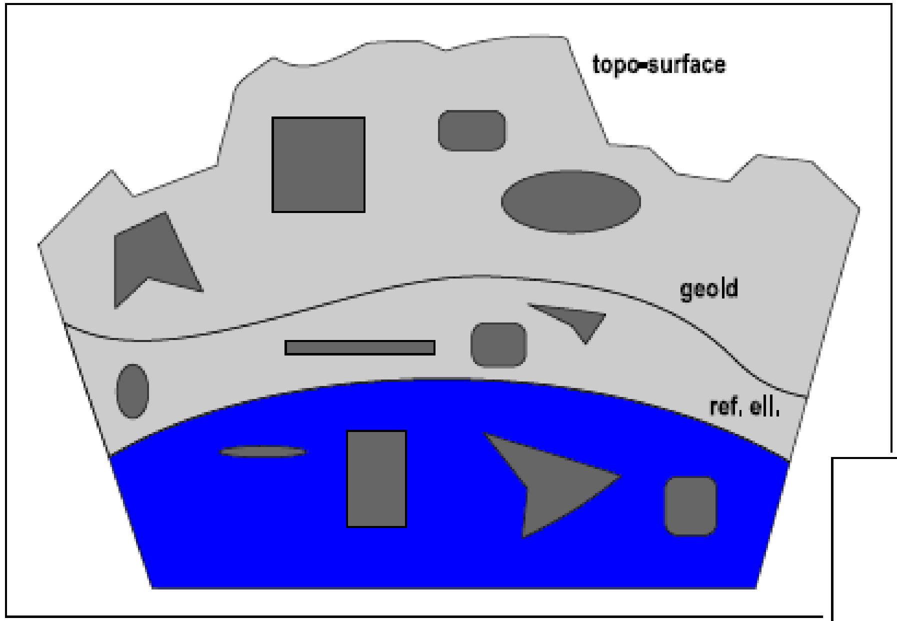
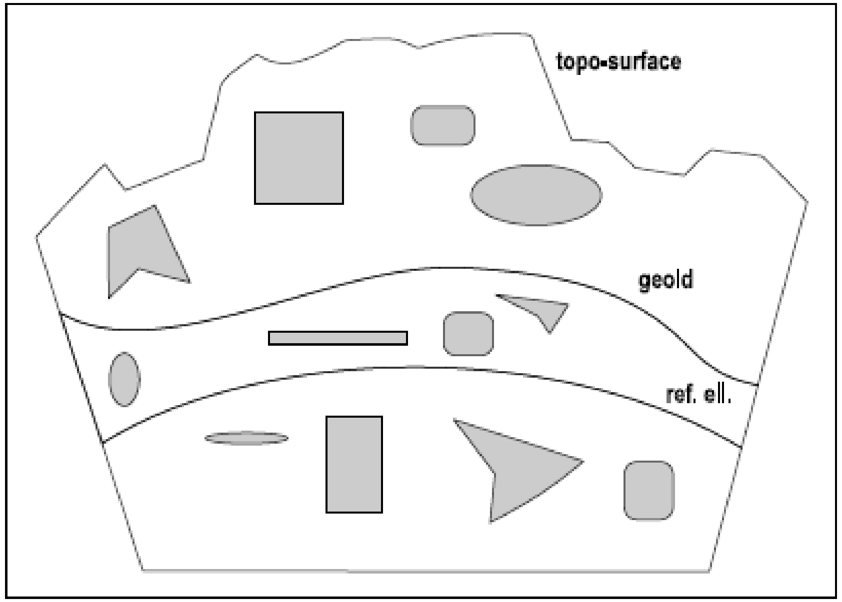
Global Deniz Suyu ve Türkiye’deki Büyük Göl Suyu Kütlelerinin Çekim Etkileri



Yoğunluk Kontrastı
Sıyırma Etkisi



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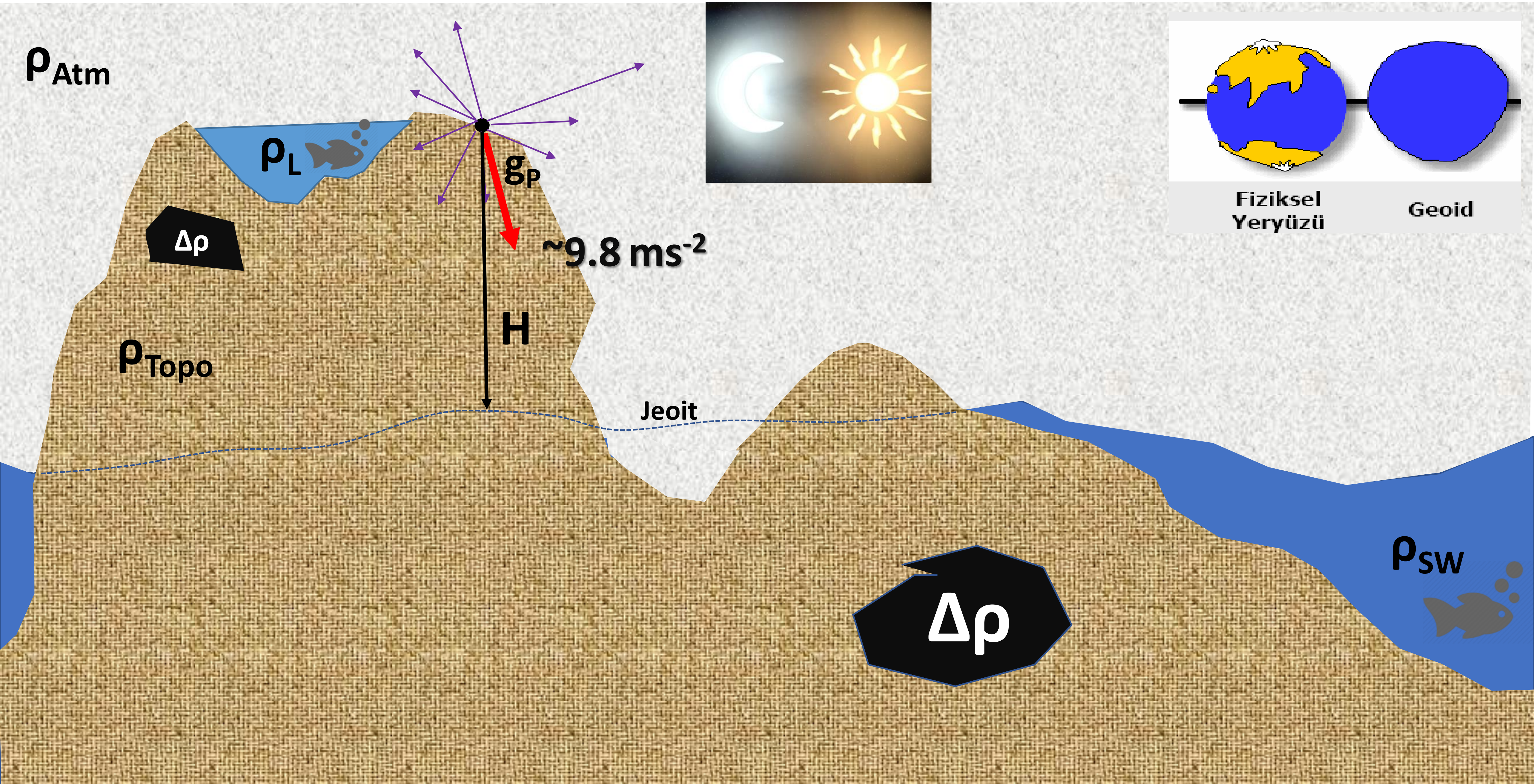
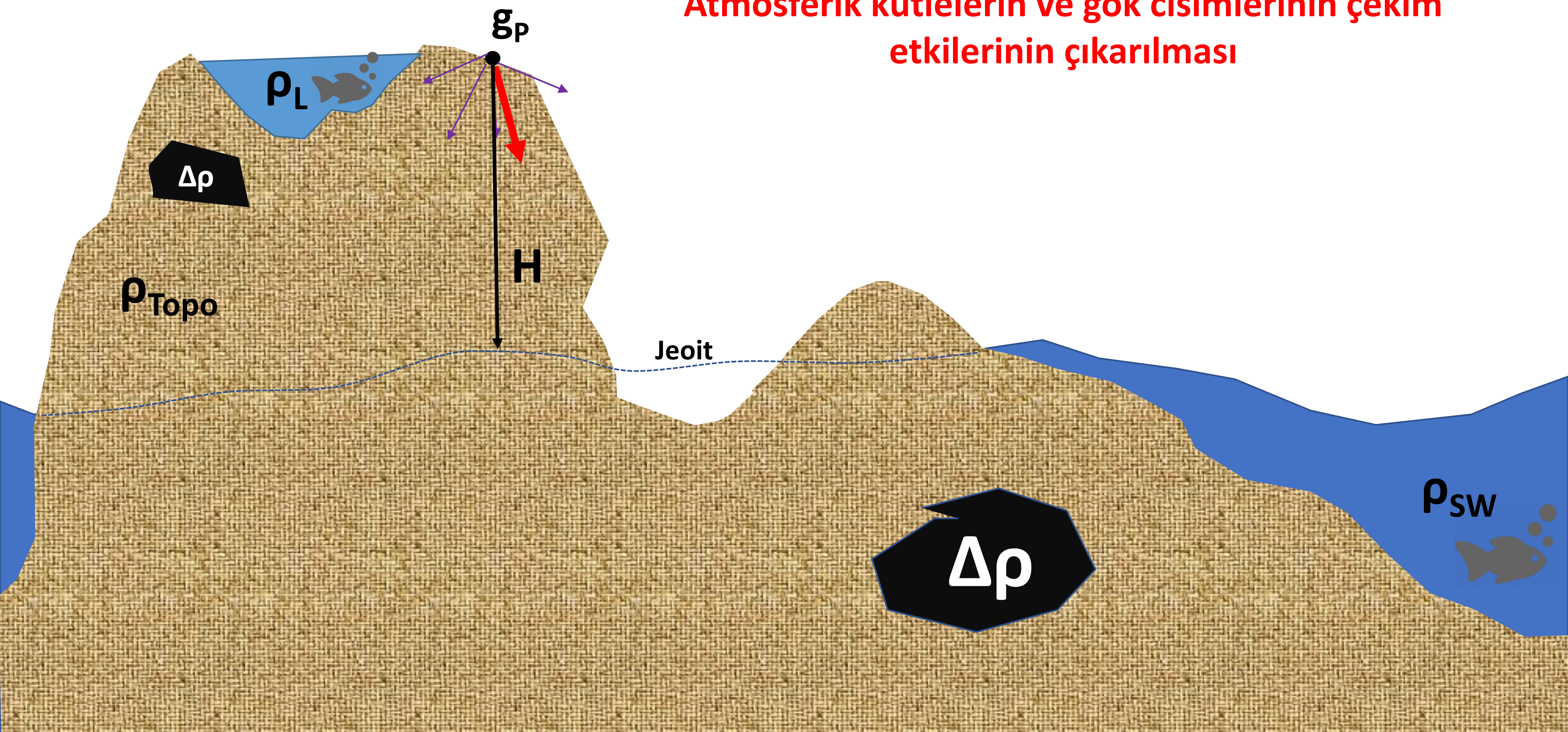
Türkiye Ulusal Jeodezi Komisyonu 2021 Yılı Bilimsel Toplantısı, 25-27 Kasım 2021, Çevrimiçi.

