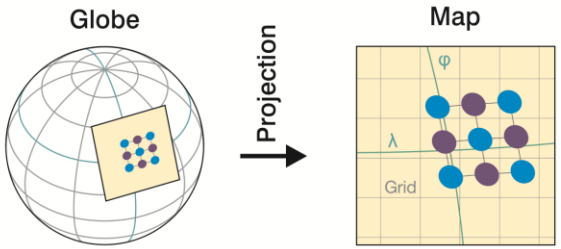
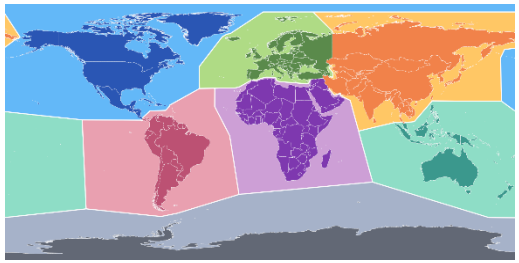
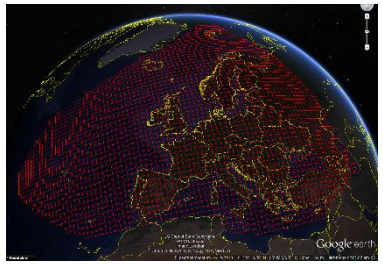






ICA European Symposium on CARTOGRAPHY
VIENNA, 10–12 NOVEMBER 2015

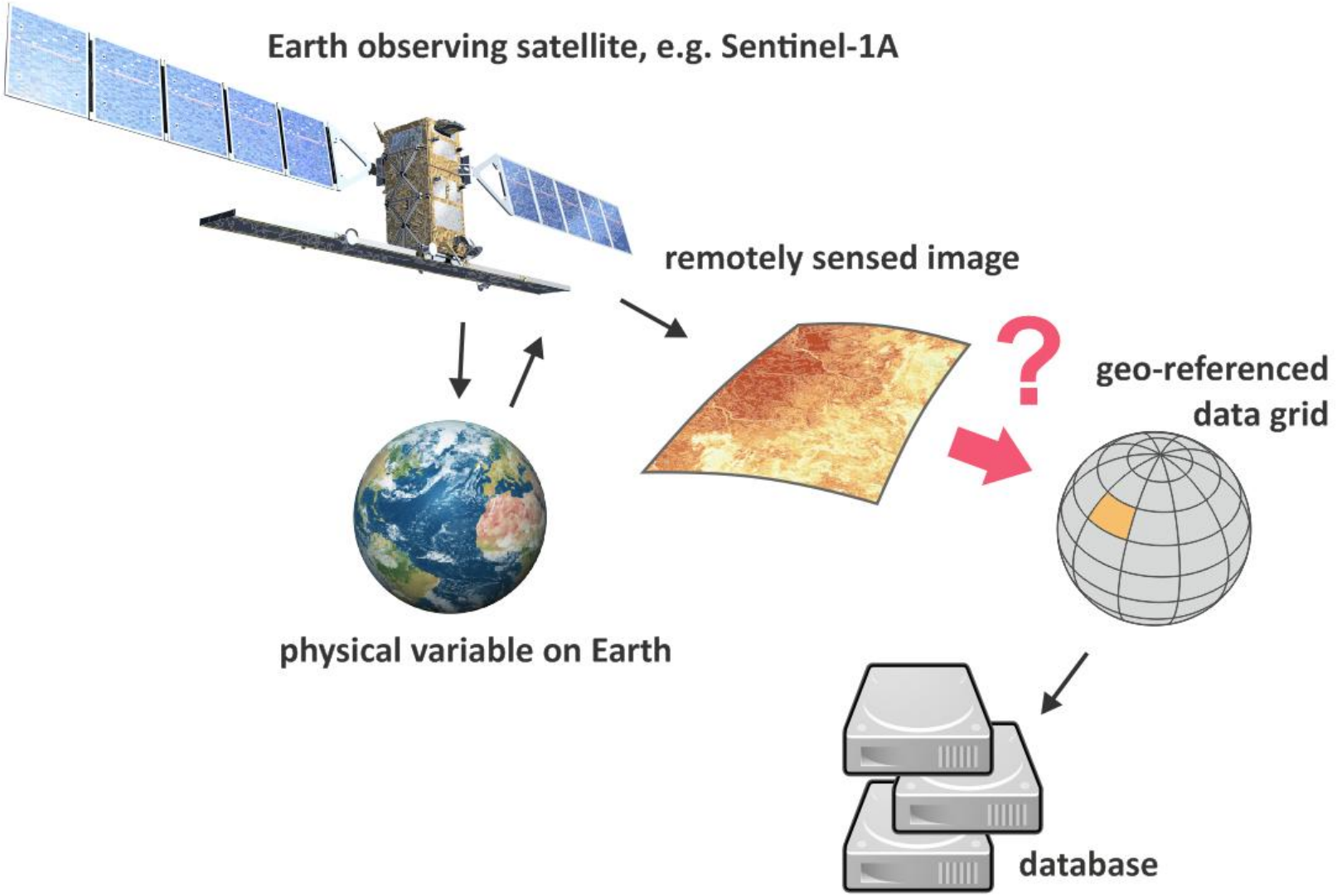
The Equi7 Grid

Optimisation of Global Grids for High-Resolution Remote Sensing Data

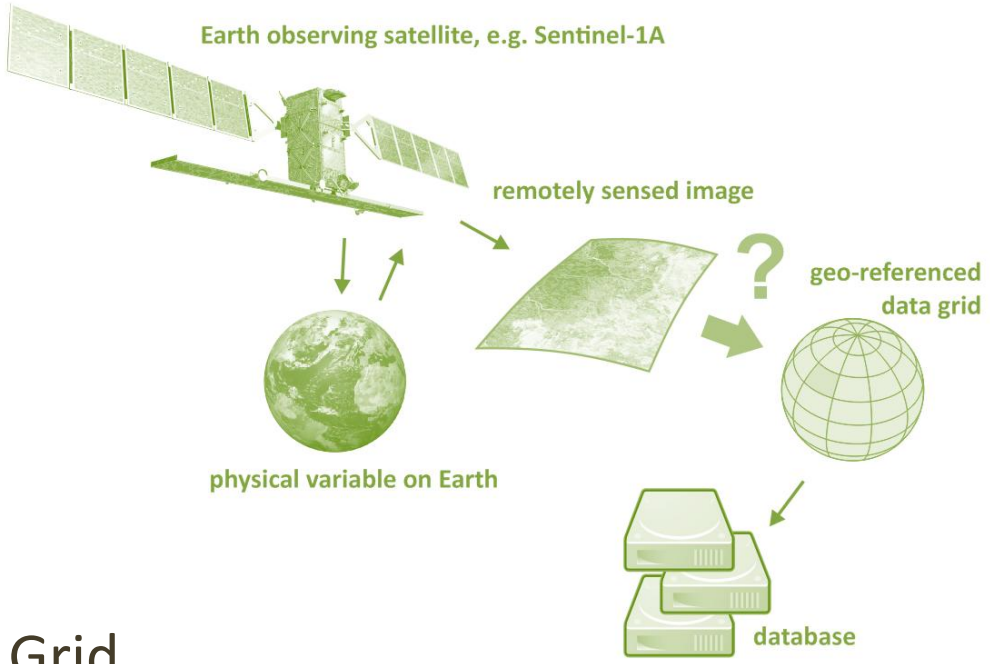
Bernhard Bauer-Marschallinger
TU Wien – Remote Sensing Research Group

EuroCarto 2015
Vienna, 2015-11-10

How to geo-reference satellite data?

