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GRASS-RaPlaT

Radio Planning Tool for GRASS

Quick Start Guide

V1.0a

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1. Introduction

This Quick Start Guide for RaPlaT (*Radio Planning Tool for GRASS*) contains the most basic information about:

- How to use the virtual machine (virtual appliance) with the preinstalled Ubuntu OS, GRASS with RaPlaT and the demo location Slovenia, MySQL and PostgreSQL.
- How to install RaPlaT on a Ubuntu machine.

Detailed information about RaPlaT, its installation and use can be found in the RaPlaT User Manual.

2. Using *Ubuntu_GRASS_RaPlaT* virtual appliance

The *Ubuntu_GRASS_RaPlaT* virtual appliance is a virtual machine (VM) with the following main software preinstalled:

- Ubuntu 12.04 LTS (Precise Pangolin) desktop 32-bit.
- MySQL 5.5.
- PostgreSQL 9.1.
- GRASS 6.4.3RC2, a development installation from the source distribution, with support for MySQL and PostgreSQL. A number of other packages (libraries), either required or optionally used by GRASS, are also installed. This GRASS version is officially a “Release Candidate” version, but marked as stable and recommended. (It has some bugs corrected, which makes it a better choice compared to 6.4.2.)
- RaPlaT GRASS add-on.

It is distributed in the OVF format (*Open Virtualization Format*) which is compatible with VM hypervisors from various vendors (e.g. with VMware Player and other VMware hypervisor products, or with VirtualBox). The distribution contains three file:

- **.ovf* file. It contains the description of the virtual machine (number of CPU’s, memory size, and many other things) in the XML text format.
- **.vmdk* (*Virtual Machine Disk*) file. It contains the VM disk image (in compressed form). This file format was originally developed by VMware but is now an open format.
- **.mf* (*Manifest File*). This file is optional. It contains the SHA1 digest of the two previously described files, and if present serves to check their integrity.

The VM disk size is 40 GB, the memory size is 1 GB, and only one processor (one processor core) is used. The configured memory size and the number of CPU’s (or CPU cores) are very modest so that VM can run on a host computer with limited resources. These settings can be easily changed in a VM hypervisor (e.g. in VMware Player). It is recommended to set a larger memory size and more CPU’s (CPU cores) if sufficient host computer resources are available, especially if one wants to use the *r.radcov*’s parallel execution support.

For personal desktop use, a suitable VM hypervisor is VMware Player (http://www.vmware.com/products/player), which is free for non-commercial use and can run on Linux or MS Windows operating systems. Another popular option is VirtualBox (http://www.virtualbox.org/, http://www.oracle.com/us/technologies/virtualization/virtualbox/overview/). For better integration of virtual machines with the host machine (mouse, display etc.), VM hypervisors are accompanied by additional software (*VMware Tools* for VMware Player, *Virtual Box Guest Additions* for VirtualBox) that has to be installed on each virtual machine (installation is performed on a running virtual machine, not on the host machine). The *Ubuntu_GRASS_RaPlaT* VM was prepared with WMware Player and has VMware Tools installed (in case of troubles it may help to reinstall them, *Player→Manage→Reinstall VMWare Tool...*). For use with VirtualBox, Virtual Box Guest Additions should be installed.

The *Ubuntu_GRASS_RaPlaT* virtual appliance is distributed as three files: *Ubuntu_GRASS_RaPlaT.ovf*, *Ubuntu_GRASS_RaPlaT-disk1.vmdk* and *Ubuntu_GRASS_RaPlaT.mf*. They must be imported into the VM hypervisor, which then builds its own native format VM files. The three files must reside in the same directory. In VMware Player, importing is started by selecting *Player→File→Open* and then the *.ovf* file. After importing has finished, the new *Ubuntu_GRASS_RaPlaT* virtual machine is available and can be selected and started (*Play virtual machine* in VMware Player). The Ubuntu booting process starts and from then on everything is very similar to a physical machine, except that the Ubuntu screen is shown in a window on the desktop of the host operating system (e.g. MS Windows).

Two Ubuntu user accounts are preconfigured, *user1* and *grassuser*, with passwords equal to the usernames. The *user1* account is the primary Ubuntu account (with the administrative *sudo* rights) and is also used for GRASS administration (GRASS database setup etc.). The *grassuser* account is an example of a general (non-privileged) Ubuntu account for GRASS users. **It is strongly recommended to change both passwords as soon as possible**, especially when (and before) enabling the remote access over the network. (The only exception could be if the virtual machine is only accessible locally on a single-user host machine where the user login session is protected by a password.)

