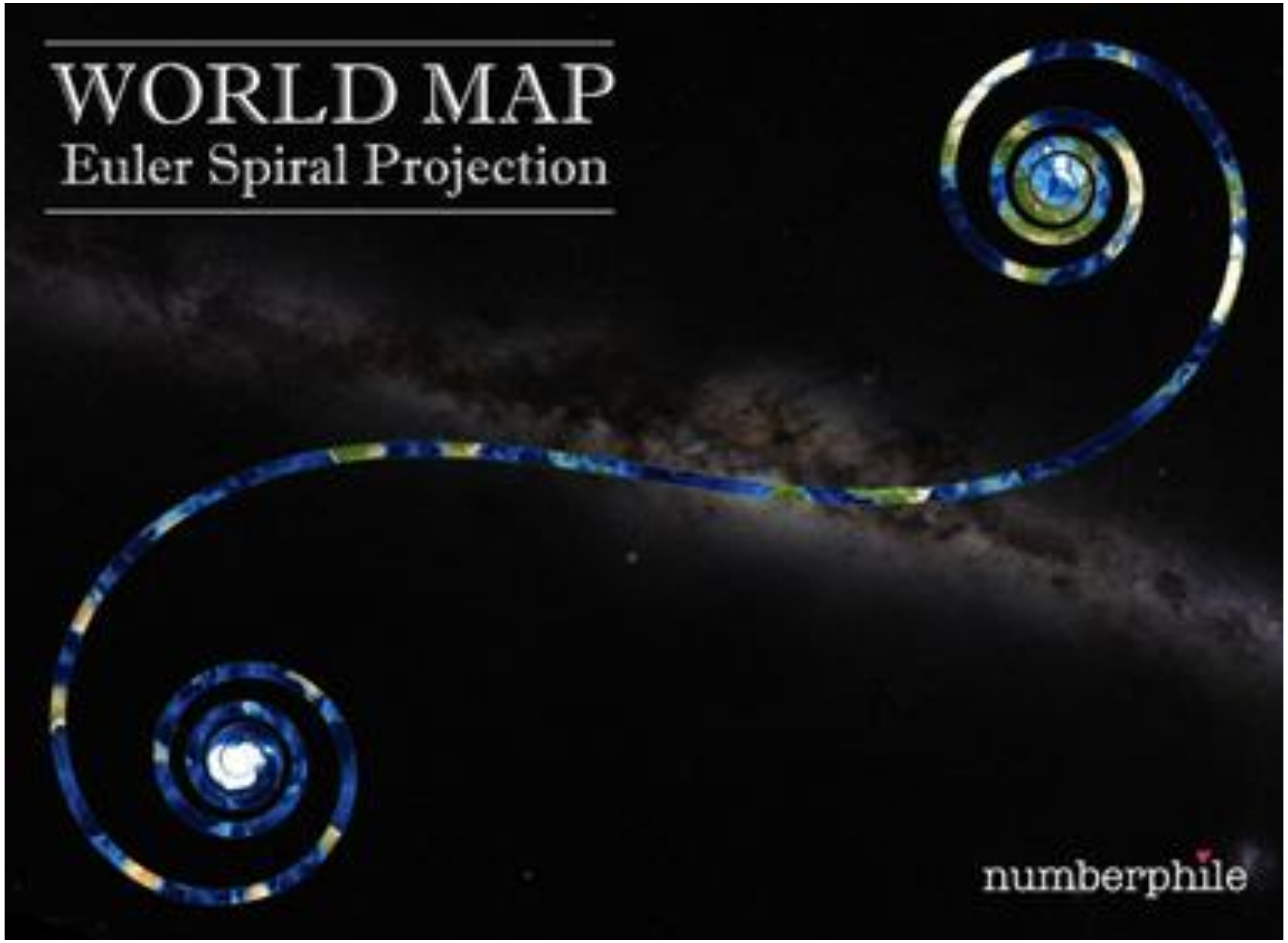
Spatial analyses on a round(ish) planet

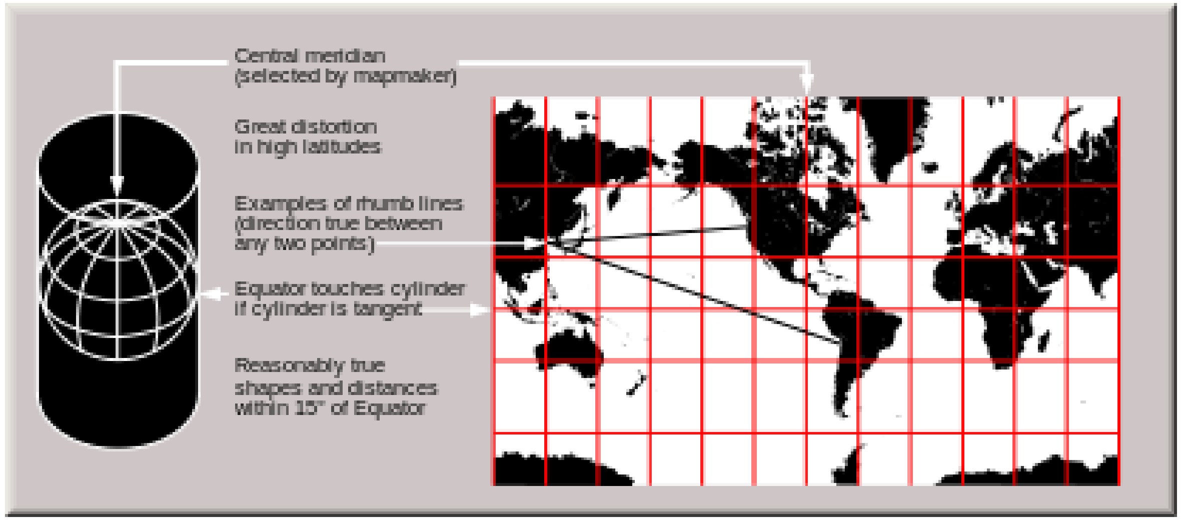
No projection is really good



https://youtu.be/wkK_HsY7S_4

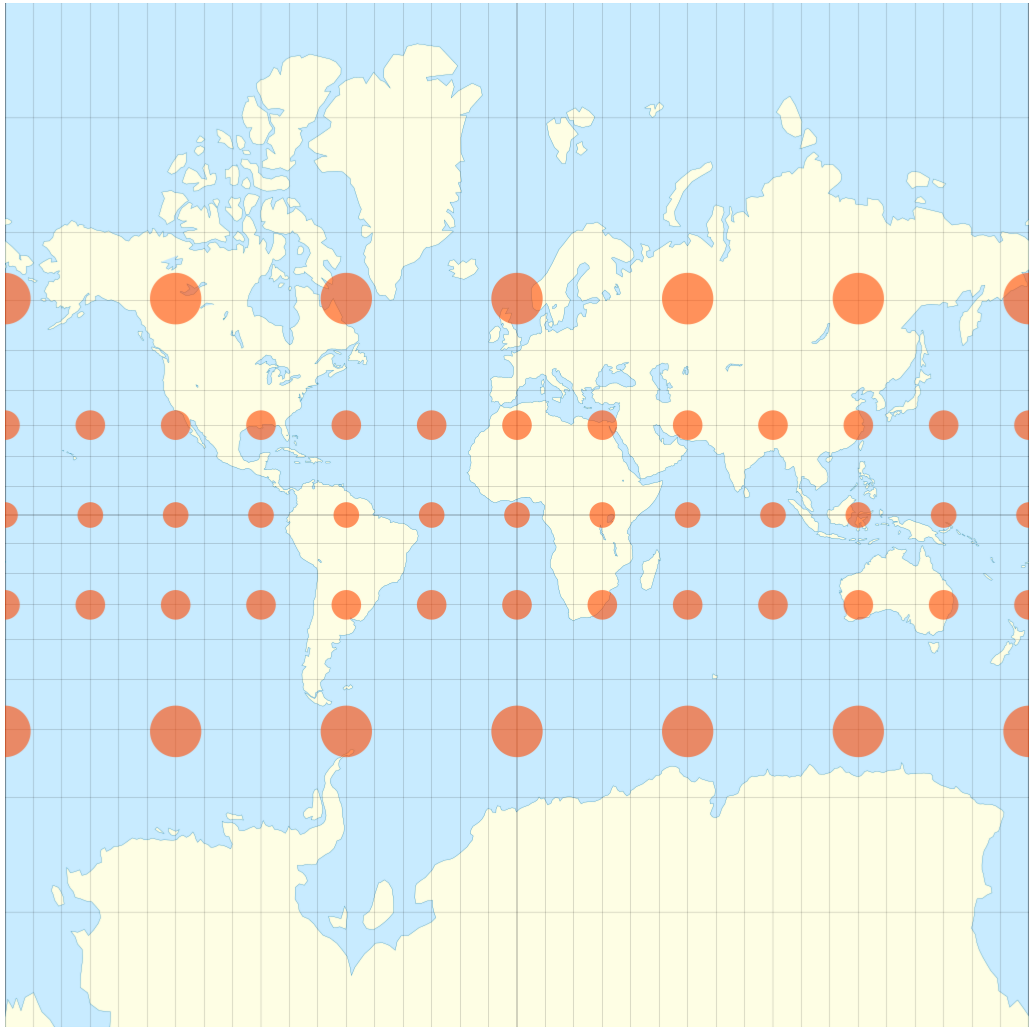
Tissot's indicatrix

Cylindrical projections

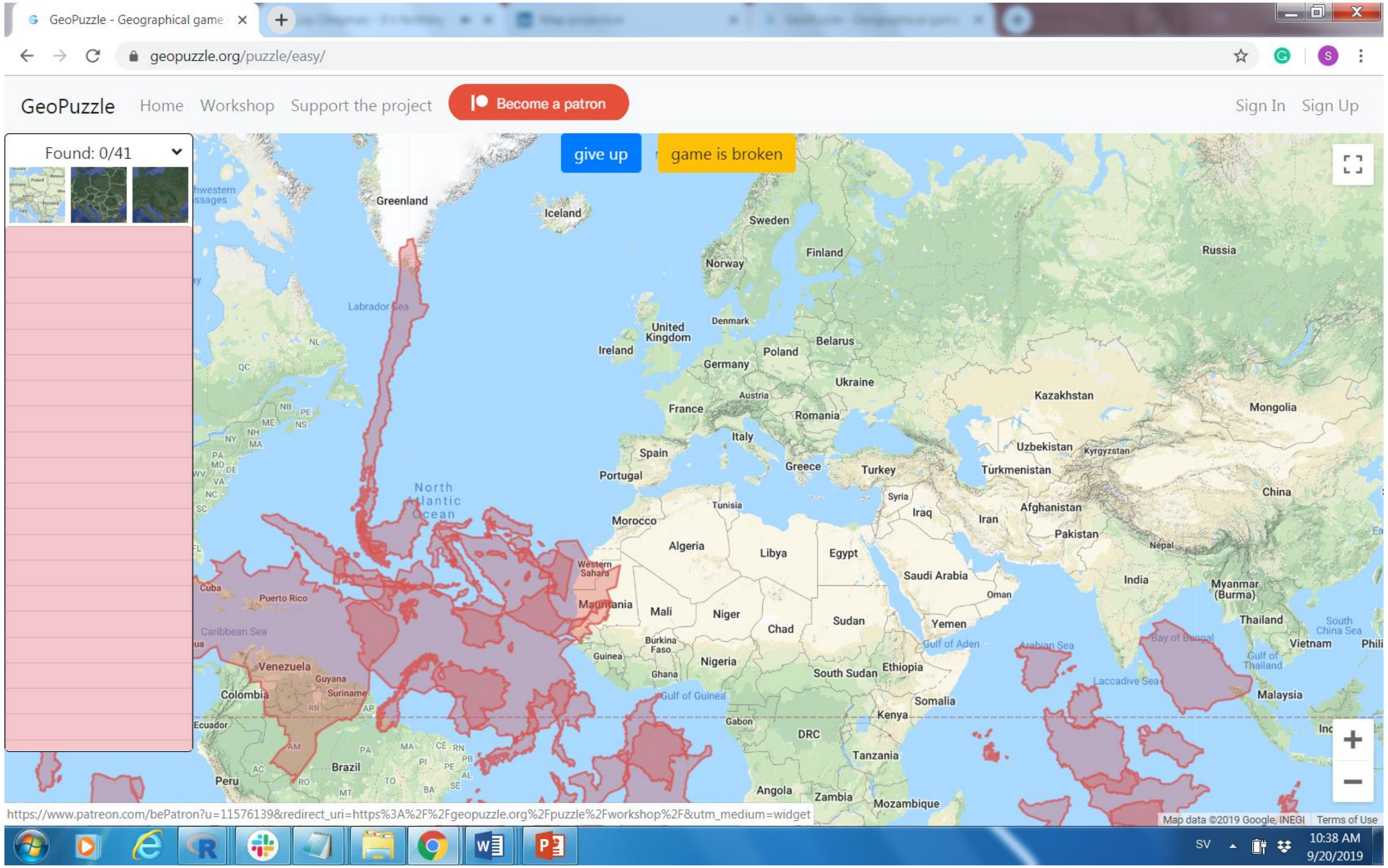


- Conformal: Shape
- Equidistant: (Some) distances
- Equal area: Area

Mercator projection (lat long) (Conformal)