Problemin Tanımı

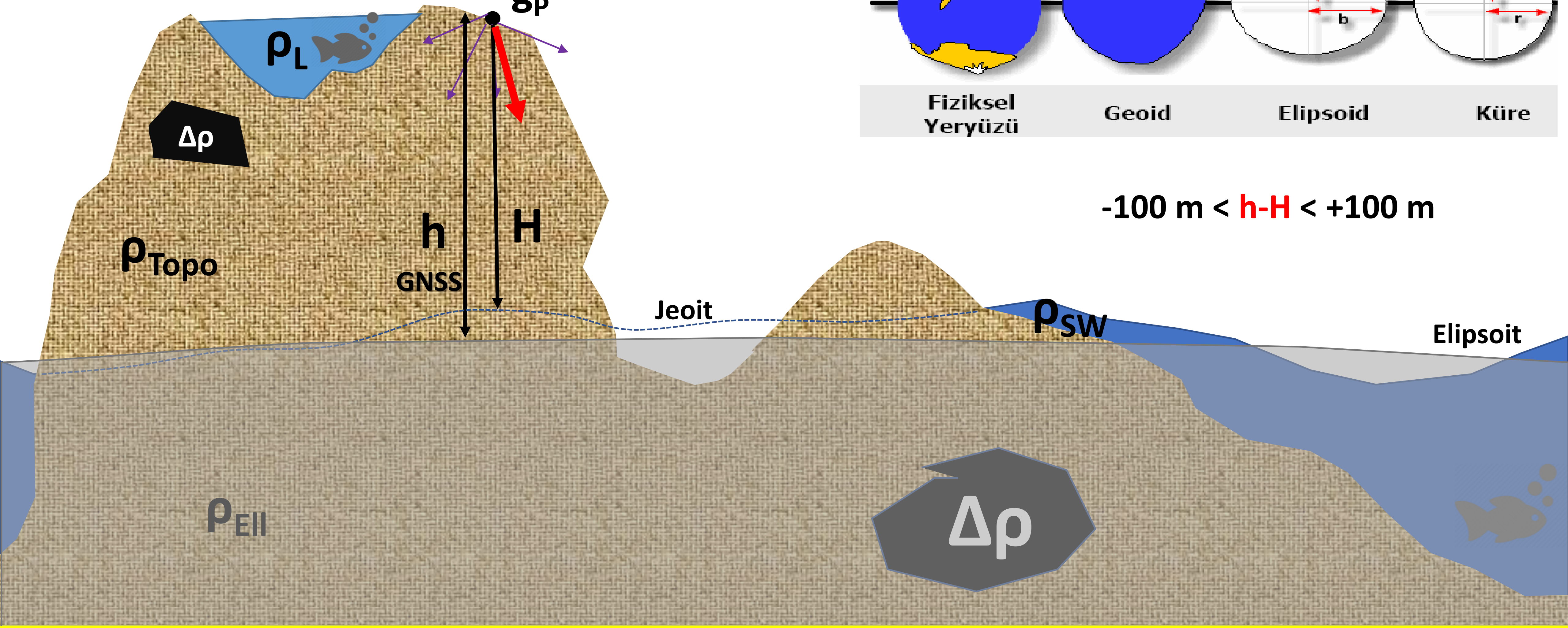


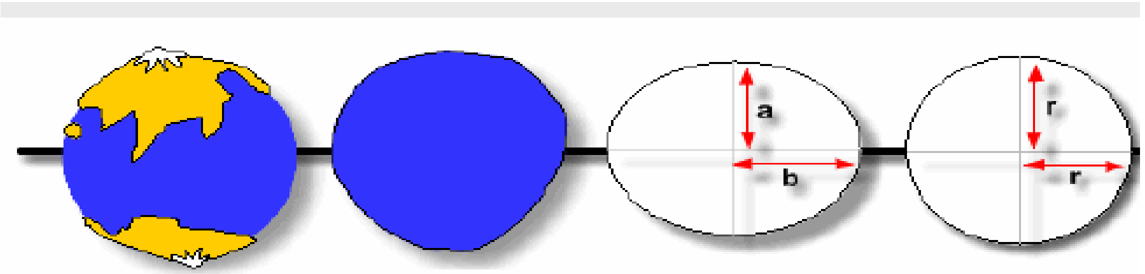
Problemin Tanımı

Atmosferik kütlelerin ve gök cisimlerinin çekim etkilerinin çıkarılması



Problemin Tanımı





-100 m < h-H < +100 m

$\sim M_{Dünya}$ kütleye sahip Yer elipsoidi (Model Dünya)

