Procesamiento de series de tiempo en GRASS GIS

Aplicaciones en Ecología y Ambiente

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Satellite imagery processing in GRASS GIS

Overview

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- Basics of Imagery processing in GRASS GIS

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- Digital Number to Reflectance

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- Cloud mask from quality band

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- Cloud mask from quality band
- Vegetation and Water indices

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- Digital Number to Reflectance
- Data fusion/Pansharpening
- Create composites
- Cloud mask from quality band
- Vegetation and Water indices
- Unsupervised classification

Basics of imagery processing in GRASS GIS

Satellite data is identical to raster data → same rules apply

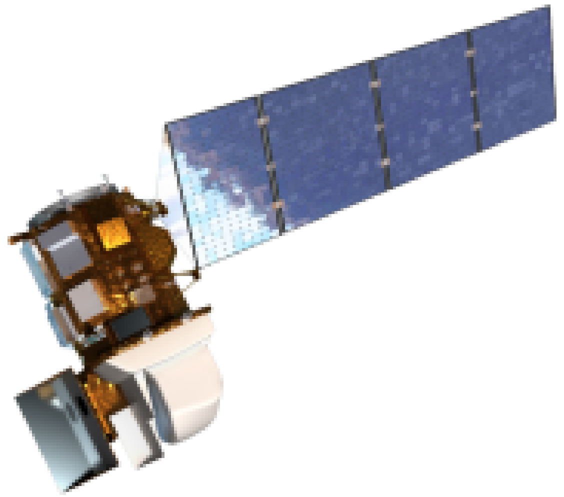
i. commands are explicitly dedicated to image processing*

For further details see: Imagery Intro manual and Image Processing wiki

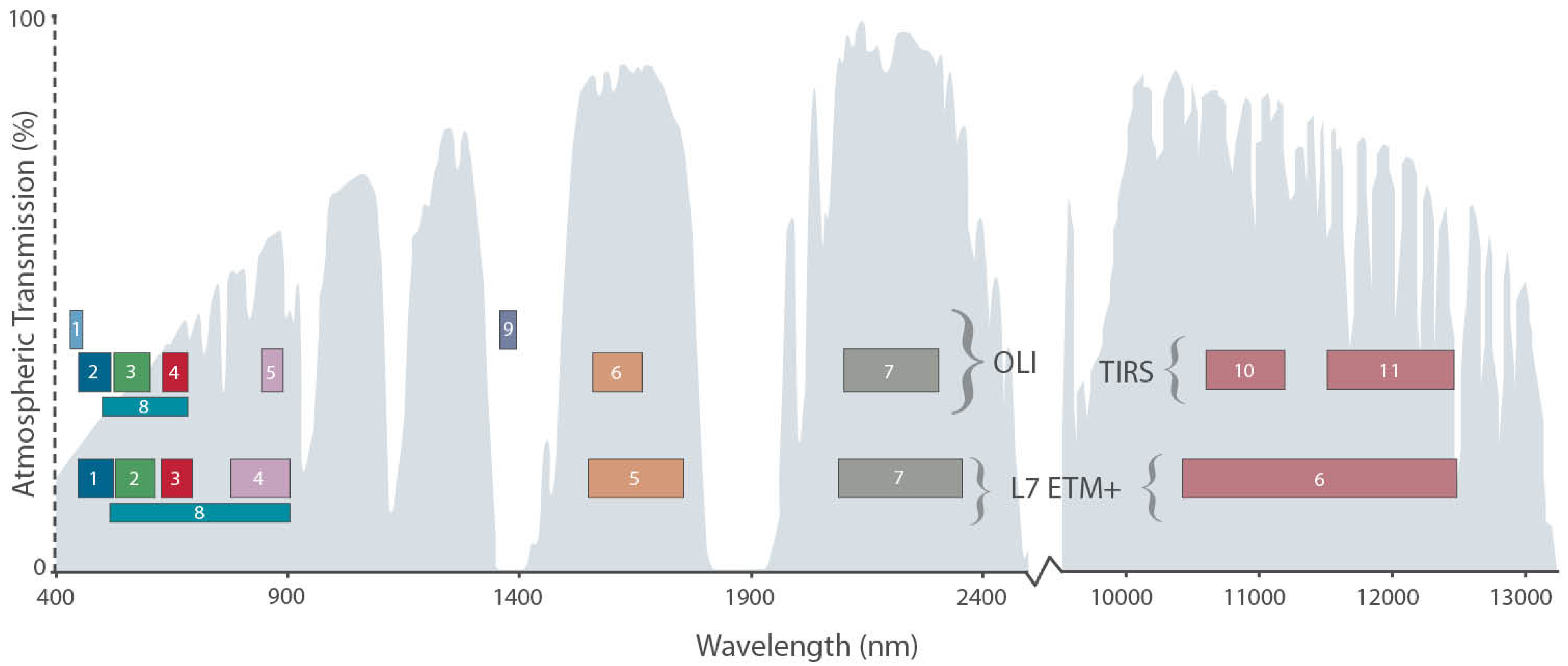
Data

Two Landsat 8 (OLI) scenes

- Dates: 16 June 2016 and 18 July 2016
- Path/Row: 015/035
- CRS: UTM zone 18 N (EPSG:32618)



Download the clipped Landsat 8 scenes, move the file to `$HOME/gisdata` and unzip it there. Also download the file with the code to follow this session.



Spectral bands of Landsat 7 ETM+ and 8 OLI. Source: https://landsat.gsfc.nasa.gov/landsat-data-continuity-mission/ and Landsat bands details

Start GRASS and create new mapset

```
#!/bin/bash
#######################################################################
# Worflow for Landsat 8 data processing in GRASS GIS
# GRASS GIS postgraduate course in Rio Cuarto
# Author: Veronica Andreo
# October, 2018
#######################################################################

# Register and download Landsat 8 scenes for NC
https://earthexplorer.usgs.gov/


#
# First settings
#


# launch GRASS GIS, -c creates new mapset landsat8
```

Start GRASS and create new mapset

```
https://earthexplorer.usgs.gov/



#
# First settings
#



# launch GRASS GIS, -c creates new mapset landsat8
grass74 $HOME/grassdata/nc_spm_08_grass7/landsat8/ -c
# check the projection of the location
g.proj -p
# list all the mapsets in the search path
g.mapsets -p
# add the mapset landsat to the search path
g.mapsets mapset=landsat operation=add
# list all the mapsets in the search path
g.mapsets -p
```

Launch GRASS GIS and create new mapset landsat8

Start GRASS and create new mapset

```
#
# First settings
#



# launch GRASS GIS, -c creates new mapset landsat8
grass74 $HOME/grassdata/nc_spm_08_grass7/landsat8/ -c
# check the projection of the location
g.proj -p
# list all the mapsets in the search path
g.mapsets -p
# add the mapset landsat to the search path
g.mapsets mapset=landsat operation=add
# list all the mapsets in the search path
g.mapsets -p
# list all the raster maps in all the mapsets in the search path
g.list type=raster
```

Check the projection

Start GRASS and create new mapset

```
# launch GRASS GIS, -c creates new mapset landsat8
grass74 $HOME/grassdata/nc_spm_08_grass7/landsat8/ -c
# check the projection of the location
g.proj -p
# list all the mapsets in the search path
g.mapsets -p
# add the mapset landsat to the search path
g.mapsets mapset=landsat operation=add
# list all the mapsets in the search path
g.mapsets -p
# list all the raster maps in all the mapsets in the search path
g.list type=raster
# set the computational region
g.region rast=lsat7_2002_20 res=30 -a
```

