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On determination of a regional vertical datum by combination of EGM, local gravity and GPS/leveling data

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Heights and vertical datums

- **heights referenced w.r.t. to a vertical datum**
- **geometric vs. physical heights :**
  - ✓ **above mean sea level (AMSL heights)**
  - ✓ **above reference geometry representing the Earth**
- **vertical datum :**
  - ✓ **(quasi-)geoid : local/global (LHS/WHS)**
  - ✓ **international reference ellipsoid (WGS, GRS)**
- **important : height transformation**
  vertical datum realization

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Physically-meaningful heights

- **traditionally determined by spirit leveling (+ gravity)**
- **refer to the mean sea level (geoid/quasi-geoid)**
- **used worldwide by national surveying agencies**
- **required in all applications where gravity matters**
- **heights (m) replaced by geopotential numbers ($m^2\ s^{-2}$)**
- **height H vs. geopotential number ΔW :**

$$H = \frac{\Delta W}{g}$$

- **with an integral mean of (actual, normal) gravity g ($m\ s^{-2}$)**

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Heights used in geodesy and surveying

- **physically-meaningful heights (leveling) :**
  - ✓ **orthometric heights (geoid)**
  - ✓ **normal heights (quasi-geoid)**
- **geometric heights (GNSS) :**
  - ✓ **geodetic (ellipsoidal) heights (reference ellipsoid)**
- **height transformation equations :**

$$H^O \approx h - N$$

$$H^N = h - \zeta$$

- **determination of geoidal heights (height anomalies)**

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Determination of the (quasi-)geoid

- based on global (EGM) and local ground/airborne gravity
  - ✓ Stokes's (Hotine's) problem (geoid)
  - ✓ Molodensky's problem (quasi-geoid)
- related issues :
  - ✓ selection of the gravity potential at the mean sea level
  - ✓ combination of global and local gravity data
  - ✓ incorporation of other data (deflections, GNSS ...)
- development of a world height system under way :
  - ➢ unique seamless worldwide vertical datum (WHS)

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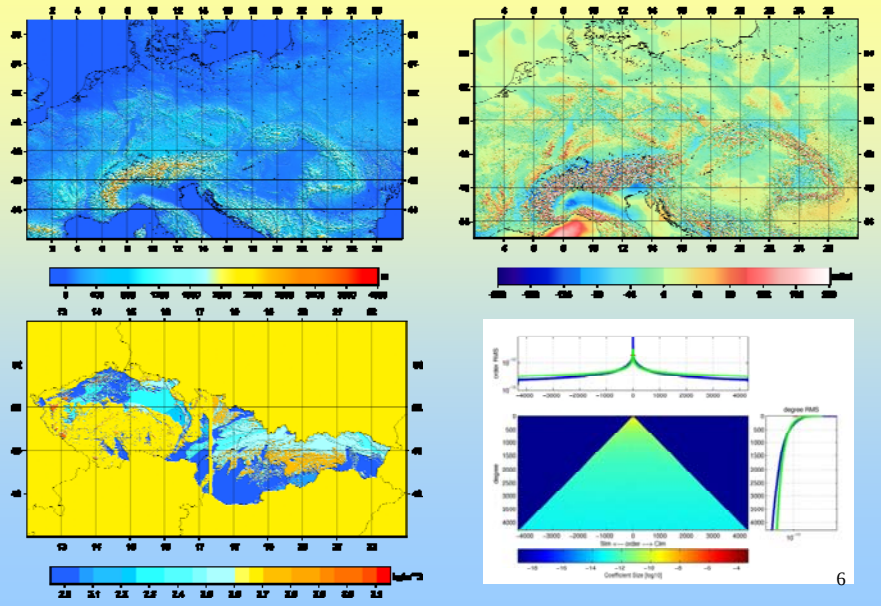
Case study of Central Europe – input data



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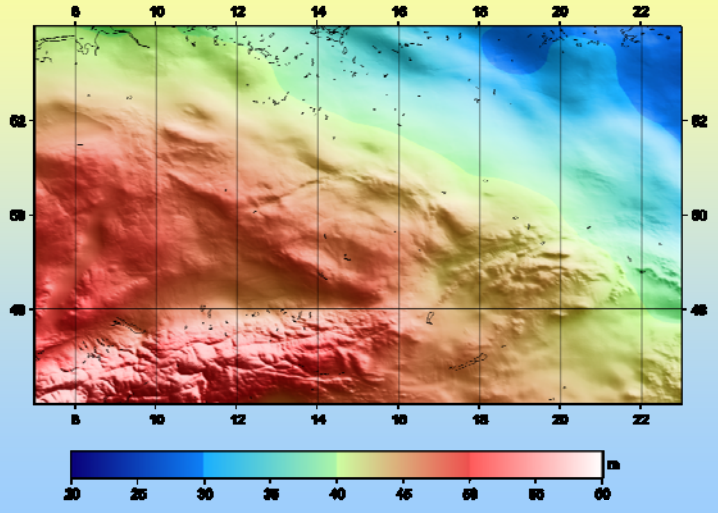
Case study of Central Europe – local geoid



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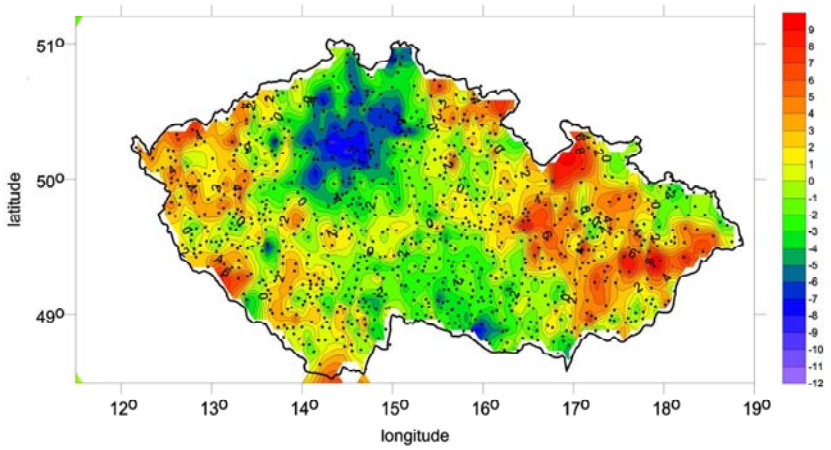
Test of EGM08 - by GPS/levelling on the territory of the Czech Republic
(GPS/levelling geoid minus EGM08 geoid)
(constant shift -43 cm, rmse = 3.3 cm)



• GPS/levelling point (accuracy about 2 cm)

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