

WS27: Unleash the power of GRASS GIS 7

Session 3 – GRASS GIS general intro

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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



GRASS GIS Database concept

GRASS Database

folder with Locations (“projects”)

Location

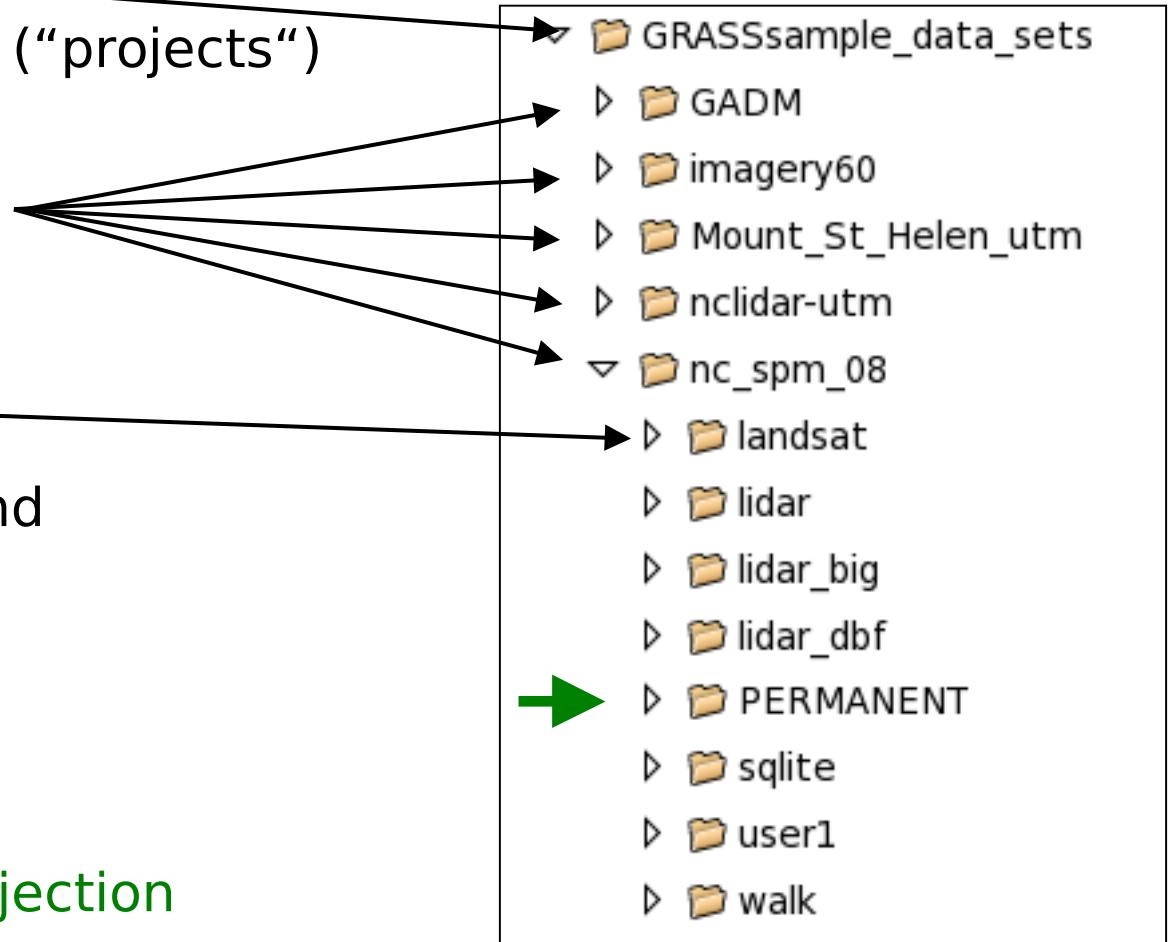
folder with Mapsets

Mapset

collection of maps and support data

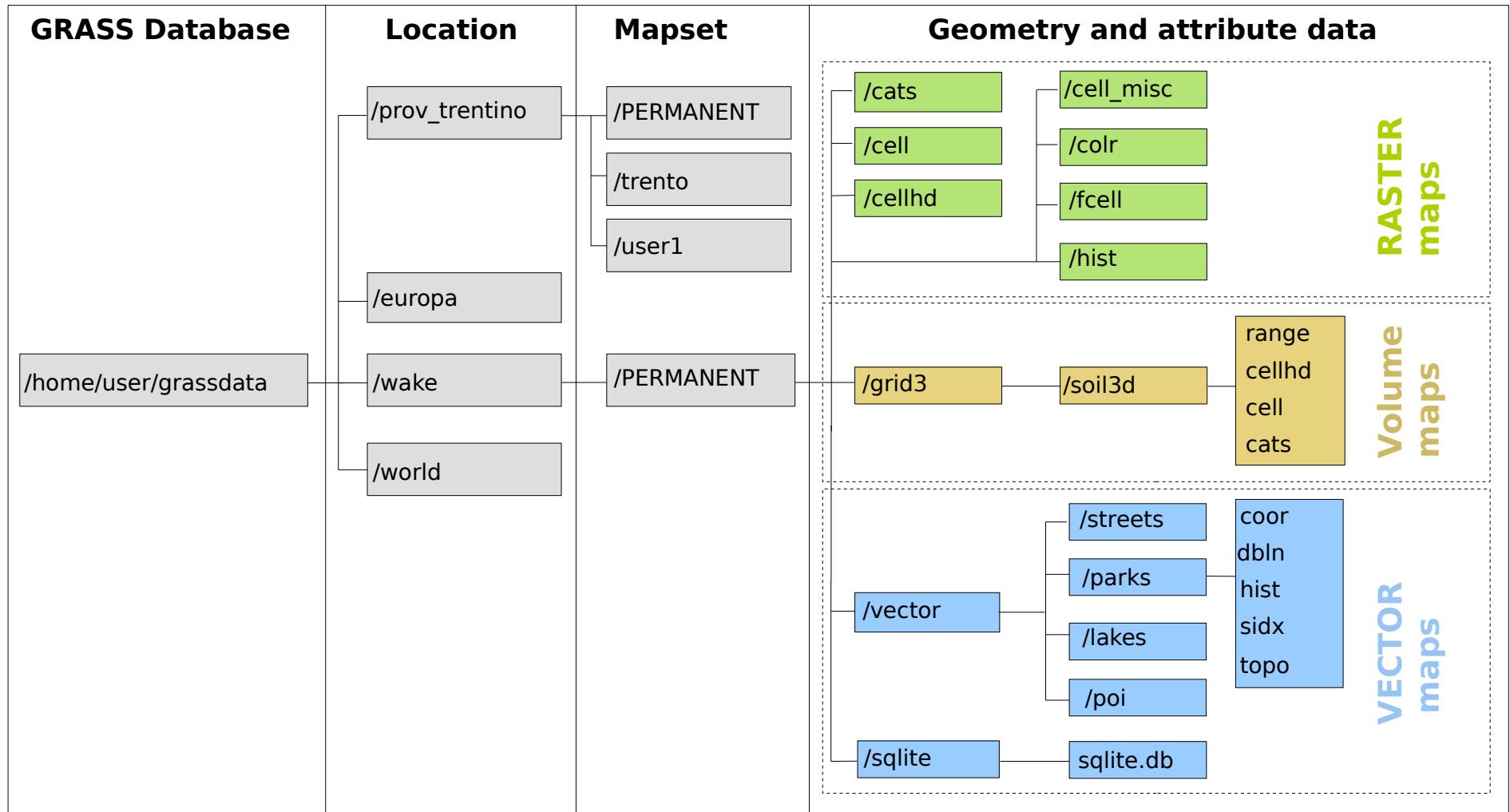
Each Location...

