Datums, Coordinate Systems, Coordinate Reference Systems and Datum Transformations

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Geodetic Terminology (ISO compliant)

- Topography
- Geoid
- Ellipsoid (or Spheroid?)
- Coordinate System (*i.e.*, system of axes)
- Prime Meridian
- Geodetic Datum
  - Local Datums
  - Geocentric Datums / Global Datums
- Ellipsoid and Datum are <u>NOT</u> synonymous!
  - Assuming otherwise can lead to a costly mistake.
- Geographic Coordinate Reference System (CRS)
  - GeogCRS have often been called "Datums"

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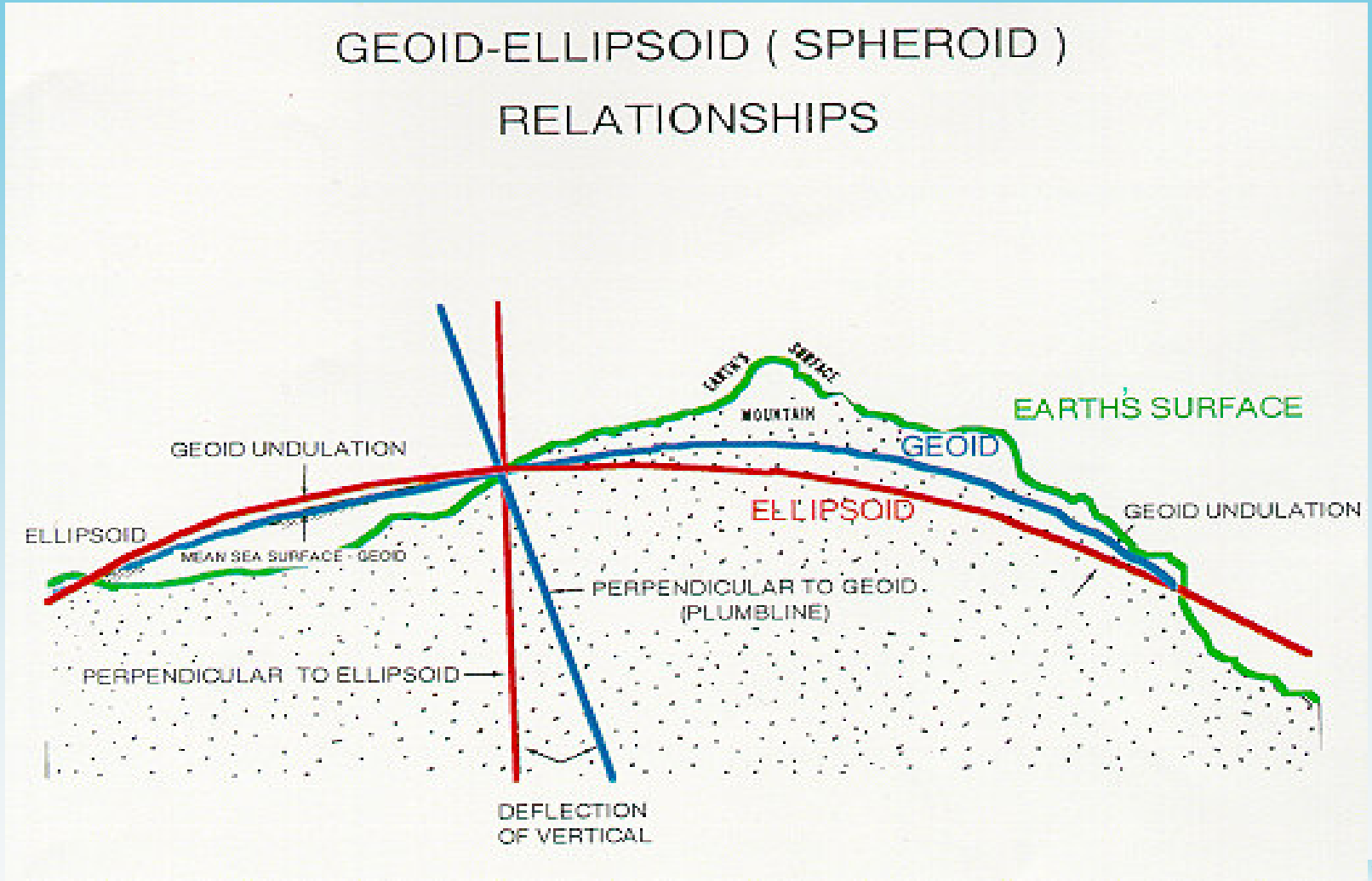
Ellipsoid, Geoid and Height Relationships



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More Terminology and Basic Truths

- Latitude and Longitude are NOT UNIQUE!

  but vary from one GeogCRS to another

  (a GeogCRS is sometimes called a datum)

- **Geodetic Transformations or "Datum Shifts" or "Datum Transformations"**
- **Map Projection**
- **Projected Coordinate Reference System (ProjCRS)**

  A Projected CRS is sometimes called a Projection.

This terminology is found in Oracle, DB2, MySQL, etc. – slowly been adopted over the years

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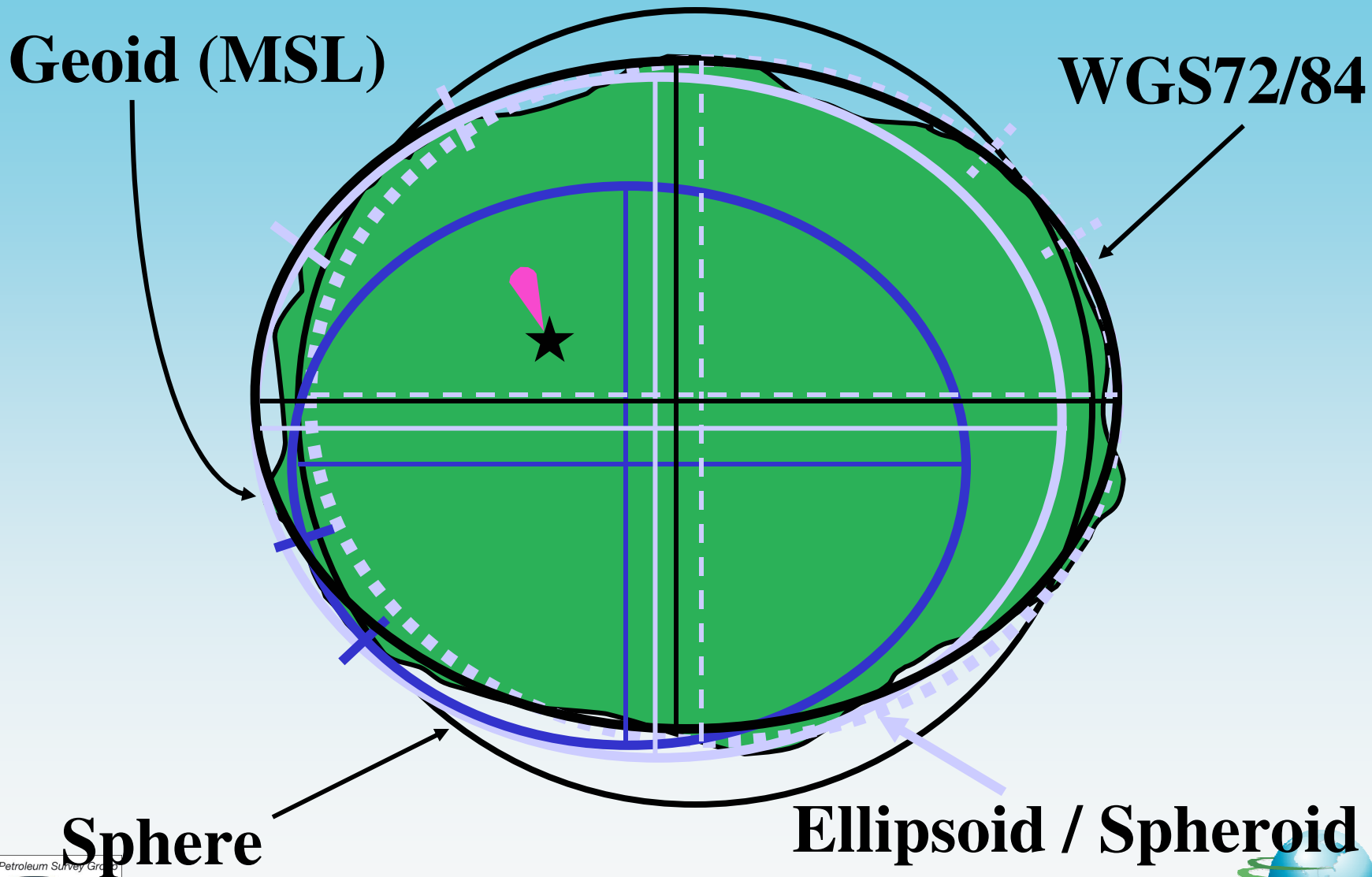
Representations of the Earth's Surface



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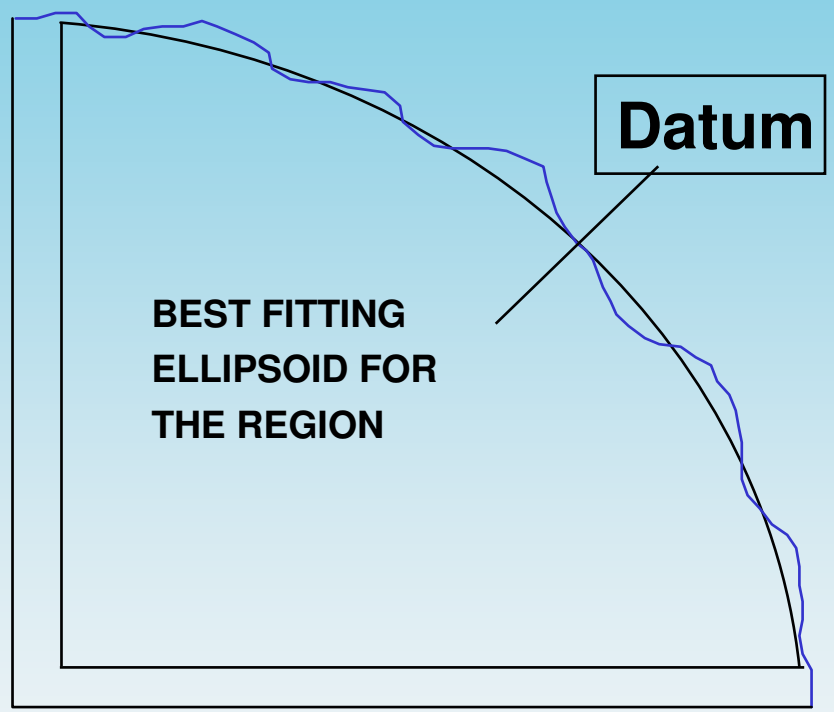
Astrogeodetic Datums

- DATUM = COORDINATE FRAME + REFERENCE ELLIPSOID
- Used for a specific region e.g. North America, Europe, South America etc.
- A coordinate frame is determined and an ellipsoid chosen to minimize the local geoid-ellipsoid separation.
- Not Earth centered!
- Hundreds have been defined for countries all over the planet



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Some Reference Ellipsoids

Ellipsoid	Semi Major Axis	Inv. Flattening
Airy 1830	6377563.396	299.3249646
Modified Airy	6377340.189	299.3249646
Australian National	6378160	298.25
Bessel 1841 (Namibia)	6377483.865	299.1528128
Bessel 1841	6377397.155	299.1528128
Clarke 1866	6378206.4	294.9786982
Clarke 1880	6378249.145	293.465
Everest (India 1830)	6377276.345	300.8017
Everest (Sabah)	6377298.556	300.8017
Everest (India 1956)	6377301.243	300.8017
Everest (Malaysia 1969)	6377295.664	300.8017
Everest (Malay. & Sing)	6377304.063	300.8017
Everest (Pakistan)	6377309.613	300.8017
Modified Fischer 1960	6378155	298.3
Helmert 1906	6378200	298.3
Indonesian 1974	6378160	298.247
International 1924	6378388	297
Krassovsky 1940	6378245	298.3
GRS 80	6378137	298.257222101
South American 1969	6378160	298.25
WGS 72	6378135	298.26
WGS 84	6378137	298.257223563

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PROJ.4 Ellipsoid (Spheroid)

Defined as :

+ellps=<name> or

+a=<semi_major_axis>

+b=<semi_minor_axis>

Or defined with:

+a=<semi_major_axis>

+rf=<inverse_flattening>

Axis defined in meters .

Examples :

“+ellps=WGS84”

“+a= 6378137.0 + rf= 298.257223563”

Use “cs2cs - le” to get a list of known ellipsoids .

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Examples of Datums

Datum Origin	+ Reference Ellipsoid	= Datum
11 main stns (UK)	Airy	OSGB36
many pts (global)	WGS72 ellipsoid	WGS72
1591+ pts (global)	WGS84 ellipsoid	WGS84
Potsdam	International 1924	ED50
La Canoa, Venez.	International 1924	PSAD56
Meades Ranch, KS	Clarke 1886	NAD27
Global, numerous pts	GRS80	NAD83
Herstmonceux, UK	Airy	OS(SN)70
Manoca Twr, Cmr.	Clarke 1880 IGN	MANOCA
Minna stn, Nigeria	Clarke 1880 RGS	MINNA
ITRF yyyy where yyyy = adj. year	GRS80	ITRS

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PROJ.4: Datums

Defined as :

+datum=<datum_name>

+towgs84= <x_shift> ,< y_shift> ,< z_shift>

+towgs84= < xs> ,< ys> ,< zs> ,< xr> ,< yr> ,< zr> ,

<s>

+nadgrids= < list of grid shift files>

Examples :

- “+datum=WGS84”
- “+towgs84= -263.0,6.0,431.0 + ellps=clark80”
- “+nadgrids= ntv1_can.dat +ellps= clrk66”

Use “cs2cs - ld ” to get a list of known datums.

