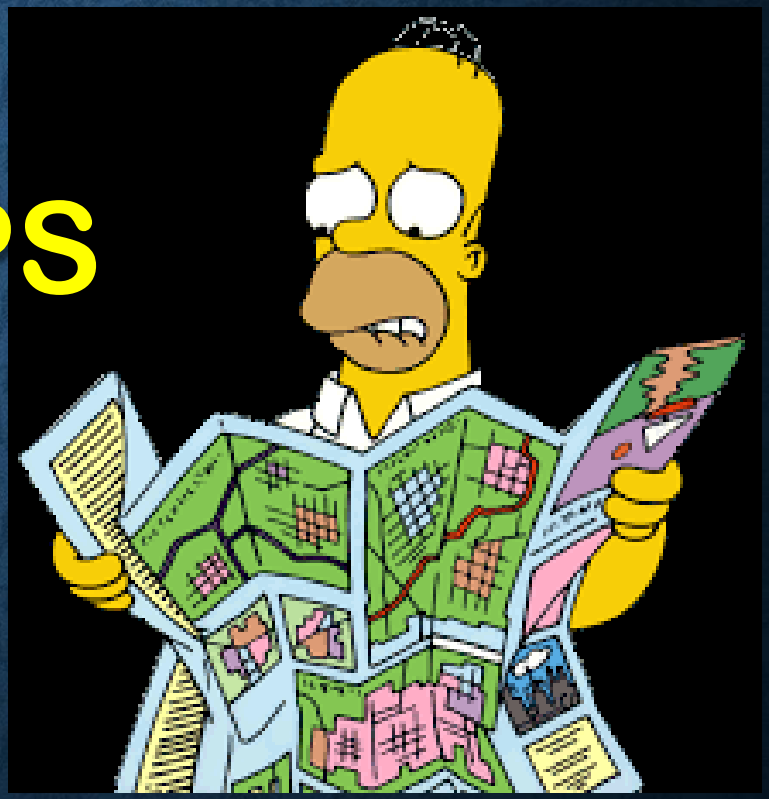

CENTRAL IDAHO AMATEUR RADIO CLUB

this presentation was created to accompany an in-person mapping & coordinate orientation session

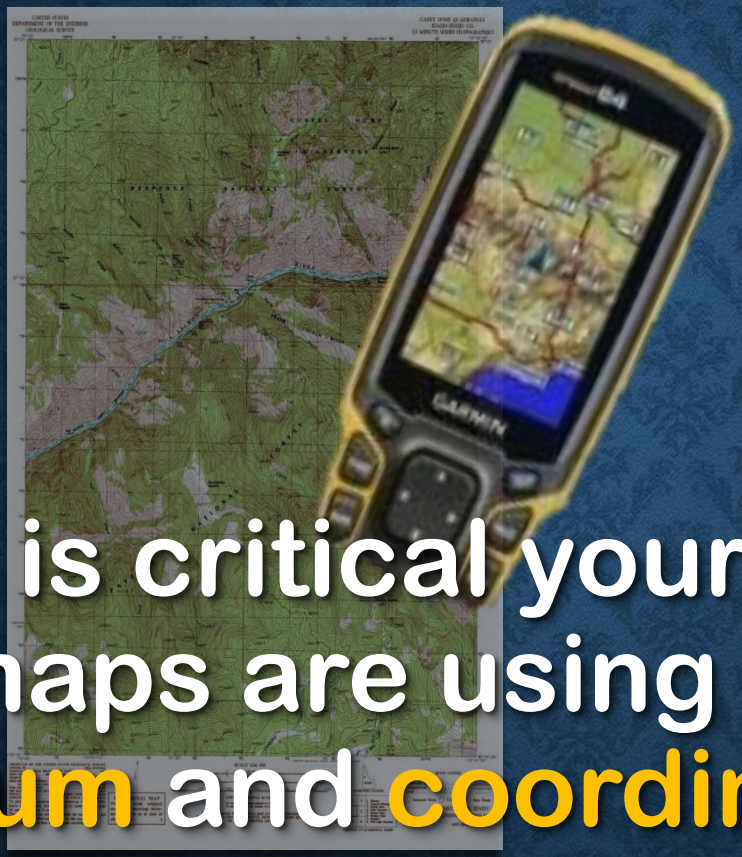
viewing it here does not have the full content of the live presentation

datums, coordinates, maps and GPS



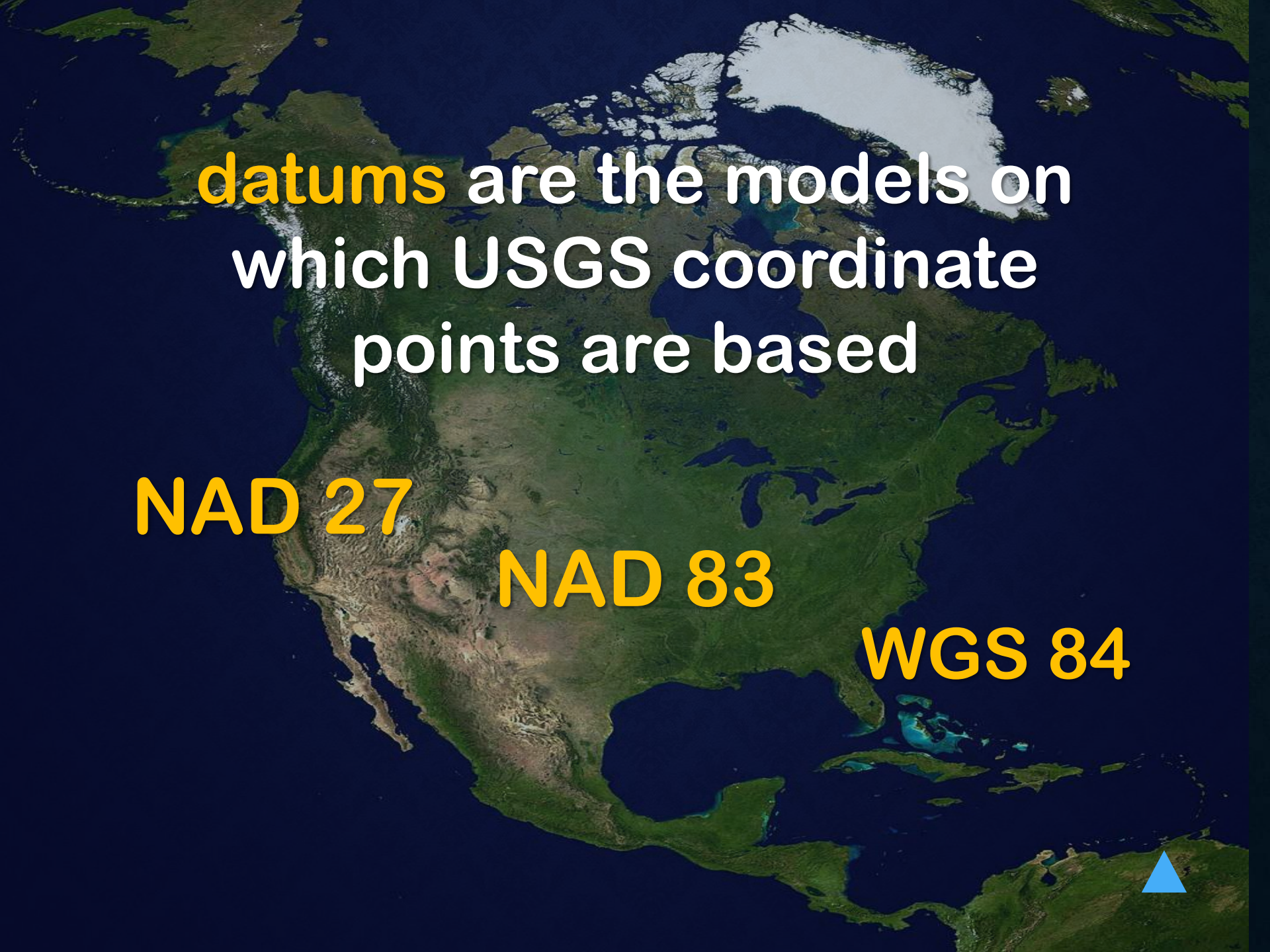
accurate position reporting isn't everything….

….it's the only thing!



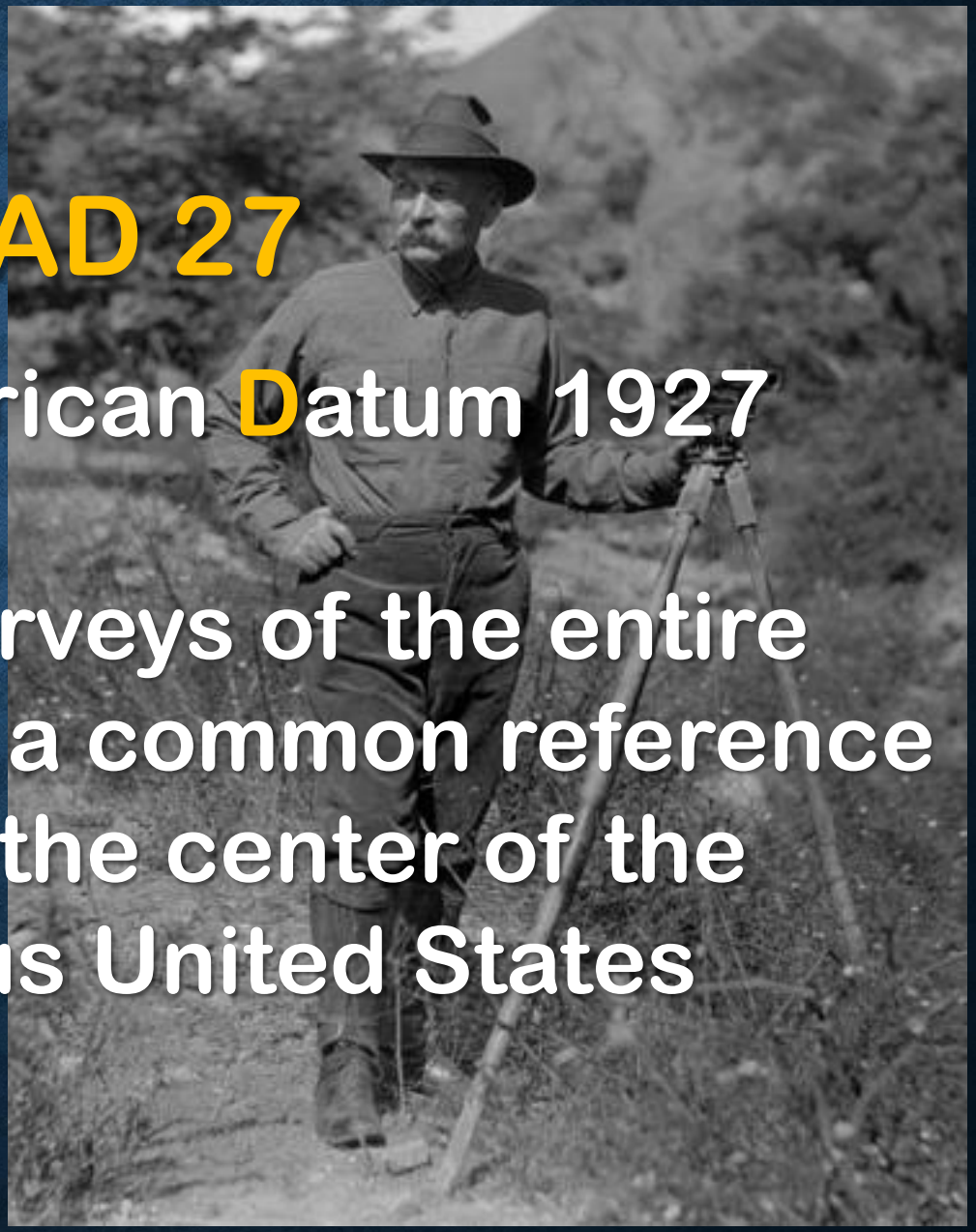
it is critical your GPS and maps are using the same **datum** and **coordinate system** as others operating with you

when operating as a group, all parties involved must be using the same coordinate system and map series


datums are the models on which USGS coordinate points are based
NAD 27
NAD 83
WGS 84

NAD 27

North American Datum 1927

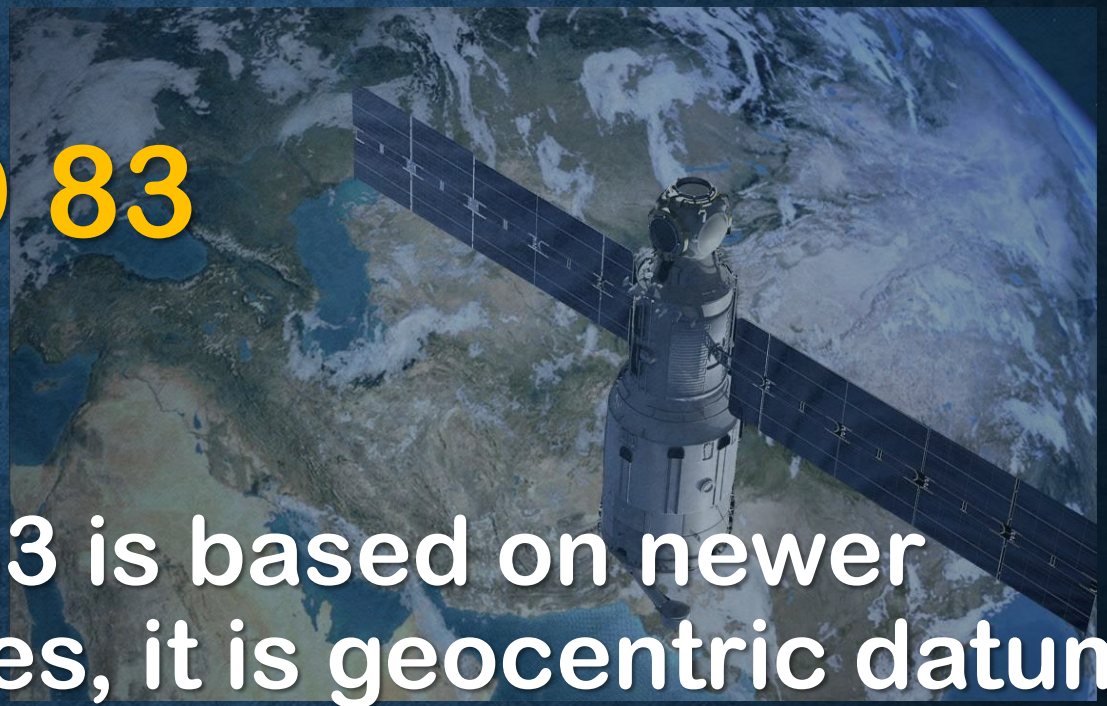


based on surveys of the entire continent from a common reference point near the center of the contiguous United States

