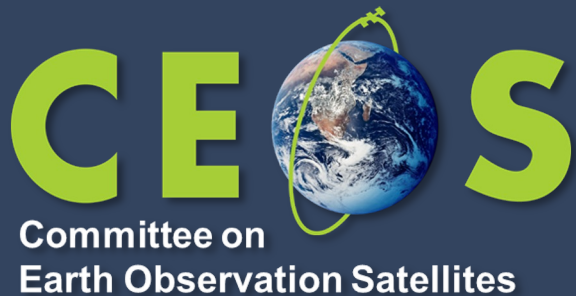


# WGCV-51

## *Terrain Mapping Subgroup (TMSG) & DEMIX Report*



**Peter Strobl, EC-JRC**

**Agenda Item 1.15**

**WGCV-51, Tokyo, Japan**

**3rd - 6th October 2022**

## Proceedings of the Terrain Mapping SubGroup (TMSG)

- Re-activated early 2020
- as of Sep 30<sup>th</sup> 2022:
  - 63 subscriptions (+1)
  - 14 countries
  - ~50% with CEOS background
  - ~30% Geomorphometry.org
  - ~35 expressed interest in the intercomparison exercise DEMIX (incl. industry!)
  - sustained and regular participation by ~20, after 2.5 years!
- main (only) activity so far is DEMIX
- (virtual) plenary planned when DEMIX results out, but latest end 2022
- (hybrid) workshop envisaged in first half 2023, supported by ESA

*Minor update!*

Subscription page: [https://ec.europa.eu/eusurvey/runner/WGCV-TMSG\\_membership](https://ec.europa.eu/eusurvey/runner/WGCV-TMSG_membership)

# Digital Elevation Inter-Comparison



## Status:

- ❖ DEMIX call for participation issued 5 May 2020
- ❖ Kick-off meeting held with 26 participants on 26&30 June 2020
- ❖ ~20 participants active (CAS, DLR, EC, ESA, ISRO, JAXA, NASA, USGS) + domain experts & industry

## Progress:

- Sub-groups currently active:
  - 1) terminology and analytical basis
  - 2) algorithms and software – open source tool box
  - 3) platforms and processing
- TEAMS channel (thanks USGS!)
  - ❖ weekly meetings of subgroup 2 (since >3 months!)
  - ❖ biweekly meetings of subgroup 3
  - ❖ meetings are recorded to allow catch-up
  - ❖ [ISPRS2021 conference paper](#) and [10 minute introductory video](#)

*Just a reminder!*

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<https://doi.org/10.5194/isprs-archives-XLIII-B4-2021-395-2021>  
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**THE DIGITAL ELEVATION MODEL INTERCOMPARISON EXPERIMENT DEMIX, A COMMUNITY-BASED APPROACH AT GLOBAL DEM BENCHMARKING**

P. A. Strobl<sup>1</sup>, C. Bielski<sup>2</sup>, P. L. Guth<sup>3</sup>, C. H. Grohmann<sup>4</sup>, J.-P. Muller<sup>5</sup>, C. López-Vázquez<sup>6</sup>, D. B. Gesch<sup>7</sup>, G. Amatulli<sup>8</sup>, S. Riazanoff<sup>9</sup>, and C. Carabajal<sup>10</sup>

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<sup>2</sup>EOXPLORE UG, Germany  
<sup>3</sup>Department of Oceanography, US Naval Academy, Annapolis MD 21402 USA  
<sup>4</sup>Institute of Energy and Environment, University of São Paulo, São Paulo, Brazil  
<sup>5</sup>Institute of Space and Climate Physics, University College London, Hainbury St Mary, Dorking, Surrey, UK  
<sup>6</sup>Imaging group, Mullard Space Science Laboratory, Dept. of Space and Climate Physics, University College London, Hainbury St Mary, Dorking, Surrey, UK  
<sup>7</sup>LaingEO Lab IGM+ORT, Universidad ORT Uruguay, Uruguay  
<sup>8</sup>Earth Resources Observation and Science Center, U.S. Geological Survey, Sioux Falls, SD 57198, USA  
<sup>9</sup>Fate University, School of the Environment, New Haven, CT, 06511, USA  
<sup>10</sup>VieoTerra, 77420 Champs-sur-Mame, France  
<sup>11</sup>SSAI, Inc. @ NASA Goddard Space Flight Center, Code 61A, Greenbelt, MD, USA