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PROJ.4 Dictionaries

- Common coordinate systems defined in dictionaries .
- Format : +init= <dictionary>:< name>
- Example: + init= epsg:4326
- Dictionaries are text files in

/ usr/ local/ share/ proj

- Search them with a text editor!
- Declarations look like:

WGS 84

<4326> +proj=longlat +datum=WGS84 +no_defs <>

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PROJ.4 Dictionaries

Distributed Dictionaries :

- epsg: Definitions for EPSG GCS and PCS.
- nad27: State plane zones keyed on USGS zone #
- nad83: State plane zones keyed on USGS zone #
- esri: ESRI extended “EPSG” database
- other.extra: OGC WMS “EPSG” extensions
- world : as sorted additional common projections

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Open Geospatial Consortium "Well Known Text"

- OGC WKT is a "standard" for exchange of coordinate systems.
- Originally from Simple Features for SQL
- Variations used by ESRI "Projection Engine", Oracle, AutoMap , Mapguide,GDAL/ OGR and PostGIS
- Not to be confused with WKT geometries

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OGR WKT Example

```
PROJCS["NAD27 / New York Eas t ",
GEOGCS["NAD27",
DATUM["Nor th _Amer ican _Datum_1927",
SPHEROID["Clarke 1866",6378206.4,294.9786982138982,
AUTHORITY["EPSG","7008"]],
AUTHORITY["EPSG","6267"]],
PRIMEM["Greenwich ",0,
AUTHORITY["EPSG","8901"]],
UNIT["d egree",0.01745329251994328,
AUTHORITY["EPSG","9122"]],
AUTHORITY["EPSG","4267"]],
PROJECTION["Tran sver s e_Mercator "],
PARAMETER["lat itud e_of_or igin ",40],
PARAMETER["cen t ral_mer id ian ",- 74.333333333333333],
PARAMETER["s cale_factor ",0.999966667],
PARAMETER["fals e_eas t in g",500000],
PARAMETER["fals e_n or th in g",0],
UNIT["US survey foot ",0.3048006096012192,
AUTHORITY["EPSG","9003"]],
AUTHORITY["EPSG","32015"]]
```

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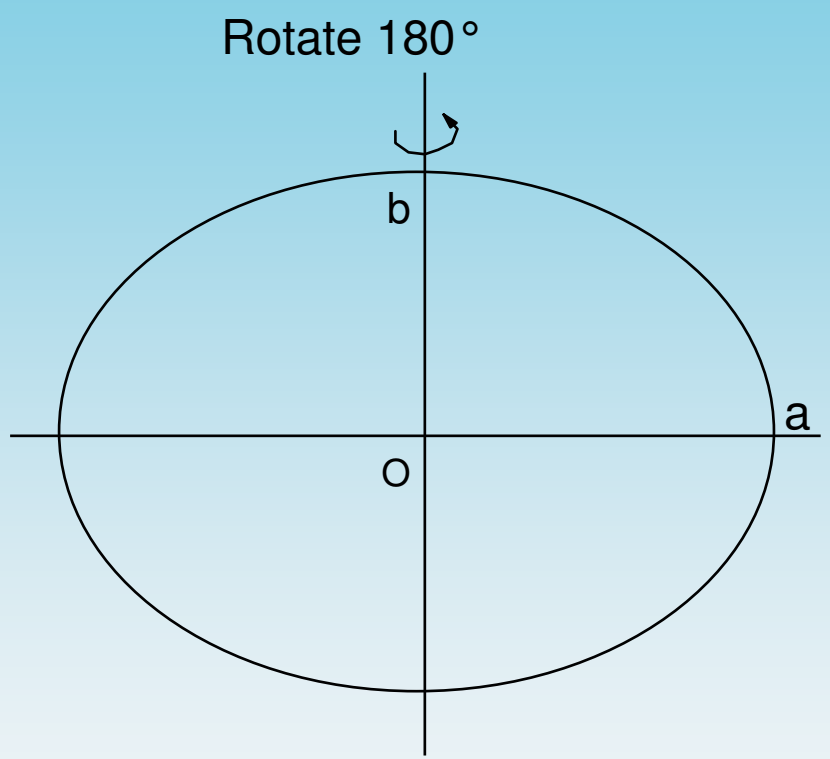
Formulae associated with the Ellipsoid

$$e^2 = \frac{(a^2 - b^2)}{a^2}$$

$$e'^2 = \frac{(a^2 - b^2)}{b^2}$$

$$Flattening = \frac{(a - b)}{a}$$



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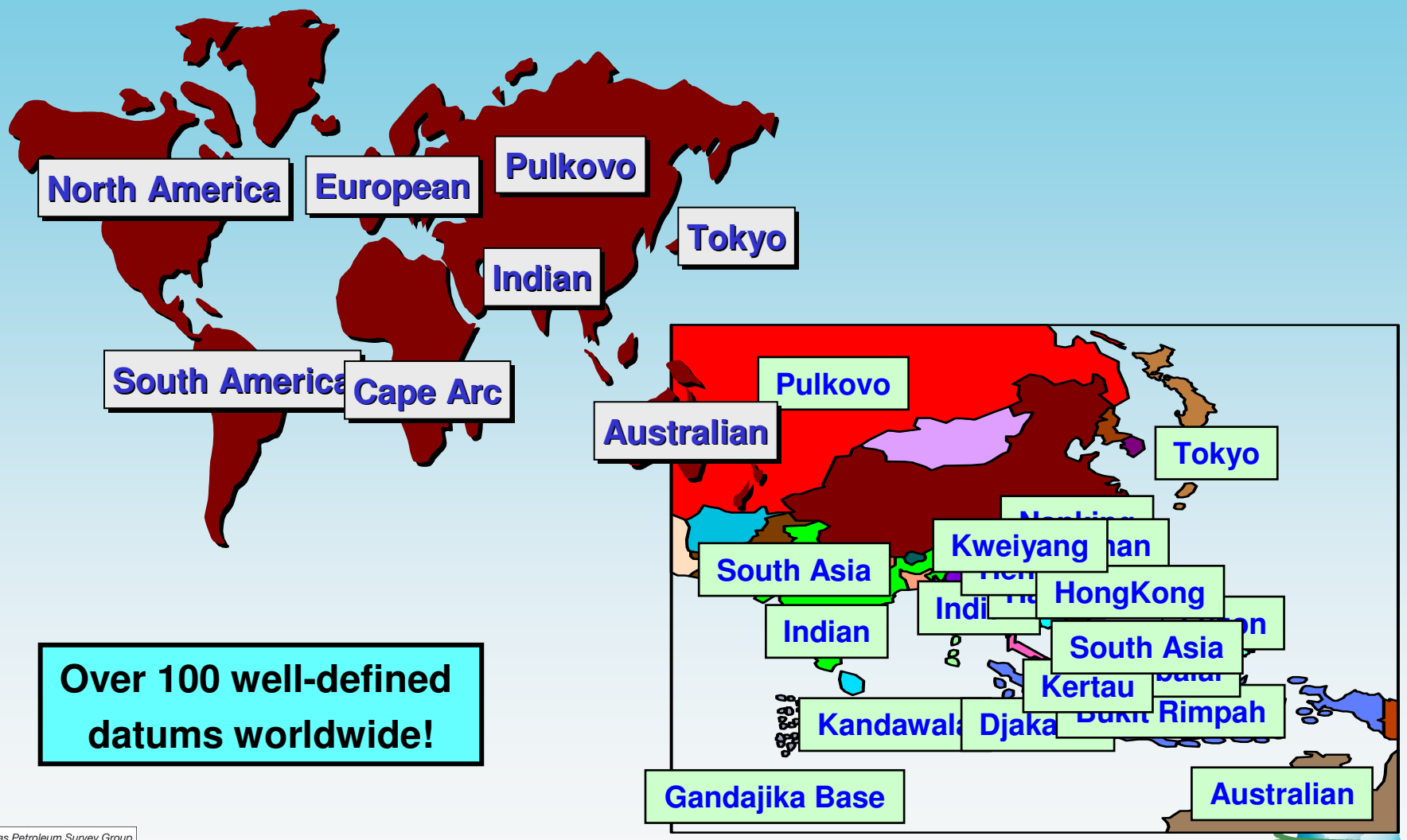
Major World Datum Blocks



Over 100 well-defined datums worldwide!

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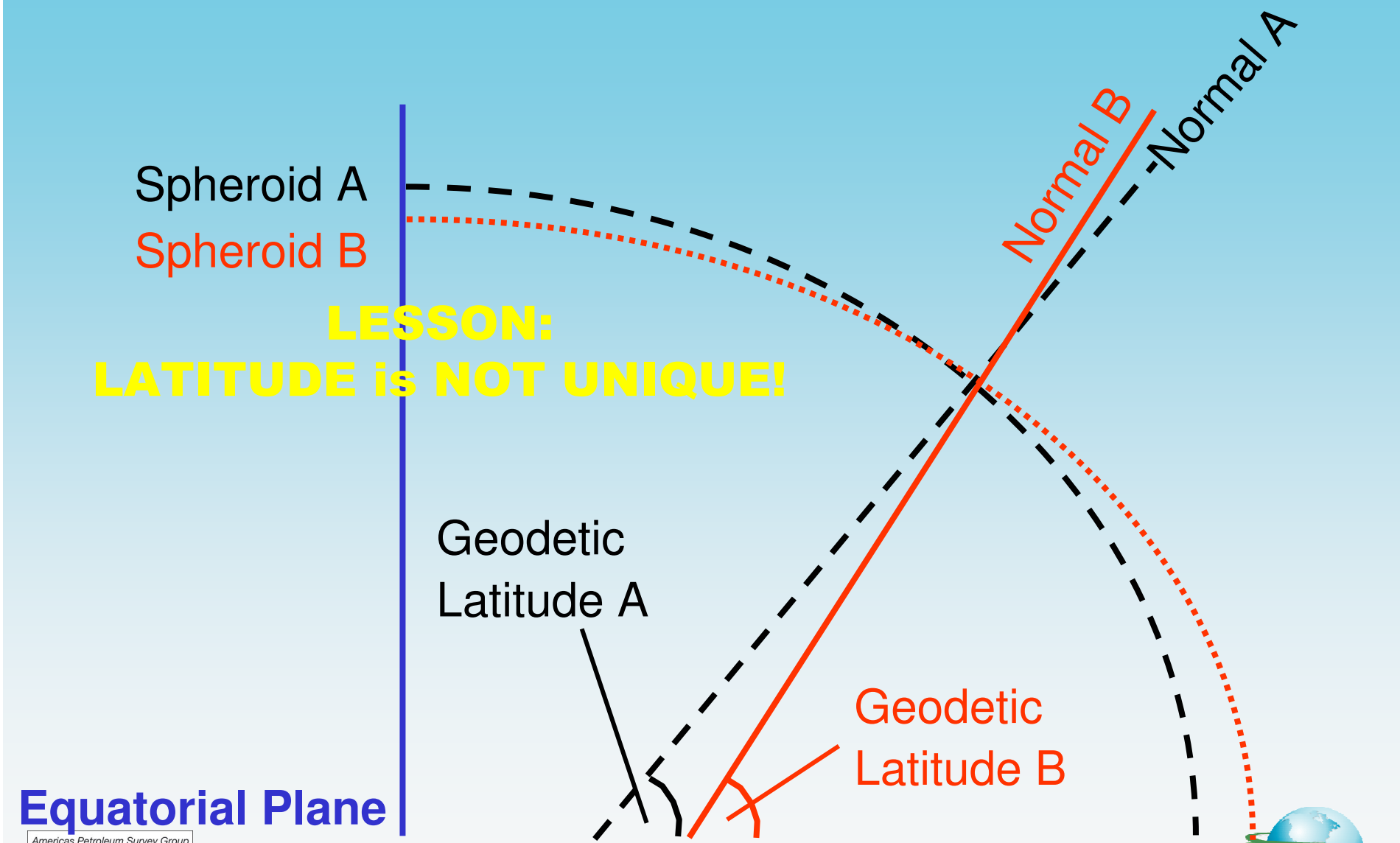
Geodetic Latitude



LESSON:
LATITUDE is NOT UNIQUE!

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Latitude and Longitude are not Unique!

A single EXAMPLE POINT offshore Cameroon, West Africa in different GeogCRS/Datums.

