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# User Manual

Sky Display

SinoATC



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# 1 Introduction

## 1.1 Overview

Sky Display is a desktop air traffic surveillance display terminal.

Sky Display receives surveillance data in Eurocontrol ASTERIX format and Mode-S/ADS-B DF format, decode and display tracks in a standard air traffic control geographical display.

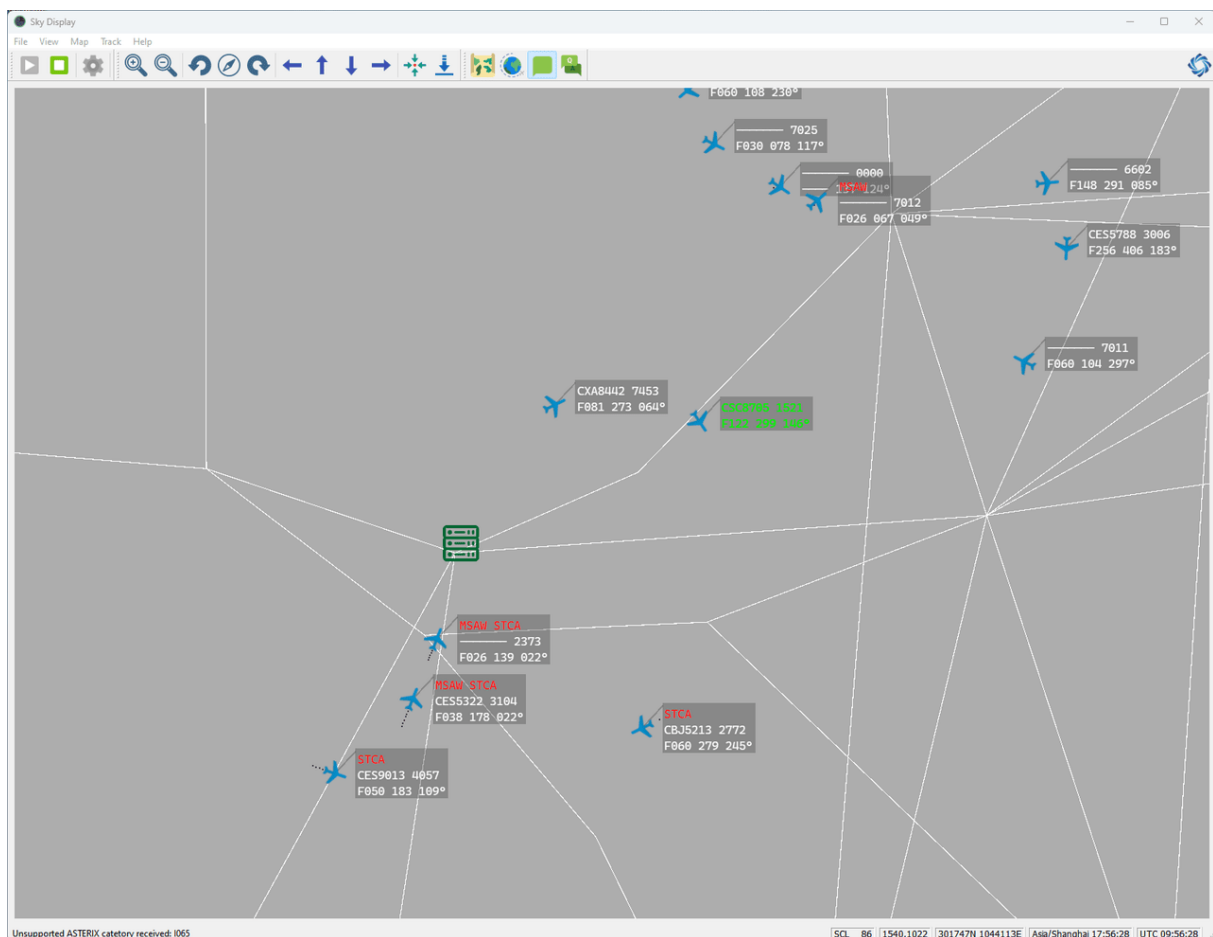


Figure 1.1: Main Window

Sky Display supports variant types of surveillance sensors and processing systems, including

- Primary radar
- Secondary radar
- Mode-S radar
- SMR (surface movement radar)
- ADS-B
- MLAT
- SDPS

Sky Display can also alerts of tracks when SafetyNet data is available.

Sky Display supports different types of maps, including

- Global aerial and road background maps, through Internet map service provider
- XML based vector maps, in open format and can be created by users

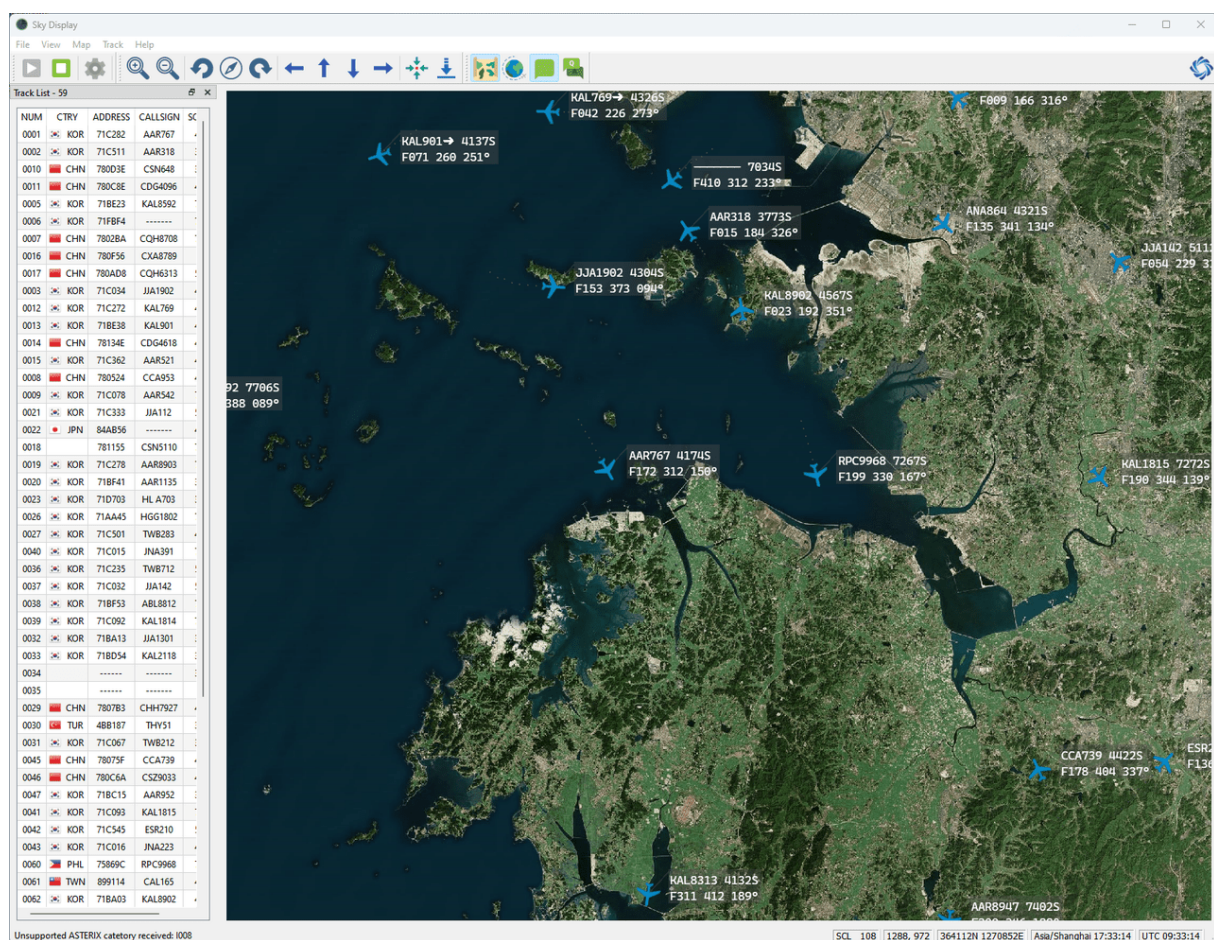


**Figure 1.2:** Aerial Background

## 2 User Interface

### 2.1 Overview

Sky Display has a modern and easy to use user interface. The main window composes of main menu, tool bars, status bar, air & ground traffic situation display (TSD) and flight lists. All functions can be accessed through main menu, and major functions can be accessed through tool bar and keyboard/-mouse actions.

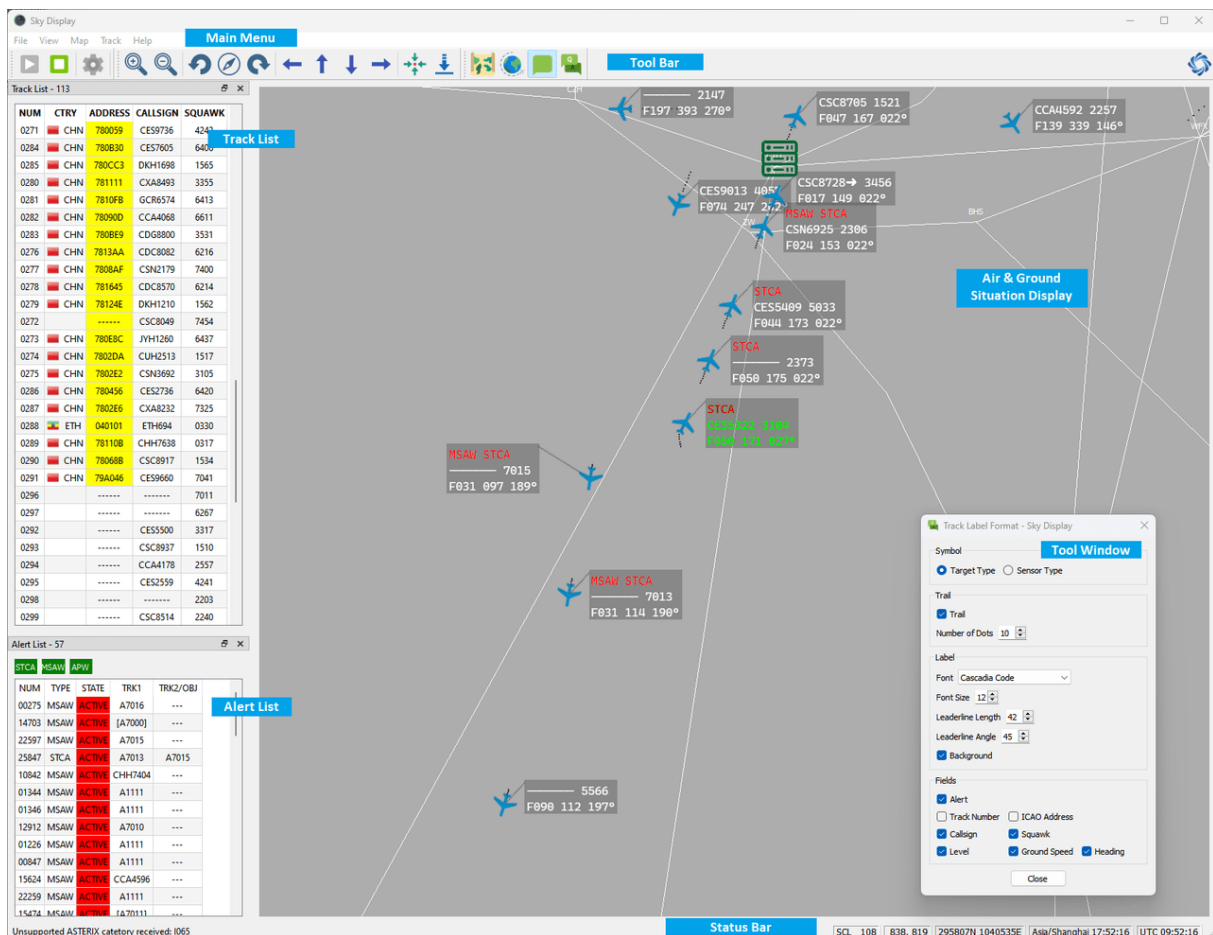


Figure 2.1: Main Window

## 2.2 Introduction

### 2.2.1 Main Menu

Main menu is on top of Sky Display main window, all functions can be accessed through cascade menu.

Below is a list of menu and submenus, with description of each menu items.

| Menu | Menu Item                         | Description                                                                                      |
|------|-----------------------------------|--------------------------------------------------------------------------------------------------|
| File | Start                             | Start receiving and processing surveillance data                                                 |
|      | Pause                             | Pause receiving and processing surveillance data                                                 |
|      | Stop                              | Stop receiving and processing surveillance data                                                  |
|      | Replay Recording File             | Open a recording file and replay it (Ctrl+O)                                                     |
|      | Replay Speed                      | Select the replay speed                                                                          |
|      | Playback Window                   | Open/Close the playback control window (Ctrl+P)                                                  |
|      | Exit                              | Exit application                                                                                 |
| View | Load Layout                       | Load default and user layout                                                                     |
|      | Load Layout -> Default            | Load default layout. Default layout is read only, it's created according to application settings |
|      | Load Layout -> <i>User Layout</i> | Load user defined layout                                                                         |
|      | Save Layout                       | Open "Layout Window" to save current layout                                                      |
|      | Full Screen                       | Toggle between window mode and full screen mode                                                  |
|      | Zoom In                           | Zoom in traffic situation display                                                                |
|      | Zoom Out                          | Zoom out traffic situation display                                                               |
|      | Rotate Right                      | Rotate traffic situation display 10 degrees clockwise                                            |
|      | Rotate Left                       | Rotate traffic situation display 10 degrees counter clockwise                                    |
|      | Rotate                            | Open "Rotate Window" to rotate any degrees                                                       |
|      | Rotate North Up                   | Reset the traffic situation display to north up orientation                                      |
|      | Move Left                         | Move traffic situation display 50 pixels to the left                                             |
|      | Move Up                           | Move traffic situation display 50 pixels up                                                      |

| Menu  | Menu Item              | Description                                                                                                           |
|-------|------------------------|-----------------------------------------------------------------------------------------------------------------------|
| Map   | Move Down              | Move traffic situation display 50 pixels down                                                                         |
|       | Move Right             | Move traffic situation display 50 pixels to the right                                                                 |
|       | Go To                  | Open “Go To Window” and move display center to any geographic coordinate, or to the location of the configured sensor |
|       | Toggle Video Map       | Toggle the display of radar video map                                                                                 |
|       | Toggle Sensor Map      | Toggle the display of sensor map                                                                                      |
|       | Toggle Range Rings     | Toggle the display of range rings                                                                                     |
|       | Set Range Rings Center | Set center of range rings                                                                                             |
|       | Range Rings            | Open “Range Rings Window”                                                                                             |
|       | Toggle Static Maps     | Toggle the display of all static maps                                                                                 |
|       | Static Maps            | Open “Static Maps Window”                                                                                             |
| Track | Toggle Weather Map     | Toggle the display of weather map                                                                                     |
|       | Weather Intensity      | Open “Weather Intensity Window” to show or hide each weather intensity level                                          |
|       | Toggle Tile Map        | Toggle the display of tile background map                                                                             |
|       | Bing Maps Downloader   | Open “Bing Maps Tile Downloader” tool                                                                                 |
|       | Toggle Track List      | Open/Close track list                                                                                                 |
| Tools | Toggle Track Label     | Toggle the display of track label                                                                                     |
|       | Track Label Format     | Open “Track Label Format Window”                                                                                      |
|       | Follow Selected Track  | Keep the display centered on the selected track                                                                       |
|       | Toggle Alert List      | Open/Close alert list                                                                                                 |
| Help  | Sensor Manager         | Open the standalone “Sensor Manager” application to edit sensor databases                                             |
|       | Static Map Editor      | Launch the standalone “Map Editor” application to edit static maps                                                    |
|       | Statistics             | Open “Statistics Window” (F8)                                                                                         |
|       | Settings               | Open “Settings Window”                                                                                                |
| Help  | Install License        | Open “License Installation Window”                                                                                    |

| Menu | Menu Item   | Description                   |
|------|-------------|-------------------------------|
|      | What' s New | Open “Changelog Window”       |
|      | Contents    | Open the built-in user manual |
|      | Cheat Sheet | Open “Cheat Sheet Window”     |
|      | About       | Open “About Window”           |

Note: Some menu items listed above may not appear in your application, or not applicable in your application, it depends on your license type.

### 2.2.2 Tool Bar

Main toolbar contains commonly used function tool buttons, the function is exactly the same with corresponding menu item.

### 2.2.3 Status Bar

Status bar is at the bottom of main window, it shows status information and application message.

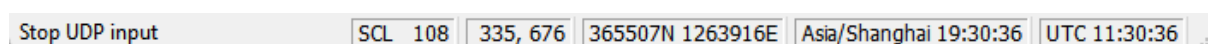


**Figure 2.2:** Status Bar

Below is a list of fields, from left to right, in status bar.

| Order | Field                    | Description                                                                                                                                          |
|-------|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Message                  | The last system message. it will disappear after 8 seconds.                                                                                          |
| 2     | Scale                    | The current scale of traffic situation map display                                                                                                   |
| 3     | Map Rotation             | The current map rotation angle, with 0.01-degree precision; positive value means clockwise rotation, negative value means counter-clockwise rotation |
| 4     | Cursor Coordinate X-Y    | X-Y pixel coordinate of cursor position                                                                                                              |
| 5     | Cursor Coordinate WGS-84 | WGS-84 coordinate of cursor position                                                                                                                 |

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| Order | Field       | Description              |
|-------|-------------|--------------------------|
| 6     | Local Clock | Clock in local time zone |
| 7     | UTC Clock   | Clock in UTC             |

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### 2.2.4 Traffic Situation Display

The traffic situation display is in the middle of main window, it displays maps, tracks and other elements.

User can use mouse and keyboard to operate in traffic situation display

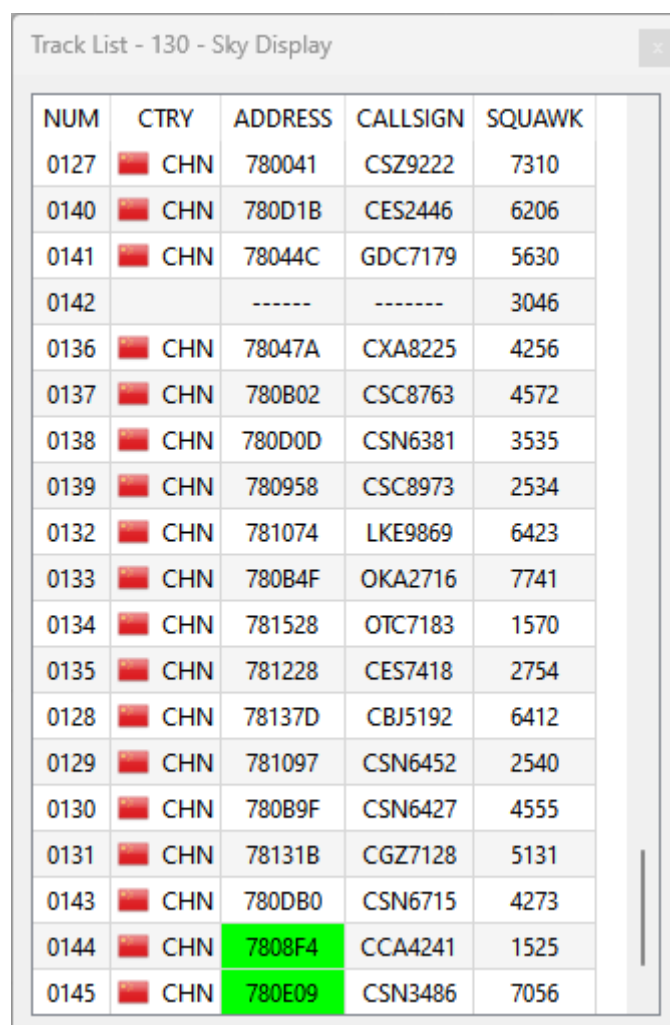
### 2.2.5 Flight List

Flight list contains information of flights, there are two types of flight lists

- Track List
- Alert List

#### 2.2.5.1 Track List

Track list contains brief information of each surveillance track.



| NUM  | CTRY                                                                                    | ADDRESS | CALLSIGN | SQUAWK |
|------|-----------------------------------------------------------------------------------------|---------|----------|--------|
| 0127 |  CHN   | 780041  | CSZ9222  | 7310   |
| 0140 |  CHN   | 780D1B  | CES2446  | 6206   |
| 0141 |  CHN   | 78044C  | GDC7179  | 5630   |
| 0142 |                                                                                         | -----   | -----    | 3046   |
| 0136 |  CHN   | 78047A  | CXA8225  | 4256   |
| 0137 |  CHN   | 780B02  | CSC8763  | 4572   |
| 0138 |  CHN   | 780D0D  | CSN6381  | 3535   |
| 0139 |  CHN   | 780958  | CSC8973  | 2534   |
| 0132 |  CHN   | 781074  | LKE9869  | 6423   |
| 0133 |  CHN   | 780B4F  | OKA2716  | 7741   |
| 0134 |  CHN   | 781528  | OTC7183  | 1570   |
| 0135 |  CHN   | 781228  | CES7418  | 2754   |
| 0128 |  CHN   | 78137D  | CBJ5192  | 6412   |
| 0129 |  CHN | 781097  | CSN6452  | 2540   |
| 0130 |  CHN | 780B9F  | CSN6427  | 4555   |
| 0131 |  CHN | 78131B  | CGZ7128  | 5131   |
| 0143 |  CHN | 780DB0  | CSN6715  | 4273   |
| 0144 |  CHN | 7808F4  | CCA4241  | 1525   |
| 0145 |  CHN | 780E09  | CSN3486  | 7056   |

**Figure 2.3:** Track List

In the title of track list window, it displays total number of surveillance tracks.

And below are fields of track list.

| Order | Field    | Description                                                          |
|-------|----------|----------------------------------------------------------------------|
| 1     | NUM      | Track number                                                         |
| 2     | CTRY     | Country of aircraft. If country is unknown, this field will be empty |
| 3     | ADDRESS  | ICAO 24-bit address. If address is unavailable, it will display “—”  |
| 4     | CALLSIGN | Callsign or ACID. If callsign is unavailable, it will display “—”    |
| 5     | SQUAWK   | Squawk or SSR code.                                                  |

### 2.2.5.2 Alert List

Alert list contains brief information of each alert.

| NUM   | TYPE | STATE  | TRK1    | TRK2/OBJ |
|-------|------|--------|---------|----------|
| 42507 | MSAW | ACTIVE | A2203   | ---      |
| 49085 | MSAW | ACTIVE | A1111   | ---      |
| 52874 | MSAW | ACTIVE | GCR6590 | ---      |
| 47560 | MSAW | ACTIVE | CHH7027 | ---      |
| 50721 | MSAW | ACTIVE | [A7401] | ---      |
| 01346 | MSAW | ACTIVE | [A1111] | ---      |
| 49200 | MSAW | ACTIVE | [A7011] | ---      |
| 49201 | MSAW | ACTIVE | A1111   | ---      |
| 22597 | MSAW | ACTIVE | A7015   | ---      |
| 12912 | MSAW | ACTIVE | [A7010] | ---      |
| 28048 | MSAW | ACTIVE | [A1111] | ---      |
| 53088 | MSAW | ACTIVE | A7016   | ---      |
| 52950 | MSAW | ACTIVE | A4554   | ---      |
| 01226 | MSAW | ACTIVE | [A1111] | ---      |
| 49119 | STCA | END    | A1111   | A1111    |
| 49229 | STCA | ACTIVE | A1111   | A1111    |
| 00847 | MSAW | ACTIVE | [A1111] | ---      |
| 40704 | MSAW | ACTIVE | [A1111] | ---      |

**Figure 2.4:** Alert List

In the title of alert list window, it displays total number of alerts.

Above list it displays status of each types of alert. Currently the supported alerts are

- STCA
- MSAW
- APW

And below are fields of alert list.

| Order | Field    | Description                                                                                                                                                        |
|-------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | NUM      | Alert number                                                                                                                                                       |
| 2     | TYPE     | Alert type, as above                                                                                                                                               |
| 3     | STATE    | Alert state. ACTIVE - alert is currently active. END - alert is ended.                                                                                             |
| 4     | TRK1     | The callsign or SSR code of first track involved in the alert                                                                                                      |
| 5     | TRK2/OBJ | The callsign or SSR code of second track, or object involved in the alert. If alert involves only one track, for example MSAW alert, this field will display “—” . |

## 2.3 Traffic Situation Display

Traffic Situation Display (TSD) is in the center of main window, and is the main HMI user will interact with Sky Display.

In TSD, a map is displayed as background, track symbols and labels are displayed over the map.

### 2.3.1 Basic Operation

User is able to zoom, pan and rotate the TSD, by using menu, tool buttons, mouse or hotkey.

Here is a list of TSD action through different way.

| TSD Operation | Menu                               | Tool Button           | Mouse                      | Hot Key               |
|---------------|------------------------------------|-----------------------|----------------------------|-----------------------|
| Pan           | View -> Move Left, Right, Up, Down | Left, Right, Up, Down | Hold right button and drag | Arrow keys            |
| Zoom          | View -> Zoom In/Out                | Zoom In, Out          | Scroll wheel               | Key - and =           |
| Rotate        | View -> Rotate Right/Left          | Rotate Right/Left     | N/A                        | Key [, ], F11 and F12 |
| Set Center    | View -> Go To                      | Go To                 | Right button double click  |                       |

Through menu *Help -> Cheat Sheet*, it will display a quick help window show commonly used mouse and keyboard actions.

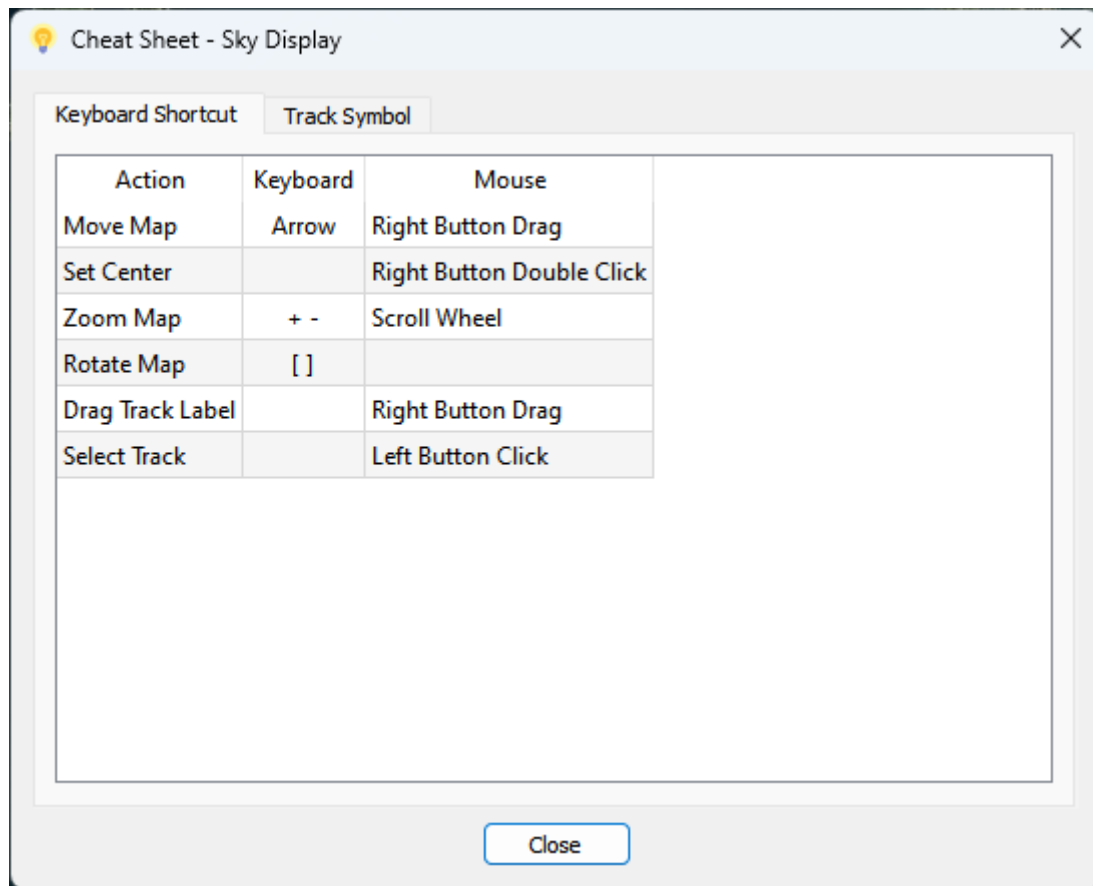


**Figure 2.5:** Cheat Sheet Window

### 2.3.2 Layout

When TSD is adjusted properly, use could save current layout and reload it later.

To save layout, access menu *View -> Save Layout*, and it will open "Layout Window" .

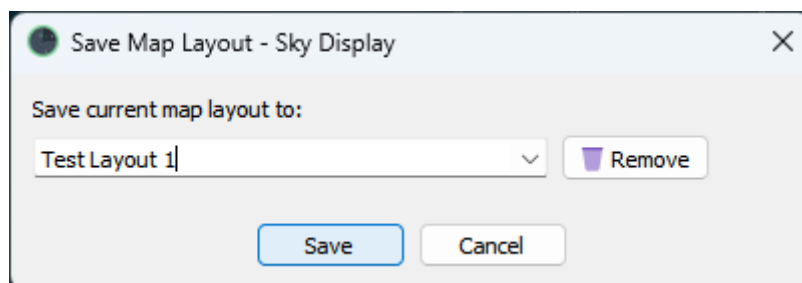


**Figure 2.6:** Layout Window

From this window, user can save current layout by assigning a new name, overwriting an existing layout, or removing an existing layout.

Later, from menu *View -> Load Layout*, user can reload layout saved before.

In the *Load Layout* submenu, there is one item named *default*, it is created by system and read-only to user. When selecting it, the TSD will recenter to “Center Coordinate” in configuration, and rotate to 0 degree (north up). User can not save layout to name “default” .

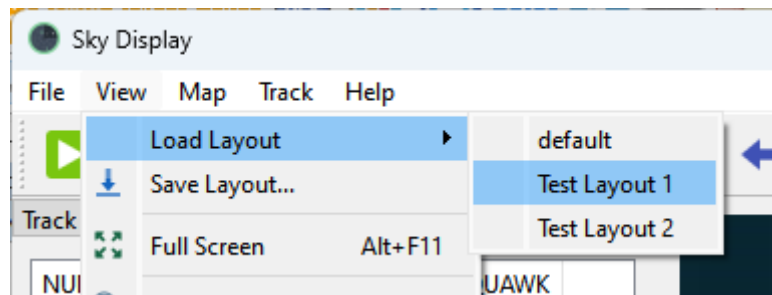


**Figure 2.7:** Layout Window

### 2.3.3 Track Display

When surveillance data is correctly received and decoded by Sky Display, track will be displayed in TSD.

A track consists of track symbol, track label, and a leaderline connecting symbol and label.



**Figure 2.8:** Track Example

User can configure track display in “Track Label Format Window” through menu *Track -> Track Label Format...*

Track Label Format - Sky Display

**Symbol**

Type ☒ Target Type ☐ Sensor Type

Size ☐ Small ☒ Medium ☐ Large

**Trail**

☐ Trail Number of Dots 10

**Velocity Vector**

☐ Vector 5 Minutes ☒ Ticks

**Label**

Font Cascadia Code

Font Size 12

Leaderline Length 42

Leaderline Angle 45

☒ Background

**Fields**

☒ Alert

☒ Track Number ☒ ICAO Address

☒ Callsign ☒ Squawk

☒ Level ☒ Selected Altitude ☒ Ground Speed

☒ Vertical Rate ☒ Heading

Close

**Figure 2.9:** Track Label Format Window

### 2.3.3.1 Track Symbol

Track symbol can be displayed by target type or sensor type.

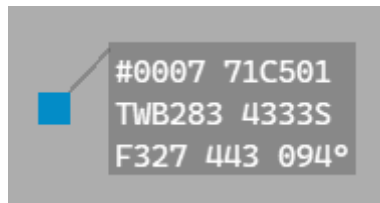


**Figure 2.10:** Mode-S SSR Track Example

From “Cheat Sheet Window” , it shows all available symbols.

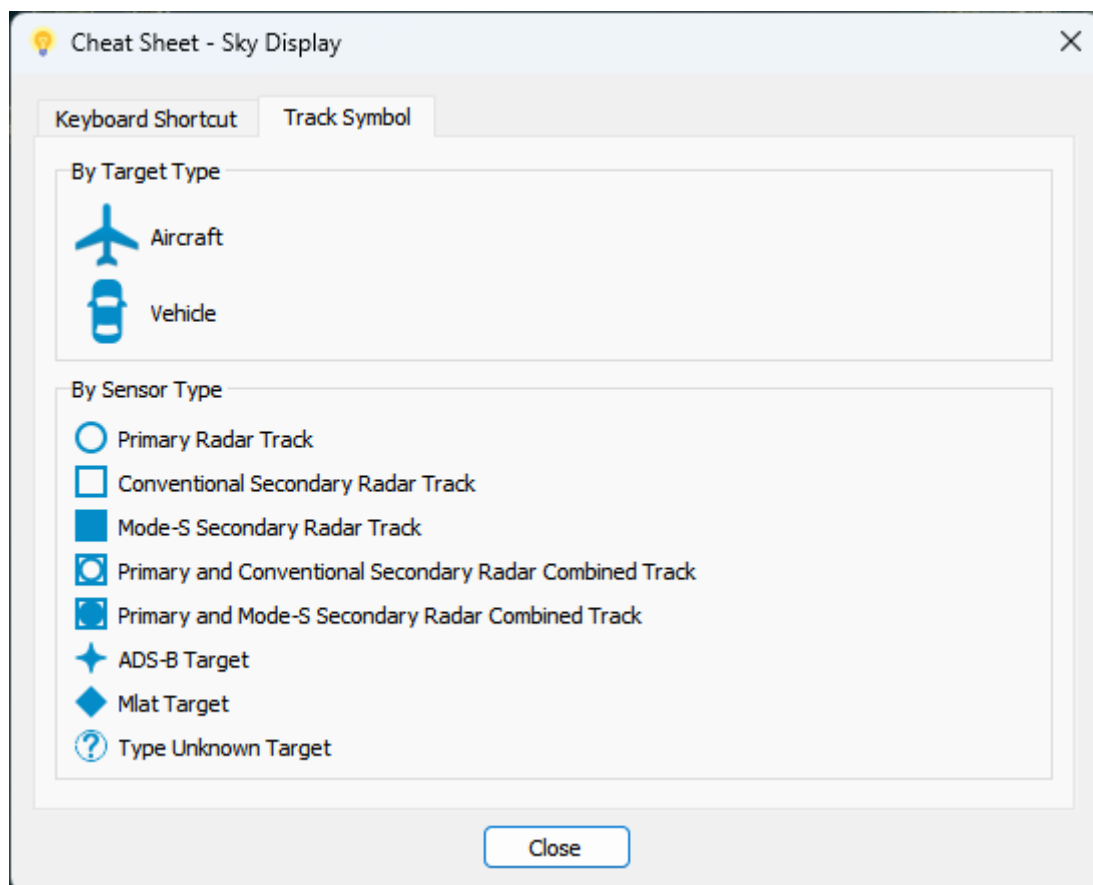


**Figure 2.11:** Cheat Sheet Window

The color of the track symbols is configurable in *Settings - Track*. The symbol size can be switched at runtime between small, medium and large in the “Track Label Format Window” .

