



# Squall Tracker Ver 2.2

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## *User's Manual*

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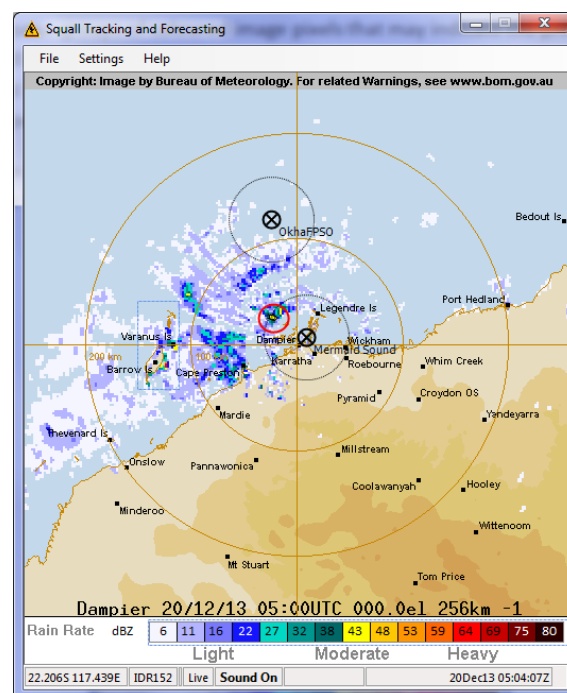
## Introduction

Squall Tracker offers the following features:

- 1) Alerts users of squalls in the general area covered by a radar location
- 2) Alerts users of impending squalls within a given radius of one or more specific locations of interest
- 3) Tracks each squall cell from formation to dissipation, handling splits and merges
- 4) Offers forecast positions for the following 10, 20, 30, 40, 50 and 60 minutes, based on the average, or trends where applicable, in recent cell movement

The Squall Tracker application downloads radar images for a given radar location at regular intervals, and detects contiguous groups of coloured image pixels that may indicate the presence of a squall. The application will warn the user both visually and audibly that possible squalls have been detected in the area covered by the radar, and if the possible squall is currently, or forecast to be, within a given radius of a specific location, another more 'urgent' visual and audible cue will be issued.

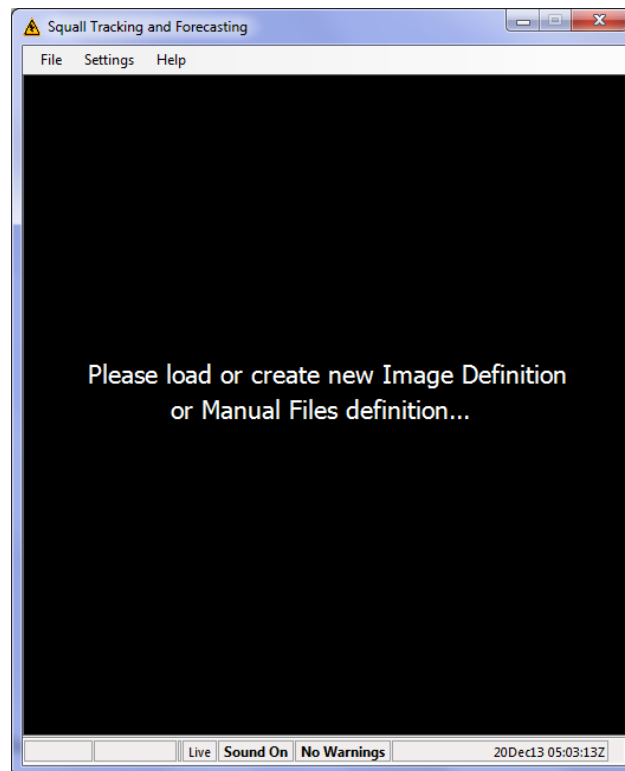
Squall Tracker can also be used to loop through historical radar images, to re-play squall events at rates much quicker than real-time.



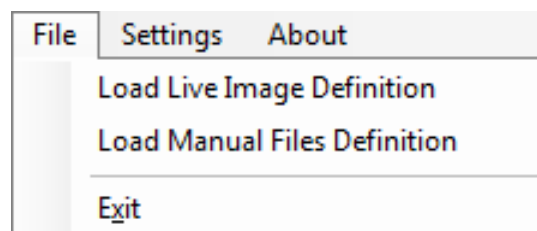
Squall Tracker is highly configurable, and is able to use the Australian Bureau of Meteorology's layered radar images (background, topography, legend, range and echo layers).

## Starting Squall Tracker

Squall Tracker starts by inviting the user to load or create an **Image Definition** or **Manual Files Definition**. If the user chooses an Image Definition, then the program runs in Live mode. If the user chooses a Manual File definition, then the program runs in Manual mode



The user can now load an **Image Definition** or **Manual Files Definition** from the File menu:



Squall Tracker may also be invoked from the command line or from a Windows Shortcut, using the arguments:

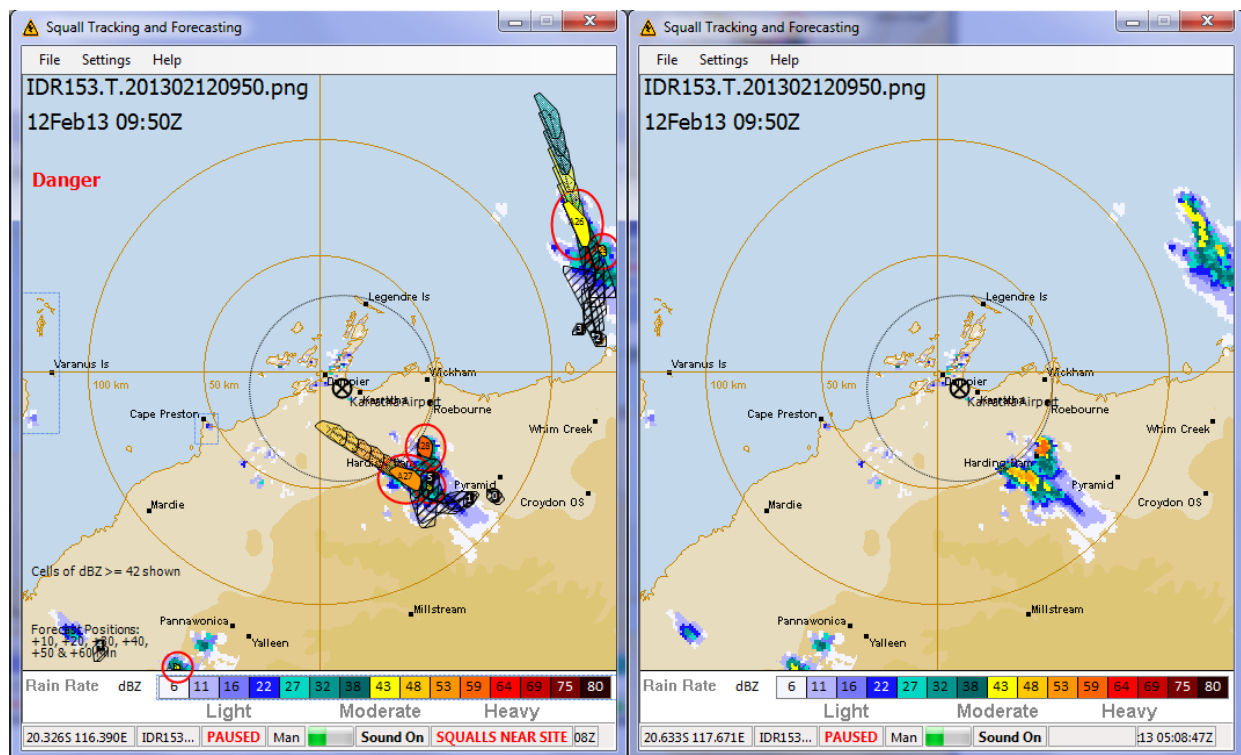
```
SquallTracker.exe -image:NameOfImageDef (e.g. -image:"Perth 128")  
SquallTracker.exe -manfiles:NameOfManualFilesDef (e.g. -manfiles:ManualFiles)
```

