
Watershed Sciences 4930 & 6920

GEOGRAPHIC INFORMATION SYSTEMS

WEEK TWO – Lecture

PROJECTIONS

Joe Wheaton

Some of slides in this lecture adapted from content
in Paul Bolstad's 'Fundamentals of GIS'



WATS 4930

HOUSEKEEPING

- Lab?
- Other Questions, Comments, Concerns...
- Today: Start Projections...
- Thursday: Finish Projections & Learn about data types...



WATS 4930

HOUSEKEEPING: READING & TASKS

GIS Classroom

[Home](#)
[About the Courses \(Syllabi\)](#)
[Grades](#)
[Instructors](#)
[Primary Learning Outcomes](#)
[Software](#)
[Course Topics](#)
[Assignments](#)
[Labs \(4930/6920/6915\)](#)
[Project \(4931/6921\)](#)
[Reading Assignments](#)
[Class Announcements](#)
[Class Calendar](#)
[Class Forum](#)
[Useful Quick References](#)
[Getting Organized and Oriented](#)
[Figure Preparation Guidelines](#)
[Great Maps!](#)
[GIS Class LibGuide](#)
[Help](#)
[© 2013 Copyright & Disclaimers](#)
[Utah State University Links](#)
[Canvas \(Submit Assignments\)](#)
[Department of Watershed Sciences](#)
[Banner Access](#)
[Current Students](#)
[Prospective Students](#)
[Open Course Ware](#)
[Other Links](#)
[ESRI Support](#)

[Assignments](#) > [Reading Assignments](#) >

First Week Tasks & Reading

posted 18 hours ago by Joe Wheaton [updated Jan 7, 2013 1:54 PM]

All of the following nine tasks are considered your homework and should be completed by **Thursday, January 10, 2013** (no lecture on Thursday):

1. Skim Chapter One of [Bolstad \(2005\)](#)
2. Browse & become familiar with organization of [Course Website](#)
3. Confirm that you have [Canvas](#) access - You'll need this for submitting assignments
4. Register as a user for the [Class Forum](#) - You'll need this for posting and answering questions
5. [Register as a new user for the Quinney Lab](#) - You'll need this for access to lab computers
6. If you do not already have an ESRI Global Account, go to [ESRI Support](#) and follow the Create New ESRI Account link. ALSO, log into [ArcGIS.com](#) and register your global ESRI account for access to ArcGIS Online (see [here](#) if confused) - You'll need this for posting to ESRI's discussion forums, subscribing to alerts, and making online maps with ArcGIS Online.
7. Install [ArcGIS](#) on your own machine (if you have one)
8. If you do not already have a Google [Gmail account](#) (not your Aggimail account), create one. - You'll need this for creating your Google Sites website and making Google Maps.
9. Make sure you have a secure means of remembering all these different usernames and passwords (e.g. [LastPass](#)). For this class alone, you will have need to regularly use the following credentials:
 - USU Banner strong ID & Password for [Canvas](#) & [Banner](#)
 - Quinney Lab - (uses your A number as username, but has a different password)
 - [Class Forum](#)
 - [Gmail](#)
 - [ESRI Support](#) and [ArcGIS.com](#)

Sorry for the long list of instructions.... But you better get used to it!

UtahStateUniversity

gis.joewheaton.org/assignments/reading-assignments

WATS 4930

YOUR QUIZ FOR TODAY

- Good Maps & Bad Maps

phpBB

GIS - WATS 4930 & 6920 Class Discussion Boards

[Search](#)

[Board index](#) > [GIS Questions & Discussions](#) > [Week 02: Abstracting the World to Digital Maps](#) > [Quiz 1 - Good Map Bad Map](#)

[FAQ](#) [Register](#) [Login](#)

[Quiz 1 - Good Map Bad Map](#)

[NEW TOPIC](#) [Search this forum](#)

77 topics • Page 1 of 4 • [1](#) [2](#) [3](#) [4](#)

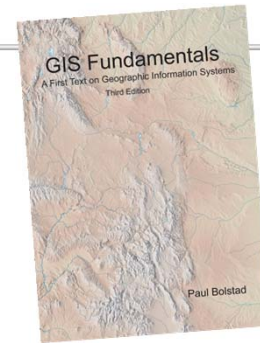
TOPICS	REPLIES	VIEWS	LAST POST
Good Map, Bad Map by flores.santi • Tue Jan 17, 2012 7:25 am	0	3	by flores.santi • Tue Jan 17, 2012 7:25 am
Good & Bad maps by nate.mcp • Tue Jan 17, 2012 7:19 am	0	1	by nate.mcp • Tue Jan 17, 2012 7:19 am
Good Map Bad Map by seagatch099 • Tue Jan 17, 2012 6:49 am	0	2	by seagatch099 • Tue Jan 17, 2012 6:49 am
Good and Bad Map by vermonator87 • Tue Jan 17, 2012 6:44 am	0	2	by vermonator87 • Tue Jan 17, 2012 6:44 am
good/bad maps by khaasut • Tue Jan 17, 2012 6:42 am	0	1	by khaasut • Tue Jan 17, 2012 6:42 am
good/bad maps by heathermcp • Tue Jan 17, 2012 6:38 am	0	3	by heathermcp • Tue Jan 17, 2012 6:38 am
Good map & bad by christopherr • Tue Jan 17, 2012 4:53 am	1	18	by joewheaton • Tue Jan 17, 2012 4:58 am
Good Map Bad Map by bradthansen • Tue Jan 17, 2012 4:50 am	0	5	by bradthansen • Tue Jan 17, 2012 4:50 am
maps by zach • Tue Jan 17, 2012 4:34 am	0	3	by zach • Tue Jan 17, 2012 4:34 am
Bad map, good map by maha • Tue Jan 17, 2012 4:17 am	0	3	by maha • Tue Jan 17, 2012 4:17 am
Good Map Bad Map by lex • Tue Jan 17, 2012 3:09 am	0	9	by lex • Tue Jan 17, 2012 3:09 am
Good Map Bad Map by buckdew21 • Tue Jan 17, 2012 1:51 am	0	6	by buckdew21 • Tue Jan 17, 2012 1:51 am

UtahStateUniversity

WATS 4930

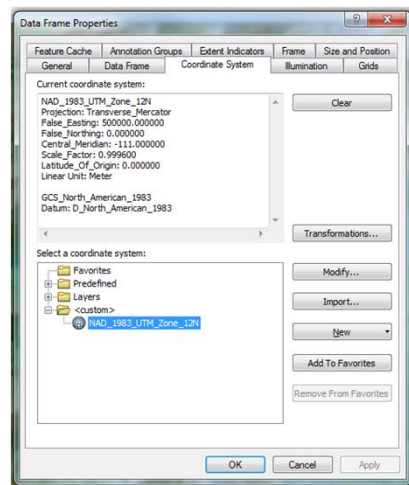
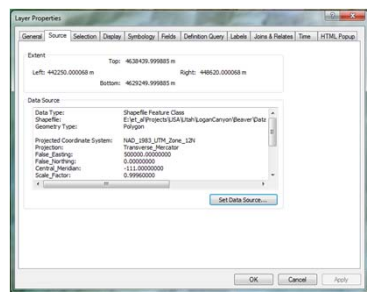
READING FOR TODAY

- You Read Chapter Three of Bolstad: "Map Projections & Coordinate Systems" (pp. 69-122)
 - Skim 70-72 (History)
 - Read pp. 72-119 in detail



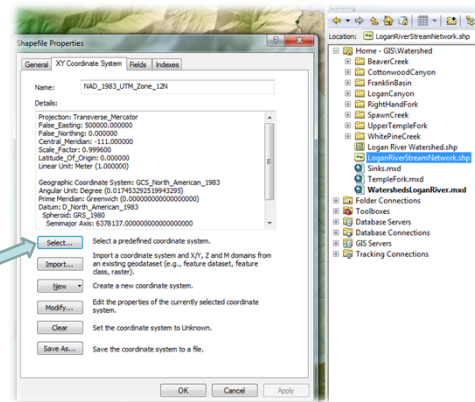
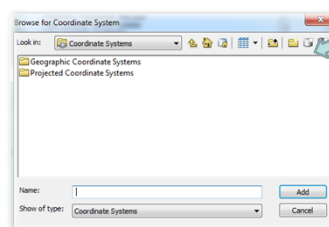
WHAT WE REALLY WANT OUT OF TODAY

- Make you not so dangerous when using coordinate systems
- Make sure you understand what you're doing when...



WHAT DO YOU NEED TO KNOW?

- What are the choices you have?
 - Select?
 - Import?
 - New?
 - Modify?



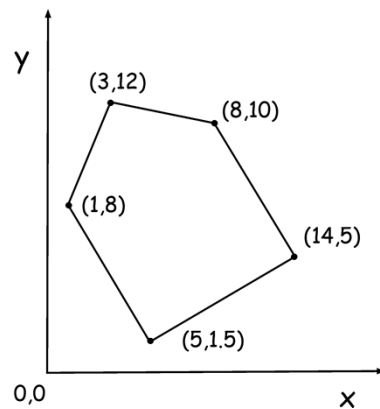
Geographic or Projected? Huh?

