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VERY LARGE TELESCOPE

VLT

Astronomical Site Monitor

ASM Data

User Manual

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Introduction

FIGURE 1. **The DIMM at La Silla - Meteo tower and DIMM on Paranal**
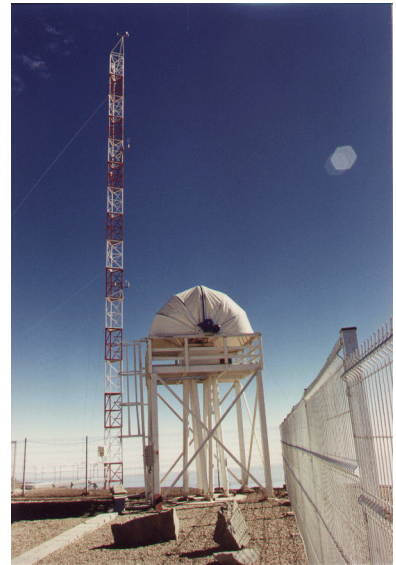
This manual describes the data produced and provided by the Astronomical Site Monitor (ASM) on Paranal and La Silla, respectively, and the user interfaces to access and display them.

Following this brief overview of the La Silla and Paranal ASMs, the individual data attributes and their detailed meaning are described in the coming chapters for each device (DIMM, Meteo, etc.).

The ASM on La Silla

- Location: Cerro La Silla 2400 m; 70 42' W; 29 16' S
- Distance from coast: 40 km

The Vaisala meteorological station was installed at La Silla in February 1985, it includes, on a 30 m high mast, a number of sensors. The archive database started storing data on January 1st, 1994. The following measurements are provided:

- 30 m level: Wind speed and direction
- 2 m level: Temperature, Humidity, Barometric pressure

The ESO seeing monitor (DIMM2) was installed in March 1991, on a 5m high tower, close to the Schmidt telescope as part of the permanent Astronomical Weather Station (AWS). Routine operation started in September 1991 and full automation was reached in December 1993. Seeing measurements were initially conducted from Cerro Vizcachas, 7 km to the East of La Silla, and once candidate site for the VLT, from Oct. 1988 to Feb. 1991. As part of the same ridge, Vizcachas and La Silla present similar seeing conditions.

The meteorological station compute and store average, root mean square and extrema of each parameter during a preset averaging period (20 min). The sampling intervals are 2 seconds for digital sensors (wind speed and direction) and one minute for analog sensors (Temperature, Humidity, Pressure). Twenty minute averages are ingested into the database.

The seeing is defined as the Full Width Half Maximum of a stellar image observed with a perfect large telescope, at 500 nm wavelength and at zenith. It is measured

over periods of a few minutes all night long. Maximum wind speed for operation is about 18 m/s and sky must be clear in the zenith area.

The ASM on Paranal

- Location: Cerro Paranal, 2635 m (after levelling, 2664 m before)
  70 24' 5" W; 24 37' 24" S
- Distance from coast: 12 km

The Vaisala meteorological station was installed in Paranal in October 1984 and upgraded in June 1998. It includes, on a 30 m high mast, a number of sensors. The following measurements are provided:

- 30 m level: Wind speed and direction, Temperature, Humidity, Particle Count
- 20 m level: Wind speed (three-dimensional), Particle Count
- 10 m level: Wind speed and direction
- 2 m level: Temperature and Humidity, Barometric pressure

The ESO seeing monitor (DIMM1) was installed in April 1987, at the northern edge of the summit, and replaced by a more modern copy (DIMM3) in September 1990. Measurements were suspended in July 1991 for the 14 months duration of the levelling work. Seeing has been then monitored during the construction period of the VLT observatory with few interruptions. Finally, DIMM3, upgraded to VLT standards and fully automatized was re-commissioned in August 98 as part of the VLT Astronomical Site Monitor (ASM). Measurements are taken at 6 m above ground.

The meteorological station compute and store average, root mean square and extrema of each parameter during preset averaging periods (1 and 20 minutes). The sampling intervals are 2 seconds for digital sensors (pressure, wind speed and direction) and one minute for analog sensors (Temperature, Humidity). One and twenty minute averages are ingested into the database (compared to only 20 min at La Silla).

The seeing is defined as the Full Width Half Maximum of a stellar image observed with a perfect large telescope, at 500 nm wavelength and at zenith. It is measured

over periods of about a minute all night long. Maximum wind speed for operation is about 18 m/s and sky must be clear in the zenith area.

The resolution of the various sensors can be taken from the tables in the coming chapters. Approximate values, applying for Paranal and La Silla, are the following:

- Wind direction: 5.63 deg (threshold: 0.3 m/s)
- Wind speed: accuracy ~2% over 10 m/s (threshold: 0.4 m/s)
- Temperature: accuracy ~0.1 deg
- Humidity: linearity about 1%
- Seeing: better than 10% above 0.25 arcsec

CHAPTER 2   *Data Displays and Access*

The data that ASM provides are presented in form of plots and numerical data panels. This chapter describes in general the available display tools, which are part of the ASM control software.