Keywords: Digital Elevation Models, DEM, data quality, interoperability, CEOS



# Subgroup 1



Job done! - currently retired  
Revised terminology and comprehensive definitions (glossary) finished  
Peer reviewed paper published:

*Just a reminder!*

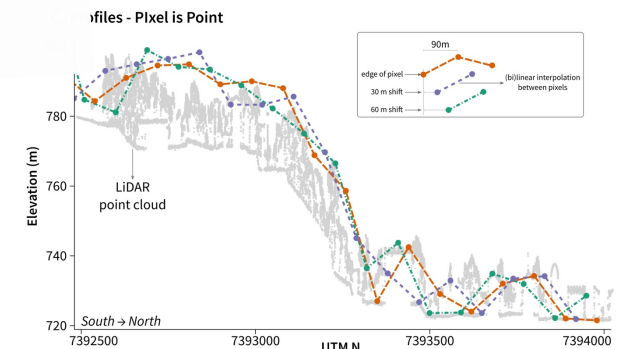
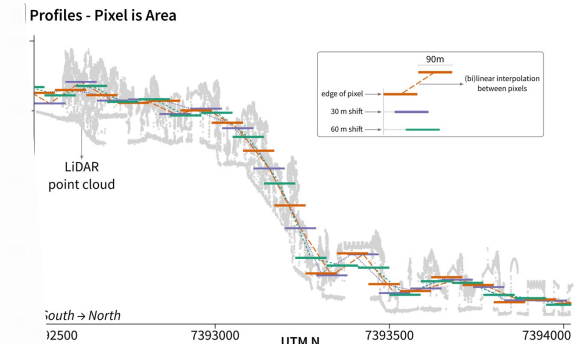
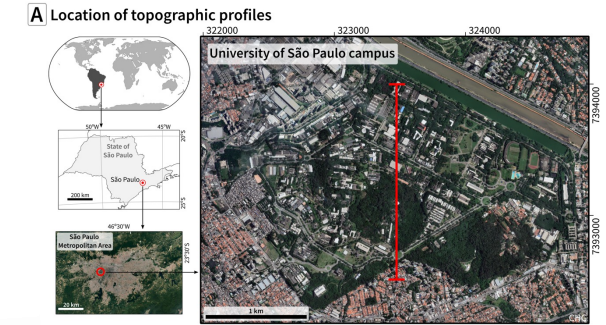
remote sensing

Article  
**Digital Elevation Models: Terminology and Definitions**  
Peter L. Guth <sup>1\*</sup>, Adriaan Van Niekerk <sup>2</sup>, Carlos H. Grohmann <sup>3</sup>, Jan-Peter Muller <sup>4</sup>, Laurence Hawker <sup>5</sup>, Igor V. Florinsky <sup>6</sup>, Dean Gesch <sup>7</sup>, Hannes I. Reuter <sup>8</sup>, Virginia Herrera-Cruz <sup>9</sup>, Serge Riazanoff <sup>10</sup>, Carlos López-Vázquez <sup>11</sup>, Claudia C. Carabajal <sup>12</sup>, Clément Albinet <sup>13</sup> and Peter Strobl <sup>14</sup>

MDPI

Digital Surface Model (DSM)  
Digital Terrain Model (DTM)

Ice Topog  
Freeboard  
Ocean/Lake Surface  
Ice draft/keel  
Subglacial Topography  
Bathymetry  
Geoid  
Ellipsoid  
Sea Level  
Bathymetry



