

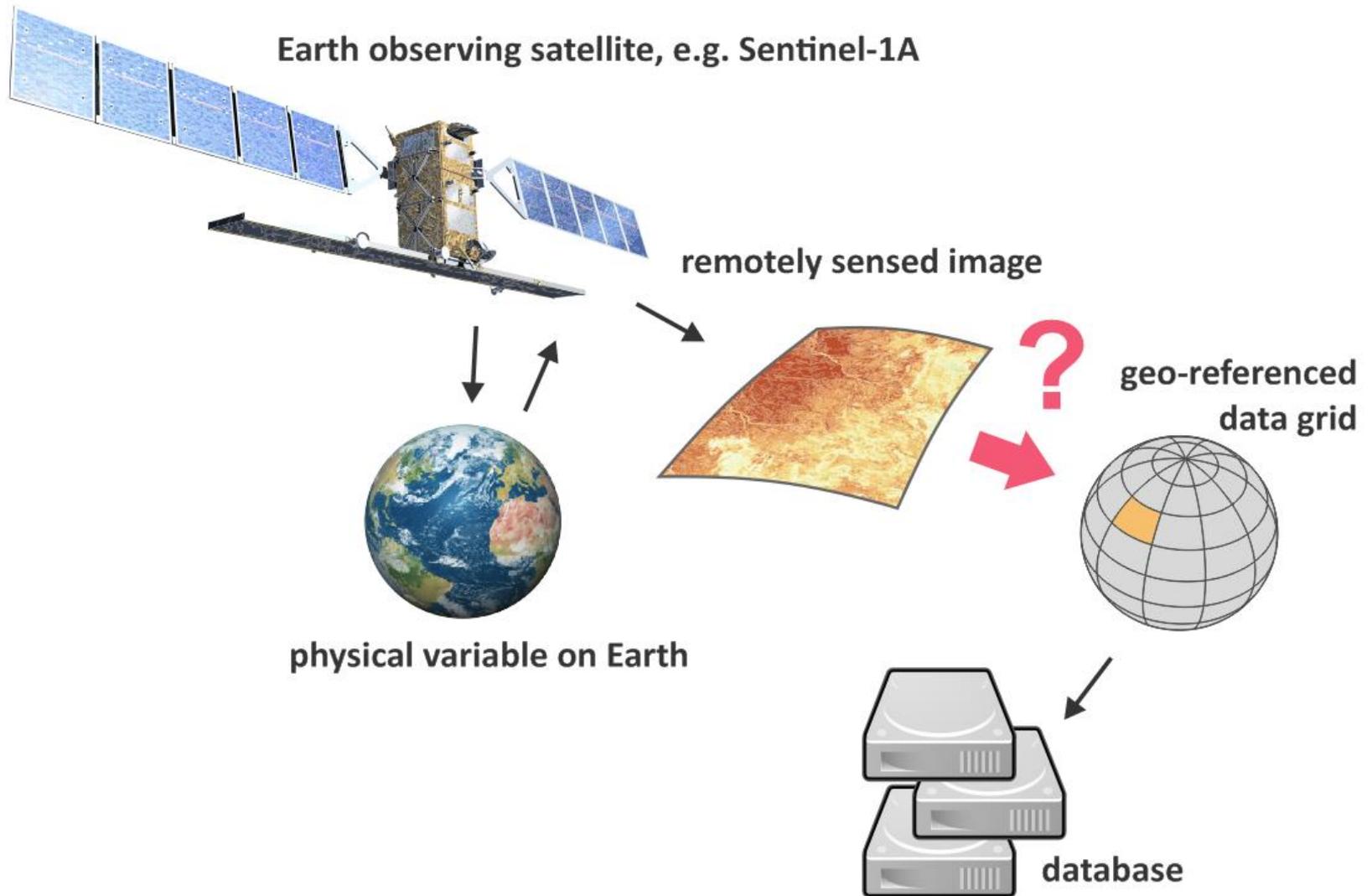
The Equi7 Grid

Optimisation of Global Grids for High-Resolution
Remote Sensing Data

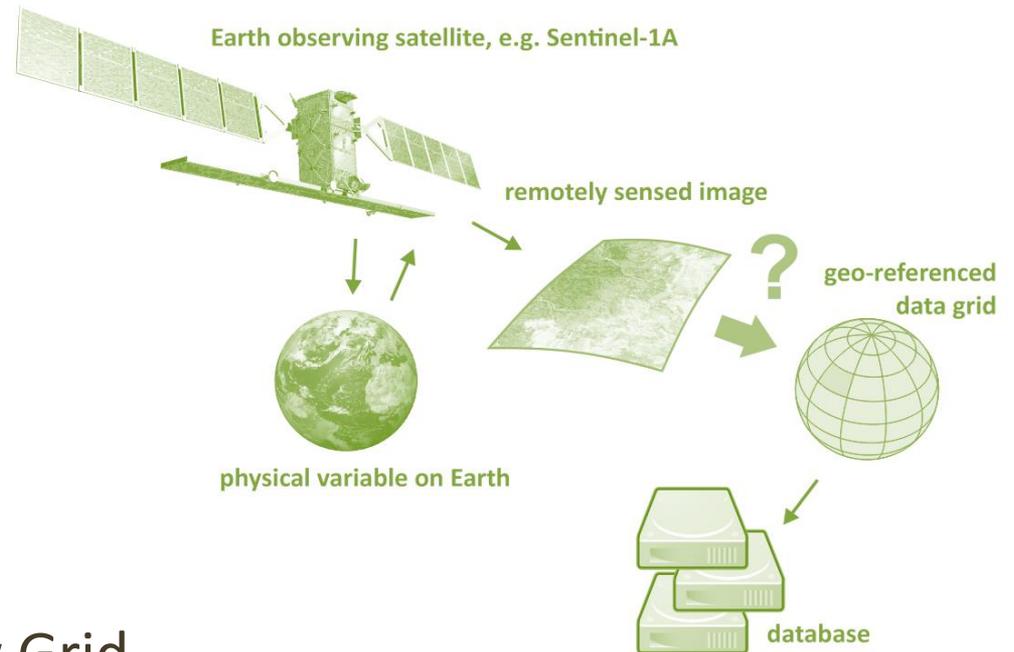
Bernhard Bauer-Marschallinger
TU Wien – Remote Sensing Research Group

EuroCarto 2015
Vienna, 2015-11-10

How to geo-reference satellite data?

