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Coordinate Systems and Datum Transformations in Action

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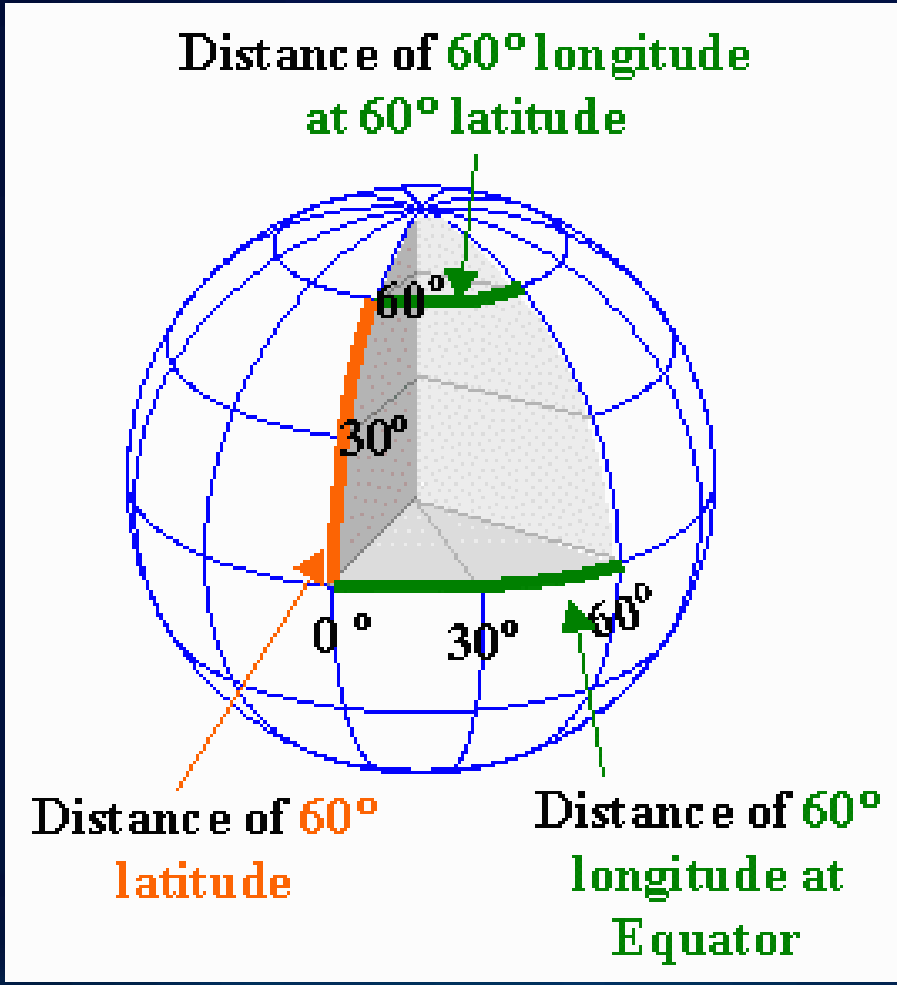
Objectives

- Coordinate systems
  - Geographic versus projected
  - Project considerations
  - ‘Gotchas’
- Identifying an unknown coordinate system
- Learn about the spatial reference
  - Storage and processing parameters
  - Setting appropriate values
- Picking a geographic/datum transformation

Note: Presentation will be available on the Proceedings CD

Coordinate systems

Geographic coordinate system



Geographic coordinate system

(gcs, geogcs)

