GRASS GIS 7:
A theoretical and practical course

Session 1 – GRASS GIS 7 intro

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http://www.mundialis.de

Session Objectives

- Database structure of GRASS GIS
- About the course data set
- First steps in using GRASS GIS 7
  - the graphical user interface (GUI)
    - displaying raster and vector maps
    - querying maps
    - adding map elements
    - map swiping with two different Landsat coverages
    - bivariate scatterplots
  - GRASS GIS command structure
    - command line or GUI?
  - Creating a perspective view

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GRASS GIS Database concept

GRASS Database

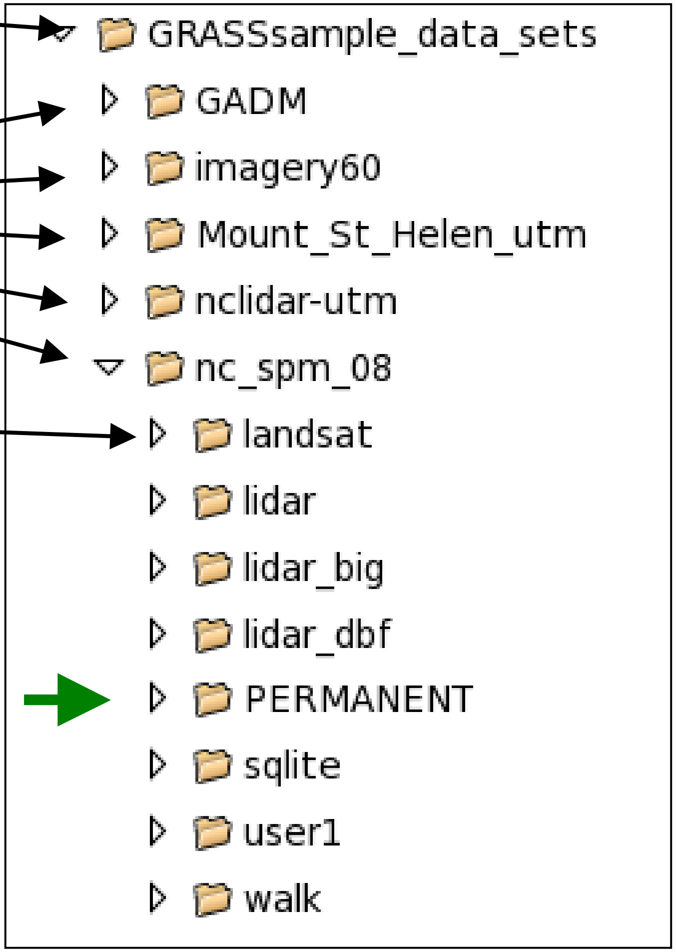
folder with Locations (“projects“)

Location

folder with Mapsets

Mapset

collection of maps and support data



Each Location...

- is defined by a projection
- can hold several mapsets
- has a PERMANENT mapset for base cartography

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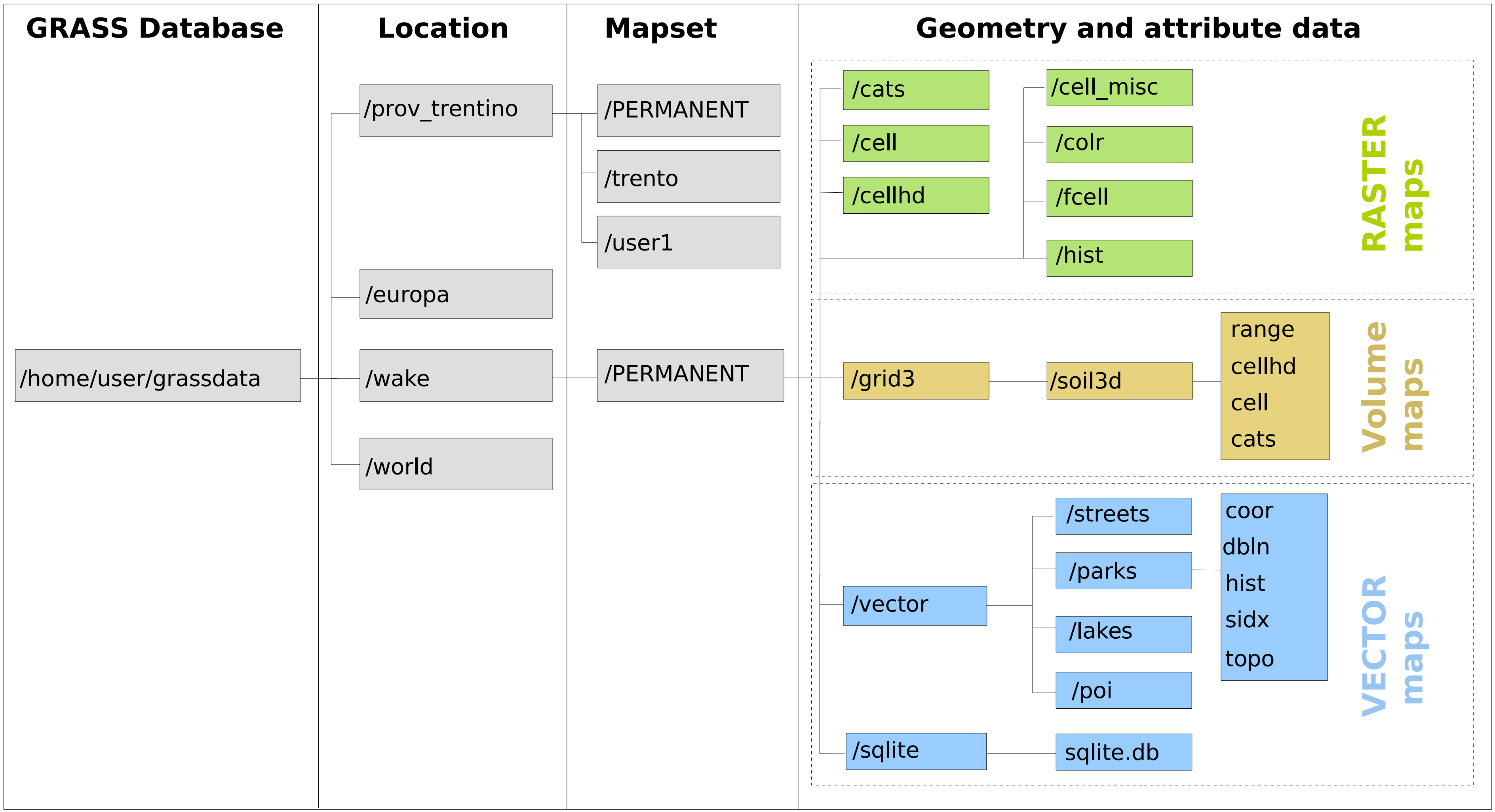
GRASS 7 Database concept: graphical view



Note: GRASS GIS is handling this for you!

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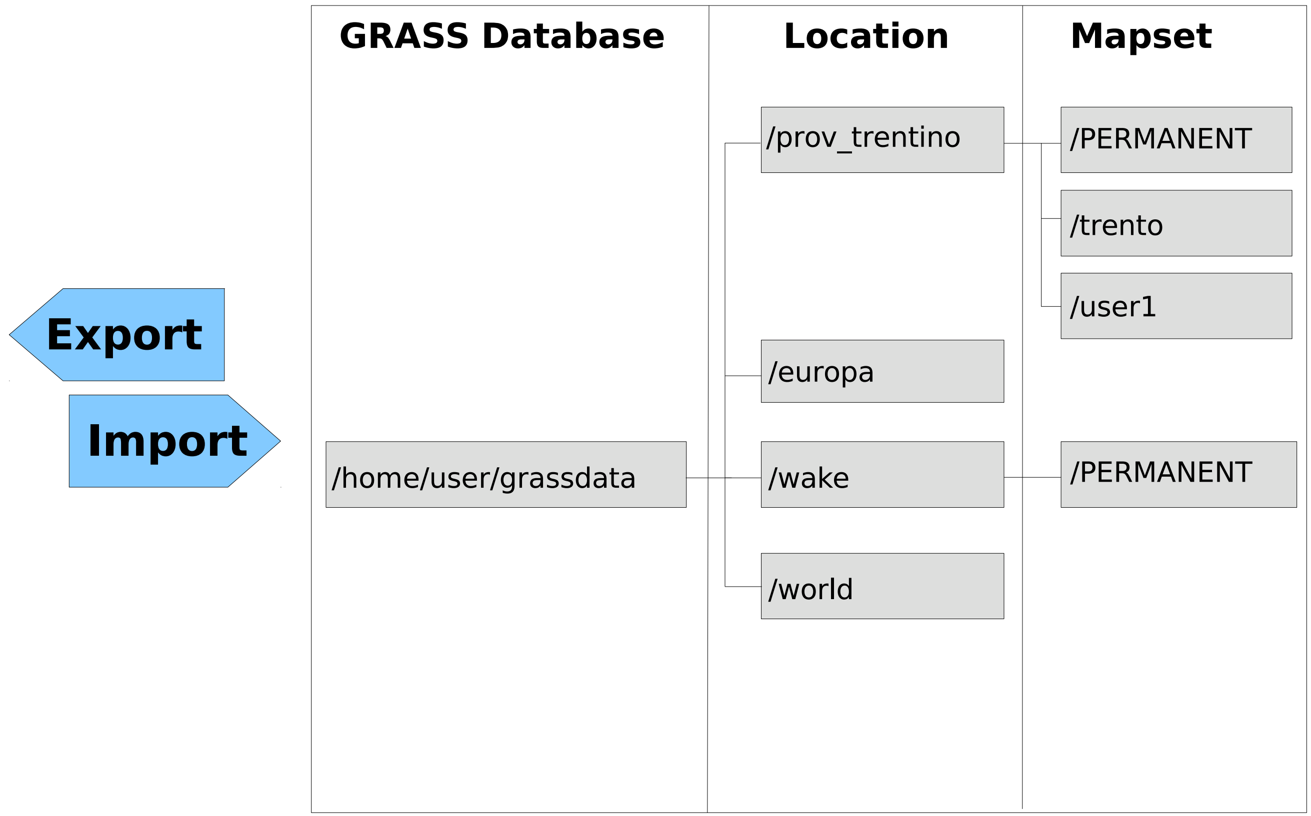
Standard GIS formats versus GRASS 7 Database

Raster
- GeoTIFF
- HDF
- NetCDF
- BIL
- ...

Vector
- SHAPE
- E00
- MapInfo
- Spatialite
- ...



Data in standard GIS formats.

Store in directory:
`/home/user/gisdata/`

or a shared network directory

Data in GRASS GIS formats.

Store in directory:
`/home/user/grassdata/`

or a shared network directory

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Preparation – Download the GRASS course data set

We'll now use an already **prepared GRASS GIS 7 Location**.
Later on in this session, we'll create an own location.

Data download at:

http://www.mundialis.de/workshops/nina2016/

```
- nc_spm_08_reduced.zip             16.2 MB (GRASS data)

- nc_boundary_county_SHP.zip         6.5 MB (SHAPE file)
- elev_ncstate_500m_tif.zip          1.9 MB (GeoTIFF file)
```

*Get **all** packages/files and save them on your computer.*

Note:

- `nc_spm_08_reduced.zip` is a reduced "North Carolina" [1] location prepared for the course, ready to use for GRASS GIS 7.

[1] http://grass.osgeo.org/download/sample-data/

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Preparation – Unpacking the course data set

Unpacking of `nc_spm_08_reduced.zip|tar.gz`
(the reduced “North Carolina” GRASS location as prepared for the course)

Linux:

- Create a directory “grassdata” in your home directory and unpack it therein:

```
mkdir $HOME/grassdata
cd $HOME/grassdata
tar xvfz /path/to/nc_spm_08_reduced.tar.gz
```

Mac OSX:

- Create a directory “grassdata” in your home directory and unpack unpack the `nc_spm_08_reduced.zip` file therein

MS-Windows:

- Create a directory “grassdata” in your “My Documents\” folder and unpack the `nc_spm_08_reduced.zip` file therein.
- Note: avoid white space in the path as well as non-ASCII characters (it may work, though)

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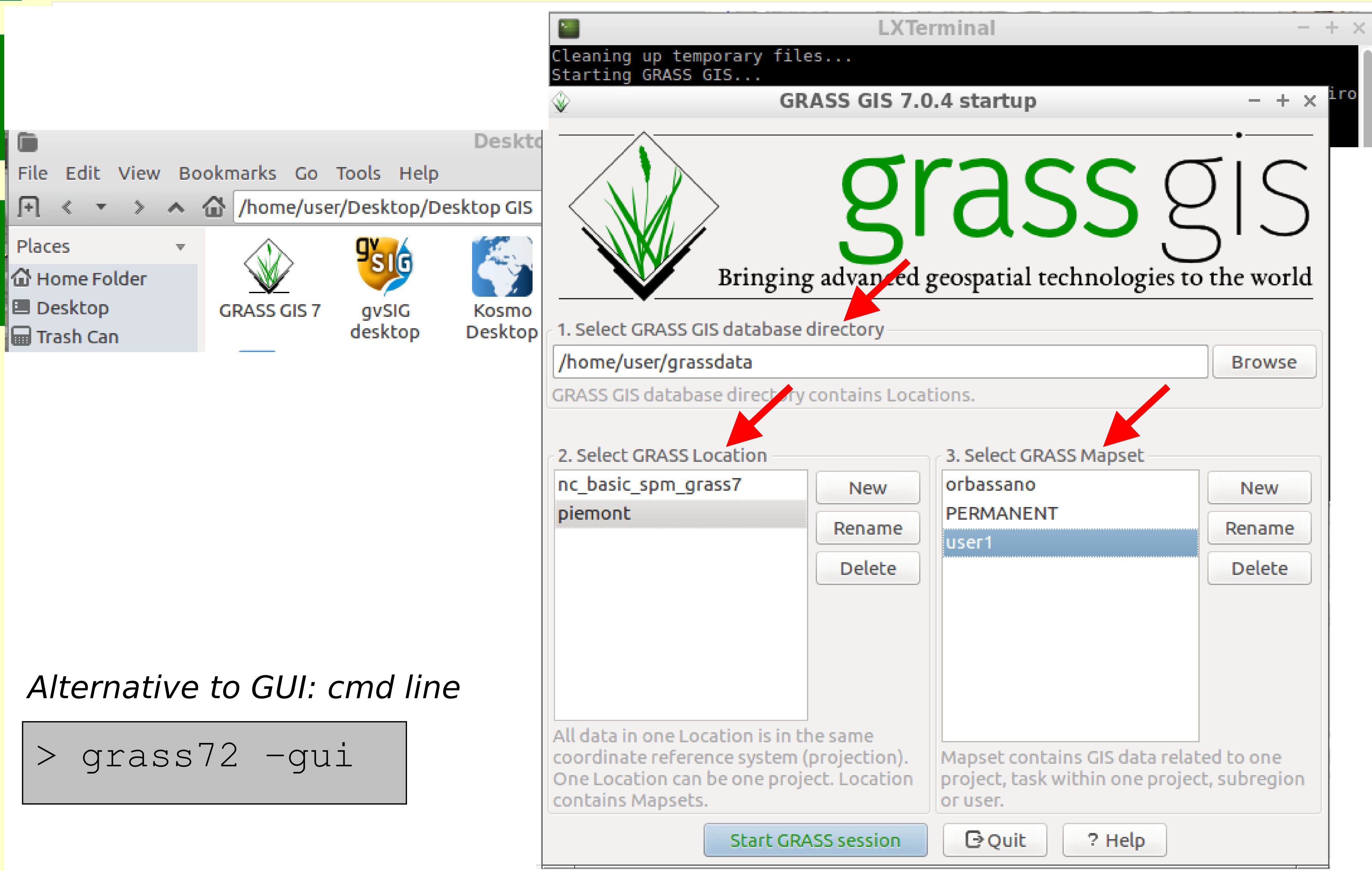
Exercise – GRASS startup and first steps



