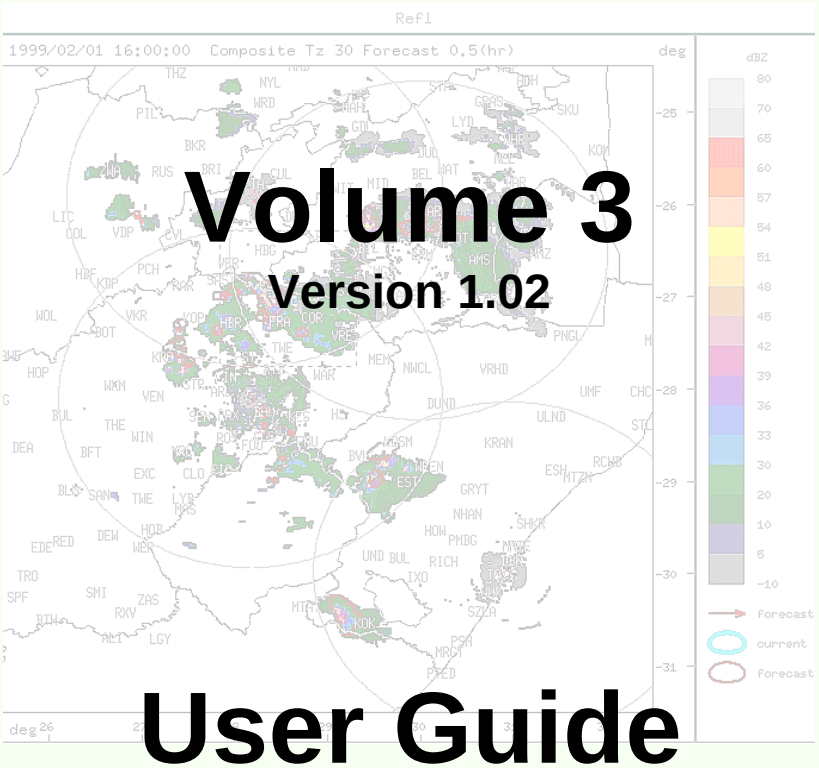
TITAN DOCUMENTATION



Volume 3

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User Guide

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INDEX

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1. INTRODUCTION

The best way to learn TITAN is to play ! This guide is intended to give you a pictorial tour of the software, but again the best way to learn about all the many functions is to play around on the computer whilst working through the relevant sections. The guide is structured as follows :

- section 2 deals with the aspects of starting up the system and related issues;
- section 3 describes the interface in great detail;
- section 4 is a basic guide of what to check when you suspect that something is wrong;
- finally in section 5 some concluding remarks and a taste of things to come in the not too distant future (it is hoped !).

To begin at the beginning - TITAN is an acronym which stands for ***Thunderstorm Identification Tracking Analysis and Nowcasting***. Development started in the early 90's by Dixon and Wiener. Dr Michael Dixon, an ex-South African, based the software on his storm-tracking software used in the pre-TITAN era in South Africa. Since then TITAN has gone through many revisions and has grown in scope, complexity and diversity.

TITAN has been used extensively for weather modification operations and also analysis. There are XX radar data acquisition system RDAS and TITAN systems currently running in operational cloud seeding programmes outside of South Africa. Locally the RDAS-TITAN combination is running with all 12 South African radars. TITAN is also the display for the merging system in use, producing the web page products.

2. WHAT IS A COLD START ?

First a warning : TITAN runs under the LINUX operating system, which is an UNIX operating system for PC s. LINUX platforms (like all UNIX systems) **do not take kindly to just being switched off.**

The PC should therefore be on no-break power and should not be switched off without performing the correct shutdown procedure. Ideally, these systems should *never be switched off.*

So you want to start TITAN but the computer is off. What to do ?

LINUX comes up with a login prompt. The login is **titan5**. It also prompts for a password (which will not be documented here). Hopefully you have that information stored somewhere safe but convenient. Once logged on an environment very Windows95/98-ish will come up. You should feel very at home !

A window (an **xterm**) will come up on screen, in which you can type the name of your start-script (which contains a list of the processes which are started) at the prompt. For most places this will simply be START.

