NAIP Technical Presentation

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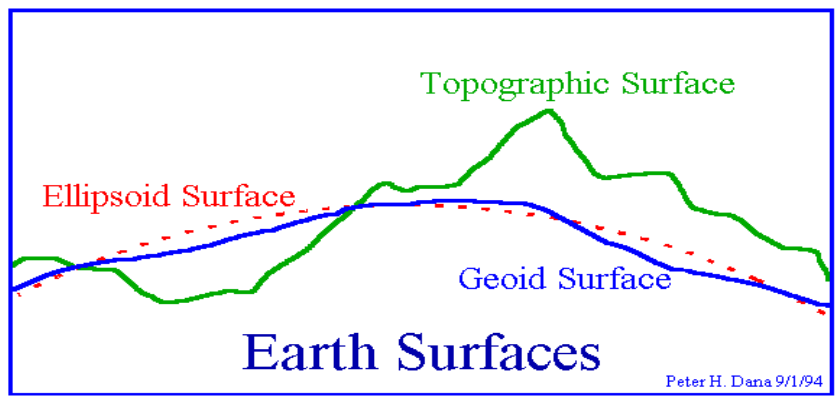
File Extensions
&
Coordinate Systems

File Extensions

- File Extension Soup
  - What's a …
    - **shp** - the file that stores the feature geometry
    - **shx** - the file that stores the index of the feature geometry
    - **dbf** - the dBASE file that stores the attribute information of features
    - prj - the file that stores the coordinate system information
    - sbn - the files that store the spatial index of the features
    - sbx - the files that store the spatial index of the features
    - mdb - relational databases that contain geographic information
    - **tif, tiff, tff** – non proprietary raster format compressed or uncompressed
    - **sid** – LizardTech proprietary standard compression raster format
    - **jpg, jpeg, jfif** – non proprietary standard compression raster format
    - **aux** – location where stat info about a raster is stored, including pointer to the pyramid (rrd) file, color map, histogram/table, coordinate system, transformation, and projection information
    - **sdw** – sid world file, stores location information (upper left) of sid image
    - **tfw** – tif world file, stores location information (upper left) of tif image
    - **rrd** – pyramid file created when you choose to build pyramids in a Reduced Resolution Dataset (RRD) file, with the same filename as the dataset.
    - **txt** – file containing textual information
    - **xml** – extensible markup language similar to html, define tags, add meaning

Coordinate Systems/Projections

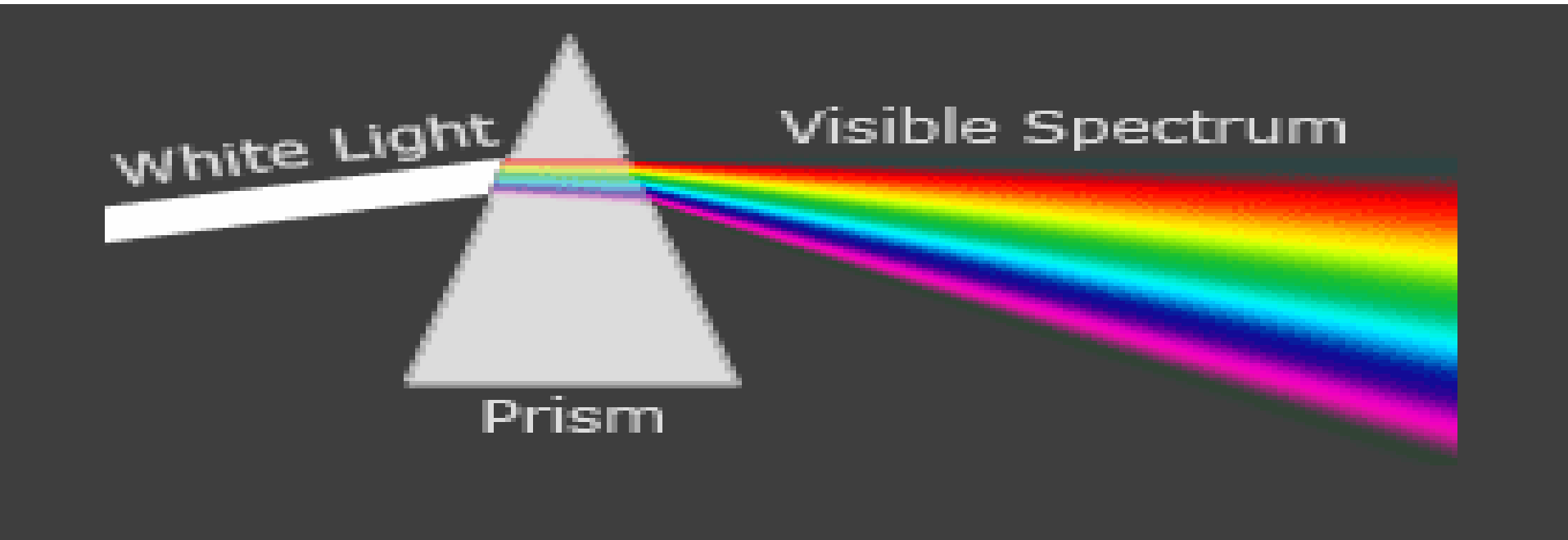
- Coordinate System – A reference system used to measure horizontal and vertical distances on a planimetric map. A coordinate system is usually defined by a map projection…There are two types of coordinate systems: **geographic** and **projected**. Geographic coordinate systems use latitude and longitude coordinates on a spherical model of the earth's surface. Projected coordinate systems use a mathematical conversion (projections) to transform latitude and longitude coordinates that fall on the earth's three-dimensional surface to a two-dimensional surface.
- Projection – Whether you assume the earth is a sphere or a spheroid, you need to transform its three-dimensional surface to create a two-dimensional map. This transformation is called a projection. In simpler terms, a projection is a mathematical attempt to place what is seen on a flat computer screen at the coordinates/location of where it really exists in the three dimensional world. Projections can be optimized to preserve shape (conformal), area (equal area), distances (equidistance), directional (true direction), or a combination of the above.
- Datums – a datum defines the position of the spheroid relative to the center of the earth. A datum provides a frame of reference for measuring locations on the surface of the earth. It defines the origin and orientation of latitude and longitude lines.
  - If the earth was a perfect sphere, this would all be much easier.
  - Local Datums
- On the Fly Projections in ArcMap
- Changing Projections in ArcCatalog
  - Shapefiles/Geodatabases
- *Actually* Reprojecting/Encoding Imagery
- Spatial Reference Data
  - Order of Application
    - ArcMap – Header, AUX, World Files
    - ArcView – TFW First