Note that if a space occurs within the definition name, double quotes should be placed around the name. Both arguments may be given simultaneously:

```
SquallTracker.exe -image:NameOfImageDef -manfiles:NameOfManualFilesDef
```

## Live Mode

In live mode, Squall Tracker will use the given **Image Definition** (previously created by the user) to download the latest live radar images for the specified radar location and immediately detect any possible squalls, alerting the user when found. The image will loop the last three processed images (with squall outlines and alerts), every second, then alternate between the latest processed image and the original image (one second per image) – both with locations of interest marked:



When a squall is detected anywhere on the radar image (away from any location of interest), a soft warning sound (by default) is emitted alerting the user, together with a (configurable) visible warning on the status bar, e.g. a red “SQUALLS ON IMAGE”. An optional warning message can also be spoken by the application, using the Windows Speech engine.

When a squall is detected or forecast to be within the radius of any location of interest, a louder (by default) claxon warning sound is emitted alerting the user, together with a (configurable) visible warning on the status bar, e.g. a red “SQUALLS NEAR SITE”. An optional danger message can also be spoken by the application, using the Windows Speech engine.

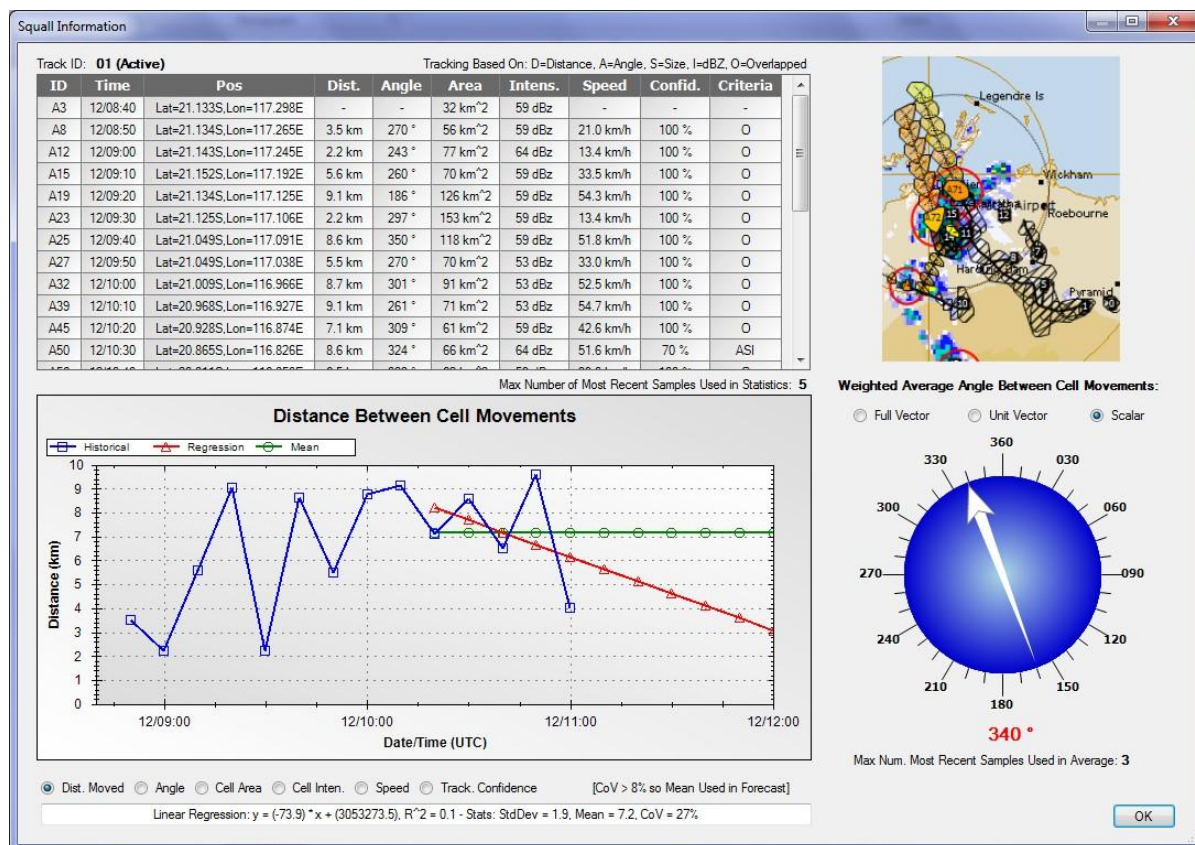
## Manual Mode

In Manual Mode, Squall Tracker will use a given **Manual Files Definition** (previously created by the user) to load the given radar image files from hard disk, using the **Image Definition** defined in the **Manual Files Definition** for the related radar location. As in Live Mode, the program will immediately detect any possible squalls on each image, alerting the user when found. The image will alternate between the processed image (with squall/track outlines and alerts) and the original image (one second per image) – both with locations of interest marked.

Each file will be looped in order every 10 seconds (configurable) before starting over again.

## Checking Track Data

Clicking on any actual or historical position in a cell track will allow the user to see all the data associated with that track:



The table shows each cell's **ID**, **position** (Lat/Lon), **distance** (km) from previous cell, **angle** from previous cell, **size** (area km<sup>2</sup>), **intensity** (dBZ), **speed** (km/h) from previous cell, **confidence level** that the cell was tracked correctly, and the **criteria** used to track the cell.

Double clicking on any row will display the forecasts issued at that time:

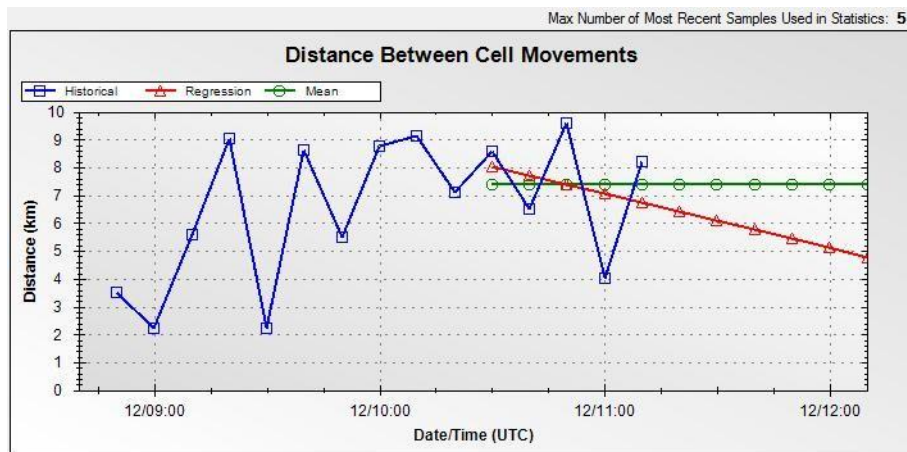
Forecast Data

ID	Time	Pos	Dist.	Angle	Area	Intens.	Speed
A27	12/10:00	Lat=21.018S, Lon=116.985E	6.2 km	301 °	107 km <sup>2</sup>	53 dBz	37.2 km/h
A27	12/10:10	Lat=20.991S, Lon=116.932E	12.4 km	301 °	107 km <sup>2</sup>	53 dBz	37.2 km/h
A27	12/10:20	Lat=20.959S, Lon=116.884E	18.6 km	301 °	107 km <sup>2</sup>	53 dBz	37.2 km/h
A27	12/10:30	Lat=20.932S, Lon=116.831E	24.8 km	301 °	107 km <sup>2</sup>	53 dBz	37.2 km/h
A27	12/10:40	Lat=20.901S, Lon=116.778E	31.0 km	301 °	107 km <sup>2</sup>	48 dBz	37.2 km/h
A27	12/10:50	Lat=20.874S, Lon=116.730E	37.2 km	301 °	107 km <sup>2</sup>	48 dBz	37.2 km/h

