"Beginners Guide to GPS Elevation" …Plus an Update on GPS Technology

A TMS Presentation

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- Elevation Definitions
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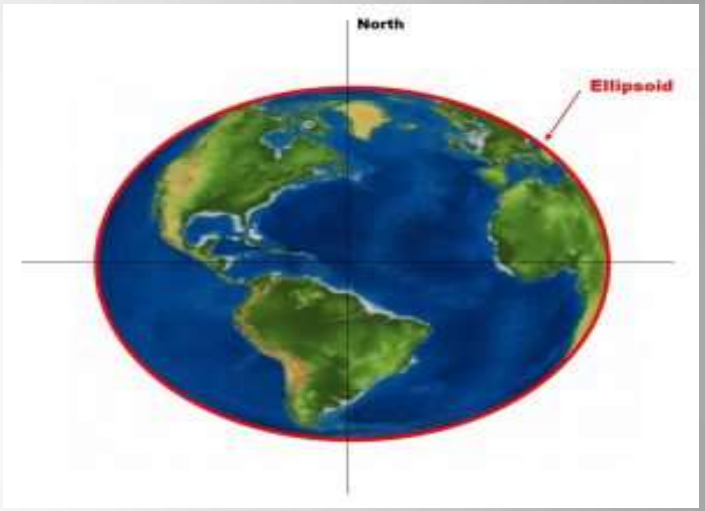
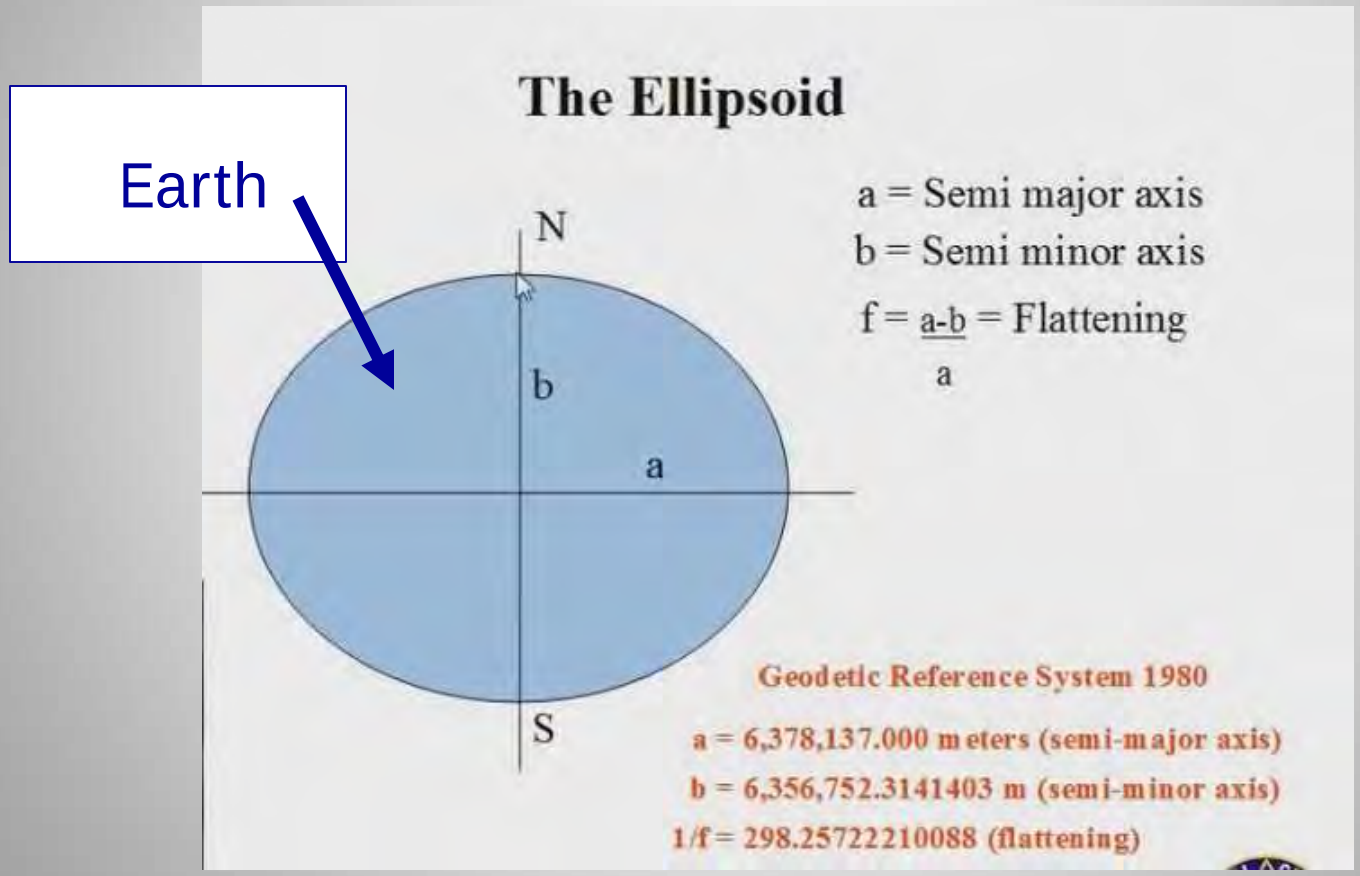