- Name
- Datum
  - Spheroid
- Prime Meridian
- Angular unit of measure

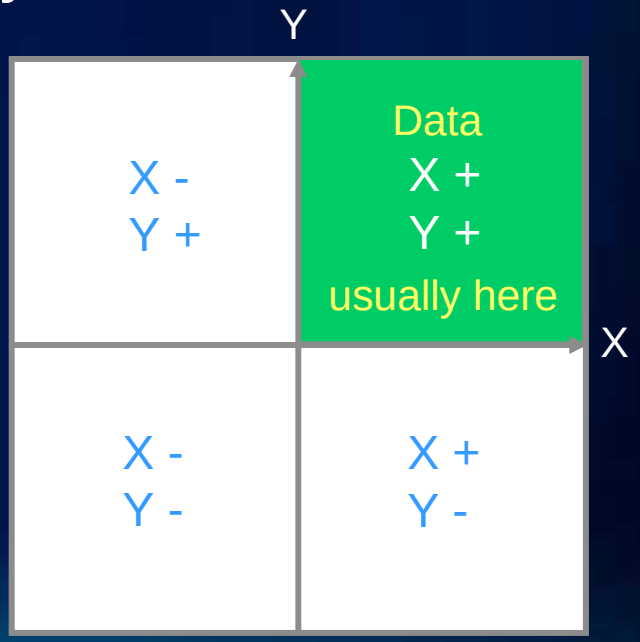
Geographic coordinate system

(gcs, geogcs)

- Name (European Datum 1950)
- Datum (European Datum 1950)
  - Spheroid (International 1924)
- Prime Meridian (Greenwich)
- Angular unit of measure (Degrees)

Projected coordinate system

- Linear units
- Lengths, angles, and areas are constant
- Shape, area, and distance may be distorted



Projected coordinate system

(pcs, projcs)

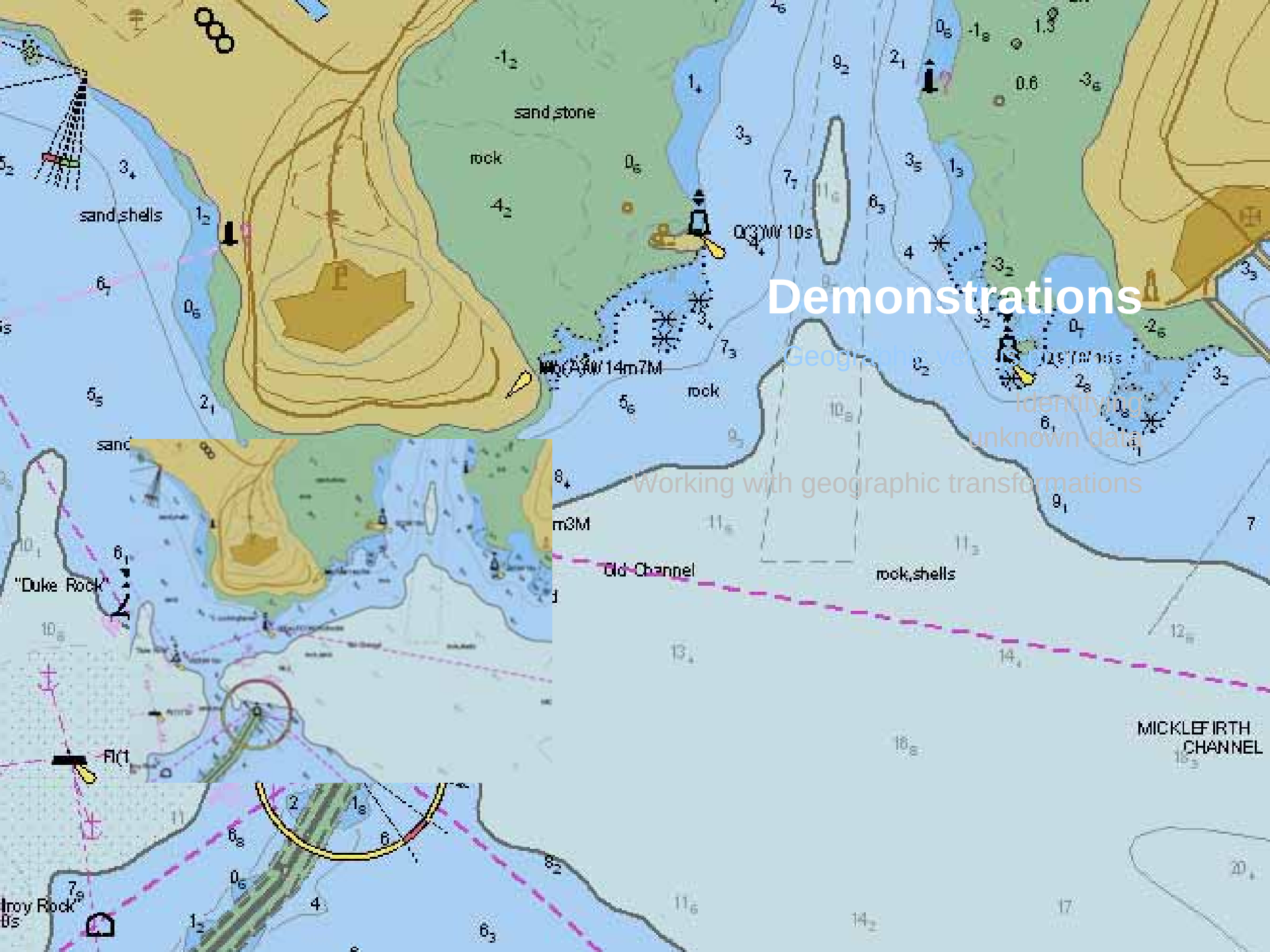
- Name
- GCS
- Map projection
- Projection parameters

