

Solid Earth Dynamics

Bill Menke, Instructor

Lecture 10

Today

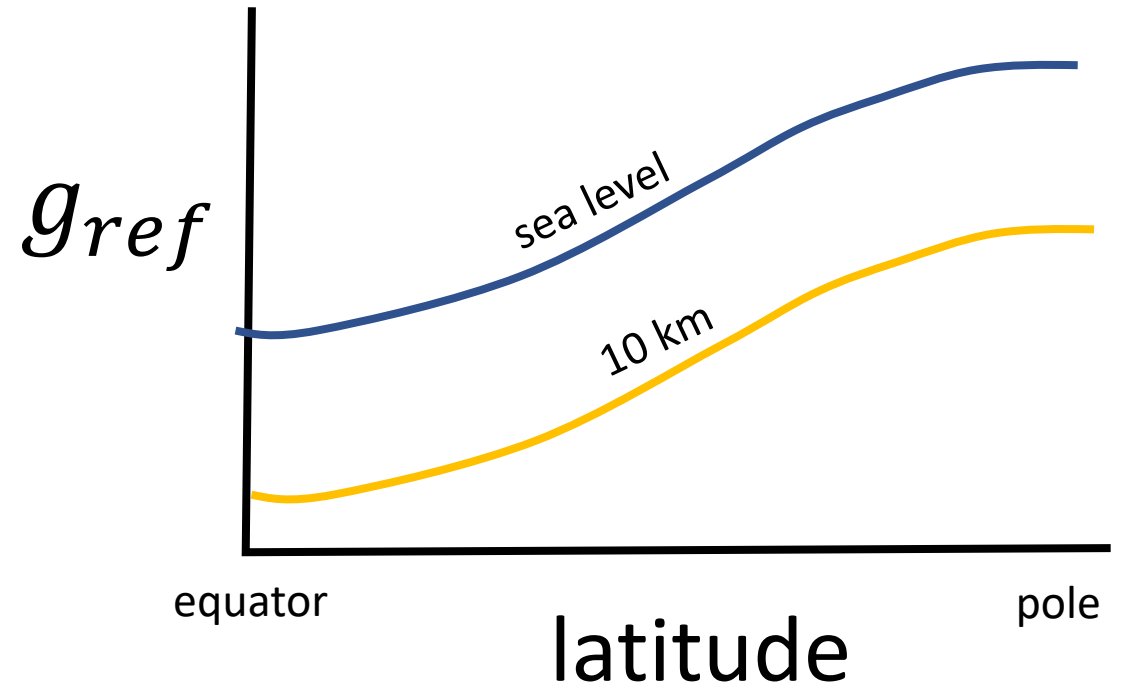
some simple gravity anomalies

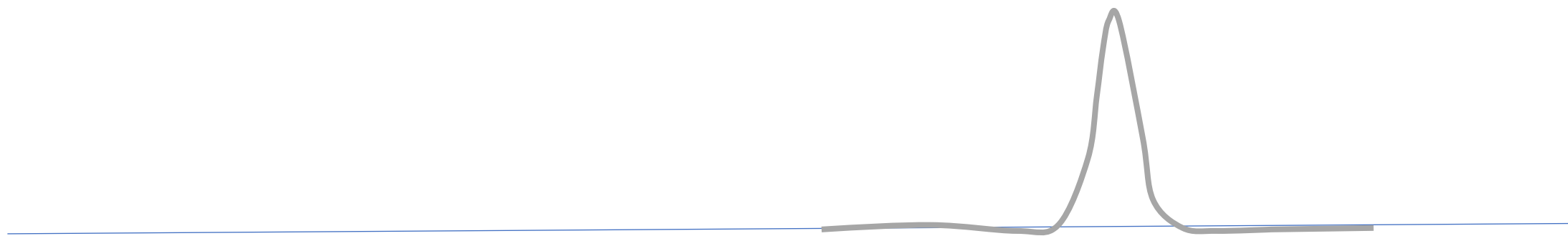
Sum of superposition

Interpreting gravity anomalies

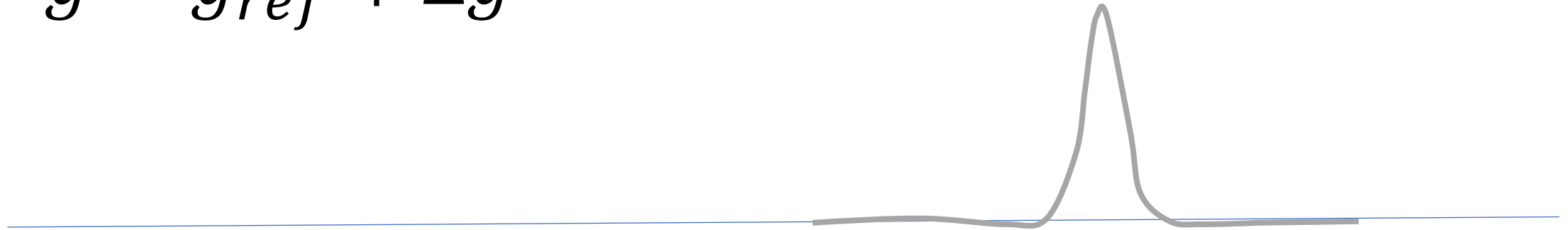
Observed Gravity = reference + anomaly

$$g = g_{ref} + \Delta g$$





$$g = g_{ref} + \Delta g$$

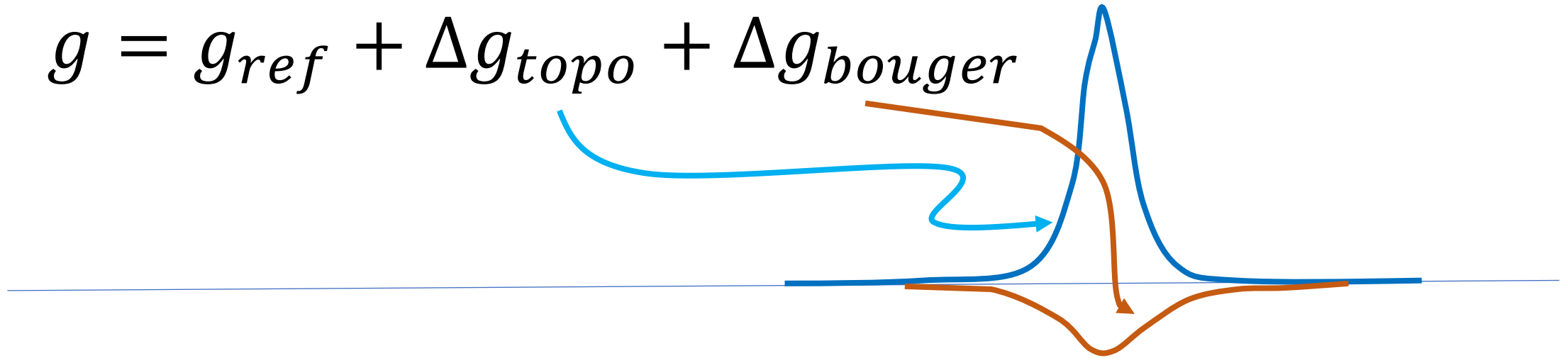


well, we can see there's a mountain ...



but is there a root?

$$g = g_{ref} + \Delta g_{topo} + \Delta g_{bouger}$$



well, we can see there's a mountain ...



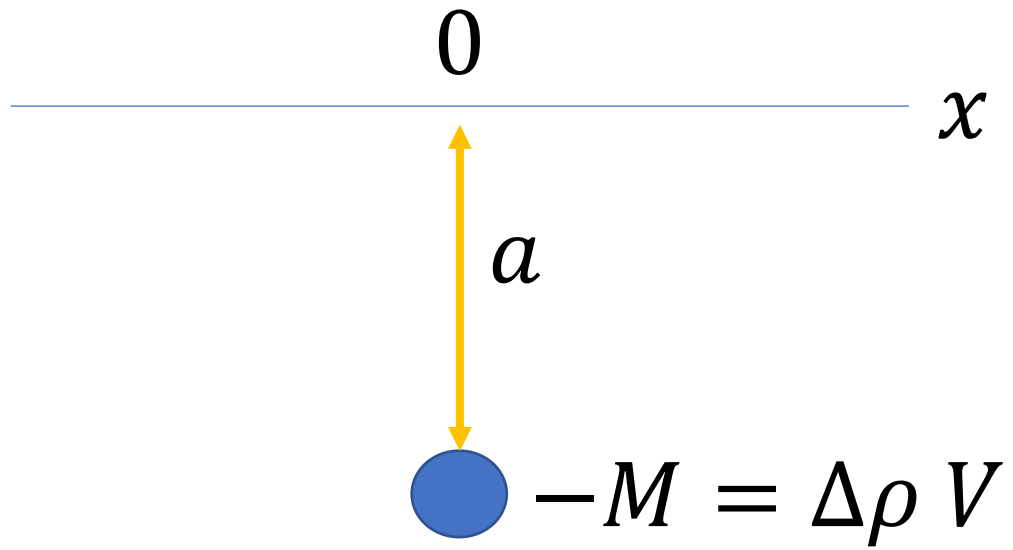
but is there a root?

$$g = g_{ref} + \Delta g_{topo} + \Delta g_{bouger}$$

predict
from
measured
topography

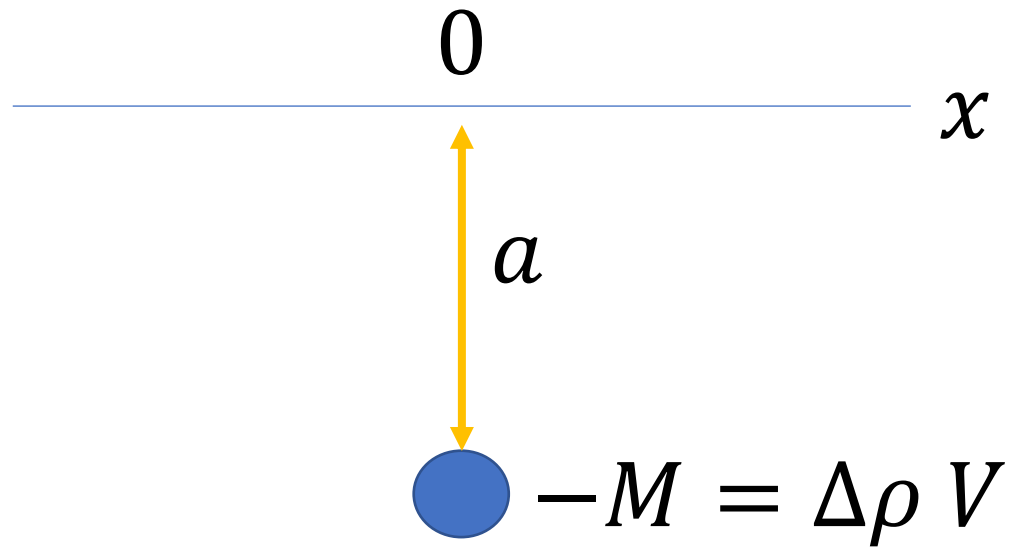
$$\Delta g_{bouger} = g - g_{ref} - \Delta g_{topo}$$