Most of these features require direct access to the ASM workstation *wasm.pl.eso.org* for Paranal, respectively *wasm.ls.eso.org* for La Silla.
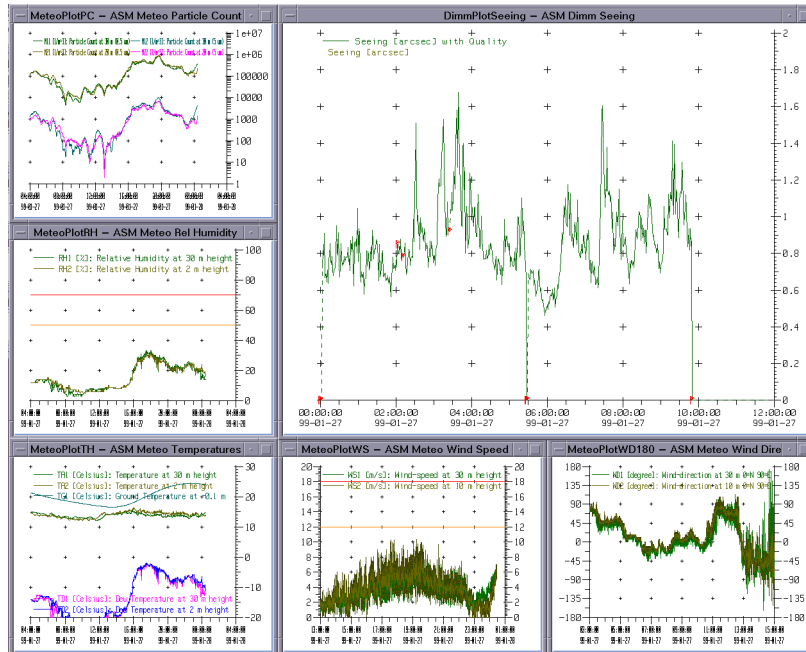
Without this access one can still query the ESO on-line archive, as shown at the end of the chapter.

The 'asm' Command

To open the ASM data displays, login on the *wasm* machine and set your *DISPLAY* variable. The typical ASM data screen can then be opened by the command:

asm

FIGURE 2. ASM typical plot screen

ASM Data Plots

Starting Plots

The ASM data plots are based on the *RtapPlotDisp*. The typical screen can be invoked with the *asm* command mentioned before, or individual plots can be opened by starting *RtapPlotDisp*. On this one can select a plot and press *View*. Note that an instance of *RtapXColorMngr* must be running for your display, which is implicitly the case for a console, but not for X-terminals. In this case type *RtapX-ColorMngr&* before.

FIGURE 3. **RtapPlotDisp with ASM plots**
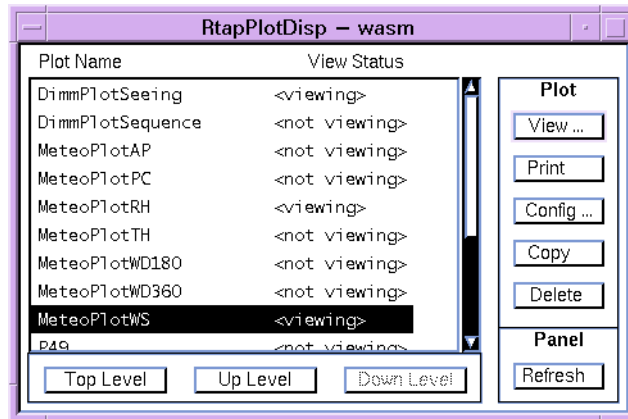
In the plot window that is opened by *View*, it is possible to move vertical and horizontal axes by clicking and dragging them. To remove the scroll arrow, click again on it.

The maximum time in the plot buffer (which one can scroll back) is normally 1.5 days.

To maintain the screen in order, the plots should not be moved or resized, but only maximized or minimized. In any case one can refresh the plot with the "Redesign" option accessible with the 3rd mouse button.

The basic arrangement of the plots on the screen can be adjusted by:

asmPlotOption 1 - to select a larger plot size (but then overlapping)

asmPlotOption 2 - to select a smaller plot size (but all at once visible)

Remark however that this will change the settings for all users of these plots, not only for the own session!

Plot Configuration

A "Config..." option is available with the 3rd mouse button which allows to disable certain pens or to change scaling and axis options. Most of these features are self-explaining, for details refer to the Rtap documentation.

The time scale should always be selected with respect to the six divisions on the horizontal axis, i.e. usually 24h, 12h, 6h, 3h, 1h is appropriate.

The vertical axis has normally a fixed (no automatic) scaling.

Programmatic Access

The normal way to access the ASM data programmatically is via remote Rtap database access to the *wasm* environment. As precondition the system configuration files */etc/hosts*, */etc/services*, and */etc$RTAPROOT/RtapEnvList* on the *wasm* as well as on the client machine must be set up correctly according to the Rtap or VLTSW documentation. */etc/passwd* on wasm needs an entry for the same user that is accessing the database from the client machine.