- Linear unit of measure

Projected coordinate system

(pcs, projcs)

- Name (NAD 1983 UTM Zone 11N)
- GCS (NAD 1983)
- Map projection (Transverse Mercator)
- Projection parameters (central meridian, latitude of origin, scale factor, false easting, false northing)
- Linear unit of measure (Meters)



Demonstrations

Geographic vector identifying unknown data

Working with geographic transformations

Key questions before starting a project

- Purpose or uses
- Area of interest
  - For local datasets, use projected coordinate systems
  - For global/small scale use geographic coordinate systems
- Required accuracy
- Characteristics and attributes
  - Raster/vector
  - Point/line/polygon
  - Distances/areas/??

Choosing the right coordinate system

- What does your boss think?
- What are other government agencies/partners using?
- For what purposes are the data going to be used?
- Minimize projecting data on the fly
  - Impacts performance

Coordinate system gotchas

- Defining a coordsys updates the metadata ONLY
  - Doesn’t affect the coordinate values
  - Define data in its current coordinate system, then project
- Datum transformations are important!
  - Omit or choose the wrong one—up to 200 m
  - Multiple ones exist—up to you to decide which one is best
  - See Knowledge Base article #21327

Another gotcha

- **Raster and CAD data may need georeferenced**

Unknown coordinate system

Unknown coordinate systems

- ALWAYS define the coordinate system
- Good professional practice—help your successor
- Units are unknown
- Map scale is incorrect
- Geodatabase tools can’t use default values

What if I don’t know my data’s coordinate system?

- Check the data provider or source
- Check any existing metadata
- Similar data types
- What coordinate systems are used in the area?
  - http://www.epsg.org http://www.epsg-registry.org

What if I don’t know my data’s coordinate system?

- Try using ArcMap to figure it out
  - See Article ID #: 24893

    HowTo: Identify an unknown coordinate system using ArcMap
  - Live Training Seminar (free)

    Working with Map Projections and Coordinate Systems in ArcGIS

    http://training.esri.com/acb2000/showdetl.cfm?did=6&Product_id=826&2

Familiarize yourself with common coordinate systems

- Know what coordsys are used in your area of interest
- Learn what the layer extents should be

San Diego, California		
NAD 1983	X / longitude	Y / latitude
Geographic	-116.67 °	33 °
UTM zone 11N	530,000 m	3,650,000 m
State Plane (CA zone 6)	1,960,000 m	593,000 m

Real world example

- **Longitude: -88.365934**
  Latitude: 28.738369

  Calculated NAD 27 XY Coords:
  Longitude: 10431702.916855
  Latitude: 1202802.892336

What do you know?

decimal degrees

Longitude: -88.365934
Latitude: 28.738369

Calculated NAD 27 XY Coords:
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What do you know?