# Subgroup 2



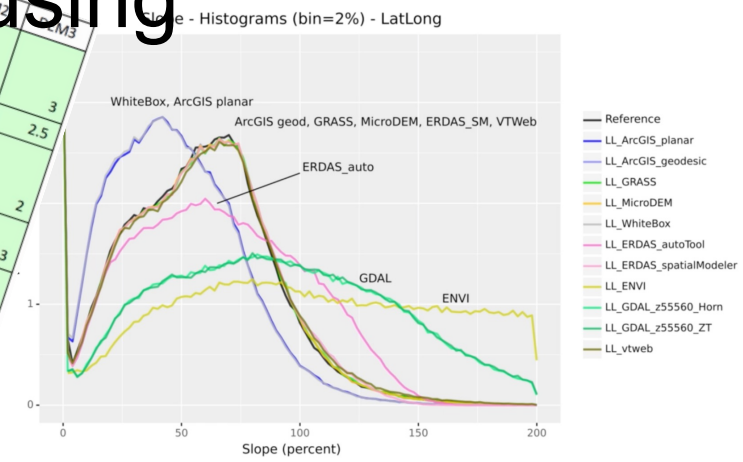
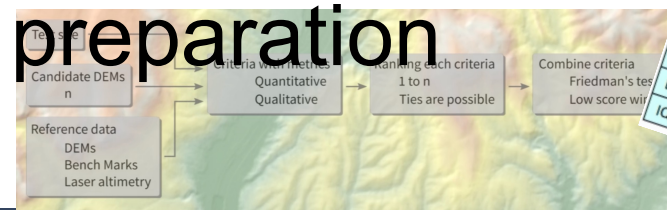
## Progress:

- ❖ Extensive test of algorithms and tools
- ❖ Criteria categories and catalogue set-up
- ❖ Criteria Consensus Documents agreed
- ❖ Reference data preparation protocols developed
- ❖ Implementation of 'wine contest' concept using Jupyter notebooks
- ❖ Peer reviewed paper on methods and results in preparation

*Just a reminder!*

Criterion Name:	Primary data fraction	Criterion ID:	A03
Version:	0.1	Date:	20211103
Category:	Performance	Target:	all
Author:	Peter Strobl		
Criterion Description:	This criterion indicates the area within a specific DEMIX-tile which is covered by valid data stemming from the candidate's main data source or instrument. To rate this criterion each cell which contains a valid measurement of the candidate's main data source or instrument (i.e. is not 'void' or 'nodata', and is not extrapolated), masked or filled in with external data or information) is counted and its area is summed up. The total of covered area is divided by the total area of the DEMIX tile.		
Criterion Ranking Basis:	The percentual coverage results of each candidate are rounded to the next integer number (0-100). The ranking is done in descending order of the percentual coverage (i.e. more coverage is better). Ties are all which have an equal (integer) percentage of coverage.		
Criterion qualitative/quantitative:	Quantitative		
Criterion requirements:	Metadata must indicate a 'no data' or 'void' value. A per-pixel mask identifying extrapolated, infilled, or masked pixels is required Candidates not fulfilling these requirements are disqualified.		

Criterion	DEM1	DEM2	DEM3
Visual, subjective assessment of the topographic profiles	1	2	2.5
Compare Elev vs slope to reference DSM	1	2.5	3
Visual comparison to slope histogram	2	2	2.5
Uniform aspect distribution without ripples	1	2	2
Slope skewness	1	2	3
Slope kurtosis	1.5	3	2
SSO diagram	1.5	1.5	3
RMSE	1.5	1.5	3
L90	1	3	3
IQR95	1	2	2
	1	2	3



- Intercomparison is only useful for (non-expert) users if they in the end get a **ranking**:

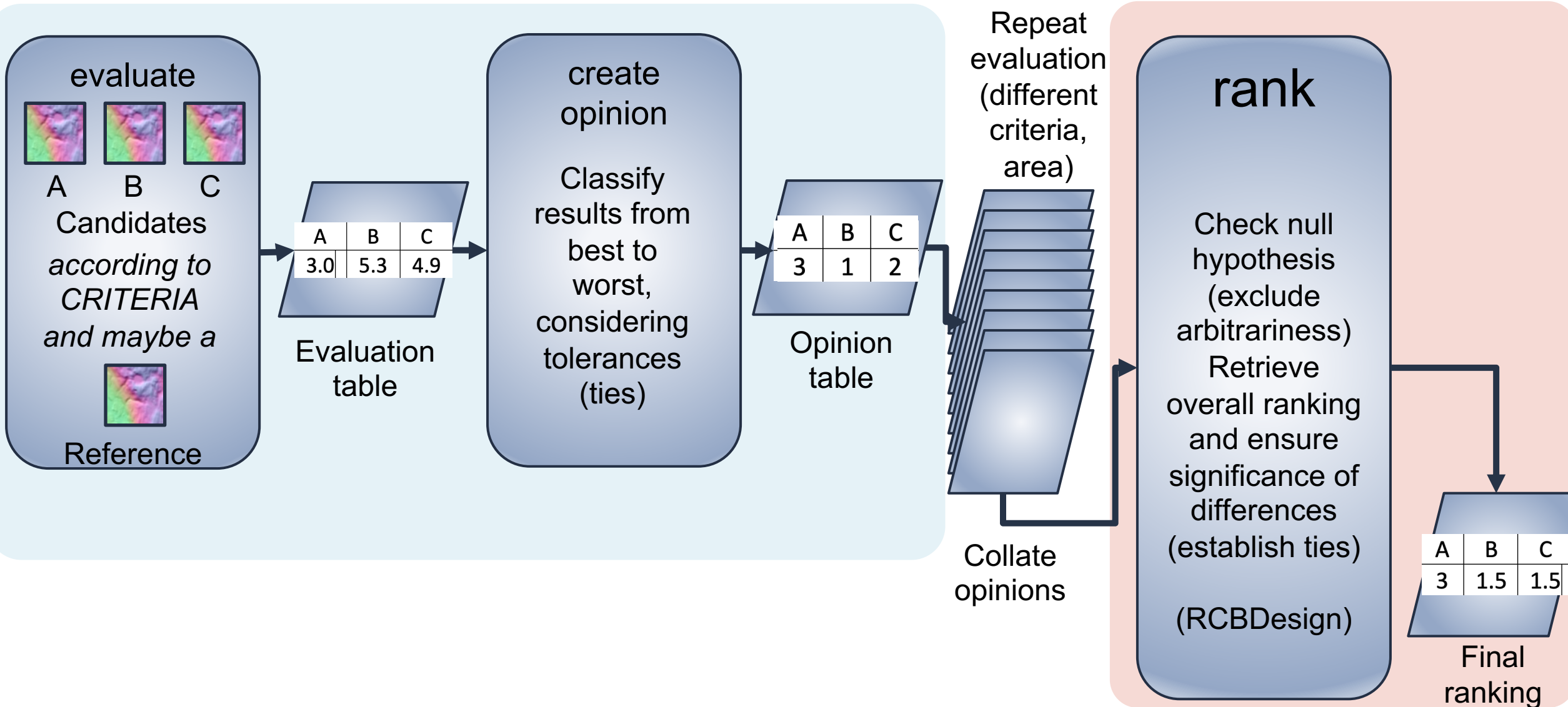
*Are there significant differences and if so which options are better and which are worse?*

- Not every user might want to apply the same criteria and even the same criteria could result in different rankings depending e.g. on location

*We are less interested in an ‘overall winner’, but the best solution in a given context!*

