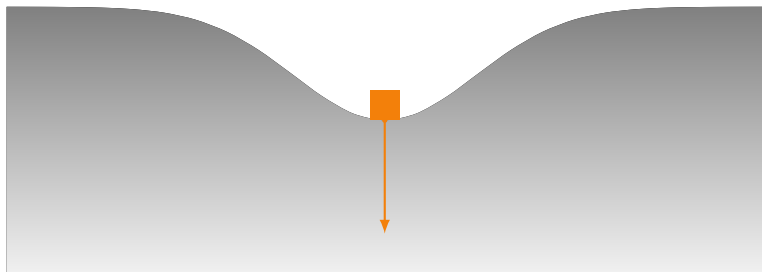


Obciążeniowe deformacje skorupy Ziemskiej

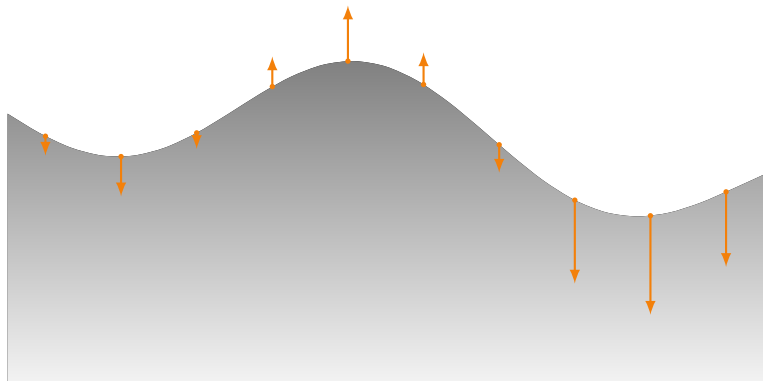
ostatnia aktualizacja
23 kwietnia 2020



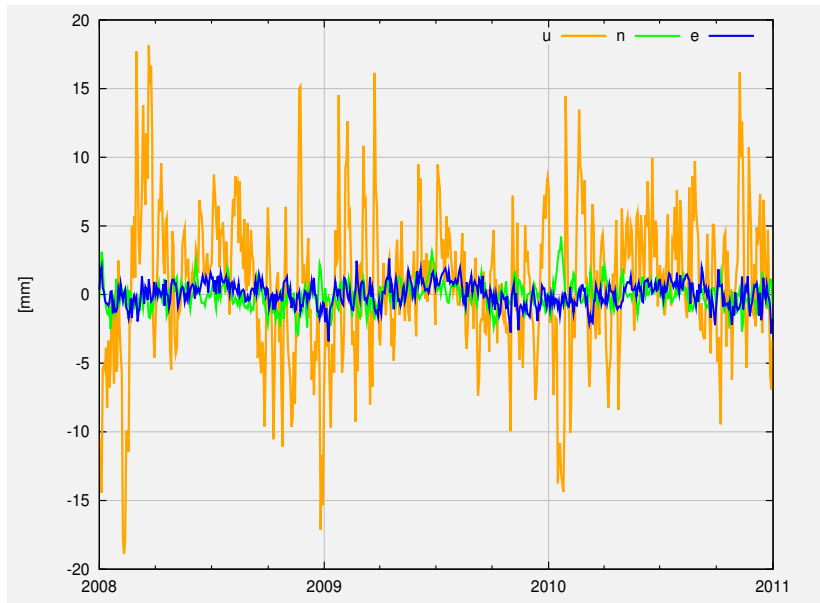
Skorupa jest elastyczna!



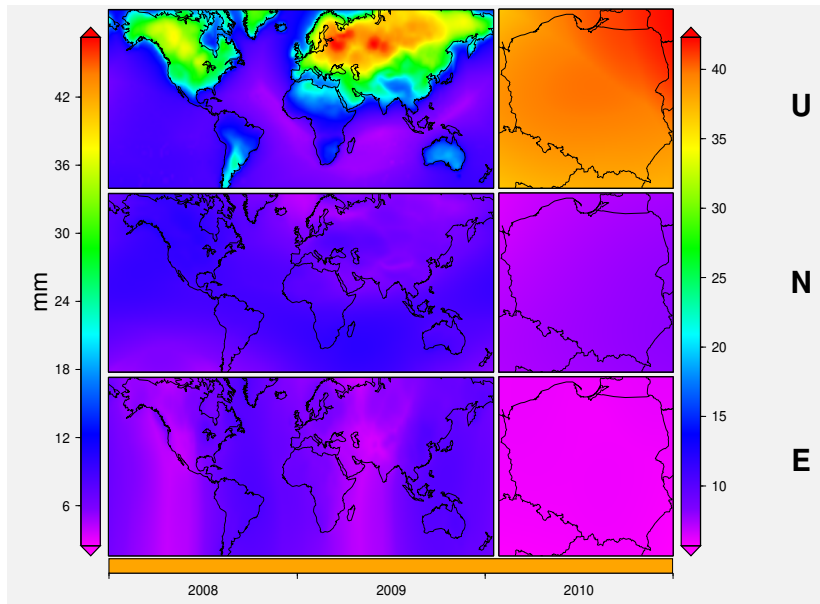
Skorupa jest elastyczna!