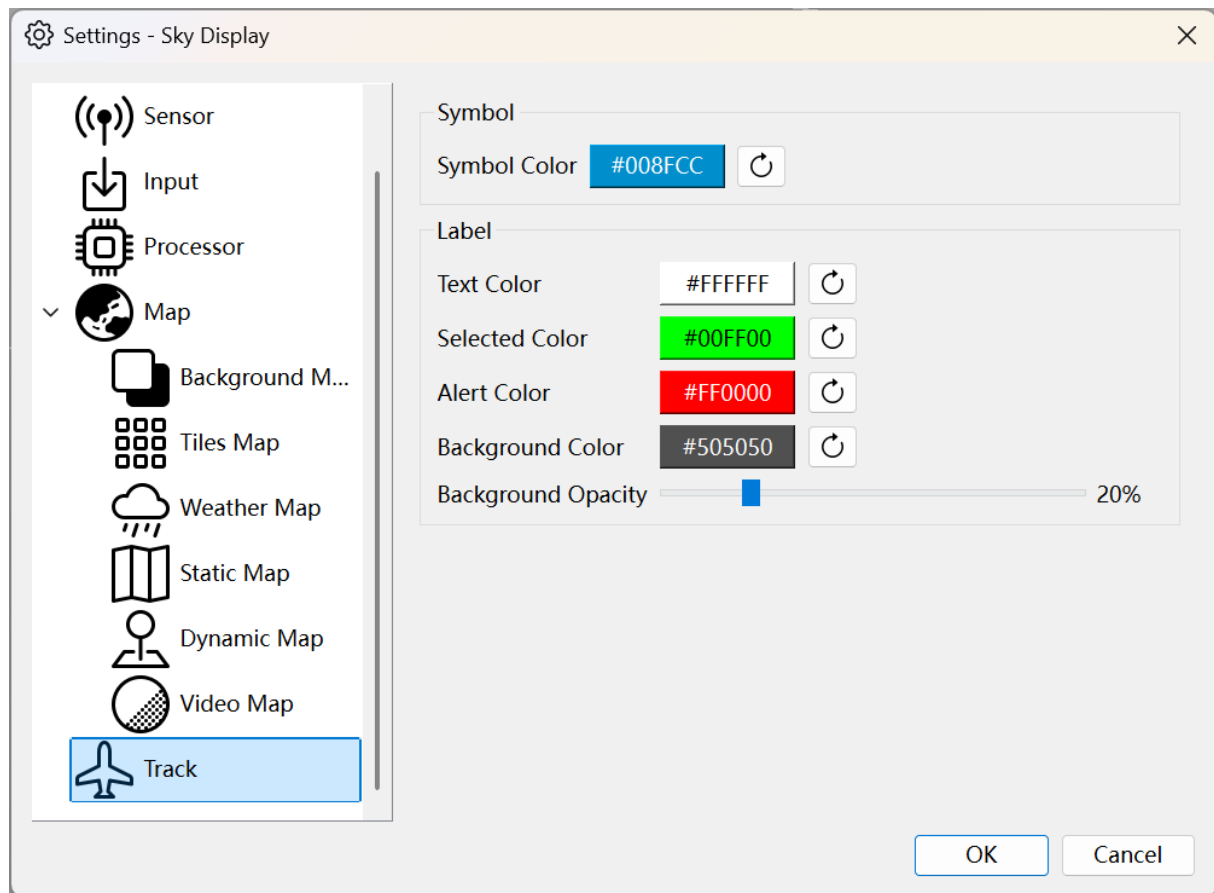


**Figure 2.12:** Track Configuration

In *Settings - Track*, it is also possible to configure the track label colors: text color, selected color, alert color, background color and background opacity.

### 2.3.3.2 Trial

Trail is dots of historical positions of a track, it's possible to enable/disable the display of trail, and configure maximum number of dots of a track.



**Figure 2.13:** Trail Dots Example

The maximum number of trail dots is 512 per track.

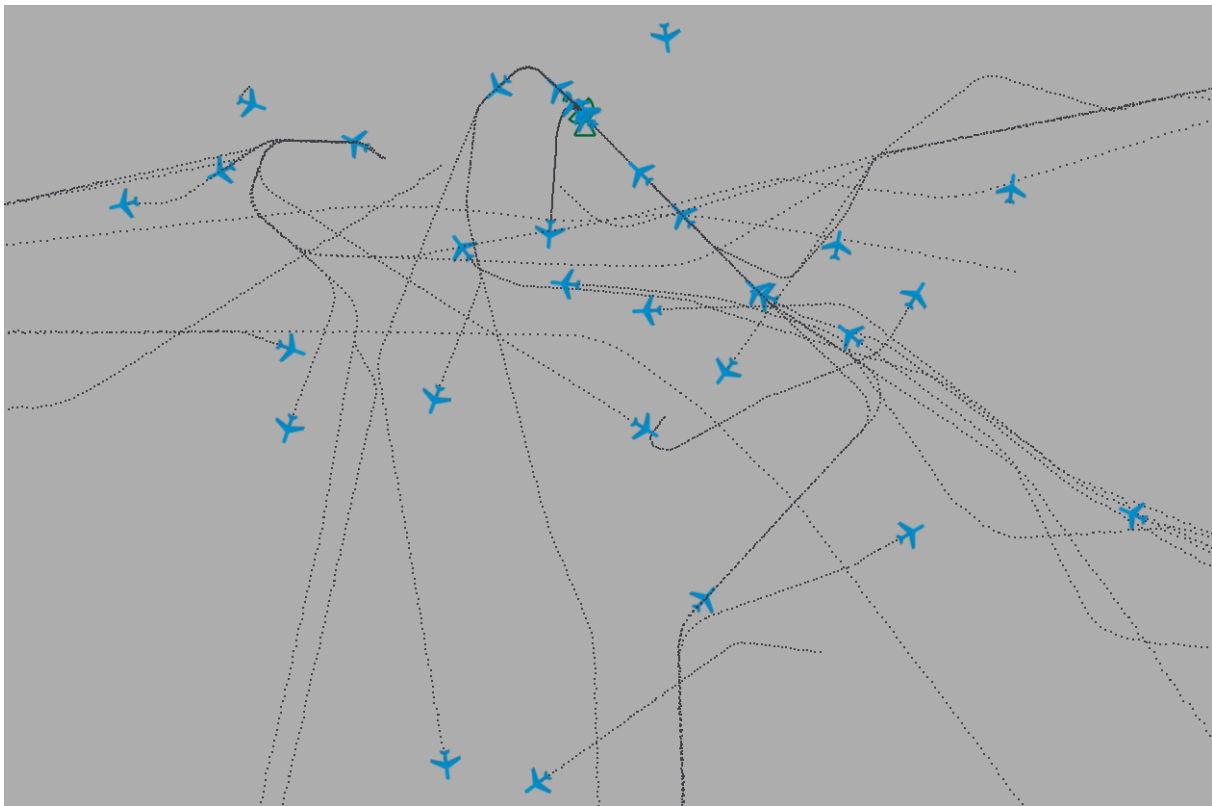


**Figure 2.14:** Track with Many Trail Dots

#### 2.3.3.3 Velocity Vector

The velocity vector is a line drawn from the track symbol along the track heading, predicting the movement of the track. It is drawn in the color of the track symbol.

The vector can be enabled in the “Track Label Format Window” . Its length represents minutes of flight based on the ground speed (default 5 minutes), or a fixed distance in NM after clicking the unit button. The length can be adjusted between 1 and 20. When Ticks is selected, tick marks are drawn on the vector at every minute (or every NM).

#### 2.3.3.4 Label

User can adjust the display style and position of labels, including

- Label font

- Label font size
- Leaderline default length
- Leaderline default angle
- Label background

Note: if label of a track is moved by mouse dragging, it's position will not be affected by options here.

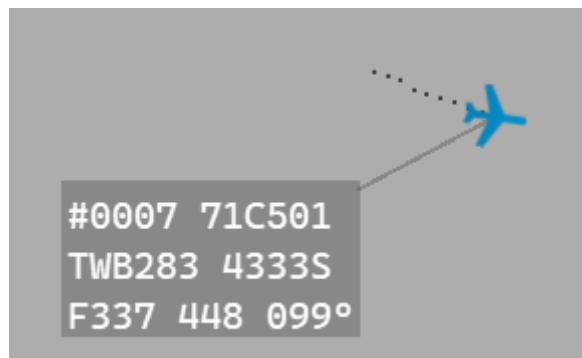


**Figure 2.15:** Label Position

### 2.3.3.5 Label Fields

User can select which fields should be displayed in track label.

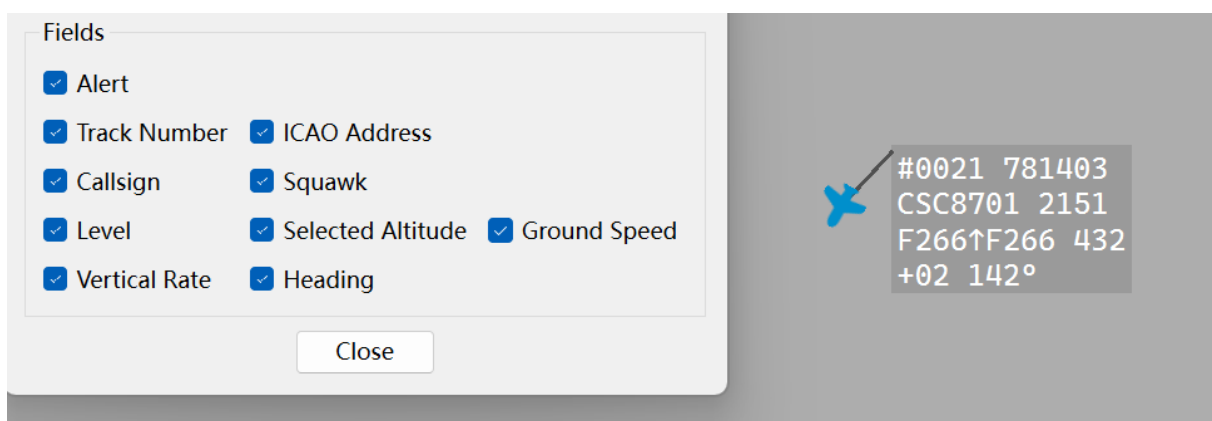


**Figure 2.16:** Field in Track Label

The selected fields are arranged in the label from top to bottom as:

| Line   | Fields                                 |
|--------|----------------------------------------|
| Alert  | Alert indicator (e.g. STCA)            |
| Line 1 | Track number, ICAO 24-bit address      |
| Line 2 | Callsign, Squawk                       |
| Line 3 | Level, Selected altitude, Ground speed |
| Line 4 | Vertical rate, Heading                 |

The level is displayed in flight levels as Fxxx. When the vertical trend of the track is known, an arrow is appended after the level: ↑ climbing, ↓ descending.

The selected altitude, the flight level selected in the aircraft and reported via Mode S, is displayed right after the level, also in Fxxx format.

The vertical rate is displayed in hundreds of feet per minute with a sign, e.g. +05 means climbing at 500 ft/min.

### 2.3.4 Track Operation

User can operate on track symbols and labels by using mouse.

| Track Operation  | Mouse Action                     |
|------------------|----------------------------------|
| Move Track Label | Hold right button and drag label |
| Select Track     | Left click on track symbol       |

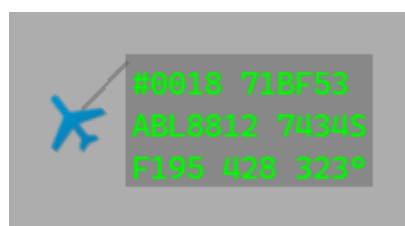


**Figure 2.17:** Selected Track

## 3 Maps

### 3.1 Overview

Sky Display has a powerful and flexible maps system to display different types of maps in air & ground traffic display (TSD).

All information and elements displayed in TSD map are separated into different map layers, each map layer could also have its sublayers.

There are four (4) main map layers, they are

- Background Map
- Tile Maps
- Static Maps
- Dynamic Maps

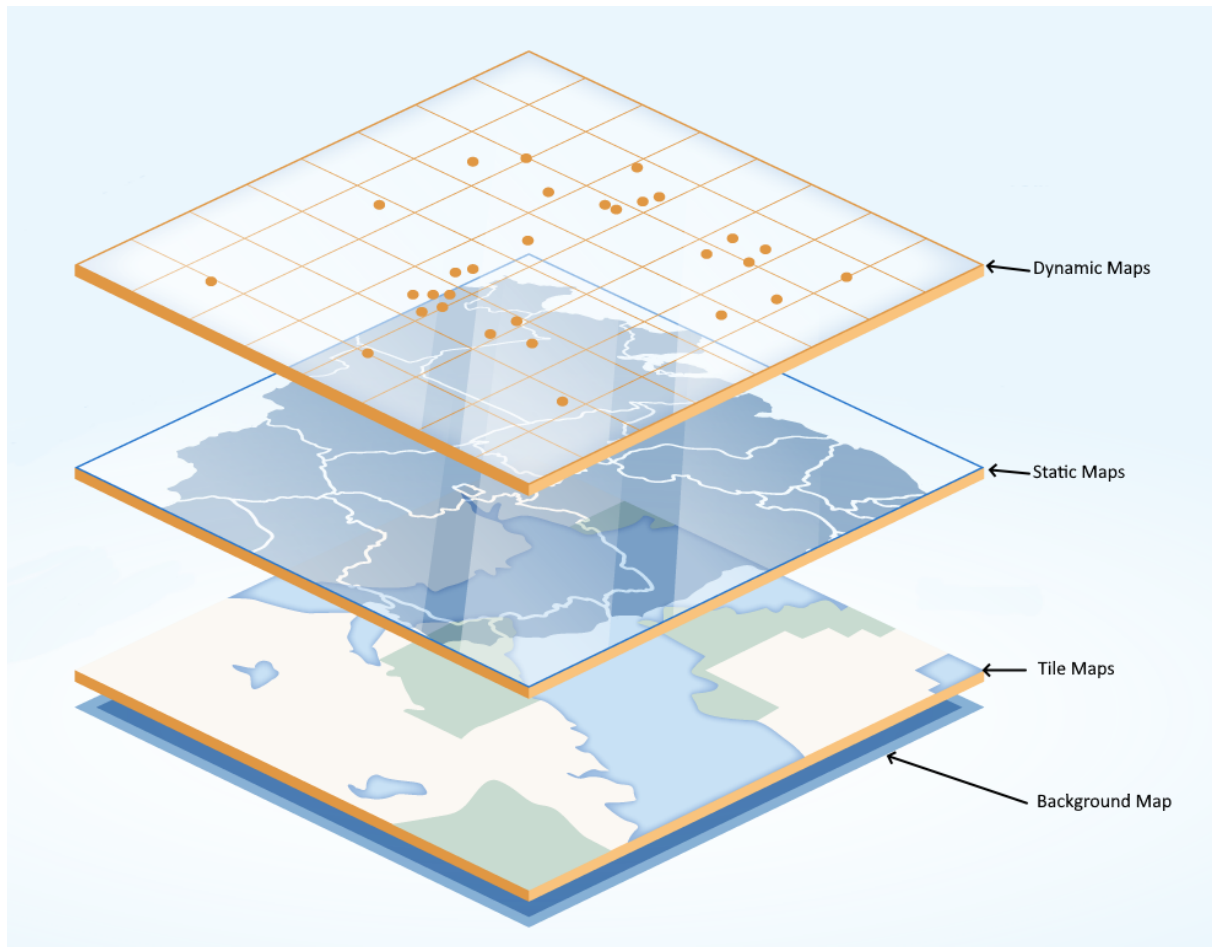


**Figure 3.1:** Map Layers

When map is to be displayed in screen, the painting system will paint different map layers from bottom to top. This means elements on upper layer could cover elements on lower layer.

## 3.2 Projection

To display a map of earth surface on flat screen, it is needed to use a projection algorithm to map a latitude-longitude coordinate into a X-Y coordinate on a plane.

The latitude-longitude coordinate used by Sky Display is WGS-84 coordinate, and the used projection algorithm is Mercator projection algorithm.

More information can be found at [https://en.wikipedia.org/wiki/Mercator\\_projection](https://en.wikipedia.org/wiki/Mercator_projection) and [https://en.wikipedia.org/wiki/World\\_Geodetic\\_System#WGS84](https://en.wikipedia.org/wiki/World_Geodetic_System#WGS84).

### 3.3 General Map Settings

In *Settings - Map - General*, it is possible to configure general map options.

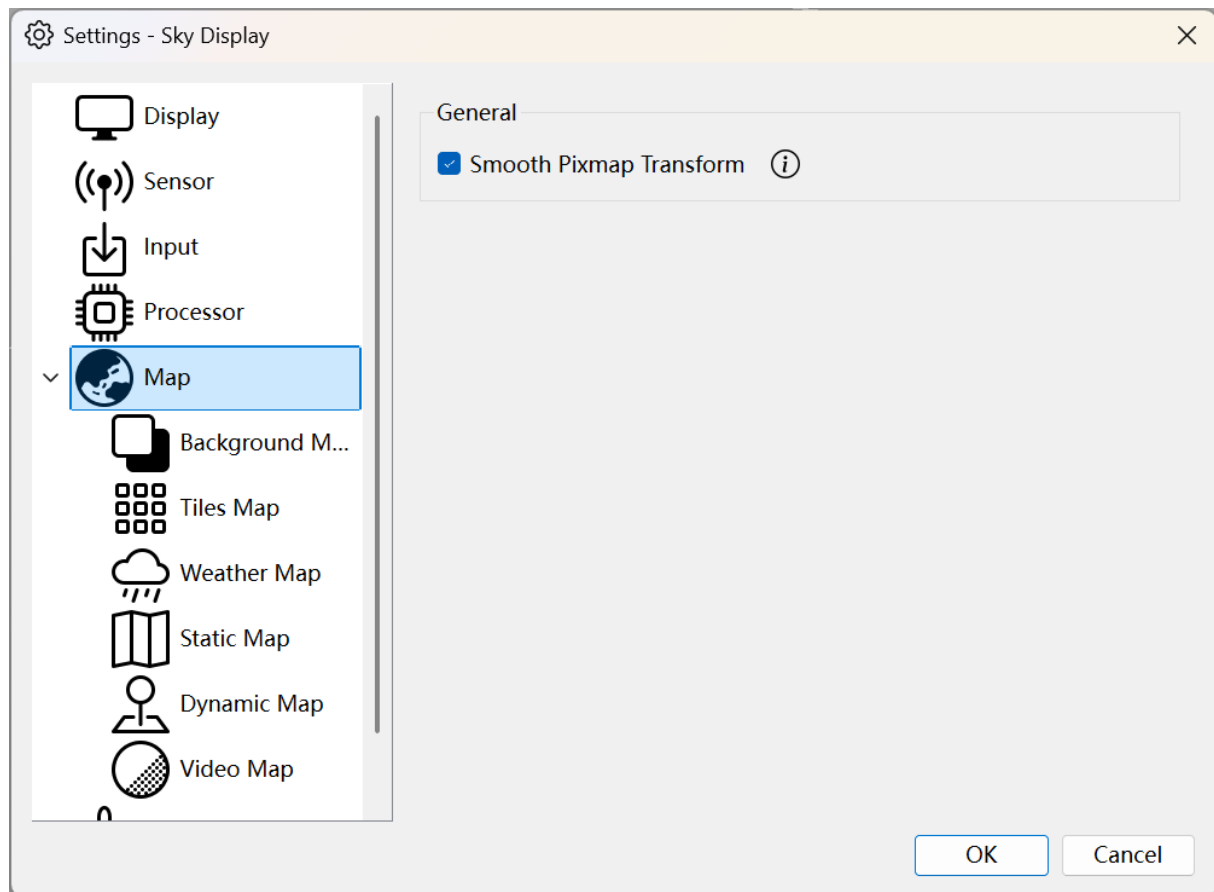


**Figure 3.2:** General Map Configuration

**Smooth Pixmap Transform:** Perform smooth resampling of tile map and static map images when they are scaled by display zoom or rotation, instead of selecting the nearest pixel. When enabled, lines and text stay clean while zooming and rotating, but map zooming and panning is slower.

### 3.4 Background Map

Background map, as explained by its name, is the background of all other map layers. And it is at the bottom of all map layers.

Background map is a solid color rectangle map covering all projection plane. It is the first layer painted when drawing the map.

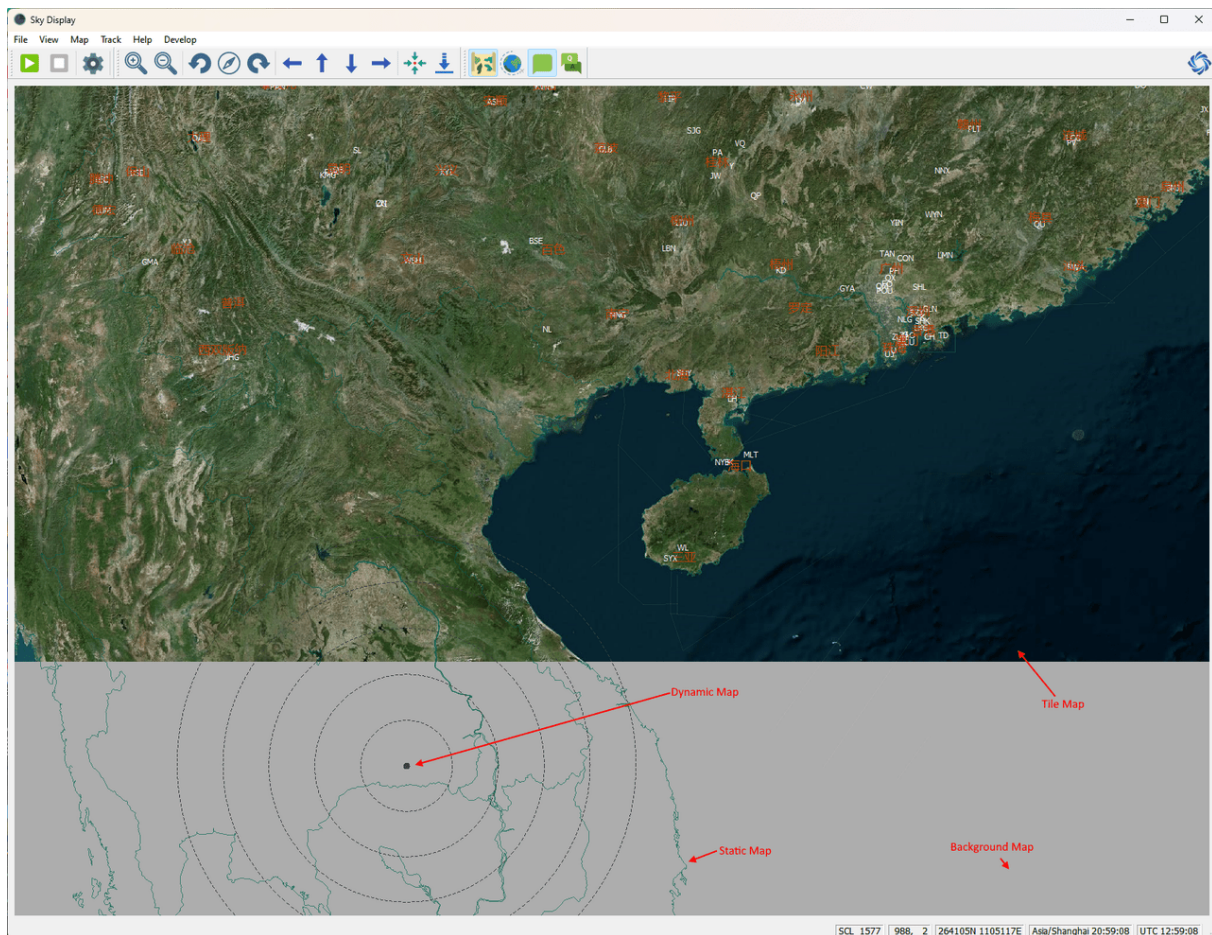


**Figure 3.3:** Background Map Example

In area not covered by any upper layer maps, the background map will be shown.

### 3.4.1 Configuration

In “*Settings - Map - Background Map*”, it is possible to configure the color of background map.

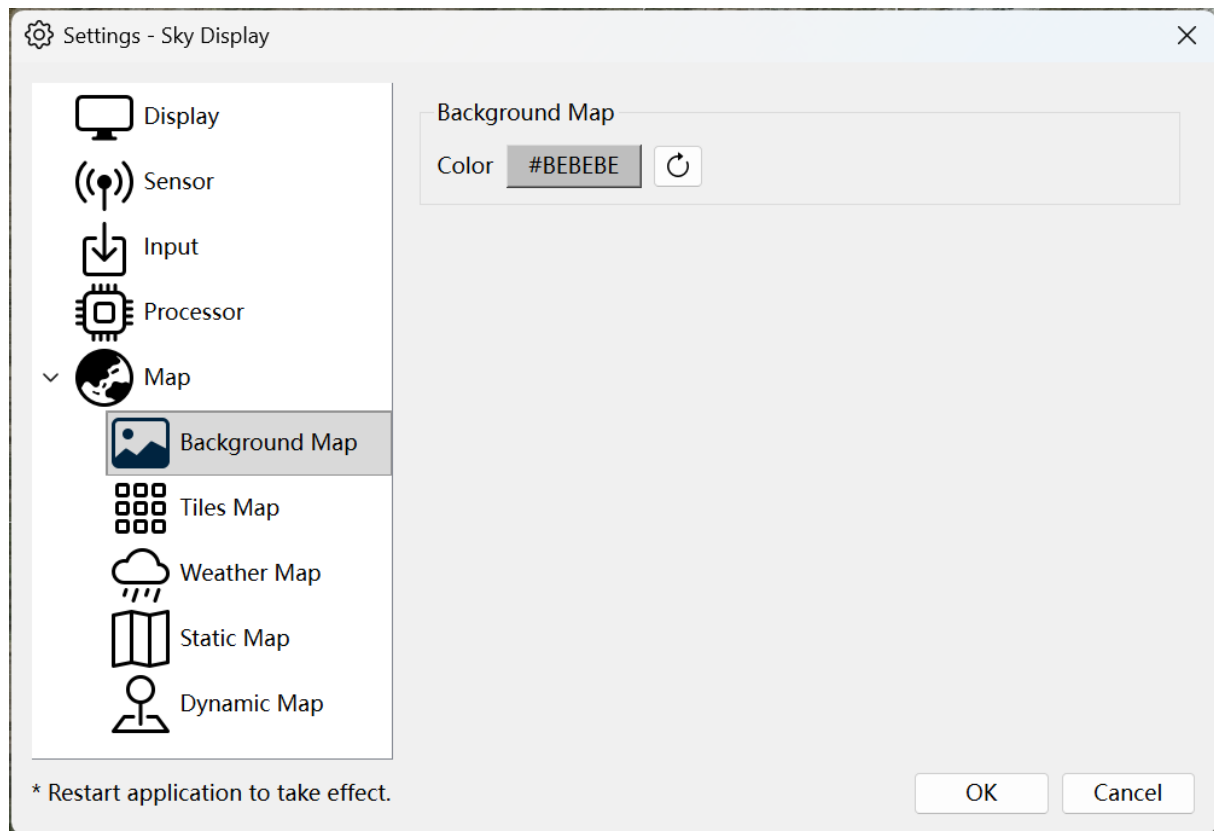


**Figure 3.4:** Background Map Configuration

The default value is gray color (#ADADAD).

### 3.5 Tile Maps

Tile maps are raster maps over background map layer. Tile maps are provided by tile maps service provider, an active Internet connection is needed to access tile map service.

Currently Sky Display supports the following tile maps service providers:

- Microsoft Bing Maps
- Google Maps
- OpenAIP
- Map World (Tianditu)
- FAA Aeronautical Charts

### 3.5.1 Configuration

In *Settings - Map - Tiles Map - General*, it is possible to configure tile map service.

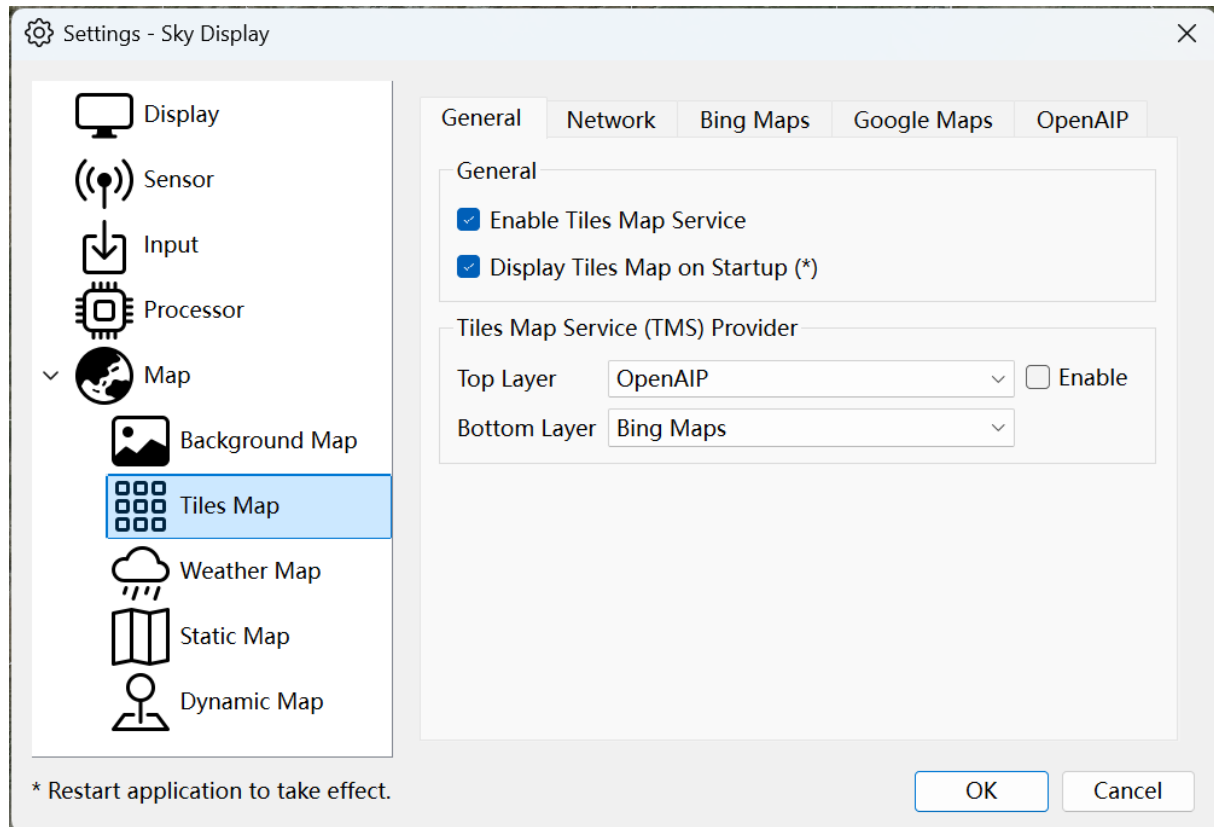


**Figure 3.5:** Tile Maps Configuration

**Enable Tiles Map Service:** Enable or disable tile maps service. When service is disabled, Sky Display will not try to connect tile maps service provider, and tile map will not be shown in TSD display.

**Display Tiles Map on Startup:** When selected, tile map layer will be automatically selected after startup. Application restart is needed for this option to take effect.

**Tiles Map Service (TMS) Provider:** Sky Display supports two tile map layers. The **Bottom Layer** is always used when tile maps service is enabled. The **Top Layer** is optional, it can be enabled with the “Enable” checkbox and is painted over the bottom layer. A typical usage is to use Bing Maps or Google Maps as the bottom layer, and OpenAIP aeronautical chart as the top layer.

In *Settings - Map - Tiles Map - Network*, it is possible to configure network options of tile maps service.

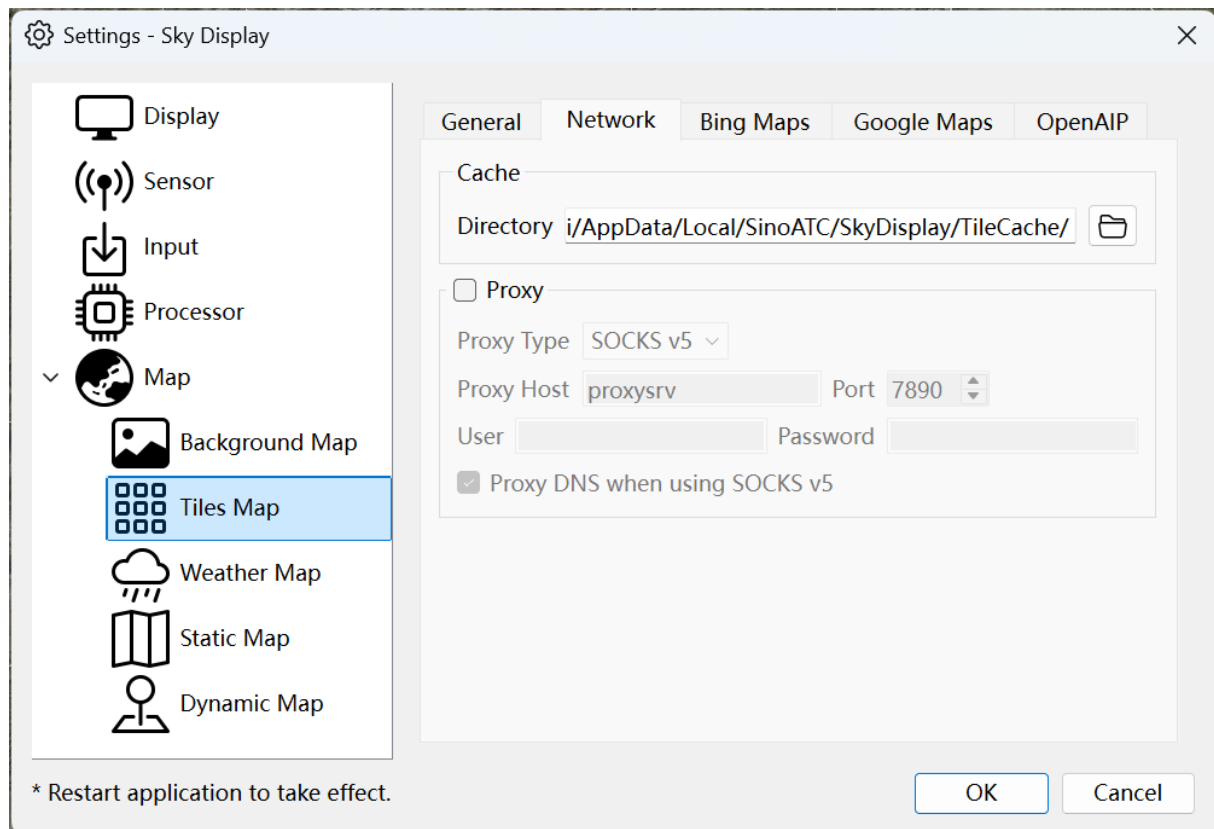


**Figure 3.6:** Tile Maps Network Configuration

**Cache Directory:** Directory to save cache files when accessing to Internet tile maps service provider. Using cache can reduce repeated requests sent to tile maps service provider and improve performance over slow Internet connection.