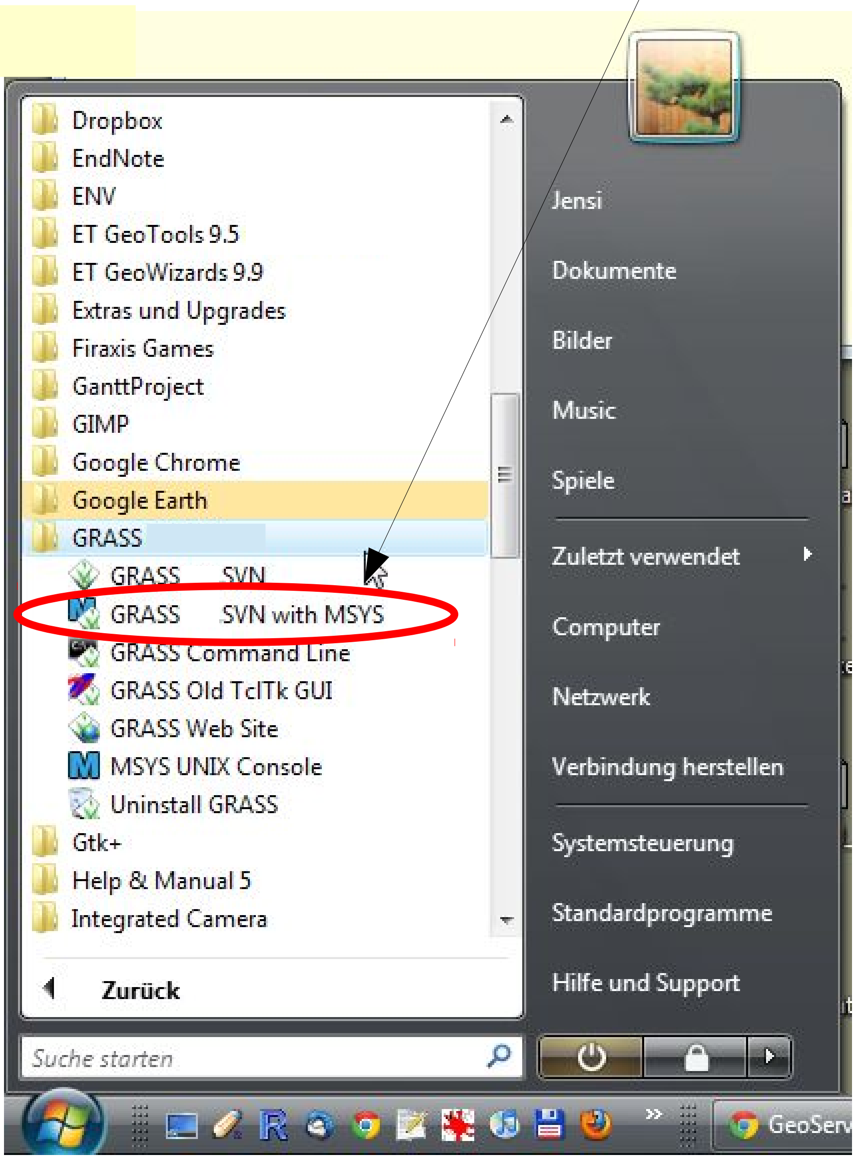
Alternative to GUI: cmd line

```
> grass72 -gui
```

Exercise – Startup of GRASS GIS

MS-Windows

GRASS GIS 7 (menu entries may differ)



Mac OSX and Linux:

... likewise via menu or via command line...

```
grass72 -gui
```

For power users:

```
grass72 -text
```

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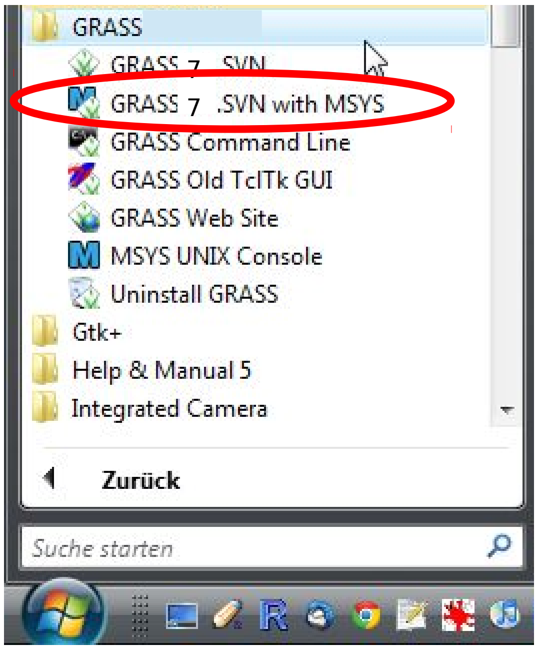
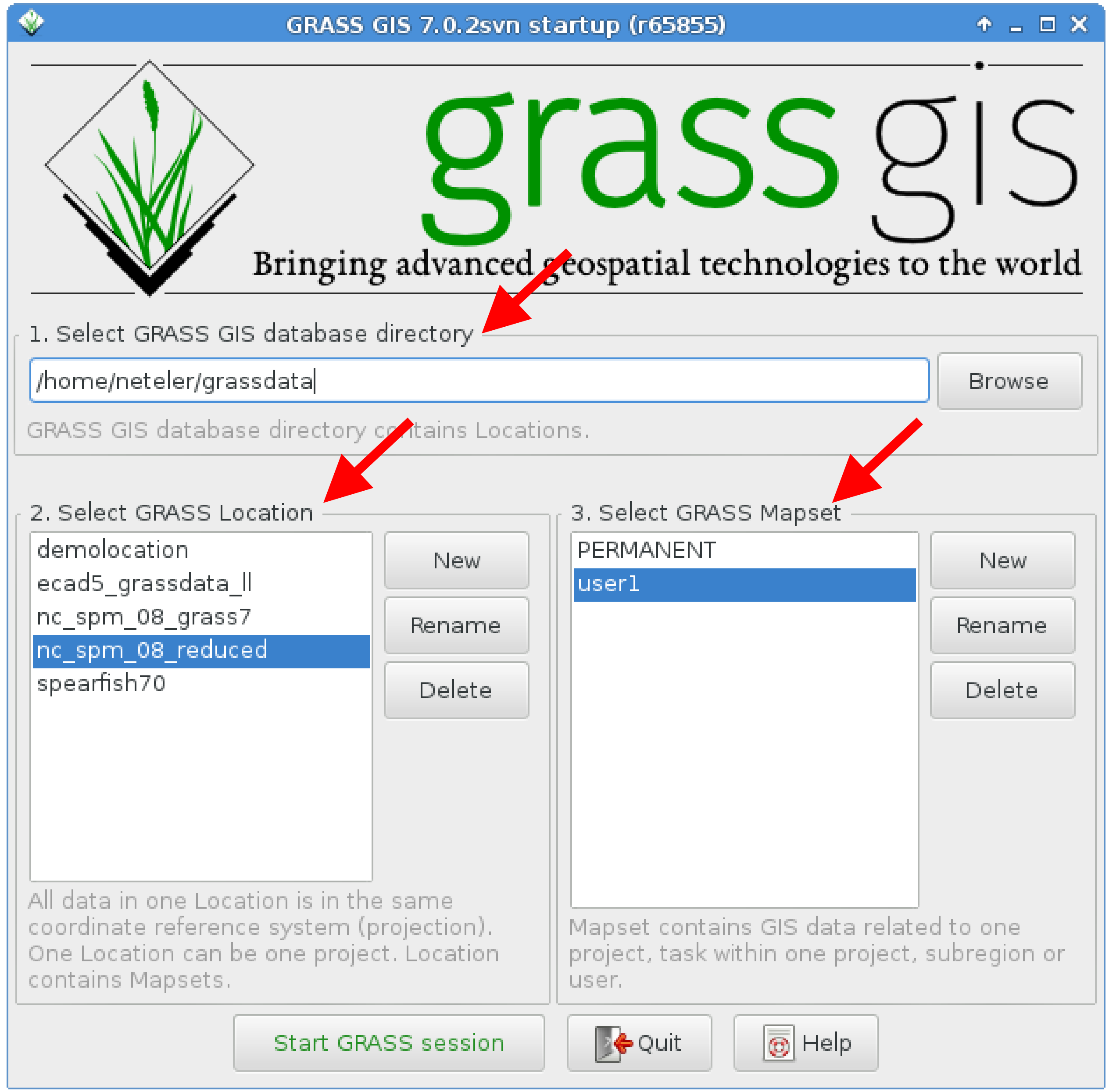
Exercise – GRASS startup and first steps






```
> grass72 -gui
```

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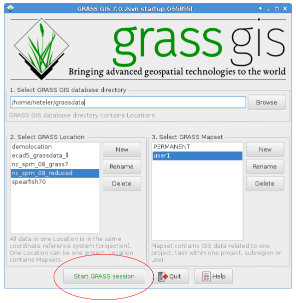
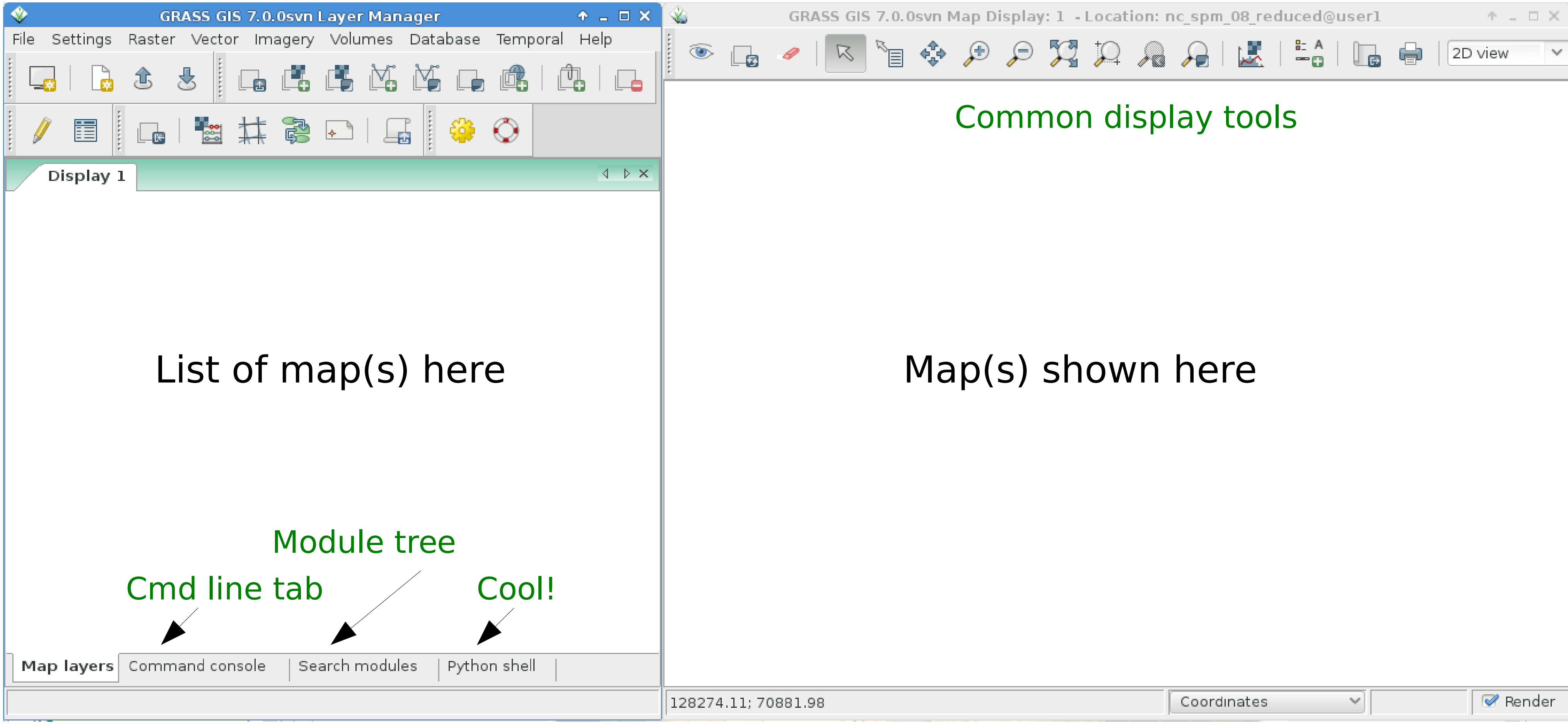
Exercise – GRASS 7 startup and first steps