List mapsets and add landsat mapset to path

Start GRASS and create new mapset

```
# check the projection of the location
g.proj -p
# list all the mapsets in the search path
g.mapsets -p
# add the mapset landsat to the search path
g.mapsets mapset=landsat operation=add
# list all the mapsets in the search path
g.mapsets -p
# list all the raster maps in all the mapsets in the search path
g.list type=raster
# set the computational region
g.region rast=lsat7_2002_20 res=30 -a


# change directory to the input Landsat 8 data
cd $HOME/gisdata/LC80150352016168LGN00
# define a variable
BASE="LC80150352016168LGN00"
```

List all available raster maps

Start GRASS and create new mapset

```
# list all the mapsets in the search path
g.mapsets -p
# add the mapset landsat to the search path
g.mapsets mapset=landsat operation=add
# list all the mapsets in the search path
g.mapsets -p
# list all the raster maps in all the mapsets in the search path
g.list type=raster
# set the computational region
g.region rast=lsat7_2002_20 res=30 -a


# change directory to the input Landsat 8 data
cd $HOME/gisdata/LC80150352016168LGN00
# define a variable
BASE="LC80150352016168LGN00"
```

Set computational region to a landsat scene

Import L8 data

```
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# launch GRASS GIS, -c creates new mapset landsat8
```

Import L8 data

```
g.mapsets -p
# list all the raster maps in all the mapsets in the search path
g.list type=raster
# set the computational region
g.region rast=lsat7_2002_20 res=30 -a


# change directory to the input Landsat 8 data
cd $HOME/gisdata/LC80150352016168LGN00
# define a variable
BASE="LC80150352016168LGN00"



#
# Import L8 data
#
```

Change directory and set variable

Import L8 data

```
#
# Import L8 data
#



# loop to import all the bands
for i in "1" "2" "3" "4" "5" "6" "7" "9" "QA" "10" "11"; do
  r.import input=${BASE}_B${i}.TIF output=${BASE}_B${i} \
   resolution=value resolution_value=30 \
   extent=region
done

# PAN band 8 imported separately because of different spatial resolutio
r.import input=${BASE}_B8.TIF output=${BASE}_B8 \
 resolution=value resolution_value=15 \
 extent=region
```

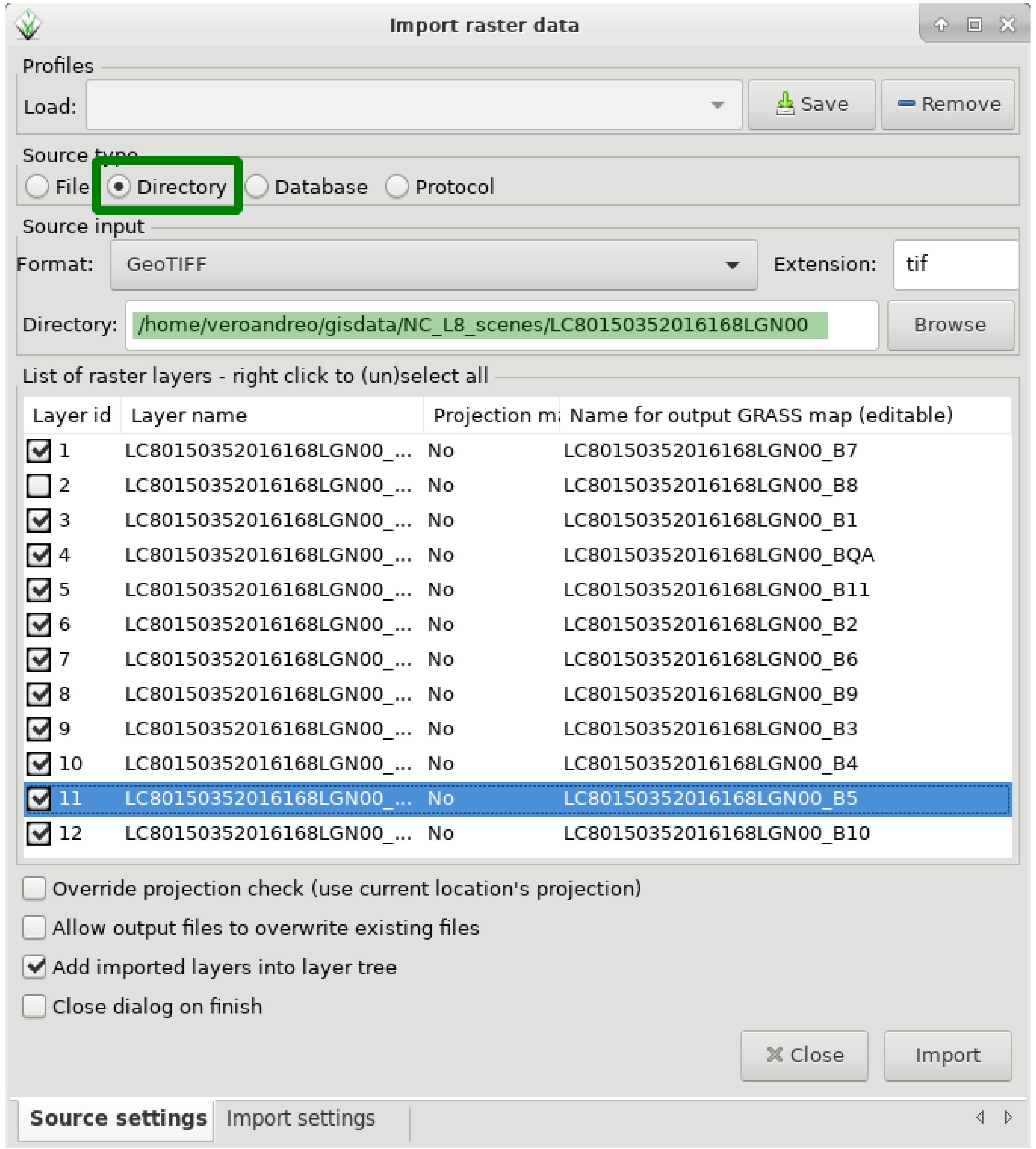
Import all the bands with 30m res, note extent=region

