



Analytical and Computer Cartography

Lecture 3:

Review: Coordinate Systems

Geographic Coordinates

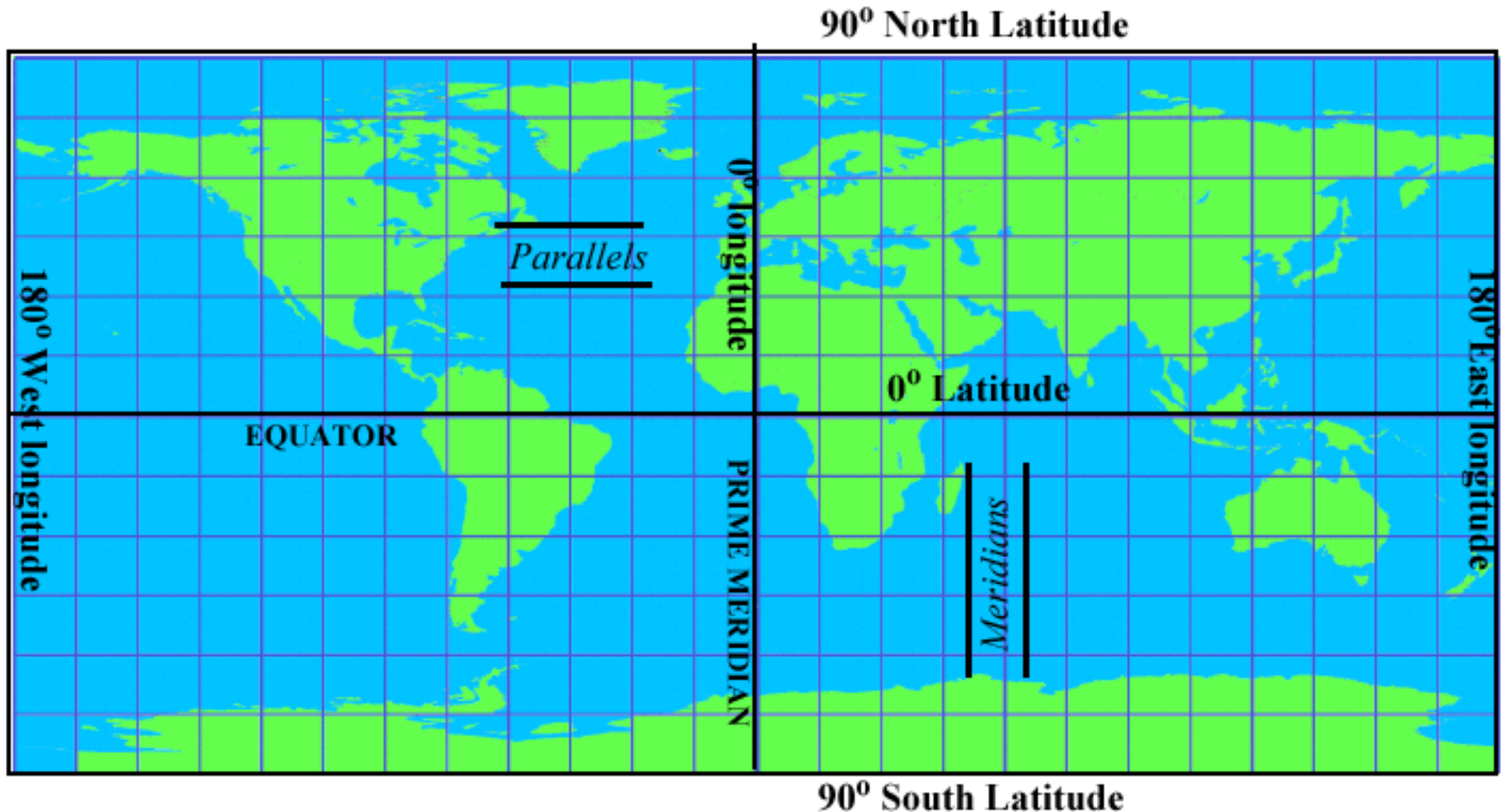


Figure 2.6 Geographic coordinates. The familiar latitude and longitude system, simply converting the angles at the earth's center to coordinates, gives the basic equirectangular projection. The map is twice as wide as high (360° east-west, 180° north-south).

NAD83

- NAD27 remained in use until the earth-centered international GRS80 was complete (Geodetic Reference System 1980)
- Then converted to NAD83, using GRS80 ellipsoid
- Very similar ellipsoid WGS84 was adopted by DOD and many other mapping agencies
- Meades ranch now just a historical relic

IERS

- Provides data on Earth orientation, on the International Celestial Reference System/Frame, on the International Terrestrial Reference System/Frame, and on geophysical fluids
- Maintains Conventions containing models, constants and standards
- Includes ITRS

IERS

LOGIN



*International Earth Rotation and
Reference Systems Service*



Organization

Data / Products / Tools

Publications

Science background

News / Meetings

Links

About IERS

Directing Board

Analysis Coordinator

Product Centres

Technique Centres

Central Bureau

ITRS Combination
Centres

Working groups

Workshops

Search website:

search item >>

Search IERS products:

Product search

Search IERS Messages:

Message search

Organization

The IERS was established in 1987 by the International Astronomical Union and the International Union of Geodesy and Geophysics. According to the Terms of Reference, the IERS accomplishes its mission through the following components: Technique Centres, Product Centres, Combination Centres, Analysis Coordinator, Central Bureau, Directing Board.

> More

Publications

The IERS issues Messages to distribute news, Bulletins to provide Earth orientation data, Technical Notes to publish research results and proceedings of workshops, and Annual Reports to inform the public about its work.

> More

Data / Products / Tools

The IERS provides data on Earth orientation, on the International Celestial Reference System/Frame, on the International Terrestrial Reference System/Frame, and on geophysical fluids. It maintains also Conventions containing models, constants and standards.

> More

Science background

Information about Earth rotation, reference frames, and observation techniques in general - Glossary - References - List of acronyms.

> More

News

- > History of the IERS:
Several pages updated
- > IERS Directing Board:
list of members updated
- > IERS Conventions
Centre: Updated

> More

Meetings

- > IAG Commission 4
"Positioning and
Applications"
Symposium
- > WDS Members' Forum
- > 2016 CODATA General
Assembly

> More

NAD2022 and NAVD2022

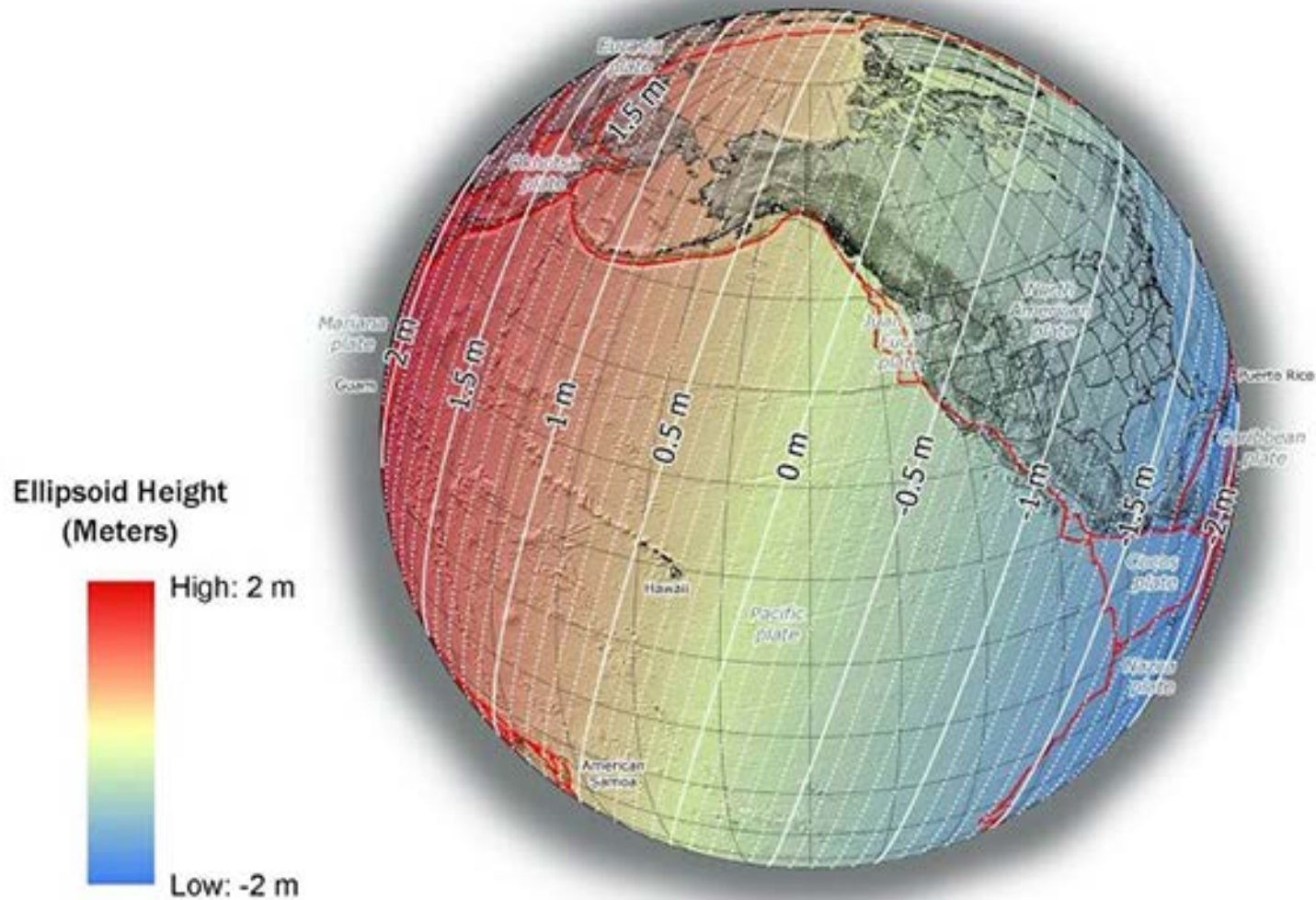
- North American Datum of 1983 will be replaced by a new geometric datum which provides latitude, longitude, height and time information.
- Will rely completely on the CORS network (continuously operating reference stations)
- NGS is completing a major project called Gravity for the Redefinition of the American Vertical Datum, or GRAV-D.
- The scale of the change will vary depending on your location, ranging from 0.5 to 1.5 meters in a horizontal direction, and 0 to 1.3 meters in elevation.
- Many state and other governmental entities passed laws on NAD83 that will need to be changed to reflect the new datum
- Will create the National Spatial Reference System

Resources

- http://alt.ngs.noaa.gov/web/science_edu/online_lessons/
- http://www.ngs.noaa.gov/corbin/class_description/NGS_Video_Library.shtml

NAD83 to NAD2022

Approximate Ellipsoid Height Change



Datums and Map Projections

- Assuming an earth model sets the initial surface that will be transformed
- Influences both position and height
- If projection does not document the datum, it may be irreversible
- Most GIS packages create metadata files that establish key parameters
- After NAD2022, time will be an integral part of position

Ways to Record Lat/Long

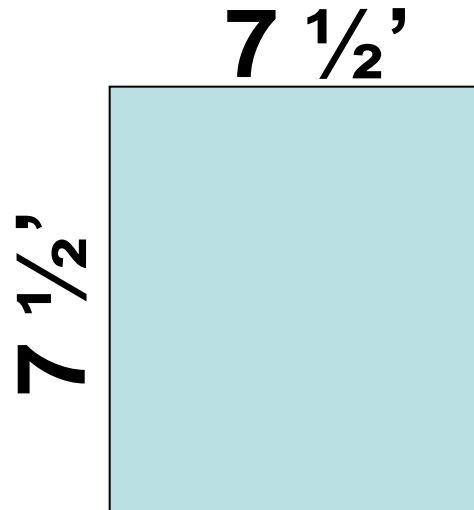
Decimal Degrees	38.8998339 -77.0463660
DMS	385359N 0770247W
Hemisphere First	N385359W0770247
Decimal Minutes	38°53.98' N 77°02.78'W
Decimal Seconds	38°53'98.333" N 77°02'78.333"W

Problems with Geographic Coordinates

- Spherical geometry difficult, need great circle arcs for many applications
- Precision depends on mixed DMS and DD origin maps
- Axes are not orthogonal
- Difficult to use algorithms for spherical measurements e.g. simple distance in $x = \cos(\phi)$
- Solution: Planar geometry
- But, price is living with an imperfect projection

USGS Topographic maps

- Seven and a half minutes of longitude wide
- Seven and a half minutes of latitude high
- So why aren't they square?