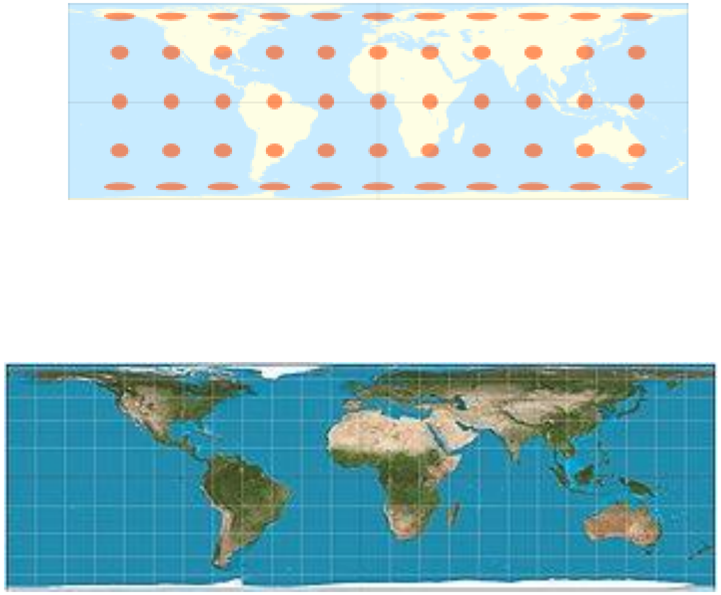
Grossly misassigned sizes



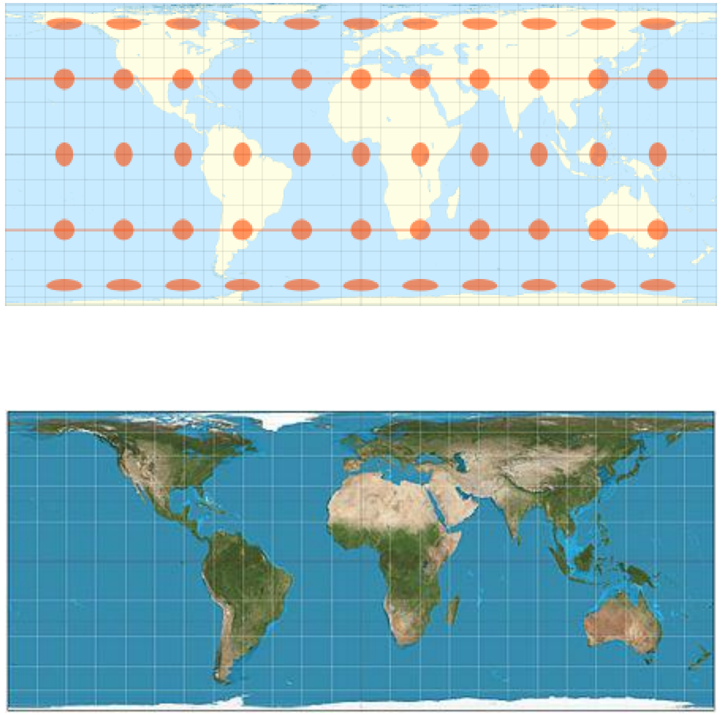
- https://geopuzzle.org/puzzle/easy/

Cylindrial equal area (Area)

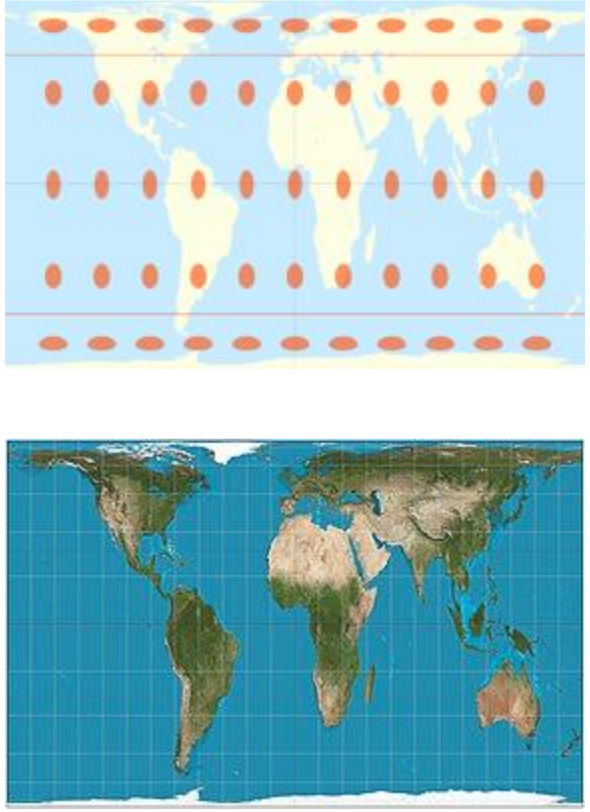
Lambert projection
(0 degrees)



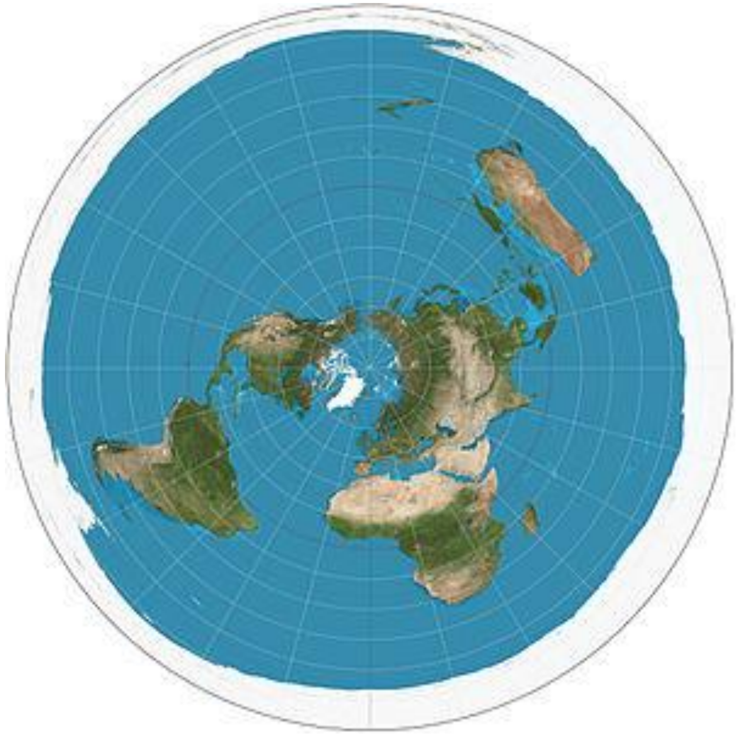
Behrman
(30 degrees)

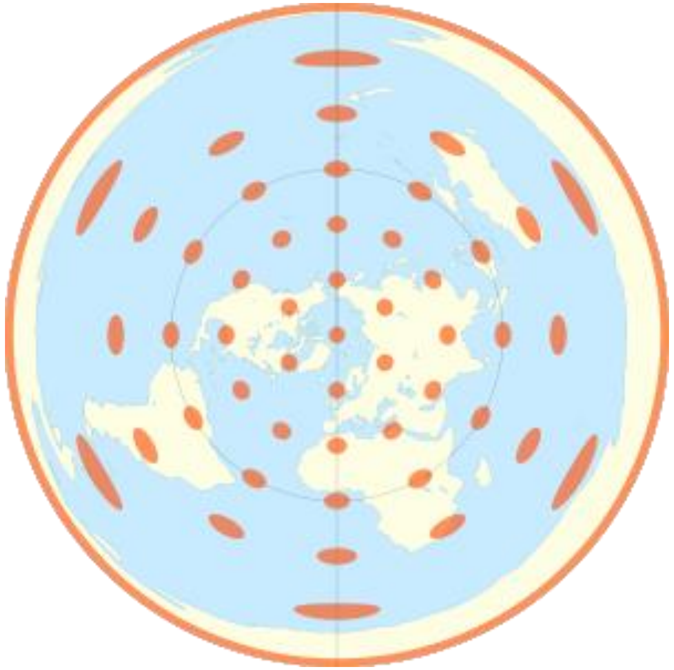


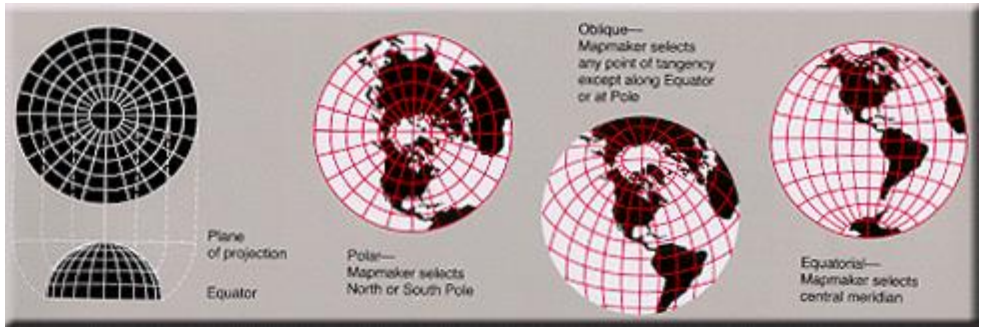
Gall–Peters projection
(45 degrees)



Azimuthal equidistant projection (distance)