Both installed database management systems, MySQL and PostgreSQL, have an empty database, *grass*, prepared for use with GRASS-RaPlaT, with necessary permissions granted to *user1* and *grassuser*. A password is preconfigured for the MySQL *root* user (administrator). It is equal to the Ubuntu *user1* account password (i.e. *user1*). Again, **it is strongly recommended to change it**, otherwise any user with an Ubuntu account can potentially login to MySQL as *root*.

You first login as *user1*. To start GRASS, you first open a Terminal window: click *Dash Home* (upper left square) and click the *Terminal* icon (if the icon is not there yet, type 'terminal' first), Fig. 1.

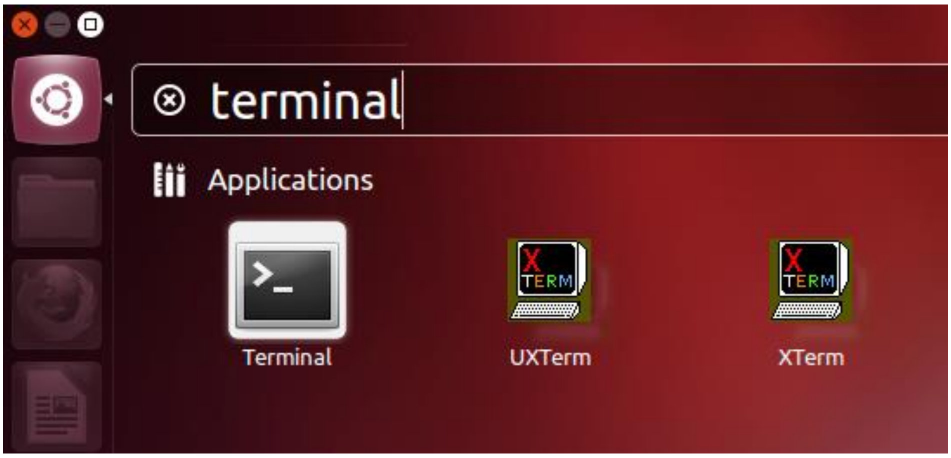
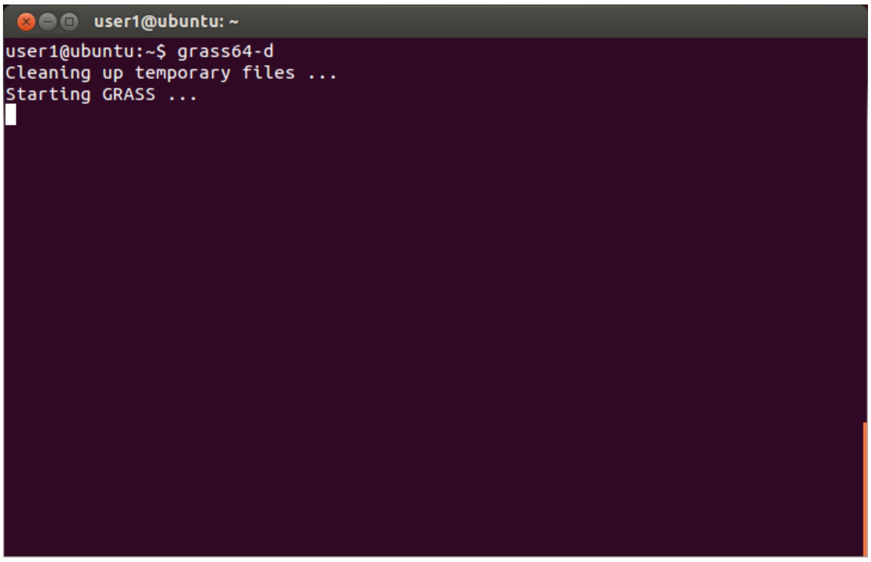


Fig. 1: Start *Terminal* (Ubuntu 12.04 - Unity interface)

