GRASS GIS in the sky

GRASS GIS as high-performance remote sensing toolbox

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https://grass.osgeo.org/

GRASS GIS Intro

GRASS GIS
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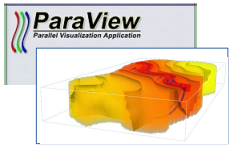
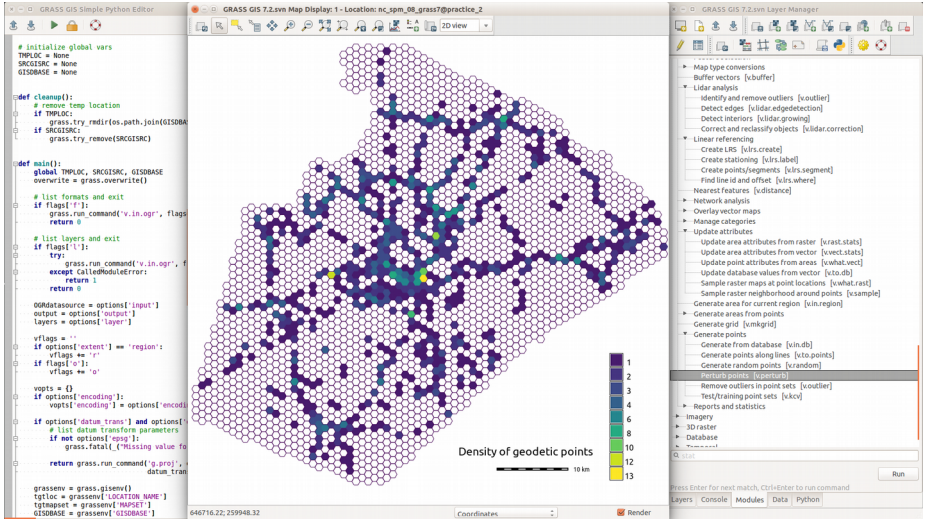
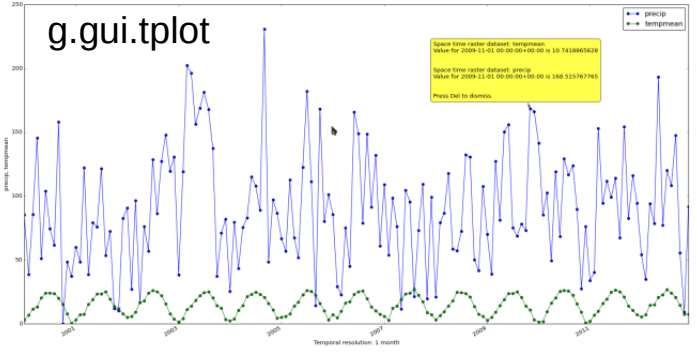
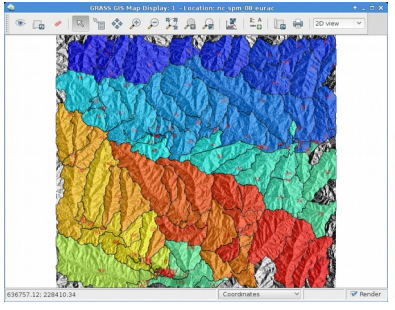
OSGeo Project

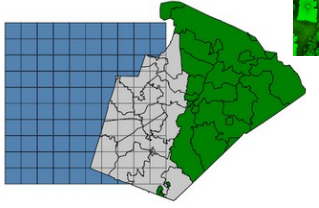
- Geographic Resources Analysis Support System
- Open Source GIS
- developed since 1984, since 1999 GNU GPL
- Portable code (many operating systems, 32/64bit)
- Your GIS backbone – linkable to:



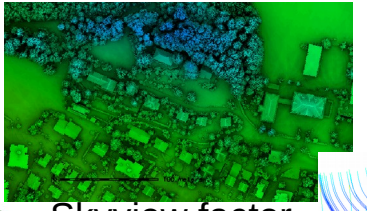


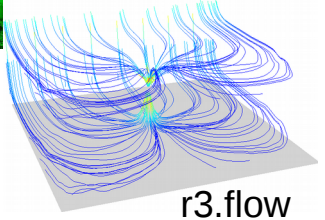






Skyview factor from LiDAR





r3.flow

GRASS GIS and Python

Using GRASS GIS from “outside” through “grass-session”

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```
pip install git+https://github.com/zarch/grass-session.git