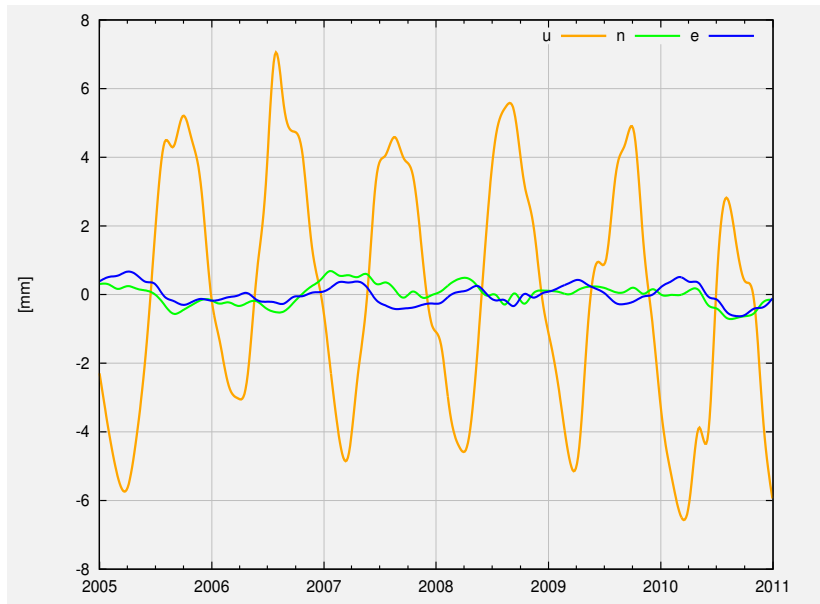
ATML – przykład JOZE



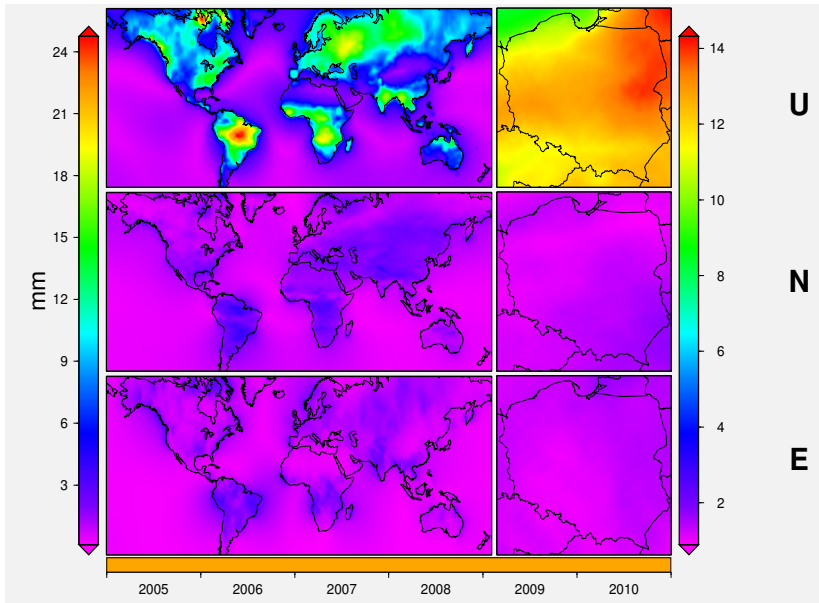
ATML



HYDL – przykład JOZE



HYDL



Ćwiczenie

Obliczyć deformacje Ziemi (składowe h, n, e) w punkcie o zadanych współrzędnych $\varphi = 52^{\circ}0'0''$ i $\lambda = 21^{\circ}0'0''$.

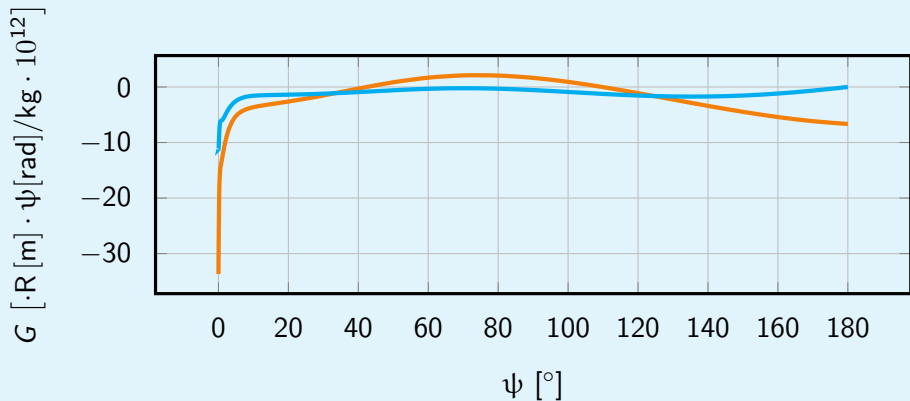
Armia niemiecka	Armia Czerwona		kg
900 000	1 336 000	żołnierzy	80
10 000	19 100	moździerzy	200
2700	3444	czołgów	30 000
2500	2900	samolotów	10 000
			<hr/>
			Σ 423 020 000
			\times 1 000
			Σ 423 020 000 000

Obciążeniowe liczby Love'a → F. Greena

$\psi [^\circ]$	G_r	G_h
0,0001	-33,640	-11,250
0,001	-33,560	-11,250
0,01	-32,750	-11,240
0,02	-31,860	-11,210
0,03	-30,980	-11,160
0,04	-30,120	-11,090
0,06	-28,440	-10,900
0,08	-26,870	-10,650
0,1	-25,410	-10,360
0,16	-21,800	-9,368
0,2	-20,020	-8,723
0,25	-18,360	-8,024
0,3	-17,180	-7,467
0,4	-15,710	-6,725
0,5	-14,910	-6,333
0,6	-14,410	-6,150
0,8	-13,690	-6,050
1	-13,010	-5,997

