2019

Unit 5

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UMassAmherst

GPS and Friends

Forrest J. Bowlick, Intro GIS

UMASS – Amherst, Fall 2018

Overview

- Reviewing Projections and Datums
  - Frustrations within the ArcMap Universe
  - How to overcome
  - Some surveys
- Global Positioning Function and Theory
- GIS Potpourri

Projecting

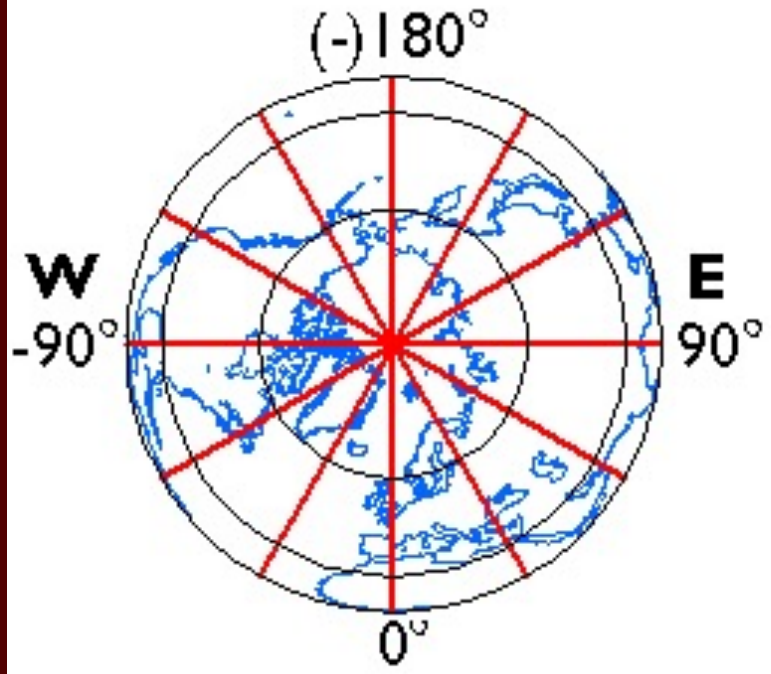
- Tx.ag/GIS5
- Anonymous
- 5 questions concerning the lab activity and this week's content

Talking ‘bout the Practical

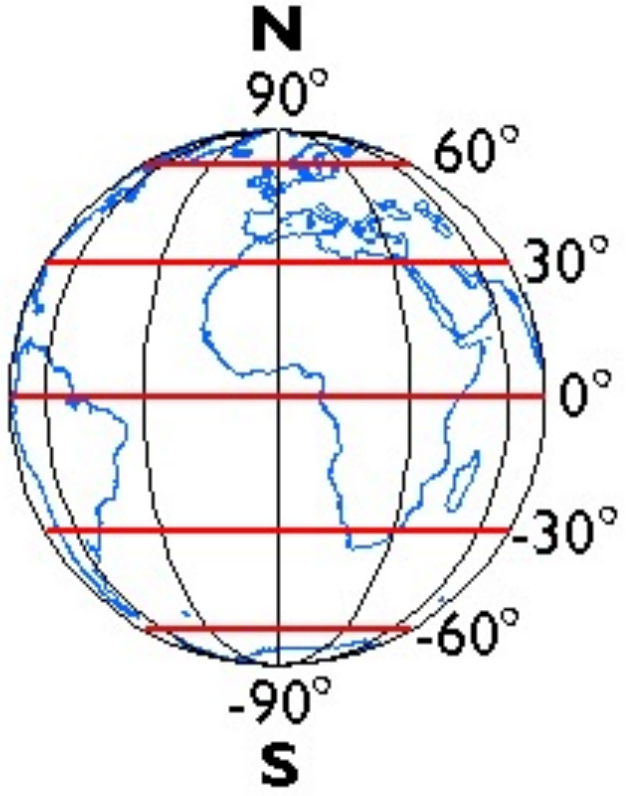
- Practical is next week!
- Held during lab time.
- You will have three hours to complete the practical, which is mostly GIS problem solving.

Review

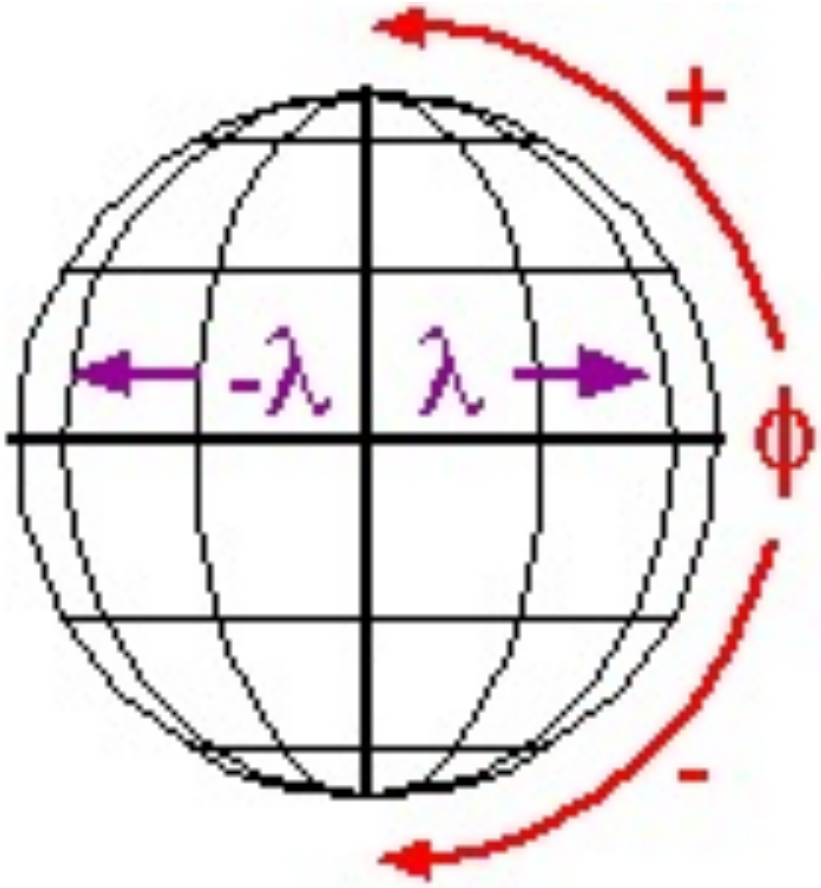
The Earth is Not Flat



Longitude



Latitude



Breaking News: Kyrie Apologizes

Kyrie Irving Is Sorry For Ironically(?) Perpetuating The Flat Earth Theory

Samer Kalaf
Monday 6:31pm • Filed to: HATE WHEN THAT HAPPENS

56.5K 69 1

SBNATION

BLOGS VIDEO NFL NBA WNBA MLB CFB SOCCER UFC GOLF NHL CBB STORE STUBHUB MORE

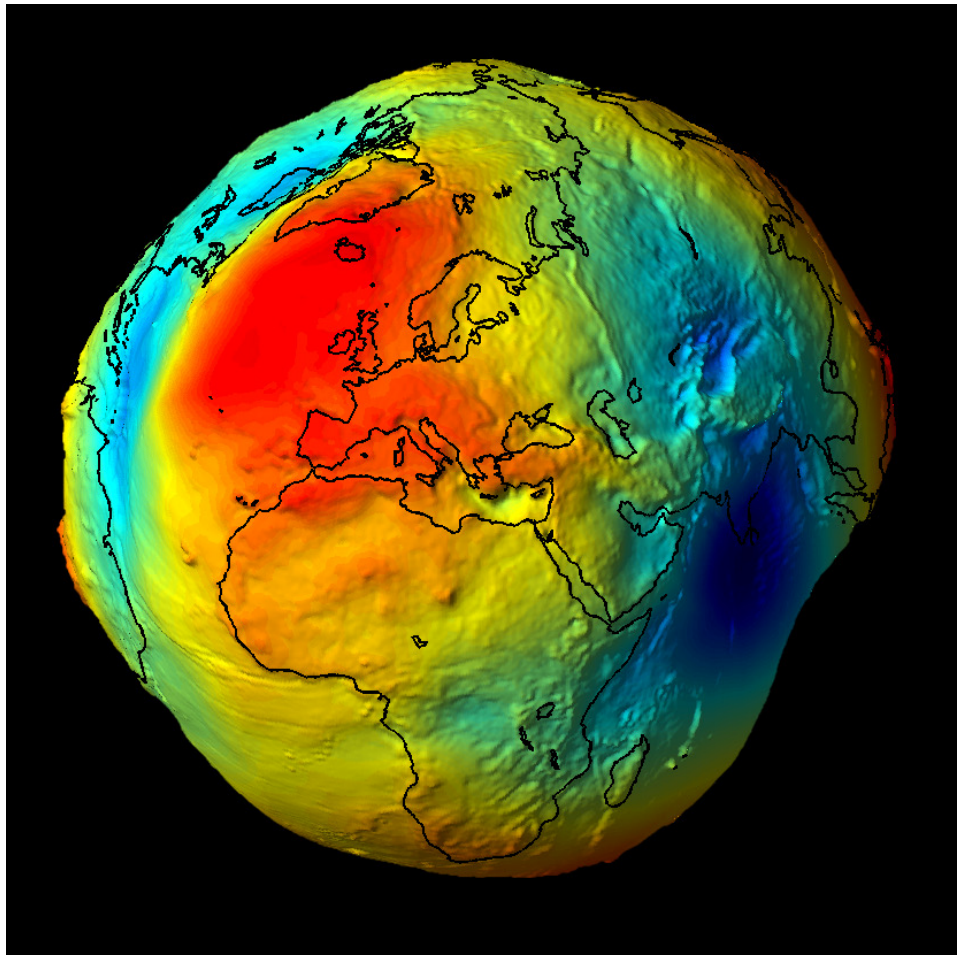
TODAY'S NBA NEWS NBA

Kyrie Irving apologizes to science teachers for spreading flat earth theories

Irving says he was in a conspiracy theory mindset and went down a rabbit hole. It happens.

