

**SPOT/Landsat  
Image Processing  
using GRASS  
in GIS-Knoppix ver. 1.2**



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The latest version of this tutorial is provided at  
SAFE portal site:

<http://www.safe.iis.u-tokyo.ac.jp/>

# **Contents**

## **Section 1. Preliminary Preparation**

- 1. How to get GIS-Knoppix CD**
- 2. Copy data to FAT formatted storage device**
- 3. How to boot a PC from GIS-Knoppix CD**
- 4. Preparation for starting GRASS**

## **Section 2. SPOT Image Processing in UTM Coordinate System**

- 1. Starting and Terminating GRASS**
- 2. Defining coordinate system and region**
- 3. Import raster data**
- 4. Display raster data**

# Contents

- 5. Create RGB image**
- 6. Raster Calculations**
- 7. Land cover classification**
- 8. Raster statistics**
- 9. Map layout**
- 10. Export raster**



# **Contents**

## **Section 3. Landsat Image Processing in UTM Coordinate System**

- 1. Defining coordinate system and region**
- 2. Import raster data**
- 3. Display raster data**
- 4. Create RGB image**
- 5. Raster Calculations**
- 6. Principal component analysis**

# **Section 1. Preliminary Preparation**

## **1. How to get GIS-Knoppix CD**

## 1.1 What is GIS-Knoppix ?

- GIS-Knoppix is a bootable Linux CD with pre-installed GIS software.
- GIS-Knoppix is based on Knoppix.

### - What is Knoppix?

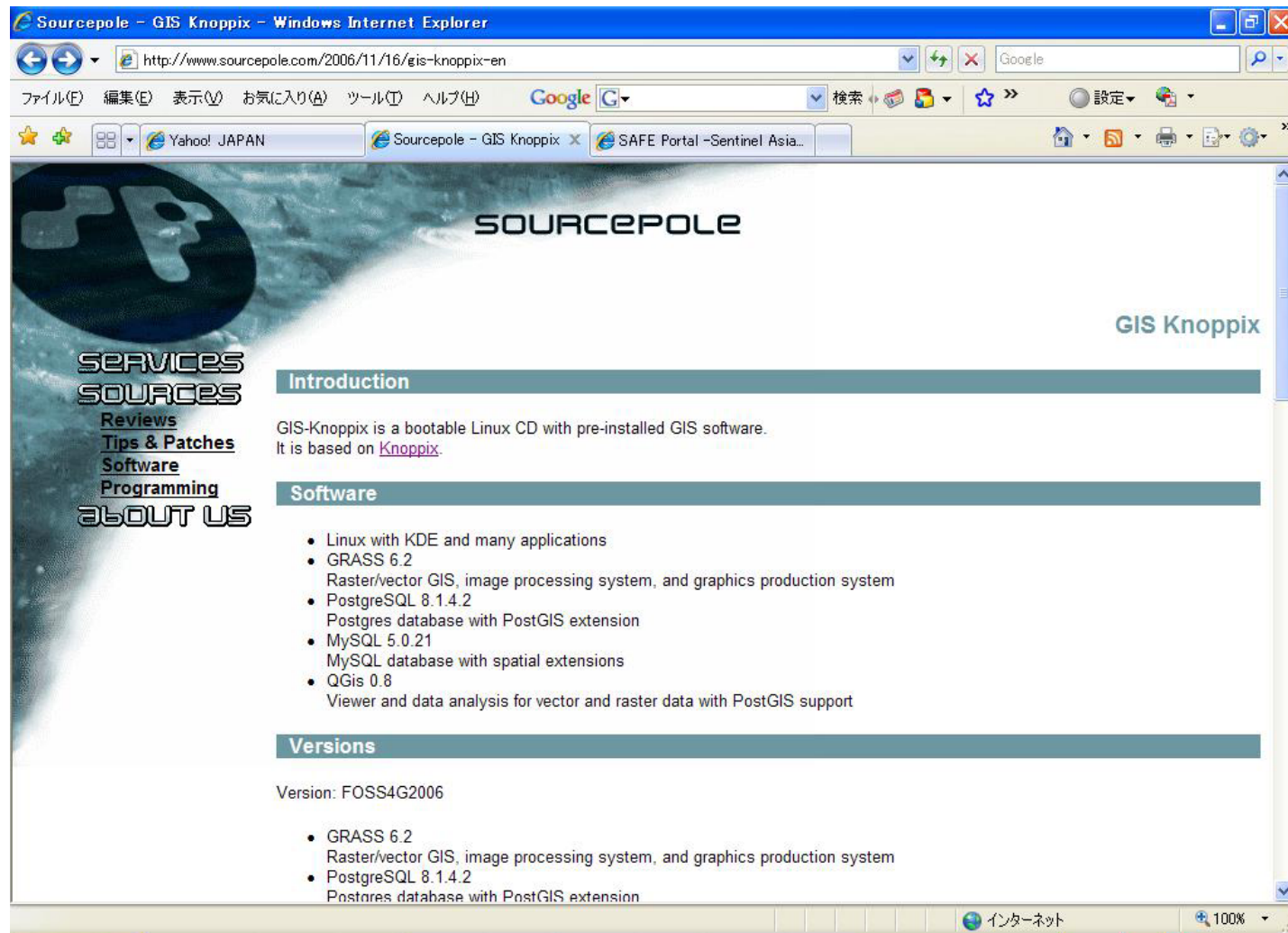
KNOPPIX is a bootable Live system on CD or DVD, consisting of a representative collection of GNU/Linux software, automatic hardware detection, and support for many graphics cards, sound cards, SCSI and USB devices and other peripherals. KNOPPIX can be used as a productive Linux system for the desktop, educational CD, rescue system, or adapted and used as a platform for commercial software product demos. It is not necessary to install anything on a hard disk.

( <http://www.knopper.net/knoppix/index-en.html> )

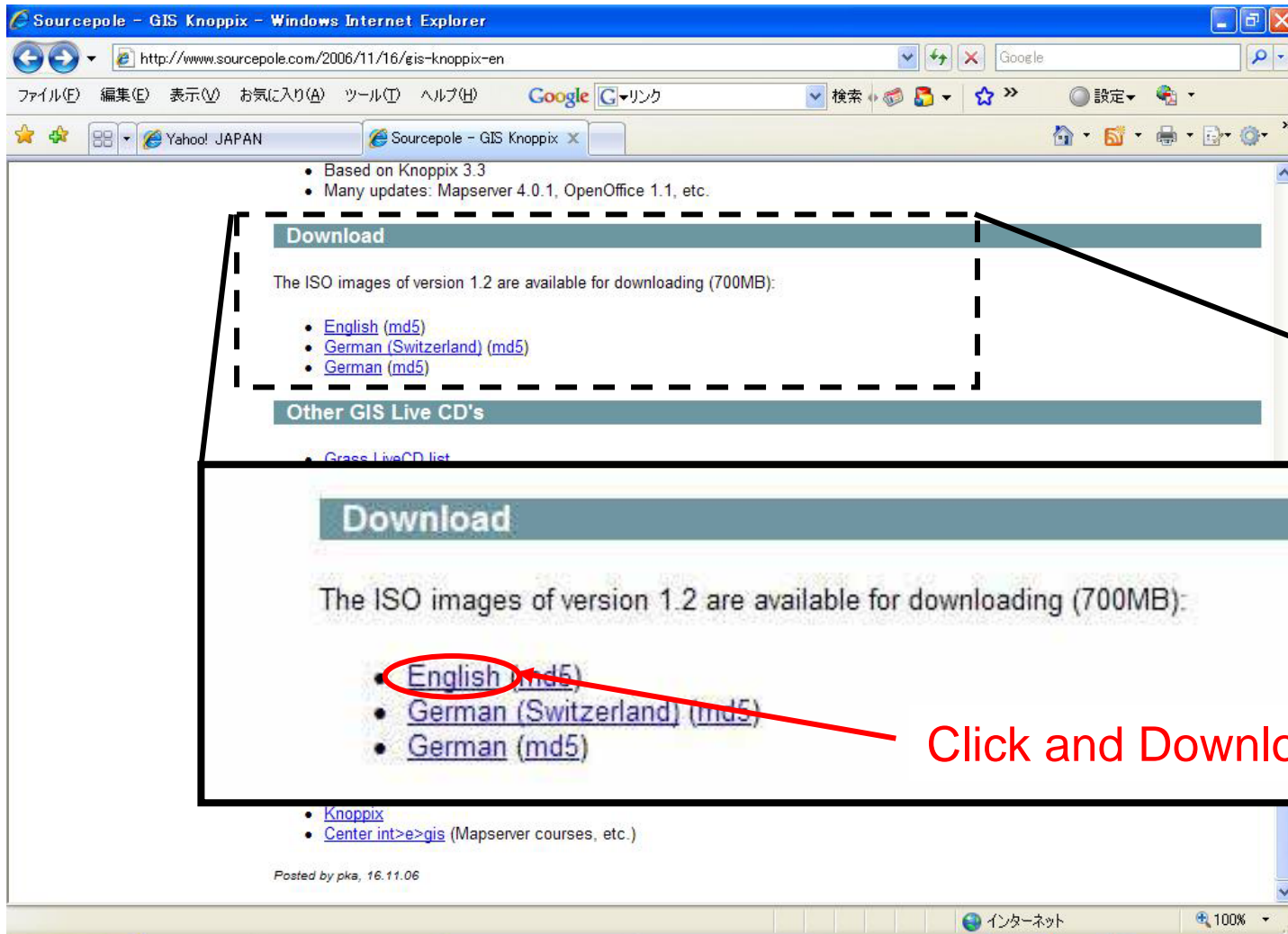
# 1.2 How to get GIS-Knoppix CD

## Step 1: Go to

“ <http://www.sourcepole.com/2006/11/16/gis-knoppix-en> ”



## Step 2: Download the ISO images of version 1.2



## **Step 3: Burn the downloaded ISO image file to a CD**

- Burning the ISO image file to a CD or DVD is a little different than just burning the file. To do it, you'll need to choose the "burn image" or "write image" option in your burning software and then choose the file.
- If your CD/DVD burning software does not have this option, download free CD/DVD burning software.

see “<http://pcsupport.about.com/od/toolsofthetrade/ht/burnisofile.htm>”

## **Section 1. Preliminary Preparation**

**2. Copy data to FAT formatted  
storage device**

# Using your windows PC,

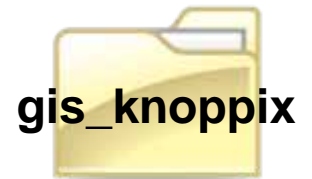
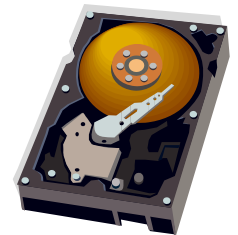
**Step 0: Insert data DVD into disc drive**

**Step 1: Make “gis\_knoppix” directory  
in your FAT formatted storage  
device**

**Step 2: Make “data” directory  
under the “gis\_knoppix”  
directory**

**Step 3: Copy data into “data”  
directory from data DVD**  
see next slide

FAT formatted  
storage device





# Data list in “Data” directory (minimum)

## · SPOT Image

- SPOT5HRVIR20071107R.tif
- SPOT5HRVIR20071107G.tif
- SPOT5HRVIR20071107IR.tif

from CD

“ Vietnam/data/SPOT ”

## · Landsat Image

- p124r52\_5t19901230\_nn1.tif
- p124r52\_5t19901230\_nn2.tif
- p124r52\_5t19901230\_nn3.tif
- p124r52\_5t19901230\_nn4.tif
- p124r52\_5t19901230\_nn5.tif
- p124r52\_5t19901230\_nn6.tif
- p124r52\_5t19901230\_nn7.tif
- p124r52\_5t19901230.met
- p124r52\_5t19901230.hdr

from CD

“ Vietnam/data/Landsat ”

# **Section 1. Preliminary Preparation**

## **3. How to boot a PC from the GIS-Knoppix CD**

## **Step 1: Change the BIOS boot order so the CD drive is listed first. Some computers are already configured this way but many are not.**

If the CD drive is not first in the boot order, your PC will start "normally" (i.e. boot from your hard drive) without even looking at what might be in your disc drive.

**Note:** After setting your optical drive as the first boot device in BIOS, your computer will check that drive for a bootable CD each time your computer starts. Leaving your PC configured this way shouldn't cause problems unless you plan on leaving a disc in the drive all the time.

**Step 2: Insert your GIS-Knoppix CD in your disc drive.**

**Step 3: Restart your computer.**

**Step 4: Watch for a “*Press any key to boot from CD...*” message.**

To boot from the CD, you'll need to press any key on your keyboard (like the space bar) within the few seconds that the message is on the screen.

If you do nothing, your computer will check for boot information on the next boot device in the list in BIOS (see Step 1) which will probably be your hard drive.

**Step 5: Your computer should now boot from the CD disc.**

If you tried the above steps but your computer did not boot from the CD or DVD properly, check out some of the tips below.

**Tips :**

1. Recheck the boot order in BIOS (Step 1).

The number one reason a bootable disc won't boot is because BIOS is not configured to check the CD/DVD drive first.

2. Do you have more than one CD or DVD drive?

Your computer probably only allows for one of your disc drives to be booted from. Insert the GIS-Knoppix CD in the other drive and restart your computer.

3. Burn a new CD.

The disc may have errors on it that reburning could correct.

# Reference

- How To Boot your Computer from a Bootable CD or DVD  
by Tim Fisher, About.com  
(<http://pcsupport.about.com/od/tipstricks/ht/bootcddvd.htm>)

# **Section 1. Preliminary Preparation**

## **4. Preparation for starting GRASS**

- **First time to work in GIS-koppix**

- 4.1 Boot PC from the GIS-knoppix CD

- 4.2 Change Keyboard layout

- 4.3 Make FAT formatted storage device writable

- 4.4a Make working directory

- **Second time or later to work in GIS-koppix**

- 4.1 Boot PC from the GIS-knoppix CD

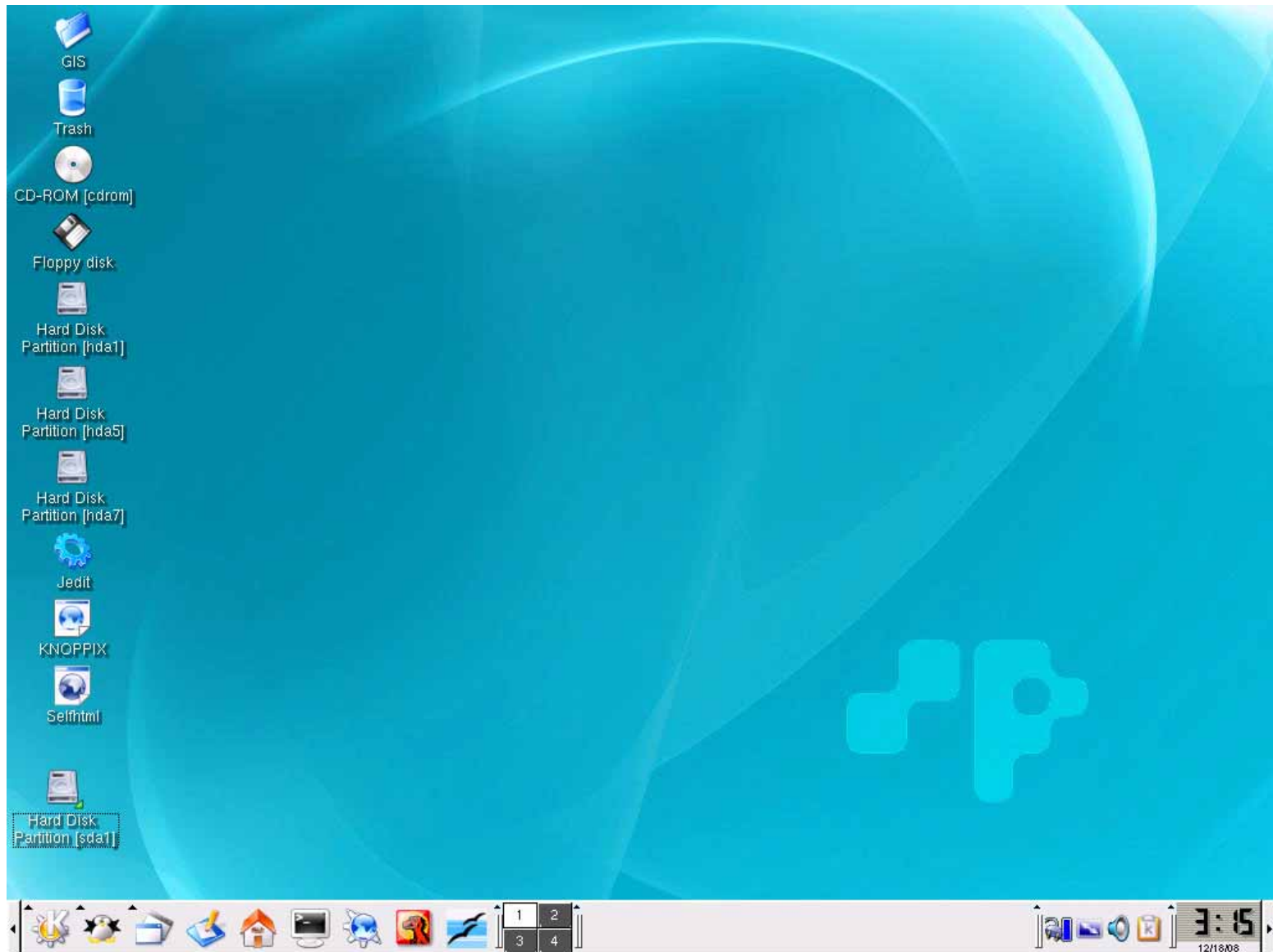
- 4.2 Change Keyboard layout

- 4.3 Make FAT formatted storage device writable

- 4.4b Move to “work” directory



# 4.1 Boot PC from the GIS-knoppix CD

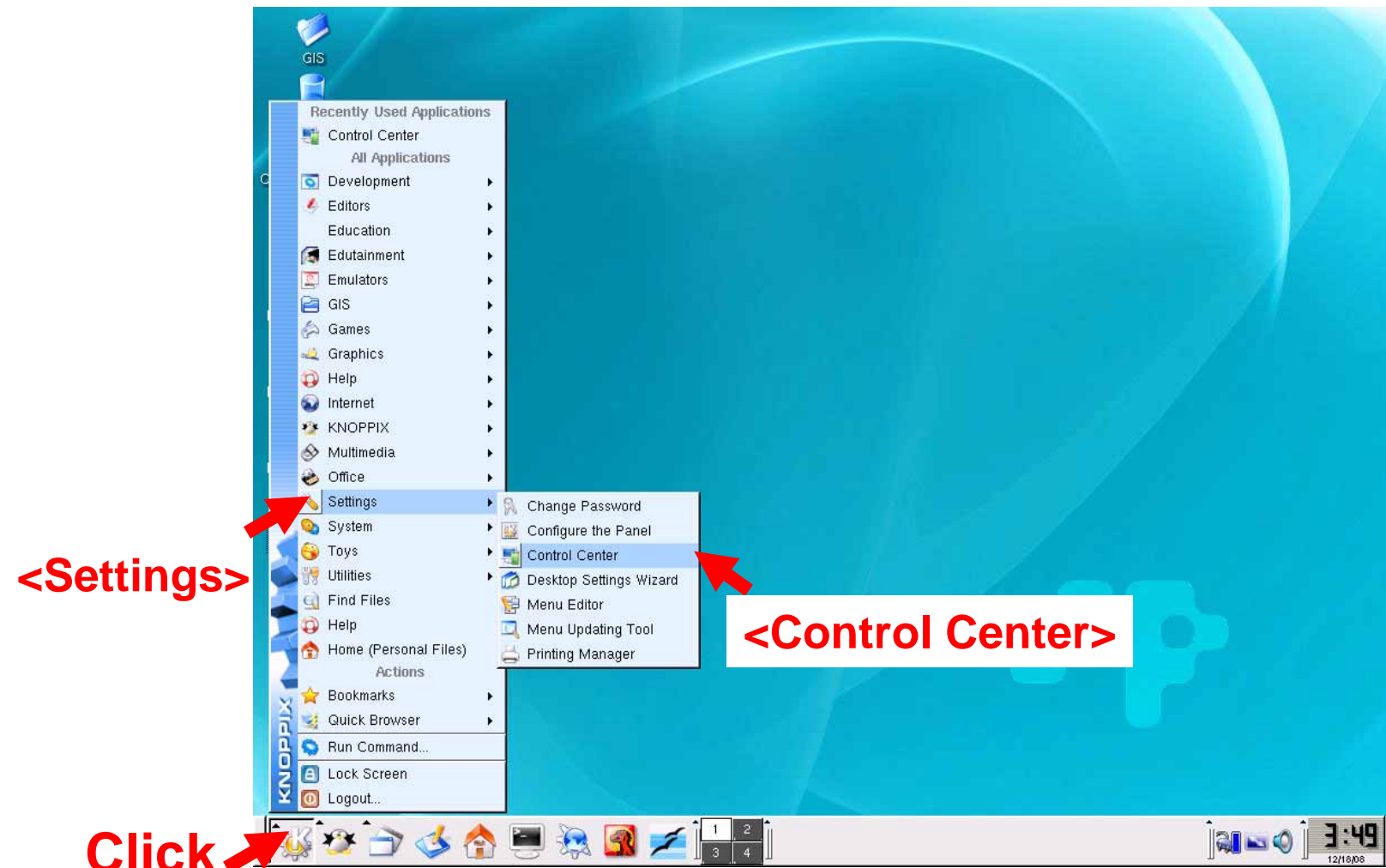


## 4.2 Change Keyboard layout

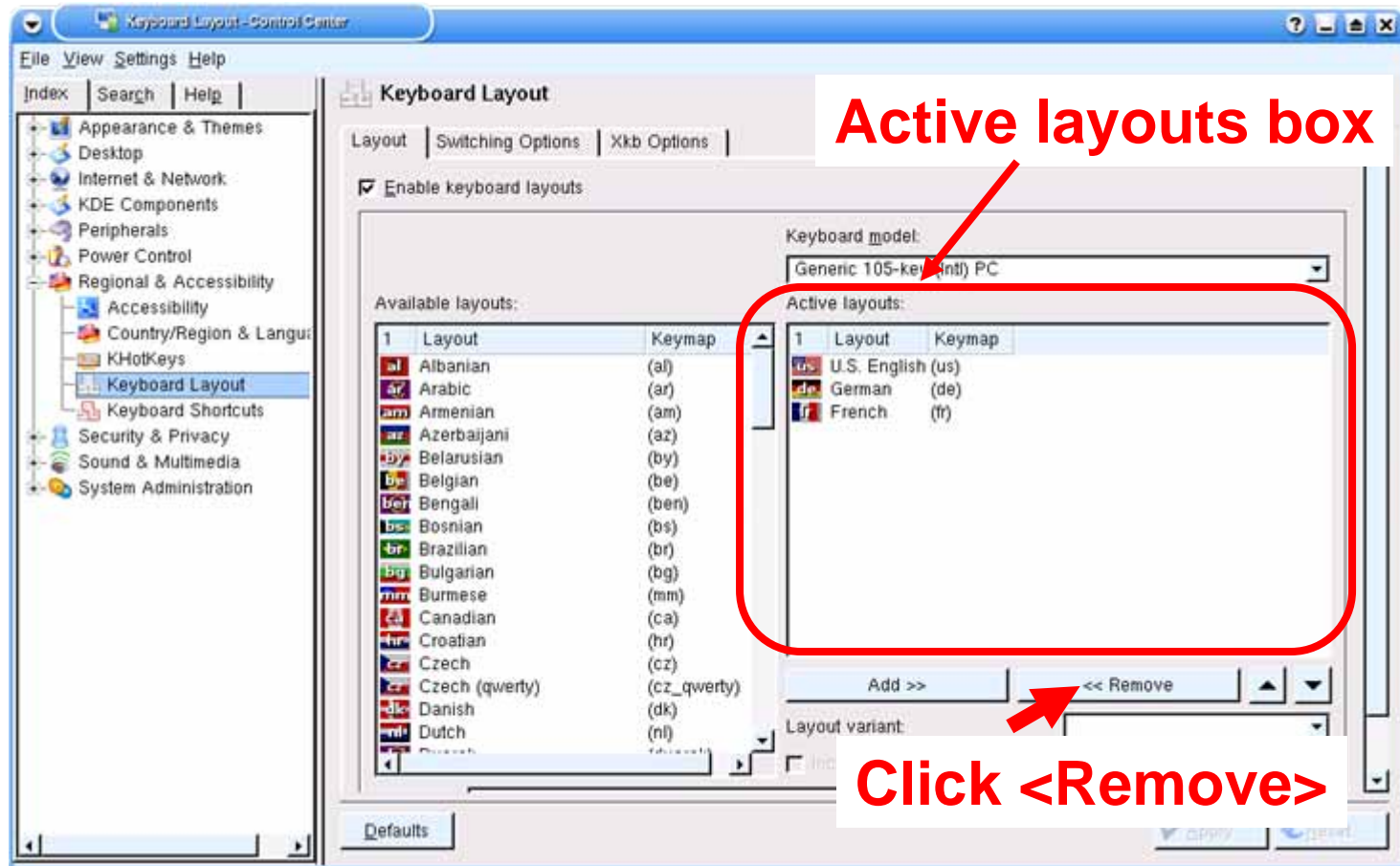
**Step1 : Click icon at bottom-left corner**

**<Settings>**

**<Control Center>**

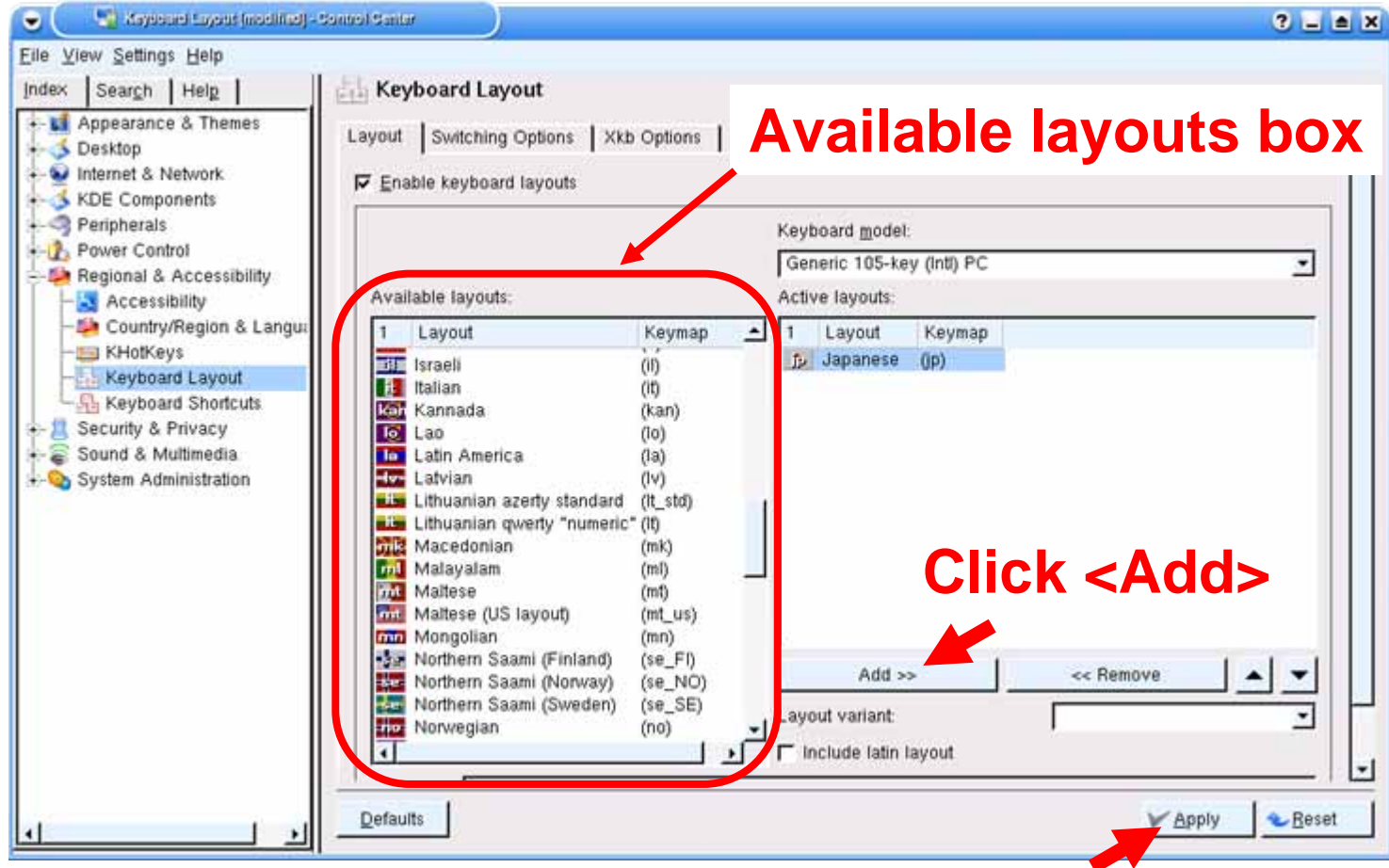


## Step2 : Click <Regional & Accessibility > Click <Keyboard Layout >



## Step3 : Select languages from Active layouts box Click <Remove>

## Step4 : Select your language from Available layouts box Click <Add>

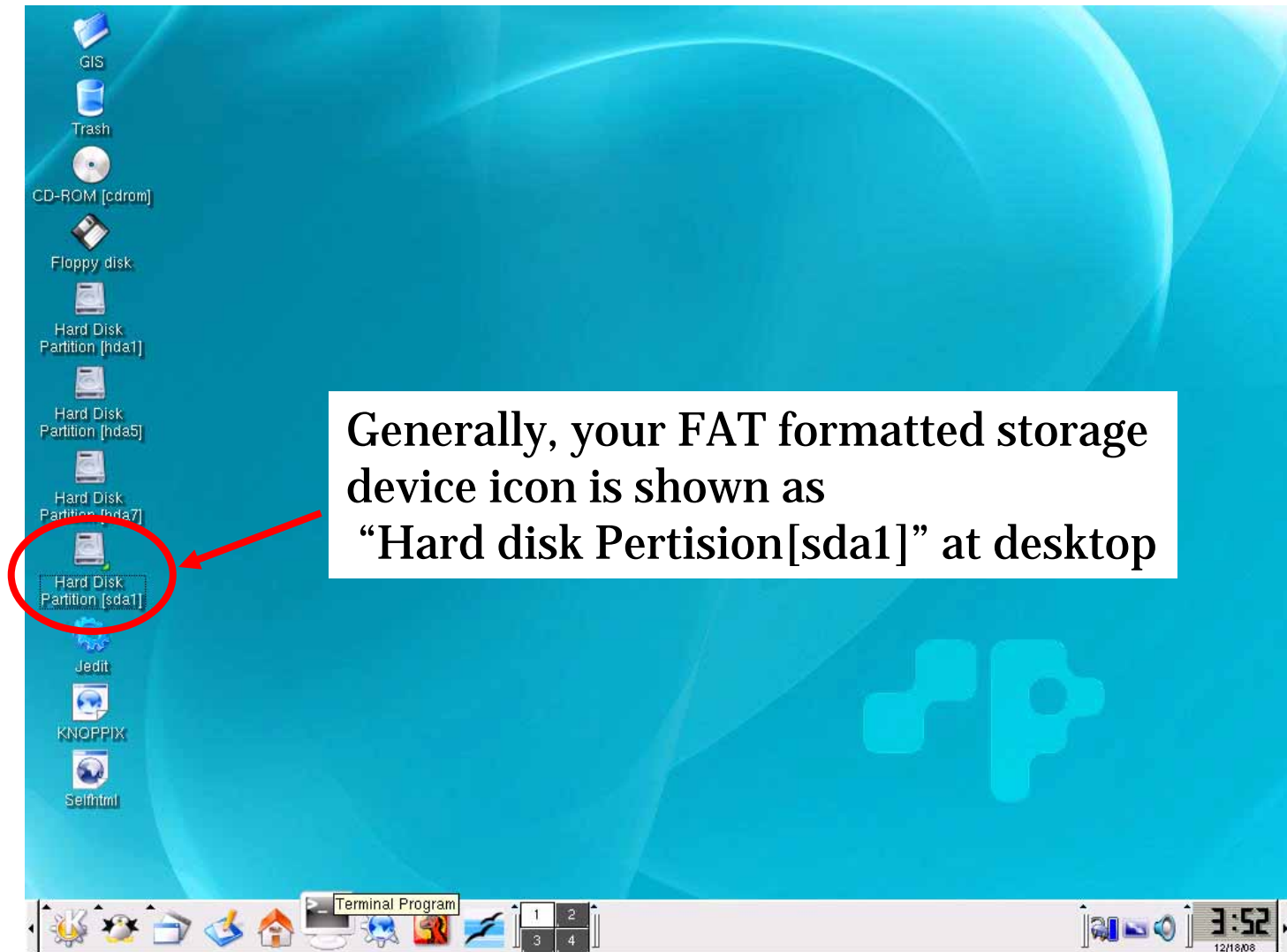


## Step5 : Click <Apply >

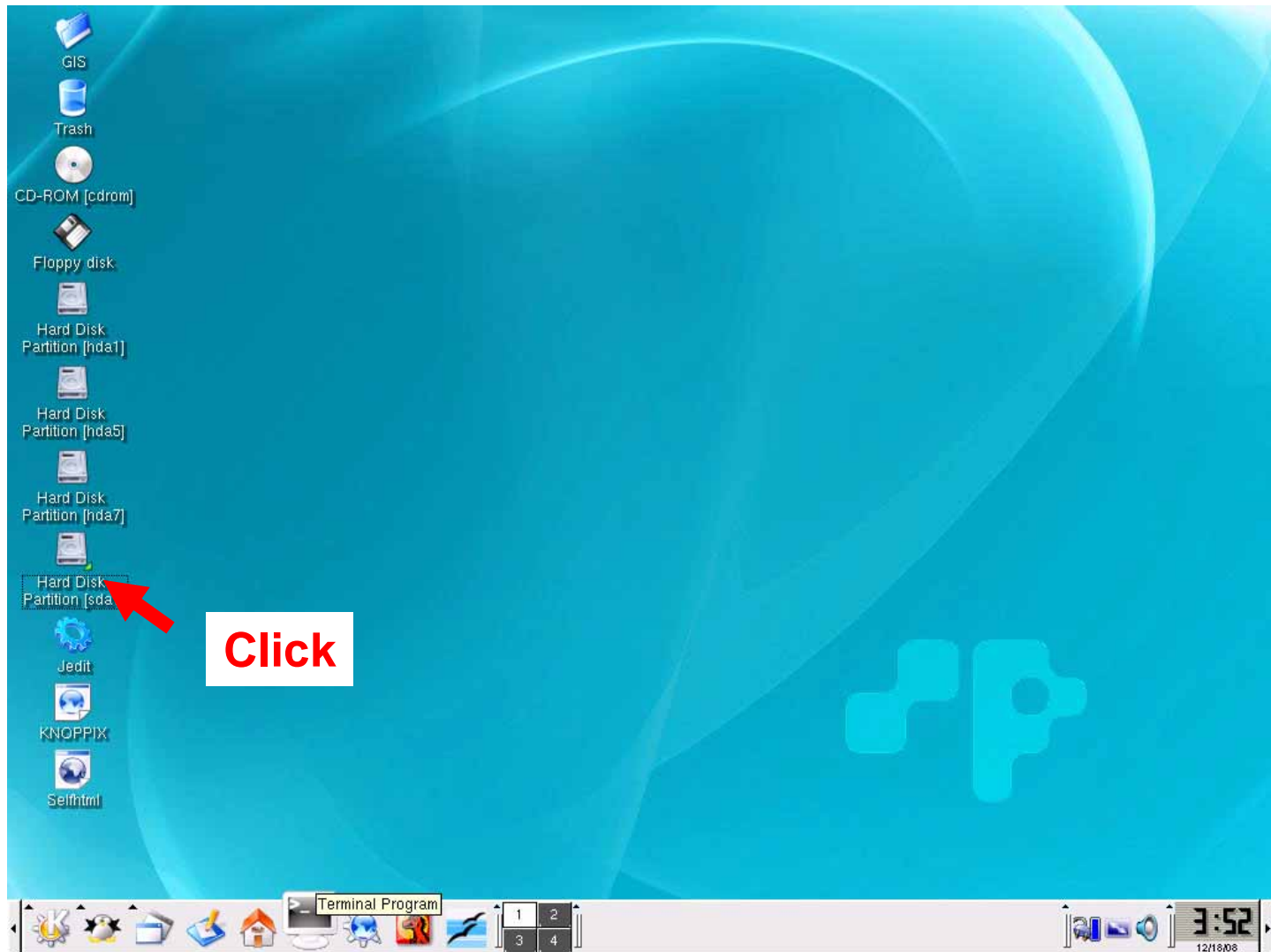
Click <Apply>

## 4.3 Make FAT formatted storage device writable

### Step1 : Connect FAT formatted storage device to PC



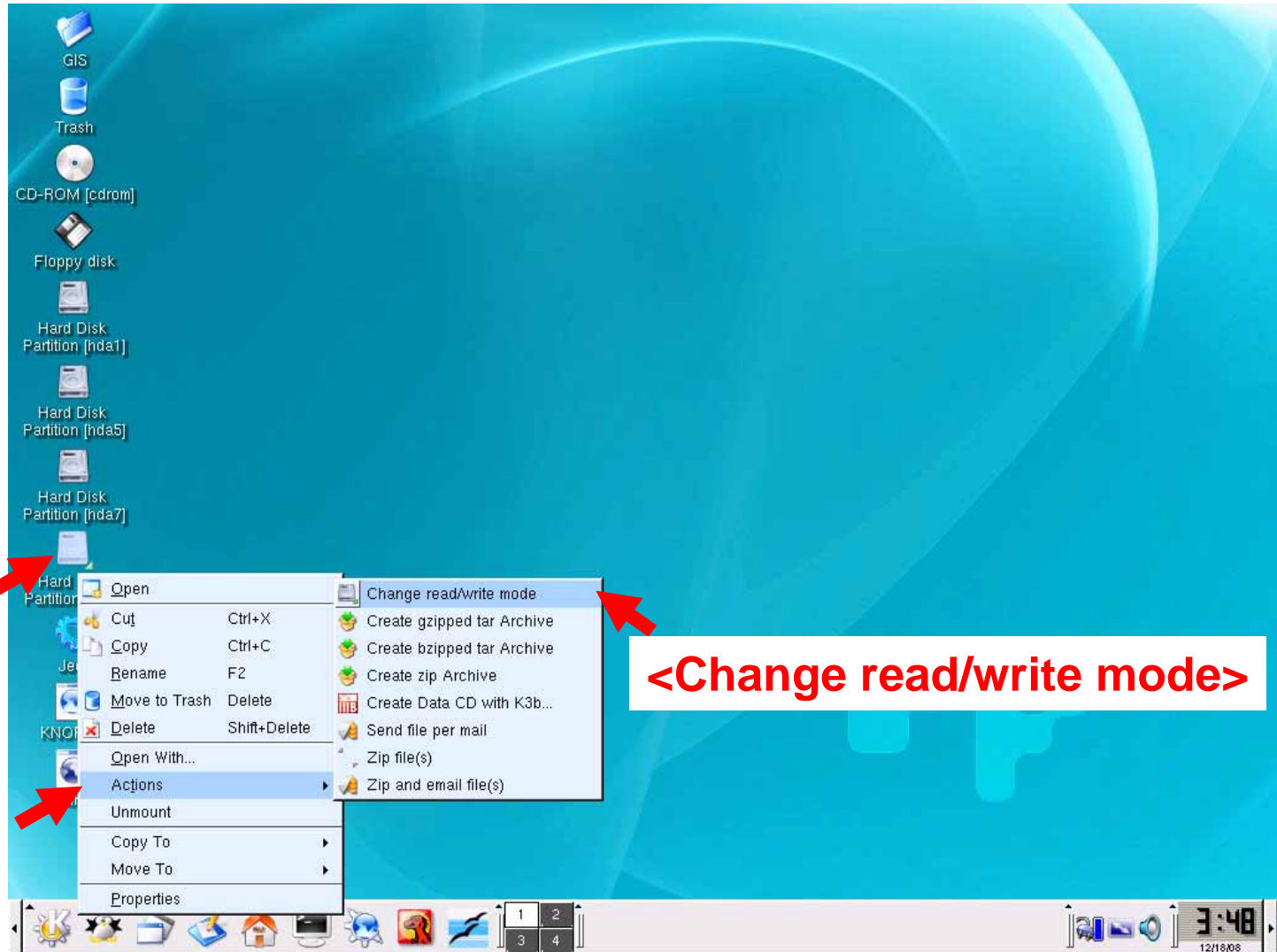
## Step2 :Mount FAT formatted storage device [sda1] by clicking the [sda1] icon





## Step2 : Right click [sda1] icon on the desktop

<Actions>                      <Change read/write mode>



## Step3 : Click <Yes >

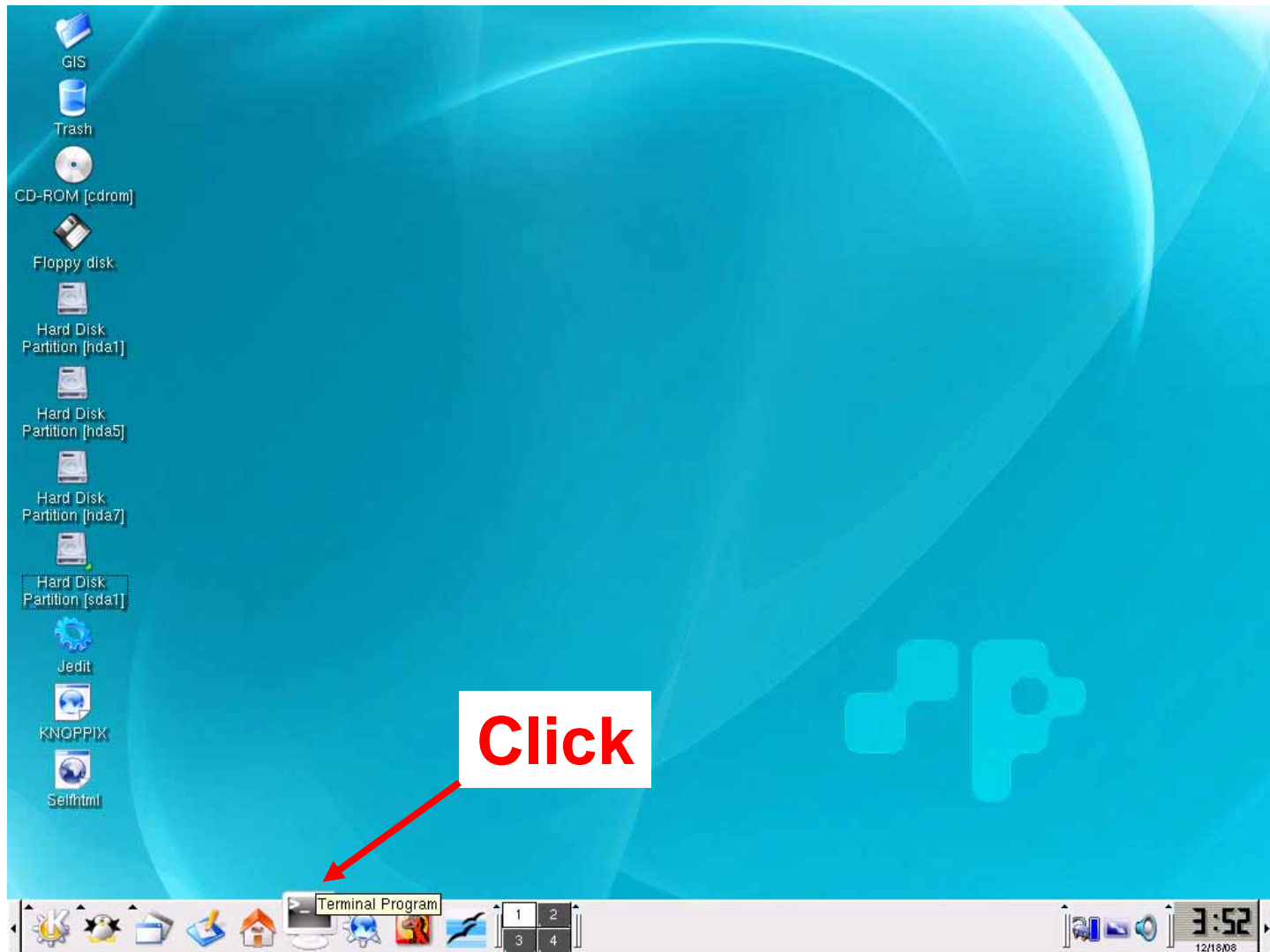


**Click**



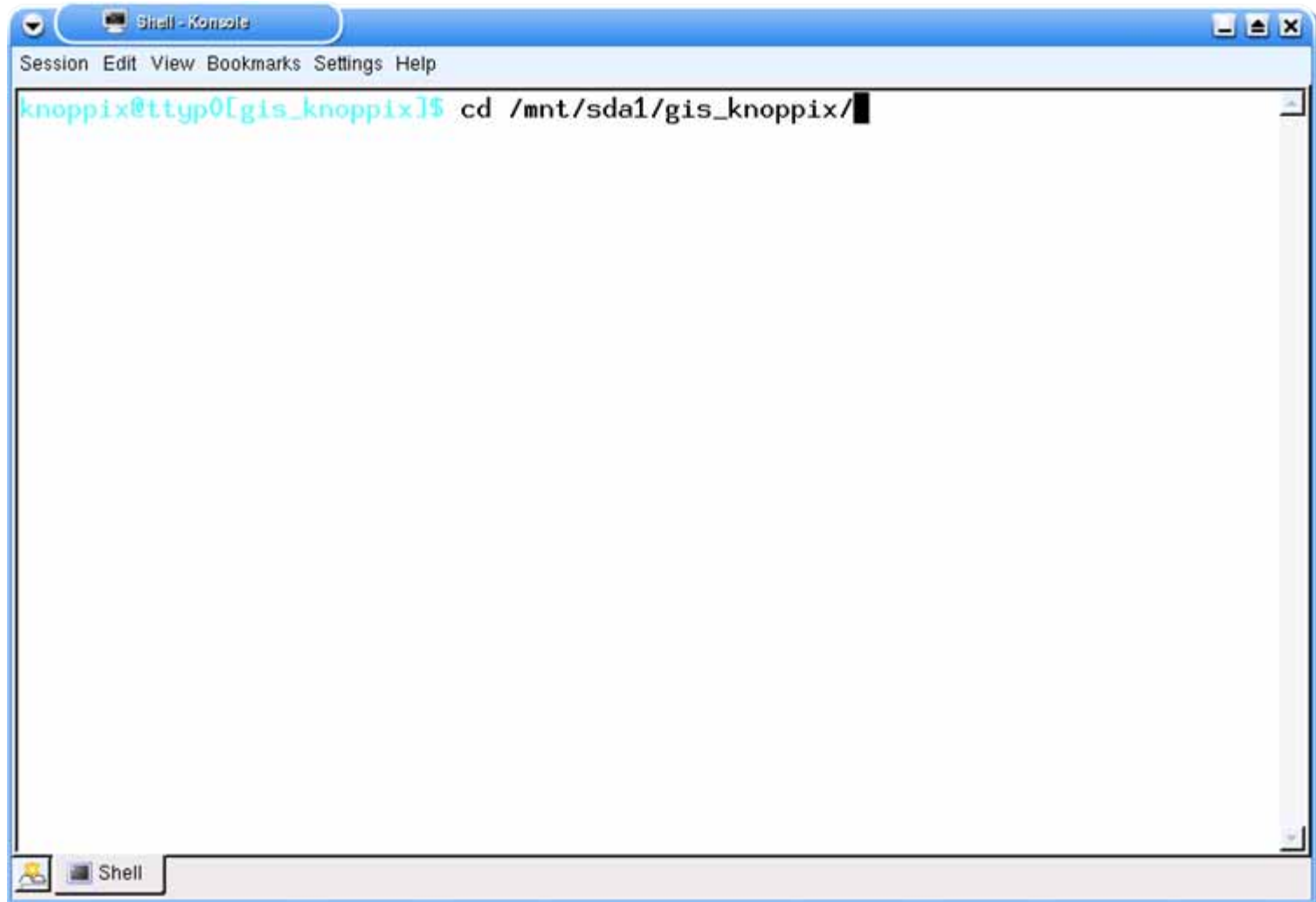
## 4.4a Make working directory

### Step1 : Open “ Terminal Program ”



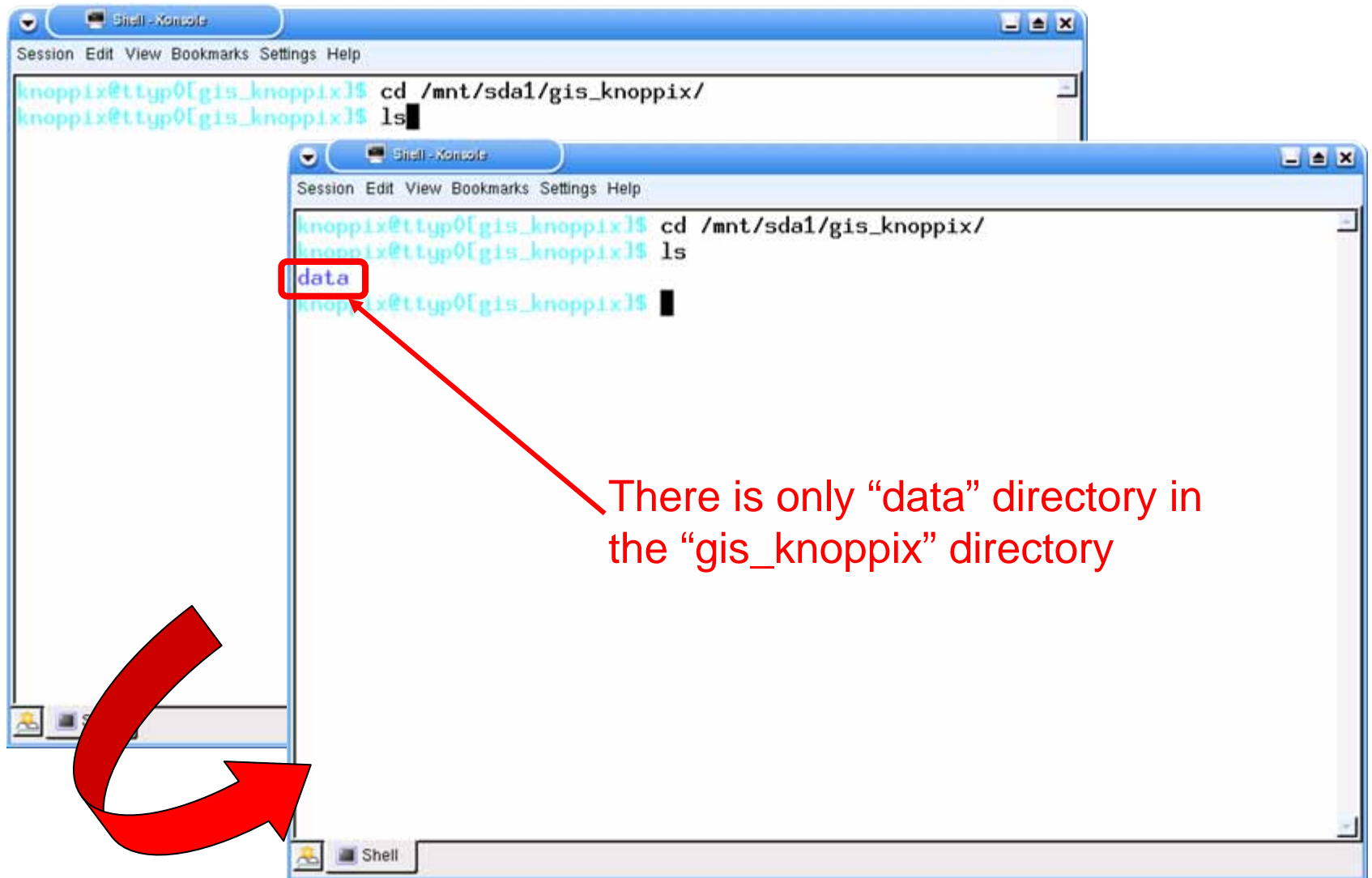
**Step2** : On the Terminal window, write following command and hit <enter(return)> key

> **cd /mnt/sda1/gis\_knoppix**      : space



The screenshot shows a terminal window with a blue title bar labeled 'Shell - Konsole'. Below the title bar is a menu bar with 'Session', 'Edit', 'View', 'Bookmarks', 'Settings', and 'Help'. The main area of the terminal is white and contains the text 'knoppix@tty0[gis\_knoppix]\$ cd /mnt/sda1/gis\_knoppix/' in a light blue font. A black cursor is positioned at the end of the command. At the bottom of the window, there is a taskbar with a 'Shell' icon and label.

**Step3 :** Check directories in the “gis\_knoppix” directory using following command and hit <enter(return)> key  
> ls



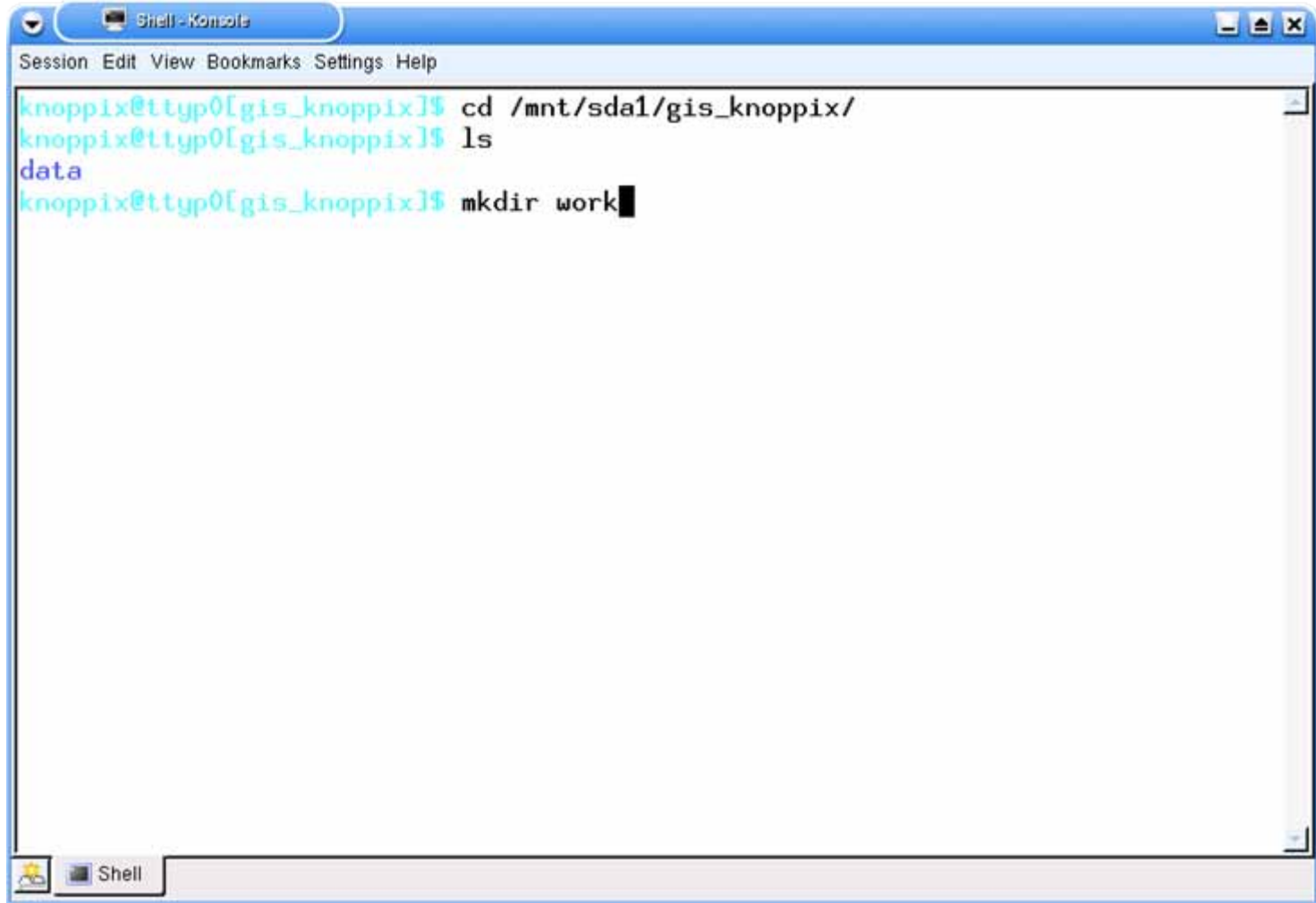
```
knoppix@tty0[gis_knoppix]$ cd /mnt/sda1/gis_knoppix/
knoppix@tty0[gis_knoppix]$ ls
```

```
knoppix@tty0[gis_knoppix]$ cd /mnt/sda1/gis_knoppix/
knoppix@tty0[gis_knoppix]$ ls
data
knoppix@tty0[gis_knoppix]$
```

There is only “data” directory in the “gis\_knoppix” directory

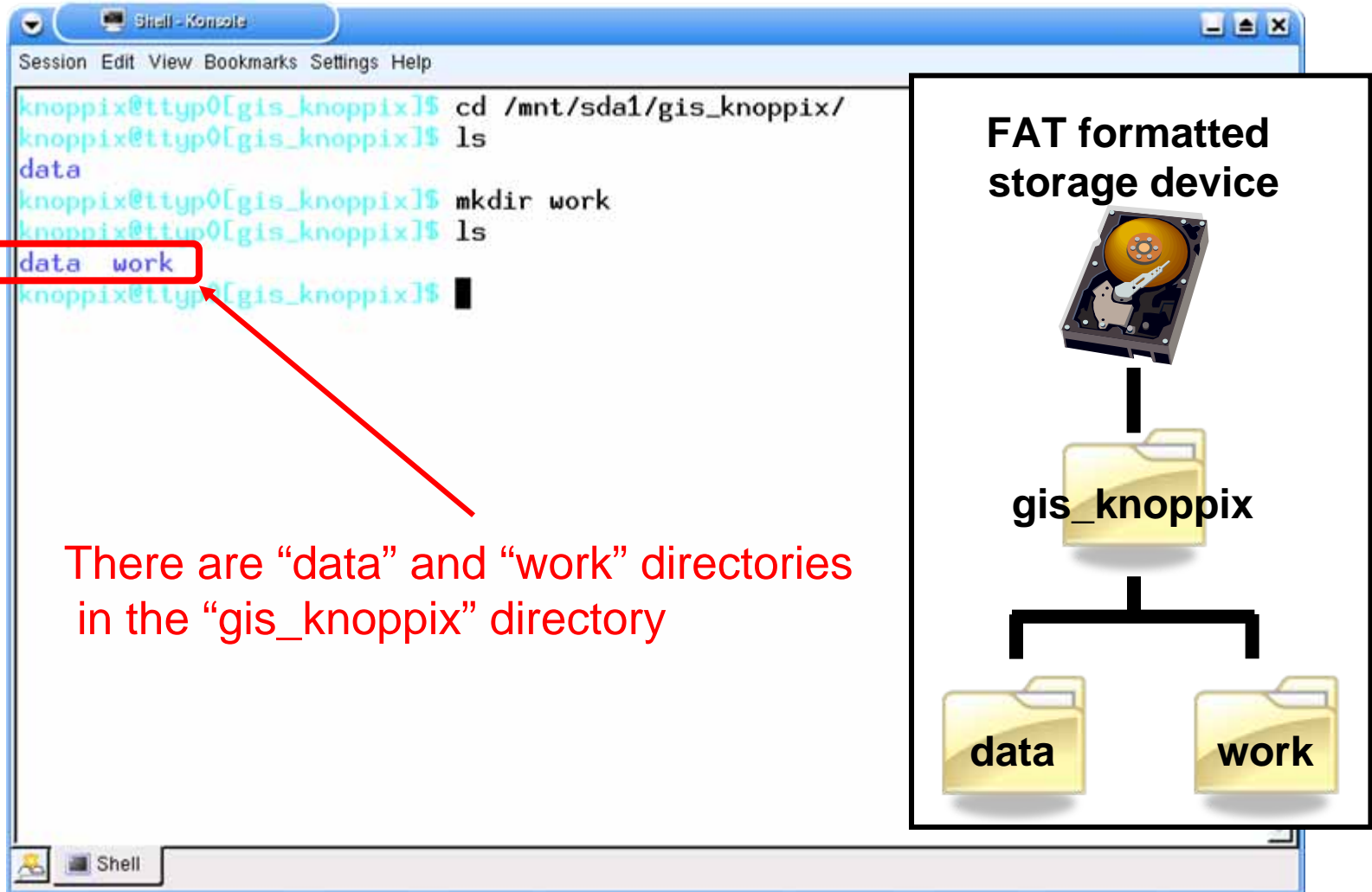
**Step4** : Make “work” directory in the “gis\_knoppix” directory using following command and hit <enter(return)> key  
> **mkdir work**

: space



```
Shell - Konsole
Session Edit View Bookmarks Settings Help
knoppix@tty0[gis_knoppix]$ cd /mnt/sda1/gis_knoppix/
knoppix@tty0[gis_knoppix]$ ls
data
knoppix@tty0[gis_knoppix]$ mkdir work
```

**Step5** : Check directories in the “gis\_knoppix” directory using following command and hit <enter(return)> key  
> ls



The image shows a terminal window on the left and a directory tree diagram on the right. The terminal window, titled 'Shell - Konsole', displays the following commands and output:

```
knoppix@tty0[gis_knoppix]$ cd /mnt/sda1/gis_knoppix/
knoppix@tty0[gis_knoppix]$ ls
data
knoppix@tty0[gis_knoppix]$ mkdir work
knoppix@tty0[gis_knoppix]$ ls
data work
knoppix@tty0[gis_knoppix]$
```

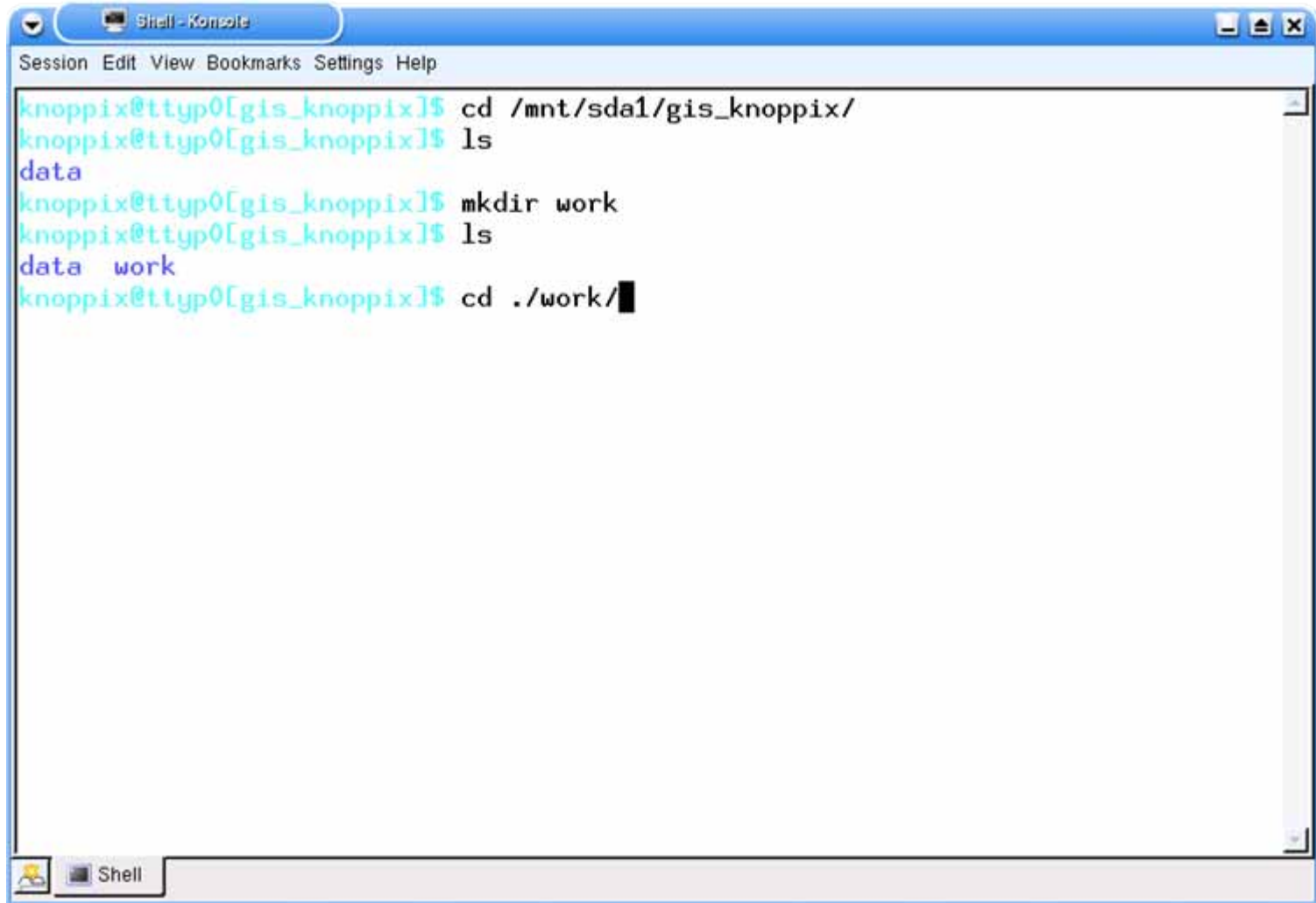
A red box highlights the output 'data work' in the terminal, and a red arrow points from this box to the text below. The directory tree diagram on the right, titled 'FAT formatted storage device', shows a hierarchy starting with a hard drive icon, followed by a folder named 'gis\_knoppix', which then branches into two subfolders: 'data' and 'work'.

There are “data” and “work” directories in the “gis\_knoppix” directory

**Step6** : Move to “work” directory using following command  
and hit <enter(return)> key

**> cd   ./work**

  : space

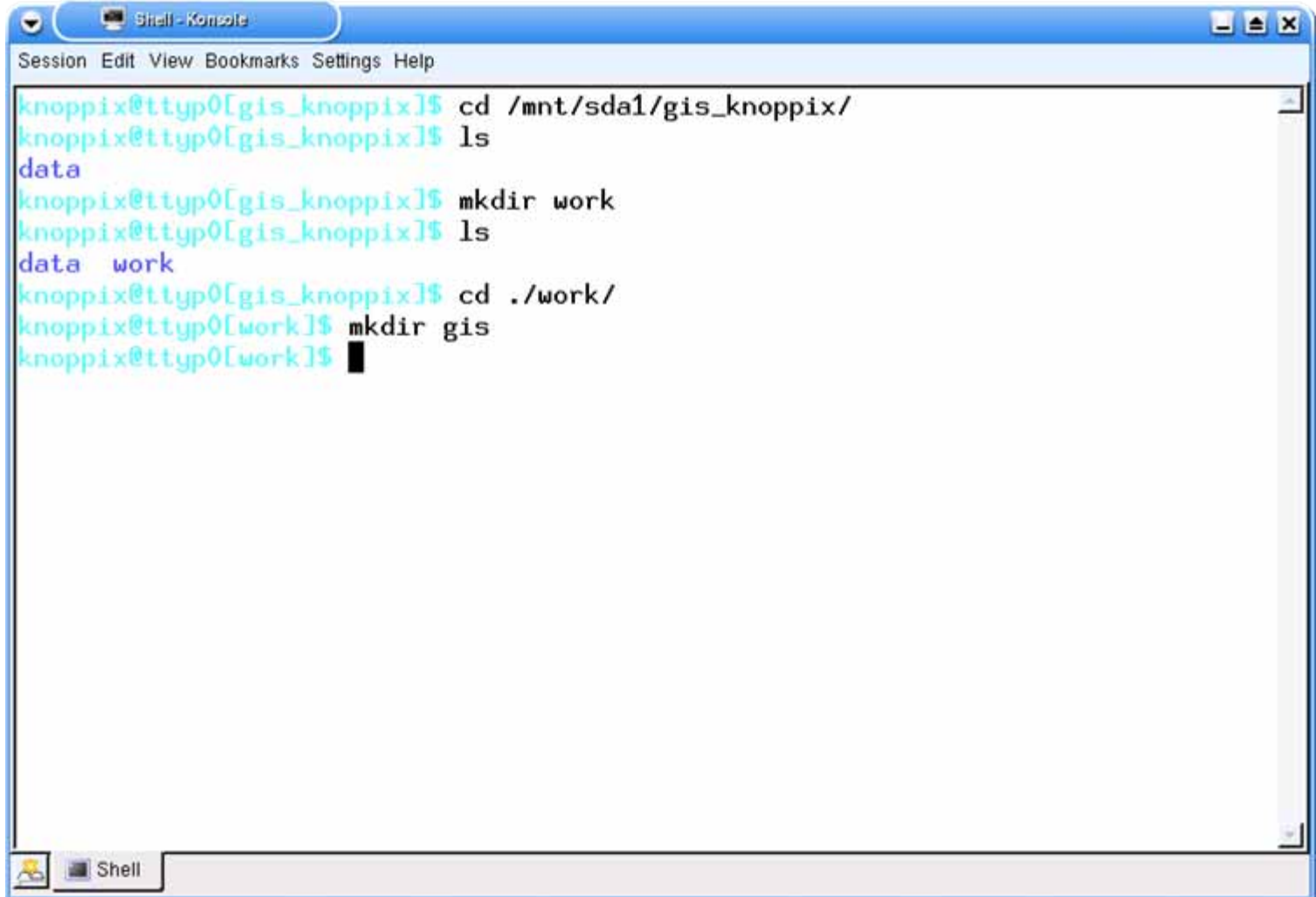


```
knoppix@tty0[gis_knoppix]$ cd /mnt/sda1/gis_knoppix/
knoppix@tty0[gis_knoppix]$ ls
data
knoppix@tty0[gis_knoppix]$ mkdir work
knoppix@tty0[gis_knoppix]$ ls
data work
knoppix@tty0[gis_knoppix]$ cd ./work/
```

**Step7** : Make “gis” directory in the “work” directory using following command and hit <enter(return)> key

**> mkdir   gis**

  : space



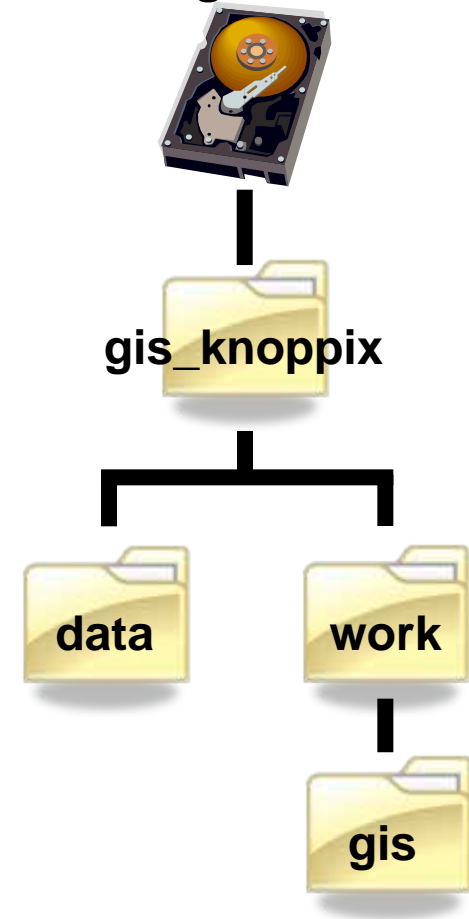
```
knoppix@tty0[gis_knoppix]$ cd /mnt/sda1/gis_knoppix/
knoppix@tty0[gis_knoppix]$ ls
data
knoppix@tty0[gis_knoppix]$ mkdir work
knoppix@tty0[gis_knoppix]$ ls
data work
knoppix@tty0[gis_knoppix]$ cd ./work/
knoppix@tty0[work]$ mkdir gis
knoppix@tty0[work]$
```

**Step8** : Check directories in the “work” directory using following command and hit <enter(return)> key  
> ls

```
Shell - Konsole
Session Edit View Bookmarks Settings Help
knoppix@tty0[gis_knoppix]$ cd /mnt/sda1/gis_knoppix/
knoppix@tty0[gis_knoppix]$ ls
data
knoppix@tty0[gis_knoppix]$ mkdir work
knoppix@tty0[gis_knoppix]$ ls
data work
knoppix@tty0[gis_knoppix]$ cd ./work/
knoppix@tty0[work]$ mkdir gis
knoppix@tty0[work]$ ls
gis
knoppix@tty0[work]$
```

There is “gis” directory in the “work” directory

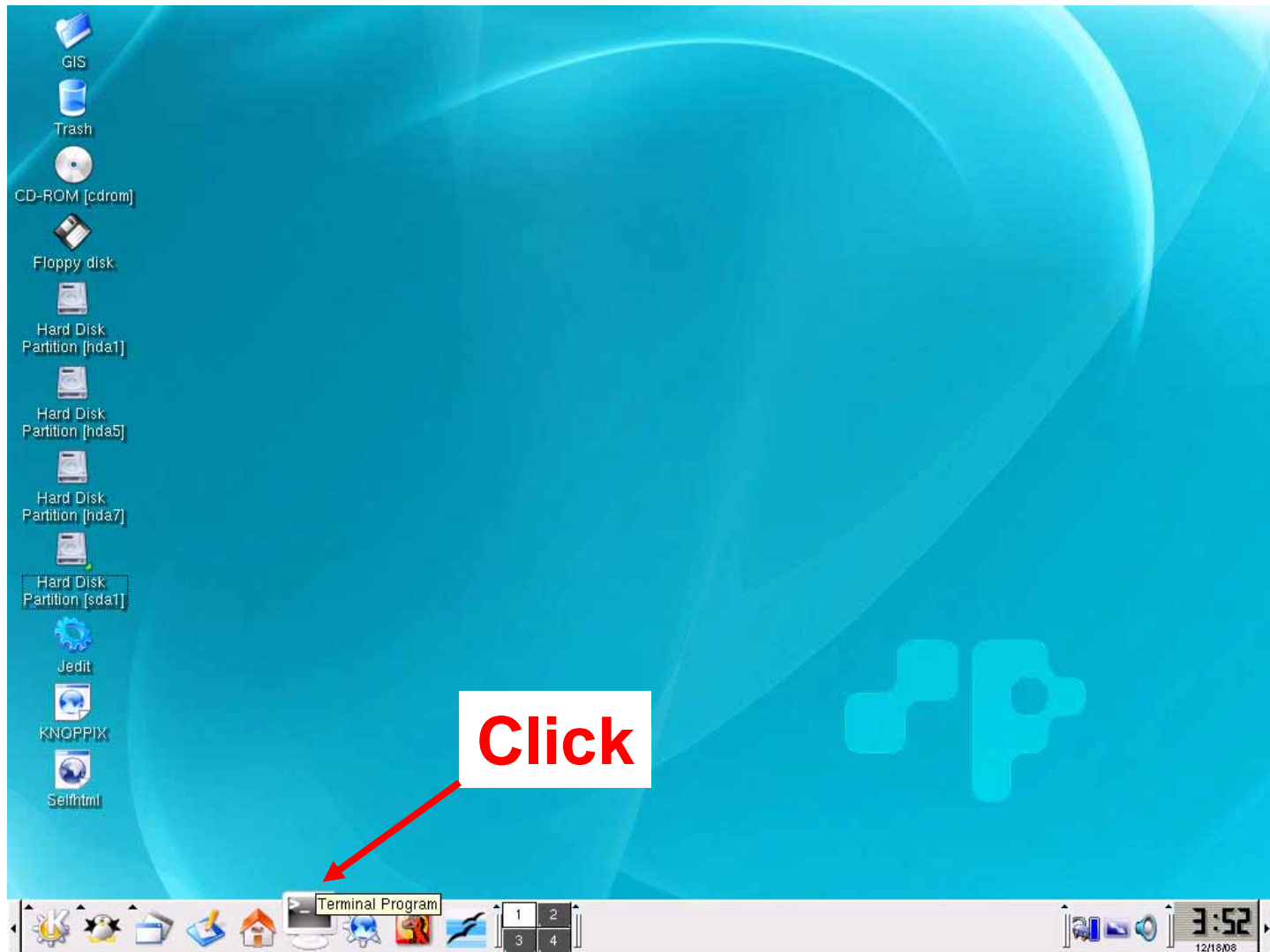
**FAT formatted  
storage device**





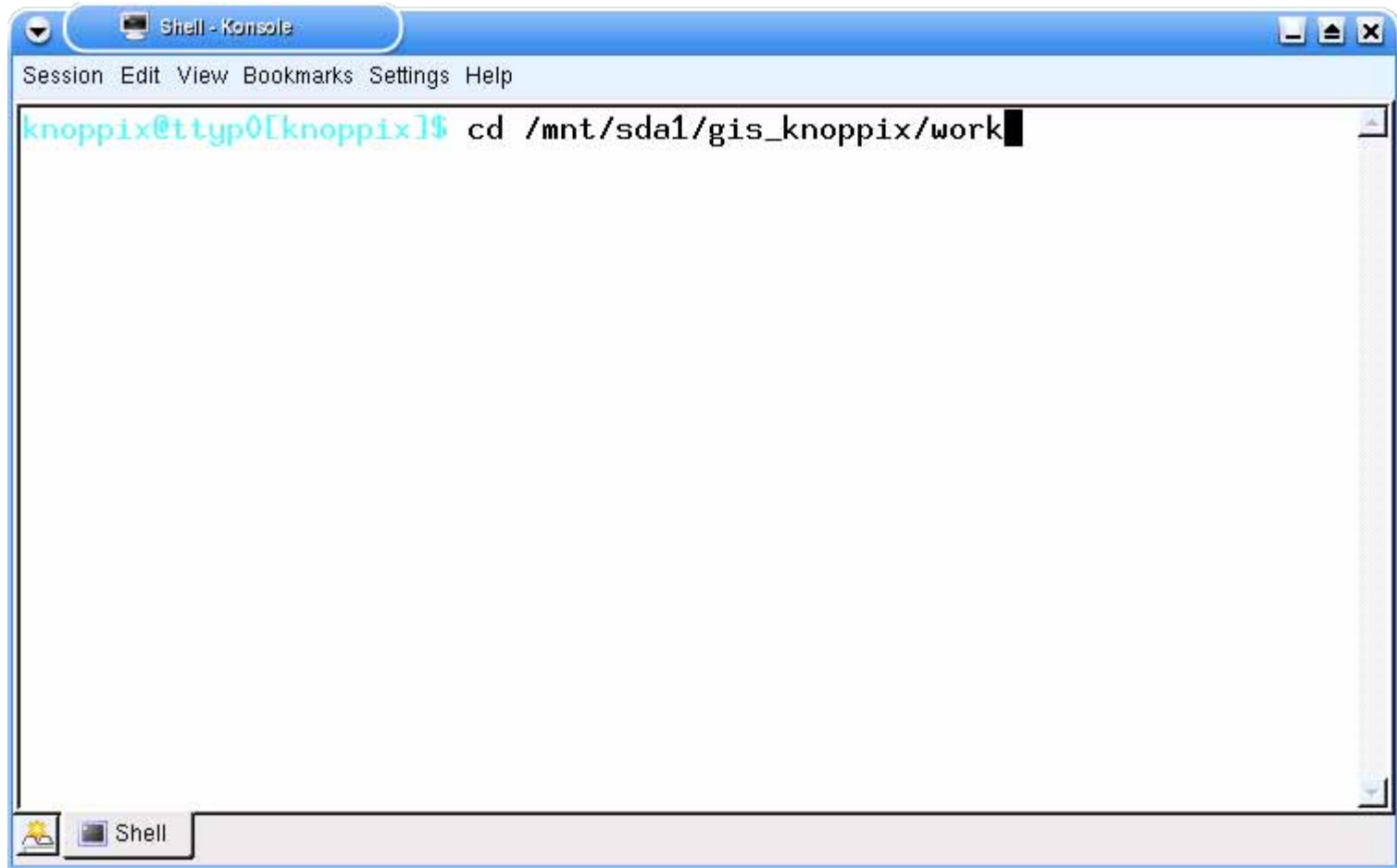
## 4.4b Move to “work” directory

### Step1 : Open “Terminal Program”



**Step2** : On the Terminal window, write following command and hit <enter(return)> key

**> cd /mnt/sda1/gis\_knoppix/work**     : space



```
knoppix@tty0[knoppix]$ cd /mnt/sda1/gis_knoppix/work
```

## **Section 2.**

# **SPOT Image Processing in UTM Coordinate System**

## **Section 2. SPOT Image Processing in UTM Coordinate System**

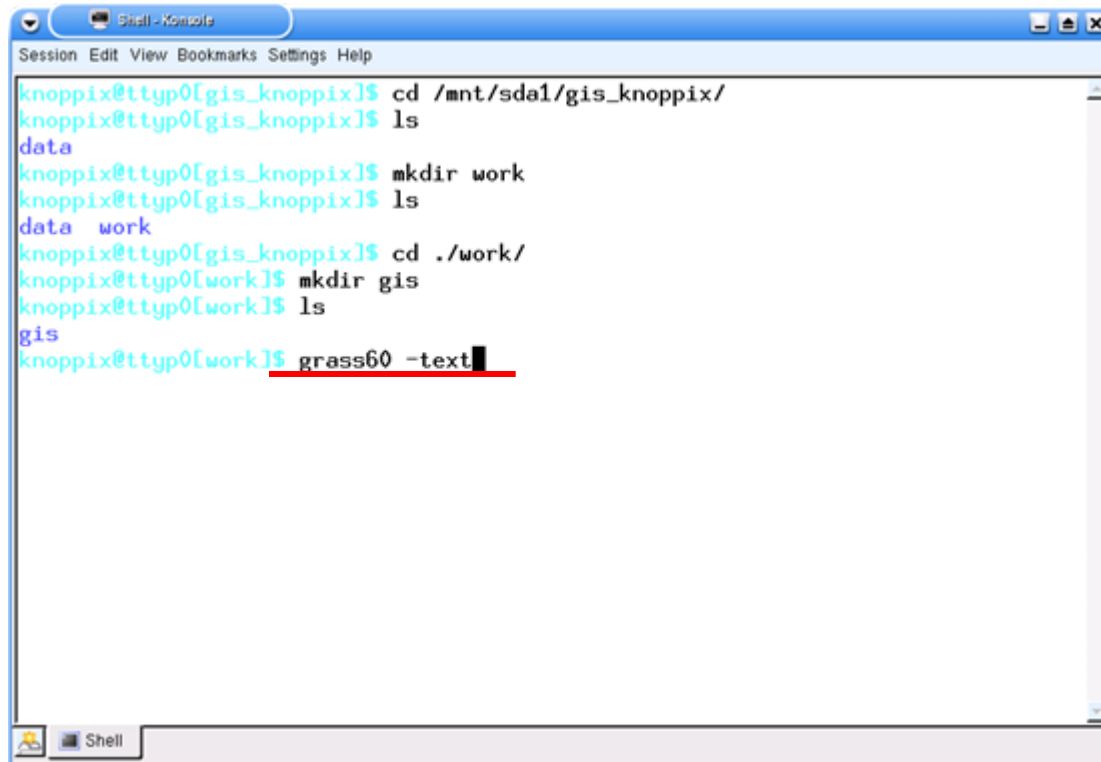
# **1. Starting and Terminating GRASS**

# 1.1 Starting GRASS

> grass60  -text  : space

This program is used to start GRASS. It will parse the command line arguments and then initialize GRASS for the user.

