The Oregon Coordinate Reference System (OCRS)

OGUG Workshop (March 15, 2017)

NOAA's, National Geodetic Survey

www.geodesy.noaa.gov

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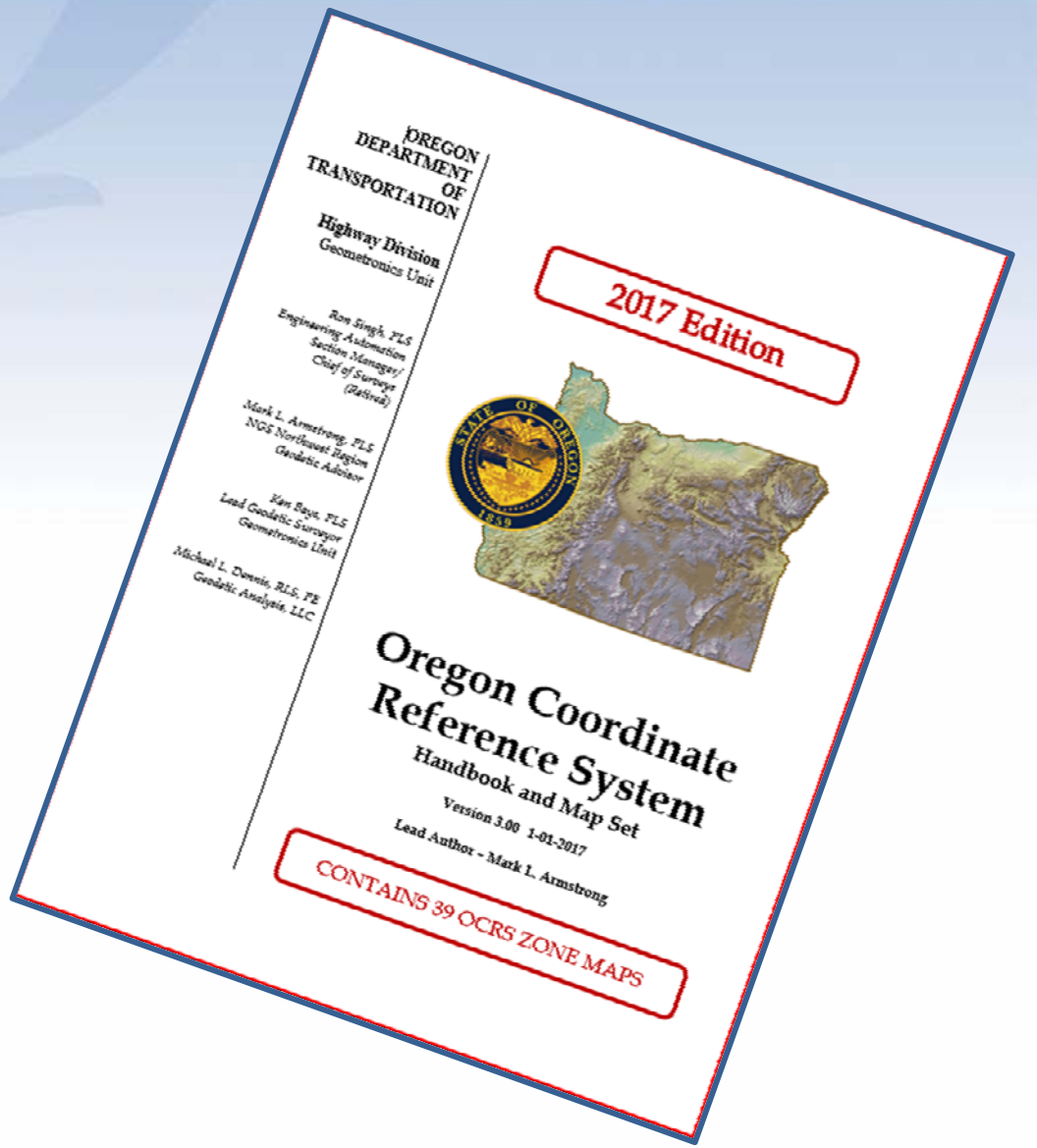
Some slide contributions by Michael Dennis

- **"OCRS Handbook and User Guide" current new version 3.01**

- Download from the OCRS webpage on the ODOT Geometronics webpage

- 39 zone maps with full State coverage

- Recommended zone for each community



ftp://ftp.odot.state.or.us/ORGN/Documents/ocrs_handbook_user_guide.pdf

What is the Oregon Coordinate Reference System (OCRS)?

- The Oregon Coordinate Reference System
  - 39 low distortion map projection zones
  - cover the entire State of Oregon.

- The 39 OCRS zones and the two OR SPCS map projection zones collectively officially make up the Oregon Coordinate System.

Quick walk-thru the OCRS Handbook

Chapter 1: History and Development of the OCRS

Chapter 2: Coordinate System Geodesy

Chapter 3: OCRS Map Projection Zones

Chapter 4: Using the OCRS in Software Programs

Chapter 5: Testing Ground vs. Grid Distances in an OCRS Zone

Chapter 6: The OCRS and the OR Real-time GNSS Network (ORGN)

Chapter 7: Legislative Adoption and Registration with the NGS

Appendix A: OCRS Zone Maps with Recommended Communities

Thanks to all those that contributed to the handbook over the last 8 years!

Chapter 1: Brief history of the OCRS and Oregon's adoption of low distortion map projections

1. 2008 - ODOT led the way – held a ODOT/OGUG LDP workshop which included 3 NGS speakers (Zilkoski, Ellingson, Minkel)
2. 2009 - ODOT made a presentation to PLSO to promote designing LDP's
3. 2009 - ODOT created a Technical Dev. Team made up of a cross section of the surveying and GIS community to design LDP's
4. 2010 - Team developed the first 15 projections focusing on the State Hwy System
5. 2010 - "OCRS Handbook and User Guide" released
6. 2010 - ODOT led roll out workshop to present the LDP's
7. 2011 - Team developed 7 more LDP zones – total 20
8. 2011 - OCRS Legislated – Bill signed by Governor
9. 2011 - OAR rules created so new OCRS Committee could make legal additions, NSRS adoption etc.
10. 2015 - Team added 7 more zones in eastern Oregon at the request of Surveyors.
11. 2016 - Team added 11 more zones to cover mountain passes and other gaps. Total 39 zones cover entire State. The OAR committee will review/approve.

Changes to the OCRS require OAR Committee approval

DIVISION 5
OREGON COORDINATE SYSTEMS

734-005-0005 Purpose
734-005-0010 Oregon Coordinate Systems
734-005-0015 Coordinate System Parameters

The **Oregon Coordinate Reference System** consists of multiple zones developed by an Oregon Department of Transportation committee of private and public land surveying, geographic information system, and academic professionals to define a system of low distortion mapping projections wherein distances computed between points on the grid plane will represent the distances measured between the same points on the ground within published zone tolerances.
Stat. Auth.: ORS 184.616, 184.619, Ch.179 OL 2011
Stats. Implemented: ORS 209.130, 209.155, 209.250, 390.770, Ch.179 OL 2011
Hist. : HWD 13-2011, f. 12-22-11, cert. ef. 1-1-12

Chapter 2: Coordinate System Geodesy

A short discussion on the parts of a 3D coordinate System

Lets start with datums / reference Frames and their realizations; 1. WGS 84(G1762) – The GPS global frame

- What our measurements are in when we use GPS
- Purposely aligned with ITRF08/IGS08(2005) but consistent with ITRF14/IGS14(2010) for the time being…

Over time expect:

- **Antenna models to be updated**
- **The NGS OPUS suite of products etc.**
- **Perhaps a new realization of WGS84(Gxxxx) more perfectly aligned with IGS14(2010)?**

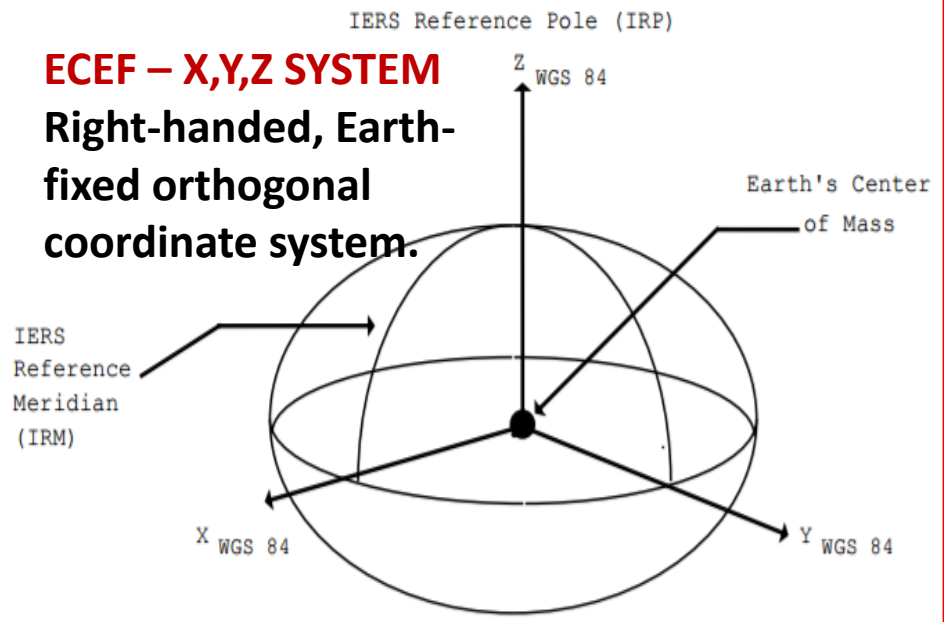


Figure 2.1 The WGS 84 Coordinate System Definition

Realizations of WGS84

Table 2.1 WGS 84 Station Coordinate Updates

Name	Implementation date		Epoch	Accuracy
	GPS Broadcast Orbits	NGA Precise Ephemeris		
WGS 84	1987	1 Jan 1987		1-2 meters
WGS 84 (G730)	29 Jun 1994	2 Jan 1994	1994.0	10 cm/component rms
WGS 84 (G873)	29 Jan 1997	29 Sep 1996	1997.0	5 cm/component rms
WGS 84 (G1150)	20 Jan 2002	20 Jan 2002	2001.0	1cm/component rms
WGS 84 (G1674)	8 Feb 2012	7 May 2012	2005.0	<1cm/component rms
WGS 84 (G1762)	16 Oct 2013	16 Oct 2013	2005.0	<1cm/component rms

WGS 84 follows the ITRF!

The Geometric Frame

- **NGS computes all 3D coordinates (LLh) in the current NSRS global frame – IGS08(2005).**
  - …then outputs the current NSRS North American Datum: **NAD 83(2011)2010.00**
  - – This is the way the OPUS works now

Current global frame = ITRF08 / IGS08

New global frame = ITRF14 / IGS14

Future global frame =(?) ITRF20 / IGS20

(there may be others - estimated dates)

A short discussion on the parts of a 3D coordinate System

- The ITRF / IGS solutions do not directly use an ellipsoid.
- ITRF solutions are specified by cartesian ECEF (Earth-Centered, Earth-Fixed) coordinates X, Y, and Z.
- BUT they can be transformed to geographical coordinates (Longitude, Latitude and Height) referred to an ellipsoid.
- BY USING GRS80 ellipsoid - recommended (aligned to the ITRF/IGS frame)

International Terrestrial Reference Frame (ITRF)

Monuments set on the Earth move as time goes by so we must consider time (an epoch) in the reporting of coordinates.

Physical movement between epoch dates

DATE OF MEASUREMENT

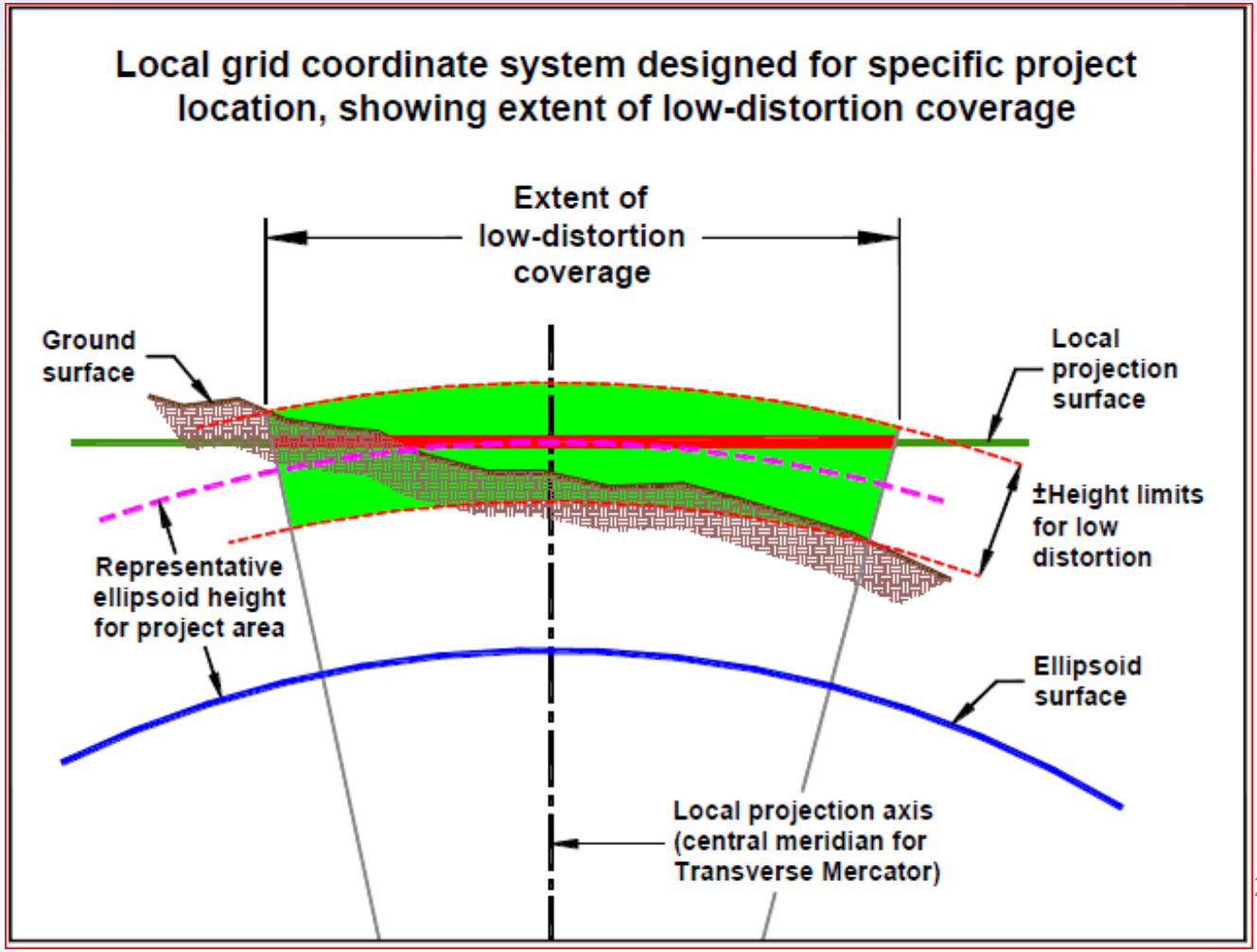
Mark: bbr2

REF FRAME:	**ITRF2008 (2005.0000)**		**IGS08 (2014.6362)**	
X:	-2394865.476 m	0.001 m	-2394865.604 m	0.001 m
Y:	-3887417.456 m	0.001 m	-3887417.434 m	0.001 m
Z:	4441294.789 m	0.001 m	4441294.740 m	0.001 m
LAT:	44 23 59.15177	0.000 m	44 23 59.14953	0.000 m
E LON:	238 21 52.63003	0.000 m	238 21 52.62459	0.000 m
W LON:	121 38 07.36997	0.000 m	121 38 07.37541	0.000 m
EL HGT:	1940.672 m	0.001 m	1940.672 m	0.001 m

INVERSE FAZ = 240 07 46.0633 From North, Ell. Dist. = 0.1388 m

A short discussion on the parts of a 3D coordinate System

- A conformal map projection converts latitude and longitude geodetic coordinates from a curved Earth surface to northings and eastings on a plane for mapping purposes.



