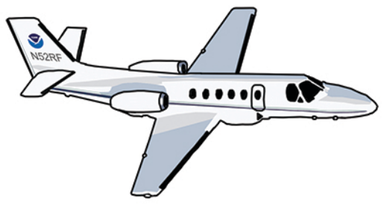
NOAA's National Geodetic Survey

GRAV-D 2015



Who is NOAA/NGS?

The National Oceanic and Atmospheric Administration (NOAA) is the nation's oldest scientific agency dating back to 1807 when Thomas Jefferson created the Survey of the Coast. This agency was created to assist the United States of America increase commerce by providing maps of the land, shore and waterways to assist shipping, the main form of commerce, and avoid ship wrecks. NOAA's mission is Science, Service and Stewardship, to understand and predict changes in climate, weather, oceans, and coasts; to share that knowledge and information with others; to conserve and manage coastal and marine ecosystems and resources.

The National Geodetic Survey (NGS) is a program office within NOAA's National Ocean Service. NGS defines the position and height framework for the US and all its territories by developing the official US datums, and geoid models used for positioning. NGS' mission is to define, maintain and provide access to the National Spatial Reference System (NSRS) to meet our nation's economic, social, and environmental needs. One critical component of the NSRS is the determination of "height" -- specifically ellipsoid height, orthometric height and dynamic height -- of any point in the United States or its territories. These surveys will greatly assist NGS in providing more accurate geoid models for determining or computing heights.

What is GRAV-D?

In 2007 the National Geodetic Survey released the Gravity for the Redefinition of the American Vertical Datum (GRAV-D) project plan. The purpose of this project is to collect, process and analyze accurate gravity data for the entire United States of America and its territories. Accurate gravity data is the foundation for the determination of heights and this project will provide the US with a gravity-based vertical datum that will provide accurate heights to within 2 cm level for much of the country.

Global Positioning Systems (GPS) has become an invaluable tool for determining position and ellipsoid heights very quickly and there is a pressing desire to attain orthometric heights similarly fast. Ellipsoid heights cannot be used to determine where water will flow, and therefore cannot be used in topographic/floodplain mapping. In order to transform from ellipsoid heights to orthometric heights, a model of the geoid must be computed, and geoid modeling can only be done with measurements of the acceleration of gravity near the Earth's surface. The gravimetric geoid created from these gravity surveys will be the first geoid that is also the official vertical datum for the US.

To learn more about GRAV-D or to download data from completed surveys you can visit the following URL:

http://geodesy.noaa.gov/GRAV-D/

What is Gravitation?

Gravitation is the force of attraction between all masses in the universe; that gravitation between two bodies is proportional to the product of their masses and inversely proportional to the square of the distance between them. According to Newton's law of gravitation two points with masses m_1 and m_2 separated by a distance l, attract each other with a force