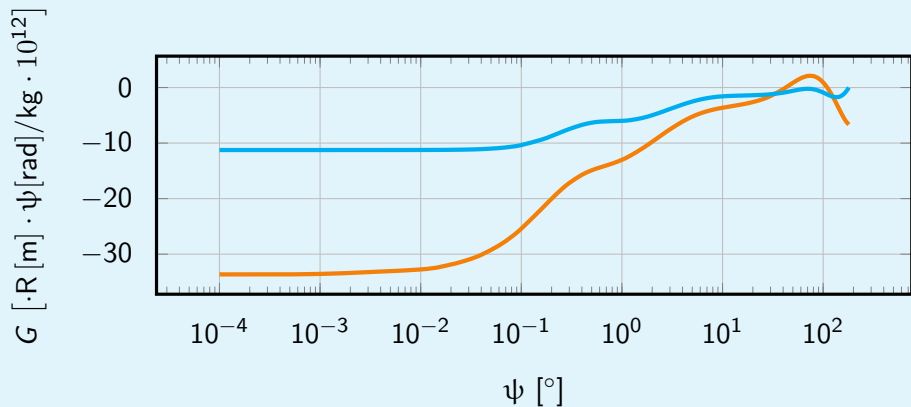
Obciążeniowe liczby Love'a \longrightarrow F. Greena

ψ [°]	G_r	G_h
0,0001	-33,640	-11,250
0,001	-33,560	-11,250
0,01	-32,750	-11,240
0,02	-31,860	-11,210
0,03	-30,980	-11,160



Obciążeniowe liczby Love'a \rightarrow F. Greena

ψ [°]	G_r	G_h
0,0001	-33,640	-11,250
0,001	-33,560	-11,250
0,01	-32,750	-11,240
0,02	-31,860	-11,210
0,03	30,980	11,160



F. Greena

$\psi [^\circ]$	G_r	G_h
1,2	-12,310	-5,881
1,6	-10,950	-5,475
2	-9,757	-4,981
2,5	-8,519	-4,388
3	-7,533	-3,868
4	-6,131	-3,068
5	-5,237	-2,523
6	-4,660	-2,156
7	-4,272	-1,915
8	-3,999	-1,754
9	-3,798	-1,649
10	-3,640	-1,582
12	-3,392	-1,504
16	-2,999	-1,435
20	-2,619	-1,386
25	-2,103	-1,312
30	-1,530	-1,211
40	-0,292	-0,926

F. Greena

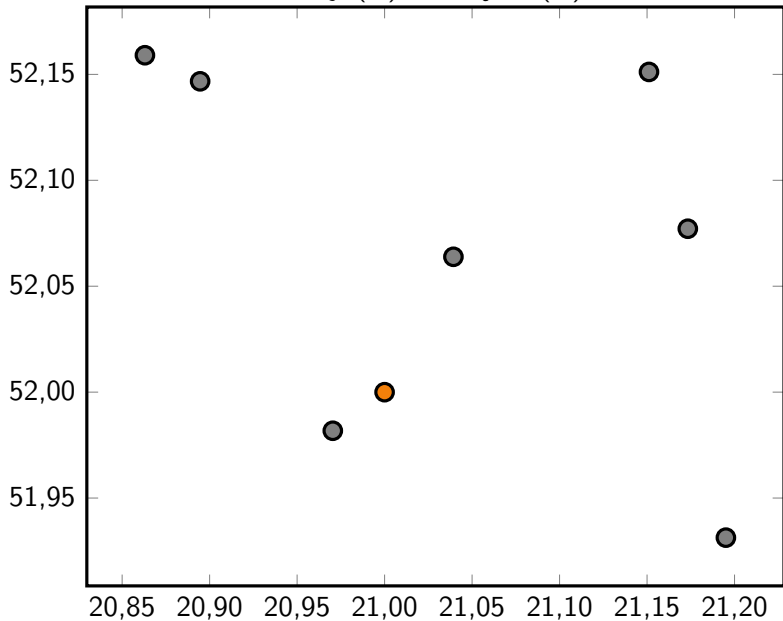
ψ [°]	G_r	G_h
50	0,848	-0,592
60	1,676	-0,326
70	2,083	-0,223
80	2,057	-0,310
90	1,643	-0,555
100	0,920	-0,894
110	-0,025	-1,247
120	-1,112	-1,537
130	-2,261	-1,706
140	-3,405	-1,713
150	-4,476	-1,540
160	-5,414	-1,182
170	-6,161	-0,657
180	-6,663	0,000