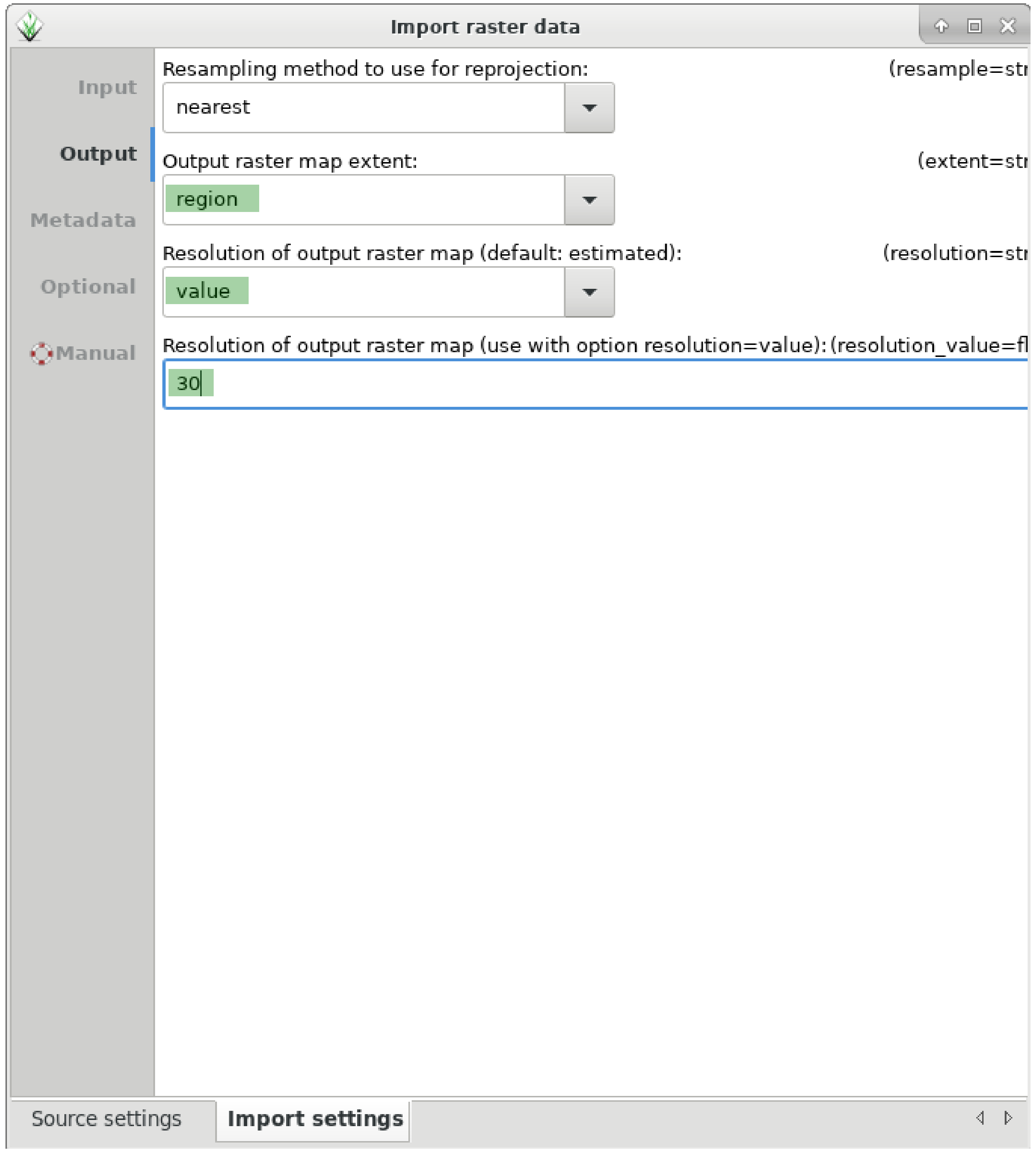
Import L8 data

```
# loop to import all the bands
for i in "1" "2" "3" "4" "5" "6" "7" "9" "QA" "10" "11"; do
  r.import input=${BASE}_B${i}.TIF output=${BASE}_B${i} \
   resolution=value resolution_value=30 \
   extent=region
done

# PAN band 8 imported separately because of different spatial resolutio
r.import input=${BASE}_B8.TIF output=${BASE}_B8 \
 resolution=value resolution_value=15 \
 extent=region



#
# DN to surface reflectance and Temperature (Atmospheric correction thr
#
```

Import PAN band separately

Directory option to import from the GUI





Task:

- *Note that we are using r.import instead of r.in.gdal to import the data. Check the difference between the two of them and explain why we used r.import here?*
- *Repeat the import step for the second scene "LC80150352016200LGN00"*

From Digital Number (DN) to Reflectance and Temperature

- Landsat 8 OLI sensor provides 16-bit data with range between 0 and 65536.
- i.landsat.toar converts DN to TOA reflectance (and brightness temperature) for all Landsat sensors. It optionally provides surface reflectance after DOS atmospheric correction.
- i.atcorr provides more complex atmospheric correction method for many sensors, i.e., S6.

DN to Reflectance and Temperature

```
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# launch GRASS GIS, -c creates new mapset landsat8
```

DN to Reflectance and Temperature

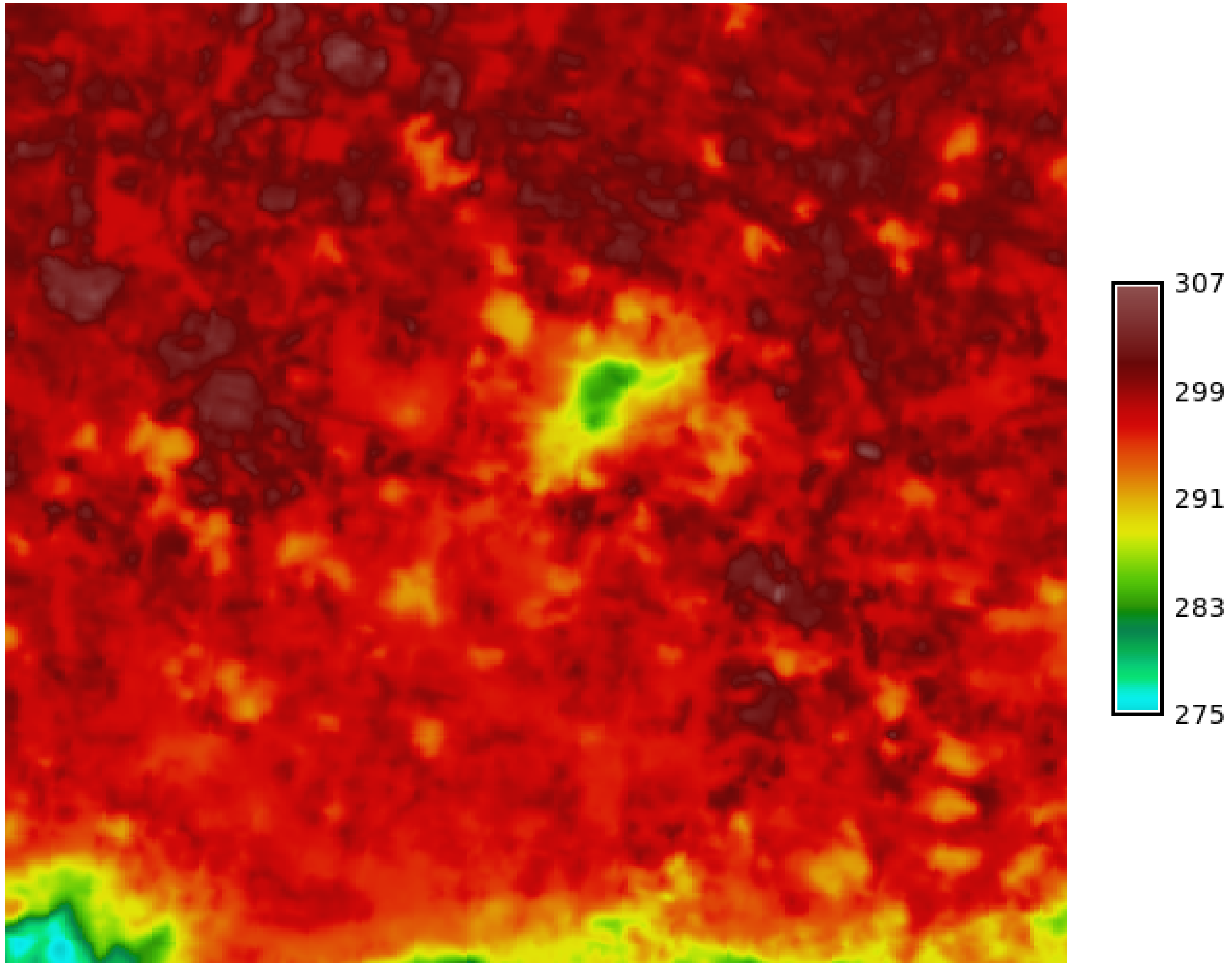
```
 extent=region


#
# DN to surface reflectance and Temperature (Atmospheric correction thr
#



# convert from DN to surface reflectance and temperature
i.landsat.toar input=${BASE}_B output=${BASE}_toar \
 metfile=${BASE}_MTL.txt sensor=oli8 method=dos1

# list output maps
g.list rast map=. pattern=${BASE}_toar*
# check info before and after for one band
r.info map=LC80150352016168LGN00_B4
r.info map=LC80150352016168LGN00_toar4
```

