

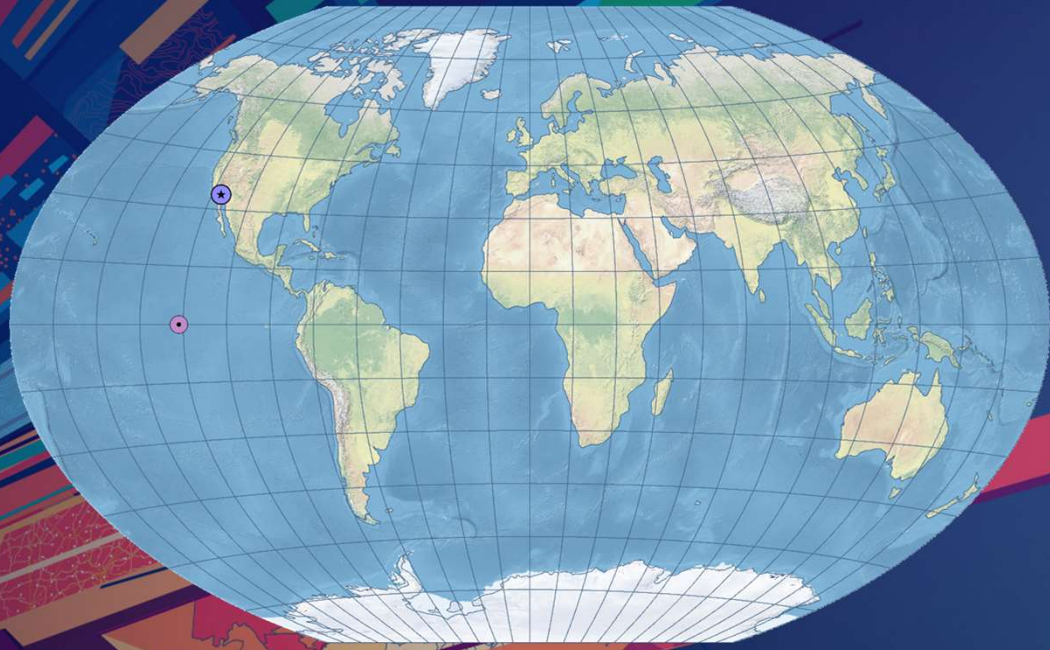


Coordinate Systems and Datum Transformations in ArcGIS

Melita Kennedy

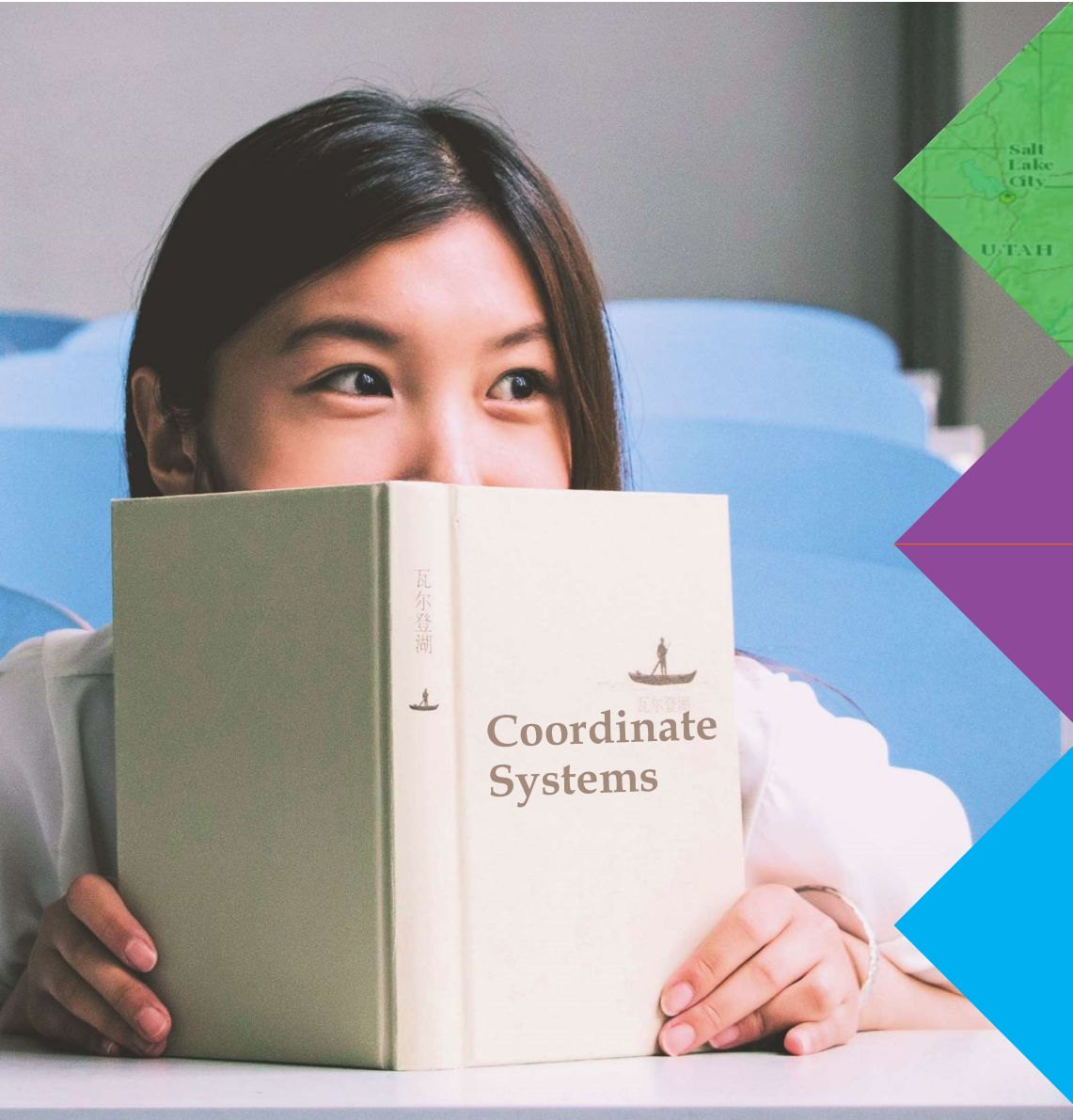
ESRI USER CONFERENCE

GIS
INSPIRING
WHAT'S
NEXT

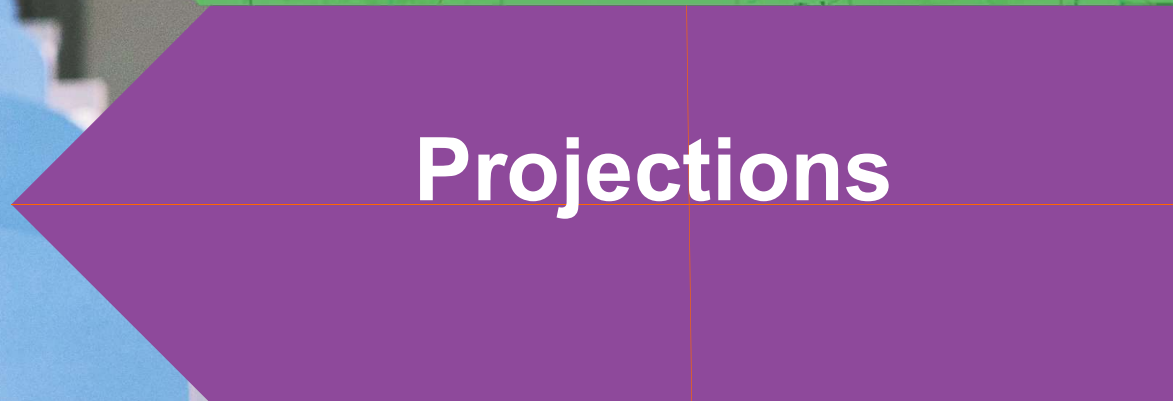


Where is my Data?

Problem



Coordinate systems



Projections



Transforming



Horizontal Coordinate Systems

Geographic and Projected

What does a coordinate system tell us?



Distance



Location



Direction

Distance

Q: How far is it from San Francisco to Los Angeles?

352.34 miles

690.67 kilometers

567.03 kilometers

620111.549 yards



Distance

Q: How far is it from San Francisco to Los Angeles?

A: It depends on the coordinate system.

352.34 miles

690.67 kilometers

567.03 kilometers

620111.549 yards



Location

Q: What are the coordinates for Los Angeles?

(-118.25, 34.05)

(1276.333, 2421.545)

(2054060.514, 3897101.109)

(-13163527.521, 4035514.817)



Location

Q: What are the coordinates for Los Angeles?

A: It depends on the coordinate system.

(-118.25, 34.05)

(1276.333, 2421.545)

(2054060.514, 3897101.109)

(-13163527.521, 4035514.817)



Direction

Q: In which direction is the North Pole?

Down

To the right

Up

Can't, not on the map



Direction

Q: In which direction is the North Pole?

A: It depends on the coordinate system.

Down

To the right

Up

Can't, not on the map



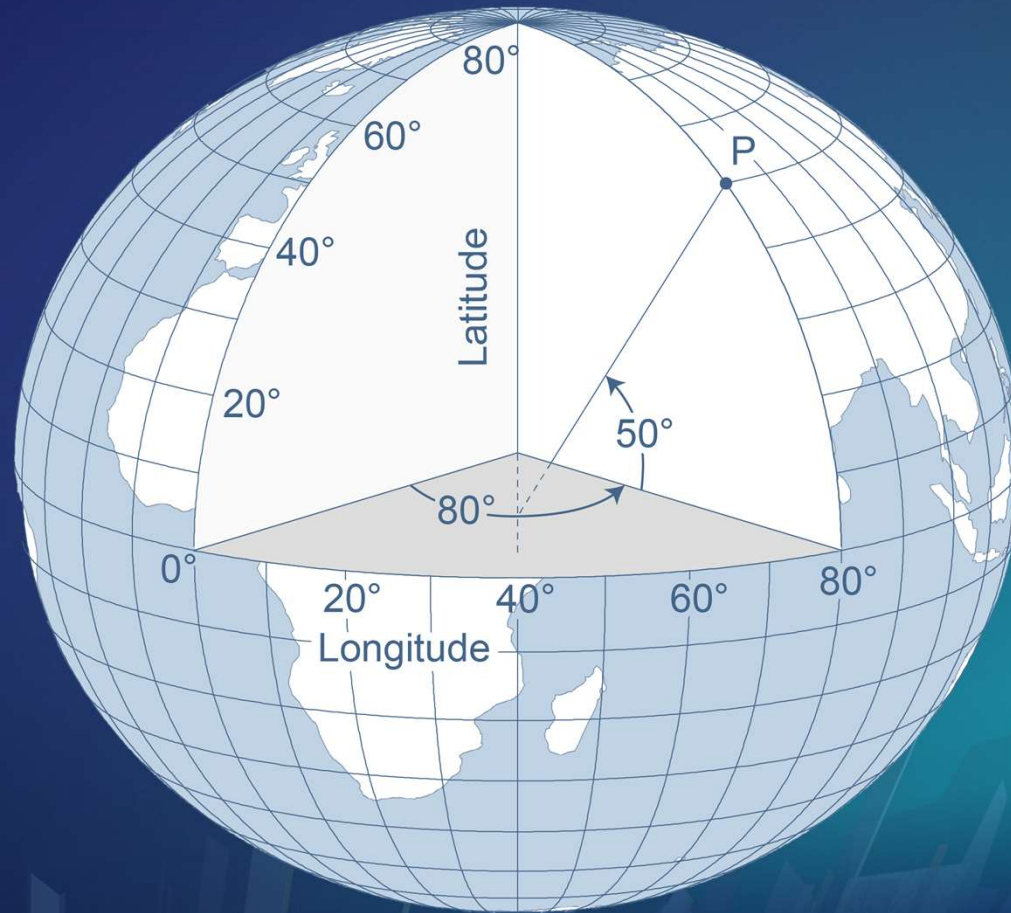
Two Kinds of Horizontal Coordinate Systems