Problemin Tanımı

Gravite Bozukluğu

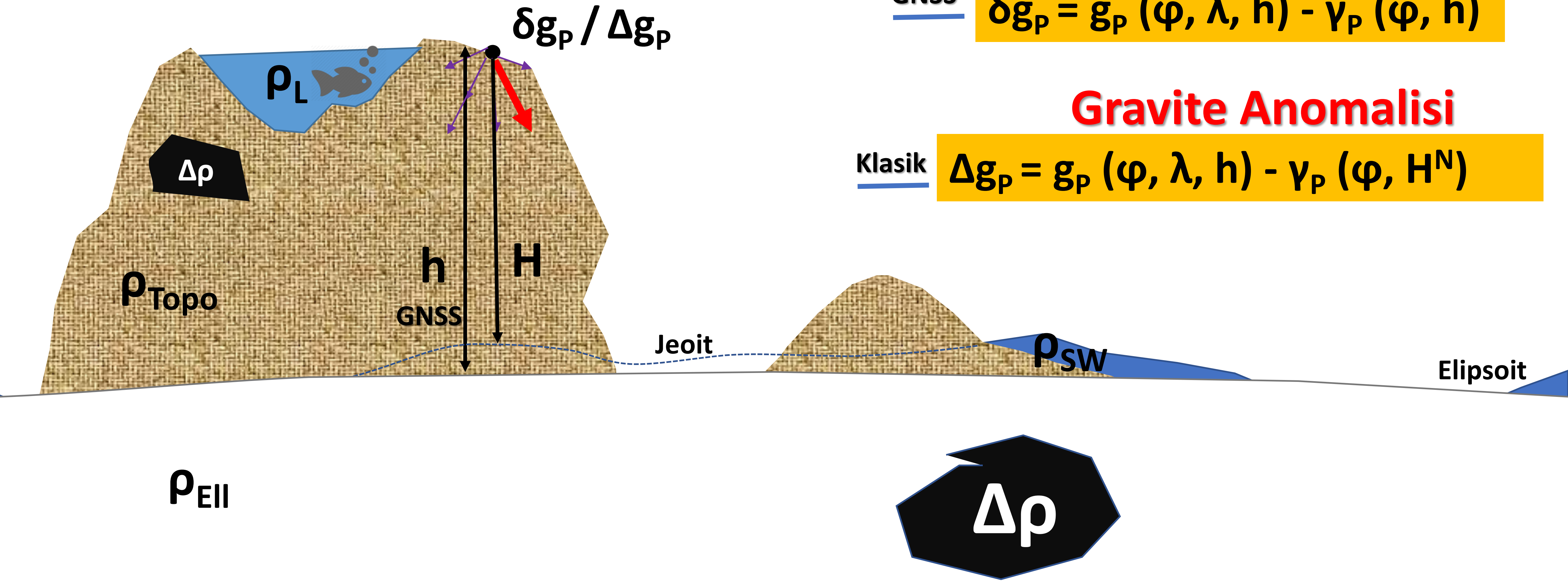
GNSS

$$\delta g_P = g_P\,(\varphi, \lambda, h) - \gamma_P\,(\varphi, h)$$

Gravite Anomalisi

Klasik

$$\Delta g_P = g_P\,(\varphi, \lambda, h) - \gamma_P\,(\varphi, H^N)$$



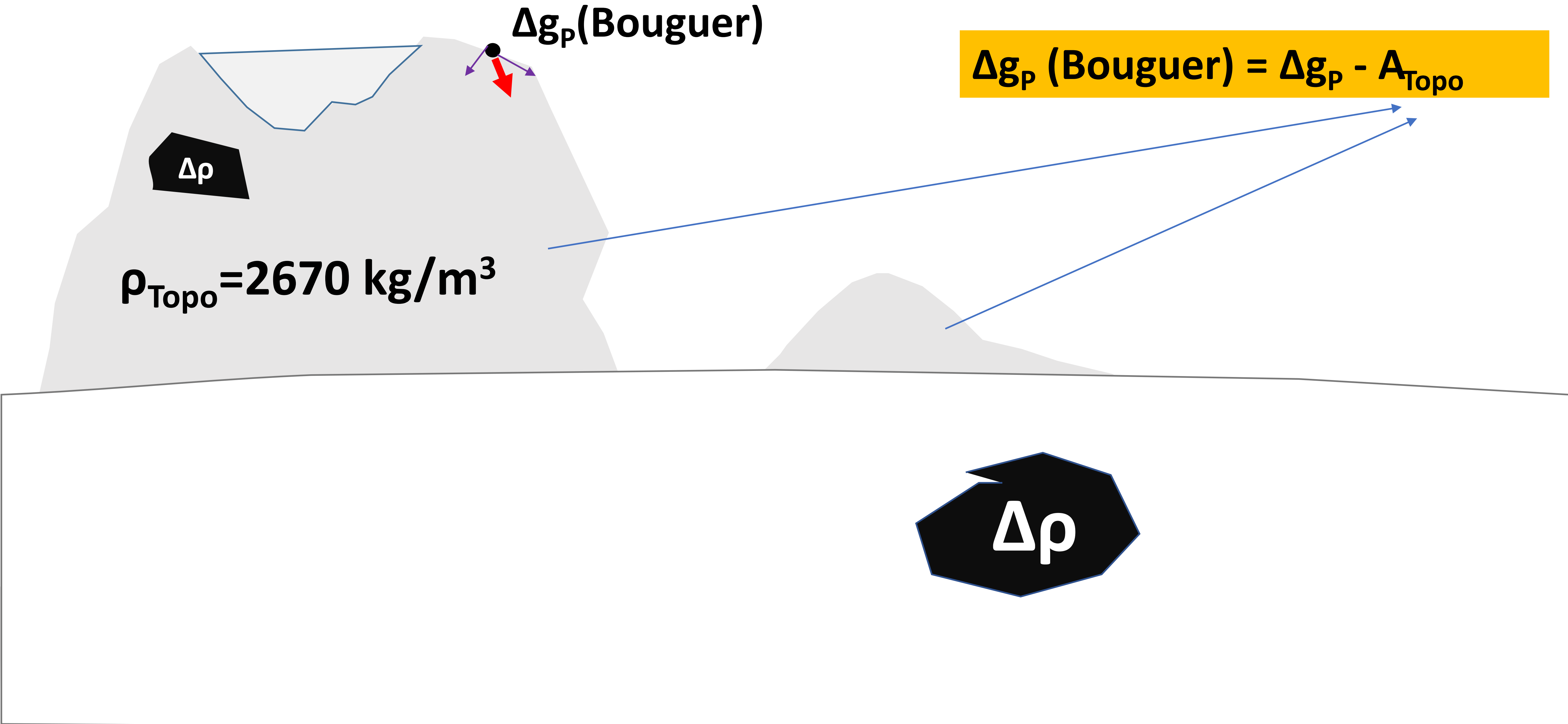
$\sim M_{Dünya}$ kütleye sahip Yer elipsoidin (Model Dünya'nın) çekim etkisi

Normal Gravite (Enlem Düzeltmesi)

Problemin Tanımı

Bouguer Gravite Anomalisi

Δg_P (Bouguer) = $\Delta g_P - A_{Topo}$



Problemin Tanımı

«Gravimetrik Sıyırma (Stripping)»

Elipsoit içinde kalan deniz/okyanus suları $\boldsymbol{\rho_{SW}}$ ile modellenmesi gerekirken $\boldsymbol{\rho_{Ell}}$ ile modellendi

$$\rho_{Ell} = 2670\ kg/m^3$$

$$\rho_{SW} = 1025\ kg/m^3$$

$$\Delta\rho(\text{Kontrast}) = 2670 - 1025 = 1645\ kg/m^3$$

Topoğrafya içinde kalan göl suları $\boldsymbol{\rho_{L}}$ ile modellenmesi gerekirken $\boldsymbol{\rho_{Topo}}$ ile modellendi

$$\rho_{Topo} = 2670\ kg/m^3$$

$$\rho_{L} = 1000\ kg/m^3$$

$$\Delta\rho(\text{Kontrast}) = 2670 - 1000 = 1670\ kg/m^3$$

Metodoloji: Newton İntegrali-Düşey Yönde Çekim İvmesi

$$A_r(\varphi_P,\lambda_P,r_P) = -G\int_{\varphi=-90^0}^{\varphi=+90^0}\int_{\lambda=-180^0}^{\lambda=+180^0}\int_{r_1}^{r_2}\boldsymbol{\rho(\varphi_Q,\lambda_Q,r_Q)}\frac{\partial L^{-1}}{\partial r}r_Q^2\cos(\varphi_Q)\,dr d\lambda d\varphi$$