TODAY'S PLAN

- I. **Coordinate Systems**
- II. Geographic Coordinates (i.e. non-projected)
- III. The Problem
 - I. Geoids -> Ellipsoids -> Spheroids
- IV. Map Projections & Projected Coordinate Systems
 - I. The basics + most common CS in GIS
 - II. Universal Transverse Mercator Coordinate System
 - III. State Plane Coordinate System
 - IV. Public Land Survey System
 - V. Others
- V. Conversions between Coordinate Systems

PLACE DESCRIBED WITH COORDINATES

- A pair or triplet of numbers, that specify location with reference to some origin



Coordinates: 1,8
3,12
8,10
14,5
5,1.5
1,8

Attributes:
Lot # :1347
Street: Willow Lane
Town: Hopkins



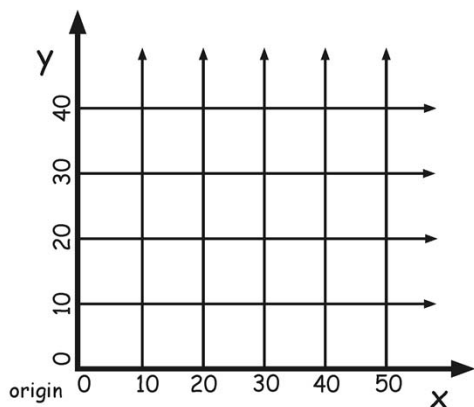
From Bolstad (2008) Figure 2-3

WATS 4930

2D VS. 3D CARTESIAN COORDINATES

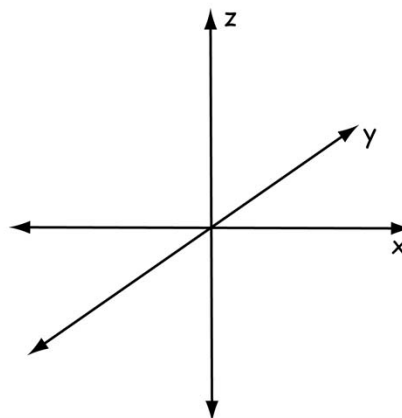
(x,y)

2 - Dimensional



(x,y,z)

3 - Dimensional

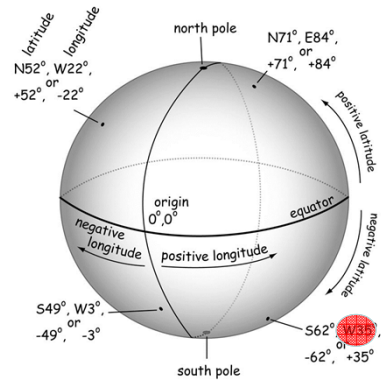
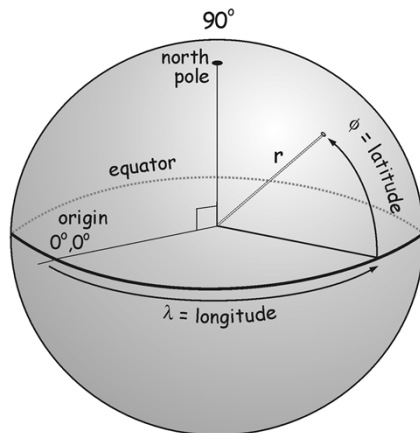


From Bolstad (2008) Figure 2-5

WATS 4930

SPHERICAL COORDINATES

Spherical coordinates



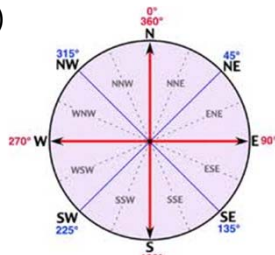
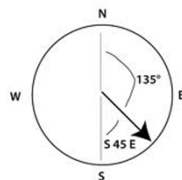
- Two angular measurements (i.e. lat/long) and a radius...

REPORTING ANGLES VS. BEARINGS

- An angle is just a measurement
– (e.g. 35°)
- A bearing is directional
– (e.g. N35°W versus S35°E)



Angles can be reported in decimal degrees (DD) or degrees-minutes-seconds (DMS)



DD from DMS
DD = D + M/60 + S/3600
e.g.
DMS = 32° 45' 28"

DD = 32 + 45/60 + 28/3600
= 32 + 0.75 + 0.0077778
= 32.7577778

DMS from DD
D = integer part
M = integer of decimal part x 60
S = 2nd decimal x 60
e.g.
DD = 24.93547
D = 24
M = integer of 0.93547 x 60
= integer of 56.1282
= 56
S = 2nd decimal x 60
= 0.1282 * 60 = 7.692
so DMS is
24° 56' 7.692"

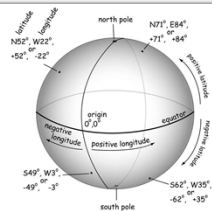
TODAY'S PLAN

- I. Coordinate Systems
- II. Geographic Coordinates (i.e. non-projected)**
- III. The Problem
 - I. Geoids -> Ellipsoids -> Spheroids
- IV. Map Projections & Projected Coordinate Systems
 - I. The basics + most common CS in GIS
 - II. Universal Transverse Mercator Coordinate System
 - III. State Plane Coordinate System
 - IV. Public Land Survey System
 - V. Others
- V. Conversions between Coordinate Systems

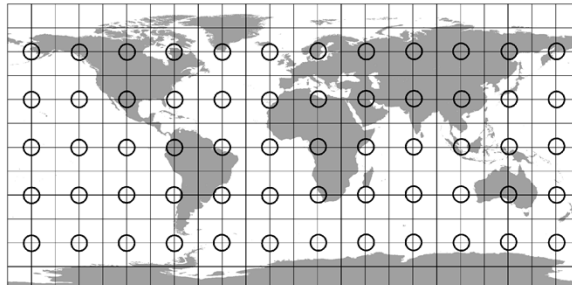
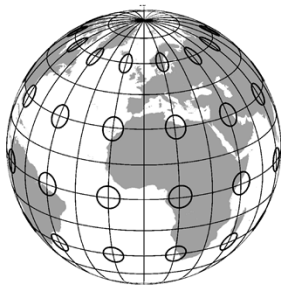
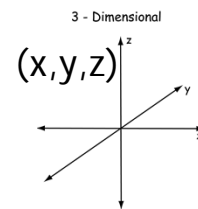


WATS 4930

SPHERICAL VS. CARTESIAN



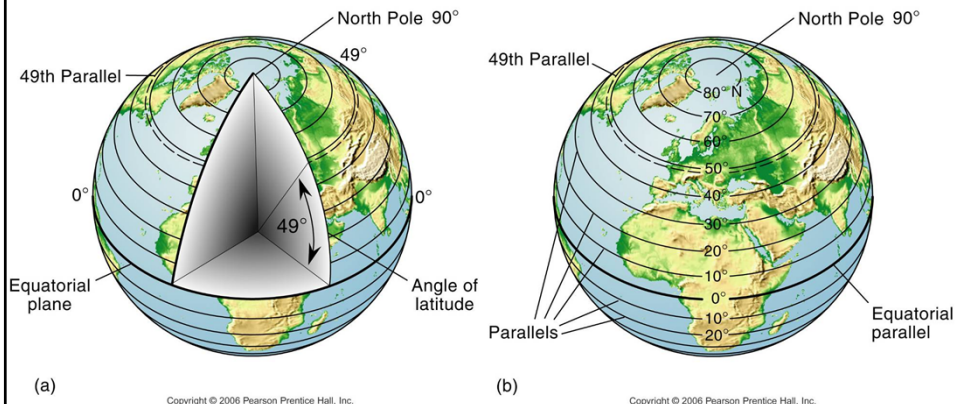
Umm, which are geographic?



WATS 4930

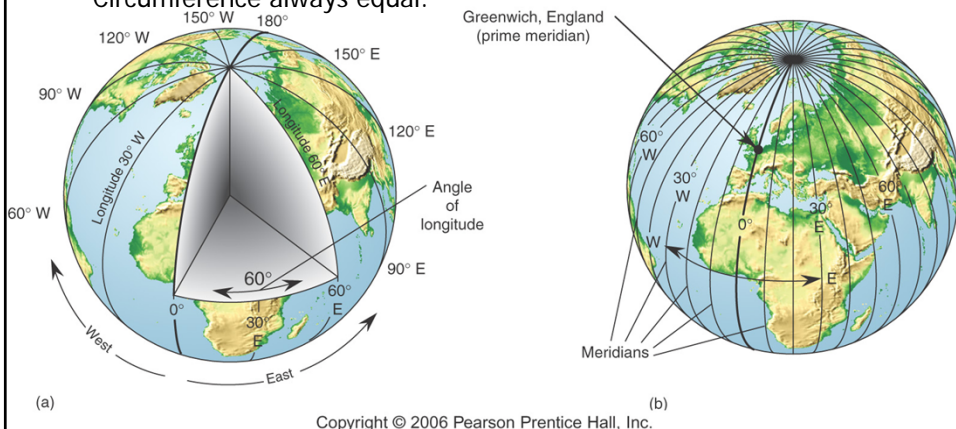
LATITUDE

- Equator is trace of plane oriented perpendicular to spin axis of earth. Defined as 0° latitude.
- Other lines of latitude defined by intersection of (double) cone whose apex is at earth center and has progressive apical angles of 0-90°. Lines called **parallels**
- 1° latitude = 111 km ALWAYS! Circumference varies!

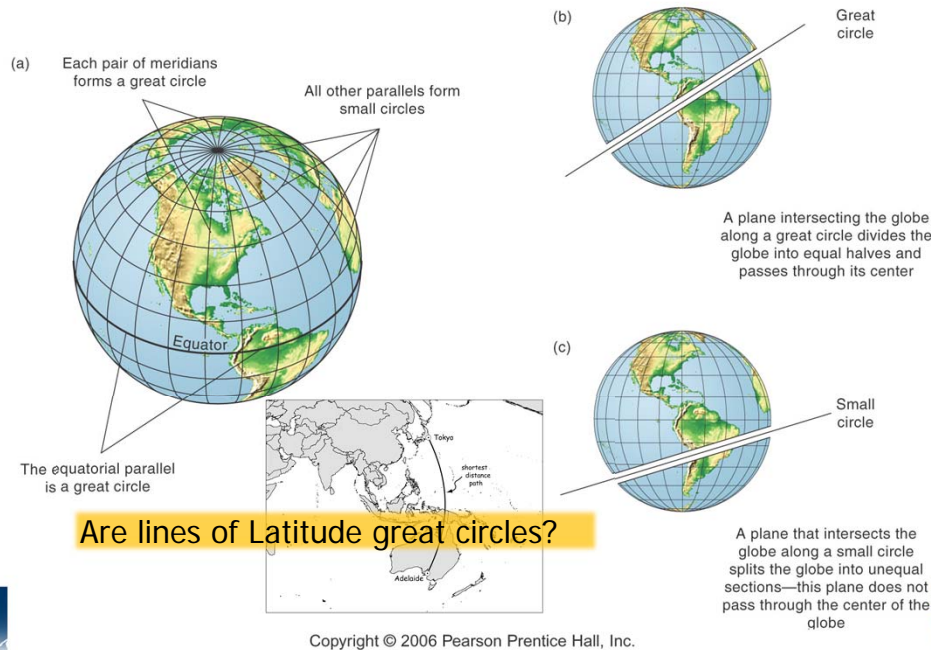


LONGITUDE

- Defined by planes which pass through earth center and spin axis, which leave a **great circle trace**, called a **meridian**
- Prime (Greenwich) meridian is defined as 0° longitude and others are defined 180° east or west from there
- 1° longitude == 111 km at equator but 0 km at poles.
Circumference always equal.