Geographic coordinates:

GeogCRS/Datum	Latitude	Longitude
Manoca	N 04° 04' 17.179”	E 008° 29' 43.774”
Minna	N 04° 04' 12.077”	E 008° 29' 41.572"
WGS 84	N 04° 04' 14.504”	E 008° 29' 39.351”

(using GULF1977 transformation from Manoca to WGS84 and MPN 1994 transformation from Minna to WGS84)

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Geographic Coordinate System – DD & DMS

- A reference system using latitude and longitude to define the location of points on the surface of a sphere or spheroid

decimal degrees (DD) -92.5

degrees/minutes/seconds (DMS) 92° 30’ 00” W

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Geographic Coordinate System

- **Universal Coordinate System (lat/lon)**
- **Lat/lon good for locating positions on surface of a globe**
- Lat/lon is not efficient for measuring distances and areas!
  - **Latitude and longitude are not uniform units of measure**
  - **One degree of longitude at equator = 111.321 km (Clarke 1866 spheroid)**
  - **One degree of longitude at 60° latitude = 55.802 km (Clarke 1866 spheroid)**

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Mixing Datums

- West Texas Central Zone — Texas
- NAD27
  - Lat: 32° N
  - Long: 105° W
- NAD83
  - 32° 00' 00.54" N
  - 105° 00' 01.87" W
- Differences
  - DE 158.8 ft
  - DN 60.9 ft
  - DR 170.0 ft
  - N 108.3 ft

- Montana South Zone — Montana
- NAD27
  - Lat: 45° N
  - Long: 112° W
- NAD83
  - 44° 59' 59.654" N
  - 112° 00' 03.075" W
- Differences
  - DE 222.0 ft
  - DN 30.0 ft
  - DR 223.7 ft
  - N 88.6 ft

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Different Datums (& GeogCRS)

ONE location offshore Brazil, represented on three different Datums (different GeogCRS).

Geographic positions:

GeogCRS/Datum	Latitude	Longitude
Aratu	20º 36’ 13.2757”N	38º 56’ 56.3341”W
SAD69	20º 36’ 17.4283”N	38º 56’ 50.1240”W
WGS84	20º 36’ 19.2794”N	38º 56’ 51.2166”W

Differences in Lat/Long coordinates are evident.

But . . . What if you didn’t have the Datum label?

Where is? 20º 36’ 15.444” N 38º 56’ 53.111” W

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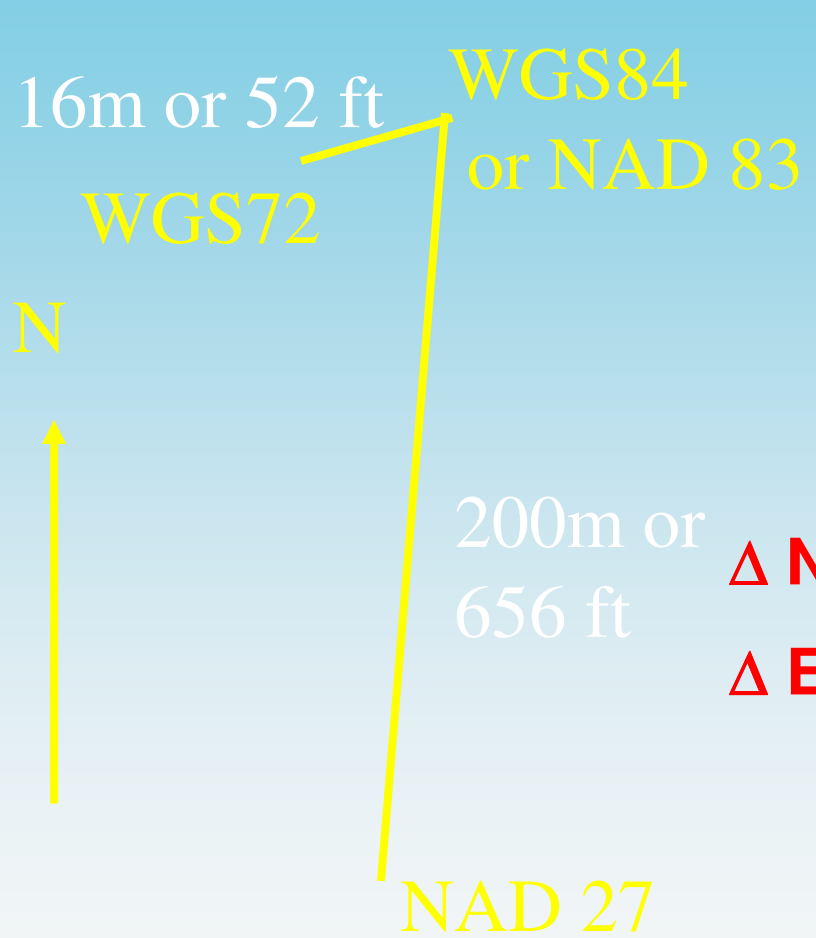
Different Datums for a Plotted Position in the Central Gulf of Mexico



WGS 84:
Lat: 27º 00' 37.53" N,
Long: 92º 14' 11.10" N

NAD 27 minus WGS 84:
Δ Latitude = -1.062"
Δ Longitude = -0.441"

Δ Northing = -199.88 m (-656 feet)

Δ Easting = + 13.76 m (45 feet)

NAD 27
Lat: 27º 00' 36.47" N
Long: 92º 14' 10.66" N

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1” of Latitude = 30.0 meters?

While working in one GeogCRS (Datum)

1” latitude = 30.9 meters,

1” longitude = 30.9 meters * cos (latitude)

This is <u>NOT</u> valid when geographic coordinates are on <u>DIFFERENT</u> datums.

–The example NAD27 and WGS84 latitude on the previous slide differs by only **1.06”** , whereas the physical offset is approximately **199.9m (656 feet)**

–Why is this the case?

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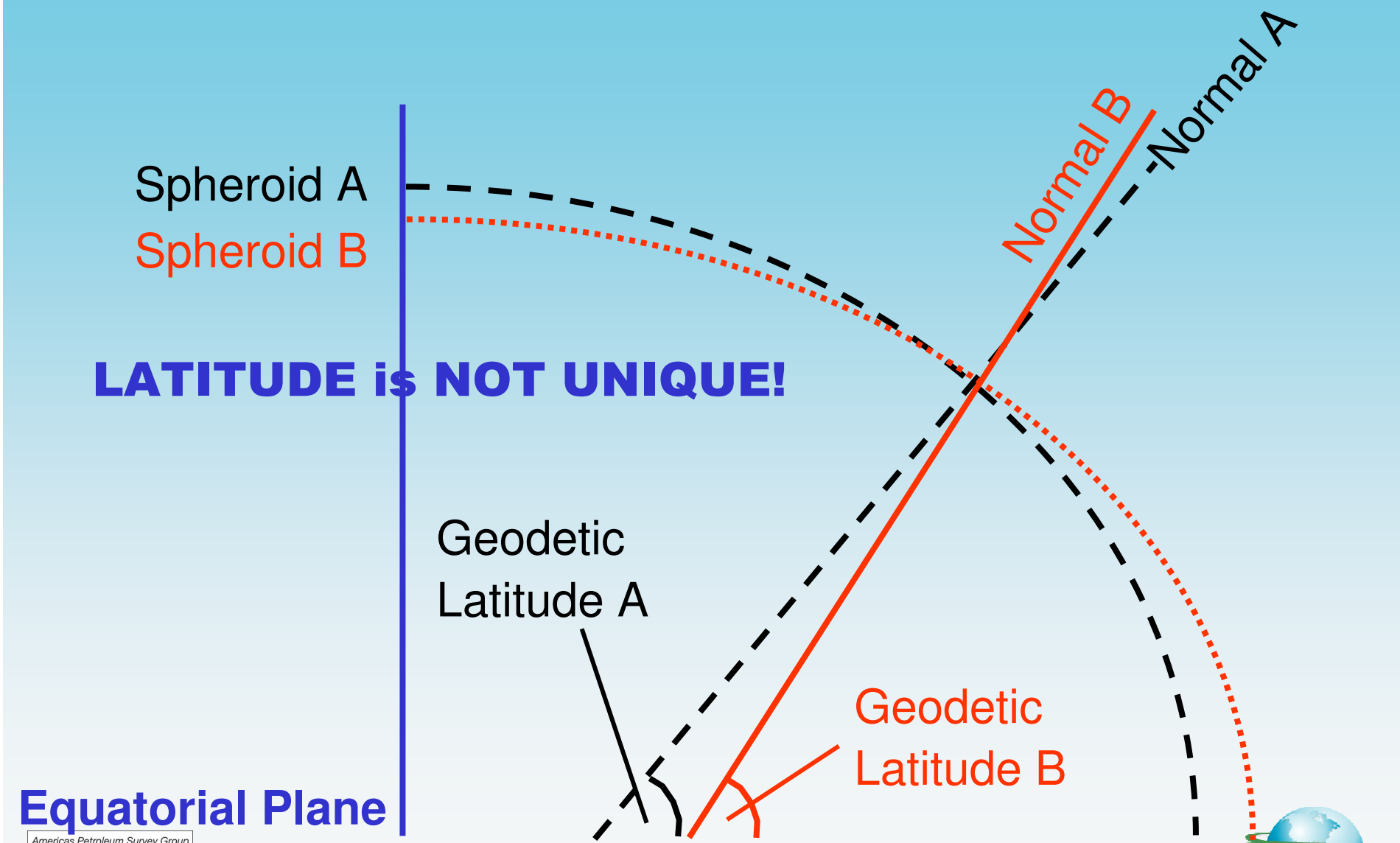
Geodetic Latitude



LATITUDE is NOT UNIQUE!

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If you remember nothing else.....

Major Point to Remember :

Latitudes and Longitudes are not unique unless qualified with a Datum or GeogCRS name!

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Geodetic Transformations (Datum Shifts)

- **How do we get from one GeogCRS (Datum) to another?**
  - Often, there are many choices available
  - How do you choose the correct transformation?
- **How did this profusion of datum transformations between the various GeogCRS occur?**
  - Little sharing of geodetic information.
  - Operators needed more accurate transformations.
  - Satellite receivers could measure directly.

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Geodetic Transformations (Datum Shifts) continued

- **Which transformation should I use?**

- **If I'm working in a "local" datum (GeogCRS), why do I need a datum shift at all?**
  - Most positioning work in the energy/mining/forestrysector is done by GPS measurements solely linked to the WGS 84 GeogCRS (& Datum)
  - To obtain coordinates in a "local" reference system, someone <u>MUST</u> transform from WGS 84 to that local GeogCRS.
  - If different datum shifts are used, then different geographic coordinates will be obtained.

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Geodetic Transformation Methods

- **How do you go from GeogCRS1 to GeogCRS2 (Datum1 to Datum2)**
  - Geocentric Translation (3-parameters)
  - 7-parameter transformations
    (Special caution MUST BE EXERCISED here!)
  - Many other transformation methods exist, with limited applications

- **Transformations are usually between two GeogCRS, but affine transformations can be between two Projected systems (ProjCRS)**

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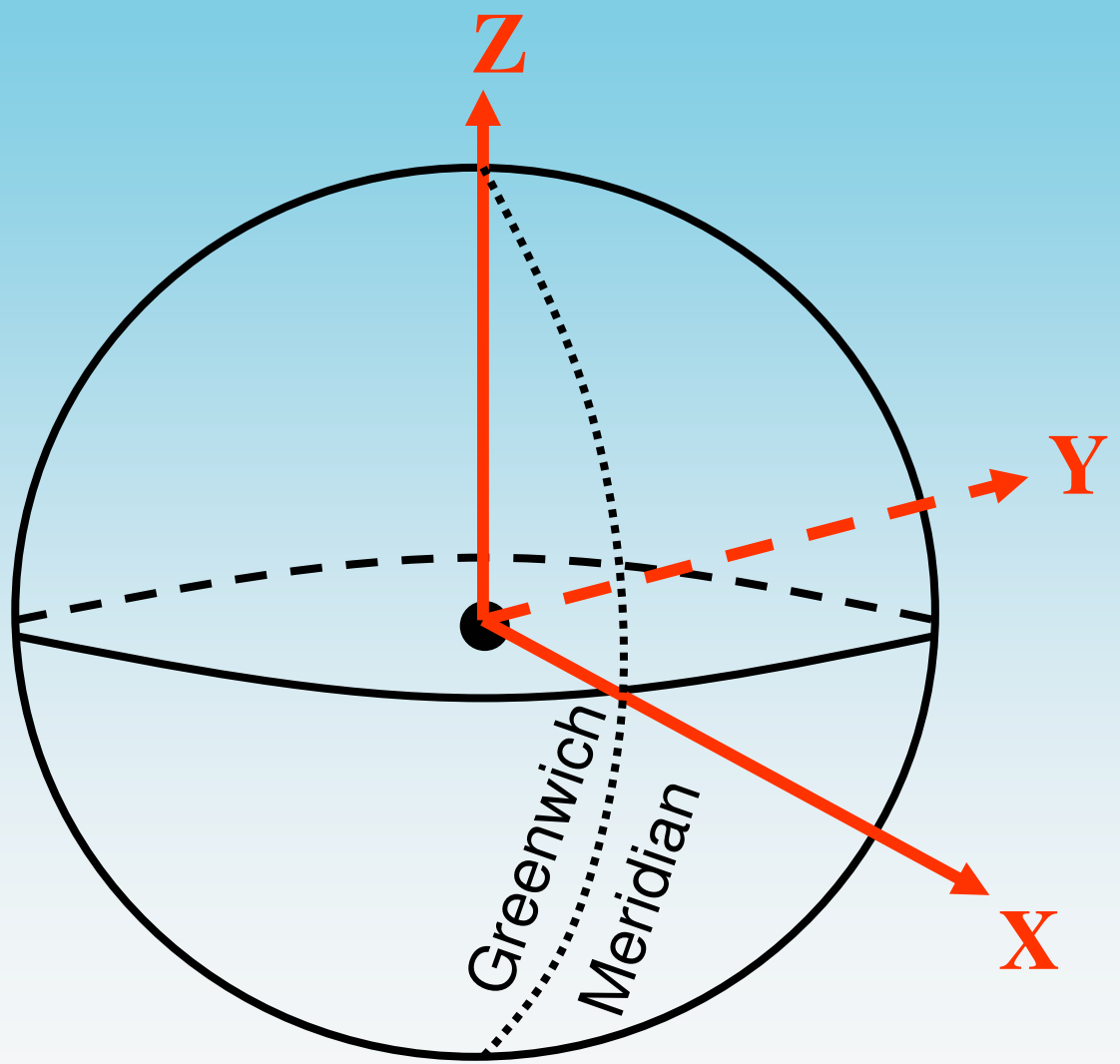
Geocentric Cartesian Co-ordinates



