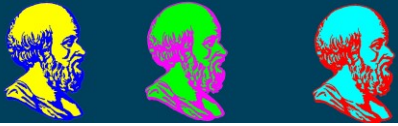


Eratosthenes

March 2023
Equinox





Work process

To allow the participation of the largest number of schools, measurements are not only carried out on the day of the equinox, but also from 3 days before this date until 3 days after.

The measurement procedure is thus adapted, limiting the problems of bad weather conditions as well as the fact that the day of the equinox falls on a Sunday.

The collaborative measure

During these 7 days, the partner schools exchange the results of their measurements of the height of their gnomon and the length of its shadow at solar noon, which define the angle of the sun at that moment.

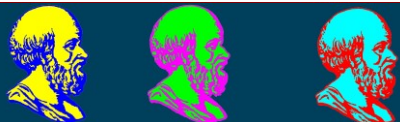
It is not necessary for these schools to be located on the same meridian: These measurements being synchronized at solar noon, it is indeed the distance between the parallels passing through these 2 schools which is used to calculate the circumference of the Earth.

The Eratosthenes historical method

The historical measurement of Eratosthenes took place during the summer solstice, with Syene (Tropic of Cancer) as a reference, ie the place where the Sun is at its zenith on this date. These conditions are also fulfilled on the day of the equinox for all places located on the equator.

Latitude and angle of the Sun

The measurements of March 20 but also those carried out during the week, thanks to a regression calculation, make it possible to verify that latitude and angle of the Sun are equal on the day of the equinox.



The collaborative measure



AMERICA



Argentina : Chivilcoy



Colombia : Guarne



Puerto Rico : Bayamón



BRAZIL : Méier, Rio de Janeiro, Del Castilho, Itajubá

EUROPE



France : Montcuq



Greece : Aigio, Athens, Stavraki, Serres, Aspropyrgos



Albania : Elbasan



Romania : Băsești, Busteni, Malovăț, Oradea,
Pogana, Slatina, Sibiu



Serbia : Niš



Spain: Vigo



Turkey : Istanbul

ASIA



Turkey : Boğazlıyan, Aydın

Table of measurements.

City	Country	School	Latitude (+N/-S) decimal(°)	Longitude (+E/-W) decimal(°)	Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
Montcuq	France	Fondation La main à la pâte	44.340	1.210	17/03/2023	14.0	14.3	45.6
Rio de Janeiro	Brazil	Centro Educacional Nosso Mundo	-22.890	-43.317	17/03/2023	37.0	-13.0	-19.4
Montcuq	France	Fondation La main à la pâte	44.340	1.210	18/03/2023	14.0	14.1	45.2
Busteni	Romania	Scoala Gimnaziala Sanatoriala	45.416	25.535	19/03/2023	19.3	20.0	46.0
Montcuq	France	Fondation La main à la pâte	44.340	1.210	19/03/2023	14.0	13.9	44.8
Aigio	Greece	1st High School of Aigio	38.252	22.079	19/03/2023	17.0	13.5	38.5
Guame	Colombia	Grupo Astrofánaticos	6.274	-75.447	19/03/2023	77.2	9.3	6.9
Băsești	Romania	Scoala Gimnaziala	47.481	23.145	20/03/2023	100.0	109.7	47.6
Oradea	Romania	Colegiul Tehnic Traian Vuia	47.064	21.916	20/03/2023	55.5	60.0	47.2
Pogana	Romania	Scoala Gimnaziala nr.1	46.313	27.575	20/03/2023	5.4	5.7	46.5
Sibiu	Romania	Colegiul National Gheorghe Lazar	45.797	24.154	20/03/2023	52.0	55.0	46.6
Busteni	Romania	Scoala Gimnaziala Sanatoriala	45.416	25.535	20/03/2023	24.5	25.0	45.6
Malovat	Romania	Scoala Gimnaziala Malovat	44.707	22.722	20/03/2023	22.1	22.0	44.9
Slatina	Romania	Secondary School Maicu Voda	44.432	24.377	20/03/2023	100.0	97.3	44.2
Montcuq	France	Fondation La main à la pâte	44.340	1.210	20/03/2023	14.0	13.7	44.4
Niš	Serbia	Gimnazija Svetozar Markovic	43.312	21.887	20/03/2023	100.0	95.8	43.8
Vigo	Spain	IES de Beade	42.201	-8.716	20/03/2023	71.4	64.0	41.9
Serres	Greece	Experimental Primary School of Serres	41.083	23.540	20/03/2023	100.0	88.0	41.3
Stavraki	Greece	Primary School of Stavraki	39.654	20.817	20/03/2023	100.0	82.0	39.4
Aigio	Greece	1st High School of Aigio	38.252	22.079	20/03/2023	49.8	39.5	38.4
Aspropyrgos	Greece	3rd High School of Aspropyrgos	38.061	23.601	20/03/2023	13.6	11.0	39.0
Athens	Greece	Experimental school agion Aanrgyron	38.028	23.726	20/03/2023	244.0	191.0	38.1
Aydin	Turkey	Bati Söke Çimento Ortaokulu	37.749	27.399	20/03/2023	7.0	5.3	37.1
Bayamón	Puerto Rico	AECM Caribbean University	18.383	-66.168	20/03/2023	25.0	8.3	18.4
Guame	Colombia	Grupo Astrofánaticos	6.274	-75.447	20/03/2023	13.0	1.4	6.1
Itajubá	Brazil	Universidade Federal de Itajubá	-22.415	-45.449	20/03/2023	48.5	-19.9	-22.3
Del Castilho	Brazil	Instituto Superior do Saber	-22.881	-43.260	20/03/2023	30.0	-13.0	-23.4
Rio de Janeiro	Brazil	Centro Educacional Nosso Mundo	-22.890	-43.317	20/03/2023	28.0	-10.0	-19.7
Chivilcoy	Argentina	Parque Cielos del Sur	-34.911	-60.014	20/03/2023	12.1	-8.4	-34.8
Băsești	Romania	Scoala Gimnaziala	47.481	23.145	21/03/2023	100.0	108.1	47.2
Oradea	Romania	Colegiul Tehnic Traian Vuia	47.064	21.916	21/03/2023	150.0	160.0	46.8
Busteni	Romania	Scoala Gimnaziala Sanatoriala	45.416	25.535	21/03/2023	8.4	8.5	45.3
Slatina	Romania	Secondary School Vlaicu Voda	44.432	24.377	21/03/2023	100.0	97.0	44.1
Montcuq	France	Fondation La main à la pâte	44.340	1.210	21/03/2023	14.0	13.5	44.0
Istanbul	Turkey	IB Şehit Şerife Bacı CPAL Avcılar	41.060	28.716	21/03/2023	248.0	214.0	40.8
Boğazlıyan	Turkey	Boğazlıyan Science and Art Center	39.200	35.189	21/03/2023	26.0	21.1	39.1
Rio de Janeiro	Brazil	Centro Educacional Nosso Mundo	-22.890	-43.317	21/03/2023	37.0	-14.0	-20.7
Malovat	Romania	Scoala Gimnaziala Malovat	44.707	22.722	22/03/2023	23.8	23.0	44.0
Montcuq	France	Fondation La main à la pâte	44.340	1.210	22/03/2023	14.0	13.4	43.7
Elbasan	Albania	Gjimnazi Vasil Kamami	41.111	20.086	22/03/2023	27.0	23.0	40.4
Del Castilho	Brazil	Instituto Superior do Saber	-22.881	-43.260	22/03/2023	30.0	-14.0	-25.0
Rio de Janeiro	Brazil	Centro Educacional Nosso Mundo	-22.890	-43.317	22/03/2023	37.0	-14.0	-20.7
Méier	Brazil	Escola Municipal Bento Ribeiro	-22.904	-43.280	22/03/2023	21.0	-6.0	-15.9
Slatina	Romania	Secondary School Maicu Voda	44.432	24.377	23/03/2023	100.0	96.7	44.0
Busteni	Romania	Scoala Gimnaziala Sanatoriala	45.416	25.535	23/03/2023	13.3	13.0	44.3
Rio de Janeiro	Brazil	Centro Educacional Nosso Mundo	-22.890	-43.317	23/03/2023	37.0	-14.0	-20.7
Montcuq	France	Fondation La main à la pâte	44.340	1.210	23/03/2023	14.0	13.2	43.3

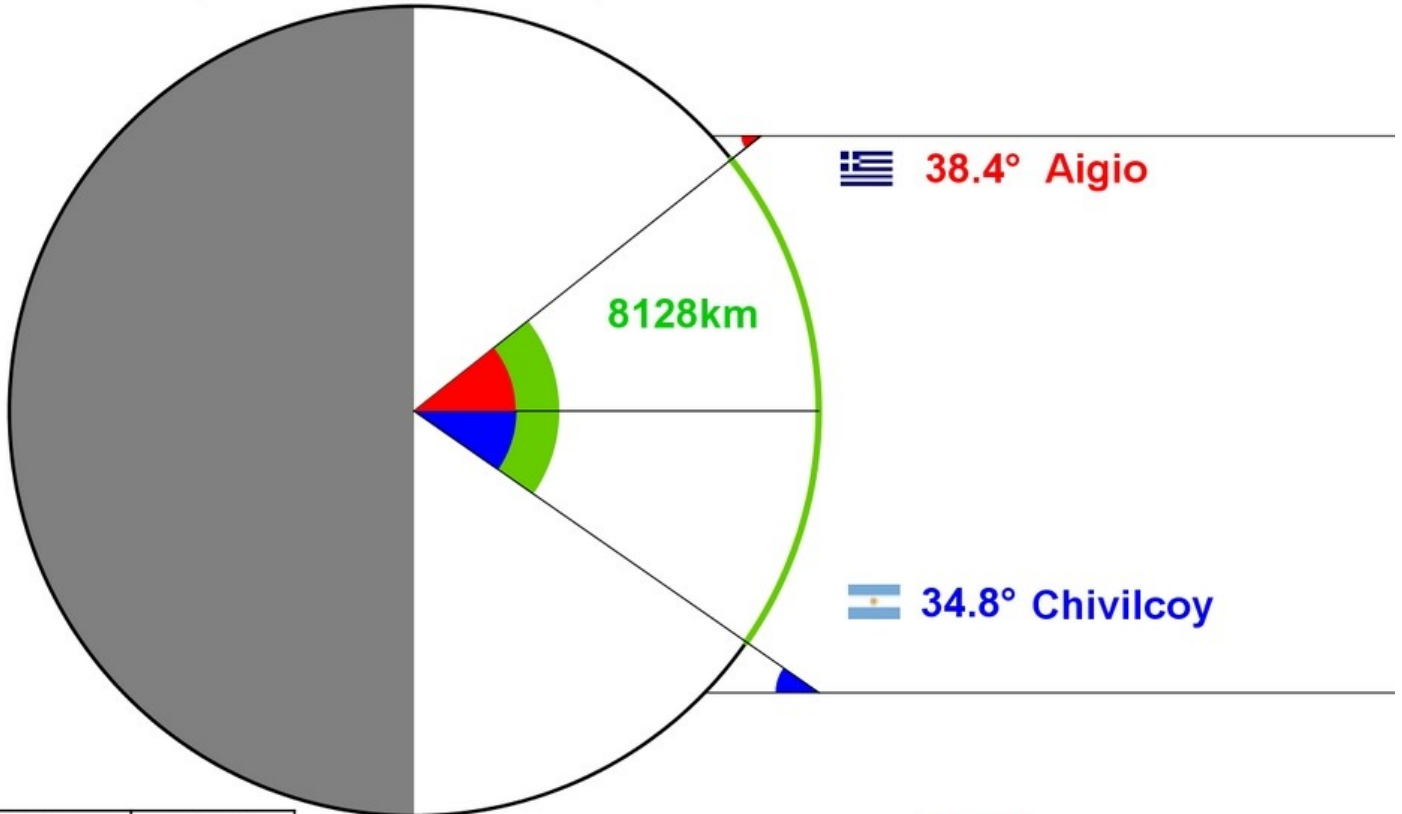
Aigio Greece

1st High School of Aigio
38.252 N 22.079 E

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
19/03/2023	17.0	13.5	38.5
20/03/2023	49.8	39.5	38.4

20/03/2023 (Aigio-Greece) Latitude: 38.252°

20/03/2023 (Chivilcoy-Argentina) Latitude: -34.911°



Distance	Angle
circumference	360°
8128km	38.4° + 34.8°

$$\text{circumference} = \frac{360^\circ \times 8128\text{km}}{38.4^\circ + 34.8^\circ} = 39974 \text{ km}$$



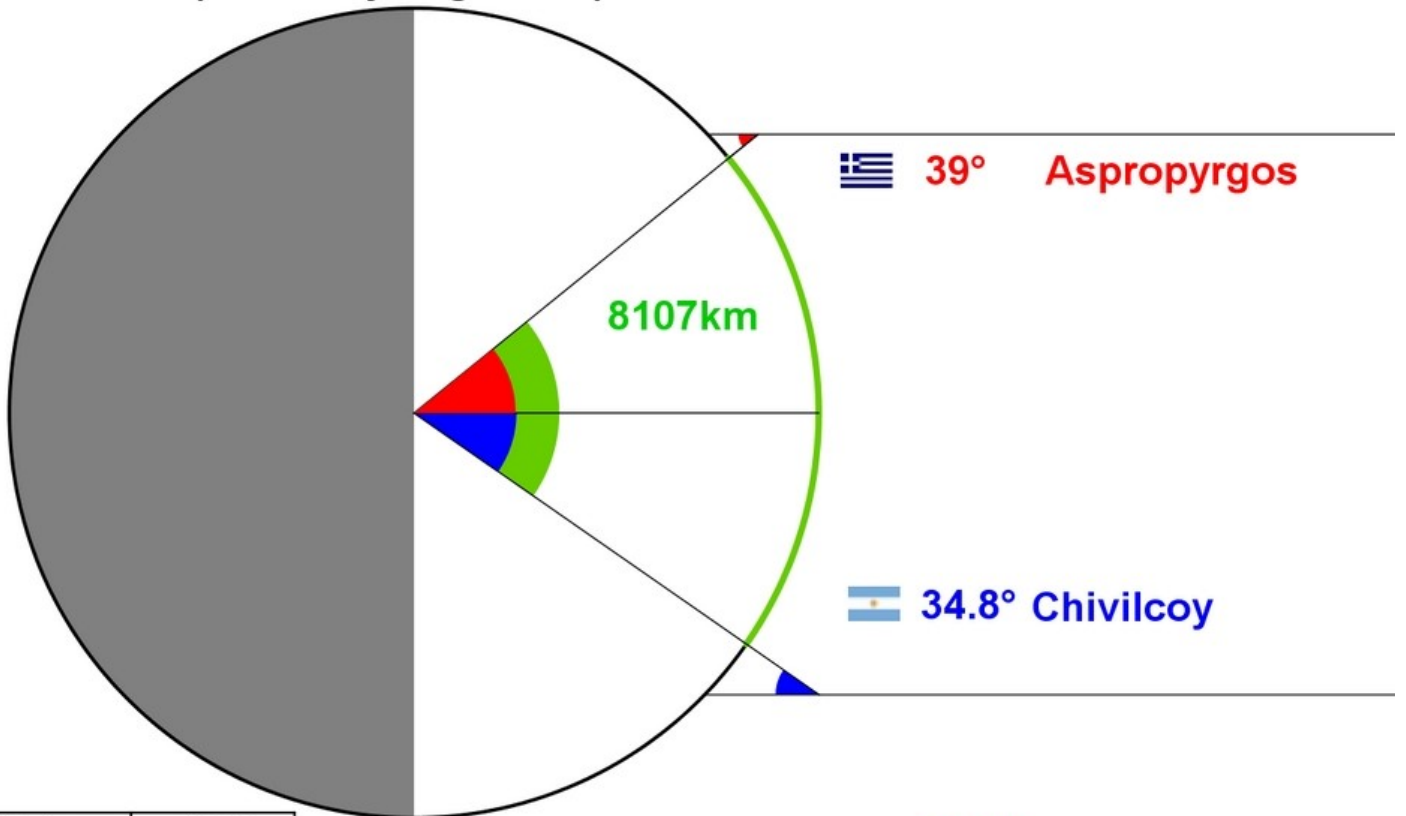
Aspropyrgos Greece

3rd High School of Aspropyrgos
38.061 N 23,601 E

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
20/03/2023	13.6	11.0	39.0

20/03/2023 (Aspropyrgos-Greece) Latitude: 38.061°

20/03/2023 (Chivilcoy-Argentina) Latitude: -34.911°



Distance	Angle
circumference	360°
8107km	39° + 34.8°

$$\text{circumference} = \frac{360^\circ \times 8107\text{km}}{39^\circ + 34.8^\circ} = 39546 \text{ km}$$



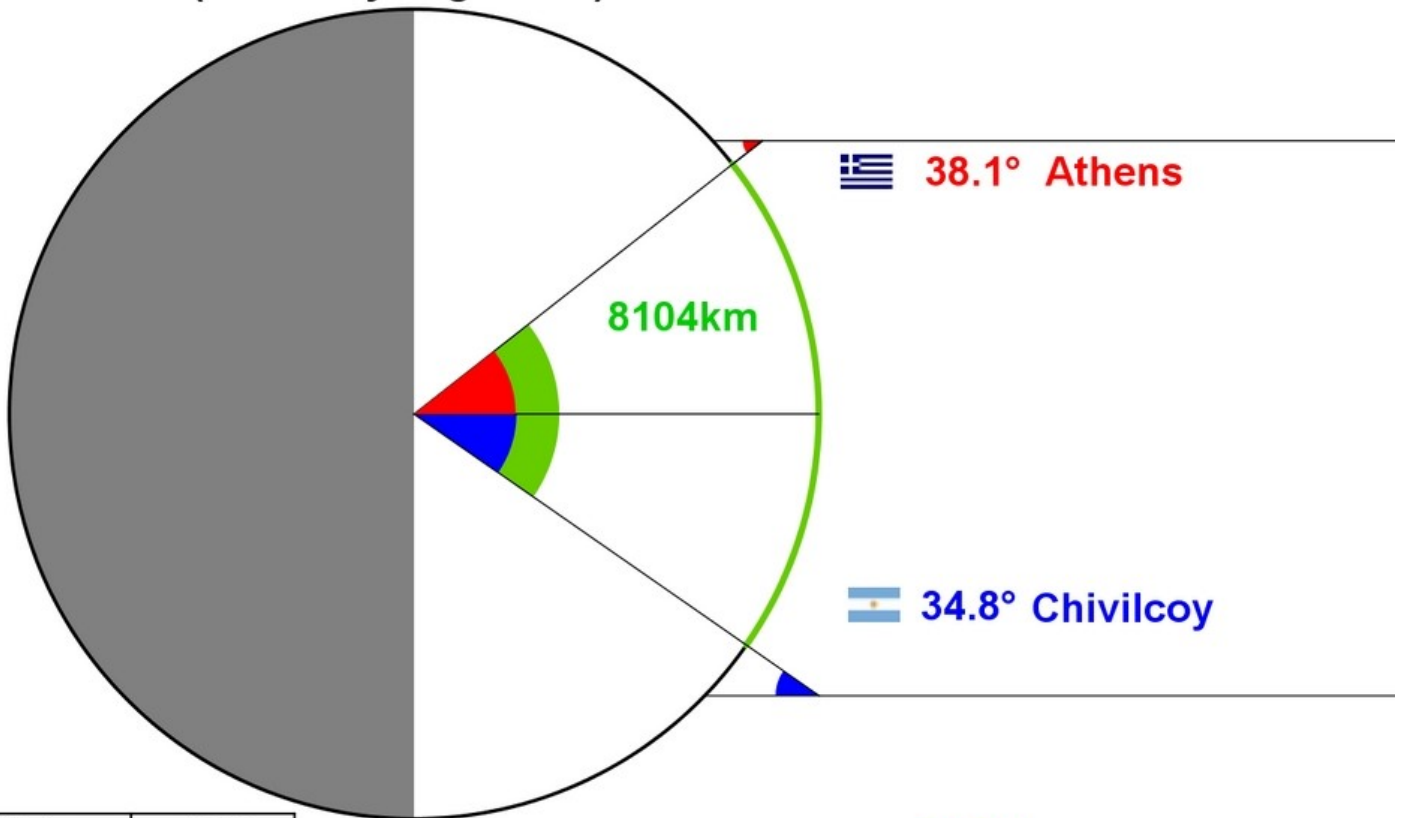
Athens Greece

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
20/03/2023	244.0	191.0	38.1

Experimental School Agion Anargyron
38.027 N 23.726 E

20/03/2023 (Athens-Greece) Latitude: 38.028°

20/03/2023 (Chivilcoy-Argentina) Latitude: -34.911°



Distance	Angle
circumference	360°
8104km	38.1° + 34.8°

$$\text{circumference} = \frac{360^\circ \times 8104\text{km}}{38.1^\circ + 34.8^\circ} = 40020 \text{ km}$$



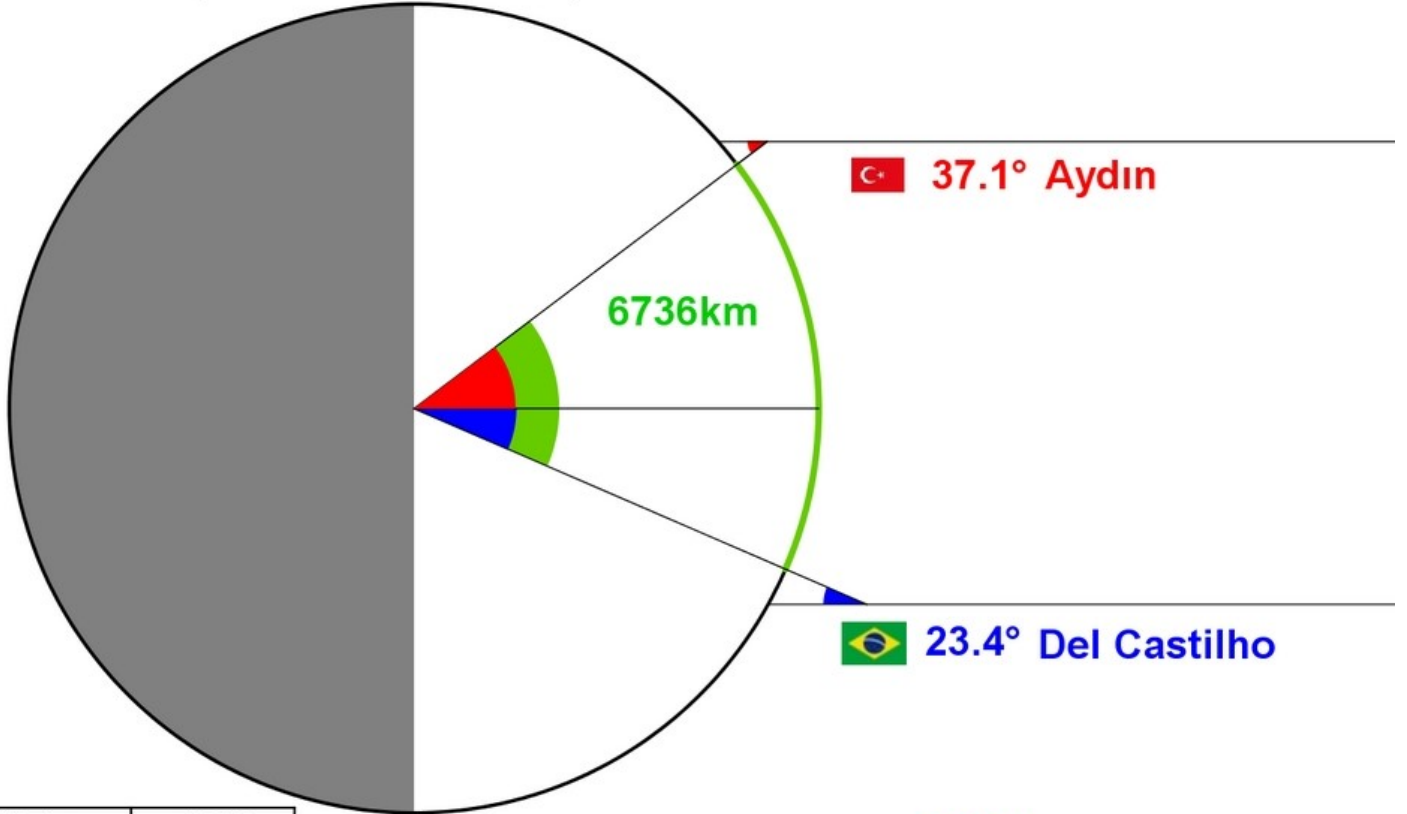
Aydın Turkey

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
20/03/2023	7.0	5.3	37.1

Batı Söke Çimento Ortaokulu
37.749 N 27.399 E

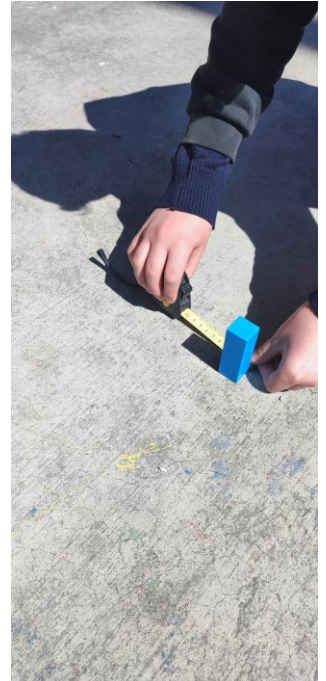
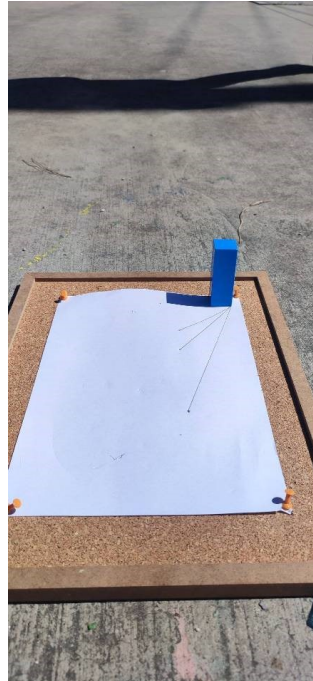
20/03/2023 (Aydın-Turkey) Latitude: 37.749°

20/03/2023 (Del Castilho-Brazil) Latitude: -22.881°



Distance	Angle
circumference	360°
6736km	37.1° + 23.4°

$$\text{circumference} = \frac{360^\circ \times 6736\text{km}}{37.1^\circ + 23.4^\circ} = 40082 \text{ km}$$