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



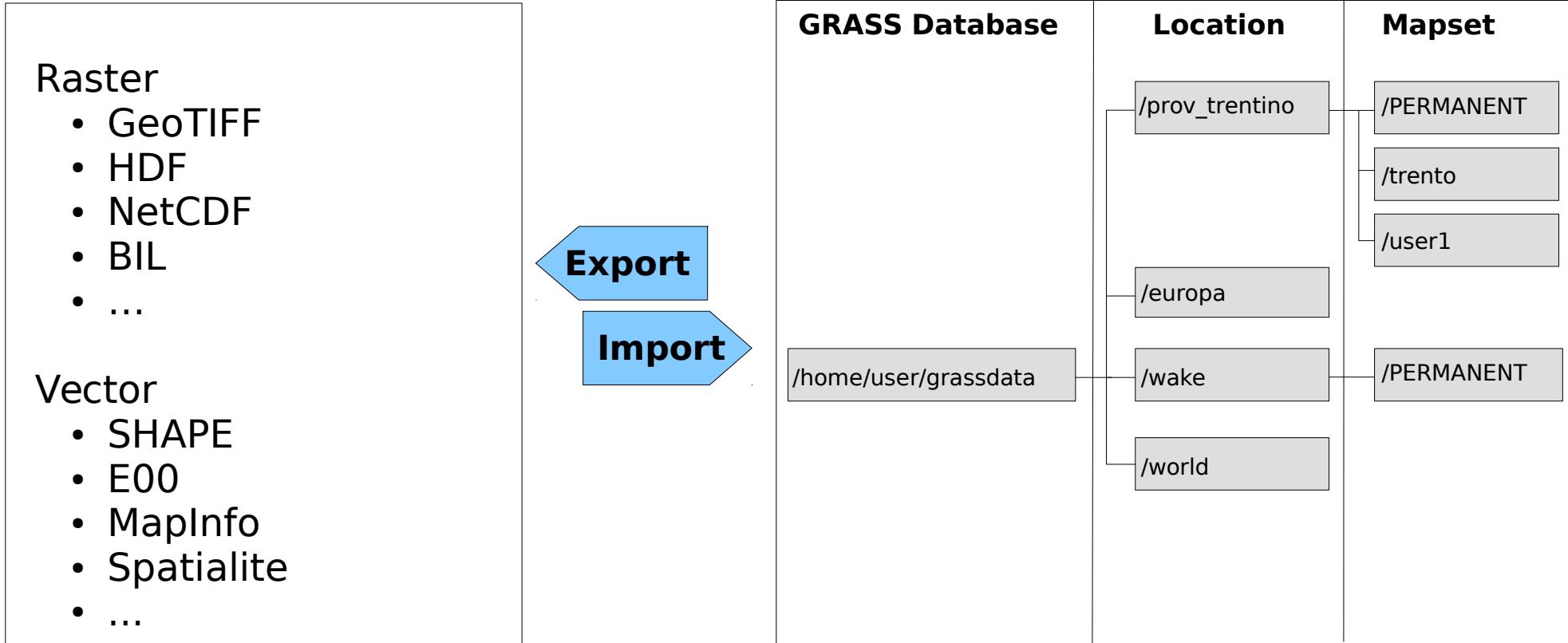


GRASS 7 Database concept: graphical view





Standard GIS formats versus GRASS 7 Database



Commonly used directory:

/home/user/grassdata/

or a shared network directory



Preparation – The GRASS GIS 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 provided on USB flash disk (or already on the computer):

Note:

- `grassdata_piemonte_version1_2015.tar.gz` is containing sample data from “Piemont, Italy” [1]. It is a dataset prepared for the course, ready for use in GRASS GIS 7.
- unpacking with `tar` tool or archive manager

[1] <https://trac.osgeo.org/grass/wiki/SampleDataset/Italy/Piemont>





Preparation – Unpacking the course data set

Unpacking of `grassdata_piemonte_version1_2015.tar.gz`
(the “Piemont” GRASS location as prepared for the course)

OSGeo-Live:

Create a directory “`grassdata`” in your home directory and
unpack the data package therein:

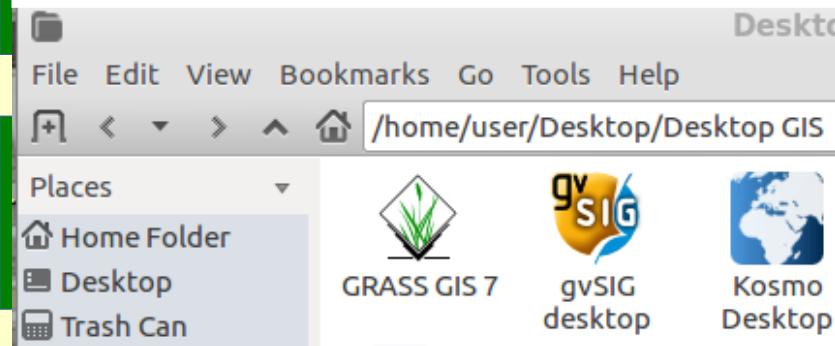


```
cd $HOME/grassdata  
mkdir piemont  
cd piemont
```

```
tar xvfz /path/to/grassdata_piemonte_version1_2015.tar.gz
```



Exercise – GRASS startup and first steps



The image shows the 'GRASS GIS 7.0.4 startup' window. It features a logo of a grass plant in a diamond shape and the text 'grass gis' in large green letters. Below it says 'Bringing advanced geospatial technologies to the world'. The window is divided into three main sections:

- 1. Select GRASS GIS database directory**: A text input field contains '/home/user/grassdata'. A red arrow points to this field.
- 2. Select GRASS Location**: A list box shows 'nc_basic_spm_grass7' and 'piemont'. 'piemont' is highlighted with a blue selection bar. Red arrows point to both the list box and the 'piemont' entry.
- 3. Select GRASS Mapset**: A list box shows 'orbassano', 'PERMANENT', and 'user1'. 'PERMANENT' is highlighted with a blue selection bar. Red arrows point to both the list box and the 'PERMANENT' entry.

