Global Grids for CARD

indispensable or unnecessary?

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European Commission

Analysis Ready Data (ARD)

An Analysis Ready Data (ARD) product is generated from raw data and processed so that it can be used **without the need for further processing** to be applied by users.

… minimum processing requirement to be an ARD-compliant product: the data **must be processed to a geo-referenced projection** to enable the position identification within the data product. …

- If “geo-referenced projection“ is to be understood as being transformed to a “***georeferenced grid***” than this requires **re-sampling**!

CEOS Analysis Ready Data (ARD)

CEOS Analysis Ready Data (CARD) are satellite data that have been processed to a minimum set of requirements and organized into a form that allows immediate analysis with a minimum of additional user effort and **interoperability** both through time and **with other datasets**.

- It is fair to assume that “other datasets” means those who also meet the CARD requirements, i.e. they are “gridded” (and thus re-sampled).

CARD Interoperability

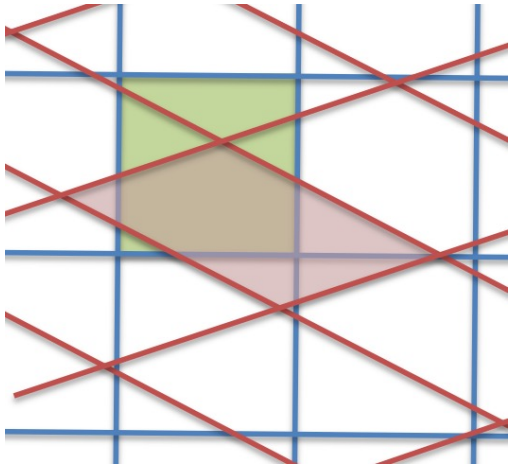
***Interoperable** Products* refers to a set of two or more ARD products which are sufficiently documented **to enable processing** across a continuum of geometric and/or radiometric standards **to permit direct** quantitative **comparison**."

- Not the *interoperable products* themselves are able to 'interoperate' (i.e. be compared or analysed together) but their derivates.
- 'Interoperability' here means a 'can' not an 'is' and, if the underlying references are not the same, it requires adaptation (processing)!
- How ready is 'ready' in ARD?

Changing references

Observations need to relate to the same standards or references to be comparable:

- scaled data (based on points)
  need to be **re-scaled** (e.g. ºF → ºC)
- gridded data (based on intervals)
  need to be **re-gridded** (or resampled)
  (e.g. 1” WGS84 /Pseudo Mercator EPSG:3857
  → 30m Mollweide EPSG:54009)



➢ Sounds doable for continuous parameters which can be interpolated (e.g. radiance, temperature), but categorical data (e.g. masks/flags)?

ARD and Datacubes

- ARD are meant to build data cubes!
- OGC data cube Community Practise* says:

All layers in a data cube need to share the same grid
to allow interoperability between layers

➢ Co-gridding is an important element of interoperability WITHIN a data cube

*https://portal.ogc.org/files/18-095r7

Datacube Interoperability

BUT

Two data cubes (or ARD datasets) do not need to share the same grid to be considered interoperable(?)

- If so, is interoperability restricted to a ‘one way’ road?
  (i.e. a specific cube can only be involved once during an analysis workflow)
- And then, how is reproducibility being secured?
  (e.g. for Cubes A,B routing A→B gives a *slightly* different result as B→A, repeating exchange and involving more Cubes worsens things considerably!)

Consequences of re-sampling for interoperability

(unless the volume of data is largely amplified each time)

- ❑ always entails an interpolation of data
- ❑ always diminishes data accuracy or entail data loss
- ❑ always is irreversible
- ❑ is (more or less) computer-intense
- ❑ **accumulates these effects when repeated!**

➢ How compatible is this with FAIR principles?

Big Geospatial Data Analysis Strategies

To avoid repeated re-sampling in complex multi-source environments there are essentially two options:

- "Point Cloud" approach:
  - Store all observations with their locations (as n-tupels)
  - Resample (all input data) to a user selected grid only at the point of analysis
  - ➢ High processing effort, only end-to-end processing, low re-usability

- "Grid System" approach:
  - Discretise (re-sample) all observations to common grid system (not only in spatial dimension!)
  - ➢ Limited number of (spatial) representations, lack of user acceptance