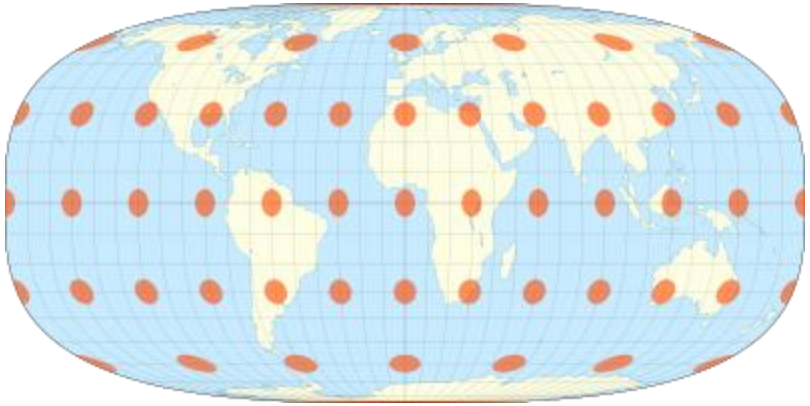




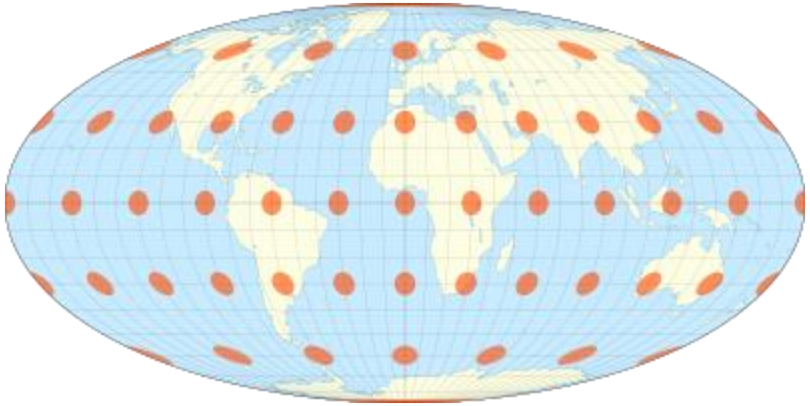


Pseudo-cylindrical projections

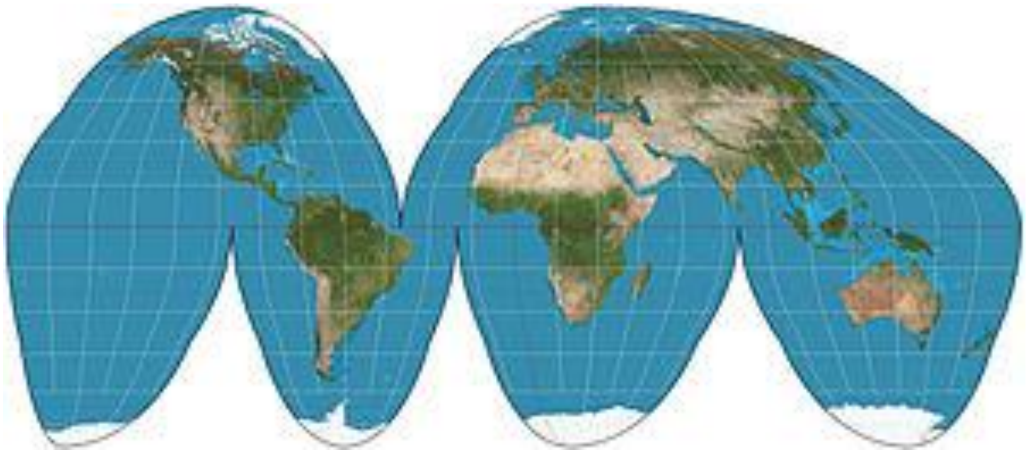
Tobler hyperelliptical projection

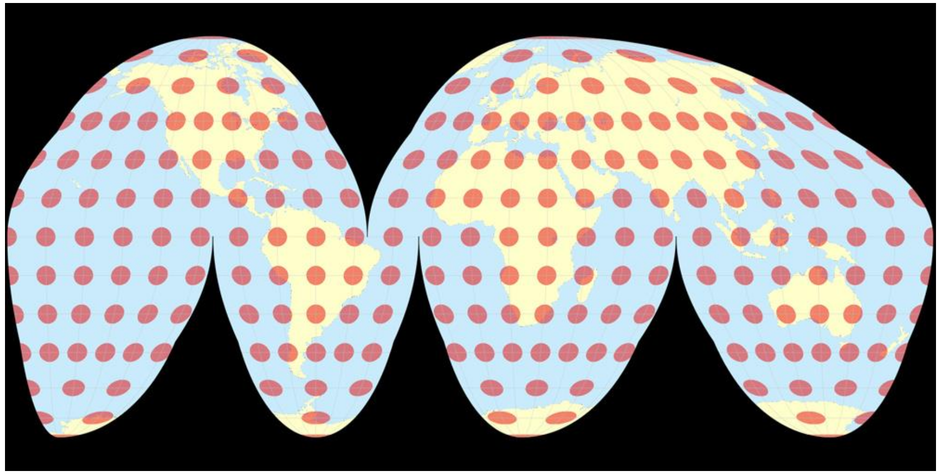


Mollweide projection

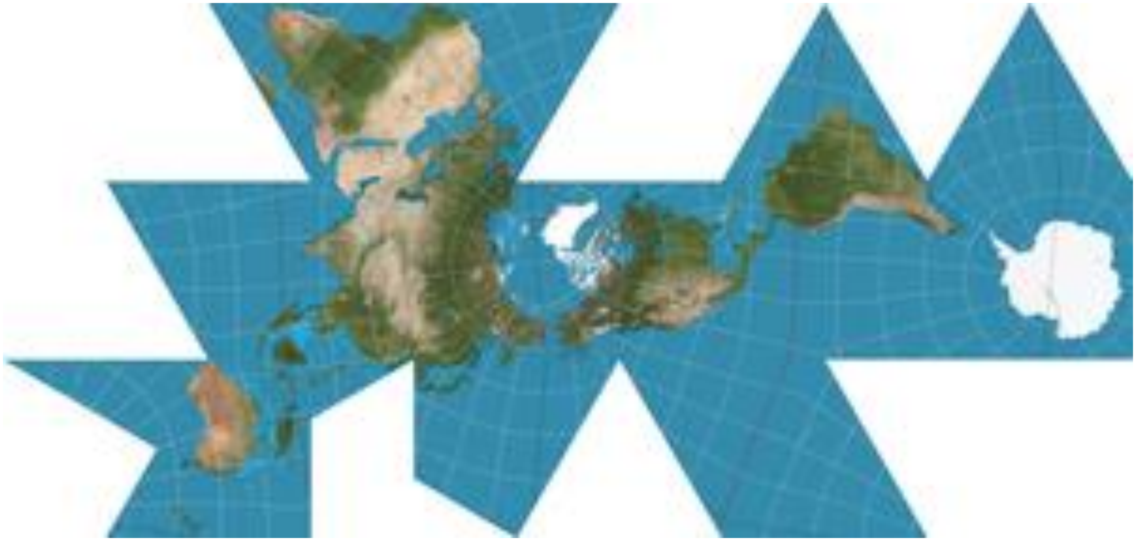


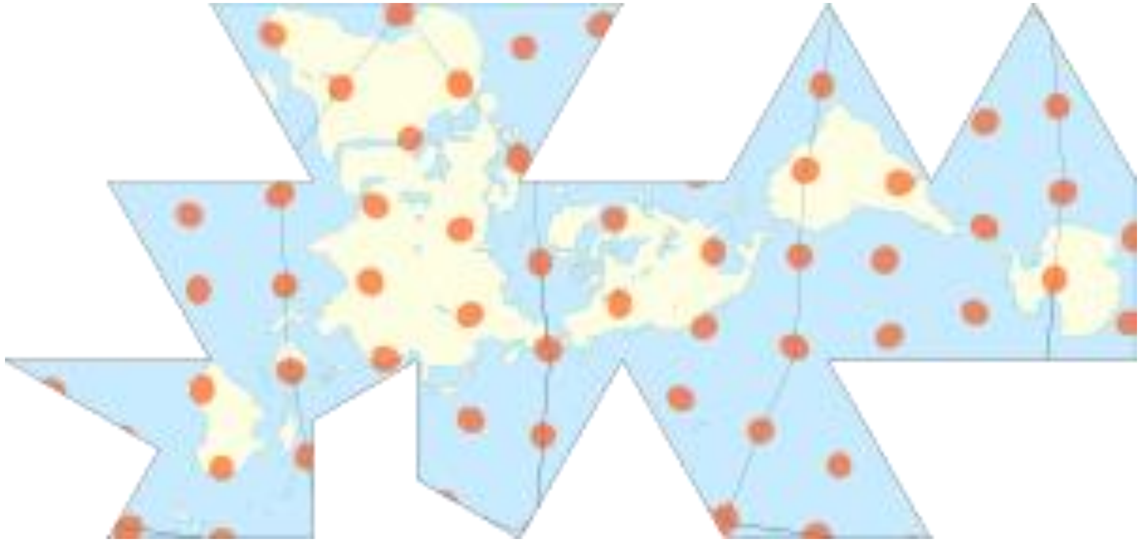
Goode homolosine projection

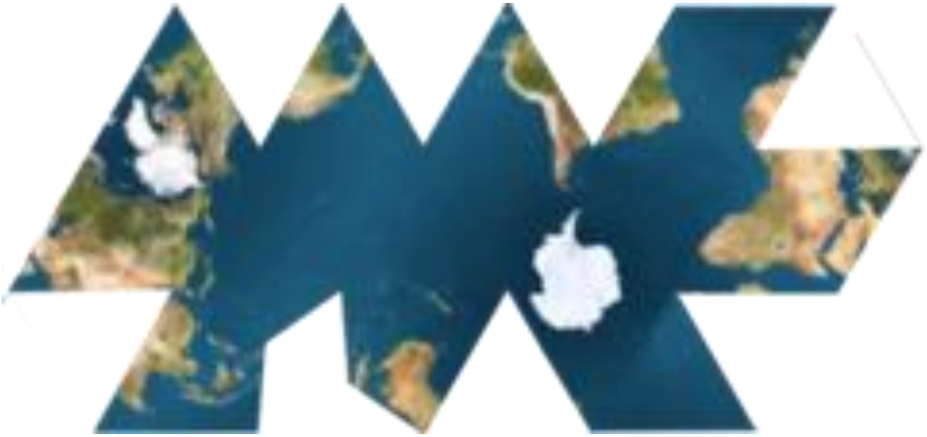


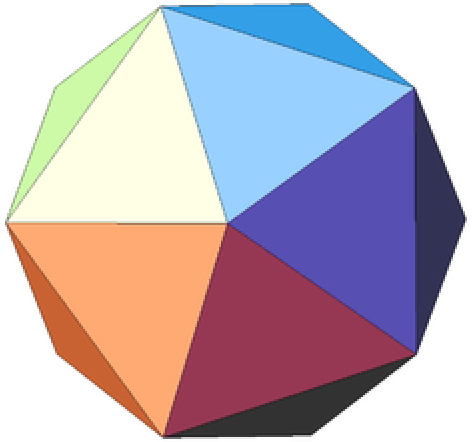


Dymaxion map





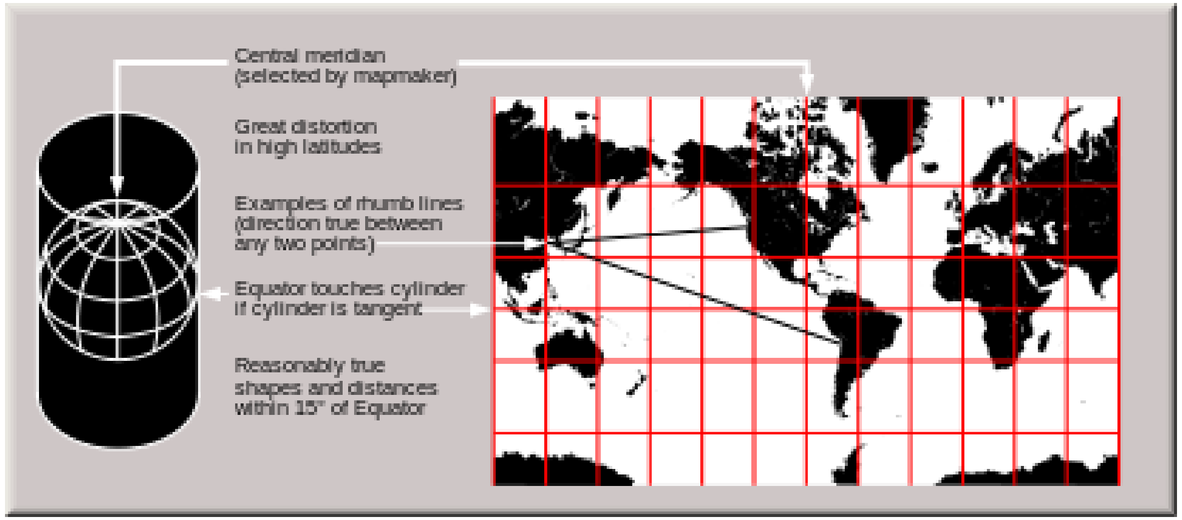




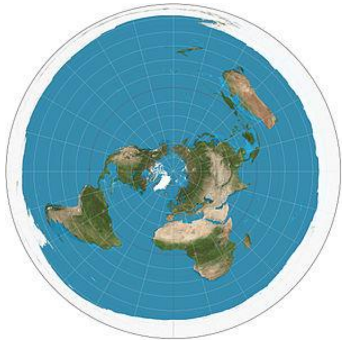
Raster projections: There is no one to one match

