



Oregon Coordinate Reference System

AOC Update
Mark Armstrong

19 November, 2009





Today

- Short Review of Low Distortion Projections
- How LDP's are designed
- Low Distortion Projections for Oregon
- Projection field testing
- Time to completion of the OCRS
- Implementation



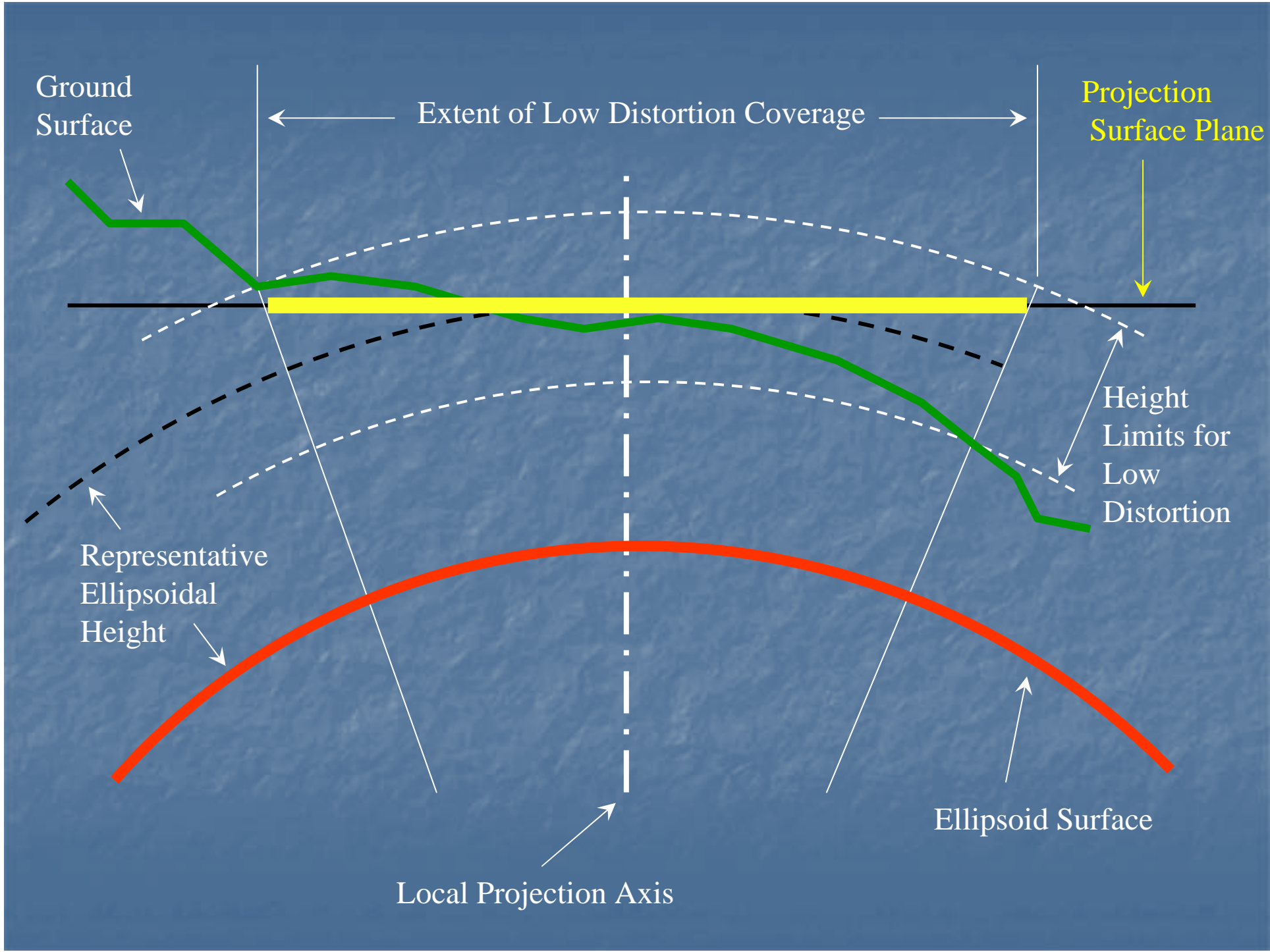
Why the State Plane map projections are deficient for certain modern day uses?

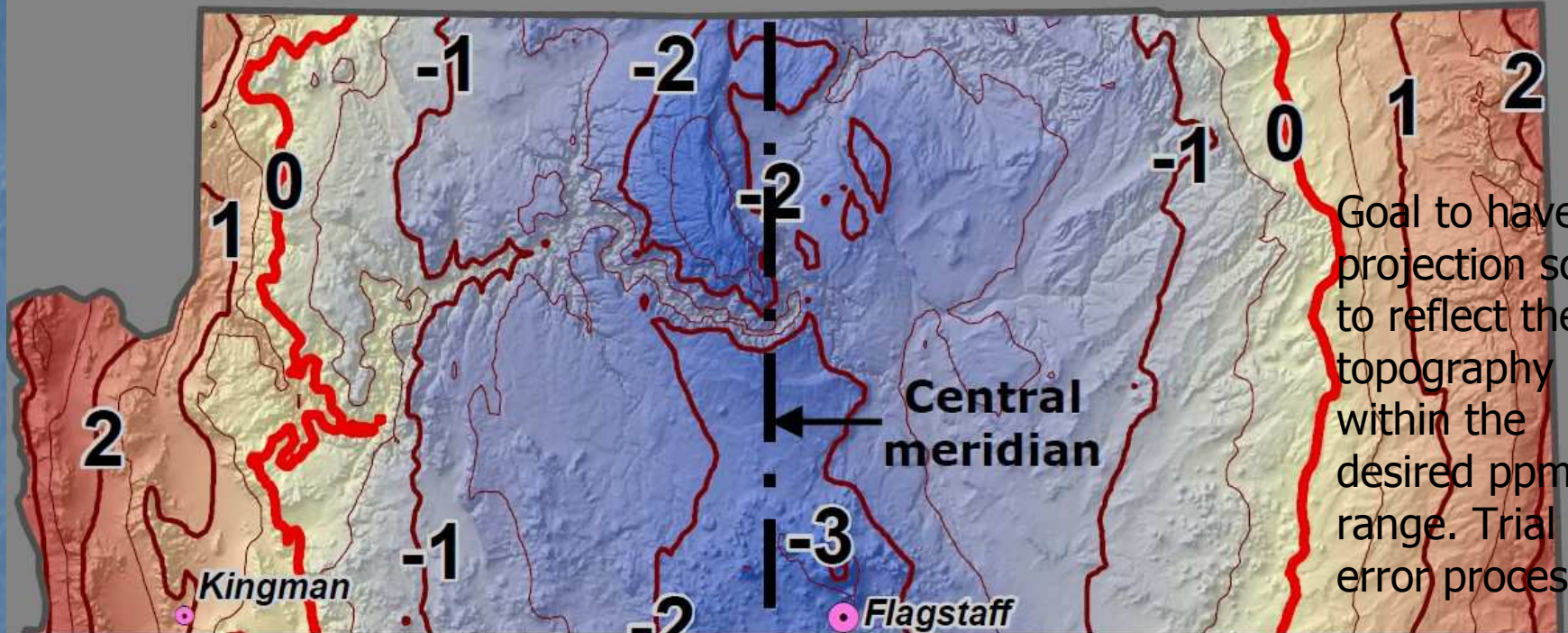
- Does not represent ground distances except near sea level
- Does not minimize distortion over large areas and varying elevations
- Does not reduce convergence angles
- Does not support combined modern projection accuracy requirements for survey and GIS
- OSP created in 1936 and adopted into legal status in 1945
- Maximum projection distortion 1:10 000



