

GRASS GIS 7: A theoretical and practical course

Session 1 – Intro: image processing

Markus Neteler

NINA 2016, Oslo, Norway

mundialis GmbH & Co. KG
<http://www.mundialis.de>





Session Objectives

- Introduction to remote sensing
 - A few concepts
 - Remote sensing with GRASS GIS
- Exercise – Exploring multispectral data
- Exercise – Visualizing RGB composites
- Color table optimization of a Landsat scene
- Exercise – NDVI Vegetation Index
- Exercise – Map algebra in image processing

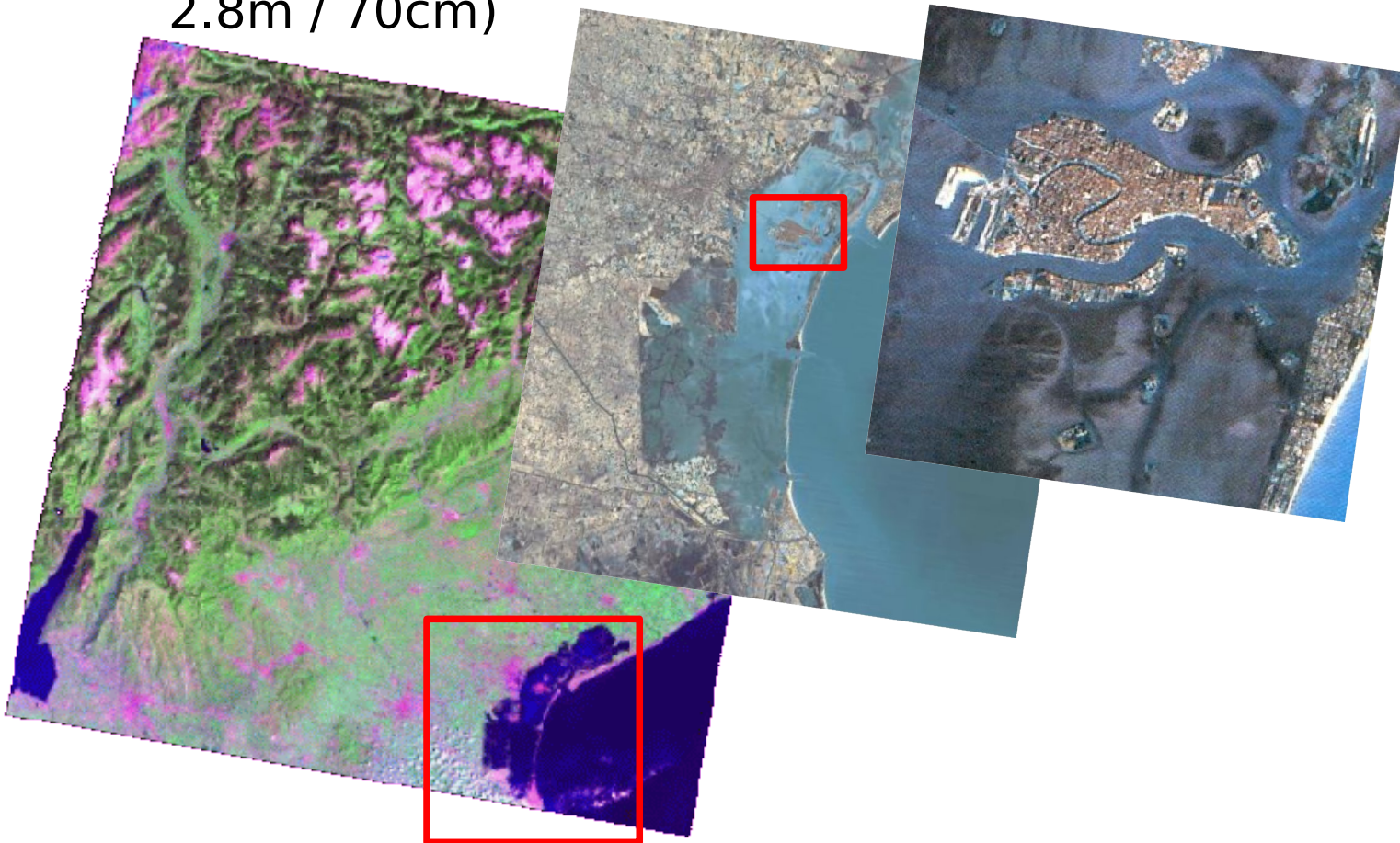


Introduction to remote sensing

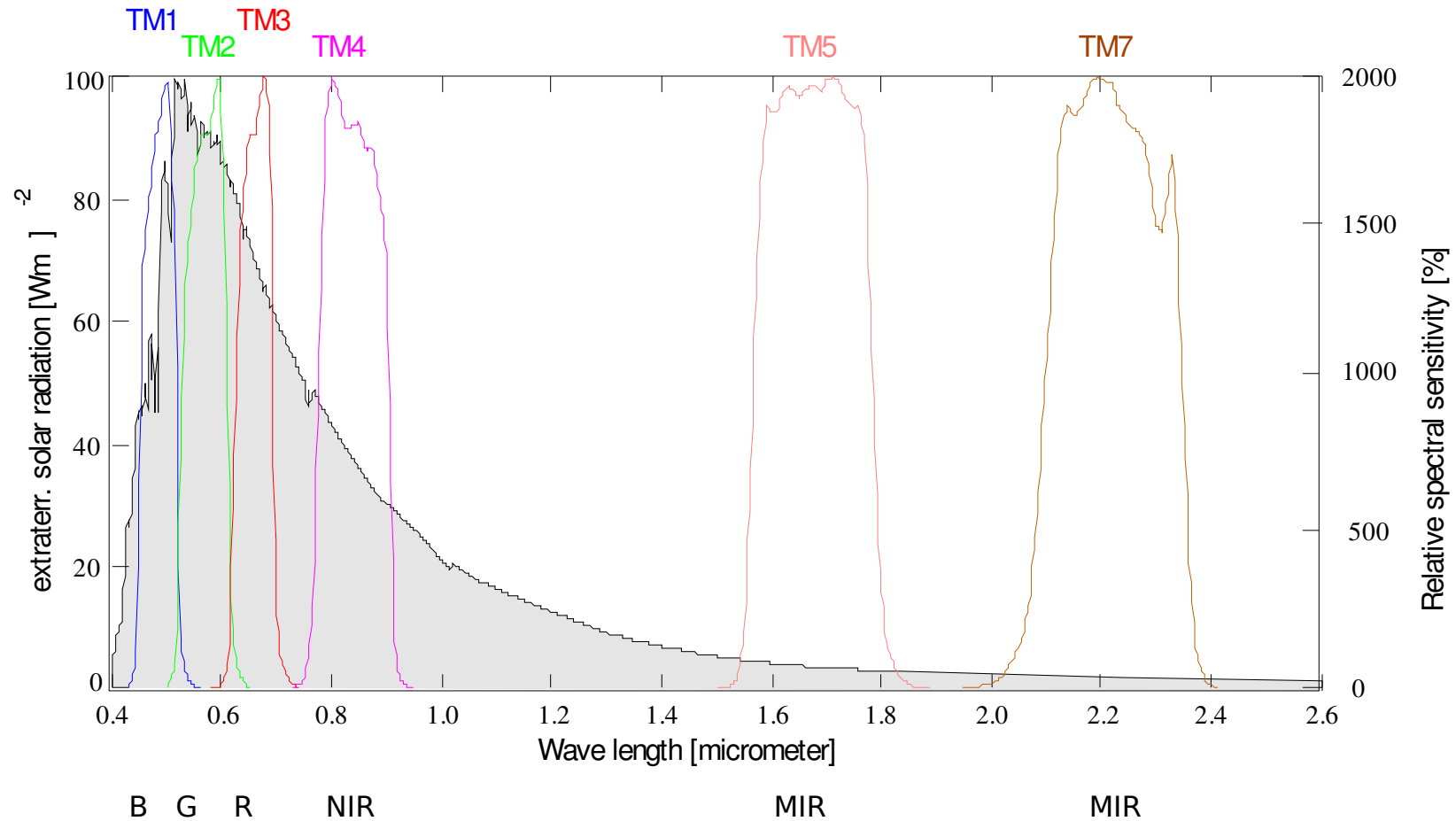
- ▶ Aerial photos: unrectified and orthophotos (resolution: 25cm – 1m)
- ▶ Nowadays even UAV (octocopter etc).



