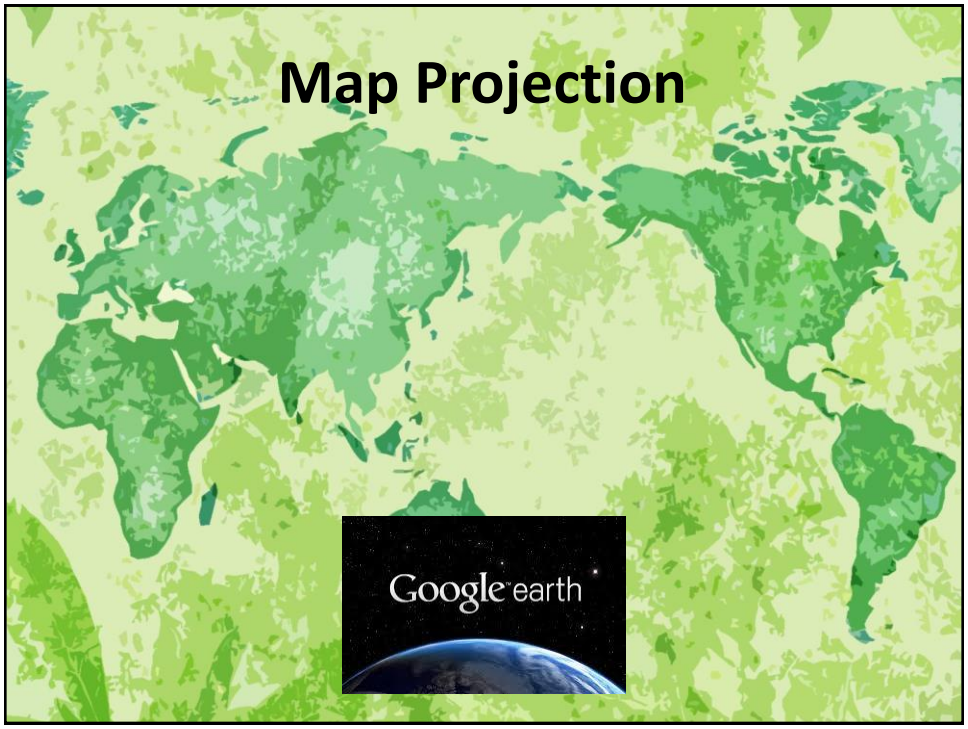
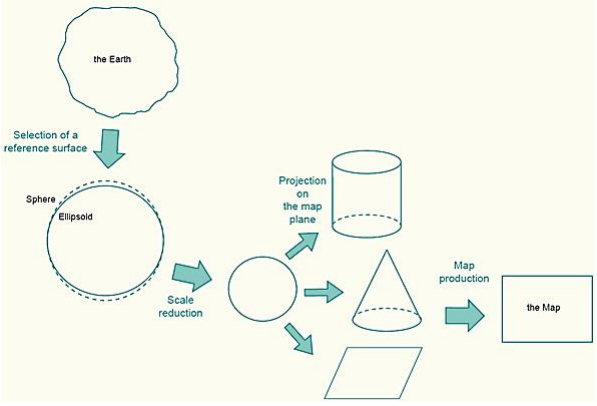
Map Projection



The Earth on a flat map

- The process of representing the Earth on a flat map

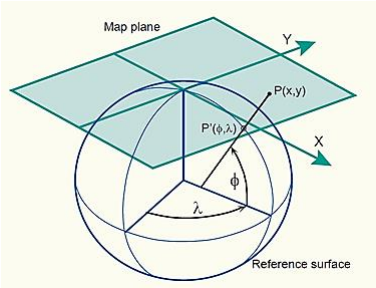


Reference Surfaces

- Two main reference surfaces are used to approximate the shape of the Earth.
  - ✓ellipsoid (also called spheroid)
  - ✓geoid
- Ellipsoid
  - ✓a relatively simple mathematical figure of the Earth
  - ✓used to measure locations, the latitude(Φ) and longitude(λ), of points of interest
  - ✓these locations on the ellipsoid are then projected onto a mapping plane
  - ✓there are many different ellipsoids defined in the world, some well-known are the WGS84, GRS80, International 1924 (also known as Hayford), Krasovsky, Bessel, or the Clarke 1880 ellipsoid
- Geoid
  - ✓the equipotential surface at mean sea level
  - ✓used for measuring heights represented on maps