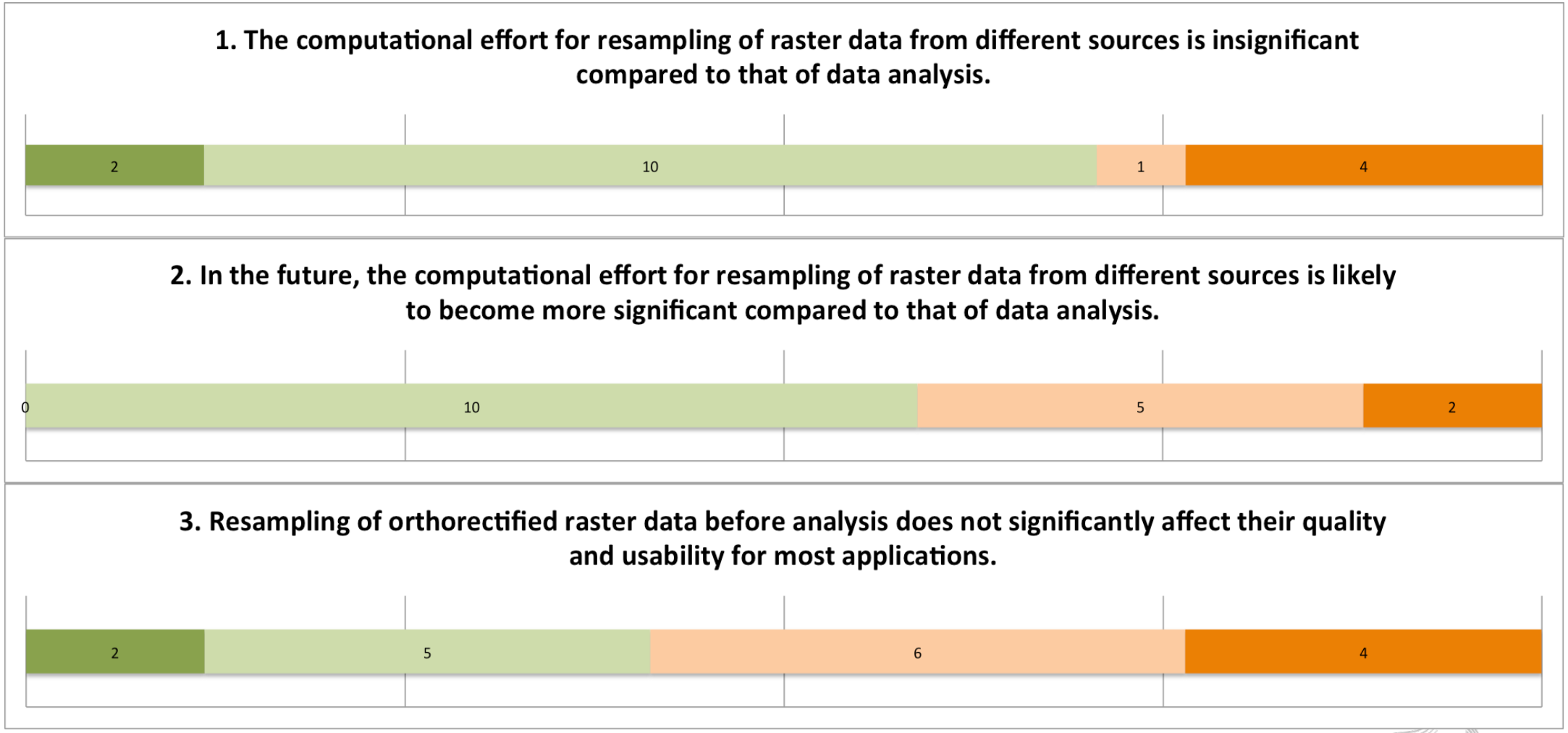
INSPIRE* wisdom

"… it would be highly desirable that all the themes with similar needs make use of the same geographical grid system in order to maintain their coherence."

Source: INSPIRE D2.8.II.1 Data Specification on Elevation – Technical Guidelines (2013)

*INSPIRE is the EU initiative to establish an infrastructure for spatial information in Europe that will help to make spatial or geographical information more accessible and interoperable for a wide range of purposes supporting sustainable development. https://inspire.ec.europa.eu/