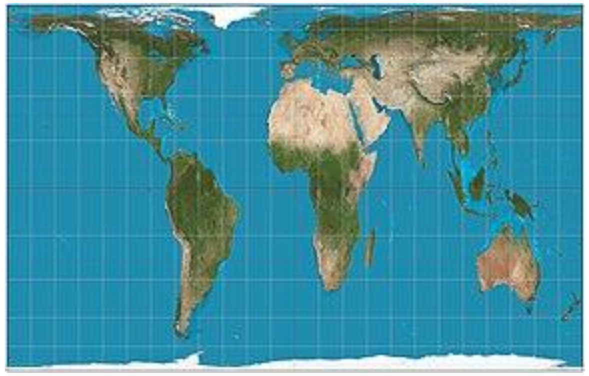
Behrman

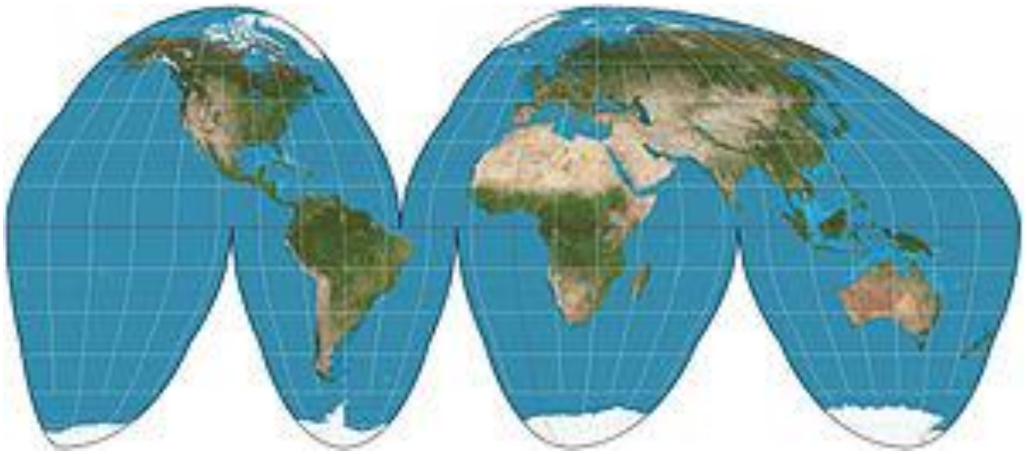
Latitude	Cell height
0	0.7
30	1
90	~10

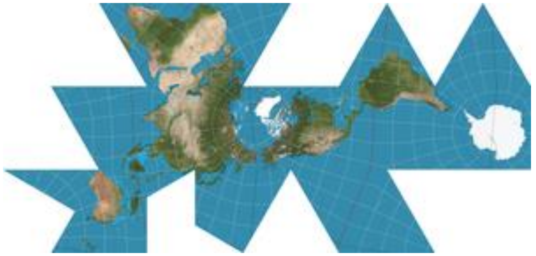


Distances can rarely be measured

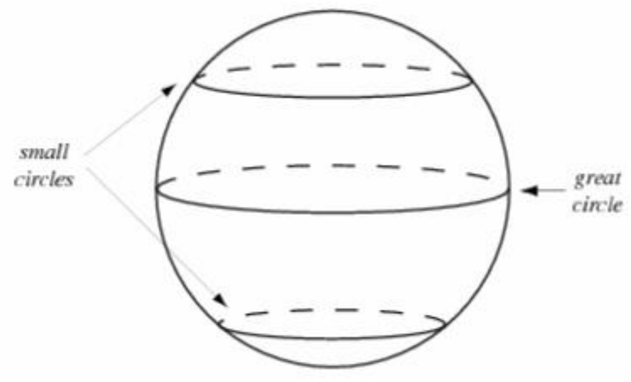


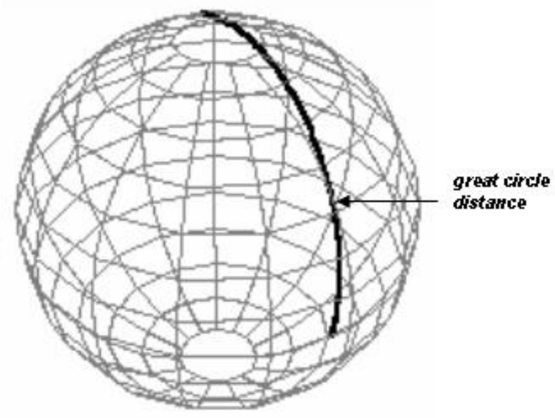


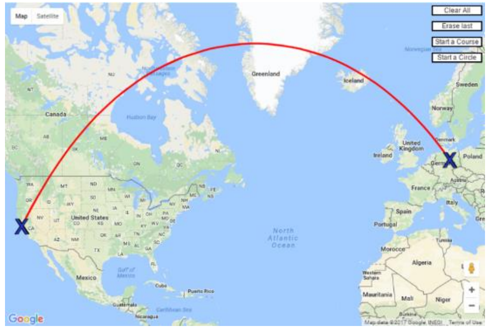




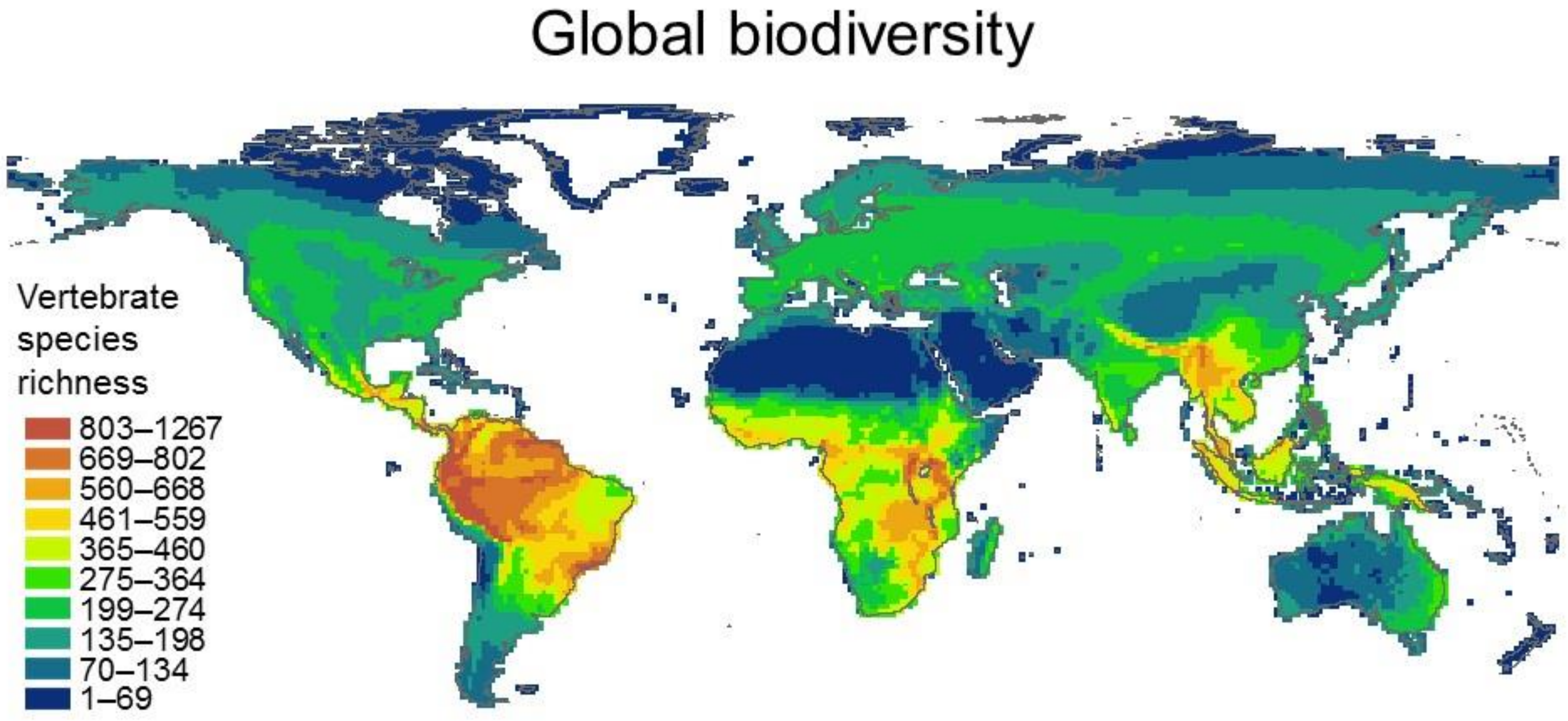
Great circle distance





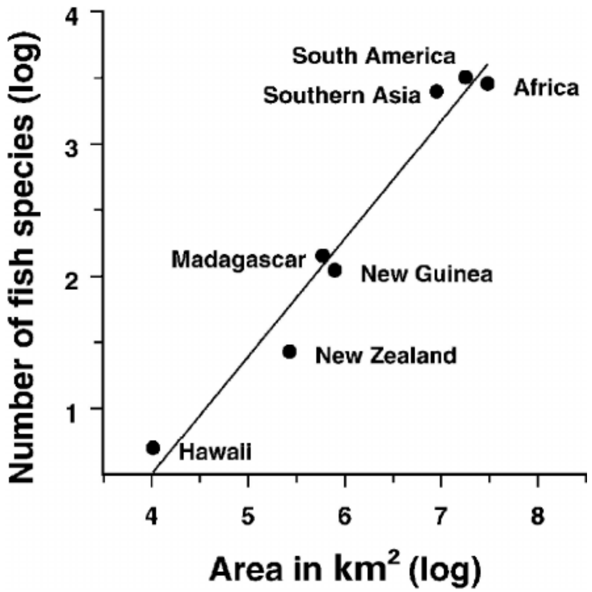


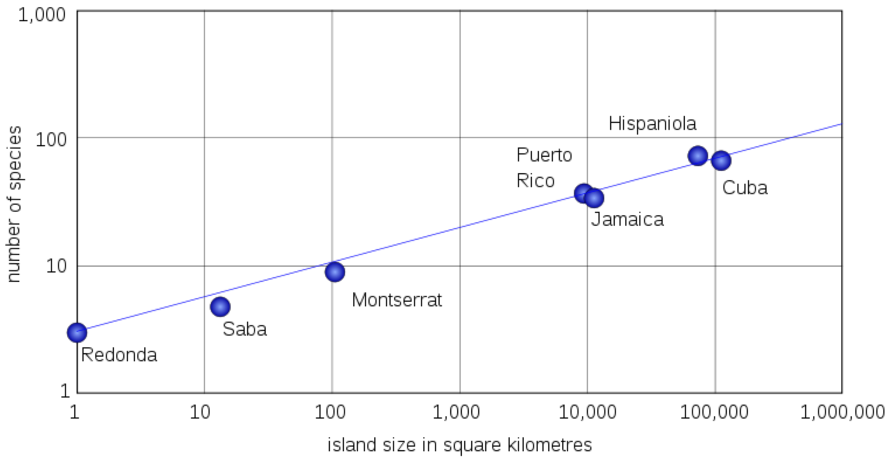
Spatial analyses: The biology



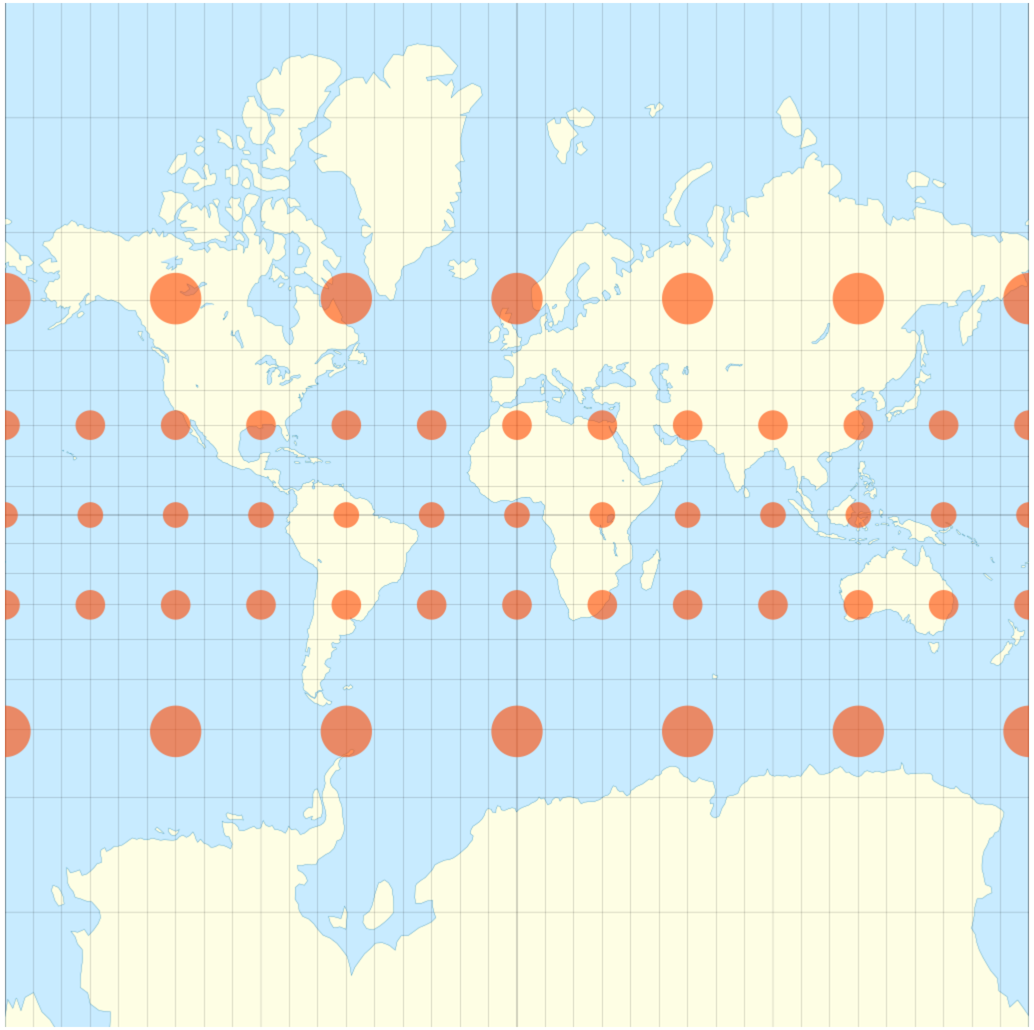
What scale makes sense?