- **We need a configurable, re-usable and expandible test environment!**

# The wine contest framework

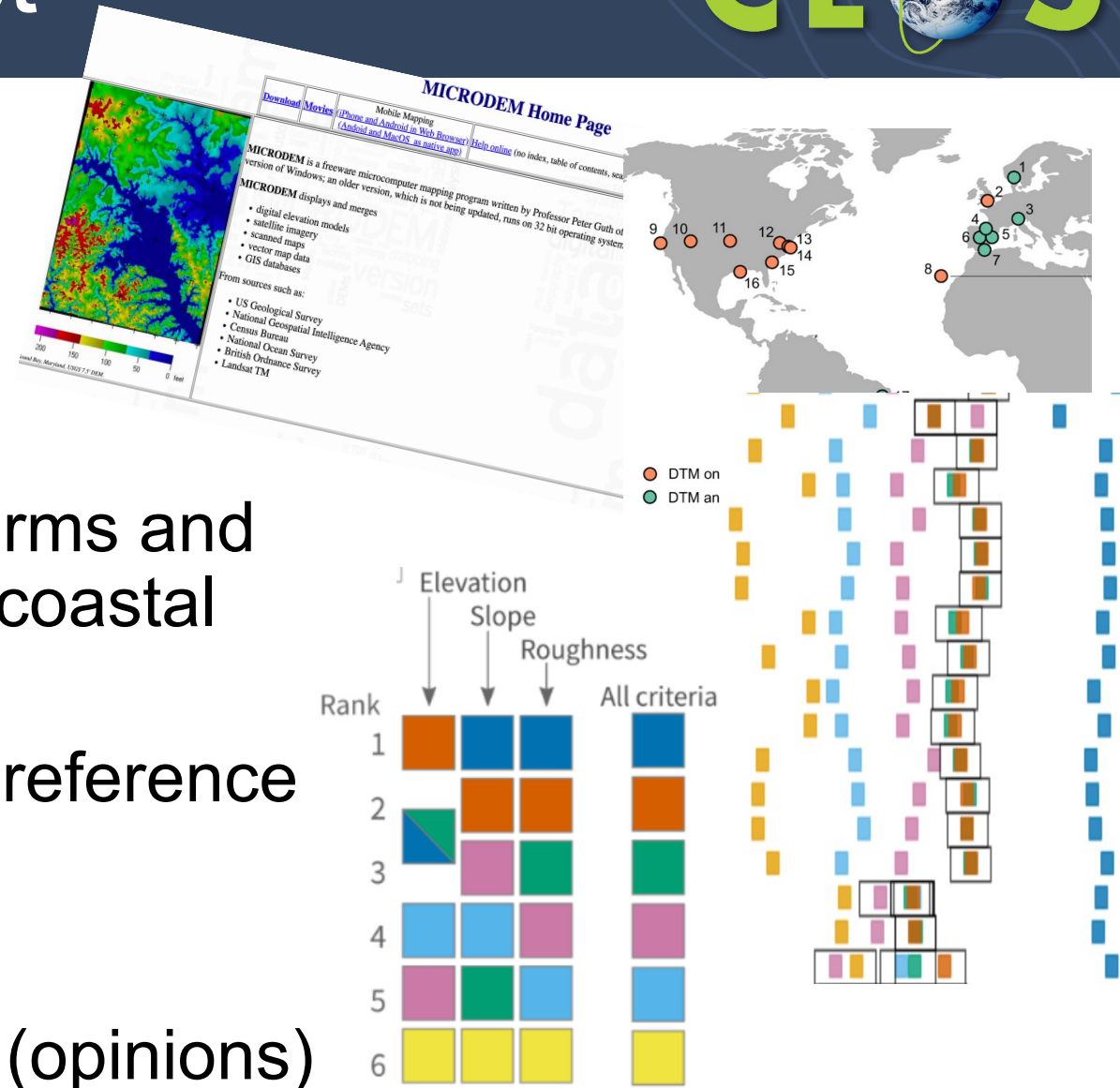




# The DEMIX wine contest



- ❖ 134 DEMIX tiles on three different continents with reference data
- ❖ Reference data preparation tool
- ❖ All major geomorphological landforms and landcover types represented incl. coastal areas (partial water)
- ❖ Pixel by pixel comparison against reference data
- ❖ 15 different criteria in 3 classes
- ❖ Just under 18.000 individual tests (opinions)





# The ranking tool



- Idea is to have a simple to use interface allowing users to filter for
  - Criteria type (elevation, slope, ...)
  - Spatial characteristics (geomorphology, landcor, ...)
  - Reference (DTM or DSM)
- Ranking is recomputed according to user's purpose
- Python notebook as base (portable and cloud compatible)

