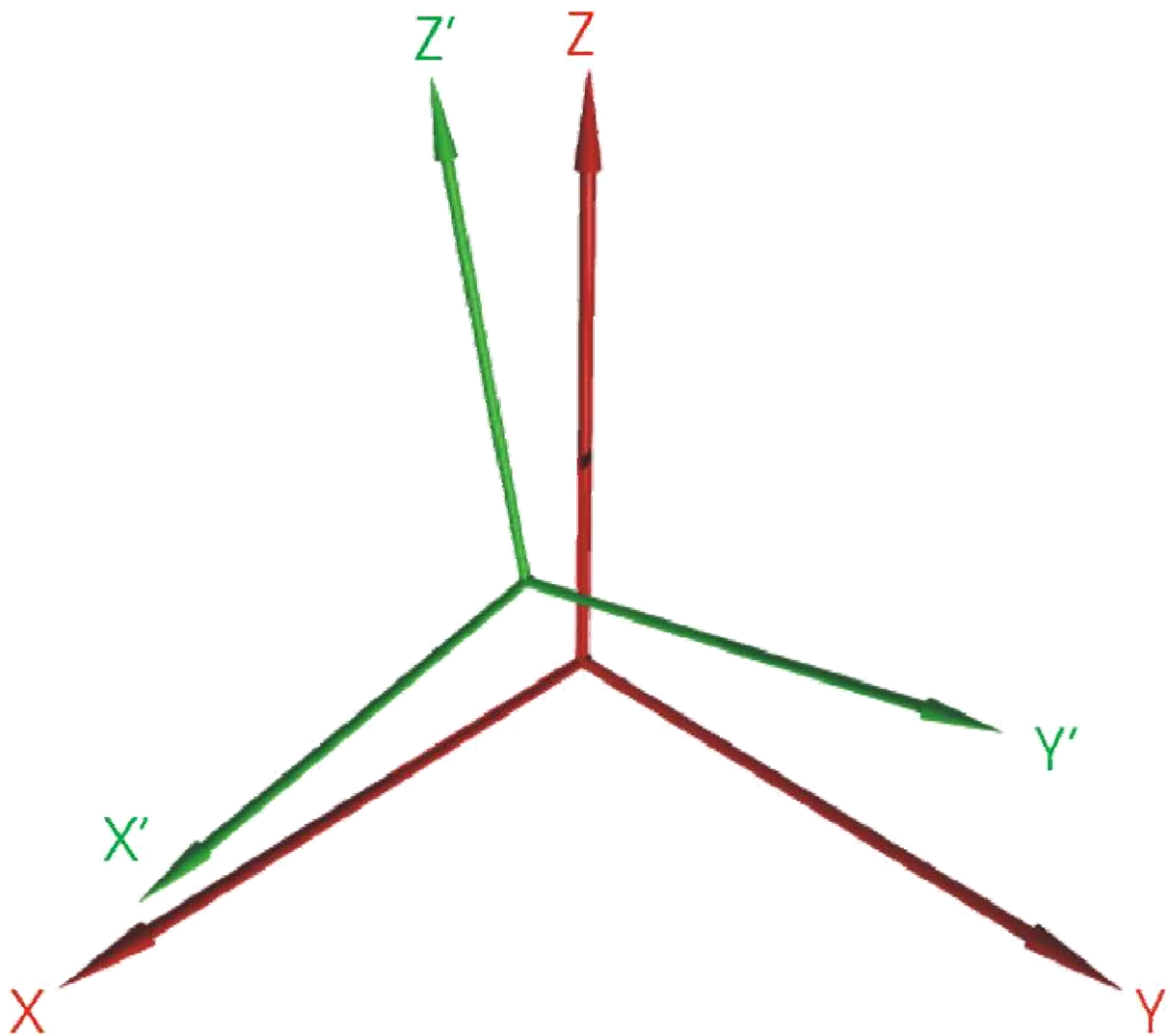
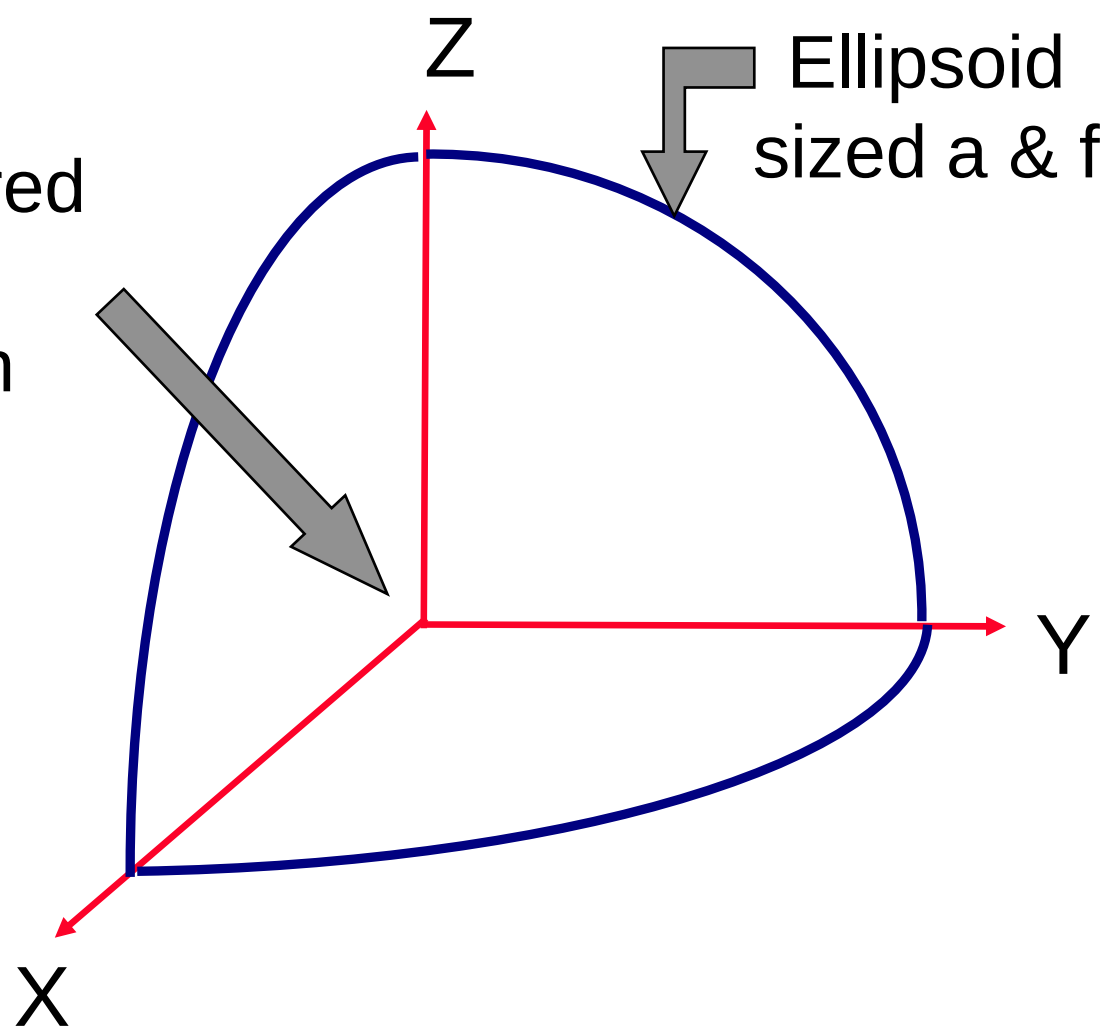
Datum Transformation and Coordinate Conversion