Then all the usual VLTSW tools (dbRead, sequencer, C/C++ library functions) can be used to access attributes in the public ASM database branch, which is located under *@wasm:ASM:Public*. Alias-based access makes life easier, so that one can simply read *@wasm<alias>Meteo.data* or *@wasm<alias>Dimm.data* to get the whole data table of Meteo and DIMM respectively. One can further detail the address, e.g. *@wasm<alias>Meteo.data(TA1L,average)* reads the 20-minute average of the air temperature at 30 m height. The first word inside the parentheses specifies the *tag* as listed in the device data tables in the coming chapters. The second requests a field and can be *value*, *average*, *maximum*, *minimum*, etc.; however, not all these fields may be available for all devices.

The module *asm* includes a C++ class *asmTCS_INTERFACE.C* which can serve as an example how to access ASM data from a C++ application.

La Silla backward compatibility

The previous system on La Silla provided the files *meteo.last* and *dimm.last* via anonymous FTP. This possibility is still available, i.e. *ftp* to *wasm.ls.eso.org*, give *anonymous* as user-name and your email address as password, then *cd pub*, and get the two files. For Paranal, however, there is no such support.

ASM Data Archive

A selected subset of the ASM data is ingested into the ESO on-line archive. Special keywords are used for each parameter, which can be looked up in the ASM data dictionary under:

http://archive.eso.org/dicb/DID/ESO-VLT-DIC.ASM-<version>

where *<version>* represents the latest release.

All public keywords used by ASM begin with 'GEN AMBI'. The description of individual keywords can be queried starting from:

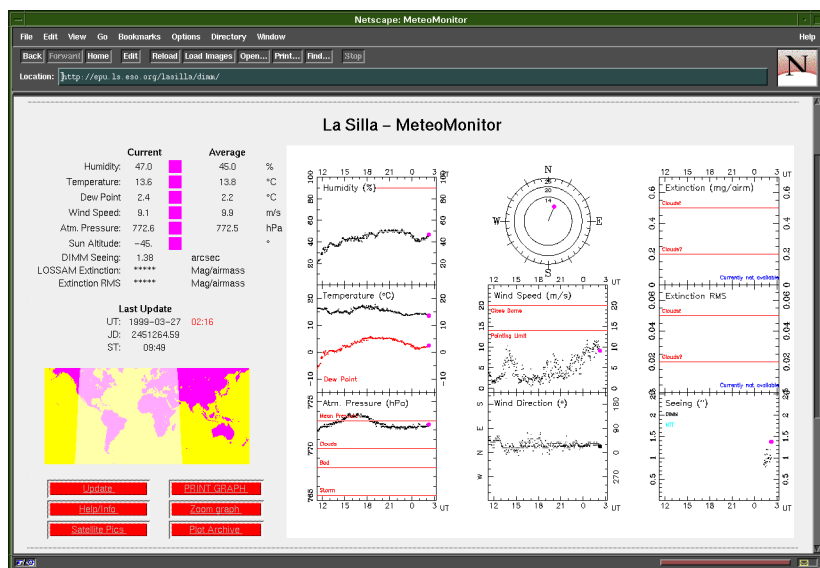*http://archive.eso.org/dicb/*

External Tools

Several web-based tools are available to display selected sets of the data provided by the ASM. They do not form a part of the ASM (control) software, but they shall anyway be mentioned here.

Meteo-Monitor

For La Silla there is the Meteo-Monitor available under:

http://epu.ls.eso.org/lasilla/dimm
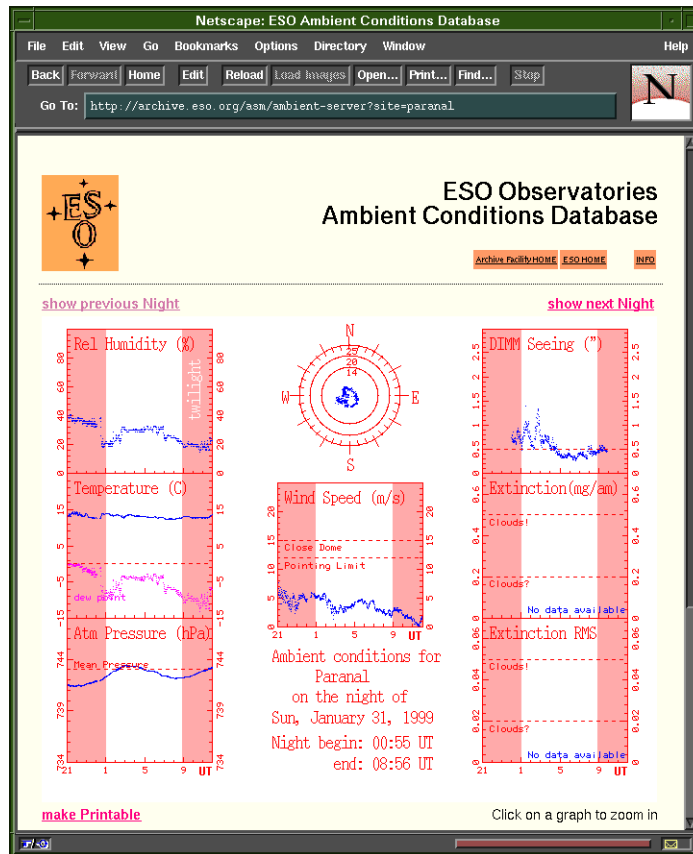
FIGURE 4. **Meteo-Monitor**

It shows the up-to-date meteo and seeing data together with trending over one day.