The graphical user interface at startup:



Main menu

Map display



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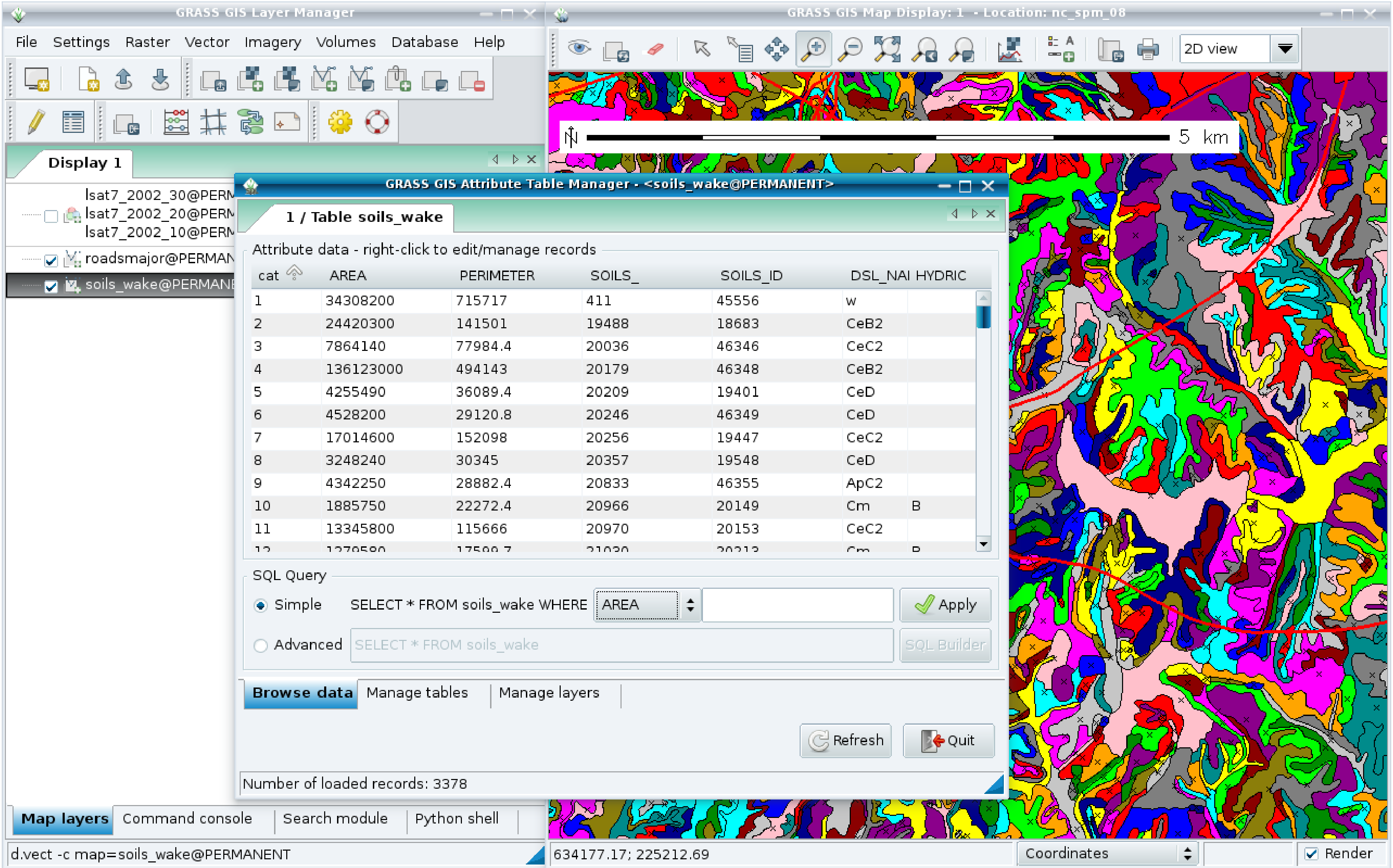
GRASS GIS GUI at full usage

(we'll reach that shortly)



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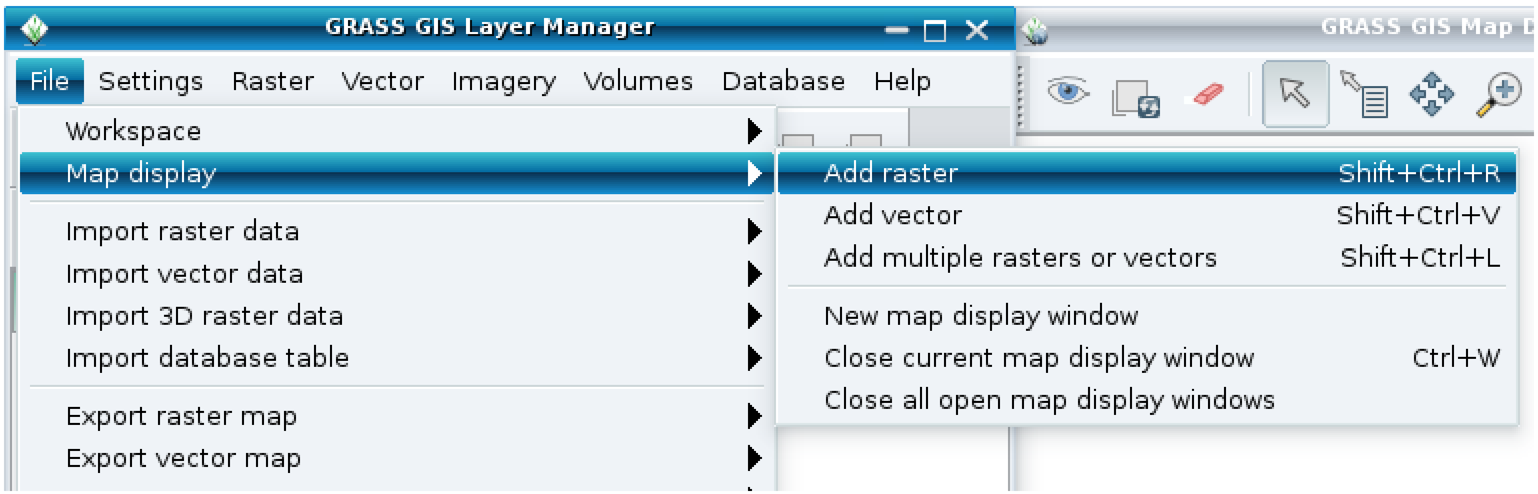
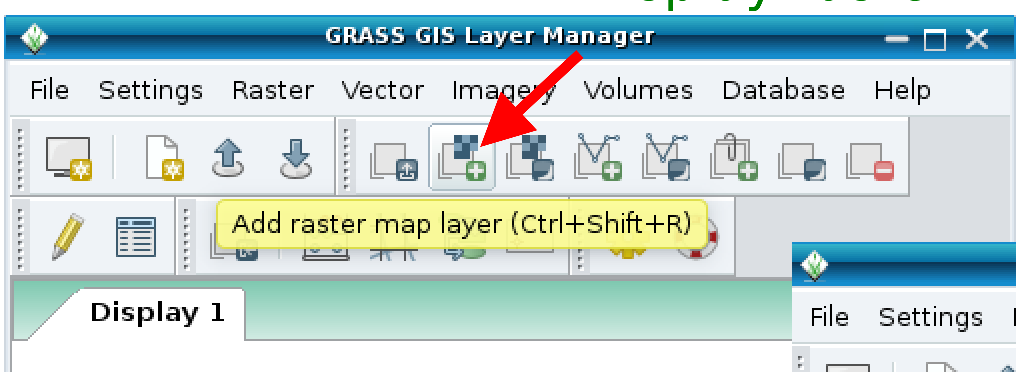
Displaying raster and vector maps

A) Using the menu

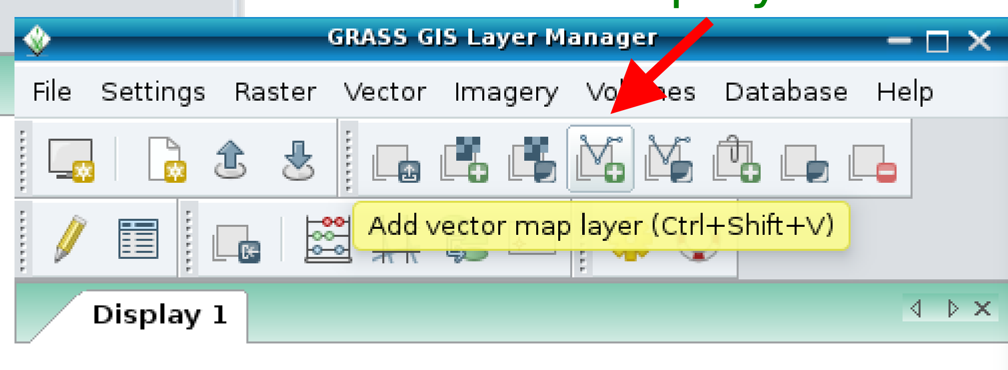


B) Using the icons

Display raster maps



Display vector maps



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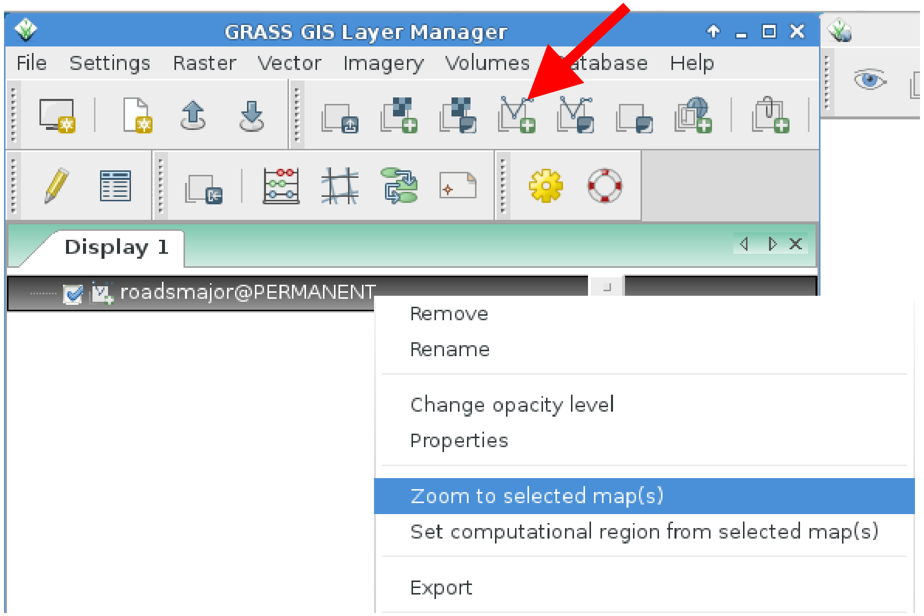
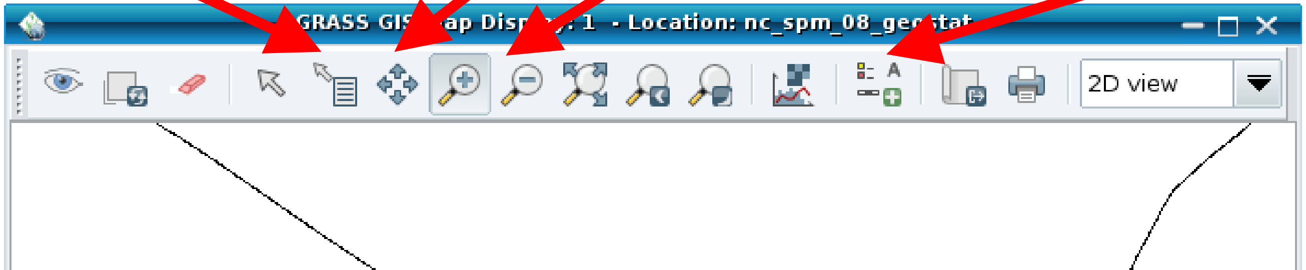
Exercise – Display the “roadsmajor” vector map

- Load the “roadsmajor” vector map into the canvas, zoom to map if needed:

Display vector maps



- **Query** map elements, **pan**, **zoom** in and out, add a **scale bar**



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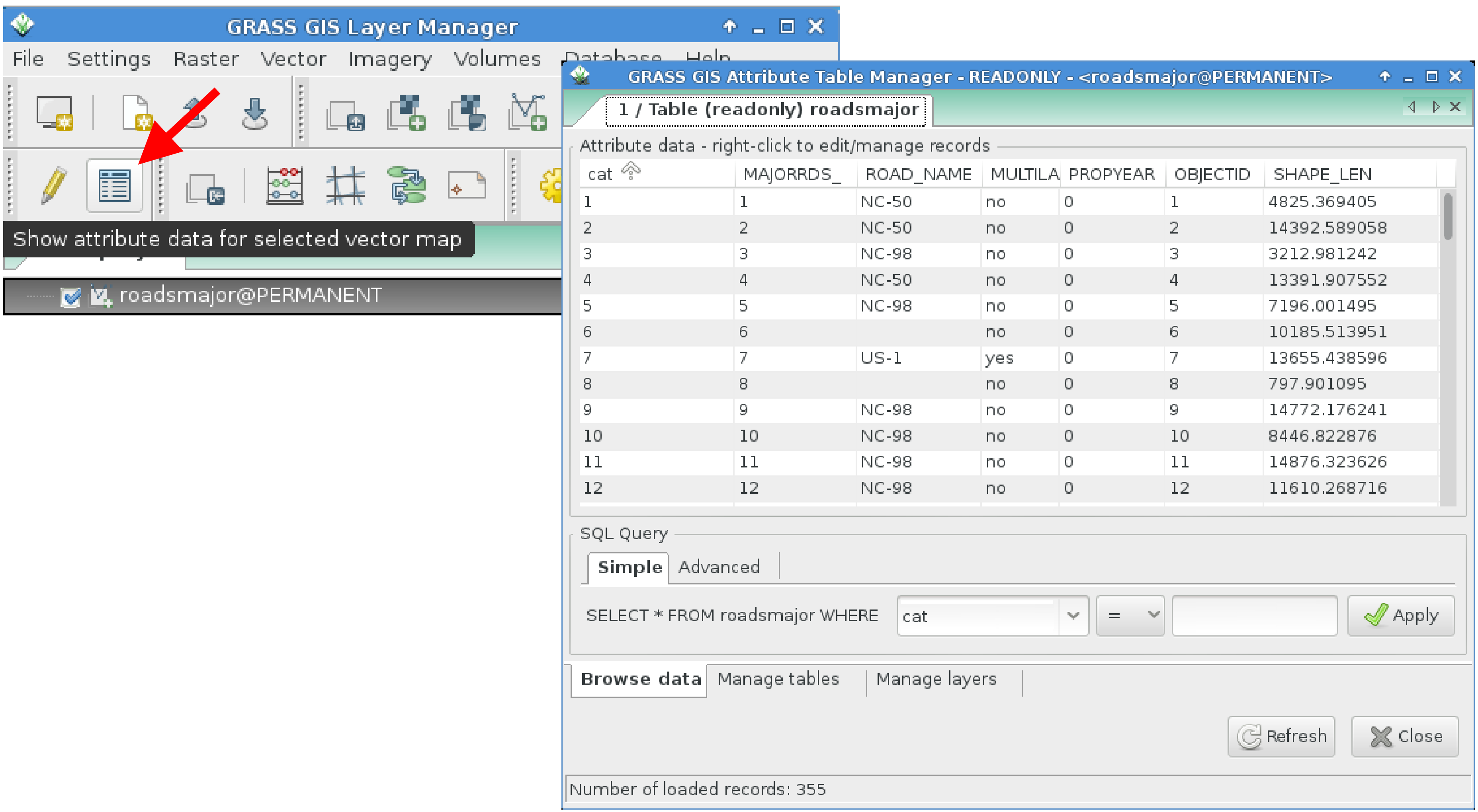
Exercise – Show vector map attributes

Open the attribute table of the “roadsmajor” vector map by

- … either *right-mouse* clicking in layer tree on map name
- … or using the related “Show Attribute table” icon



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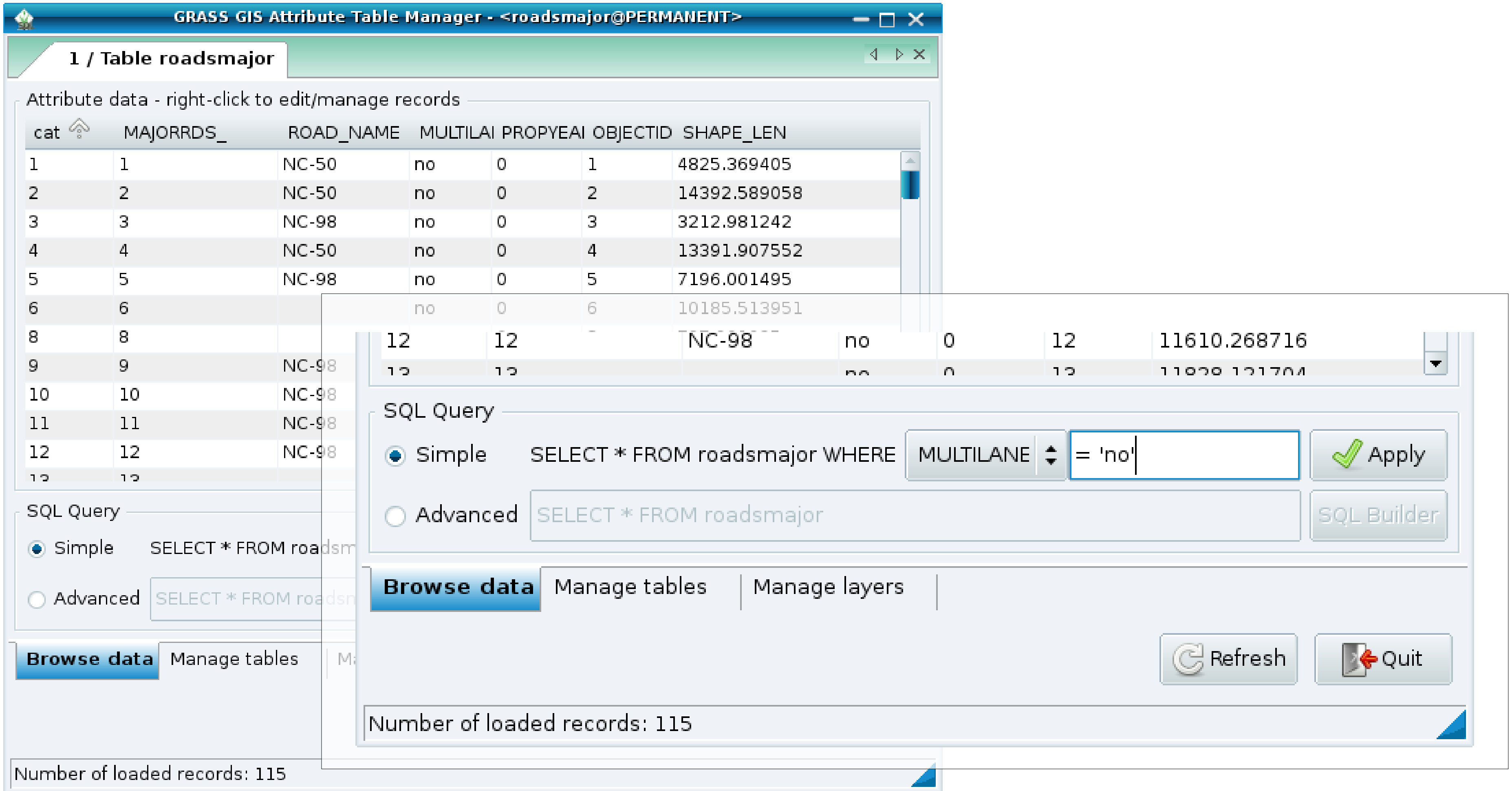
Exercise – SQL queries of attributes

Select the **single lane roads** in the “roadsmajor” vector map

- Use “Simple” SQL query
- The selected vectors will be highlighted in the map display



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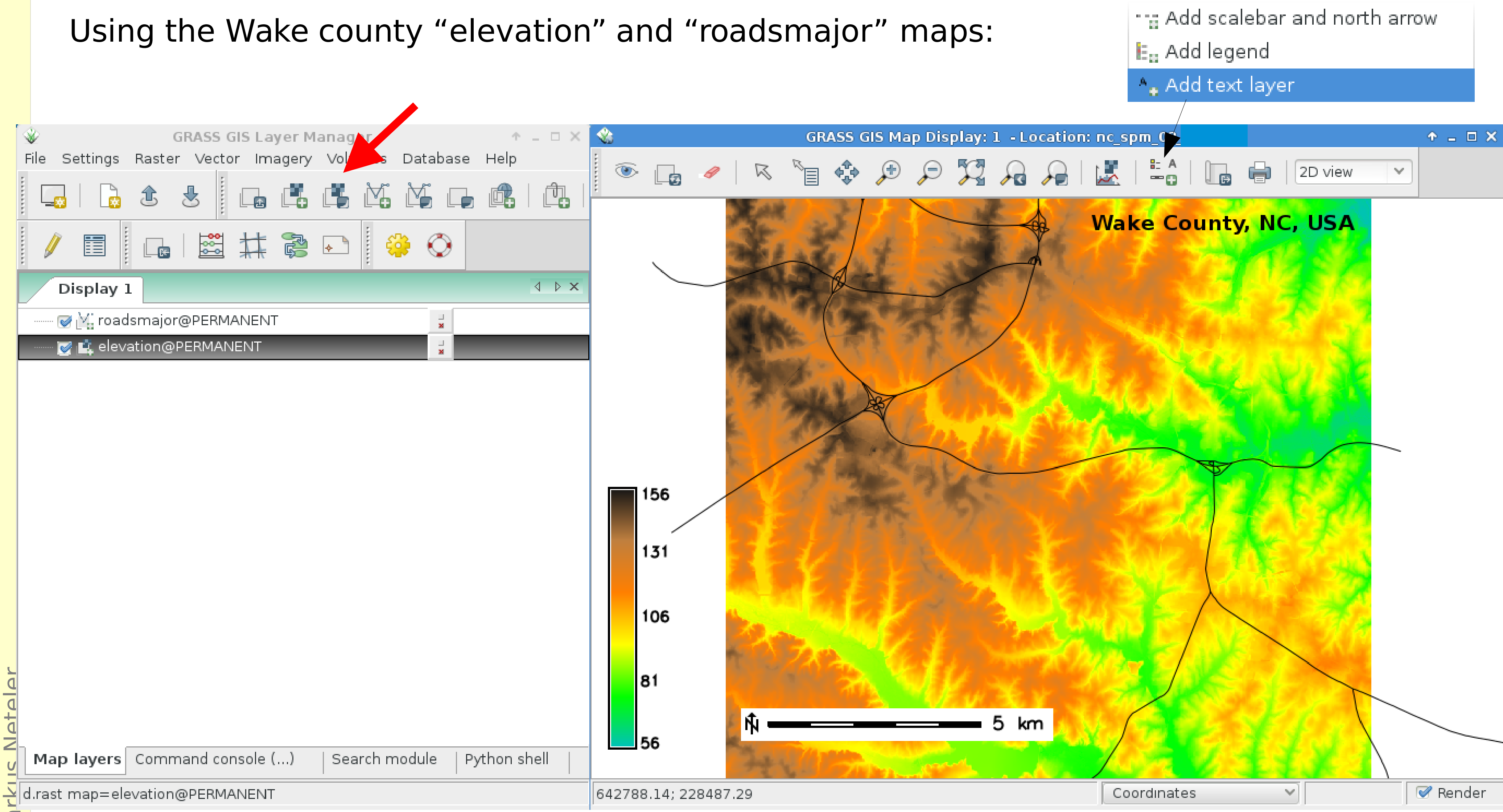
Exercise – Adding map elements

Using the Wake county “elevation” and “roadsmajor” maps:



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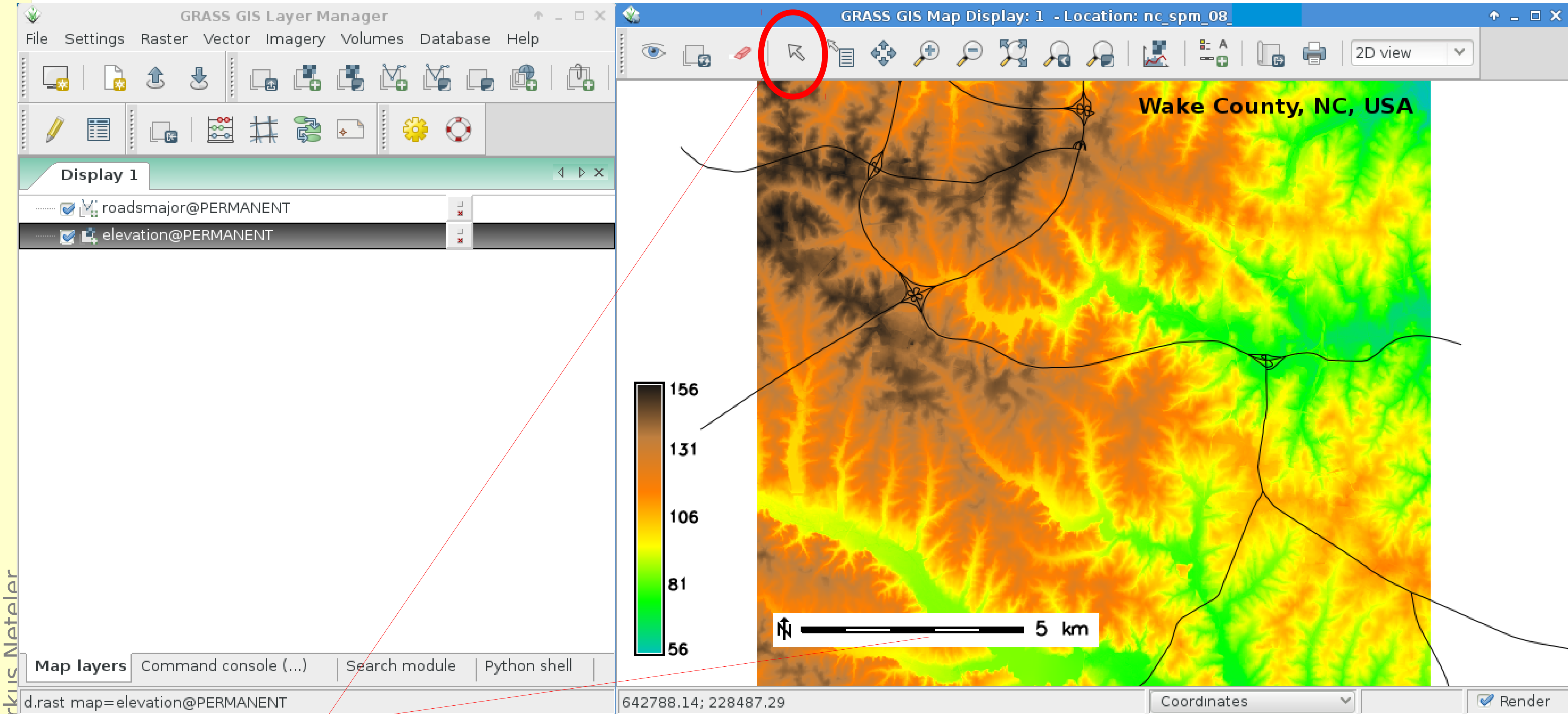
Exercise – Modify element settings and position

Using the Wake county “elevation” and “roadsmajor” maps:



Use pointer to
- move map elements
- edit element settings with
  a click

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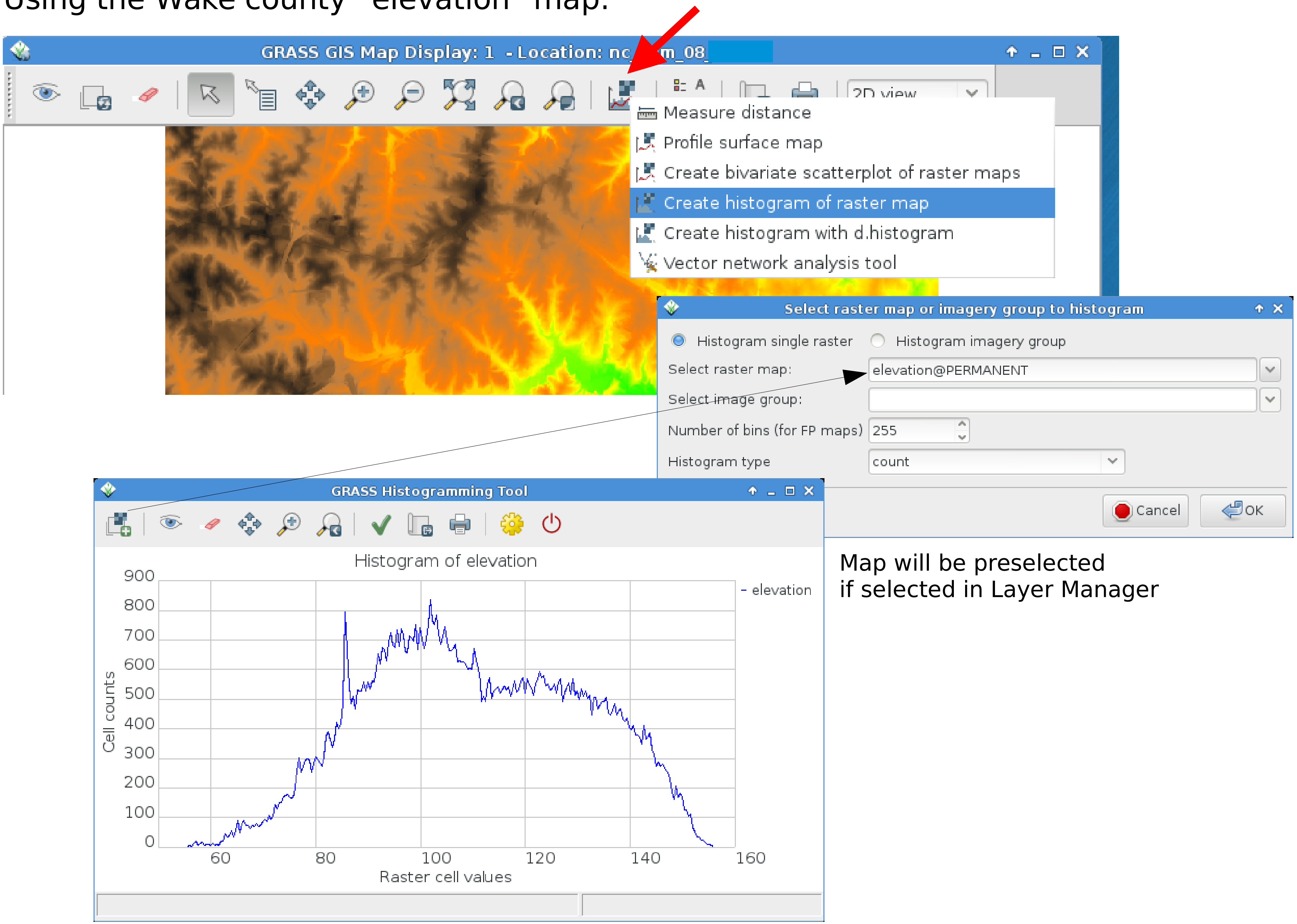
Exercise – Map histogram tool

Using the Wake county "elevation" map:



Map will be preselected
if selected in Layer Manager

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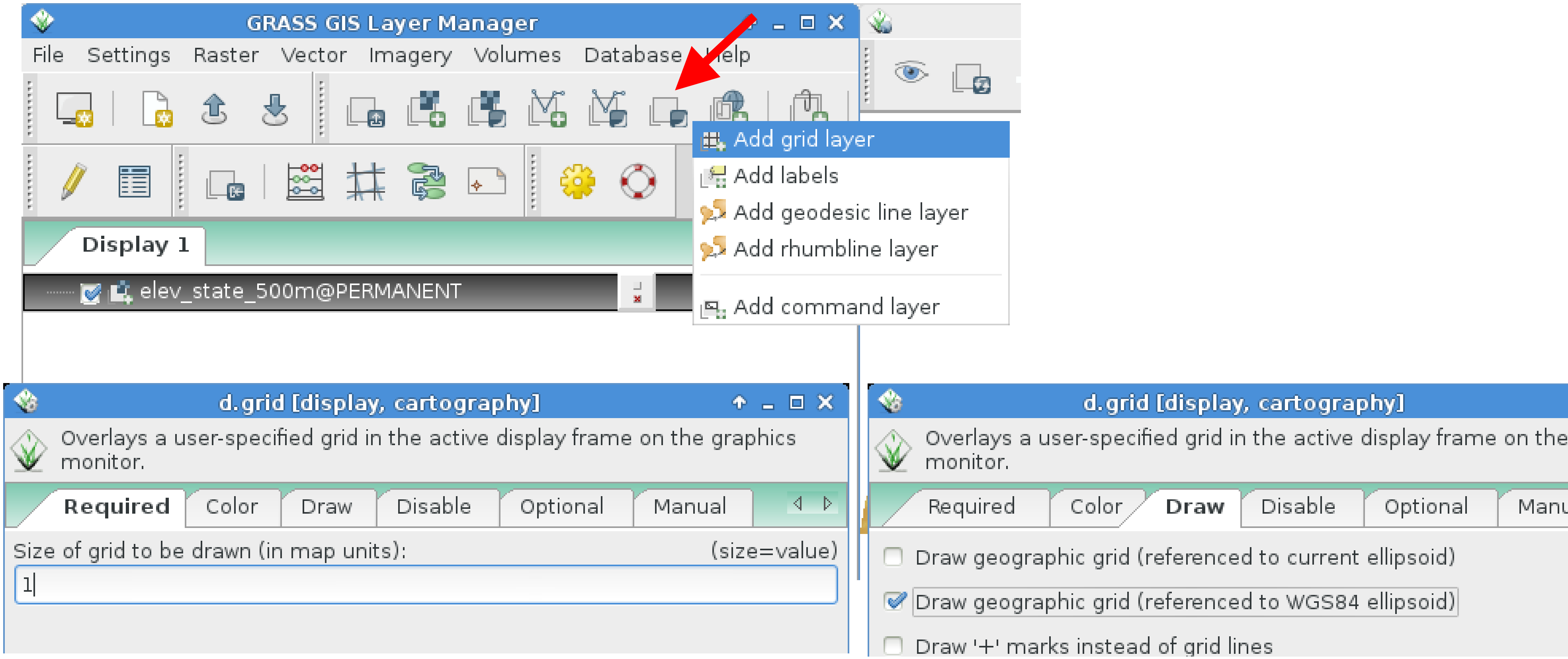
Exercise – Adding a Lat-Long grid to the map

Using the NC state “elev_state_500m” map:



Select a grid size in grid unts (here: LL – 1 deg) → Draw grid as LatLong WGS84 grid

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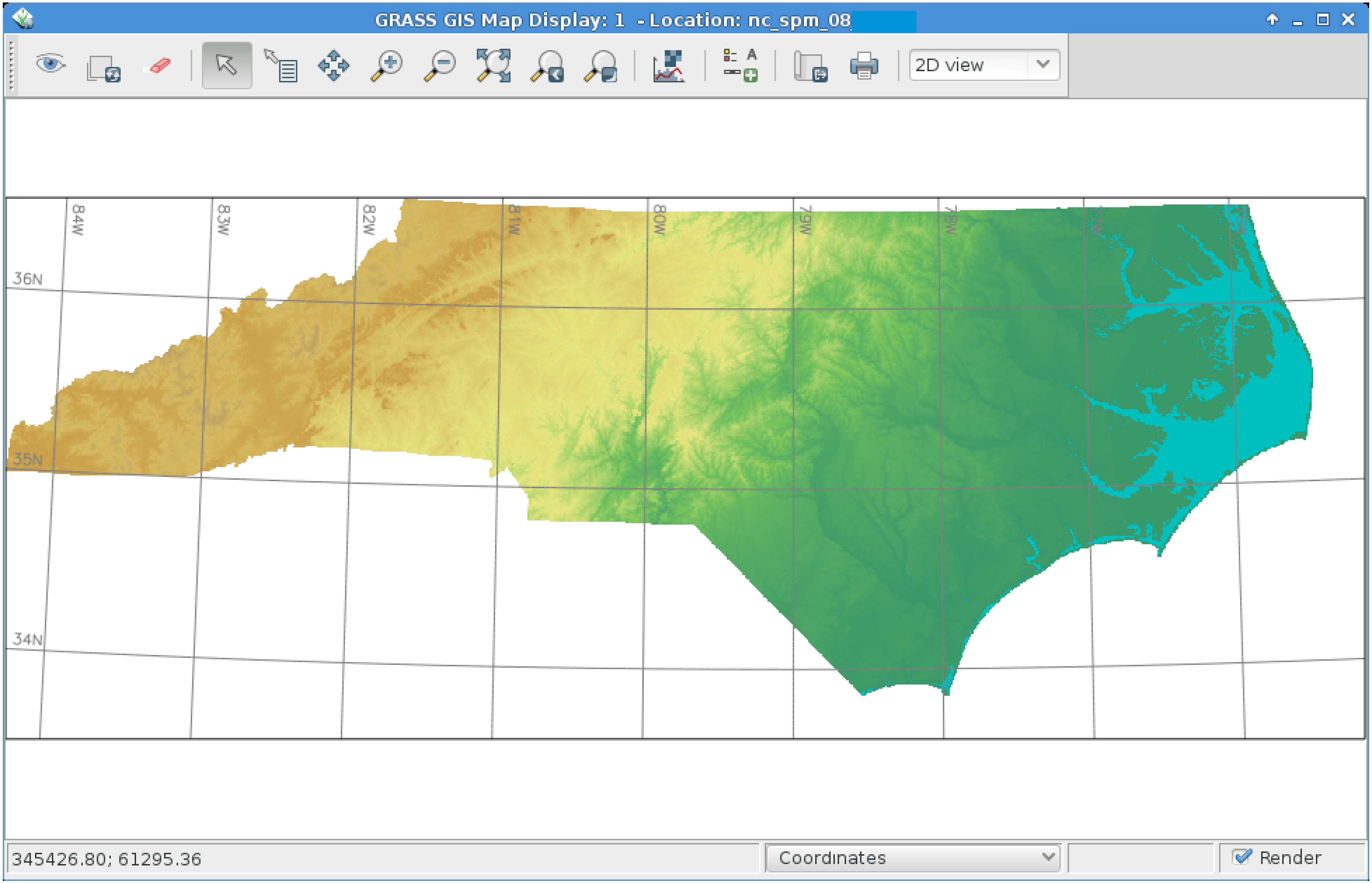
Exercise – Adding a Lat-Long grid to the map

Using the NC state "elev_state_500m" map:



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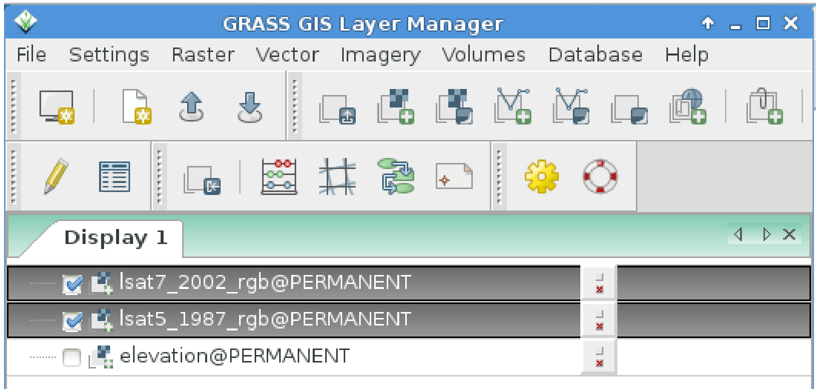
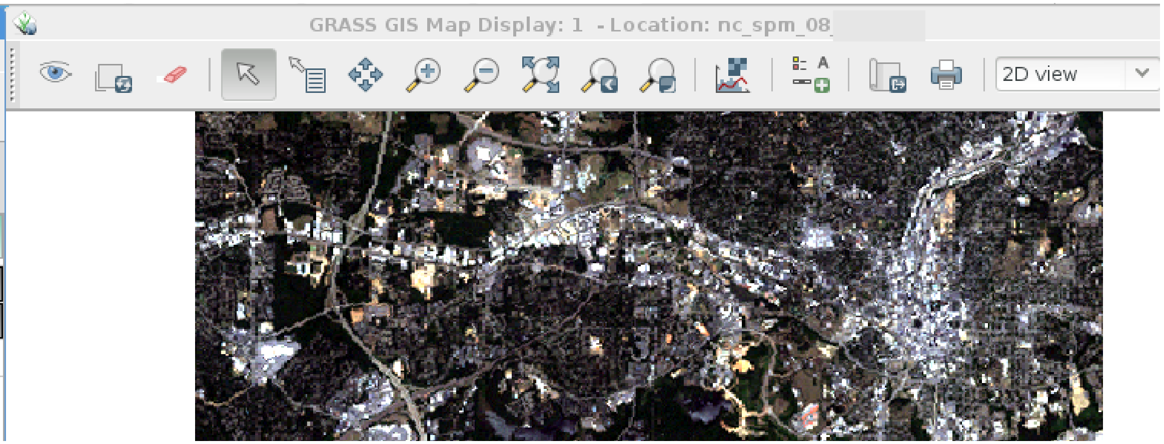
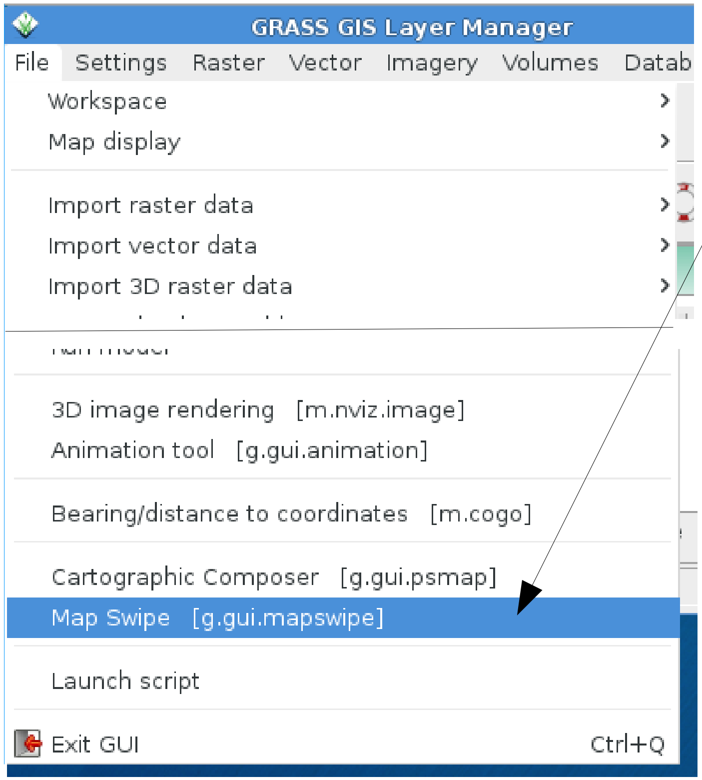
Exercise – Map swiping for multitemporal maps