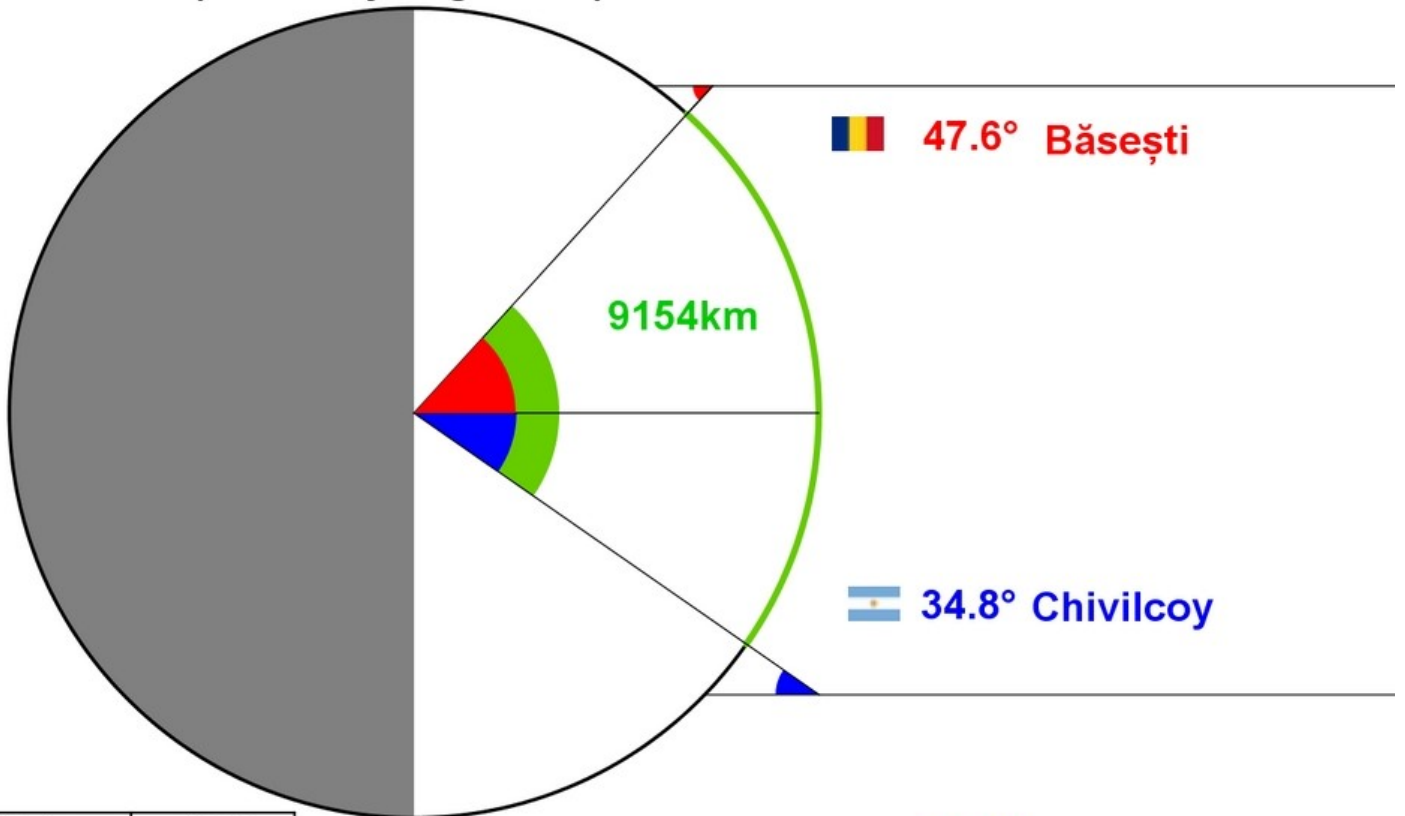
Băsești Romania

Scoala Gimnaziala
47.481 N 23.145 E

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
20/03/2023	100.0	109.7	47.6
21/03/2023	100.0	108.1	47.2

20/03/2023 (Băsești-Romania) Latitude: 47.481°

20/03/2023 (Chivilcoy-Argentina) Latitude: -34.911°



Distance	Angle
circumference	360°
9154km	47.6° + 34.8°

$$\text{circumference} = \frac{360^\circ \times 9154\text{km}}{47.6^\circ + 34.8^\circ} = 39993 \text{ km}$$



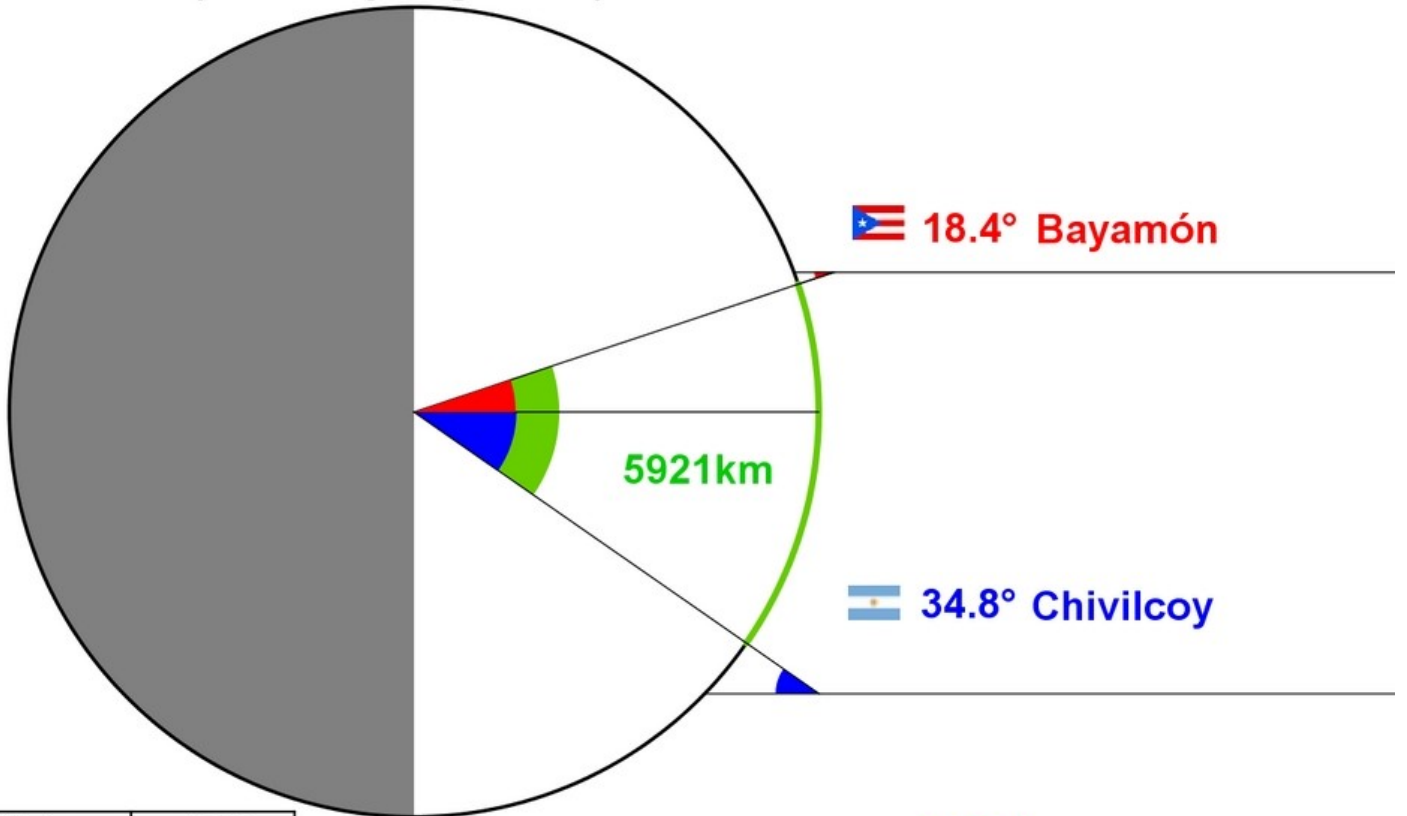
Bayamón Puerto Rico

AECM Caribbean University
18.383 N 66.168 W

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
20/03/2023	25.0	8.3	18.4

20/03/2023 (Bayamón-Puerto Rico) Latitude: 18.383°

20/03/2023 (Chivilcoy-Argentina) Latitude: -34.911°



Distance	Angle
circumference	360°
5921km	18.4° + 34.8°

$$\text{circumference} = \frac{360^\circ \times 5921\text{km}}{18.4^\circ + 34.8^\circ} = 40067 \text{ km}$$



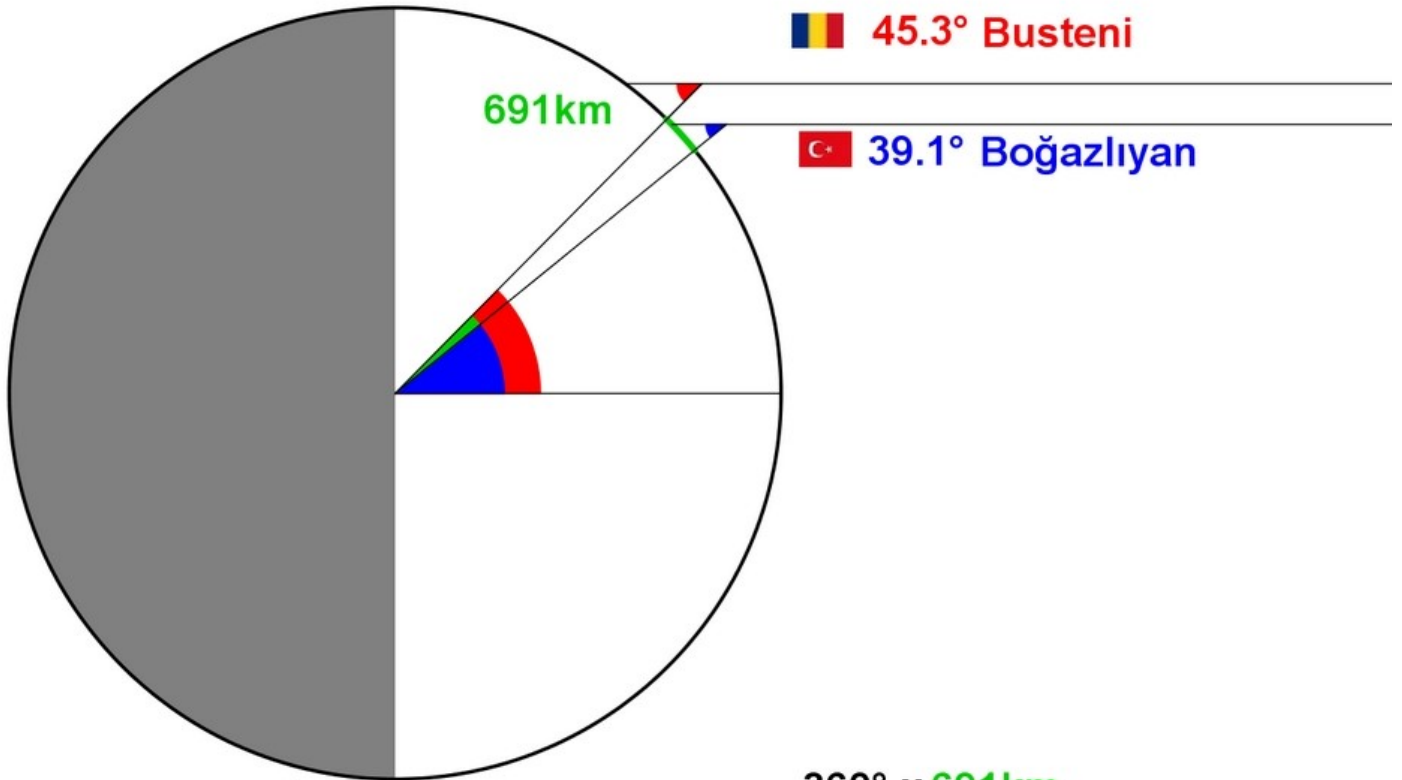
Boğazlıyan Turkey

Boğazlıyan Science and Art Center
39.200 N 35.189 E

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
21/03/2023	26.0	21.1	39.1

21/03/2023 (Busteni-Romania) Latitude: 45.416°

21/03/2023 (Boğazlıyan-Turkey) Latitude: 39.2°

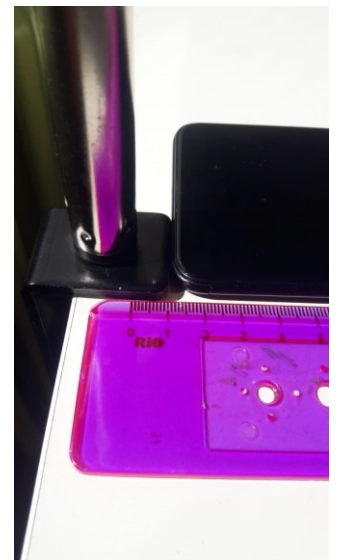
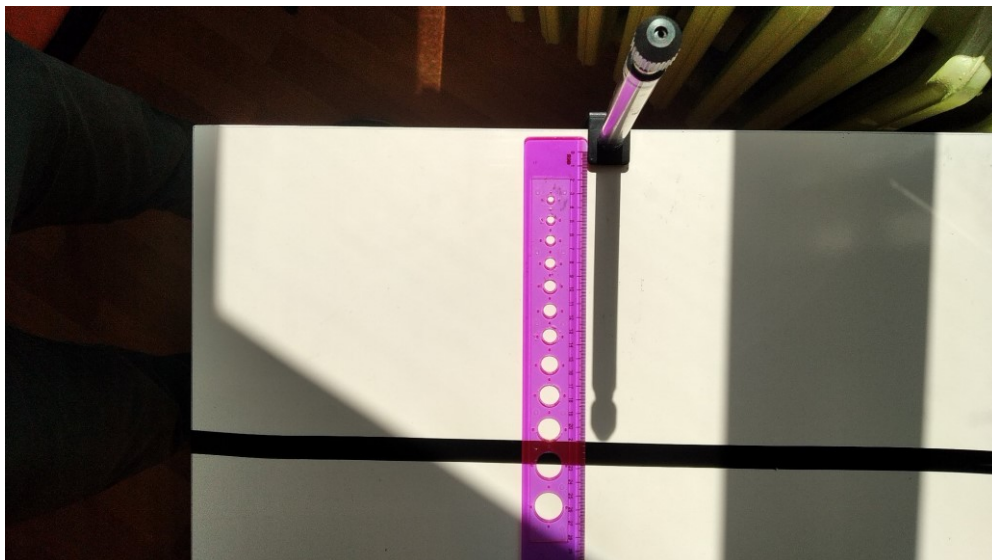


 45.3° Busteni

 39.1° Boğazlıyan

Distance	Angle
circumference	360°
691km	45.3° - 39.1°

$$\text{circumference} = \frac{360^\circ \times 691\text{km}}{45.3^\circ - 39.1^\circ} = 40123 \text{ km}$$



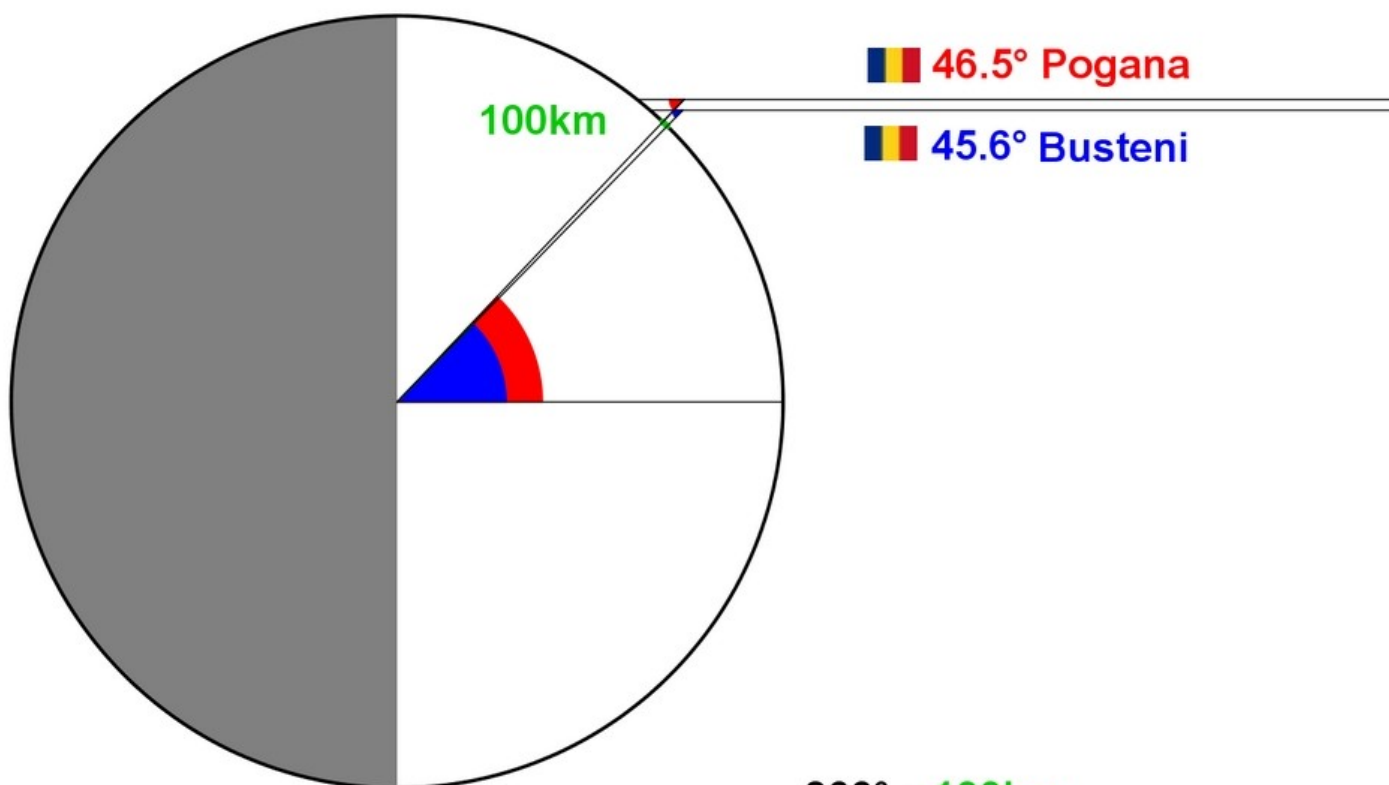
Busteni Romania

Scoala Gimnaziala Sanatoriala
45.416 N 25.535 E

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
19/03/2023	19.3	20.0	46.0
20/03/2023	24.5	25.0	45.6
21/03/2023	8.4	8.5	45.3
23/03/2023	13.3	13.0	44.3

20/03/2023 (Pogana-Romania) Latitude: 46.313°

20/03/2023 (Busteni-Romania) Latitude: 45.416°



Distance	Angle
circumference	360°
100km	46.5° - 45.6°

$$\text{circumference} = \frac{360^\circ \times 100\text{km}}{46.5^\circ - 45.6^\circ} = 40000 \text{ km}$$



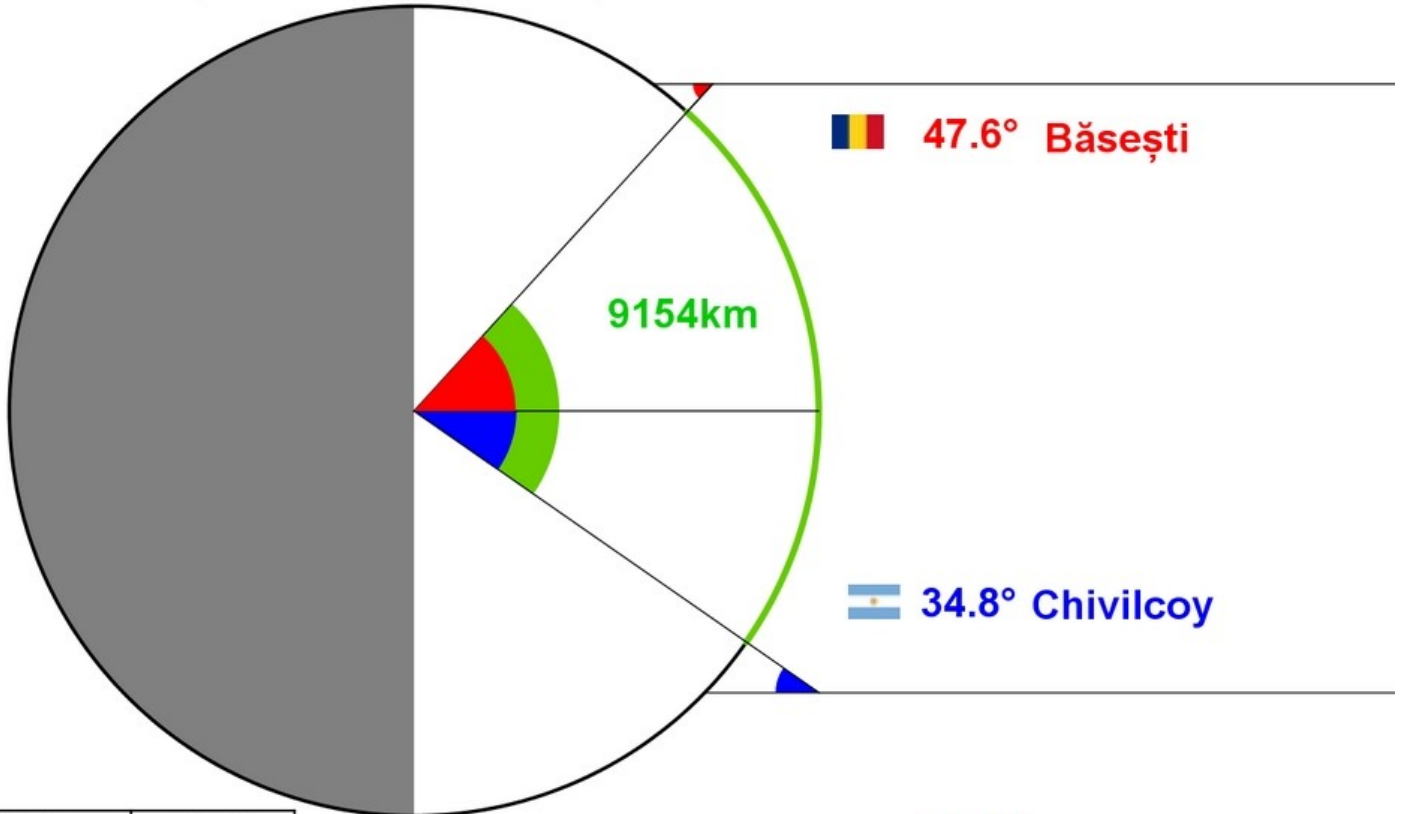
Chivilcoy Argentina

Parque Cielos del Sur
34.911 S 60.014 W

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
20/03/2023	12.1	-8.4	-34.8

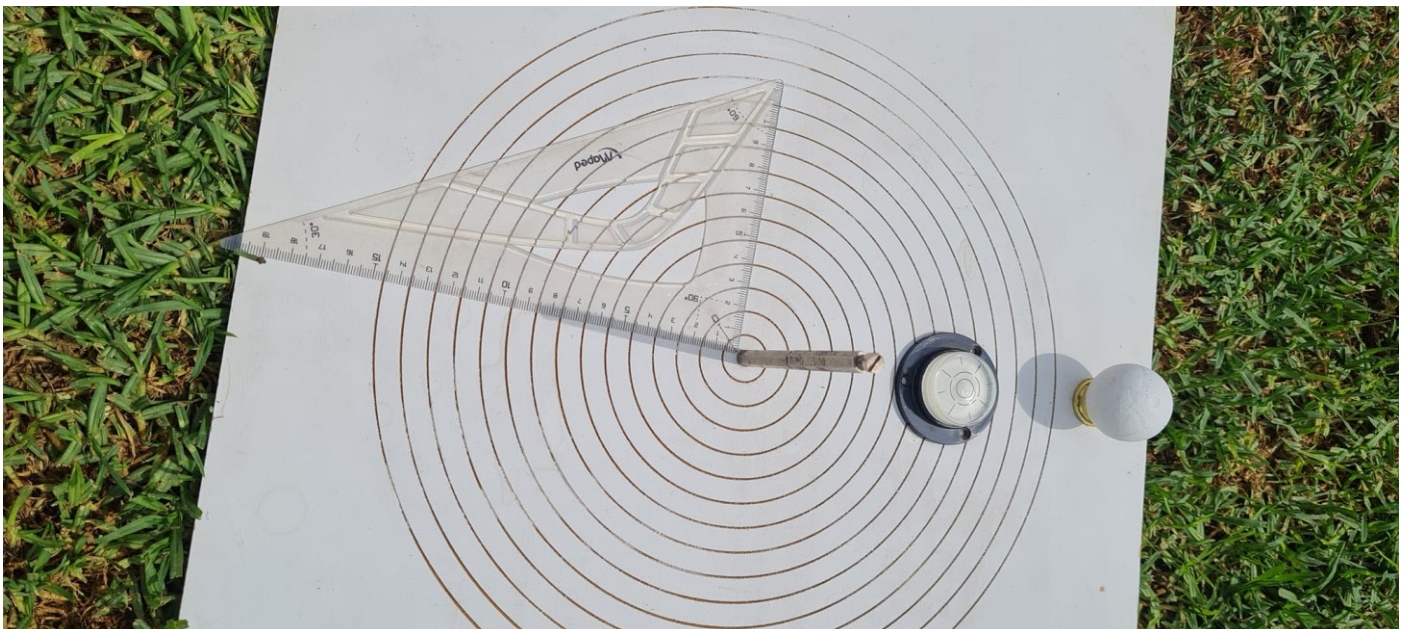
20/03/2023 (Băsești-Romania) Latitude: 47.481°

20/03/2023 (Chivilcoy-Argentina) Latitude: -34.911°



Distance	Angle
circumference	360°
9154km	47.6° + 34.8°

$$\text{circumference} = \frac{360^\circ \times 9154\text{km}}{47.6^\circ + 34.8^\circ} = 39993 \text{ km}$$



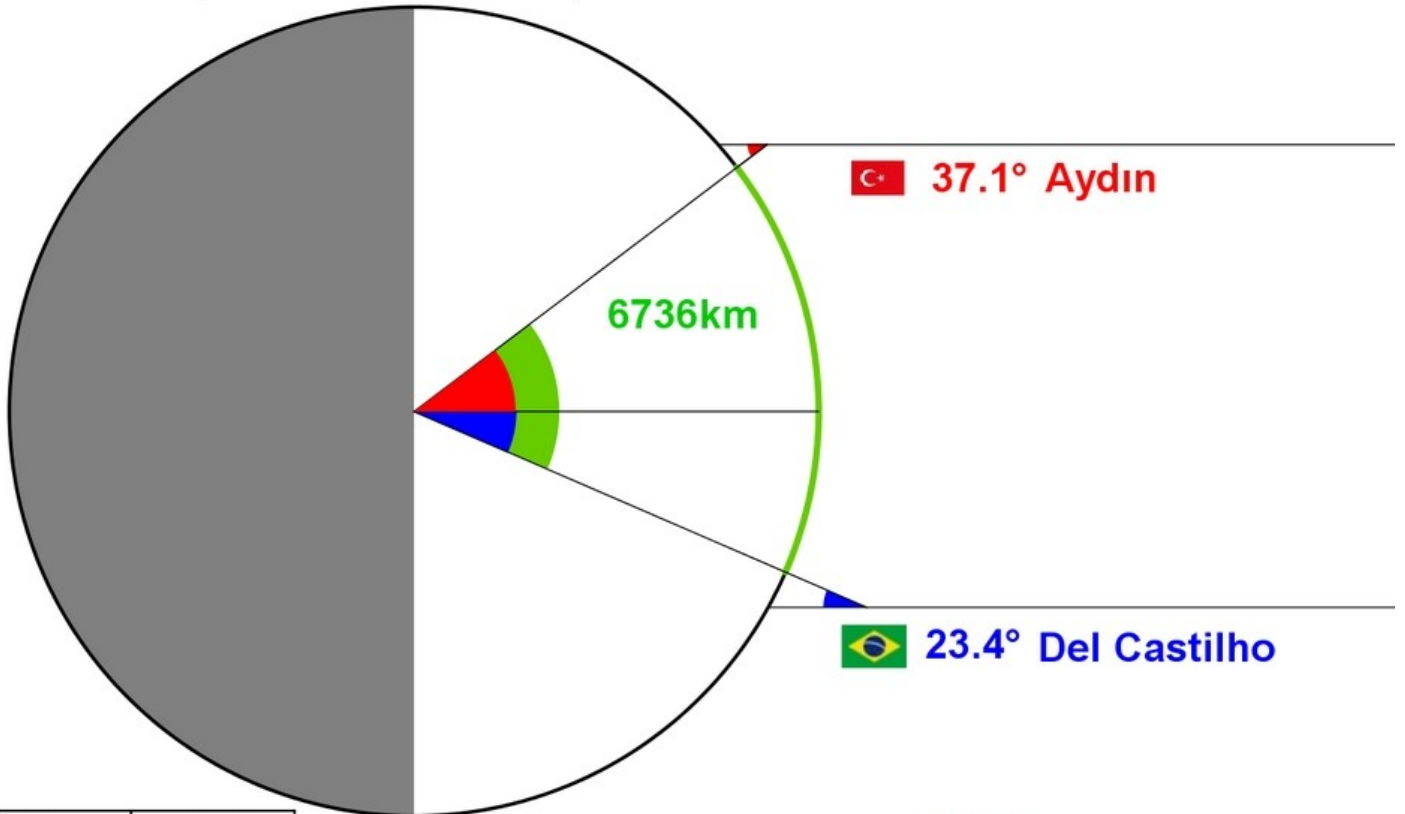
Del Castilho Brazil

Instituto Superior do Saber
22.881 S -43.260 W

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
20/03/2023	30.0	-13.0	-23.4
22/03/2023	30.0	-14.0	-25.0

