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St Ursula’s College
Toowoomba
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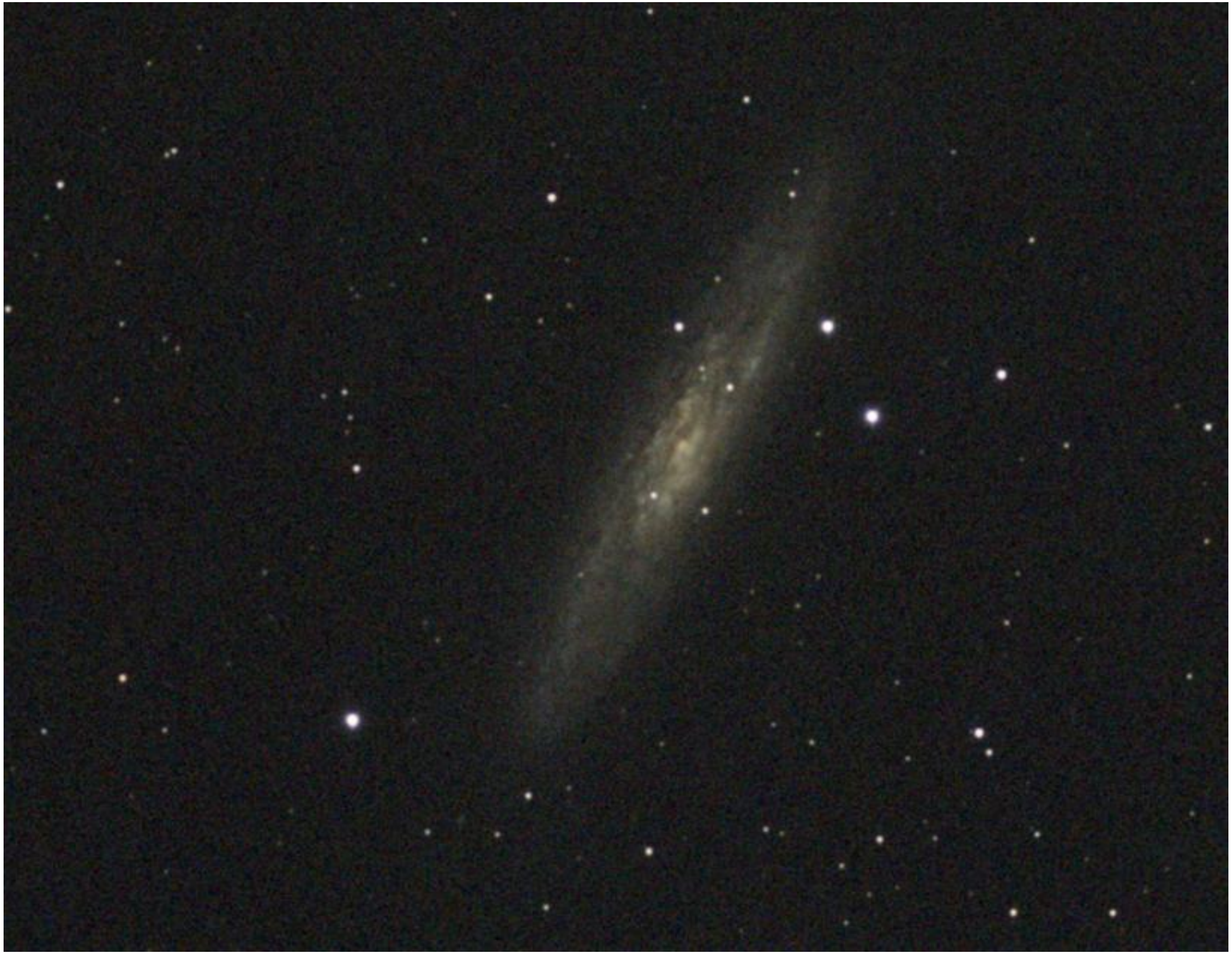
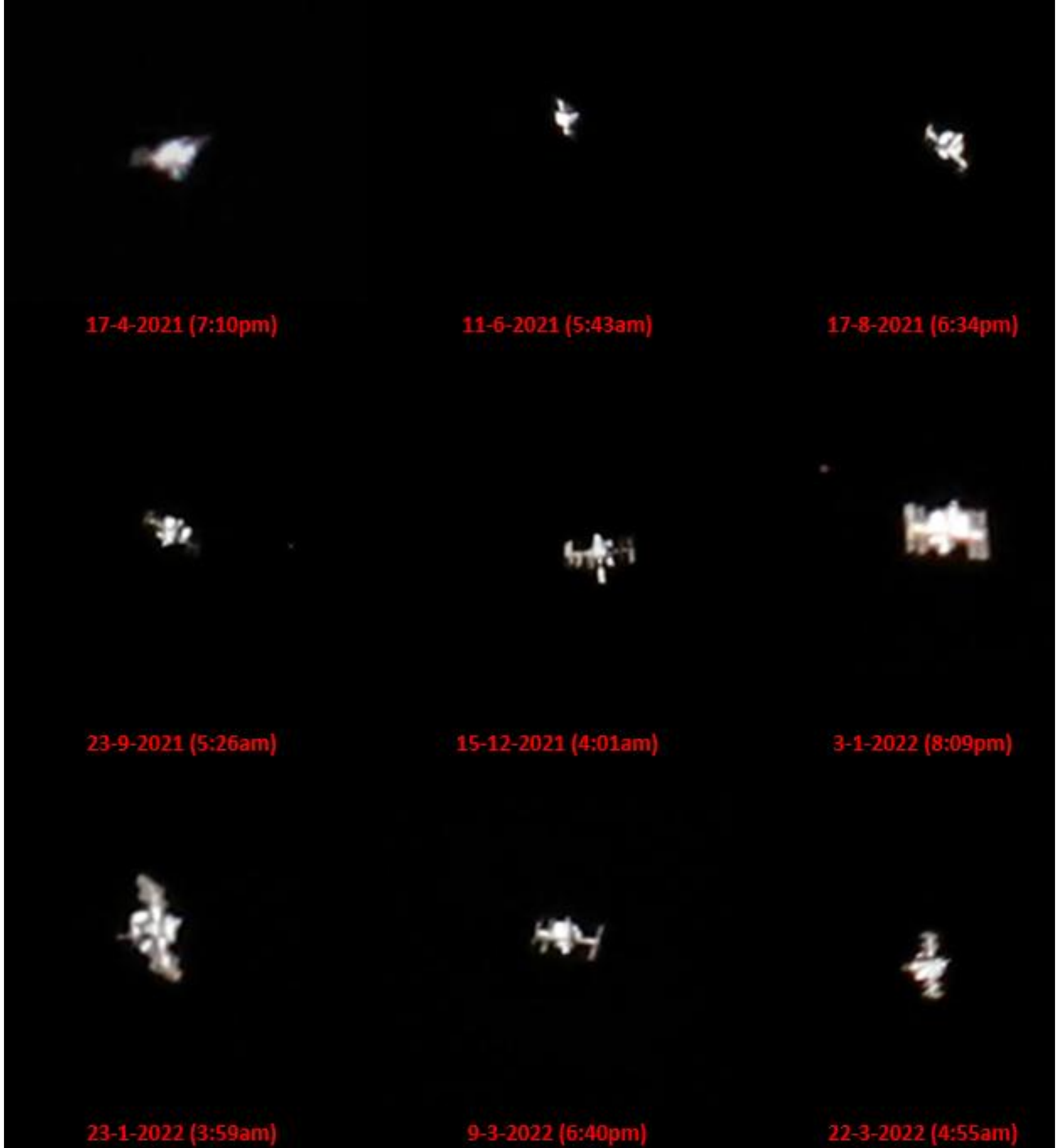


1. ISS and brightness (magnitude)
2. Cepheid variables and distance calculations
3. Length of daylight hours and latitude
4. The Great Red Spot (GRS) of Jupiter

Jupiter
Mars
Small Magellanic Clou
Meteor
Large Magellanic Cloud
Venus

ISS facts

- Orbits 16 times a day
- Speed = 27,600 km/h
  or 8 km/second
- One orbit takes 92 mins


17-4-2021 (7:10pm)
11-6-2021 (5:43am)
17-8-2021 (6:34pm)
23-9-2021 (5:26am)
15-12-2021 (4:01am)
3-1-2022 (8:09pm)
23-1-2022 (3:59am)
9-3-2022 (6:40pm)
22-3-2022 (4:55am)

Stellar Magnitudes

In 129 B.C., the ancient Greek astronomer Hipparchus classified stars using a magnitude scale from 1 to 6. He called the brightest stars "first magnitude" which meant a "1" represented the brightest stars. The faintest stars were classified as "sixth magnitude" and were represented by a "6".

Object	Magnitude
Sun	-26
Full moon	-13
Venus at brightest	-4.6
Jupiter at brightest	-2.9
Mars at brightest	-2.6
Sirius, the brightest star	-1.5
Alpha Centauri	0.1
Polaris, the north star	2
Faintest star visible with 7 × 35 binoculars.	8
Stars barely visible with the Hubble telescope.	30

Starlink G4-19 launched successfully at 16:09 UTC on 17th June from Kennedy Space Center. Get predictions for your location.

Configuration

- Login (optional)
- Change your observing location

Satellites

- Live sky view
- Starlink - dynamic 3D orbit display
- ISS Interactive 3D Visualization
- Interactive Animation of Tesla Roadster Trajectory
- 10-day predictions for satellites of special interest
  - ISS
  - Tiangong
  - Starlink passes for all objects from a launch
  - X-37B
  - N. Korean satellite
  - Hubble Space Telescope
  - Envisat
- Daily predictions for brighter satellites
- Satellite database
- Spacecraft escaping the Solar System
- Amateur Radio Satellites - All Passes
- Height of the ISS

Astronomy

- Solar Eclipses
- Interactive sky chart
- Sky chart (old version)
- Sun
- Moon
- Planets
- Solar system chart
- Comets

HEAVENS ABOVE

ISS - Visible Passes

Hom

Search period start: 03 July 2022 00:00
Search period end: 13 July 2022 00:00
Orbit: 414 x 420 km, 51.6° (Epoch: 23 June)

< >

Passes to include: ◉ visible only ○ all

Click on the date to get a star chart and other pass details.

Date	Brightness (mag)	Start			Highest point			End			Pass type
		Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.	
07 Jul	-3.0	18:32:16	10°	SSW	18:34:48	36°	S	18:34:48	36°	S	visible
08 Jul	-2.4	17:44:19	10°	SSW	17:47:03	22°	SE	17:49:46	10°	E	visible
08 Jul	-1.0	19:21:04	10°	WSW	19:23:02	20°	WNW	19:23:02	20°	WNW	visible
09 Jul	-2.6	18:32:12	10°	SW	18:35:26	44°	NW	18:38:37	10°	NNE	visible
10 Jul	-3.8	17:43:42	10°	SW	17:47:06	82°	SE	17:50:27	10°	NE	visible
11 Jul	-0.2	18:33:56	10°	WNW	18:35:06	11°	NW	18:36:16	10°	NW	visible
12 Jul	-0.9	17:44:08	10°	WSW	17:46:51	23°	NW	17:49:34	10°	N	visible

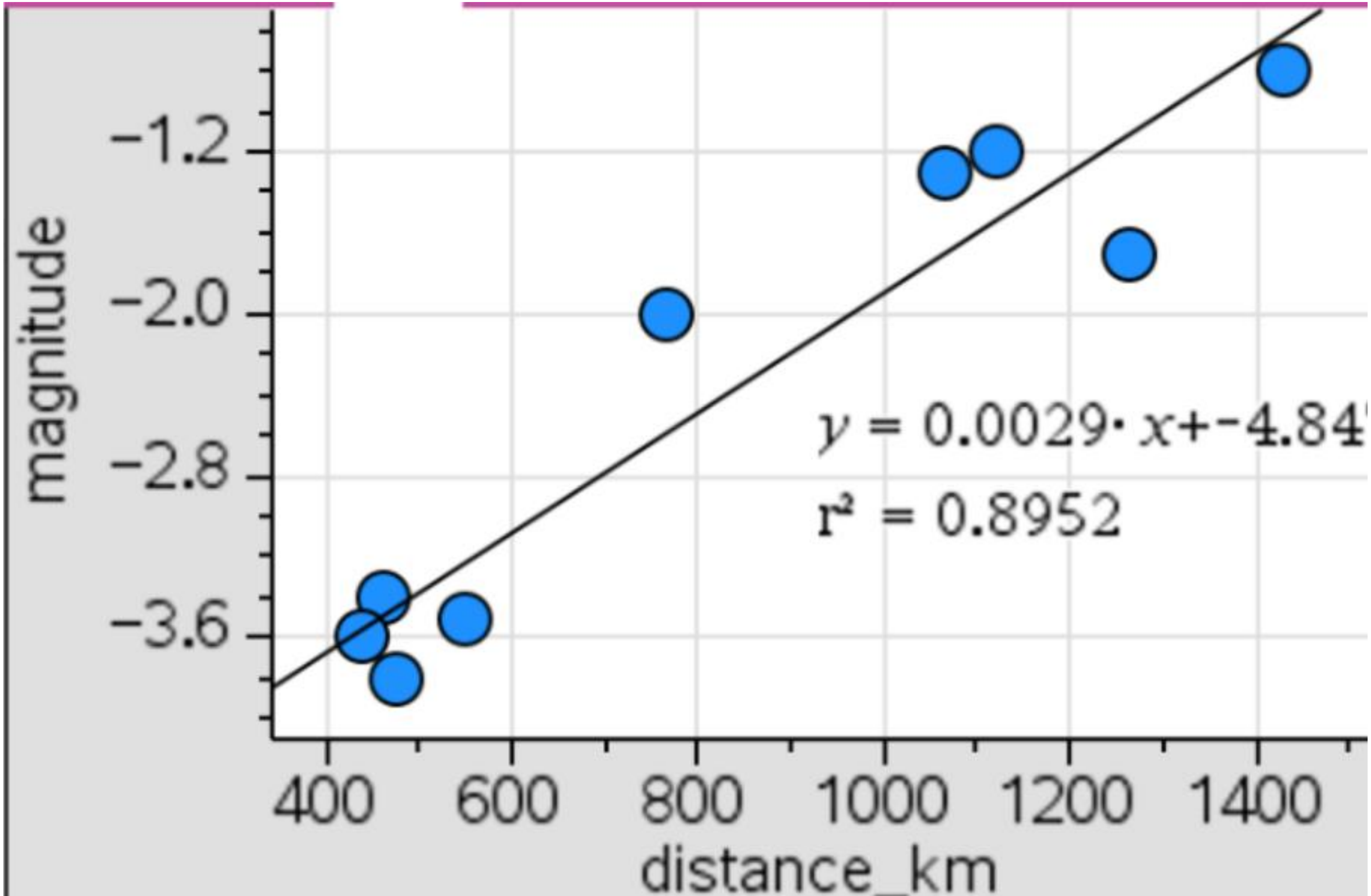
NE
NW
SE
SW
Canes Venatici
Leo Minor
Corona Borealis
Bootes
Hercules
Coma Berenices
Leo
Cancer
Serpens
Virgo
Sextans
Ophiuchus
Libra
Moon
Corvus
Crater
Hydra
Scutum
Antlia
Pyxis
Centaurus
Lupus
Scorpius
Sagittarius
Norma
Vela
Puppis
Corona Australis
Ara
Triangulum Australe
Circinus
Musca
Carina
Telescopium
Apus
Chamaeleon
Volans
Pavo
Octans
Mensa
Dorado
Pictor
Indus
Hydrus
Reticulum
17:47
17:48
© Heavens-Above.com

Date: 10 July 2022

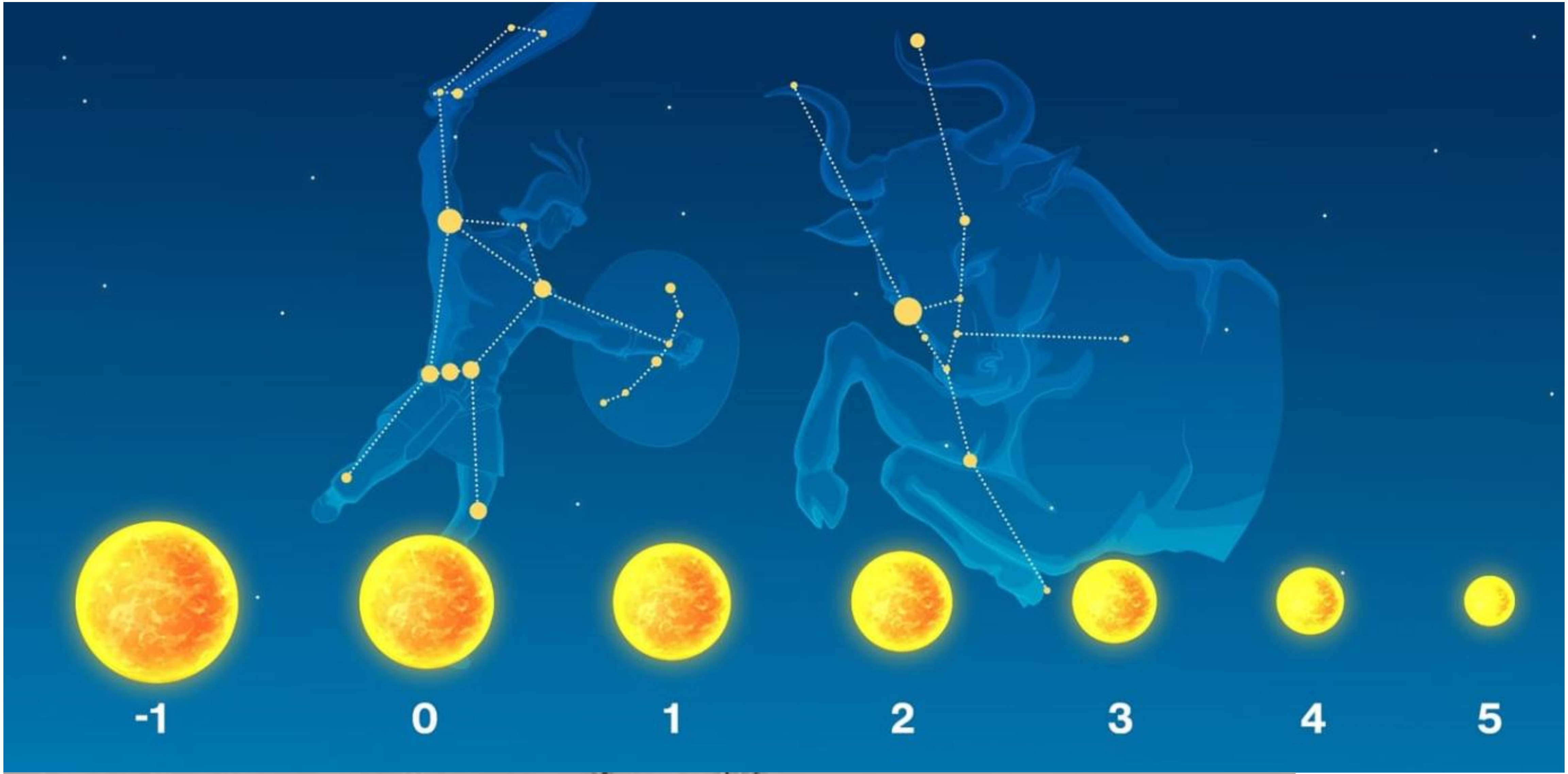
Orbit: 414 x 420 km, 51.6° (Epoch: 23 June)

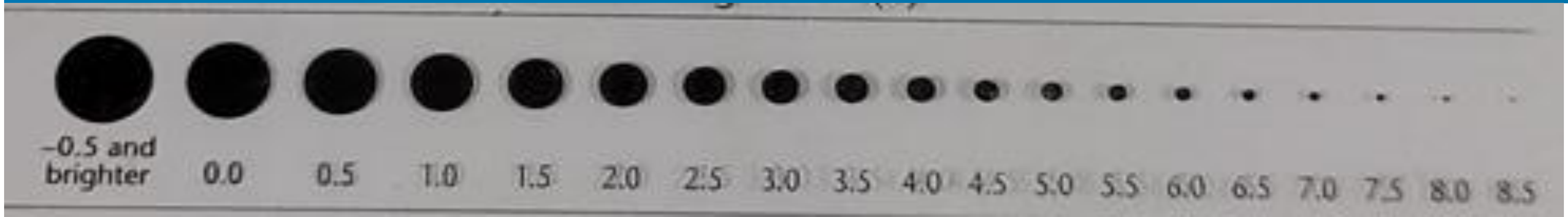
Event	Time	Altitude	Azimuth	Distance (km)	Brightness	Sun altitude
Rises	17:41:36	0°	222° (SW)	2,376	0.4	-6.8°
Reaches altitude 10°	17:43:43	10°	221° (SW)	1,506	-0.7	-7.2°
Maximum altitude	17:47:06	82°	132° (SE)	426	-3.8	-7.9°
Drops below altitude 10°	17:50:26	10°	44° (NE)	1,487	-1.2	-8.6°
Sets	17:52:31	0°	43° (NE)	2,342	-0.2	-9.0°

Magnitude (m)	Altitude (degrees)	Altitude (km)
-1.2	18	1122
-3.8	82	426
-2	31	764
-1.7	14	1262
-3.4	67	462
-1.3	19	1064
-0.8	12	1428
-3.6	74	441
-3.5	49	548



magnitude
−1.2
−2.0
−2.8
−3.6
400
600
800
1000
1200
1400
distance_km
y = 0.0029· x+−4.84
r² = 0.8952

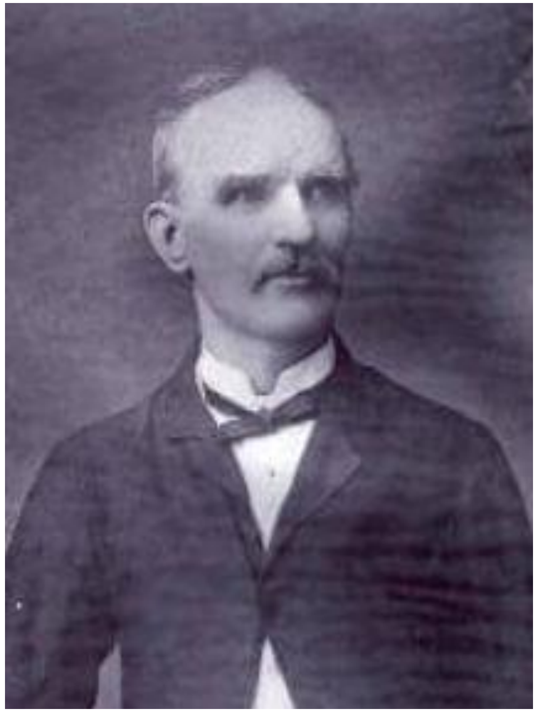

-1
0
1
2
3
4
5


-0.5 and brighter
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5

In 1856, Oxford astronomer Norman Pogson suggested a mathematical definition for a star's magnitude based on how bright a star was. The star's brightness could be defined in terms of the star's radiant flux.