NAD 27

was replaced by more accurate NAD 83 but remains important as many past surveys and topo maps were created using NAD 27

NAD 83



NAD 83 is based on newer technologies, it is geocentric datum having no initial starting point on the earth

a location point having a given latitude and longitude in NAD 27 may be displaced on the order of many tens of meters from the same latitude and longitude as given in NAD 83

WGS 84

World Geodetic System

WGS 84 defines an Earth-centered Earth-fixed coordinate system

the standard used in cartography, geodesy, and satellite navigation including GPS

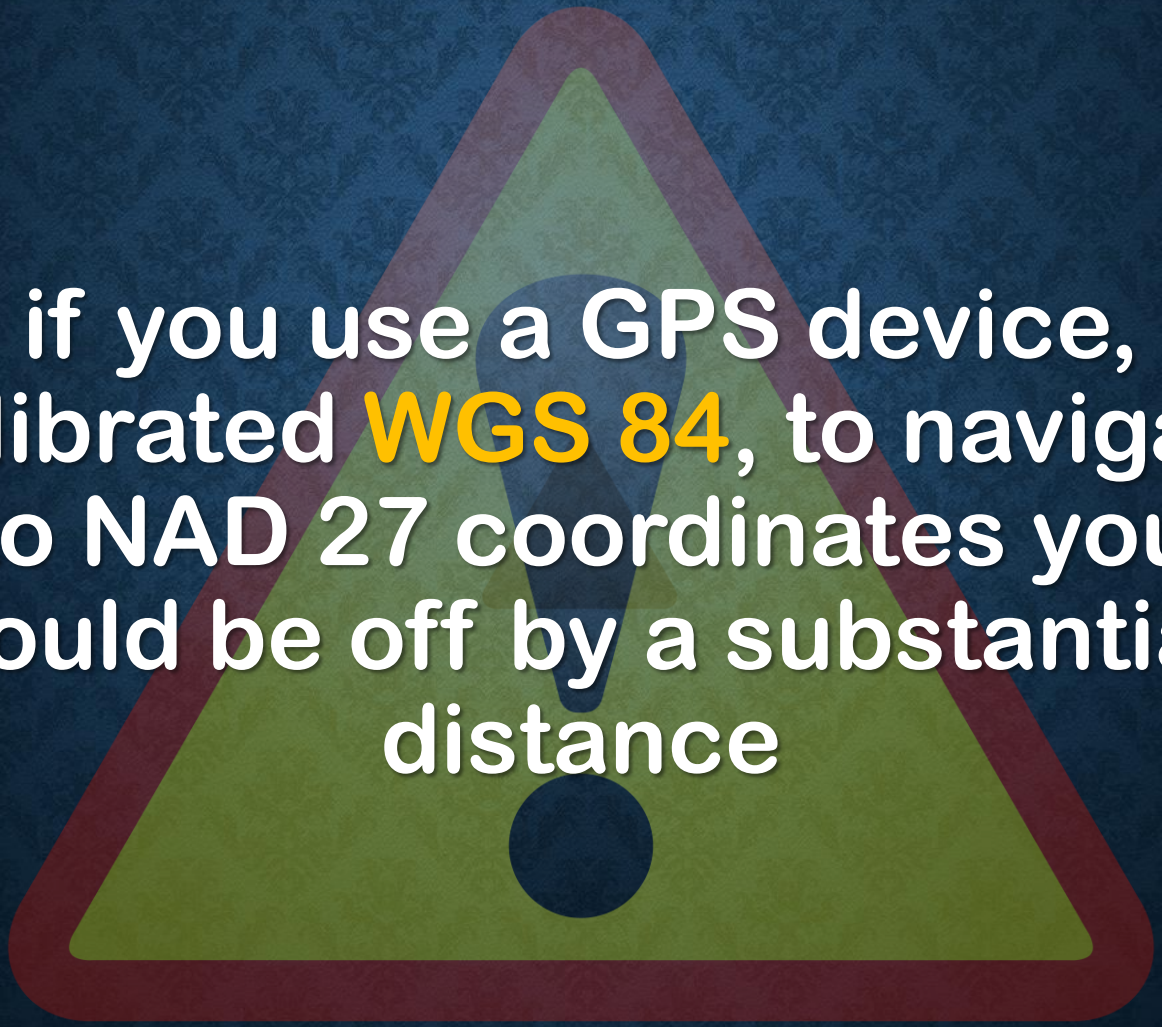
WGS 84

WGS 84 is calibrated to the average of stations located all over the world

accuracy is within two meters (6.5ft) of NAD 83

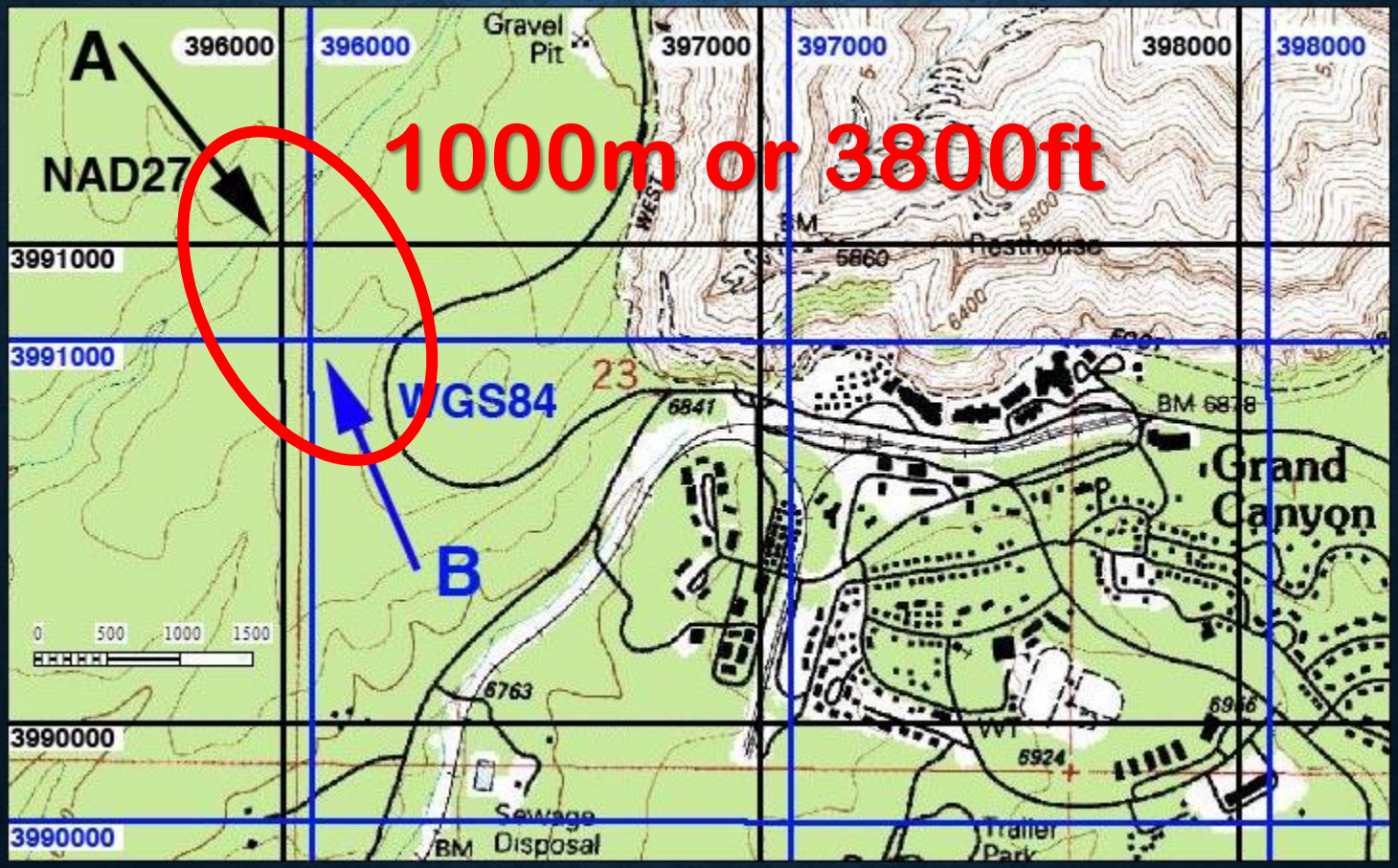
WGS 84 is the current standard for most consumer GPS products

Google Earth uses WGS 84 datum exclusively

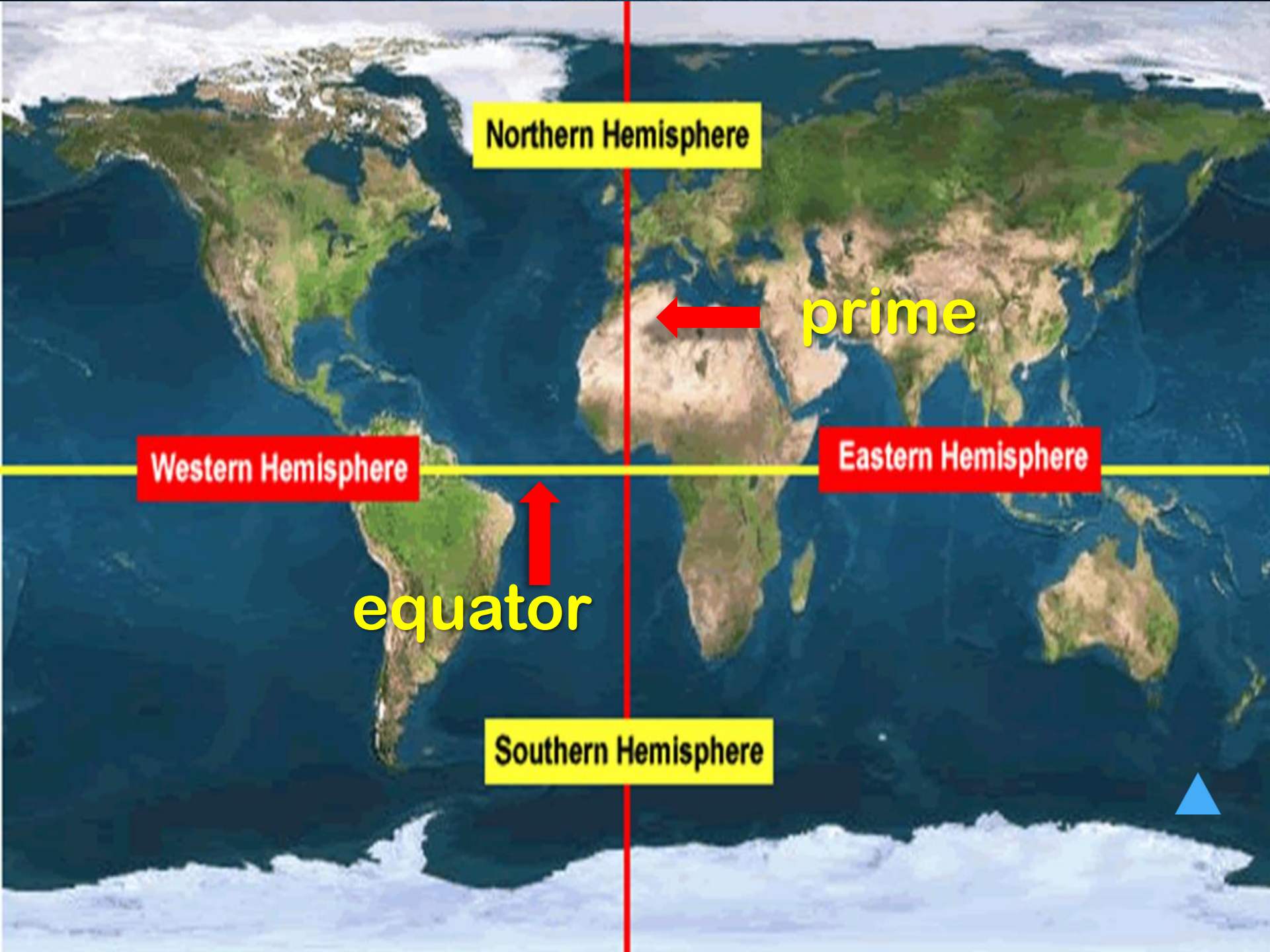


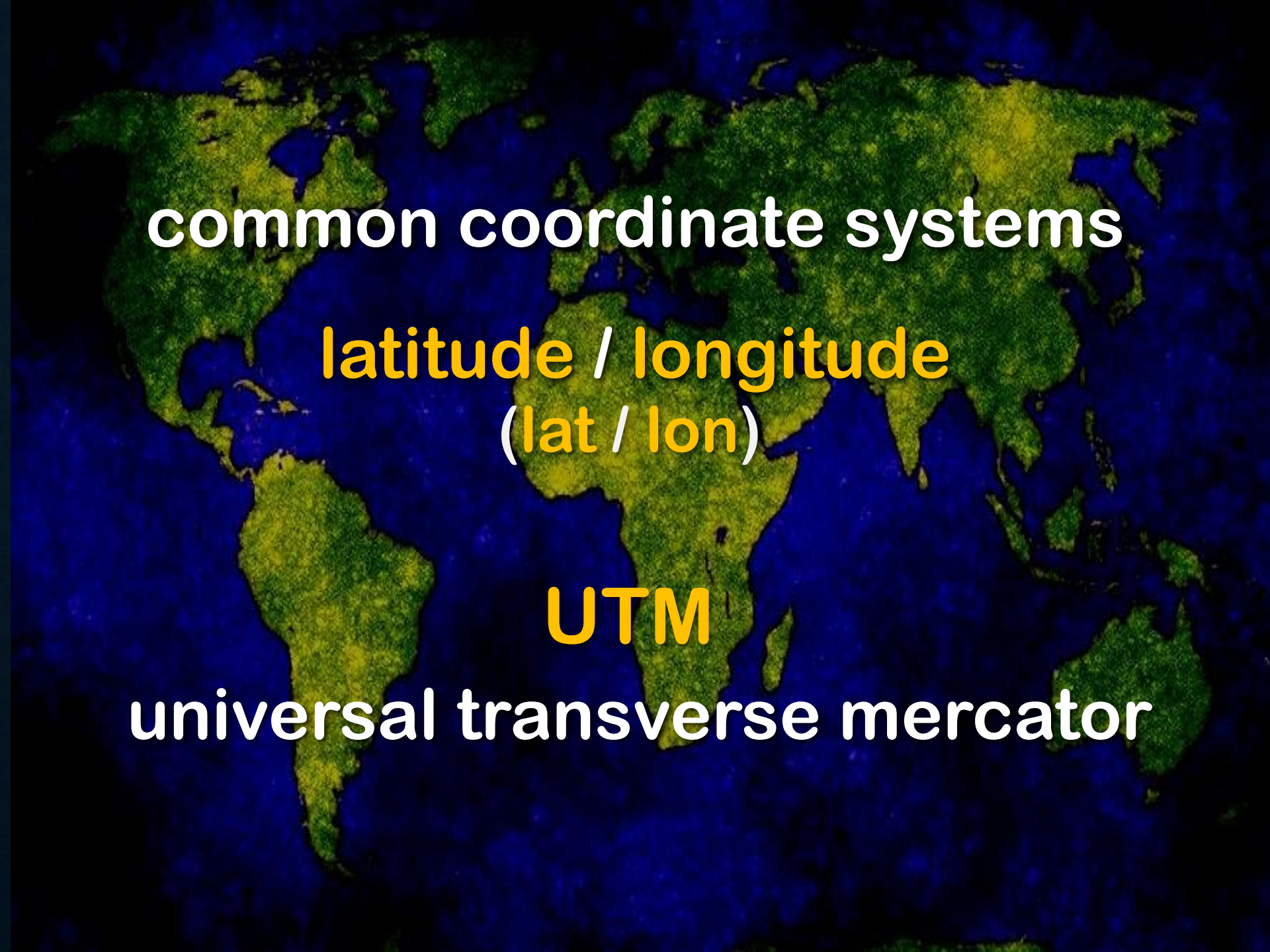
if you use a GPS device, calibrated WGS 84, to navigate to NAD 27 coordinates you could be off by a substantial distance