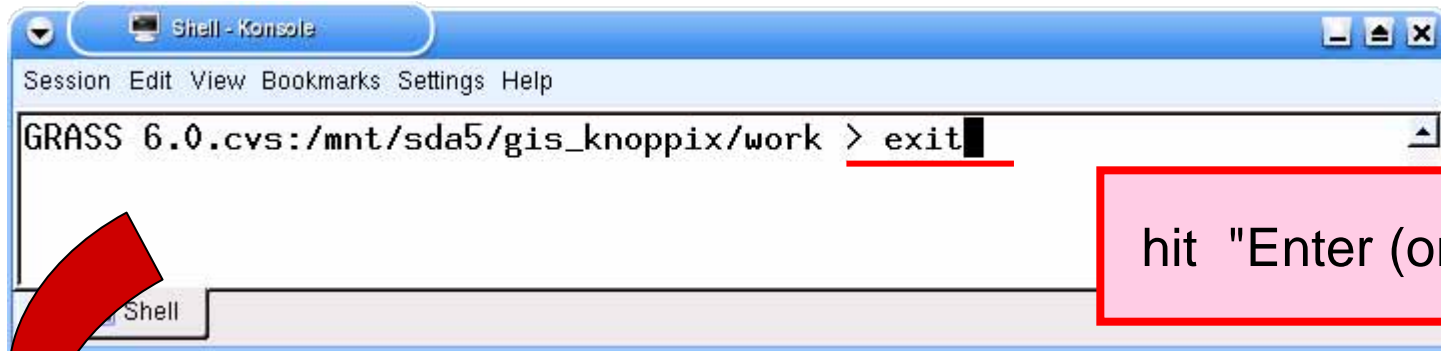
**-text** : Indicates that the text based user interface should be used



```
knoppix@tty0[gis_knoppix]$ cd /mnt/sda1/gis_knoppix/
knoppix@tty0[gis_knoppix]$ ls
data
knoppix@tty0[gis_knoppix]$ mkdir work
knoppix@tty0[gis_knoppix]$ ls
data work
knoppix@tty0[gis_knoppix]$ cd ./work/
knoppix@tty0[work]$ mkdir gis
knoppix@tty0[work]$ ls
gis
knoppix@tty0[work]$ grass60 -text
```

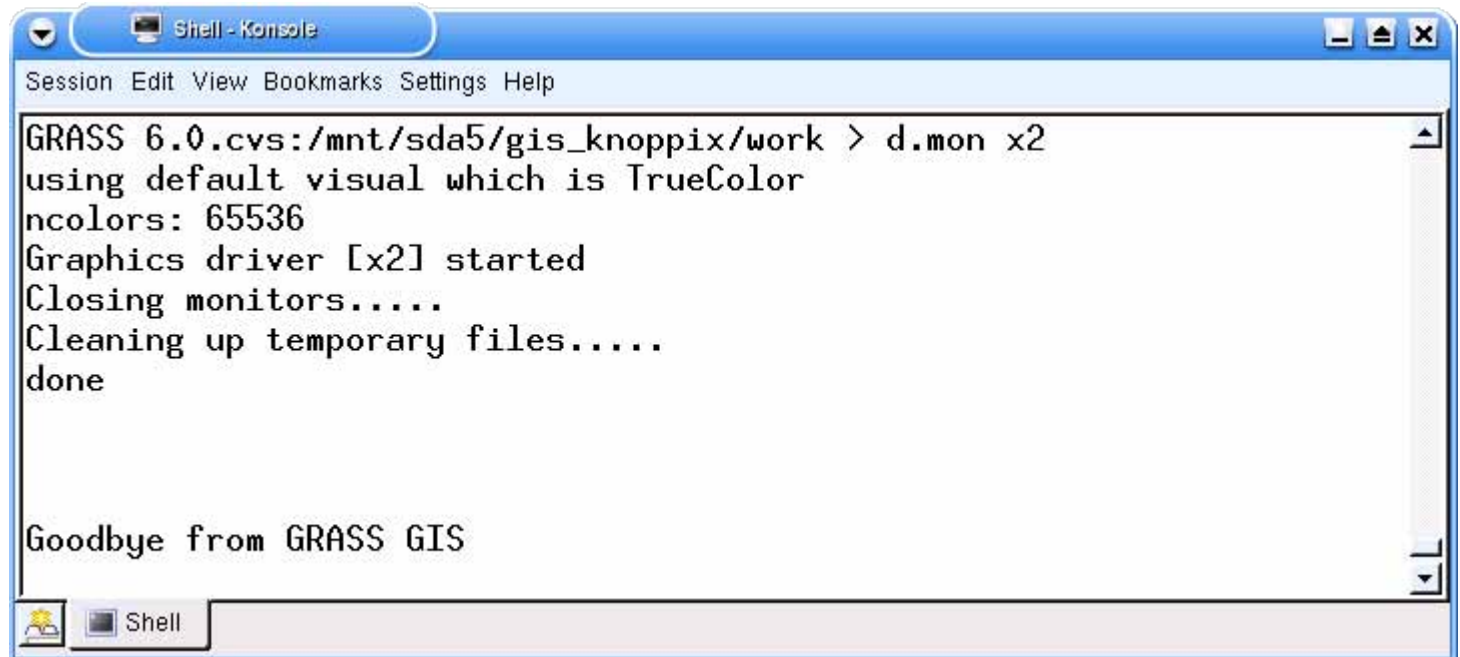
# 1.2 Terminate GRASS

> exit



```
Shell - Konsole
Session Edit View Bookmarks Settings Help
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > exit
```

hit "Enter (or Return)"



```
Shell - Konsole
Session Edit View Bookmarks Settings Help
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.mon x2
using default visual which is TrueColor
ncolors: 65536
Graphics driver [x2] started
Closing monitors.....
Cleaning up temporary files.....
done

Goodbye from GRASS GIS
```

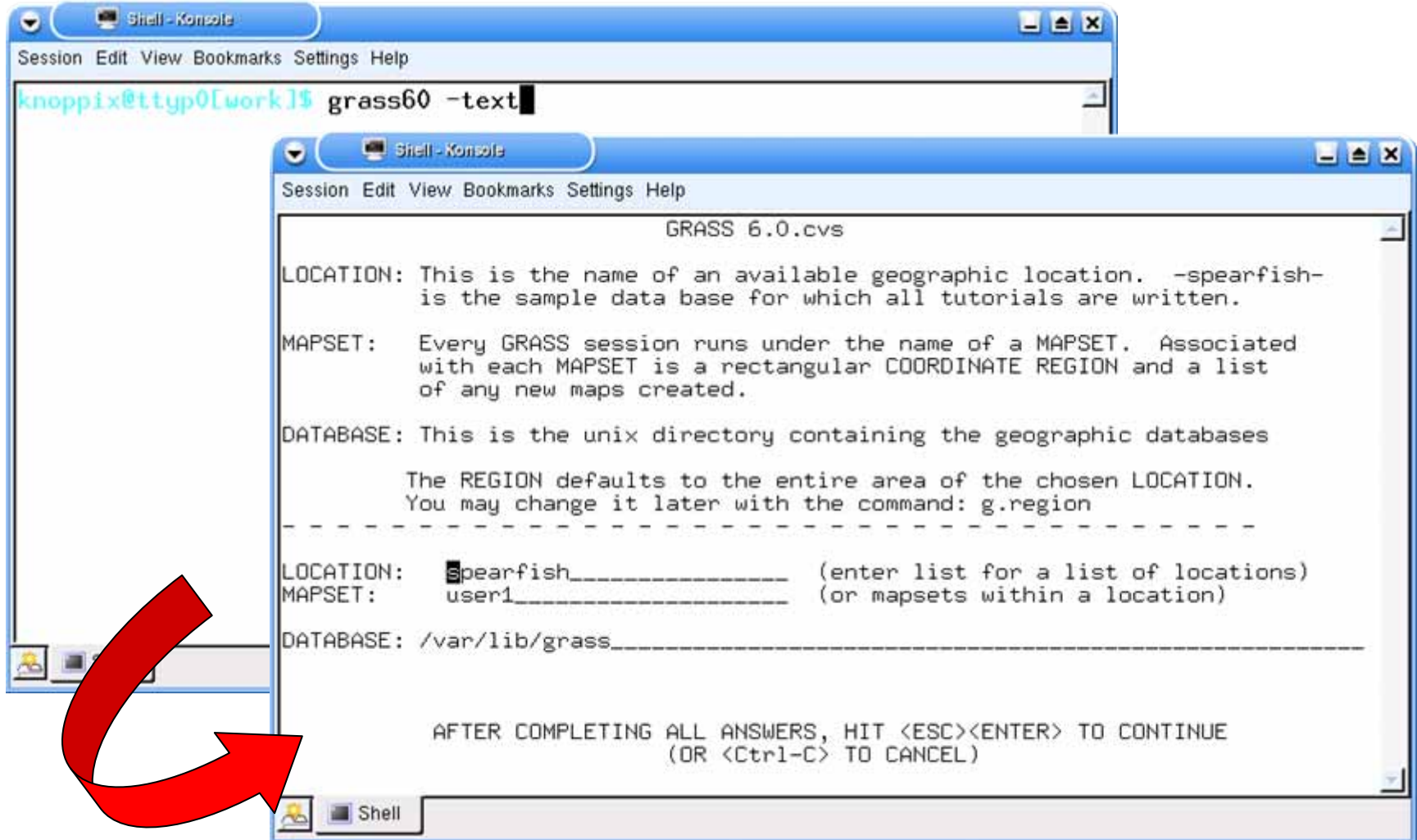
## **Section 2. SPOT Image Processing in UTM Coordinate System**

# **2. Defining coordinate system and region**

## 2.1 Starting GRASS

> grass60 -text

: space



```
knoppix@tty0[work]$ grass60 -text
```

GRASS 6.0.cvs

LOCATION: This is the name of an available geographic location. -spearfish- is the sample data base for which all tutorials are written.

MAPSET: Every GRASS session runs under the name of a MAPSET. Associated with each MAPSET is a rectangular COORDINATE REGION and a list of any new maps created.

DATABASE: This is the unix directory containing the geographic databases

The REGION defaults to the entire area of the chosen LOCATION.  
You may change it later with the command: g.region

-----

LOCATION: Spearfish (enter list for a list of locations)  
MAPSET: user1 (or mapsets within a location)

DATABASE: /var/lib/grass

-----

AFTER COMPLETING ALL ANSWERS, HIT <ESC><ENTER> TO CONTINUE  
(OR <Ctrl-C> TO CANCEL)

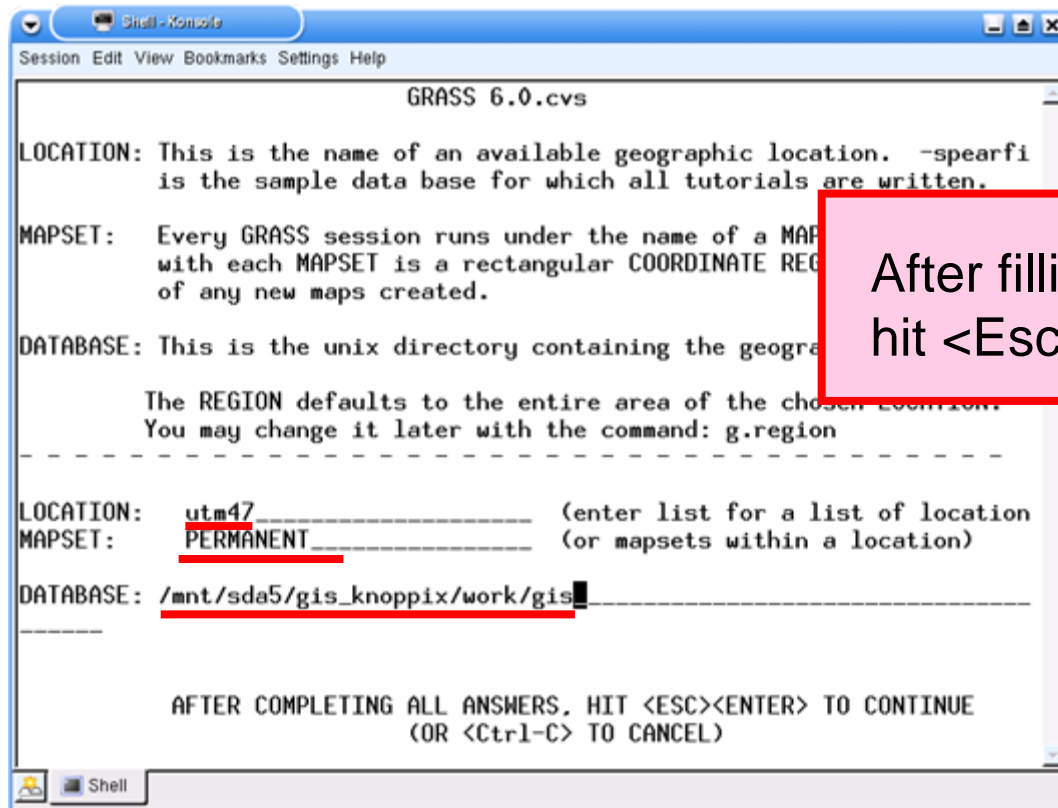


## 2.2 Determination of LOCATION, MAPSET, DATABASE

LOCATION: **utm47** ( in this case, UTM Zone is 47 )

MAPSET: **PERMANENT**

DATABASE: **/mnt/sda1/gis\_knoppix/work/gis**



The screenshot shows a terminal window titled "Shell - Konsole" with a menu bar (Session, Edit, View, Bookmarks, Settings, Help). The window displays the GRASS 6.0.cvs installation process. It prompts the user to enter a LOCATION, MAPSET, and DATABASE. The user has entered "utm47" for LOCATION, "PERMANENT" for MAPSET, and "/mnt/sda5/gis\_knoppix/work/gis" for DATABASE. The text "After filling the above information, hit <Esc> + <Enter (or Return) >" is overlaid on the right side of the terminal window. The terminal also shows instructions for the REGION defaults and a prompt to hit <ESC><ENTER> to continue or <Ctrl-C> to cancel.

```
GRASS 6.0.cvs

LOCATION: This is the name of an available geographic location. -spearfi
is the sample data base for which all tutorials are written.

MAPSET: Every GRASS session runs under the name of a MAP
with each MAPSET is a rectangular COORDINATE REC
of any new maps created.

DATABASE: This is the unix directory containing the geogra

The REGION defaults to the entire area of the chosen location.
You may change it later with the command: g.region

-----

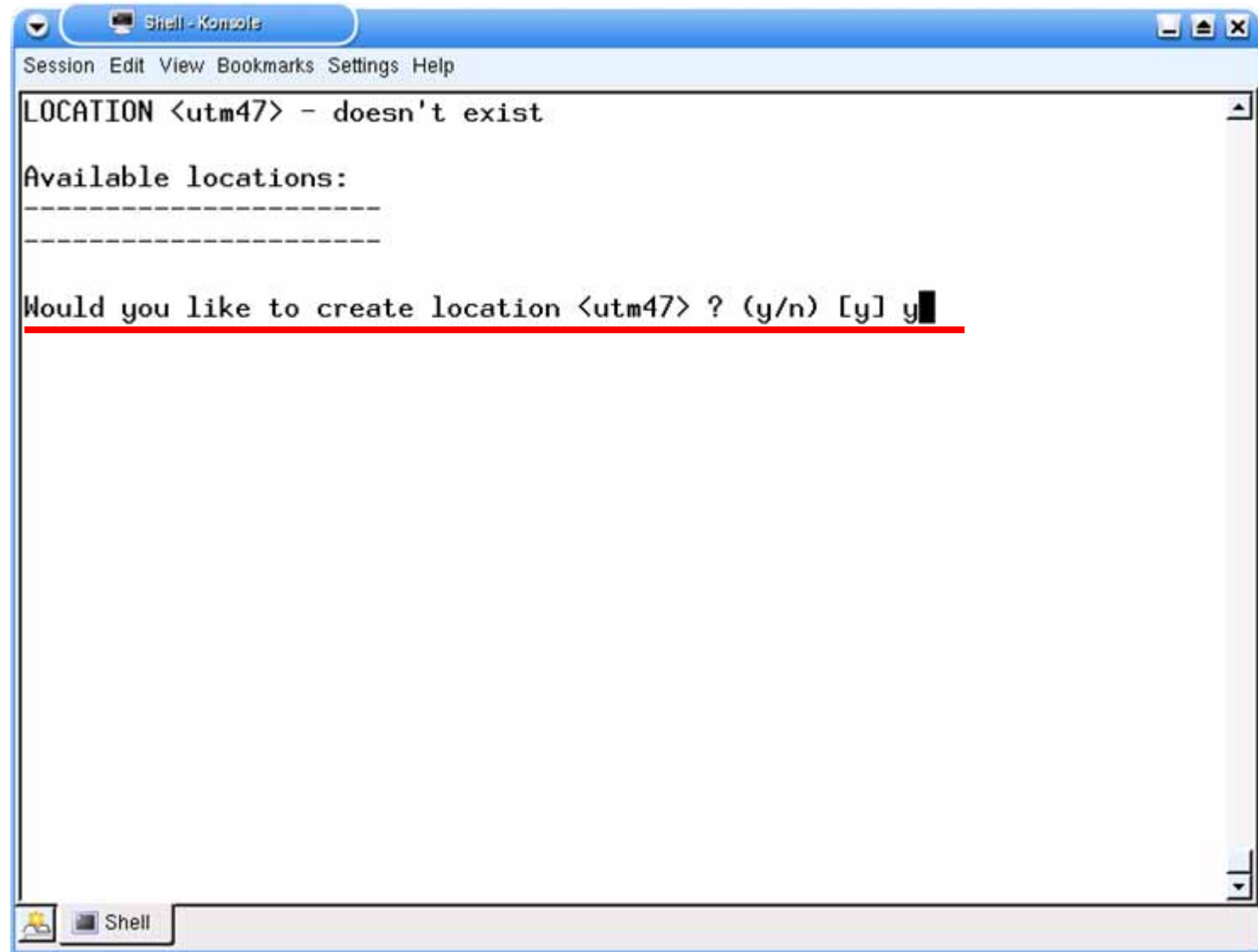
LOCATION: utm47 (enter list for a list of location
MAPSET: PERMANENT (or mapsets within a location)
DATABASE: /mnt/sda5/gis_knoppix/work/gis

-----

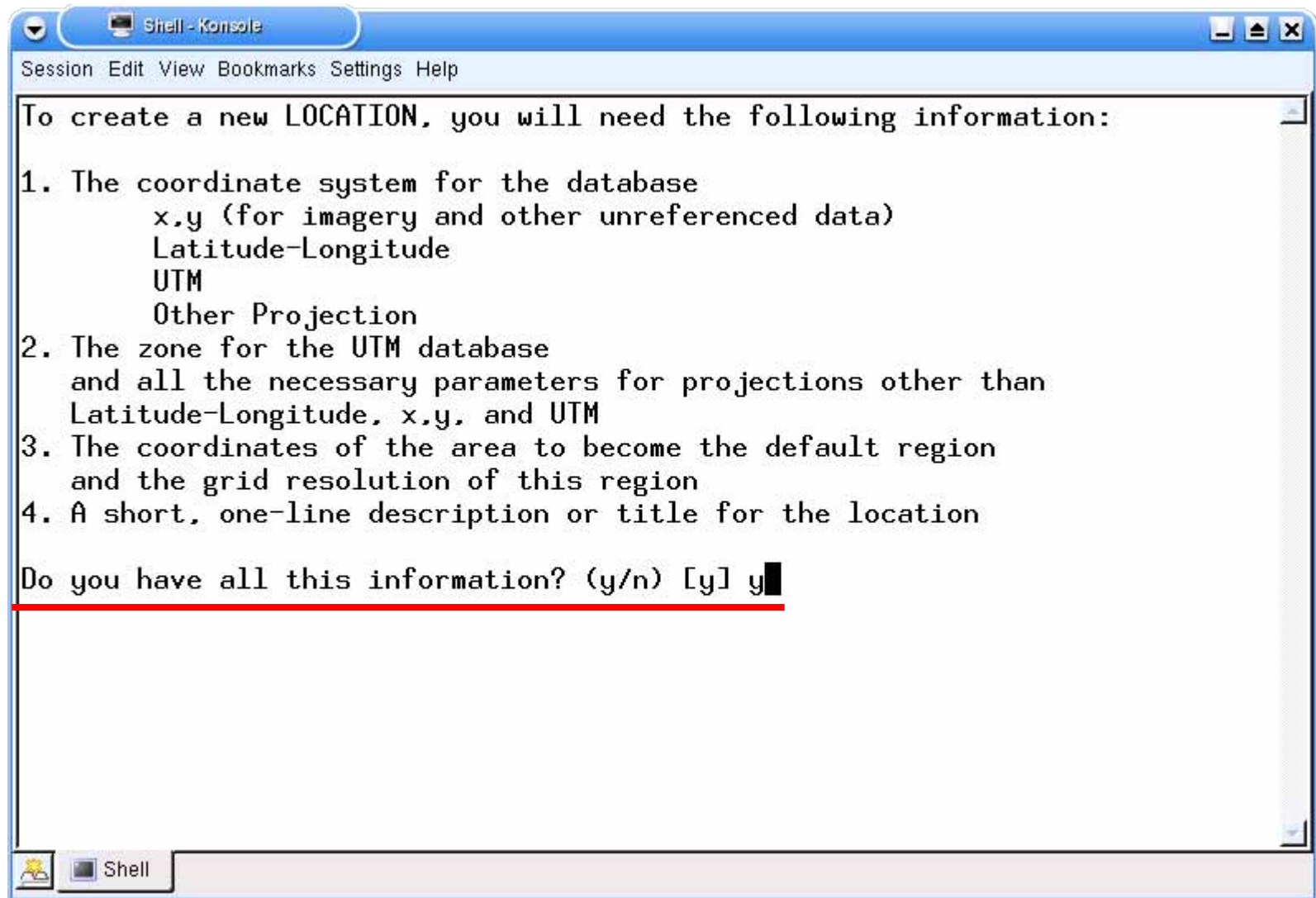
AFTER COMPLETING ALL ANSWERS, HIT <ESC><ENTER> TO CONTINUE
(OR <Ctrl-C> TO CANCEL)
```

After filling the above information,  
hit <Esc> + <Enter (or Return) >

enter < y >, then hit < Enter (or Return) >



enter < y >, then hit < Enter (or Return) >



```
Shell - Konsole
Session Edit View Bookmarks Settings Help

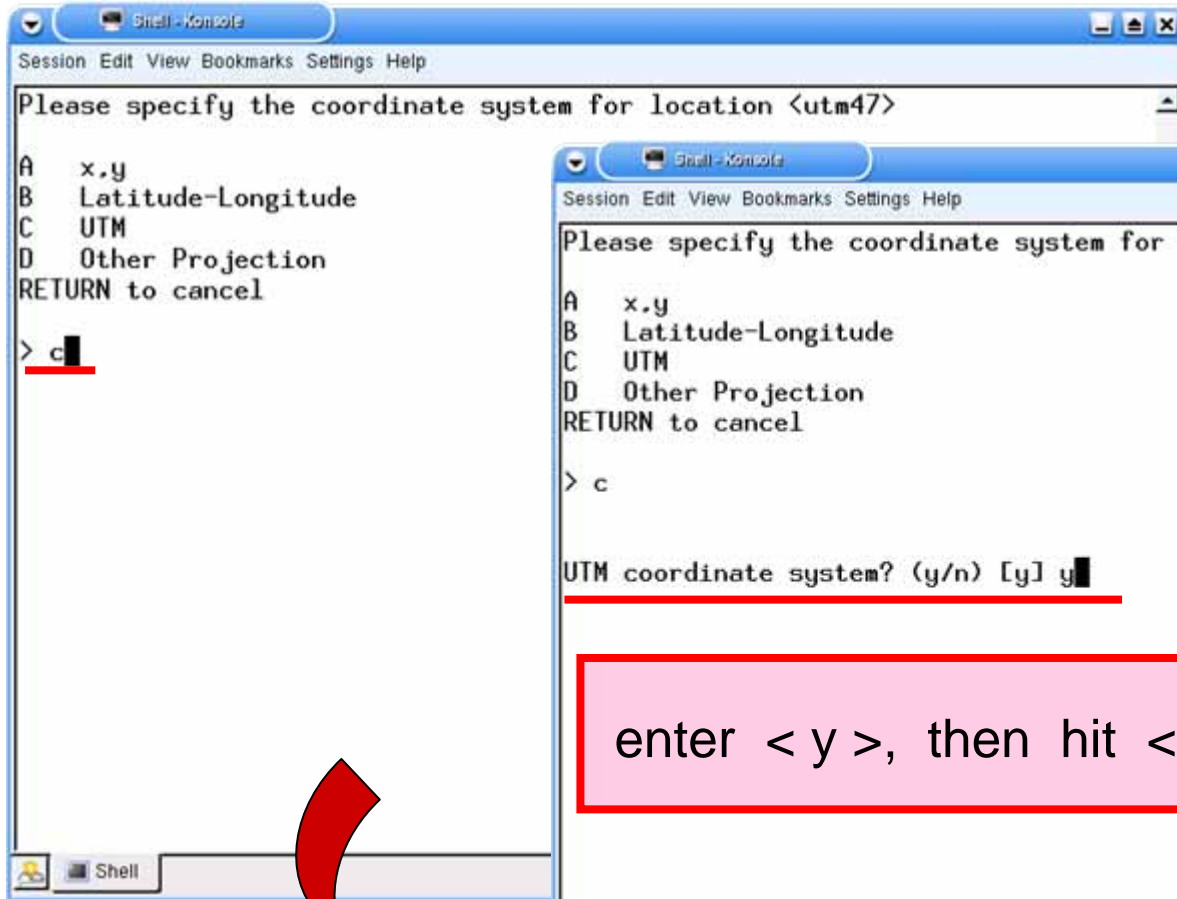
To create a new LOCATION, you will need the following information:

1. The coordinate system for the database
    x,y (for imagery and other unreferenced data)
    Latitude-Longitude
    UTM
    Other Projection
2. The zone for the UTM database
    and all the necessary parameters for projections other than
    Latitude-Longitude, x,y, and UTM
3. The coordinates of the area to become the default region
    and the grid resolution of this region
4. A short, one-line description or title for the location

Do you have all this information? (y/n) [y] y
```

## 2.3 Selection of projection : Latitude-longitude coordinate

enter < c >, then hit < Enter (or Return) >

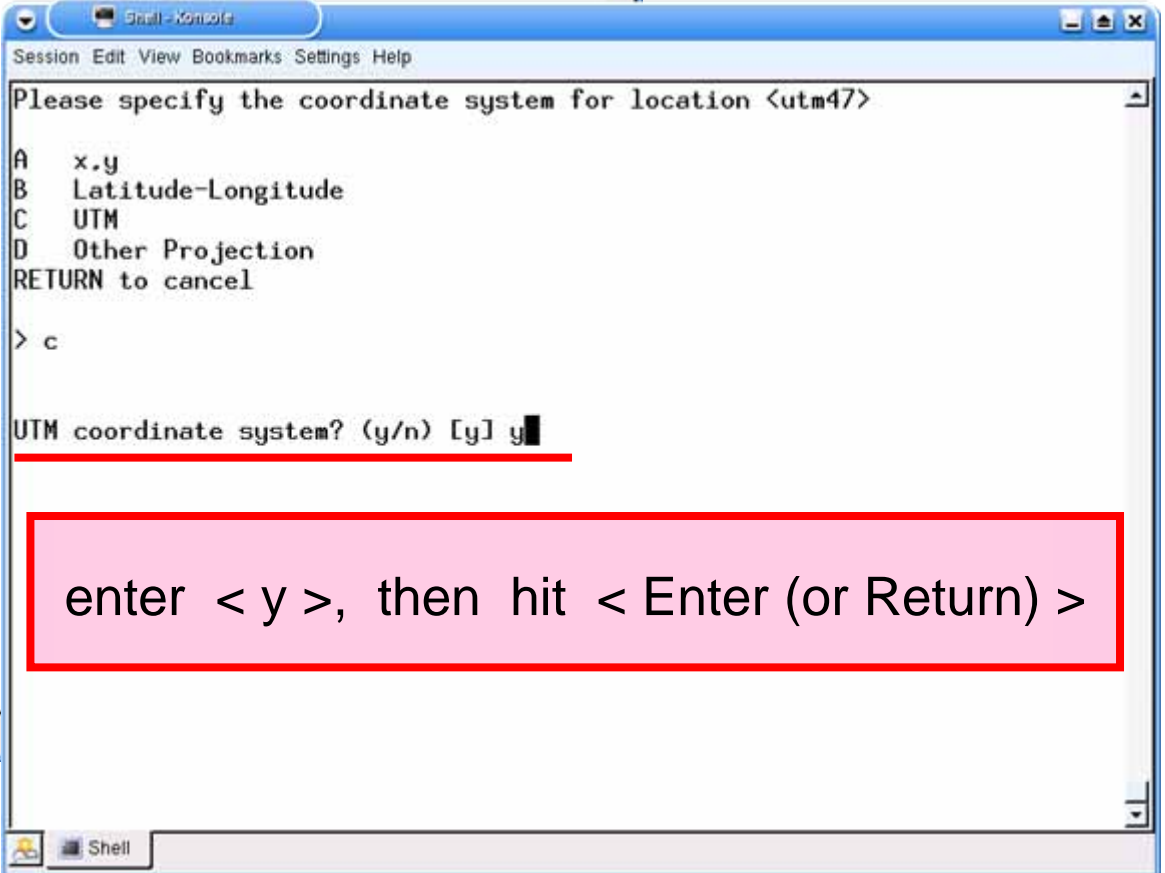


```
Shell - Konsole
Session Edit View Bookmarks Settings Help

Please specify the coordinate system for location <utm47>

A  x.y
B  Latitude-Longitude
C  UTM
D  Other Projection
RETURN to cancel

> c
```



```
Shell - Konsole
Session Edit View Bookmarks Settings Help

Please specify the coordinate system for location <utm47>

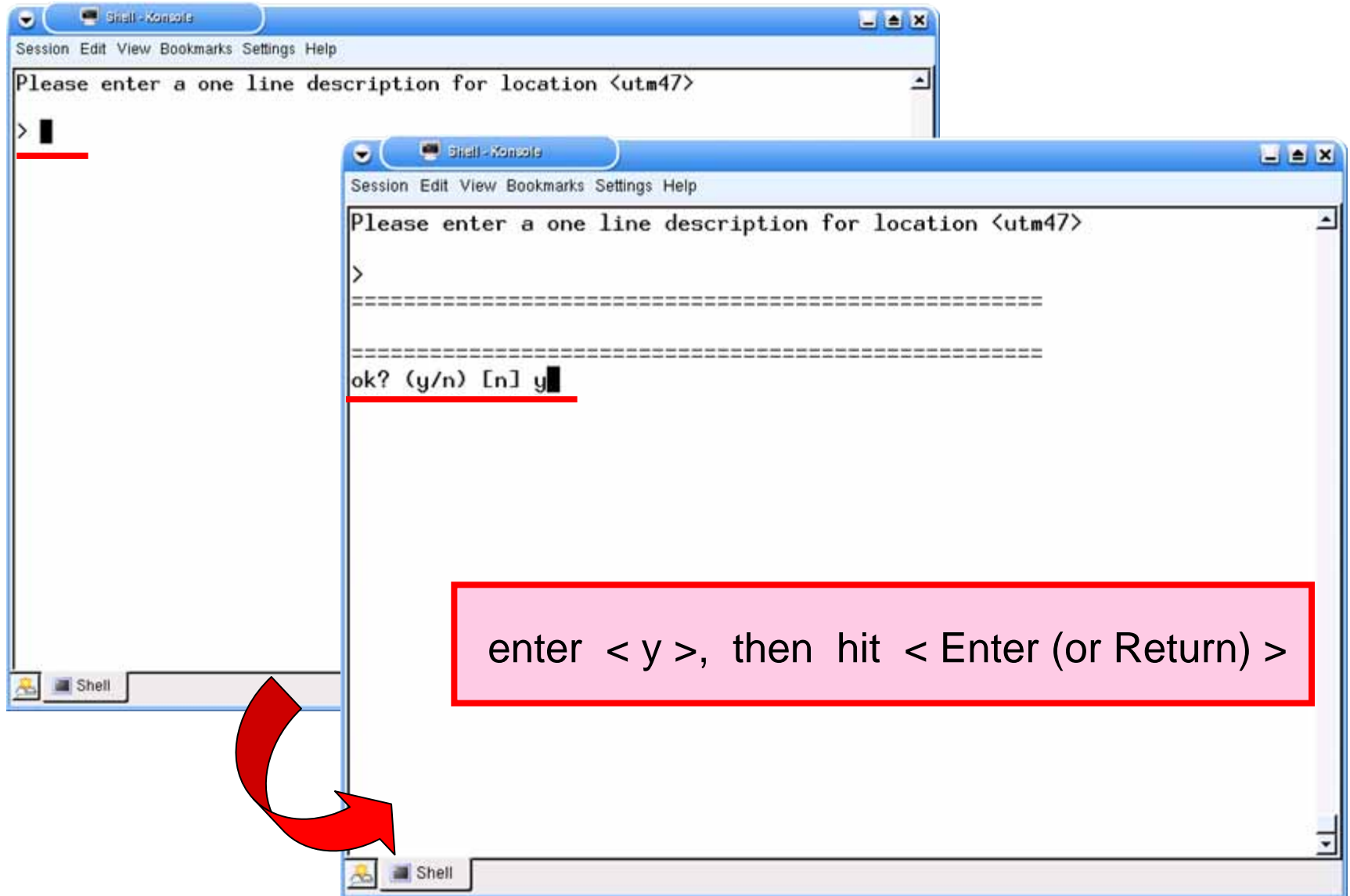
A  x.y
B  Latitude-Longitude
C  UTM
D  Other Projection
RETURN to cancel

> c

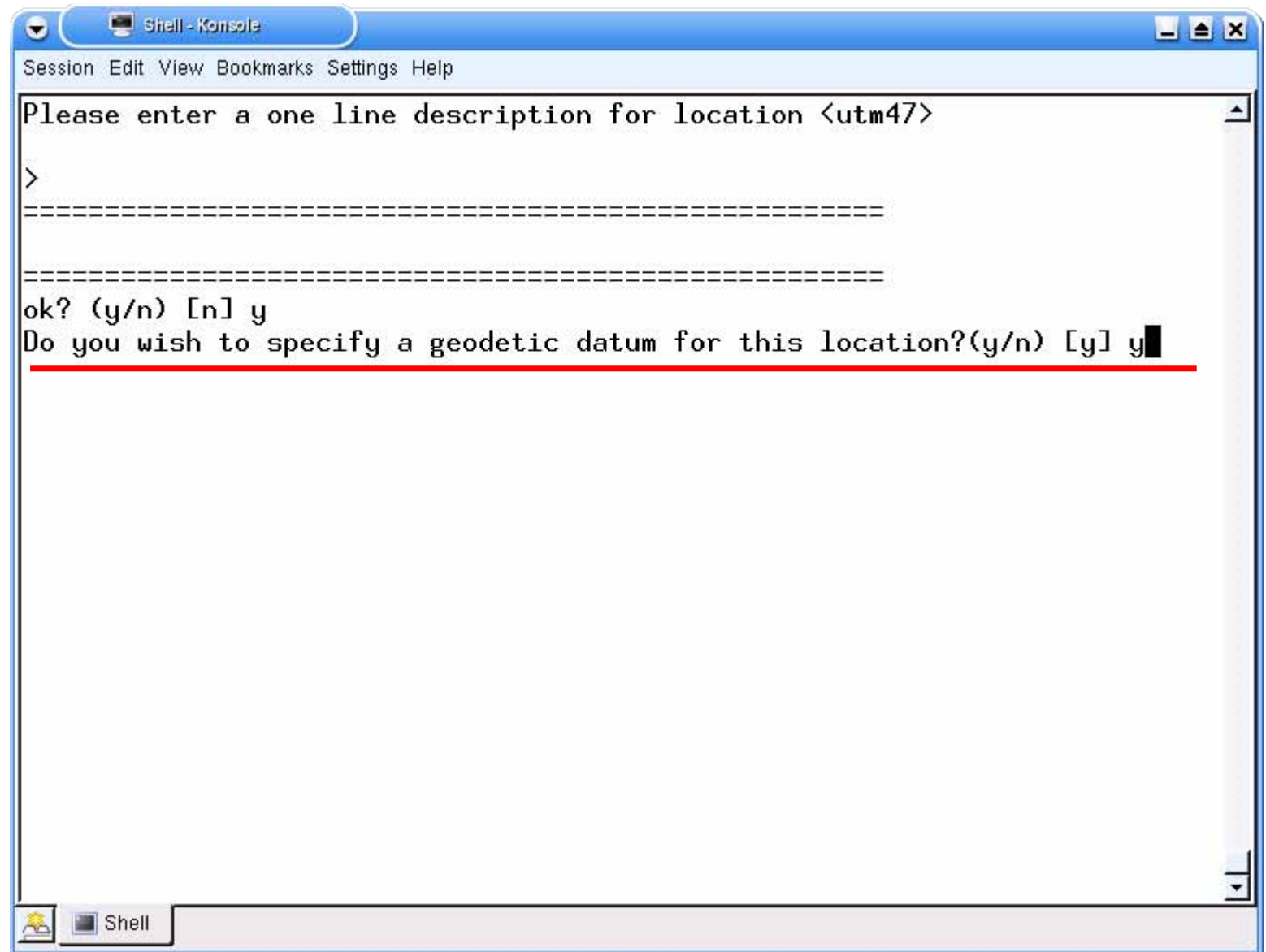
UTM coordinate system? (y/n) [y] y
```

enter < y >, then hit < Enter (or Return) >

just hit < Enter (or Return) >



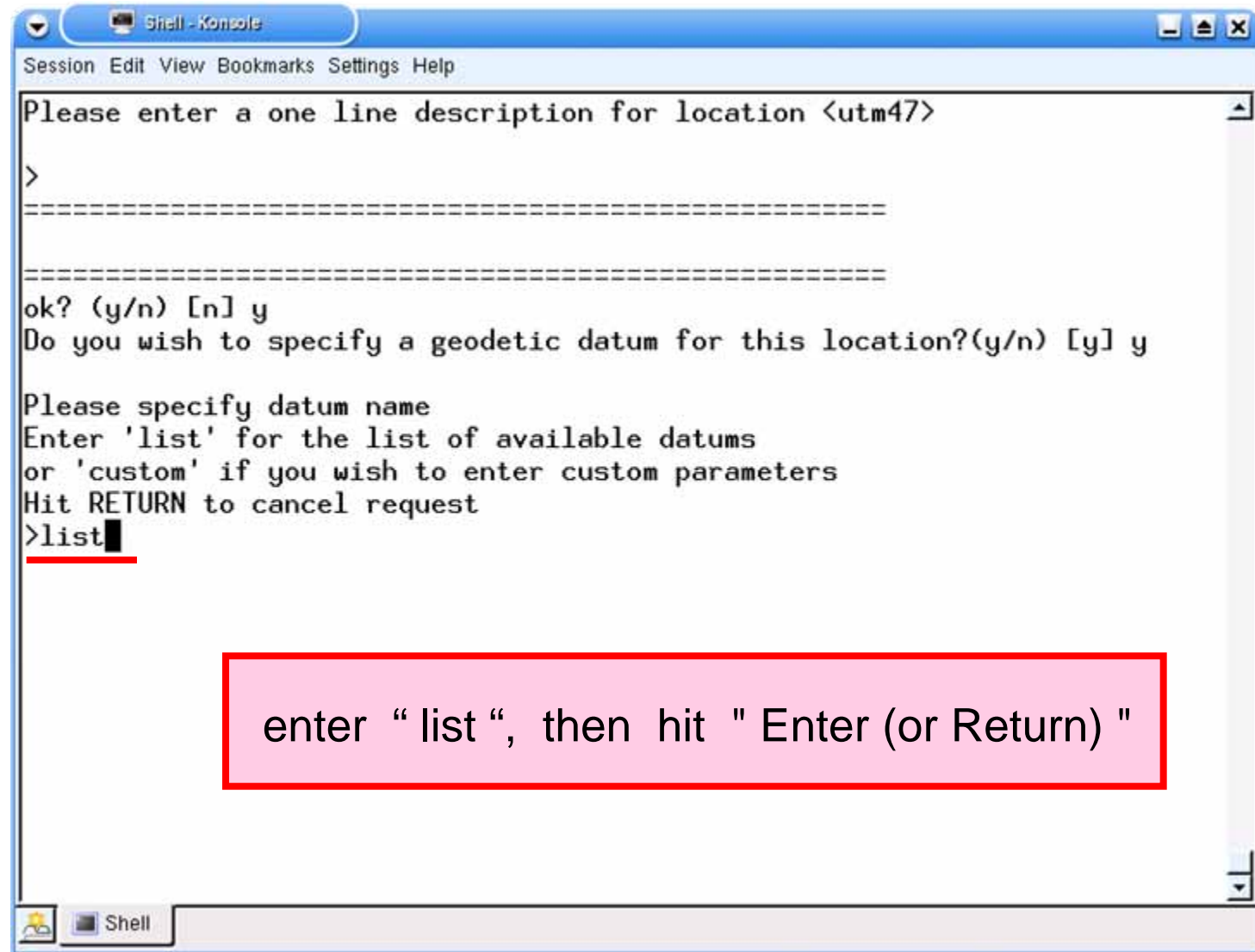
enter "y", then hit "Enter (or Return)"



```
Shell - Konsole
Session Edit View Bookmarks Settings Help

Please enter a one line description for location <utm47>
>
=====
=====
ok? (y/n) [n] y
Do you wish to specify a geodetic datum for this location?(y/n) [y] y
```

## 2.4 Selection of datum



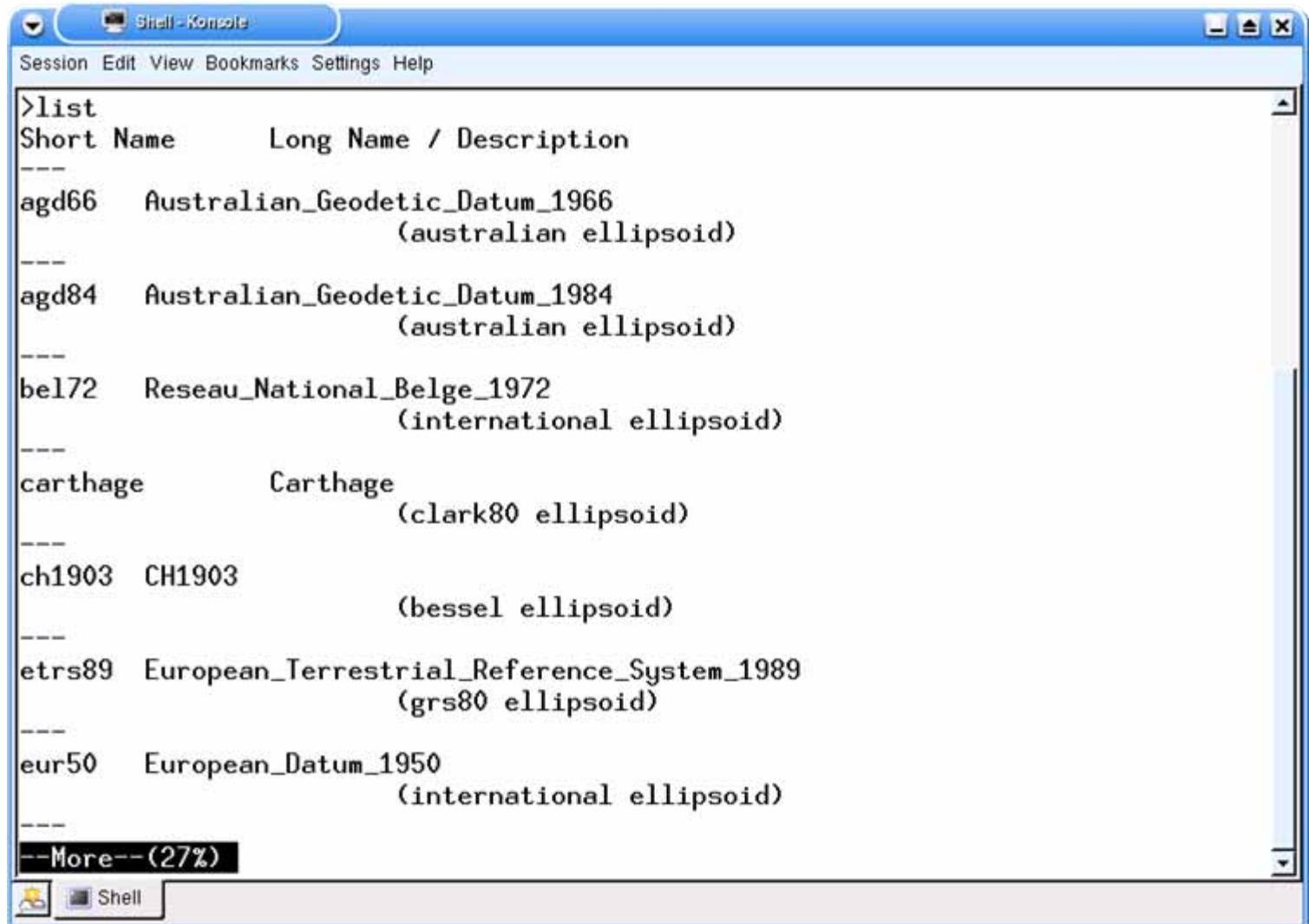
```
Shell - Konsole
Session Edit View Bookmarks Settings Help

Please enter a one line description for location <utm47>
>
=====
=====
ok? (y/n) [n] y
Do you wish to specify a geodetic datum for this location?(y/n) [y] y

Please specify datum name
Enter 'list' for the list of available datums
or 'custom' if you wish to enter custom parameters
Hit RETURN to cancel request
>list
```

enter " list ", then hit " Enter (or Return) "

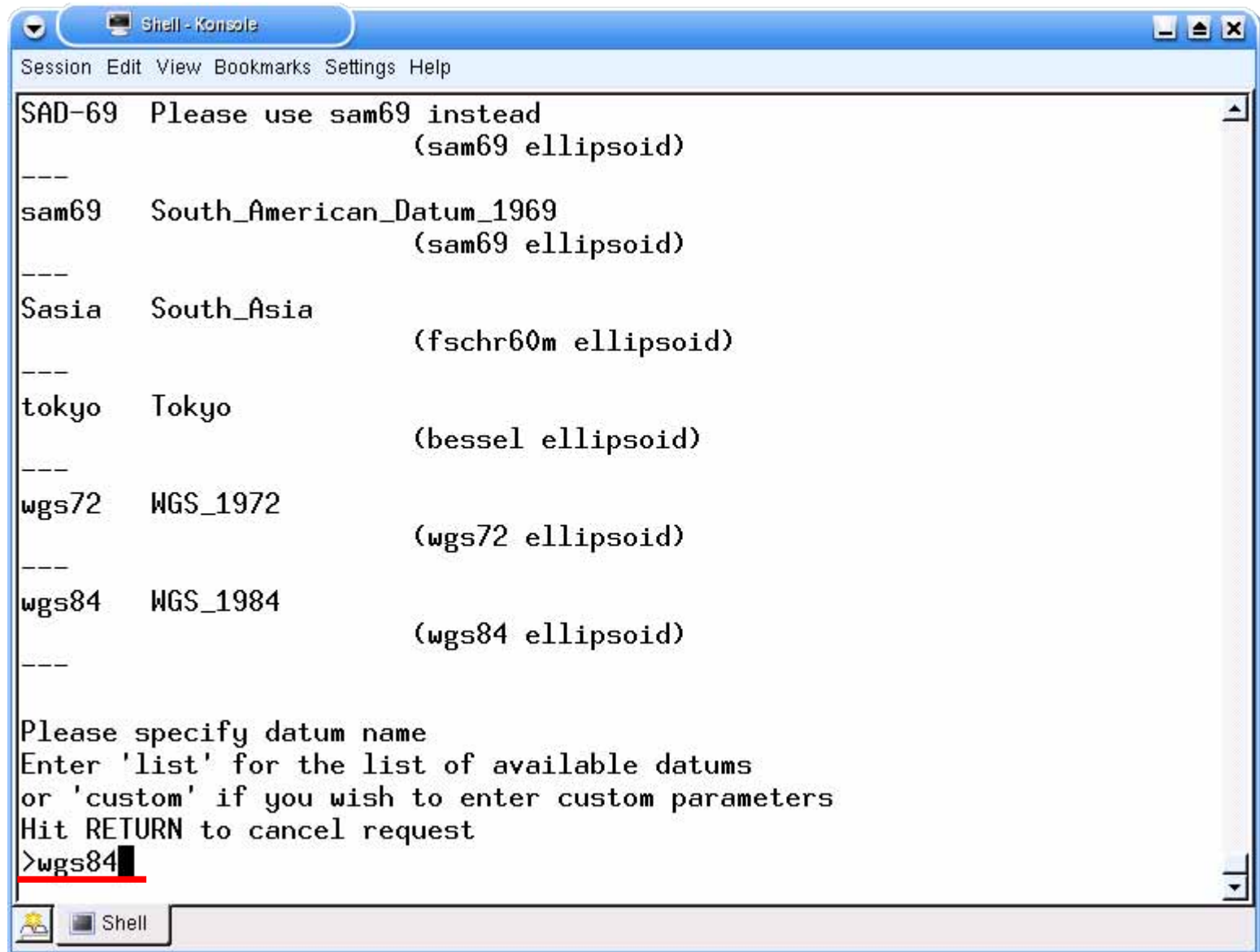
hit "Space" key for page down



```
>list
Short Name      Long Name / Description
----
agd66   Australian_Geodetic_Datum_1966
              (australian ellipsoid)
----
agd84   Australian_Geodetic_Datum_1984
              (australian ellipsoid)
----
bel72   Reseau_National_Belge_1972
              (international ellipsoid)
----
carthage      Carthage
              (clark80 ellipsoid)
----
ch1903  CH1903
              (bessel ellipsoid)
----
etrs89  European_Terrestrial_Reference_System_1989
              (grs80 ellipsoid)
----
eur50   European_Datum_1950
              (international ellipsoid)
----
--More--(27%)
```



enter "wgs84", then hit "Enter (or Return)"



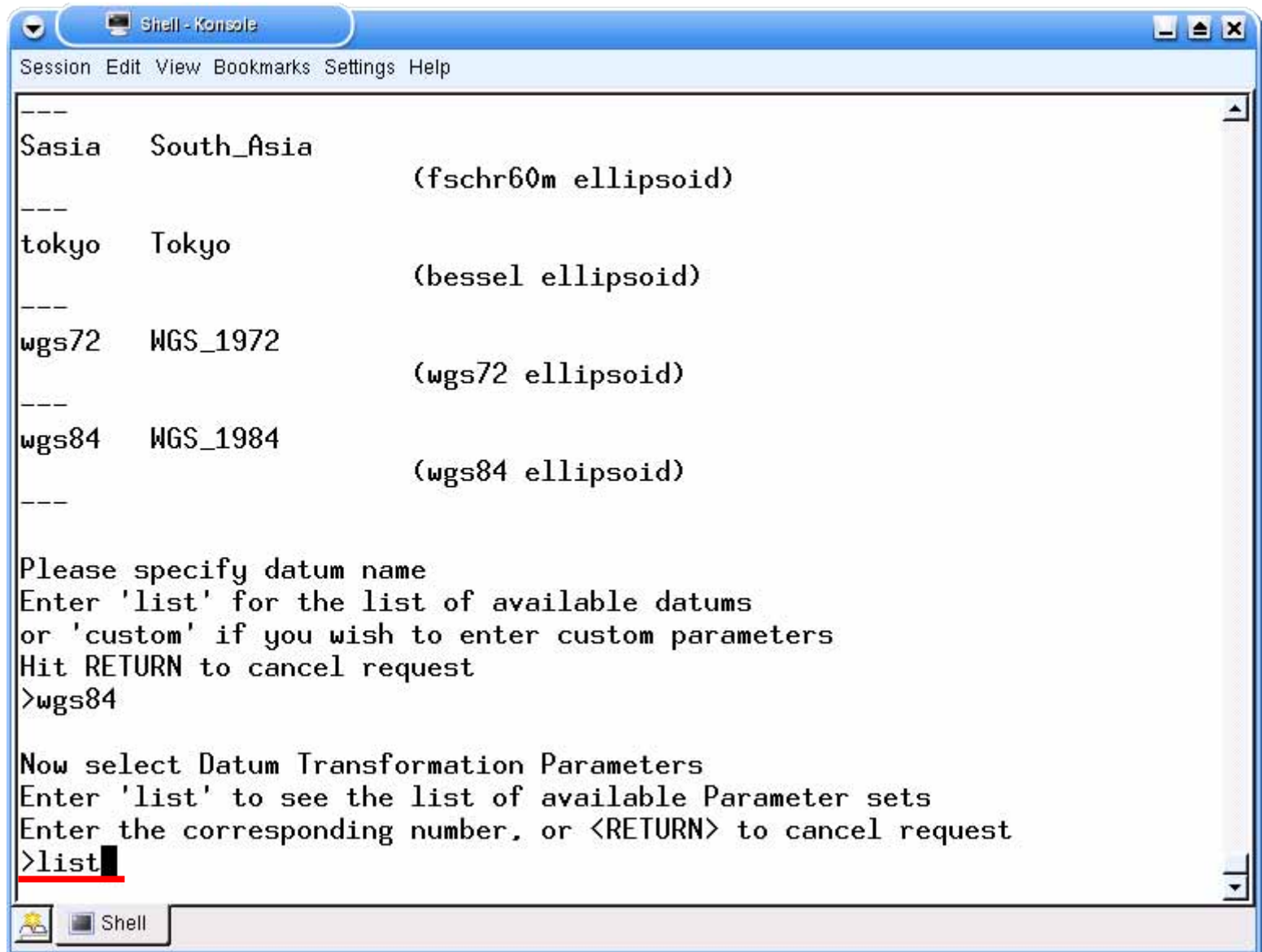
The screenshot shows a terminal window titled "Shell - Konsole". The window has a menu bar with "Session", "Edit", "View", "Bookmarks", "Settings", and "Help". The terminal content is as follows:

```
SAD-69  Please use sam69 instead
              (sam69 ellipsoid)
---
sam69   South_American_Datum_1969
              (sam69 ellipsoid)
---
Sasia   South_Asia
              (fschr60m ellipsoid)
---
tokyo   Tokyo
              (bessel ellipsoid)
---
wgs72   WGS_1972
              (wgs72 ellipsoid)
---
wgs84   WGS_1984
              (wgs84 ellipsoid)
---

Please specify datum name
Enter 'list' for the list of available datums
or 'custom' if you wish to enter custom parameters
Hit RETURN to cancel request
>wgs84
```

The input ">wgs84" is underlined with a red line, and a black cursor is at the end of the line. The terminal window has a taskbar at the bottom with a "Shell" icon and label.

enter "list", then hit "Enter (or Return)"

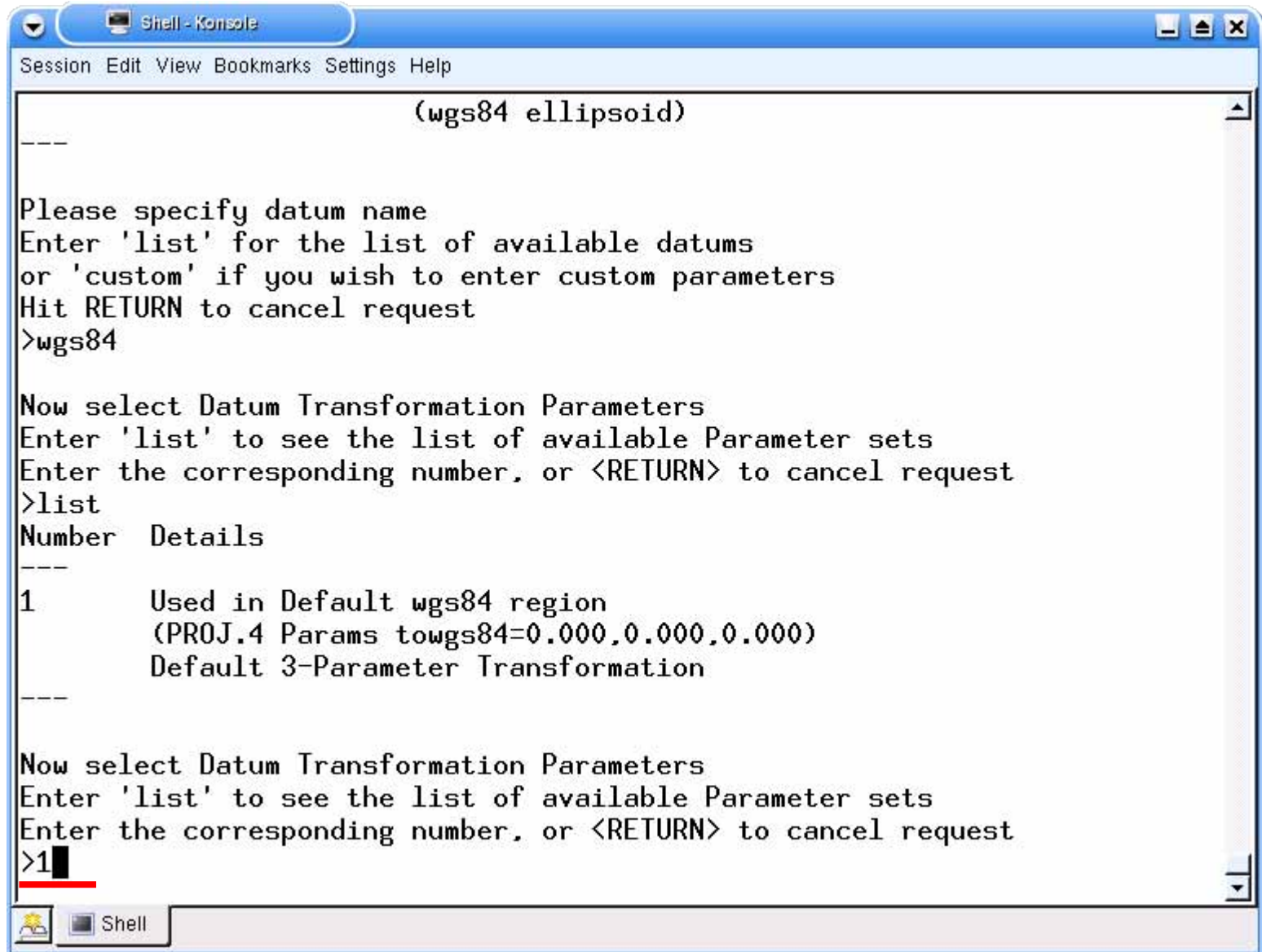


The screenshot shows a terminal window titled "Shell - Konsole" with a menu bar (Session, Edit, View, Bookmarks, Settings, Help). The terminal content is as follows:

```
---  
Sasia    South_Asia  
          (fschr60m ellipsoid)  
---  
tokyo    Tokyo  
          (bessel ellipsoid)  
---  
wgs72    WGS_1972  
          (wgs72 ellipsoid)  
---  
wgs84    WGS_1984  
          (wgs84 ellipsoid)  
---  
  
Please specify datum name  
Enter 'list' for the list of available datums  
or 'custom' if you wish to enter custom parameters  
Hit RETURN to cancel request  
>wgs84  
  
Now select Datum Transformation Parameters  
Enter 'list' to see the list of available Parameter sets  
Enter the corresponding number, or <RETURN> to cancel request  
>list
```

The text ">list" is underlined with a red line. At the bottom of the window, there is a taskbar with a "Shell" icon and label.

enter " 1 ", then hit "Enter (or Return)"



```
Shell - Konsole
Session Edit View Bookmarks Settings Help

(wgs84 ellipsoid)
---
Please specify datum name
Enter 'list' for the list of available datums
or 'custom' if you wish to enter custom parameters
Hit RETURN to cancel request
>wgs84

Now select Datum Transformation Parameters
Enter 'list' to see the list of available Parameter sets
Enter the corresponding number, or <RETURN> to cancel request
>list
Number  Details
---
1       Used in Default wgs84 region
        (PROJ.4 Params towgs84=0.000,0.000,0.000)
        Default 3-Parameter Transformation
---

Now select Datum Transformation Parameters
Enter 'list' to see the list of available Parameter sets
Enter the corresponding number, or <RETURN> to cancel request
>1
```

enter " 47 ", then hit "Enter (or Return)"

```
Shell - Konsole
Session Edit View Bookmarks Settings Help

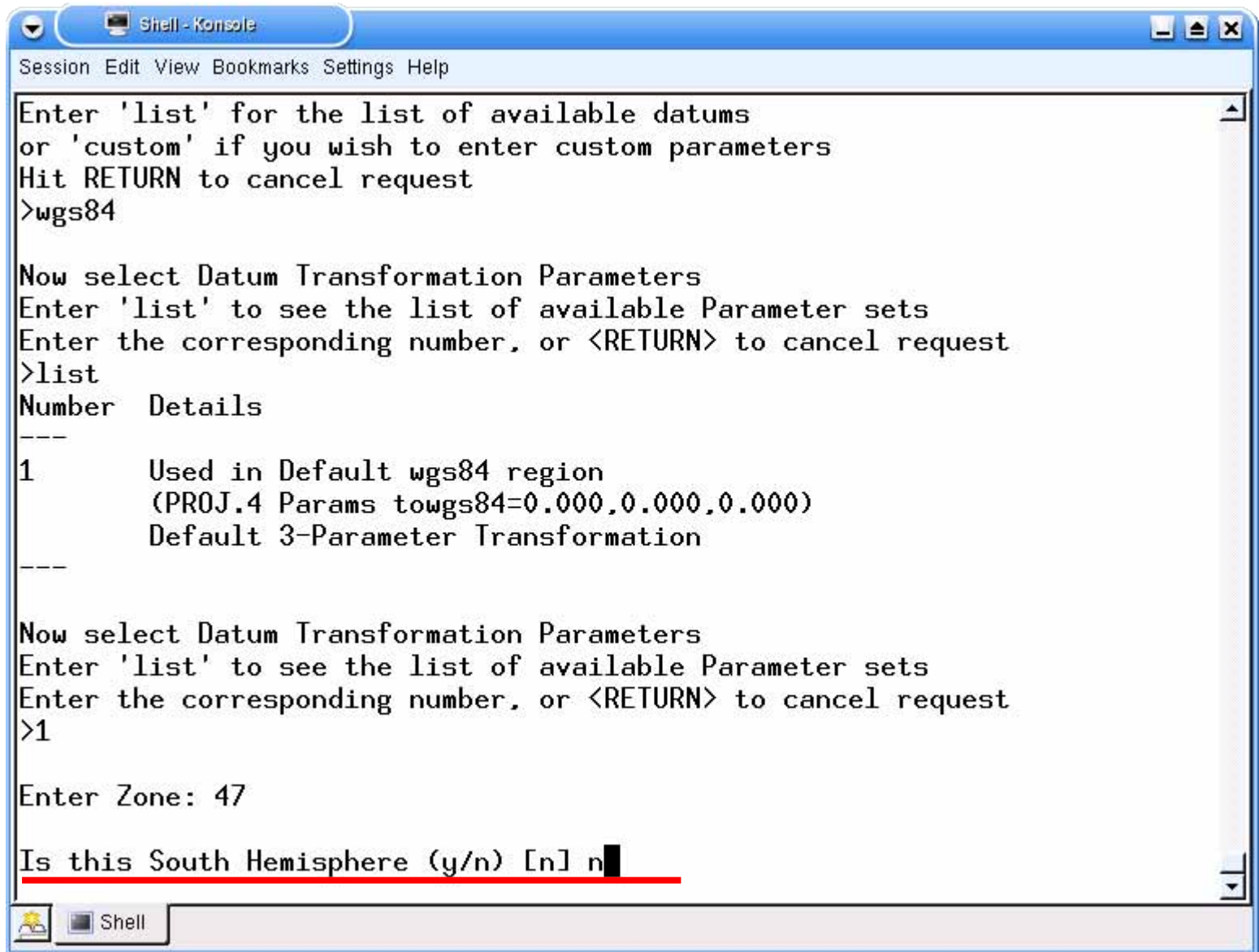
Please specify datum name
Enter 'list' for the list of available datums
or 'custom' if you wish to enter custom parameters
Hit RETURN to cancel request
>wgs84

Now select Datum Transformation Parameters
Enter 'list' to see the list of available Parameter sets
Enter the corresponding number, or <RETURN> to cancel request
>list
Number  Details
---
1        Used in Default wgs84 region
        (PROJ.4 Params towgs84=0.000,0.000,0.000)
        Default 3-Parameter Transformation
---

Now select Datum Transformation Parameters
Enter 'list' to see the list of available Parameter sets
Enter the corresponding number, or <RETURN> to cancel request
>1

Enter Zone: 47
```

enter "n", then hit "Enter (or Return)"



```
Shell - Konsole
Session Edit View Bookmarks Settings Help

Enter 'list' for the list of available datums
or 'custom' if you wish to enter custom parameters
Hit RETURN to cancel request
>wgs84

Now select Datum Transformation Parameters
Enter 'list' to see the list of available Parameter sets
Enter the corresponding number, or <RETURN> to cancel request
>list
Number  Details
---
1       Used in Default wgs84 region
        (PROJ.4 Params towgs84=0.000,0.000,0.000)
        Default 3-Parameter Transformation
---

Now select Datum Transformation Parameters
Enter 'list' to see the list of available Parameter sets
Enter the corresponding number, or <RETURN> to cancel request
>1

Enter Zone: 47

Is this South Hemisphere (y/n) [n] n
```

## 2.5 Definition of region

```
Shell - Konsole
Session Edit View Bookmarks Settings Help

DEFINE THE DEFAULT REGION

===== DEFAULT REGION =====
| NORTH EDGE: 1 |
|               |
| WEST EDGE    | EAST EDGE
| 0            | 1
| SOUTH EDGE: 0 |
|=====|

PROJECTION: 1 (UTM)                ZONE: 47

GRID RESOLUTION
  East-West: 1
  North-South: 1

AFTER COMPLETING ALL ANSWERS, HIT <ESC><ENTER> TO CONTINUE
(OR <Ctrl-C> TO CANCEL)
```

You can use “space” key to erase letters.

You can use “ ” key to move.

## Define the region which includes entire Vietnam

NORTH EDGE : **10000**

SOUTH EDGE : **0**

WEST EDGE : **0**

EAST EDGE : **10000**

GRID RESOLUTION    East-West : **20**  
                                 North-South : **20**

These numbers have no means. You can reset these parameters later to match the imported images.



Shell - Konsole

Session Edit View Bookmarks Settings Help

DEFINE THE DEFAULT REGION

```
===== DEFAULT REGION =====
| NORTH EDGE:10000_____ |
|                               |
WEST EDGE |                               | EAST EDGE
0_____ |                               | 10000_____
| SOUTH EDGE:0_____ |
|                               |
=====
```

PROJECTION: 1 (UTM) ZONE: 47

GRID RESOLUTION

East-West: 20\_\_\_\_

North-South: 20\_\_\_\_

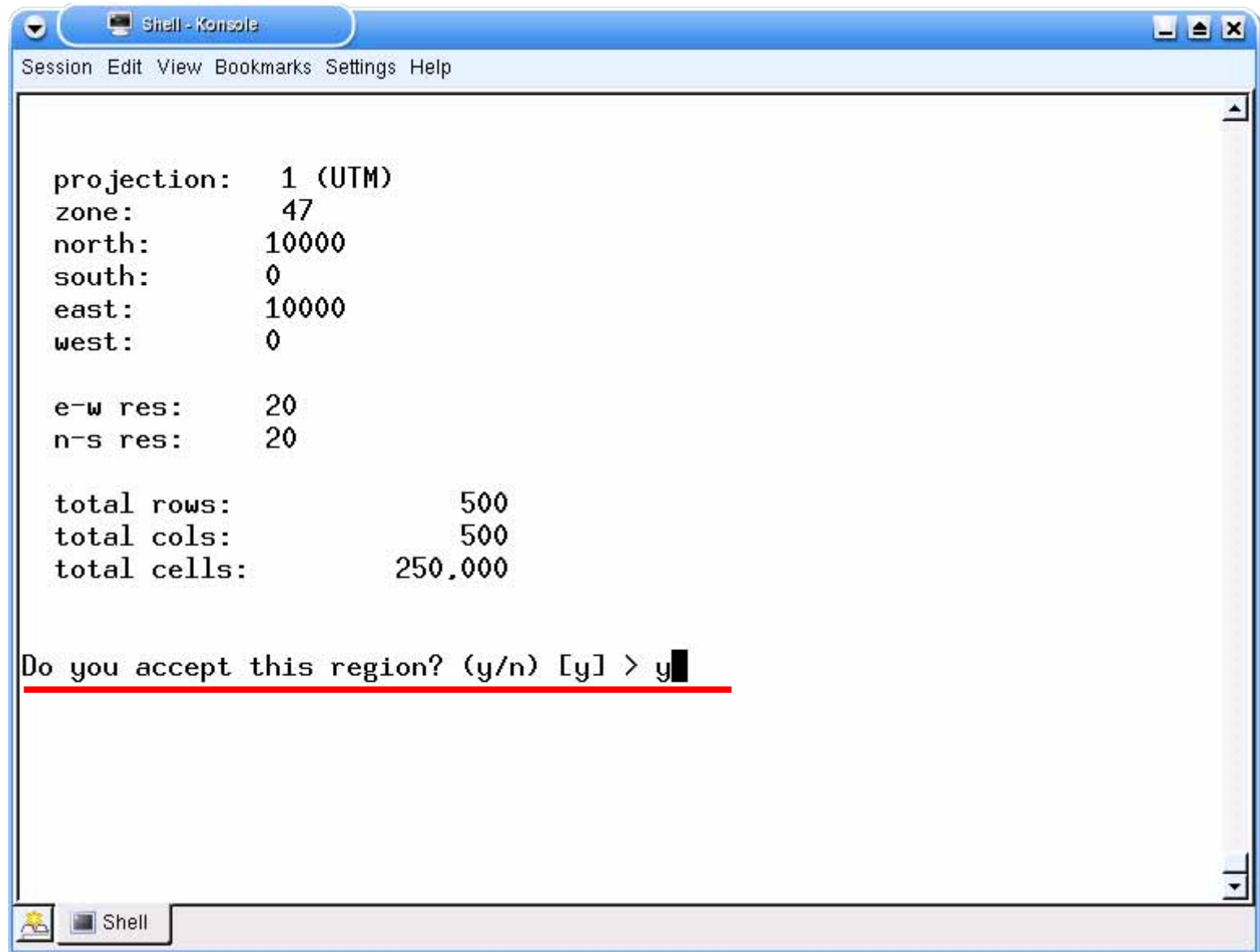
AFTER COMPLETING ALL ANSWERS, HIT <ESC><ENTER> TO CONTINUE  
(OR <Ctrl-C> TO CANCEL)

Shell

After filling the above information,  
hit "Esc" + "Enter (or Return)"



enter "y", then hit "Enter (or Return)"



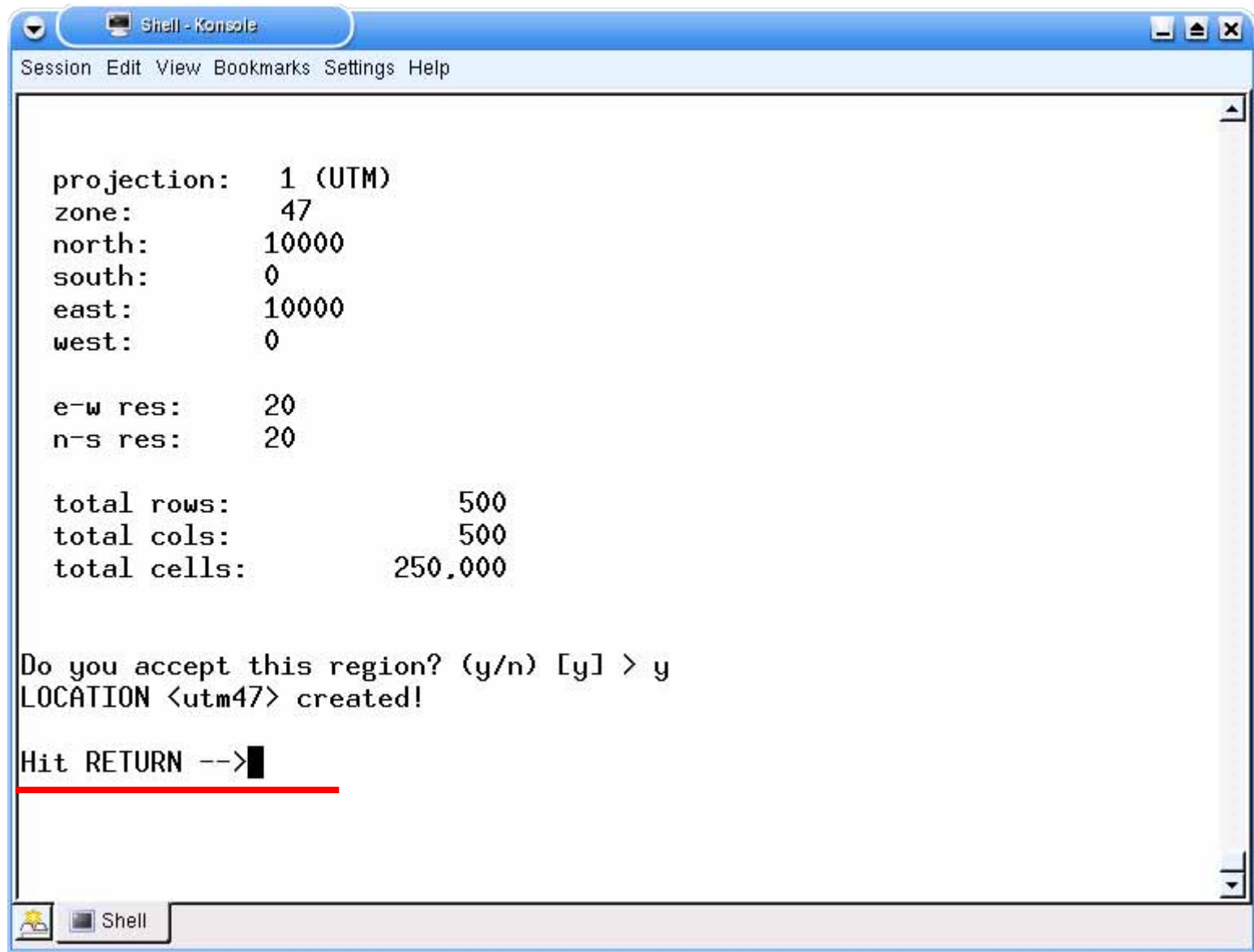
The screenshot shows a terminal window titled "Shell - Konsole". The window has a menu bar with "Session", "Edit", "View", "Bookmarks", "Settings", and "Help". The terminal content displays the following text:

```
projection: 1 (UTM)
zone: 47
north: 10000
south: 0
east: 10000
west: 0

e-w res: 20
n-s res: 20

total rows: 500
total cols: 500
total cells: 250,000
```

Below this text, a red line underlines the prompt: "Do you accept this region? (y/n) [y] > y". The cursor is positioned at the end of the input "y". At the bottom of the window, there is a taskbar with a "Shell" icon and label.



The screenshot shows a terminal window titled "Shell - Konsole". The window has a menu bar with "Session", "Edit", "View", "Bookmarks", "Settings", and "Help". The terminal content displays the following text:

```
projection: 1 (UTM)
zone:      47
north:     10000
south:     0
east:      10000
west:      0

e-w res:   20
n-s res:   20

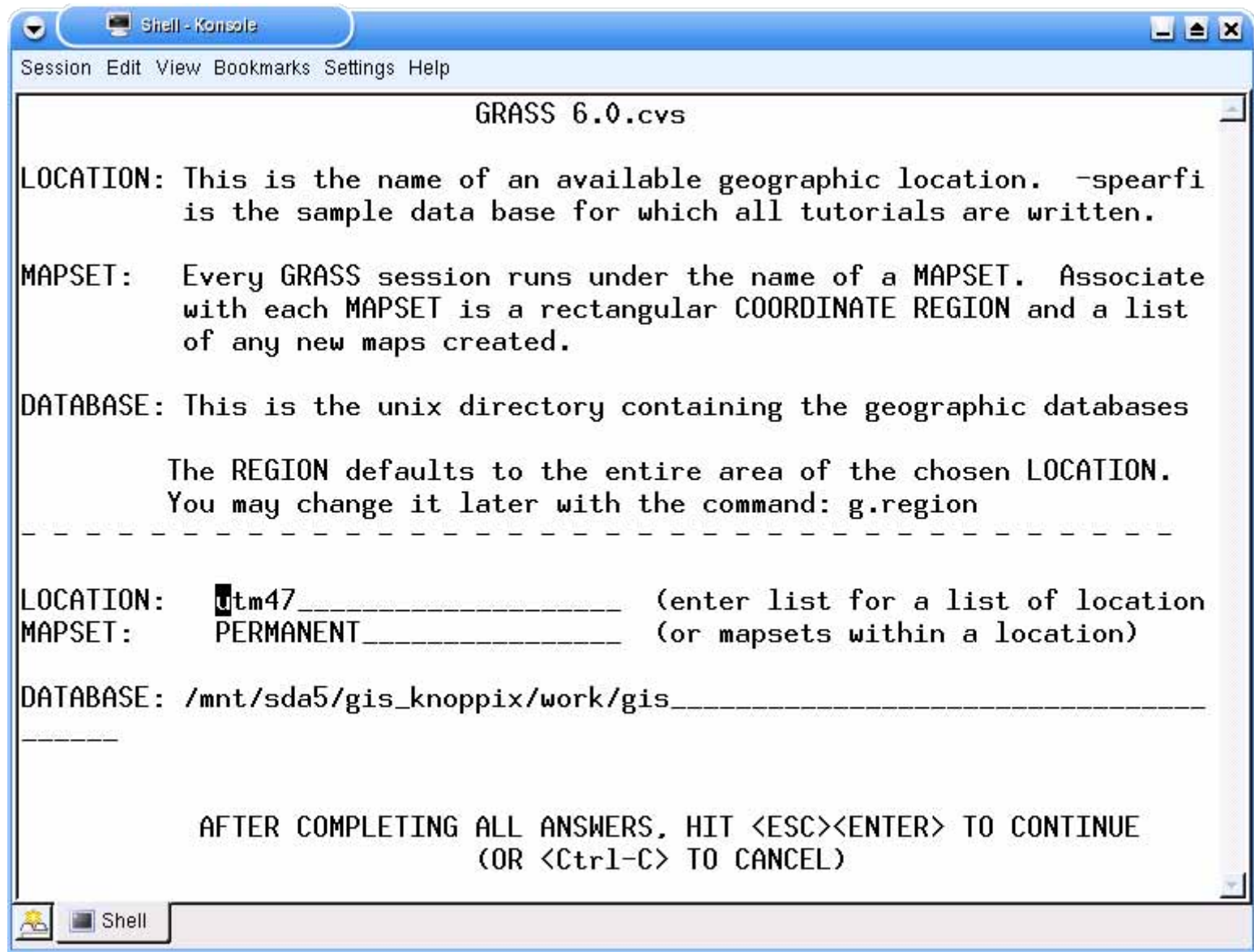
total rows:      500
total cols:      500
total cells:     250.000

Do you accept this region? (y/n) [y] > y
LOCATION <utm47> created!

Hit RETURN -->
```

A red horizontal line is drawn under the "Hit RETURN -->" prompt. The terminal window has a status bar at the bottom with a "Shell" tab and a "Shell" icon.

hit "Enter (or Return)"



```
GRASS 6.0.cvs

LOCATION: This is the name of an available geographic location. -spearfi
         is the sample data base for which all tutorials are written.

MAPSET:  Every GRASS session runs under the name of a MAPSET. Associate
         with each MAPSET is a rectangular COORDINATE REGION and a list
         of any new maps created.

DATABASE: This is the unix directory containing the geographic databases

         The REGION defaults to the entire area of the chosen LOCATION.
         You may change it later with the command: g.region
-----

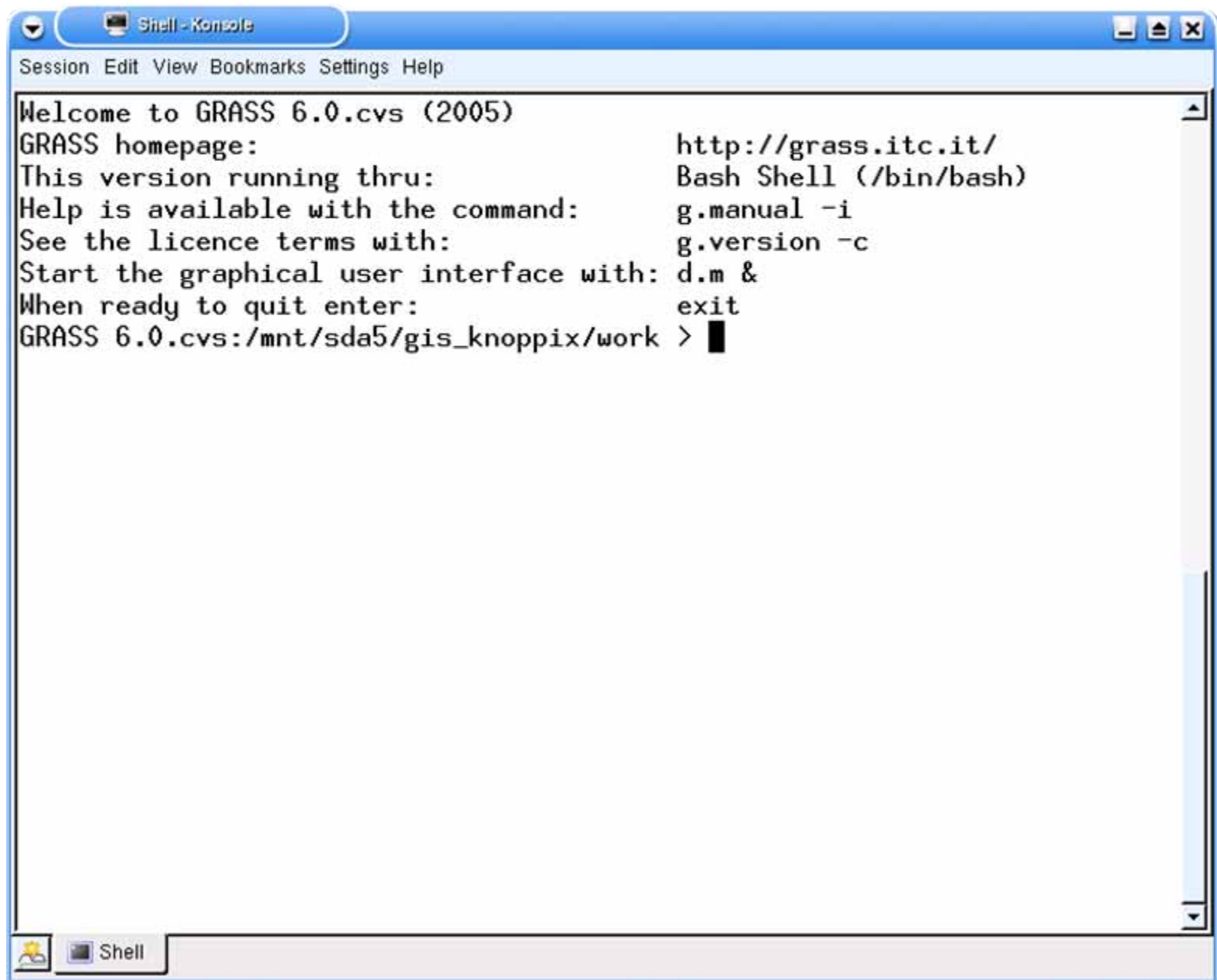
LOCATION:  utm47_____ (enter list for a list of location
MAPSET:   PERMANENT_____ (or mapsets within a location)

DATABASE: /mnt/sda5/gis_knoppix/work/gis_____

-----

AFTER COMPLETING ALL ANSWERS, HIT <ESC><ENTER> TO CONTINUE
        (OR <Ctrl-C> TO CANCEL)
```

enter “y”, then hit “Esc” + “Enter (or Return)”



```
Shell - Konsole
Session Edit View Bookmarks Settings Help

Welcome to GRASS 6.0.cvs (2005)
GRASS homepage: http://grass.itc.it/
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
Start the graphical user interface with: d.m &
When ready to quit enter: exit
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > █
```

## **Section 2. SPOT Image Processing in UTM Coordinate System**

# **3. Import raster data**

## 3.1 Import SPOT5 images

```
> r.in.gdal input=A output=B
```

A = /mnt/sda1/gis\_knopix/data/(input file name)

B = (output file name)

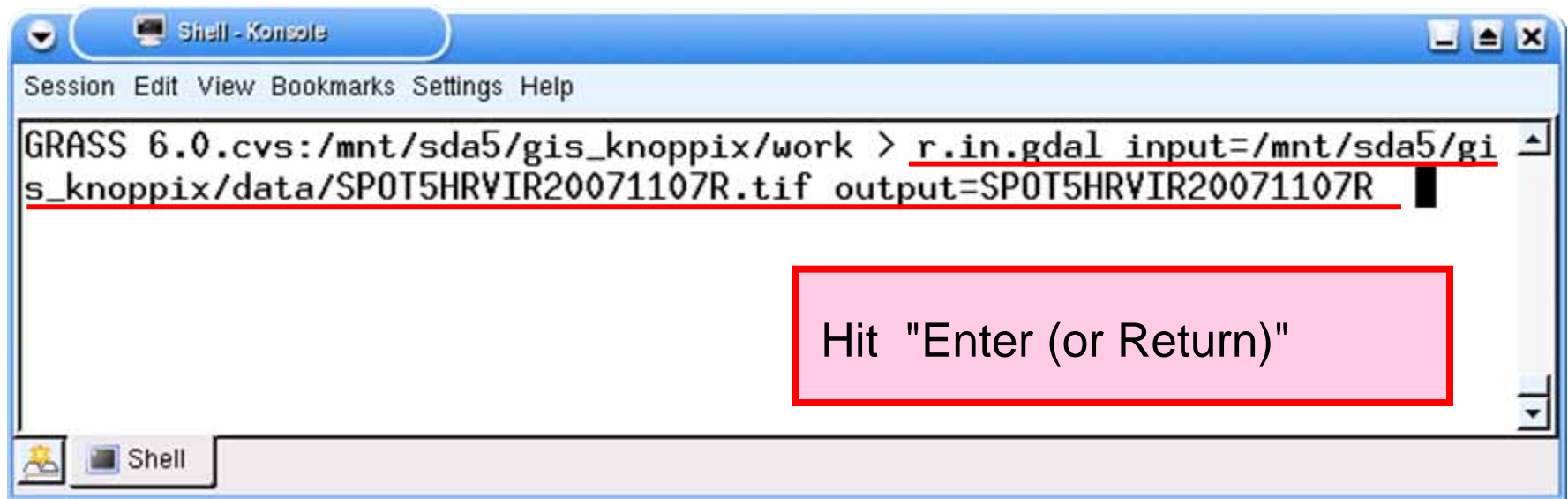
*r.in.gdal* allows a user to create a (binary) GRASS raster map layer, or imagery group, from any GDAL supported raster map format, with an optional title.