Lets check two locations

Flag Island, Minnesota at $49^{\circ}22'N$



Card Sound, Florida at $25^{\circ}22'N$



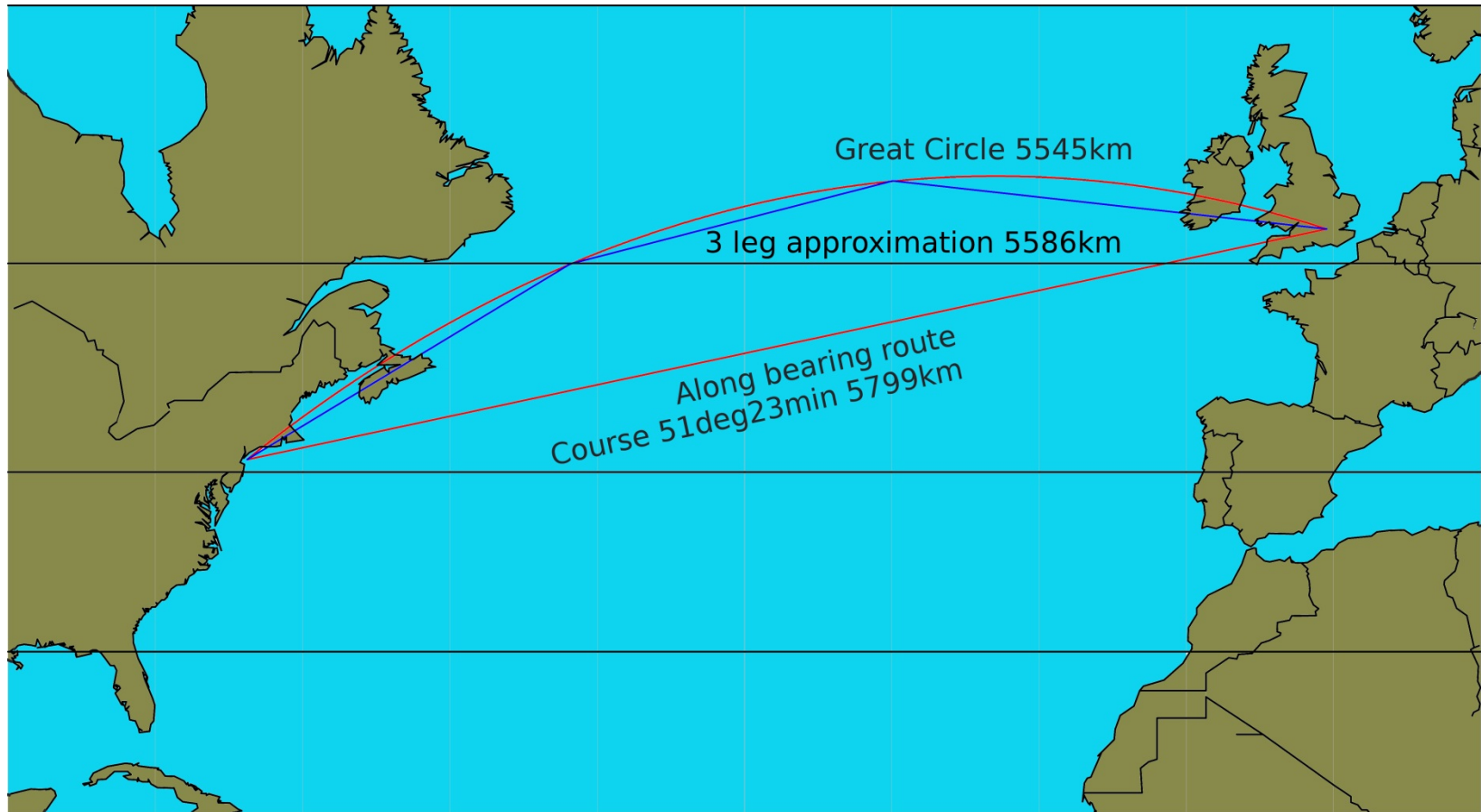
Using Projections

- Choice of projection allows control over map center, plus pattern of distortion
- Can optimize projection for map purpose, e.g. choose standard parallels
- Allows customizations for particular maps and applications, e.g. navigation
- Often chosen once then choice remains in place
- E.g. Mercator for navigation by compass

Great circles are straight on some conformal projections (Gnomic): Note crossing angles



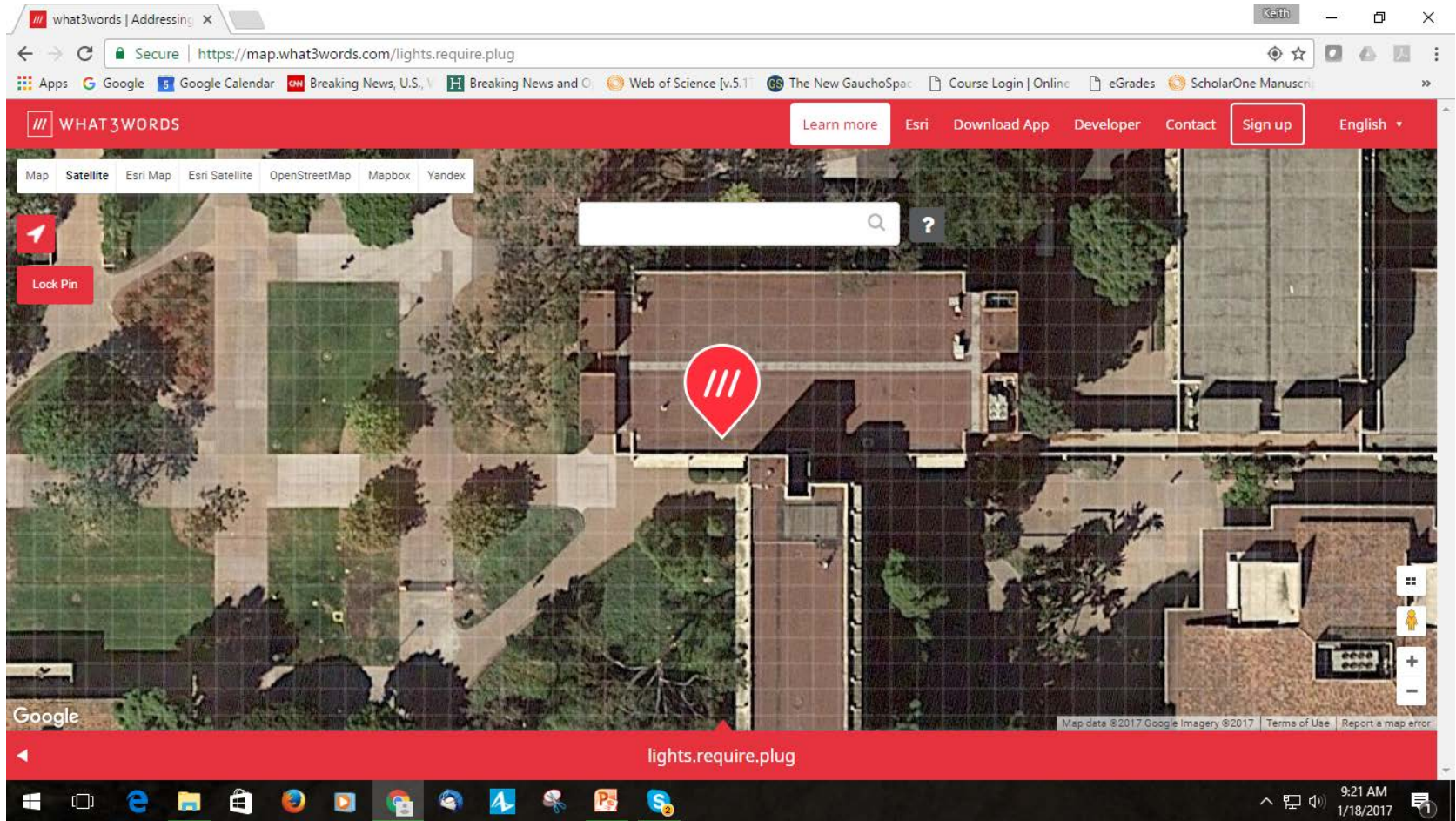
JFK to LHR: Approximating a great circle on the Mercator. Only 41km farther (0.74%)



Projection and Coordinate Systems

- A coordinate system is a standardized method for assigning codes to locations so that locations can be found using the codes alone
- Standardized coordinate systems use absolute locations
- In a coordinate system, the *x*-direction value is the *easting* and the *y*-direction value is the *northing*
- Most systems make both values positive
- Can use letters, numbers
- Can interweave digits for *x* and *y*

What3words: 3 x 3m squares

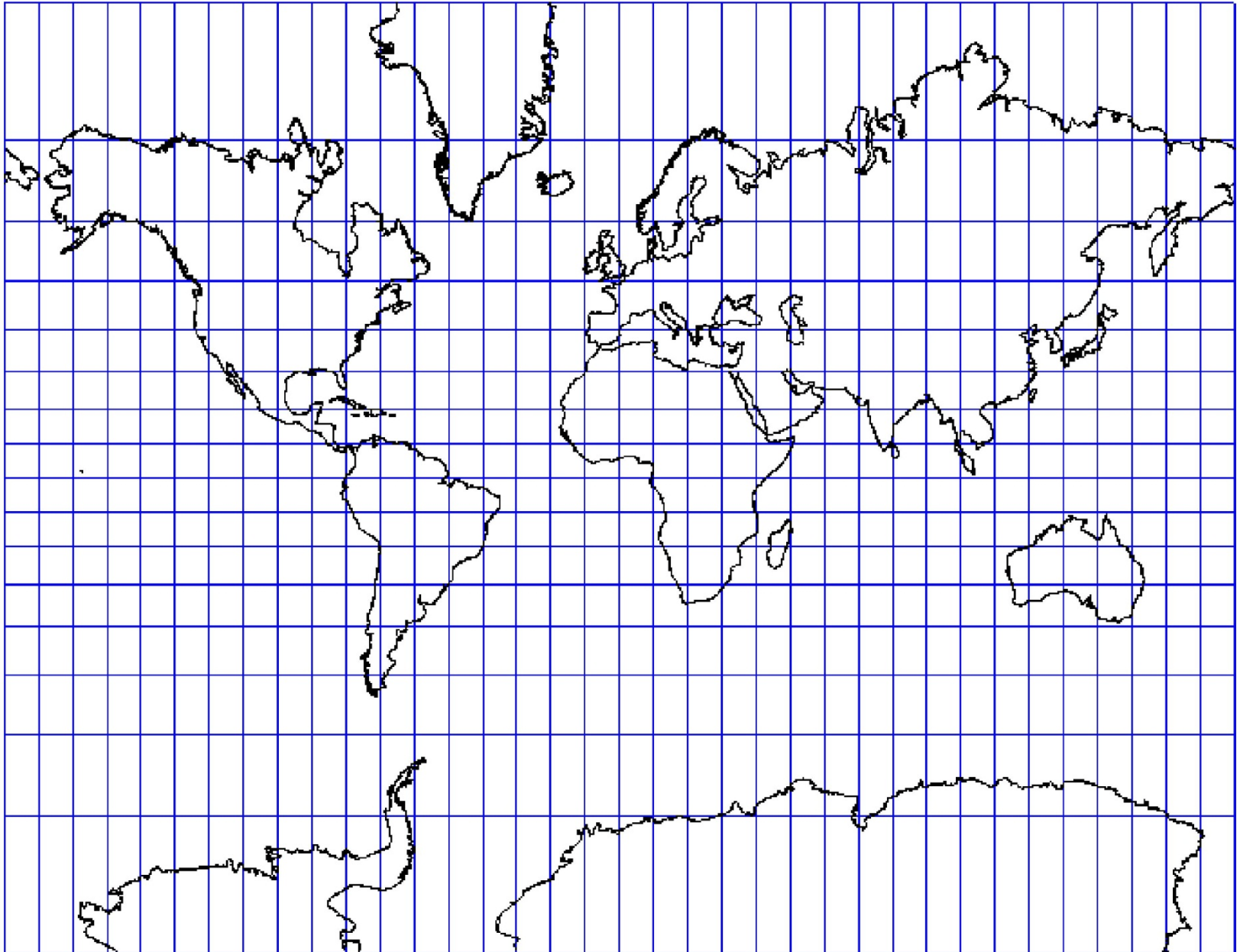


<https://map.what3words.com/lights.require.plug>

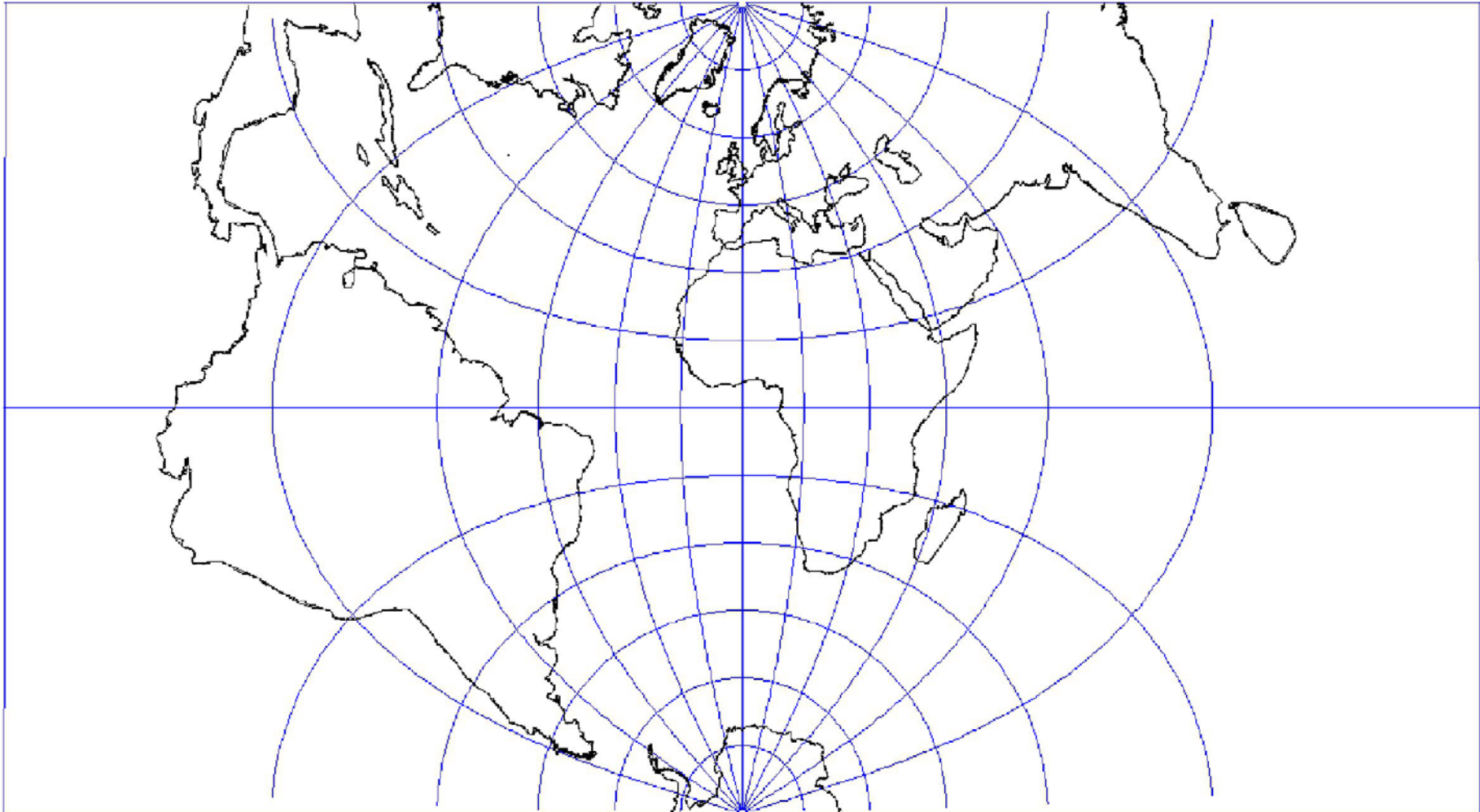
Coordinate Systems for the US

- Some standard coordinate systems used in the United States are
 - geographic coordinates
 - universal transverse Mercator system
 - military grid/MGRS/National grid
 - state plane
- To compare or edge-match, both maps **MUST** be in the same coordinate system.