Cartesian Coordinate System

WGS -84 is
Earth Centered
Earth Fixed;
Origin to with
+/- 10 cm



Datums and Defining Parameters

To translate one datum to another we must know the relationship between the chosen ellipsoids in terms of position and orientation. The relationship is is defined by 7 constants.

A. ***3*** - Distance of the ellipsoid center from the center of the earth (**ΔX, ΔY, ΔZ**)

B. **3** - Rotations around the X, Y, and Z of the Cartesian Coordinate System Axes (**ε, ψ, ω**)

C. **1** - Scale change (**S**) of the survey control network

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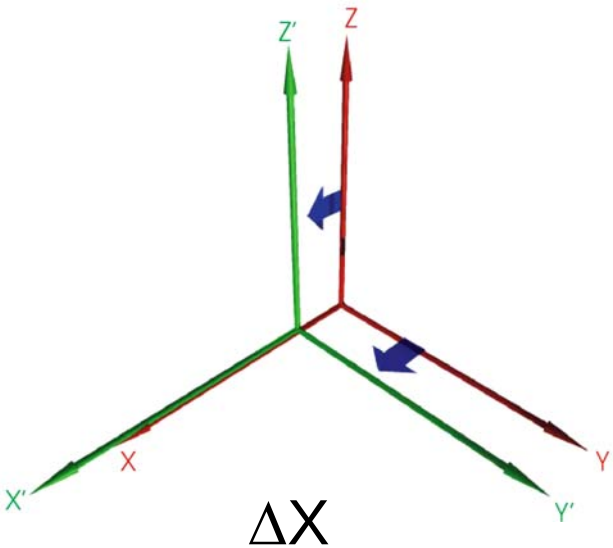
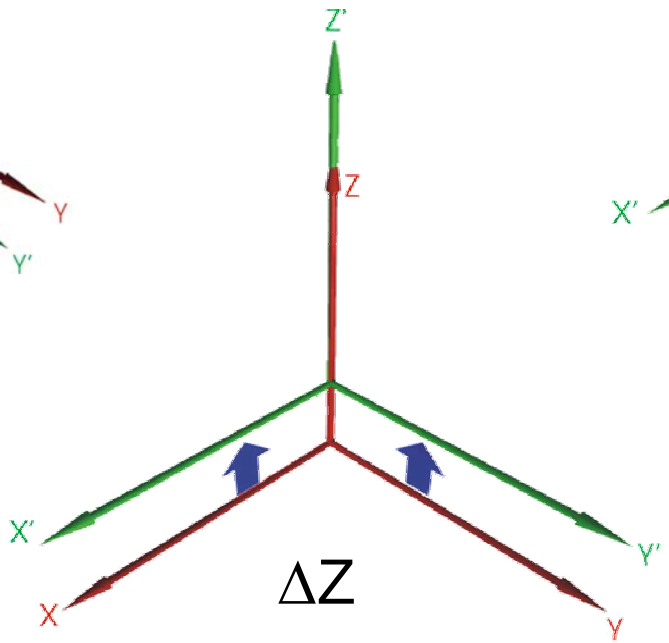
2 - The size and shape of the ellipsoid (semi major axis **a** and flattening **f** approximately 1/298

Translations (3 Parameters)