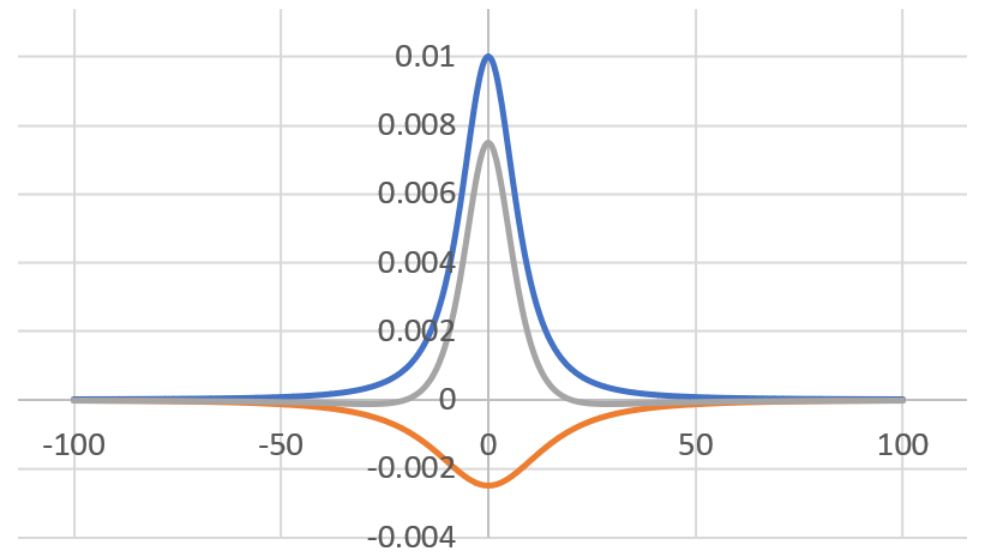


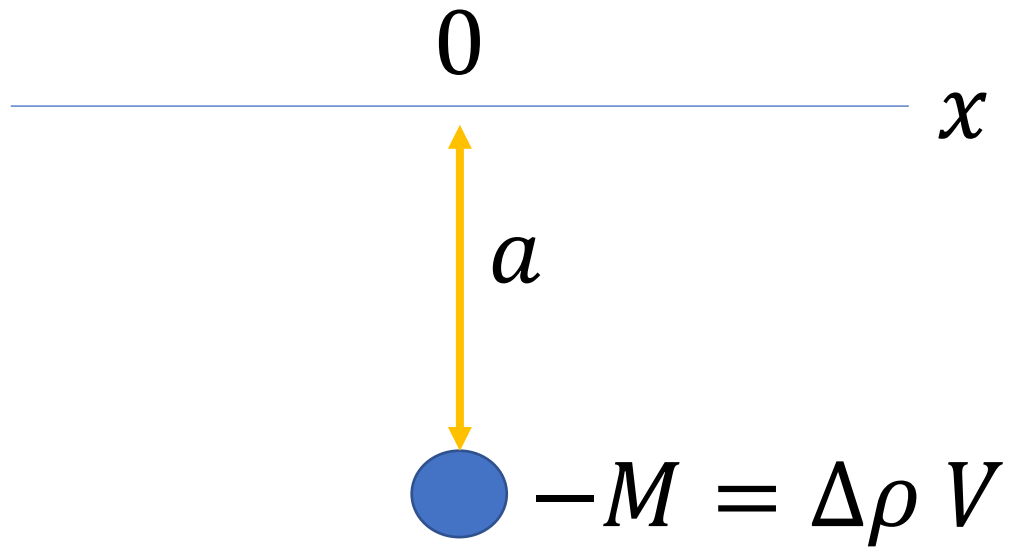
$$\Delta g_z = \frac{-\gamma M a}{(x^2 + a^2)^{3/2}}$$

Sphere



$$\Delta g_z = \frac{-\gamma M a}{(x^2 + a^2)^{3/2}}$$

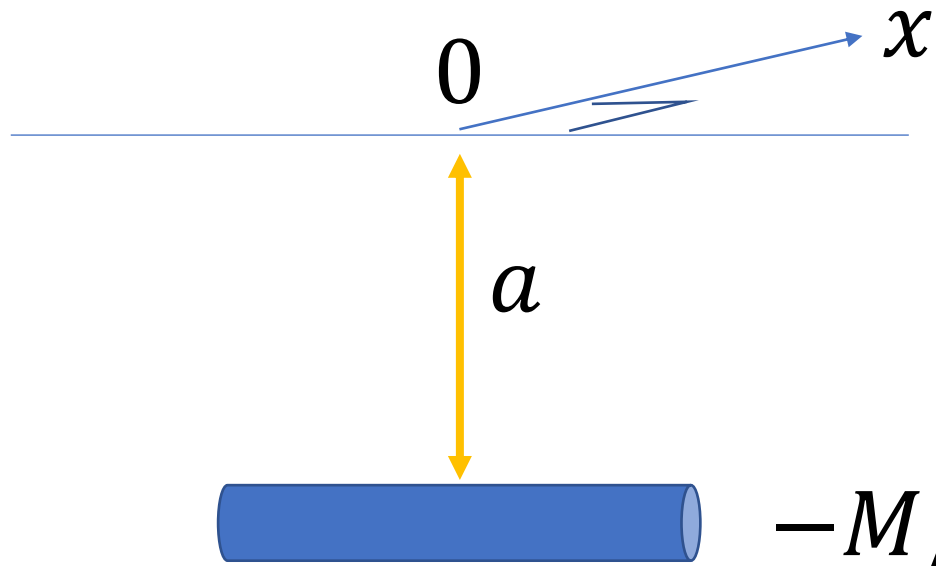




$$\Delta g_z = \frac{-\gamma M a}{(x^2 + a^2)^{3/2}}$$

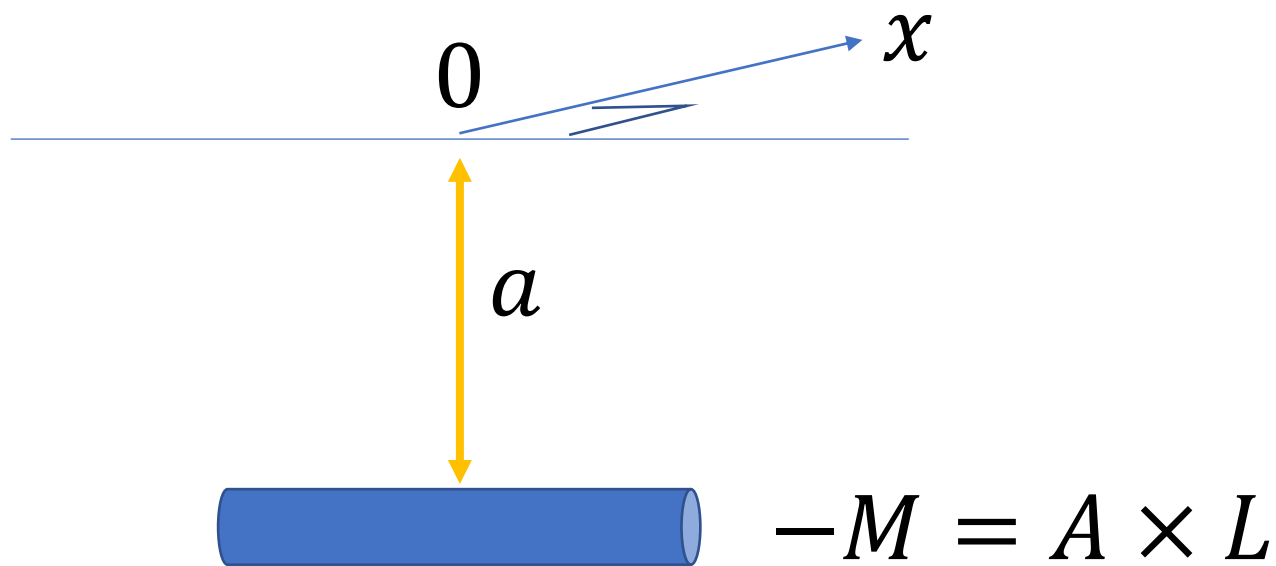
gamma	6.67E-11
V	1.00E+12
Drho	500
a	10000
x	0
Dg m/s2	-3.33E-04
D mgal	-33.35

indefinitely long cylinder



$$-M/L = \Delta\rho A$$

$$\Delta g_z = \frac{-2\gamma\Delta\rho A a}{x^2 + a^2}$$

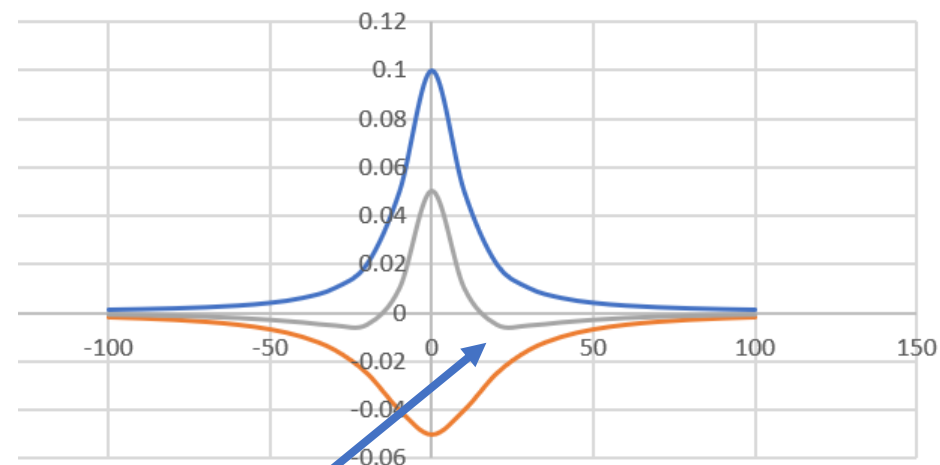


$$\Delta g_z = \frac{-2\gamma\Delta\rho A a}{x^2 + a^2}$$

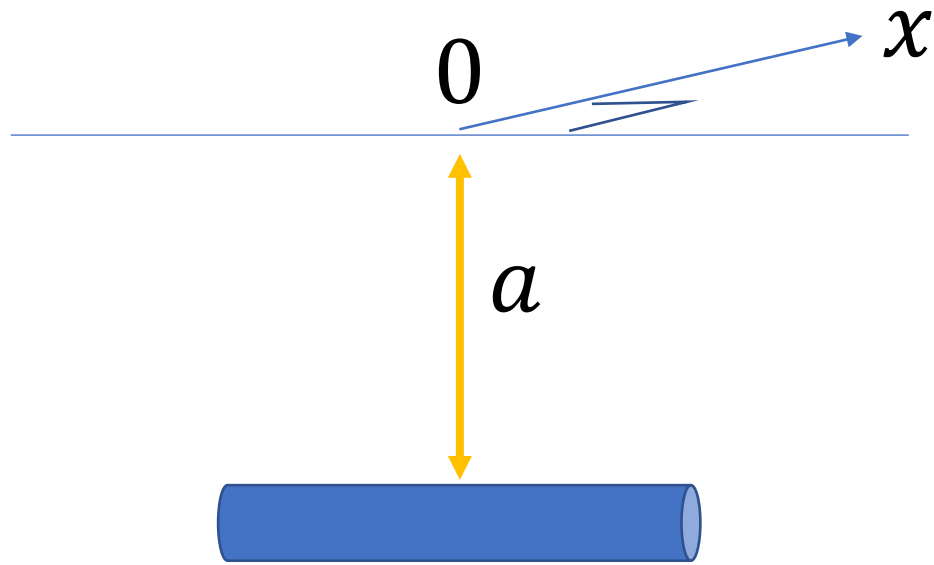
1	gamma	6.67E-11
2	V	1.00E+12
3	A	1.00E+08
4	Drho	500
5	a	10000
6	x	0
7		