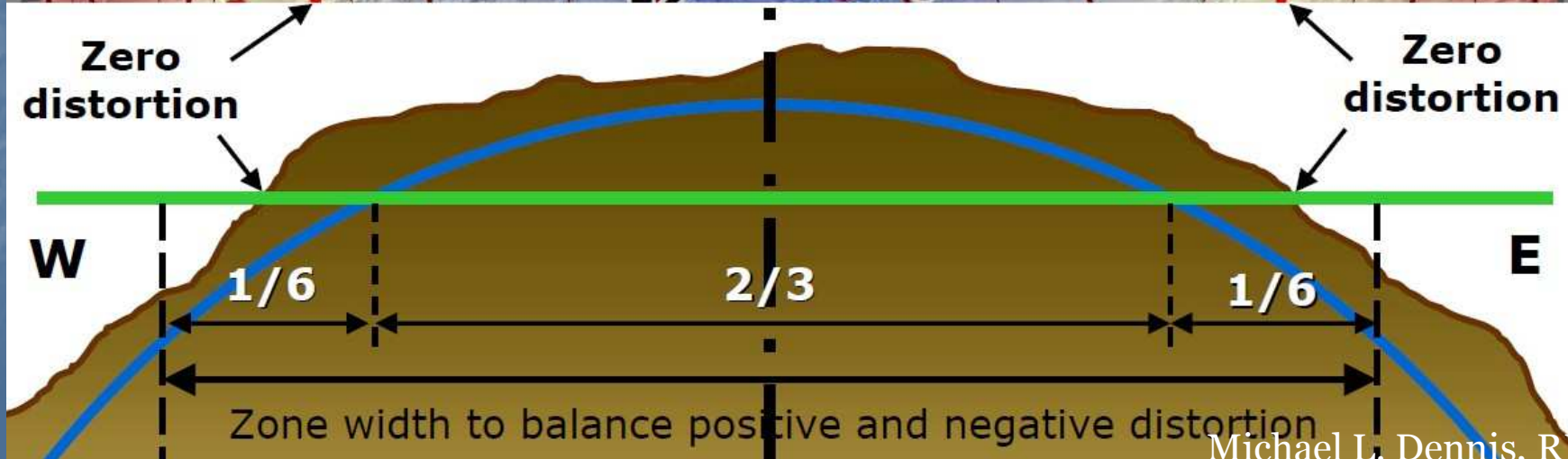
Low Distortion Projections Offer...

- Minimize difference between “Grid” and “Ground” distances over significantly large areas
- Projection distortion design +/-10 – 20ppm (1:100 000 – 1:50 000). Best practices goal.
- Central meridian and latitude near site, reducing distortion and convergence angles
- Full coordinate systems – easy to transform to any other definition
- Maintains solid relationship to NSRS (CORS)





Goal to have the projection scaled to reflect the topography within the desired ppm range. Trial and error process.





Activity Since March 2009

- April 7th, Oct. 26th, 2009 meetings
- Developed best practices list and goals
- Developed Technical Team
- Developed test projections for Portland, Salem, Eugene and Willamette Valley
- Alpha testing underway
- Draft OCRS Handbook and User Guide
- Additional zone map projections planned