ASM Archive Ambient Server

Selected data of the Paranal and La Silla ASMs is available on the ESO archive web site under:

http://archive.eso.org/asm/ambient-server

FIGURE 5. ASM Archive Ambient Server

In the lower part also sun and moon data for the selected night are displayed.

DIMM Data

DIMM means *Differential Image Motion Monitor*. A 30 cm class automated telescope is used to image a target star and split the light path into two spots by means of a special optics setup. Among other values, from that image, the *Seeing* is determined by measuring the differential motion of the two spots over a sequence of exposures.

The DIMM provides the following parameters:

Keyword GEN AMBI	Tag	Parameter	Unit	Update Interval
FWHM	Seeing	Seeing at 500 nm wavelength at zenith	arcsec	typ. 60 s
DIMM AIRMASS	Airmass	Airmass of target star		
DIMM RA	PosAlpha	RA of target star	HHMMSS	
DIMM DEC	PosDelta	Declination of target star	DDMMSS	

Seeing

The plot *DimmPlotSeeing* displays the seeing curve.

**FIGURE 6. Seeing Plot (DimmPlotSeeing)**
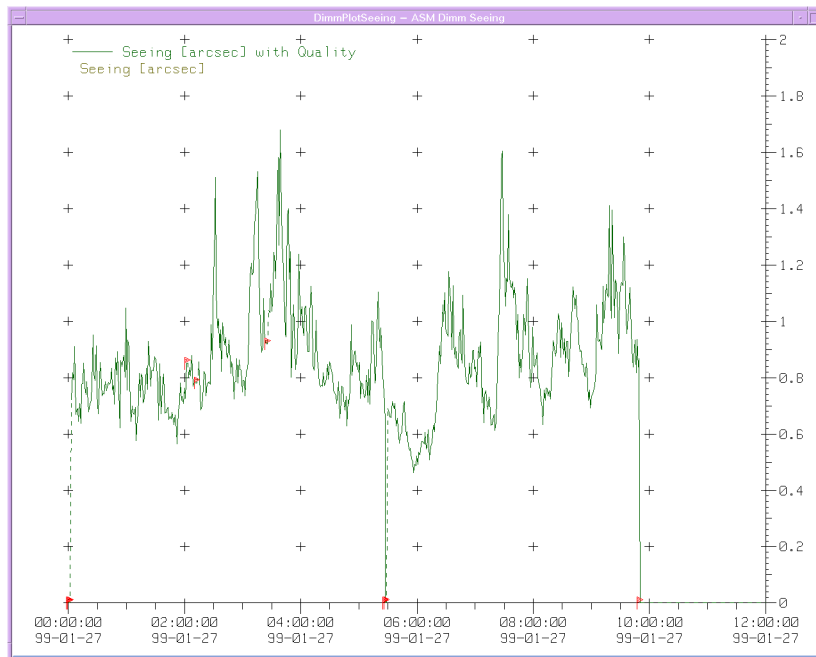
Two curves are available which both display the same value. For the green curve (Seeing with Quality), *red flags* in the plot indicate rejected sequences, i.e. those for which the configured validation criteria were not met (sorry, you are not permitted to change these!). Alternatively the yellow curve can be enabled for which no quality indication is plotted. Note that if both curves are enabled, the yellow is plotted *over* the green one.

While the DIMM cannot deliver new data, e.g. when the telescope presets to a new target star, during bad weather conditions when the DIMM must close, or in case of a system failure, the plotted curve is forced to zero. As soon as valid new data is ready, the normal curve plotting is resumed.

Although two consecutive seeing samples are connected with a straight line, it does of course not mean that there are valid values in between. Only the samples themselves represent valid seeing data. Even in the "red-flag-case" a dotted line is plotted, simply repeating the last valid value.

To display the current seeing value and its attributes, a small panel can be opened with the command *asmDimm*.

FIGURE 7. asmDimm panel
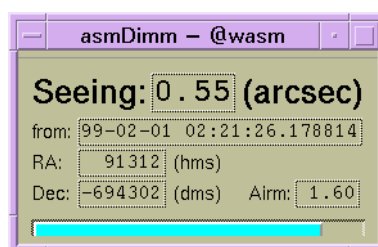
When no up-to-date seeing value can be provided (which is for the same cases as when red flags in the plot appear), then its display becomes shaded.

The panel shows additionally the parameters for which the seeing has been determined: the time as well as position and airmass of the target star.

The moving bar indicates the progress of an ongoing measurement. When the bar arrives at the right edge, the seeing display is updated.