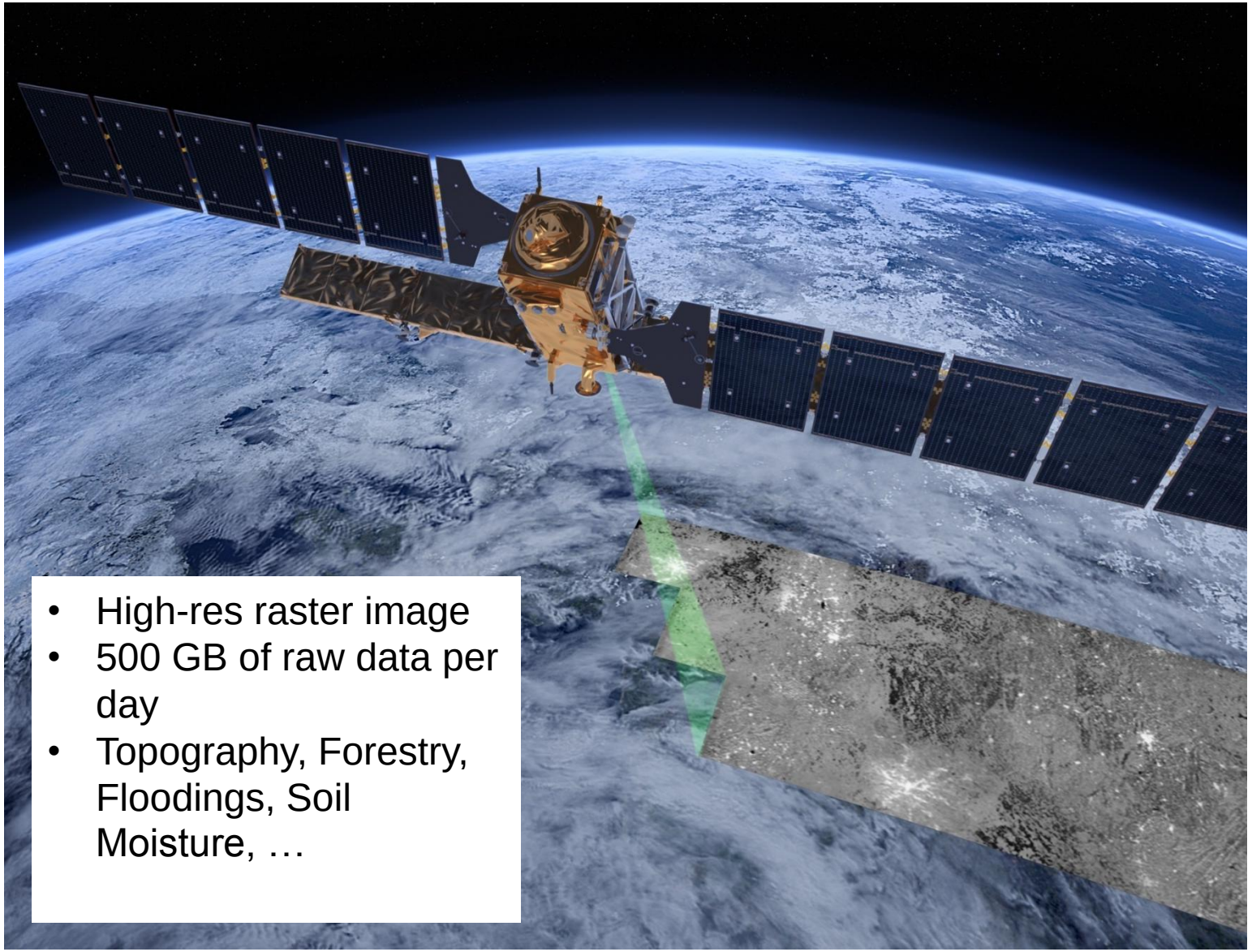


Content



1) Motivation for a new Grid
2) Theory + Optimisation Analysis
3) Equi7 Grid Definition
4) Outreach & Distribution

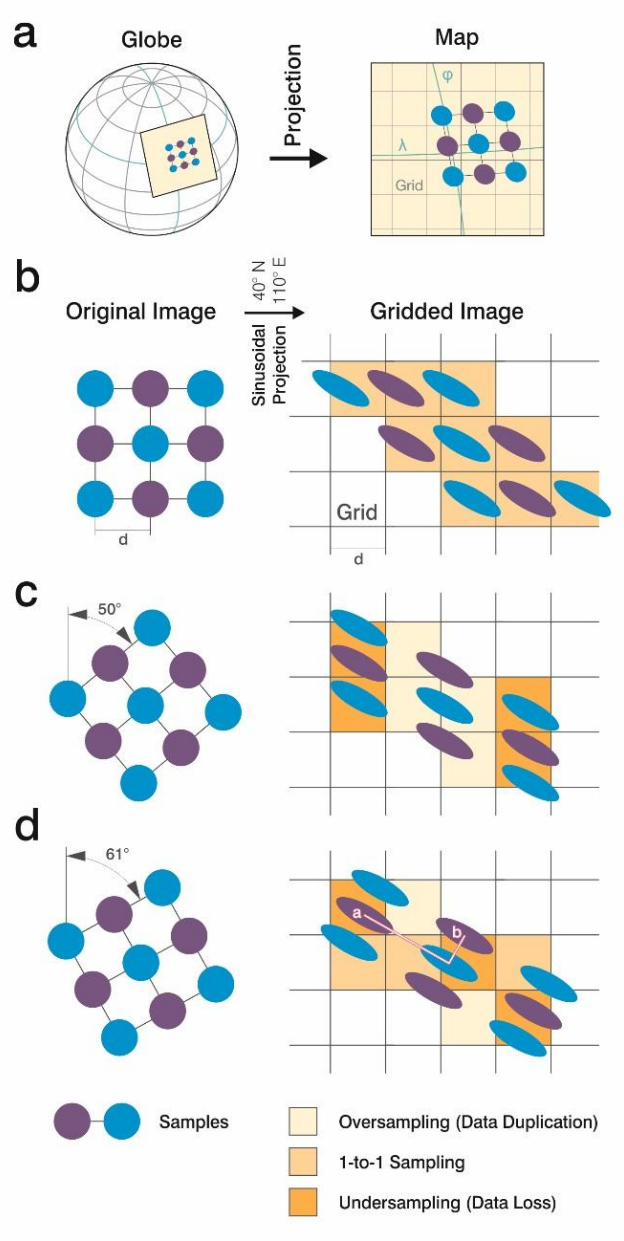
Example: Sentinel-1 Imaging Radar



- High-res raster image
- 500 GB of raw data per day
- Topography, Forestry, Floodings, Soil Moisture, …

The Equi7 Grid: Motivation

- High resolution satellite imagery
  - should be stored efficiently
  - should be stored geometrically correct
- Computation: needs arrays
  - Planar, orthogonal data system is needed
- global map projection distort the images
  - oversampling
    - data volume / processing time ⇧
  - neighbourhood relationships disordered
    - geometric accuracy ⇩