3D Yoğunluk

$$A_r(\varphi_P,\lambda_P,r_P) = -G\int_{\varphi=-90^0}^{\varphi=+90^0}\int_{\lambda=-180^0}^{\lambda=+180^0}\boldsymbol{\rho(\varphi_Q,\lambda_Q)}\int_{r_1}^{r_2}\frac{\partial L^{-1}}{\partial r}r_Q^2\cos(\varphi_Q)\,dr d\lambda d\varphi$$

2D Yoğunluk

$$A_r(\varphi_P,\lambda_P,r_P) = -G\boldsymbol{\rho}\int_{\varphi=-90^0}^{\varphi=+90^0}\int_{\lambda=-180^0}^{\lambda=+180^0}\int_{r_1}^{r_2}\frac{\partial L^{-1}}{\partial r}r_Q^2\cos(\varphi_Q)\,dr d\lambda d\varphi$$

Sabit Yoğunluk

$$A_r(\varphi_P,\lambda_P,r_P) = -G\boldsymbol{\Delta\rho}\int_{\varphi=-90^0}^{\varphi=+90^0}\int_{\lambda=-180^0}^{\lambda=+180^0}\int_{r_1}^{r_2}\frac{\partial L^{-1}}{\partial r}r_Q^2\cos(\varphi_Q)\,dr d\lambda d\varphi$$

Sabit Yoğunluk Kontrastı

Metodoloji: Newton İntegrali Çözümü

$$A_r(\varphi_P, \lambda_P, r_P) = -G\Delta\rho \int_{\varphi=-90^0}^{\varphi=+90^0} \int_{\lambda=-180^0}^{\lambda=+180^0} \int_{r_1}^{r_2} \frac{\partial L^{-1}}{\partial r} r_Q^2 \cos(\varphi_Q)\, dr\, d\lambda\, d\varphi$$

İleri Modelleme (Forward Modelling) Yöntemleri

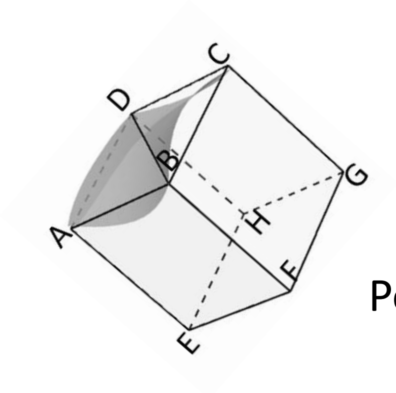
- Polihedra (Polyhedra)
- Prizma (Prism)
- Tesseroit (Tesseroid)
- Çizgi Kütle (Mass Line)
- Tabaka Kütle (Mass Layer)
- Nokta Kütle (Point Mass)
- Silindirik Şablonlar (Cylindrical Templates)
- 3-D numerik integrasyon
  - Gauss-Legendre Quadrature (GLQ)
  - Basit Quadrature
  - …
- 2-D numerik integrasyon
  - Gauss-Legendre Quadrature (GLQ)
  - Basit Quadrature
  - …

Spektral Yöntemler

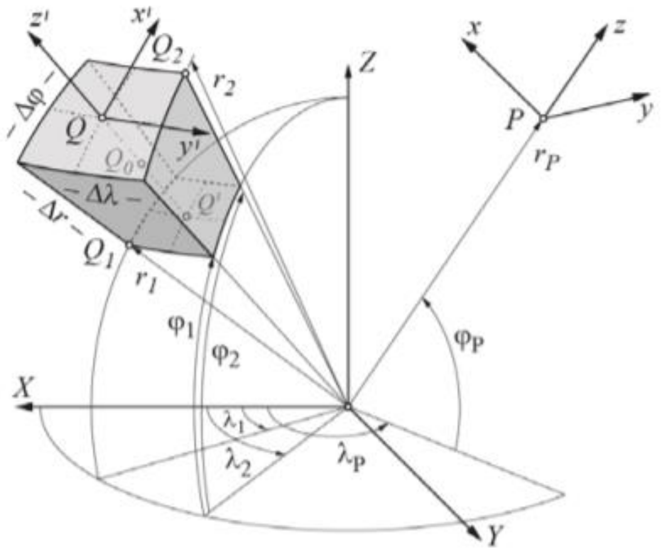
- 2-D FFT
- Küresel/Elipsodial Harmonikler

Newton İntegrali Çözümü- İleri Modelleme Yöntemleri

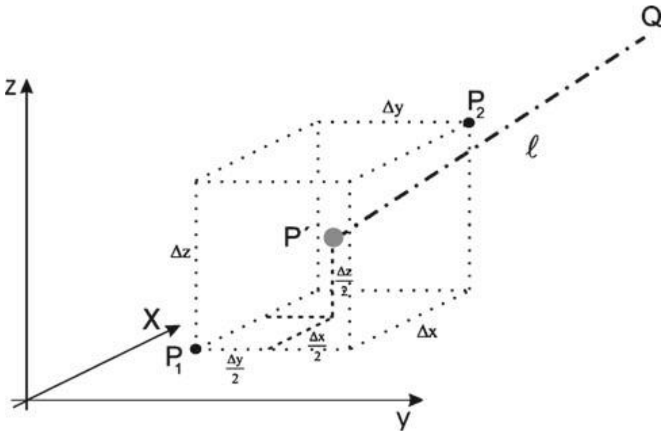
Wild-Pfeiffer (2008)



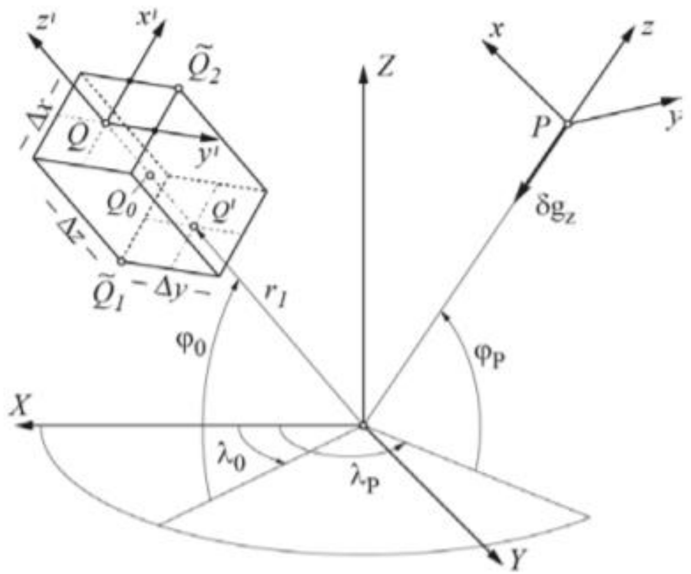
Polihedra



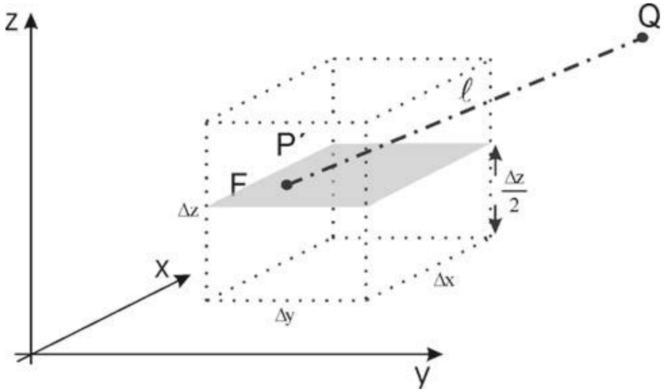
Tesseroit



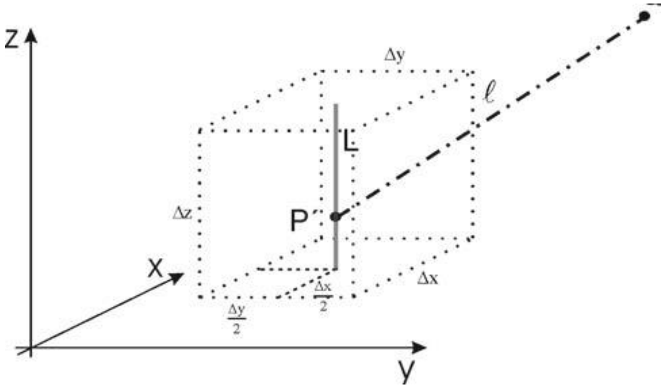
Nokta Kütle



Prizma



Tabaka Kütle



Çizgi Kütle

Metodoloji: Newton İntegrali Çözümü-2D Sayısal İntegrasyon

$$A_r(\varphi_P, \lambda_P, r_P) = -G\Delta\rho \int_{\varphi=-90^0}^{\varphi=+90^0} \int_{\lambda=-180^0}^{\lambda=+180^0} \boxed{\int_{r_1}^{r_2} \frac{\partial L^{-1}}{\partial r} r_Q^2 dr} \cos(\varphi_Q)\, d\lambda d\varphi$$