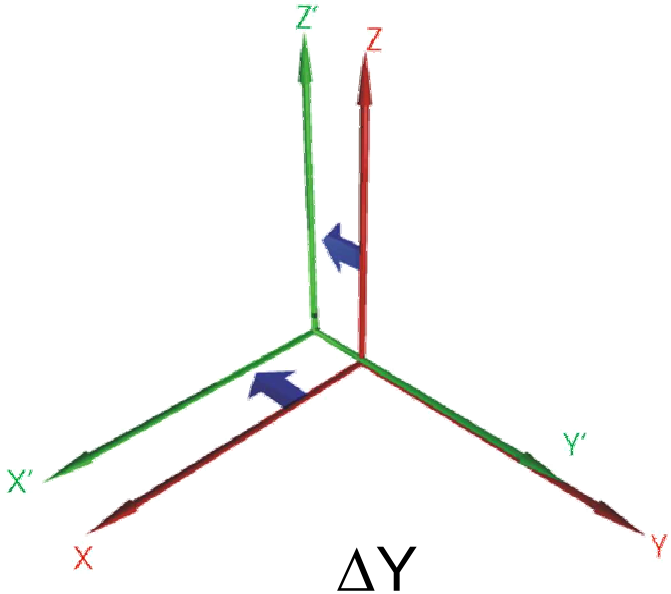
Movement of points <u>along</u> an Axis



ΔX



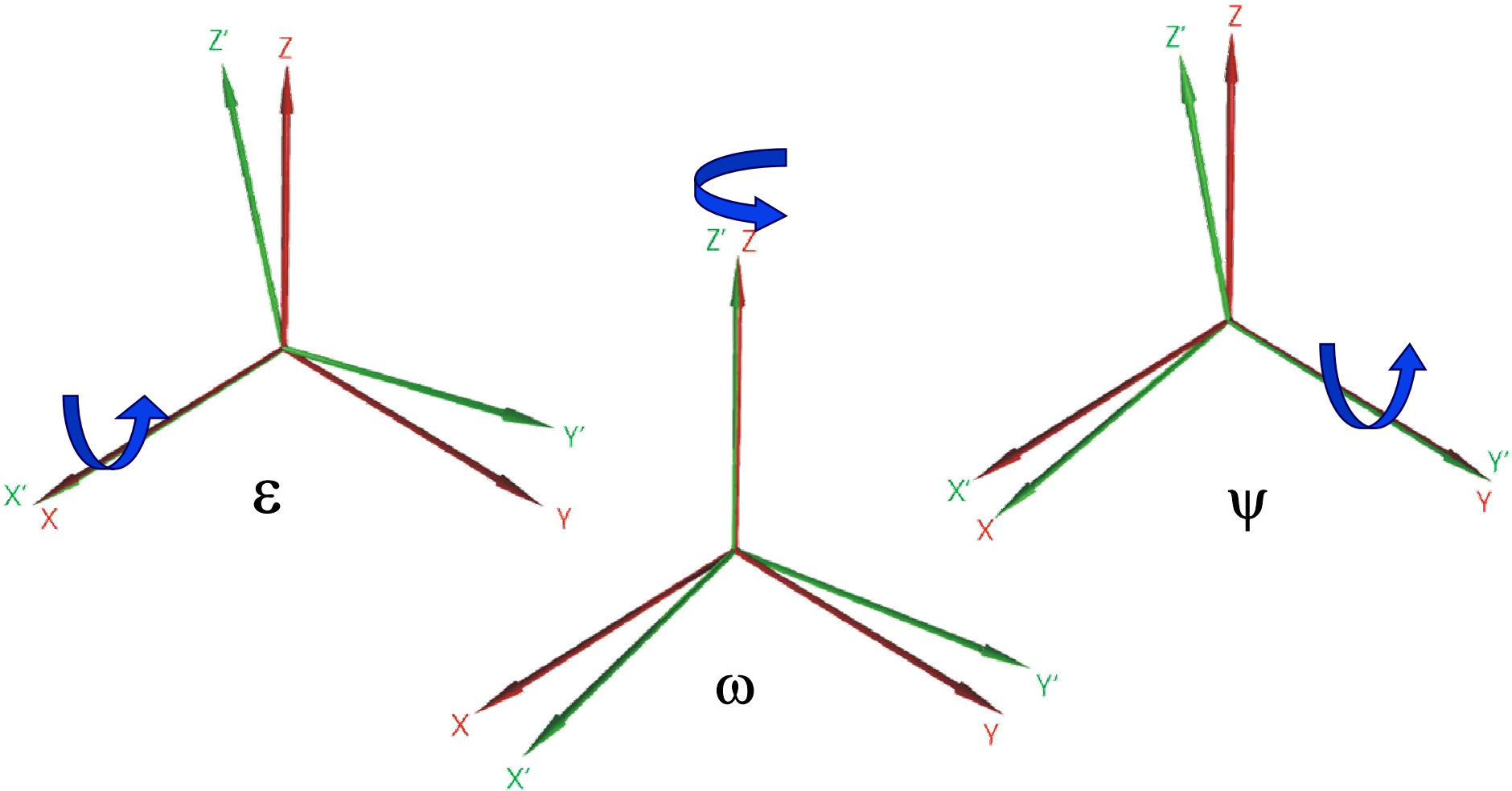
ΔZ



ΔY