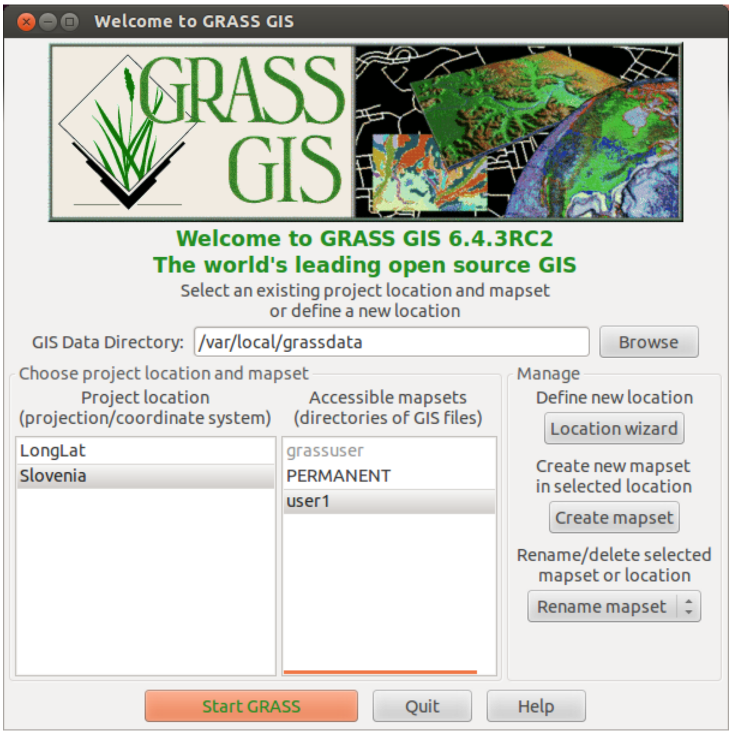
In the *Terminal* window type *grass64-d* (this is a symbolic link that points to the original GRASS startup script), Fig. 2. (If you don't remember exactly a command or just want to save yourself typing, in Ubuntu you can always type just the beginning of a command and then TAB to autocomplete, or a second TAB to show multiple options).



```
user1@ubuntu:~$ grass64-d
Cleaning up temporary files ...
Starting GRASS ...
```

Fig. 2: Start *GRASS* in the *Terminal* window

In the *Welcome to GRASS GIS* window select *location Slovenia* and *mapset user1* and press *Start GRASS* (Fig. 3).



Welcome to GRASS GIS 6.4.3RC2
The world's leading open source GIS
Select an existing project location and mapset
or define a new location

GIS Data Directory: /var/local/grassdata

Choose project location and mapset

Project location (projection/coordinate system)	Accessible mapsets (directories of GIS files)
LongLat	grassuser
Slovenia	PERMANENT
	user1

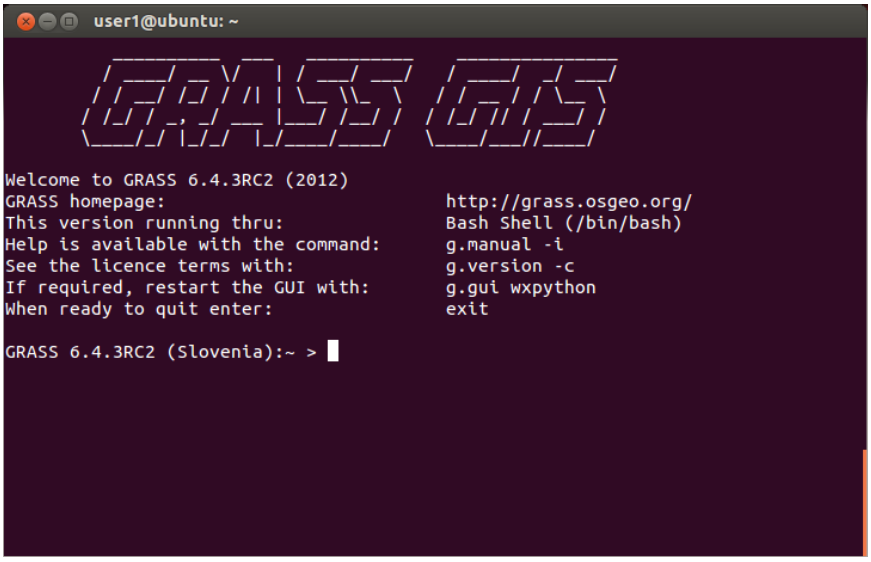
Manage
Define new location

Create new mapset in selected location

Rename/delete selected mapset or location

Fig. 3: GRASS *Welcome* window.

GRASS starts running. The GRASS run-time environment is established for the existing *Terminal* window, which now serves also as the GRASS command line interface (in addition to its normal system use), Fig. 4.



```
user1@ubuntu: ~
          __________  ___   __________    _______________
         / ____/ __ \/   | / ___/ ___/   / ____/  _/ ___/
        / / __/ /_/ / /| | \__ \\_  \   / / __ / / \__ \
       / /_/ / _, _/ ___ |___/ /__/ /  / /_/ // / ___/ /
       \____/_/ |_/_/  |_/____/____/   \____/___//____/

Welcome to GRASS 6.4.3RC2 (2012)
GRASS homepage:                          http://grass.osgeo.org/
This version running thru:               Bash Shell (/bin/bash)
Help is available with the command:      g.manual -i
See the licence terms with:              g.version -c
If required, restart the GUI with:       g.gui wxpython
When ready to quit enter:                exit

GRASS 6.4.3RC2 (Slovenia):~ >
```

Fig. 4: *GRASS* is running (command line interface)

In addition to the command line interface, the GRASS graphical user interface (GUI) is automatically started. It consists of two windows: the *GRASS GIS Layer Manager* window and the first *GRASS GIS MAP Display* window (Fig. 5). (Additional *Map Display* windows can be opened later as needed.)