JRC-INSPIRE GRG Workshop 2017



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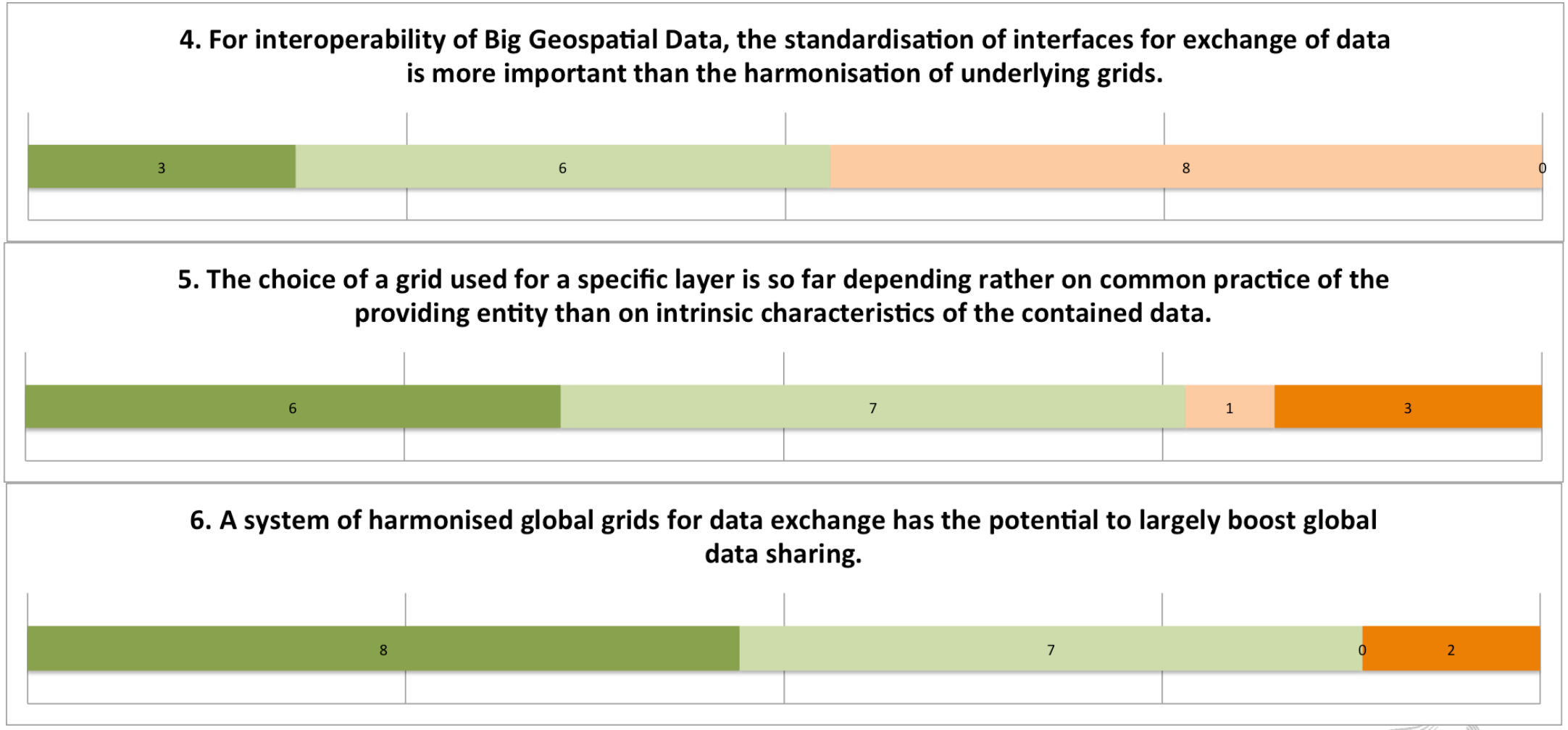
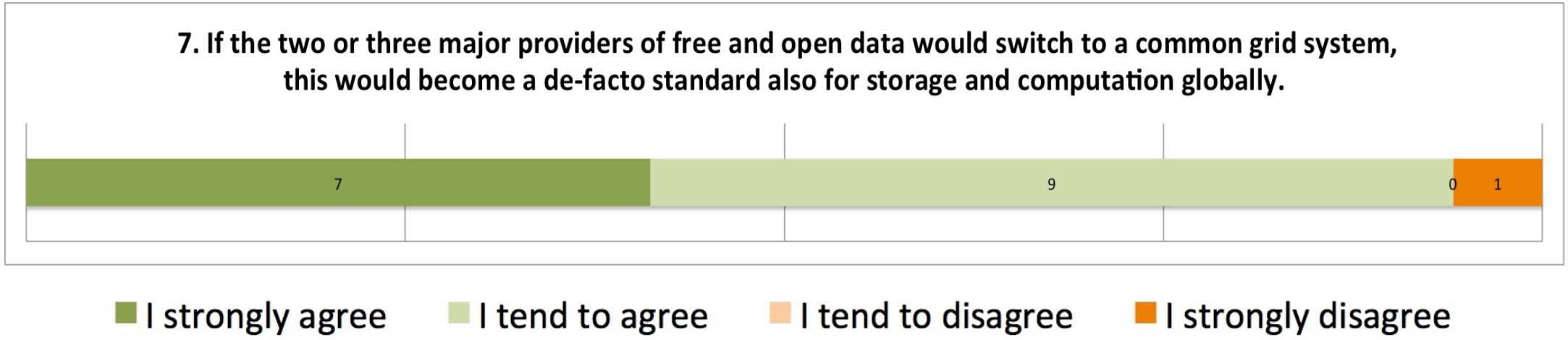
JRC-INSPIRE Workshop 2017 Questionnaire