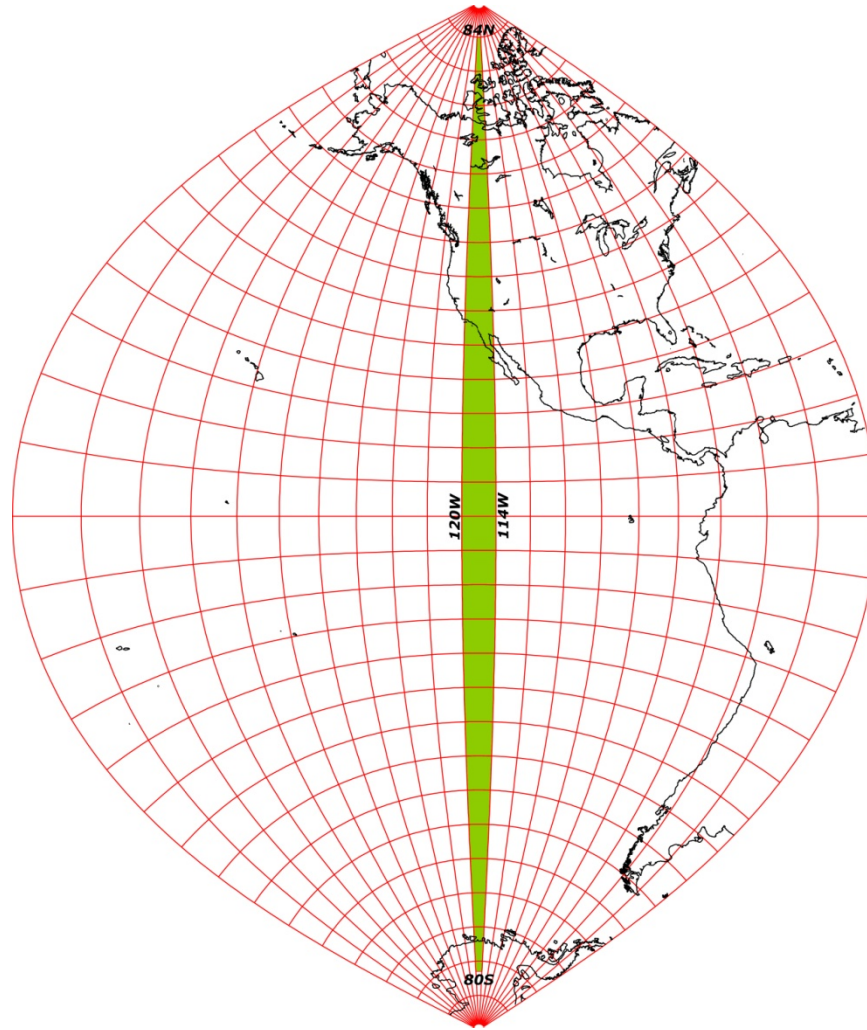
Equatorial Mercator



Transverse Mercator



The advantage of the transverse Mercator projection



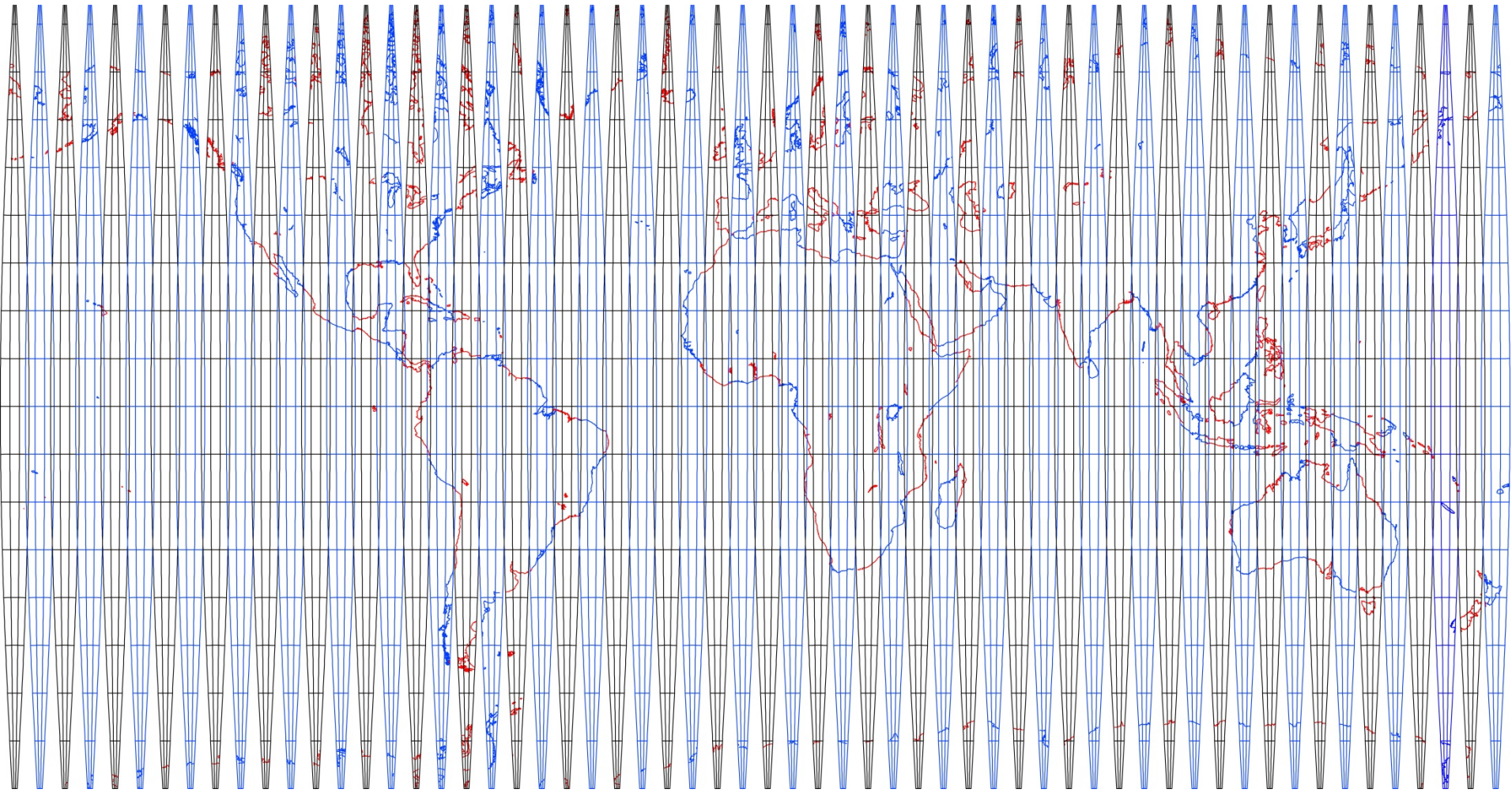
UTM

- Universal transverse Mercator coordinate system
- Basis for 3 grid systems: Civilian UTM, MGRS and US National Grid
- Used in Hybrid form by geohack
- Uses 60 projections with 6 degrees between central meridians