In the U.S.

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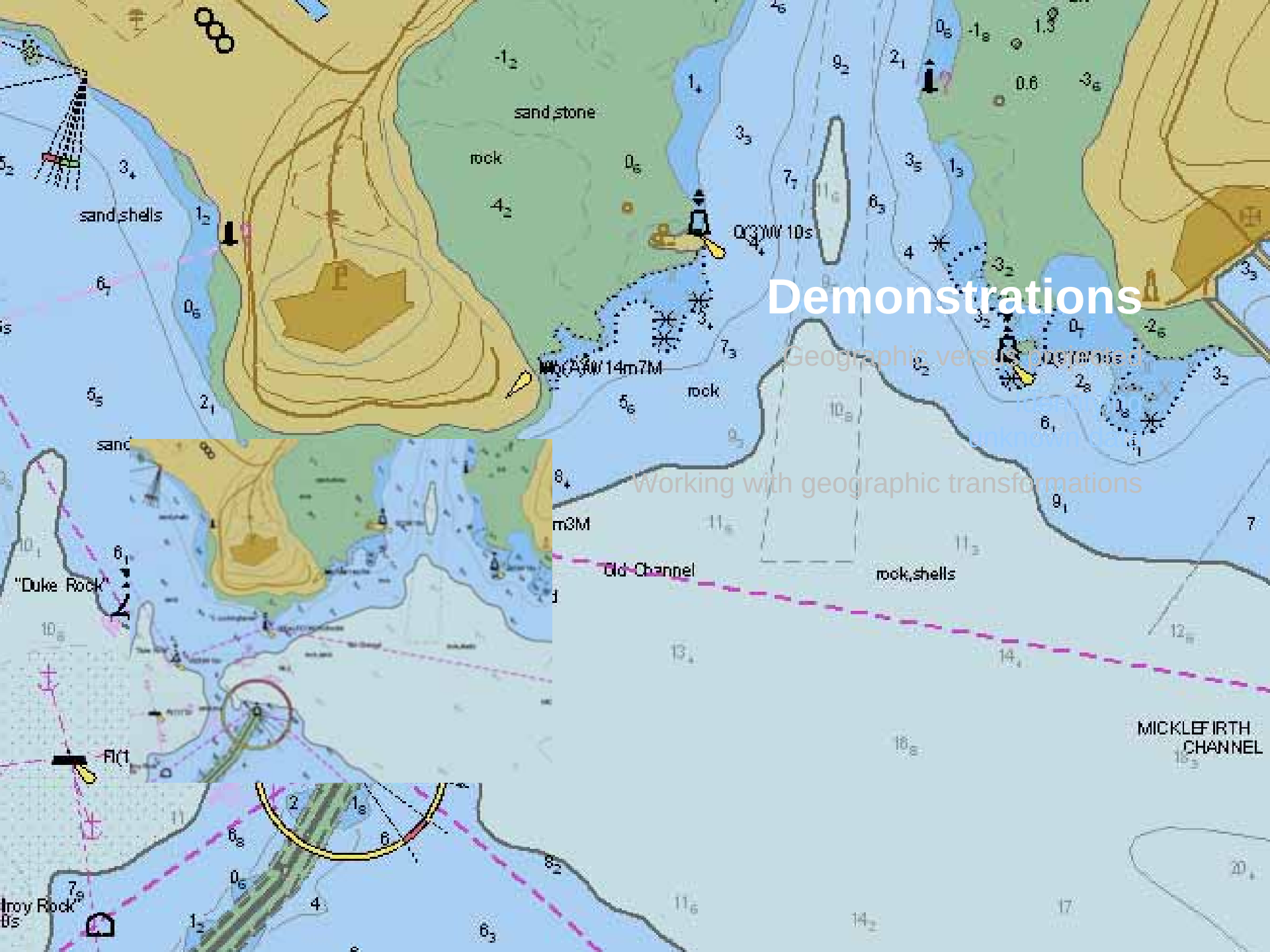
X or Y?