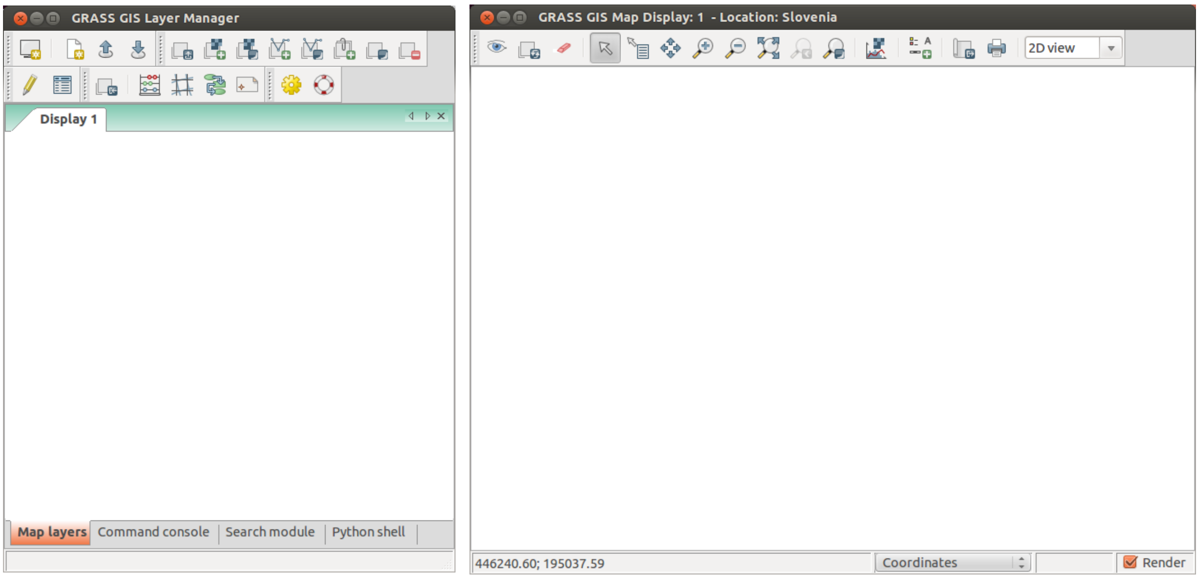
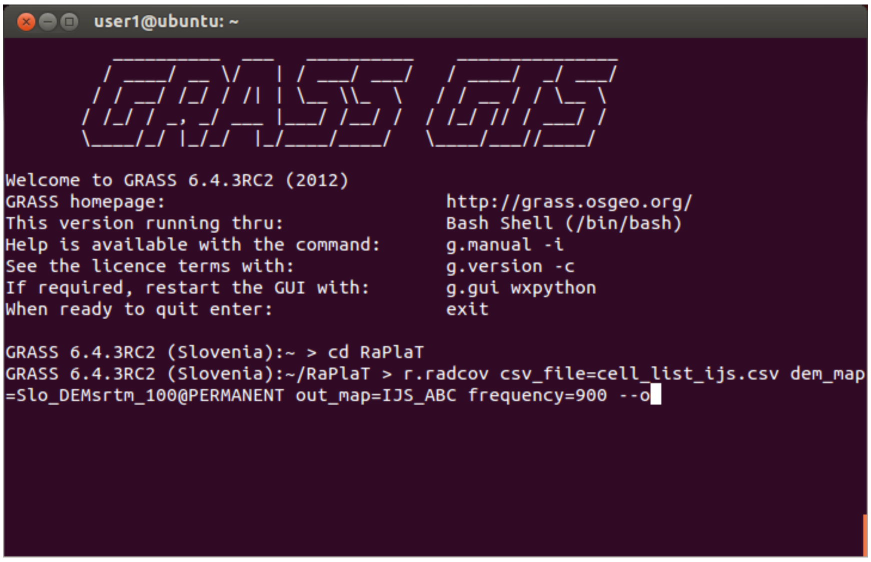


Fig. 5: *GRASS* GUI - The *Layer Manager* window and the first *Map Display* window

We can now change to the *RaPlaT* directory and run the demo radio coverage computation by executing the following command (Fig. 6):

```
r.radcov csv_file=cell_list_ijs.csv dem_map=Slo_DEMsrtm_100@PERMANENT
out_map=IJS_ABC frequency=900 --o
```



```
Welcome to GRASS 6.4.3RC2 (2012)
GRASS homepage:                          http://grass.osgeo.org/
This version running thru:               Bash Shell (/bin/bash)
Help is available with the command:      g.manual -i
See the licence terms with:              g.version -c
If required, restart the GUI with:       g.gui wxpython
When ready to quit enter:                exit

GRASS 6.4.3RC2 (Slovenia):~ > cd RaPlaT
GRASS 6.4.3RC2 (Slovenia):~/RaPlaT > r.radcov csv_file=cell_list_ijs.csv dem_map
=Slo_DEMsrtm_100@PERMANENT out_map=IJS_ABC frequency=900 --o
```