- ▶ Satellite data: usually multi-channel data (res.: 30m / 15m / 2.8m / 70cm)

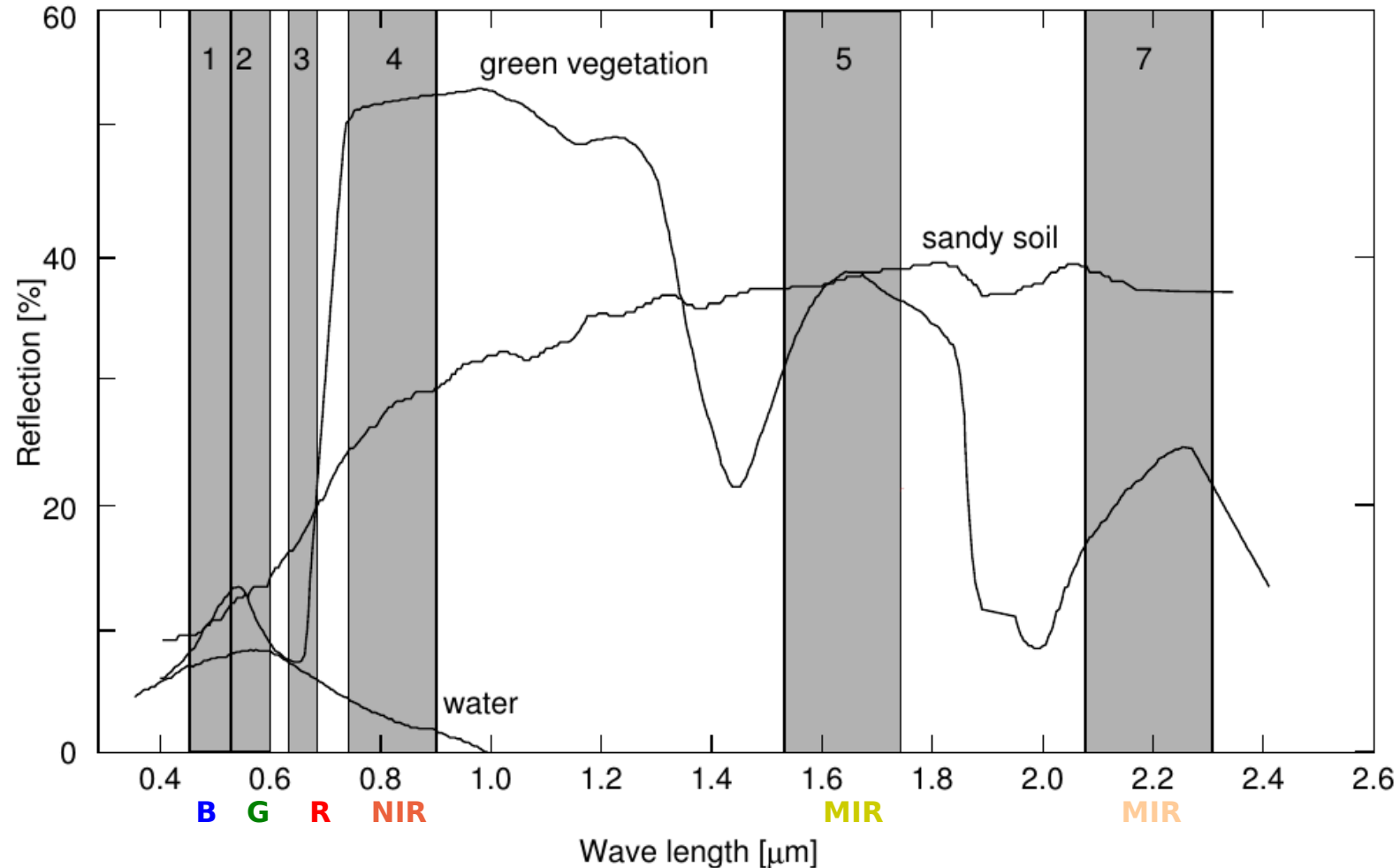
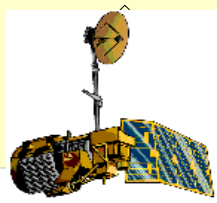


Remote sensing: multispectral data



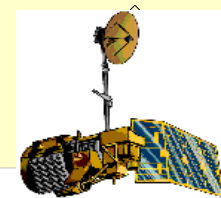
Solar spectrum and LANDSAT TM channels (thermal channel 6 not shown)

Remote sensing: multispectral data

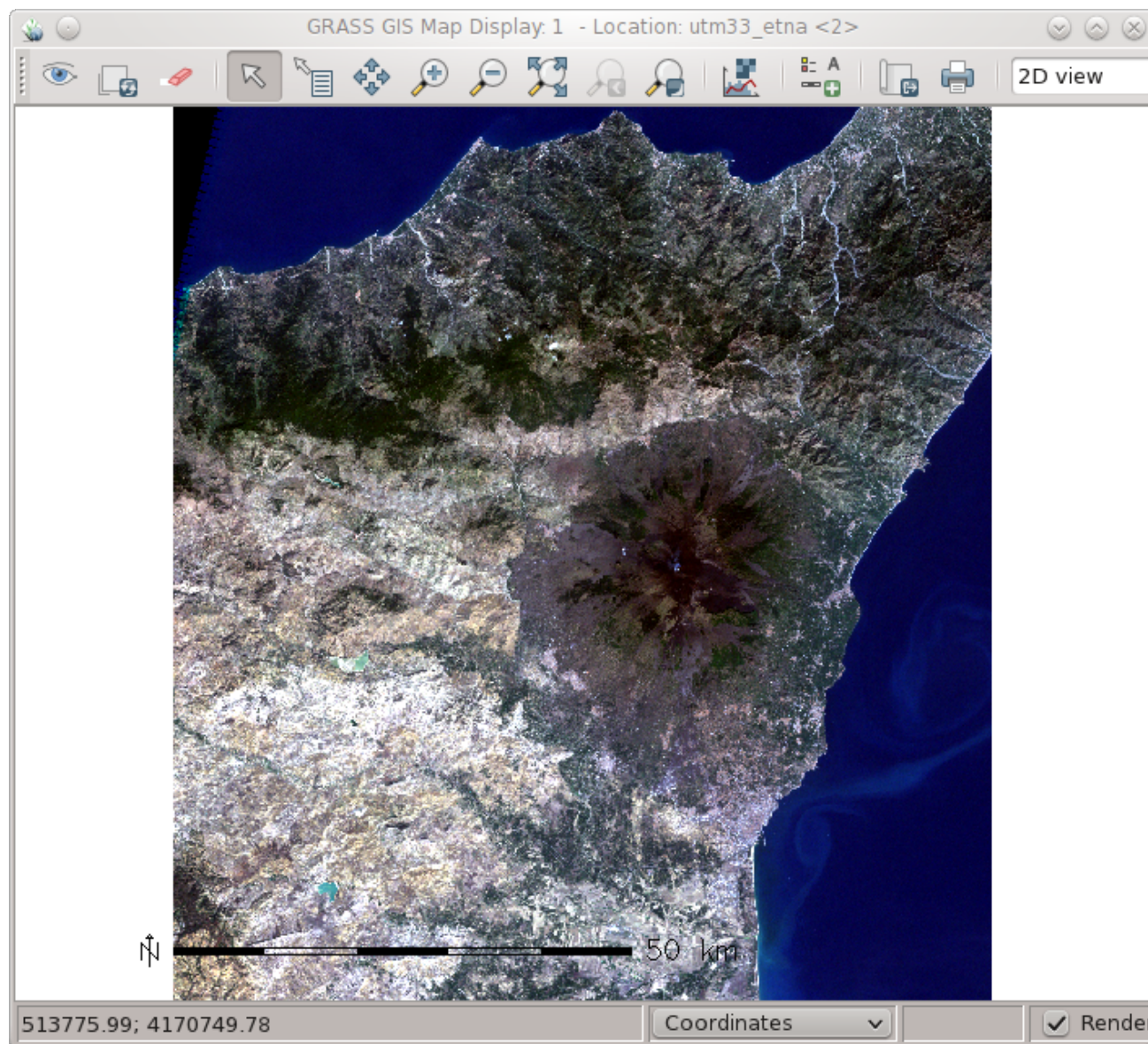


Reflectance curves (green vegetation, sandy soil, and water) and LANDSAT channels (thermal channel 6 not shown)

