EGM702 – Photogrammetry and Advanced Image Analysis

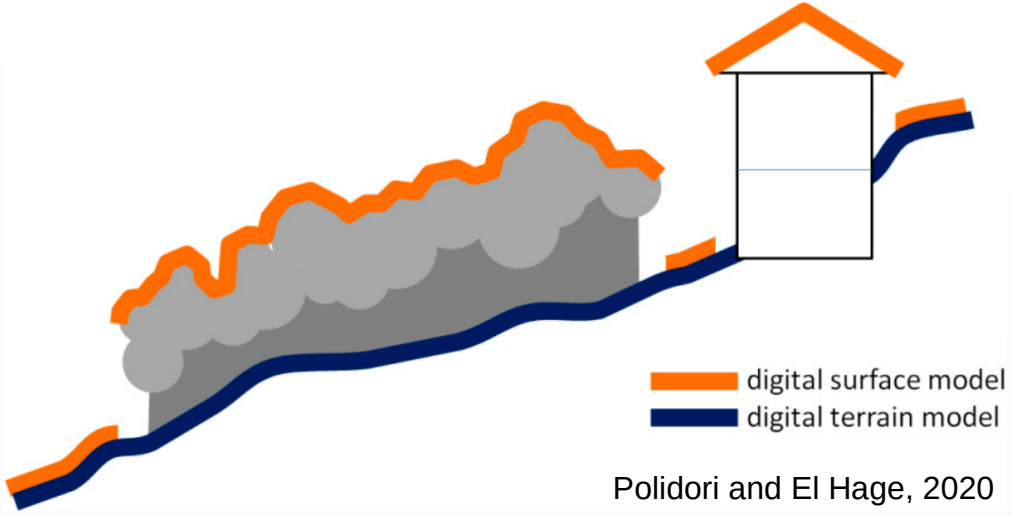
Week 2, Part 1: DEM Accuracy and Analysis

Week 2 Outline

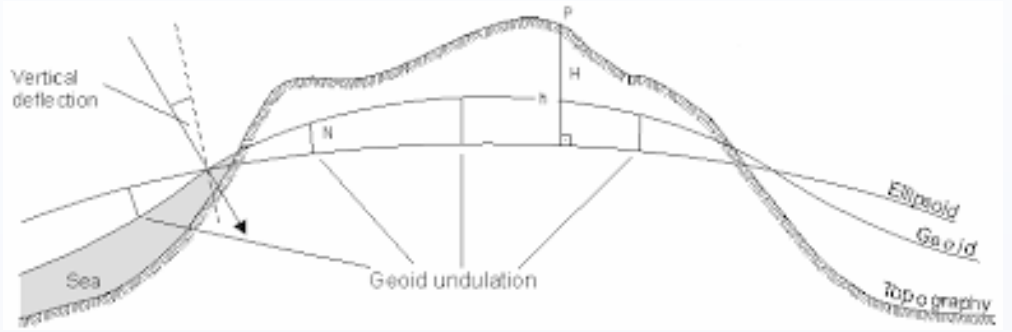
1. DEM Accuracy & Analysis
2. Topographic Analysis
3. Spatial Statistics
4. Principles of LiDAR
5. Where to find DEMs
6. DEM Applications

What is a DEM?

- Digital Elevation Model
- Different flavours:
  - Digital Surface Model (DSM)
  - Digital Terrain Model (DTM)
- Considerations:
  - Data source
  - Application
- What does elevation represent?
  - Orthometric height (above geoid)
  - Height above Ellipsoid