Fig. 6: Running RaPlaT demo - *r.radcov*

The radio transmitter network configuration together with the corresponding radio signal propagation models and their parameters is defined by the table in the *cell_list_ijs.csv* file (a CSV-format text file, which can be opened and edited either with a general text editor, or more conveniently with a spreadsheet application such as OpenOffice Spreadsheet). The following is printed on the screen during the demo *r.radcov* command execution:

```
GRASS 6.4.3RC2 (Slovenia):~/RaPlaT > r.radcov csv_file=cell_list_ijs.csv
dem_map=Slo_DEMsrtm_100@PERMANENT out_map=IJS_ABC frequency=900 --o

Number of detected processors = 1

READING AND CHECKING THE ANTENNAS-MAPPING CSV TABLE ...
Number of .MSI files found: 1

READING AND CHECKING THE RADIO SECTOR CSV TABLE ...
Standard CSV file format detected

GETTING THE LIST OF EXISTING MODEL AND SECTOR FILES
FROM PREVIOUS SIMULATION RUNS IN THE CURRENT MAPSET...

DELETING UNNEEDED MODEL AND SECTOR FILES FROM
PREVIOUS SIMULATION RUNS IN THE CURRENT MAPSET...

STARTING RADIO COVERAGE COMPUTATION...

----- PROCESSING MODELS -----
Temporarily changing the existing current region:
N = 195000.0
W E = 370000.0 630000.0
S = 25000.0
res E-W/N-S = 100.0/100.0
to the extended computation region:
N = 194950.0
W E = 370050.0 629950.0
S = 25050.0
res E-W/N-S = 100.0/100.0
> IJS-A-1 (1./1)
r.hata inputDEM=Slo_DEMsrtm_100@PERMANENT
output=_hata_urban_460697_99918_20_10_900 area_type=urban
coordinate=460697,99918 ant_height=20 radius=10 frequency=900 --overwrite
< (1./_)
```

```
----- PROCESSING SECTORS -----
> IJS-A-1 (1./3)
r.sector pathloss_raster=_hata_urban_460697_99918_20_10_900@user1
inputDEM=Slo_DEMsrtm_100@PERMANENT
output=IJS-A-1_hata_urban_460697_99918_20_10_900_30_0_0_COS-21
ant_data_file=/usr/local/src/grass-6.4.3RC2/dist.i686-pc-linux-
gnu/etc/radio_coverage/antenna_diagrams/_demo_/COS_21.MSI
beam_direction=30 mech_tilt=0 height_agl=20 radius=10 east=460697
north=99918 --overwrite
< (1./_)
> IJS-B-2 (2./3)
r.sector pathloss_raster=_hata_urban_460697_99918_20_10_900@user1
inputDEM=Slo_DEMsrtm_100@PERMANENT
output=IJS-B-2_hata_urban_460697_99918_20_10_900_135_0_0_COS-21
ant_data_file=/usr/local/src/grass-6.4.3RC2/dist.i686-pc-linux-
gnu/etc/radio_coverage/antenna_diagrams/_demo_/COS_21.MSI
beam_direction=135 mech_tilt=0 height_agl=20 radius=10 east=460697
north=99918 --overwrite
< (2./_)
> IJS-C-3 (3./3)
r.sector pathloss_raster=_hata_urban_460697_99918_20_10_900@user1
inputDEM=Slo_DEMsrtm_100@PERMANENT
output=IJS-C-3_hata_urban_460697_99918_20_10_900_270_0_0_COS-21
ant_data_file=/usr/local/src/grass-6.4.3RC2/dist.i686-pc-linux-
gnu/etc/radio_coverage/antenna_diagrams/_demo_/COS_21.MSI
beam_direction=270 mech_tilt=0 height_agl=20 radius=10 east=460697
north=99918 --overwrite
< (3./_)

----- GENERATING FINAL RESULTS - RASTER MAP AND DB (OPTIONALLY) -----
Temporarily changing current region to the computation region:
N = 194950.0
W E = 370050.0 629950.0
S = 25050.0
res E-W/N-S = 100.0/100.0
> WRITE RASTER MAP ONLY
r.MaxPower 'cell_input=/tmp/tmpOOZBfy' output=IJS_ABC table=out_db
driver=none 'database=$GISDBASE/$LOCATION_NAME/$MAPSET/dbf' dbperf=1
cell_num=5 --overwrite
Processing 3 cells...
Sorting receive power values
 100%
Finished sorting receive power values
Processing of 1 model(s) took 1.95[s], i.e. 1.95[s/model]
Processing of 3 sector(s) took 6.69[s], i.e. 2.23[s/sector]
Writing of output raster map took 4.44[s]
Processing finished
GRASS 6.4.3RC2 (Slovenia):~/RaPlaT >
```