The screenshot shows a Google Colab notebook interface. At the top, the title is 'DEMIX\_wineContest\_SIMPLE.ipynb' with a star icon. Below the title is a menu bar with 'File', 'Edit', 'View', 'Insert', 'Runtime', 'Tools', 'Help', and a link 'Changes will not be saved'. The notebook content is divided into sections: a title 'SIMPLE version of the DEMIX notebook' by 'Carlos H Grohmann' dated '2022-08-11', followed by an 'Instructions' section. The instructions state that this is a simple version of the notebook requiring only 3 cells to run, and that the first cell downloads auxiliary data, functions, and CSV files from GitHub, while the second cell produces a lot of text output. Below the instructions, there are two code cells. The first cell contains a series of '!wget' and '!unzip' commands to download external files: 'Friedmans\_tables.zip', 'demix\_wine\_functions.py', 'demix\_wine\_contest\_matrix\_18aug2022.csv', 'hillshade\_criterion.csv', and 'demix\_wine\_contest\_matrix\_simple\_example.csv'. The second cell contains a 'pip install' command for the 'qgrid' package and an 'import' statement for 'sys', 'os', and 'pandas' as 'pd'.

```
[ ] # get external files - Friedman tables, custom DEMIX functions and CSV files used for the analysis
!wget https://github.com/lukewys/Friedmans_tables.zip # Friedmans_tables.zip
!unzip Friedmans_tables.zip
!wget https://github.com/lukewys/demix_wine_functions.py # demix_wine_functions.py
!wget https://github.com/lukewys/demix_wine_contest_matrix_18aug2022.csv # demix_wine_contest_matrix_18aug2022.csv
!wget https://github.com/lukewys/hillshade_criterion.csv # hillshade_criterion.csv
!wget https://github.com/lukewys/demix_wine_contest_matrix_simple_example.csv # demix_wine_contest_matrix_simple_example.csv

# install qgrid, a version that works with Colab
!pip install git+https://github.com/lukewys/qgrid.git

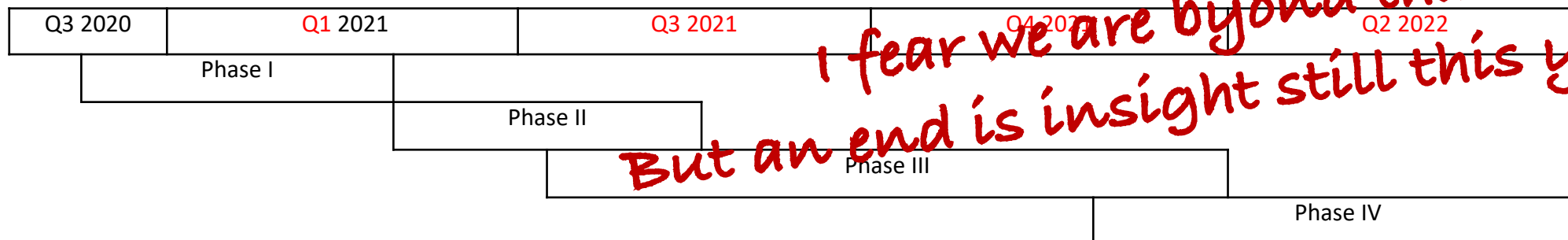
# imports
import sys,os
import pandas as pd
```



## ❖ DEMIX to be performed in 4 phases

- I. General agreement among main contributors (data owners) on approach & scope; Call for expression of interest to further partners (commercial tbd); circulation of JRC Workshop report (in preparation) & selection of base ( $\Delta x$ ,  $\Delta y$ ,  $\Delta z$ ) & extended (slope, aspect, morphology) testing methods and algorithms; Identification of suitable test areas (at least 1 per continent);
- II. Cross-comparison of all participating data sets on test areas and, if feasible, identification of a reference dataset (at DGED L1). If available and where applicable cross-comparison to suitable orthorectified (reference?) imagery (Sentinel-2?); Workshop to exchange experiences from the test areas and agree on details of an eventual global roll-out;
- III. Feasibility testing & potential global roll out of at least base tests & determination of suitable aggregation scale for reporting;
- IV. Calculation of agreed comparison metrics for all candidates and publication of results.

## ❖ Timeline



*I fear we are beyond that!  
But an end is insight still this year...*

# What's next?



- Finalisation of SG2 paper
- Consolidation of VTWeb platform for reference DEM access
- Wrap up DEMIX
- Then it's definitely time for a TMSG plenary!  
... and maybe a new chair or at least a co-chair 😅
- Ideas for future activities:
  - DEMIX reloaded: more criteria, more reference tiles, fully in the cloud
  - GCPIX: intercomparison of GCP libraries
  - GDMIX: spatial matching and comparison of global GCPs and DEMs



# Thank you!

Big thanks to all active volunteers!  
In particular the sub-group leaders:  
Peter Guth, Carlos Grohman,  
Conrad Bielski, Serge Riazanoff  
and Carlos López-Vázquez, the wine contest mastermind!