Larger areas have more species

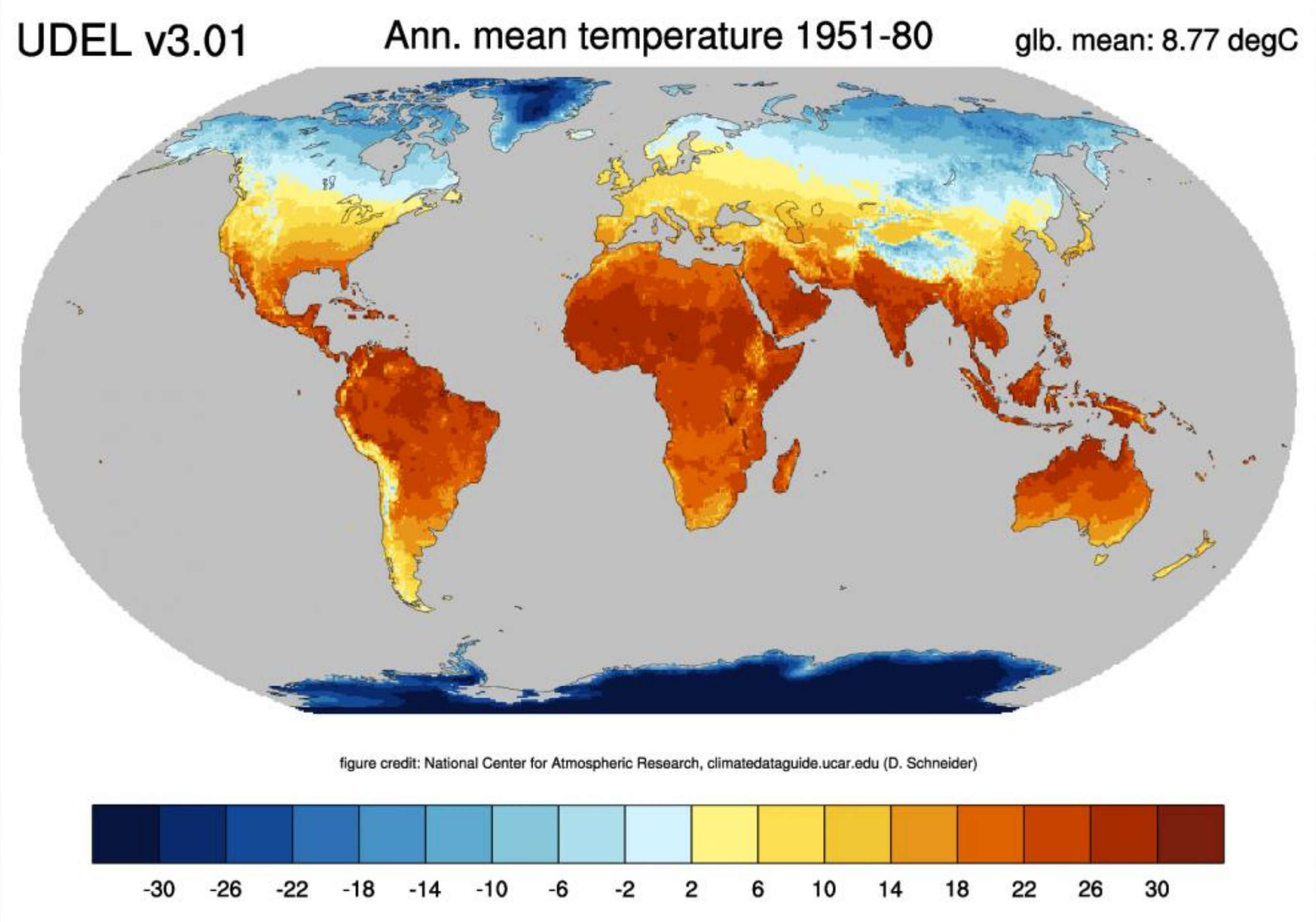


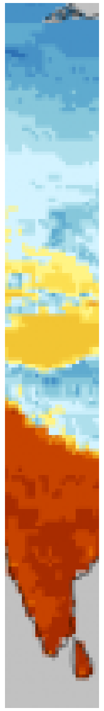


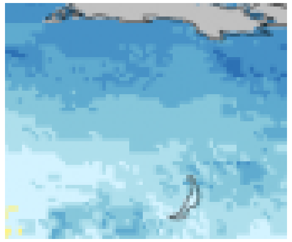
Do **<u>not</u>** analyze lat long diveristy

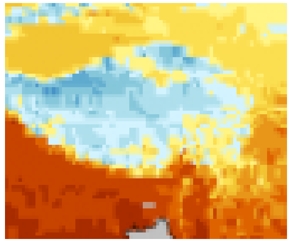


Cells should be quadratic (if possible)



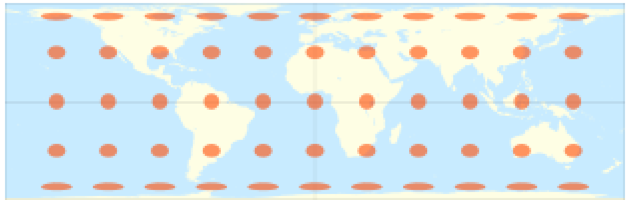




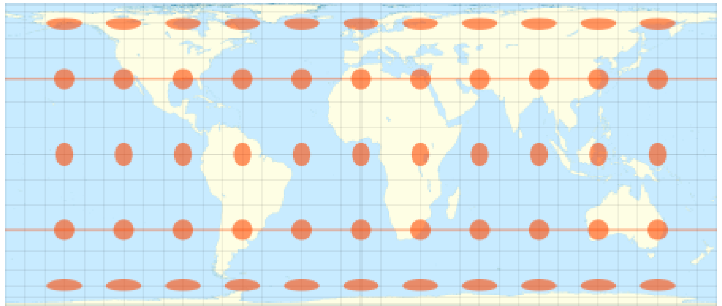


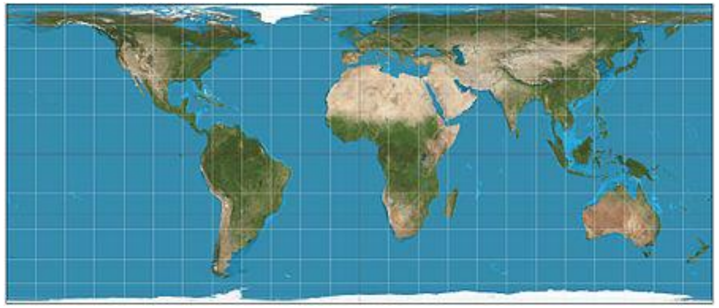
Cylindrial equal area projections are problematic

Lambert projection
(0 degrees)

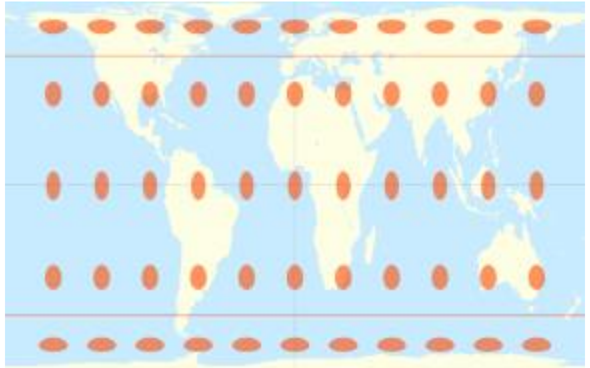


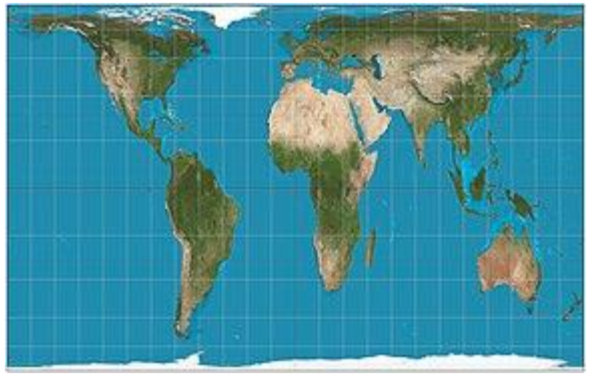
Behrman
(30 degrees)





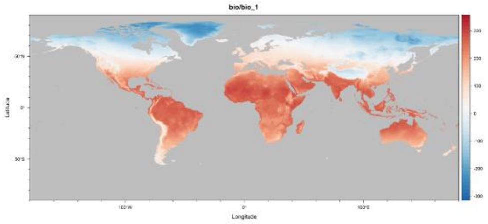
Gall–Peters projection
(45 degrees)

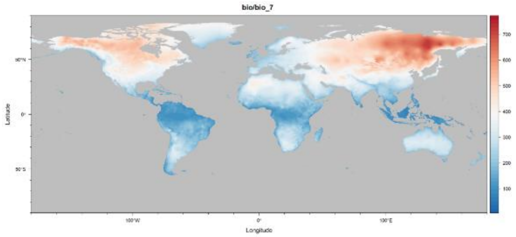


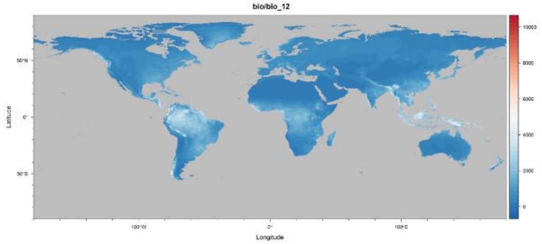


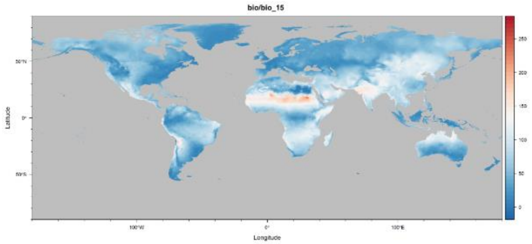
Think about the biology

BIO1 = Annual Mean Temperature
BIO2 = Mean Diurnal Range (Mean of monthly (max temp - min temp))
BIO3 = Isothermality (BIO2/BIO7) (×100)
BIO4 = Temperature Seasonality (standard deviation ×100)
BIO5 = Max Temperature of Warmest Month
BIO6 = Min Temperature of Coldest Month
BIO7 = Temperature Annual Range (BIO5-BIO6)
BIO8 = Mean Temperature of Wettest Quarter
BIO9 = Mean Temperature of Driest Quarter
BIO10 = Mean Temperature of Warmest Quarter
BIO11 = Mean Temperature of Coldest Quarter
BIO12 = Annual Precipitation
BIO13 = Precipitation of Wettest Month
BIO14 = Precipitation of Driest Month
BIO15 = Precipitation Seasonality (Coefficient of Variation)
BIO16 = Precipitation of Wettest Quarter
BIO17 = Precipitation of Driest Quarter
BIO18 = Precipitation of Warmest Quarter
BIO19 = Precipitation of Coldest Quarter