By Kristian Winfield | @Krisplashed | Oct 1, 2018, 5:56pm EDT

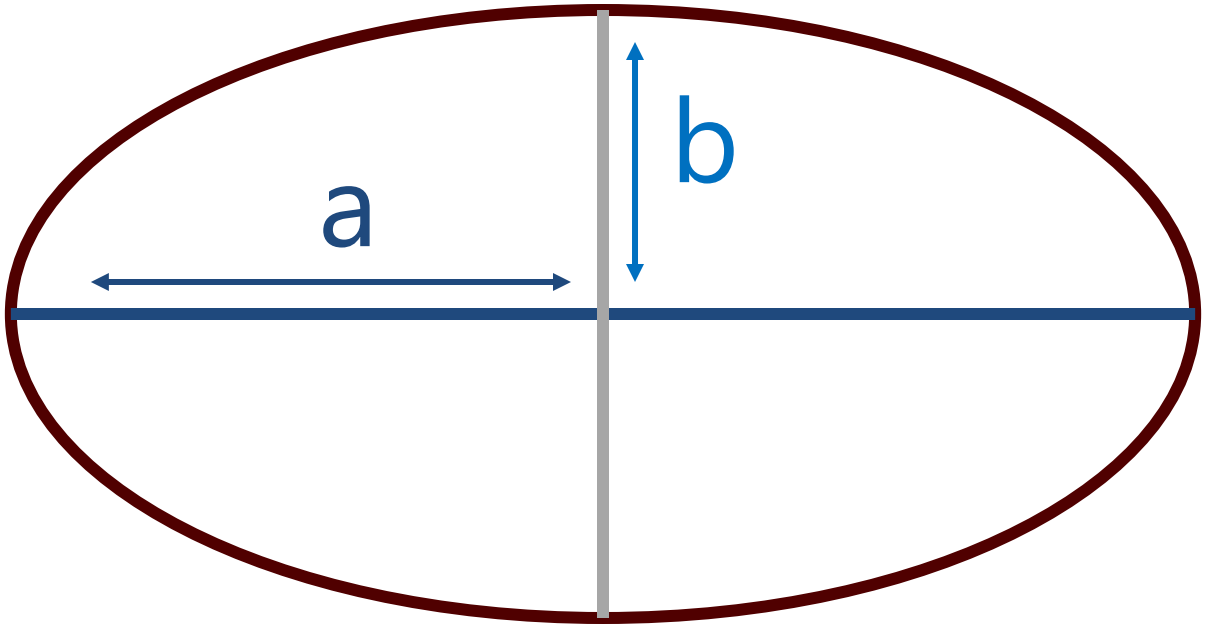
Geoid



http://en.es-static.us/upl/2011/04/geoid_bumpy.jpg

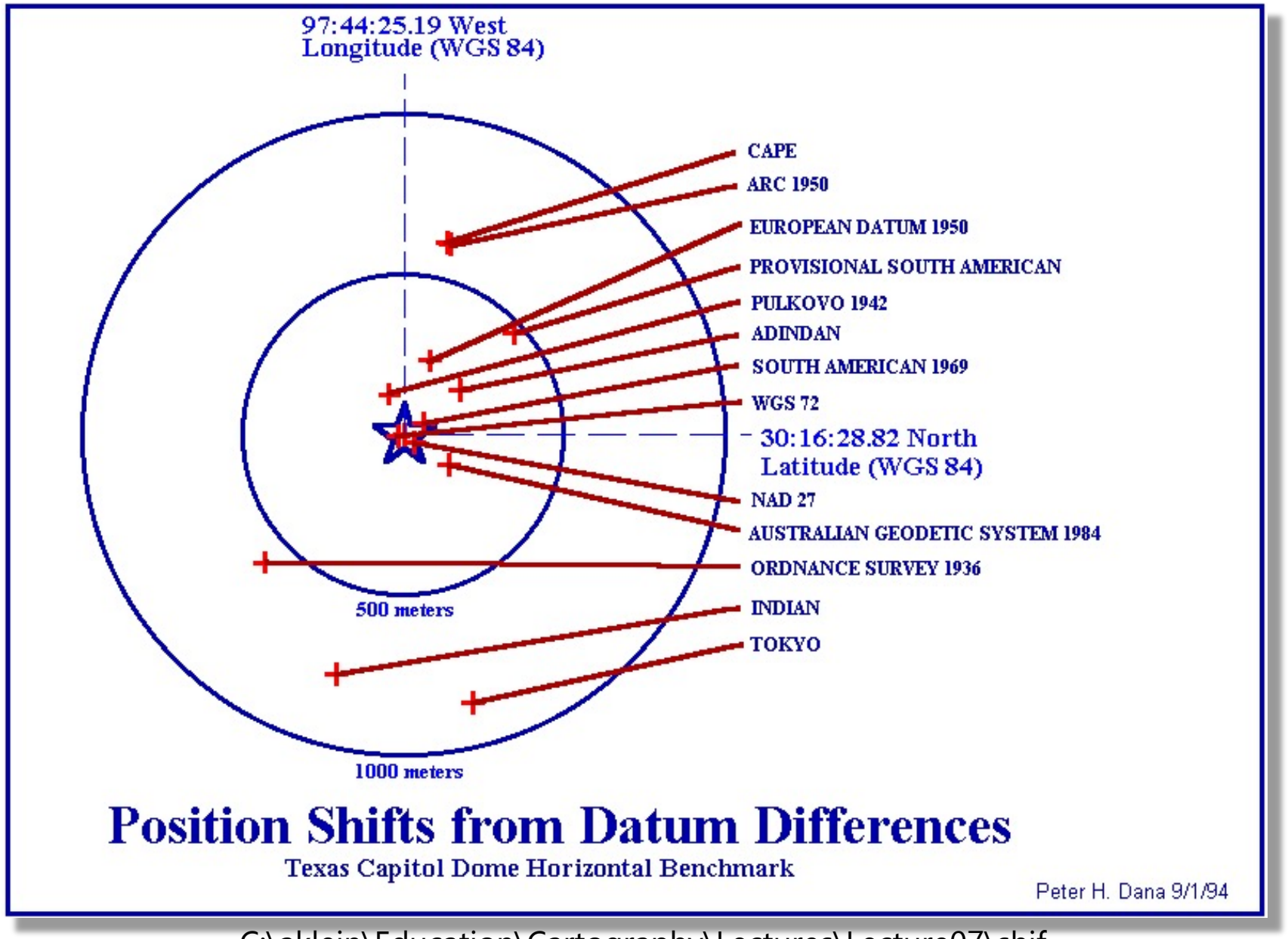
- Shape is called an oblate spheroid
- True shape of the Earth

The Ellipsoid



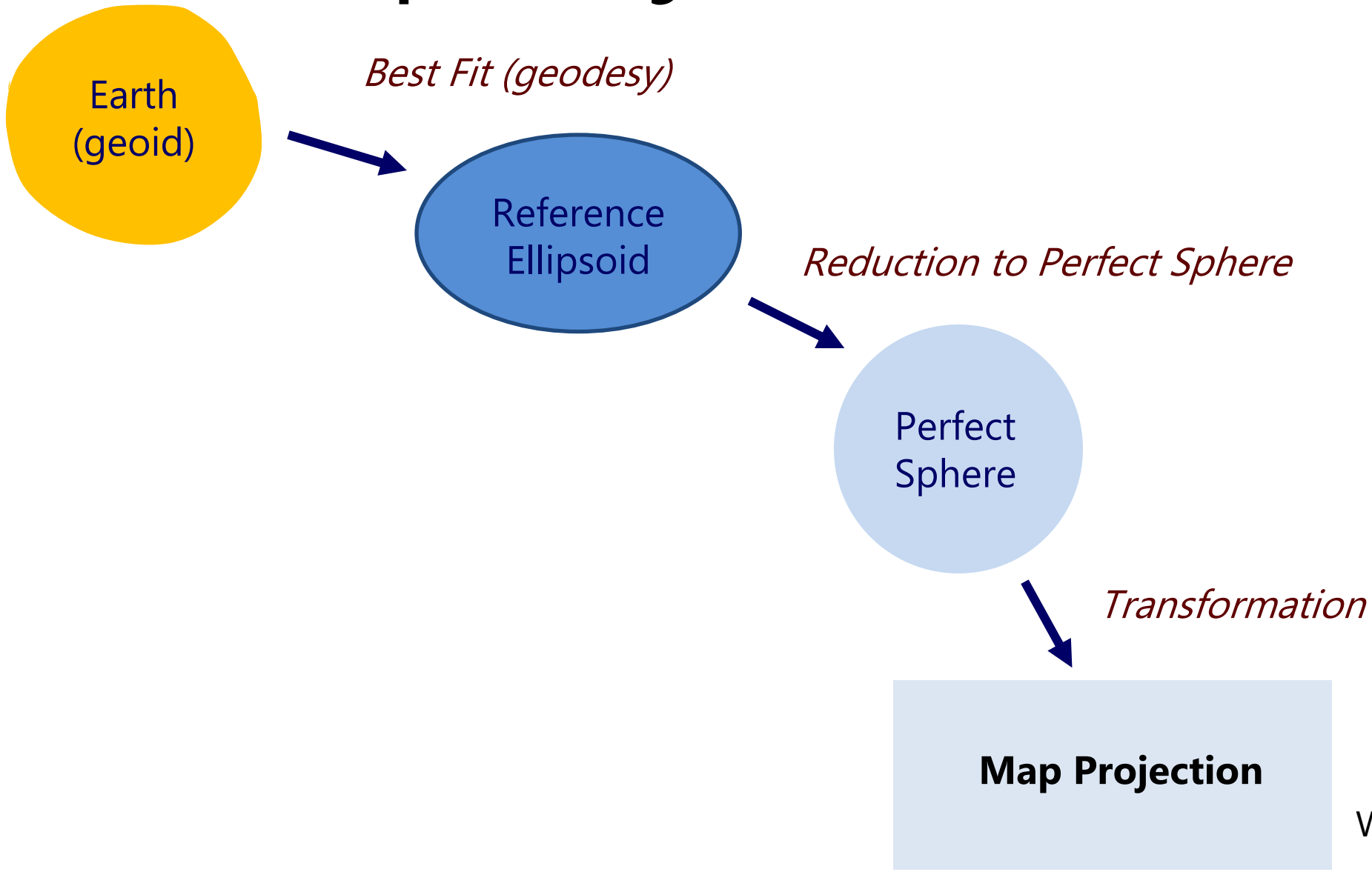
a - semi major axis (equatorial radius)
b - semi minor axis (parallel to the rotation axis)
f = (a-b)/a or flattening

Does it Make a Difference?



C:\aklein\Education\Cartography\Lectures\Lecture07\shif

The Map Projection Process



Workflow by A. Klein

Properties of a Globe

The Globe Preserves:

Area

Shape

Distance

Direction

Maps Can Be:

Equal Area

Conformal

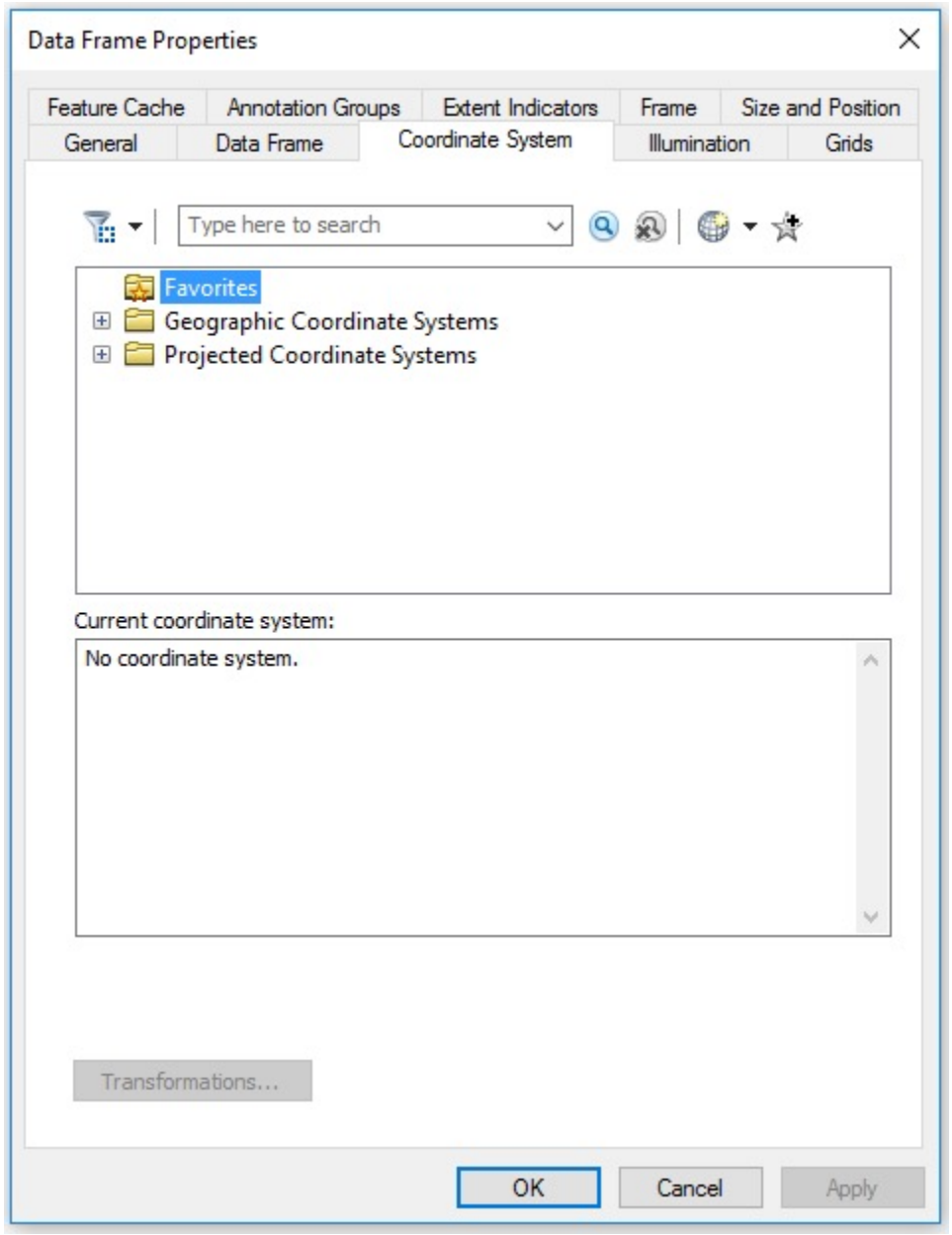
Equidistant

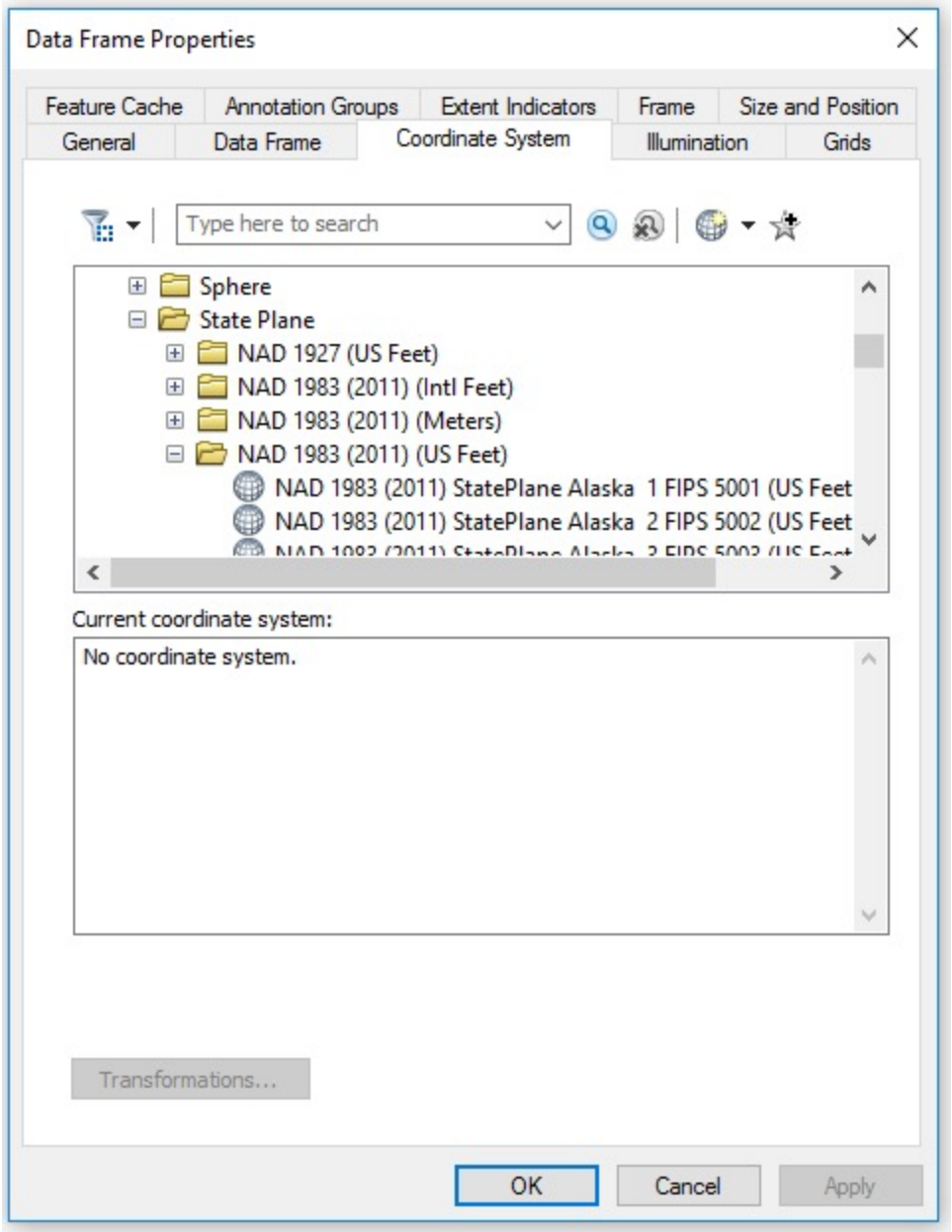
Azimuthal

https://play.kahoot.it/#/k/1f48b7e2-c152-4548-aeb4-76e1131700b8

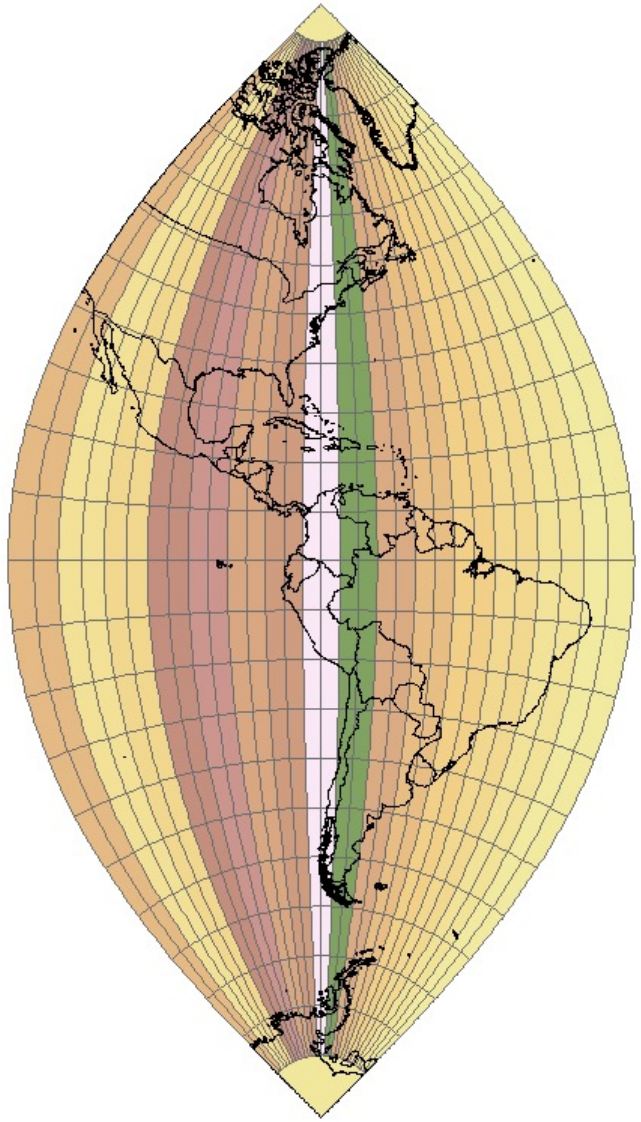
Why are Projections so _ in ArcMap?

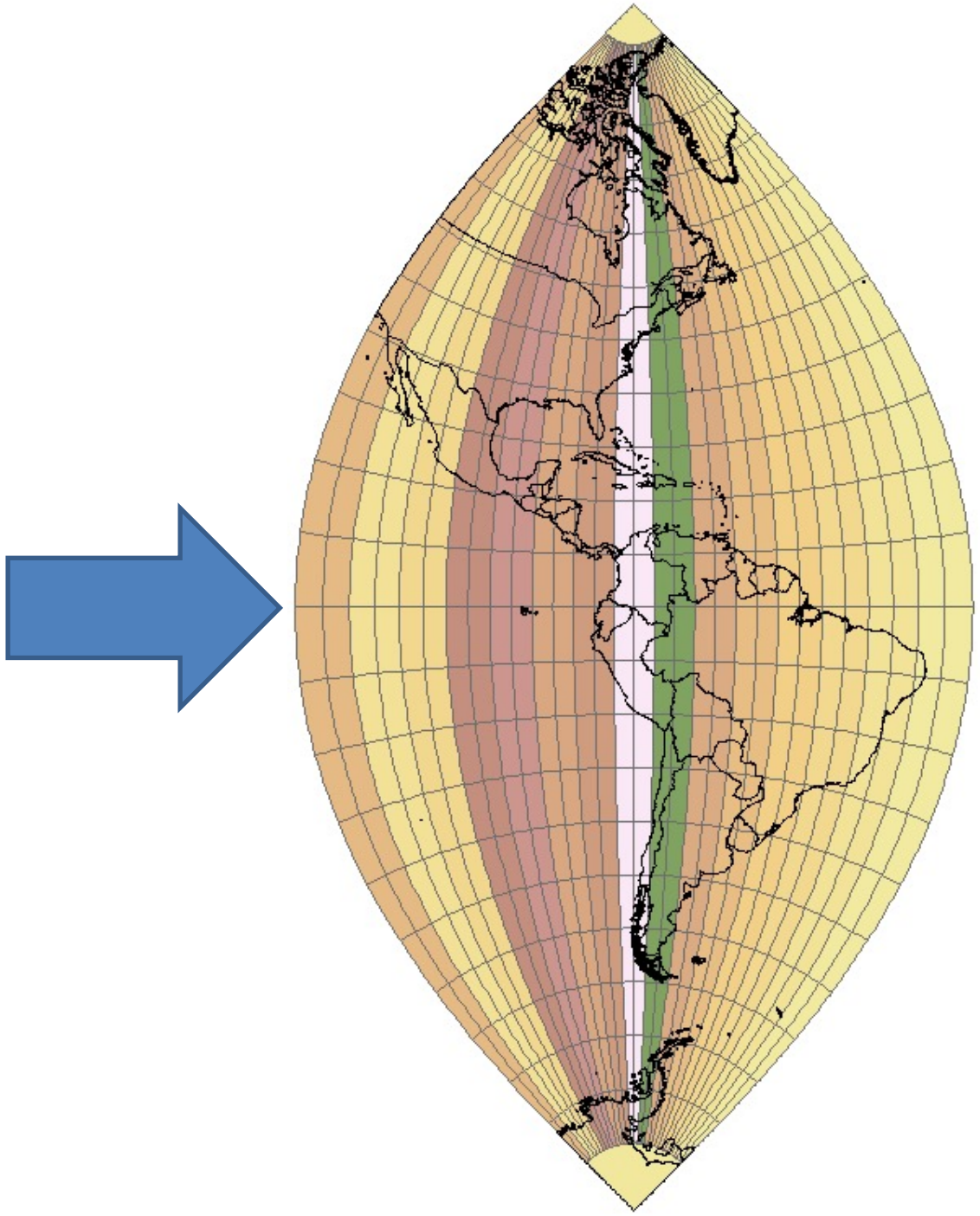
- There are over 6,000 projections loaded into ArcMap
  - Plus you can define your own!
- Each of them has their own uses.
- Navigate smart!

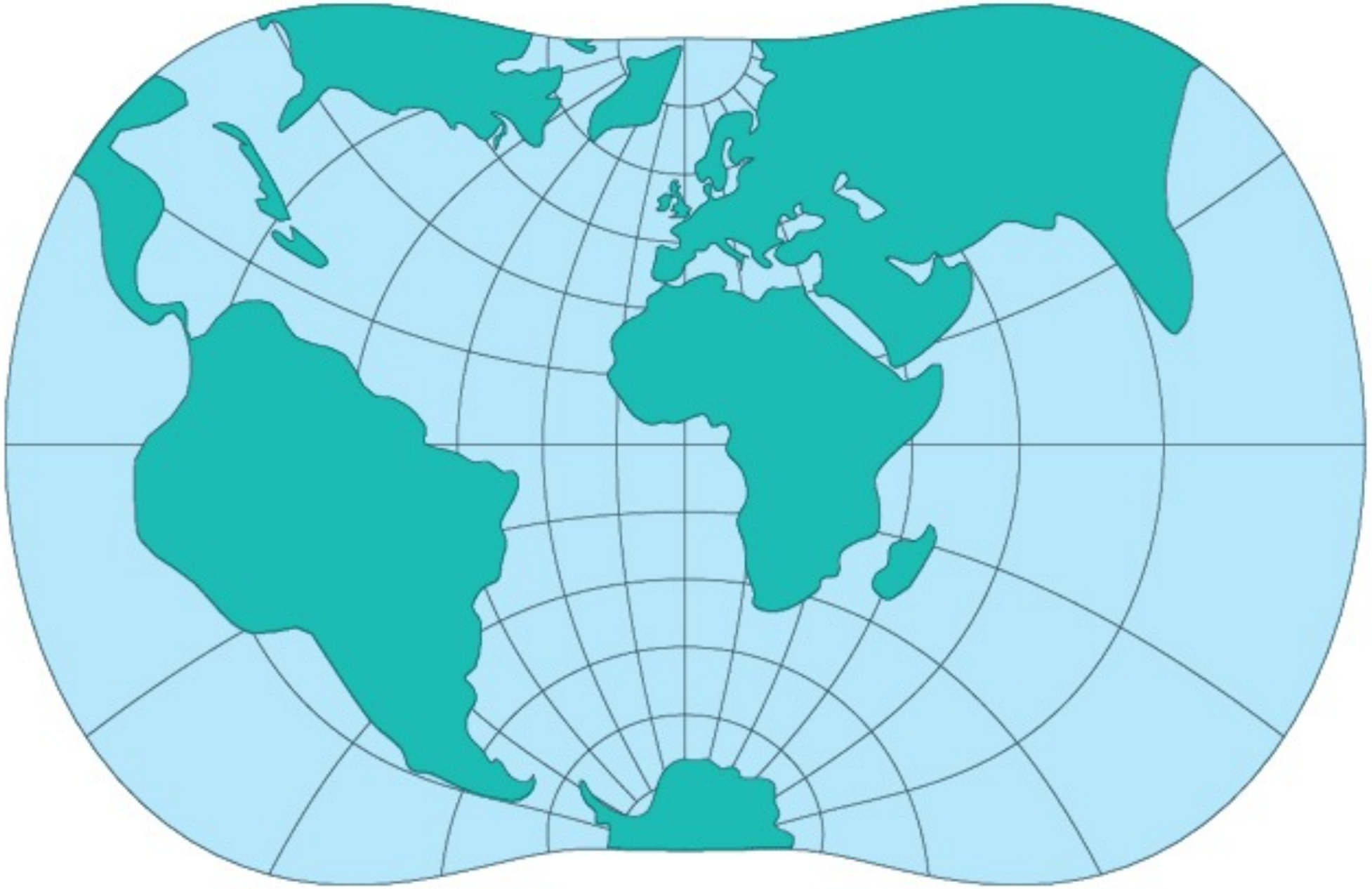

Data Frame Properties
Feature Cache
Annotation Groups
Extent Indicators
Frame
Size and Position
General
Data Frame
Coordinate System
Illumination
Grids
Type here to search
Favorites
Geographic Coordinate Systems
Projected Coordinate Systems
Current coordinate system:
No coordinate system.
Transformations...
OK
Cancel
Apply


Data Frame Properties
Feature Cache
Annotation Groups
Extent Indicators
Frame
Size and Position
General
Data Frame
Coordinate System
Illumination
Grids
Type here to search
Sphere
State Plane
NAD 1927 (US Feet)
NAD 1983 (2011) (Intl Feet)
NAD 1983 (2011) (Meters)
NAD 1983 (2011) (US Feet)
NAD 1983 (2011) StatePlane Alaska 1 FIPS 5001 (US Feet
NAD 1983 (2011) StatePlane Alaska 2 FIPS 5002 (US Feet
Current coordinate system:
No coordinate system.
Transformations...
OK
Cancel
Apply

What is Happening







Questions?

Location

- We can describe location in two ways: Relative and Absolute.
- Relative location requires some understanding of distance or relation.
- Absolute location requires precise understanding of some measurement technique.

Relative Location

- Relative location positions you in relation to another object.
- In this example, we can say that Hawaii is south of Alaska.