20/03/2023 (Aydın-Turkey) Latitude: 37.749°

20/03/2023 (Del Castilho-Brazil) Latitude: -22.881°



Distance	Angle
circumference	360°
6736km	37.1° + 23.4°

$$\text{circumference} = \frac{360^\circ \times 6736\text{km}}{37.1^\circ + 23.4^\circ} = 40082 \text{ km}$$



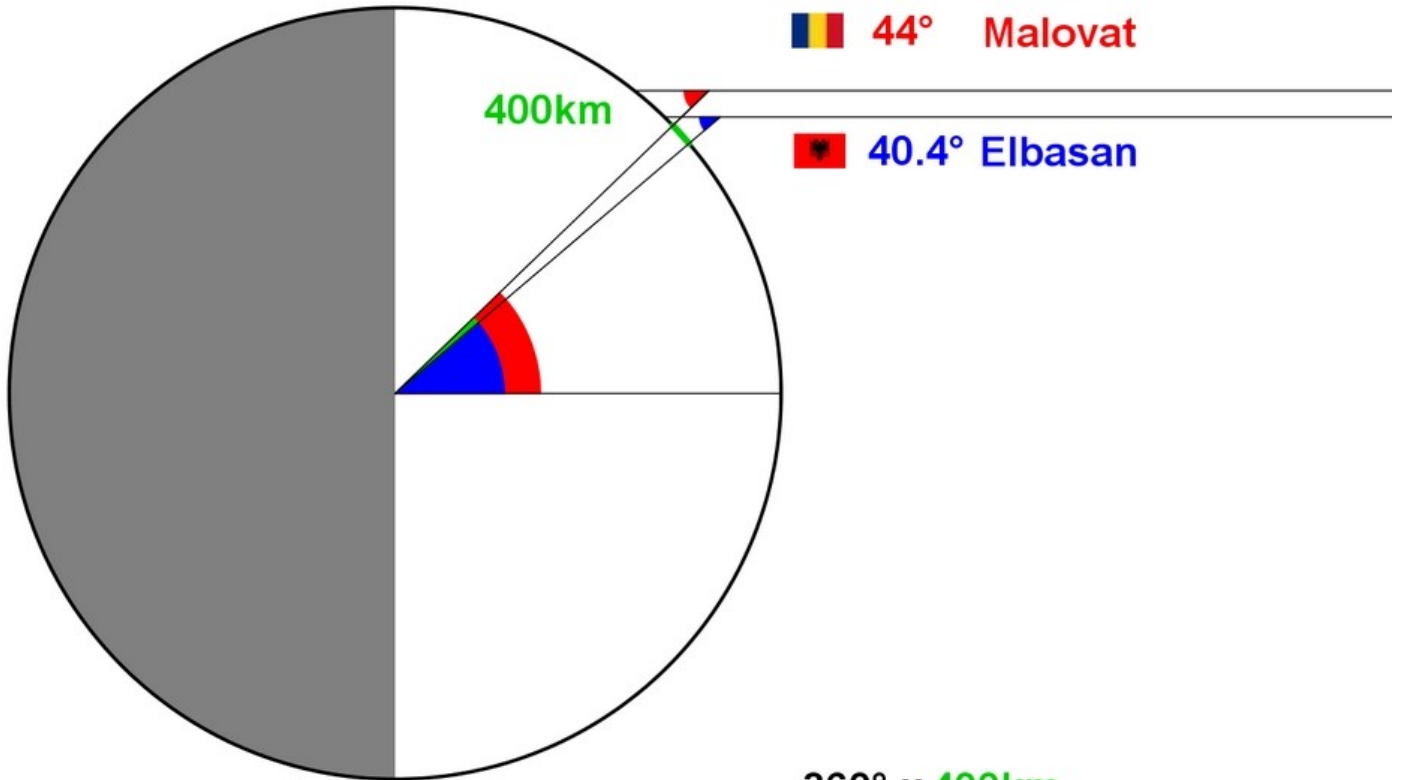
Elbasan Albania

Gjimnazi Vasil Kamami
41.111 N 20.086 E

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
22/03/2023	27.0	23.0	40.4

22/03/2023 (Malovat-Romania) Latitude: 44.707°

22/03/2023 (Elbasan-Albania) Latitude: 41.111°



Distance	Angle
circumference	360°
400km	44° - 40.4°

$$\text{circumference} = \frac{360^\circ \times 400\text{km}}{44^\circ - 40.4^\circ} = 40000 \text{ km}$$



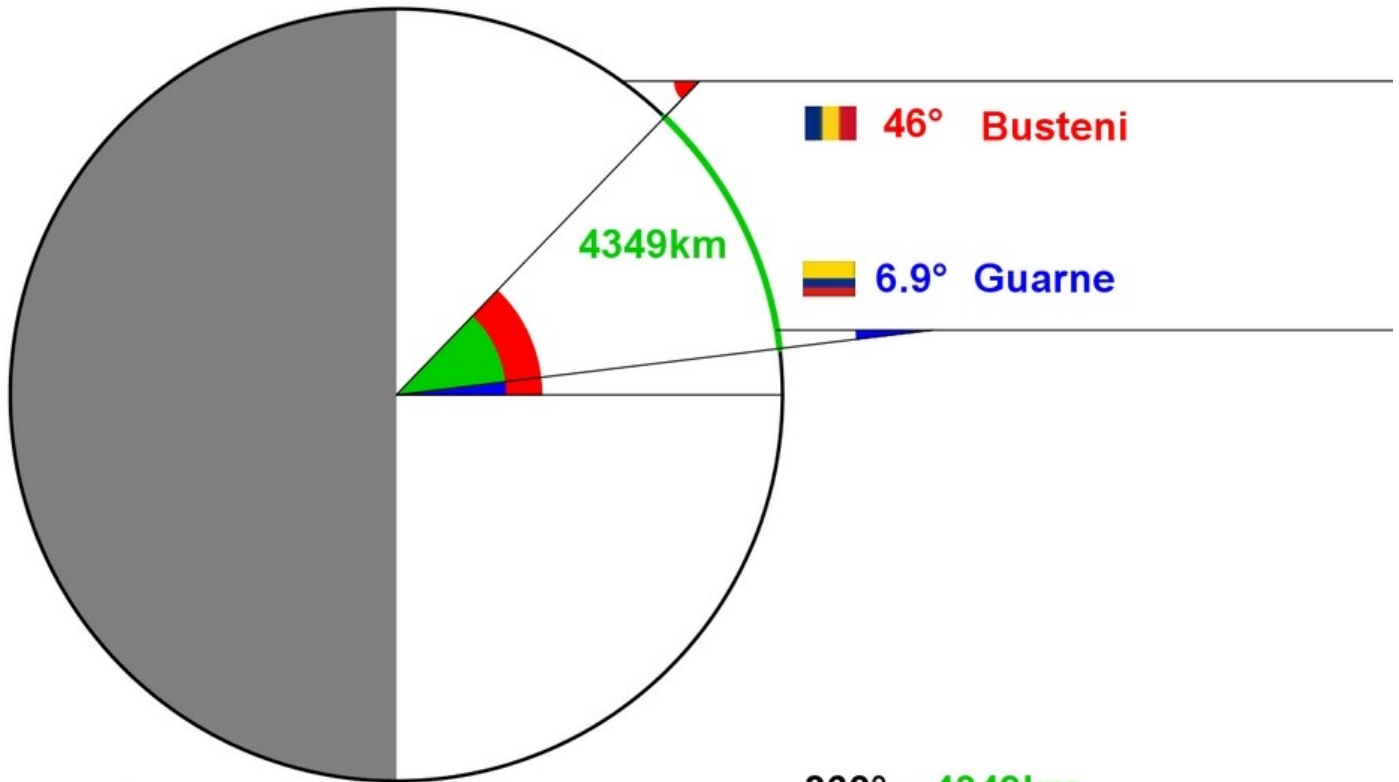
Guarne Colombia

Grupo Astrofánaticos
6.274 N 75.447 W

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
19/03/2023	77.2	9.3	6.9
20/03/2023	13.0	1.4	6.1

19/03/2023 (Busteni-Romania) Latitude: 45.416°

19/03/2023 (Guarne-Colombia) Latitude: 6.274°



Distance	Angle
circumference	360°
4349km	46° - 6.9°

$$\text{circumference} = \frac{360^\circ \times 4349\text{km}}{46^\circ - 6.9^\circ} = 40042 \text{ km}$$



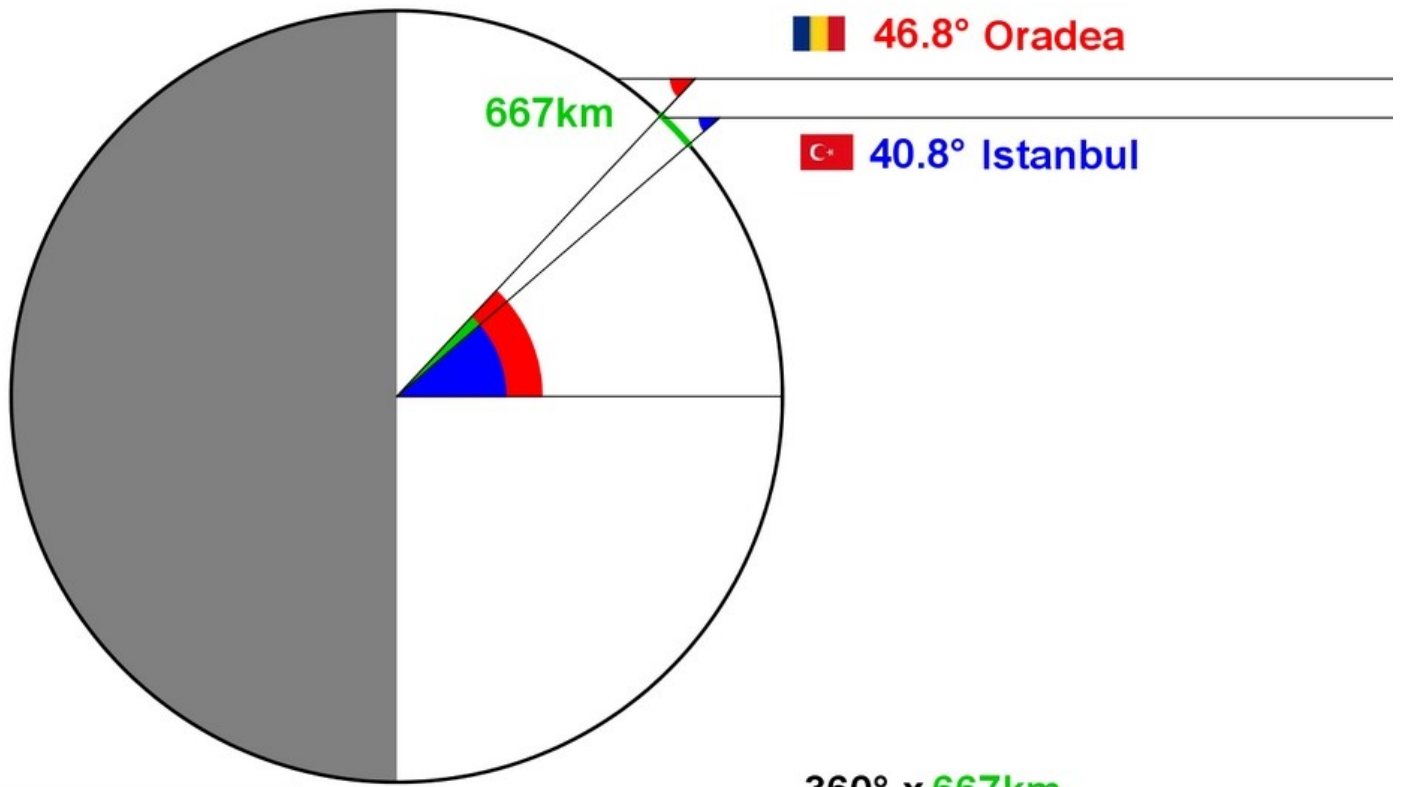
Istanbul Turkey

IB Şehit Şerife Bacı CPAL Avcılar
41.060 N 28.716 E

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
21/03/2023	248.0	214.0	40.8

21/03/2023 (Oradea-Romania) Latitude: 47.064°

21/03/2023 (Istanbul-Turkey) Latitude: 41.06°

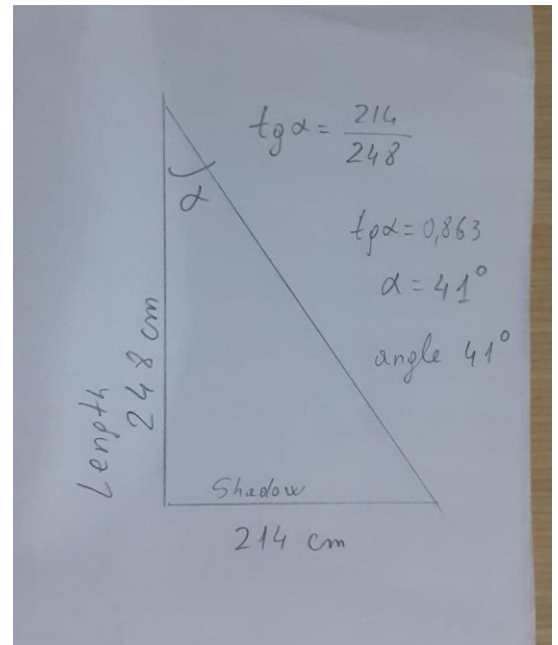


 46.8° Oradea

 40.8° Istanbul

Distance	Angle
circumference	360°
667km	46.8° - 40.8°

$$\text{circumference} = \frac{360^\circ \times 667\text{km}}{46.8^\circ - 40.8^\circ} = 40020 \text{ km}$$

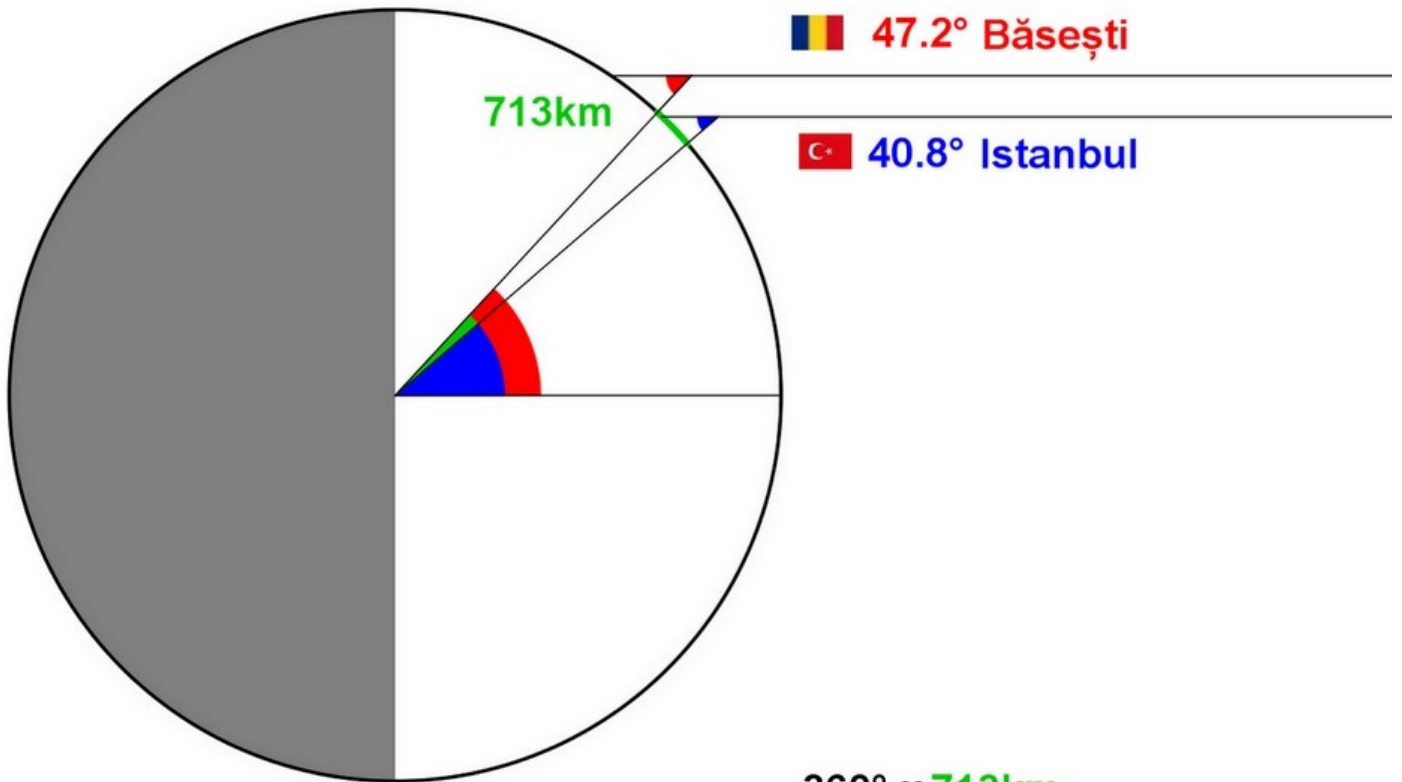


Itajubá Brazil

Universidade Federal de Itajubá
22.415 S 45.449 W

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
20/03/2023	48.5	-19.9	-22.3

21/03/2023 (Băsești-Romania) Latitude: 47.481°
21/03/2023 (Istanbul-Turkey) Latitude: 41.06°

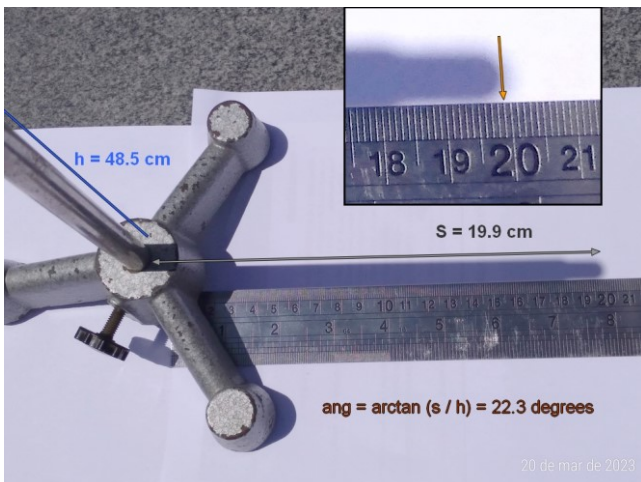


 47.2° Băsești

 40.8° Istanbul

Distance	Angle
circumference	360°
713km	47.2° - 40.8°

$$\text{circumference} = \frac{360^\circ \times 713\text{km}}{47.2^\circ - 40.8^\circ} = 40106 \text{ km}$$



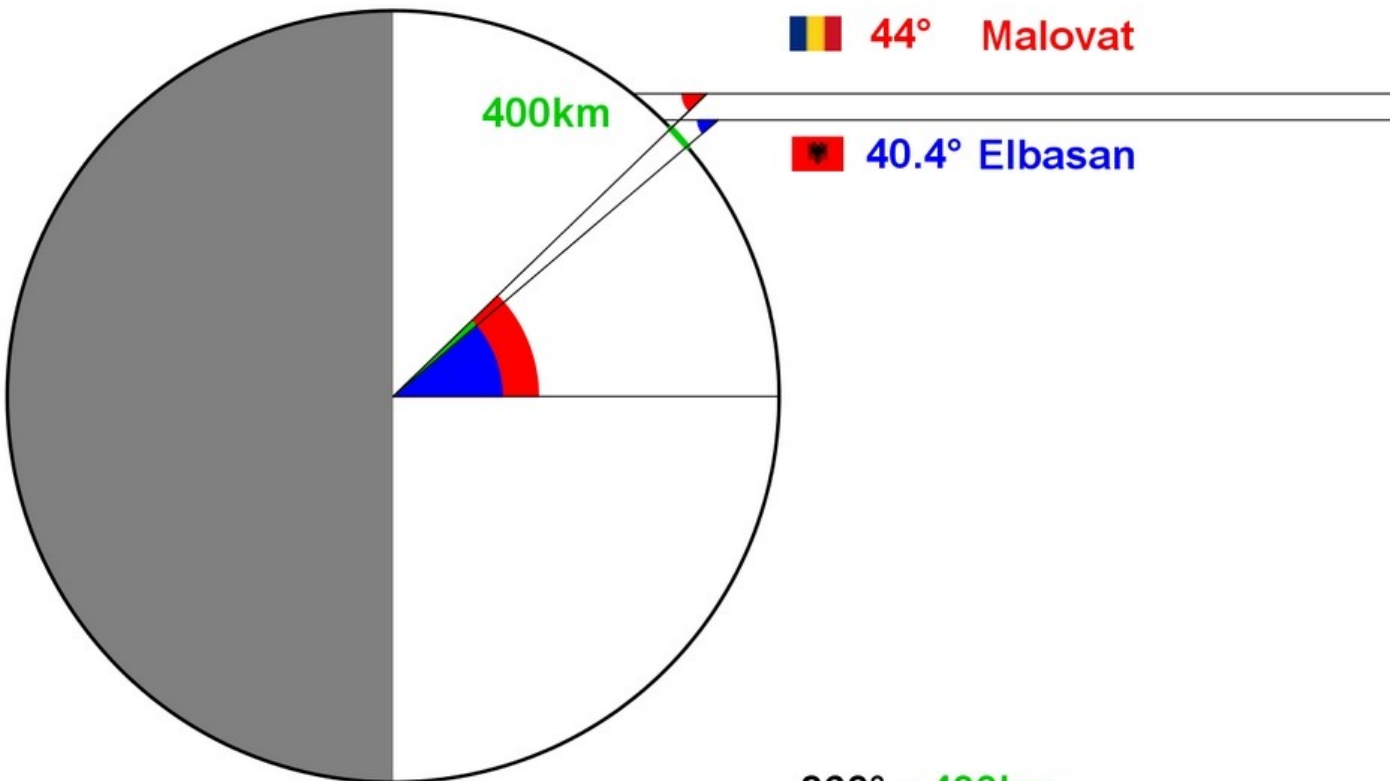
Malovat Romania

Scoala Gimnaziala Malovat
44.707 N 22.722 E

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
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20/03/2023	22.1	22.0	44.9
22/03/2023	23.8	23.0	44.0

22/03/2023 (Malovat-Romania) Latitude: 44.707°
22/03/2023 (Elbasan-Albania) Latitude: 41.111°



Distance	Angle
circumference	360°
400km	44° - 40.4°

$$\text{circumference} = \frac{360^\circ \times 400\text{km}}{44^\circ - 40.4^\circ} = 40000 \text{ km}$$



Méier Brazil

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
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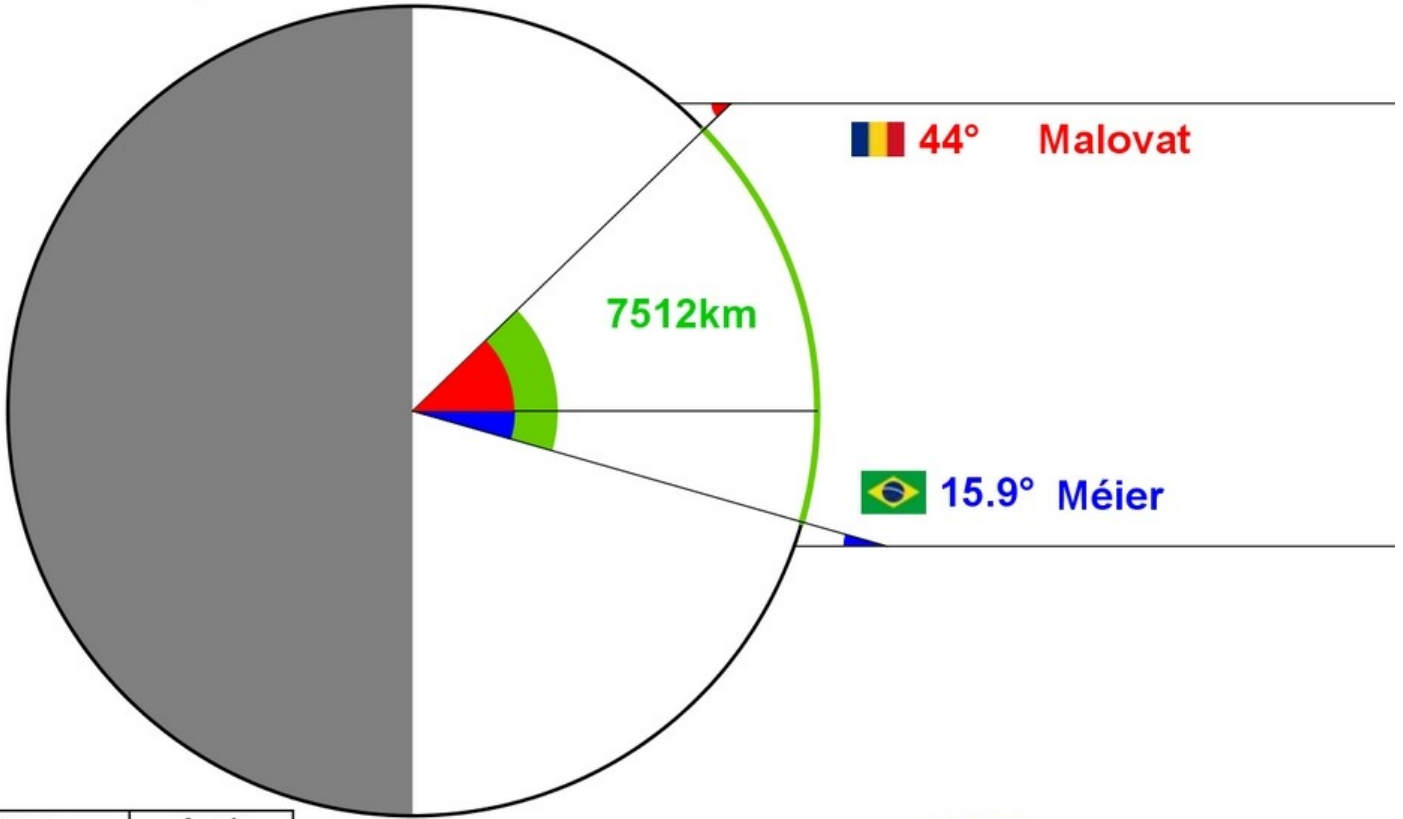
22/03/2023 21.0 -6.0 -15.9

Escola Municipal Bento Ribeiro

22.904 N 43.280 W

22/03/2023 (Malovat-Romania) Latitude: 44.707°

22/03/2023 (Méier-Brazil) Latitude: -22.904°



Distance	Angle
circumference	360°
7512km	44° + 15.9°

$$\text{circumference} = \frac{360^\circ \times 7512\text{km}}{44^\circ + 15.9^\circ} = 45147 \text{ km}$$