Demonstrations

Geographic versus projected

Unknown

Working with geographic transformations



The spatial reference

Spatial reference

- Coordinate system (projection)
- Tolerance
- Resolution
- Domain (extent)

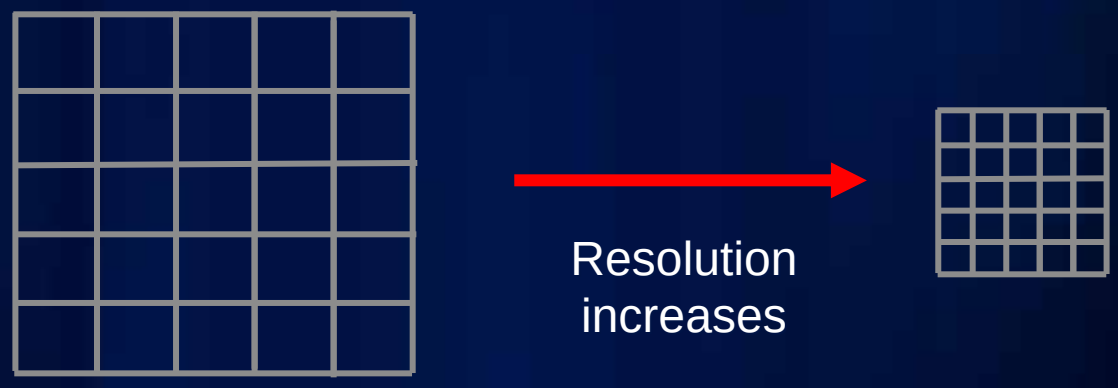
- *Cannot be changed!*

Tolerance

- Stored as part of feature class schema
- Used throughout the software
  - Map's spatial reference
  - Spatial selections/queries
  - Topology
  - Geoprocessing
- Define the tolerance based on data accuracy, not storage accuracy

Resolution and spatial domain

- **Domain and resolution are complementary properties**
  - **i.e., increase in resolution results in decrease in domain extent**



- **Domain defined using the valid extent of the horizontal coordinate system**

Resolution

- ArcGIS supports resolutions < 1 micrometer
  - Varies slightly by coordinate system
- Why don’t we just use the minimum resolution?
  - Performance Impact
    - Storage cost
    - Processing performance
- Our default (1/10 mm) balances storage precision and performance
  - Defaults should be used in most cases

