GRASS GIS 7:
A theoretical and practical course

Session 1 – Intro: image processing

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Session Objectives

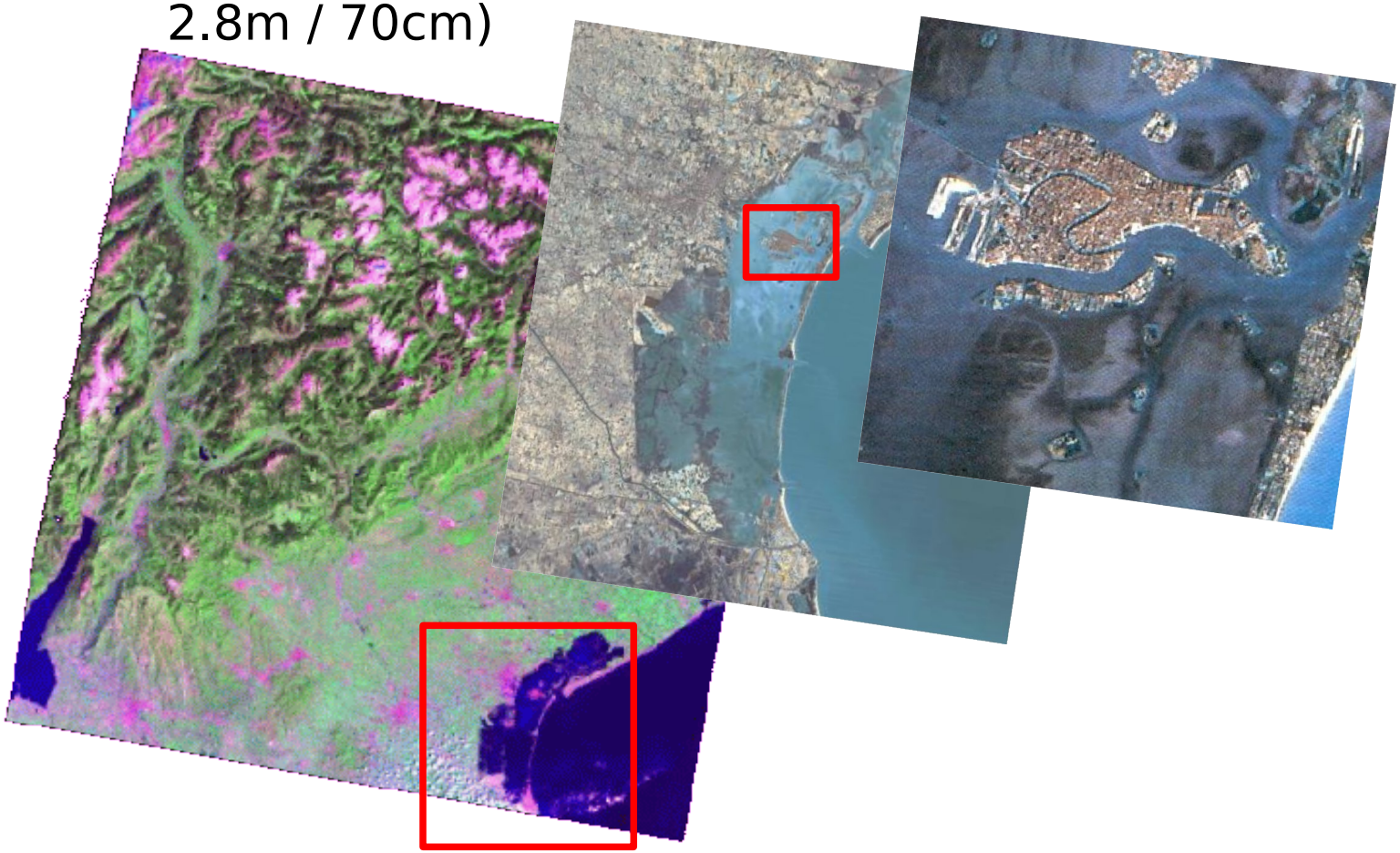
- Introduction to remote sensing
  - A few concepts
  - Remote sensing with GRASS GIS
- Exercise – Exploring multispectral data
- Exercise – Visualizing RGB composites
- Color table optimization of a Landsat scene
- Exercise – NDVI Vegetation Index
- Exercise – Map algebra in image processing

Introduction to remote sensing

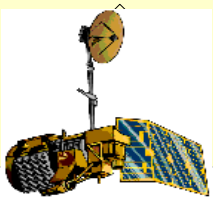
- Aerial photos: unrectified and orthophotos (resolution: 25cm – 1m)

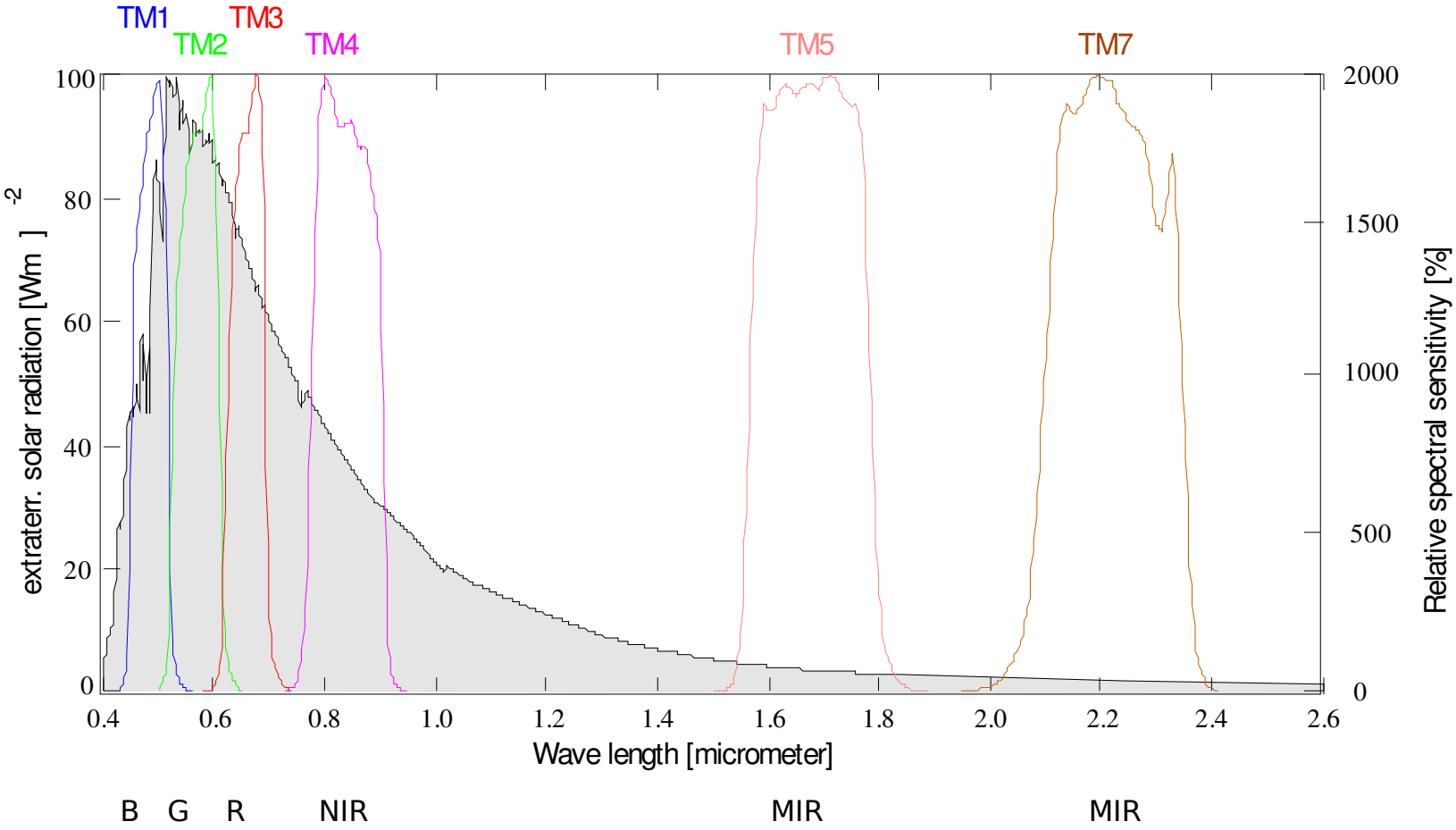
- Nowadays even UAV (octocopter etc).

