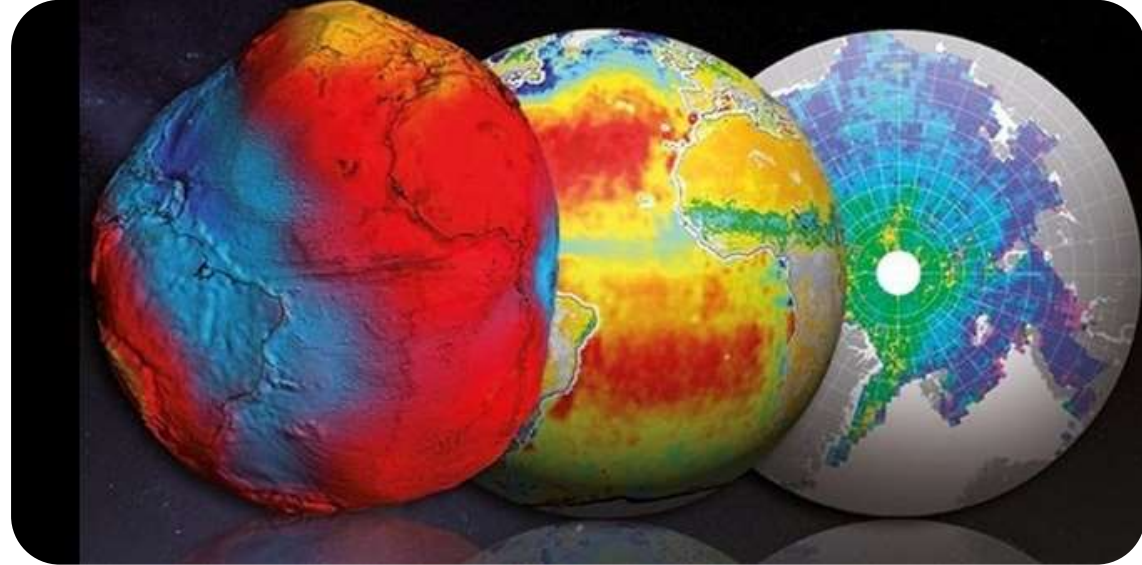
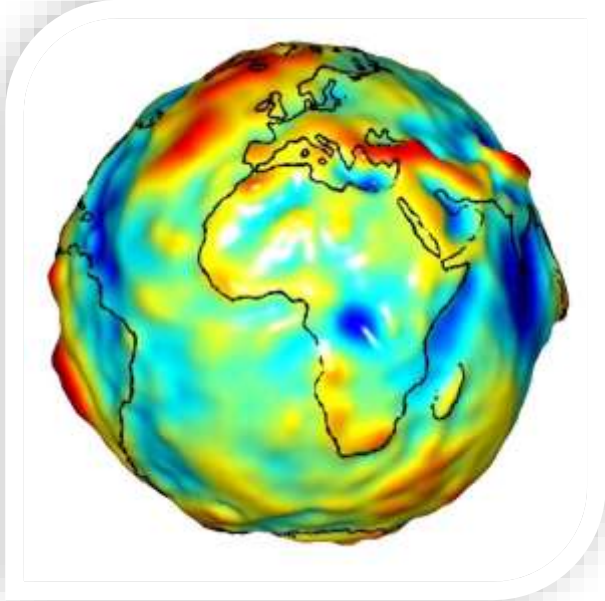