The computation uses the DEM map *Slo_DEMsrtm_100* from the *PERMANENT mapset* (*Slo_DEMsrtm_100@PERMANENT*) and generates the resulting radio coverage map *IJS_ABC* in the *user1 mapset* (*IJS_ABC@user1*). Additionally, it generates four intermediate radio propagation path loss GRASS maps - one by *r.hata* (a radio propagation model) and three by *r.sector* (with antenna radiation patterns applied):

```
_hata_urban_460697_99918_20_10_900@user1
IJS-A-1_hata_urban_460697_99918_20_10_900_30_0_0_COS-21@user1
IJS-B-2_hata_urban_460697_99918_20_10_900_135_0_0_COS-21@user1
IJS-C-3_hata_urban_460697_99918_20_10_900_270_0_0_COS-21@user1
```

We will now display the *IJS_ABC* and *Slo_DEMsrtm_100* maps (Fig. 8). In the *Layer Manager* window we add them to the *Map Display Window*, using the *Add Raster Map Layer* button, in the following order (so that the DEM map is behind the radio coverage map, their order can also be changed later in the Layer Manager window), Fig. 7:

```
Slo_DEMsrtm_100@PERMANENT
IJS_ABC@user1
```

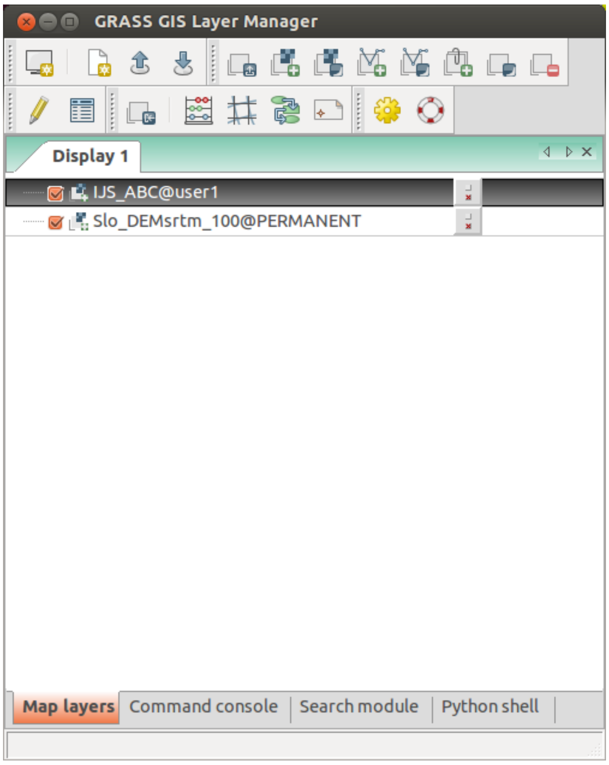