Geographic coordinate system

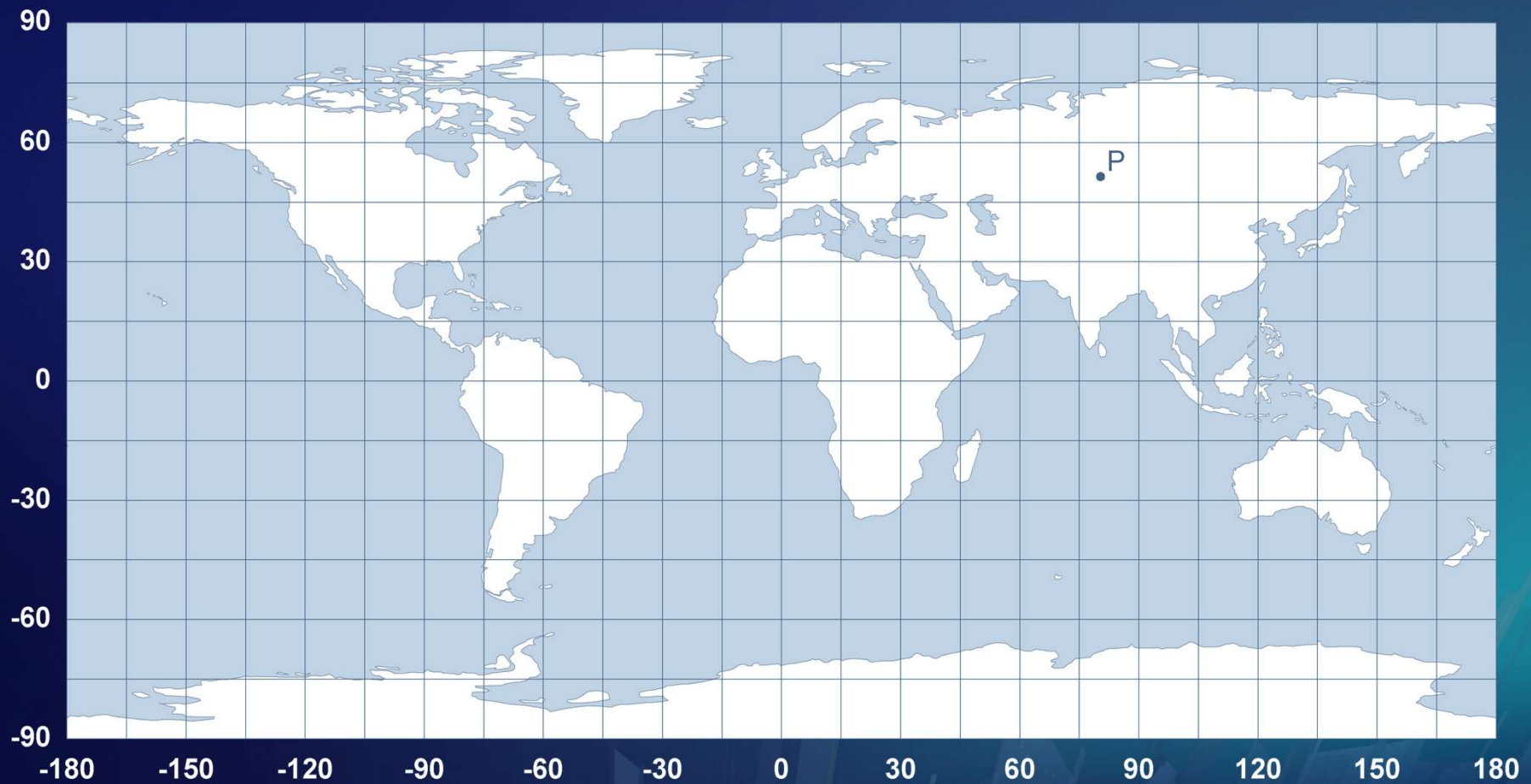
Projected coordinate system

Geographic Coordinate System (GCS)

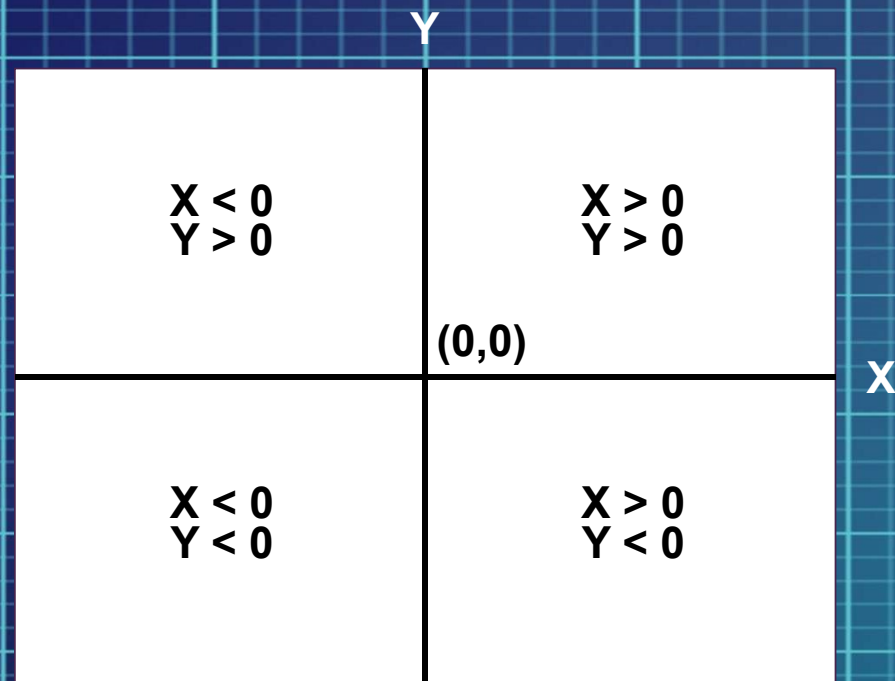
- 3D spherical surface
- Point P has:
 - Longitude – 80° E
 - Latitude – 50° N



Geographic Coordinate System (GCS)