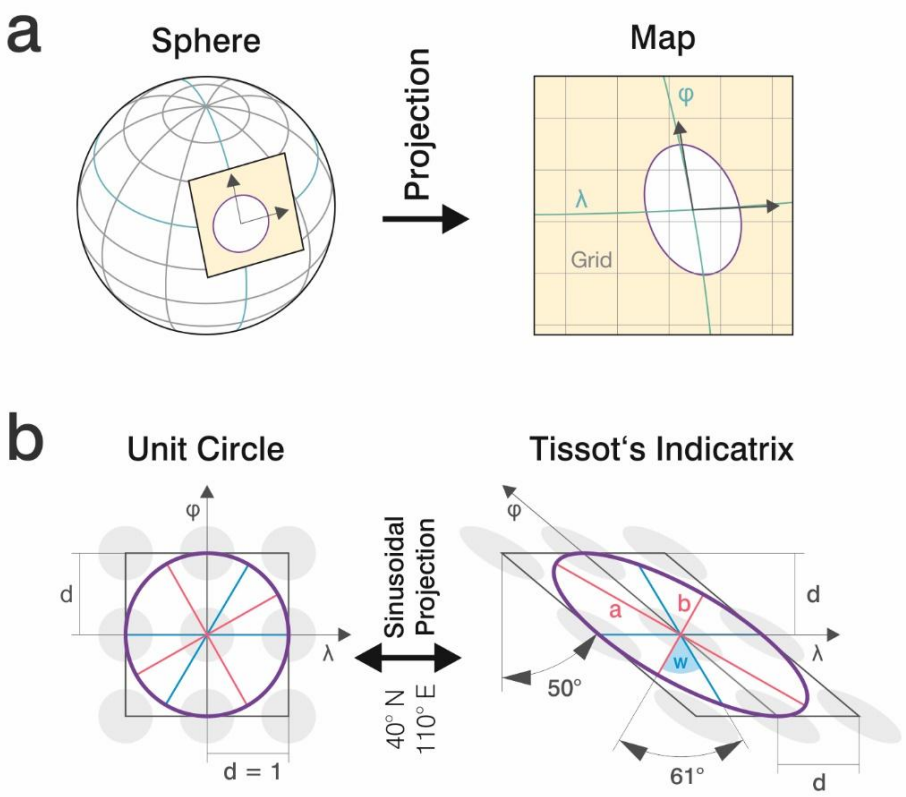


The GOF

- New Metric:
  - *Grid Oversampling Factor*

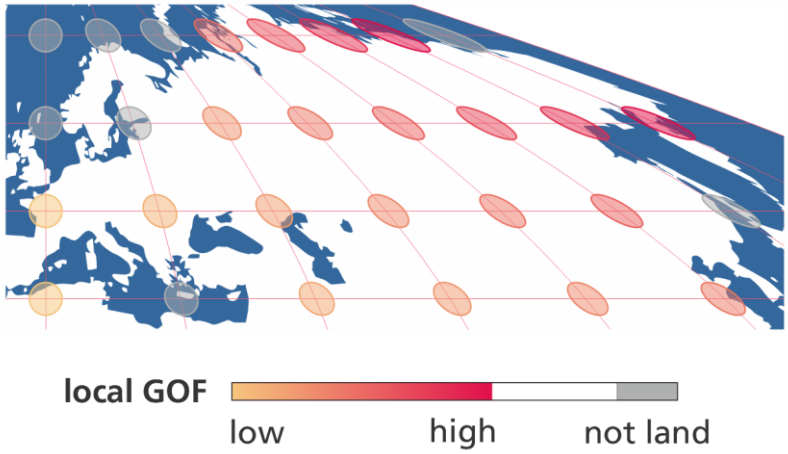
$$GOF_i = \frac{a_i b_i}{b_{min}^2}$$

- Measures ratio btw
  - local area distortion
  - global minimum scale factor
- How much more pixels are in output than in input grid? - compared to necessary pixel amout representing the same information

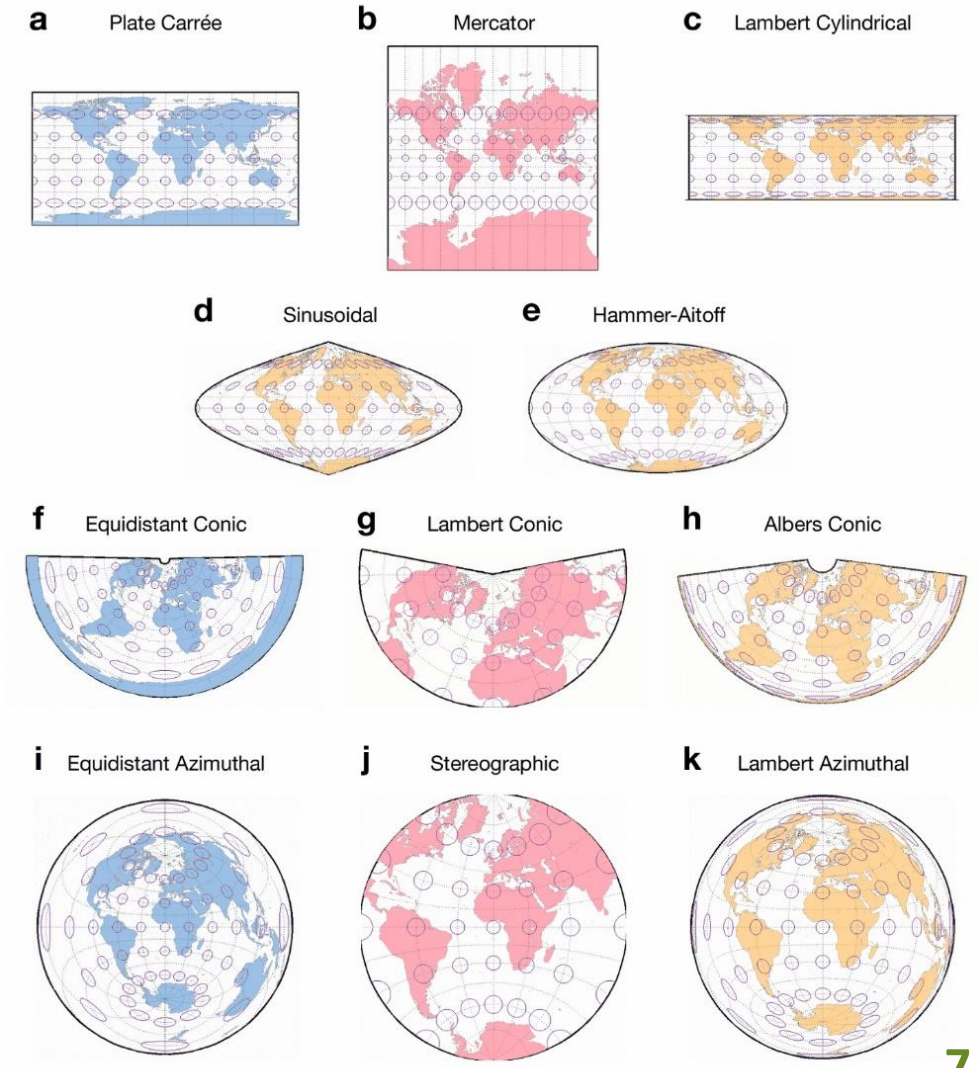


Optimisation Method

- For each projection
  - calculate GOF at each 1°-location
  - average GOF over land
  - optimise projection centre