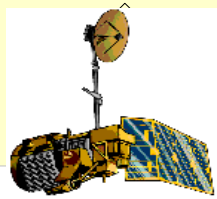
Available data – Landsat example



Note: e.g entire Landsat archive is freely available at <http://earthexplorer.usgs.gov/>



Remote sensing with GRASS GIS



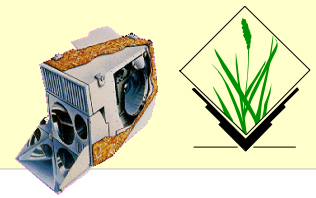
Features

- ▶ Geocoding of unreferenced (even scanned historical) aerial and satellite imagery
- ▶ Reprojection of georeferenced imagery
- ▶ Radiometric enhancement (correction of atmospheric effects, of illumination effects due to rugged terrain = “flattening” etc.)
- ▶ Image Fusion (merge of high-res PAN channel with color channels)
- ▶ PCA, Fourier Transform, ...
- ▶ Classification (unsupervised and supervised)
- ▶ Supported satellites: AVHRR, MODIS, Landsat, Sentinel-2, Aster, Quickbird, Geoeye, Worldview, ...

See also:

http://grasswiki.osgeo.org/wiki/Image_processing

Exercise – Starting GRASS GIS for the session



GRASS GIS 7.0.2svn startup (r65855)

 **grass gis**
Bringing advanced geospatial technologies to the world

1. Select GRASS GIS database directory

GRASS GIS database directory contains Locations.

2. Select GRASS Location

demolocation
ecad5_grassdata_ll
nc_spm_08_grass7
nc_spm_08_reduced
spearfish70

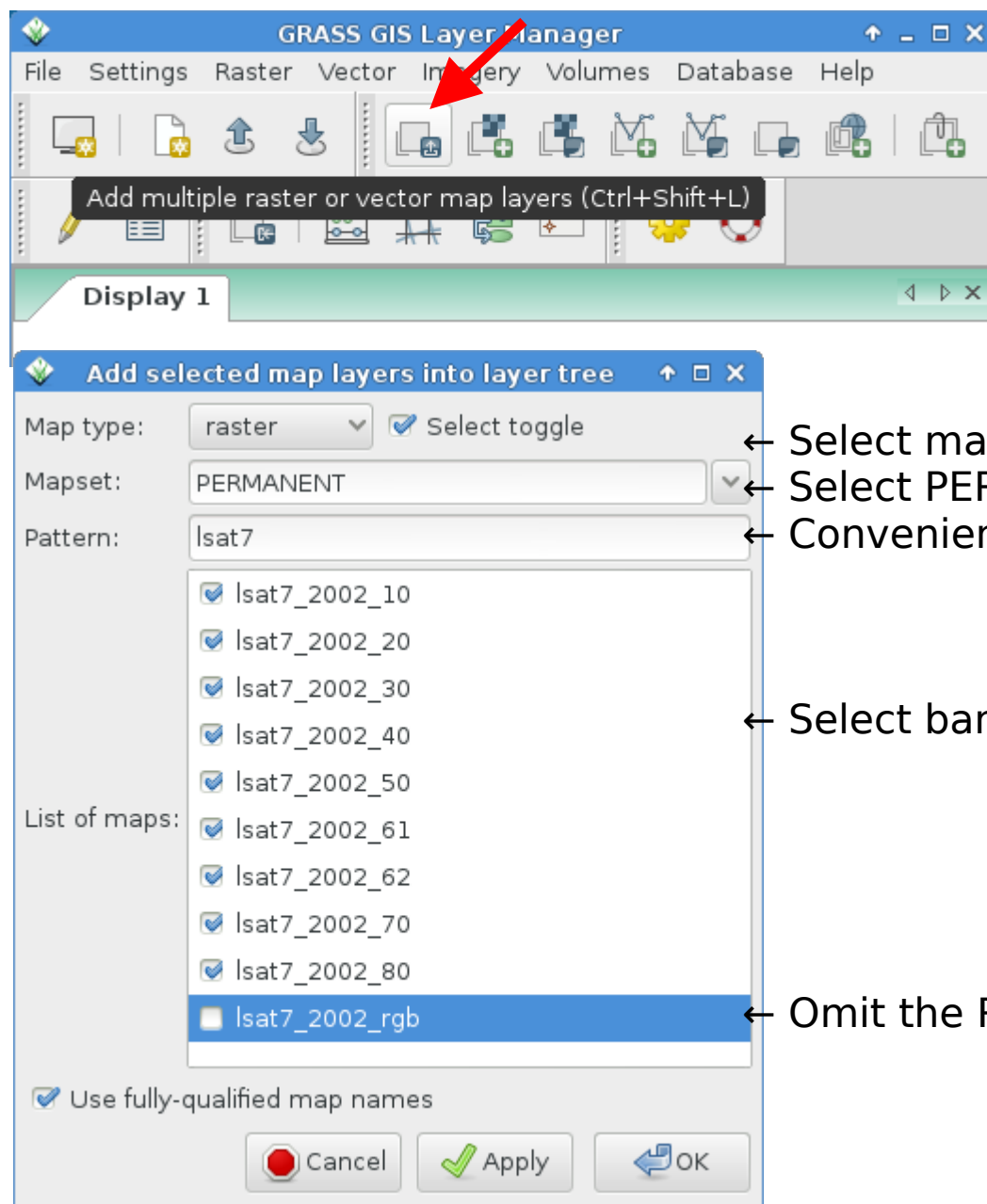
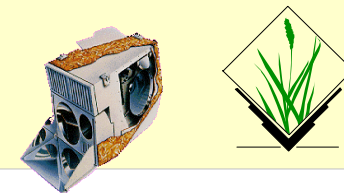
All data in one Location is in the same coordinate reference system (projection). One Location can be one project. Location contains Mapsets.

3. Select GRASS Mapset

PERMANENT
user1

Mapset contains GIS data related to one project, task within one project, subregion or user.

Exercise – Exploring multispectral data



Load all LANDSAT 7 2002 bands into the Layer Manager

← Select map type (here: raster)