He suggested that a star of magnitude 1 is 2.5 times brighter than a star of magnitude 2. This can be written as a ratio of intensities.

$$\frac{I_1}{I_2} = 2.5.$$



A difference of 5 magnitudes represents a change in brightness by a factor of 100. [$2.5^5 \approx 100$]

The general formula is:

$$\frac{I_2}{I_1} = 10^{0.4(m_1 - m_2)}$$

Example 1

How many times brighter is the full moon than Venus?

Consider the magnitude of Venus (M_1) and of the full Moon (M_2). Using the table above, the magnitudes differ by 8.4 (-4.6 - -13 = 8.4) Using the above equation the intensity of the full Moon to the intensity of Venus is:

$$\frac{I_2}{I_1} = 10^{0.4(-4.6 - -13)} = 10^{0.4 \times 8.4} = 10^{3.36} = 2290.86$$

The Moon is approximately 2291 times brighter than Venus.

Example 2

V Puppis is a variable star with its magnitude changing from 4.7 to 5.2 every $1\frac{1}{2}$ days. How many times more intense is it at its brightest than at its faintest?

$$\frac{I_2}{I_1} = 10^{0.4(5.2-4.7)} = 10^{0.4\times 0.5} = 10^{0.2} = 1.585$$

At is brightest V Puppis is 1.6 times brighter than at its faintest.

Example 3

On April 1st 1998 Comet Hale-Bopp was at magnitude 8.4. It was on its way out of the solar system. Earlier comet Hale-Bopp made its closest approach to the Sun on April 1st 1997. If Hale-Bopp was approximately 6500 times brighter when it made its closest approach, determine its approximate magnitude.

$$\frac{I_2}{I_1} = 6500, \quad 6500 = 10^{0.4(8.4 - M)}, \; 6500 = 10^{0.4 \times 8.4} \times 10^{-0.4 M}$$

$$\frac{6500}{10^{3.36}} = 10^{-0.4 M}, \; 2.8373 = 10^{-0.4 M}, 10^{0.4529} = 10^{-0.4 M}$$

$$0.4529 = -0.4 M$$

$$M = -1.1$$

Distance formula

The distance formula relates the apparent magnitude (m), absolute magnitude (M) and the distance d (in parsecs) as follows:

$$m - M = 5\log(d) - 5$$

One parsec is approximately 3.26 light years and the absolute magnitude (M) of a star is its magnitude when viewed from a distance of 10 parsecs or 32.6 light years.

The equation can be rearranged to give the following:

$$d = 10^{(m-M+5)/5}$$

The expression $m - M$ is known as the distance modulus and is a measure of the distance to the object. If the distance modulus is 0, then the object is exactly 10 parsecs away. If the distance modulus is negative, the object is closer than 10 parsecs and its apparent magnitude(m) is brighter than its absolute magnitude (M). If the distance modulus is positive, the object is further than 10 parsecs and its apparent magnitude (m) is less bright than its absolute magnitude (M).

Cepheid variables

Eta Aquilae was the first Cepheid recognized to exhibit variability following observations by Edward Pigott in 1784.

But it was his friend, John Goodricke who is credited as discovering the periodic nature of Delta (δ) Cephei, the prototype of the class.

Day	Apparent magnitude
1	**3.6**
2	**3.9**
3	**4.2**
4	**4.3**
5	**4**
6	**3.7**
7	**3.5**
8	**3.8**

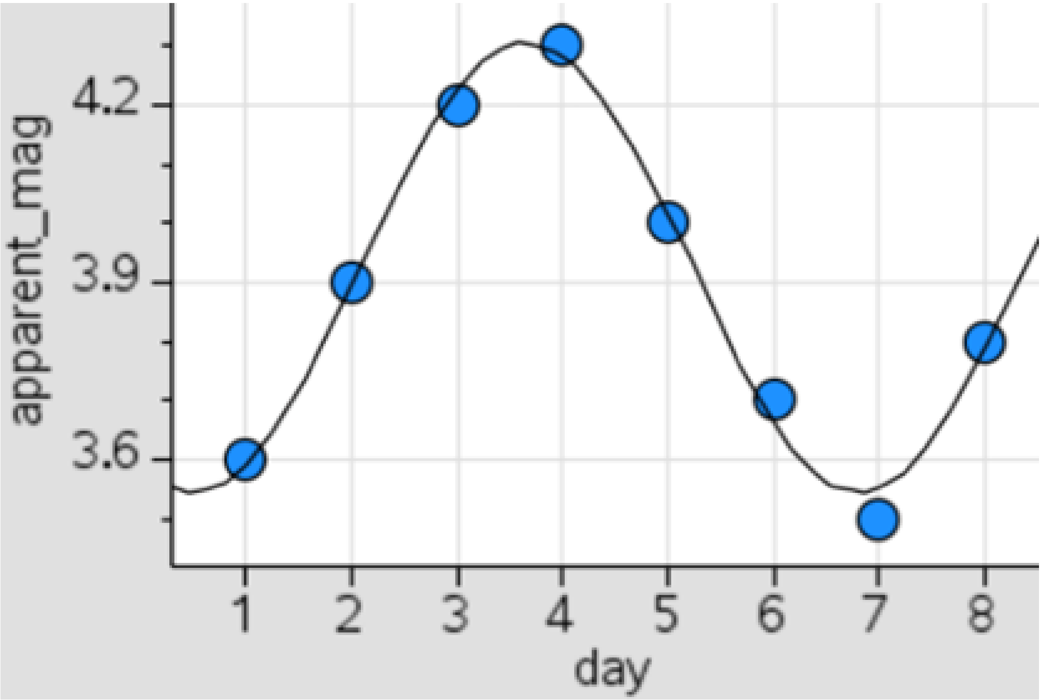


Figure 1: Plot of apparent magnitude verses days for the Cepheid variable Eta Aquilae

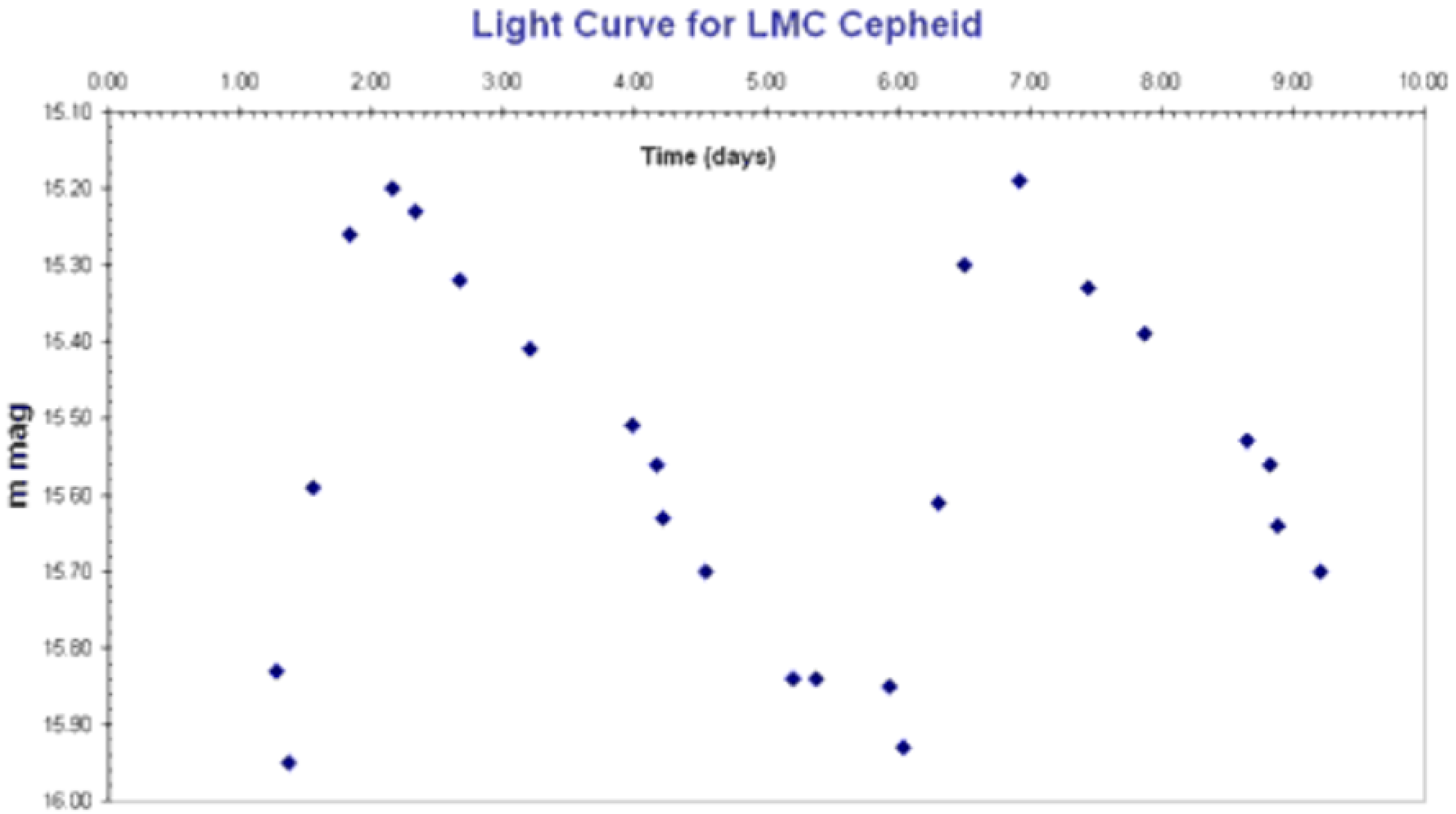


Figure 3: Light curve for a Cepheid in the Large Magellanic Clouds. (Source: National Telescope Facility)

Cepheid	Apparent magnitude (m)	Period (days)
1	11.45	31.43
2	11.24	35.58
3	11.84	31.21
4	11.41	34.23
5	11.17	37.46
6	11.63	32.92
7	11.38	36.97
8	11.21	34.01
9	11.79	30.59
10	11.32	35.76
11	11.51	32.11
12	11.14	37.65
13	11.27	35.01
14	11.72	31.87
15	11.36	36.21
16	11.43	34.98
17	11.78	30.88
18	11.29	35.32
19	11.19	37.12
20	11.66	32.43
21	11.49	33.76
22	11.26	35.43
23	11.97	29.94
24	11.33	34.76
25	11.15	36.56

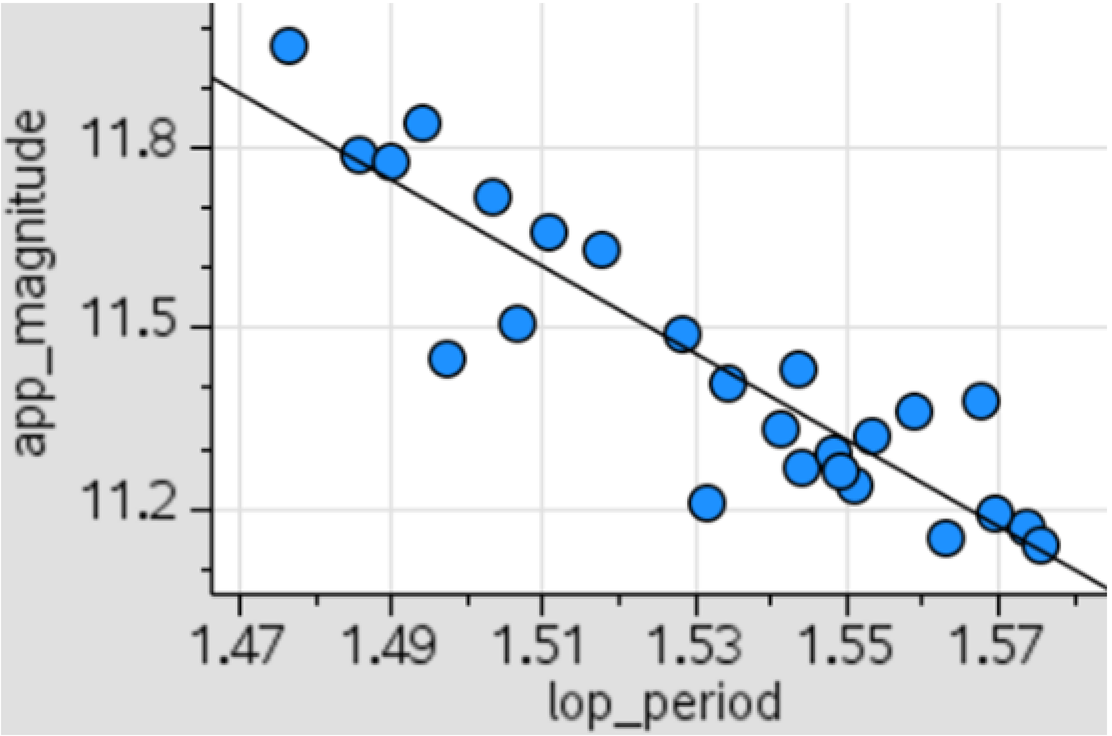


Figure 2: The table lists the apparent magnitude and period of 25 Cepheid variables. Leavitt plotted the log of the period against the apparent magnitude to obtain a linear relationship. She found that brighter Cepheids had longer periods.

Leavitt's equation relating apparent magnitude (m) and period (P) was then converted into an equation involving absolute magnitude (M) and period (P).

$$M = -2.76\log(P) - 1.4$$

The relationship became known as the Period Luminosity relationship or Leavitt's law, whereby the absolute magnitude (M) of a Cepheid is linked to the log of its period (in days).

For example, suppose a Cepheid in a distant galaxy has a period of 30 days, then its absolute magnitude (M) is:

$$\begin{aligned} M &= -2.76\log(30) - 1.4 \\ &= -5.48 \end{aligned}$$

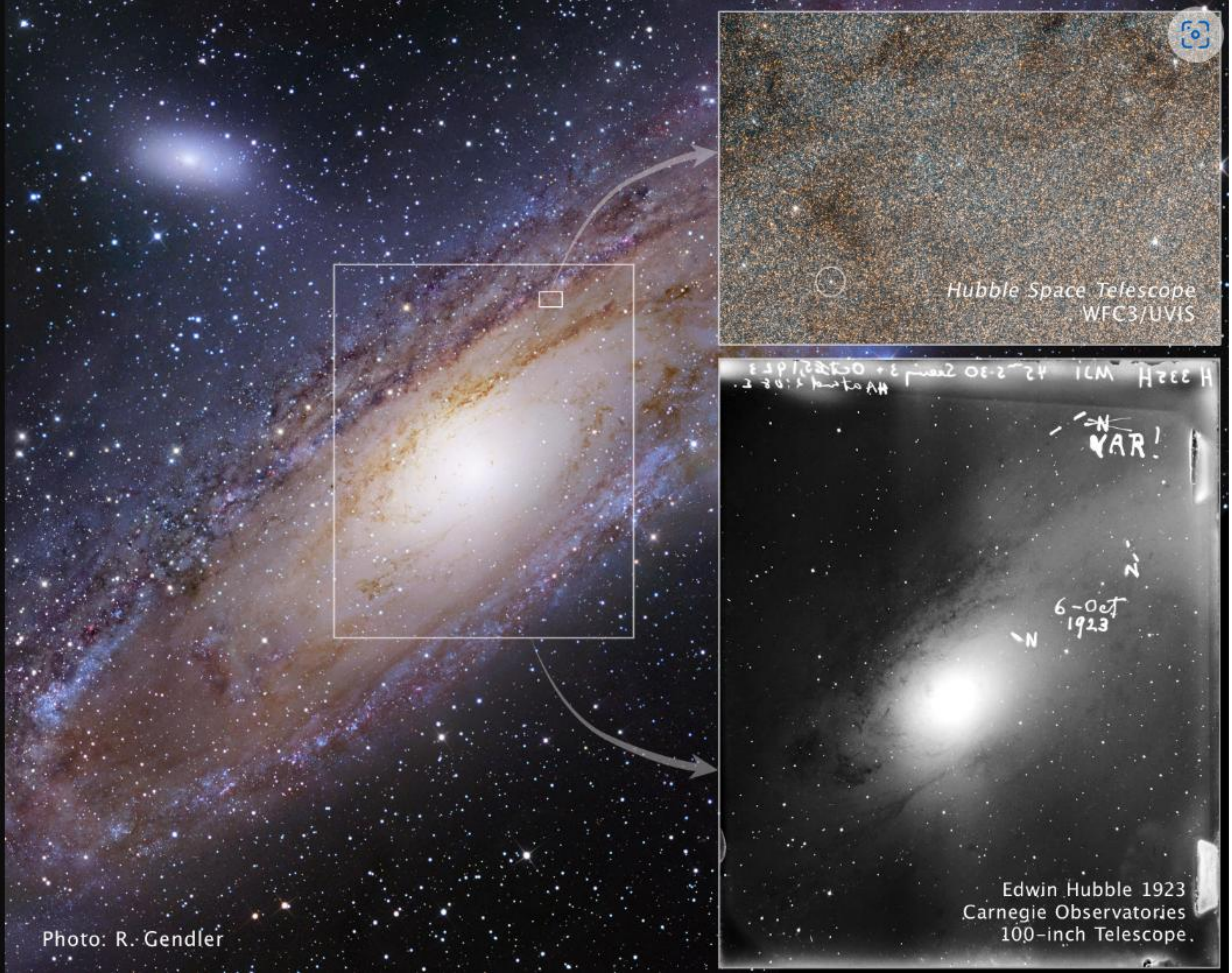
To calculate the distance to a galaxy, all that is needed is the apparent magnitude (m) and the period of a Cepheid in the galaxy of interest. The distance formula is then used to determine the distance in parsecs. The distance formula relates the apparent magnitude (m), absolute magnitude (M) and the distance d (in parsecs) as follows:

$$m - M = 5\log(d) - 5$$

One parsec is approximately 3.26 light years and the absolute magnitude (M) of a star is its magnitude when viewed from a distance of 10 parsecs or 32.6 light years.

The equation can be rearranged to give the following:

$$d = 10^{(m-M+5)/5}$$


Hubble Space Telescope
WFC3/UVIS
VAR!
6-Oct
1923
N
Edwin Hubble 1923
Carnegie Observatories
100-inch Telescope
Photo: R. Gendler

Calculating the distance to a galaxy

Apparent mean magnitude (m) = 15.56 and the period = 4.76 days.

The absolute magnitude (M) is first determined by using the equation:

$$M = -2.76\log(P) - 1.4$$

$$M = -2.76\log(4.76) - 1.4$$

$$= -3.27$$

These apparent magnitude (m), and absolute magnitude (M) are then subbed into the distance equation.

$$d = 10^{(m-M+5)/5}$$

$$d = 10^{(15.56-(-3.27)+5)/5}$$

$$d = 10^{4.766}$$

$= 58344.5\ parsecs$ or 190203 light years

Questions

1. A Cepheid variable has a period of 18 days and an apparent magnitude of 14.3. How far away is the Cepheid variable star.

Questions

1. A Cepheid variable has a period of 18 days and an apparent magnitude of 14.3. How far away is the Cepheid variable star.