# in future, the stable "grass-session" release
# will be available with:
# pip install grass-session
```

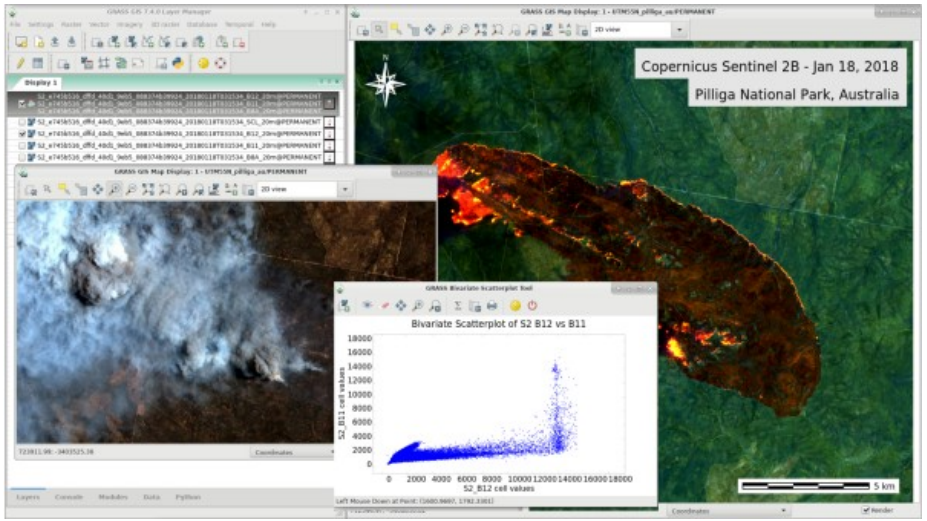
Finally easy use of GRASS GIS
as a processing backend in Python!

Combine with GDAL, OTB, ...

```python
#!/usr/bin/env python
# filename: test_session.py

from grass_session import Session
from grass.script import core as gcore

# create a new location from EPSG code (can also be a GeoTIFF or SHP or ... file)
with Session(gisdb="/tmp", location="location",
             create_opts="EPSG:4326"):
   # do something in permanent
   print(gcore.parse_command("g.gisenv", flags="s"))
# {u'GISDBASE': u"'/tmp/';",
#  u'LOCATION_NAME': u"'epsg3035';",
#  u'MAPSET': u"'PERMANENT';",}