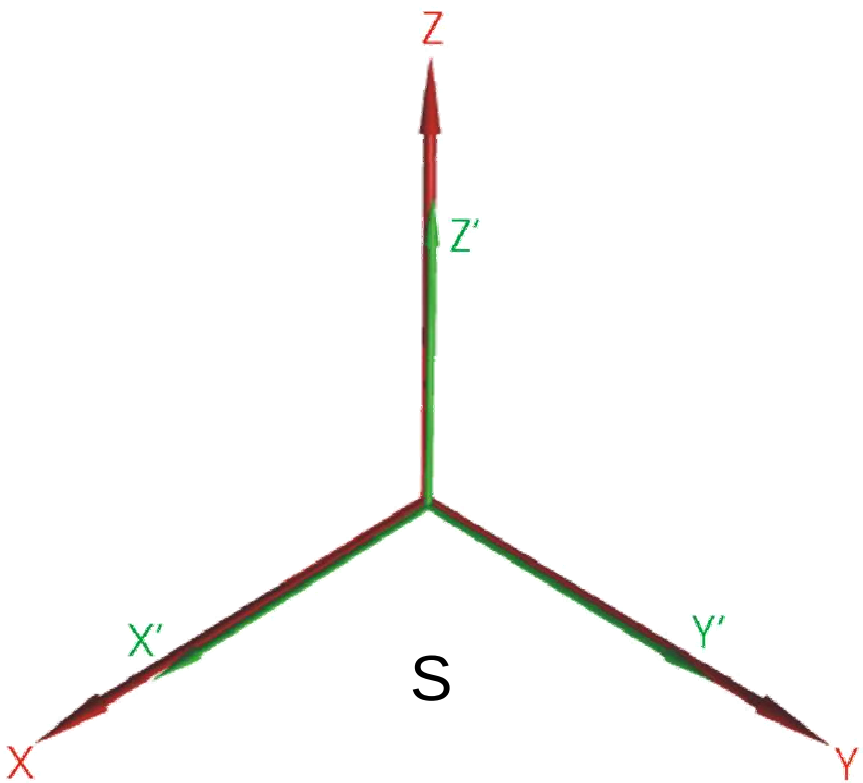
Rotations (3 Parameters)

Movement of points <u>around</u> an Axis



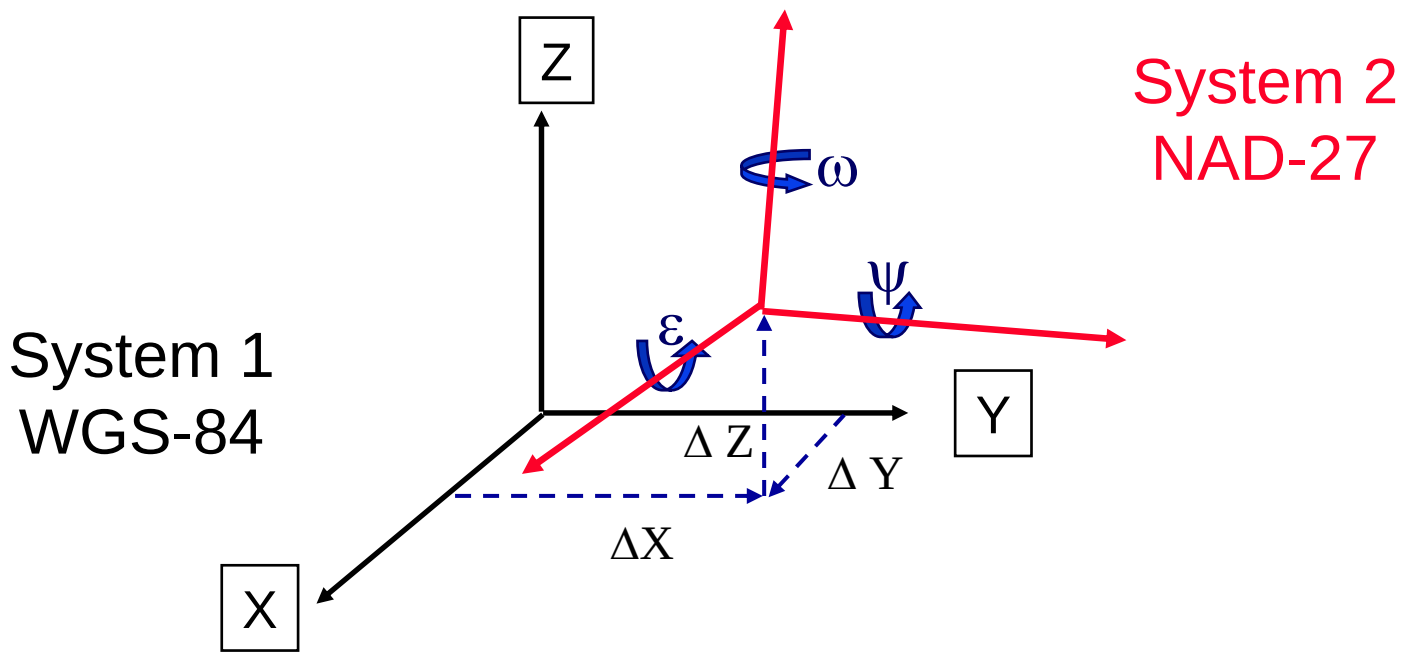
Scale (1 Parameter)

