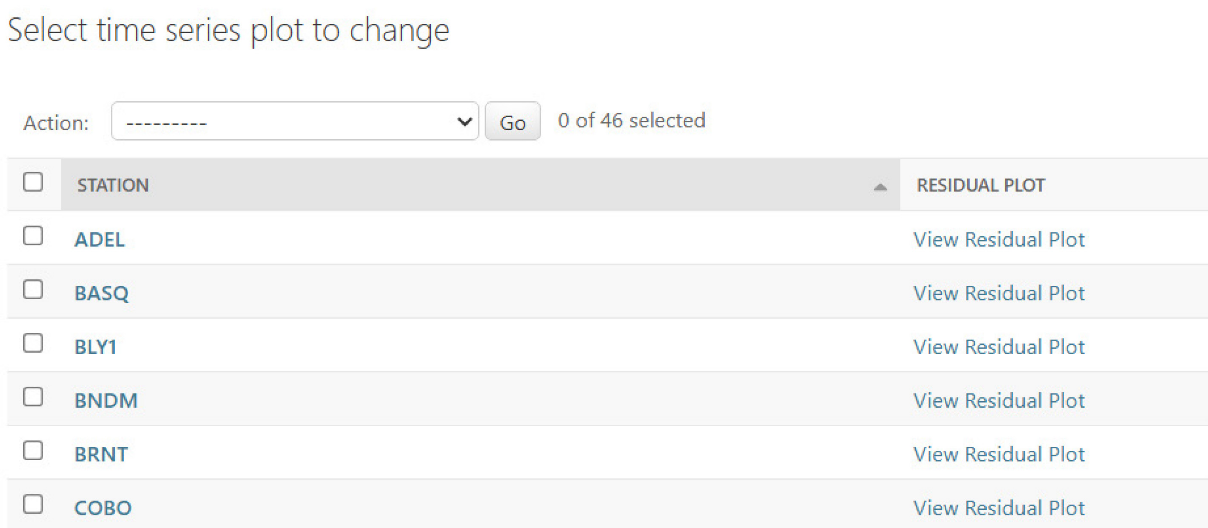
- Interactive Plot Viewer: Residuals are displayed in an interactive time series chart.
- Component Panels: Separate vertical panels for East, North, and Up components (in centimeters).
- Solution Types:
    - By default, only OPUS Static residuals are shown.
    - You can toggle Session and Network solutions using the legend.
- Threshold Visualization:
    - Residuals are shown in red if they exceed:
        - 2 cm in East or North
        - 4 cm in Up
    - All other residuals are shown in black (or blue for network solutions).

- Hover Information: Detailed tooltips appear when hovering over any point, showing:
  - Solution type
  - Ephemeris type
  - Component (East, North, Up)
  - Residual value (in cm)
  - Date and Day-of-Year (DOY) range (for Network)



2. How to Use the Plot Viewer

- Open the Time Series Plots page for any station.
- Review the OPUS Static residuals (loaded by default).
- Use the legend to enable or disable other solution types (Session, Network).
- Use the date range slider beneath the plot to zoom in on a specific time period.
- Hover over points for detailed values and metadata.