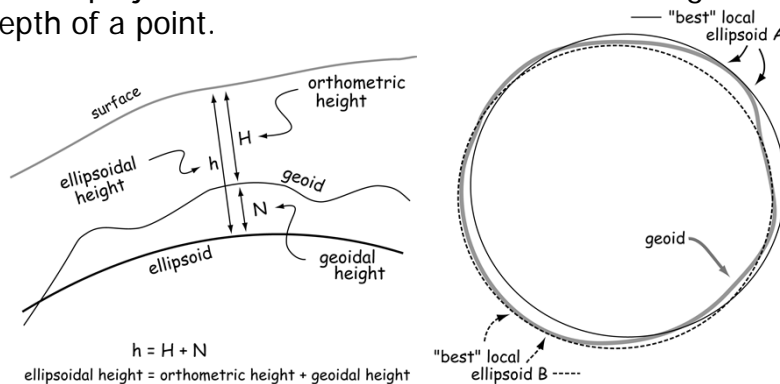


GREAT CIRCLES AND SMALL CIRCLES



DATUM & VERTICAL COORDINATE SYSTEMS

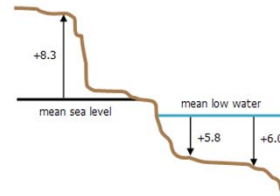
- The datum is a curvilinear surface that wraps around the globe. It is mathematically defined to represent the "average" earth radius. A datum is needed to make the correct projection, and to establish the correct height or depth of a point.



SOME COMMON EXAMPLES

Datum

- Artificial Surface
 - Sphere (Approximate shape)
 - Oblate Ellipsoid (Truer shape)
 - Geoid (Approximate Sea Level)



North American Datum – A geoidal Coordinate System

- NAD-27(?) -
- NAD-83(?)
- 10's of meters difference!

World Geodetic System (GPS)

- WGS84(?) – A spheroidal coordinate system...



http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#What_are_vertical_coordinate_systems/0030000014000000

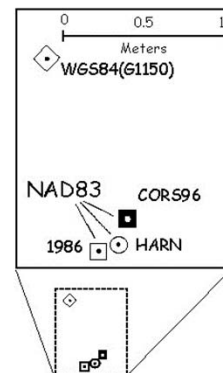
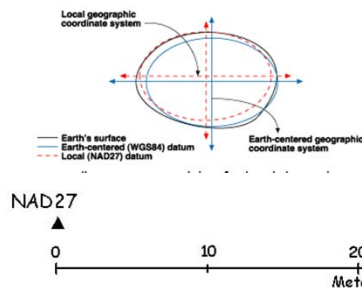
WATS 4930

ALL THOSE DIFFERENT CHOICES MATTER

Examples of Datum Shifts

New Jersey control point, successive datum transformations applied

Datum	Longitude (W)	Latitude(N)	Shift(m)
NAD27	74° 12' 3.86927"	40° 47' 0.76531"	36.3
NAD83(1986)	74° 12' 2.39240"	40° 47' 1.12726"	0.04
NAD83(HARN)	74° 12' 2.39069"	40° 47' 1.12762"	0.05
NAD83(CORS96)	74° 12' 2.39009"	40° 47' 1.12936"	0.95
WGS84(G1150)	74° 12' 2.39720"	40° 47' 1.15946"	



WATS 4930

TODAY'S PLAN

- I. Coordinate Systems
- II. Geographic Coordinates (i.e. non-projected)
- III. The Problem**
 - I. Geoids -> Ellipsoids -> Spheroids
- IV. Map Projections & Projected Coordinate Systems
 - I. The basics + most common CS in GIS
 - II. Universal Transverse Mercator Coordinate System
 - III. State Plane Coordinate System
 - IV. Public Land Survey System
 - V. Others
- V. Conversions between Coordinate Systems



WATS 4930

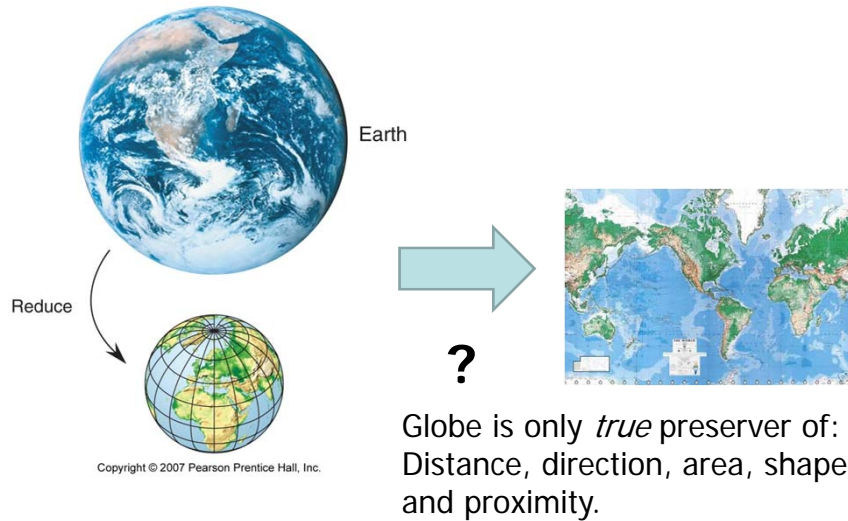
WHAT CHARACTERISTICS WOULD A PERFECT MAP HAVE?

- **Distances** could be measured accurately
- **Directions** could be measured accurately
 - By extension, proximity too
- **Areas** could be measured accurately
- **Shape** would not be **distorted**
- Do we have such a map for earth?



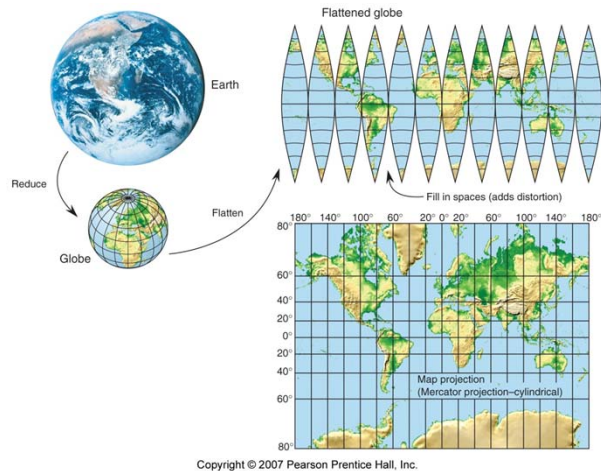
WATS 4930

WE DO! BUT, HOW DO WE MAKE IT FLAT?



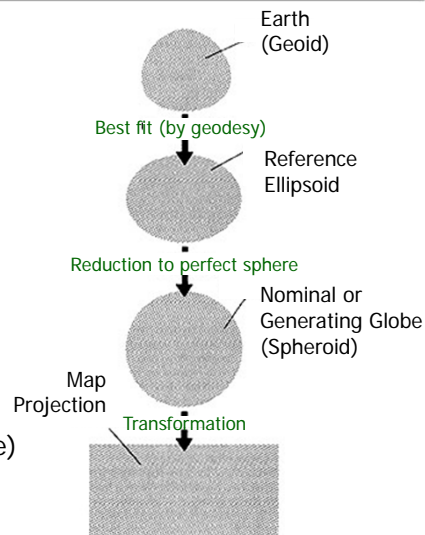
THE PROJECTION DILEMMA

- The globe is a 3D surface
- A 2D Surface is a sheet, cylinder or cone



MAP PROJECTIONS

- Earth is a Geoid
 - Transformed mathematically (geodesy) to a simpler shape
- Simpler shape is a reference ellipsoid
 - Further transformed (mathematically) into an actual sphere or spheroid
- Called nominal, reference, or generating globe
 - Further transformed (mathematically) into a flat (plane) surface
 - This is where much of the distortion gets added to the map



From Dr. Krygier (OWU):

http://krygier.owu.edu/krygier_html/geog_222/geog_222_lo/geog_222_lo13.html

WATS 4930

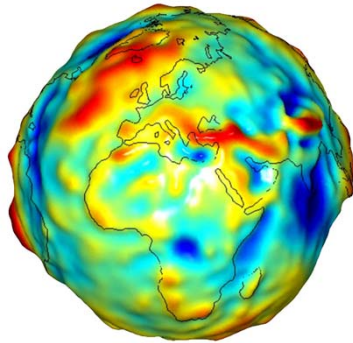
TODAY'S PLAN

- I. Coordinate Systems
- II. Geographic Coordinates (i.e. non-projected)
- III. The Problem**
 - I. Geoids -> Ellipsoids -> Spheroids**
- IV. Map Projections & Projected Coordinate Systems
 - I. The basics + most common CS in GIS
 - II. Universal Transverse Mercator Coordinate System
 - III. State Plane Coordinate System
 - IV. Public Land Survey System
 - V. Others
- V. Conversions between Coordinate Systems

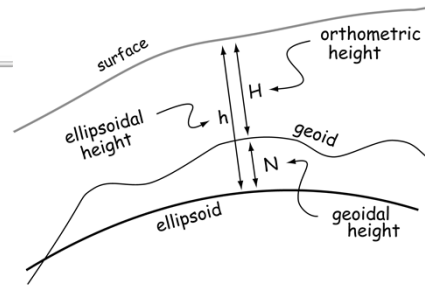


WATS 4930

GEOID

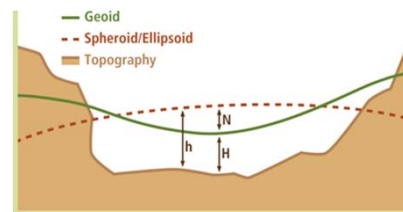


Earth's gravity field...
explains geoid shape

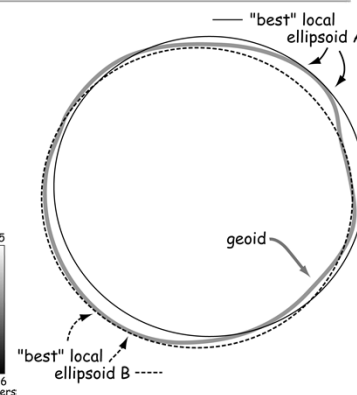
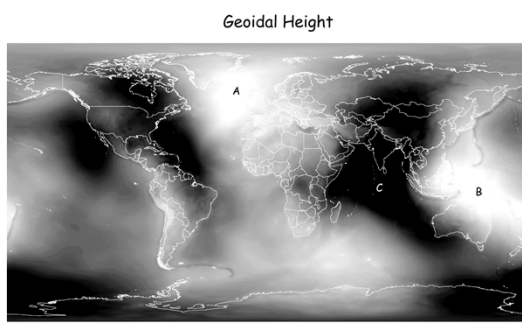


$$h = H + N$$

ellipsoidal height = orthometric height + geoidal height

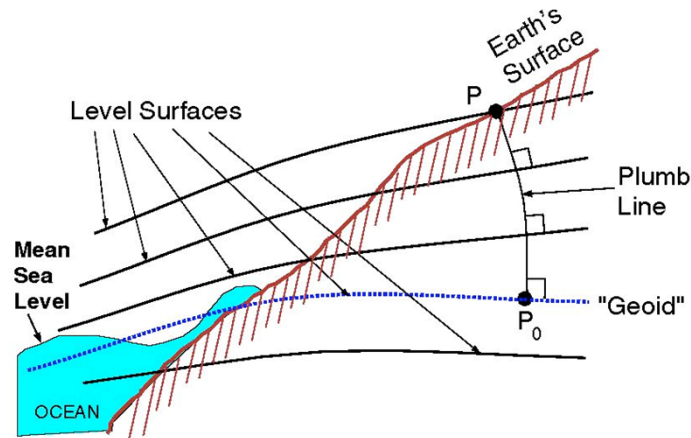


AN ELIPSOID DOESN'T WORK GREAT EVERYWHERE



A geoid is the equipotential surface of the Earth's gravity field which best fits, in a least squares sense, global mean sea level