Przykład

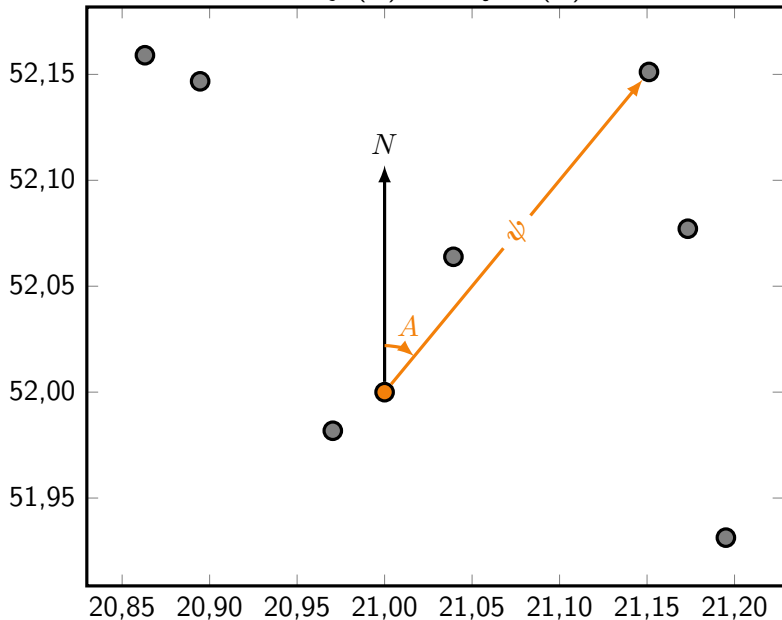
■ Dane do przykładu

#	nr	fi [st dz]	la [st dz]	masa [kg]
#	0	52.15118	21.15111	65015827173.4
	0	52.15906	20.86303	103000210135.2
	0	52.14675	20.89458	62677738747.4
	0	51.98179	20.97040	13673689960.4
	0	52.07716	21.17330	61120632423.4
	0	52.06391	21.03934	45207476347.0
	0	51.93133	21.19506	72324428541.2

■ Rozmieszczenie stacji (●) i obciążeń (●).

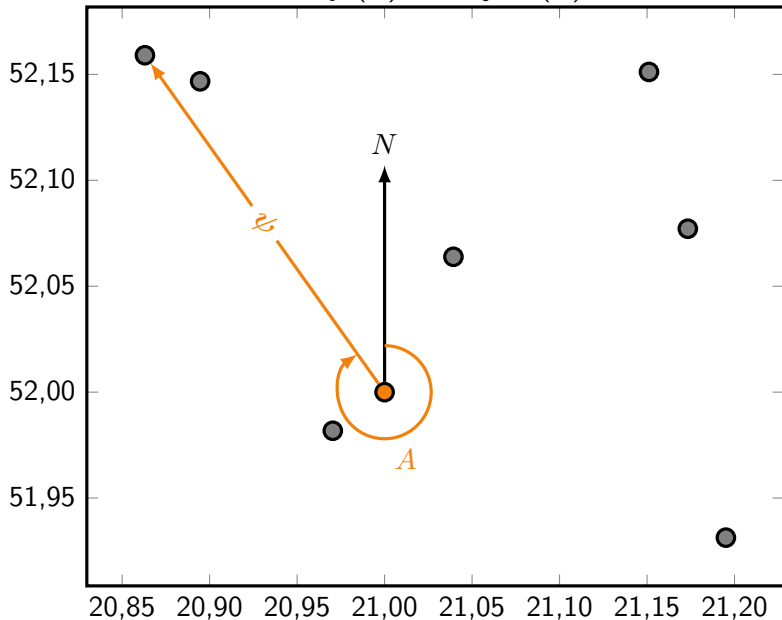


■ Rozmieszczenie stacji (●) i obciążeń (●).

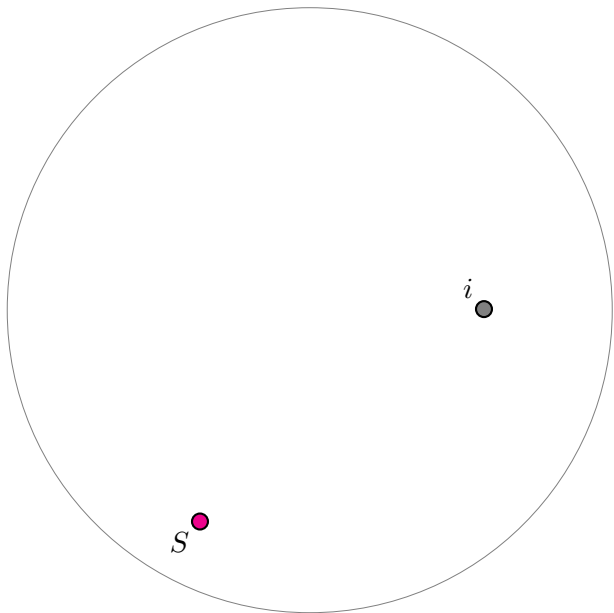


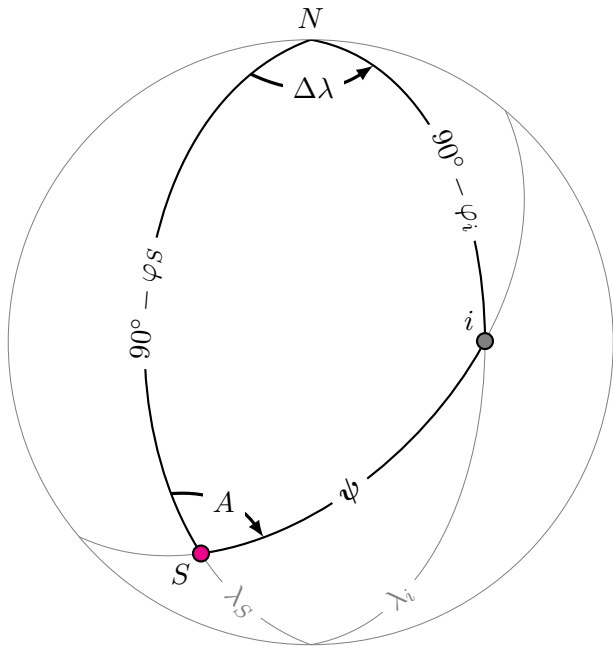
Z wzorów trygonometrii sferycznej

■ Rozmieszczenie stacji (●) i obciążeń (●).