Color, Light, and Atmospheric Conditions

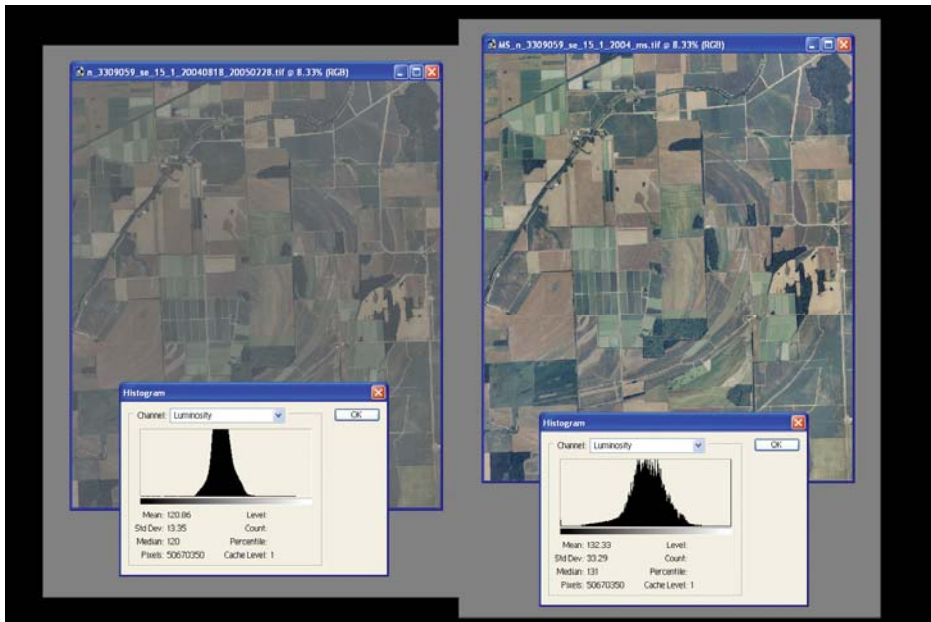
Colors

- What is the most important color to see?
  - Shades of green/red/blue?
  - Depends on what you're looking for…



