Calculation the Earth Gravity Najaf and Kufa city / Iraq with New Model

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Abstract

In this research paper, The Earth gravity between Najaf and Kufa city/ Iraq (latitude 32.5 – 33.5^0), has been studies, and the Earth gravity for altitude (30-60 m) for Troposphere layer (60-1030m) above sea level has been calculated. The results explained that the Earth gravity in this region was less than that in sea level, A new model for Earth gravity with altitude has been found; and it was very compatible with the word research.

Key words: The Earth gravity**,** Najaf and Kufa city

حساب الجاذبية الارضية بين مدينتي النجف والكوفة في العراق بموديل رياضي جديد

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الملخص:

في هذا البحث تم دراسة الجاذبية الارضية للمنطقة بين مدينتي النجف والكوفة في العراق (خط العرض 33.5^0 –32.5)،حيث تم حساب الجذب الارضي للارتفاع من 30-60 متر بين المدينتين وكذلك للطبقة الجوية الاولى التروبوسفير من 60-1030 متر فوق مستوى سطح البحر. اوضحت النتائج التي تم الحصول عليها ان الجذب الارضي في هذه المنطقة اقل مما هو عليه عند مستوى سطح البحر، كما تم الحصول على موديل جديد للجذب الارضي مع الارتفاع وكانت نتائجه متوافقة بشكل كبير مع البحوث العالمية المنشورة.

الكلمات المفتاحية: الجاذبية الأرضية ، النجف ، الكوفة

1- Introduction:

Historically, gravity has played a central role in studies of dynamic processes in the earth's interior and is also important in exporting geophysics. The concept of gravity is relatively simple, high precision measurements of the gravity field are inexpensive and quick, and spatial variations in the gravitational acceleration give important information about the dynamical state of earth [1]. Tracking data from some tens of satellites at different altitudes and orbit inclinations have over the last three decades gradually improved the knowledge of the Earth's gravity field[2]. The limitations are due to the attenuation of the gravitational signal with altitude, the sparse tracking data coverage, and the difficulties in modeling the non-gravitational forces for most of the satellites [3]. However, the study of the gravity of earth is not easy since many corrections have to be made to isolate the small signal due to dynamic processes, and the underlying theory although perhaps more elegant than, for instance, in seismology is complex[2,4]. The gravitational field of the Earth has been mapped by several techniques, including analyses of satellite tracking data, terrestrial measurement campaigns, and satellite altimetry of the ocean surface [5]. Recently, the Earth gravity has been a significant subject of study due to its impact on the topography of the Earth in which there are several hypotheses determining the Earth gravity such as the studies at Syowa Station, Antarctica, Nigeria , The North American and the Syowa Station, East Antarctica [6,7,8,9].

2- Theory of the Earth gravity:

The gravity on the ellipsoid can be derived from the gravitational potential U [10]:

$$U = \frac{GM}{r} + \frac{GMa^2}{r^3} J_2 \left[\frac{3}{2} sin^2 \emptyset - \frac{1}{2}\right] - \frac{1}{2}\omega^2 r^2 cos^2 \emptyset \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

where: G, M, ω are the gravitational constant, mass of the earth and the angular speed of the earth rotation respectively. The second term in equation (1) is due to spheroidal shape of the earth. J_2 is a constant determined by the distribution of mass and the term in bracket is the second degree harmonic giving the spheroidal shape. The third term is the centrifugal potential and *r* is the radius of the spheroid and varies with geographic latitude, $\emptyset$ according to:

$$r(\emptyset) = a(1 - f sin^2) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

a is the radius of the earth and f represents the flattering of the earth.

So the ellipsoidal model can now be written Thus, for GRS30, GRS1967, GRS80 and WGS84.

$$g_o = 9.78049(1 + 0.0052884sin^2\emptyset - 0.0000059sin^2 2\emptyset) \quad \text{(GRS30)} \quad (3)$$

$$g_0 = 9.78031846(1 + 0.0053024sin^2\emptyset - 0.0000058sin^2 2\emptyset) \quad \text{(GRS1967)} \quad (4)$$

$$g_0 = 9.7803267714\left\{\frac{1+0.00193185138639\,sin^2\emptyset}{\sqrt{1-0.00669437999013\,sin^2\emptyset}}\right\} \quad \text{(GRS80)} \quad (5)$$

$$g_o = 9.7803185(1 + 0.00527889sin^2\emptyset + 0.000023462sin^4\emptyset) \quad \text{(WGS84)} \quad (6)$$