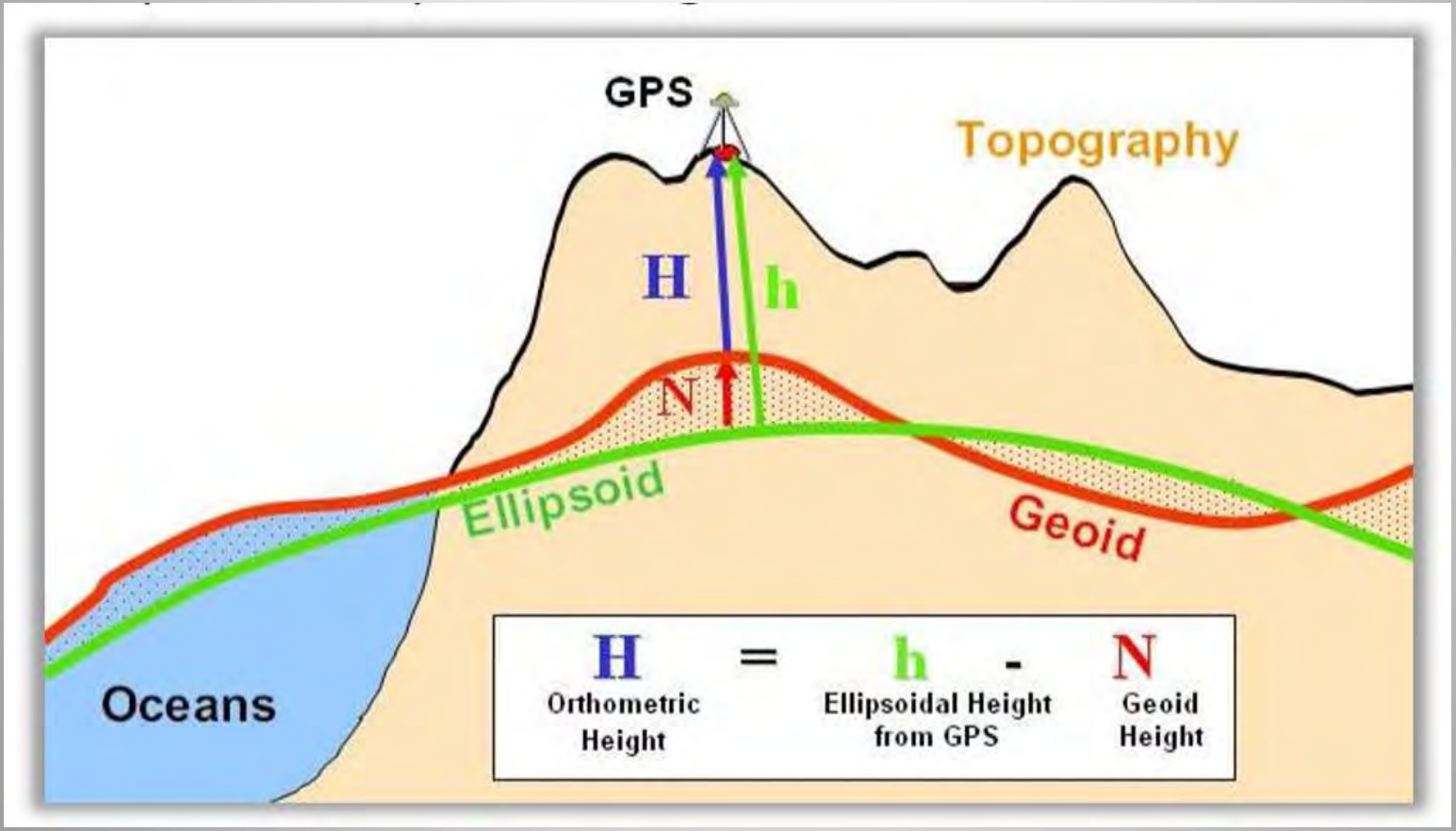
The Dreaded Definitions

- Elevations
  - Ellipsoid Height – Elevation above or below the reference Ellipsoid
    - Ellipsoid- Theoretical concept of earth's surface above or below a perfect reference ellipsoid
    - All GPS units calculate elevation relative to the ellipsoid. Some automatically convert to MSL
  - Mean Sea Level (MSL) An arithmetic average height of the sea with respect to the earth's surface
  - Geoid - Representation of the earth's surface based on earth's gravity which best fits mean sea level.