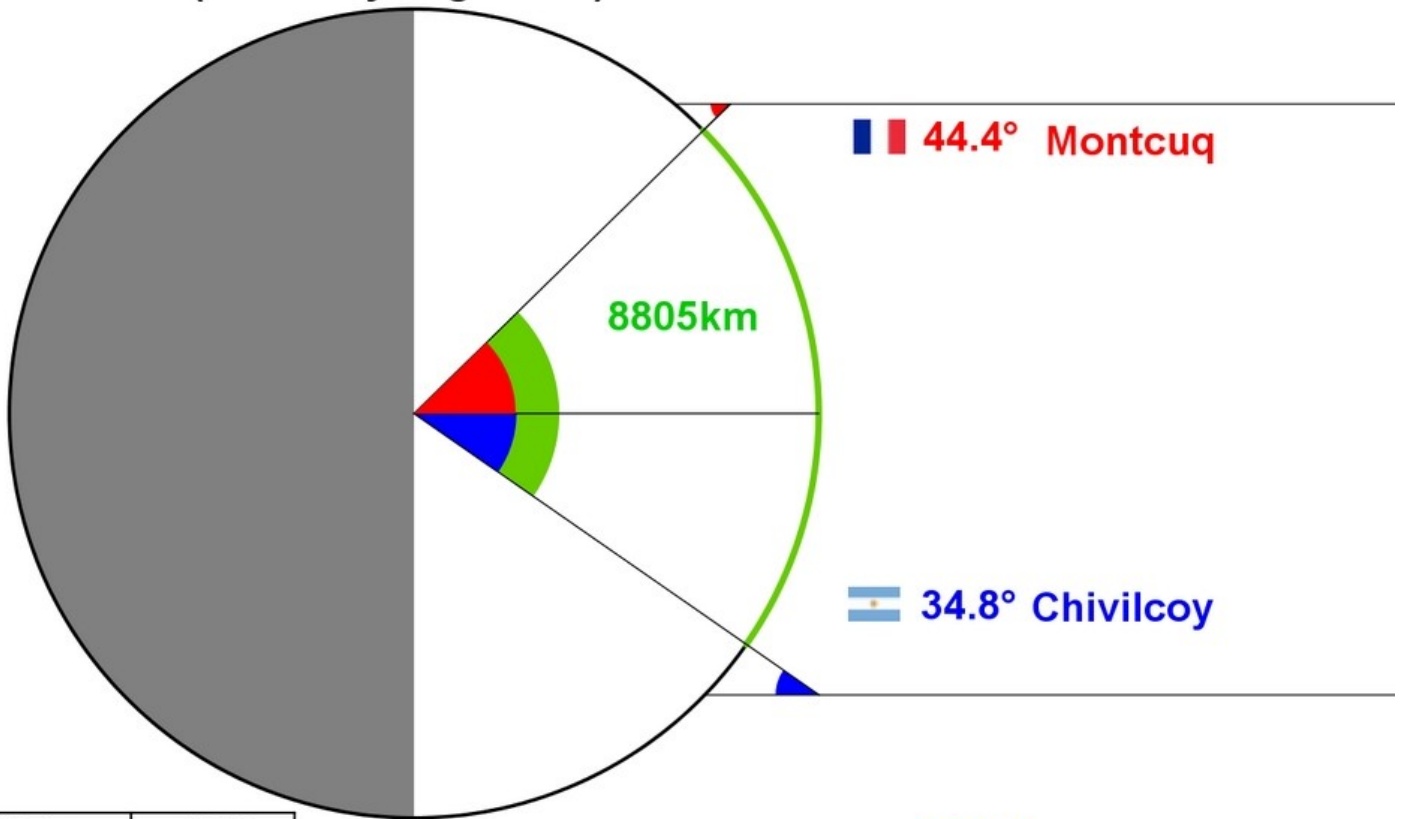
Montcuq France

Fondation La main à la pâte
44.340 N 1.210 E

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
17/03/2023	14.0	14.3	45.6
18/03/2023	14.0	14.1	45.2
19/03/2023	14.0	13.9	44.8
20/03/2023	14.0	13.7	44.4
21/03/2023	14.0	13.5	44.0
22/03/2023	14.0	13.4	43.7
23/03/2023	14.0	13.2	43.3

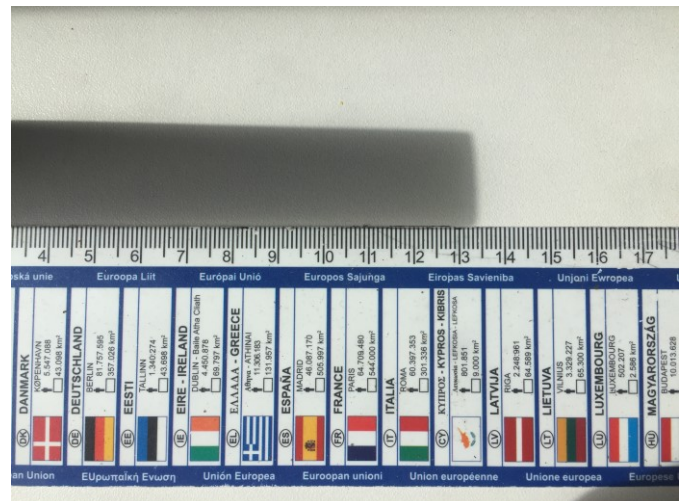
20/03/2023 (Montcuq-France) Latitude: 44.34°

20/03/2023 (Chivilcoy-Argentina) Latitude: -34.911°



Distance	Angle
circumference	360°
8805km	44.4° + 34.8°

$$\text{circumference} = \frac{360^\circ \times 8805\text{km}}{44.4^\circ + 34.8^\circ} = 40023 \text{ km}$$



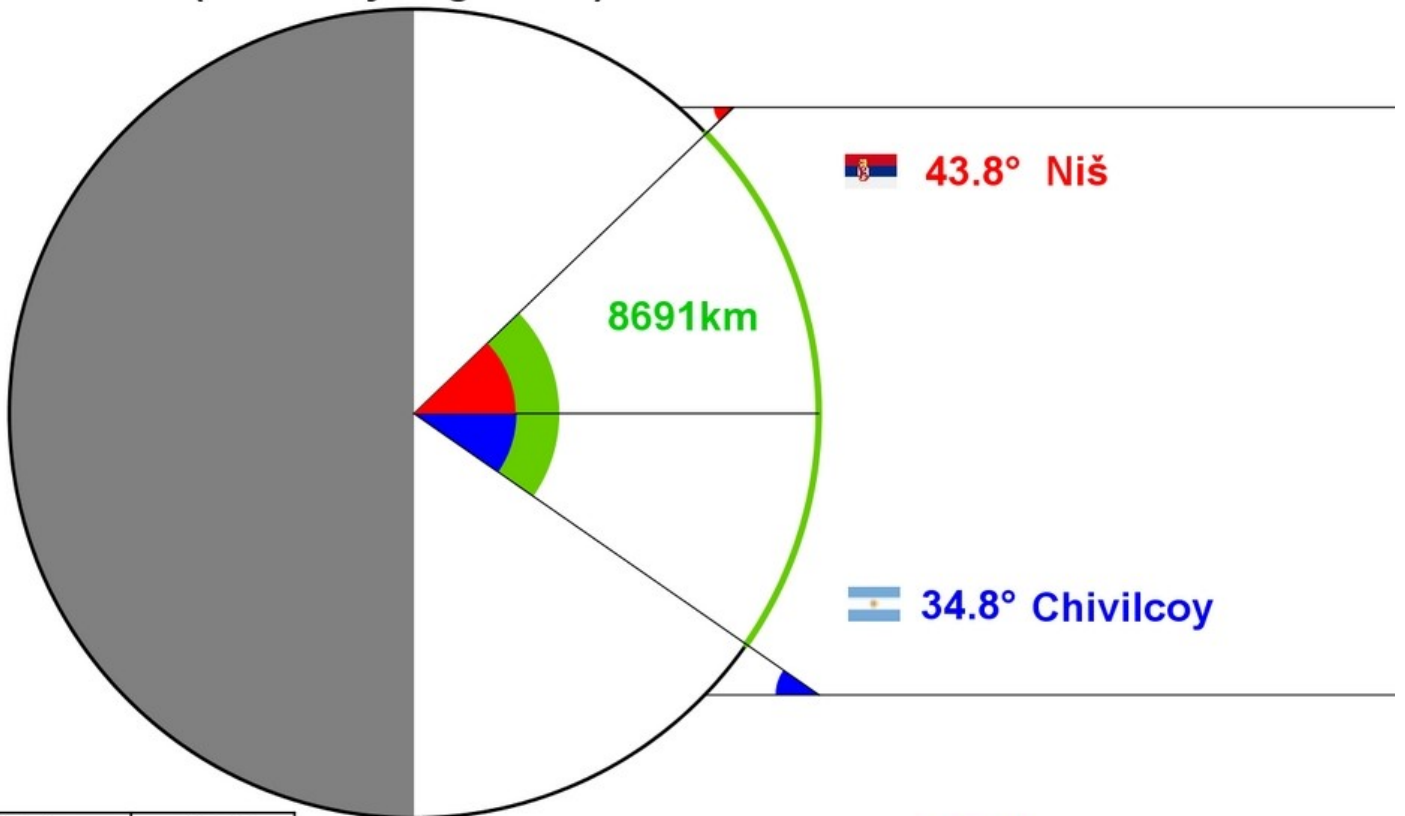
Niš Serbia

Gimnazija Svetozar Markovic
43.312 N 21.887 E

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
20/03/2023	100.0	95.8	43.8

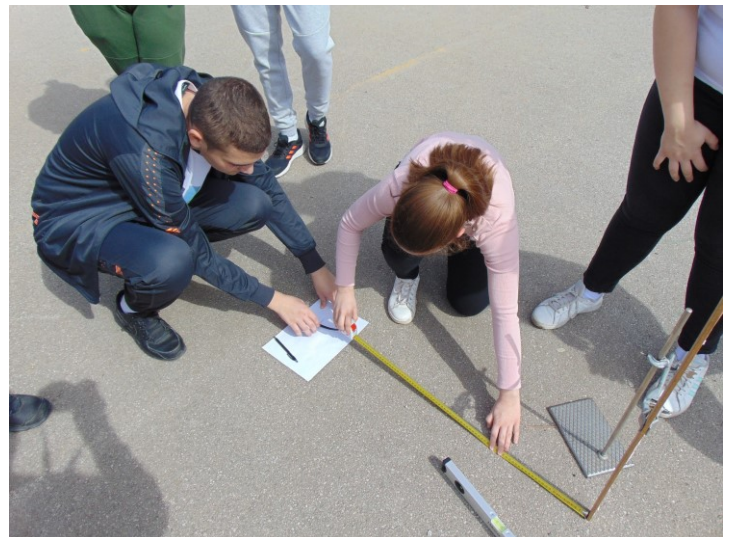
20/03/2023 (Niš-Serbia) Latitude: 43.312°

20/03/2023 (Chivilcoy-Argentina) Latitude: -34.911°



Distance	Angle
circumference	360°
8691km	43.8°+ 34.8°

$$\text{circumference} = \frac{360^\circ \times 8691\text{km}}{43.8^\circ + 34.8^\circ} = 39806 \text{ km}$$



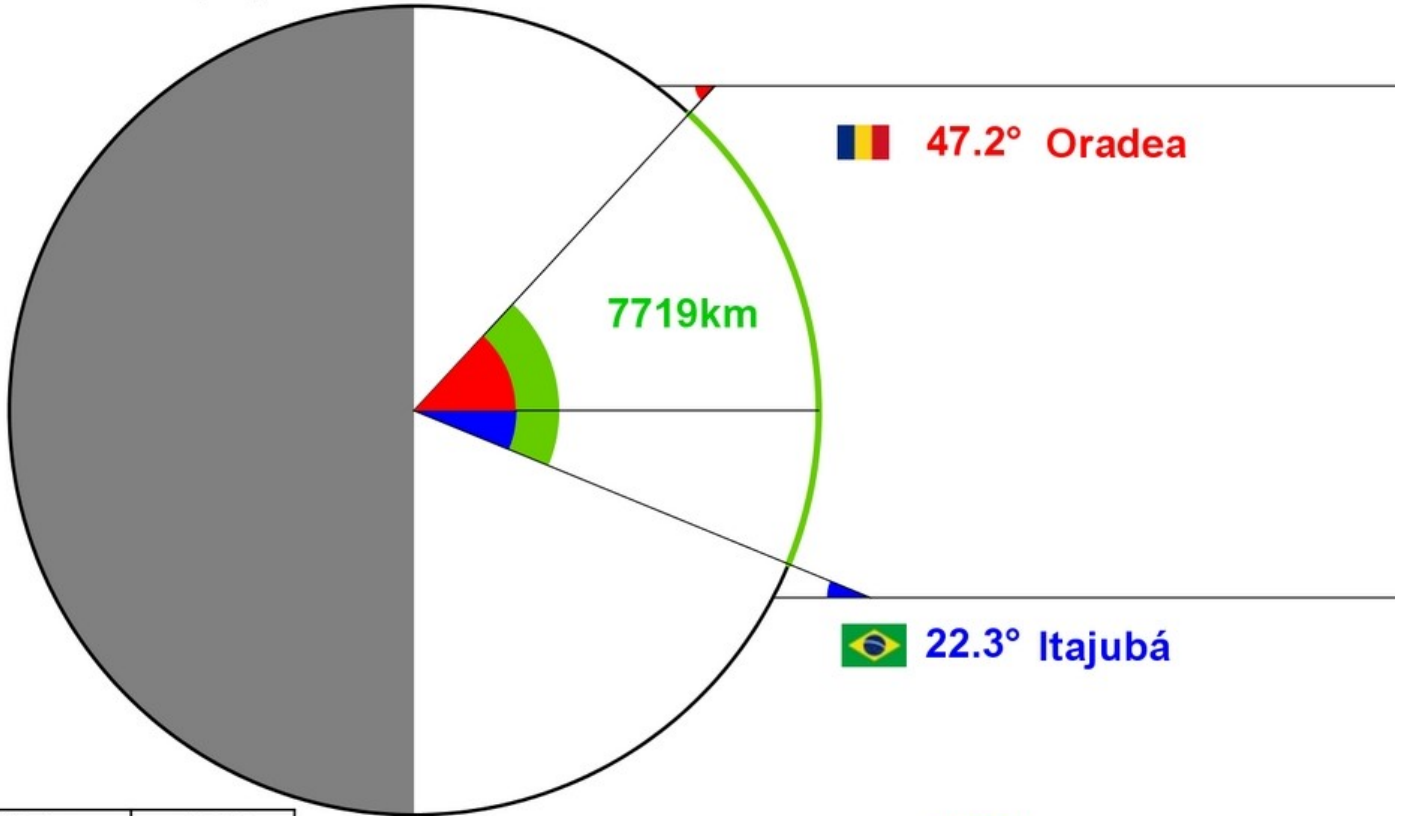
Oradea Romania

Colegiul Tehnic Traian Vuia
47.064 N 21.916 E

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
20/03/2023	55.5	60.0	47.2
21/03/2023	150.0	160.0	46.8

20/03/2023 (Oradea-Romania) Latitude: 47.064°

20/03/2023 (Itajubá-Brazil) Latitude: -22.415°



Distance	Angle
circumference	360°
7719km	47.2° + 22.3°

$$\text{circumference} = \frac{360^\circ \times 7719\text{km}}{47.2^\circ + 22.3^\circ} = 39983 \text{ km}$$



Pogana Romania

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
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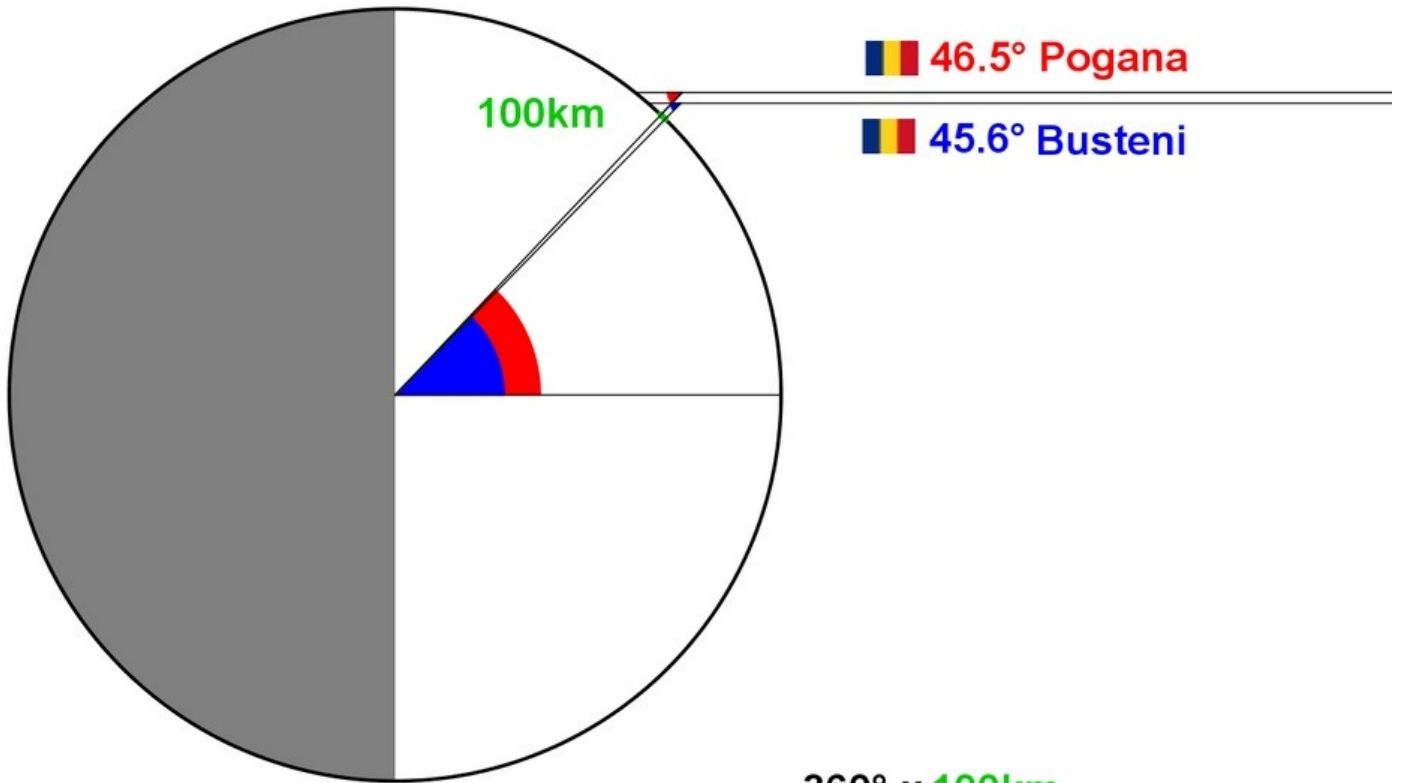
20/03/2023 5.4 5.7 46.5

Școala Gimnaziala Pogana

46.313 N 27.575 E

20/03/2023 (Pogana-Romania) Latitude: 46.313°

20/03/2023 (Busteni-Romania) Latitude: 45.416°



Distance	Angle
circumference	360°
100km	46.5° - 45.6°

$$\text{circumference} = \frac{360^\circ \times 100\text{km}}{46.5^\circ - 45.6^\circ} = 40000 \text{ km}$$



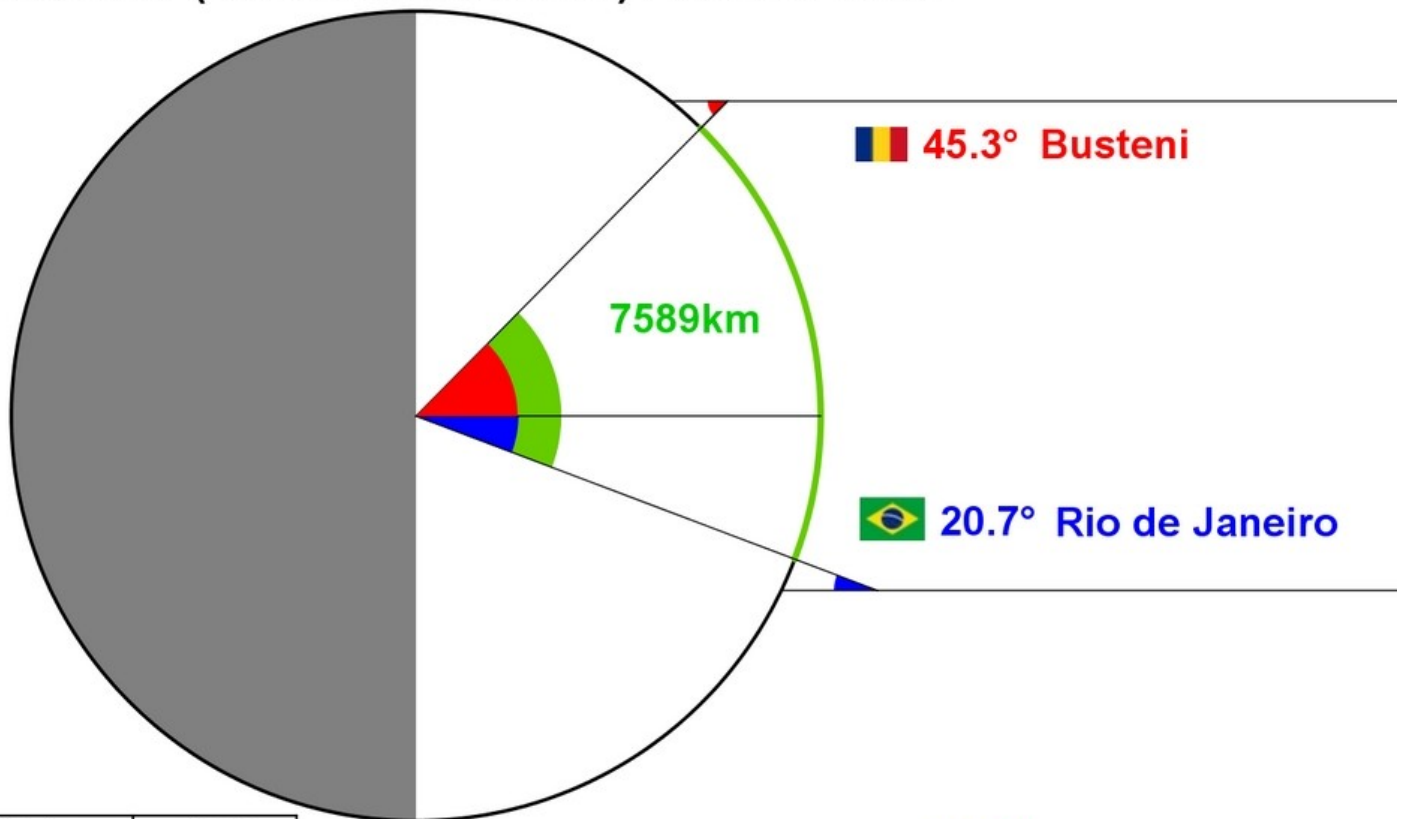
Rio de Janeiro Brazil

Centro Educacional
Nosso Mundo
22.890 S 43.317 W

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
17/03/2023	37.0	-13.0	-19.4
20/03/2023	28.0	-10.0	-19.7
21/03/2023	37.0	-14.0	-20.7
22/03/2023	37.0	-14.0	-20.7
23/03/2023	37.0	-14.0	-20.7

21/03/2023 (Busteni-Romania) Latitude: 45.416°

21/03/2023 (Rio de Janeiro-Brazil) Latitude: -22.89°



Distance	Angle
circumference	360°
7589km	45.3° + 20.7°

$$\text{circumference} = \frac{360^\circ \times 7589\text{km}}{45.3^\circ + 20.7^\circ} = 41395 \text{ km}$$



Serres Greece

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
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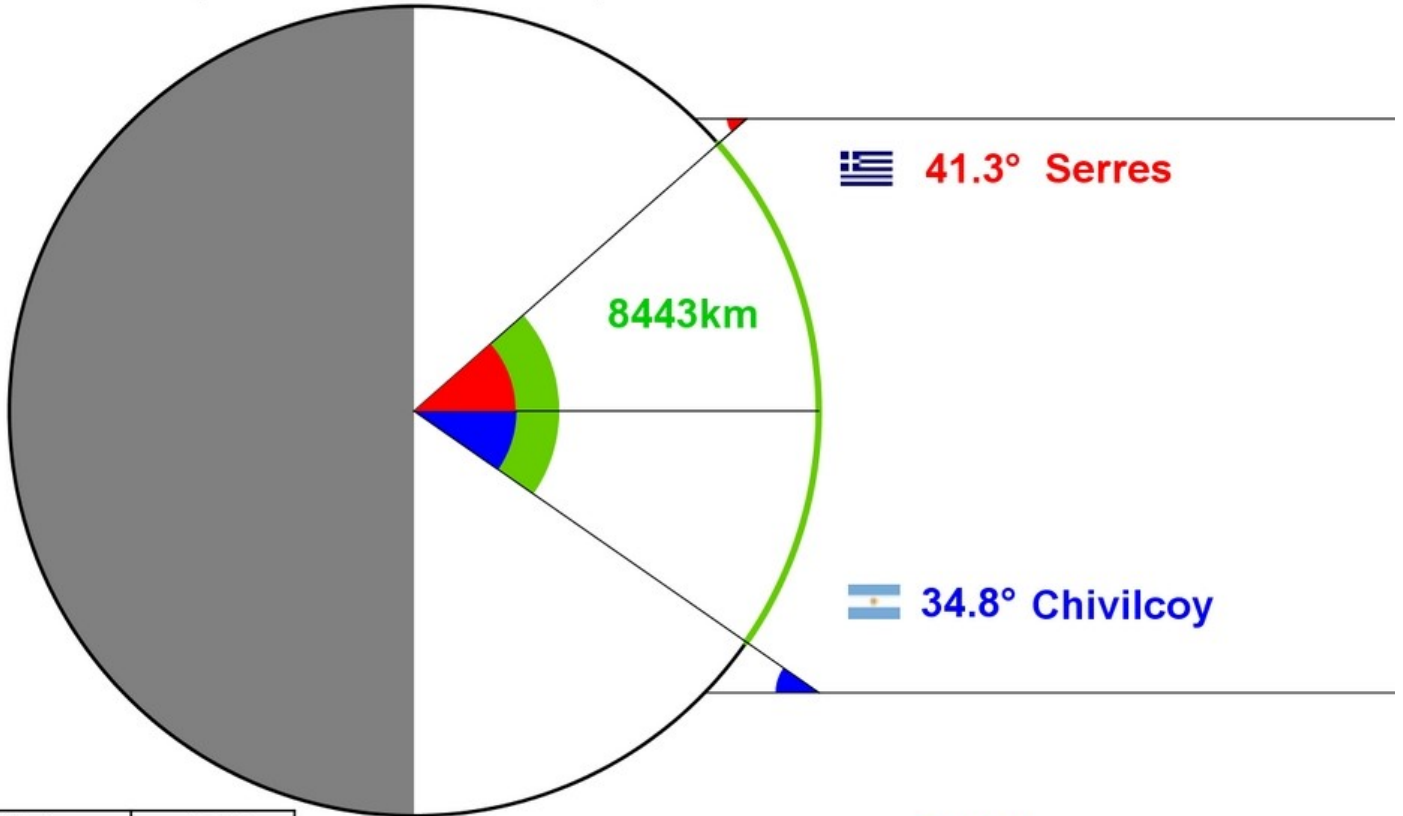
20/03/2023	100.0	88.0	41.3
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Experimental Primary School of Serres

41.083 N 23.540 E

20/03/2023 (Serres-Greece) Latitude: 41.083°

20/03/2023 (Chivilcoy-Argentina) Latitude: -34.911°



Distance	Angle
circumference	360°
8443km	41.3° + 34.8°

$$\text{circumference} = \frac{360^\circ \times 8443\text{km}}{41.3^\circ + 34.8^\circ} = 39941 \text{ km}$$