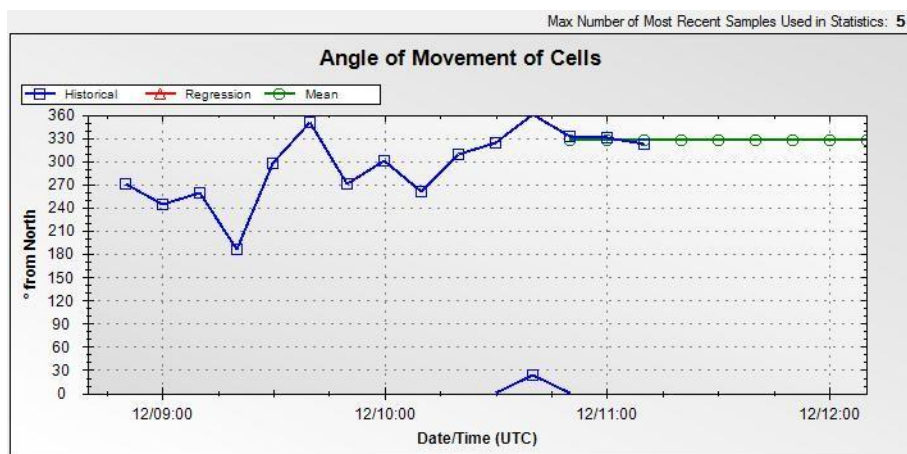
OK

The graph shows the data for each element plotted against time (in blue), together with the mean (in green) and the linear regression (in red):

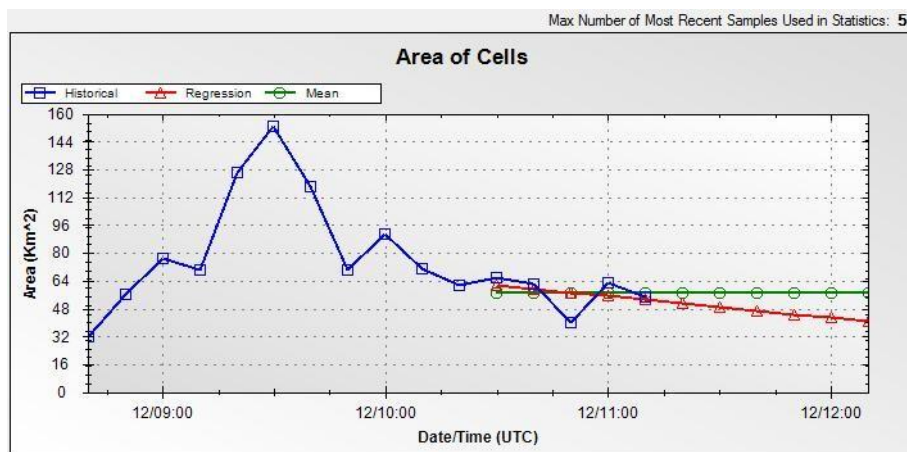
Distance:



Angle:

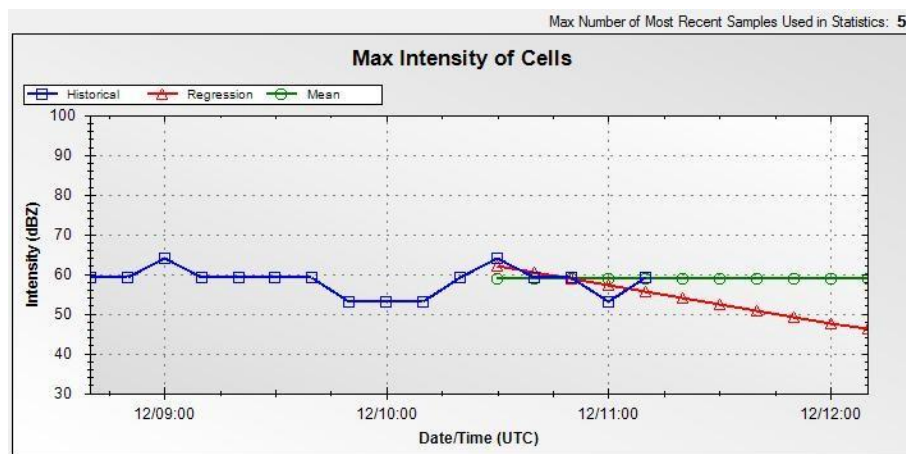


Size:

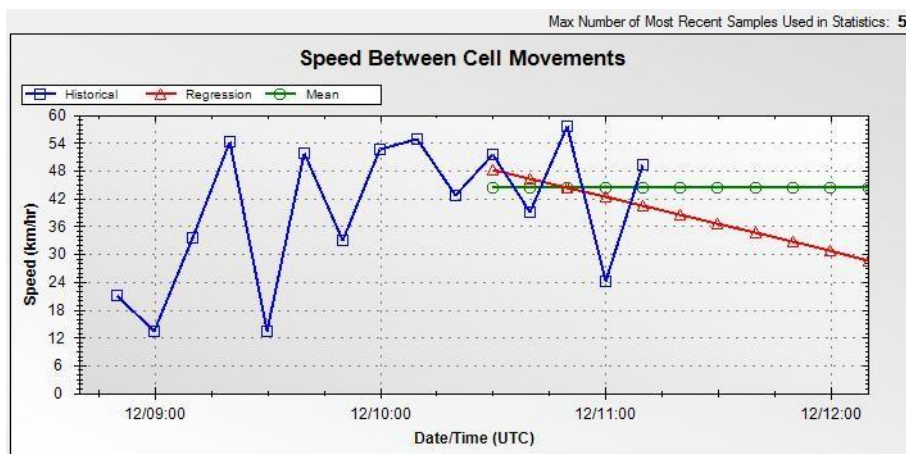




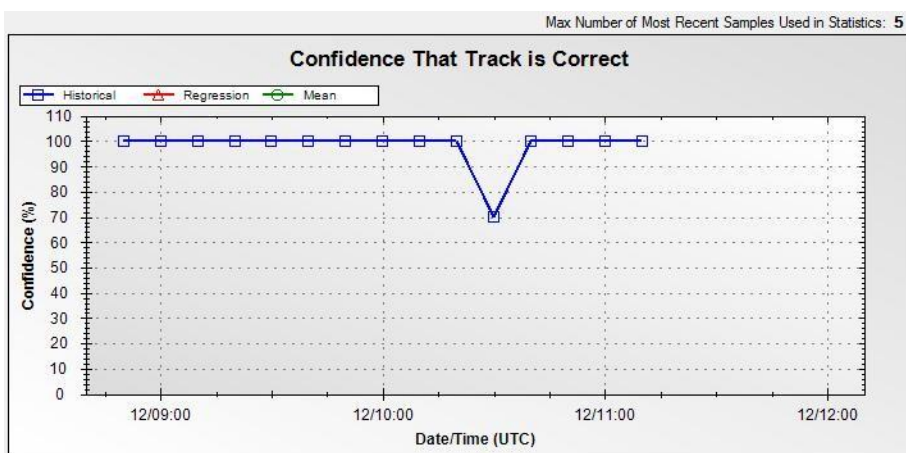
## Intensity:



## Speed:

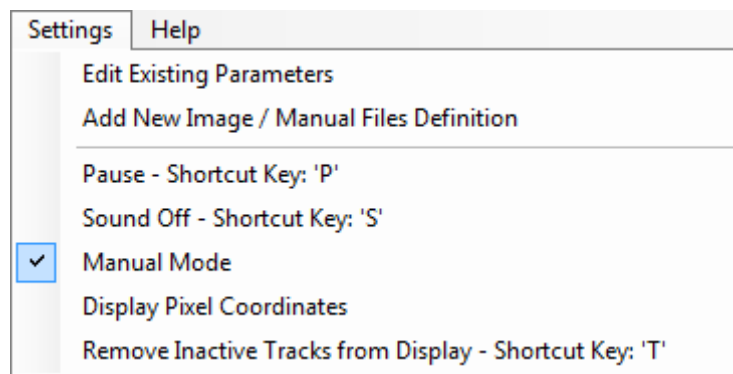


## Confidence Level:





## The Settings Menu



### Pause

Clicking the Settings | Pause menu item to *checked*, or pressing the 'P' or 'p' key, will pause the image updates, and the status bar will display the word "**PAUSED**".