where g_o is called normal gravity. The variation due to Earth's rotation is on the order of(± 0.03 m/s$^{2)}$) [7,11,12]. The inverse-square law of gravitation provides an expression for (g) as a function of altitude with sufficient accuracy for most model-atmosphere computations[13]:

$$g = g_0 \frac{r}{r+a} \quad (7)$$

where a is altitude

3. Results and Discussion:

This paper we calculates the Earth gravity in the region of Najaf and Kufa cities in Iraq (latitude 33.5^0-32.5^0, longitude 44.5^0-45.5^0)and altitude 30m in Kufa and 60m in Najaf city above sea level). By using matlab program, it has been found that the earth gravity in this region latitude 33.5^0-32.5^0) is from 9.7953m/s^2 to 9.793m/s^2 see Fig.(1); the Earth gravity has been calculated from altitude 30m to 1030m in tropospheric layer in the same region, see Fig.(2).Besides, the study has found the gravity for altitude from 30 to 60m (between region of Najaf and Kufa city) from (9.806562m/s^2 to 9.8064665 m/s^2)see Fig. (3). This study has found the gravity is less than the earth gravity as sea level Fig.(4). The earth gravity effects the topography of earth so the study of the gravity is very important in geography earth.

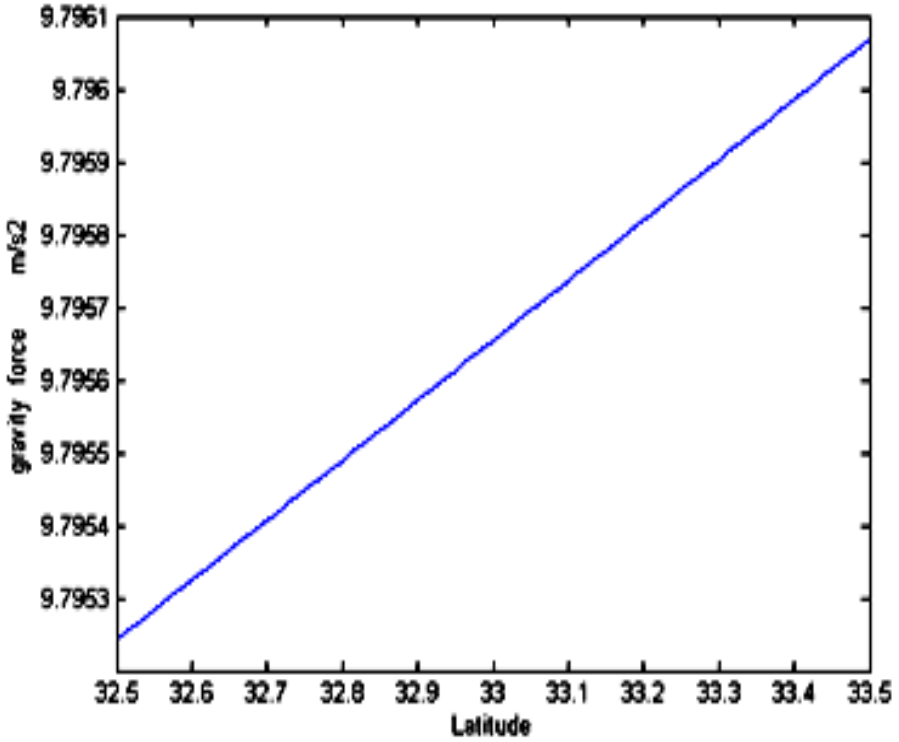

Fig. (1): The Earth Gravity between the latitudes 33.5^0-32.5^0

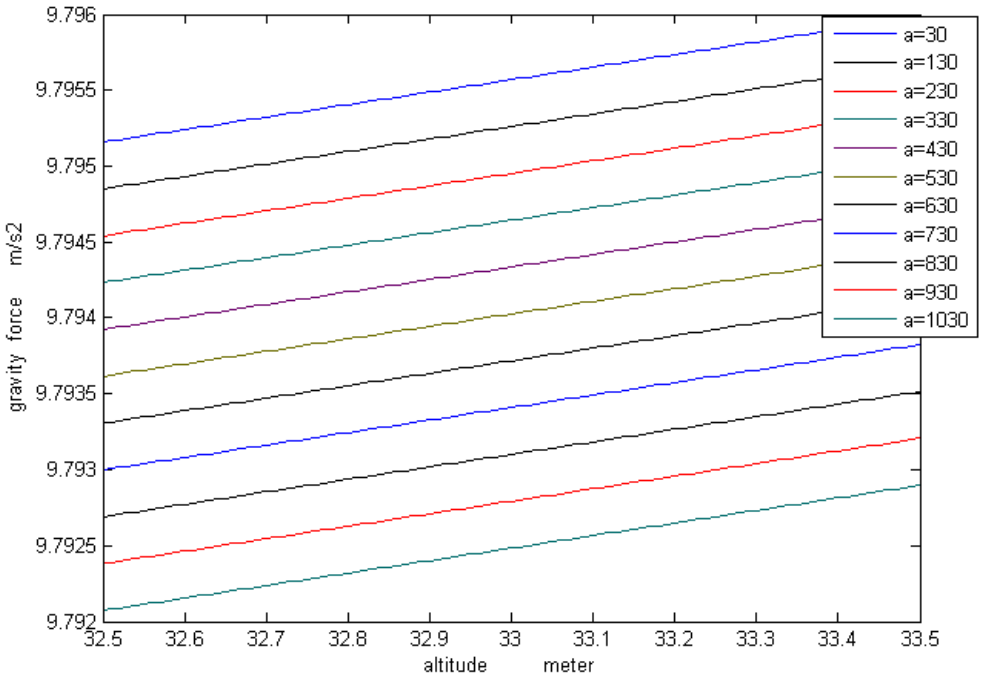

Fig.(2): The Earth Gravity from Altitude 30m to 1030m in Tropospheric Layer

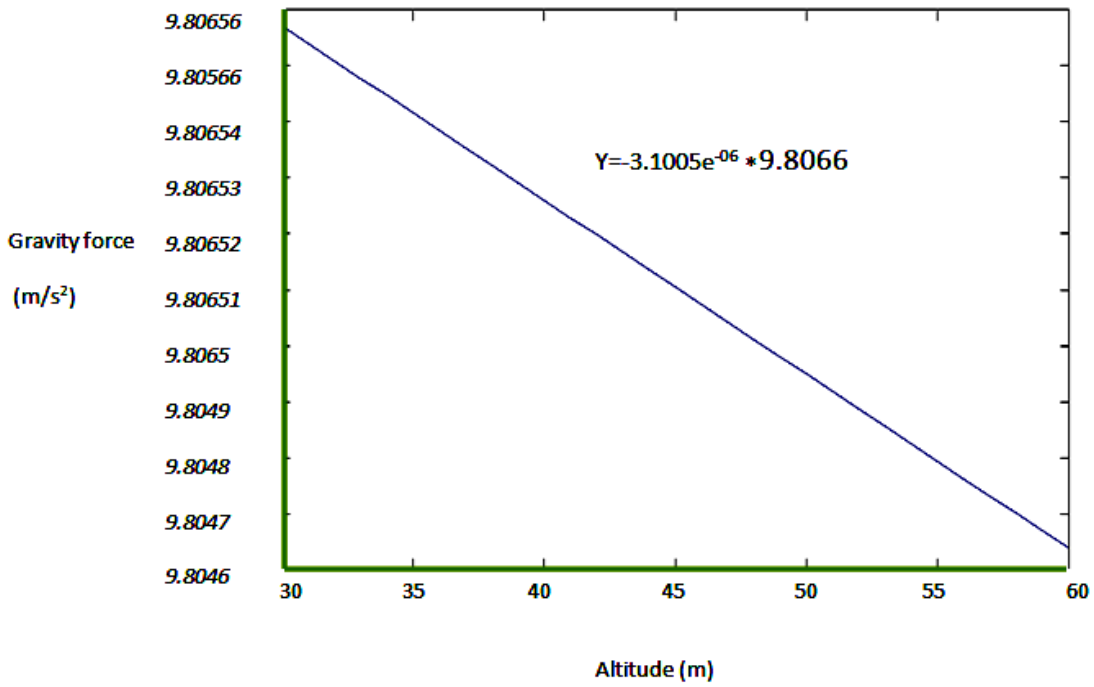

Fig. (3): The Earth Gravity for Altitude from 30 to 60m between Region of Najaf and Kufa City