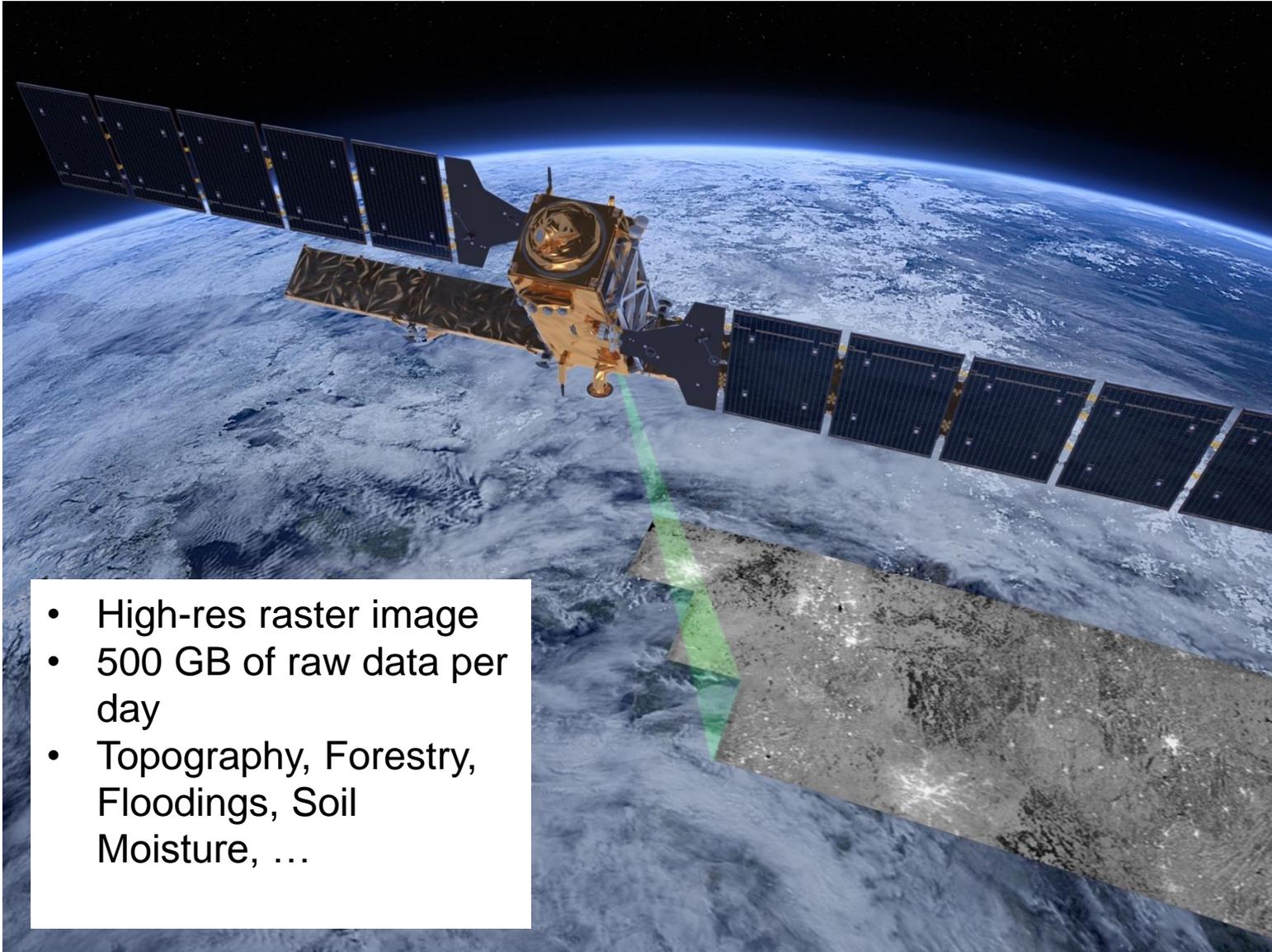


Content



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

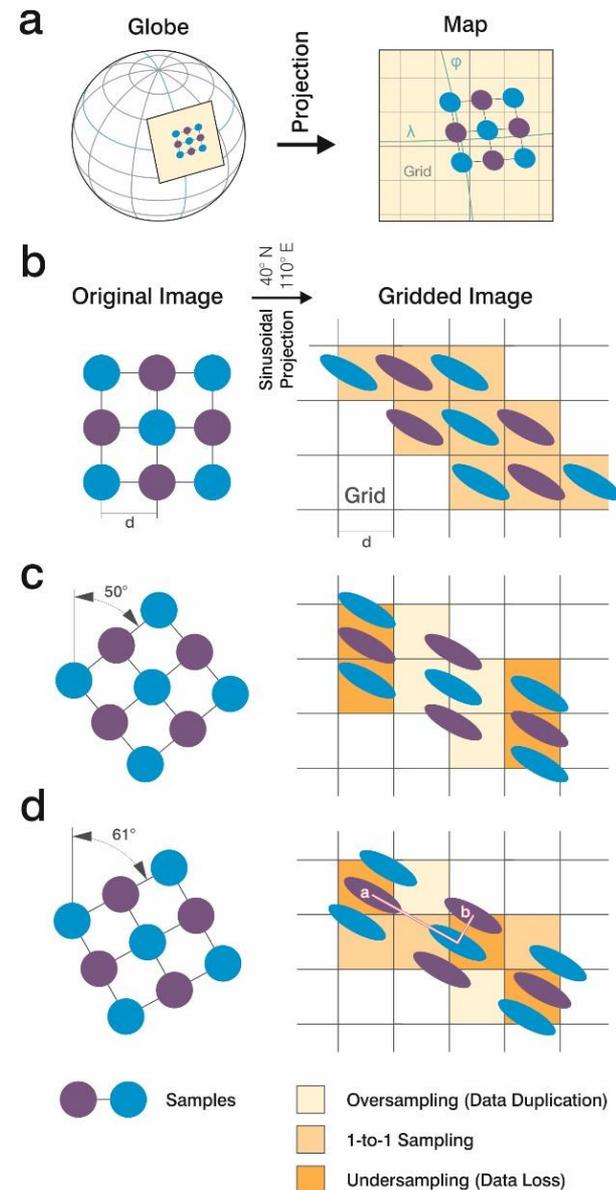
Example: Sentinel-1 Imaging Radar



- 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 ↓

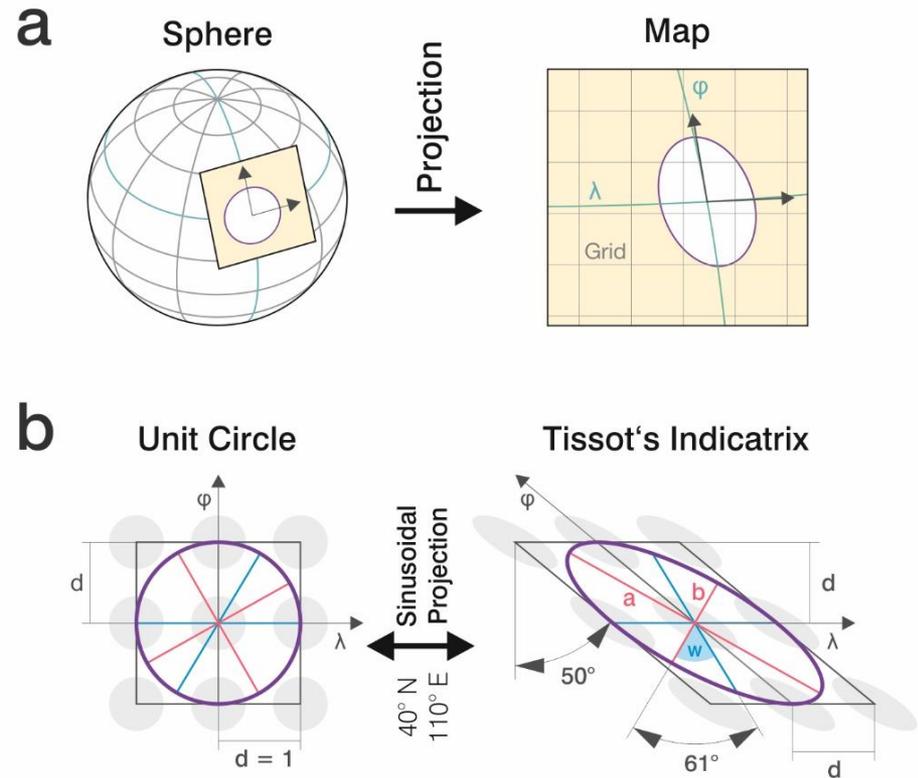


The GOF

- New Metric:
 - *Grid Oversampling Factor*