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



Remote sensing: multispectral data

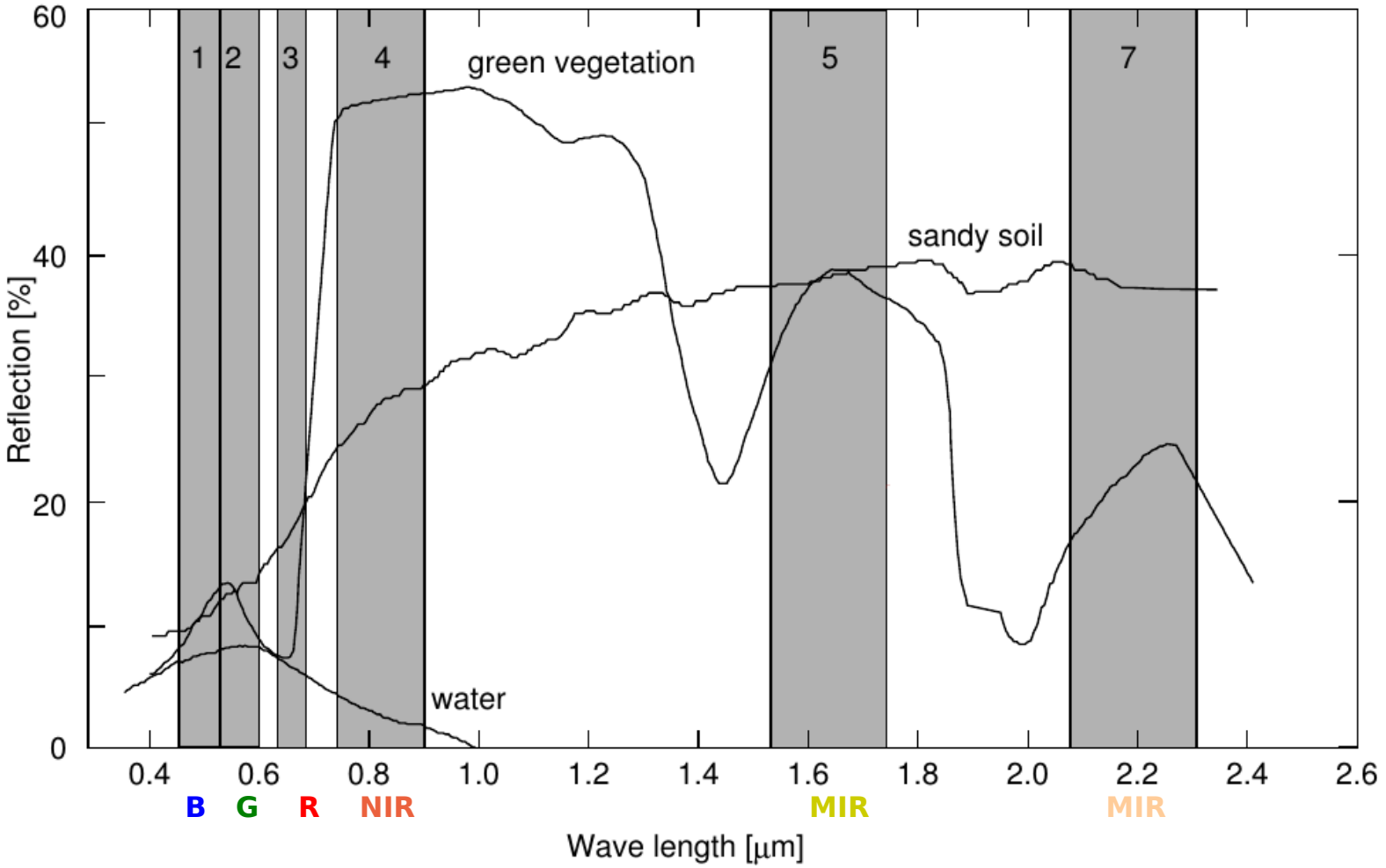




Solar spectrum and LANDSAT TM channels (thermal channel 6 not shown)