Load the LANDSAT 5 (1987) and 7 (2002) **RGB composites** of Wake county:

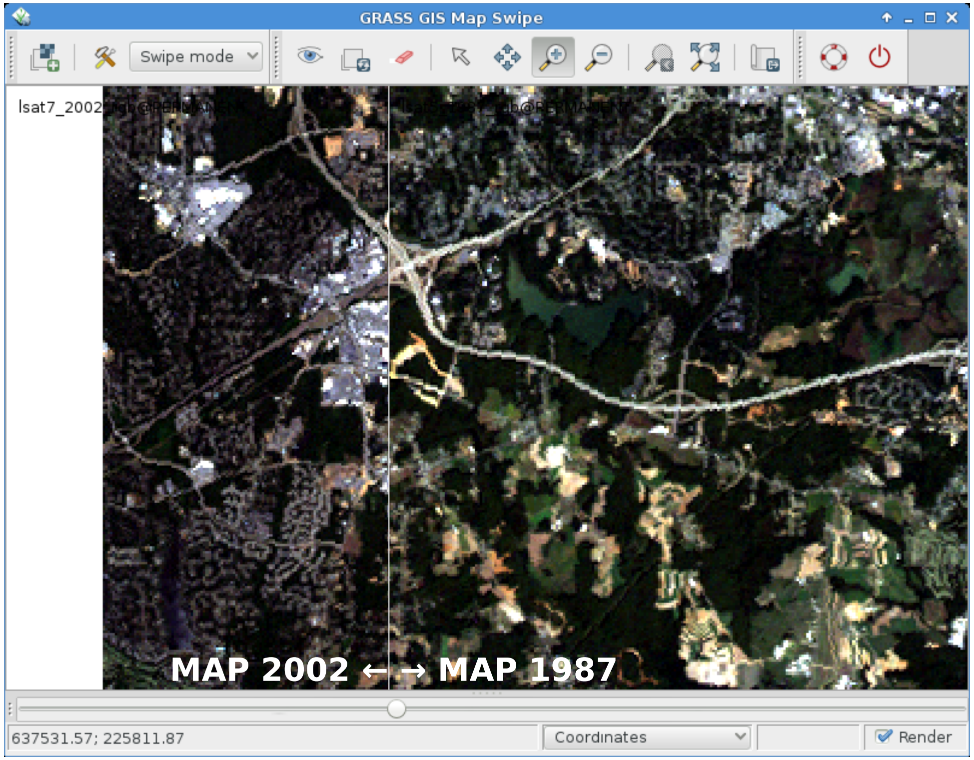


Select both LANDSAT maps (CTRL-click)





Switch to “map swipe” view



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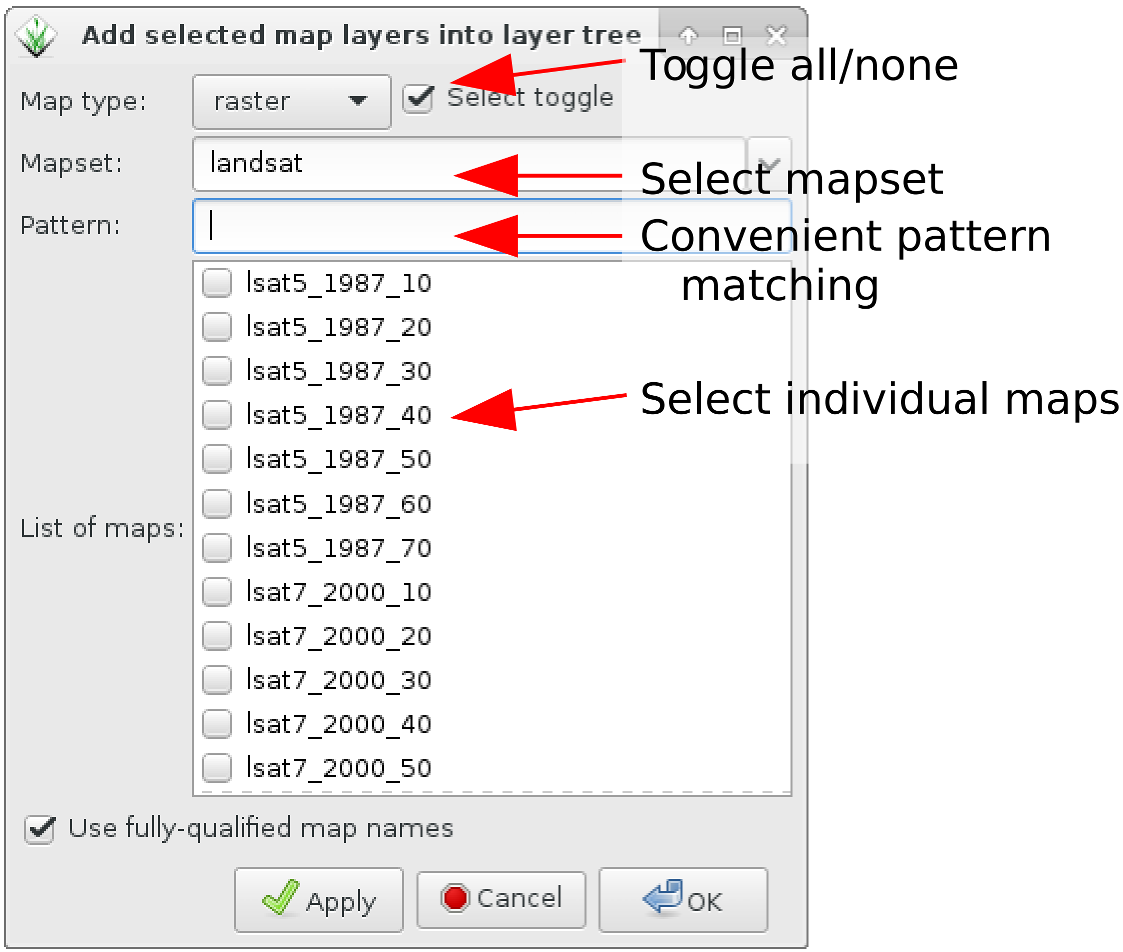
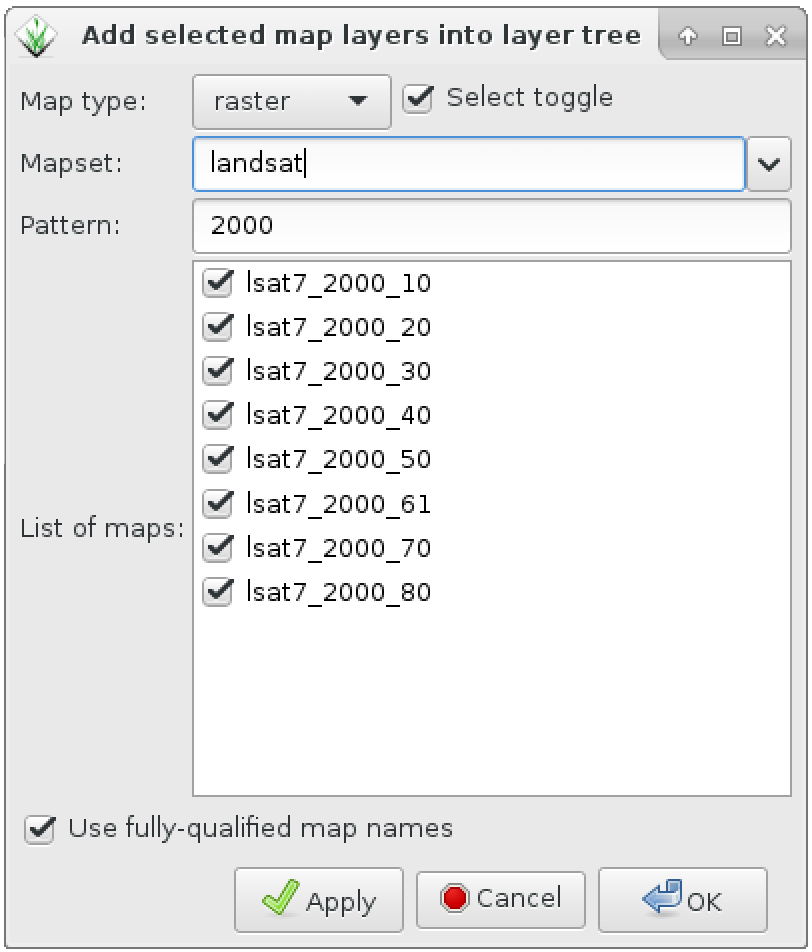
Exercise – Convenient map selector

Load the LANDSAT **channels red and green** using the convenient map selector





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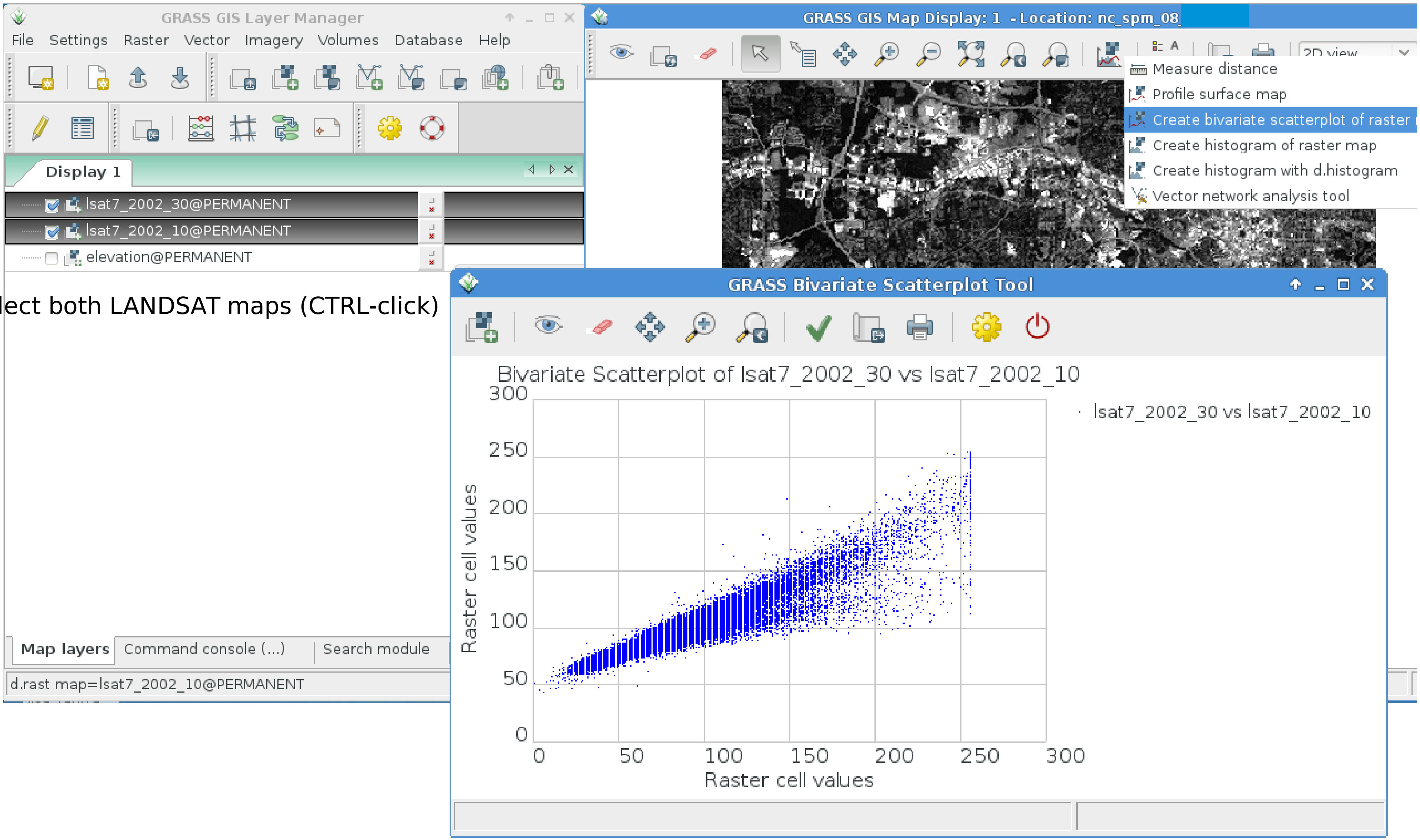
Exercise – Bivariate Scatterplots

Load the LANDSAT 7 2002 **channels 1 and 3** of Wake county.