# create a new mapset in an existing location
with Session(gisdb="/tmp", location="location", mapset="test",
             create_opts=""):
    # do something in the test mapset.
    print(gcore.parse_command("g.gisenv", flags="s"))
# {u'GISDBASE': u"'/tmp/';",
#  u'LOCATION_NAME': u"'epsg3035';",
#  u'MAPSET': u"'test';",}
```

GRASS GIS 7.4 Release

https://trac.osgeo.org/grass/wiki/Grass7/NewFeatures74



- New: Get demo data at start screen
- GUI: data catalog improved
- Most of ortho-rectification brought back
- r.in.gdal + r.external: provide support for import of raster maps exceeding 90N or 90S or with an EW extent larger than 360 degrees
- r.out.gdal: possibility to create overviews which enhances the compatibility with other GIS software packages
- v.clip added for easy vector clipping
- … (480 fixes and improvements with respect to 7.2.0)

GRASS GIS 7.4 Release

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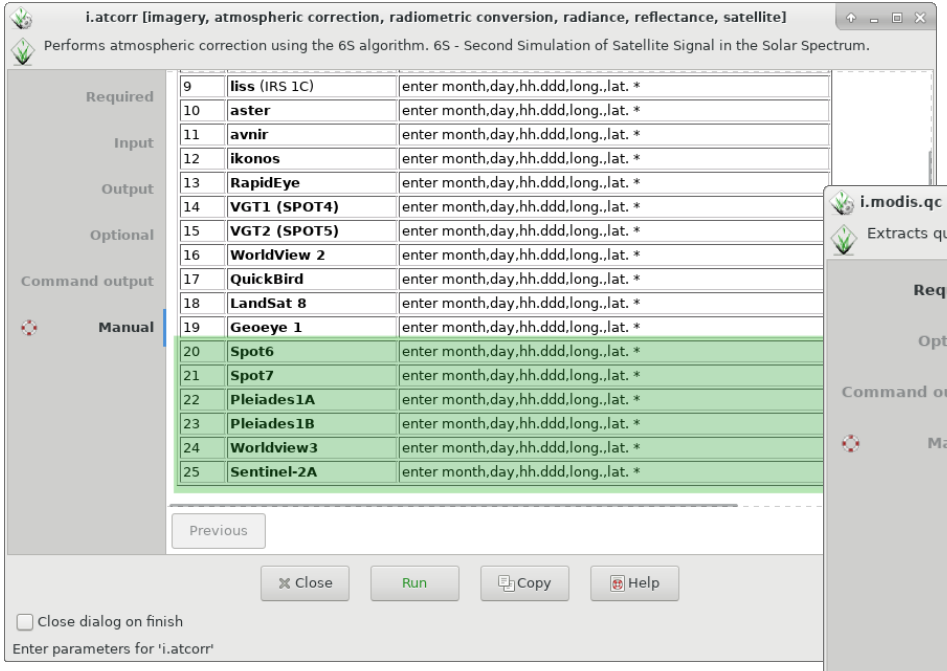