Neteler/Mitasova 2002

Remote sensing: multispectral data

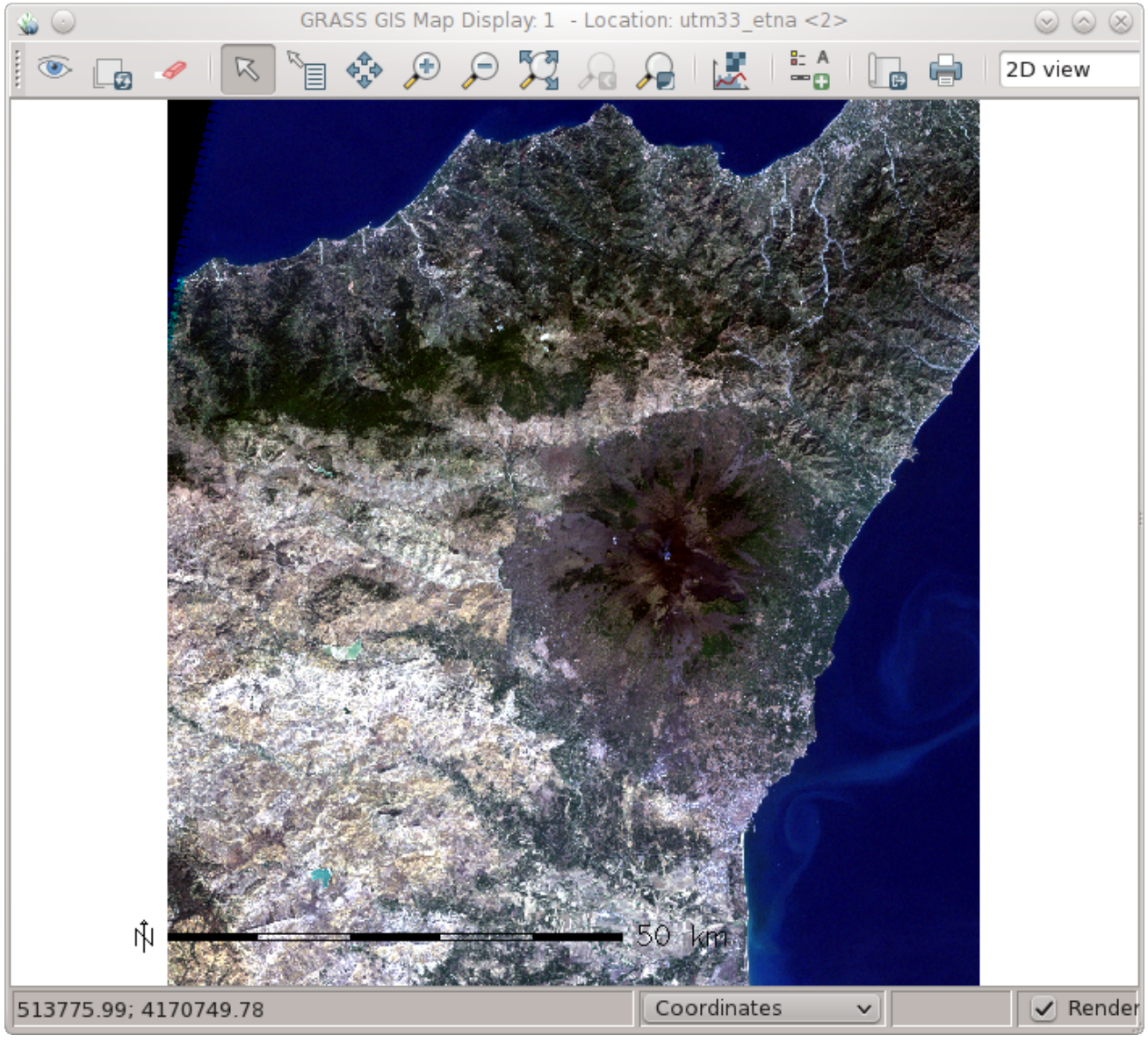


Reflectance curves (green vegetation, sandy soil, and water) and LANDSAT channels (thermal channel 6 not shown)

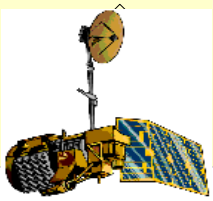
Neteler/Mitasova 2002

Available data – Landsat example

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



Remote sensing with GRASS GIS

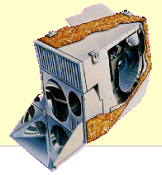


Features

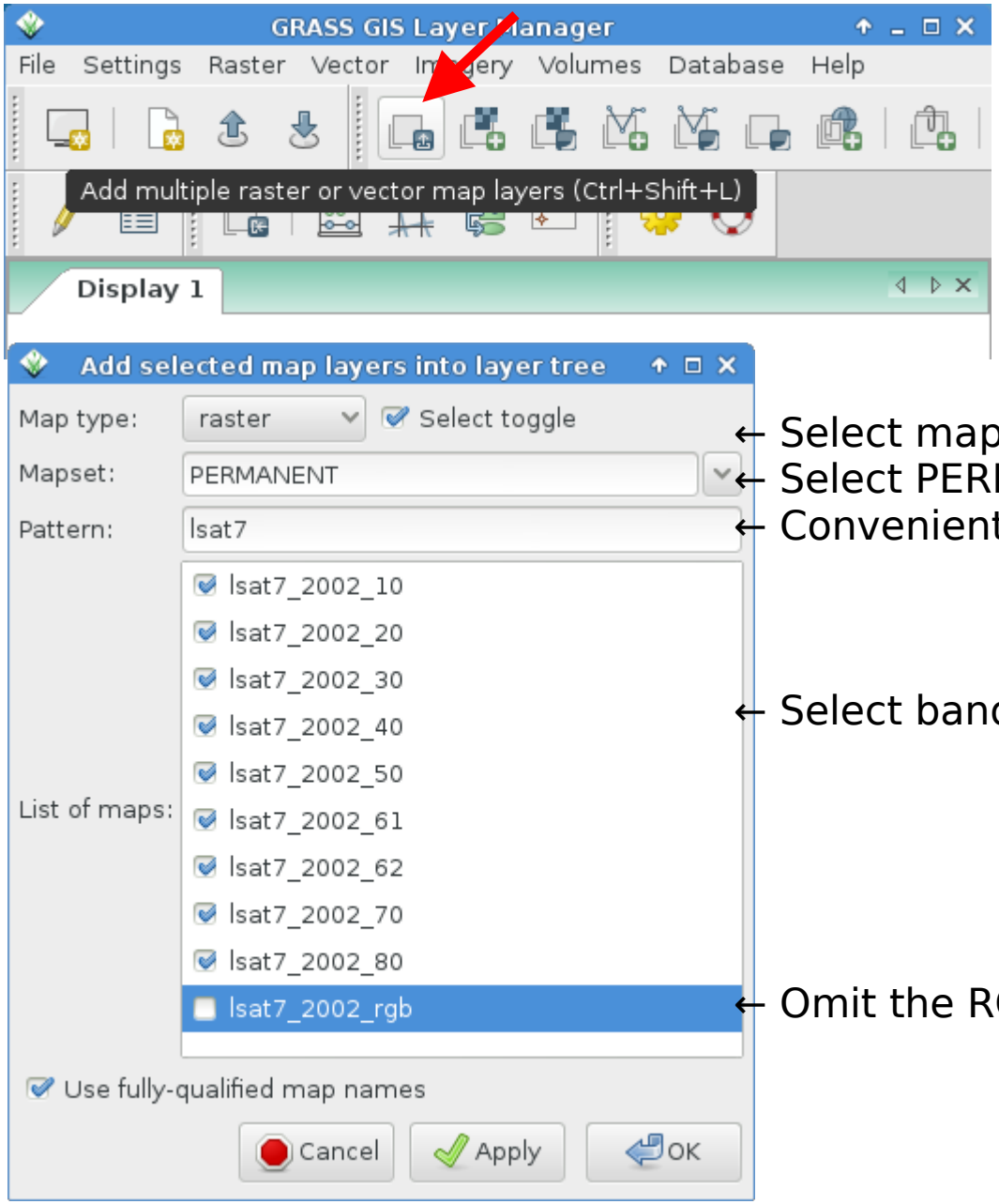
- Geocoding of unreferenced (even scanned historical) aerial and satellite imagery
- Reprojection of georeferenced imagery
- Radiometric enhancement (correction of atmospheric effects, of illumination effects due to rugged terrain = “flattening” etc.)
- Image Fusion (merge of high-res PAN channel with 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



Exercise – Exploring multispectral data



Load all LANDSAT 7 2002 bands into the Layer Manager

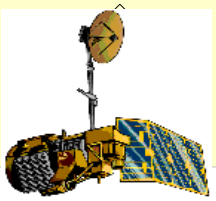
← Select map type (here: raster)
← Select PERMANENT mapset
← Convenient search tool