At the bottom, there are buttons for 'Start GRASS session', 'Quit', and 'Help'.

Alternative to GUI: cmd line

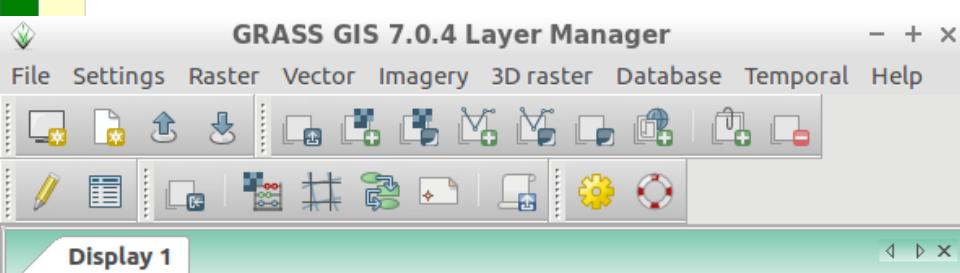
```
> grass70 --gui
```



Exercise – GRASS 7 startup and first steps

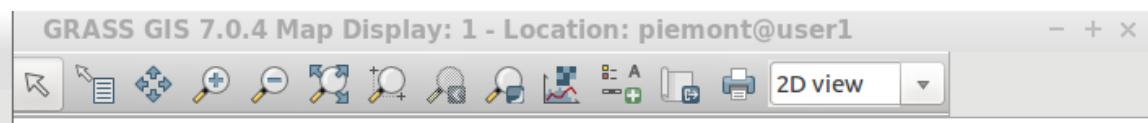
The graphical user interface at startup:

Main menu



List of map(s) here

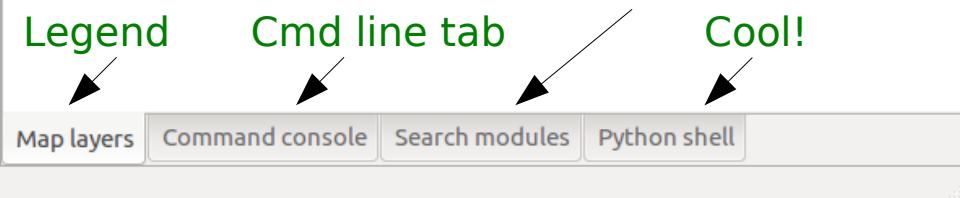
Map display



Common display tools

Map(s) shown here

Module tree

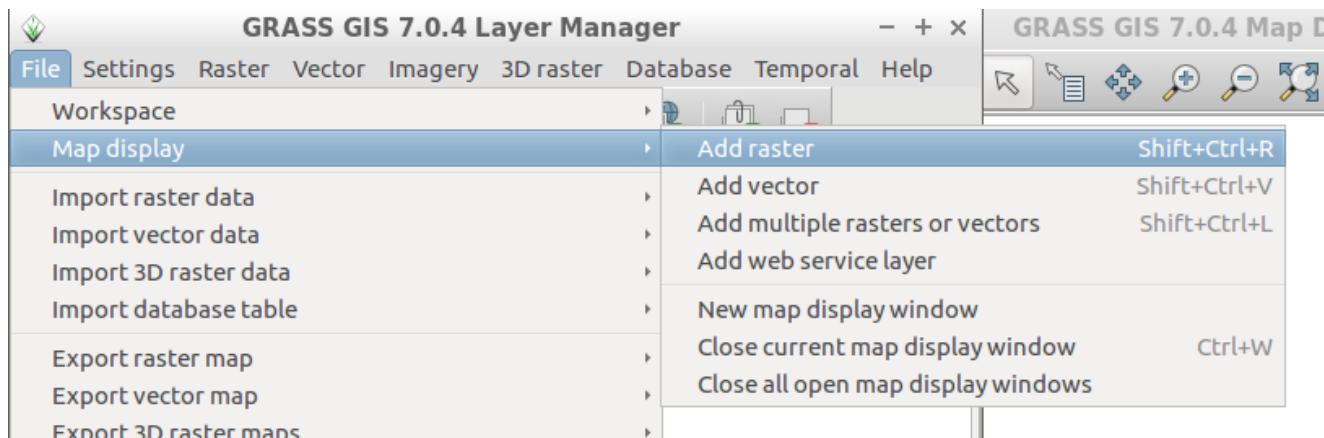


Cool!