10		
11	Dg m/s2	-6.67E-04
12	Fg mgal	-66.70
13		

twice as big as sphere



and has bigger trough



height scale as a^{-1}

width scales as a

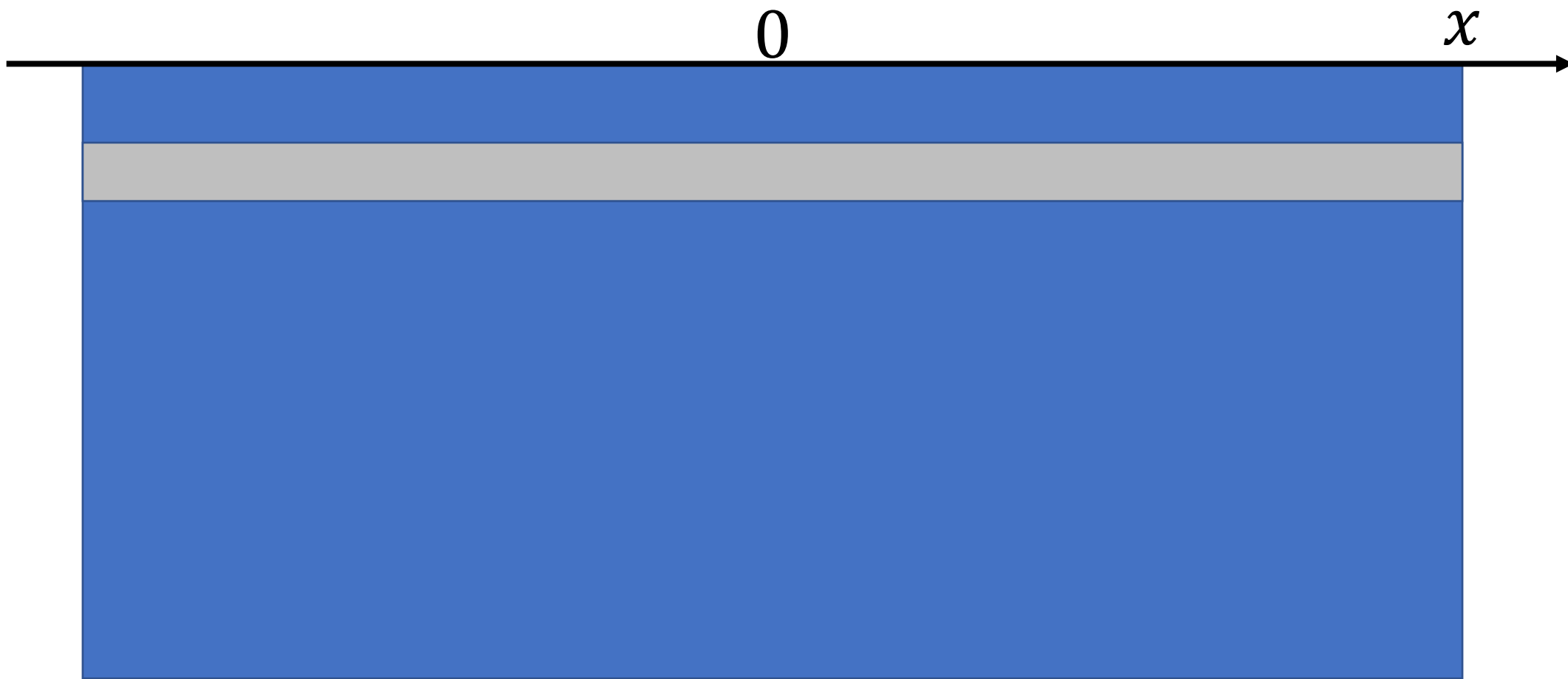
$$\Delta g_z = \frac{-2\gamma\Delta\rho A a}{x^2 + a^2}$$

divide top and bottom by a^2

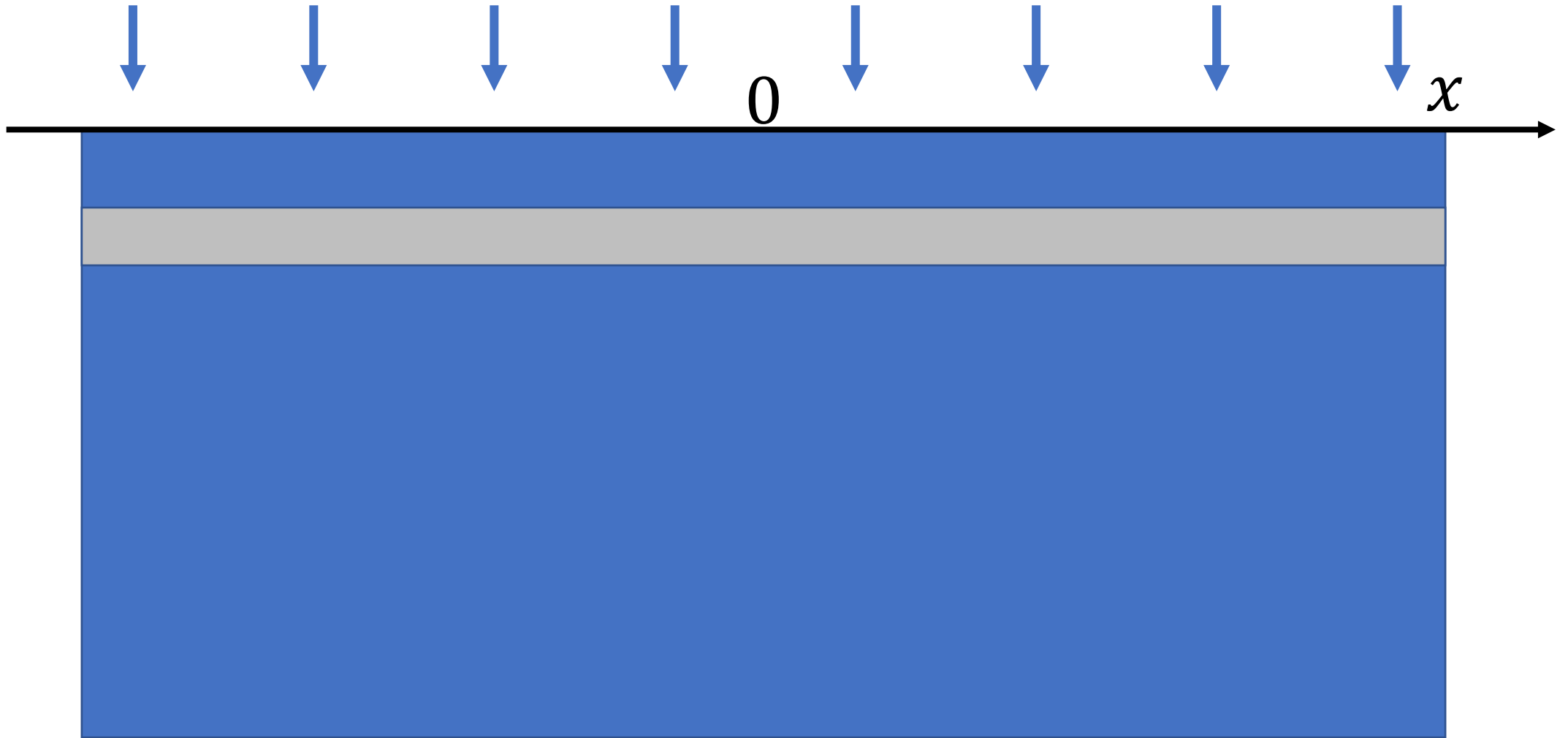
$$\Delta g_z = (-2\gamma\Delta\rho A) \frac{a^{-1}}{1 + (x/a)^2}$$