Once START has been entered the familiar TITAN display should come up on screen and all the processes required have been started in the background.

So far so good. Now we are ready to play. One last word, the LINUX environment has the same task bar at the bottom of the screen as Windows95/98. All the windows (which are often tiled, one behind the other) can be accessed in this manner i.e. bringing them to the foreground. A window can also be activated by clicking on the blue bar at the top of each window.

3. THE INTERFACE

The TITAN ensemble consists of 6 possible windows. Each of these will be described in the next few paragraphs. The system is mouse driven and the effect of a left- and right-clicks will be reviewed. There is also on-line help for each of the windows.

Depending on whether you have a two-button or three-button mouse, determines how certain commands are executed. The instructions are given in terms of a three-button mouse with its middle button activated. If the middle button is not activated or you have a two-button mouse then the same effect may be achieved by clicking both buttons simultaneously.

The following abbreviations are used in the Tables 1 to 6 :

L - left button/click	M - middle button/click	R - right button/click	D - double click

Therefore L-D = left button double click etc.

When the START script is executed two processes get started which drive the TITAN display :

- **rview** which opens the TITAN window and enables the vertical section function
- **time_hist** which opens and updates the Track data time scale, Storm time history, Storm time-ht profile and reflectivity distribution windows.

Each of these windows will now be described and an example of each is shown in one of its configurations. You will realize at the end of this section that the system is very flexible and configurable and it would be impossible to show all the options here.

It is suggested that you find a day in your archive with sufficient convective development to make the process of going through these options informative as well as fun, especially once you reach section 3.3. Sections 3.1 and 3.2 will equip you to find some interesting weather .

Suggested activities are in italics.

3.1 The TITAN Window

Figure 1 shows a typical TITAN window. This example is a merged reflectivity field referenced to latitude-longitude which are published on the web. Locally, at each radar site, a Cartesian frame of reference is used.