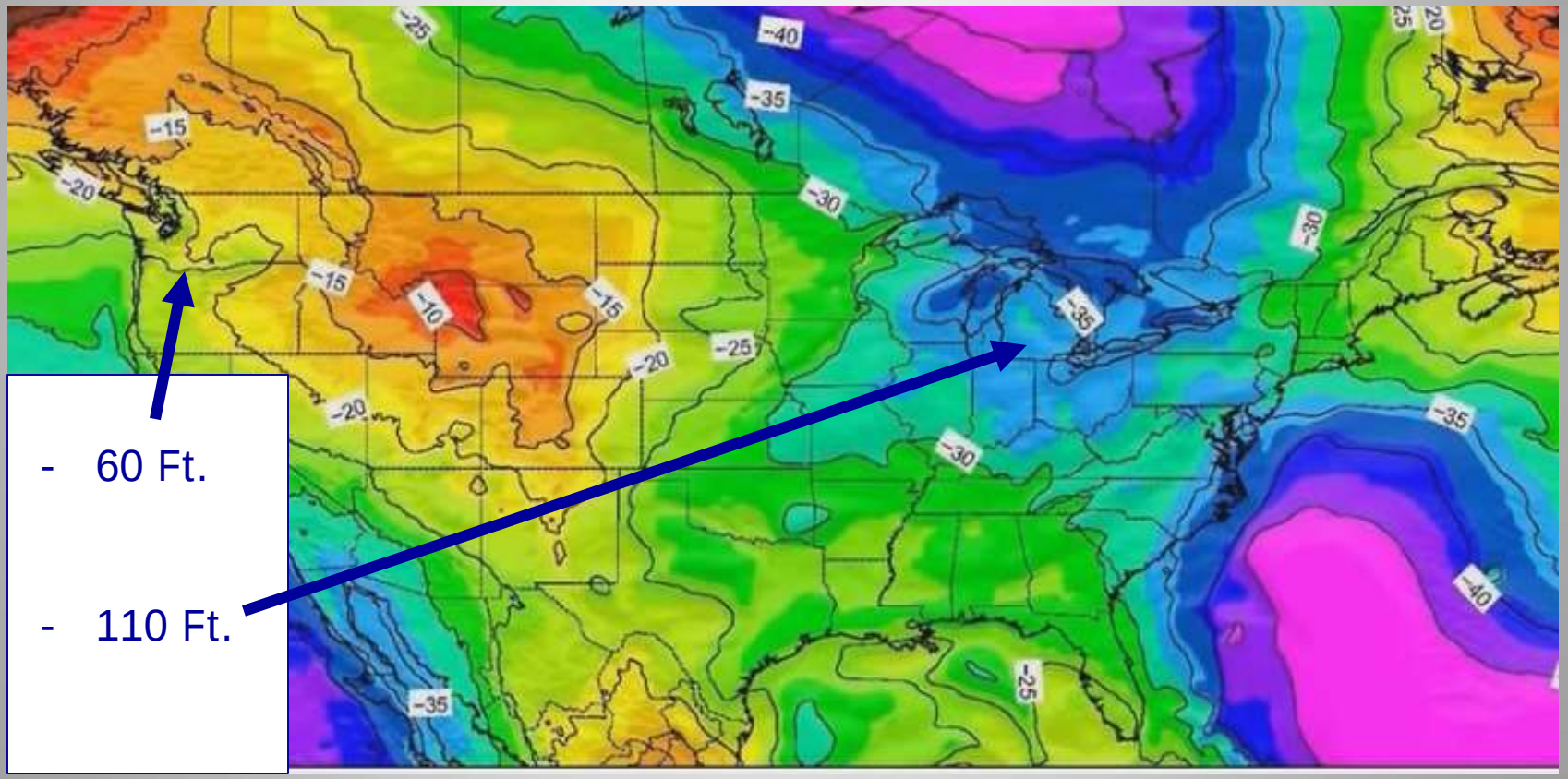
The Ellipsoid In More Detail



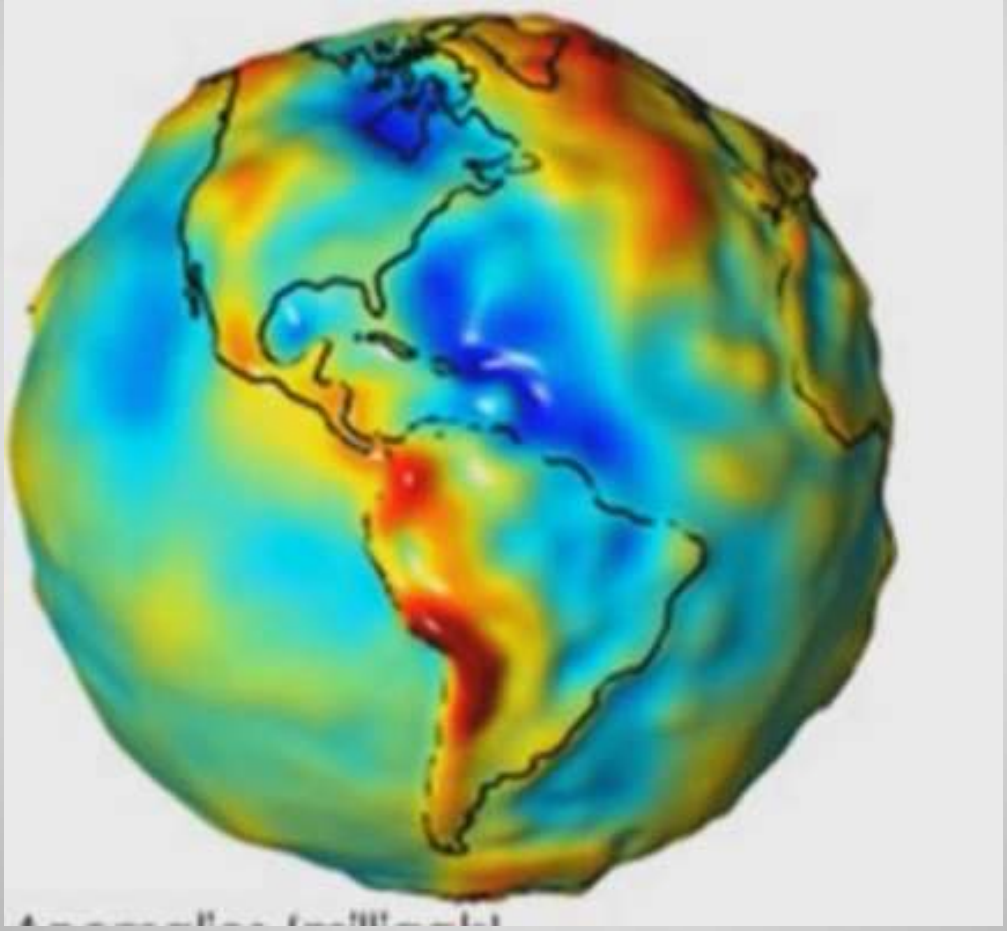
Ellipsoid & Geoid



Geoid Separations



Gravity Varies Over the Earth



The Problems with Mean Sea Level

- The Earth is not perfectly round
- Tides go in and out and it is difficult to come up with an average over a big area
- Doesn't make much sense when inland a long ways (Geoid models solve this)

Why Elevation Is Important

- We need to know direction of water flow
- Elevation is important when landing airplanes.
- Risk of Flooding in many areas
- Road Building; avoiding maximum slope

Elevation Errors

- Ellipsoidal vs Geoid Heights (MSL)
  - 40 to 120 feet difference in the US
- Selecting the correct vertical datum
  - For Surveyors looking for centimeter accuracy
- Equipment Capability
  - GPS elevation accuracy is twice as bad as horizontal accuracy
    - 5 meter horizontal accuracy = 10 meter Elevation accuracy

Quiz

- Two 6’ tall men are at opposite ends of the Great Salt Lake at the waters edge
- Distance between them is 76 miles
- Question: If a straight line is drawn from the top of one head to the other head, will the mid-point of the line be:
  - Above the water
  - At the water
  - Below the water