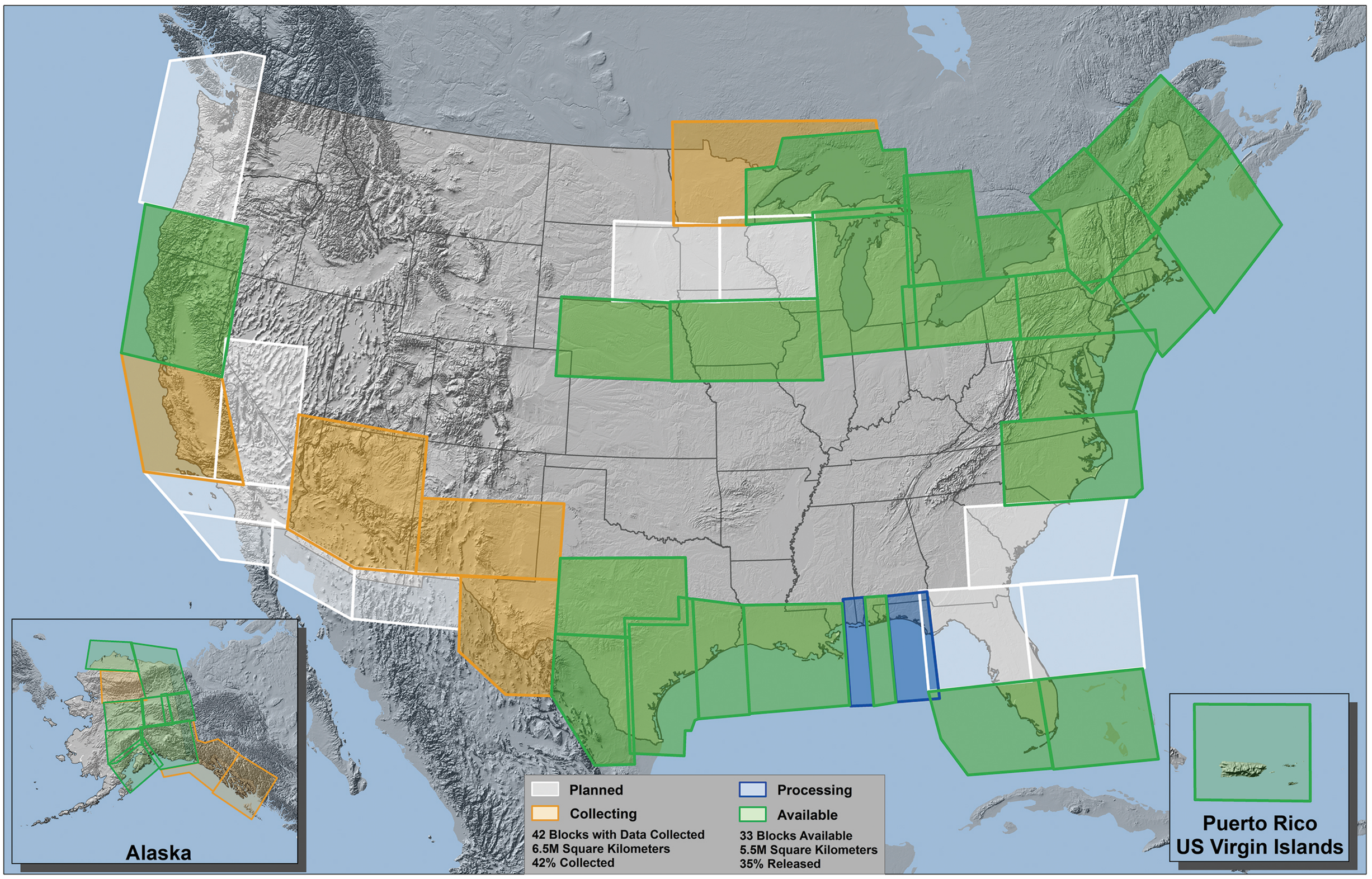
$$F = G(m_1 m_2 / l^2)$$

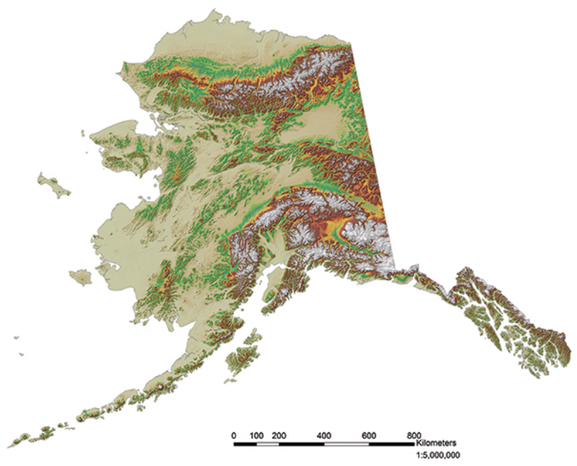
where G is Newton's gravitational constant.

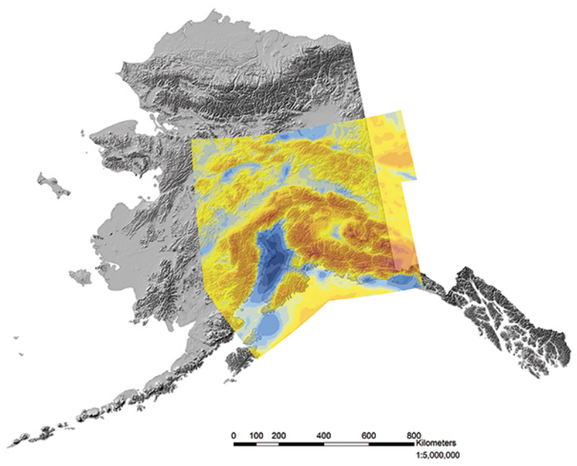
Rearranging the variables in the above formula provides the formula to express the accelration of mass m_2 due to the force exerted by the mass m_1 at a distance of l from m_1 .

$$a_2 = F/m_2 = G(m_1 / l^2)$$

Of particular importance is the attraction of the Earth's mass for bodies near its surface. The force acting on a body at rest on the Earth's surface is the resultant of gravitational force and the centrifugal force of the Earth's rotation. This combination of gravitational and centrifugal forces is what we call "gravity".







Gravity and Topography

Gravity measurements are influenced by both the distribution of mass and the centrifugal force due to Earth's rotation, as mentioned above. To make gravity measurements useful for determining heights, the gravity observations must be corrected and reduced using several computational processes. One of the most useful reduced quantities is the gravity disturbance, which is the difference between corrected observed gravity and an idealized model of Earth's gravity. This difference is directly related to density variation in the Earth that affect heights. The gravity disturbance is determined at the height where gravity is observed, so to make the values consistent they are computed at a height of zero to obtain free-air gravity disturbances. But the free-air gravity disturbances include the gravitational effect of topographic masses, and it must be accounted for when using gravity for geoid modeling and other height calculations. To do this, models of topographic gravitation are derived from digital elevation models and density estimates. The final result of all these computations is a gravity model that can be used for height determination, including derivation of a model of the geoid that can be combined with GNSS to obtain accurate orthometric heights.

National Geodetic Survey
National Ocean Service
National Oceanic and Atmospheric Administration
United States Department of Commerce

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Data Sources: NOAA, USGS, U.S. Census, Esri
Datum: North American Datum of 1983 (2011)
Projection: USA Contiguous Lambert Conformal Conic