Convert from DN to surface reflectance and temperature - DOS method

DN to Reflectance and Temperature

```
#



# convert from DN to surface reflectance and temperature
i.landsat.toar input=${BASE}_B output=${BASE}_toar \
 metfile=${BASE}_MTL.txt sensor=oli8 method=dos1

# list output maps
g.list rast map=. pattern=${BASE}_toar*
# check info before and after for one band
r.info map=LC80150352016168LGN00_B4
r.info map=LC80150352016168LGN00_toar4



#
# Image fusion
#
```

Check info before and after conversion for one band



L8 band 10 with kelvin color pallete

Task:

- *Repeat the conversion step for the second scene "LC80150352016200LGN00"*
- *Set the color palette of Band 10 of LC80150352016200LGN00 to "kelvin" and visualize*

Data fusion/Pansharpening

We'll use the PAN band 8 (15 m resolution) to downsample other spectral bands to 15 m resolution

i.fusion.hpf applies a high pass filter addition method

Data fusion/Pansharpening

```
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https://earthexplorer.usgs.gov/



#
# First settings
#



# launch GRASS GIS, -c creates new mapset landsat8
```

Data fusion/Pansharpening

```
r.info map=LC80150352016168LGN00_B4
r.info map=LC80150352016168LGN00_toar4



#
# Image fusion
#



# Install the reqquired addon
g.extension extension=i.fusion.hpf

# Set the region
g.region rast=lsat7_2002_20 res=15 -a

# Apply the fusion based on high pass filter
i.fusion.hpf -l -c pan=${BASE}_toar8 \
 msx=`g.list type=raster mapset=. pattern=${BASE}_toar[1-7] separator=,
 center=high \
```

Install extension

Data fusion/Pansharpening

```
#
# Image fusion
#



# Install the reqquired addon
g.extension extension=i.fusion.hpf

# Set the region
g.region rast=lsat7_2002_20 res=15 -a

# Apply the fusion based on high pass filter
i.fusion.hpf -l -c pan=${BASE}_toar8 \
 msx=`g.list type=raster mapset=. pattern=${BASE}_toar[1-7] separator=,
 center=high \
 modulation=max \
 trim=0.0
```

Set the region

Data fusion/Pansharpening

```
# Install the reqquired addon
g.extension extension=i.fusion.hpf


# Set the region
g.region rast=lsat7_2002_20 res=15 -a

# Apply the fusion based on high pass filter
i.fusion.hpf -l -c pan=${BASE}_toar8 \
 msx=`g.list type=raster mapset=. pattern=${BASE}_toar[1-7] separator=,
 center=high \
 modulation=max \
 trim=0.0

# list the fused maps
g.list type=raster mapset=. pattern=${BASE}_toar*.hpf

# display original and fused maps
g.gui.mapswipe first=LC80150352016168LGN00_toar5 \
```

Run the fusion

Data fusion/Pansharpening

```
g.region rast=lsat7_2002_20 res=15 -a

# Apply the fusion based on high pass filter
i.fusion.hpf -l -c pan=${BASE}_toar8 \
 msx=`g.list type=raster mapset=. pattern=${BASE}_toar[1-7] separator=,
 center=high \
 modulation=max \
 trim=0.0

# list the fused maps
g.list type=raster mapset=. pattern=${BASE}_toar*.hpf

# display original and fused maps
g.gui.mapswipe first=LC80150352016168LGN00_toar5 \
 second=LC80150352016168LGN00_toar5.hpf



#
# Image Composites
```

List fused maps

Data fusion/Pansharpening

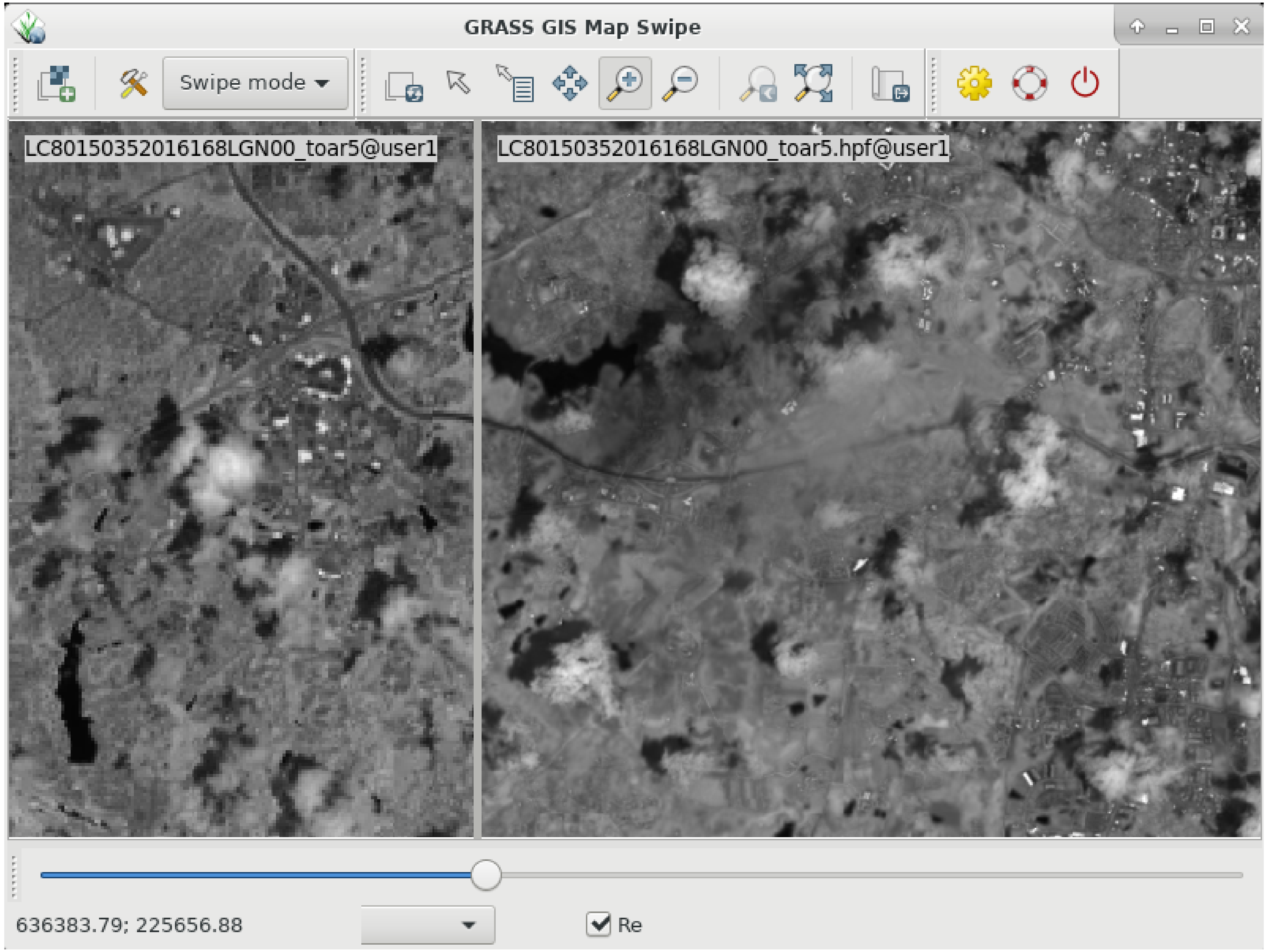
```
 msx=`g.list type=raster mapset=. pattern=${BASE}_toar[1-7] separator=,
 center=high \
 modulation=max \
 trim=0.0

# list the fused maps
g.list type=raster mapset=. pattern=${BASE}_toar*.hpf

# display original and fused maps
g.gui.mapswipe first=LC80150352016168LGN00_toar5 \
 second=LC80150352016168LGN00_toar5.hpf

#
# Image Composites
#
```