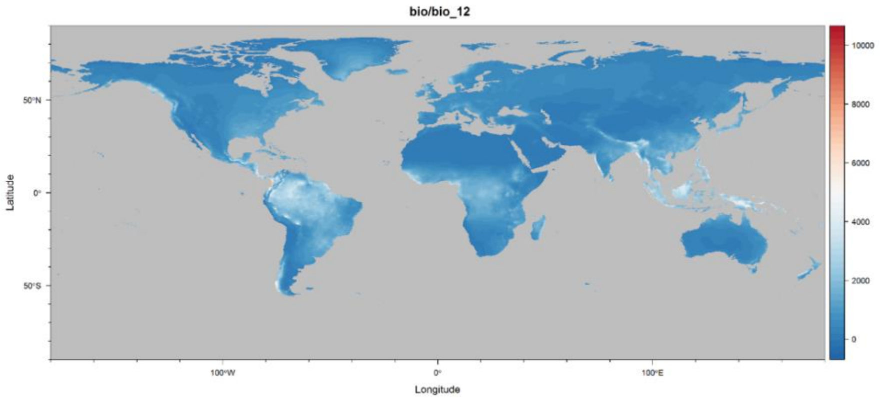


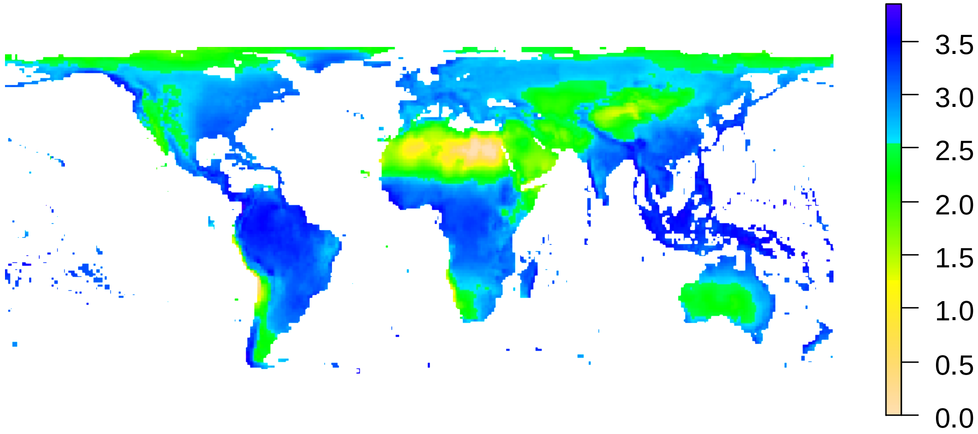






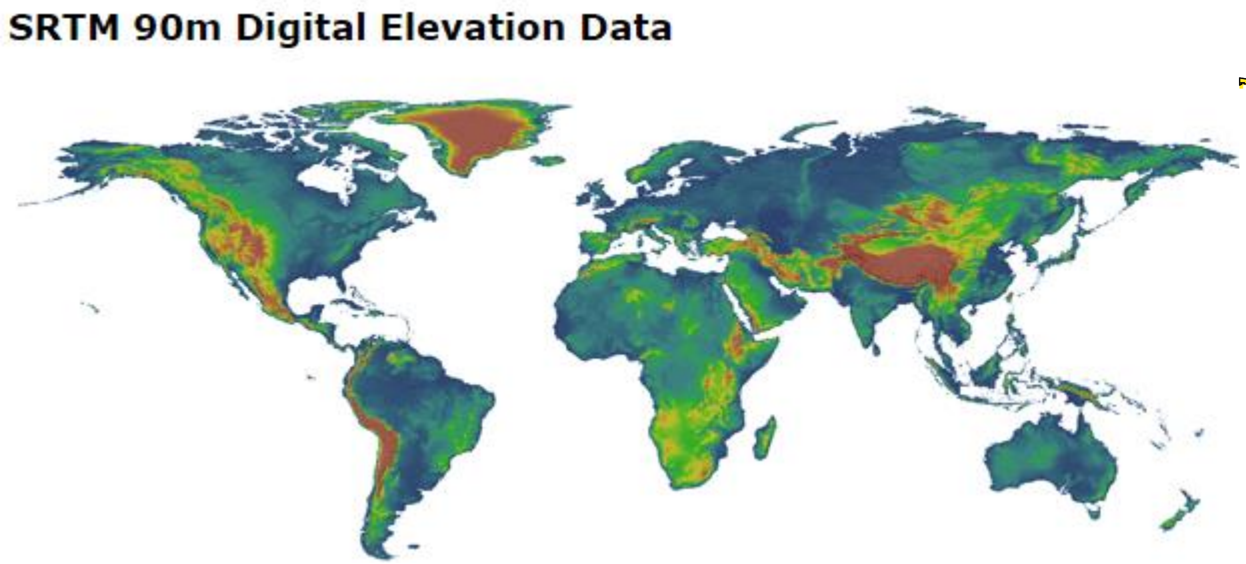
Data transformation

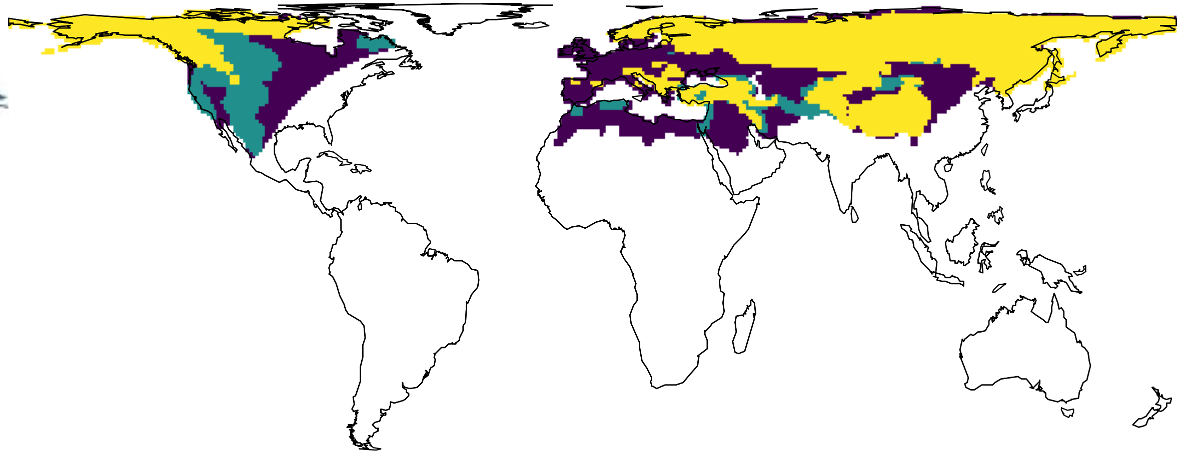




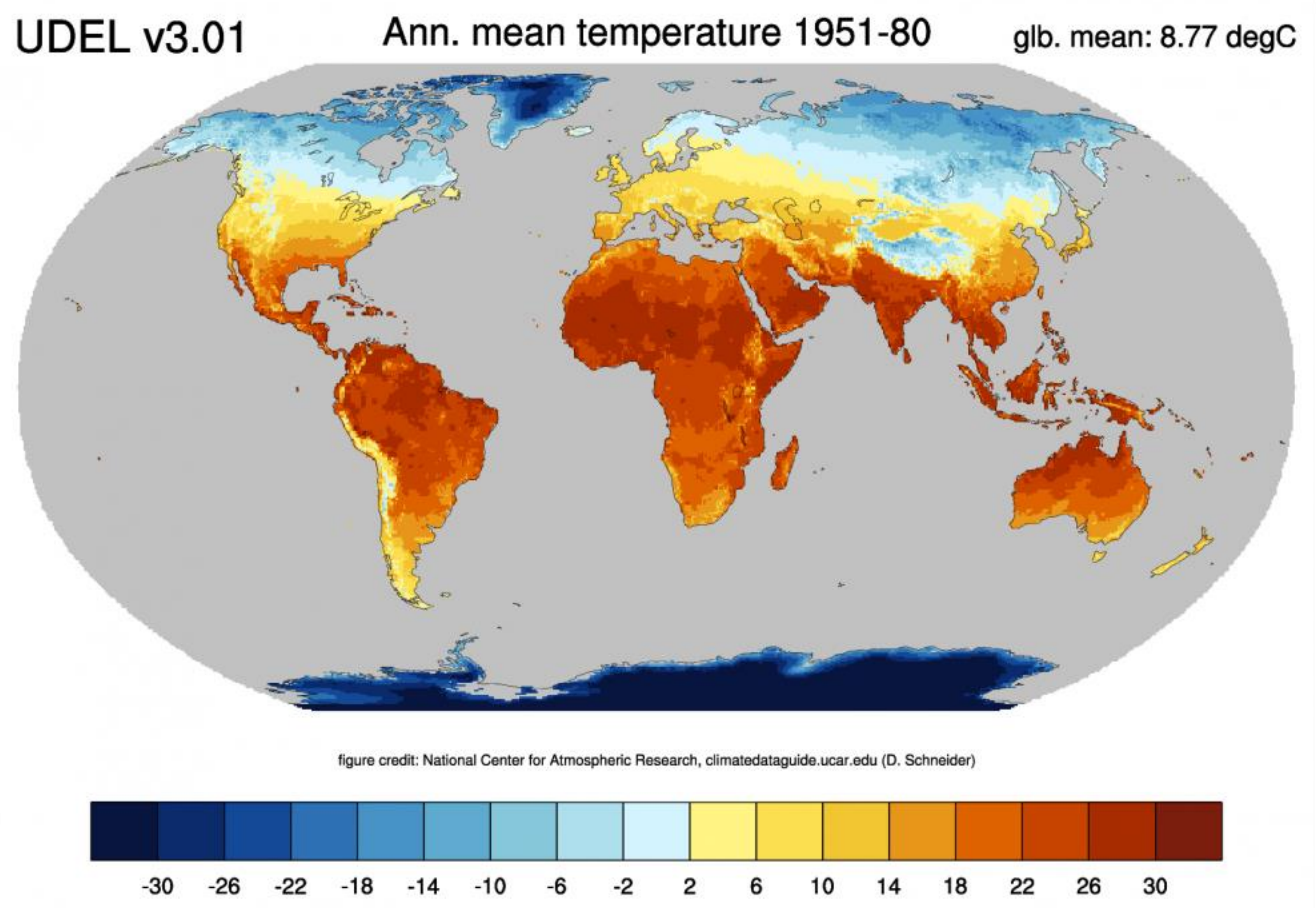
Interannual climatic variation

What does predictors mean?

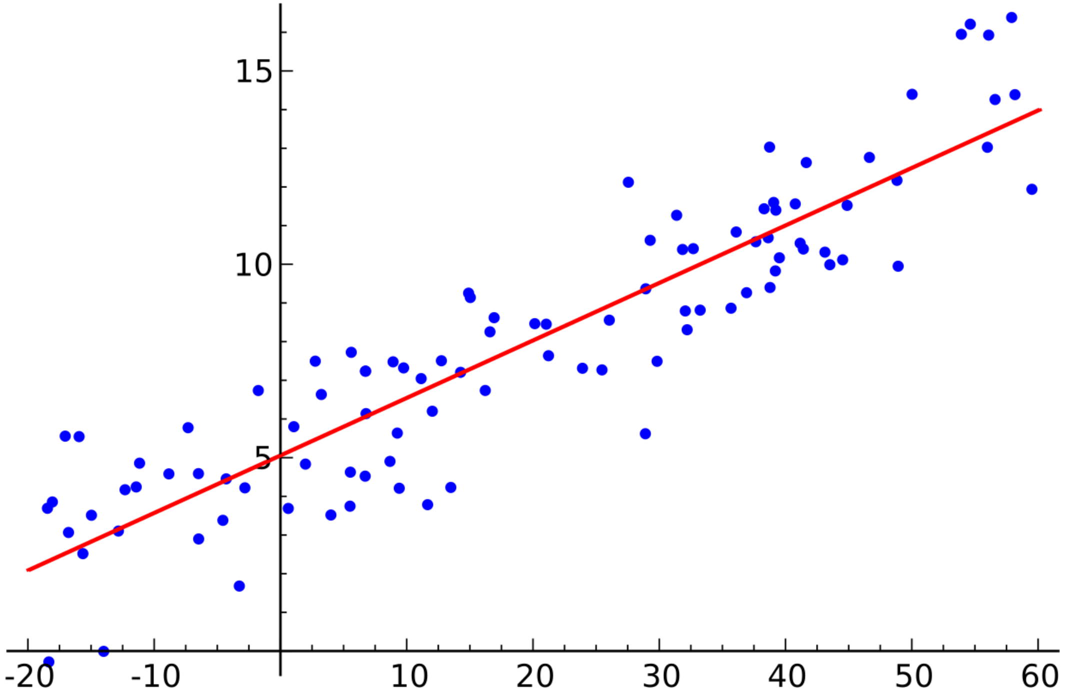




Spatial analyses: The analyses



Linear regression



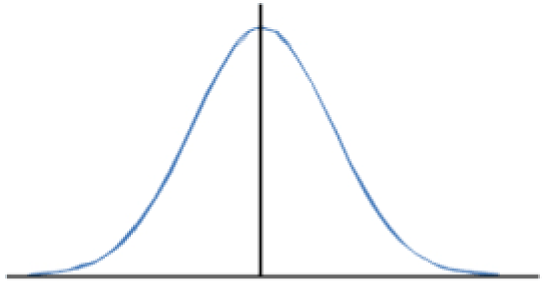
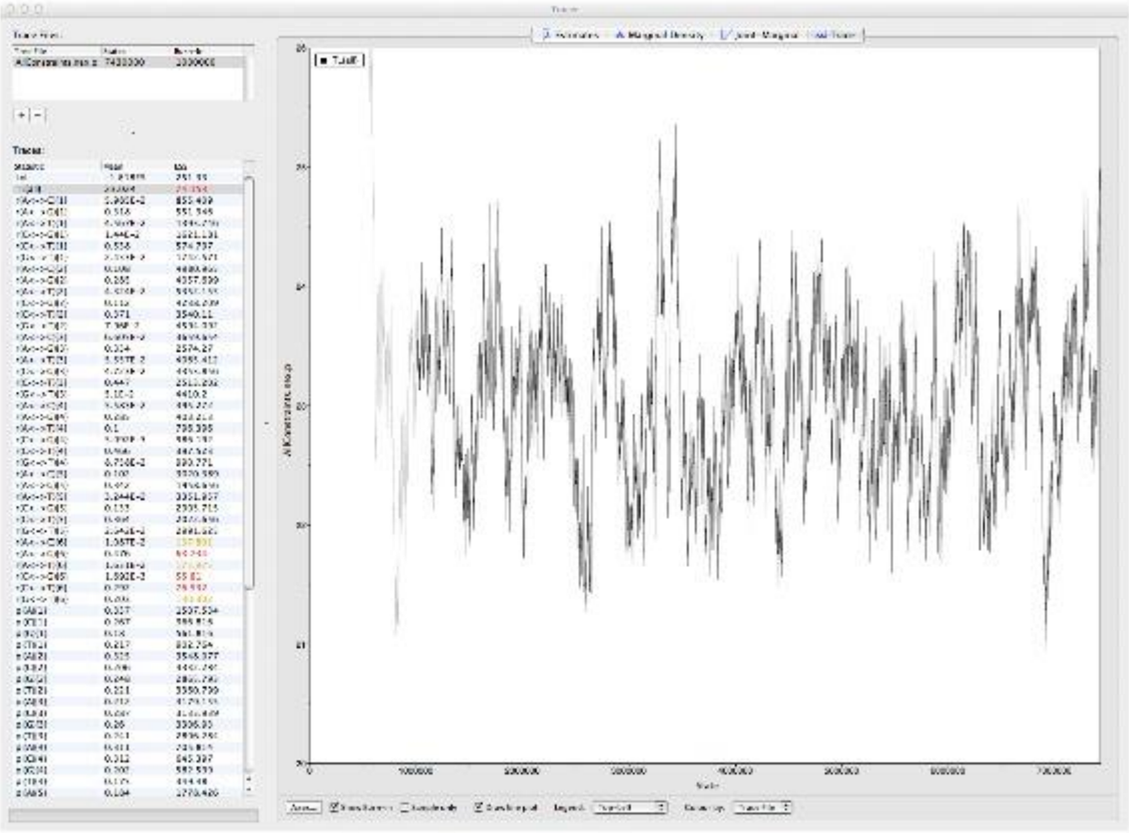
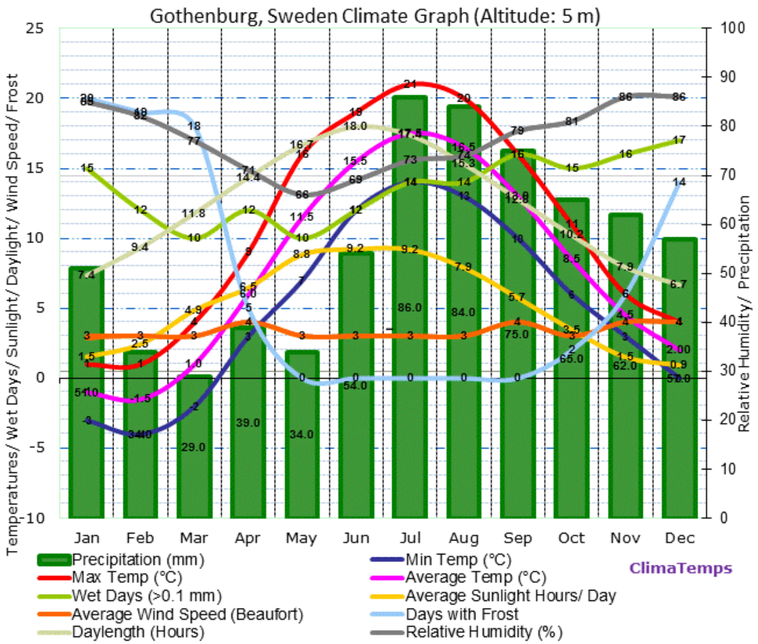


Figure 1 Normal distribution curve.