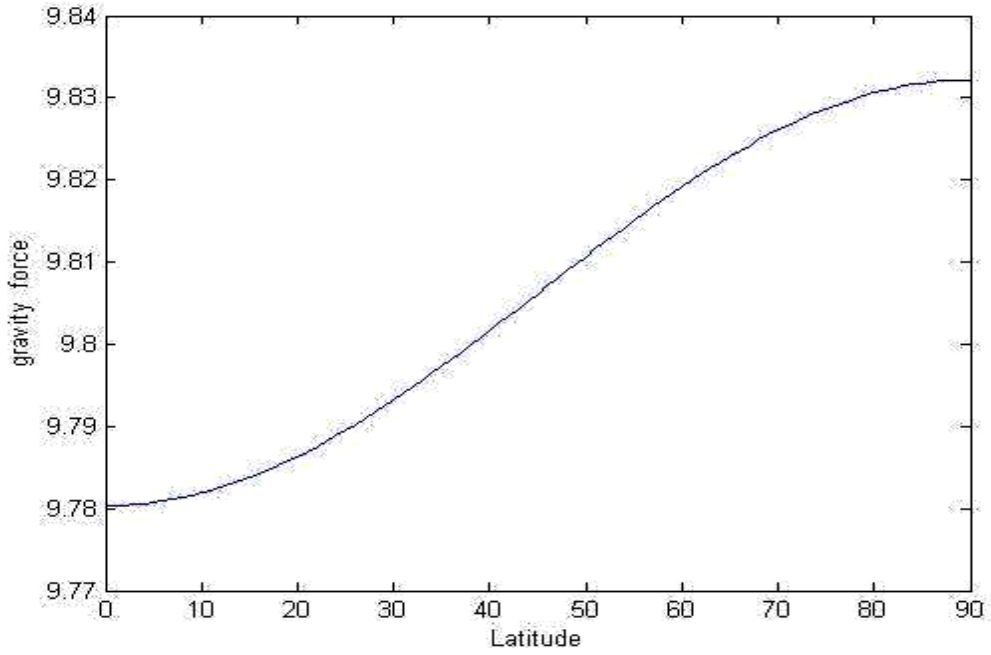

Fig.(4): The Earth gravity at Sea Level

In this study, a new model has been found, as fellows:-

$$g_0 = 9.80665\,(-3.1616 * 10^{-7} a + 1) \qquad \text{.. (8)}$$

This is used to calculate the gravity force where this eq. is in compatible with the result of eq. (7).

The lines counter in area between (longitude 44.5^0-45.5^0) and (latitude 33.5^0-32.5^0) for altitude (30m -700m) is shown in Fig. (5).