← Select bands 1-8

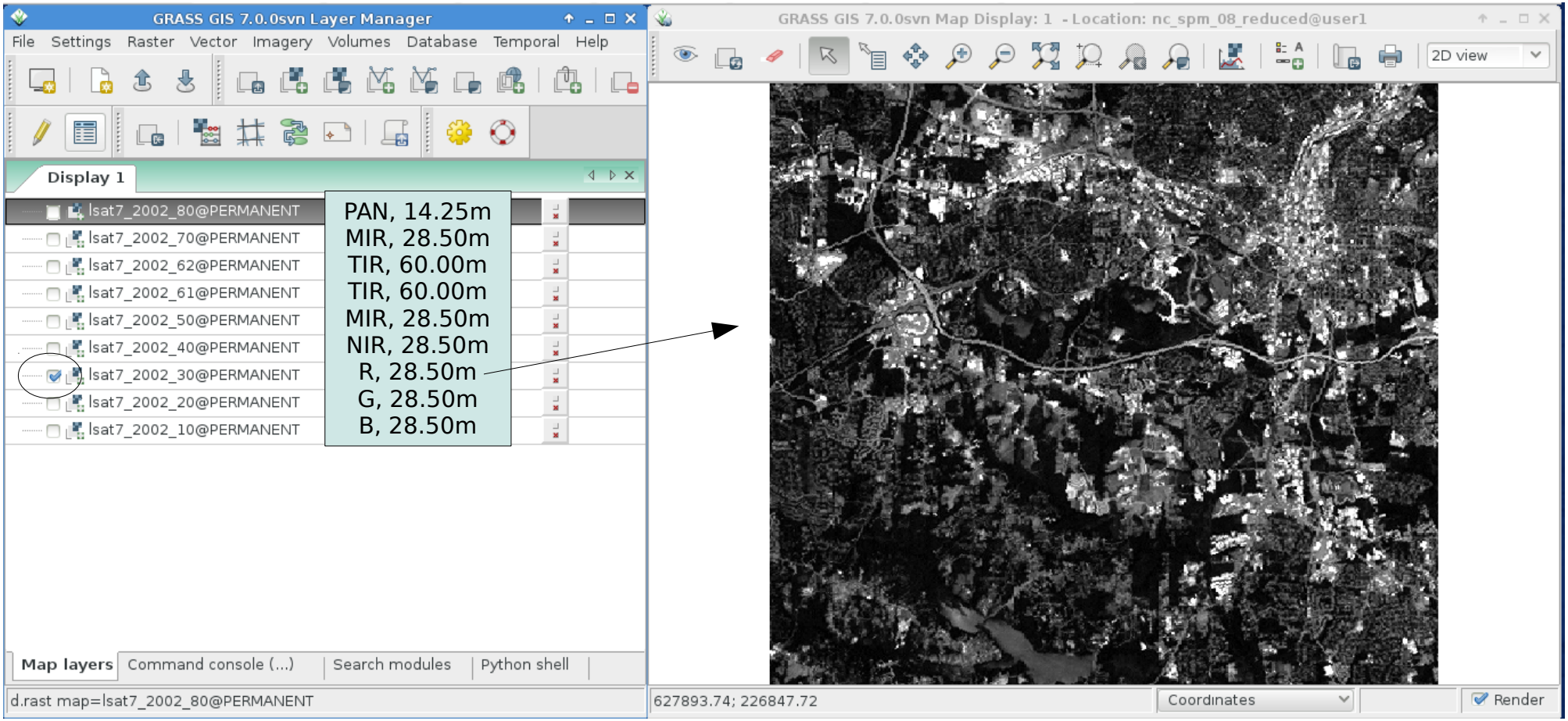
← Omit the RGB composite

Now look at the individual bands and observe the differences

Exercise – Exploring multispectral data



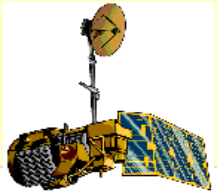
Now explore the various channels and their differences
(if needed, re-order the image stack first in the layer tree)



LANDSAT7

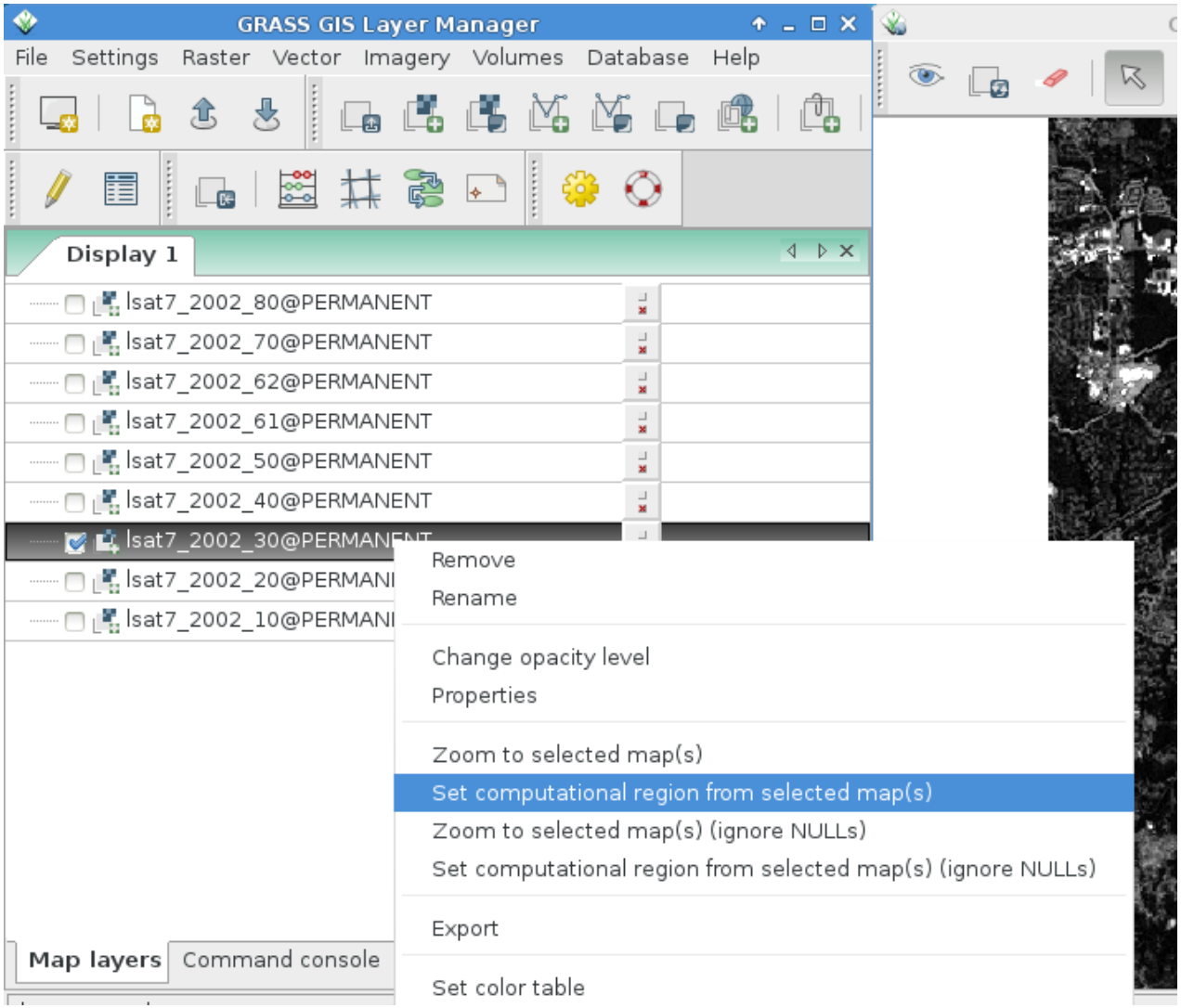
PAN = panchromatic,	*14.25m res*
TIR = thermal infrared,	*60.00m res*
MIR = mid infrared,	*28.50m res*
NIR = near infrared,	*28.50m res*
RGB = red, green, blue,	*28.50m res*