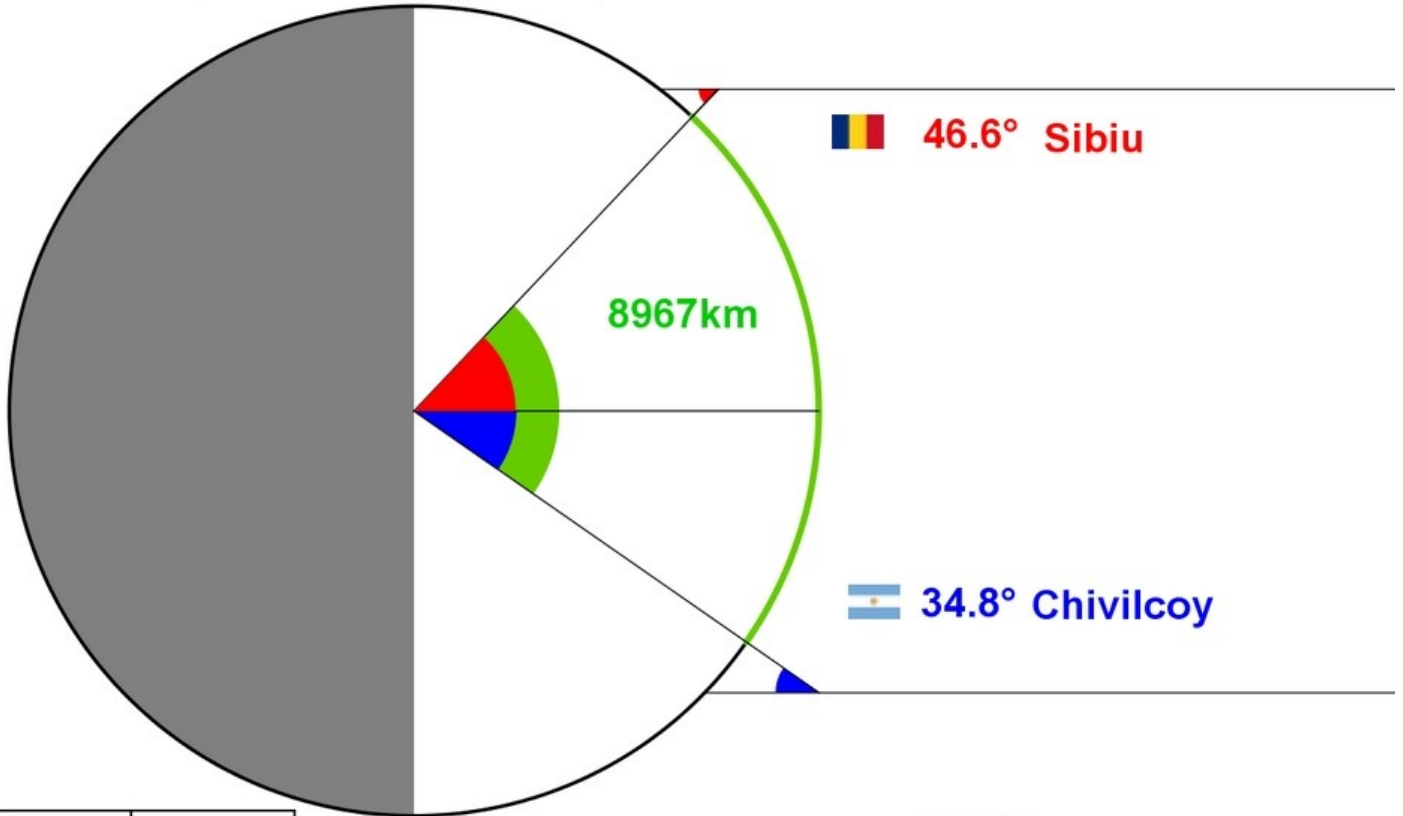
Sibiu Romania

Colegiul National Gheorghe Lazar
45.797 N 24.154 E

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
20/03/2023	52.0	55.0	46.6

20/03/2023 (Sibiu-Romania) Latitude: 45.797°

20/03/2023 (Chivilcoy-Argentina) Latitude: -34.911°



Distance	Angle
circumference	360°
8967km	46.6° + 34.8°

$$\text{circumference} = \frac{360^\circ \times 8967\text{km}}{46.6^\circ + 34.8^\circ} = 39657 \text{ km}$$

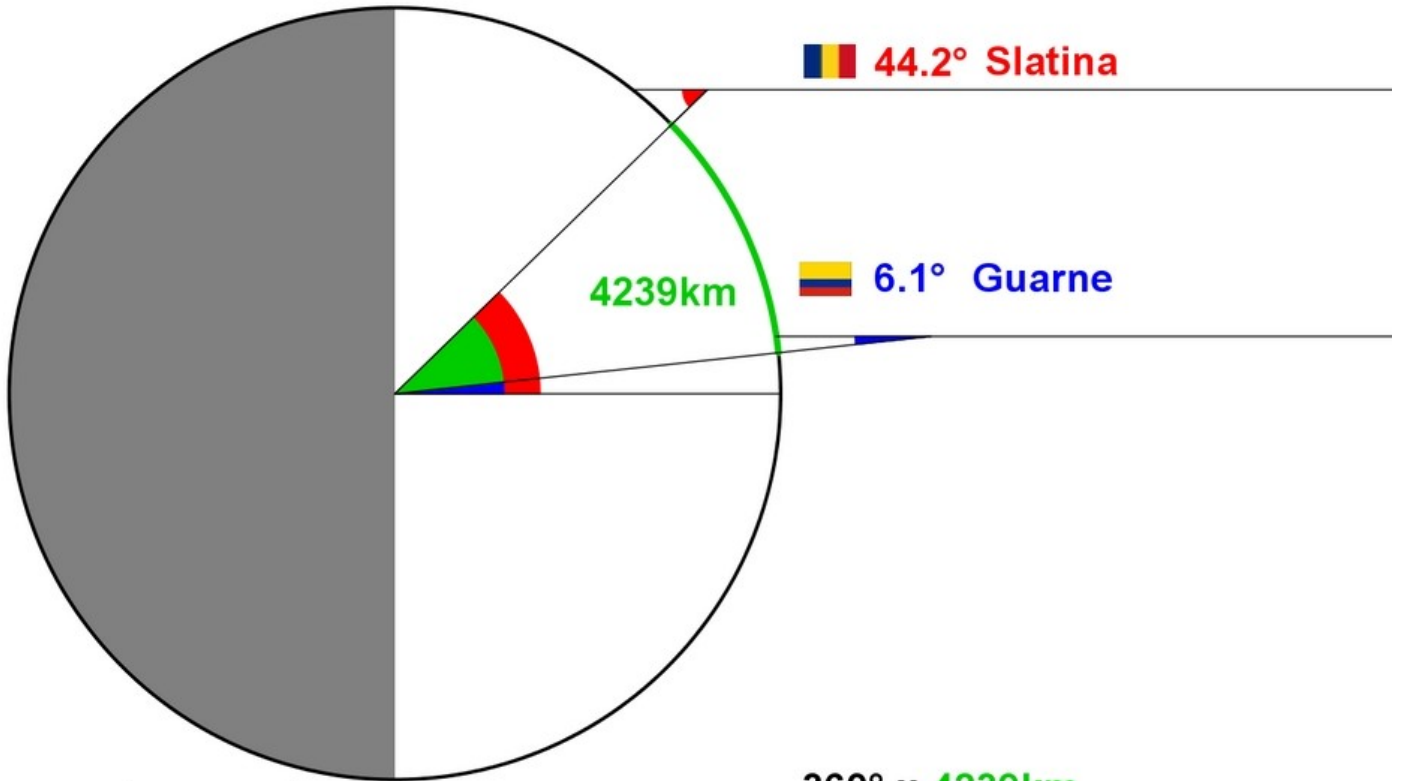


Slatina Romania

Secondary School Vlaicu Voda
44.432 N 24.377 E

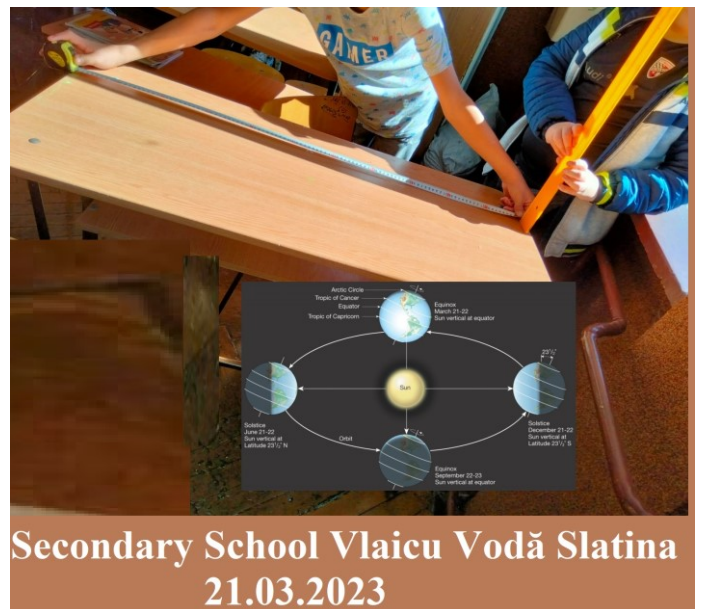
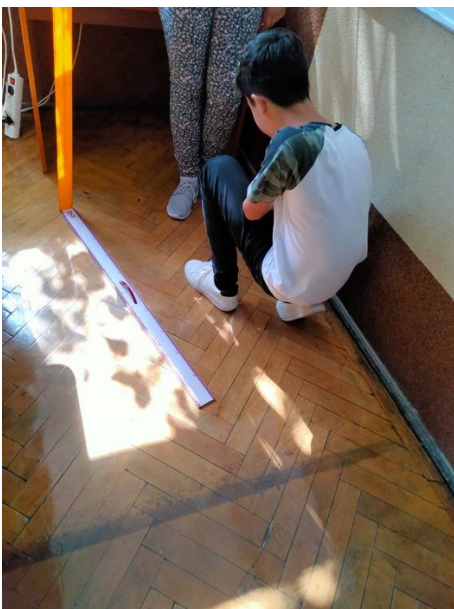
Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
20/03/2023	100.0	97.3	44.2
21/03/2023	100.0	97.0	44.1
23/03/2023	100.0	96.7	44.0

20/03/2023 (Slatina-Romania) Latitude: 44.432°
20/03/2023 (Guarne-Colombia) Latitude: 6.274°



Distance	Angle
circumference	360°
4239km	44.2° - 6.1°

$$\text{circumference} = \frac{360^\circ \times 4239\text{km}}{44.2^\circ - 6.1^\circ} = 40054 \text{ km}$$



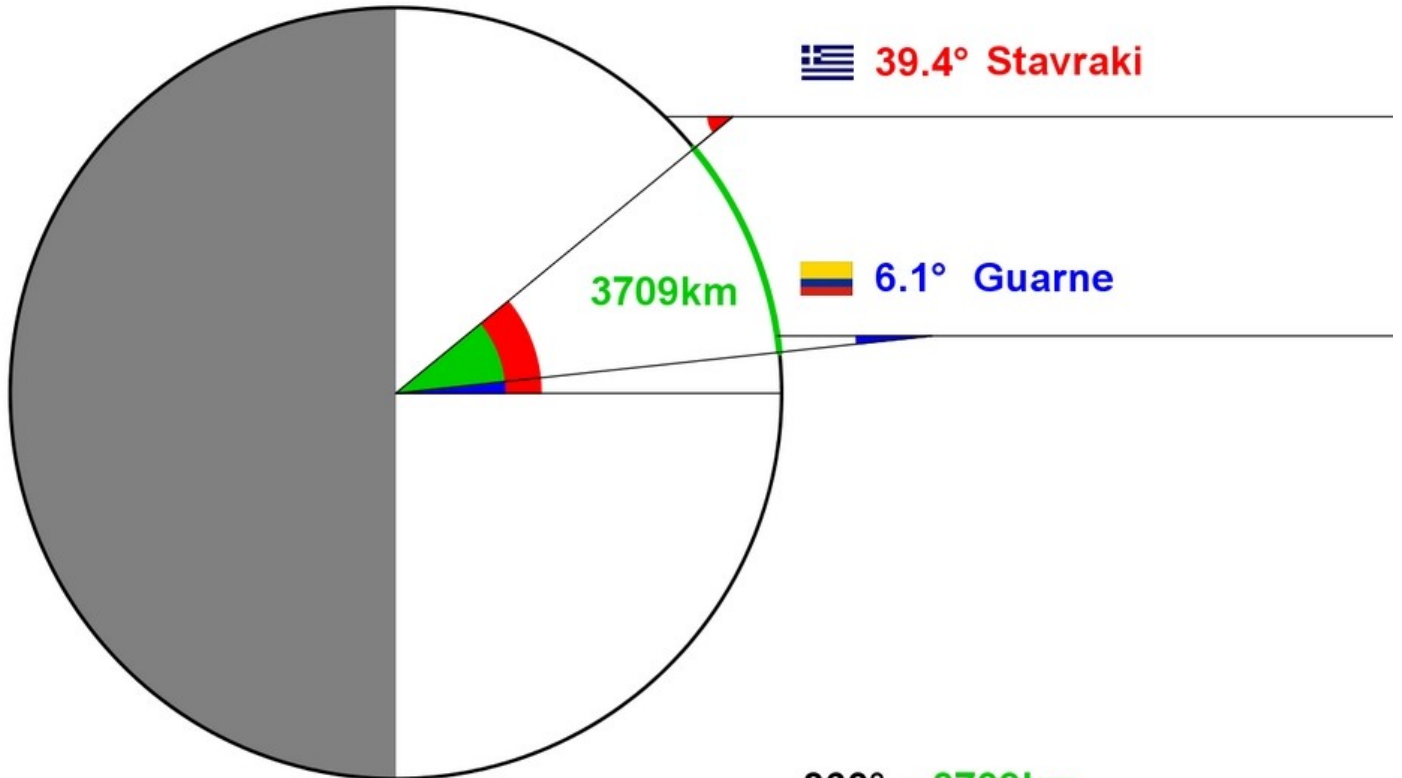
Stavraki Greece

Primary School of Stavraki
39.654 N 20.817 E

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
20/03/2023	100.0	82.0	39.4

20/03/2023 (Stavraki-Greece) Latitude: 39.654°

20/03/2023 (Guarne-Colombia) Latitude: 6.274°



Distance	Angle
circumference	360°
3709km	39.4° - 6.1°

$$\text{circumference} = \frac{360^\circ \times 3709\text{km}}{39.4^\circ - 6.1^\circ} = 40097 \text{ km}$$



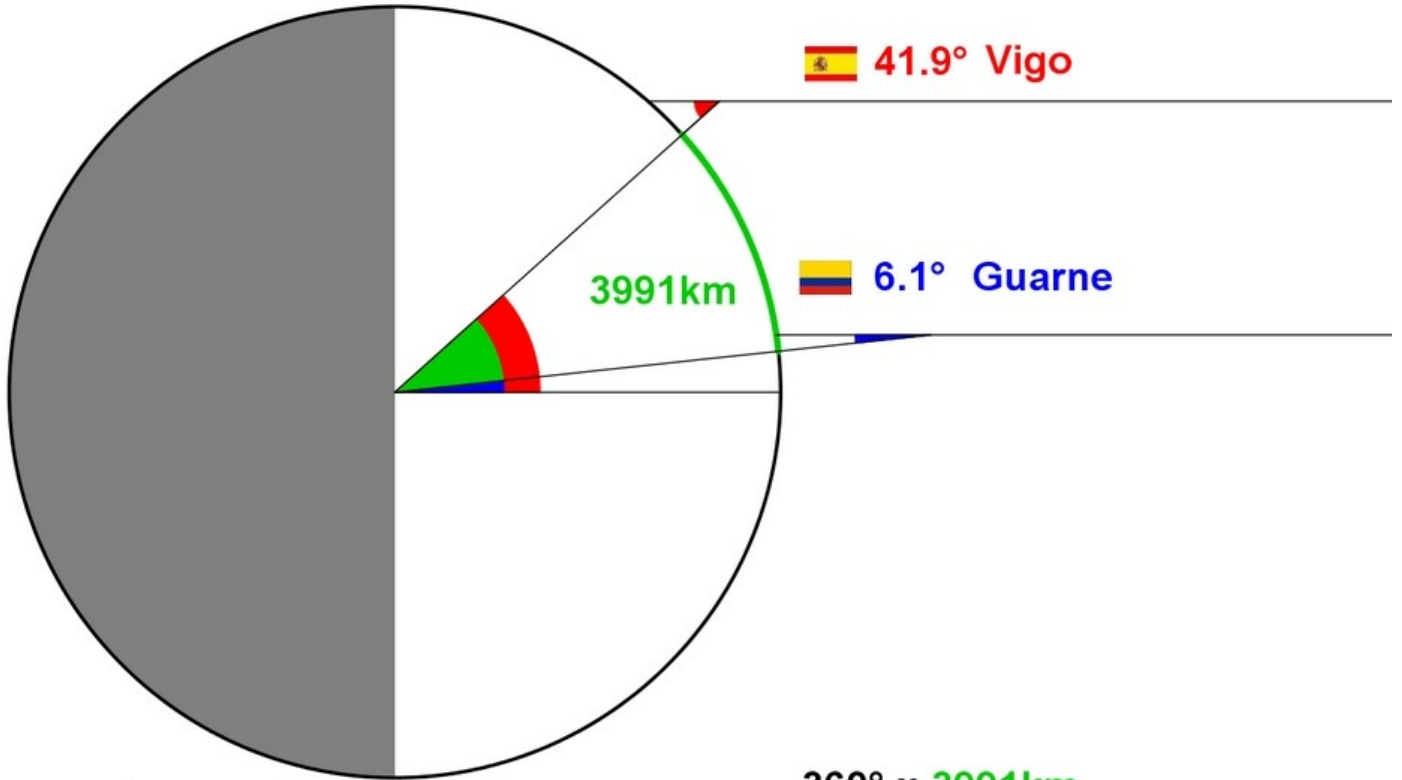
Vigo Spain

IES de Beade
42.201 N 8.716 W

Date	Gnomon height [cm]	Shadow length [cm]	Angle (°)
20/03/2023	71.4	64.0	41.9

20/03/2023 (Vigo-Spain) Latitude: 42.201°

20/03/2023 (Guarne-Colombia) Latitude: 6.274°



Distance	Angle
circumference	360°
3991km	41.9° - 6.1°

$$\text{circumference} = \frac{360^\circ \times 3991\text{km}}{41.9^\circ - 6.1^\circ} = 40133 \text{ km}$$





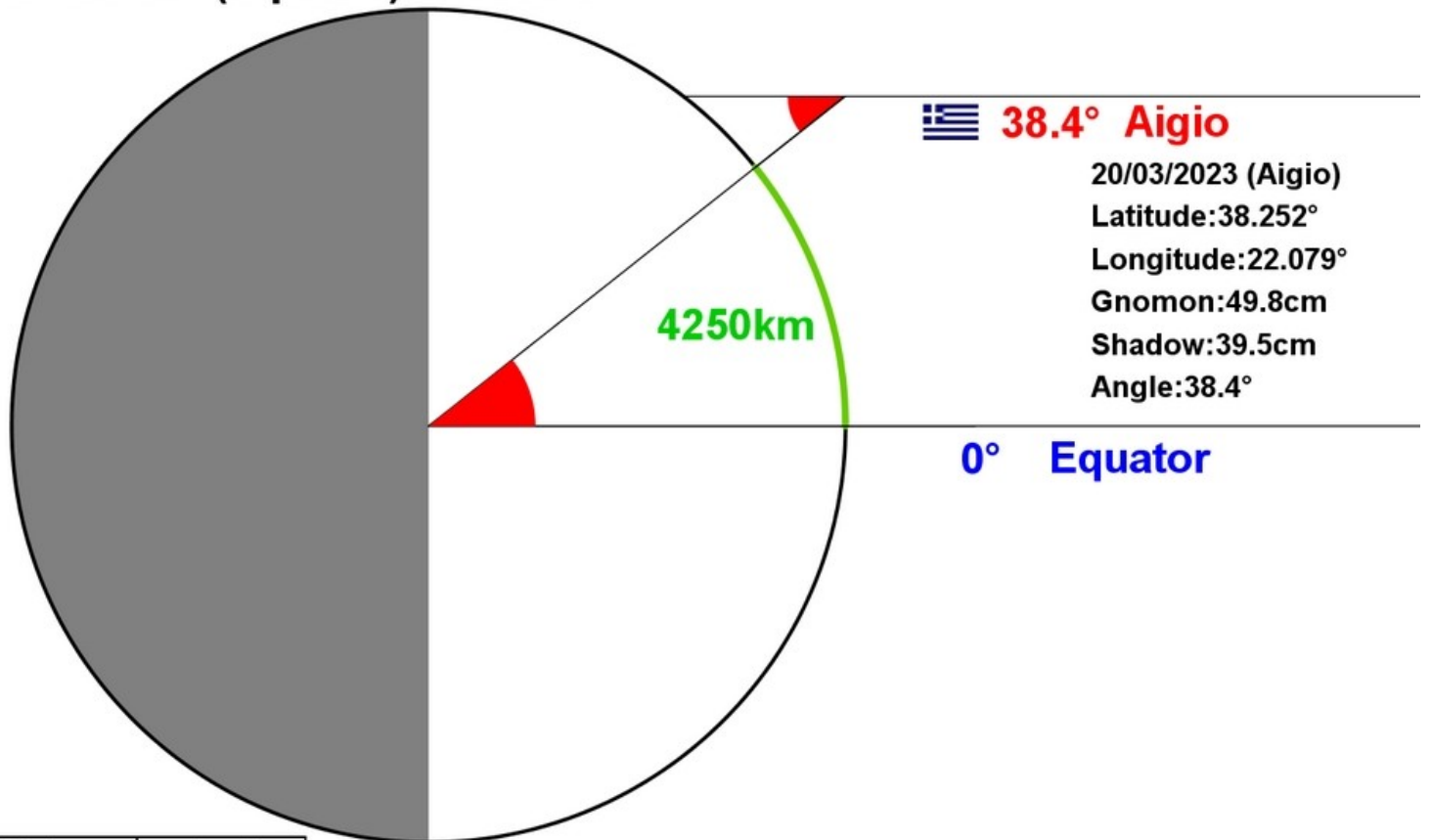
The Eratosthenes method

Table of measurements.

20 March 2023	Latitude	Angle of the sun (°)	Distance to equator (km)	Circumference (km)
Băsești	47.481	47.6	5275	39895
Oradea	47.064	47.2	5229	39882
Pogana	46.313	46.5	5145	39832
Sibiu	45.797	46.6	5088	39306
Busteni	45.416	45.6	5046	39837
Malovat	44.707	44.9	4967	39824
Slatina	44.432	44.2	4936	40203
Montcuq	44.340	44.4	4926	39941
Niș	43.312	43.8	4812	39551
Vigo	42.201	41.9	4689	40287
Serres	41.083	41.3	4564	39783
Stavraki	39.654	39.4	4406	40258
Aigio	38.252	38.4	4250	39844
Aspropyrgos	38.061	39.0	4229	39037
Athens	38.028	38.1	4225	39921
Aydın	37.749	37.1	4194	40696
Bayamón	18.383	18.4	2042	39952
Guarne	6.274	6.1	697	41134
Itajubá	-22.415	-22.3	-2490	40197
Del Castilho	-22.881	-23.4	-2542	39108
Rio de Janeiro	-22.890	-19.7	-2543	46471
Chivilcoy	-34.911	-34.8	-3879	40128
Equator	0.000	0.0	0	

20/03/2023 (Aigio-Greece) Latitude: 38.252°

20/03/2023 (Equator) Latitude: 0°



 **38.4° Aigio**

20/03/2023 (Aigio)
Latitude:38.252°
Longitude:22.079°
Gnomon:49.8cm
Shadow:39.5cm
Angle:38.4°

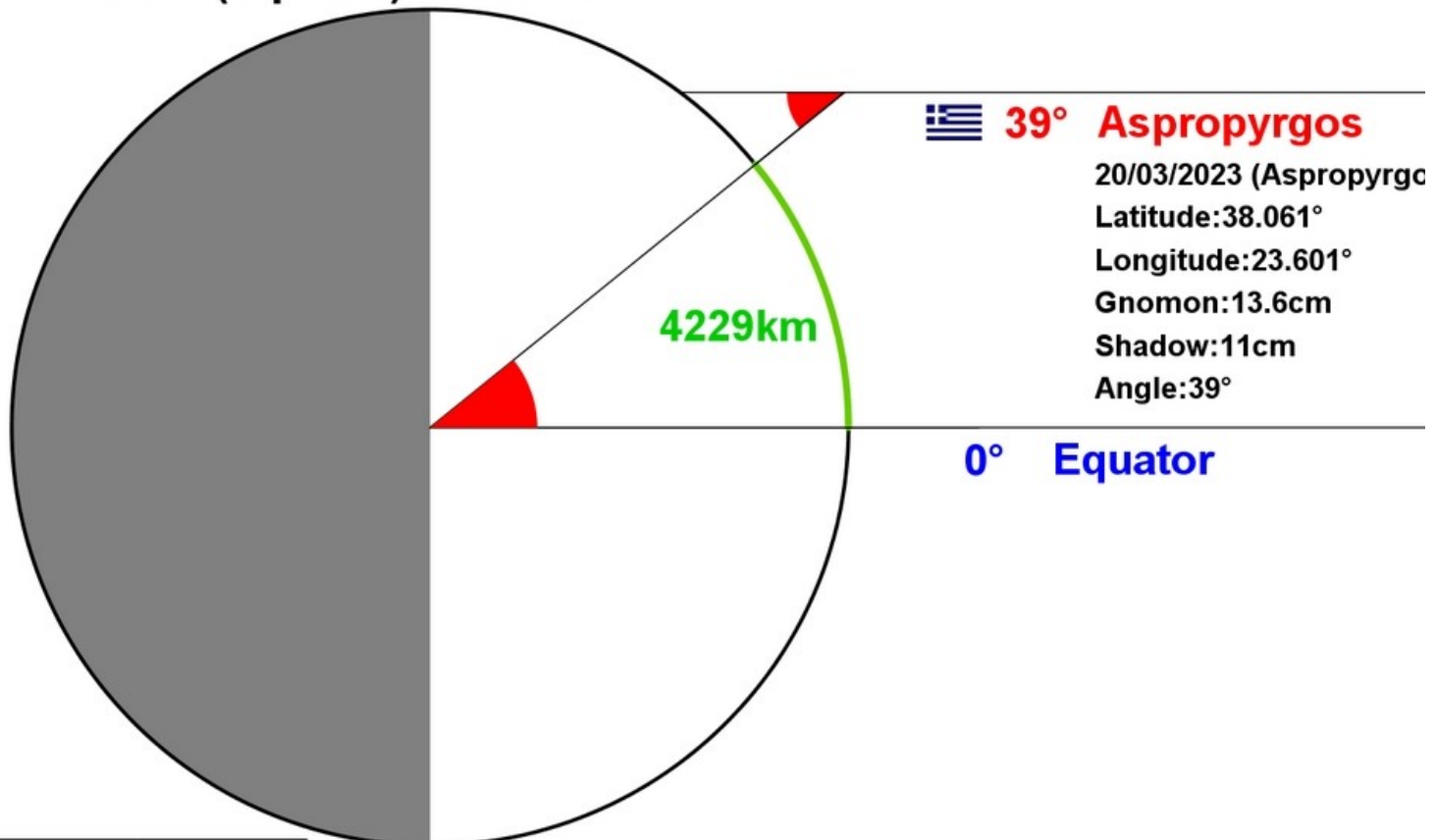
0° Equator

Distance	Angle
circumference	360°
4250km	38.4°

$$\text{circumference} = \frac{360^\circ \times 4250\text{km}}{38.4^\circ} = 39844 \text{ km}$$

20/03/2023 (Aspropyrgos-Greece) Latitude: 38.061°

20/03/2023 (Equator) Latitude: 0°



 **39° Aspropyrgos**

20/03/2023 (Aspropyrgos)
Latitude:38.061°
Longitude:23.601°
Gnomon:13.6cm
Shadow:11cm
Angle:39°