Solution:

First determine absolute magnitude (M)

$M = -2.76\log(18) - 1.4$

$= -4.86$

Next substitute the apparent magnitude (m) and absolute magnitude (M) into the distance formula.

$d = 10^{(m-M+5)/5}$

$= 10^{(14.3-(-4.86)+5)/5}$

$= 10^{4.832}$

$=$ 67920.4 parsecs or 221420.4 light years.

2. A Cepheid variable has a period of 10 days and an apparent magnitude of 12.5. Calculate its distance from Earth using the period-luminosity relation and the distance modulus formula.

2. A Cepheid variable has a period of 10 days and an apparent magnitude of 12.5. Calculate its distance from Earth using the period-luminosity relation and the distance modulus formula.

Solution:

$M = -2.76 \log(10) - 1.4$

= -4.16

$d = 10^{(m-M+5)/5}$

$= 10^{(12.5-(-4.16)+5)/5}$

$= 10^{4.332}$

$= 21478.3$ parsecs or 70019.3 light years.

Leavitt's ground breaking work was ignored for over four years until Ejnar Hertzsprung recognised the implications of what the unsung Leavitt had done. Edwin Hubble suggested that she should receive the Nobel Prize, while the Swedish mathematician Gosta Mittag-Leffler went even further and wrote her a letter in 1926 about nominating her for the Nobel Prize, not realizing that she had been dead for 4 years. As the Nobel Prize is not awarded posthumously, Henerietta never received her nomination.

3. Can you determine the length of daylight hours from any given latitude on Earth?

One day solar graph
(St Ursula's College Chapel)

6 month solargraph from the pool. Lowest path is the winter solstice (June 21)

Making a pinhole camera

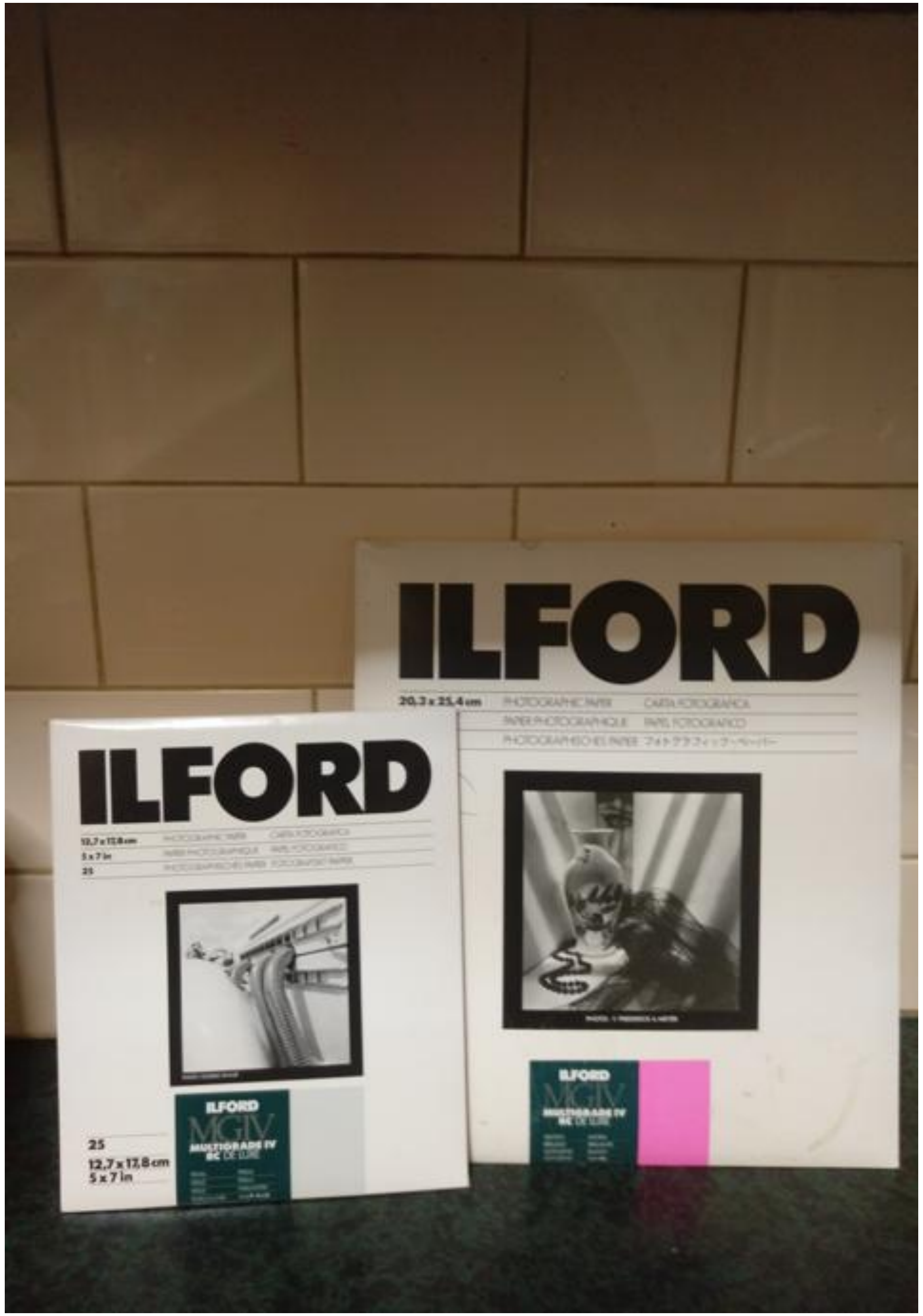
Pringles tin or Monster can works best.

Drill a hole and cover with alfoil.
Hole needs to be roughly one-third of the distance from the top.

Use a thumb-tack or pin to make a hole 1/3 of the distance from the top of the Monster can. (Pin works best)

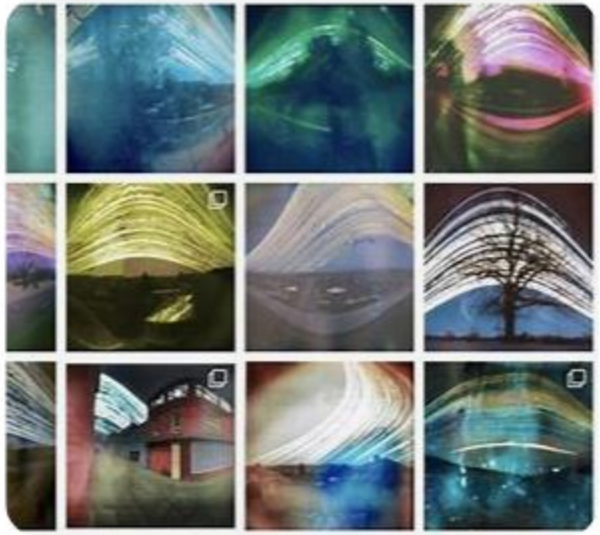
Hole covered with alfoil and secured with tape

Most school media departments have ILFORD's photographic paper



Insert the photographic paper inside the pinhole camera. Ensure the shiny photographic side faces the pinhole

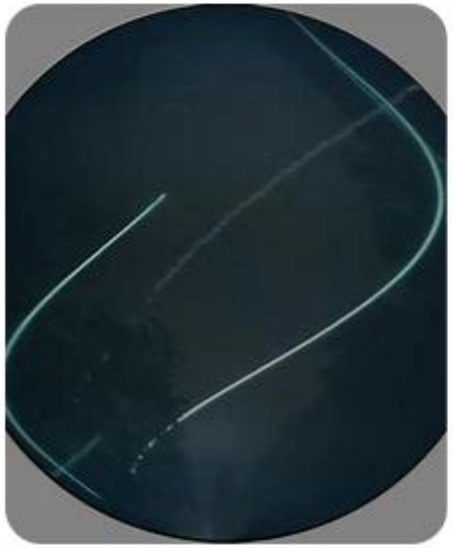
Use some black insulation tape to make a shutter.



Film Friday: Solarcan Puck is a compact solargraph camera i...

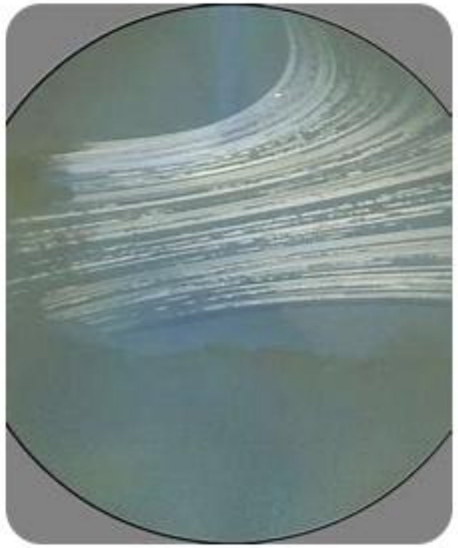
Solarcan Puck is a Limited-Time Palm-Sized Pinhole Sol...

Solarcan Puck is a Limited-Time Pinhole Solargraph Camera ...



Solarcan Puck is a Limited-Time Palm-S...

Solarcan Puck is a Limited-Time Palm-Sized Pinhole Solargraph Camera ...

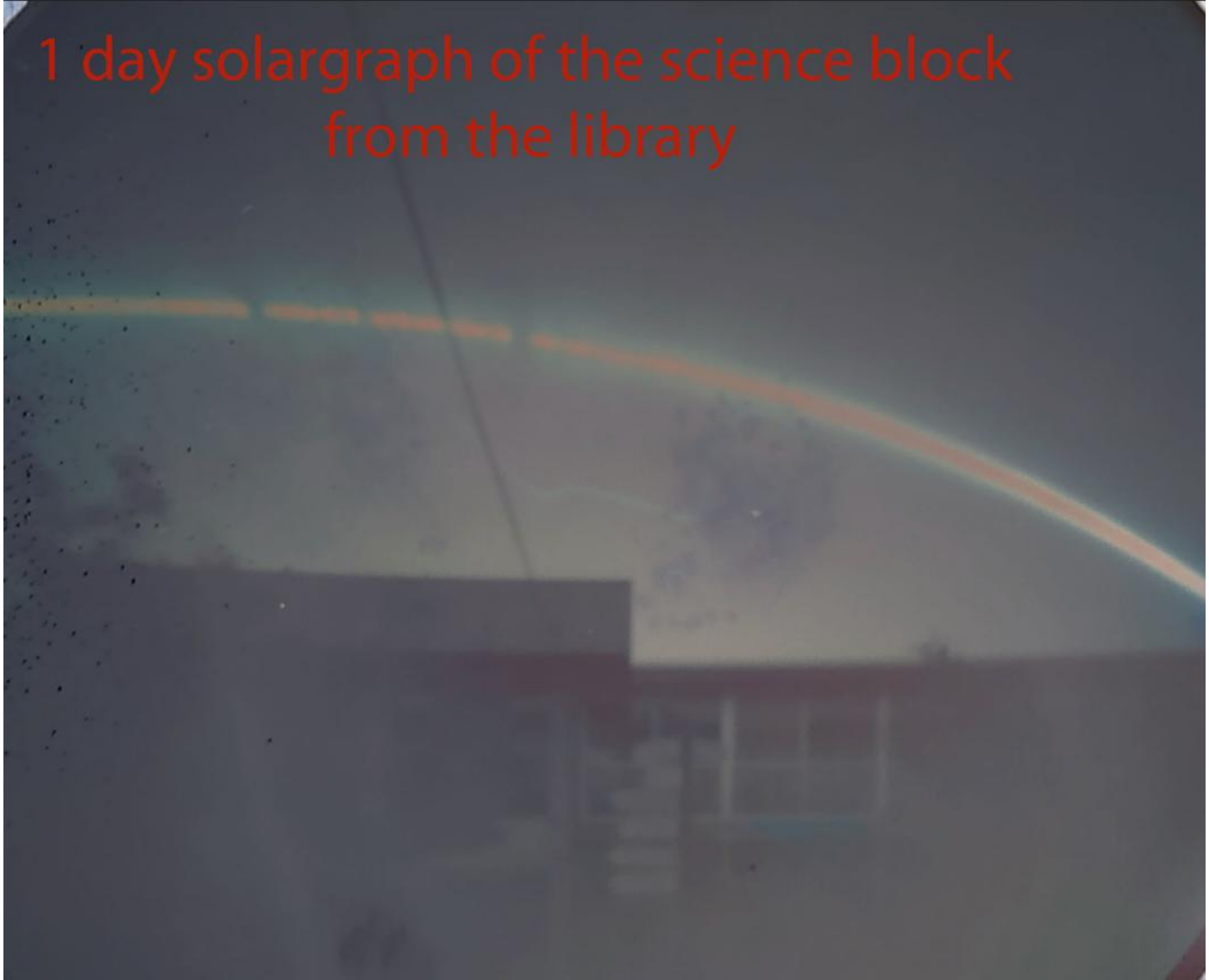


Solarcan Puck is a Limited-Time Palm-S...

Secure the pinhole camera with tape. Make sure it points north. Remove the shutter and attach it below the pinhole.

9 day solargraph of the setting Sun over the Chapel

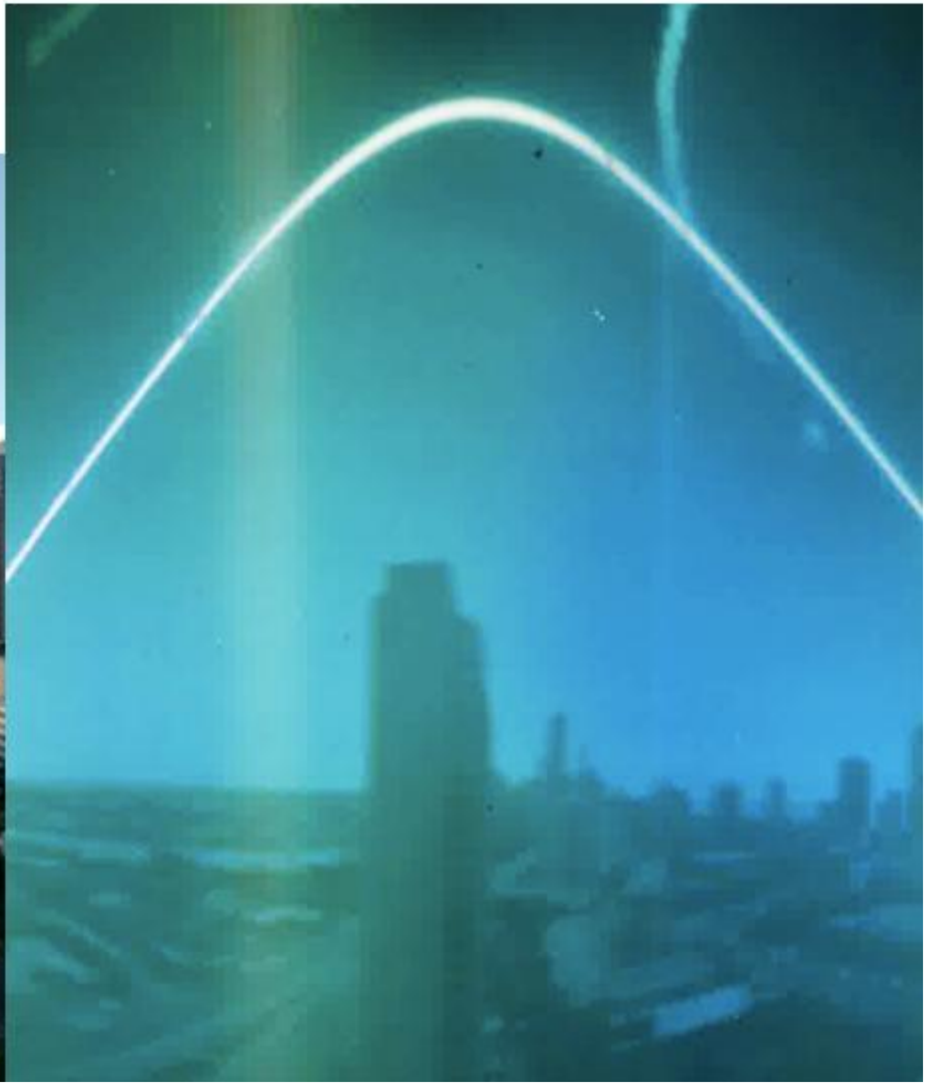
1 day solargraph of the science block from the library