LOCAL ASSUMED COORDINATES - Reserve for very special small scale non-GNSS work!

<u>Assumed</u> flat plane coordinates (ie: N10,000, E20,000, 500) are <u>not considered here!</u>

They cannot be geo-referenced or used with the OCRS or State Plane map projections!

Key Things to Remember

- **Grid coordinates from any map projection are Datum/frame dependent, so if you…**
  - change the datum/frame (or realization) understand that the grid N, E, coordinates **WILL** change.
  - Elevations (ortho heights) are dependent on the Hybrid geoid model chosen when using GNSS.
  - Don't mix grid coordinates from different datum even with the same LDP zone.
  - LDP's no different than procedures you've commonly followed when using State Plane zones.

Ellipsoid (h) to Ortho (H) requires geoid model

- Current NSRS Hybrid Geoid Model = GEOID12B
  - Yields NAVD 88 Ortho height (H)
    - H=h-(N) (N = geoid separation)

- Current NSRS Gravimetric Model = USGG12

- NGS annual experimental model = xgeoid16B which will produce ortho heights consistent with the new vertical datum in 2022..

Chapter 3: OCRS Map Projection Zones

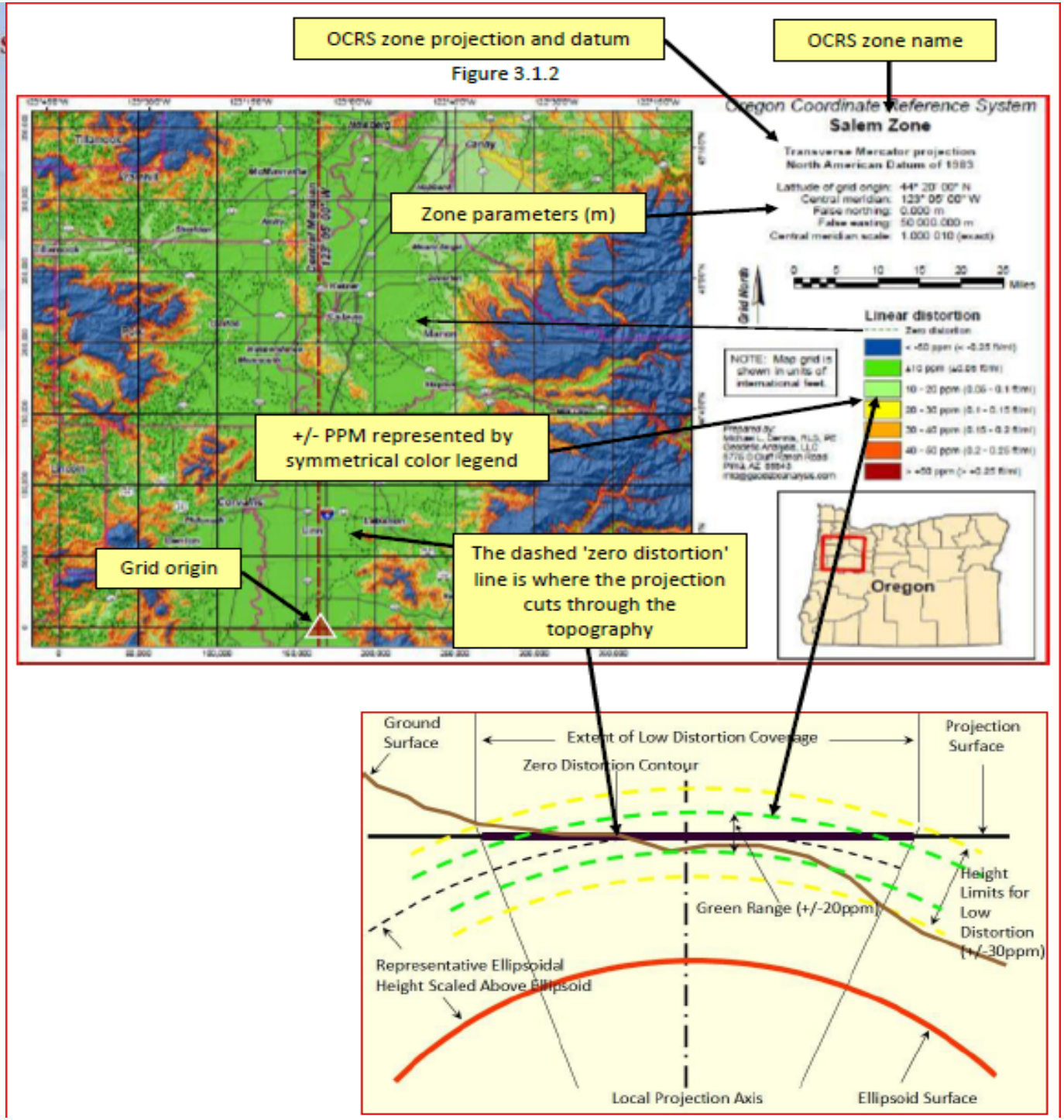
PAGE 23

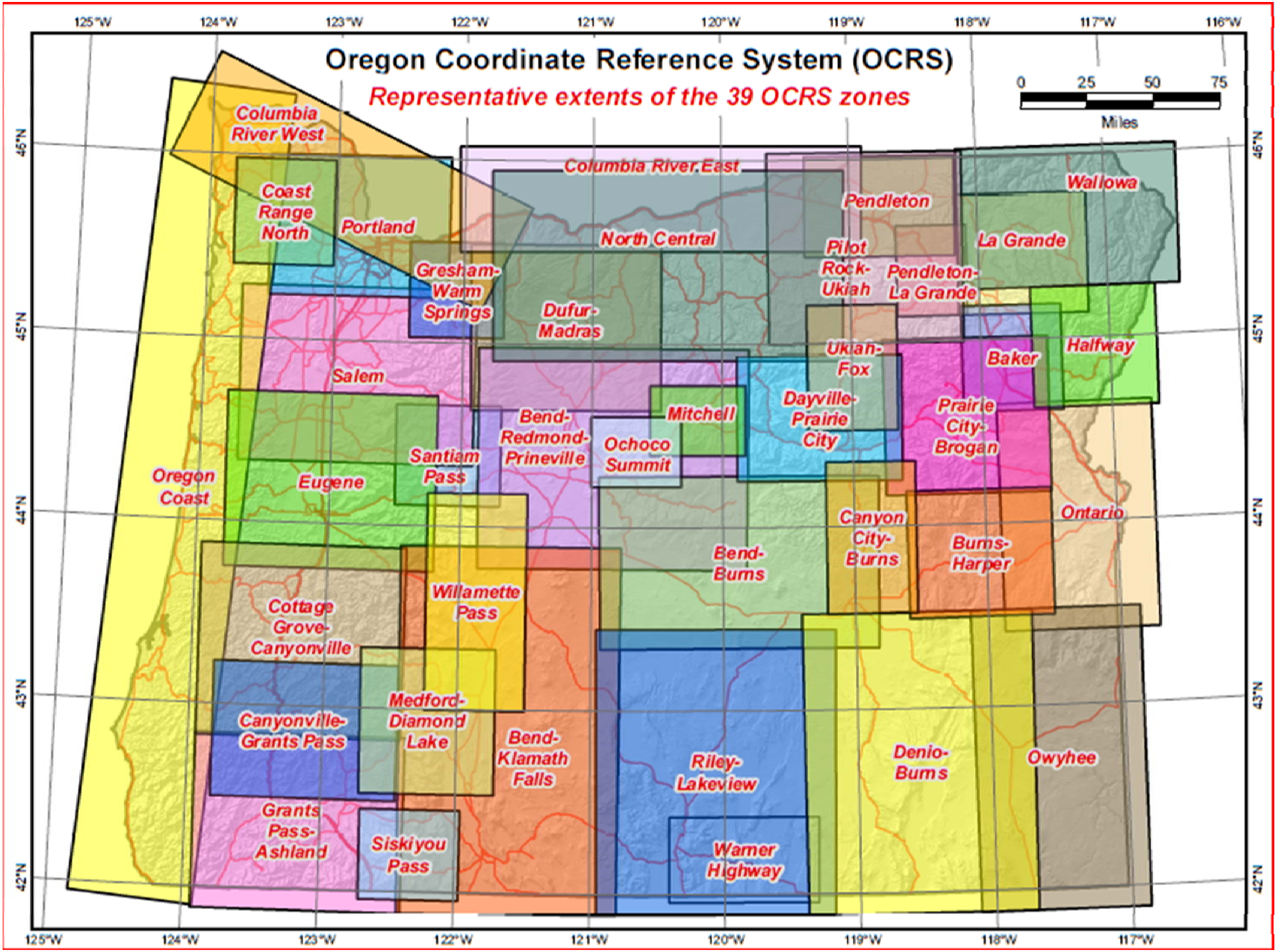
3.1.1 The OCRS zone catalogue

Table 3.1.1

	Zone Name*	Projection	Latitude of Grid Origin	Standard Parallel & Grid Origin	Central Meridian	False Northing (m)	False Easting (m)	Scale (exact)
1	Baker	TM	44°30'00"N		117°50'00"W	0	40 000	1.000 160
2	Bend-Burns	LCC		43°40'00"N	119°45'00"W	60 000	120 000	1.000200
3	Bend-Klamath Falls	TM	41°45'00"N		121°45'00"W	0	80 000	1.000 200
4	Bend-Redmond-Prineville	LCC		44°40'00"N	121°15'00"W	130 000	80 000	1.000 120
5	Burns-Harper	TM	43°30'00"N		117°40'00"W	0	90 000	1.000140
6	Canyon City-Burns	TM	43°30'00"N		119°00'00"W	0	20 000	1.000 220
7	Canyonville-Grants Pass	TM	42°30'00"N		123°20'00"W	0	40 000	1.000 070
8	Coast Range North	LCC		45°35'00"N	123°25'00"W	20 000	30 000	1.000045
9	Columbia River East	LCC		45°40'00"N	120°30'00"W	30 000	150 000	1.000 008
10	Cottage Grove-Canyonville	TM	42°50'00"N		123°20'00"W	0	50 000	1.000 023
11	Dayville-Prarie City	TM	44°15'00"N		119°38'00"W	0	20 000	1.000 120

Map Interpretation




Oregon Coordinate Reference System (OCRS)
Representative extents of the 39 OCRS zones
0 25 50 75
Miles
125°W
124°W
123°W
122°W
121°W
120°W
119°W
118°W
117°W
116°W
46°N
45°N
44°N
43°N
42°N
Columbia River West
Columbia River East
Coast Range North
Portland
Pendleton
Wallowa
North Central
La Grande
Pilot Rock-Ukiah
Pendleton-La Grande
Gresham-Warm Springs
Dufur-Madras
Halfway
Ukiah-Fox
Baker
Salem
Dayville-Prairie City
Prairie City-Brogan
Mitchell
Bend-Redmond-Prineville
Ochoco Summit
Santiam Pass
Oregon Coast
Eugene
Canyon City-Burns
Ontario
Bend-Burns
Burns-Harper
Willamette Pass
Cottage Grove-Canyonville
Medford-Diamond Lake
Canyonville-Grants Pass
Bend-Klamath Falls
Riley-Lakeview
Denio-Burns
Owyhee
Grants Pass-Ashland
Siskiyou Pass
Warner Highway

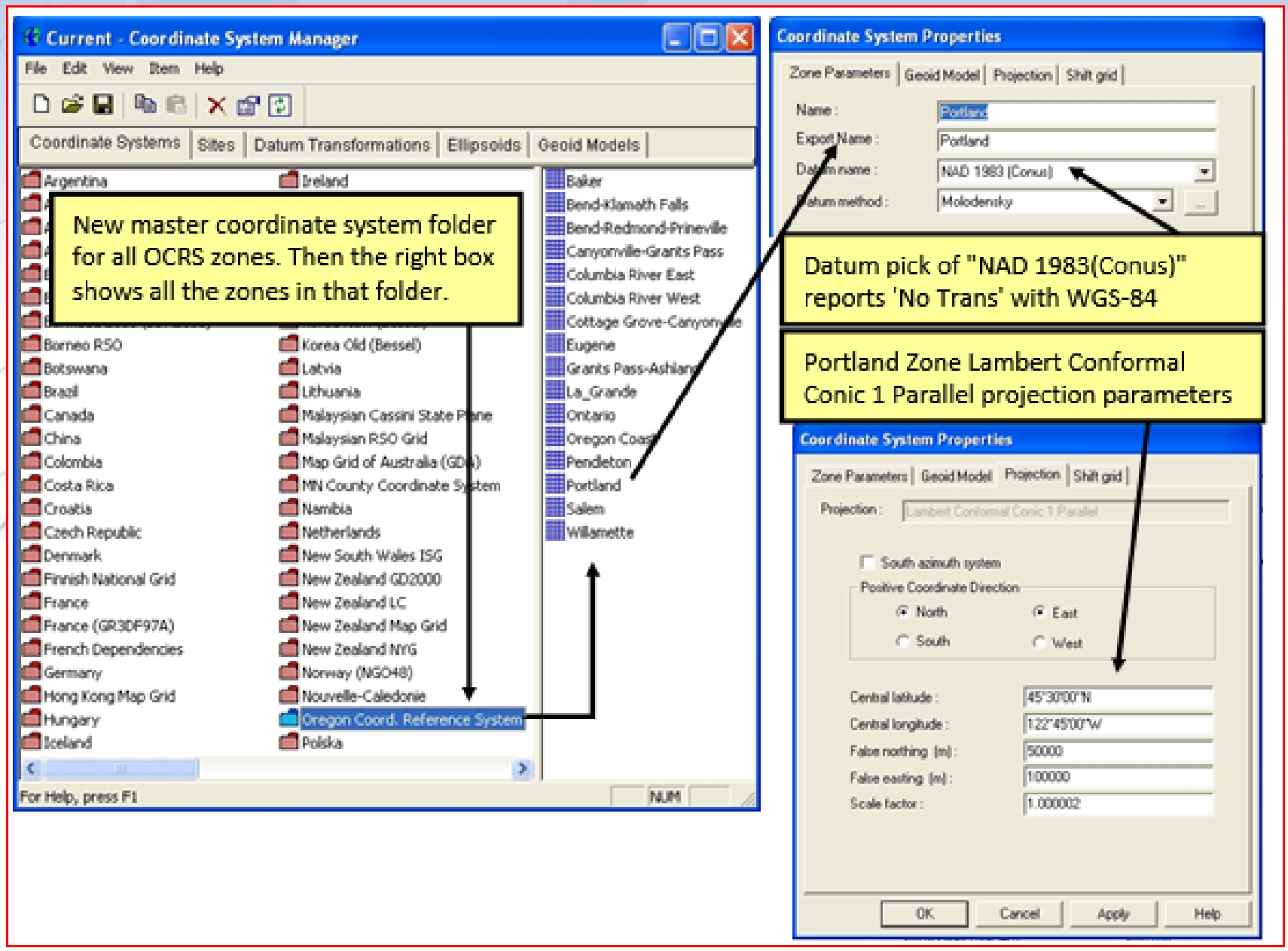
Chapter 4: Using the OCRS in Software

Each piece of software has it's own programmatic path for users to enter the map projection zone parameters. Most our self explanatory as you enter the data.