Z wzorów trygonometrii sferycznej







N

$$\psi = 2 \arcsin \left(\sqrt{\sin^2 \left(\frac{\Delta\varphi}{2} \right) + \cos \varphi_S \cos \varphi_i \sin^2 \left(\frac{\Delta\lambda}{2} \right)} \right)$$

lub

$$\psi = \arccos \left(\sin \varphi_S \sin \varphi_i + \cos \varphi_S \cos \varphi_i \cos \Delta\lambda \right)$$

$$A = \arcsin \left(\frac{\cos \varphi_i \cdot \sin \Delta\lambda}{\sin \psi} \right)$$

φ [°]	λ [°]
52,15118	21,15111
52,15906	20,86303
52,14675	20,89458
51,98179	20,97040
52,07716	21,17330
52,06391	21,03934
51,93133	21,19506

$\varphi [^\circ]$	$\lambda [^\circ]$	$\psi [^\circ]$	$A [^\circ]$
52,15118	21,15111	0,17743	31,50436
52,15906	20,86303	0,17996	332,16545
52,14675	20,89458	0,16042	336,21799
51,98179	20,97040	0,02577	225,03884
52,07716	21,17330	0,13160	54,03421
52,06391	21,03934	0,06834	20,72626
51,93133	21,19506	0,13842	119,66588



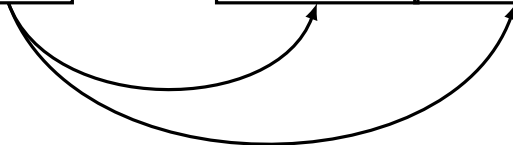
$\varphi [^\circ]$
52,15118
52,15906
52,14675
51,98179
52,07716
52,06391
51,93133

$\lambda [^\circ]$
21,15111
20,86303
20,89458
20,97040
21,17330
21,03934
21,19506

$\psi [^\circ]$
0,17743
0,17996
0,16042
0,02577
0,13160
0,06834
0,13842

$A [^\circ]$
31,50436
332,16545
336,21799
225,03884
54,03421
20,72626
119,66588

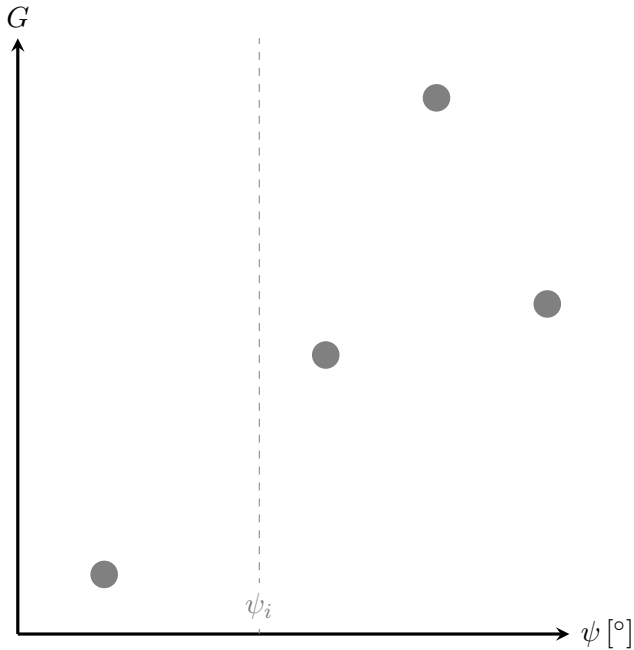
$G_r [\cdot 10^{12} \cdot \psi \cdot R]$	$G_h [\cdot 10^{12} \cdot \psi \cdot R]$
-20,96783	-9,07977
-20,85453	-9,03873
-21,77891	-9,36098
-31,35075	-11,18368
-23,36291	-9,84832
-27,77098	-10,80200
-22,96377	-9,73318



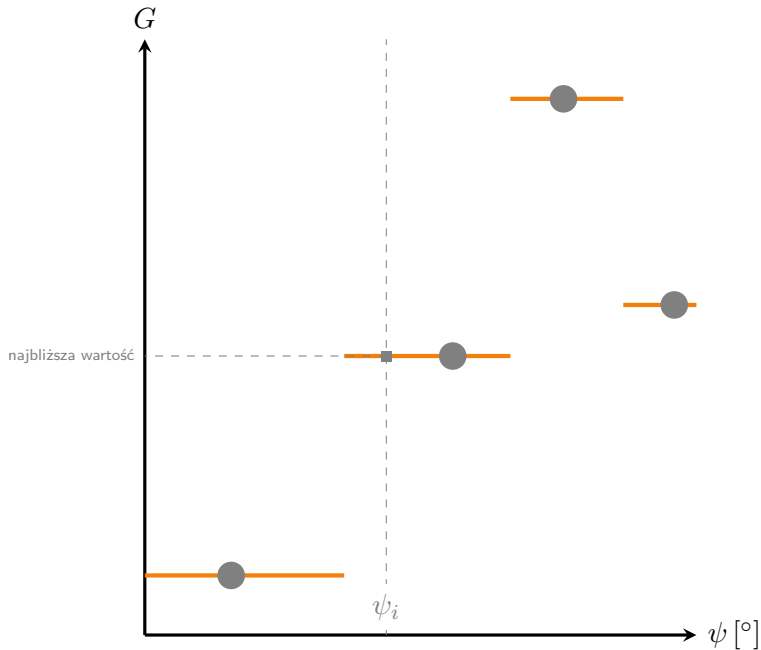
M [kg]	ψ [°]	A [°]	G_r [$\cdot 10^{12} \cdot \psi \cdot R$]	G_h [$\cdot 10^{12} \cdot \psi \cdot R$]
65 015 830 000	0, 17743	31, 50436	-20, 96783	-9, 07977
103 000 200 000	0, 17996	332, 16545	-20, 85453	-9, 03873
62 677 740 000	0, 16042	336, 21799	-21, 77891	-9, 36098
13 673 690 000	0, 02577	225, 03884	-31, 35075	-11, 18368
61 120 630 000	0, 13160	54, 03421	-23, 36291	-9, 84832
45 207 480 000	0, 06834	20, 72626	-27, 77098	-10, 80200
72 324 430 000	0, 13842	119, 66588	-22, 96377	-9, 73318

