Geographic (Datum) and Vertical Transformations: A Deep Dive

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Where is my transformation?
Demo in ArcGIS Pro
Why do we need to transform our data?

WGS 1984

ED 1950
Why do we need to transform our data?
Two Kinds of Transformations

Geographic (datum) transformation

Vertical transformation
Geographic (Datum) Transformations

- Between two geographic coordinate systems:
  - D48 (old datum)
  - D96 (ETRS89, new)

Source: GURS
Geographic (Datum) Transformations

- Multiple transformations
  - Various areas, extents
  - Different accuracies

Source: GURS

D48 (old datum)  D96 (ETRS89, new)
Geographic (Datum) Transformations

• Multiple transformations
  - Various areas, extents
  - Different accuracies

D48 (old datum)

D96 (ETRS89, new)
How do I find transformations?
Transformation List

• Envelope intersections
  - Data
  - Geographic CS
  - Transformation

Sources: GURS, EPSG
Transformation List

- Envelope intersections
  - Data
  - Geographic CS
  - Transformation

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Sources: GURS, EPSG
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• Envelope intersections
  - Data
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Transformation List

- Envelope intersections
- Accuracy
Transformation List

- Envelope intersections
- Accuracy

- New since ArcGIS 10.4 and Pro 1.4

- Resource: EPSG (epsg-registry.org)
Geographic (Datum) Transformations

Demo in ArcGIS Pro
Vertical Transformations

Ellipsoidal Heights (NAD83)

NAD_1983_To_NAVD88_CONUS_GEOID12B_Height

Orthometric Heights (NAVD 88)
The Origin for Height or Depth

- Ellipsoidal height \((h)\)
  - Geometric datum

- Gravity-related height \((H)\)
  - Vertical datum, e.g. geoid
Types of Vertical Transformations

- Between ellipsoidal and gravity related heights
- Used with GNSS

Vertical transformation using geoid model
Types of Vertical Transformations

- Between two geographic coordinate systems
- Heights are ellipsoidal

GCS A / VCS A  3D Geog. Transformation  GCS B / VCS B
Types of Vertical Transformations

• Between two gravity related heights

GCS A / VCS 2

Vertical Transformation

GCS A / VCS 1
Types of Vertical Transformations

- Between two gravity related heights
- May require interpolation GCS
Types of Vertical Transformations

- Between two gravity related heights
- May require interpolation GCS
Types of Vertical Transformations

- Between two gravity related heights
- May require interpolation GCS
Types of Vertical Transformations

- Between two gravity related heights
- May require interpolation GCS

GCS A / VCS 1 → 2D Geog. Transformation → GCS C / VCS 1

GCS A / VCS 2 → ~2D Geog. Transformation → GCS C / VCS 2

Vertical Transformation
Vertical Transformations
Demo in ArcGIS Pro
Why couldn’t we transform a layer?

- Restricted to four (4) steps in a path
  - 2 geographic
  - 2 vertical

NAD 1927  |  NAD 83 (2011)
NGVD 1929 | NAD 83 (2011)
Why couldn’t we transform a layer?

- Restricted to four (4) steps in a path
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Why couldn’t we transform a layer?

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  - 2 geographic
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NAD 1927  
NGVD 1929  
NAD 1983  
NAVD 1988  
NAD\_1927\_To\_NAD\_1983\_NADCON  
NGVD29\_To\_NAVD88\_NAD83\_ECW
Why couldn’t we transform a layer?

• Restricted to four (4) steps in a path
  - 2 geographic
  - 2 vertical

NAD 1927
NGVD 1929
NAD_1927_To_NAD_1983_NADCON
NGVD29_To_NAVD88_NAD83_ECW
~NAD_1983_To_NAVD88_CONUS_GEOID12B_Height
NAD 1983
Why couldn’t we transform a layer?

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NAD 1927
NGVD 1929

NAD_1927_To_NAD_1983_NADCON
NGVD29_To_NAVD88_NAD83_ECW
~NAD_1983_To_NAVD88_CONUS_GEOID12B_Height
~WGS_1984_(ITRF00)_To_NAD_1983

WGS 1984
Why couldn’t we transform a layer?

• Restricted to four (4) steps in a path
  - 2 geographic
  - 2 vertical

NAD 1927
NGVD 1929
NAD 83 (2011)

NAD_1927_To_NAD_1983_NADCON
NGVD29_To_NAVD88_NAD83_ECW
~NAD_1983_To_NAVD88_CONUS_GEOID12B_Height
~WGS_1984_(ITRF00)_To_NAD_1983
WGS_1984_(ITRF08)_To_NAD_1983_2011
ArcGIS Coordinate Systems Data
ArcGIS Coordinate Systems Data

• 1.5 GB additional data install

• GEOCON v1.0

• NTv2 (CA, ES, CH, UK)

• VERTCON / GEOID12B

• Geoids (JP, NZ, CH)

• EGM2008 (1’ x 1’, 2.5’ x 2.5’)

Geographic Transformations

Vertical Transformations
## More about Coord. Systems, Reference Frames, Transformations, Map Projections

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