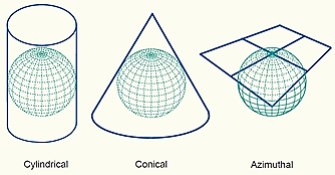
Map Projections

- To produce a map the curved reference surface of the Earth, approximated by an ellipsoid or a sphere, is transformed to the flat plane of the map by means of a **map projection**.
- In other words
  - ✓each point on the reference surface of the Earth with ***geographic coordinates*** (Φ, λ)
  - ✓may be transformed to set of ***Cartesian coordinates***(x, y) or map coordinates representing positions on the map plane



Map Projections

- Hundreds of map projections are developed in order to accurately represent a particular map or to best suit a particular type of map.
- Examples of map projections are Transverse Mercator (also known as Gauss-Krüger), equidistant cylindrical and conic projection, Lambert's azimuthal, conic and cylindrical projection, stereographic projection, and various others.
- Map projections are typically classified according to the geometric surface from which they are derived: cylinder, cone or plane. The three classes of map projections are respectively ***cylindrical***, ***conical***, and ***azimuthal***.



Map Projections

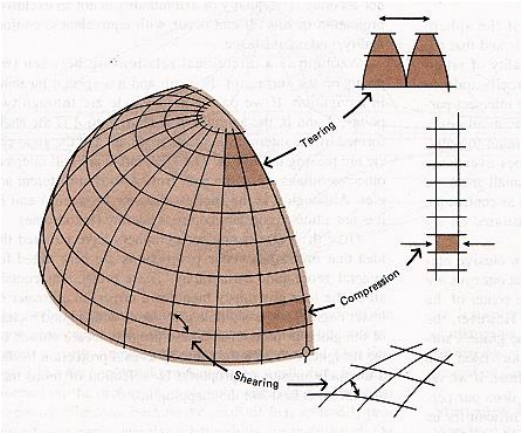
- Furthermore map projections are typically classified *according to the distortion properties* of a map.
- The three distortion properties of map projections are respectively:
  - ✓ ***equal-area*** (or equivalent)
  - ✓ ***equidistant***
  - ✓ ***conformal***

Defining Map Projection

- A ***map projection*** is a system in which locations on the curved surface of the Earth are displayed on a flat sheet or surface according to some set of rules.
  - ✓ http://www.youtube.com/watch?v=X4wgFSHZXBg

Sources of Distortion

- Globe is **only true representation** of Earth distance, direction, area, and shape.
- Projected maps contain distortions (error) → area, shape, distance, and direction.
- Cartographers decide **which characteristics** to distort and **how much** distortion is acceptable.

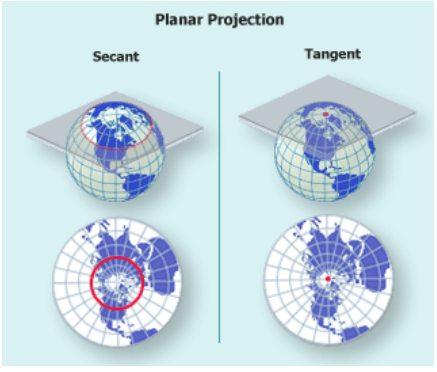


Developable Surfaces

- ***Developable Surface*** – surface that can be made flat by cutting it along certain lines then unfolded or unrolled.