Applies 80°S to 84°N



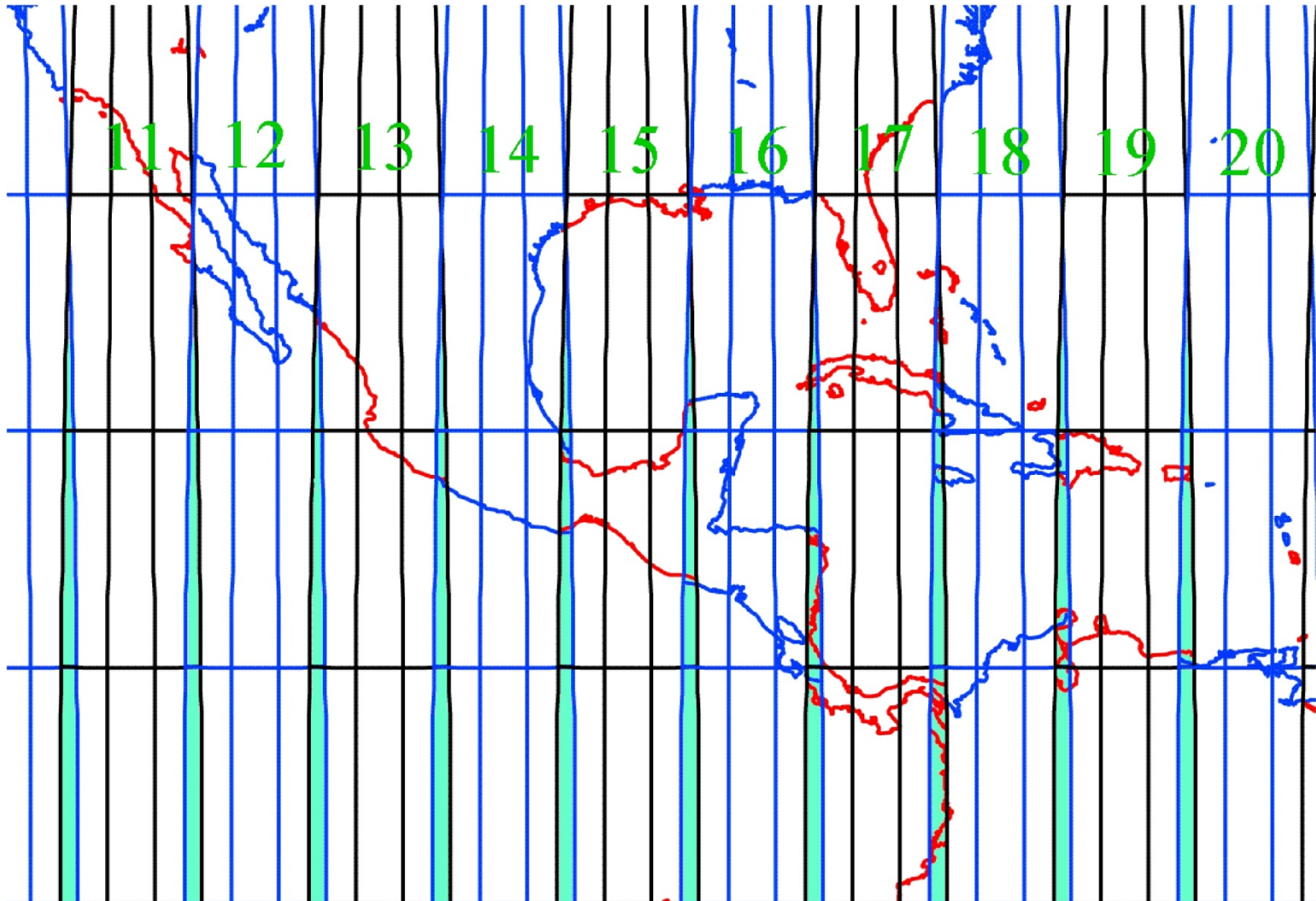
60 zones each 6° of longitude wide



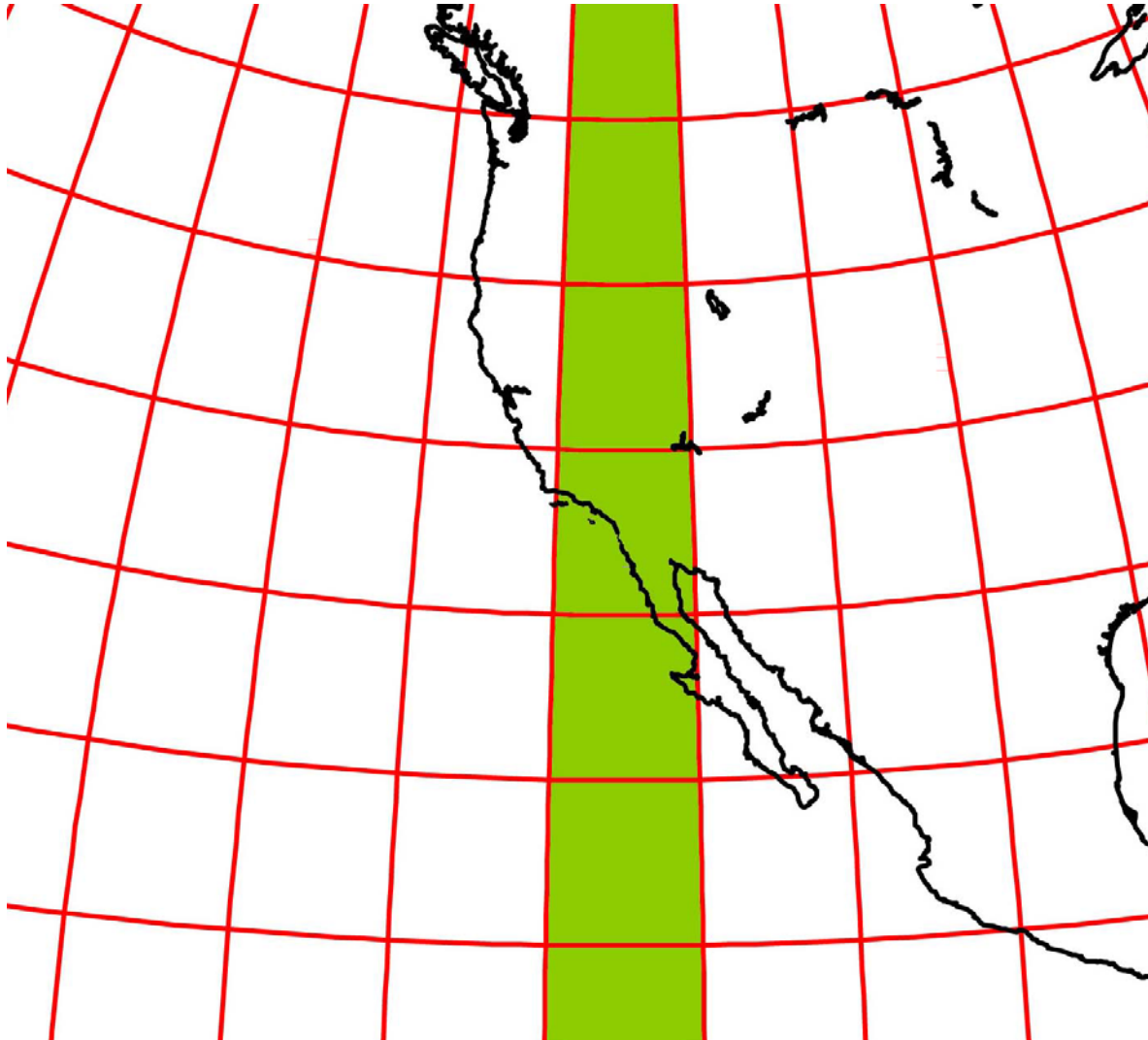
UTM Zones

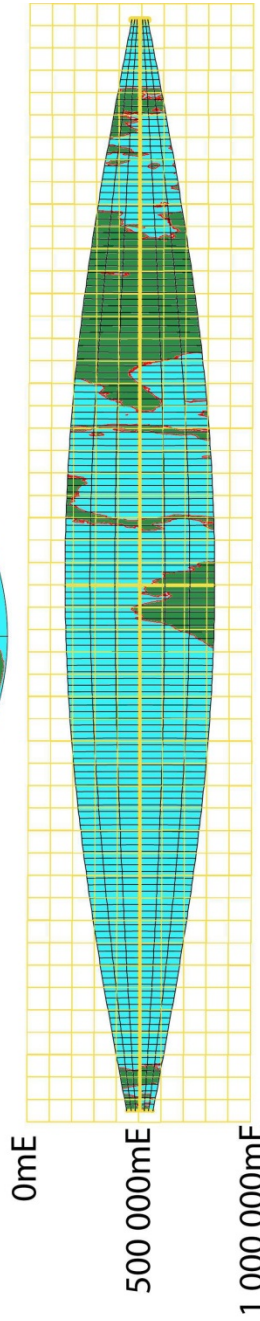
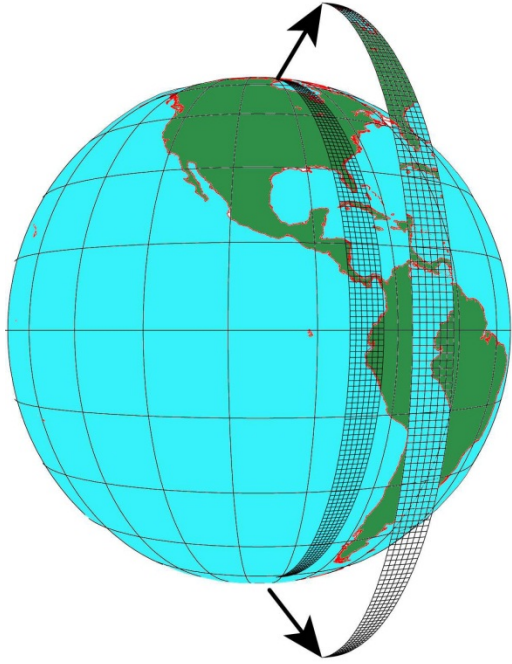
- One degree = 111,111m
- Six degrees = 666,666
- Set Zone false origin so that central meridian is 500,000m
- Gives 166,666m of overlap on each side at equator
- Overlap ends at about 25°N/S

Zones overlap slightly when 1 million meters wide



Zone 11N





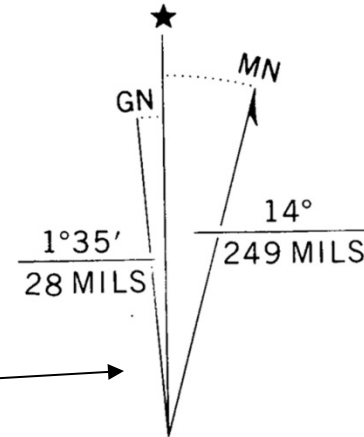
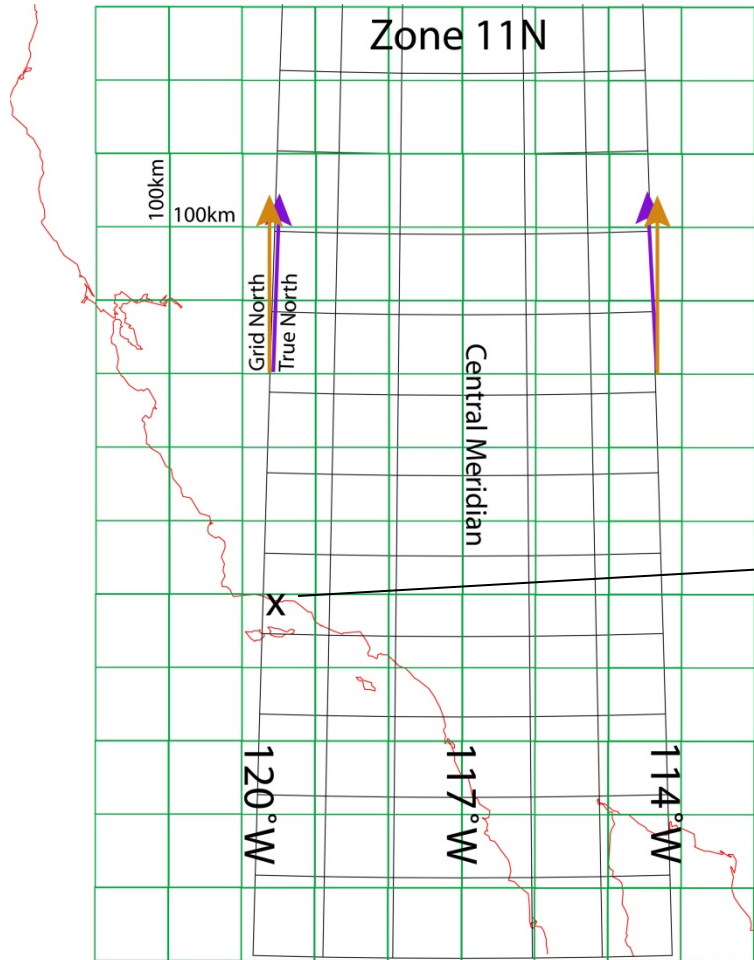
Equator
0mN, 17N
10 000 000mN, 17S

0mE

500 000mE

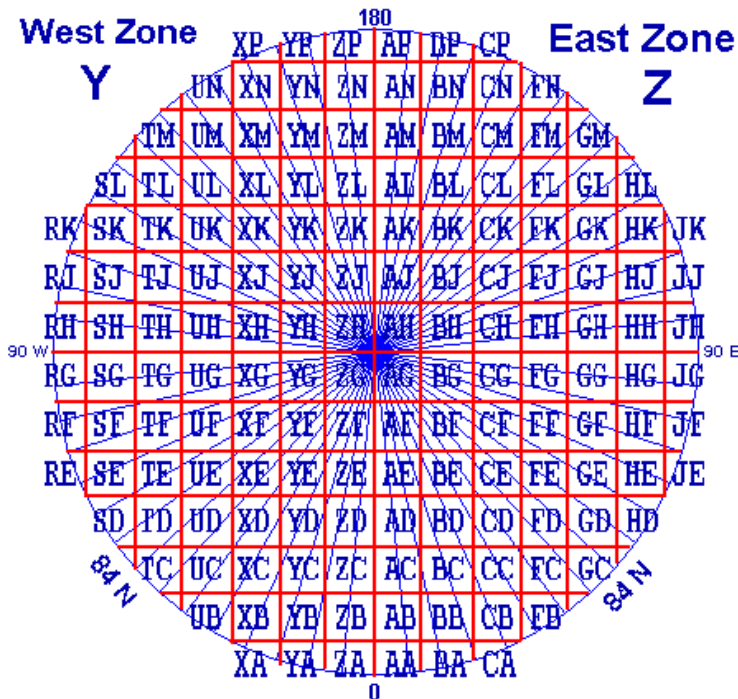
1 000 000mE

Grid north and the Zone

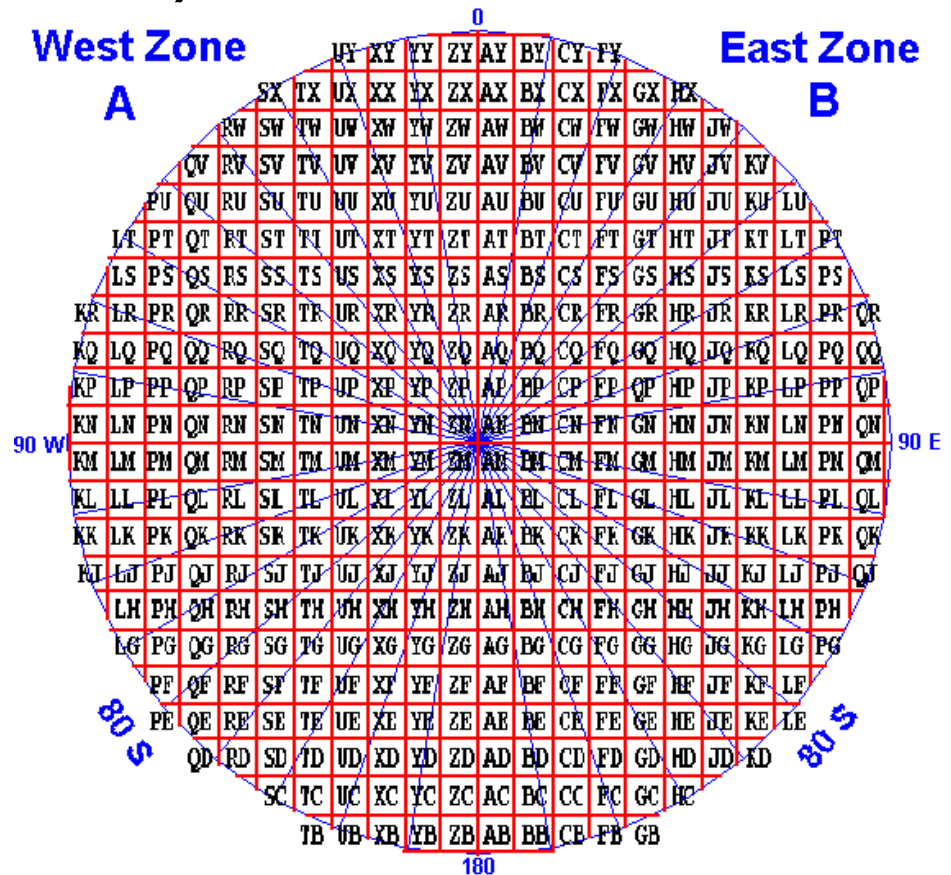


UTM GRID AND 1988 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

Universal Polar Stereographic (UPS)



North Polar Area UPS Grid



South Polar Area UPS Grid

Example, GPS fix

238499E; 3811905N 11, N




Geohack Isla Vista

GeoHack - Isla Vista, Cali X

Secure | <https://tools.wmflabs.org/geohack/geohack.php?pagename:>

Apps Google Google Calendar Breaking News, U.S., V Breaking News and O

GeoHack - Isla Vista, California



WGS84 34° 24' 48" N, 119° 51' 39" W
 34.413333, -119.860833
Geo URI <geo:34.413333,-119.860833>
UTM 11S 237055 3811699
Zoom 6 **Scale**
Region [US](#) **Type**
Title [Isla Vista, California](#) (edit | report inaccuracies)

Contents Global and Local services · Wikipedia articles · Photos

View this location in [Google Maps](#), in [Open](#)

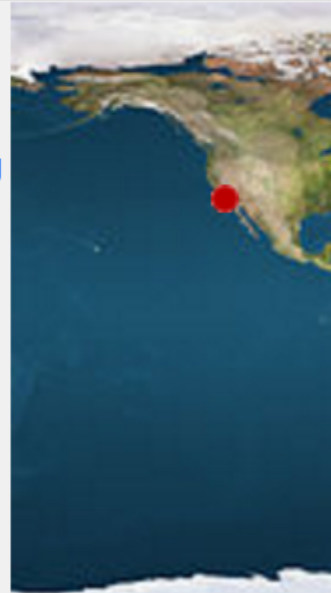
Global services

Service	Map	Satellite	Topo	
ACME Mapper	Map	Satellite	Topo	Terrain , Mapnik
Apple Maps	Map	Satellite		
Arctic.io				Daily Satellite
Bing Maps	Map	Aerial		Bird's Eye
Blue Marble Navigator		Satellite		Night Lights
Flash Earth		Satellite		
Fourmilab		Satellite		
GeaBios		Satellite		
GeoNames		Satellite		Text (XML)
Google Earth ^{note}		Open		w/ meta data

Views
 ■ [Template](#)
 ■ [Talk](#)
 ■ [View source](#)
 ■ [History](#)