GEOID – EQUIPOTENTIAL SURFACE



Level Surface = Equipotential Surface

H (Orthometric Height) = Distance along Plumb line (P_0 to P)

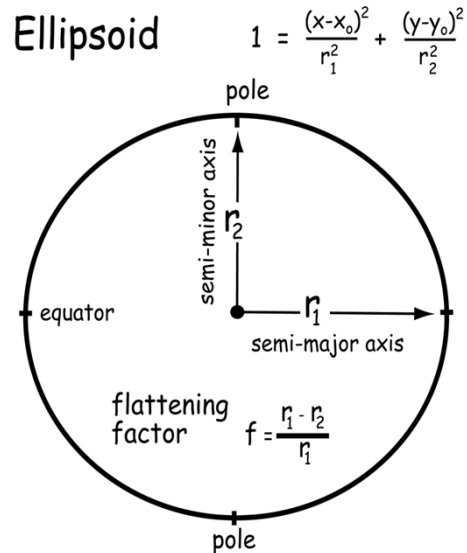


From: http://www.ngs.noaa.gov/GEOID/geoid_def.html

WATS 4930

ELLIPSOID

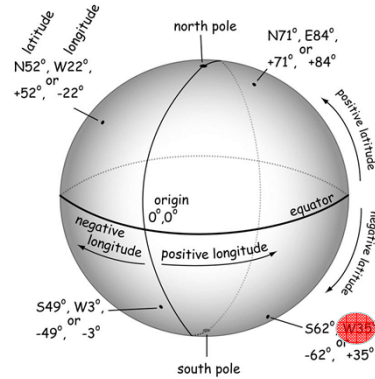
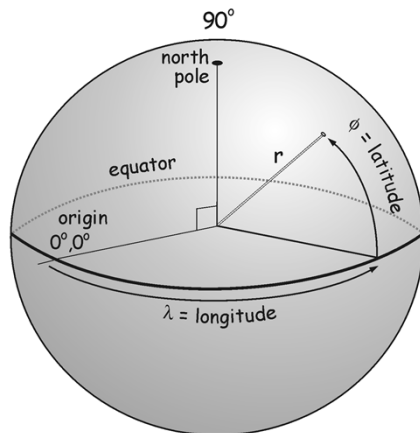
- The earth **IS NOT** a perfect sphere
- So we approximate it with an Ellipsoid
- Ellipsoid is a sphere that is slightly flattened at poles
- A.K.A. Spheroid



WATS 4930

RECALL, SPHERICAL COORDINATES

Spherical coordinates



- Two angular measurements (i.e. lat/long) and a radius...

WHY SHOULD I CARE ABOUT THE EARTH'S SHAPE?

- Position depends on it!
- GIS is all about mapping positions
- In particular, **elevations** are adjusted relative to earth's 'shape'
- Shape modeled as an ellipsoid



TODAY'S PLAN

- I. Coordinate Systems
- II. Geographic Coordinates (i.e. non-projected)
- III. The Problem
 - I. Geoids -> Ellipsoids -> Spheroids
- IV. Map Projections & Projected Coordinate Systems**
 - I. The basics + most common CS in GIS
 - II. Universal Transverse Mercator Coordinate System
 - III. State Plane Coordinate System
 - IV. Public Land Survey System
 - V. Others
- V. Conversions between Coordinate Systems

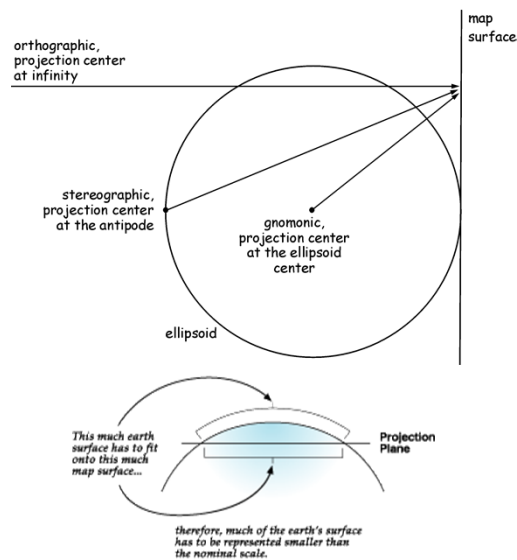
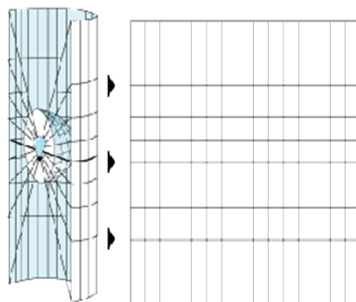


WATS 4930

WHAT IS A PROJECTION?

Why would it be distorted?

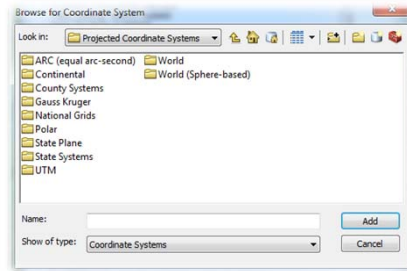
- Squeeze or stretch?



http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/About_map_projections/003r000000q000000/

WATS 4930

CHOICE OF PROJECTION



Will Depend On:

- Extent of your Map
 - The whole globe?
 - Just a hemisphere
 - The poles?
 - A Continent
 - A State
 - A locality
- Location of your Map
 - High vs. Low latitudes?
 - Where longitudinally?

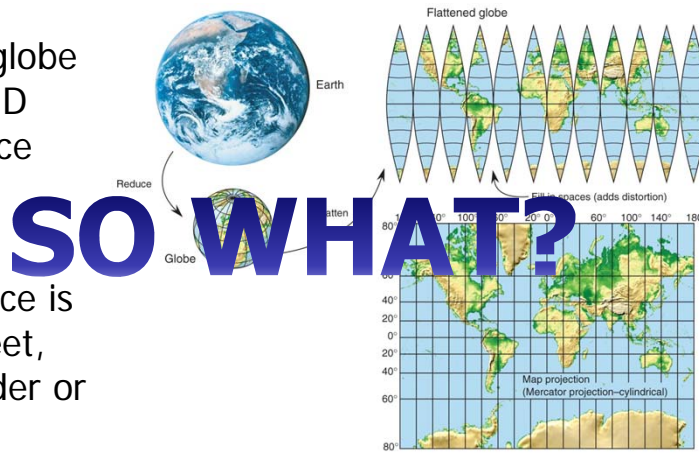
TODAY'S PLAN

- I. Coordinate Systems
- II. Geographic Coordinates (i.e. non-projected)
- III. The Problem
 - I. Geoids -> Ellipsoids -> Spheroids
- IV. Map Projections & Projected Coordinate Systems**
 - I. The basics + most common CS in GIS**
 - II. Universal Transverse Mercator Coordinate System
 - III. State Plane Coordinate System
 - IV. Public Land Survey System
 - V. Others
- V. Conversions between Coordinate Systems

THE PROJECTION DILEMMA

- The globe is a 3D surface

- A 2D Surface is a sheet, cylinder or cone

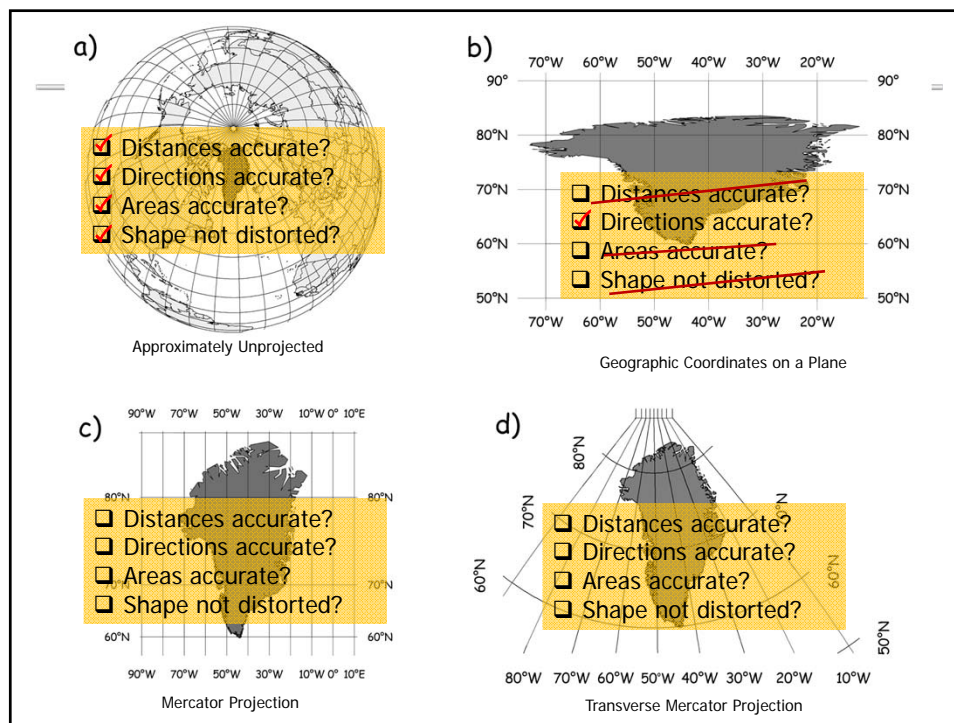
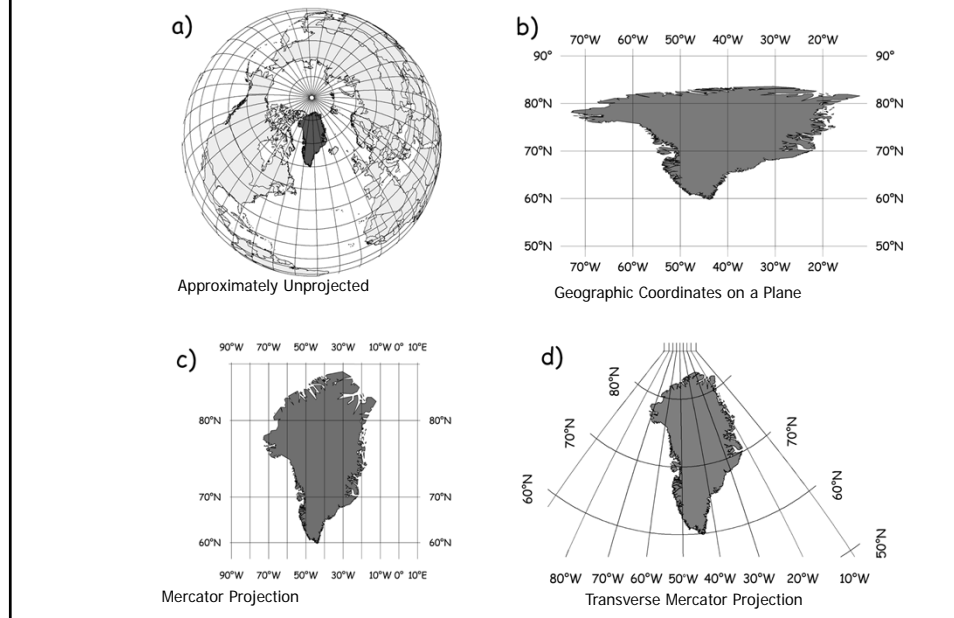