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Leads to: Axis Order Confusion

- From the perspective of a geographic software design three coordinate systems can potentially be addressed. Each differ either in the order of the coordinate tuple or in the direction of increasing values.
- Mathematical
  - Axis Order (X,Y)
  - Signed values, increase to the right und upwards
- Computer Graphics
  - Axis Order (X,Y)
  - Unsigned values increase to the bottom and to the right. The resutling graphics (often the screen or window size) size is a limit
- Geographical Coordinate Systems
  - Axis Order varies, sometimes (Y,X), othertimes (X,Y)
  - Signed values increase right and up limited to -180, -90, 180, 90 (a shperoid)
- All result in an ordered pair of numbers describing a position in space but there is some confusion as to the order.
- http://wiki.osgeo.org/index.php/Axis_Order_Confusion

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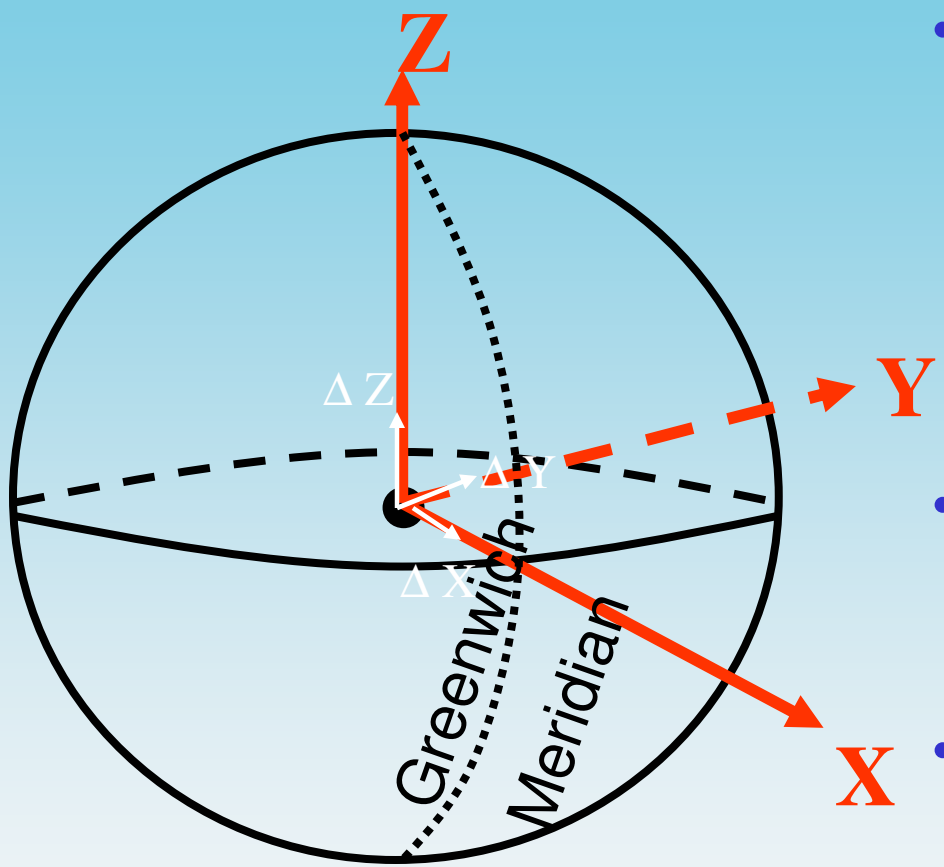
Geocentric Translations



- Geocentric Translations along the ellipsoid's coordinate axes, expressed as:
  ΔX, ΔY, & ΔZ
- Most common transformation
- NIMA TR8350.2 tables use this method.

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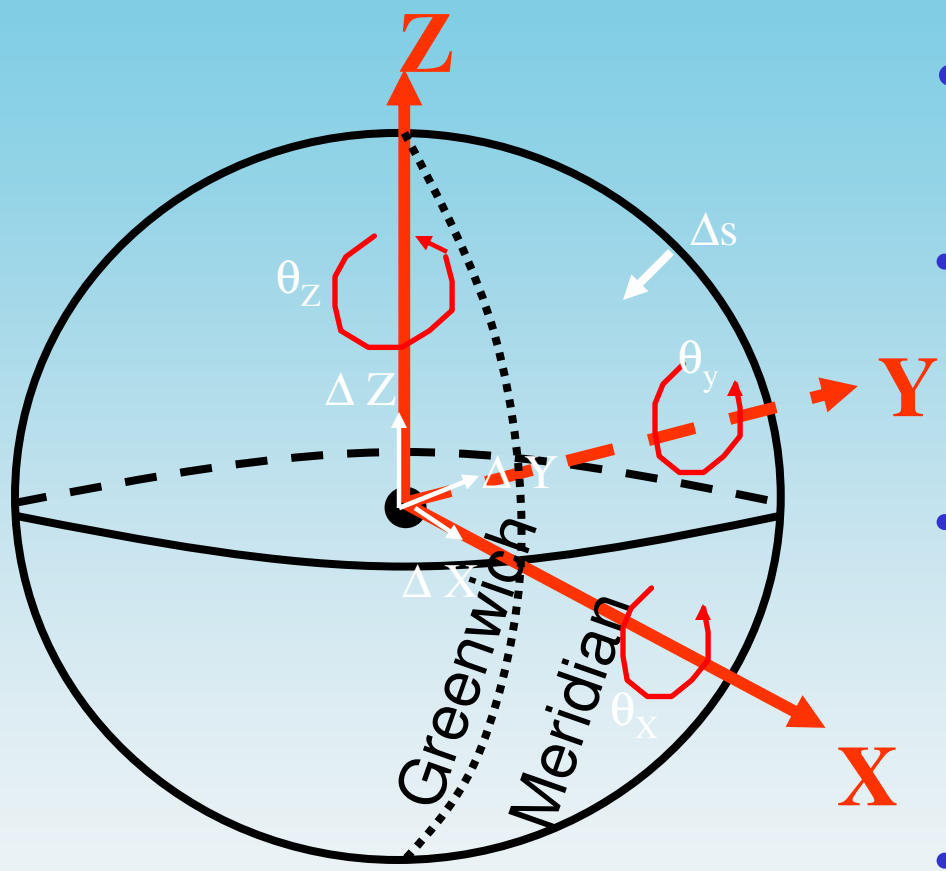
7-Parameter Transformations



- **Parameters are:**
- **3 translations**
  Δ X, ΔY, ΔZ
- **3 rotations, one about each axis: rX, rY, rZ (or θ_X, θ_Y, θ_Z)**
- **Scale change (or Δs)**

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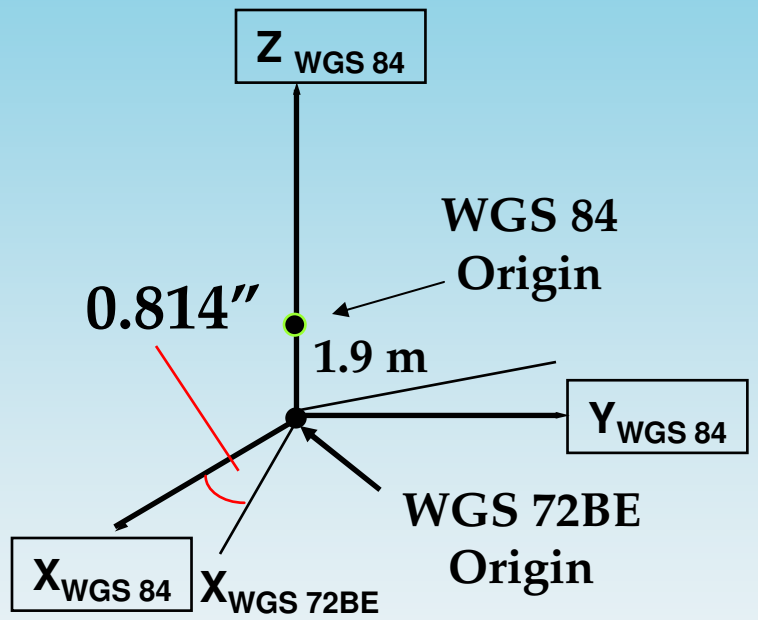
Local to WGS 72BE to WGS 84 Datum

- Many transformations from Local Datums to WGS72 BE were obtained using Transit Satellite Receivers.
- Combined with WGS72BE to WGS 84, these yield transformations from Local Datum to WGS 84.
- Scale and Rotation terms are important and <u>cannot be ignored</u>.



Δ-scale = -0.38ppm for WGS 72BE to WGS 84

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7-parameter (and 10-parameter) Datum Transformations

- CAUTION: two different rotation conventions for 7-parameter transformations are accepted for use.
  - Position Vector 7-parameter Transformation
  - Coordinate Frame Rotation
- BOTH are sanctioned by UKOOA

- How about 10-parameter transforations?
  - The Molodenski-Badekas transformation allows for rotation about a specific point.
  - Other ten-parameter transformations allow for earth's velocity!

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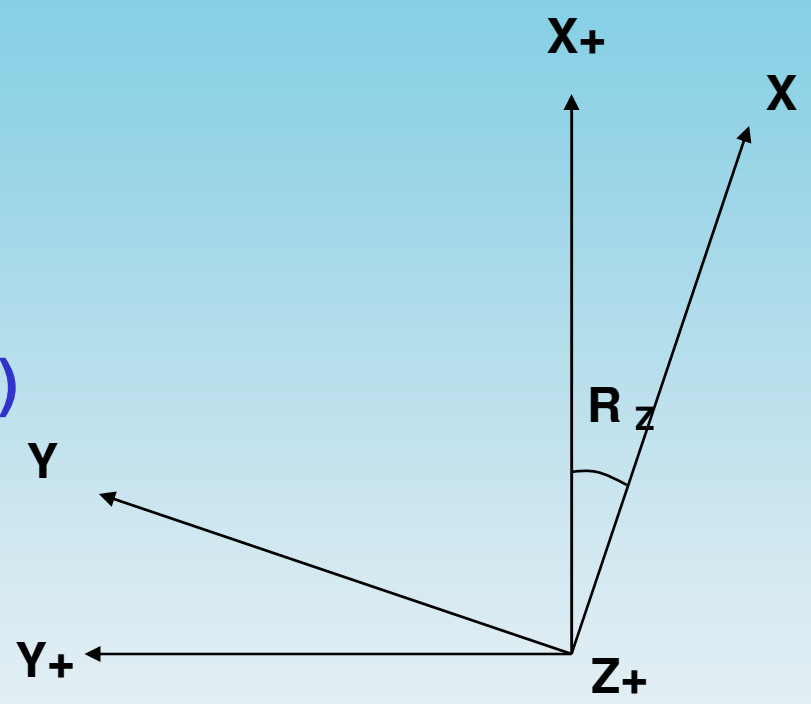
Coordinate Frame Rotation (about the Z-axis)

- θz, rotation about the Z axis is applied here.
- If you were on the earth looking up, the rotations would be reversed (to Position Vector Rotation)



Looking down on the earth from above the North Pole

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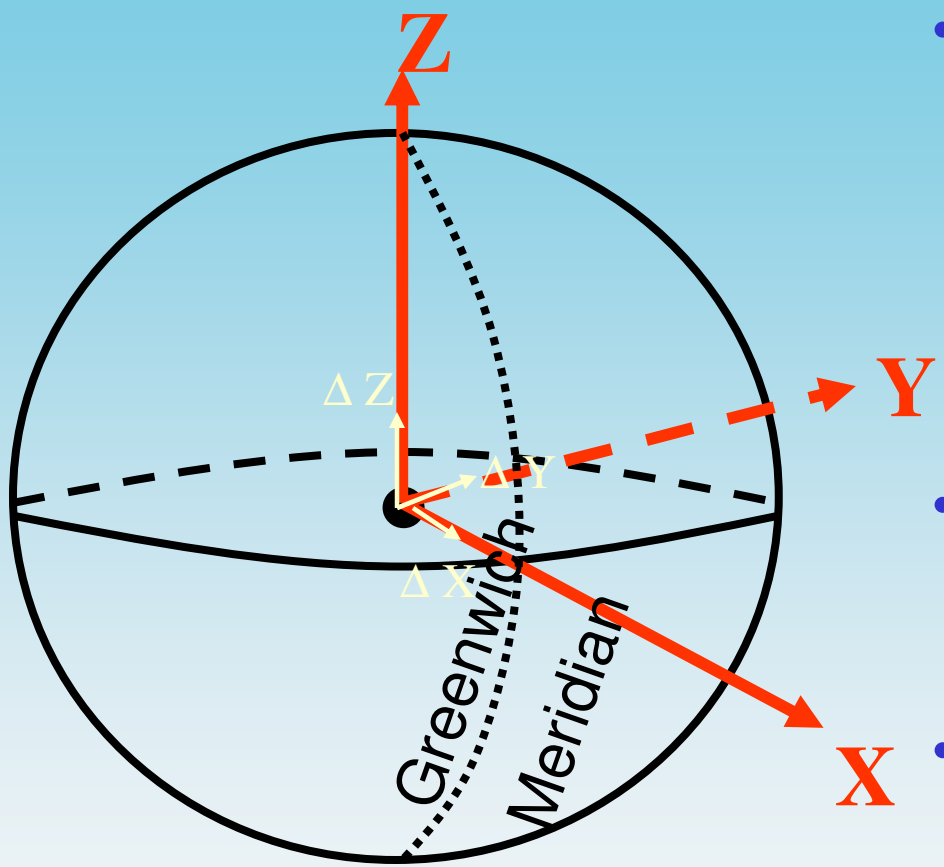
Geocentric Translations