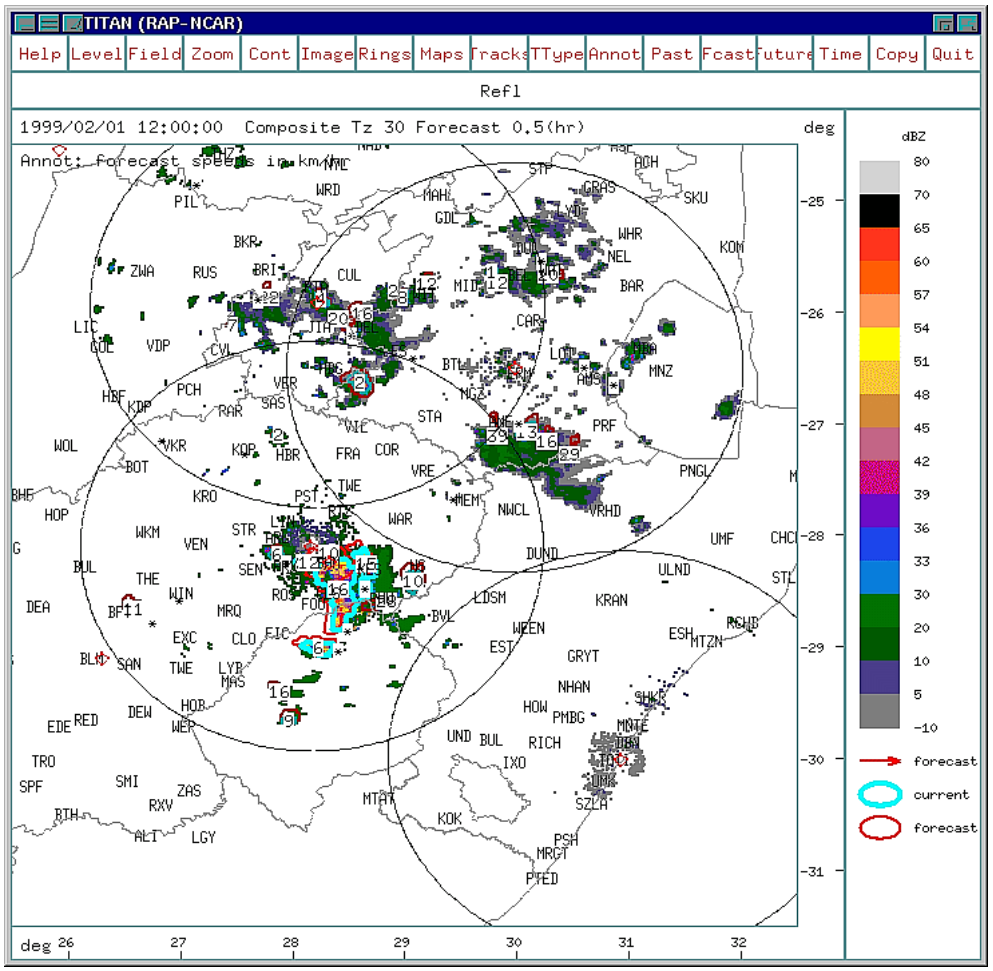

Figure 1
The TITAN window set to show the CAPPI composite field, 30 dBZ tracks and 30 minute forecast of storm movement, annotated to show the forecast speed in km/h.

How to zoom ?

Hold down L and drag over area you want to zoom into. You can then move your zoomed area by holding down M and dragging the mouse in the direction you wish to move.

How to make a vertical section ?

Hold down R and drag through storm you wish to look at.

How to select a storm for display in time_hist ?

The graphs shown in the right-hand windows may not be for the storm that you are interested in. L-D on the storm track to display the simple track or R-D on storm to display the complex track.

So what s the difference between a simple and a complex track ?

TITAN employs a complicated storm tracking algorithm which assigns numbers to each track that is identified. Storms are tracked if their volume/area above a given reflectivity threshold exceeds a critical value.

Sometimes the simple and complex tracks are the same - that is when the storm does not merge with another storm or split during its trackable lifetime.

More often though, a storm exhibits a much more complex behavioural pattern. When distinct events such as merges and splits occur the tracking algorithm then decides (based on pre-determined criteria) whether a new track number should be assigned, and whether it is related to another previous track.

For example Track 210 or Track 210/210 imply that this is complex track 210 which is the same as simple track 210.

On the other hand Track 210/214 implies that the complex track (or original track) is 210 and the track segment you are looking at is simple track 214.

Hopefully you have lots of storms on your display right now. Try clicking on different storms and finding simple and complex storm tracks. Can you see how the displays in the time_hist windows change as you switch between the complex and simple tracks ?

What happens when I click but don t drag ?

TITAN has a useful function which is mainly due to its application in weather modification operations. A L click at a given point gives the (X,Y) position of the point referenced to ?? in the blue window bar. If you click on another point, the distance between the two points and the bearing (referenced to magnetic north ?) are displayed.

Table 1
List of all the menu options and their functionality.

Menu Option	Description
Help	L on help will cause the help window to appear. L on any of the other menu options the functioning of that option is displayed *Try it on the screen. See how the contents of the help menu changes as you click on different buttons.*
Level	L to step down in height, R to step up in height, M to create composite (maximum reflectivity in a vertical column) *Try it for yourself. Note the ranges at which data is lost at the lower heights and how the availability of data increases as you step up.*
Field	The number and sequence of fields may vary from site to site. Typically there are at least 3 fields - reflectivity, precip and VIL (Vertically Integrated Liquid Water - this is an indicator of storm severity and the likelihood of hail) Step up through the sequence of fields using L, reverse sequence using R. *Try this on your system. What fields are there ?*
Zoom	Please refer to the section ***How to zoom ?*** in this section. This button allows you to move between zoom states. L takes you to the previous zoom state (if there was one), R zooms out back to the larger domain and M removes any previous zoom states. *Try the whole sequence of zooming in on a storm you want to take a closer look at. Then zoom out, zoom in and cancel. Why not try and move your zoomed area around as described in* ***How to zoom ?***
Cont	Toggle contours on (R) / off (L)
Image	Toggle field image on and off. I.e. you may want only the contours and not the underlying field. *Try the different combinations on your current field.*
Rings	Toggle the range rings on (R) / off (L)
Maps	Toggle maps off (L), limited (M) and on (R)
Tracks	Toggle track features off (L) and on (R). Partial tracks may be viewed using M when set to do so.
TType	Track graphic type L - toggle the motion vectors on and off; M - toggle the track shape between ellipses and polygons; R - toggle track fill on and off.