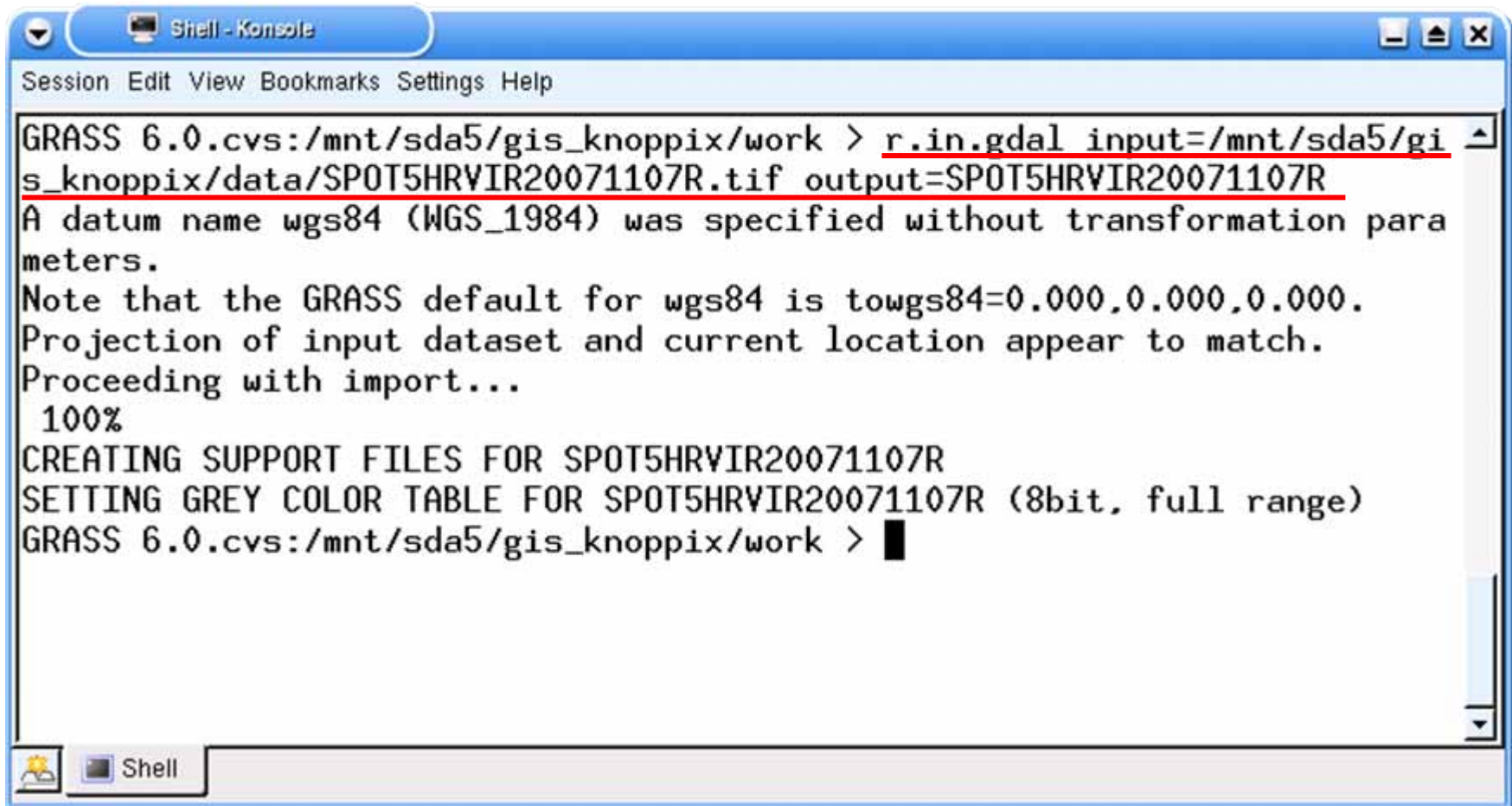
|                  |  |
|------------------|--|
| <b>r.in.gdal</b> | ARC/INFO ASCII/Binary GRID, BIL, ERDAS (LAN, IMG),<br>USGS DOQ, JPEG, SAR CEOS, EOSAT, GeoTIFF,<br>PPM/PNM, SDTS DEM,<br>GIF, PNG<br>(see also <a href="http://www.gdal.org/formats_list.html">http://www.gdal.org/formats_list.html</a> ) |
|------------------|--|

If the SPOT5 images are stored in the “data” folder:

```
> r.in.gdal input=/mnt/sda1/gis_knoppix/data/SPOT5HRVIR20071107R  
output=SPOT5HRVIR20071107R
```

: space





The screenshot shows a terminal window titled "Shell - Konsole". The window has a menu bar with "Session", "Edit", "View", "Bookmarks", "Settings", and "Help". The terminal content shows the execution of the command `r.in.gdal input=/mnt/sda5/gis_knoppix/data/SPOT5HRVIR20071107R.tif output=SPOT5HRVIR20071107R`. The output indicates that the datum name `wgs84` (WGS\_1984) was specified without transformation parameters. It notes that the GRASS default for `wgs84` is `towgs84=0.000,0.000,0.000` and that the projection of the input dataset and current location appear to match. The process proceeds with import, reaching 100% completion. It then creates support files for `SPOT5HRVIR20071107R` and sets a grey color table for the output (8bit, full range). The terminal ends with the prompt `GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work >` and a cursor.

```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.in.gdal input=/mnt/sda5/gis_knoppix/data/SPOT5HRVIR20071107R.tif output=SPOT5HRVIR20071107R
A datum name wgs84 (WGS_1984) was specified without transformation parameters.
Note that the GRASS default for wgs84 is towgs84=0.000,0.000,0.000.
Projection of input dataset and current location appear to match.
Proceeding with import...
 100%
CREATING SUPPORT FILES FOR SPOT5HRVIR20071107R
SETTING GREY COLOR TABLE FOR SPOT5HRVIR20071107R (8bit, full range)
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > █
```

Please import other band images (G, IR)!!



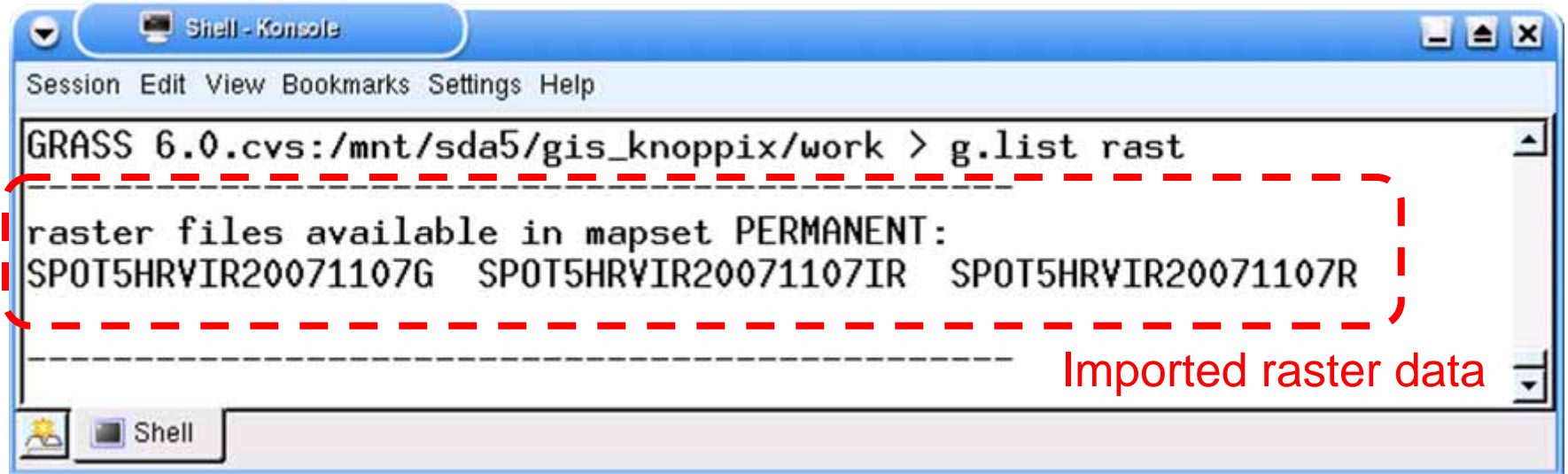
```
Shell - Konsole
Session Edit View Bookmarks Settings Help

GRASS 6.0.cvs:~ > r.in.gdal input=/mnt/sda5/gis_knoppix/data/
SPOT5HRVIR20071107G.tif output=SPOT5HRVIR20071107G
A datum name wgs84 (WGS_1984) was specified without transform
ation parameters.
Note that the GRASS default for wgs84 is towgs84=0.000,0.000,
0.000.
Projection of input dataset and current location appear to ma
tch.
Proceeding with import...
 100%
CREATING SUPPORT FILES FOR SPOT5HRVIR20071107G
SETTING GREY COLOR TABLE FOR SPOT5HRVIR20071107G (8bit, full
range)
GRASS 6.0.cvs:~ > r.in.gdal input=/mnt/sda5/gis_knoppix/data/
SPOT5HRVIR20071107IR.tif output=SPOT5HRVIR20071107IR
A datum name wgs84 (WGS_1984) was specified without transform
ation parameters.
Note that the GRASS default for wgs84 is towgs84=0.000,0.000,
0.000.
Projection of input dataset and current location appear to ma
tch.
Proceeding with import...
 100%
CREATING SUPPORT FILES FOR SPOT5HRVIR20071107IR
SETTING GREY COLOR TABLE FOR SPOT5HRVIR20071107IR (8bit, full
range)
```

## 3.2 List imported raster data

```
> g.list type = rast
```

␣ : space



The screenshot shows a terminal window titled "Shell - Konsole". The command prompt is "GRASS 6.0.cvs:/mnt/sda5/gis\_knoppix/work > g.list rast". The output is "raster files available in mapset PERMANENT:" followed by three file names: "SPOT5HRVIR20071107G", "SPOT5HRVIR20071107IR", and "SPOT5HRVIR20071107R". A red dashed box highlights the output text. A red label "Imported raster data" points to the output.

```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > g.list rast
```

raster files available in mapset PERMANENT:  
SPOT5HRVIR20071107G SPOT5HRVIR20071107IR SPOT5HRVIR20071107R

Imported raster data

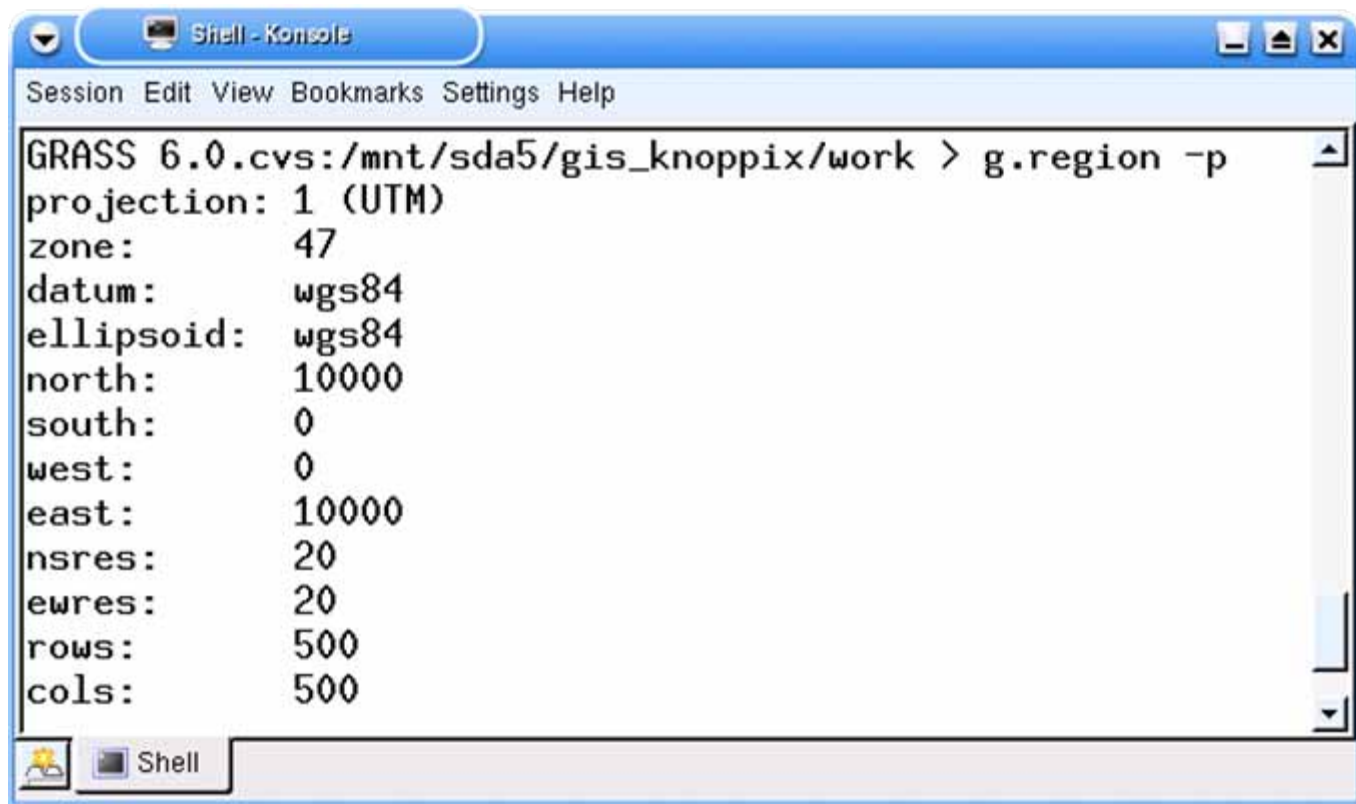
*g.list* allows the user to list user-specified, available and accessible files from *mapsets* under the user's current location.

## 3.3 Set region to match imported raster map

### 3.3.1 Check the current region

`g.region -p`

: space

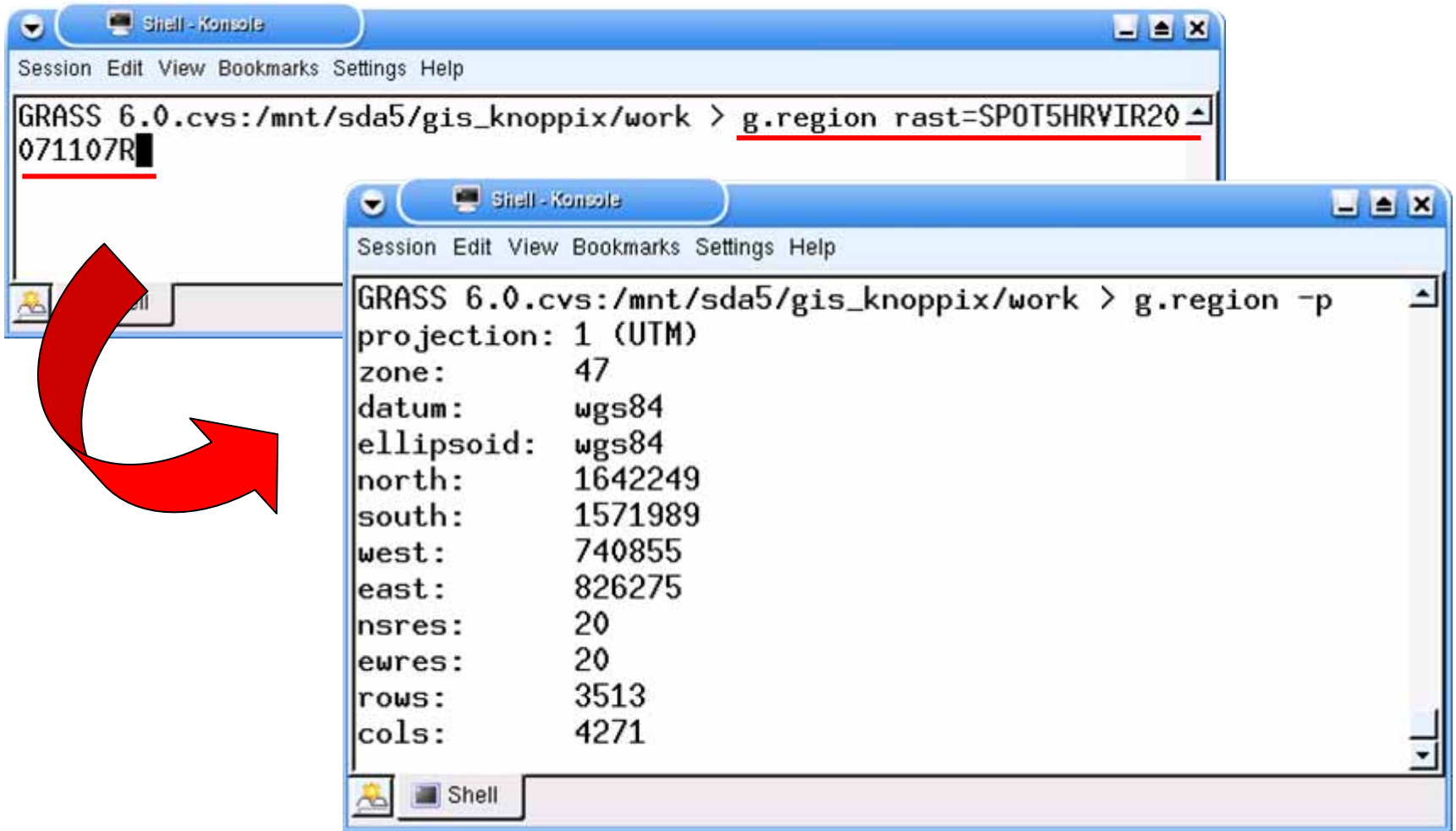


```
Shell - Konsole
Session Edit View Bookmarks Settings Help
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > g.region -p
projection: 1 (UTM)
zone:      47
datum:     wgs84
ellipsoid: wgs84
north:     10000
south:     0
west:      0
east:      10000
nsres:     20
ewres:     20
rows:      500
cols:      500
```

### 3.3.2 Set region to match imported raster map

`g.region rast = "(imported raster map)"`

: space



The image shows two terminal windows from the GRASS GIS environment. The top window shows the command `g.region rast=SPOT5HRVIR20` being entered. The bottom window shows the output of the command `g.region -p`, which displays the current region's projection and resolution settings. A large red arrow points from the first window to the second, indicating the sequence of operations.

```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > g.region rast=SPOT5HRVIR20
071107R
```

```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > g.region -p
projection: 1 (UTM)
zone:      47
datum:     wgs84
ellipsoid: wgs84
north:     1642249
south:     1571989
west:      740855
east:      826275
nsres:     20
ewres:     20
rows:      3513
cols:      4271
```

## **Section 2. SPOT Image Processing in UTM Coordinate System**

# **4. Display raster data**

## Step 0. Import raster data

See “3. Import raster data”

## Step 1. Launch monitor

```
> d.mon x#
```

# = 0, 1, 2, ..., 6       : space

*d.mon* allows the user to start, select, list, query the status of, release control of, stop, and unlock control of, available graphics monitors.

## Step 2. Display raster

```
> d.rast map = A
```

A = (input file name)       : space

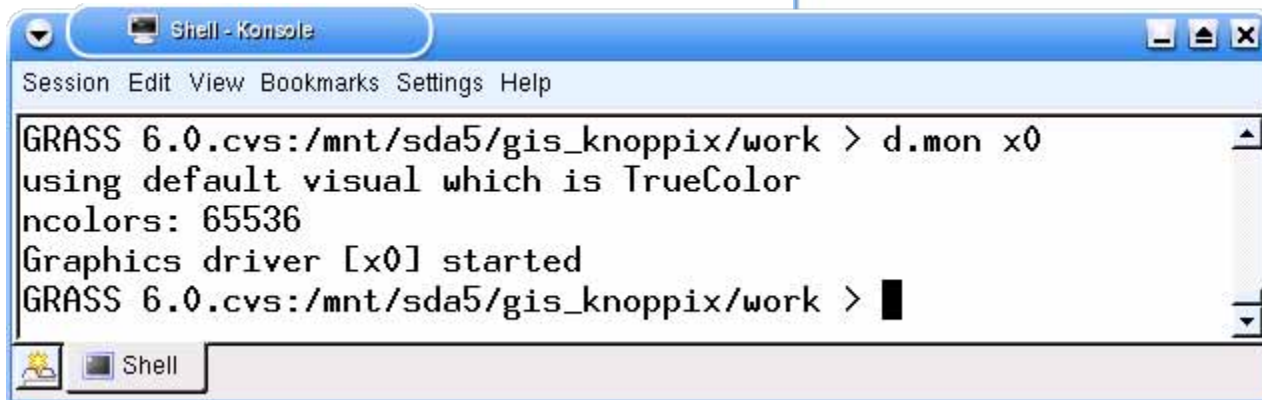
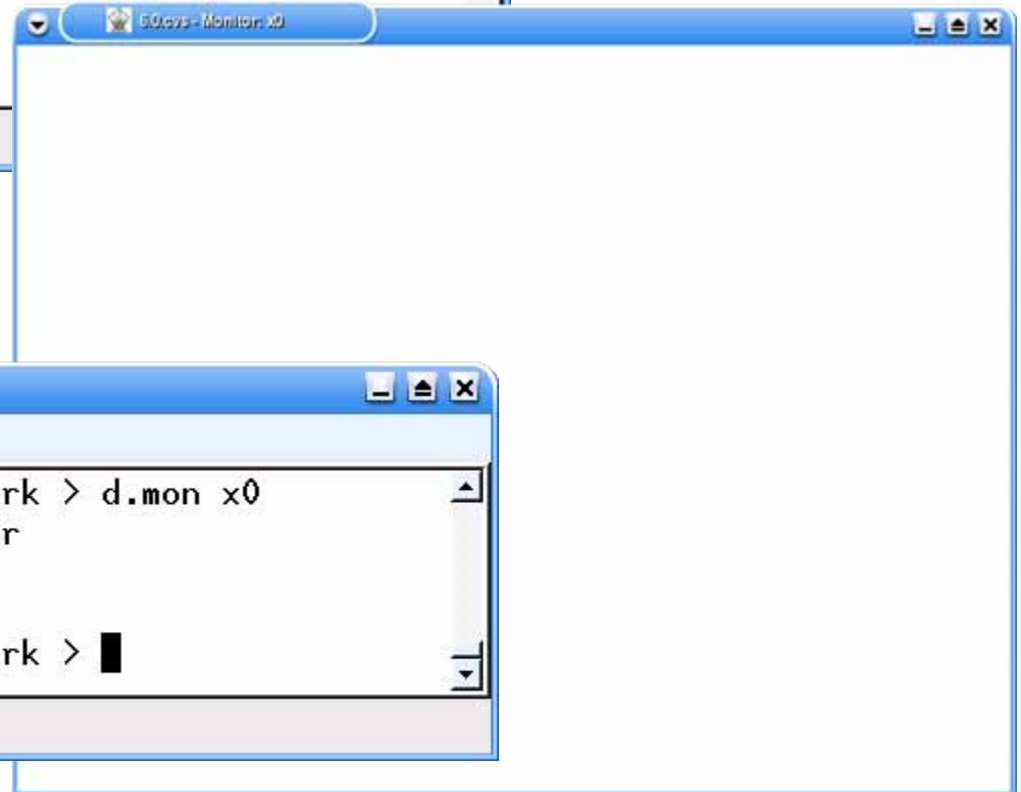
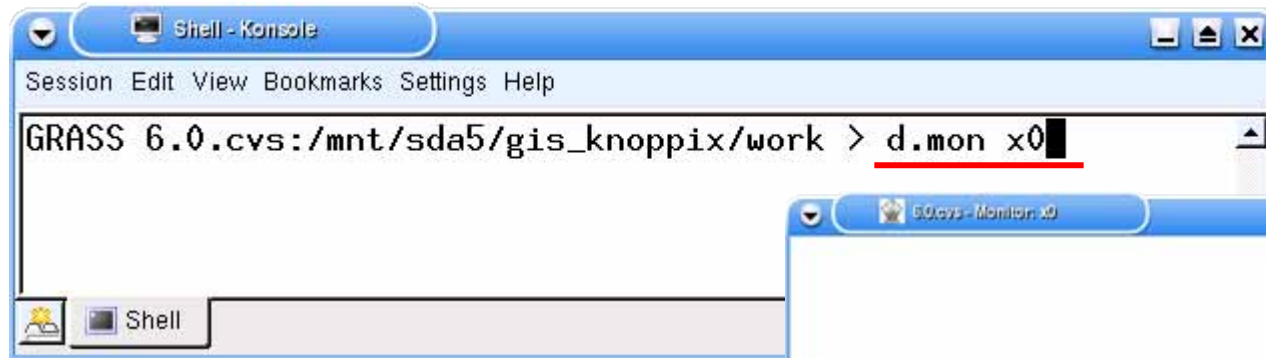
*d.rast* displays raster map layer(s) *name* in the active display frame on the graphics monitor.

# 4.1 Launch Monitor

> d.mon x#

# = 0, 1, 2, ..., 6

: space

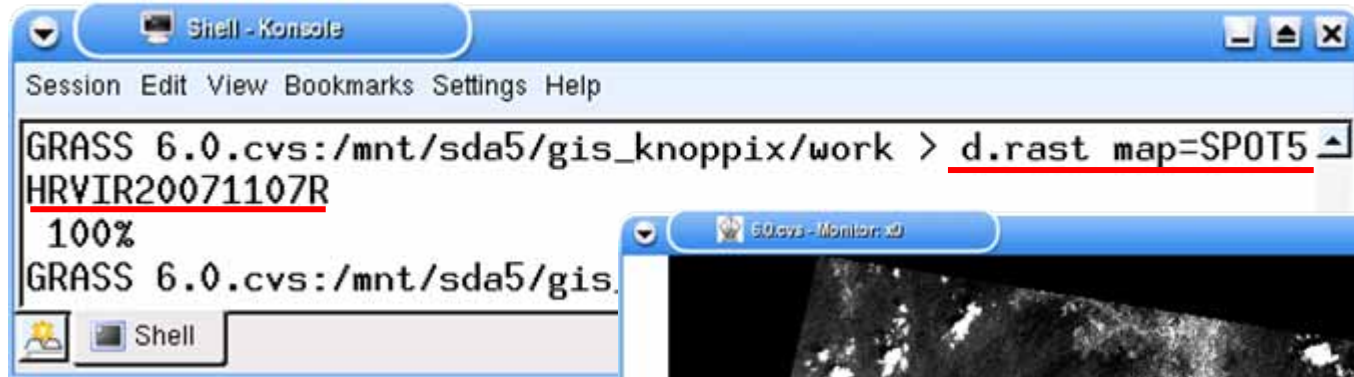




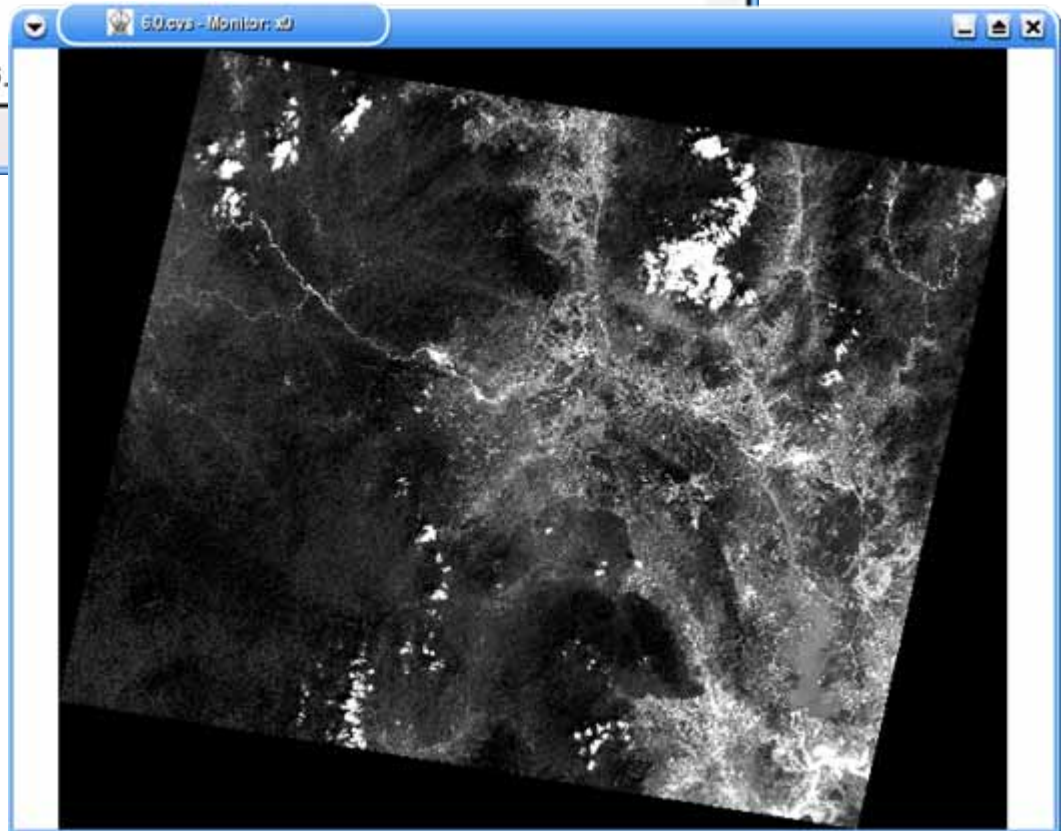
## 4.2 Display raster image

> d.rast  map = A

A = (input file name)  : space



```
Shell - Konsole
Session Edit View Bookmarks Settings Help
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.rast map=SPOT5
HRVIR20071107R
100%
GRASS 6.0.cvs:/mnt/sda5/gis.
```





## 4.3 Change image color

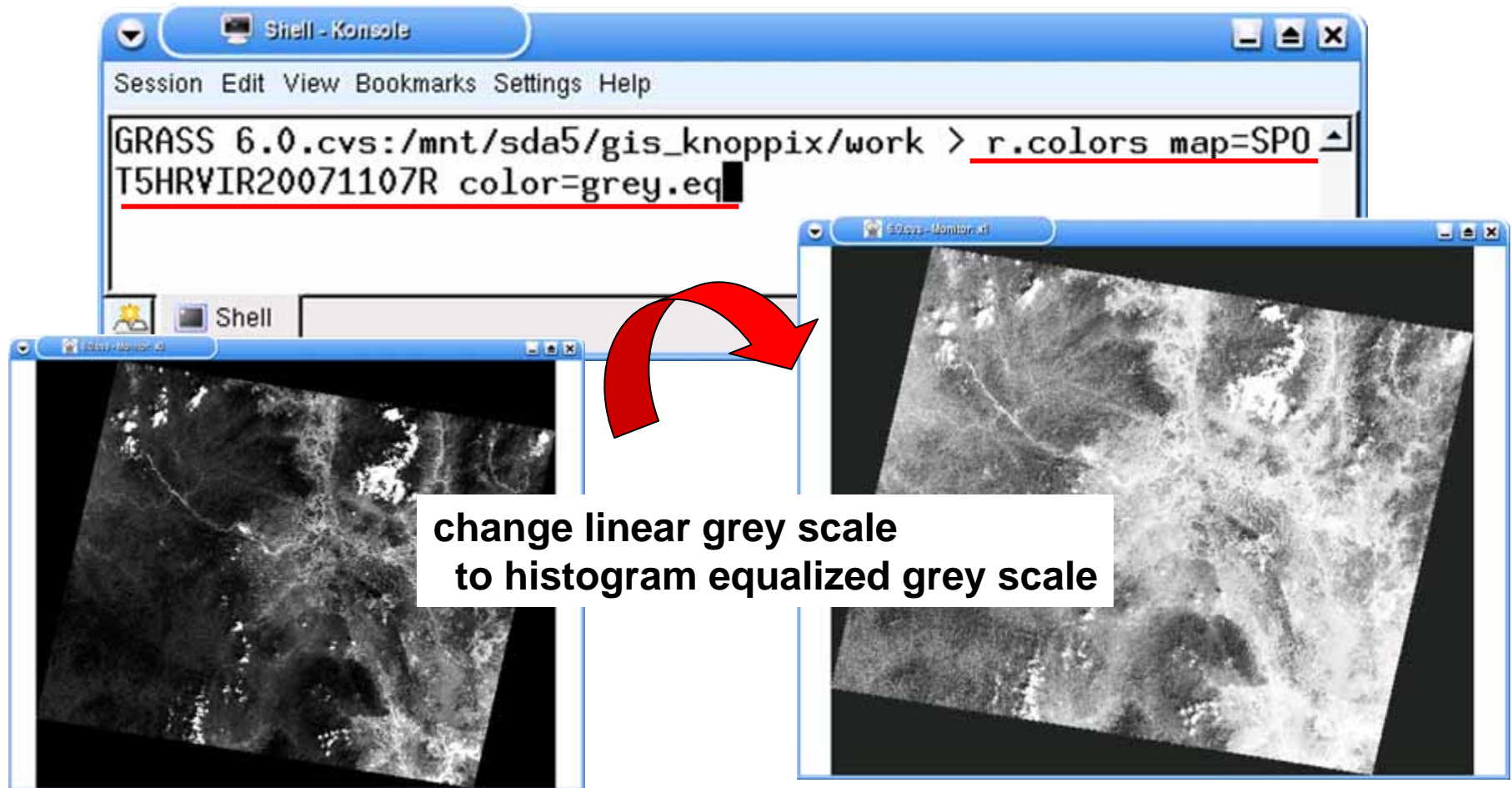
□ : space

```
> r.colors □ map = A □ color = type
```

A = (input file name)

B = (type of color table)

***r.colors*** allows the user to create and/or modify the color table for a raster map layer.



## 4.4 Display three images in RGB composite

```
> r.rgb red=A green=B blue=C
```

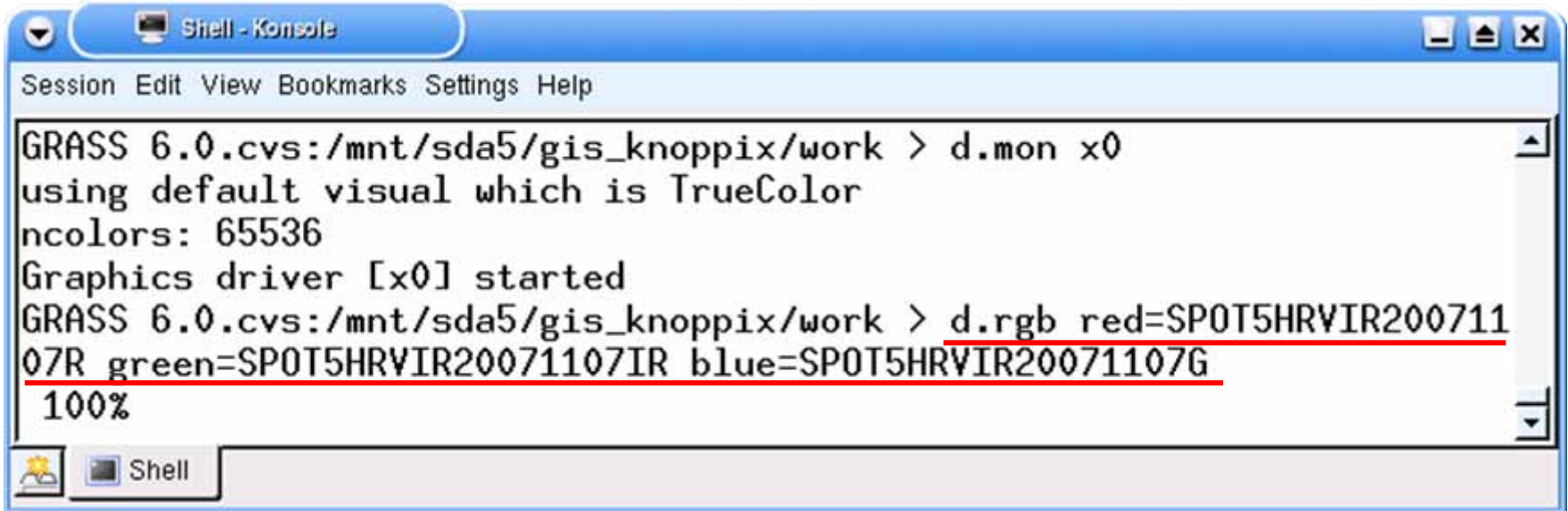
A = (file name1)

B = (file name2)    : space

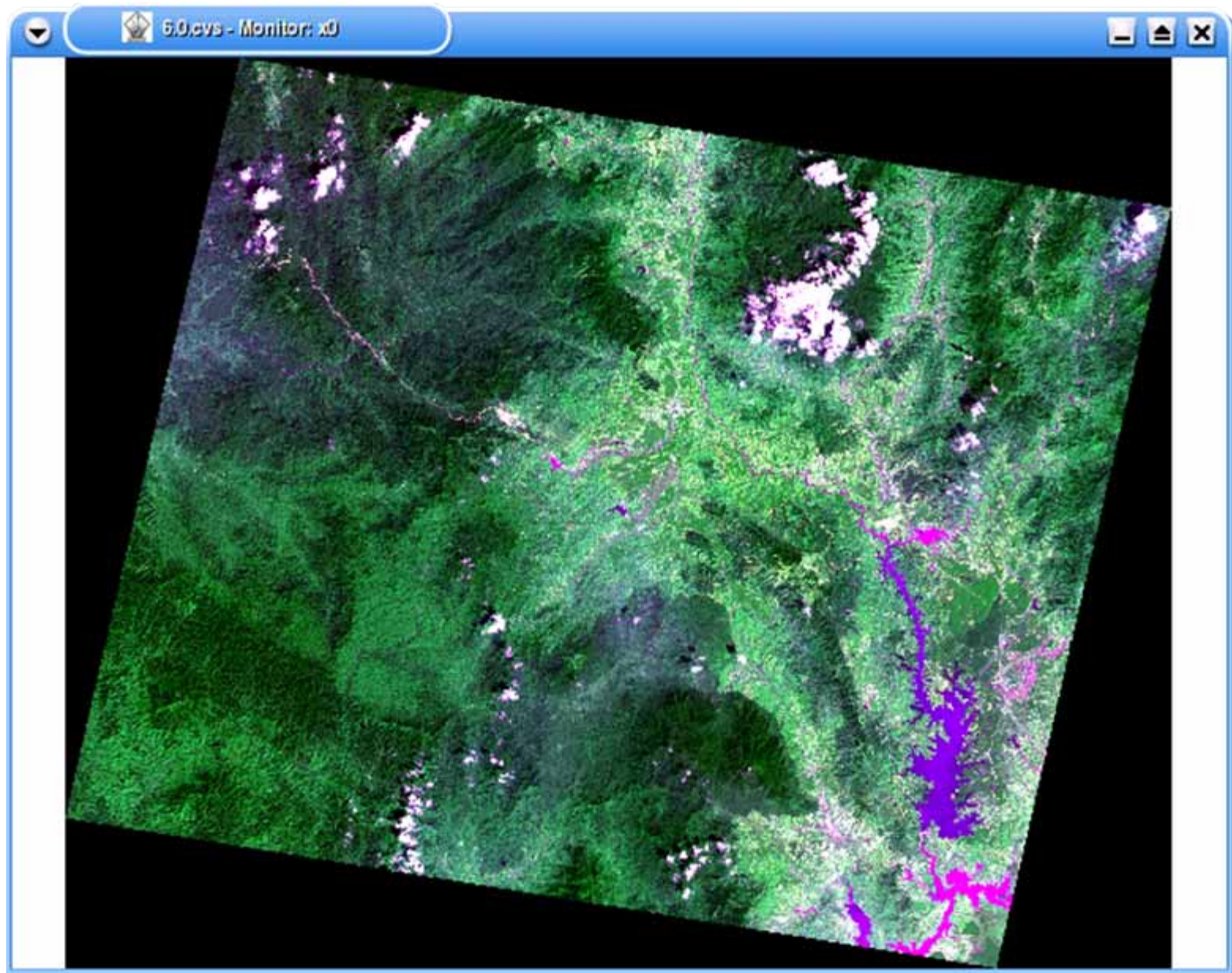
C = (file name3)

**d.rgb** - Displays three user-specified raster map layers as red, green, and blue overlays in the active graphics frame. **This command does not create new image file.**

The color table of each image must be “grey-scale”.



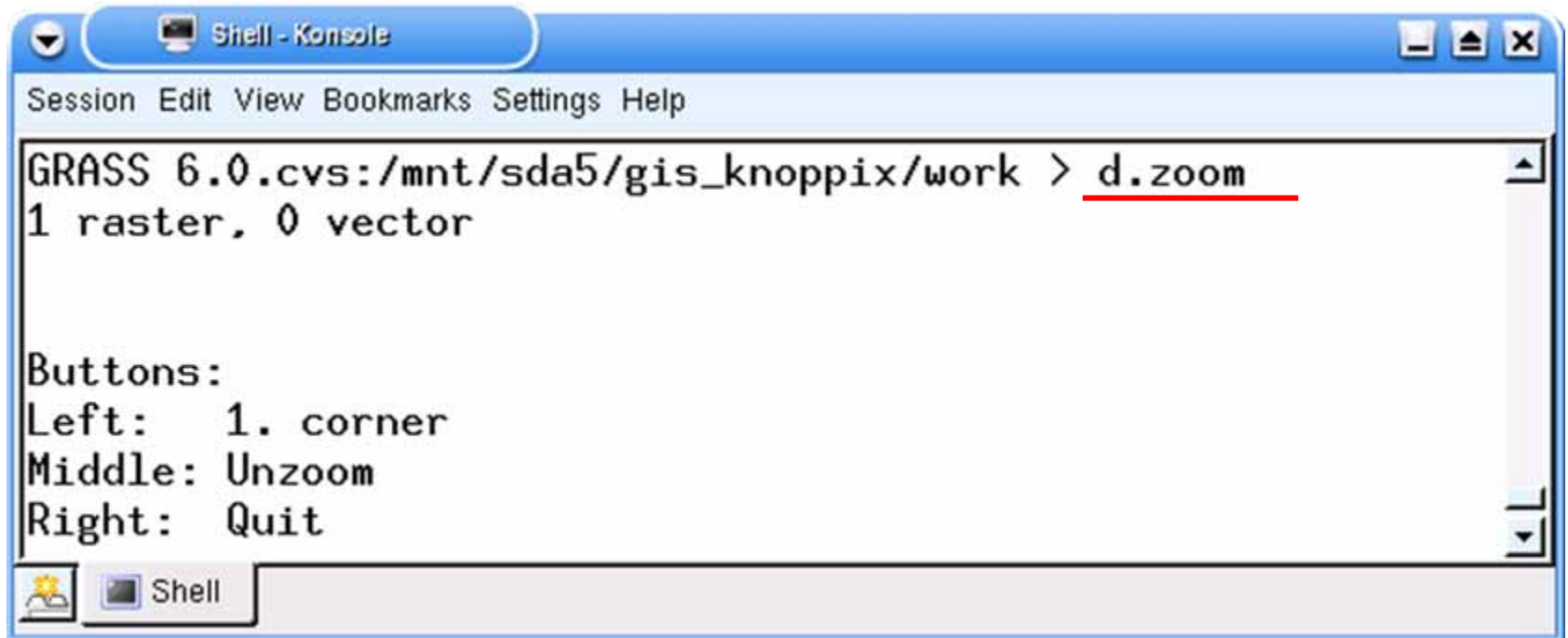
```
Shell - Konsole
Session Edit View Bookmarks Settings Help
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.mon x0
using default visual which is TrueColor
ncolors: 65536
Graphics driver [x0] started
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.rgb red=SPOT5HRVIR200711
07R green=SPOT5HRVIR20071107IR blue=SPOT5HRVIR20071107G
100%
```



## 4.5 Zoom in the image

```
> d.zoom
```

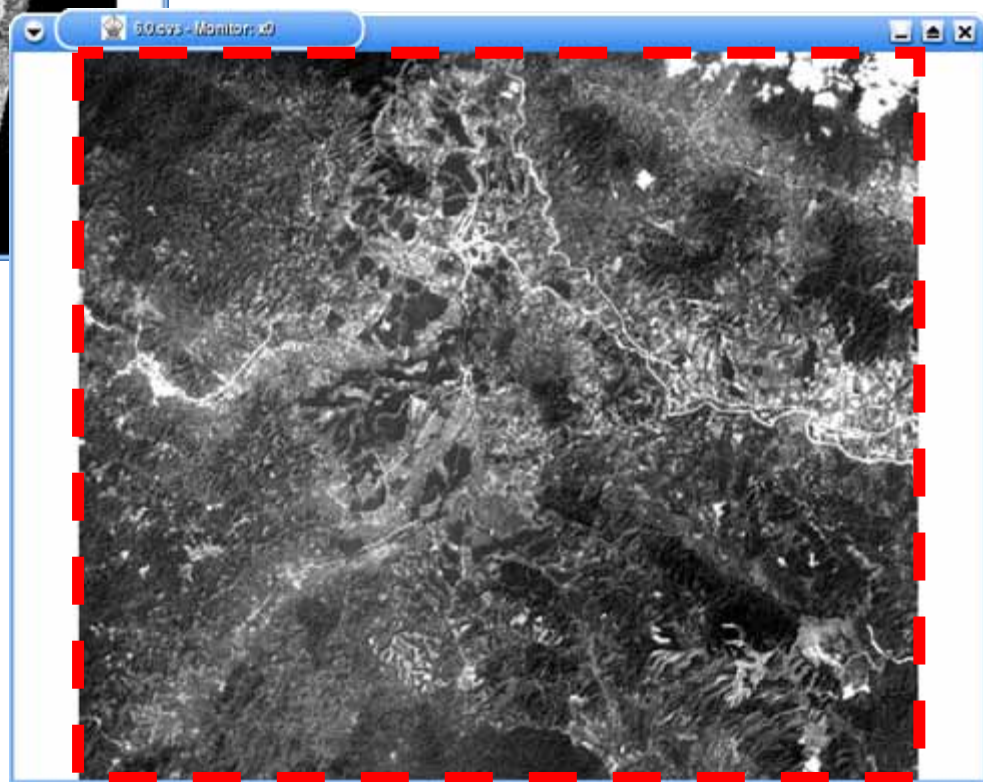
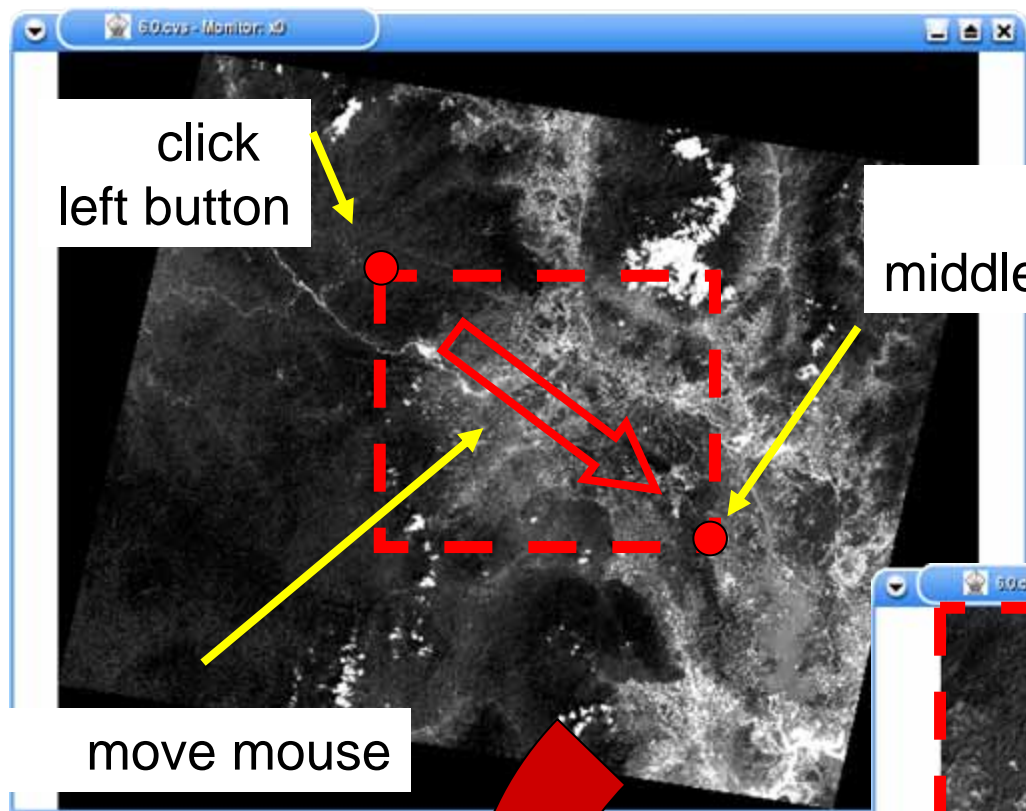
***d.zoom*** allows the user to change the current geographic region settings interactively, with a mouse.



```
Shell - Konsole
Session Edit View Bookmarks Settings Help
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.zoom
1 raster, 0 vector

Buttons:
Left: 1. corner
Middle: Unzoom
Right: Quit
```

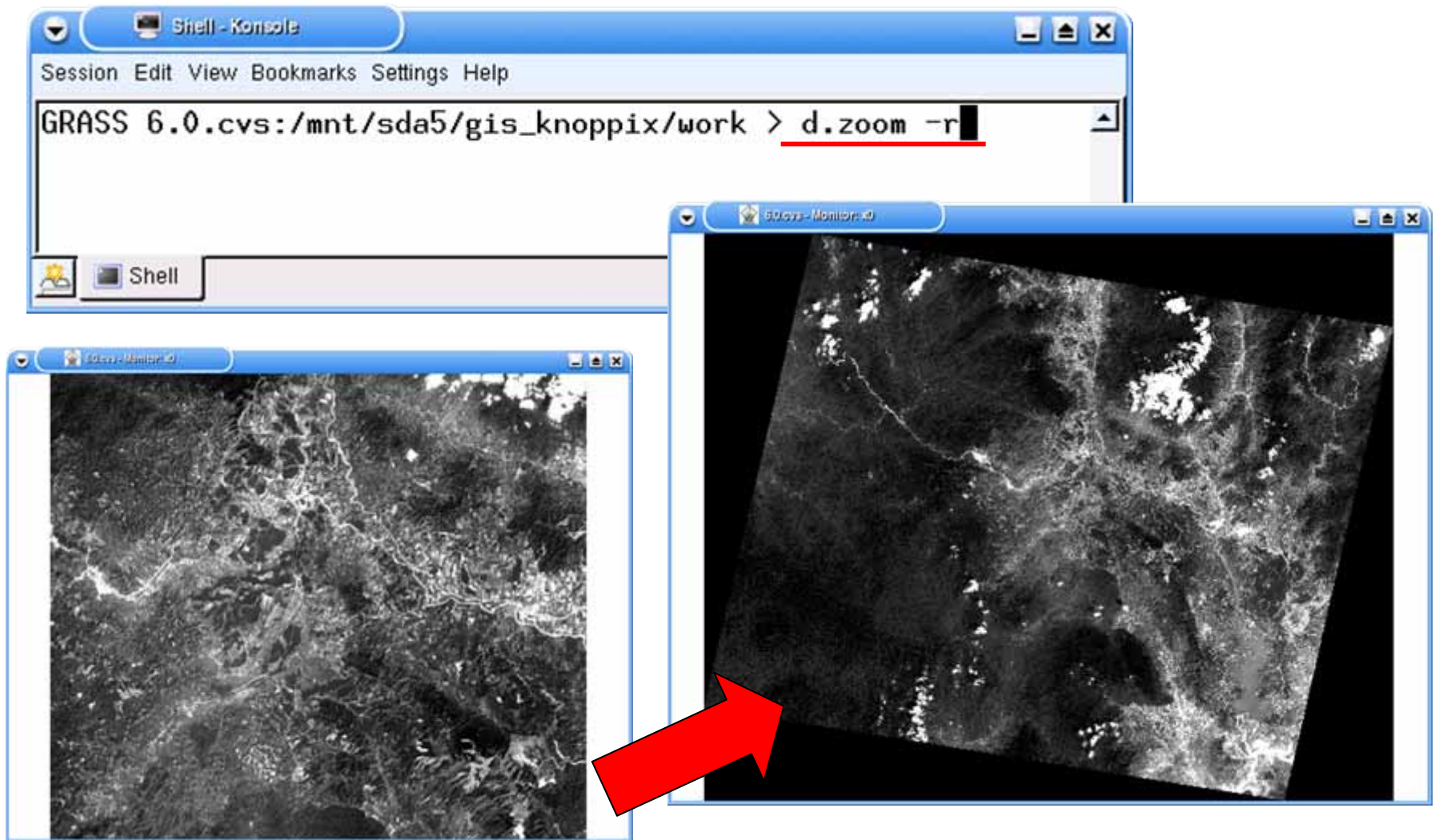




## - Return to the previous zoom

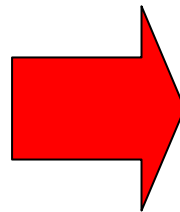
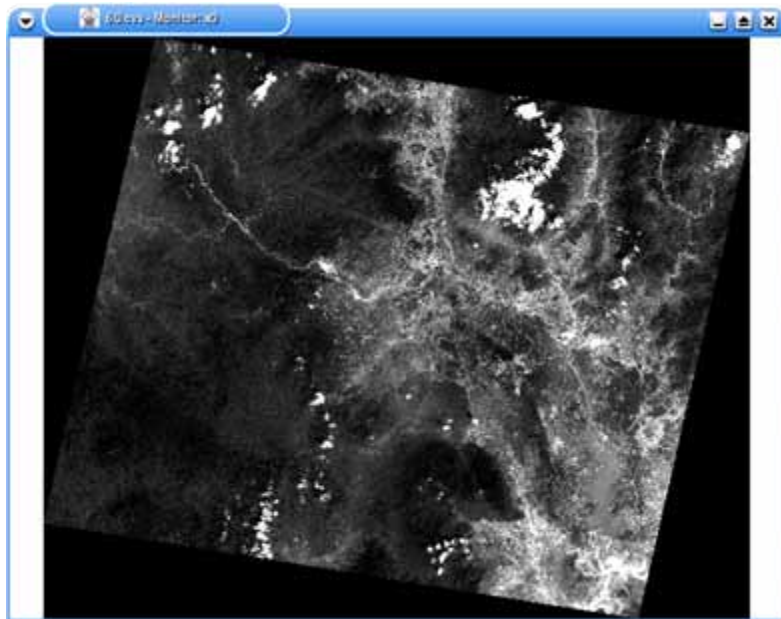
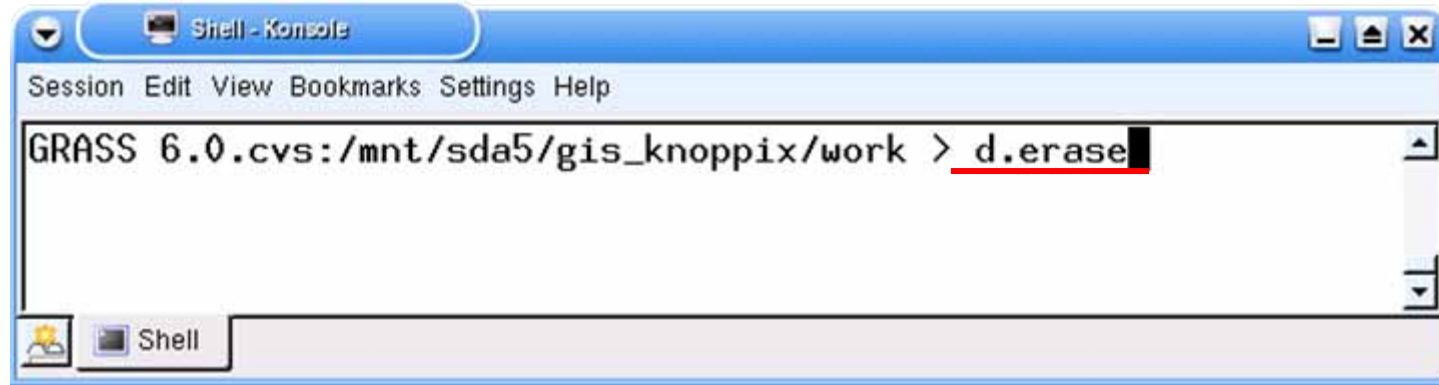
```
> d.zoom -r
```

␣ : space



## 4.6 Erase the contents from active display

> d.erase

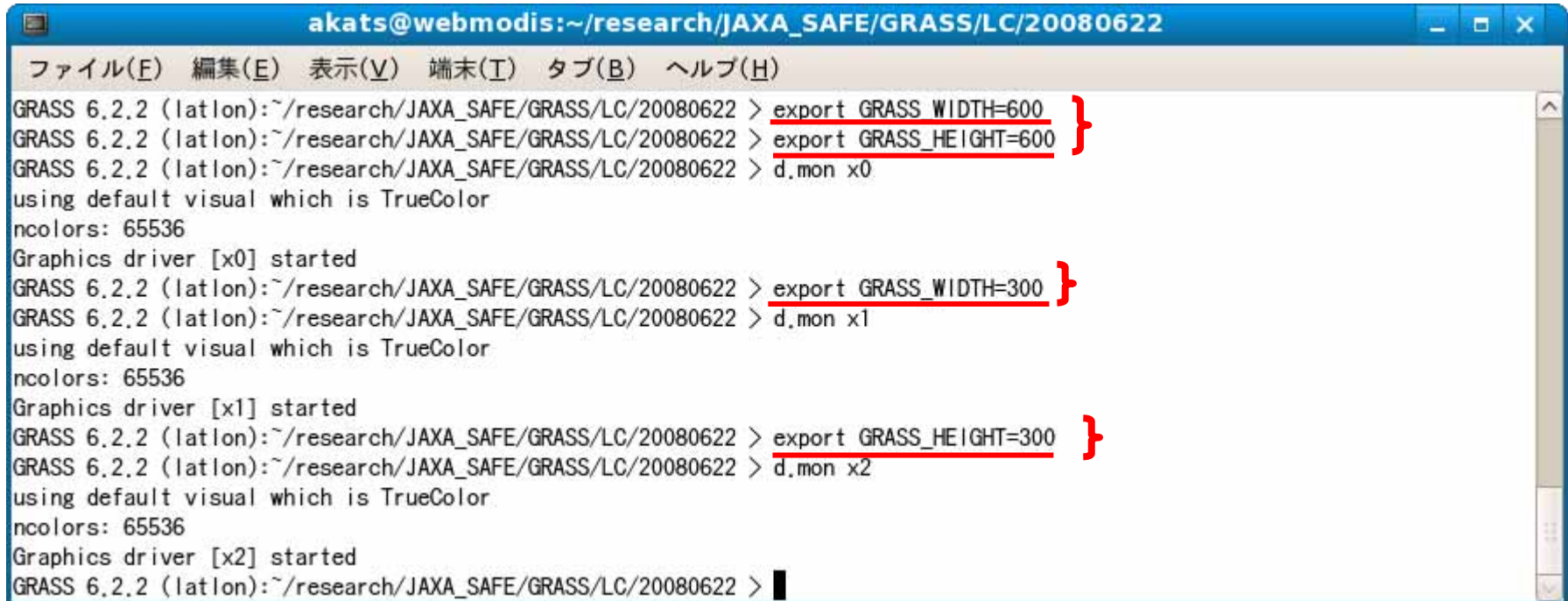


## 4.7 Change monitor size

> export GRASS\_WIDTH = "###"

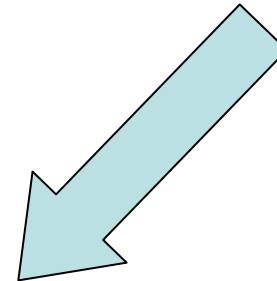
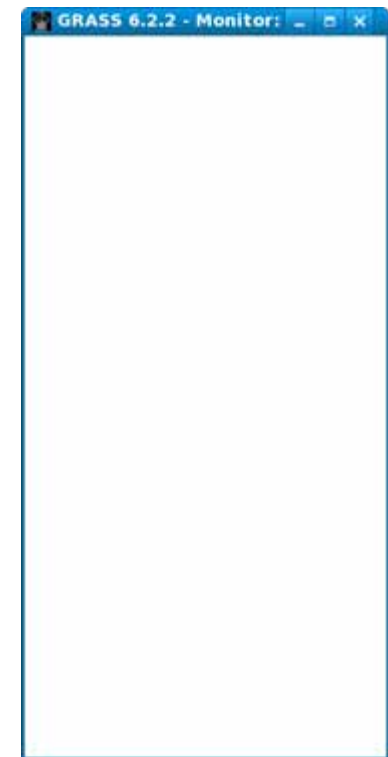
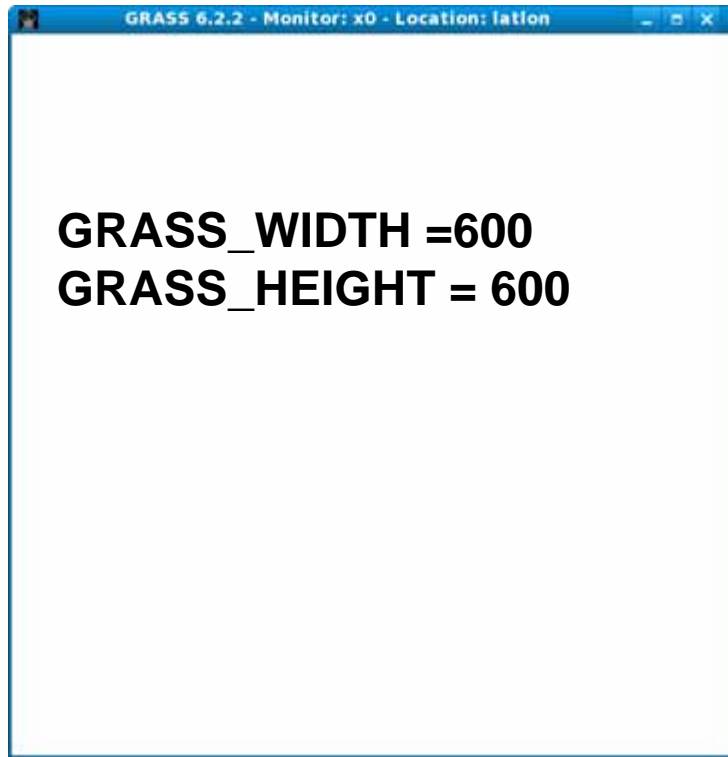
□ : space

> export GRASS\_HEIGHT = "###"



```
akats@webmodis:~/research/JAXA_SAFE/GRASS/LC/20080622
ファイル(F) 編集(E) 表示(V) 端末(T) タブ(B) ヘルプ(H)
GRASS 6.2.2 (latlon):~/research/JAXA_SAFE/GRASS/LC/20080622 > export GRASS_WIDTH=600 }
GRASS 6.2.2 (latlon):~/research/JAXA_SAFE/GRASS/LC/20080622 > export GRASS_HEIGHT=600 }
GRASS 6.2.2 (latlon):~/research/JAXA_SAFE/GRASS/LC/20080622 > d.mon x0
using default visual which is TrueColor
ncolors: 65536
Graphics driver [x0] started
GRASS 6.2.2 (latlon):~/research/JAXA_SAFE/GRASS/LC/20080622 > export GRASS_WIDTH=300 }
GRASS 6.2.2 (latlon):~/research/JAXA_SAFE/GRASS/LC/20080622 > d.mon x1
using default visual which is TrueColor
ncolors: 65536
Graphics driver [x1] started
GRASS 6.2.2 (latlon):~/research/JAXA_SAFE/GRASS/LC/20080622 > export GRASS_HEIGHT=300 }
GRASS 6.2.2 (latlon):~/research/JAXA_SAFE/GRASS/LC/20080622 > d.mon x2
using default visual which is TrueColor
ncolors: 65536
Graphics driver [x2] started
GRASS 6.2.2 (latlon):~/research/JAXA_SAFE/GRASS/LC/20080622 > █
```





**GRASS\_WIDTH = 300**  
**GRASS\_HEIGHT = 600**

**GRASS\_WIDTH = 300**  
**GRASS\_HEIGHT = 300**



## **Section 2. SPOT Image Processing in UTM Coordinate System**

### **5. Create RGB image**

## Step 0. Import images for R,G, B

## Step 1. change color map to “grey scale map” respectively

```
> r.colors [map=A] color= grey
```

A = (input file name)

[ ] : space

## Step 2. composite images

```
> r.composite [red = A] [green = B] [blue = C] output = D
```

[ ] : space

A, B, C = (input file name)      D = (output file name)

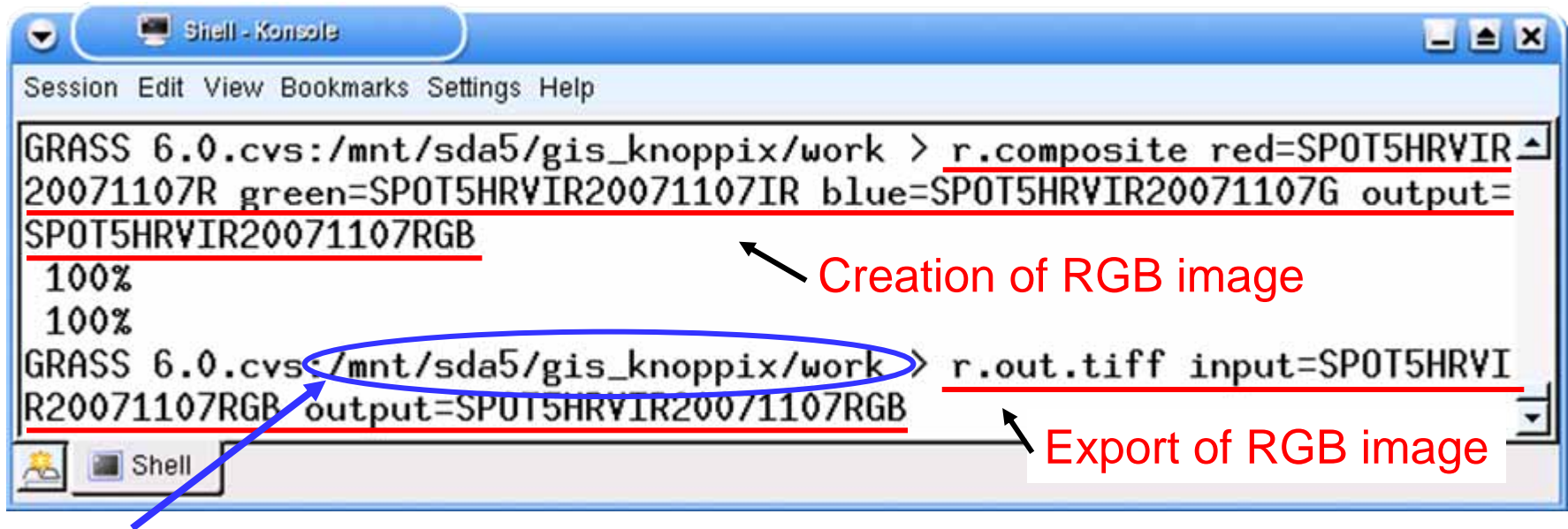
## Step 3. save composite images as TIFF file

```
> r.out.tiff [input = D] output = E
```

[ ] : space

D = (input file name)      E = (output file name)

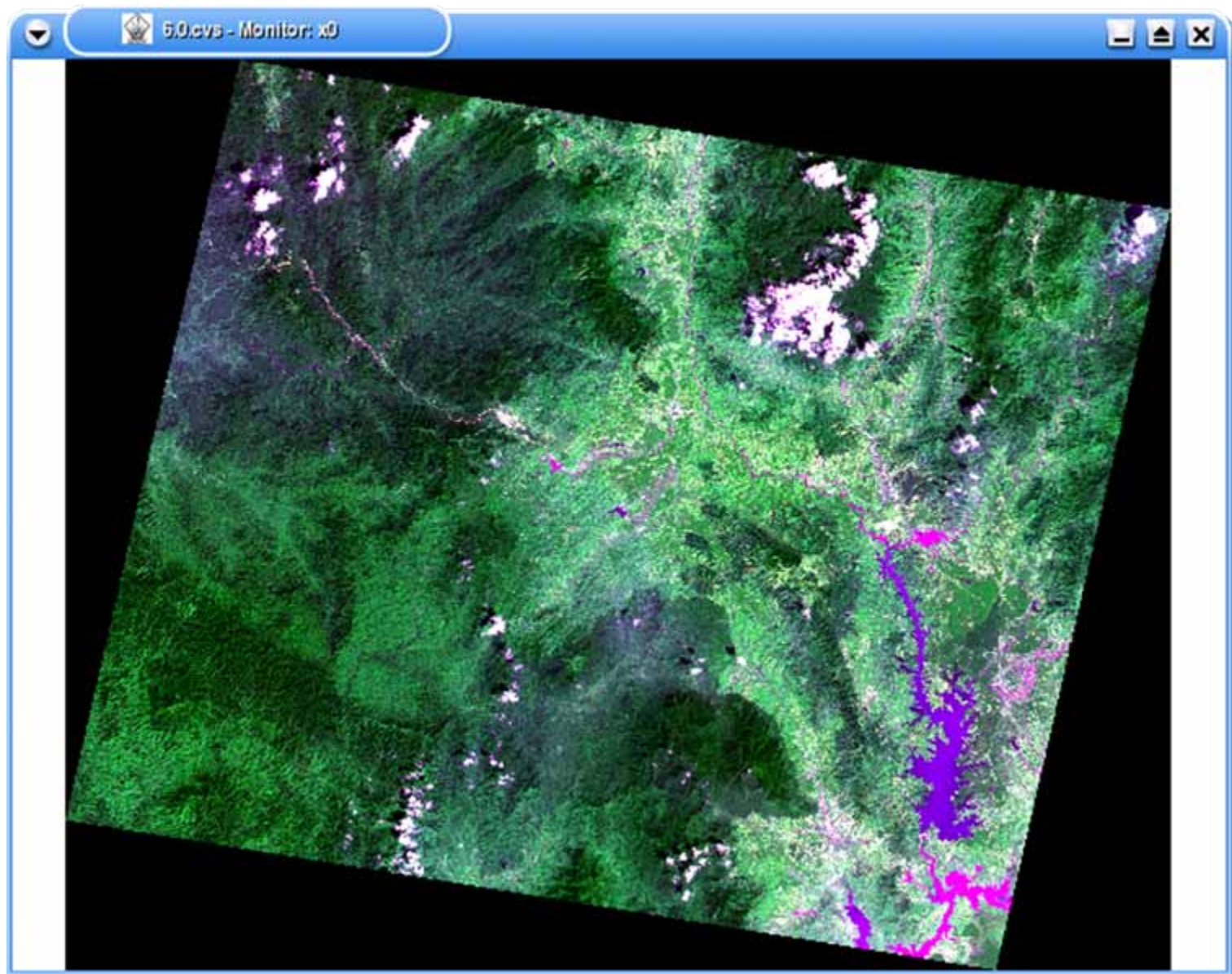
# Create & import RGB image from SPOT5 images



```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.composite red=SPOT5HRVIR20071107R green=SPOT5HRVIR20071107IR blue=SPOT5HRVIR20071107G output=SPOT5HRVIR20071107RGB
100%
100%
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.out.tiff input=SPOT5HRVIR20071107RGB output=SPOT5HRVIR20071107RGB
```

The RGB image will be exported to this directory

***r.composite*** - Combines red, green and blue map layers into a single composite map layer. **This command creates new image file.**



## **Section 2. SPOT Image Processing in UTM Coordinate System**

# **6. Raster calculations**

## **6.1 Calculation of NDVI**

## **6.2 Masking**

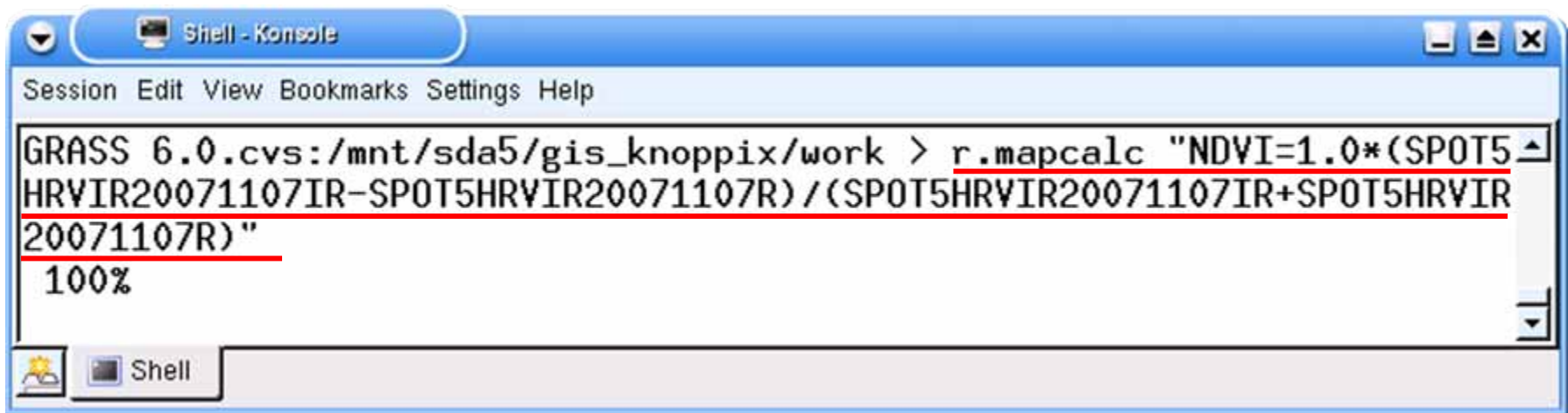
## 6.1 Calculation of NDVI

```
> r.mapcalc "NDVI = 1.0 * (A - B) / (A + B)"
```

A = (input file name1)  
B = (input file name2)

␣: space

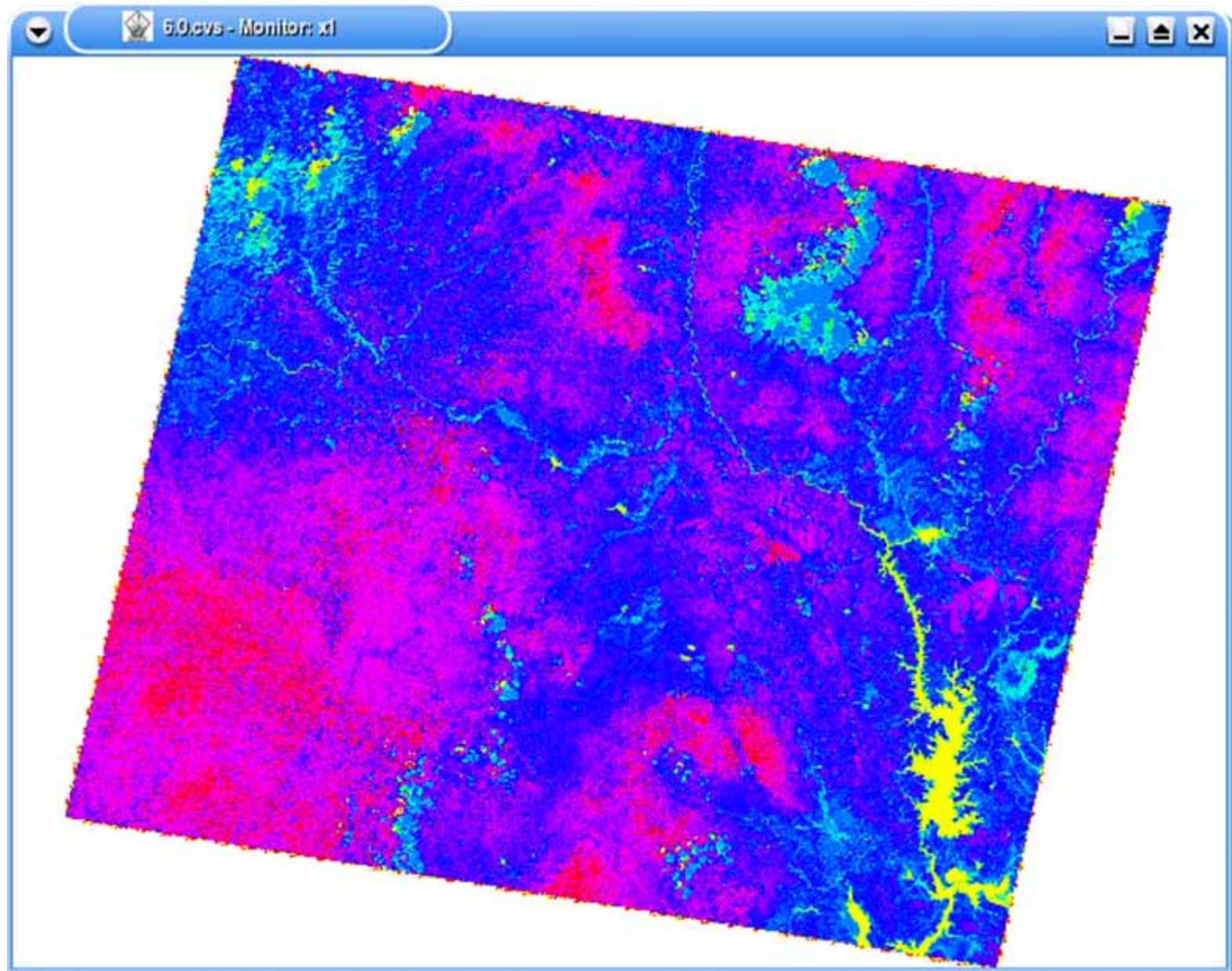
It is important to include a multiplier of 1.0 at the beginning of the map algebra expression when integer values are divided.



```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.mapcalc "NDVI=1.0*(SPOT5HRVIR20071107IR-SPOT5HRVIR20071107R)/(SPOT5HRVIR20071107IR+SPOT5HRVIR20071107R)"
100%
```

The screenshot shows a terminal window titled 'Shell - Konsole'. The command prompt is 'GRASS 6.0.cvs:/mnt/sda5/gis\_knoppix/work >'. The command entered is 'r.mapcalc "NDVI=1.0\*(SPOT5HRVIR20071107IR-SPOT5HRVIR20071107R)/(SPOT5HRVIR20071107IR+SPOT5HRVIR20071107R)". The output shows '100%'.