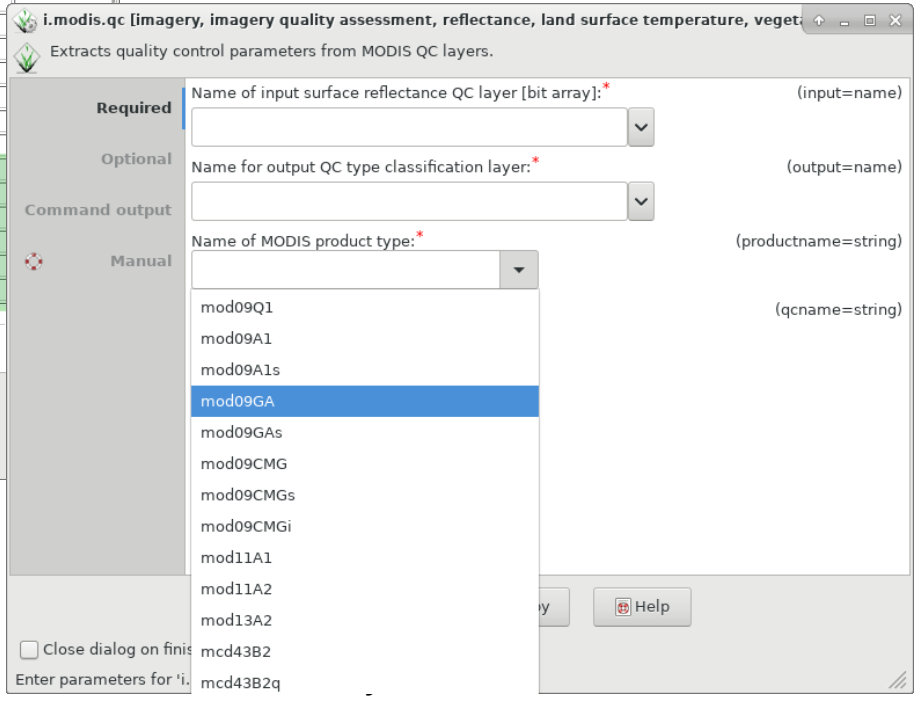
- Atmospheric correction updated with new satellites
- MODIS product processing made easy





Remote sensing in GRASS GIS : a long history

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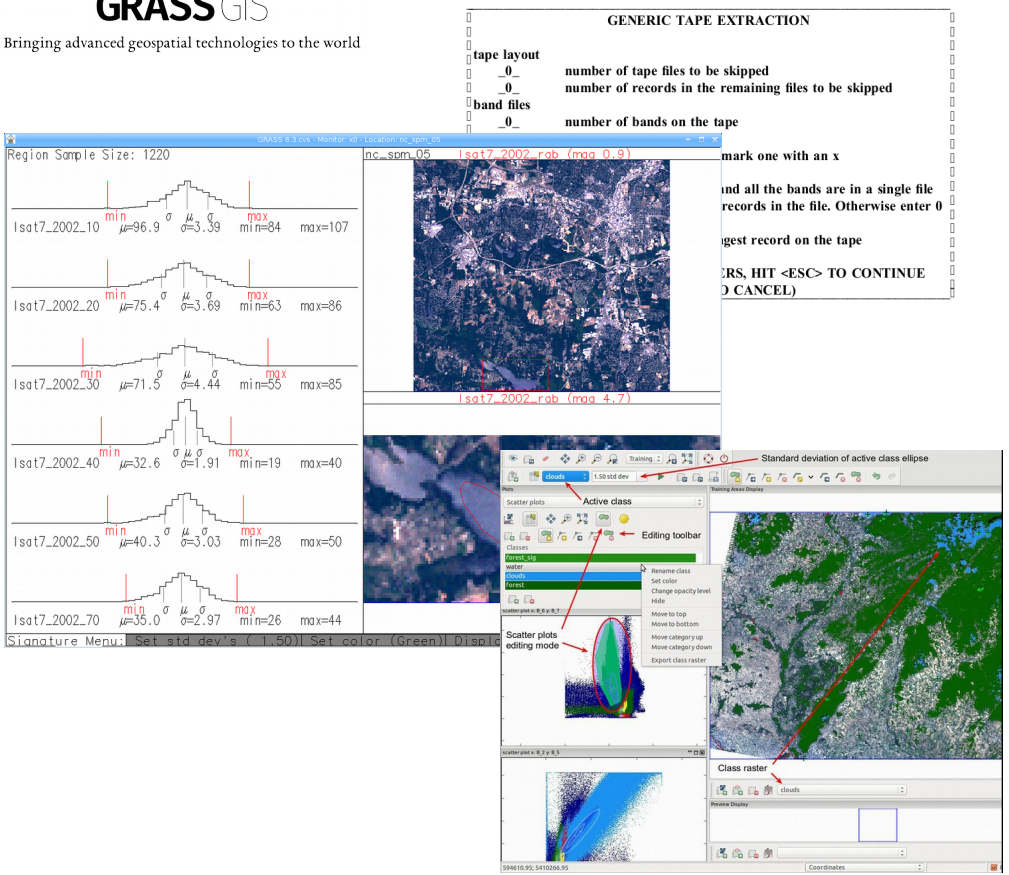
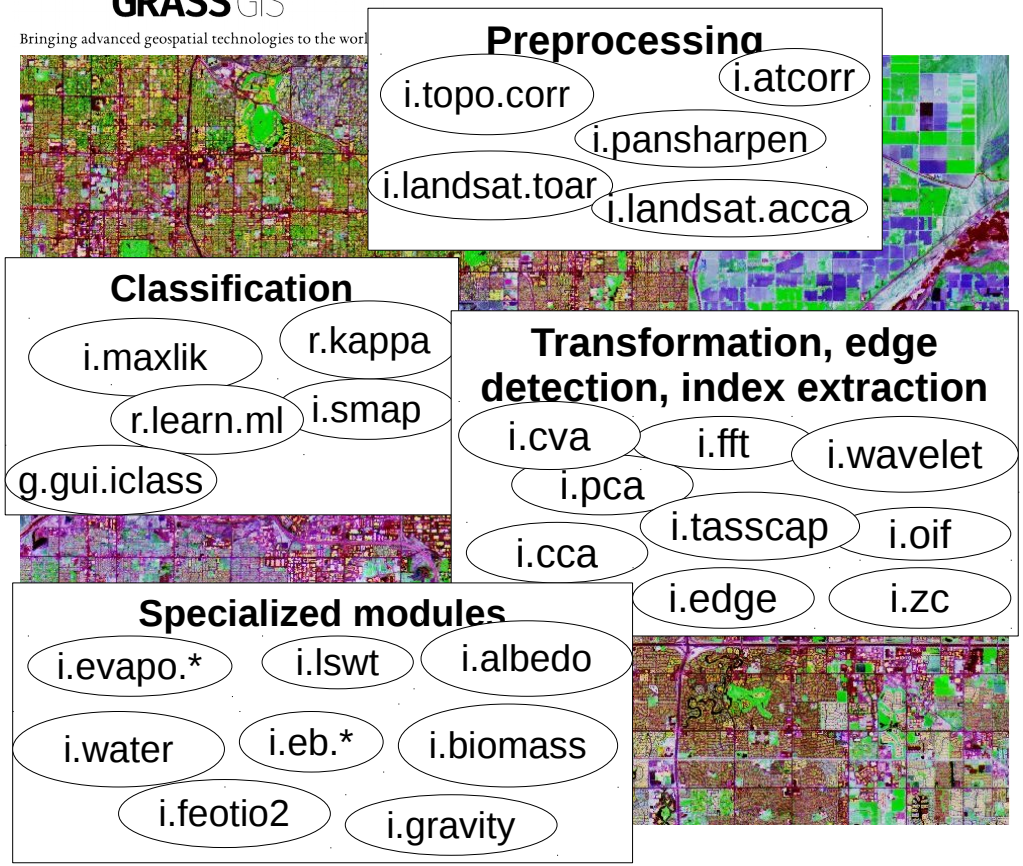


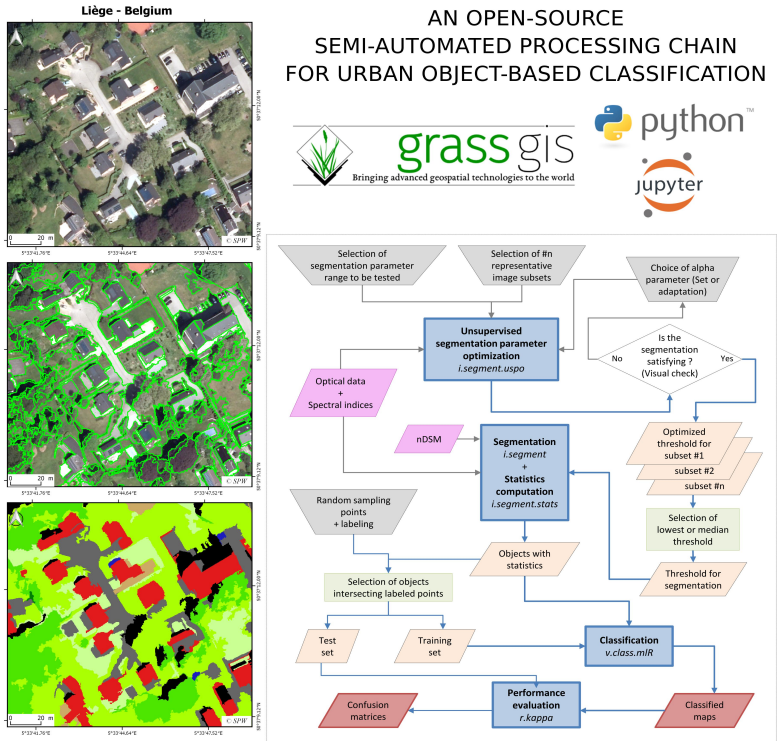
- Imagery submodule already available for GRASS 1.1 in 1986
- i.* modules fully integrated in version 3.0 in 1988
- Steady improvement and additions ever since
- From simple text terminal to X-monitors to a modern GUI
- Memory efficient modules

Remote sensing in GRASS GIS : pixel-based techniques



- Pixel-based tools for satellite and aerial imagery
- Most state-of-the-art methods implemented
- Complete toolchain from pre-processing to classification
- Many highly specialized tools

Remote sensing in GRASS GIS : object-based image analysis



source : http://dx.doi.org/10.3390/rs9040358

- Complete toolchain from segmentation to classification