Exercise – Getting the region right



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

or use `g.region ...`



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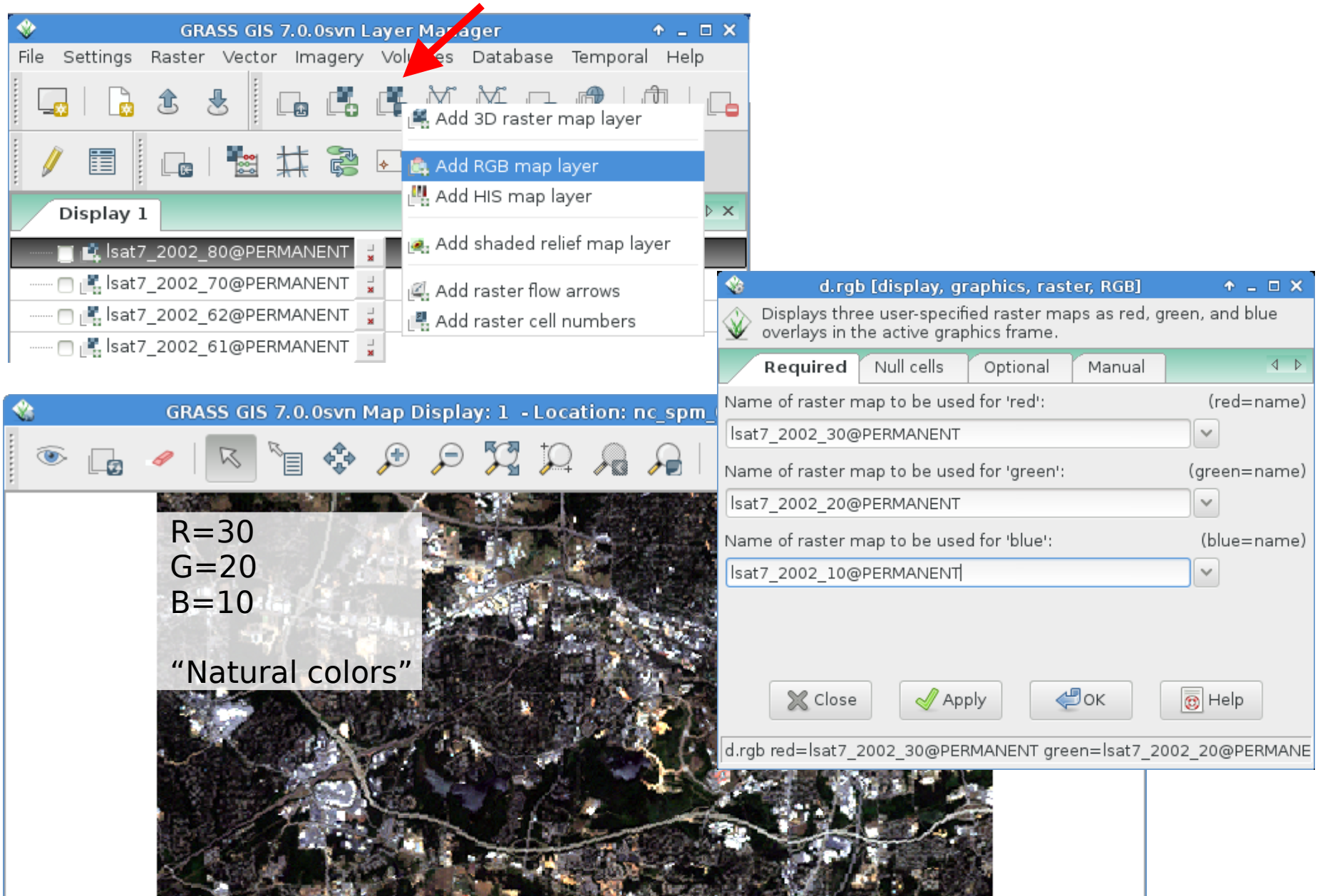
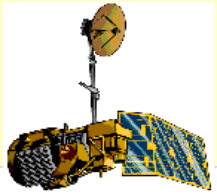
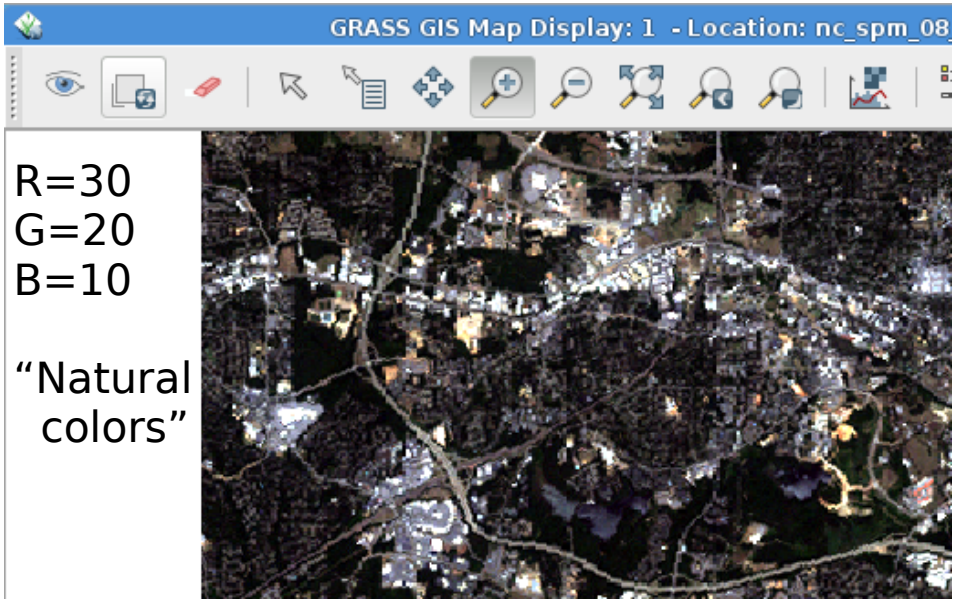
Exercise – Visualizing RGB composites

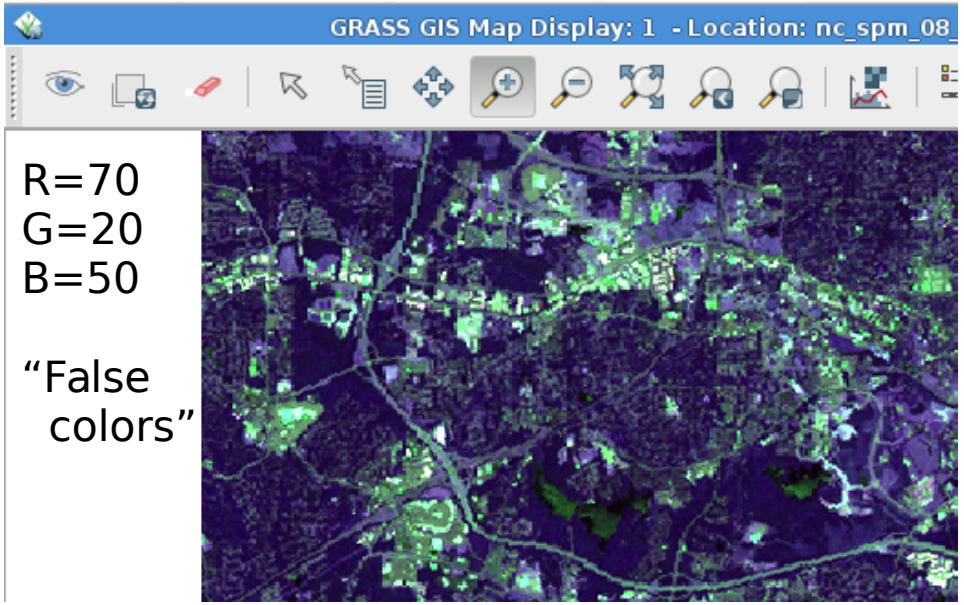
RGB view of LANDSAT ETM:



Exercise – Visualizing RGB composites



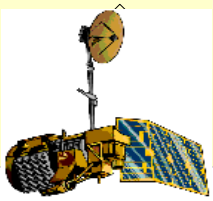




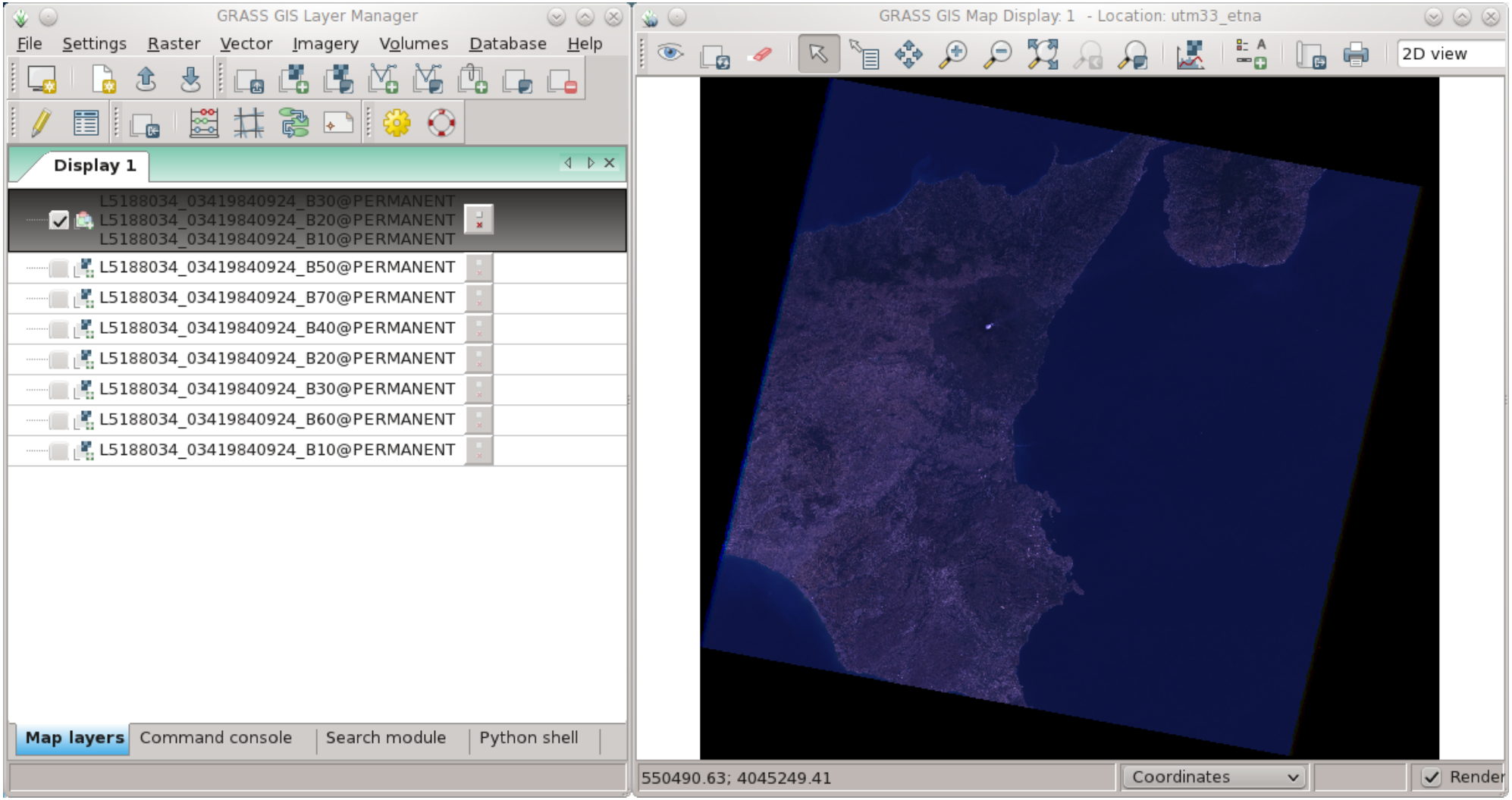
Extra hints

```
# 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

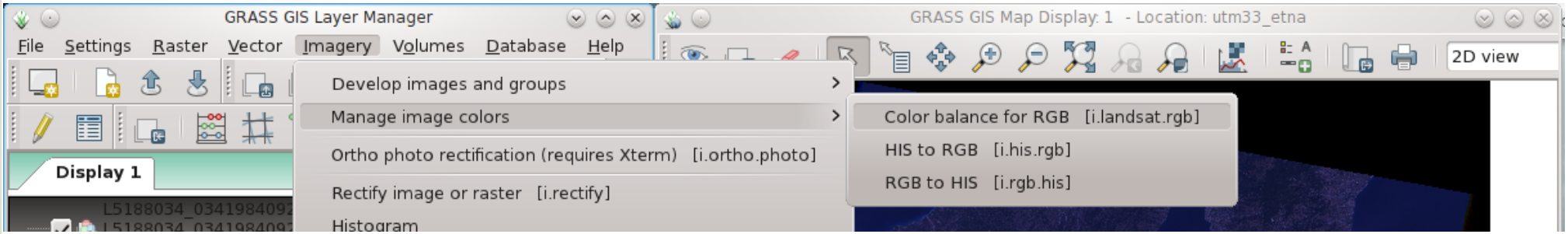


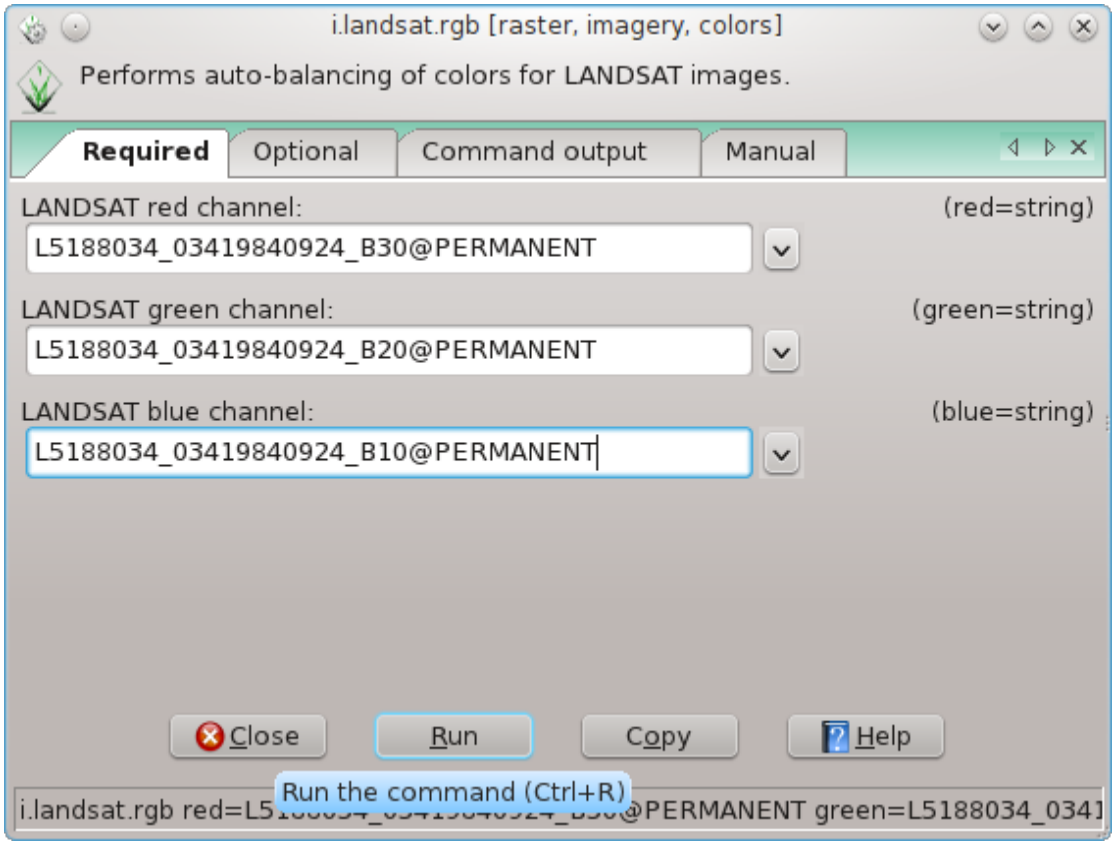
Another example: Sicily



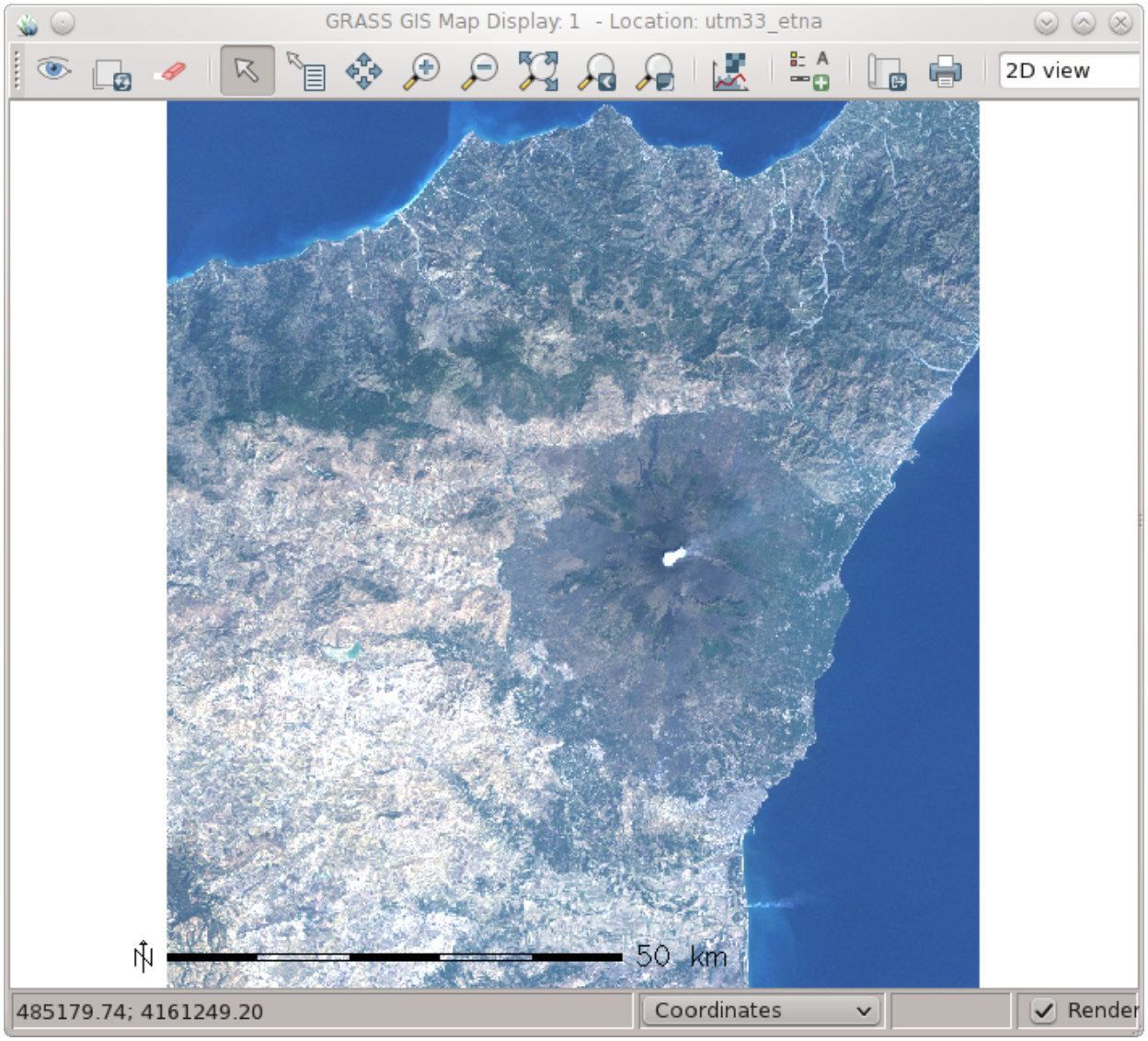
Already nice but too dark...: we need to improve the color tables