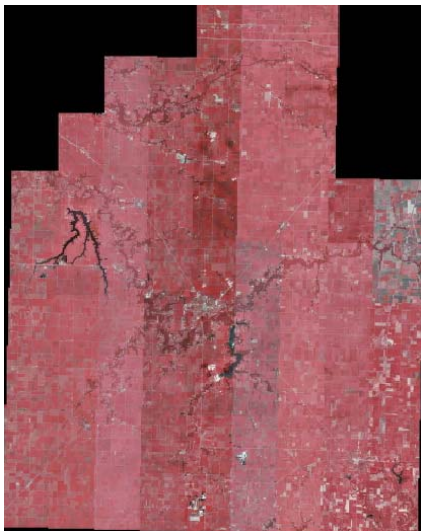
Color Samples

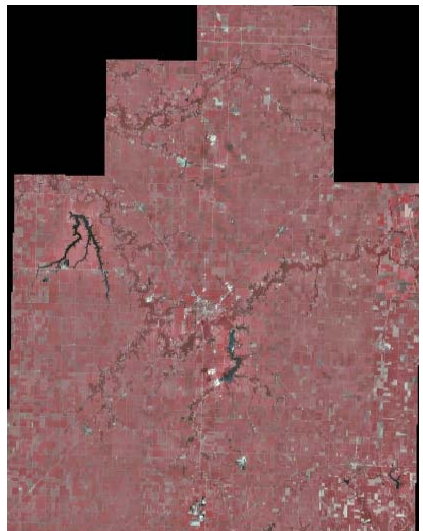
- NAIP Color Samples
  - For Each State
    - Approved by APFO Color Team
    - Approved by State Coordinator/Specialist
    - Forwarded to Vendor as Part of Award Package



Color Balancing

- NAIP Contract Requires Color Balancing
  - But what is your target image?
    - Color adjusted/balanced image
      - adds contrast, more interpretable, pleasing to the eye
    - Unbalanced/raw data
      - may lead to an inconsistent, patchwork CCM





NAIP04 CCM Christiansen County, Illinois

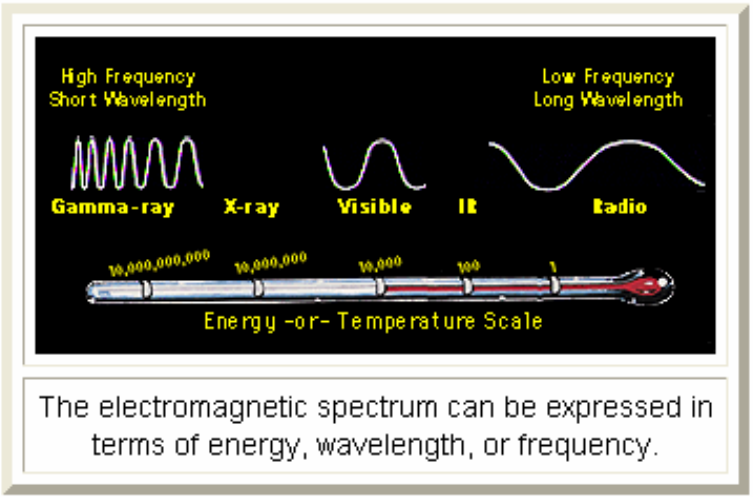
What is Bit-Depth?

- # of possible colors a particular pixel can hold.
  - With 8 bit, each channel has 256 (2 to the 8th) different possible intensity values for each primary color, so an RGB pixel can hold 256 to the 3rd or > 16 million different colors = true color
  - With 16 bit, this number is 2 to the 16th x 2 to the 16th x 2 to the 16th or 281 trillion colors
  - Human eye can only discern around 10 million colors
- File Sizes

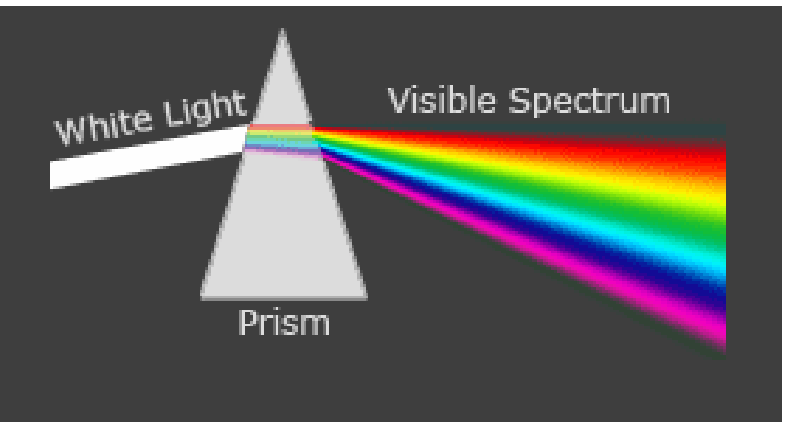
http://www.cambridgeincolour.com/home.htm

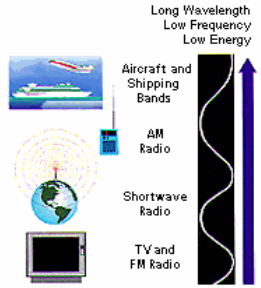
So, how many values are possible for a BW image that can only hold 1 bit per pixel? What about 2 bits per pixel?