**Proxy:** When selected, all requests to tile maps service provider are sent via the specified proxy server.

**Proxy Type** is SOCKS v5. **Proxy Host** and **Port** specify the address of proxy server. **User** and **Password** are used when the proxy server requires authentication. When **Proxy DNS when using SOCKS v5** is selected, host name resolution is done by the proxy server.

### 3.5.2 Microsoft Bing Maps

Microsoft Bing Maps provides tiles service for all earth surface.

In *Settings - Map - Tiles Map - Bing Maps*, it is possible to configure “Bing Maps” service.

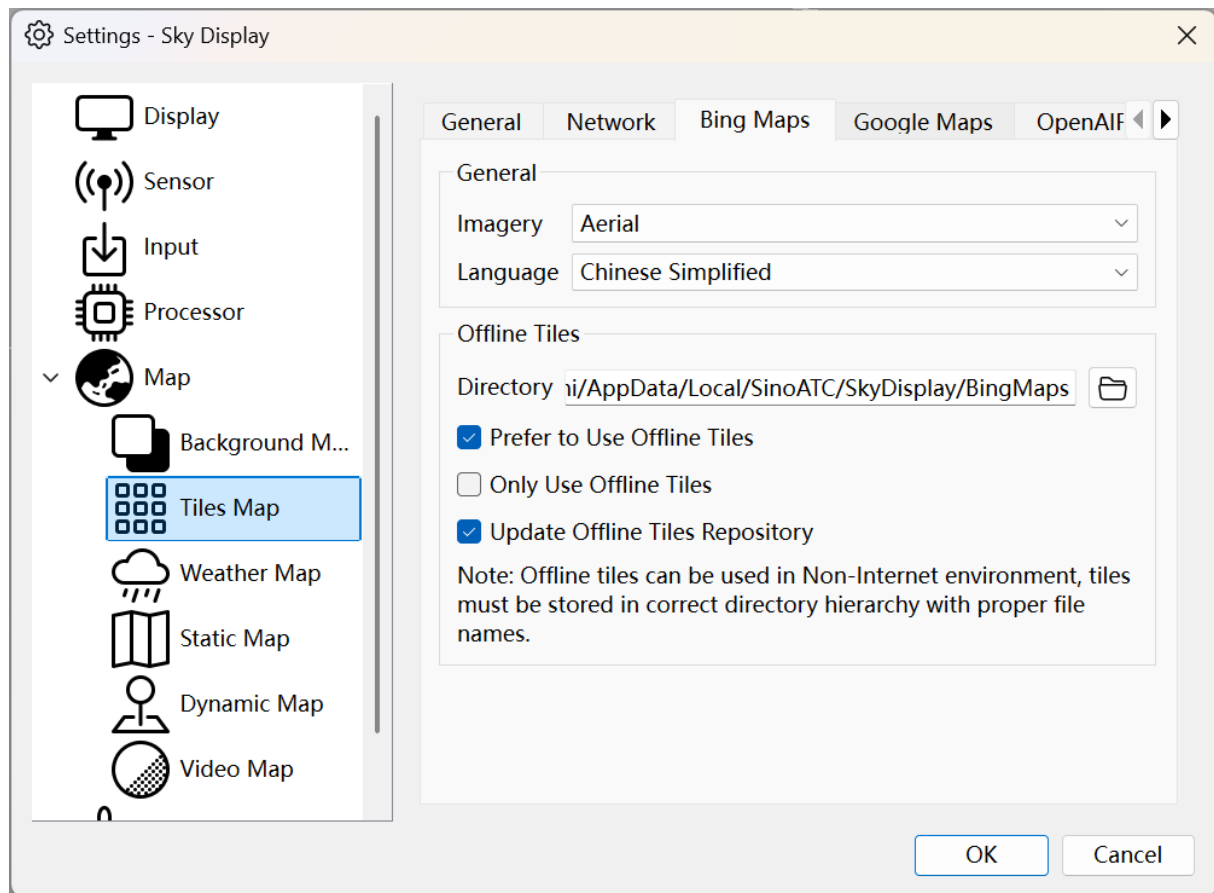


**Figure 3.7:** Bing Maps Configuration

**Imagery** and **Language**: Bing Maps supports different map styles and map languages. These two options control which map style and languages will be requested.

The supported imagery sets are:

- Aerial
- Aerial with Labels
- Road
- Road Light
- Road Gray
- Road Dark

And supported languages are:

- English
- Chinese Simplified

- Chinese Traditional
- French
- Indonesian
- Malay
- Spanish

It has to be mentioned that not all languages are supported in all imagery sets, if specified language is not applicable, Bing Maps will revert to English.

Below are examples of different imagery sets and languages.

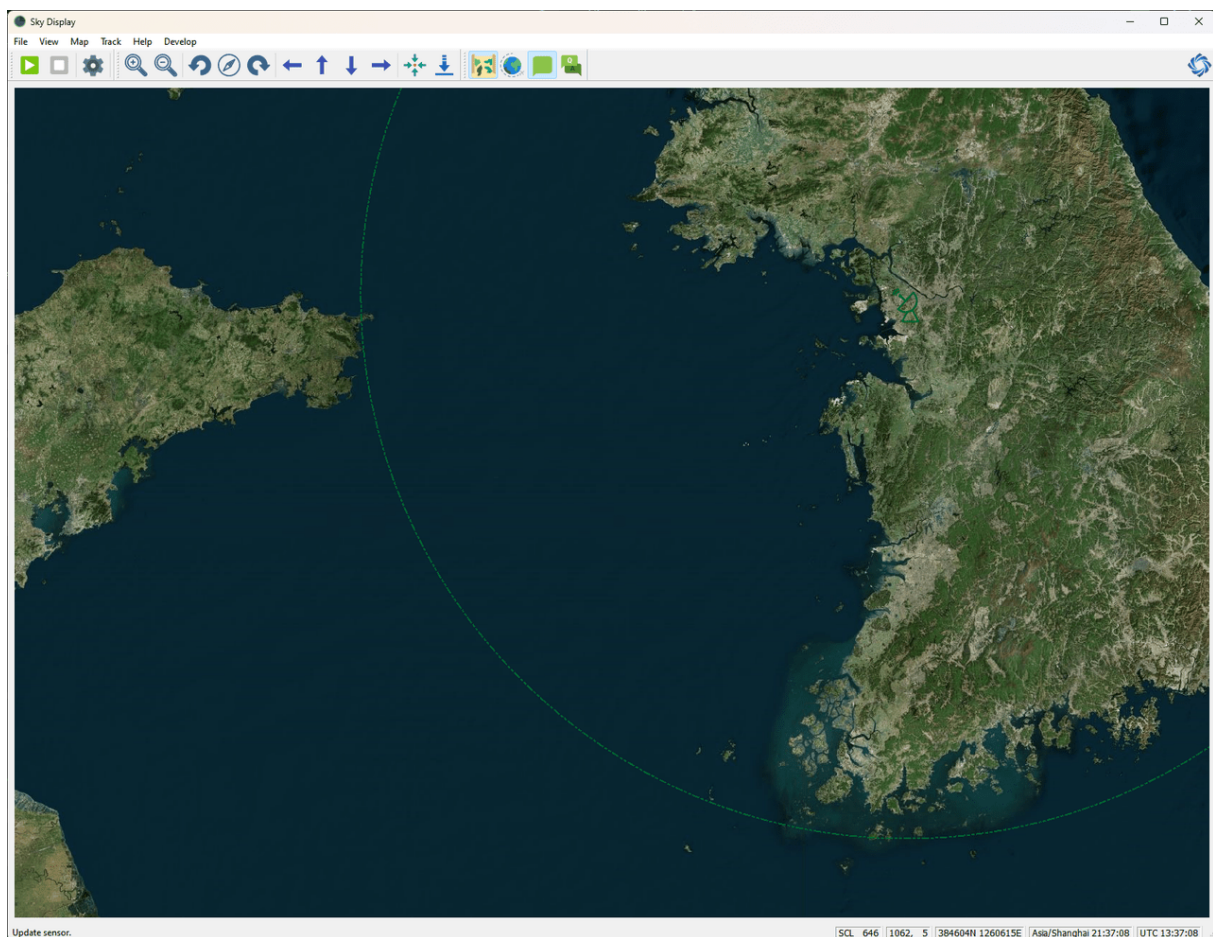


**Figure 3.8:** Aerial

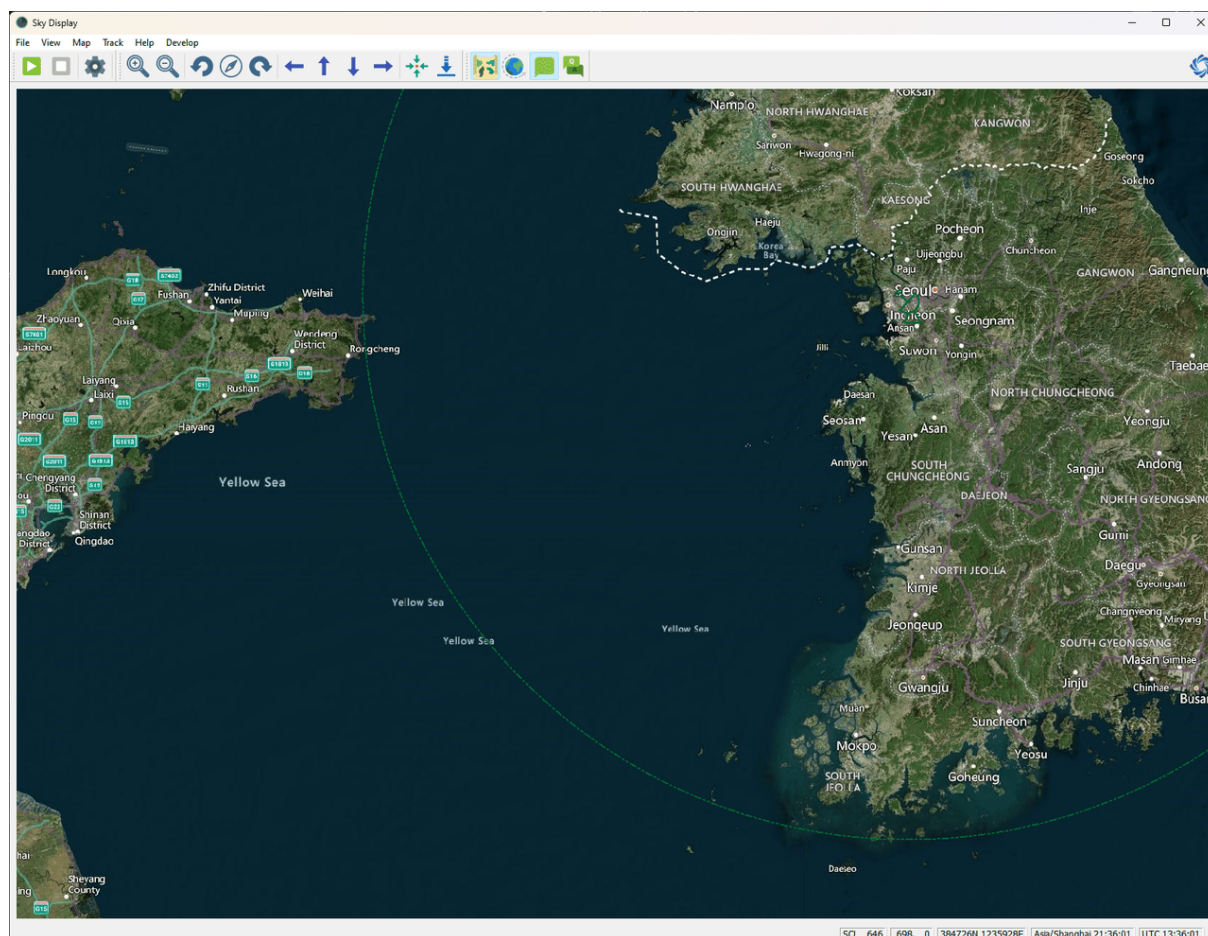


**Figure 3.9:** Aerial with Labels

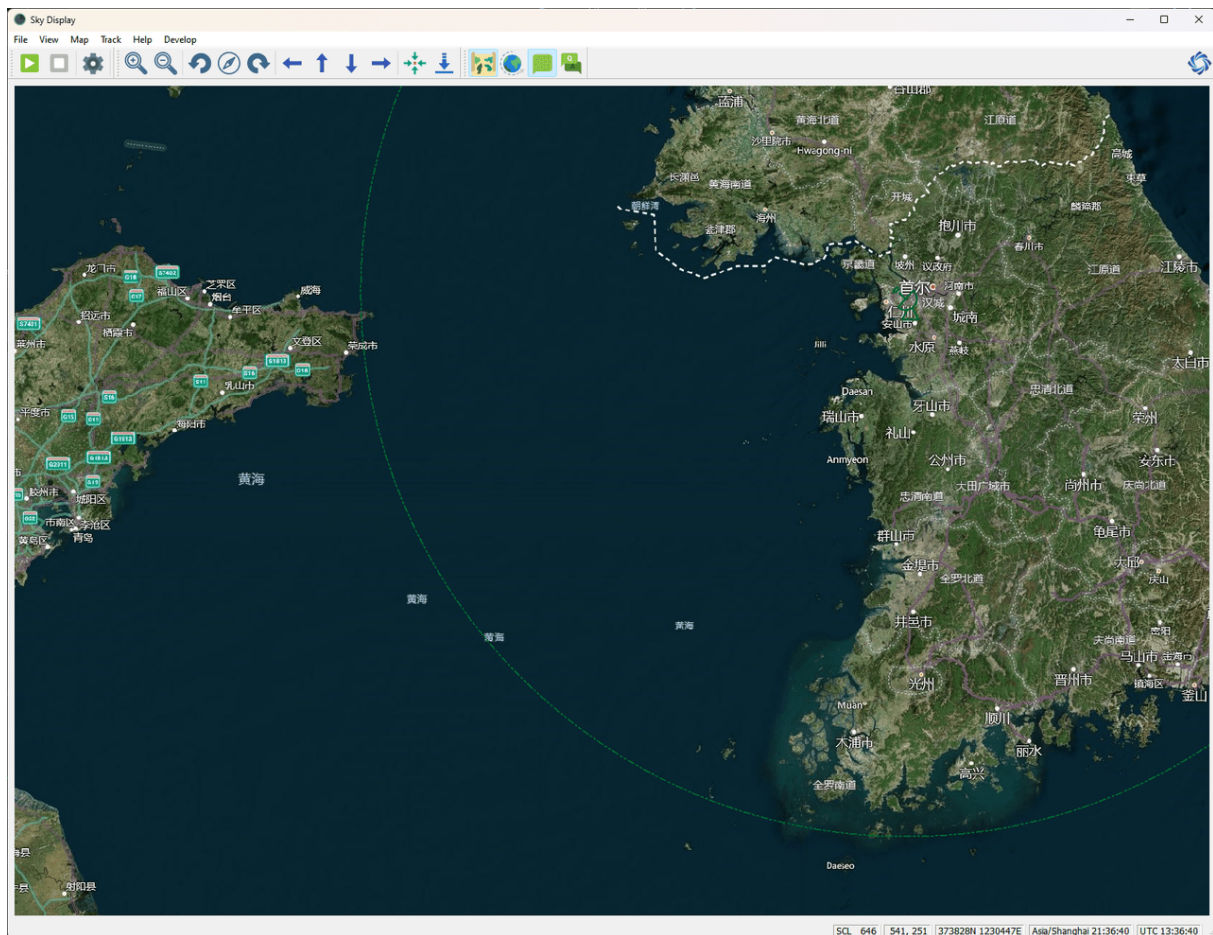


**Figure 3.10:** Aerial with Labels in Chinese

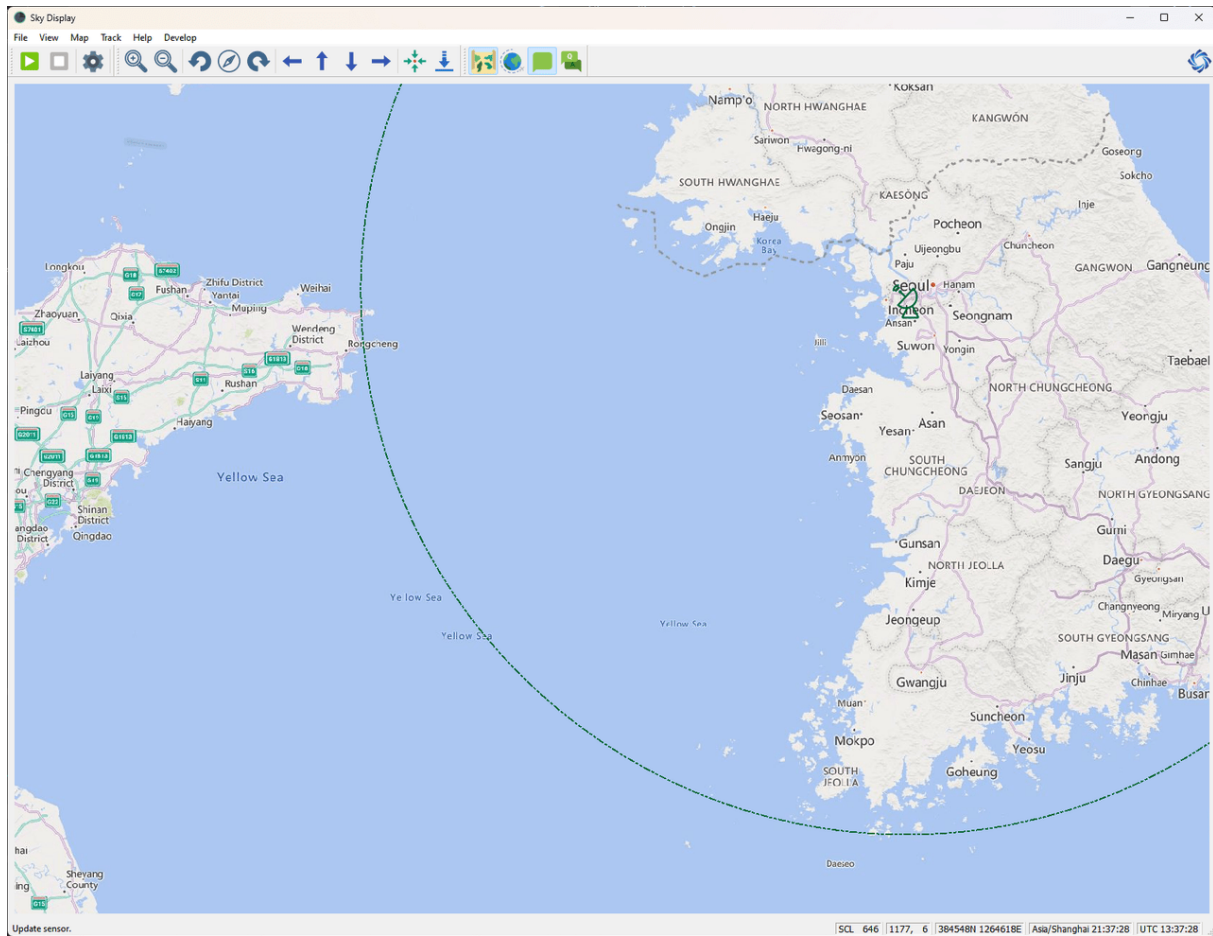
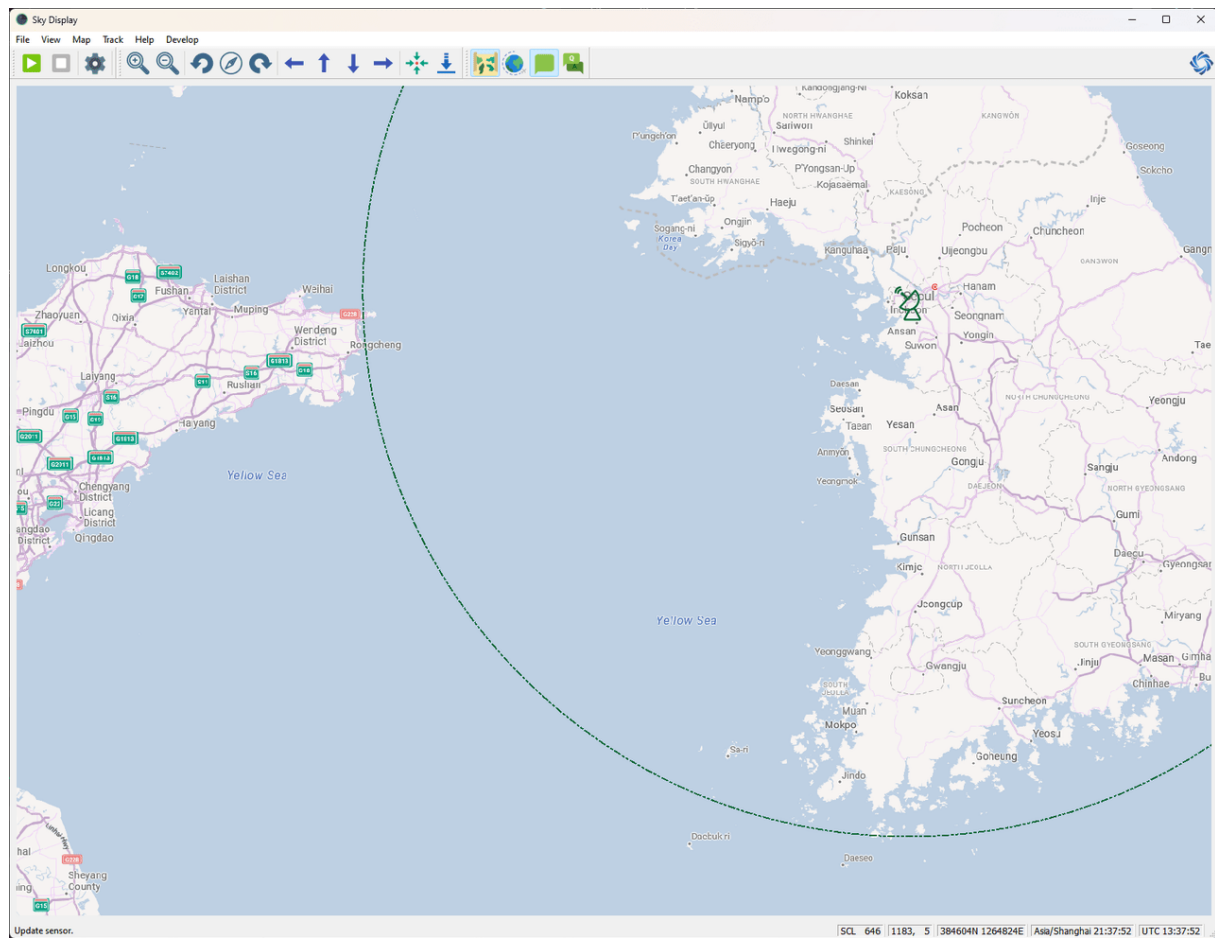


**Figure 3.11:** Road

**Figure 3.12:** Road Lite

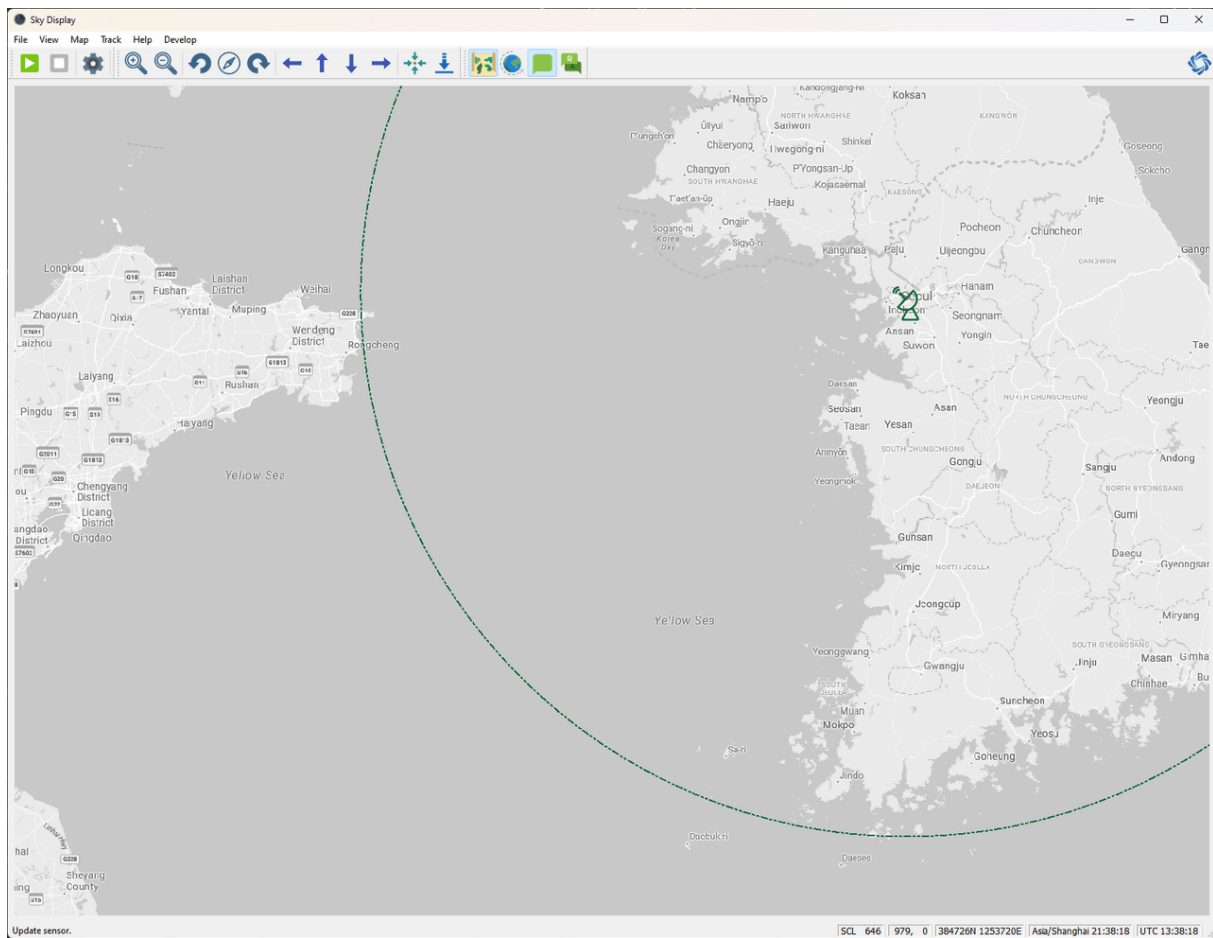


**Figure 3.13:** Road Gray

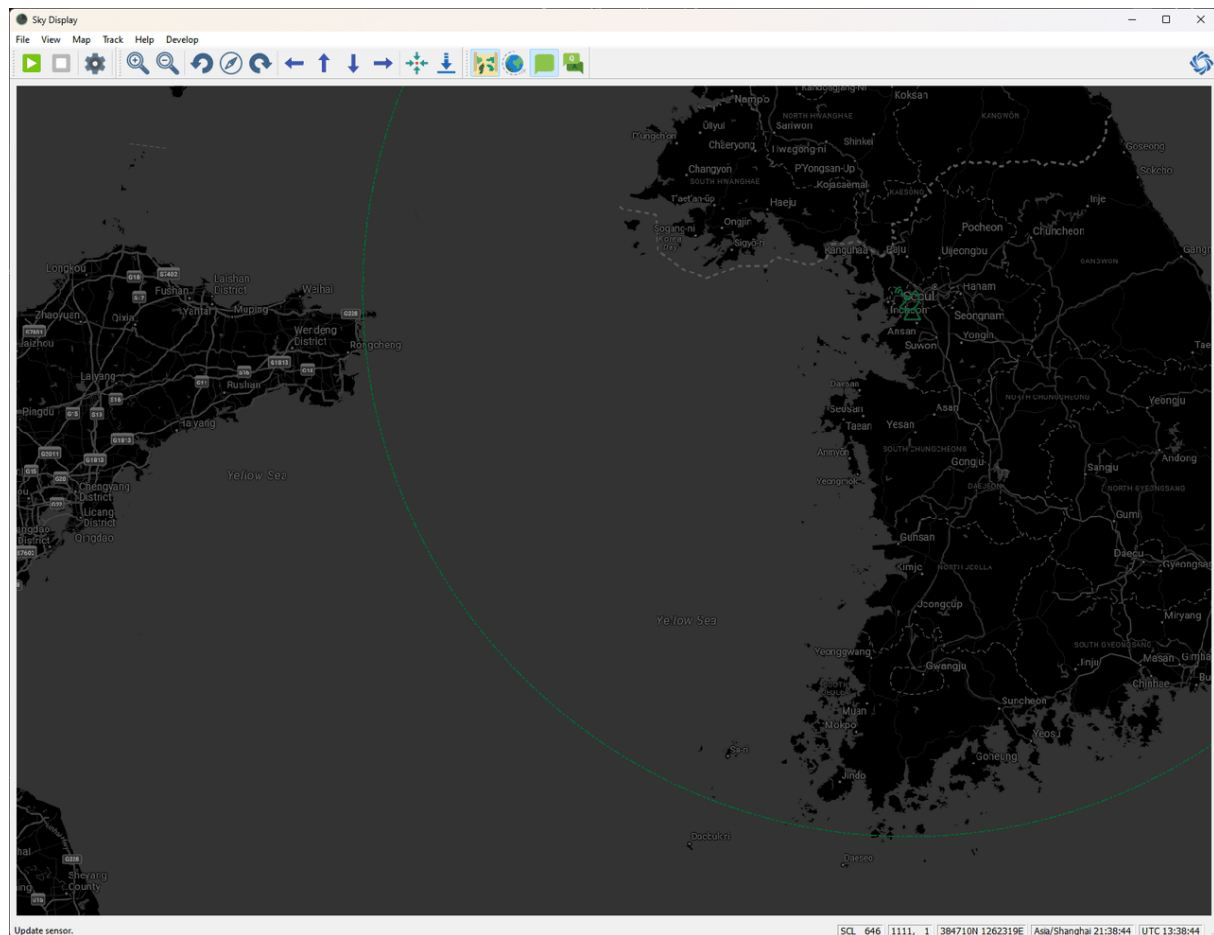


**Figure 3.14:** Road Dark

Sky Display also supports **Offline Tiles** for Bing Maps.

In Non-Internet environment, Sky Display can use pre-downloaded tile files to display tile map layer in interesting area.

**Offline Tiles Directory:** Directory to store Bing Maps offline tiles repository. This directory must be readable and writable to application.

**Prefer to Use Offline Tiles:** System will first check if needed tile file exists in offline repository. If existing, system will use offline tile and will not request to online service.

**Only Use Offline Tiles:** Even a needed tile file doesn't exist in offline repository, system will not request it to online service. This option can be used in Non-Internet environment.

**Update Offline Tiles Repository:** When one tile is downloaded from online service, system will automatically save it into offline repository.

### 3.5.3 Google Maps

Google Maps provides tiles service for all earth surface.

In *Settings - Map - Tiles Map - Google Maps*, it is possible to configure “Google Maps” service.

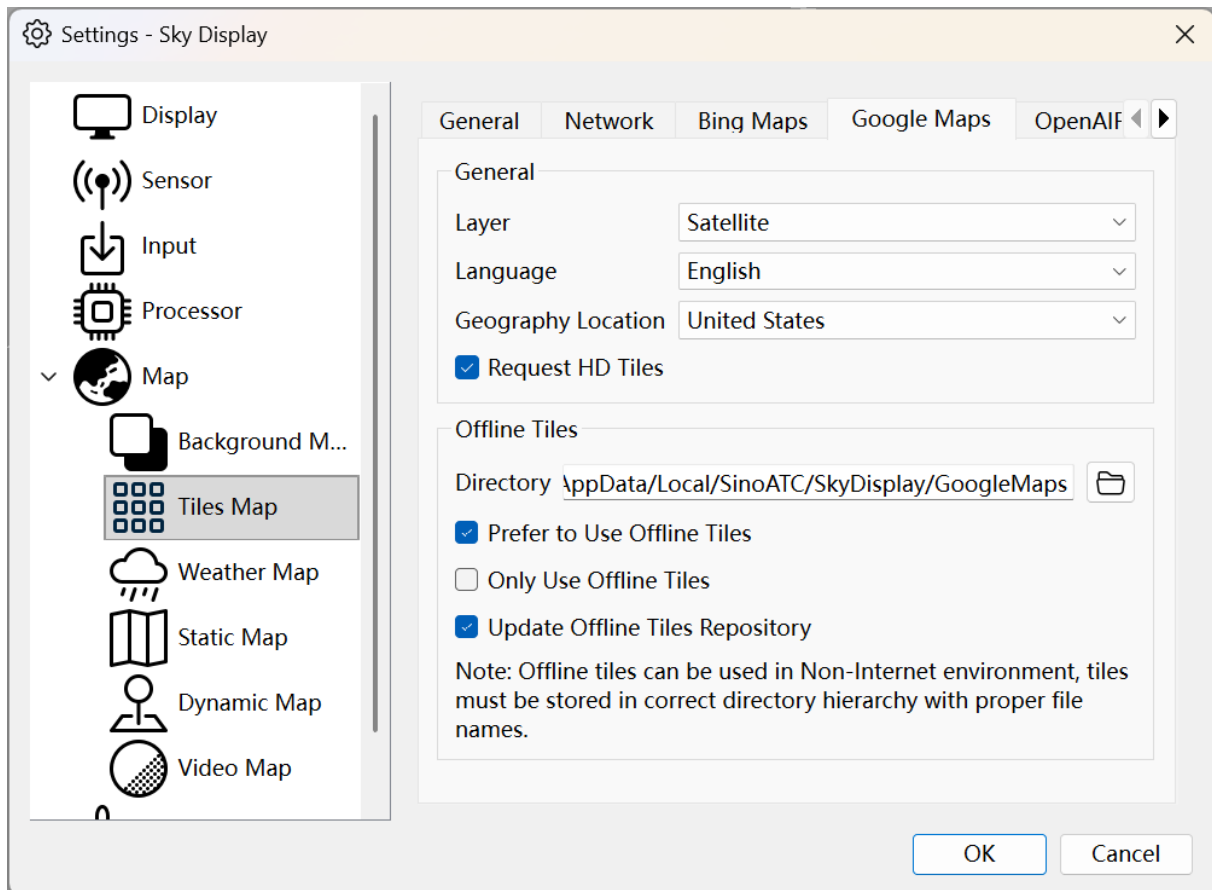


**Figure 3.15:** Google Maps Configuration

**Layer:** Google Maps supports different map layers. The supported layers are:

- Map
- Road
- Terrain
- Satellite
- Map with Terrain
- Satellite with Road
- Terrain with Road

**Language:** Language of map labels. The supported languages are the same as Bing Maps, please refer to section “Microsoft Bing Maps” .

**Geography Location:** Geography location used when requesting tiles from Google Maps service. Select the location matching the area of interest. The supported locations are:

- China
- Indonesia
- Malaysia
- Spain
- United States

**Request HD Tiles:** When selected, Google Maps serves re-rendered 512px tiles with doubled pixel density, so map text stays sharp on high-DPI screens. This option uses about four times the data volume.

Below are examples of different layers.