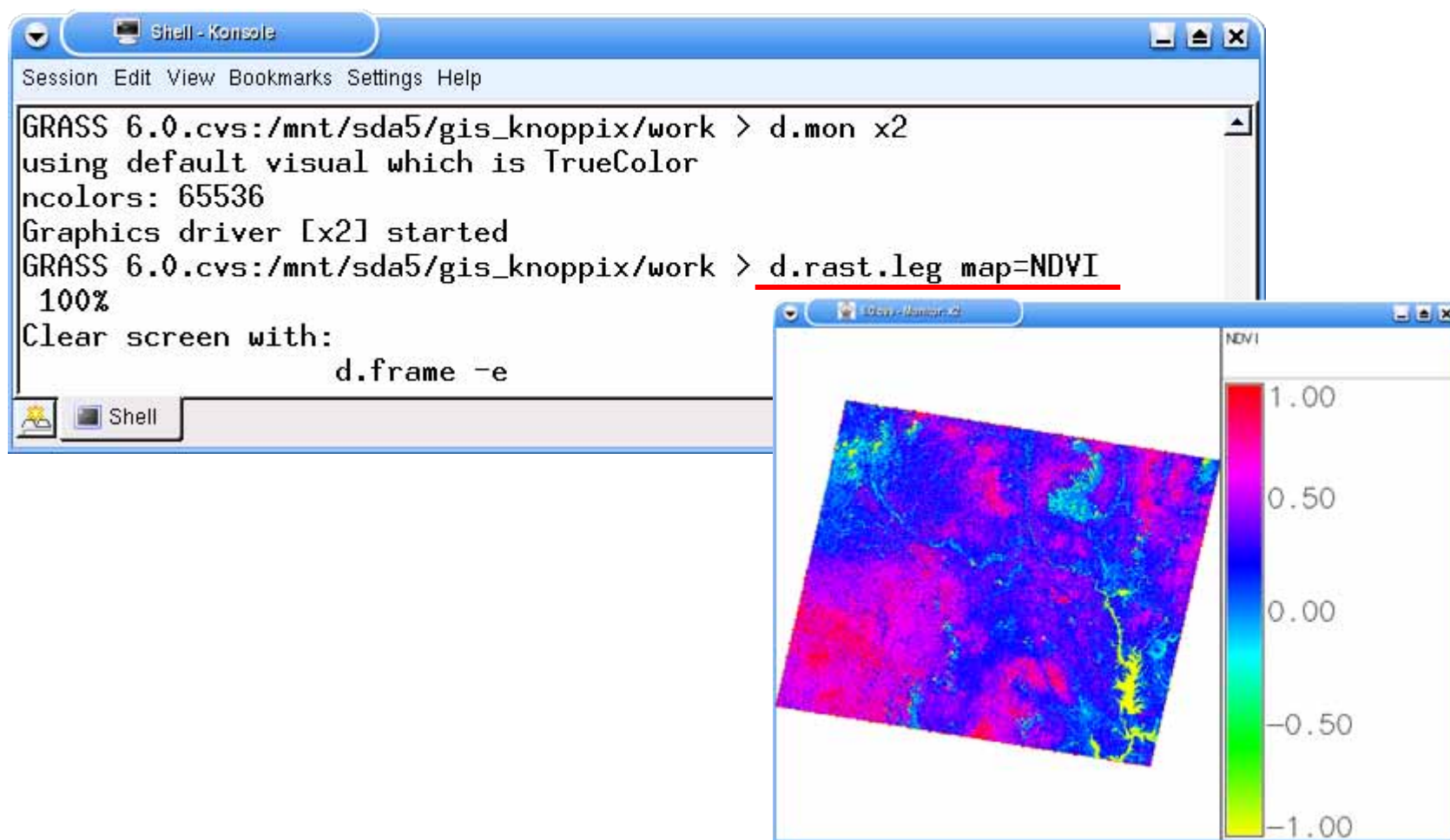
# Display legend with raster image

```
> d.rast.legend map = A
```

A = (file name)

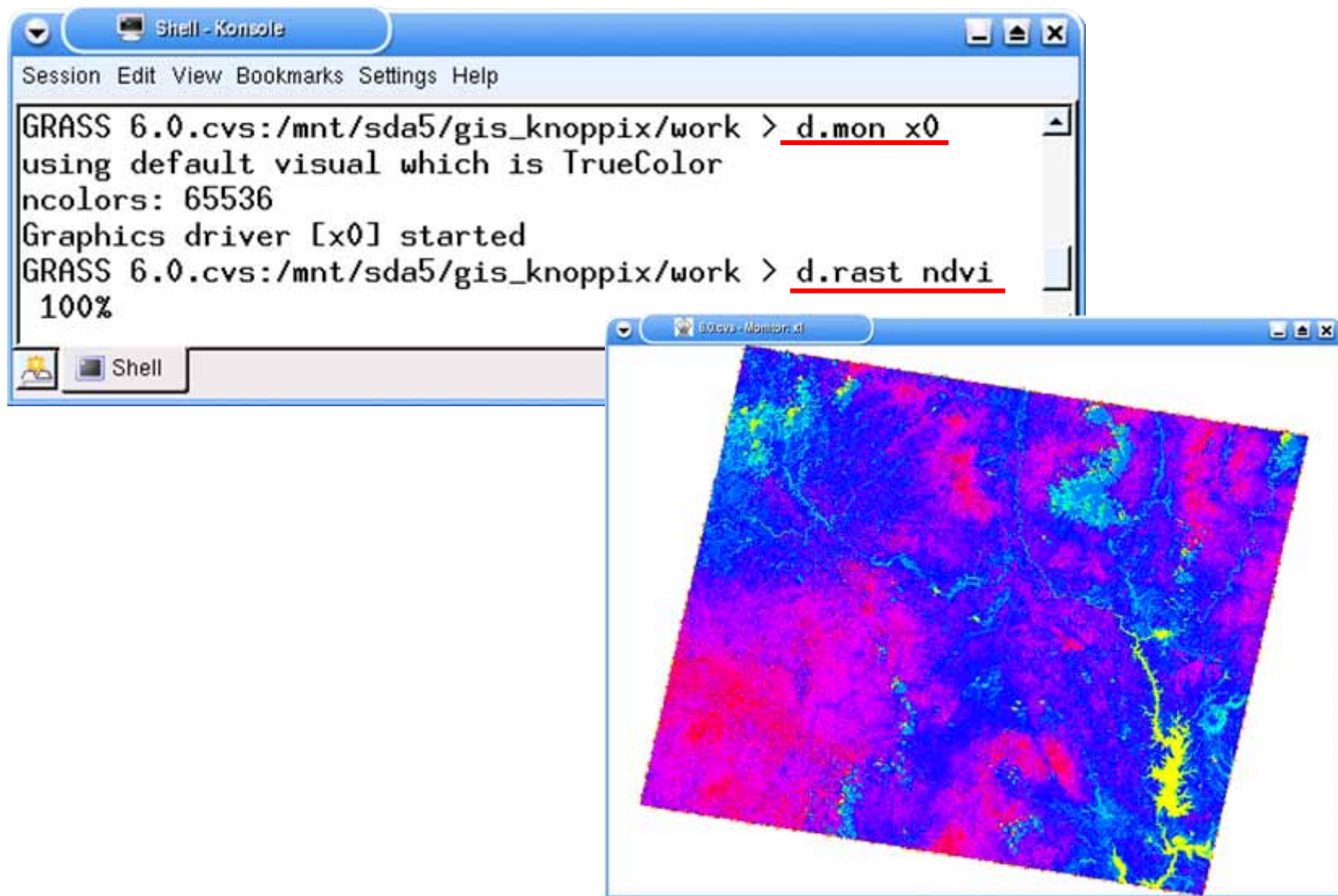
: space

***d.rast.legend*** - Displays a raster map and its legend on a graphics window



# 6.2 Masking

## 6.2.1 Display raster data





## 6.2.2 Search raster value

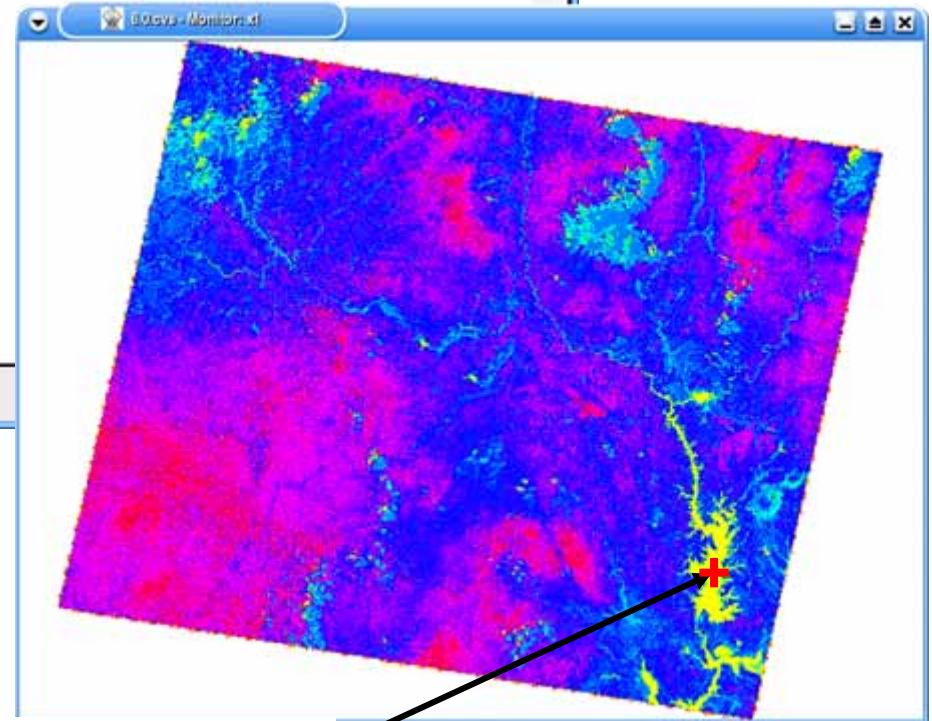
> d.what.rast

```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.what.rast

Buttons
Left:  what's here
Right: quit

808284.875(E) 1587280.54166667(N)
ndvi in PERMANENT, quant  (-1)
ndvi in PERMANENT, actual (-0.971014)

807406.375(E) 1605143.375(N)
ndvi in PERMANENT, quant  (-1)
ndvi in PERMANENT, actual (-0.969112)
```



To quit this process, click  
right button on the display  
window

click left button

## 6.2.3 Create mask image

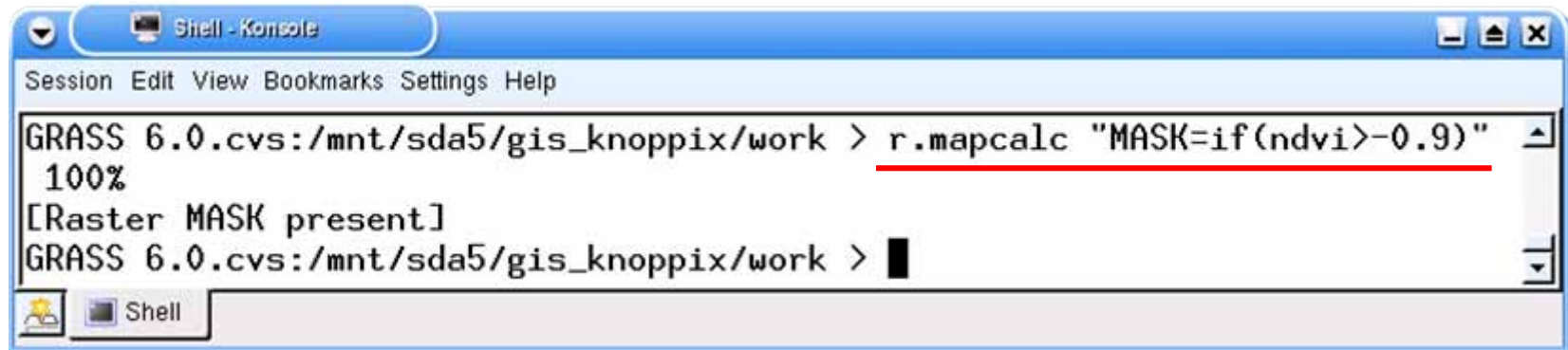
```
> r.mapcalc " MASK = if ( # * A )"
```

A = original file name

# = value

\* = operator (ex. ==, <=, >=)

␣ : space



```
Shell - Konsole
Session Edit View Bookmarks Settings Help
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.mapcalc "MASK=if(ndvi>-0.9)"
100%
[Raster MASK present]
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > █
```

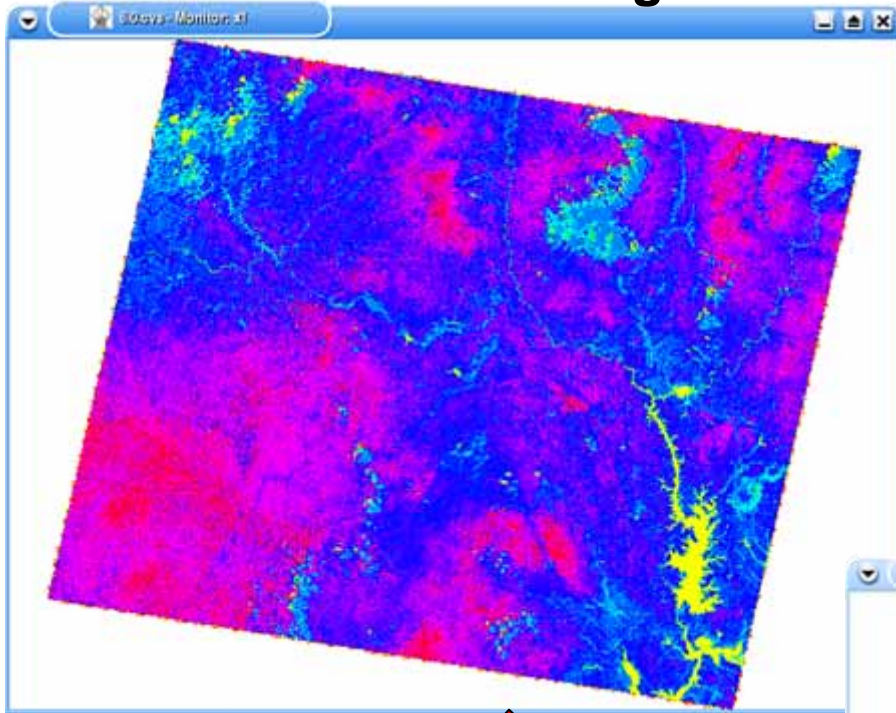
**original image**

**MASK image**

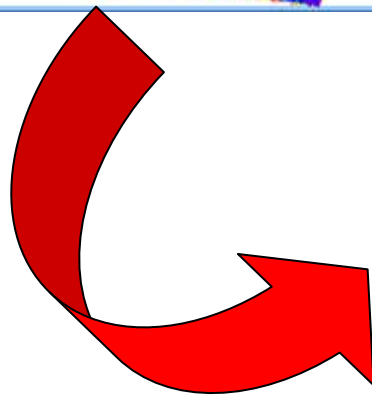
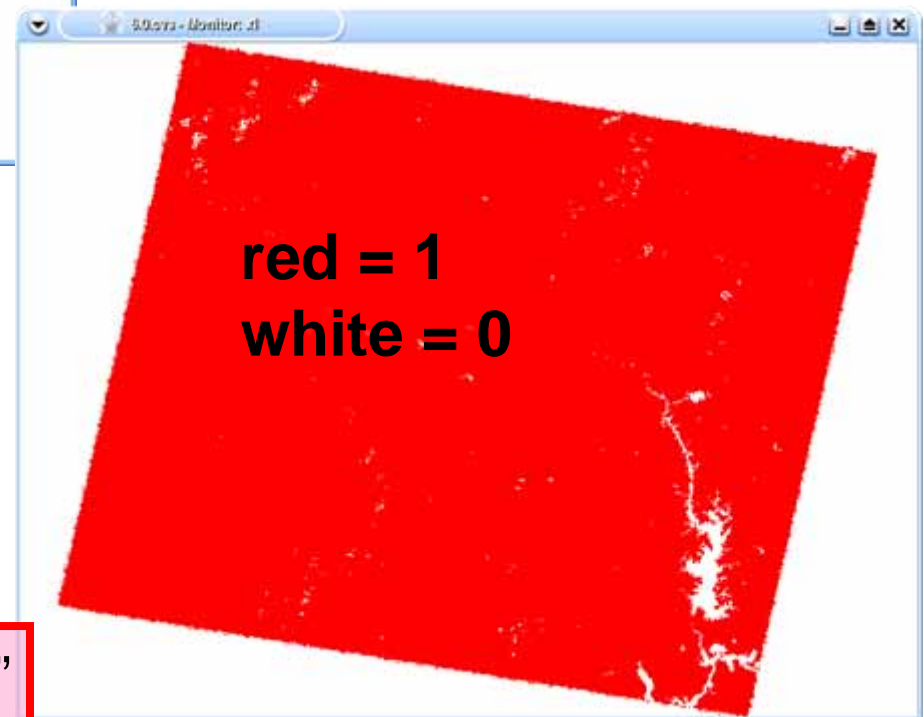
-0.9 < ndvi value  $\Rightarrow$  MASK value = 1

ndvi value  $\leq$  -0.9  $\Rightarrow$  MASK value = 0

ndvi image



MASK image



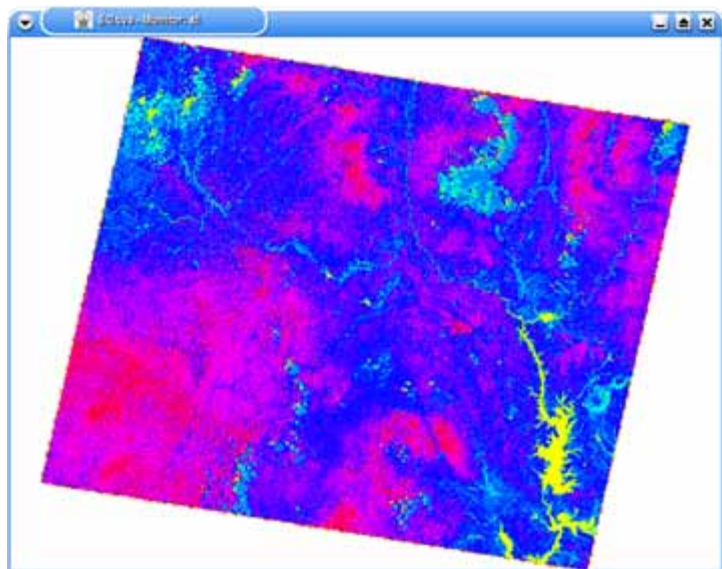
`r.mapcalc "MASK = if ( ndvi > -0.9 )"`

## 6.2.6 Display raster image with mask

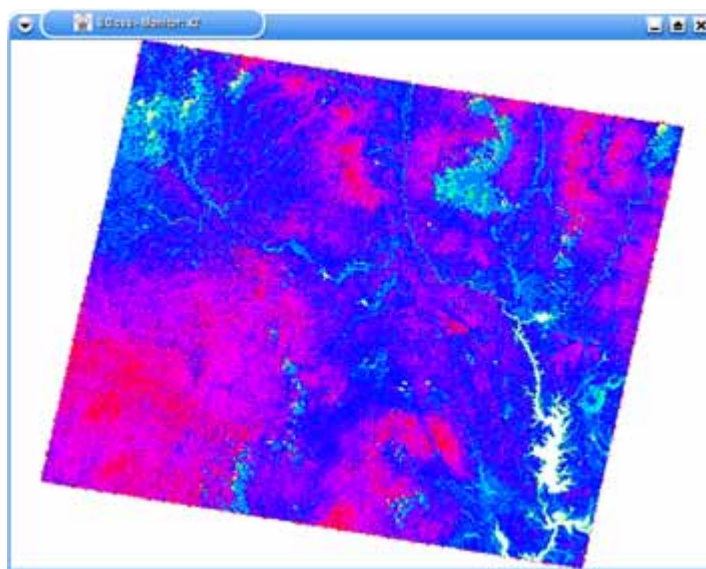
```
Shell - Konsole
Session Edit View Bookmarks Settings Help
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.mon x2
using default visual which is TrueColor
ncolors: 65536
Graphics driver [x2] started
[Raster MASK present]
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.rast ndvi
100%
[Raster MASK present]
```

This phrase shows that MASK is active.

original image



displayed image



original image



mask



displayed image

## 6.2.7 Remove mask

```
> g.remove rast=MASK
```

: space

***g.remove*** removes data base element files from the user's current mapset.

Once you create MASK, the following processes (commands) are affected by the MASK until you remove it.



The screenshot shows a terminal window titled "Shell - Konsole" with a menu bar (Session, Edit, View, Bookmarks, Settings, Help). The terminal content is as follows:

```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.mapcalc "MASK=if(ndvi>-0.9)"
100%
[Raster MASK present]
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.mon x0
using default visual which is TrueColor
ncolors: 65536
Graphics driver [x0] started
[Raster MASK present]
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > g.remove rast=MASK
REMOVE [MASK]
raster
header
category
color MISSING
history
misc
fcell MISSING
g3dcell MISSING
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.mon x1
using default visual which is TrueColor
ncolors: 65536
Graphics driver [x1] started
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > █
```

Annotations on the screenshot:

- A red circle around the first "[Raster MASK present]" message, with a red arrow pointing to it and the text "MASK is active".
- A red circle around the second "[Raster MASK present]" message, with a red arrow pointing to it and the text "Creation of MASK".
- A blue arrow pointing from the text "This command is affected by MASK." to the `d.mon x0` command.
- A red circle around the `g.remove rast=MASK` command, with a red arrow pointing to it and the text "MASK removal".
- A blue arrow pointing from the text "This command is not affected by MASK." to the `d.mon x1` command.
- A large blue curved arrow pointing from the "MASK removal" text to the `d.mon x1` command.

[ Raster MASK present ] disappeared

## **Section 2. SPOT Image Processing in UTM Coordinate System**

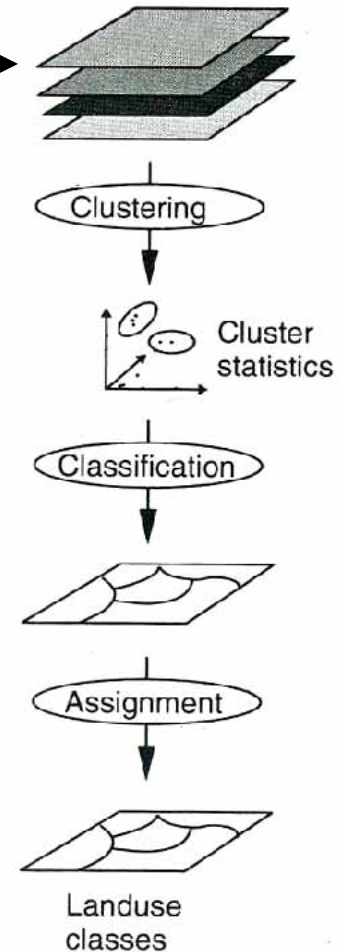
# **7. Land cover classification**

# 7.1 Unsupervised Classification

< Data List >

· Images for classification

MODIS 10-days composite images  
(CH1, CH2, CH3, CH4, CH5, CH6, CH7)



## 7.1.0 Import raster data (imagery files)

### 7.1.1 Create group and subgroup of imagery files

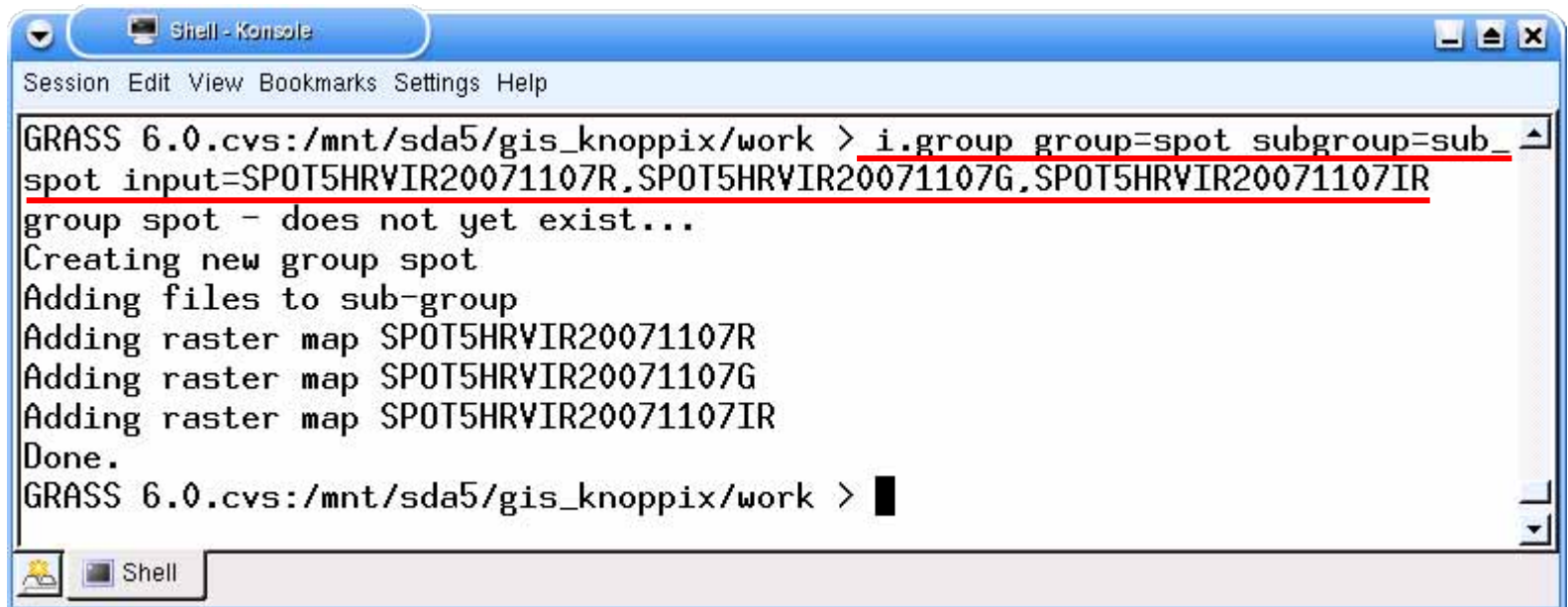
> i.group [group=A] [subgroup=B] [input=C, D, ...]

A = ( name of group )

B = ( name of subgroup )

C, D, ... = ( name of input data )

[ ] : space



```
Shell - Konsole
Session Edit View Bookmarks Settings Help
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > i.group group=spot subgroup=sub_
spot input=SPOT5HRVIR20071107R,SPOT5HRVIR20071107G,SPOT5HRVIR20071107IR
group spot - does not yet exist...
Creating new group spot
Adding files to sub-group
Adding raster map SPOT5HRVIR20071107R
Adding raster map SPOT5HRVIR20071107G
Adding raster map SPOT5HRVIR20071107IR
Done.
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > █
```

## 7.1.2 Clustering of image data

```
> i.cluster  $\square$  group = A  $\square$  subgroup = B  $\square$  sigfile = C  $\square$  classes = D
```

A = (name of image group)

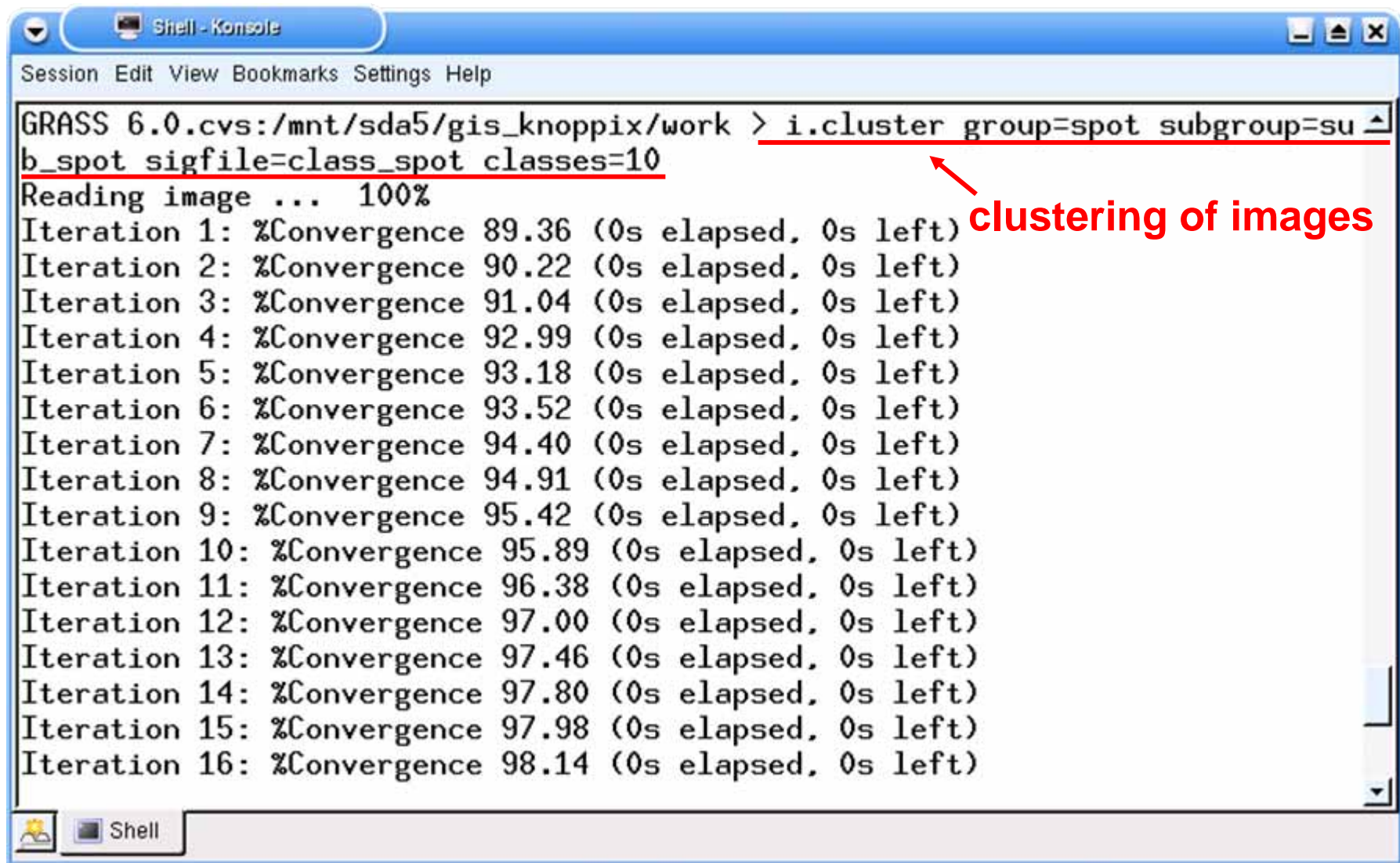
B = (name of subgroup)

C = (File contains result signatures )

D = (Initial number of classes )

$\square$  : space

***i.cluster*** - An imagery function that generates spectral signatures for land cover types in an image using a clustering algorithm.



The screenshot shows a terminal window titled "Shell - Konsole". The command prompt is "GRASS 6.0.cvs:/mnt/sda5/gis\_knoppix/work >". The command entered is i.cluster group=spot subgroup=su followed by a red arrow pointing to it with the text "clustering of images". Below the command, the output shows "b\_spot sigfile=class\_spot classes=10" and "Reading image ... 100%". Then, 16 iterations of convergence are listed, showing an increasing percentage of convergence from 89.36% to 98.14%.

```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > i.cluster group=spot subgroup=su
b_spot sigfile=class_spot classes=10
Reading image ... 100%
Iteration 1: %Convergence 89.36 (0s elapsed, 0s left)
Iteration 2: %Convergence 90.22 (0s elapsed, 0s left)
Iteration 3: %Convergence 91.04 (0s elapsed, 0s left)
Iteration 4: %Convergence 92.99 (0s elapsed, 0s left)
Iteration 5: %Convergence 93.18 (0s elapsed, 0s left)
Iteration 6: %Convergence 93.52 (0s elapsed, 0s left)
Iteration 7: %Convergence 94.40 (0s elapsed, 0s left)
Iteration 8: %Convergence 94.91 (0s elapsed, 0s left)
Iteration 9: %Convergence 95.42 (0s elapsed, 0s left)
Iteration 10: %Convergence 95.89 (0s elapsed, 0s left)
Iteration 11: %Convergence 96.38 (0s elapsed, 0s left)
Iteration 12: %Convergence 97.00 (0s elapsed, 0s left)
Iteration 13: %Convergence 97.46 (0s elapsed, 0s left)
Iteration 14: %Convergence 97.80 (0s elapsed, 0s left)
Iteration 15: %Convergence 97.98 (0s elapsed, 0s left)
Iteration 16: %Convergence 98.14 (0s elapsed, 0s left)
```

## 7.1.3 Classify images by Maximum Likelihood method

```
> i.maxlik group = A subgroup = B sigfile = C class = D
```

A = (name of image group)

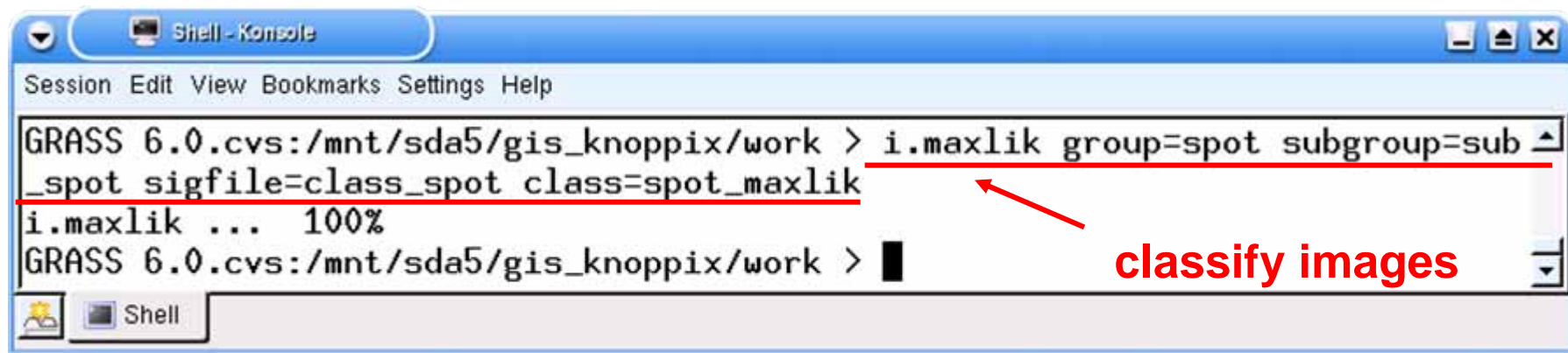
B = (name of subgroup)

C = (name of signaturefile)

D = (output file name)

: space

*i.maxlik* is a maximum-likelihood discriminant analysis classifier.



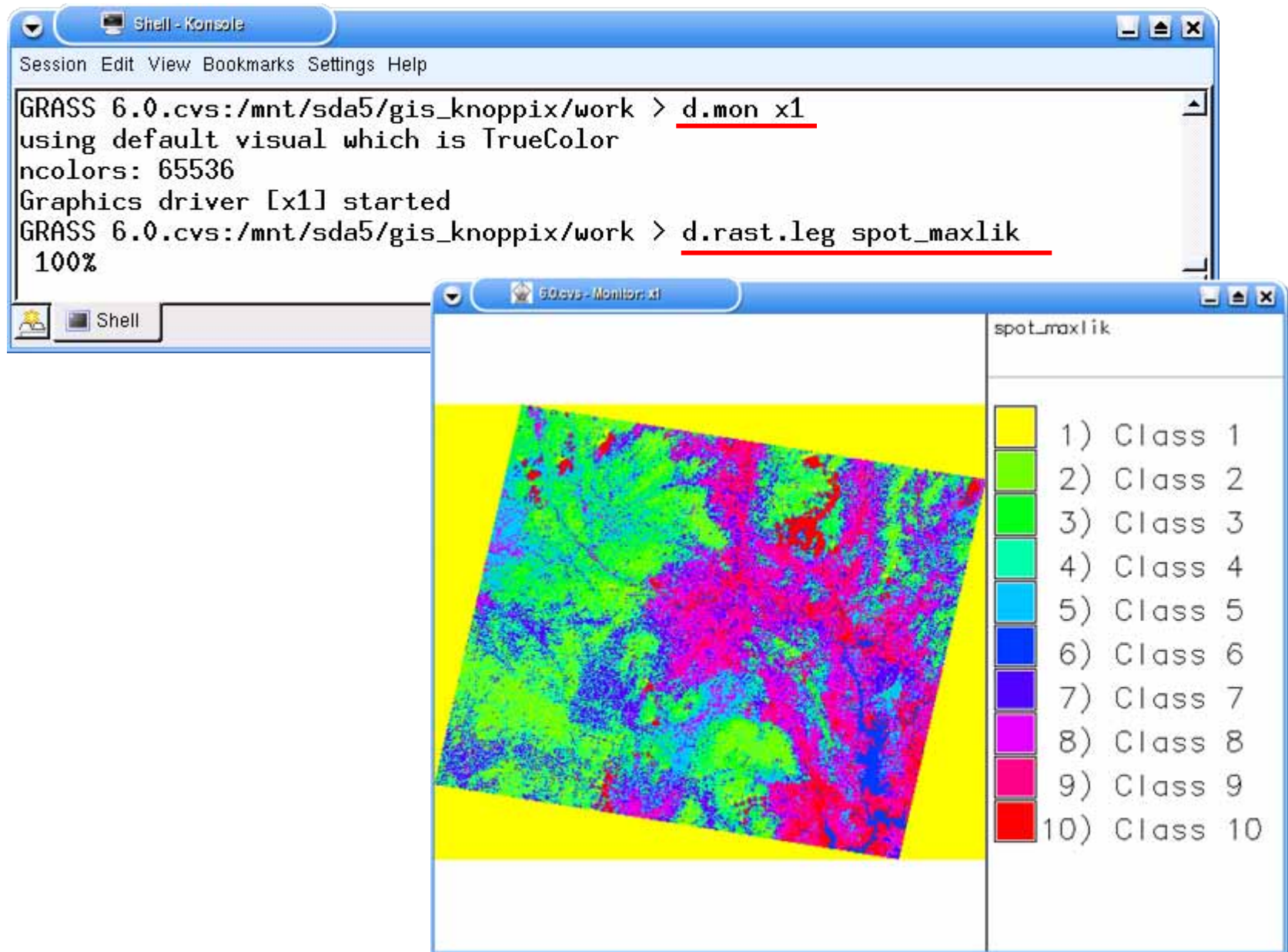
The screenshot shows a terminal window titled "Shell - Konsole" with a menu bar (Session, Edit, View, Bookmarks, Settings, Help). The command prompt shows the user is in the directory "/mnt/sda5/gis\_knoppix/work". The command entered is `i.maxlik group=spot subgroup=sub_spot sigfile=class_spot class=spot_maxlik`, which is underlined in red. Below the command, the output shows `i.maxlik ... 100%`. A red arrow points from the text "classify images" to the command. The terminal window has a taskbar at the bottom with icons for a shell and a file manager.

```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > i.maxlik group=spot subgroup=sub  
_spot sigfile=class_spot class=spot_maxlik  
i.maxlik ... 100%  
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > 
```

**classify images**



## 7.1.4 Display classification result





## 7.2 Unsupervised Classification with “Mask”

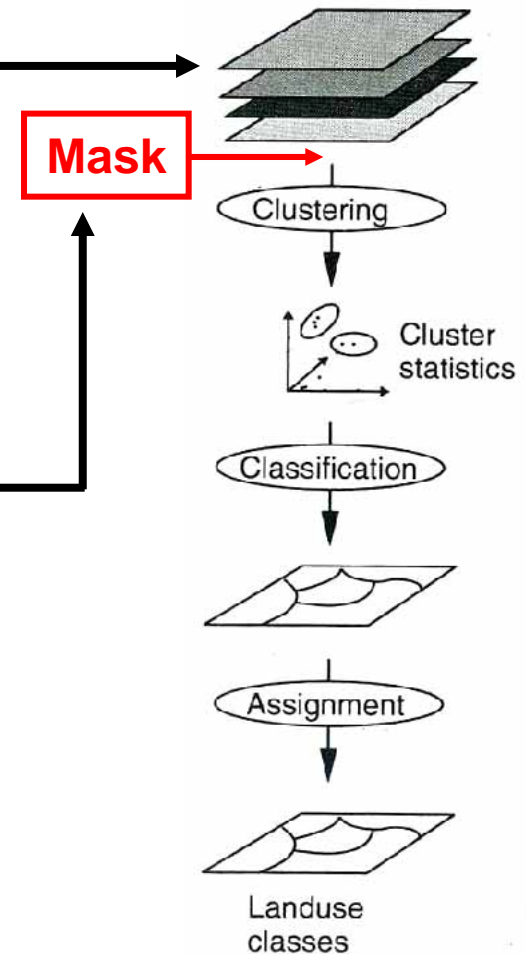
### < Data List >

- Images for classification

MODIS 10-days composite images  
(CH1, CH2, CH3, CH4, CH5, CH6, CH7)

- Images for Masking

- Water and cloud shadow Mask



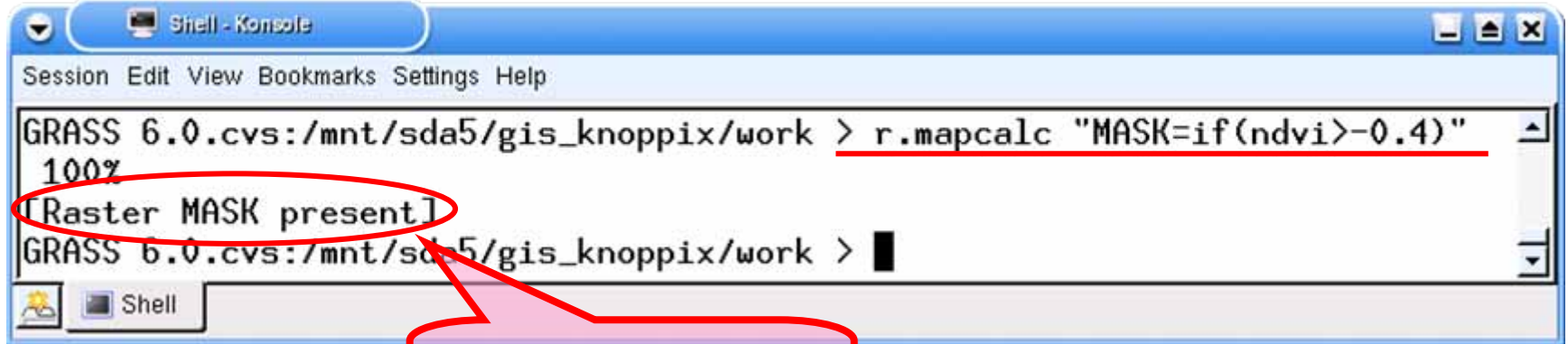
## 7.2.0 Import raster data (imagery files)

### 7.2.1 Create group and subgroup of imagery files

*see “7.1.1”*

### 7.2.2 Import raster data and create mask

In this case,  $\text{ndvi} \leq -0.4$  water or cloud shadow



The screenshot shows a terminal window titled "Shell - Konsole". The command prompt is "GRASS 6.0.cvs:/mnt/sda5/gis\_knoppix/work". The command entered is `r.mapcalc "MASK=if(ndvi>-0.4)"`, which is underlined in red. The output shows "100%" and "[Raster MASK present]", which is circled in red. The prompt then returns to "GRASS 6.0.cvs:/mnt/sda5/gis\_knoppix/work >".

```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.mapcalc "MASK=if(ndvi>-0.4)"
100%
[Raster MASK present]
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work >
```

The MASK is active

## 7.2.3 Clustering of image data

```
> i.cluster [group = A [subgroup = B [sigfile = C [classes = D
```

A = (name of image group)

B = (name of subgroup)

C = (File contains result signatures )

D = (Initial number of classes )

[ ] : space

***i.cluster*** - An imagery function that generates spectral signatures for land cover types in an image using a clustering algorithm.

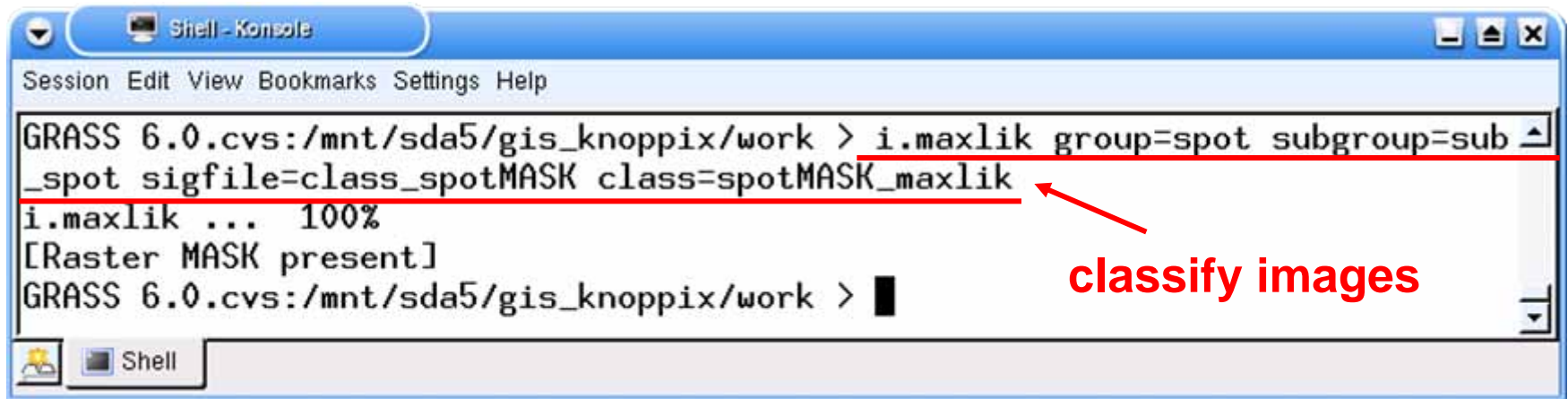
```
Shell - Konsole
Session Edit View Bookmarks Settings Help

GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > i.cluster group=spot subgroup=su
b_spot sigfile=class_spotMASK classes=10
Reading image ... 100%
Iteration 1: %Convergence 86.10 (0s elapsed, 0s left)
Iteration 2: %Convergence 84.54 (0s elapsed, 0s left)
Iteration 3: %Convergence 85.29 (0s elapsed, 0s left)
Iteration 4: %Convergence 92.82 (0s elapsed, 0s left)
Iteration 5: %Convergence 95.26 (0s elapsed, 0s left)
Iteration 6: %Convergence 96.11 (0s elapsed, 0s left)
Iteration 7: %Convergence 96.56 (0s elapsed, 0s left)
Iteration 8: %Convergence 97.30 (0s elapsed, 0s left)
Iteration 9: %Convergence 97.56 (0s elapsed, 0s left)
Iteration 10: %Convergence 97.74 (0s elapsed, 0s left)
Iteration 11: %Convergence 97.66 (0s elapsed, 0s left)
Iteration 12: %Convergence 97.51 (0s elapsed, 0s left)
Iteration 13: %Convergence 97.57 (0s elapsed, 0s left)
Iteration 14: %Convergence 97.90 (0s elapsed, 0s left)
Iteration 15: %Convergence 98.12 (0s elapsed, 0s left)
[Raster MASK present]
```

clustering of images

## 7.2.4 Classify images by Maximum Likelihood method

*see “7.1.3”*

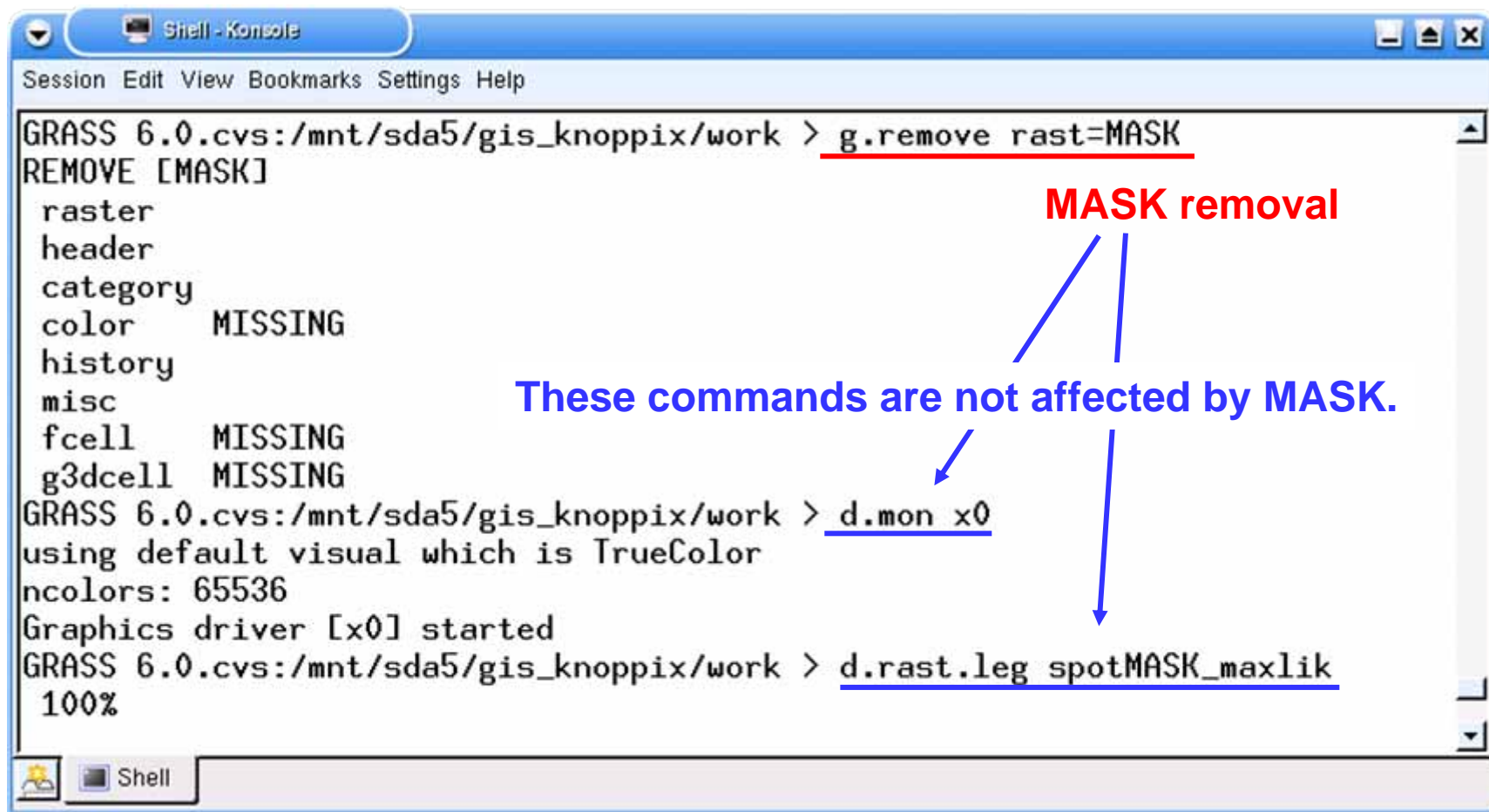


The screenshot shows a terminal window titled "Shell - Konsole". The prompt is "GRASS 6.0.cvs:/mnt/sda5/gis\_knoppix/work >". The command entered is `i.maxlik group=spot subgroup=sub _spot sigfile=class_spotMASK class=spotMASK_maxlik`. The output shows "i.maxlik ... 100%" and "[Raster MASK present]". A red arrow points from the text "classify images" to the command line. The window has a menu bar with "Session", "Edit", "View", "Bookmarks", "Settings", and "Help". The status bar at the bottom shows a "Shell" tab.

```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > i.maxlik group=spot subgroup=sub _spot sigfile=class_spotMASK class=spotMASK_maxlik
i.maxlik ... 100%
[Raster MASK present]
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work >
```

**classify images**

## 7.2.5 Display classification result



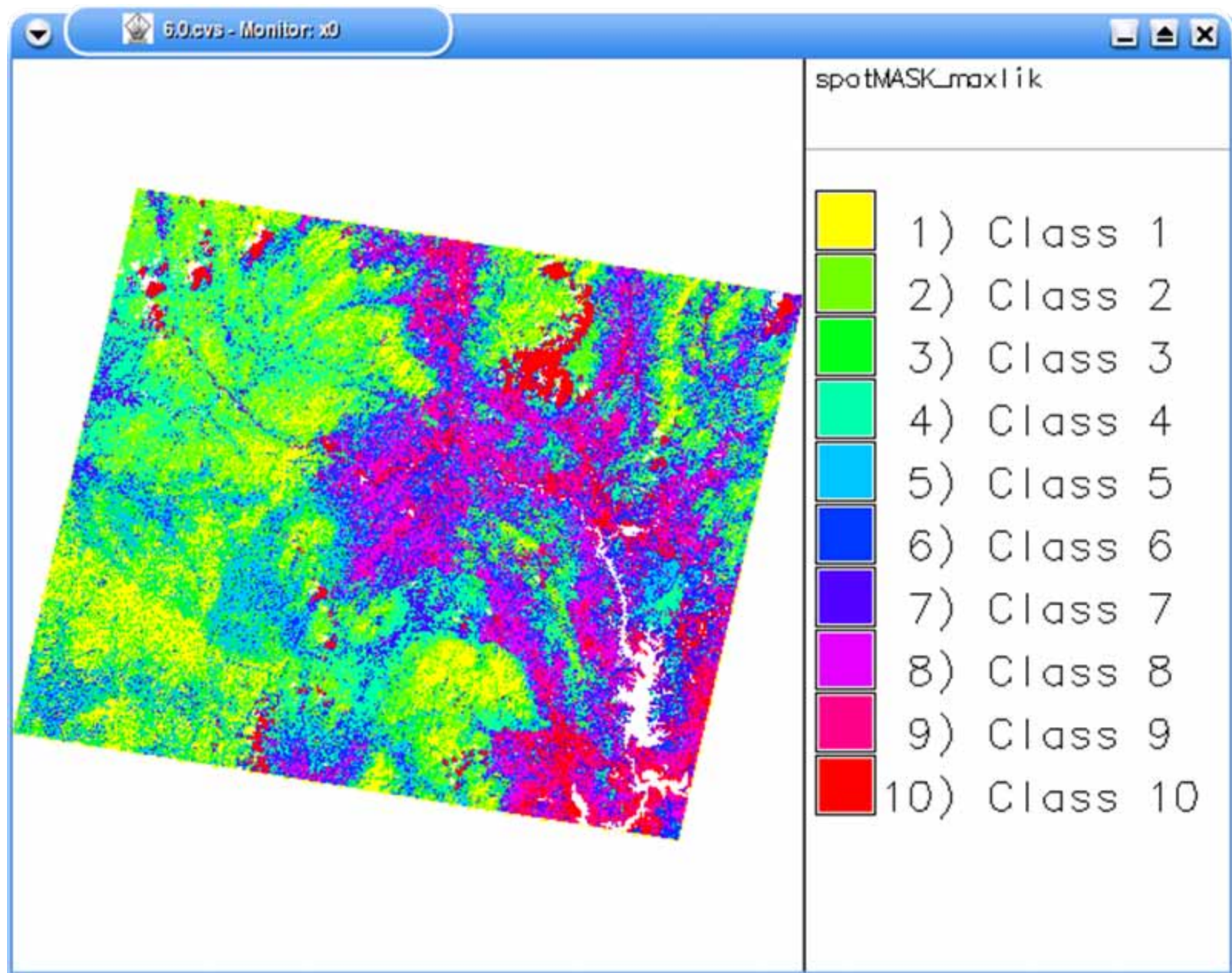
The screenshot shows a terminal window titled "Shell - Konsole" with a menu bar (Session, Edit, View, Bookmarks, Settings, Help). The terminal output shows the execution of GRASS GIS commands. The first command is `g.remove rast=MASK`, which is underlined in red. Below it, the output lists the components of the mask that are being removed: raster, header, category, color (MISSING), history, misc, fcell (MISSING), and g3dcell (MISSING). The second command is `d.mon x0`, which is underlined in blue. Below it, the output shows the default visual settings: using default visual which is TrueColor, ncolors: 65536, and Graphics driver [x0] started. The third command is `d.rast.legend spotMASK_maxlik`, which is underlined in blue. Below it, the output shows 100% completion. Annotations include the text "MASK removal" in red with two blue arrows pointing to the first and second commands, and the text "These commands are not affected by MASK." in blue with two blue arrows pointing to the second and third commands.

```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > g.remove rast=MASK
REMOVE [MASK]
raster
header
category
color    MISSING
history
misc
fcell    MISSING
g3dcell  MISSING
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.mon x0
using default visual which is TrueColor
ncolors: 65536
Graphics driver [x0] started
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.rast.legend spotMASK_maxlik
100%
```

**MASK removal**

**These commands are not affected by MASK.**





## 7.3 Reclassification of results

### 7.3.1 Search raster data information

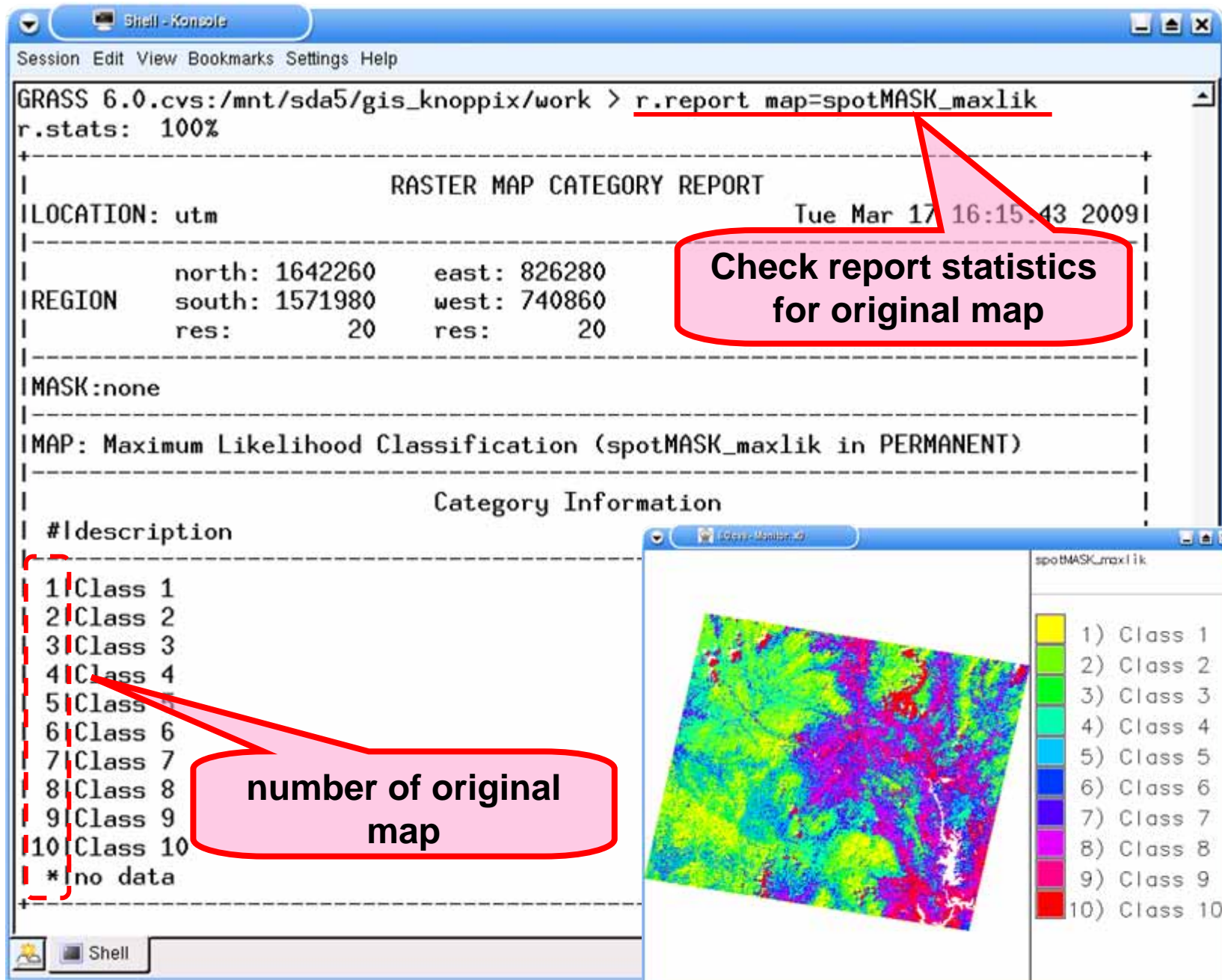
```
> r.report  map = A
```

A = (original map)

 : space

*r.report* allows the user to set up a series of report parameters to be applied to a raster map layer, and creates a report.





## 7.3.2 Reclassification

> r.reclass □ input = A □ output = B ↵

> a b = □ class1 ↵

> c d e = □ class2 ↵

> f n o = □ class3 ↵

> . . . . . ↵

> end ↵

□ : space

**A = (original map)**

**B = (reclassified map)**

**a, b, . . .**  
**= (number of original map)**

**, , . . .**  
**= (number of new map)**

**class1, class2, . . .**  
**= (category label of new map)**

Shell - Konsole

Session Edit View Bookmarks Settings Help

```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.reclass input=spot MASK_maxlik output=spotMASK_maxlik_reclass
```

Enter rule(s), "end" when done, "help" if you need it

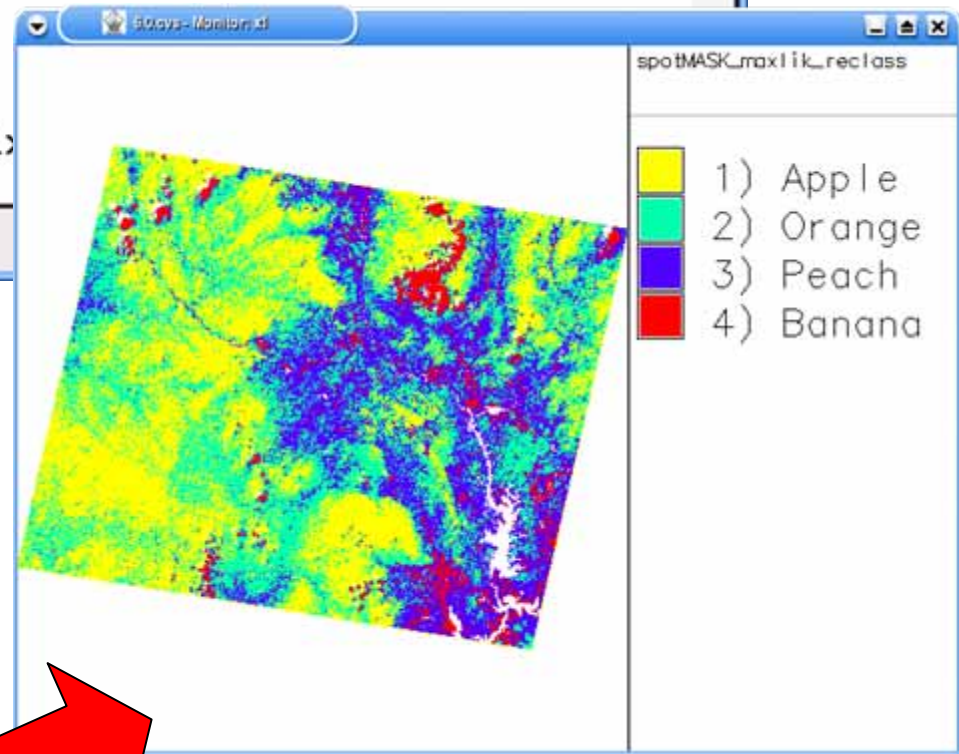
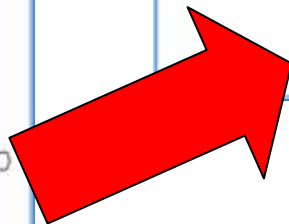
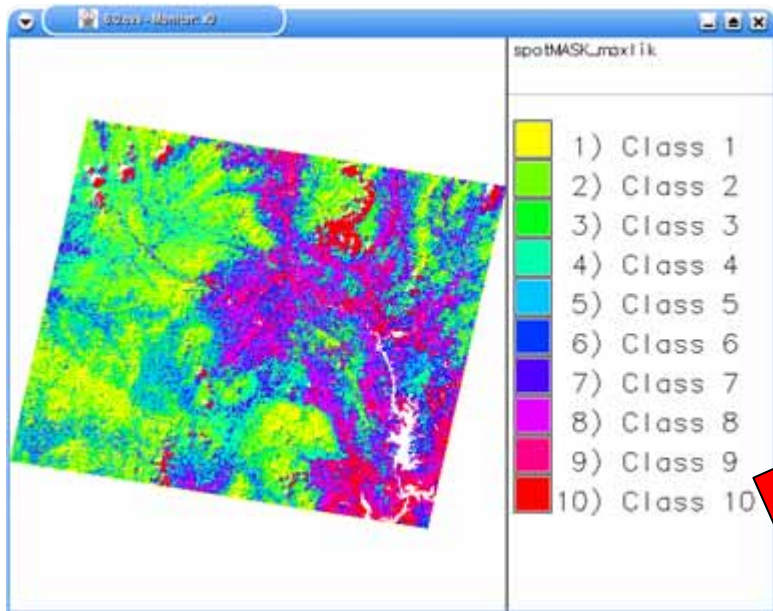
Data\_range is 1 to 10

```
> 1 2 3 = 1 Apple
> 4 5 6 = 2 Orange
> 7 8 9 = 3 Peach
> 10 = 4 Banana
> end
```

GRASS 6.0.cvs:/mnt/sda5/gis\_knoppix

Shell

**Reclassification**



## **Section 2. SPOT Image Processing in UTM Coordinate System**

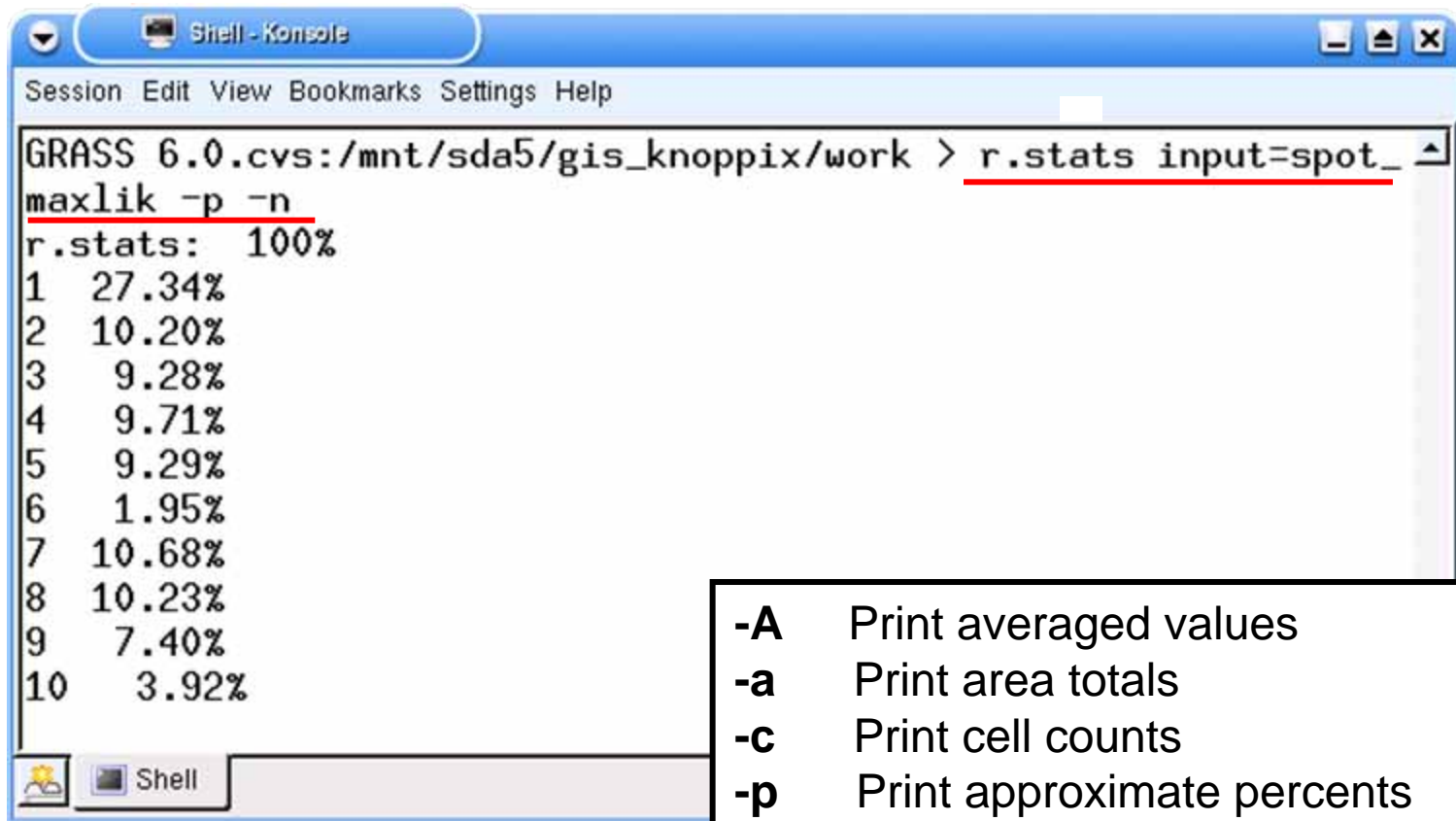
### **8. Raster statistics**

# 8.1 Generates area statistics for raster data

> r.stats input = A -p -n

A = (input file name)

: space



The screenshot shows a terminal window titled "Shell - Konsole" with a menu bar (Session, Edit, View, Bookmarks, Settings, Help). The command prompt shows the user is in the directory "/mnt/sda5/gis\_knoppix/work". The command entered is "r.stats input=spot\_maxlik -p -n". The output shows "r.stats: 100%" followed by a list of 10 categories and their percentages.

```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.stats input=spot_maxlik -p -n
r.stats: 100%
1 27.34%
2 10.20%
3 9.28%
4 9.71%
5 9.29%
6 1.95%
7 10.68%
8 10.23%
9 7.40%
10 3.92%
```

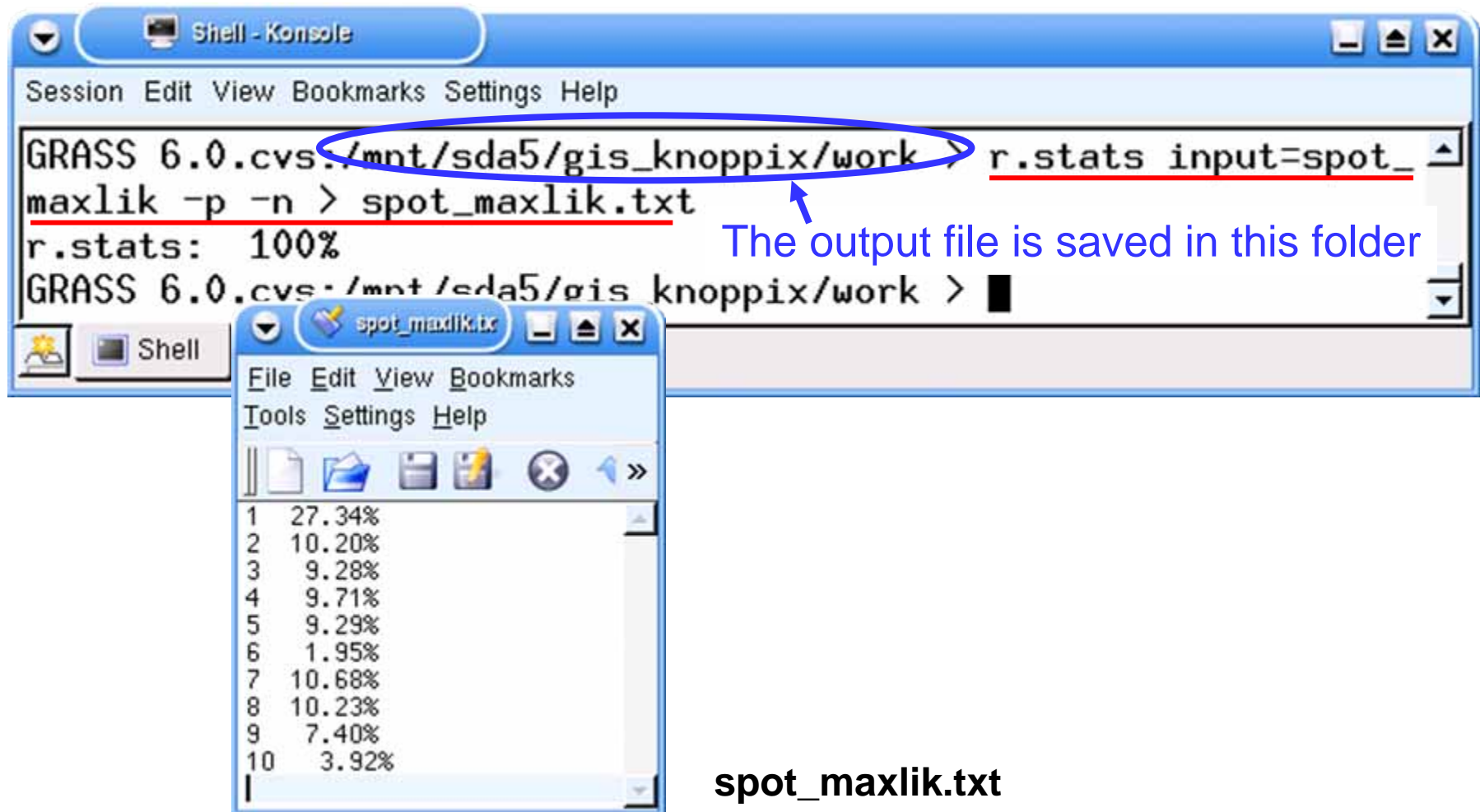
- A Print averaged values
- a Print area totals
- c Print cell counts
- p Print approximate percents
- l Print category labels
- n Suppress reporting of any NULLs

## 8.2 Export area statistics for raster data in text format

```
> r.stats input = A -p -n > B.txt
```

A = (input file name)

B = (output file name)



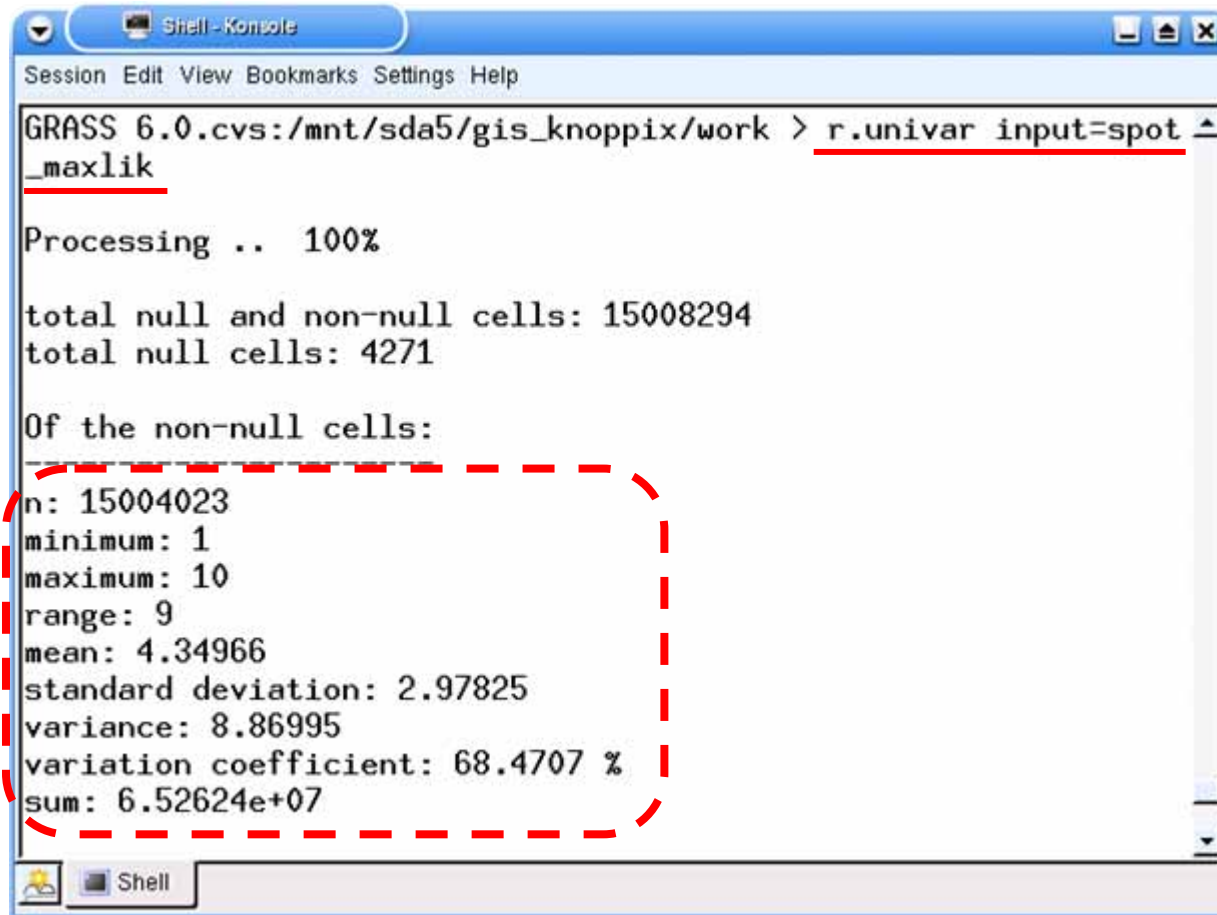


## 8.3 Calculation of univariate statistics from a raster map

> r.univar  input = A

A = (input file name)

: space



```
Shell - Konsole
Session Edit View Bookmarks Settings Help
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.univar input=spot
_maxlik

Processing .. 100%

total null and non-null cells: 15008294
total null cells: 4271

Of the non-null cells:
-----
n: 15004023
minimum: 1
maximum: 10
range: 9
mean: 4.34966
standard deviation: 2.97825
variance: 8.86995
variation coefficient: 68.4707 %
sum: 6.52624e+07
```

## **Section 2. SPOT Image Processing in UTM Coordinate System**

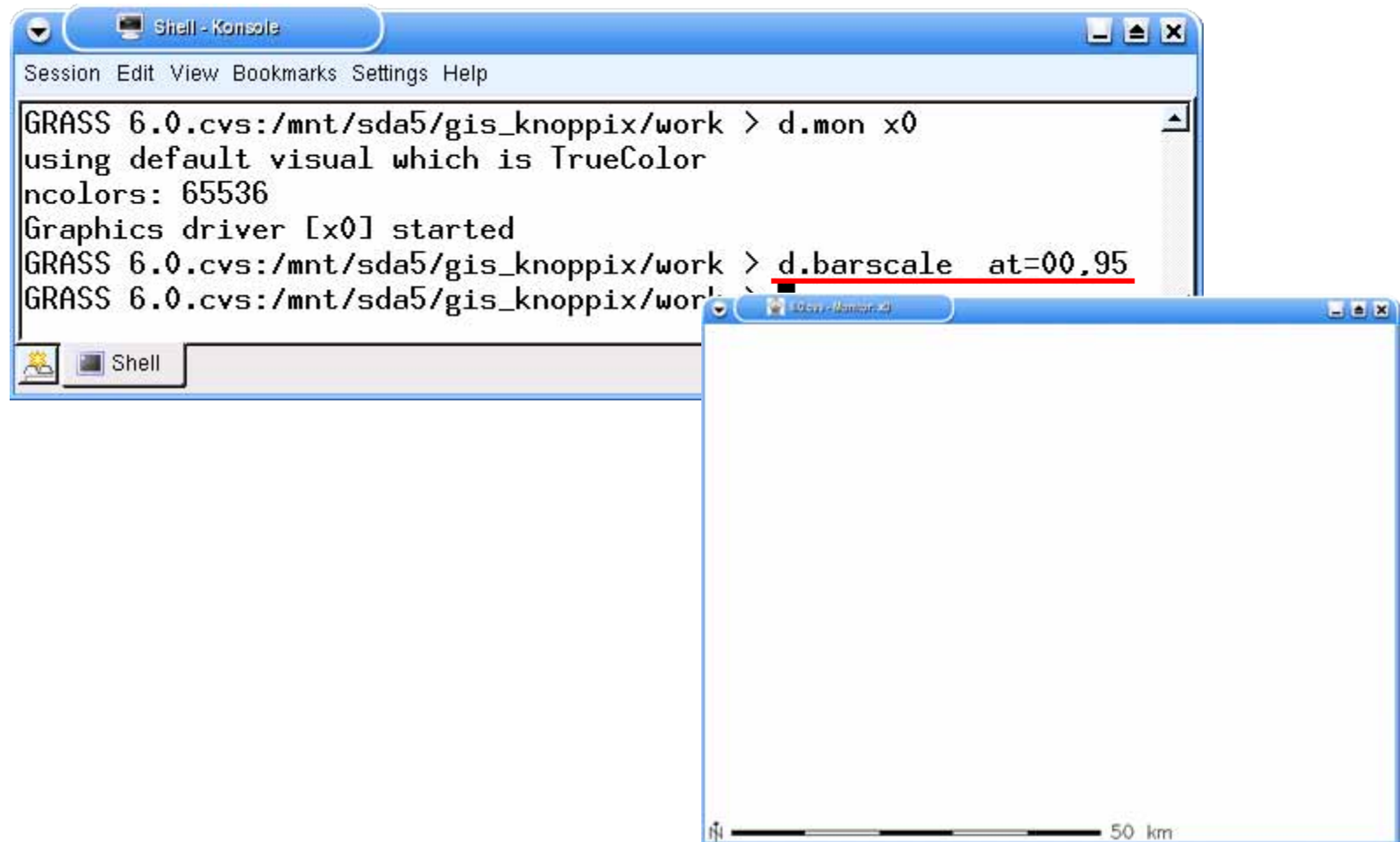
### **9. Map layout**



## 9.1 Display scale bar and north arrow

> d.barscale  $\square$  map= A  $\square$  at=x,y      x,y: [0,0] is top-left of frame  $\square$  : space

**d.barscale** - Displays a barscale on GRASS monitor.

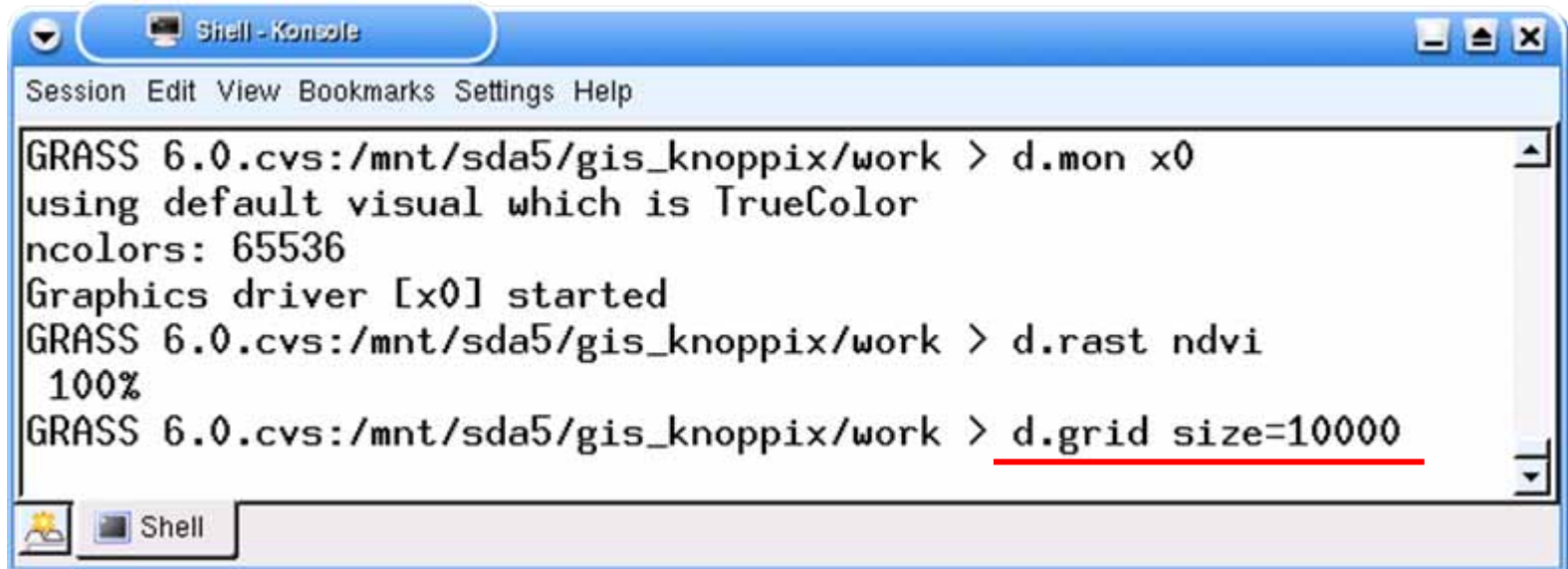


## 9.2 Display Grid line

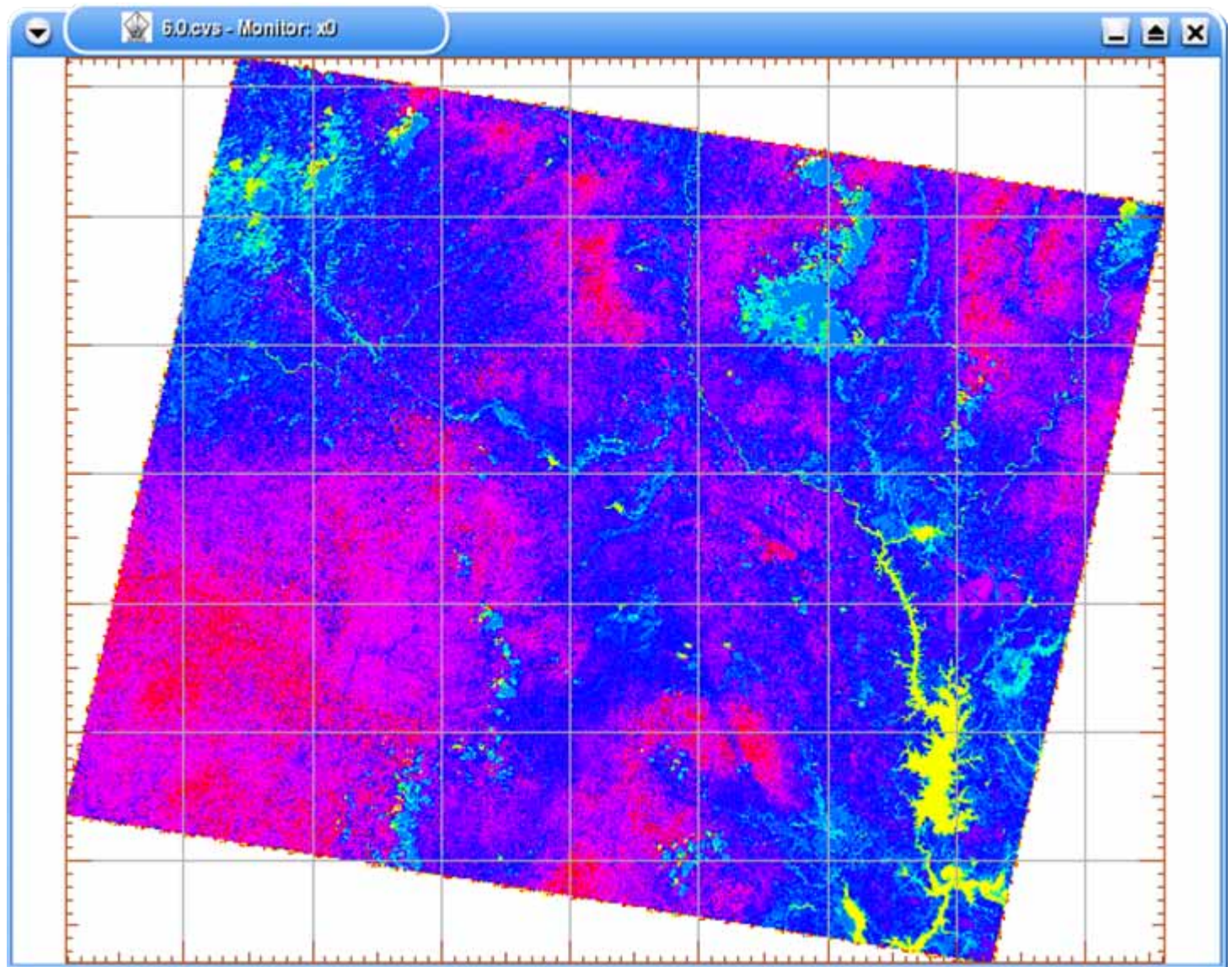
```
> d.grid  size=x
```

  : space

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



```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.mon x0
using default visual which is TrueColor
ncolors: 65536
Graphics driver [x0] started
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.rast ndvi
100%
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.grid size=10000
```



## **Section 2. SPOT Image Processing in UTM Coordinate System**

# **10. Export raster**

**10.1 Export a raster to a binary file**

**10.2 Export a raster to a TIFF file**

**10.3 Export displayed image to PNG file**

# 10.1 Export a raster to a binary file

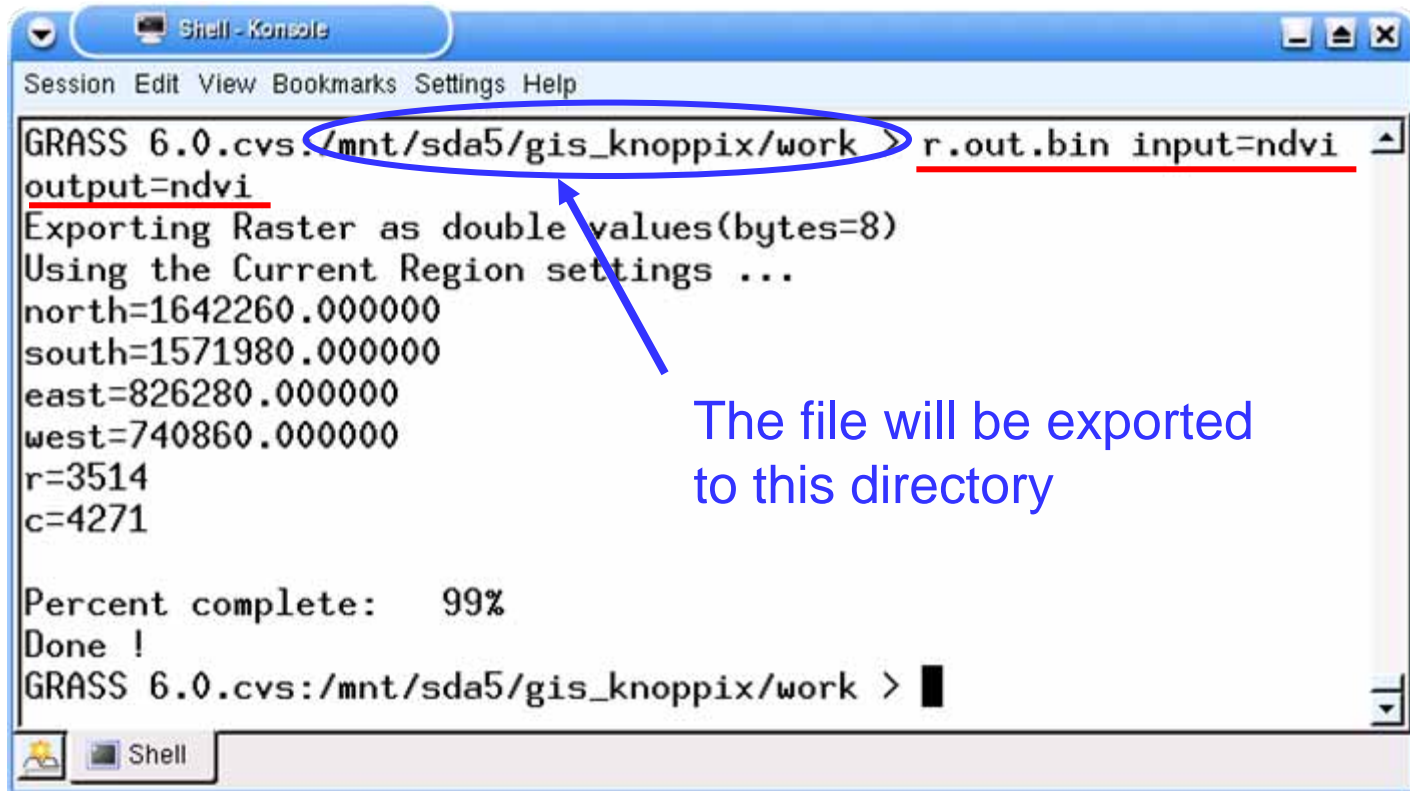
□ : space

```
> r.out.bin □ input = " A " □ output = " B "
```

A = (input file name)

B = (output file name)

The *r.out.bin* program exports a GRASS raster map to a binary array file.