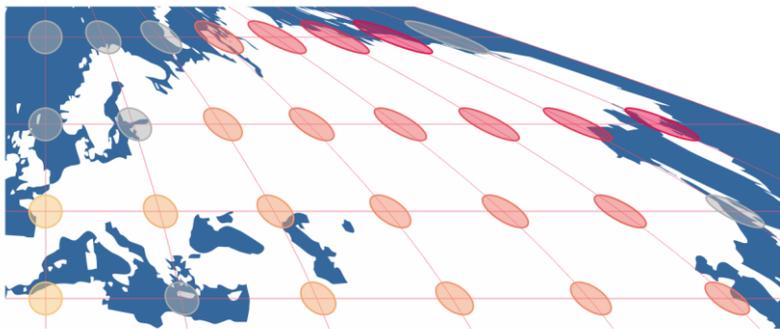
$$GOF_i = \frac{a_i b_i}{b_{min}^2}$$

- 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 amount representing the same information

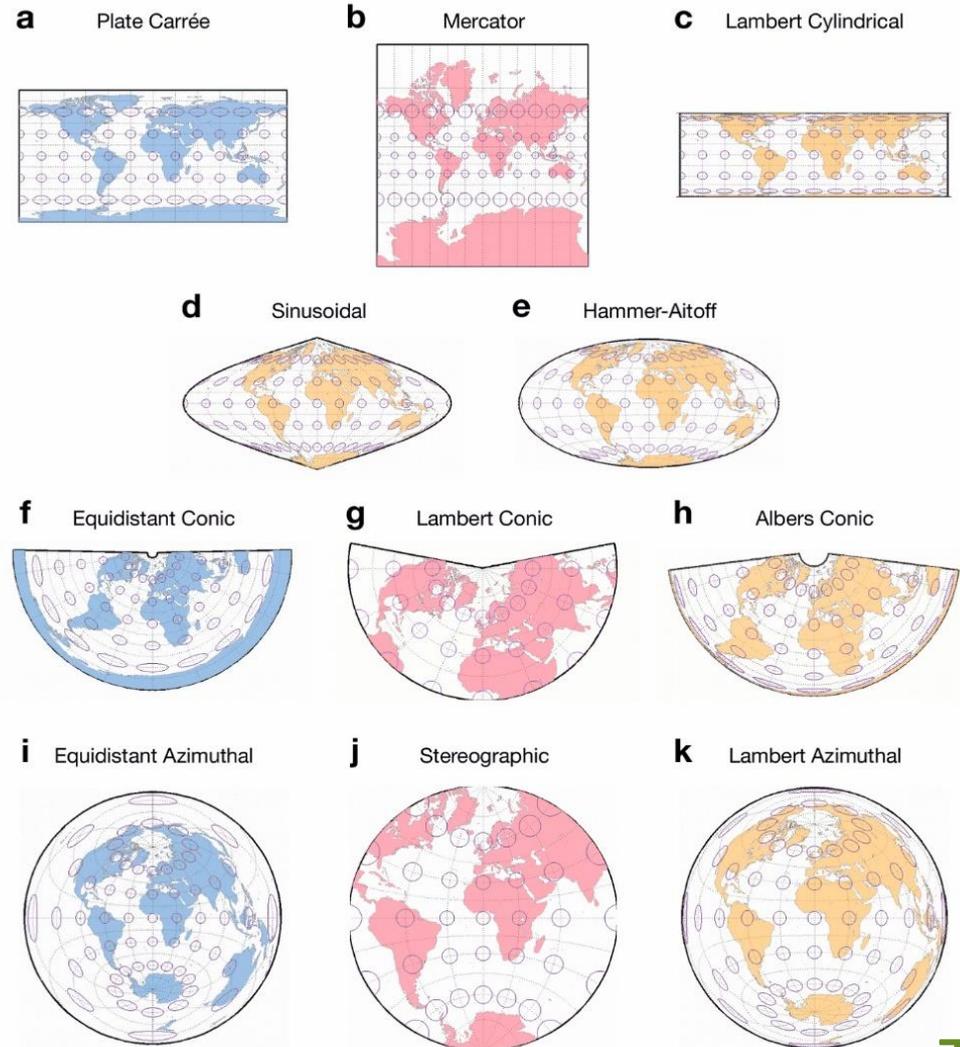


Optimisation Method

- 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 individual projections, the better