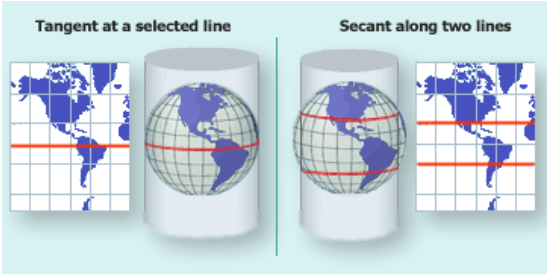
Planar (Azimuthal) Family

- Projecting a spherical surface onto a plane tangent or secant to the sphere.
- Lambert Equal Area, Azimuthal equidistant, orthographic



Cylindrical Family

- Projecting a spherical surface onto a cylinder tangent or secant to the earth's surface
- Mercator, Goode's Interrupted Homolosine, Robinson



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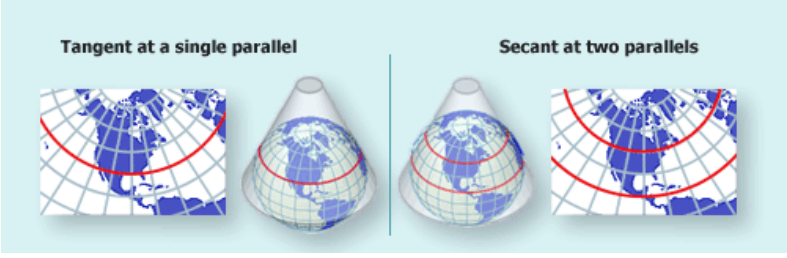
Conic Family

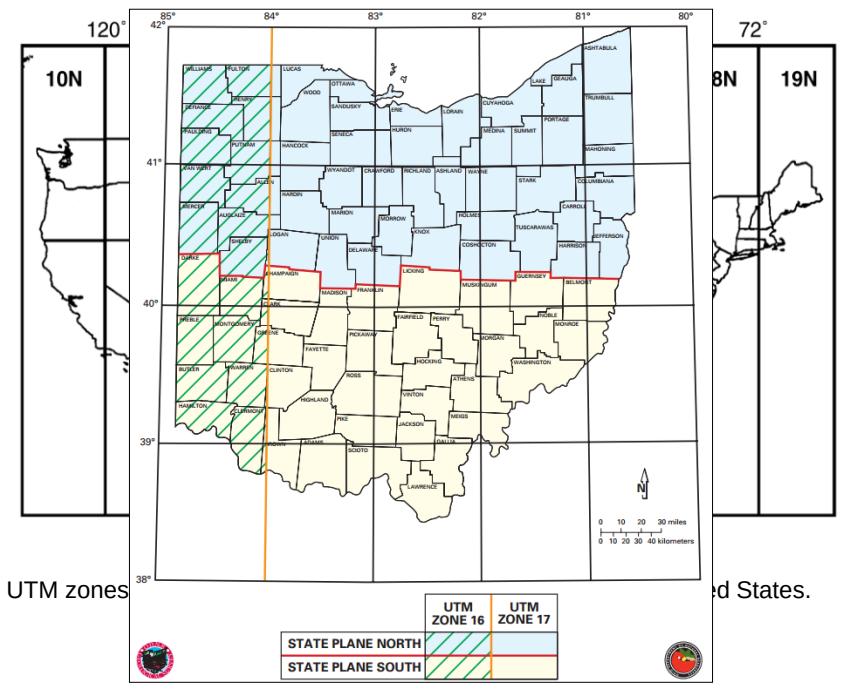
- Projecting a spherical surface onto a cone tangent or secant to the sphere.
- Lambert Conformal Conic, Albers Equal Area



Types of Map Projections

- Types of map projections (part 1)
  - ✓ http://www.youtube.com/watch?v=pWAOghajt7A
  - ✓ from 4:54
- Types of map projections (part 2)
  - ✓ http://www.youtube.com/watch?v=3OgZkkib9bA
  - ✓ from 2:35 (coordinate systems)

- About Mercator
  - ✓ http://www.businessinsider.com/mercator-projection-v-gall-peters-projection-2013-12
  - ✓ http://www.businessinsider.com/greenland-africa-comparison-2014-5



UTM zones ed States.