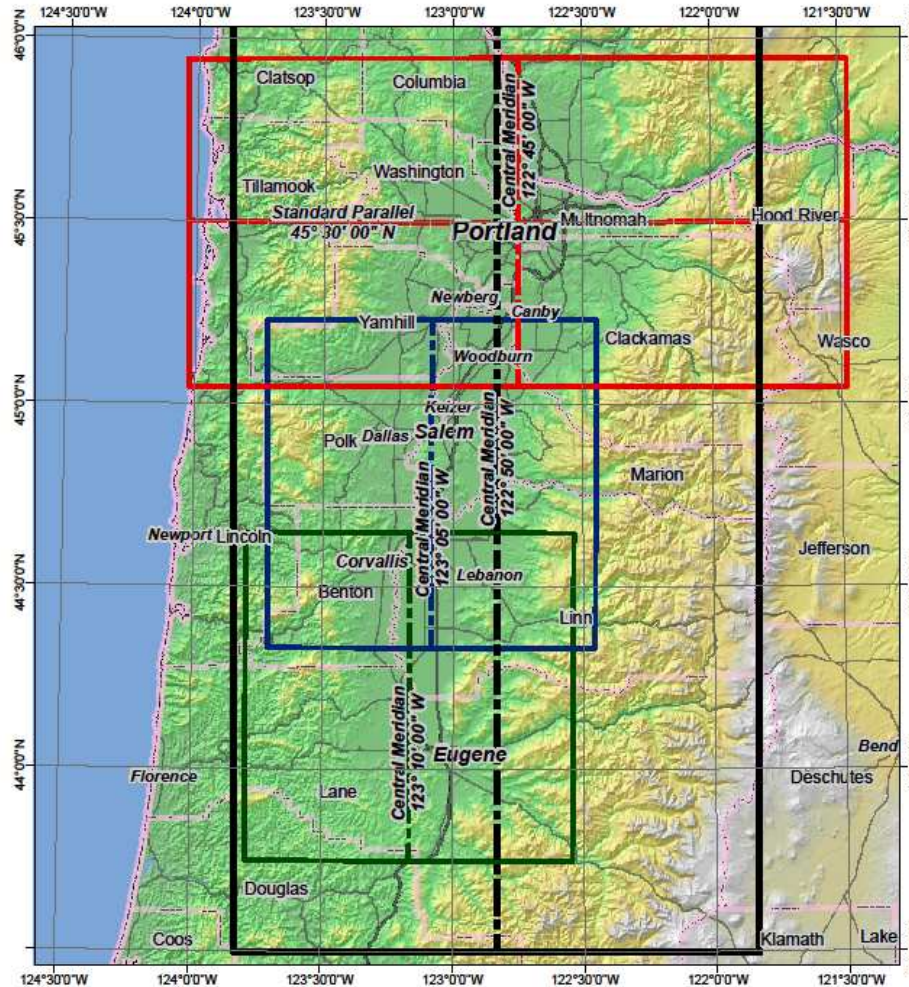


Combined Map Projection Distortion Goals

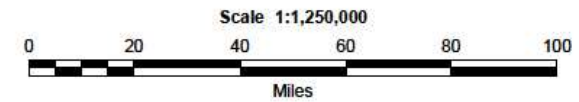
PPM	Feet/Mile	Ratio
+/- 10	+/- 0.05	1:100,000
+/- 20	+/- 0.1	1:50,000



Current Zones



PRELIMINARY
Oregon Coordinate Reference System
Zones in northwestern part of state

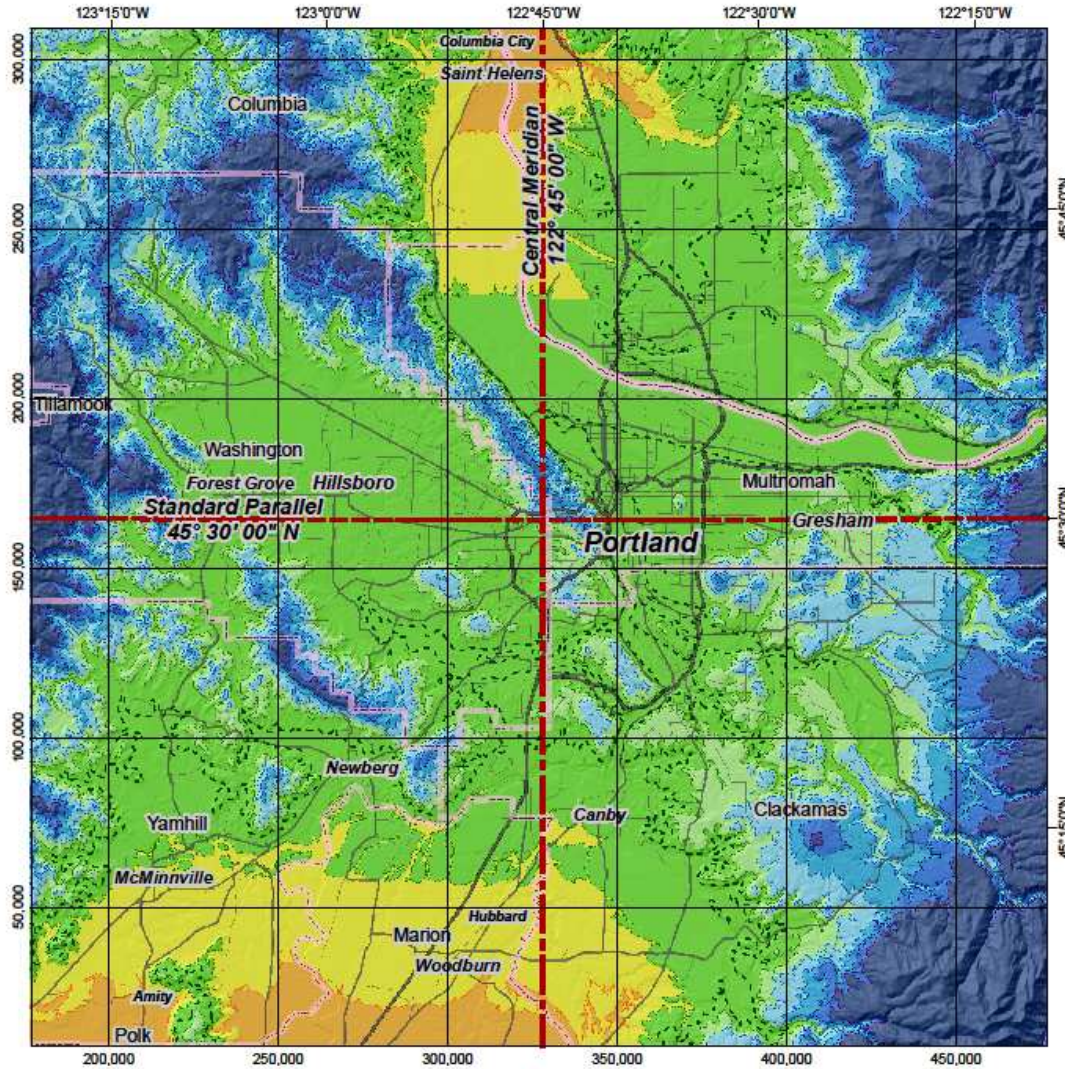


OCRS zone extents in NW Oregon

- Regional Willamette Valley Zone extents
- Regional Willamette Valley Zone central meridian
- Local Portland Zone extents
- Local Portland Zone central meridian
- Local Portland Zone standard parallel
- Local Salem Zone extents
- Local Salem Zone central meridian
- Local Eugene Zone extents
- Local Eugene Zone central meridian