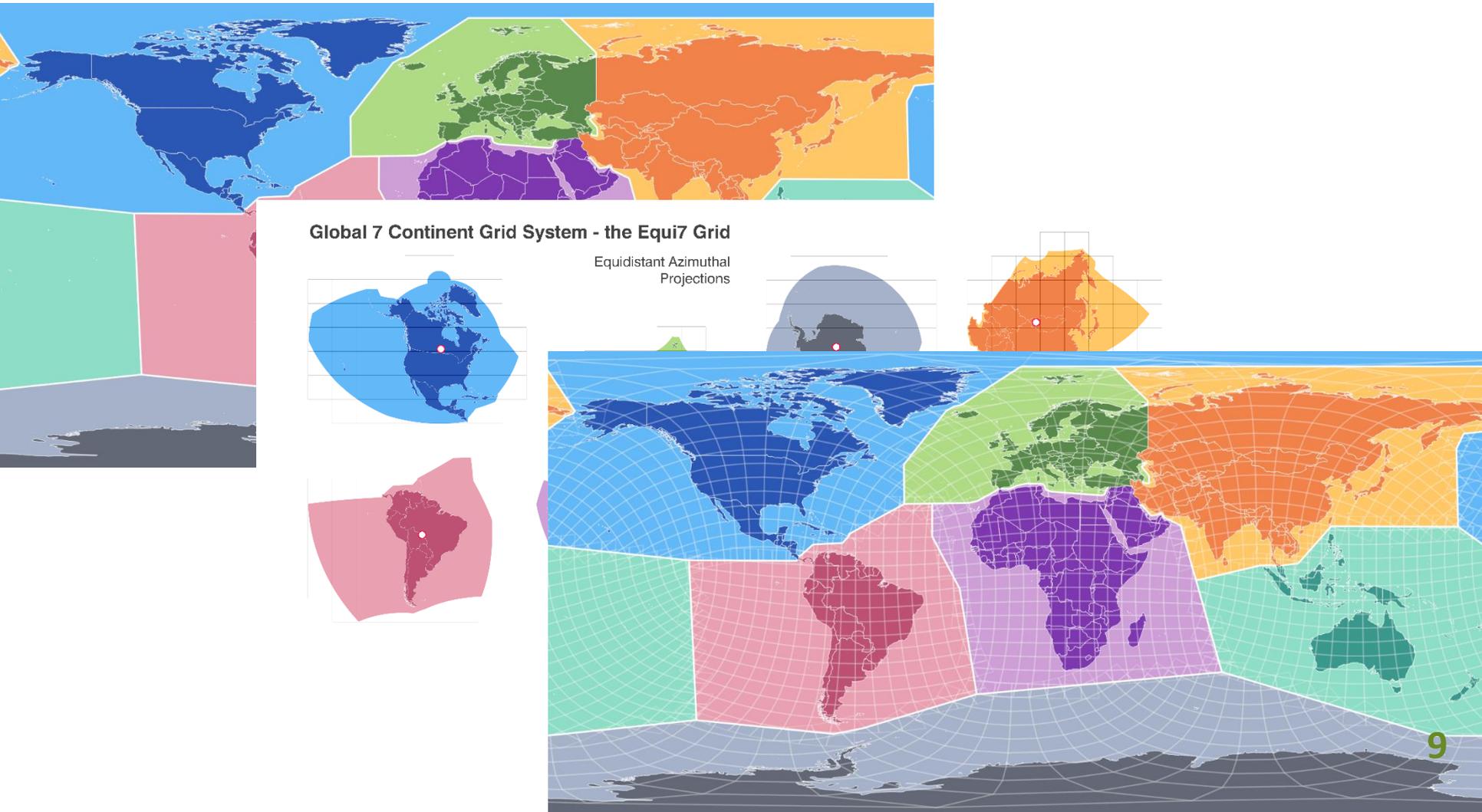
→ Pragmatic solution

- 7 Continents with Azimuthal Equidistant

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

The Idea of the Equi7 Grid

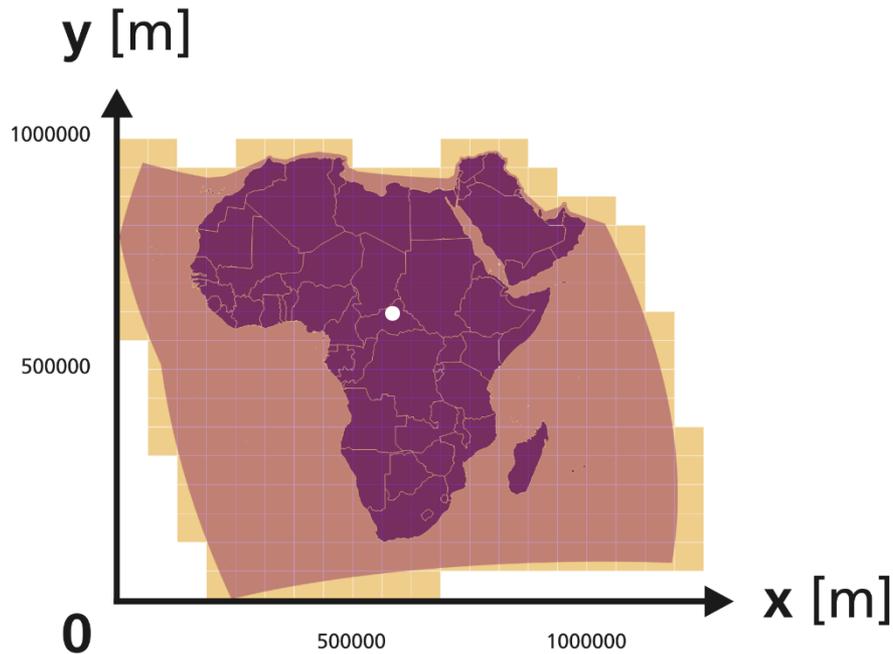
7 continental zones: individually projected