Some software may already contain some or perhaps all of the OCRS zones?

- EPSG – European Petroleum Survey Group maintains and international Geodetic Parameter Dataset Registry.
  - Software vendors may access this database to streamline projection input into various software.

You can also enter the OCRS zones into your software



How will you know if you got the right answers after entering a zones parameters?

Zone parameter virtual grid coordinate software check

If you have entered the OCRS zone parameters into your vendor's software and successfully created new OCRS coordinate systems, then by entering the input lat/long values from the table below, your grid coordinates should match these results exactly to five decimal places.

Point Name	Latitude (N)	Longitude (W)	Northing (m)	Easting (m)
Bend-Redmond-Prineville1	44 15 35.14513	121 08 52.31624	84783.59542	88157.16577
Bend-Redmond-Prineville2	44 05 37.43097	121 12 11.97934	66327.93549	83738.15165
Bend-Redmond-Prineville3	44 18 20.44566	121 33 21.22192	89927.19462	55588.29029

Picking an OCRS Zone to use in your project

BEND-REDMOND-PRINEVILLE ZONE

Example

Recommended Communities

It is recommended that OCRS users apply this zone when working in the vicinity of the following communities. More than one zone may work well for a community depending on the exact location and elevation of the project.

Parts of south Jefferson County, west Crook County, and Deschutes County encompassing the communities of:

Madras, Metolius, Culver, Terrebonne, Sisters, Redmond, Prineville, Powell Butte, Tumalo, Alfalfa, Bend, Brothers

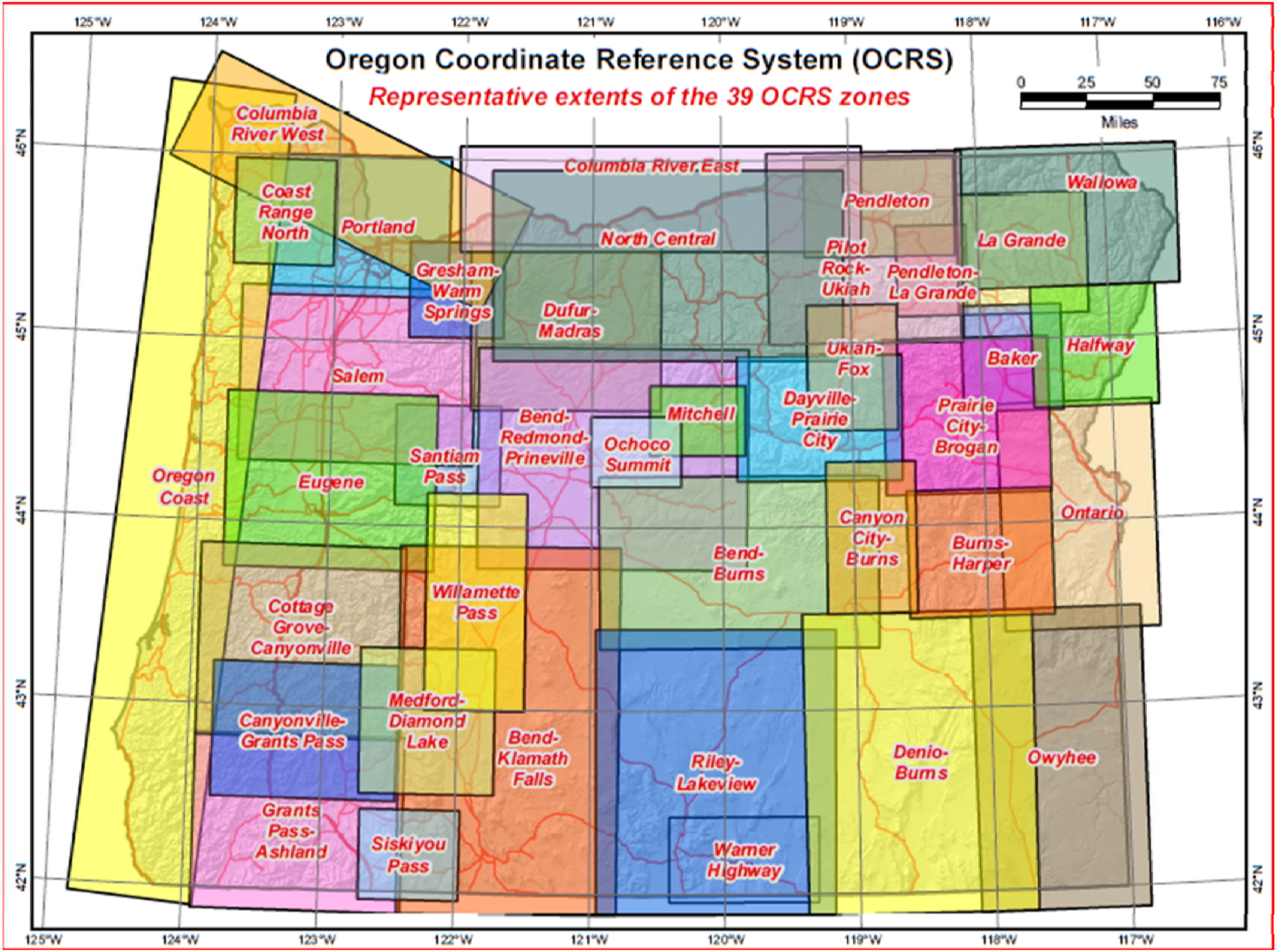
As a Guideline, use the following RULES:

1. Avoid using negative coordinate numbers. (Each zone was optimized with map limits of positive N & E coordinates)

2. Use the recommended zone for the community (city or place) as found in Appendix A.

3. Use the zone your project is in. If your project overlaps two or more zones use the zone with the lowest distortion level that also meets rules #1 & 2.

4. Always document your zone in you survey map metadata or narrative.


Oregon Coordinate Reference System (OCRS)
Representative extents of the 39 OCRS zones
0 25 50 75
Miles
125°W
124°W
123°W
122°W
121°W
120°W
119°W
118°W
117°W
116°W
46°N
45°N
44°N
43°N
42°N
Columbia River West
Columbia River East
Coast Range North
Portland
Pendleton
Wallowa
North Central
La Grande
Pilot Rock-Ukiah
Pendleton-La Grande
Gresham-Warm Springs
Dufur-Madras
Halfway
Ukiah-Fox
Baker
Salem
Dayville-Prairie City
Prairie City-Brogan
Mitchell
Bend-Redmond-Prineville
Ochoco Summit
Santiam Pass
Oregon Coast
Eugene
Canyon City-Burns
Ontario
Bend-Burns
Burns-Harper
Willamette Pass
Cottage Grove-Canyonville
Medford-Diamond Lake
Canyonville-Grants Pass
Bend-Klamath Falls
Riley-Lakeview
Denio-Burns
Owyhee
Grants Pass-Ashland
Siskiyou Pass
Warner Highway

What is a low distortion map projection (LDP)

The term 'low distortion' refers to minimizing both the horizontal distortion from presenting a curved surface on a plane and the vertical distortion as projections are also scaled to a height representative of the regional area covered.

Advantages;

- ✓ LDP grid coordinate distances closely match the same distance measured on the ground.
- ✓ Low overall distortion and reduced convergence angles.
- ✓ Easy to transform between other coordinate zone systems.
- ✓ Maintains a datum/frame relationship to the National Spatial Reference System (NSRS).
- ✓ Survey, engineering, and GIS friendly allows for all work in a community use the same coordinate system.

Linear distortion due to Earth curvature

Typ. OCRS

Zone Width (miles)	Maximum Linear Distortion		
	PPM	Feet/Mile	Ratio
16	+/- 1	+/- 0.005	1:1,000,000
50	+/- 10	+/- 0.05	1:100,000
71	+/- 20	+/- 0.1	1:50,000
112	+/- 50	+/- 0.3	1:20,000
158	+/- 100	+/- 0.5	1:10,000
317	+/- 400	+/- 2.1	1:2,500

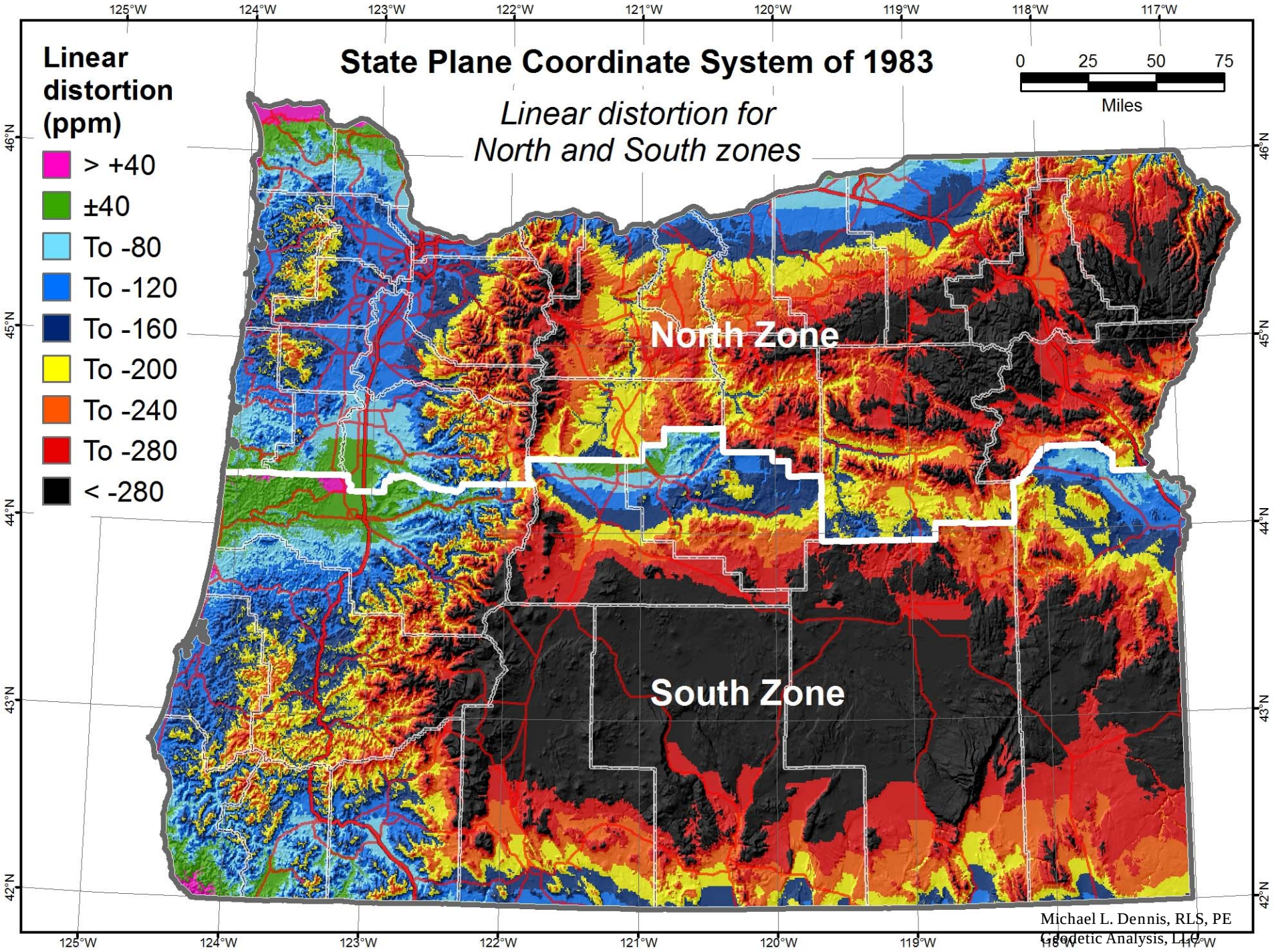
Distortion due to height above ellipsoid

Height (ft) (above ellipsoid)	Maximum Linear Distortion		
	PPM	Feet/Mile	Ratio
100	4.8	0.03	1:209,000
400	19	0.1	1:52,000
1,000	48	0.25	1:21,000
2,000	96	0.5	1:10,500
4,000	191	1	1:5,200
7,000	335	1.8	1:3,000