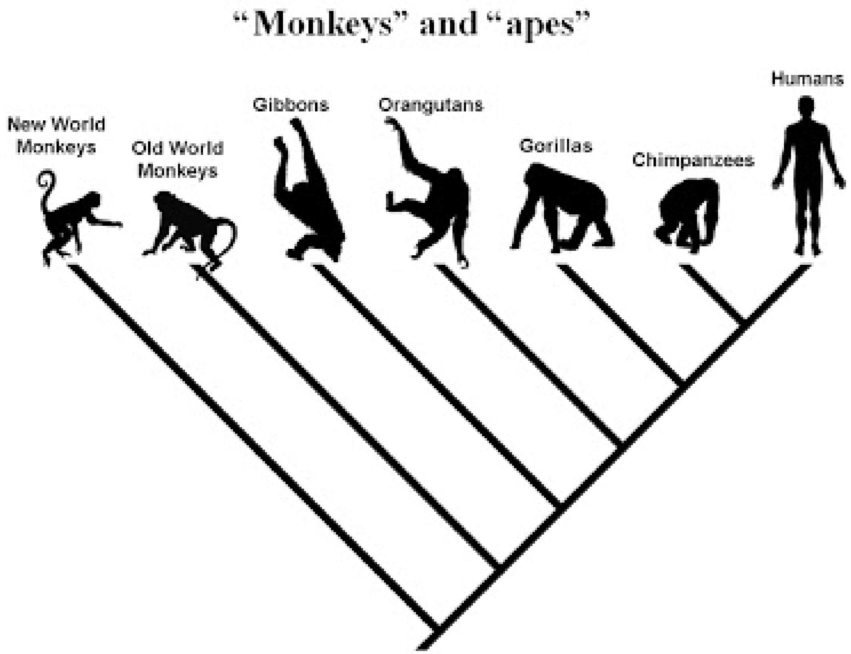
$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} \ldots.+\varepsilon_i$$

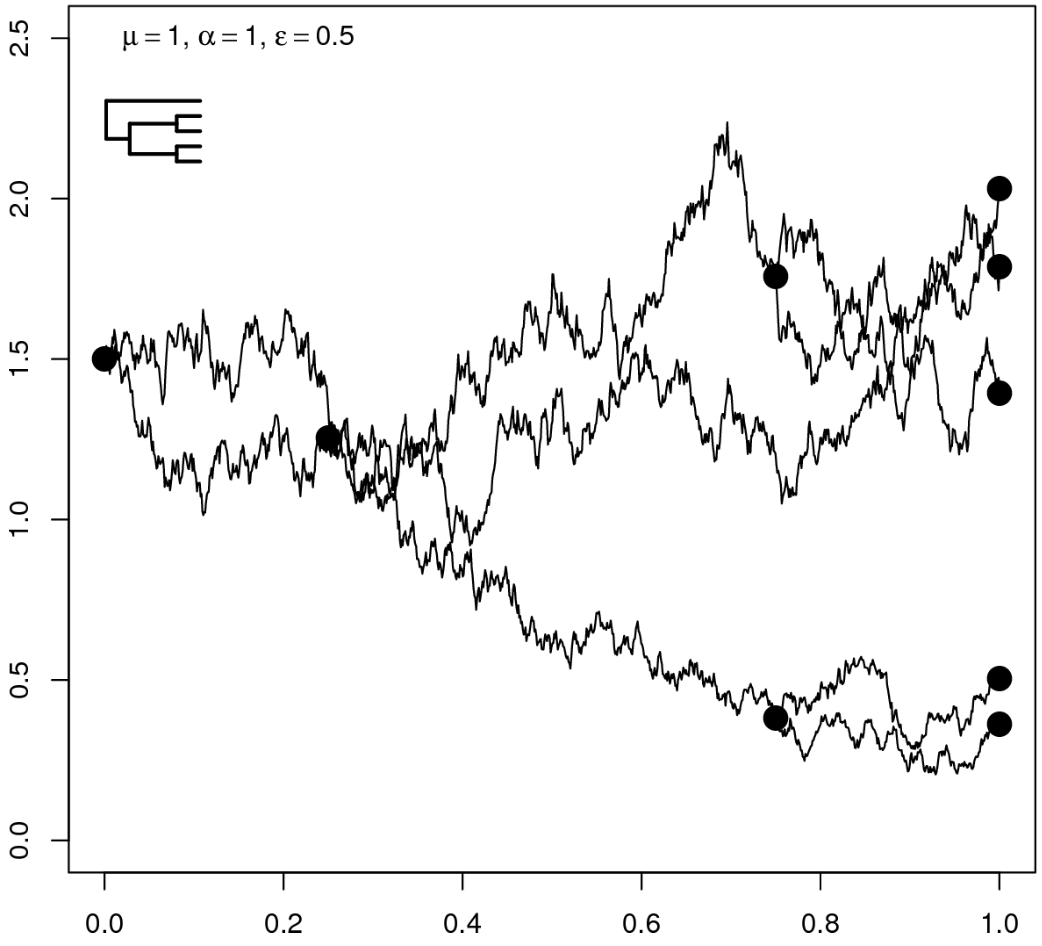
Temporal autocorrelation



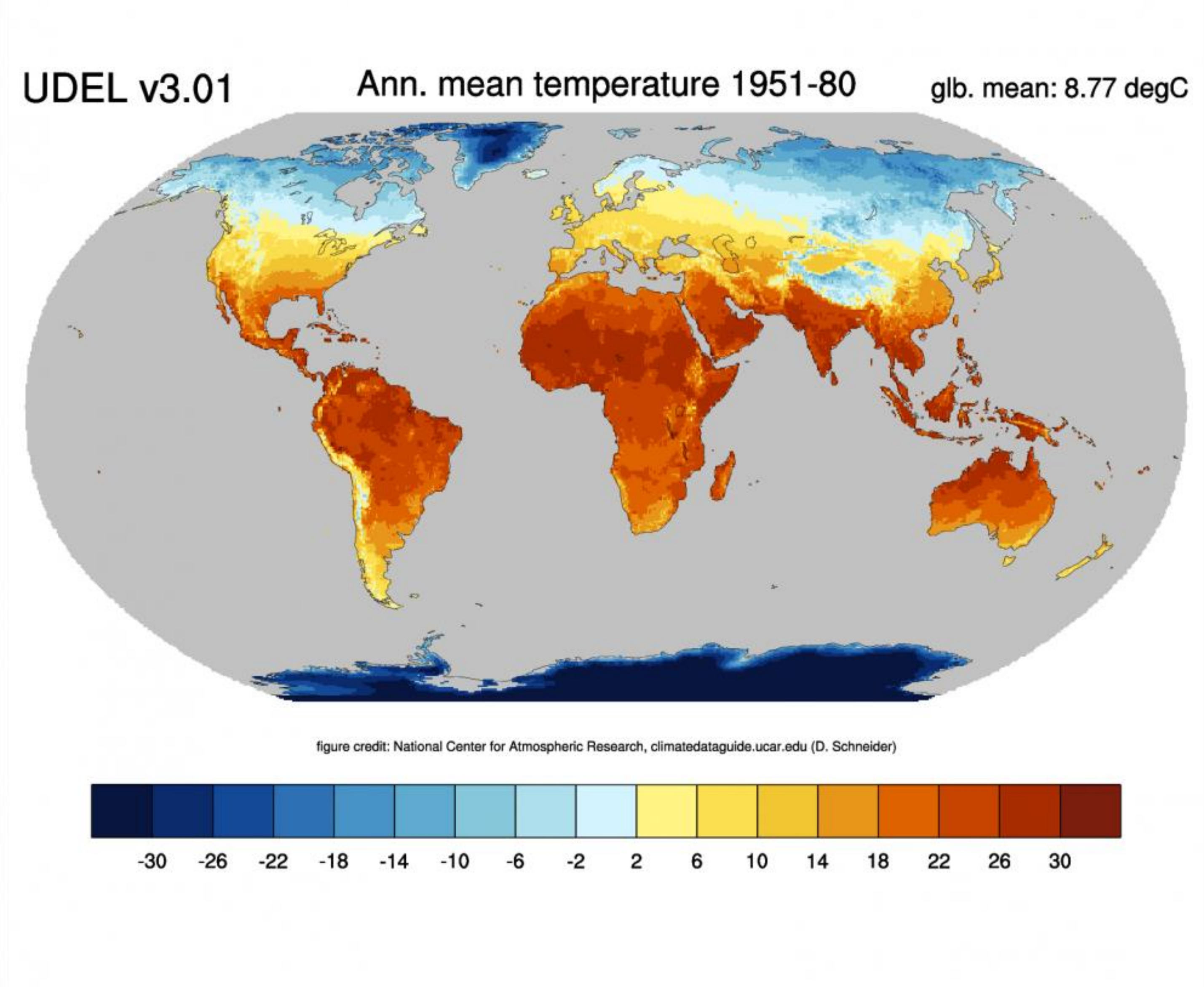


Phylogenetic autocorrelation (e.g brownian motion)





Spatial autocorrelation



Formula for Moran's I

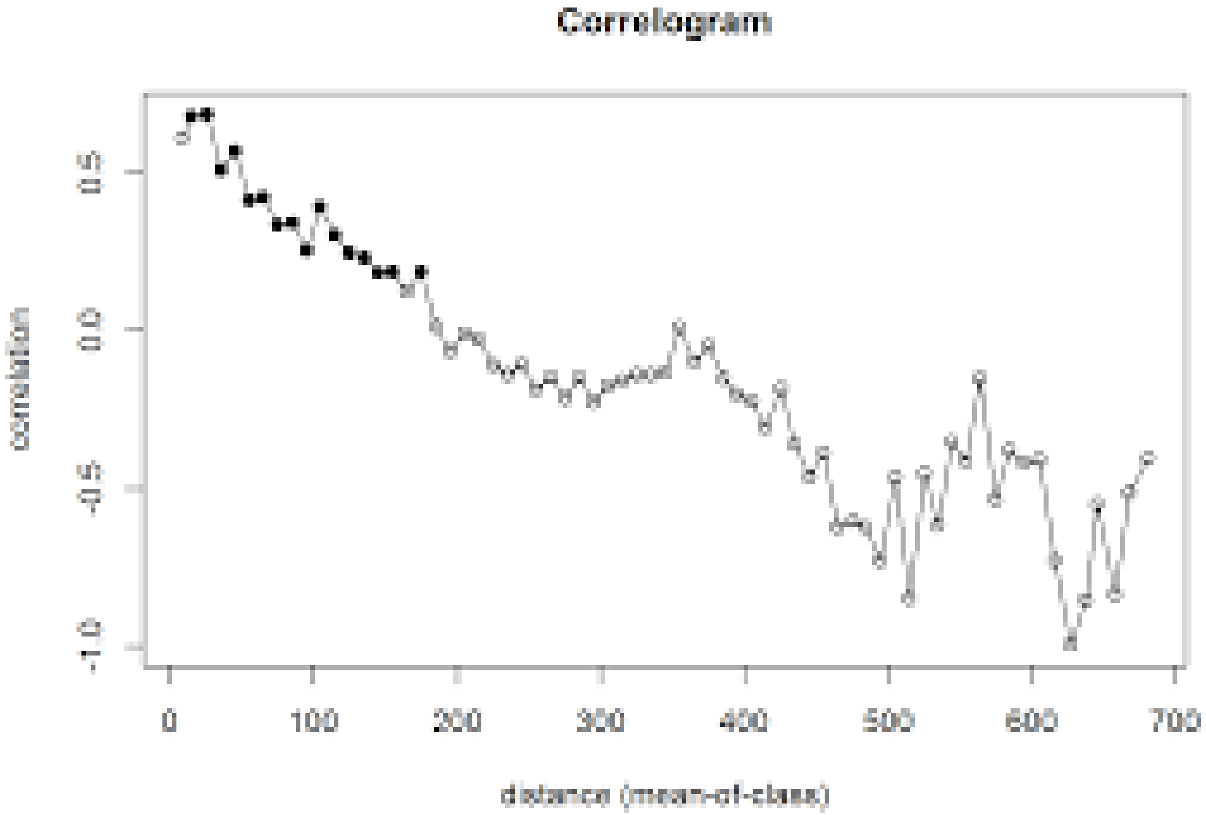
$$I = \frac{N \sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij} (x_i - \bar{x})(x_j - \bar{x})}{\left(\sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}\right) \sum_{i=1}^{n} (x_i - \bar{x})^2}$$

