Assignment Week 1: Euler poles, plate motions and deformation zones

Goal: To use Euler poles to express plate motions, and to express velocities of deforming zones with respect to any plate.

Tools: to be developed by the students. PyGMT for making figures.

Datasets:

A) Euler poles from Kreemer et al. (2014) (doi: 10.1002/2014GC005407), see table http://geodesy.unr.edu/GSRM/poles.IGS08

For an explanation of the abbreviations of the plates, see figure 1 of Bird (2003, https://doi.org/10.1029/2001GC000252).

B) Nevada Geodetic Laboratory linear velocity estimates http://geodesy.unr.edu from GNSS data, using the MIDAS velocities in the IGS14 reference frame (aligned to ITRF). Download the file in with velocities in the IGS14 reference, and read the readme file for information on the contents and background.

A map with all available GNSS sites can be found at:
http://geodesy.unr.edu/NGLStationPages/gpsnetmap/GPSNetMap.html

Assignment:

a) Study the Euler pole equations and implement the equations from the lecture notes. Check that you understand the parameters and their units that enter the equations.

b) Check that your implementation is correct by checking against the following plate motion for Delft, assuming we sit on the Eurasian plate.

Latitude: 51.986 degrees
Longitude: 4.388 degrees

Plate motion:

Velocity north: 15.5350 mm/yr
Velocity east: 17.4573 mm/yr

c) Choose a plate boundary with available GNSS data close to both sides of the boundary. Select a number of GNSS sites (e.g. 10) at both sides of the plate boundary, preferably at various distances.

d) For these GNSS site locations, compute the rigid plate velocities using Euler poles from Kreemer et al. (2014). Take the MIDAS linear velocities, and subtract the rigid plate

motion from the velocities. Make sure you can compute the velocity with respect to both neighbouring plates. If so, proceed.

e) Show the velocities for your selected GNSS sites in three different figures, namely:

   1) in the global IGS/ITRF frame
   2) with respect to one of neighboring plates
   3) with respect to the other neighboring plate

f) Comment on how far the deformation zone of the plate boundary reaches. If you do not find velocities that approach near zero, can this be solved by taking a site at a larger distance?

Hand in your answers preferably as python notebook, using abundant comments. The notebook should contain figures for e) and a discussion of your findings for f).

Please hand in your answers at Brightspace, before the next lab session.