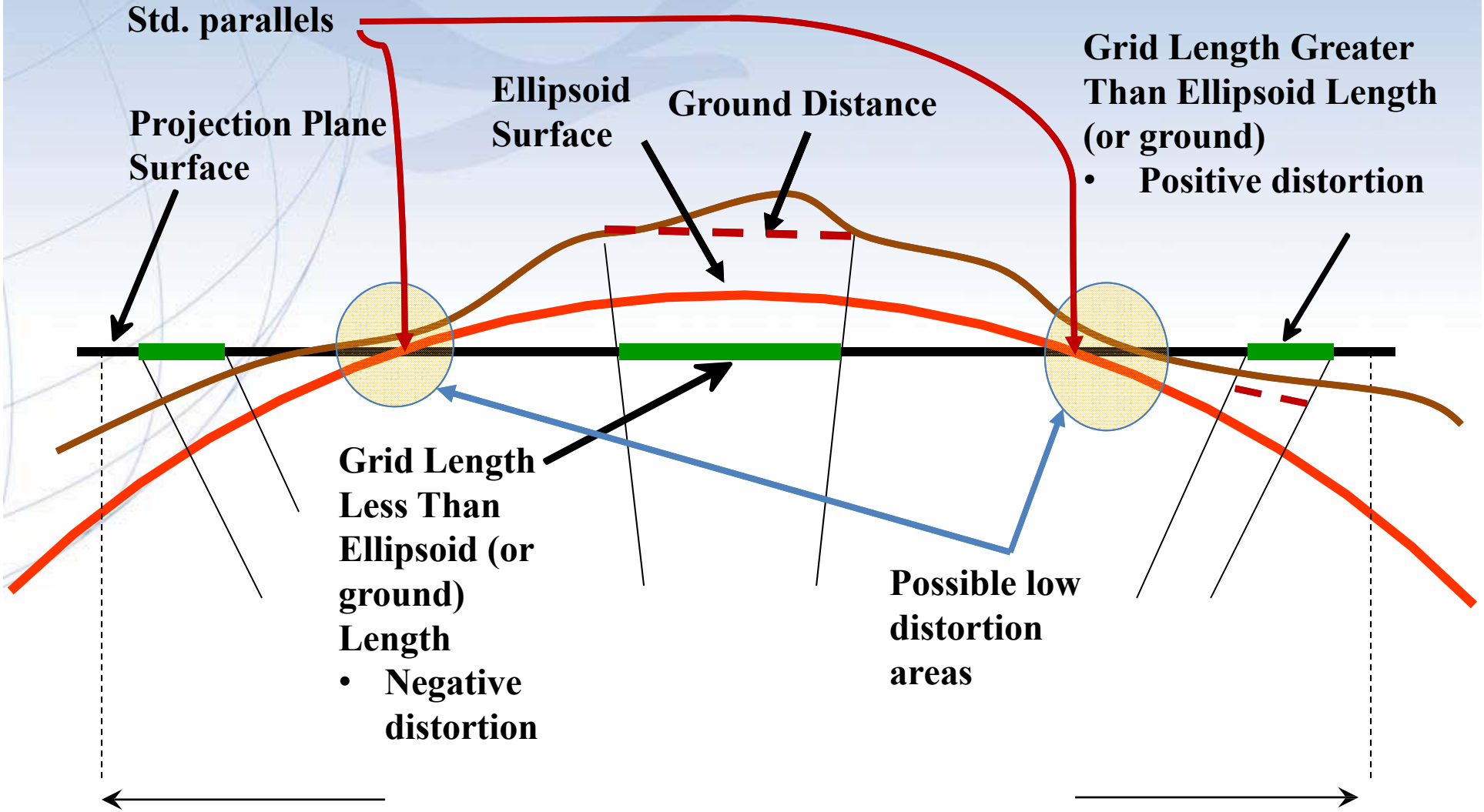
Good rule of thumb

NGS policy on changes to plane coordinate systems

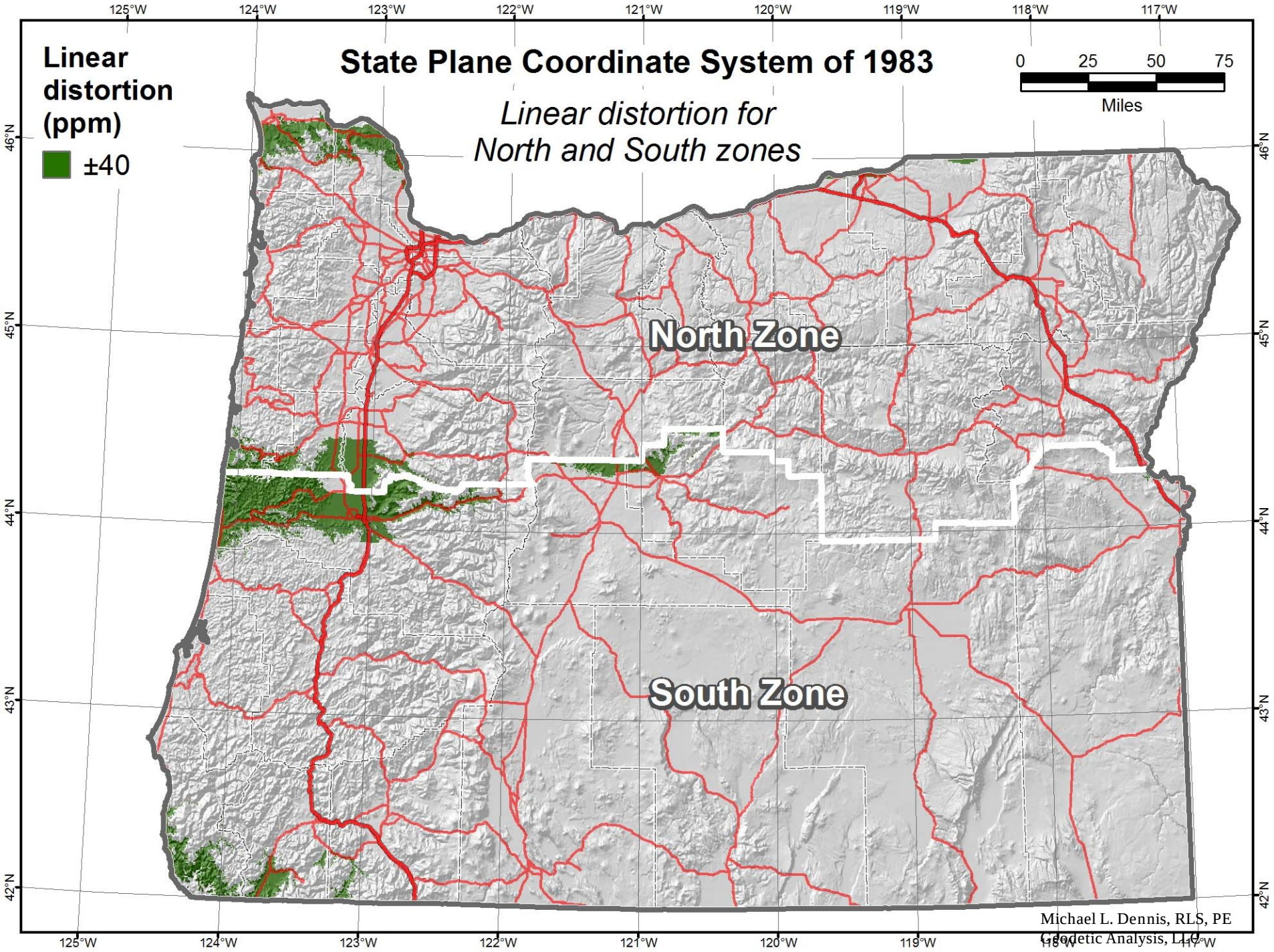
- 1. All requests for changes must be submitted in writing to the Director, NGS, and must be co-signed by those State agencies and organizations most involved in the use, collection, and distribution of spatial data including, but not limited to, the State Department of Transportation, State Office of GIS, and state land surveyor professional organizations. Hereafter these groups are referred to as the "State." Required agencies and organizations will be determined by NGS on a state-by-state basis. A similar request must also be submitted to the U.S. Geological Survey (USGS) to ensure integrity of NSRS with USGS national mapping products and services.
- 2.All new SPC zones or supplemental projections shall use the two basic map projections, the Lambert Conformal Conic or the Mercator (transverse or oblique), defined at the surface of the ellipsoid of the current Datum (Geodetic Reference System 1980 - GRS 80).
- 3.All changes must be adopted by State Law (or State Regulation when such Regulation is regulated by public notices and hearings and no opposition exist). Such Law must include a complete description of the revised SPCS zones and geometric parameters. A specified conversion factor between meters and feet (U.S. Survey or International) is strongly recommended to be included in the legislation. NGS will publish coordinates only in those legislated units.
- 4.Zones will continue to be defined by International, State and county boundaries, and by the counties contained therein. (See Federal Register Notice "Policy on Publication of Plane Coordinates," Vol. 42, Nol. 57, pages 15943-15944, published March 24, 1977.)
- 5. SPCS changes will ensure that the resulting coordinate differences are sufficiently large (by at least 10,000 meters) to ensure that no confusion will exist with the current NAD 83 coordinate values.
- **http://geodesy.noaa.gov/INFO/Policy/files/082012_State_Plane_Coordinate_Policy.pdf**
- 7.Should NGS estimate significant expenses resulting from changes to the existing SPCS, NGS may require State reimbursement. These costs would be for coordinate conversion, data base extraction and publication software required to support computation, publication and distribution of new coordinate values as part of NSRS.
- 8.To facilitate public awareness, the State shall develop an education program that includes an article detailing the rationale for the development of the changes, the process of review and examination of the issues, the final design criteria, and a workshop or seminar to be presented at a State-wide surveying and mapping conference . The article shall be submitted for publication in one or more surveying and mapping periodicals (e.g., American Congress on Surveying and Mapping Bulletin, Professional Surveyor, or P.O.B. magazines). In addition, this article will be made available on the web sites of the sponsoring agencies defined as the "State." Any requests for technical support from NGS requiring travel expenses for NGS personnel shall be reimbursed by the State.


State Plane Coordinate System of 1983
Linear distortion for
North and South zones
Linear distortion (ppm)
> +40
±40
To -80
To -120
To -160
To -200
To -240
To -280
< -280
0 25 50 75
Miles
North Zone
South Zone
125°W
124°W
123°W
122°W
121°W
120°W
119°W
118°W
117°W
46°N
45°N
44°N
43°N
42°N
Michael L. Dennis, RLS, PE
Geodetic Analysis, LLC

A View of Linear Distortion



Maximum Projection Zone Width For Balanced Positive and Negative Distortion


State Plane Coordinate System of 1983
Linear distortion for North and South zones
Linear distortion (ppm)
±40
0 25 50 75
Miles
North Zone
South Zone
125°W
124°W
123°W
122°W
121°W
120°W
119°W
118°W
117°W
46°N
45°N
44°N
43°N
42°N
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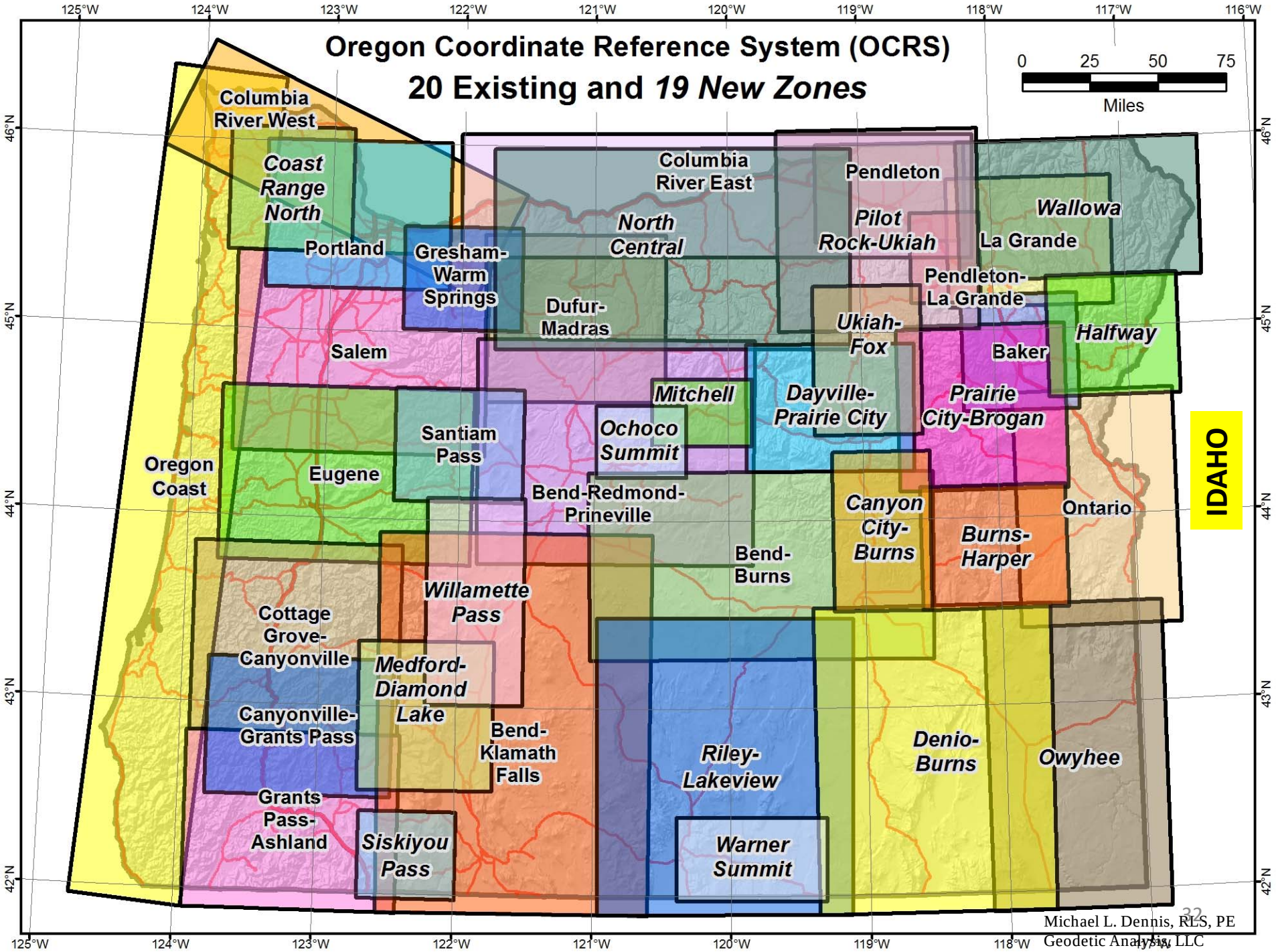