Changing the distance <u>between</u> points

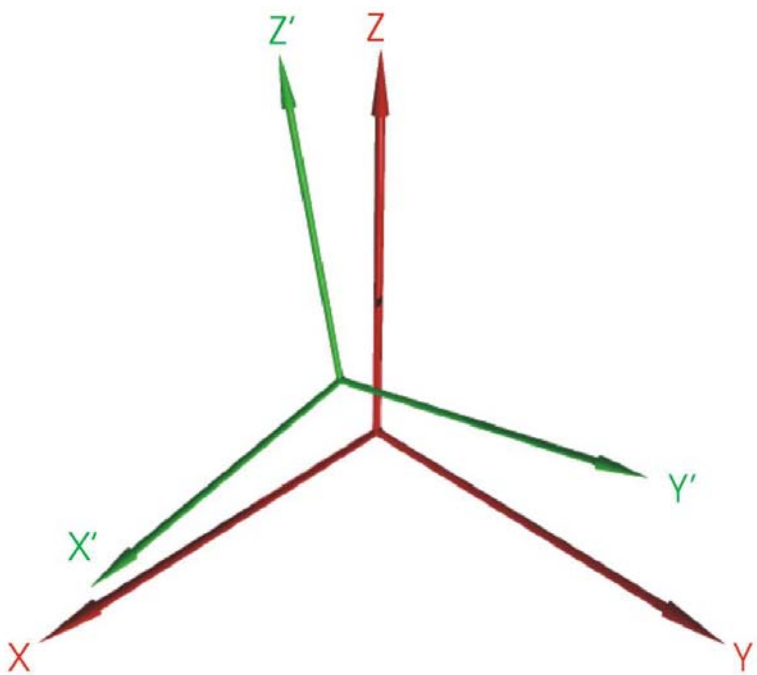


Differences Between Horizontal Datums

- The two ellipsoid centers called Δ X, Δ Y, Δ Z
- The rotation about the X,Y, and Z axes in seconds of arc
- The difference in size between the two ellipsoids
- Scale Change of the Survey Control Network ΔS

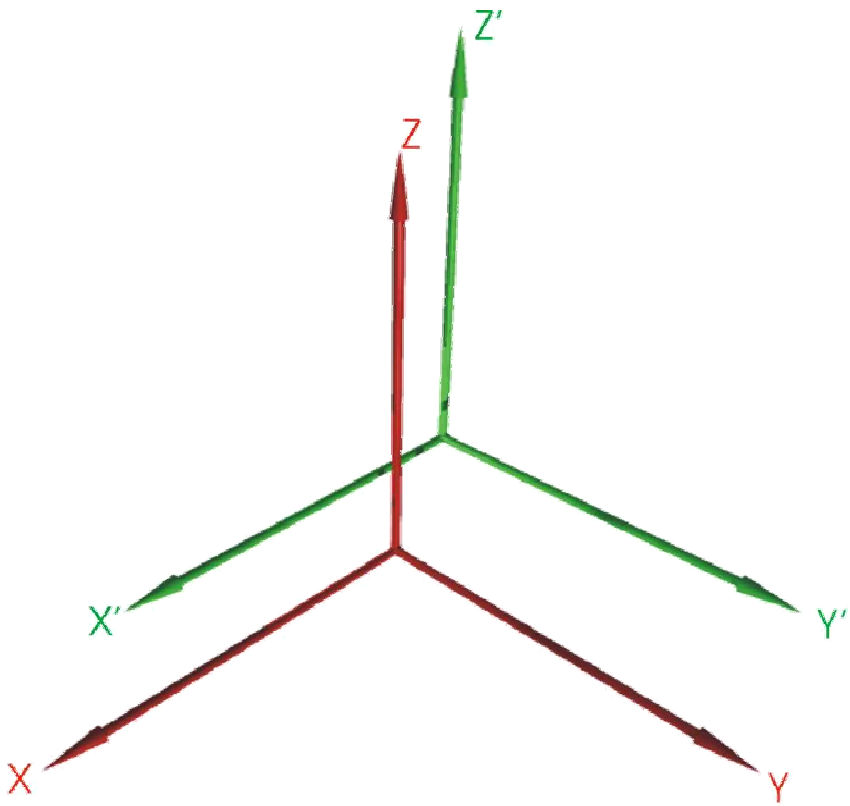


7 Parameters



$$\begin{pmatrix} X' \\ Y' \\ Z' \end{pmatrix} = S\,R_{xyz} \begin{pmatrix} X \\ Y \\ Z \end{pmatrix} + \begin{pmatrix} \Delta X \\ \Delta Y \\ \Delta Z \end{pmatrix}$$

3 Parameters



$$\begin{pmatrix} X' \\ Y' \\ Z' \end{pmatrix} = \begin{pmatrix} X \\ Y \\ Z \end{pmatrix} + \begin{pmatrix} \Delta X \\ \Delta Y \\ \Delta Z \end{pmatrix}$$