← Select PERMANENT mapset

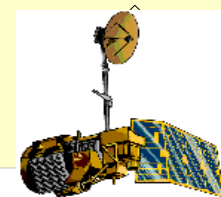
← Convenient search tool

← Select bands 1-8

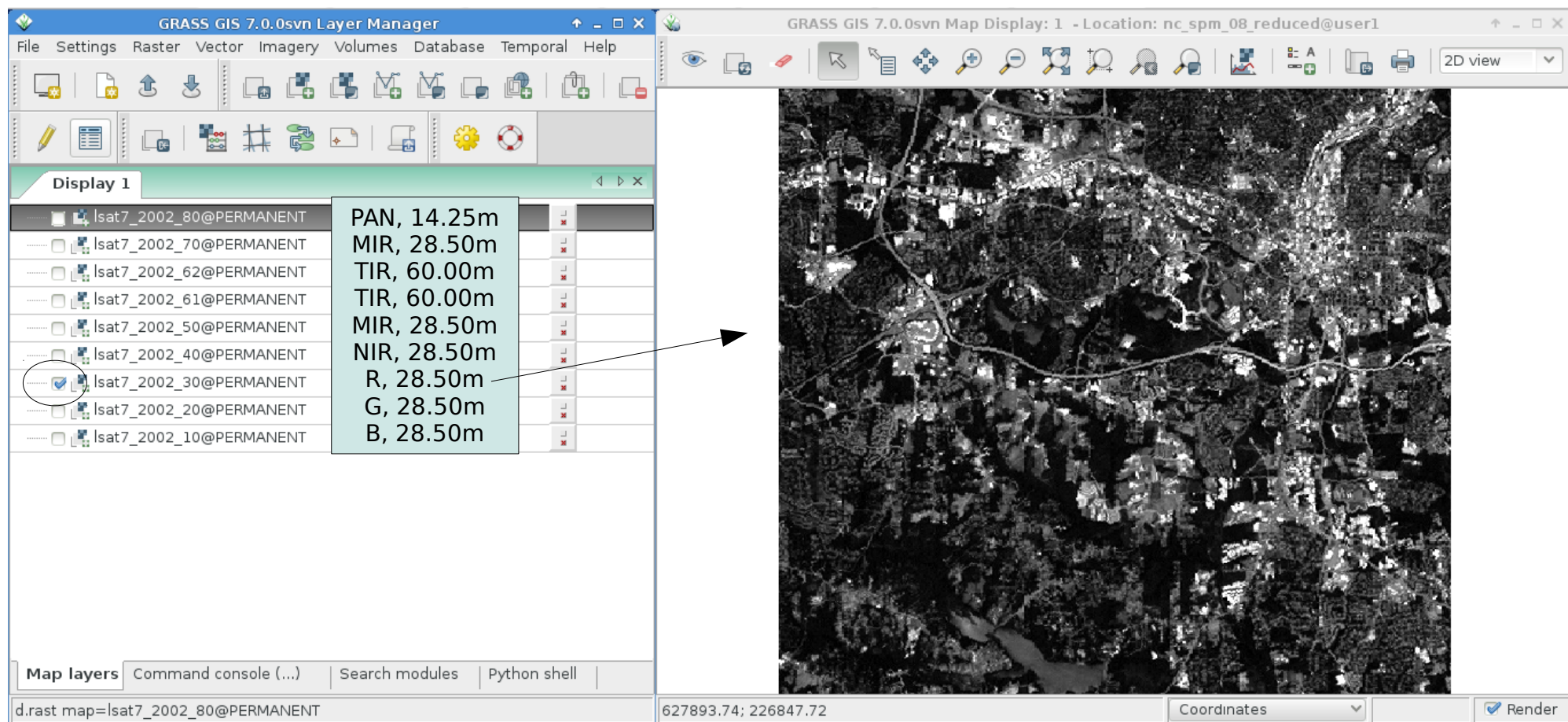
← Omit the RGB composite

Now look at the individual bands and observe the differences

Exercise – Exploring multispectral data



Now explore the various channels and their differences
(if needed, re-order the image stack first in the layer tree)



The screenshot shows the GRASS GIS 7.0.0svn interface. The 'Layer Manager' window on the left lists several satellite image layers. The 'Map Display' window on the right shows a grayscale image of a landscape. An arrow points from the 'Isat7_2002_30@PERMANENT' layer in the Layer Manager to the Map Display window.

Layer Name	Resolution
Isat7_2002_80@PERMANENT	PAN, 14.25m
Isat7_2002_70@PERMANENT	MIR, 28.50m
Isat7_2002_62@PERMANENT	TIR, 60.00m
Isat7_2002_61@PERMANENT	TIR, 60.00m
Isat7_2002_50@PERMANENT	MIR, 28.50m
Isat7_2002_40@PERMANENT	NIR, 28.50m
Isat7_2002_30@PERMANENT	R, 28.50m
Isat7_2002_20@PERMANENT	G, 28.50m
Isat7_2002_10@PERMANENT	B, 28.50m

Map layers: Command console (...) Search modules Python shell

d.rast map=Isat7_2002_80@PERMANENT

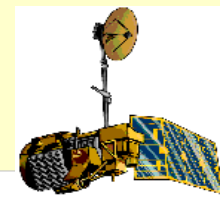
627893.74; 226847.72

Coordinates Render

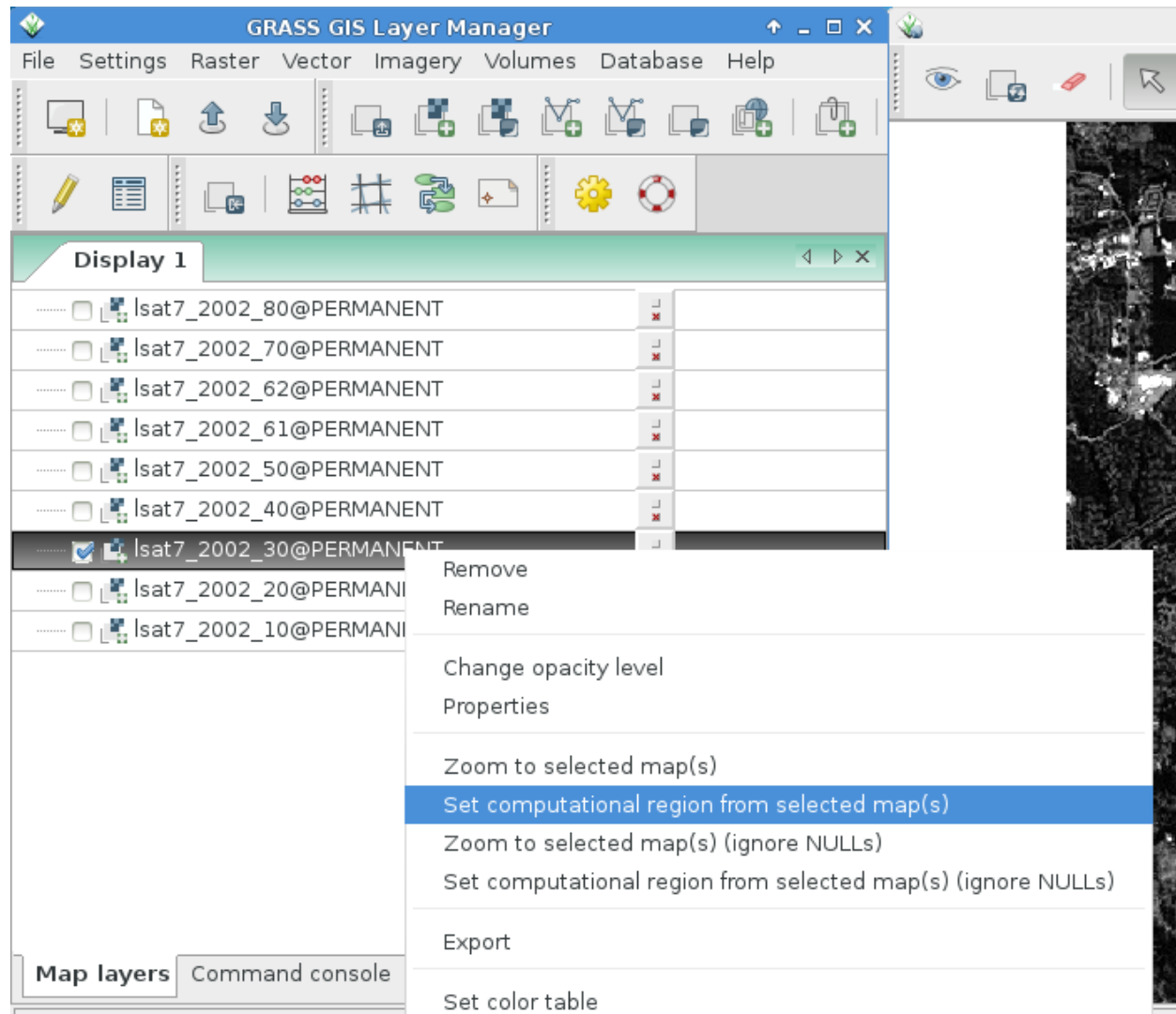
LANDSAT7

PAN = panchromatic, 14.25m res
TIR = thermal infrared, 60.00m res
MIR = mid infrared, 28.50m res
NIR = near infrared, 28.50m res
RGB = red, green, blue, 28.50m res

Exercise – Getting the region right



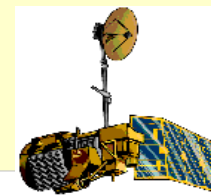
Set first computational region to e.g. TM band 3 (red)
or use `g.region ...`



