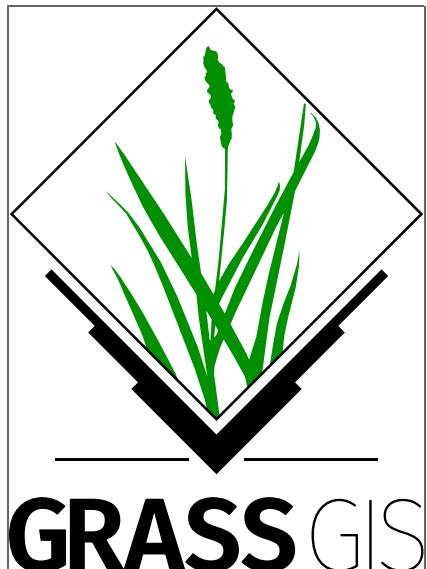


GRASS GIS 8: from Desktop to Big Data Cubes

Markus Neteler

& Verónica Andreo, Vaclav Petras, Anna Petrasova



Open Source Geospatial Slovenija 2022

github.com/neteler/grass-gis-talks-markus/

About the presenter...

- Co-founder and senior consultant at mundialis, Bonn (DE)
- PhD in Geography, Univ. of Hannover
- Years of researcher's life in Trento, Italy
- Since 2016 in Bonn, Germany @ mundialis
- Since 1997 active in the **GRASS GIS** project
- Co-founder of **OSGeo**, GFOSS.it and FOSSGIS e.V.

<https://www.mundialis.de/neteler/>



Overview of this talk

- For newcomers: which GRASS GIS?
- A better GUI experience in GRASS 8.2+
- Interfaces to other software
- Exciting new features in GRASS 8.2+
- GRASS GIS is ready for the cloud
- Community contributions
- Get involved

For newcomers: which GRASS GIS?

- **GRASS GIS** (Geographic Resources Analysis Support System), a FOSS suite used for geospatial data management and analysis, image processing, spatial modeling, and visualization.
- Originally developed by the U.S. Army CERL for land management and environmental planning (1982-1995).
- Founding member of OSGeo (2006)
- **39 years of continuous geospatial development**

The 1st user manual for (what would become) GRASS GIS was published by J. Westervelt and M. O'Shea on 29 July 1983...

This is why the GRASS GIS #community celebrates today 39 years of continuous #opensource development & geospatial coolness!! 😁

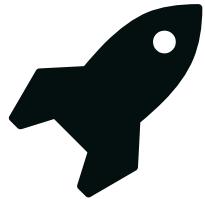
Happy birthday #GRASSGIS!! 🎉🥳🍺



GRASS GIS general features

- Free and open source, you can use, modify, improve, share
- Large amount of tools: **+500 core modules, +300 addons**
- Graphical User Interface and command line
- C API, Python API and libraries
- Interface/connection with R, QGIS, REST API, WPS, etc.
- Different data types supported: raster (including satellite imagery), **3D raster or voxel**, vector and, space-time datasets.

A better GUI experience in GRASS 8.2+

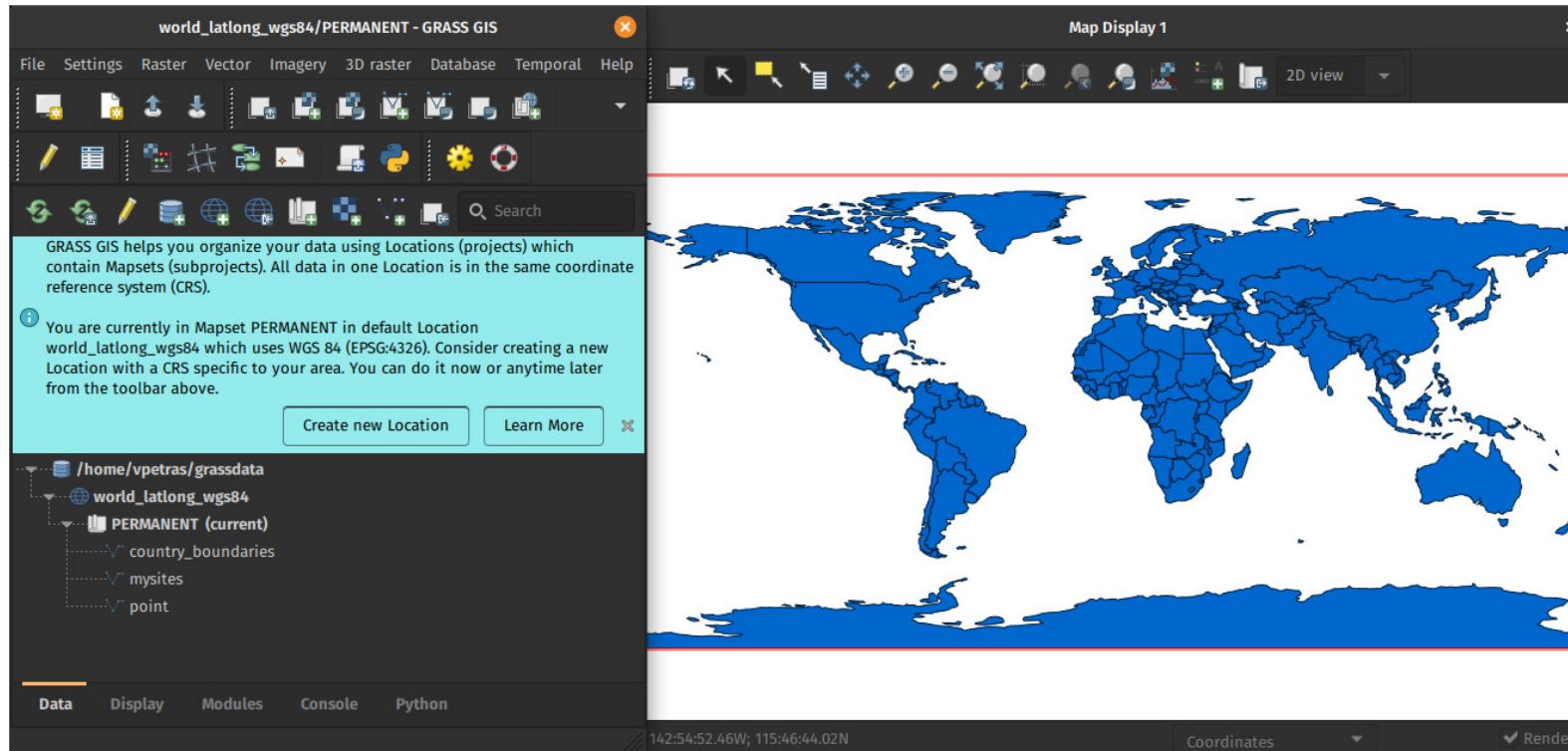


Improved First-time User Experience



Improved First-time User Experience

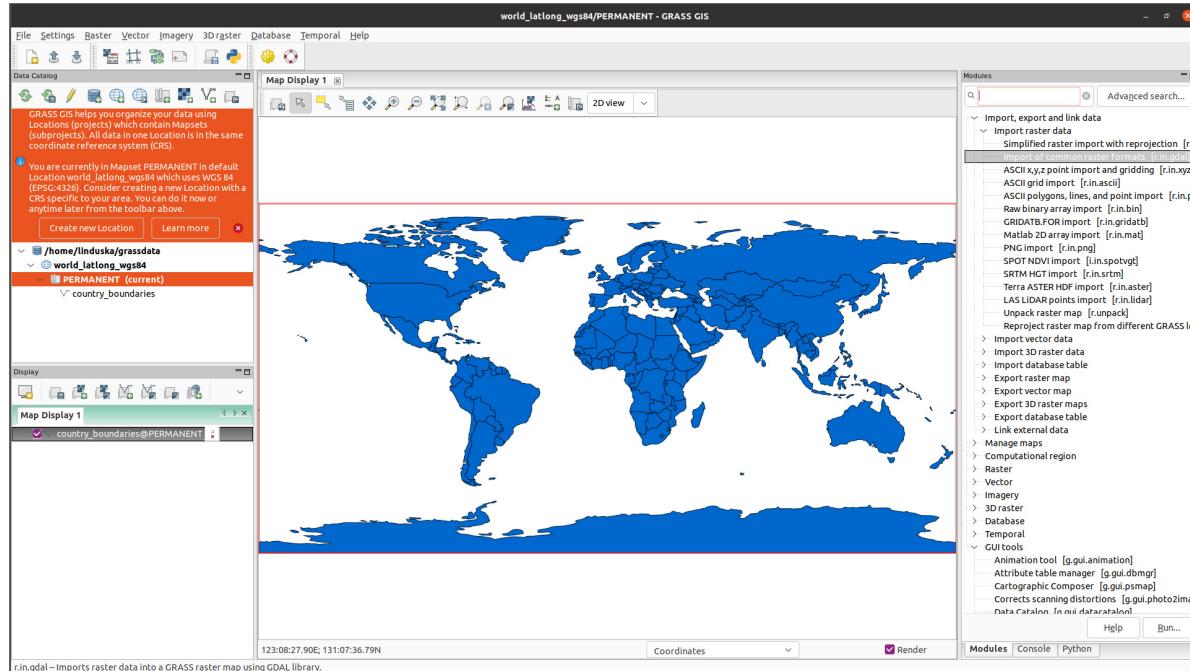
Initial project sets up automatically. Guidance provided for next steps.



by Linda Kladivova & rest of the community (many reviews, calls, user surveys, ...)