### Sound Off

Clicking the Settings | Sound Off menu item to *checked*, or pressing the 'S' or 's' key, will turn the warning sounds off. *Note that the sound will automatically turn on again after 30 minutes (configurable).*

### Manual Mode

Clicking the Settings | Manual Mode menu item will switch run modes between Manual Mode and Live Mode.

### Display Pixel Coordinates

Clicking the Settings | Display Pixel Coordinates menu item to *checked*, will cause the status bar to display pixel coordinates instead of Latitude and Longitude when the mouse is moved over the image

### Remove Inactive Tracks from Display

Clicking the Settings | Remove Inactive Tracks from Display menu item tells the system to clear all inactive tracks on the display ***the next time the image is updated***. The inactive tracks will **not** be erased immediately.

### Edit Existing Parameters

#### System Options:

The System Options apply to the running system for all Image and Manual Files Definitions:

**Configure Parameters**

System Options | Australian Radar Configuration | Image Configuration | Manual Mode Configuration

Wave file to play when a squall is detected anywhere in the frame (leave blank if none)  
 Notify.wav

Play period of above wave file (Secs): 15

Wave file to play when a squall is detected near a client location (leave blank if none)  
 Alarm.wav

Play period of above wave file (Secs): 30

Maximum time for sound off (Mins): 30

Check New Image Period (Secs): 30

Manual Image Update Period (Secs): 5

Previous Image Loop Count (Live Mode Only): 3

Old Track Display Interval (Hours): 2 (0 = Indefinite)

☐ Manual Mode?  
☐ Show Squall Size?  
☒ Show Squall Outline?  
☒ Track And Forecast Squalls?  
☒ Loop Previous Images?  
☐ Show Cell Labels?

☒ Save Debug Comments to Debug.txt?  
☐ Append New Debug Comments to Last Debug File?  
☐ Display Pixel Coordinates?  
☐ Save Live Processed Images To File?  
☒ Save Tracks To File?  
☐ Show Track Labels?

Label Position (From Location) - Reload Definition after Saving  
☒ Top/Left ☐ Top/Right ☐ Bottom/Left ☐ Bottom/Right

Status Bar Warning Message: SQUALLS NEAR SITE

Status Bar Danger Message: SQUALLS ON IMAGE

Optional Images and Track File FTP Destination Directory (FTP Path)

FTP Username: anonymous FTP Password: \*\*\*\*\*

Images and Track FTP destination directory (FTP path starting with ftp://ftp, e.g. ftp://ftp.xxxxx.com)

Save Close

**Configure Parameters**

System Options | Australian Radar Configuration | Image Configuration | Manual Mode Configuration

Australian Radar File Locations

Show? Background image location: ☒ ftp://ftp2.bom.gov.au/anon/gen/radar\_transparencies/ Background File Name: background.png

Topography image location: ☒ ftp://ftp2.bom.gov.au/anon/gen/radar\_transparencies/ Topography File Name: topography.png

Range image location: ☒ ftp://ftp2.bom.gov.au/anon/gen/radar\_transparencies/ Range File Name: range.png

Locations image location: ☒ ftp://ftp2.bom.gov.au/anon/gen/radar\_transparencies/ Locations File Name: locations.png

User image directory [1]: ☒ C:\SquallDetector\ User image file name [1]: DBZLabels.png

User image directory [2]: ☐ User image file name [2]:

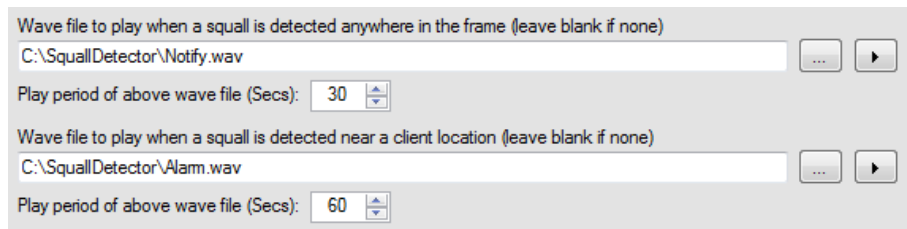
User image directory [3]: ☐ User image file name [3]:

Legend image file: ftp://ftp2.bom.gov.au/anon/gen/radar\_transparencies/IDR.legend.0.png

Live radar images location: ftp://ftp2.bom.gov.au/anon/gen/radar/

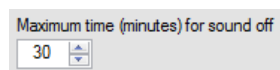
Save Close

### Wave Files:



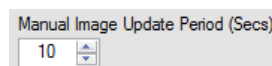
The user may change the default wave files to play when squall warnings are active, as well as the period between sounds.

### Sound Off Timeout:



The user may change the default period that governs when the sound is automatically switched back on.

### Manual Image Update Period:

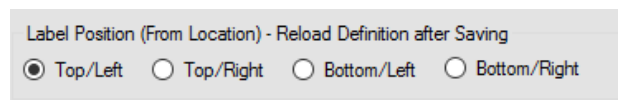


The user may change the default period between image file updates in Manual Mode.

### Options:

Option	Explanation
<input checked="" type="checkbox"/> Manual Mode?	Toggle between Manual and Live Modes
<input type="checkbox"/> Show Squall Size?	If checked, displays the size of the squall area in square pixels
<input checked="" type="checkbox"/> Show Squall Outline?	If checked, outlines the detected squall area in blue
<input checked="" type="checkbox"/> Track And Forecast Squalls?	Turns on the Tracking and Forecasting features
<input checked="" type="checkbox"/> Loop Previous Images?	If checked, the last 3 received (processed) images will loop before the current image
<input checked="" type="checkbox"/> Show Cell Labels?	If checked, displays a unique label for each detected squall cell
<input checked="" type="checkbox"/> Save Debug Comments to Debug.txt?	If checked, saves internal debug comments to the file Debug.txt in the working directory. Useful for fixing any bugs
<input checked="" type="checkbox"/> Append New Debug Comments to Last Debug File?	If checked, internal debug comments are appended to an existing Debug.txt file, instead of starting a new file every time Squall Tracker restarts
<input type="checkbox"/> Display Pixel Coordinates?	If checked, Squall Tracker's status bar displays mouse coordinates in pixels instead of Lat/Long
<input checked="" type="checkbox"/> Save Live Processed Images To File	If checked, the processed images will be saved to hard disk, in "today's" directory off the working directory
<input checked="" type="checkbox"/> Save Tracks To File?	If checked, the tracks will be saved to hard disk, in "today's" directory off the working directory
<input checked="" type="checkbox"/> Show Track Labels?	If checked, displays a unique label for each track

## Location Label Position




Label Position (From Location) - Reload Definition after Saving

☒ Top/Left   ☐ Top/Right   ☐ Bottom/Left   ☐ Bottom/Right

The user may change the position of all location labels to be either Top/Left, Top/Right, Bottom/Left or Bottom/Right of the location position. After saving the configuration, reload the definition file for the changes to take effect.