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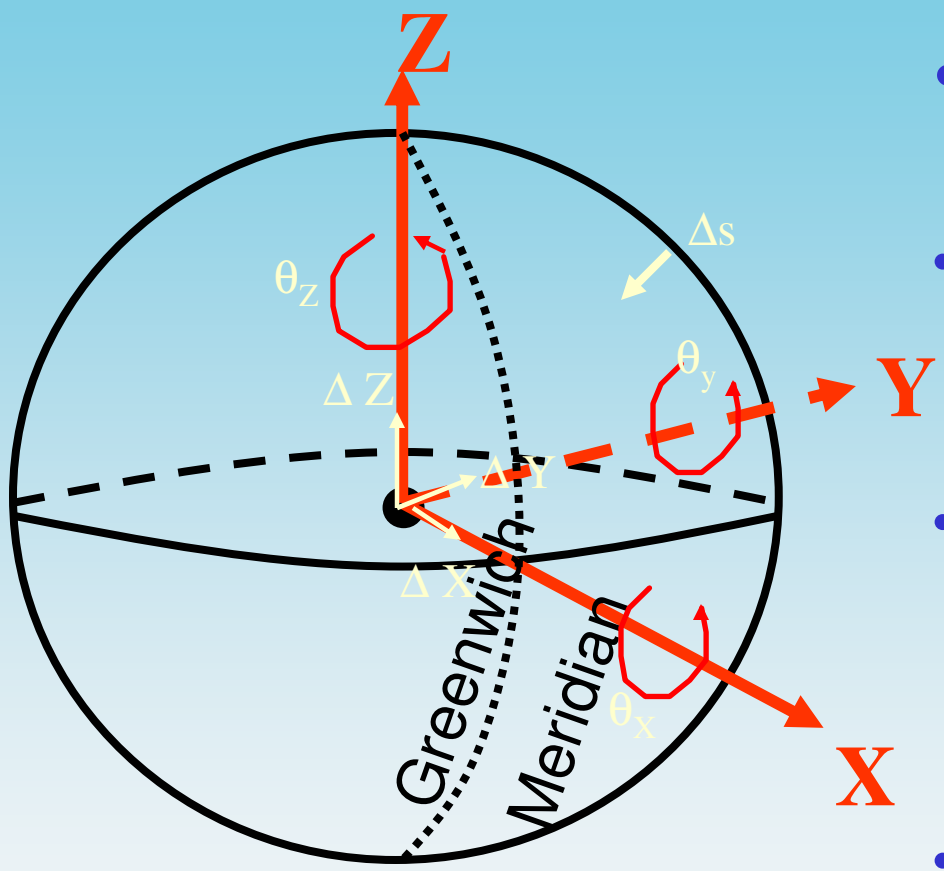
7-Parameter Transformations



- **Parameters are:**
- **3 translations**
  Δ X, ΔY, ΔZ
- **3 rotations, one about each axis: rX, rY, rZ (or θ_X, θ_Y, θ_Z)**
- **Scale change (or Δs)**

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Datum Shifting – Grid Shift Files

- Uses a grid of offset values over region
- Gives best approximat ion of correction for irregular transformations
- Commonly used for NAD27 to NAD83
- PROJ.4 includes traditional US NAD27 to NAD83 files as well as Canadian NTv1
- Also supports Canadian NTv2 format now sometimes used in other countries
- Use + nadgrids=keyword.
- No explicit support in WKT.

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Datum Shifting – 3/ 7 parameter

- 3 parameter – simple offset in 3 sp ace
- 7 parameter – offset , rotate and scale
- Just an approximation
- Often different values in different regions for a single datum
- Often hard to find good values
- Use + towgs84= keyword
- TOWGS84[] in WKT

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Datum Shifting – Examples

- +datum=WGS84 is

  +ellps=WGS84 +towgs84= 0,0,0
- +datum= GRS87 is

  +ellps=GRS80 +towgs84=-199.87,74.79,246.62
- +datum=NAD27 is

  +ellps=clrk66 +nadgrids=@conus,@alaska,@ntv2_0.gsb,@ntv1_can.dat

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Gotchas

- PROJ.4 *may* d efault to WGS84 ellpsoid if not given , be explicit!
- Aea and lcc projections have d efault standard parallels for USA ... u s e +no_def.
- Longitude signs matter , Victoria is *west* of Greenwich - which is a negative longitud e.
- Alternate axis orientation not supported.
- Did you down load grid shift files?
- False easting/northing *always* in meters.
- Europeans do +towgs84 signs backwards.

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Tips with PROJ.4

- Test a known point with command line tools .
- Use - v flag with cs2cs to see actual values used.
- Verify datum shift is doing something.
- Are grid shift files being found?
- Set PROJ_DEBUG environment variable to see files accessed.
- Don't trust the “epsg” dictionary, especially with regard to datum shifting and uncommon projections.

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Latitude and Longitude

ARE

NOT

UNIQUE!

Latitude an Longitude coordinates must be combined with a Geographic Coordinate Reference System (GeogCRS) / Datum in order to guarantee uniqueness.

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A Geodetic Datum

Is simply

An ELLIPSOID of Revolution

Coupled TO THE EARTH
at a specific location
(or in a specific manner)

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Problems in Geodesy

- To correctly define the coordinates of a point and provide accurate mapping details of the Coordinate Reference System (GeogCRS or ProjCRS) must be known and adequately documented.
- Without this information, coordinates will often be misinterpreted, leading to positional inaccuracies and costly mistakes.
- GEODETIC PARAMETERS are often completely ignored until after the problem has happened.

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Document Everything!

- Document the geodetic data that is used.
- Every document or chart that contains coordinates (Latitudes, Longitudes, Eastings or Northings) should be annotated with
  - Datum Name (NOT simply the ellipsoid)
  - Projection Data

    and where appropriate
  - Geodetic Transformation
    (and method if unclear)
    - Every 7-parameter transformation should specify method (rotation convention)!

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EPSG database (www.epsg.org)

The EPSG database comprises:

Coordinate Reference Systems

- Geographic and Projected CRS
- Vertical and Engineering [local] CRS
- Compound CRS

- Geodetic Transformation Data
  - Concatenated Data [sequential steps are required]
  - Single geodetic transformations of all types
  - transformations between vertical systems
- Ancilliary Data
  - Ellipsoids, Prime Meridians, Units of Measure, etc.
- Associated reports and forms to access data.
- Database available in SQL and MS Access

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Other References

- EPSG Guidance Note 7. Download free from European Petroleum Survey Group's website at

  www.epsg.org

- "Geodesy for the Layman", U.S. National Imagery and Mapping Agency, download free from NIMA's G&G website at

  www.nima.mil/GandG/geolay/toc.htm

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EPSG – From an Open Source Perspective

- Standard enumeration of widely used coordinate systems ,datums, units, etc.
- Basis of the geotiff format.
- Used in WMS and many other web service requests.
- Used in many software packages

eg. WGS84 is EPSG:4326

UTM 11 North, WGS84 is EPSG:32611

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Using EPSG

- Lookups can be tricky, usually use a search the /usr/ local/ share/gdal/ pcs.csv and gcs.csv files in a text editor !
- Sticky note:WGS84 (4326), NAD83 (4269), NAD27(4267)
- If the code # is larger than 32767 then it isn't a real EPSG code

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Useful EPSG Web-Sites

- http://www.spatialreference.org
- A Look-up Tool for EPSG Numbers by Howard Butler & Christopher Schmidt

- http://www.petrosysguru.com/cgi-bin/epsg/ps_epsg.php?MODE=MENU
- Petrosys - EPSG Coordinate Reference Browser

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Useful EPSG Web-Sites

- http://ocean.csl.co.uk/experimental/index.php
- This site is a public server provided by Concept Systems Limited as a host for the European Petroleum Survey Group's (EPSG) database of geodetic parameters and Coordinate Reference Systems.

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Map Projections and their Application to Spatial Data

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"Every map user and maker should have a basic understanding of projections no matter how much computers seem to have automated the process."

- John P. Snyder

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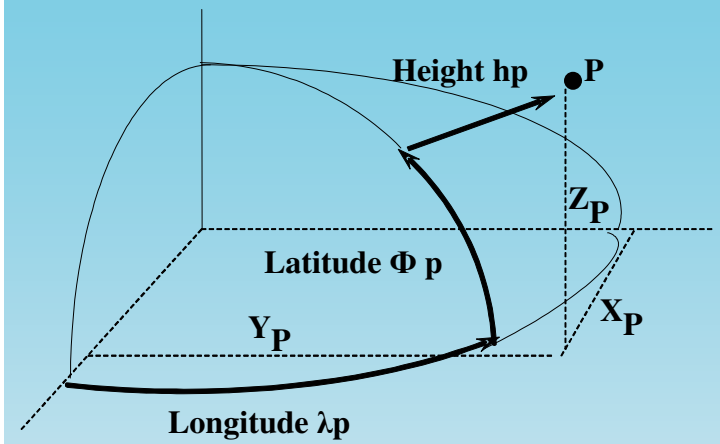
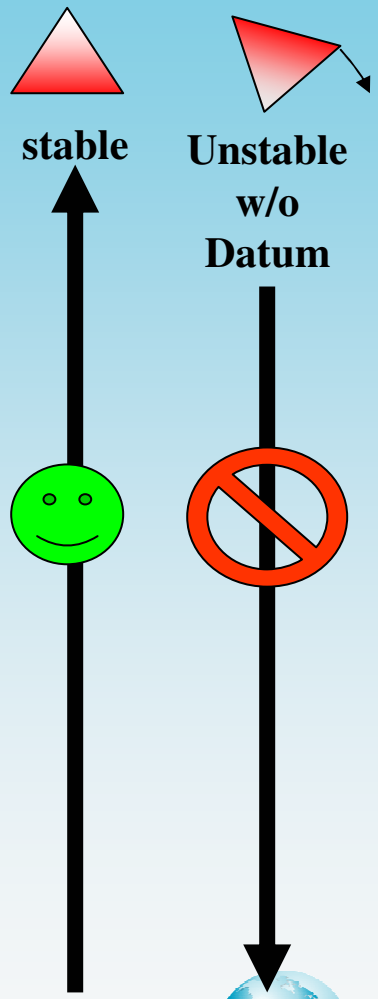
Hierarchy of Mapping



Projected CRS
is derivative
of the Datum
(Geog CRS)
Easting, Northing,
Elevation (above MSL)

Datum (includes ellipsoid)
is the Foundation
X,Y,Z Cartesian and Lat Long, Ht



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Flattening the Earth – Map Projections

This process of flattening the earth will cause distortions in one or more of the following spatial properties:

- **Shape**
  - Conformal map projections preserve shape
- **Area**
  - Equal area map projections preserve area
- **Distance/Scale**
  - Equidistant map projections preserve distance
- **Direction/Angle**
  - Azimuthal map projections preserve true direction

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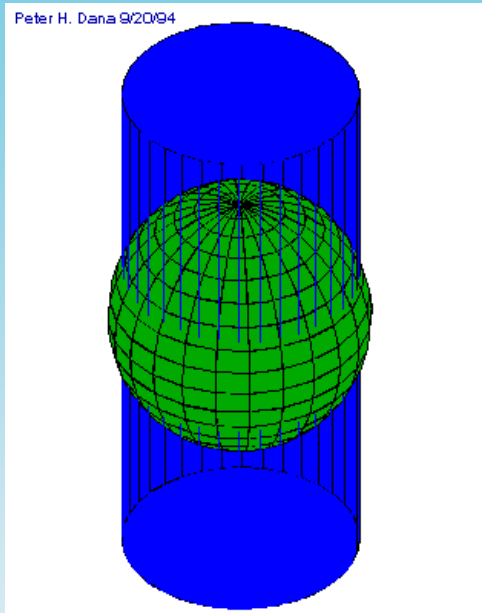
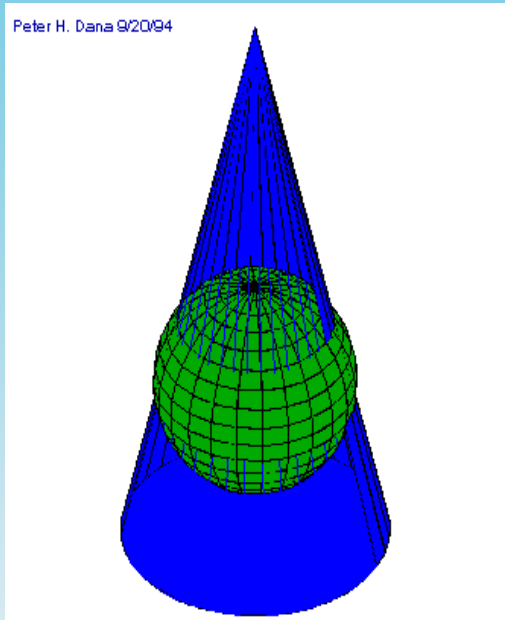
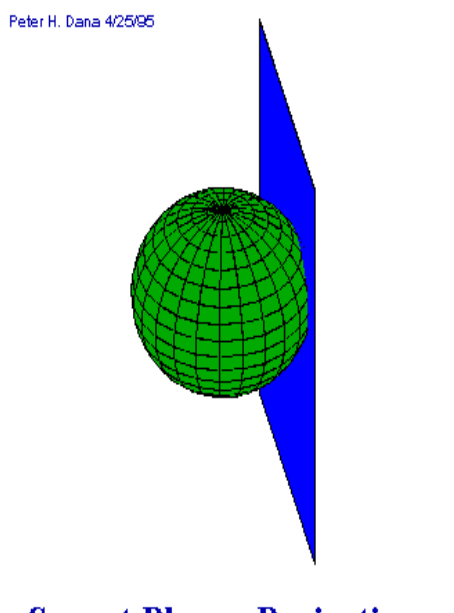
Cartography Secant Surfaces