Color table optimization of a Landsat scene





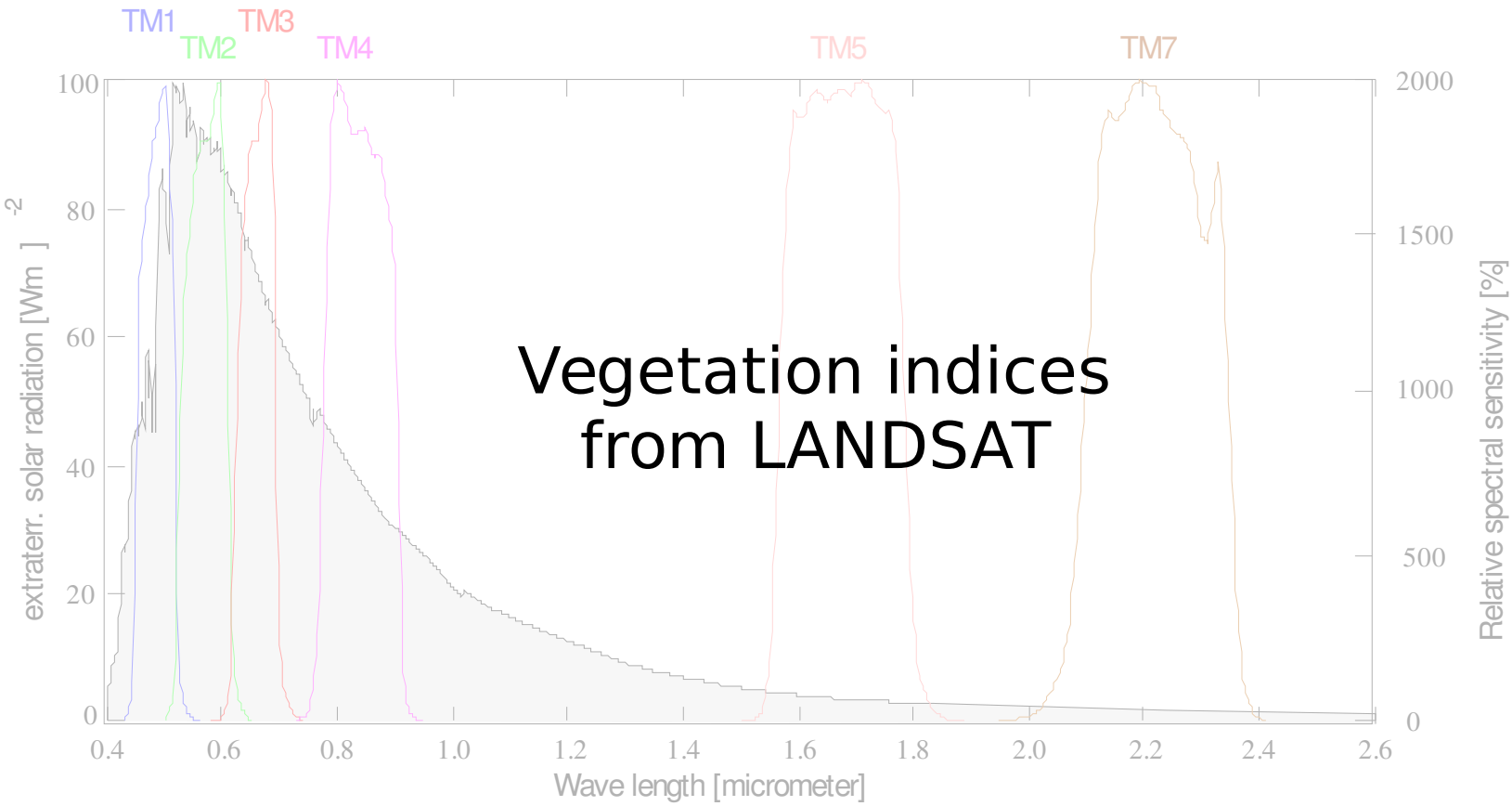
Color table optimization of a Landsat scene



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/

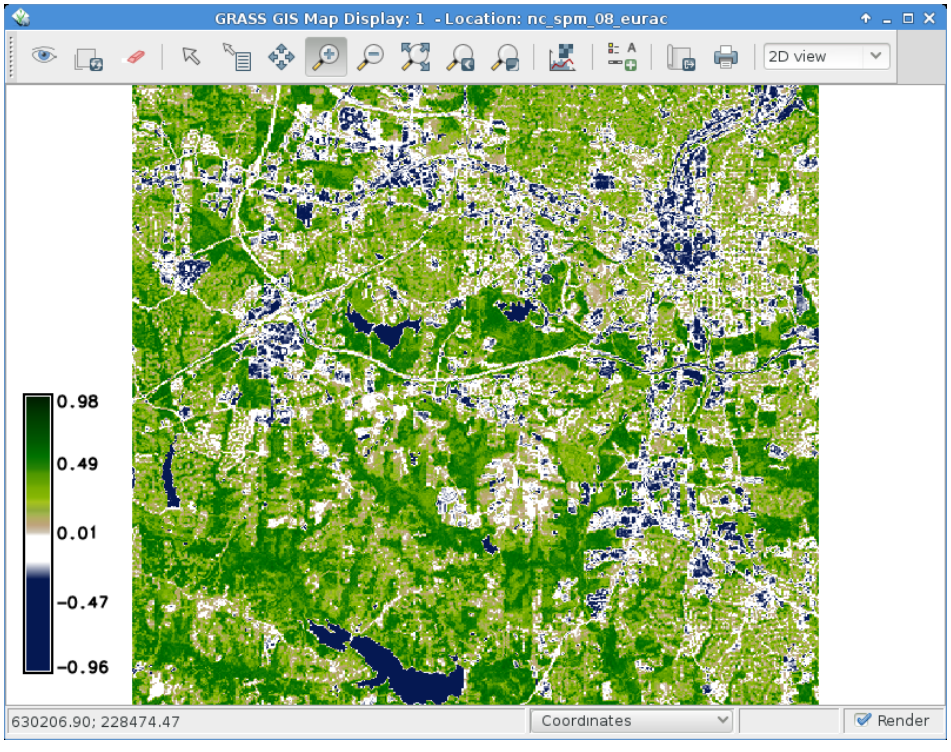


Vegetation indices from LANDSAT

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:

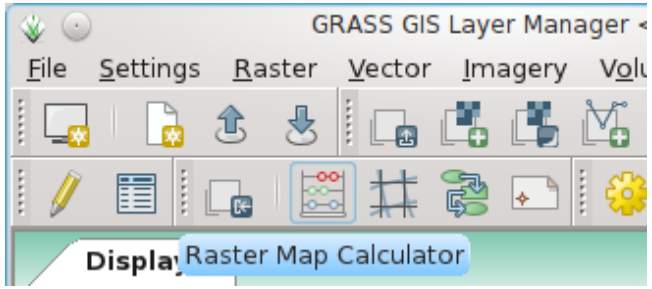
```
# HTML manual
g.manual r.colors