## Status Bar Warning Messages:



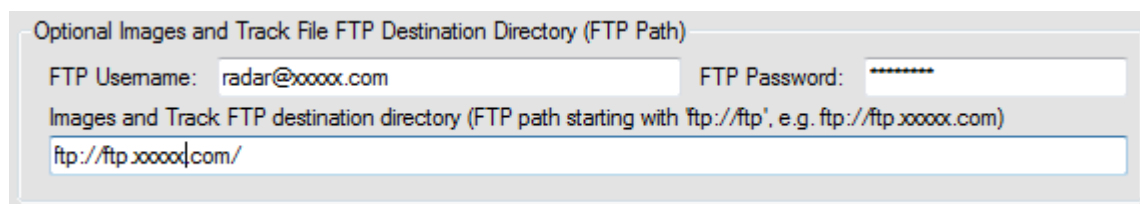
Status Bar Warning Message:

Status Bar Danger Message:

The user may change the message that gets flashed on the status bar in red when squalls appear on the radar image (warning) and when a squall is near a location of interest (danger).

## Optional Images and Track File FTP Destination Directory (FTP Path)

The user may specify an optional FTP path to which images and tracks are copied if ☒ Save Live Processed Images To File is checked:



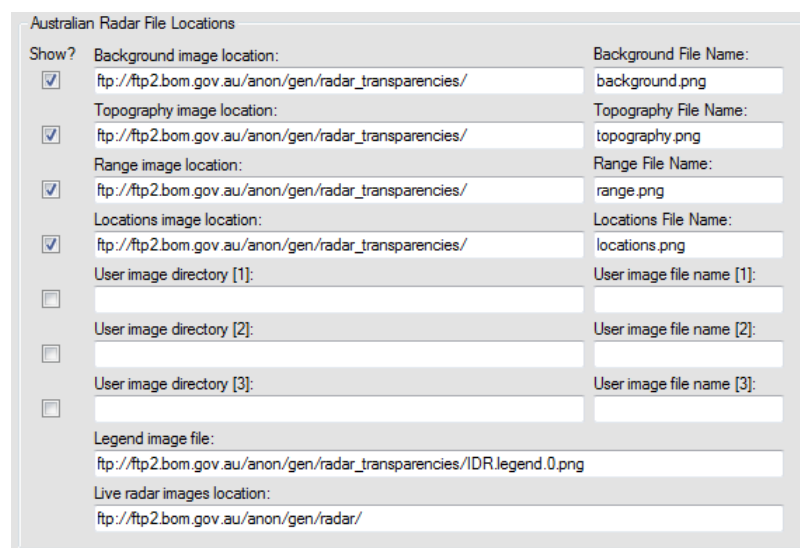
Optional Images and Track File FTP Destination Directory (FTP Path)

FTP Username:  FTP Password:

Images and Track FTP destination directory (FTP path starting with ftp://ftp, e.g. ftp://ftp.xxxxxx.com)

The user must enter the username and password first, then type in the FTP address of the server (with 'ftp://' in front of the address) which will receive the files. When the user leaves the address field, the system will check if the FTP site is valid, and if not, will warn the user and reset the focus back to the address field. If the validation continues to fail, blank out the address field and investigate why the server will not accept requests.

## Australian Radar File Locations:



Australian Radar File Locations

Show?	Background image location:	Background File Name:
<input checked="" type="checkbox"/>	<input type="text" value="ftp://ftp2.bom.gov.au/anon/gen/radar_transparencies/"/>	<input type="text" value="background.png"/>
<input checked="" type="checkbox"/>	Topography image location:	Topography File Name:
<input checked="" type="checkbox"/>	<input type="text" value="ftp://ftp2.bom.gov.au/anon/gen/radar_transparencies/"/>	<input type="text" value="topography.png"/>
<input checked="" type="checkbox"/>	Range image location:	Range File Name:
<input checked="" type="checkbox"/>	<input type="text" value="ftp://ftp2.bom.gov.au/anon/gen/radar_transparencies/"/>	<input type="text" value="range.png"/>
<input checked="" type="checkbox"/>	Locations image location:	Locations File Name:
<input checked="" type="checkbox"/>	<input type="text" value="ftp://ftp2.bom.gov.au/anon/gen/radar_transparencies/"/>	<input type="text" value="locations.png"/>
<input type="checkbox"/>	User image directory [1]:	User image file name [1]:
<input type="checkbox"/>	<input type="text"/>	<input type="text"/>
<input type="checkbox"/>	User image directory [2]:	User image file name [2]:
<input type="checkbox"/>	<input type="text"/>	<input type="text"/>
<input type="checkbox"/>	User image directory [3]:	User image file name [3]:
<input type="checkbox"/>	<input type="text"/>	<input type="text"/>
Legend image file:		
<input type="text" value="ftp://ftp2.bom.gov.au/anon/gen/radar_transparencies/IDR.legend.0.png"/>		
Live radar images location:		
<input type="text" value="ftp://ftp2.bom.gov.au/anon/gen/radar/"/>		

The user may change the default FTP locations of the BoM radar files, should BoM decide to relocate their FTP radar images.

The user may turn off layers that are displayed in Squall Tracker when using Australian Radar images by unchecking the appropriate *Show?* check box. The legend and live radar echo layers cannot be turned off.

Three user overlays may also be specified, and if the appropriate [Show] check box is checked, these overlays will be included on the processed image.

## Image Configuration:

The Image Definition is created and maintained in the following tab:

Configure Parameters

System Options Australian Radar Configuration **Image Configuration** Manual Mode Configuration

Image Parameters

The name/URL of the NON-Australian radar image to download:

OR, the Australian Radar ID (e.g. IDR153):  
IDR152

Radar Latitude: -20.654 Radar Longitude: 116.682 Min DBz Value to Detect: 42

Radar X Position in Pixels: 257 Radar Y Position in Pixels: 257 Max CoV% for Regression: 8.0

How many pixels to the km? 1 Image Update Time (min): 10 Preferred Angle Ave. Method: Scalar

Max Most Recent Positions to Use for Fcst Stats: 5 Max Most Recent Positions to Use for Fcst Angle: 3 Max Cell Speed Allowed (km/h): 100

A map of colours with their equivalent radar DBZ values:

Color	DBZ
[A=255, R=40, G=0, B=0]	180.0DBz
[A=255, R=120, G=0, B=0]	75.0DBz
[A=255, R=200, G=0, B=0]	69.0DBz
[A=255, R=255, G=0, B=0]	64.0DBz
[A=255, R=255, G=100, B=0]	59.0DBz
[A=255, R=255, G=150, B=0]	53.0DBz
[A=255, R=255, G=200, B=0]	48.0DBz
[A=255, R=255, G=255, B=0]	43.0DBz
[A=255, R=0, G=102, B=102]	38.0DBz
[A=255, R=0, G=150, B=144]	32.0DBz
[A=255, R=0, G=216, B=195]	27.0DBz

Add Colour/DBZ  
Edit Colour/DBZ  
Remove Colour/DBZ

Please complete above fields before filling in the following fields

Exclusion Rectangles:

{X=106,Y=215,Width=39,Height=83}  
{X=116,Y=515,Width=396,Height=24}

Add Exclusion Rect  
Remove Exclusion Rect

Client Locations:

Mermaid Sound: {Lat=-20.588,Lon=116.764}/40//  
OkhaFPSO: {Lat=-19.589,Lon=116.446}/40/Possible squalls on radar/Danger - squalls

Add Location  
Edit Location  
Remove Location

Minimum width of squall (Pixels): 3 Minimum height of squall (Pixels): 3

Save As... Save Close

The following information **MUST** be supplied before adding colours, exclusion rectangles and locations to the Image Definition.