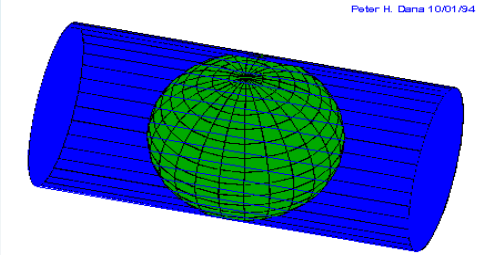
Secant Cylindrical Projection



Secant Conic Projection



Secant Planar Projection



Transverse Cylindrical Projection Surface

Courtesy of Peter H Dana, The Geographer's Craft Project, Geography Department, University of Texas

Why not the Globe? Types of Projection

- Mercator
- Transverse Mercator
- Universal Transverse Mercator
- Lambert Conformal Conic
- Other - Various

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PROJ.4 Command Usage

Command:

cs2cs +proj=latlong +datum=WGS84

+to +proj=utm +zone=11 +datum=WGS84

Input:

-118.0 33.0

Output:

406582.22 3651730.97 0.00

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PROJ.4: Projection Parameters

- +lon_0= <angle>
  - Central Meridian , Longitude of Origin, Center Long
- +lat_0= <angle>
  - Latitude of Origin , Center Latitude
- +k= < scale_factor>
- +x_0= <false_easting>
- +y_0= <false_northing>

Almost all projections have + lon_0, +x_0, +y_0.

Map Projections - Shape and Scale

- **Conformality also called Orthomorphism**
  - Angular integrity between points is retained
  - Scale distortion at a point is independent of direction/ is the same in all directions
  - Small shapes are honoured
- **Equidistant**
  - Scale along certain lines is true
- **Equal Area**
  - True area is represented

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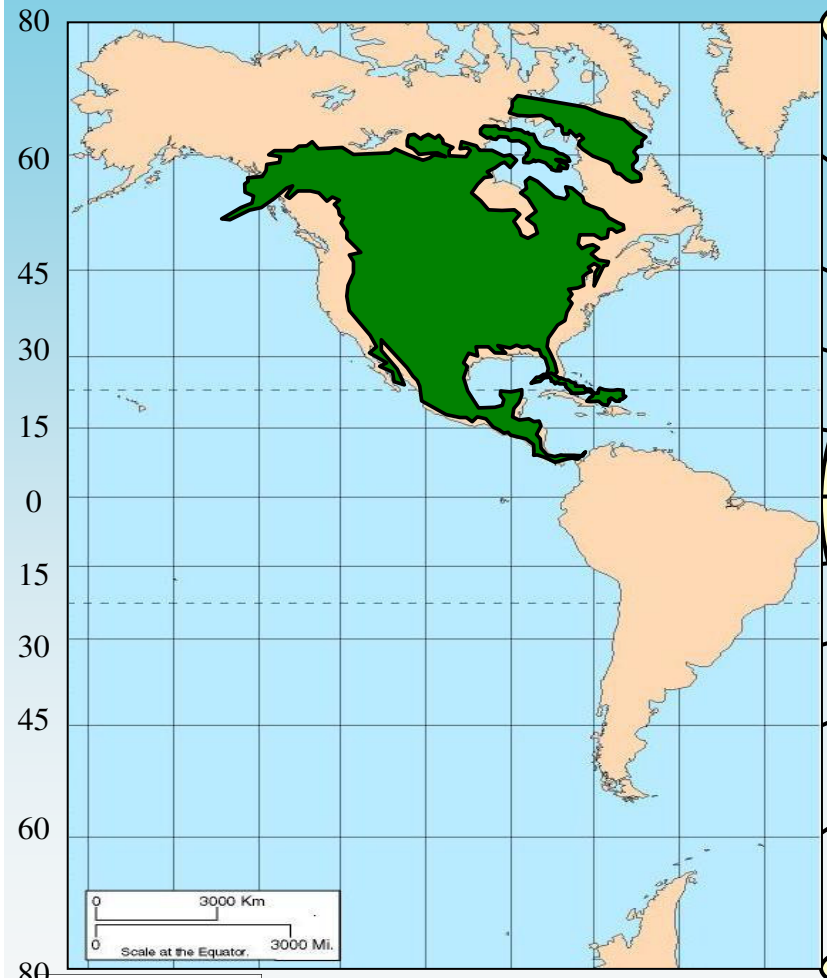
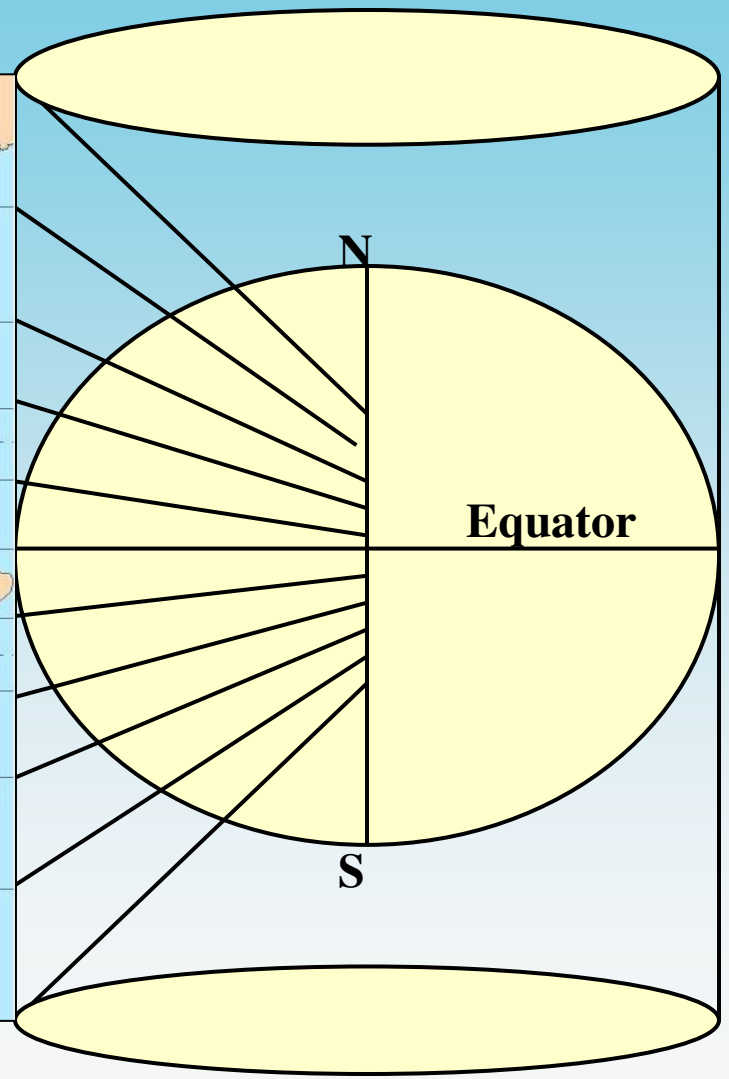
Mercator Projection





Scale Distortion (N:1)

[1/cos(lat)]

0 °	1
48 °	1.5
60 °	2
71 °	3
76 °	4
80°	6

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Mercator Class and Use

- Cylindrical
- Usually Tangent
- Orientation - Equatorial
- Conformal (Shape OK over small area)
- Not equal area, Not constant scale, Not perspective
- Rhumb Lines become straight lines, Great Circles are curved lines
- Cannot map above 80° - i.e. cannot include poles
- Used for navigational charts

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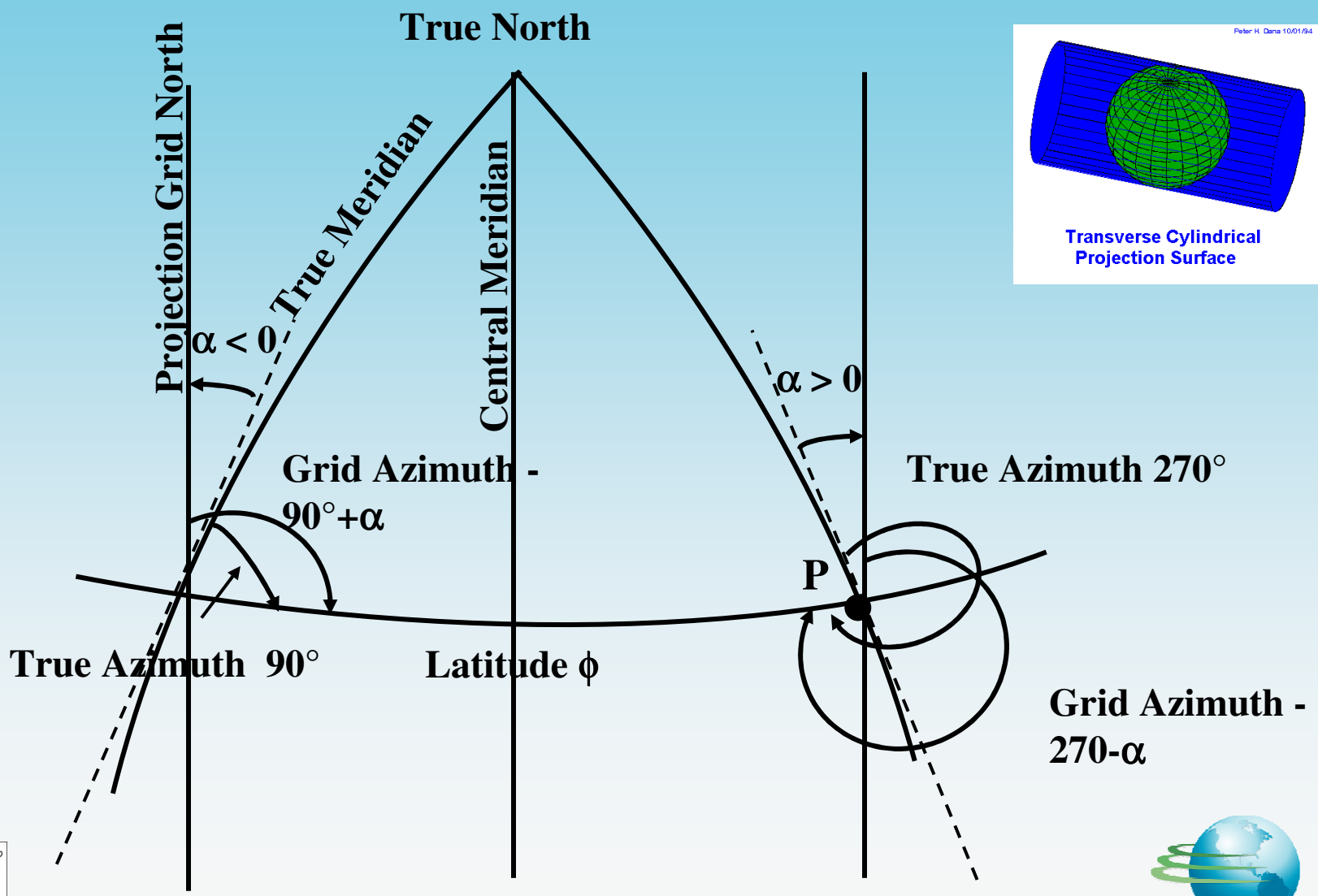
TM - Convergence



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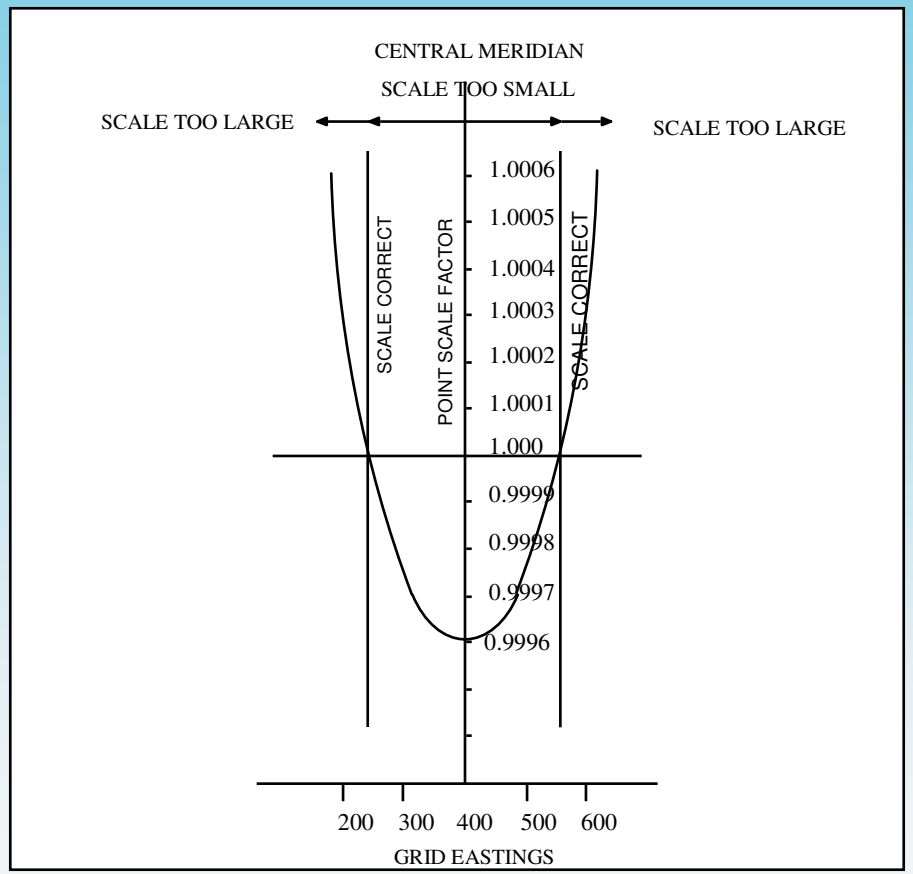
TM - Scale Factor Distribution