JRC-INSPIRE Workshop 2017 Questionnaire



Geodata representation in the 21st century

Questions for the leading global EO data providers:

Continuous (point-clouds) or discrete (grids)?

If grids then:

Global or continental,
mono-resolution or hierarchical?

Which criteria for 'good' global grids?
(e.g. Goodchild/Kimerling)

Main candidate global grid(system)s?

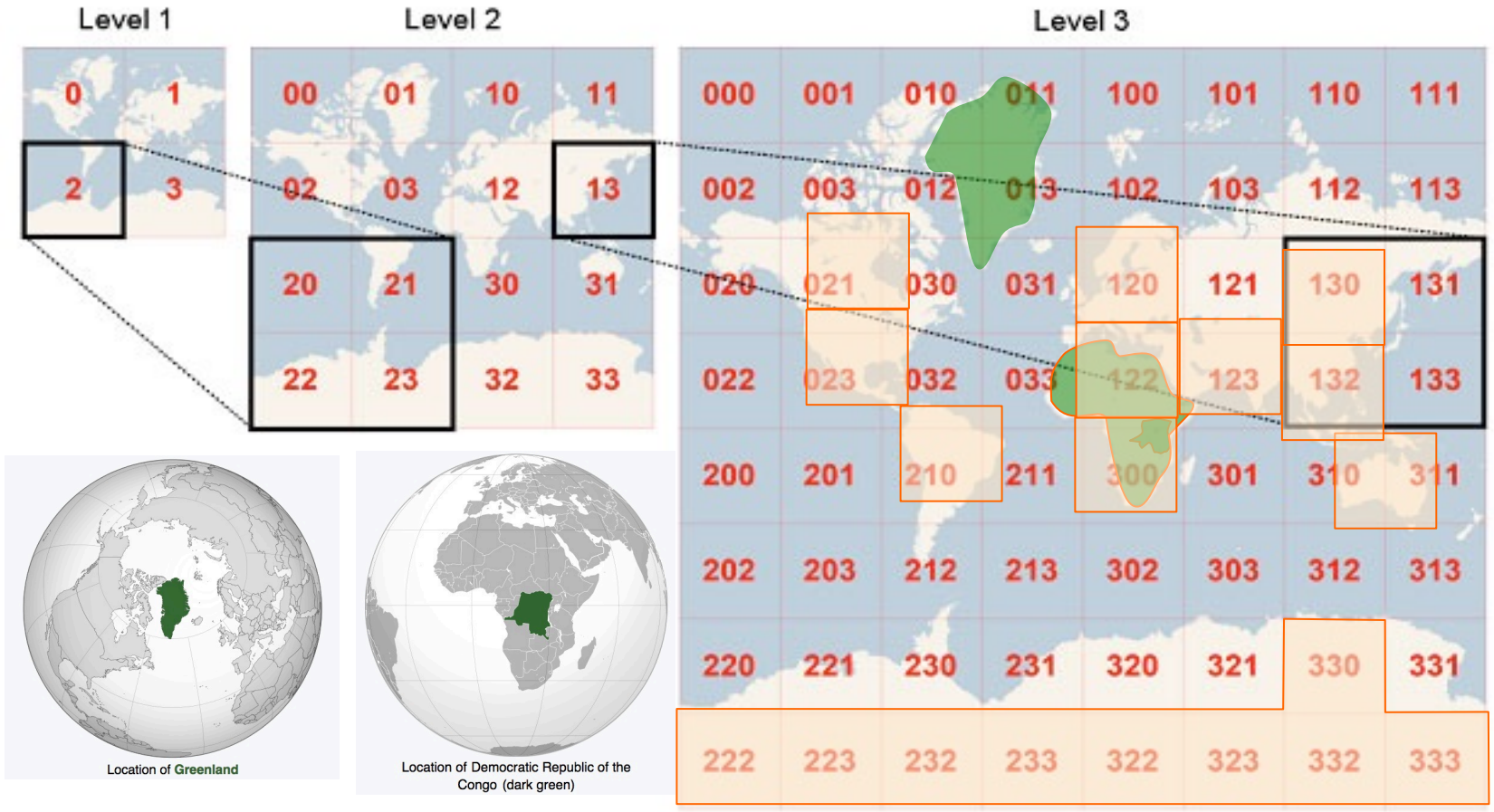
Separate or together?