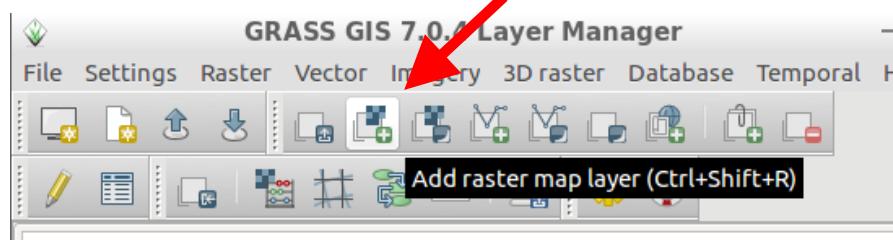
Displaying raster and vector maps

A) Using the menu

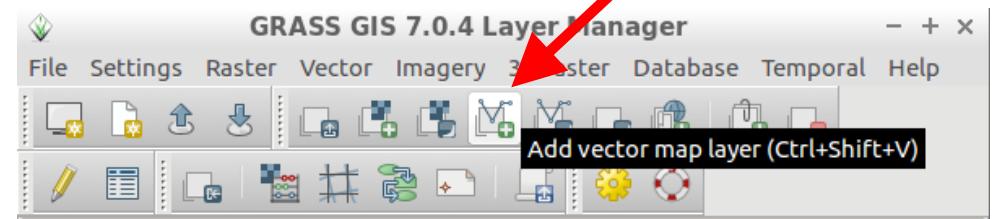


B) Using the icons

Display raster maps



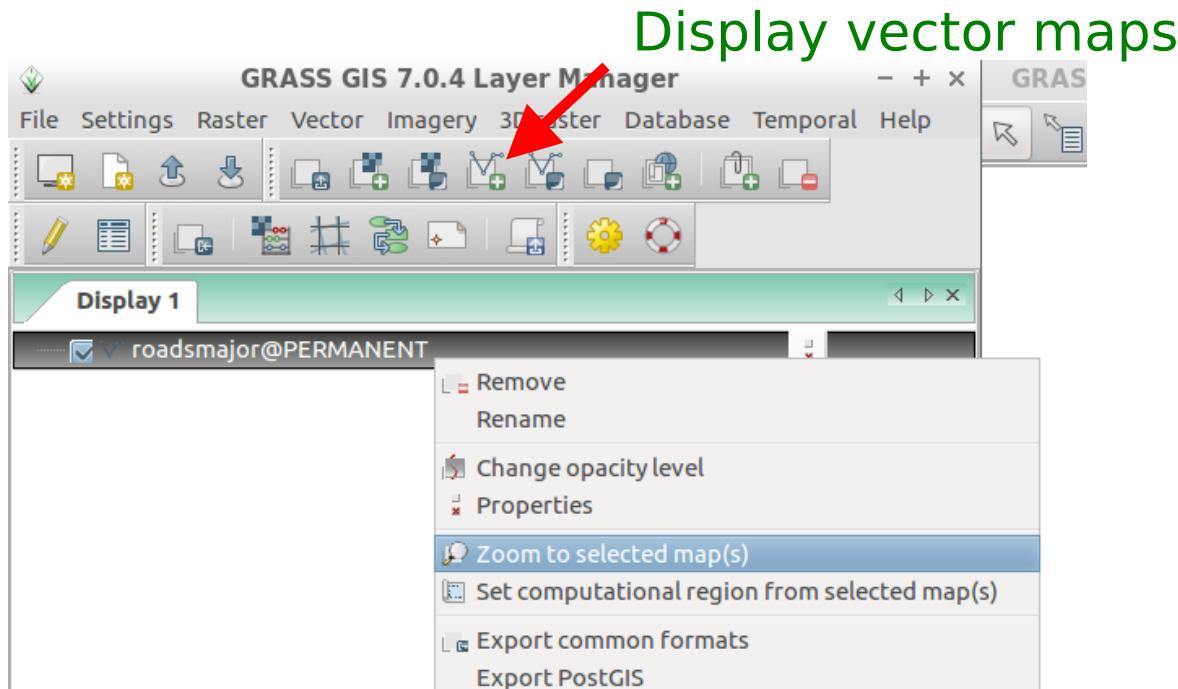
Display vector maps



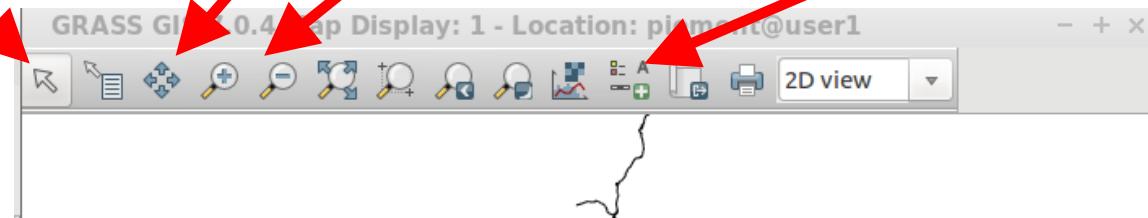


Exercise – Display the “roadsmajor” vector map

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



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





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

The screenshot shows the GRASS GIS 7.0.4 interface. The main window title is "GRASS GIS 7.0.4 Map Display: 1 - Location: piemont@user1". The left sidebar is titled "GRASS GIS 7.0.4 Layer Manager" and lists a single vector map named "roadsmajor@PERMANENT" with a checked checkbox. The central area is titled "GRASS GIS Attribute Table Manager...NLY - <roadsmajor@PERMANENT>" and displays a table titled "1 / Table (readonly) roadsmajor". The table has two columns: "PATR" and "NOME". The data is as follows:

	PATR	NOME
1	R	SR 229 DEL LAGO D'ORTA
2	R	SR 229 DEL LAGO D'ORTA
3	R	SR 142 BIELLESE
4	R	SR 142 BIELLESE
5	R	SR 229 DEL LAGO D'ORTA
6	S	SS 231
7	S	SS 26
8	S	SS 26
9	R	SR 457 DI MONCALVO
10	D	SR 457 DI MONCALVO

Below the table is a "SQL Query" section with tabs for "Simple" and "Builder". The "Simple" tab contains the query: "SELECT * FROM roadsmajor WHERE cat". There are dropdown menus for "cat" and "=" followed by an "Apply" button. At the bottom of the table area are buttons for "Browse data" (which is highlighted in blue), "Manage tables", and "Manage layers". At the very bottom of the window, it says "Number of loaded records: 1085".



Exercise – SQL queries of attributes

Selecting a **road type** in the “roadsmajor” vector map

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

GRASS GIS 7.0.4 Layer Manager GRASS GIS 7.0.4 Map Display: 1 - Location: piemont@user1

File Settings Raster Vector Imagery 3D raster Database Temporal Help

GRASS GIS Attribute Table Manager...NLY - <roadsmajor@PERMANENT>

1 / Table (readonly) roadsmajor

Attribute data - right-click to edit/manage records

cat	PATR	NOME
135	A	Tangenziale di TORINO
136	A	Tangenziale di TORINO
138	A	A 4
139	A	A 4
142	A	Tangenziale di TORINO
143	A	Tangenziale di TORINO
144	A	Tangenziale di TORINO
145	A	Tangenziale di TORINO
146	A	Tangenziale di TORINO
158	A	A 26/7

Display 1

SQL Query

Simple Builder

SELECT * FROM roadsmajor WHERE PATR = 'A'