### The Name/URL of the Radar Image to Download:

The name/URL of the radar image to download:

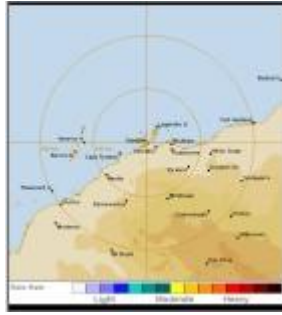
The user may supply the name of a radar image to download from a source other than the Australian BoM. This option is currently disabled as no testing has been done on this feature.

### The Australian Radar ID:

OR, the Australian radar ID (e.g. IDR153):  
IDR152

To download and view Australian BoM images, the user must enter the Radar ID. This ID is used to format all the appropriate Australian radar image layers. Once the user has entered a valid ID, the thumbnail image to the right of the tab will update with the appropriate overlay images:





### The Radar Latitude and Longitude:

Radar Latitude:	Radar Longitude:
-20.654	116.682

The user must supply the radar's latitude and longitude in decimal degrees, to 2 or 3 decimal places. This information is used to compute the lat/long of locations of interest.

### The Minimum dBZ Reflectivity Value That Defines a Possible Squall:

Min DBz Value for Squalls:
42

### The Radar Pixel Location:

Radar X Position in Pixels:	Radar Y Position in Pixels:
256	256

The user must supply the radar's pixel position. This data is initially computed from the loaded image (when the user supplied the Radar ID), but may be updated. This information is used to compute the lat/long of locations of interest.

### Max CoV% for Regression

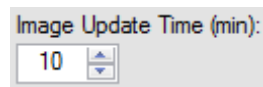
When computing the forecast statistics, Squall Tracker needs to make a decision as to whether to use the mean distance/angle/area/intensity of the last few positions (see "Max. Most Recent Positions to Use for Fcst Stats/Angle" below) or the linear regression of each of those elements over those position (i.e. trend). The Coefficient of Variance percentage (Standard Deviation / Mean x 100) was found to be a good metric to determine whether the trend was realistic, and the value of 8% gave good results during testing, below which the trend (regression) is used in forecasting. Setting this value to 0% will ensure that the mean is always used, and 100% will ensure that the trend (regression) is always used. The latter is **NOT** recommended.

### The Pixel to Kilometre Conversion:

How many pixels to the km?
1

The user must supply the number of pixels per kilometre. The Australian radar images for 128km range usually have 2 pixels per km, whilst images for 256km range are 1 pixel per km.

## The Image Update Time:

A small control window titled "Image Update Time (min):" containing a numeric input field with the value "10" and a vertical spinner control.

The user must give the frequency of images supplied by BoM. These differ from radar site to radar site. Perth and Dampier update their images every 10 minutes, whilst Melbourne and Sydney update their images every 6 minutes.

## Preferred Angle Average Method

Three methods of averaging angles are available: Scalar (arithmetic mean), Unit Vector (vector average assuming a distance of 1 unit for each angle), and Full Vector (vector average using the actual distance moved for each angle). The default is Scalar.

## Max. Most Recent Positions to Use for Fcst Stats

The maximum number of recent positions to use to determine the mean and trend of distance/area/intensity for use in forecasting. The number actually used may be less if the number of recent positions is less than this max. The default value is 5.

## Max. Most Recent Positions to Use for Fcst Angle

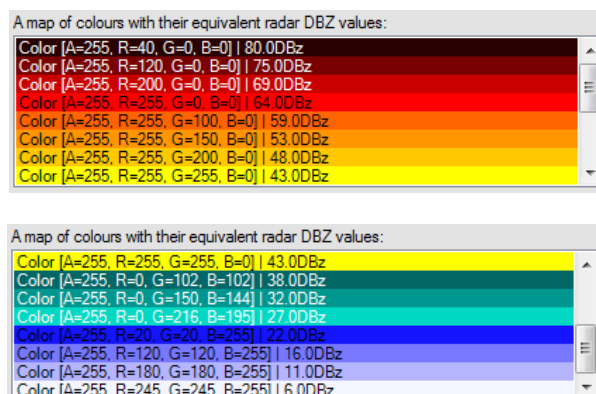
The maximum number of recent positions to use to determine the mean and trend of angle for use in forecasting. The number actually used may be less if the number of recent positions is less than this max. The default value is 3.

## Max. Cell Speed Allowed (km/h)

During tracking, whilst determining which current cells 'are' previous cells which have moved, all neighbouring cell are tested. Those cells that are too far away are judged by the speed the previous cell would have had to move to reach that current cell position. The maximum speed allowed may be set by the user, and the default is 100 km/h.

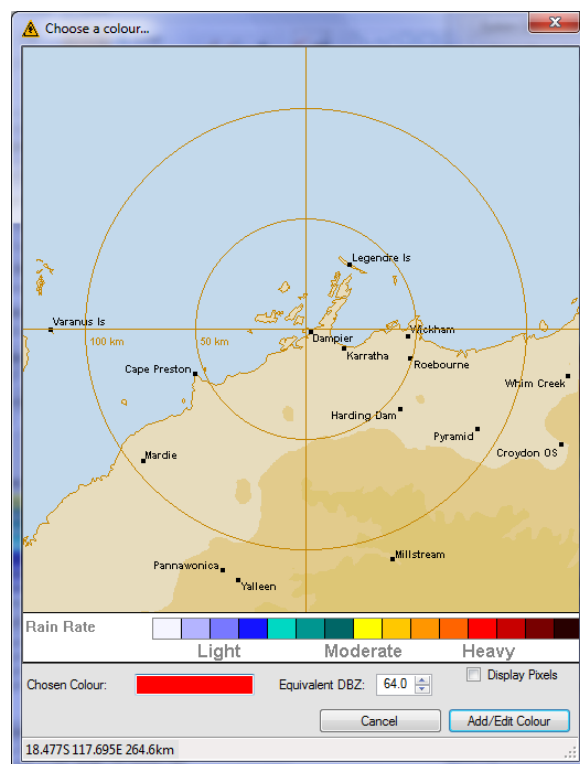
The following fields may now be created or updated.


## Squall Colour to dBZ Mapping:



The user must specify the colours and their equivalent dBZ reflectivity values used on the selected radar image, that Squall Tracker will flag as a possible squall. All pixels that have a colour with an equivalent dBZ value greater than “**The Minimum dBZ Reflectivity Value That Defines a Possible Squall**” given above retain their original colours, and all other colours are internally changed to black, before the resultant image is analysed for ‘blobs’. The polygons for each ‘blob’ are considered possible squall areas.

To add a colour, click [Add Colour]. The following dialog is displayed with the latest combined radar image:



Click a colour on the image’s palette:  to record the colour and specify the equivalent dBZ value, then on click [Add/Edit Colour]. This colour will be added to the list of colours, together with it’s RGB values and dBZ value. Repeat this process for the other colours in the palette.