M. Goodchild (2019):
So, in the final analysis, the big-picture question for DGGSs remains the same as it has been for more than two decades: *how do we use the compelling arguments for these multi-resolution systems to persuade the larger scientific community to adopt them, in preference to the distorted representations of digital maps?*
https://doi.org/10.3138/cart.54.1.preface

Criteria for (spatial) discretisation

- assessable: based on ellipsoidal Earth model
- unambiguous: every point on the surface belongs to a cell
- gap free: no point on the surface belongs to more than one cell
- hierarchical: grids can be refined from coarser to finer levels following mathematical rules (cell refinement)
- nested: finer level cells do not overlap coarser cells
- intrinsic: the grid is a product of a mathematical tessellation of the ellipsoid, a cell is only determined by location
- instantaneous: the grid is defined for any point in time

The WMTS standard (base EPSG:3857)



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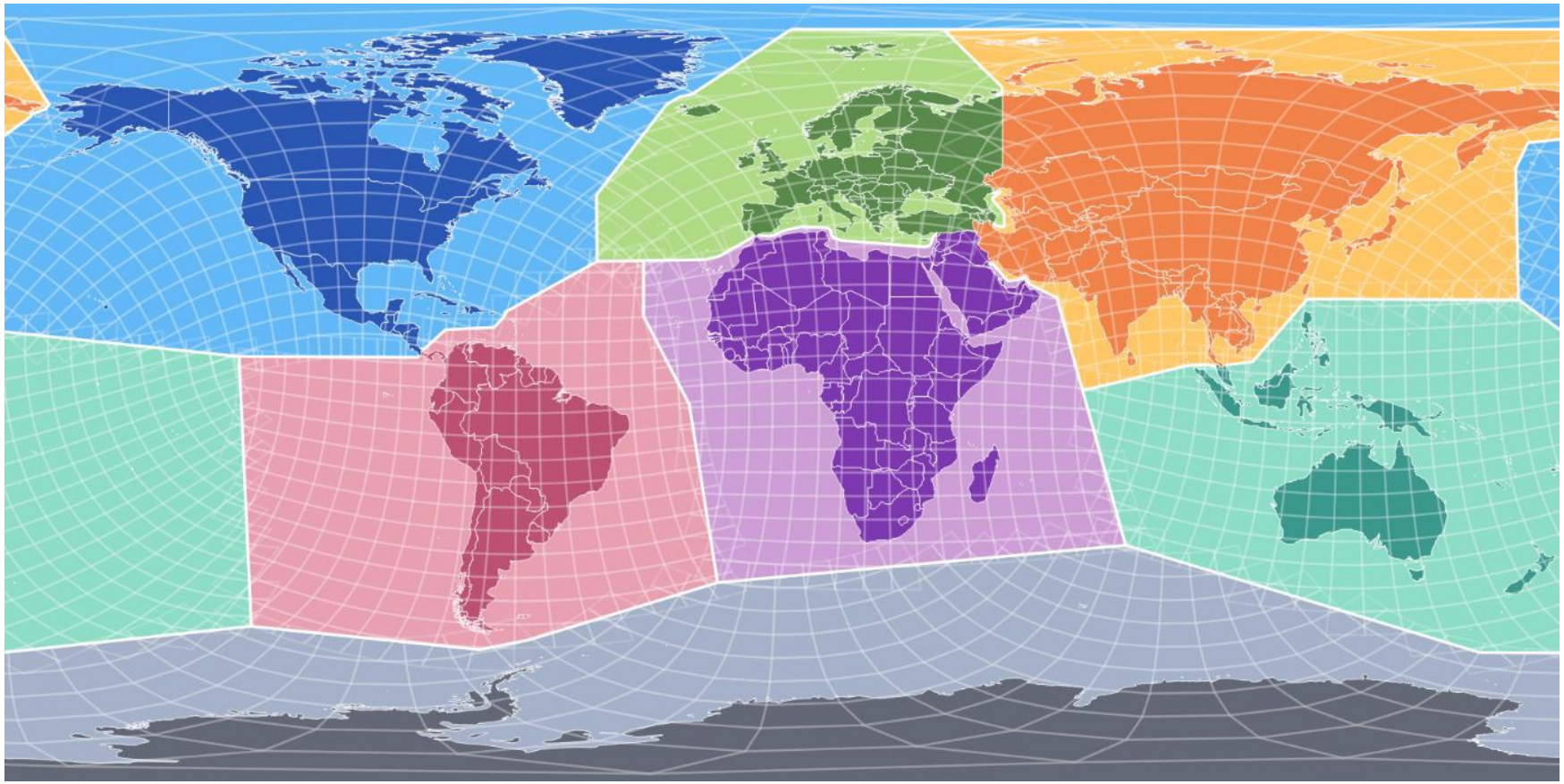
The EQUI7 grid (TU Vienna)