(Novák, 2000)

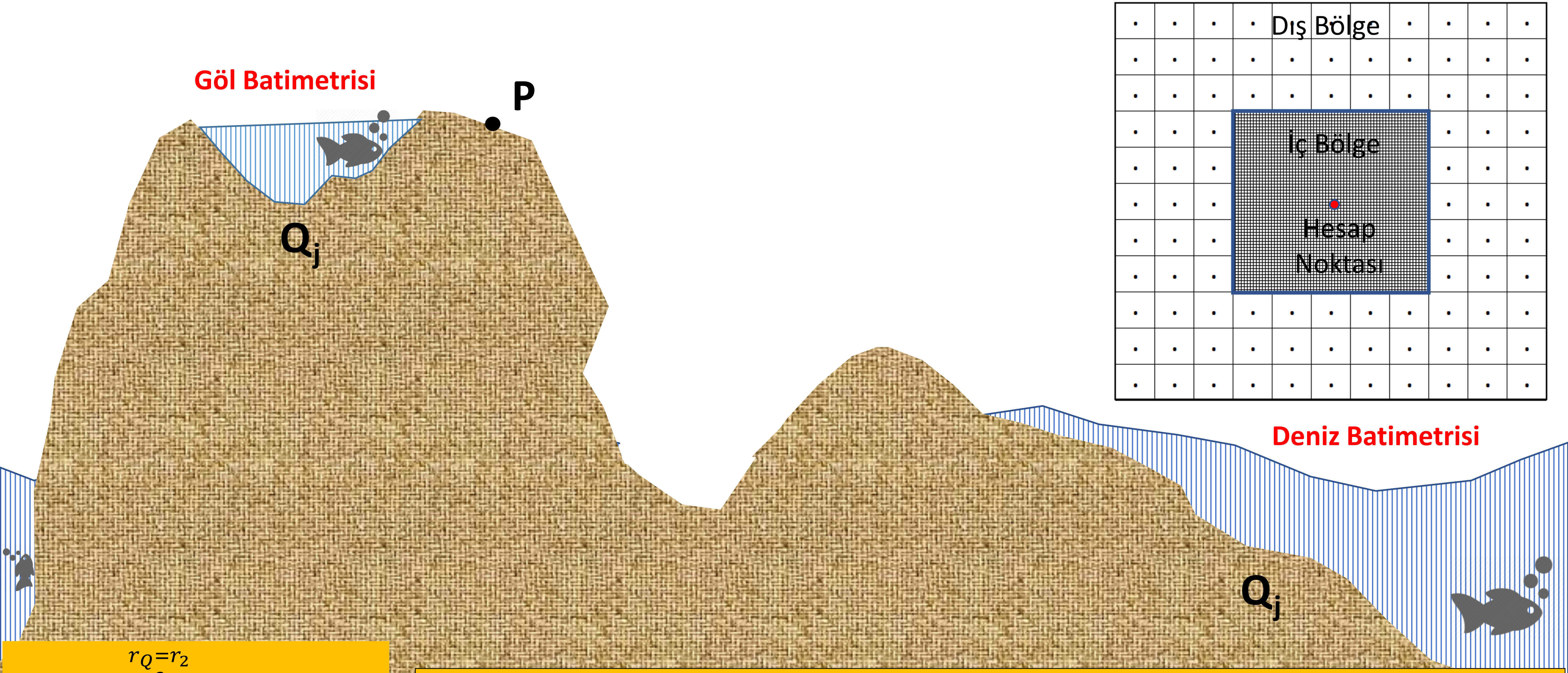
$$K = \int_{r_Q=r_1}^{r_Q=r_2} \frac{\partial L^{-1}}{\partial r_Q} r_Q^2\, dr_Q = \left| \frac{(3r_P^2 + r_Q^2)\cos(\psi_{PQ}) + r_P r_Q (1 - 6\cos^2(\psi_{PQ}))}{L} + r_P (3\cos^2(\psi_{PQ}) - 1) \ln\left| r_Q - r_P \cos(\psi_{PQ}) + L \right| \right|_{r_Q = r_1}^{r_Q = r_2}$$

$$L = L(\varphi_P, \lambda_P, r_P, \varphi_Q, \lambda_Q, r_Q) = \sqrt{r_P^2 + r_Q^2 - 2 r_P r_Q \cos(\psi_{PQ})}$$

$$\cos(\psi_{PQ}) = \cos(\varphi_P)\cos(\varphi_Q) + \sin(\varphi_P)\sin(\varphi_Q)\cos(\lambda_P - \lambda_Q)$$

$$A_r(\varphi_P, \lambda_P, r_P) = -G\Delta\rho \sum_j K_j \cos(\varphi_{Q_j})\, \Delta\lambda\Delta\varphi$$