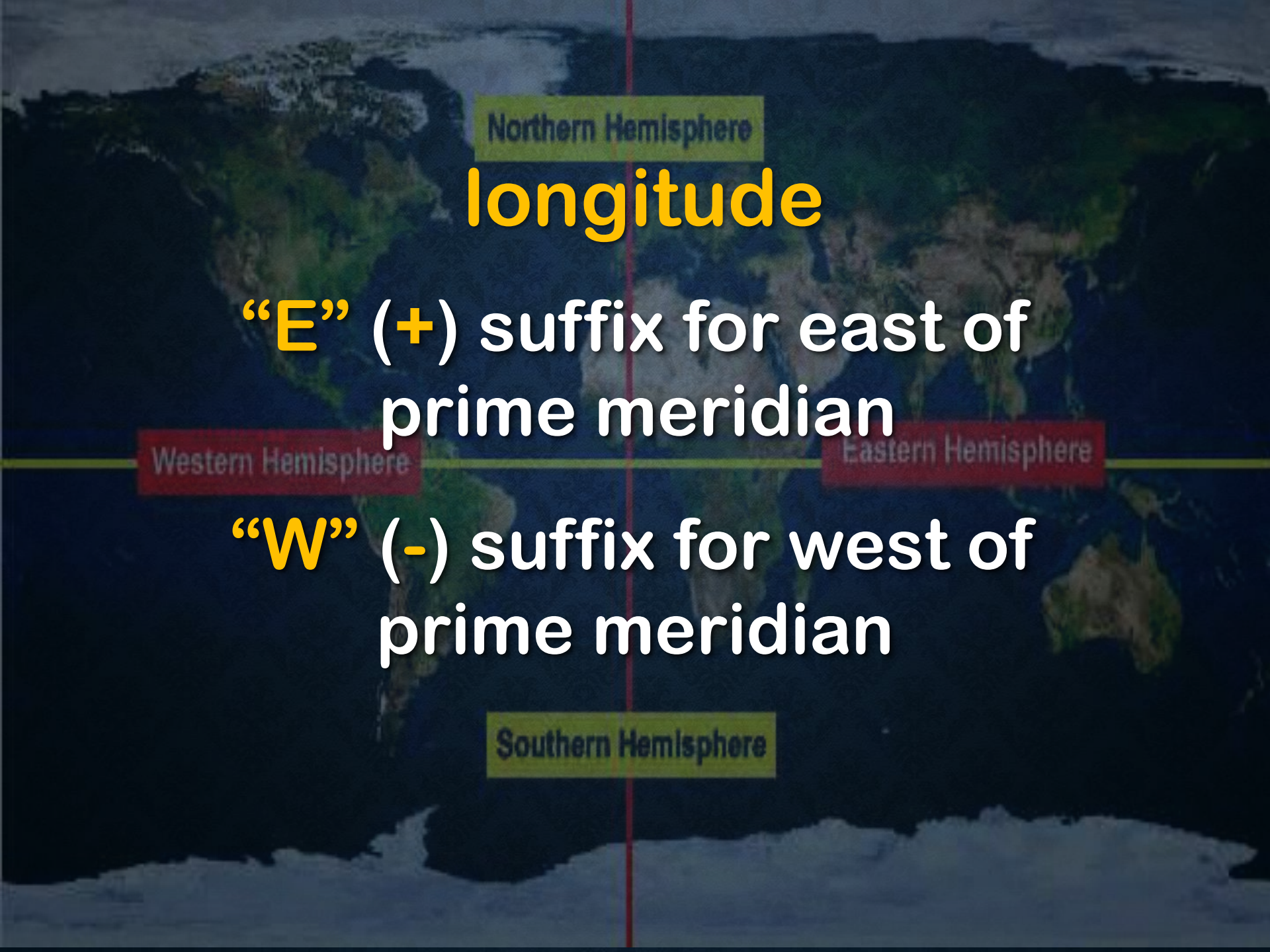
WGS 84 vs NAD 27




navigation


Northern Hemisphere
prime
Western Hemisphere
Eastern Hemisphere
equator
Southern Hemisphere


common coordinate systems
latitude / longitude
(lat / lon)
UTM
universal transverse mercator



longitude

"E" (+) suffix for east of prime meridian

"W" (-) suffix for west of prime meridian

latitude

"N" (-) suffix is a location north of the Equator

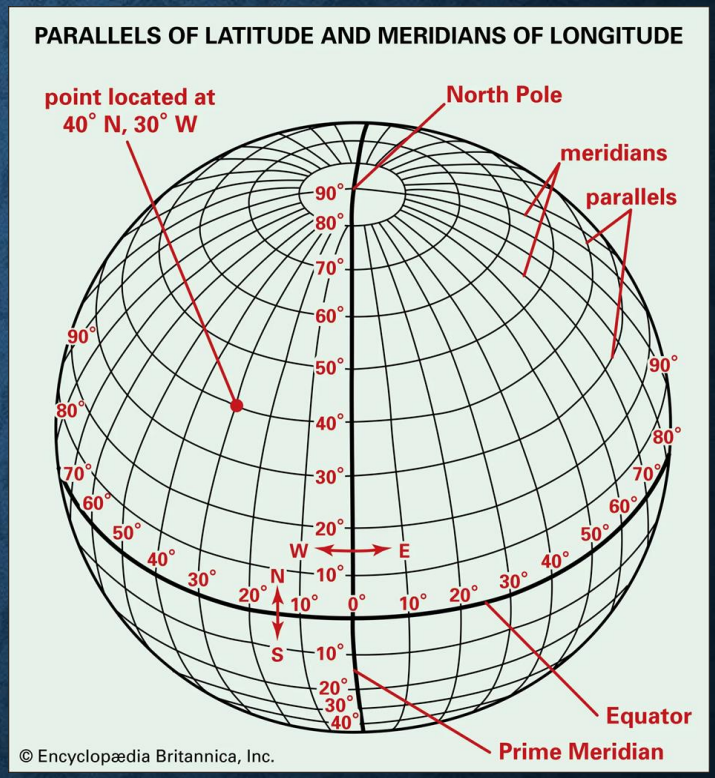
"S" (+) suffix is a location south of the Equator

one degree of latitude equals 69 miles on the earth's surface

one degree of latitude can be divided into 60 minutes, one minute equals 1.15 miles

one minute can be divided into 60 seconds, one second of latitude equals 101 ft

latitude lines are parallel, no matter where you are on earth, latitude lines are the same distance apart