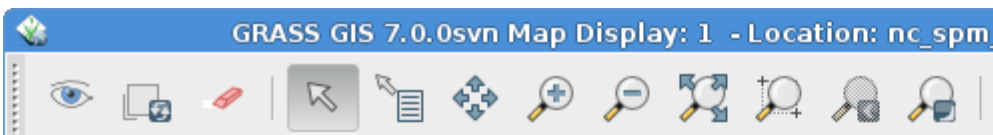
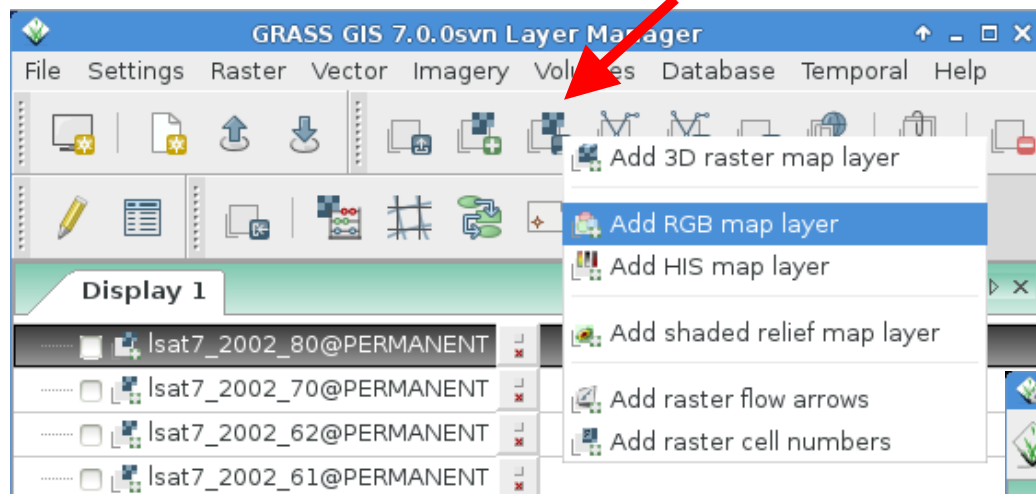
LANDSAT7

PAN = panchromatic, 14.25m res
TIR = thermal infrared, 60.00m res
MIR = mid infrared, 28.50m res
NIR = near infrared, 28.50m res
RGB = red, green, blue, 28.50m res

Exercise – Visualizing RGB composites

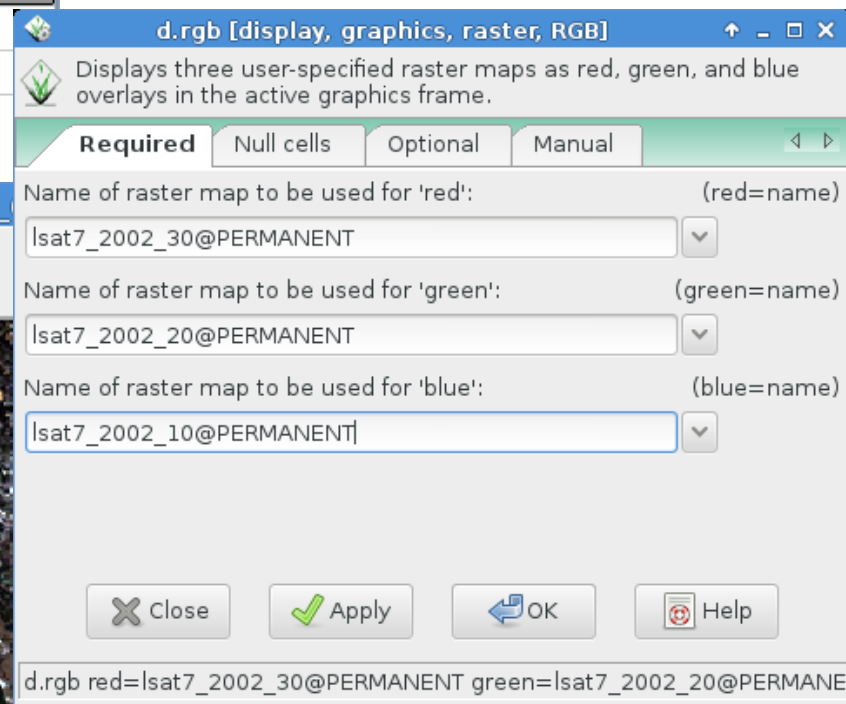


RGB view of LANDSAT ETM:

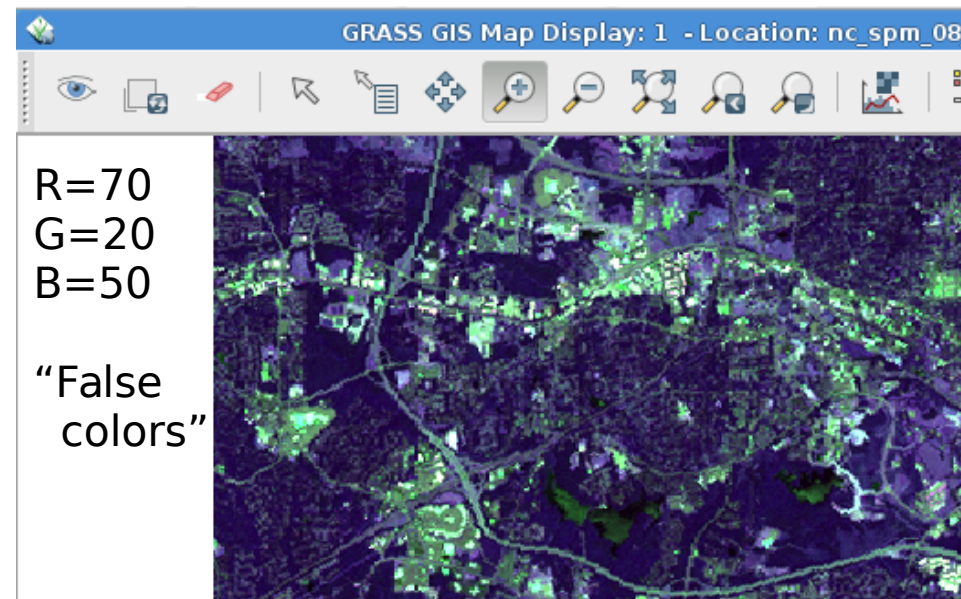
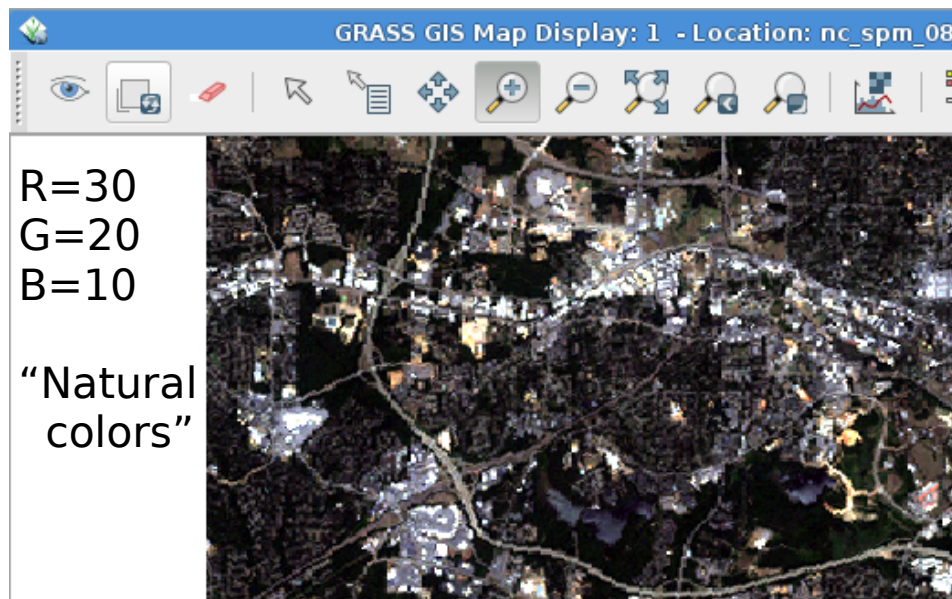
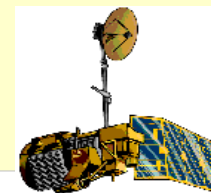


R=30
G=20
B=10

“Natural colors”