Single-Window GUI

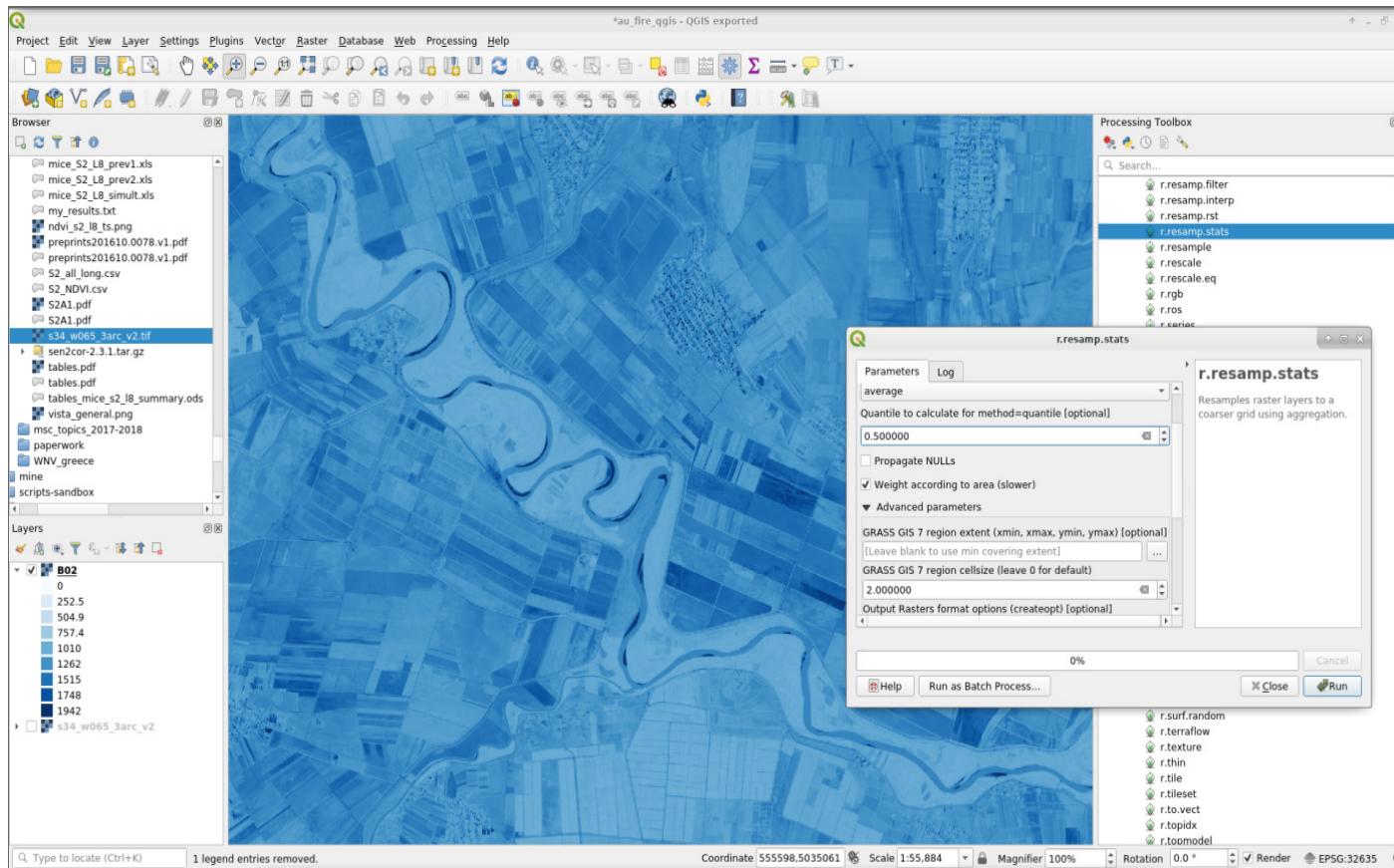
Integration of results from Google Summer of Code 2021



One GUI window with optimized layout with dockable widgets.
by Linda Kladivova

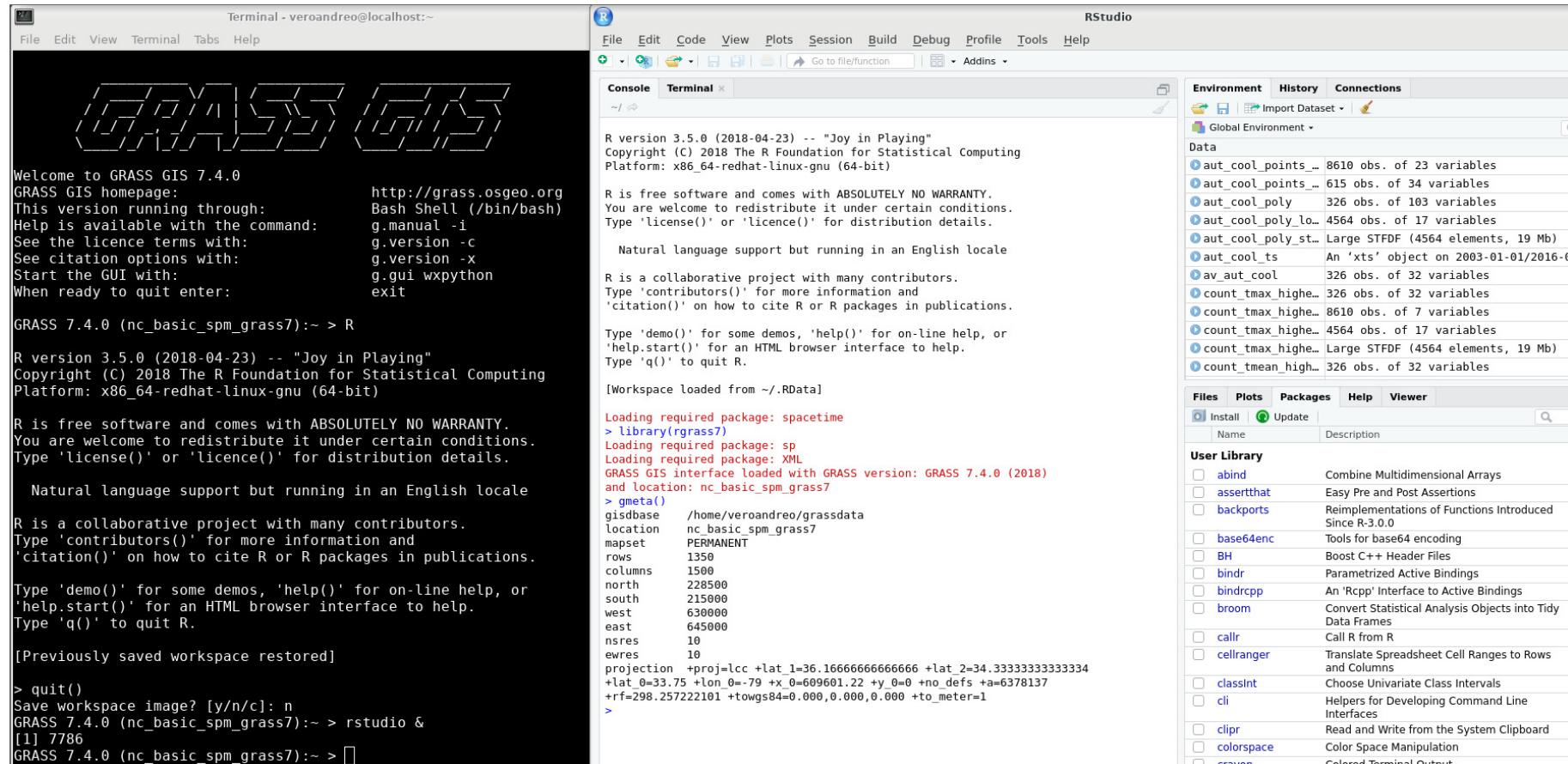
Available in 8.2+: *Settings > Preferences > General*

QGIS Interface



Using GRASS through "Processing" in QGIS

R Interfaces



The image shows two side-by-side windows. On the left is a terminal window titled "Terminal - veroandreo@localhost:~". It displays the GRASS GIS 7.4.0 welcome message, which includes a small logo of a map made of lines. Below the logo, it provides information about the version, homepage, and how to use the command-line interface. It also shows the R version 3.5.0 prompt and some basic R code related to the GRASS interface.