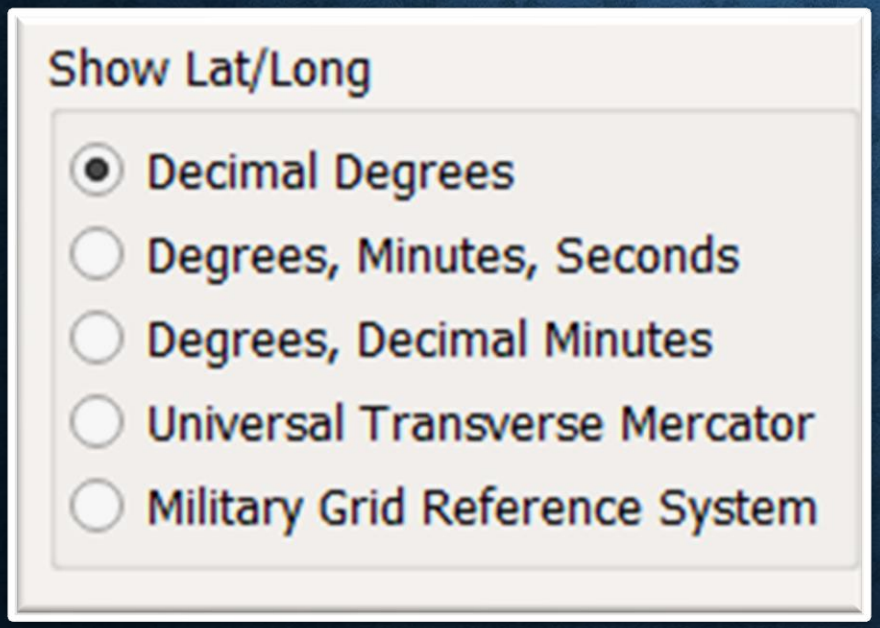
longitude

Easterly or Westerly

0° at prime meridian
Greenwich, England

longitudinal lines converge as they approach the poles

coordinates can be given in several formats



google earth offers five coordinate options

decimal degrees

44.912094° / -116.097559°

degrees, minutes, seconds

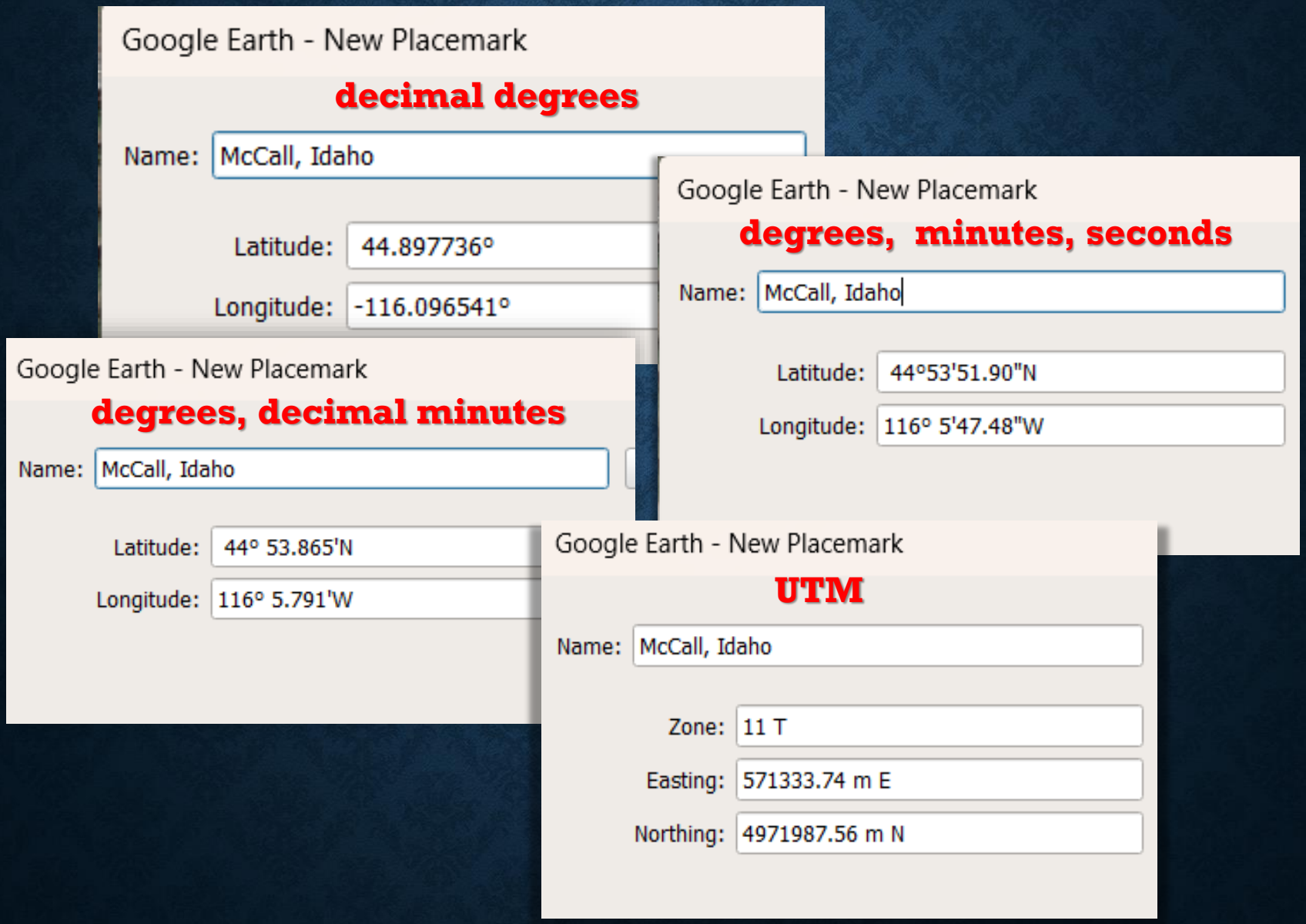
44°54'43.54" N / 116°51’51.21" W

degrees, decimal minutes

44°54.725 N / 116°5.854’W

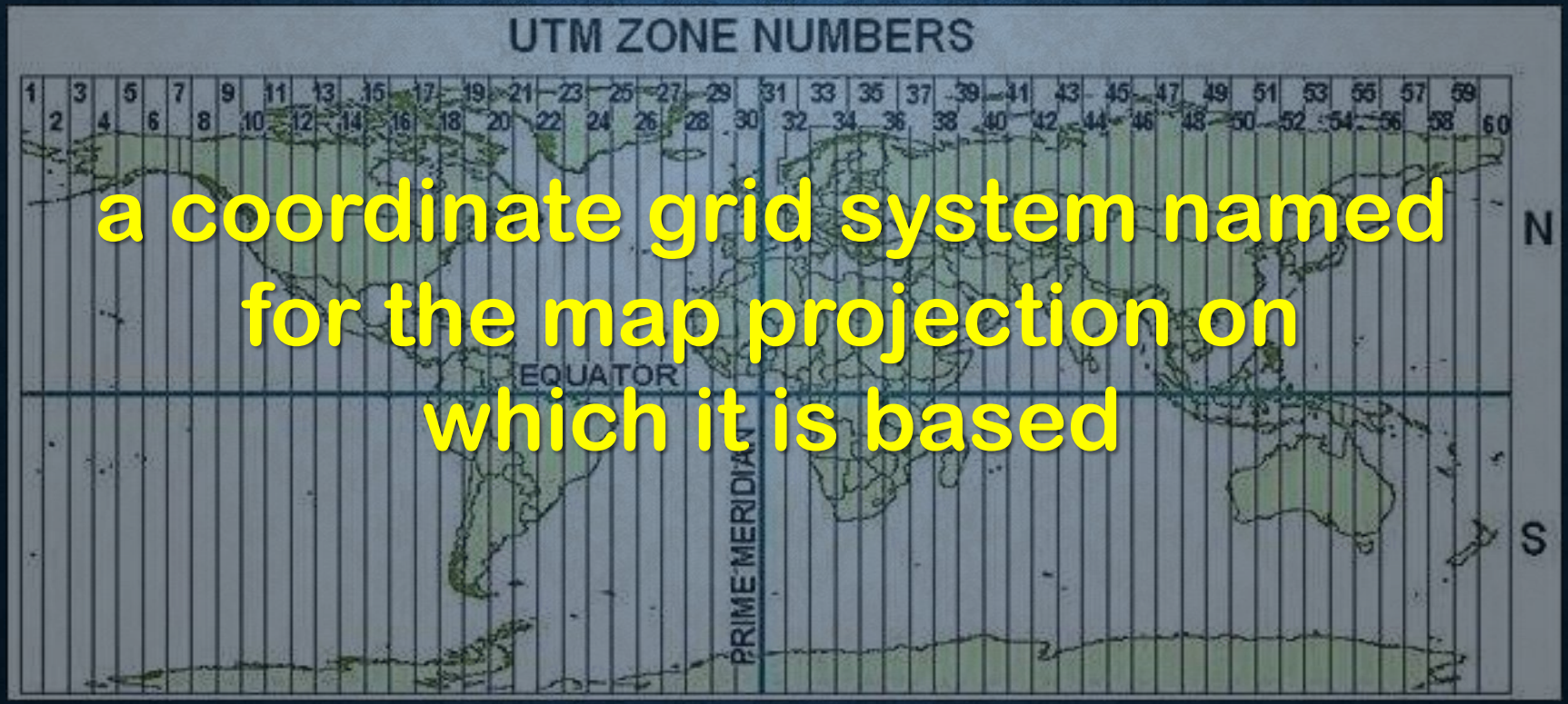
UTM

11T 571234.23 m N / 4973581.36 m N


Google Earth - New Placemark
decimal degrees
Name: McCall, Idaho
Latitude: 44.897736°
Longitude: -116.096541°
Google Earth - New Placemark
degrees, minutes, seconds
Name: McCall, Idaho
Latitude: 44°53'51.90"N
Longitude: 116° 5'47.48"W
Google Earth - New Placemark
degrees, decimal minutes
Name: McCall, Idaho
Latitude: 44° 53.865'N
Longitude: 116° 5.791'W
Google Earth - New Placemark
UTM
Name: McCall, Idaho
Zone: 11 T
Easting: 571333.74 m E
Northing: 4971987.56 m N

UTM

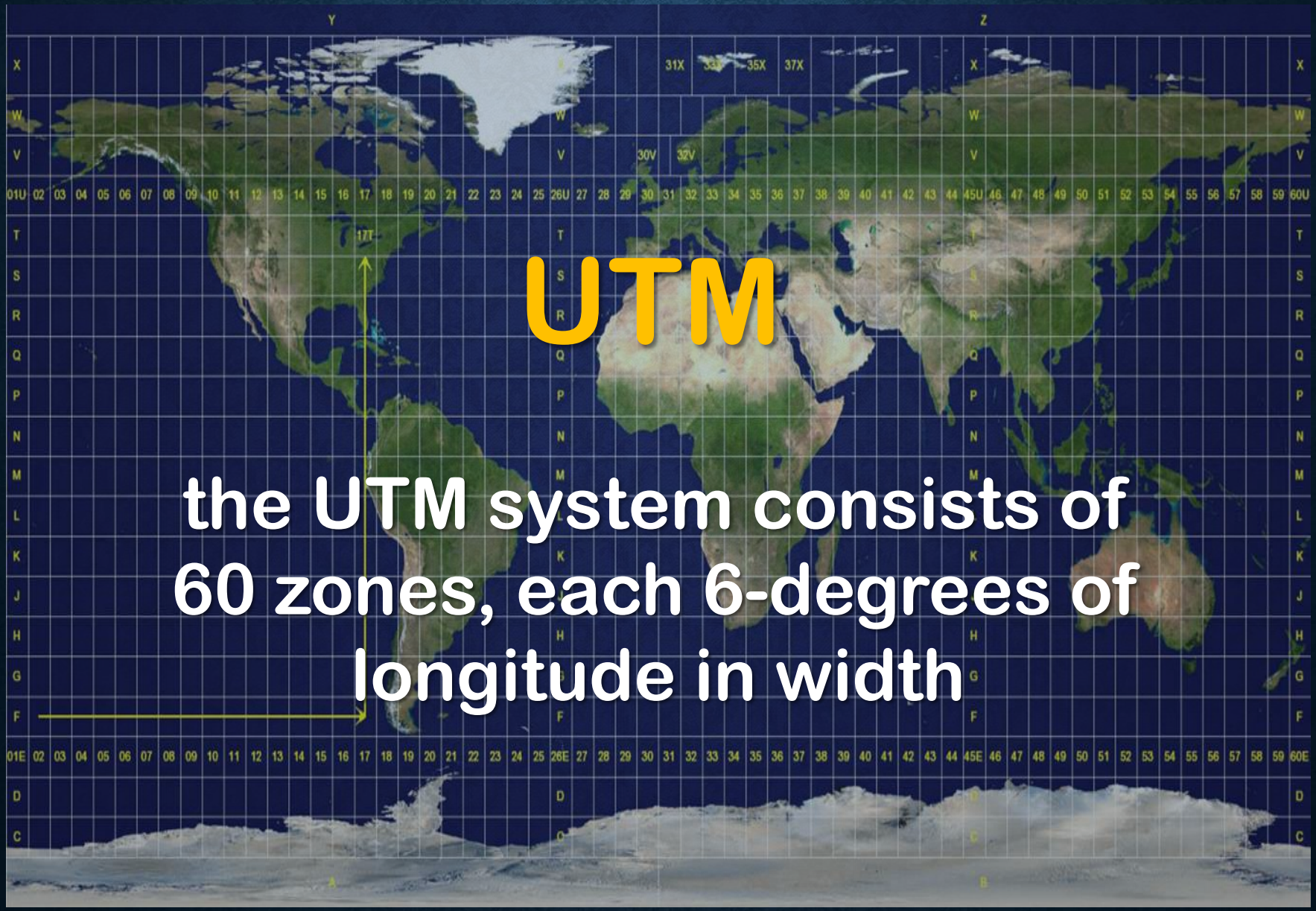
Universal Transverse Mercator



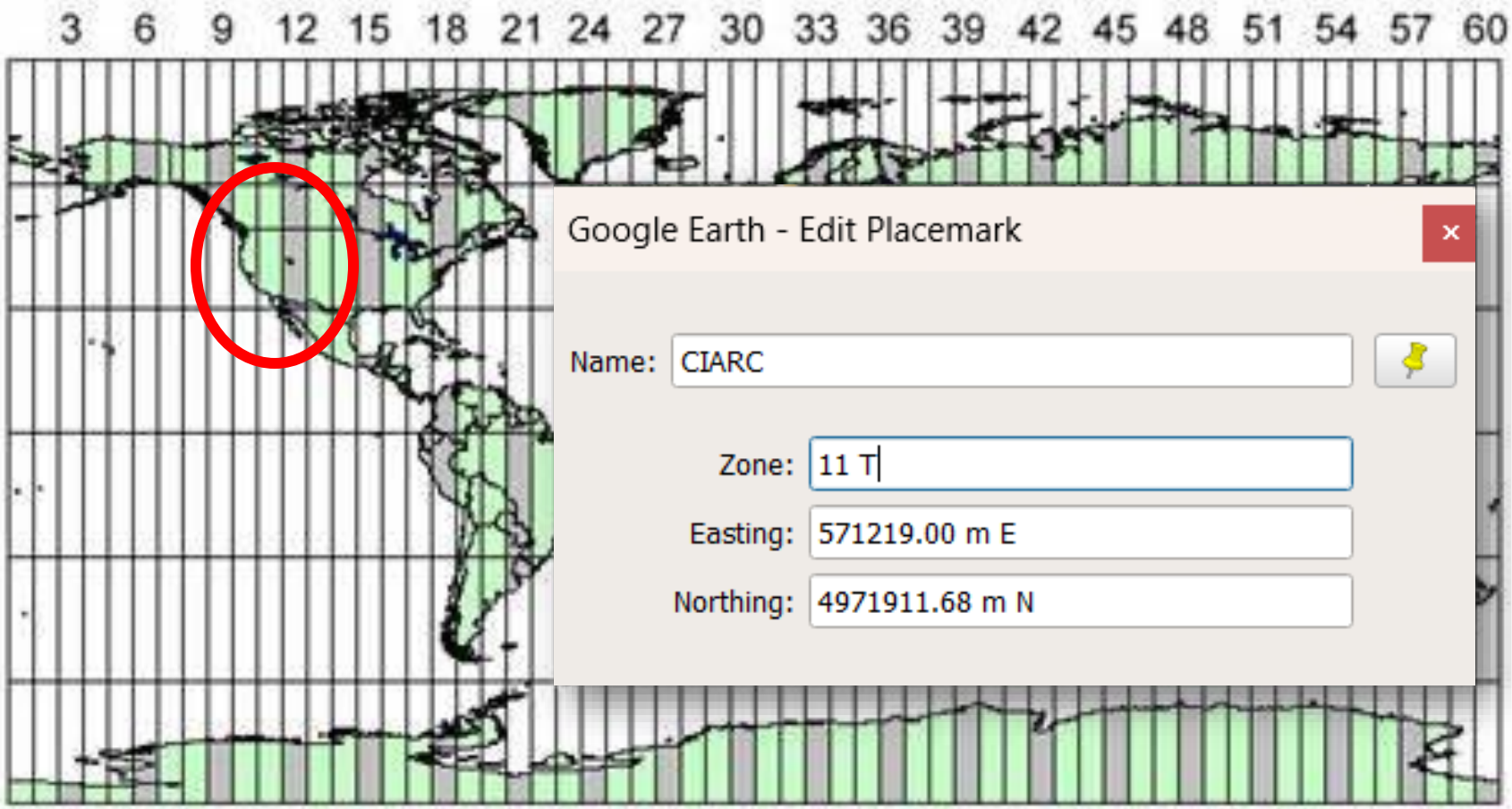
a coordinate grid system named for the map projection on which it is based

with the advent of consumer GPS receivers, many map users are adopting the UTM grid system