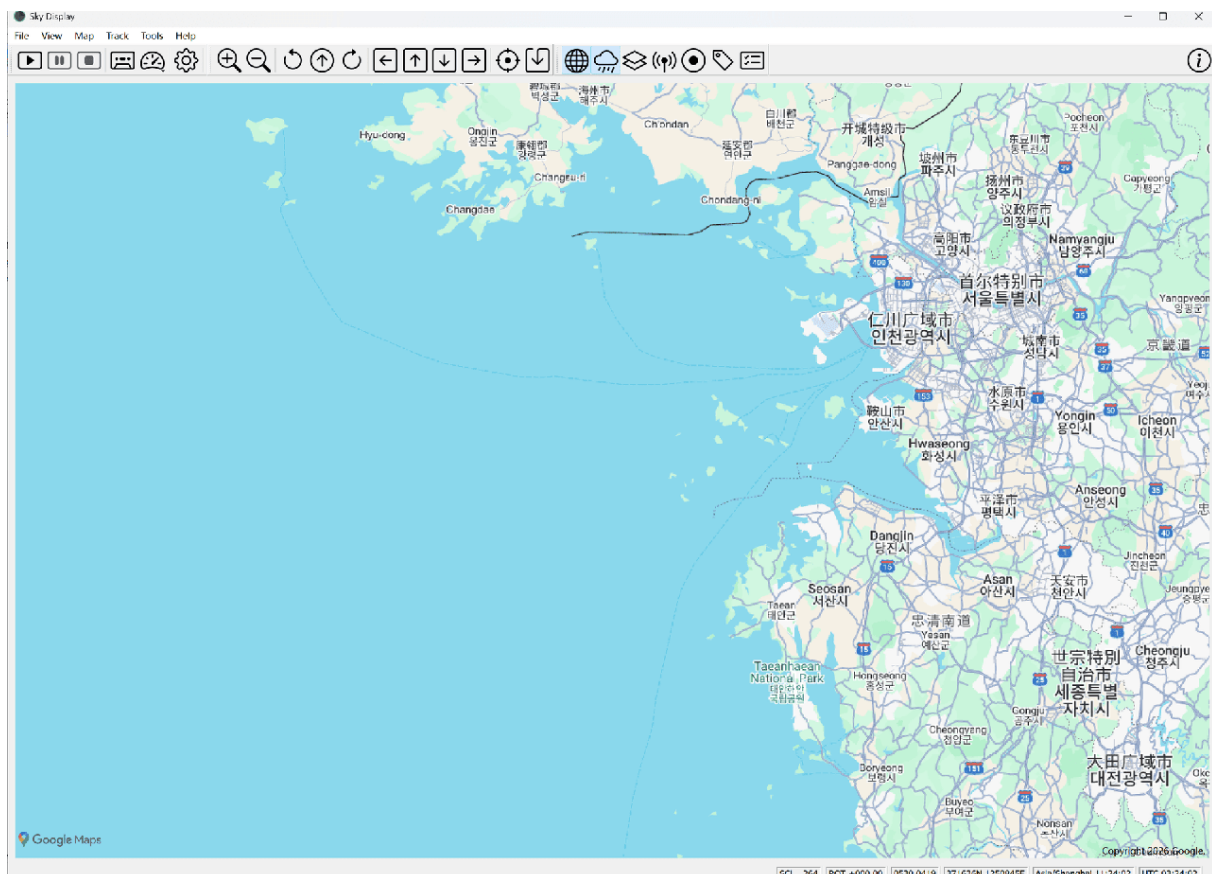


**Figure 3.16:** Map

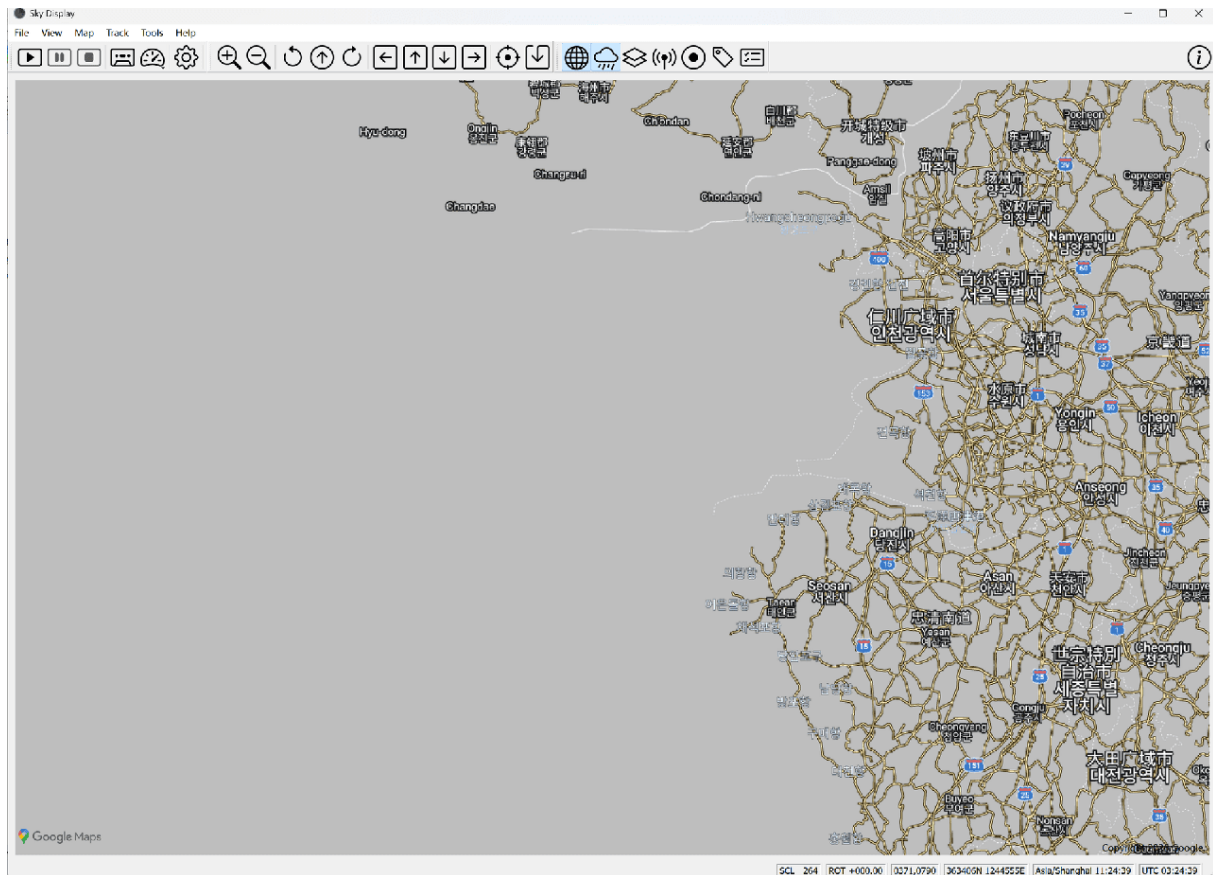


**Figure 3.17:** Road

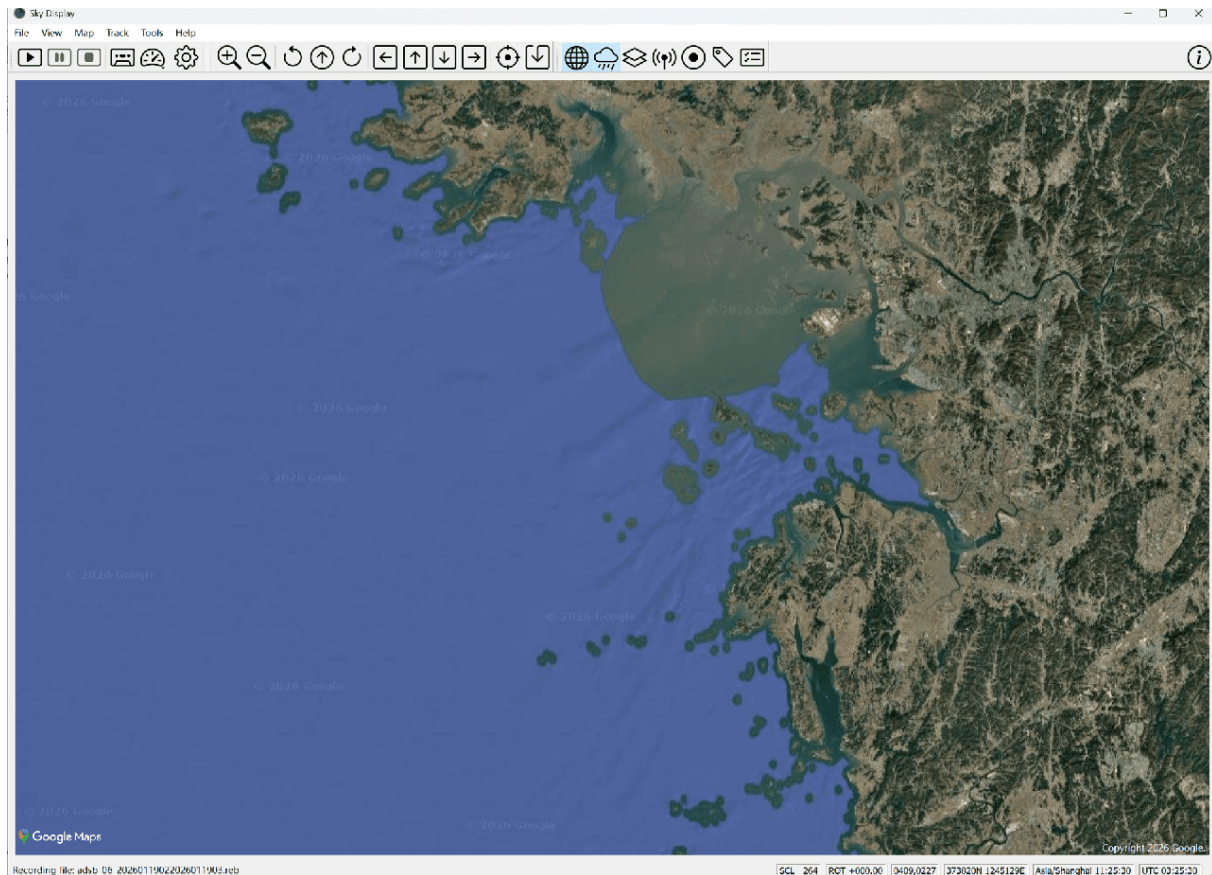


**Figure 3.18:** Satellite

Sky Display also supports **Offline Tiles** for Google Maps. The offline tiles options and behavior are the same as Bing Maps, please refer to section “Microsoft Bing Maps” .

### 3.5.4 OpenAIP

OpenAIP is a tile map service providing aeronautical charts. As it is an overlay style chart map, it is typically used as the top layer over another tile map service.

In *Settings - Map - Tiles Map - OpenAIP*, it is possible to configure “OpenAIP” service.

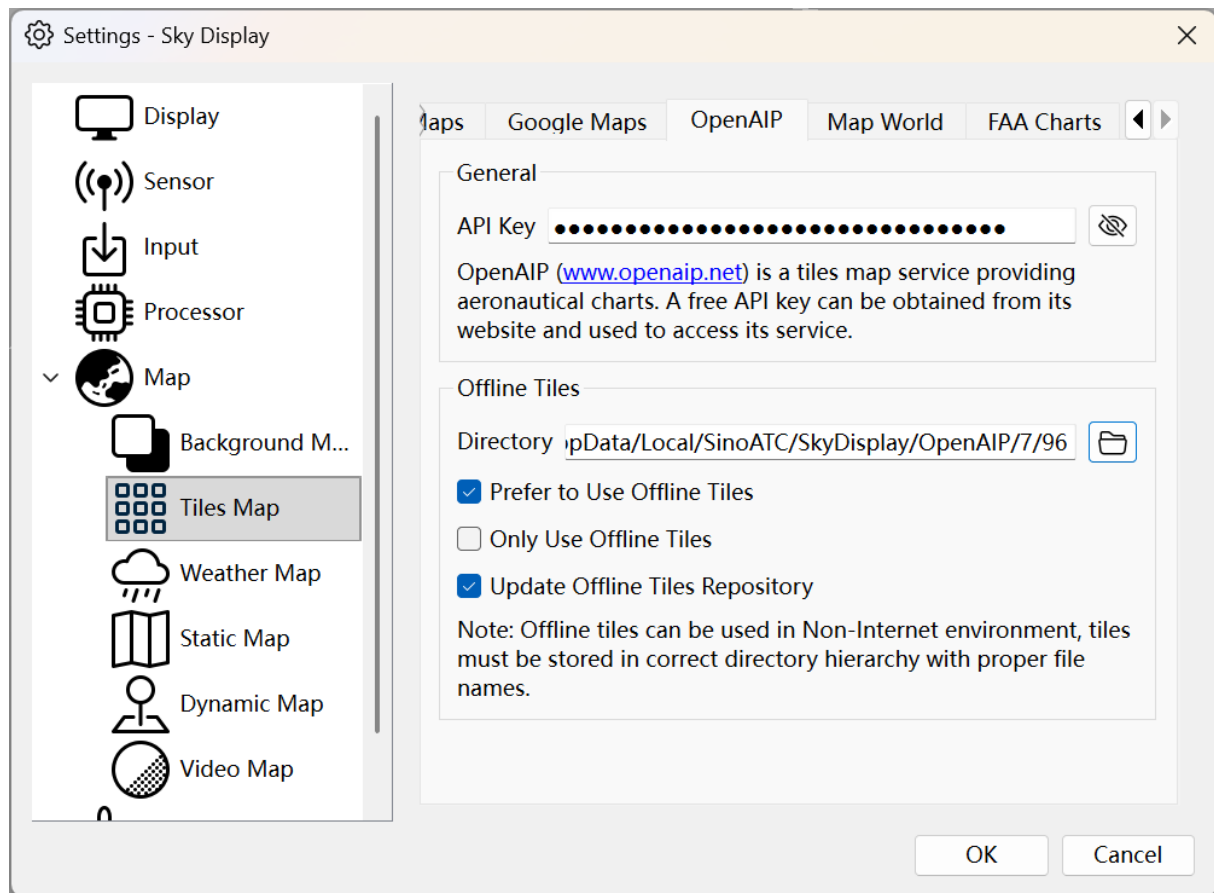


**Figure 3.19:** OpenAIP Configuration

**API Key:** A free API key can be obtained from OpenAIP website, and it is required to access OpenAIP tile map service.

Below is an example of OpenAIP aeronautical chart displayed over Bing Maps.

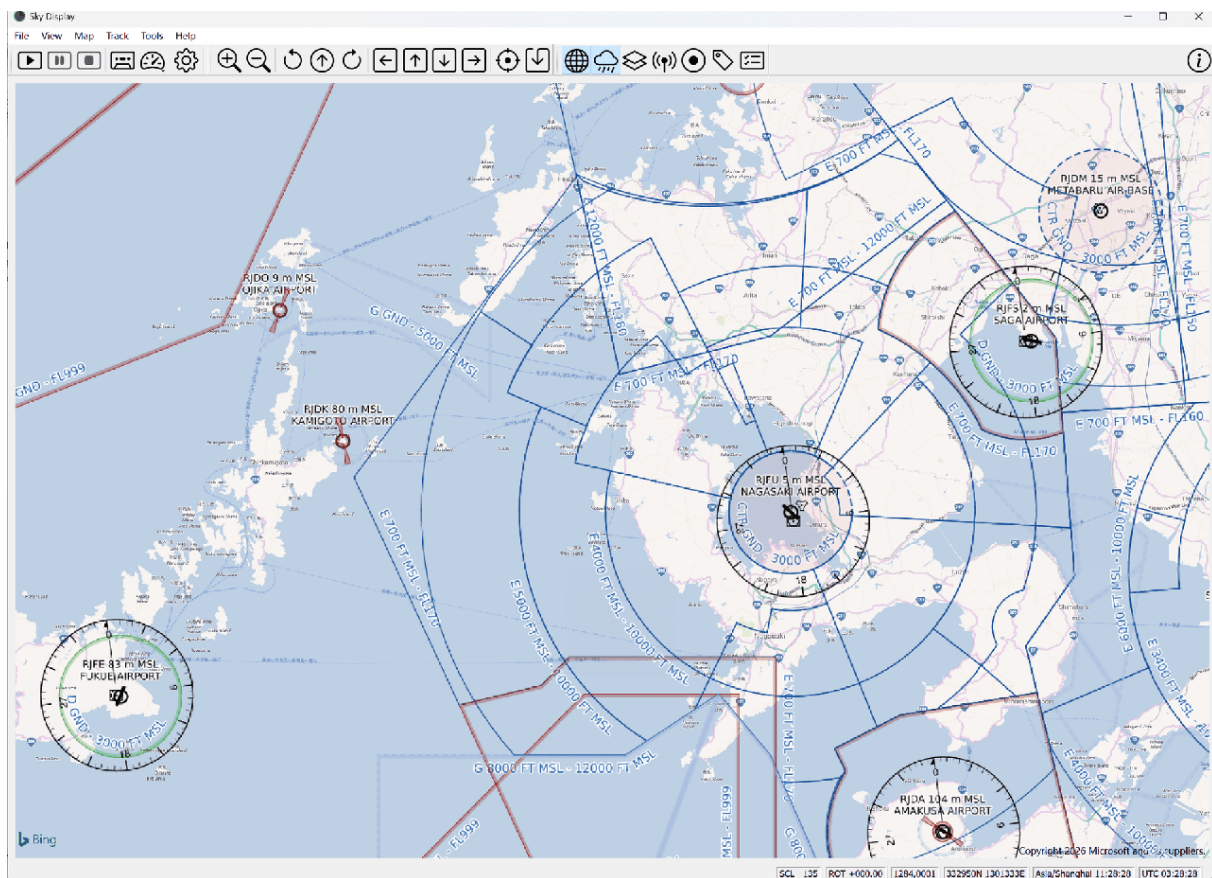


**Figure 3.20:** OpenAIP

Sky Display also supports **Offline Tiles** for OpenAIP. The offline tiles options and behavior are the same as Bing Maps, please refer to section “Microsoft Bing Maps” .

### 3.5.5 Map World (Tianditu)

Map World (Tianditu) is the national public tile map service of China. An API key is required to access the service.

In *Settings - Map - Tiles Map - Map World*, it is possible to configure “Map World” service.

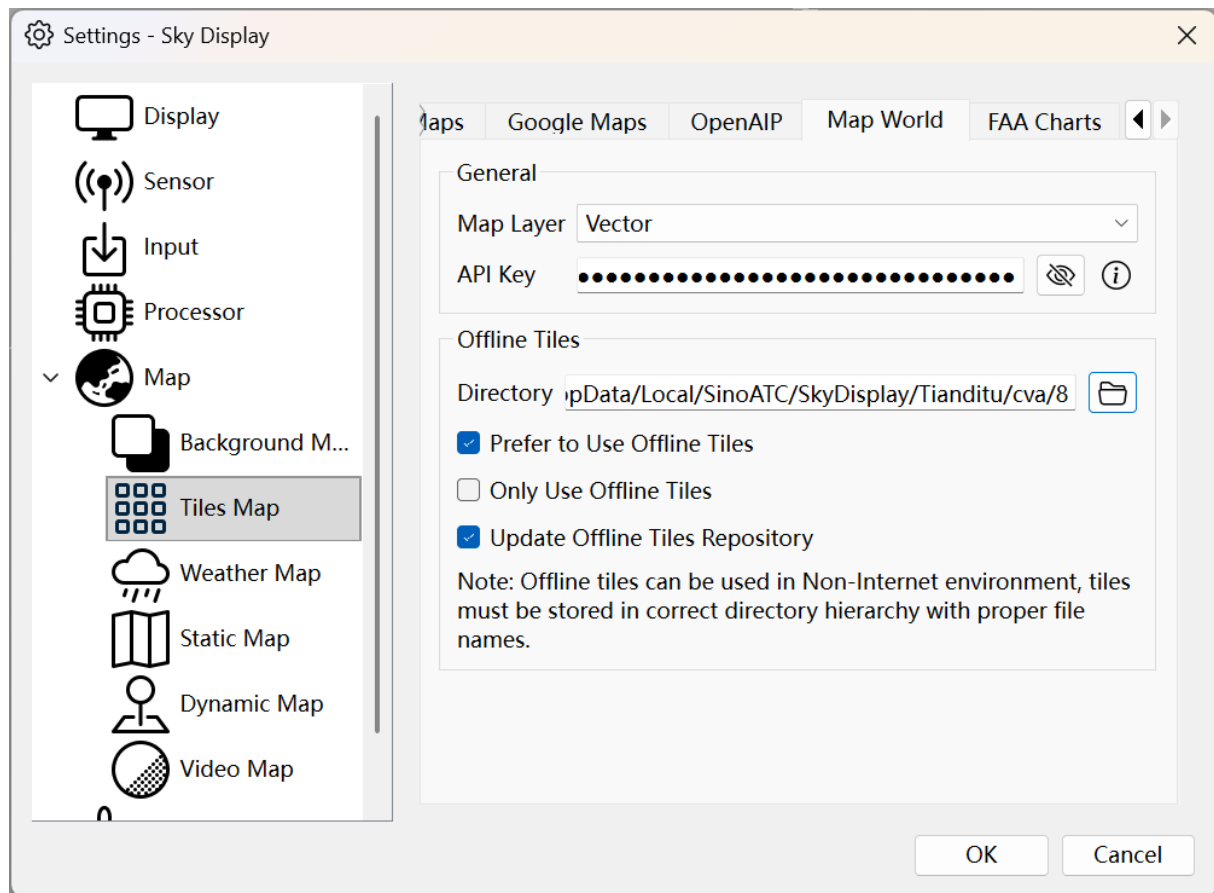


**Figure 3.21:** Map World Configuration

**Layer:** The base map layer to be requested:

- Imagery
- Vector
- Terrain

**API Key:** The service access key issued by Map World. A key can be applied for after registration on the Map World website; the info button next to the field explains the application steps.

**Offline Tiles:** The offline tiles options and behavior are the same as Bing Maps, please refer to section “Microsoft Bing Maps” .

Map World base maps can be combined with a transparent **annotation layer** containing place names, roads and boundaries. The annotation layer is provided as a separate tile service and can be selected for the top tile layer, typically over the Map World base map in the bottom layer. The annotation layer shares the API key and offline settings with the Map World base map.

### 3.5.6 FAA Aeronautical Charts

The FAA publishes public aeronautical charts which Sky Display provides as a tile map service, no API key required.

In *Settings - Map - Tiles Map - FAA Charts*, it is possible to select the chart to be displayed:

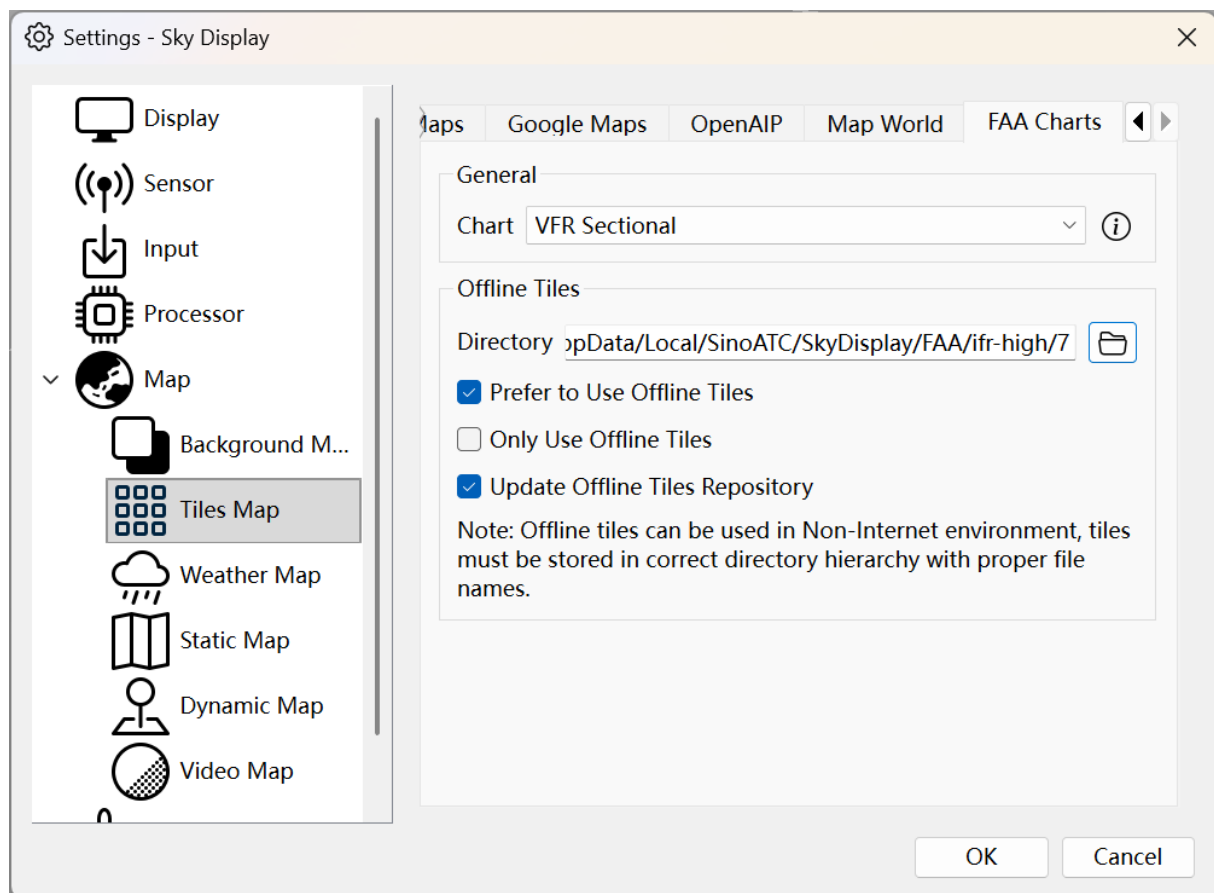


**Figure 3.22:** FAA Charts Configuration

- VFR Sectional
- VFR Terminal
- IFR AreaLow (IFR Enroute Low)
- IFR High (IFR Enroute High)

The charts cover the United States only, and each chart type has its own zoom level range. As the charts are opaque, the provider is typically used as the bottom layer.

**Offline Tiles:** The offline tiles options and behavior are the same as Bing Maps, please refer to section “Microsoft Bing Maps” . Offline tiles are stored per chart type.

### 3.6 Static Maps

Static maps are vector maps over tile map layer.

Static maps are defined by user in XML or binary files. Sky Display will load static map files on startup, extract information, and paint them over tile map layer.

The information stored in static map files are geodetic data. For example, a country border line is a polygon with many vertex points, each point has a longitude and latitude. Sky Display will first map all geodetic points with WGS-84 coordinate to an X-Y point on projection plane, and later map each point to a pixel on map display. As all these conversion and mapping are dynamic, it doesn't lose any accuracy or resolution during map zooming, panning or rotating.

Static map layer can contain different sublayers, in "Static Maps" window, it is possible to enable and disable the display of each sublayer.

For checked sublayers, system will decide to display it or hide it according to current zooming, and options in static map index file.

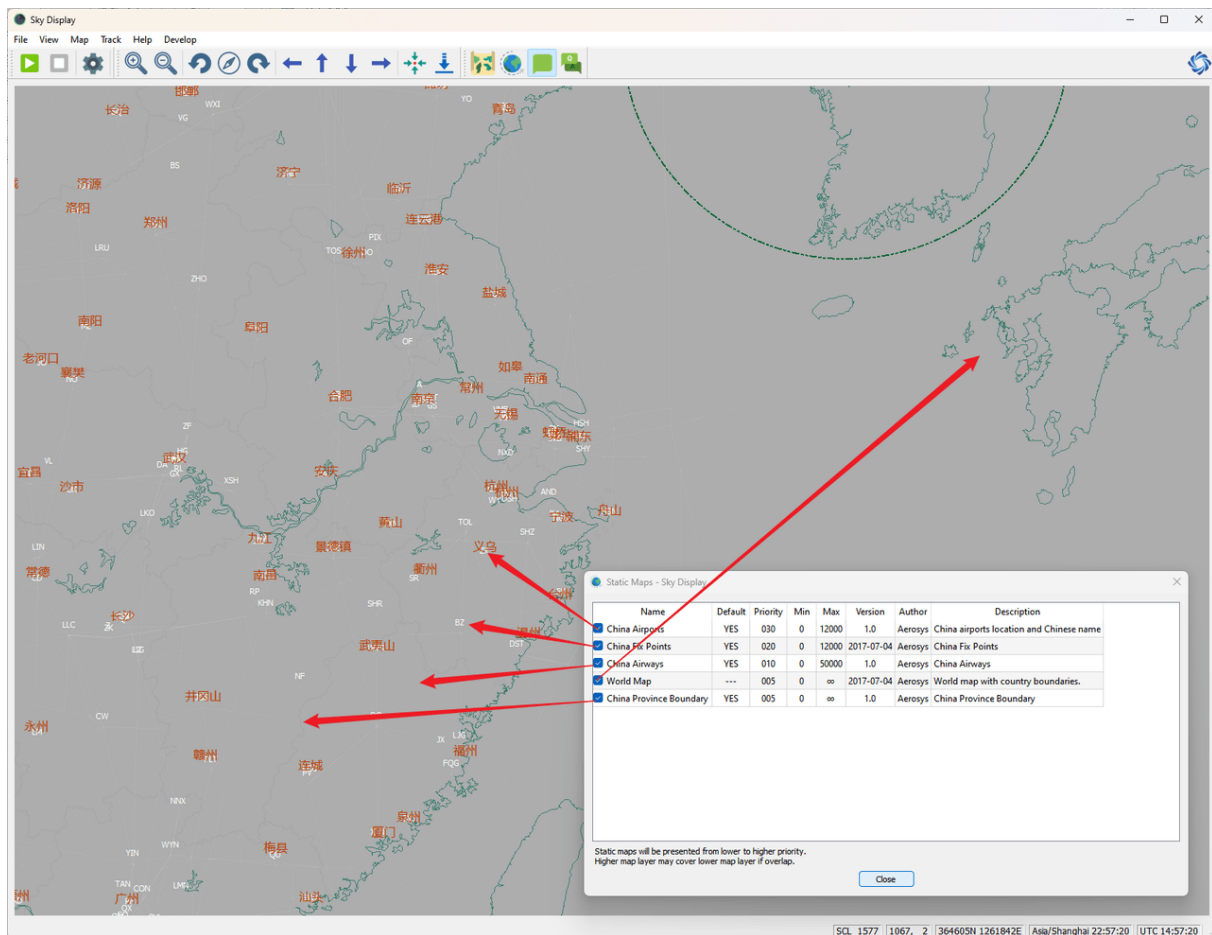


Figure 3.23: Static Maps Window

### 3.6.1 Configuration

In *Settings - Map - Static Maps*, it is possible to configure static map service.

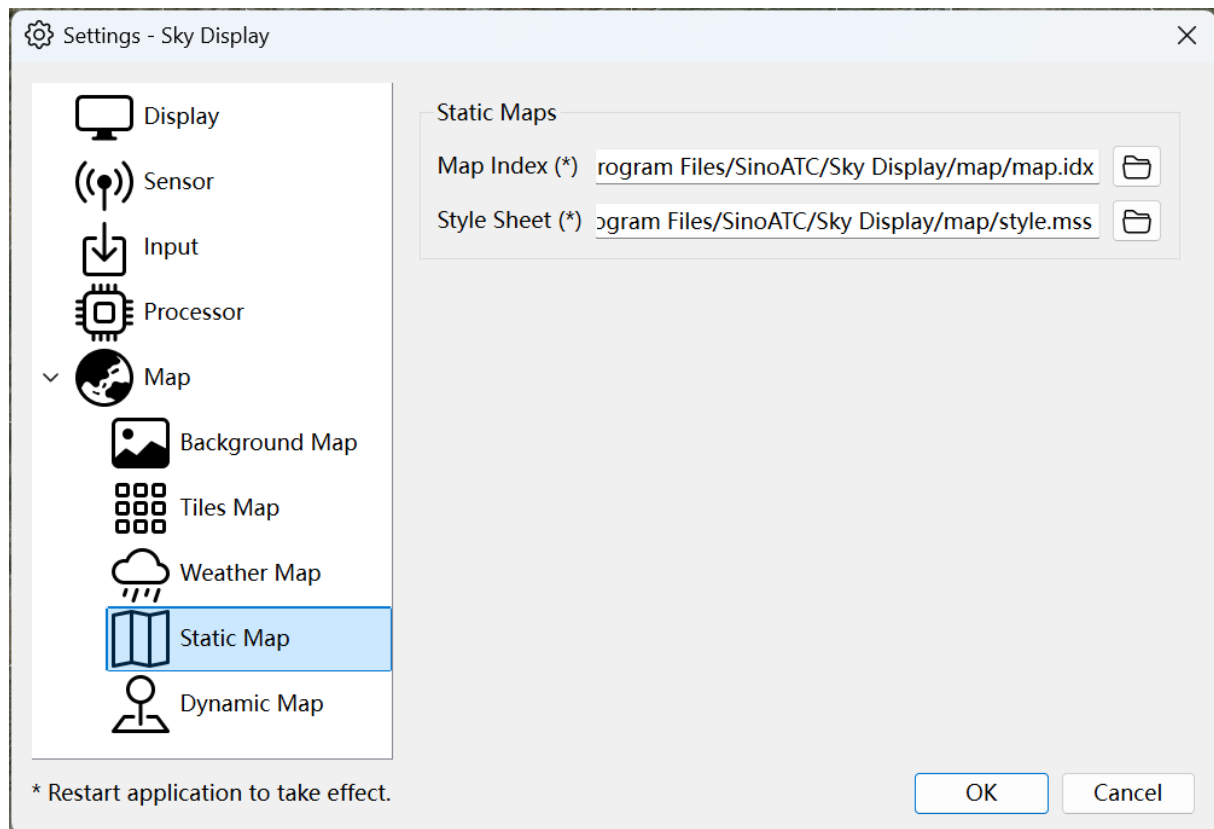


**Figure 3.24:** Static Maps Configuration

**Map Index:** Static map index file.

**Style Sheet:** Static map style sheet file.

**\*\*Symbol Size (\*\*):** The default size of static map point symbols: Small (24x24 Pixel), Medium (32x32 Pixel), or Large (48x48 Pixel). The default is Medium. Restart the application to take effect.

Static map elements are colored by the style sheet. The style class matching the class attribute of an element group defines the color of all elements in the group, including point symbols such as VOR/DME and waypoint symbols. Point symbols are rendered as vector graphics and stay sharp on high-DPI displays.

### 3.6.2 Map Editor

Static maps can be created and edited with the standalone “Map Editor” application. It can be launched from menu *Tools -> Static Map Editor*, or by running `map-editor.exe` in the application directory.

The Map Editor opens and saves SkyXML map files (.xml), exports compiled SkyBinary map files (.map), and imports Legacy format maps. Elements are organized in groups, edited in a property panel with a coordinate table, and the map is shown in a live preview that renders the map exactly as Sky Display does. An undo/redo history and polyline/polygon conversion are available.

For detailed information of static map files, please go to section “Static Map ICD” .

## 3.7 Dynamic Maps

Dynamic maps are maps generated dynamically by Sky Display. Dynamic maps are painted over static map layer.

There are four types of dynamic map.

- Sensor Map
- Range Rings
- Weather Map
- Video Map

### 3.7.1 Sensor Map

Sensor map is generated by using sensor configuration.