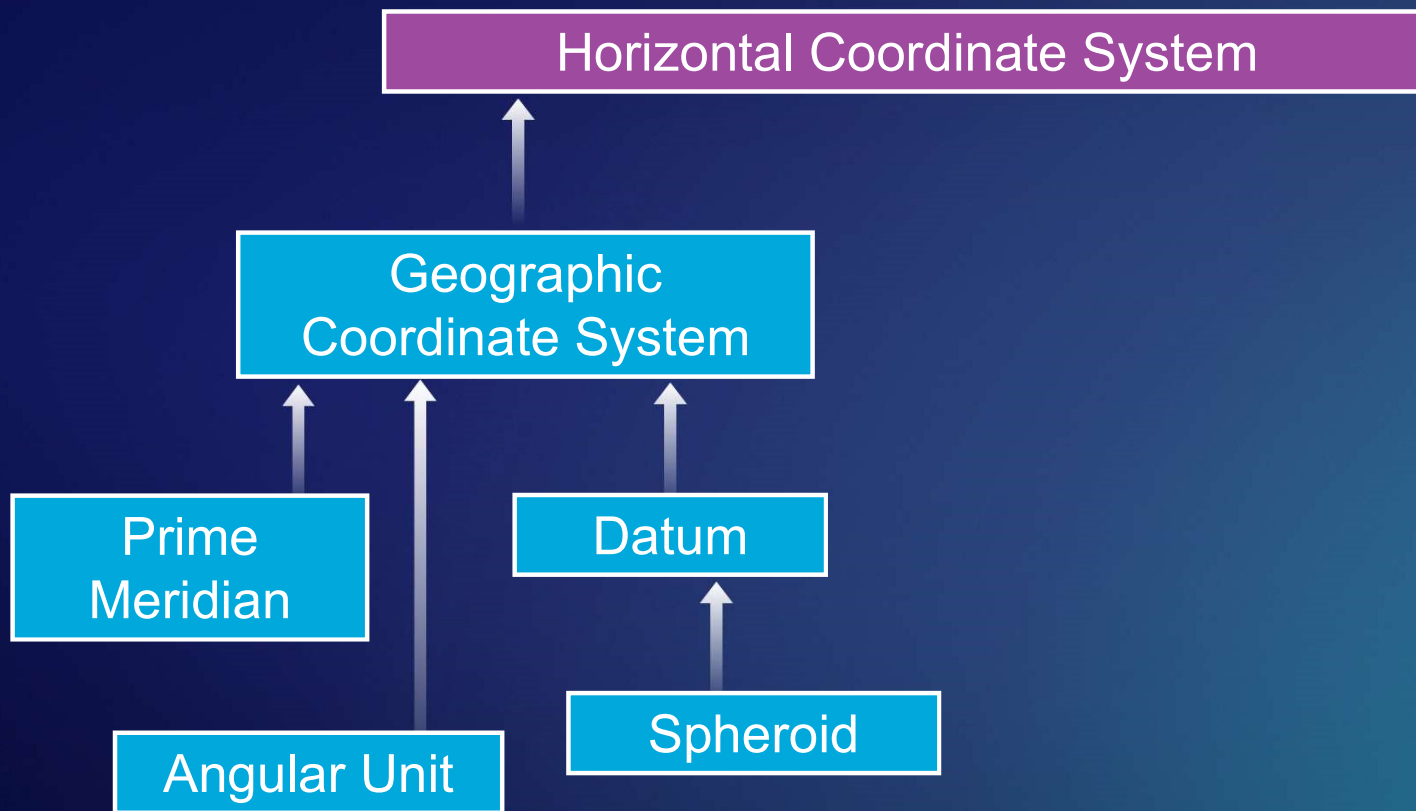


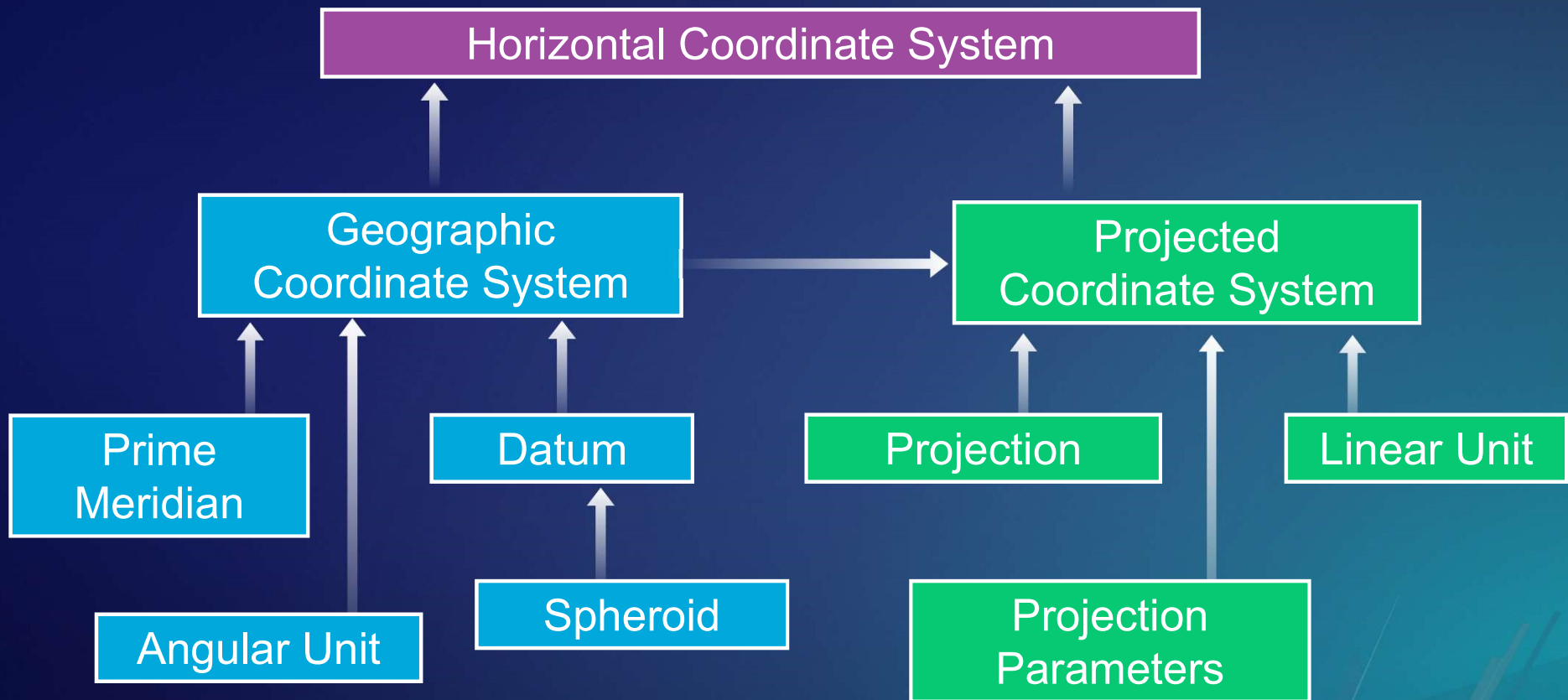
Projected Coordinate System (PCS)



Horizontal Coordinate System





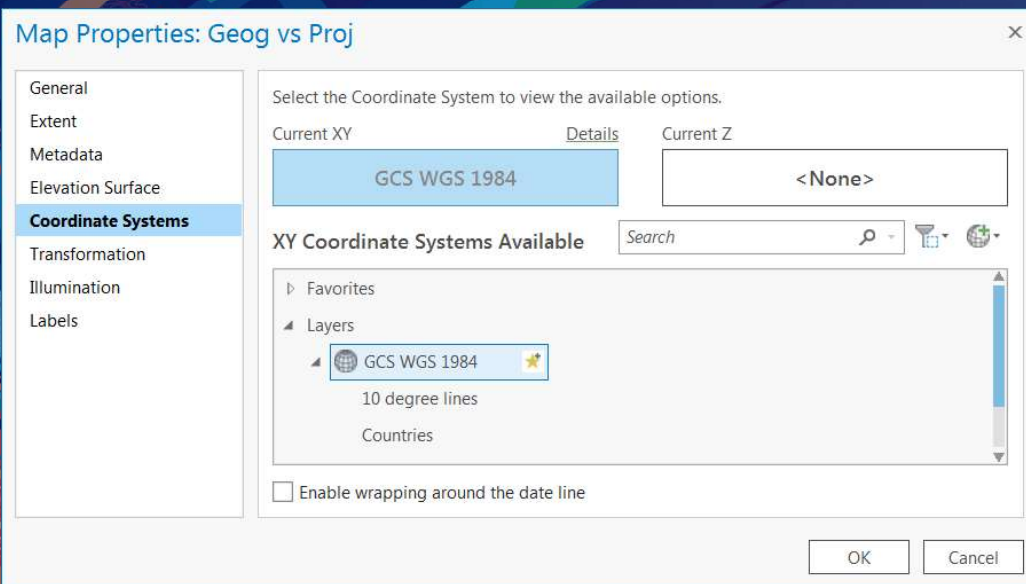


Two Ways to Specify a Coordinate System

Well-known ID

Well-known text





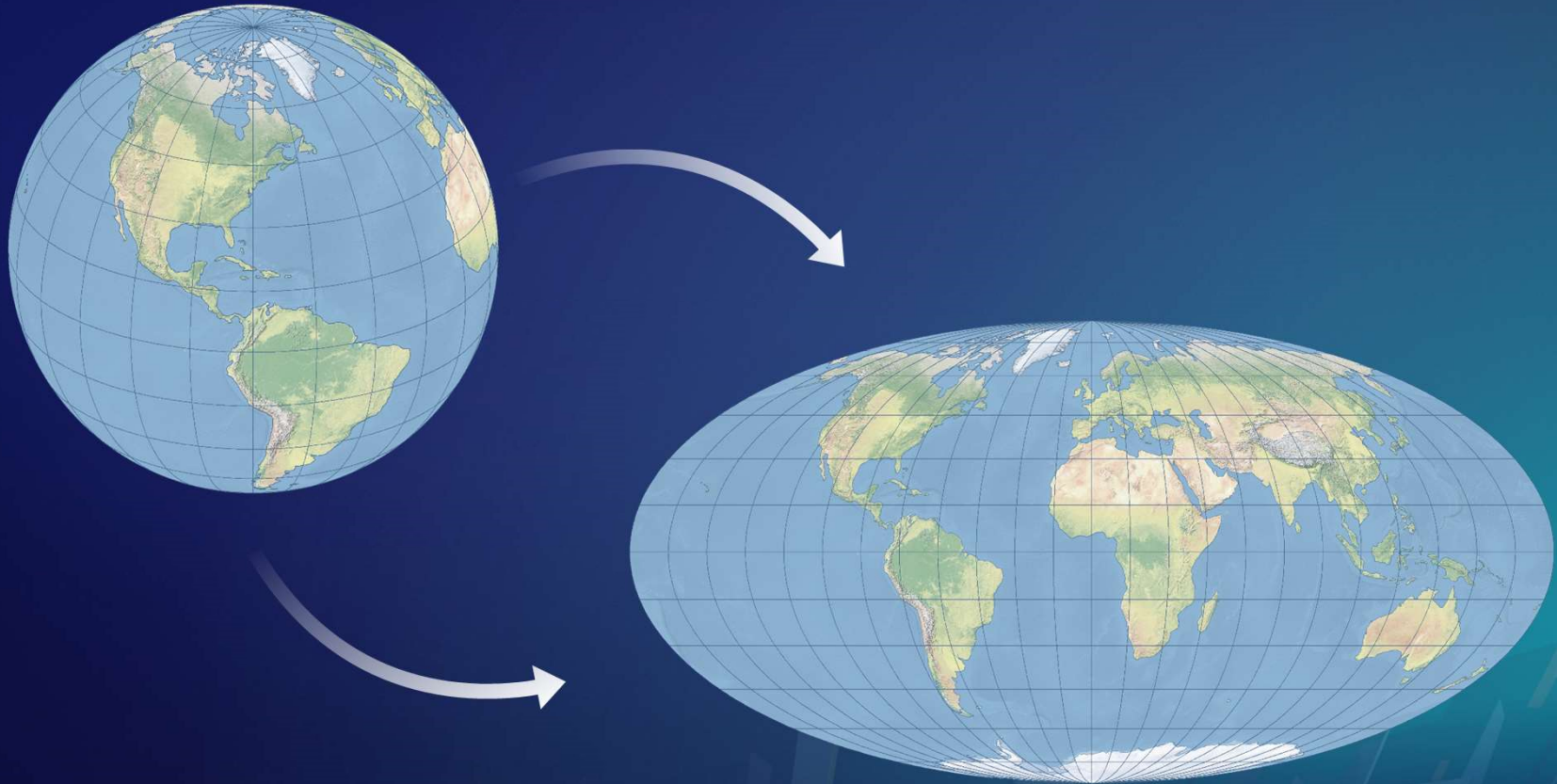
Horizontal Coordinate Systems

Demo in ArcGIS Pro

The background is a dark blue gradient. On the left, there are faint, light blue contour lines. On the right, there are several overlapping, semi-transparent geometric shapes in shades of teal, orange, and red, along with a faint grid pattern. The overall aesthetic is modern and technical.

Map projections

Projecting to a Different Coordinate System





Why are there so many map projections?