Copyright © 2007 Pearson Prentice Hall, Inc.

WHAT CHARACTERISTICS WOULD A PERFECT MAP HAVE?

- **Distances** could be measured accurately
- **Directions** could be measured accurately
 - By extension, proximity too
- **Areas** could be measured accurately
- **Shape** would not be distorted

HOW BIG IS GREENLAND ACTUALLY?



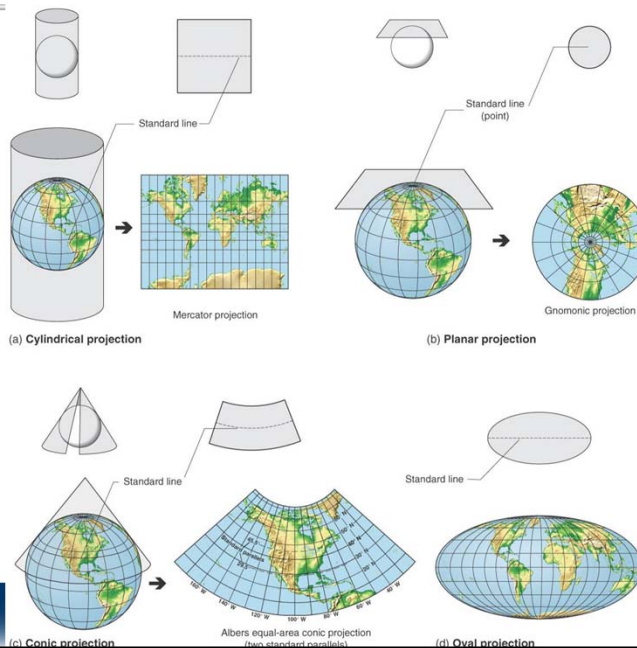
CLASSES OF MAP PROJECTIONS

Question:

To preserve:

- Equal areas?
(i.e. equivalence)
- True Shape?
(i.e. conformality)

Standard Line is
contact
point(s)



1. PLANAR PROJECTIONS

- Preserves Shape (true-shape) with meridians parallel.
- Preserves area
- But...

Planar aspects



Polar

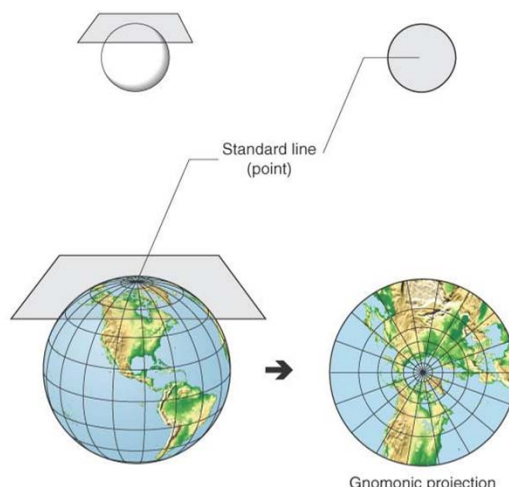


Equatorial



Oblique

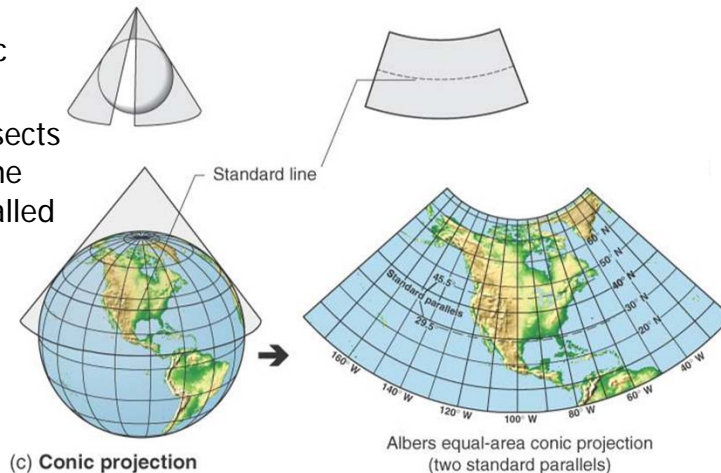
A plane is placed over a globe. The plane can touch the globe at the pole (polar case), the equator (equatorial case), or another line (oblique case).



2. CONIC PROJECTIONS

Regular Conic Projection:

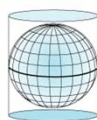
- cone intersects earth at one latitude, called standard parallel



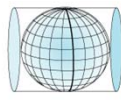
3. CYLINDRICAL PROJECTIONS

- Preserves Shape (true-shape) with meridians parallel.
- Does NOT preserve Area!
- Great circle routes are not the shortest!

Cylindrical aspects



Normal

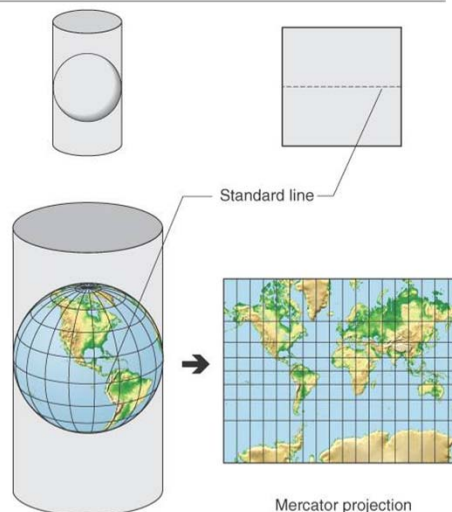


Transverse



Oblique

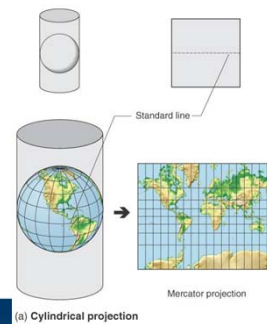
A cylinder is placed over a globe. The cylinder can touch the globe along a line of latitude (normal case), a line of longitude (transverse case), or another line (oblique case).



(a) Cylindrical projection

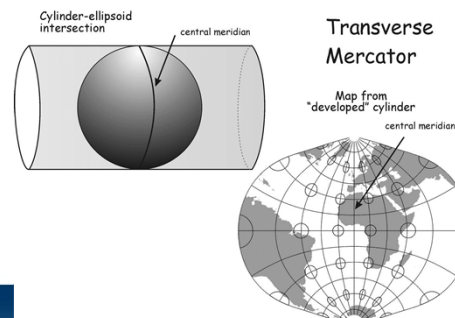
MERCATOR PROJECTION

- Vertical cylinder touches globe at equator.
- Projection from earth center outward to cylinder.
- Distorts higher latitudes but keeps directions true throughout map.
- Good for worldwide navigation.



TRANSVERSE MERCATOR

- Horizontal cylinder touches globe
- Projection from earth center outward
- Accurate areas within 15° of intersecting meridian, accurate directions
- Used in many USGS maps

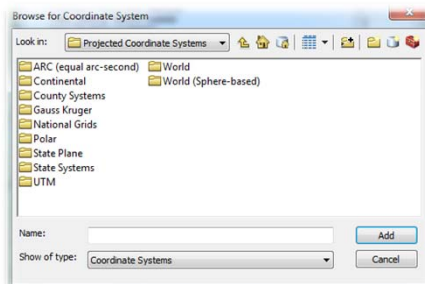


VISUALIZING PROJECTIONS

- Unfolding the earth:
<http://www.youtube.com/watch?v=b1xXTi1nFCo>



CHOICE OF PROJECTION



Will Depend On:

- Extent of your Map
 - The whole globe?
 - Just a hemisphere
 - The poles?
 - A Continent
 - A State
 - A locality
- Location of your Map
 - High vs. Low latitudes?
 - Where longitudinally?