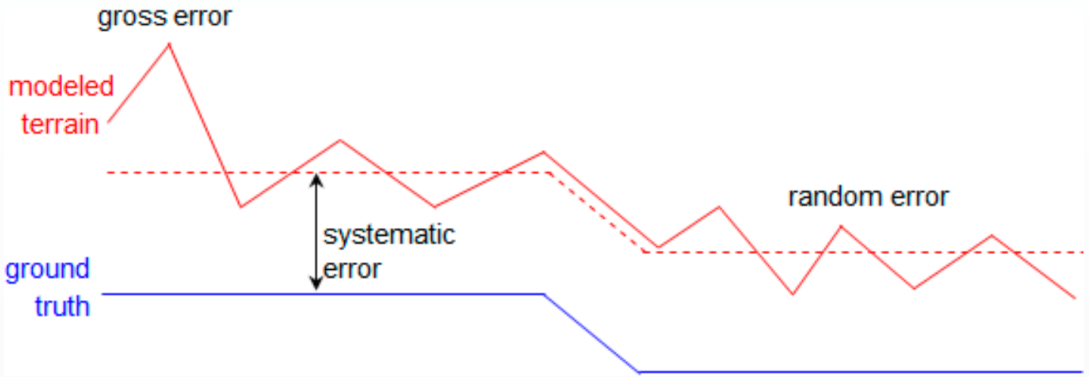


Polidori and El Hage, 2020



Systematic and Random Errors

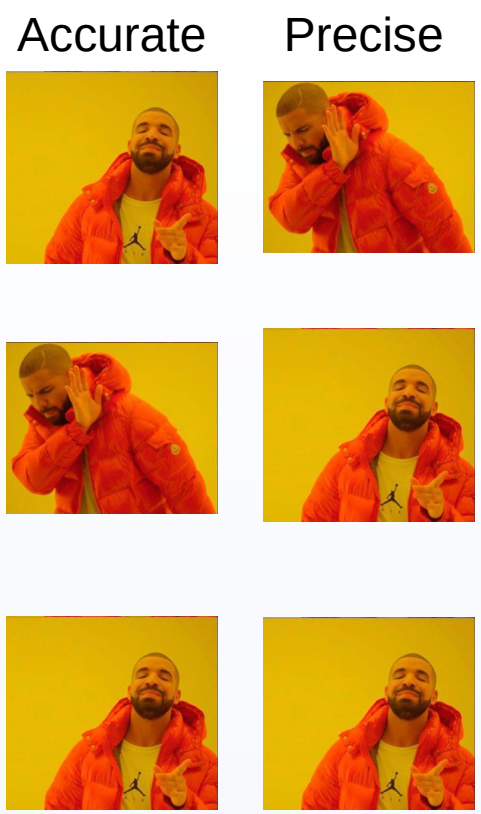
- Two main categories of error
- Random:
  - Related to “image” issues
  - Parallax matching, resolution, acquisition geometry
  - Not something we can correct
  - Mostly affect precision
- Systematic:
  - Bias
  - External orientation
  - May be modelled/corrected
  - Mostly affect accuracy



Polidori and El Hage, 2020

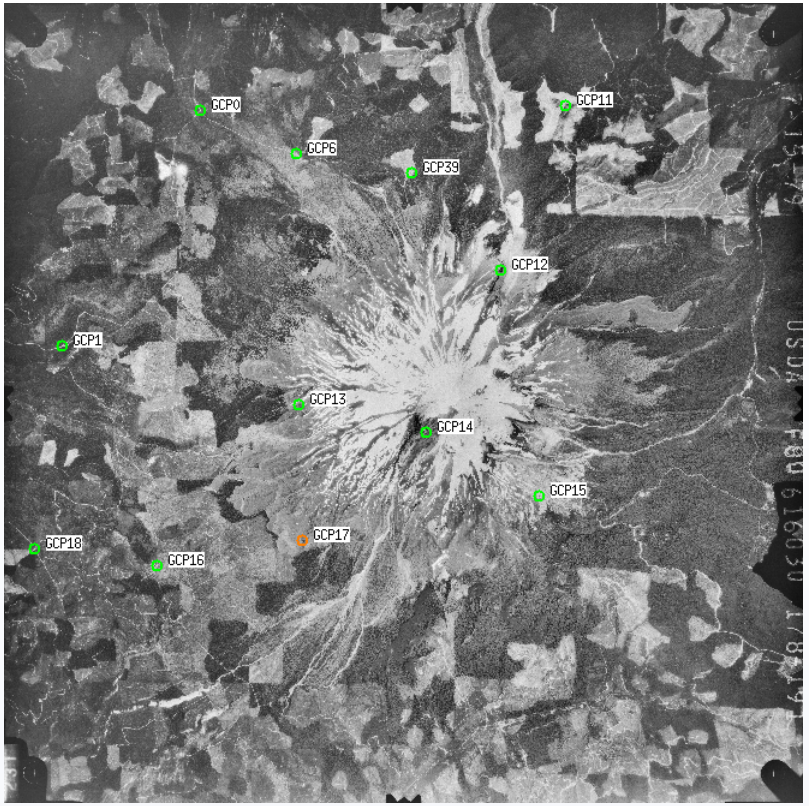
Accuracy and Precision

- Accuracy: how close a measurement comes to a standard/known value
- Precision: how close two or more measurements are