Understanding Light



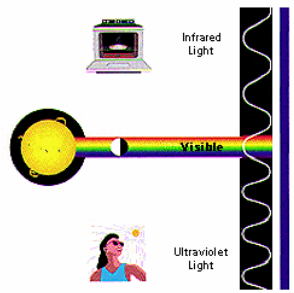
The electromagnetic spectrum can be expressed in terms of energy, wavelength, or frequency.





Radio: yes, this is the same kind of energy that radio stations emit into the air for your boom box to capture and turn into your favorite Mozart, Madonna, or Coolio tunes. But radio waves are also emitted by other things ... such as stars and gases in space. You may not be able to dance to what these objects emit, but you can use it to learn what they are made of.

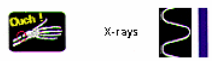
Microwaves: they will cook your popcorn in just a few minutes! In space, microwaves are used by astronomers to learn about the structure of nearby galaxies, including our own Milky Way!



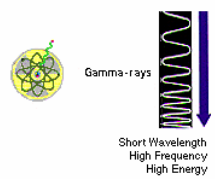
Infrared: we often think of this as being the same thing as 'heat', because it makes our skin feel warm. In space, IR light maps the dust between stars.

Visible: yes, this is the part that our eyes see. Visible radiation is emitted by everything from fireflies to light bulbs to stars ... also by fast-moving particles hitting other particles.

Ultraviolet: we know that the Sun is a source of ultraviolet (or UV) radiation, because it is the UV rays that cause our skin to burn! Stars and other "hot" objects in space emit UV radiation.



X-rays: your doctor uses them to look at your bones and your dentist to look at your teeth. Hot gases in the Universe also emit X-rays .



Gamma-rays: radioactive materials (some natural and others made by man in things like nuclear power plants) can emit gamma-rays. Big particle accelerators that scientists use to help them understand what matter is made of can sometimes generate gamma-rays. But the biggest gamma-ray generator of all is the Universe! It makes gamma radiation in all kinds of ways.

http://imagine.gsfc.nasa.gov

Understanding Light

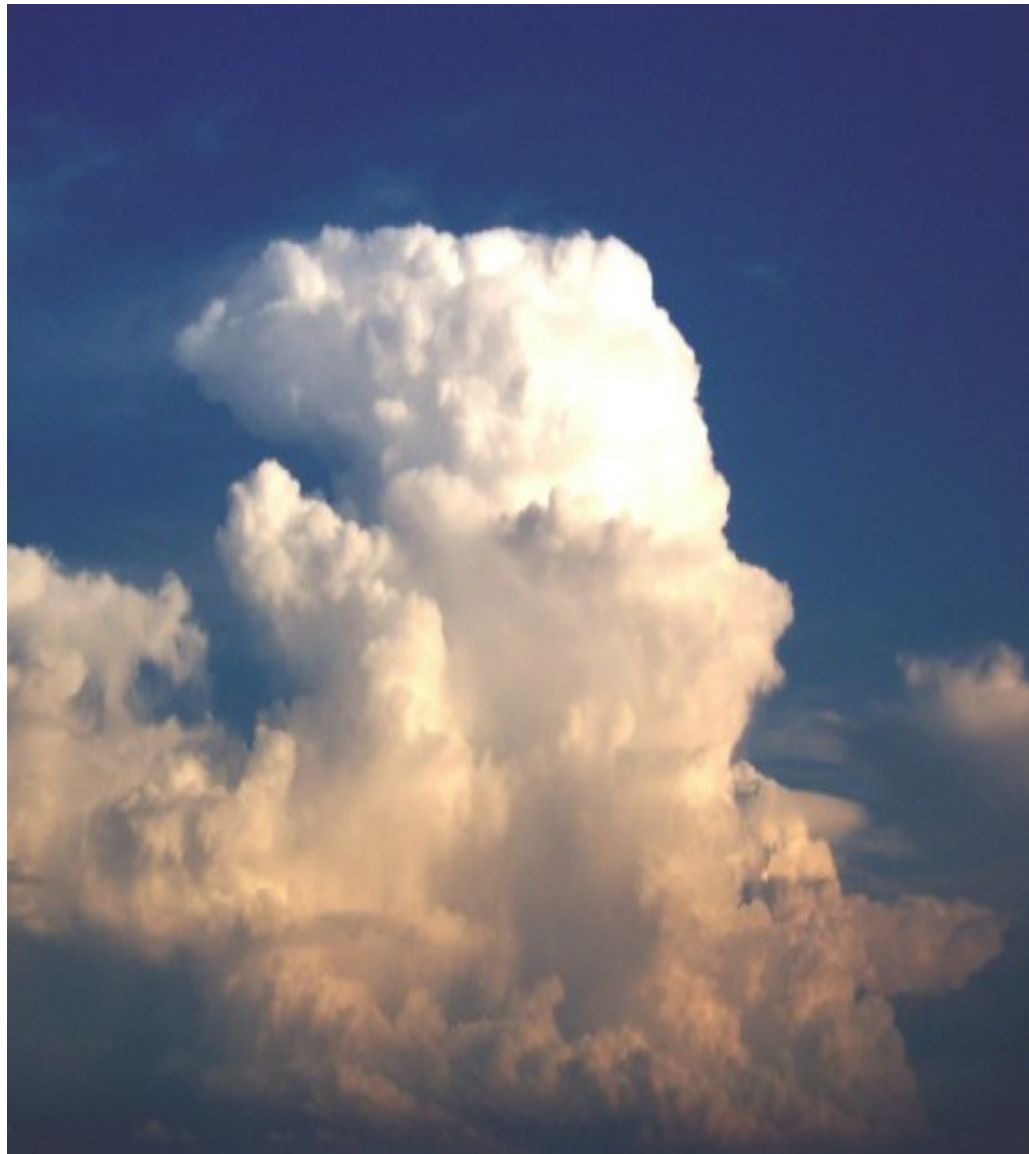
- Four Electromagnetic Radiation (EMR) Interactions With Matter
  - Transmission
    - Process by which incident radiation passes through matter w/o measurable attenuation
  - Reflection (spectral reflection)
    - Process by which incident radiation “bounces off” the surface of a substance in a single, **predictable** manner
  - Scattering (diffuse reflection)
    - Incident radiation is dispersed or spread out **unpredictably** in many directions
  - Absorption
    - Incident radiation is taken into the medium