It contains a sensor location symbol, to indicate the location and type of sensor. It also contains a coverage circle, to indicate the theoretical coverage of sensor.

From menu *Map* -> *Toggle Sensor Map*, it's possible to toggle the display of sensor map.

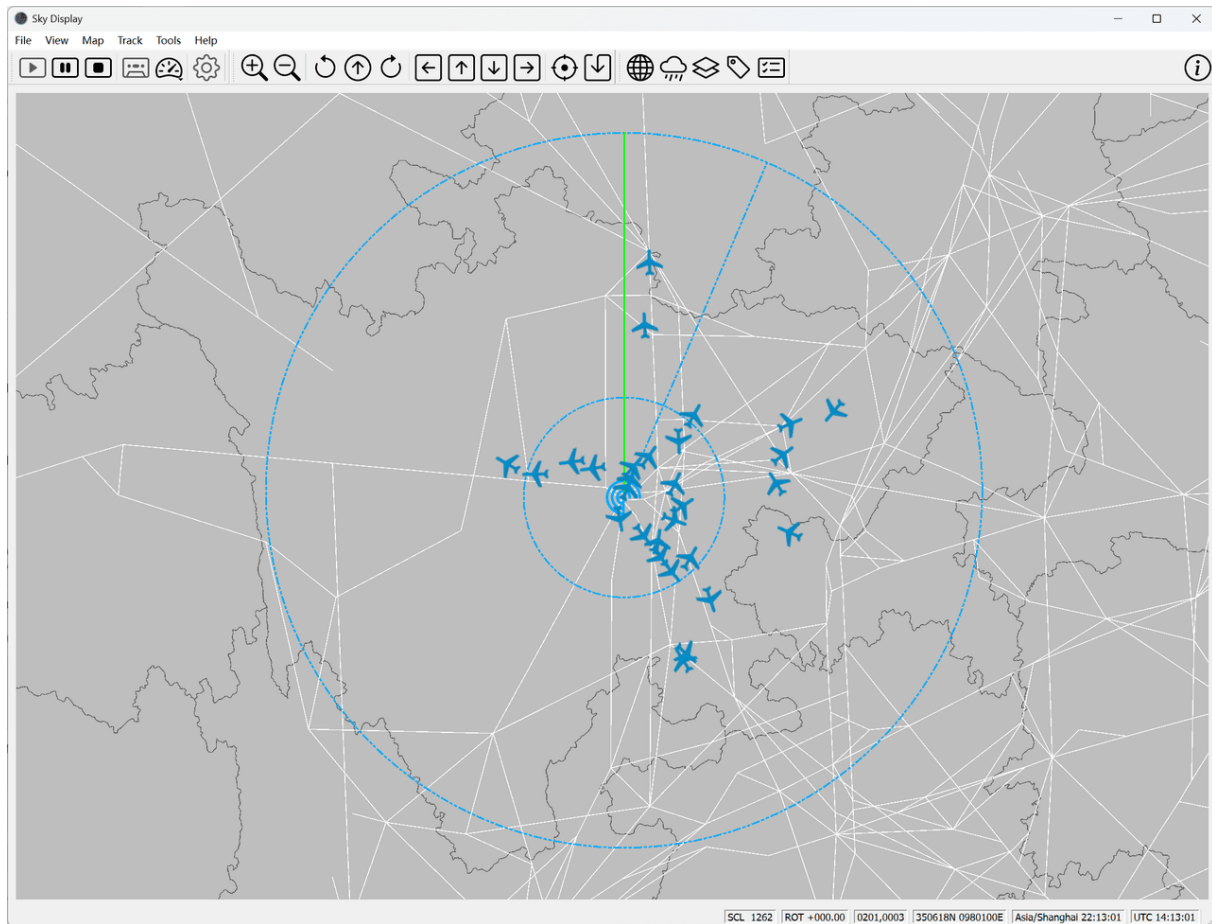


**Figure 3.25:** Sensor Map

In “Settings - Map - Dynamic Map - Sensor” , it is possible to configure the sensor map:

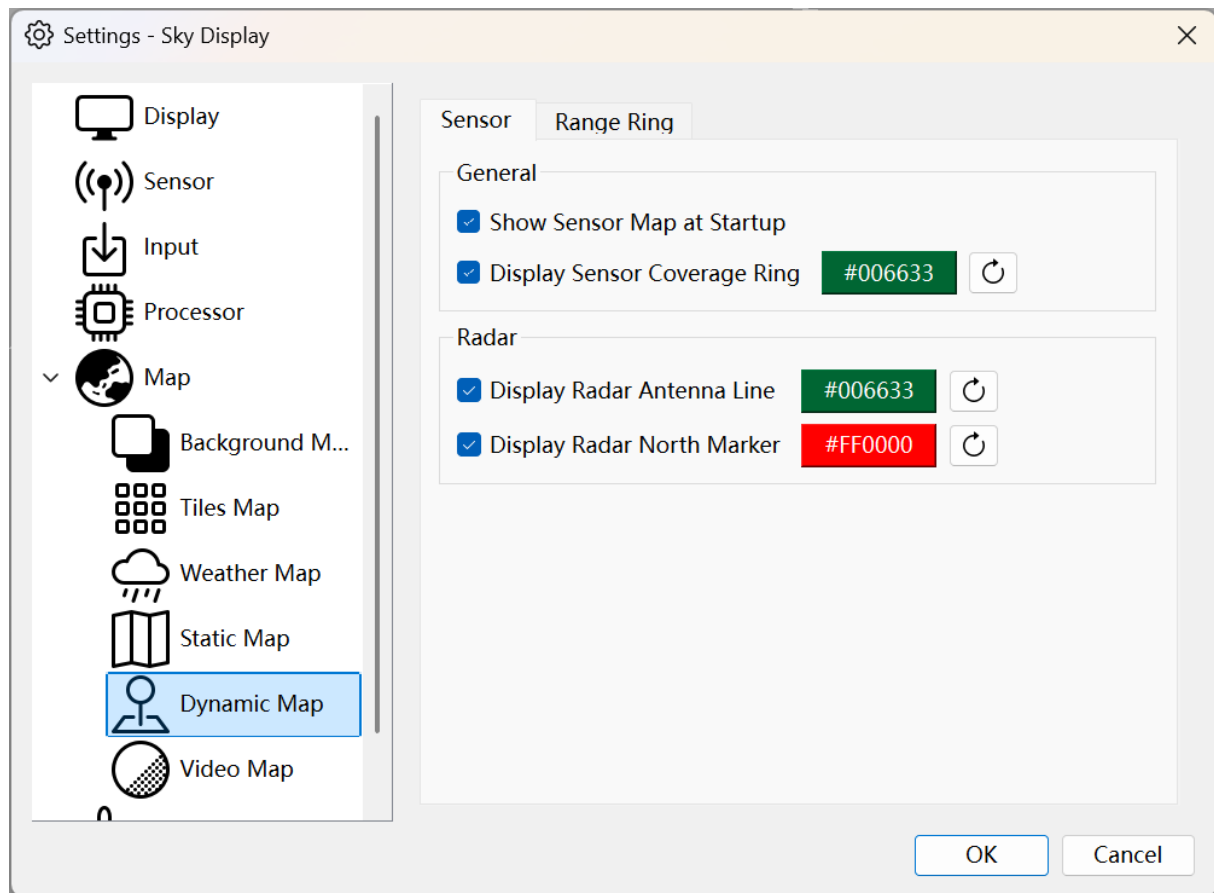


**Figure 3.26:** Sensor Map Configuration

**Display Sensor Map on Startup:** Show the sensor map automatically when the application starts.

**Display Sensor Coverage:** Show or hide the sensor coverage circles.

**Sensor Symbol Color:** The color of the sensor symbol.

**Display Radar Antenna Line** and **Antenna Line Color:** Show or hide the radar antenna rotation line, and select its color.

**Display Radar North Marker** and **North Marker Color:** Show or hide the radar north marker, and select its color.

### 3.7.2 Range Rings

Range rings are a series of concentric circles displayed on map.

I contains a center dot, and a number of concentric circles with same distance among them.

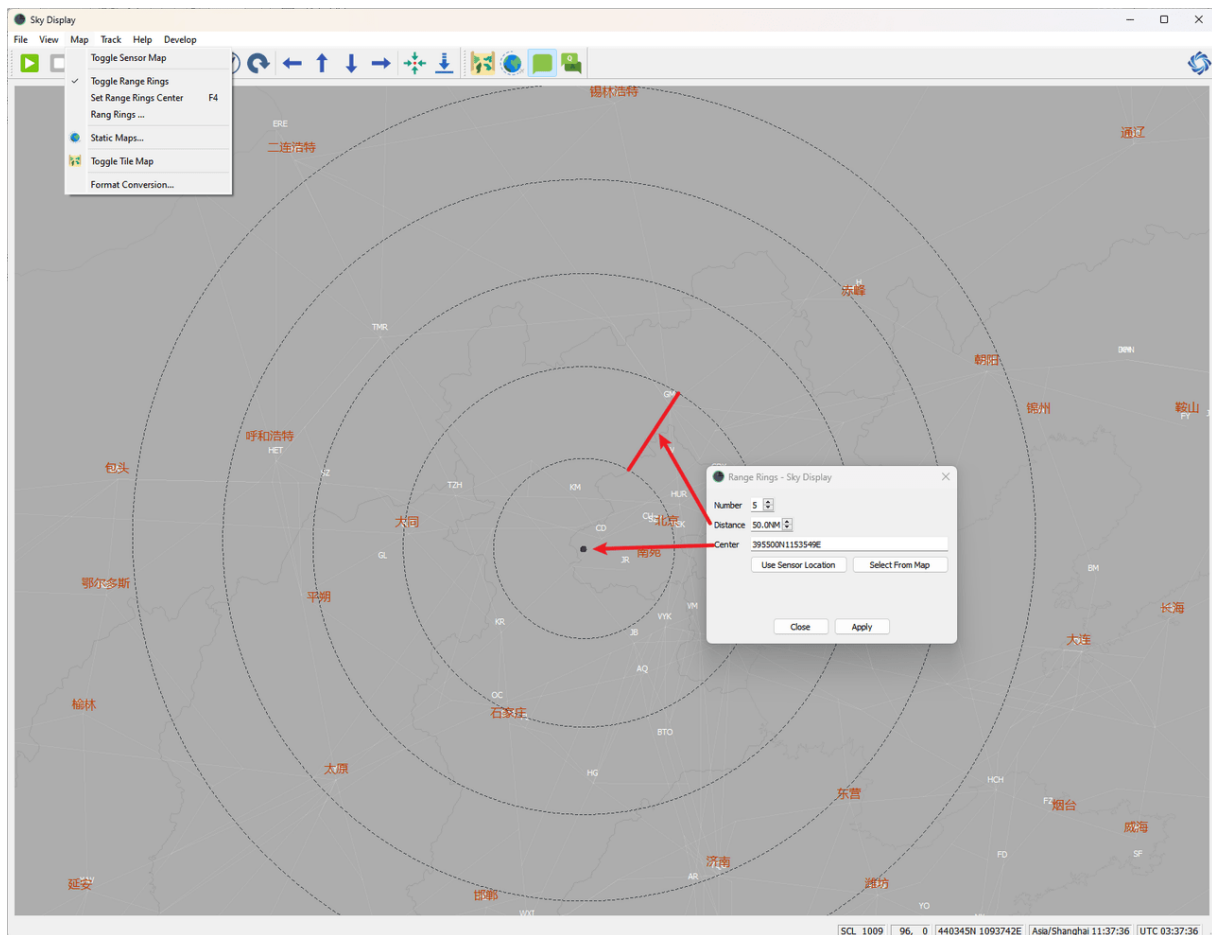


**Figure 3.27:** Range Rings

From menu *Map* -> *Toggle Range Rings*, it's possible to toggle the display of range rings.

From menu *Map* -> *Set Range Rings Center*, it's possible to set range rings' center by clicking on map.

From menu *Map* -> *Range Rings*, it will open Range Rings configuration window, and more configurations can be set in this window.

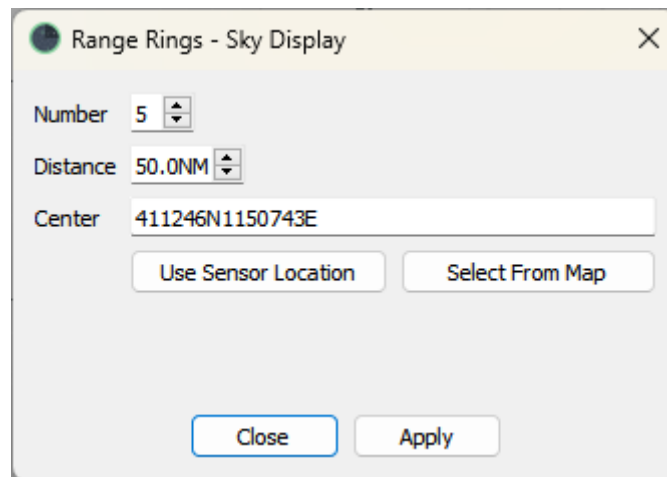


**Figure 3.28:** Range Rings Configuration

**Number:** The number of rings, from 1 to 10.

**Distance:** The radial distance between each two rings, from 0.1 to 50 NM.

**Center:** The WGS-84 coordinate of center point.

**Use Sensor Location:** Set center to be the same with sensor location.

**Select From Map:** Set center by clicking on map.

In “*Settings - Map - Dynamic Map - Range Ring*” , it is possible to configure the default appearance of range rings:

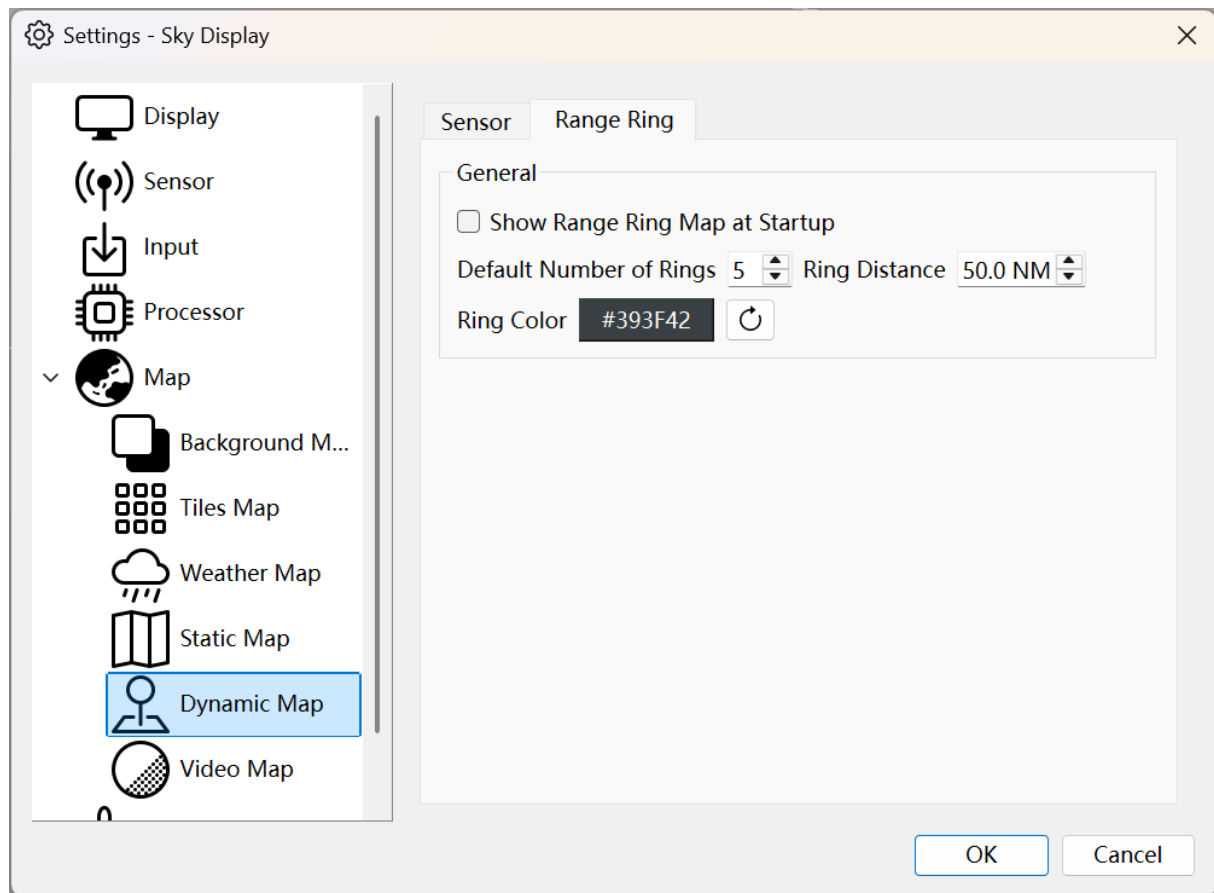


**Figure 3.29:** Range Ring Map Configuration

**Display Range Ring Map on Startup:** Show the range rings automatically when the application starts.

**Default Number of Rings:** The initial number of rings of the range ring map.

**Ring Distance:** The initial radial distance between each two rings, in NM.

**Ring Color:** The color of the range rings.

### 3.7.3 Weather Map

Weather map displays weather pictures received in ASTERIX CAT8 messages from radar sensors.

A weather picture is made of polar vectors anchored to the radar site. Each vector is colored according to its weather intensity level (0-7).

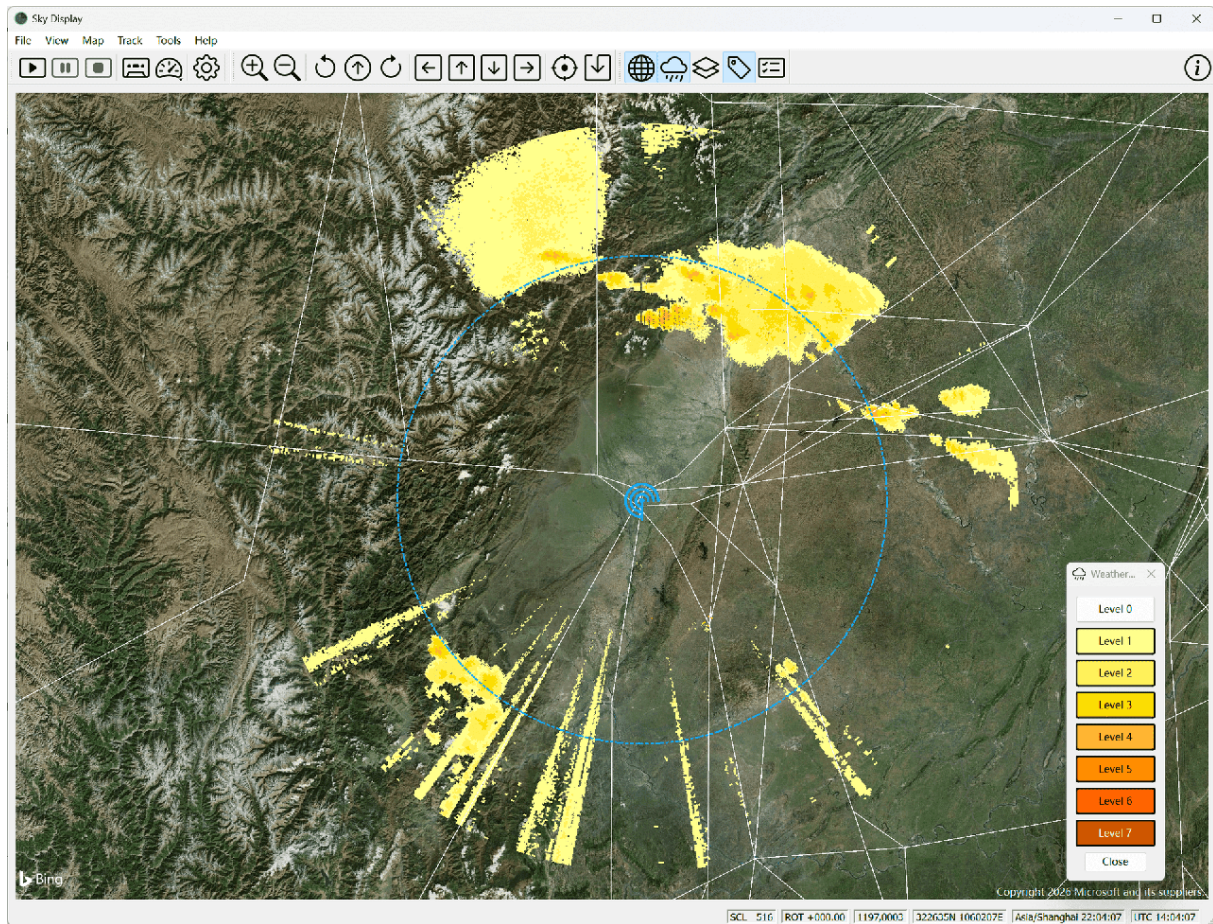


**Figure 3.30:** Weather Map

From menu *Map -> Toggle Weather Map* or from the map toolbar, it's possible to toggle the display of weather map.

In “*Settings - Map - Weather Map*” , more configurations can be set.

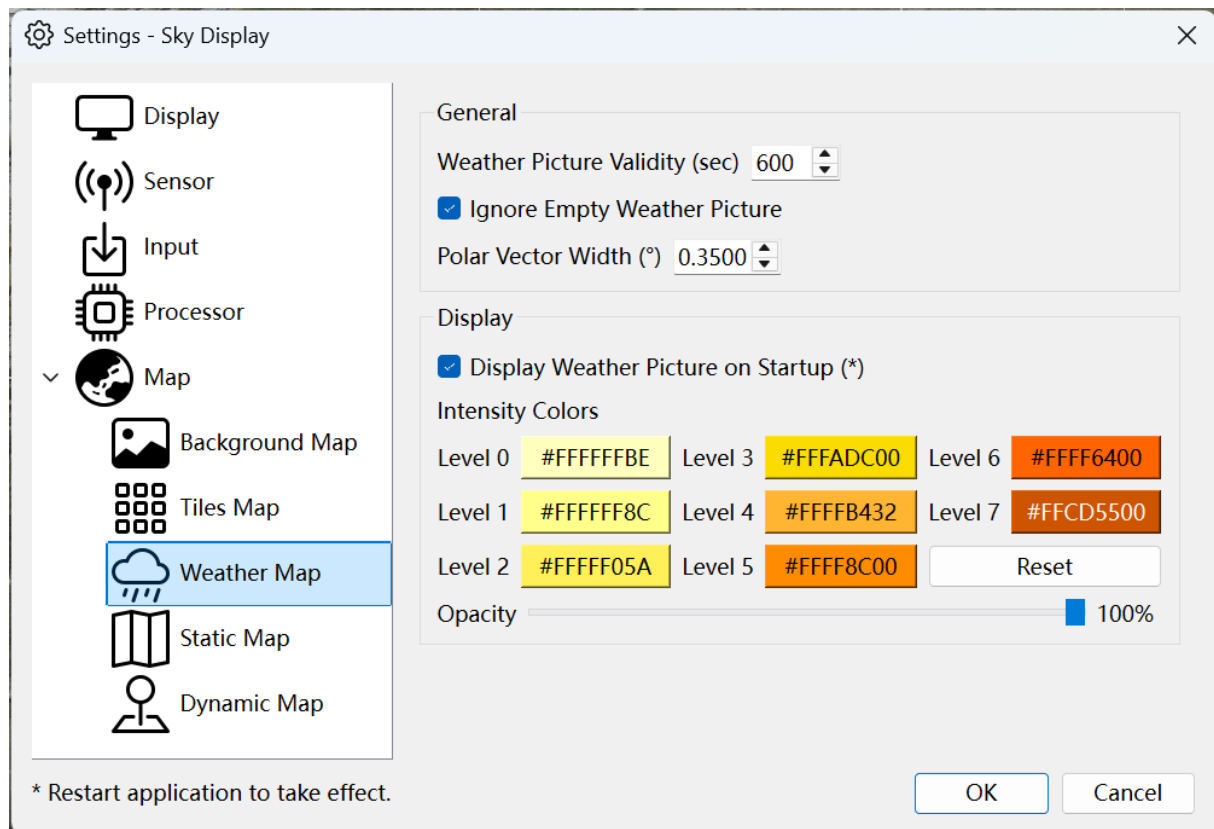


**Figure 3.31:** Weather Map Configuration

**Display Weather Picture on Startup:** Show weather map automatically when the application starts.

**Intensity Colors:** The color of each intensity level (0-7). A predefined color scheme can be selected, and each level can also be customized individually with a color picker. Additional color schemes can be loaded from a `weather-color-scheme.json` file in the application directory.

**Opacity:** Global opacity of the weather picture.

**Weather Picture Validity (sec):** How long a weather picture stays valid. Expired pictures are removed from the map. 0 means the picture never expires.

**Automatic Polar Vector Width:** Draw each polar vector with the radar's azimuth sampling step derived from the weather picture, so that adjacent vectors tile seamlessly at every range. When the spacing cannot be derived from the picture (e.g. too few vectors), the default vector width is used instead.

**Default Polar Vector Width:** The angular width of each polar vector, in degrees. Used as-is when "Automatic Polar Vector Width" is disabled, and as the fallback width when the spacing cannot be

derived from the picture.

**Ignore Empty Weather Picture:** Drop received weather pictures that contain no vectors, so that they do not overwrite the current picture.

From menu *Map -> Weather Intensity*, it opens the “Weather Intensity Window”, where each intensity level (0-7) can be shown or hidden individually. Each level button is painted with the color of the level, so it is easy to identify which level is currently displayed.

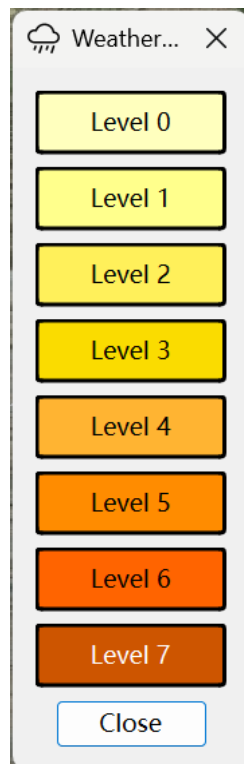


**Figure 3.32:** Weather Intensity Window

### 3.7.4 Video Map

Video map displays radar video echoes received in ASTERIX CAT240 video messages from SMR (surface movement radar) sensors. It is the topmost map layer, painted above all other maps, so the video is displayed over static, dynamic and tile maps like on a traditional radar video display.

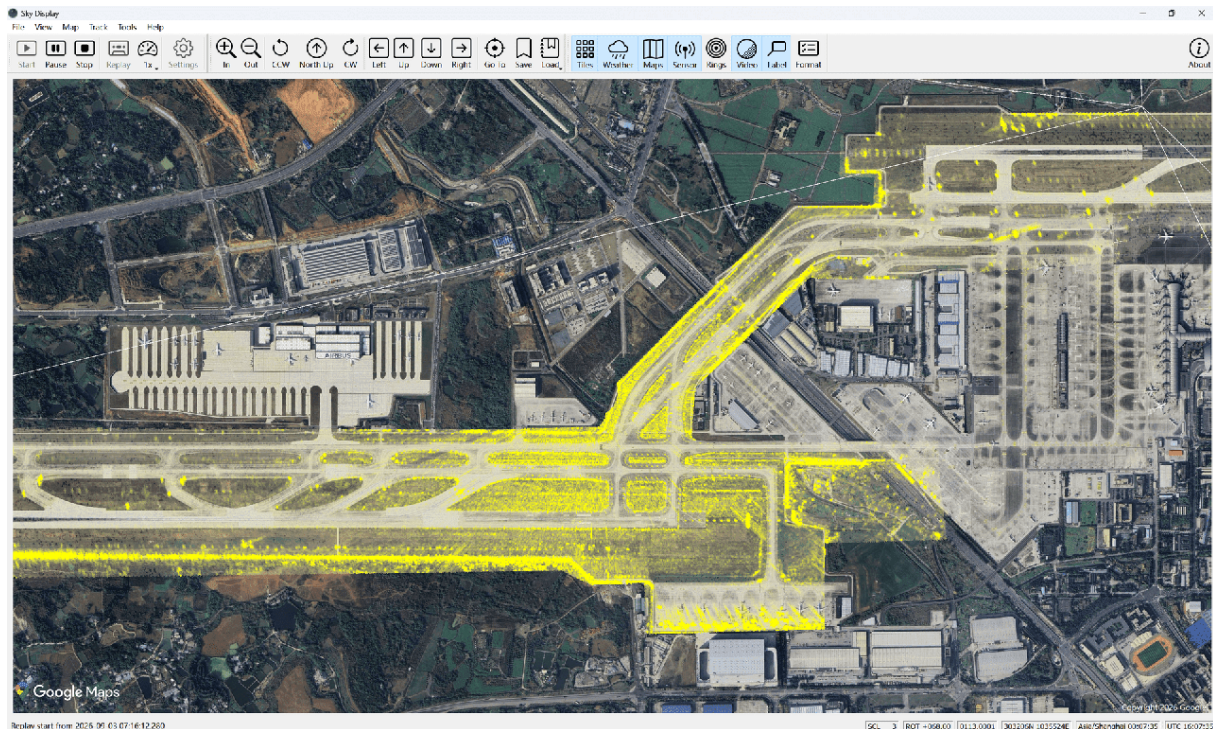


**Figure 3.33:** Video Map

The video is anchored to the site of the configured SMR sensor, so a sensor of type “SMR” must be configured and selected. The ACP value in the sensor settings (azimuth count pulses per antenna rotation) determines the azimuth resolution of the video picture.

From menu *Map -> Toggle Video Map* or from the map toolbar, it's possible to toggle the display of video map.

In “*Settings - Map - Video Map*” , more configurations can be set.

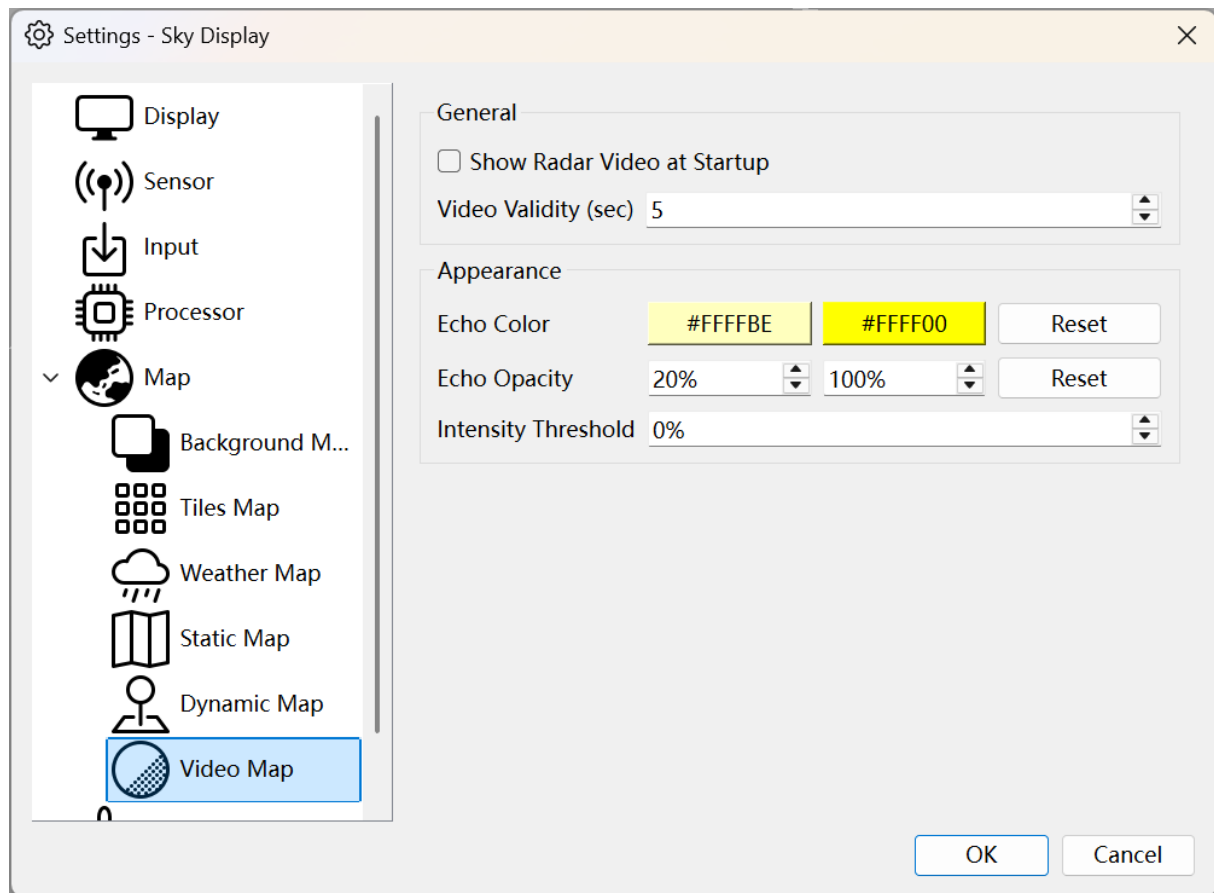


**Figure 3.34:** Video Map Configuration

**Show Radar Video at Startup:** Show the video map automatically when the application starts.

**Video Validity (sec):** How long the video picture stays valid. An expired picture is removed from the map. 0 means the picture never expires.

**Echo Color:** The color of video echoes. Weak echoes are drawn with the low echo color, strong echoes with the high echo color, and colors in between are interpolated.

**Echo Opacity:** The transparency of video echoes. Weak and strong echoes have separate opacity settings; echoes in between are interpolated.

**Intensity Threshold (%):** Video cells with an amplitude below this percentage of the full scale are not displayed.

## 4 Sensor

### 4.1 Overview

Sky Display is able to display surveillance data from variant types of sensors, including

- Radar (Primary, Secondary and Mode-S)
- SMR (Surface Movement Radar)
- ADS-B
- MLAT (MLAT and WAM)
- SDPS

As different sensor has different characteristics and different parameters, user must properly define all parameters in Sky Display to have received be correctly decoded, processed and presented.

### 4.2 Configuration

In *Settings* -> *Sensor*, it's possible to find all configurations related to sensor.