Coordinate Conversion & Datum Transformation

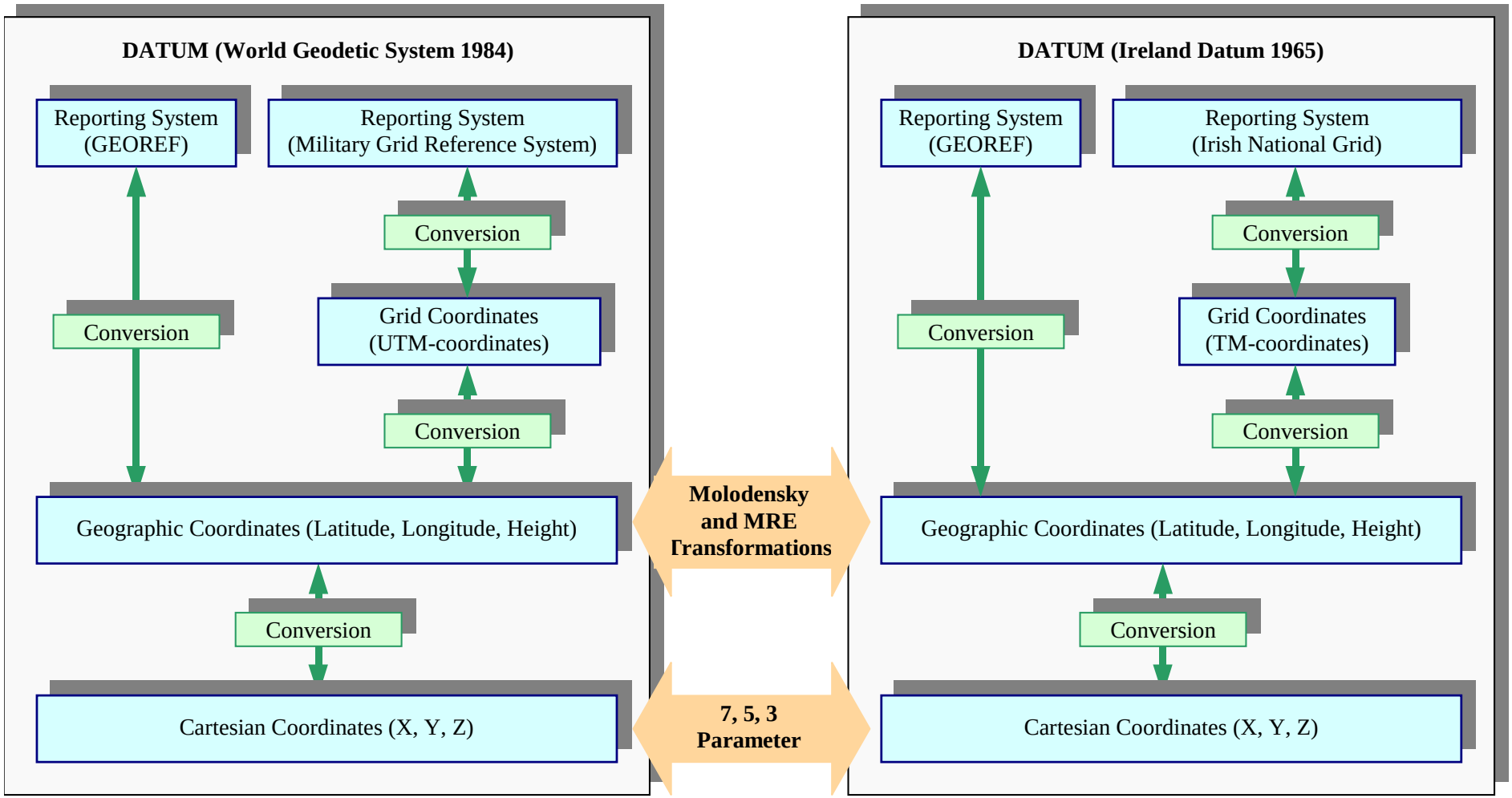
- *References: NIMA TR8350.2, TEC-SR-7, DMA TM 8358.1*
- Convert from Grid to Geographic Coordinates
- Convert from Geographic to Cartesian Coordinates
- Apply Datum Transformation

  3 Parameter (ΔX, ΔY, ΔZ, and a & f of Ellipsoid)*

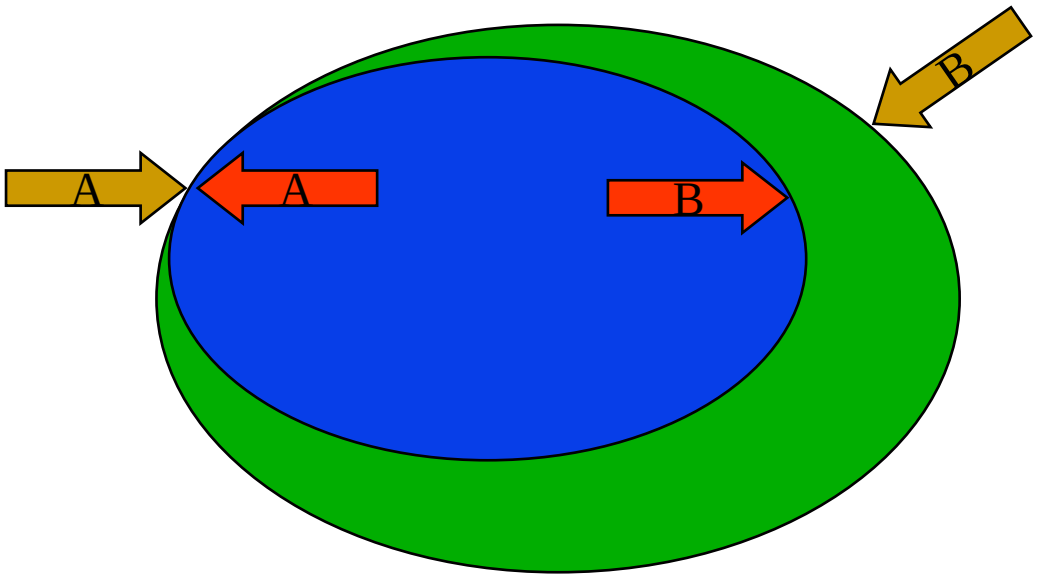
  7 Parameter (ΔX ε, ΔY ψ, ΔZ ω, ΔS, a & F of Ellipsoid)