Comparing Science Image Quality to DIMM Data

One should apply the following rules:

- Use 'long exposures', i.e. longer than ca. 30 seconds
- Convert the DIMM data (given at airmass = 1) to observing airmass, multiplying DIMM data by $(\text{airmass})^{0.6}$.
- Convert the DIMM data (given at wavelength $\lambda_0 = 0.5\ \mu m$) to observing center wavelength λ, multiplying DIMM data by $(\lambda_0/\lambda)^{0.2}$.
- Rebin DIMM data to the exact time span of the science exposure.

- Eight-meter class telescopes have reduced image motion due to finite outer scale of turbulence, leading to an improvement of up to 10% compared to the DIMM data.

Meteo Data

The automatic weather stations of La Silla and Paranal are not the same, therefore the provided data set is different. Consequently also the plots may differ in appearance. The subsequent images show the Paranal version.

La Silla provides the following parameters; note that some of the tags have a different assignment than those for Paranal:

Keyword GEN AMBI	Tag	Parameter	Unit	Range (Accuracy)	Update Interv.	Statistics Interval
TEMP1 TEMP2 TEMP3	TA1L TA2L TG1L	Temperature @ 30 m Temperature @ 2 m Ground Temperature @ -0.1 m	C	-40 .. +60 (+/- 0.2)	60 s	20 min
TEMPDEW2	TD2L	Dew Temperature @ 2 m	C		60 s	20 min
RHUM2	RH2L	Relative Humidity @ 2 m	%	0 .. 100 (+/- 1)	60 s	20 min
PRES PRESQNH	PA1L QHNL	Local Air Pressure @ 2 m Normalized Pressure (sea level)	mbar	600 .. 1100 (+/- 0.1)	60 s	20 min
WIND SPEED1 WIND SPEED2 WIND SPEED3	WS1L WS3L WS2L	Wind Speed @ 30 m Wind Speed @ 20 m Wind Speed @ 10 m	m/s	0.4 .. 75 (+/- 0.5)	60 s	20 min

Keyword GEN AMBI	Tag	Parameter	Unit	Range (Accuracy)	Update Interv.	Statistics Interval
WIND DIR1 WIND DIR2 WIND DIR3	WD1L WS3L WD2L	Wind Direction @ 30 m Wind Direction @ 20 m Wind Direction @ 10 m *(North = 0, East = 90)*	deg	0 .. 360 (+/- 3.0, res- olution 5.6) WS>0.4 m/s	60 s	20 min

For *Paranal* the following Meteo data is provided:

Keyword [a] GEN AMBI	Tag [b]	Parameter	Unit	Range (Accuracy)	Update Interv.	Statistics Interval
TEMP1 TEMP2	TA1x TA2x	Air Temperature @ 30 m Air Temperature @ 2 m	C	-40 .. +60 (+/- 0.2)	60 s	1 + 20 min
TEMP3	TG1x	Ground Temperature @ -0.1 m	C	-40 .. +60	60 s	1 + 20 min
TEMPDEW1 TEMPDEW2	TD1x TD2x	Dew Temperature @ 30 m Dew Temperature @ 2 m	C		60 s	1 + 20 min
RHUM1 RHUM2	RH1x RH2x	Relative Humidity @ 30 m Relative Humidity @ 2 m	%	0 .. 100 (+/- 1)	60 s	1 + 20 min
PRES PRESQNH	PA1x QHNx	Local Air Pressure @ 2 m Normalized Pressure (sea level)	hPa	500 .. 1100 (+/- 0.1)	60 s	1 + 20 min
(not archived)	PT3	Pressure trend over 3 hours	hPa		60 s	20 min
WIND SPEED1 WIND SPEED2	WS1x WS2x	Wind Speed @ 30 m Wind Speed @ 10 m	m/s	0.4 .. 75 (+/- 0.5)	60 s	1 + 20 min
WIND DIR1 WIND DIR2	WD1x WD2x	Wind Direction @ 30 m Wind Direction @ 10 m *(North = 0, East = 90)*	deg	0 .. 360 (+/- 3.0, res- olution 5.6) WS>0.4 m/s	60 s	1 + 20 min
WIND SPEEDU WIND SPEEDV WIND SPEEDW	UU3x UV3x UW3x	Wind Speed @ 20 m U comp. Wind Speed @ 20 m V comp. Wind Speed @ 20 m W comp. *U: horizontal into 330 deg* *V: horizontal into 240 deg* *W: vertical up*	m/s	-60 .. +60 (U/V: 1.5%, W: 3% rms, resol. 0.01)	60 s	1 + 20 min
DUSTS1 DUSTL1 DUSTS2 DUSTL2	M11L M12L M21L M22L	0.5 μm Particle Count @ 30 m 5.0 μm Particle Count @ 30 m 0.5 μm Particle Count @ 20 m 5.0 μm Particle Count @ 20 m	$1/m^3$	$0 .. 10^7$	60 s	20 min