The screenshot shows a terminal window titled "Shell - Konsole". The command prompt is "GRASS 6.0.cvs:/mnt/sda5/gis\_knoppix/work >". The command entered is r.out.bin input=ndvi, with the directory path circled in blue and an arrow pointing to it with the text "The file will be exported to this directory". The output shows the command is executed with "output=ndvi" (underlined in red), and it exports the raster as double values (bytes=8) using current region settings. The region settings are listed: north=1642260.000000, south=1571980.000000, east=826280.000000, west=740860.000000, r=3514, c=4271. The progress is 99% complete, and it ends with "Done !". The prompt returns to "GRASS 6.0.cvs:/mnt/sda5/gis\_knoppix/work >".

```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.out.bin input=ndvi
output=ndvi
Exporting Raster as double values(bytes=8)
Using the Current Region settings ...
north=1642260.000000
south=1571980.000000
east=826280.000000
west=740860.000000
r=3514
c=4271

Percent complete: 99%
Done !
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > █
```

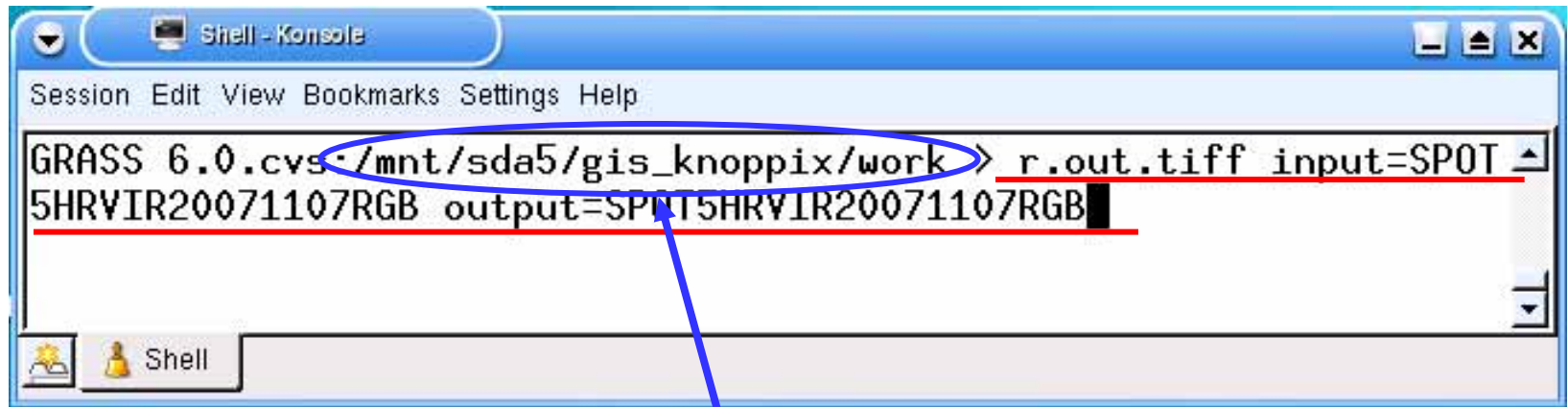
## 10.2 Export a raster to a TIFF file

␣ : space

```
> r.out.tiff ␣input = A ␣output = B
```

A = (input file name)

B = (output file name)



```
GRASS 6.0.cvs: /mnt/sda5/gis_knoppix/work > r.out.tiff input=SPOT5HRVIR20071107RGB output=SPOT5HRVIR20071107RGB
```

The file will be exported to this directory



## 10.3 Export displayed image to PNG file

> d.mon  start = PNG

> d.rast  map = A

A = (input file name1)

> d.vect  map = B

B = (input file name2)

> d.mon  stop = PNG

: space

This will write a file named *map.png* to be created in your current directory



```
端末
ファイル(E) 編集(E) 表示(V) 端末(T) タブ(B) ヘルプ(H)
端末
When ready to quit enter:          exit
GRASS 6.2.2 (latlon):/mnt/usr9/home/akats/research2/WebMODIS/GRASS > d.mon start=PNG
PNG: GRASS_TRUECOLOR status: FALSE
PNG: collecting to file: map.png.
      GRASS_WIDTH=640, GRASS_HEIGHT=480
Graphics driver [PNG] started
GRASS 6.2.2 (latlon):/mnt/usr9/home/akats/research2/WebMODIS/GRASS > d.rast rgb
100%
GRASS 6.2.2 (latlon):/mnt/usr9/home/akats/research2/WebMODIS/GRASS > d.vect boundary type=boundary color=yellow width=2
GRASS 6.2.2 (latlon):/mnt/usr9/home/akats/research2/WebMODIS/GRASS > d.vect city icon=basic/point fcolor=red size=15
GRASS 6.2.2 (latlon):/mnt/usr9/home/akats/research2/WebMODIS/GRASS > d.vect city display=attr attrcol=label lsize=12
GRASS 6.2.2 (latlon):/mnt/usr9/home/akats/research2/WebMODIS/GRASS > d.mon stop=PNG
Monitor 'PNG' terminated
GRASS 6.2.2 (latlon):/mnt/usr9/home/akats/research2/WebMODIS/GRASS >
```



## **Section 3.**

# **Landsat Image Processing in UTM Coordinate System**

## **Section 3. Landsat Image Processing in UTM Coordinate System**

### **1. Defining coordinate system and region**

# **1.0 Check Row/Path and UTM Zone of image**

The Row/Path and UTM zone of the images for this training;

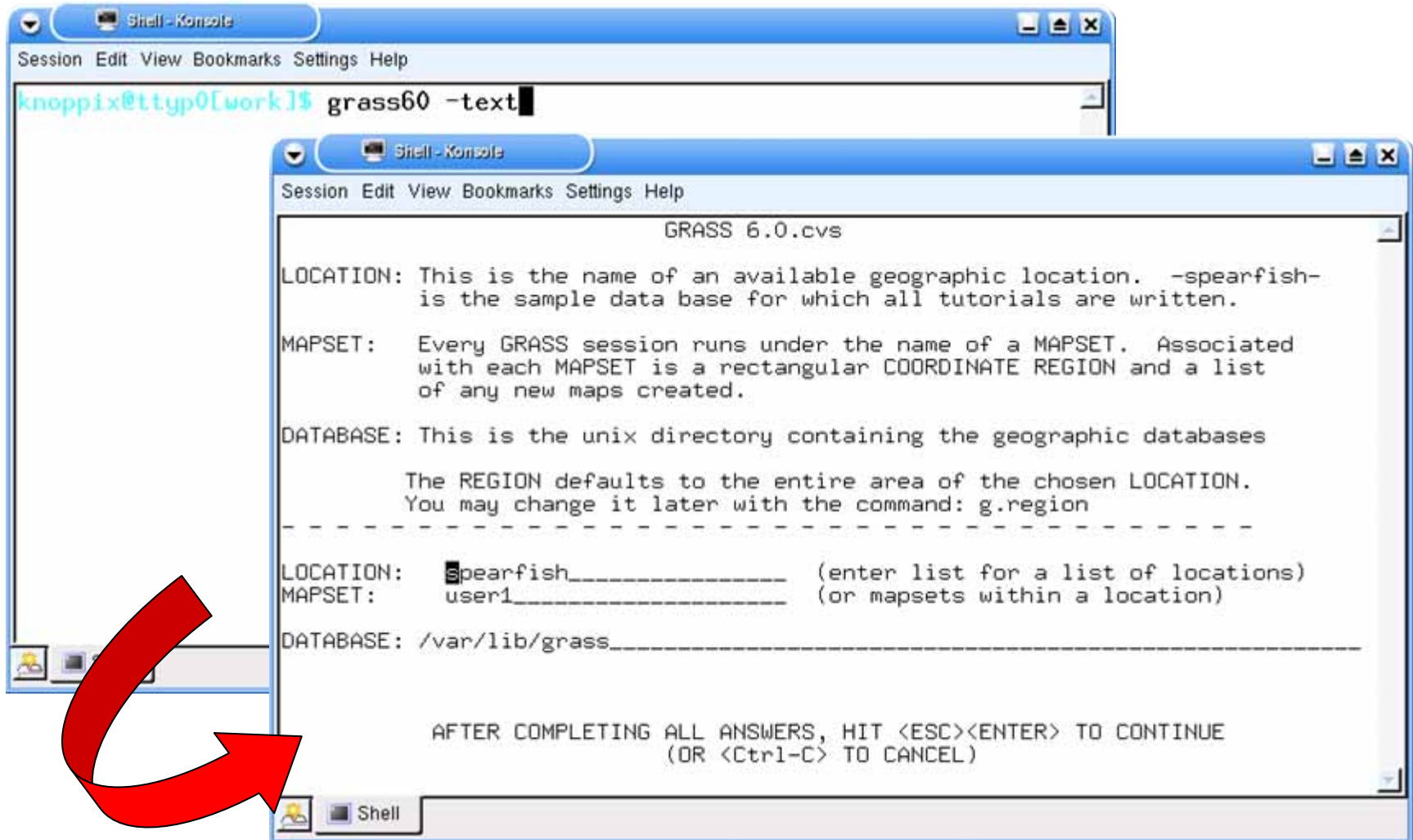
- Path : 124  
Row : 52
- UTM zone : 48
- Data Acquisition Date : 1990-12-30

**\* Landsat images in GeoCover data set are provided with a UTM projection, using the WGS-84 datum.**

# 1.1 Starting GRASS

> grass60 -text

: space



```
knoppix@tty0[work]$ grass60 -text
```

GRASS 6.0.cvs

LOCATION: This is the name of an available geographic location. -spearfish- is the sample data base for which all tutorials are written.

MAPSET: Every GRASS session runs under the name of a MAPSET. Associated with each MAPSET is a rectangular COORDINATE REGION and a list of any new maps created.

DATABASE: This is the unix directory containing the geographic databases

The REGION defaults to the entire area of the chosen LOCATION. You may change it later with the command: g.region

-----

LOCATION:  (enter list for a list of locations)

MAPSET:  (or mapsets within a location)

DATABASE:

-----

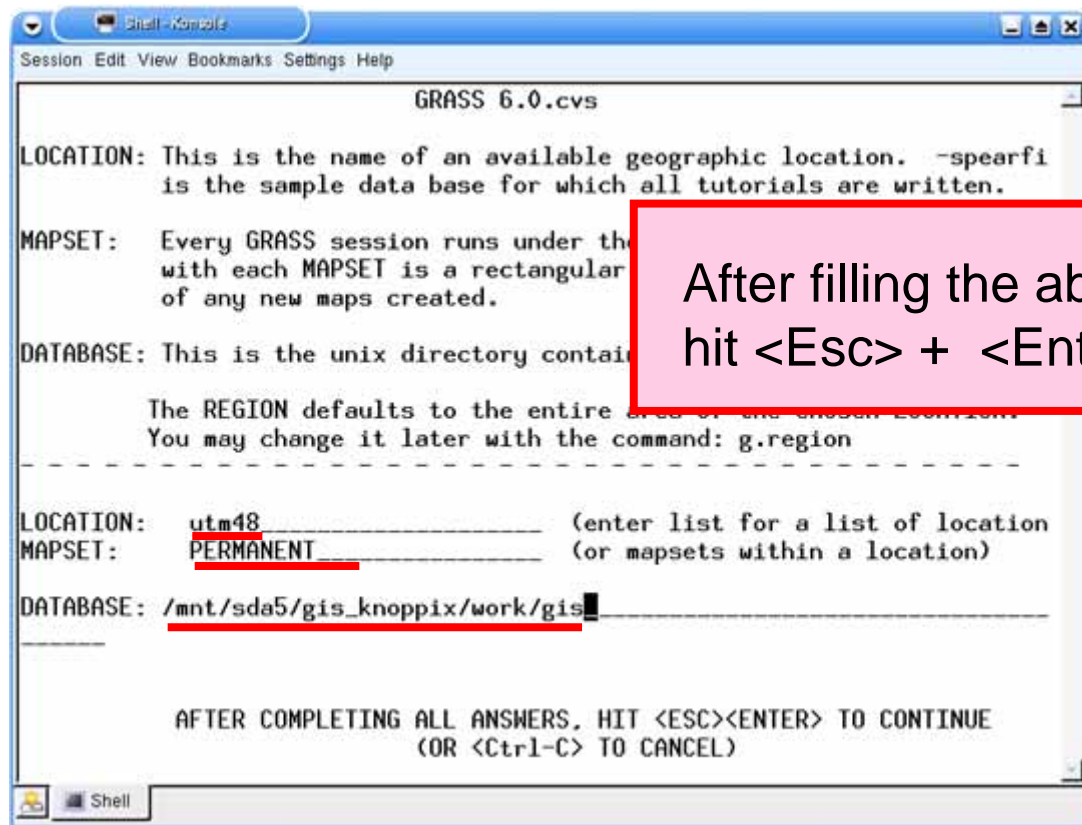
AFTER COMPLETING ALL ANSWERS, HIT <ESC><ENTER> TO CONTINUE (OR <Ctrl-C> TO CANCEL)

## 1.2 Determination of LOCATION, MAPSET, DATABASE

LOCATION: **utm48**

MAPSET: **PERMANENT**

DATABASE: **/mnt/sda1/gis\_knoppix/work/gis**



The screenshot shows a terminal window titled "GRASS 6.0.cvs" with a menu bar (Session, Edit, View, Bookmarks, Settings, Help). The window displays the following text:

```
LOCATION: This is the name of an available geographic location. -spearfi
is the sample data base for which all tutorials are written.

MAPSET: Every GRASS session runs under the
with each MAPSET is a rectangular
of any new maps created.

DATABASE: This is the unix directory containi

The REGION defaults to the entire area of the chosen location.
You may change it later with the command: g.region

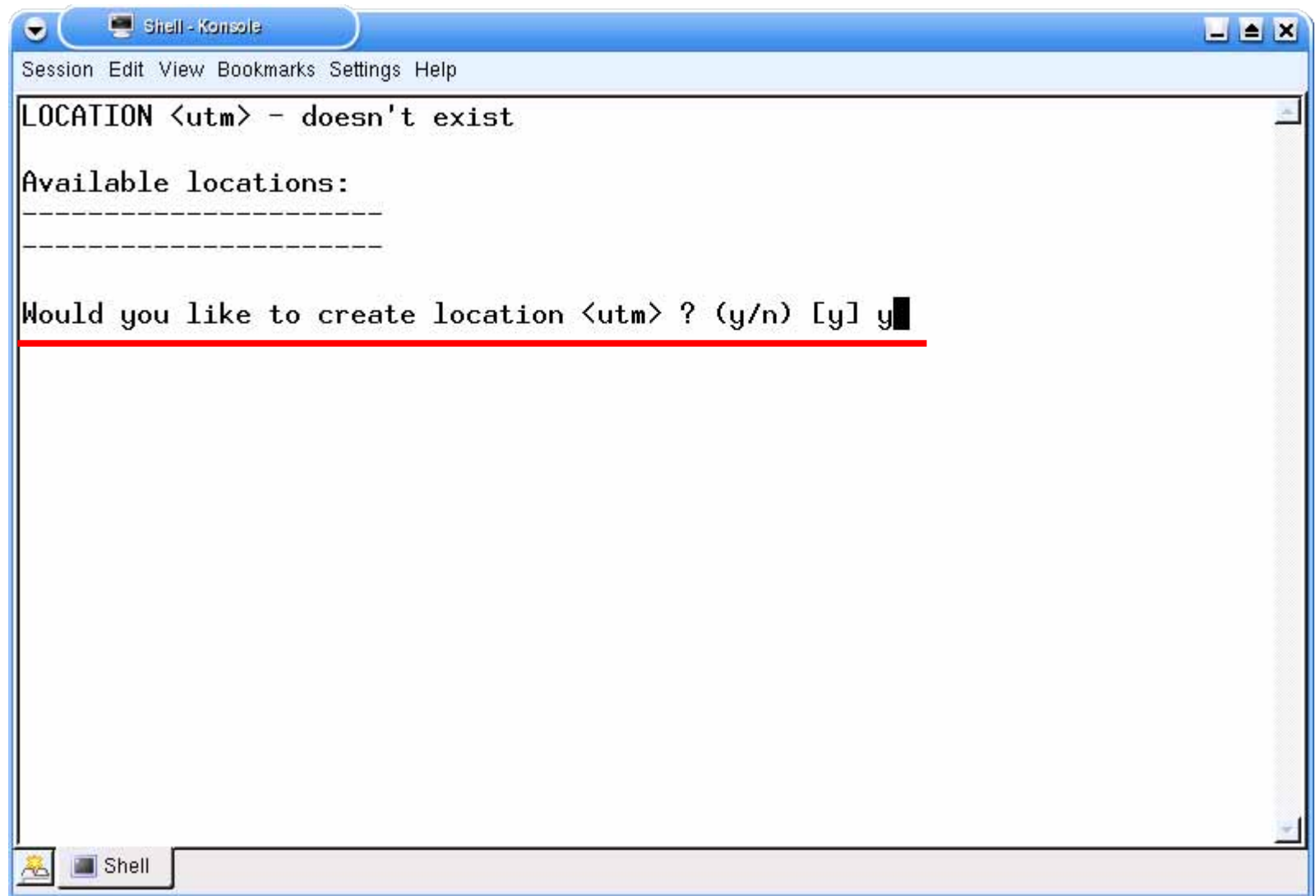
-----

LOCATION:  utm48          (enter list for a list of location
MAPSET:   PERMANENT      (or mapsets within a location)
DATABASE: /mnt/sda5/gis_knoppix/work/gis
```

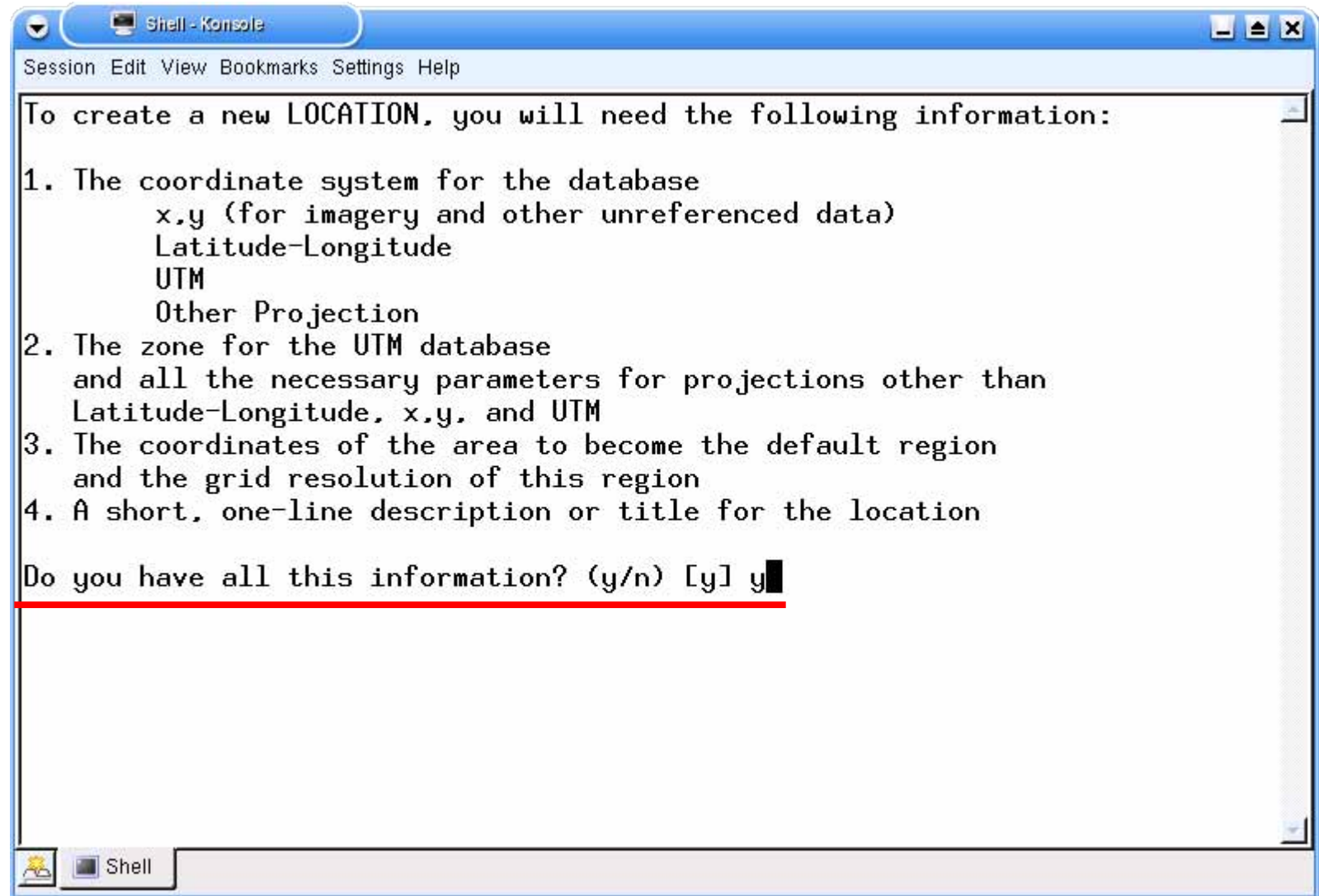
At the bottom, it says: "AFTER COMPLETING ALL ANSWERS, HIT <ESC><ENTER> TO CONTINUE (OR <Ctrl-C> TO CANCEL)".

After filling the above information,  
hit <Esc> + <Enter (or Return) >

enter < y >, then hit < Enter (or Return) >



enter < y >, then hit < Enter (or Return) >



```
Shell - Konsole
Session Edit View Bookmarks Settings Help

To create a new LOCATION, you will need the following information:

1. The coordinate system for the database
    x,y (for imagery and other unreferenced data)
    Latitude-Longitude
    UTM
    Other Projection
2. The zone for the UTM database
    and all the necessary parameters for projections other than
    Latitude-Longitude, x,y, and UTM
3. The coordinates of the area to become the default region
    and the grid resolution of this region
4. A short, one-line description or title for the location

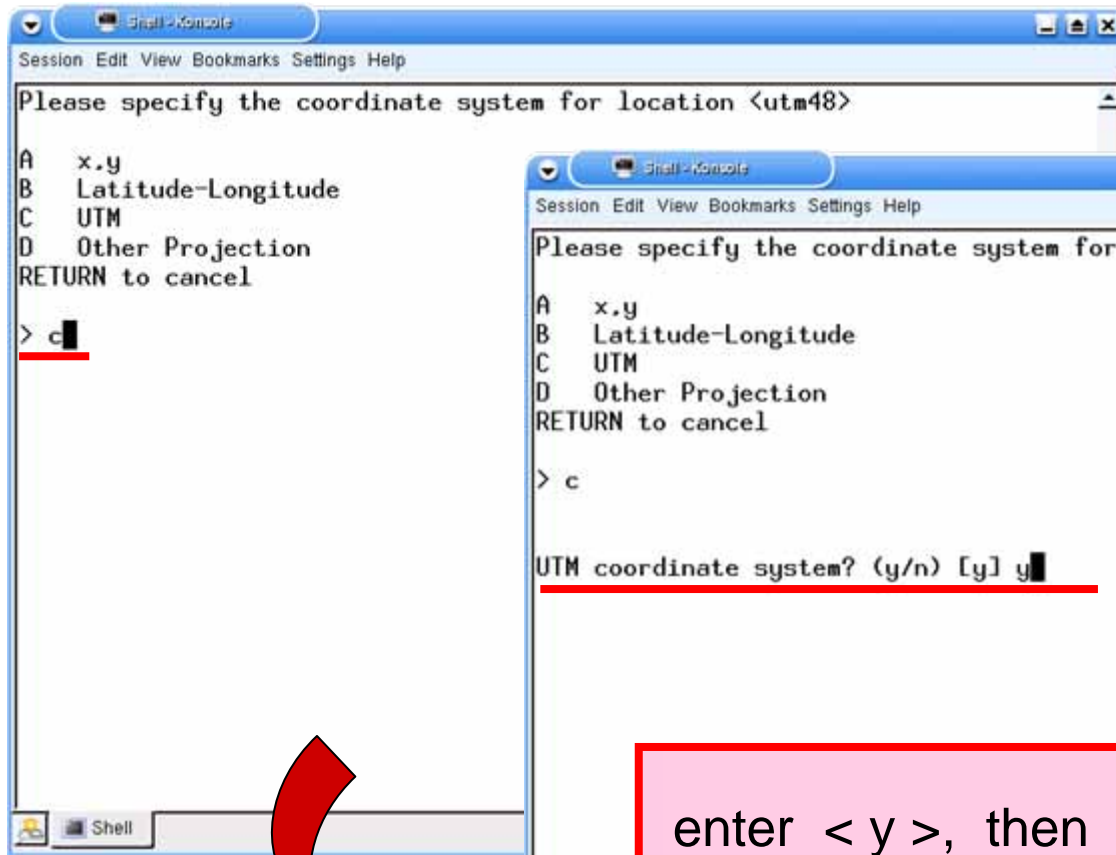
Do you have all this information? (y/n) [y] y
```



# 1.3 Selection of projection

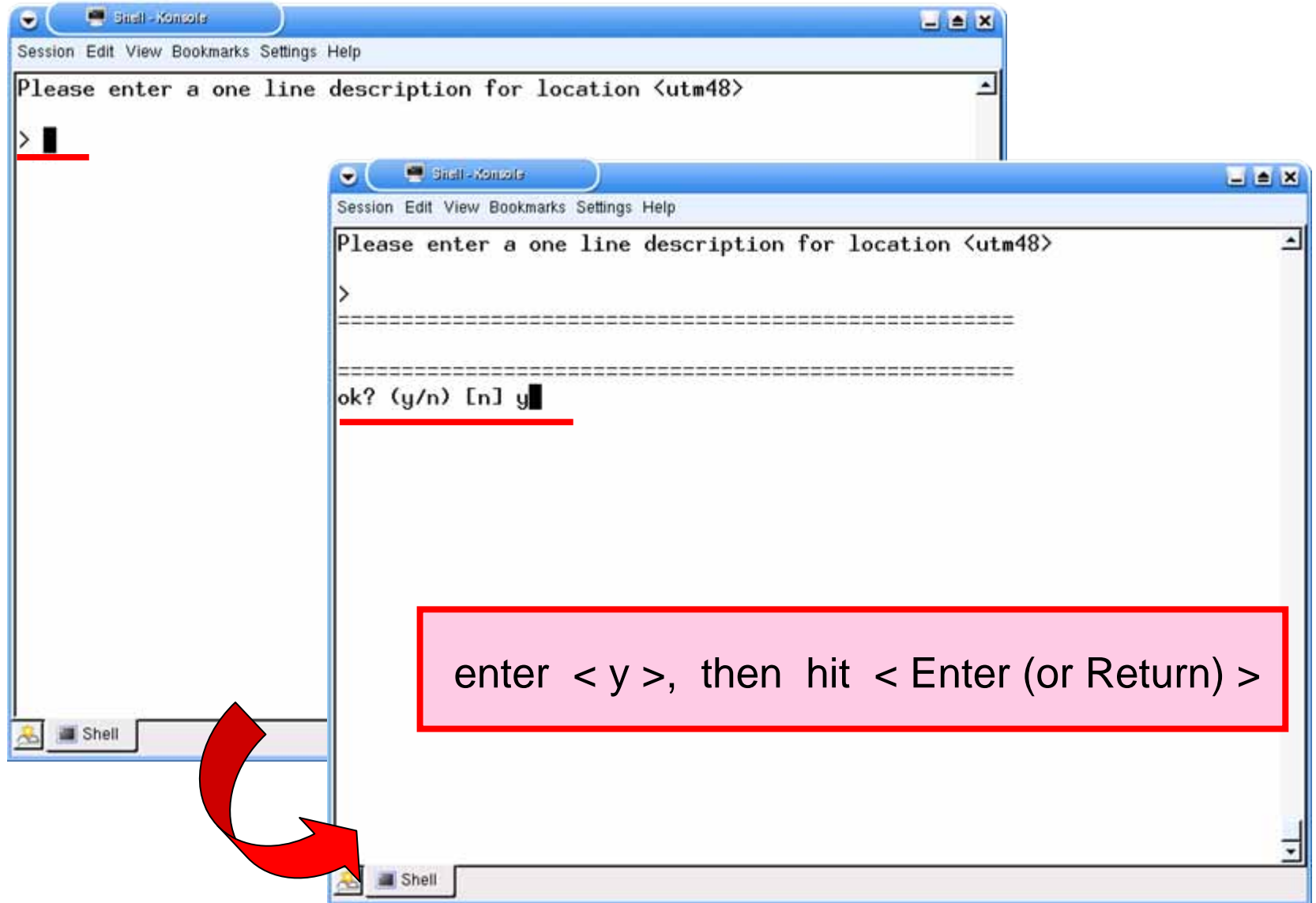
## : Latitude-longitude coordinate

enter < c >, then hit < Enter (or Return) >

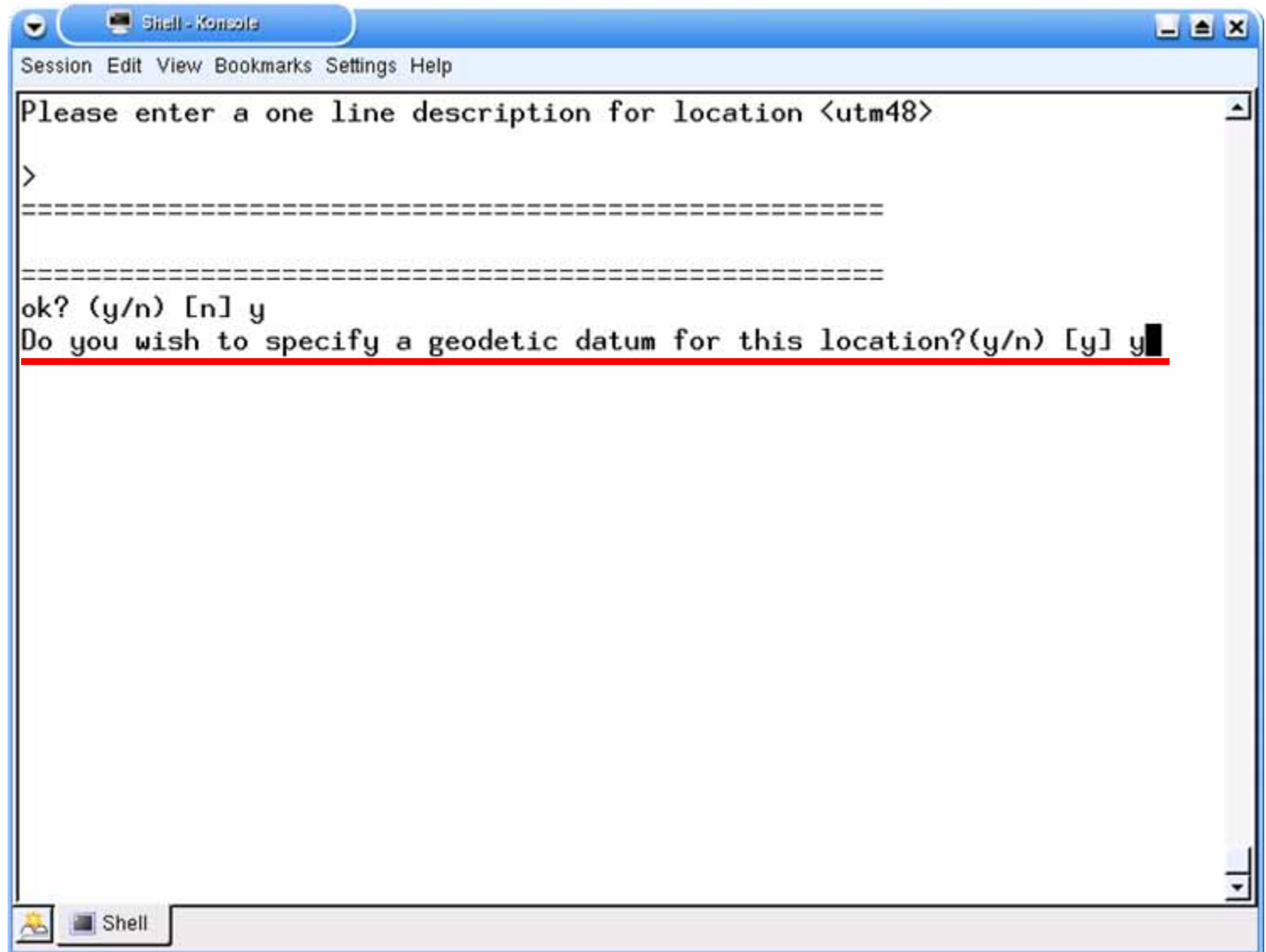


enter < y >, then hit < Enter (or Return) >

just hit < Enter (or Return) >



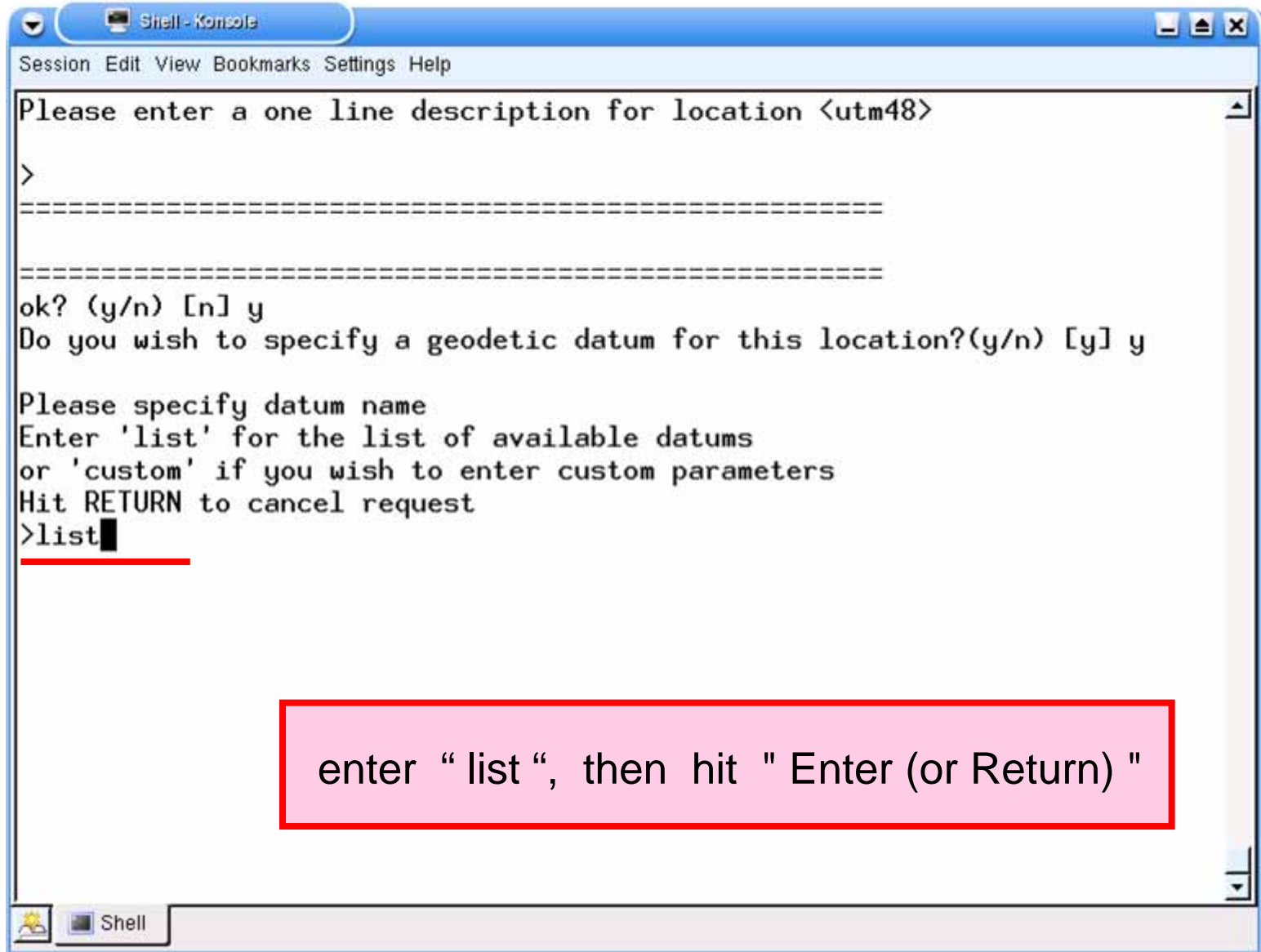
enter " y ", then hit " Enter (or Return) "



```
Shell - Konsole
Session Edit View Bookmarks Settings Help

Please enter a one line description for location <utm48>
>
=====
=====
ok? (y/n) [n] y
Do you wish to specify a geodetic datum for this location?(y/n) [y] y
```

# 1.4 Selection of datum



```
Shell - Konsole
Session Edit View Bookmarks Settings Help

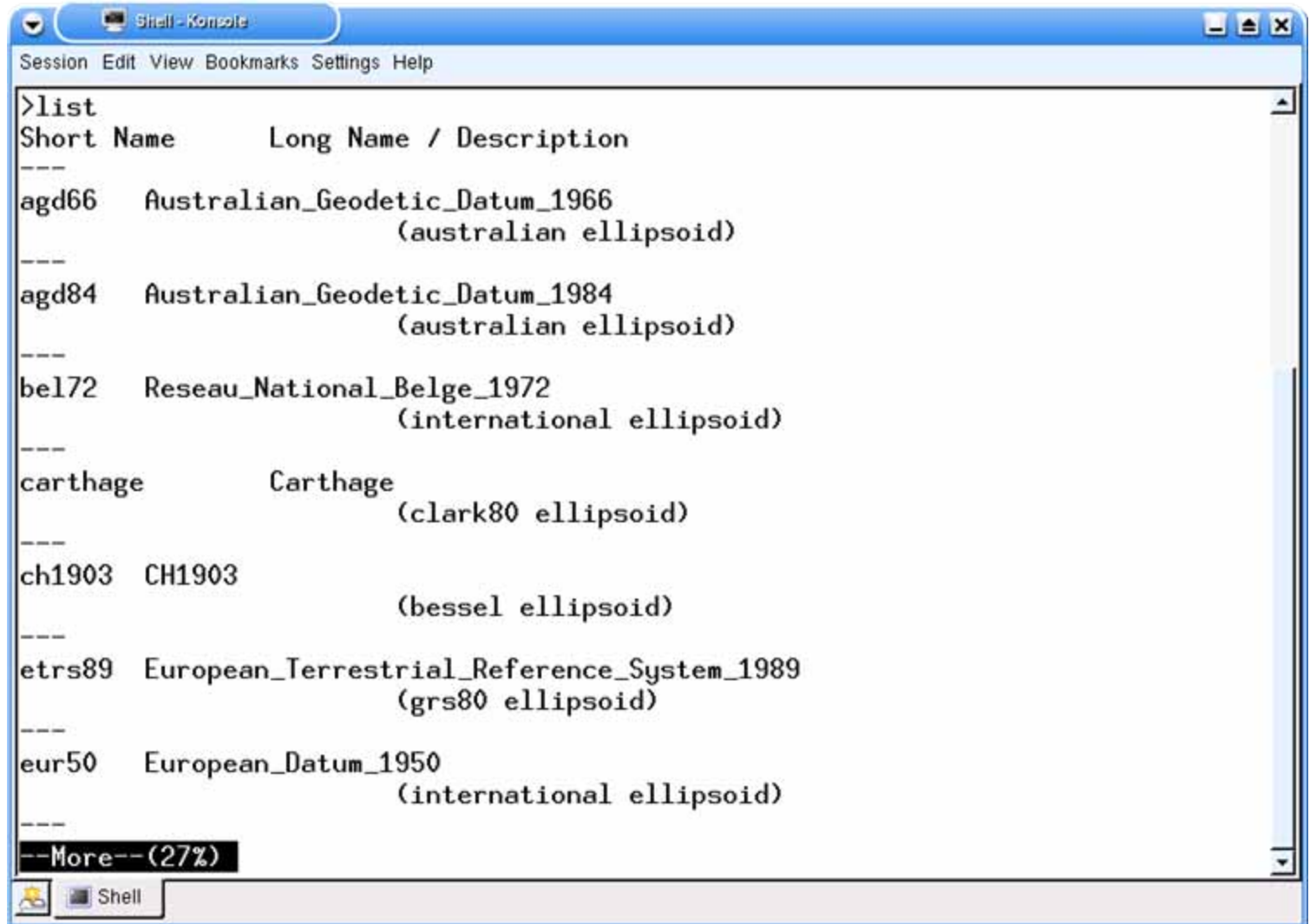
Please enter a one line description for location <utm48>

>
=====
=====
ok? (y/n) [n] y
Do you wish to specify a geodetic datum for this location?(y/n) [y] y

Please specify datum name
Enter 'list' for the list of available datums
or 'custom' if you wish to enter custom parameters
Hit RETURN to cancel request
>list
```

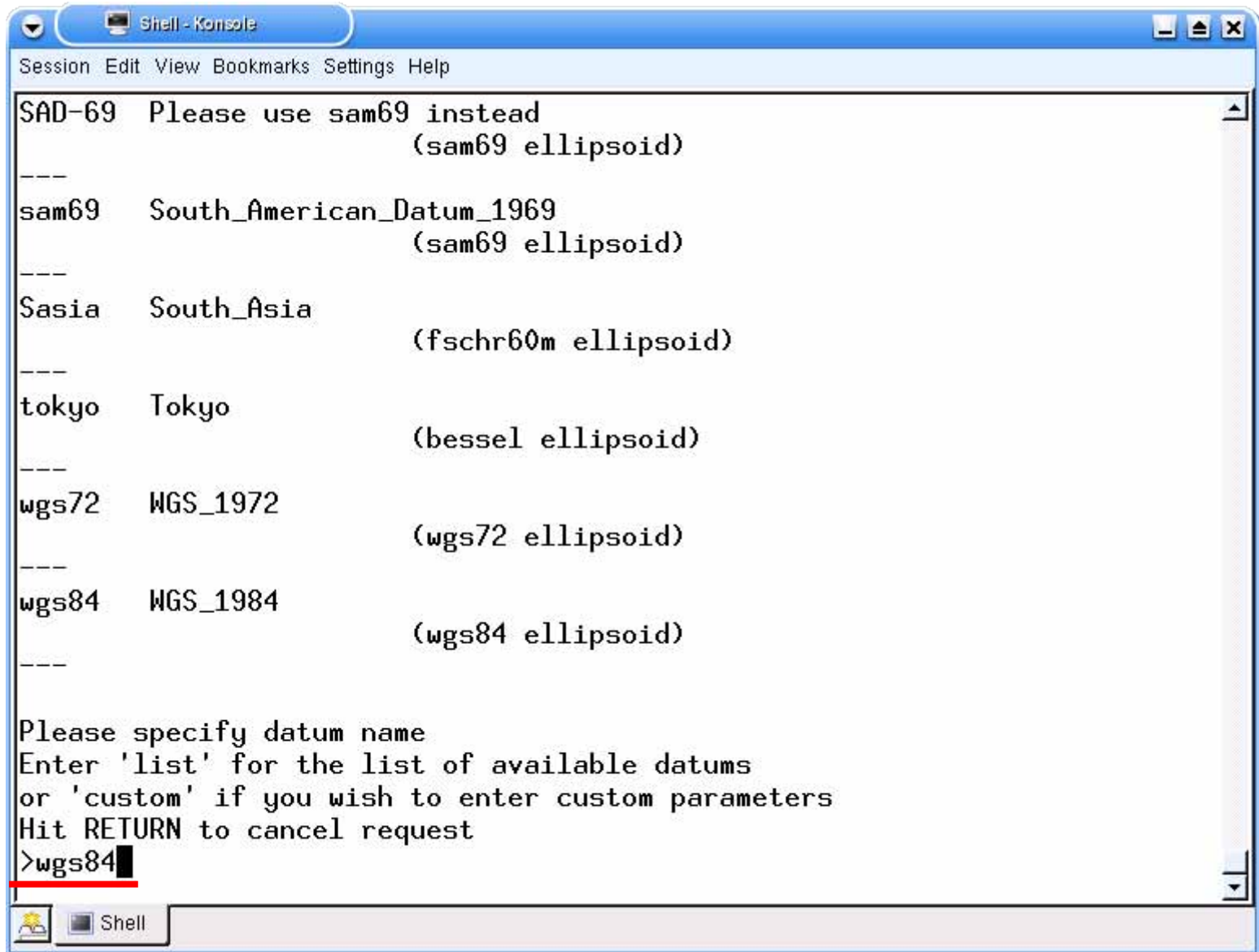
enter " list ", then hit " Enter (or Return) "

hit "Space" key for page down



```
>list
Short Name      Long Name / Description
----
agd66   Australian_Geodetic_Datum_1966
              (australian ellipsoid)
----
agd84   Australian_Geodetic_Datum_1984
              (australian ellipsoid)
----
bel72   Reseau_National_Belge_1972
              (international ellipsoid)
----
carthage      Carthage
              (clark80 ellipsoid)
----
ch1903  CH1903
              (bessel ellipsoid)
----
etrs89  European_Terrestrial_Reference_System_1989
              (grs80 ellipsoid)
----
eur50   European_Datum_1950
              (international ellipsoid)
----
--More--(27%)
```

enter "wgs84", then hit "Enter (or Return)"

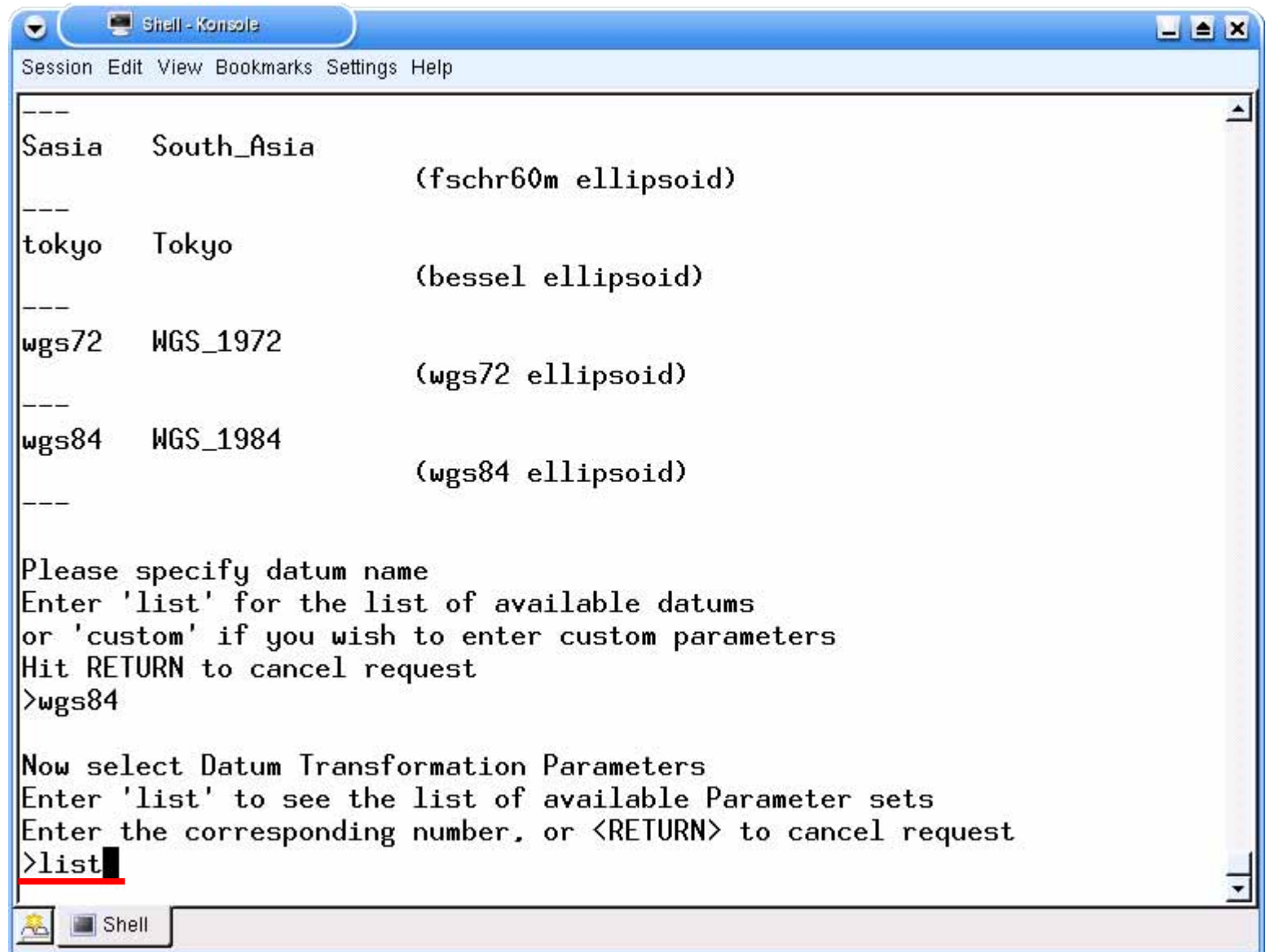


```
Shell - Konsole
Session Edit View Bookmarks Settings Help

SAD-69 Please use sam69 instead
      (sam69 ellipsoid)
---
sam69 South_American_Datum_1969
      (sam69 ellipsoid)
---
Sasia South_Asia
      (fschr60m ellipsoid)
---
tokyo Tokyo
      (bessel ellipsoid)
---
wgs72 WGS_1972
      (wgs72 ellipsoid)
---
wgs84 WGS_1984
      (wgs84 ellipsoid)
---

Please specify datum name
Enter 'list' for the list of available datums
or 'custom' if you wish to enter custom parameters
Hit RETURN to cancel request
>wgs84
```

enter "list", then hit "Enter (or Return)"



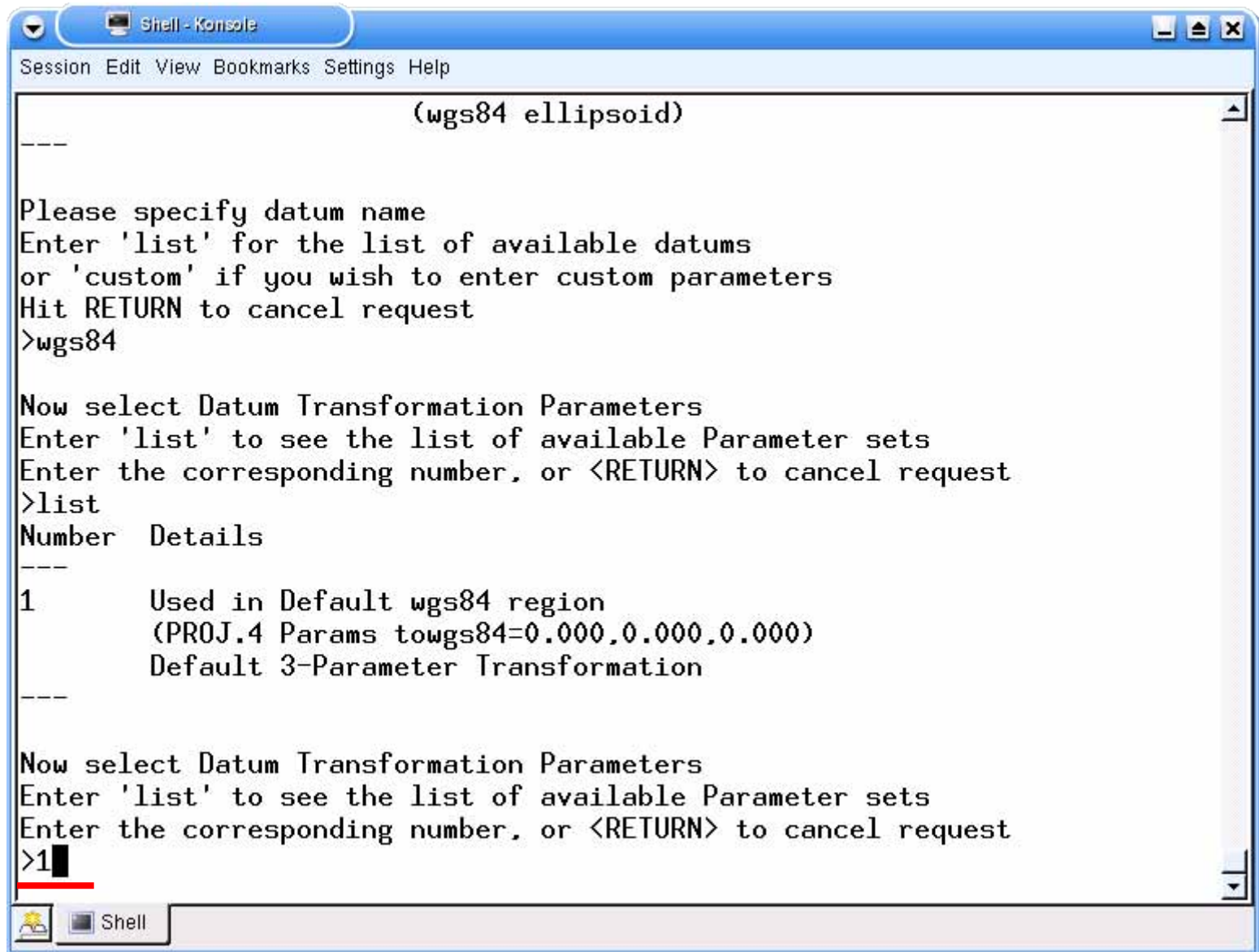
```
Shell - Konsole
Session Edit View Bookmarks Settings Help

----
Sasia  South_Asia
                                     (fschr60m ellipsoid)
----
tokyo   Tokyo
                                     (bessel ellipsoid)
----
wgs72   WGS_1972
                                     (wgs72 ellipsoid)
----
wgs84   WGS_1984
                                     (wgs84 ellipsoid)
----

Please specify datum name
Enter 'list' for the list of available datums
or 'custom' if you wish to enter custom parameters
Hit RETURN to cancel request
>wgs84

Now select Datum Transformation Parameters
Enter 'list' to see the list of available Parameter sets
Enter the corresponding number, or <RETURN> to cancel request
>list
```

enter " 1 ", then hit "Enter (or Return)"



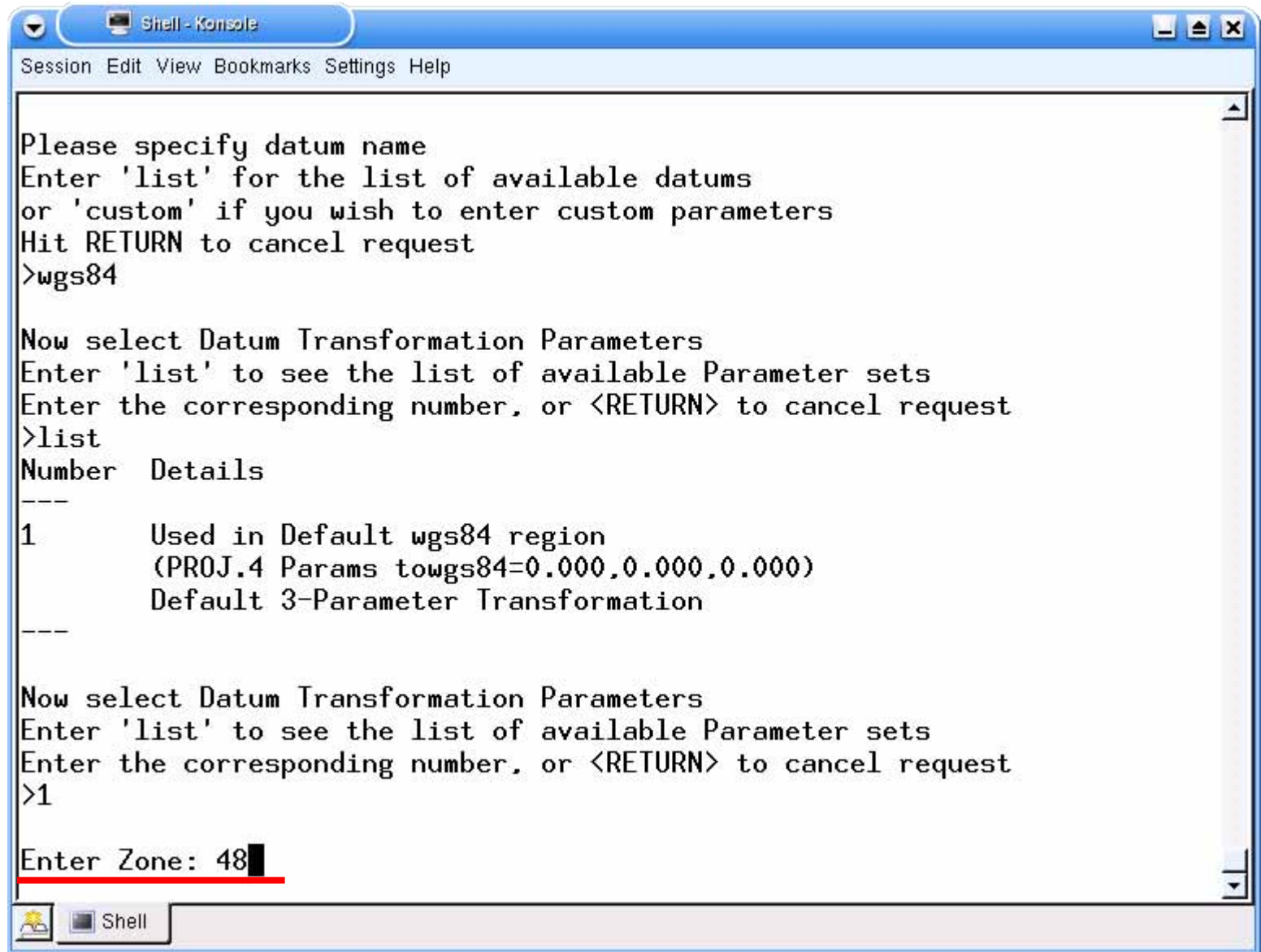
```
Shell - Konsole
Session Edit View Bookmarks Settings Help

(wgs84 ellipsoid)
---
Please specify datum name
Enter 'list' for the list of available datums
or 'custom' if you wish to enter custom parameters
Hit RETURN to cancel request
>wgs84

Now select Datum Transformation Parameters
Enter 'list' to see the list of available Parameter sets
Enter the corresponding number, or <RETURN> to cancel request
>list
Number  Details
---
1       Used in Default wgs84 region
        (PROJ.4 Params towgs84=0.000,0.000,0.000)
        Default 3-Parameter Transformation
---
Now select Datum Transformation Parameters
Enter 'list' to see the list of available Parameter sets
Enter the corresponding number, or <RETURN> to cancel request
>1
```



enter "48", then hit "Enter (or Return)"



```
Shell - Konsole
Session Edit View Bookmarks Settings Help

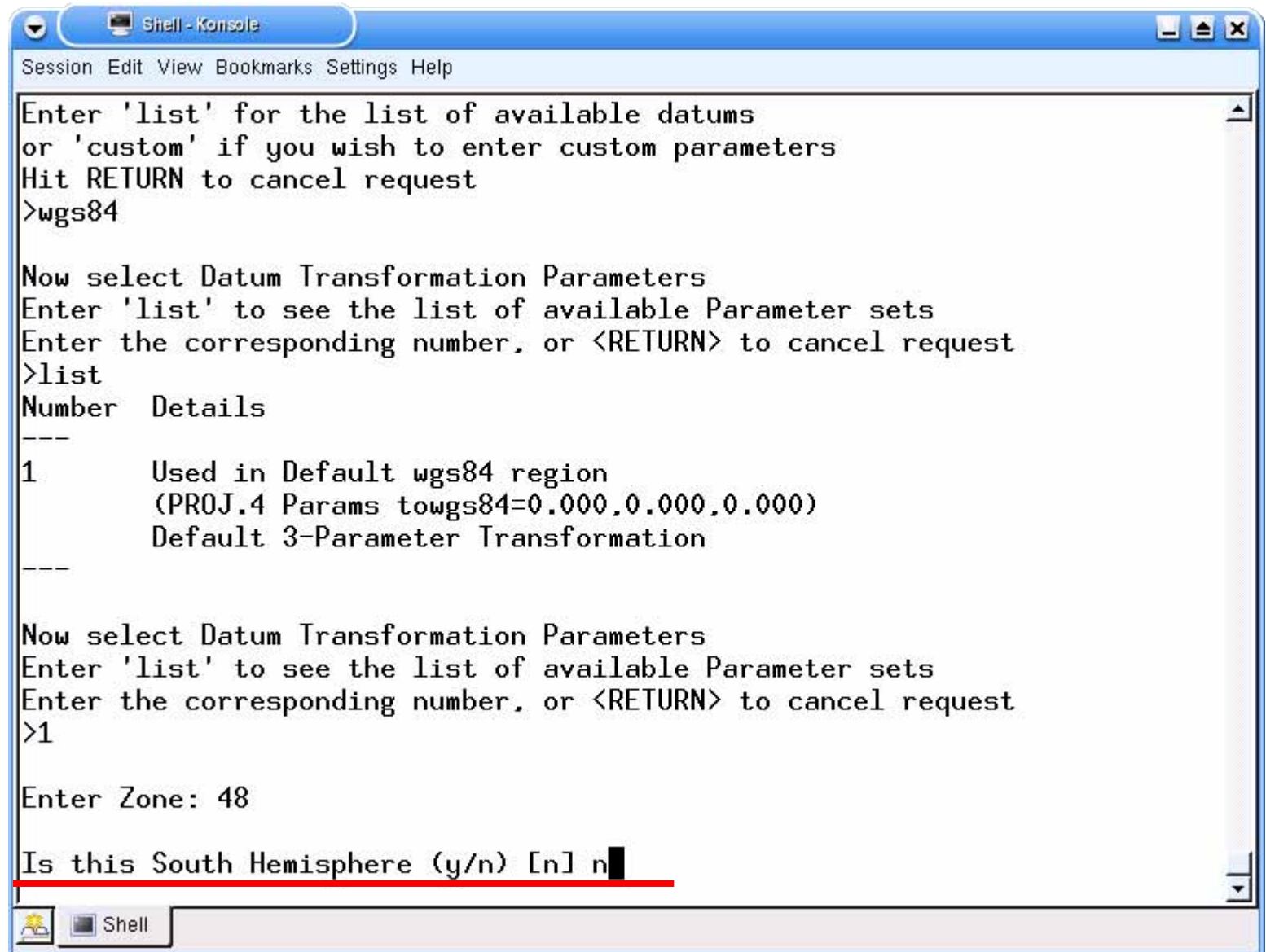
Please specify datum name
Enter 'list' for the list of available datums
or 'custom' if you wish to enter custom parameters
Hit RETURN to cancel request
>wgs84

Now select Datum Transformation Parameters
Enter 'list' to see the list of available Parameter sets
Enter the corresponding number, or <RETURN> to cancel request
>list
Number Details
---
1      Used in Default wgs84 region
      (PROJ.4 Params towgs84=0.000,0.000,0.000)
      Default 3-Parameter Transformation
---

Now select Datum Transformation Parameters
Enter 'list' to see the list of available Parameter sets
Enter the corresponding number, or <RETURN> to cancel request
>list

Enter Zone: 48
```

enter "n", then hit "Enter (or Return)"



```
Shell - Konsole
Session Edit View Bookmarks Settings Help

Enter 'list' for the list of available datums
or 'custom' if you wish to enter custom parameters
Hit RETURN to cancel request
>wgs84

Now select Datum Transformation Parameters
Enter 'list' to see the list of available Parameter sets
Enter the corresponding number, or <RETURN> to cancel request
>list
Number  Details
----
1       Used in Default wgs84 region
        (PROJ.4 Params towgs84=0.000,0.000,0.000)
        Default 3-Parameter Transformation
----

Now select Datum Transformation Parameters
Enter 'list' to see the list of available Parameter sets
Enter the corresponding number, or <RETURN> to cancel request
>1

Enter Zone: 48

Is this South Hemisphere (y/n) [n] n
```

# 1.5 Definition of region

```

Shell - Konsole
Session Edit View Bookmarks Settings Help

      DEFINE THE DEFAULT REGION

===== DEFAULT REGION =====
| NORTH EDGE: 1 |
|               |
WEST EDGE |     | EAST EDGE
0         |     | 1
| SOUTH EDGE: 0 |
=====

PROJECTION: 1 (UTM)                ZONE: 48

      GRID RESOLUTION
      East-West: 1
      North-South: 1

AFTER COMPLETING ALL ANSWERS, HIT <ESC><ENTER> TO CONTINUE
(OR <Ctrl-C> TO CANCEL)

```

You can use “space” key to erase letters.

You can use “ ” key to move.

## Define the region which includes entire Vietnam

NORTH EDGE : **10000**

SOUTH EDGE : **0**

WEST EDGE : **0**

EAST EDGE : **10000**

GRID RESOLUTION    East-West : **30**  
                                 North-South : **30**

These numbers have no means. You can reset these parameters later to match the imported images.

Shell - Konsole

Session Edit View Bookmarks Settings Help

DEFINE THE DEFAULT REGION

```
===== DEFAULT REGION =====
| NORTH EDGE:10000_____ |
|                               |
WEST EDGE |                               | EAST EDGE
0_____ |                               | 10000_____
| SOUTH EDGE:0_____ |
|                               |
=====
```

PROJECTION: 1 (UTM) ZONE: 48

GRID RESOLUTION

East-West: 30\_\_\_\_\_

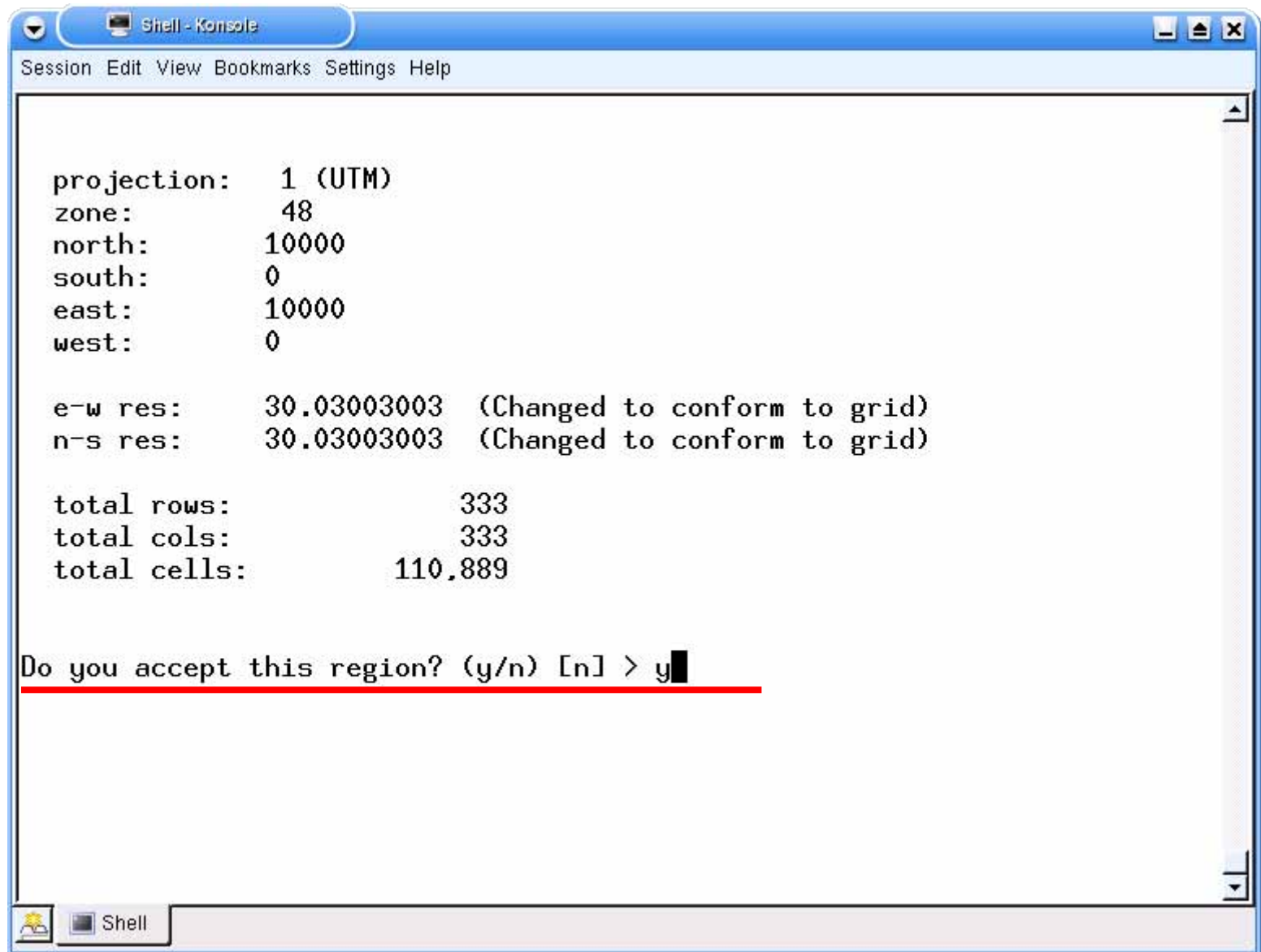
North-South: 30\_\_\_\_\_

AFTER COMPLETING ALL ANSWERS, HIT <ESC><ENTER> TO CONTINUE  
(OR <Ctrl-C> TO CANCEL)

Shell

After filling the above information,  
hit "Esc" + "Enter (or Return)"

enter "y", then hit "Enter (or Return)"



The screenshot shows a terminal window titled "Shell - Konsole" with a menu bar (Session, Edit, View, Bookmarks, Settings, Help). The terminal displays the following text:

```
projection: 1 (UTM)
zone: 48
north: 10000
south: 0
east: 10000
west: 0

e-w res: 30.03003003 (Changed to conform to grid)
n-s res: 30.03003003 (Changed to conform to grid)

total rows: 333
total cols: 333
total cells: 110.889

Do you accept this region? (y/n) [n] > y
```

The prompt "Do you accept this region? (y/n) [n] > y" is underlined with a red line, and the character 'y' has been entered, followed by a cursor.

```
projection: 1 (UTM)
zone:      48
north:     10000
south:     0
east:      10000
west:      0

e-w res:   30.03003003 (Changed to conform to grid)
n-s res:   30.03003003 (Changed to conform to grid)

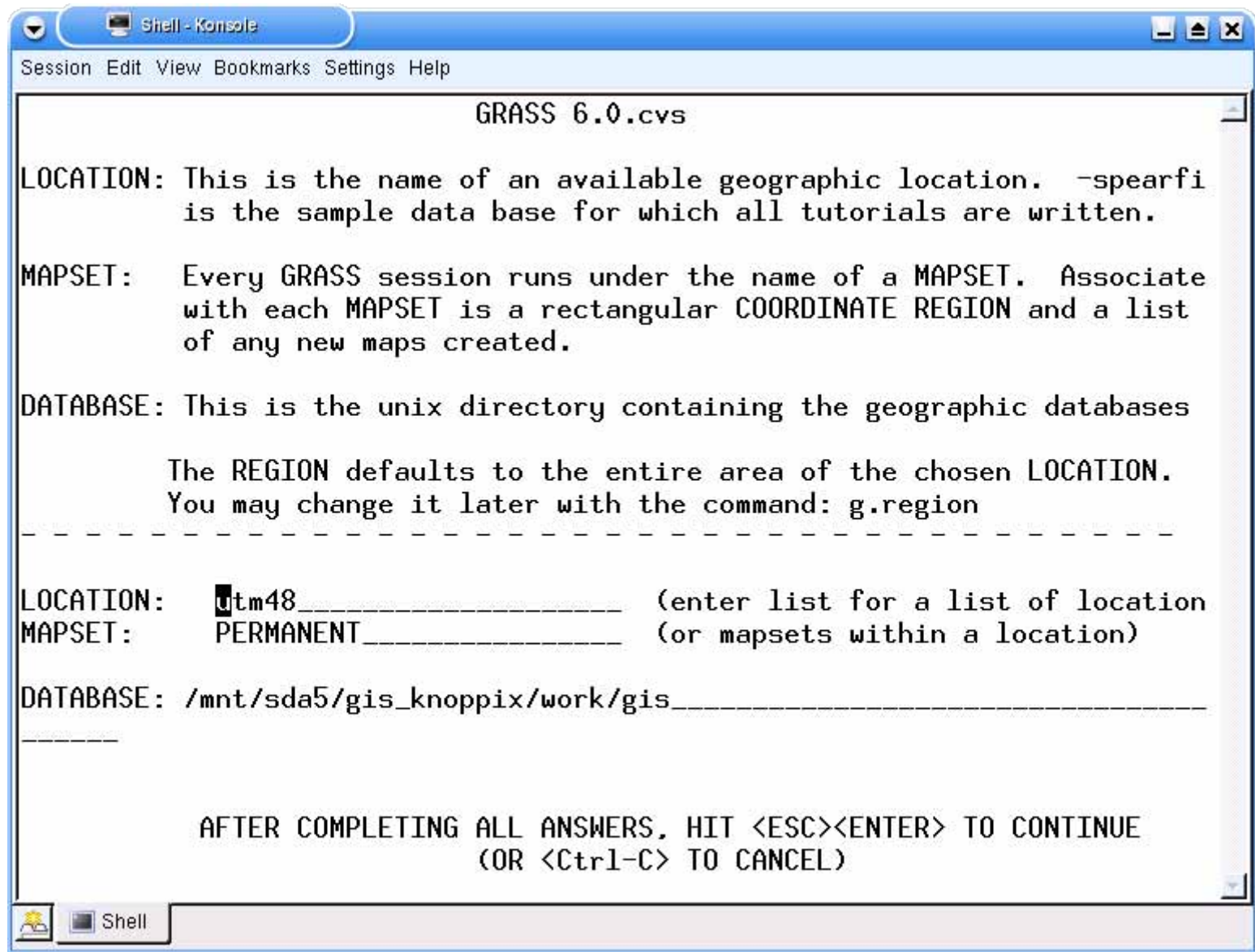
total rows:          333
total cols:          333
total cells:        110,889

Do you accept this region? (y/n) [n] > y
LOCATION <utm48> created!

Hit RETURN -->
```

hit "Enter (or Return)"





```
GRASS 6.0.cvs

LOCATION: This is the name of an available geographic location. -spearfi
         is the sample data base for which all tutorials are written.

MAPSET:  Every GRASS session runs under the name of a MAPSET. Associate
         with each MAPSET is a rectangular COORDINATE REGION and a list
         of any new maps created.

DATABASE: This is the unix directory containing the geographic databases

         The REGION defaults to the entire area of the chosen LOCATION.
         You may change it later with the command: g.region
-----

LOCATION:  Utm48_____ (enter list for a list of location
MAPSET:   PERMANENT_____ (or mapsets within a location)

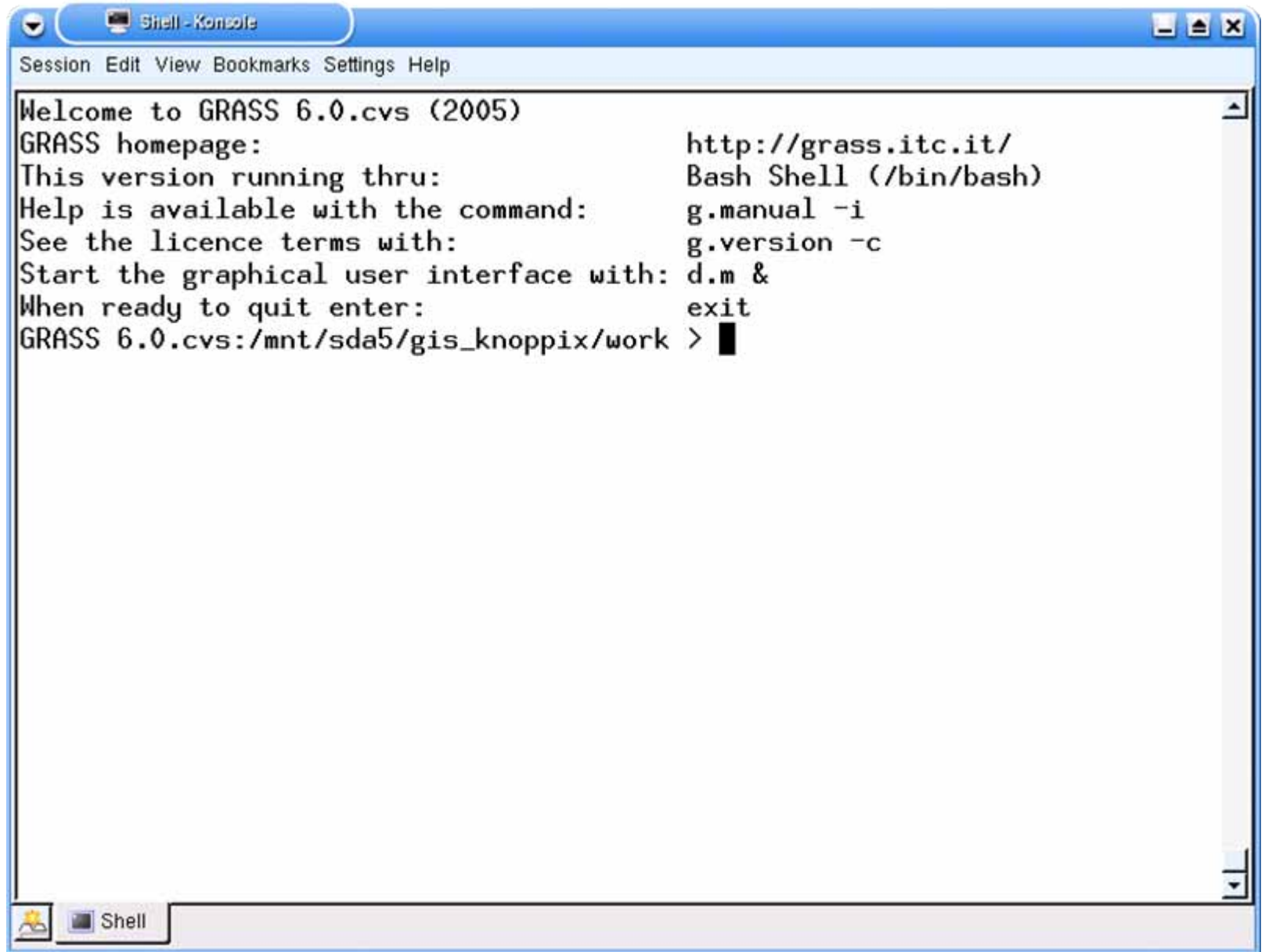
DATABASE: /mnt/sda5/gis_knoppix/work/gis_____

-----

AFTER COMPLETING ALL ANSWERS, HIT <ESC><ENTER> TO CONTINUE
        (OR <Ctrl-C> TO CANCEL)
```

enter "y", then hit "Esc" + "Enter (or Return)"





The image shows a terminal window titled "Shell-Konsole". The window has a menu bar with "Session", "Edit", "View", "Bookmarks", "Settings", and "Help". The terminal content displays the GRASS 6.0.cvs (2005) welcome message, including the homepage URL, version information, help command, license command, graphical user interface command, and quit command. The prompt shows the current directory as /mnt/sda5/gis\_knoppix/work.

```
Welcome to GRASS 6.0.cvs (2005)
GRASS homepage:                http://grass.itc.it/
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
Start the graphical user interface with: d.m &
When ready to quit enter:        exit
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > █
```

## **Section 3. Landsat Image Processing in UTM Coordinate System**

### **2. Import raster data**

## 2.1 Import Landsat images

Landsat images in GeoCover data set are provided in a standard GeoTIFF format with a UTM projection, using the WGS-84 datum.

```
> r.in.gdal input=A output=B
```

A = /mnt/sda1/gis\_knopix/data/(input file name)

B = (output file name)

*r.in.gdal* allows a user to create a (binary) GRASS raster map layer, or imagery group, from any GDAL supported raster map format, with an optional title.

|                  |  |
|------------------|--|
| <b>r.in.gdal</b> | ARC/INFO ASCII/Binary GRID, BIL, ERDAS (LAN, IMG),<br>USGS DOQ, JPEG, SAR CEOS, EOSAT, GeoTIFF,<br>PPM/PNM, SDTS DEM,<br>GIF, PNG<br>(see also <a href="http://www.gdal.org/formats_list.html">http://www.gdal.org/formats_list.html</a> ) |
|------------------|--|

## In data directory,

p124r52\_5t19901230\_nn1.tif

Band1(0.45 - 0.52  $\mu\text{m}$ )

p124r52\_5t19901230\_nn2.tif

Band 2(0.52 – 0.60  $\mu\text{m}$ )

p124r52\_5t19901230\_nn3.tif

Band3(0.63 - 0.69  $\mu\text{m}$ )

p124r52\_5t19901230\_nn4.tif

Band4(0.75 - 0.90  $\mu\text{m}$ )

p124r52\_5t19901230\_nn5.tif

Band5(1.55 - 1.75  $\mu\text{m}$ )

p124r52\_5t19901230\_nn6.tif

Band6(10.40 – 12.50  $\mu\text{m}$ )

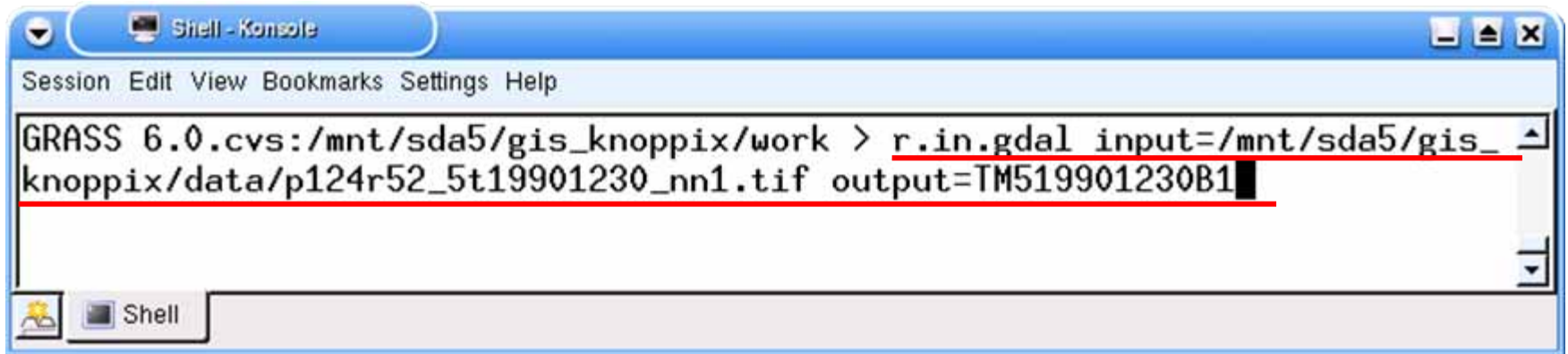
p124r52\_5t19901230\_nn7.tif

Band7(2.08 - 2.35  $\mu\text{m}$ )

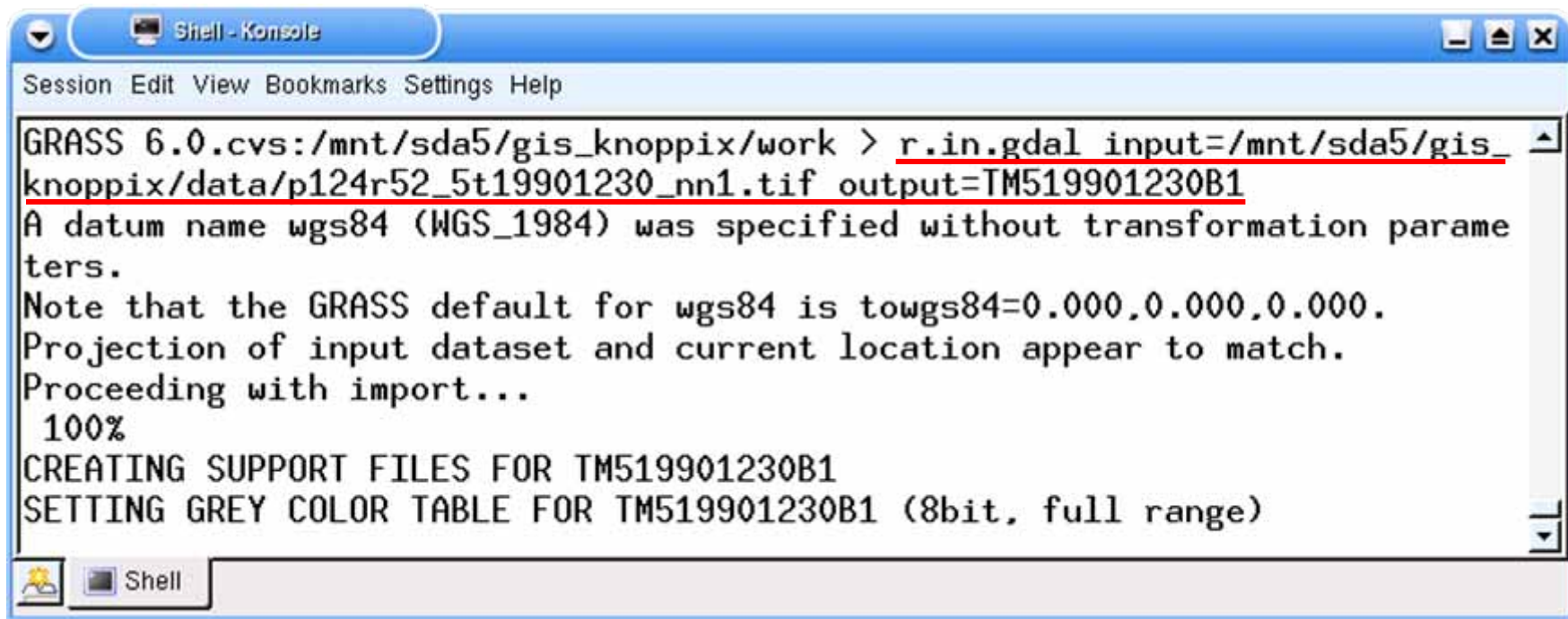
If the Landsat images are stored in the “data” folder:

```
> r.in.gdal input=/mnt/sda1/gis_knoppix/data/p124r52_5t19901230_nn1.tif  
output=TM519901230B1
```

: space



Hit "Enter (or Return)"



The screenshot shows a terminal window titled "Shell - Konsole". The menu bar includes "Session", "Edit", "View", "Bookmarks", "Settings", and "Help". The command prompt shows the user is in the directory `/mnt/sda5/gis_knoppix/work` and has executed the command `r.in.gdal input=/mnt/sda5/gis_knoppix/data/p124r52_5t19901230_nn1.tif output=TM519901230B1`. The command and its arguments are underlined in red. The output of the command is as follows:

```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.in.gdal input=/mnt/sda5/gis_knoppix/data/p124r52_5t19901230_nn1.tif output=TM519901230B1
A datum name wgs84 (WGS_1984) was specified without transformation parameters.
Note that the GRASS default for wgs84 is towgs84=0.000,0.000,0.000.
Projection of input dataset and current location appear to match.
Proceeding with import...
100%
CREATING SUPPORT FILES FOR TM519901230B1
SETTING GREY COLOR TABLE FOR TM519901230B1 (8bit, full range)
```

At the bottom of the window, there is a taskbar with a "Shell" icon and a "Shell" label.