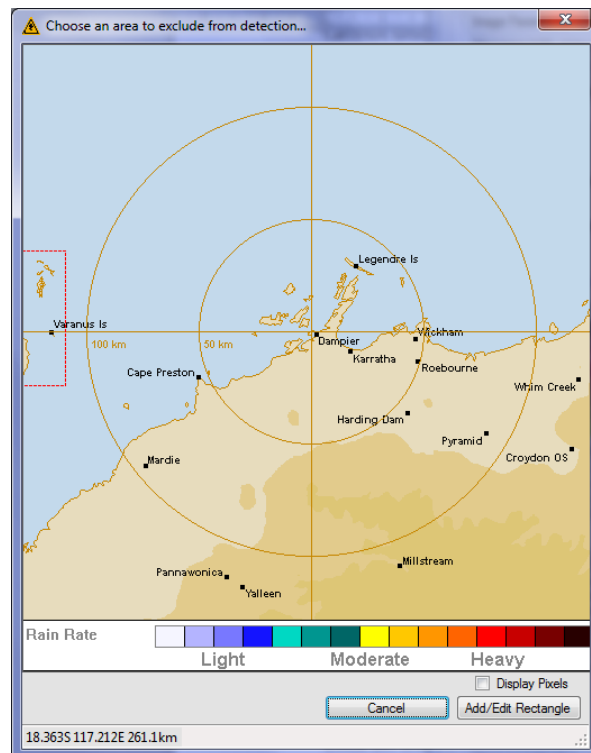
To remove a colour from the colour list, select that item and click [Remove Colour].

### Exclusion Rectangles:



The user may specify those areas that should NOT be analysed, i.e. areas where false squall echoes are frequent, and the colour palette, which obviously must be excluded, since Squall Tracker cannot distinguish between an echo image and a palette colour.

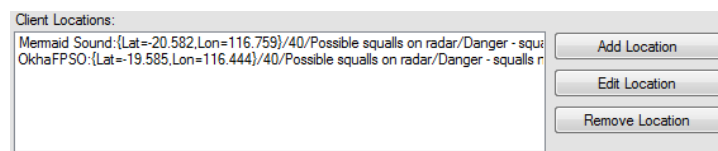
To add an exclusion rectangle, click [Add Exclusion Rect]. The following dialog is displayed with the latest combined radar image:



Click on the map and (holding the right mouse button), drag the mouse cursor to see a dashed red line form a rectangle. Do this for areas on the image that must be excluded from analysis. When one rectangle has been selected, click [Add/Edit Rectangle]. This rectangle will be added to the list of rectangles. Repeat this process for more exclusion rectangles.

To remove a rectangle from the rectangle list, select that item and click [Remove Exclusion Rect].

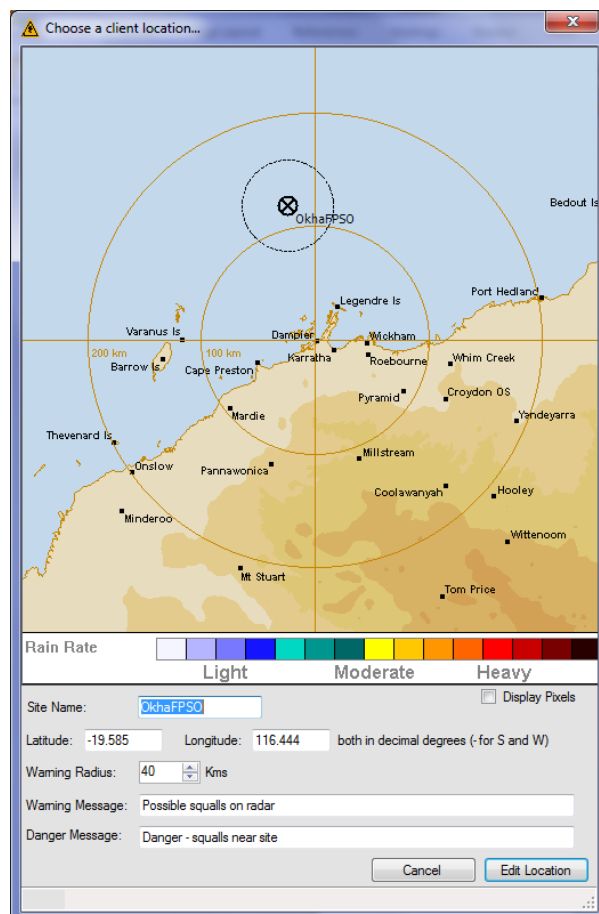
#### Client Locations:



The user may specify locations of interest (i.e. client locations) on the image, that should a squall approach a location, the application will warn the user that a squall may be imminent. For each location, the following information must be given:

- 1) The name of the location
- 2) The Lat/Long of the location
- 3) The radius from the location that differentiates between a warning and danger
- 4) Optional spoken sentences for warnings and when the site is in danger. These sentences are spoken using the Windows Speech engine

To add a client location or location of interest, click [Add Location], or to edit an existing location, select a location to edit in the list, and click [Edit Location]. The following dialog is displayed with the latest combined radar image:



Enter or edit the name of the location.

To select the position of a location, either click on the image at the appropriate position, or manually enter the Lat/Long in the Latitude/Longitude text boxes in decimal degrees. Note that the latitude is negative for positions south of the equator, and the longitude is negative for positions west of the UTC meridian.

Enter or edit the warning radius, in km.

Enter or edit the optional spoken warning/danger messages.

To remove a location from the location list, select that item and click [Remove Location].

### The Minimum Squall Sizes:

Minimum width of squall (Pixels):	Minimum height of squall (Pixels):
5	5

The user must specify the minimum width and height of any 'blob' on the image above which it will be analysed, and below which it will be ignored.

### Save Image Definition:

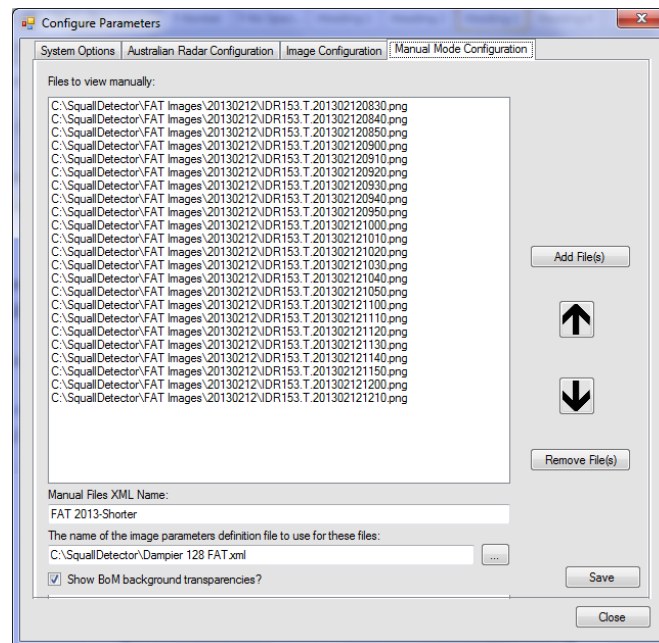
Click the [Save] button to save this **Image Definition** to the current existing image definition. For new definitions, the program will request an Image Definition Name (the file name) for the definition.

Click the [Save As...] button to save this **Image Definition** to a new image definition name. The program will request an Image Definition Name (the file name) for the definition.

The definition will be saved under the given name as an XML file, e.g. *DefName.xml*

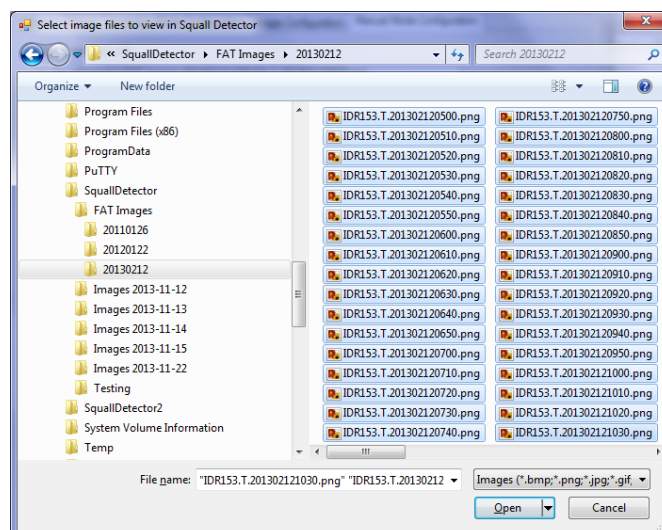
### Manual Mode Configuration:

The Manual Mode Definition is created and maintained in the following tab:



### Add Files:

To add files to the list of files to view in a loop in Manual Mode, click [Add File(s)]:



Select all the files that must be looped and click [Open]. These files will be added to the list.