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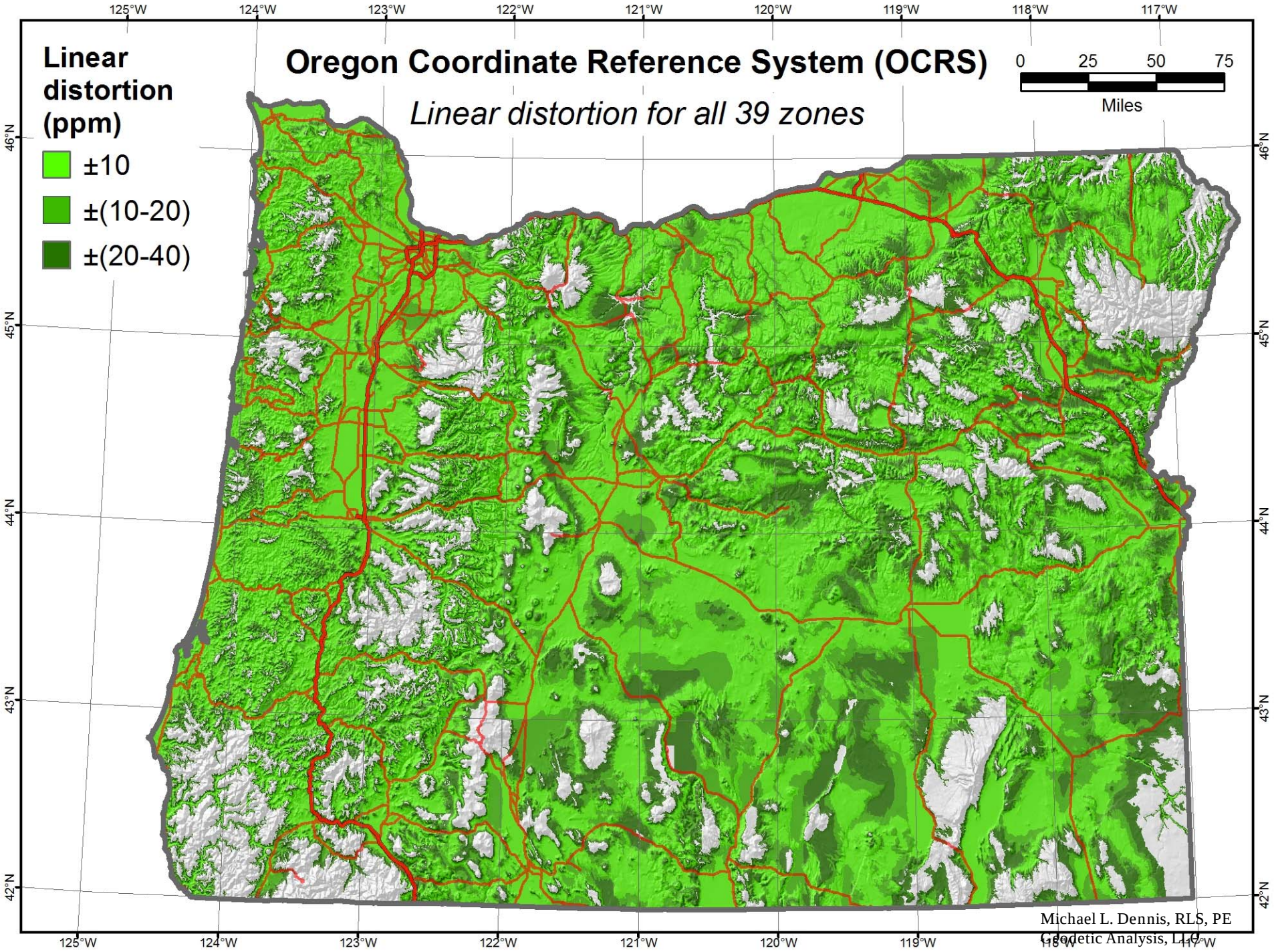
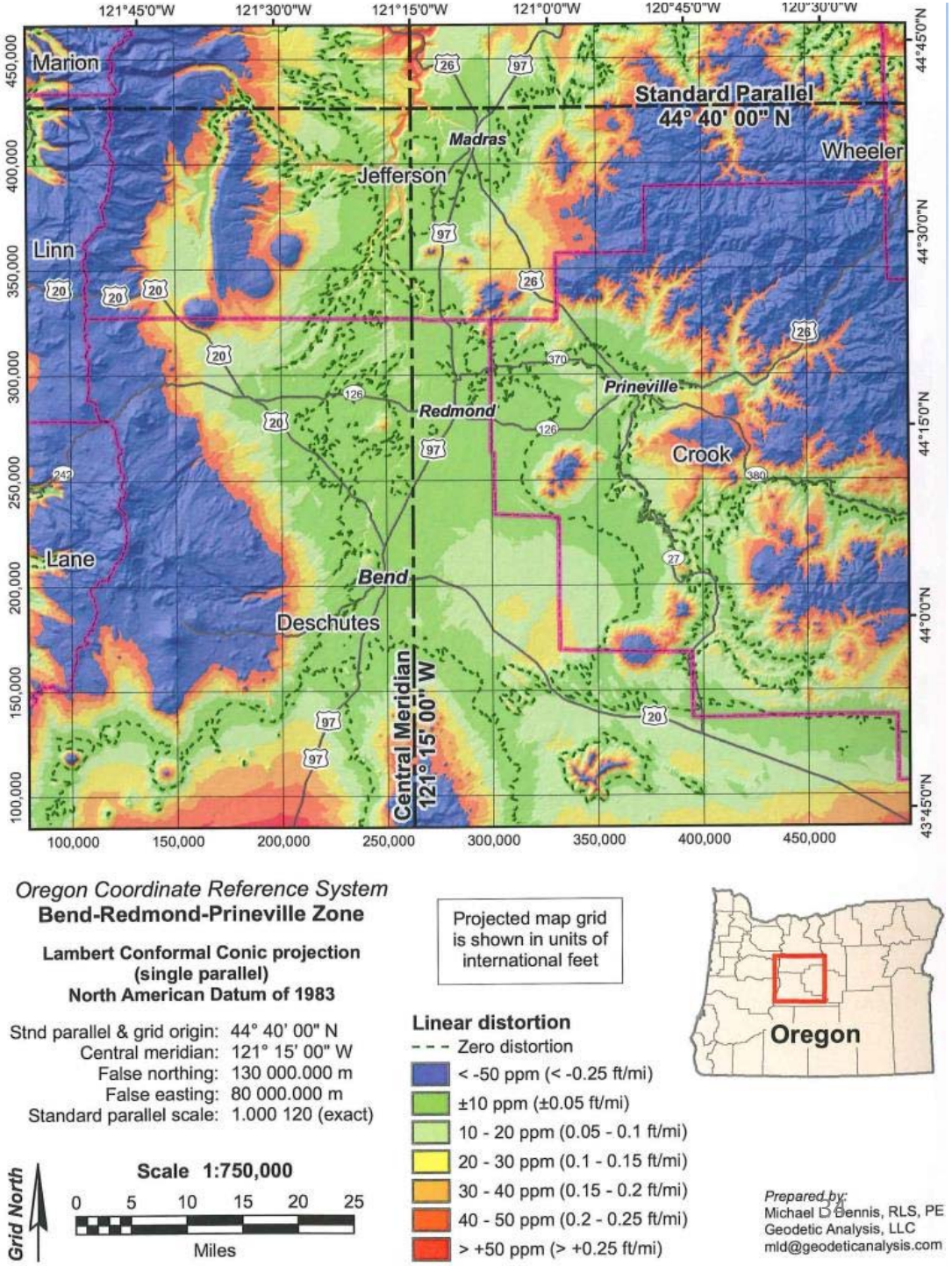

Oregon Coordinate Reference System (OCRS)
Linear distortion for all 39 zones
Linear distortion (ppm)
±10
±(10-20)
±(20-40)
0 25 50 75
Miles
125°W
124°W
123°W
122°W
121°W
120°W
119°W
118°W
117°W
46°N
45°N
44°N
43°N
42°N
Michael L. Dennis, RLS, PE
Geodetic Analysis, LLC

OREGON LDP COVERAGE

- 39 ZONES – Cover entire state. Optimized for the largest areas possible

- All State highways covered
- Total distortion optimized at near +/- 20 ppm level

- Zones named by City (ie; Bend-Redmond-Prineville) or mountain pass etc.
- Zone parameters user and software friendly
- Zones recommended for each community



Sample from the new OCRS Handbook – Appendix A.

GRANTS PASS-ASHLAND ZONE

Recommended Communities

It is recommended that OCRS users apply this zone when working in the vicinity of the following communities. More than one zone may work well for a community depending on the exact location and elevation of the project.

Parts of Josephine County, and Jackson County encompassing the communities of:

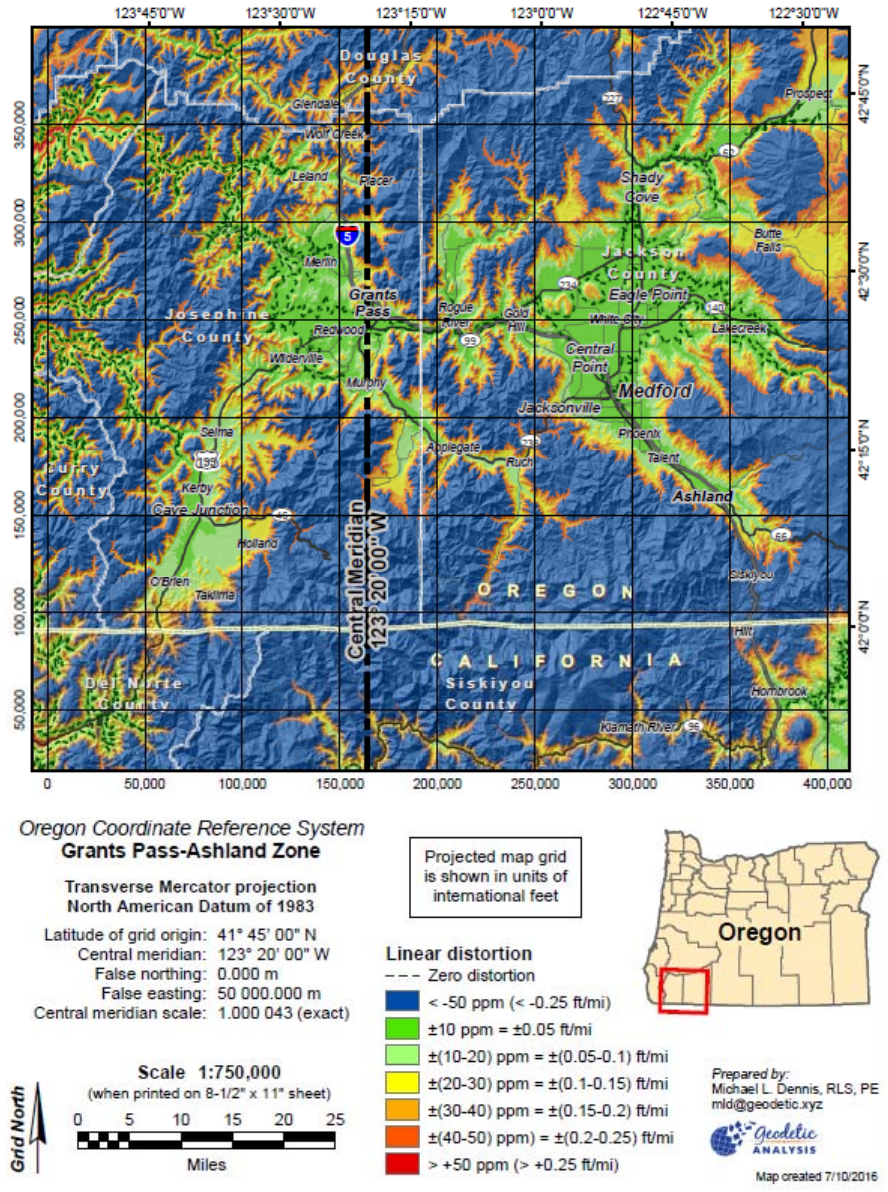
Merlin, Grants Pass, Redwood, Wilderville, Selma, Kerby, Cave Junction, O'brien, Murphy, Rogue River, Gold Hill, Eagle Point, White City, Central Point, Lakecreek, Medford, Jacksonville, Phoenix, Talent, Ashland

Zone parameter virtual grid coordinate software check

If you have entered the OCRS zone parameters into your vendor's software and successfully created new OCRS coordinate systems, then by entering the input lat/long values from the table below, your grid coordinates should match these results exactly to five decimal places.

Point Name	Latitude (N)	Longitude (W)	Northing (m)	Easting (m)
Grants Pass-Ashland1	42 06 16.06850	123 40 53.51268	39431.29476	21197.50808
Grants Pass-Ashland2	42 12 56.39712	122 42 25.17018	51915.05751	101719.61390
Grants Pass-Ashland3	42 22 01.47650	122 52 28.13141	68646.39250	87798.66183

APPENDIX A



Recommended communities & virtual grid coordinate check

BAKER ZONE

Recommended Communities

It is recommended that OCRS users apply this zone when working in the vicinity of the following communities. More than one zone may work well for a community depending on the exact location and elevation of the project.

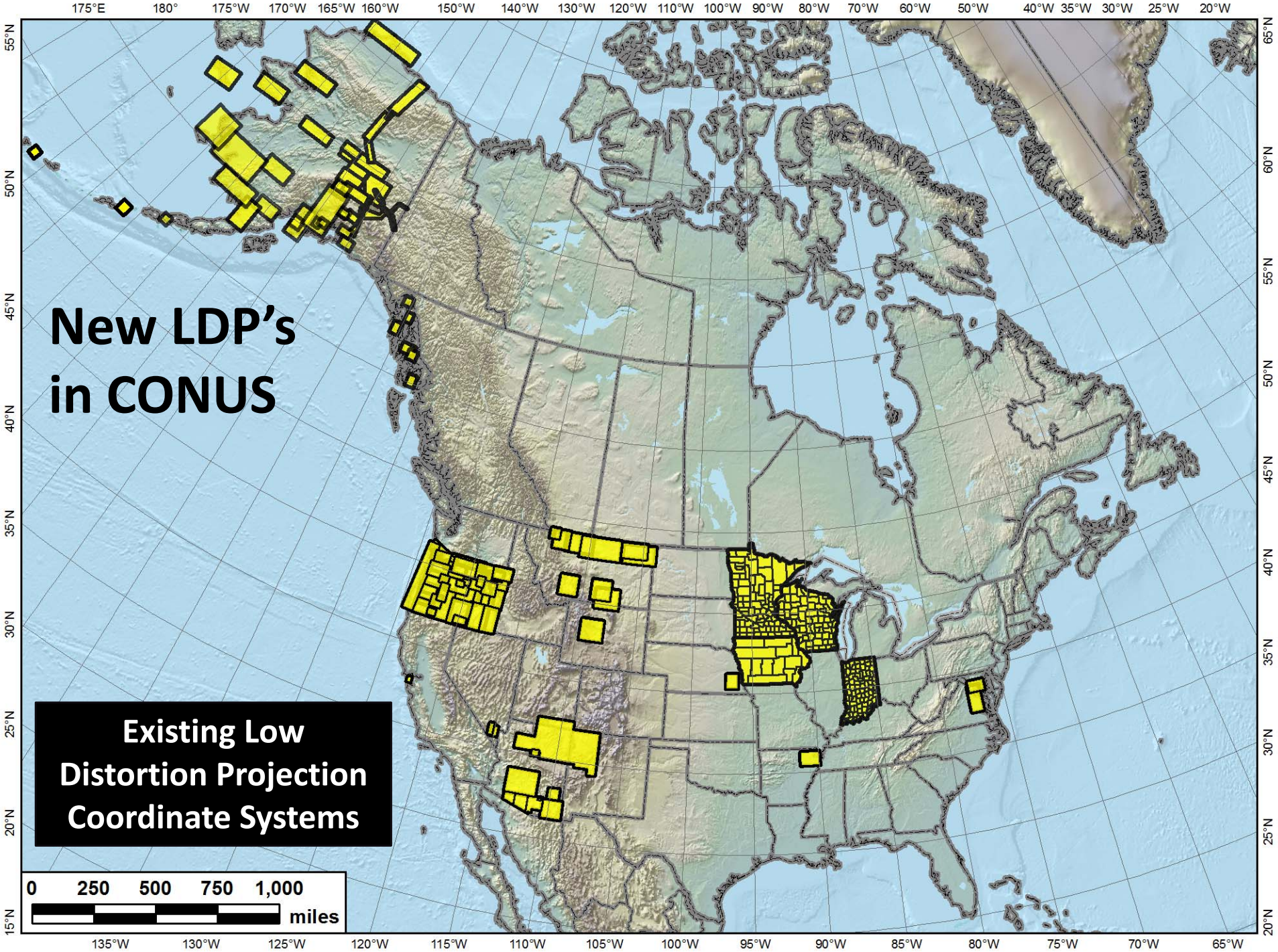
Parts of Baker County, and south Union County encompassing the communities of:

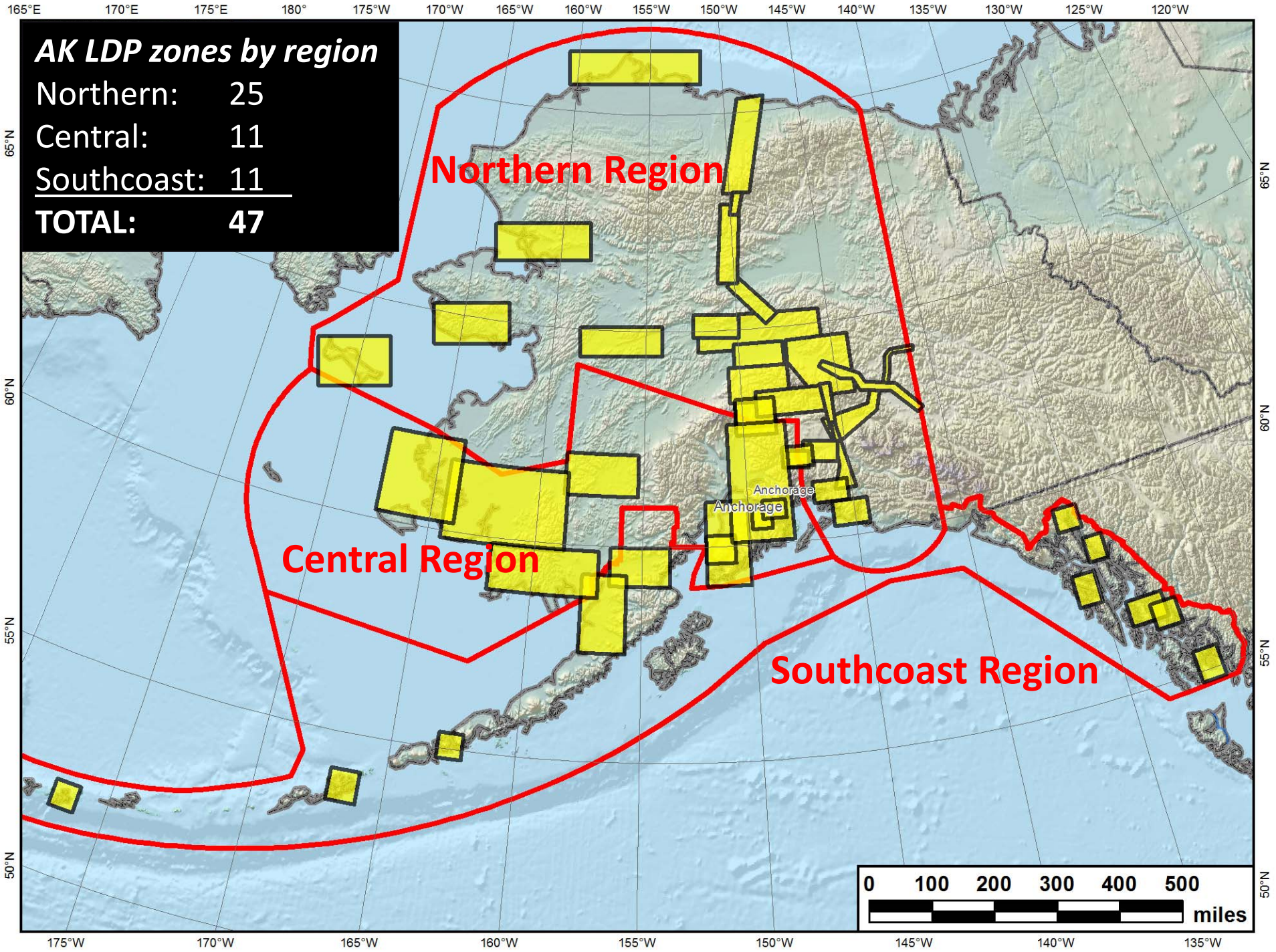
Baker City, Keating, Pondosa, Telocaset, North Powder, Haines

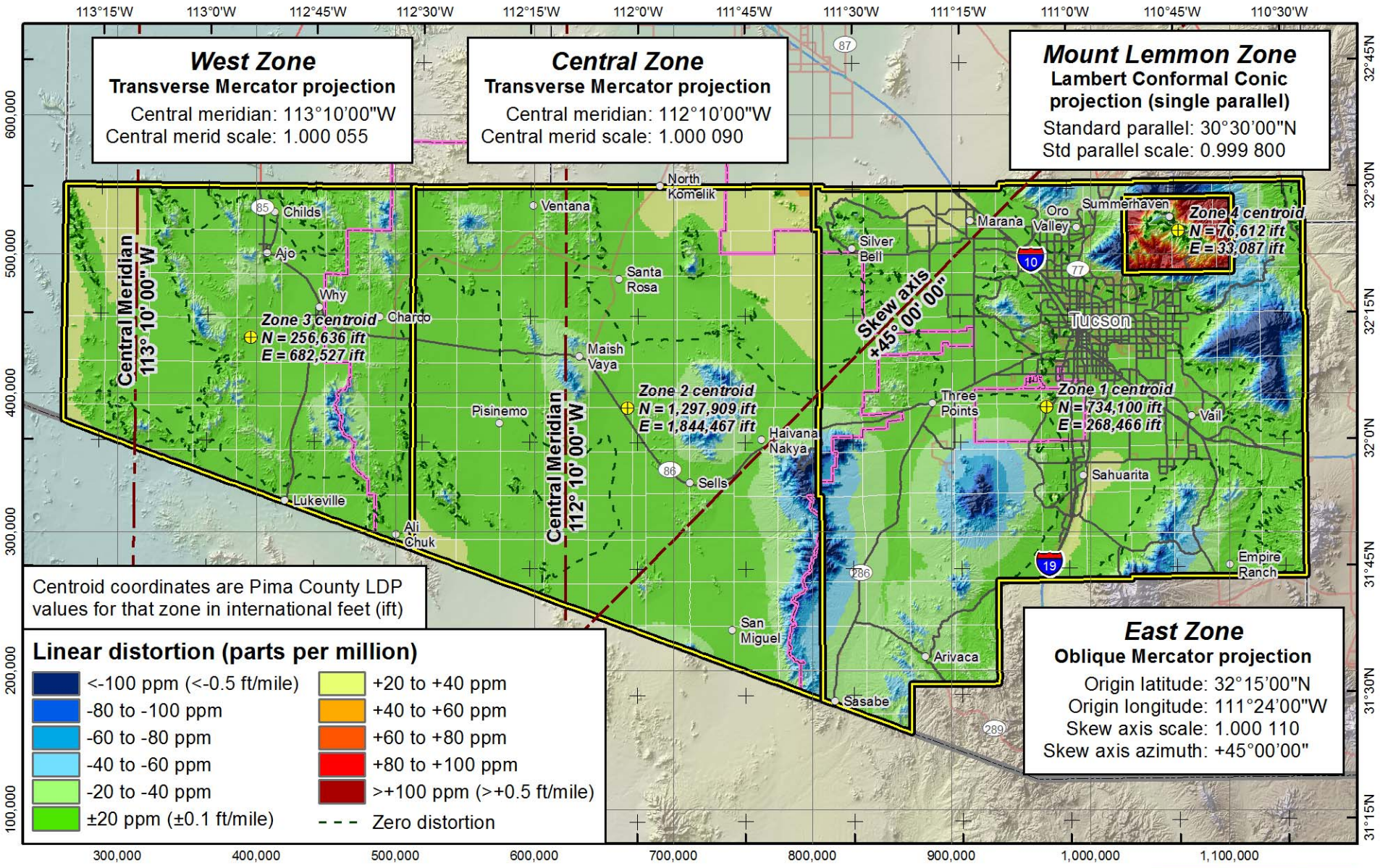
Zone parameter virtual grid coordinate software check

If you have entered the OCRS zone parameters into your vendor's software and successfully created new OCRS coordinate systems, then by entering the input lat/long values from the table below, your grid coordinates should match these results exactly to five decimal places.

Point Name	Latitude (N)	Longitude (W)	Northing (m)	Easting (m)
Baker 1	44 49 57.80936	117 48 54.56244	36980.20833	41437.60083
Baker 2	44 52 07.48389	117 54 26.35126	40986.29136	34152.16275
Baker 3	44 40 24.70946	117 59 40.97048	19299.09877	27201.54461


New LDP's in CONUS
Existing Low Distortion Projection Coordinate Systems
0 250 500 750 1,000
miles
175°E 180° 175°W 170°W 165°W 160°W 150°W 140°W 130°W 120°W 110°W 100°W 90°W 80°W 70°W 60°W 50°W 40°W 35°W 30°W 25°W 20°W
55°N 50°N 45°N 40°N 35°N 30°N 25°N 20°N 15°N
65°N 60°N 55°N 50°N 45°N 40°N 35°N 30°N 25°N 20°N
135°W 130°W 125°W 120°W 115°W 110°W 105°W 100°W 95°W 90°W 85°W 80°W 75°W 70°W 65°W


AK LDP zones by region
Northern: 25
Central: 11
Southcoast: 11
TOTAL: 47
Northern Region
Central Region
Southcoast Region
Anchorage
Anchorage
0 100 200 300 400 500
miles
165°E 170°E 175°E 180° 175°W 170°W 165°W 160°W 155°W 150°W 145°W 140°W 135°W 130°W 125°W 120°W
65°N
60°N
55°N
50°N
175°W 170°W 165°W 160°W 155°W 150°W 145°W 140°W 135°W



Pima County Low Distortion Projection Coordinate System *(preliminary)*

All zones (large zones clipped to townships)

Projected grid is SPCS 83 AZ C (international feet)

The Best LDPs are the ones…

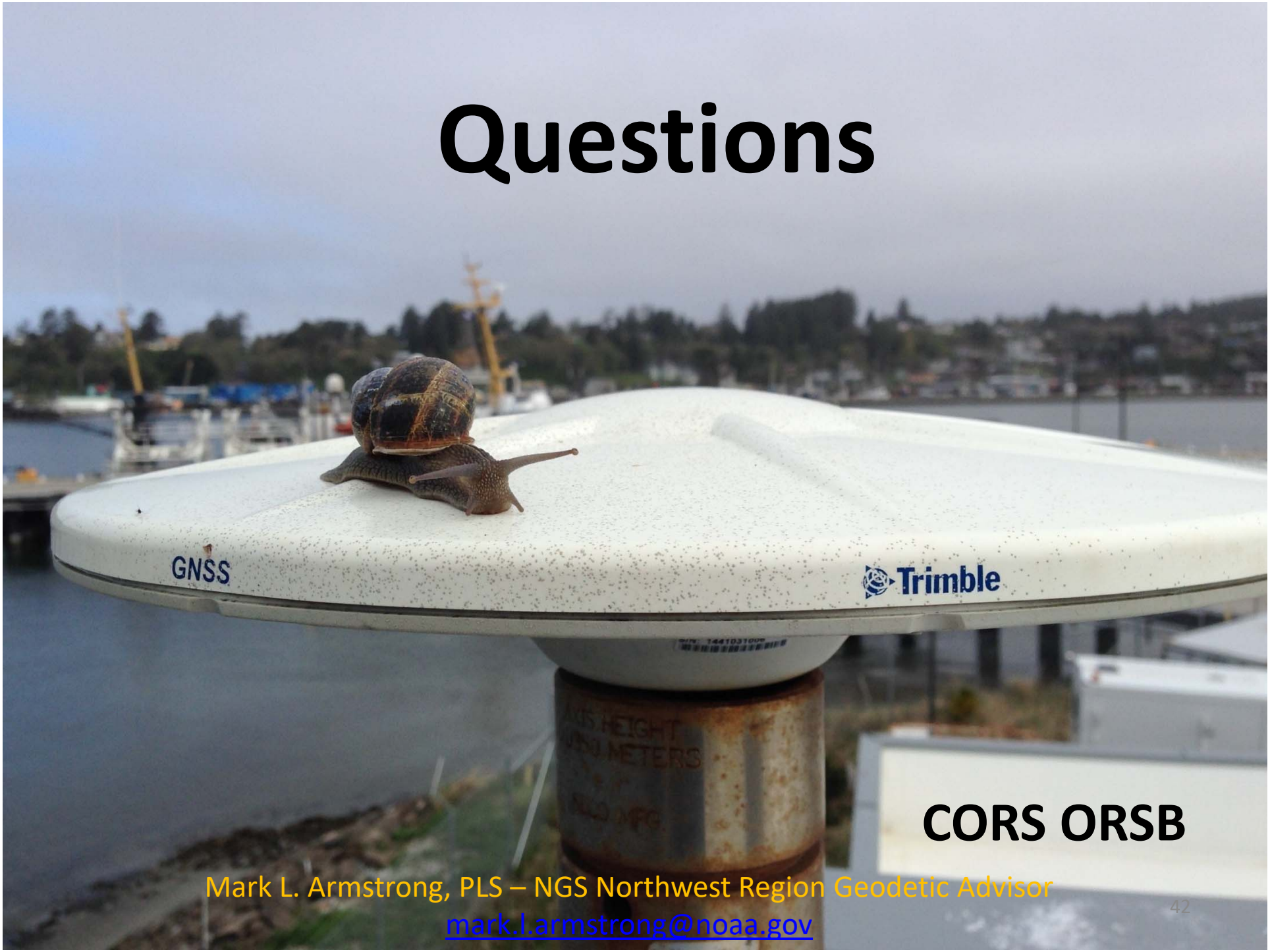
- That were sufficiently studied to produce the best results for the specified region of concern.
- That are USED …and appreciated!
- That last along time…because they work so well!
- That are legislated into state survey and mapping law… managed by a group of surveying and mapping professionals

Conclusions

Low Distortion Projections are…

- A standardized method for minimizing distortion over largest area possible.
  - -Performance and simplicity superior to other methods
  - -Satisfies needs of both the GIS and surveying communities, GPS and terrestrial measurements
- Enables direct use of survey data in a GIS
- Reduces proliferation of local systems
  - -Provides an established LDP zone for ALL projects where grid distances are consistent with ground.
- Documentation (metadata) is **essential**
- Facilitates data transferability… local data would be readily available to others for overlaying maps, emergency management, utility needs, design etc.