Select both LANDSAT maps (CTRL-click)

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Overview: GRASS GIS command structure

prefix	***function class***	***type of command***	***example***
g.*	general	general data management	*g.rename: renames map*
d.*	display	graphical output	*d.rast: display raster map* *d.vect: display vector map*
r.*	raster	raster processing	*r.mapcalc: map algebra* *r.univar: univariate statistics*
v.*	vector	vector processing	*v.clean: topological cleaning*
i.*	imagery	imagery processing	*i.pca: Principal Components Analysis on imagery group*
r3.*	voxel	3D raster processing	*r3.stats: Voxel statistics*
db.*	database	database management	*db.select: select value(s) from table*
ps.*	postscript	map creation in PostScript format	*ps.map: PostScript map creation*
t.*	temporal	Space-time cubes	*t.rast.aggregate: Raster time series aggregation*

Ninja trick: on command line, type the desired prefix (e.g. v.)
and then <tab><tab> to complete the command name

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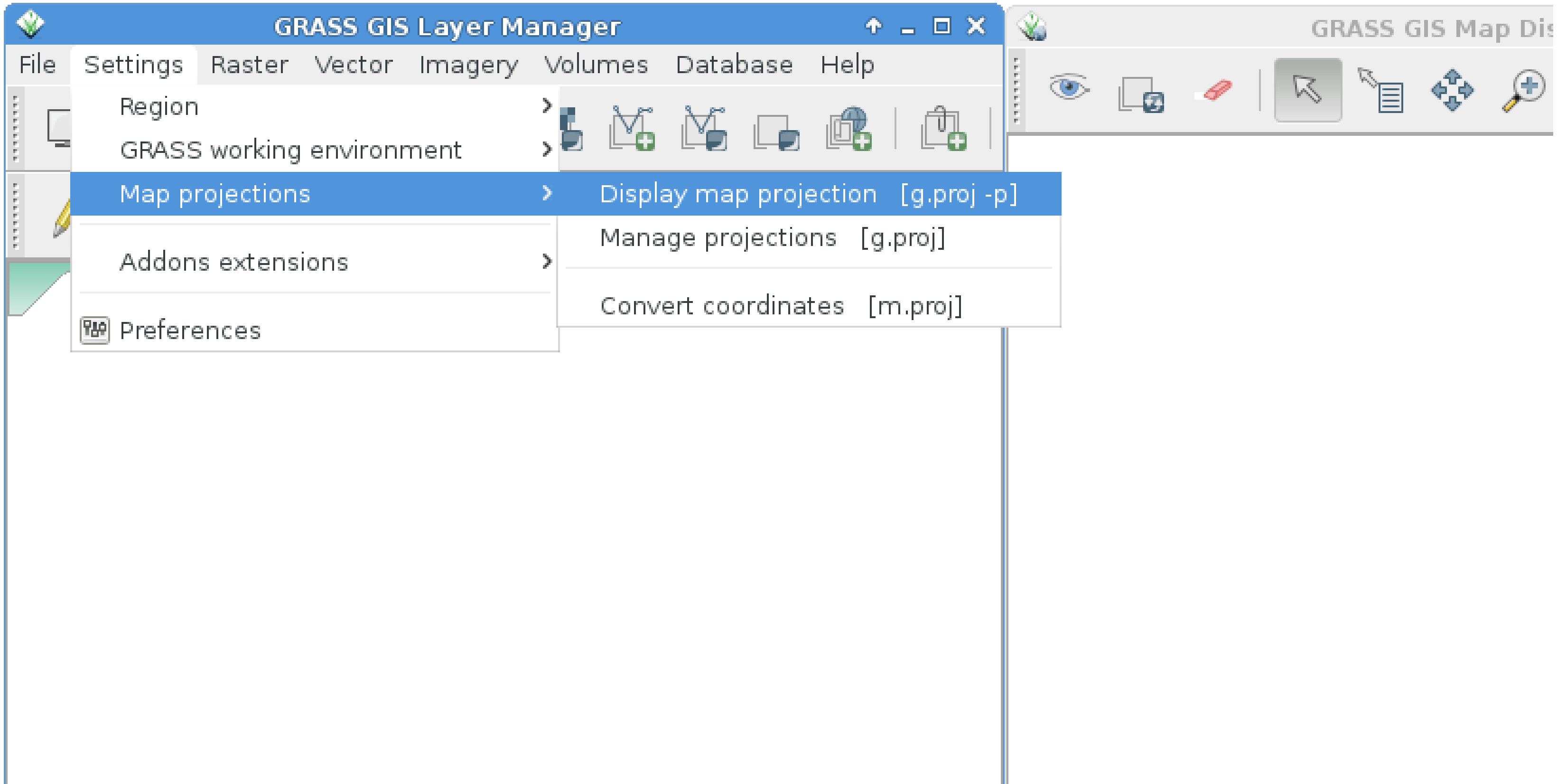
Exercise – GRASS startup and first steps

Know where you are...

get projection information for the North Carolina Location

command: `g.proj`

wxGUI: Settings → Map projections → Manage projections



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Exercise – GRASS startup and first steps

Know where you are...

get projection information for the North Carolina sample data set:

```
name            : Lambert Conformal Conic
proj            : lcc
datum           : nad83
a               : 6378137.0
es              : 0.006694380022900787
lat_1           : 36.16666666666666
lat_2           : 34.33333333333334
lat_0           : 33.75
lon_0           : -79
x_0             : 609601.22
y_0             : 0
units           : meters
```

```
Different formats
> g.proj -p
> g.proj -w
> g.proj -t
> g.proj -e
```

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GRASS Database concept – Projection

Know where you are...

get projection information for the
North Carolina sample data set:

```
name      : Lambert Conformal Conic
proj      : lcc
datum     : nad83
a         : 6378137.0
es        : 0.006694380022900787
lat_1     : 36.16666666666666
lat_2     : 34.33333333333334
lat_0     : 33.75
lon_0     : -79
x_0       : 609601.22
y_0       : 0
units     : meters
```

Projection name
projection
geodetic datum
ellipsoid GRS80
standard parallels
reference latitude
reference longitude
lon and lat shifts
(false easting/northing)

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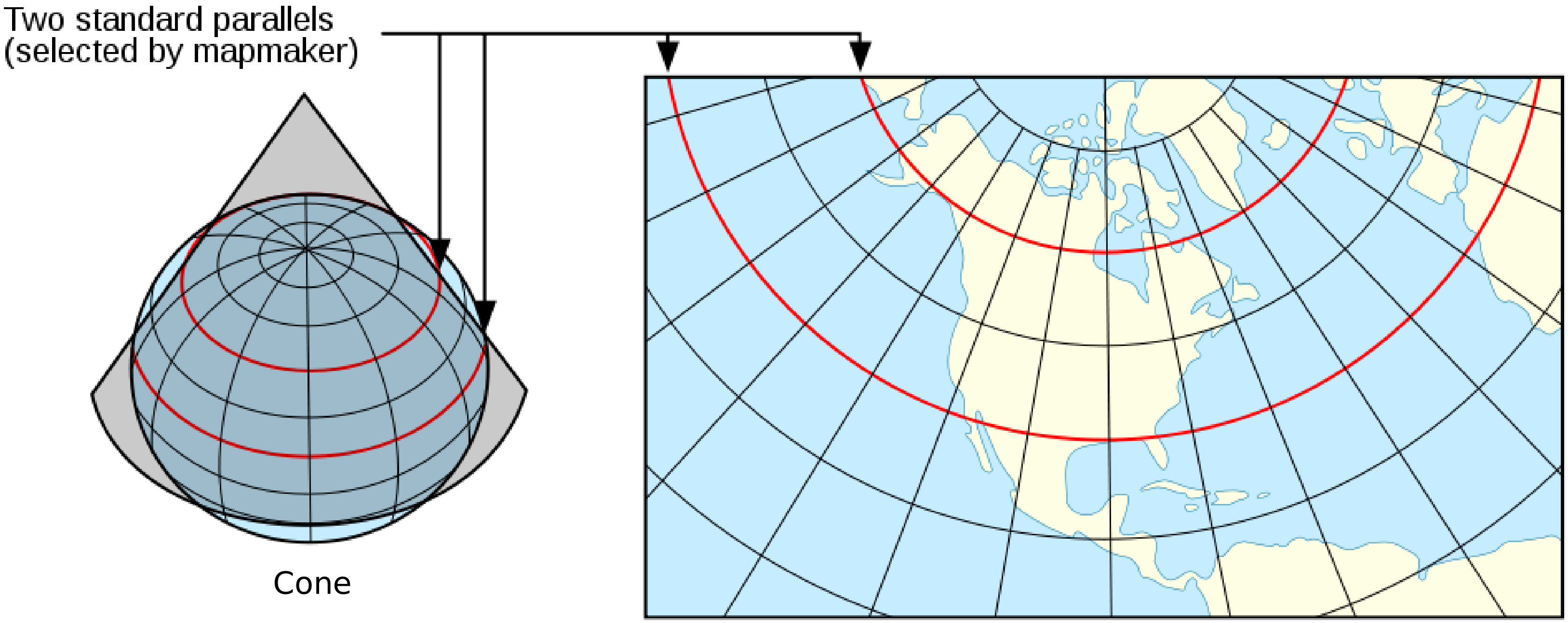
GRASS Database concept – Projection

Projection of the North Carolina Location:

NAD83(HARN) / North Carolina – EPSG code: 3358



+proj=lcc
+lat_1=36.16666666666666 +lat_2=34.33333333333334
+lat_0=33.75 +lon_0=-79
+x_0=609601.22 +y_0=0
+ellps=GRS80 +units=m +no_defs

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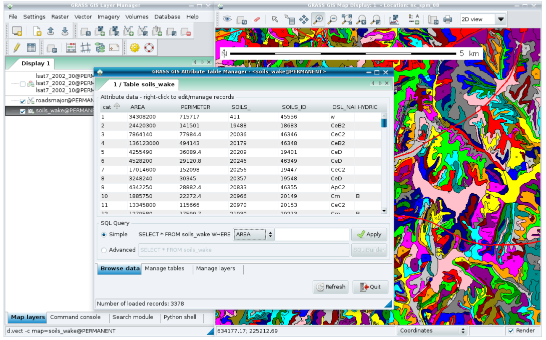
Graphical user interface versus Command line

- GRASS GIS offers a graphical user interface



- On command line, there is (text) help:

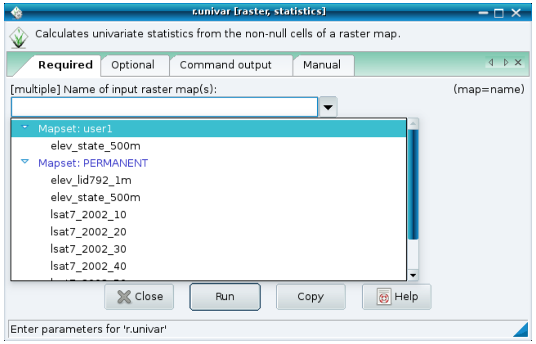
```
> r.univar --help
```

```
GRASS 7.0.2svn (nc_spm_08_grass7):~ > r.univar --help

Description:
 Calculates univariate statistics from the non-null cells of a raster map.
 Statistics include number of cells counted, minimum and maximum cell values, range,
 arithmetic mean, population variance, standard deviation, coefficient of variation,
 and sum.

Keywords:
 raster, statistics, univariate statistics, zonal statistics

Usage:
 r.univar [-get] map=name[,name,...] [zones=name] [output=name]
   [percentile=value[,value,...]] [separator=character] [--overwrite]
   [--help] [--verbose] [--quiet] [--ui]

Flags:
  -g   Print the stats in shell script style
  -e   Calculate extended statistics
  -t   Table output format instead of standard output format
 --o   Allow output files to overwrite existing files
 --h   Print usage summary
 --v   Verbose module output
 --q   Quiet module output
 --ui  Force launching GUI dialog

Parameters:
        map   Name of raster map(s)
      zones   Raster map used for zoning, must be of type CELL
     output   Name for output file (if omitted or "-" output to stdout)
 percentile   Percentile to calculate (requires extended statistics flag)
              options: 0-100
              default: 90
  separator   Field separator
               Special characters: pipe, comma, space, tab, newline
              default: pipe
GRASS 7.0.2svn (nc_spm_08_grass7):~ >
```

There are flags (e.g. `-g`) and parameters (e.g. `map=`)

- From command line, you can open the module's GUI (just call the command without parameters)

```
> r.univar
```