# HEIGHT SYSTEM MODERNIZATION AND GEOID MODELLING STUDIES IN TURKEY

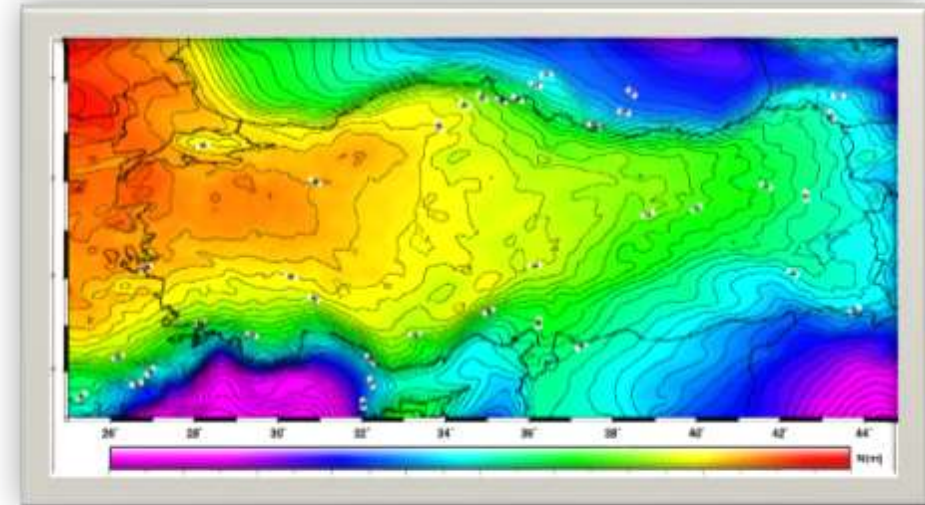


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# TALK OUTLINE

- Turkey National Sea Level Monitoring System (TUDES)
- Turkey National Vertical Control Network
- Turkish Height System Modernization Project
- Turkey Geoid



# Turkey National Sea Level Monitoring System

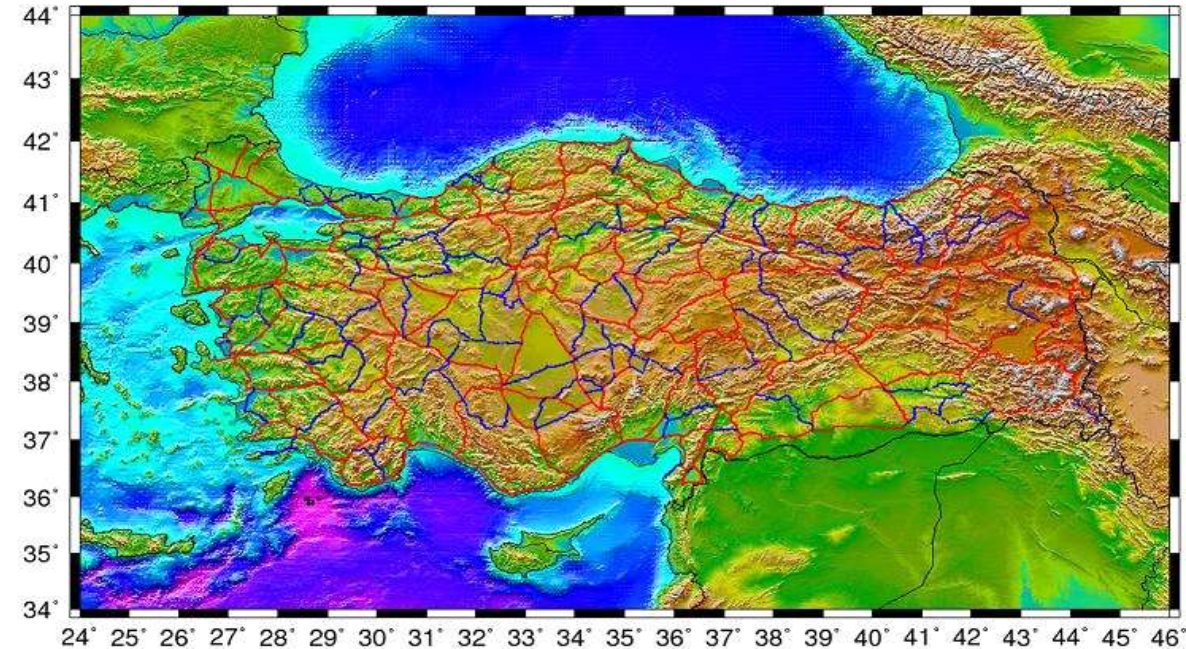
- **Data Center:** General Command of Mapping, Ankara-Turkey
- Total of 20 tide-gauge stations
- It records:
  - Sea Level
  - Parameters that affect sea level such as: relative humidity, pressure, and wind velocity & direction



Tide-gauge Stations of Turkey National Sea Level Monitoring System (General Command of Mapping, 2015)

# Turkey National Vertical Control Network

- The precision of point heights: 0.3 cm to 9 cm after the adjustment.
- *The vertical datum for the TNVCN-99* : arithmetic mean of instantaneous sea level measurements of Antalya tide-gauge station between the years 1936 and 1971.