the UTM system is simpler to use than latitude & longitude


UTM
the UTM system consists of 60 zones, each 6-degrees of longitude in width

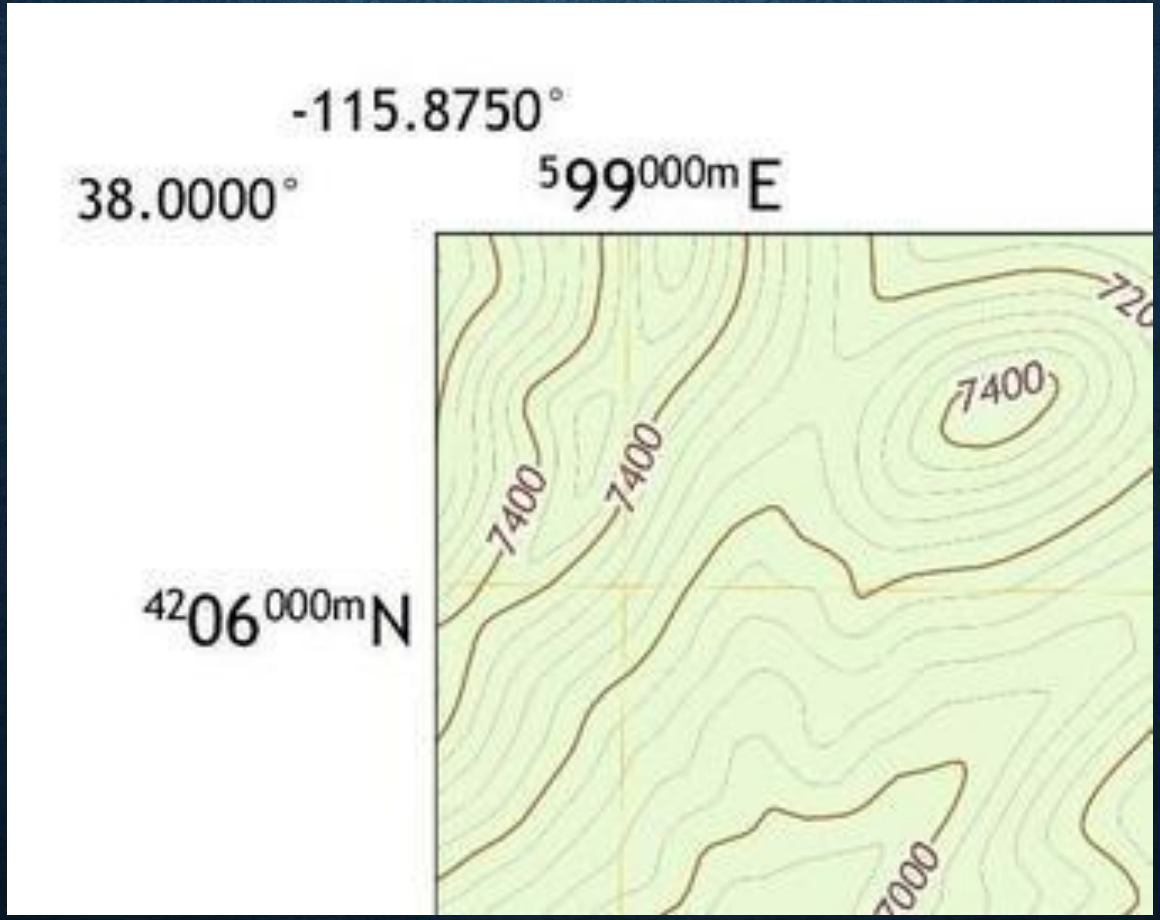
World UTM Zones



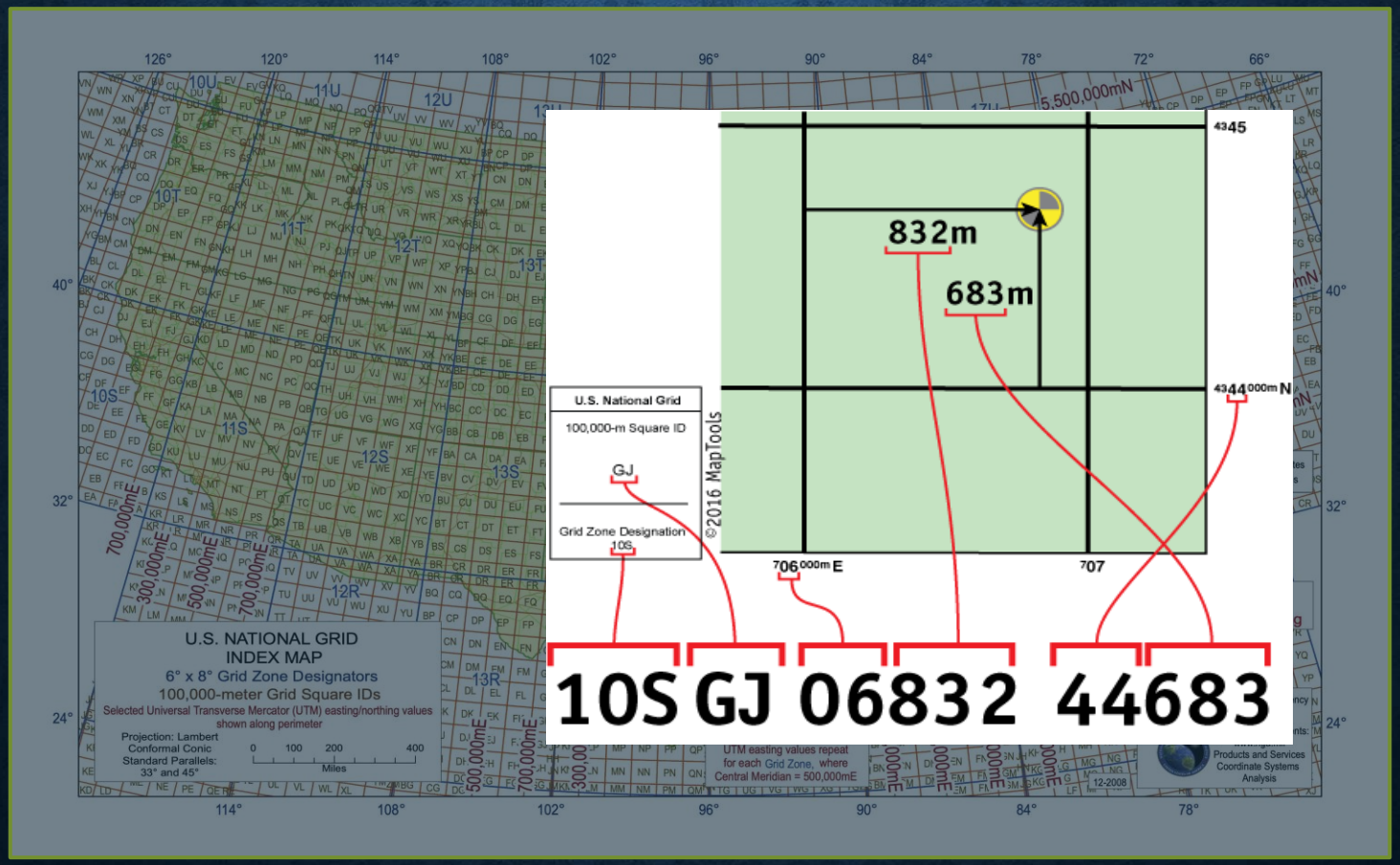
most USGS topo maps produced after 1977 show UTM tic marks on the sides of the map every 1,000m

those produced after 2009 include full UTM grid lines

lat / lon & UTM “tics” on topo maps



united states national grid (USNG)



USNG

nationally consistent grid system

extensible resolution

four digits: 1,000 square meters

six digits: 100 square meters

eight digits: 10 square meters

ten digits: 1 square meter

which systems to use

served agencies requirements

paper map standards

GPS receiver capabilities

mapping software capabilities

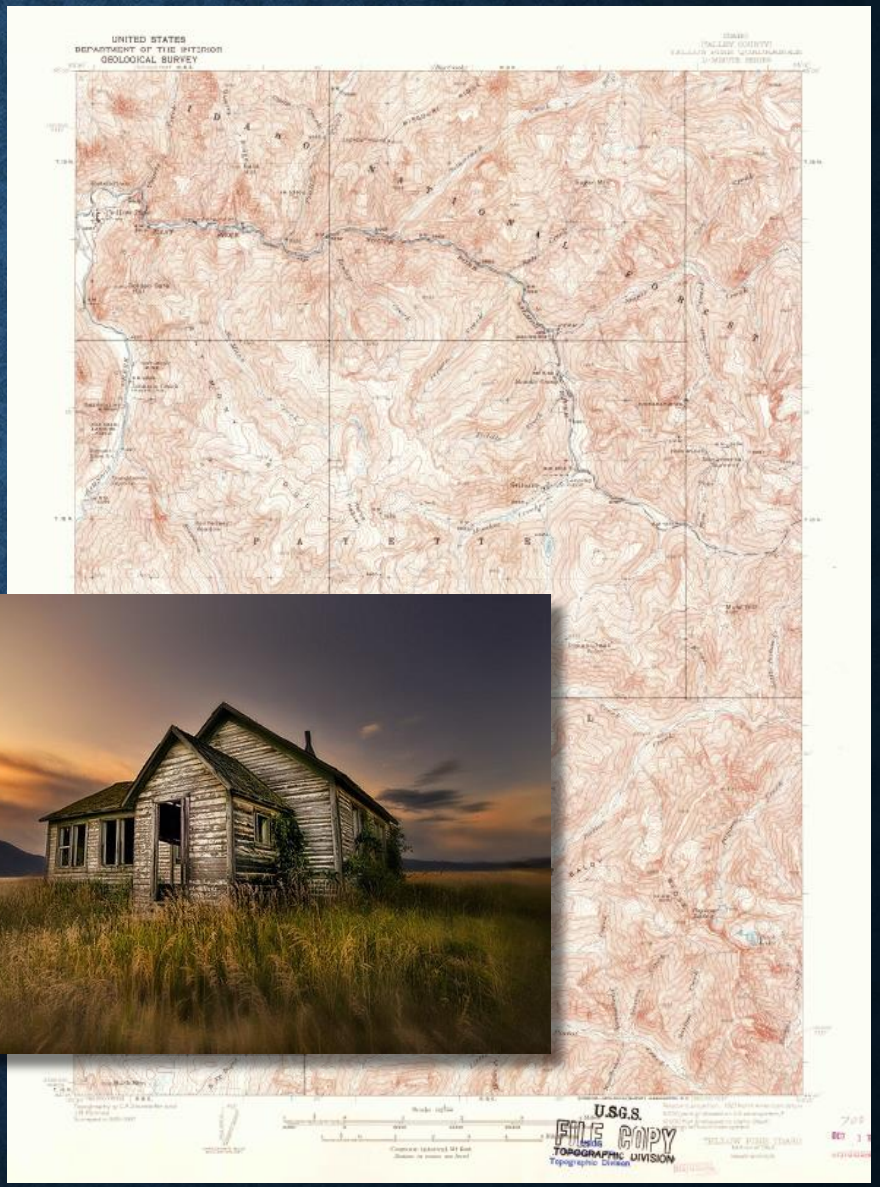
web applications, i.e
google earth

topo maps & GPS

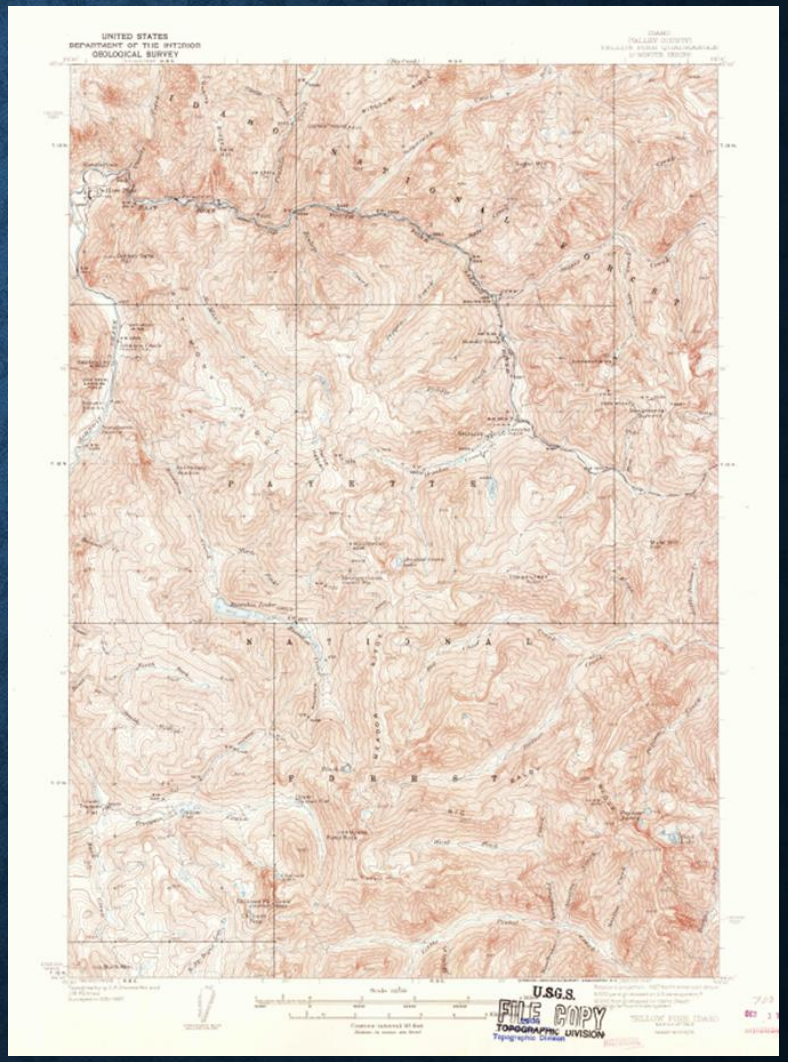
USGS

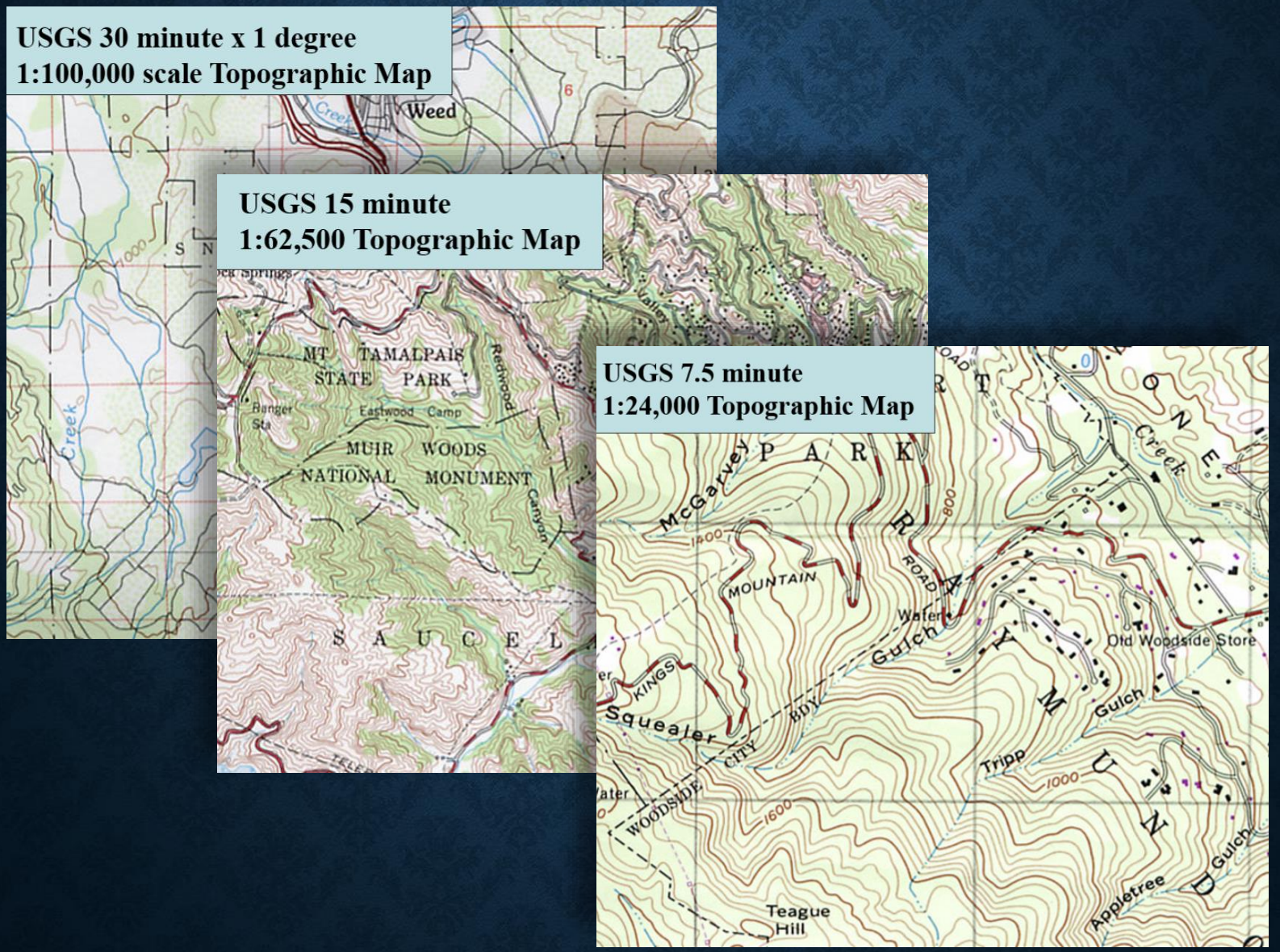
the geological survey publishes several types of maps using several scales