- Division into
  - Hemispheres
  - Continents



Optimisation Results

- The lower the average GOF, the less distortion/oversampling

@ Projections

- Equal-area perform worst
- Angle-preserving are better
- Equidistant are best

@ Global subdivision

- The smaller the extent of inidividual projections, the better

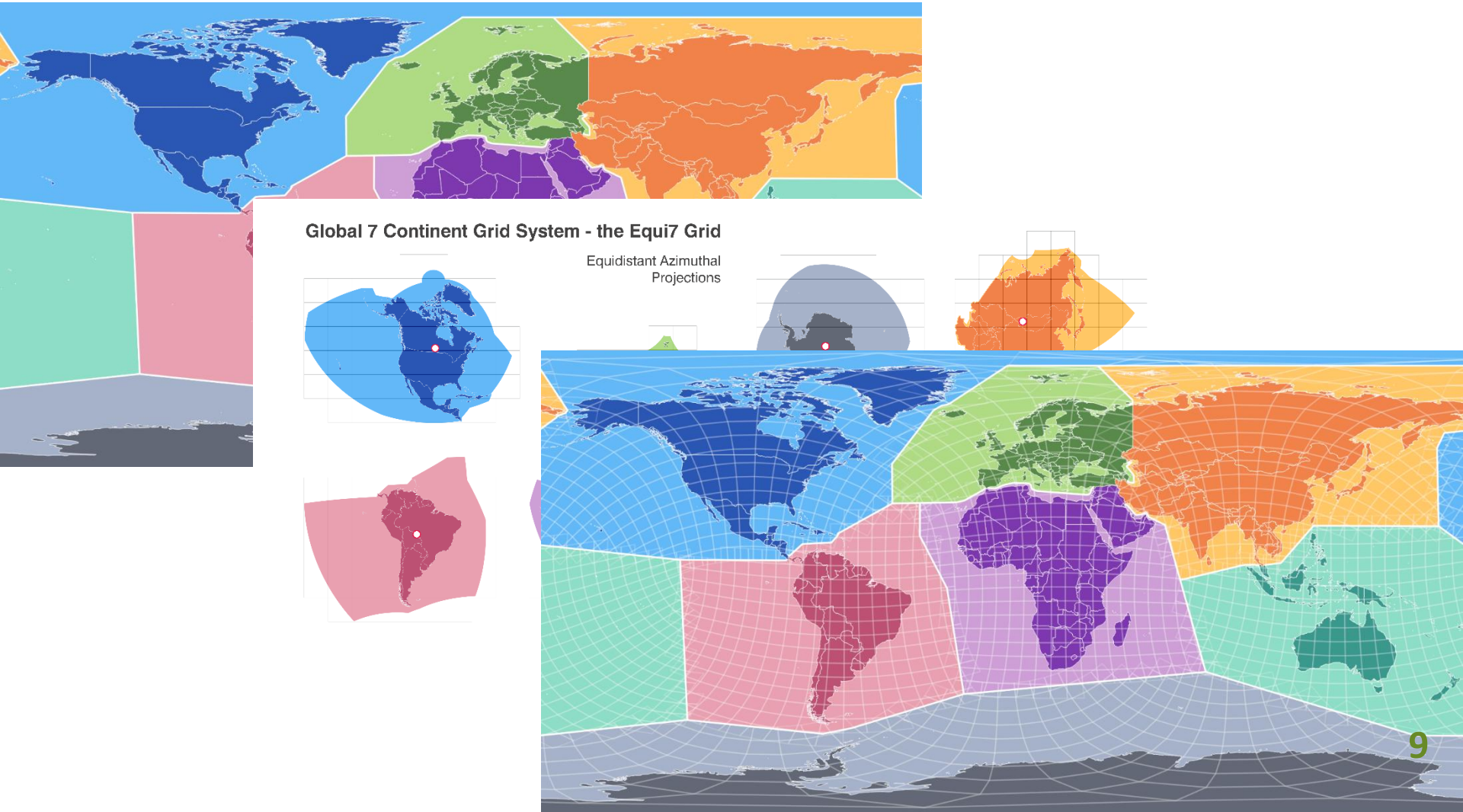
→ Pragmatic solution

- 7 Continents with Azimuthal Equidistant

Global Grid System $-56 < \varphi < 72$	preserves	mean GOF
Set of 1 Projection: Zone B		
Plate Carrée	Scales Longitude	1.36
Set of 2 Projections: Zones D+E		
Equidistant Conic	Scales Longitude	1.04
Lambert Conic	Angles	1.08
Albers Conic	Areas	1.17
Global Grid System $-90 < \varphi < 90$	preserves	mean GOF
Set of Projections: 7 Continents		
Equidistant Azimuthal	Centric Scales	1.02
Stereographic	Angles	1.07
Lambert Azimuthal	Areas	1.14

The Idea of the Equi7 Grid

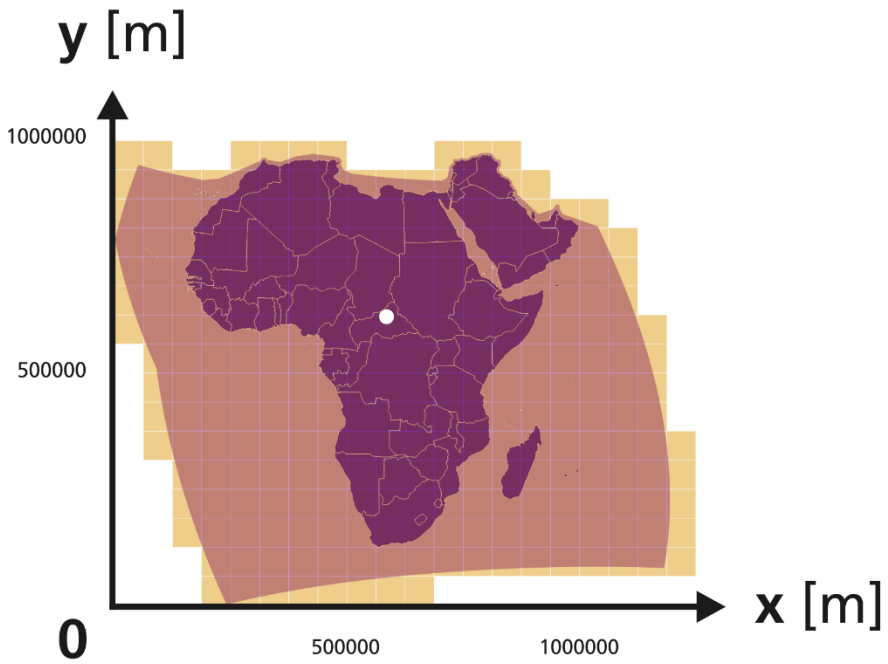
7 continental zones: individually projected