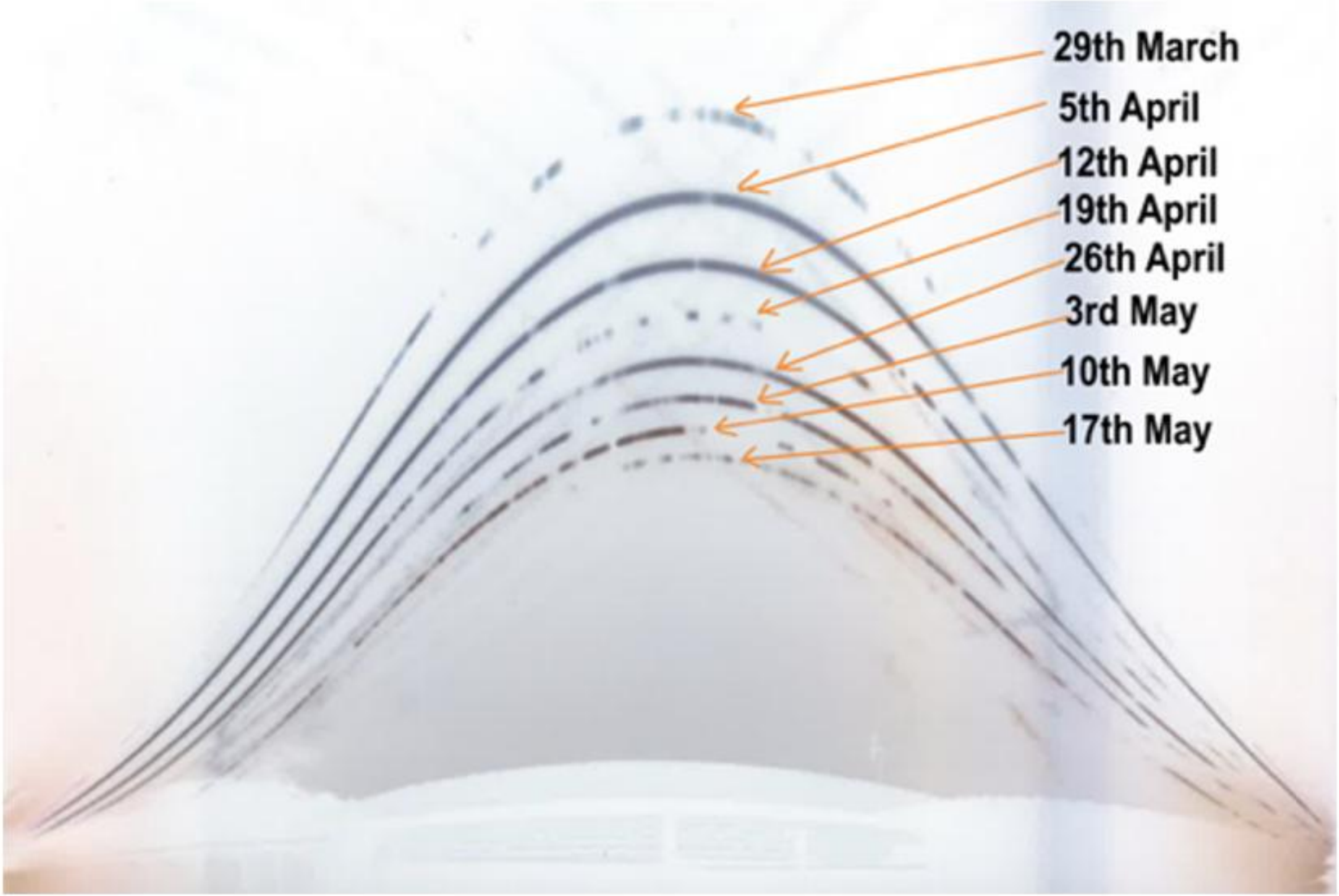



Rome St 1 day
solargraph

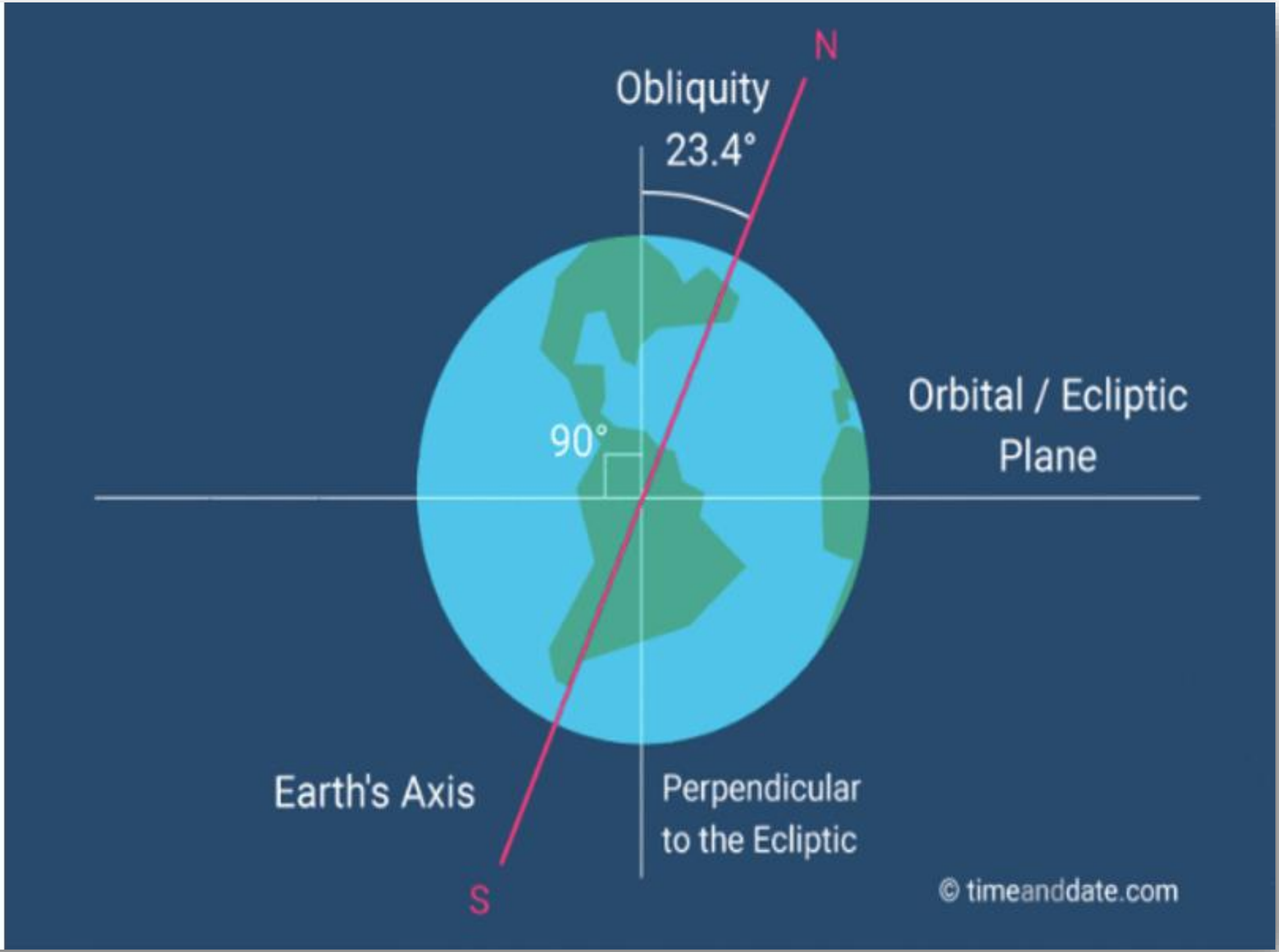
Two day solargraph from Garda

Gold Coast solargraph 17th April 2019

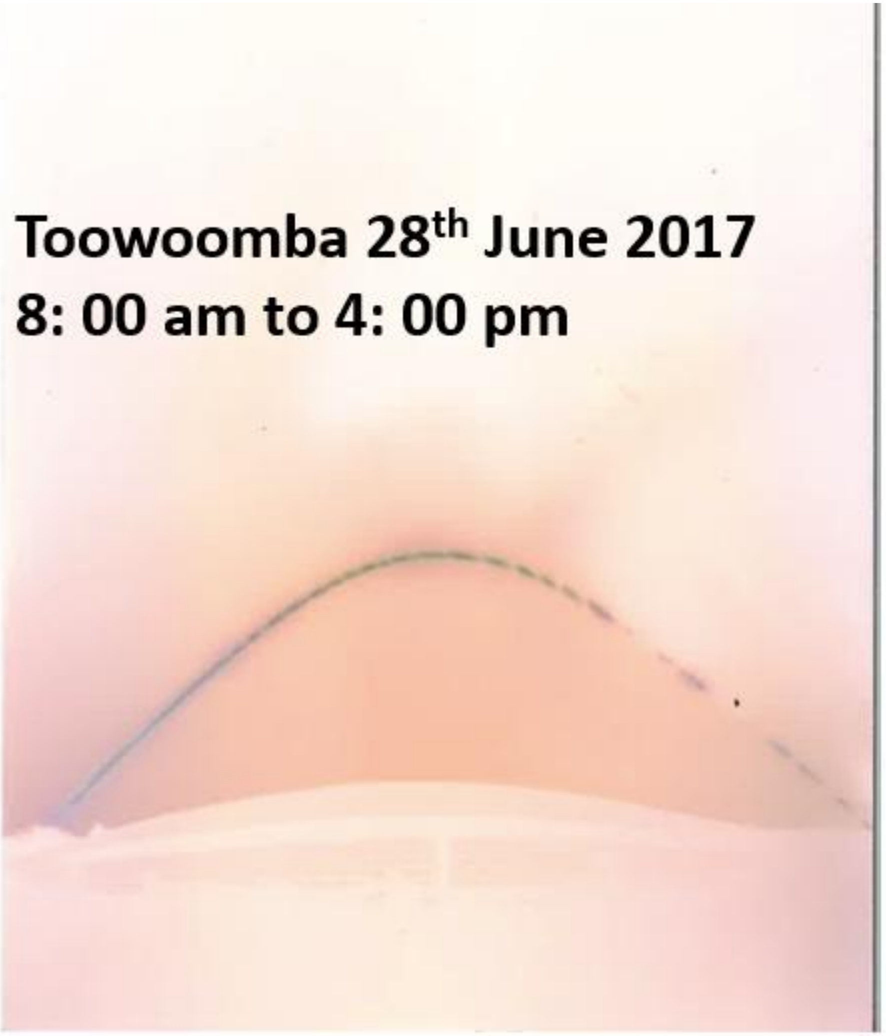



29th March
5th April
12th April
19th April
26th April
3rd May
10th May
17th May

Solargraphs offer direct proof of the tilt of the Earth's axis



Toowoomba 28th June 2017
8: 00 am to 4: 00 pm

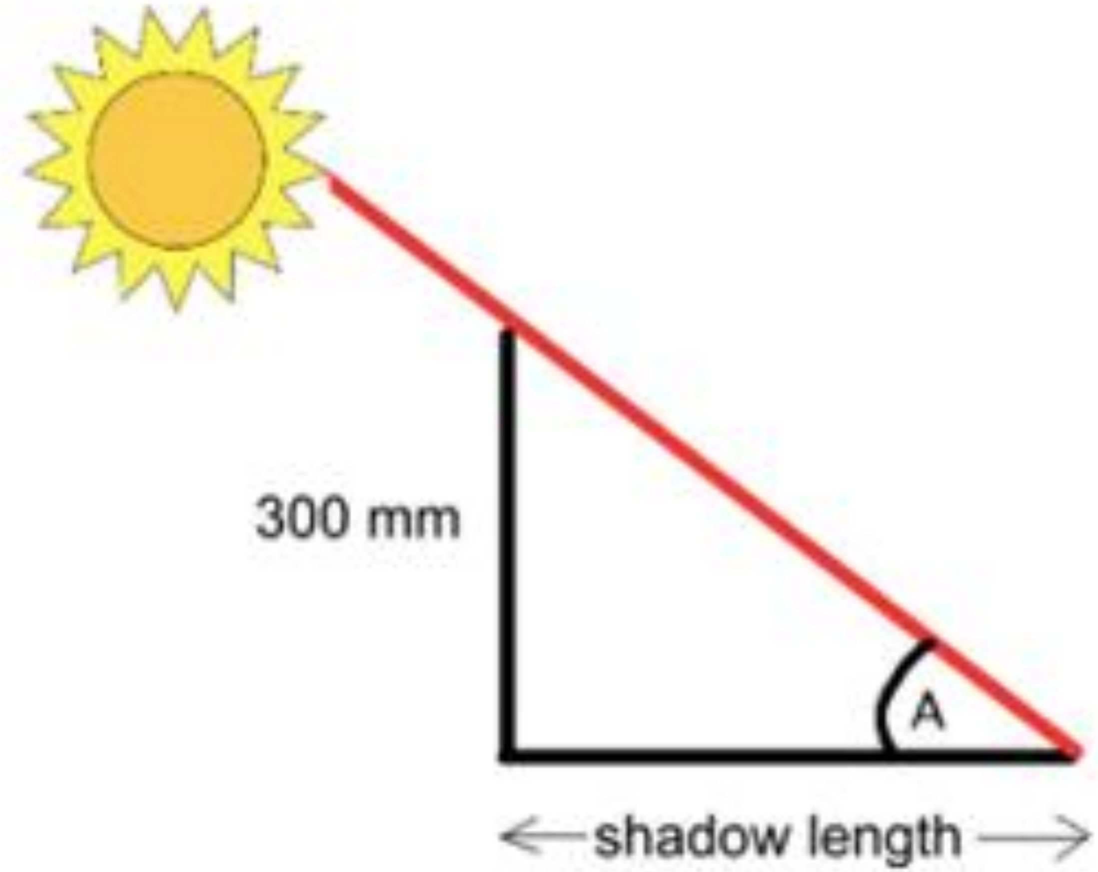


Maximum altitude 39.19°.

Rockhampton 28th June 2017
8: 00 am to 4: 00 pm

Maximum altitude 43.37°

Figure 6: Shadow stick data at 10: 00 am



The tan ratio was used to determine the altitude of the Sun

Making an analemma (a one year project)

An analemma is a visual record showing the variation in the Sun's position in the sky over the course of a year, as viewed at a fixed time of day and from a fixed location on the Earth.

To record an analemma:

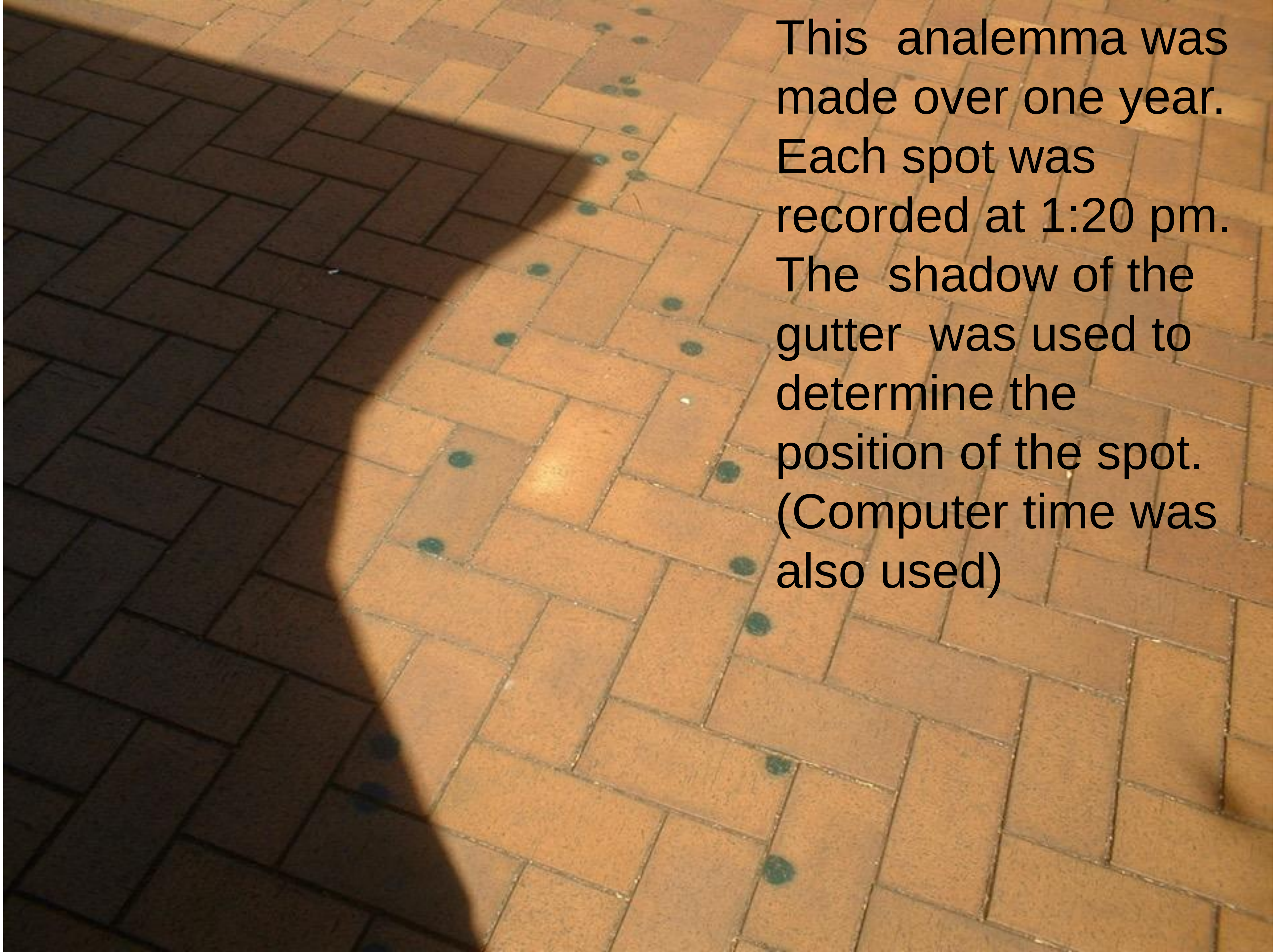
-can of spray paint

-plastic ice cream lid stencil

- wait one year

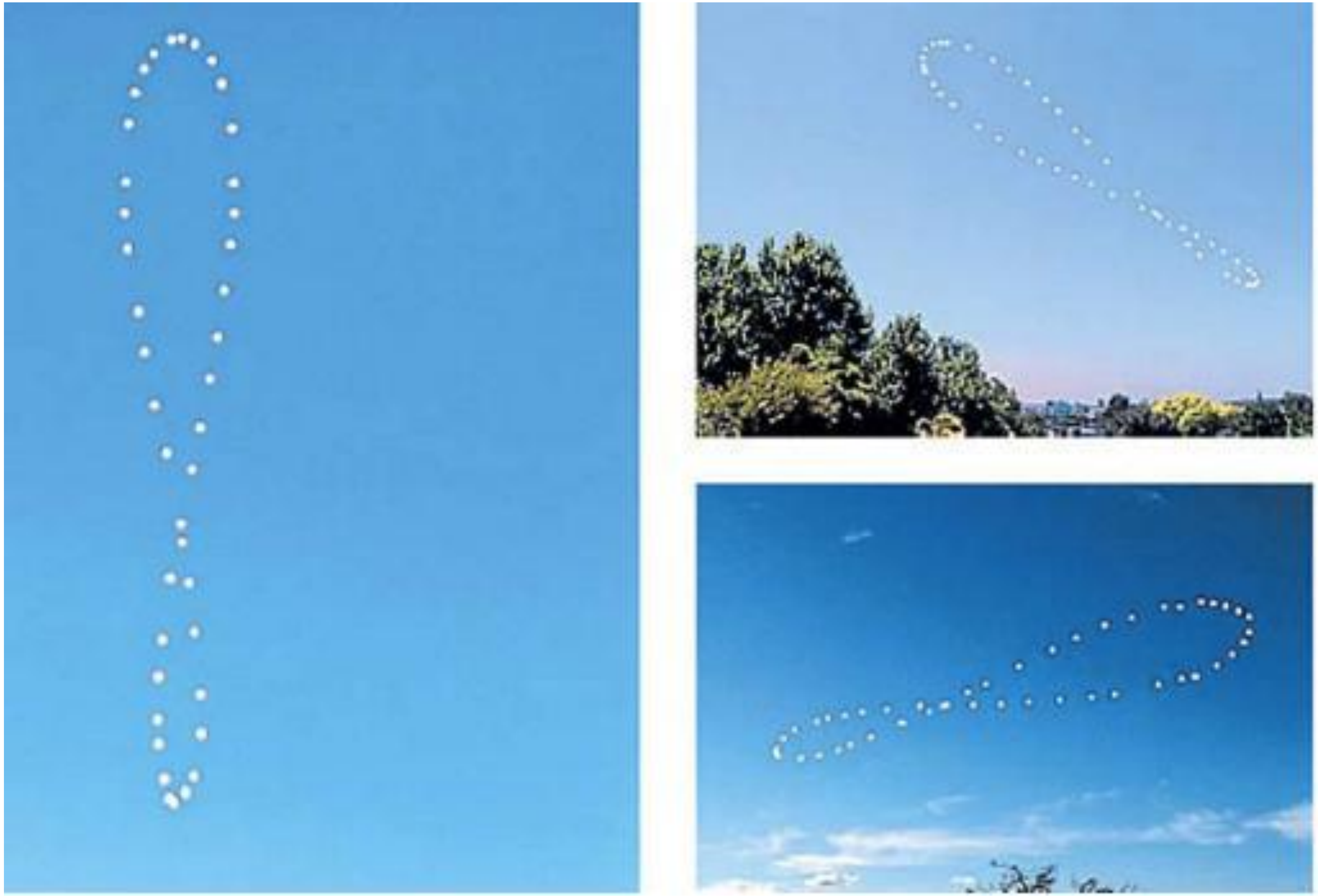
Expensive method with camera + solar filter

Cheap method with spray paint

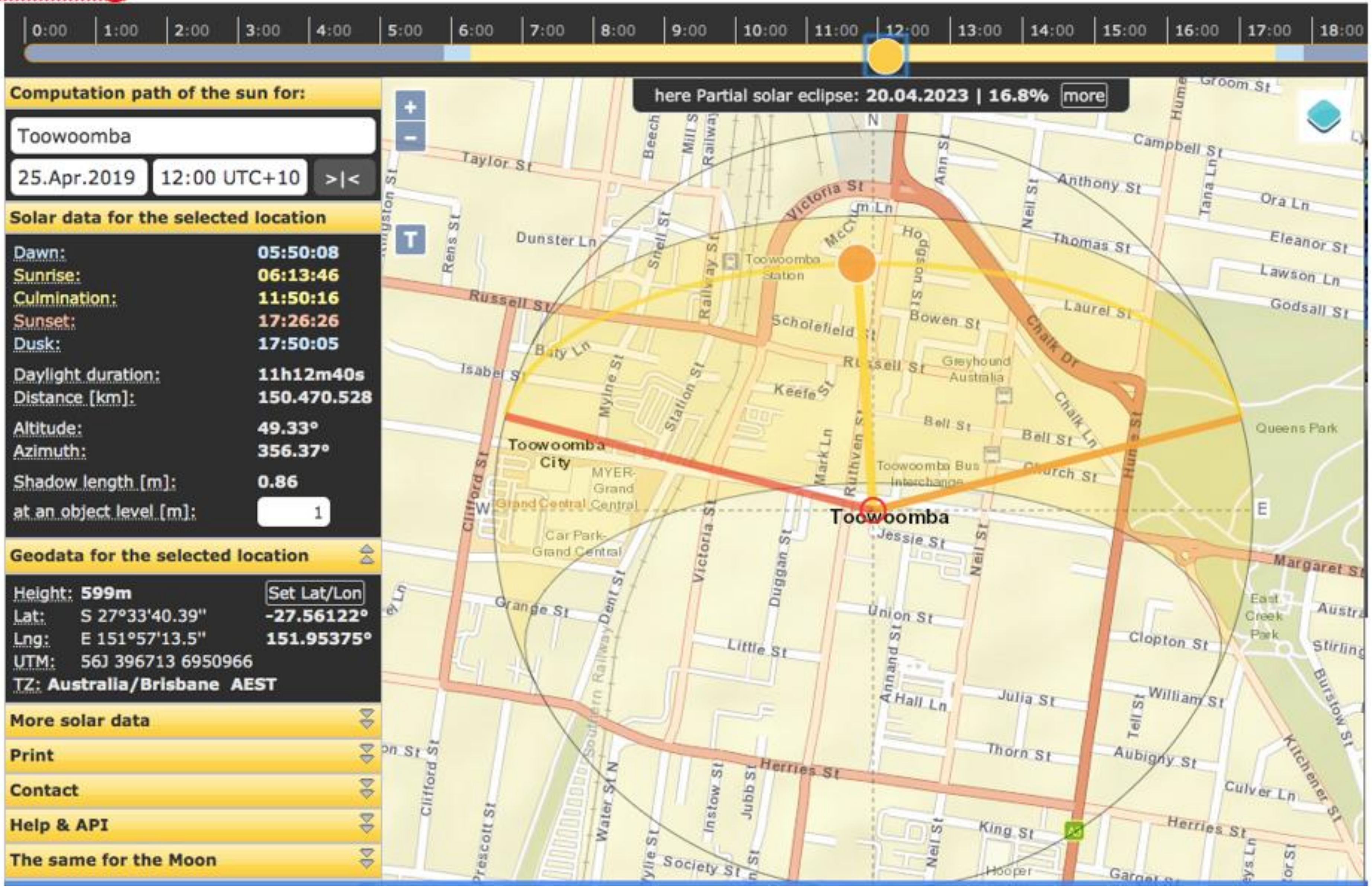


This analemma was made over one year. Each spot was recorded at 1:20 pm. The shadow of the gutter was used to determine the position of the spot. (Computer time was also used)