historical maps can give insight into archaic features, locations and names



historical maps may lack the precise coordinates found on contemporary topo maps

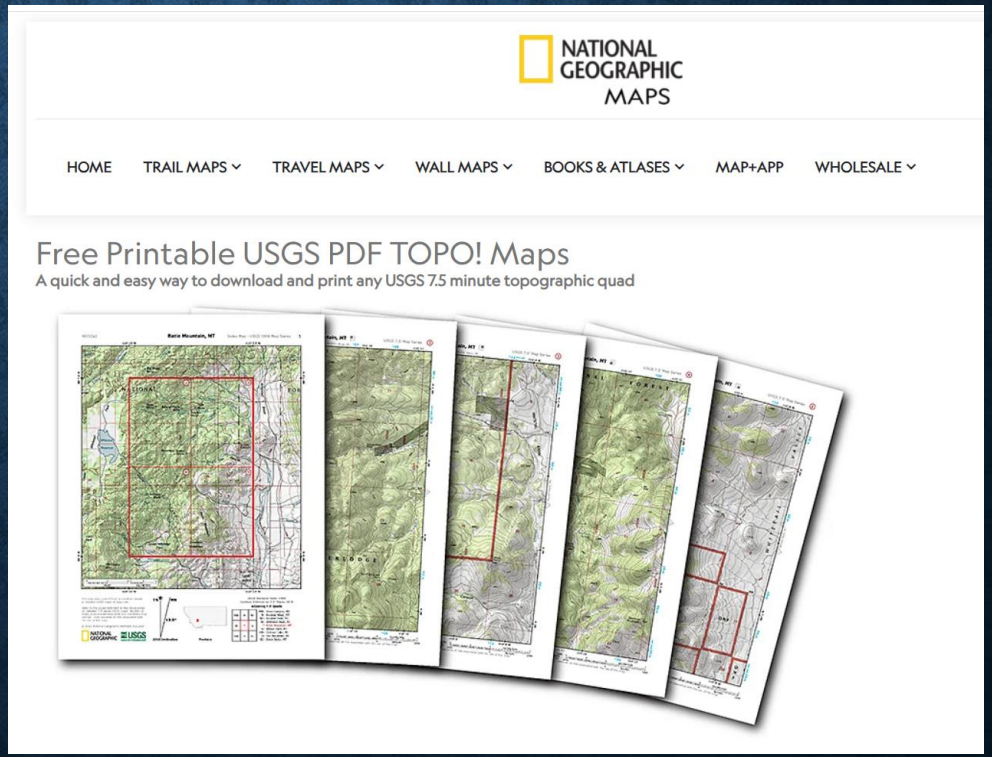



USGS 30 minute x 1 degree
1:100,000 scale Topographic Map
Weed
USGS 15 minute
1:62,500 Topographic Map
MT TAMALPAIS
STATE PARK
Ranger Sta
Eastwood Camp
MUIR WOODS
NATIONAL MONUMENT
Redwood Canyon
S A U C E L
USGS 7.5 minute
1:24,000 Topographic Map
McGarvey
P A R K
MOUNTAIN
ROAD
Water
Old Woodside Store
KINGS
Squealer
CITY
Gulch
Tripp
1000
1600
WOODSIDE
Teague Hill
Appletree
Creek

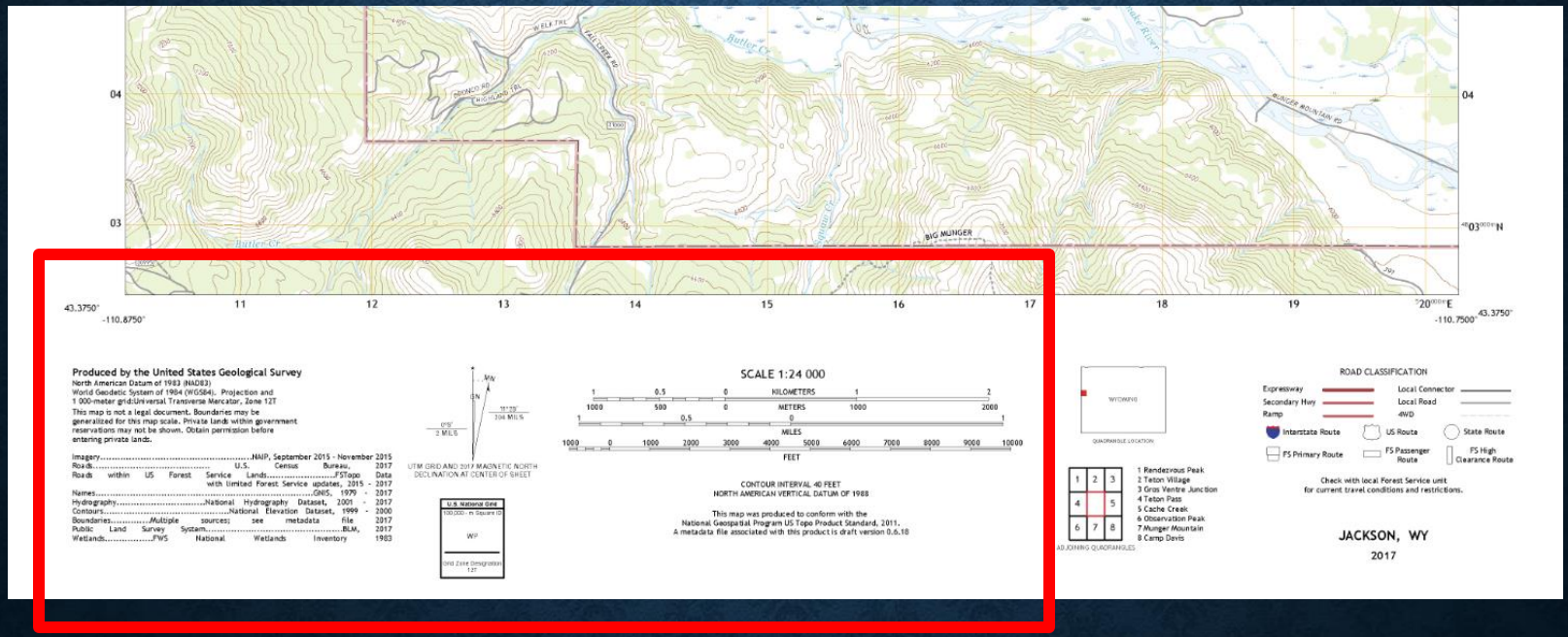
1:24,000-scale (7.5-minute) topo map

7.5 minute “quadrangle” topo maps are the most common as they offer the most complete surface detail

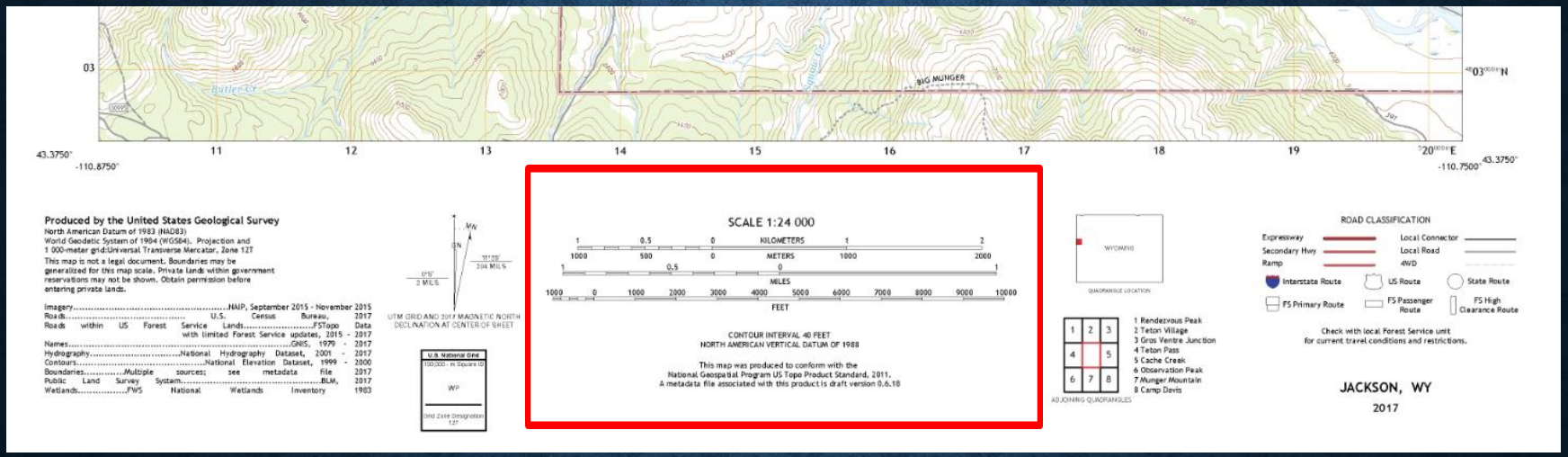
commercial topo maps such as national geographic topo are based on USGS 7.5-minute maps



the map scale, datum, and the coordinate system(s) utilized will appear in map margins

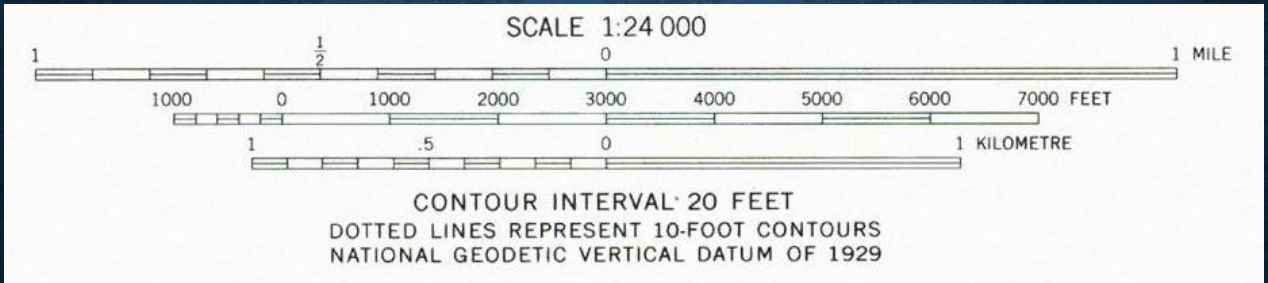


MAP SCALES


03
Butler Cr
BIG MUNGER
43.3750°
-110.8750°
11
12
13
14
15
16
17
18
19
-110.7500°
43.3750°
Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
1 000-meter grid:Universal Transverse Mercator, Zone 12T
This map is not a legal document. Boundaries may be generalized for this map scale. Private lands within government reservations may not be shown. Obtain permission before entering private lands.
Imagery.....NAIP, September 2015 - November 2015
Roads.....U.S. Census Bureau, 2017
Roads within US Forest Service Lands.....FSTopo Data with limited Forest Service updates, 2015 - 2017
Names.....GNIS, 1979 - 2017
Hydrography.....National Hydrography Dataset, 2001 - 2017
Contours.....National Elevation Dataset, 1999 - 2000
Boundaries.....Multiple sources; see metadata file 2017
Public Land Survey System.....BLM, 2017
Wetlands.....FWS National Wetlands Inventory 1983
MN
GN
0°15'
3 MILS
11°28'
204 MILS
UTM GRID AND 2017 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET
U.S. National Grid
100,000- m Square ID
WP
Grid Zone Designation
12T
SCALE 1:24 000
1 0,5 0 KILOMETERS 1 2
1000 500 0 METERS 1000 2000
1 0,5 0 1
MILES
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000
FEET
CONTOUR INTERVAL 40 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988
This map was produced to conform with the National Geospatial Program US Topo Product Standard, 2011. A metadata file associated with this product is draft version 0.6.18
WYOMING
QUADRANGLE LOCATION
1 2 3
4 5
6 7 8
ADJOINING QUADRANGLES
1 Rendezvous Peak
2 Teton Village
3 Gros Ventre Junction
4 Teton Pass
5 Cache Creek
6 Observation Peak
7 Munger Mountain
8 Camp Davis
ROAD CLASSIFICATION
Expressway
Secondary Hwy
Ramp
Local Connector
Local Road
4WD
Interstate Route
US Route
State Route
FS Primary Route
FS Passenger Route
FS High Clearance Route
Check with local Forest Service unit for current travel conditions and restrictions.
JACKSON, WY
2017

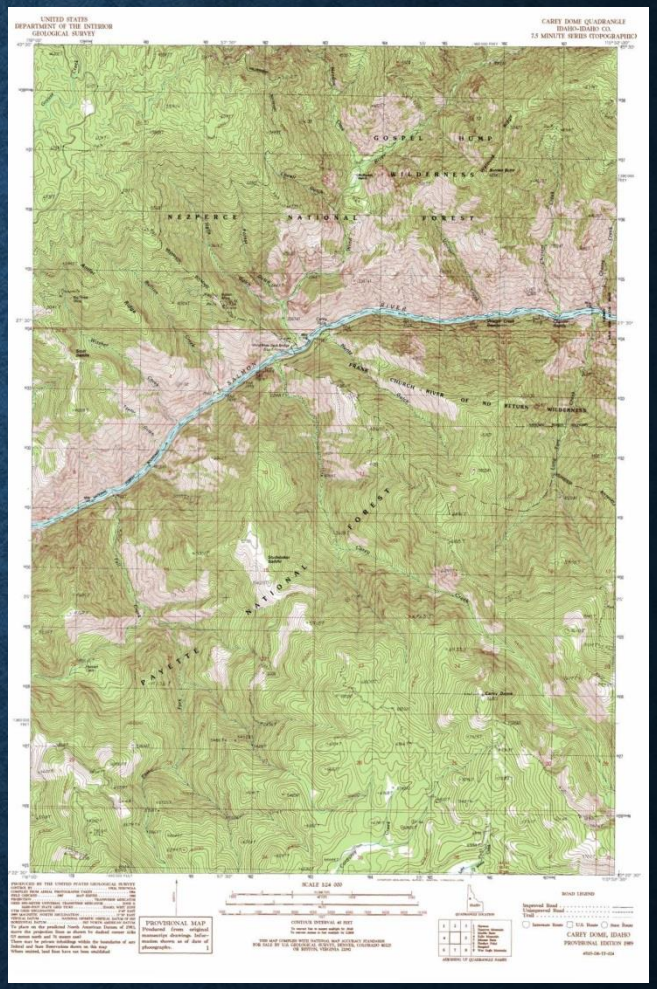
the scale used for 7.5 minute topographic mapping is 1:24,000

each linear inch on the map equals 2000 linear feet on the ground

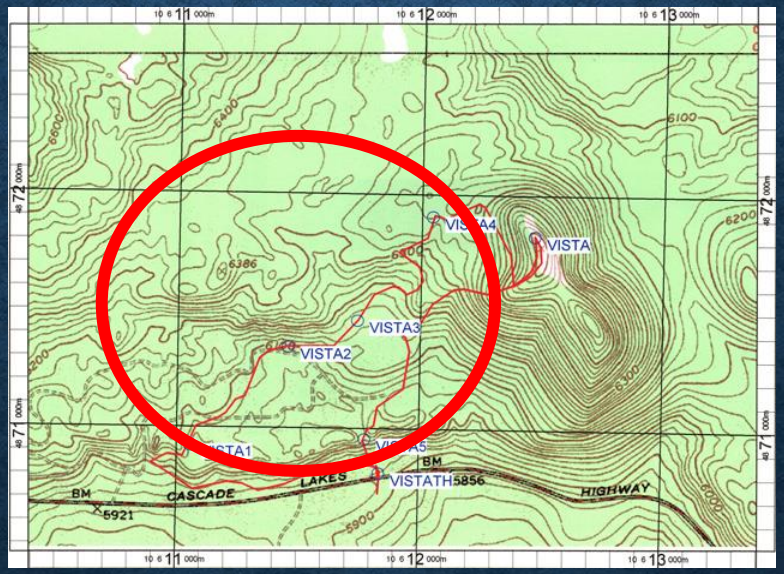


the map distance scale does not take into consideration the terrain

a 7.5 min quadrangle map shows 7.5 min latitude and 7.5 min longitude and covers an area of 49 x 70 miles