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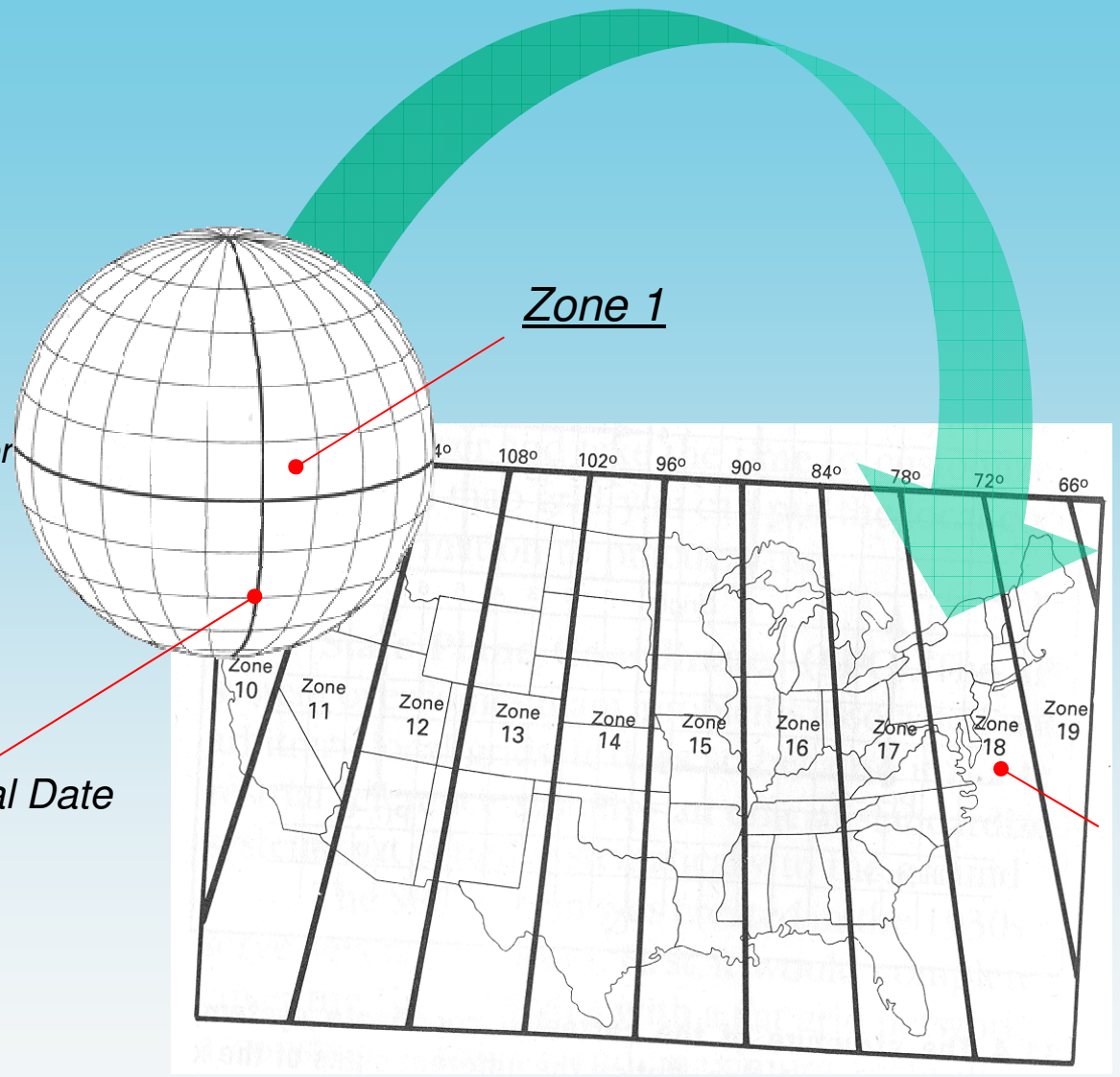
UTM – Another Definition



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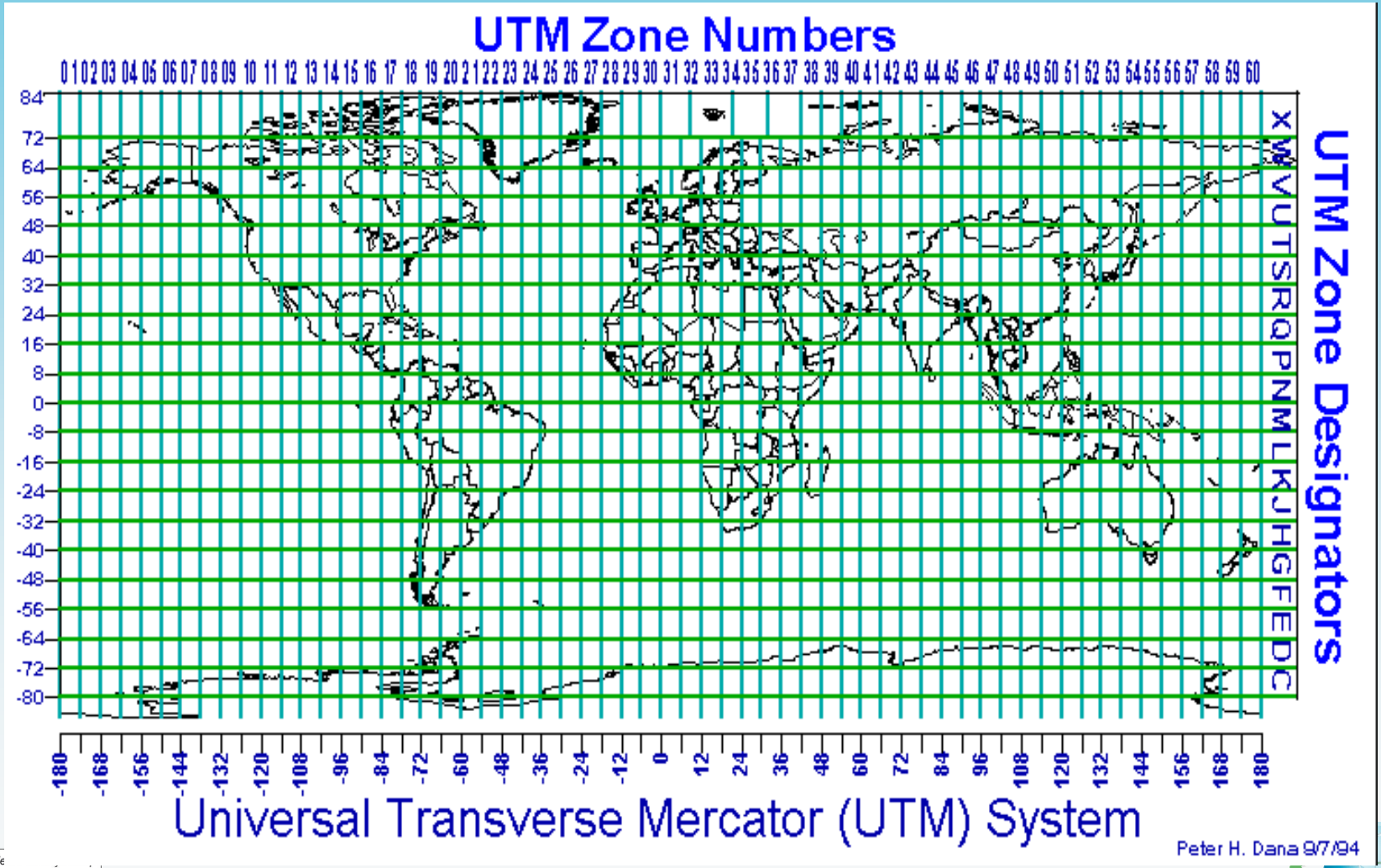
UTM Zones



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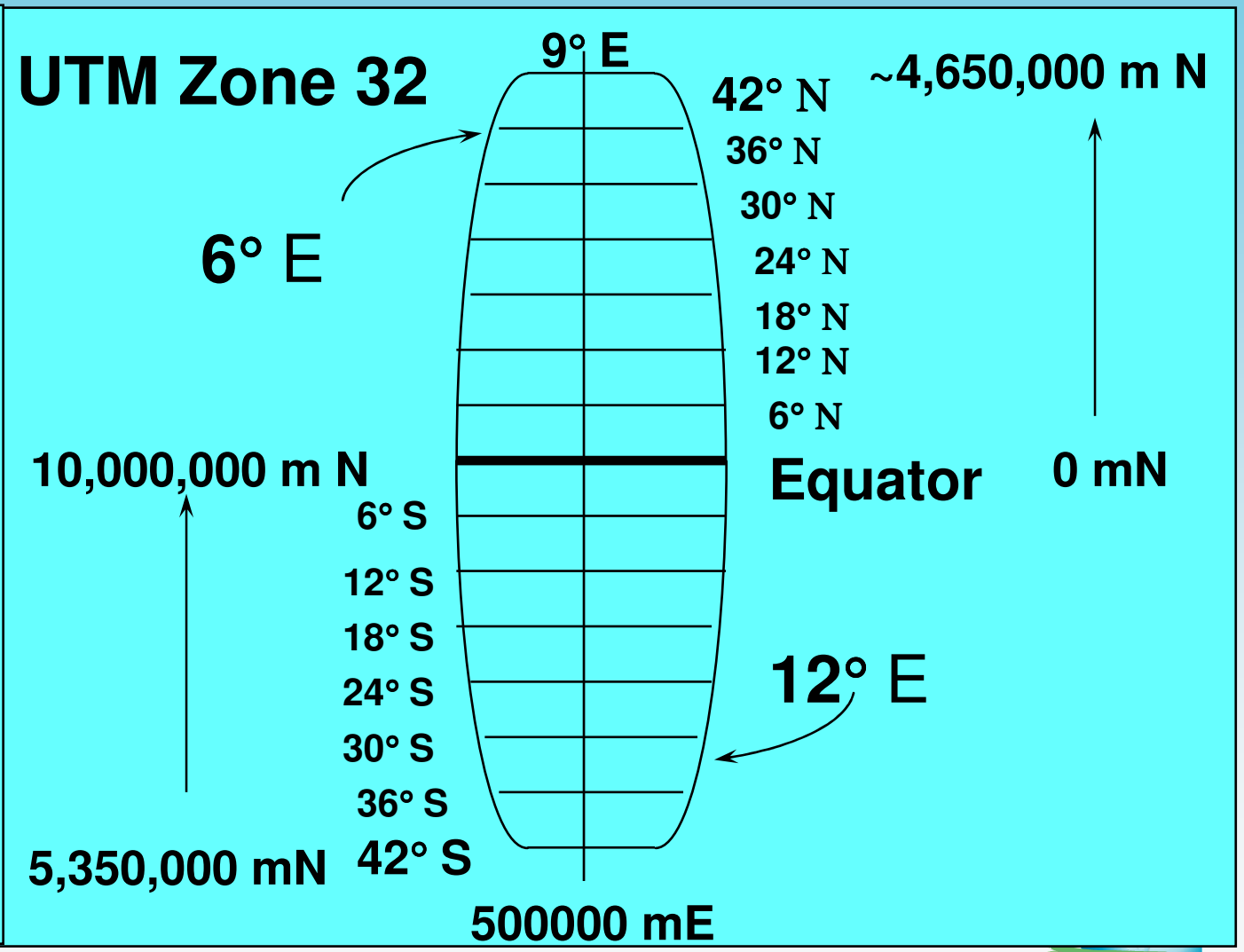
UTM Example

UTM
6° Zones
ev. odd 3°
Zone # 1-60 fm
177° W thru
Greenwich
to 177° E.
Units Meters.
Origin
CM
FE 500,000 mE
FN 0 mN
or
10,000,000 mN
at Equator



TM/UTM Class and Use

- Cylindrical
- Secant (UTM always, TM Usually)
- Transverse (Polar) Orientation
- Conformal
- Algorithmic (non-geometrical)
- TM Used in predominantly N-S geographic areas - many USGS and other national map series including some SPCS
- UTM used for large scale charts world wide
- Adjoining TM maps in same zone match at E/W edge
- UTM SF at CM allows 1:2,500 scale error (.9996)
- SPCS SF at CM allows 1:10,000 scale error

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Using PROJ.4 For Projections

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Transverse Mercator

Aka Gauss - Kruger

+proj= tmerc + lon_0= <central meridian>

+lat_0= <latitude of origin> +k= <scale factor>

+x_0= <false easting> +y_0= <false northing>

- Example (UTM 11 North):

+proj=tmerc + lon_0=-117 + lat_0=0

+k= 0.9996

+x_0=500000 +y_0=0

+datum=WGS84

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Lambert Conic Conformal (2SP)

+proj= lcc + lat_1=< 1st std. Parallel>

+lat_2= <2nd std. Parallel>

+lat_0= <origin lat> +lon_0= <origin long>

+x_0= <false easting> +y_0=< false northing>

- Example (Tennessee State Plane):

+proj=lcc +lat_1=35.25 + lat_2=36.25

+lat_0= 34.40 + lon_0=-86

+x_0=609601.2192024384

+y_0=30480.06096012192

+datum= NAD27 +units=ft

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Universal Transverse Mercator

Aka UTM

+ proj=utm + zone= zone>

- Example (UTM zone in which Ottawa falls)

+proj=utm + zone=17 +datum=WGS84

- Just an alias for :

+ proj= tmerc + lon_0=-81 +k=0.9996

+ x_0=500000 +datum=WGS84

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An Example of projections - Brasil

Datum	Ellipsoid	Projections
Aratu	International 1924	UTM 22, 23, 24
Corrego Allegre	International 1924	UTM 23, 24
PSAD56	International 1924	UTM 22
SAD69	GRS 1967 or International 1967	UTM 18-22, 24
Sirgas	GRS80	UTM 18S, 19-22 N&S, 23-25 S
WGS84	WGS84	Same as Sirgas

Total of 28 projections!