- Including
  - unsupervised segmentation parameter optimization
  - high performance object statistics calculation
  - module-level parallelization
- Recently created module for SLIC superpixel creation

Remote sensing in GRASS GIS : plus so much more !

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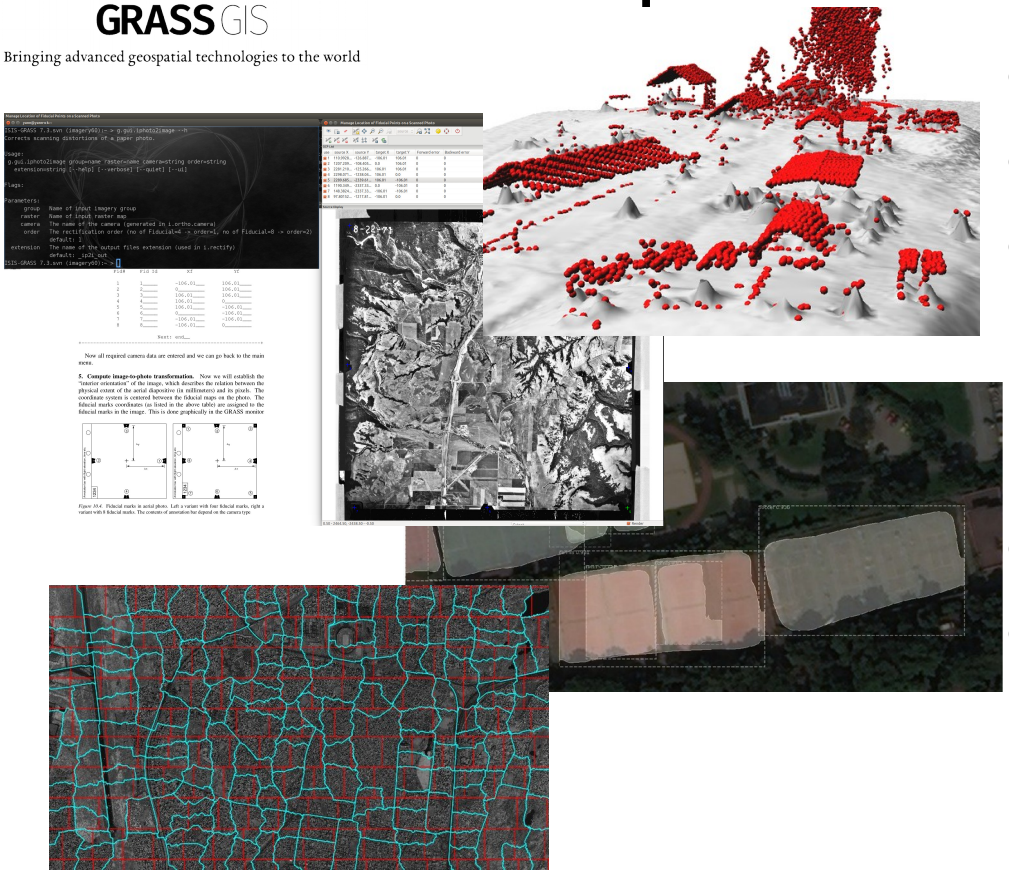
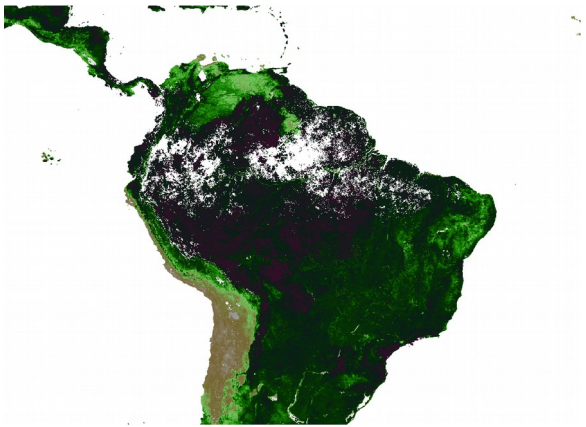
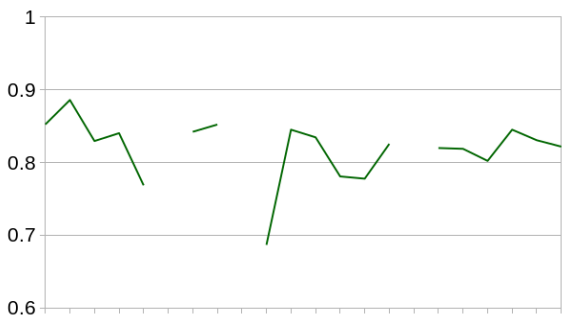


- Suite of LiDAR data tools
- Suite for creation of orthophotos
- Current developments :
  - convolutional neural networks
  - cutlines for semantically sensitive tiling
  - etc, etc
- Constantly growing list of extensions
- Permanent work on performance improvements

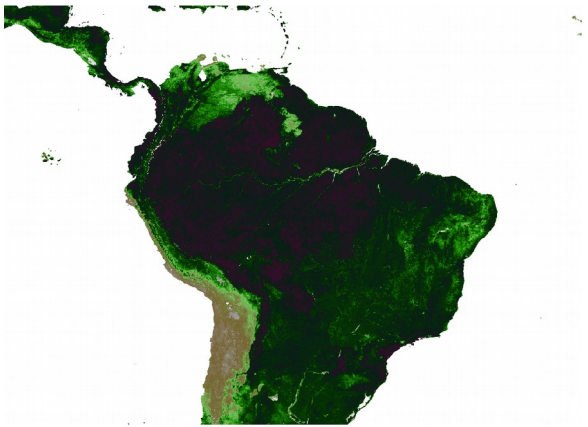
High-performance computing

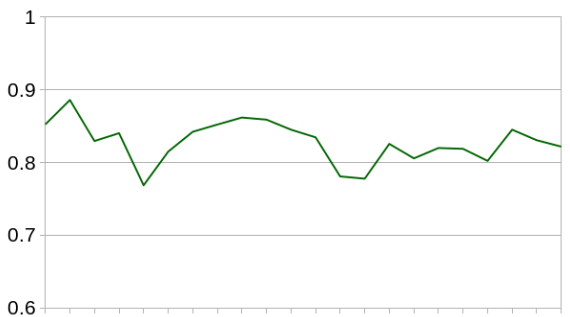
Example: NDVI time series





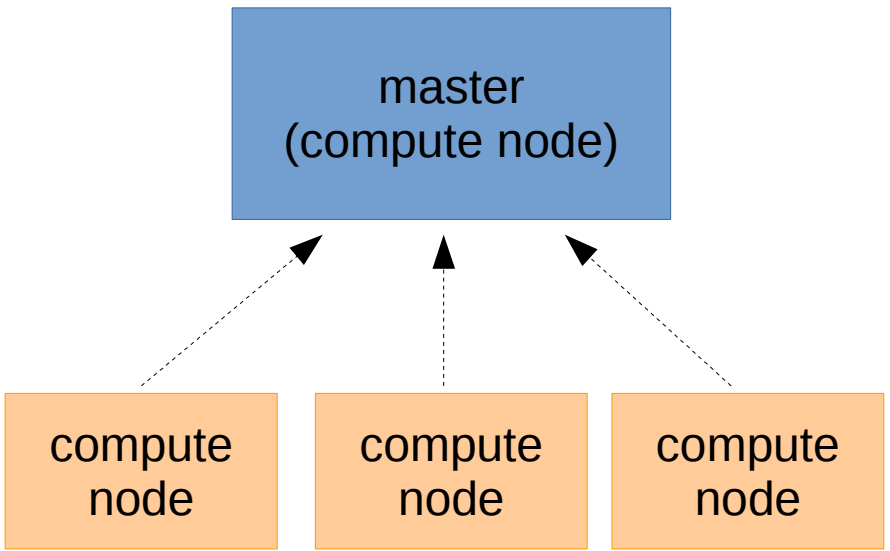
Harmonic Analysis of Time Series (HANTS)





High-performance computing

General HPC layout