Fig. 7: Selecting two maps for the display

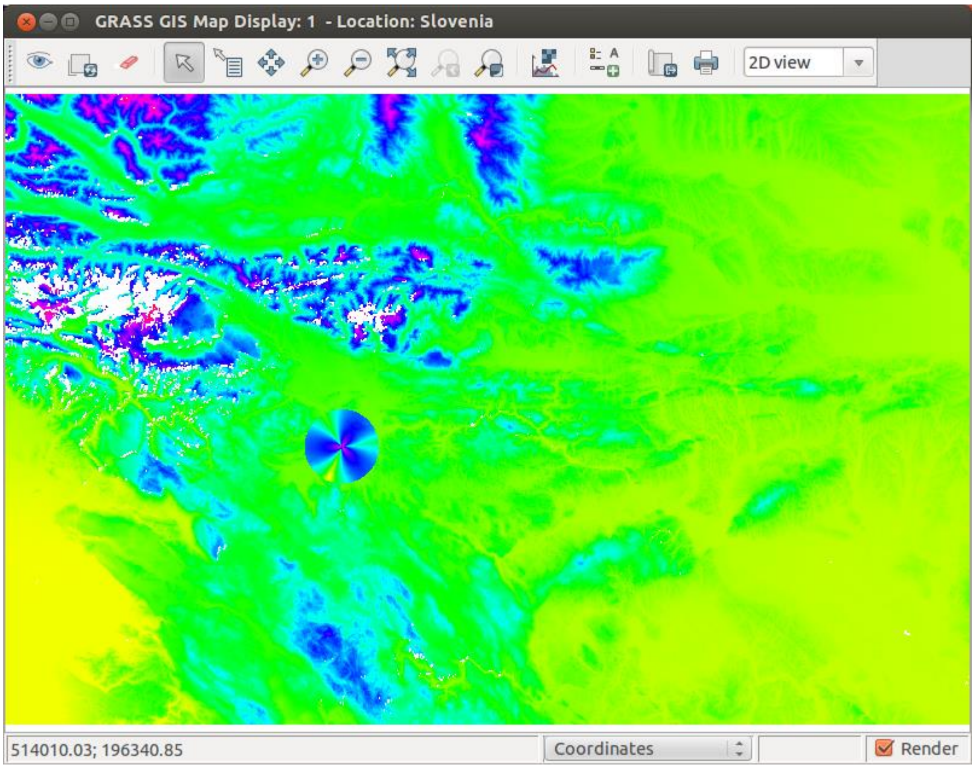


Fig. 8: Displaying the maps - radio coverage on top of DEM

The zoomed-in radio coverage map only (without the background DEM map) and with the color legend added (the received signal strength in [dBm]) is shown in Fig. 9.

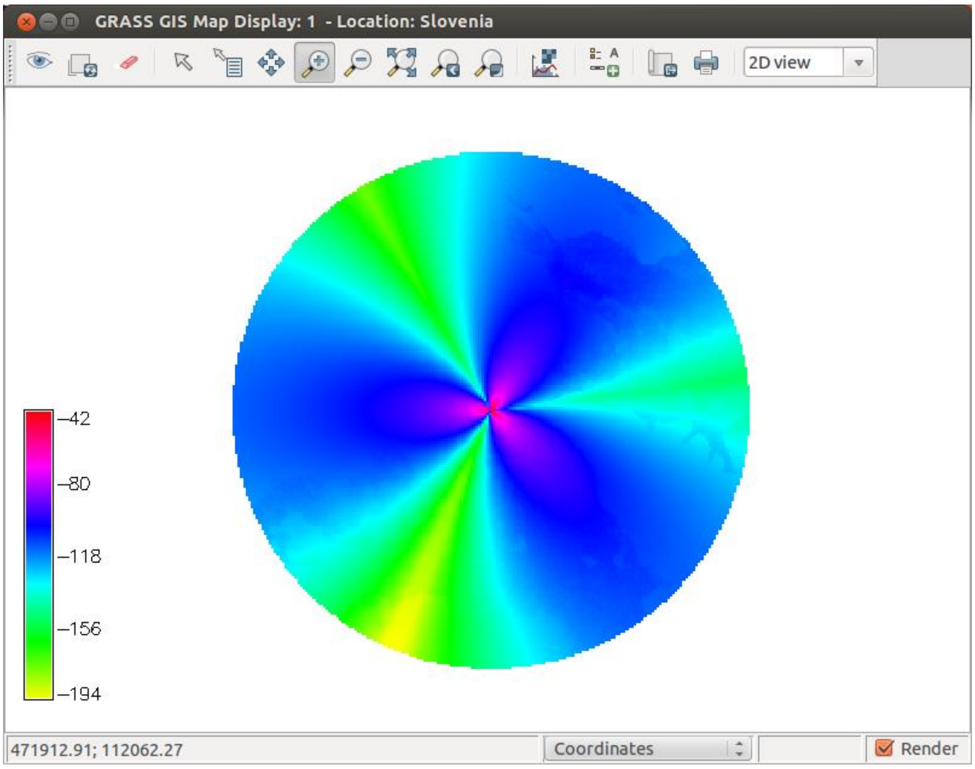


Fig. 9: The radio coverage map, zoomed in, with the legend (in [dBm])

While GRASS starts its GUI automatically, it does not close it on exit (i.e. when the user finishes using GRASS by typing the command *exit* in its Terminal window). The GRASS GUI (which is useless without the running GRASS application that started it) must be closed manually by closing its *Layer Manager* window.

3. Installing *RaPlaT*

The complete RaPlaT distribution consists of four tar.gz archive files:

- RaPlaT_modules.tar.gz
- RaPlaT_etc_radio_coverage.tar.gz
- RaPlaT_demolocs.tar.gz
- RaPlaT_cmds.tar.gz

RaPlaT_modules.tar.gz is the main archive file and contains the source code of all RaPlaT modules (C and Python), with each module in its own subdirectory.