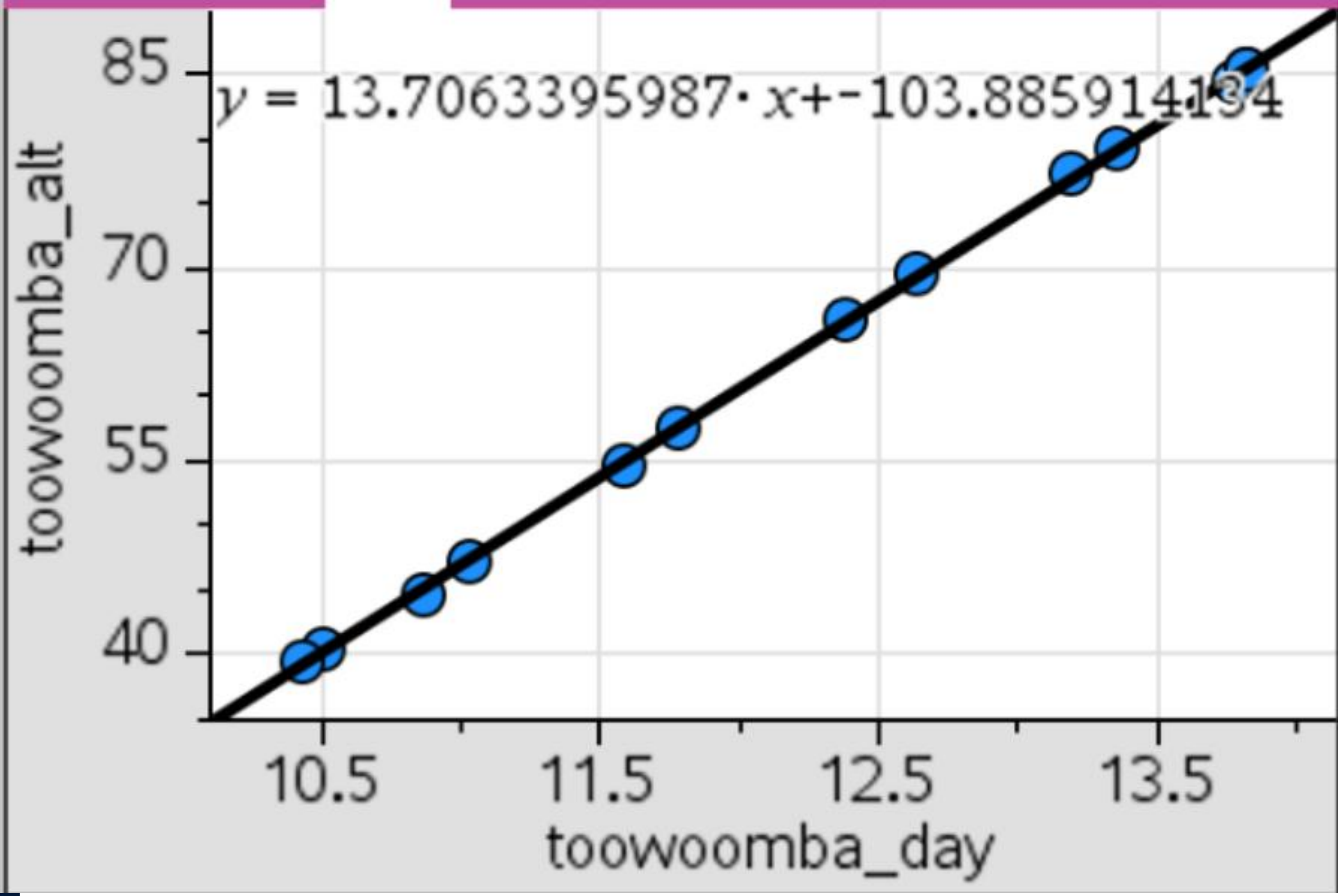
Is this analemma recorded in the northern or southern hemisphere?

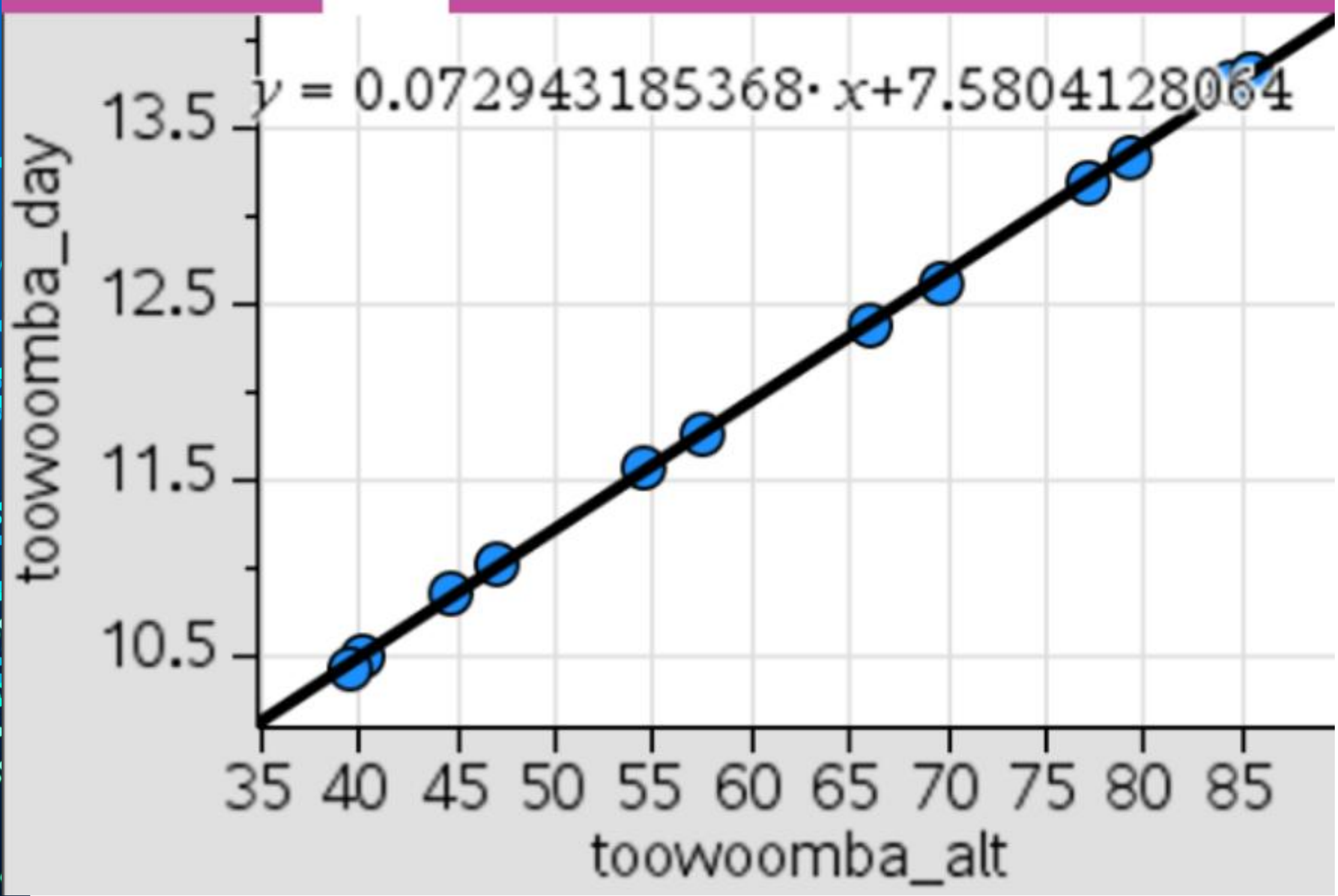


www.suncalc.org

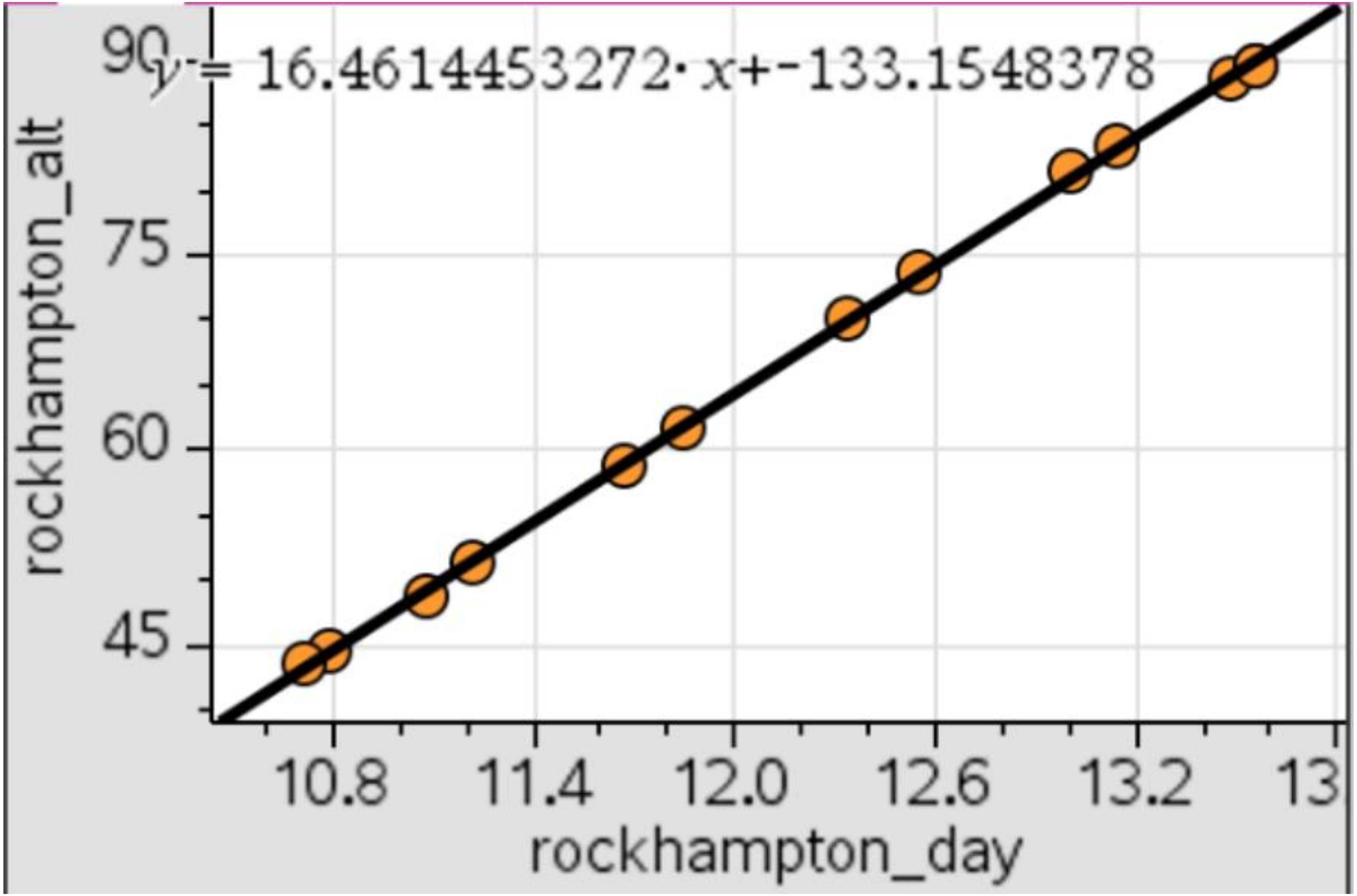


Date	Day number	Townsville alt	Caloundra alt	Queenstown alt	London alt	Quito alt	Toowoomba alt	Rockhampton Alt	Mexico City Alt	San Antonia alt
2nd Jan	2	86.36	86.1	67.88	15.68	67.66	85.34	89.52	44.74	37.76
2nd Feb	33	87.53	79.99	61.78	21.86	73.58	79.23	83.41	53.99	44
2nd March	61	77.92	70.39	52.18	31.5	83.25	69.63	73.8	63.66	53.67
2nd April	92	65.8	58.26	40.06	43.62	84.63	57.5	61.68	75.79	65.8
2nd May	122	55.36	47.83	29.62	54.02	74.24	47.06	51.24	86.16	76.18
2nd June	153	48.56	41.03	22.82	60.74	67.56	40.27	44.45	87.16	82.85
2nd July	183	47.73	40.19	21.98	61.49	66.85	39.43	43.61	86.46	83.55
2nd August	214	53.02	45.48	27.25	56.13	72.25	44.72	48.9	88.13	78.14
2nd Sept	245	62.86	53.32	37.08	46.24	82.16	54.56	58.74	78.21	68.22
2nd Oct	275	74.34	66.8	48.55	34.76	86.34	66.04	70.22	66.71	56.73
2nd Nov	306	85.5	77.96	59.72	23.64	75.23	77.2	81.38	55.6	45.62
2nd Dec	336	87.3	85.15	66.92	16.53	68.14	84.39	88.57	48.53	38.54
2nd Jan	367	86.36	86.1	67.88	15.68	67.66	85.34	89.52	47.74	37.76

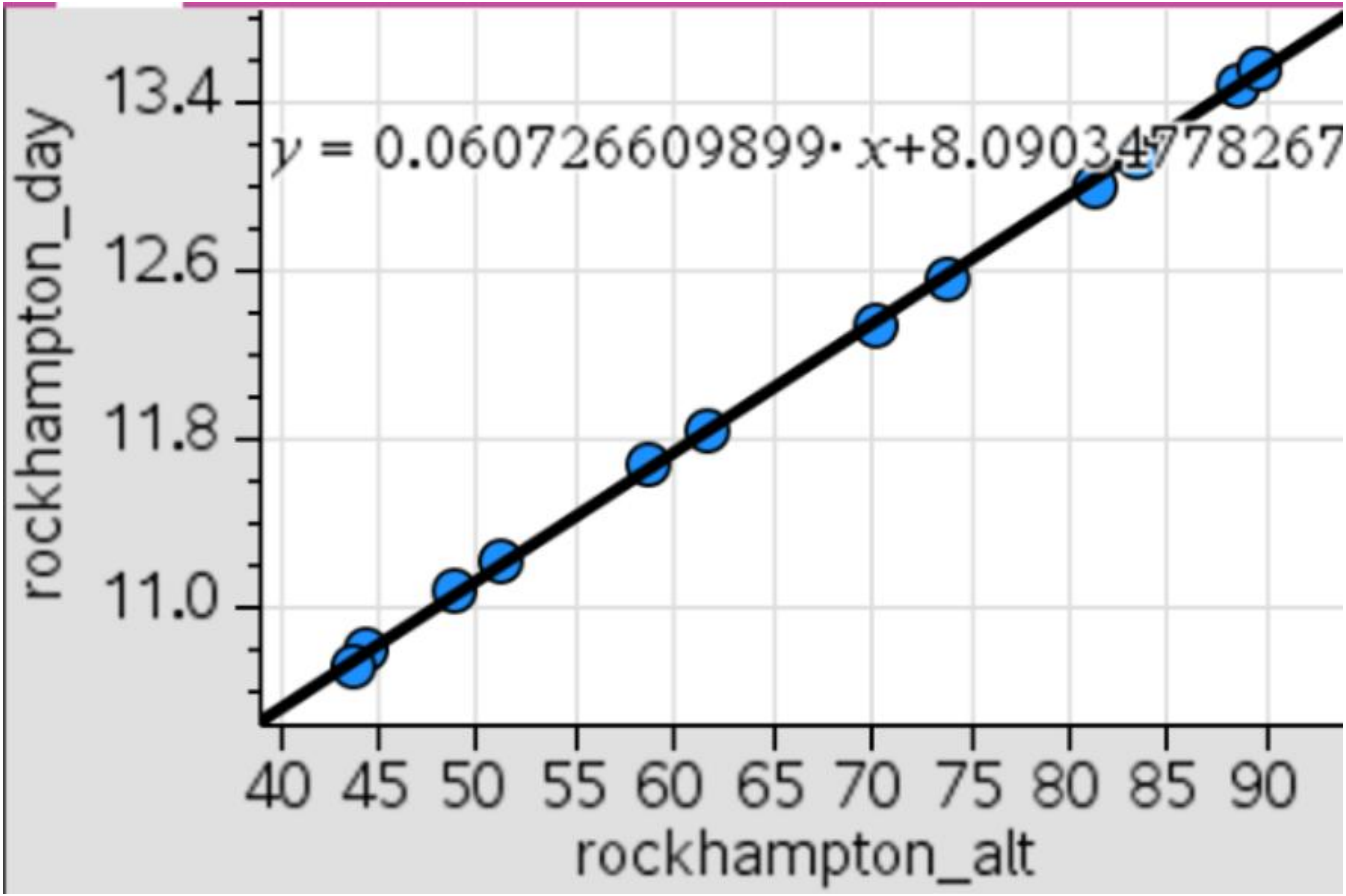

y = 13.7063395987· x+-103.885914134
toowoomba_alt
85
70
55
40
10.5
11.5
12.5
13.5
toowoomba_day



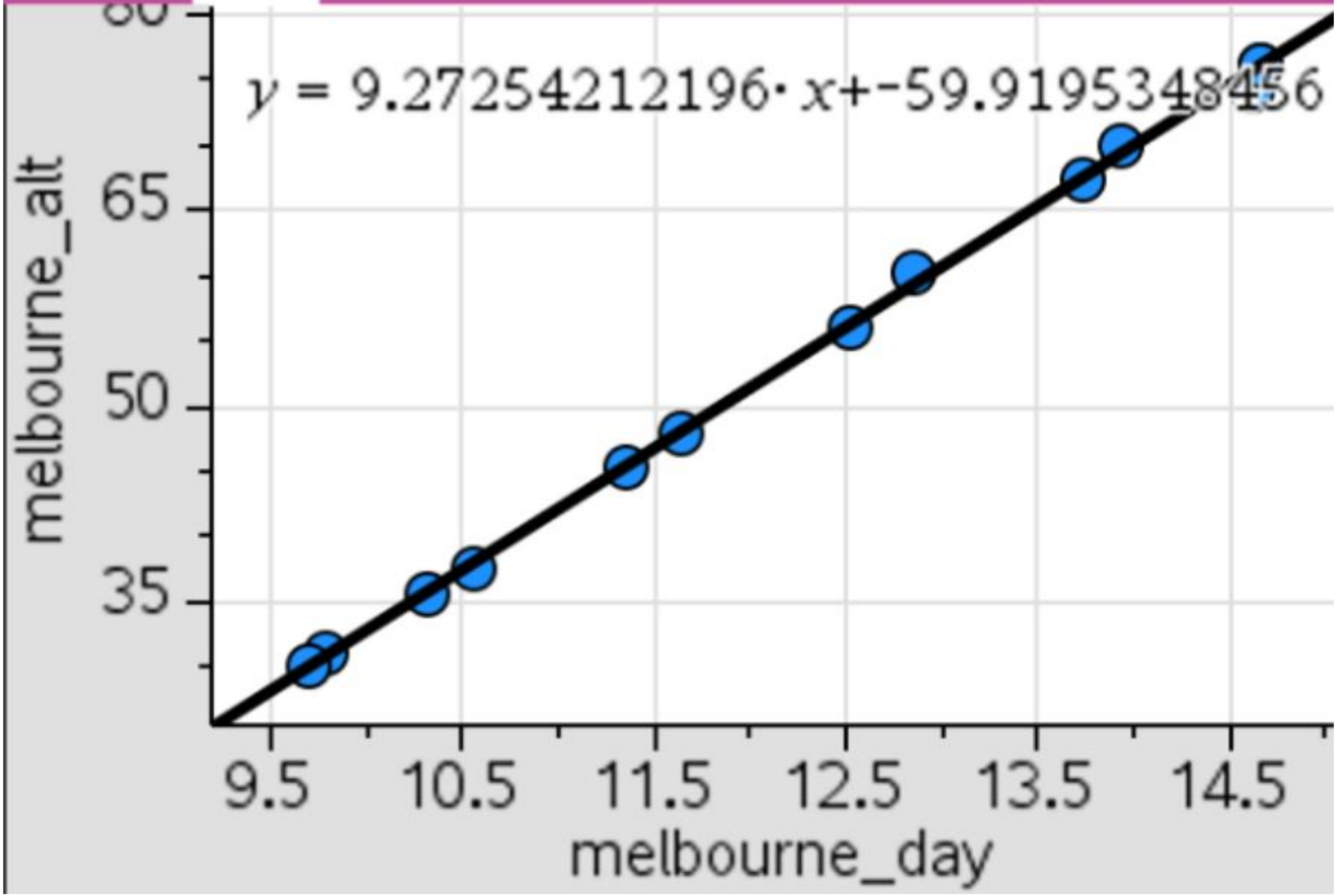
y = 0.072943185368· x+7.5804128064
toowoomba_day
toowoomba_alt
13.5
12.5
11.5
10.5
35
40
45
50
55
60
65
70
75
80
85