- Shape
- Area
- Direction
- Distance



Illustration by Charles Preppernau, geographer.xyz

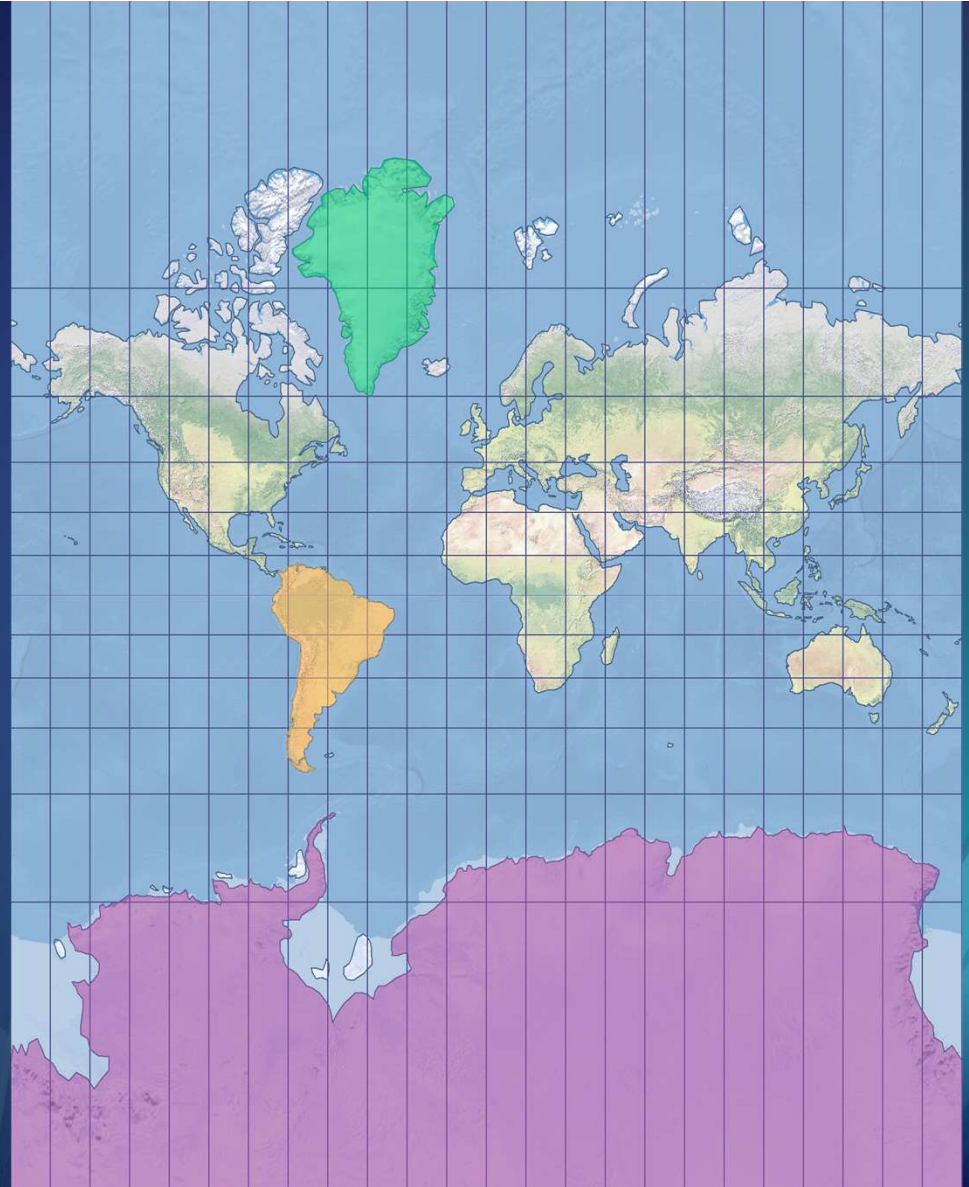
Web Mercator Projection

Q: Which is bigger?

Greenland

South America

Antarctica



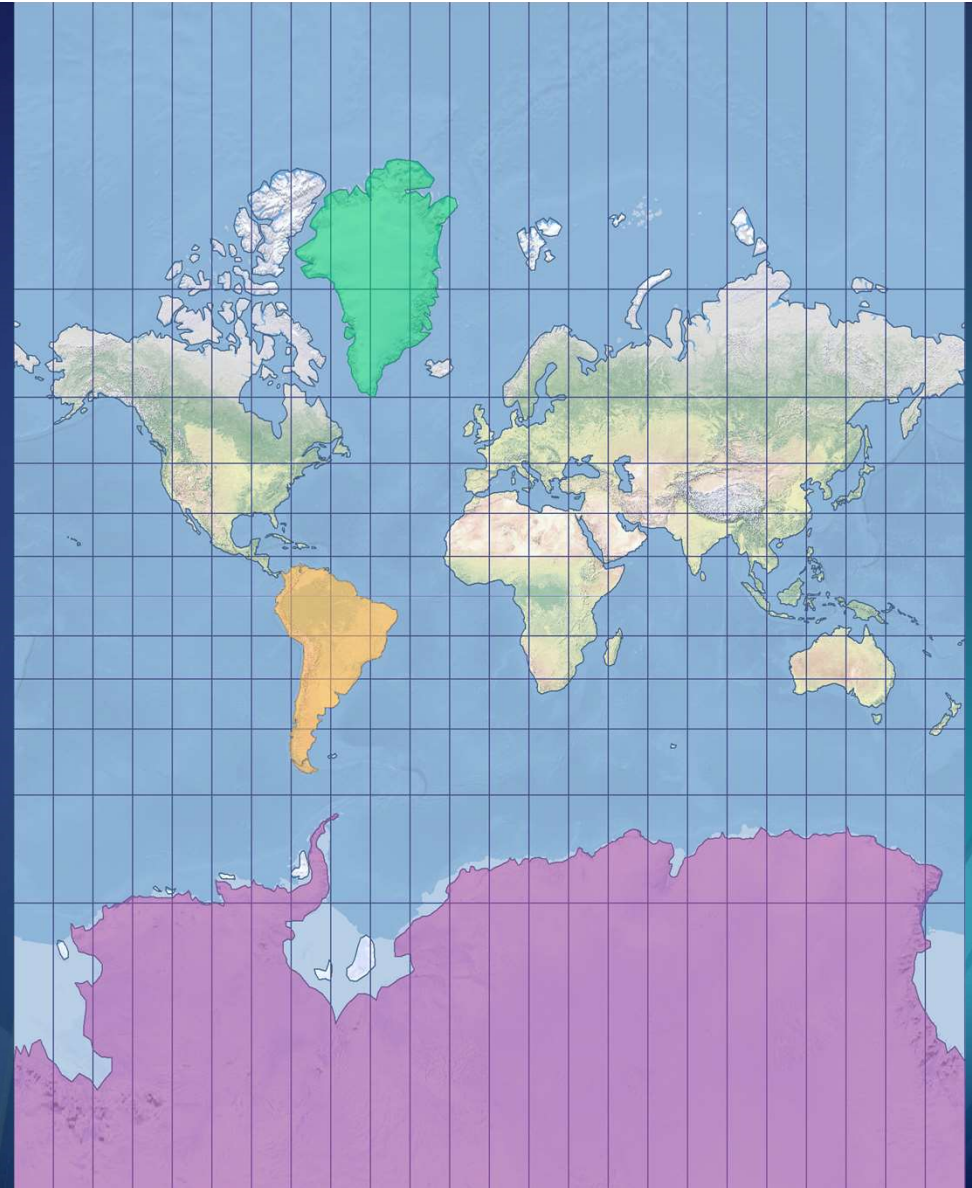
Web Mercator Projection

Q: Which is bigger?

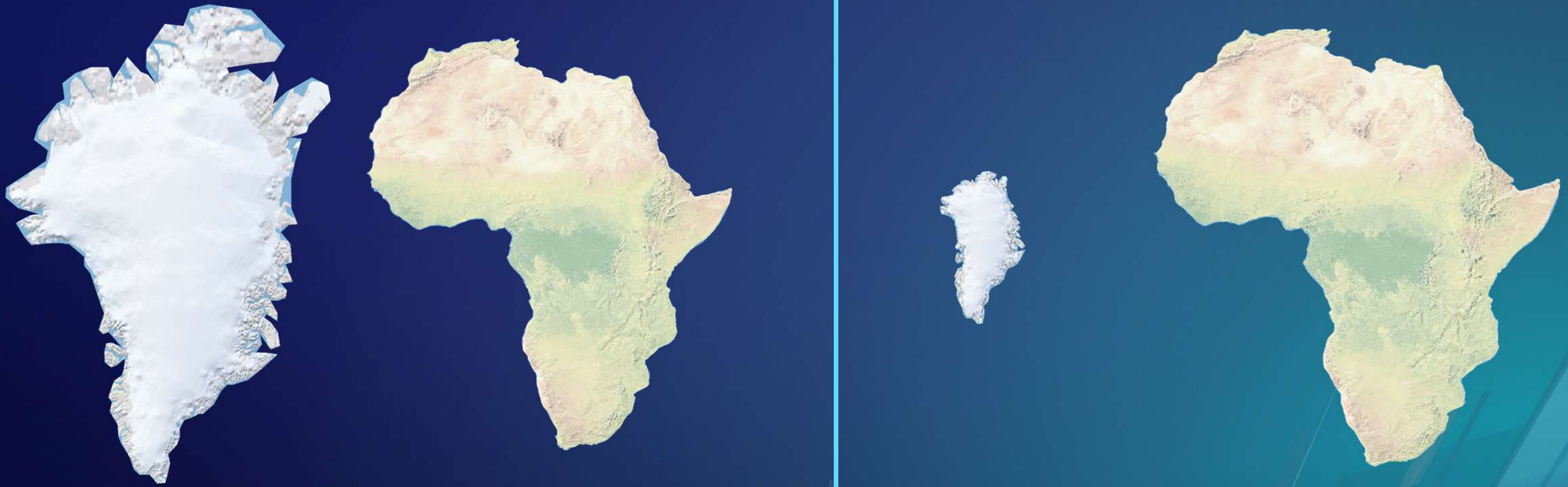
Greenland ~ 2 166 000 km²

South America ~ 17 840 000 km²

Antarctica ~ 14 000 000 km²



Web Mercator Projection vs. Reality



Selection

Q: Which projection is the best?

Albers equal-area

Stereographic

Azimuthal equidistant

Transverse Mercator



Selection

Q: Which projection is the best?

A: It depends on what you are doing.