Exercise – Visualizing RGB composites



Extra hints

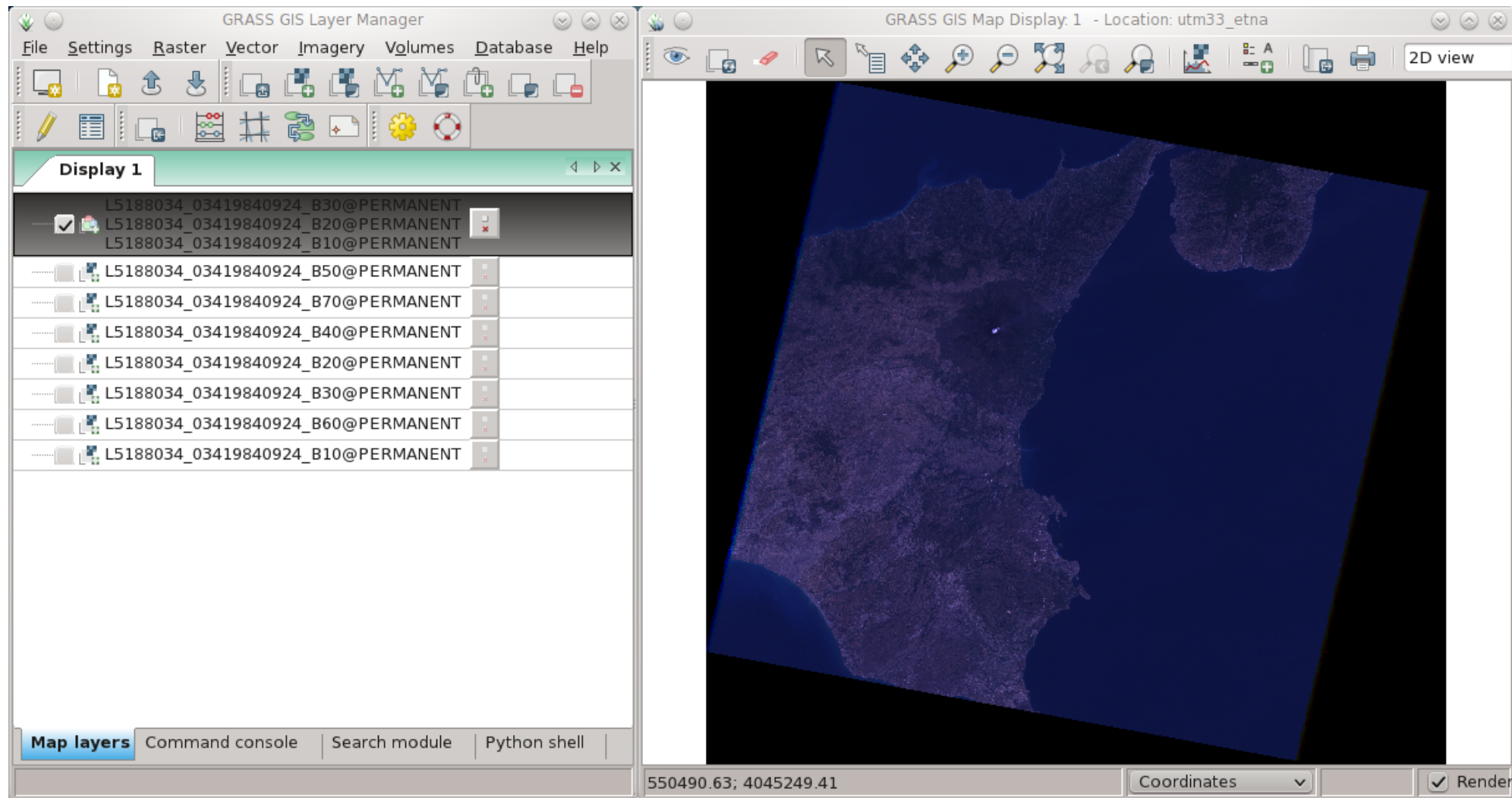
```
# prettify color tables based on histogram analysis:  
i.colors.enhance b=lsat7_2002_10 g=lsat7_2002_20 \  
                  r=lsat7_2002_30
```

```
# to save composites as a map, use r.composite):  
r.composite b=lsat7_2002_10 g=lsat7_2002_20 \  
            r=lsat7_2002_30 output=lsat7_2002_rgb
```

Color table optimization of a Landsat scene

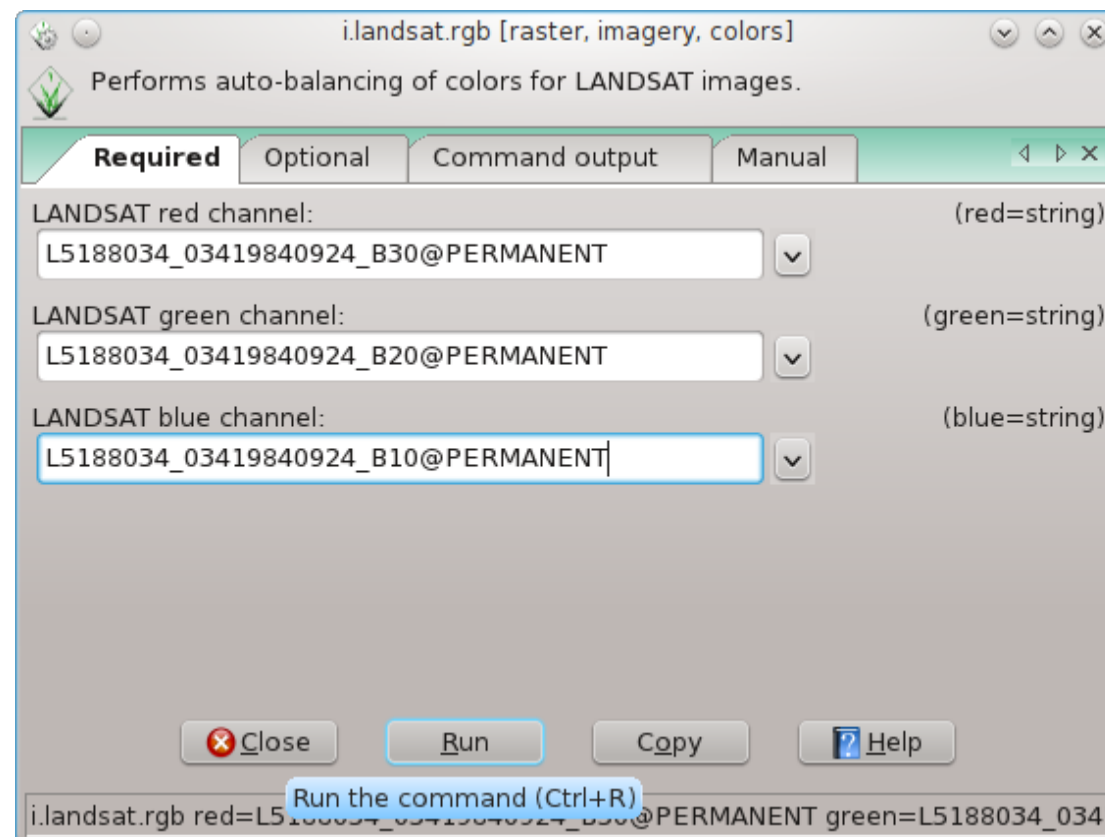
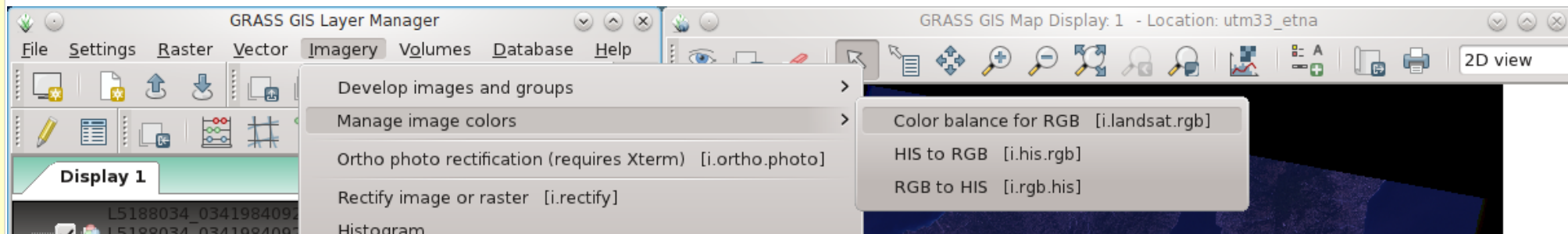
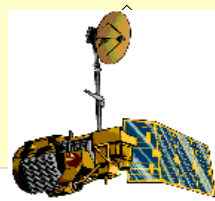