Questions



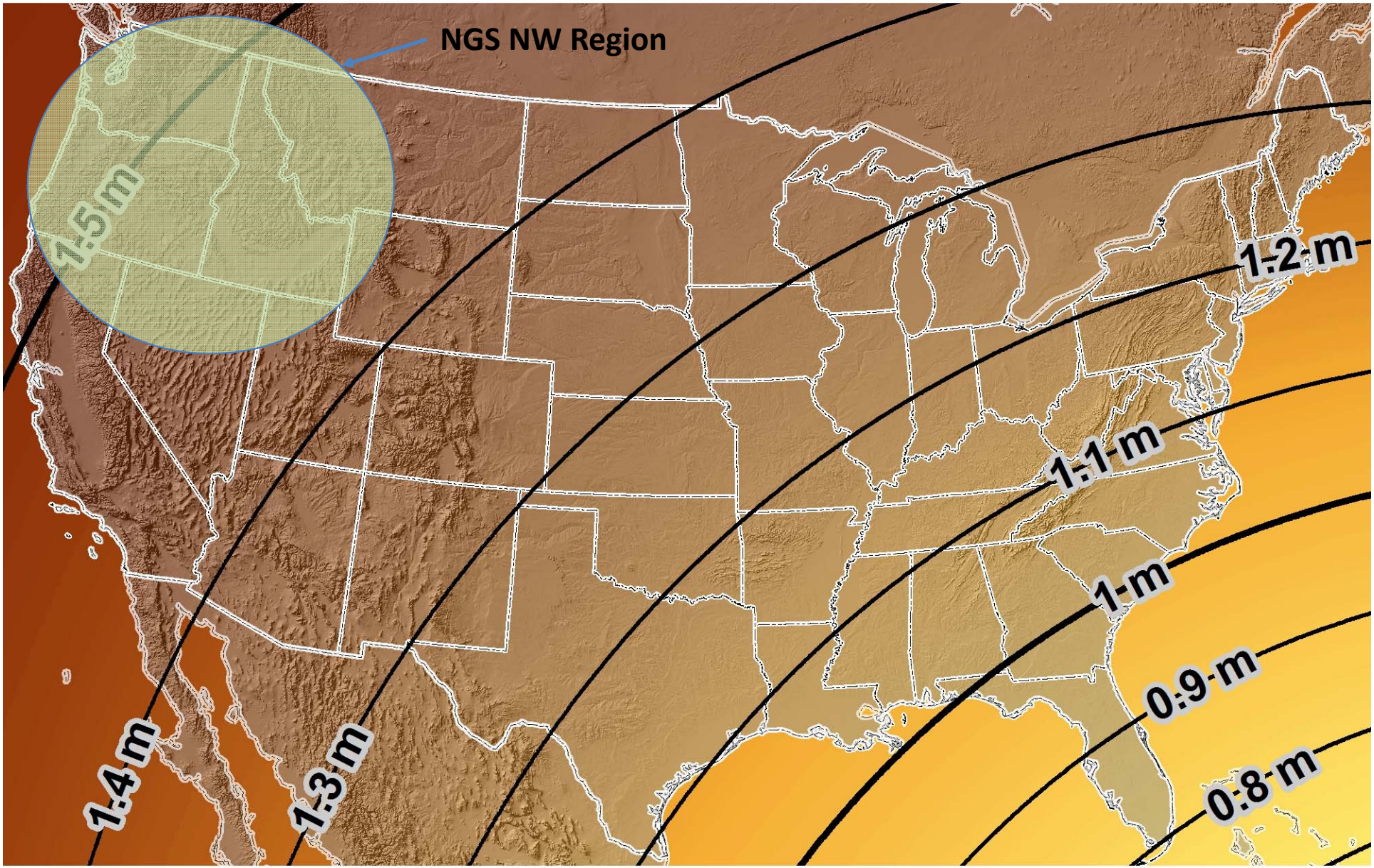
CORS ORSB

Mark L. Armstrong, PLS – NGS Northwest Region Geodetic Advisor
mark.l.armstrong@noaa.gov

New datum/frame coming in 2022

- Lets have an open discussion/forum…
- What changes to expect?
- What do we need to do to prepare?
  - OAR Committee – adopt the new datums
  - Parameter changes to SPCS and all LDP zones?
  - Migrate survey and GIS to the NSRS (NADCON5)
  - What will the new datum/frames look like?
  - 5 years and counting – starting now!

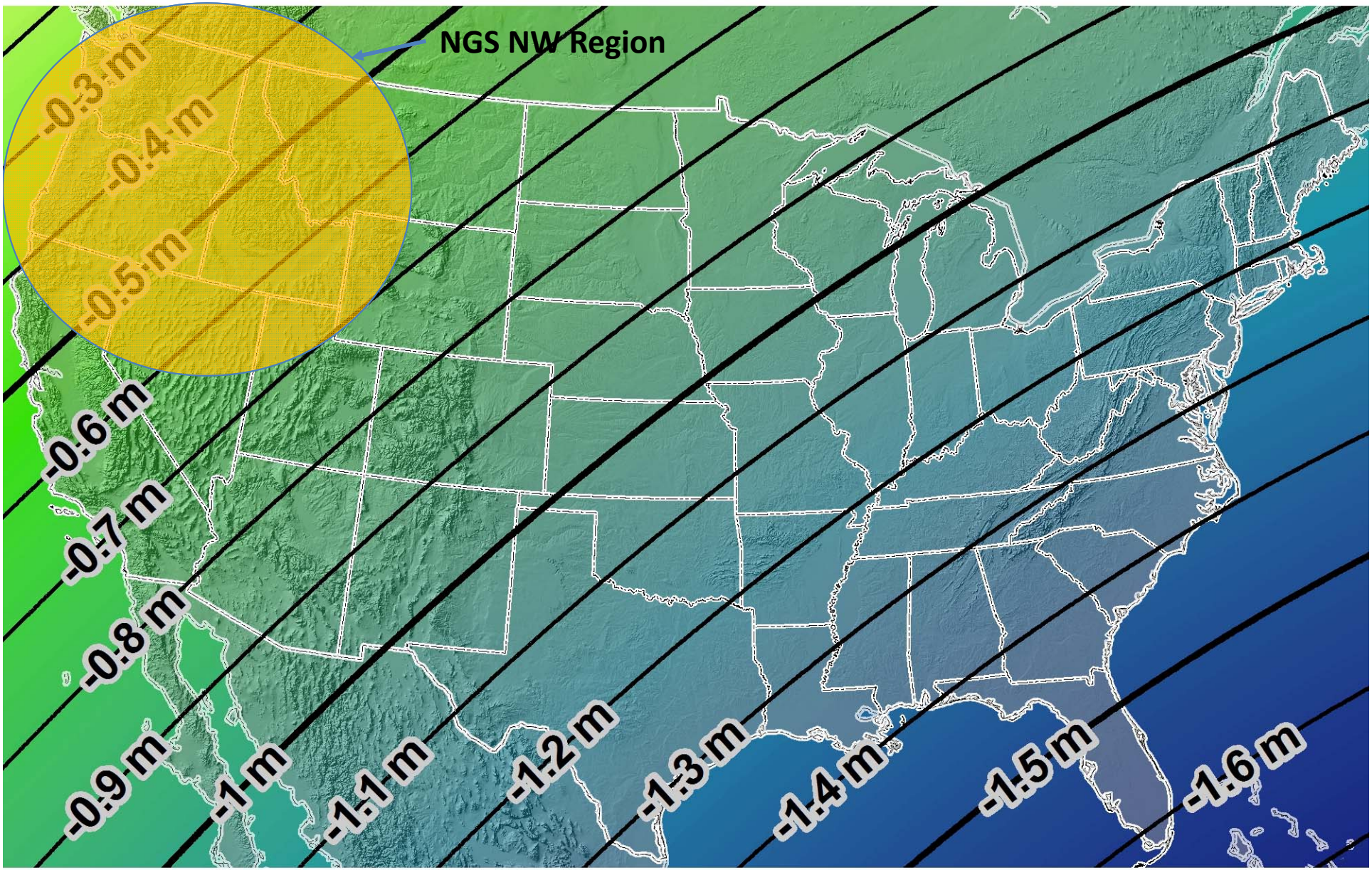
Estimated horizontal change from NAD 83 to new geometric datum



The future path for the Oregon Coordinate System

- With the change in datums/frame coming in 2022 the NGS is recommending that every State apply a change to the false easting and/or northing of their plane coordinate systems.
- This is recommended so the new northings and eastings look entirely different and cannot be confused with the old ones.
- Remember this also occurred when the change was made from NAD 27 to NAD 83.
- Within 6 months to a year the NGS will request that all States plan and prepare to supply NGS with new parameters to their State Plane Coordinate Systems.
- It is somewhat likely (maybe) that NGS will have some way for States with LDPs to supply that information to NGS. We shall see?

Estimated ellipsoid height change from NAD 83 to new geometric datum



Delta h = h(ITRF 05) minus h(NAD 83) at 2020.0

New datum/frame names coming in 2022

GEOMETRIC FRAMES:

North American Terrestrial Reference Frame of 2022 (NATRF2022)

Pacific Terrestrial Reference Frame of 2022 (PTRF2022)

Mariana Terrestrial Reference Frame of 2022 (MTRF2022)

Caribbean Terrestrial Reference Frame of 2022 (CTRF2022)

GEOPOTIENTIAL DATUM:

North American-Pacific Geopotential Datum of 2022 (NAPGD2022)

Future geometric realizations

- **Each of the four frames named will be identical (equal to) to the latest IGS reference frame (as available in 2022) at an epoch to be determined.**
- **The geometric frames will be FIXED PLATE and change every +/-5 years based on the most recent ITRF.**
- **All Continuously Operating Reference Stations (CORS) velocities which deviate from the rotation of a rigid plate will be captured in a residual 3-D velocity model.**

Oregon State Plane Coordinate System

OREGON NORTH ZONE (Designation 3601)

Oregon State Plane NORTH - NAD 1983

Lambert Conformal Conic Two Standard Parallel Projection (Secant)

Changes in 2022 NATRF2022 (CONUS)

Central Meridian:	-120° 30’ (W)	?
Latitude of Origin:	43° 40’	?
Standard Parallel (South):	44° 20’	?
Standard Parallel (North):	46°	?
False Northing:	0.000 m	?
False Easting:	2 500 000.000 m	? (2 300 000.000)???
Max scale error:	~1:9 500 (±105 ppm)	?

QUESTIONS:

Is it possible to improve the OR SPCS by changing all the parameters?

The minimum change would be the false easting and/or perhaps false northing?

Oregon State Plane Coordinate System

OREGON NORTH ZONE (Designation 3601)

Oregon State Plane SOUTH - NAD 1983

Lambert Conformal Conic Two Standard Parallel Projection (Secant)

Changes in 2022 NATRF2022 (CONUS)

Central Meridian:	-120° 30’ (W)	?
Latitude of Origin:	41° 40’	?
Standard Parallel (South):	42° 20’	?
Standard Parallel (North):	44°	?
False Northing:	0.000 m	?
False Easting:	1 500 000.000 m	? (1 300 000.000)???
Max scale error:	~1:9 500 (±105 ppm)	?

QUESTIONS:

Is it possible to improve the OR SPCS by changing all the parameters?

The minimum change would be the false easting and/or perhaps false northing?

The basis of the new Geometric Frame

- **NGS computes all 3D coordinates (LLh) in the current NSRS global frame.**
  - …then outputs the current NSRS North American Datum: NAD 83(2011)2010.00
  - This is the way the OPUS works now

Current global frame = ITRF08 / IGS08

New global frame = ITRF14 / IGS14

Future global frame =(?) ITRF20 / IGS20

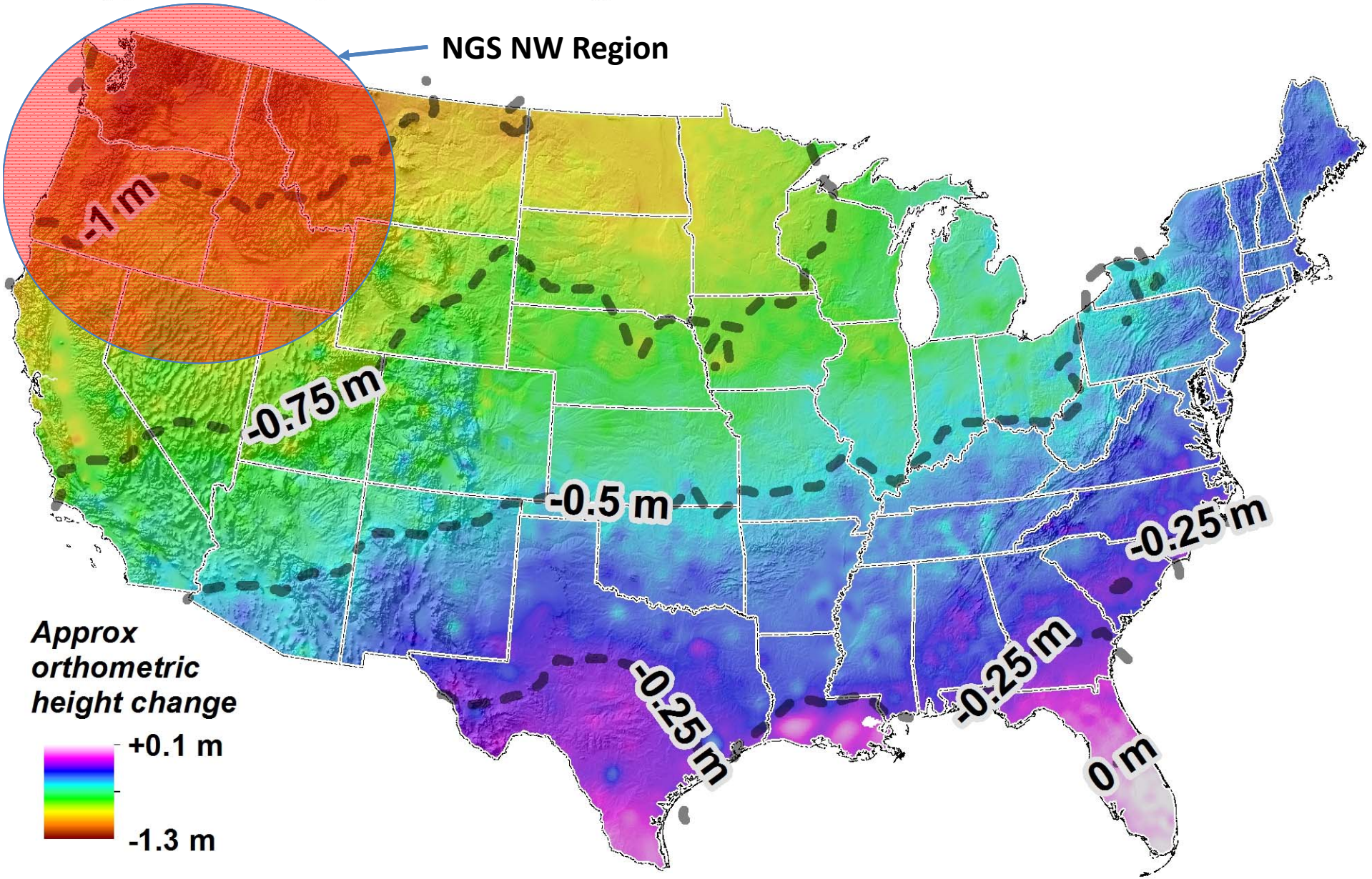
(there may be others - estimated dates)