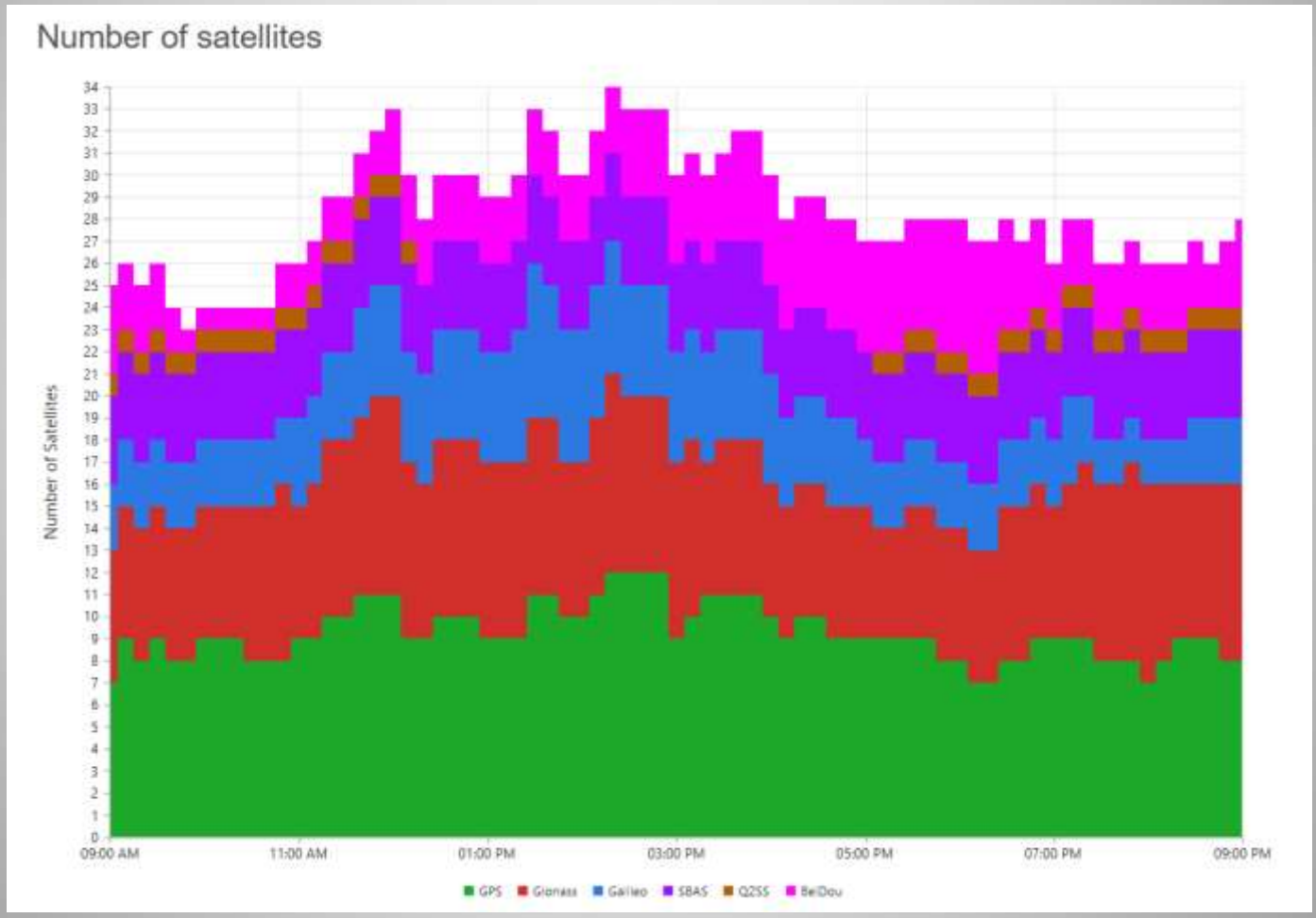
Current Status of GNSS System

• GPS satellites (US)	31
• GLONASS satellites	24
• Galileo satellites	14
• Beidou (China) satellites	15
• QZSS (Japan) satellites	3
• SBAS (WAAS)	2

	89

Satellite Status March 31, 2018

Portland, Oregon 10 Degree Mask



L5 Signal – It's Starting To Help

- Used in all new Survey Grade GPS units
- 18 GPS Satellites with L5 by 2018
- All Beidou and Galileo Satellites will have L5
- 25% stronger signal that L1
- Coming to consumer grade units **soon**.

Broadcom's New Chip For Smart Phones

- BCM47755
  - 30 Centimeter accuracy potential
  - L1 and L5 Capable
  - GNSS
  - Low Power Consumption ****
  - **Designed for "Urban Canyons"**
  - Available in Smartphones 2018
    - Which phones? Broadcom **won't say.**

Conclusion

- Figuring elevations was easier in the 1400's when the earth was flat. ;>)
- Know what elevation your GPS is giving you. Ellipsoidal/MSL
- 89 GNSS satellites available today
- "GNSS technology will change more in the next 3 years than it has in the past 15 years" – Quote by Eric Gakstatter 2018 (Surveying Editor GPS World mag)

Thanks!

For all your GPS Work:

- May your elevations be accurate
- May your smart phone never give you bad directions.
- May your Lithium ion batteries never blow up.

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