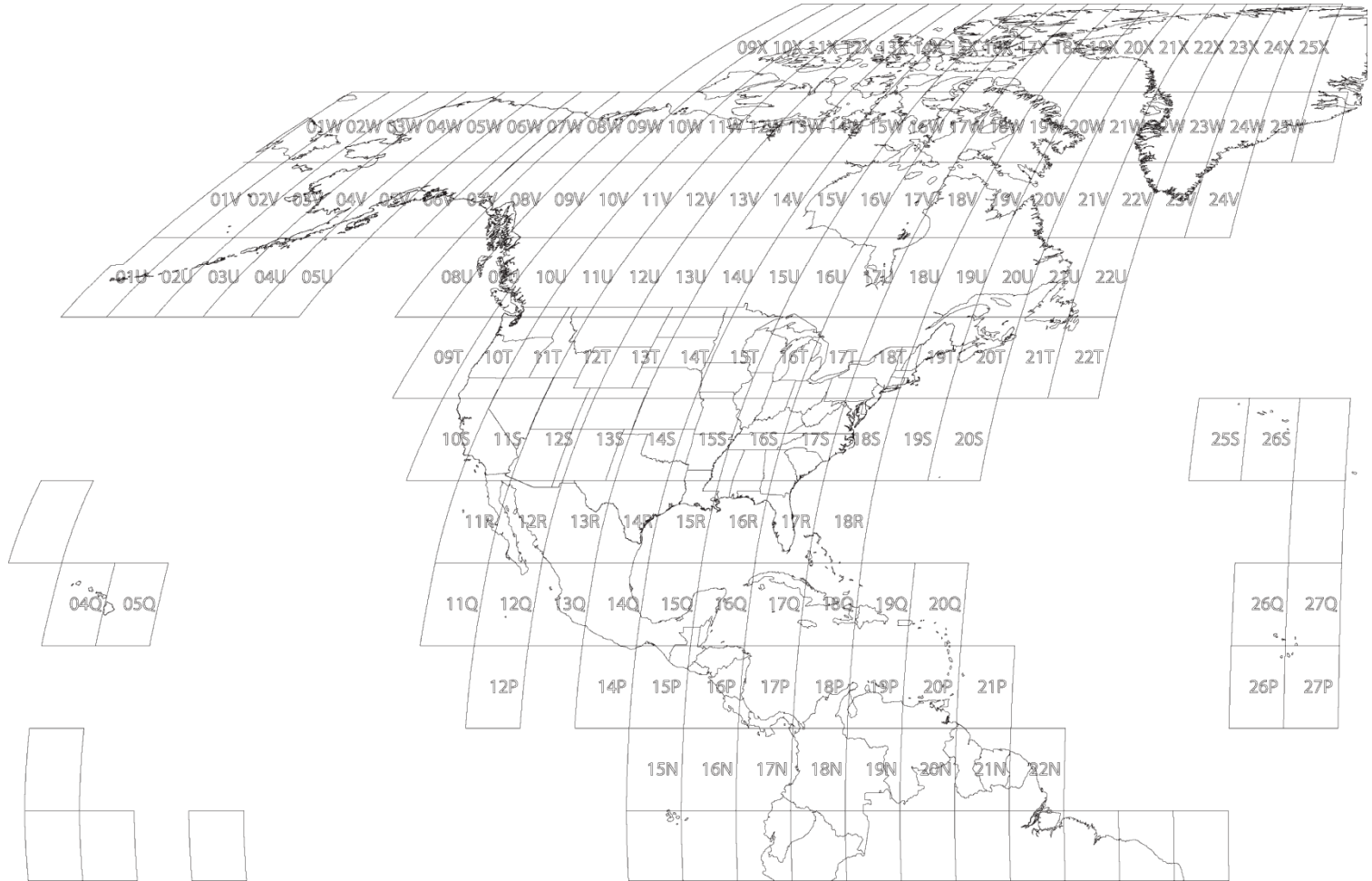
Languages
 ■ Afrikaans
 ■ Alemannisch
 ■ العربية
 ■ Aragonés
 ■ অসমীয়া
 ■ Asturianu
 ■ বাংলা
 ■ Беларуская
 ■ Беларуская (тарашкевіца)
 ■ भोजपुरी
 ■ Български
 ■ Bosanski
 ■ Brezhoneg
 ■ Català
 ■ Čeština

WGS84 34° 24' 48" N, 119° 51' 39" W
 34.413333, -119.860833
Geo URI <geo:34.413333,-119.860833>
UTM 11S 237055 3811699
Zoom 6 **Scale** ± 1:100000
Region [US](#) **Type** city
Title [Isla Vista, California](#) (edit | report inaccuracies)



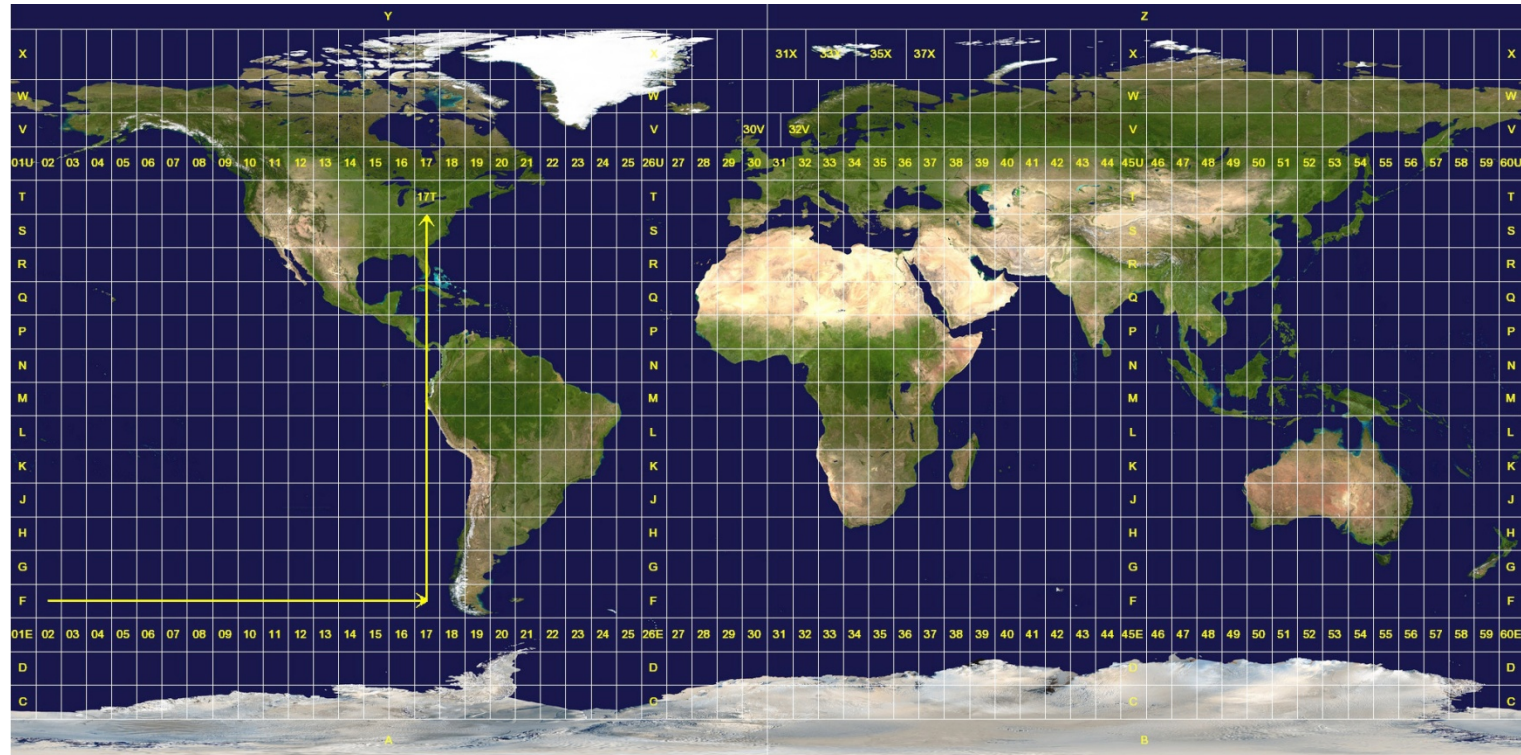
ACME			Topo NEXRAD DOQ
CalTopo			Topo
GPS Visualizer		USDA Aerial	USGS Topo
Historic Aerials		Historic Aerials	
MapQuest	Map	Labeled satellite	Live traffic
MSR Maps (TerraServer-USA)		USGS Aerial	USGS Topo
NASA/MSFC GOES		Satellite	
National Weather Service			Weather
TerraFly		Satellite	
TopoQuest		USGS Aerial	Topo
Trails.com			Topo

UTM zones in the USA



Military Grid Coordinates

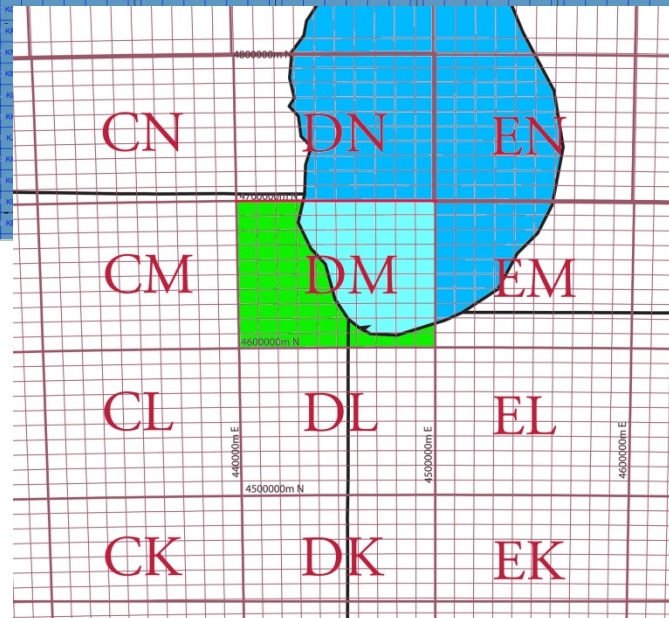
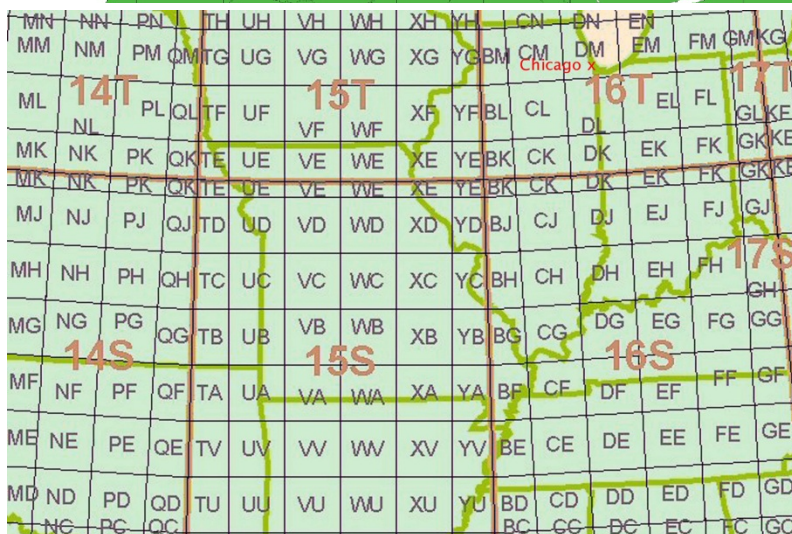
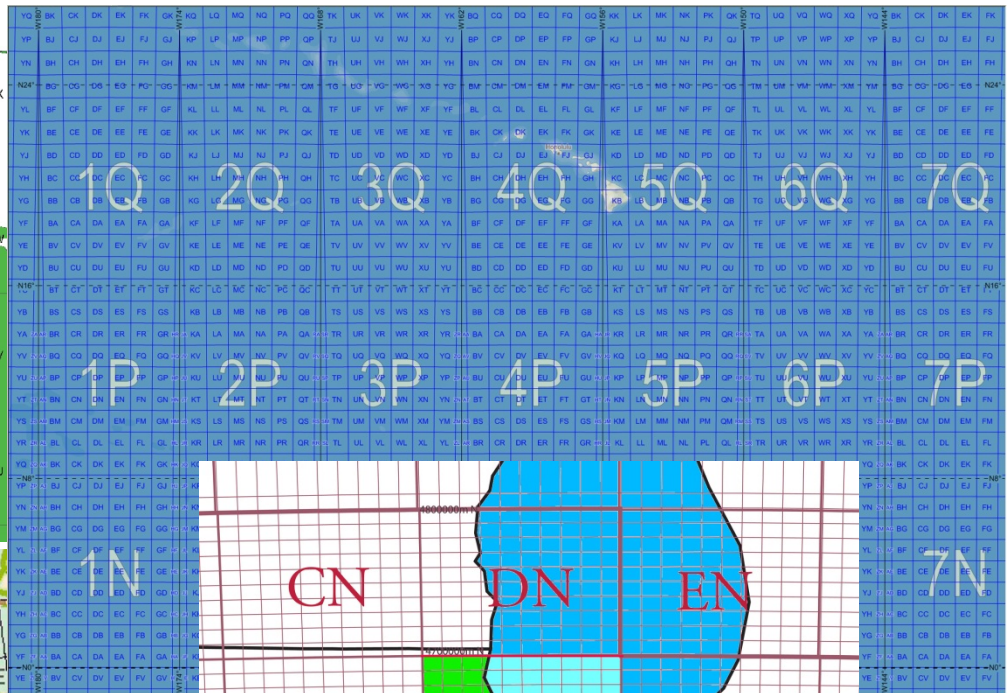
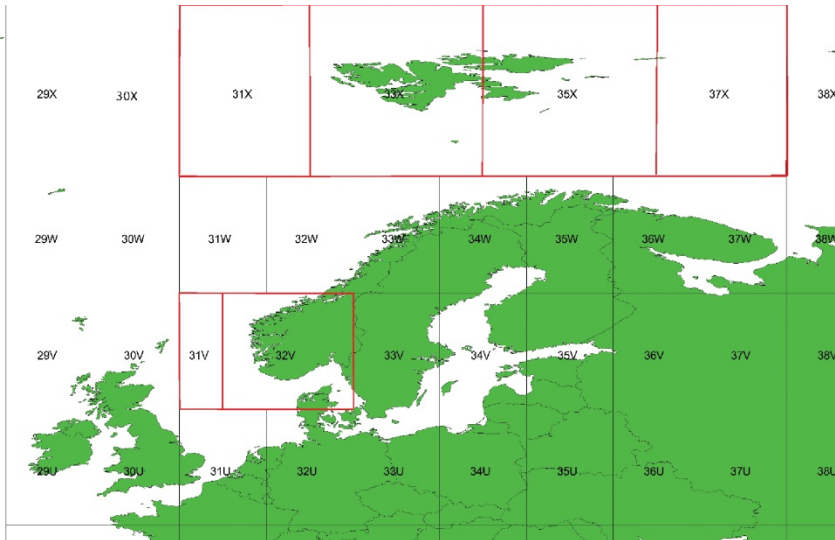
First Reference (6 x 8 degrees)