Menu Option	Description
Annot	Change the track property displayed by stepping through them using successive R clicks. When a track number has been assigned the first scan an * appears for the forecast speed. The algorithm uses the first scan after the track was identified to determine how far the storm has moved and in which direction. This is then used to make a forecast which is then displayed. *Try the annotate option on your system and see what track properties you have.*
Past	L to switch the past off, M to get the last 30 minutes and R to switch all the past tracks on (this reflects the actual storm behaviour)
Fcast	L to switch the forecast off, M to show the forecast from the present (now) and R to plot the forecasts for all the scans
Future	L to switch the future off, M to plott 30 minutes future and R to switch all the future tracks on (this also reflects actual storm behaviour) *Switch on all past, future and forecasts and see what it looks like ! Switch off systematically. Compare the forecast to the actual storm behaviour*
Time	not activated
Copy	L to print to printer (when connected); R to create a window dump file
Quit	quit **rview** with any button

3.2 The Track data time scale window

This window allows you to manoeuver backwards and forwards in time. The times in this window and the TITAN window must at ALL TIMES correspond. There are two ways of using the window. By L-clicking just above 1000 hours for instance, the time will jump to 1000 from 1200. The blue line gives the current time and the red horizontal line indicates the forecast period is activated. This is the preferred way of moving around when bigger jumps (but less than 24 hours) want to be made.

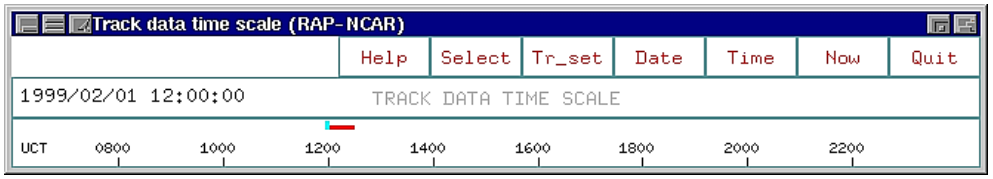

Figure 2
The Track data time scale showing the time of the data on display in the TITAN window and the forecast interval.

Table 2
List of all the menu options and their functionality.

Menu Option	Description
Help	L on help will cause the help window to appear for all the time_hist buttons. By clicking on any of the other menu options the functioning of that option is displayed.
Select	L on select followed by a L - simple track, M - partial track and R - complex track on a given storm in the TITAN window has the same effect as D-L, D-M or D-R as previously described. *Check this by doing some of your own testing.*
Tr_set	Used for weather modification operations. L keeps tabs on all the tracks at current time; R keep tabs on all the tracks during the operational period
Date	Increment (R) / decrement (L) day by 1
Time	Increment (R) / decrement (L) time by volume scan period
Now	Any button will take you to the most current time in real-time mode
Quit	Close all the time_hist windows

Spend some time checking that you know how to move backwards and forwards in time, how to use the time line and how to select tracks for display before going on to the next section.

3.3 The Storm time history window

This is where it becomes interesting and we can start to apply what we know to what we see, or learn from what we see ! You should now be quite comfortable in with **rview** and moving backwards and forwards in time. From now on we will be looking at how the storms behaved themselves. This is afterall what the forecasting component is all about.