USA_orthographic.svg.png

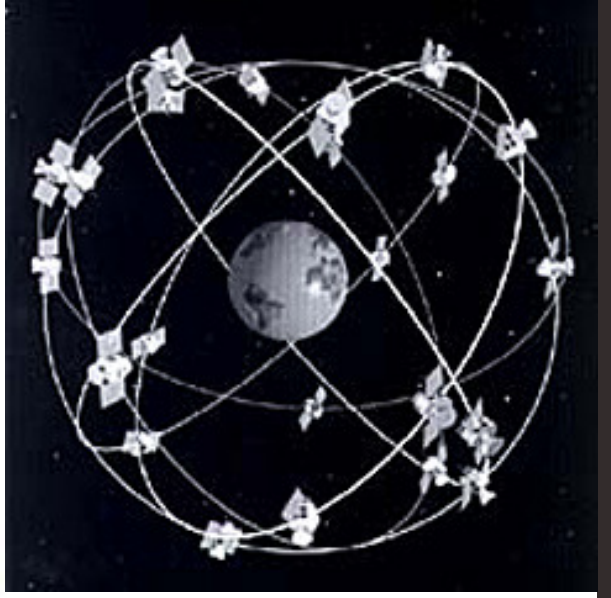
Absolute Location

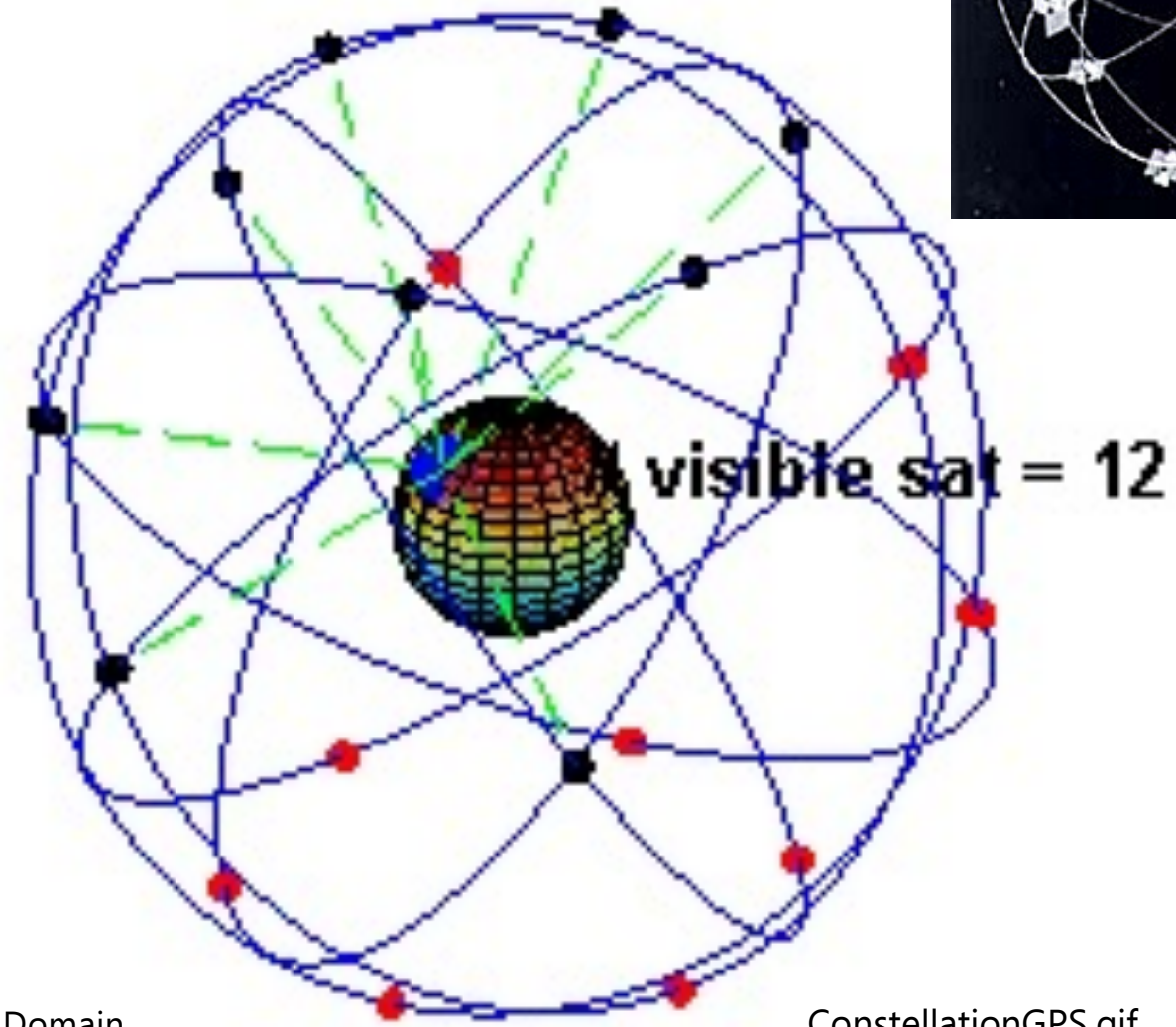
Absolute locations references some standardized grid or location system, like latitude and longitude along with a datum, like the World Geodetic System.

1-Mini-GPS-ured-point-5-kafepauza.jpg More info here.

GPS

The global positioning system allows us to know our absolute location, with reasonable accuracy, anywhere on the planet.



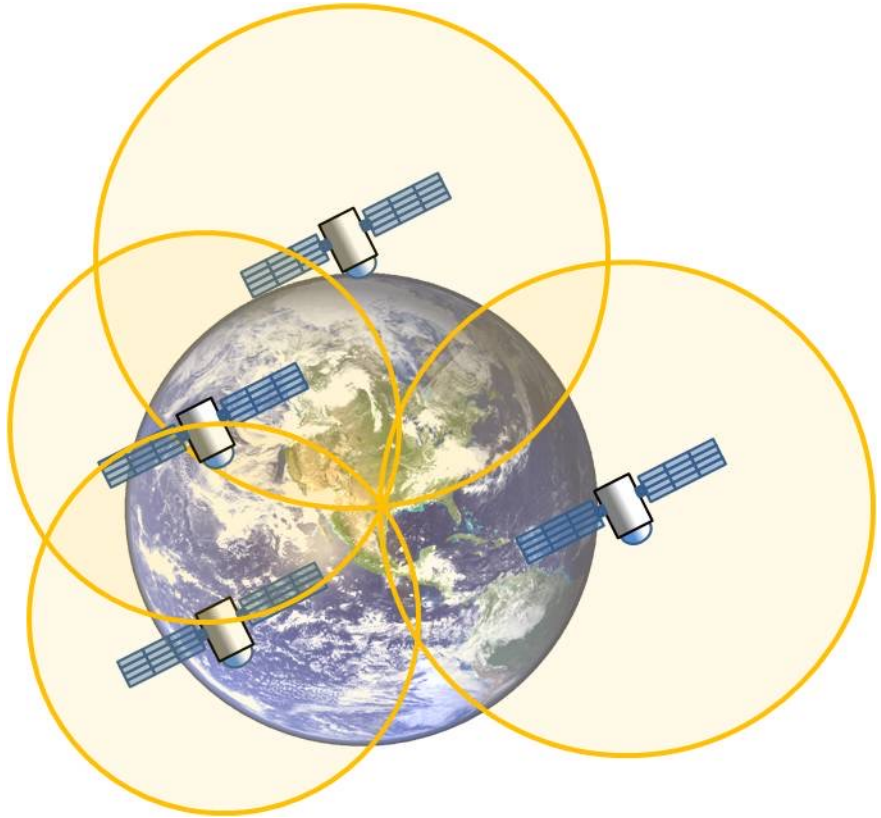


Top right, from NOAA, Center, from El Pak. Both Public Domain.

ConstellationGPS.gif

GPS II

- Consider imaginary spheres centered on each GPS satellite.
- GPS receiver uses time and speed (of light) to calculate distance to satellite.

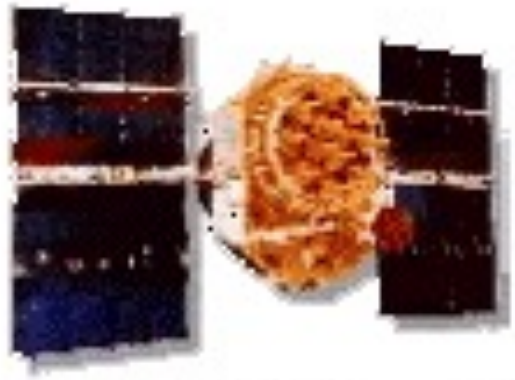


3dtriangulation.jpg Adapted from Quiring 2012, pp.

GPS III

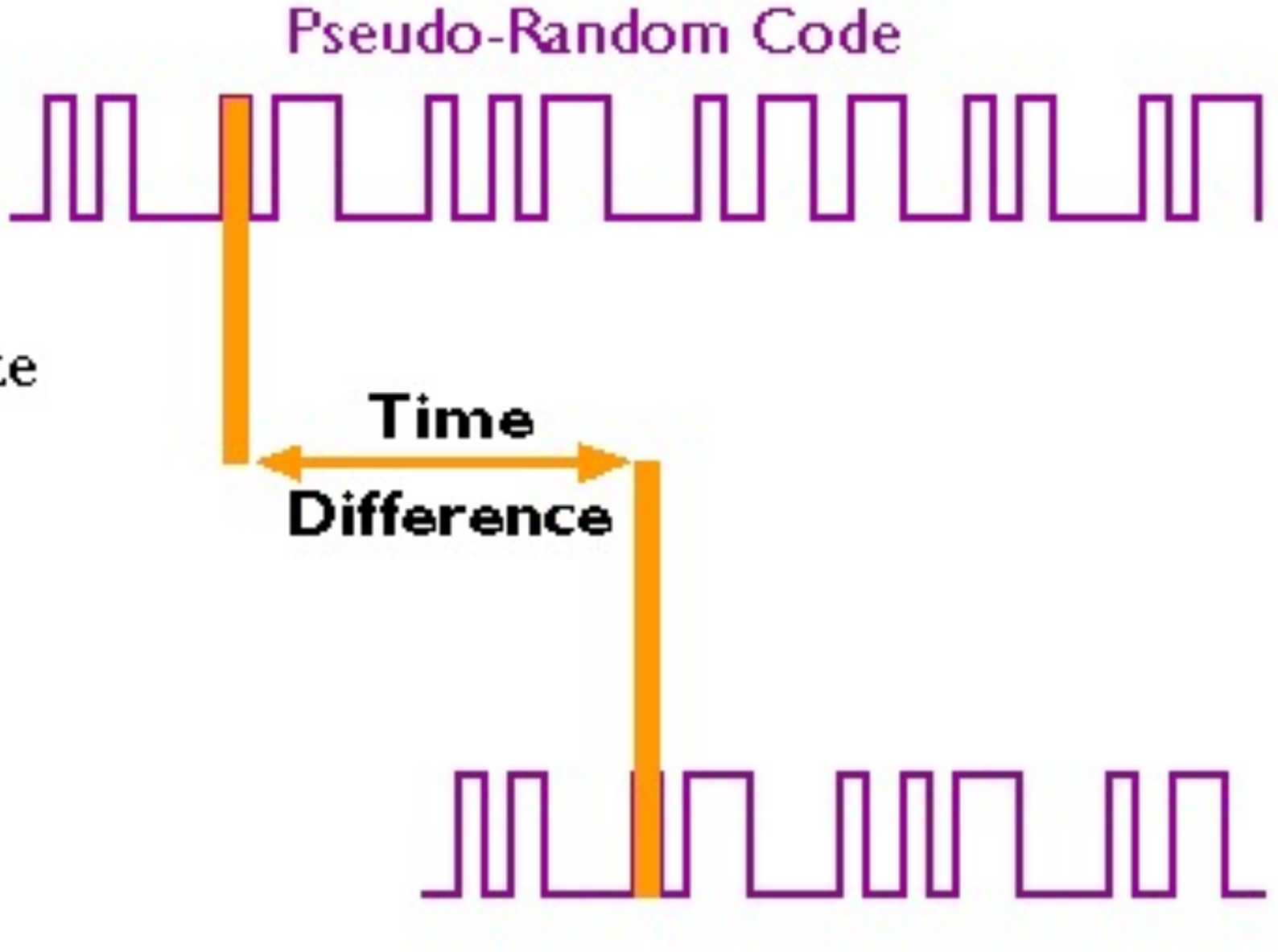
http://en.wikipedia.org/wiki/File:GPS_Satellite_NASA_art-iif.jpg

- All electromagnetic radiation (radio waves to x-rays) travel at speed of light (300,000,000 meters/second).
- GPS systems use radio waves to transmit information.



NAVSTAR Satellite Transmitter

GPS Receiver

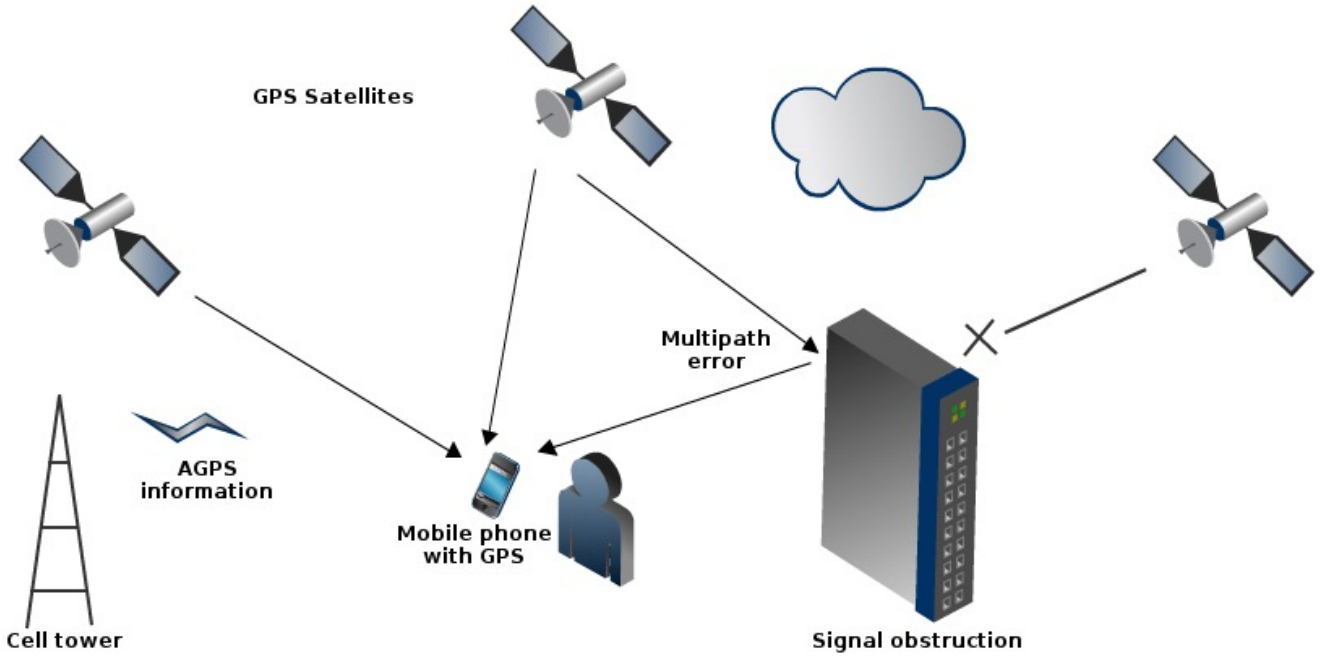


https://www.e-education.psu.edu/natureofgeoinfo/book/export/html/1796, gps_time_difference.gif

GPS V

GPS radio signal can be affected by many factors, including:

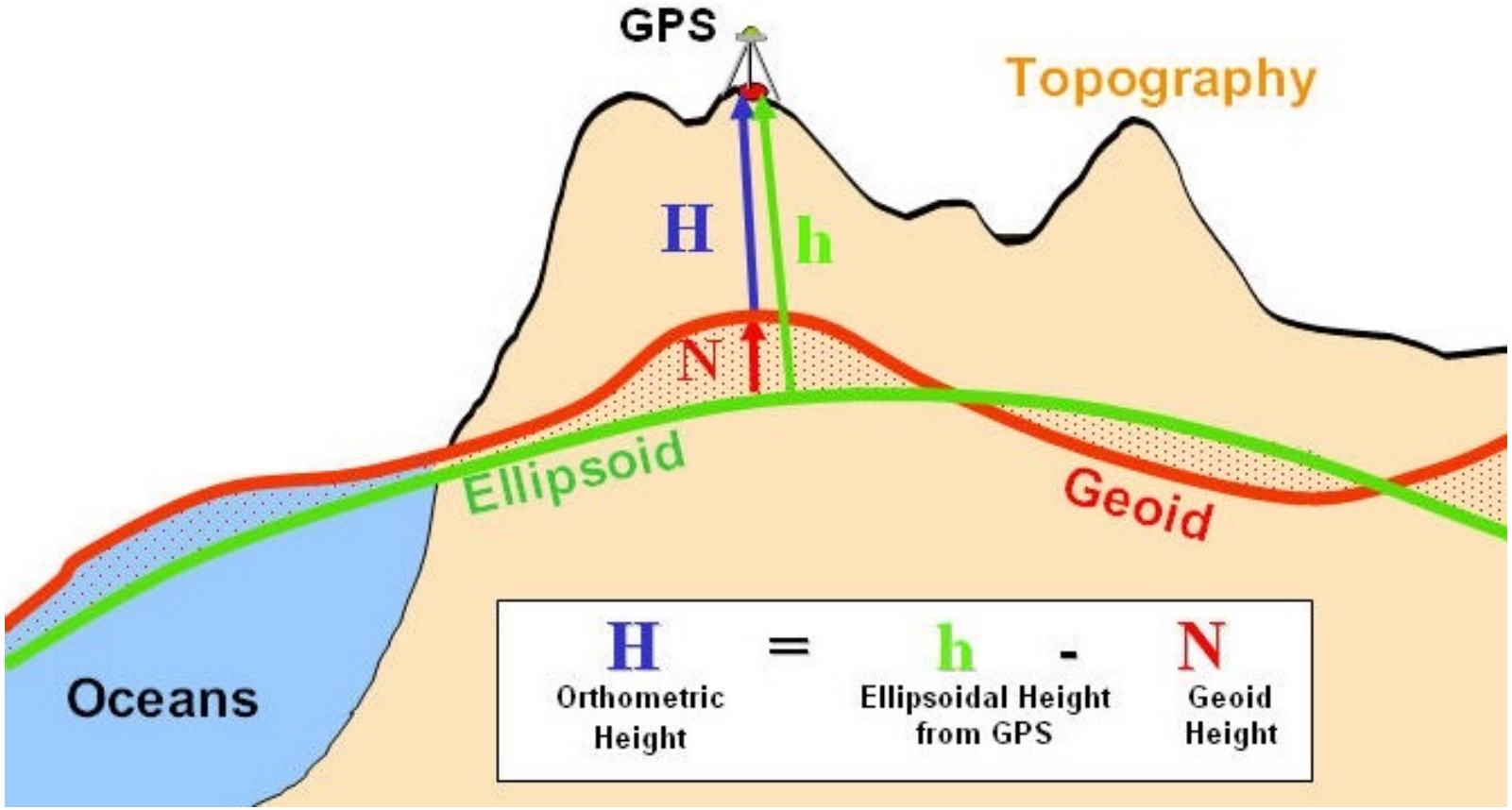
- Clouds or other atmospheric conditions.
- Proximity to buildings and other structures, and even water.
- Terrain features like mountains.
- Earth's rotation.
- Current satellite configuration.



https://strava.zendesk.com/entries/21443922-why-is-gps-data-sometimes-inaccurate

GPS Issues

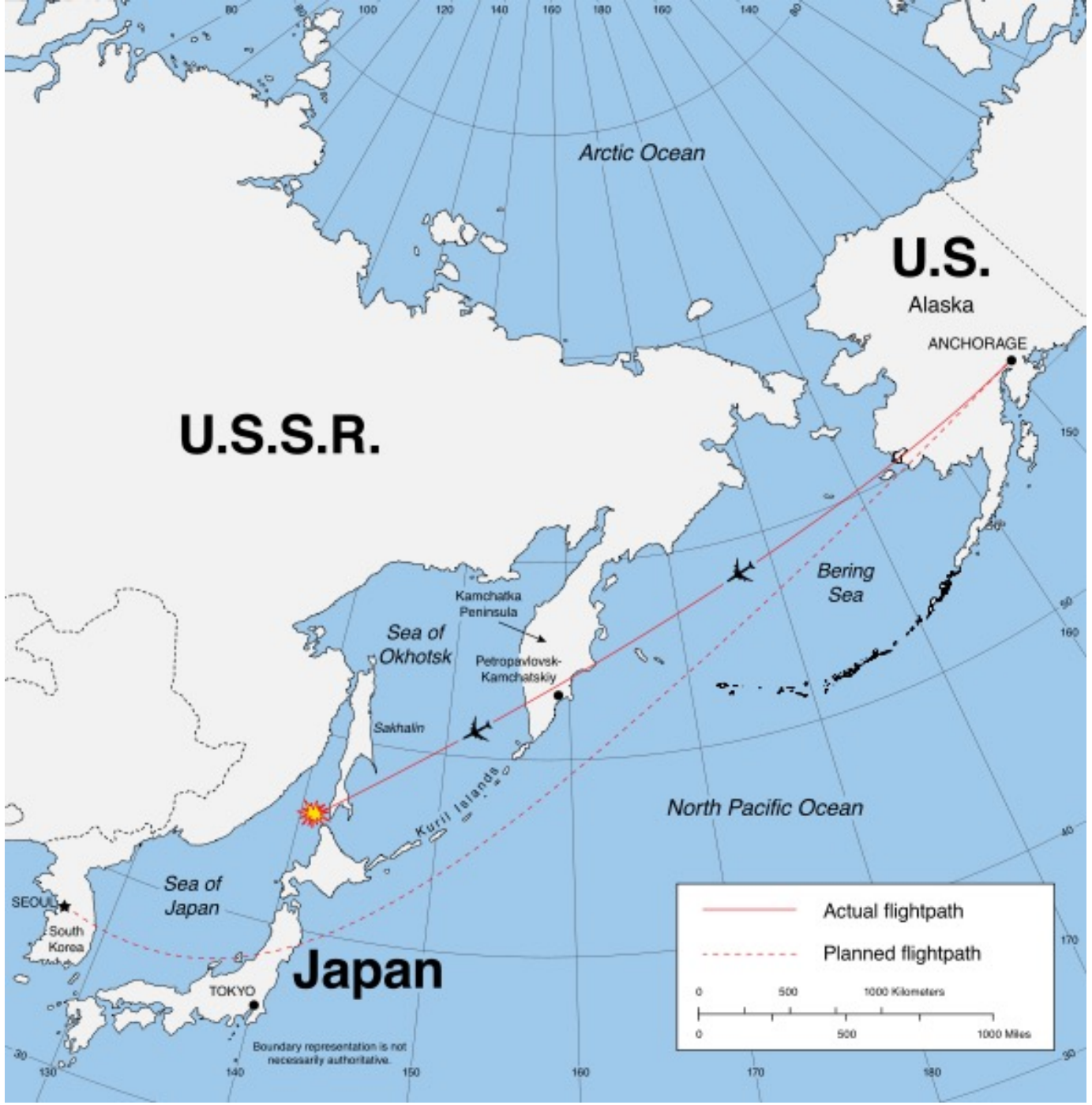
Despite the general reliability of GPS, it is not a perfect system. Atmospheric and physical features distort and confuse the GPS signal, while the shape of the planet is also a difficulty.



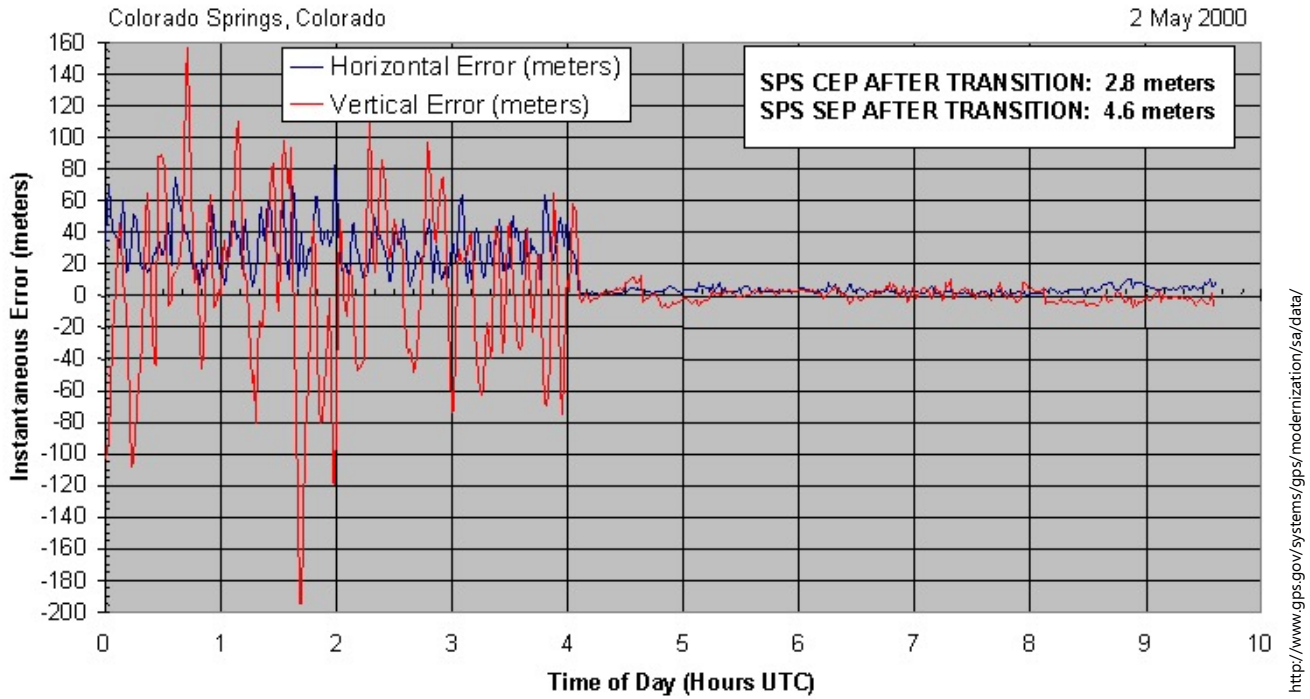
geoid-ellipsoidal-orthometric_height.jpg

From: University of

- On September 1, 1983, navigational errors cause KAL 007 to stray into prohibited Soviet airspace.
- Soviet MiG-23 interceptors shoot down KAL 007, killing all 269 people aboard.
- President Ronald Reagan orders U.S. military to make GPS system available for civilian use.



KAL007.png http://en.wikipedia.org/wiki/File:KAL007.svg



- May 2, 2000: President Clinton orders U.S. military to cease intentional scrambling of GPS satellite signals used by civilians.

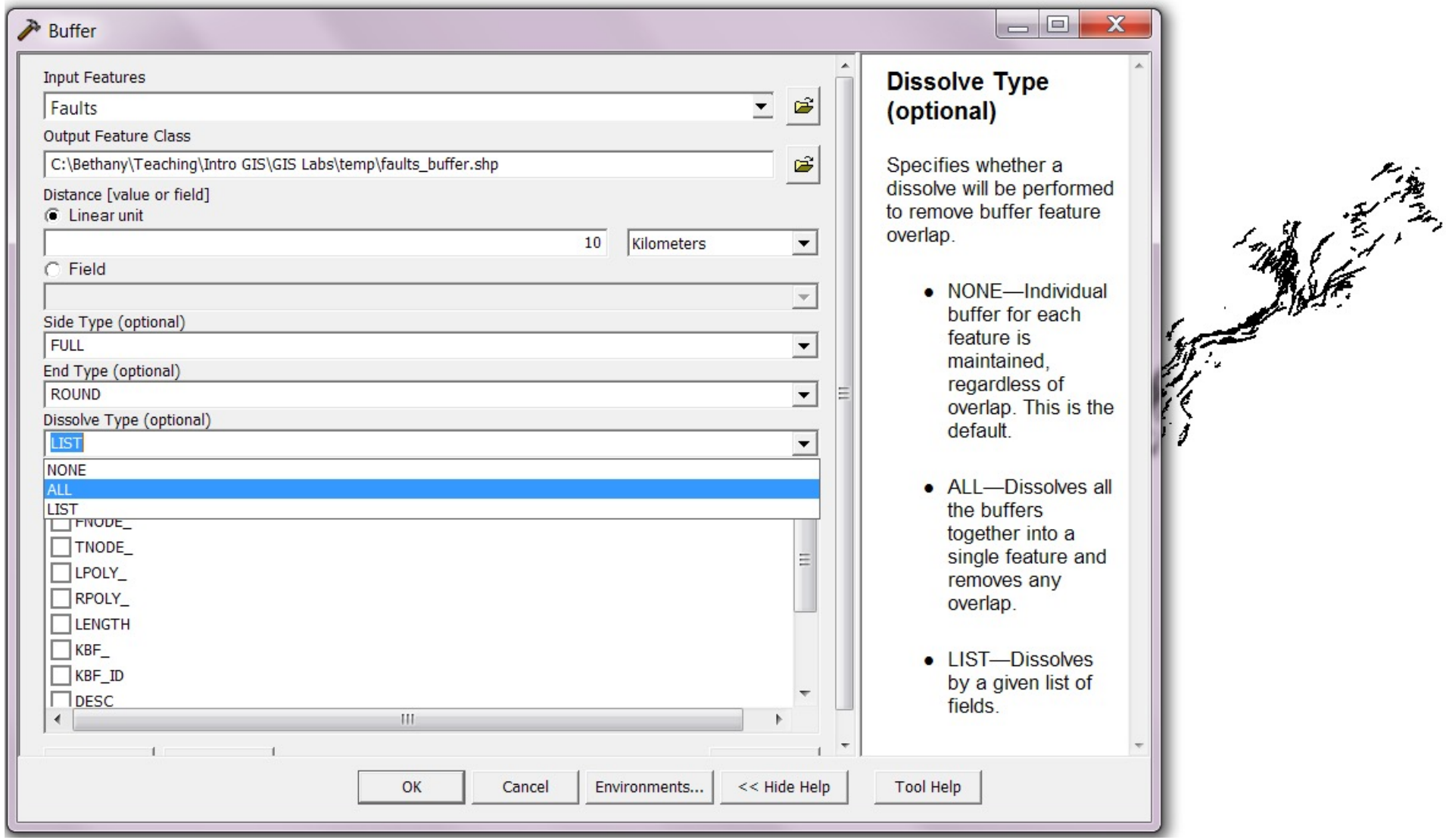
- Effectively improved GPS receiver accuracy by 10x.

Questions?