a. This is the keyword with which the 1-min average of this parameter is archived in the ESO on-line database.
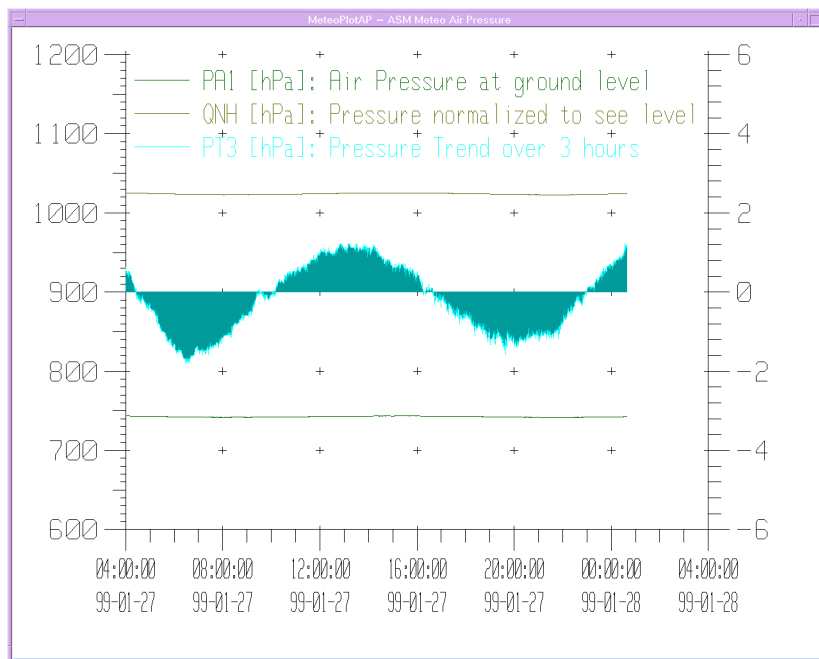
b. This is the tag in the Rtap database table and in the log file for this parameter. 'x' can be 'S' for 1 min or 'L' for 20 min statistics interval.

Air Pressure

This plot shows the air pressure, actual and normalized for sea level. For Paranal also a pressure trend over the last 3 hours is provided.

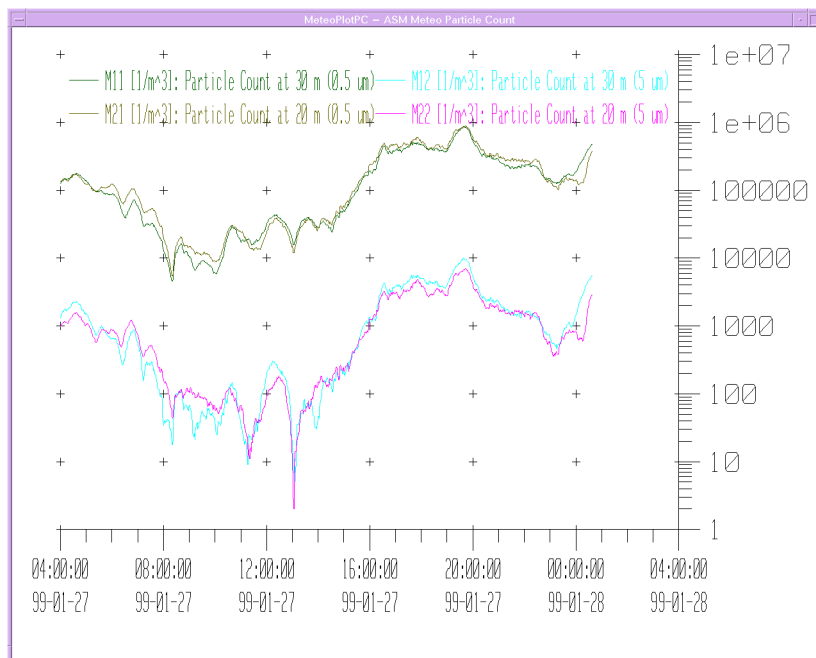**FIGURE 8. Air Pressure Plot (MeteoPlotAP)**

Particle Count

This plot shows in four curves the particle count (dust) in 20 and 30 m height, for particles of 5 and 0.5 μm each.

The scaling is logarithmic to accomplish a reasonable display over the whole possible range (1 to 10 million particles per m^3).
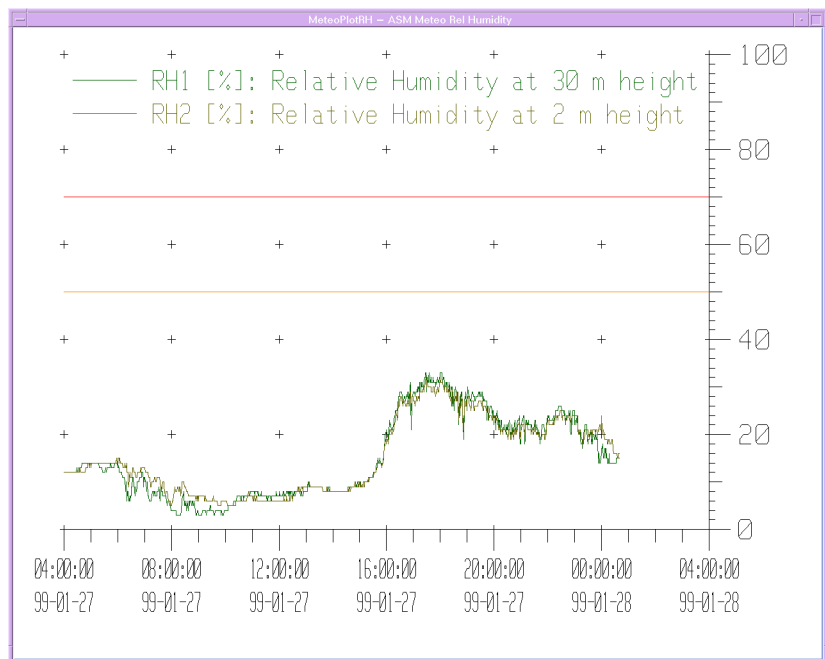
FIGURE 9. **Particle Count Plot (MeteoPlotPC)**