On the right is the RStudio interface. The title bar says "RStudio". The main area has tabs for "Console" and "Terminal". The "Console" tab shows the same R code and output as the terminal window. The "Terminal" tab shows the GRASS GIS 7.4.0 welcome message. The right pane of RStudio contains the "Environment" tab, which lists various R objects such as "aut_cool_points_nc" and "aut_cool_poly". It also includes sections for "Files", "Plots", "Packages", "Help", and "Viewer".

```
Terminal - veroandreo@localhost:~
```

```
File Edit View Terminal Tabs Help
```

```
Welcome to GRASS GIS 7.4.0
GRASS GIS homepage: http://grass.osgeo.org
This version running through: Bash Shell (/bin/bash)
Help is available with the command: g.manual -i
See the licence terms with: g.version -c
See citation options with: g.version -x
Start the GUI with: g.gui wxpython
When ready to quit enter: exit

GRASS 7.4.0 (nc_basic_spm_grass7):~ > R

R version 3.5.0 (2018-04-23) -- "Joy in Playing"
Copyright (C) 2018 The R Foundation for Statistical Computing
Platform: x86_64-redhat-linux-gnu (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

  Natural language support but running in an English locale

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

[Previously saved workspace restored]

> quit()
Save workspace image? [y/n/c]: n
GRASS 7.4.0 (nc_basic_spm_grass7):~ > rstudio &
[1] 7786
GRASS 7.4.0 (nc_basic_spm_grass7):~ > 
```

```
RStudio
```

```
File Edit Code View Plots Session Build Debug Profile Tools Help
```

```
Console Terminal x
```

```
R version 3.5.0 (2018-04-23) -- "Joy in Playing"
Copyright (C) 2018 The R Foundation for Statistical Computing
Platform: x86_64-redhat-linux-gnu (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
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Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

[Workspace loaded from ~/.RData]

Loading required package: spacetime
> library(rgrass7)
Loading required package: sp
Loading required package: XML
GRASS GIS interface loaded with GRASS version: GRASS 7.4.0 (2018)
and location: nc_basic_spm_grass7
> gmeta()
gisbase   /home/veroandreo/grassdata
location  nc_basic_spm_grass7
mapset    PERMANENT
rows      1350
columns   1500
north     228500
south     215000
west      630000
east      645000
nsres     10
ewres     10
projection +proj=lcc +lat_1=36.16666666666666 +lat_2=34.3333333333334
+lat_0=33.75 +lon_0=-79 +x_0=609601.22 +y_0=0 +no_defs +a=6378137
+rf=298.257222101 +towgs84=0.000,0.000,0.000 +to_meter=1
>
```

```
Environment History Connections
```

```
Global Environment
```

```
Data
```

- aut_cool_points_nc 8610 obs. of 23 variables
- aut_cool_points_nc 615 obs. of 34 variables
- aut_cool_poly 326 obs. of 103 variables
- aut_cool_poly_lo_ 4564 obs. of 17 variables
- aut_cool_poly_st_ Large STFDF (4564 elements, 19 Mb)
- aut_cool_ts An 'xts' object on 2003-01-01/2016-01-01
- av_aut_cool 326 obs. of 32 variables
- count_tmax_highe_ 326 obs. of 32 variables
- count_tmax_highe_ 8610 obs. of 7 variables
- count_tmax_highe_ 4564 obs. of 17 variables
- count_tmax_highe_ Large STFDF (4564 elements, 19 Mb)
- count_tmean_high_ 326 obs. of 32 variables

```
Files Plots Packages Help Viewer
```

```
Install Update
```

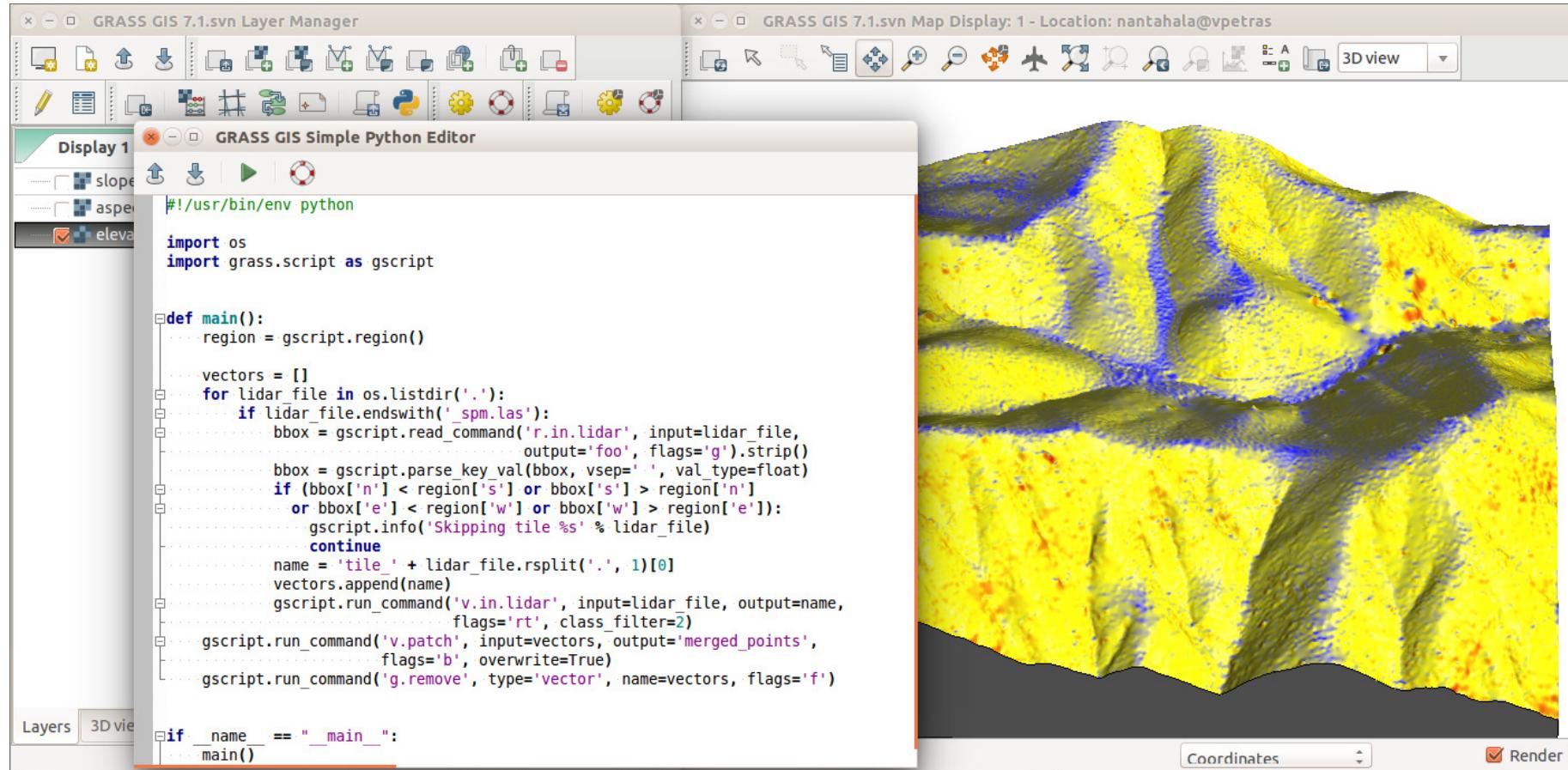
```
Name Description
```

```
User Library
```

- abind Combine Multidimensional Arrays
- assertthat Easy Pre and Post Assertions
- backports Reimplementations of Functions Introduced Since R-3.0.0
- base64enc Tools for base64 encoding
- BH Boost C++ Header Files
- bindr Parametrized Active Bindings
- bindrcpp An 'Rcpp' Interface to Active Bindings
- broom Convert Statistical Analysis Objects into Tidy Data Frames
- callr Call R from R
- cellranger Translate Spreadsheet Cell Ranges to Rows and Columns
- classInt Choose Univariate Class Intervals
- cli Helpers for Developing Command Line Interfaces
- clipr Read and Write from the System Clipboard
- colorspace Color Space Manipulation
- crayon Colored Terminal Output