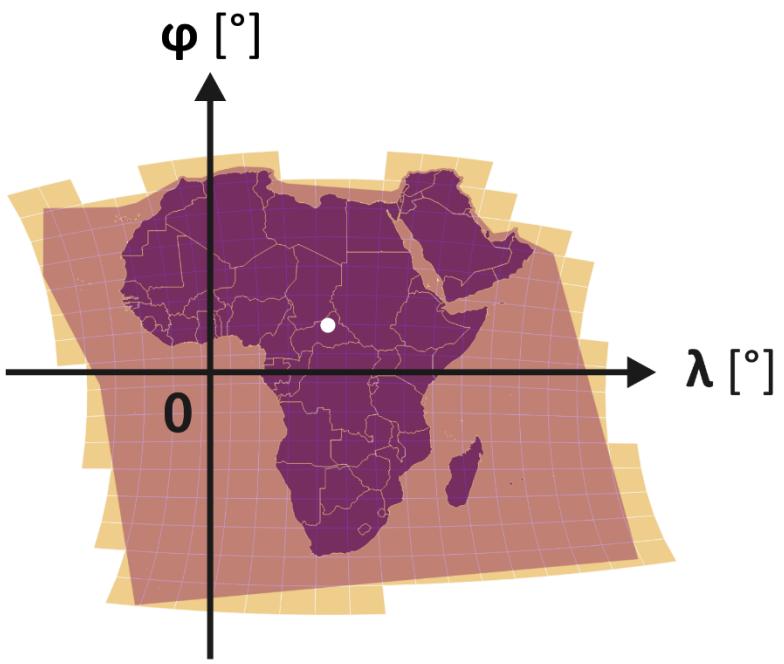
Coordinates & Tiles

- Metric coordinates in projected plane
- Lower-Left-defined

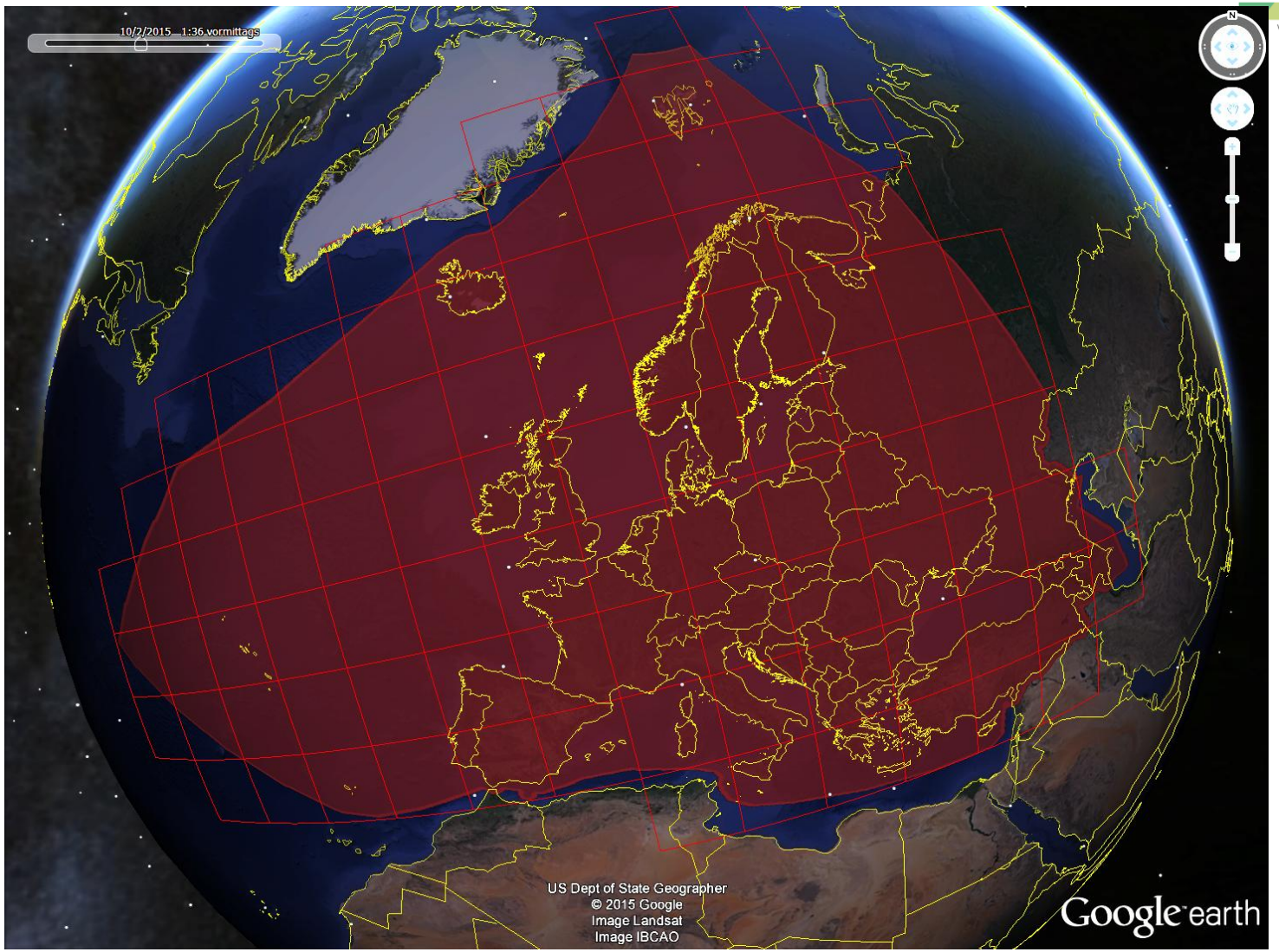
Azimuthal Equidistant



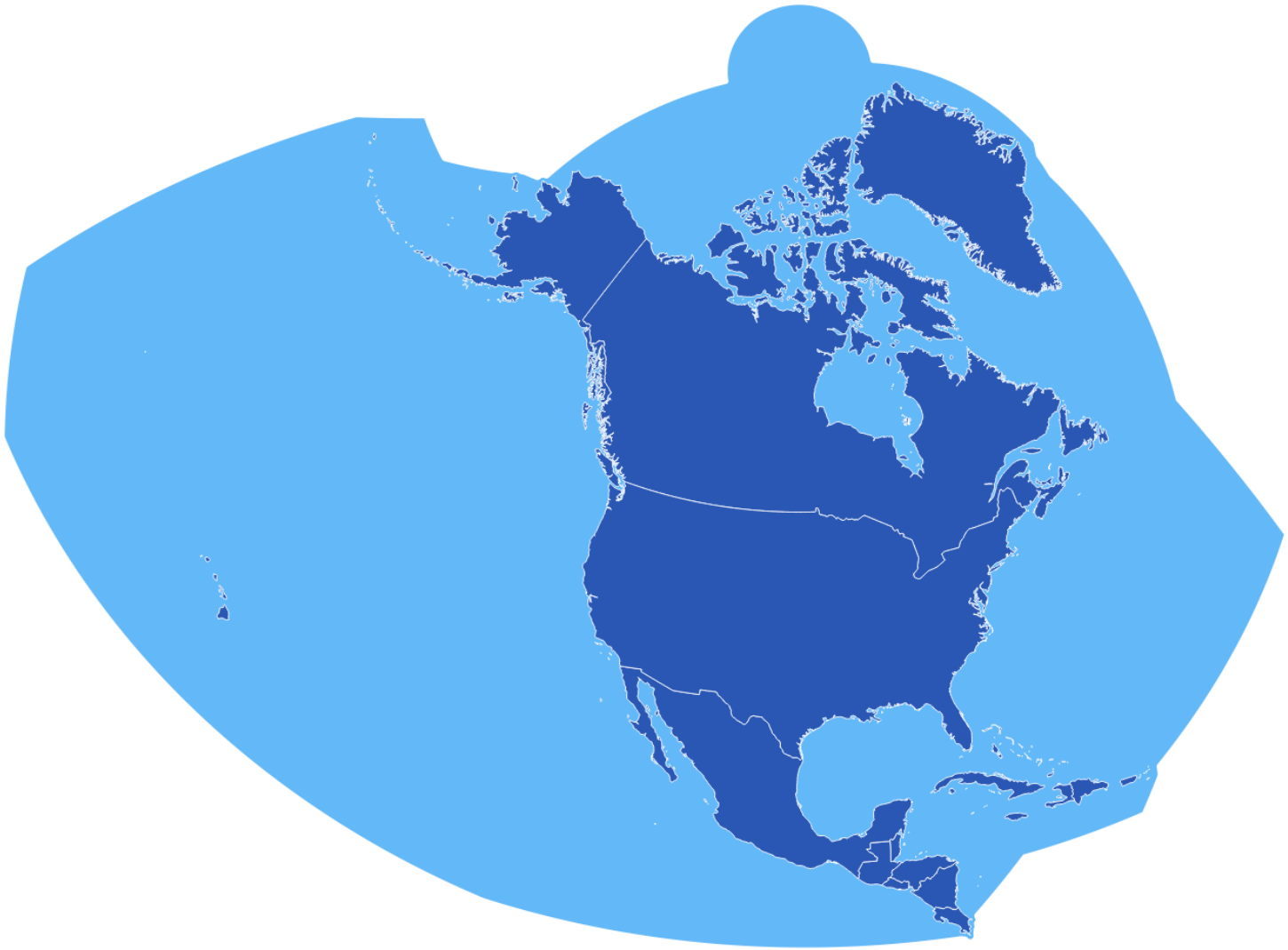
Lat-Lon (WGS84)