TODAY'S PLAN

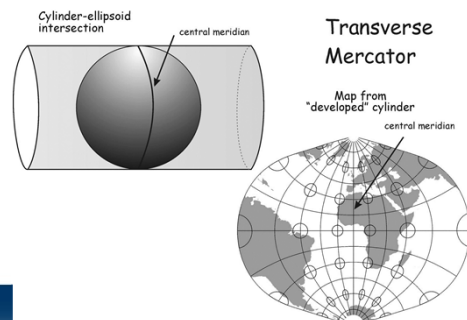
- I. Coordinate Systems
- II. Geographic Coordinates (i.e. non-projected)
- III. The Problem
 - I. Geoids -> Ellipsoids -> Spheroids
- IV. Map Projections & Projected Coordinate Systems**
 - I. The basics + most common CS in GIS
 - II. Universal Transverse Mercator Coordinate System**
 - III. State Plane Coordinate System
 - IV. Public Land Survey System
 - V. Others
- V. Conversions between Coordinate Systems



WATS 4930

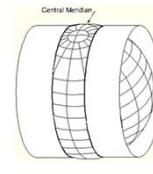
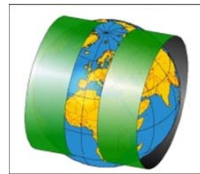
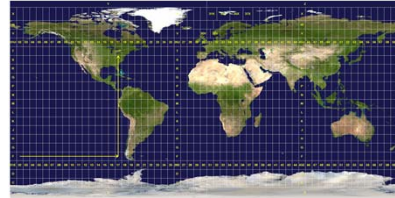
TRANSVERSE MERCATOR

- Horizontal cylinder touches globe
- Projection from earth center outward
- Accurate areas within 15° of intersecting meridian, accurate directions
- Used in many USGS maps



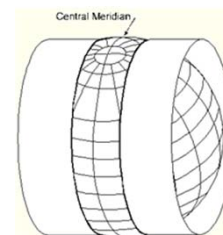
UTM KEY: ADJECTIVE IS *TRANSVERSE*

- Designed to cover the world, excluding the Arctic and Antarctic regions
- To keep scale distortions within acceptable limits, 60 narrow, longitudinal zones of six degrees longitude in width are defined and numbered from 1 to 60.
- We are in UTM grid zone 12 N which covers the area 108° W - 114°



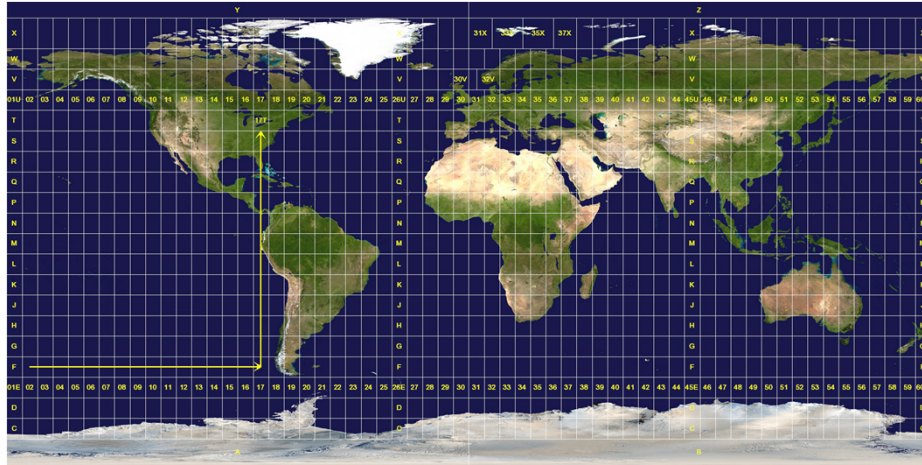
UNIVERSAL TRANSVERS MERCATOR (UTM)

- Horizontal cylinder whose diameter is less than earth's diameter
- Intersects twice so that ring is formed. Ring is 6° wide at equator
- Projection from earth center outward
- Used in many USGS and British Ordnance Survey maps
- Minimal distortion and accurate directions ring

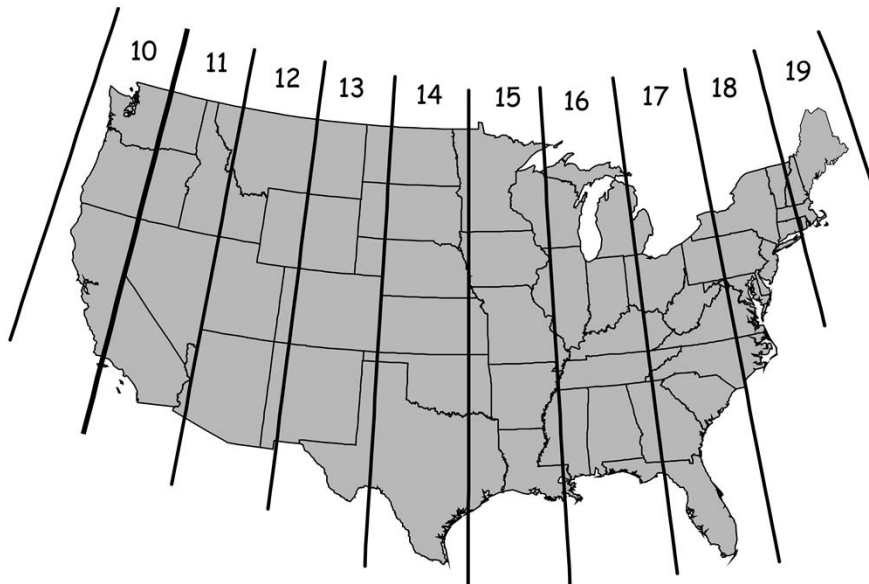


UNITS: Meters

UTM ZONES

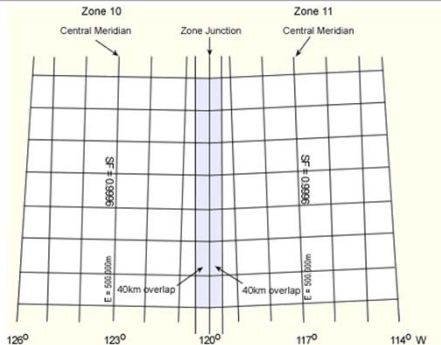


UTM ZONES IN LOWER 48...



UTM ... EACH ZONE HAS ITS OWN CM

- Each zone has own central meridian.
- CM always Easting value always 500,000 m; to avoid negative coordinates
- For positions north of the equator, the equator is given a Northing value of 0m
- For positions south of the equator, the equator is given a (false) Northing value of 10,000,000 m



From: <http://kartoweb.itc.nl/geometrics/Map%20projections/body.htm>

UtahStateUniversity

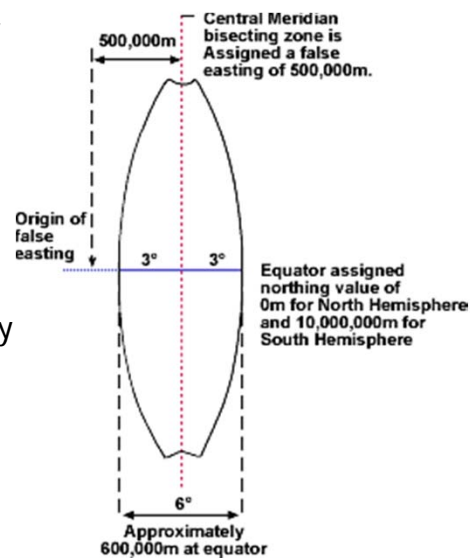
WATS 4930

UTM - HOW FAR IS SIX DEGREES?

- About 600,000 m at equator

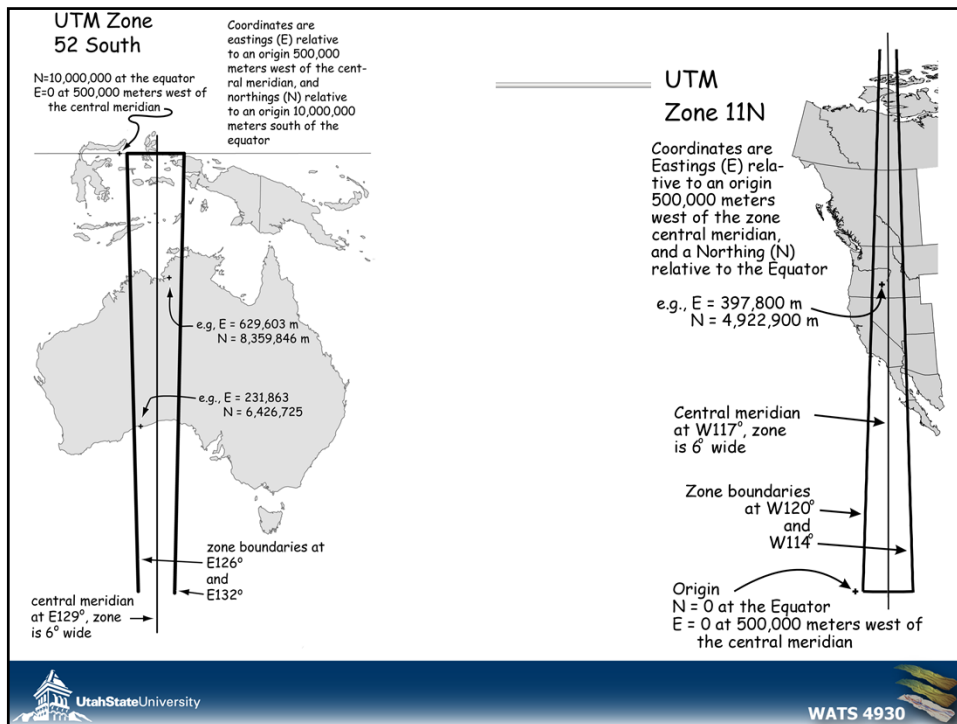
Positioning

- To locate within a zone, the distance in meters is measured from a reference point.
- **Central meridian** arbitrarily labeled 500,000 m **easting**
- **Equator** is labeled 0 m **northing**