B. Bauer-Marschallinger, Optimisationof global grids for high-resolution remote sensing data, Computers & Geosciences, 2014
doi:10.1016/j.cageo.2014.07.005

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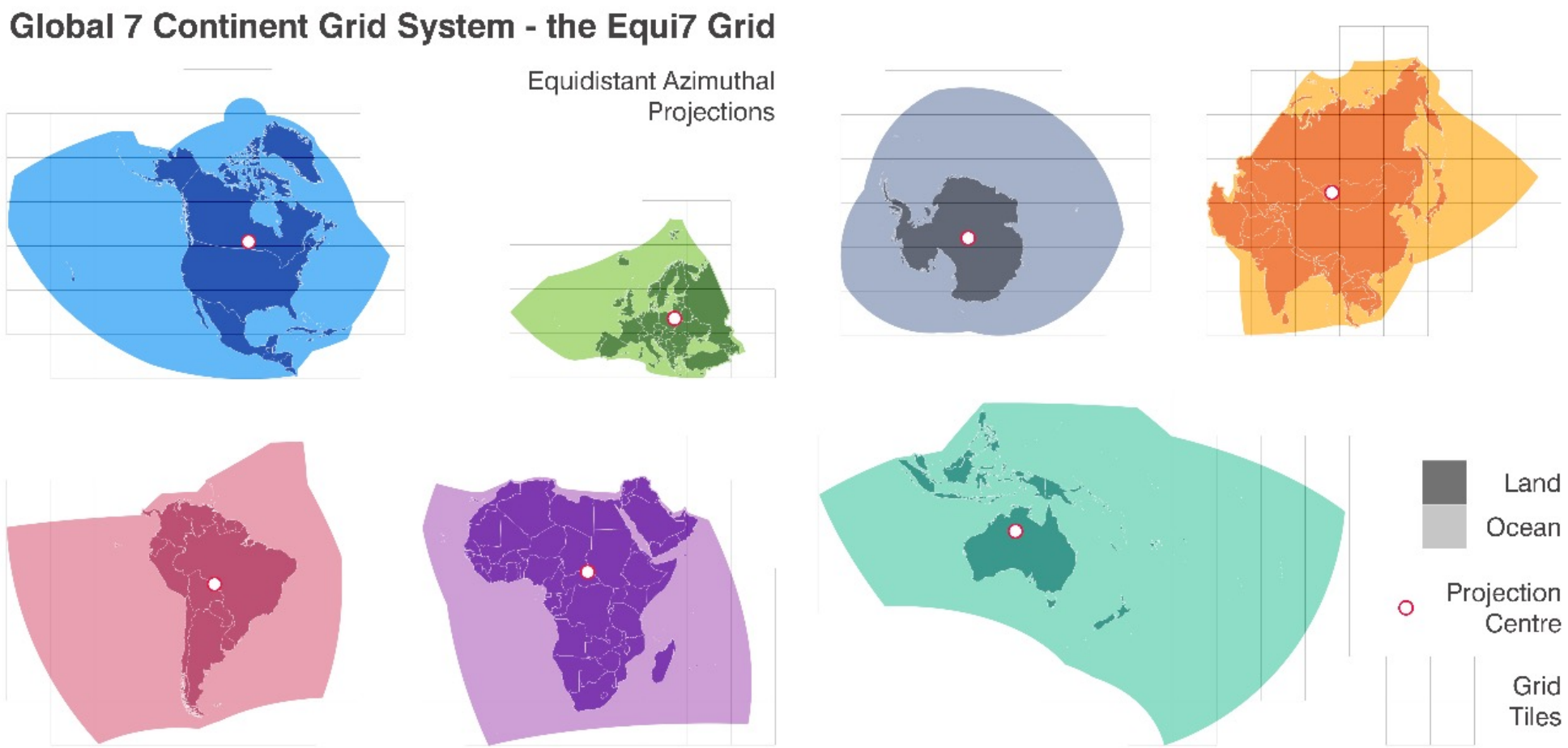
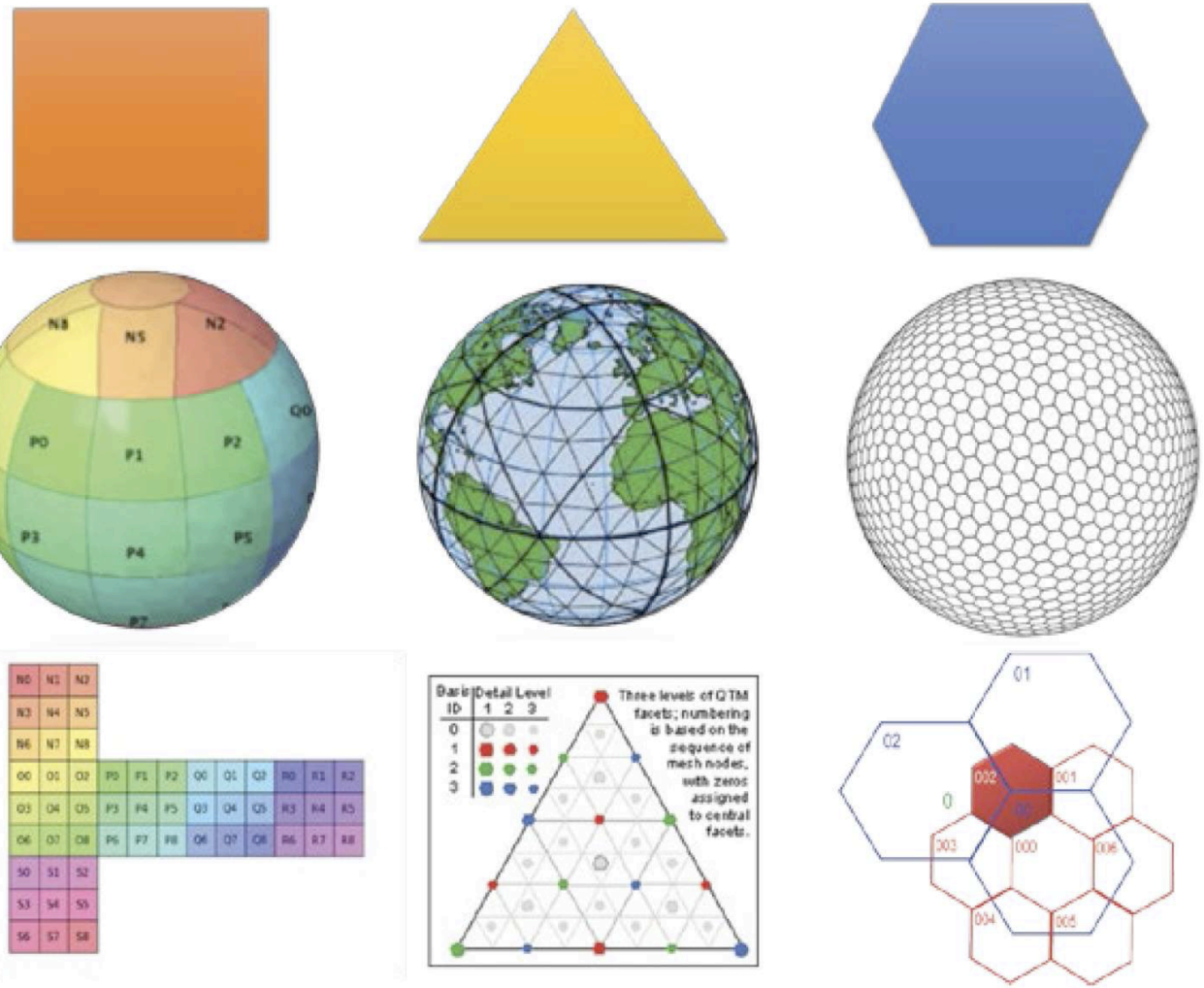


Discrete Global Grid Systems

"…spatial reference system uses hierarchical tessellation of cells to partition and address the globe.

"DGGS are characterized by properties of cell structure, geo-encoding, quantization strategy and associated mathematical functions."