Avery, Thomas Eugene, and Graydon, Lennis Berlin. Fundamentals of Remote Sensing and Airphoto Interpretation, Fifth Edition, Prentice Hall, 1992

Who can give real world examples of each of the four interactions?

Clouds

- Clouds
  - Reflect Light (EMR)
  - Absorb Light (EMR)
  - Obscure View!!!
    - Cloud cover and cloud shadow
  - 10% Rule
    - Cloud cover or cloud shadow (DOQQs)



Atmospheric Scattering

- Visible Light
  - Rayleigh Scattering (molecular)
    - Caused by oxygen and nitrogen molecules
    - Most influential at altitudes above 4.5 km (~15,000 ft)
    - Scattering inversely proportional to fourth power of wavelength
      - So, blue at .4um scattered five times as readily as red at .6um.
      - Why is the sky blue?
  - Mie Scattering (non-molecular)
    - Important scattering agents include: water vapor, smoke, dust, volcanic ash, salt crystals, etc.
    - Most influential at altitudes below 4.5 km
    - Depending on factors, blue scattered more readily than red

Avery, Thomas Eugene, and Graydon, Lennis Berlin. Fundamentals of Remote Sensing and Airphoto Interpretation, Fifth Edition, Prentice Hall, 1992

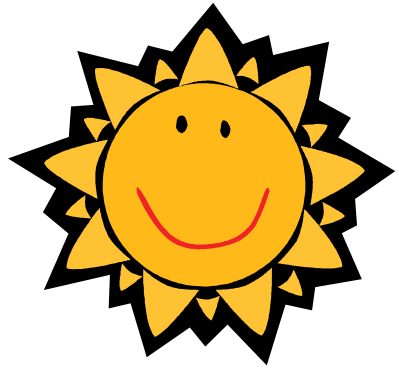
Average flying altitude for NAIP?

Atmospheric Scattering

- Visible Light
  - Skylight
    - Skylight is primarily blue
    - Skylight prevents absolute darkness in shadows
  - Haze
    - Sky radiation is manifest as haze to our eyes
    - Causes distant landscapes to look blue-gray
  - Radiation Reaching a Sensor
    - S=S(s)+S(a)
    - S(a) contains no info about the earths surface and acts as a masking agent when remote sensors record info
      - Most affected wavelengths are ultraviolet and blue
      - Results in a bluish tint in color photos

Avery, Thomas Eugene, and Graydon, Lennis Berlin. Fundamentals of Remote Sensing and Airphoto Interpretation, Fifth Edition, Prentice Hall, 1992