UtahStateUniversity

WATS 4930



TODAY'S PLAN

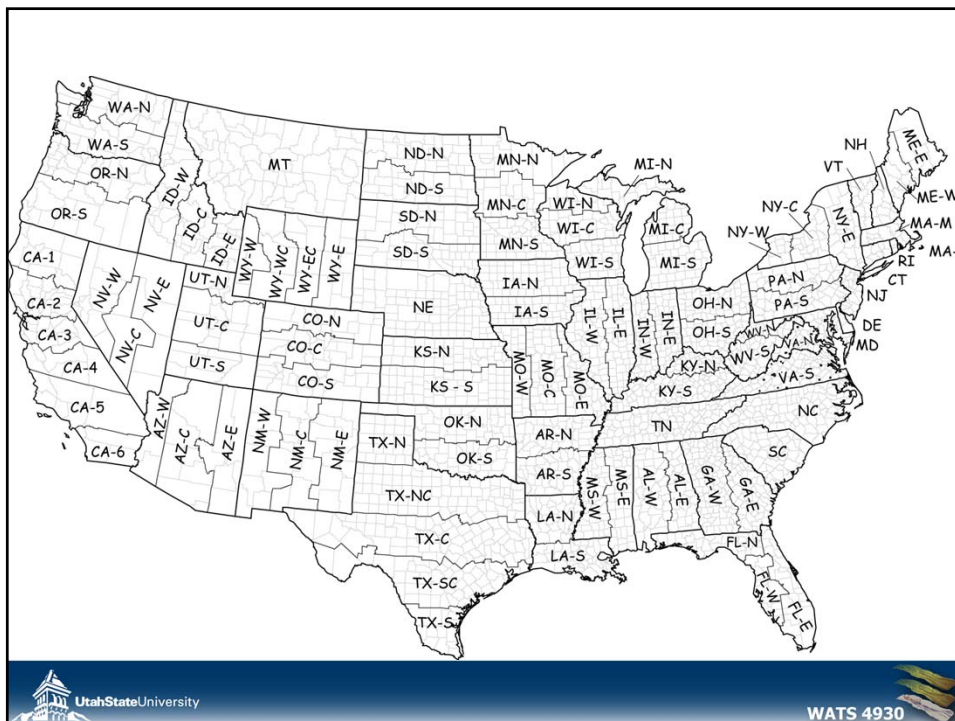
- I. Coordinate Systems
- II. Geographic Coordinates (i.e. non-projected)
- III. The Problem
 - I. Geoids -> Ellipsoids -> Spheroids
- IV. Map Projections & Projected Coordinate Systems**
 - I. The basics + most common CS in GIS
 - II. Universal Transverse Mercator Coordinate System
- III. State Plane Coordinate System**
- IV. Public Land Survey System
- V. Others
- V. Conversions between Coordinate Systems

STATE PLANE SYSTEMS

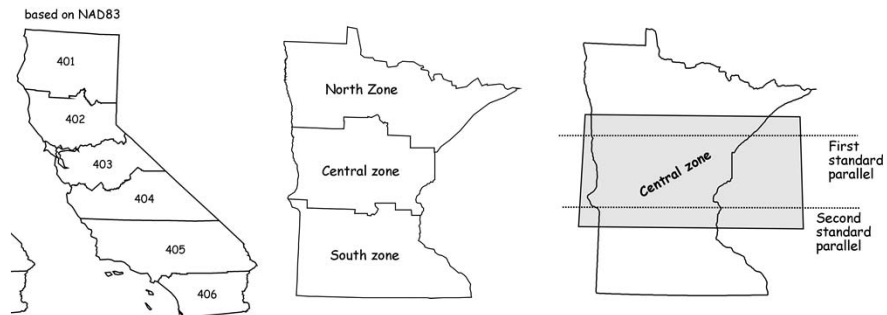
- Used 3 projections to minimize distortion to one part in 10,000:
 - Lambert conformal conic
 - Transverse Mercator Projection
 - Oblique Mercator Projection (for Alaska)



- Differs from UTM in origin:
 - Easting origin always arbitrary number of feet west of the western boundary of the zone
 - The northing origin not at the equator as in UTM, instead placed arbitrary number of feet south of the state border



CA and MN STATE PLANE EXAMPLES



- Some states have 1, most have 2-3, CA has 6

TODAY'S PLAN

- I. Coordinate Systems
- II. Geographic Coordinates (i.e. non-projected)
- III. The Problem
 - I. Geoids -> Ellipsoids -> Spheroids
- IV. Map Projections & Projected Coordinate Systems**
 - I. The basics + most common CS in GIS
 - II. Universal Transverse Mercator Coordinate System
 - III. State Plane Coordinate System
- IV. Public Land Survey System**
- V. Others
- V. Conversions between Coordinate Systems

FEDERAL LAND SURVEY – TRS or PLSS

- Initiated in the late 1700s. All but the original 13 states, and a few states derived from them, are covered by this system. Other exceptions occur in the SW United States, where land surveys may be based upon Spanish land grants, and in areas of rugged terrain that were never surveyed.
- State determines a principal meridian (longitude) and a base line (latitude). A grid is created by survey additional lines that are parallel to the principal meridian and base line and are 6 miles apart.
- NOT TRULY A COORDINATE SYSTEM!



WATS 4930

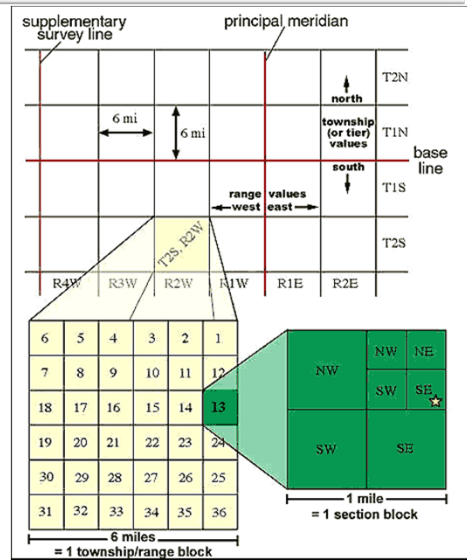
FEDERAL LAND SURVEY – TRS or PLSS

- Townships are the north-south 6-mile by 6-mile squares of land and ranges are the east-west 6-mile by 6-mile squares of land.
- The township and ranges are divided into 36 1-mile by 1-mile sections. The sections are numbered from 1-36 beginning in the northeast corner of the township or range.
- Sections are then divided into quarters which can become increasingly quartered and are labeled by direction (NW, NE, SW, SE).



WATS 4930

- So where are we?



30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	
6	5	4	3	2	1			22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
7	8	9	10	11	12			27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
18	17	16	15	14	13			34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
19	20	21	22	23	24			3	2	1																				
30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	
6	5	4	3	2	1			21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
7	8	9	10	11	12			27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
18	17	16	15	14	13			34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
19	20	21	22	23	24			3	2	1																				
30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	
6	5	4	3	2	1			21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
7	8	9	10	11	12			27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
18	17	16	15	14	13			34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
19	20	21	22	23	24			3	2	1																				
30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58			

	6	5	4	3	2	1
	7	8	9	10	11	12
	18	17	16	15	14	13
	19	20	21	22	23	24
	30	29	28	27	26	25
	31	32	33	34	35	36

TODAY'S PLAN

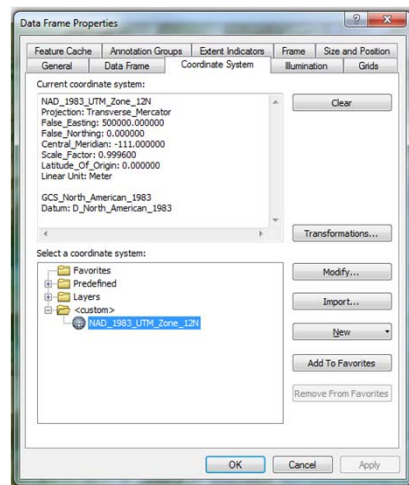
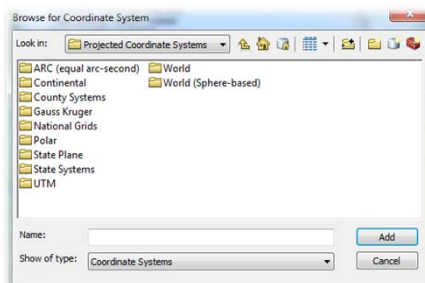
- I. Coordinate Systems
- II. Geographic Coordinates (i.e. non-projected)
- III. The Problem
 - I. Geoids -> Ellipsoids -> Spheroids
- IV. Map Projections & Projected Coordinate Systems**
 - I. The basics + most common CS in GIS
 - II. Universal Transverse Mercator Coordinate System
 - III. State Plane Coordinate System
 - IV. Public Land Survey System
- V. Others**
- V. Conversions between Coordinate Systems



WATS 4930

FINDING OTHER COORDINATE SYSTEMS

- You can browse...
- You can make your own...



WATS 4930

TODAY'S PLAN

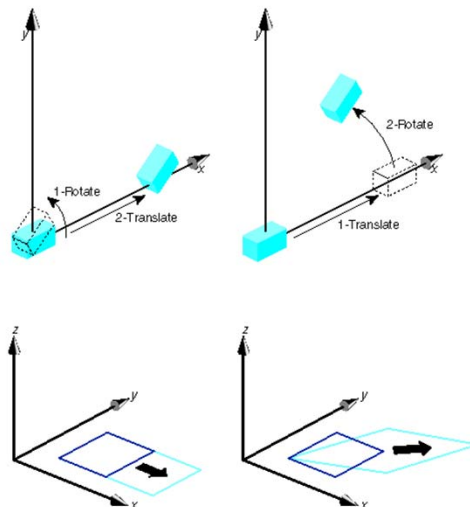
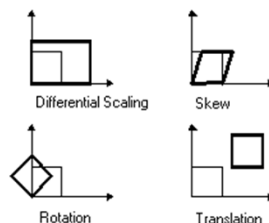
- I. Coordinate Systems
- II. Geographic Coordinates (i.e. non-projected)
- III. The Problem
 - I. Geoids -> Ellipsoids -> Spheroids
- IV. Map Projections & Projected Coordinate Systems
 - I. The basics + most common CS in GIS
 - II. Universal Transverse Mercator Coordinate System
 - III. State Plane Coordinate System
 - IV. Public Land Survey System
 - V. Others
- V. Conversions between Coordinate Systems**



WATS 4930

WAYS TO TRANSFORM VECTOR DATA

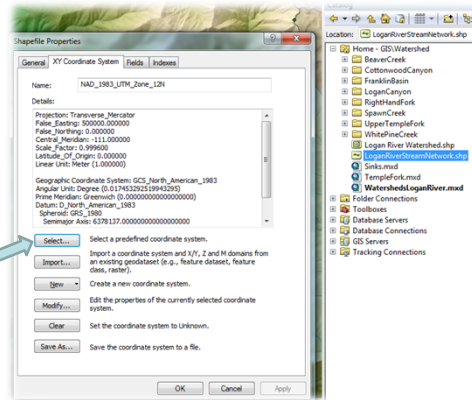
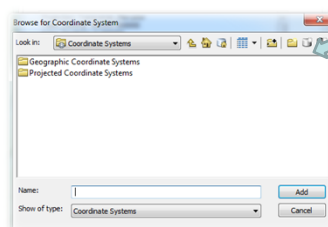
1. Scale (relative to?)
2. Rotate (about what?)
3. Translate (i.e. shift)
4. Skew



https://geodata.ethz.ch/geovite/tutorials/1.3GeodataAndSpatialRelation/en/html/unit_u2GeoRef.html
techpubs.sgi.com/library/tpl/cai-bin/getdoc.cai?coll=0650&db=bks&fname=/SGI_Developer/Cos3C_PG/ch06.html

WHAT DO YOU NEED TO KNOW?