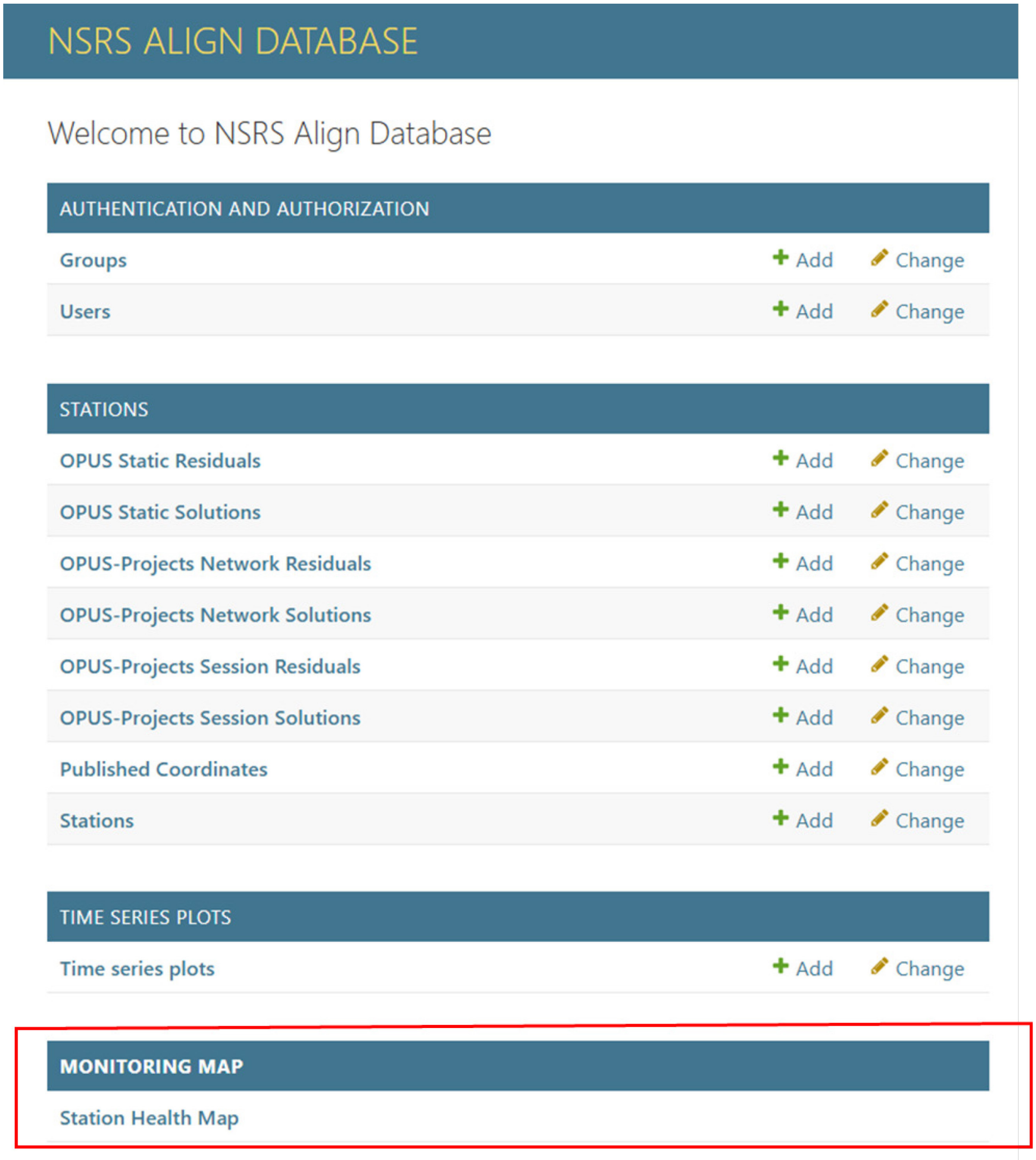


3. Notes on Data Generation

- Plots are generated automatically by the system using a scheduled script.
- Residuals are computed from:
  - OPUS Static Solutions
  - Session Solutions
  - Network Solutions
- No manual input is required from users.

4.4 MONITORING MAP: ADMIN INTERFACE GUIDE

The Monitoring Map module provides a network-wide health overview of every GNSS station.



Two independent map layers are available:

Layer	Residual Source	Temporal Basis
Daily Health Map	OPUS Static residuals	Individual days
Weekly Health Map	Fully-constrained network residuals	Aggregated weeks

Both layers use identical thresholds and color logic; the only difference is the counting period.

Color	Exceedance Count [1]	Pop-up Fields
Green	0	• Station ID • Days / Weeks above threshold • Latitude & Longitude
Yellow	1	• Station ID • Days / Weeks above threshold • Latitude & Longitude
Orange	2 -4	• Station ID • Days / Weeks above threshold • Latitude & Longitude
Red	≥ 5	• Station ID • Days / Weeks above threshold • Latitude & Longitude

[1] "Exceedance" means at least one residual component exceeded the threshold.