Please import other band images(Band2 ~ Band7)!!

The screenshot shows a terminal window titled "Shell - Konsole". The menu bar includes "Session", "Edit", "View", "Bookmarks", "Settings", and "Help". The terminal text shows the execution of the `r.in.gdal` command for two different input files. The first command processes `p124r52_5t19901230_nn2.tif` into `TM519901230B2`. The second command processes `p124r52_5t19901230_nn3.tif` into `TM519901230B3`. Red underlines highlight the command lines, and red arrows point from the labels "Band2" and "Band3" to these lines.

```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.in.gdal input=/mnt/sda5/gis_knoppix/data/p124r52_5t19901230_nn2.tif output=TM519901230B2
A datum name wgs84 (WGS_1984) was specified without transformation parameters.
Note that the GRASS default for wgs84 is towgs84=0.000,0.000,0.000.
Projection of input dataset and current location appear to match.
Proceeding with import...
100%
CREATING SUPPORT FILES FOR TM519901230B2
SETTING GREY COLOR TABLE FOR TM519901230B2 (8bit, full range)
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.in.gdal input=/mnt/sda5/gis_knoppix/data/p124r52_5t19901230_nn3.tif output=TM519901230B3
```

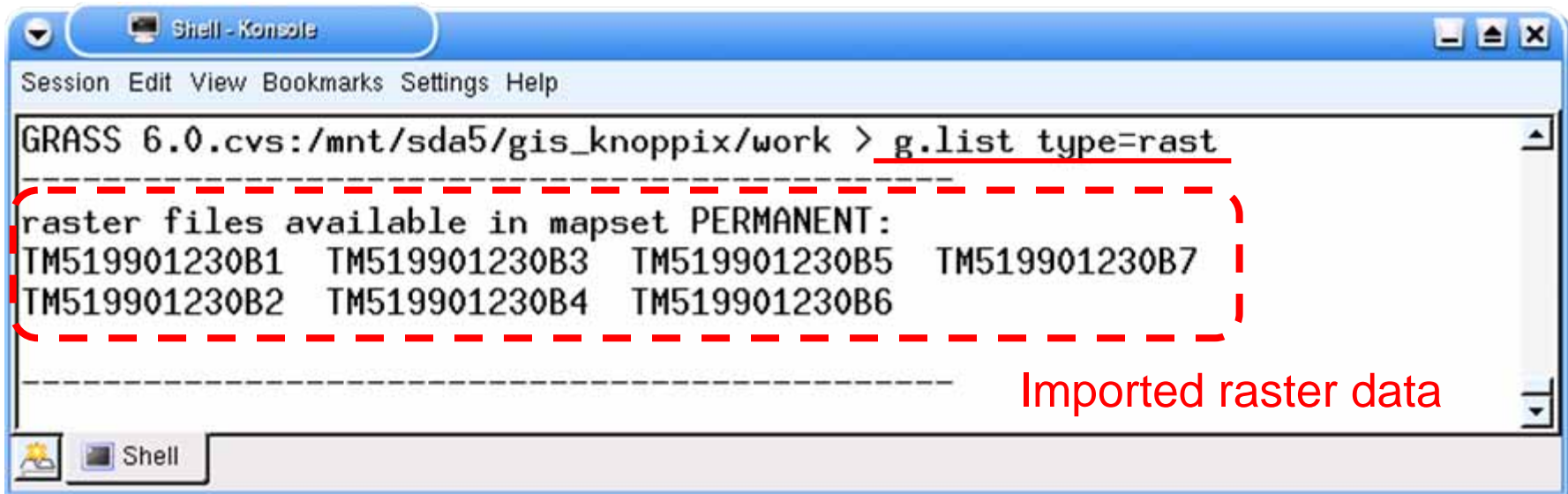
Band2

Band3

## 2.2 List imported raster data

```
> g.list  type = rast
```

: space



The screenshot shows a terminal window titled "Shell - Konsole". The command prompt is "GRASS 6.0.cvs:/mnt/sda5/gis\_knoppix/work >". The command entered is `g.list type=rast`. The output is:

```
raster files available in mapset PERMANENT:
TM519901230B1  TM519901230B3  TM519901230B5  TM519901230B7
TM519901230B2  TM519901230B4  TM519901230B6
```

A red dashed box highlights the output text. Below the box, the text "Imported raster data" is written in red.

*g.list* allows the user to list user-specified, available and accessible files from *mapsets* under the user's current location.

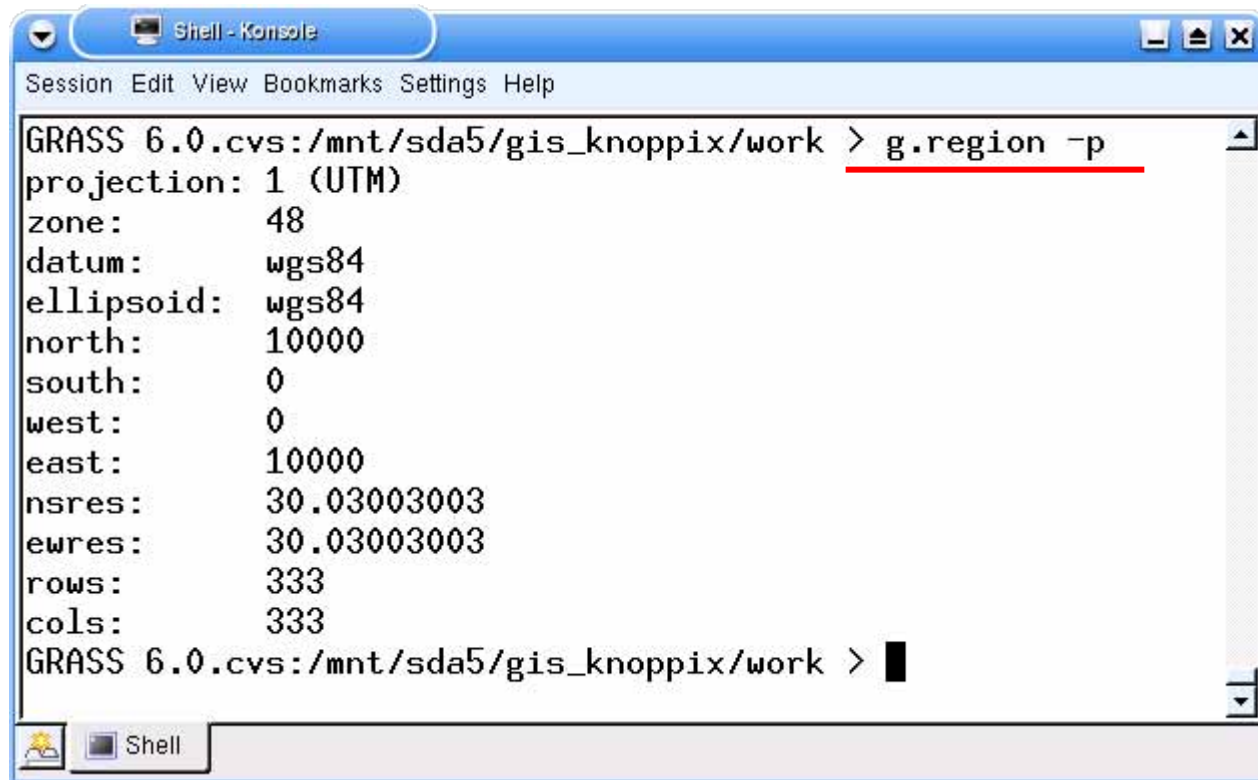


## 2.3 Set region to match imported raster map

### 2.3.1 Check the current region

`g.region -p`

: space

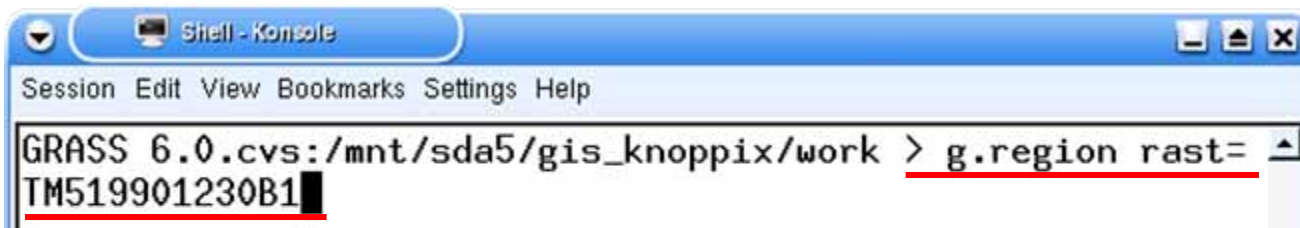


```
Shell - Konsole
Session Edit View Bookmarks Settings Help
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > g.region -p
projection: 1 (UTM)
zone:      48
datum:     wgs84
ellipsoid: wgs84
north:     10000
south:     0
west:      0
east:      10000
nsres:     30.03003003
ewres:     30.03003003
rows:      333
cols:      333
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > █
```

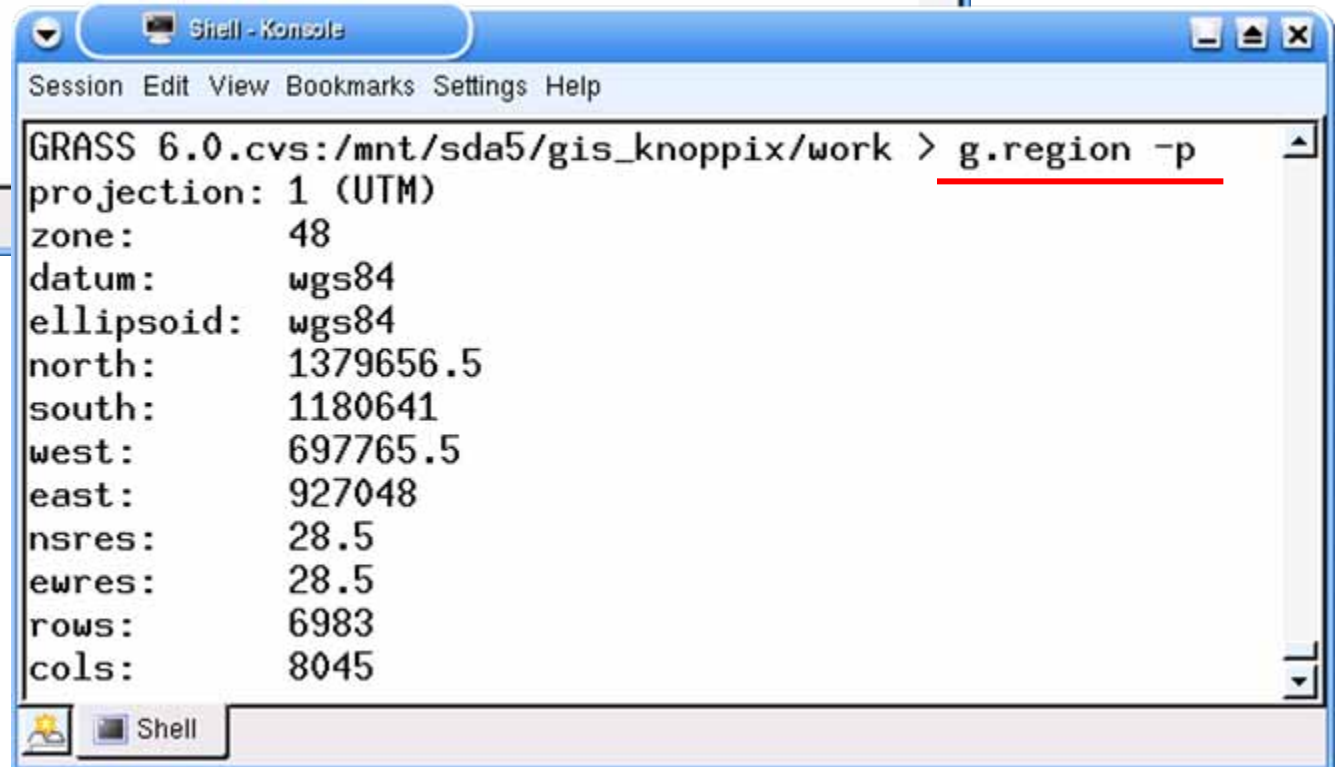
## 2.3.2 Set region to match imported raster map

`g.region rast = "(imported raster map)"`

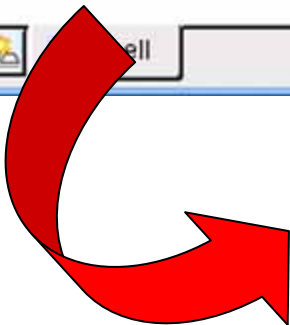
: space



```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > g.region rast=  
TM519901230B1
```



```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > g.region -p  
projection: 1 (UTM)  
zone: 48  
datum: wgs84  
ellipsoid: wgs84  
north: 1379656.5  
south: 1180641  
west: 697765.5  
east: 927048  
nsres: 28.5  
ewres: 28.5  
rows: 6983  
cols: 8045
```



## **Section 3. Landsat Image Processing in UTM Coordinate System**

# **3. Display raster data**

## Step 0. Import raster data

See “2. Import raster data”

## Step 1. Launch monitor

```
> d.mon x#           # = 0, 1, 2, ..., 6           : space
```

*d.mon* allows the user to start, select, list, query the status of, release control of, stop, and unlock control of, available graphics monitors.

## Step 2. Display raster

```
> d.rast map = A           A = (input file name)       : space
```

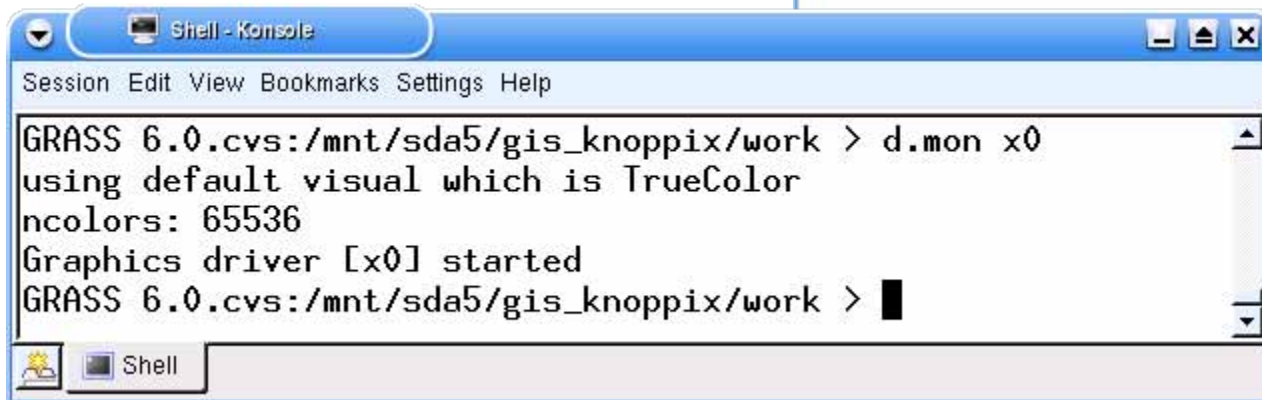
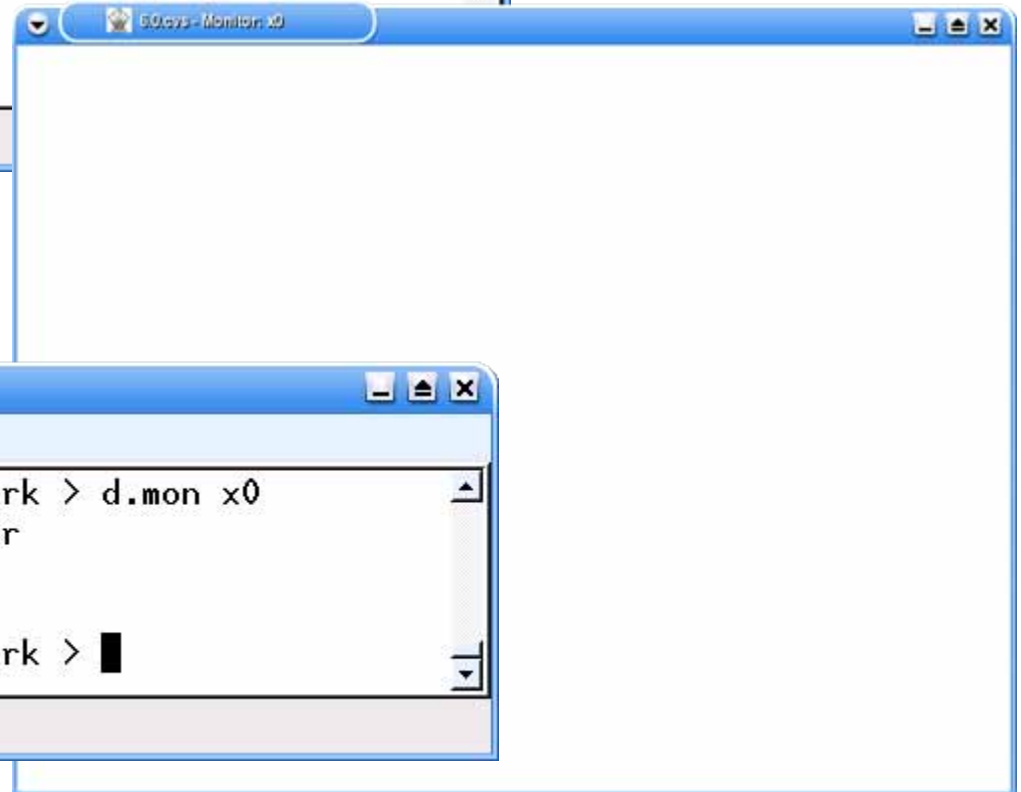
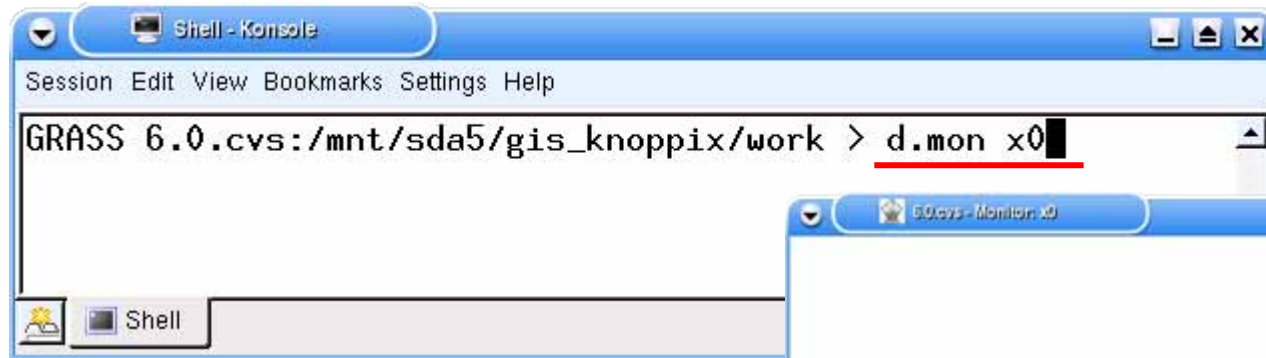
*d.rast* displays raster map layer(s) *name* in the active display frame on the graphics monitor.

# 3.1 Launch Monitor

> d.mon `x#`

# = 0, 1, 2, ..., 6

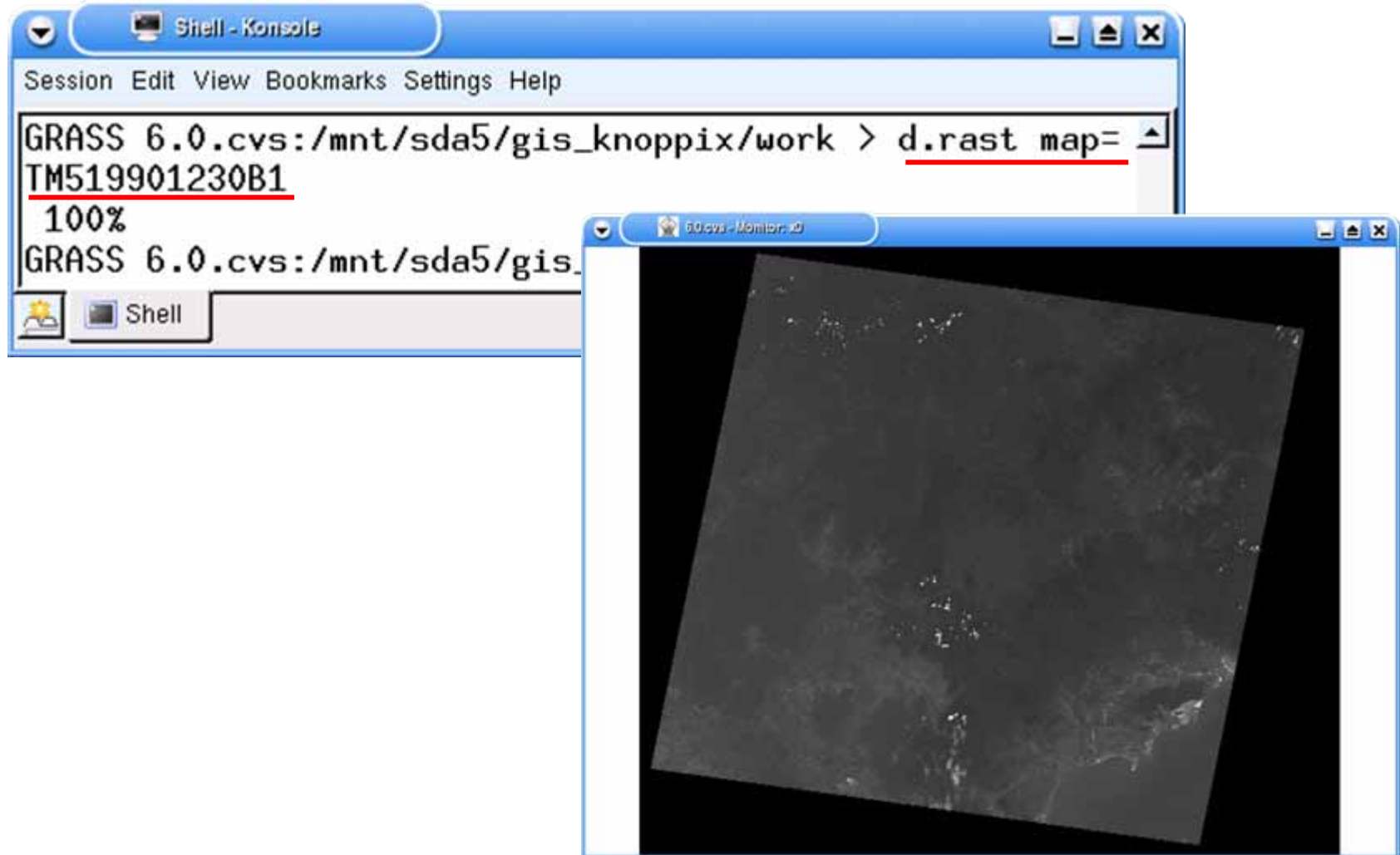
: space



## 3.2 Display raster image

> d.rast map = A

A = (input file name)    : space



## 3.3 Change image color

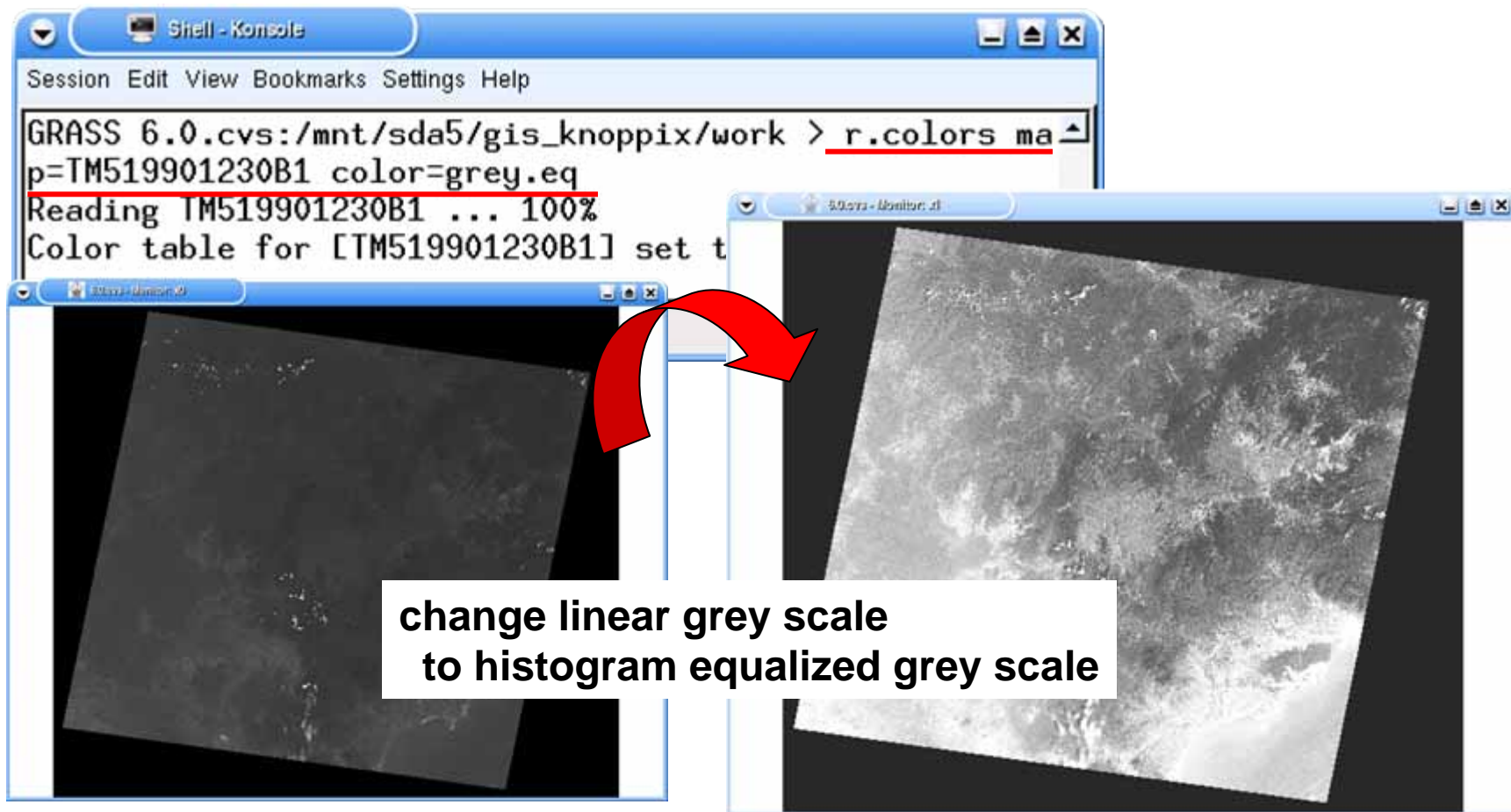
□ : space

```
> r.colors □map = A □color = type
```

A = (input file name)

B = (type of color table)

**r.colors** allows the user to create and/or modify the color table for a raster map layer.



## 3.4 Display three images in RGB composite

```
> r.rgb red=A green=B blue=C
```

A = (file name1)

B = (file name2)

C = (file name3)

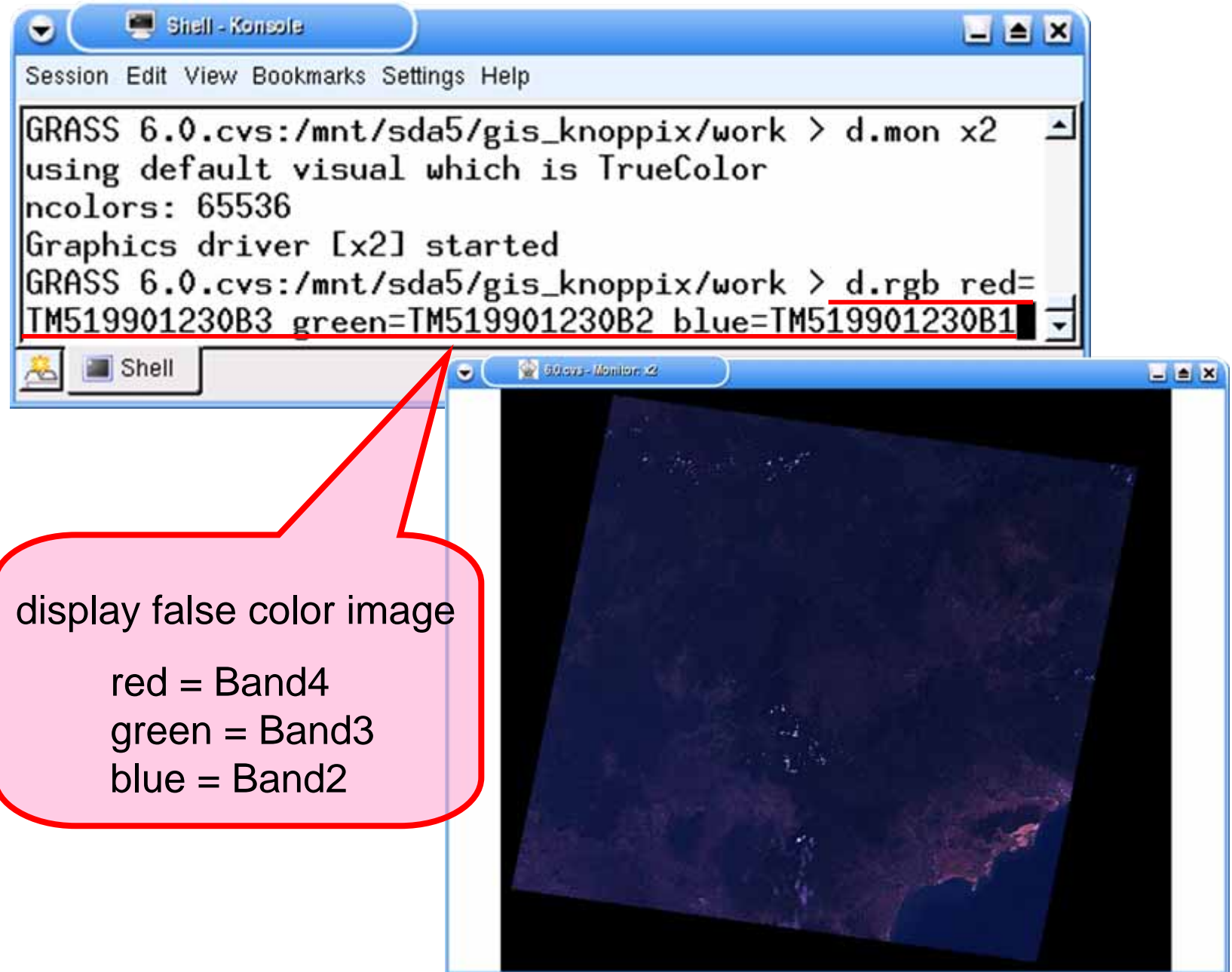
: space

***d.rgb*** - Displays three user-specified raster map layers as red, green, and blue overlays in the active graphics frame. **This command does not create new image file.**

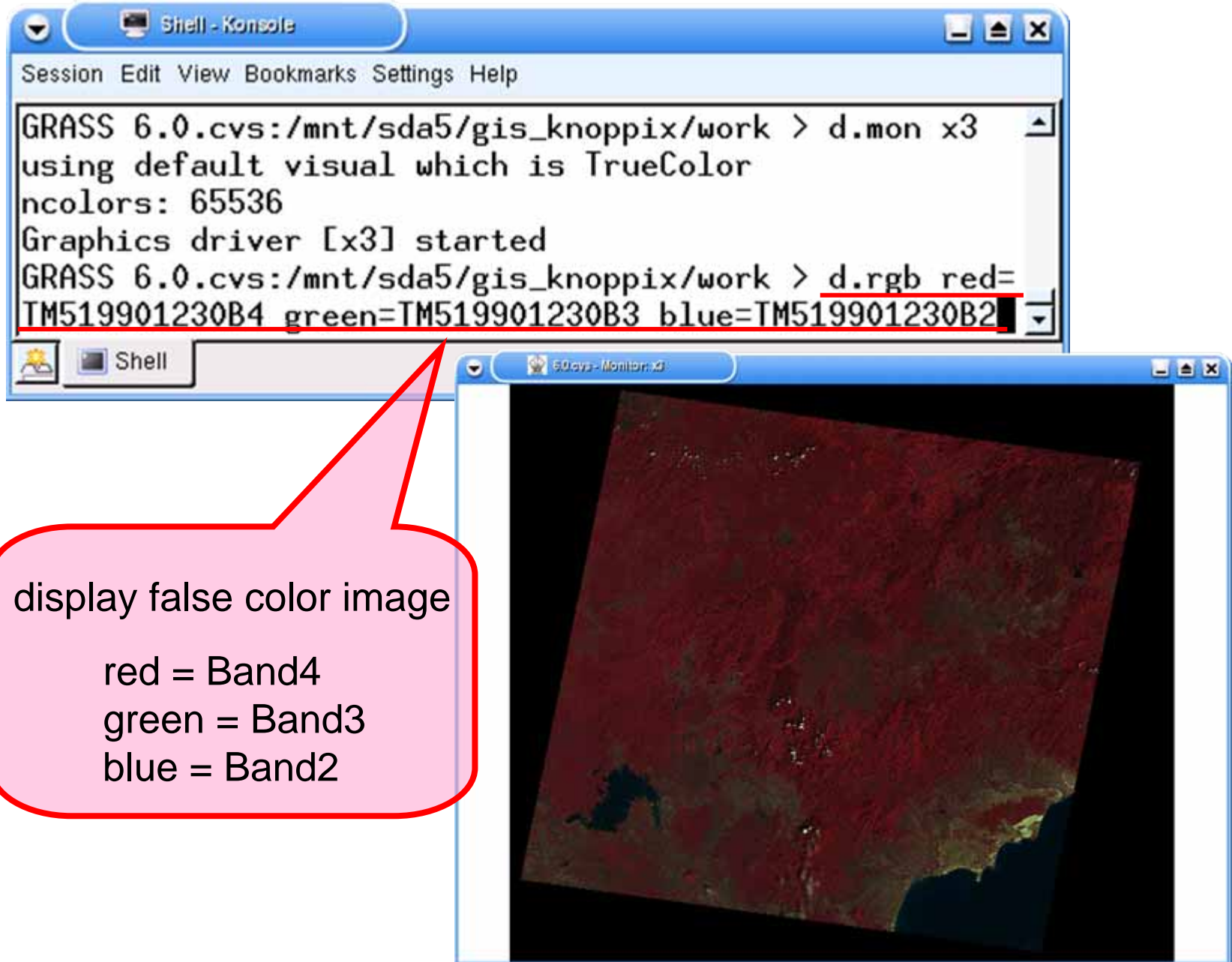
The color table of each image must be “**grey-scale**”.



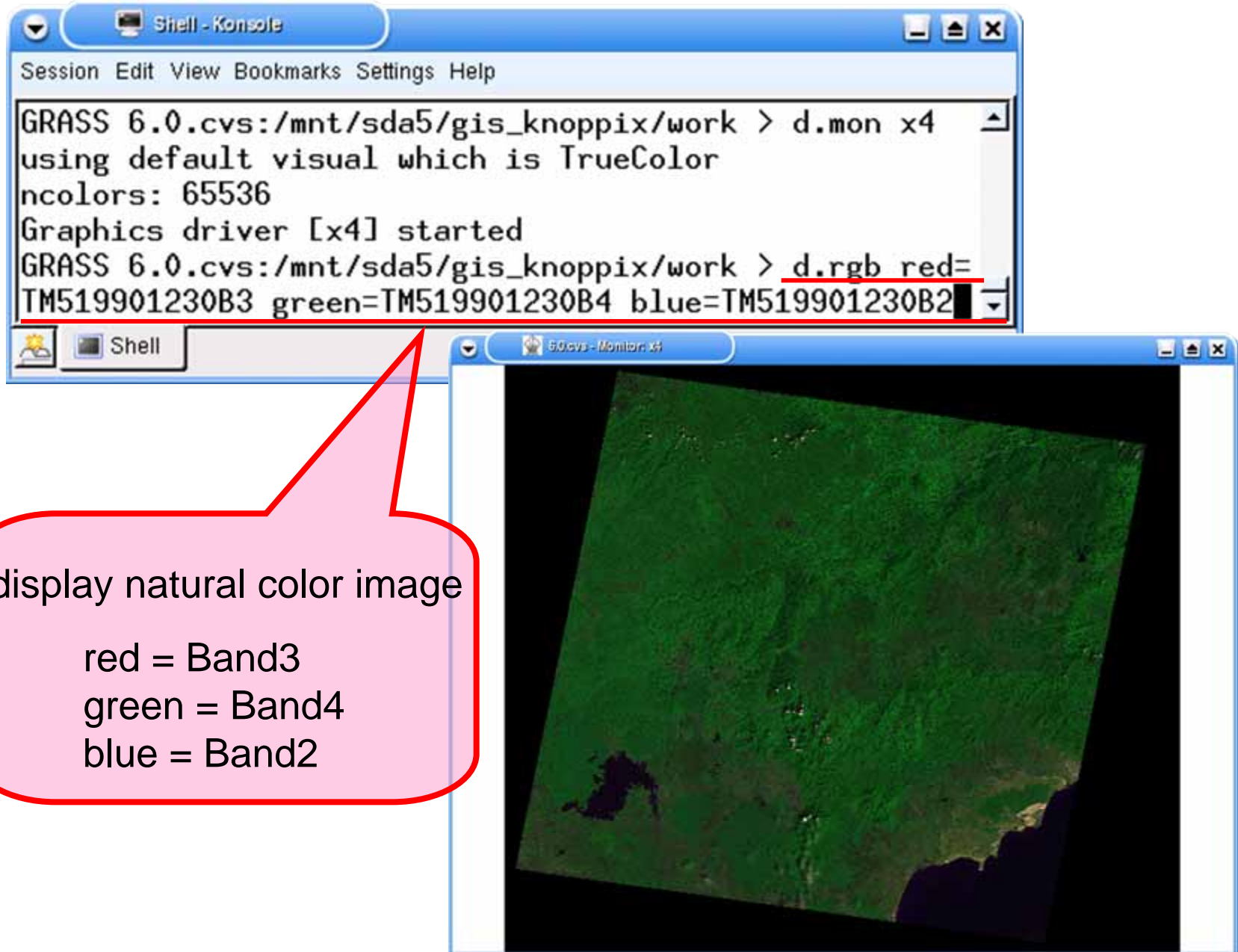
### 3.4.1 Display true color composite image



### 3.4.2 Display false color composite image



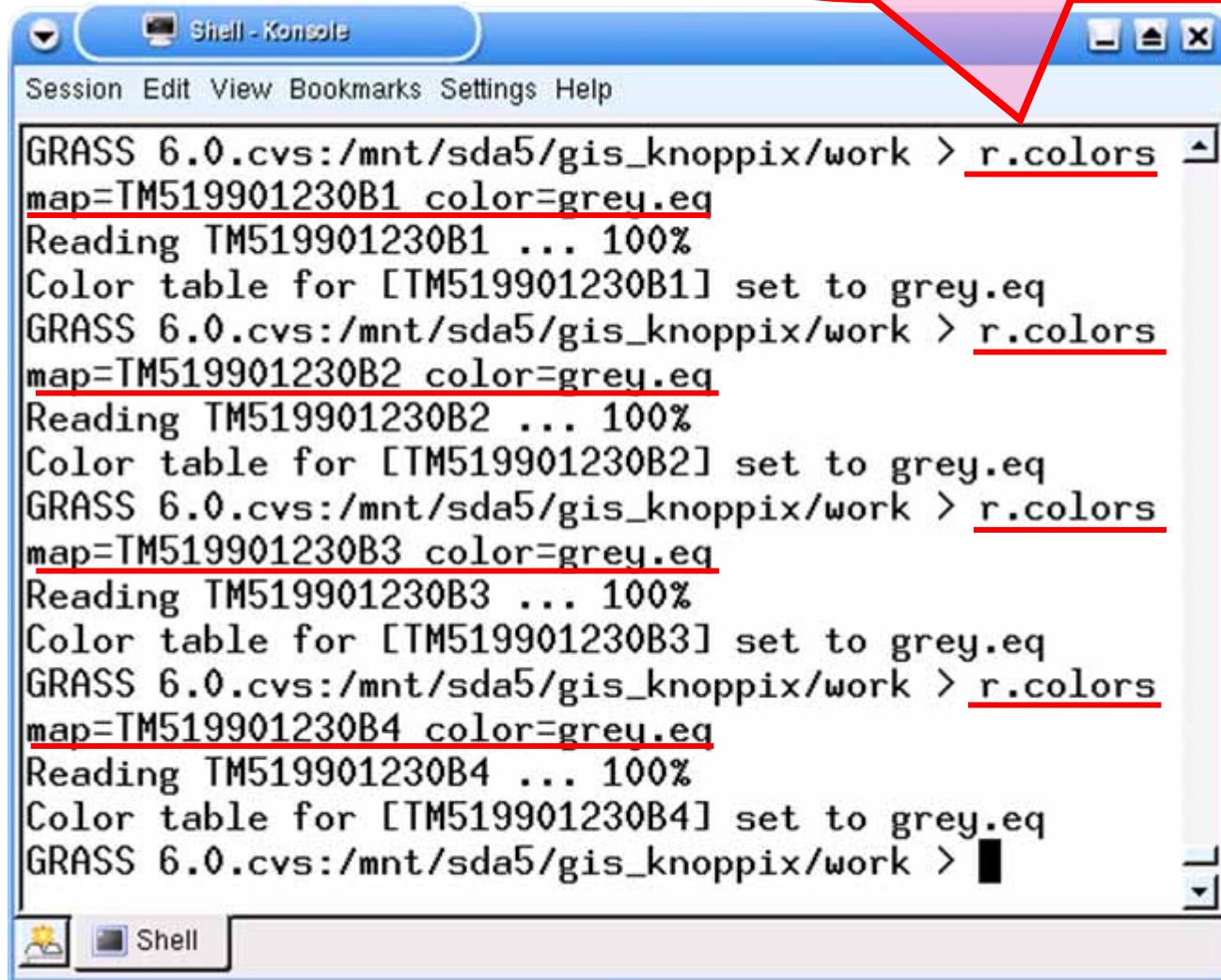
### 3.4.3 Display natural color composite image



## 3.5 Display RGB image using rescaled images

### 3.5.1 Rescale color table

change linear grey scale  
to histogram equalized grey scale



```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.colors  
map=TM519901230B1 color=grey.eq  
Reading TM519901230B1 ... 100%  
Color table for [TM519901230B1] set to grey.eq  
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.colors  
map=TM519901230B2 color=grey.eq  
Reading TM519901230B2 ... 100%  
Color table for [TM519901230B2] set to grey.eq  
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.colors  
map=TM519901230B3 color=grey.eq  
Reading TM519901230B3 ... 100%  
Color table for [TM519901230B3] set to grey.eq  
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.colors  
map=TM519901230B4 color=grey.eq  
Reading TM519901230B4 ... 100%  
Color table for [TM519901230B4] set to grey.eq  
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > █
```



## 3.5 Display RGB image using rescaled images

### 3.5.1 Rescale color table

change linear grey scale  
to histogram equalized grey scale

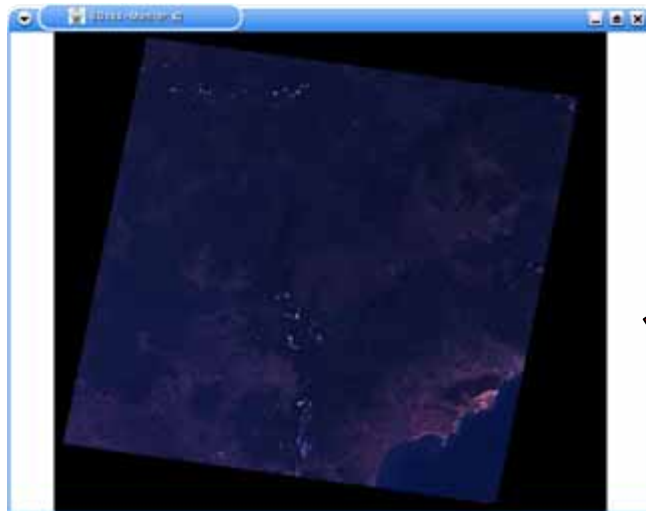
```
akats@webmodis:~/research/JAXA_SAFE/GRASS/temp20081007
ファイル(E) 編集(E) 表示(V) 端末(T) タブ(B) ヘルプ(H)
GRASS 6.2.2 (utm):~/research/JAXA_SAFE/GRASS/temp20081007 > r.colors map=B1 color=grey.eq
Reading B1 ... 100%
Color table for [B1] set to grey.eq
GRASS 6.2.2 (utm):~/research/JAXA_SAFE/GRASS/temp20081007 > r.colors map=B2 color=grey.eq
Reading B2 ... 100%
Color table for [B2] set to grey.eq
GRASS 6.2.2 (utm):~/research/JAXA_SAFE/GRASS/temp20081007 > r.colors map=B3 color=grey.eq
Reading B3 ... 100%
Color table for [B3] set to grey.eq
GRASS 6.2.2 (utm):~/research/JAXA_SAFE/GRASS/temp20081007 > █
```

### 4.5.2 Display true color image using rescaled images

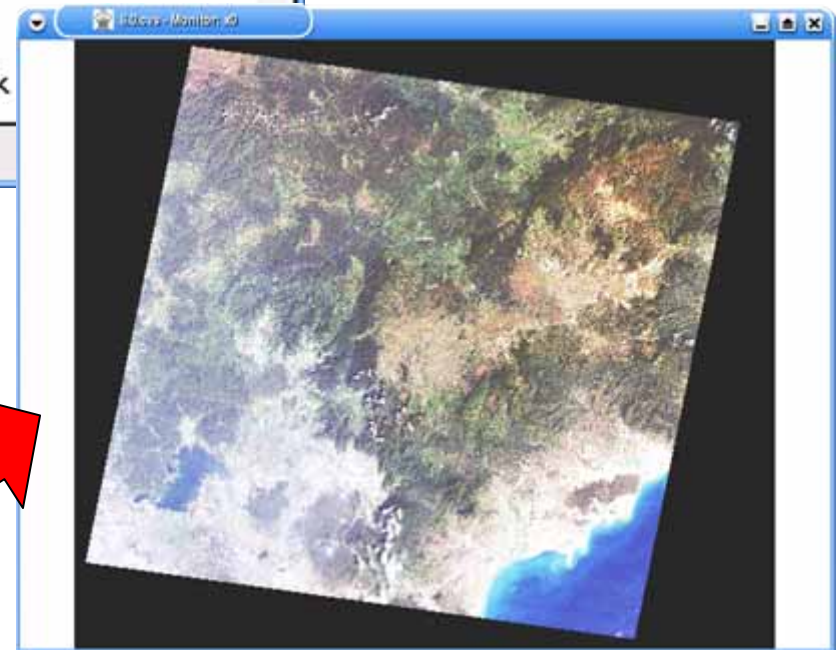
```
akats@webmodis:~/research/JAXA_SAFE/GRASS/temp20081007
ファイル(E) 編集(E) 表示(V) 端末(T) タブ(B) ヘルプ(H)
GRASS 6.2.2 (utm):~/research/JAXA_SAFE/GRASS/temp20081007 > d.mon x2
using default visual which is TrueColor
ncolors: 65536
Graphics driver [x2] started
GRASS 6.2.2 (utm):~/research/JAXA_SAFE/GRASS/temp20081007 > d.rgb blue=B1 green=B2 red=B3
100%
GRASS 6.2.2 (utm):~/research/JAXA_SAFE/GRASS/temp20081007 > █
```

## 3.5.2 Display true color composite image using rescaled images

```
Shell - Konsole
Session Edit View Bookmarks Settings Help
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.mon x0
using default visual which is TrueColor
ncolors: 65536
Graphics driver [x0] started
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.rgb red
=TM519901230B3 green=TM519901230B2 blue=TM519901230B
1
100%
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work
```



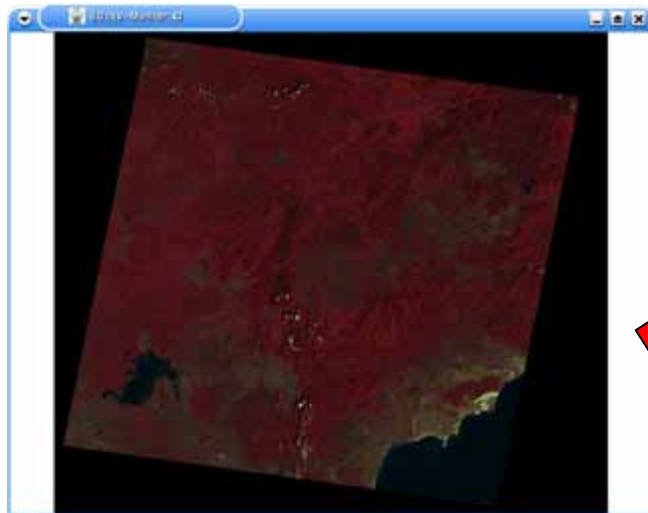
RGB image  
from linear grey scaled images



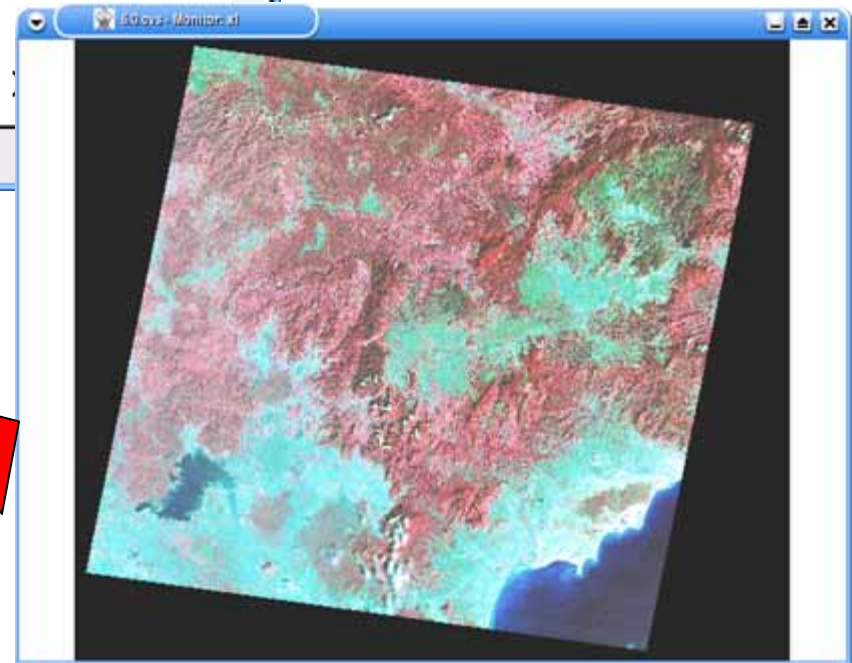
RGB image  
from histogram equalized grey scaled image

### 3.5.3 Display false color composite image using rescaled images

```
Shell - Konsole
Session Edit View Bookmarks Settings Help
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.mon x1
using default visual which is TrueColor
ncolors: 65536
Graphics driver [x1] started
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.rgb red
=TM519901230B4 green=TM519901230B3 blue=TM519901230B
2
100%
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work
```



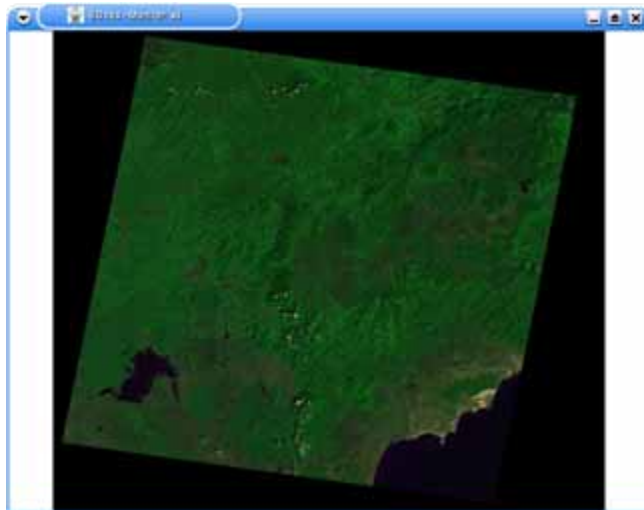
RGB image  
from linear grey scaled images



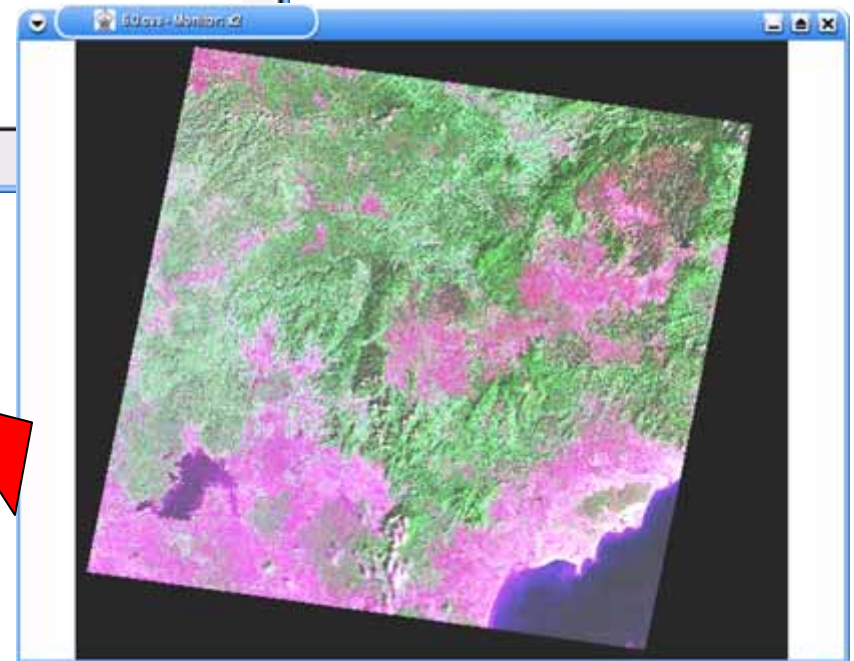
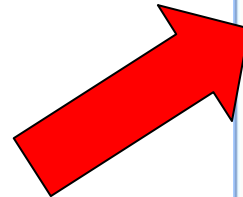
RGB image  
from histogram equalized grey scaled image

## 3.5.4 Display natural color composite image using rescaled images

```
Shell - Konsole
Session Edit View Bookmarks Settings Help
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.mon x2
using default visual which is TrueColor
ncolors: 65536
Graphics driver [x2] started
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.rgb red
=TM519901230B3 green=TM519901230B4 blue=TM519901230B
2
100%
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work
```



RGB image  
from linear grey scaled images



RGB image  
from histogram equalized grey scaled image



## 3.6 Display histogram

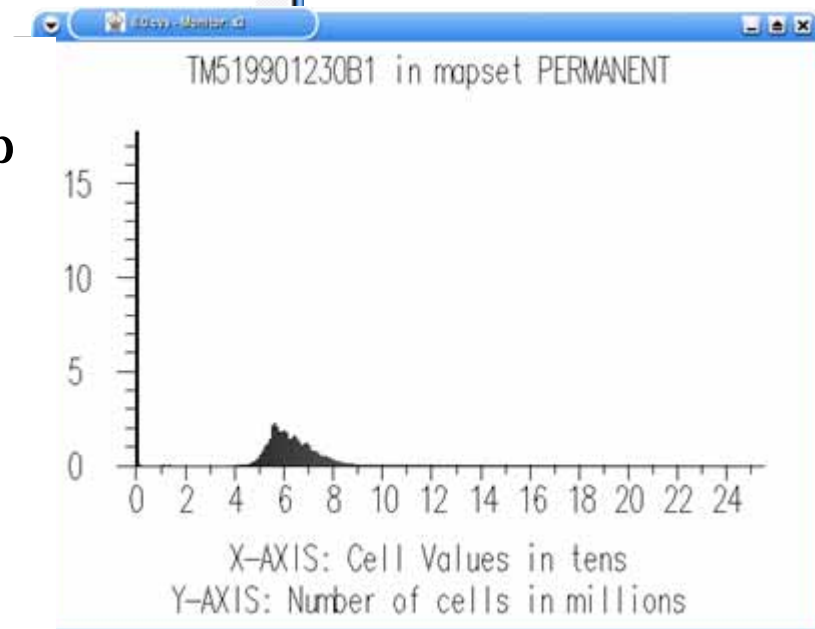
```
> d.histogram map = A
```

A = (file name)

```
Shell - Konsole
Session Edit View Bookmarks Settings Help
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.mon x3
using default visual which is TrueColor
ncolors: 65536
Graphics driver [x3] started
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.histogram
map=TM519901230B1
r.stats: 100%
```

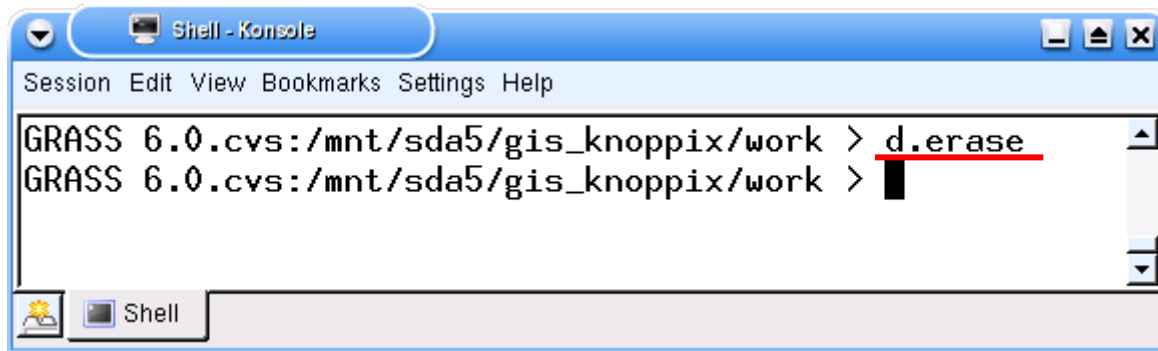
*d.histogram* displays the category-value distribution for a user-specified raster map layer, in the form of a bar chart or a pie chart.

The display will be displayed in the active display frame on the graphics monitor, using the colors in the raster map layer's color table. The program determines the raster file's category value distribution by counting cells.

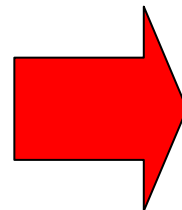
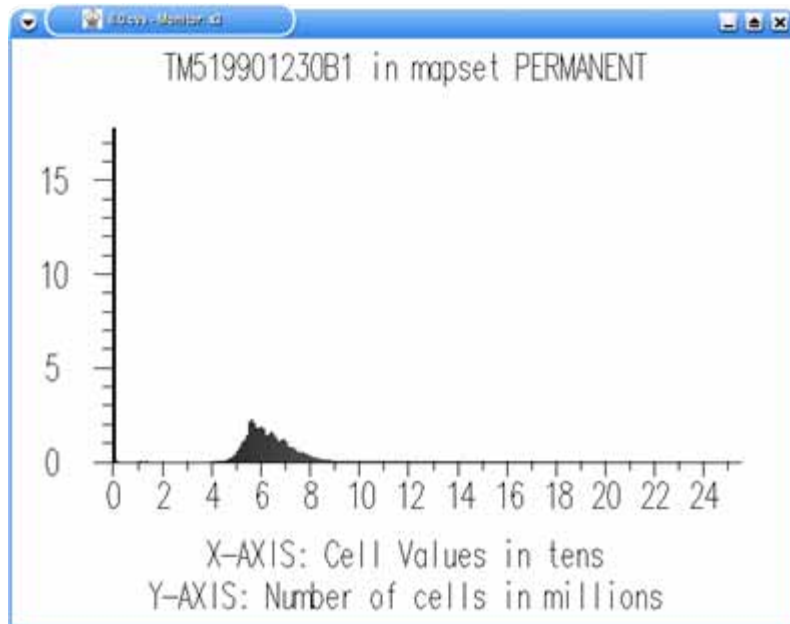


## 3.6 Erase the contents from active display

```
> d.erase
```



```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.erase
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > █
```



## **Section 3. Landsat Image Processing in UTM Coordinate System**

### **4. Create RGB image**

## Step 0. Import images for R,G, B

## Step 1. change color map to “grey scale map” respectively

```
> r.colors [map=A] color= grey
```

A = (input file name)

[ ] : space

## Step 2. composite images

```
> r.composite [red = A] [green = B] [blue = C] output = D
```

[ ] : space

A, B, C = (input file name)

D = (output file name)

## Step 3. save composite images as TIFF file

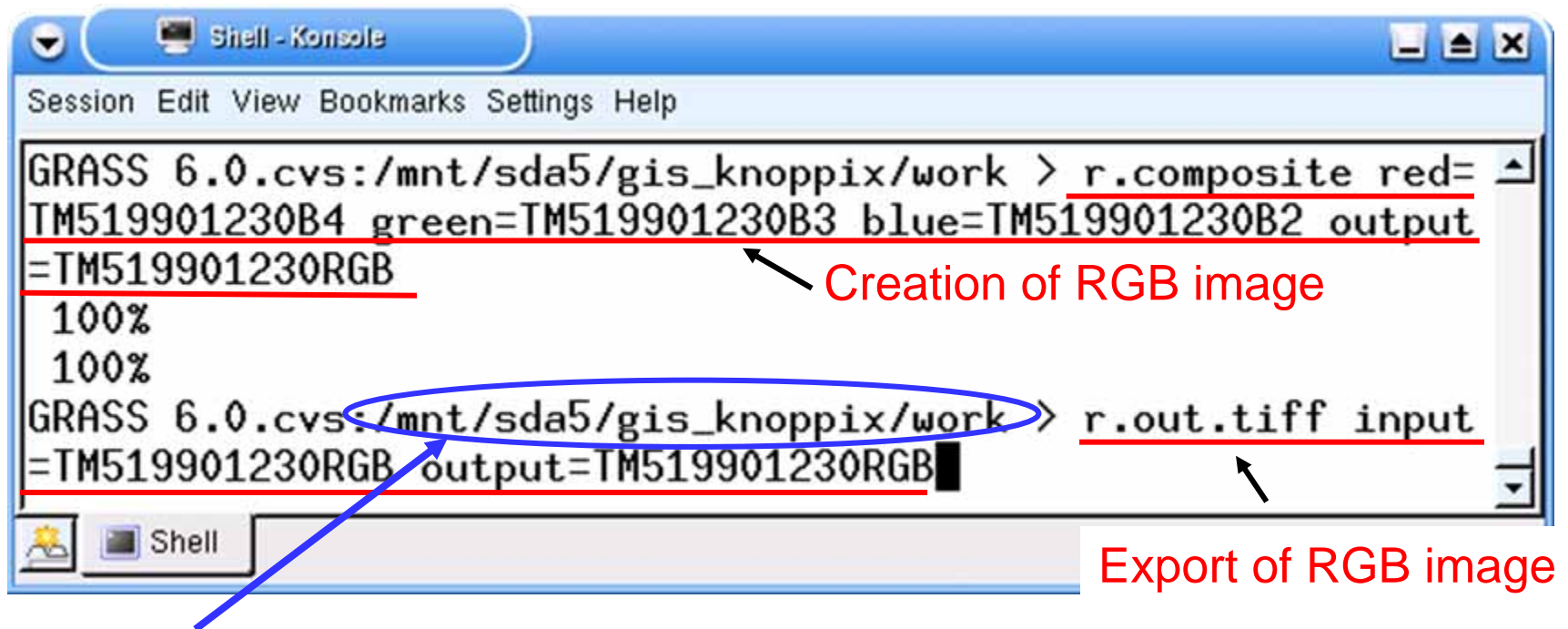
```
> r.out.tiff [input = D] output = E
```

[ ] : space

D = (input file name)

E = (output file name)

# Create & import RGB image from Landsat images



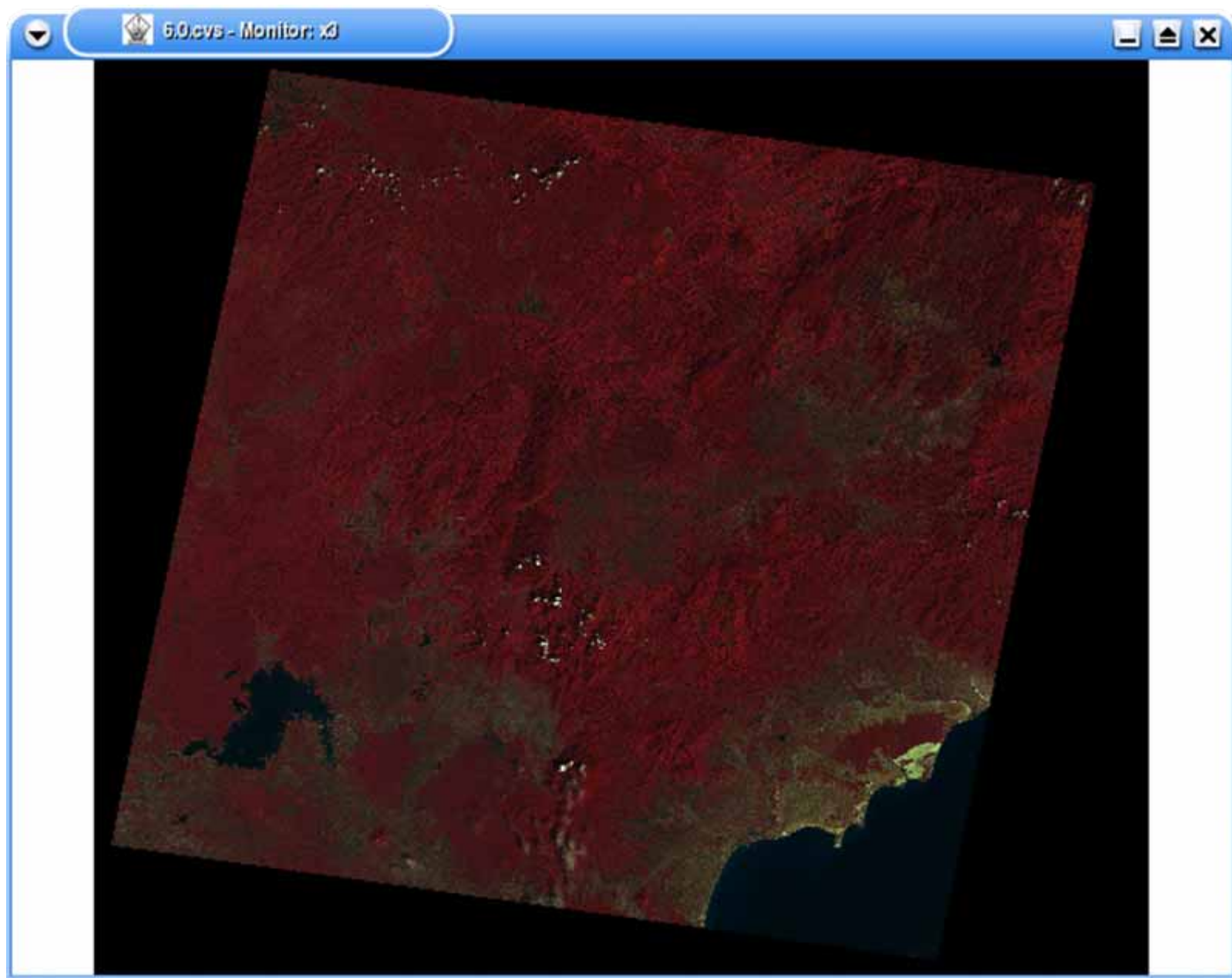
```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.composite red=  
TM519901230B4 green=TM519901230B3 blue=TM519901230B2 output  
=TM519901230RGB  
100%  
100%  
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.out.tiff input  
=TM519901230RGB output=TM519901230RGB
```

Creation of RGB image

Export of RGB image

The RGB image will be exported to this directory

***r.composite*** - Combines red, green and blue map layers into a single composite map layer. **This command creates new image file.**



## **Section 3. Landsat Image Processing in UTM Coordinate System**

# **5. Raster calculation**



## 5.1 Conversion of DN into radiance

- Landsat image files have DN (Digital Number) which has no physical meaning.
- We need to convert DN(Band1,2,3,4,5,and 7) into radiance in order to calculate some indices, such as NDVI.

$$\text{Landsat4/5 : } L = G_{\text{rescale}} \times \text{DN} + B_{\text{rescale}}$$

$L$  : Spectral Radiance ( $\text{W}/\text{m}^2\text{sr } \mu\text{m}$ )

$G_{\text{rescale}}$  :  $(L_{\text{max}} - L_{\text{min}}) / 255$

$B_{\text{rescale}}$  :  $L_{\text{min}}$

DN : Digital Number (raw value of data)

Landsat7 : see Appendix B

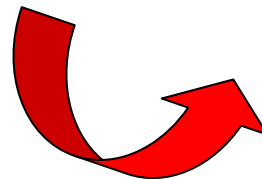
## 5.1.1 Conversion coefficients of Landsat4/5

| Rescaling Gain ( $G_{rescale}$ ) and Bias ( $B_{rescale}$ ) |                           |               |                           |               |                            |               |                       |               |
|---|---------------------------|---------------|---------------------------|---------------|----------------------------|---------------|-----------------------|---------------|
| Processing Date   | Mar 1, 1984 - May 4, 2003 |               | May 5, 2003 - Apr 1, 2007 |               | Apr 2, 2007 - Present      |               |                       |               |
| Acquisition Date  | Mar 1, 1984 - May 4, 2003 |               | Mar 1, 1984 - Apr 1, 2007 |               | Mar 1, 1984 - Dec 31, 1991 |               | Jan 1, 1992 - Present |               |
| Band  | $G_{rescale}(IC)$         | $B_{rescale}$ | $G_{rescale}(LUT03)$      | $B_{rescale}$ | $G_{rescale}(LUT07)$       | $B_{rescale}$ | $G_{rescale}(LUT07)$  | $B_{rescale}$ |
| 1   | 0.602431                  | -1.52         | 0.762824                  | -1.52         | 0.668706                   | -1.52         | 0.762824              | -1.52         |
| 2   | 1.175100                  | -2.84         | 1.442510                  | -2.84         | 1.317020                   | -2.84         | 1.442510              | -2.84         |
| 3   | 0.805765                  | -1.17         | 1.039880                  | -1.17         | 1.039880                   | -1.17         | 1.039880              | -1.17         |
| 4   | 0.814549                  | -1.51         | 0.872588                  | -1.51         | 0.872588                   | -1.51         | 0.872588              | -1.51         |
| 5   | 0.108078                  | -0.37         | 0.119882                  | -0.37         | 0.119882                   | -0.37         | 0.119882              | -0.37         |
| 6   | 0.055158                  | 1.2378        | 0.055158                  | 1.2378        | 0.055158                   | 1.2378        | 0.055158              | 1.2378        |
| 7   | 0.056980                  | -0.15         | 0.065294                  | -0.15         | 0.065294                   | -0.15         | 0.065294              | -0.15         |

G. Chander, .B L. Markham, and J. A. Barsi, Revised Landsat-5 Thematic Mapper Radiometric Calibration. IEEE GEOSCIENCE AND REMOTE SENSING LETTERS, VOL. 4, NO. 3, JULY 2007

Extract “Processing Data (Production date)” from meta file (p124r52\_5t19901230.met) in “/mnt/sda1/gis\_knoppix/data”.

In this case, { Processing Date : 2001-05-16  
Acquisition Data : 1990-12-30



| Processing Date  | Mar 1, 1984 - May 4, 2003 |               |
|------------------|---------------------------|---------------|
| Acquisition Date | Mar 1, 1984 - May 4, 2003 |               |
| Band             | $G_{rescale}(IC)$         | $B_{rescale}$ |
| 1                | 0.602431                  | -1.52         |
| 2                | 1.175100                  | -2.84         |
| 3                | 0.805765                  | -1.17         |
| 4                | 0.814549                  | -1.51         |
| 5                | 0.108078                  | -0.37         |
| 6                | 0.055158                  | 1.2378        |
| 7                | 0.056980                  | -0.15         |

## 5.1.2 Calculation of radiance using “*r.mapcalc*” command

When DN is equal to 0, the radiance should be 0.

This rule is embedded in the following calculation

```
> r.mapcalc "output =if(input==0, 0, 1.0*gain *input+bias)"
```

output : output file name

input : input file name

gain/bias :  $G_{\text{rescale}}$  &  $B_{\text{rescale}}$

␣ : space

```
Shell - Konsole
Session Edit View Bookmarks Settings Help

GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.mapcalc "TM519
901230B1R=if(TM519901230B1==0,0.1.0*0.602431*TM519901230B1-
1.52)"
100%
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.mapcalc "TM519
901230B2R=if(TM519901230B2==0,0.1.0*1.175100*TM519901230B2-
2.84)"
100%
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.mapcalc "TM519
901230B3R=if(TM519901230B3==0,0.1.0*0.805765*TM519901230B3-
1.17)"
100%
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.mapcalc "TM519
901230B4R=if(TM519901230B4==0,0.1.0*0.814549*TM519901230B4-
1.51)"
100%
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.mapcalc "TM519
901230B5R=if(TM519901230B5==0,0.1.0*0.108078*TM519901230B5-
0.37)"
100%
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.mapcalc "TM519
901230B7R=if(TM519901230B7==0,0.1.0*0.056980*TM519901230B7-
0.15)"
100%
```

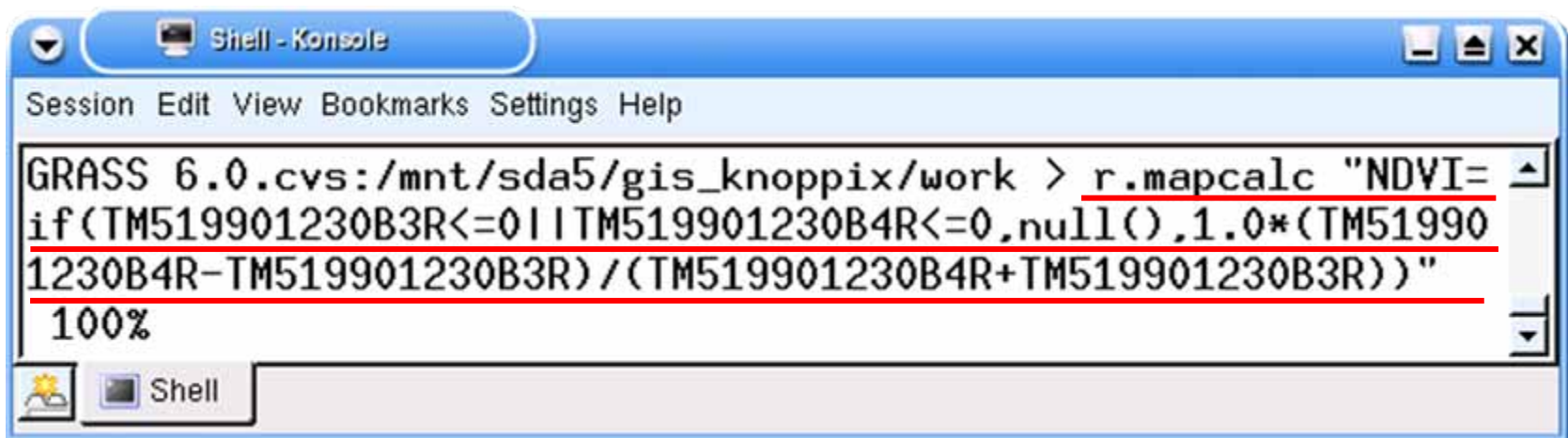
## 5.2 Calculation of NDVI

```
> r.mapcalc "NDVI = if(A<=0 || B<=0, null(), 1.0*(A-B)/(A+B))"
```

□ : space

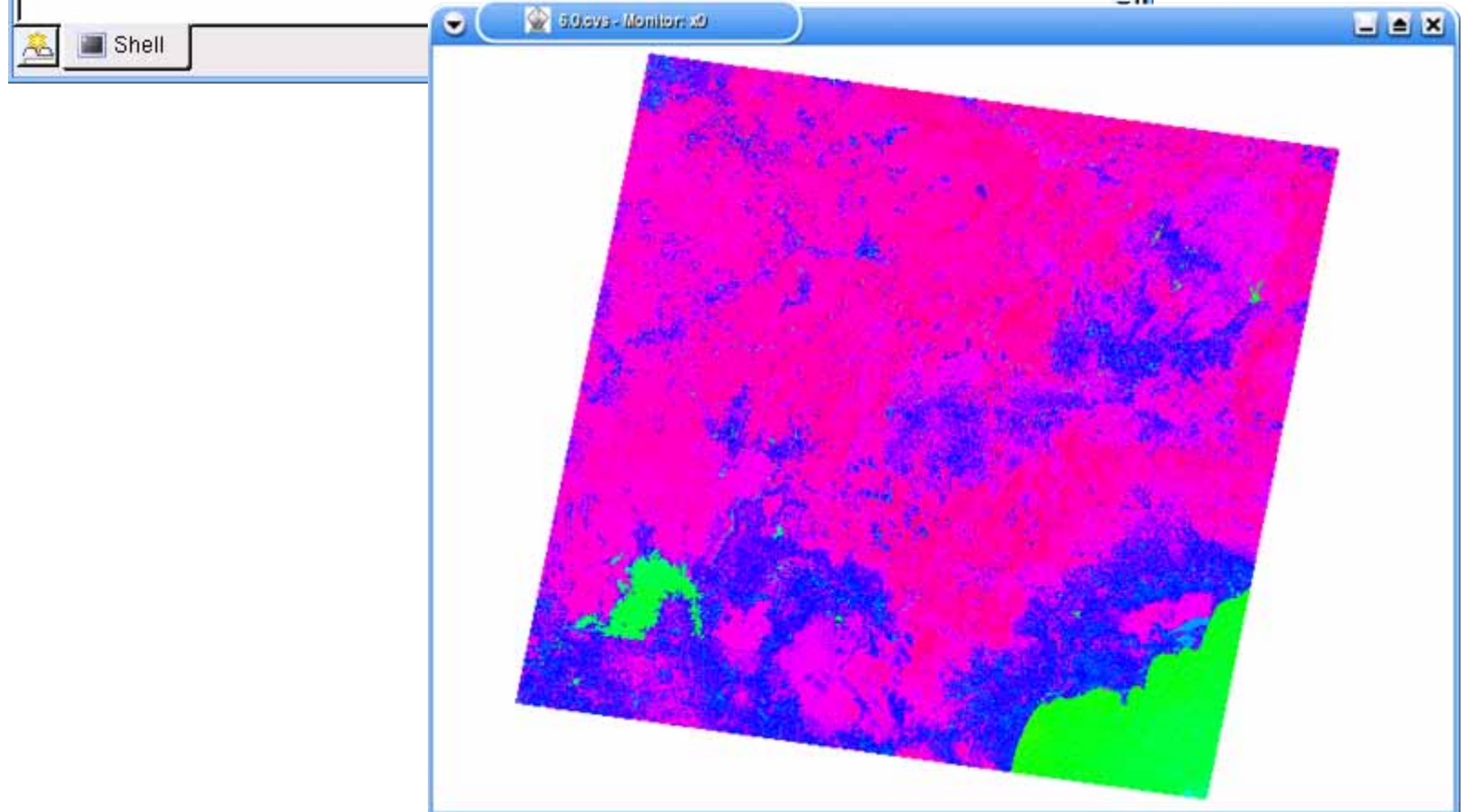
A = (NIR Band image)                      B = (RED Band image)

When "A<=0" or "B <= 0", the ndvi value is null  
else "ndvi = 1.0\*(A-B)/(A+B) "



```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.mapcalc "NDVI=
if(TM519901230B3R<=0||TM519901230B4R<=0,null(),1.0*(TM51990
1230B4R-TM519901230B3R)/(TM519901230B4R+TM519901230B3R))"
100%
```

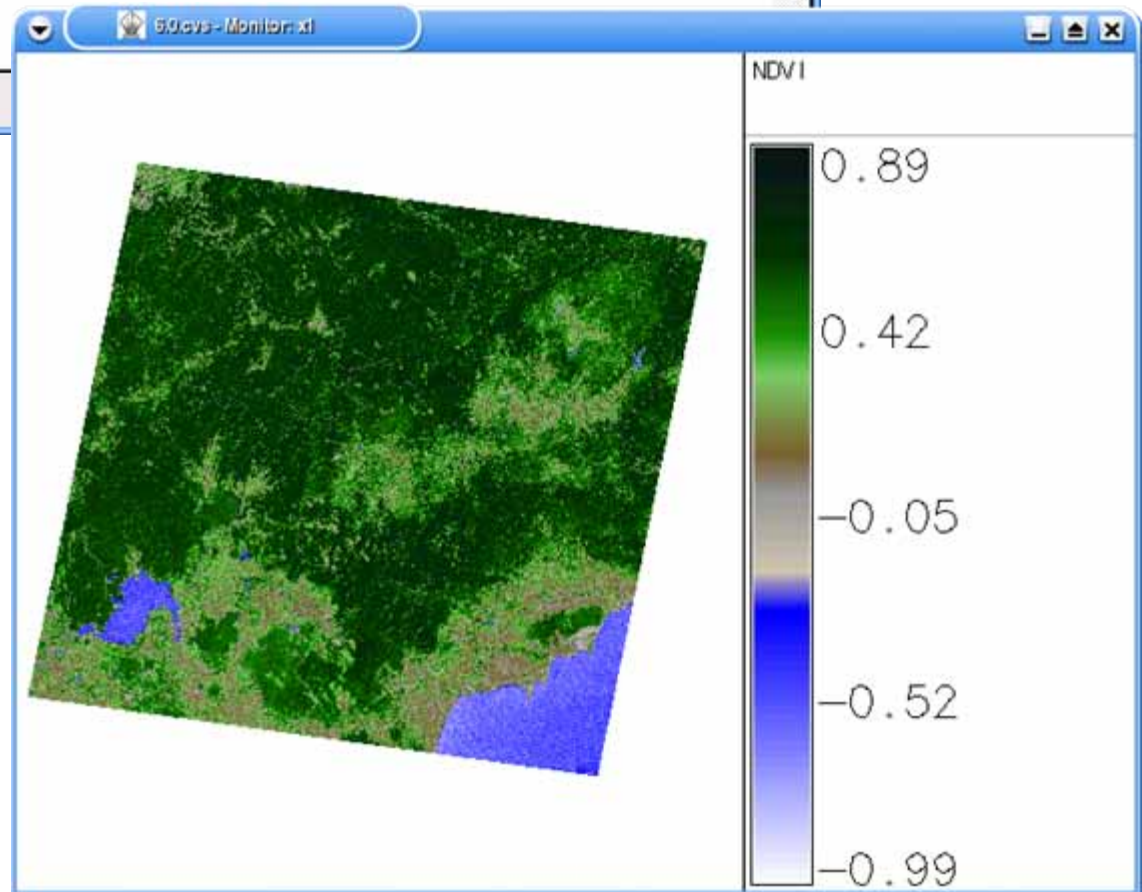
```
Shell - Konsole
Session Edit View Bookmarks Settings Help
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.mon x0
using default visual which is TrueColor
ncolors: 65536
Graphics driver [x0] started
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.rast NDVI
100%
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > █
```





```
Shell - Konsole
Session Edit View Bookmarks Settings Help
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.colors map=NDVI
rules=ndvi
Color table for [NDVI] set to ndvi
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.mon x1
using default visual which is TrueColor
ncolors: 65536
Graphics driver [x1] started
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.rast.legend NDVI
100%
Clear screen with:
```

"ndvi" denotes the color table pre-defined in GRASS





## 5.3 Deriving LST from thermal band (Band6)

Step1 : Convert digital number (DN) to spectral radiances

$$\text{Landsat4/5 : } L = G_{\text{rescale}} \times \text{DN} + B_{\text{rescale}}$$

Landsat7 : see Appendix B

Step2 : Convert spectral radiances to temperatures

$$T = \frac{K_2}{\ln\left(\frac{K_1}{L} + 1\right)} - 273.15 \quad (\text{deg.C})$$

## 5.3.1 Conversion of DN to spectral radiances

Table 2. Landsat4/5 TM Calibration Coefficients

| Rescaling Gain ( $G_{\text{rescale}}$ ) and Bias ( $B_{\text{rescale}}$ ) |                           |                      |                             |                      |                             |                      |                             |                      |
|---|---------------------------|----------------------|-----------------------------|----------------------|-----------------------------|----------------------|-----------------------------|----------------------|
| Processing Date   | Mar 1, 1984 - May 4, 2003 |                      | May 5, 2003 - Apr 1, 2007   |                      | Apr 2, 2007 - Present       |                      |                             |                      |
| Acquisition Date  | Mar 1, 1984 - May 4, 2003 |                      | Mar 1, 1984 - Apr 1, 2007   |                      | Mar 1, 1984 - Dec 31, 1991  |                      | Jan 1, 1992 - Present       |                      |
| Band  | $G_{\text{rescale(IC)}}$  | $B_{\text{rescale}}$ | $G_{\text{rescale(LUT03)}}$ | $B_{\text{rescale}}$ | $G_{\text{rescale(LUT07)}}$ | $B_{\text{rescale}}$ | $G_{\text{rescale(LUT07)}}$ | $B_{\text{rescale}}$ |
| 1   | 0.602431                  | -1.52                | 0.762824                    | -1.52                | 0.668706                    | -1.52                | 0.762824                    | -1.52                |
| 2   | 1.175100                  | -2.84                | 1.442510                    | -2.84                | 1.317020                    | -2.84                | 1.442510                    | -2.84                |
| 3   | 0.805765                  | -1.17                | 1.039880                    | -1.17                | 1.039880                    | -1.17                | 1.039880                    | -1.17                |
| 4   | 0.814549                  | -1.51                | 0.872588                    | -1.51                | 0.872588                    | -1.51                | 0.872588                    | -1.51                |
| 5   | 0.108078                  | -0.37                | 0.119882                    | -0.37                | 0.119882                    | -0.37                | 0.119882                    | -0.37                |
| 6   | 0.055158                  | 1.2378               | 0.055158                    | 1.2378               | 0.055158                    | 1.2378               | 0.055158                    | 1.2378               |
| 7   | 0.056980                  | -0.15                | 0.065294                    | -0.15                | 0.065294                    | -0.15                | 0.065294                    | -0.15                |

$$\text{Landsat 4/5: } L = G_{\text{rescale}} \times \text{DN} + B_{\text{rescale}}$$

$L$  : Spectral Radiance ( $\text{W}/\text{m}^2\text{sr } \mu\text{m}$ )

$G_{\text{rescale}}$  :  $(L_{\text{max}} - L_{\text{min}}) / 255$

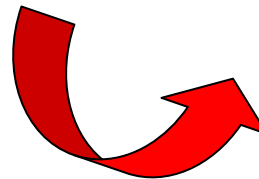
$B_{\text{rescale}}$  :  $L_{\text{min}}$

DN : Digital Number (raw value of data)

Extract "Processing Data (Production date)" from meta file (p124r52\_5t19901230.met) in "/mnt/sda1/gis\_knoppix/data".