TNVCN-99 Network(General Command of Mapping,2016)

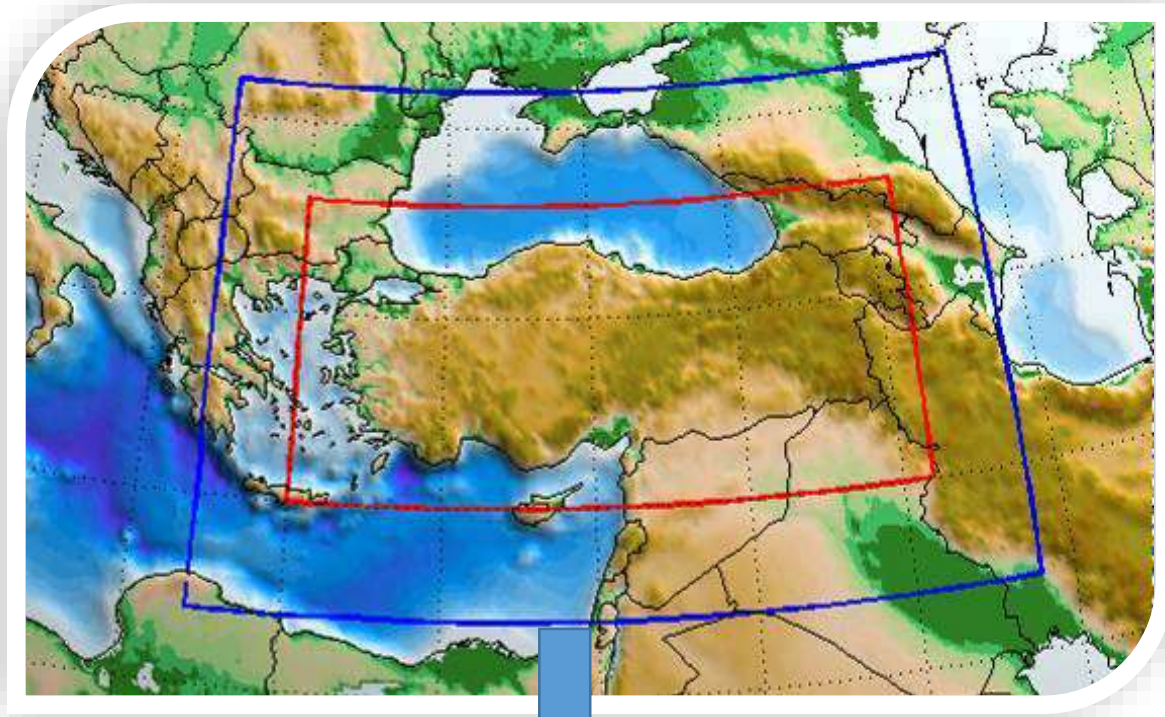
## Turkey National Vertical Control Network-Earthquake at 1999

- *Earthquake at Northwest side of Turkey-1999* :  
-second-order leveling lines of 1300 km were re-measured to determine the displacements after the earthquakes.
- *The differences in Helmert orthometric heights* :  
between -52.7 and +28.8 cm



**Earthquake Zone-  
1999**

# Turkish Height System Modernization Project



Project Area (Simav et al.,2015)



Absolute Gravimetry- Approximate Point Positions (Simav et al.,2015)



# Turkish Height System Modernization Project

## **The Reasons for Implementing Turkish Vertical Reference System Modernization Project**

- -The number of Turkish Vertical Control Network benchmarks are decreasing because of the destruction.
- -The vertical and horizontal coordinates of the TNVCN (Turkish National Vertical Control Network) benchmarks change due to ground dynamics.
- -The accuracy and resolution of the gravity and GNSS/Leveling data are not enough to compute a Turkey Geoid Model with a sufficient accuracy.
- -The computed Turkey Geoid Models could not reach the sufficient accuracy so far; thus, they cannot be used in determination of the physical heights.

# Turkey Geoid

1978

- Astrogeodetic Geoid (**Ayan**)

1987

- South-West Anatolia Doppler Geoid (**Ayhan et al.**)

1991

- Turkey Gravimetric Geoid – 1991 (TG-91) (**Ayhan**)

1993

- Turkey Doppler Geoid – 1993 (**Ayhan and Kılıçoğlu**)

1999

- Turkey Geoid – 1999A (TG-99A) (**Ayhan et al.**)

2003

- Turkey Geoid – 2003 (TG 03) (**Kılıçoğlu et al.**)

2007

- Turkey Geoid – 2007 (TG-07) (**Yıldız et al.**)