Browse data Manage tables Manage layers

Map layers C

Number of loaded records: 173

Field **PATR**

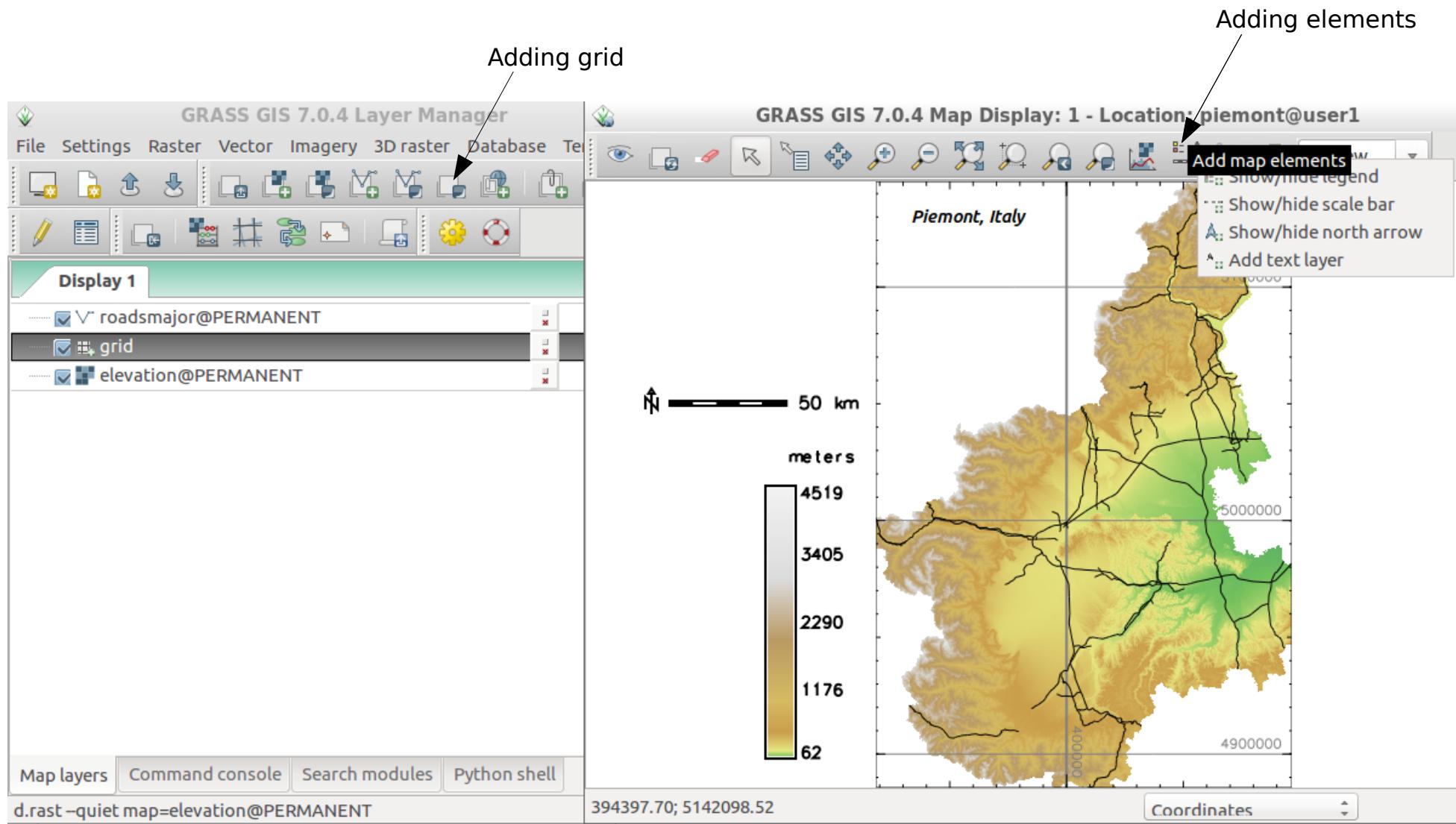
A: Autostrade (highways)
P: Strade provinciali
R: Strade regionali
S: Strade statali
T: Strade provinciali (ex statali)

Coordinates



Exercise – Adding a grid and map elements

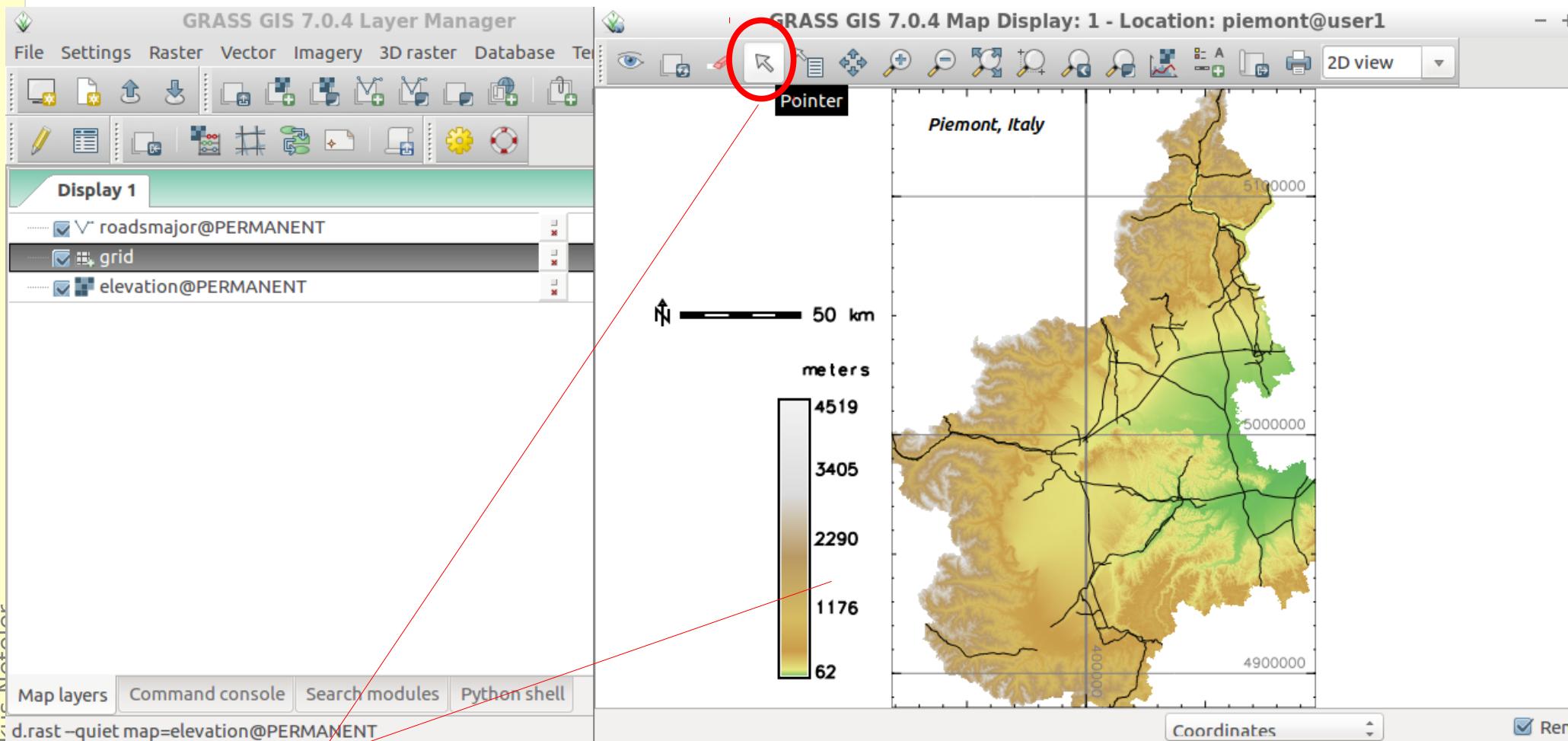
Using the “elevation” (raster) and “roadsmajor” (vector) maps:





Exercise – Modify element settings and position

Using the “elevation” (raster) and “roadsmajor” (vector) maps:



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



Exercise – Adding a Lat-Long grid to the map

Using the “elevation” map:

The GRASS GIS Layer Manager window is open. A red arrow points from the 'Raster' menu bar to the 'Add grid layer' option in the dropdown menu. The 'Display 1' tab is selected, showing a single layer named 'elev_state_500m@PERMANENT'. The toolbar below the menu bar contains various icons for file operations and layer management.