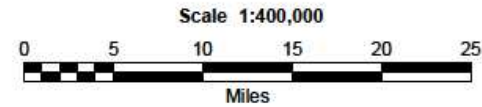
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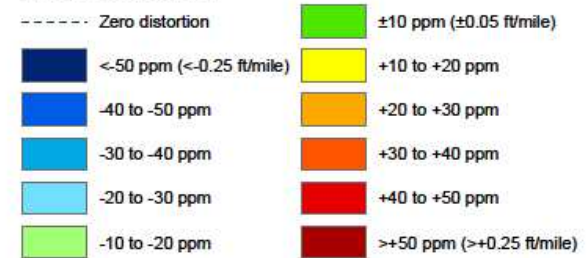
PRELIMINARY
Oregon Coordinate Reference System
Local Portland Zone

Lambert Conformal Conic projection (single parallel)
North American Datum of 1983

Standard parallel & grid origin: 45° 30' 00" N
 Central meridian: 122° 45' 00" W
 False northing: 50,000,000 m
 False easting: 100,000,000 m
 Standard parallel scale: 1.000 002 (exact)



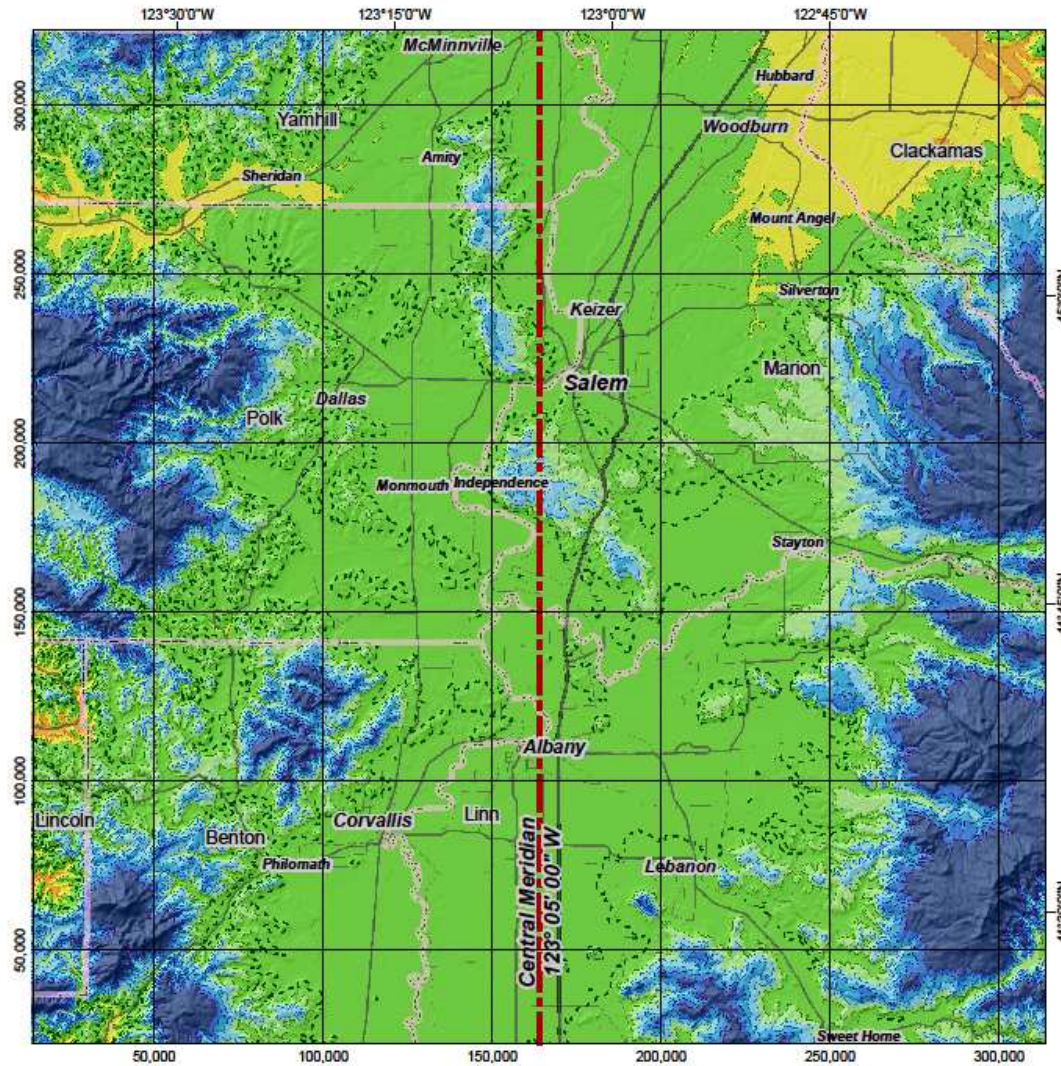
Linear distortion



NOTE: Map grid is shown in units of international feet.