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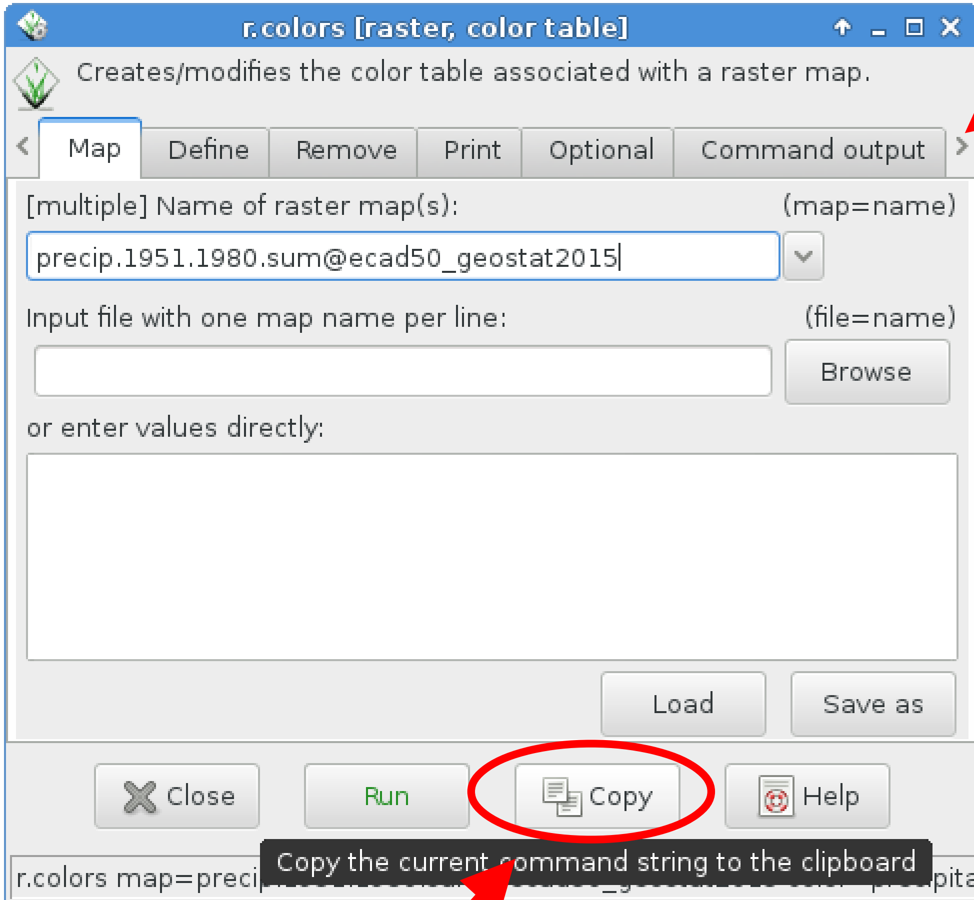
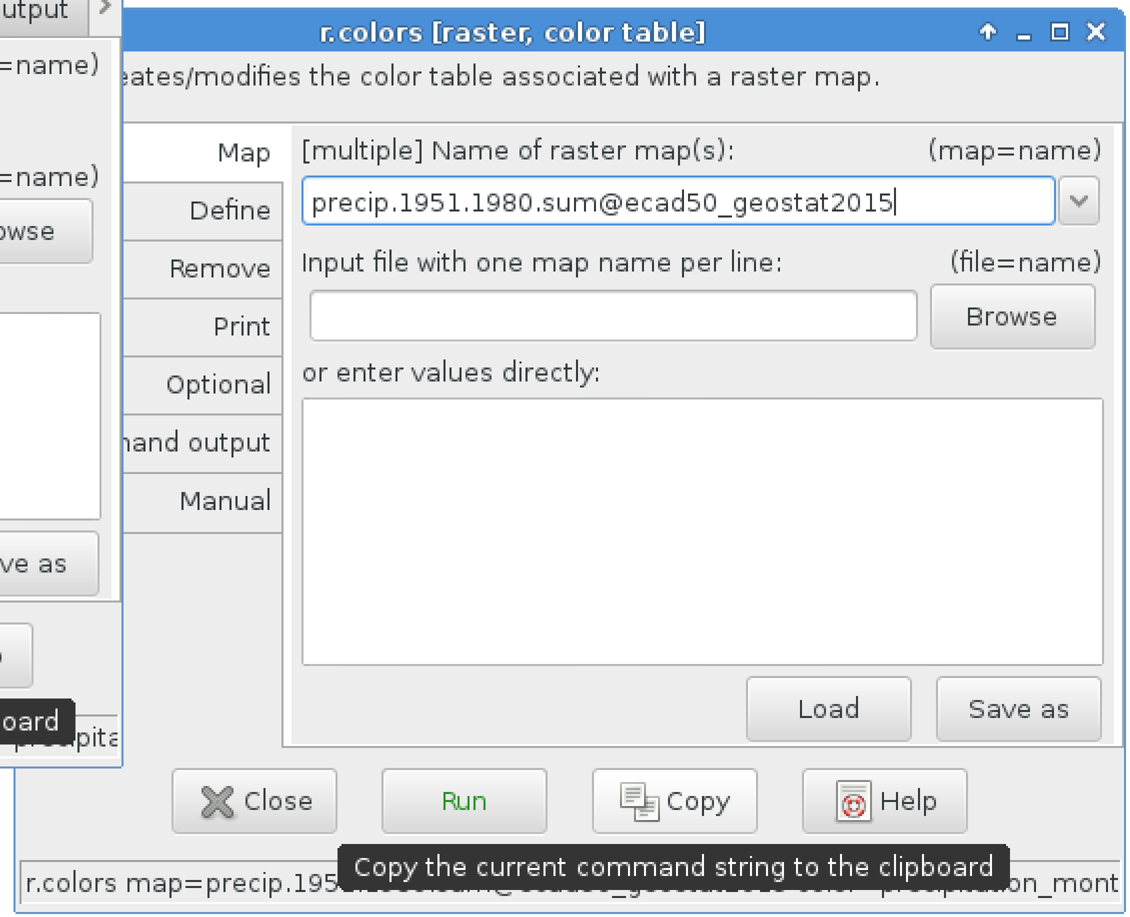
Graphical user interface versus Command line

STYLE: Menu: Settings → GUI Settings → Appearance → Module dialog style: Basic top/left



Cycle through
the various tabs



You may copy the command
to your documentation

The graphical user interface effectively generates the respective command for the command line (and also writes to the shell “history”)

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Command line at its best: 1/2

Advantages of the command line

- Run “`history`” to see all your previous commands, “forever”
- **History** is stored individually per MAPSET (note that the history of each map is stored within the map's metadata, for this use `r|r3|v.info`)
- **Search** in history with CTRL-R
- **Save** it **to a file**:
  `history > my_protocol.sh`
- `Note for Windows users: no history command but “Command console” tab → “Log file”`

```
GRASS 7.0.4 (piemont):~ > v.univar --help

Description:
 Calculates univariate statistics of vector map features.
 Variance and standard deviation is calculated only for points if specified.

Keywords:
 vector, statistics, univariate statistics, attribute table, geometry

Usage:
 v.univar [-gewd] map=name [layer=string] [type=string[,string,...]]
  [column=name] [where=sql_query] [percentile=value] [--help]
  [--verbose] [--quiet] [--ui]

Flags:
 -g   Print the stats in shell script style
 -e   Calculate extended statistics
 -w   Weigh by line length or area size
 -d   Calculate geometric distances instead of attribute statistics
--h   Print usage summary
--v   Verbose module output
--q   Quiet module output
--ui  Force launching GUI dialog

Parameters:
        map   Name of vector map
               Or data source for direct OGR access
      layer   Layer number or name
```

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Command line at its best: 2/2

Advantages of the command line

- Polish protocol file, use “# comment” to annotate it

- **Rerun** such a protocol file in a later GRASS GIS session with `sh my_protocol.sh`

```
#!/bin/sh

# MN, 2009, 2013
# convert ECAD gridded data to final Celsius data
# run in
#  grass70 /grassdata/latlong/ecad90_climate/

VER=9.0
STARTDATE=19500101
ENDNUM=23191
# FYI:
#  date -d '1950-01-01 23191 days' +"%Y-%m-%d"
#  2013-06-30

# tx_0.25deg_reg_v9.0.nc
IN=tx
VAR=tmax

#####################
if  [ -z "$GISBASE" ] ; then
    echo "You must be in GRASS GIS to run this program." >&2
    exit 1
fi
export GRASS_OVERWRITE=1
export GRASS_MESSAGE_FORMAT=plain

# import. Band 1 = first day
r.in.gdal -o input=${IN}_0.25deg_reg_v$VER.nc output=${VAR} memory=6000

# initialization, use YYYY.DOY format
MYDATE=`date -d "$STARTDATE 0 days" +"%Y.%j"`
# generates: 1950.001

# i is NC layer number, GDAL bands start with 1
for i in `seq 1 $ENDNUM` ; do

  g.region rast=${VAR}.$i
  # save with YYYY.DOY
  r.mapcalc "${VAR}.$MYDATE = if(${VAR}.$i == -9999, null(), ${VAR}.$i / 100.)"
  g.remove --q rast=${VAR}.$i
  r.colors ${VAR}.$MYDATE color=celsius

  # careful: $i starts with 0!!
  DAYOFFSET=`expr $i - 1`
  MYDATE=`date -d "$STARTDATE $DAYOFFSET days" +"%Y.%j"`
done

exit 0
```

Note: a simplified command line is included in the graphical user interface, tab “Command console”.

It offers a “Command prompt protocol” button.

- These script will work for decades...

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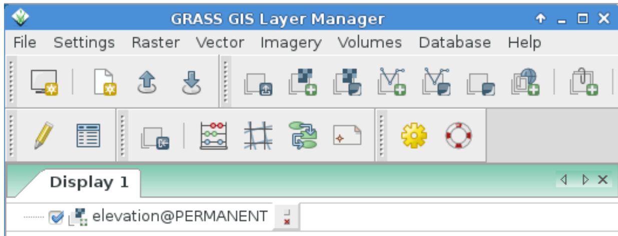
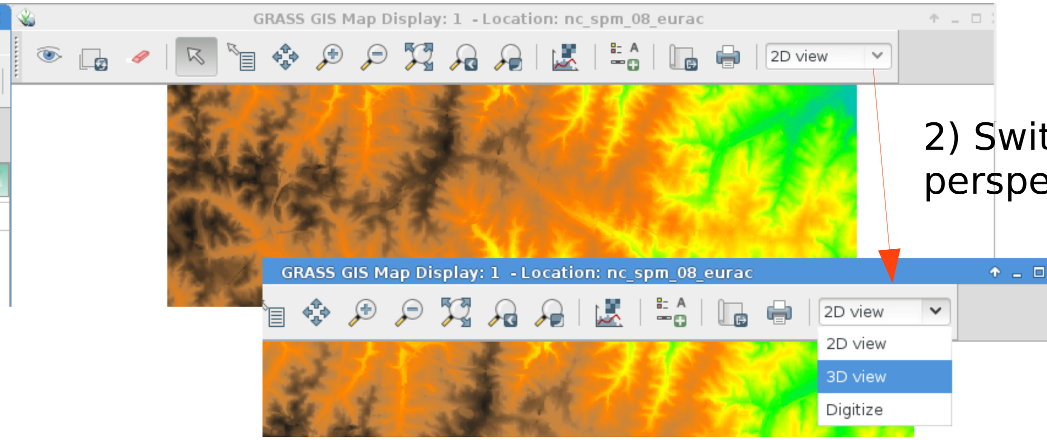
Exercise – Perspective view

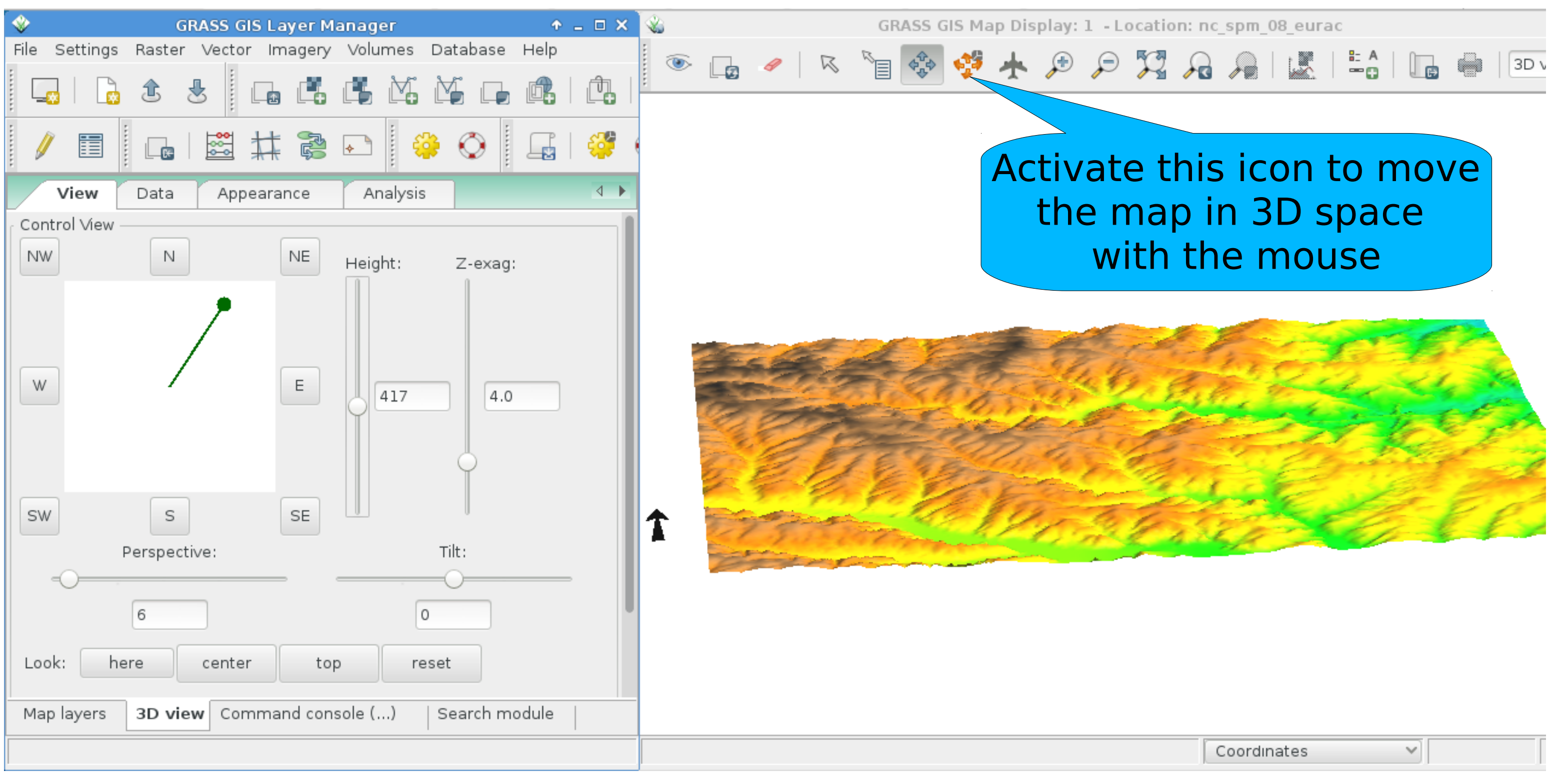
Load the Wake county "elevation" map (this tool requires OpenGL support):



1) Load and visualize DEM (set computational region to it) (load also vector map(s) if you want to use them) into the Layer Manager



2) Switch to perspective view



Eventually switch back to 2D mode...

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