Example: EU-subgrid

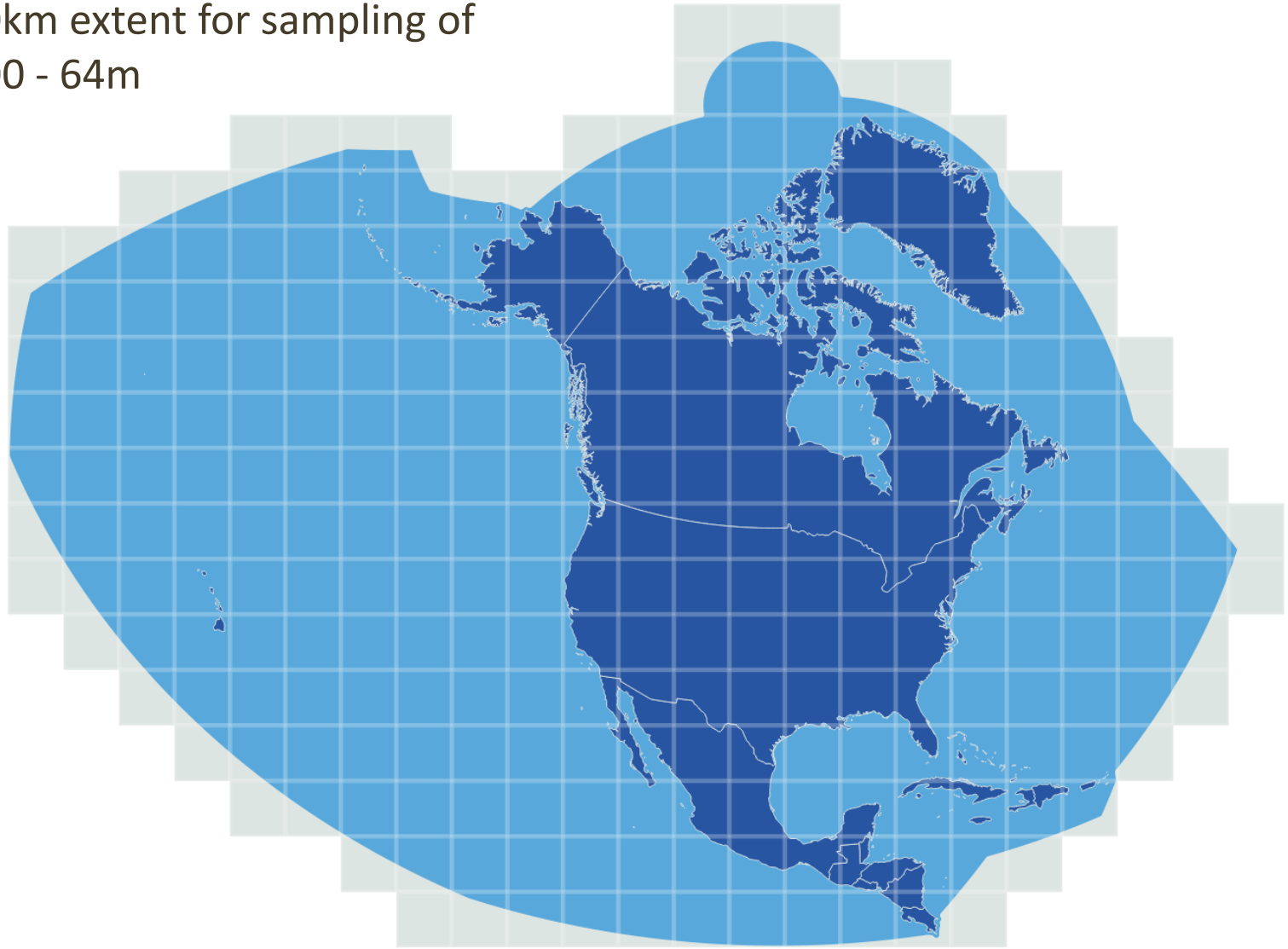


Equi7Grid-Tiling: 3 Levels



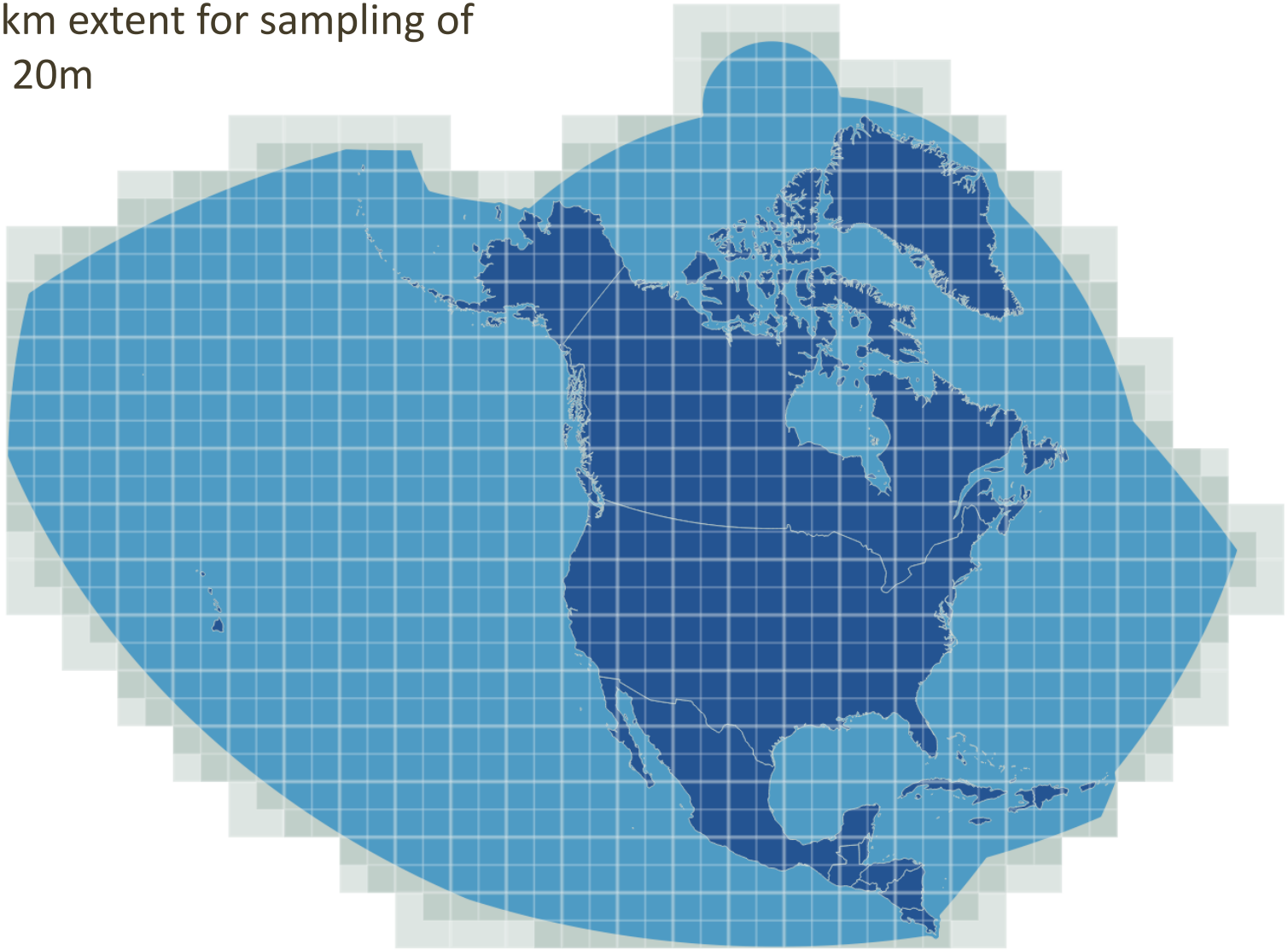
Tiling T6

600km extent for sampling of
1000 - 64m



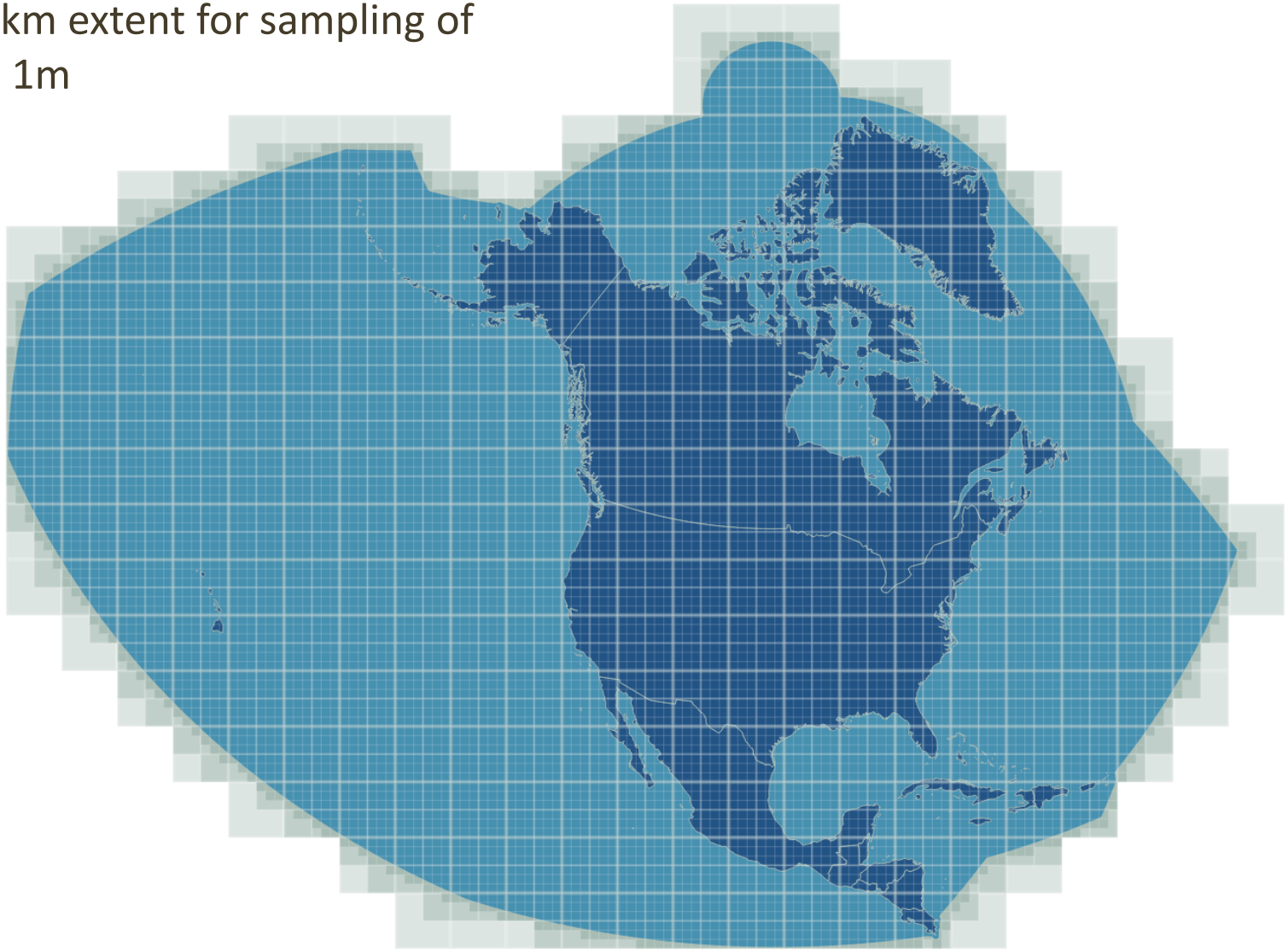
Tiling T3

300km extent for sampling of
60 - 20m

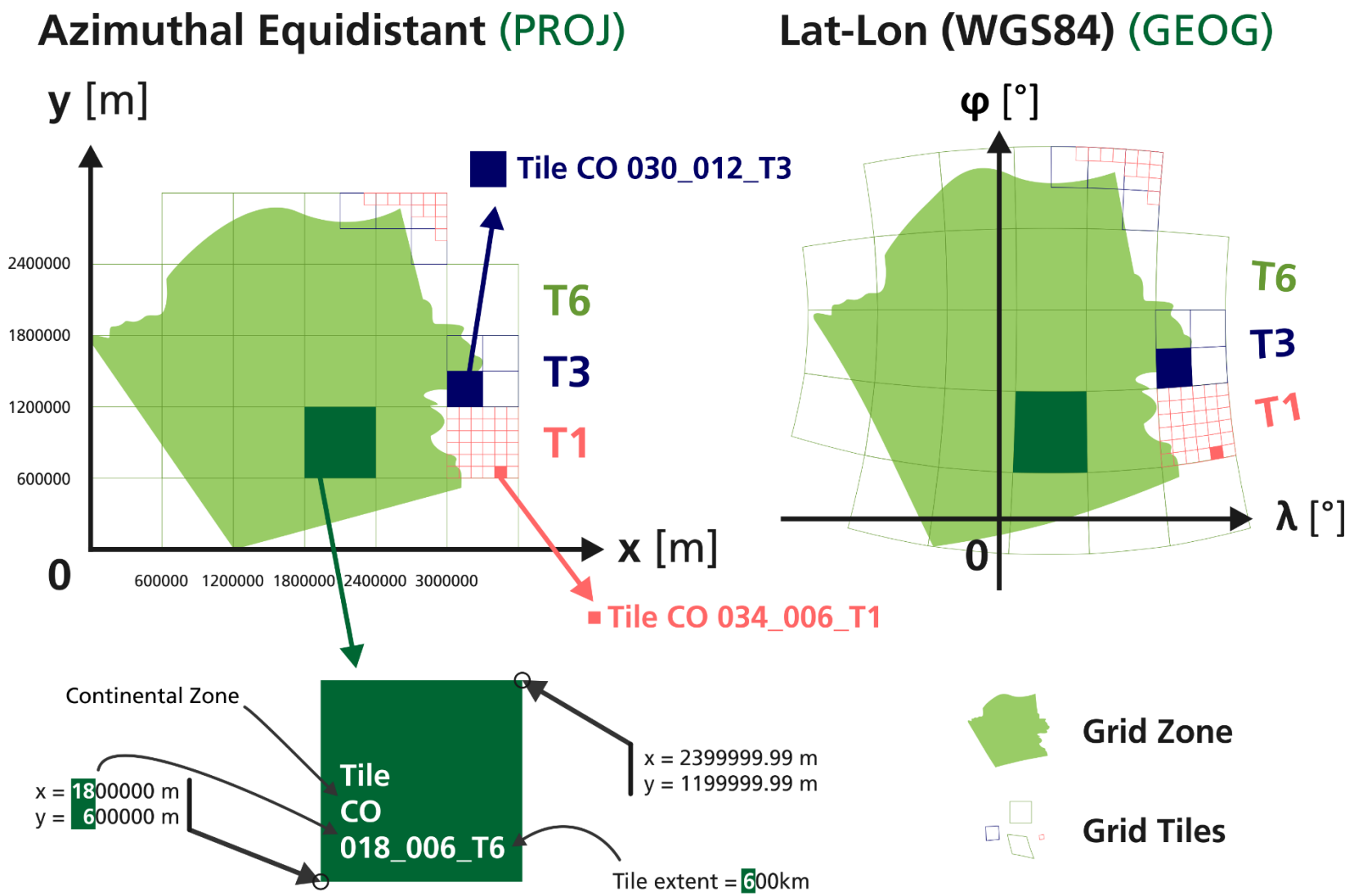


Tiling T1

100km extent for sampling of
16 - 1m

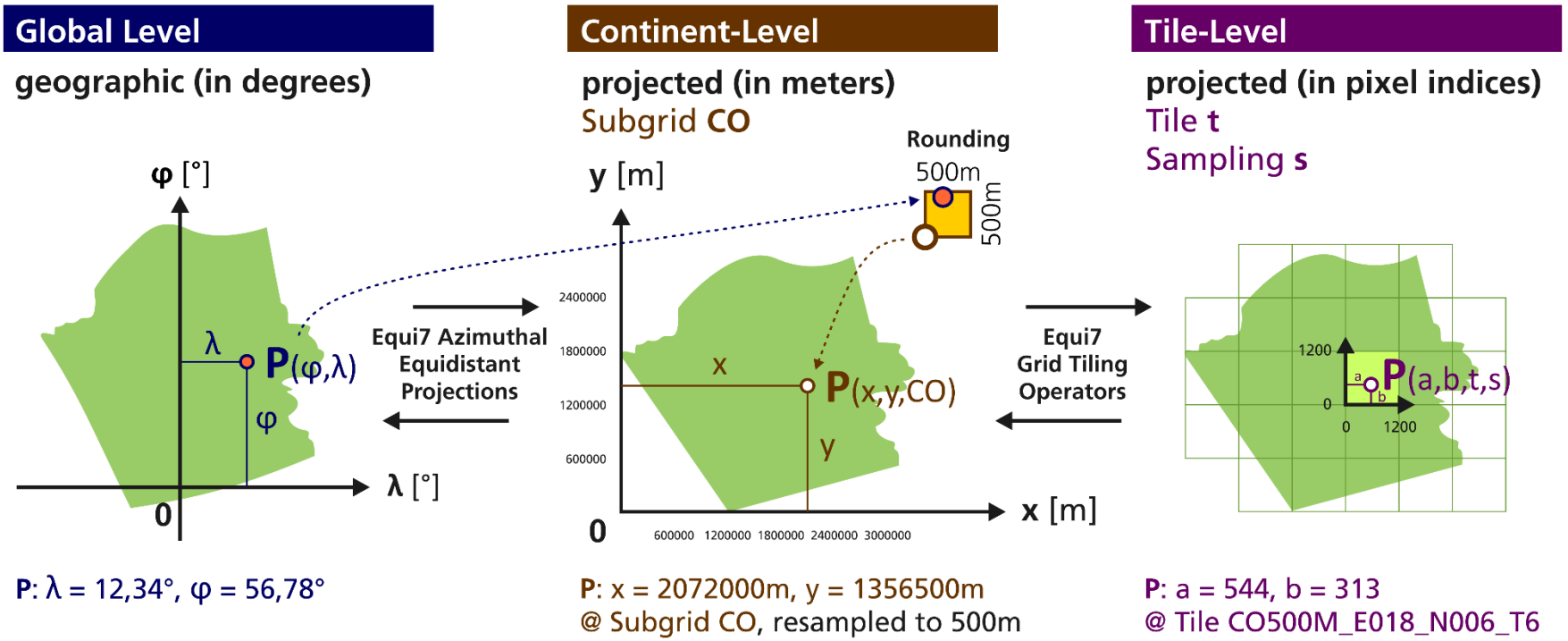


Tiling Definitions



Pixel Locating and Indexing

- From global to continental
  - Azimuthal Equidistant Projection
- From continental to tile
  - Tiling Operators



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Optimisation of global grids for high-resolution remote sensing data

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ABSTRACT

Upcoming remote sensing systems onboard satellites will generate unprecedented volumes of spatial data, hence challenging processing facilities in