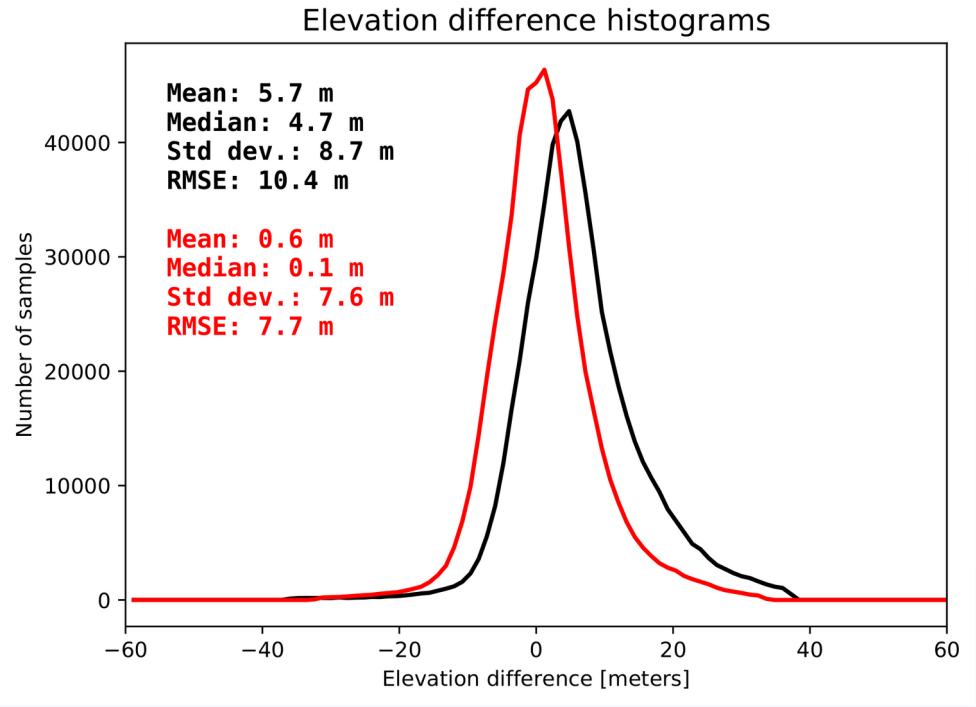
Internal Accuracy

- Estimated only from the calibration & orientation
- Measure using control points:
  - Hold back some points from bundle adjustment (check points)
  - Bundle adjustment residuals