Threshold Definitions

A residual is flagged if:

- East or North component exceeds 2 cm.
- Up component exceeds 4 cm.

The system ensures that only residuals associated with the current Published Coordinates are considered.

Processing Logic (Summary of Back-end Scripts)

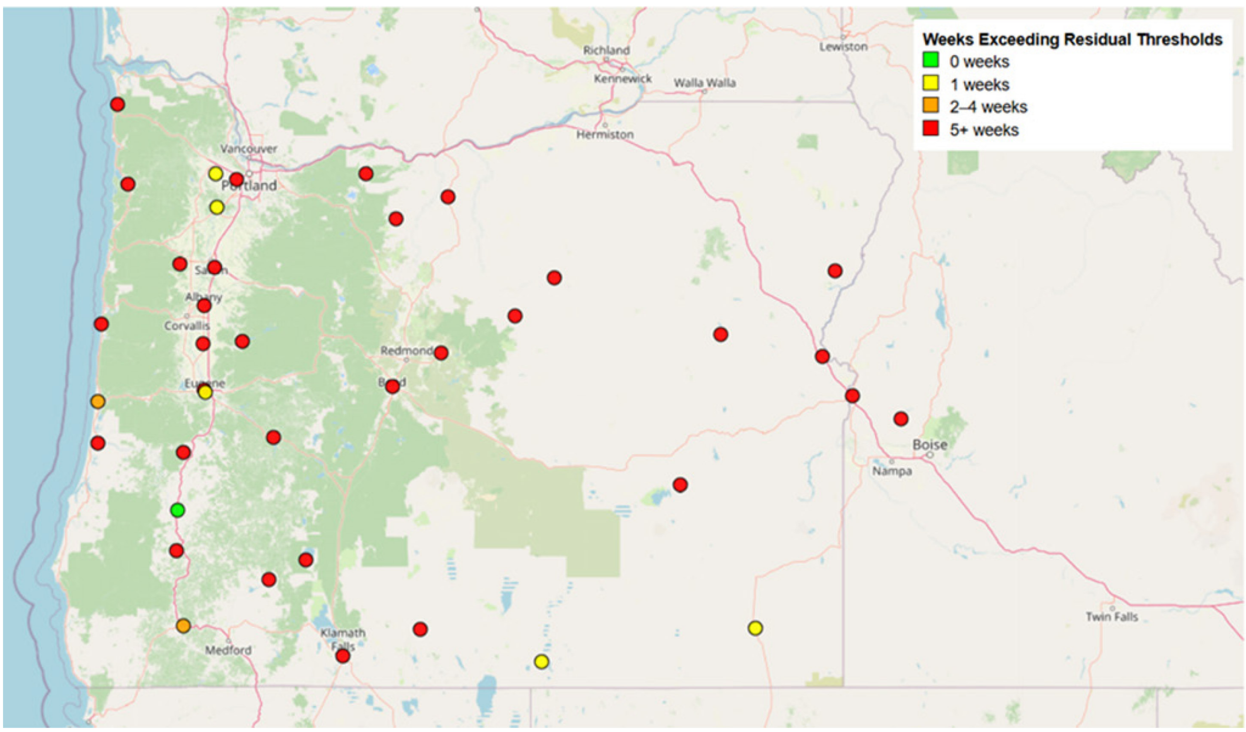
- Exact-match filter : residuals tied to superseded coordinates are discarded.
- Ephemeris preference : if both broadcast and precise solutions exist for the same epoch, the precise result is kept.
- Flagging : Boolean flag set when thresholds are exceeded.
- Rolling count :
    - Daily layer: totals flagged days (residual_flag_count).
    - Weekly layer: totals flagged weeks (network_residual_flag_count).
- Severity class : count mapped to a color index (0 – 3).