Using GRASS through R and Rstudio

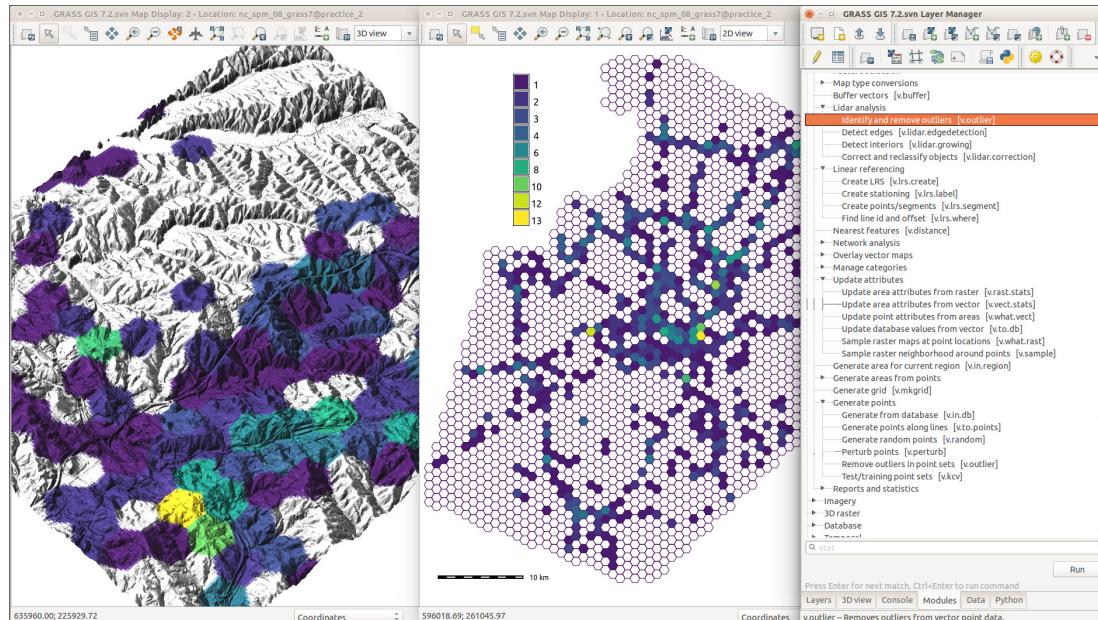
Python Interface



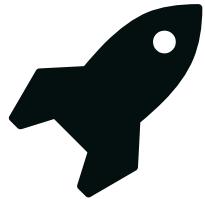
Python and GRASS

All-in-one software suite

- All matured tools available right away
- Download of experimental tools possible
- Network analysis, hydrology, remote sensing, OBIA, time series, ...

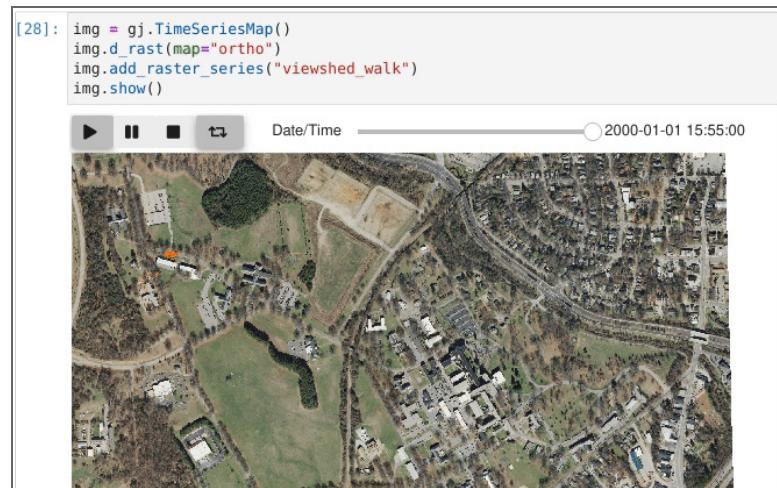
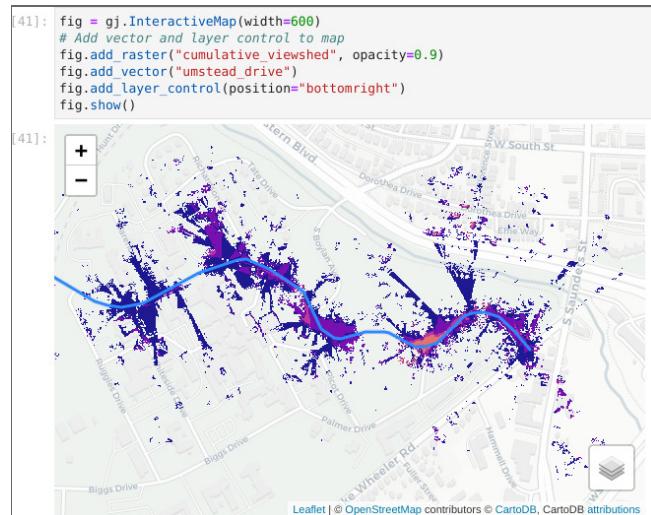


Exciting new features in GRASS 8.2+



Integration of GRASS GIS and Jupyter Notebooks

- Notebooks: Mix of text, code, results, images, ...
- Usage: Prototyping, reproducibility, tutorials, ...
- Now in GRASS GIS: Python functions for easy integration

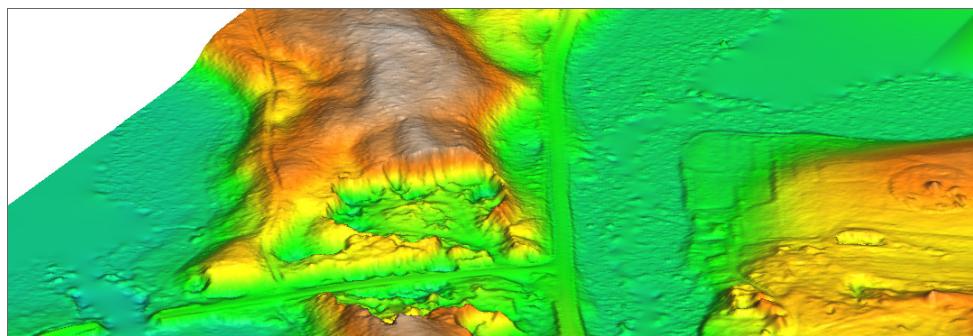
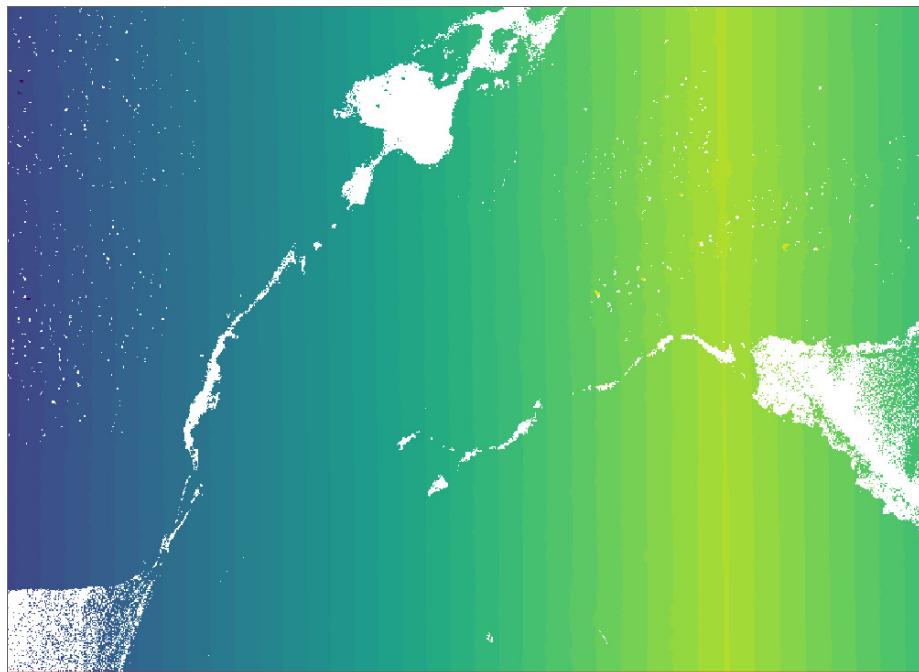


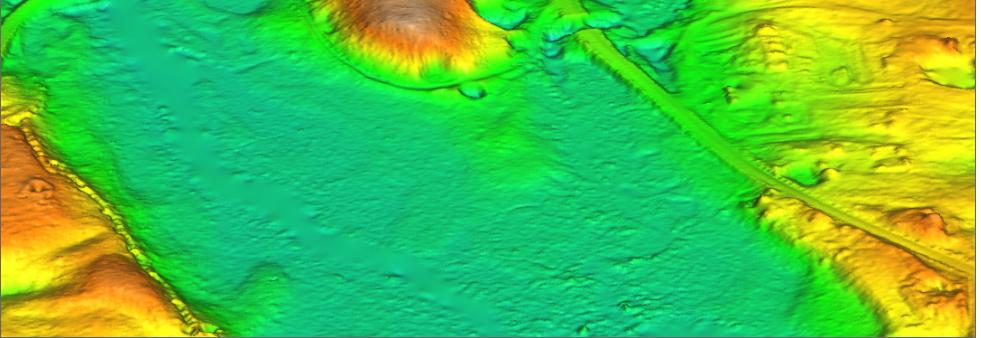
tinyurl.com/grass-rc2 (run in Binder)

by Vaclav Petras, Anna Petrasova, Caitlin Haedrich

Fast LiDAR data import with PDAL

- import of any point dimension (including user defined ones e.g. from PDAL filters)
- support of 19 binning methods (including eigenvalues)
- point filtering by values in any dimension





by Vaclav Petras and Māris Nartišs

GRASS GIS is ready for the cloud



GRASS in docker containers

- Different flavours
- Built and updated automatically
- Can be deployed anywhere you need them