- Where:

N is the number of observations (points or polygons)
$\bar{X}$ is the mean of the variable
X_i is the variable value at a particular location
X_j is the variable value at another location
W_{ij} is a weight indexing location of *i* relative to *j*

(or dumbed down)

Morans I varies between -1 and 1. 1 is perfect positive correlation



Spatial Simultaneous Autoregressive Error Model

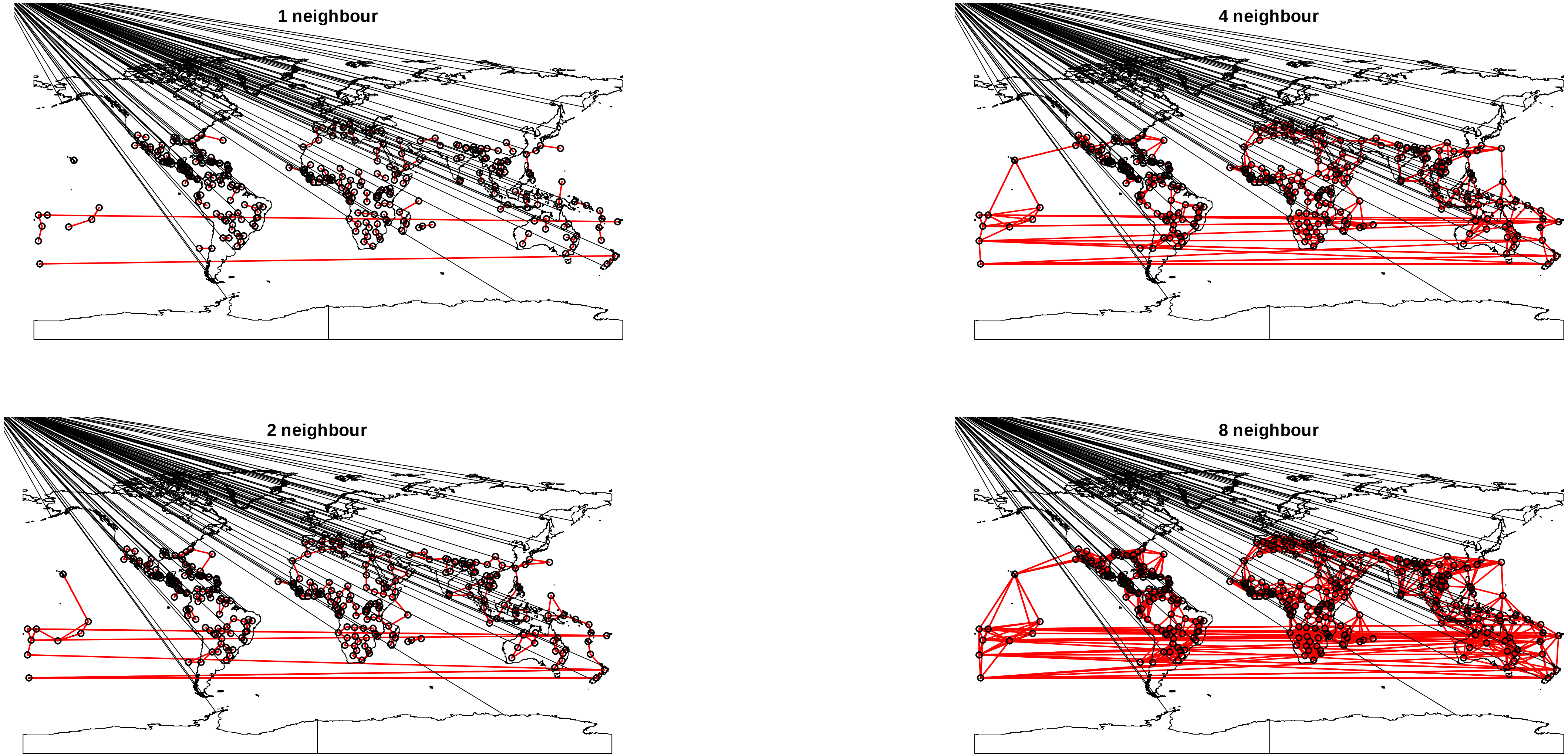
$$\mathbf{SAR_{err}} \quad Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} \ldots . + \lambda W u + \varepsilon_i$$

$$\mathbf{LM} \quad Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} \ldots . + \varepsilon_i$$

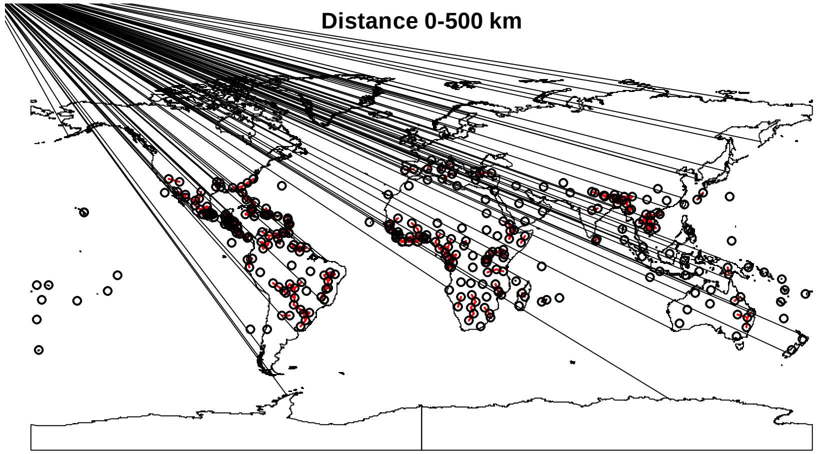
$SAR_{lag} \quad Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} \ldots . + \rho W Y_i + \varepsilon_i$

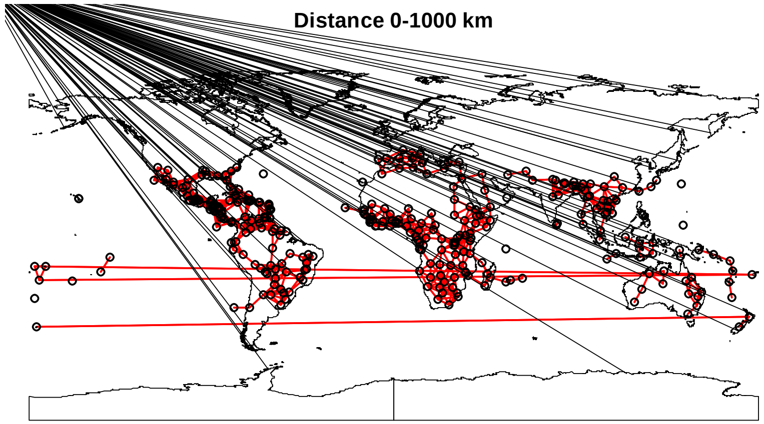
$SAR_{mix} \quad Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} \ldots . + \rho W Y_i + \lambda W u + \varepsilon_i$

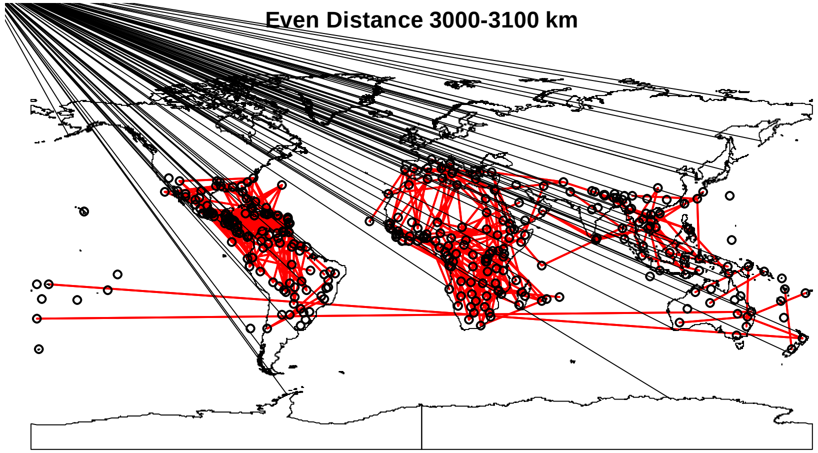
Wu: u: Neighborhood: Number



Wu: u: Neighborhood: Distance





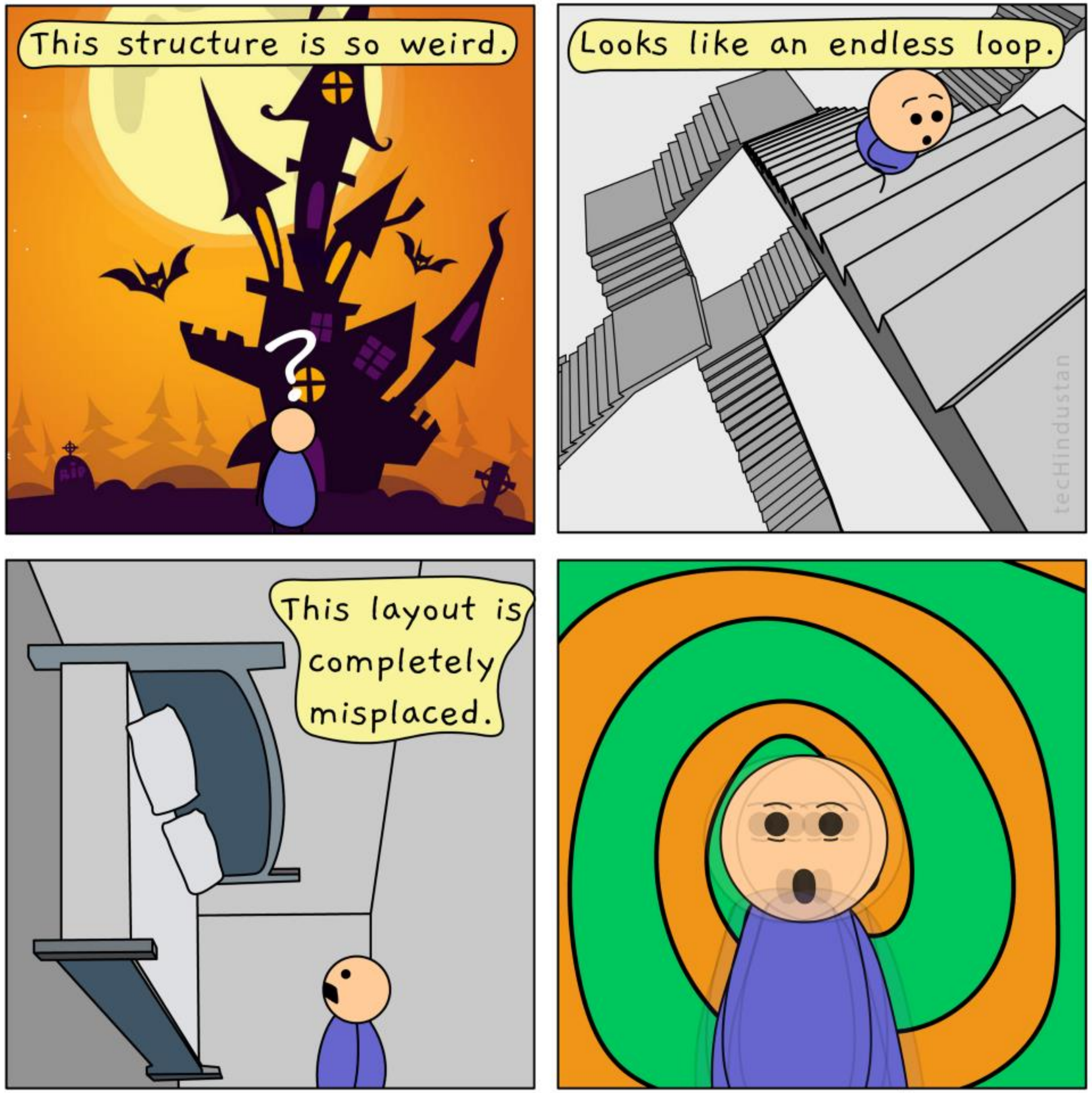


Wu: W: Neighborhood: Weight

$$\mathbf{SAR_{err}}\ \ Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} \ldots.\ \lambda Wu + \varepsilon_i$$

- W
  - [[1]] : 0.33 0.33 0.33
  - [[2]] : 0.20 0.20 0.20 0.20 0.20
- B
  - [[1]] : 1 1 1
  - [[2]] : 1 1 1 1 1

- C
  - [[1]] : 0.06 0.06 0.06
  - [[2]] : 0.06 0.06 0.06 0.06 0.06 B
- U
  - [[1]] : 0.0002 0.0002 0.0002
  - [[2]] : 0.0002 0.0002 0.0002 0.0002 0.0002
- S
  - [[1]] : 0.151 0.151 0.151
  - [[2]] : 0.117 0.117 0.117 0.117 0.117



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