area under curve
 = width times height
 doesn't depend on a

indefinitely long layer

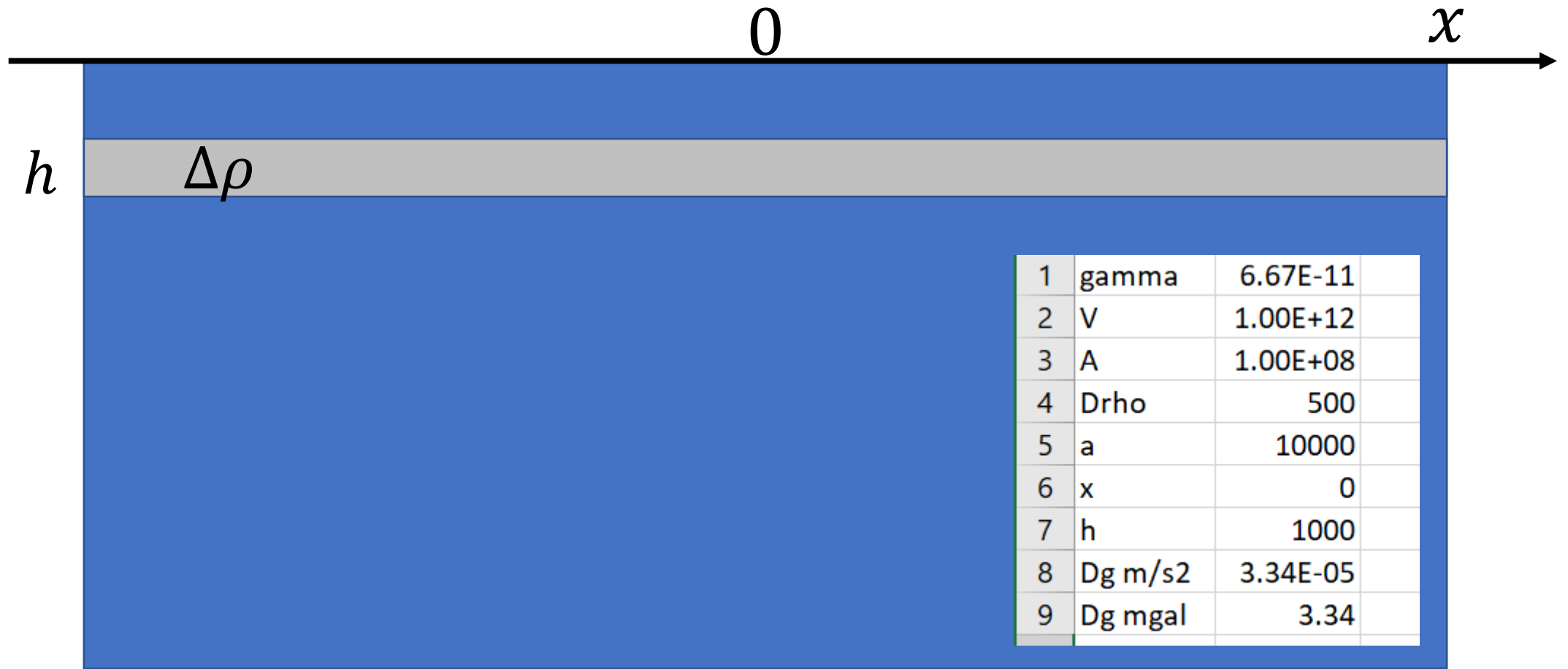


indefinitely long layer: constant anomaly, independent of height

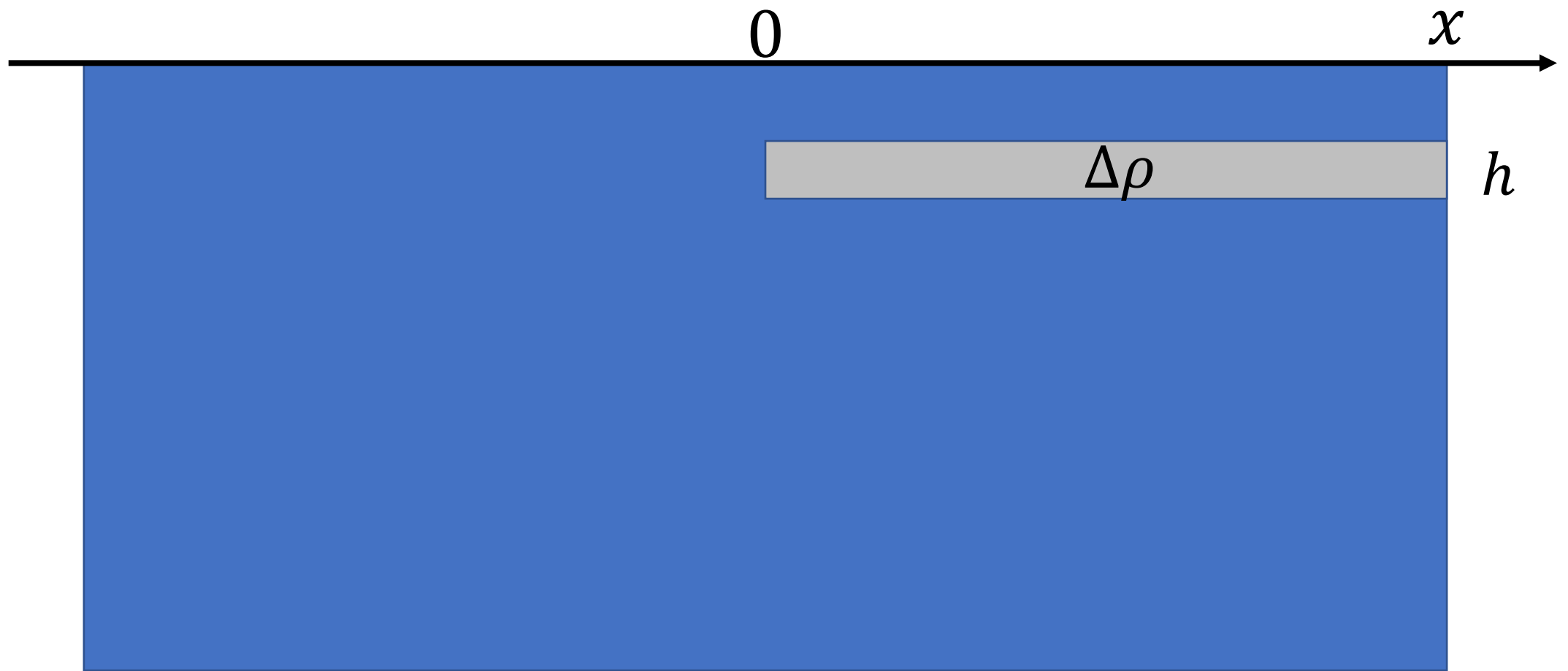


indefinitely long layer: constant anomaly

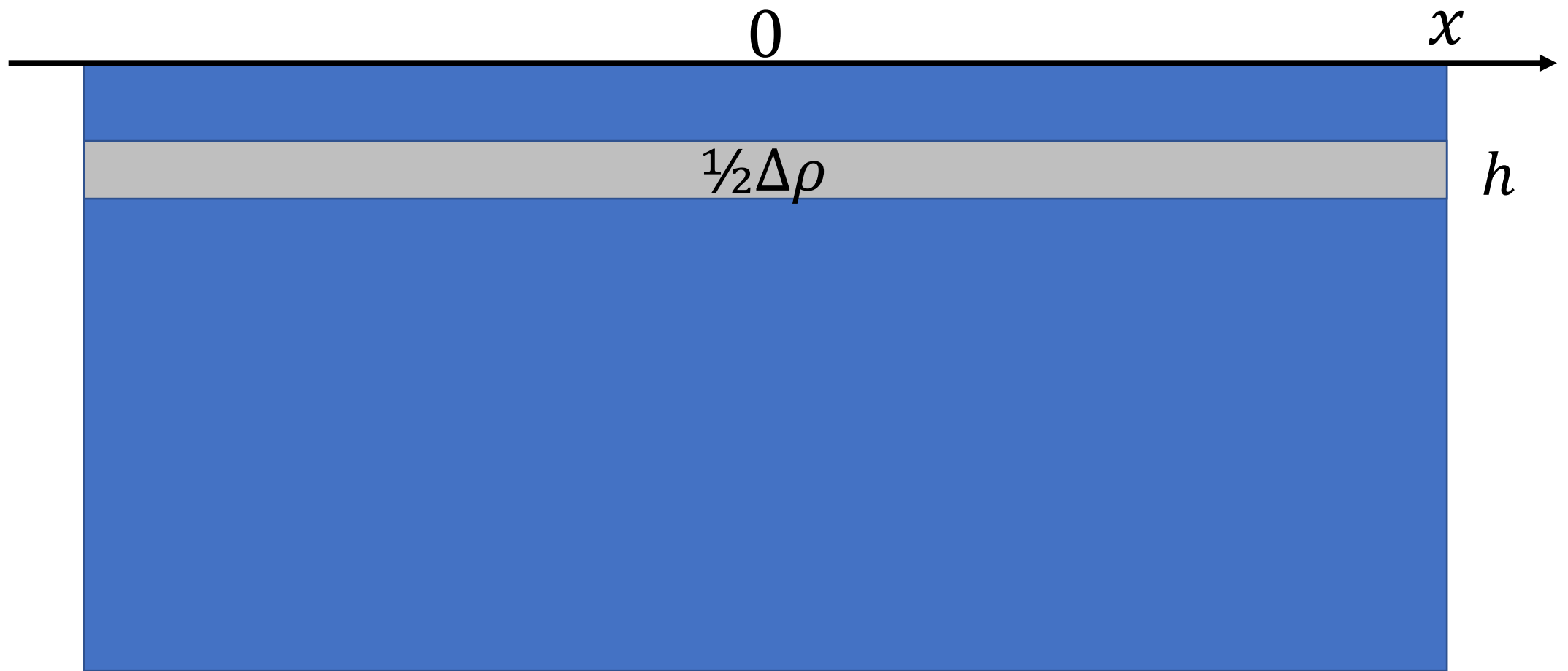
$$\Delta g_z = \gamma h \Delta \rho$$



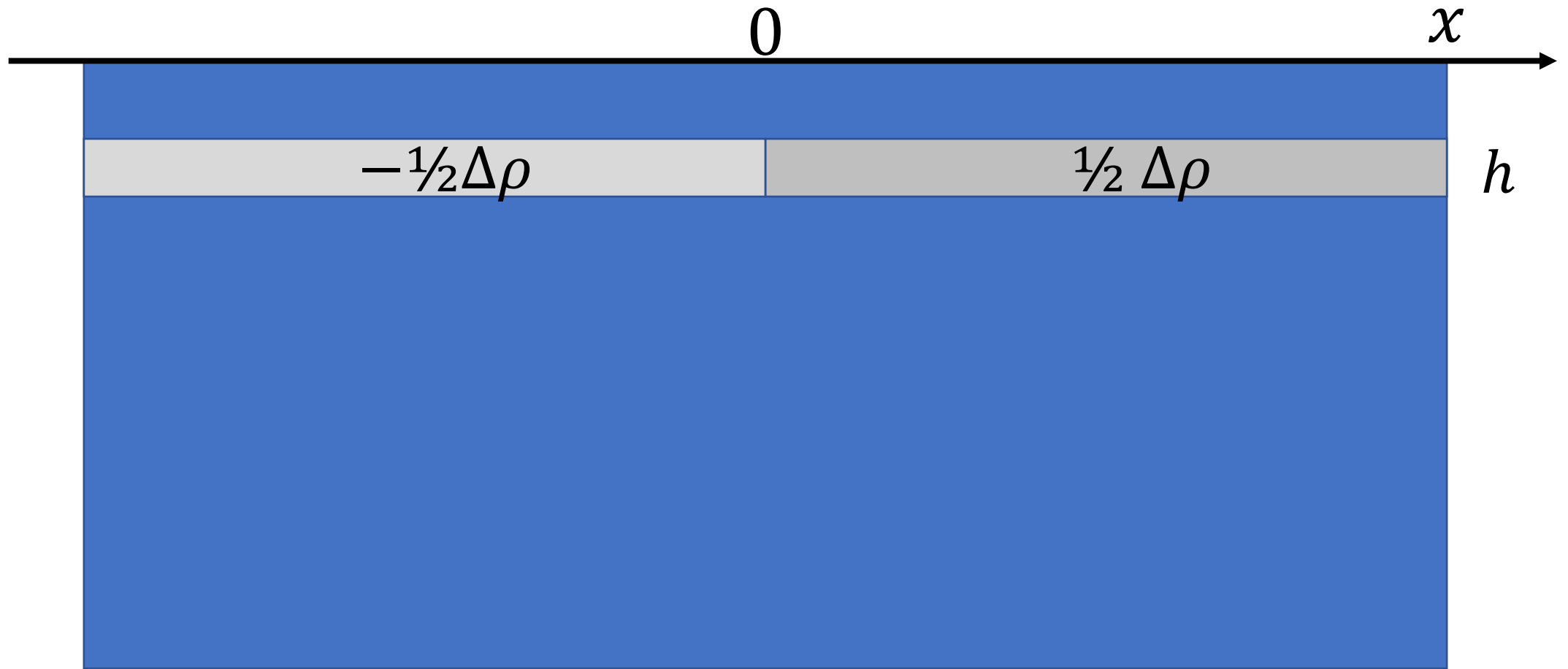
half-layer



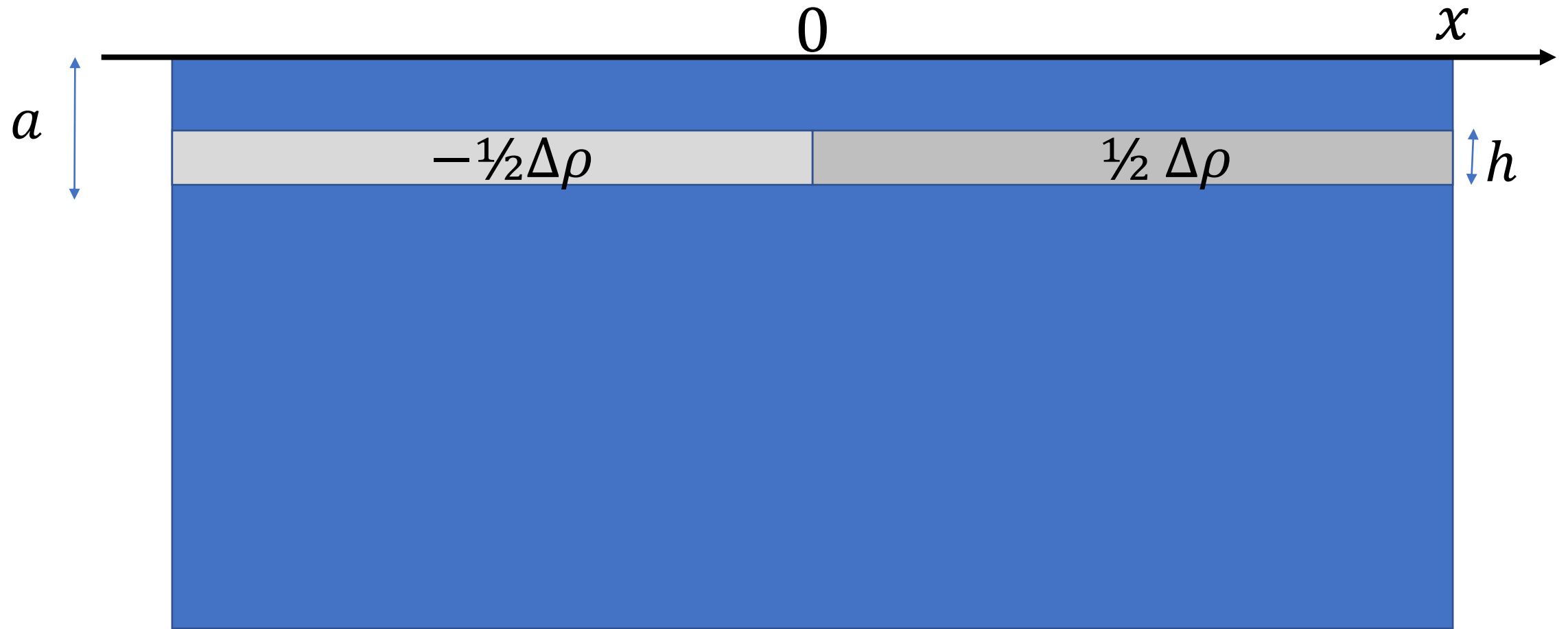
$$\Delta g_z = \gamma h \Delta \rho \quad \text{plus ...}$$

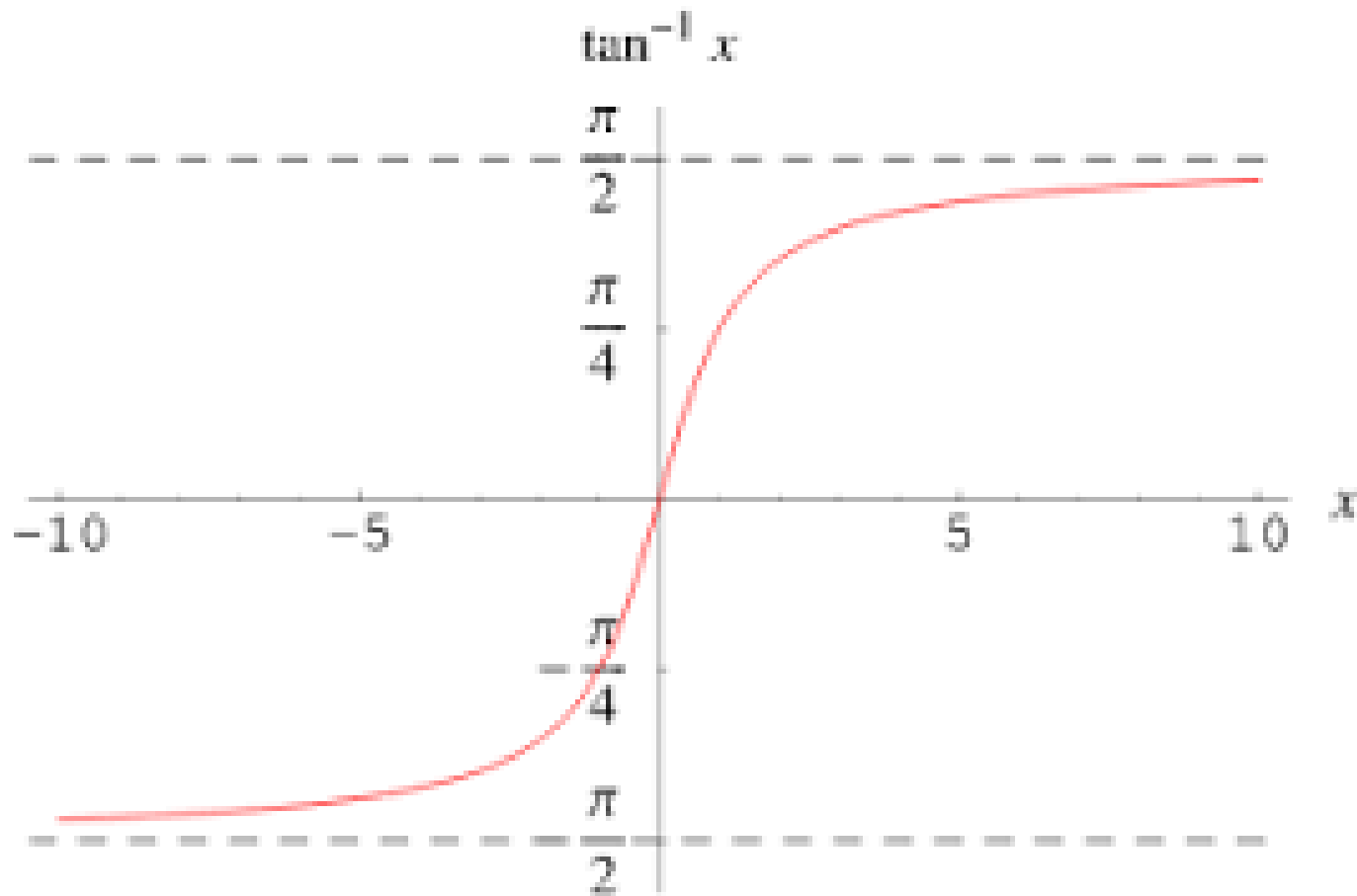


$$\Delta g_z = -\gamma h \Delta \rho + \text{something that's anti-symmetric}$$