In this case, { Processing Date : 2001-05-16  
Acquisition Data : 1990-12-30

| Processing Date  | Mar 1, 1984 - May 4, 2003 |                      |
|------------------|---------------------------|----------------------|
| Acquisition Date | Mar 1, 1984 - May 4, 2003 |                      |
| Band             | G <sub>rescale</sub> (IC) | B <sub>rescale</sub> |
| 1                | 0.602431                  | -1.52                |
| 2                | 1.175100                  | -2.84                |
| 3                | 0.805765                  | -1.17                |
| 4                | 0.814549                  | -1.51                |
| 5                | 0.108078                  | -0.37                |
| 6                | 0.055158                  | 1.2378               |
| 7                | 0.056980                  | -0.15                |



$$L = G_{\text{rescale}} \times \text{DN} + B_{\text{rescale}}$$

→  $L = 0.055158 \times \text{DN} + 1.2378$

```

Shell - Konsole
Session Edit View Bookmarks Settings Help
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.mapcalc "TM51
9901230B6R=if(TM519901230B6==0,0,1.0*0.055158*TM519901230B
6+1.2378)"
100%

```

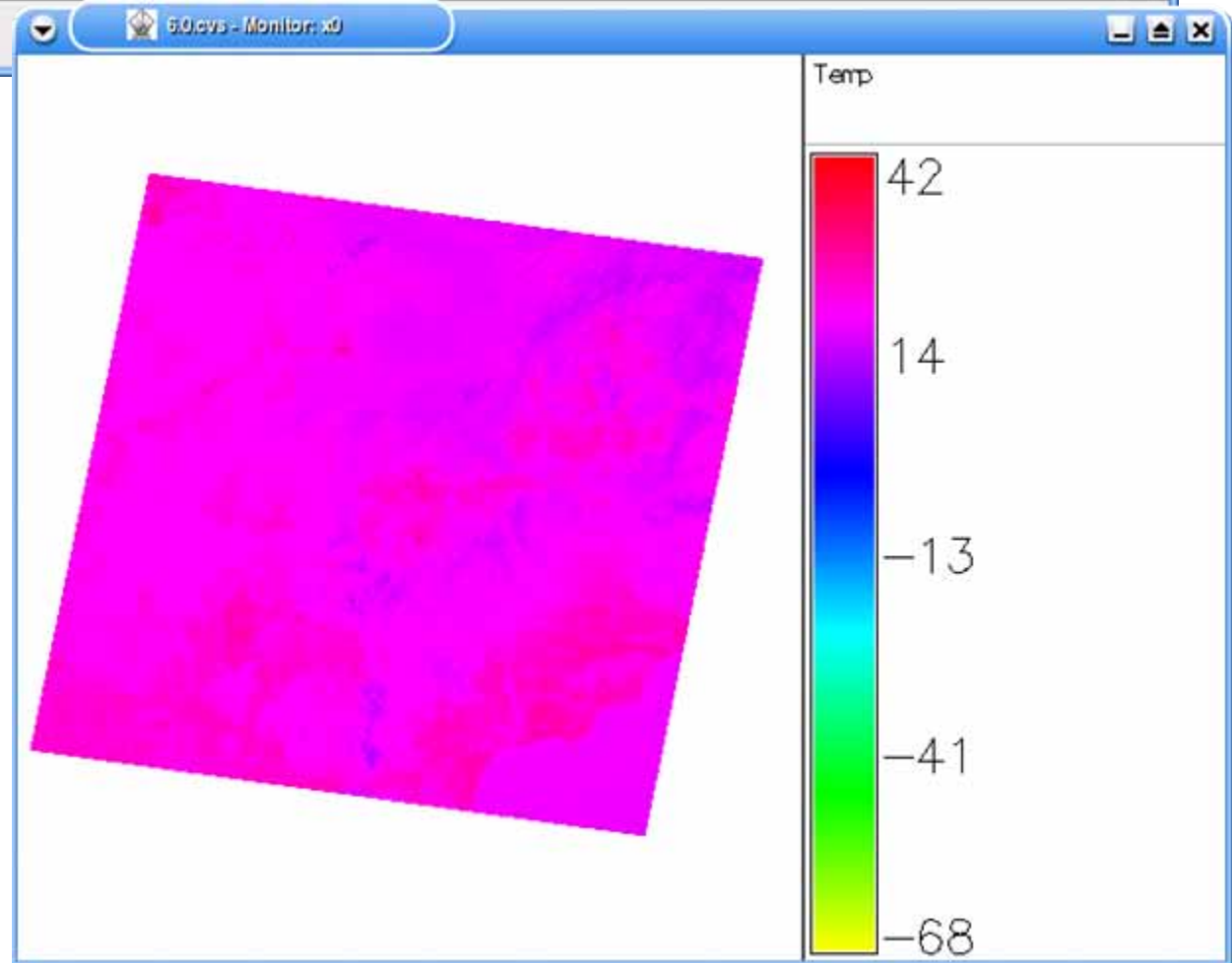
### 5.3.2 Conversion of spectral radiances to temperatures

Table 3. Thermal Band Calibration Constants

|          | $K_1$  | $K_2$   |
|----------|--------|---------|
| Landsat4 | 671.62 | 1284.3  |
| Landsat5 | 607.76 | 1260.56 |
| Landsat7 | 666.09 | 1282.71 |

$$T = \frac{K_2}{\ln\left(\frac{K_1}{L} + 1\right)} - 273.15 \quad (\text{deg.C})$$

```
Shell - Konsole
Session Edit View Bookmarks Settings Help
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.mapcalc "Temp  
=((1260.56/log((607.76/TM519901230B6R)+1.0))-273.15)"  
100%  
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > █
```



## 5.4 Histogram equalization

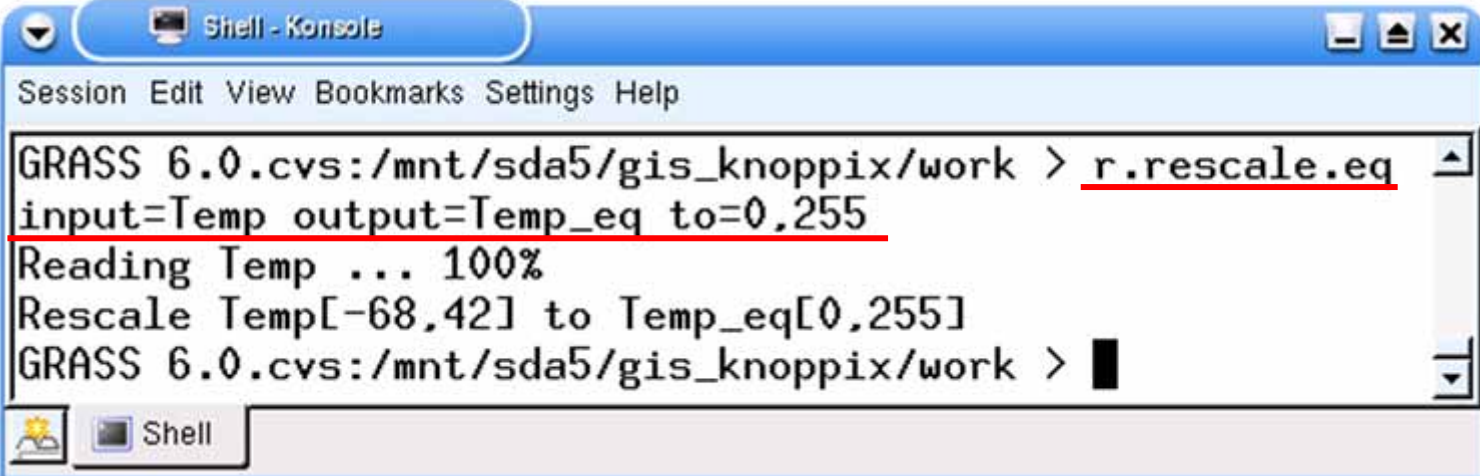
□ : space

```
> r.rescale.eq □ input = A □ output = B □ to = 0, 255
```

A = (input file name)

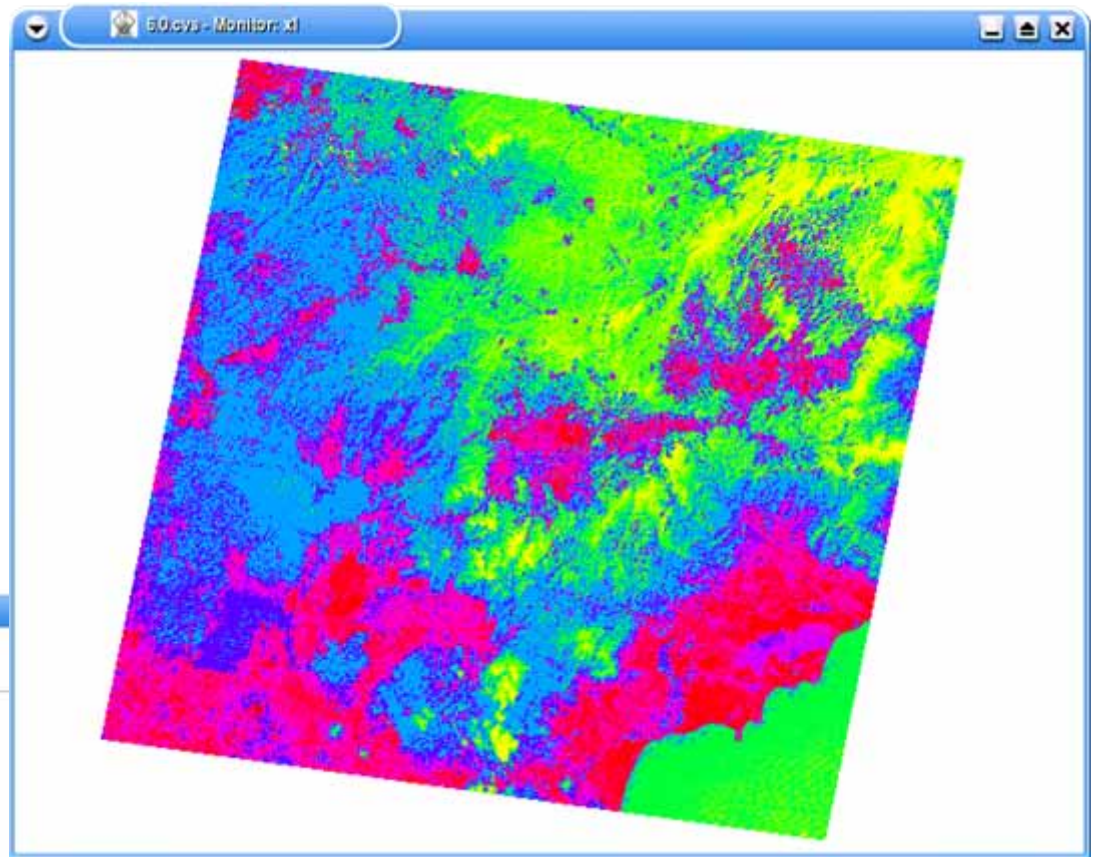
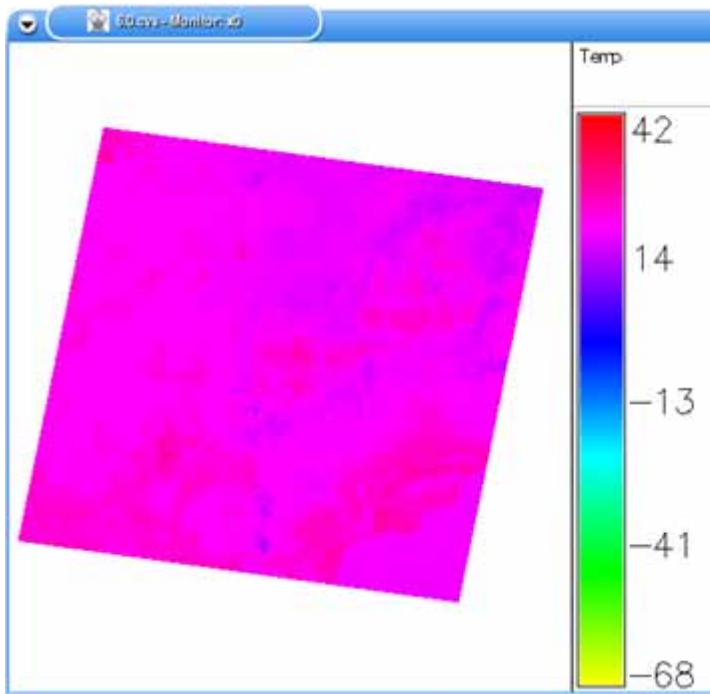
B = (output file name)

*r.rescale.eq* rescales histogram equalized the range of category values in a raster map layer.



```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.rescale.eq  
input=Temp output=Temp_eq to=0,255  
Reading Temp ... 100%  
Rescale Temp[-68,42] to Temp_eq[0,255]  
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > █
```

The screenshot shows a terminal window titled 'Shell - Konsole'. The command prompt is 'GRASS 6.0.cvs:/mnt/sda5/gis\_knoppix/work >'. The user enters the command r.rescale.eq followed by input=Temp output=Temp\_eq to=0,255 on the next line. The output shows 'Reading Temp ... 100%' and 'Rescale Temp[-68,42] to Temp\_eq[0,255]'. The prompt returns to 'GRASS 6.0.cvs:/mnt/sda5/gis\_knoppix/work >' with a cursor. The window has a menu bar with 'Session', 'Edit', 'View', 'Bookmarks', 'Settings', and 'Help'. At the bottom, there is a 'Shell' tab with a sun icon.





## **Section 3. Landsat Image Processing in UTM Coordinate System**

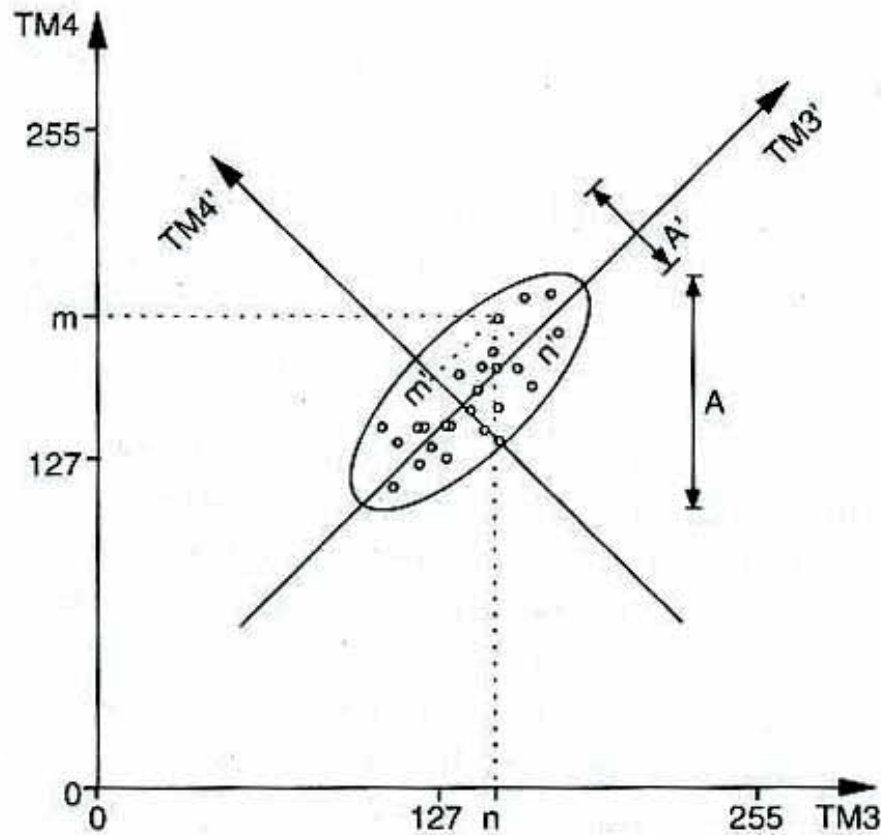
# **6. Principal component analysis**

- Multispectral image channels often contain correlations due to similarities of the spectral response of the observed objects or slightly overlapping filter functions of the spectral sensor.
- This leads to redundancies within the data set.
- The “Principal Component Analysis (PCA)” has been developed to transform such a data set to a new data set without correlations between the channels.
- This will concentrate the image information in fewer image channels (reduction of image dimensionality), which is of particular interest for hyperspectral data.

- The PCA transforms the original multispectral data set to a new spectral coordinate system, the Principal Component axes, which are orthogonal to each other.
- In general, the first principal component (PC) image contains the maximum possible variance of the original images.
- The second principal component image contains the maximum possible variance not stored in the first PC image, as the second PC axis is orthogonal to the first PC axis.

- The number of PC images is identical to the number of input channels. The higher PC images explain remaining variances. Since the amount of variance decrease from the first to the last PC, uncorrelated noise (and sometimes some remaining high frequencies) is found in the PC image.

- PCA is sometimes used for image compression, as it allows the image information to be concentrated in fewer channels.
- PCA is also sometimes used to generate additional channels to obtain more variables for classification process.



PCA applied to channel TM3 and TM4 of a LANDSAT-TM5 data set. Both the original spectral axes (channel TM3, TM4) and PC axes (PCA transformed channels TM3', TM4') are shown.

## 6.1 Principal component analysis (PCA)

```
> i.pca input= "A, B, C, . . ." output=" "
```

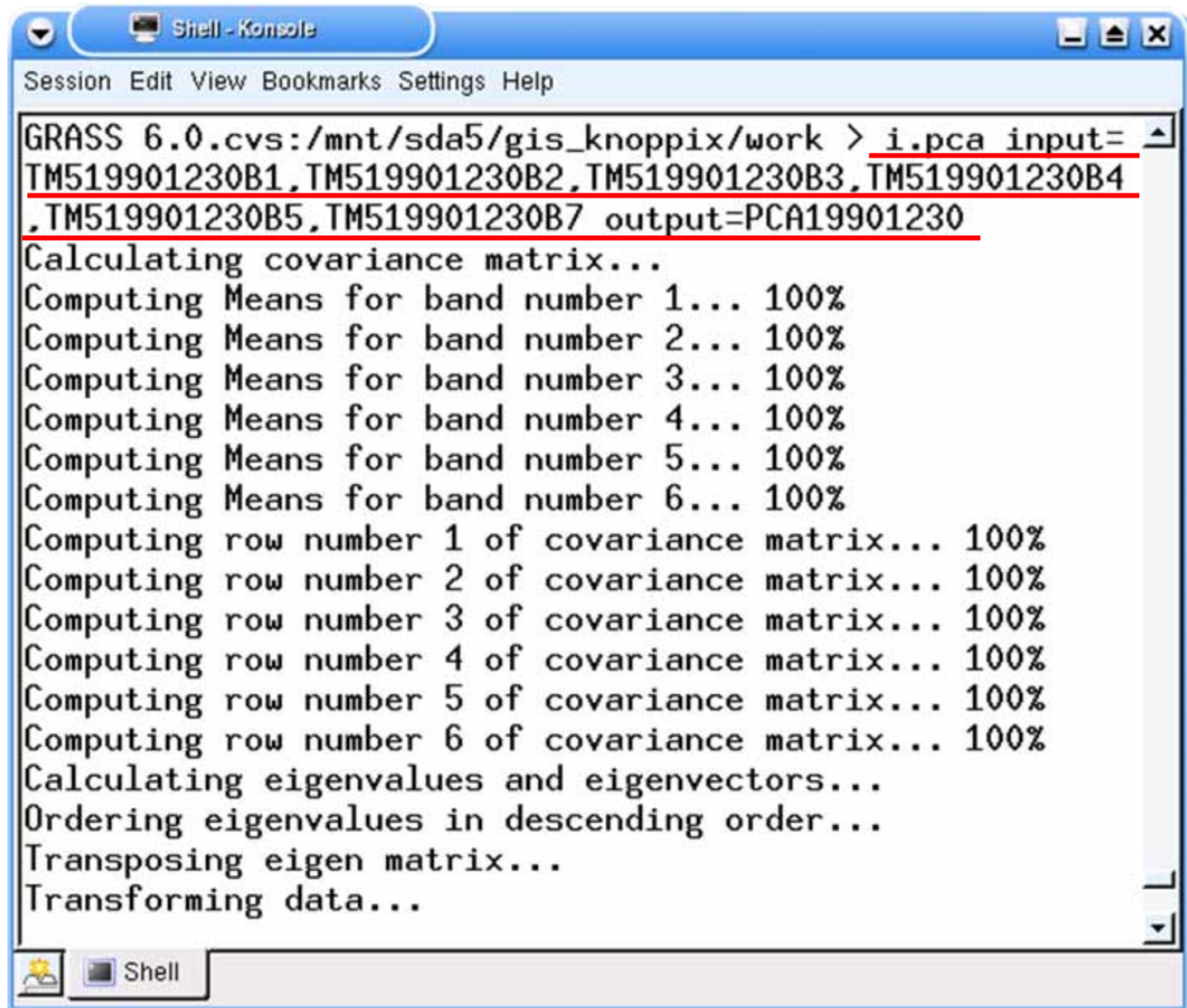
: space

A, B, C, . . . = (input file name)

" " = a prefix for the transformed PC image files,  
which will be enumerated incrementally

*i.pca* : Principal components analysis (pca) program  
for image processing.

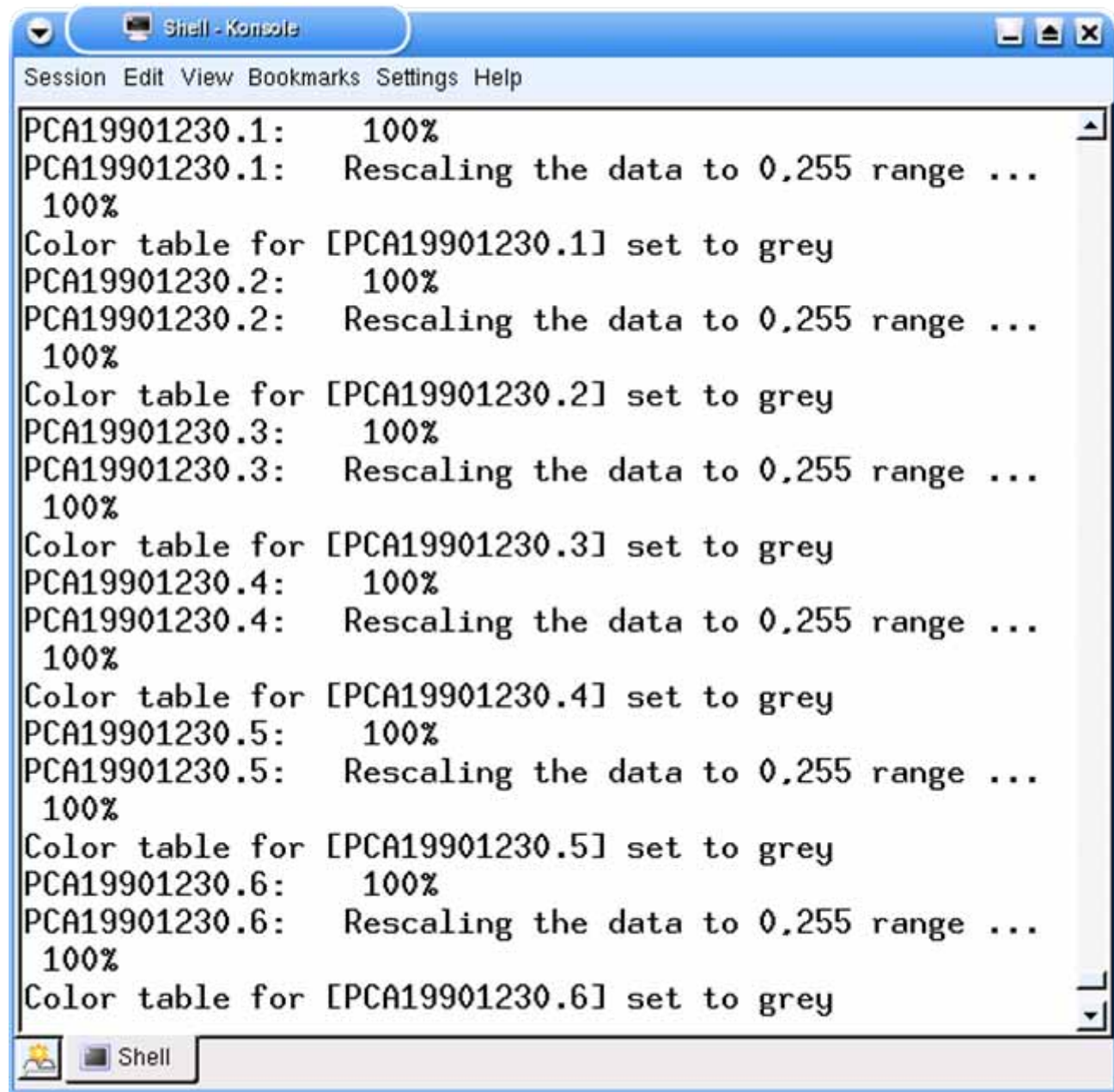




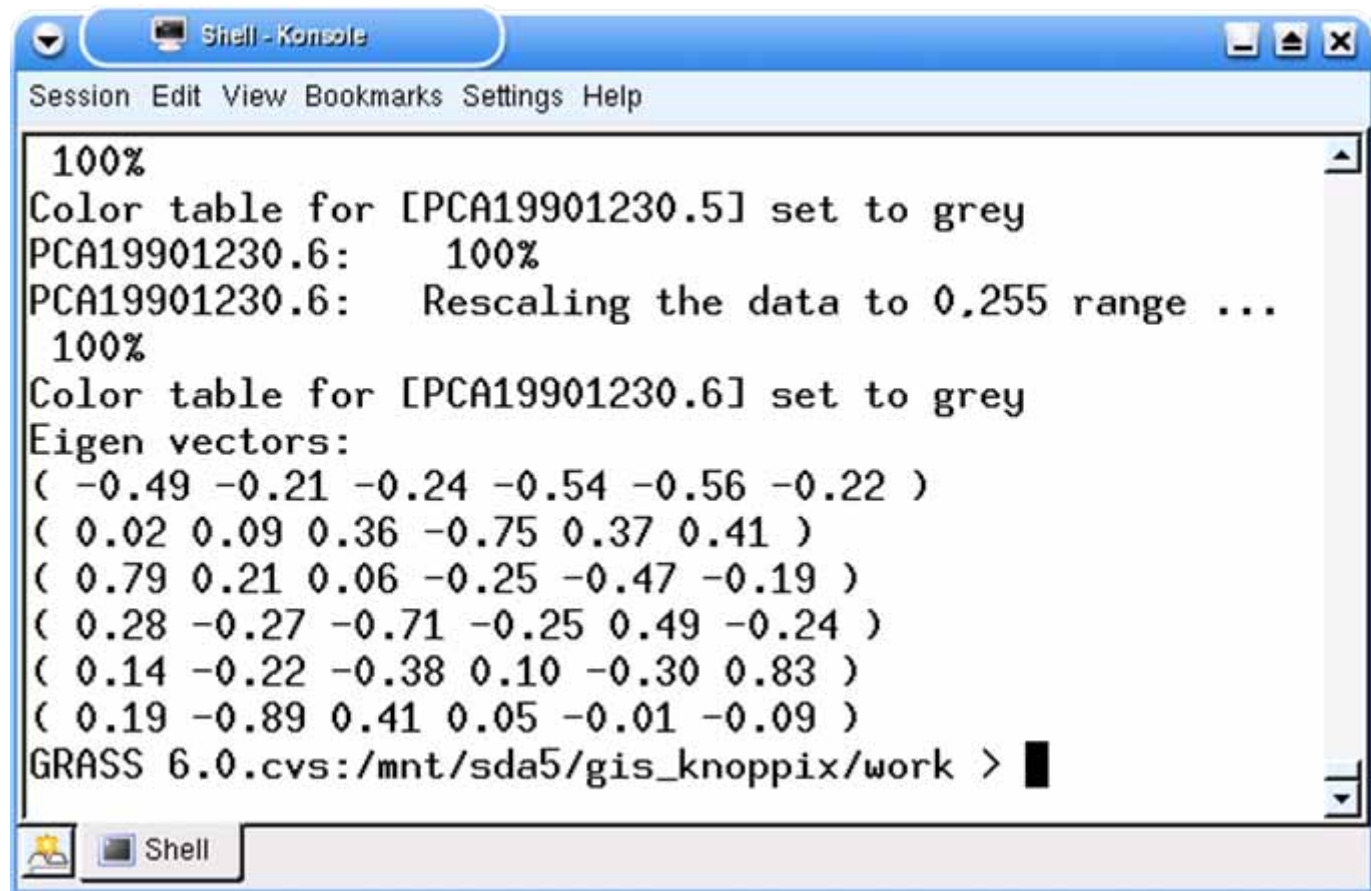
The screenshot shows a terminal window titled "Shell - Konsole" with a menu bar containing "Session", "Edit", "View", "Bookmarks", "Settings", and "Help". The terminal text shows a GRASS 6.0 command to perform PCA on six input maps. The command is: `GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > i.pca input=TM519901230B1, TM519901230B2, TM519901230B3, TM519901230B4, TM519901230B5, TM519901230B7 output=PCA19901230`. The output shows progress for calculating the covariance matrix, computing means for each band (1-6) at 100%, computing each row of the covariance matrix (1-6) at 100%, calculating eigenvalues and eigenvectors, ordering eigenvalues, transposing the eigen matrix, and transforming the data.

```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > i.pca input=
TM519901230B1, TM519901230B2, TM519901230B3, TM519901230B4
, TM519901230B5, TM519901230B7 output=PCA19901230
Calculating covariance matrix...
Computing Means for band number 1... 100%
Computing Means for band number 2... 100%
Computing Means for band number 3... 100%
Computing Means for band number 4... 100%
Computing Means for band number 5... 100%
Computing Means for band number 6... 100%
Computing row number 1 of covariance matrix... 100%
Computing row number 2 of covariance matrix... 100%
Computing row number 3 of covariance matrix... 100%
Computing row number 4 of covariance matrix... 100%
Computing row number 5 of covariance matrix... 100%
Computing row number 6 of covariance matrix... 100%
Calculating eigenvalues and eigenvectors...
Ordering eigenvalues in descending order...
Transposing eigen matrix...
Transforming data...
```

# In this case, we use DN for PCA.



```
PCA19901230.1: 100%
PCA19901230.1: Rescaling the data to 0,255 range ...
100%
Color table for [PCA19901230.1] set to grey
PCA19901230.2: 100%
PCA19901230.2: Rescaling the data to 0,255 range ...
100%
Color table for [PCA19901230.2] set to grey
PCA19901230.3: 100%
PCA19901230.3: Rescaling the data to 0,255 range ...
100%
Color table for [PCA19901230.3] set to grey
PCA19901230.4: 100%
PCA19901230.4: Rescaling the data to 0,255 range ...
100%
Color table for [PCA19901230.4] set to grey
PCA19901230.5: 100%
PCA19901230.5: Rescaling the data to 0,255 range ...
100%
Color table for [PCA19901230.5] set to grey
PCA19901230.6: 100%
PCA19901230.6: Rescaling the data to 0,255 range ...
100%
Color table for [PCA19901230.6] set to grey
```

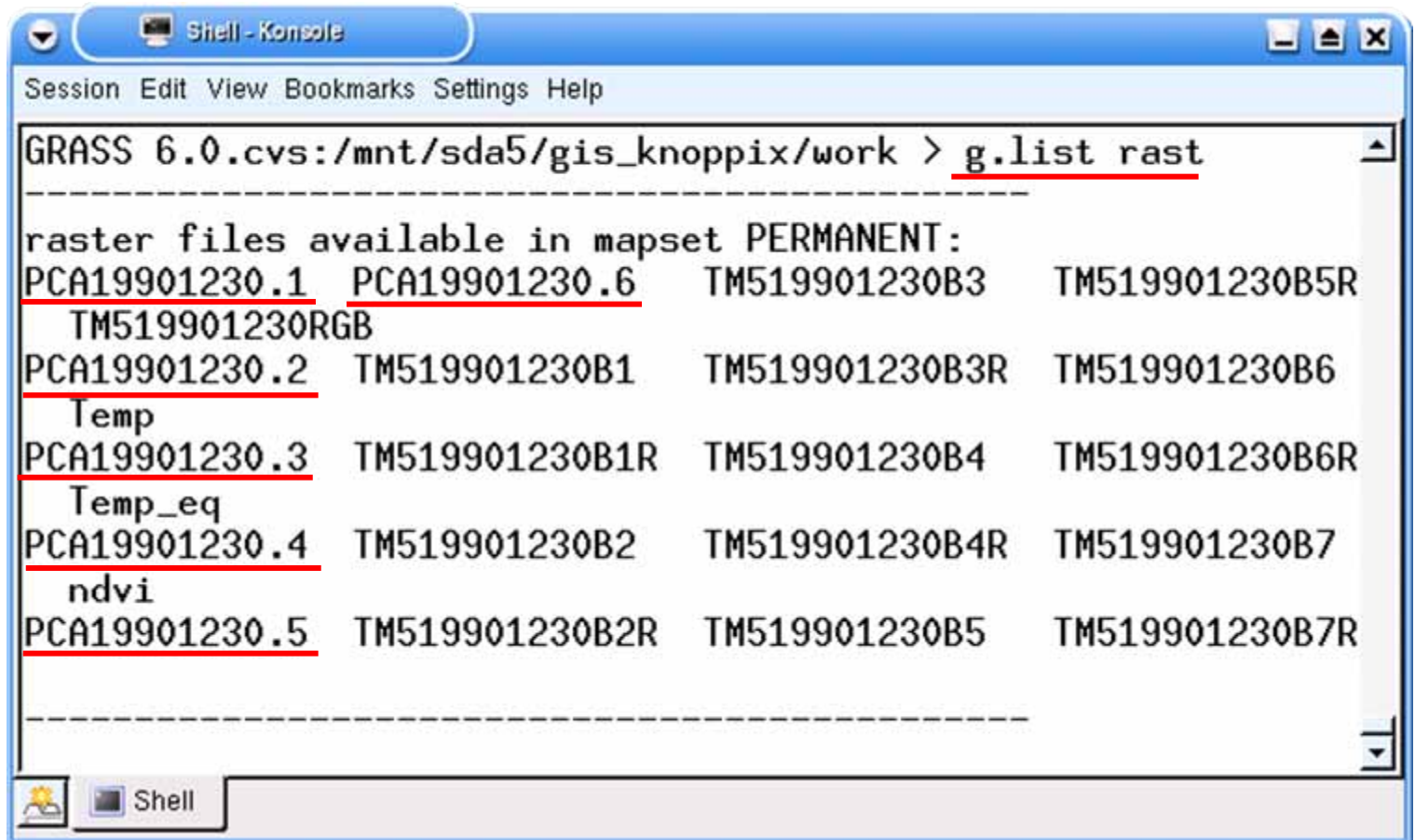


A screenshot of a terminal window titled "Shell - Konsole". The window has a menu bar with "Session", "Edit", "View", "Bookmarks", "Settings", and "Help". The terminal output shows the following text:

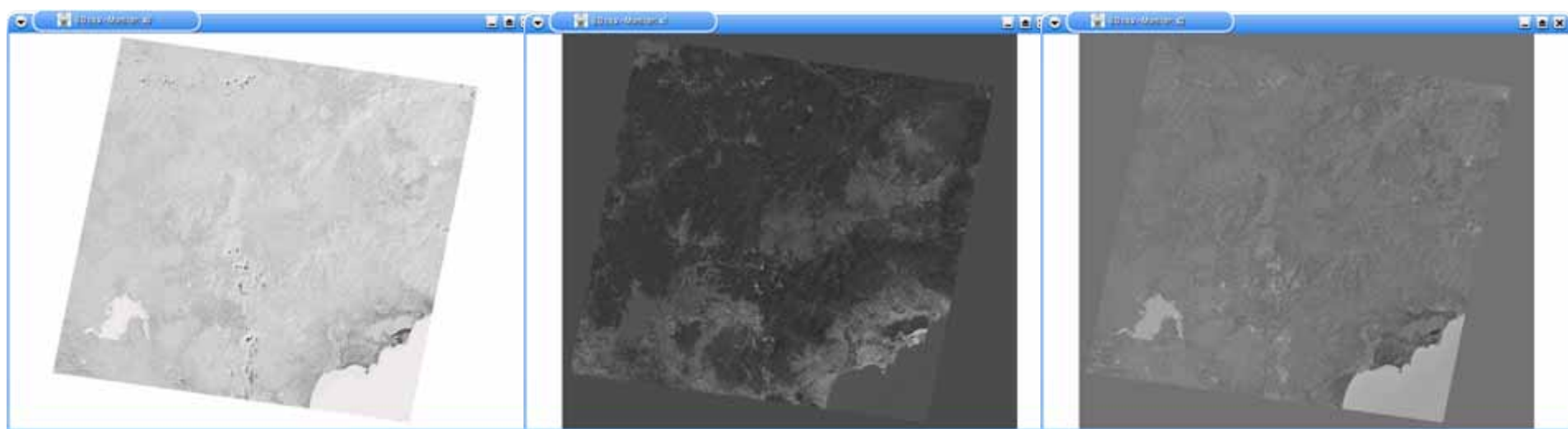
```
100%
Color table for [PCA19901230.5] set to grey
PCA19901230.6: 100%
PCA19901230.6: Rescaling the data to 0,255 range ...
100%
Color table for [PCA19901230.6] set to grey
Eigen vectors:
( -0.49 -0.21 -0.24 -0.54 -0.56 -0.22 )
( 0.02 0.09 0.36 -0.75 0.37 0.41 )
( 0.79 0.21 0.06 -0.25 -0.47 -0.19 )
( 0.28 -0.27 -0.71 -0.25 0.49 -0.24 )
( 0.14 -0.22 -0.38 0.10 -0.30 0.83 )
( 0.19 -0.89 0.41 0.05 -0.01 -0.09 )
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work >
```

The terminal window has a taskbar at the bottom with a "Shell" icon and label.

## List the results



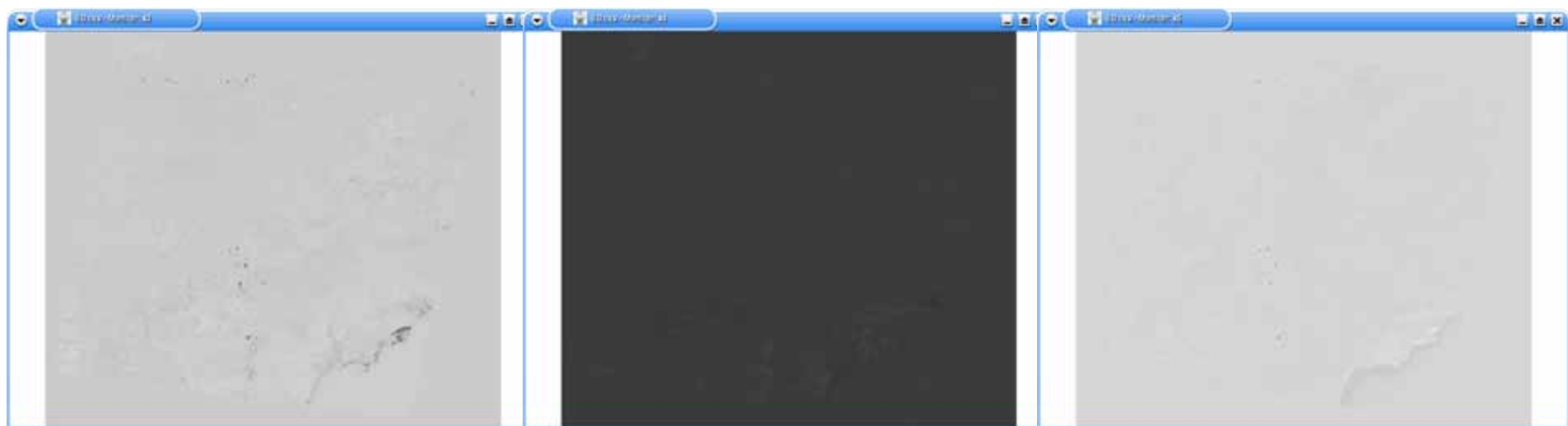
```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > g.list rast
-----
raster files available in mapset PERMANENT:
PCA19901230.1  PCA19901230.6    TM519901230B3    TM519901230B5R
    TM519901230RGB
PCA19901230.2  TM519901230B1    TM519901230B3R   TM519901230B6
    Temp
PCA19901230.3  TM519901230B1R   TM519901230B4    TM519901230B6R
    Temp_eq
PCA19901230.4  TM519901230B2    TM519901230B4R   TM519901230B7
    ndvi
PCA19901230.5  TM519901230B2R   TM519901230B5    TM519901230B7R
-----
```



PC1

PC2

PC3



PC4

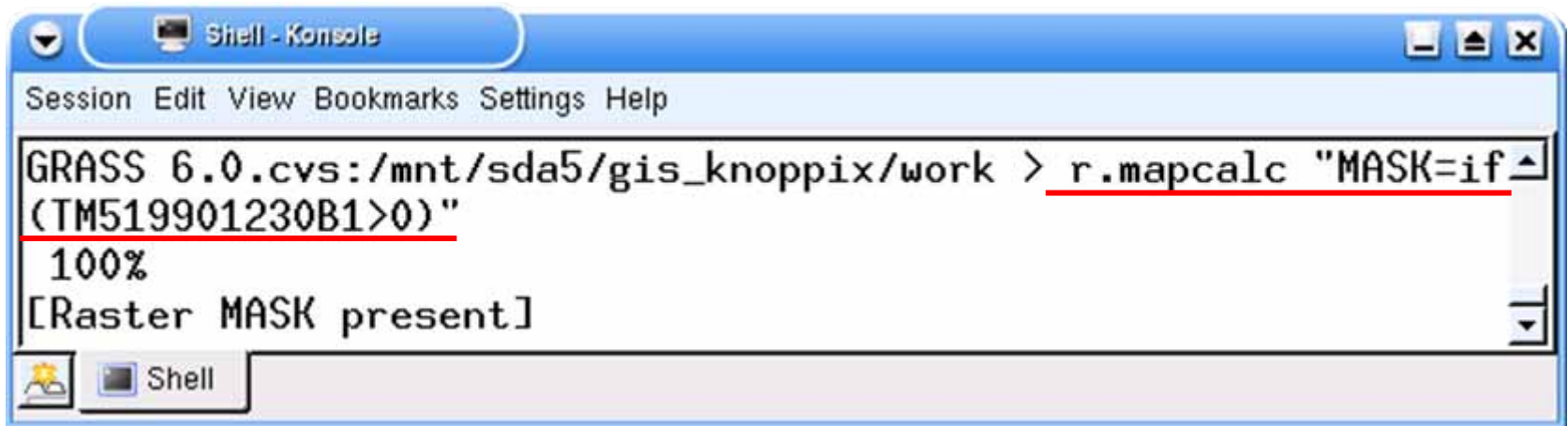
PC5

PC6

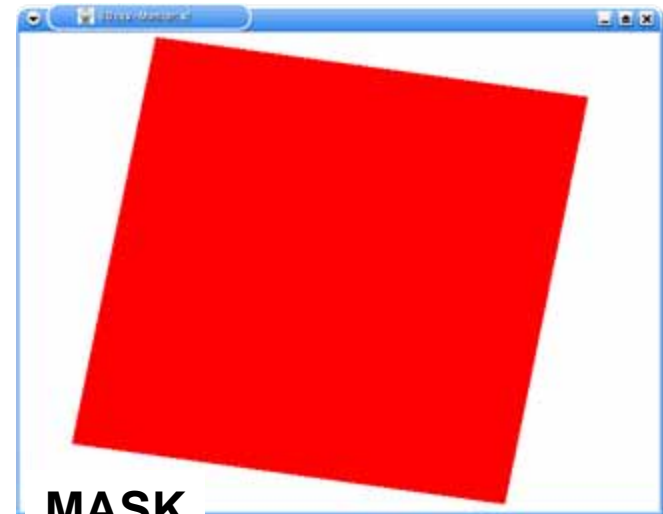
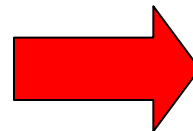
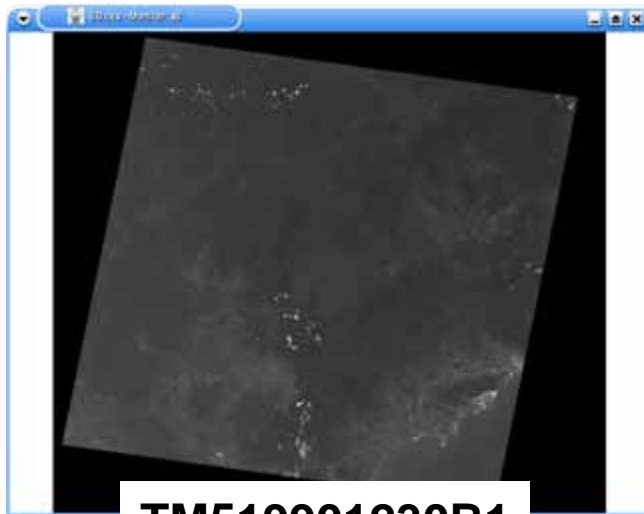


# 6.2 Unsupervised classification using PCA results with MASK

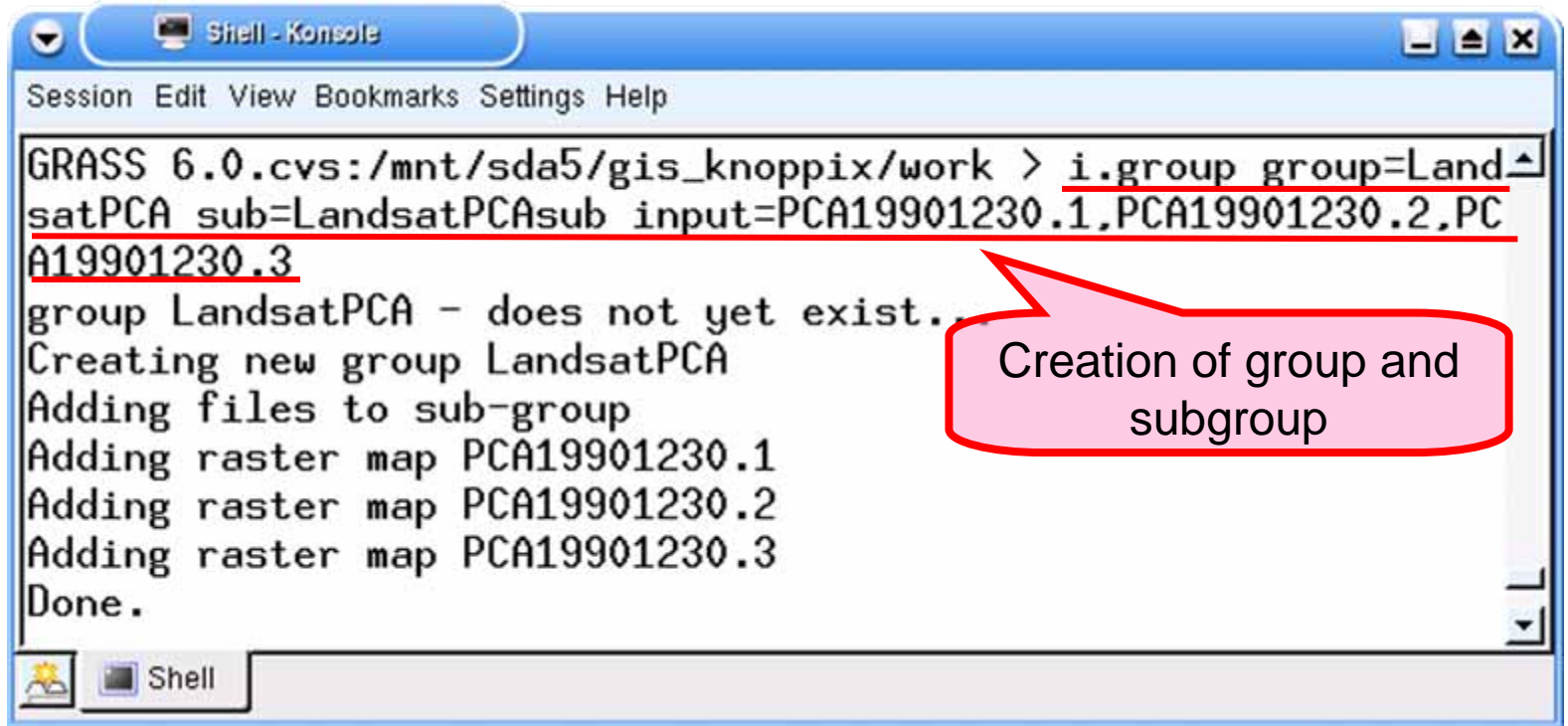
## 6.2.1 Create MASK



```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > r.mapcalc "MASK=if  
(TM519901230B1>0)"  
100%  
[Raster MASK present]
```



## 6.2.1 Create group and subgroup of imagery files



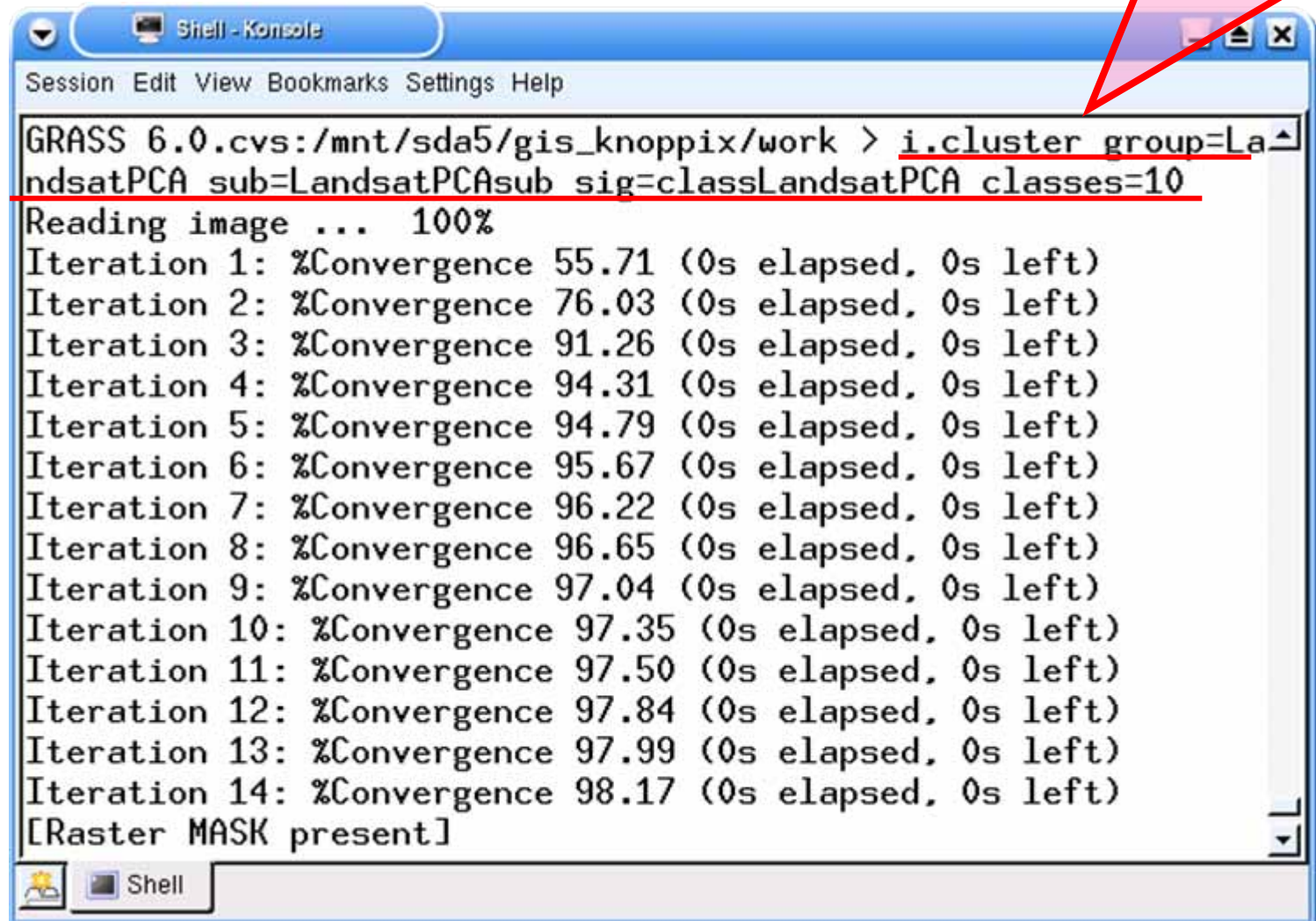
The screenshot shows a terminal window titled "Shell - Konsole" with a menu bar (Session, Edit, View, Bookmarks, Settings, Help). The command prompt shows the GRASS 6.0 CVS directory. A red line underlines the command: `i.group group=LandsatPCA sub=LandsatPCAsub input=PCA19901230.1,PCA19901230.2,PCA19901230.3`. The output shows the group "LandsatPCA" being created and the three input files being added to the subgroup "LandsatPCAsub". A red callout bubble points to the command and output, containing the text "Creation of group and subgroup".

```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > i.group group=LandsatPCA  
sub=LandsatPCAsub input=PCA19901230.1,PCA19901230.2,PCA19901230.3  
group LandsatPCA - does not yet exist.  
Creating new group LandsatPCA  
Adding files to sub-group  
Adding raster map PCA19901230.1  
Adding raster map PCA19901230.2  
Adding raster map PCA19901230.3  
Done.
```

Creation of group and subgroup

## 6.2.2 Clustering of the images of PAC result

Clustering of image data

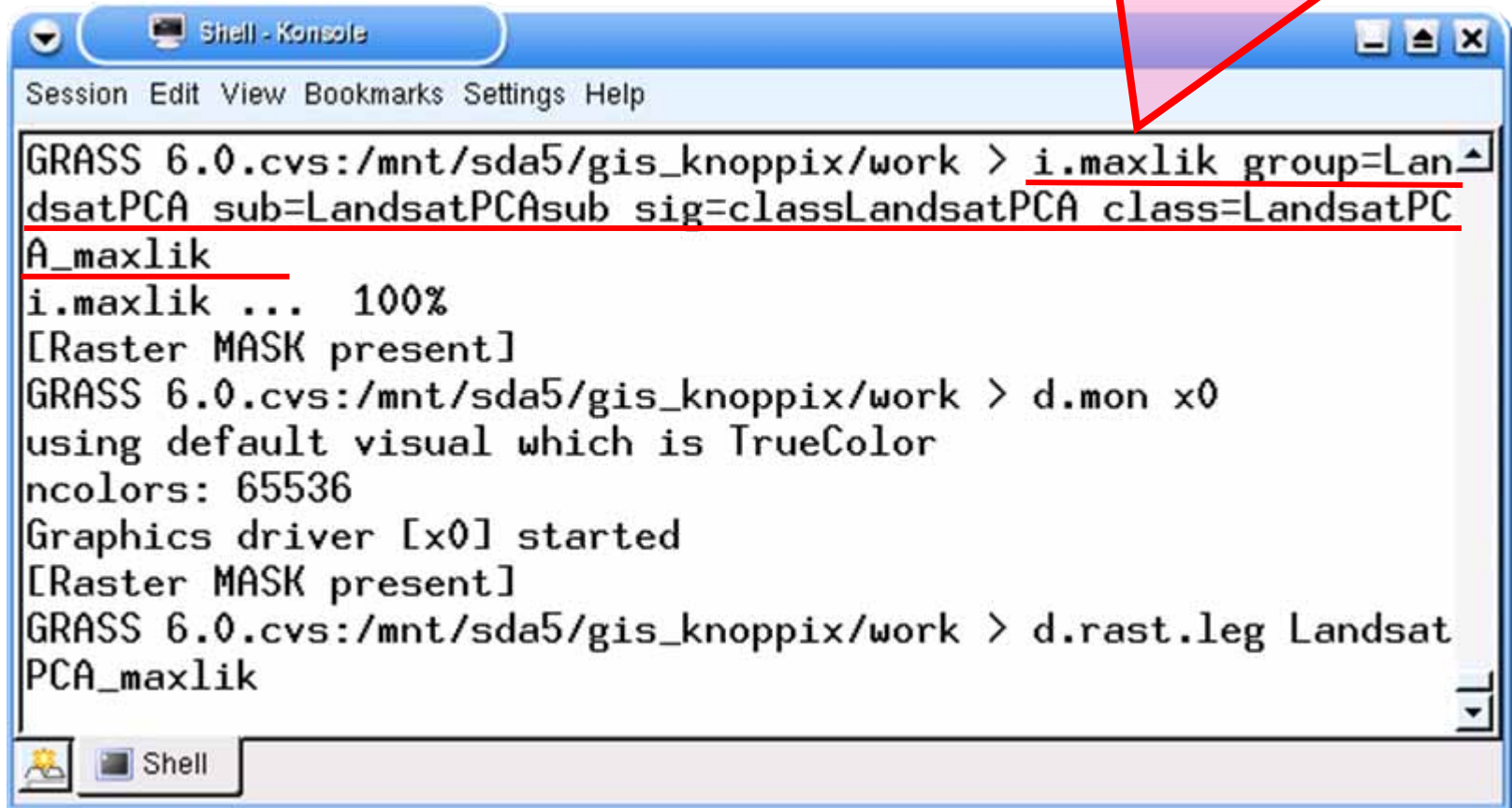


The screenshot shows a terminal window titled "Shell - Konsole" with a menu bar containing "Session", "Edit", "View", "Bookmarks", "Settings", and "Help". The terminal displays the command `i.cluster group=LandsatPCA sub=LandsatPCAsub sig=classLandsatPCA classes=10` and its output. The output indicates that the image was read successfully (100%) and then shows 14 iterations of the clustering process. Each iteration reports a convergence percentage that increases from 55.71% to 98.17%. The terminal also shows "[Raster MASK present]" at the bottom of the output.

```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > i.cluster group=LandsatPCA sub=LandsatPCAsub sig=classLandsatPCA classes=10
Reading image ... 100%
Iteration 1: %Convergence 55.71 (0s elapsed, 0s left)
Iteration 2: %Convergence 76.03 (0s elapsed, 0s left)
Iteration 3: %Convergence 91.26 (0s elapsed, 0s left)
Iteration 4: %Convergence 94.31 (0s elapsed, 0s left)
Iteration 5: %Convergence 94.79 (0s elapsed, 0s left)
Iteration 6: %Convergence 95.67 (0s elapsed, 0s left)
Iteration 7: %Convergence 96.22 (0s elapsed, 0s left)
Iteration 8: %Convergence 96.65 (0s elapsed, 0s left)
Iteration 9: %Convergence 97.04 (0s elapsed, 0s left)
Iteration 10: %Convergence 97.35 (0s elapsed, 0s left)
Iteration 11: %Convergence 97.50 (0s elapsed, 0s left)
Iteration 12: %Convergence 97.84 (0s elapsed, 0s left)
Iteration 13: %Convergence 97.99 (0s elapsed, 0s left)
Iteration 14: %Convergence 98.17 (0s elapsed, 0s left)
[Raster MASK present]
```



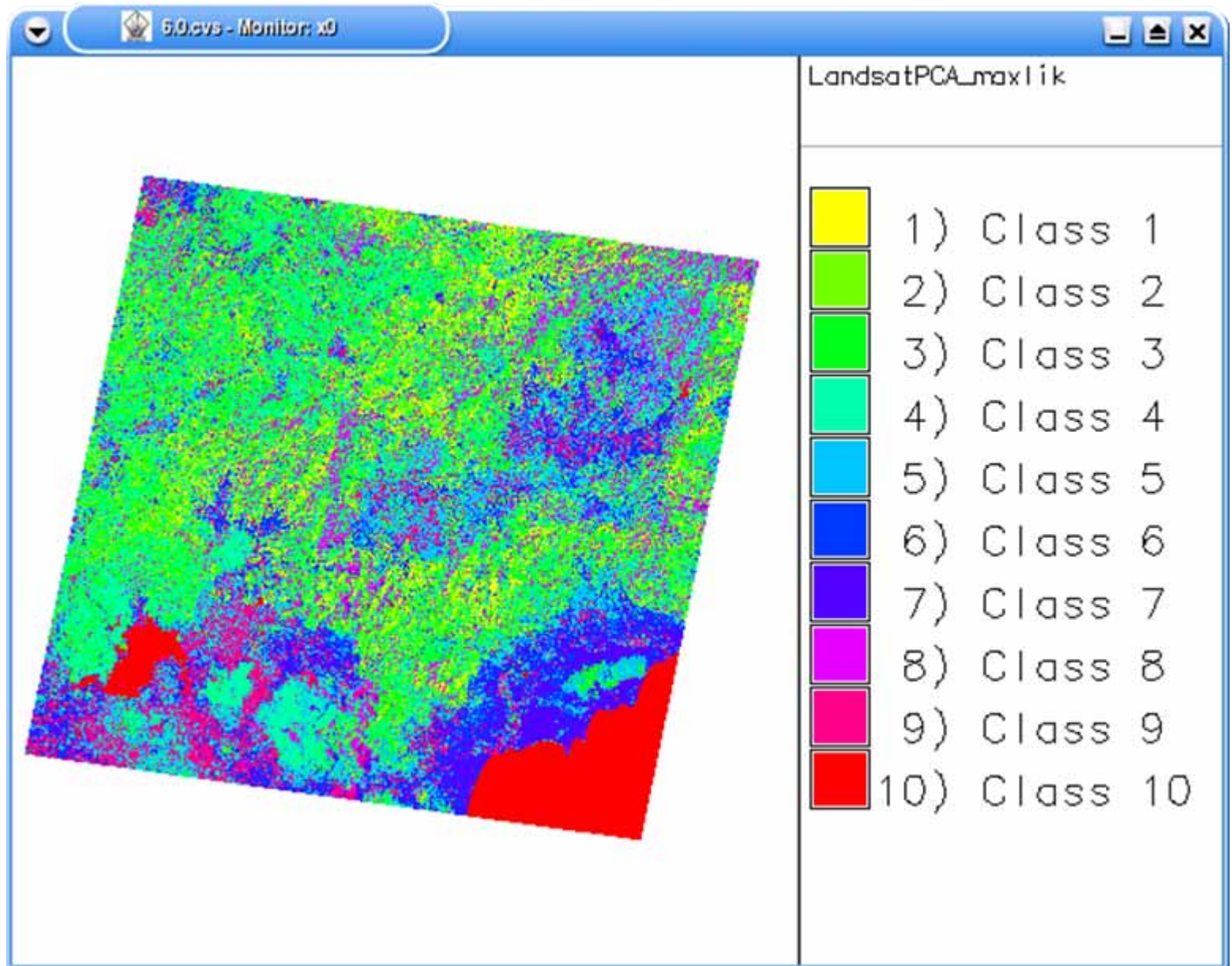
Classify images by Maximum Likelihood method



The screenshot shows a terminal window titled "Shell - Konsole" with a menu bar containing "Session", "Edit", "View", "Bookmarks", "Settings", and "Help". The terminal text is as follows:

```
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > i.maxlik group=LandsatPCA  
sub=LandsatPCAsub sig=classLandsatPCA class=LandsatPCA  
A_maxlik  
i.maxlik ... 100%  
[Raster MASK present]  
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.mon x0  
using default visual which is TrueColor  
ncolors: 65536  
Graphics driver [x0] started  
[Raster MASK present]  
GRASS 6.0.cvs:/mnt/sda5/gis_knoppix/work > d.rast.legend LandsatPCA_maxlik
```

The command line and the output file name "A\_maxlik" are underlined in red. The terminal window has a taskbar at the bottom with a "Shell" icon and label.



## **Section 2. Data Processing in UTM Coordinate System**

# **Reference**

1. GRASS GIS 6.2.4cvs Reference Manual  
[http://grass.itc.it/grass62/manuals/html62\\_user/index.html](http://grass.itc.it/grass62/manuals/html62_user/index.html)
2. Introduction to GIS, Dr. Kenlo NASAHARA (NISHIDA, maiden name),  
Tsukuba University, Japan  
<http://ryuiki.agbi.tsukuba.ac.jp/~nishida/lecture/07-GIS/>
3. Remote Sensing Image Processing using GRASS , Dr. Junichi SUSAKI,  
Kyoto University, Japan  
<http://www.envinfo.uee.kyoto-u.ac.jp/user/susaki/>
4. Markus Neteler and Helena Mitasova, Open source GIS  
– A GRASS GIS approach – Third edition, Springer 2008
5. GDF Hannover: GRASS 6 Course material  
<http://www.gdf-hannover.de/media.php?id=0&lg=en>

# **Appendix A**

## **GRASS command list**

***r.in.bin*** : Import a binary raster file into a GRASS raster map layer.

## SYNOPSIS

**r.in.bin** [-sdbh] **input**=*string* **output**=*name* [**title**=*"phrase"*] [**bytes**=*integer*]  
[**north**=*float*] [**south**=*float*] [**east**=*float*] [**west**=*float*] [**rows**=*float*] [**cols**=*float*]  
[**anull**=*float*] [--**overwrite**]

Flags:

- s** Signed data (high bit means negative value)
- f** Import as Floating Point Data (default: Integer)
- d** Import as Double Precision Data (default: Integer)
- b** Byte Swap the Data During Import
- h** Get region info from GMT style header
- overwrite** Force overwrite of output files

Parameters:

|                                |  |
|--------------------------------|--|
| <b>input</b> = <i>string</i>   | Bin raster file to be imported                   |
| <b>output</b> = <i>name</i>    | Name for output raster map                       |
| <b>title</b> = <i>"phrase"</i> | Title for resultant raster map                   |
| <b>bytes</b> = <i>integer</i>  | Number of bytes per cell (1, 2, 4) Default: 1    |
| <b>north</b> = <i>float</i>    | Northern limit of geographic region (outer edge) |
| <b>south</b> = <i>float</i>    | Southern limit of geographic region (outer edge) |
| <b>east</b> = <i>float</i>     | Eastern limit of geographic region (outer edge)  |
| <b>west</b> = <i>float</i>     | Western limit of geographic region (outer edge)  |
| <b>rows</b> = <i>float</i>     | Number of rows                                   |
| <b>cols</b> = <i>float</i>     | Number of columns                                |
| <b>anull</b> = <i>float</i>    | Set Value to NULL                                |

***r.in.gdal*** : Import GDAL supported raster file into a binary raster map layer.

## SYNOPSIS

**r.in.gdal** [-oefk] **input**=*string* **output**=*name* [**band**=*integer*] [**target**=*string*]  
[**title**=*"phrase"*] [**location**=*string*] [--**overwrite**]

Flags:

- o**      Override projection (use location's projection)
- e**      Extend location extents based on new dataset
- f**      List supported formats then exit
- k**      Keep band numbers instead of using band color names
- overwrite**      Force overwrite of output files

Parameters:

|                                 |   |
|---------------------------------|---|
| <b>input</b> = <i>string</i>    | Raster file to be imported  |
| <b>output</b> = <i>name</i>     | Name for output raster map  |
| <b>band</b> = <i>integer</i>    | Band to select (default is all bands)                               |
| <b>target</b> = <i>string</i>   | Name of location to read projection from<br>for GCPs transformation |
| <b>title</b> = <i>"phrase"</i>  | Title for resultant raster map                                      |
| <b>location</b> = <i>string</i> | Name for new location to create                                     |



***g.list*** : Lists available GRASS data base files of the user-specified data type to standard output.

## SYNOPSIS

**g.list** [-f] **type**=*datatype* [**mapset**=*string*]

Flags:           **-f**           verbose listing (also list map titles)

Parameters:   **type**=*datatype*           data type  
  Options: *rast,rast3d,vect,oldvect,asciivect,icon*  
  *labels,sites,region,region3d,group,3dview*  
              **mapset**=*string*           mapset to list (default: current search path)

***d.mon*** : To establish and control use of a graphics display monitor.

## SYNOPSIS

**d.mon** [-**ILprs**] [**start**=*string*] [**stop**=*string*] [**select**=*string*] [**unlock**=*string*]

Flags:

- l** List all monitors
- L** List all monitors (with current status)
- p** Print name of currently selected monitor
- r** Release currently selected monitor
- s** Do not automatically select when starting

Parameters:

|                               |                                    |
|-------------------------------|------------------------------------|
| <b>start</b> = <i>string</i>  | Name of graphics monitor to start  |
| <b>stop</b> = <i>string</i>   | Name of graphics monitor to stop   |
| <b>select</b> = <i>string</i> | Name of graphics monitor to select |
| <b>unlock</b> = <i>string</i> | Name of graphics monitor to unlock |

***d.rast*** : Displays and overlays raster map layers in the active display frame on the graphics monitor

## SYNOPSIS

**d.rast** [-oix] **map**=*string* [**catlist**=*cat*[-*cat*][,*cat*[-*cat*],...]] [**vallist**=*val*[-*val*][,*val*[-*val*],...]] [**bg**=*color*]

Flags:

- o**     Overlay (non-null values only)
- i**     Invert catlist
- x**     Don't add to list of rasters and commands in monitor

Parameters:

- map**=*string*     Raster map to be displayed
- catlist**=*cat*[-*cat*][,*cat*[-*cat*],...]  
                    List of categories to be displayed (INT maps)
- vallist**=*val*[-*val*][,*val*[-*val*],...]  
                    List of values to be displayed (FP maps)
- bg**=*color*     Background color (for null)  
                    Options: *white,black,red,green,blue,yellow,magenta,*  
                              *cyan,aqua,grey,gray,orange,brown,purple,*  
                              *violet,indigo*

***r.colors*** : Creates/Modifies the color table associated with a raster map layer .

## SYNOPSIS

**r.colors** [-wql] **map**=*name* [**color**=*type*] [**rast**=*string*] [**rules**=*string*]

Flags:

|           |                           |
|-----------|---------------------------|
| <b>-w</b> | Keep existing color table |
| <b>-q</b> | Quietly                   |
| <b>-l</b> | List rules                |

Parameters:    **map**=*name*                      Name of input raster map  
                   **color**=*type*                      Type of color table  
    Options: *aspect, grey, grey.eq, grey.log, byg, byr, gyr, rainbow, ramp, random, ryg, wave, rules*  
    **aspect**: aspect oriented grey colors  
    **grey**: linear grey scale  
    **grey.eq**: histogram equalized grey scale  
    **grey.log**: histogram logarithmic transformed  
    grey scale  
    **byg**: blue through yellow to green colors  
    **byr**: blue through yellow to red colors  
    **gyr**: green through yellow to red colors  
    **rainbow**: rainbow color table  
    **ramp**: color ramp  
    **random**: random color table  
    **ryg**: red through yellow to green colors  
    **wave**: color wave  
    **rules**: create new color table by rules  
                   **rast**=*string*                      Raster map name from which to copy color table  
                   **rules**=*string*                      Name of predefined rules file  
    Options: *aspect, terrain, gyr, slope, elevation, grey, ramp, bcyr, evi, srtm, ryg, rainbow, wave, population, byr, ndvi, etopo2, byg*

***r.report*** : Reports statistics for raster map layers.

## SYNOPSIS

**r.report** [-hfqenNCi] **map**=string[,string,...] [**units**=string[,string,...]]  
[**null**=string] [**pl**=integer] [**pw**=integer] [**output**=string] [**nsteps**=integer]

Flags:

- h** Suppress page headers
- f** Use formfeeds between pages
- q** Quiet
- e** Scientific format
- n** Filter out all no data cells
- N** Filter out cells where all maps have no data
- C** Report for cats fp ranges (fp maps only)
- i** Read fp map as integer (use map's quant rules)

Parameters:

|                                   |  |            |
|-----------------------------------|--|------------|
| <b>map</b> =string[,string,...]   | Raster map(s) to report on   |            |
| <b>units</b> =string[,string,...] | mi(les),me(ters),k(ilometers),a(cres),h(ectares),<br>c(ell_counts),p(ercent_cover) |            |
| <b>null</b> =string               | Character representing no data cell value  | Default: * |
| <b>pl</b> =integer                | Page length (default: 0 lines)   |            |
| <b>pw</b> =integer                | Page width (default: 79 characters)  |            |
| <b>output</b> =string             | Name of an output file to hold the report  |            |
| <b>nsteps</b> =integer            | Number of fp subranges to collect stats from                                       |            |
|                                   | Default: 255   |            |

**d.zoom** : Allows the user to change the current geographic region settings interactively, with a mouse..

## SYNOPSIS

**d.zoom** [-fphjr] **rast**=string[,string,...] [**vector**=string[,string,...]] [**zoom**=float]

## Flags:

- f Full menu (zoom + pan) & Quit menu
- p Pan mode
- h Handheld mode
- j Just redraw given maps using default colors
- r Return to previous zoom

## Parameters:

**rast**=string[,string,...] Name of raster map

**vector**=string[,string,...] Name of vector map

**zoom**=float      magnification: >1.0 zooms in, <1.0 zooms out  
Options: 0.001-1000.0  
Default: 0.75



# ***g.region***

: Program to manage the boundary definitions for the geographic region.

## SYNOPSIS

```
g.region [-dplecmau3gb] [region=name] [rast=name[,name,...]] [rast3d=name]
[vect=name] [3dview=name] [n=value] [s=value] [e=value] [w=value] [t=value]
[b=value] [res=value] [res3=value] [nsres=value] [ewres=value] [tbres=value]
[zoom=name] [align=name] [save=name] [--overwrite]
```

Flags:

- d** Set from default region
- p** Print the current region
- l** Print the current region in lat/long on current ellipsoid/datum
- e** Print the current region extent
- c** Print the current region map center coordinates
- m** Print region resolution in meters (geodesic)
- a** Align region to resolution (default = align to bounds, works only for 2D resolution )
- u** Do not update the current region
- 3** Print also 3D settings
- g** Print the current region (shell script style)
- b** Print the maximum bounding box in lat/long on WGS84 (-g mode only)
- overwrite** Force overwrite of output files

Parameters:

|                                      |   |
|--------------------------------------|---|
| <b>region</b> = <i>name</i>          | Set current region from named region                              |
| <b>rast</b> = <i>name[,name,...]</i> | Set region to match this raster map                               |
| <b>rast3d</b> = <i>name</i>          | Set region to match this 3D raster map<br>(both 2D and 3D values) |
| <b>vect</b> = <i>name</i>            | Set region to match this vector map                               |
| <b>3dview</b> = <i>name</i>          | Set region to match this 3dview file                              |
| <b>n</b> = <i>value</i>              | Value for the northern edge (format dd:mm:ss{N S})                |
| <b>s</b> = <i>value</i>              | Value for the southern edge (format dd:mm:ss{N S})                |
| <b>e</b> = <i>value</i>              | Value for the eastern edge (format ddd:mm:ss{E W})                |
| <b>w</b> = <i>value</i>              | Value for the western edge (format ddd:mm:ss{E W})                |
| <b>t</b> = <i>value</i>              | Value for the top edge  |
| <b>b</b> = <i>value</i>              | Value for the bottom edge   |
| <b>res</b> = <i>value</i>            | Grid resolution 2D (both north-south and east-west)               |
| <b>res3</b> = <i>value</i>           | 3D grid resolution (north-south, east-west and top-bottom)        |
| <b>nsres</b> = <i>value</i>          | North-south grid resolution 2D (format dd:mm:ss)                  |
| <b>ewres</b> = <i>value</i>          | East-west grid resolution 2D (format dd:mm:ss)                    |
| <b>tbres</b> = <i>value</i>          | Top-bottom grid resolution 3D                                     |
| <b>zoom</b> = <i>name</i>            | Raster map to zoom into   |
| <b>align</b> = <i>name</i>           | Raster map to align to  |
| <b>save</b> = <i>name</i>            | Save the current region to region definition file                 |

**d.legend** : Displays a legend for a raster map in the active frame of the graphics monitor.

## SYNOPSIS

**d.legend** [-vcnsmf] **map**=*string* [**color**=*string*] [**lines**=*integer*] [**thin**=*integer*]  
[**labelnum**=*integer*] [**at**=*bottom,top,left,right*] [**use**=*catnum[,catnum,...]*] [**range**=*min,max*]

Flags:

- v** Do not show category labels
- c** Do not show category numbers
- n** Skip categories with no label
- s** Draw smooth gradient
- m** Use mouse to size & place legend
- f** Flip legend

Parameters:

|                               |  |
|-------------------------------|--|
| <b>map</b> = <i>string</i>    | Name of raster map   |
| <b>color</b> = <i>string</i>  | Sets the legend's text color<br>Options: <i>red,orange,yellow,green,blue,indigo,violet,white,black,gray,brown,magenta,aqua,grey,cyan,purple</i><br>Default: <i>black</i> |
| <b>lines</b> = <i>integer</i> | Number of text lines (useful for truncating long legends)<br>Options: <i>0-1000</i> Default: <i>0</i>  |
| <b>thin</b> = <i>integer</i>  | Thinning factor (thin=10 gives cats 0,10,20...)<br>Options: <i>1-1000</i> Default: <i>1</i>  |

**labelnum**=*integer*      Number of text labels for smooth gradient legend  
Options: 2-100      Default: 5

**at**=*bottom,top,left,right*      Screen coordinates to place the legend  
(as percentage)      Options: 0-100

**use**=*catnum[,catnum,...]*      List of discrete category numbers/values  
for legend

**range**=*min,max*      Use a subset of the map range for the legend (min,max)

***d.rast.leg*** : Displays a raster map and its legend on a graphics window

## SYNOPSIS

**d.rast.leg** [-n] **map**=*string* [**num\_of\_lines**=*integer*]

## Flags:

**-n**     omit entries with missing label

## Parameters:

**map**=*string*     raster input map

**num\_of\_lines**=*integer*     Number of lines to appear in the legend

***d.histogram*** : Displays a histogram in the form of a pie or bar chart for a user-specified raster file.

## SYNOPSIS

**d.histogram** [-nqC] **map**=*string* [**color**=*string*] [**style**=*string*] [**nsteps**=*integer*]

Flags:

- n** Display information for null cells
- q** Gather the histogram quietly
- C** Report for ranges defined in cats file (fp maps only)

Parameters:

|                                |  |
|--------------------------------|--|
| <b>map</b> = <i>string</i>     | Raster map for which histogram will be displayed   |
| <b>color</b> = <i>string</i>   | Color for legend and title<br>Options: <i>red,orange,yellow,green,blue,indigo,violet,white,black,gray,brown,magenta,aqua,grey,cyan,purple</i><br>Default: <i>black</i> |
| <b>style</b> = <i>string</i>   | Indicate if a pie or bar chart is desired Default: <i>bar</i>  |
| <b>nsteps</b> = <i>integer</i> | Number of steps to divide the data range into (fp maps only)   |
| Default: 255                   |  |

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

## SYNOPSIS

**d.grid** [-gwnbt] **size**=*value* [**color**=*string*] [**origin**=*easting,northing*]  
[**bordercolor**=*string*]

Flags:

- g** Draw geographic grid (referenced to current ellipsoid)
- w** Draw geographic grid (referenced to WGS84 ellipsoid)
- n** Disable grid drawing
- b** Disable border drawing
- t** Disable text drawing

Parameters:

|   |   |
|---|---|
| <b>size</b> = <i>value</i>              | Size of grid to be drawn  |
| <b>color</b> = <i>string</i>            | Sets the grid color, either a standard GRASS color or<br>R:G:B triplet (separated by colons) Default: <i>gray</i> |
| <b>origin</b> = <i>easting,northing</i> | Lines of the grid pass through this coordinate<br>Default: <i>0,0</i>   |
| <b>bordercolor</b> = <i>string</i>      | Sets the border color, either a standard GRASS color<br>or R:G:B triplet Default: <i>brown</i>                    |

***d.erase*** : Erase the contents of the active display frame  
with user defined color .

## SYNOPSIS

**d.erase** [-f] [**color**=*string*]

Flags:           **-f**     Remove all frames and erase the screen  
                 **-x**     Don't add to list of commands in monitor

Parameters:    **color**=*string*     Color to erase with, either a standard GRASS color  
                                      or R:G:B triplet (separated by colons)  
                                      Default: *white*



***v.external*** : Create a new vector as a read-only link to OGR layer.

Available drivers: GRASS,ESRI Shapefile,MapInfo File,UK .NTF,SDTS,  
TIGER,S57,DGN,VRT,AVCBin,REC,Memory,CSV,GML,  
KML,GMT,SQLite,ODBC,PGeo,PostgreSQL,MySQL

## SYNOPSIS

**v.external** *dsn=string* [**output=***name*] [**layer=***string*] [--**overwrite**]

Flags:           **--overwrite**      Force overwrite of output files

Parameters:    **dsn=***string*            OGR datasource name.