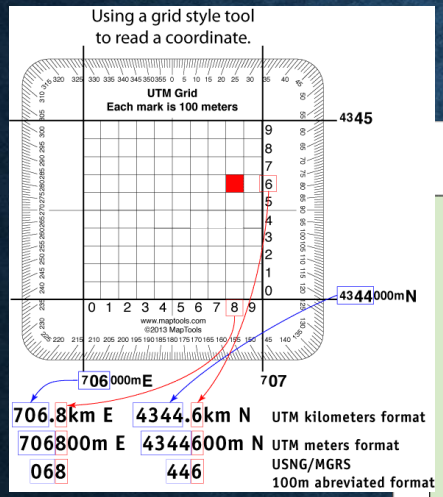


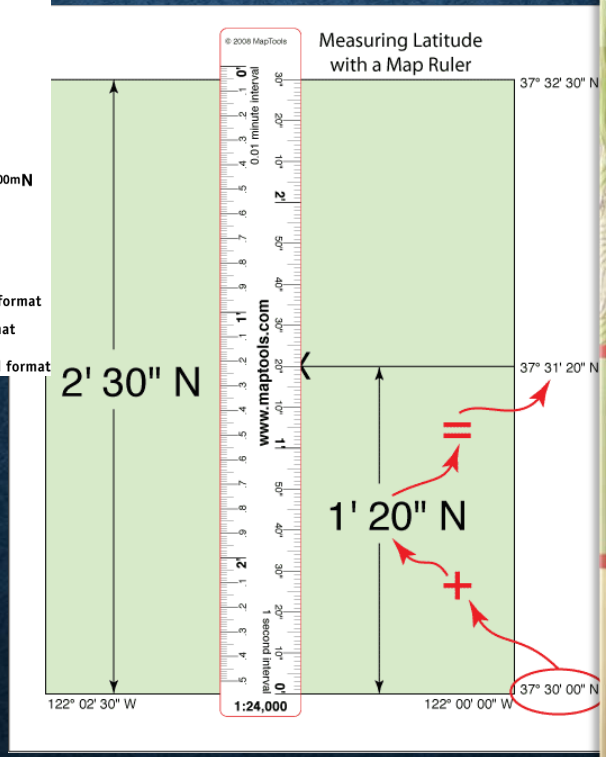
squares on the 7.5 min x 7.5 min map represent 2000 ft x 2000 ft



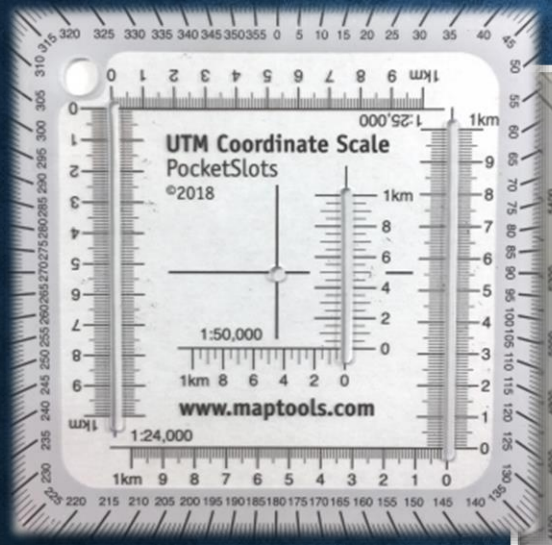
note: the lines on the map appear slanted as they conform to the curvature of the earth

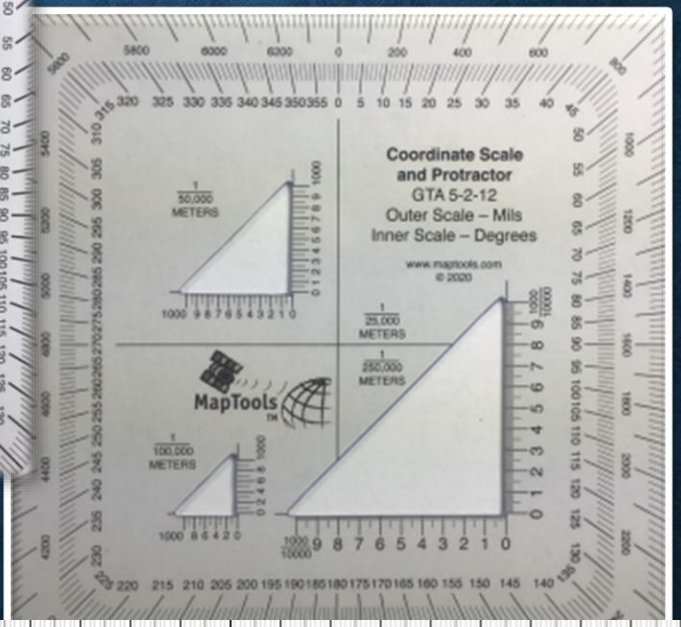
identifying specific coordinates on a topo map