OPUS Coordinates - Solution Report

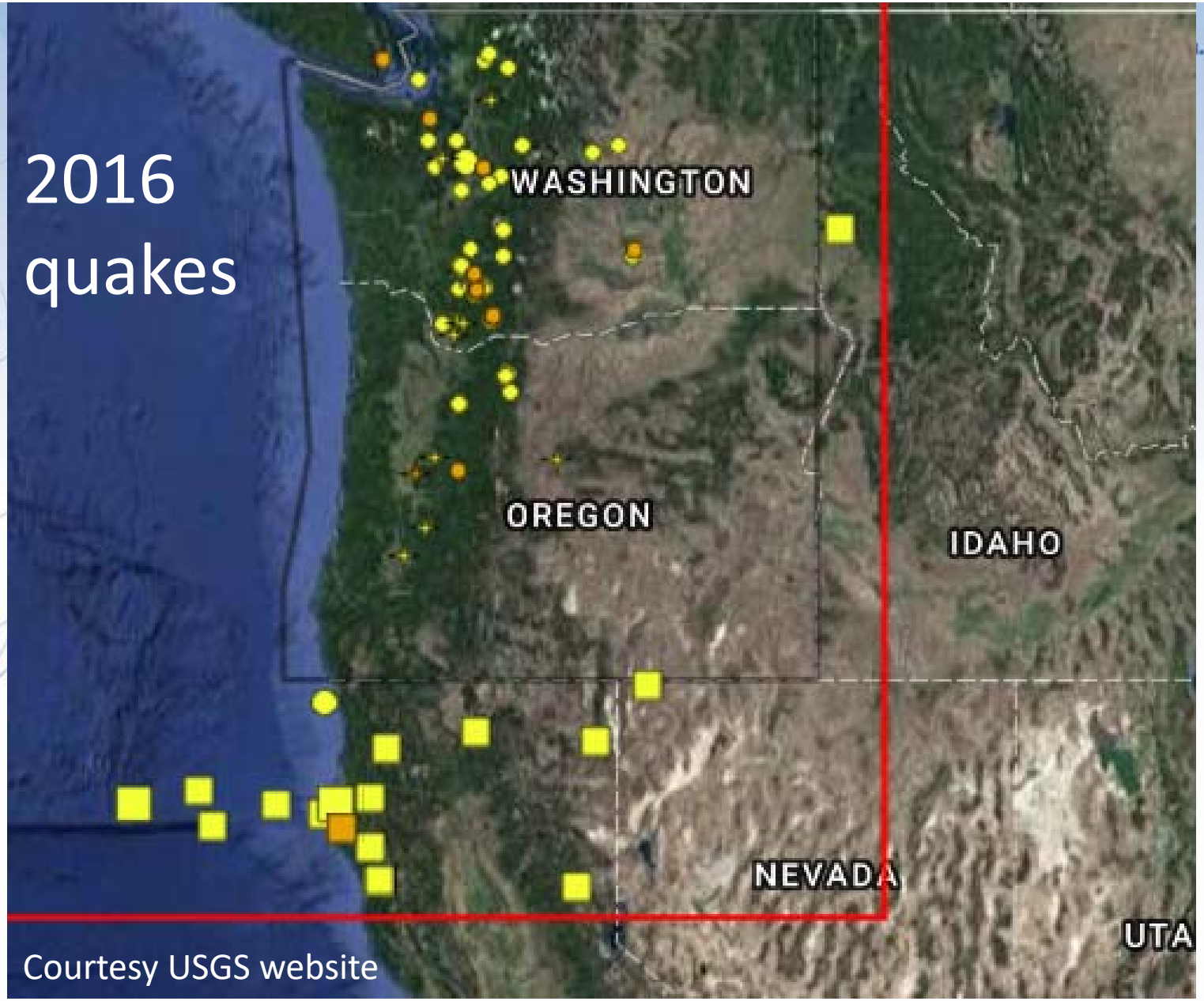
bbr2230u.14o.txt created: 2015-11-30 19:13 UTC downloaded: 2016-01-13 17:22 UTC

```
                         NGS OPUS SOLUTION REPORT
                         ========================

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy

      USER: mark.l.armstrong@noaa.gov              DATE: February 24, 2015
RINEX FILE: bbr2230u.14o                           TIME: 16:31:44 UTC


  SOFTWARE: page5  1209.04 master50.pl 022814      START: 2014/08/18  20:12:00
 EPHEMERIS: igs18061.eph [precise]                  STOP: 2014/08/18  23:50:00
  NAV FILE: brdc2300.14n                        OBS USED:  8512 /  8680   :  98%
  ANT NAME: TPSHIPER_SR     NONE              # FIXED AMB:    34 /    34   : 100%
ARP HEIGHT: 0.492                             OVERALL RMS: 0.014(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000)              IGS08 (EPOCH:2014.6299)

        X:     -2394864.738(m)   0.019(m)          -2394865.605(m)   0.019(m)
        Y:     -3887418.647(m)   0.018(m)          -3887417.427(m)   0.018(m)
        Z:      4441294.723(m)   0.008(m)           4441294.732(m)   0.008(m)

      LAT:   44 23 59.13603      0.012(m)        44 23 59.14947      0.012(m)
    E LON:  238 21 52.68664      0.007(m)       238 21 52.62438      0.007(m)
    W LON:  121 38  7.31336      0.007(m)       121 38  7.37562      0.007(m)
   EL HGT:         1941.073(m)   0.024(m)              1940.662(m)   0.024(m)
 ORTHO HGT:        1962.449(m)   0.043(m) [NAVD88 (Computed using GEOID12A)]

                      UTM COORDINATES    STATE PLANE COORDINATES
                       UTM (Zone 10)         SPC (3601 OR N)
Northing (Y) [meters]    4917180.405           82099.445
Easting (X)  [meters]     608671.367         2409554.793
Convergence  [degrees]     0.95487424          -0.80518486
Point Scale                0.99974523           0.99998394
Combined Factor            0.99944104           0.99967968
```

Approximate predicted change from NAVD 88 to new vertical datum



Predicted change estimated as NAVD 88 "zero" (datum) surface *minus* most recent NGS gravimetric geoid (USGG2009)



Quakes may cause a discontinuity in time/velocity model and need to be accounted for… but difficult to do.

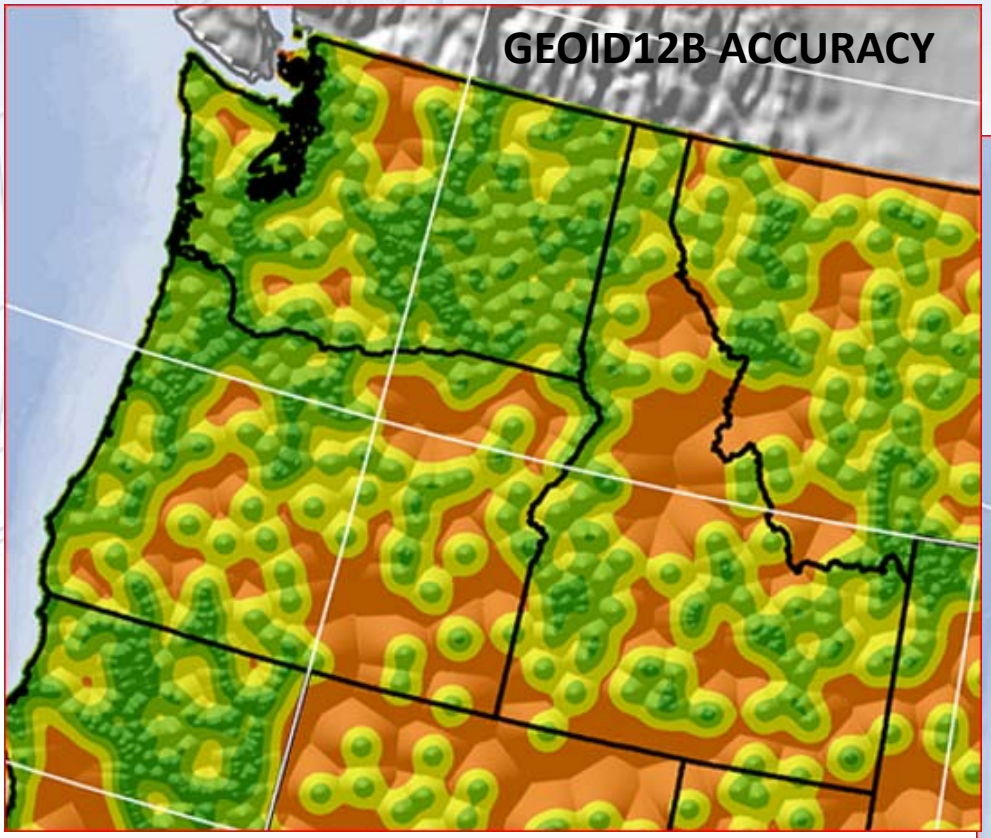
NOAA's National Geodetic Survey Positioning America for the Future geodesy.noaa.gov

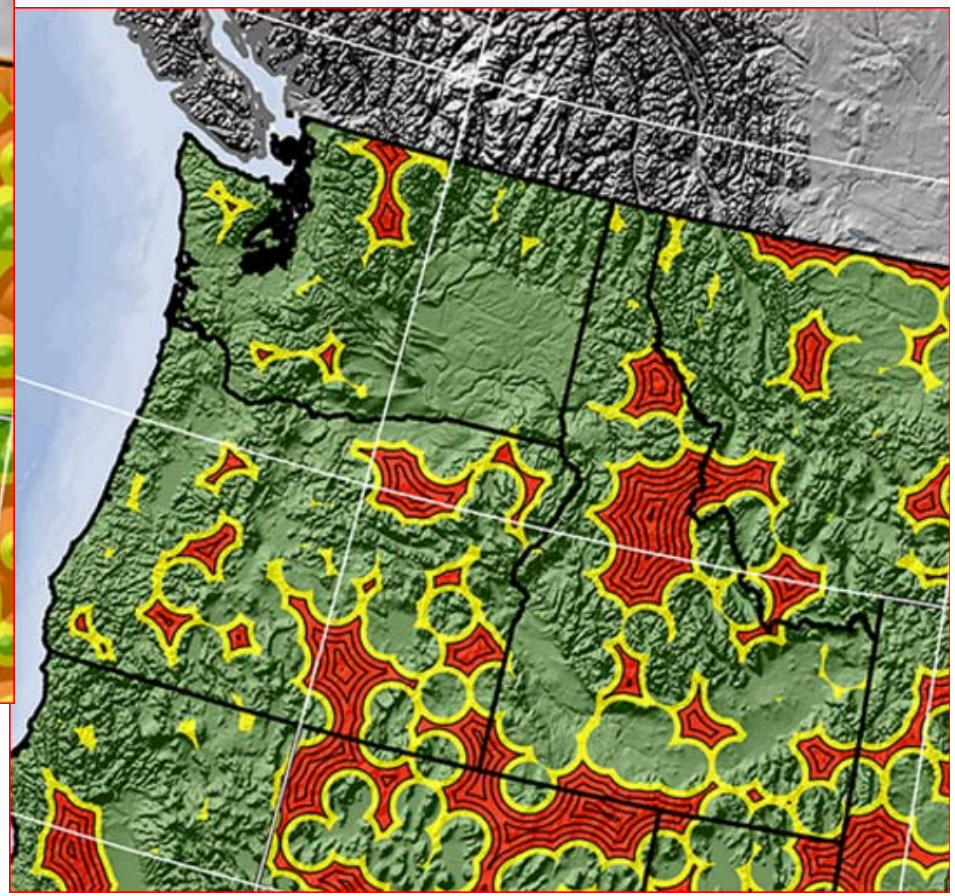
GPS ON BENCH MARKS CAMPAIGN

https://www.ngs.noaa.gov/GPSonBM/

Share your observations and solutions with the OPUS Database

You can help improve the new vertical datum transformation by observing a benchmark in the gaps





National Surveyors Week will be celebrated nationwide March 19-25, 2017

Stay current and visit the NGS NEW Datums web page

The new reference frames (geometric and geopotential) will rely primarily Global Navigation Satellite Systems (GNSS) such as the Global Positioning System (GPS) as well as an updated and time-tracked geoid model. This paradigm will be easier and more cost-effective to maintain.

How YOU can influence and help shape NGS products and services

1. **Fill out the NGS webpage popup survey form quarterly. NGS tabulates responses, reviews and focuses on the biggest needs.**
2. Ask questions about products by emailing the right team….?
   - NOS NGS OPUS ngs.opus@noaa.gov
   - NOS NGS Opus Database ngs.opus.db@noaa.gov
   - NOS NGS OPUS Projects ngs.opus.projects@noaa.gov
   - NOS NGS CORS ngs.cors@noaa.gov
   - NOS NGS Absolute Antenna Calibrations ngs.absantcal@noaa.gov

Questions

Photo by Pat Barott