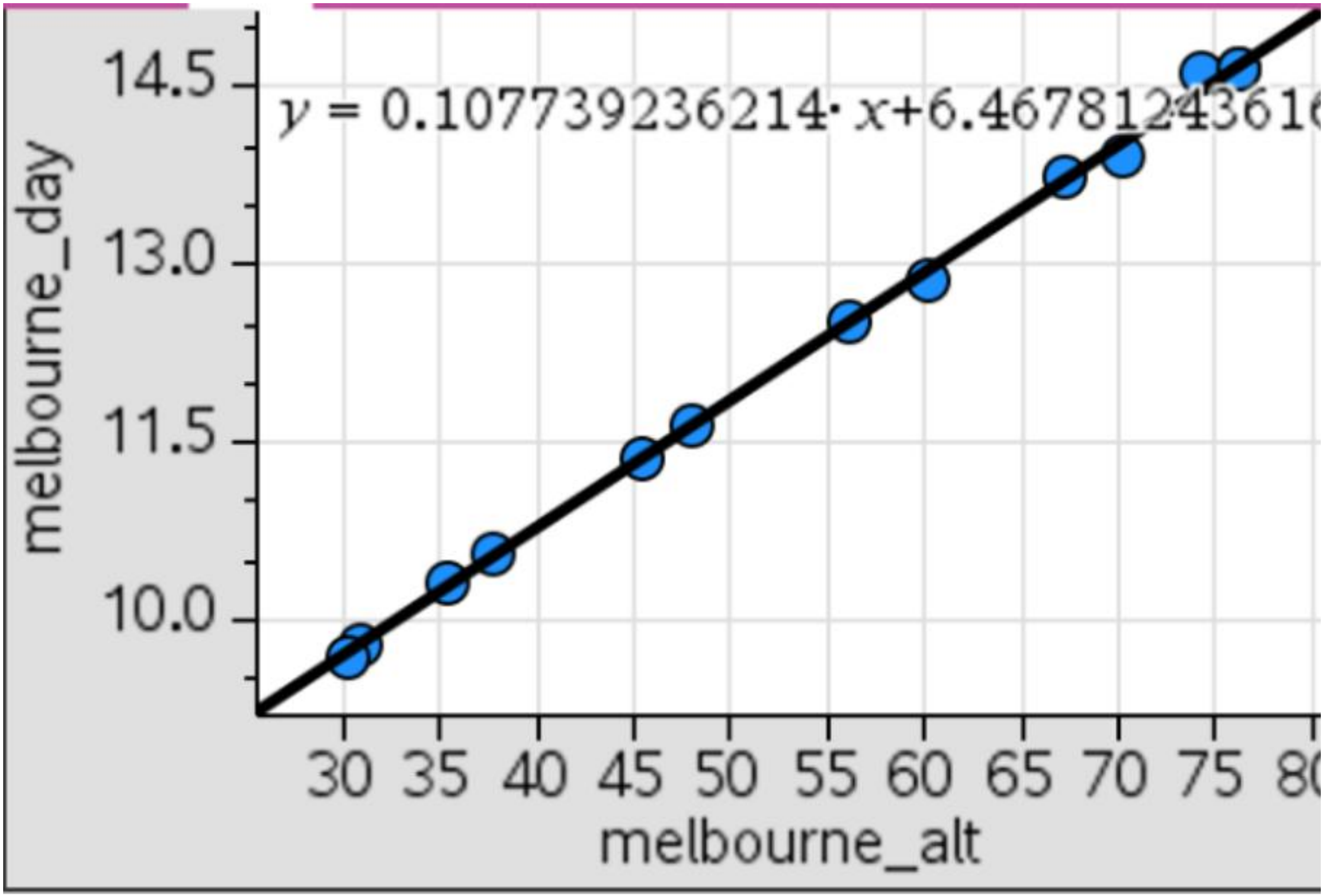
y = 16.4614453272·x+-133.1548378
rockhampton_alt
90
75
60
45
10.8
11.4
12.0
12.6
13.2
13
rockhampton_day



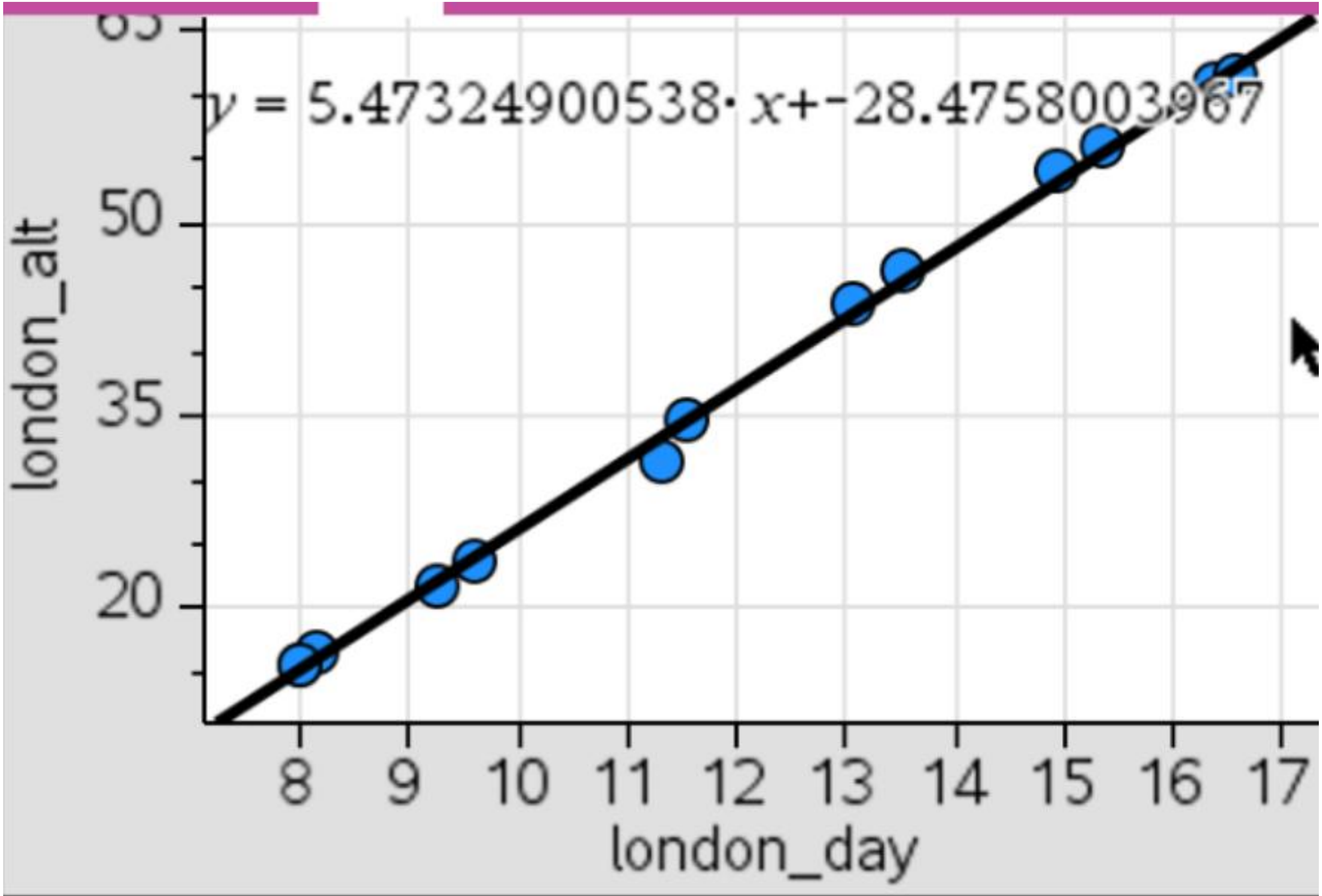
rockhampton_day
13.4
12.6
11.8
11.0
y = 0.0607266609899· x+8.0903477826
40 45 50 55 60 65 70 75 80 85 90
rockhampton_alt



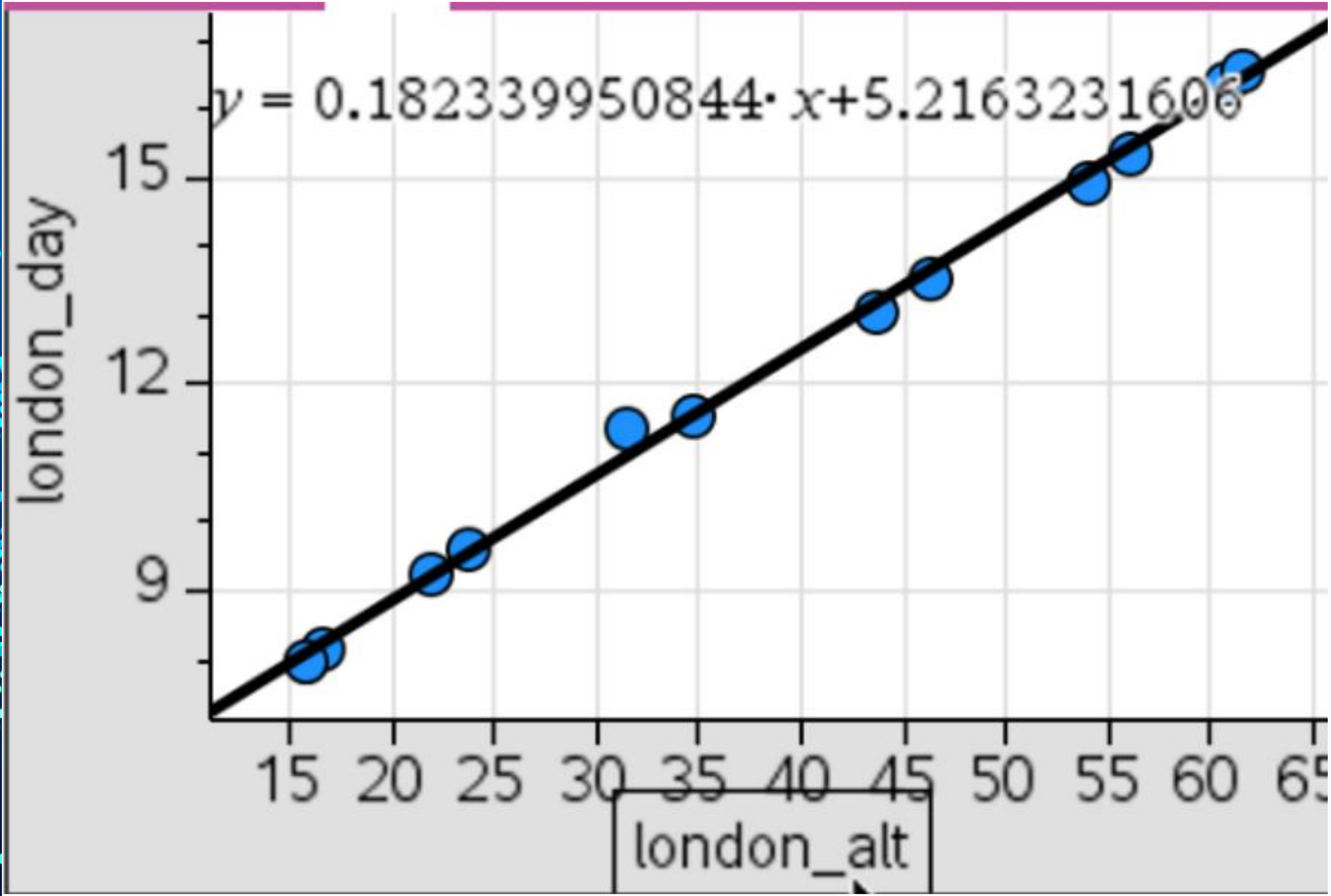
y = 9.27254212196·x+-59.9195348456
melbourne_alt
65
50
35
9.5
10.5
11.5
12.5
13.5
14.5
melbourne_day



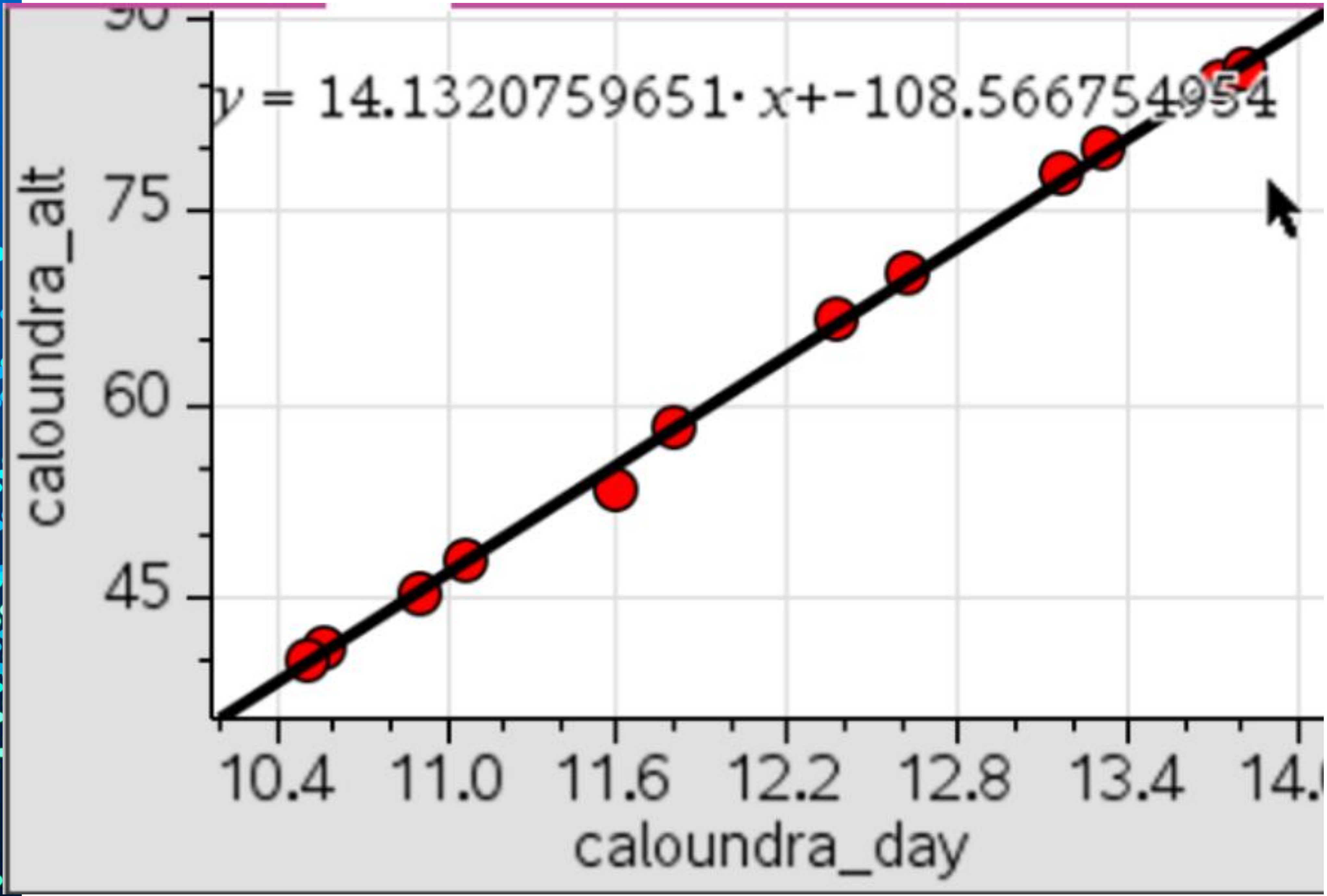
y = 0.107739236214· x+6.4678124361
melbourne_day
14.5
13.0
11.5
10.0
30 35 40 45 50 55 60 65 70 75 80
melbourne_alt



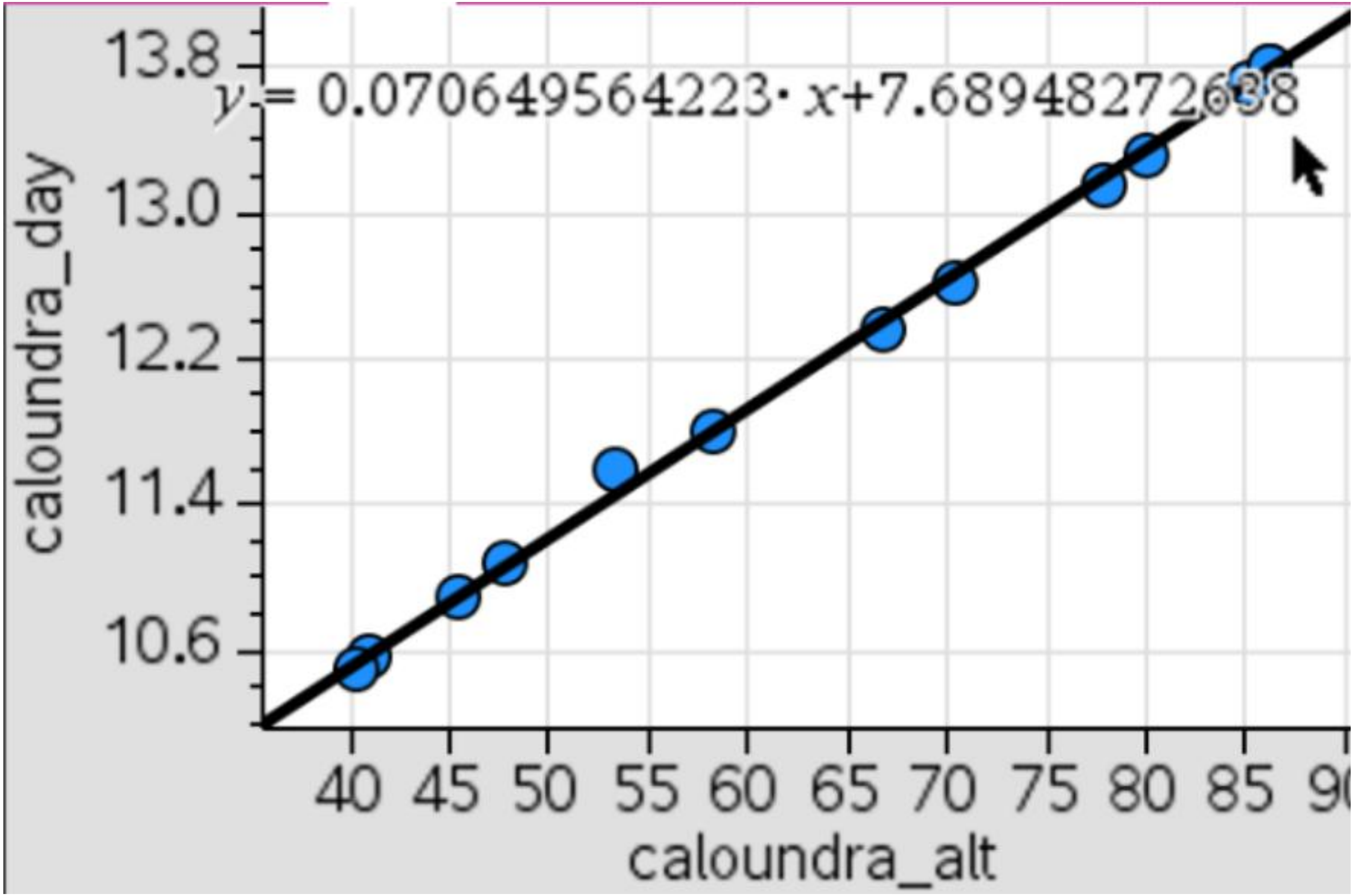
y = 5.47324900538· x+-28.4758003967
london_alt
london_day
65
50
35
20
8
9
10
11
12
13
14
15
16
17