Albers equal-area

Stereographic

Azimuthal equidistant

Transverse Mercator



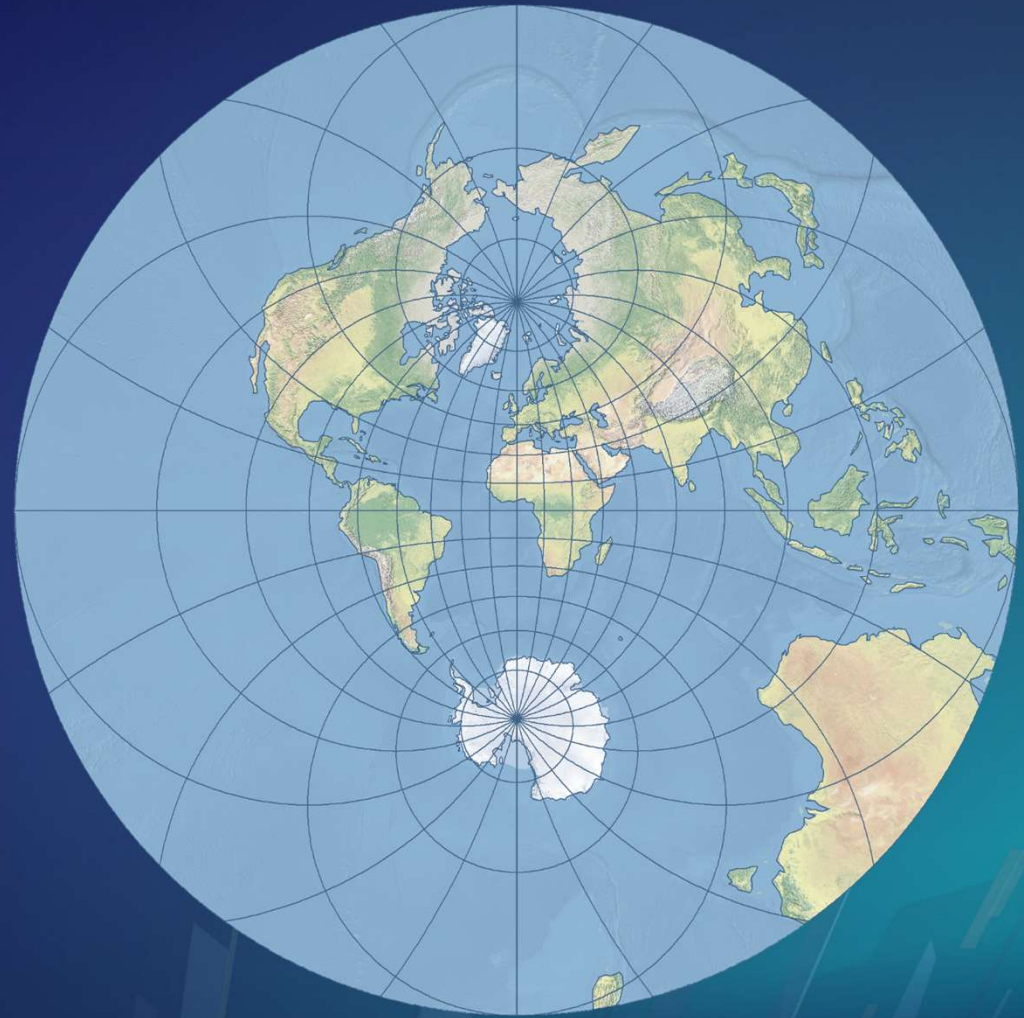
Preserve Area

- Albers equal-area conic



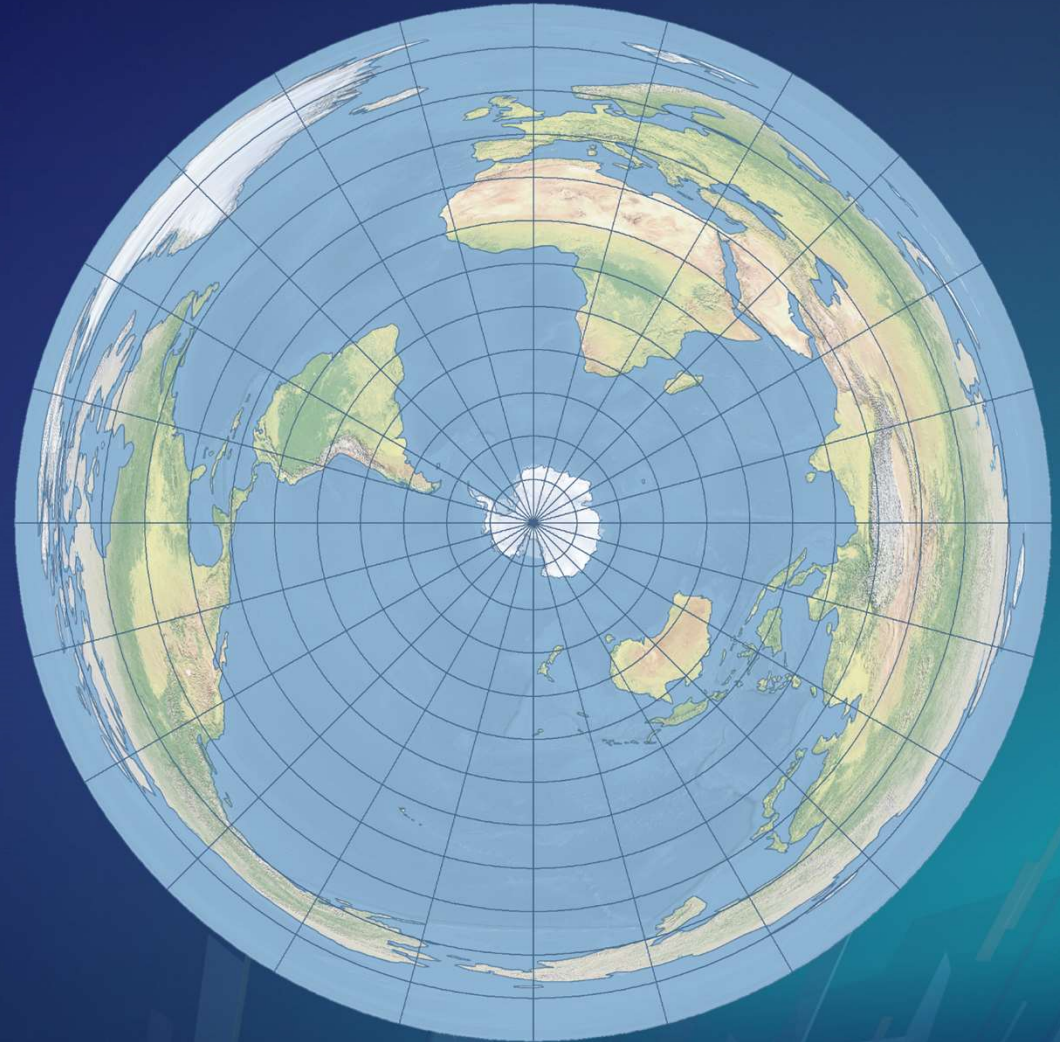
Preserve Angles

- Stereographic
 - Only at infinitesimal scale



Preserve Direction and Distance

- Azimuthal equidistant
 - Only from the center

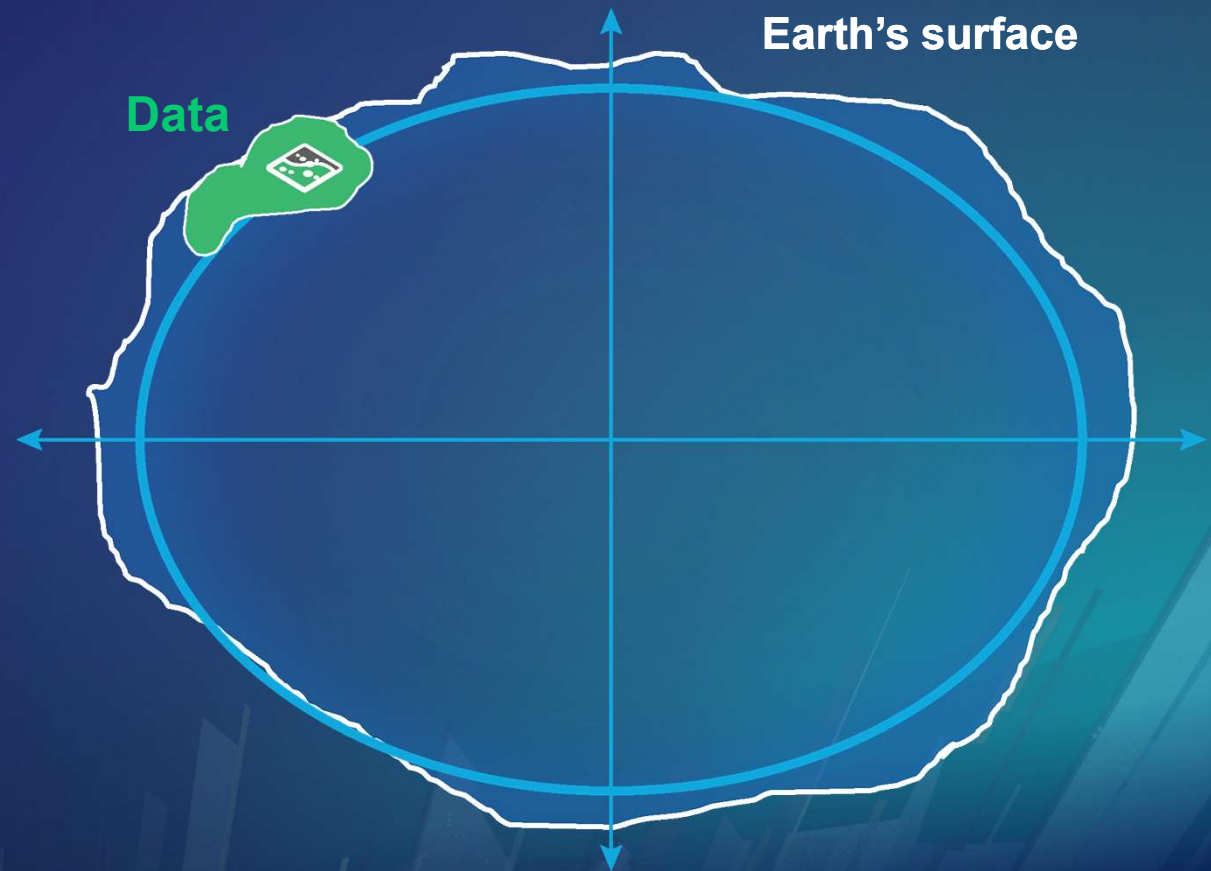