terms of storage and processing capacities. Thus, an efficient handling of remote sensing data is of vital importance, demanding a well-suited definition of spatial grids for the data's storage and manipulation. For high-resolution image data, regular grids defined by map projections have been identified as practicable, cognisant of their drawbacks due to geometric distortions. To this end, we defined a new metric named grid oversampling factor (GOF) that estimates local data oversampling appearing during projection of generic satellite images to a regular raster grid. Based on common map projections, we defined sets of spatial grids optimised to minimise data oversampling. Moreover, they ensure that data undersampling cannot occur at any location. From the resulting GOF-values we concluded that equidistant projections are most suitable, with a global mean oversampling of 2% when using a system of seven continental grids (introduced under the name Equi7 Grid). Opposed to previous studies that suggested equal-area projections, we recommend the Plate Carrée, the Equidistant Conic and the Equidistant Azimuthal projection for global, hemispherical and continental grids, respectively.

- Equi7 Grid @ GitHub: https://github.com/bbauerma/Equi7Grid
  - Shapefiles
  - Python software
  - Documentation

} Work in Progress

GitHub

Summary

- High resolution geo-imagery needs map projections
  - Distortions cost…
    - disk volume
    - processing time
    - accuracy

→ Equi7 Grid minimises raster distortions

  - 7 continental zones – projected with Azimuthal Equidistant

- Definition by
  - Shapefiles
  - Projections (Well Known Texts)
  - Tiling + Sampling System
- Distribution via
  - Computer & Geosciences
  - GitHub
  - remote.sensing@geo.tuwien.ac.at
  - https://rs.geo.tuwien.ac.at

Thank you for the attention!