Metodoloji: Newton İntegrali Çözümü-2D Sayısal İntegrasyon

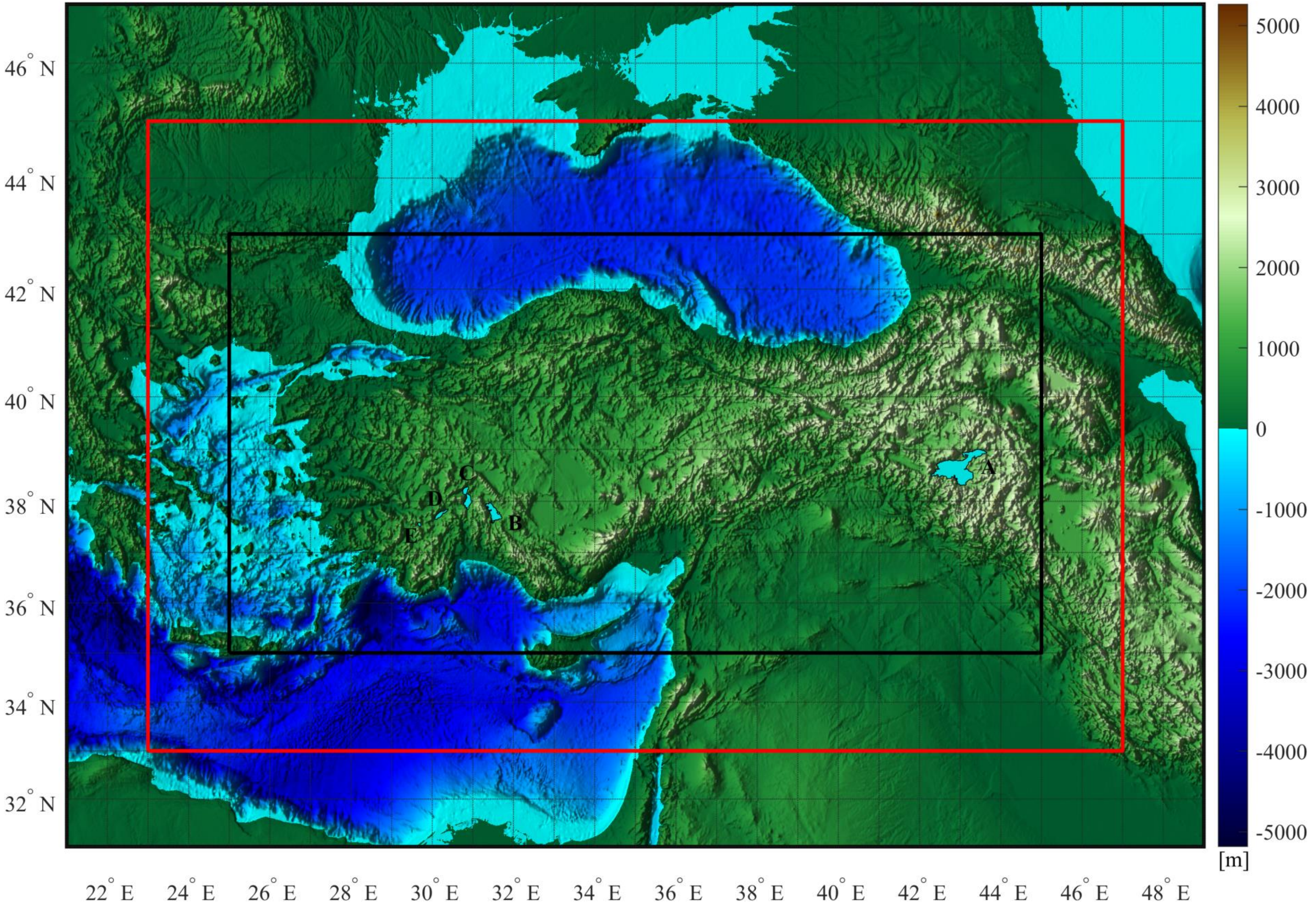


$$K = \int_{r_Q=r_1}^{r_Q=r_2} \frac{\partial L^{-1}}{\partial r_Q} r_Q^2 \, dr_Q$$

$\boldsymbol{r_1 = R - H^{Deniz\ Derinliği}}$ $\quad$ $\boldsymbol{r_2 = R}$ $\quad$ **=> okyanus batimetrisi**

$\boldsymbol{r_1 = R + H^{Göl\ Tabanı}}$ $\quad$ $\boldsymbol{r_2 = R + H^{Göl\ Yüzeyi}}$ $\quad$ **=> göl batimetrisi**

Çalışma Bölgesi



- 25°D - 45°D / 35°K - 43°K
- Hesap noktaları 1' × 1’ yay dakikası aralıklı ve yeryüzünde
- Karalarda: 410756 nokta
- Denizde: 166925 nokta
- Toplam: 577681 hesap noktası
- Hesap Noktası H_{max} = 5009.1m
- Hesap Noktası H_{min} = 0.0 m

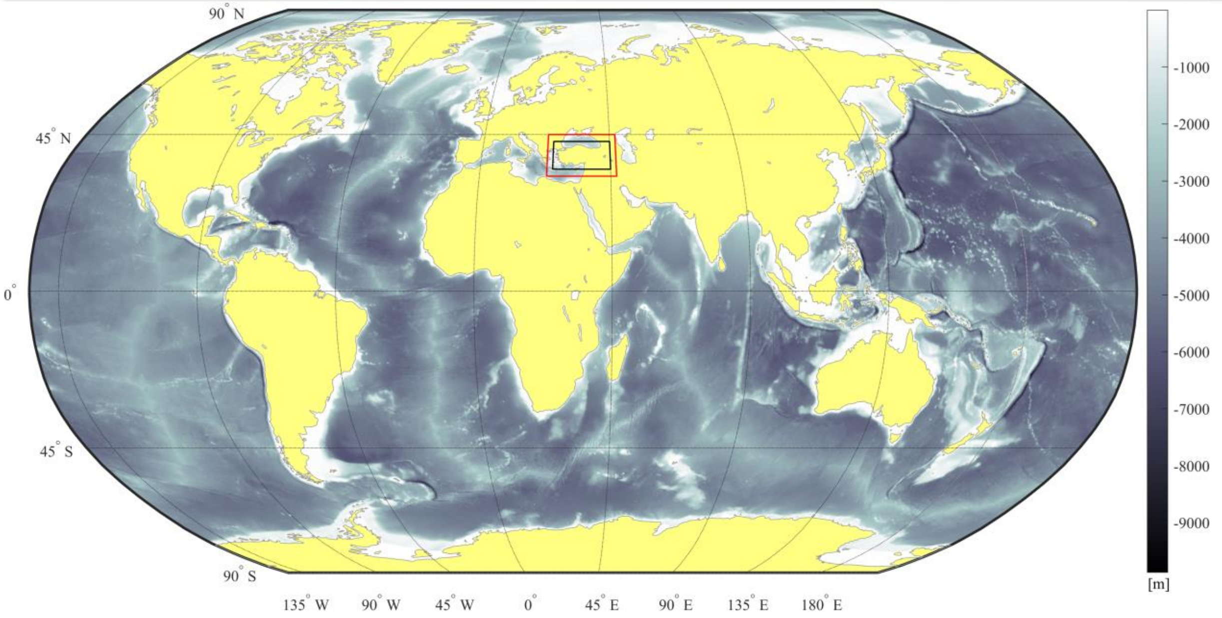
Veriler

- **ASTER Global Sayısal Yükseklik Modeli**
  - ASTER GDEM
  - 1" × 1" yay-saniyesi
  - https://gdemdl.aster.jspacesystems.or.jp/index_en.html,
  - https://search.earthdata.nasa.gov/search/

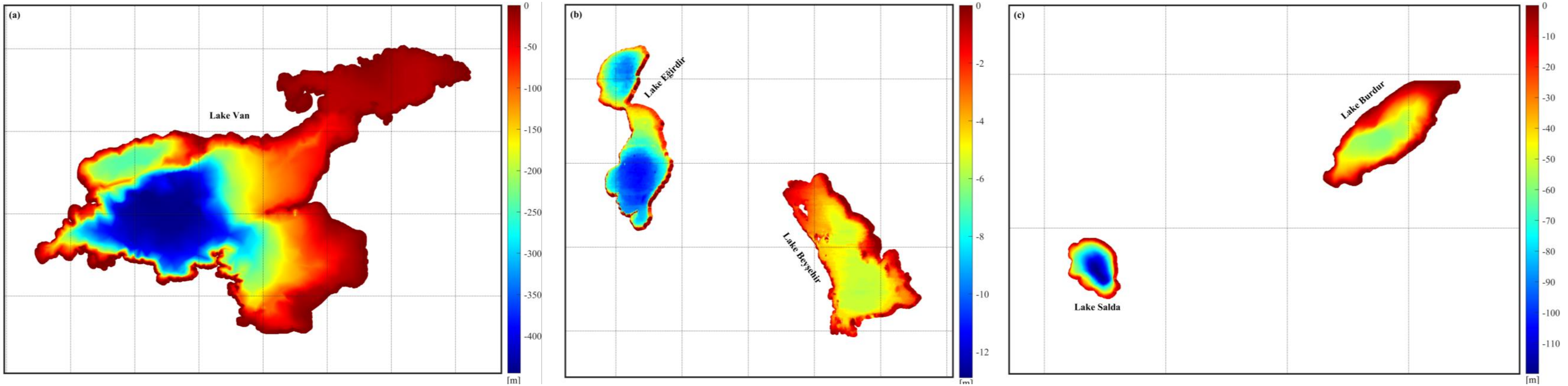
- **SRTM15+ Global Batimetri ve Topoğrafya**
  - SRTM15+V2.0
  - 15" × 15" yay-saniyesi (İç Bölge)
  - 15’ × 15’ yay-dakikası (Dış Bölge – Blok Ortalaması)
  - https://topex.ucsd.edu/WWW_html/srtm15_plus.html

- **Göl Batimetrisi**
  - GPS destekli sesli-iskandil (echo sounder)
  - Van, Beyşehir, Eğirdir, Burdur ve Salda Gölleri
  - 3" × 3" yay-saniyesi
  - Devlet Su İşleri Genel Müdürlüğü