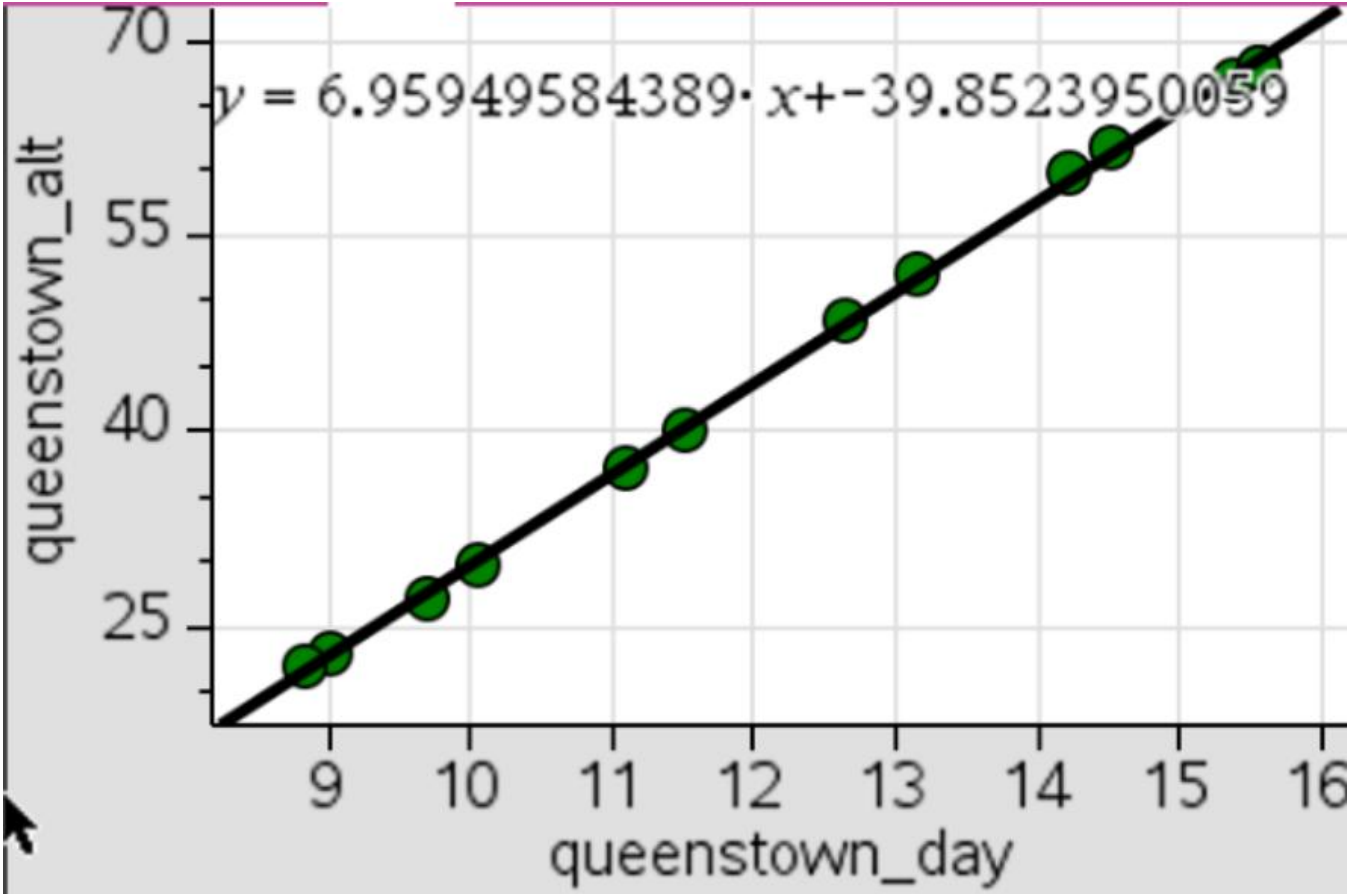


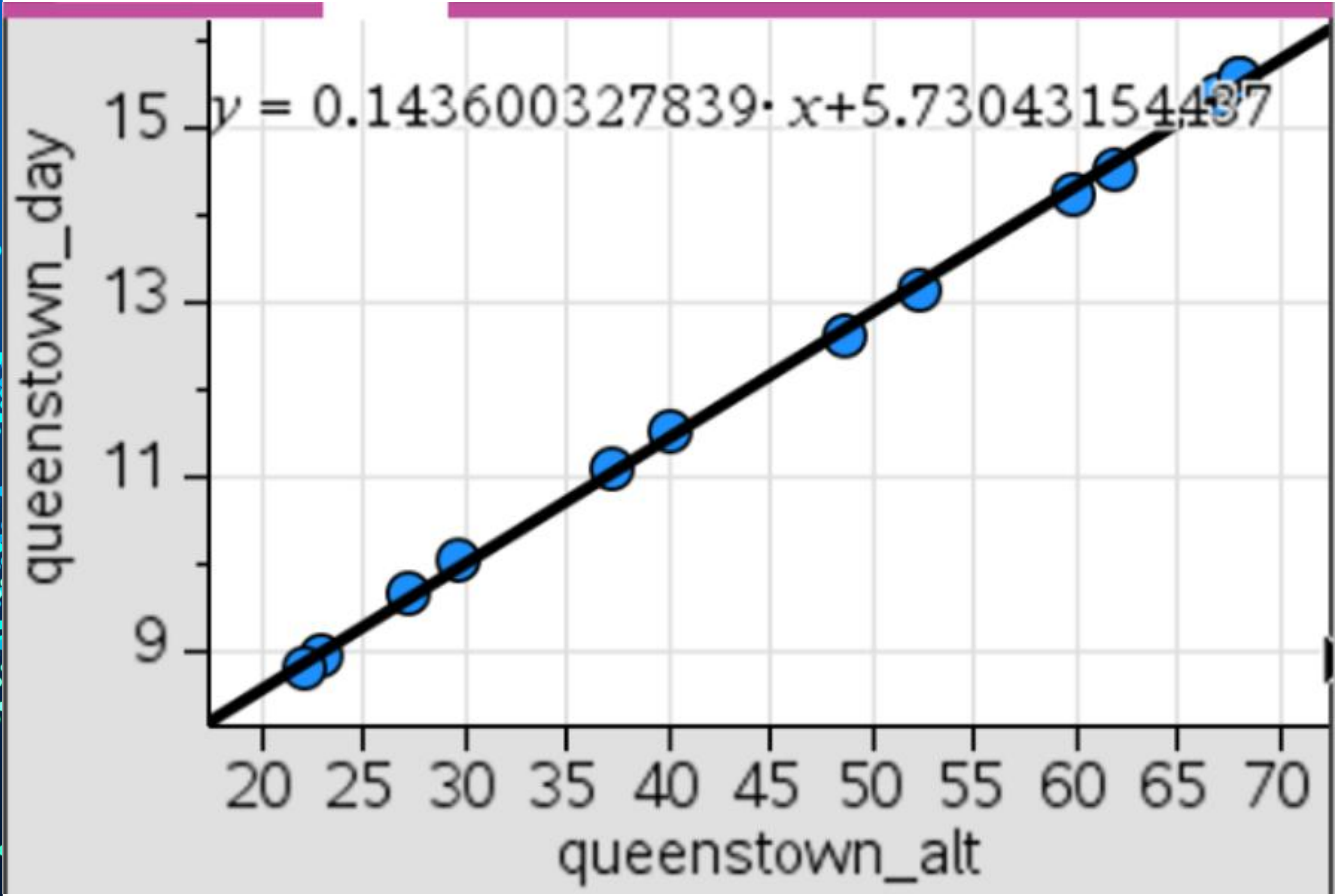
y = 0.182339950844· x+5.2163231606
london_day
15
12
9
15 20 25 30 35 40 45 50 55 60 65
london_alt

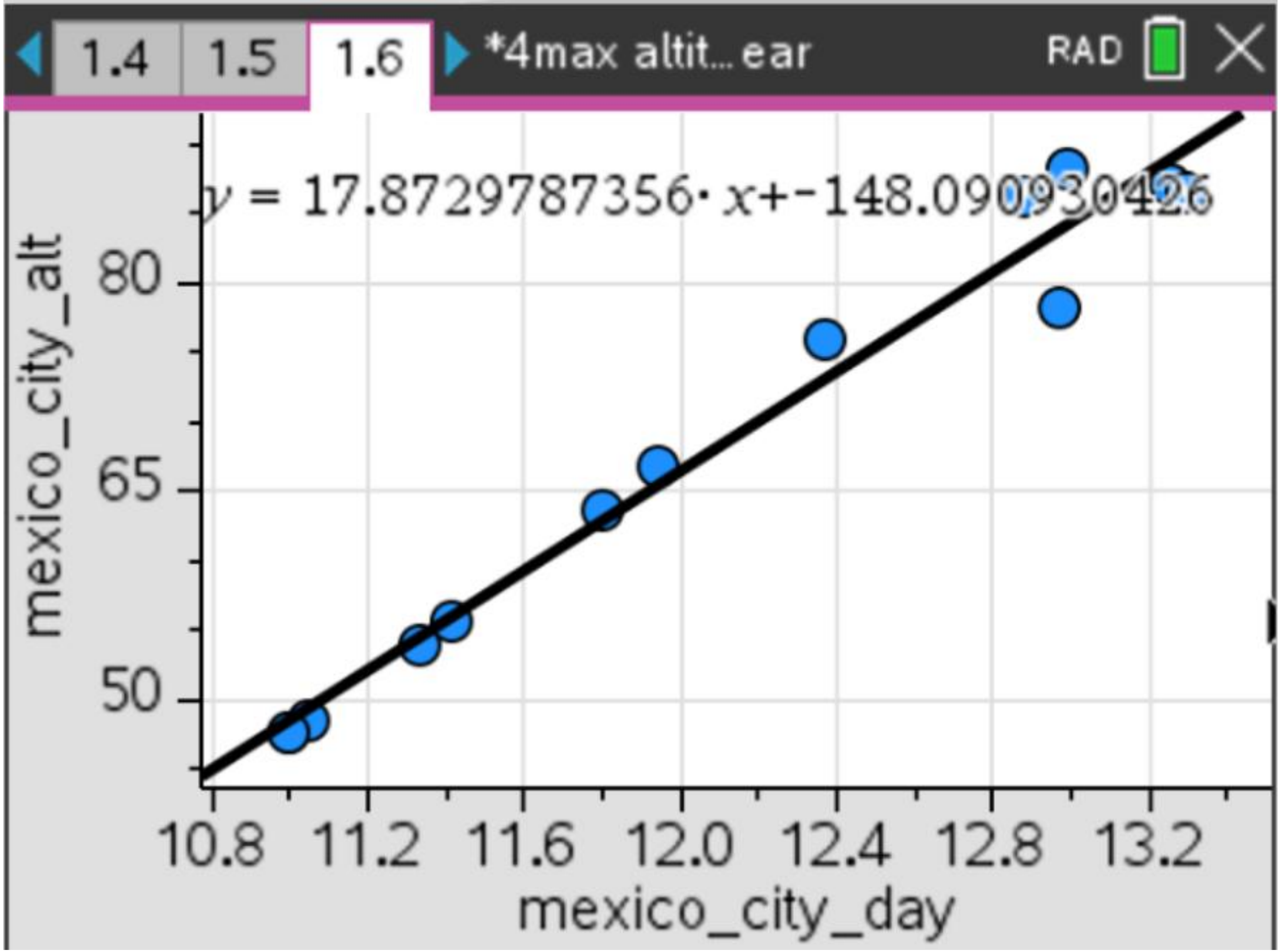


y = 14.1320759651·x+-108.566754954
caloundra_alt
90
75
60
45
10.4
11.0
11.6
12.2
12.8
13.4
caloundra_day

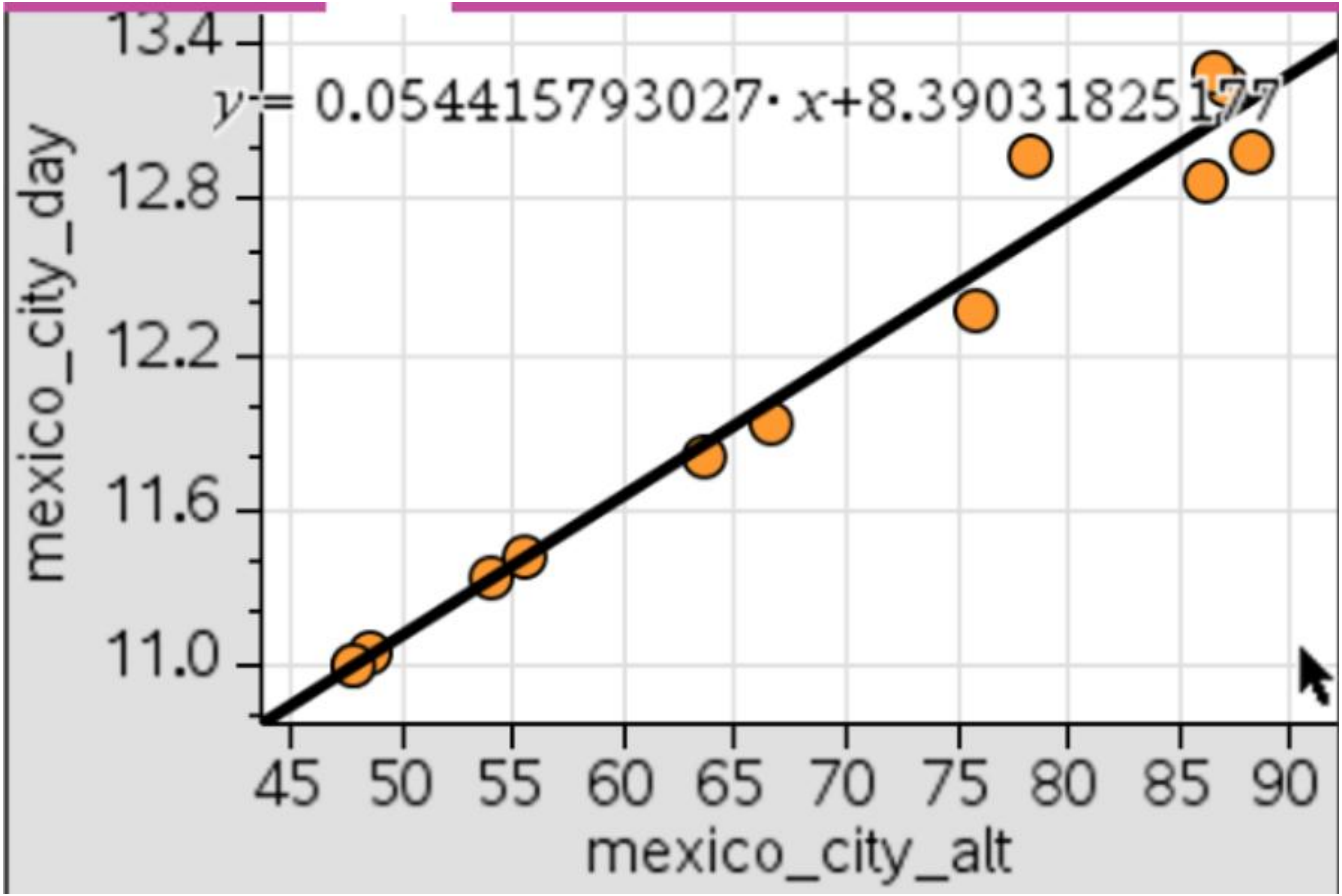

y = 0.070649564223· x+7.68948272638
13.8
13.0
12.2
11.4
10.6
caloundra_day
40 45 50 55 60 65 70 75 80 85 90
caloundra_alt


y = 6.959495584389·x+-39.8523950059
queenstown_alt
queenstown_day
70
55
40
25
9
10
11
12
13
14
15
16

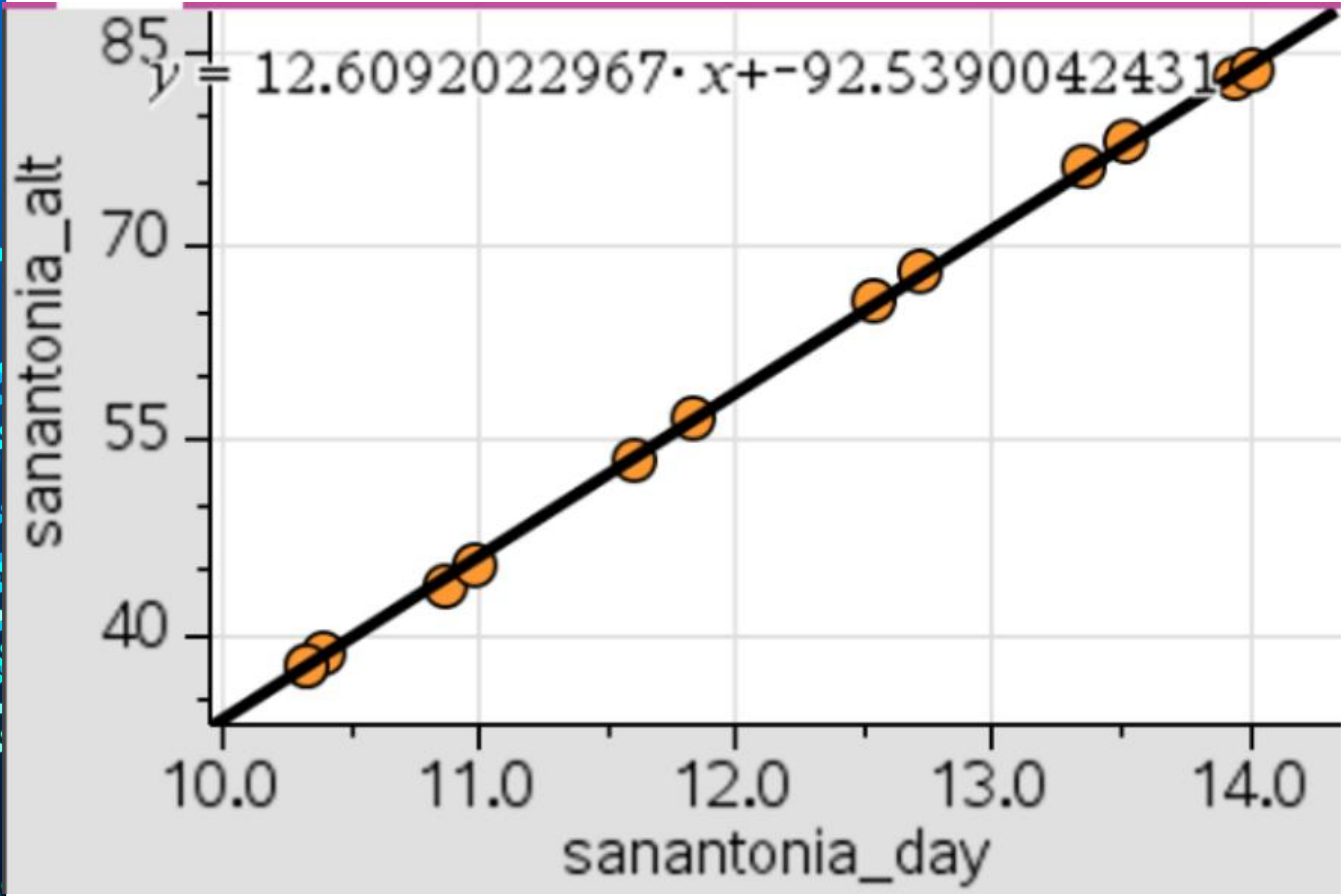

y = 0.143600327839· x+5.73043154437
queenstown_day
15
13
11
9
20
25
30
35
40
45
50
55
60
65
70
queenstown_alt



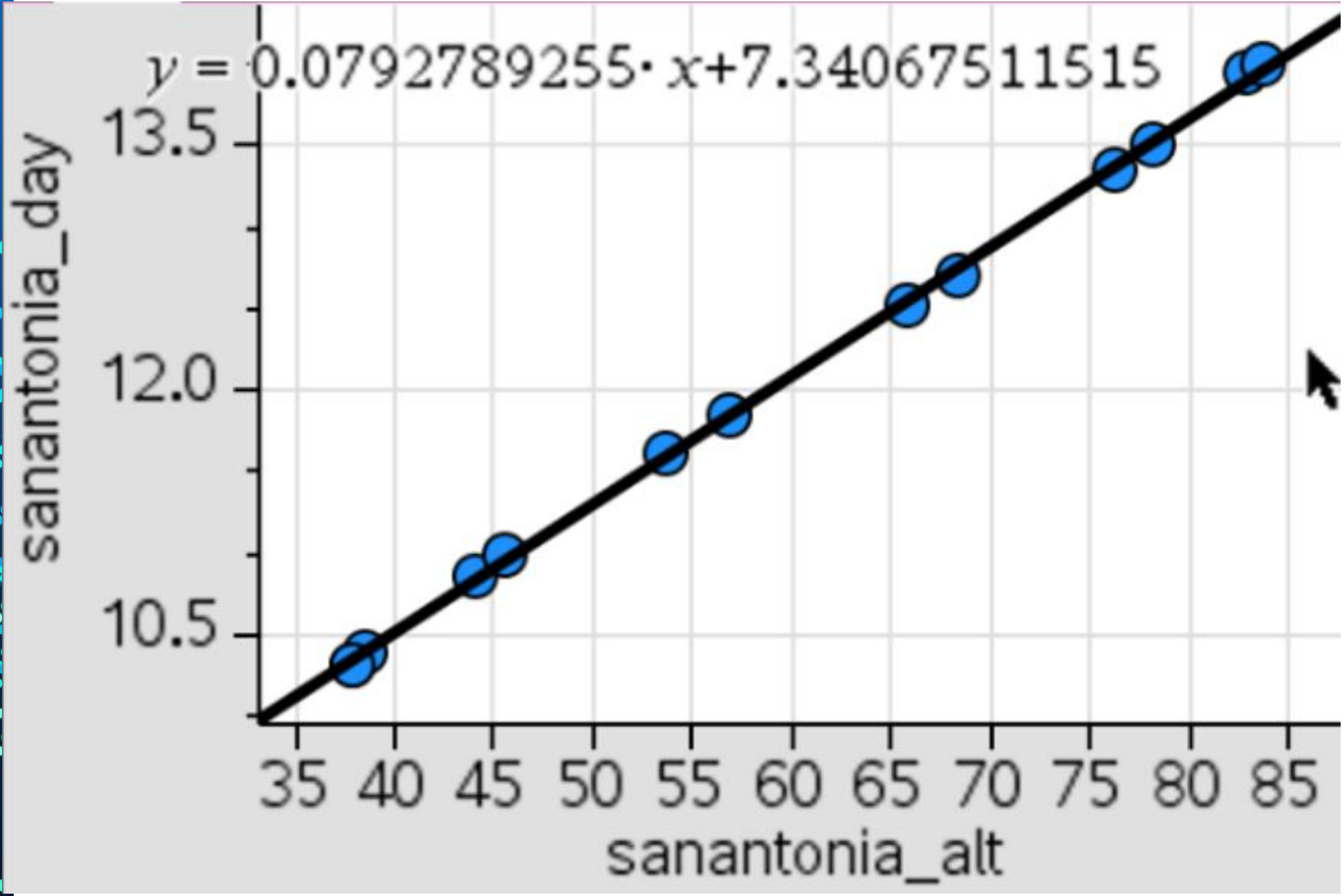
1.4
1.5
1.6
*4max altit... ear
RAD
y = 17.8729787356· x+-148.090930426
mexico_city_alt
80
65
50
10.8
11.2
11.6
12.0
12.4
12.8
13.2
mexico_city_day