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

Exercise – Map algebra in image processing

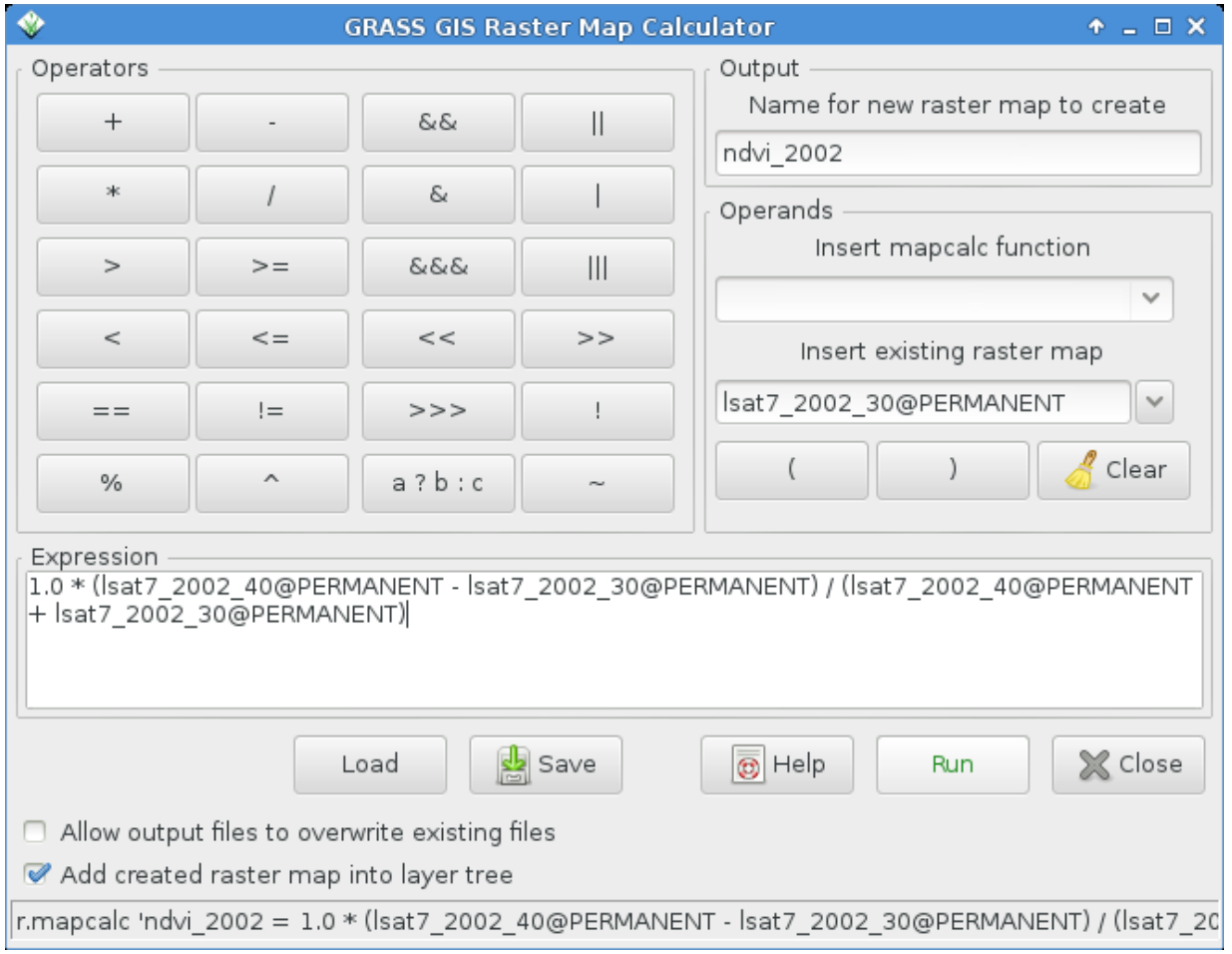
Vegetation index from LANDSAT ETM: Using Red (3) and NIR (4)

NDVI = 1.0 * (NIR - R)/(NIR + R)

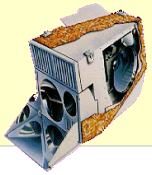
Use the raster map calculator



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