USMG: 2nd Reference 100,000m cells

YQ	BK	CK	DK	EK	FK	GK	LQ	MQ	NQ	PQ	QQ	TK	UK	VK	WK	XK	YK	BQ	CQ	DQ	EQ	FQ	GQ	KK	LK	MK	NK	PK	OQ	UQ	VQ	WQ	XQ	YQ	BK	CK	DK	EK	FK							
YP	BJ	CJ	DJ	EJ	FJ	GJ	KP	LP	MP	NP	PP	QP	TJ	UJ	VJ	WJ	XJ	YJ	BP	CP	DP	EP	FP	GP	KJ	LJ	MJ	NJ	PJ	QJ	TP	UP	VP	WP	XP	YP	BJ	CJ	DJ	EJ	FJ					
YN	BH	CH	DH	EH	FH	GH	KN	LN	MN	NN	PN	QN	TH	UH	VH	WH	XH	YH	BN	CN	DN	EN	FN	GN	KH	LH	MH	NH	PH	QH	TN	UN	VN	WN	XN	YN	BH	CH	DH	EH	FH					
N24	BG	CG	DG	EG	FG	GG	KM	LM	MM	NM	PM	QM	TG	UG	VG	WG	XG	YG	BM	CM	DM	EM	FM	GM	KG	LG	MG	NG	PG	QG	TM	UM	VM	WM	XM	YM	BG	CG	DG	EG	N24					
YL	BF	CF	DF	EF	FF	GF	KL	LL	ML	NL	PL	QL	TF	UF	VF	WF	XF	YF	BL	CL	DL	EL	FL	GL	KF	LF	MF	NF	PF	QF	TL	UL	VL	WL	XL	YL	BF	CF	DF	EF	FF					
YK	BE	CE	DE	EE	FE	GE	KK	LK	MK	NK	PK	QK	TE	UE	VE	WE	XE	YE	BK	CK	DK	EK	FK	GK	KF	LE	ME	NE	PE	QE	TK	UK	VK	WK	XK	YK	BE	CE	DE	EE	FE					
YJ	BD	CD	DD	ED	FD	GD	KJ	LJ	MJ	NJ	PJ	QJ	TD	UD	VD	WD	XD	YD	BJ	CJ	DJ	EJ	FJ	GJ	KD	LD	MD	ND	PD	QD	TJ	UJ	VJ	WJ	XJ	YJ	BD	CD	DD	ED	FD					
YH	BC	CC	DC	EC	FC	GC	KH	LH	MH	NH	PH	QH	TC	UC	VC	WC	XC	YC	BH	CH	DH	EH	FH	GH	KC	LC	MC	NC	PC	QC	TH	UH	VH	WH	XH	YH	BC	CC	DC	EC	FC					
YG	BB	CB	DB	EB	FB	GB	KG	LG	MG	NG	PG	QG	TB	UB	VB	WB	XB	YB	BG	CG	DG	EG	FG	GG	KB	LB	MB	NB	PB	QB	TG	UG	VG	WG	XG	YG	BB	CB	DB	EB	FB					
YF	BA	CA	DA	EA	FA	GA	KF	LF	MF	NF	PF	QF	TA	UA	VA	WA	XA	YA	BF	CF	DF	EF	FF	GF	KA	LA	MA	NA	PA	QA	TF	UF	VF	WF	XF	YF	BA	CA	DA	EA	FA					
YE	BV	CV	DV	EV	FV	GV	KE	LE	ME	NE	PE	QE	TV	UV	VV	WV	XV	YV	BE	CE	DE	EE	FE	GE	KV	LV	MV	NV	PV	QV	TE	UE	VE	WE	XE	YE	BV	CV	DV	EV	FV					
YD	BU	CU	DU	EU	FU	GU	KD	LD	MD	ND	PD	QD	TU	UU	VU	WU	XU	YU	BD	CD	DD	ED	FD	GD	KU	LU	MU	NU	PU	QU	TD	UD	VD	WD	XD	YD	BU	CU	DU	EU	FU					
N16	BT	CT	DT	ET	FT	GT	KC	LC	MC	NC	PC	QC	TC	UC	VC	WC	XC	YC	BC	CC	DC	EC	FC	GC	KT	LT	MT	NT	PT	QT	TC	UC	VC	WC	XC	YC	BT	CT	DT	ET	N16					
YB	BS	CS	DS	ES	FS	GS	KB	LB	MB	NB	PB	QB	TS	US	VS	WS	XS	YS	BB	CB	DB	EB	FB	GB	KS	LS	MS	NS	PS	QS	TB	UB	VB	WB	XB	YB	BS	CS	DS	ES	FS					
YA	BR	CR	DR	ER	FR	GR	KA	LA	MA	NA	PA	QA	RA	SA	TA	UA	VA	WA	XA	YA	BR	CR	DR	ER	FR	GR	KA	LA	MA	NA	PA	QA	RA	SA	TA	UA	VA	WA	XA	YA	BR	CR	DR	ER	FR	
YV	BO	CO	DO	EO	FO	GO	KV	LV	MV	NV	PV	QV	RV	SV	TV	UV	VV	WV	XV	YV	BO	CO	DO	EO	FO	GO	KQ	LQ	MQ	NQ	PQ	QQ	TV	UV	VV	WV	XV	YV	BO	CO	DO	EO	FO			
YU	BP	CP	DP	EP	FP	GP	KU	LU	MU	NU	PU	QU	RU	SU	TU	UU	VU	WU	XU	YU	BP	CP	DP	EP	FP	GP	KP	LP	MP	NP	OP	PU	QU	RU	SU	TU	UU	VU	WU	XU	YU	BP	CP	DP	EP	FP
YT	BN	CN	DN	EN	FN	GN	KT	LT	MT	NT	PT	QT	RU	SU	TU	UU	VU	WU	XU	YU	BN	CN	DN	EN	FN	GN	KN	LN	MN	NN	PN	QN	RU	SU	TU	UU	VU	WU	XU	YU	BN	CN	DN	EN	FN	
YS	BM	CM	DM	EM	FM	GM	KS	LS	MS	NS	PS	QS	RM	SM	TM	UM	VM	WM	XM	YM	BS	CS	DS	ES	FS	GS	KM	LM	MM	NM	PM	QM	RU	SU	TS	US	VS	WS	XS	YS	BM	CM	DM	EM	FM	
YR	BL	CL	DL	EL	FL	GL	KR	LR	MR	NR	PR	QR	RL	SL	TL	UL	VL	WL	XL	YL	BR	CR	DR	ER	FR	GR	KL	LL	ML	NL	PL	QL	RU	SV	TR	UR	VR	WR	XR	YR	BL	CL	DL	EL	FL	
YQ	BK	CK	DK	EK	FK	GK	KQ	LQ	MQ	NQ	PQ	QQ	RQ	SQ	TQ	UQ	VQ	WQ	XQ	YQ	BK	CK	DK	EK	FK	GK	LK	MK	NK	PK	QK	RQ	SQ	TQ	UQ	VQ	WQ	XQ	YQ	BK	CK	DK	EK	FK		
YP	BJ	CJ	DJ	EJ	FJ	GJ	KP	LP	MP	NP	PP	QP	RJ	SJ	TJ	UJ	VJ	WJ	XJ	YJ	BJ	CJ	DJ	EJ	FJ	GP	KJ	LJ	MJ	NJ	PJ	QJ	RJ	SJ	TJ	UJ	VJ	WJ	XJ	YJ	BJ	CJ	DJ	EJ	FJ	
YN	BH	CH	DH	EH	FH	GH	KN	LN	MN	NN	PN	QN	RH	SH	TH	UH	VH	WH	XH	YH	BN	CN	DN	EN	FN	GN	KH	LH	MH	NH	PH	QH	RH	SH	TH	UH	VH	WH	XH	YH	BN	CH	DH	EH	FH	
YM	BA	CA	DA	EA	FA	GA	KM	LM	MM	NM	PM	QM	RM	SM	TM	UM	VM	WM	XM	YM	BA	CA	DA	EA	FA	GM	KG	LG	MG	NG	PG	QG	RM	SM	TM	UM	VM	WM	XM	YM	BA	CA	DA	EA	FA	
YL	BF	CF	DF	EF	FF	GF	KL	LL	ML	NL	PL	QL	RF	SF	TF	UF	VF	WF	XF	YF	BL	CL	DL	EL	FL	GL	KF	LF	MF	NF	PF	QF	RF	SF	TF	UF	VF	WF	XF	YF	BF	CF	DF	EF	FF	
YK	BE	CE	DE	EE	FE	GE	KK	LK	MK	NK	PK	QK	RE	SE	TE	UE	VE	WE	XE	YE	BK	CK	DK	EK	FK	GK	KE	LE	ME	NE	PE	QE	RE	SE	TE	UE	VE	WE	XE	YE	BE	CE	DE	EE	FE	
YJ	BD	CD	DD	ED	FD	GD	KJ	LJ	MJ	NJ	PJ	QJ	RD	SD	TD	UD	VD	WD	XD	YD	BJ	CJ	DJ	EJ	FJ	GJ	KD	LD	MD	ND	PD	QD	RD	SD	TD	UD	VD	WD	XD	YD	BD	CD	DD	ED	FD	
YH	BC	CC	DC	EC	FC	GC	KH	LH	MH	NH	PH	QH	RC	SC	TC	UC	VC	WC	XC	YC	BH	CH	DH	EH	FH	GH	KC	LC	MC	NC	PC	QC	RC	SC	TC	UC	VC	WC	XC	YC	BC	CC	DC	EC	FC	
YG	BB	CB	DB	EB	FB	GB	KG	LG	MG	NG	PG	QG	RB	SB	TB	UB	VB	WB	XB	YB	BG	CG	DG	EG	FG	GG	KB	LB	MB	NB	PB	QB	RB	SB	TB	UB	VB	WB	XB	YB	BB	CB	DB	EB	FB	
YF	BA	CA	DA	EA	FA	GA	KF	LF	MF	NF	PF	QF	RA	SA	TA	UA	VA	WA	XA	YA	BF	CF	DF	EF	FF	GF	KA	LA	MA	NA	PA	QA	RA	SA	TA	UA	VA	WA	XA	YA	BA	CA	DA	EA	FA	
YE	BV	CV	DV	EV	FV	GV	KE	LE	ME	NE	PE	QE	RV	SV	TV	UV	VV	WV	XV	YV	BE	CE	DE	EE	FE	GE	KV	LV	MV	NV	PV	QV	RV	SV	TV	UV	VV	WV	XV	YV	BE	CV	DV	EV	FV	

MGRS Grid Cell Designators

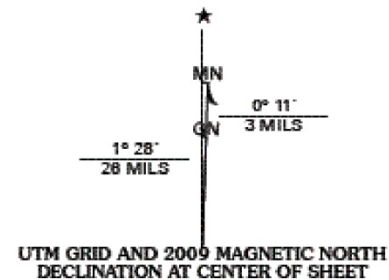


MGRS/National Grid



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 15R
 10 000-foot ticks: Louisiana Coordinate System of 1983
 (south zone)

Imagery.....NAIP, September 2007
 Roads.....National Transportation Dataset, 2004
 Names.....GNIS, 2008



U.S. National Grid
100,000-m Square ID
YP
Grid Zone Designation
15R

Anatomy of a MGRS coordinate

4QGZD only, precision level $6^\circ \times 8^\circ$ (in most cases)