The screenshot shows the 'GRASS GIS for Docker' website. At the top, there's a navigation bar with 'Quick links' to GRASS 8.2 (current), GRASS 7.8 (legacy), and GRASS 8.3 (preview). Below this is a note that GRASS GIS Docker Images are provided and maintained by mundialis. A link to a version matrix for GRASS GIS, PROJ, GDAL, and PDAL is also present. The main content area is titled 'GRASS GIS 8.2.0 (current)'. It contains a note that the Docker images are generated from the GRASS GIS releasebranch_8_2. Below this, there are four items listed with their Docker image names and sizes:

- Alpine based (190 MB, with Python 3 and PDAL)
docker pull mundialis/grass-py3-pdal:8.2.0-alpine
- Debian 10 based (1.2 GB, with Python 3 and PDAL)
docker pull mundialis/grass-py3-pdal:8.2.0-debian
- Ubuntu 20.04 based (1.3 GB, with Python 3 and PDAL)
docker pull mundialis/grass-py3-pdal:8.2.0-ubuntu

See <https://grass.osgeo.org/download/docker/>

actinia: The GRASS GIS REST API

- Open source REST API for scalable, distributed, high performance processing of geo data using GRASS GIS
- More details in this [FOSS4G presentation](#)
- Wanna try? Follow this [tutorial](#) for a demo user
- Available on : https://github.com/mundialis/actinia_core



```
Resource accepted
Resource poll status: finished
Processing successfully finished

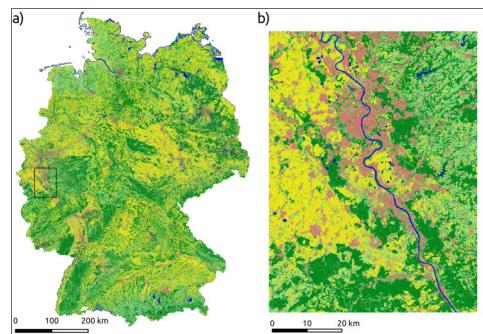
+-----+
| Map: treecover2000@hansen_global_f Date: Fri Apr 9 22:17:
| Mapset: hansen_global_forest_south_am Login of Creator: mundialis
| Location: latlong_wgs84
| DataBase: /actinia_core/workspace/temp_db/gisdbase_a735a33f8c894
| Title: treecover2000
| Timestamp: none
+-----+
| Type of Map: raster          Number of Categories: 100
| Data Type: CELL
| Rows: 136000
| Columns: 152000
| Total Cells: 20672000000
| Projection: Latitude-longitude
|   N: 51S 17E  S: 51S 76W Res: 0:00:00.9
|   E: 38W  W: 76W Res: 0:00:00.9
| Range of data: min = 1 max = 100
| Data Description:
|   generated by r.in.gdal
| Comments:
|   r.in.gdal -a -k -r input="treecover2000 epsg4326.tif" output=
|   ver2000* memory=13896 offset=0 num_digits=0
+-----+
{'resources': [], 'status': 'https://actinia.mundialis.de/api/v1/resources/veroandreo/resource_id:f88d8608-f1b6-4738-a361-91288370041b'}  
GRASS :-> ace location="latlong_wgs84" render_raster="treecover2000@hansen_global_forest_south_america"  
Trying to render raster_layers map treecover2000 of mapset hansen_global_forest_south_america  
[INFO]
```

by Carmen Tawalika, Anika Weinmann, Markus Neteler, Sören Gebbert, ...

Germany land-cover mapping based on Sentinel-2 data

GRASS modules in use (excerpt):

- *i.vi*
- *t.rast.series*
- *r.learn.ml2*
- *r.change.info*

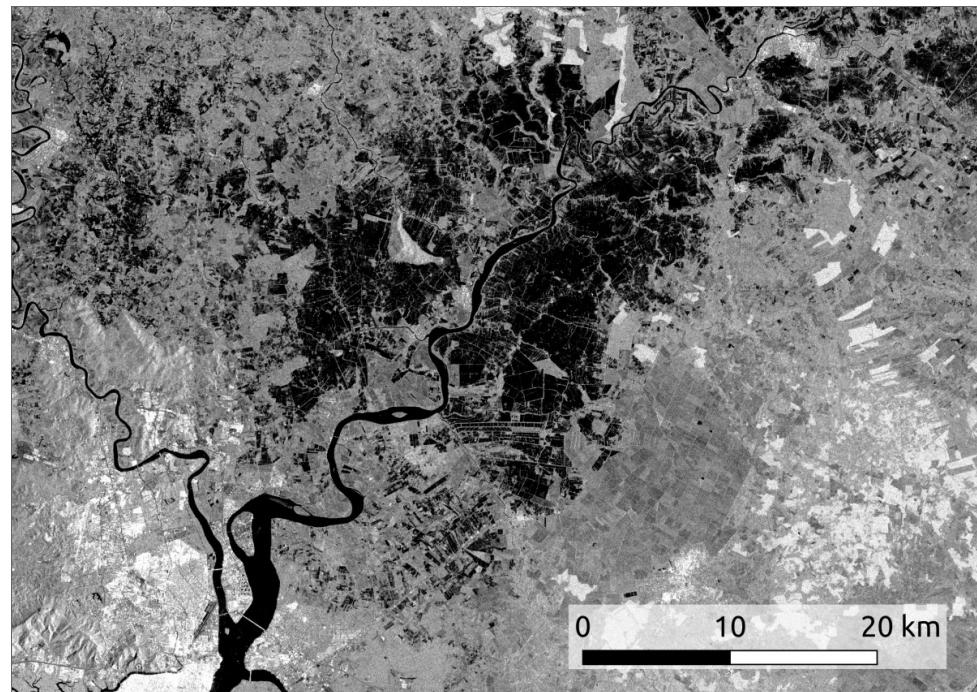


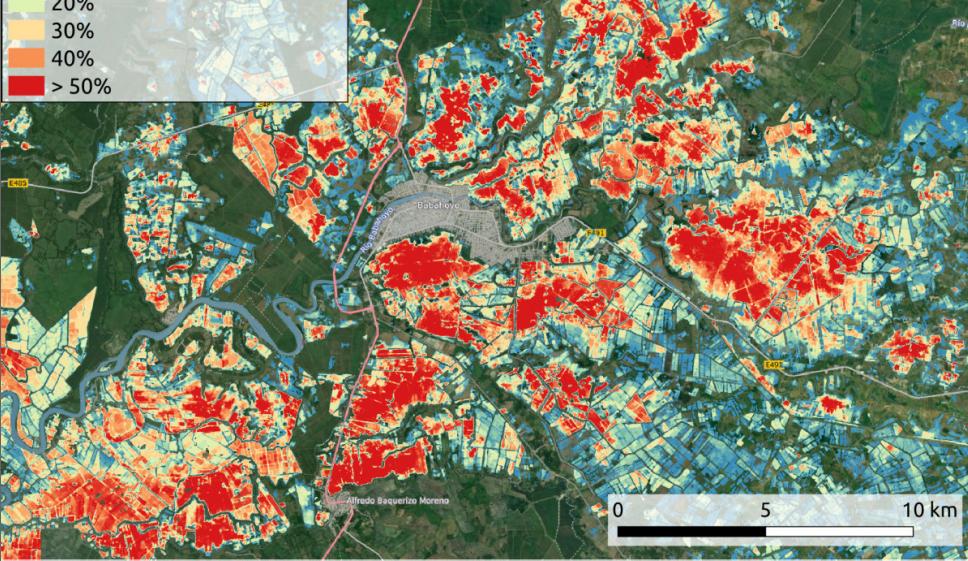
For details, follow [this](#) blog post.

Flood Mapping in Ecuador based on Sentinel-1 data

GRASS modules in use (excerpt):

- *r.mapcalc*
- *i.segment*
- *t.rast.algebra*
- *t.rast.series*





For details, follow [**this**](#) blog post.

Selected addons contributed by the community



Spatial Query of Projections

g.projpicker queries projections spatially using user-drawn geometries and set-theoretic logical operators. It requires [ProjPicker](#).