Visualize differences



Original 30m data and fused 15m data

GRASS GIS

Task: *Repeat the fusion step for the second scene "LC80150352016200LGN00"*

Image Composites

```
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#
# First settings
#



# launch GRASS GIS, -c creates new mapset landsat8
```

Image Composites

```
#
# Image Composites
#

# enhance the colors
i.colors.enhance red=${BASE}_toar4.hpf \
 green=${BASE}_toar3.hpf \
 blue=${BASE}_toar2.hpf \
 strength=95

# display RGB
d.mon wx0
d.rgb red=${BASE}_toar4.hpf \
 green=${BASE}_toar3.hpf \
 blue=${BASE}_toar2.hpf
```

Enhance the colors for natural color composition

Image Composites

```
# enhance the colors
i.colors.enhance red=${BASE}_toar4.hpf \
 green=${BASE}_toar3.hpf \
 blue=${BASE}_toar2.hpf \
 strength=95

# display RGB
d.mon wx0
d.rgb red=${BASE}_toar4.hpf \
 green=${BASE}_toar3.hpf \
 blue=${BASE}_toar2.hpf

# create RGB composites
r.composite red=${BASE}_toar4.hpf \
 green=${BASE}_toar3.hpf \
 blue=${BASE}_toar2.hpf \
 output=${BASE}_toar.hpf_comp_432
```

Display RGB combination - d.rgb

Image Composites

```
# display RGB
d.mon wx0
d.rgb red=${BASE}_toar4.hpf \
 green=${BASE}_toar3.hpf \
 blue=${BASE}_toar2.hpf

# create RGB composites
r.composite red=${BASE}_toar4.hpf \
 green=${BASE}_toar3.hpf \
 blue=${BASE}_toar2.hpf \
 output=${BASE}_toar.hpf_comp_432

# enhance the colors
i.colors.enhance red=${BASE}_toar5.hpf \
 green=${BASE}_toar4.hpf \
 blue=${BASE}_toar3.hpf \
 strength=95
```

Create RGB 432 composite

Image Composites

```
blue=${BASE}_toar2.hpf

# create RGB composites
r.composite red=${BASE}_toar4.hpf \
 green=${BASE}_toar3.hpf \
 blue=${BASE}_toar2.hpf \
 output=${BASE}_toar.hpf_comp_432

# enhance the colors
i.colors.enhance red=${BASE}_toar5.hpf \
 green=${BASE}_toar4.hpf \
 blue=${BASE}_toar3.hpf \
 strength=95

# create RGB composites
r.composite red=${BASE}_toar5.hpf \
 green=${BASE}_toar4.hpf \
 blue=${BASE}_toar3.hpf \
 output=${BASE}_toar.hpf_comp_543
```

Enhance the colors for false color composition

Image Composites

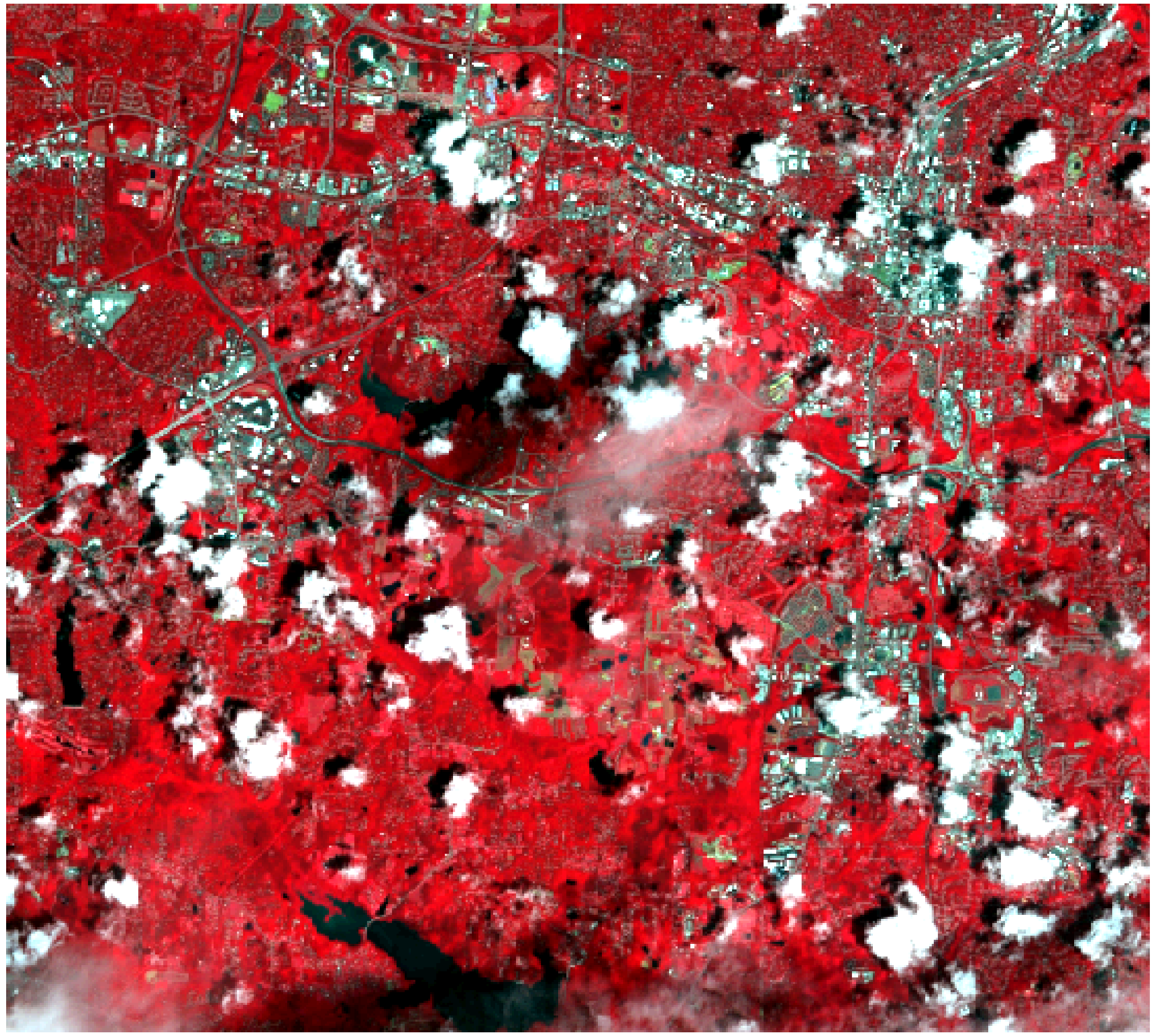
```
# enhance the colors
i.colors.enhance red=${BASE}_toar5.hpf \
 green=${BASE}_toar4.hpf \
 blue=${BASE}_toar3.hpf \
 strength=95

# create RGB composites
r.composite red=${BASE}_toar5.hpf \
 green=${BASE}_toar4.hpf \
 blue=${BASE}_toar3.hpf \
 output=${BASE}_toar.hpf_comp_543

# display false color composite
d.mon wx0
d.rast ${BASE}_toar.hpf_comp_543
```