Relative Humidity

Relative humidity is measured in two heights for Paranal. La Silla provides only one value.

FIGURE 10. Relative Humidity Plot (MeteoPlotRH)

The orange and red limit lines are just recommendations to close the telescope when the humidity exceeds this value, they have no other effect. Interactive configuration of these lines is not supported.
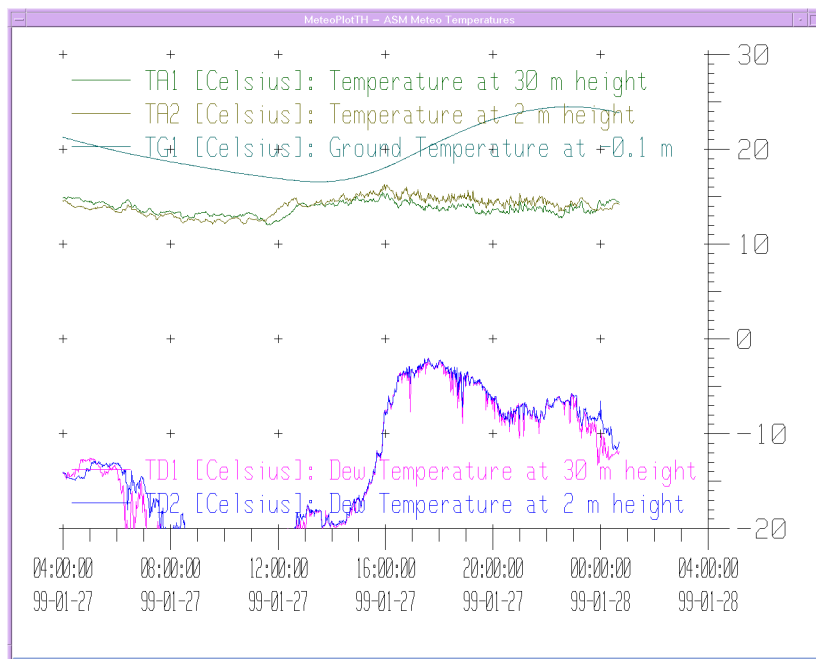
Temperature and Dew-Point

The air temperature is measured in two heights, with additional ground temperature.

The dew point is a calculated value depending on air temperature, humidity, and pressure. It is recommended to close the telescope when the dew point comes near the air temperature, in either height.

FIGURE 11. Temperatures Plot (MeteoPlotTH)

For Paranal the dew point is provided for two heights, while for La Silla there is only one.

Wind Speed and Direction

These two plots contain the average as well as the minimum and maximum values of the last minute. The area between minimum and maximum appears shaded, while the average is drawn as solid line in between. Therefore one can easily see the variability in wind speed (gusts) and wind direction.

The green curve shows the sensor data for 30 meter height and is connected to the vertical axis on the left, the yellow shows for 10 meter and connects to the right axis.
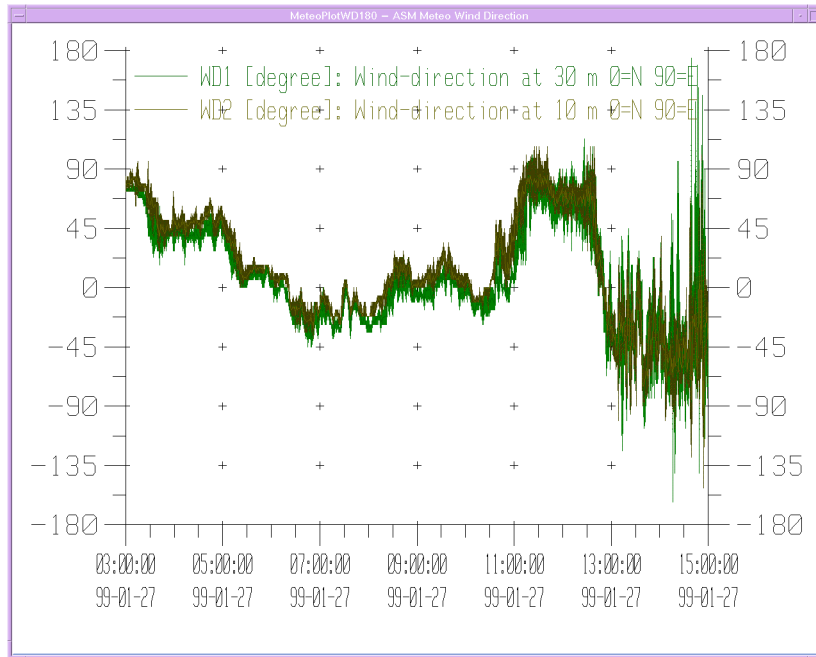
The preferable time scale for both is 6 hours.