Search & Navigation

- When you start the GE and just ZI (use Zoom Slider)
  - ✓ you are in …
- GE is an interactive virtual globe
  - ✓ turn on the 3D buildings layer and type in
  - ✓ in search panel, type in miami univ…
    : country, state, city name, or zip code
    : landmarks (Cincinnati Zoo)
    : full address
    : lat & lon coord.
    (try N39 W84, then N39.50922 W84.73412)
  - ✓ get directions
  - ✓ save your searches to 'My Places'
- Navi controls appear top right corner, if you don't see them
  - ✓ View menu > Show Navigation > Automatically
- Zoom in & explore
  - ✓ zoom slider, look joystick, sun icon, move joystick…

Navigation

- Zoom slider
  - ✓ zoom in/out
    : you can also ZI to a location by double-clicking
  - ✓ double click anywhere on the map or a specific placemark
  - ✓ using ZS to zoom closer will gradually tilt the viewing angle
- Look joystick
  - ✓ to adjust your perspective while standing in the same spot
  - ✓ drag north button (N) around the ring
  - ✓ To return to a North up perspective?

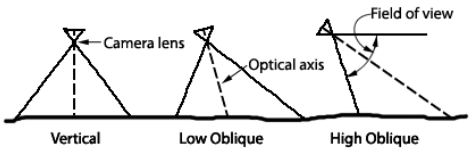
Navigation (2)

- Sun icon
  - ✓ to see sunlight & shadows
  - ✓ move the slider to adjust the actual time & date represented by the sun's position
  - ✓ when was the image taken? tell morning or afternoon?
  - ✓ let's go to Seoul and check what time it is there

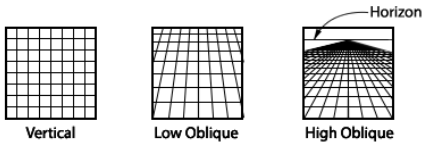
- Move joystick
  - ✓ move to different locations
  - ✓ you can also move around by using the arrow keys

Types of Air Photos

- oblique: at an angle (diverging from vertical) to the ground
  - ✓ high oblique: includes the horizon
- vertical: perpendicular to the ground



Camera orientation for various types of aerial photographs

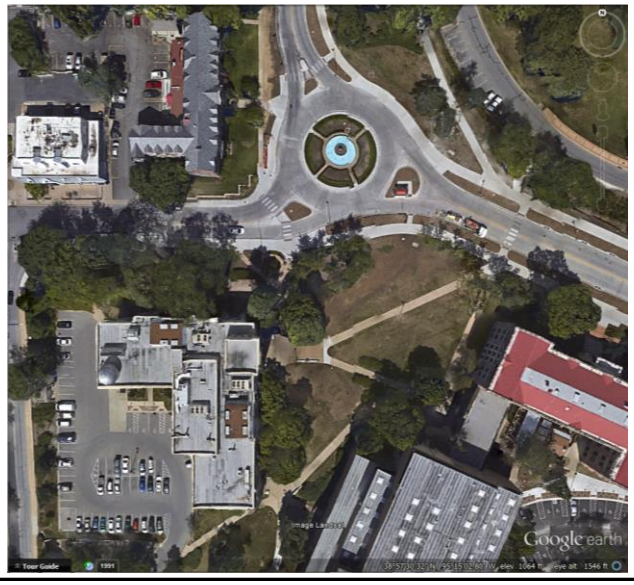


How a grid of section lines appears on various types of photos.

Advantages of Using Each?