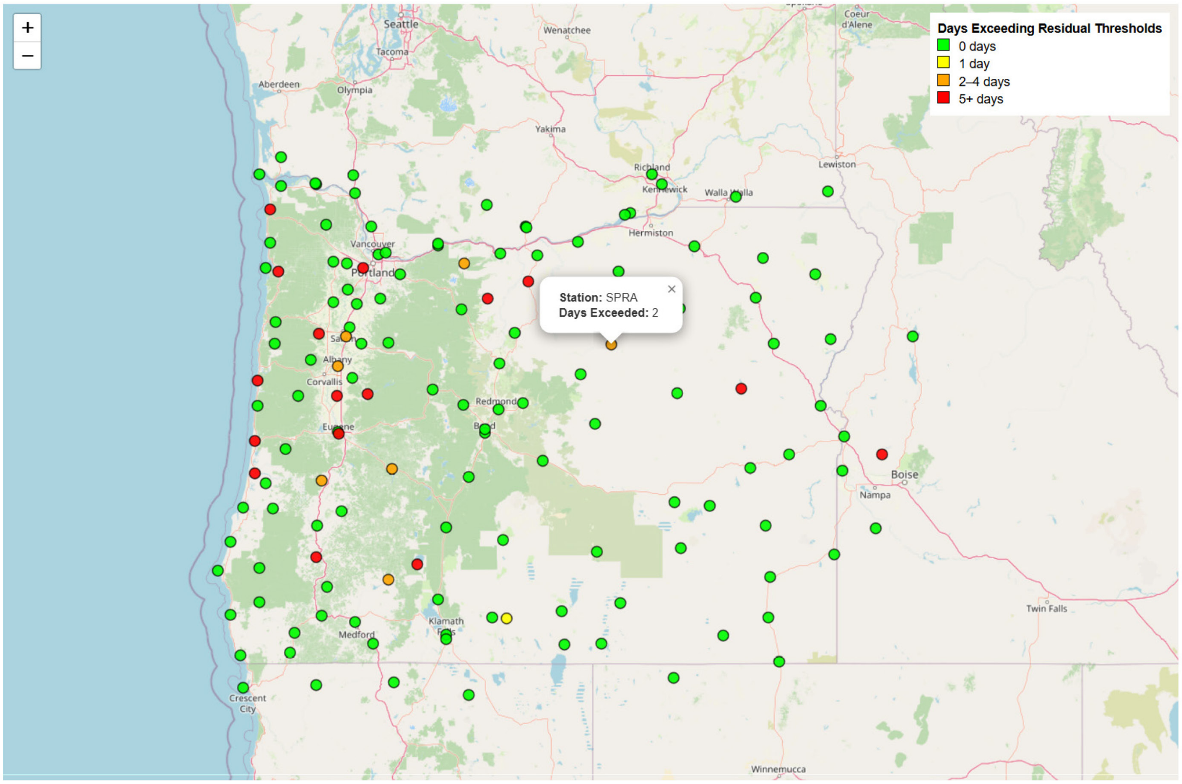
- GeoJSON feed : the station_residual_map_geojson view supplies the data; the front-end Leaflet page switches between "opus" (daily) and "network" (weekly).

Whenever a station's Published Coordinates change, all historic residuals linked to the previous reference are excluded automatically; exceedance counts are recomputed from zero.

Operating the Monitoring Map

- In the admin dashboard open Map Tools → Station Health Map.
- Use the Residual Type dropdown to toggle between Weekly and Daily layers.
- Review marker colors for an at-a-glance network status; hover or click for detailed counts.
- Prioritize investigation of stations shown in orange or red.
- Launch the Time-Series Plots tool from the station detail page for a full historical view.





Days Exceeding Residual Thresholds
0 days
1 day
2–4 days
5+ days
Station: SPRA
Days Exceeded: 2
Seattle
Tacoma
Wenatchee
Aberdeen
Olympia
Yakima
Richland
Kennewick
Walla Walla
Hermiston
Lewiston
Vancouver
Portland
Salem
Albany
Corvallis
Eugene
Redmond
Bend
Boise
Nampa
Medford
Klamath Falls
Twin Falls
Crescent City
Winnemucca