$$\Delta g_z = \gamma h \Delta \rho \left[\frac{1}{2} + \frac{1}{2} \frac{2}{\pi} \tan^{-1} \left(\frac{x}{a} \right) \right]$$





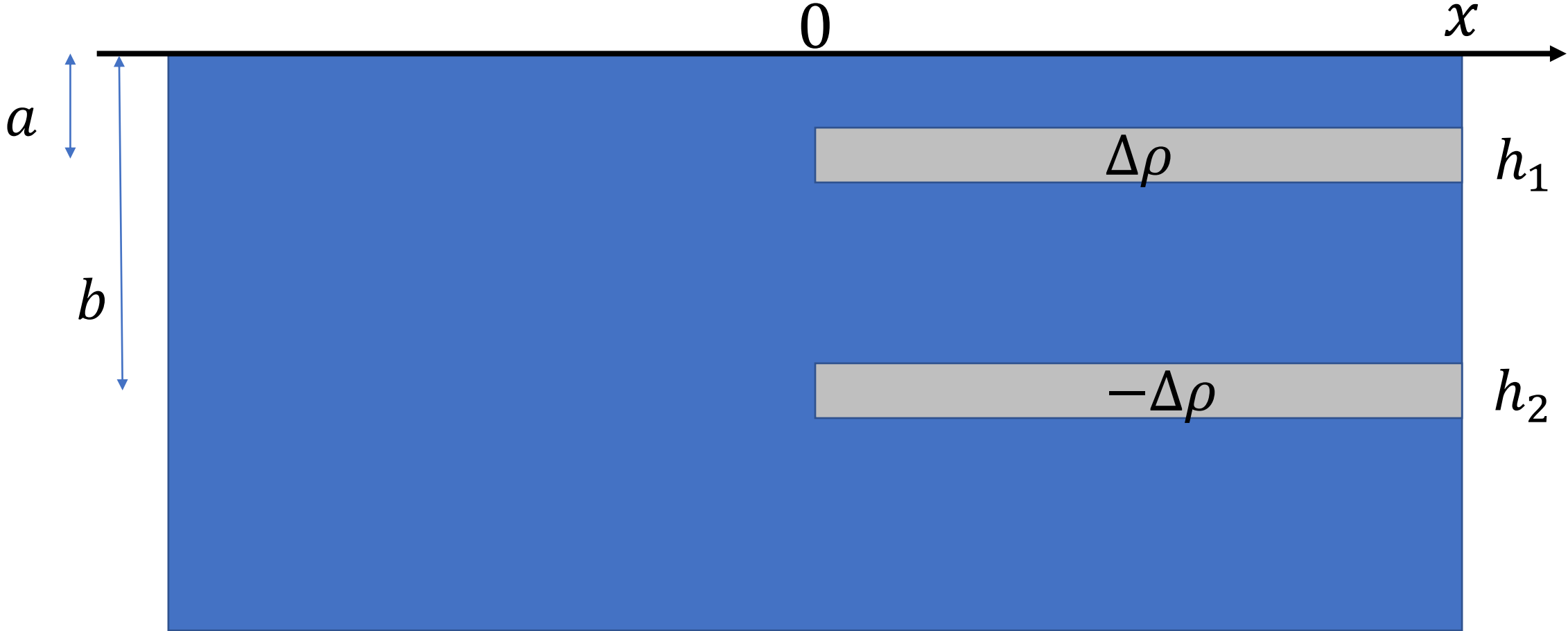
$$x \rightarrow \infty \tan^{-1} \left(\frac{x}{a} \right) \rightarrow \frac{\pi}{2}$$

$$x \rightarrow -\infty \tan^{-1} \left(\frac{x}{a} \right) \rightarrow -\frac{\pi}{2}$$

$$\Delta g_z = \gamma h \Delta \rho \left[\frac{1}{2} + \frac{1}{2} \frac{2}{\pi} \tan^{-1} \left(\frac{x}{a} \right) \right]$$

edge in isostatic balance

$$\Delta g_z = \gamma h \Delta \rho \left[\frac{1}{2} \frac{2}{\pi} \tan^{-1} \left(\frac{x}{a} \right) - \frac{1}{2} \frac{2}{\pi} \tan^{-1} \left(\frac{x}{b} \right) \right]$$