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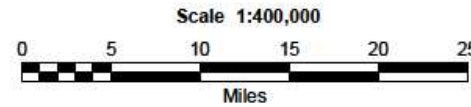




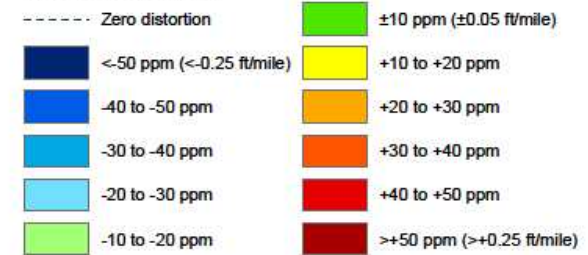
PRELIMINARY
Oregon Coordinate Reference System
Local Salem Zone

Transverse Mercator projection
North American Datum of 1983

Latitude of grid origin: 44° 20' 00" N
 Central meridian: 123° 05' 00" W
 False northing: 0.000 m
 False easting: 50,000.000 m
 Central meridian scale: 1.000 010 (exact)



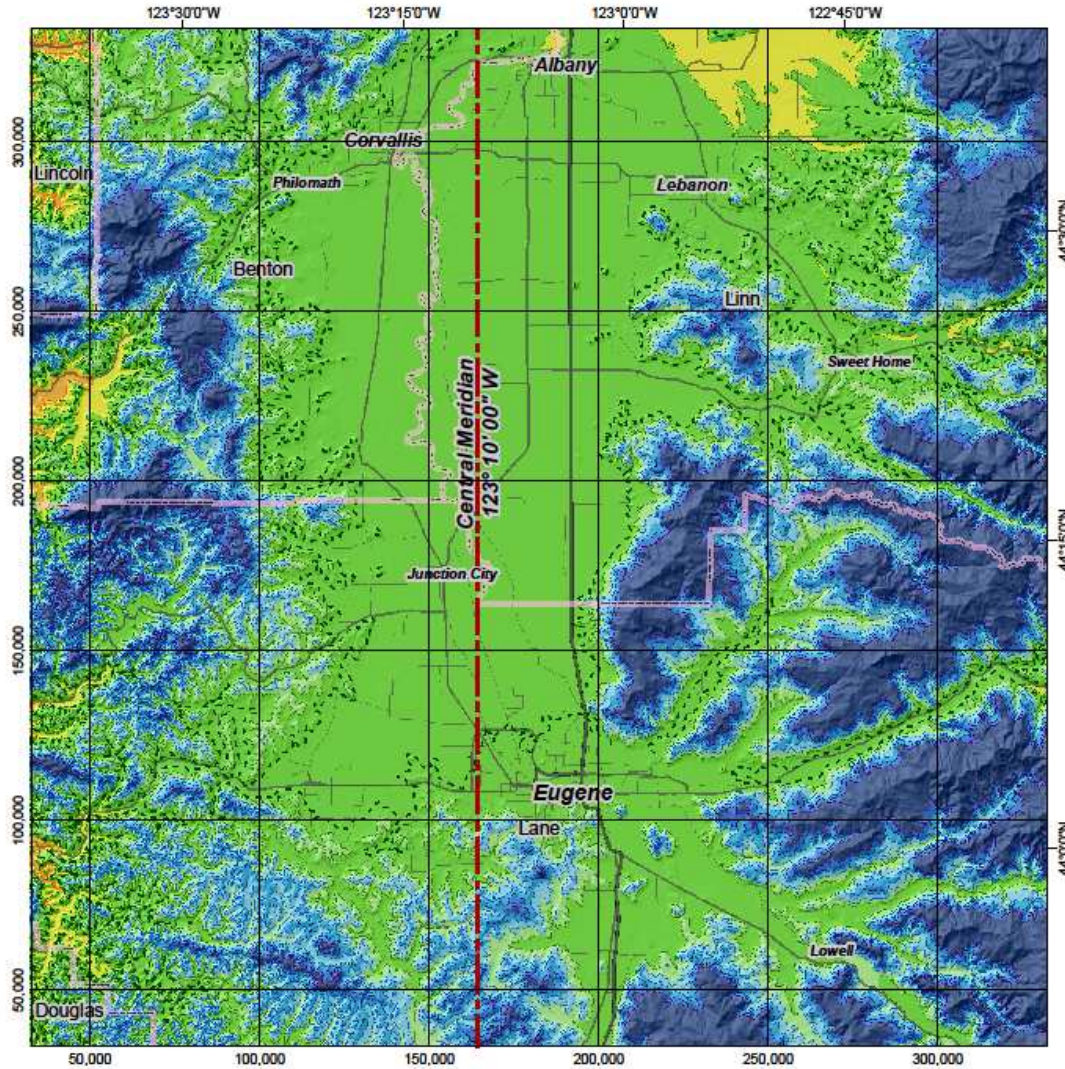
Linear distortion



NOTE: Map grid is shown in units of international feet.

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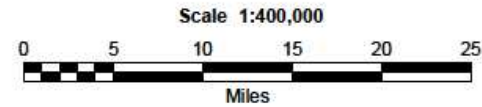




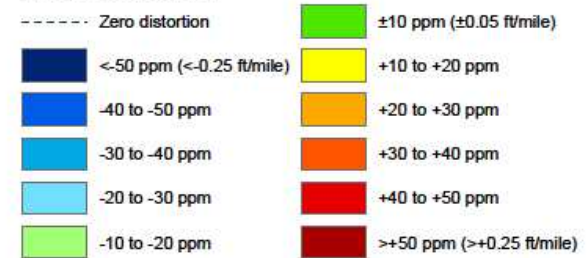
PRELIMINARY
Oregon Coordinate Reference System
Local Eugene Zone

Transverse Mercator projection
North American Datum of 1983

Latitude of grid origin: 43° 45' 00" N
 Central meridian: 123° 10' 00" W
 False northing: 0.000 m
 False easting: 50,000.000 m
 Central meridian scale: 1.000 015 (exact)