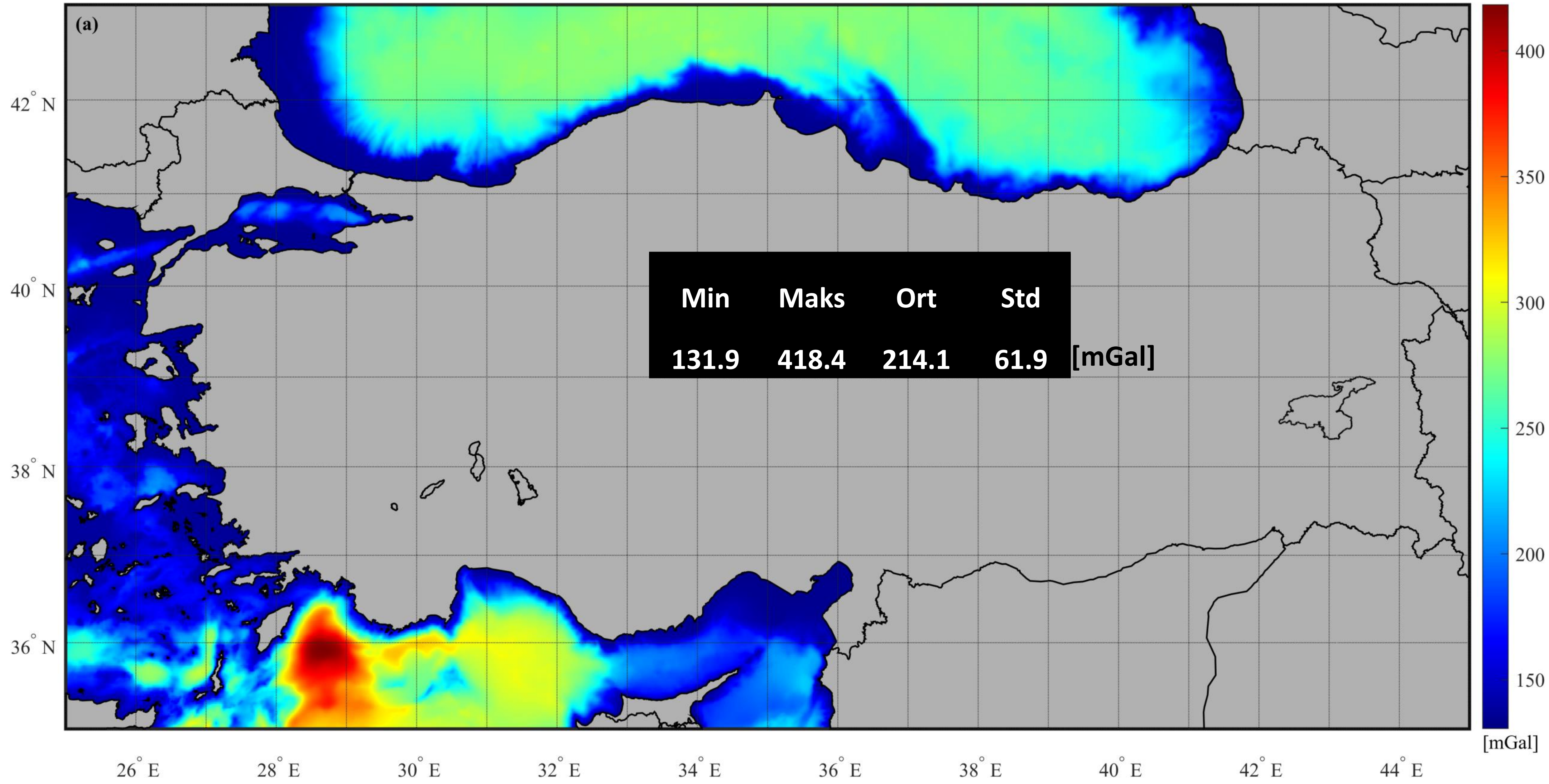
Veriler



Batimetri	Maksimum Derinlik [m]
SRTM15+	–9874.4
Van Gölü	–445.0
Beyşehir Gölü	–6.1
Eğirdir Gölü	–12.9
Burdur Gölü	–60.3
Salda Gölü	–119.9