4QFJGZD and 100 km SQ_ID, precision level 100 km

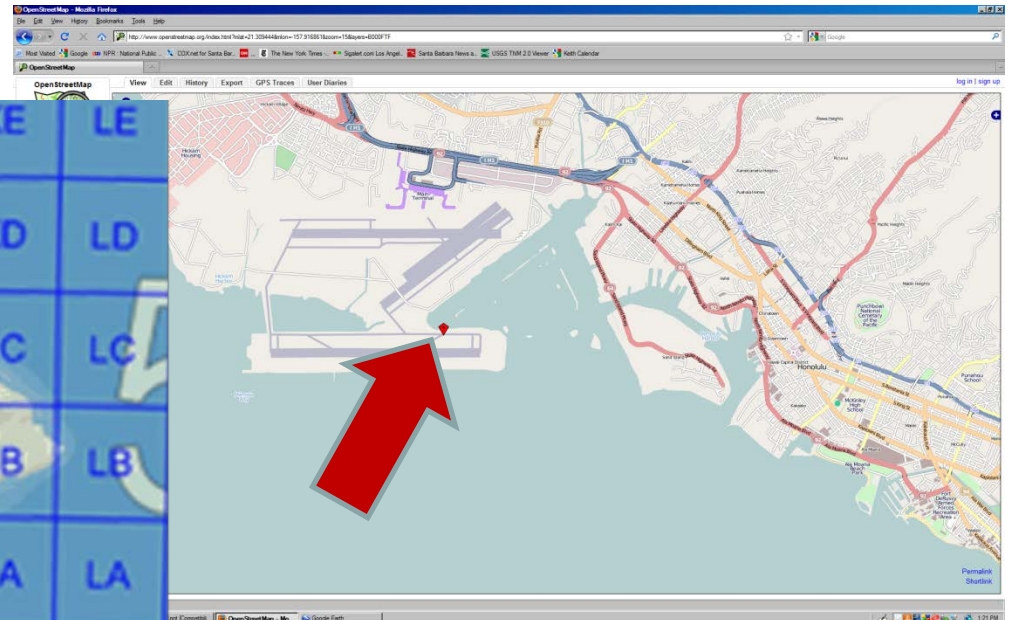
4QFJ16precision level 10 km

4QFJ1267precision level 1 km

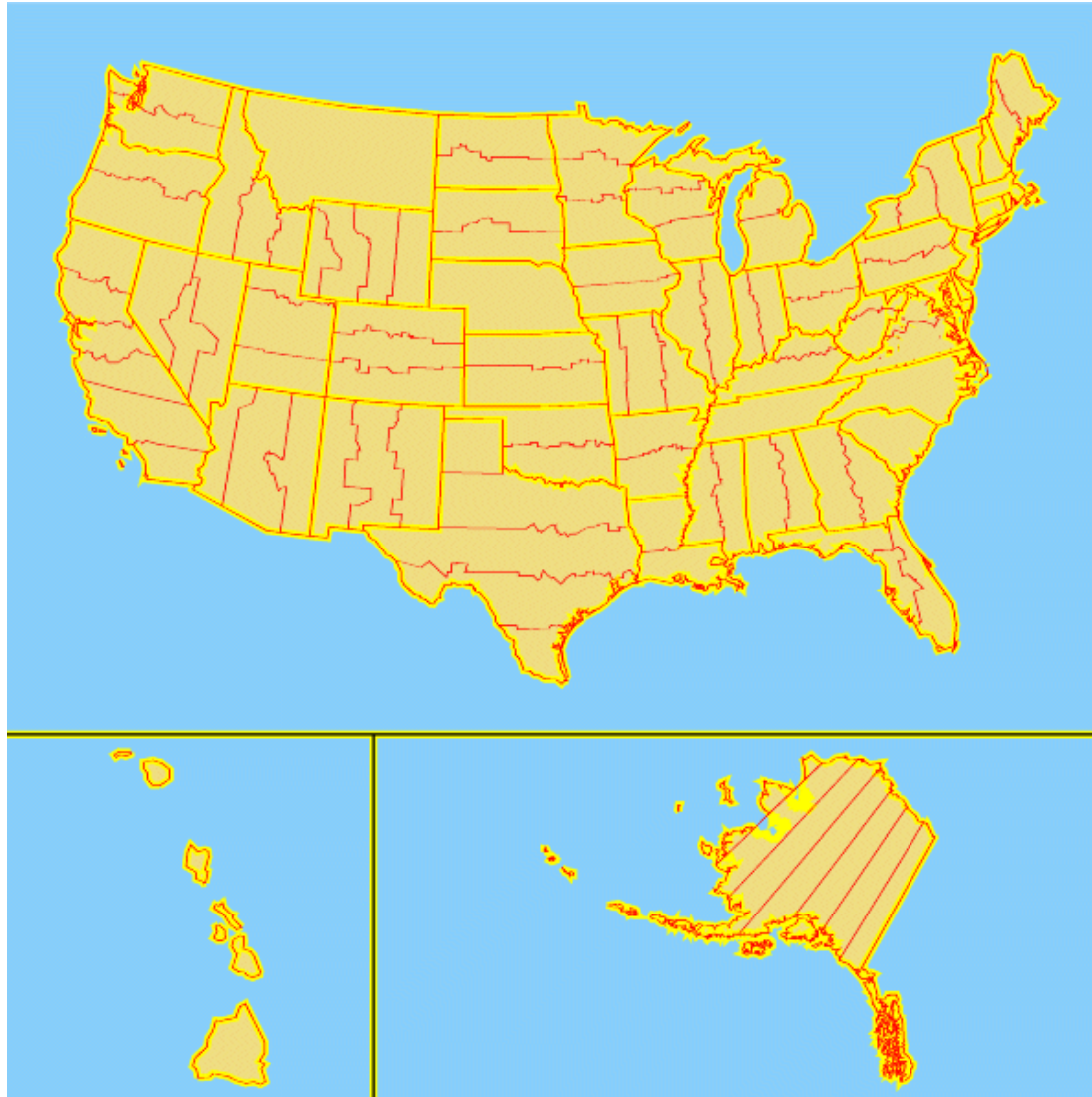
4QFJ123678precision level 100 m

4QFJ12346789precision level 10 m

4QFJ1234567890precision level 1 m

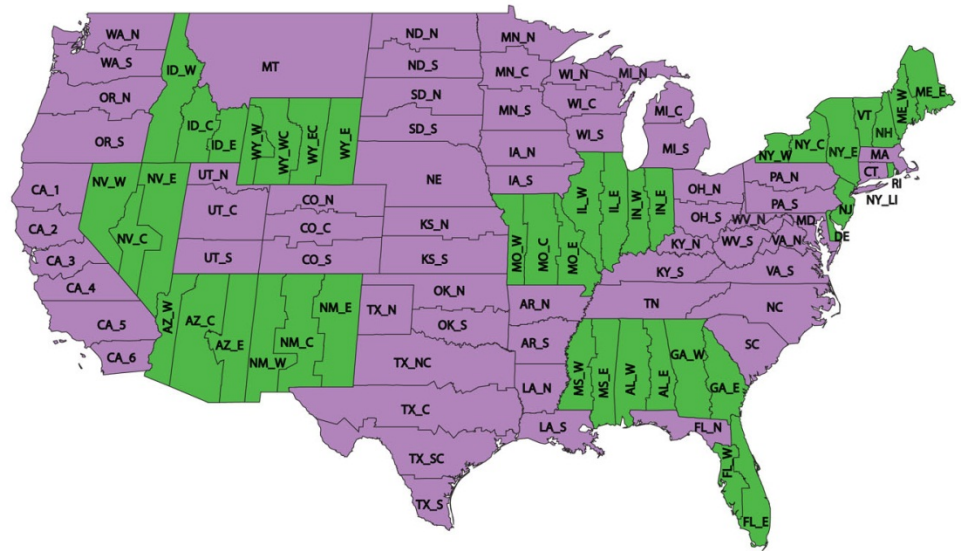
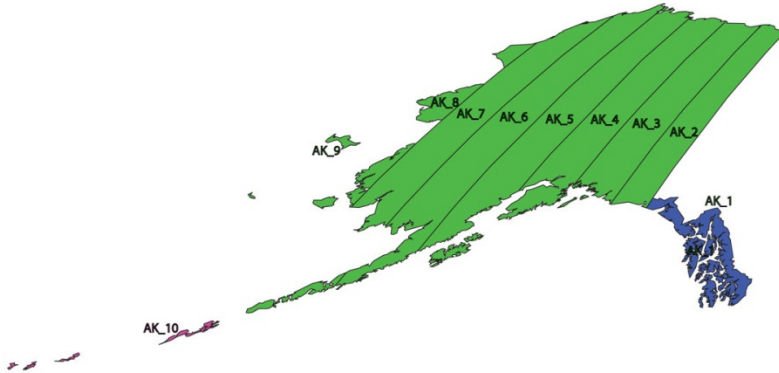


State Plane Coordinates



Zones:

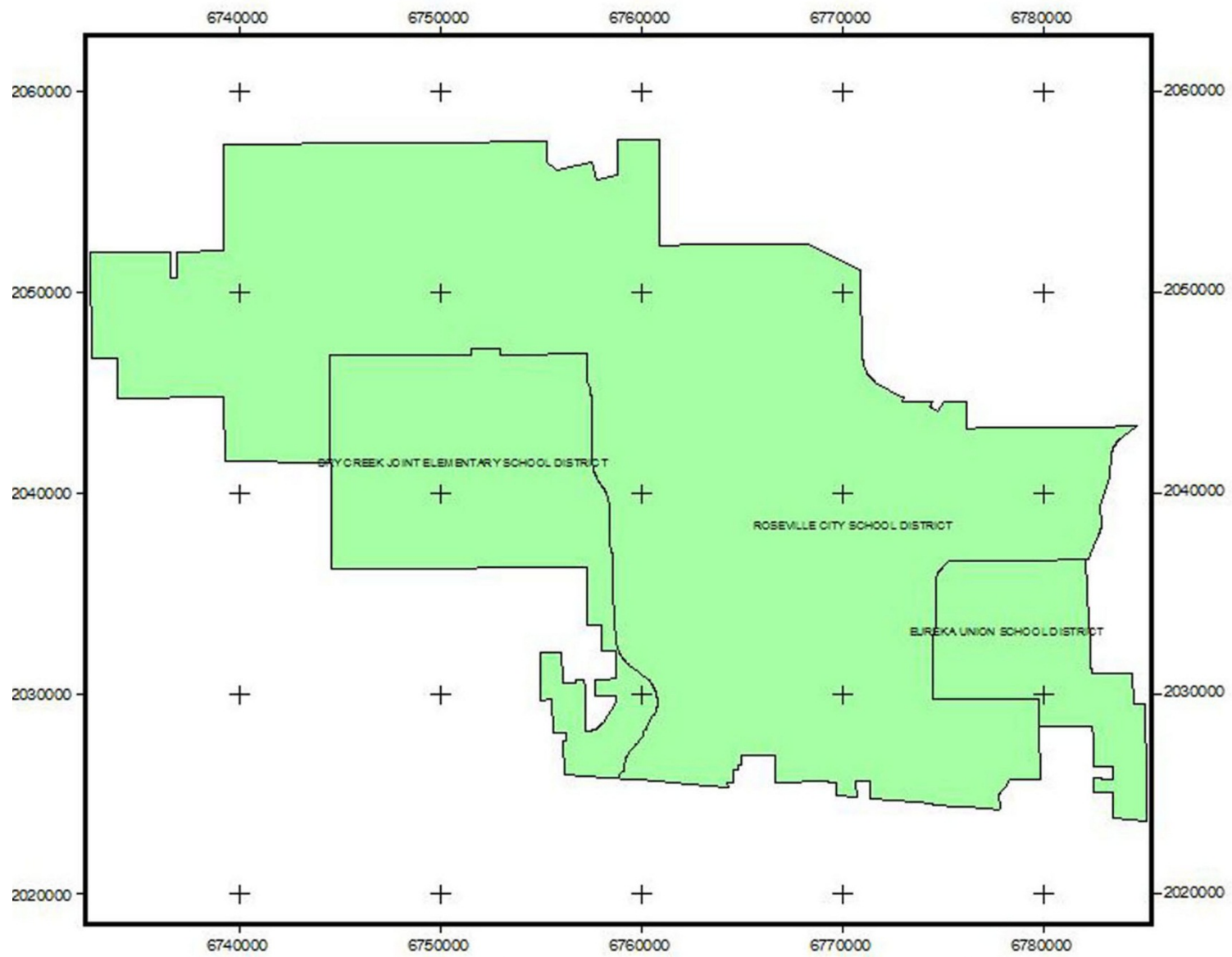
Lambert Conformal Conic vs. Transverse Mercator (Plus one Hotine Oblique Mercator)



HL_3-5



Roseville, CA School Districts



State Plane Coordinates in meters California Zone 2

Measurement: Just use GPS






6 decimal places
 $0.000001^\circ \times 111111\text{m}$
 $=0.11\text{m}$

Converting

Firefox

NGS GEODETIC TO SPC

 **GEODETIC to SPC**  

This page is maintained by [NGS Software Requests](#) updated:06/06/11.12:12:47

This utility uses NGS program [SPCS83](#) or program [GPPCGP](#) to convert NAD83 or NAD27 Geodetic Positions to State Plane Coordinates (SPC)

This utility supports Internet Explorer versions 6.0+ and Netscape versions 6.0+.

NAD83 (SPCS83)
 NAD27 (GPPCGP)

LATITUDE = example = N385930.99999
LONGITUDE = example = W0985930.99999
ZONE = Leave ZONE blank if you want the program to determine it.

[NOS Home](#) | [Contact Info](#) | [Privacy Policy](#) | [Disclaimer](#) | [Document Viewers](#)

Web site owner: [National Geodetic Survey \(NGS\)](#),
[National Oceanic & Atmospheric Administration \(NOAA\)](#)

www.earthpoint.us

The screenshot shows a Mozilla Firefox browser window with the address bar displaying <http://www.earthpoint.us/Convert.aspx>. The page title is "Convert Coordinates - Earth Point". The main heading is "Earth Point" with the tagline "Tools for Google Earth". A navigation menu on the left includes links for Home, Sign In / Buy Subscription, Boise Real Estate Listings, County Records, Utilities, and Other. The main content area is titled "Convert Coordinates - Calculate a position in a variety of formats." and contains a text box stating "A user account is not needed for the features on this web page." Below this, there are instructions and a "Calc" button. A "Position:" input field is also present. A table at the bottom provides a detailed description of various coordinate formats.

Earth Point Tools for Google Earth [Sign In / Buy Subscription](#) [Contact](#)

Convert Coordinates - Calculate a position in a variety of formats.

A user account is **not** needed for the features on this web page.

Enter latitude/longitude or position. Click the corresponding "Calc" button. Lat/Lon, UTM, UPS, MGRS, USNG, Georef, and State Plane are supported. WGS84 datum.

NEW: State Plane coordinates for the United States are supported. [Accepted formats...](#)

HINT: If you have many coordinates to convert, try [Batch Convert](#).

Latitude: Longitude:

Free. User account is not needed.