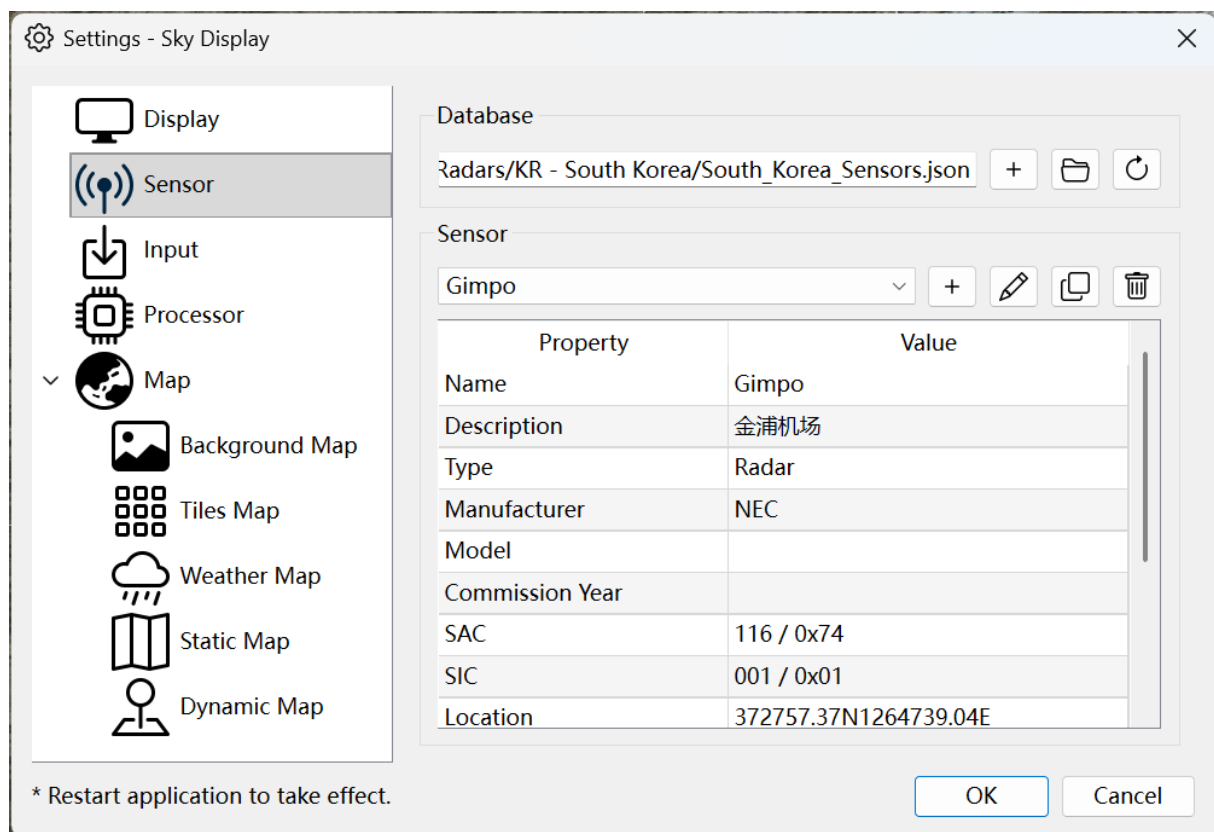


**Figure 4.1:** Sensor Configuration

#### 4.2.1 Database

System is able to save sensor parameters into a sensor database, and load later. So it is not necessary to reconfigure all sensor parameters when connecting Sky Display to a different sensor.

The sensor database is a JSON format plain text file.

**Database:** Location of the database JSON file.

**New:** Create a new sensor database file.

**Open:** Open an existing sensor database file.

**Reload (F5):** Reload sensors from the database file.

#### 4.2.2 Sensor

**Sensor List:** Drop-down list of sensors stored in the database, sorted alphabetically. If the database contains sensors with duplicated names, the duplicated names are renamed automatically when the

database is loaded.

**New:** Create a new sensor and edit its parameters in the “Sensor Window” .

**Edit:** Edit the parameters of the selected sensor in the “Sensor Window” .

**Duplicate:** Create a new sensor by copying the selected sensor.

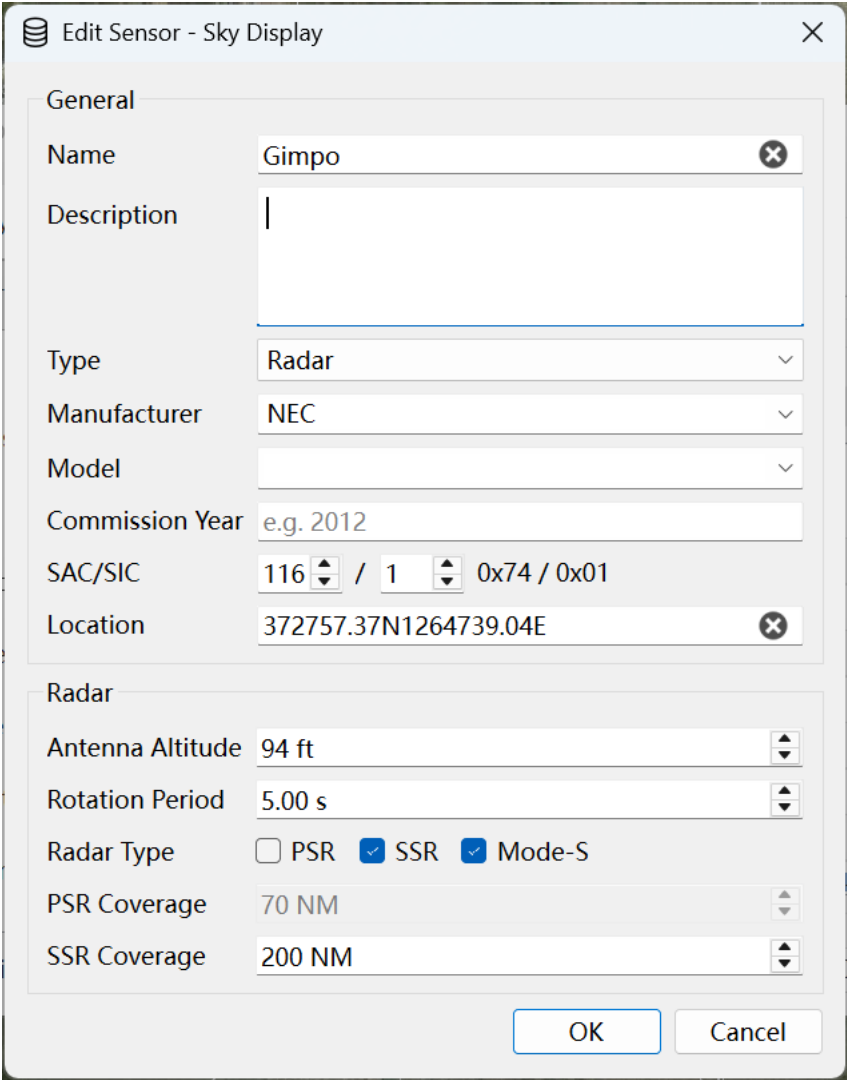
**Delete:** Delete the selected sensor from the database.

**Parameter Table:** The table below shows all parameters of the selected sensor. SAC/SIC codes are shown in hexadecimal.

### 4.2.3 Sensor Window

The “Sensor Window” is used to create or edit a sensor. It contains a General group and a type-specific group.

#### 4.2.3.1 General



The screenshot shows a dialog box titled "Edit Sensor - Sky Display" with a close button (X) in the top right corner. The dialog is divided into two sections: "General" and "Radar".

**General Section:**

- Name:** A text field containing "Gimpo" with a clear button (X) on the right.
- Description:** A large empty text area.
- Type:** A dropdown menu showing "Radar".
- Manufacturer:** A dropdown menu showing "NEC".
- Model:** A dropdown menu.
- Commission Year:** A text field with the placeholder "e.g. 2012".
- SAC/SIC:** Two spinners showing "116" and "1", followed by a slash and two more spinners showing "0x74" and "0x01".
- Location:** A text field containing "372757.37N1264739.04E" with a clear button (X) on the right.

**Radar Section:**

- Antenna Altitude:** A spinner showing "94 ft".
- Rotation Period:** A spinner showing "5.00 s".
- Radar Type:** Three checkboxes: "PSR" (unchecked), "SSR" (checked), and "Mode-S" (checked).
- PSR Coverage:** A spinner showing "70 NM".
- SSR Coverage:** A spinner showing "200 NM".

At the bottom right of the dialog are "OK" and "Cancel" buttons.

**Figure 4.2:** Sensor Window General

**Name:** Name of sensor, it must be unique in sensor database.

**Description:** Free text description of sensor.

**Type:** Type of sensor.

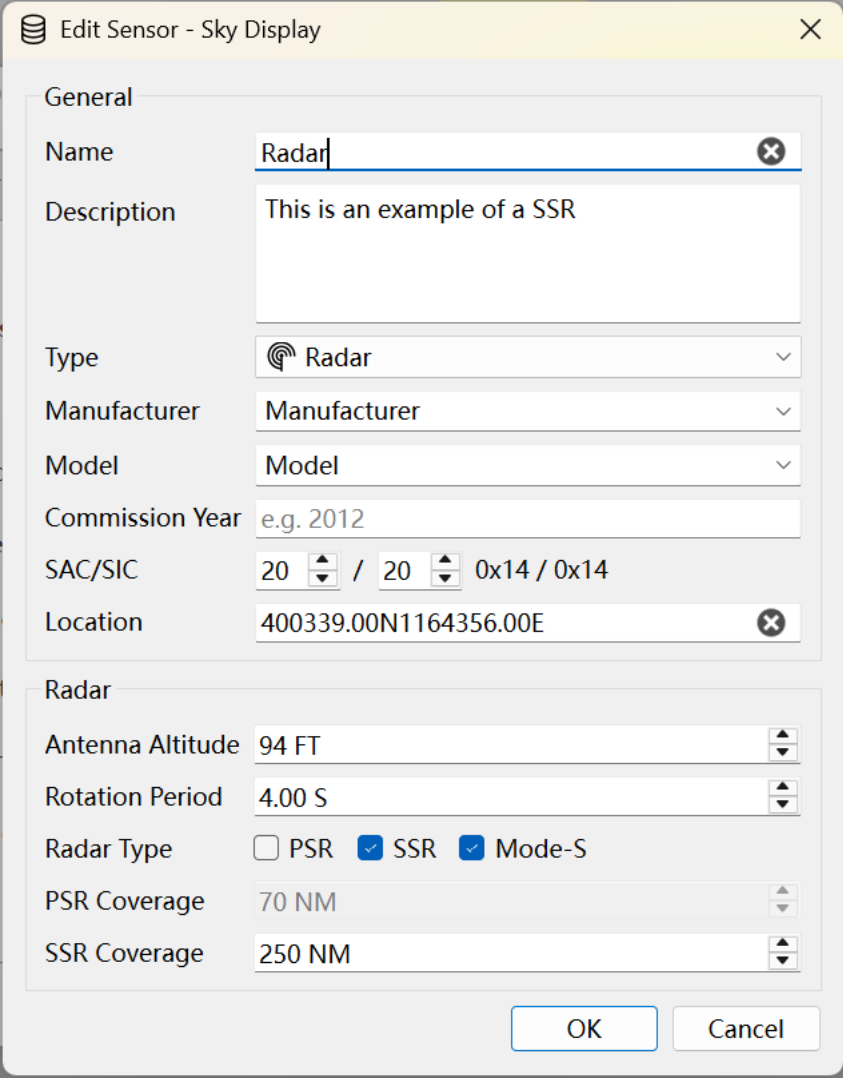
**Manufacturer** and **Model:** Manufacturer and model of the sensor.

**Commission Year:** Year the sensor was commissioned, for example 2012.

**SAC/SIC:** Sensor area code and sensor identification code, in hexadecimal.

**Location:** Location of sensor in WGS-84 coordinate. The format is DDMMSS.ss(N|S)DDDMMSS.ss(E|W).

#### 4.2.3.2 Radar



**Edit Sensor - Sky Display**

**General**

Name: Radar

Description: This is an example of a SSR

Type: Radar

Manufacturer: Manufacturer

Model: Model

Commission Year: e.g. 2012

SAC/SIC: 20 / 20 0x14 / 0x14

Location: 400339.00N1164356.00E

**Radar**

Antenna Altitude: 94 FT

Rotation Period: 4.00 S

Radar Type: ☐ PSR ☒ SSR ☒ Mode-S

PSR Coverage: 70 NM

SSR Coverage: 250 NM

OK Cancel

**Figure 4.3:** Sensor Window Radar

Radar configuration is only used when sensor type is “Radar” .

**Antenna Altitude:** Altitude in feet of radar antenna.

**Antenna Rotation Period:** Antenna rotation period in seconds, from 1 second to 20 seconds.

**Type:** Type of radar.

**PSR Coverage:** Coverage of radar primary capability.

**SSR/Mode-S Coverage:** Coverage of radar secondary capability.

#### 4.2.3.3 ADS-B

The screenshot shows a dialog box titled "Edit Sensor - Sky Display". It has two main sections: "General" and "ADS-B".

**General Section:**

- Name:** ADS-B
- Description:** This is an example of one ADS-B ground receiver.
- Type:** ((P)) ADS-B
- Manufacturer:** Manufacturer
- Model:** Model
- Commission Year:** 2000
- SAC/SIC:** 10 / 10 0x0A / 0x0A
- Location:** 400339.00N1164356.00E

**ADS-B Section:**

- Coverage:** 250 NM
- Update Interval:** 0.00 S
- Versions:** ☒ 0.23 ☒ 0.26 ☒ 1.0 ☒ 2.1 ☒ 2.2

At the bottom right, there are "OK" and "Cancel" buttons.

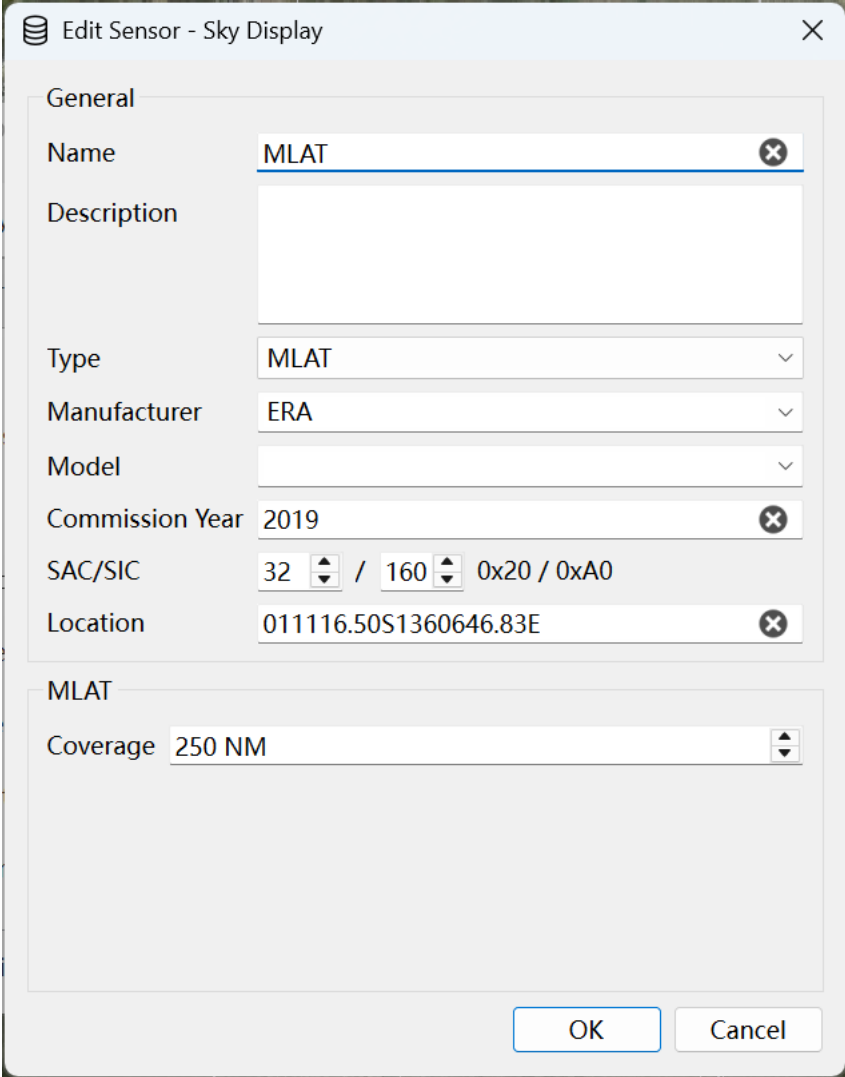
**Figure 4.4:** Sensor Window ADS-B

ADS-B configuration is only used when sensor type is "ADS-B" .

**Coverage:** Coverage of ADS-B ground station.

**Versions:** CAT021 version(s) supported by the ADS-B ground station.

#### 4.2.3.4 MLAT



The screenshot shows a dialog box titled "Edit Sensor - Sky Display" with a close button (X) in the top right corner. The dialog is divided into two main sections: "General" and "MLAT".

**General Section:**

- Name:** A text field containing "MLAT" with a clear button (X) on the right.
- Description:** An empty text area.
- Type:** A dropdown menu showing "MLAT".
- Manufacturer:** A dropdown menu showing "ERA".
- Model:** A dropdown menu showing an empty field.
- Commission Year:** A text field containing "2019" with a clear button (X) on the right.
- SAC/SIC:** A field with two spinners showing "32" and "160", followed by "0x20 / 0xA0".
- Location:** A text field containing "011116.50S1360646.83E" with a clear button (X) on the right.

**MLAT Section:**

- Coverage:** A text field containing "250 NM" with a clear button (X) on the right.

At the bottom right of the dialog are "OK" and "Cancel" buttons.

**Figure 4.5:** Sensor Window MLAT

MLAT configuration is only used when sensor type is "MLAT" .

**Coverage:** Coverage of MLAT system.

**Processing Options:** Options for ASTERIX processor.

**Ignore WGS-84 coordinates (I020/041) and Ignore cartesian coordinates (I020/042):**

Some MLAT system outputs both WGS-84 coordinates and cartesian coordinates, especially for MLAT used in airport environment for ground movement surveillance. These two options indicate which coordinate should be used by Sky Display ASTERIX processor to present MLAT tracks on screen.

#### 4.2.3.5 SDPS

The screenshot shows a dialog box titled "Edit Sensor - Sky Display". It has two tabs: "General" and "SDPS".

**General Tab:**

- Name:** ATMAS
- Description:** This is an example of ATM automation system.
- Type:** SDPS (with a gear icon)
- Manufacturer:** Manufacturer
- Model:** Model
- Commission Year:** e.g. 2012
- SAC/SIC:** 30 / 30 0x1E / 0x1E
- Location:** 400339.00N1164356.00E

**SDPS Tab:**

- Coverage:** 400 NM
- Update Interval:** 5.00 S

At the bottom right, there are "OK" and "Cancel" buttons.

**Figure 4.6:** Sensor Window SDPS

SDPS configuration is only used when sensor type is "SDPS" .

**Coverage:** Coverage of SDPS system.

**Processing Options:** Options for ASTERIX processor.

**Ignore WGS-84 coordinates (I062/105) and Ignore cartesian coordinates (I062/100):**

Some SDPS system outputs both WGS-84 coordinates and cartesian coordinates, especially for SDPS used in airport environment for ground movement surveillance. These two options indicate which coordinate should be used by Sky Display ASTERIX processor to present SDPS tracks on screen.

**Correct 180° Longitude Wrap (I062/I05):**

Some SDPS systems encode I062/I05 longitude as a 25-bit signed value, so longitudes beyond +/-90 degrees are wrapped by 180 degrees (e.g. east longitude 105 degrees is decoded as -75 degrees). When this option is selected, Sky Display ASTERIX processor adds 180 degrees back to negative I062/I05 longitude values before further processing.

**4.2.3.6 SMR**

SMR configuration is only used when sensor type is “SMR” .

**Antenna Altitude:** Altitude in feet of SMR antenna.

**Rotation Period:** Antenna rotation period in seconds.

**Coverage:** Coverage of the SMR, in NM.

**ACP:** Azimuth Count Pulses, the number of azimuth pulses per antenna rotation. It determines the azimuth resolution of the radar video picture displayed by the video map.

**4.3 Sensor Manager**

Besides the sensor settings page, Sky Display provides a standalone “Sensor Manager” application for editing sensor databases. It can be launched from menu *Tools -> Sensor Manager*, or by running [sensor-manager.exe](#) in the application directory.

Sensor Manager edits the same JSON sensor database files as Sky Display. Several databases can be open at the same time, each database is displayed as a top-level tree node, and the sensors of the database are grouped by sensor type. The sensor window used to create and edit sensors is the same as in Sky Display.

Sensors can be searched by free text (Ctrl+F) across all open databases, matching all fields shown in the info table. Before the first save of a database file in a session, a timestamped backup file is created next to it.

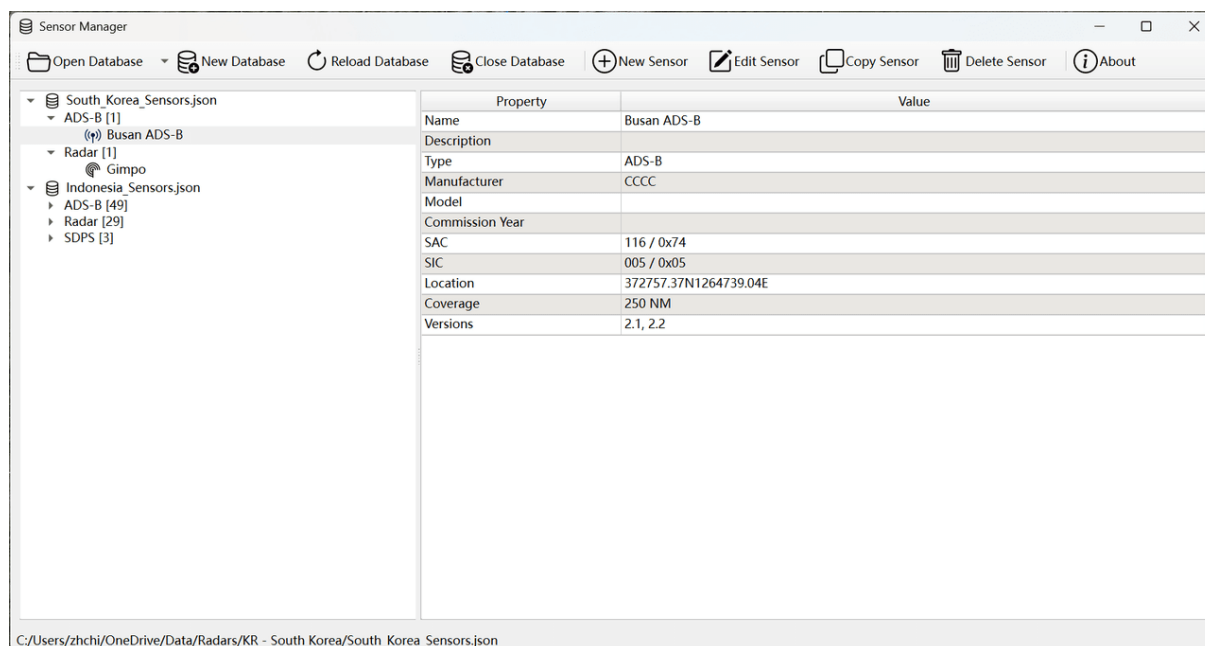


Figure 4.7: Sensor Manager

## 4.4 Sensor Database File

The sensor database is a JSON format plain text file. Below is an example of sensor database file. Common fields are mandatory, type-specific fields are needed only for sensors of the corresponding type.

```
[
  {
    "coverage": 500,
    "location": "401649.00N1162350.00E",
    "name": "SDPS",
    "sac": 12,
    "sic": 6,
    "type": "sdps"
  },
  {
    "antenna_altitude": 94,
    "commission_year": 2012,
    "description": "Primary surveillance radar of example airport",
    "location": "401649.00N1162350.00E",
    "manufacturer": "Example",
    "modes": true,
    "model": "R-2000",
    "name": "Radar 1",
```

```

    "psr": false,
    "psr_coverage": 70,
    "rotation_period": 4,
    "sac": 12,
    "sic": 1,
    "ssr": true,
    "ssr_coverage": 200,
    "type": "radar"
  },
  {
    "coverage": 250,
    "location": "401649.00N1162350.00E",
    "name": "ADS-B 1",
    "sac": 12,
    "sic": 3,
    "type": "adsb",
    "versions": ["0.26", "2.1"]
  },
  {
    "coverage": 250,
    "location": "401649.00N1162350.00E",
    "name": "MLAT",
    "sac": 12,
    "sic": 5,
    "type": "mlat"
  },
  {
    "acp": 2048,
    "antenna_altitude": 30,
    "coverage": 5.5,
    "location": "401649.00N1162350.00E",
    "name": "SMR 1",
    "rotation_period": 1,
    "sac": 12,
    "sic": 7,
    "type": "smr"
  }
]

```

Common fields of each sensor:

| Field                     | Description                          |
|---------------------------|--------------------------------------|
| <code>name</code>         | Sensor name, unique in database      |
| <code>description</code>  | Free text description, optional      |
| <code>manufacturer</code> | Manufacturer of the sensor, optional |
| <code>model</code>        | Model of the sensor, optional        |

---

| Field                        | Description                                                                                                     |
|------------------------------|-----------------------------------------------------------------------------------------------------------------|
| <code>commission_year</code> | Commission year, or null when unset                                                                             |
| <code>type</code>            | Sensor type: <code>radar</code> , <code>smr</code> , <code>adsb</code> , <code>m1at</code> or <code>sdps</code> |
| <code>sac/sic</code>         | Sensor area code and sensor identification code                                                                 |
| <code>location</code>        | Location in DDMMSS.ss(N S)DDDMMSS.ss(E W) format                                                                |

---

Type-specific fields: radar sensors use `antenna_altitude`, `rotation_period`, `psr`, `ssr`, `modes`, `psr_coverage` and `ssr_coverage`; SMR sensors use `antenna_altitude`, `rotation_period`, `coverage` and `acp`; ADS-B sensors use `coverage` and `versions`; MLAT and SDPS sensors use `coverage`.

## 5 Processor

### 5.1 Overview

Sky Display use internal processors to process received data, decode and extract useful information, and present tracks on display.

Currently, three processor are available

- ASTERIX Processor
- 1090ES ADS-B Processor
- Alenia SIR-M Radar Processor

### 5.2 Introduction

Different processor supports different input data and different types of sensors.

The processor type, sensor type and input surveillance data type must match to allow Sky Display correctly process and display tracks.

Below is a list of combination supported by Sky Display.

| Processor | Sensor Type              | Input Data              |
|-----------|--------------------------|-------------------------|
| ASTERIX   | Radar (PSR, SSR, Mode-S) | ASTERIX CAT 1/2/34/48   |
| ASTERIX   | SMR                      | ASTERIX CAT 10          |
| ASTERIX   | ADS-B                    | ASTERIX CAT 21/23       |
| ASTERIX   | MLAT/WAM                 | ASTERIX CAT 19/20       |
| ASTERIX   | SDPS                     | ASTERIX CAT 10/62       |
| ASTERIX   | Safety Net               | ASTERIX CAT 4           |
| 1090ES    | ADS-B                    | Mode-S Downlink Message |

| Processor    | Sensor Type | Input Data                      |
|--------------|-------------|---------------------------------|
| Alenia SIR-M | Radar (SSR) | Alenia SIR-M Radar Data Message |

Note: Safety Net is not a standalone sensor type, alerts contained in ASTERIX CAT 4 data must be linked to another surveillance data such as CAT62 to display alerts over tracks.

Note: ASTERIX CAT 240 radar video messages are not processed into tracks. They are decoded and displayed by the video map when an SMR sensor is configured, see section “Video Map” in the Maps chapter.

In *Settings -> Processor -> General*, it is possible to select processor to be used.

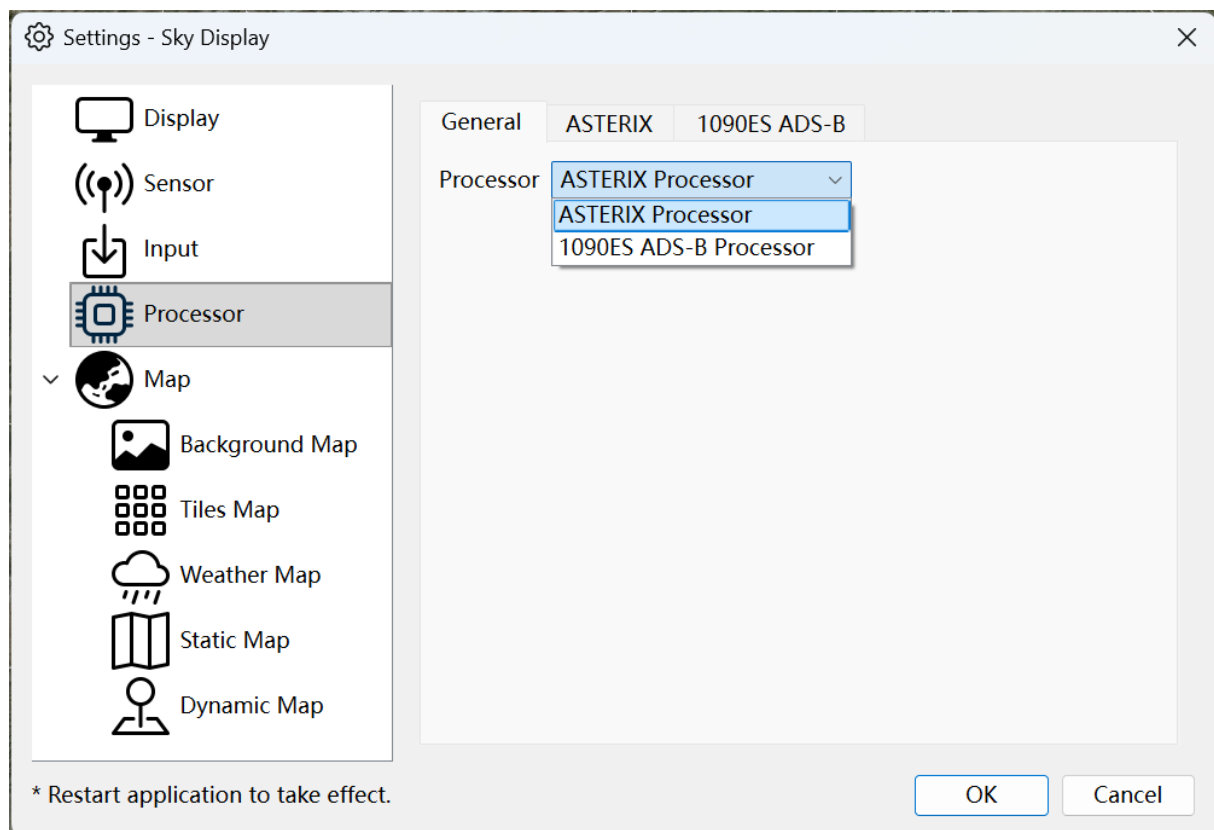


**Figure 5.1:** Processor Configuration

### 5.2.1 ASTERIX Processor

ASTERIX processor receives and processes Eurocontrol ASTERIX data.

As ASTERIX data is ready for display without extra processing, ASTERIX processor will only convert received data into proper internal format for display and will not make extra processing such as coasting or smoothing.

In *Settings -> Processor -> ASTERIX*, it is possible to configure the ASTERIX processor.

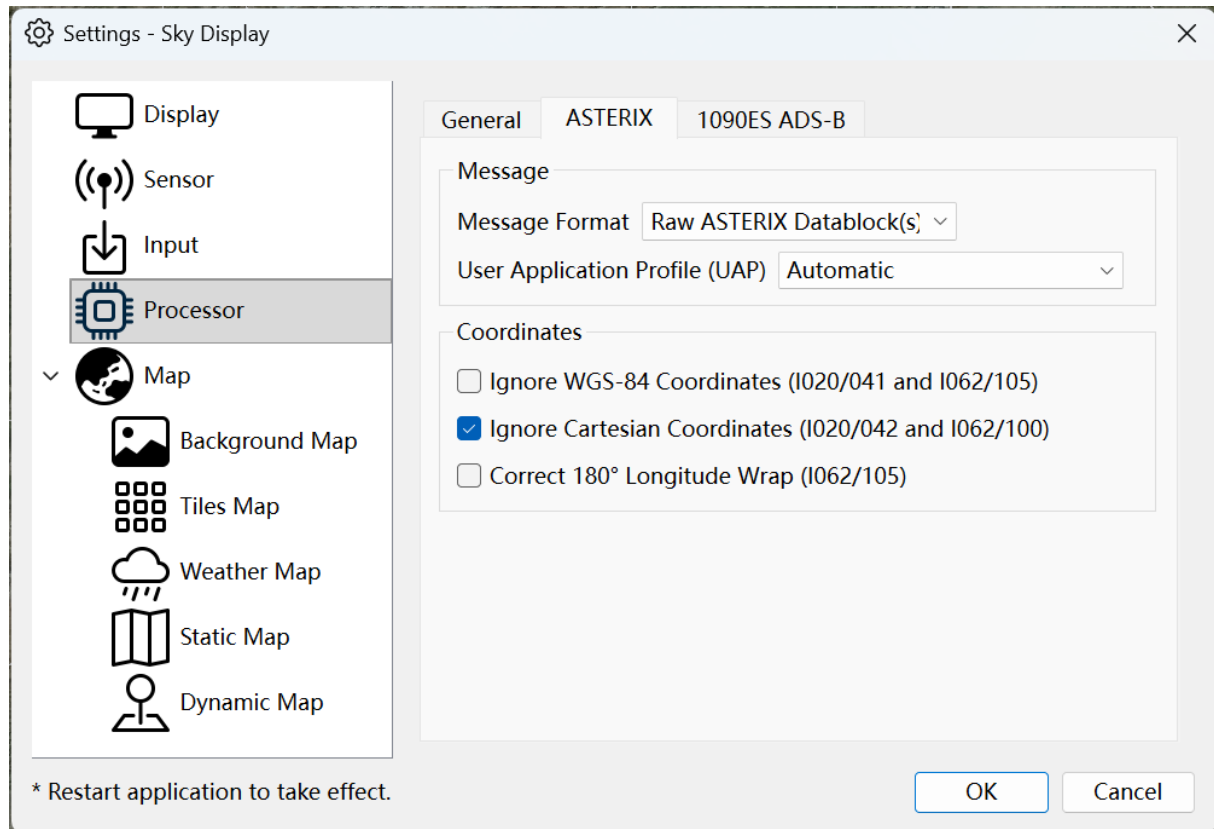


**Figure 5.2:** ASTERIX Processor Configuration

**Message Format:** The format of received ASTERIX message, including

- Raw ASTERIX Datablock(s) - ASTERIX data blocks without any extra header or meta info
- HDLC Frame - ASTERIX data blocks encapsulated in HDLC frames
- ManagAir Message - ASTERIX data blocks encapsulated in ManagAir messages

**User Application Profile (UAP):** The UAP used to decode ASTERIX data. When “Automatic” is selected, the processor will select proper UAP automatically according to received data.

**Ignore WGS-84 Coordinates (I020/041 and I062/105):** When selected, WGS-84 coordinates in MLAT (CAT020) and SDPS (CAT062) data are ignored, and Cartesian coordinates are used instead.

**Ignore Cartesian Coordinates (I020/042 and I062/100):** When selected, Cartesian coordinates in

MLAT (CAT020) and SDPS (CAT062) data are ignored, and WGS-84 coordinates are used instead.

**Correct 180° Longitude Wrap (I062/I05):** When selected, the longitude in SDPS (CAT062) data is corrected for systems that do not apply the 180° wrap in I062/I05.

**Verify SAC/SIC:** When selected, each decoded ASTERIX data block is checked against the SAC/SIC of the configured sensor, and only matching data blocks are processed further. A mismatching SAC/SIC is reported as a warning once until the configuration is applied again. The option is disabled by default.

### 5.2.2 1090ES ADS-B Processor

1090ES ADS-B processor is an ADS-B processor, it receives standard mode-s downlink (DF) message received from aircraft transponder, decode and generate ADS-B tracks, and send tracks for further display.

1090ES ADS-B processor works only with ADS-B sensor type.