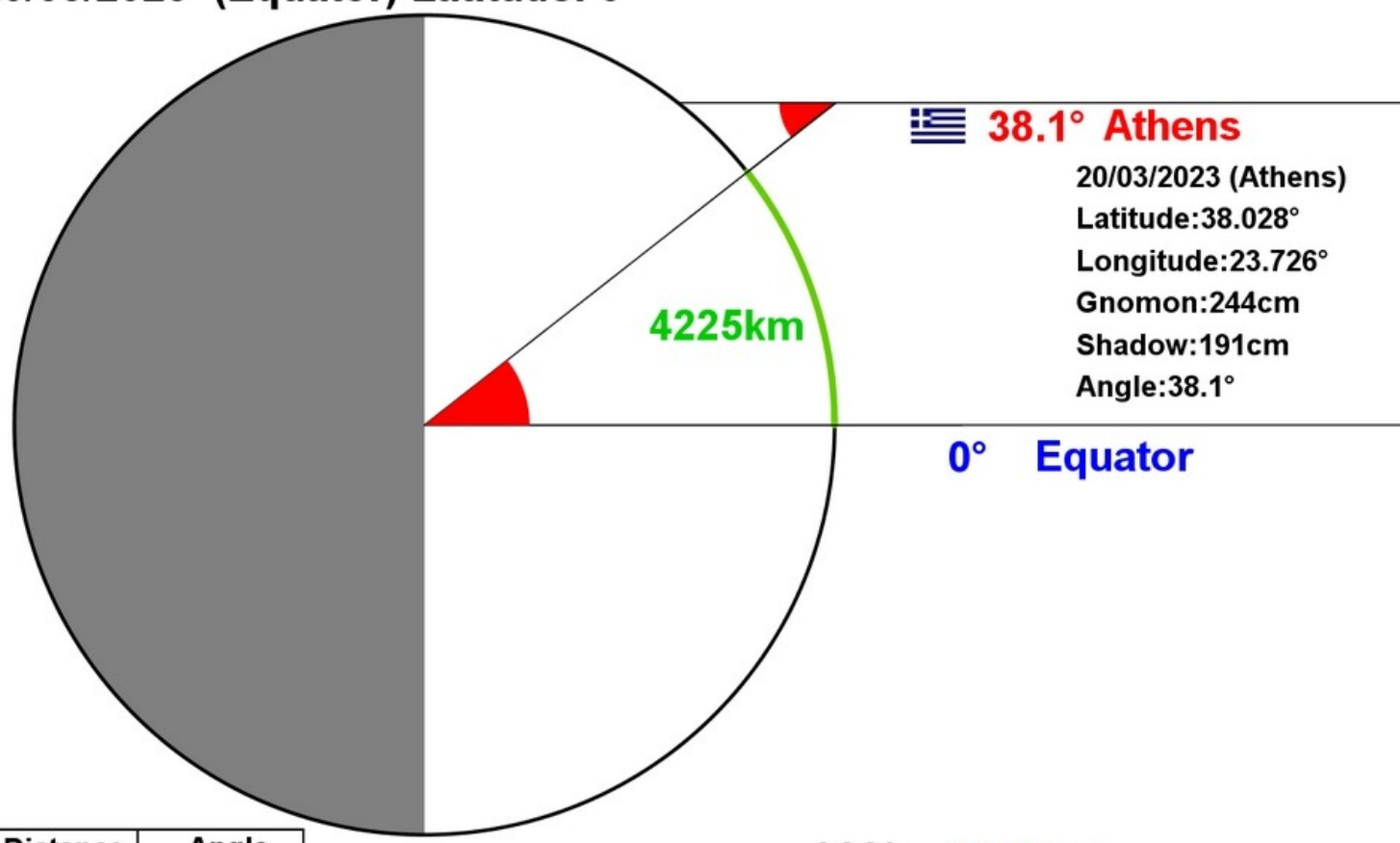
0° Equator

Distance	Angle
circumference	360°
4229km	39°

$$\text{circumference} = \frac{360^\circ \times 4229\text{km}}{39^\circ} = 39037 \text{ km}$$

20/03/2023 (Athens-Greece) Latitude: 38.028°

20/03/2023 (Equator) Latitude: 0°



 **38.1° Athens**
 20/03/2023 (Athens)
 Latitude:38.028°
 Longitude:23.726°
 Gnomon:244cm
 Shadow:191cm
 Angle:38.1°

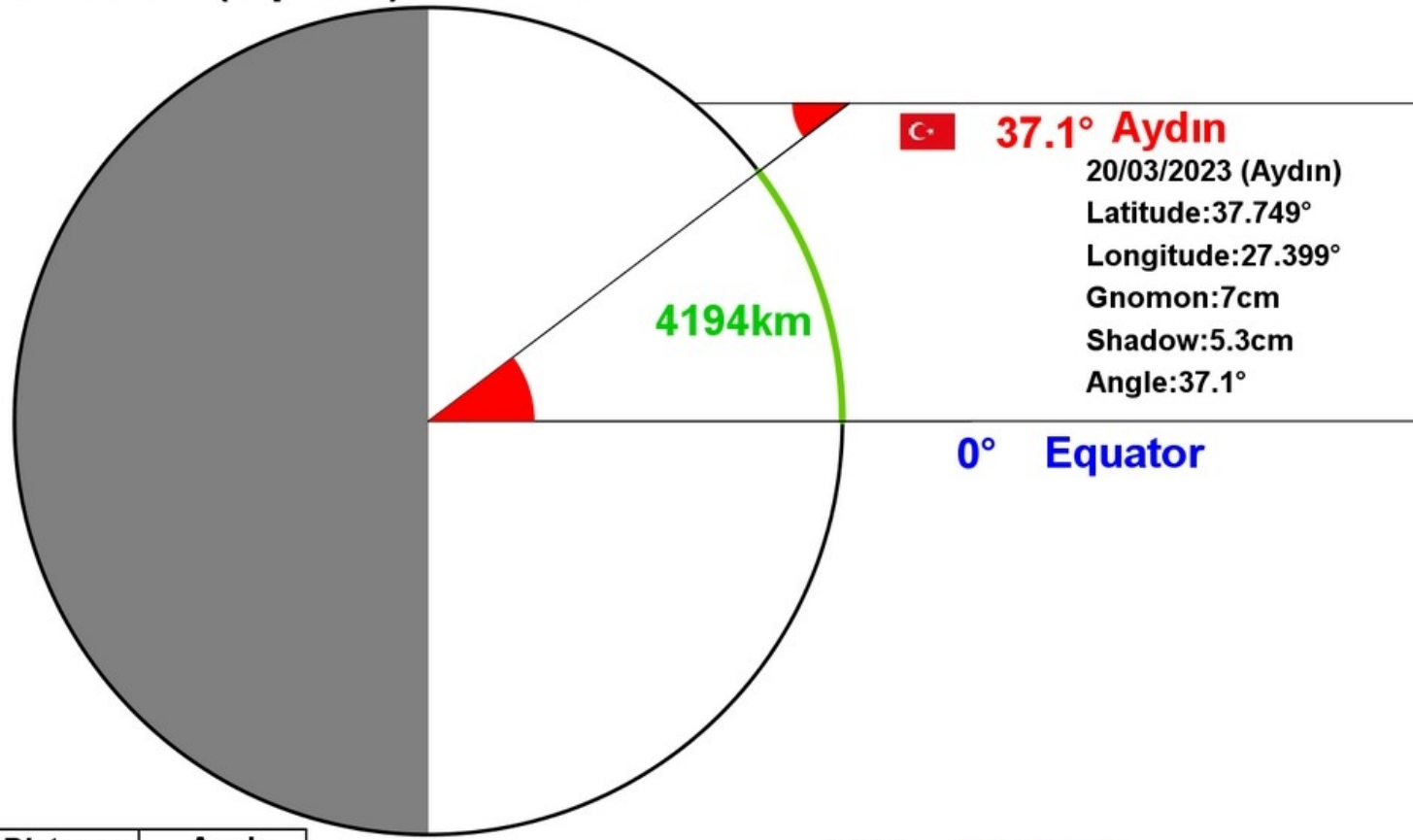
0° Equator

Distance	Angle
circumference	360°
4225km	38.1°

circumference = $\frac{360^\circ \times 4225\text{km}}{38.1^\circ} = 39921 \text{ km}$

20/03/2023 (Aydın-Turkey) Latitude: 37.749°

20/03/2023 (Equator) Latitude: 0°



 **37.1° Aydın**
 20/03/2023 (Aydın)
 Latitude:37.749°
 Longitude:27.399°
 Gnomon:7cm
 Shadow:5.3cm
 Angle:37.1°

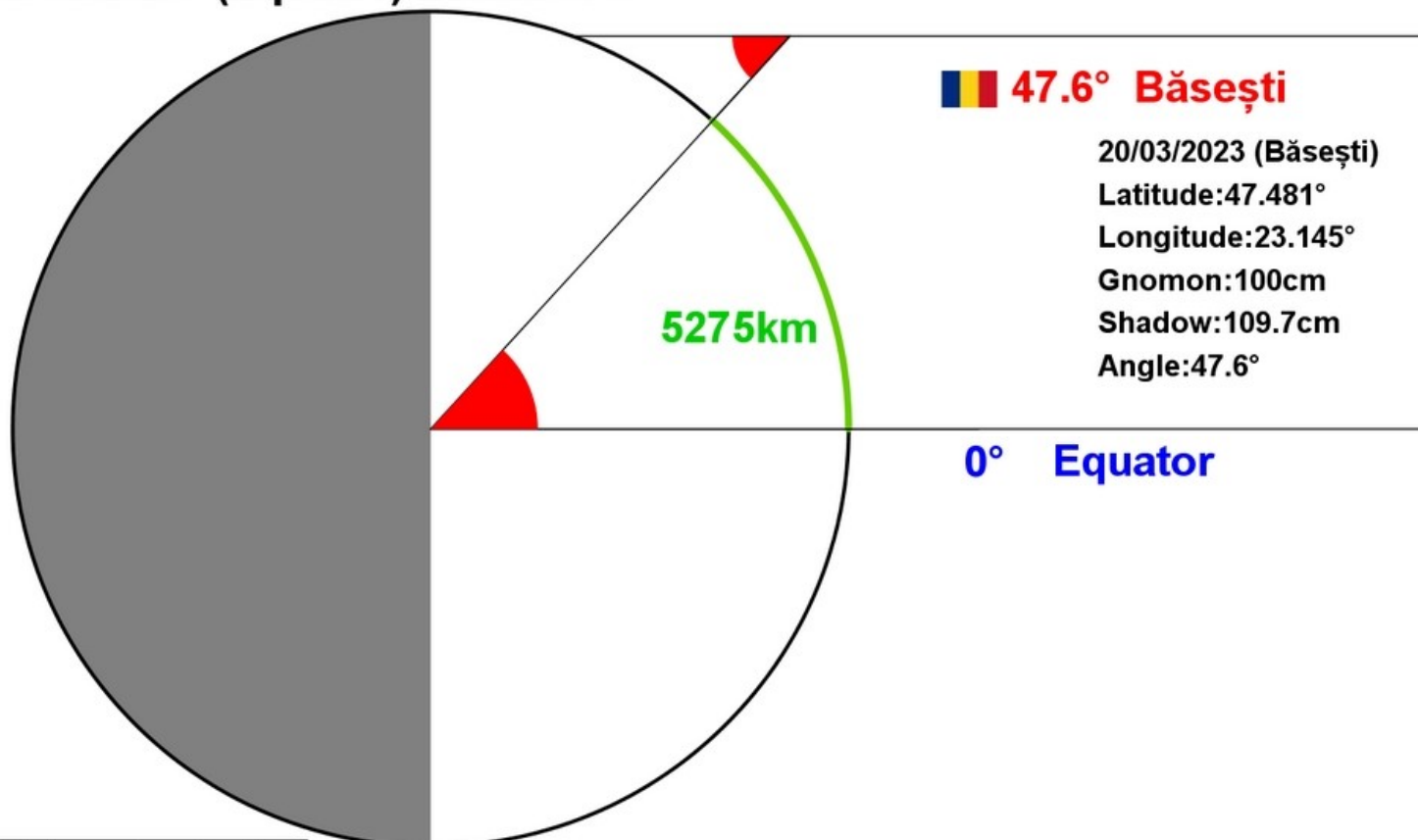
0° Equator

Distance	Angle
circumference	360°
4194km	37.1°

circumference = $\frac{360^\circ \times 4194\text{km}}{37.1^\circ} = 40696 \text{ km}$

20/03/2023 (Băsești-Romania) Latitude: 47.481°

20/03/2023 (Equator) Latitude: 0°



 **47.6° Băsești**

20/03/2023 (Băsești)
 Latitude:47.481°
 Longitude:23.145°
 Gnomon:100cm
 Shadow:109.7cm
 Angle:47.6°

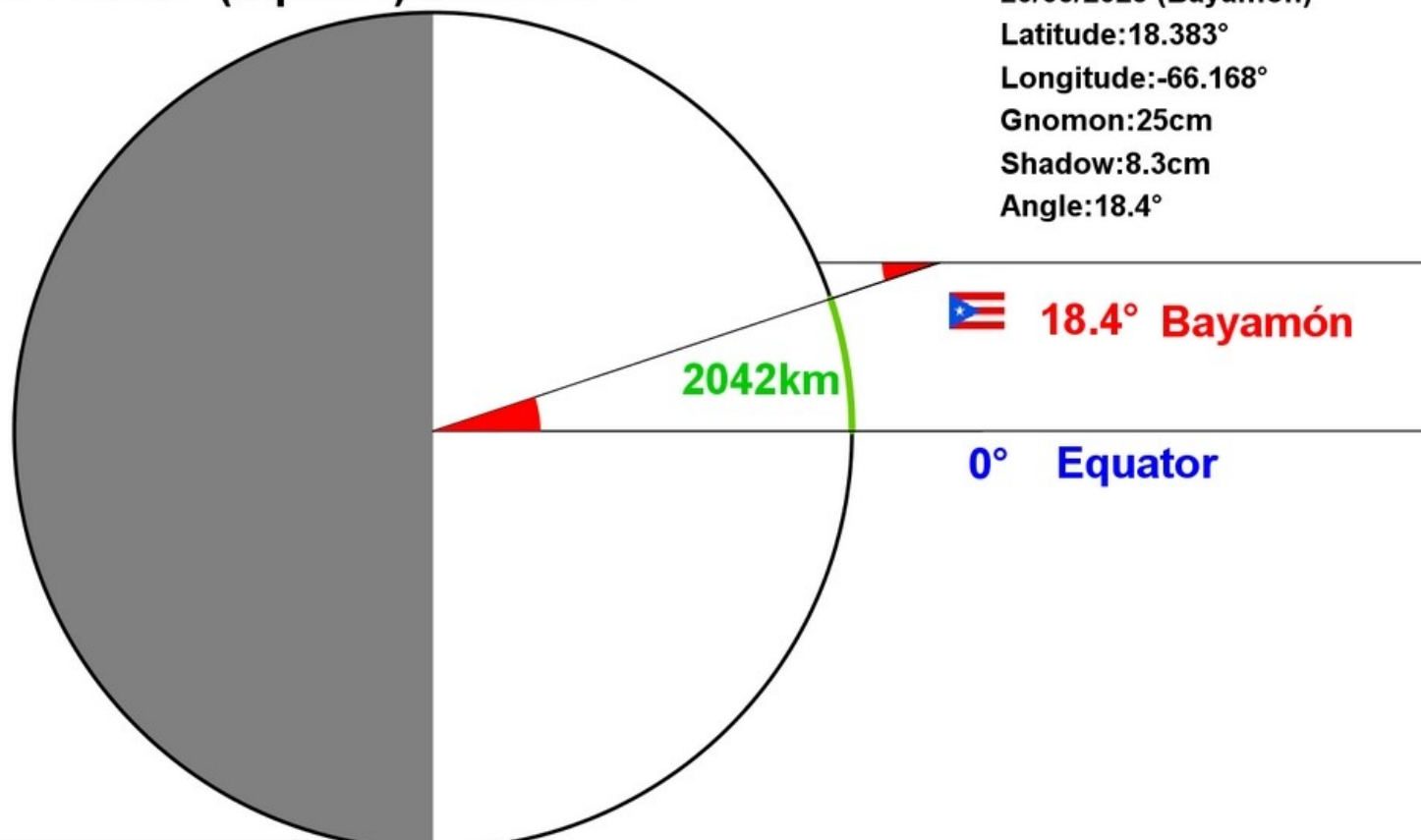
0° Equator

Distance	Angle
circumference	360°
5275km	47.6°

$$\text{circumference} = \frac{360^\circ \times 5275\text{km}}{47.6^\circ} = 39895 \text{ km}$$

20/03/2023 (Bayamón-Puerto Rico) Latitude: 18.383°

20/03/2023 (Equator) Latitude: 0°



 **18.4° Bayamón**

20/03/2023 (Bayamón)
 Latitude:18.383°
 Longitude:-66.168°
 Gnomon:25cm
 Shadow:8.3cm
 Angle:18.4°

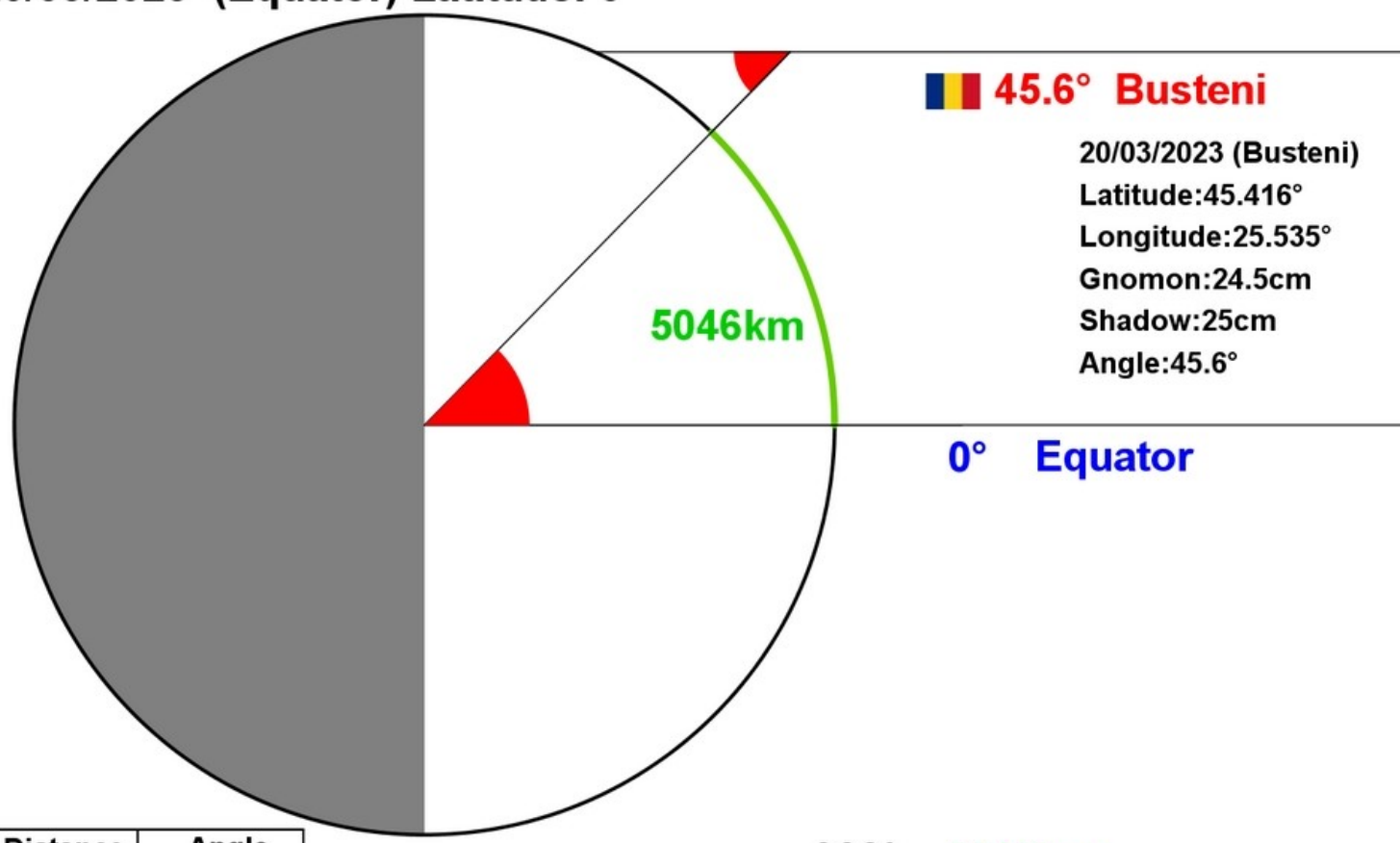
0° Equator

Distance	Angle
circumference	360°
2042km	18.4°

$$\text{circumference} = \frac{360^\circ \times 2042\text{km}}{18.4^\circ} = 39952 \text{ km}$$

20/03/2023 (Busteni-Romania) Latitude: 45.416°

20/03/2023 (Equator) Latitude: 0°

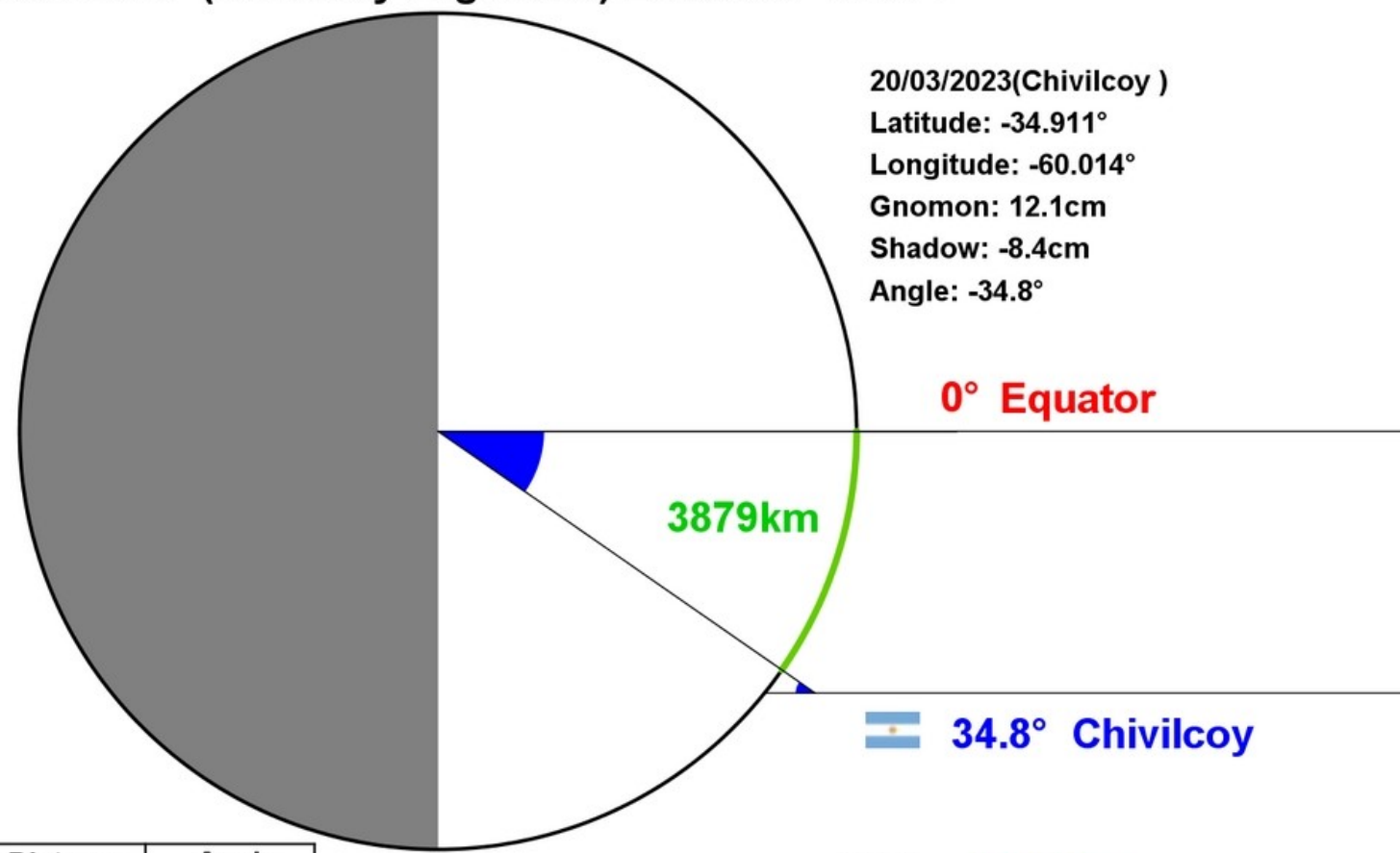


Distance	Angle
circumference	360°
5046km	45.6°

circumference = $\frac{360^\circ \times 5046\text{km}}{45.6^\circ} = 39837 \text{ km}$

20/03/2023 (Equator) Latitude: 0°

20/03/2023 (Chivilcoy-Argentina) Latitude: -34.911°



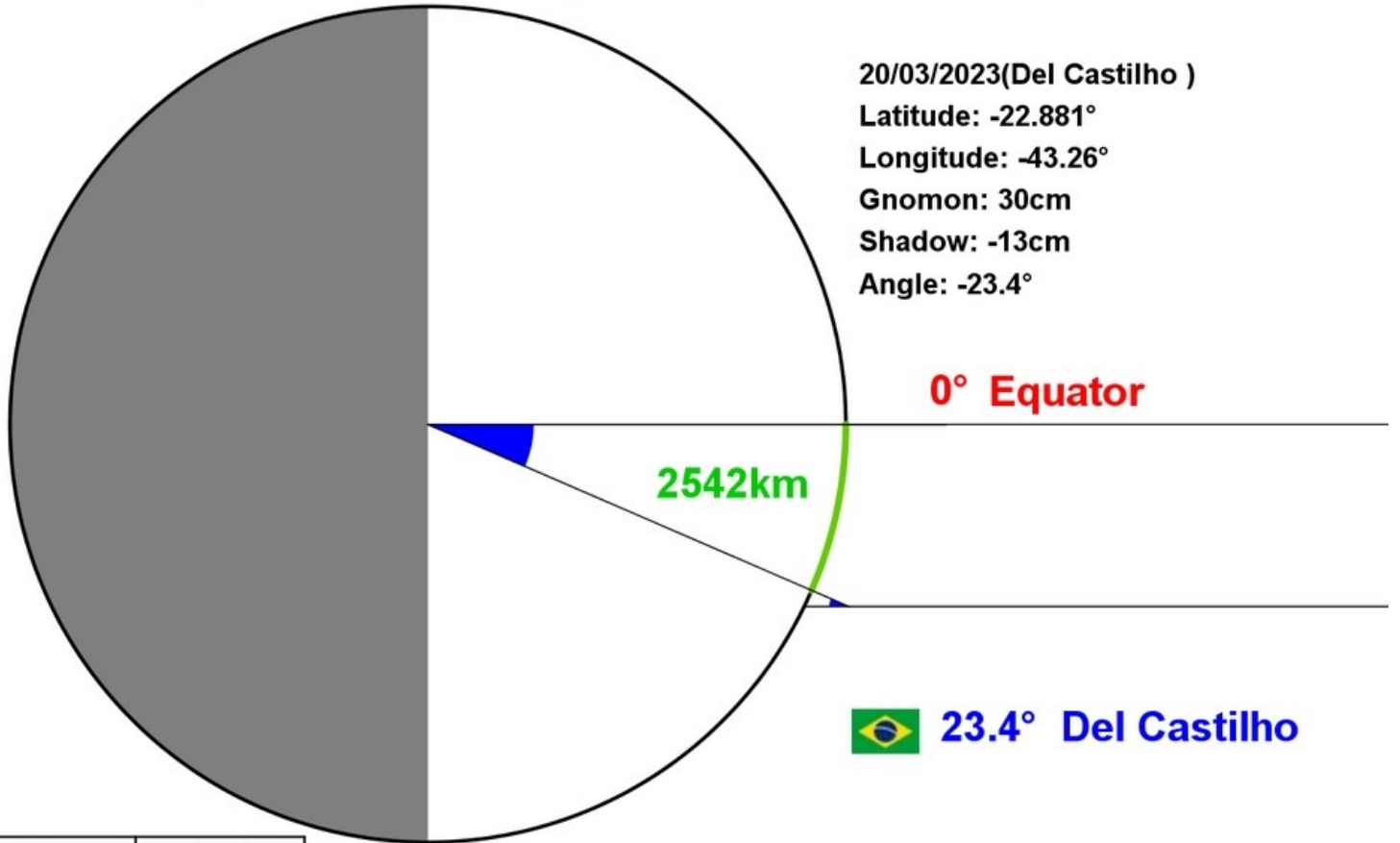
Distance	Angle
circumference	360°
3879km	34.8°

circumference = $\frac{360^\circ \times 3879\text{km}}{34.8^\circ} = 40128 \text{ km}$

20/03/2023 (Equator) Latitude: 0°

20/03/2023 (Del Castilho-Brazil) Latitude: -22.881°

20/03/2023(Del Castilho)
Latitude: -22.881°
Longitude: -43.26°
Gnomon: 30cm
Shadow: -13cm
Angle: -23.4°