  **** For most uses 3 parameter shifts are acceptable***
- Compute New Geographic Coordinates
- Compute New UTM, MGRS etc. Coordinates
- Error in transformation propagates to final coordinates

Transformation Process

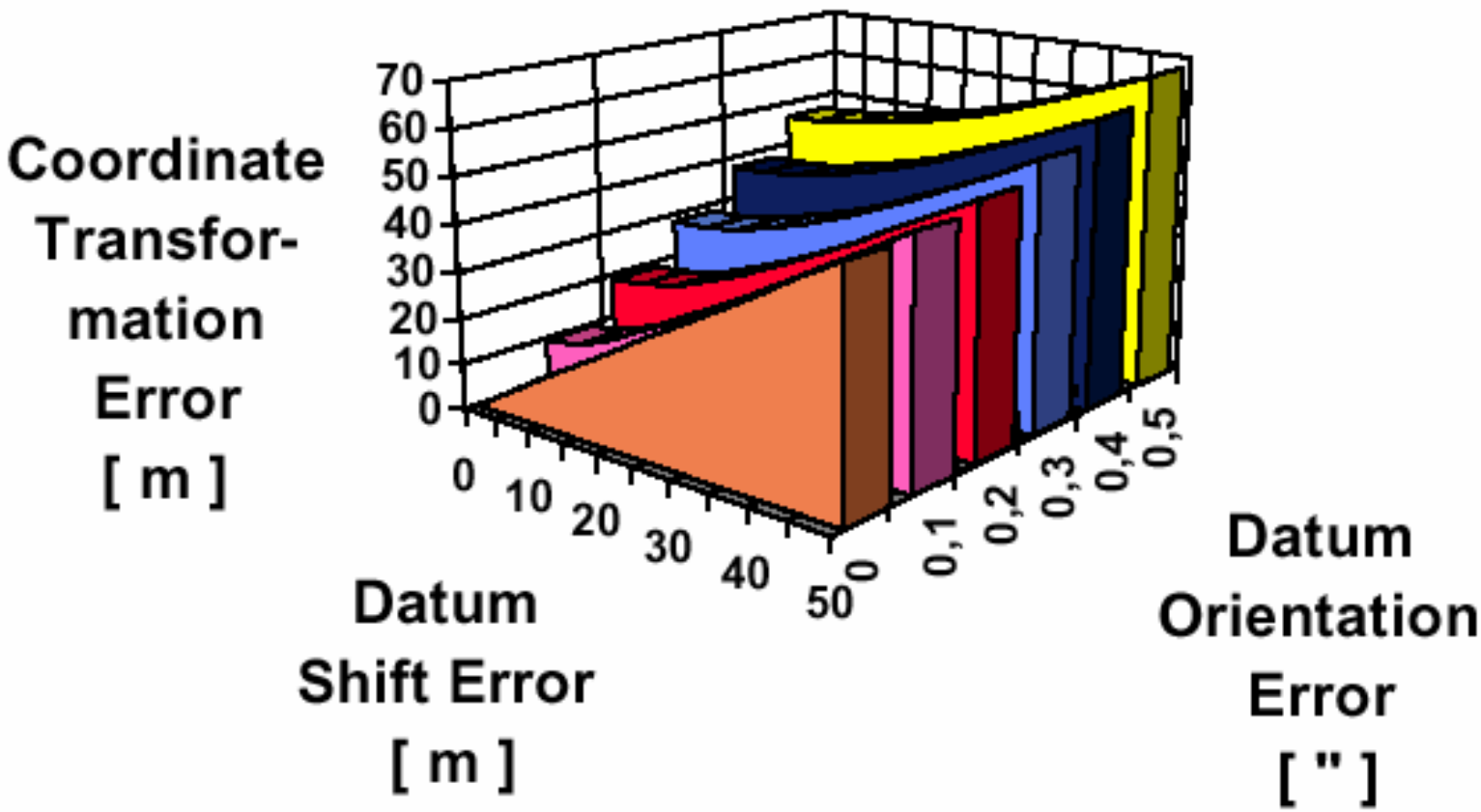


Transformation Error



The Shift required depends on the location on the datums. It is not constant.