Create RGB 543 composite

Image Composites

```
 strength=95

# create RGB composites
r.composite red=${BASE}_toar5.hpf \
 green=${BASE}_toar4.hpf \
 blue=${BASE}_toar3.hpf \
 output=${BASE}_toar.hpf_comp_543

# display false color composite
d.mon wx0
d.rast ${BASE}_toar.hpf_comp_543



#
# Cloud mask from the QA layer
#
```

Display the composite raster



True color and False color composites of the Landsat 8 image dated 18 July 2016

Task: *Create the composites for the second scene "LC80150352016200LGN00"*

Cloud mask from the QA layer

- Landsat 8 provides a quality layer which contains 16bit integer values that represent *bit-packed combinations of surface, atmosphere, and sensor conditions that can affect the overall usefulness of a given pixel.*
- i.landsat8.qc reclassifies Landsat8 QA band according to pixel quality.

More information about L8 quality band at http://landsat.usgs.gov/qualityband.php

Apply cloud mask from QA layer

```
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```

Apply cloud mask from QA layer

```
d.mon wx0
d.rast ${BASE}_toar.hpf_comp_543



#
# Cloud mask from the QA layer
#



# install the extension
g.extension extension=i.landsat8.qc

# create a rule set
i.landsat8.qc cloud="Maybe,Yes" output=Cloud_Mask_rules.txt

# reclass the BQA band based on the rule set created
r.reclass input=${BASE}_BQA output=${BASE}_Cloud_Mask rules=Cloud_Mask_
```

Install i.landsat8.qc extension

Apply cloud mask from QA layer

```
#
# Cloud mask from the QA layer
#



# install the extension
g.extension extension=i.landsat8.qc

# create a rule set
i.landsat8.qc cloud="Maybe,Yes" output=Cloud_Mask_rules.txt

# reclass the BQA band based on the rule set created
r.reclass input=${BASE}_BQA output=${BASE}_Cloud_Mask rules=Cloud_Mask_

# report the area covered by clouds
r.report -e map=${BASE}_Cloud_Mask units=k
```

Create the rule set with clouds QA band

Apply cloud mask from QA layer

```
#

# install the extension
g.extension extension=i.landsat8.qc

# create a rule set
i.landsat8.qc cloud="Maybe,Yes" output=Cloud_Mask_rules.txt

# reclass the BQA band based on the rule set created
r.reclass input=${BASE}_BQA output=${BASE}_Cloud_Mask rules=Cloud_Mask_

# report the area covered by clouds
r.report -e map=${BASE}_Cloud_Mask units=k

# display reclassified map
d.mon wx0
d.rast ${BASE}_Cloud_Mask
```

Reclass the BQA band based on the rule set created

Apply cloud mask from QA layer

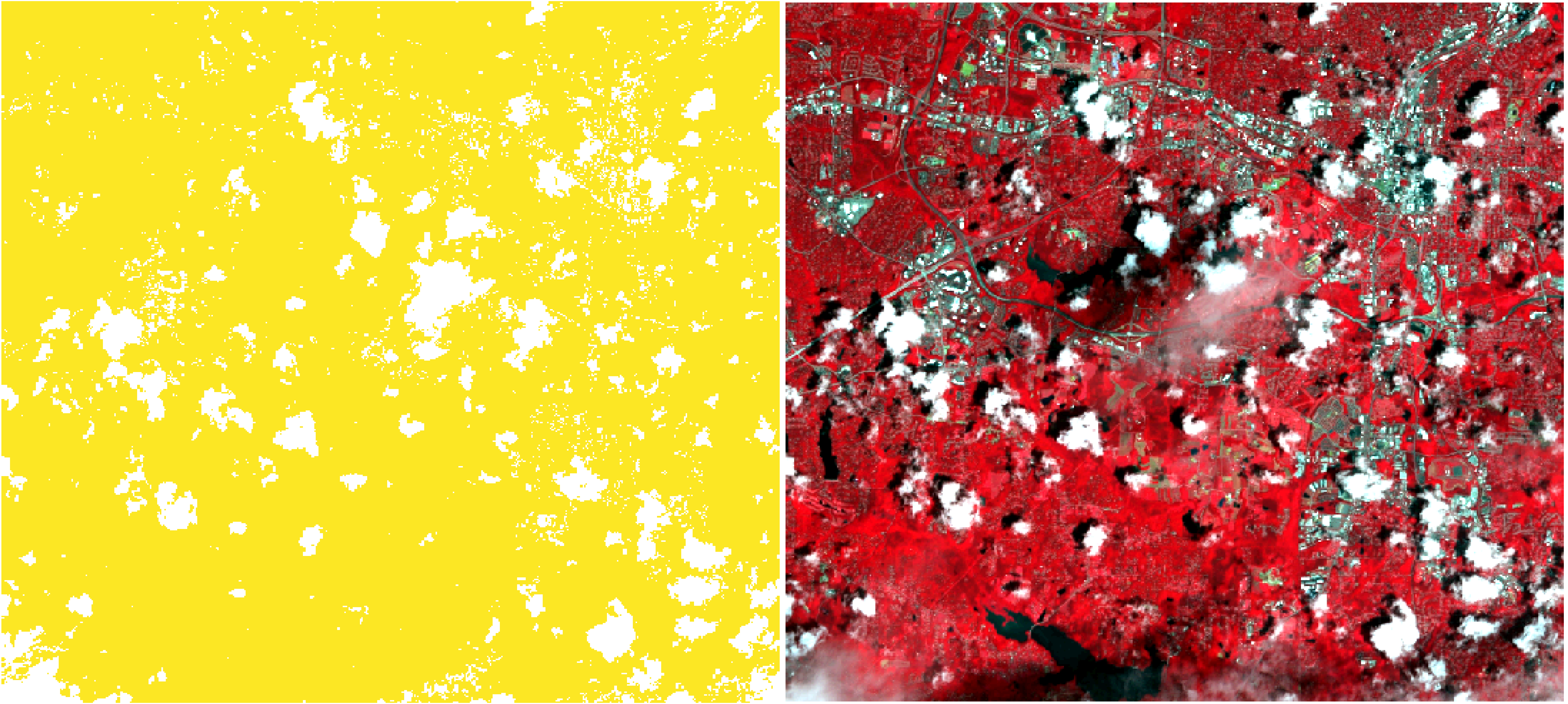
```
# install the extension
g.extension extension=i.landsat8.qc

# create a rule set
i.landsat8.qc cloud="Maybe,Yes" output=Cloud_Mask_rules.txt

# reclass the BQA band based on the rule set created
r.reclass input=${BASE}_BQA output=${BASE}_Cloud_Mask rules=Cloud_Mask_

# report the area covered by clouds
r.report -e map=${BASE}_Cloud_Mask units=k

# display reclassified map
d.mon wx0
d.rast ${BASE}_Cloud_Mask



#
```

Report the area covered by cloud

Apply cloud mask from QA layer

```
# create a rule set
i.landsat8.qc cloud="Maybe,Yes" output=Cloud_Mask_rules.txt

# reclass the BQA band based on the rule set created
r.reclass input=${BASE}_BQA output=${BASE}_Cloud_Mask rules=Cloud_Mask_