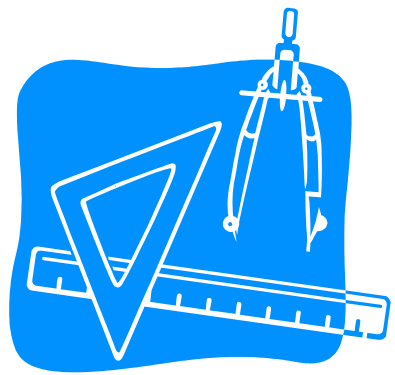
Sun Angle



- Function of latitude, time of day/year
- Low Verses High
  - Shadow
  - Goal of Image
    - Ex. Agricultural land verses archeological sites

Avery, Thomas Eugene, and Graydon, Lennis Berlin. Fundamentals of Remote Sensing and Airphoto Interpretation, Fifth Edition, Prentice Hall, 1992

Map Accuracy Standards



Map Accuracy Standards

- National Map Accuracy Standards (NMAS)
  - Revised June 1947
    - Horizontal Accuracy
      - For maps on publication scales larger than 1:20,000, not more than 10 percent of the points tested shall be in error by more than 1/30 inch, measured on the publication scale; for maps on publication scales of 1:20,000 or smaller, 1/50 inch. These limits of accuracy shall apply in all cases to positions of well-defined points only.

Map Accuracy Standards

- NAIP
  - Horizontal Accuracy (DOQQs & CCMs)
    - All DOQQs shall have 90% of all well-defined points tested fall within the specified distance listed below to the same location identified on Government furnished baseline orthophoto control imagery.

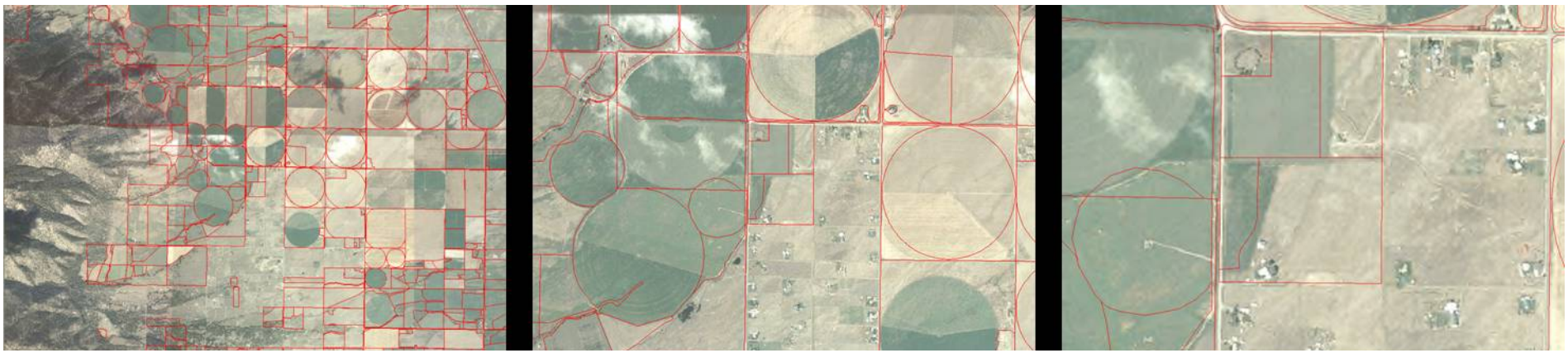
Ground Sample Distance	Horizontal Accuracy
1-meter	5.0-meters
2-meter	10.0-meters

Map Accuracy Standards

- Service Center Agency Data Management Plan for Ortho Imagery (NAIP)
  - Horizontal Accuracy Applies to Scale
    - Hardcopy plots of the compressed county ortho mosaics can be horizontally accurate to NMAS for 1:12,000 maps. Map accuracy also applies to a display scale of 1:12,000
    - Why does map accuracy apply to scale?

Map Accuracy Standards

- NAIP
  - What this means to you
    - Print/view a map at a larger scale than 1:12000…



1:40,000 Screen Capture 1:12,000 Screen Capture 1:4,800 Screen Capture

2004 NAIP and Certified CLU – Baker County, OR

Map Accuracy Standards

- NAIP
  - Accuracy applies to a scale of 1:12000 or 1”=1000’=304.8 meters
    - So what does a 5 meter (16.4’) offset look like on a 1:12000 print? ((.0833’)X16.4’)/1000=.016393 inches or approximately 1/60”.
    - A print display of 1:4800 is 1”=400’ on paper. 5 meters on a 1:4800 scale print is .04098 inches or approximately 1/25”.
    - A print display of 1:1200 is 1”=100’ on paper. 5 meters on a 1:1200 scale print is .16393 inches or 1/6”.
  - The data is the same, but the look of the data will vary drastically depending on scale; the reason map accuracy references a particular scale