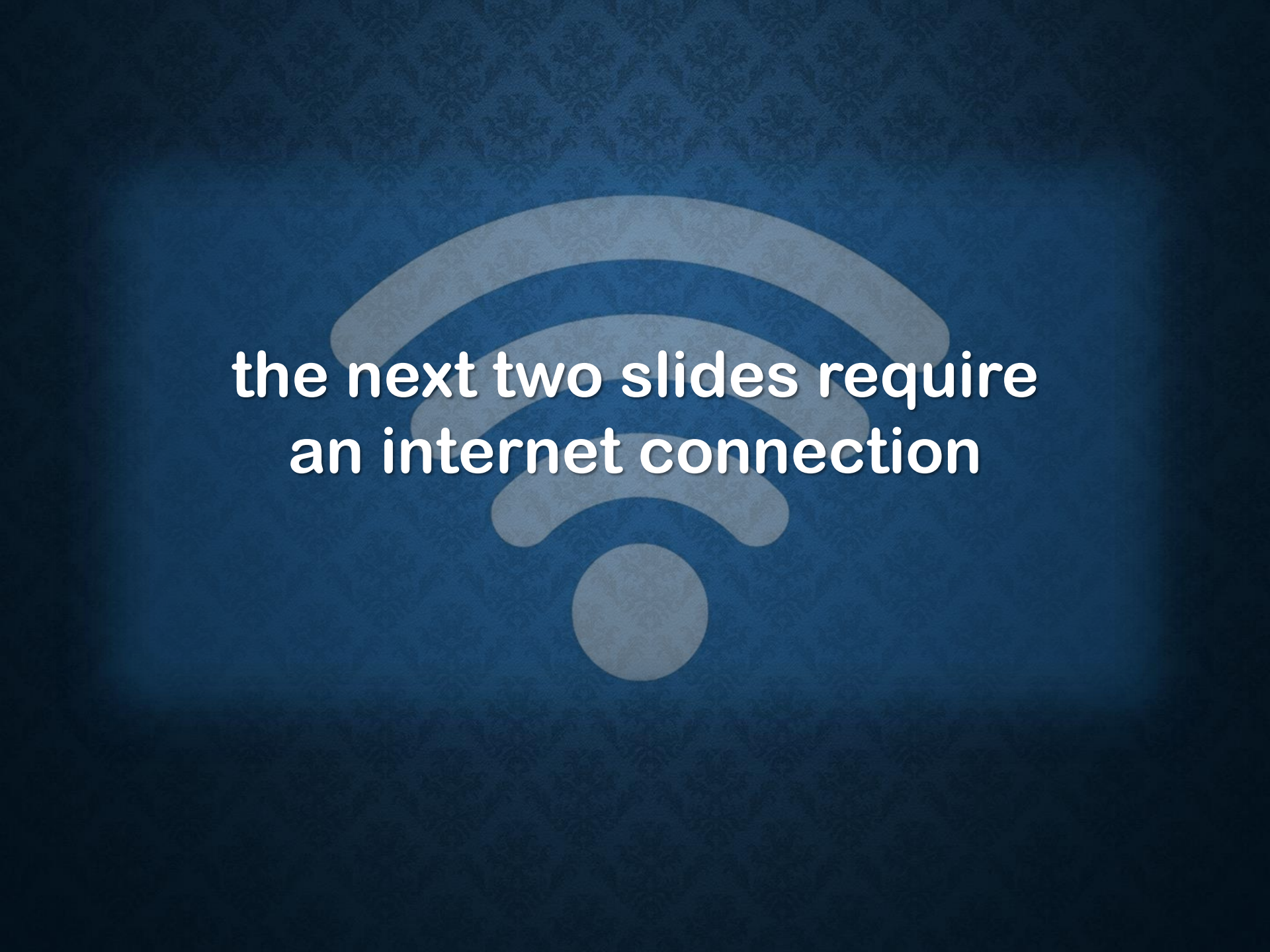




coordinate finding tools

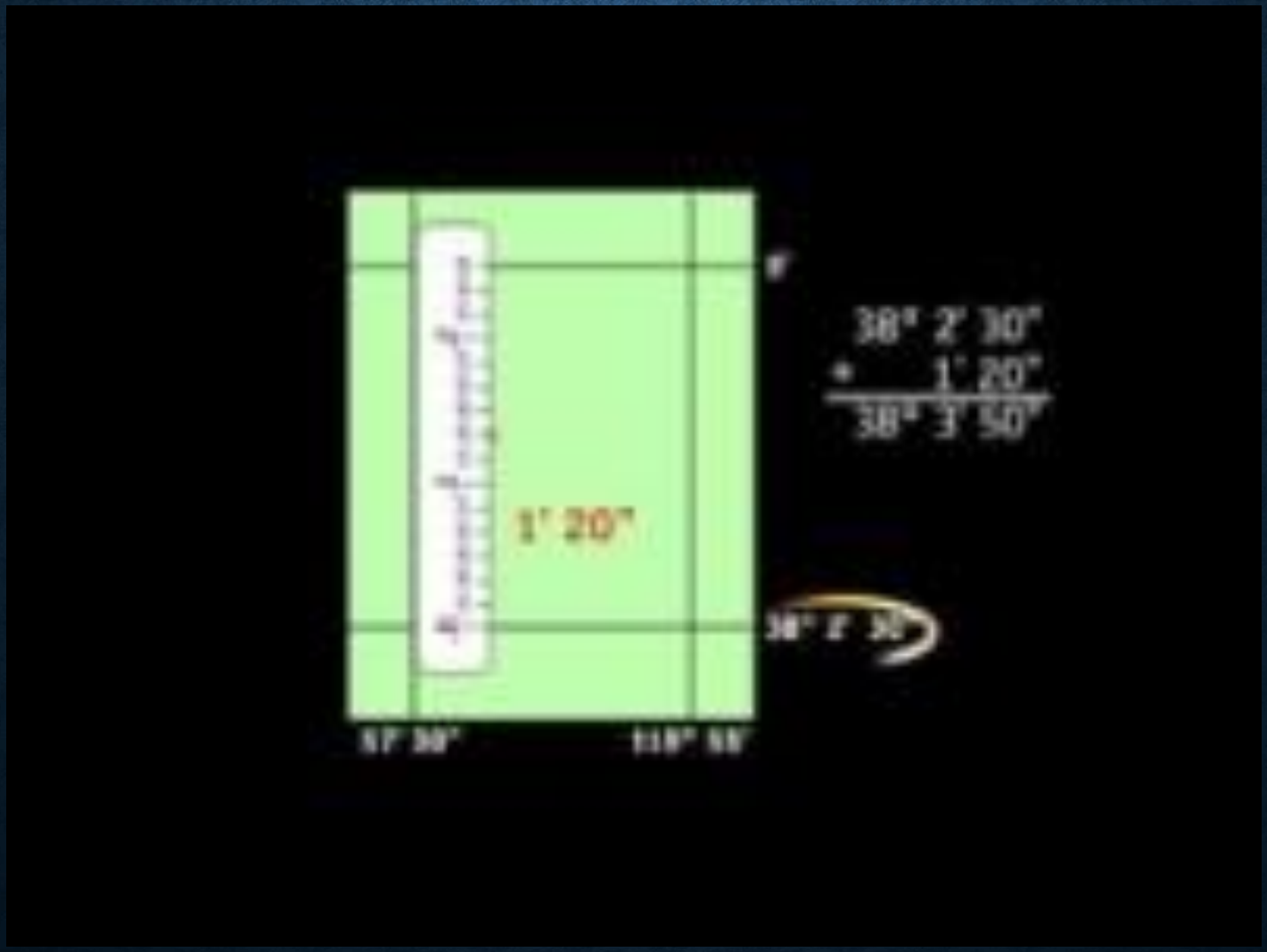


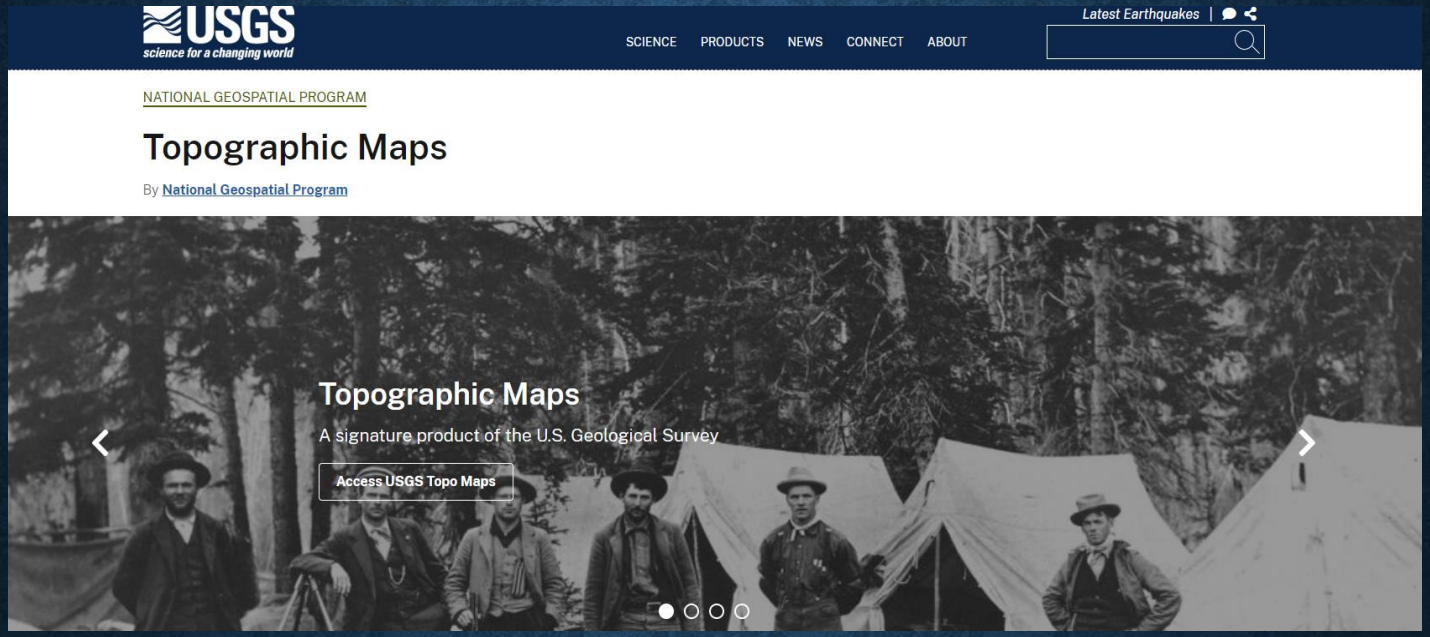



the next two slides require
an internet connection

plotting UTM on a paper topo map

plotting lat / lon on a paper map





https://www.usgs.gov/programs/national-geospatial-program/topographic-maps

GPS

global positioning system

GPS receivers

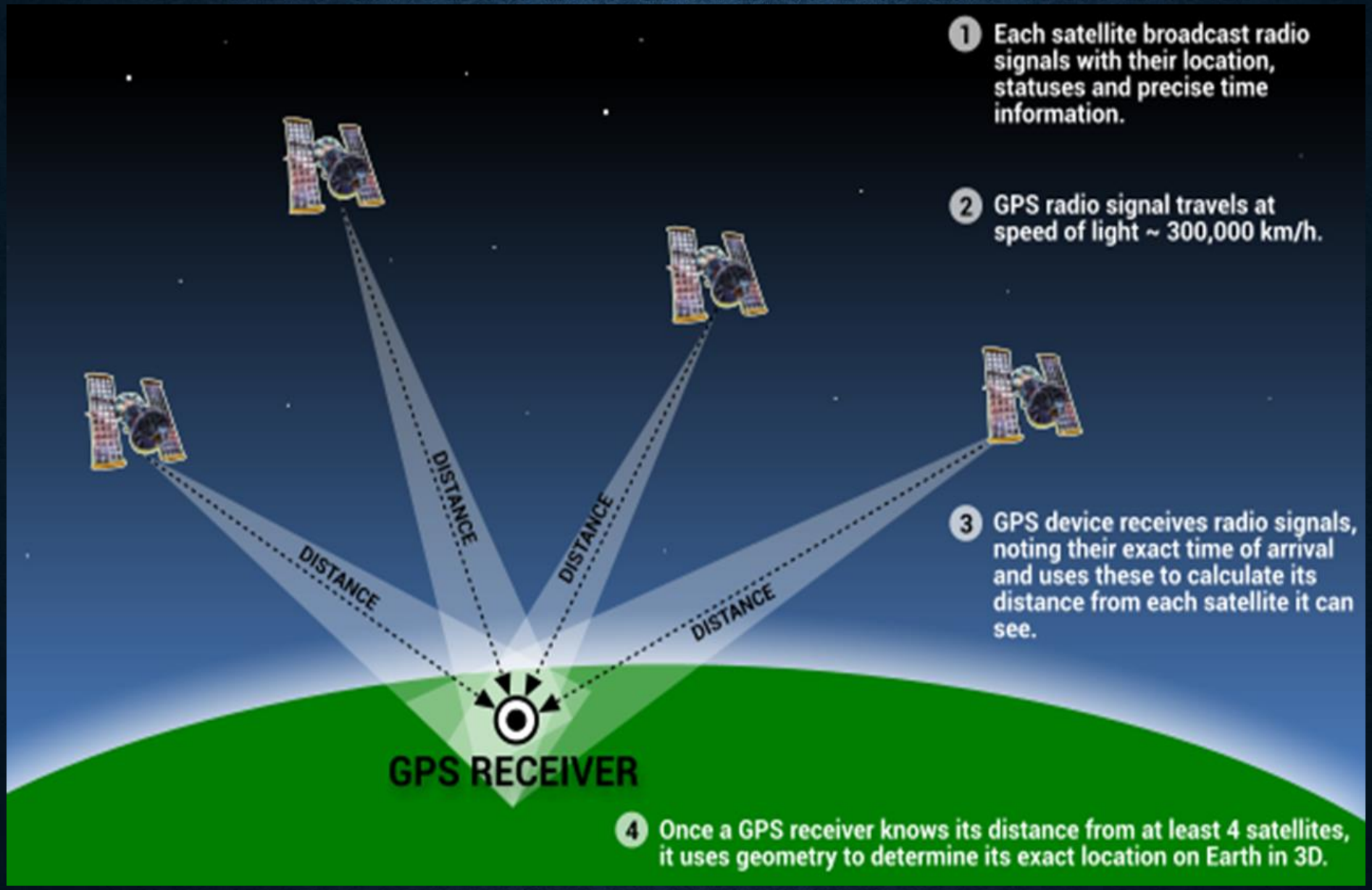
how they work

which system to use

useful applications

hardware enhancements

GPS units use data from these satellites to triangulate a position on the ground


1 Each satellite broadcast radio signals with their location, statuses and precise time information.
2 GPS radio signal travels at speed of light ~ 300,000 km/h.
DISTANCE
DISTANCE
DISTANCE
DISTANCE
3 GPS device receives radio signals, noting their exact time of arrival and uses these to calculate its distance from each satellite it can see.
GPS RECEIVER
4 Once a GPS receiver knows its distance from at least 4 satellites, it uses geometry to determine its exact location on Earth in 3D.

commercial GPS is a satellite-based navigation system made up of 32 global satellites

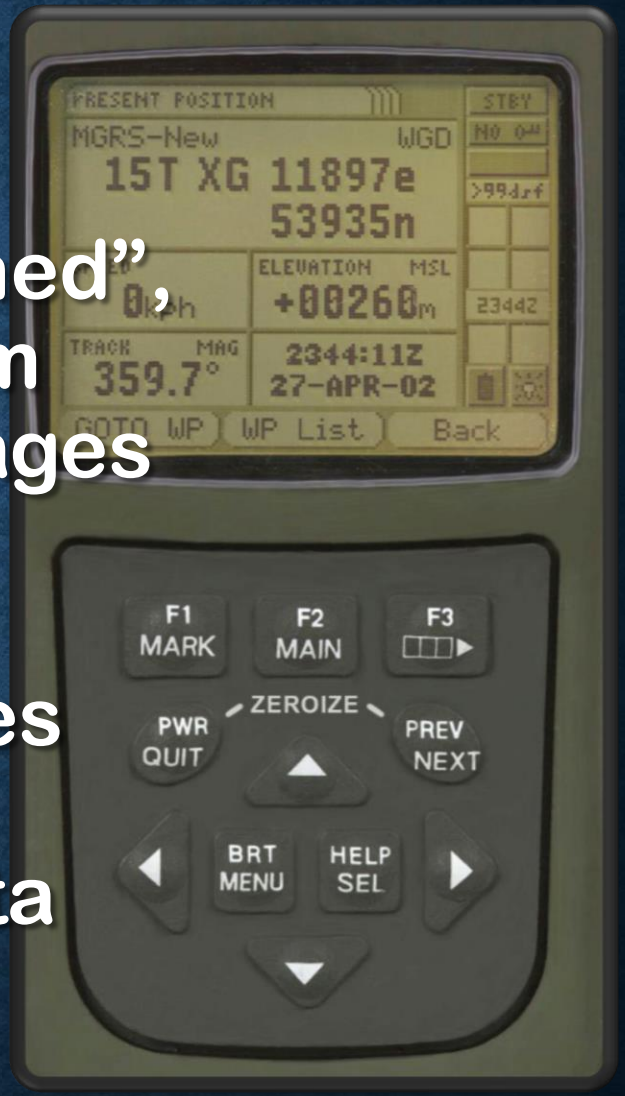
the U.S. military operates

about 24 geo-stationary navigation satellites known as the

NAVSTAR System

NAVSTAR is a “hardened”, highly accurate system and can create 3D images from satellite data

system access requires specialized modules to decode position data



military GPS receivers utilize the selective availability anti-spoofing module (SAASM) to access the precise positioning service signal for enhanced accuracy and signal protection not available to commercial equipment

to program a GPS device, first determine which **map datum** and **coordinate system** to use

most consumer GPS devices allow position format and datum selection

the more satellites
the GPS sees, the more accurate
the position read-out

typically, 4 satellites are
required for
minimum accuracy

12 satellites produce a high
degree of accuracy

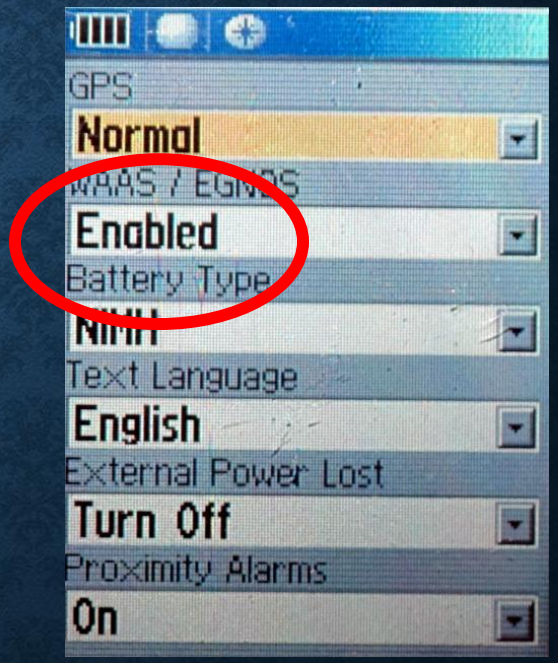
WAAS

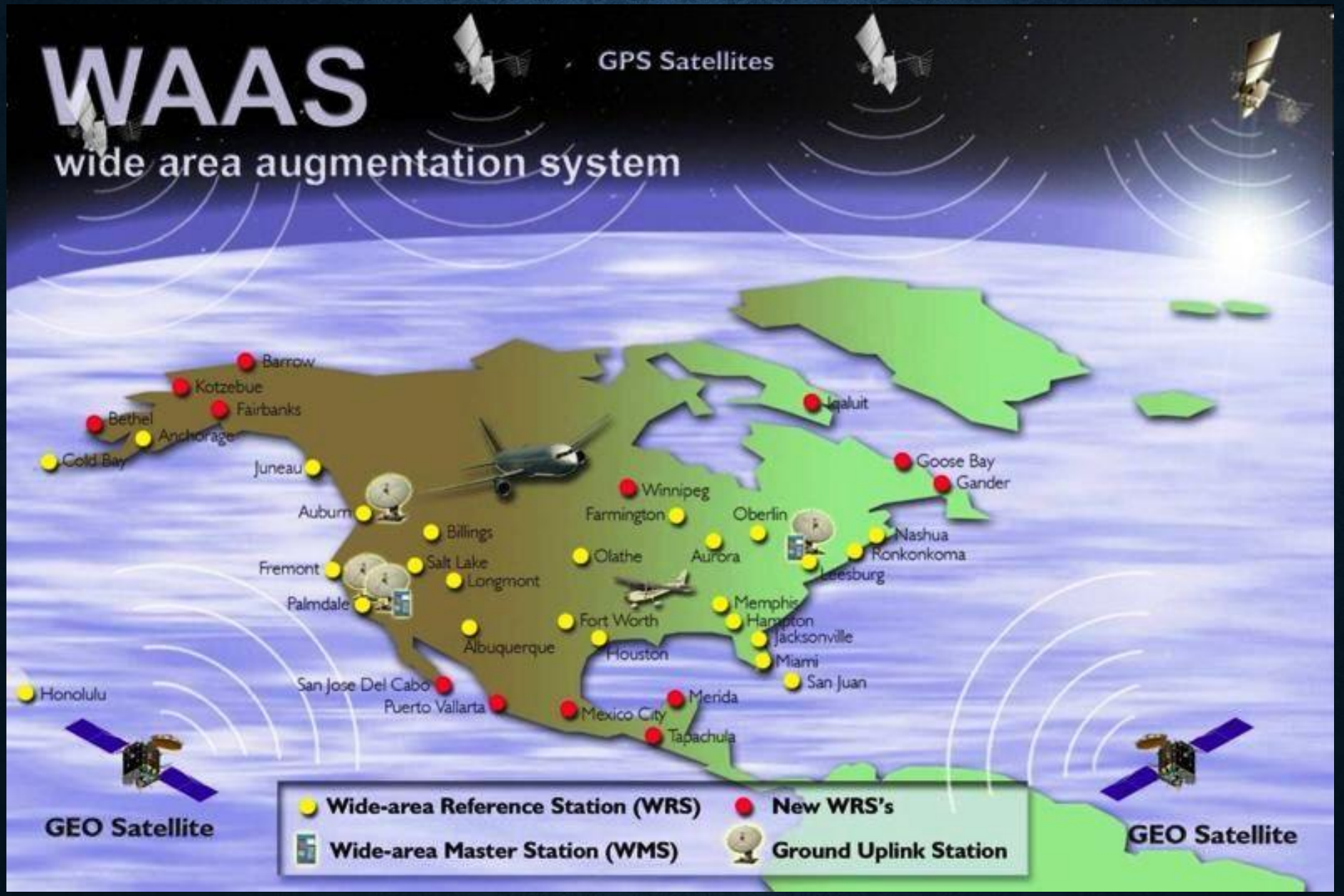
Wide Area Augmentation System

ground based GPS error correction system enhances accuracy

WAAS was developed by the FAA to enhance aircraft navigation and to augment ils approaches

most consumer GPS devices today are WAAS enabled




WAAS
wide area augmentation system
GPS Satellites
Barrow
Kotzebue
Fairbanks
Bethel
Anchorage
Cold Bay
Juneau
Auburn
Billings
Fremont
Salt Lake
Longmont
Palmdale
Albuquerque
Fort Worth
Houston
Winnipeg
Farmington
Olathe
Aurora
Oberlin
Iqaluit
Goose Bay
Gander
Nashua
Ronkonkoma
Leesburg
Memphis
Hampton
Jacksonville
Miami
San Juan
Merida
Mexico City
Tapachula
San Jose Del Cabo
Puerto Vallarta
Honolulu
GEO Satellite
GEO Satellite
Wide-area Reference Station (WRS)
New WRS's
Wide-area Master Station (WMS)
Ground Uplink Station

links to more training, resources and useful applications can be found at

ciarc.org