ISO 19170-1 Geographic information — Discrete Global Grid Systems Specifications — Part 1:Core Reference System and Operations, and Equal Area Earth Reference System
https://www.iso.org/standard/32588.html



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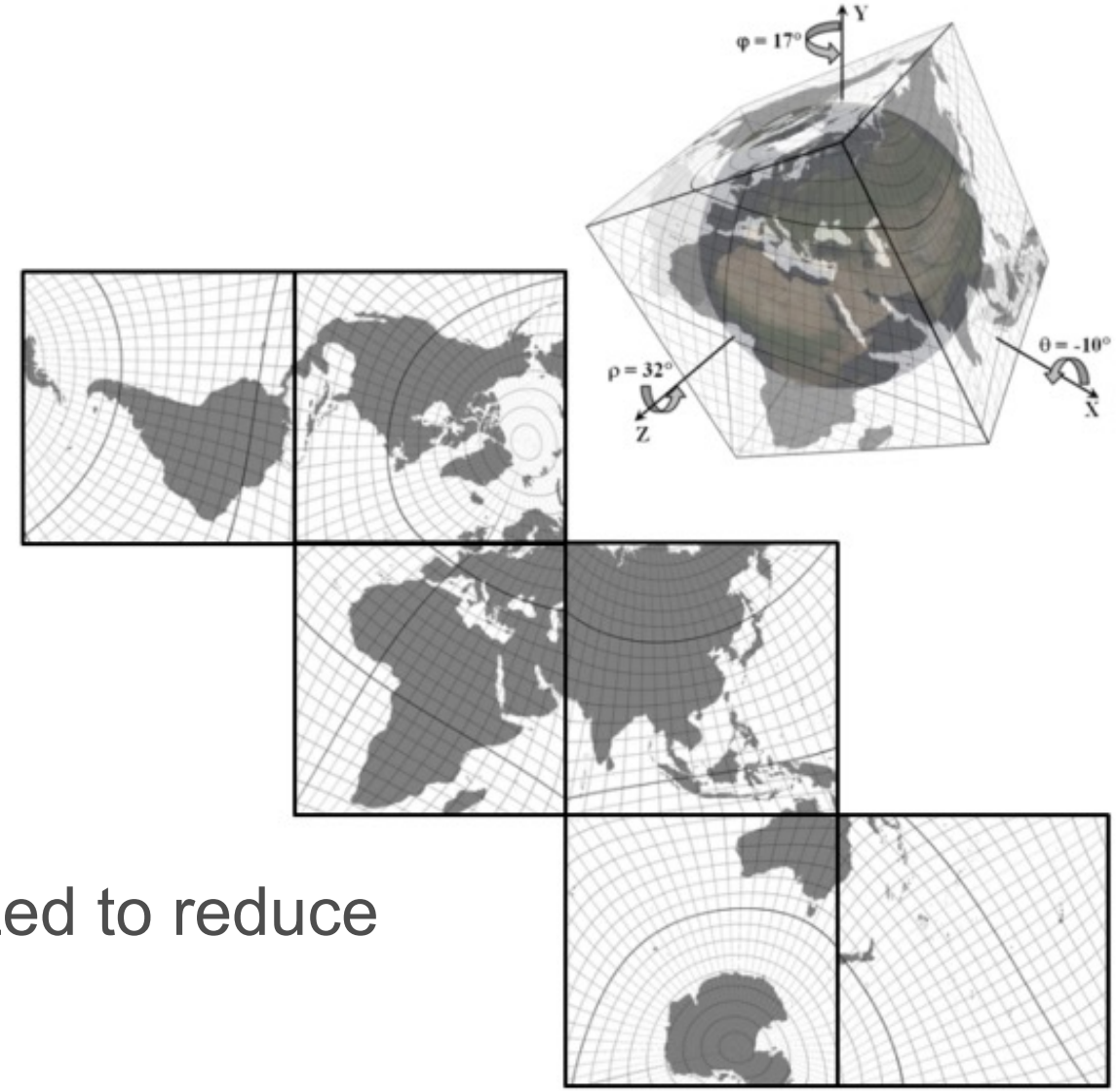
DGGS optimization

- After the main choices, i.e.:
  - shape (”square”)
  - Refinement ratio (4 - quadtree)
  - ➢ “cube-sphere mapping”
- Cube sphere mapping can be optimized to reduce distortions e.g. over land masses



Dimirijevic A., Strobl P., *Continuous 2D Maps Based on Spherical Cube Datasets,* Proc. 55th International Scientific Conference on Information, Communication and Energy Systems and Technologies (ICEST), doi:10.1109/ICEST49890.2020.9232678, 2020

Discussion

- Does CARD require gridding?
- Is interoperability (in a processing chain restricted to a ‘one way’ road?
- How is reproducibility being secured when data are resampled?
- How compatible is repeated resampling with FAIR principles?
- Is there room for a “common global CARD grid system”
- Which are the top priority criteria for a CARD global grid?

Thank you!
Any questions?

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