$$\Delta r = \sum_{i=1}^n G_{r_i} \cdot M_i \quad \Delta h_{n,e} = \sum_{i=1}^n G_{h_i} \cdot M_i \cdot \left\{ \begin{array}{l} -\cos A \\ -\sin A \end{array} \right\}$$

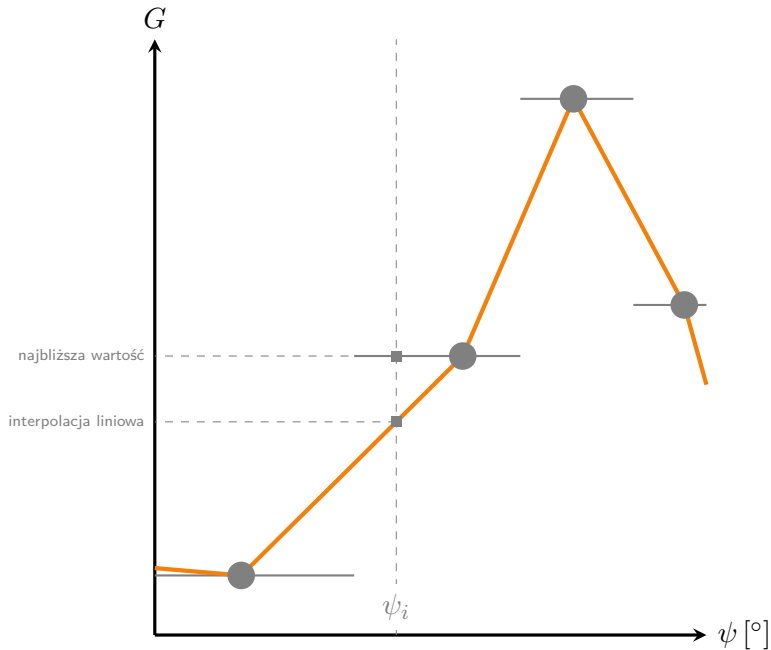
Problem do przemyślenia



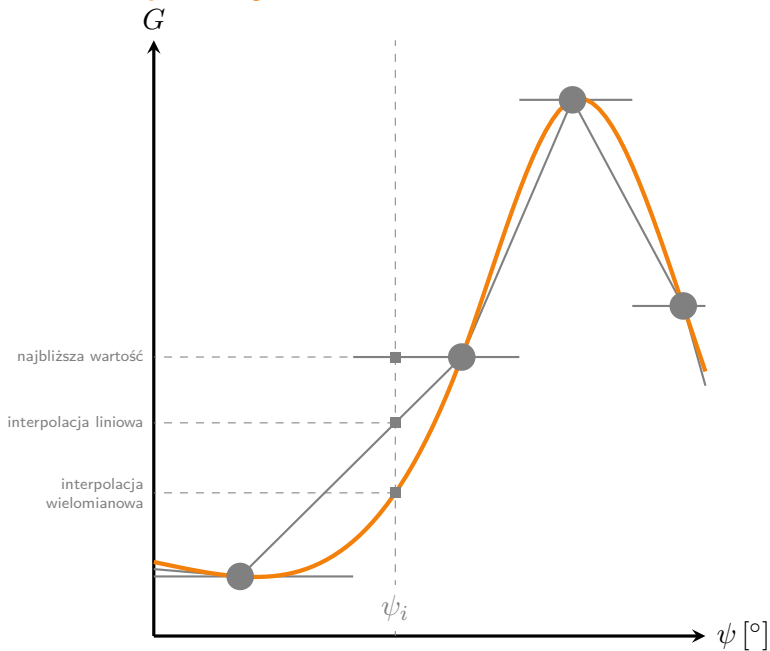
Problem do przemyślenia



Problem do przemyślenia