# report the area covered by clouds
r.report -e map=${BASE}_Cloud_Mask units=k

# display reclassified map
d.mon wx0
d.rast ${BASE}_Cloud_Mask



#
# Vegetation and Water Indices
#
```

Display the reclassified map



False color composite and the derived cloud mask of the Landsat 8 image dated 16 June 2016

Task: *Visually compare the cloud coverage with the false color composite*

Vegetation and water indices

```
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```

Vegetation and water indices

```
d.mon wx0
d.rast ${BASE}_Cloud_Mask



#
# Vegetation and Water Indices
#



# Set the cloud mask to avoid computing over clouds
r.mask raster=${BASE}_Cloud_Mask

# Compute NDVI
r.mapcalc expression="${BASE}_NDVI = (${BASE}_toar5.hpf - ${BASE}_toar4
# Set the color palette
r.colors map=${BASE}_NDVI color=ndvi

# Compute NDWI
```

Set the cloud mask to avoid computing over clouds

Vegetation and water indices

```
#
# Vegetation and Water Indices
#



# Set the cloud mask to avoid computing over clouds
r.mask raster=${BASE}_Cloud_Mask

# Compute NDVI
r.mapcalc expression="${BASE}_NDVI = (${BASE}_toar5.hpf - ${BASE}_toar4
# Set the color palette
r.colors map=${BASE}_NDVI color=ndvi

# Compute NDWI
r.mapcalc expression="${BASE}_NDWI = (${BASE}_toar5.hpf - ${BASE}_toar6
# Set the color palette
r.colors map=${BASE}_NDWI color=ndwi
```

Compute NDVI and set color pallete

Vegetation and water indices

```
# Set the cloud mask to avoid computing over clouds
r.mask raster=${BASE}_Cloud_Mask


# Compute NDVI
r.mapcalc expression="${BASE}_NDVI = (${BASE}_toar5.hpf - ${BASE}_toar4
# Set the color palette
r.colors map=${BASE}_NDVI color=ndvi

# Compute NDWI
r.mapcalc expression="${BASE}_NDWI = (${BASE}_toar5.hpf - ${BASE}_toar6
# Set the color palette
r.colors map=${BASE}_NDWI color=ndwi


# Remove the mask
r.mask -r


# display maps
d.mon wx0
```

Compute NDWI and set color pallete

Vegetation and water indices

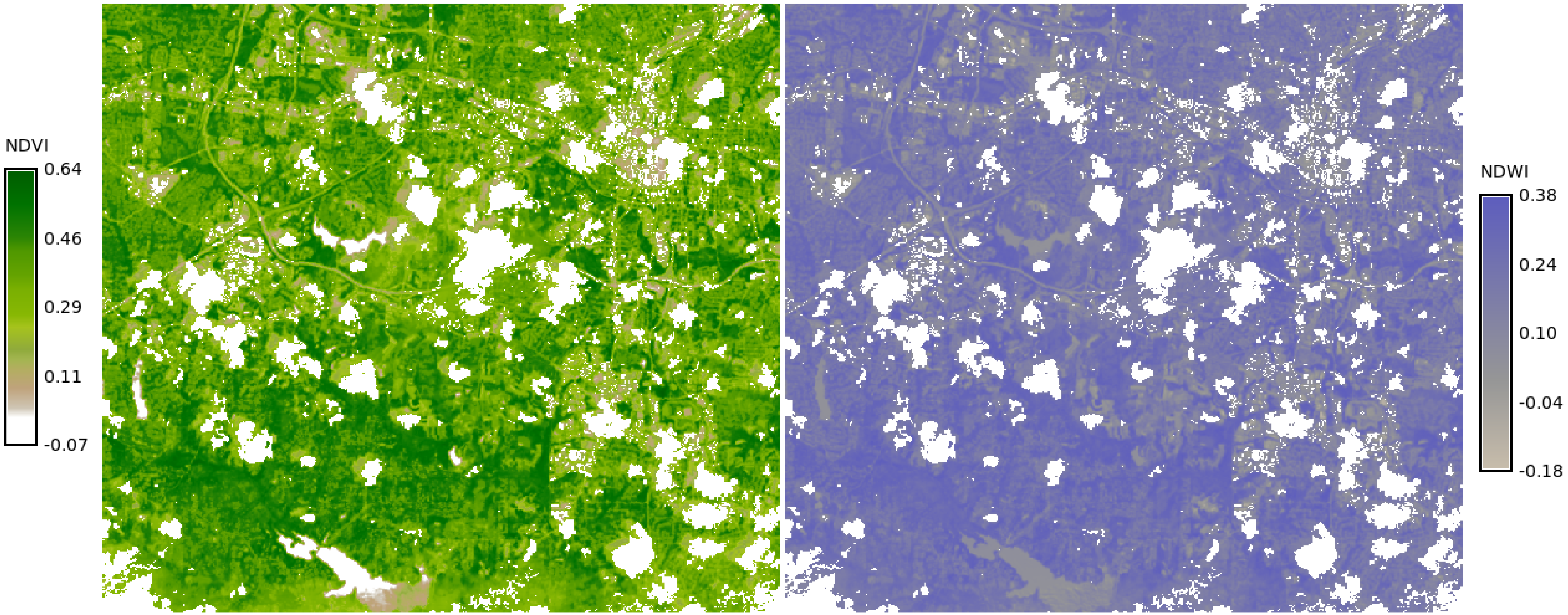
```
r.mapcalc expression="${BASE}_NDVI = (${BASE}_toar5.hpf - ${BASE}_toar4
# Set the color palette
r.colors map=${BASE}_NDVI color=ndvi

# Compute NDWI
r.mapcalc expression="${BASE}_NDWI = (${BASE}_toar5.hpf - ${BASE}_toar6
# Set the color palette
r.colors map=${BASE}_NDWI color=ndwi

# Remove the mask
r.mask -r

# display maps
d.mon wx0
d.rast map=${BASE}_NDVI
d.rast map=${BASE}_NDWI
```

Remove the mask

Vegetation and water indices

```
# Compute NDWI
r.mapcalc expression="${BASE}_NDWI = (${BASE}_toar5.hpf - ${BASE}_toar6
# Set the color palette
r.colors map=${BASE}_NDWI color=ndwi

# Remove the mask
r.mask -r

# display maps
d.mon wx0
d.rast map=${BASE}_NDVI
d.rast map=${BASE}_NDWI



#
# Unsupervised Classification
#
```

Display the maps



NDVI and NDWI derived from Landsat 8 image dated 16 June 2016

Task: *Compute the vegetation indices from the second scene "LC80150352016200LGN00"*

Unsupervised Classification

Unsupervised Classification

- Group the images: i.group

Unsupervised Classification

- Group the images: i.group
- Generate signatures for n classes: i.cluster

Unsupervised Classification

- Group the images: i.group
- Generate signatures for n classes: i.cluster
- Classify using Maximum likelihood: i.maxlik

Unsupervised classification

```
#!/bin/bash
#######################################################################
# Worflow for Landsat 8 data processing in GRASS GIS
# GRASS GIS postgraduate course in Rio Cuarto
# Author: Veronica Andreo
# October, 2018
#######################################################################

# Register and download Landsat 8 scenes for NC
https://earthexplorer.usgs.gov/



#
# First settings
#



# launch GRASS GIS, -c creates new mapset landsat8
```