Datum (Geographic) Transformations

Transforming Means Changing Datum

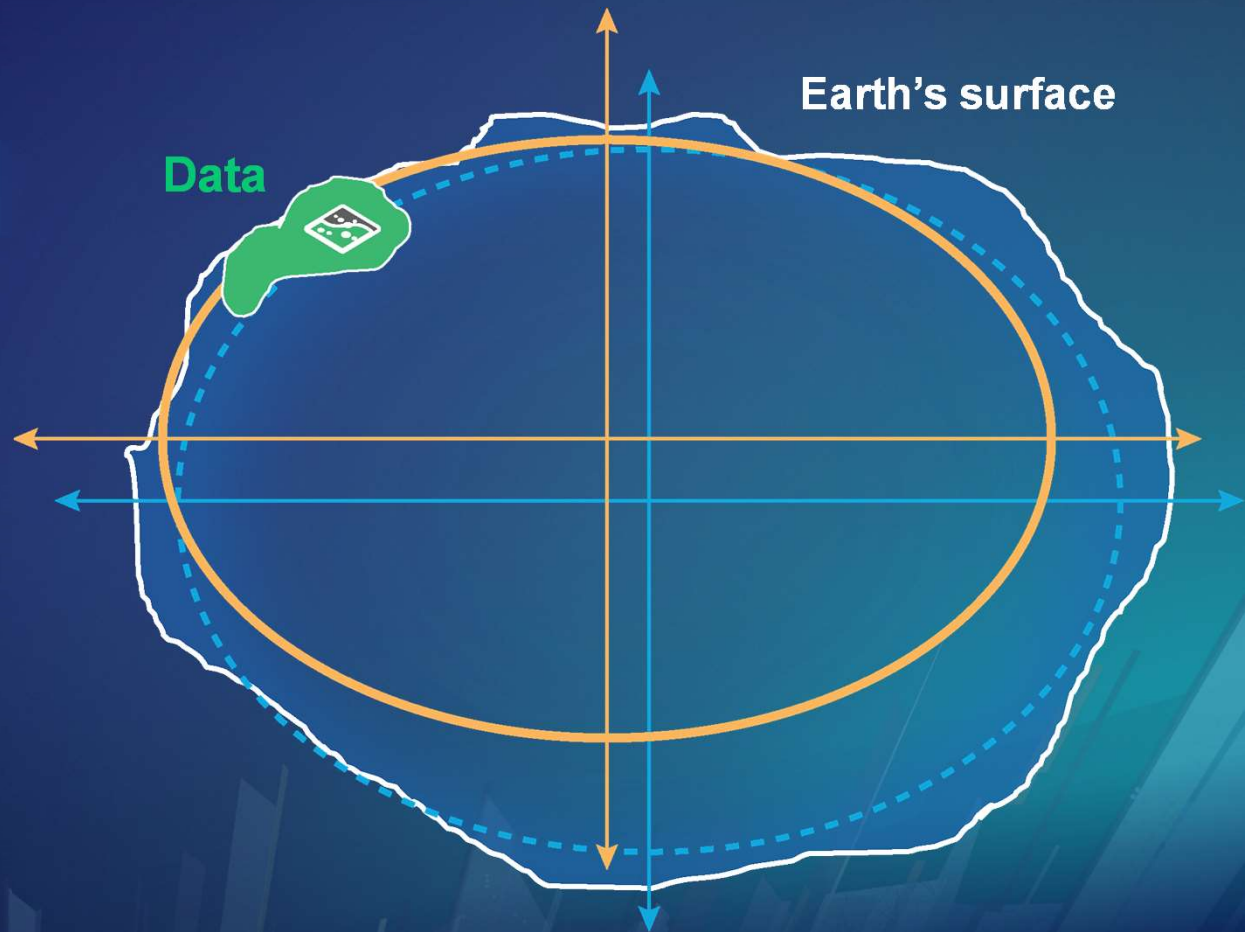
Earth-centered datum (WGS 84)



Transforming Means Changing Datum

Earth-centered datum (WGS 84)

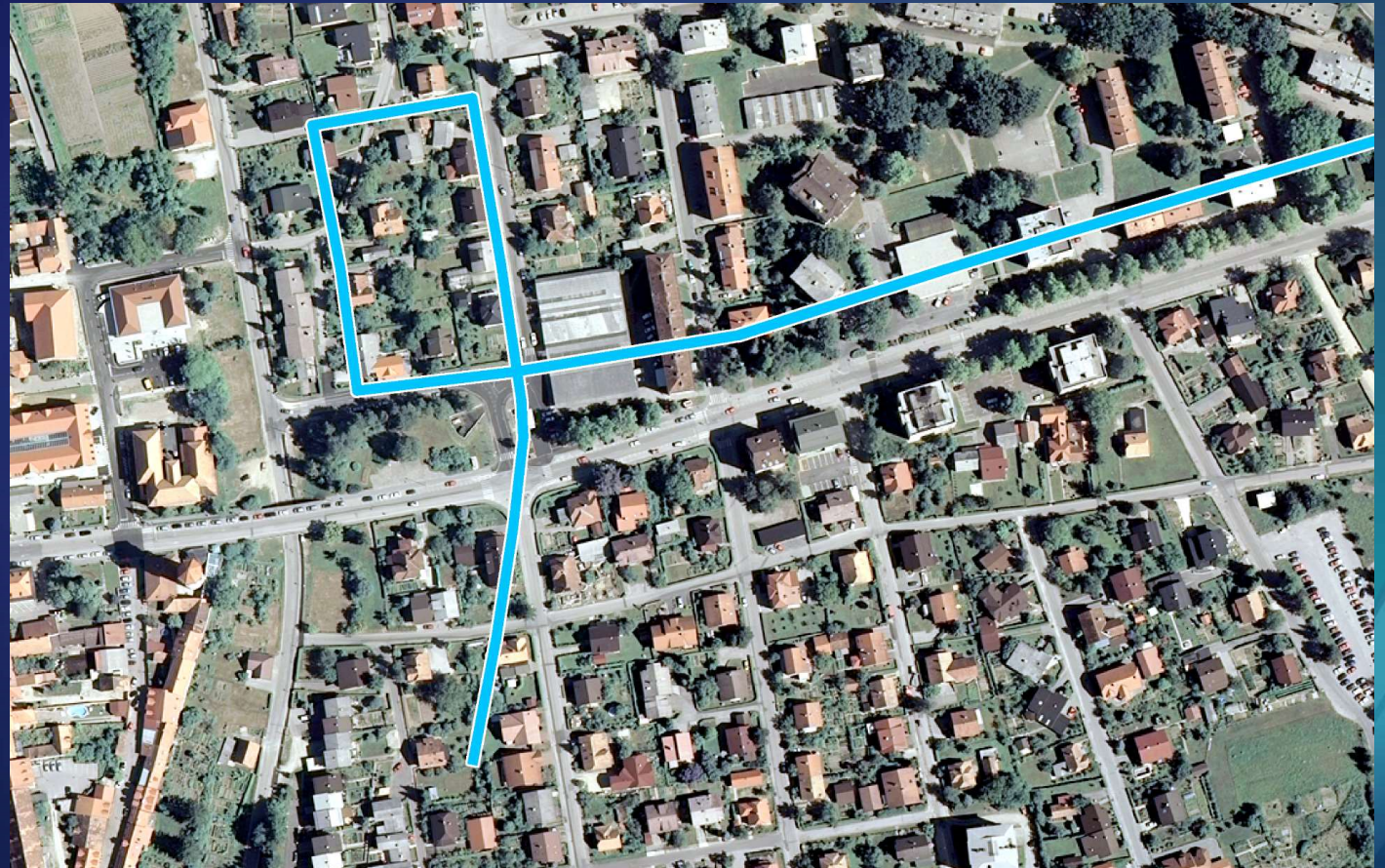
Local datum (NAD 27)



Why do we need to transform our data?

WGS 1984

ED 1950

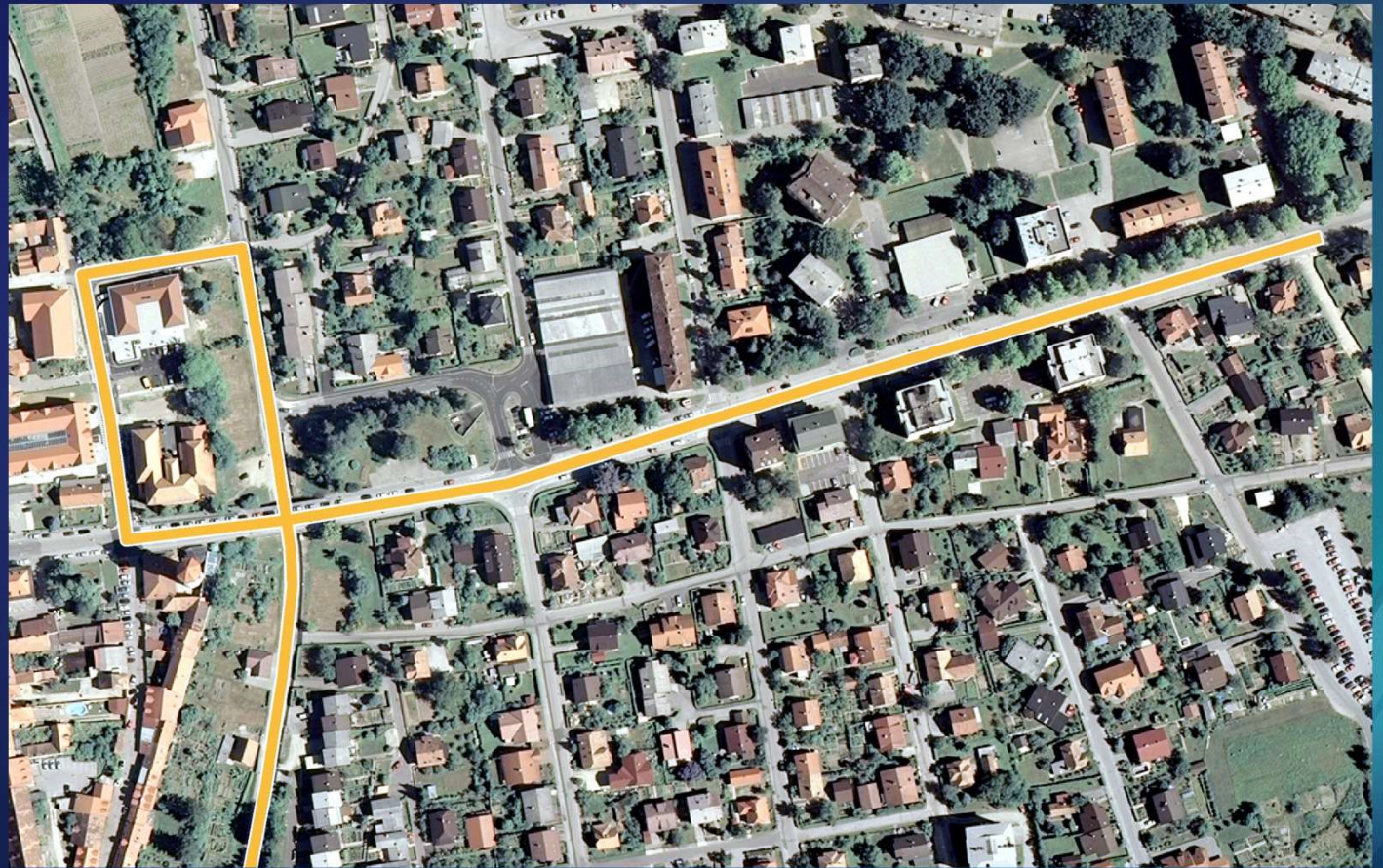


Why do we need to transform our data?