- oblique
  - ✓ covers more area from a given flying height
  - ✓ oblique angle is more familiar to us (more like horizontal)
  - ✓ some objects not visible on vertical photos may be seen
  - ✓ shadows may give clues
- vertical
  - ✓ scale is constant
  - ✓ measurements of directions are easier
  - ✓ easier to use for mapping (positional accuracy)
  - ✓ easier to interpret than and better for stereo (there is no masking)
  - ✓ less atmosphere to penetrate

Vertical Photo



Low Oblique Photo

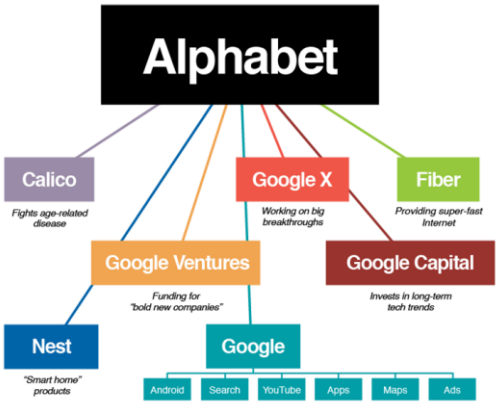
High Oblique Photo

Street View

- Drag a pegman to Uptown
  - ✓blue border appears…
  - ✓(double-) click to move in that direction
  - ✓just click and drag to change view
  - ✓use navigation controls as well
  - ✓you can use arrow keys and wheel on your mouse
- Move a pegman to E Spring St.
  - ✓which building is under construction? what year?
  - ✓switch to ground-level view

The Google Empire

- **Google's mission is to conquer the world.**



- Google is building a hardware empire, and this is what it looks like
- List

Google: don’t be evil?

- Google Street View
- Google Privacy Issues
  - ✓ google maps: an invasion of policy?
  - ✓ google concedes that drive-by prying violated privacy
- Why Google Is the New Evil Empire
  - ✓ *We don’t need you to type at all because we know where you are. We know where you’ve been. We can more or less guess what you’re thinking about … Is that over the line?*
- CAN WE ALL JUST ADMIT GOOGLE IS AN EVIL EMPIRE?
  - ✓ *Google doesn’t care about you. It cares about your data. Act accordingly*.
- Google: From "Don't Be Evil" to Evil Empire?
  - ✓ *We now allow Google to determine what is important, relevant, and true on the Web and in the world. We trust and believe that Google acts in our best interest. But we have surrendered control over the values, methods, and processes that make sense of our information ecosystem.*

Drawing & Measuring

- Add a path
  - ✓ see an elevation profile
- Measure the distance
  - ✓ area?

Travel Back in Time

- Find the clock icon
  - ✓ there is historical imagery available in the location
  - ✓ check out MU, Cincinnati

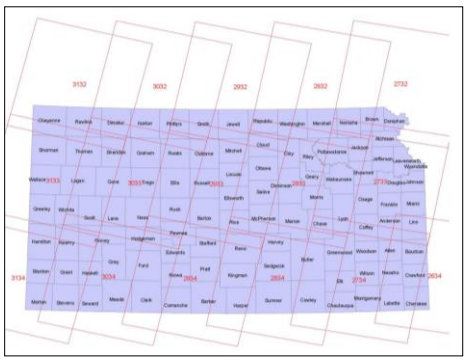
Placemarks, Tour, 3D Trees

- Add a placemark
- Create a tour
- 3D trees in
  - ✓ Cacoal, Brazil
  - ✓ Tokyo, Japan

More …

- Sky, Moon, & Mars
- KML
  - ✓ https://nsidc.org/data/google_earth/
  - ✓ http://earthquake.usgs.gov/learn/kml.php