Replacement Imagery

- Why Imagery of the Same Location on Earth Looks Different From Year to Year
  - Digital Elevation Model (DEM)
  - Aerial Triangulation Solution (AT)
  - Parallax
  - Sun Angle
  - Orthorectification
  - Control
  - Sensor
  - Weather
  - Post Processing (Film or Digital)
  - Land Use/Land Cover Changes
  - Image Resolution

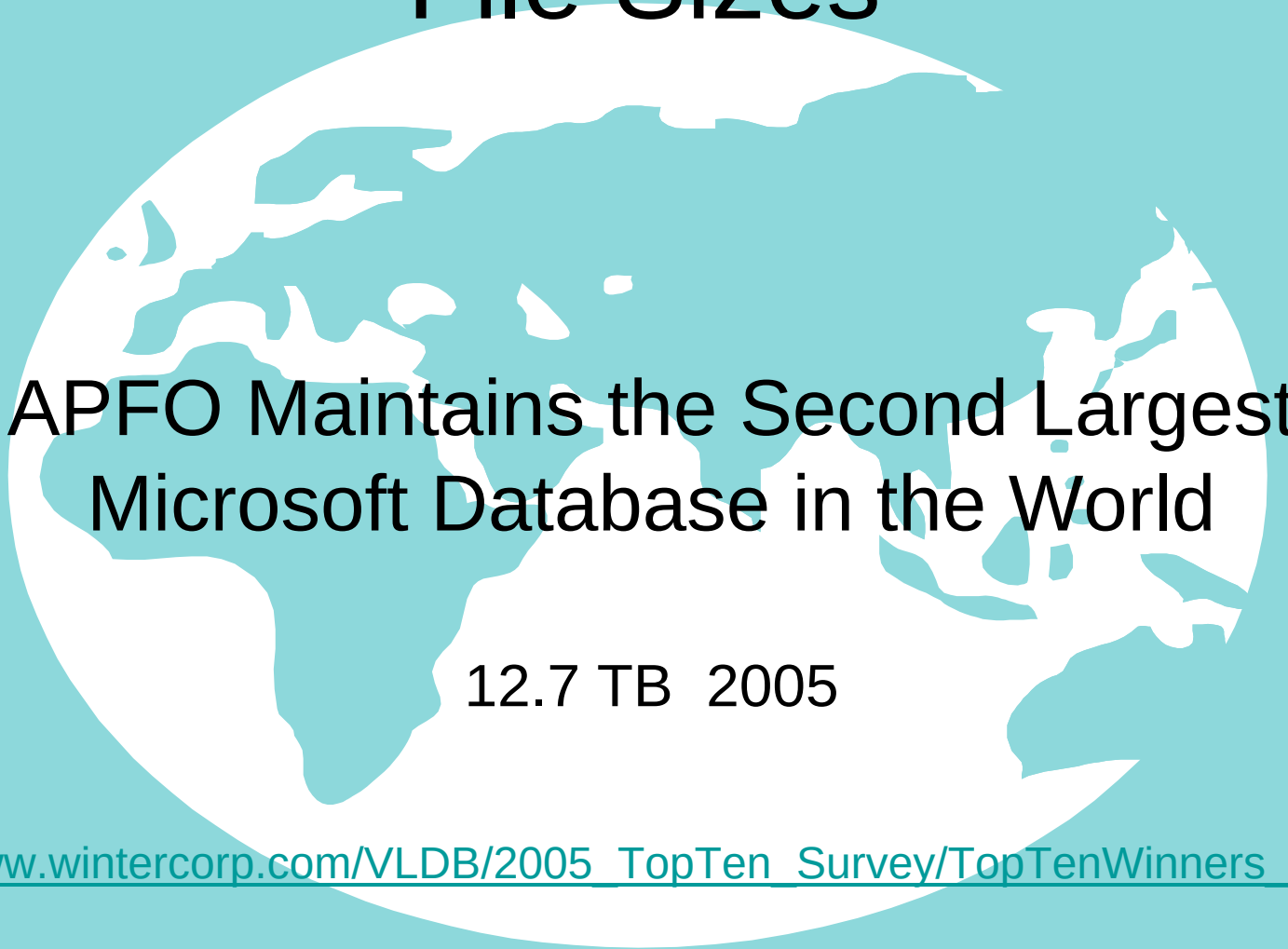
http://www.fsa.usda.gov/Internet/FSA_File/replacement_image_2006_updatep.pdf

Image Resolution

- Resolution
  - What is it?
  - How does it affect what is viewed?
  - Increased file sizes with higher resolution
    - 2m to 1m = file size x 4 (approx.)
    - 1m to 1ft = file size x 9 (approx.)
    - Why? Hint…think of a square
  - “Things get fuzzy when I zoom in too far”

If I had a 1 meter resolution image and a 6 inch resolution image of the same area, all other things being equal, about how much larger would the file size of the 6 inch be?