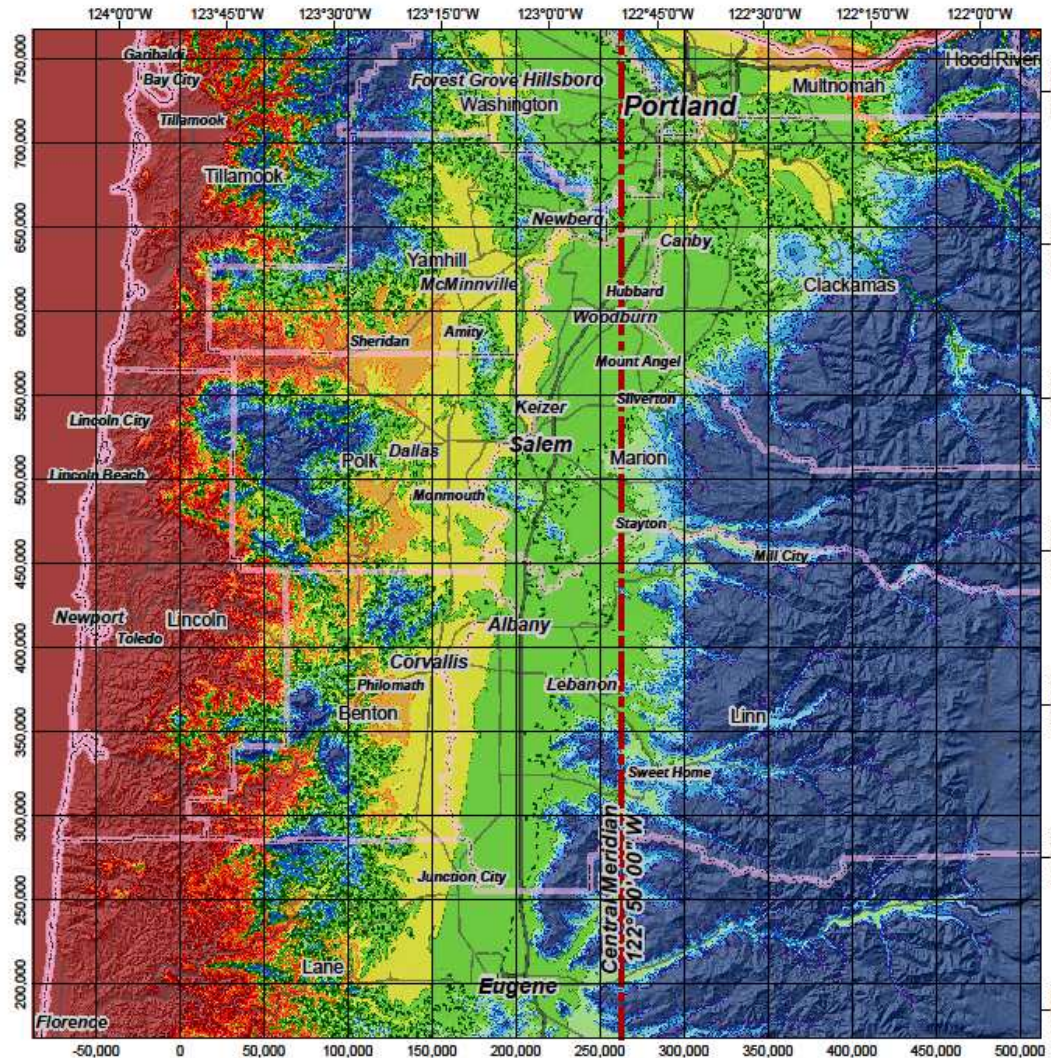
Linear distortion



NOTE: Map grid is shown in units of international feet.

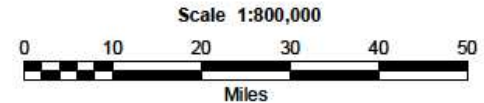
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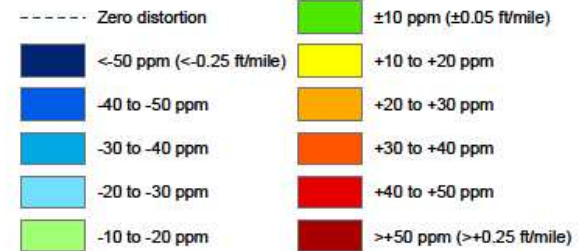


PRELIMINARY
Oregon Coordinate Reference System
Regional Willamette Valley Zone

Transverse Mercator projection
North American Datum of 1983
 Latitude of grid origin: 43° 30' 00" N
 Central meridian: 122° 50' 00" W
 False northing: 0.000 m
 False easting: 80,000.000 m
 Central meridian scale: 1.000 010 (exact)



Linear distortion



NOTE: Map grid is shown in units of international feet.

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Short Baseline Test Results

Click.....

OCRS Alpha Testing - Short Baseline Testing On NOAA Calibrated Base Lines (Pass/Fail Test)
GPS Measurement of Grid Zone Distances vs. NGS Record Ground Distances (Horizontal)

How to use this spreadsheet. With the particular projection zone parameters (coordinate system) in your data collector or post processing software take GPS measurements on the end point monuments for the NGS calibrated baselines shown below and determine your measured horizontal grid dist. between the monuments. Enter that metric value in the yellow box to the min. The NGS hor. distance is considered the record value (Blue box). The NGS CBL record value has been extracted from the NGS webpage: <http://www.ngs.noaa.gov/CRLINES/BASELINES/> or the absolute value horizontal difference is shown in the orange box. The allowable error at 10ppm (or 20ppm) level. This is a Pass/Fail test. Fail only means that the result is outside of the 10ppm (or 20ppm) level. If the difference is less than or equal to the allowed error then the measurement on the map projection passes (red box). The only entry needed is the appropriate local zone grid distance entered in the yellow box.