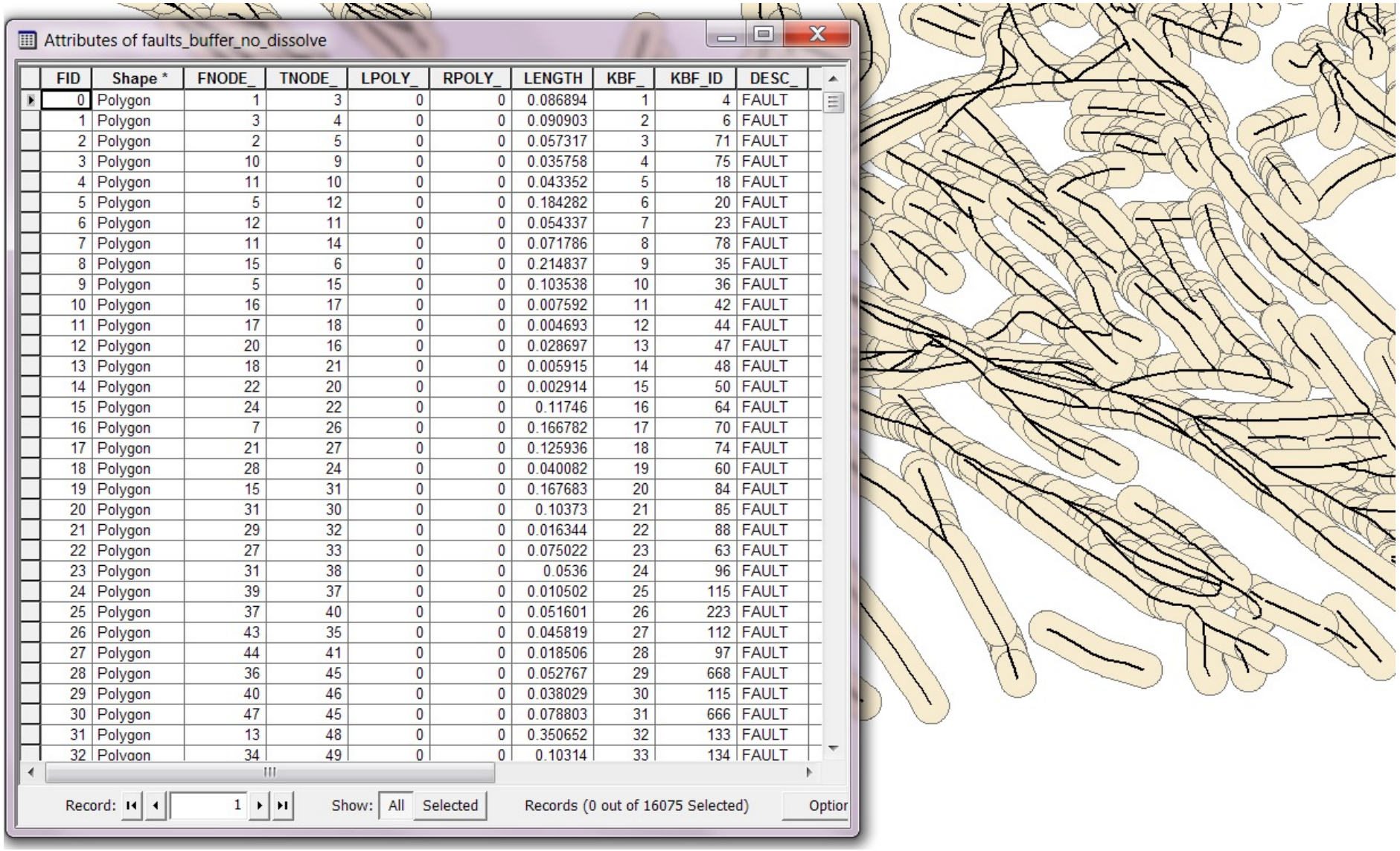
POTPOURRI

Dissolve

Dissolve II


Buffer
Input Features
Faults
Output Feature Class
C:\Bethany\Teaching\Intro GIS\GIS Labs\temp\faults_buffer.shp
Distance [value or field]
Linear unit
10
Kilometers
Field
Side Type (optional)
FULL
End Type (optional)
ROUND
Dissolve Type (optional)
LIST
NONE
ALL
LIST
TNODE_
LPOLY_
RPOLY_
LENGTH
KBF_
KBF_ID
DESC
OK
Cancel
Environments...
<< Hide Help
Tool Help
Dissolve Type (optional)
Specifies whether a dissolve will be performed to remove buffer feature overlap.
NONE—Individual buffer for each feature is maintained, regardless of overlap. This is the default.
ALL—Dissolves all the buffers together into a single feature and removes any overlap.
LIST—Dissolves by a given list of fields.

Dissolve III



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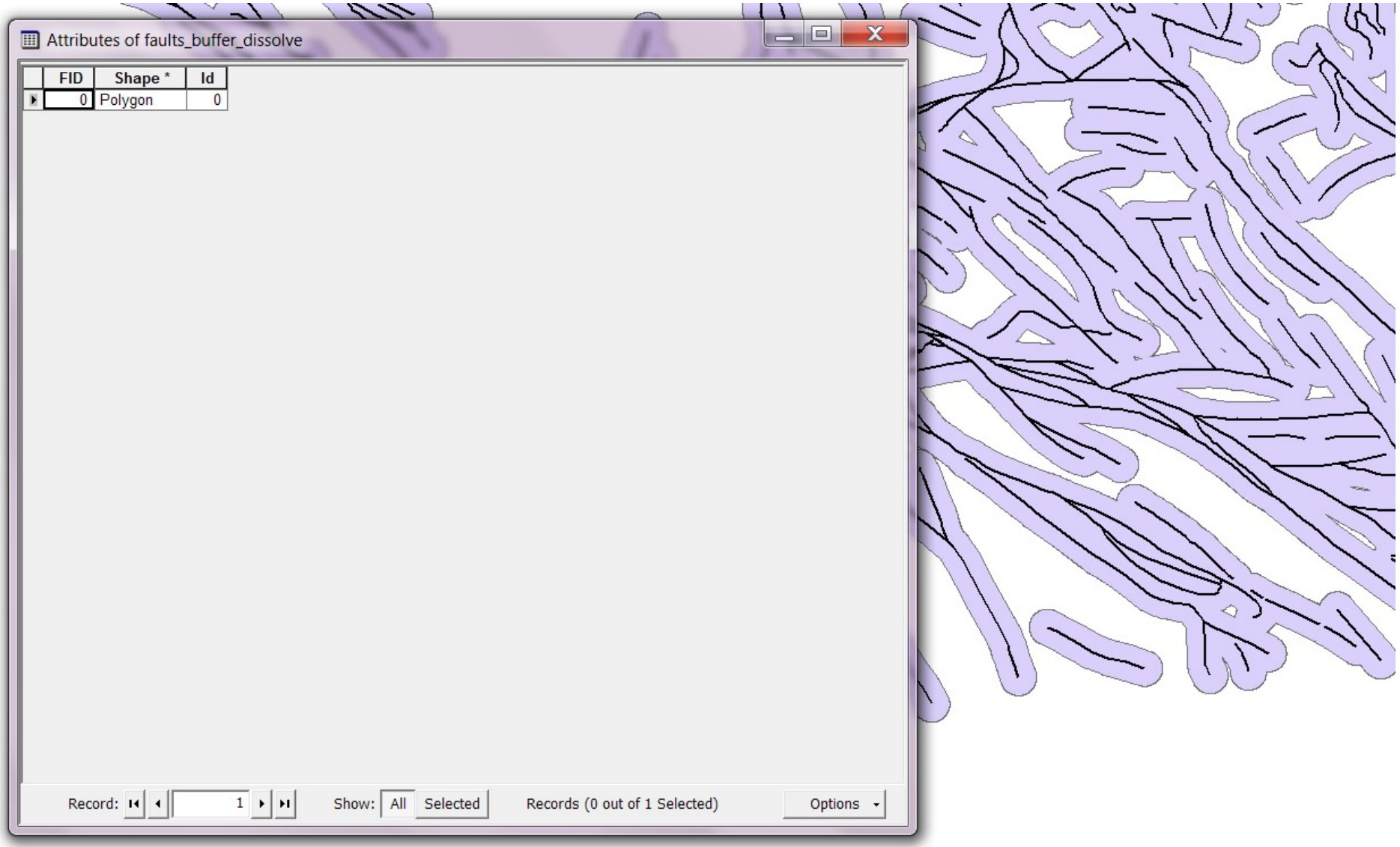
1	Polygon	3	4	0	0	0.090903	2	6	FAULT
2	Polygon	2	5	0	0	0.057317	3	71	FAULT
3	Polygon	10	9	0	0	0.035758	4	75	FAULT
4	Polygon	11	10	0	0	0.043352	5	18	FAULT
5	Polygon	5	12	0	0	0.184282	6	20	FAULT
6	Polygon	12	11	0	0	0.054337	7	23	FAULT
7	Polygon	11	14	0	0	0.071786	8	78	FAULT
8	Polygon	15	6	0	0	0.214837	9	35	FAULT
9	Polygon	5	15	0	0	0.103538	10	36	FAULT
10	Polygon	16	17	0	0	0.007592	11	42	FAULT
11	Polygon	17	18	0	0	0.004693	12	44	FAULT
12	Polygon	20	16	0	0	0.028697	13	47	FAULT
13	Polygon	18	21	0	0	0.005915	14	48	FAULT
14	Polygon	22	20	0	0	0.002914	15	50	FAULT
15	Polygon	24	22	0	0	0.11746	16	64	FAULT
16	Polygon	7	26	0	0	0.166782	17	70	FAULT
17	Polygon	21	27	0	0	0.125936	18	74	FAULT
18	Polygon	28	24	0	0	0.040082	19	60	FAULT
19	Polygon	15	31	0	0	0.167683	20	84	FAULT
20	Polygon	31	30	0	0	0.10373	21	85	FAULT
21	Polygon	29	32	0	0	0.016344	22	88	FAULT
22	Polygon	27	33	0	0	0.075022	23	63	FAULT
23	Polygon	31	38	0	0	0.0536	24	96	FAULT
24	Polygon	39	37	0	0	0.010502	25	115	FAULT
25	Polygon	37	40	0	0	0.051601	26	223	FAULT
26	Polygon	43	35	0	0	0.045819	27	112	FAULT
27	Polygon	44	41	0	0	0.018506	28	97	FAULT
28	Polygon	36	45	0	0	0.052767	29	668	FAULT
29	Polygon	40	46	0	0	0.038029	30	115	FAULT
30	Polygon	47	45	0	0	0.078803	31	666	FAULT
31	Polygon	13	48	0	0	0.350652	32	133	FAULT
32	Polygon	34	49	0	0	0.10314	33	134	FAULT

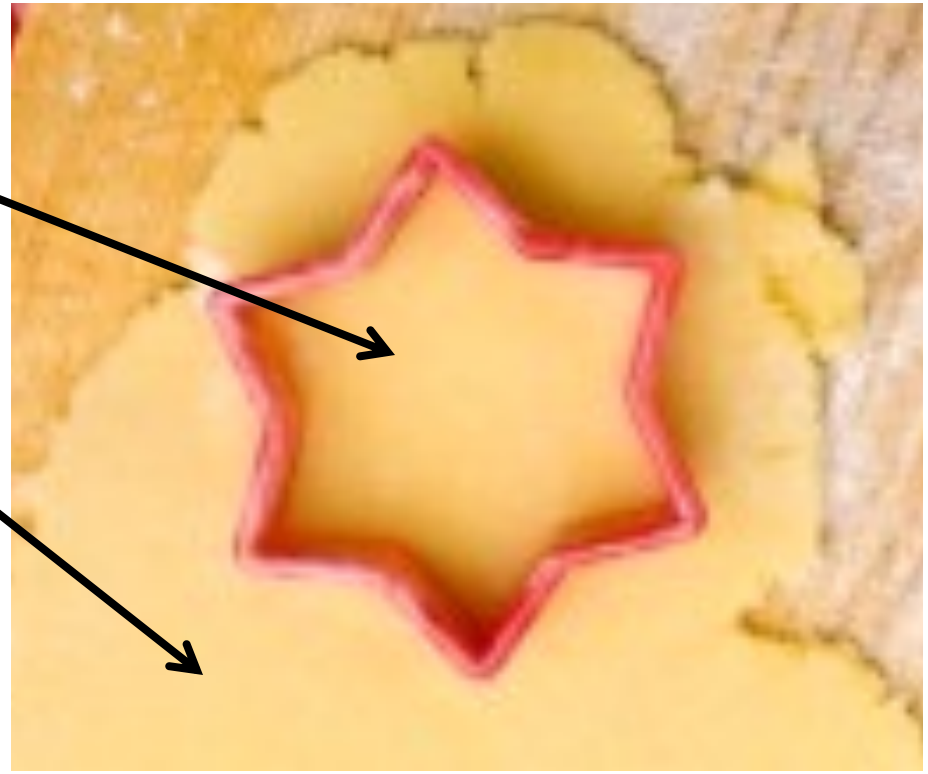
Dissolve IV


Attributes of faults_buffer_dissolve
FID
Shape *
Id
0
Polygon
0
Record:
1
Show:
All
Selected
Records (0 out of 1 Selected)
Options