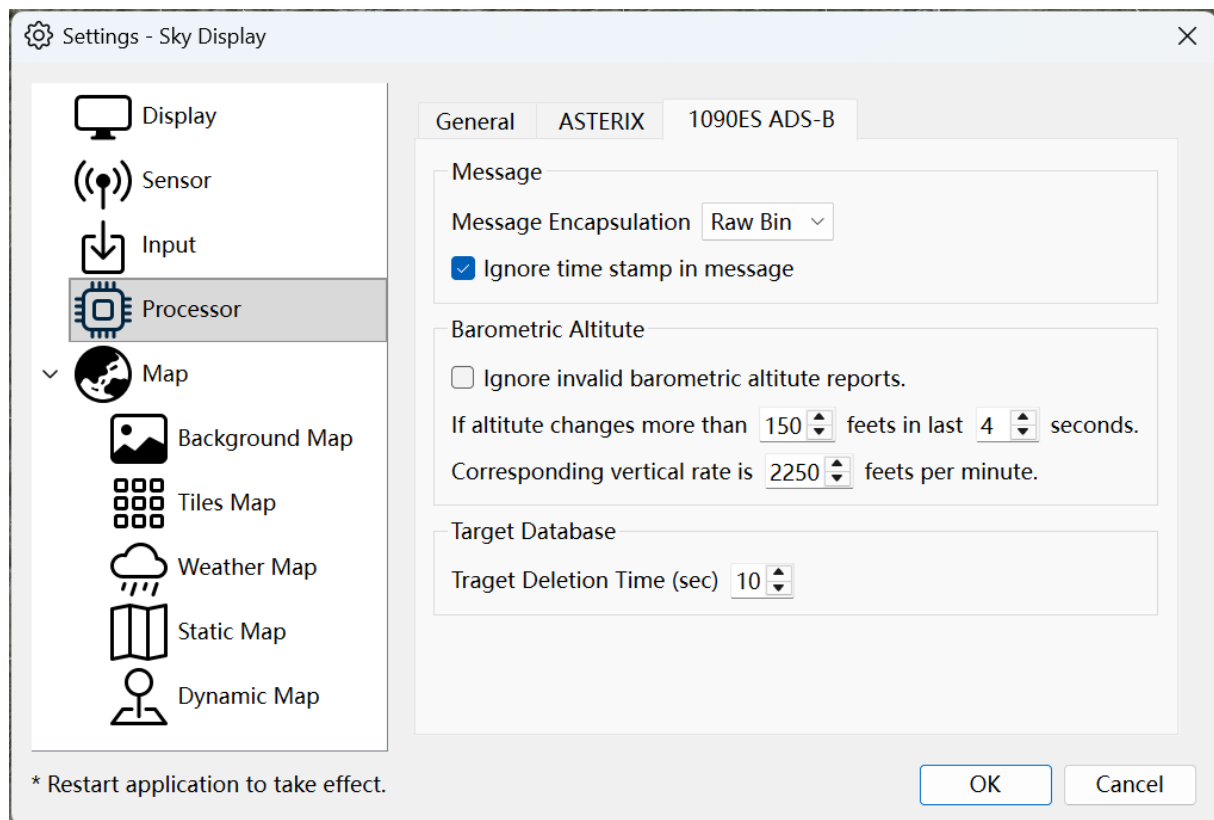


**Figure 5.3:** 1090ES ADS-B Processor Configuration

**Message Encapsulation:**

The encapsulation format of DF message, including

- Raw Bin - Binary message without any extra header or meta info
- Raw Hex - Same with “Raw Bin” but message is in ASCII hex text
- Beast - Beast format used by many commercial ADS-B receiver
- AVR - Text format message used by many commercial ADS-B receiver

**Ignore time stamp in message:** If selected, processor will use message receiving time instead of time stamp in original message. This option is useful when Sky Display is used to replay recorded data.

**5.2.3 Alenia SIR-M Radar Processor**

The Alenia SIR-M processor receives and processes the proprietary radar data messages of the Alenia SIR-M secondary surveillance radar (non-Mode S). Messages are decoded directly and tracks are created and updated from the track records carried in the mono radar data messages, no conversion to ASTERIX is involved.

Displayed information per track:

- External track number
- Track symbol by detection type: PSR / SSR / combined
- Position relative to the configured radar site
- Mode 3/A code
- Level in feet
- Ground speed (knots) and heading
- Track state “coasting”

The antenna north marker and rotation line are driven by the radar’s north marker message, and the antenna azimuth is updated at each sector change.

Plot records contained in the data messages are not used to create tracks, as they carry no track identity.

In *Settings -> Processor -> Alenia SIR-M*, it is possible to configure the processor.

**Message Format:** The encapsulation of the received messages:

- Raw Radar Data: the bare radar data message
- HDLC Frame: HDLC framing bytes before the message
- ManagAir Message: a ManagAir header before the message

Note: the HDLC frame encapsulation (open/close flags and frame check sequence) is handled by the radar front-end hardware and must be stripped before the messages reach Sky Display. The “HDLC Frame” option applies to messages that still carry the HDLC address/control bytes.

Note: meteo map messages are not supported and are skipped.

Alenia SIR-M recording files can be replayed directly via the Recording File input.

### 5.3 Feed Data to Processor

Sky Display supports different communication protocols to receive and feed surveillance data to selected processor.

Currently it supports

- UDP Unicast/Multicast/Broadcast
- Async Serial (RS232)
- Recording File (Replay)

In *Settings -> Input -> General*, it is possible to select which communication protocol to be used.

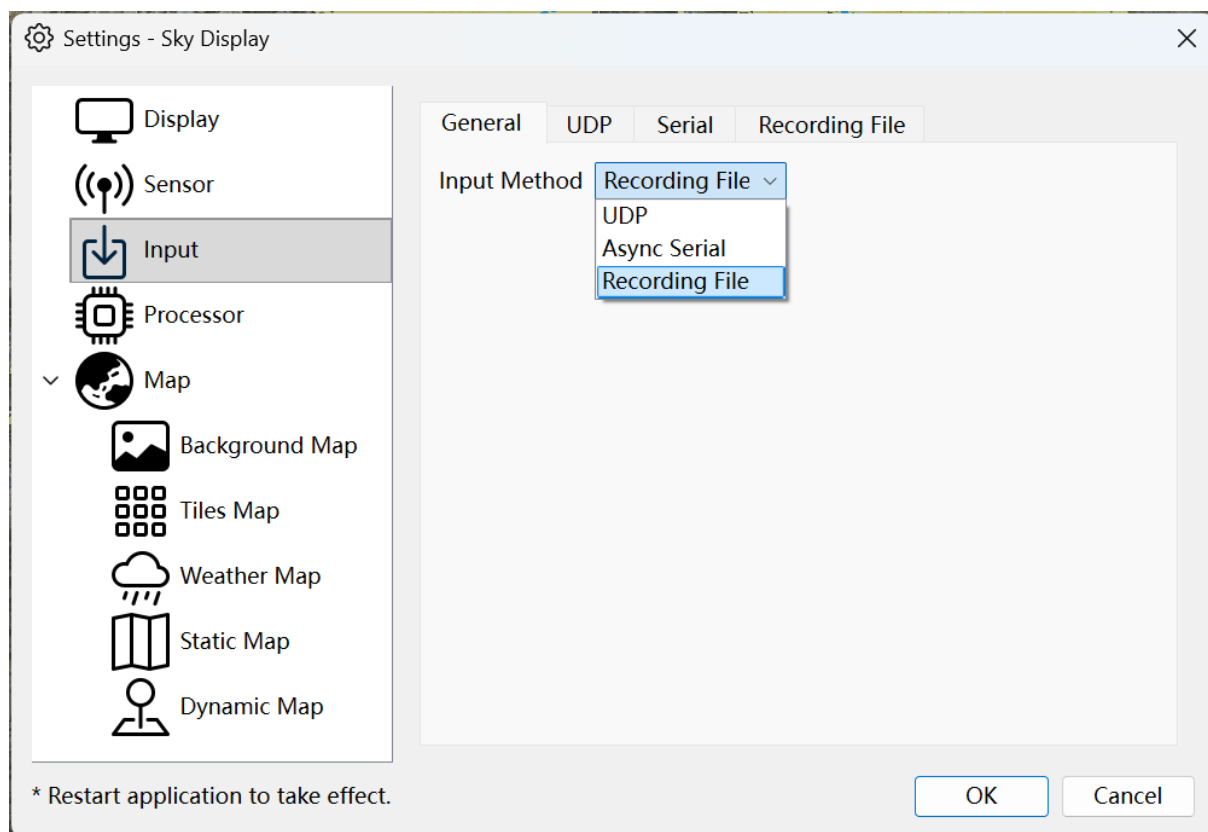


**Figure 5.4:** Input Configuration

### 5.3.1 UDP Protocol

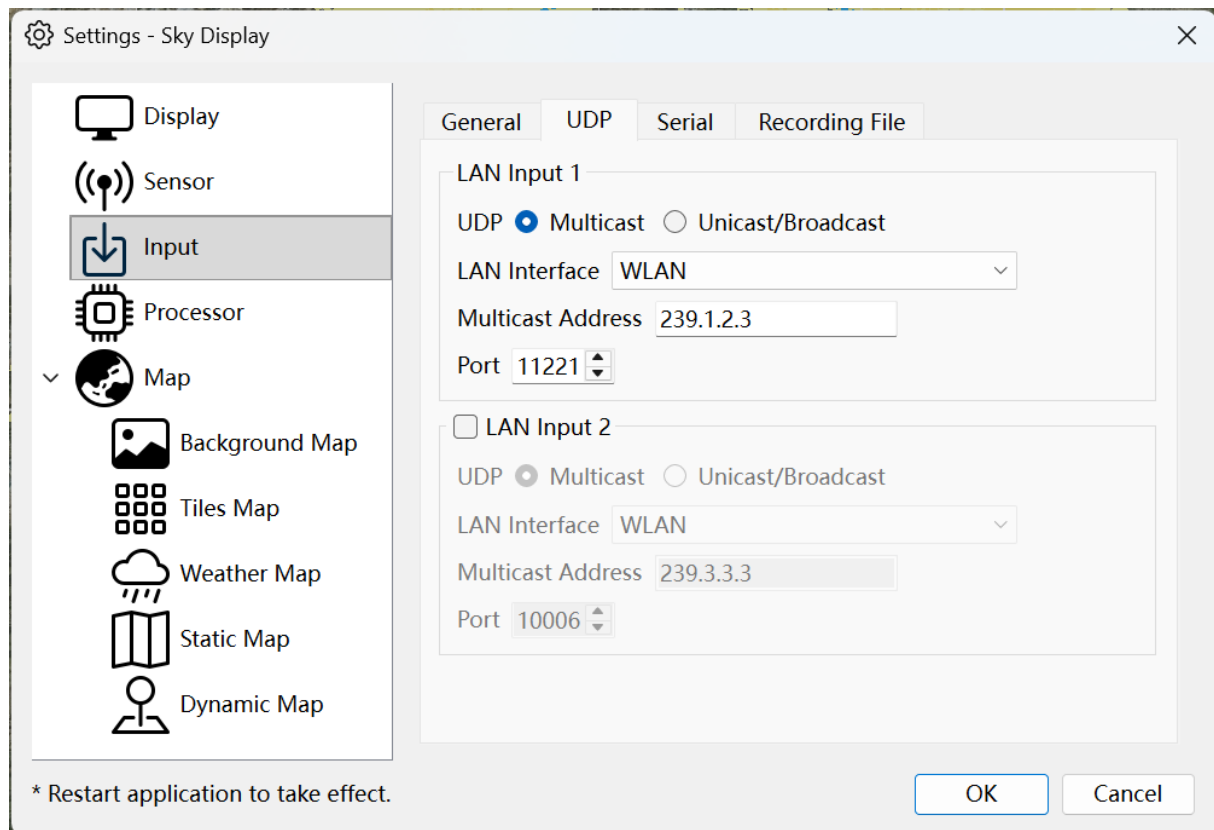


**Figure 5.5:** UDP Configuration

**UDP Multicast or UDP Unicast/Broadcast:** Which type of UDP messages to be used.

**LAN Interface:** LAN interface to be used to join and receive UDP multicast.

**Multicast Address:** Address of multicast group.

**Port:** Port number or service.

**LAN Input 2:**

System supports dual UDP inputs at the same time, messages received from any input will be sent to selected processor for further processing. This is useful in some scenario such as surveillance data and safenet data comes from different remote servers.

### 5.3.2 Async Serial Protocol

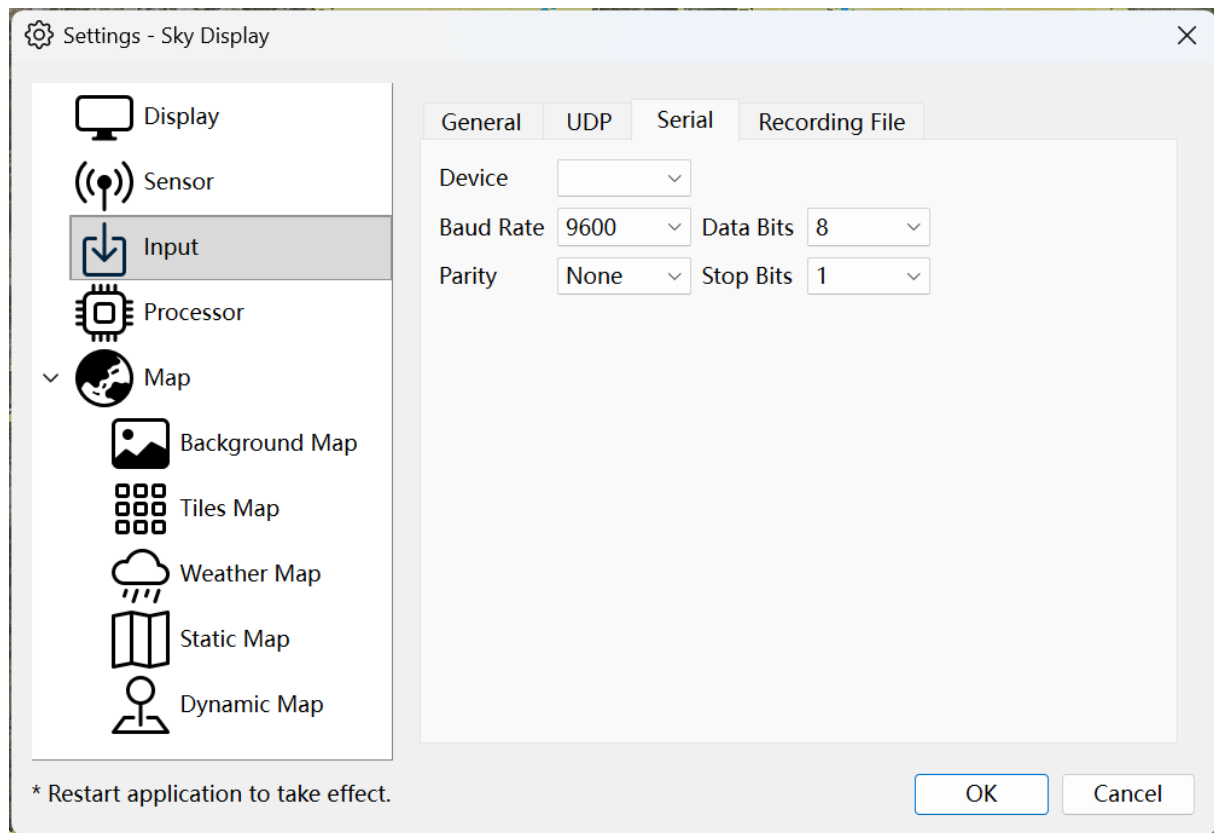


**Figure 5.6:** Async Serial Configuration

**Device:** Serial devices, empty is serial device doesn't exist.

**Baud Rate, Data Bits, Parity, Stop Bits:** RS232 parameters, the configuration here should match the parameters specified by serial data transmitter.

### 5.3.3 Recording File Protocol (Replay)

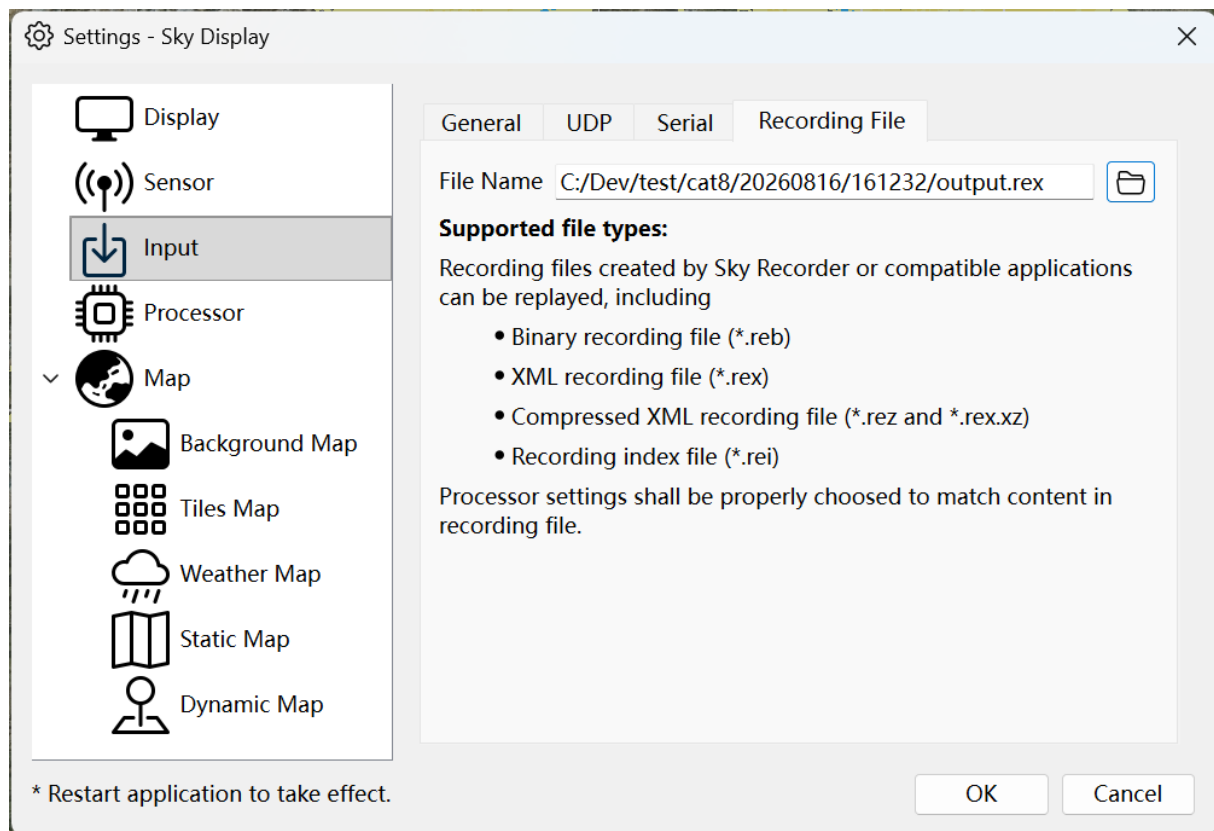


**Figure 5.7:** Recording File Configuration

Instead of receiving data from a network or serial device, Sky Display can replay a recorded surveillance data file. The recorded data is sent to the selected processor the same way as received from a real sensor, so it is useful to review and analyze past surveillance data.

The following file formats are supported:

- REB/REX/REZ recording files and their index files (\*.rei)
- pcap network capture files (\*.pcap, UDP packets only)
- pcapng network capture files (\*.pcapng, UDP packets only)

**File Name:** The recording file to be replayed. Use the “Browse recording file” button to select it.

To control the replay, use the File menu and the playback window:

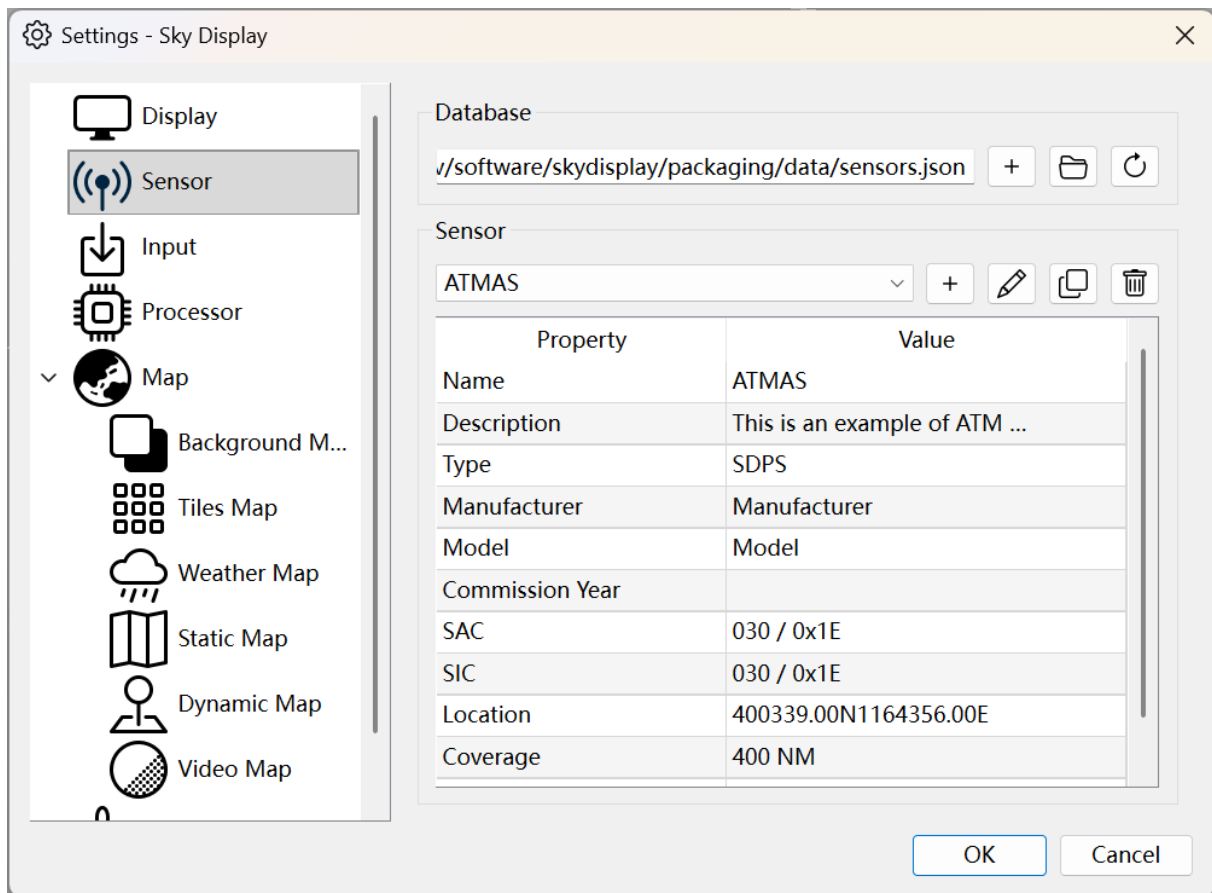
**Replay Recording File** (File menu): Open a recording file and start replay.

**Replay Speed** (File menu): Adjust the playback speed.

**Playback Window** (File menu, Ctrl+P): Open/Close the playback window.

The playback window provides:

- **Input Method, Processor:** The same options as in the input configuration, for quick switching while replaying.
- **Sensor:** Select a sensor and press the crosshair button to center the display on the sensor and zoom to the sensor coverage.
- **File Name:** The recording file to be replayed. Use the “Open recording file” button to select it.
- **Rewind:** When auto rewind is on and the replay reaches the end of the file, it automatically rewinds to the begin time and continues playing.
- **File Begin, Replay Begin:** The begin time is displayed in UTC, and can be reset to the file begin time.
- **Replay Time:** The current replay time.
- **Replay Speed:** Speed buttons from 0.5x to 8x. Max speed is only available in debug mode, through the “Replay Speed” menu.
- **Start, Pause, Stop:** Replay controls.

**Figure 5.8:** Playback Window

## 6 Use Cases

### 6.1 AvionixTech ADS-B Receiver

AvionixTech ADSB-RE1090 is a high performance, portable and easy to use ADS-B ground receiver.



**Figure 6.1:** AvionixTech ADSB-RE1090

ADS-B (Automatic Dependent Surveillance - Broadcast) is a system or a technique. ADS-B uses airborne GPS and several other equipments to obtain the aircraft own position and other information, then uses communication equipment onboard to transmit the aircraft own position and other information. ADS-B ground receivers and other aircrafts around can use communication equipment to get these information, so to monitor the aircraft, or to say, “see” the aircraft.

The main ground surveillance technique used to be radar. Radar is expensive, a lot of work to install and maintain. While ADS-B ground receivers are cheap, easy to install and maintain. A cheaper and easier way for ground surveillance solution, even possible to replace radar in the future.

ADSB-RE1090 is a high performance, portable and easy to use ADS-B ground receiver. ADSB-RE1090 can be a replacement of once famous SBS-3 ADS-B ground receiver.

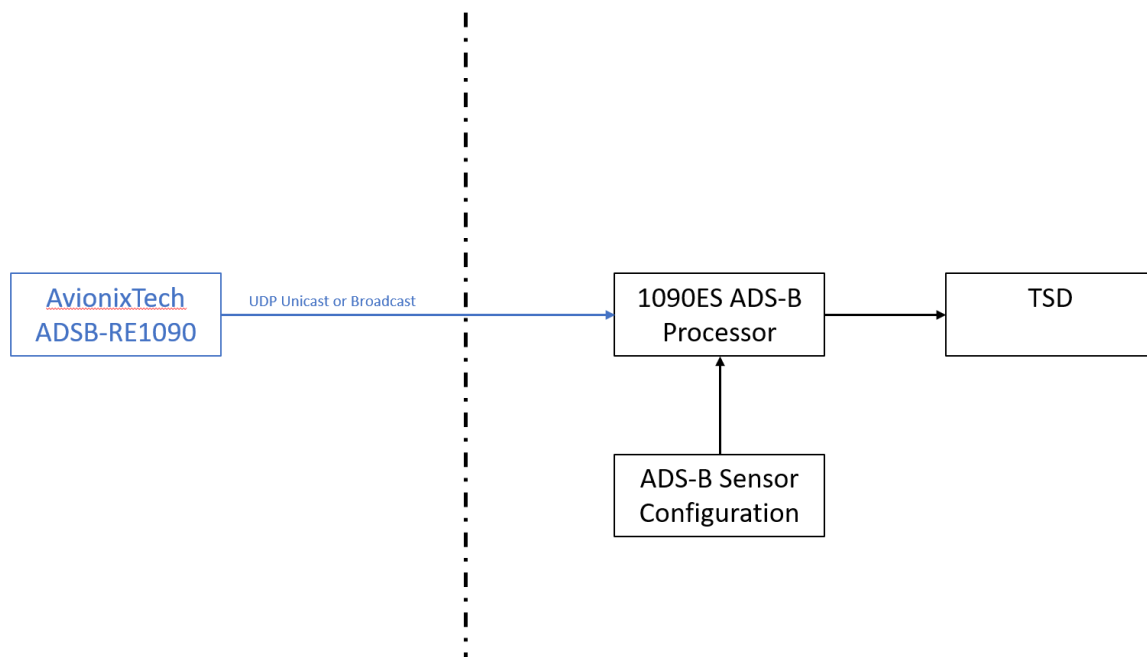
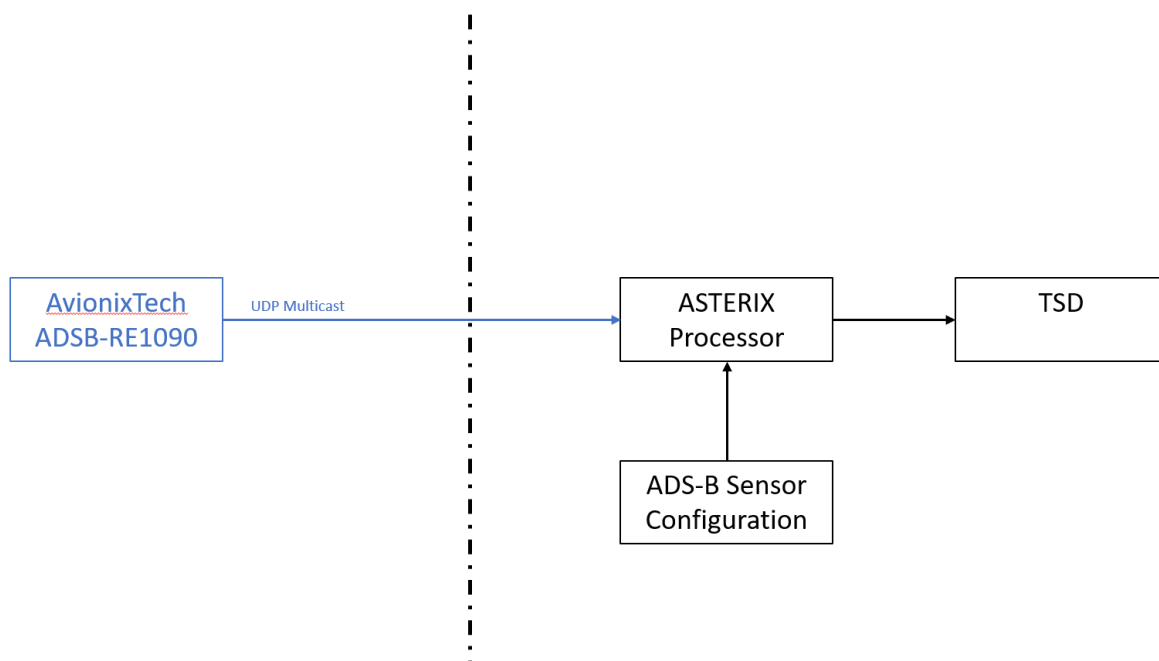
<https://www.avionix-tech.com/products/ads-b/ads-b-ground-receiver-adsb-re1090/>

Sky Display is the standard display terminal of AvionixTech ADS-B products.

### **6.1.1 Connection**

AvionixTech ADSB-RE1090 is able to output both processed ASTERIX CAT-21 target reports, and unprocessed DF messages.

Sky Display receives and processes both of these two formats from AvionixTech ADSB-RE1090.

**Figure 6.2:** ADSB-RE1090 Mode-S Connection**Figure 6.3:** ADSB-RE1090 ASTERIX Connection

## 6.1.2 Configuration

### 6.1.2.1 Using Mode-S Message

In ADSB-RE1090 configuration page, go to section “*Adsb Output Modes*” :

#### Adsb Output Modes

---

ADS-B and Mode-S raw data output network protocol

udp\_broadcast ▼

ADS-B and Mode-S raw data output UDP address

255.255.255.255

ADS-B and Mode-S raw data output UDP port

5110

ADS-B and Mode-S raw data format

binary ▼

**Figure 6.4:** ADSB-RE1090 Mode-S Configuration

Set “*ADS-B and Mode-S raw data output network protocol*” to **udp\_broadcast** or **udp\_unicast**, depending on your needs.

if **udp\_broadcast** is selected, set “*ADS-B and Mode-S raw data output UDP address*” to **broadcast address of PC running Sky Display**, and set “*ADS-B and Mode-S raw data output UDP port*” to **any free port number (5110here)**.

if **udp\_unicast** is selected, set “*ADS-B and Mode-S raw data output UDP address*” to **IP address of PC running Sky Display**, and set “*ADS-B and Mode-S raw data output UDP port*” to **any free port number (5110here)**.

Set “*ADS-B and Mode-S raw data format*” to the **binary**.

Restart ADS-B receiver if needed.

In Sky Display settings.

Set “Input -> General -> Protocol” to **UDP**.

Set “Input -> UDP -> LAN Input 1 -> UDP” to **Unicast/Broadcast**.

Set “Input -> UDP -> LAN Input 1 -> Port” to the **same port number with ADSB-RE1090 (5110 here)**.

Set “Processor-> General-> Processor” to **1090ES ADS-B Processor**.

Set “Processor-> 1090ES ADS-B -> Message Encapsulation” to **RawBin**.

Set “Sensor -> General -> Type” to **ADS-B**.

Set other ADS-B sensor parameters according to your installation, especially “Location” .

#### **6.1.2.2 Using ASTERIX CAT21 Message**

In ADSB-RE1090 configuration page, go to section “Adsb Output Asterix” :

## Adsb Output Asterix

---

### Cat021 Data Output Network Protocol

udp\_broadcast ▼

### Cat021 data output multicast address

224.0.5.13

### Cat021 data output multicast port

5000

### Cat021 data output UDP address

255.255.255.255

### Cat021 data output UDP port

5000

**Figure 6.5:** ADSB-RE1090 ASTERIX Configuration

**Cat021 data output mode**

event ▼

**Cat021 data output time period**

500 ▼

**Cat021 data version**

2.4 ▼

**SAC**

128

**SIC**

128

**Figure 6.6:** ADSB-RE1090 ASTERIX Configuration

Set “Cat021 Data Output Network Protocol” to **any one**, depending on your needs.

if **udp\_multicast** is selected, set “Cat021 data output multicast address” to **any valid multicast address (224.0.5.13 here)** to be used, and set “Cat021 data output multicast port” to **any free port number (5000 here)**.

if **udp\_broadcast** is selected, set “Cat021 data output UDP address” to **broadcast address of PC running Sky Display**, and set “Cat021 data output UDP port” to **any free port number (5000 here)**.

if **udp\_unicast** is selected, set “Cat021 data output UDP address” to **IP address of PC running Sky Display**, and set “Cat021 data output UDP port” to **any free port number (5000 here)**.

Set “Cat021 data output mode” to the **event**.

Set “Cat021 data output time period” to the **500 millisecond**.

Set “Cat021 data version” to the **0.26**.

Set “SAC & SIC” to the **any valid values (128/128 here)**.

Restart ADS-B receiver if needed.

In Sky Display settings.

Set “Input -> General -> Protocol” to **UDP**.

Set “Input -> UDP -> LAN Input 1 -> UDP” to **Multicast** or **Unicast/Broadcast**, to be the same with ADSB-RE1090 configuration.

Set “Input -> UDP -> LAN Input 1 -> Port” to the **same port number with ADSB-RE1090 (5000 here)**.

If **Multicast** is selected, select correct “LAN Interface” connecting to ADSB-RE1090 device, and fill “Multicast Address” with the same multicast address (224.0.5.13 here) with ADSB-RE1090.

Set “Processor-> General-> Processor” to **ASTERIX Processor**.

Set “Sensor -> General -> Type” to **ADS-B**.

Set other ADS-B sensor parameters according to your installation, especially “Location” .

## 6.2 Radarcape ADS-B Receiver

Radarcape is a popular low cost ADS-B receiver.



**Figure 6.7:** Radarcape

A receiver and decoder specially developed for ADS-B and Mode A/C gives the Radarcape the best sensitivity and thus range in its class. The integrated GNSS receiver provides highly accurate time stamps for multilateration (MLAT), which in conjunction with the Jetvision MLAT Server allows the determination of positions of aircraft with Mode-S or Mode A/C transponder only or the verification of ADS-B positions.

With its built-in performance processor and consistently efficient programming, the Radarcape

can track an unlimited number of aircraft and display them to multiple viewers simultaneously and independently.

With its built-in performance processor and consistently efficient programming, the Radarcape can track an unlimited number of aircraft and display them to multiple viewers simultaneously and independently.

<http://radarcape.com/>

Sky Display is tested working well as display terminal of Radarcape

### 6.2.1 Connection

Sky Display receives “Binary formatted raw data with all Mode-S data formats” (aka “Port 10006 data”) from Radarcape.