WGS 1984



ED 1950



Geographic (Datum) Transformation

NAD 1927

NAD_1927_To_WGS_1984_1

WGS 1984



Geographic (Datum) Transformation



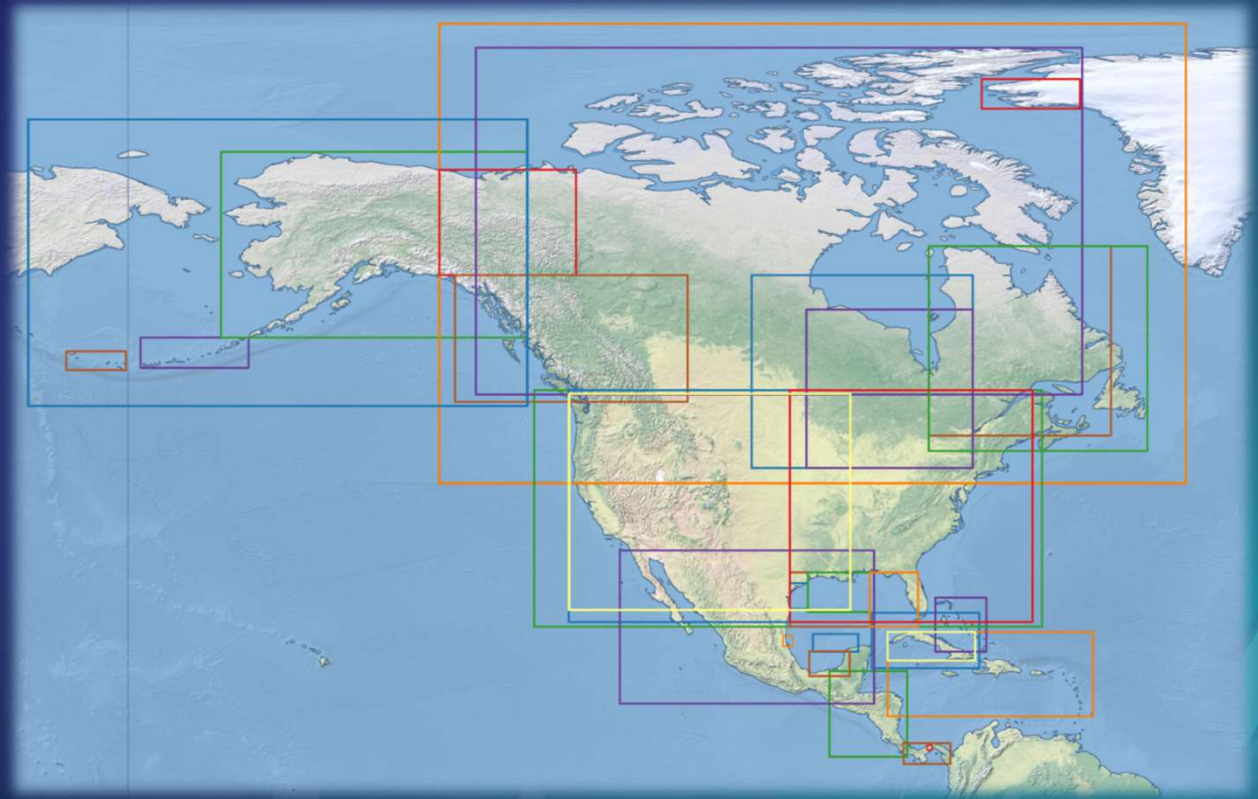
Defined for Certain Area

- 33 transformations:

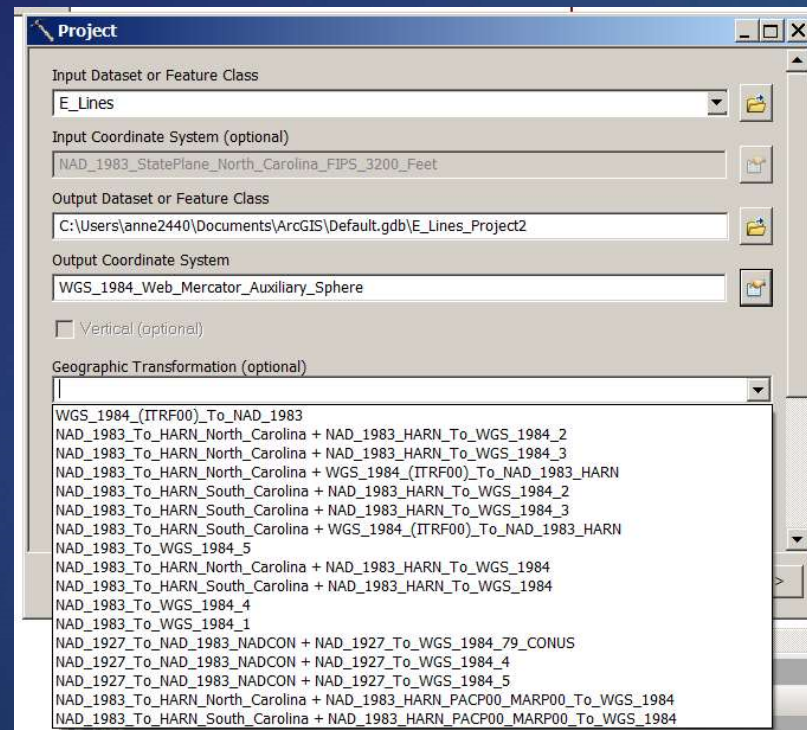
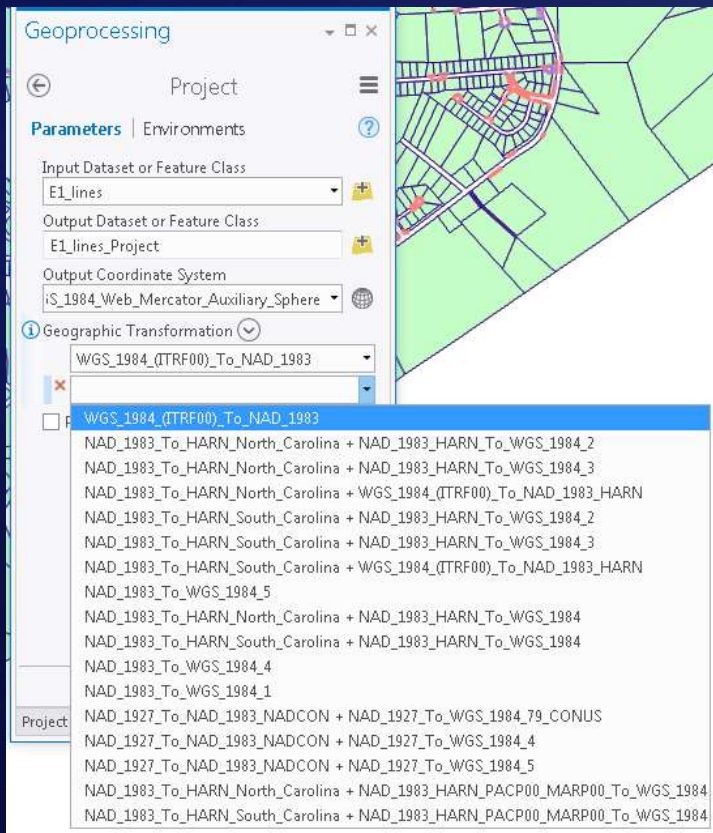
NAD 27



WGS 84

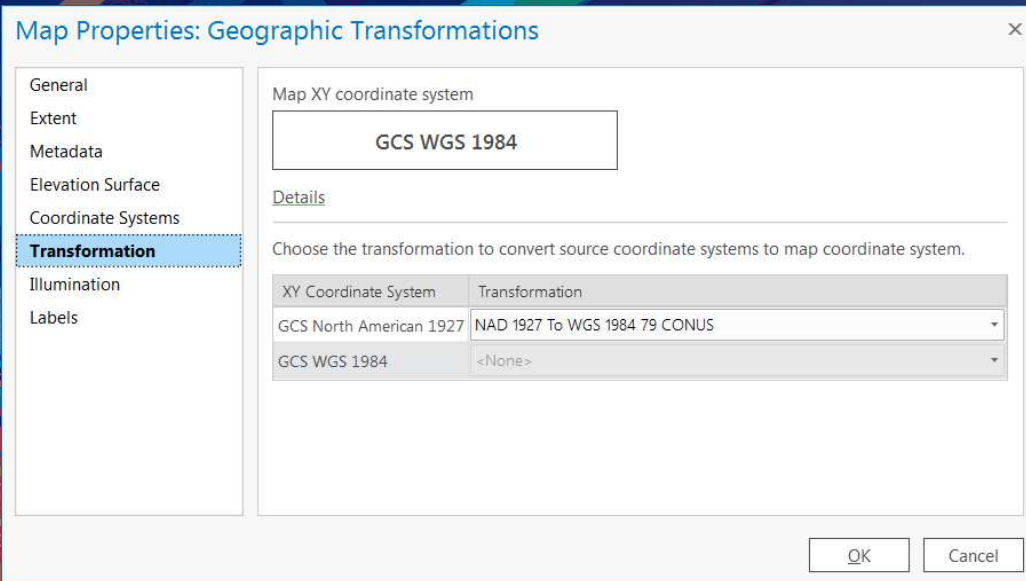


How do I find transformations?



ArcGIS REST Services Directory

[Home](#) > [services](#) > [Utilities](#) > [Geometry \(GeometryServer\)](#) > [findTransformations](#)



Geographic Transformations

Demo in ArcGIS Pro

ArcGIS Coordinate Systems Data

The screenshot shows the Esri MyEsri website interface. The left sidebar contains a navigation menu with 'Data and Content' highlighted by a red arrow and the number 3. The main content area shows a search for 'coordinate systems' and a list of download links for 'ArcGIS Coordinate Systems Data' for various ArcGIS products (Pro, Desktop, Enterprise) and versions. A red arrow and the number 2 point to the 'Downloads' link in the breadcrumb navigation. Another red arrow and the number 1 point to the 'Downloads' link in the 'My Organizations' menu.

Product Components

- Data and Content **3**
- Apps
- Database Support Files
- Developer Tools
- Language Packs
- Media
- Download ISO Files
- Request Media

Access to Coordinate Systems

Navigate to MyEsri
Select My Organizations
Downloads
Data and Content

Language: English

esri ArcGIS Industries About Support

My Esri

Dashboard My Profile My Organizations **1**

Overview Transactions Licensing Downloads

Select the items below that you want to download.

coordinate systems X Sort By: Files

Files Product Version **2**

Product	Version	Size	Action
ArcGIS Pro	2.1	920.81 MB	Download
ArcGIS Desktop	10.6	920.81 MB	Download
ArcGIS Desktop	10.5	903.16 MB	Download
ArcGIS Desktop	10.5.1	902.99 MB	Download
ArcGIS Enterprise (Windows)	10.5	903.16 MB	Download
ArcGIS Enterprise (Windows)	10.5.1	902.99 MB	Download
ArcGIS Enterprise (Windows)	10.6	920.81 MB	Download

ArcGIS Coordinate Systems Data

- 1.5 GB additional data install
- GEOCON v1.0
 - NAD 1983 HARN, NSRS2007, 2011
- NTV2 (CA, ES, CH, UK)
- VERTCON / GEOID12B
- Geoids (JP, NZ, CH)
- EGM2008 (1' x 1', 2.5' x 2.5')

Geographic
Transformations

Vertical
Transformations

Now you understand...