Reminder – Clip & Erase

Clip keeps the info inside the shape

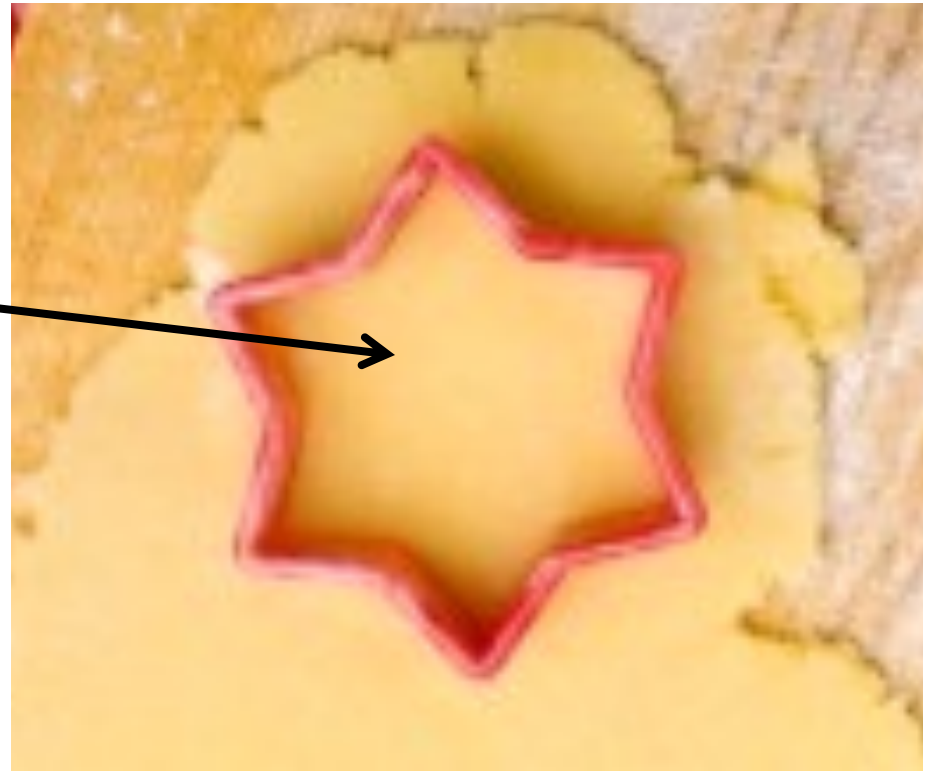
Erase keeps the info outside the shape



http://us.cdn4.123rf.com/168nwm/stylephotographs/stylephotographs1105/stylephotographs110500087/9622106-star-shaped-red-cookie-cutter-on-a-cookie-d

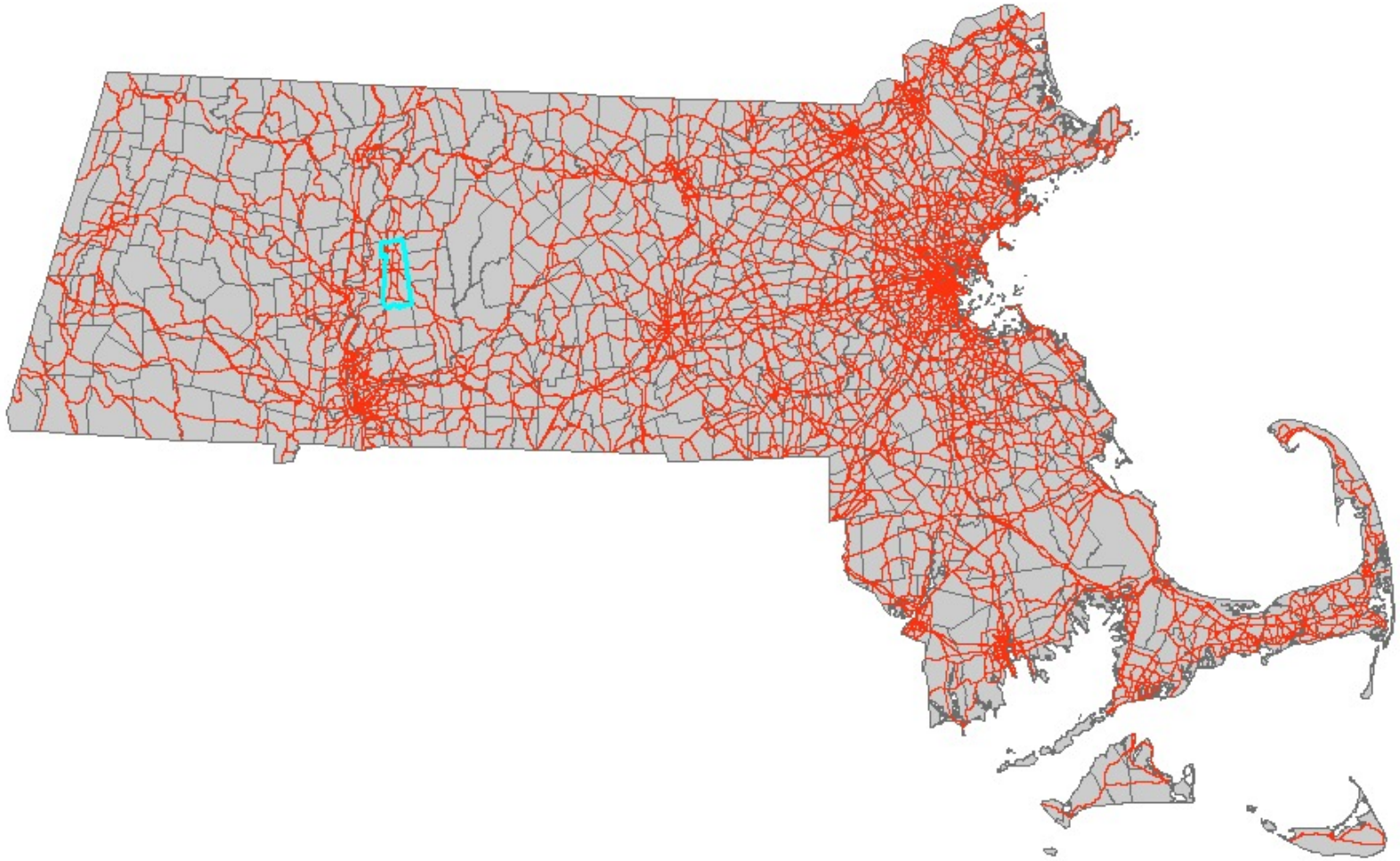
Intersect

Intersect is like a clip (you end up with the inside), except you retain the attributes from BOTH shapefiles



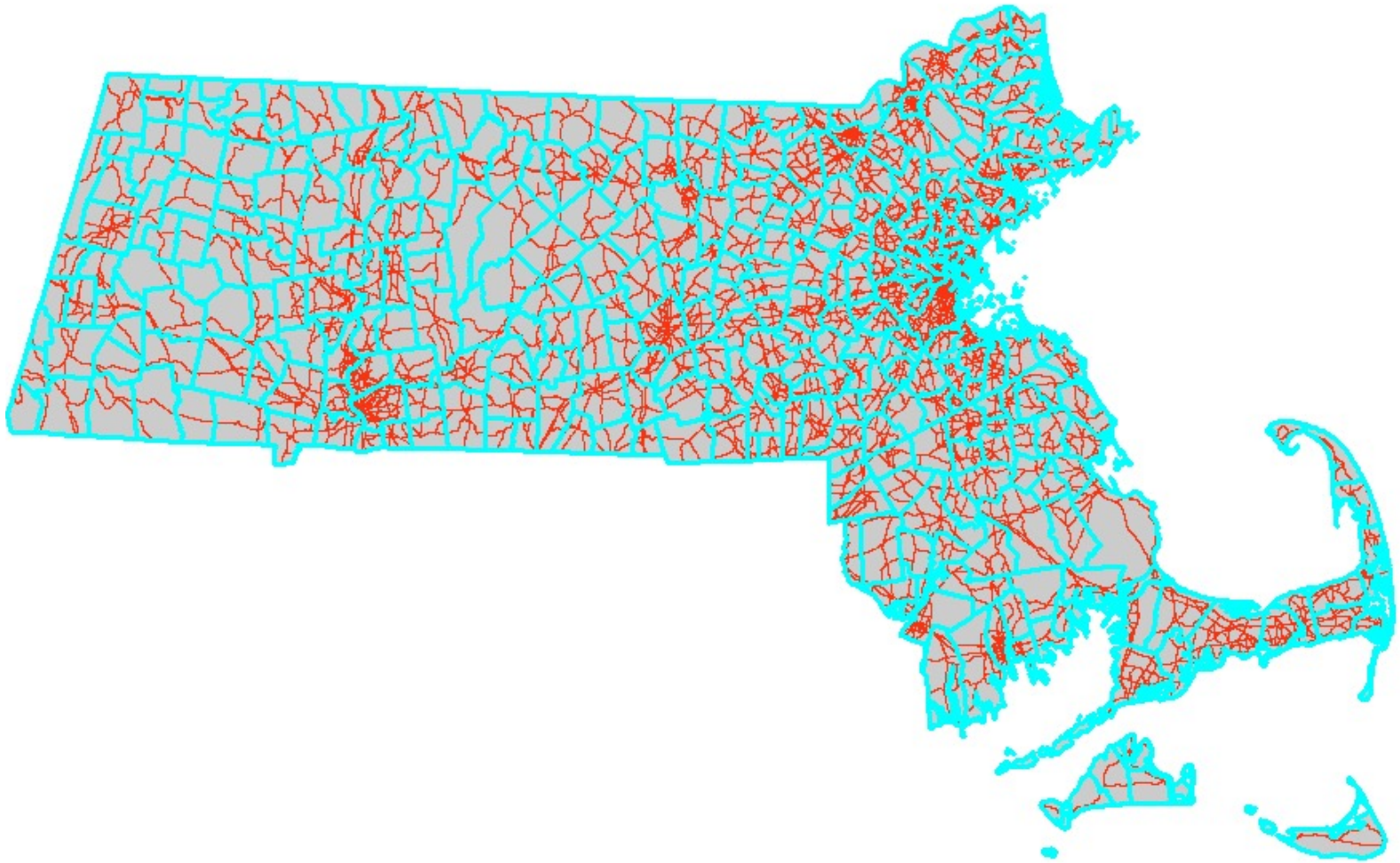
Intersect II

What is the total length of major roads in Amherst?



Intersect III

What is the total length of major roads in all MA towns?



Intersect IV

What is the total length of major roads in all MA towns?

Table

EOTMAJROADS_ARC

CLASS	ADMIN_TYPE	STREET_NAME	RT_NUMBER	ALTRTNUM1	ALTRTNUM2	ALTRTNUM3	ALTRTNUM4
3	2	COLLEGE HIGHWAY	202	10	57	<Null>	<Null>
2	2	MEMORIAL DRIVE	3	2	3A	<Null>	<Null>
2	2	MYSTIC STREET	3	2A	3A	<Null>	<Null>
2	2	MYSTIC STREET	3	2A	3A	60	<Null>
2	2	ALEWIFE BROOK PARKWAY	3	2	3A	16	<Null>
2	2	ALEWIFE BROOK PARKWAY	3	2	3A	16	<Null>
2	2	CONCORD AVENUE	3	2	3A	16	<Null>
2	2	CONCORD AVENUE	3	2	3A	16	<Null>
2	2	FRESH POND PARKWAY	3	2	3A	<Null>	<Null>
2	2	FRESH POND PARKWAY	3	2	3A	16	<Null>
3	2	ALEWIFE BROOK- CONCORD AVE ROTARY	3	2	3A	16	<Null>
3	2	ALEWIFE BROOK PARKWAY	3	2	3A	16	<Null>
3	2	FRESH POND PARKWAY	3	2	3A	<Null>	<Null>
3	2	FRESH POND PARKWAY	3	2	3A	16	<Null>
3	2	SOZIO ROTARY	3	2	3A	16	<Null>
3	2	SOZIO ROTARY	3	2	3A	16	<Null>

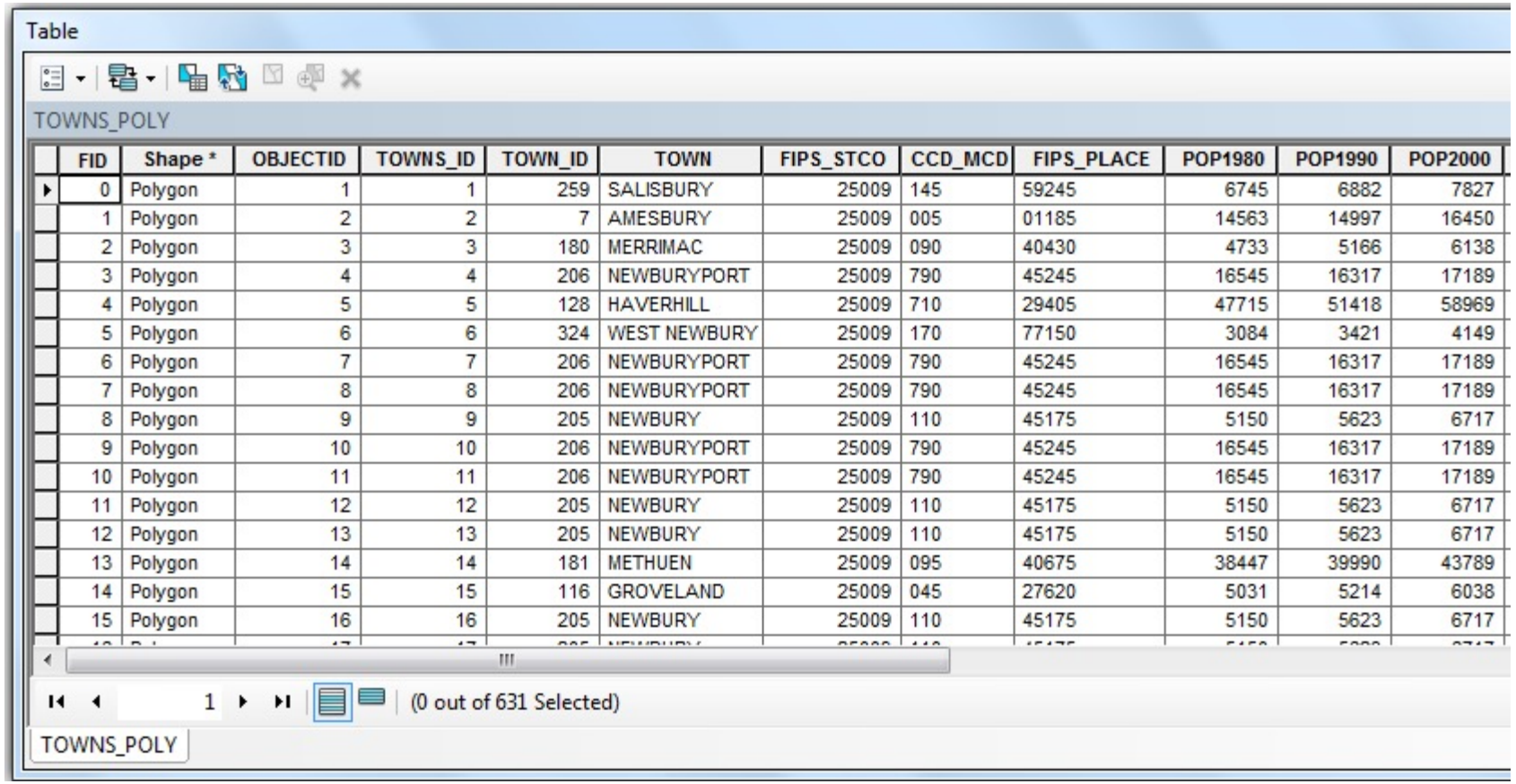
0 (0 out of 15819 Selected)

EOTMAJROADS_ARC

Roads attribute table *BEFORE*

Intersect V

What is the total length of major roads in all MA towns?