Transformation Error

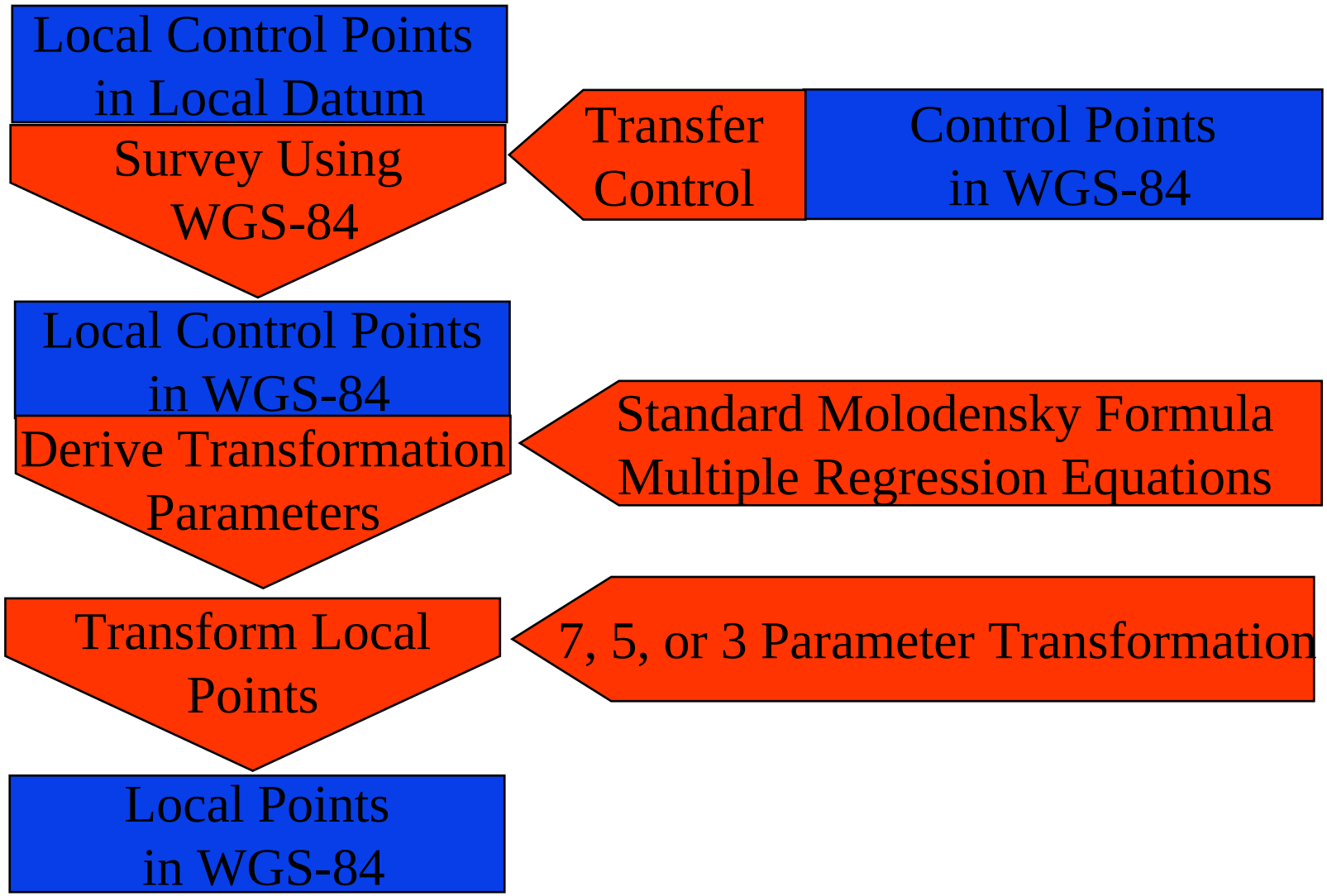


3 Parameter Determination

Continent: ATLANTIC OCEAN														
Local Geodetic Datums		Reference Ellipsoids and Parameter Differences			No. of Satellite Stations Used	Transformation Parameters								
Name	Code	Name	Δa(m)	Δf x 10^4		Cycle Number	Pub. Date	ΔX(m)		ΔY(m)		ΔZ(m)	
ANTIGUA ISLAND ASTRO 1943	AIA	Clarke 1880	-112.145	-0.54750714									
Antigua and Leeward Islands					1	0	1991	-270	±25	13	±25	62	±25
ASCENSION ISLAND 1958	ASC	International 1924	-251	-0.14192702									
Ascension Island					2	0	1991	-205	±25	107	±25	53	±25
ASTRO DOS 71/4	SHB	International 1924	-251	-0.14192702									
St. Helena Island					1	0	1987	-320	±25	550	±25	-494	±25
BERMUDA 1957	BER	Clarke 1866	-69.4	-0.37264639									
Bermuda Islands					3	0	1987	-73	±20	213	±20	296	±20
CAPE CANAVERAL	CAC	Clarke 1866	-69.4	-0.37264639									
Mean Solution (Bahamas and Florida)					19	0	1991	-2	±3	151	±3	181	±3

Most Transformation Parameters can be found in the NIMA technical report *"Department of Defense World Geodetic System 1984"* (TR 8350.2) NSN: 7643-01-402-0347

More Precise Determination



Transformation Software

MADTRAN Mapping Accuracy Transformations - No longer recommended.

DTCC4 DMA transformation program - No longer recommended.

CORPSCON Survey Accuracy Transformations for Continental US, Alaska, Hawaii, Virgin Islands and Puerto Rico

GEOTRANS2 Mapping Accuracy Transformations for preset datums and coordinate systems. The DoD recommended system.

FalconView Mapping Accuracy Transformations in conjunction with map display and mission planning - single transformations

PLGR/EPLGR Built in transformation software for coordinate transformations

Geographic Translator 2 (GEOTRANS2)

Converts coordinates among a wide variety of coordinate systems, map projections, and datums.

- 11 different coordinate systems and map projections
- Over 200 different datums
- Choose between Ellipsoid and MSL height
- Program can receive coordinates from a text file, convert them, and output results in another file.
- Mapping Level Transformations

Summary

- 7, 5, or 3 Parameter Transformation
- Survey vs Mapping Accuracy Transformations
- Traditional Parameter Derivation and application
- Geotrans Software