2009

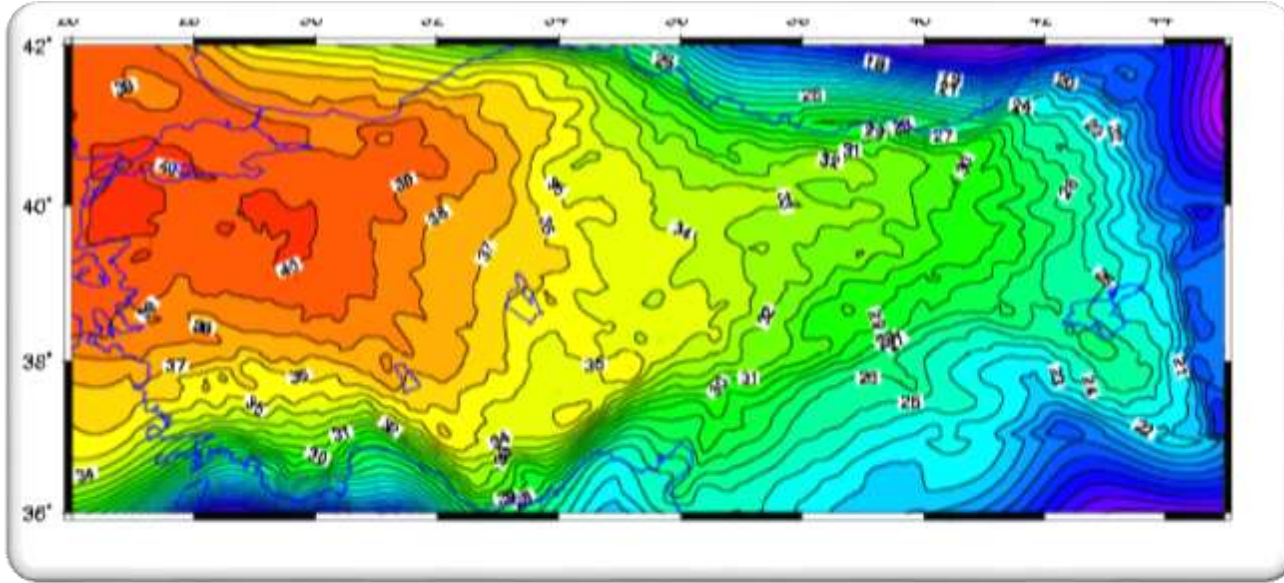
- Turkey Hybrid Geoid (THG 09) (**Kılıçoğlu et al.**)

2013

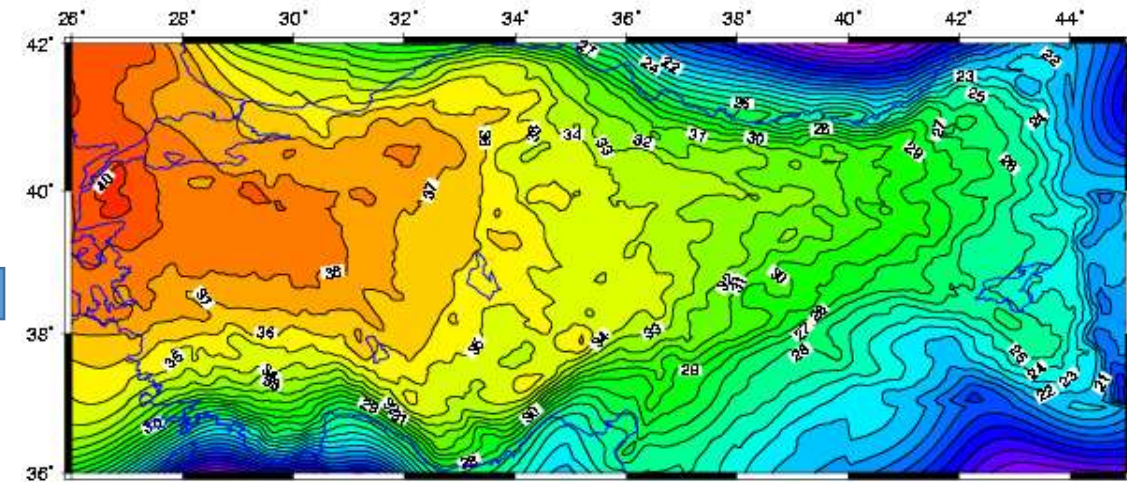
- Turkey Geoid – 2013 (TG-13) (**Yıldız et al.**)