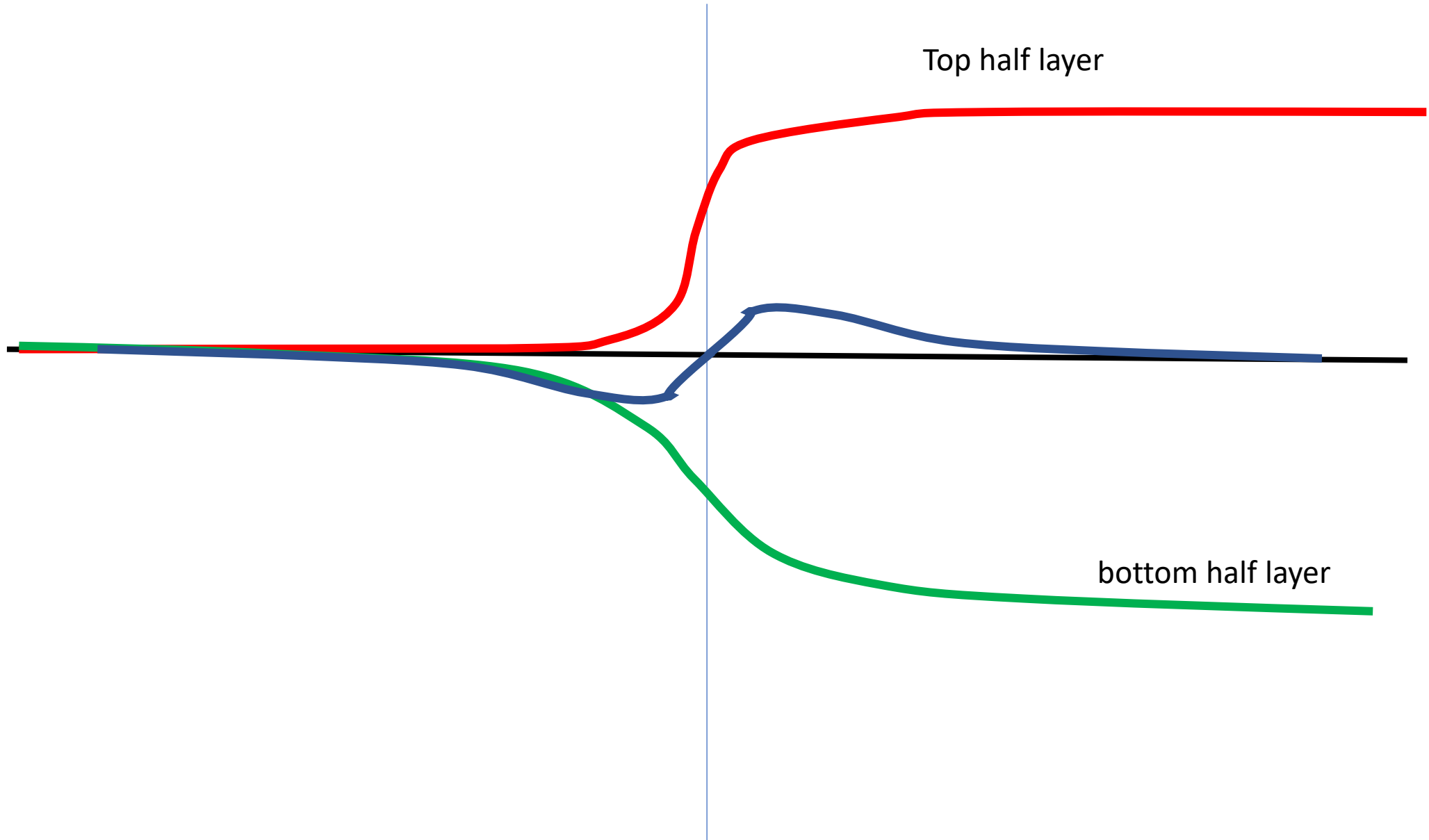


Top half layer

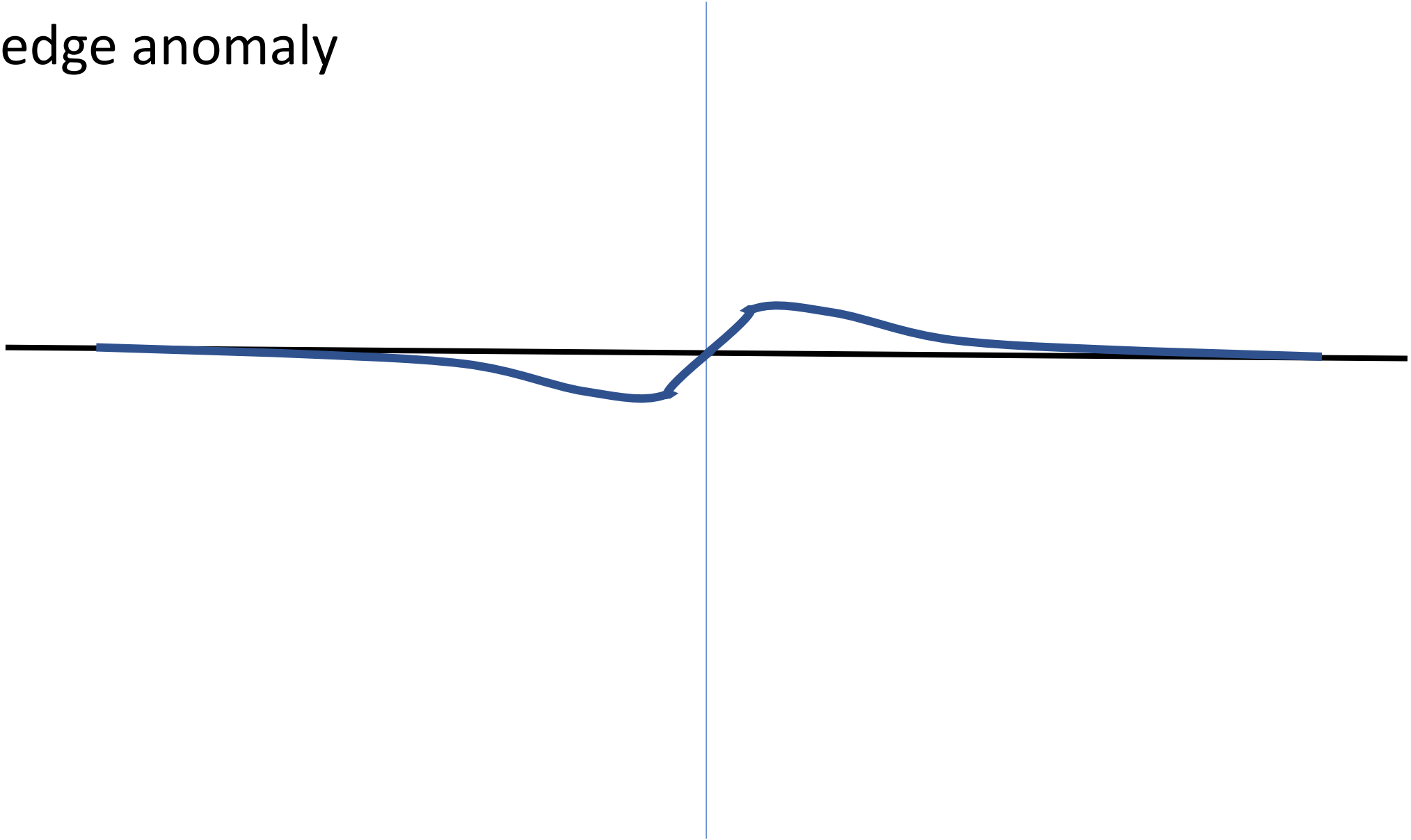


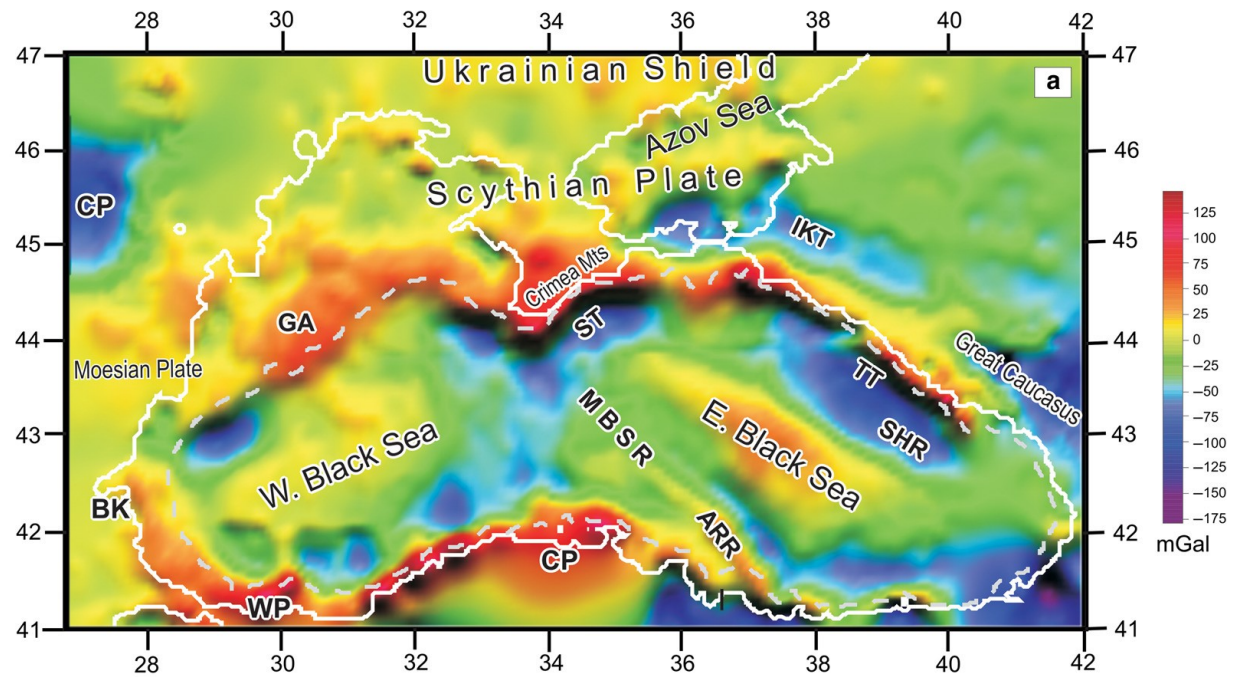
bottom half layer