The screenshot shows a map of the southeastern United States with state boundaries and major cities labeled. A red polygon is drawn over the state of North Carolina. Below the map is a modal window titled "Query". The window contains a table of projection options:

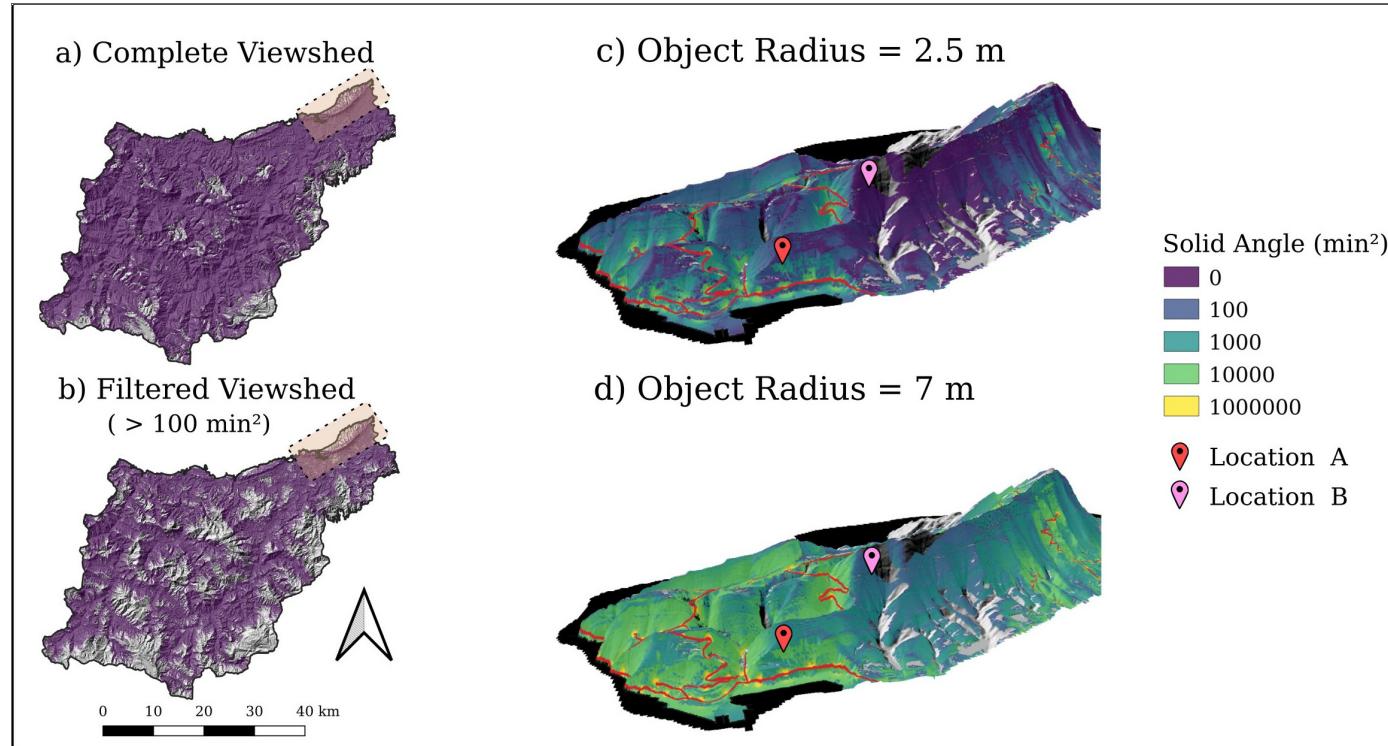
ID	Name
EPSG:8768	NAD83 / North Carolina (ftUS) + NAVD88 ...
EPSG:2264	NAD83 / North Carolina (ftUS)
EPSG:32019	NAD27 / North Carolina
EPSG:32119	NAD83 / North Carolina
EPSG:3358	NAD83(HARN) / North Carolina
EPSG:3359	NAD83(HARN) / North Carolina (ftUS)
EPSG:3404	NAD83(HARN) / North Carolina (ftUS)
EPSG:3631	NAD83(NSRS2007) / North Carolina
EPSG:3632	NAD83(NSRS2007) / North Carolina (ftUS)
EPSG:6542	NAD83(2011) / North Carolina
EPSG:6543	NAD83(2011) / North Carolina (ftUS)
ESRI:102719	NAD_1983_StatePlane_North_Carolina_Fl...
ESRI:103121	NAD_1983_2011_StatePlane_North_Caroli...
ESRI:103122	NAD_1983_2011_StatePlane_North_Caroli...
ESRI:103500	NAD_1983_CORS96_StatePlane_North_C...
ESRI:103501	NAD_1983_CORS96_StatePlane_North_C...

Below the table is a search bar with the placeholder "Search" and two buttons: "Query" and "Cancel".

addon by Huidae Cho

Can you see that landslide??

r.survey allows to assess whether objects of certain size could be detected by an observer moving along roads or sitting on a flying object



addon by Ivan Marchesini

Visual Exposure to a Defined Source

r.viewshed.exposure - Weighted cumulative viewshed analysis defining visual exposure to a source



addon by Zofie Cimburova and Stefan Blumentrath

Get involved! Your contribution is welcome!



Code contributions

GRASS GIS development is GitHub-centered: core, addons, website

- File bug reports or feature requests
- All issues and PR's are publicly visible
- Ask, comment, suggest also in Github **Discussions**
- *"Fork me on [GitHub](#)"* and suggest changes or fix bugs via pull requests
- Create your own addon! See this nice workshop for a guideline: **How to write a Python tool for GRASS**

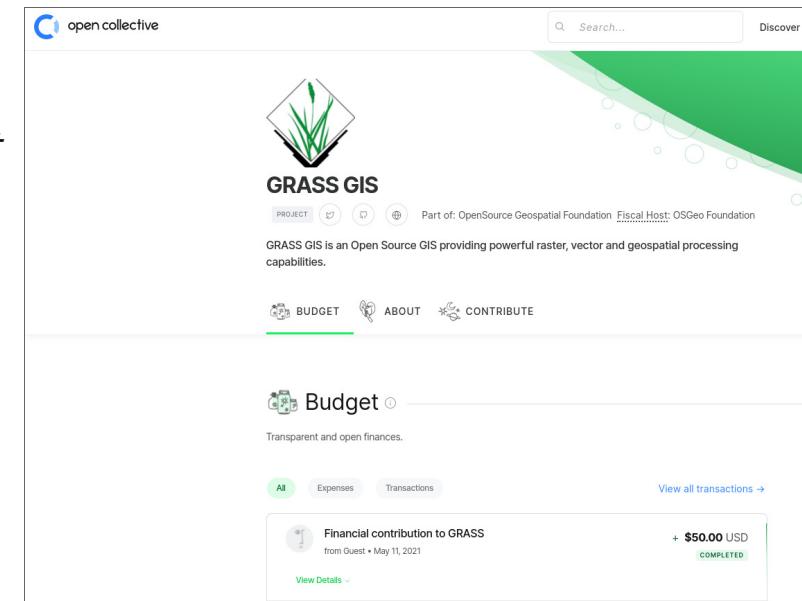


Sponsoring: how to...?

- Individuals:
 - Time: organize virtual community event, fix typos, ...
 - Money: opencollective.com/grass (new!)
- Organizations:
 - Time: employee time
 - Money: pay developers (companies) to add features or fix bugs

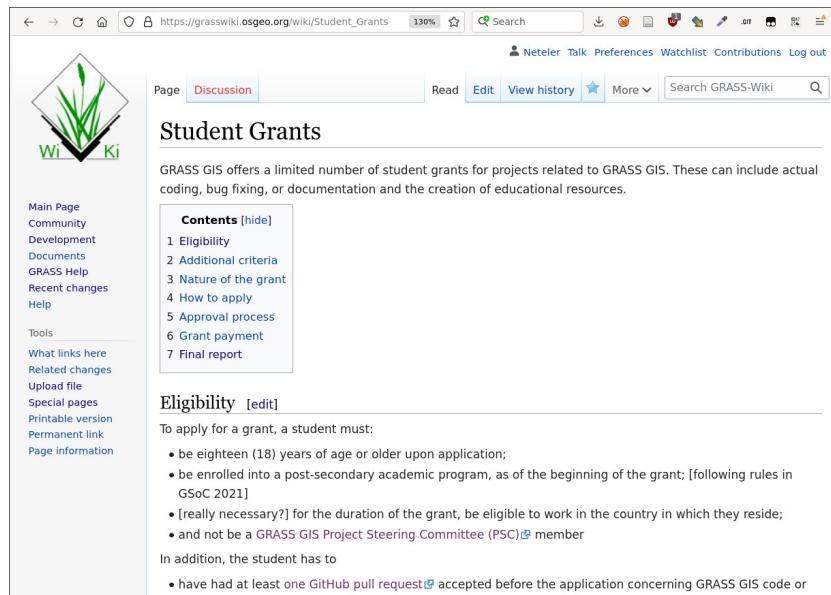
"One of the greatest benefits of GRASS GIS is that its environments gives us a plethora of options for manipulating data and testing/designing our automation/workflow processes."

<https://opencollective.com/grass>



Student grants program: coding for money!

- GRASS GIS offers a limited number of student grants.
- These can include actual coding, bug fixing, or documentation and the creation of educational resources.



The screenshot shows a web browser displaying the GRASS-Wiki page for "Student Grants". The URL in the address bar is https://grasswiki.osgeo.org/wiki/Student_Grants. The page content includes a sidebar with links like Main Page, Community, Development, Documents, GRASS Help, Recent changes, Help, Tools, What links here, Related changes, Upload file, Special pages, Printable version, Permanent link, and Page information. The main content area has a heading "Student Grants" and a paragraph about the grants. A "Contents" sidebar lists sections: 1 Eligibility, 2 Additional criteria, 3 Nature of the grant, 4 How to apply, 5 Approval process, 6 Grant payment, and 7 Final report. The "Eligibility" section contains a list of requirements for applicants.