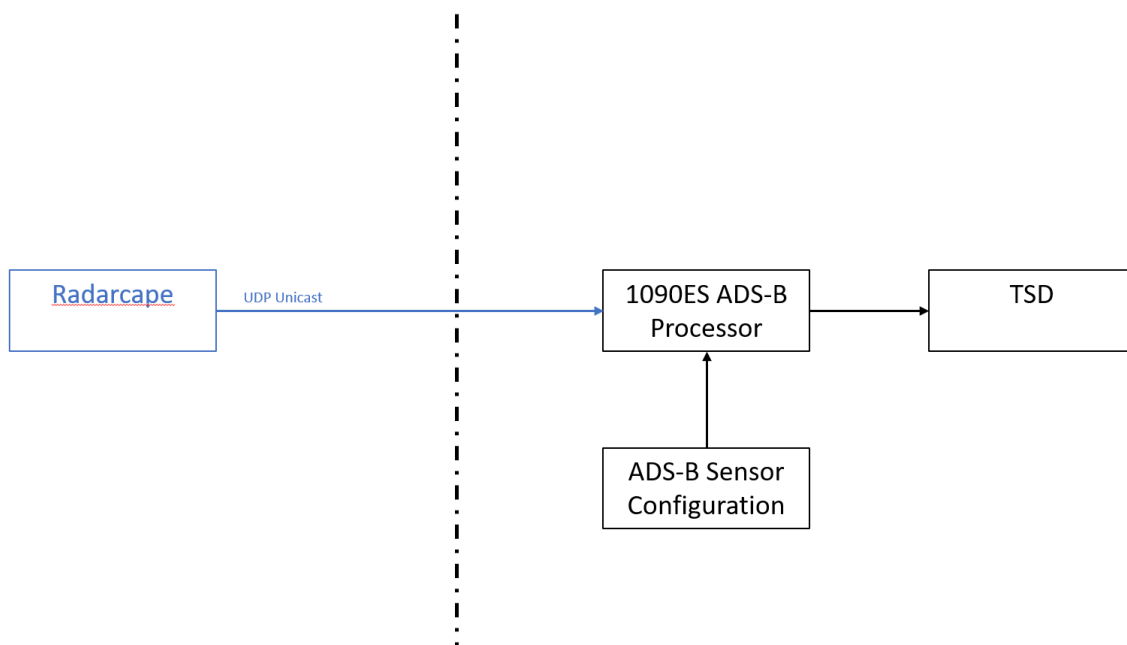


**Figure 6.8:** Radarcape Connection

### 6.2.2 Configuration

In Radarcape settings streaming page, go to section “Port 10006 UDP Server” .

The screenshot shows a web browser window with the address bar displaying "10.10.15.15/settings\_streaming.html". The page header includes the "jetvision" logo and the text "True Air Traffic". The main content area is titled "Receiving Server(s) for Port 10004 UDP Data" and contains an empty text input field. Below this, the section "Port 10005 UDP Server" is shown, with a description "Binary formatted raw data of aircrafts without position". It includes a dropdown menu for "Enable/Disable Port 10005 UDP Output" set to "Disabled", and another empty text input field for "Receiving Server(s) for Port 10005 UDP Data". The next section, "Port 10006 UDP Server", has a description "Binary formatted raw data with all Mode-S data formats (CRC pre-checked, no". It features a dropdown menu for "Enable/Disable Port 10006 UDP Output" set to "Enabled", and a text input field for "Receiving Server(s) for Port 10006 UDP Data" containing the value "10.10.15.18:50000".

**Figure 6.9:** Radarcape Configuration

Set “Enable/Disable Port 10006 UDP Output” to **Enabled**.

Set “Receiving Server(s) for Port 10006 UDP Data” to the **IP and port of PC running Sky Display**.

In Sky Display settings.

Set “Input -> General -> Protocol” to **UDP**.

Set “Input -> UDP -> LAN Input 1 -> UDP” to **Unicast/Broadcast**.

Set “Input -> UDP -> LAN Input 1 -> Port” to the **same port number with Radarcape (5000 here)**.

Set “*Processor->General->Processor*” to **1090ES ADS-B Processor**.

Set “*Processor->1090ES ADS-B->Message Encapsulation*” to **Beast**.

Set “*Sensor ->General ->Type*” to **ADS-B**.

Set other ADS-B sensor parameters according to your installation, especially “*Location*” .

## 7 Static Map ICD

### 7.1 Introduction

#### 7.1.1 Scope

This document defines the format and structure of static map files.

#### 7.1.2 Target Reader

The target reader of this document is end user. End user could define needed static map file according to this document.

#### 7.1.3 Applicability

This document is applicable to software version 0.2.0 and above.

### 7.2 Description

#### 7.2.1 Static Map Structure and Definition

System static map consists of data and style. The map data includes elements in a map, such as poly-line, polygon, label, symbol, image. The map style defines how map element is rendered, such as line width, line style and color.

System defines three types of files:

- Map layer file (.xml、.map)

Each map layer file defines one layer of map. Each map layer can include any type and any number of map elements.

The .xml file is layer file in XML format; and .map file is layer file in binary format.

- Map index file (.idx)

Index file is to define layers included in static map, and attributes of each layer.

System could load only one index file at one time.

- Map style file (.mss)

Style sheet file defines the display of each map element.

System could load only one style file at one time.

The relationship of each types of file is shown below.

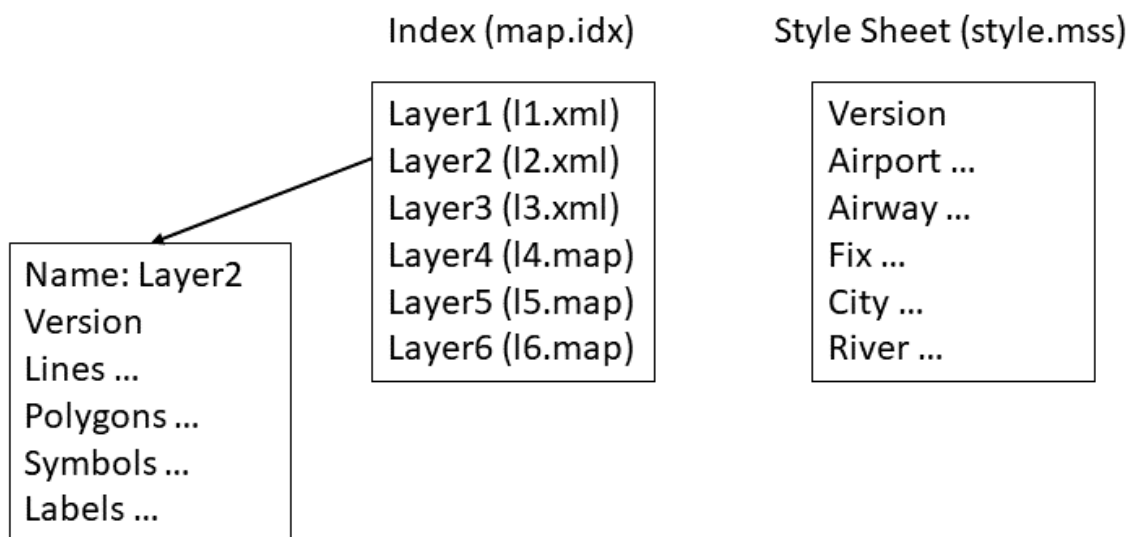


**Figure 7.1:** Map Structure

### 7.2.2 Index File Format

Index file defines all layers of static map, and attributes of each layer.

Index file is a XML format plain text file.

This is an example of index file.

```
<?xml version="1.0" encoding="utf-8" ?>
<map>
  <meta>
    <name>ZBAA</name>
```

```

<title>ZBAA Airport</title>
<description>Beijing Capital Airport</description>
<author>SinoATC</author>
<version>2020-03-06</version>
<comment></comment>
</meta>
<index>
  <file visible="false" priority="4" maxzoom="400" format="xml">chn-
aerodrome-zbaa-satellite.xml</file>
  <file visible="true" priority="5" maxzoom="400" format="xml">chn-
aerodrome-zbaa-layout.xml</file>
  <file visible="false" priority="6" maxzoom="400" format="xml">chn-
aerodrome-zbaa-deicing-pad.xml</file>
  <file visible="false" priority="6" maxzoom="400" format="map">chn-
aerodrome-zbaa-parking-stand.map</file>
</index>
</map>

```

The meaning of each XML element is

| Element     | Parent Element | Compulsory | Description                                                                                                                                                                   |
|-------------|----------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| map         | -              | Yes        | Root element                                                                                                                                                                  |
| meta        | map            | Yes        | File meta data                                                                                                                                                                |
| name        | meta           | Yes        | Name of static map. It could contain letter, number, underscore, and hyphen. It shall not contain space.                                                                      |
| title       | meta           | Yes        | Title of static map                                                                                                                                                           |
| description | meta           | Yes        | Description of static map                                                                                                                                                     |
| author      | meta           | Yes        | Author of static map                                                                                                                                                          |
| version     | meta           | Yes        | Version of static map                                                                                                                                                         |
| comment     | meta           | No         | Comments, invisible to software user.                                                                                                                                         |
| index       | map            | Yes        | Layer index                                                                                                                                                                   |
| file        | index          | Yes        | File name of each layer file. The file name is case sensitive. If index file and layer files are not in the same directory, it should contain relative path before file name. |

The meaning of each attribute of “file” element is

| Attribute | Type        | Default Value | Description                                                                                                                               |
|-----------|-------------|---------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| visible   | Boolean     | false         | If system should display this map layer by default.                                                                                       |
| priority  | Integer     | 50            | Priority of lay, the greater number has higher priority. Layer with higher priority will be displayed over the layer with lower priority. |
| minzoom   | Integer     | 0             | The minimal zoom to display the layer. If current zoom is less than this value, the layer will not be shown.                              |
| maxzoom   | Integer     | $\infty$      | The maximum zoom to display the layer. If current zoom is greater than this value, the layer will not be shown.                           |
| format    | Enumeration | unknown       | Format of layer file. Currently system supports two formats: “xml” and “map” .                                                            |

System will load each layer files according to index file, and display each layer with proper priority according to the attributes in index file.

In “Static Maps Window” , user can turn on and turn off the display of each layer.

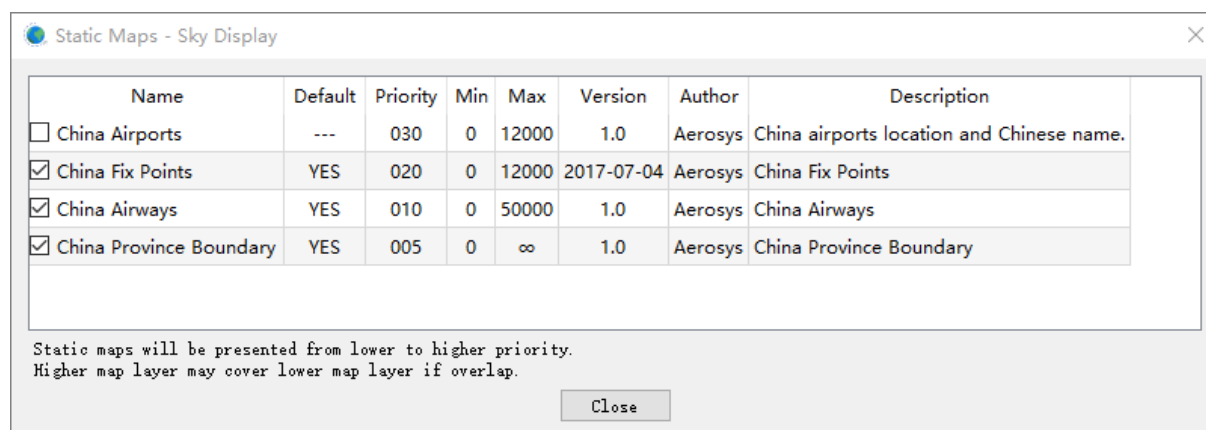


**Figure 7.2:** Static Maps Window

### 7.2.3 Layer File Format

Each layer file represents one layer in static map, each layer could include any types and any number of map elements.

This document describes layer file in XML format, it can be edited and converted into MAP format with the Map Editor.

This is an example of layer file.

```
<?xml version="1.0" encoding="UTF-8"?>
<map>
  <meta>
    <name>chn-aerodrome-zbaa-layout</name>
    <title>ZBAA Layout</title>
    <description>Beijing Capital Airport Layout</description>
    <author>SinoATC</author>
    <version>2017-07-04</version>
    <comment>Converted from legacy format.</comment>
  </meta>
  <data>
    <group name="runway" class="aerodrome_runway">
      <polygon>
        <coordinate>400607.26N1163409.89E</coordinate>
        <coordinate>400607.44N1163411.92E</coordinate>
        <coordinate>400424.48N1163428.08E</coordinate>
        <coordinate>400424.28N1163426.01E</coordinate>
        <coordinate>400607.26N1163409.89E</coordinate>
      </polygon>
      <polygon>
        <coordinate>400521.81N1163540.16E</coordinate>
        <coordinate>400522.02N1163542.58E</coordinate>
        <coordinate>400319.73N1163601.81E</coordinate>
        <coordinate>400319.47N1163559.25E</coordinate>
        <coordinate>400521.81N1163540.16E</coordinate>
      </polygon>
      <label>
        <caption>W506</caption>
        <coordinate>400558N1163429E</coordinate>
      </label>
      <image name="chn-aerodrome-zbaa-satellite">
        <file>chn-aerodrome-zbaa-satellite.png</file>
        <northwest>400639.42N1163400.61E</northwest>
        <southeast>400224.66N1163727.64E</southeast>
      </image>
    </group>
  </data>
</map>
```

The meaning of each XML element is

| Element     | Parent Element | Compulsory | Description                                                                                                                                                                                                                                               |
|-------------|----------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| map         | -              | Yes        | Root element                                                                                                                                                                                                                                              |
| meta        | map            | Yes        | File meta data                                                                                                                                                                                                                                            |
| name        | meta           | Yes        | Name of layer. It could contain letter, number, underscore, and hyphen. It shall not contain space.                                                                                                                                                       |
| title       | meta           | Yes        | Title of layer                                                                                                                                                                                                                                            |
| description | meta           | Yes        | Description of layer                                                                                                                                                                                                                                      |
| author      | meta           | Yes        | Author of layer                                                                                                                                                                                                                                           |
| version     | meta           | Yes        | Version of layer                                                                                                                                                                                                                                          |
| comment     | meta           | No         | Comments, invisible to software user.                                                                                                                                                                                                                     |
| data        | map            | Yes        | Layer data                                                                                                                                                                                                                                                |
| group       | data           | Yes        | Element group. Element group is the smallest logical unit in a layer, it contains a group of elements and specifies its style. Each data element can contain any number of groups, and each group can contain any number of map elements.                 |
| polyline    | group          | No         | Polyline element. It contains a series of coordinate elements, each coordinate element represents a vertex of the polyline.                                                                                                                               |
| polygon     | group          | No         | Polygon element. It contains a series of coordinate elements, each coordinate element represents the vertex of the polygon line.                                                                                                                          |
| label       | group          | No         | Label element. It is used to place a text label at specific position on the map. It contains two sub elements, caption and coordinate, representing the text content and position.                                                                        |
| image       | group          | No         | Image element. It is used to display an image at specific position on the map. It contains three sub elements, file, northwest and southeast, representing image file name, position of top-left of the image, and position of bottom-right of the image. |

| Element | Parent Element | Compulsory | Description                                                                                                                                                                               |
|---------|----------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| symbol  | group          | No         | Symbol element. It is used to display a standard symbol at specific position on the map. It contains two sub elements, type and coordinate, representing type of the symbol and position. |

**Note**

- The group element and map element (polyline, polygon, label, image, symbol) element contains an optional attribute “name” . It can be used by file maintainer to mark each map element or group, it is not displayed anywhere.
- The group element contains class attribute, which is compulsory, and it specifies a “style name” defined in style sheet file. When rendering a map layer, system will check the style definition in style sheet file, and use it for map painting.

**7.2.3.1 Polyline Element**

Polyline element consists of a series of coordinate sub elements, each coordinate element is a vertex of the polyline.

This is an example of polyline element.

```
<polyline name="RWY-01-centerline">
  <coordinate>400607.26N1163409.89E</coordinate>
  <coordinate>400424.48N1163428.08E</coordinate>
</polyline>
```

The meaning of each XML element is

| Element  | Parent Element | Compulsory | Description      |
|----------|----------------|------------|------------------|
| polyline | group          | No         | Polyline element |

| Element    | Parent Element | Compulsory | Description                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------|----------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| coordinate | polyline       | Yes        | WGS-84 coordinate. It can be in both high and low accuracy format. In both formats minutes and seconds are two digits, and the degrees are written without leading zeros. The low accuracy format is DDMMSS[N S]DDDMMSS[E W] (e.g. 400558N1163429E, 395309N994553E), and the high accuracy format appends a two-digit fractional second to the seconds of both parts: DDMMSS.SS[N S]DDDMMSS.SS[E W] (e.g. 400607.26N1163409.89E). |

### 7.2.3.2 Polygon Element

Polygon element consists of a series of coordinate sub element, each coordinate element if a vertex of polygon.

This is an example of polygon element.

```
<polygon>
  <coordinate>400521.81N1163540.16E</coordinate>
  <coordinate>400522.02N1163542.58E</coordinate>
  <coordinate>400319.73N1163601.81E</coordinate>
  <coordinate>400319.47N1163559.25E</coordinate>
  <coordinate>400521.81N1163540.16E</coordinate>
</polygon>
```

The meaning of each XML element is

| Element | Parent Element | Compulsory | Description     |
|---------|----------------|------------|-----------------|
| polygon | group          | No         | Polygon element |

| Element    | Parent Element | Compulsory | Description                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------|----------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| coordinate | polygon        | Yes        | WGS-84 coordinate. It can be in both high and low accuracy format. In both formats minutes and seconds are two digits, and the degrees are written without leading zeros. The low accuracy format is DDMSS[N S]DDMMSS[E W] (e.g. 400558N1163429E, 395309N994553E), and the high accuracy format appends a two-digit fractional second to the seconds of both parts: DDMSS.SS[N S]DDMMSS.SS[E W] (e.g. 400607.26N1163409.89E). |

### 7.2.3.3 Label Element

Label element is used to place a text label at specific position on the map. It contains two sub elements, caption and coordinate, representing the text content and position.

This is an example of label element.

```
<label>
  <caption>W506</caption>
  <coordinate>400558N1163429E</coordinate>
</label>
```

The meaning of each XML element is

| Element    | Parent Element | Compulsory | Description                                                           |
|------------|----------------|------------|-----------------------------------------------------------------------|
| label      | group          | No         | Label element                                                         |
| caption    | label          | Yes        | Label text content                                                    |
| coordinate | label          | Yes        | Label position, format is the same with coordinate element in polygon |

#### Note

- caption element supports Unicode character (e.g. Chinese character), but it can only be correctly rendered when it is supported by the font of its style.

### 7.2.3.4 Image Element

Image element is used to display an image at specific position on the map. It contains three sub elements, file, northwest and southeast, representing image file name, position of top-left of the image, and position of bottom-right of the image.

This is an example of image element.

```
<image name="chn-aerodrome-zbaa-satellite">
  <file>chn-aerodrome-zbaa-satellite.png</file>
  <northwest>400639.42N1163400.61E</northwest>
  <southeast>400224.66N1163727.64E</southeast>
</image>
```

The meaning of each XML element is

| Element   | Parent Element | Compulsory | Description                                                                                                                                                 |
|-----------|----------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| image     | group          | No         | Image element                                                                                                                                               |
| file      | image          | Yes        | File name. It supports PNG file with alpha channel. The transparent part of the image will be rendered transparent in map too. The image must be rectangle. |
| northwest | image          | Yes        | Coordinate of image top-left point, format is the same with coordinate element in polygon                                                                   |
| southeast | image          | Yes        | Coordinate of image bottom-right point, format is the same with coordinate element in polygon                                                               |

### 7.2.3.5 Symbol Element

Symbol element is used to display a standard symbol at specific position on the map. It contains two sub elements, type and coordinate, representing type of the symbol and position.

The meaning of each XML element is

```
<symbol name="ADADE">
  <type>vordme</type>
  <coordinate>400639.42N1163400.61E</coordinate>
</symbol>
```

The meaning of each XML element is

| Element    | Parent Element | Compulsory | Description                                                               |
|------------|----------------|------------|---------------------------------------------------------------------------|
| symbol     | group          | No         | Symbol element                                                            |
| type       | symbol         | Yes        | Type of symbol                                                            |
| coordinate | symbol         | Yes        | Position of symbol, format is the same with coordinate element in polygon |

The type element of a symbol defines type of symbol to be displayed, currently system supports the following symbols.

| Type                   | Symbol                                                                                |
|------------------------|---------------------------------------------------------------------------------------|
| default                |    |
| wpt                    |    |
| wpt-compulsory         |  |
| wpt-flyover            |  |
| wpt-compulsory-flyover |  |
| int                    |  |
| int-compulsory         |  |
| int-flyover            |  |
| int-compulsory-flyover |  |
| vfr                    |  |
| vfr-compulsory         |  |
| vfr-flyover            |  |
| vfr-compulsory-flyover |  |
| ndb                    |  |
| ndb-compulsory         |  |
| ndb-flyover            |  |
| ndb-compulsory-flyover |  |
| vor                    |  |
| vor-compulsory         |  |

| Type                      | Symbol |
|---------------------------|--------|
| vor-flyover               |        |
| vor-compulsory-flyover    |        |
| vordme                    |        |
| vordme-compulsory         |        |
| vordme-flyover            |        |
| vordme-compulsory-flyover |        |
| tacan                     |        |
| tacan-compulsory          |        |
| tacan-flyover             |        |
| tacan-compulsory-flyover  |        |
| vortac                    |        |
| vortac-compulsory         |        |
| vortac-flyover            |        |
| vortac-compulsory-flyover |        |

**Note**

- Symbols are rendered as vector graphics (SVG), so they stay sharp on high-DPI displays.
- The symbol color comes from the color element of the style class matching the class attribute of the group containing the symbol. Symbols in the same group share the color of the group style, the same as polylines, polygons and labels.
- If the type element references an unknown symbol type, the default symbol is displayed instead.

**7.2.4 Style File Format**

Style sheet file defines the style to be used to display map elements.

Style sheet file is an XML format plain text file.

This is an example of style sheet file.

```
<?xml version="1.0" encoding="utf-8" ?>
<map>
```

```

<meta>
  <name>Default Map Style Sheet</name>
  <description>Default Map Style Sheet</description>
  <author>SinoATC</author>
  <version>2020-02-19</version>
  <comment></comment>
</meta>
<style>
  <class name="airway">
    <color>#FFFFFF</color>
    <pen>
      <line>solid</line>
      <width>1</width>
    </pen>
    <brush>
      <pattern>solid</pattern>
    </brush>
  </class>
  <class name="aerodrome_deicing_pad_label">
    <color>#8E8E8E</color>
    <pen>
      <line>solid</line>
      <width>1</width>
    </pen>
    <brush>
      <pattern>solid</pattern>
    </brush>
    <font>
      <family>Microsoft YaHei</family>
      <point>9</point>
    </font>
  </class>
  <class name="aerodrome_parking_stand_label">
    <color>#8E8E8E</color>
    <pen>
      <line>solid</line>
      <width>1</width>
    </pen>
    <brush>
      <pattern>solid</pattern>
    </brush>
    <font>
      <family>Microsoft YaHei</family>
      <point>9</point>
    </font>
  </class>
</style>
</map>

```

The meaning of each XML element is

| Element     | Parent Element | Compulsory | Description                                                                                                                                                                                            |
|-------------|----------------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| map         | 无              | Yes        | Root element                                                                                                                                                                                           |
| meta        | map            | Yes        | File meta data                                                                                                                                                                                         |
| name        | meta           | Yes        | Style sheet name                                                                                                                                                                                       |
| title       | meta           | Yes        | Title of style sheet                                                                                                                                                                                   |
| description | meta           | Yes        | Description of style sheet                                                                                                                                                                             |
| author      | meta           | Yes        | Author of style sheet                                                                                                                                                                                  |
| version     | meta           | Yes        | Version of style sheet                                                                                                                                                                                 |
| comment     | meta           | No         | Comments, invisible to software user.                                                                                                                                                                  |
| style       | map            | Yes        | Style definition                                                                                                                                                                                       |
| class       | style          | Yes        | Class of style. Each style sheet file could include any number of classes. Class element must contain “name” attribute. It is the name of a style, and it must be unique with in one style sheet file. |
| color       | class          | No         | Color, the format is #RRGGBB, the same as HTML color. If omitted, black is used.                                                                                                                       |
| pen         | class          | No         | Pen style                                                                                                                                                                                              |
| line        | pen            | No         | Pen line style, current version supports: solid, dash, dot, dashdot and dashdotdot                                                                                                                     |
| color       | pen            | No         | Pen color                                                                                                                                                                                              |
| width       | pen            | No         | Pen width                                                                                                                                                                                              |
| brush       | class          | No         | Bursh style                                                                                                                                                                                            |
| color       | brush          | No         | Brush color                                                                                                                                                                                            |
| pattern     | brush          | No         | Brush filling pattern, current version supports: solid and cross                                                                                                                                       |
| font        | class          | No         | Font style                                                                                                                                                                                             |
| family      | font           | No         | Font name. Font can be correctly rendered only when it is installed.                                                                                                                                   |
| point       | font           | No         | Font size                                                                                                                                                                                              |

**Note**

- When the class attribute of group element in layer file matches the name attribute of class element in style sheet file, system will use the defined style to render elements in group.
- The color element uses RGB value to specify a color, it is the same with HTML color. See [https://www.w3schools.com/colors/colors\\_hexadecimal.asp](https://www.w3schools.com/colors/colors_hexadecimal.asp) for more information. The color applies to all elements in the group, including symbol elements.

## 7.3 Schema Validation

The layer file and style sheet formats are formally described by two XML schema (XSD) files, so that map files can be checked for conformance automatically:

- `skymap-layer.xsd` –schema of the layer file format
- `skymap-style.xsd` –schema of the style sheet format

The schema files are referenced here by file name only; their location depends on the deployment.

Conformance check is performed with `xmllint`, the command line tool shipped with `libxml2`:

```
xmllint --noout --schema skymap-layer.xsd chn-airports.xml
xmllint --noout --schema skymap-style.xsd style.mss
```

- `--noout` suppresses the document output; a conforming file produces no output and `xmllint` exits with code 0.
- On violation, `xmllint` prints the line number and the reason of each violation, and exits with a non-zero code.
- Multiple files and shell wildcards are accepted, so all layers of a map can be checked in one run:

```
xmllint --noout --schema skymap-layer.xsd *.xml
```

**Note**

- The schemas describe the formats as they are read and written by the system. Unknown symbol types are rejected by the schema, while the renderer itself falls back to the default symbol for them.

## 8 Changelog

### 8.1 Version 1

#### 8.1.1 Version 1.9.0 Release 2026-10-10

- Added selected altitude to the track label (radar, SDPS and MLAT);
- Added vertical rate and vertical trend to the track label;
- Added a velocity vector to the track display;
- Reworked the replay panel into a modeless replay window; selecting a sensor zooms to the sensor coverage;
- Added 8x replay speed; Max speed is only available in debug mode;
- Added a performance statistics window (F8);
- Added an update interval attribute to ADS-B and SDPS sensors;
- Added a tile map sampling quality option;
- Added Indonesian UI translation;
- Mode S derived track data is no longer displayed when outdated;
- Improved the responsiveness of the interface under heavy surveillance data load;
- Improved map and track label rendering performance;
- Fixed incorrect track positions when sensors report Cartesian coordinates;

#### 8.1.2 Version 1.8.0 Release 2026-09-16

- Added CAT240 SMR radar video display;
- Added the Alenia SIR-M radar processor;
- Added SMR (surface movement radar) sensor type;
- Added weather picture display from ASTERIX CAT8 radar weather data;
- Added a Verify SAC/SIC option to the ASTERIX processor;
- Added support for replaying pcap and pcapng capture files (*.pcap*, *.pcapng*);
- Added auto rewind for recording file replay;
- Added Map World (Tianditu) tile map provider;
- Added FAA public aeronautical charts tile map provider;

- Added Google Maps language and HD tiles options;
- Track and static map symbols are rendered as vector graphics with configurable color and size;
- Track label colors are configurable;
- Improved track selection linkage between the map and the track list;
- New standalone Map Editor application for editing static maps;
- New Sensor Manager tool for editing sensor databases;
- New sensor settings page;
- New Dynamic Map settings page;
- Range ring map is now configurable;
- Added portable mode;
- UI style is now selectable in Display settings;
- Toolbar text under icons can be toggled in Display settings;
- Fixed LAN Input 2 multicast fields not being enabled correctly;
- Fixed a disabled tile map proxy breaking DNS resolution;
- Fixed a startup crash when restoring a modified dock layout;
- Fixed a spurious “Recording file is invalid” warning at startup;
- Fixed map layouts with “/” in their names not loading;
- Fixed tiles not loading while following a selected track;
- Fixed the ADS-B coverage circle not drawn on the sensor map;
- Fixed static map polygon outlines and drawing order;
- Fixed SDPS position display across the 180-degree meridian;
- Crash log is created automatically when the application crashes;
- Completed the migration to Qt 6.

### 8.1.3 Version 1.7.0 Release 2026-06-06

- Improved tile map logos for Bing Maps, OpenAIP, and Google Maps: sharper rendering on high-resolution displays and better visibility on both light and dark map backgrounds;
- Tile map copyright text now remains readable regardless of the map background color;
- Added a “Rotate North Up” command in the View menu to quickly reset the map to a north-up orientation;
- Status bar now displays the current map rotation angle between the scale and cursor coordinates, with 0.01-degree precision and signed clockwise/counter-clockwise values;
- Static map lines now keep a consistent width when zooming in and out;
- Improved overall map rendering smoothness.

#### **8.1.4 Version 1.6.0 Release 2026-06-05**

- Added a visual Static Map Editor for creating and editing maps directly within the application;
- Existing SkyBinary map files continue to work seamlessly;
- Enhanced replay controls with adjustable playback speed and the ability to reset the start time;
- Sharper text and labels on high-DPI displays;
- Faster and smoother map and track rendering;
- User interface now supports English and Simplified Chinese, including a Chinese user manual;
- Improved main menu organization and an expanded cheat sheet with map symbols.

#### **8.1.5 Version 1.5.0 Release 2026-02-10**

- Added file replay functionality to review recorded surveillance data;
- New replay control window for starting, pausing, and scrubbing through recordings;
- Support for `.rei` recording files;
- Ability to set a specific start time when replaying a file;
- Sensor names are now shown in the replay control window.

#### **8.1.6 Version 1.4.0 Release 2026-01-30**

- Radar sensor map now visualizes antenna rotation;
- Radar sensor map displays north mark and sector coverage lines;
- Improved sensor map appearance and behavior;
- Track labels display more cleanly;
- User interface refinements.

#### **8.1.7 Version 1.3.0 Release 2025-12-17**

- Added Google Maps as an additional tile map background option;
- Support for overlaying two tile map layers simultaneously;
- Tile map settings are now configurable in the settings window;
- Smoother tile map zooming and level selection.

#### **8.1.8 Version 1.2.0 Release 2025-11-02**

- Added OpenAIP ([www.openaip.net](http://www.openaip.net)) as a tile map background option;
- Double-click or use the menu to center the map on a selected track;

- Extended demo mode runtime;
- Additional serial input options;
- Various user interface and input handling improvements.

### **8.1.9 Version 1.1.0 Release 2023-09-11**

- Configure a SOCKS5 proxy for accessing tile map services;
- Bing Maps supports offline tile storage and download;
- Additional Bing Maps imagery styles and localization options;
- Customize the background color behind tile maps;
- Processor and input settings are now organized in separate tabs;
- Added a built-in user manual;
- Fixed an issue that could cause a crash when deleting an unselected sensor.

### **8.1.10 Version 1.0.0 Release 2023-09-06**

- Added Bing Maps as a tile map background option;
- Added a tile map downloader for Bing Maps;
- Settings window layout and usability improvements;
- Fixed a crash that could occur when deleting an unselected sensor.

## **8.2 Version 0**

### **8.2.1 Version 0.13.0 Release 2023-06-27**

- User interface refinements;
- Improved display quality on Windows high-DPI screens;
- Updated documentation generation.

### **8.2.2 Version 0.12.0 Release 2022-04-21**

- Receive and display 1090ES ADS-B surveillance targets;
- Integrated ADS-B decoding and tracking.

### **8.2.3 Version 0.11.0 Release 2021-05-09**

- Static maps can now include navigation symbols;
- Static maps can include PNG images;
- Assign display priority to individual map layers;
- Receive surveillance data from two UDP sources at the same time.

### **8.2.4 Version 0.10.0 Release 2020-11-09**

- Support for MLAT (multilateration) data inputs;
- Support for SDPS surveillance data inputs with flexible coordinate display options;
- Support for safety net alerts including STCA, MSAW, and APW;
- Alerts are displayed in a dedicated alert list;
- Alert status is shown directly on track labels.

### **8.2.5 Version 0.9.0 Release 2020-06-18**

- Select tracks by clicking on the map or in the track list;
- Sensor positions are displayed with higher precision;
- Added a “What’s New” window to highlight changes after updates;
- Install and manage license keys from within the application;
- Map converter tool for preparing map files;
- Fixed an issue that occasionally prevented map dragging when track labels were hidden.

### **8.2.6 Version 0.8.0 Release 2020-04-24**

- Support for SDPS surveillance data inputs;
- Improved SDPS track processing and display;
- Fixed unexpected activation of range ring center setting;
- Fixed reversed left/right map movement.

### **8.2.7 Version 0.7.0 Release 2020-03-23**

- Display configurable range rings around sensors;
- Static maps now support standard ICAO navigation symbols.

**8.2.8 Version 0.6.0 Release 2020-03-17**

- Added a sensor database for managing sensor information;
- Dynamic sensor map shows sensor positions and coverage areas;
- Zoom level is displayed in the status bar;
- Configure the system center point used on startup;
- Fixed an issue where mouse wheel zoom had no effect.

**8.2.9 Version 0.5.0 Release 2020-03-07**

- Drag track labels with the mouse to reposition them;
- Added a keyboard shortcut cheat sheet window.

**8.2.10 Version 0.4.0 Release 2020-03-06**

- New XML-based map file format for easier editing;
- New binary map file format for faster loading;
- Legacy map file format is no longer supported.

**8.2.11 Version 0.3.0 Release 2020-03-01**

- Support for primary radar track inputs;
- Support for secondary radar track and plot inputs;
- Sensor configuration dialog for setting up data sources;
- Configure the local time zone displayed in the application.

**8.2.12 Version 0.2.0 Release 2020-02-29**

- Runs on Raspberry Pi with Raspbian;
- Track trails show recent historical positions;
- Labels connect to tracks with leader lines;
- Map appearance is customizable via style files;
- Map index files speed up loading of large map sets;
- Full-screen display mode;
- Clock shown in the status bar.

**8.2.13 Version 0.1.0 Release 2020-02-16**

- Initial release;
- Receive and display ADS-B surveillance targets;
- Display tracks on the map and in a sortable list;
- Manage and display static maps;
- Customize the information shown in track labels;
- Save and restore map layouts;
- Cursor coordinates shown in the status bar.