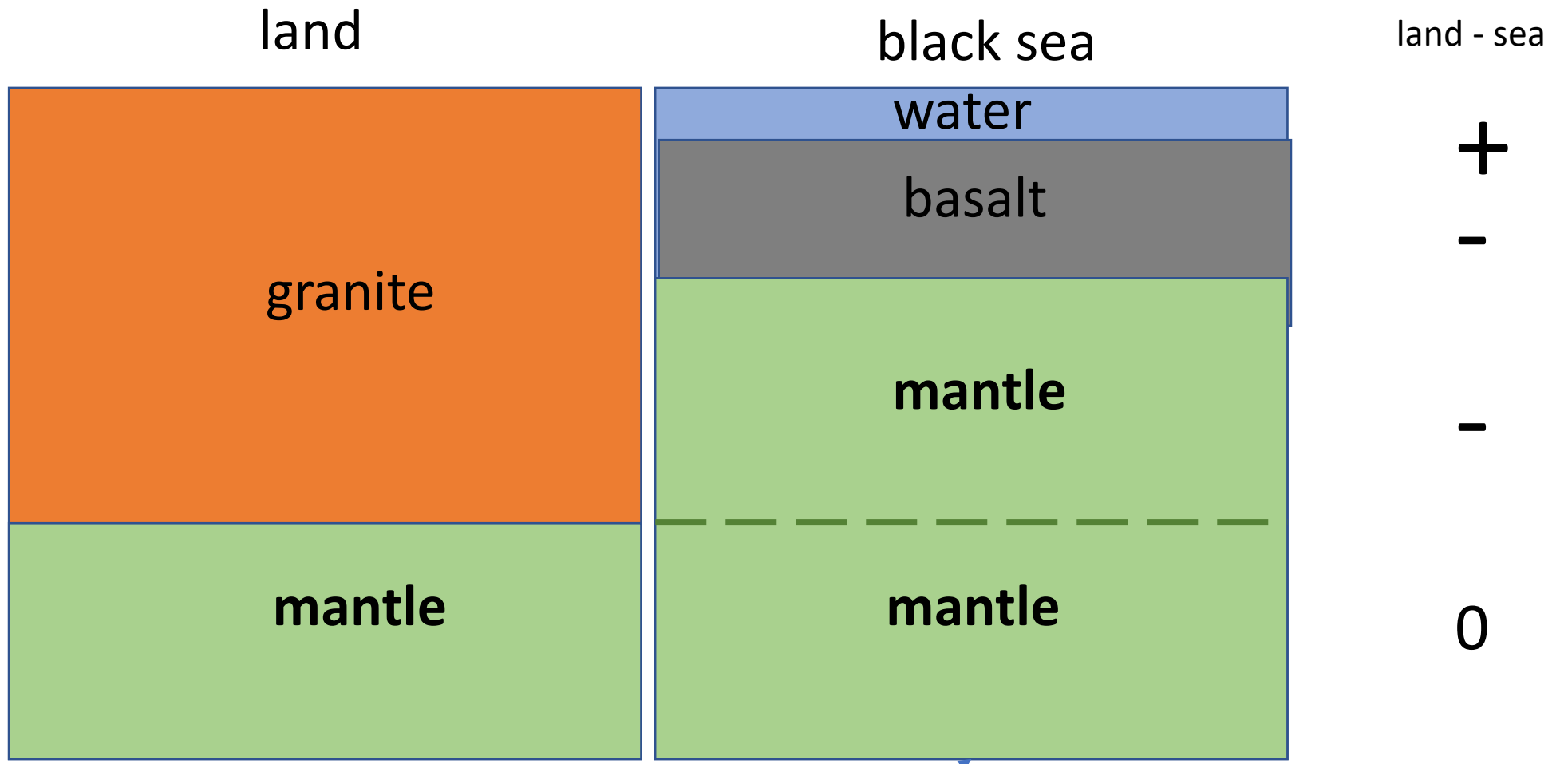




edge anomaly

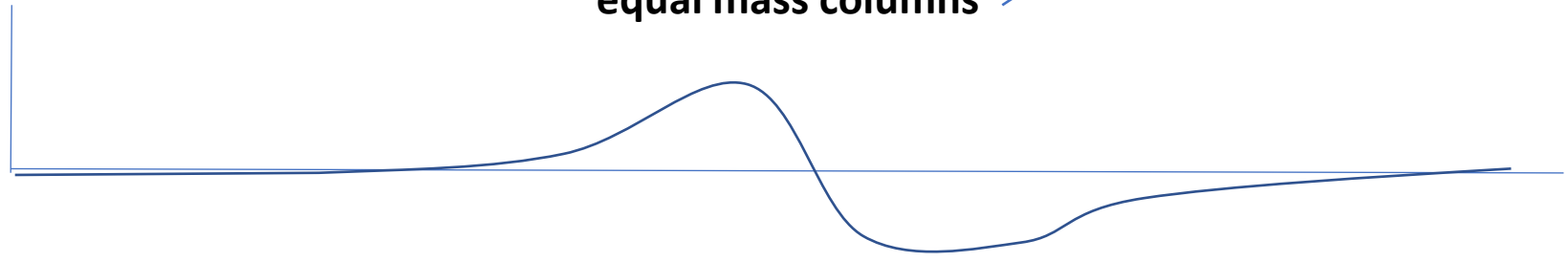


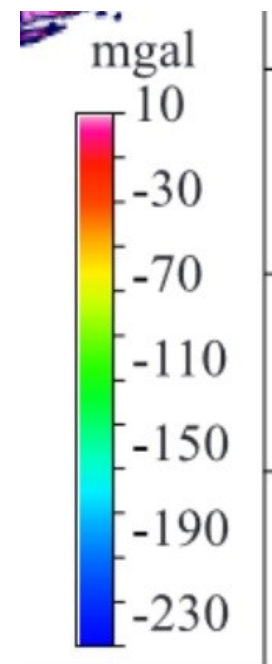
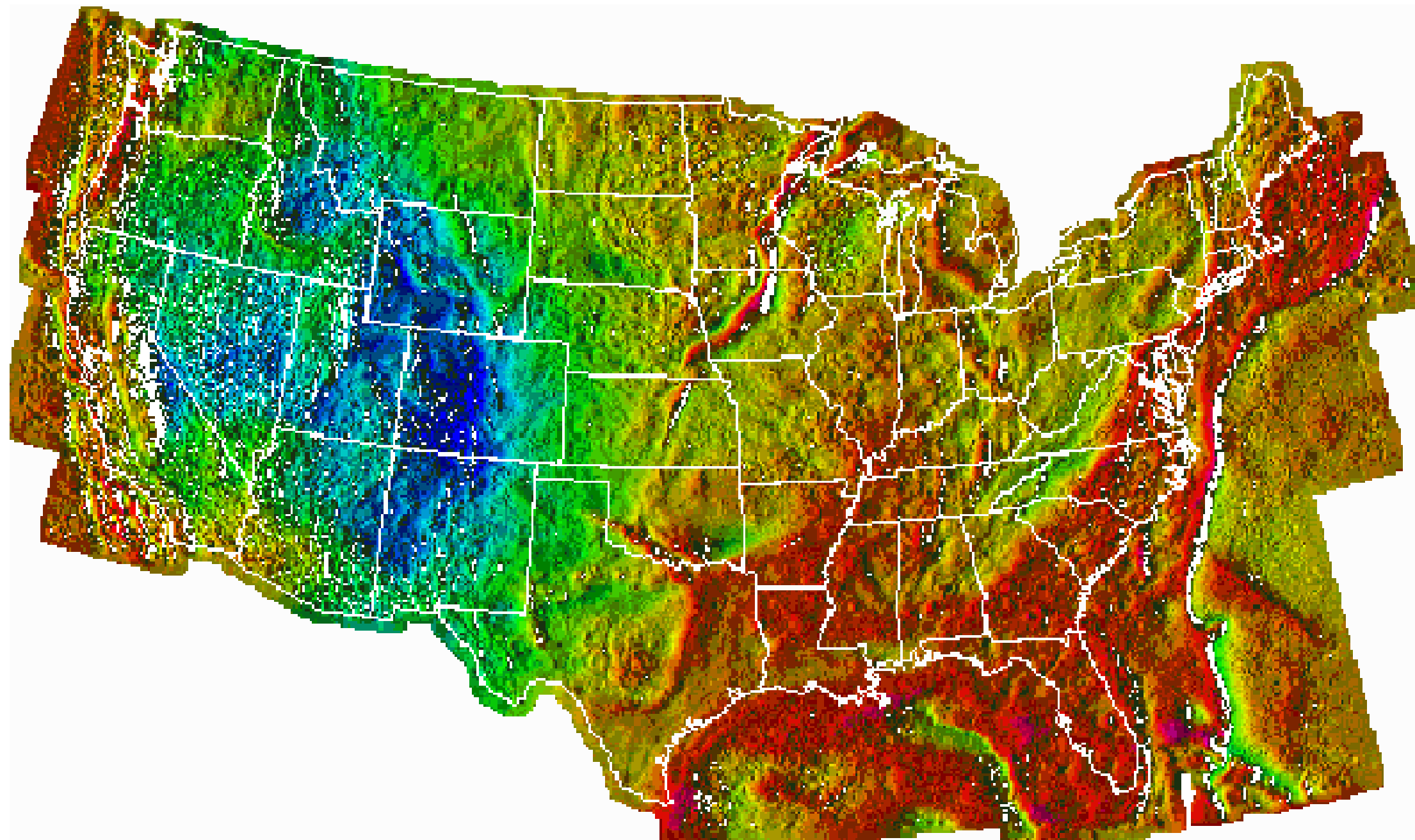