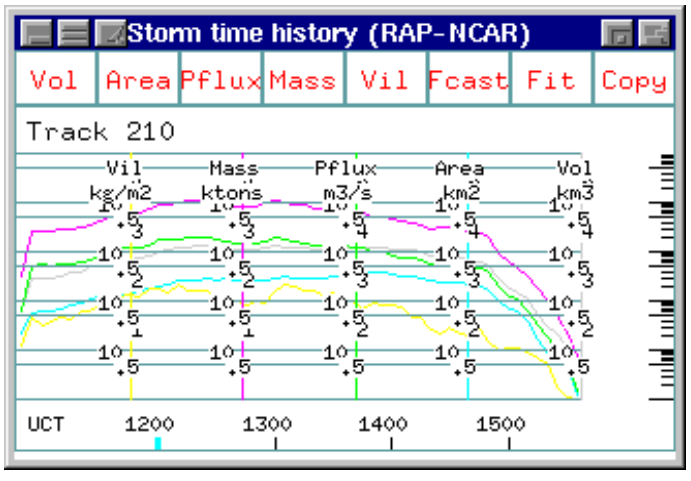

Figure 3
Storm time history showing the VIL, Mass, Precipitation flux, area and volume for the highlighted track or storm.

When everything is switched on in this window it appears quite chaotic. One can be selective about what you want to see here though, as Table 3 will tell you.

Table 3
List of all the menu options and their functionality.

Menu Option	Description
Vol	Toggle the storm volume on (R) and off (L).
Area	Toggle the storm area on (R) and off (L).
Pflux	Toggle the precipitation flux on (R) and off (L).
Mass	Toggle the precipitation mass on (R) and off (L).
Vil	This is the default. L on this button brings up a blank window !
Fcast	Toggle the forecast for the volume, area, precip flux, precip mass and VIL off (L), show from present (M) and all times (R) *See what happens when you play around with this option. How do the forecasts compare with the real thing ?*
Fit	A parabolic fit can be performed on each of the individual time series displayed. These fits can be displayed (R) and or switched off (L). *This is an interesting option. The simple approximation of a storm s life cycle is a parabola. How do your storms compare to the fit ?*
Copy	Print to printer (if connected).

Don t be in a hurry to move on to the next section. Play around with the options and see how the scales change. How do the forecasts shape up for your storms ? Get a feel for how the algorithms employed behave.

It is also worthwhile mentioning the time line at the bottom of EACH of the time_hist windows, which give you exactly the same maneouverablity as the Track data time scale window.

Try moving around by double-clicking an hour later to where you are now. Watch what happens ....

As far as I m concerned this next window is the best window of the lot. This little display is so jam-packed with goodies, it s quite amazing !

3.4 The Storm time-ht profile window

This window gives a given storm in a nutshell. At a glance you get an idea of how the storm top is increasing or collapsing. Whether the storm centroid is moving up (watch that for hail for instance) or whether the storm core is descending to the base (i.e. it s raining out - or hailing !) etc.

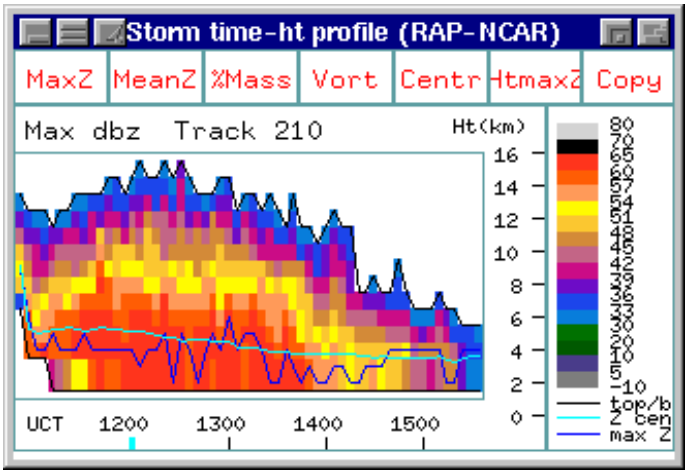

Figure 4
Storm time-ht profile of the selected track (210) showing the maximum dBZ per scan for the track. The height of the maximum reflectivity (above mean sea level) and the mass-weighted centroid of the reflectivity Z is also shown.

Again this display can be made to look as busy or as simplistic as you like. Tune it until you like it !

Table 4
List of all the menu options and their functionality.