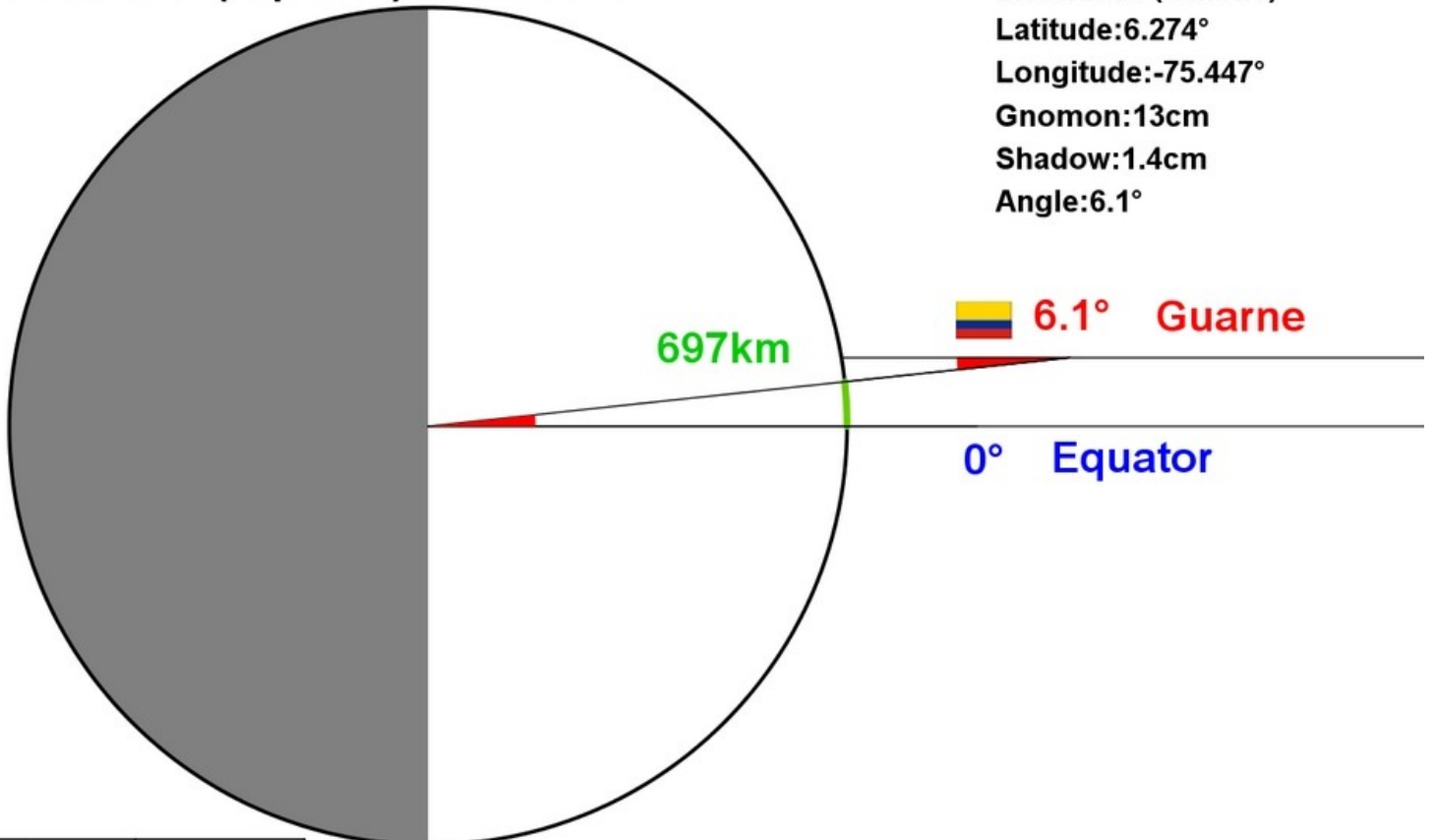
Distance	Angle
circumference	360°
2542km	23.4°

$$\text{circumference} = \frac{360^\circ \times 2542\text{km}}{23.4^\circ} = 39108 \text{ km}$$

20/03/2023 (Guarne-Colombia) Latitude: 6.274°

20/03/2023 (Equator) Latitude: 0°

20/03/2023 (Guarne)
Latitude:6.274°
Longitude:-75.447°
Gnomon:13cm
Shadow:1.4cm
Angle:6.1°

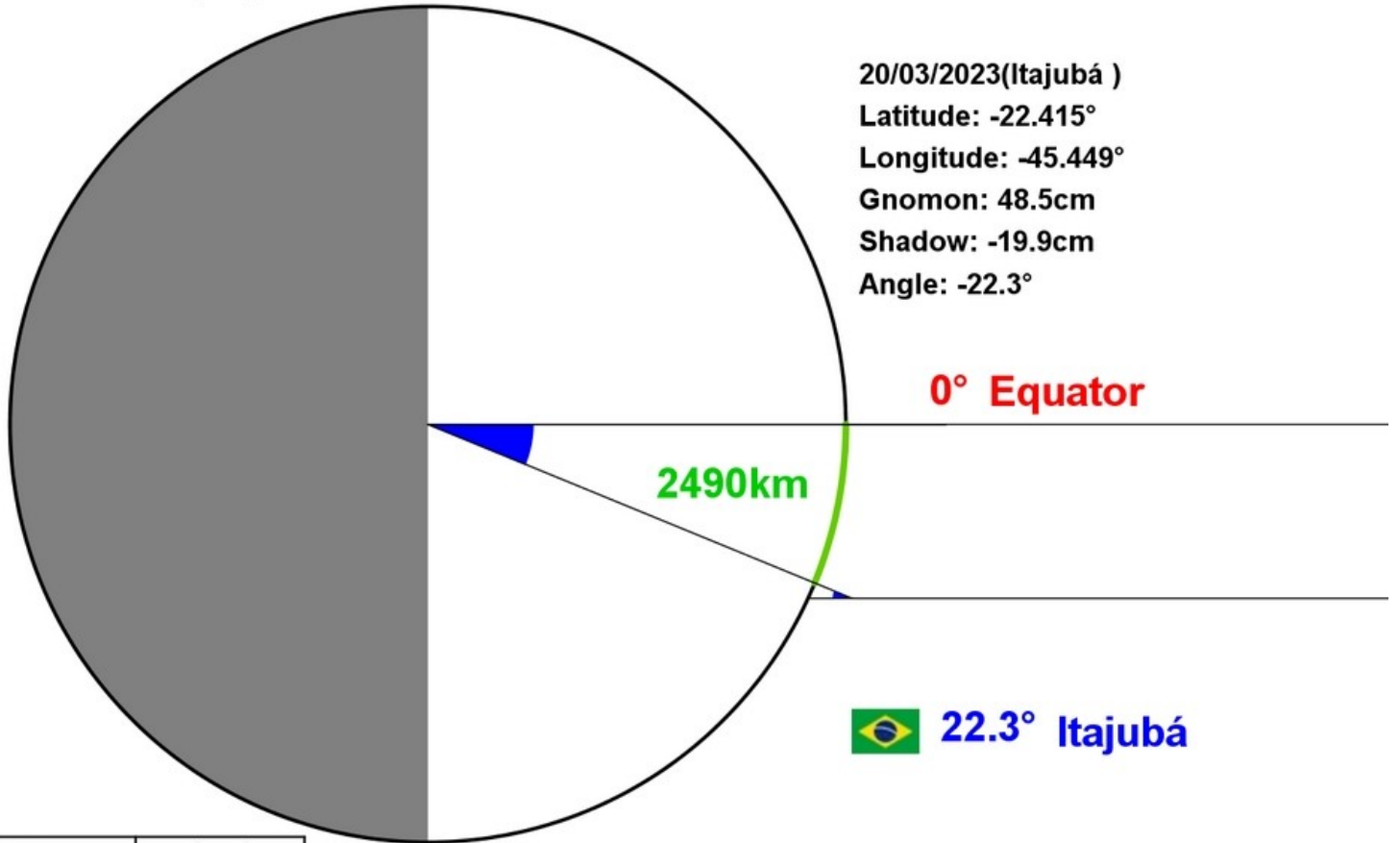


Distance	Angle
circumference	360°
697km	6.1°

$$\text{circumference} = \frac{360^\circ \times 697\text{km}}{6.1^\circ} = 41134 \text{ km}$$

20/03/2023 (Equator) Latitude: 0°

20/03/2023 (Itajubá-Brazil) Latitude: -22.415°



20/03/2023(Itajubá)
 Latitude: -22.415°
 Longitude: -45.449°
 Gnomon: 48.5cm
 Shadow: -19.9cm
 Angle: -22.3°

0° Equator

2490km

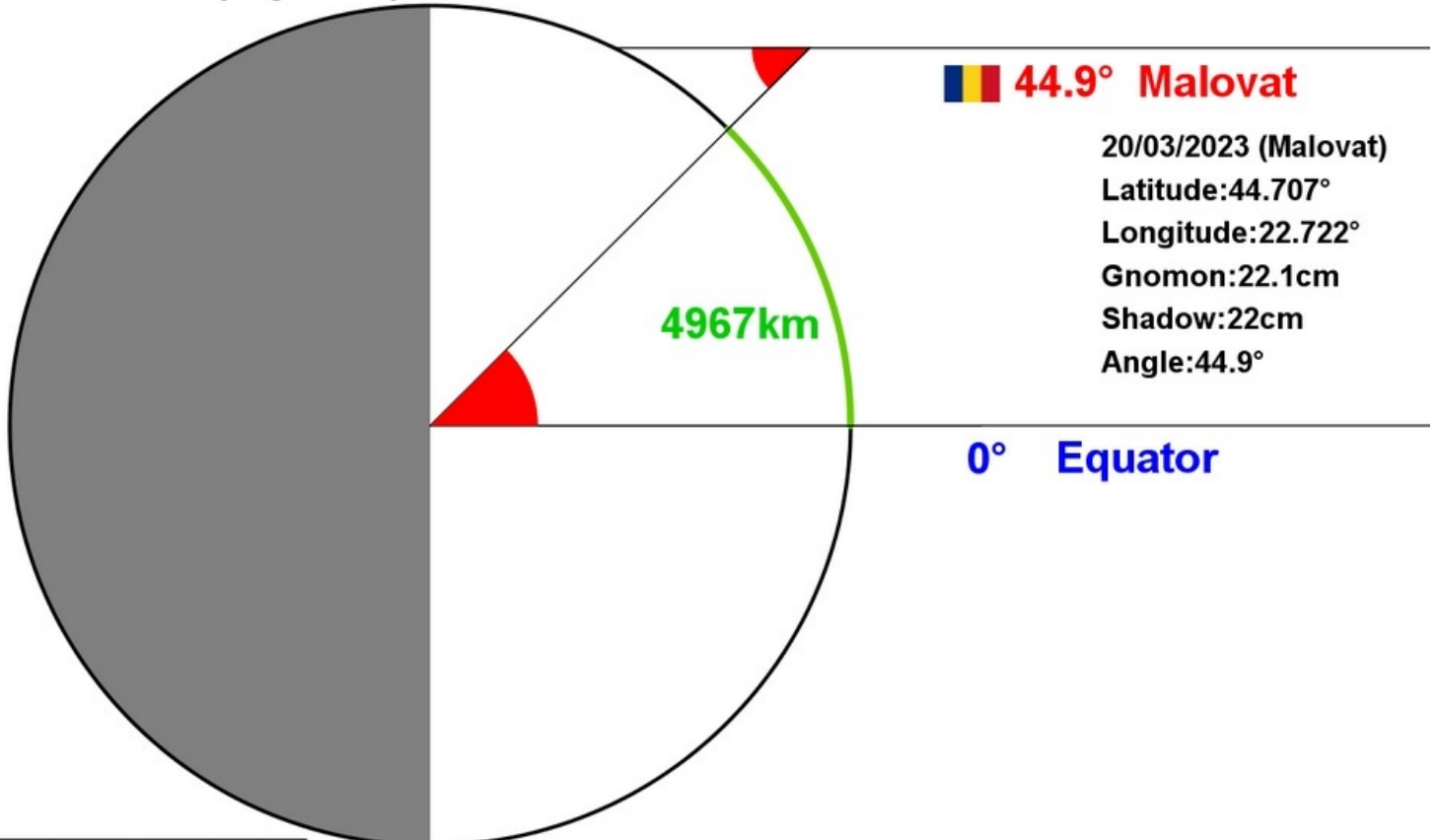
 22.3° Itajubá

Distance	Angle
circumference	360°
2490km	22.3°

$$\text{circumference} = \frac{360^\circ \times 2490\text{km}}{22.3^\circ} = 40197 \text{ km}$$

20/03/2023 (Malovat-Romania) Latitude: 44.707°

20/03/2023 (Equator) Latitude: 0°



 44.9° Malovat

20/03/2023 (Malovat)
 Latitude:44.707°
 Longitude:22.722°
 Gnomon:22.1cm
 Shadow:22cm
 Angle:44.9°

0° Equator

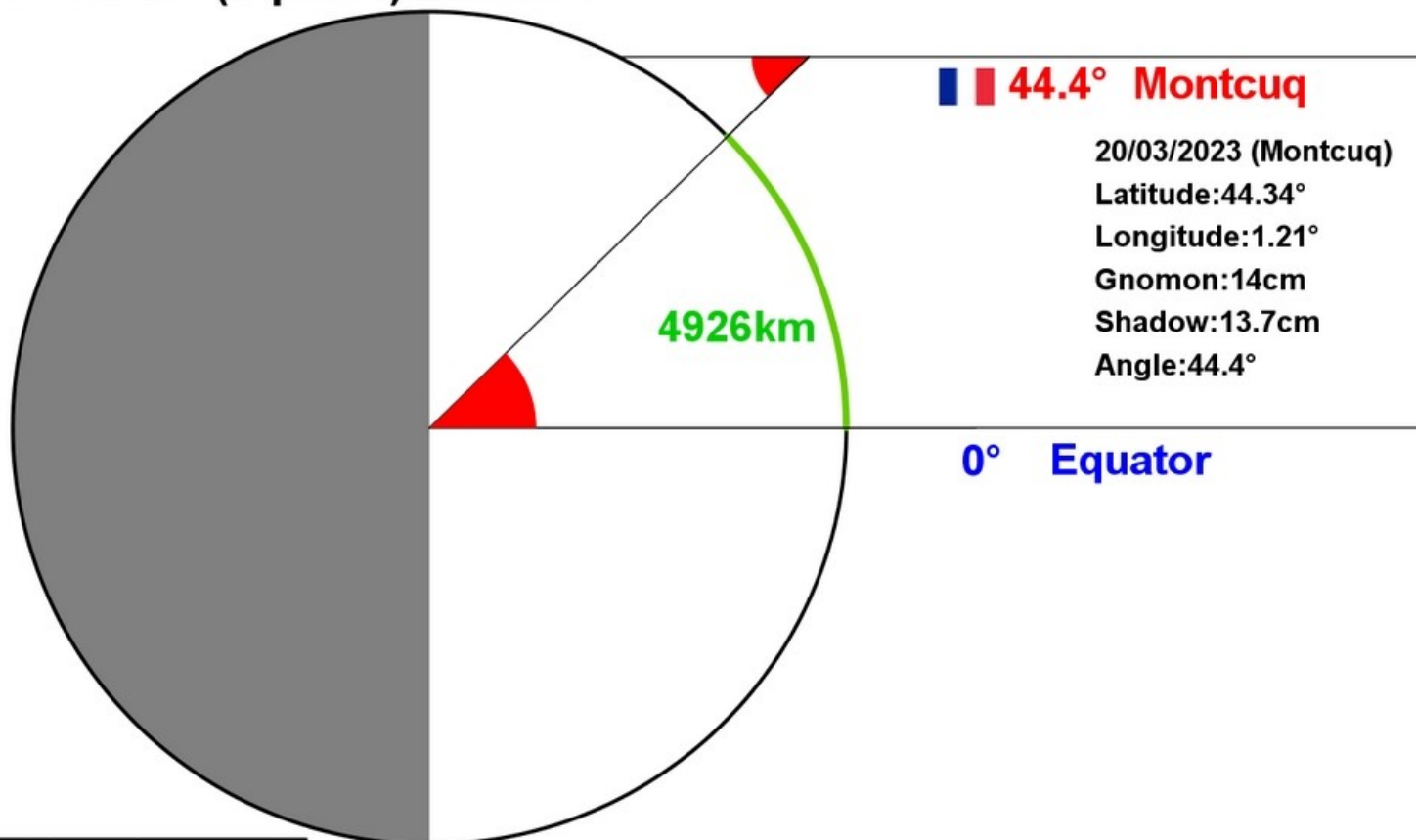
4967km

Distance	Angle
circumference	360°
4967km	44.9°

$$\text{circumference} = \frac{360^\circ \times 4967\text{km}}{44.9^\circ} = 39824 \text{ km}$$

20/03/2023 (Montcuq-France) Latitude: 44.34°

20/03/2023 (Equator) Latitude: 0°



 **44.4° Montcuq**

20/03/2023 (Montcuq)
Latitude:44.34°
Longitude:1.21°
Gnomon:14cm
Shadow:13.7cm
Angle:44.4°

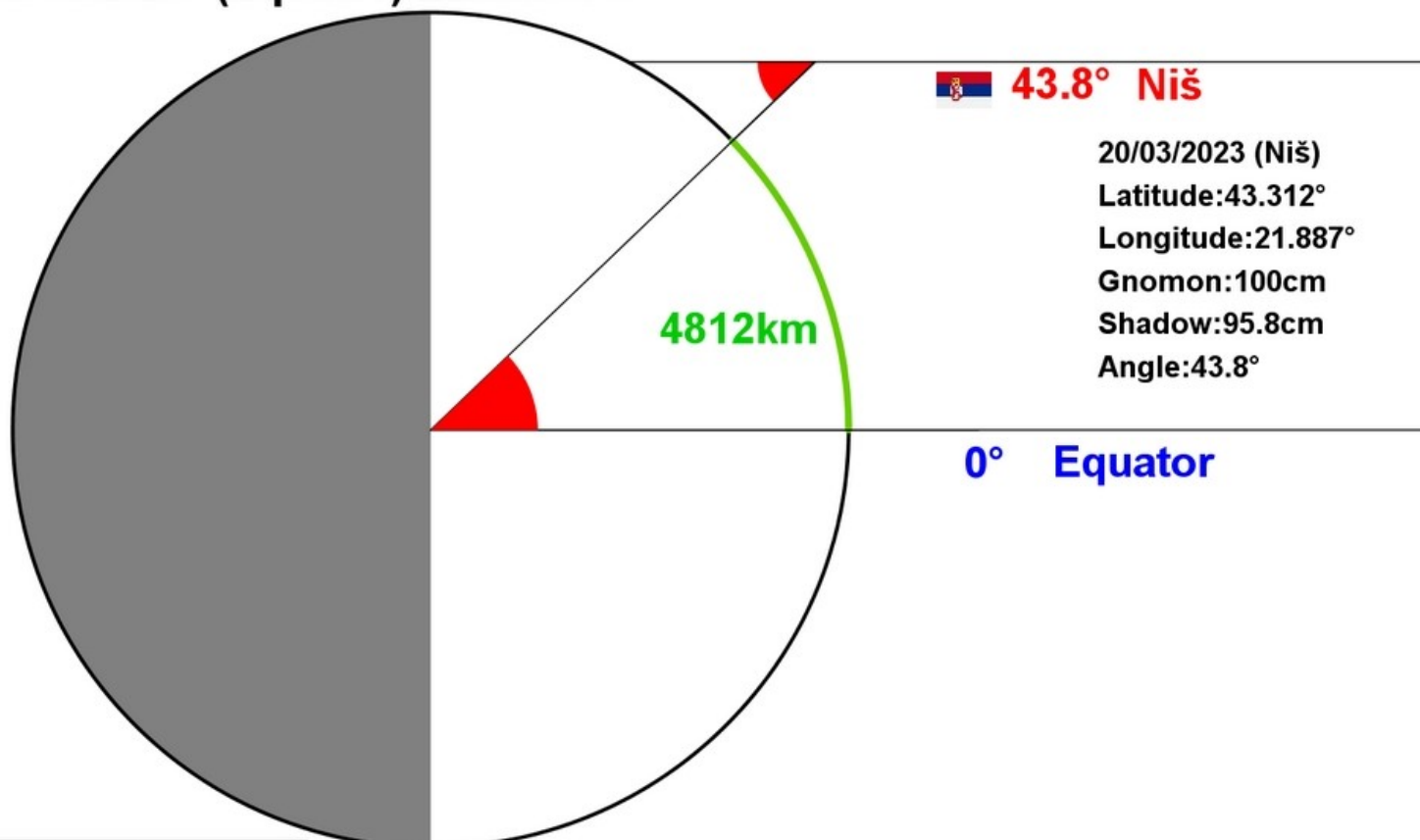
0° Equator

Distance	Angle
circumference	360°
4926km	44.4°

$$\text{circumference} = \frac{360^\circ \times 4926\text{km}}{44.4^\circ} = 39941 \text{ km}$$

20/03/2023 (Niš-Serbia) Latitude: 43.312°

20/03/2023 (Equator) Latitude: 0°



 **43.8° Niš**

20/03/2023 (Niš)
Latitude:43.312°
Longitude:21.887°
Gnomon:100cm
Shadow:95.8cm
Angle:43.8°

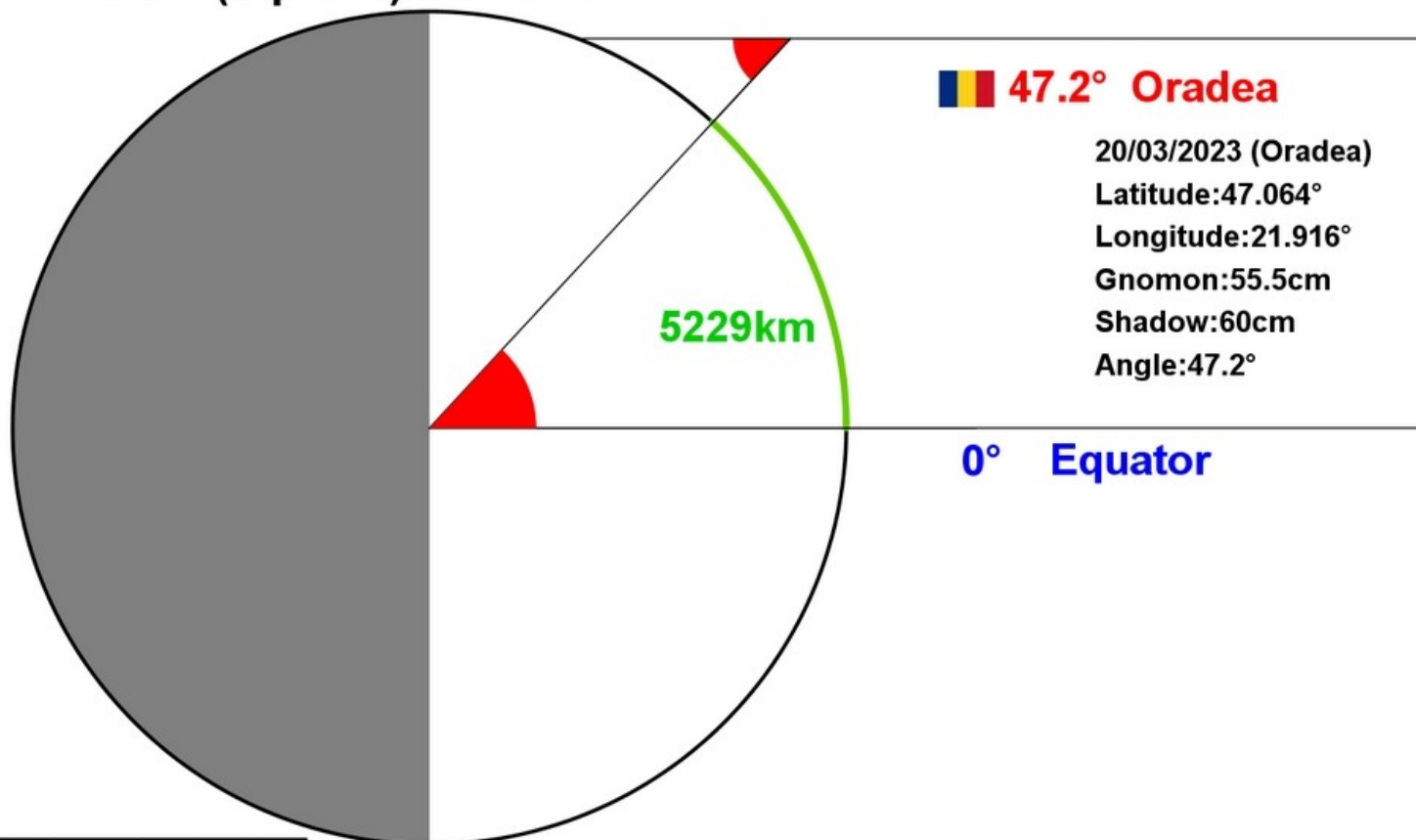
0° Equator

Distance	Angle
circumference	360°
4812km	43.8°

$$\text{circumference} = \frac{360^\circ \times 4812\text{km}}{43.8^\circ} = 39551 \text{ km}$$

20/03/2023 (Oradea-Romania) Latitude: 47.064°

20/03/2023 (Equator) Latitude: 0°

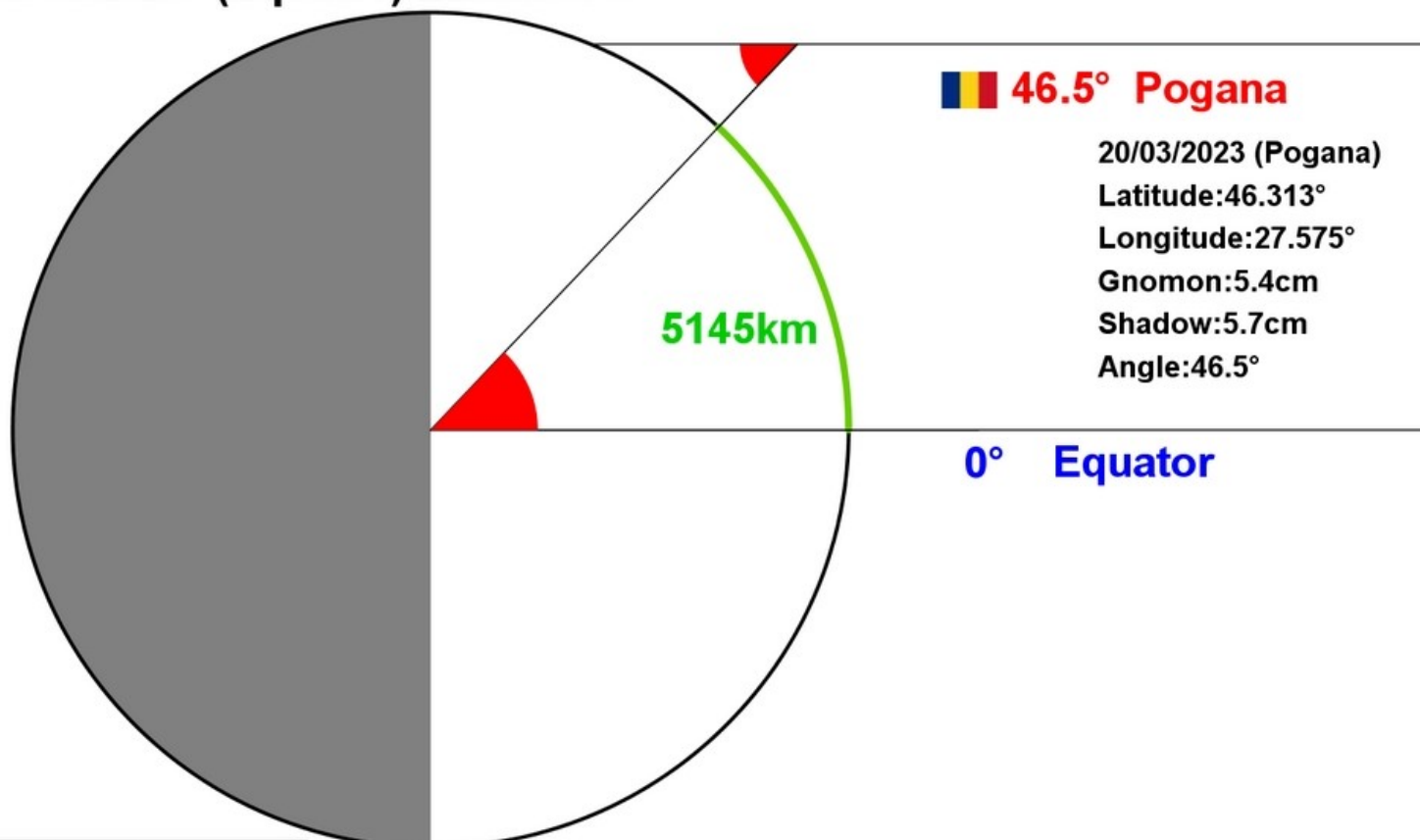


Distance	Angle
circumference	360°
5229km	47.2°

$$\text{circumference} = \frac{360^\circ \times 5229\text{km}}{47.2^\circ} = 39882 \text{ km}$$