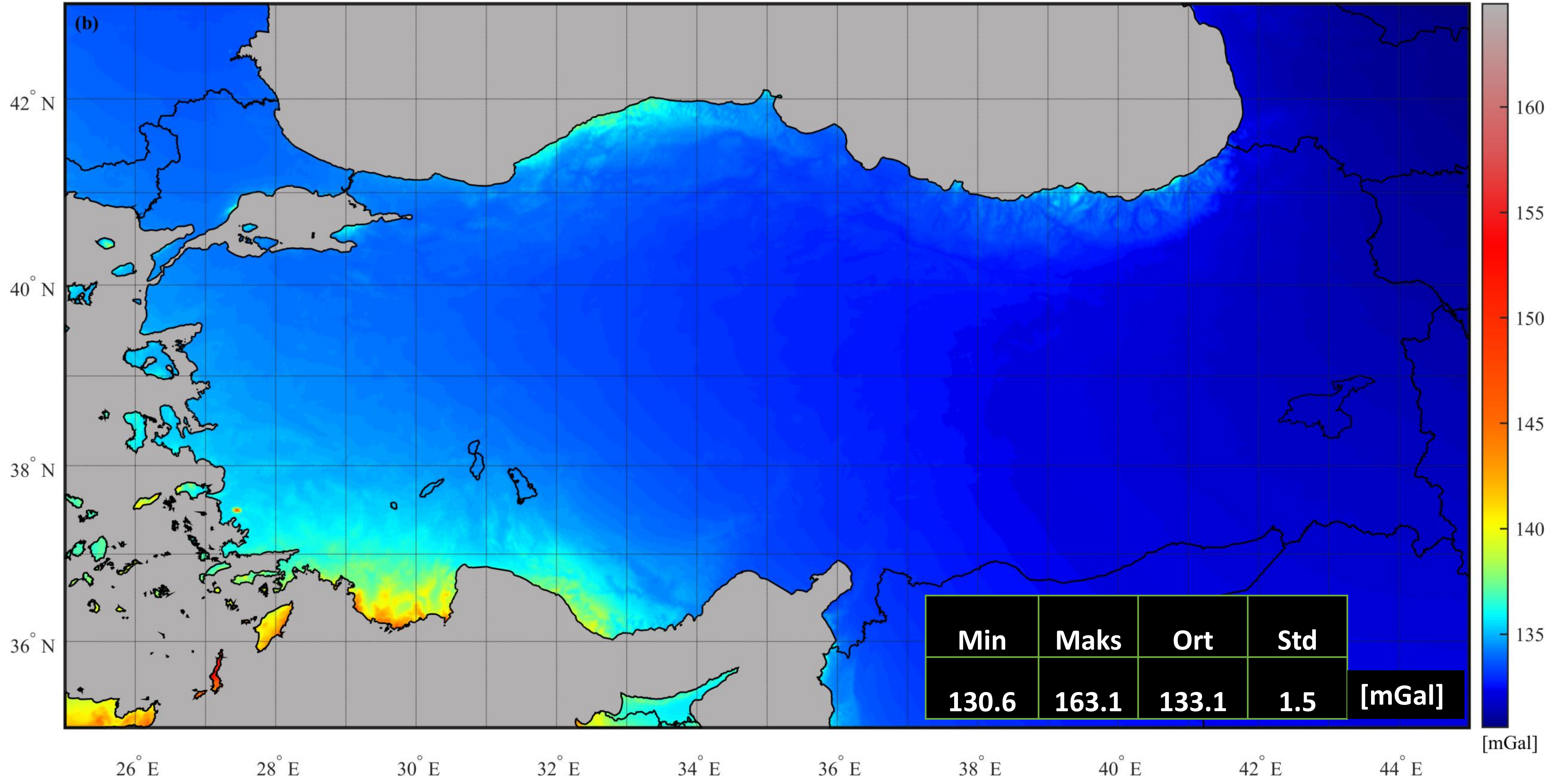


Sonuçlar: Deniz Suyu Sıyırma Etkileri



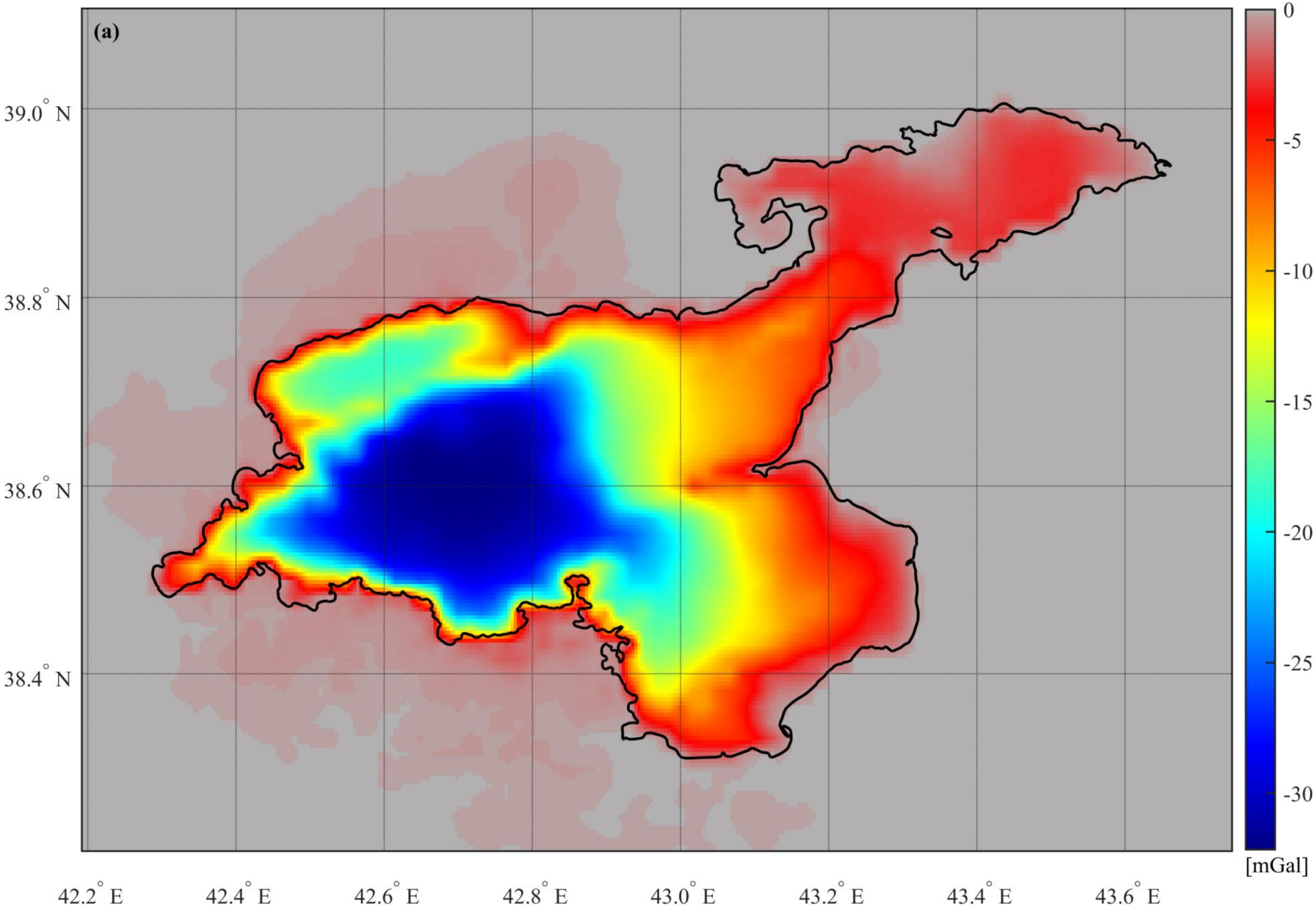
Min	Maks	Ort	Std	
131.9	418.4	214.1	61.9	[mGal]

Sonuçlar: Deniz Suyu Sıyırma Etkileri



Min	Maks	Ort	Std	
130.6	163.1	133.1	1.5	[mGal]

Sonuçlar: Deniz Suyu Sıyırma Etkileri



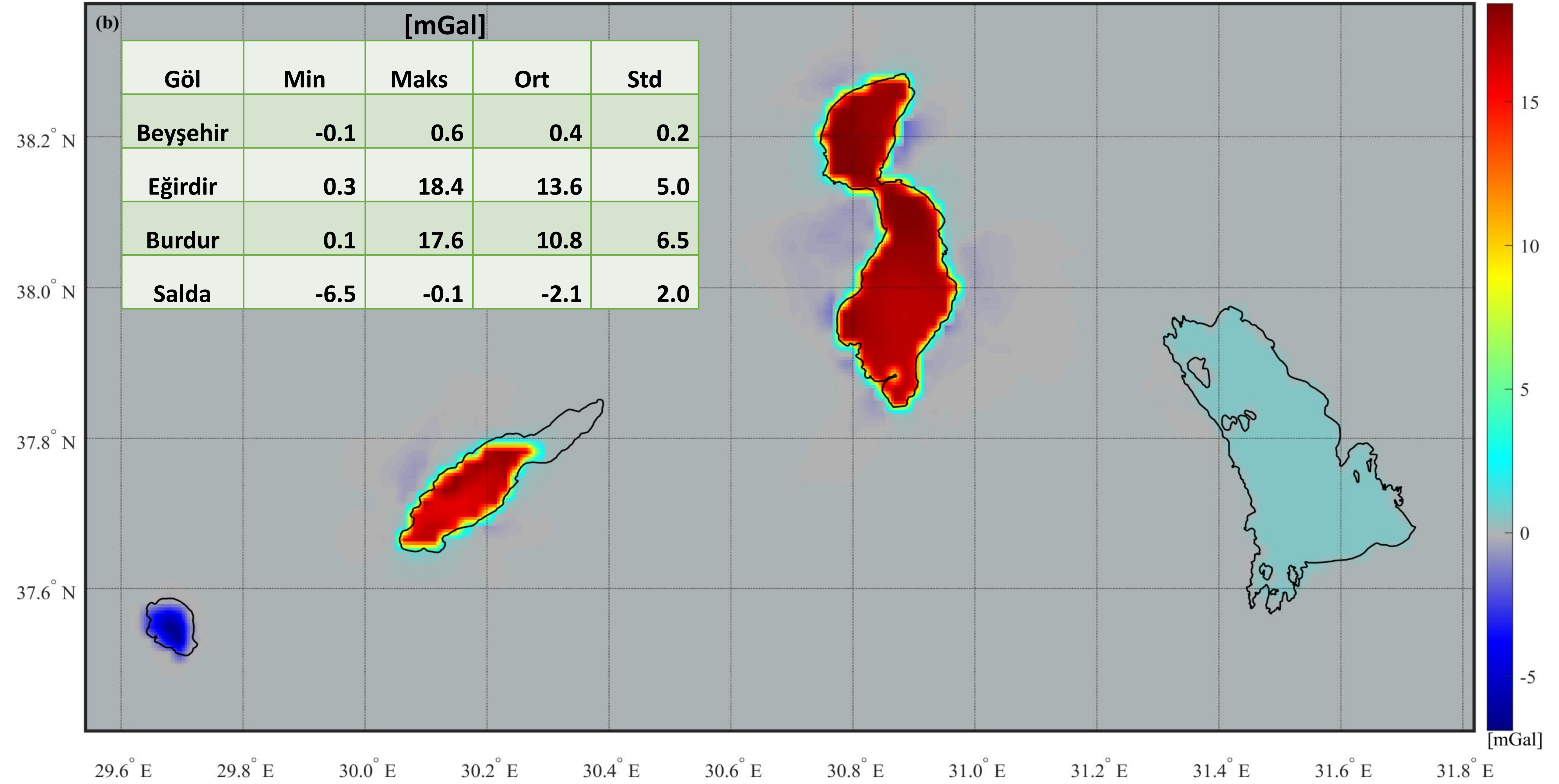
[mGal]

Min	-32.2
Maks	0.0
Ort	-11.1
Std	10.1

Sonuçlar: Deniz Suyu Sıyırma Etkileri

[mGal]

Göl	Min	Maks	Ort	Std
Beyşehir	-0.1	0.6	0.4	0.2
Eğirdir	0.3	18.4	13.6	5.0
Burdur	0.1	17.6	10.8	6.5
Salda	-6.5	-0.1	-2.1	2.0



Teşekkür

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Research Article

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doi:10.3906/yer-2105-38

Quantifying the bathymetric stripping gravity corrections of global seawater and major lakes over Turkey

Mehmet SİMAV*, Hasan YILDIZ
General Directorate of Mapping, Ankara, Turkey

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****** Çalışma sonucunda elde edilen ürünlere ve çalışmada geliştirilen programlara erişim için mehmet.simav@harita.gov.tr e-posta adresinden temasa geçebilirsiniz.***