Another example: Sicily

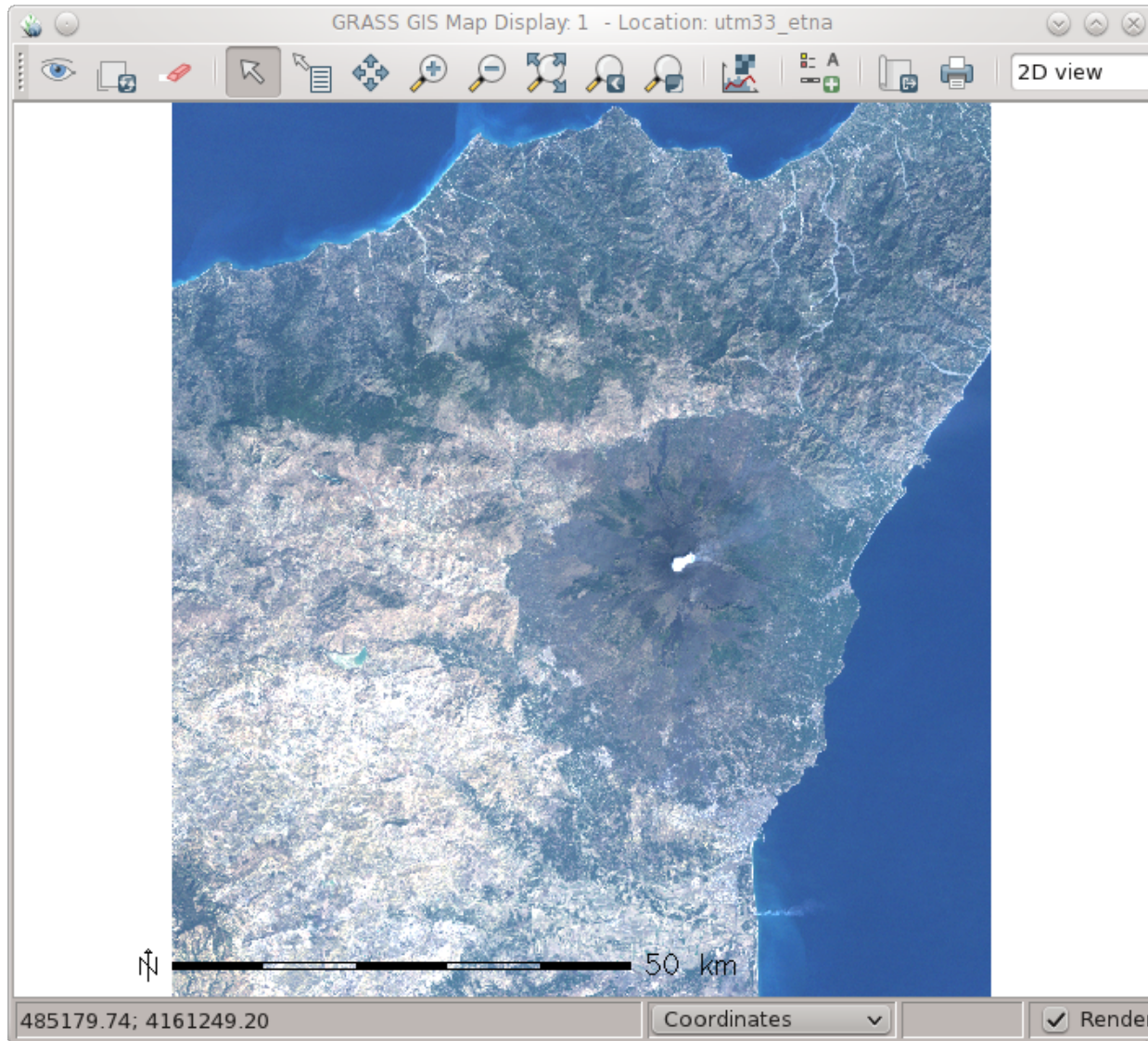


Already nice but too dark...: we need to improve the color tables

Color table optimization of a Landsat scene



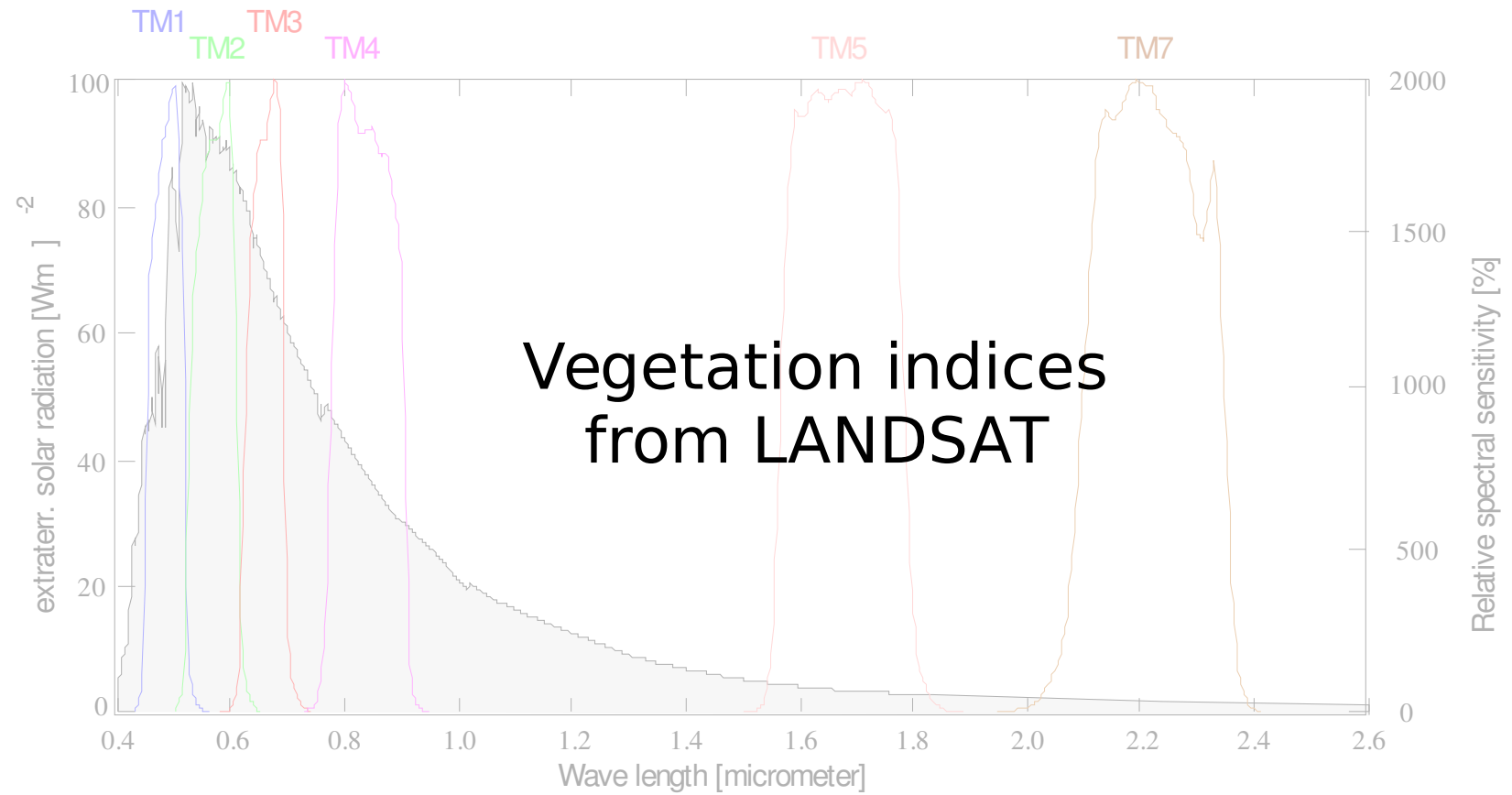
Color table optimization of a Landsat scene



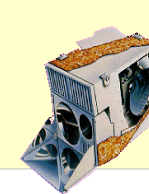
Landsat TM5
1984-09-24

`i.colors.enhance`

NOTE: For a recent **Landsat 8** example, North Carolina, see
<http://courses.neteler.org/processing-landsat8-data-in-grass-gis-7/>



Exercise – NDVI Vegetation Index



Vegetation index NDVI from LANDSAT ETM:

```
# set computational region to the red band
g.region raster=lsat7_2002_30 -p
```