GRASS GIS offers a limited number of student grants for projects related to GRASS GIS. These can include actual coding, bug fixing, or documentation and the creation of educational resources.

Contents [hide]

- 1 Eligibility
- 2 Additional criteria
- 3 Nature of the grant
- 4 How to apply
- 5 Approval process
- 6 Grant payment
- 7 Final report

Eligibility [edit]

To apply for a grant, a student must:

- be eighteen (18) years of age or older upon application;
- be enrolled into a post-secondary academic program, as of the beginning of the grant; [following rules in GSoC 2021]
- [really necessary?] for the duration of the grant, be eligible to work in the country in which they reside;
- and not be a GRASS GIS Project Steering Committee (PSC) member

In addition, the student has to

- have had at least one GitHub pull request accepted before the application concerning GRASS GIS code or

https://grasswiki.osgeo.org/wiki/Student_Grants

Thanks for your attention!!

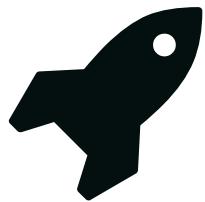


grass.osgeo.org

github.com/neteler/grass-gis-talks-markus

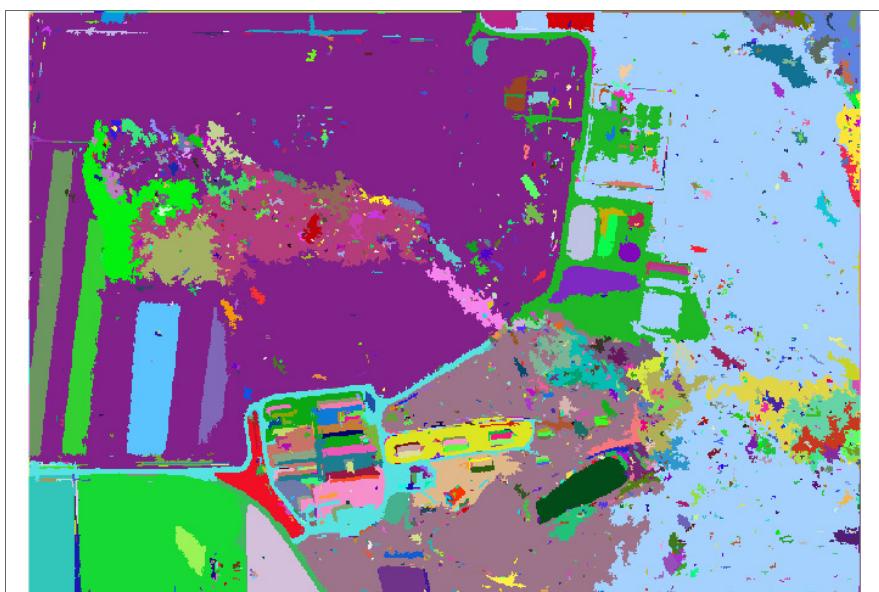
 [@MarkusNeteler](https://twitter.com/MarkusNeteler)

Bonus material



Creating a Gabor filter bank

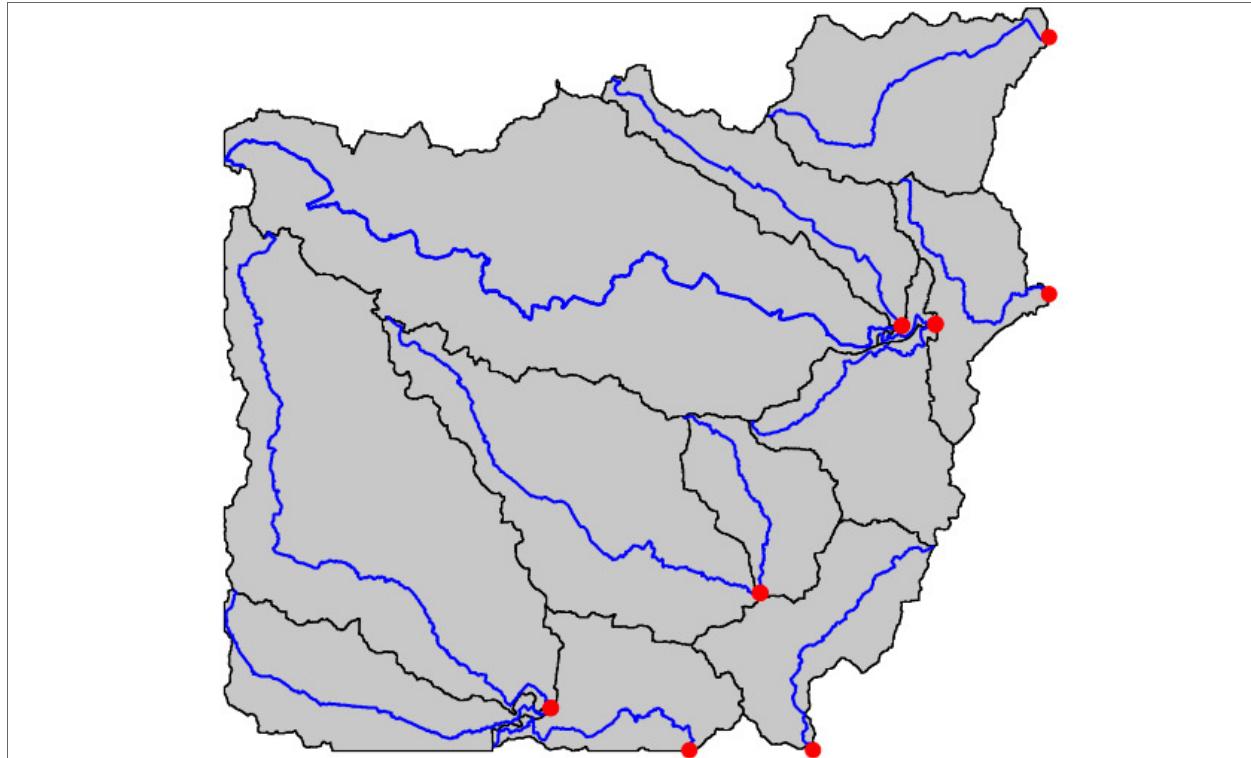
i.gabor creates directional filters for image segmentation using *i.segment*. It requires NumPy and SciPy.



addon by Owen Smith

Hydrologic Parameters Using a Flow Direction Raster

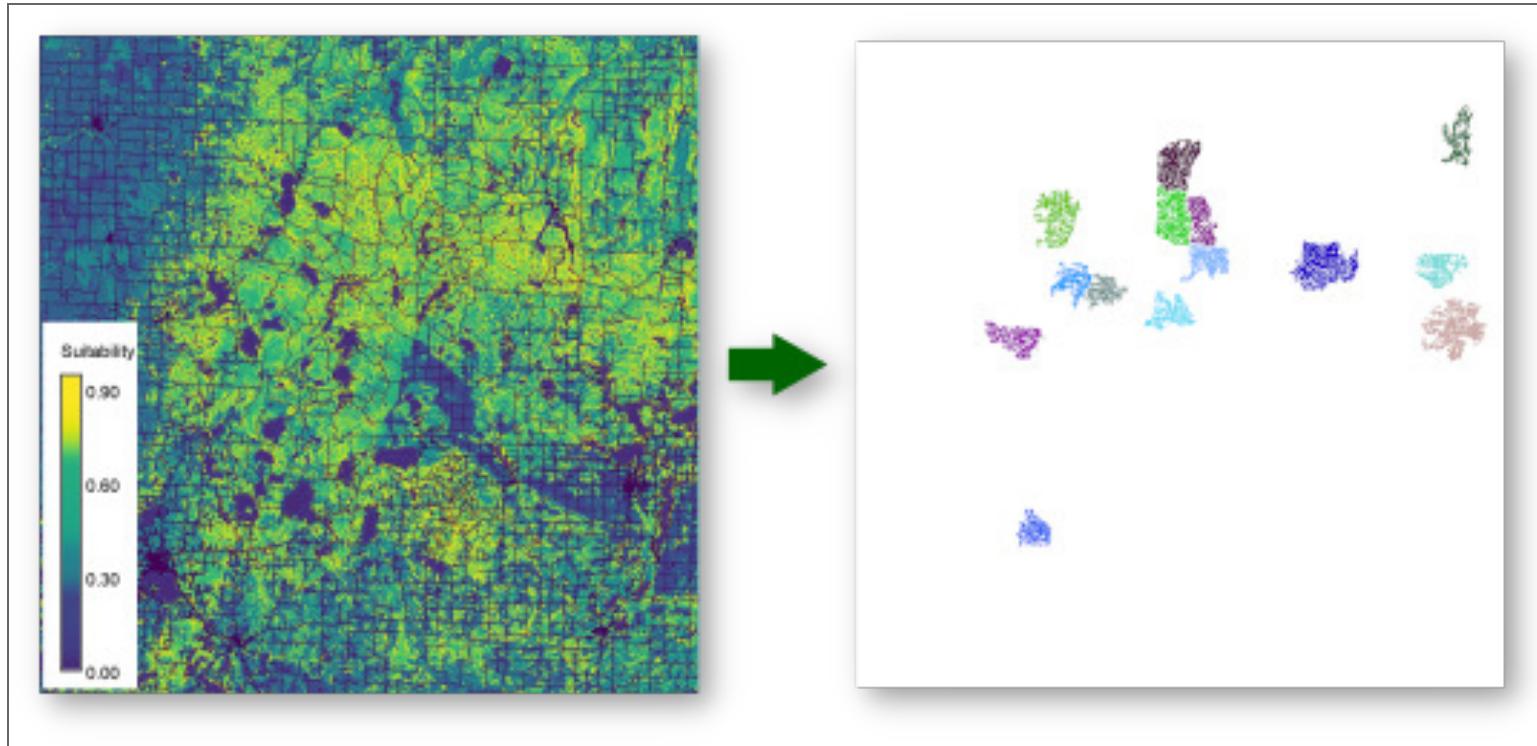
r.accumulate calculates weighted flow accumulation, subwatersheds, stream networks, and longest flow paths using a flow direction map.