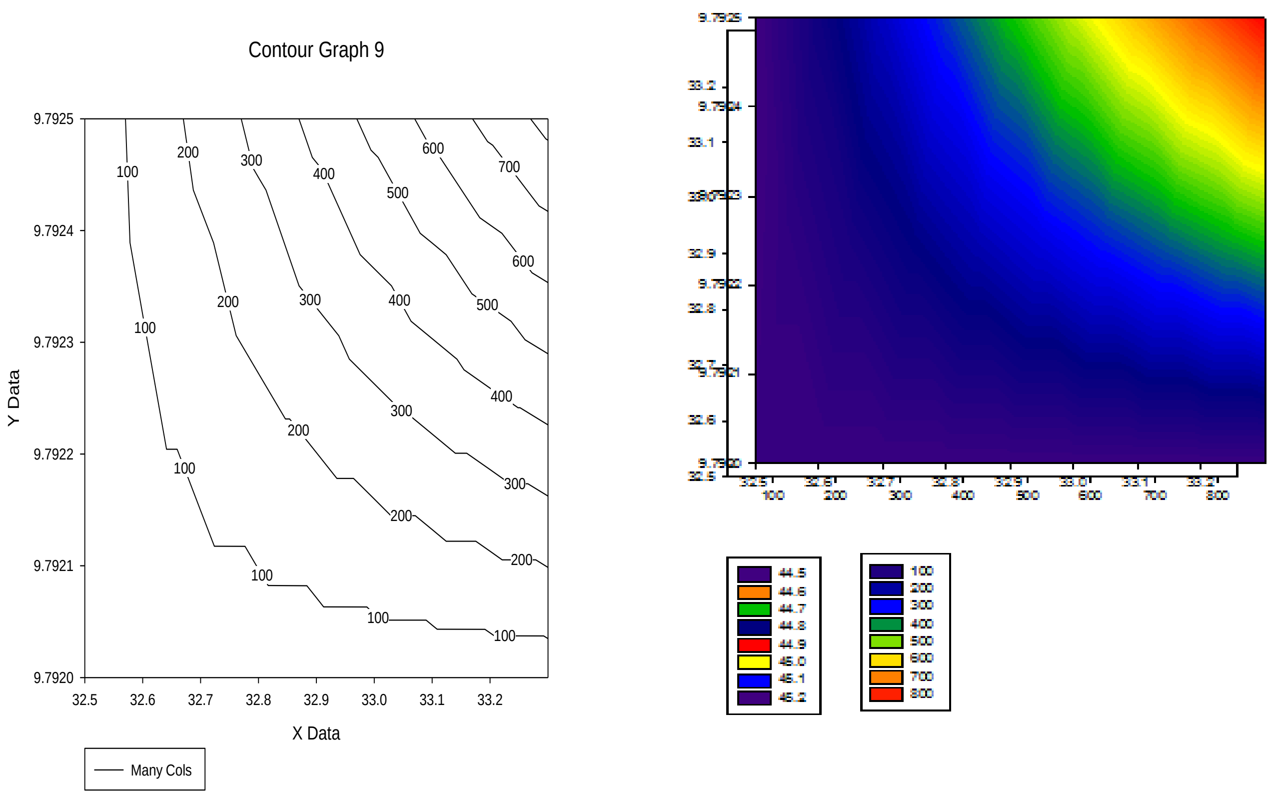

Fig.(5): The Contour Gravity at different altitude

5- Conclusions:

The Earth gravity has been a significant subject of study due to its impact on the topography of the Earth, where the results explained that the Earth gravity in this region(Najaf and Kufa city/ Iraq (latitude 32.5 – 33.5^0)) was less than that in sea level this very important because the earth gravity effects the topography of earth. A new model for Earth gravity with altitude has been found; and it was very compatible with the results of: GRS30, GRS1967, GRS80 and WGS84 model and we can use this model and addition to the word models to calculation the Earth gravity.

6- Acknowledgement:

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7- References:

[1] R. Rummel." Gravity and Topography of Moon and Planes" Earth, Moon, and Planets (2005),No. 94,PP. 103–111.

[2] Christoph R.,Roland Schmidt, Frank Flechtner, Rolf K¨onig, Ulrich Meyer and Karl-Hans Neumayer ," An Earth gravity field model complete to degree and order 150 from GRACE: EIGEN-GRACE02S" Journal of Geodynamics xxx (2004) xxx–xxx.

[3] Biancaleand, R., Balmino, G., Lemoine, J.-M., Marty, J.-C., Moynot, B., Barlier, F., Exertier, P., Laurain, O. and Gegout". A new global Earth's gravity field model from satellite orbit perturbations: GRIM5-S1" Geophys. Res. (2011)Lett. 27, PP.3611–3614.

[4] Mark A. Wieczorek" The gravity and topography of the terrestrial planets" Submitted to Treatise on Geophysics 1 January 2006, accepted 25 July 2006. Publication expected Fall 2007.

[5] Roberts, R. L., Hinze, W. J., and Leap, D. I., " Application of the gravity method to the investigation of a landfill in glaciated midcontinent"U.S.A.: a case history, in Ward, S.H., Ed., Geotechnical and environmental geophysics:, 2, Society Exploration Geophysicists, (1990),PP.253-259.

[6] Kazuo Shibuya, Koichiro Doi, and Shigeru Aoki" Precise determination of geoid height and free-air gravity anomaly at Syowa Station, Antarctica" Earth Planets Space, (1999),No.51,PP. 159–168.

[7] A. A. Okiwelu, E. E. Okwueze and C. E. Onwukwe" Evaluation of Accuracy of the Geodetic Reference Systems for the Modelling of Normal Gravity Fields of Nigeria" Applied Physics Research (2010),Vol. 2, No. 2..

[8] William J. Hinze, Carlos Aiken, John Brozena, Bernard Coakley and David Dater" New standards for reducing gravity data: The North American gravity database" GEOPHYSICS, Vol. 70, NO. 4 (JULY-AUGUST 2005); PP. J25–J32.

[9] Odamaki, M.,Y.Michida, I. Noguchi,Y. Iwanaga, S. Ikeda, and K. Iwamoto" Mean sea-level observed at Syowa Station, East Antarctica" Proc. NIPR Symp. Antarct. Geosci.(1991),No. 5,PP. 20–28.

[10] Milsom, J*" The Geological field guide series*" (2003). *Field Geophysics* (3rded.). London: Wiley, (Chapter 2).

[11]Li Fei, Yue Jian-Li1 and Zhang Li-Ming" Determination of Geoid by GPS/Gravity Data" Chinese Journal Of Geophysics,(2005),Vol.48, No.2, PP. 326-330.

[12] Sandwell, David. (2002). Reference Earth Model-WGS84. [Online] Available: http://www.ipnas.ulg.ac.be/garner/donneesGPS/FormeDelaTerre.Pdf (August18, 2010). Woollard, G. P. (1950). The Gravity meter as a geodetic instrument. Geophysics, 15, 1-27.

[13] U.S. Standard Atmosphere, 1976, National Oceanic and Atmospheric Administration, , United States Air Force, Washington, D.C. October 1976.