### Remove Files:

Select the files to be removed from the list, and click [Remove File(s)]:

### Move Files:



Select one file to be moved and click the [UP] button to move the file upwards in the list, or the [DOWN] button to move the button downwards in the list.

### The Name of the Manual Files Definition (File Name):

Manual Files XML Name:
Squall Event Jan 2012

Enter the name of the manual files definition. The associated XML file will be saved under this name.

### The Image Definition to Use For These Files:

The name of the image parameters definition to use for these files:
Dampier 128

The user must specify the **Image Definition** to use to view these manual files. For example, the file images to loop may from the Melbourne radar, so a Melbourne image definition must be used (to get the appropriate pixels per km conversion and radar positions).

### Show BoM Background Transparencies

If the selected images only comprise echoes, and require BoM transparencies (background, topography, range etc), check the following check box. If the images are already composites of all the transparencies, uncheck this box.

<input checked="" type="checkbox"/> Show BoM background transparencies?
-------------------------------------------------------------------------

### Save Manual Files Definition:

Click the [Save] button to save this **Manual Files Definition**.

## Add New Image/ Manual Files Definition

Adding either a new **Image Definition** or a **Manual Files Definition** follows the same process as in “Edit Existing Parameters” above, except that all fields are either blank or initialized to default values on entry.

## Status Bar

### Live Mode

20.256S 117.697E	IDR152	PAUSED	Live	Sound Off	SQUALLS ON IMAGE	13 04:47:51Z
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20.878S 117.115E	IDR152	Live	Sound On			20Dec13 04:48:49Z
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### Manual Mode

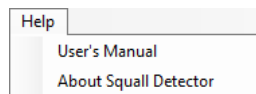
22.783S 119.127E	IDR153...	PAUSED	Man	<input type="checkbox"/>	Sound On	13 14:23:51Z
------------------	-----------	--------	-----	--------------------------	----------	--------------

22.783S 119.127E	IDR153...	Man	<input type="checkbox"/>	Sound On	SQUALLS NEAR SITE	13 14:21:36Z
------------------	-----------	-----	--------------------------	----------	-------------------	--------------

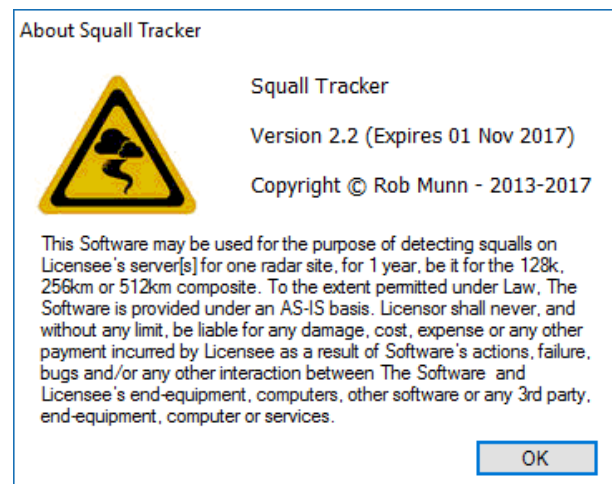
The status bar displays:

- 1) The current mouse position as Lat/Long, or in pixels if the Settings | Display Pixel Coordinates menu item is *checked*
- 2) The current image name, or BoM radar ID
- 3) A red warning message reminding the user that the application has been paused
- 4) An indication of the current run mode, i.e. Live or Manual mode
- 5) In manual mode, a progress bar indicating the progress of the entire image loop
- 6) A red warning message reminding the user that the application's sound is off
- 7) A flashing red warning message regarding squalls on the image, or simply "No Warnings"
- 8) The current date and time in UTC

## Help



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## Appendices

### Detection in Squall Tracker

- 1) Each pixel of the raw radar image (the image containing only radar returns) is examined to see if it's colour's associated dBz value is greater than that specified by the user in the Image Definition's field: "The Minimum dBZ Reflectivity Value That Defines a Possible Squall" (default 40 dBZ)
- 2) If the associated dBZ value is less, then that pixel is set to black, otherwise it's colour is unchanged
- 3) The AForge imaging library (<http://www.aforge.net/>) is used to extract all the non-black 'blobs' into an array, which is then enumerated extracting the 'convex hull' polygon coordinates, blob area and centroid position, as well as the maximum dBZ values from the blobs' colours. Each blob is assigned a unique ID (A0 to ZZ99)
- 4) The lat/long of each blob's centroid is then computed using the radar position as a reference.
- 5) 'Blobs' now become 'cells' or 'squalls'

### Tracking in Squall Tracker

- 1) Each previous cell is compared to each current cell.
- 2) If the previous cell and the current cell overlap (intersect) then the current cell is the previous cell. A previous cell may merge with two different current cells if they overlap to form a split, or two previous cell may merge with one current cell to form a join. A tracking confidence level of 100% is given to overlapped cells
- 3) If no overlap is determined, then cells are compared using the '[Hungarian Algorithm](#)' to find the cell with:
  - a. The shortest distance
  - b. The closest (smallest difference) angle match
  - c. The closest (smallest difference) size match
  - d. The closest (smallest difference) intensity match
- 4) The algorithm returns the indices in the current cell array that 'match' each index in the previous array. Each element 'match' (distance, angle, area and intensity) is collectively considered and a determination made as to which current cell is the best candidate to 'mate' with each previous cell
- 5) A tracking confidence level for each 'match' is determined by how many matches were made by the algorithm, and which elements were matches, where *Distance* is assigned 40%, *Angle* is assigned 30%, *Size* is assigned 20% and *Intensity* is assigned 10%
- 6) For each previous cell position, each existing active track is enumerated to determine if it already has that previous position, and if it does, updates the track with the 'matched' current position. If not, a new track is created and the previous and current 'matched' position are added, and a track ID is assigned.
- 7) As the track is updated with the new positions, all the required statistics (mean, stddev, slope, intercept,  $R^2$ , CoV, etc) are computed, and the forecasts determined. See next section.

## Forecasting in Squall Tracker

- 1) For each of 10, 20, 30, 40, 50 and 60 minutes:
- 2) Calculate the distance the cell is expected to move during the forecast period. If the distance's Coefficient of Variance is less than 8% (or user value), use linear regression otherwise use the mean
- 3) Calculate the angle the cell is expected to move towards during the forecast period, by using the weighted mean (this value depends on what method of averaging the user chose – default is Scalar). The weighted mean is the average of the earliest position's angle, plus 2 x the average of the next earliest position, plus 3 x the next and so on until the latest position, which carries the most weight as it has been counted more than the others.
- 4) Calculate the amount the cell is expected increase/decrease in area. If the size's Coefficient of Variance is less than 8% (or user value), use linear regression otherwise use the mean
- 5) Calculate the intensity the cell is expected to be during the forecast period. If the intensity's Coefficient of Variance is less than 8% (or user value), use linear regression otherwise use the mean
- 6) Calculate the Lat/Long of the forecast position, using the current Lat/Long as a reference
- 7) Calculate the area of the forecast polygon, centred on the centroid, adjusting the polygon's size
- 8) Adjust the polygon to cover the forecast position