Components

- master with job/queue manager
- compute nodes

  disk space per CPU core

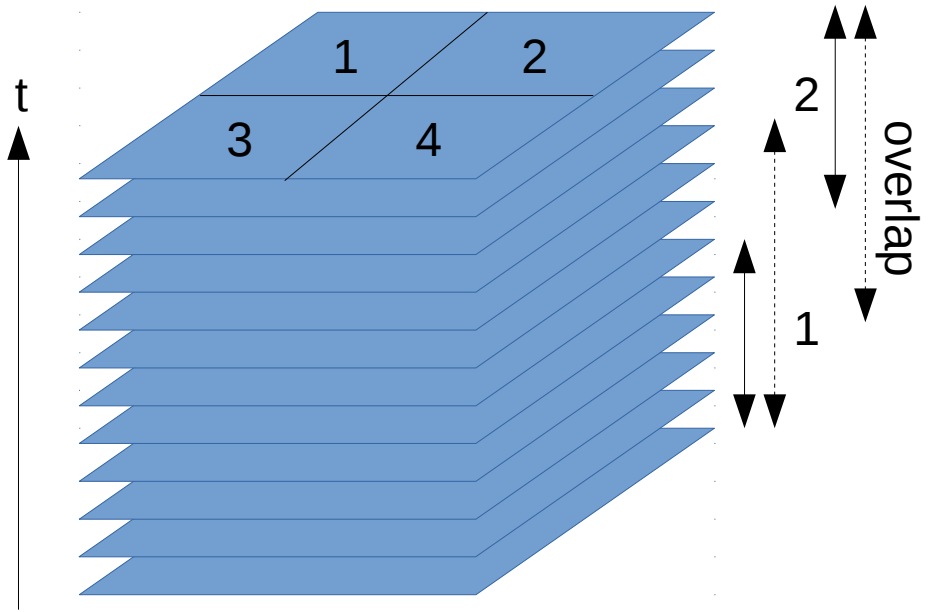
  RAM per CPU core

  ideally one SSD per node

Parallelization :
several GRASS commands
running at the same time

High-performance computing

Chunks for parallel processing



Temporal processing

- spatial chunks

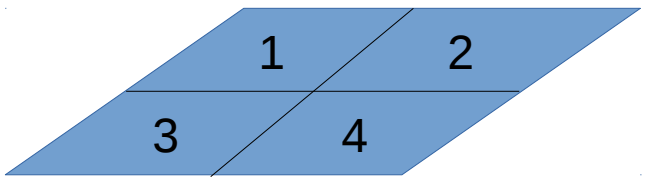
  need to be mosaiked at the end

  or

- temporal chunks

  need overlap

High-performance computing



Spatial chunks

computational region

- North, South, West, East
- rows, columns

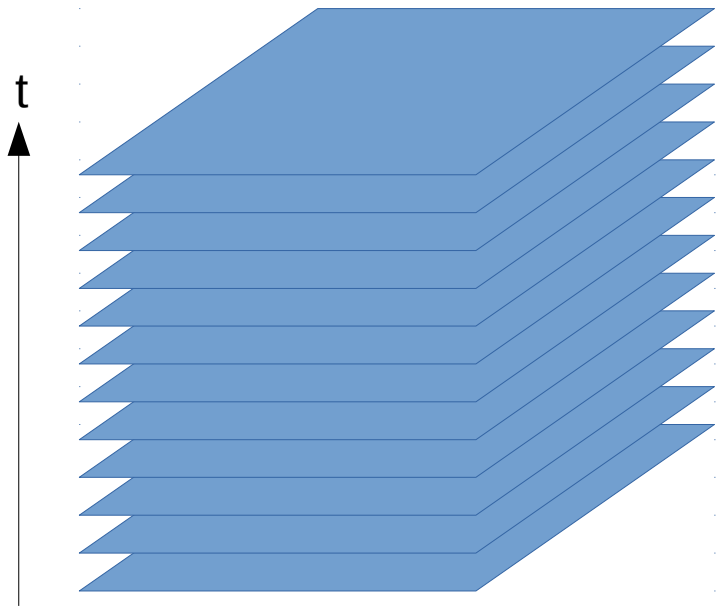
pre-defined regions,

one for each chunk (tile)

Alternative

- create X tiles from one raster map (r.tile)

High-performance computing



Chunks for parallel processing

Spatial processing

- each time step as one chunk

  or

- spatial chunks

  not recommended

  → spatial discontinuities

High-performance computing

script 1

GRASS commands

script 2