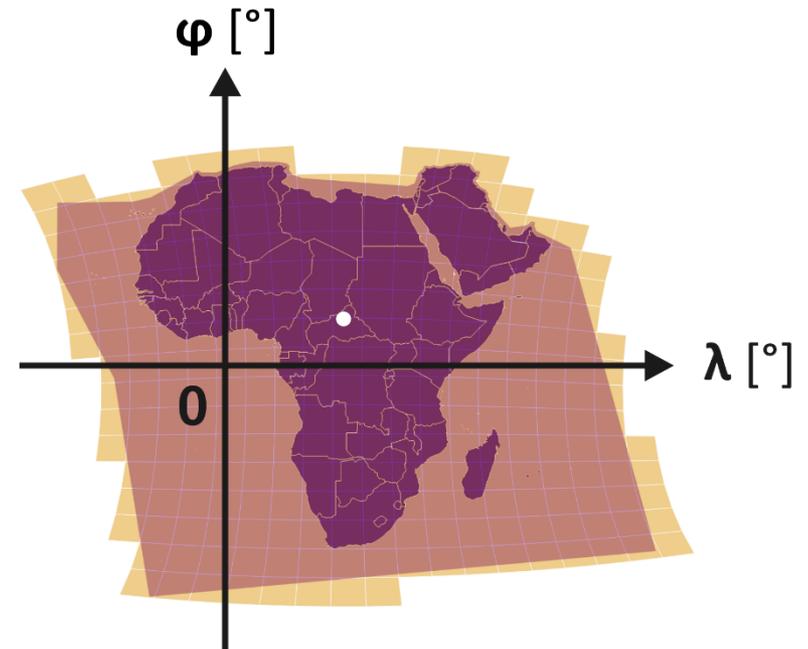
Coordinates & Tiles

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

Azimuthal Equidistant



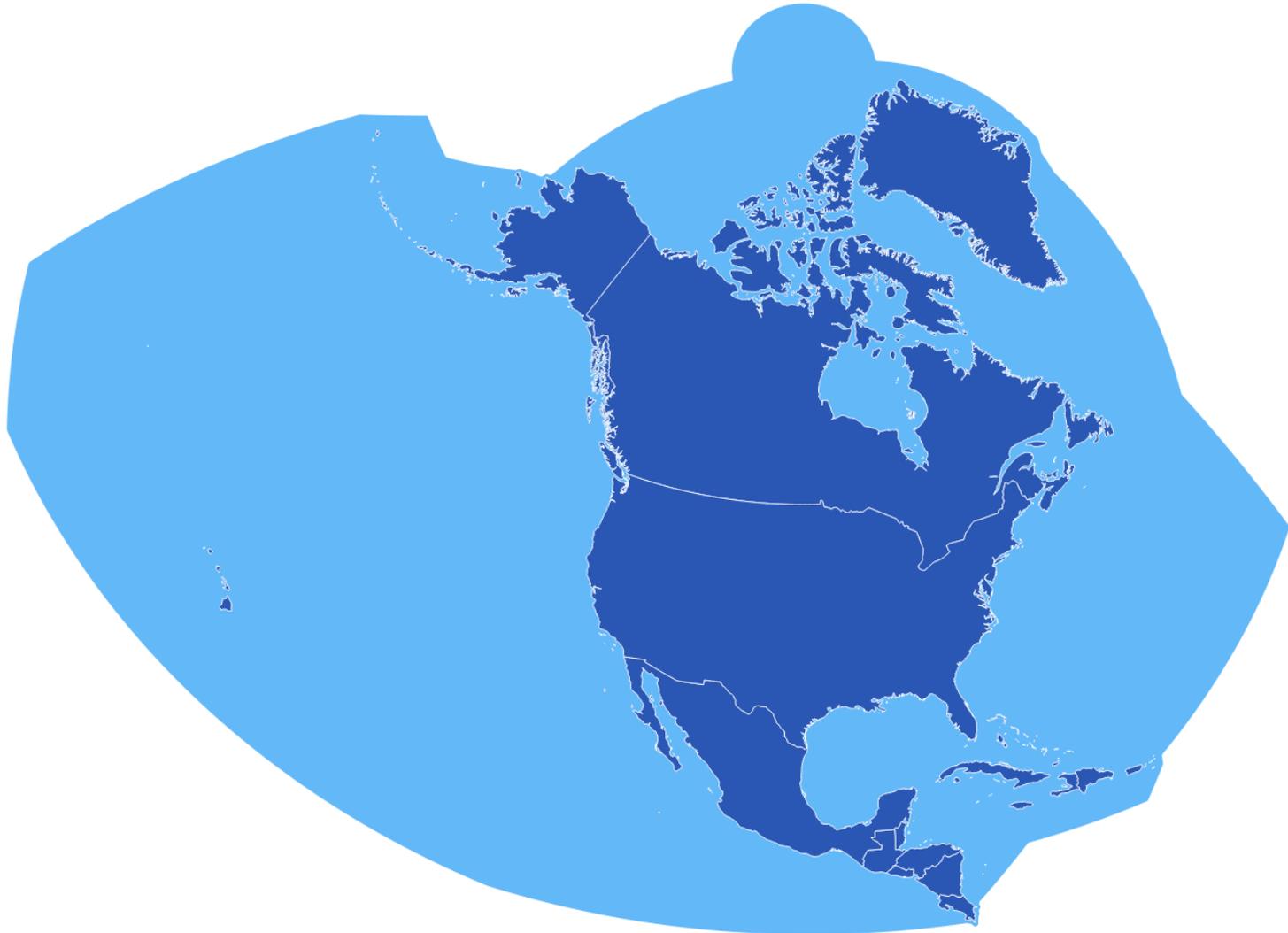
Lat-Lon (WGS84)