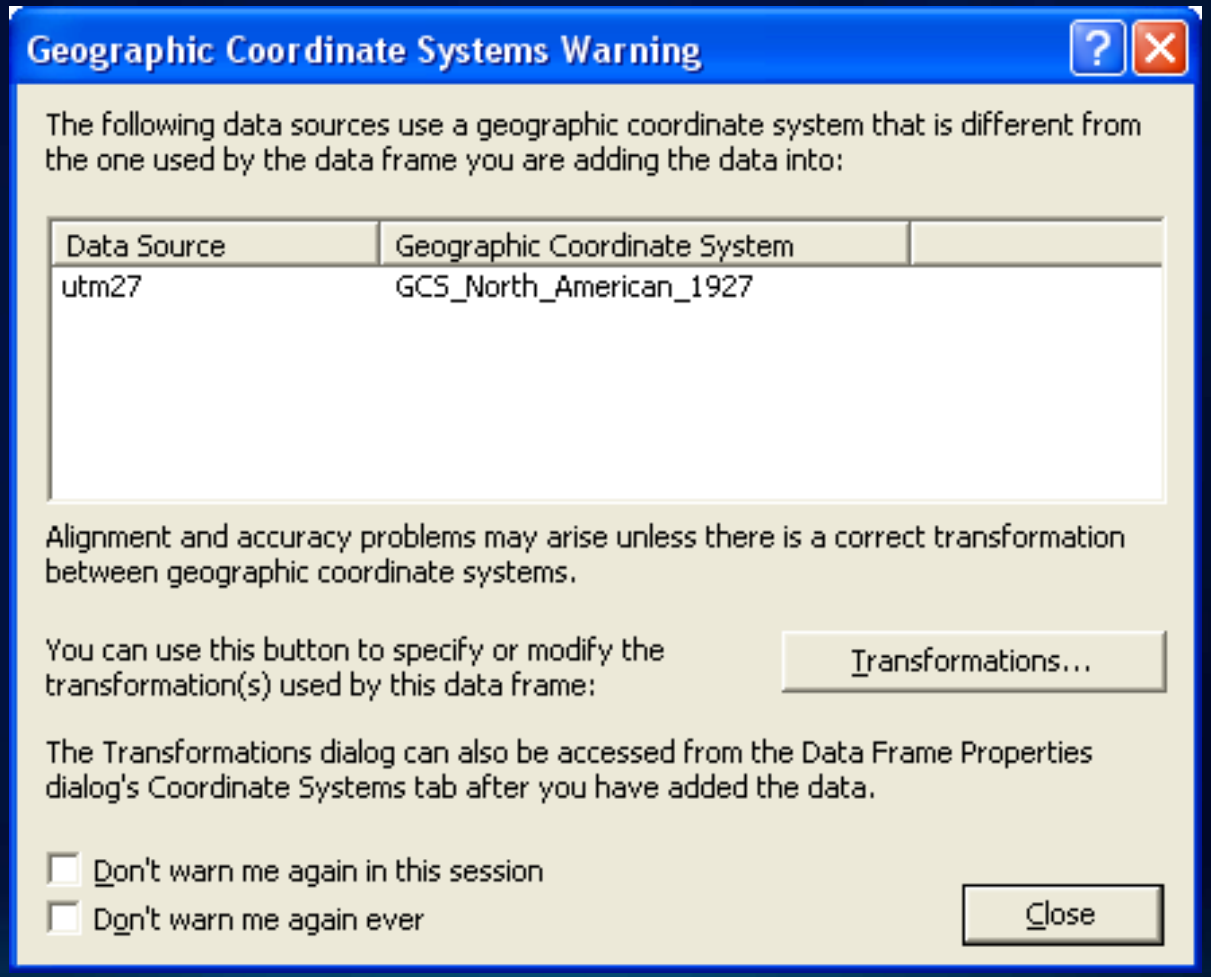
Geographic (datum) transformations

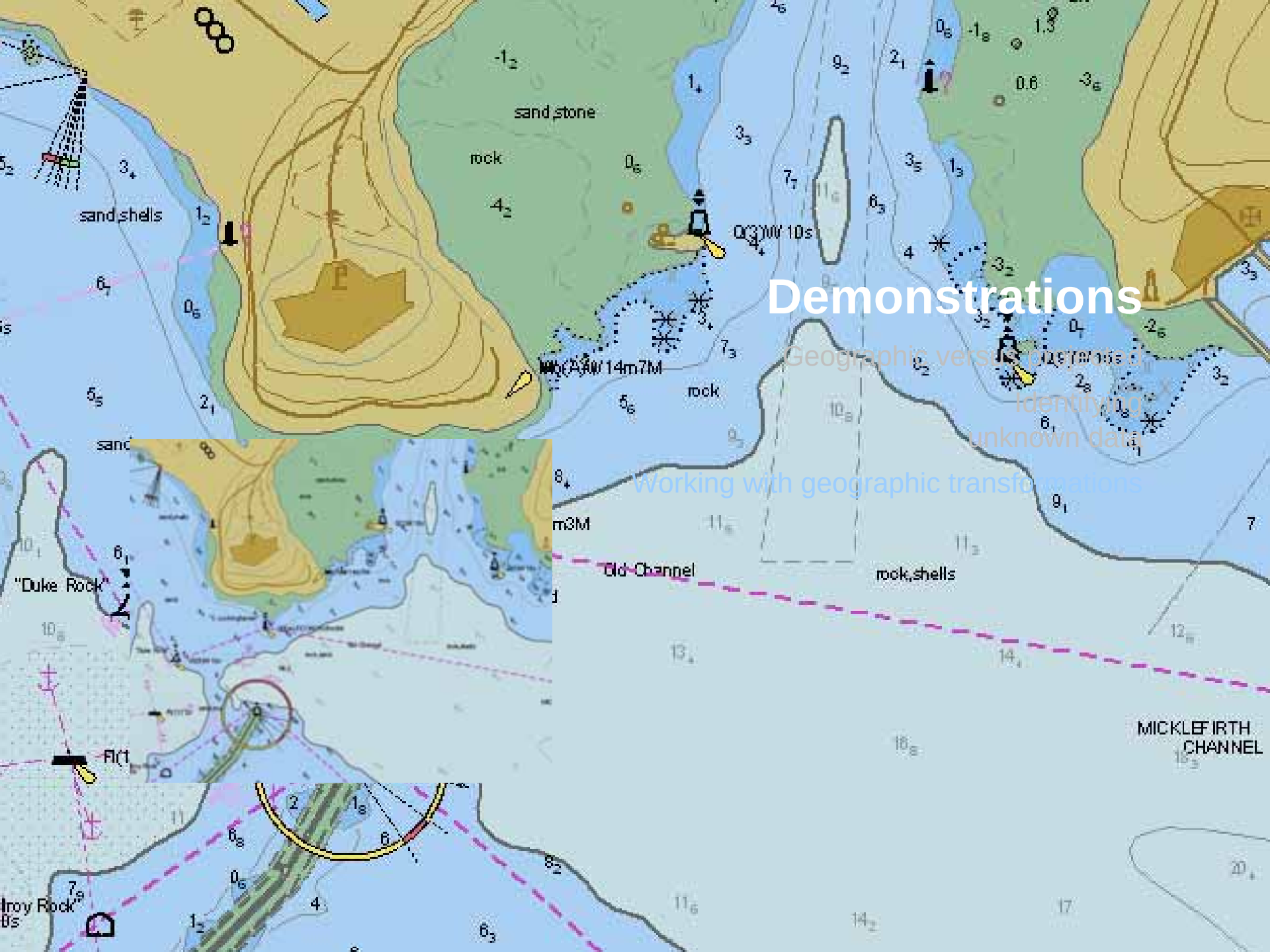
Geographic transformations

- Convert between two geographic coordinate systems
- Offsets can be significant

San Diego, California		
Geographic	Longitude	Latitude
NAD 1927	-116.6691455°	32.9999533°
NAD 1983	-116.6700000°	33.0000000°
NAD 1983 HARN	-116.6700004°	33.0000000°

Warning: different geographic coordinate system…





Demonstrations

Geographic versus projected

Identifying unknown data

Working with geographic transformations

Wrap-up

Where to find help

- Projection team schedule
- Geodatabase Management Island
  - Tuesday 9 am – 3 pm, 4:30 pm – 6 pm
  - Wednesday 9 am – 3 pm, 5 pm – 6 pm
  - Thursday 9 am – 1:30 pm

  (Weds 10 am – 12 pm: all members of projection team)

More information

- **Don't forget the Knowledge Base!**
  - **http://support.esri.com**
    - **23025, 29129, 24893, 29035, 17420**
- **ESRI forums for user-to-user help**
  - **http://forums.arcgis.com**
- **Virtual Campus**
  - **http://campus.esri.com**
  - **Live Training Seminar and Course**

- ***http://www.epsg.org***
  - Database of coordinate systems & datums
  - *Guidance Note 7*

Books, etc.

- **Maher.** *Lining Up Data in ArcGIS*
- ***Meyer.*** *Introduction to Geometrical and Physical Geodesy.*
- **Snyder.** *Map Projections: A Working Manual*
  - **http://pubs.er.usgs.gov/djvu/PP/PP_1395.pdf**
- **Flacke & Kraus.** *Coordinate systems in ArcGIS*
- **Snyder & Voxland.** *An Album of Map Projections*. **USGS PP 1453**
  - **http://infotrek.er.usgs.gov/pubs**
- **Iliffe.** *Datums and Map Projections*

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