1. create unique GISRC, unique mapset
2. run *script 1*
3. copy results
4. delete GISRC, mapset

script 3

job manager settings
run *script 2*

always check return codes

GRASS installation setup

- environmental variables
- paths

GRASS session setup

- variable GISRC for rc file
  - GRASS database
  - location
  - mapset

High-performance computing

temporary GRASS GIS session

script 2

Arguments : first and last time step

1. **create temporary GISRC, mapset**
   with unique names, using a pre-defined mapset template
2. run *script 1* in temporary mapset
3. copy results, one for each time step, from temporary mapset to final mapset
4. **delete temporary GISRC, mapset**
   rm -rf $GISRC */path/to/temp_mapset*

GISRC: name of file with GRASS variables

GISRC contents:

- GISDBASE: name
- LOCATION_NAME: name
- MAPSET: name

} directories

LOCATION_NAME: sub-directory of GISDBASE

MAPSET: sub-directory of LOCATION_NAME

export GISRC=/path/to/tmpgisrc

Ideally all on a SSD scratch disk

http://grass.osgeo.org/wiki

High-performance computing

job with task(s), here task = script 2

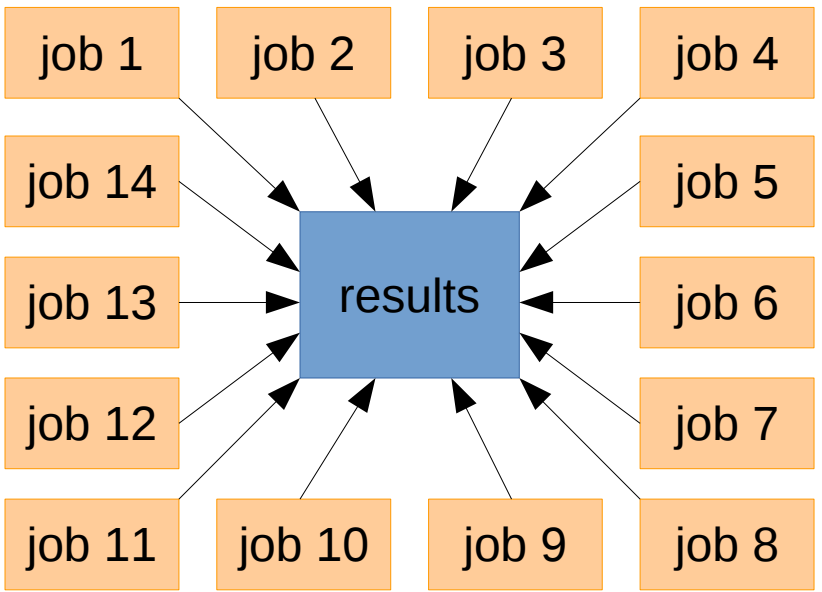
job 1 : running
job 2 : running
job 3 : running
job 4 : running
job 5 : **waiting**
job 6 : **waiting**
job 7 : **waiting**
job 8 : **waiting**

waiting : no hardware resources available

job/queue manager

- Select / create a queue
- submit a job to a queue
- start a job when hardware resources are available
- redirect stdout and stderr to unique files

High-performance computing



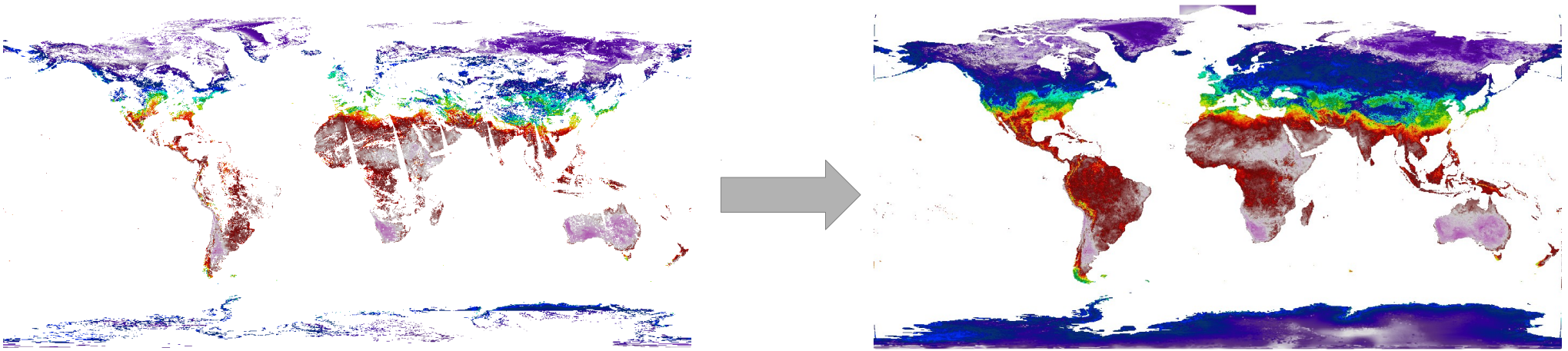
Collect results

- Copy results to one common GRASS mapset
  - → this is the I/O bottleneck
  - try nice / ionice

cluster file systems

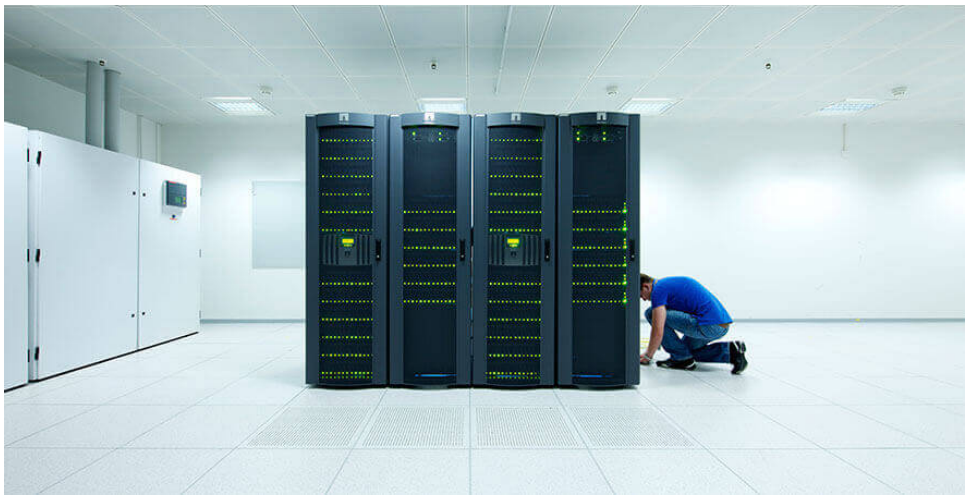
High-performance computing

MODIS Land Surface Temperature



temporal + spatial processing

High-performance computing



Most important

Have a **good admin**

that fixes the system

after you broke it

Neteler M, Metz M, 2011 – 2018, pers. com.