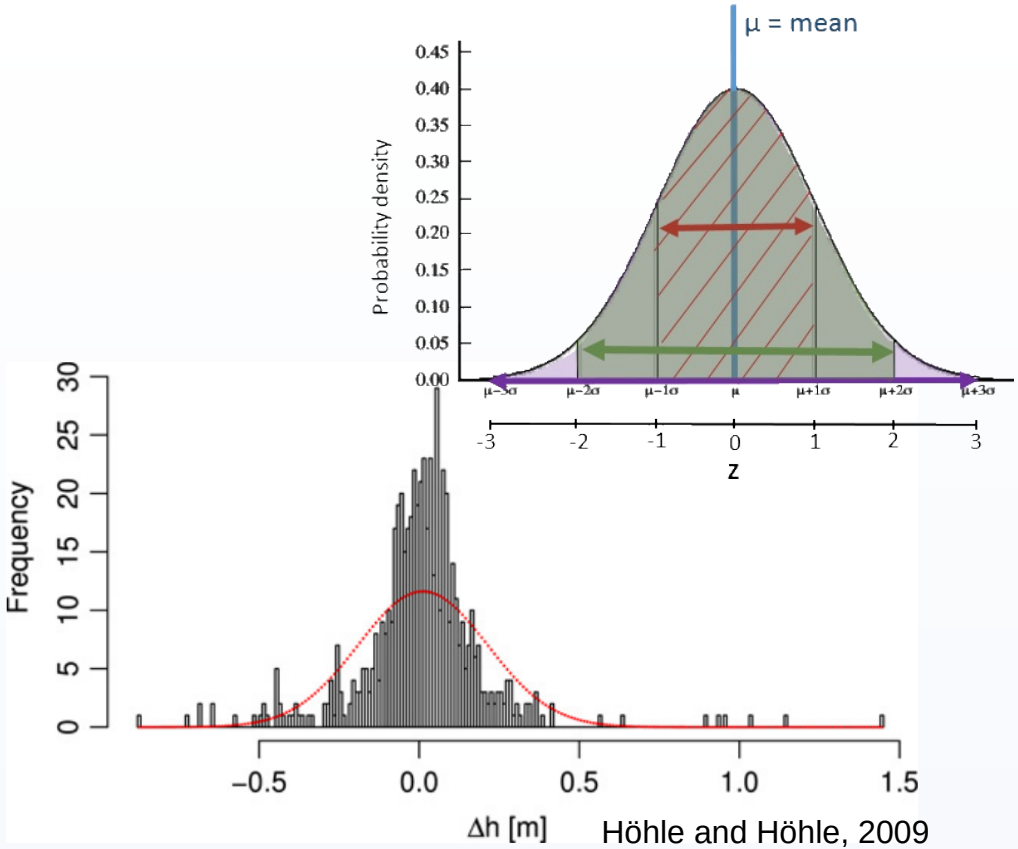
External Accuracy

- Independent validation
- Comparison to other data sources:
  - High-quality DEMs
  - GPS measurements
  - LiDAR
  - ICESat
- Example: air photo to AW3D30 global DEM
- Can also use derived parameters



Statistics

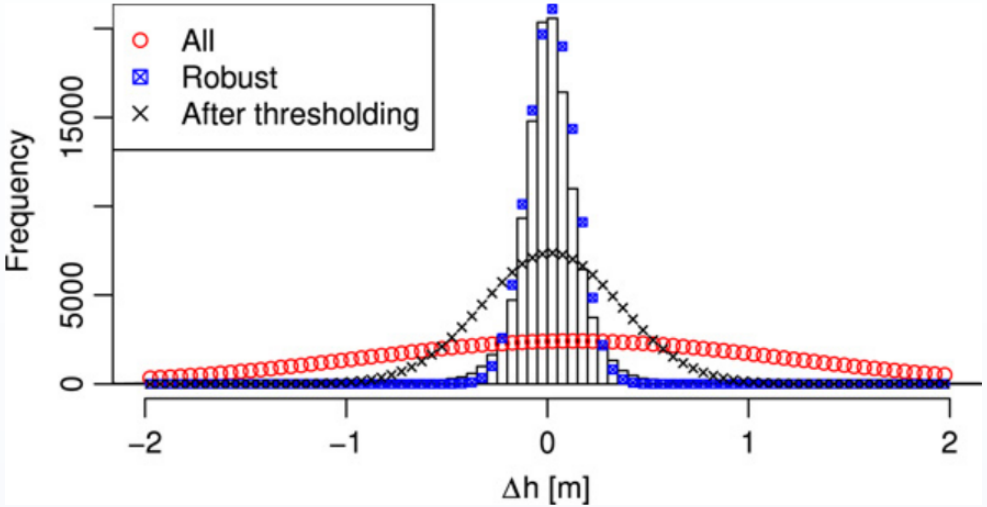
- Often, we use mean (μ) and standard deviation (σ) to describe data
- Assumption that data are normally distributed
- For DEMs, this is often not the case!
- Often, other measures are more useful



Höhle and Höhle, 2009

Statistics

- Instead of μ,σ use:
  - μ: median (50%)
  - σ: normalized median absolute deviation (NMAD)
  - Quantiles (e.g., 68.3%, 95%)
- Less sensitive to large outliers (robust)



Höhle and Höhle, 2009

Summary

- DEMs may represent different surfaces – important to keep this in mind
- Accuracy & Precision is impacted by different causes
- To evaluate DEMs, we can use external or internal metrics (with/without independent data)
- Important to keep statistics in mind – μ/σ are not always the most appropriate measures!

Additional resources

- Polidori and El Hage, 2020 [Remote Sensing]
- Höhle and Höhle, 2009 [ISPRS]
- Gesch et al., 2016 [ISPRS]
- Hengl and Reuter, 2011 [Geomorphometry]