FIGURE 12. Wind Speed Plot (MeteoPlotWS)
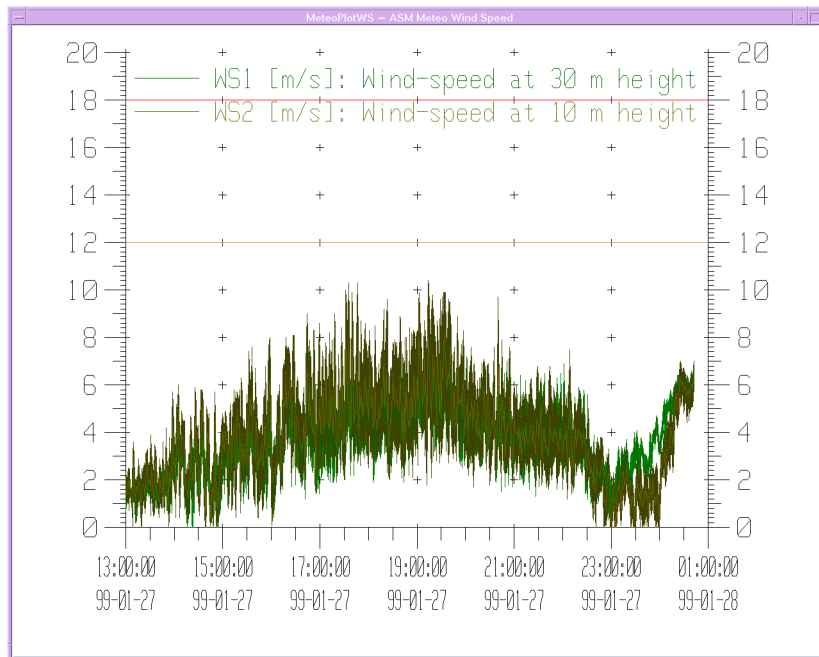
As for humidity, the orange and red limit lines are just recommendations to close the telescope when this value is exceeded. They have no other effect. Interactive configuration of these lines is not supported.

FIGURE 13. **Wind Direction Plot (MeteoPlotWD180/360)**

There are two versions of the wind direction plot:

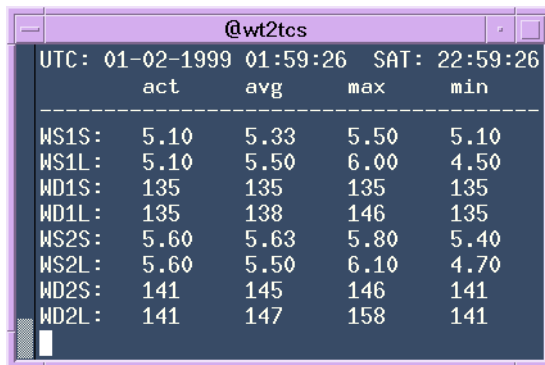*MeteoPlotWD180* - with +/- 180 degree scaling, preferably for North direction

MeteoPlotWD360 - with 0..360 degree scaling, preferably for South direction

Normally the direction is measured from 0 to 360 degrees. Since the plots connect two consecutive points with a line, a problem occurs when the direction wraps around from 0 to 360 (north). Such a plot would look awkward for direction around north. In this case one should select the other plot with +/- 180 degree scaling, and vice versa.

Note that only the data of two height are included in the plot, although for La Silla and Paranal wind data for three heights are provided.The middle height is actually omitted. Also the three-dimensional data of Paranal is not shown.

To display the current wind parameters in numerical form, enter the command *asm-MeteoWind*. The latest data will then be updated on your terminal.

FIGURE 14. asmMeteoWind display


```
                          @wt2tcs
UTC: 01-02-1999 01:59:26  SAT: 22:59:26
            act      avg      max      min
       ------------------------------------
WS1S:   5.10     5.33     5.50     5.10
WS1L:   5.10     5.50     6.00     4.50
WD1S:   135      135      135      135
WD1L:   135      138      146      135
WS2S:   5.60     5.63     5.80     5.40
WS2L:   5.60     5.50     6.10     4.70
WD2S:   141      145      146      141
WD2L:   141      147      158      141
```

In the shown tags for Paranal, 'S' stands for 1-minute statistics and 'L' for 20-minute statistics. The instant value 'act' is for both the same.

CHAPTER 5   *Schluß*

```
wasm asm:~ 44 > msgSend "" asmwsControl getsune ""
MESSAGEBUFFER:
Next sun event in 10h:15m (now is night).
```

Schluß