Unsupervised classification

```
d.rast map=${BASE}_NDVI
d.rast map=${BASE}_NDWI



#
# Unsupervised Classification
#



# list the bands needed for classification
g.list type=raster mapset=. pattern=${BASE}_toar*.hpf

# add maps to an imagery group for easier management
i.group group=${BASE}_hpf subgroup=${BASE}_hpf \
 input=`g.list type=raster mapset=. pattern=${BASE}_toar*.hpf sep=","`

# statistics for unsupervised classification
i.cluster group=${BASE}_hpf subgroup=${BASE}_hpf \
```

List all maps with pattern

Unsupervised classification

```
#
# Unsupervised Classification
#

# list the bands needed for classification
g.list type=raster mapset=. pattern=${BASE}_toar*.hpf

# add maps to an imagery group for easier management
i.group group=${BASE}_hpf subgroup=${BASE}_hpf \
 input=`g.list type=raster mapset=. pattern=${BASE}_toar*.hpf sep=","`

# statistics for unsupervised classification
i.cluster group=${BASE}_hpf subgroup=${BASE}_hpf \
 sig=${BASE}_hpf \
 classes=5 \
 separation=0.6
```

Create an imagery group for ease of management

Unsupervised classification

```
# list the bands needed for classification
g.list type=raster mapset=. pattern=${BASE}_toar*.hpf

# add maps to an imagery group for easier management
i.group group=${BASE}_hpf subgroup=${BASE}_hpf \
 input=`g.list type=raster mapset=. pattern=${BASE}_toar*.hpf sep=","`

# statistics for unsupervised classification
i.cluster group=${BASE}_hpf subgroup=${BASE}_hpf \
 sig=${BASE}_hpf \
 classes=5 \
 separation=0.6

# Maximum Likelihood unsupervised classification
i.maxlik group=${BASE}_hpf subgroup=${BASE}_hpf \
 sig=${BASE}_hpf \
 output=${BASE}_hpf.class \
 rej=${BASE}_hpf.rej
```

Get statistics -signatures- for unsupervised classification

Unsupervised classification

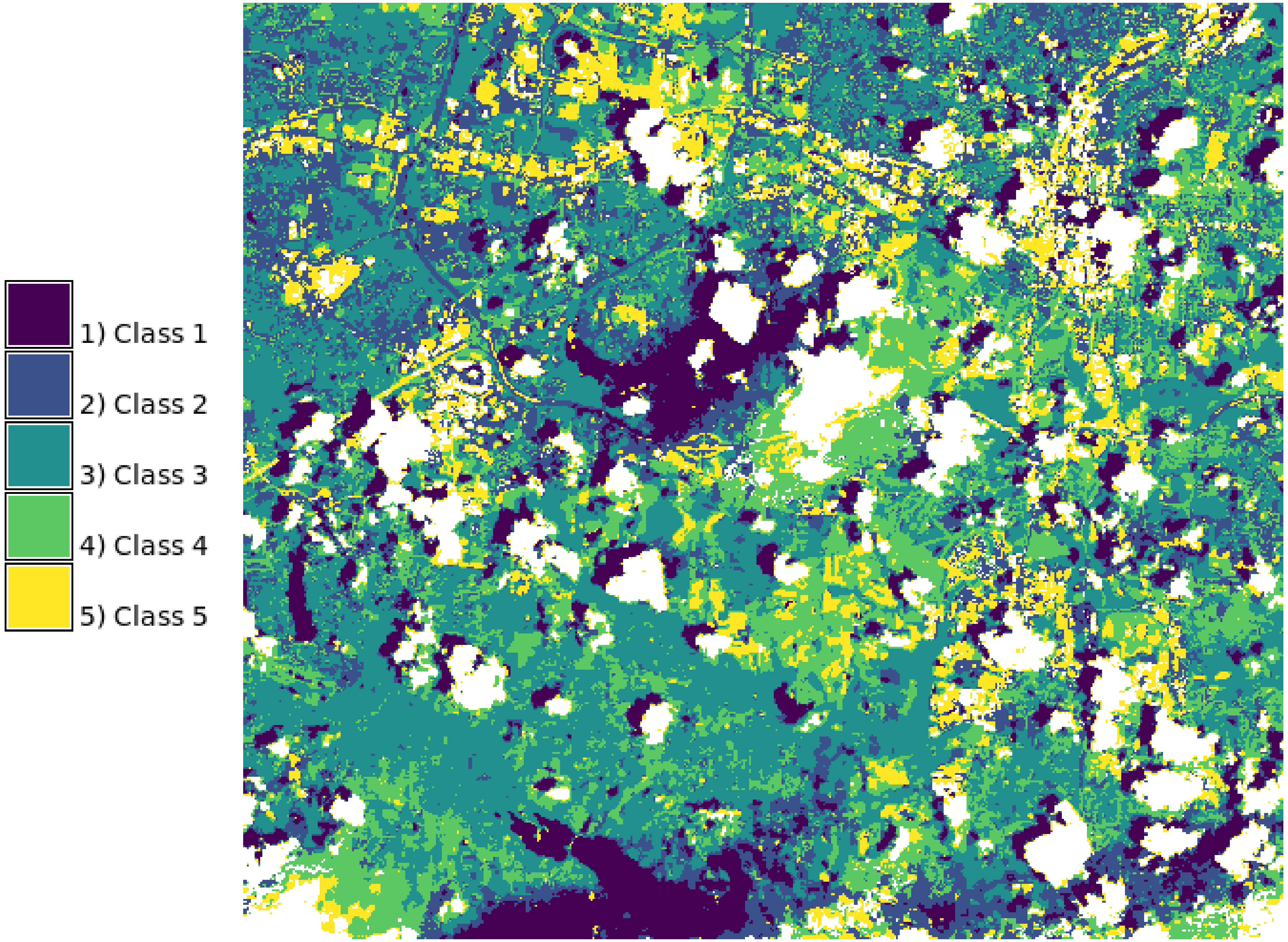
```
 input=`g.list type=raster mapset=. pattern=${BASE}_toar*.hpf sep=","`

# statistics for unsupervised classification
i.cluster group=${BASE}_hpf subgroup=${BASE}_hpf \
 sig=${BASE}_hpf \
 classes=5 \
 separation=0.6

# Maximum Likelihood unsupervised classification
i.maxlik group=${BASE}_hpf subgroup=${BASE}_hpf \
 sig=${BASE}_hpf \
 output=${BASE}_hpf.class \
 rej=${BASE}_hpf.rej

# display results
d.mon wx0
d.rast map=${BASE}_hpf.class
```

Unsupervised classification

Unsupervised classification

```
input=`g.list type=raster mapset=. pattern=${BASE}_toar*.hpf sep=,`

# statistics for unsupervised classification
i.cluster group=${BASE}_hpf subgroup=${BASE}_hpf \
 sig=${BASE}_hpf \
 classes=5 \
 separation=0.6

# Maximum Likelihood unsupervised classification
i.maxlik group=${BASE}_hpf subgroup=${BASE}_hpf \
 sig=${BASE}_hpf \
 output=${BASE}_hpf.class \
 rej=${BASE}_hpf.rej

# display results
d.mon wx0
d.rast map=${BASE}_hpf.class
```

Display classified map



Unsupervised classification - Landsat 8 image dated 16 June 2016

More derived information could be obtained from:

- texture measures (r.texture),
- diversity measures (r.diversity),
- contextual information (r.neighbors),
- etc.

Learn more about classification in GRASS GIS

- Topic classification in GRASS GIS manual
- Image classification in the GRASS wiki
- Classification examples at GRASS GIS course IRSAE 2018
- Classification with Random Forest at GRASS GIS presentation GEOSTAT 2018

QUESTIONS?

Thanks for your attention!!

GRASS GIS

Move on to:

Exercise 3: Working with Sentinel 2 images

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GitPitch