For radio coverage computation, RaPlaT needs information about the transmit antennas radiation patterns. Each type of antenna is specified in a MSI-format file (for antennas with multiple electrical tilts there is an MSI file for each of the possible electrical tilt values). In addition to the MSI files, RaPlaT needs an *antenna types table*, i.e. a CSV-format file containing the MSI file names and some basic characteristics of all supported antenna types (see RaPlaT User Manual for details). *RaPlaT_etc_radio_coverage.tar.gz* contains a minimal set of data required to run the demo examples: a MSI file for one (artificially created) antenna, and the corresponding antenna types file.

RaPlaT_demolocs.tar.gz contains GRASS demo *locations* (see the previous chapter and the RaPlaT User Manual for details):

- *Slovenia*, used for demo radio coverage computations. It contains Slovenia DEM (based on the publicly available global SRTM maps).
- *LongLat*, used for processing of the SRTM maps.

RaPlaT_cmds.tar.gz contains commands and CSV-format files used to run the demo RaPlaT computations (see the previous chapter and RaPlaT User Manual).

The following installation procedures presume the existence of the user accounts *user1* (the primary Ubuntu account with *sudo* permissions) and *grassuser* (a generic non-privileged GRASS user), and the group *grass* (all GRASS users should become its members). Both, *user1* and *grassuser* should be members of *grass*. The following commands would create the *grassuser* account, the *grass* group and configure *group* membership, presuming that *user1* already exists:

```
        sudo addgroup grass
        sudo adduser user1 grass
        sudo adduser grassuser
        sudo adduser grassuser grass
```

3.1. RaPlaT_modules.tar.gz

This archive contains RaPlaT modules - C (source code) and Python modules. The procedure to install them is as follows:

Extract the archive to the *doc* subdirectory in the main GRASS source directory (*$GISBASE/../doc*, e.g. */usr/local/src/grass-6.4.3RC2/doc*):

```
cd /usr/local/src/grass-6.4.3RC2/doc
tar -xvzf /home/user1/Downloads/RaPlaT_modules.tar.gz
```

The modules directories will be created in the *raster* and *python* subdirectories.

Build all modules (change the *grass_src_dir* variable value in the *RaPlaT_make* script properly if your main GRASS source directory is different):

```
cd /usr/local/src/grass-6.4.3RC2/doc
./RaPlaT_make
```

If successful, the script execution finishes with the message:

```
Script finished successfully
```

3.2. RaPlaT_etc_radio_coverage.tar.gz

This archive contains the *radio_coverage* directory containing the demo antenna files. Extract it to the *etc* subdirectory in the GRASS *dist…* subdirectory, i.e. *$GISBASE/etc*, e.g. */usr/local/src/grass-6.4.3RC2/dist.i686-pc-linux-gnu/etc* (*$GISBASE* is an environment variable defined by the running GRASS application in its *Terminal* window):

```
cd /usr/local/src/grass-6.4.3RC2/dist.i686-pc-linux-gnu/etc
tar -xvzf /home/user1/Downloads/RaPlaT_etc_radio_coverage.tar.gz
```

3.3. RaPlaT_demolocs.tar.gz

This archive contains two RaPlaT GRASS demo *locations*, *Slovenia* and *LongLat*.

If the GRASS database directory does not exist yet (e.g. the GRASS application has just be installed and not used yet), it must first be created:

```
cd /var/local
sudo mkdir grassdata
sudo chown user1:grass grassdata
```

Extract the archive file to the GRASS database directory (*/var/local/grassdata* in our case):

```
cd /var/local/grassdata
tar -xvzf /home/user1/Downloads/RaPlaT_demolocs.tar.gz
```

Set the ownership of the GRASS *mapset grassuser* of GRASS *location Slovenia* (to *grassuser*):

```
sudo chown -R grassuser /var/local/grassdata/Slovenia/grassuser
```

In the example above, the main database directory is named *grassdata* and located in */var/local*. When GRASS is run for the first time, its database directory must be defined in its GUI *Welcome* window (Fig. 3, *GIS Data Directory*).

3.4. RaPlaT_cmds.tar.gz

This archive contains user files for the RaPlaT demo computations:

- *cmds.txt* - various RaPlaT commands,
- *cell_list_ijs.csv* - cell list file for *r.radcov*,

- *pwmx_cell_list* - cell list file for *r.MaxPower* (it is used only for the demo execution of *r.MaxPower* when it is called directly; it is not used with *r.radcov* since it generates this file automatically from its input cell list file, but as a temporary file with a different auto-generated name).

Extract the archive file to your RaPlaT working directory, e.g. *$HOME/RaPlaT*, */home/user1/RaPlaT*. The following commands create a RaPlaT working directory and extract the archive (*cd* is equivalent to *cd $HOME*):

```
cd
mkdir RaPlaT
cd RaPlaT
tar -xvzf /home/user1/Downloads/RaPlaT_cmds.tar.gz
```