Projecting your data

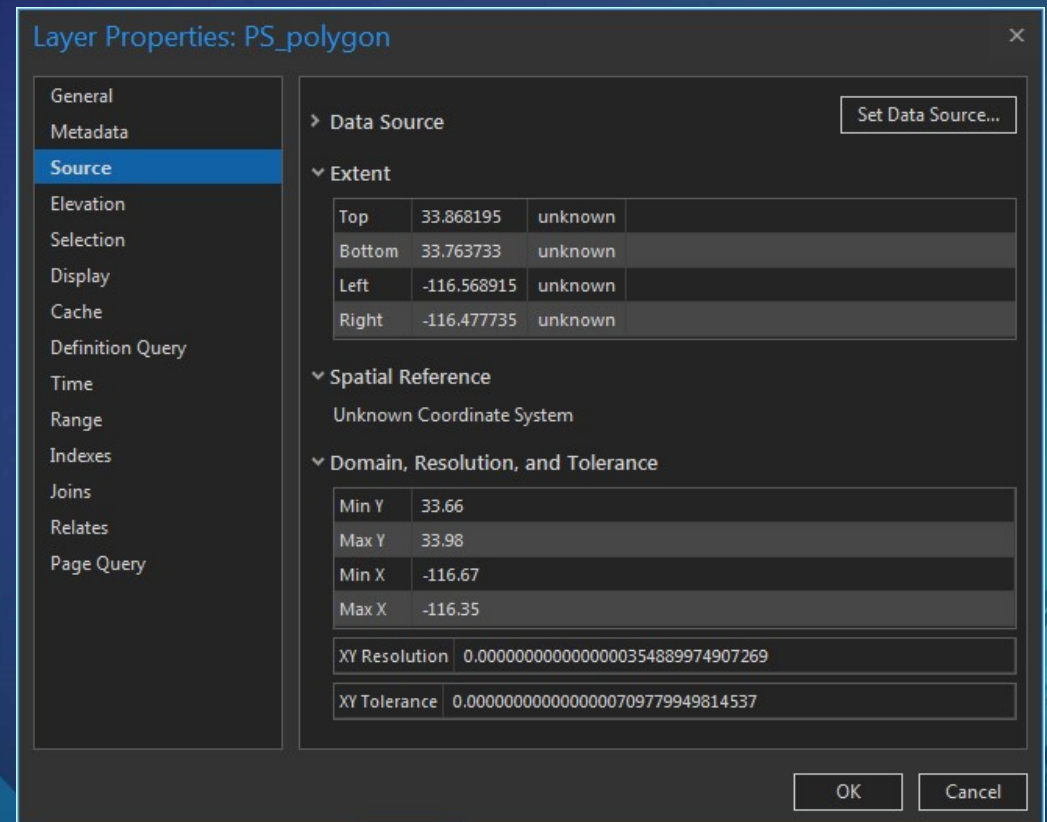
Transforming your data

Unknown Coordinate Systems

The background features a dark blue gradient with abstract geometric patterns. On the left, there are thin, overlapping lines in shades of teal and red. On the right, there are larger, more complex shapes, including a prominent red and orange diagonal band, and various blue and green rectangular and polygonal elements. The overall aesthetic is modern and technical.

Unknown Coordinate Systems

- ALWAYS define the coordinate system
- Good professional practice (help your successor and user)
- Units are unknown
- Map scale is incorrect
- Geodatabase tools can't use default values



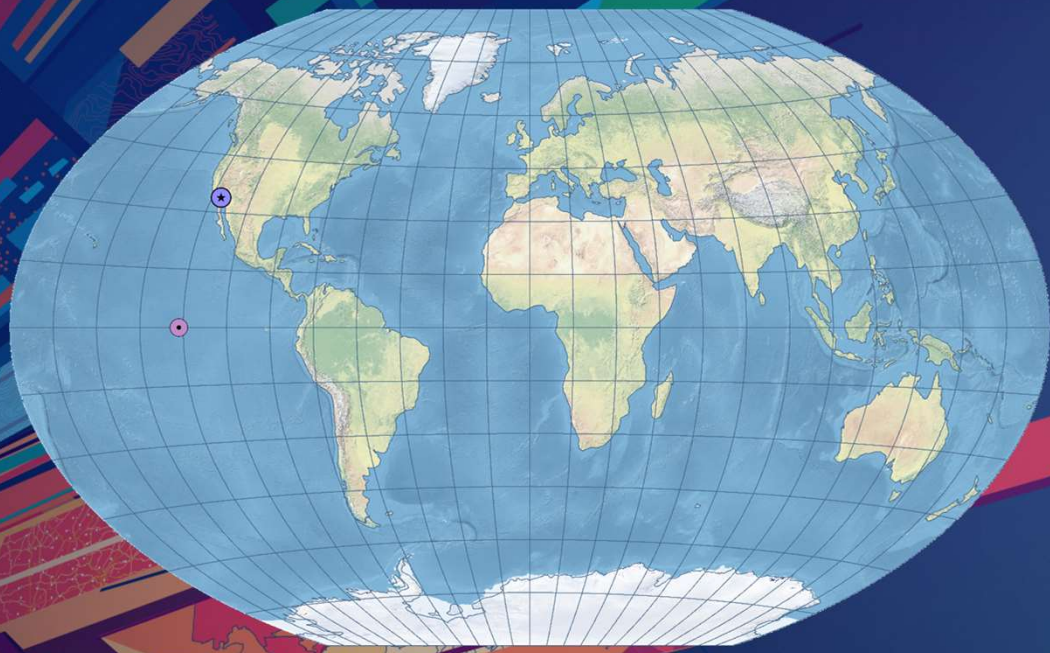
What if the coordinate system is unknown?

- Check the data provider or source
- Check any existing metadata
- What coordinate systems are used in the area?
 - <http://www.epsg-registry.org>
- Try using ArcMap to figure it out
 - <http://esriurl.com/11518>
 - *HowTo: Identify an unknown coordinate system using ArcMap*
- *Lining Up Data in ArcGIS, Margaret Maher*

Familiarize Yourself with Common Systems

- Know what ones are used in the area
- Learn what the layer extents should be

NAD 1983	X / longitude	Y / latitude
Geographic	-116.67 °	33.0 °
UTM zone 11N	530,000 m	3,650,000 m
State Plane (California zone 6)	1,960,000 m	593,000 m



Where is my Data?

Solution

Resources

- Don't forget the Knowledge Base / Technical Articles!
 - <http://esriurl.com/11518>
- Esri forums for user-to-user help
 - <http://geonet.esri.com>
- <http://www.epsg.org>
 - Database of coordinate systems & datums
 - *Guidance Note 7-2*

- Lining Up Data in ArcGIS, *Margaret Maher*



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

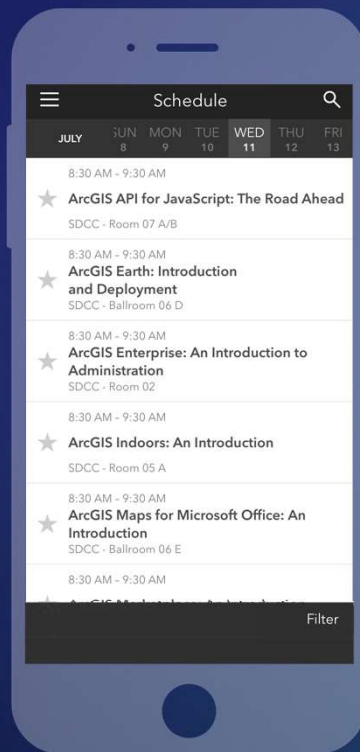
WORKSHOP	LOCATION	TIME FRAME
<ul style="list-style-type: none">• Geographic (datum) and Vertical Transformations: A Deep Dive• Coordinate Systems and Datum Transformations in ArcGIS• Coordinate System Standards	<ul style="list-style-type: none">• Room 17 B• Room 05 B• Esri Showcase: Spotlight Theater	<ul style="list-style-type: none">• Today, 4:00 – 5:00 pm• Tomorrow, 10:00 – 11:00 am• Tomorrow, 12:15 – 12:35 pm
<ul style="list-style-type: none">• What's New in High Accuracy GNSS Data Collection, from Eos Positioning Systems• Collector for ArcGIS: Working with High Accuracy Data	<ul style="list-style-type: none">• Room 30 A• Ballroom 06 D	<ul style="list-style-type: none">• Tomorrow, 11:30 – 12:30 pm• Tomorrow, 4:00 – 5:00 pm

Please Take Our Survey on the App

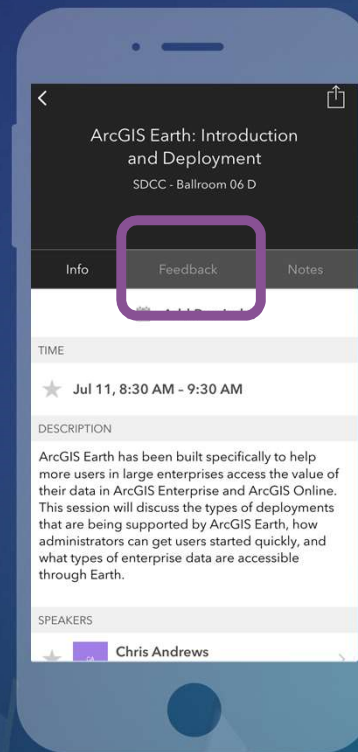
Download the Esri Events app and find your event



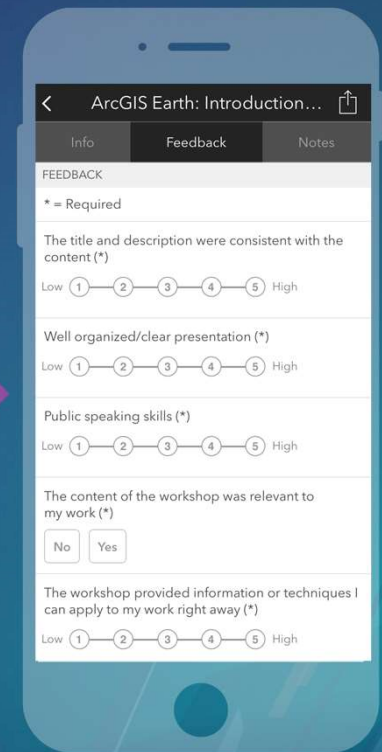
Select the session you attended



Scroll down to find the feedback section



Complete answers and select "Submit"





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THE
SCIENCE
OF
WHERE