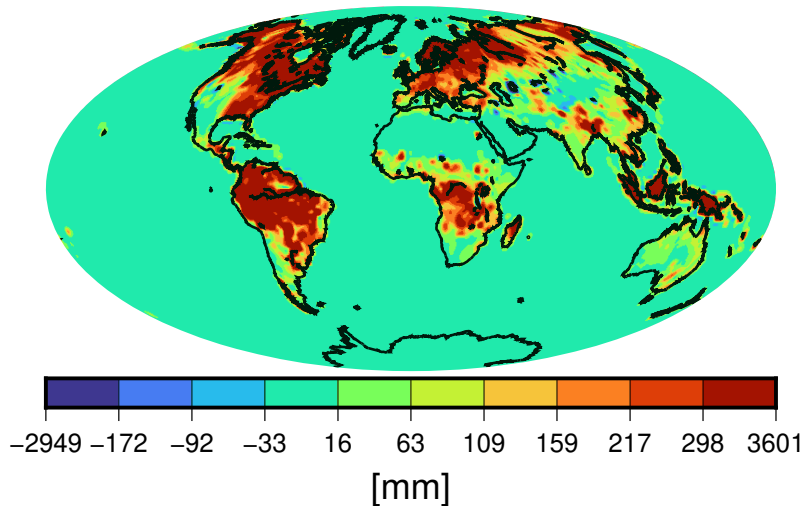


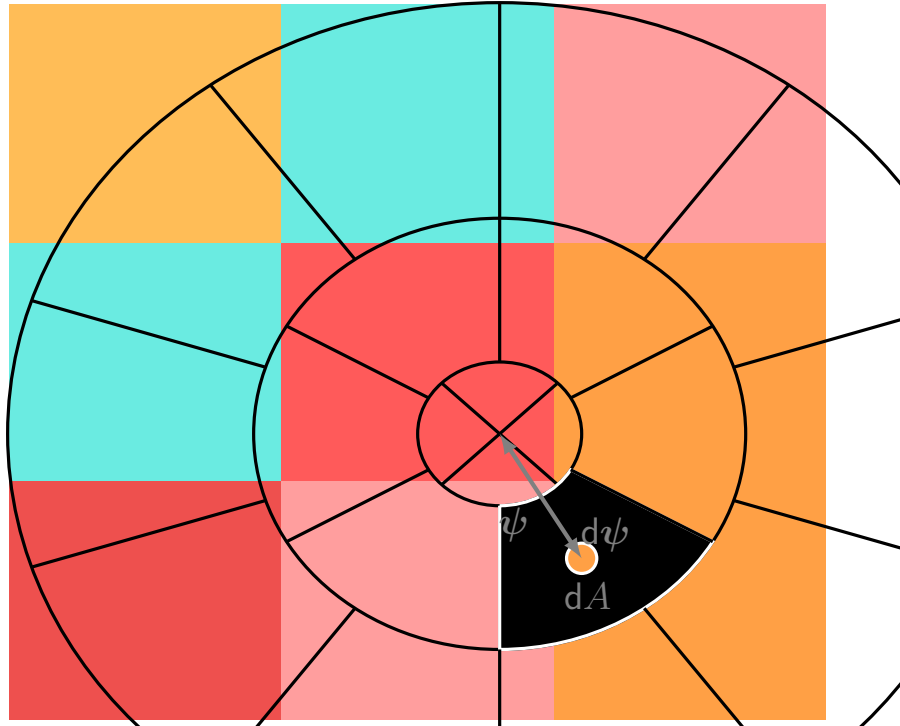
Problem do przemyślenia

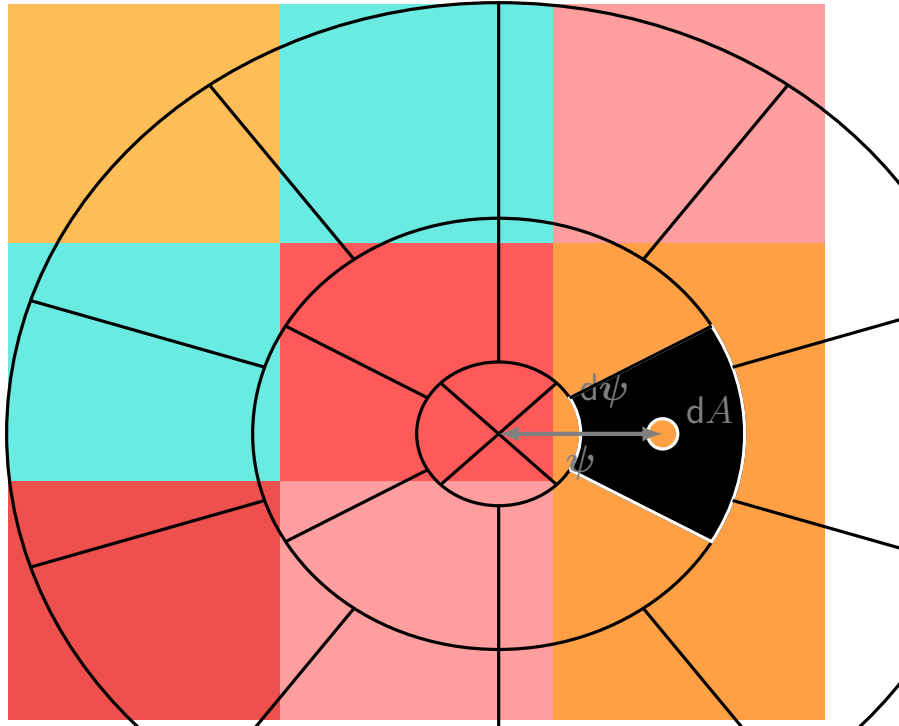


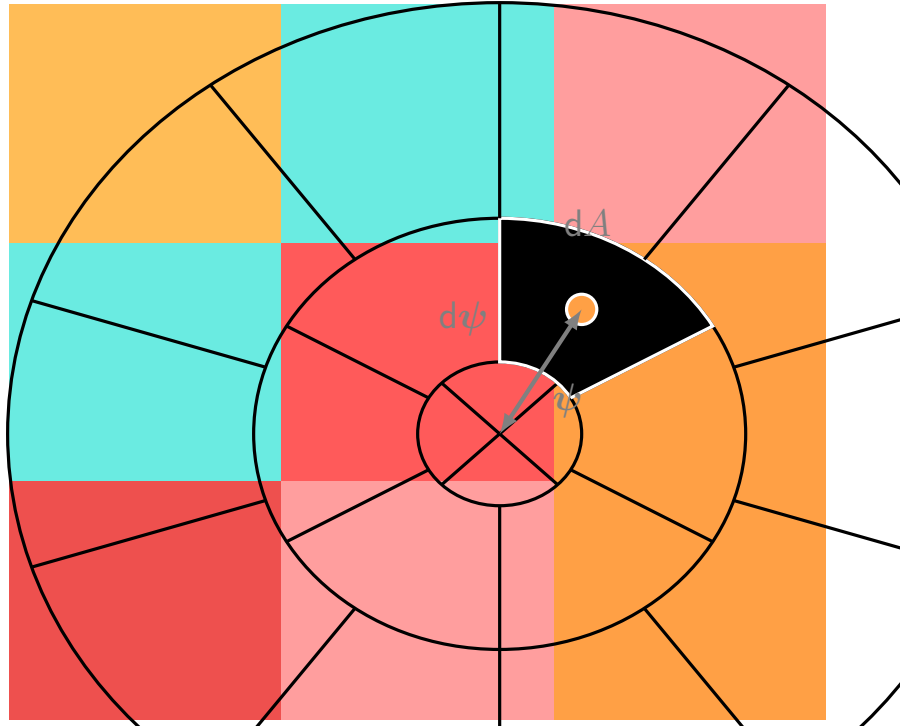
Materiały dodatkowe

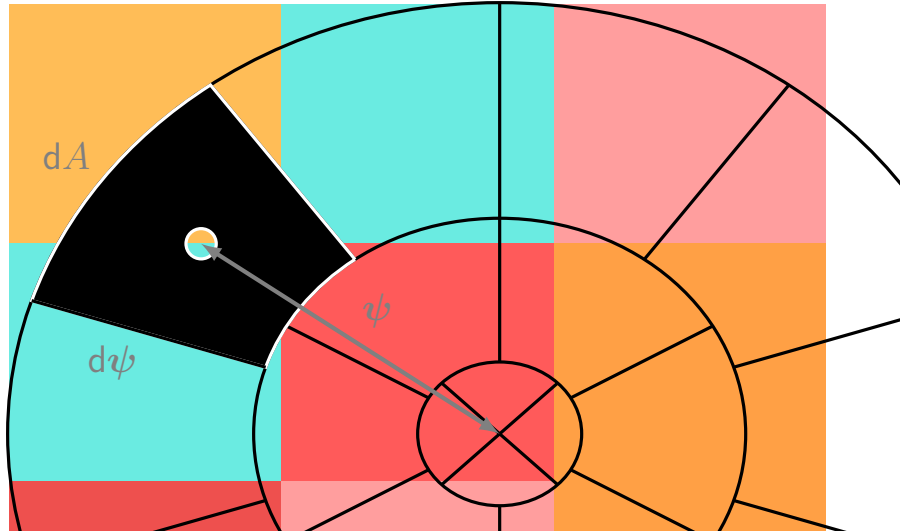
Obciążenia powierzchniowe



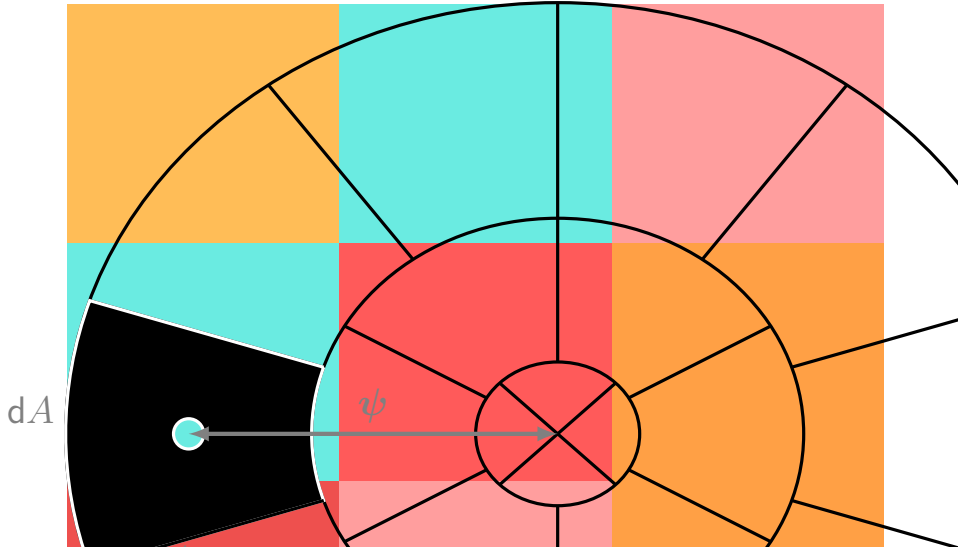








$$\Delta r = \int_{i=1}^n G_{r_i} \cdot M_i \quad \Delta h_{n,e} = \int_{i=1}^n G_{h_i} \cdot M_i \cdot \left\{ \begin{array}{l} -\cos A \\ -\sin A \end{array} \right\}$$



$$\Delta r = \sum_{i=1}^n G_{r_i} \cdot dP \cdot \rho \quad \Delta h_{n,e} = \sum_{i=1}^n G_{h_i} \cdot M_i \cdot \left\{ \begin{array}{l} -\cos A \\ -\sin A \end{array} \right\}$$