File Sizes



APFO Maintains the Second Largest Microsoft Database in the World

12.7 TB 2005

http://www.wintercorp.com/VLDB/2005_TopTen_Survey/TopTenWinners_2005.asp

File Sizes

Multiples of bytes					
Decimal prefixes (SI)			Binary prefixes (IEC 60027-2)		
Name	Symbol	Multiple	Name	Symbol	Multiple
kilobyte	kB	10^3	kibibyte	KiB	2^{10}
megabyte	MB	10^6	mebibyte	MiB	2^{20}
gigabyte	GB	10^9	gibibyte	GiB	2^{30}
terabyte	TB	10^{12}	tebibyte	TiB	2^{40}
petabyte	PB	10^{15}	pebibyte	PiB	2^{50}
exabyte	EB	10^{18}	exbibyte	EiB	2^{60}
zettabyte	ZB	10^{21}	zebibyte	ZiB	2^{70}
yottabyte	YB	10^{24}	yobibyte	YiB	2^{80}

Image Compression

- What Is It?
  - APFO Website
    - http://www.fsa.usda.gov/Internet/FSA_File/compression_2006_updatep.pdf
- What Formats?
  - MrSID (MG2 & MG3), ECW, JPEG 2000
  - MG3 vs. MG2
- Lossy vs. Lossless Compression
- Compression Ratios

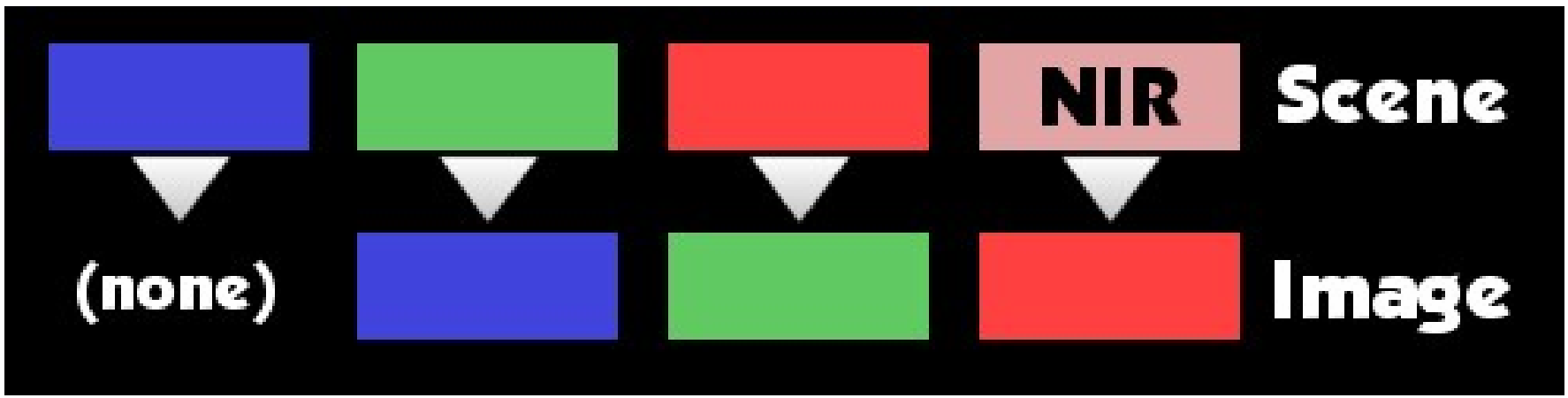
Color Calibration

- Basics
  - Hardware/Software system that calibrates monitors so that an image will appear the same on all monitors (monitors, printers, scanners, etc.)
    - Lighting conditions, individual color perception, and other factors can still affect a calibrated system
    - APFO uses Monaco Optix 1.0
    - Why we sent hard copy color samples rather than digital samples to States and vendors
    - http://www.cambridgeincolour.com/home.htm

Natural Color vs. CIR

- Natural Color
  - 3 band RGB
- CIR
  - 3 band IRRG
    - Green light shown as blue
    - Red light shown as green
    - NIR shown as red

- http://spatialnews.geocomm.com/features/topoimagery01/



Natural Color vs. CIR

- What about 4 band imagery?
  - IRRGB
  - ArcGIS can only represent 3 bands at a time, but the digital product can produce two distinct views of the same location

Can both film and digital cameras acquire 4 band imagery?

Questions?