Local Portland Zone (10ppm Single Parallel Lambert Map Projection)									
PELLSBORO CBL (1987) US DEPARTMENT OF COMMERCE - NOAA CALIBRATION BASE LINE DATA									
FROM STATION	ELEV (M)	TO STATION	ELEV (M)	HORIZONTAL	MARK - MARK	ERROR/MM			
0	80.990	1370	82.301	1366.9648	1370.0217				
ORGN or Static GPS Method	Meas. Grid Zone Horiz. Distance=		1369.995	H. Ground Dist. From NGS=	1369.995	Difference=	0.003	Pass/Fail=	Pass
GPS data gathered by Randy Oberg, Processed by Mark Armstrong									
1:000 000 Allowed Error= 0.003									
AURORA CBL (1976, 1990, 2000 RE MEASURED) US DEPARTMENT OF COMMERCE - NOAA CALIBRATION BASE LINE DATA									
FROM STATION	ELEV (M)	TO STATION	ELEV (M)	HORIZONTAL	MARK - MARK	ERROR/MM			
0 (PLSO 7)	88.840	1530 (PLSO 7)	88.361	1530.5701	1530.5701				
ORGN or Static GPS Method	Meas. Grid Zone Horiz. Distance=		1530.570	H. Ground Dist. From NGS=	1530.570	Difference=	0.000	Pass/Fail=	Pass
Data from Marion County									
1:000 000 Allowed Error= 0.000									
MCMINNVILLE CBL (1969, 2001) US DEPARTMENT OF COMMERCE - NOAA CALIBRATION BASE LINE DATA									
FROM STATION	ELEV (M)	TO STATION	ELEV (M)	HORIZONTAL	MARK - MARK	ERROR/MM			
0	48.375	1130	47.223	1129.9614	1129.9620				
ORGN or Static GPS Method	Meas. Grid Zone Horiz. Distance=		1129.960	H. Ground Dist. From NGS=	1129.963	Difference=	0.003	Pass/Fail=	Pass
GPS data gathered by Randy Oberg, Processed by Mark Armstrong									
1:000 000 Allowed Error= 0.003									
Local Salem Zone (10ppm Transverse Mercator Map Projection)									
ALBANY CBL (1962, 2000 RE MEASURED)									
FROM STATION	ELEV (M)	TO STATION	ELEV (M)	HORIZONTAL	MARK - MARK	ERROR/MM			
0	86.689	1240	87.066	1239.9699	1239.9901				
ORGN or Static GPS Method	Meas. Grid Zone Horiz. Distance=		1239.990	H. Ground Dist. From NGS=	1239.988	Difference=	0.002	Pass/Fail=	Pass
Data from Marion County									
1:000 000 Allowed Error= 0.002									
MCMINNVILLE CBL (1969, 2001) US DEPARTMENT OF COMMERCE - NOAA CALIBRATION BASE LINE DATA									
FROM STATION	ELEV (M)	TO STATION	ELEV (M)	HORIZONTAL	MARK - MARK	ERROR/MM			
0	48.375	1130	47.223	1129.9614	1129.9620				
ORGN or Static GPS Method	Meas. Grid Zone Horiz. Distance=		1129.959	H. Ground Dist. From NGS=	1129.963	Difference=	0.004	Pass/Fail=	Pass
GPS data gathered by Randy Oberg, Processed by Mark Armstrong									
1:000 000 Allowed Error= 0.004									
Local Eugene Zone (10ppm Transverse Mercator Map Projection)									
EUGENE CBL (1994, 2001 RE MEASURED) US DEPARTMENT OF COMMERCE - NOAA CALIBRATION BASE LINE DATA									
FROM STATION	ELEV (M)	TO STATION	ELEV (M)	HORIZONTAL	MARK - MARK	ERROR/MM			
0	120.578	1200	118.553	1199.9714	1199.9751				
ORGN or Static GPS Method	Meas. Grid Zone Horiz. Distance=		1199.970	H. Ground Dist. From NGS=	1199.973	Difference=	0.003	Pass/Fail=	Pass
GPS data gathered by Randy Oberg and Mark Armstrong									
1:000 000 Allowed Error= 0.003									
Regional Willamette Zone (20ppm Transverse Mercator Map Projection)									
PELLSBORO CBL (1987) US DEPARTMENT OF COMMERCE - NOAA CALIBRATION BASE LINE DATA									
FROM STATION	ELEV (M)	TO STATION	ELEV (M)	HORIZONTAL	MARK - MARK	ERROR/MM			
0	80.990	1370	82.301	1366.9648	1370.0217				
ORGN or Static GPS Method	Meas. Grid Zone Horiz. Distance=		1370.000	H. Ground Dist. From NGS=	1369.995	Difference=	0.005	Pass/Fail=	Pass
GPS data gathered by Randy Oberg, Processed by Mark Armstrong									
2:000 000 Allowed Error= 0.005									
AURORA CBL (1976, 1990, 2000 RE MEASURED) US DEPARTMENT OF COMMERCE - NOAA CALIBRATION BASE LINE DATA									
FROM STATION	ELEV (M)	TO STATION	ELEV (M)	HORIZONTAL	MARK - MARK	ERROR/MM			
0 (PLSO 7)	88.840	1530 (PLSO 7)	88.361	1530.5701	1530.5701				
ORGN or Static GPS Method	Meas. Grid Zone Horiz. Distance=		1530.570	H. Ground Dist. From NGS=	1530.570	Difference=	0.000	Pass/Fail=	Pass
Data from Marion County									
2:000 000 Allowed Error= 0.000									
ALBANY CBL (1962, 2000 RE MEASURED)									
FROM STATION	ELEV (M)	TO STATION	ELEV (M)	HORIZONTAL	MARK - MARK	ERROR/MM			
0	86.689	1240	87.066	1239.9699	1239.9901				
ORGN or Static GPS Method	Meas. Grid Zone Horiz. Distance=		1240.000	H. Ground Dist. From NGS=	1239.985	Difference=	0.015	Pass/Fail=	Pass
Data from Marion County									
2:000 000 Allowed Error= 0.015									
MCMINNVILLE CBL (1969, 2001) US DEPARTMENT OF COMMERCE - NOAA CALIBRATION BASE LINE DATA									
FROM STATION	ELEV (M)	TO STATION	ELEV (M)	HORIZONTAL	MARK - MARK	ERROR/MM			
0	48.375	1130	47.223	1129.9614	1129.9620				
ORGN or Static GPS Method	Meas. Grid Zone Horiz. Distance=		1129.959	H. Ground Dist. From NGS=	1129.963	Difference=	0.004	Pass/Fail=	Pass
GPS data gathered by Randy Oberg, Processed by Mark Armstrong									
2:000 000 Allowed Error= 0.004									
EUGENE CBL (1994, 2001 RE MEASURED) US DEPARTMENT OF COMMERCE - NOAA CALIBRATION BASE LINE DATA									
FROM STATION	ELEV (M)	TO STATION	ELEV (M)	HORIZONTAL	MARK - MARK	ERROR/MM			
0	120.578	1200	118.553	1199.9714	1199.9751				
ORGN or Static GPS Method	Meas. Grid Zone Horiz. Distance=		1199.970	H. Ground Dist. From NGS=	1199.973	Difference=	0.003	Pass/Fail=	Pass
GPS data gathered by Randy Oberg and Mark Armstrong 8-28-08									
2:000 000 Allowed Error= 0.003									

On NGS Calibrated Baselines in each zone.