Menu Option	Description
MaxZ	Maximum reflectivity of a track during the volume scan at each height. L to switch data off, only height lines remain, R to put back.
MeanZ	Mean reflectivity of a track during the volume scan at each height. L to switch data off, only height lines remain, R to put back.
%Mass	Percentage Mass of a track during the volume scan at each height. L to switch data off, only height lines remain, R to put back. Here one can determine where the mass of the storm is it concentrated. Is it at higher altitudes ? i.e. the storm is top-heavy or is most of the mass concentrated near the base.
Vort	Vorticity - not activated without Doppler radar data.
Centr	Height line showing the height of the reflectivity weighted centroid for each volume scan. L to switch data off, only height lines remain, R to put back.
HtmaxZ	Height of the maximum reflectivity detected for a track. L to switch data off, only height lines remain, R to put back.
Copy	print to printer (where connected)

Spend some time, toggling between the different data fields. Can you see follow the storm life cycle. When was the storm at its most intense ? Look at the behaviour of the centroids. Can you determine the possible onset of precipitation at the ground from this display ? Based on the depth and the reflectivity intensity will the rain be light and general or an intense thundershower ?

These are the kinds of questions to ask yourself as you look at this display. Here interpretation is the

key.

3.5 The Reflectivity distribution window

This diagram is summarized a given track in a more statistical fashion. Its interpretation is a little more difficult and maybe not as obvious. It is however useful to see how a storm intensifies by seeing how the yellow hues in Figure 5 occupy an increasingly larger volume of the total volume of the storm. The histograms are cumulative, so that each time the expression F (Z <= x) = X is evaluated. From Figure 5 at the extreme end of the track, F (Z <= 36 dBZ) = 38 %, F (Z <= 39 dBZ) = 60 %.

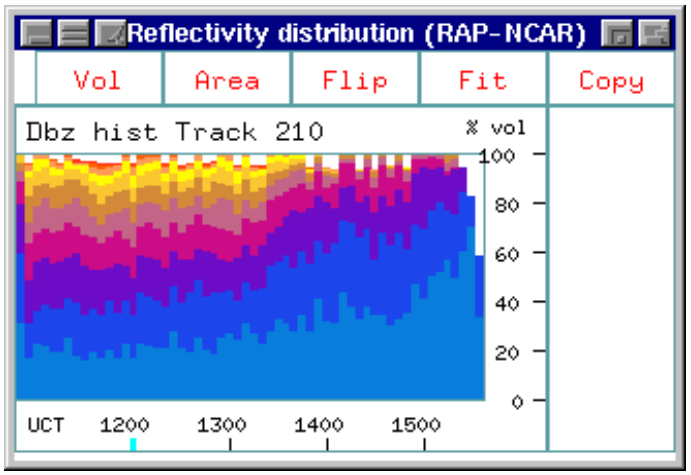

Figure 5
Reflectivity distribution for a selected storm showing the percentage volume above a given dBZ threshold.

Take some time to understand how a cumulative histogram works. Then try toggling the buttons on and off as described in Table 5.

Table 5
List of all the menu options and their functionality.

Menu Option	Description
Vol	Cumulative histogram of the percentage volume vs reflectivity (any button)
Area	Cumulative histogram of the percentage area vs reflectivity (any button)
Flip	Reverse the y-axis
Fit	Fit a statistical distribution to the data. L - off, R - on
Copy	print to printer (when connected)

3.6 The Vertical Section Window

The last window is the vertical section window, which actually forms part of **rview.** Using by following the instructions laid out in How to make a vertical section ? this window will appear giving a vertical slice through the storm at the requested location. This is helpful in identifying important radar features such as a bounded weak echo region (BWER), the height of the 45 dBZ contour (an important

indicator for hail), new development on a storm flank and many other features. The interpretation of radar data is not a trivial matter and needs some skill and experience (that can only be gained with lots of practice !)