GRASS GIS Layer Manager

Add grid layer

Add labels

Add geodesic line layer

Add rhumbline layer

Add command layer

Display 1

elev_state_500m@PERMANENT

d.grid [display, cartography]

Overlays a user-specified grid in the active display frame on the graphics monitor.

Required Color Draw Disable Optional Manual

Size of grid to be drawn (in map units): (size=value)

0.5

Don't forget about this if you want a LatLong grid!

The d.grid [display, cartography] configuration dialog is open. A red arrow points to the 'Draw geographic grid (referenced to WGS84 ellipsoid)' checkbox, which is checked. Other options available include 'Draw geographic grid (referenced to current ellipsoid)' and 'Draw '+' marks instead of grid lines'.

d.grid [display, cartography]

Overlays a user-specified grid in the active display frame on the g monitor.

Required Color Draw Disable Optional Manual

Draw geographic grid (referenced to current ellipsoid)

Draw geographic grid (referenced to WGS84 ellipsoid)

Draw '+' marks instead of grid lines

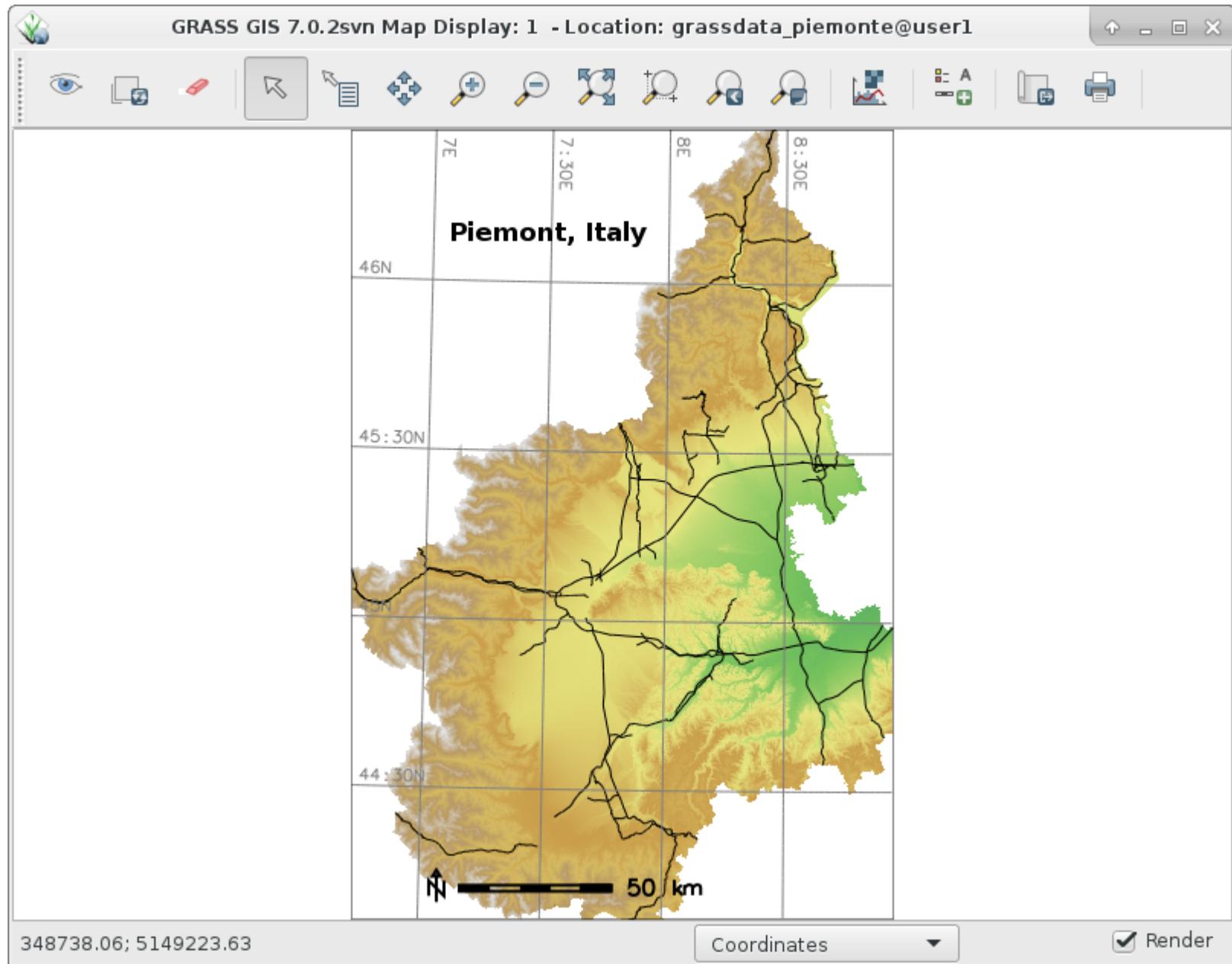
Select a grid size in grid units (here: LL – 0.5 deg)

→ Draw grid as LatLong WGS84 grid



Exercise – Adding a Lat-Long grid to the map

Using the Piemont “elevation” map:





Exercise – Map histogram tool

Using the “elevation” map:

GRASS GIS 7.0.2svn Map Display: 1 - Location: grassdata_piemonte@user1

Piemont, Italy

Measure distance
Measure area
Profile surface map
Create bivariate scatterplot of raster maps
Create histogram of raster map
Create histogram with d.histogram
Vector network analysis tool

50 km

GRASS GIS Histogramming Tool

Histogram of raster map <elevation@PERMANENT>

Cell counts

Raster cell values meters

Note: Map will be preselected if selected in Layer Manager

Select raster map or imagery group to histogram

Histogram single raster Histogram imagery group

Select raster map: elevation@PERMANENT

Select image group:

Number of bins (for FP maps) 25 - +

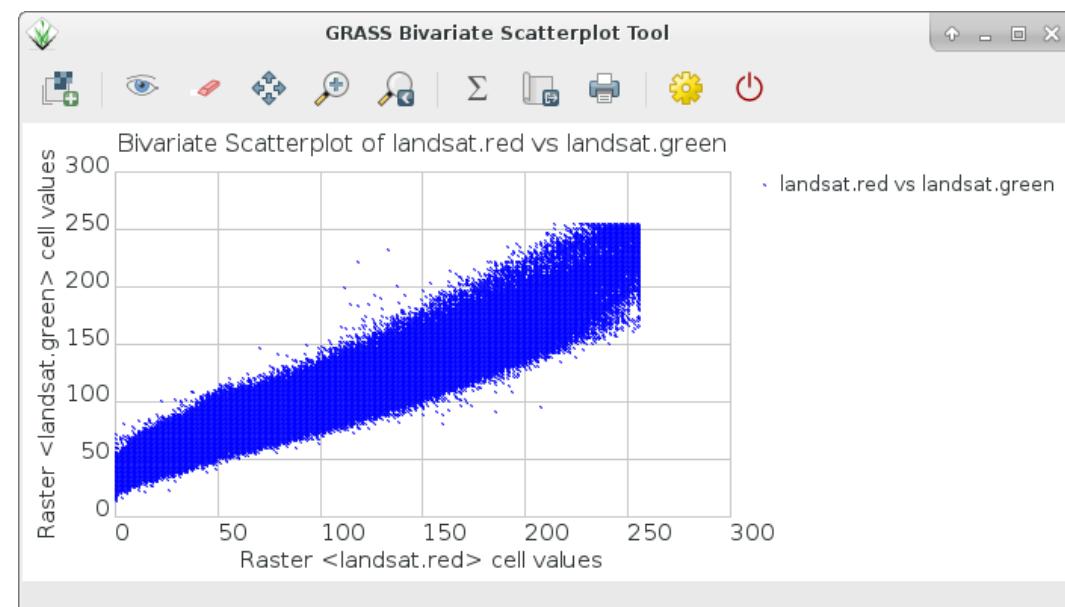
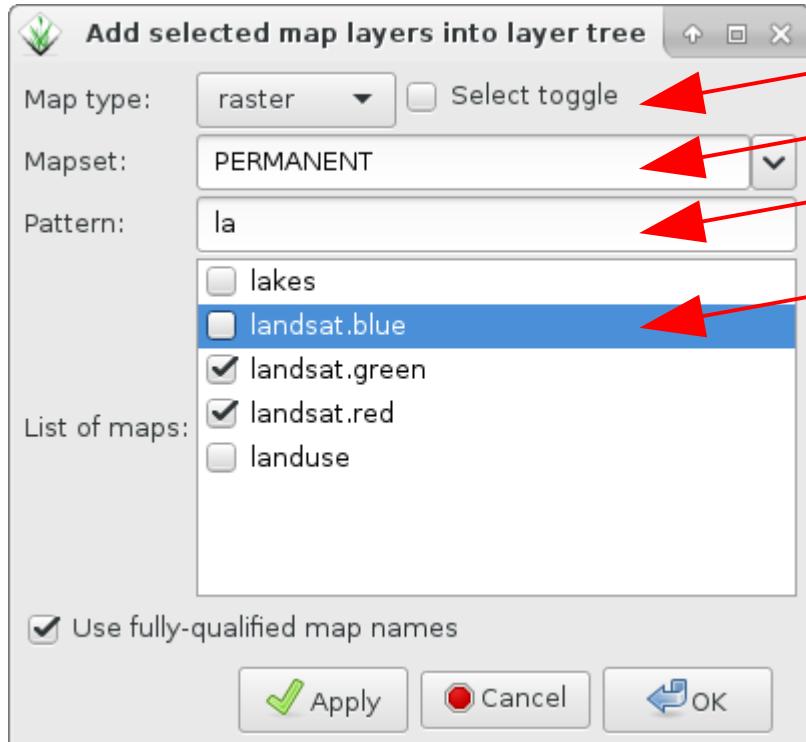
Histogram type count

Cancel OK

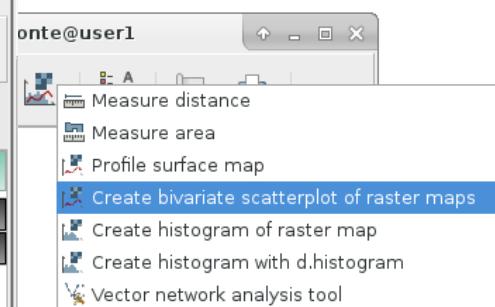
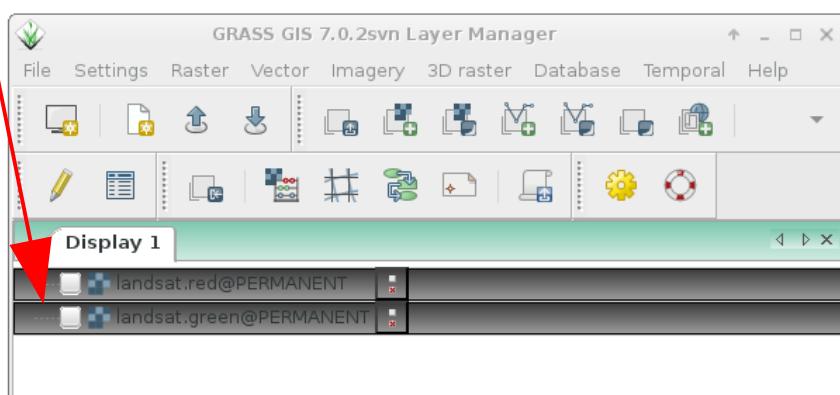


Exercise – Bivariate Scatterplots

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



Select both LANDSAT maps
(CTRL-click)



The scatterplot respects
the computational
region!



Exercise – GRASS startup and first steps

Know where you are...

get projection information for the Piemont sample data set:

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

name: Universal Transverse Mercator
proj: utm
datum: wgs84
ellps: wgs84
zone: 32
no_defs: defined

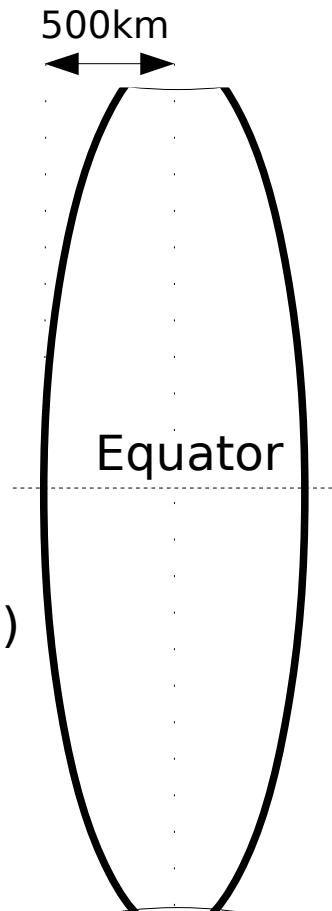
units: metres



GRASS Database concept – Projection

Universal Transverse Mercator

- Covers 84°N – 80°S , worldwide used
- *Poles covered by Universal Polar Stereographic (UPS)*
- 60 **zones** with a width of 6° longitude, numbered 1-60,
every zone is an own projection!
- **stripes** of 8° latitude with letters C – X, omitting I, O
- **False easting:** 500000m
- **False northing:** northern hemisphere: 0m
southern hemisphere: 10000000m (10 Mio)
- **Scale Factor** along meridian: 0.9996
due to that secante case, not tangent
- **Ellipsoid:** various (wgs84, clark66, international...)
- **Geodetic datum:** various (wgs84, ...)
- Index of the UTM Zones:
<http://www.dmap.co.uk/utmworld.htm>