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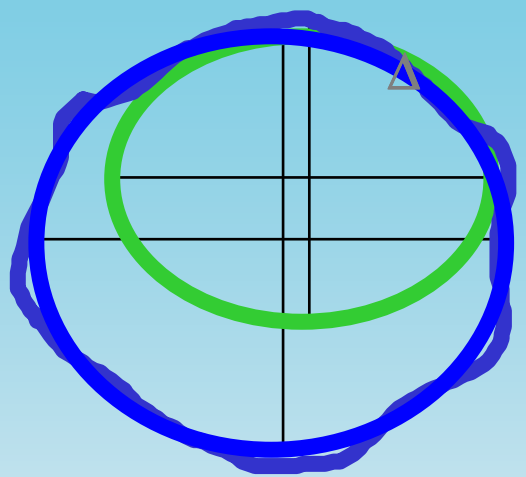
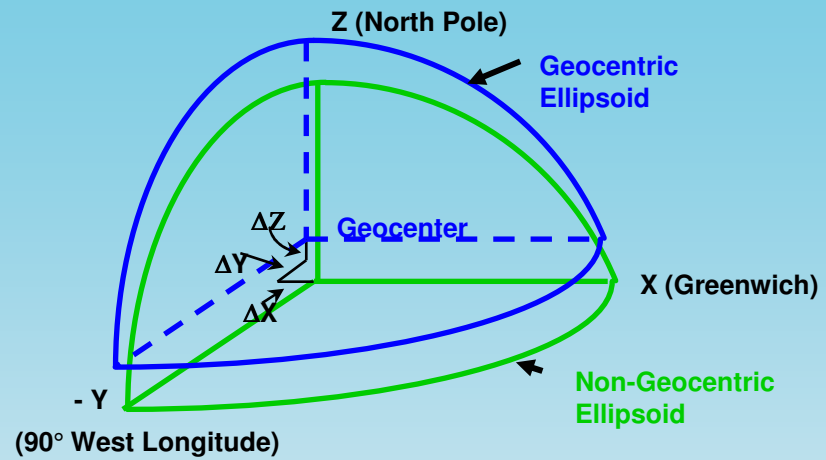
Mixing Projections - Brazil Example





Datum	Latitude	Longitude	Local to WGS84	Local to Local
Aratu	20º 36' 13.2757"N	38º 56' 56.3341"W	236.7	220.56
SAD69	20º 36' 17.4283"N	38º 56' 50.1240"W	65.12	
WGS84	20º 36' 19.2794"N	38º 56' 51.2166"W		

Datum	Easting UTM 24S	Northing UTM 24S	Local to WGS84	Local to Local
Aratu	505,316.4	2,278,317.4	214.7	208.8
SAD69	505,495.9	2,278,424.1	58.4	
WGS84	505,464.2	2,278,473.1		

Coordinates are of the SAME physical point

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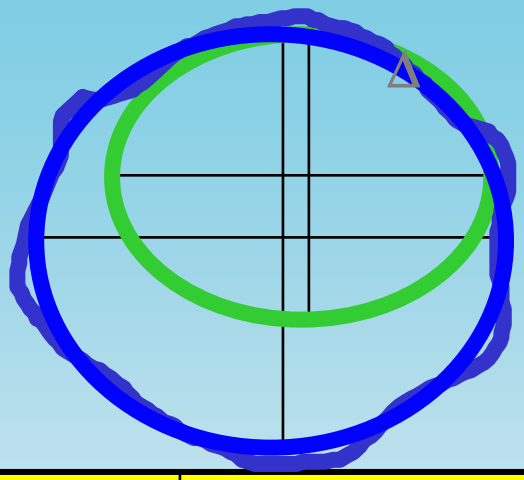
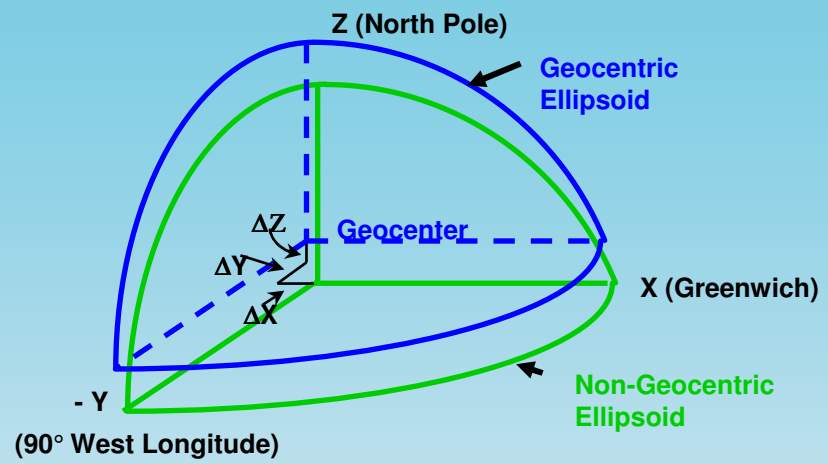
Mixing Datums - Nigeria/Cameroon Example





Datum	Latitude	Longitude	Local to WGS84	Local to Local
Manoca	N 04° 04' 17.179"	E 008° 29' 43.774"	159.3 meters	170.8 meters
Minna	N 04° 04' 12.077"	E 008° 29' 41.572"	101.3 meters	170.8 meters
WGS84	N 04° 04' 14.504"	E 008° 29' 39.351"	0 meters	

Datum	Easting	Northing	Local to WGS84	Local to Local
Manoca	443,999.9	449,999.9	141.4	170.7 meters
Minna	443,932.0	449,843.4	134.1	170.7 meters
WGS84	443,864.6	449,959.3	0 meters	

Note that Manoca and Minna both use the Clarke 1880 Ellipsoid…. Knowing the ellipsoid is not enough!

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Mixing Projection Coordinates UTM

- West Texas UTM Zone 13 N
- NAD27
  - Easting: 500,000m
  - Northing: 3540248m
- NAD83
  - Easting: 499951m
  - Northing: 3540452m
- Differences (ft)
  - DE 161.1 ft
  - DN 669.3 ft
  - DR 688.3 ft

- Montana UTM Zone 12N
- NAD27
  - Easting: 421182m
  - Northing: 4983220m
- NAD83
  - Easting: 421117m
  - Northing: 4983427m
- Differences (ft)
  - DE 213.7 ft
  - DN 680.1 ft
  - DR 712.9 ft

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Reference Orientations

4 Norths

True North	Direction of the meridian through a point
Gyro North	Differs from true north by the gyro correction
Grid North	Differs from True North by the convergence
Magnetic North	Differs from True North by Declination

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First Question……?

What is the first question you should ask when presented with spatial data coordinates or a new map……?

a. Got the time?

b. What's for breakfast?

c. Who invited you anyway?

Or……

What are the datum and projection?

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Current Work Environment

- Distributed computing – Multiple users
- Multiple sources of data
- New data in satellite, legacy data in local datums
- Low training budgets
- Little oversight
- Few procedures

Interdepartmental cooperation is vital – who will coordinate this?

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Other Applications

- Blue Marble Geographic Calculator
- ArcView
- ERMapper
- AutoCAD
- Atlas Seismic
- Excel
- NADCON
- Other Web-Based applications

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Data Types

- Satellite/Aerial Image
- ASCII
- Shapefile
- DEM
- Bathymetry
- DWG/DRG
- Digitized data (Accuracy 0.06” at Scale)

Do you know the references?

Datum, Projection, Height, Orientation!

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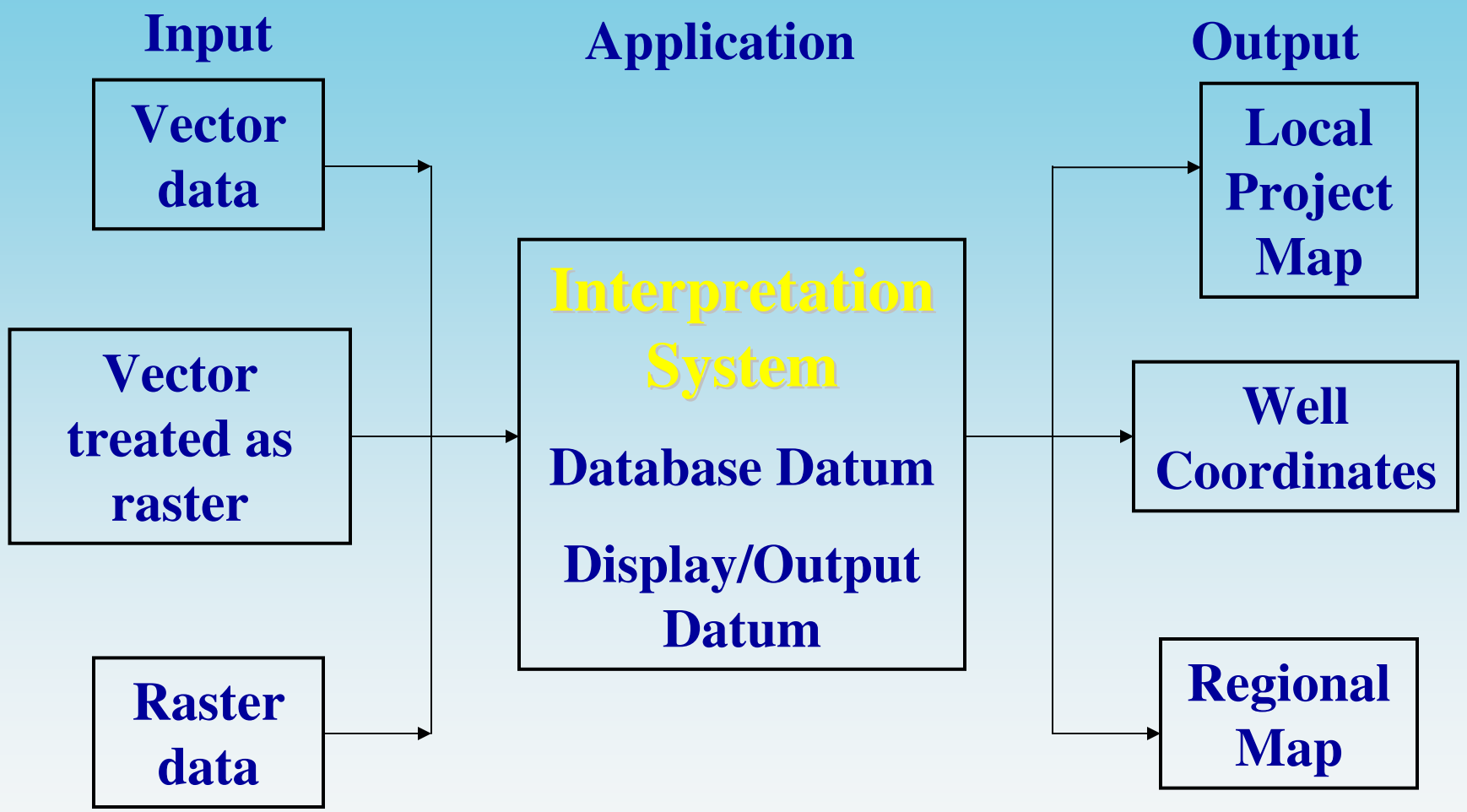
Interpreting the "Unknown Datum"



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Summary of Spatial References

Know the references – Always ask!

- Datum
- Projection
- Elevation/Ht
- Orientation
- Units of measurement

QC/Audit and record references in detail especially when transferring data between functions

- In Field
- From field to office
- When downloading data from DB or web
- When converting data before or during loading
- From function to function

If in doubt – Get Help!

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Spatial Data Management

- A Staff GIS Team to manage develop…
  - Procedures
  - Qualified Training and support
  - Data input and preparation
  - Interdepartmental coordination and transfer
- A Rigorous Audit Trail
- High Level Corporate support
- An Enterprise Wide Vision

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Conclusions

Spatial data references are…..

- Often poorly managed or ignored
- A Line Management responsibility
- A Corporate/Staff function as well
- Done well…. a low cost Competitive Advantage
- Done badly…. a Huge Risk and a potential Death Knell for the Corporation/Organization

…….a fiduciary responsibility to shareholders and employees!!

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