Example: EU-subgrid

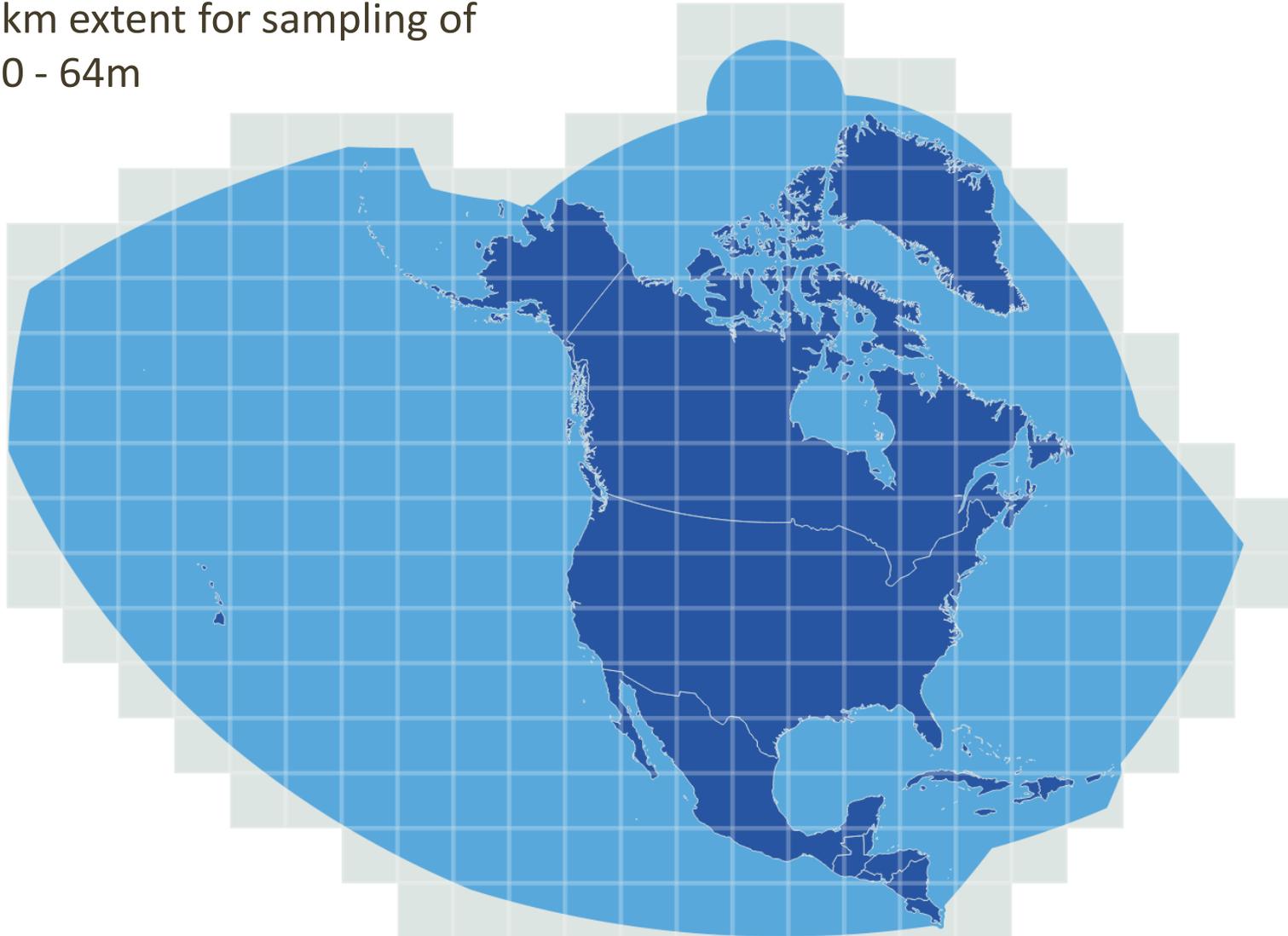


Equi7Grid-Tiling: 3 Levels



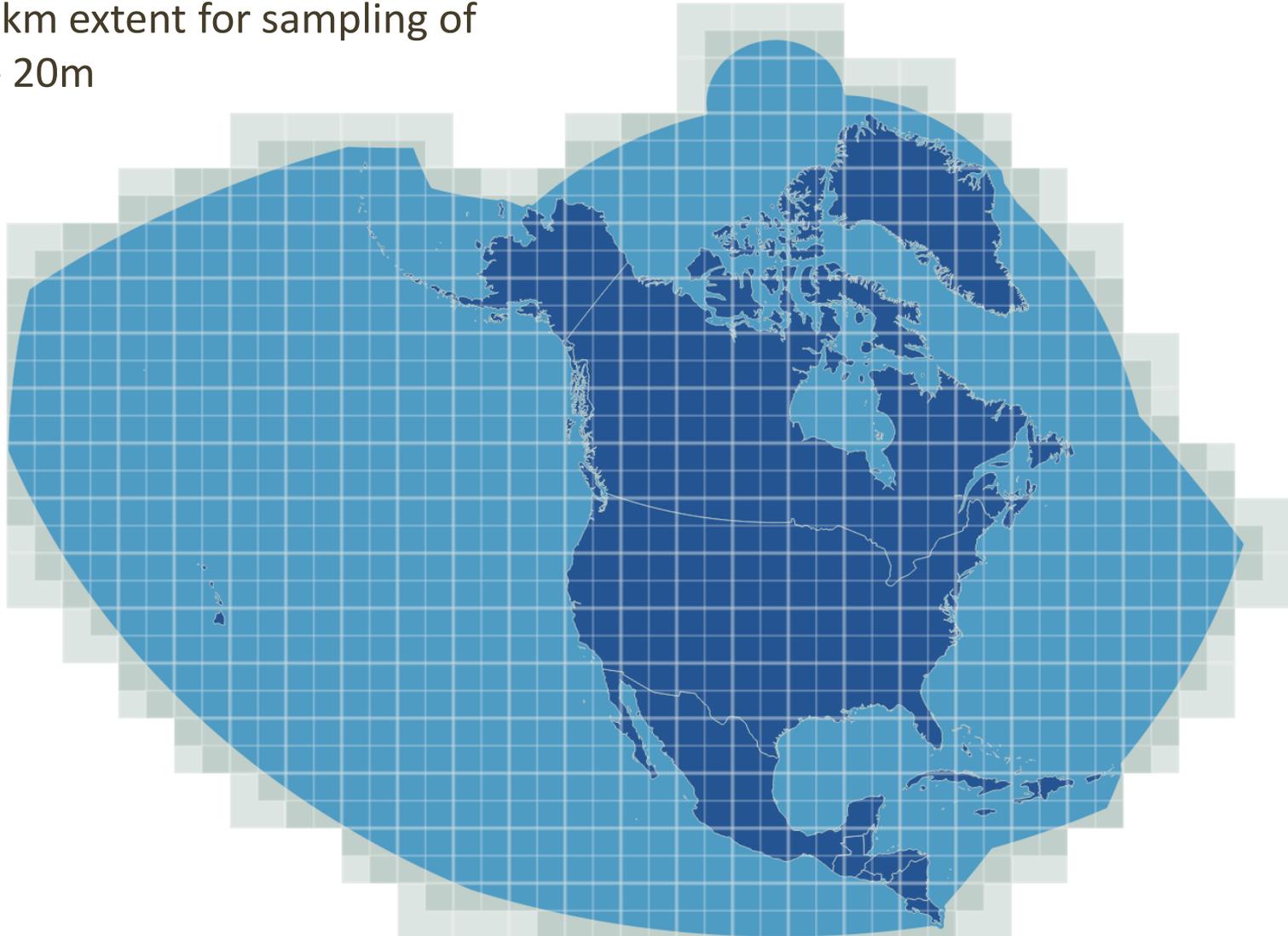
Tiling T6

600km extent for sampling of
1000 - 64m



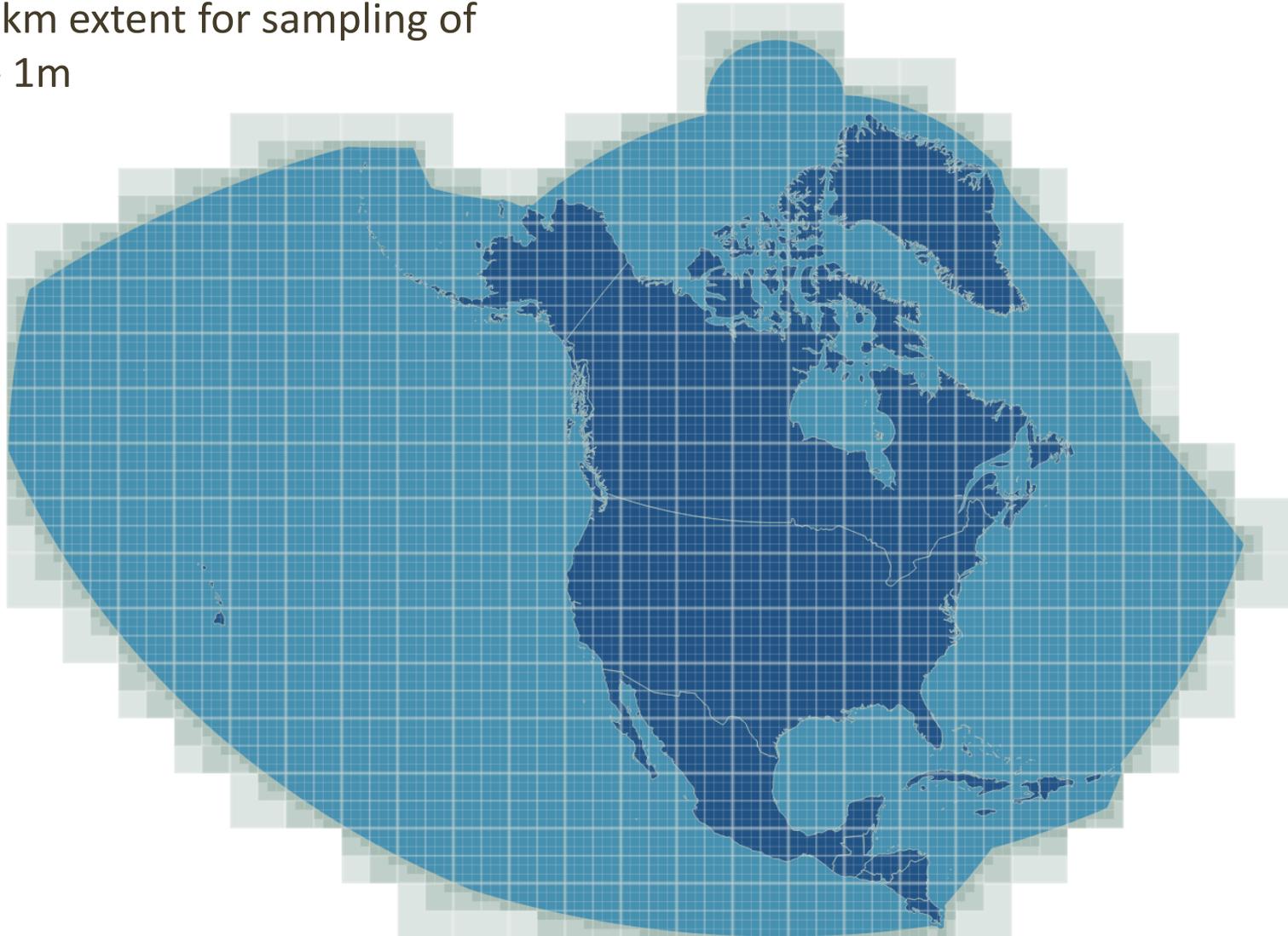
Tiling T3

300km extent for sampling of
60 - 20m



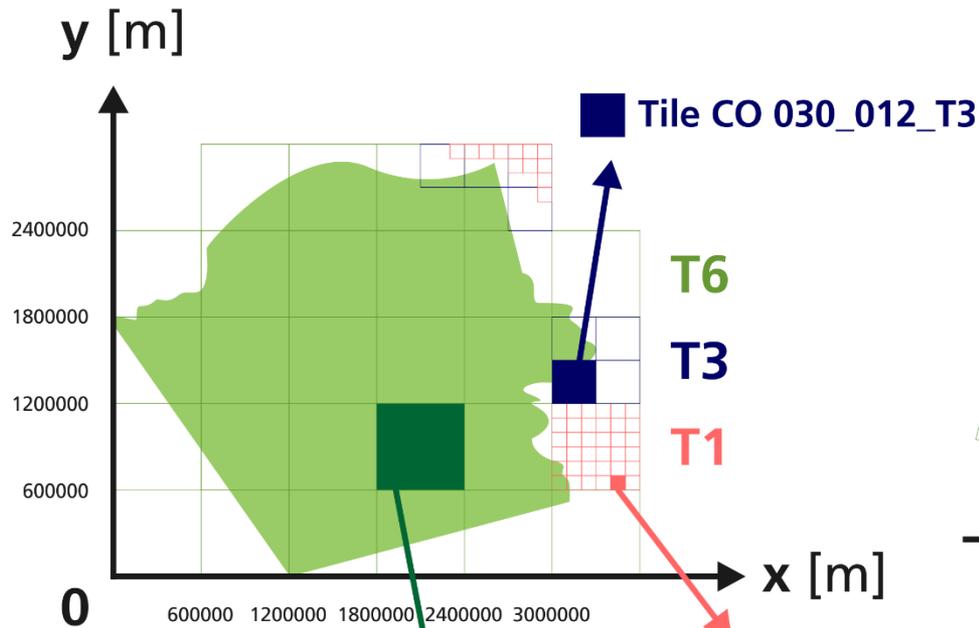
Tiling T1

100km extent for sampling of
16 - 1m

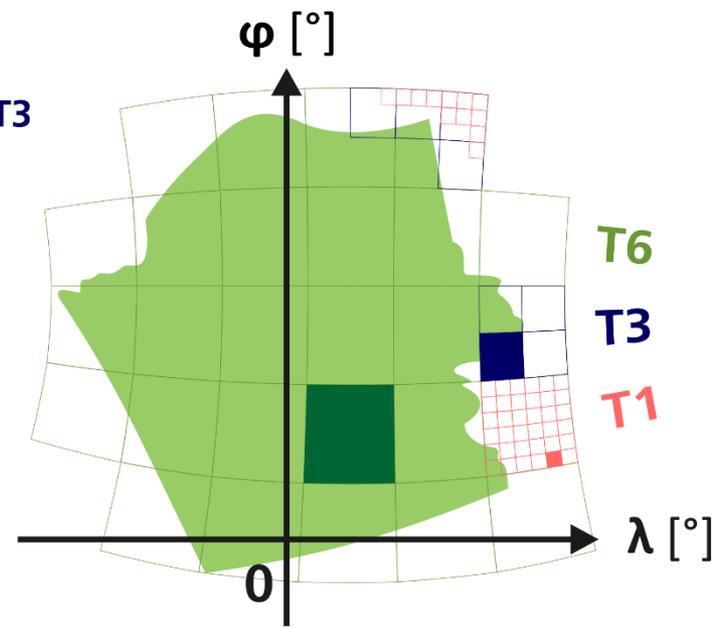


Tiling Definitions

Azimuthal Equidistant (PROJ)



Lat-Lon (WGS84) (GEOG)

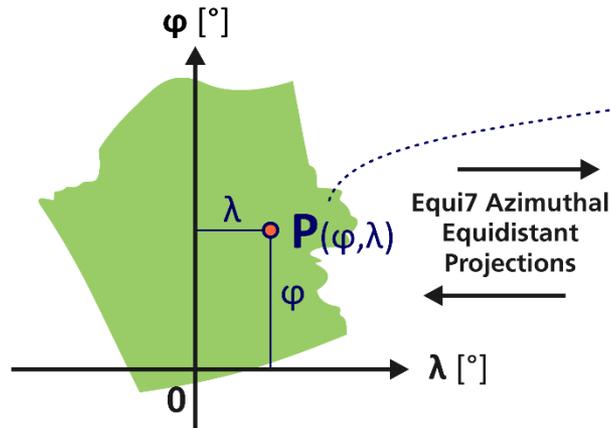