Overview: GRASS GIS command structure

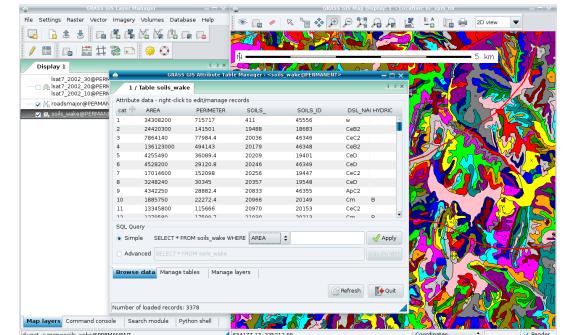
prefix	function class	type of command	example
g.*	general	general data management	<i>g.rename: renames map</i>
d.*	display	graphical output	<i>d.rast: display raster map</i> <i>d.vect: display vector map</i>
r.*	raster	raster processing	<i>r.mapcalc: map algebra</i> <i>r.univar: univariate statistics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

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



Graphical user interface versus Command line

- GRASS GIS offers a graphical user interface



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

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

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

```
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]

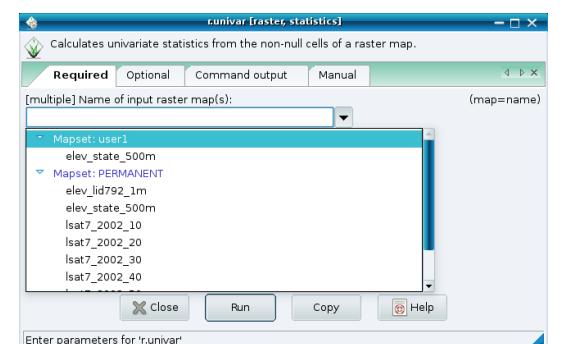
Flags:
    -g Print the stats in shell script style
    -e Calculate extended statistics
    -t Table output format instead of standard output format
    -o Allow output files to overwrite existing files
    -h Print usage summary
    -v Verbose module output
    -q Quiet module output
    -ui Force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

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

```
> r.univar
```





Graphical user interface versus Command line

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

The screenshot shows two side-by-side versions of the GRASS GIS 'r.colors' module dialog. The left dialog is in 'Basic top/left' style, featuring a tab bar at the top with 'Map' (selected), 'Define', 'Remove', 'Print', 'Optional', and 'Command output'. Below the tabs are input fields for raster map names and an input file, and a text area for direct entry. At the bottom are 'Load', 'Save as', and 'Run' buttons, with 'Copy' highlighted by a red circle. A tooltip says 'Copy the current command string to the clipboard'. The right dialog is in 'Basic bottom' style, lacking the tab bar; instead, it has a vertical stack of buttons on the left: 'Map', 'Define', 'Remove', 'Print', 'Optional', 'Command output', and 'Manual'. It has similar input fields and a 'Run' button at the bottom. A tooltip on the 'Run' button says 'Copy the current command string to the clipboard'.

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”)



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 [-gwd] 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
```



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

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...

```
#!/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

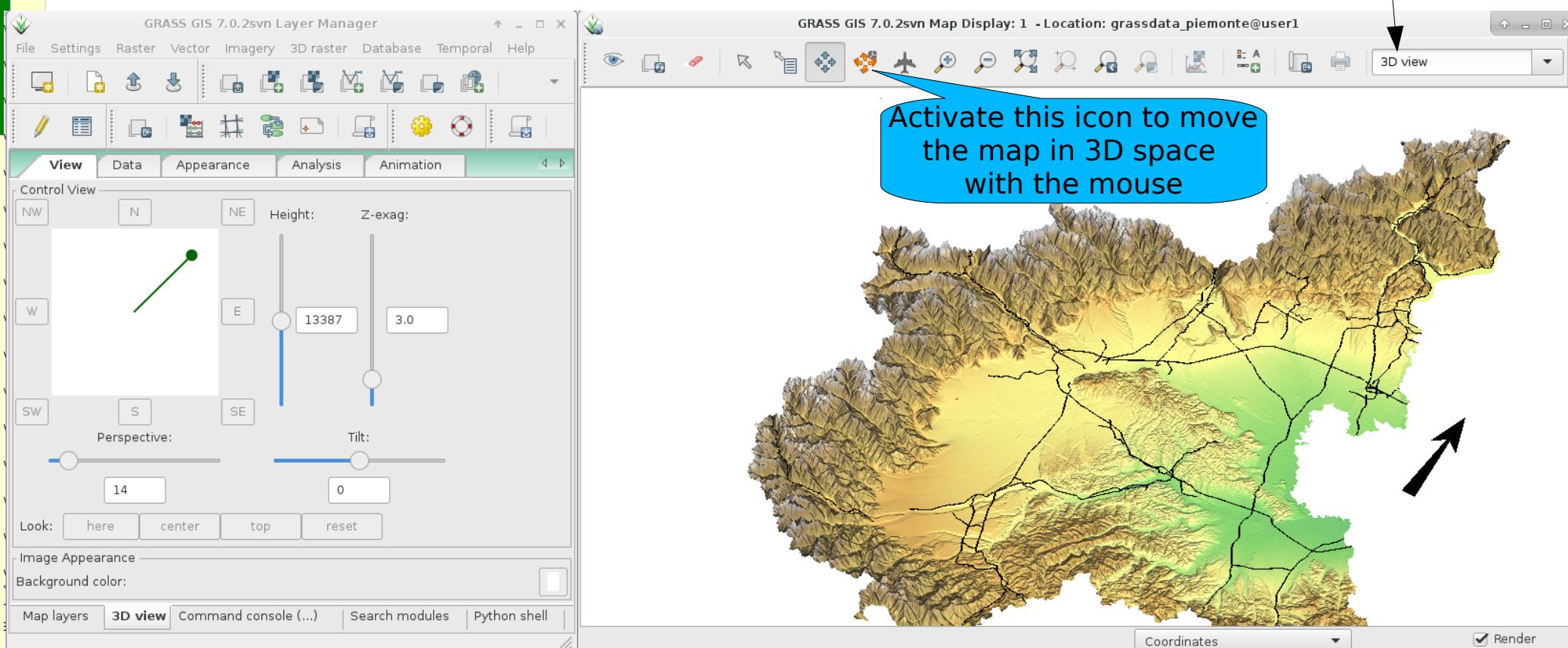
    # careful: $i starts with 0!!
    DAYOFFSET=`expr $i - 1`
    MYDATE=`date -d "$STARTDATE $DAYOFFSET days" +"%Y.%j"`
done
exit 0
```



Exercise – Perspective view

Load the Piemont “elevation” map:

- 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...