Table

TOWNS_POLY

FID	Shape *	OBJECTID	TOWNS_ID	TOWN_ID	TOWN	FIPS_STCO	CCD_MCD	FIPS_PLACE	POP1980	POP1990	POP2000
0	Polygon	1	1	259	SALISBURY	25009	145	59245	6745	6882	7827
1	Polygon	2	2	7	AMESBURY	25009	005	01185	14563	14997	16450
2	Polygon	3	3	180	MERRIMAC	25009	090	40430	4733	5166	6138
3	Polygon	4	4	206	NEWBURYPORT	25009	790	45245	16545	16317	17189
4	Polygon	5	5	128	HAVERHILL	25009	710	29405	47715	51418	58969
5	Polygon	6	6	324	WEST NEWBURY	25009	170	77150	3084	3421	4149
6	Polygon	7	7	206	NEWBURYPORT	25009	790	45245	16545	16317	17189
7	Polygon	8	8	206	NEWBURYPORT	25009	790	45245	16545	16317	17189
8	Polygon	9	9	205	NEWBURY	25009	110	45175	5150	5623	6717
9	Polygon	10	10	206	NEWBURYPORT	25009	790	45245	16545	16317	17189
10	Polygon	11	11	206	NEWBURYPORT	25009	790	45245	16545	16317	17189
11	Polygon	12	12	205	NEWBURY	25009	110	45175	5150	5623	6717
12	Polygon	13	13	205	NEWBURY	25009	110	45175	5150	5623	6717
13	Polygon	14	14	181	METHUEN	25009	095	40675	38447	39990	43789
14	Polygon	15	15	116	GROVELAND	25009	045	27620	5031	5214	6038
15	Polygon	16	16	205	NEWBURY	25009	110	45175	5150	5623	6717

1 (0 out of 631 Selected)

TOWNS_POLY

Towns attribute table *BEFORE*

Intersect VI

What is the total length of major roads in all MA towns?

Table

roads_in_MA_towns

STREET_NAM	RT_NUMBER	TOWNS_ID	TOWN_ID	TOWN	FIPS_STCO	CCD_MCD	FIPS_PLACE	POP1980
RAMP-RT 140 NB TO RT 195 EB		566	201	NEW BEDFORD	25005	770	45000	97738
RAMP-RT 140 NB TO RT 195 WB		566	201	NEW BEDFORD	25005	770	45000	97738
RAMP-RT 140 NB TO RT 95 NB		388	99	FOXBOROUGH	25021	045	24820	14388
RAMP-RT 140 SB TO RT 195 EB		566	201	NEW BEDFORD	25005	770	45000	97738
RAMP-RT 140 SB TO RT 195 EB		566	201	NEW BEDFORD	25005	770	45000	97738
RAMP-RT 140 SB TO RT 195 EB		566	201	NEW BEDFORD	25005	770	45000	97738
RAMP-RT 140 SB TO RT 195 WB		566	201	NEW BEDFORD	25005	770	45000	97738
RAMP-RT 140 SB TO RT 495 NB		413	167	MANSFIELD	25005	050	38225	14089
RAMP-RT 140 SB TO RT 95 NB		388	99	FOXBOROUGH	25021	045	24820	14388
RAMP-RT 140 TO RT 2 WB		111	332	WESTMINSTER	25027	290	77010	5353
RAMP-RT 140 TO RT 2 WB		111	332	WESTMINSTER	25027	290	77010	5353
RAMP-RT 140 TO RT 2 WB		111	332	WESTMINSTER	25027	290	77010	5353
RAMP-RT 140 TO RT 24 NB		428	293	TAUNTON	25005	220	69170	45411
RAMP-RT 140 TO RT 24 NB		428	293	TAUNTON	25005	220	69170	45411
RAMP-RT 140 TO RT 24 NB		428	293	TAUNTON	25005	220	69170	45411
RAMP-RT 16 EB TO RT 1 NB		200	248	REVERE	25025	510	56585	43141

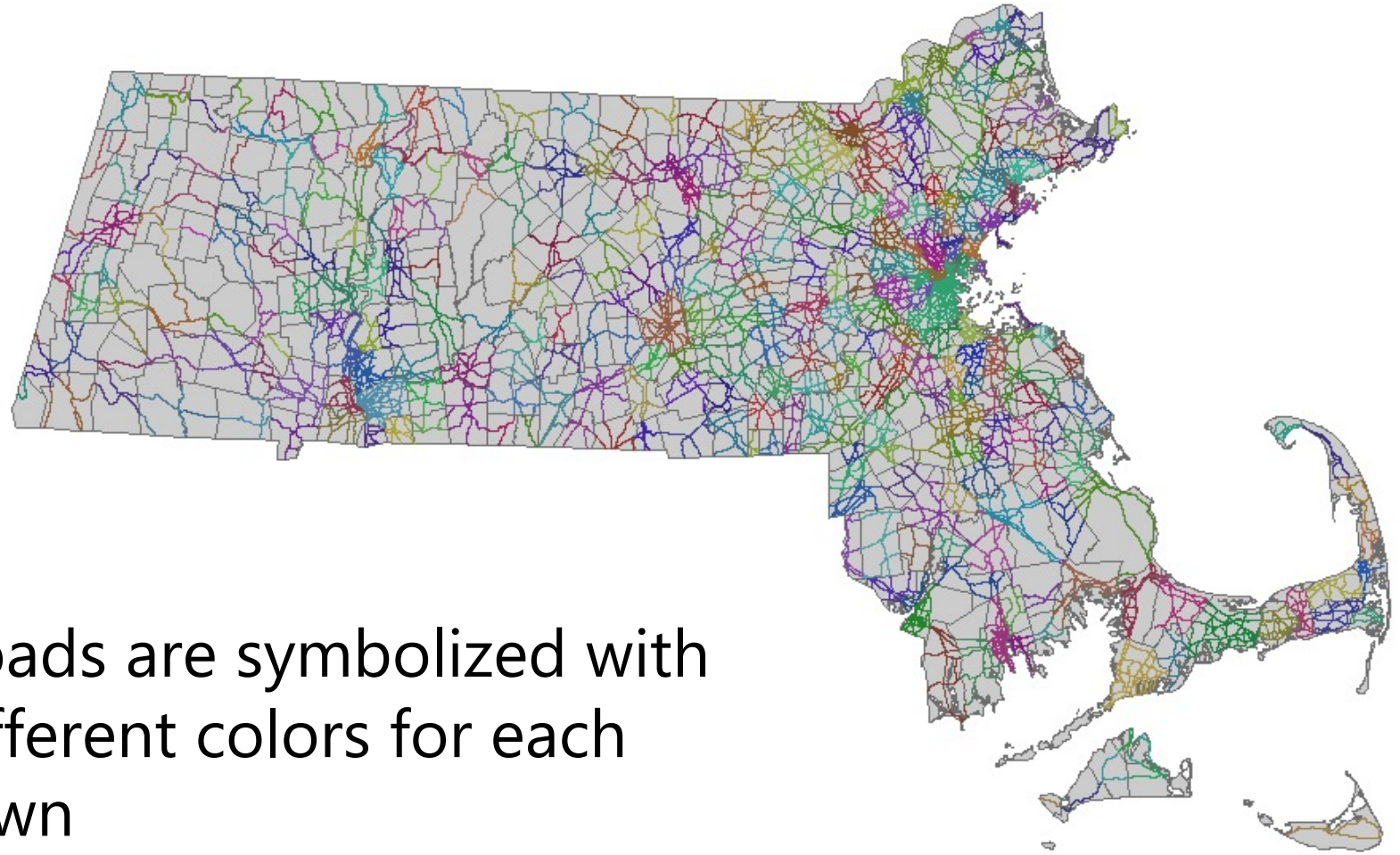
0 (0 out of 18081 Selected)

roads_in_MA_towns

Intersected attribute table *AFTER*

Intersect VII

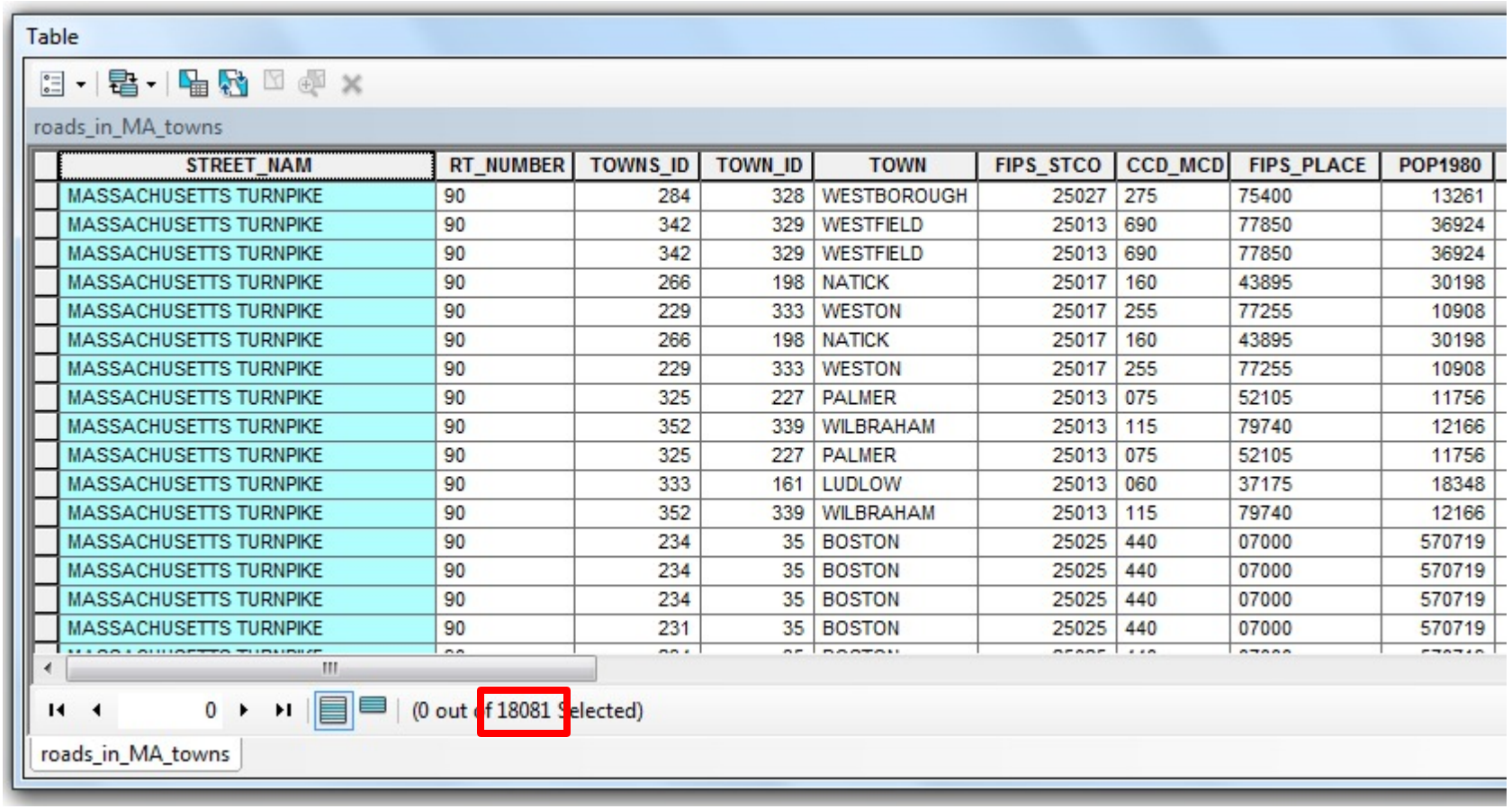
What is the total length of major roads in all MA towns?



Roads are symbolized with different colors for each town

Intersect VIII

What is the total length of major roads in all MA towns?



STREET_NAM	RT_NUMBER	TOWNS_ID	TOWN_ID	TOWN	FIPS_STCO	CCD_MCD	FIPS_PLACE	POP1980
MASSACHUSETTS TURNPIKE	90	284	328	WESTBOROUGH	25027	275	75400	13261
MASSACHUSETTS TURNPIKE	90	342	329	WESTFIELD	25013	690	77850	36924
MASSACHUSETTS TURNPIKE	90	342	329	WESTFIELD	25013	690	77850	36924
MASSACHUSETTS TURNPIKE	90	266	198	NATICK	25017	160	43895	30198
MASSACHUSETTS TURNPIKE	90	229	333	WESTON	25017	255	77255	10908
MASSACHUSETTS TURNPIKE	90	266	198	NATICK	25017	160	43895	30198
MASSACHUSETTS TURNPIKE	90	229	333	WESTON	25017	255	77255	10908
MASSACHUSETTS TURNPIKE	90	325	227	PALMER	25013	075	52105	11756
MASSACHUSETTS TURNPIKE	90	352	339	WILBRAHAM	25013	115	79740	12166
MASSACHUSETTS TURNPIKE	90	325	227	PALMER	25013	075	52105	11756
MASSACHUSETTS TURNPIKE	90	333	161	LUDLOW	25013	060	37175	18348
MASSACHUSETTS TURNPIKE	90	352	339	WILBRAHAM	25013	115	79740	12166
MASSACHUSETTS TURNPIKE	90	234	35	BOSTON	25025	440	07000	570719
MASSACHUSETTS TURNPIKE	90	234	35	BOSTON	25025	440	07000	570719
MASSACHUSETTS TURNPIKE	90	234	35	BOSTON	25025	440	07000	570719
MASSACHUSETTS TURNPIKE	90	231	35	BOSTON	25025	440	07000	570719

You will end up with more features than you started with

Final Projects

- The list for signing up for projects is almost* live.

- Some are ‘ideas’ and ‘explorations’, while others have more concrete production goals and expectations.