Landsat Orbit



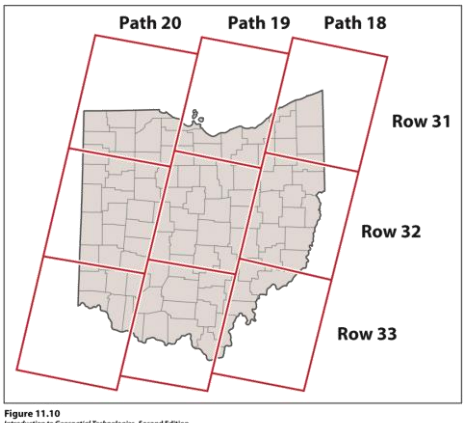


Figure 11.10
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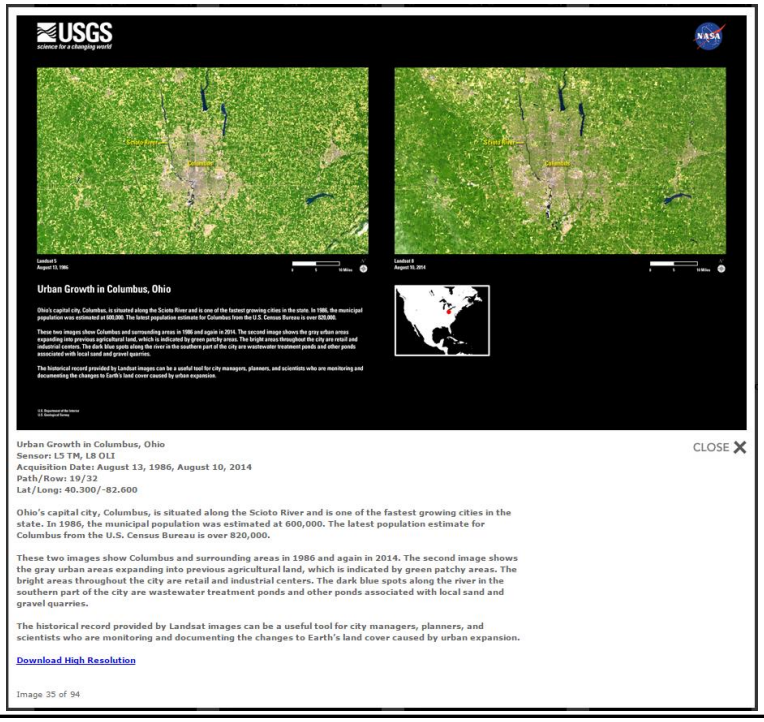
82,277 mi²

44,825 mi²



Urban Growth in Columbus, Ohio
Sensor: L5 TM, L8 OLI
Acquisition Date: August 13, 1986, August 10, 2014
Path/Row: 19/32
Lat/Long: 40.300/-82.600

CLOSE

Ohio's capital city, Columbus, is situated along the Scioto River and is one of the fastest growing cities in the state. In 1986, the municipal population was estimated at 600,000. The latest population estimate for Columbus from the U.S. Census Bureau is over 820,000.

These two images show Columbus and surrounding areas in 1986 and again in 2014. The second image shows the gray urban areas expanding into previous agricultural land, which is indicated by green patchy areas. The bright areas throughout the city are retail and industrial centers. The dark blue spots along the river in the southern part of the city are wastewater treatment ponds and other ponds associated with local sand and gravel quarries.

The historical record provided by Landsat images can be a useful tool for city managers, planners, and scientists who are monitoring and documenting the changes to Earth's land cover caused by urban expansion.

Download High Resolution

Image 35 of 94

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Path/Row Shapefiles

The WRS-1 and WRS-2 shape files include path/row scene boundaries and geographic coordinates.

Ascending and Descending:	wrs1_asc_desc.zip - .zip (14.6 MB) wrs2_asc_desc.zip - .zip (9.02 MB)
Descending only:	wrs1_descending.zip - .zip (7.71 MB) wrs2_descending.zip - .zip (4.75)

Geographic coverage: -180 to 180 degrees longitude, -82.6 to 82.6 degrees latitude
Projection information: Geographic
Units: Decimal Degrees (DD)
Datum: WGS84
Region attribute for the path/row is "pr."

KML Files

Keyhole Markup Language (KML) files can be uploaded to Google Earth, or other geospatial software implementing KML encoding.

WRS-2 scene boundaries (worldwide) - .kml (34.2 MB)

WRS-2 scene center points (north latitude and west longitude only) - .kml (3.4 MB)