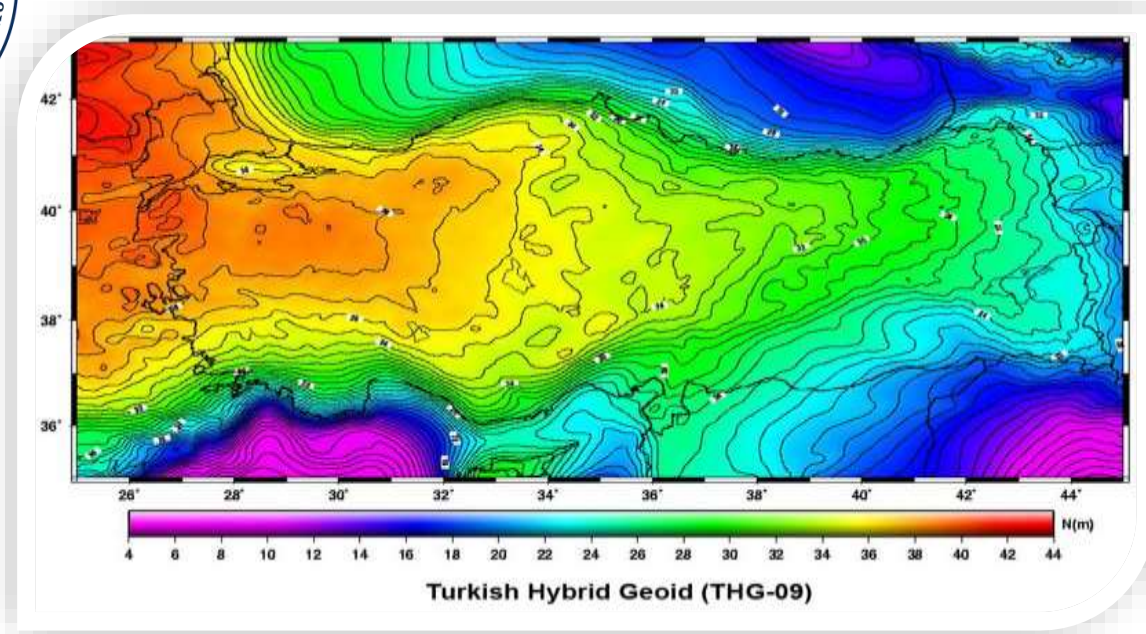
None of the TG03, the TG07, TG09 and TG13 geoid models could achieve an accuracy better than 8.6 cm in terms of standard deviations of geoid height residuals at the test points. Standards for determination and use of local GPS/levelling surfaces as parametric models for transformation of the GPS ellipsoidal heights into the regional vertical datum are determined by the Large-scale Maps and Spatial Data Production Regulation.



**TG-91** (Ayhan,1992)



**TG-99A** (Ayhan et al.; Kılıçoğlu,2002)



**THG-09** (Kılıçoğlu et al.,2011)

- As indicated by the results of the latest geoid models in Turkey, the accuracy cannot meet the demand. The gravity data and the methods used in the computation are effective in the accuracy of the geoid model. Today, new technologies in absolute and airborne gravimetry and the launch of satellite gravity missions have enhanced geoid modelling capabilities, which enables an alternative definition of the height reference surface referring to a precise geoid model.

# CONCLUSION

- This study has summarized the historical perspective of Turkish vertical control approaches, their current situation and developments. The problems in levelling-based vertical control approach have led Turkish researchers to find an alternative approach to vertical control. From this point of view, geoid-based vertical datum approach is under consideration as an alternative way. The maximum accuracy of the regional geoid models achieved in Turkey is 8.6 cm, but the accuracy should be at least 5 cm according to the Large-scale Map and Map Production Regulation. Datum inconsistencies and quality of the terrestrial gravity data are effective on the rough accuracy of the computed geoid models. A modernization project is still in progress to achieve a 1-2 cm accuracy regional geoid model and to re-define the vertical datum of Turkey based on this model. The Modernization Project also aims to recover the gravity infrastructure of the country. The method used in the computation of the geoid model and the quality of the satellite-based data are efficient in obtaining the required accuracy. Until reaching the aimed accuracy (1-2 cm accuracy regional geoid model), the local GPS/levelling surface models will be used as geodetic infrastructure in Turkey.



*THANK YOU FOR YOUR PATIANCE.*

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