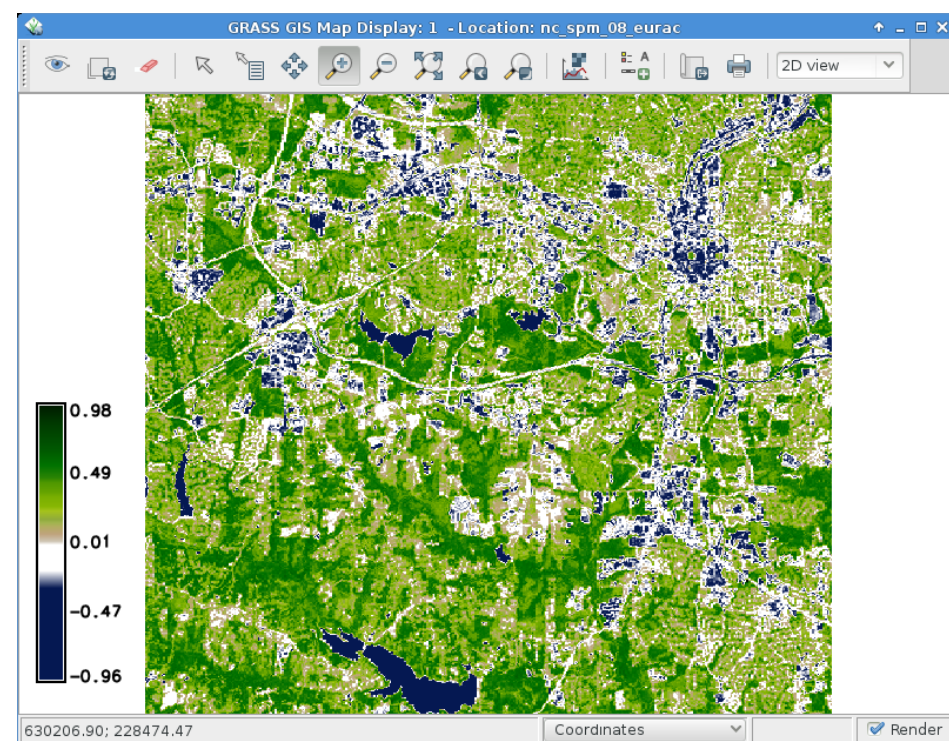
```
# Calculate NDVI (adapt map names to real names + next slide):
r.mapcalc "ndvi = 1.0 * (etm4 - etm3) / (etm4 + etm3)"
```

```
# Apply predefined NDVI color table
r.colors map=ndvi color=ndvi
d.rast.leg ndvi
```

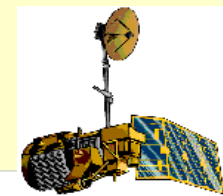
Documentation of modules:

```
# HTML manual
g.manual r.colors
```

```
# text manual
g.manual -m r.colors
```



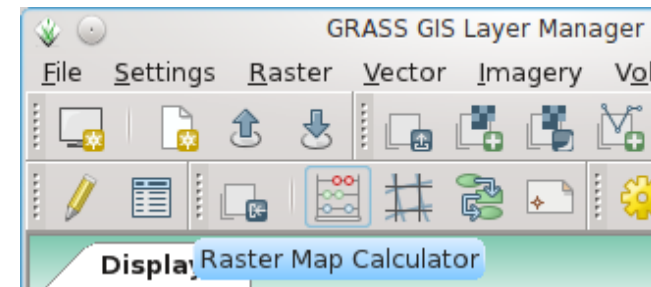
Exercise – Map algebra in image processing



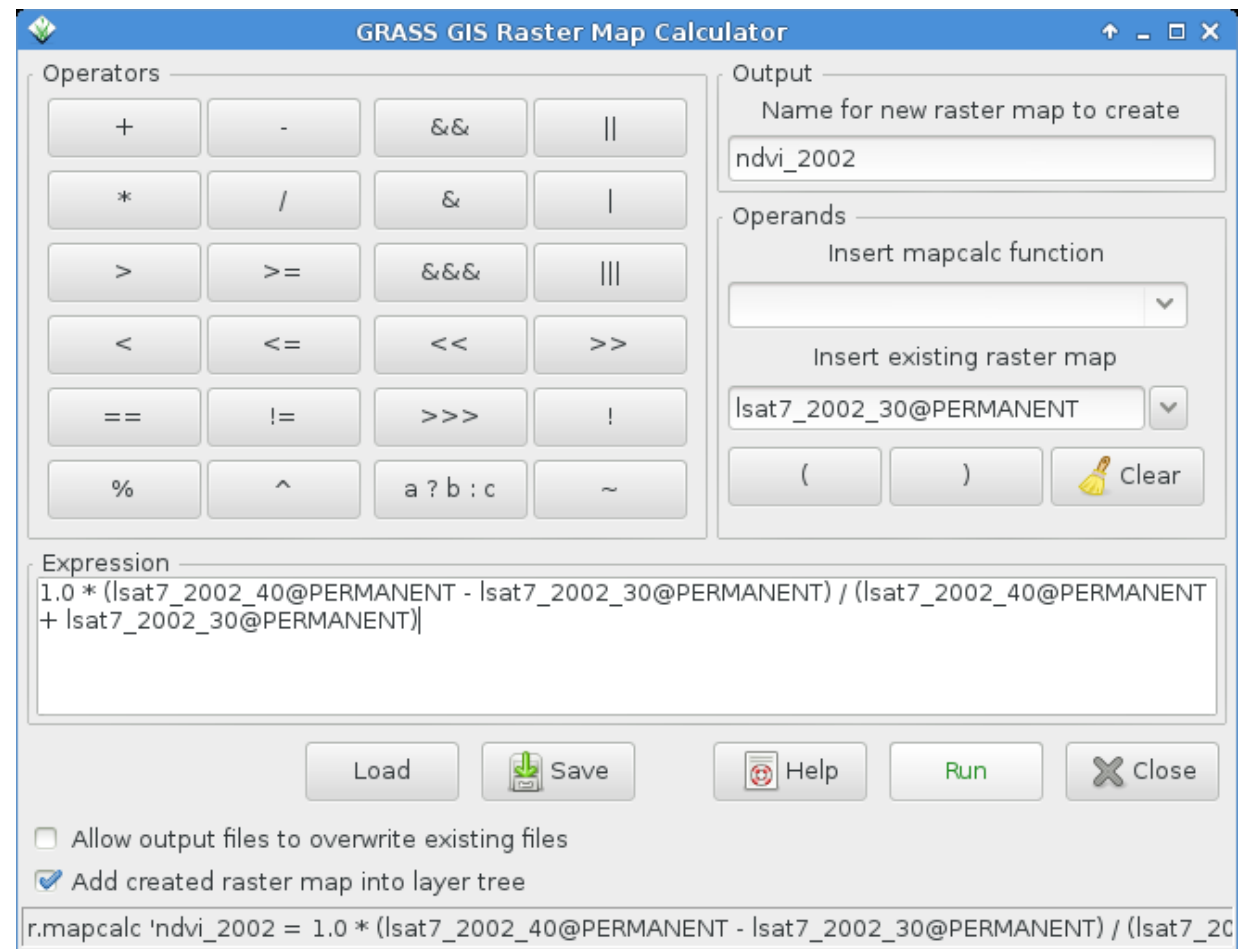
Vegetation index from LANDSAT ETM: Using Red (3) and NIR (4)

$$\text{NDVI} = 1.0 * (\text{NIR} - \text{R}) / (\text{NIR} + \text{R})$$

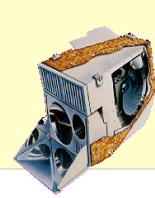
Use the raster map calculator



Note: *since integer channels are used, we need to enforce a floating point calculation with 1.0 multiplication or float() operator*



FYI – more Vegetation Indices



i.vi - Calculates different types of vegetation indices.
Uses red and nir bands mostly, and some indices
require additional bands.

arvi: Atmospherically Resistant Vegetation Indices

dvi: Difference Vegetation Index

evi: Enhanced Vegetation Index

evi2: Enhanced Vegetation Index 2

gvi: Green Vegetation Index

gari: Green Atmospherically Resistant Vegetation Index

gemi: Global Environmental Monitoring Index

ipvi: Infrared Percentage Vegetation Index

msavi: Modified Soil Adjusted Vegetation Index

msavi2: second Modified Soil Adjusted Vegetation Index

ndvi: Normalized Difference Vegetation Index

pvi: Perpendicular Vegetation Index

savi: Soil Adjusted Vegetation Index

sr: Simple Ratio

vari: Visible Atmospherically Resistant Index

wdvi: Weighted Difference Vegetation Index