The measurement of gravitation on a moving vehicle, such as an aircraft, requires an accurate determination of its kinematic acceleration, derivable only from the geometric position of the vehicle by numerical differentiation. Two types of error enter the computation: the model error, depending largely on the temporal resolution of the position data, and the effect of position error. For typical 1 Hz GPS data, simulated from an actual, accurately known aircraft trajectory, the central-difference differentiator, having nearly perfect frequency response over a bandwidth that depends on the filter order, is limited to about 0.02 m/s² (standard deviation) for a general, high-dynamic, aircraft trajectory, such as a lidar mission. For quieter, dedicated, airborne gravimetry trajectories, this differentiator performs about an order of magnitude better, where the error is almost directly proportional to the dynamics of the platform. Averaging over time reduces the model error by orders of magnitude. A higher sampling rate of positions, say 10 Hz, similarly reduces the model error. Uncorrelated position error is controlled with sufficient smoothing, and correlated position error is generally less detrimental. In summary, the key factors affecting the kinematic acceleration error are, aside from the order of the differentiator, the sampling rate, the platform dynamics, and the amount of smoothing needed to suppress both high-frequency model error and position uncertainty. Tradeoff analyses are given that indicate processing strategies specifically for GPS as a kinematic accelerometer.