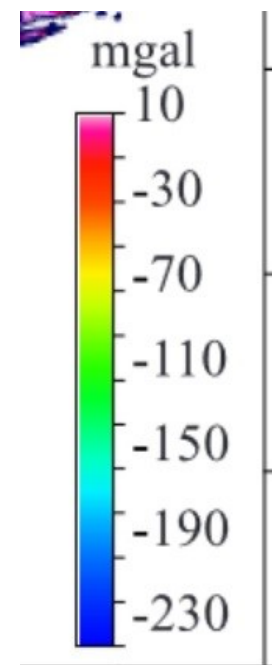
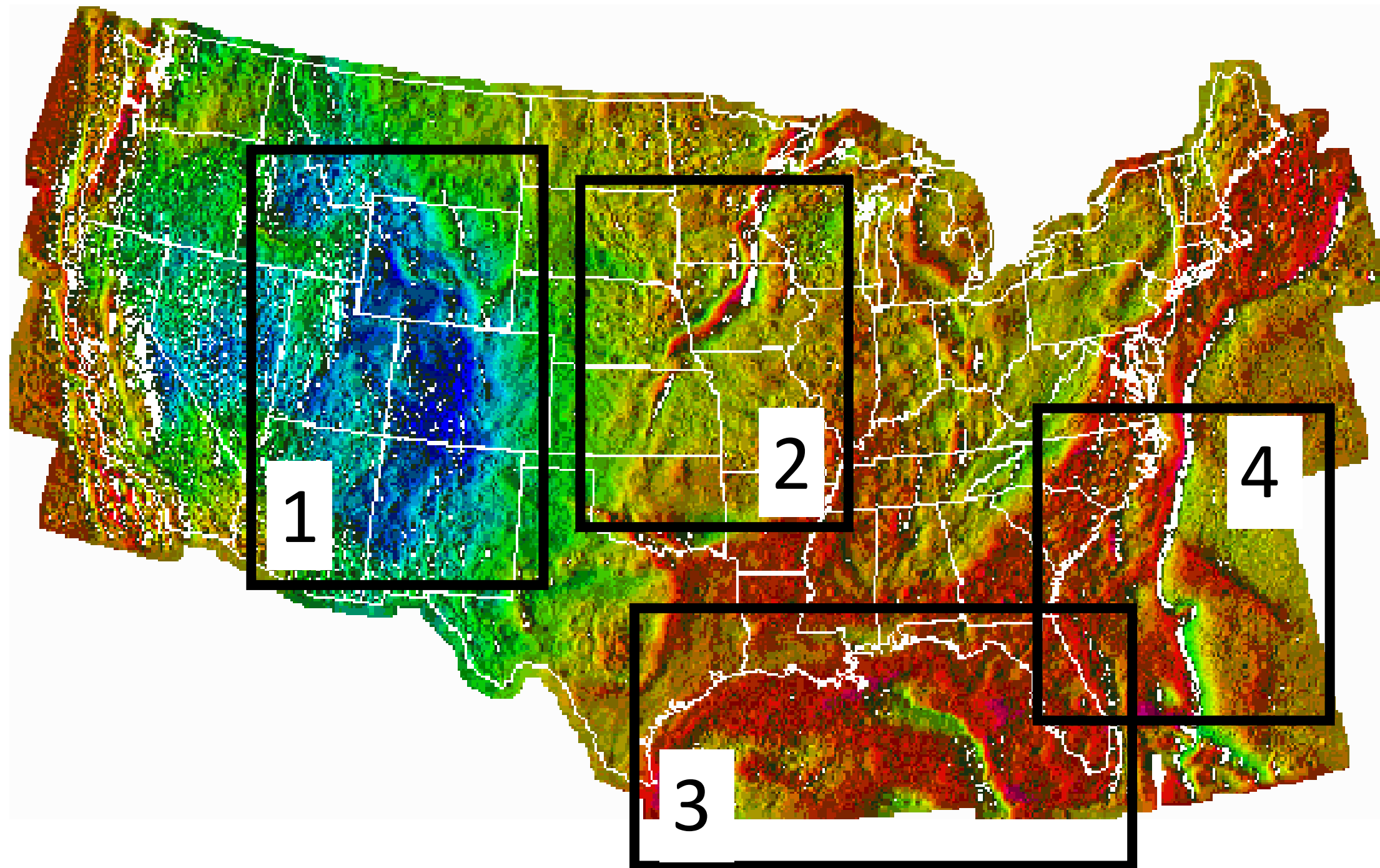


equal mass columns

g_z





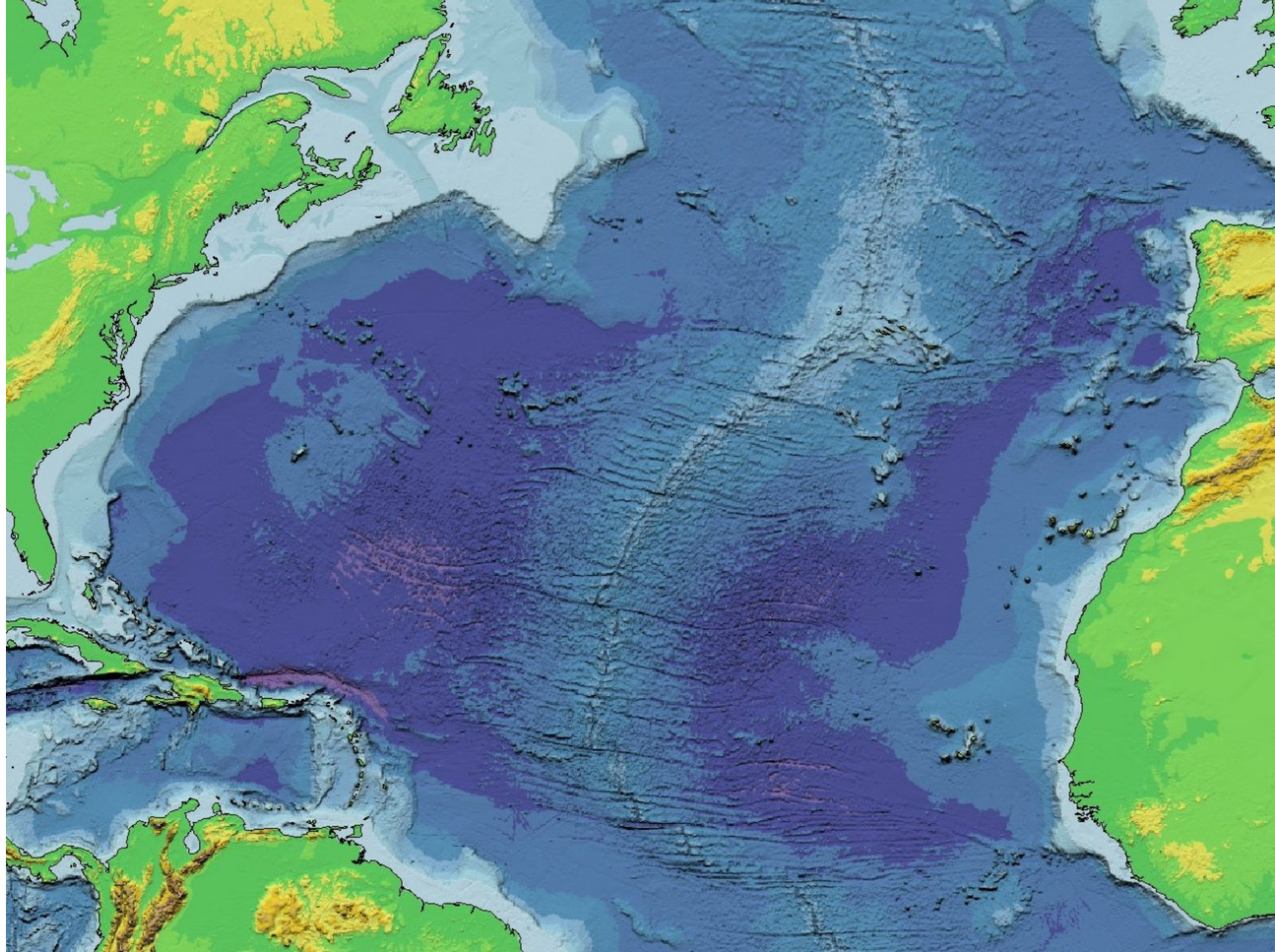


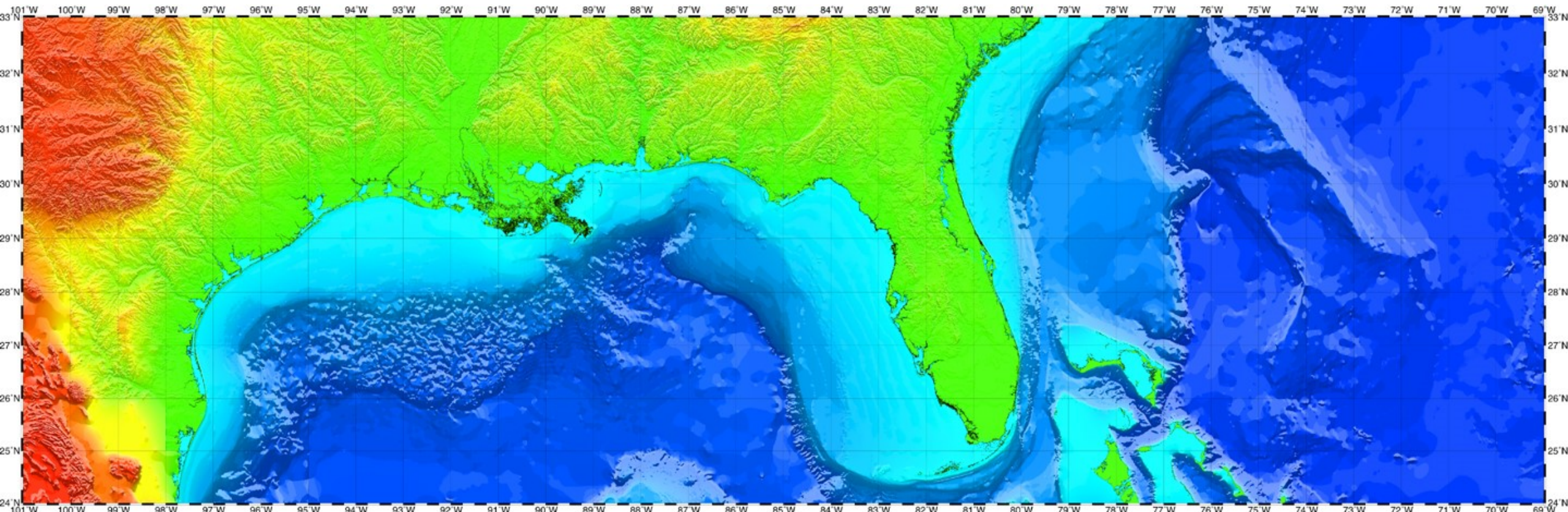
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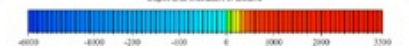
U.S. National Oceanic and Atmospheric Administration,
National Environmental Satellite, Data, and Information Service,
National Geophysical Data Center



0 100 200 300
km

Mercator Projection Scale 1:2,000,000

Depth and Elevation in Meters



Intergovernmental Oceanographic Commission