by Huidae Cho

Ecological applications

r.suitability.regions allows to identify suitable regions, e.g., for endangered species, starting from suitability maps.

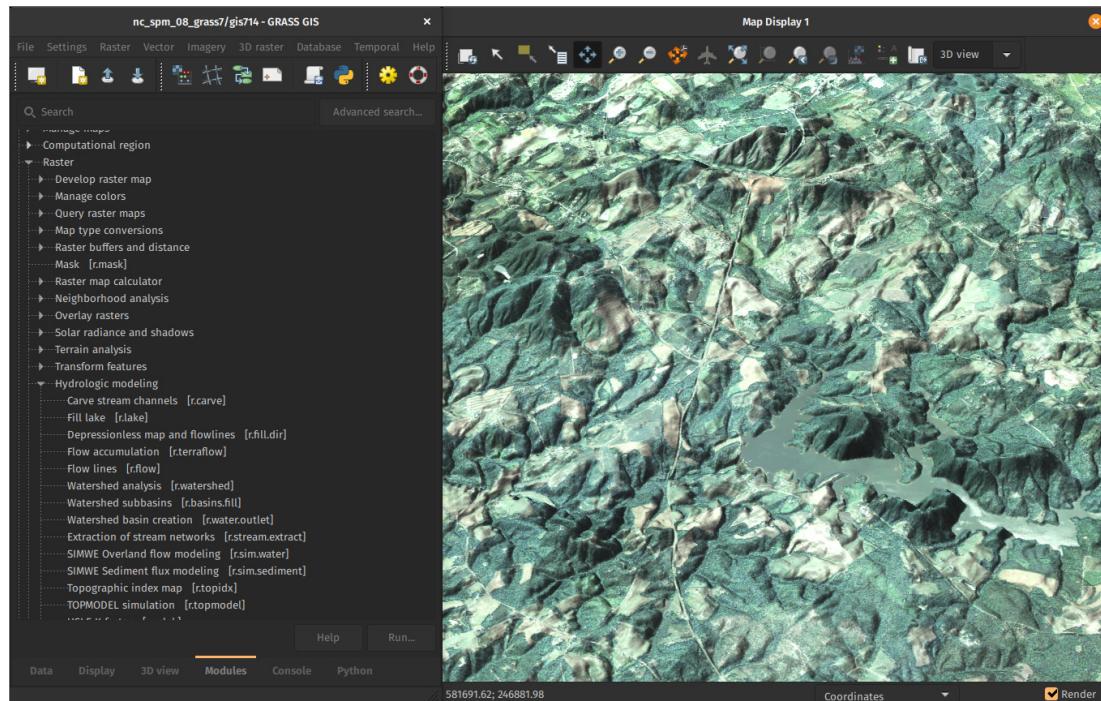


[addon](#) by Paulo van Breugel

More data: Sentinel, THREDDS, ..., netCDF, CSV

Automated download and import of common datasets

i.sentinel, i.modis, i.landsat, r.in.usgs, r.in.nasadem, m.crawl.thredds, t.rast.import.netcdf, ...

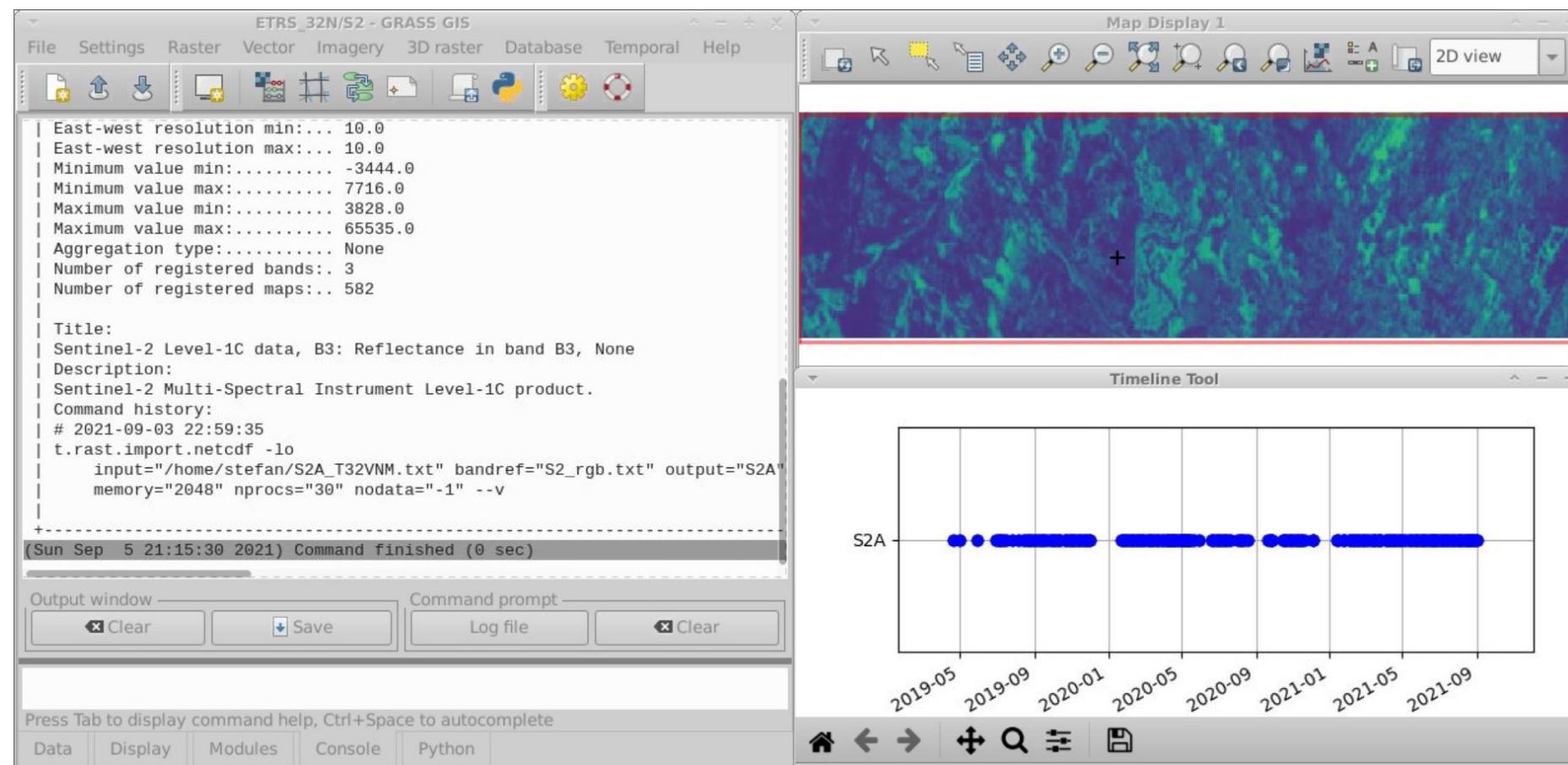


by Fondazione Edmund Mach, OpenGeoLabs, mundialis, GSOC, NC State University, CONICET, Norwegian Institute for Nature Research, ...

Tap directly into FAIR data warehouses

GRASS GIS UNDERSTANDS NETCDF DATA THAT FOLLOWS THE CF-CONVENTION

- **m.crawl.thredds**: Lists URLs for netCDF datasets on Thredds servers
- **t.rast.import.netcdf**: Makes Spatio-temporal data in netCDF format directly available for analysis in GRASS STRDS (also without downloading)



Enjoy data delivered right into your GRASS GIS database from e.g.:

thredds.ucar.edu/thredds/catalog.html



Norwegian National Ground Segment for Satellite Data



by Stefan Blumentrath (Norwegian Institute for Nature Research - NINA)