Distances from 1100-1300 meters.

Used NGS record measured ground EDM distance vs. the zone grid distance measured with dual frequency GPS.

Excellent Results!



Long Baseline Testing

Click.....

OCRS Local Portland Zone Long Baseline Alpha Testing
Inverse Report

User name: Mark Armstrong Date & Time: 5/24/2009 12:04
 Coordinate System: OCRS LOCAL PORTLAND Zone: OCRS LOCAL PORTLAND
 Project Datum: NAD 1983 (Corus) COR896
 Vertical Datum: Geoid Model: GEOID03 (Corus)
 Coordinate Units: Meters
 Distance Units: Meters
 Height Units: Meters

Ground distance manual calculation*
 Data from 24 hour RINEX files from date 5-19-2009 Processed and inverted in TGO.
 Coordinates are not from a fixed adjustment and for baseline distance determination only (unconstrained positions).

Grid	Zone	Cartesian (WGS-84)
7428		
Northing: 89159.980m	Latitude: 45°51'04.83480"W	X: -3439995.850m
Easting: 61962.752m	Longitude: 123°14'22.05671"W	Y: -3722187.619m
Elevation: 198.608m	Height: 177.704	Z: -4553877.521m
Convergence: -0°20'56.789678"		
Inverse:		
Grid Azimuth: 169°55'08"	NS Fwd Azimuth: 169°34'11"	Delta X: -8260.393m
Grid Distance: 35403.362	NS Back Azimuth: 340°37'43"	Delta Y: -24207.355m
Delta Elevation: -33.131m	Ellipsoid Dist: 35403.643	Delta Z: -24390.150m
I-T Correction: 0°00'00.446791"	Ground Dist (TGO): 35404.370	Slope Dist: 35404.449
Elevation Scale Factor: 0.99997947	Delta Height: -33.919m	
Grid Scale Factor: 1.000009	Ground Dist. Calc.**: 35404.393	
Combined Factor: 0.99998847		
8411		
Northing: 54302.500m	Latitude: 45°32'16.75202"W	X: -3447656.243m
Easting: 68179.844m	Longitude: 123°09'26.64210"W	Y: -3746485.266m
Elevation: 105.567m	Height: 83.825	Z: -4529467.371m
Convergence: -0°17'26.063137"		
7428		
Northing: 89159.980m	Latitude: 45°51'04.83480"W	X: -3439995.850m
Easting: 61962.752m	Longitude: 123°14'22.05671"W	Y: -3722187.619m
Elevation: 198.608m	Height: 177.704	Z: -4553877.521m
Convergence: -0°20'56.789678"		
Inverse:		
Grid Azimuth: 92°36'57"	NS Fwd Azimuth: 92°15'56"	Delta X: 34957.867m
Grid Distance: 42504.069	NS Back Azimuth: 272°39'28"	Delta Y: -24139.489m
Delta Elevation: -112.417m	Ellipsoid Dist: 42503.223	Delta Z: -1353.186m
I-T Correction: 0°00'04.152909"	Ground Dist (TGO): 42504.097	Slope Dist: 42504.1
Elevation Scale Factor: 0.99998106	Delta Height: -113.434m	
Grid Scale Factor: 1.00001993	Ground Dist. Calc.**: 42504.093	
Combined Factor: 1.00000099		
8414		
Northing: 57220.077m	Latitude: 45°50'05.50428"W	X: -3404437.983m
Easting: 104462.500m	Longitude: 122°41'34.15594"W	Y: -3746827.401m
Elevation: 86.261m	Height: 84.27	Z: -4552524.333m
Convergence: 0°02'26.815370"		

Tested long distances 30k – 120k between established PBO CORS stations in each zone.

Ground distances between stations calculated base on Vincenty Formula scaled to the average ellipsoid height of the stations.

Ground distance then compared to processed grid zone distance.



Medium Length Baseline Testing

- Medium distance testing 4k – 8k
- Ground distances measured with EDM and prism bank.
- N-S and E-W lines measured. One set in each zone.
- Same points observed with dual frequency GPS and processed in grid zone.
- Compare ground distance vs. grid distance.



New Zone Planning

- Regional Zones (+/-20ppm) 1:50 000
 - Central Oregon (Hwy. 97) – 2 Zones
 - Oregon Coast (Hwy. 101) – 2 Zones
 - Eastern Oregon (I-84) – 1 Zone
 - Southern Oregon (I-5) – 3 Zones
- Local Urban Zones (+/-10ppm) 1:100 000
 - Glendale – Gold Hill – 1 Zone
 - Medford – Ashland – 1 Zone
 - Klamath Falls – 1 Zone
 - Sisters – Redmond –Prineville - Bend – 1 Zone
 - Ontario – 1 Zone



Primary OCRS Coverage

- ~18 Total local and regional zones
- Cover main urban areas of the state
- Cover major highway system corridors
- Other zones may be created as needed in the future



ORGN (RTN) Testing

- Test to push new zone coordinate systems to rovers in the field.
- Each zone would have a particular port assignment??
- User would accept disclaimer and perform own QC.
- Users could also just pick a zone coordinate system they placed in their data collector.



OCRS Handbook and User Guide

- 1st draft written
- ODOT review
- Technical team review
- Outside review
- Adoption and presentation
 - TBA - April 2010 rollout at ODOT/OGUG workshop
 - Legislative preparation



Oregon Department of Transportation



Stay Tuned