20/03/2023 (Pogana-Romania) Latitude: 46.313°

20/03/2023 (Equator) Latitude: 0°

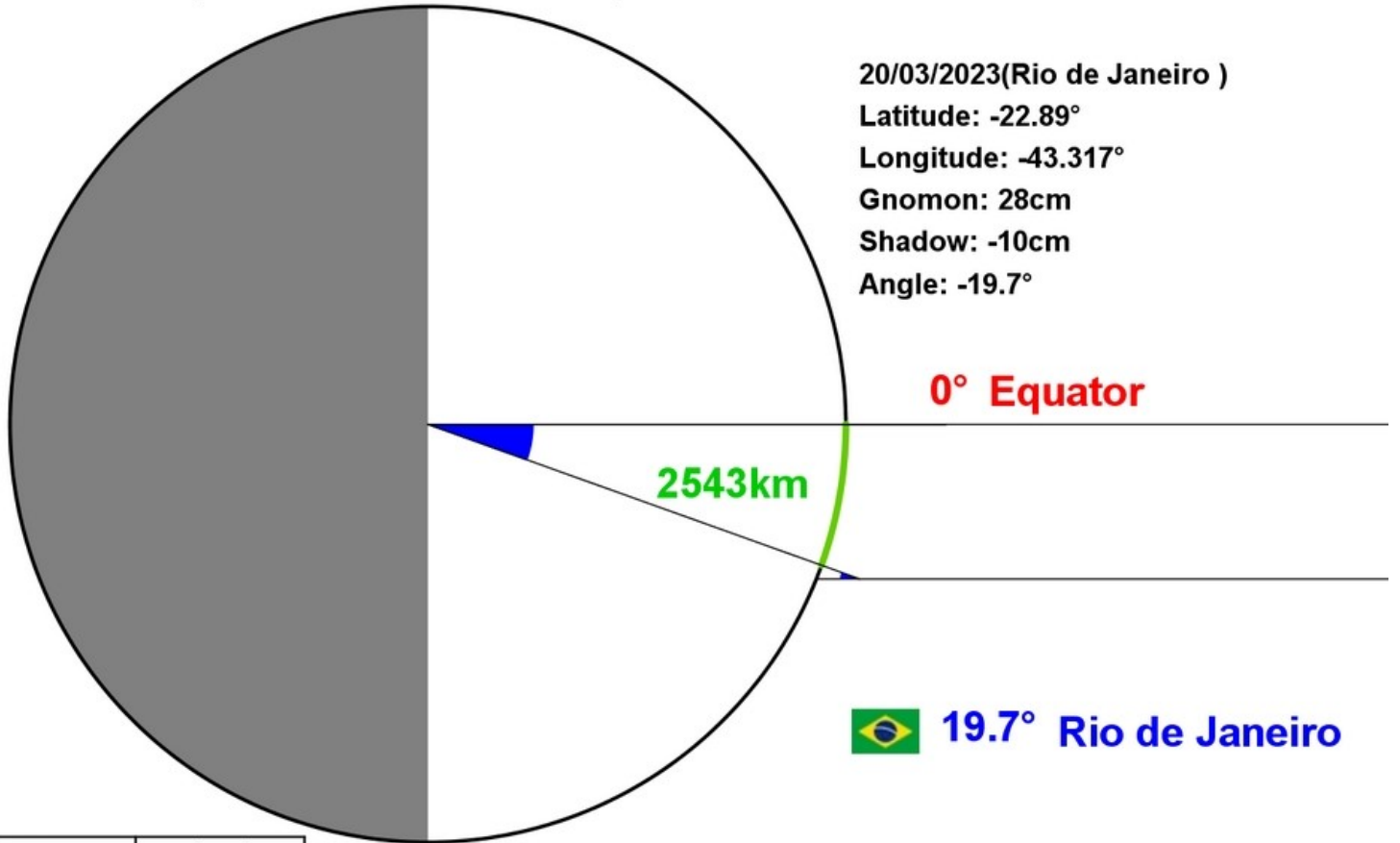


Distance	Angle
circumference	360°
5145km	46.5°

$$\text{circumference} = \frac{360^\circ \times 5145\text{km}}{46.5^\circ} = 39832 \text{ km}$$

20/03/2023 (Equator) Latitude: 0°

20/03/2023 (Rio de Janeiro-Brazil) Latitude: -22.89°



20/03/2023(Rio de Janeiro)
 Latitude: -22.89°
 Longitude: -43.317°
 Gnomon: 28cm
 Shadow: -10cm
 Angle: -19.7°

0° Equator

2543km

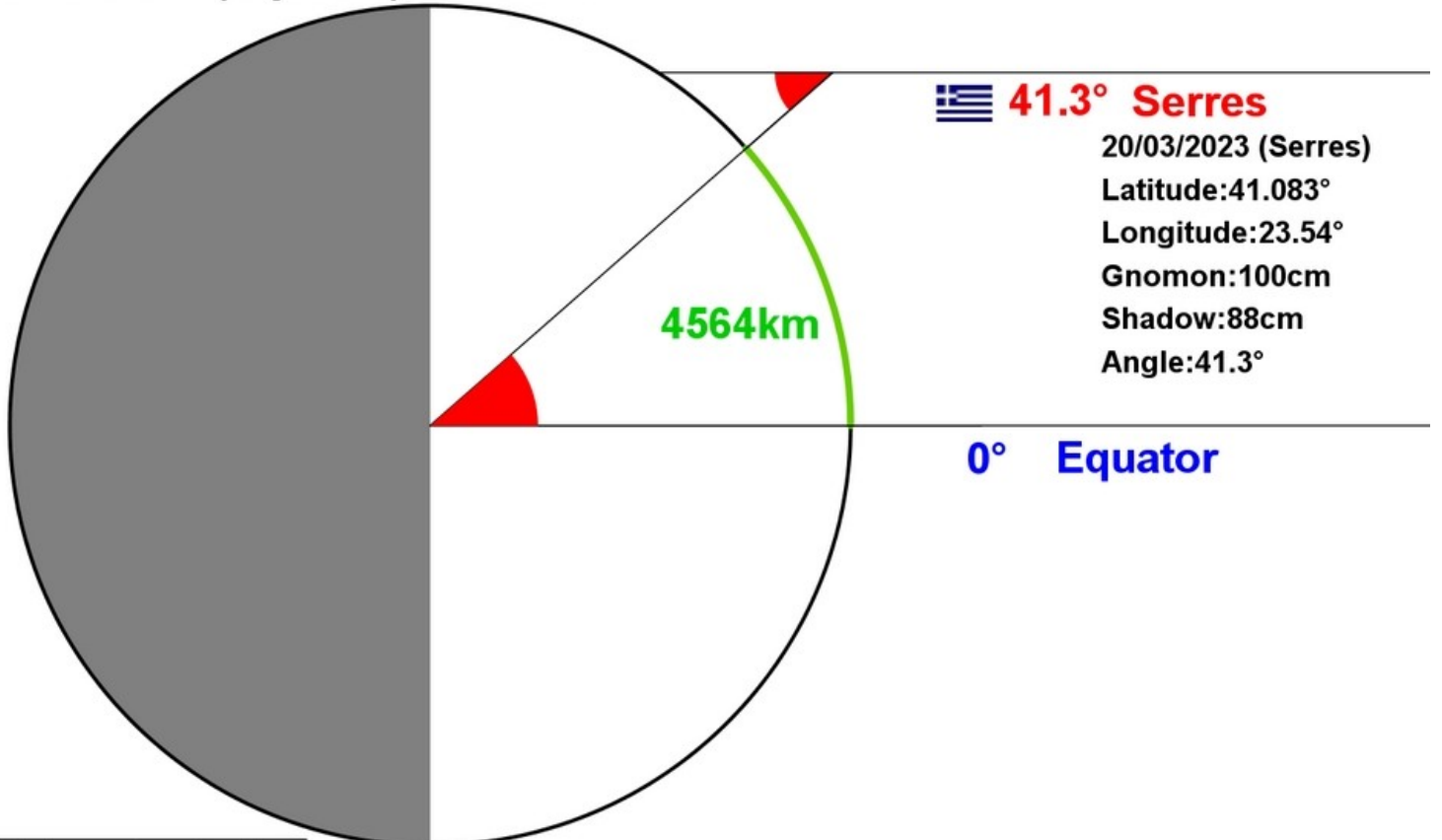
 19.7° Rio de Janeiro

Distance	Angle
circumference	360°
2543km	19.7°

$$\text{circumference} = \frac{360^\circ \times 2543\text{km}}{19.7^\circ} = 46471 \text{ km}$$

20/03/2023 (Serres-Greece) Latitude: 41.083°

20/03/2023 (Equator) Latitude: 0°



 41.3° Serres

20/03/2023 (Serres)
 Latitude:41.083°
 Longitude:23.54°
 Gnomon:100cm
 Shadow:88cm
 Angle:41.3°

0° Equator

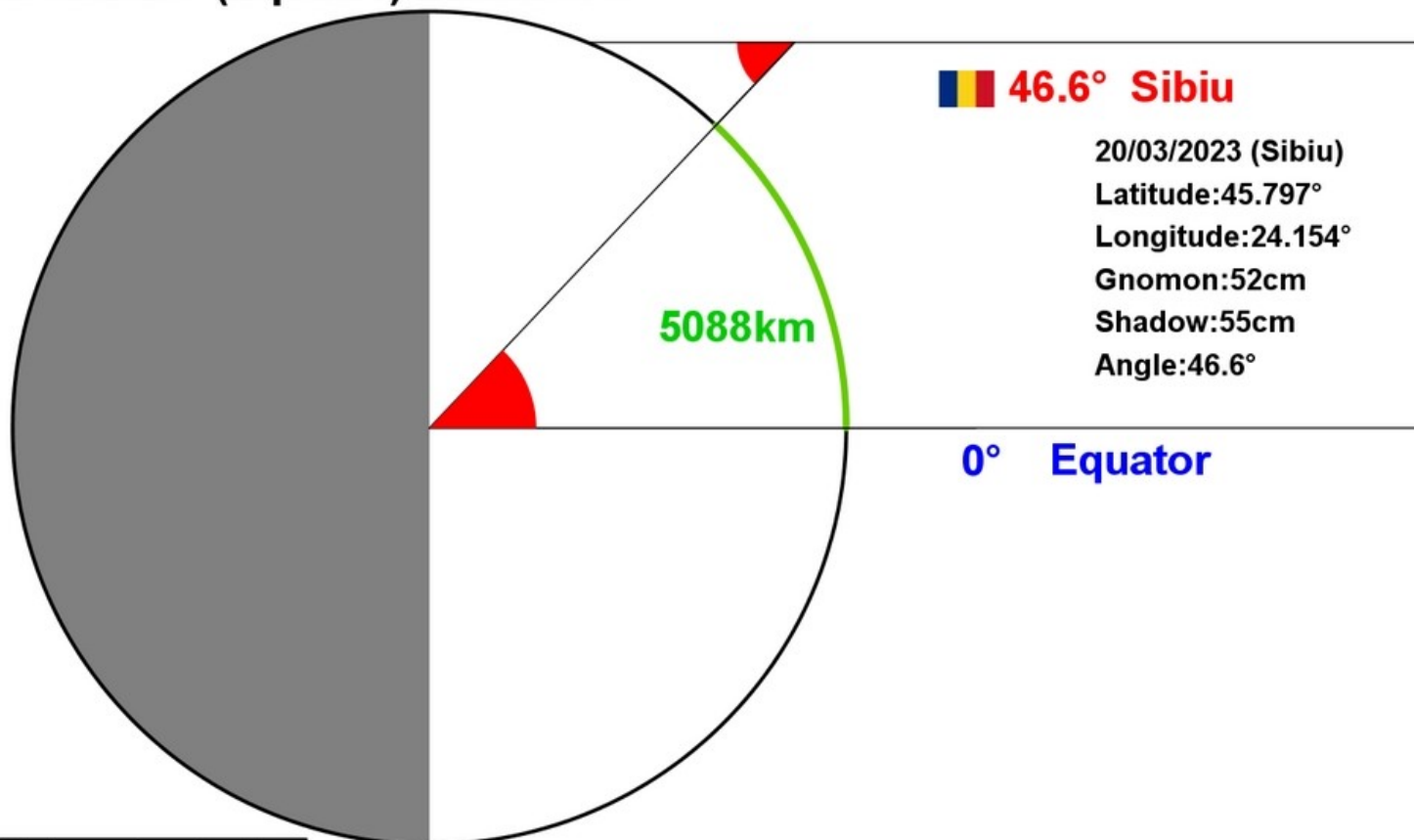
4564km

Distance	Angle
circumference	360°
4564km	41.3°

$$\text{circumference} = \frac{360^\circ \times 4564\text{km}}{41.3^\circ} = 39783 \text{ km}$$

20/03/2023 (Sibiu-Romania) Latitude: 45.797°

20/03/2023 (Equator) Latitude: 0°



 **46.6° Sibiu**

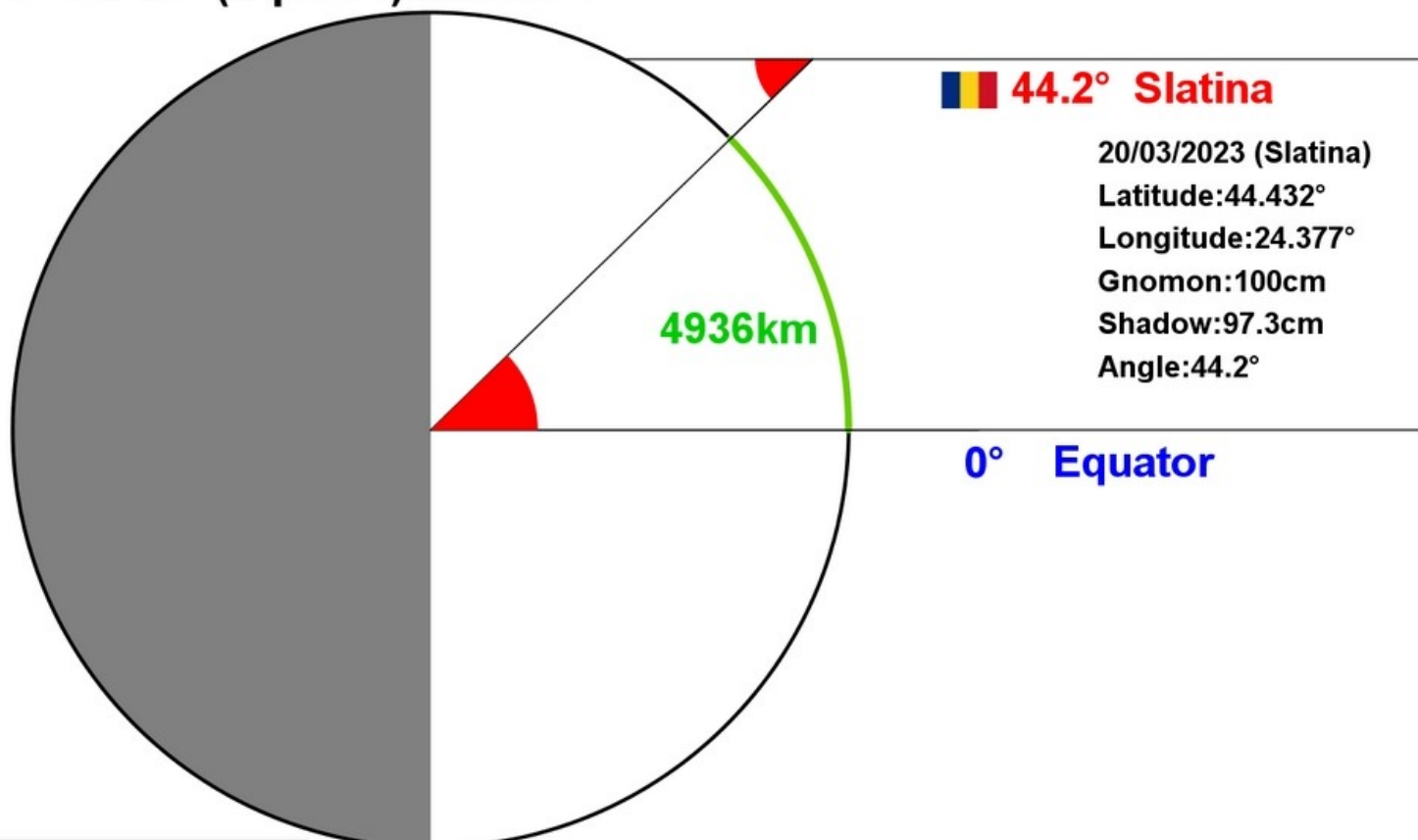
20/03/2023 (Sibiu)
Latitude:45.797°
Longitude:24.154°
Gnomon:52cm
Shadow:55cm
Angle:46.6°

Distance	Angle
circumference	360°
5088km	46.6°

$$\text{circumference} = \frac{360^\circ \times 5088\text{km}}{46.6^\circ} = 39306 \text{ km}$$

20/03/2023 (Slatina-Romania) Latitude: 44.432°

20/03/2023 (Equator) Latitude: 0°



 **44.2° Slatina**

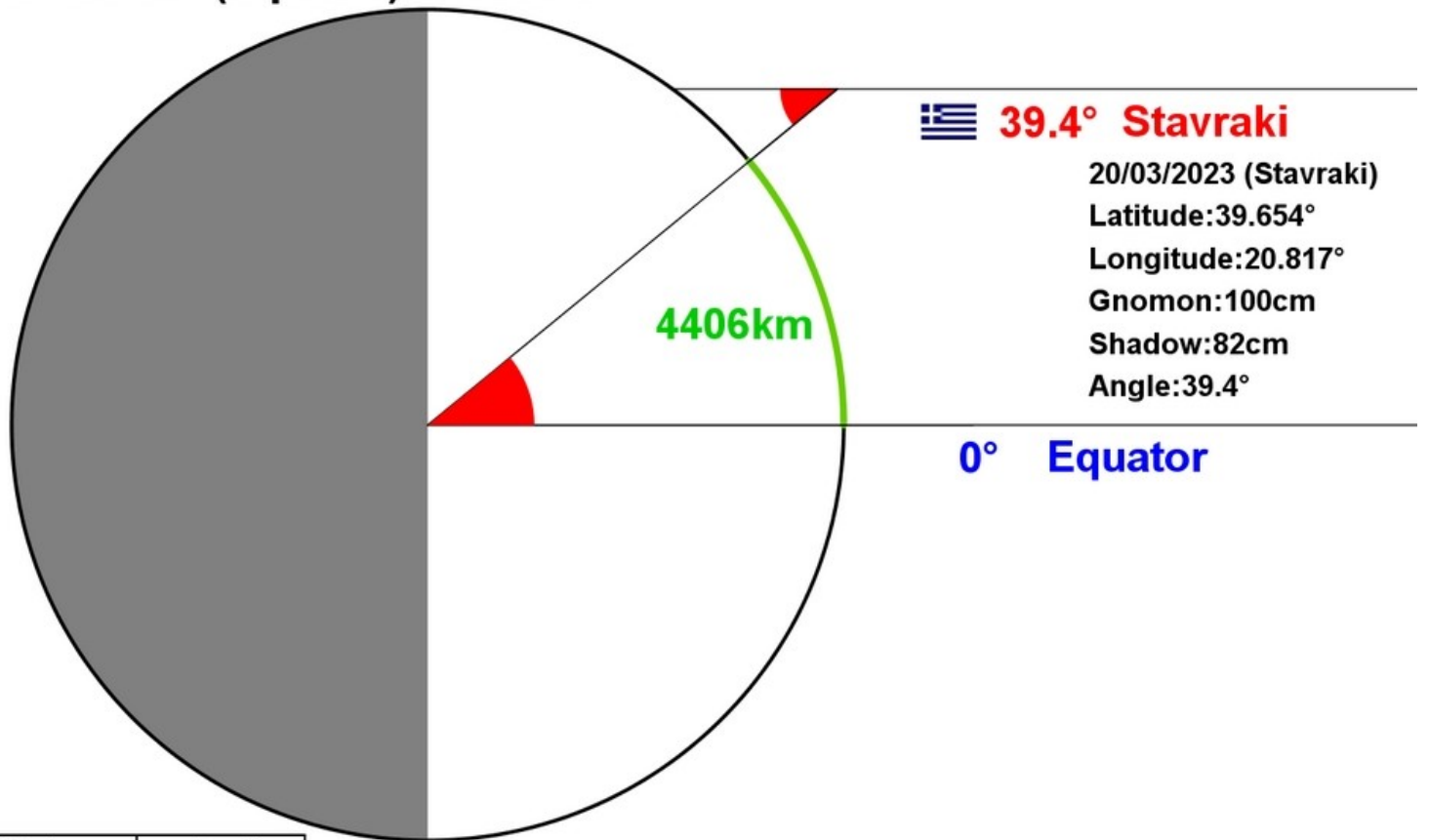
20/03/2023 (Slatina)
Latitude:44.432°
Longitude:24.377°
Gnomon:100cm
Shadow:97.3cm
Angle:44.2°

Distance	Angle
circumference	360°
4936km	44.2°

$$\text{circumference} = \frac{360^\circ \times 4936\text{km}}{44.2^\circ} = 40203 \text{ km}$$

20/03/2023 (Stavraki-Greece) Latitude: 39.654°

20/03/2023 (Equator) Latitude: 0°



 **39.4° Stavraki**

20/03/2023 (Stavraki)
Latitude:39.654°
Longitude:20.817°
Gnomon:100cm
Shadow:82cm
Angle:39.4°

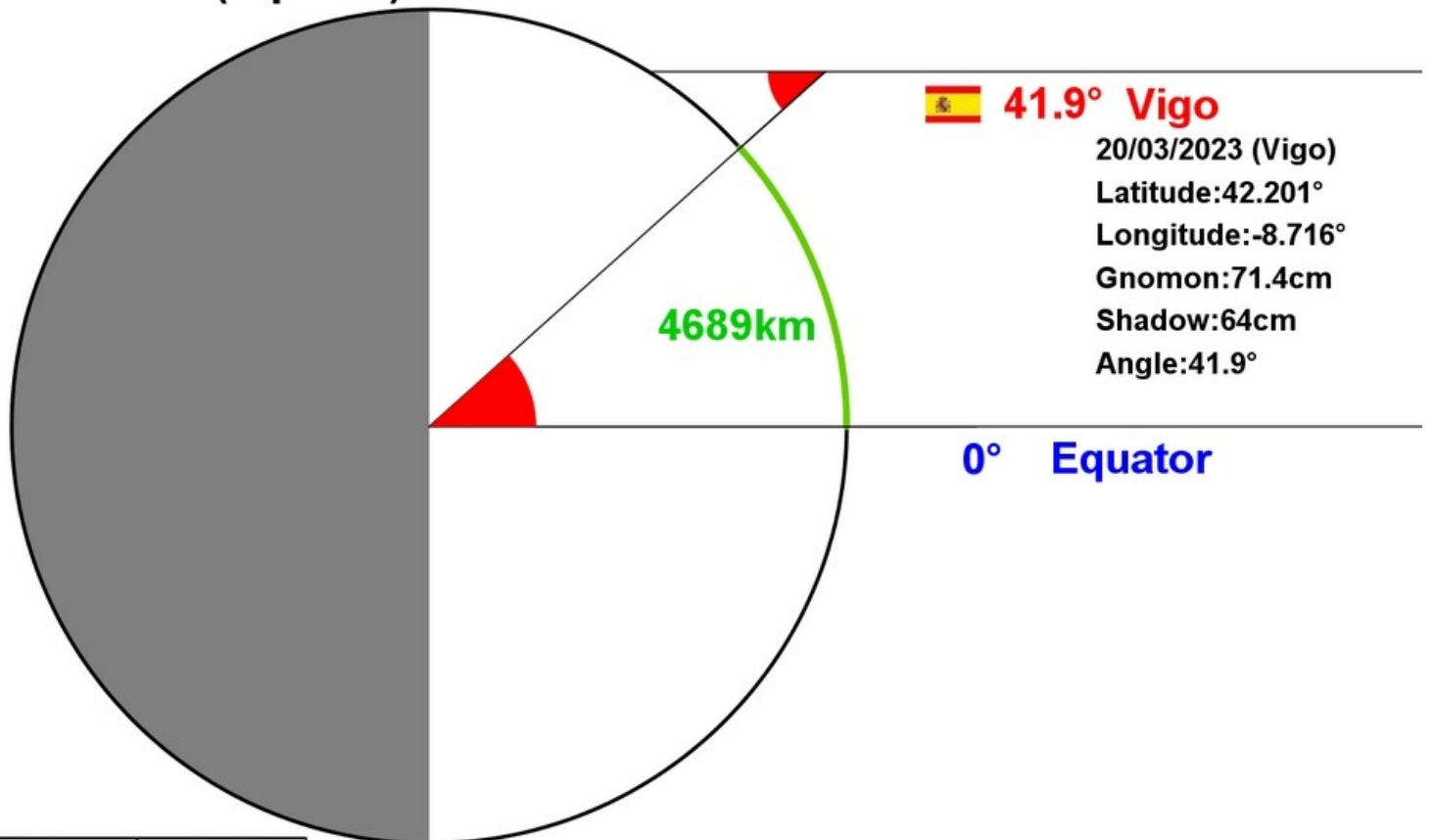
0° Equator

Distance	Angle
circumference	360°
4406km	39.4°

$$\text{circumference} = \frac{360^\circ \times 4406\text{km}}{39.4^\circ} = 40258 \text{ km}$$

20/03/2023 (Vigo-Spain) Latitude: 42.201°

20/03/2023 (Equator) Latitude: 0°



 **41.9° Vigo**

20/03/2023 (Vigo)
Latitude:42.201°
Longitude:-8.716°
Gnomon:71.4cm
Shadow:64cm
Angle:41.9°

0° Equator

Distance	Angle
circumference	360°
4689km	41.9°

$$\text{circumference} = \frac{360^\circ \times 4689\text{km}}{41.9^\circ} = 40287 \text{ km}$$



Angle of the Sun and latitude

26 schools realized 47 measures of the angle of the sun from 17 to 23 March at solar noon. This angle decreases by 0.4° per day and is equal to the latitude on the day of the equinox (taking into account the measurement errors)

City	Latitude (+N/-S)	Angle ($^\circ$) 17/03	Angle ($^\circ$) 18/03	Angle ($^\circ$) 19/03	Angle ($^\circ$) 20/03	Angle ($^\circ$) 21/03	Angle ($^\circ$) 22/03	Angle ($^\circ$) 23/03
Aigio	38.252			38.5	38.4			
Aspropyrgos	38.061				39.0			
Athens	38.027				38.1			
Aydın	37.749				37.1			
Bäseşti	47.481				47.6	47.2		
Bayamón	18.383				18.4			
Boğazlıyan	39.200					39.1		
Busteni	45.416			46.0	45.6	44.7		44.3
Chivilcoy	-34.911				-34.8			
Del Castilho	-22.881				-23.4		-25.0	
Elbasan	41.111						40.4	
Guame	6.274			6.9	6.1			
Istanbul	41.060					40.8		
Itajubá	-22.415				-22.3			
Malovat	44.707				44.9		44.0	
Méier	-22.904						-15.9	
Montcuq	44.340	45.4	45.2	44.8	44.4	44.0	43.7	43.3
Niš	43.312				43.8			
Oradea	47.064				47.2	46.8		
Pogana	46.313				46.5			
Rio de Janeiro	-22.890	-19.4			-19.7	-20.7	-20.7	-20.7
Serres	41.083				41.3			
Sibiu	45.797				46.6			
Slatina	44.432				44.2	44.1		44.0
Stavraki	39.654				39.4			
Vigo	42.201				41.9			

