GLADYS WEST

Born in 1930, in rural Virginia, Gladys West, grew up in a farming community and faced racial segregation but was determined to pursue higher education. After earning a degree in mathematics, she worked as a programmer at the Naval Proving Ground in Virginia (now known as the Naval Surface Warfare Center).

West began her career during a time when computers were still evolving, and much of the work required meticulous hand calculations. She later became a skilled programmer on the IBM 7030 "Stretch" computer, one of the most powerful of its time. Later on, her meticulous work on satellite data processing helped create models of the Earth's shape, which would become essential in calculating accurate global positioning.

This model allowed for unprecedented accuracy in positioning calculations, forming the basis for the Global Positioning System (GPS).

Despite her foundational contributions, West's work went largely unrecognized for decades. In 2018, the U.S. Air Force inducted her into the Space and Missile Pioneers Hall of Fame, acknowledging her role in the history of satellite-based navigation.

" You're working every day, you're not thinking, 'What impact is this going to have on the world?' You're thinking, 'I've got to get this right. "

One of Gladys West's most technically demanding projects was modeling the Earth's geoid—the true, irregular shape of Earth. Unlike a perfect sphere, the Earth's shape varies slightly due to gravitational forces, mountains, valleys, and the distribution of mass. Her role required advanced programming skills to process vast amounts of data and generate a model accurate enough for what would later become GPS.

Although West retired before the Gravity Recovery and Climate Experiment (GRACE) mission, her contributions laid the foundation for such work. The GRACE satellite, which launched in 2002, used gravitational measurements to map changes in Earth's gravity field—something West's early models helped to make possible. West's geoid model became fundamental for projects like GRACE, as her work allowed scientists to better understand the Earth's gravitational anomalies and their effect on global measurements.

More Information: GPS Gladys West GRACE Mission

Experiment: Gravitational Impact for GPS Accuracy

The Earth's gravitational field isn't uniform; gravity is slightly stronger or weaker depending on location. Use a "gravitational anomaly map" to see how gravity varies at each location.

1. Calculate Distance Between Points: Choose three pairs of locations on a globe or 3D model of the Earth:

– One pair over the ocean,
– One pair over flat land,
– One pair over mountainous terrain.

• Use this formula for each pair to estimate the distance between points:

$$d = R \times \theta$$

Where:
– d is the distance
– R is Earth's radius, which changes slightly based on terrain (use R = 6, 371 km for ocean, 6, 373 km for land, and 6, 378 km for mountains),
– θ is the angle between the points (measured on a globe).

2. Adjust for Gravitational Differences: Small gravitational differences can subtly affect GPS signals, so we adjust our distance calculation to include this:

$$d_{adjusted} = d \times \left(1 + \frac{\Delta g}{g_{average}}\right)$$

– Δg is the difference in gravity from the average (9.8 m/s²). This means if gravity at a point is slightly higher or lower than 9.8, we'll adjust our distance accordingly.

3. **Compare to GPS Data**: - Use an online tool to look up the real GPS distance for each point pair and compare the GPS-measured distances to your calculated values and see if the terrain (different radii) and gravitational adjustments made a difference.

4. **Error Analysis:** Calculate the difference between your calculated distances and the GPS data. Discuss why GPS must consider these small changes in gravity and elevation to stay accurate—just like Gladys West did.