- What are the choices you have?
 - Select?
 - Import?
 - New?
 - Modify?



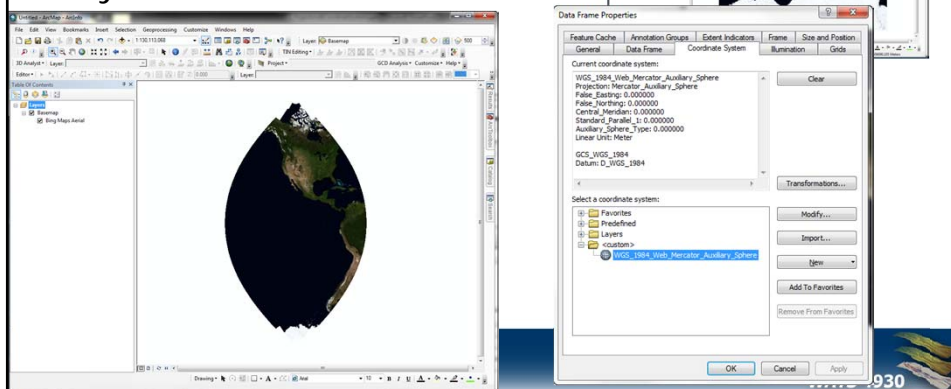
Geographic or Projected? Huh?



WATS 4930

A GOOD WAY TO APPRECIATE DIFFERENCES & TRANSFORMATIONS

- Start ArcMap
- Load Bing Imagery Basemap
- Change the Coordinate System of the Data Frame



DO NOT CONFUSE THE DIFFERENCES:

- Your *data* can **only** have **one** coordinate system (geographic or projected) associated with it!
 - This SHOULD not be changed without 'transforming' the data!
- Your *data frame* can be changed to many coordinate systems, many times...
 - Each time you do this, you are '**transforming**' and/or re-projecting the data '**on the fly**'
 - When you do this, your data IS NOT transformed and is kept in its original coordinate system
- "On the fly" visualization/transformation eliminates need to have data exist in multiple transformations



WATS 4930

TODAY'S PLAN

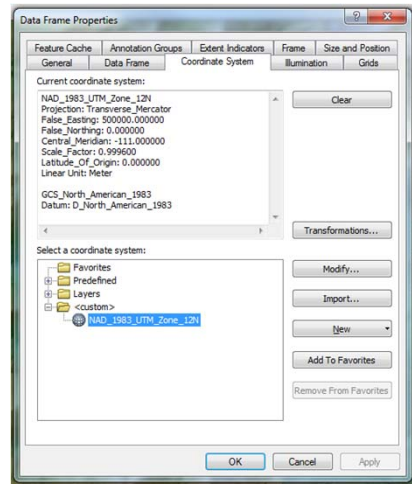
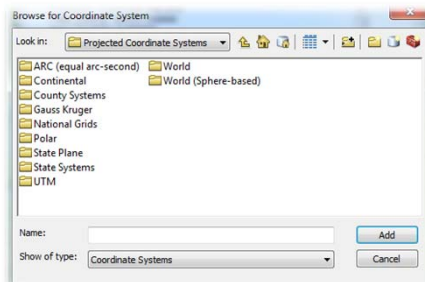
- I. Coordinate Systems
- II. Geographic Coordinates (i.e. non-projected)
- III. The Problem
 - I. Geoids -> Ellipsoids -> Spheroids
- IV. Map Projections & Projected Coordinate Systems
 - I. The basics + most common CS in GIS
 - II. Universal Transverse Mercator Coordinate System
 - III. State Plane Coordinate System
 - IV. Public Land Survey System
 - V. Others
- V. Conversions between Coordinate Systems



WATS 4930

WHAT WE REALLY WANTED OUT OF TODAY

- Make you not so dangerous when using coordinate systems
- Make sure you understand what you're doing when...



MAKE SENSE?

QUIZ 2 DUE BY THURSDAY (ON Canvas)

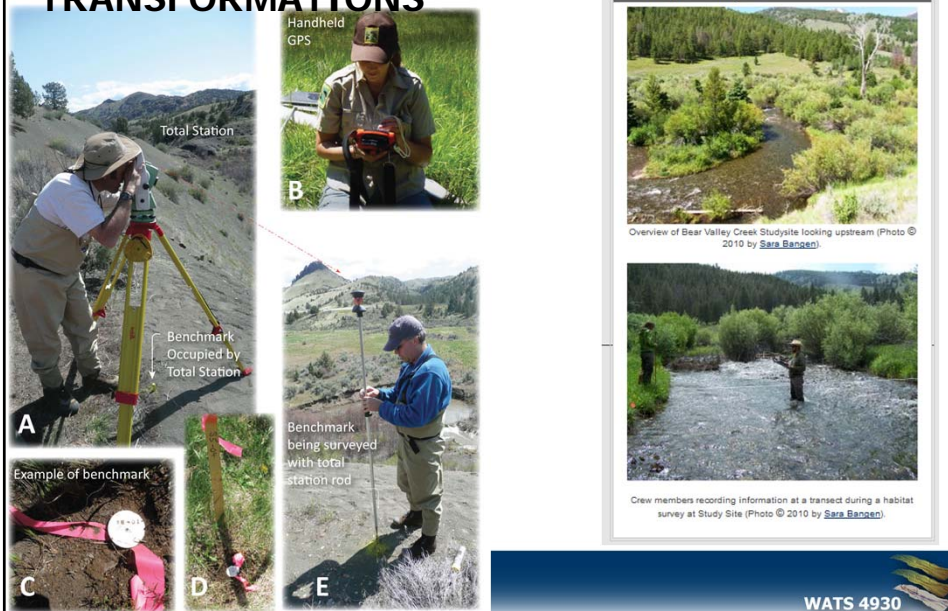
IN LAB THIS WEEK...

1. Do I know the difference between a geographic and a projected coordinate system?
2. Do I know the difference between Cartesian, polar and cylindrical coordinate systems?
3. What is an assumed coordinate system?
4. When is it necessary to transform my data from one coordinate system to another?
5. What is the appropriate transformation method to use?
6. When I download data, how do I know what coordinate system it is in?
7. How do I know if my data are in the right place?



WATS 4930

LAB 2 – COORDINATE DATA, PROJECTIONS & TRANSFORMATIONS



LAB 2 – COORDINATE DATA, PROJECTIONS & TRANSFORMATIONS

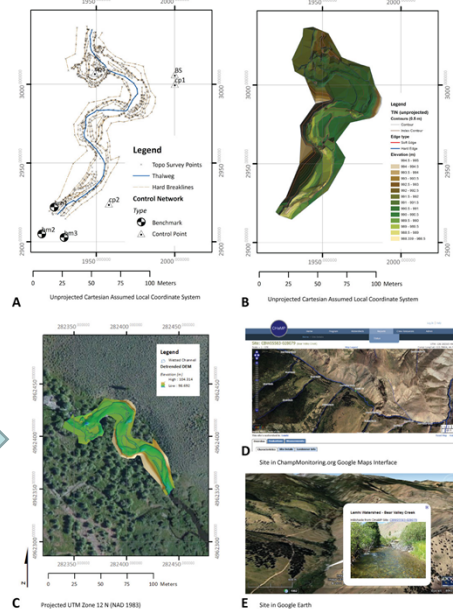
Raw TS Data:

Local, Assumed,
Cartesian Coordinate
System



Transformed TS Data:

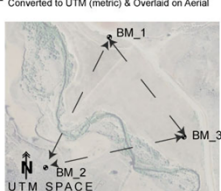
Projected in UTM Zone
12N, real world
coordinate system



LAB 2 – COORDINATE DATA, PROJECTIONS & TRANSFORMATIONS

```
bm,northing,easting,elevation
1,4962349,282436,1956
2,4962333,282449,1959
3,4962345,282457,1958
```

A GPS BENCHMARKS

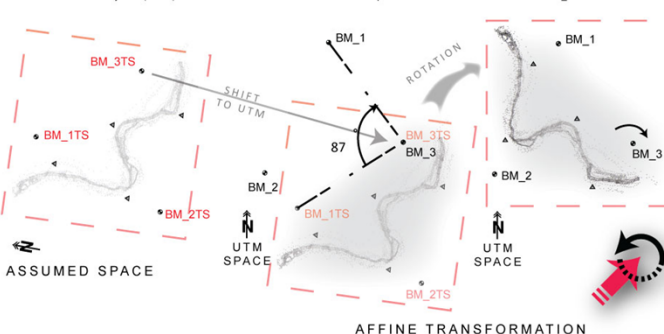


Three intervisible benchmarks,
spread out across survey area
& acquired with both GPS & TS




B TOTAL STATION SURVEY:

Assumed Coordinate System (metric)



WATS 4930

READING FOR THURSDAY

**UtahStateUniversity**
DEPARTMENT OF WATERSHED SCIENCES

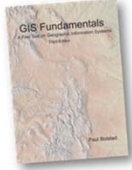
ADVANCED GIS COURSES
WATS 4930/6920, 4931/6921, 6915


Search this site

GIS Classroom
Home
▼ About the Courses (Syllabi)
Grades
Instructors
Primary Learning Outcomes
Software
Course Topics
▼ Assignments
Labs (4930/6920/6915)
Project (4931/6921)
Reading Assignments
Class Announcements
Class Calendar
Class Forum
▼ Useful Quick References
Getting Organized and Oriented
Figure Preparation Guidelines
Nice Maps!
GIS Class LibGuide
Help
© 2013 Copyright & Disclaimers

Assignments > Reading Assignments >
Reading for Thursday, January 17th, 2013
posted Jan 14, 2013, 11:41 AM by Joe Wheaton
Finish reading the following by **Thursday, January 17, 2012** (before lecture):

- Although Bolstad's chapter is a nice generic review, it is actually more helpful to talk specifically about the data formats that ESRI uses. Read through the following pages:
 - [How a GIS represents and models geographic information](#)
 - [Three fundamental representations of geographic information layers](#)
 - [About Geographic Data Formats](#)
- Skim very briefly the following from Chapter Two (Data Models) of [Bolstad \(2005\)](#)
 - pp 25-30 in detail (especially part on coordinate data)
 - skim page 31 on Attribute Data
 - skim pp 32-42 on Vector Data
 - skim pp 42-46 on Raster Data
 - skip pp 47-60 (or very quickly flip through)
 - pp 61-62 in detail starting with 'Common File Formats'



**UtahStateUniversity**

WATS 4930