Pixel Locating and Indexing

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

Global Level

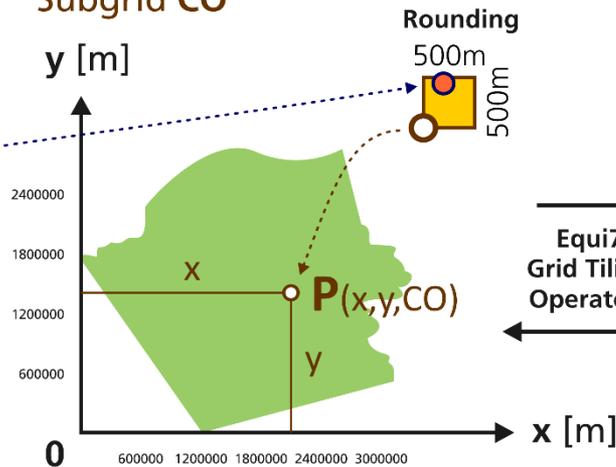
geographic (in degrees)



P: $\lambda = 12,34^\circ$, $\varphi = 56,78^\circ$

Continent-Level

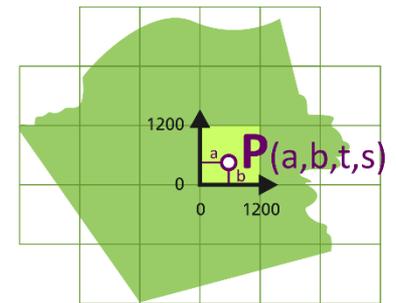
projected (in meters)
Subgrid CO



P: $x = 2072000\text{m}$, $y = 1356500\text{m}$
@ Subgrid CO, resampled to 500m

Tile-Level

projected (in pixel indices)
Tile t
Sampling s



P: $a = 544$, $b = 313$
@ Tile CO500M_E018_N006_T6

Distribution

Computer & Geosciences

- Peer-reviewed article:

[doi:10.1016/j.cageo.2014.07.005](https://doi.org/10.1016/j.cageo.2014.07.005)

*Bernhard Bauer-Marschallinger, Daniel Sabel, Wolfgang Wagner, **Optimisation of global grids for high-resolution remote sensing data**, Computers & Geosciences, Volume 72, November 2014, Pages 84-93.*



- Equi7 Grid @ GitHub: <https://github.com/bbauerma/Equi7Grid>

- Shapefiles

- Python software

- Documentation

Work in Progress



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!***