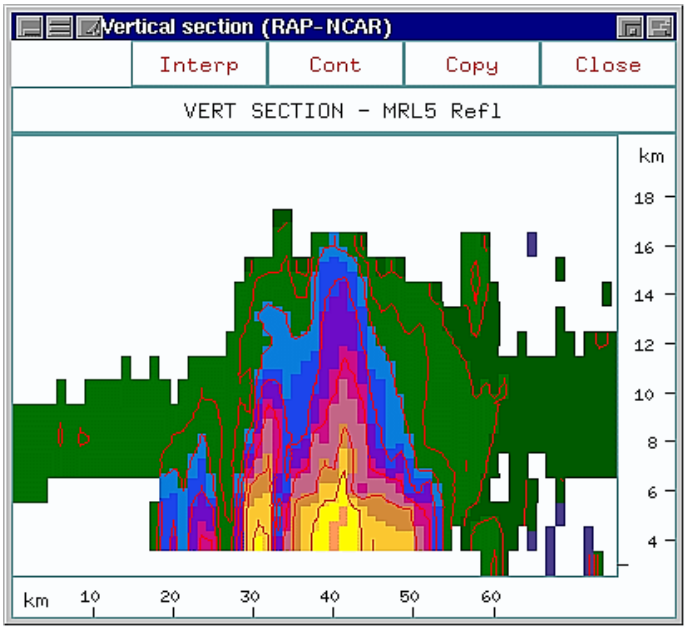

Figure 6
Vertical section through a storm referenced to mean sea level. Small vertical line indicates the lowest CAPPI level.

Figure 6 shows a particularly spectacular storm specimen with echo tops (which are lower than the actual cloud tops) of up tp 18 km ASL ! The 45 dBZ contour is also well in excess of 10 km ASL (approx 7-8 km AGL). Note the fact that the highest reflectivities are situated near cloud base implying that this storm is raining (or maybe hailing) out. Table 6 summarized all the options of the window.

Table 6
List of all the menu options and their functionality.

Menu Option	Description
Interp	A smoothing algorithm can be employed, which can be toggled on (R)and off (L).
Cont	The vertical section can be contoured (default) or the contours can be switched off (L), and restored (R).
Copy	L will print to the printer (when connected) and R will do a window dump to file.
Close	Any button will close the vertical section.

Take the time to see what happens when you toggle the interpolation and contour buttons. Which do you prefer ?

We've come to the end of the tutorial style of this section. Hope you enjoyed working the TITAN display and that you are now more comfortable with all its functions.

4. TROUBLE SHOOTING

If you suspect that something has gone (horribly) wrong e.g.

- the tracks have disappeared; or
- the times in the TITAN window and Track data time scale window are not the same; or
- the display is not updating; or
- the screen has frozen up

the first course of action (if the screen or PC has not frozen up) is to kill all the processes by returning to the task bar and accessing the **xterm** and typing KILL at the prompt. **Do not type START before you have done a KILL.** This may spawn a new process of a running process, and will likely bring no joy as it may cause your system to hang-up completely (if it hasn't already done so) ! Your script may have a different name. Please check with the system administrator for your START and KILL script names if you are unsure.

If the system has hung-up the only other alternative is to do a hard reboot or to switch off. As mentioned previously LINUX systems do not like this, so they go into a disk checking sequence on re-boot. This may take some time. If the system re-boots and the login screen appears then all is well. You can then proceed as discussed in section 2.

If this does not fix the problem then there may be :

- a radar problem (display does not update, RDAS is not sending data, radar elevation problem)
- a computer hardware problem (disk has crashed);
- a communications problem.

The key to keeping the system up and running is vigilance. Check the display regularly. Check that

- the date and time is current
- the data coming in looks ok (no noise or funny spikes);
- tracks are running (if the message NO TRACK DATA AVAILABLE is on screen - you've got trouble);

It's only by using the system and becoming familiar with radar data that you will come to know the signs to look out for.

5. CONCLUDING REMARKS

Hopefully you find using this manual helpful and informative. This guide is still under development and very much dependent on feedback from the users. As the system develops further this guide will be updated and revised. It is envisaged that other basic skills such as the interpretation of radar data and the new products under development will also be included in future - so watch this space !

ACKNOWLEDGEMENTS

Many thanks to all the people who have already contributed to the guide ! May there be many more contributors ! And happy users !

APPENDIX A

Important information relevant to your site :

Host Name : _____

Login : _____

Password : _____

Your start script : _____

Your kill script : _____