Examples:

ESRI Shapefile: directory containing shapefiles

MapInfo File: directory containing mapinfo files

**output=***name*      Output vector, if not given, available layers are  
printed only

**layer=***string*      OGR layer name. If not given, available layers are  
printed only.

Examples:

ESRI Shapefile: shapefile name

MapInfo File: mapinfo file name

***v.in.ascii*** : Convert GRASS ascii file or points file to binary vector .

## SYNOPSIS

**v.in.ascii** [-ztenb] [input=*string*] output=*name* [format=*string*] [fs=*string*]  
[skip=*integer*] [columns=*string*] [x=*integer*] [y=*integer*] [z=*integer*]  
[cat=*integer*] [--overwrite]

Flags:

- z** Create 3D file
- t** Do not create table in points mode
- e** Create a new empty map and exit. Nothing is read from input.
- n** Don't expect a header when reading in standard format
- b** Do not build topology in points mode
- overwrite** Force overwrite of output files

Parameters:

|                               |   |
|-------------------------------|---|
| <b>input</b> = <i>string</i>  | ASCII file to be converted to binary vector file,<br>if not given reads from standard input       |
| <b>output</b> = <i>name</i>   | Name for output vector map  |
| <b>format</b> = <i>string</i> | Input file format<br>Options: <i>point,standard</i> Default: <i>point</i>                         |
| <b>fs</b> = <i>string</i>     | Field separator Default: <i>/</i>   |
| <b>skip</b> = <i>integer</i>  | Number of header lines to skip at top of input file<br>(written to map history) Default: <i>0</i> |

|                                |  |
|--------------------------------|--|
| <b>columns</b> = <i>string</i> | Columns definition for points mode in SQL style, for example:<br>'x double precision, y double precision, cat int, name varchar(10)'                             |
| <b>x</b> = <i>integer</i>      | Number of column used as x coordinate (first column is 1) for points mode Default: 1   |
| <b>y</b> = <i>integer</i>      | Number of column used as y coordinate (first column is 1) for points mode Default: 2   |
| <b>z</b> = <i>integer</i>      | Number of column used as z coordinate (first column is 1) for points mode. If 0, z coordinate is not used. Default: 0  |
| <b>cat</b> = <i>integer</i>    | Number of column used as category (first column is 1) for points mode. If 0, unique category is assigned to each row and written to new column 'cat'. Default: 0 |

|             |                              |   |
|-------------|------------------------------|---|
| Parameters: | <b>map</b> = <i>name</i>     | Name of input raster map  |
|             | <b>color</b> = <i>type</i>   | Type of color table   |
|             |                              | Options: <i>aspect, grey, grey.eq, grey.log, byg, byr, gyr, rainbow, ramp, random, ryg, wave, rules</i>                                     |
|             |                              | <b>aspect</b> : aspect oriented grey colors   |
|             |                              | <b>grey</b> : linear grey scale   |
|             |                              | <b>grey.eq</b> : histogram equalized grey scale   |
|             |                              | <b>grey.log</b> : histogram logarithmic transformed grey scale  |
|             |                              | <b>byg</b> : blue through yellow to green colors  |
|             |                              | <b>byr</b> : blue through yellow to red colors  |
|             |                              | <b>gyr</b> : green through yellow to red colors   |
|             |                              | <b>rainbow</b> : rainbow color table  |
|             |                              | <b>ramp</b> : color ramp  |
|             |                              | <b>random</b> : random color table  |
|             |                              | <b>ryg</b> : red through yellow to green colors   |
|             |                              | <b>wave</b> : color wave  |
|             |                              | <b>rules</b> : create new color table by rules  |
|             | <b>rast</b> = <i>string</i>  | Raster map name from which to copy color table  |
|             | <b>rules</b> = <i>string</i> | Name of predefined rules file   |
|             |                              | Options: <i>aspect, terrain, gyr, slope, elevation, grey, ramp, bcyr, evi, srtm, ryg, rainbow, wave, population, byr, ndvi, etopo2, byg</i> |

***d.vect*** : Displays GRASS vector data in the active frame on the graphics monitor.

## SYNOPSIS

```
d.vect [-vacix] map=name [type=string[,string,...]] [display=string[,string,...]]  
[attrcol=string] [icon=string] [size=integer] [layer=integer] [cats=range]  
[where=sql_query] [width=integer] [wcolumn=string] [wscale=float] [color=string]  
[fcolor=string] [rgb_column=string] [llayer=integer] [lcolor=string] [bcolor=string]  
[bcolor=string] [lsize=integer] [font=string] [xref=string] [yref=string] [minreg=float]  
[maxreg=float]
```

Flags:

- v** Run verbosely
- a** Get colors from map table column (of form RRR:GGG:BBB)
- c** Random colors according to category number (or layer number if 'layer=-1' is given)
- i** Use values from 'cats' option as line ID
- x** Don't add to list of vectors and commands in monitor (it won't be drawn if the monitor is refreshed)

Parameters:

- map**=*name* Name of input vector map
- type**=*string[,string,...]* Type Options: *point,line,boundary,centroid,area,face*  
Default: *point,line,boundary,centroid,area,face*
- display**=*string[,string,...]* Display Options: *shape,cat,topo,dir,attr,zcoor*  
Default: *shape*
- attrcol**=*string* Name of column to be displayed
- icon**=*string* Point and centroid symbol Options:  
*basic/marker,basic/x,basic/point,basic/pushpin,basic/cross2,*  
*basic/star,basic/diamond,basic/octagon,basic/arrow2,basic/box,*  
*basic/arrow1,basic/circle,basic/triangle,basic/cross1,*  
*demo/smrk,demo/muchomurka,extra/compass,*  
*extra/fancy\_compass,extra/airport,extra/4pt\_star,extra/adcp,*  
*extra/dive\_flag,extra/alpha\_flag,extra/half-circle,extra/target*  
Default: *basic/x*
- size**=*integer* Icon size Default: 8
- layer**=*integer* Layer number. If -1, all layers are displayed. Default: 1
- cats**=*range* Category values Example: 1,3,7-9,13
- where**=*sql\_query* WHERE conditions of SQL statement without 'where' keyword. (example: income < 1000 and inhab >= 10000)
- width**=*integer* Line width Default: 0
- wcolumn**=*string* Name of column for line widths (these values will be scaled by wscale)
- wscale**=*float* Scale factor for wcolumn Default: 1

|             |                                   |  |   |
|-------------|-----------------------------------|--|---|
| Parameters: | <b>color</b> = <i>string</i>      | Line color   | Default: <i>black</i>   |
|             | <b>fcolor</b> = <i>string</i>     | Area fill color  | Default: <i>200:200:200</i>   |
|             | <b>rgb_column</b> = <i>string</i> | Name of color definition column (for use with -a flag)<br>Default: <i>GRASSRGB</i> |   |
|             | <b>llayer</b> = <i>integer</i>    | Layer for labels   | Default: <i>1</i>   |
|             | <b>lcolor</b> = <i>string</i>     | Label color  | Default: <i>red</i>   |
|             | <b>bgcolor</b> = <i>string</i>    | Label background color   | Default: <i>none</i>  |
|             | <b>bcolor</b> = <i>string</i>     | Label border color   | Default: <i>none</i>  |
|             | <b>lsize</b> = <i>integer</i>     | Label size (pixels)  | Default: <i>8</i>   |
|             | <b>font</b> = <i>string</i>       | Font name  | Options: <i>cyrilc,gothgbt,gothgrt,gothitt,greekc,greekcs,greekp,greeks,italicc,italiccs,italict,romanc,romanccs,romand,romans,romant,scriptc,scripts</i><br>Default: <i>romans</i> |
|             | <b>xref</b> = <i>string</i>       | Label horizontal justification   | Options: <i>left,center,right</i><br>Default: <i>left</i>   |
|             | <b>yref</b> = <i>string</i>       | Label vertical justification   | Options: <i>top,center,bottom</i><br>Default: <i>center</i>   |
|             | <b>minreg</b> = <i>float</i>      | Minimum region size (average from height and width) when map is displayed          |   |
|             | <b>maxreg</b> = <i>float</i>      | Maximum region size (average from height and width) when map is displayed          |   |

***v.to.rast*** : Converts a binary GRASS vector map layer into a GRASS raster map layer.

## SYNOPSIS

**v.to.rast** *input=name output=name [use=string] [column=name] [layer=integer] [value=float] [rows=integer] [--overwrite]*

Flags:           **--overwrite**       Force overwrite of output files

|             |                      |  |               |
|-------------|----------------------|--|---------------|
| Parameters: | <b>input=name</b>    | Name of input vector map                       |               |
|             | <b>output=name</b>   | Name for output raster map                     |               |
|             | <b>use=string</b>    | Source of raster values:                       |               |
|             |                      | attr - read values from attribute table        |               |
|             |                      | cat - use category values                      |               |
|             |                      | val - use value specified by value option      |               |
|             |                      | z - use z coordinate (points or contours only) |               |
|             |                      | dir - output as flow direction (lines only)    |               |
|             |                      | Options: <i>attr,cat,val,z,dir</i>             |               |
|             |                      | Default: <i>attr</i>                           |               |
|             | <b>column=name</b>   | Column name (type must be numeric)             |               |
|             | <b>layer=integer</b> | Layer number                                   | Default: 1    |
|             | <b>value=float</b>   | Raster value                                   | Default: 1    |
|             | <b>rows=integer</b>  | number of rows to hold in memory               | Default: 4096 |



***r.composite*** : Combines red, green and blue map layers into a single composite map layer .

## SYNOPSIS

**r.composite** [-dc] **red**=*string* **green**=*string* **blue**=*string* [**levels**=*integer*]  
[**lev\_red**=*integer*] [**lev\_green**=*integer*] [**lev\_blue**=*integer*] **output**=*string*  
[--overwrite]

Flags:

- d** Dither
- c** Use closest color
- overwrite** Force overwrite of output files

Parameters:

|                                   |   |                |
|-----------------------------------|---|----------------|
| <b>red</b> = <i>string</i>        | Name of raster map layer to be used for.        |                |
| <b>green</b> = <i>string</i>      | Name of raster map layer to be used for.        |                |
| <b>blue</b> = <i>string</i>       | Name of raster map layer to be used for.        |                |
| <b>levels</b> = <i>integer</i>    | Number of levels to be used for each component. |                |
|                                   | Options: 1-256                                  | Default: 32    |
| <b>lev_red</b> = <i>integer</i>   | Number of levels to be used for.                | Options: 1-256 |
| <b>lev_green</b> = <i>integer</i> | Number of levels to be used for.                | Options: 1-256 |
| <b>lev_blue</b> = <i>integer</i>  | Number of levels to be used for.                | Options: 1-256 |
| <b>output</b> = <i>string</i>     | Name of raster map to contain results .         |                |

***r.out.tiff*** : Exports a GRASS raster file to a 8/24bit TIFF image file at the pixel resolution of the currently defined region.

## SYNOPSIS

**r.out.tiff** [-ptlv] **input**=*string* **output**=*string* [**compression**=*string*]

Flags:

- p** TIFF Palette output (8bit instead of 24bit).
- t** Output TIFF world file
- l** Output Tiled TIFF
- v** Verbose mode.

Parameters:

|                                    |  |
|------------------------------------|--|
| <b>input</b> = <i>string</i>       | Existing raster file name                |
| <b>output</b> = <i>string</i>      | File name for new TIFF file.             |
| <b>compression</b> = <i>string</i> | TIFF file compression                    |
|                                    | Options: <i>none,packbit,deflate,lzw</i> |
|                                    | Default: <i>none</i>                     |

***d.what.rast*** : Allows the user to interactively query the category contents of multiple raster map layers at user specified locations within the current geographic region.

## SYNOPSIS

**d.what.rast** [-1tc] **map**=*name*[,*name*,...] [**fs**=*character*]

Flags:

- 1** Identify just one location
- t** Terse output. For parsing by programs
- c** Print out col/row for the entire map in grid resolution of the region

Parameters:

|   |                                   |
|---|-----------------------------------|
| <b>map</b> = <i>name</i> [, <i>name</i> ,...] | Name of existing raster map(s)    |
| <b>fs</b> = <i>character</i>                  | Field separator (terse mode only) |
|   | Default: :                        |

***r.mapcalc*** : performs arithmetic on raster map layers. New raster map layers can be created which are arithmetic expressions involving existing raster map layers, integer or floating point constants, and functions

operators in *r.mapcalc*

| Operator | Meaning                 | Type         | Priority |
|----------|-------------------------|--------------|----------|
| ^        | Exponent                | arithmetical | 5        |
| %        | Rate (Modulo)           | arithmetical | 4        |
| /        | Division                | arithmetical | 4        |
| *        | Multiplication          | arithmetical | 4        |
| +        | Addition                | arithmetical | 3        |
| -        | Subtraction             | arithmetical | 3        |
| ==       | equal                   | logical      | 2        |
| !=       | unequal                 | logical      | 2        |
| >        | greater than            | logical      | 2        |
| >=       | greater than or equal   | logical      | 2        |
| <        | less than               | logical      | 2        |
| <=       | less than or equal      | logical      | 2        |
| &&       | and                     | logical      | 1        |
|          | or                      | logical      | 1        |
| #        | pre-separation operator | arithmetical | -        |

## features in *r.mapcalc*

| Feature                 | Meaning   | Type           |
|-------------------------|---|----------------|
| abs(x)                  | return absolute value of x                        | *a             |
| atan(x)                 | inverse tangent of x (result is in degrees)       | F <sup>b</sup> |
| atan(x,y)               | inverse tangent of y/x (result is in degrees)     | F              |
| cos(x)                  | cosine of x (x is in degrees)                     | F              |
| double(x)               | convert x to double-precision floating point      | F              |
| eval([x,y,...]z)        | evaluate values of listed expr, pass results to z |                |
| exp(x)                  | exponential function of x                         | F              |
| exp(x,y)                | x to the power y                                  | F              |
| float(x)                | convert x to floating point                       | F              |
| graph(x,x1,y1[x2,y2..]) | convert the x to a y based on points in a graph   | F              |
| if                      | decision options:                                 | *              |
| if(x)                   | 1 if x not zero, 0 otherwise                      |                |
| if(x,a)                 | a if x not zero, 0 otherwise                      |                |
| if(x,a,b)               | a if x not zero, b otherwise                      |                |
| if(x,a,b,c)             | a if x > 0, b if x is zero, c if x < 0            |                |
| int(x)                  | convert x to integer [ truncates ]                |                |
| isnull(x)               | check if x = NULL                                 | I              |
| log(x)                  | natural log of x                                  | F              |
| log(x,b)                | log of x base b                                   | F              |
| max(x,y[,z...])         | largest value of those listed                     | *              |
| median(x,y[,z...])      | median value of those listed                      | *              |
| min(x,y[,z...])         | smallest value of those listed                    | *              |
| mode(x,y[,z...])        | mode value of those listed                        | *              |
| not(x)                  | 1 if x is zero, 0 otherwise                       |                |
| rand(a,b)               | random value between a and b                      |                |
| round(x)                | round x to nearest integer                        | I <sup>c</sup> |
| sin(x)                  | sine of x (x is in degrees)                       | F              |
| sqrt(x)                 | square root of x                                  | F              |
| tan(x)                  | tangent of x (x is in degrees)                    | F              |

internal variables in *r.mapcalc*

| Variable | Meaning                               |
|----------|---------------------------------------|
| row()    | current row of moving window          |
| col()    | current col of moving window          |
| x()      | current x-coordinate of moving window |
| y()      | current y-coordinate of moving window |
| ewres()  | current east-west resolution          |
| nsres()  | current north-south resolution        |
| null()   | NULL value                            |

***g.remove*** : Removes data base element files from the user's current mapset.

## SYNOPSIS

```
g.remove [rast=string[,string,...]] [rast3d=string[,string,...]] [vect=string[,string,...]]  
[oldvect=string[,string,...]] [asciivect=string[,string,...]] [icon=string[,string,...]]  
[labels=string[,string,...]] [sites=string[,string,...]] [region=string[,string,...]]  
[region3d=string[,string,...]] [group=string[,string,...]] [3dview=string[,string,...]]
```

|             |                                       |                                 |
|-------------|---------------------------------------|---------------------------------|
| Parameters: | <b>rast</b> =string[,string,...]      | rast file(s) to be removed      |
|             | <b>rast3d</b> =string[,string,...]    | rast3d file(s) to be removed    |
|             | <b>vect</b> =string[,string,...]      | vect file(s) to be removed      |
|             | <b>oldvect</b> =string[,string,...]   | oldvect file(s) to be removed   |
|             | <b>asciivect</b> =string[,string,...] | asciivect file(s) to be removed |
|             | <b>icon</b> =string[,string,...]      | icon file(s) to be removed      |
|             | <b>labels</b> =string[,string,...]    | labels file(s) to be removed    |
|             | <b>sites</b> =string[,string,...]     | sites file(s) to be removed     |
|             | <b>region</b> =string[,string,...]    | region file(s) to be removed    |
|             | <b>region3d</b> =string[,string,...]  | region3d file(s) to be removed  |
|             | <b>group</b> =string[,string,...]     | group file(s) to be removed     |
|             | <b>3dview</b> =string[,string,...]    | 3dview file(s) to be removed    |

***r.rescale.eq*** : Rescales histogram equalized the range of category values in a raster map layer.

## SYNOPSIS

**r.rescale.eq** [-q] **input**=*string* [**from**=*min,max*] **output**=*string* **to**=*min,max*  
[**title**=*"phrase"*] [--**overwrite**] **Flags:**

Flags:

|                    |                                 |
|--------------------|---------------------------------|
| <b>-q</b>          | Quiet                           |
| <b>--overwrite</b> | Force overwrite of output files |

Parameters:

|                                |   |
|--------------------------------|---|
| <b>input</b> = <i>string</i>   | The name of the raster map to be rescaled                                 |
| <b>from</b> = <i>min,max</i>   | The input data range to be rescaled<br>(default: full range of input map) |
| <b>output</b> = <i>string</i>  | The resulting raster map name   |
| <b>to</b> = <i>min,max</i>     | The output data range   |
| <b>title</b> = <i>"phrase"</i> | Title for new raster map  |



***r.univar*** : Calculates univariate statistics from the non-null cells of a raster map.

## SYNOPSIS

**r.univar** [-qg] **map**=*name*

## Flags:

**-q**     Quiet mode  
**-g**     Print the stats in shell script style

Parameters:    **map**=*name*        Name of input raster map

*r.univar* calculates univariate statistics of a raster map. This includes the number of cells counted, minimum and maximum cell values, range, arithmetic mean, population variance, standard deviation, and coefficient of variation.

***r.null*** : Creates explicitly the NULL-value bitmap file.

## SYNOPSIS

**r.null** [-fincr] **map**=string [**setnull**=val[-val][, val[-val],...]] [**null**=float]

Flags:

- f** Only do the work if the map is floating-point
- i** Only do the work if the map is integer
- n** Only do the work if the map doesn't have a NULL-value bitmap file
- c** create NULL-value bitmap file validating all data cells
- r** remove NULL-value bitmap file

Parameters:

|  |  |
|--|--|
| <b>map</b> =string                         | Raster map for which to edit null file |
| <b>setnull</b> =val[-val][, val[-val],...] | List of cell values to be set to NULL  |
| <b>null</b> =float                         | The value to replace the null value by |

***r.stats*** : Generates area statistics for raster map layers.

## SYNOPSIS

**r.stats** [-1AacplqnNgxCri] **input**=*string*[,*string*,...] [**fs**=*character*|*space*|*tab*]  
[**nv**=*string*] [**output**=*string*] [**nsteps**=*integer*]

Flags:

- 1 One cell (range) per line
- A Print averaged values instead of intervals
- a Print area totals
- c Print cell counts
- p Print APPROXIMATE percents (total percent may not be 100%)
- l Print category labels
- q Quiet
- n Suppress reporting of any NULLs
- N Suppress reporting of NULLs when all values are NULL
- g Print grid coordinates (east and north)
- x Print x and y (column and row)
- C Report for cats fp ranges (fp maps only)
- r Print raw indexes of fp ranges (fp maps only)
- i Read fp map as integer (use map's quant rules)

|             |   |  |                       |
|-------------|---|--|-----------------------|
| Parameters: | <b>input</b> = <i>string[,string,...]</i> | Raster input maps(s)                         |                       |
|             | <b>fs</b> = <i>character/space/tab</i>    | Output field separator                       | Default: <i>space</i> |
|             | <b>nv</b> = <i>string</i>                 | String representing no data cell value       |                       |
|             |   | Default: *                                   |                       |
|             | <b>output</b> = <i>string</i>             | Output file name                             |                       |
|             | <b>nsteps</b> = <i>integer</i>            | Number of fp subranges to collect stats from |                       |
|             |   | Default: 255                                 |                       |

***i.group*** : Creates and edits groups and subgroups of imagery files.

## SYNOPSIS

**i.group** [-rl] **group**=*string* [**subgroup**=*string*] [**input**=*string*[,*string*,...]]

Flags:

|           |  |
|-----------|--|
| <b>-r</b> | Remove selected files from specified group |
| <b>-l</b> | List files from specified (sub)group       |

Parameters:

|   |                                       |
|---|---------------------------------------|
| <b>group</b> = <i>string</i>                        | Name of imagery group                 |
| <b>subgroup</b> = <i>string</i>                     | Name of imagery sub-group             |
| <b>input</b> = <i>string</i> [, <i>string</i> ,...] | Name of raster(s) to include in group |

***i.gensig*** : Generates statistics for i.maxlik from raster map layer.

## SYNOPSIS

**i.gensig** **trainingmap=string** **group=string** **subgroup=string** **signaturefile=string**

|             |                             |                                 |
|-------------|-----------------------------|---------------------------------|
| Parameters: | <b>trainingmap=string</b>   | ground truth training map       |
|             | <b>group=string</b>         | imagery group                   |
|             | <b>subgroup=string</b>      | subgroup containing image files |
|             | <b>signaturefile=string</b> | resultant signature file        |

***i.maxlik*** : An imagery function that classifies the cell spectral reflectances in imagery data based on the spectral signature information generated by either `i.cluster`, `i.class`, or `i.gensig`.

## SYNOPSIS

**i.maxlik** [-q] **group**=*string* **subgroup**=*string* **sigfile**=*string* **class**=*string*  
[**reject**=*string*]

Flags:           **-q**     Run quietly

|             |                                 |  |
|-------------|---------------------------------|--|
| Parameters: | <b>group</b> = <i>string</i>    | Imagery group to be classified                   |
|             | <b>subgroup</b> = <i>string</i> | Subgroup containing image files to be classified |
|             | <b>sigfile</b> = <i>string</i>  | Signatures to use for classification             |
|             | <b>class</b> = <i>string</i>    | Raster map to hold classification results        |
|             | <b>reject</b> = <i>string</i>   | Raster map to hold reject threshold results      |

***r.digit*** : provides the user with a way to draw lines, areas, and circles on a monitor screen, and to save these features in a cell file

### **THE PROCESS:**

1. Choose to define an area or line, quit, or finish. If you quit, the session exits with nothing created. If you choose to finish (*done*), you will be prompted for a new map name; the new map is then created.
2. If you choose to make an area or line you must identify the category number for that area or line.
3. Using the mouse trace the line or circumscribe the area; or, finish (go to Step 1).



***i.cluster*** : An imagery function that generates spectral signatures for land cover types in an image using a clustering algorithm. The resulting signature file is used as input for i.maxlik, to generate an unsupervised image classification

## SYNOPSIS

**i.cluster** [-q] **group**=*string* **subgroup**=*string* **sigfile**=*string* **classes**=*integer*  
[**seed**=*string*] [**sample**=*row\_interval,col\_interval*] [**iterations**=*integer*]  
[**convergence**=*float*] [**separation**=*float*] [**min\_size**=*integer*] [**reportfile**=*string*]

Flags:           **-q**     Run quietly

## Parameters:

|  |  |                           |
|--|--|---------------------------|
| <b>group</b> = <i>string</i>                     | Group of imagery files to be clustered |                           |
| <b>subgroup</b> = <i>string</i>                  | Subgroup name in the above group       |                           |
| <b>sigfile</b> = <i>string</i>                   | File contains result signatures        |                           |
| <b>classes</b> = <i>integer</i>                  | Initial number of classes              | Options: 1-255            |
| <b>seed</b> = <i>string</i>                      | File contains initial signatures       |                           |
| <b>sample</b> = <i>row_interval,col_interval</i> | Sampling intervals (by row and col)    |                           |
|  |  | ; default: ~10,000 pixels |
| <b>iterations</b> = <i>integer</i>               | Maximum number of iterations           | Default: 30               |
| <b>convergence</b> = <i>float</i>                | Percent convergence                    | Options: 0-100            |
|  |  | Default: 98.0             |

**separation**=*float*

Cluster separation

Default: *0.0*

**min\_size**=*integer*

Minimum number of pixels in a class

Default: *17*

**reportfile**=*string*

Name of an output file to contain final report

***i.pca*** : Principal components analysis (pca) program for image processing.

## SYNOPSIS

**i.pca** **input**=*string*[,*string*,...] **output**=*string* [**rescale**=*min,max*] [--**overwrite**]

## Flags:

**--overwrite** Force overwrite of output files

## Parameters:

|   |   |
|---|---|
| <b>input</b> = <i>string</i> [, <i>string</i> ,...] | input layer name  |
| <b>output</b> = <i>string</i>                       | output layer name   |
| <b>rescale</b> = <i>min,max</i>                     | Rescaling range output (For no rescaling use 0,0)<br>Default: 0,255 |

***nviz*** : Visualization and animation tool for GRASS data.

# **Appendix B**

## **Conversion to Radiance**

## B.1 DN to Radiance conversion equation of Landsat7 ETM+

$$L = \frac{(L_{\max} - L_{\min}) * (DN - QCAL_{\min})}{QCAL_{\max} - QCAL_{\min}} + L_{\min}$$

L : Spectral radiance(W/m<sup>2</sup>sr μ m)

L<sub>min</sub> : Spectral radiance that is scaled to QCAL<sub>min</sub>

L<sub>max</sub> : Spectral radiance that is scaled to QCAL<sub>max</sub>

QCAL<sub>min</sub> : the minimum quantized calibrated pixel value  
(corresponding to L<sub>min</sub>) in DN  
= 1 for NLAPS products processed after 4/4/2004  
= 0 for NLAPS products processed before 4/5/2004

QCAL<sub>max</sub> : the maximum quantized calibrated pixel value  
(corresponding to L<sub>max</sub>) in DN  
= 255

## B.2 Extraction of conversion coefficients from meta file (header file)

open meta file, for example “p107r035\_7x20010924.met”,  
and find following descriptions

```
.....  
GROUP = L1G_PRODUCT_METADATA  
      BAND_COMBINATION = "123456678"  
      CPF_FILE_NAME = "L7CPF20010701_20010930_04"  
      GROUP = MIN_MAX_RADIANCE  
          LMAX_BAND1 = 191.600  
          LMIN_BAND1 = -6.200  
          LMAX_BAND2 = 196.500  
          LMIN_BAND2 = -6.400  
          LMAX_BAND3 = 152.900  
          LMIN_BAND3 = -5.000  
          LMAX_BAND4 = 241.100  
          LMIN_BAND4 = -5.100  
          LMAX_BAND5 = 31.060  
          LMIN_BAND5 = -1.000  
          LMAX_BAND61 = 17.040  
          LMIN_BAND61 = 0.000  
          LMAX_BAND62 = 12.650  
          LMIN_BAND62 = 3.200  
          LMAX_BAND7 = 10.800  
          LMIN_BAND7 = -0.350  
          LMAX_BAND8 = 243.100  
          LMIN_BAND8 = -4.700  
      END_GROUP = MIN_MAX_RADIANCE
```

(continue)

.....

GROUP = MIN\_MAX\_PIXEL\_VALUE

QCALMAX\_BAND1 = 255.0

QCALMIN\_BAND1 = 1.0

QCALMAX\_BAND2 = 255.0

QCALMIN\_BAND2 = 1.0

QCALMAX\_BAND3 = 255.0

QCALMIN\_BAND3 = 1.0

QCALMAX\_BAND4 = 255.0

QCALMIN\_BAND4 = 1.0

QCALMAX\_BAND5 = 255.0

QCALMIN\_BAND5 = 1.0

QCALMAX\_BAND61 = 255.0

QCALMIN\_BAND61 = 1.0

QCALMAX\_BAND62 = 255.0

QCALMIN\_BAND62 = 1.0

QCALMAX\_BAND7 = 255.0

QCALMIN\_BAND7 = 1.0

QCALMAX\_BAND8 = 255.0

QCALMIN\_BAND8 = 1.0

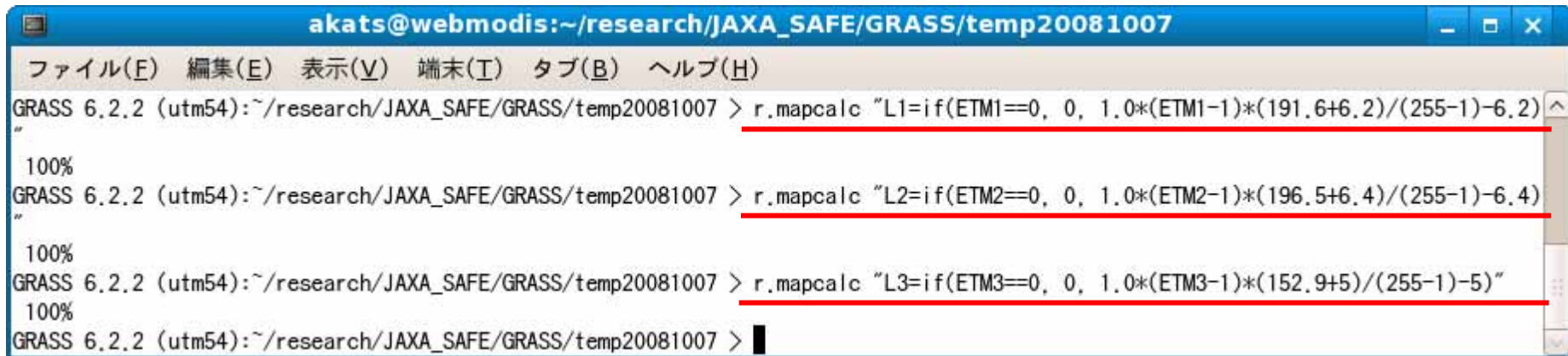
END\_GROUP = MIN\_MAX\_PIXEL\_VALUE

.....



## B.3 Calculation of radiance using “*r.mapcalc*”

```
> r.mapcalc "B =if(A==0, 0, 1.0*(A - QCALmin)*(Lmax - Lmin)/(QCALmax - QCALmin) + Lmin)"
```



The screenshot shows a terminal window titled "akats@webmodis:~/research/JAXA\_SAFE/GRASS/temp20081007". The window contains a menu bar with Japanese labels: ファイル(F), 編集(E), 表示(V), 端末(T), タブ(B), ヘルプ(H). The terminal output shows three sequential GRASS 6.2.2 commands, each followed by a progress bar reaching 100%.

```
akats@webmodis:~/research/JAXA_SAFE/GRASS/temp20081007
ファイル(F) 編集(E) 表示(V) 端末(T) タブ(B) ヘルプ(H)
GRASS 6.2.2 (utm54):~/research/JAXA_SAFE/GRASS/temp20081007 > r.mapcalc "L1=if(ETM1==0, 0, 1.0*(ETM1-1)*(191.6+6.2)/(255-1)-6.2)"
100%
GRASS 6.2.2 (utm54):~/research/JAXA_SAFE/GRASS/temp20081007 > r.mapcalc "L2=if(ETM2==0, 0, 1.0*(ETM2-1)*(196.5+6.4)/(255-1)-6.4)"
100%
GRASS 6.2.2 (utm54):~/research/JAXA_SAFE/GRASS/temp20081007 > r.mapcalc "L3=if(ETM3==0, 0, 1.0*(ETM3-1)*(152.9+5)/(255-1)-5)"
100%
GRASS 6.2.2 (utm54):~/research/JAXA_SAFE/GRASS/temp20081007 > █
```

```
akats@webmodis:~/research/JAXA_SAFE/GRASS/temp20081007
ファイル(F) 編集(E) 表示(V) 端末(T) タブ(B) ヘルプ(H)
GRASS 6.2.2 (utm54):~/research/JAXA_SAFE/GRASS/temp20081007 > r.colors map=L1 color=grey
Color table for [L1] set to grey
GRASS 6.2.2 (utm54):~/research/JAXA_SAFE/GRASS/temp20081007 > r.colors map=L2 color=grey
Color table for [L2] set to grey
GRASS 6.2.2 (utm54):~/research/JAXA_SAFE/GRASS/temp20081007 > r.colors map=L3 color=grey
Color table for [L3] set to grey
GRASS 6.2.2 (utm54):~/research/JAXA_SAFE/GRASS/temp20081007 > d.rgb blue=L1 green=L2 red=L3
100%
GRASS 6.2.2 (utm54):~/research/
```



R:G:B =  
Band3:Band2:Band1

# **Appendix C**

## **How to get Landsat images**

# Step1: Go to “GLCF: Earth Science Data Interface”

( <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp> )

The screenshot shows the GLCF Earth Science Data Interface (ESDI) web application. The browser window title is "GLCF: Earth Science Data Interface - Windows Internet Explorer". The address bar shows the URL "http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp". The page features a navigation bar with links: Home, Map Search, Product Search, Path/Row Search, Workspace, Login, Help, Contact Us, and GLCF. The main content area includes a welcome message, a description of the interface, and three search options: Map Search, Path/Row Search, and Product Search. A login section is also present on the right side.

**Welcome to the Earth Science Data Interface (ESDI) at the Global Land Cover Facility**

The Earth Science Data Interface is the GLCF's web application for searching, browsing, and downloading data from our online holdings. To start, click on one of the images below:

- Map Search**: A map of Brazil with a red rectangle highlighting a region in the southeast.
- Path/Row Search**: A table for searching data by path and row.
- Product Search**: A map of Brazil with a red rectangle highlighting a region in the southeast.

**ESDI Login**

Email:   
Password:   
**Submit** **Register**  
Lost password?

**What's new in ESDI?**

- No news at this time

[Older News...](#)

**Tips:**

- If you are looking for Landsat data, use the [Path/Row Search](#) if you know the paths and rows for your area of interest. You can also use the [Map Search](#) to browse and query using an interactive map. You must use the Map Search when looking for Landsat Mosaics.
- If you are looking for any of our MODIS or AVHRR derived products or other hosted products, use the [Product Search](#). Browse and query these data by supplying parameters through a simple interface. This method is much easier than using the Map Search.

**Other Links:**

- \*\*Help Us Help You!\*\***

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# Step2 : Click “ Map Search ”

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http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp

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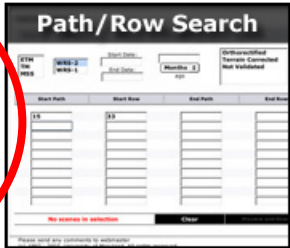

GLCF: Earth Science Data Interface

## Global Land Cover Facility Earth Science Data Interface

Home Map Search Product Search Path/Row Search Workspace Login Help Contact Us GLCF

### Welcome to the Earth Science Data Interface (ESDI) at the Global Land Cover Facility

The Earth Science Data Interface is the GLCF's web application for searching, browsing, and downloading data from our online holdings. To start, click on one of the images below:



**Click**

**Tips:**

- If you are looking for Landsat data, use the [Path/Row Search](#) if you know the paths and rows for your area of interest. You can also use the [Map Search](#) to browse and query using an interactive map. You must use the [Map Search](#) when looking for Landsat Mosaics.
- If you are looking for any of our MODIS or AVHRR derived products or other hosted products, use the [Product Search](#). Browse and query these data by supplying parameters through a simple interface. This method is much easier than using the [Map Search](#).

**Other Links:**

- **\*\*Help Us Help You!\*\***

Please send any comments to [glcf@umiacs.umd.edu](mailto:glcf@umiacs.umd.edu)  
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ESDI Login

Email:   
Password:   
**Submit Register**  
[Lost password?](#)

What's new in ESDI?

- No news at this time

[Older News...](#)

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GLCF: Earth Science Data Interface

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**No datasets selected**

**Landsat Imagery**

☐ ETM+  
☐ TM  
☐ MSS

**Other Imagery**

☐ ASTER

**Elevation Data**

☐ SRTM, Degree Tiles  
☐ SRTM, WRS2 Tiles  
☐ SRTM, GTOPO30  
☐ SRTM, GTOPO30 Mosaic

**MODIS Products**

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☐ 16-Day Vegetation Index  
☐ VCF, Regional  
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Date/Type Path/Row Lat/Long Place Draw Map Layers

500x250

**No images in selection** Preview & Download Update Map

Enter dates as mm/dd/yyyy or yyyy-mm-dd

Start Date: End Date:

# Step3 : Check boxes in “ Landsat Imagery ”

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No datasets selected

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- ☒ ETM+
- ☒ TM
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**Other Imagery**

- ☐ ASTER

**Elevation Data**

- ☐ SRTM, Degree Tiles
- ☐ SRTM, WRS2 Tiles
- ☐ SRTM, GTOPO30
- ☐ SRTM, GTOPO30 Mosaic

**MODIS Products**

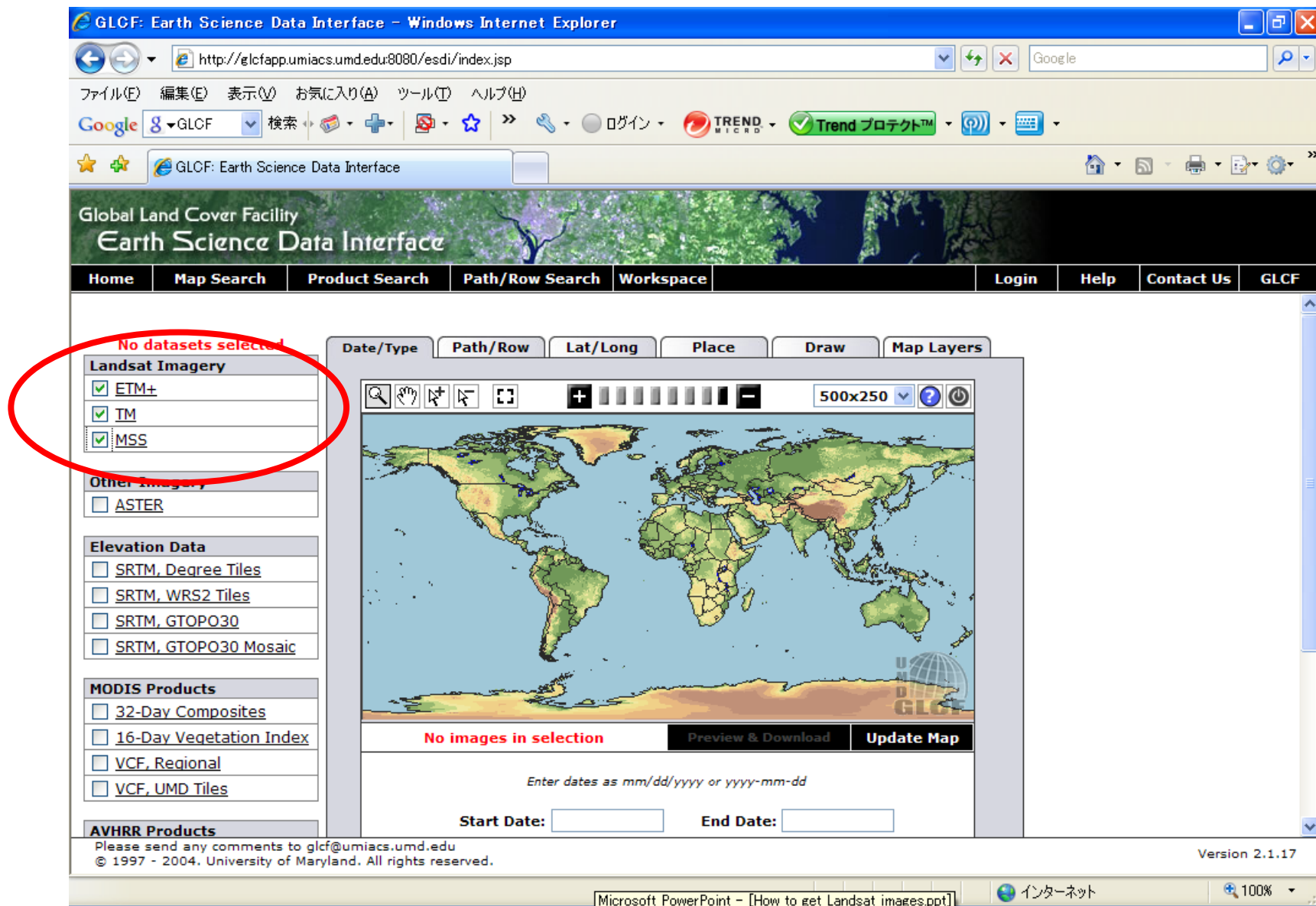
- ☐ 32-Day Composites
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# Step4 : Click “ Update Map ”

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**Landsat Imagery**

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- ☒ TM
- ☒ MSS

**Other Imagery**

- ☐ ASTER

**Elevation Data**

- ☐ SRTM, Degree Tiles
- ☐ SRTM, WRS2 Tiles
- ☐ SRTM, GTOPO30
- ☐ SRTM, GTOPO30 Mosaic

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GLCF: Earth Science Data Interface

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☒ TM

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**Elevation Data**

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☐ SRTM, WRS2 Tiles

☐ SRTM, GTOPO30

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☐ VCF, Regional

☐ VCF, UMD Tiles

**AVHRR Products**

Date/Type Path/Row Lat/Long Place Draw Map Layers

500x250

**No images in selection** Preview & Download Update Map

Enter dates as mm/dd/yyyy or yyyy-mm-dd

Start Date: End Date:

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# Step5 : Click to zoom up

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**Click**

**Landsat Imagery**

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- ☒ TM
- ☒ MSS

**Other Imagery**

- ☐ ASTER

**Elevation Data**

- ☐ SRTM, Degree Tiles
- ☐ SRTM, WRS2 Tiles
- ☐ SRTM, GTOPO30
- ☐ SRTM, GTOPO30 Mosaic

**MODIS Products**

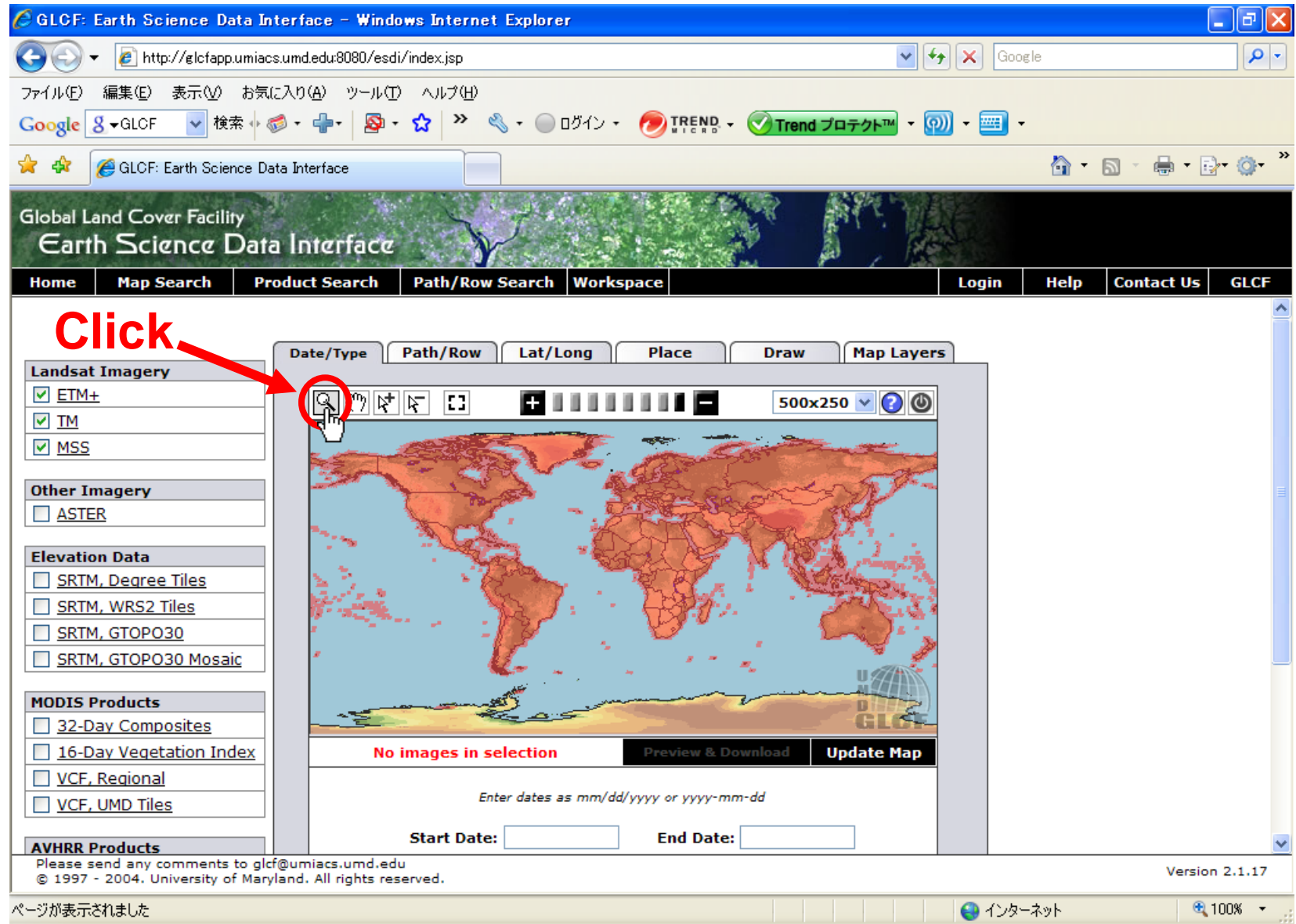
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# Step6 : Click the area you want to enlarge

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- ☒ ETM+
- ☒ TM
- ☒ MSS

**Other Imagery**

- ☐ ASTER

**Elevation Data**

- ☐ SRTM, Degree Tiles
- ☐ SRTM, WRS2 Tiles
- ☐ SRTM, GTOPO30
- ☐ SRTM, GTOPO30 Mosaic

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**Date/Type Path/Row Lat/Long Place Draw Map Layers**

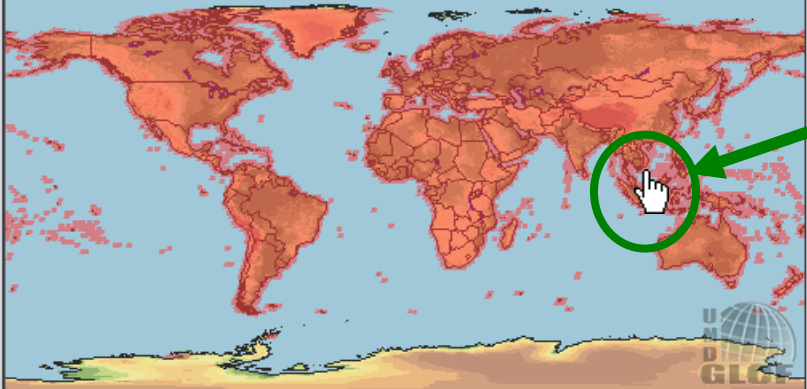
500x250

**Click**

No images in selection Preview & Download Update Map

Enter dates as mm/dd/yyyy or yyyy-mm-dd

Start Date: End Date:



# Repeat “Step6”

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- ☒ MSS

**Other Imagery**

- ☐ ASTER

**Elevation Data**

- ☐ SRTM, Degree Tiles
- ☐ SRTM, WRS2 Tiles
- ☐ SRTM, GTOPO30
- ☐ SRTM, GTOPO30 Mosaic

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**Date/Type Path/Row Lat/Long Place Draw Map Layers**

500x250

**Click**

No images in selection

Preview & Download Update Map

Enter dates as mm/dd/yyyy or yyyy-mm-dd

Start Date: End Date:

# Step7 : Click to select the area

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**Click**

Date/Type Path/Row Lat/Long Place Draw Map Layers

**Landsat Imagery**

- ☒ ETM+
- ☒ TM
- ☒ MSS

**Other Imagery**

- ☐ ASTER

**Elevation Data**

- ☐ SRTM, Degree Tiles
- ☐ SRTM, WRS2 Tiles
- ☐ SRTM, GTOPO30
- ☐ SRTM, GTOPO30 Mosaic

**MODIS Products**

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- ☐ 16-Day Vegetation Index
- ☐ VCF, Regional
- ☐ VCF, UMD Tiles

**AVHRR Products**

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500x250

No images in selection Preview & Download Update Map

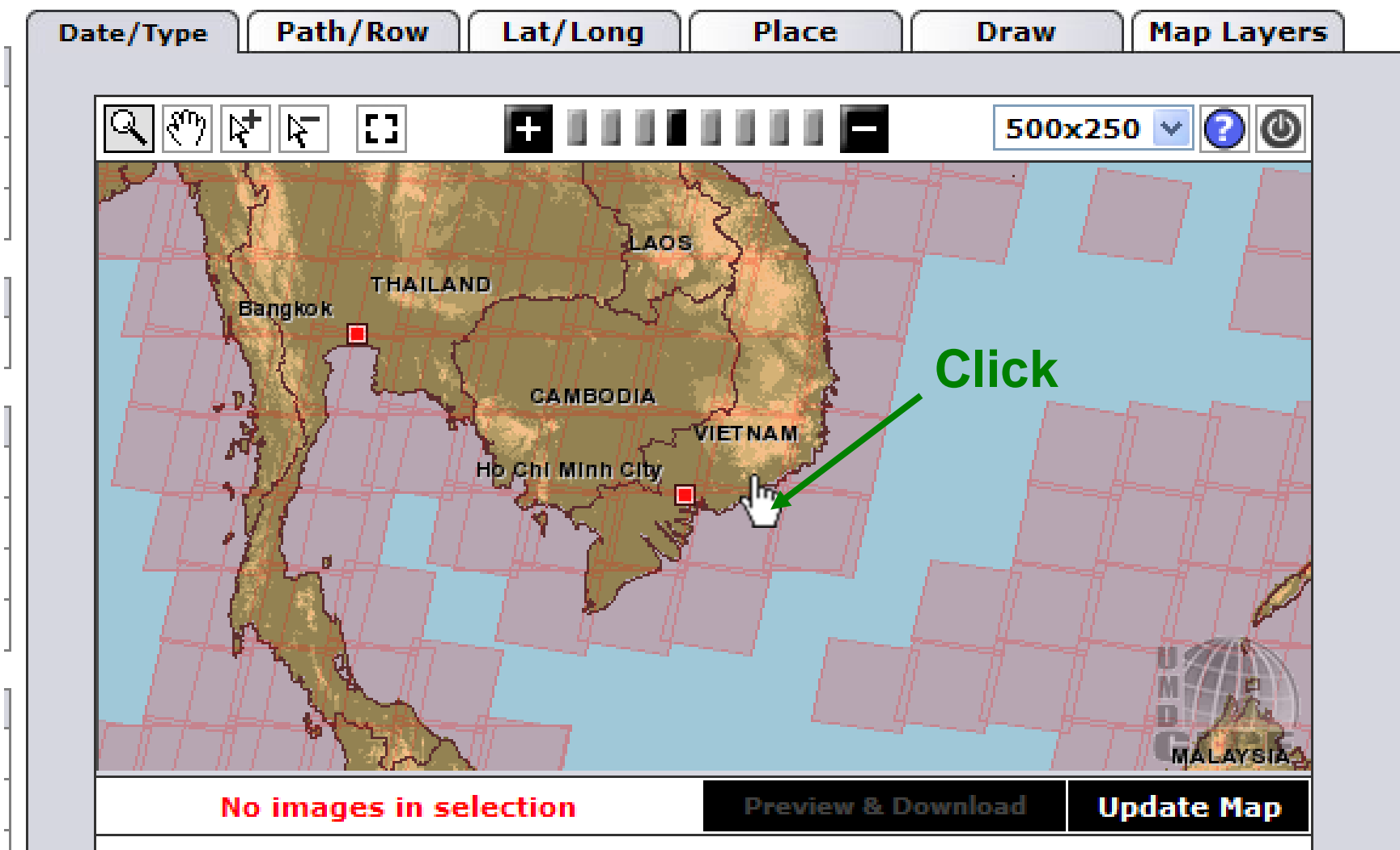
Enter dates as mm/dd/yyyy or yyyy-mm-dd

Start Date: End Date:

Version 2.1.17

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# Step8 : Search images

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**Landsat Imagery**

- ☒ ETM+
- ☒ TM
- ☒ MSS

**Other Imagery**

- ☐ ASTER

**Elevation Data**

- ☐ SRTM, Degree Tiles
- ☐ SRTM, WRS2 Tiles
- ☐ SRTM, GTOPO30
- ☐ SRTM, GTOPO30 Mosaic

**MODIS Products**

- ☐ 32-Day Composites
- ☐ 16-Day Vegetation Index
- ☐ VCF, Regional
- ☐ VCF, UMD Tiles

**AVHRR Products**

Date/Type Path/Row Lat/Long Place Draw Map Layers

500x250

5 image(s) in selection

**Preview & Download** Update Map

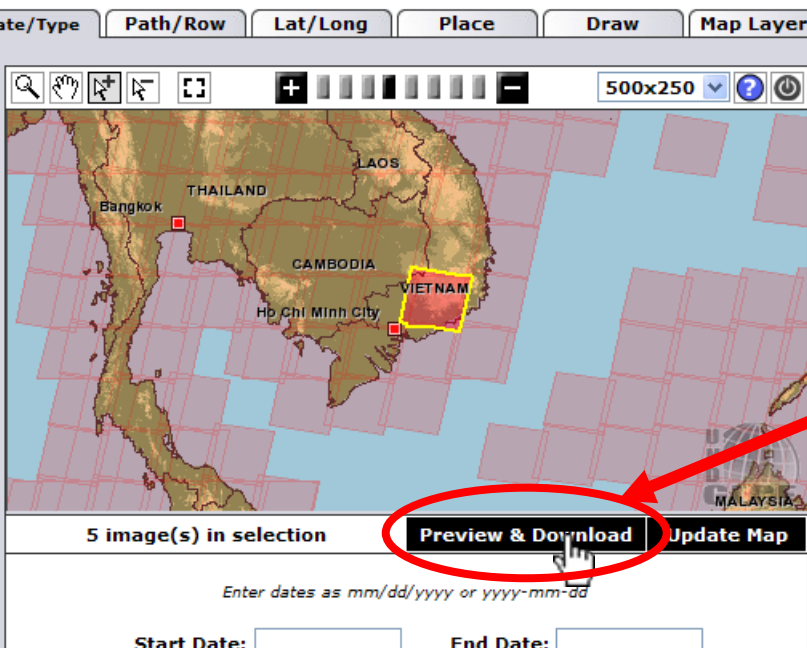
Enter dates as mm/dd/yyyy or yyyy-mm-dd

Start Date: End Date:

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# Search Results

GLCF: Earth Science Data Interface - Windows Internet Explorer

http://glcfapp.umi.acs.umd.edu:8080/esdi/index.jsp

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Global Land Cover Facility  
Earth Science Data Interface

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TM  
WRS-2, Path 124, Row 052  
1990-12-30  
EarthSat  
Ortho, GeoCover  
Cambodia, Vietnam  
Online: 013-147  
Compressed Size: 143 MB; Actual Size: 502 MB

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Ho Chi Minh City

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Search Results (5)

| [ ID ]                  | Status | [ WRS: P/R ] | [ Acq. Date ] | Dataset | Producer | Attr.           | Type    | Location          |
|-------------------------|--------|--------------|---------------|---------|----------|-----------------|---------|-------------------|
| <a href="#">013-147</a> | Online | 2: 124/052   | 1990-12-30    | TM      | EarthSat | Ortho, GeoCover | GeoTIFF | Cambodia, Vietnam |
| <a href="#">034-655</a> | Online | 1: 133/052   | 1973-01-01    | MSS     | EarthSat | Ortho, GeoCover | GeoTIFF | Vietnam           |
| <a href="#">034-656</a> | Online | 1: 133/052   | 1976-01-31    | MSS     | EarthSat | Ortho, GeoCover | GeoTIFF | Vietnam           |
| <a href="#">040-051</a> | Online | 2: 124/052   | 2001-02-03    | ETM+    | EarthSat | Ortho, GeoCover | GeoTIFF | Cambodia, Vietnam |
| <a href="#">040-052</a> | Online | 2: 124/052   | 2002-01-05    | ETM+    | EarthSat | Ortho, GeoCover | GeoTIFF | Cambodia, Vietnam |

Please send any comments to glcf@umiacs.umd.edu  
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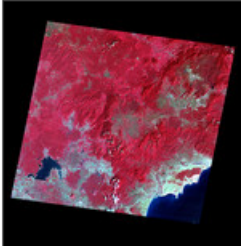
# Step9 : Download images

GLCF: Earth Science Data Interface - Windows Internet Explorer

http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp

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Earth Science Data Interface


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TM  
WRS-2, Path 124, Row 052  
1990-12-30  
EarthSat  
Ortho, GeoCover  
Cambodia, Vietnam  
Online: 013-147  
Compressed Size: 143 MB; Actual Size: 502 MB

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Search Results (5)

| [ ID ]                  | Status | [ WRS: P/R ] | [ Acq. Date ] | Dataset | Producer | Attr.           | Type    | Location          |
|-------------------------|--------|--------------|---------------|---------|----------|-----------------|---------|-------------------|
| <a href="#">013-147</a> | Online | 2: 124/052   | 1990-12-30    | TM      | EarthSat | Ortho, GeoCover | GeoTIFF | Cambodia, Vietnam |
| <a href="#">034-655</a> | Online | 1: 133/052   | 1973-01-01    | MSS     | EarthSat | Ortho, GeoCover | GeoTIFF | Vietnam           |
| <a href="#">034-656</a> | Online | 1: 133/052   | 1976-01-31    | MSS     | EarthSat | Ortho, GeoCover | GeoTIFF | Vietnam           |
| <a href="#">040-051</a> | Online | 2: 124/052   | 2001-02-03    | ETM+    | EarthSat | Ortho, GeoCover | GeoTIFF | Cambodia, Vietnam |
| <a href="#">040-052</a> | Online | 2: 124/052   | 2002-01-05    | ETM+    | EarthSat | Ortho, GeoCover | GeoTIFF | Cambodia, Vietnam |

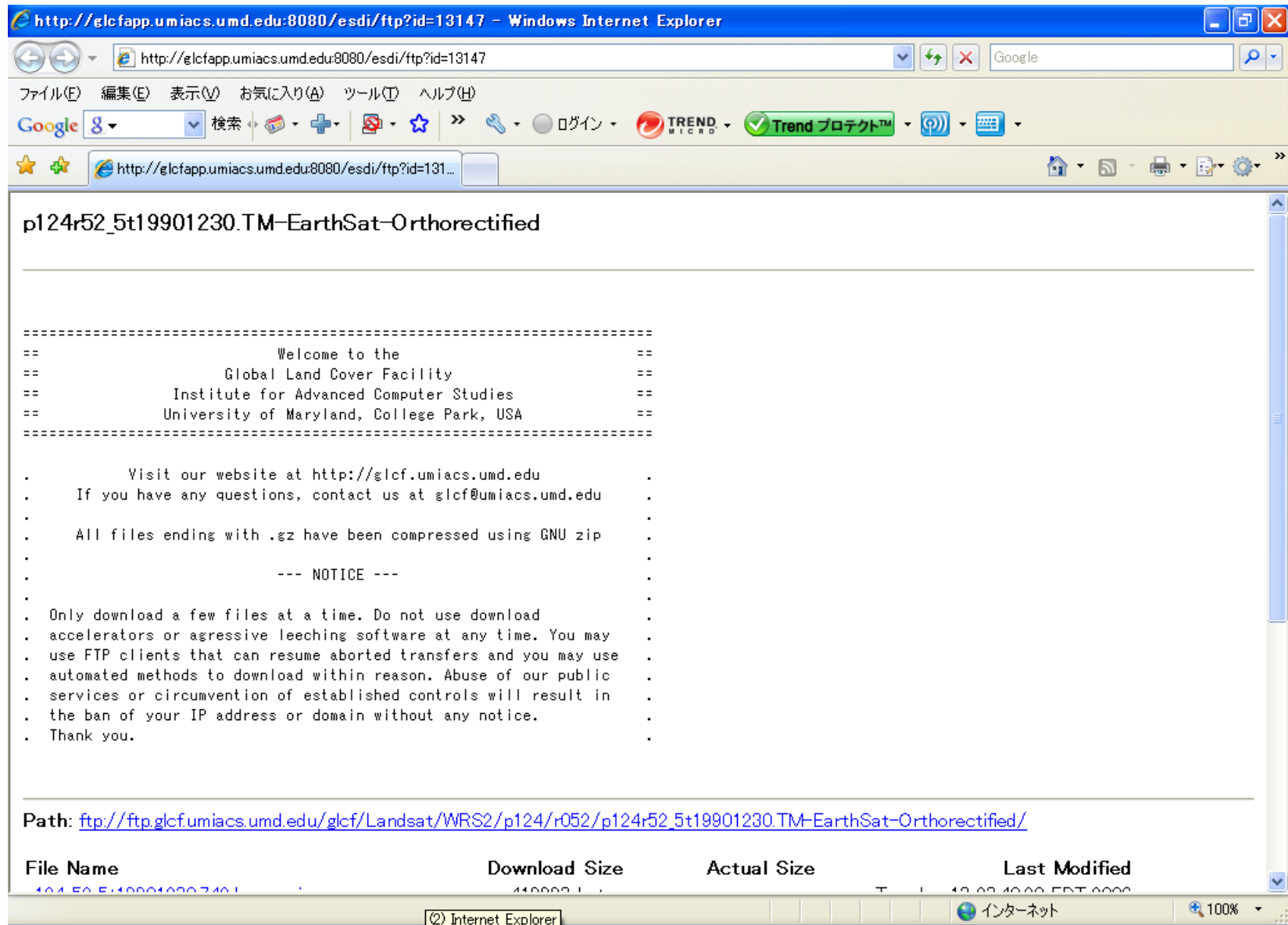
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# If you click “download”, this window will open



# At the bottom of the window,

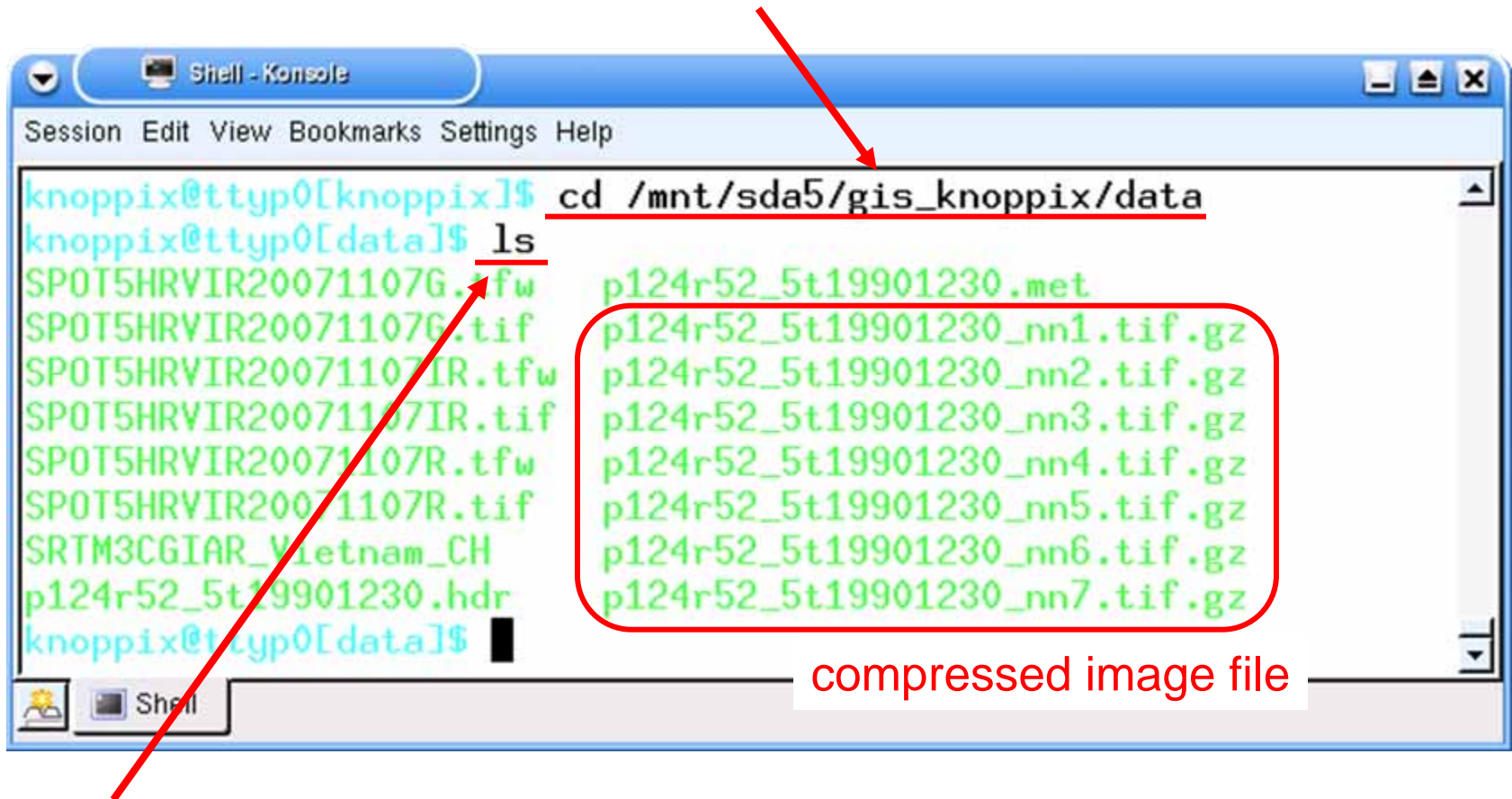
Path: [ftp://ftp.glcf.umiacs.umd.edu/glcf/Landsat/WRS2/p124/r052/p124r52\\_5t19901230.TM-EarthSat-Orthorectified/](ftp://ftp.glcf.umiacs.umd.edu/glcf/Landsat/WRS2/p124/r052/p124r52_5t19901230.TM-EarthSat-Orthorectified/)

| File Name  | Download Size  | Actual Size    | Last Modified                |
|--|----------------|----------------|------------------------------|
| <a href="#">p124r52_5t19901230.742.browse.jpg</a>  | 419993 bytes   |                | Tue Jun 13 23:40:20 EDT 2006 |
| <a href="#">p124r52_5t19901230.742.preview.jpg</a> | 11636 bytes    |                | Tue Jun 13 23:40:20 EDT 2006 |
| <a href="#">p124r52_5t19901230.browse.jpg</a>      | 378157 bytes   |                | Tue Jun 13 23:40:20 EDT 2006 |
| <a href="#">p124r52_5t19901230.hdr</a>             | 1536 bytes     |                | Mon Aug 19 12:41:43 EDT 2002 |
| <a href="#">p124r52_5t19901230.met</a>             | 28749 bytes    |                | Mon Aug 19 12:42:14 EDT 2002 |
| <a href="#">p124r52_5t19901230.preview.jpg</a>     | 11150 bytes    |                | Tue Jun 13 23:40:20 EDT 2006 |
| <a href="#">p124r52_5t19901230.tar.742.jpg</a>     | 55364 bytes    |                | Mon Aug 19 12:42:46 EDT 2002 |
| <a href="#">p124r52_5t19901230.tar.jpg</a>         | 51433 bytes    |                | Mon Aug 19 12:43:18 EDT 2002 |
| <a href="#">p124r52_5t19901230_nn1.tif.gz</a>      | 20354993 bytes | 57119994 bytes | Mon Aug 19 12:50:49 EDT 2002 |
| <a href="#">p124r52_5t19901230_nn2.tif.gz</a>      | 17450763 bytes | 57119994 bytes | Mon Aug 19 12:52:19 EDT 2002 |
| <a href="#">p124r52_5t19901230_nn3.tif.gz</a>      | 20839368 bytes | 57119994 bytes | Mon Aug 19 12:44:58 EDT 2002 |
| <a href="#">p124r52_5t19901230_nn4.tif.gz</a>      | 28718419 bytes | 57119994 bytes | Mon Aug 19 12:46:32 EDT 2002 |
| <a href="#">p124r52_5t19901230_nn5.tif.gz</a>      | 30132147 bytes | 57119994 bytes | Mon Aug 19 12:48:09 EDT 2002 |
| <a href="#">p124r52_5t19901230_nn6.tif.gz</a>      | 9468553 bytes  | 57119994 bytes | Mon Aug 19 12:48:48 EDT 2002 |
| <a href="#">p124r52_5t19901230_nn7.tif.gz</a>      | 23331551 bytes | 57119994 bytes | Mon Aug 19 12:50:15 EDT 2002 |

download all files

# Step10 : Uncompress image files

1. Move to directory which image files are stored



The screenshot shows a terminal window titled "Shell - Konsole". The command prompt is `knoppix@tty0[knoppix]$`. The user enters `cd /mnt/sda5/gis_knoppix/data`, which is underlined in red. The prompt changes to `knoppix@tty0[data]$`. The user then enters `ls`, which is underlined in red. The output of the `ls` command is listed in green text:

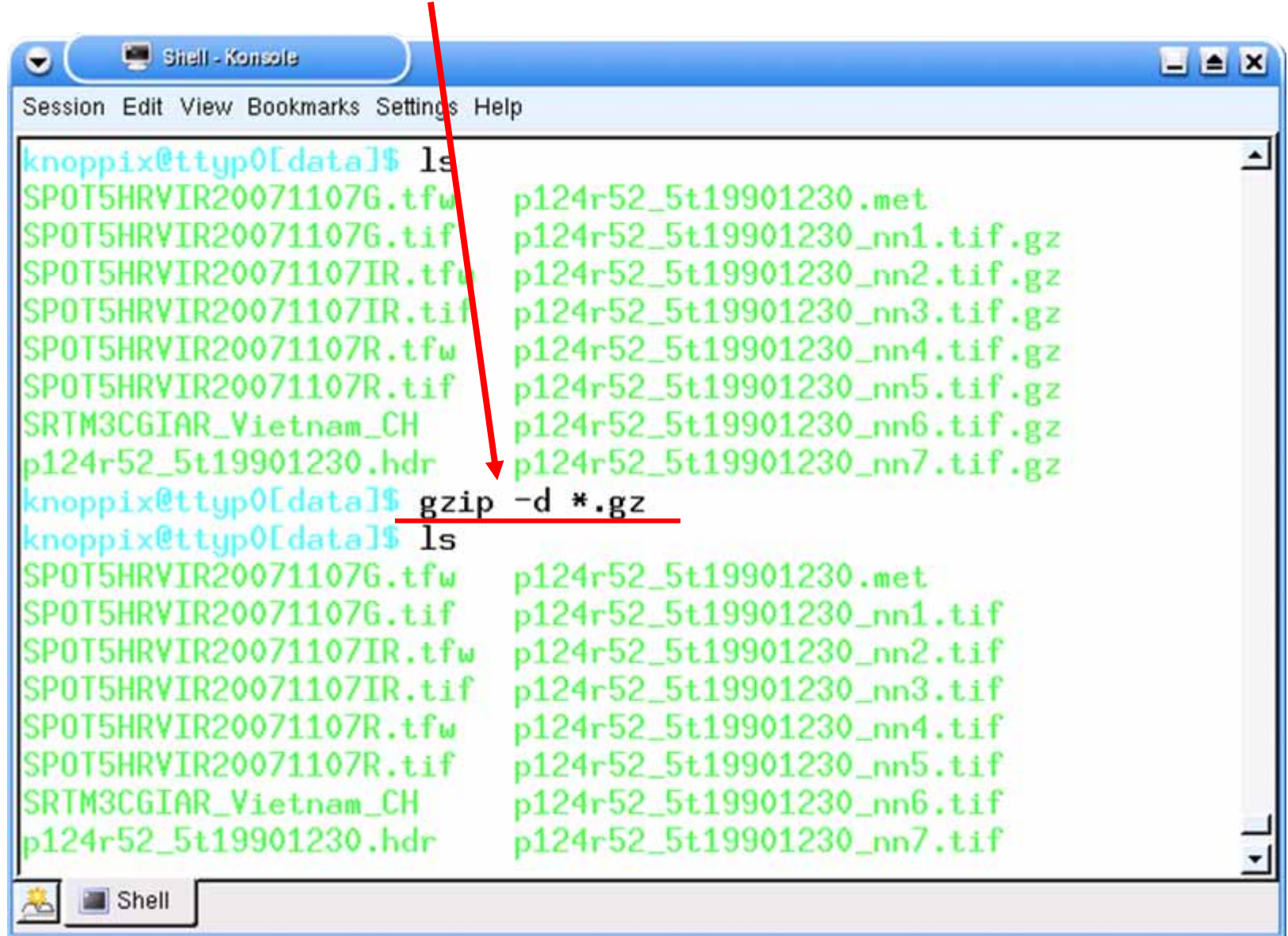
```
SPOT5HRVIR20071107G.tfw  p124r52_5t19901230.met  
SPOT5HRVIR20071107G.tif  p124r52_5t19901230_nn1.tif.gz  
SPOT5HRVIR20071107IR.tfw p124r52_5t19901230_nn2.tif.gz  
SPOT5HRVIR20071107IR.tif p124r52_5t19901230_nn3.tif.gz  
SPOT5HRVIR20071107R.tfw  p124r52_5t19901230_nn4.tif.gz  
SPOT5HRVIR20071107R.tif  p124r52_5t19901230_nn5.tif.gz  
SRTM3CGIAR_Vietnam_CH    p124r52_5t19901230_nn6.tif.gz  
p124r52_5t19901230.hdr   p124r52_5t19901230_nn7.tif.gz
```

A red arrow points from the first step of the list to the `cd` command. Another red arrow points from the second step of the list to the `ls` command. A red box highlights the list of files, and a red label "compressed image file" points to it.

2. List the files in "data" directory



### 3. Uncompress the compressed image files



The screenshot shows a terminal window titled "Shell - Konsole". The prompt is `knoppix@tty0[data]$`. The first command is `ls`, which lists the contents of the directory. The output shows a list of files, including `p124r52_5t19901230_nn1.tif.gz` through `p124r52_5t19901230_nn7.tif.gz`. A red arrow points from the text "3. Uncompress the compressed image files" to the `gzip -d *.gz` command. The second command is `gzip -d *.gz`, which is underlined. The third command is `ls`, which lists the contents of the directory again. The output shows the same list of files, but the `.gz` extensions have been removed, indicating that the files have been successfully uncompressed.

```
knoppix@tty0[data]$ ls
SPOT5HRVIR20071107G.tfw  p124r52_5t19901230.met
SPOT5HRVIR20071107G.tif  p124r52_5t19901230_nn1.tif.gz
SPOT5HRVIR20071107IR.tfw p124r52_5t19901230_nn2.tif.gz
SPOT5HRVIR20071107IR.tif p124r52_5t19901230_nn3.tif.gz
SPOT5HRVIR20071107R.tfw  p124r52_5t19901230_nn4.tif.gz
SPOT5HRVIR20071107R.tif  p124r52_5t19901230_nn5.tif.gz
SRTM3CGIAR_Vietnam_CH    p124r52_5t19901230_nn6.tif.gz
p124r52_5t19901230.hdr   p124r52_5t19901230_nn7.tif.gz
knoppix@tty0[data]$ gzip -d *.gz
knoppix@tty0[data]$ ls
SPOT5HRVIR20071107G.tfw  p124r52_5t19901230.met
SPOT5HRVIR20071107G.tif  p124r52_5t19901230_nn1.tif
SPOT5HRVIR20071107IR.tfw p124r52_5t19901230_nn2.tif
SPOT5HRVIR20071107IR.tif p124r52_5t19901230_nn3.tif
SPOT5HRVIR20071107R.tfw  p124r52_5t19901230_nn4.tif
SPOT5HRVIR20071107R.tif  p124r52_5t19901230_nn5.tif
SRTM3CGIAR_Vietnam_CH    p124r52_5t19901230_nn6.tif
p124r52_5t19901230.hdr   p124r52_5t19901230_nn7.tif
```

# **Appendix D**

## **How to get Lat/Lon information**

go to

[http://landsat.usgs.gov/tools\\_latlong.php](http://landsat.usgs.gov/tools_latlong.php)

Landsat Missions – Microsoft Internet Explorer

ファイル(F) 編集(E) 表示(V) お気に入り(A) ツール(T) ヘルプ(H)

戻る 進む 検索 お気に入り

アドレス(D) [http://landsat.usgs.gov/tools\\_latlong.php](http://landsat.usgs.gov/tools_latlong.php)

Google

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**Landsat Missions**

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## WRS-2 Path/Row to Latitude/Longitude Converter

Type the parameters that you want to convert.

Path:  Row:

Latitude:  Longitude:   
+ is North, - is South + is East, - is West

☒ Convert from WRS-2 Path/Row to Latitude/Longitude  
☐ Convert from Latitude/Longitude to WRS-2 Path/Row

☒ Descending Node  
☐ Ascending Node

Accessibility FOIA Privacy Policies and Notices

U.S. Department of the Interior | U.S. Geological Survey  
URL: <http://landsat.usgs.gov> Sitemap  
Page Contact Information: [landsat@usgs.gov](mailto:landsat@usgs.gov)  
Page Last Modified: October 14, 2008

USA.gov TAKE PRIDE IN AMERICA

webmodis.lis.u-tokyo.ac.jp6 (akats) インターネット



The Path/Row of image ;

Path : 124 , Row : 52

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**NASA**

**Landsat Missions**

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## 2 Path/Row to Latitude/Longitude

Type the parameters that you want to convert.

Path:  Row:

Latitude:  Longitude:   
+ is North, - is South + is East, - is West

☒ Convert from WRS-2 Path/Row to Latitude/Longitude  
☐ Convert from Latitude/Longitude to WRS-2 Path/Row

☒ Descending Node  
☐ Ascending Node

Click "convert"

Landsat Missions - Windows Internet Explorer

http://landsat.usgs.gov/tools\_latlong.php

ファイル(F) 編集(E) 表示(V) お気に入り(A) ツール(T) ヘルプ(H)

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Landsat Missions

☐ Convert from Latitude/Longitude to WRS-2 Path/Row

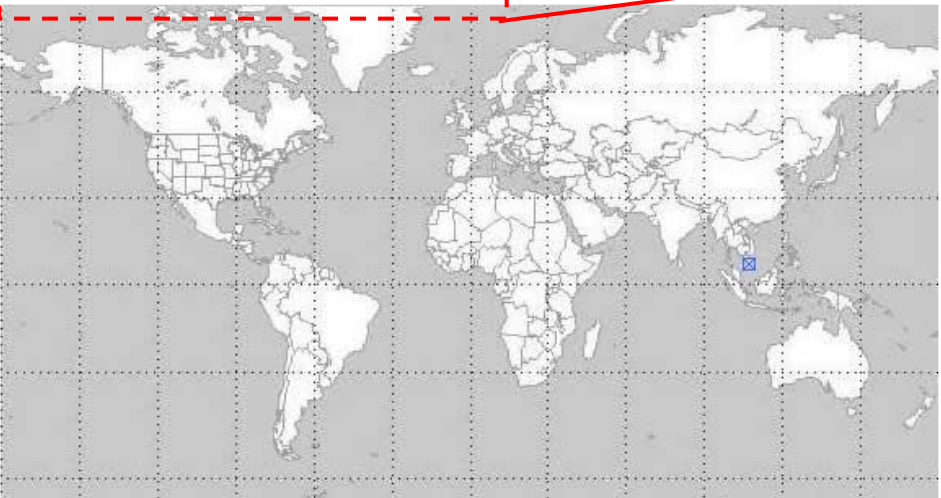
☒ Descending Node  
☐ Ascending Node

**The nearest scene center is at:**

|           |          |            |           |
|-----------|----------|------------|-----------|
| Path:     | 124      | Row:       | 52        |
| Latitude: | 11.568   | Longitude: | 107.835   |
|           | 11° 34'N |            | 107° 50'E |

**The nearest scene center is at:**

|           |          |            |           |
|-----------|----------|------------|-----------|
| Path:     | 124      | Row:       | 52        |
| Latitude: | 11.568   | Longitude: | 107.835   |
|           | 11° 34'N |            | 107° 50'E |



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**The nearest scene center is at:**

|           |          |            |           |
|-----------|----------|------------|-----------|
| Path:     | 124      | Row:       | 52        |
| Latitude: | 11.568   | Longitude: | 107.835   |
|           | 11° 34'N |            | 107° 50'E |

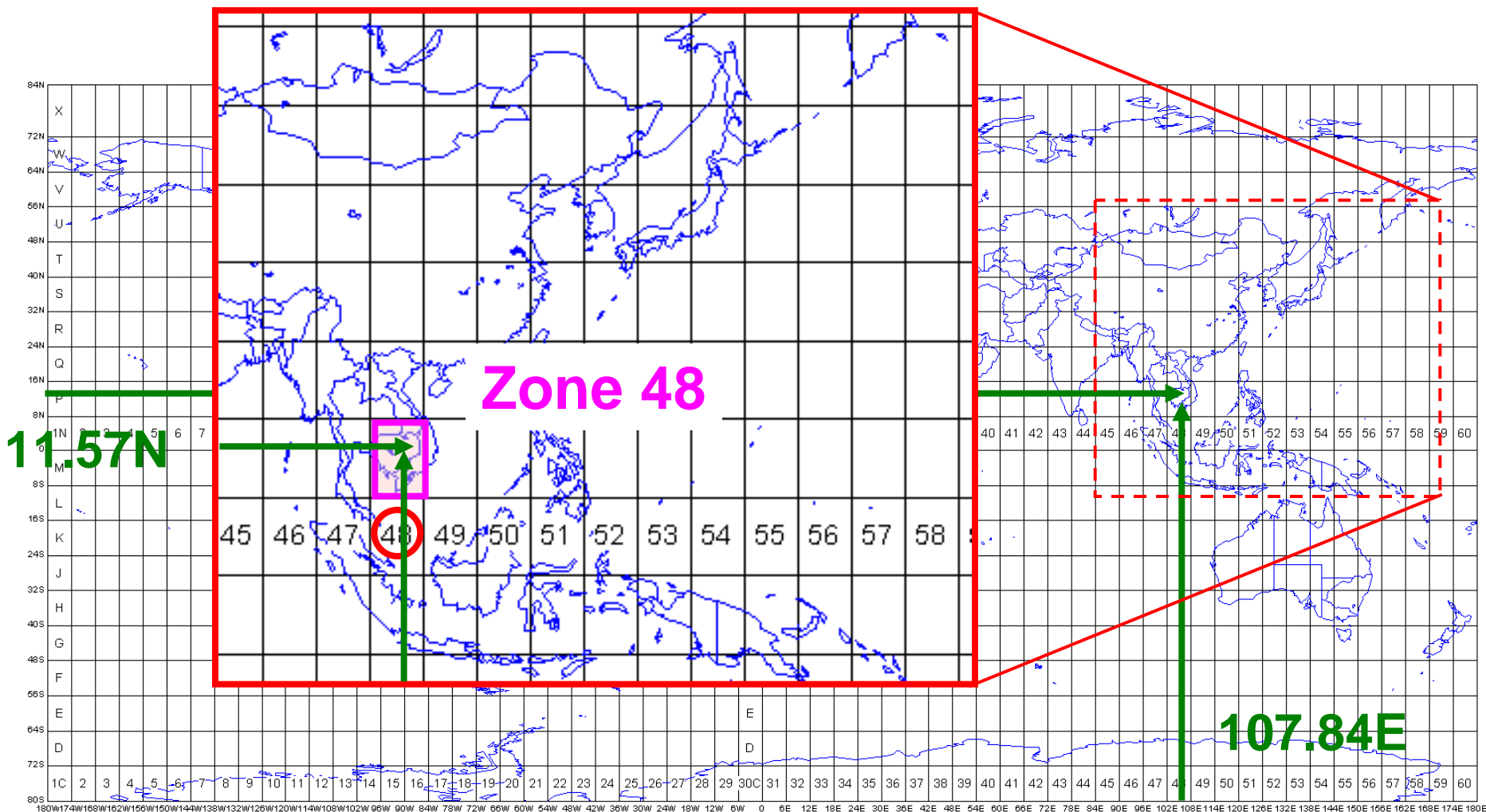
**Image center Lat/Lon**

**11.57N 107.84E**

# **Appendix E**

## **How to get UTM zone**

Scene center latitude : 11.57N , Scene center longitude : 107.84E



<http://www.dmap.co.uk/utmworld.htm>