OR

Position:

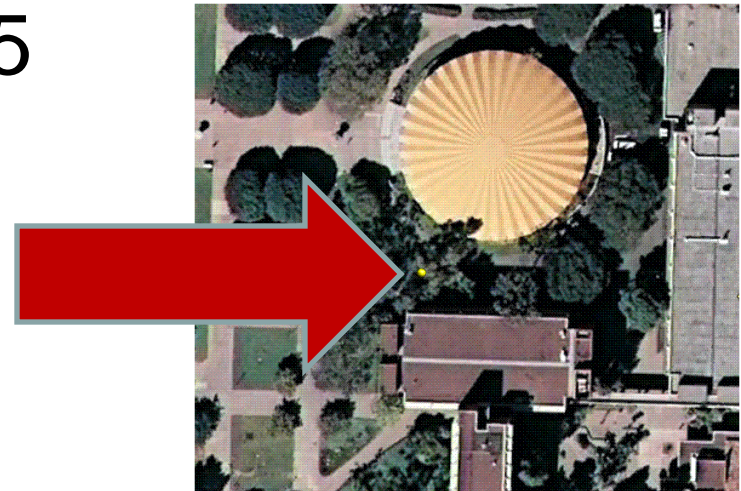
Free. User account is not needed.

This page accepts a wide variety of latitude/longitude and position formats.

Value	Description
Latitude	Latitude of point. Google Earth uses the WGS84 geodetic datum. Valid formats include: N43°38'19.39" 43°38'19.39"N 43 38 19.39 43.63871944444445 If expressed in decimal form, northern latitudes are positive, southern latitudes are negative.
Longitude	Longitude of point. Valid formats include: W116°14'28.86" 116°14'28.86"W -116 14 28.86 -116.2413513485235 If expressed in decimal form, eastern longitudes are positive, western longitudes are negative.
Position	The position of the icon, in a number of formats: Lat/Lon , UTM , UPS , MGRS , MGRS Polar , USNG (identical to MGRS), Georef , and State Plane . Used in place of Latitude and Longitude. The following positions refer to 38° 57' 33.804" N, 95° 15' 55.739" W which is

Coordinate examples

- 238,479 mE; 3,811,950 mN; 11, N
- 11SKU3847911950
- 11SKU3847911950 NAD83
- N 34°24'57.24" W 119°50'42.9"
- 603153 1830382 CA 5



Code Libraries

- Matthew's Map Projection Software
<http://www.users.globalnet.co.uk/~arcus/mps/>
- PROJ.4 <https://trac.osgeo.org/proj/>
- GEOTRANS <http://earth-info.nga.mil/GandG/geotrans/>
- Java Map projection Library
<http://javamapprojlib.sourceforge.net/>

Sarah E. Battersby, Daniel “daan” Strebe & Michael P. Finn (2016) Shapes on a plane: evaluating the impact of projection distortion on spatial binning, *Cartography and Geographic Information Science*, <http://dx.doi.org/10.1080/15230406.2016.1180263>

- Issue: Much social data is “binned” by lat/long grid cells, not taking into account projection distortion
- Suggest ways that cells can be equalized: using hexagons and binning by equal areas

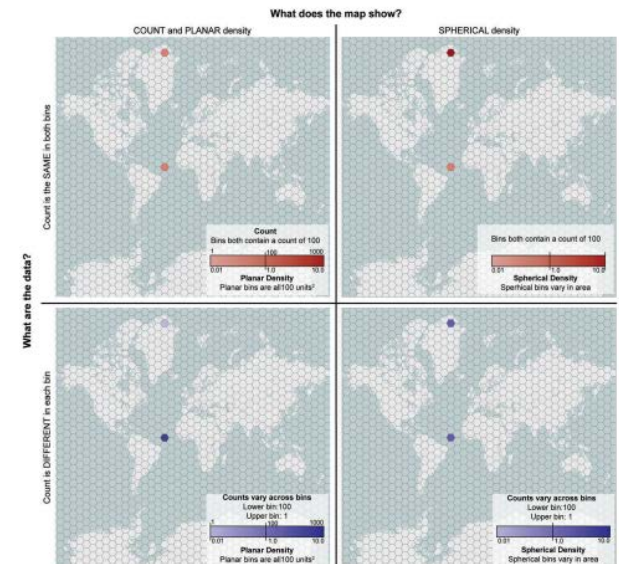


Figure 1. Regular spatial bins on a nonequal area projection (Web Mercator in this example) present challenges for users to appropriately estimate both quantity and density in the same visualization. If the reader assumes that the spatial bins represent the same area, the assumed density values will also be equivalent for both locations (left column). However, if spherical area is (more appropriately) used to calculate density, as seen in the right column, it is apparent that the density is different.

Fits distortion analysis tradition

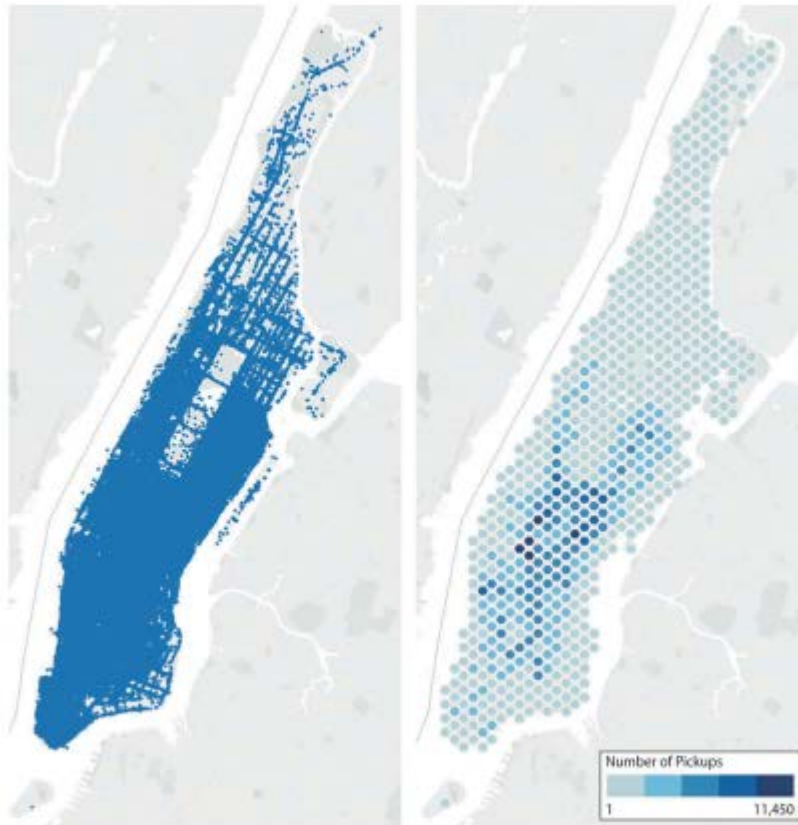


Figure 3. Taxi cab pickup locations in Manhattan as raw point locations (left) and as counts after being binned into a hexagonal grid (data from Andres Monroy – <http://www.andresmh.com/nyctaxitrips/>).

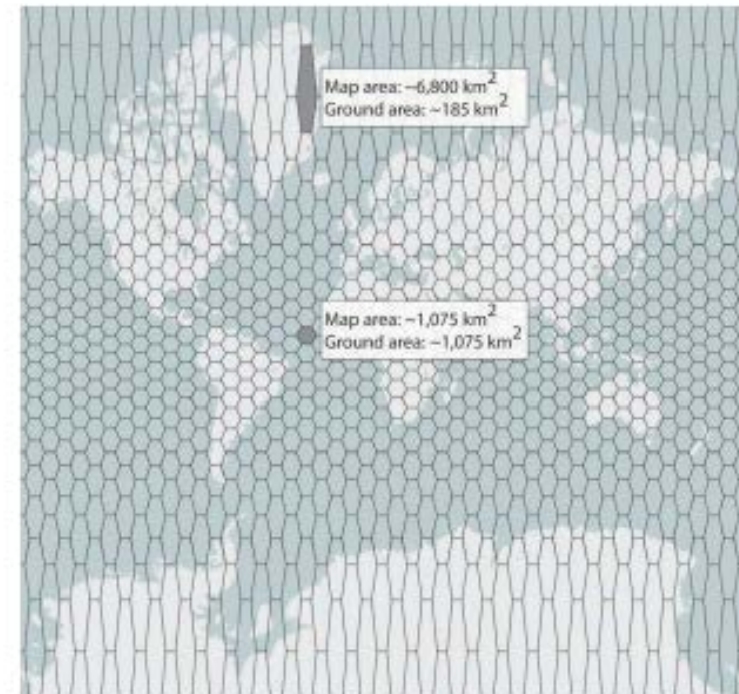


Figure 6. Hexagonal bins defined as 10° side on a plate carrée projection, and projected onto a Web Mercator base map. Measurements listed provide relative map area and ground area.

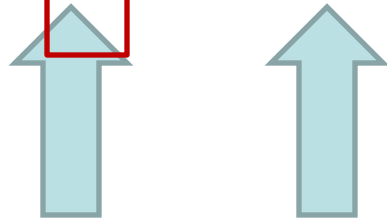
Degree of digit variation in a line

- 4QFJ12345 67890
- 4QFJ12347 67897
- 4QFJ12349 67899
- 4QFJ12352 67903
- 4QFJ12355 67907
- 4QFJ12356 67910

Red values do not change
Green values are 2 of 10
possible values
Blue digits are 2 of 10
possible values
Purple digits are 5 of 10
possible values

Suspicious

- 4QFJ12345 67890
- 4QFJ12340 67897
- 4QFJ12340 67899
- 4QFJ12355 67903
- 4QFJ12355 67907
- 4QFJ12360 67910



Always 0 or 5, rounded?

But only in the Easting

Information content

- For any digit n at any one significant digit location out of N possible digit values or states (10 for decimal), I is defined, where:

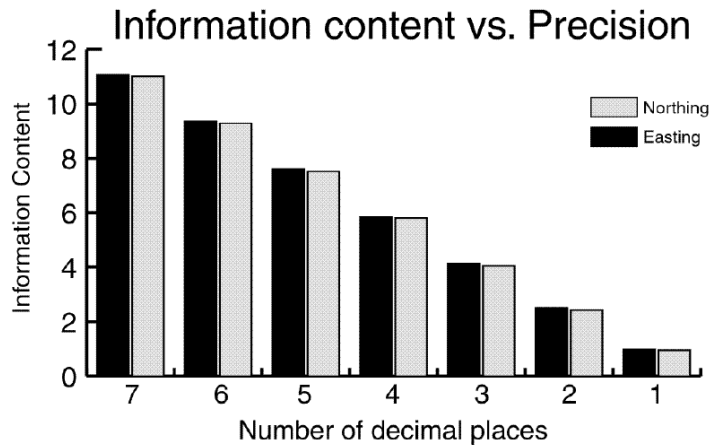
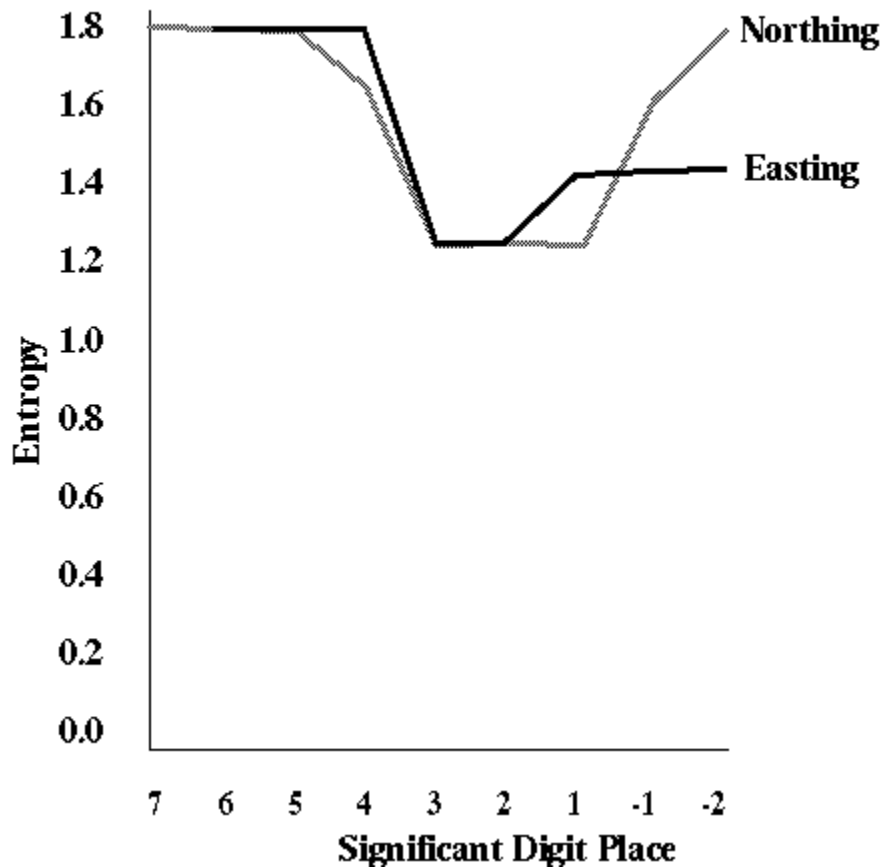
$$I_n = \sum_1^N \left| \frac{D}{\sum D_n} - \frac{1}{N} \right|$$

First digit of the coordinates are all “4” so nine digits would have no occurrence ($0.0 - 0.1 \times 9 = -0.9$) and one digit would occur alone ($1.0 - 0.1 = 0.9$), which sums to 1.8.

If all values are equally represented, $I = 0.0$

The Coordinate Digit Density Function

Coordinate Digit Density Function: Long Island Coastline



Summary

- Geographic Reference System allows positions to be described
- Geographic coordinates are not planar
- Euclidean coordinates need a plane, and orthogonal axes
- Many standard coordinate systems are in use e.g. State Plane, UTM, MGRS, National Grid
- We can compute information content for sets of coordinates
- Coordinate digits can be redundant to random
- To merge and overlap maps, they must be in the same map projection, datum and coordinate system