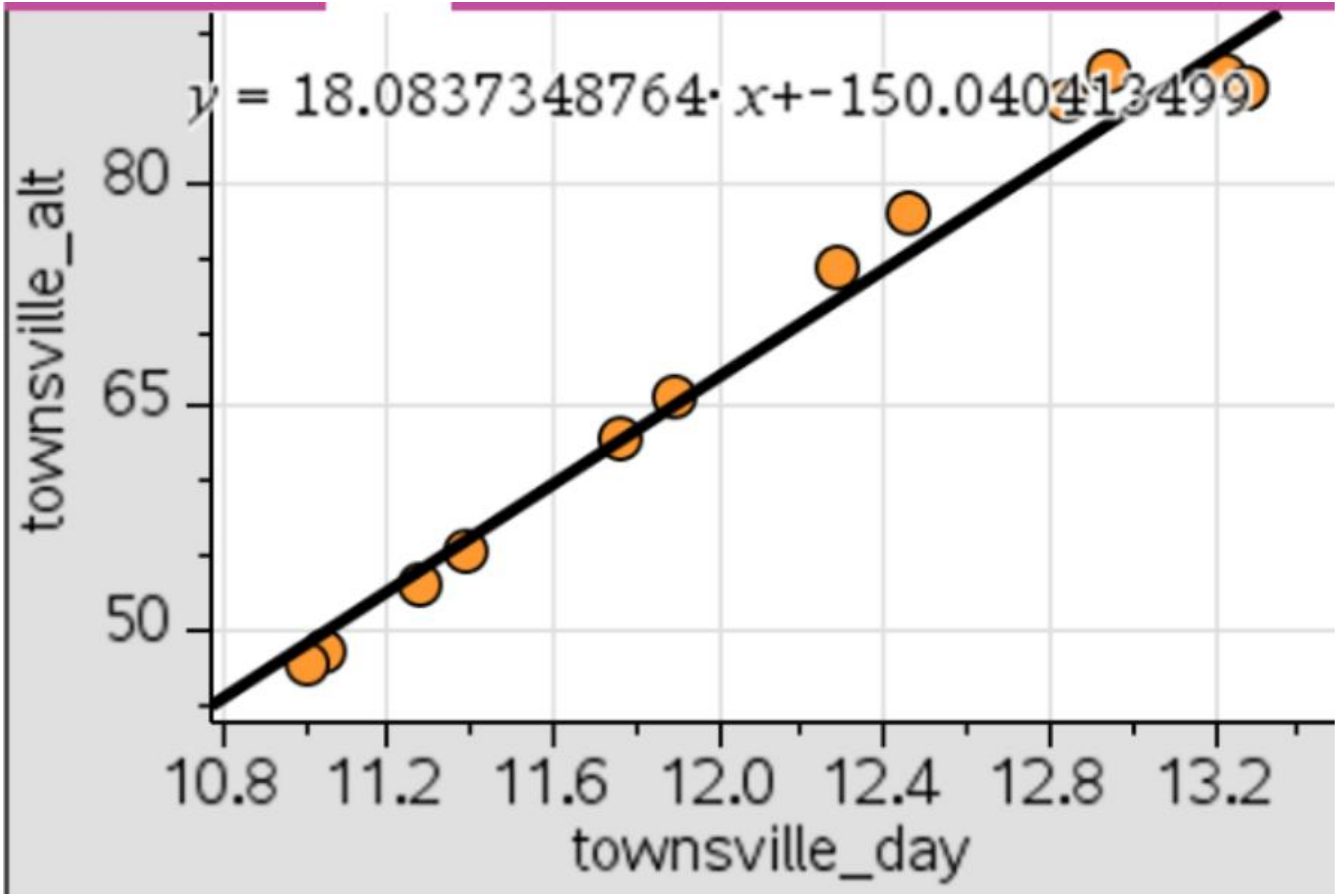
y = 0.054415793027·x+8.39031825177
mexico_city_day
mexico_city_alt
13.4
12.8
12.2
11.6
11.0
45
50
55
60
65
70
75
80
85
90



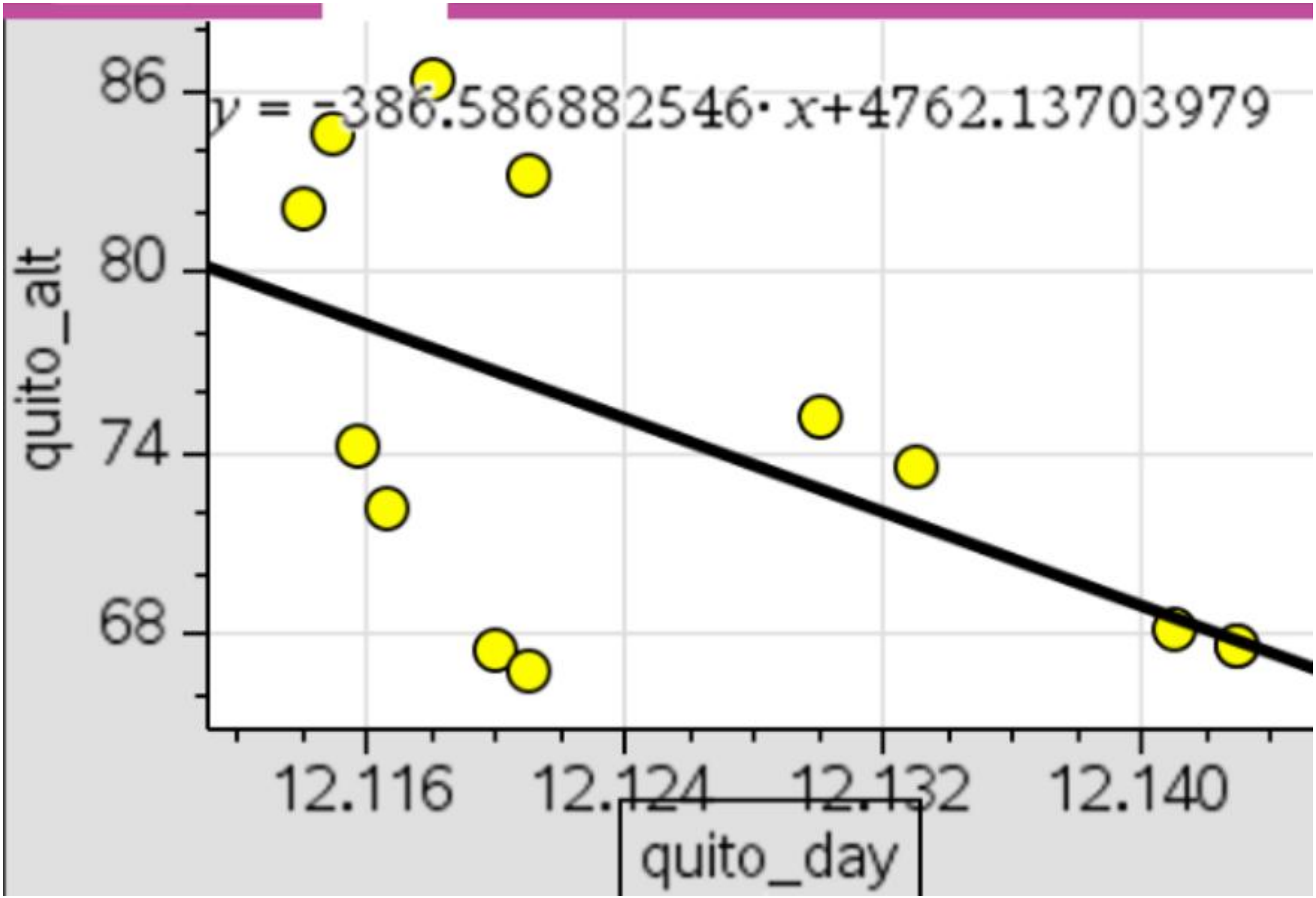
y = 12.6092022967·x+-92.5390042431
85
70
55
40
sanantonia_alt
10.0
11.0
12.0
13.0
14.0
sanantonia_day



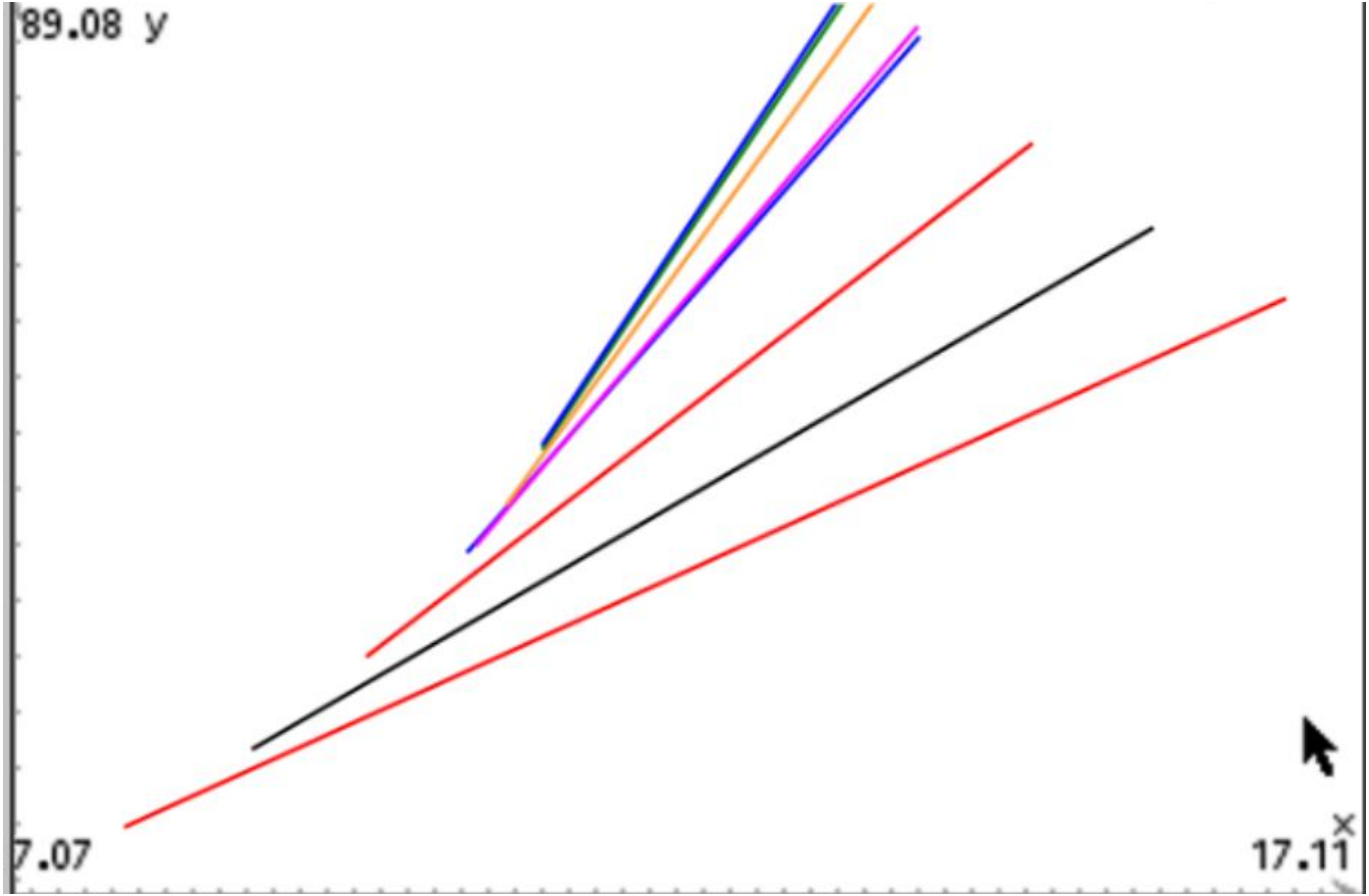
y = 0.0792789255· x+7.34067511515
13.5
12.0
10.5
sanantonia_day
35
40
45
50
55
60
65
70
75
80
85
sanantonia_alt



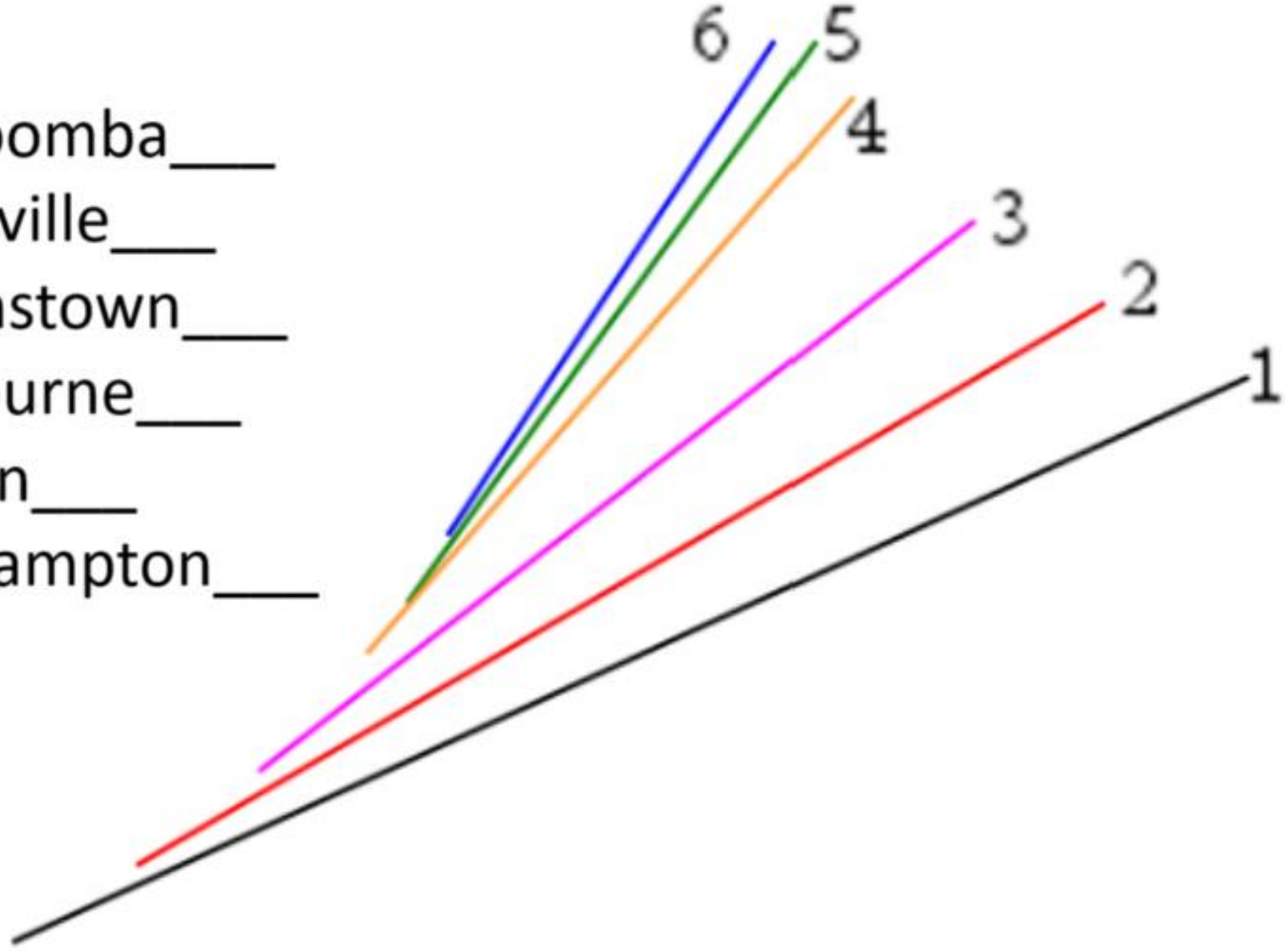
y = 18.0837348764· x+-150.040413499
80
65
50
townsville_alt
10.8
11.2
11.6
12.0
12.4
12.8
13.2
townsville_day



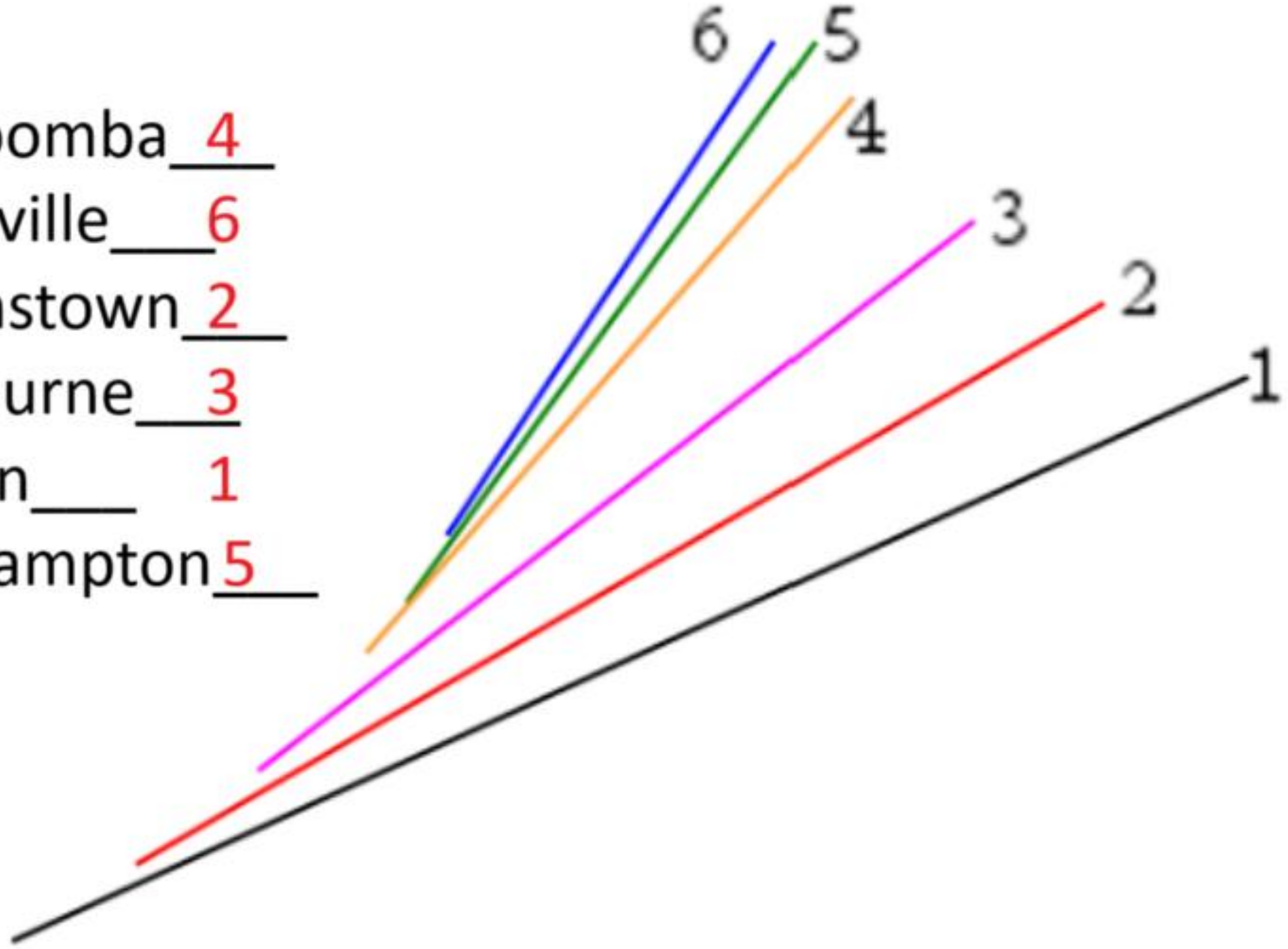
$y = -386.586882546 \cdot x + 4762.13703979$
86
80
74
68
quito_alt
12.116
12.124
12.132
12.140
quito_day


89.08 y
7.07
17.11
x

Toowoomba___
Townsville___
Queenstown___
Melbourne___
London___
Rockhampton___



Toowoomba_4__
Townsville___6
Queenstown_2___
Melbourne___3
London___ 1
Rockhampton5___



Event App

App Download Instructions

Step 1: Download the App 'Arinex One' from the App Store or Google Play

App Store

Google Play

Step 2: Enter Event Code: **mav**

Step 3: Enter the email you registered with

Step 4: Enter the Passcode you receive via email and click 'Verify'. Please be sure to check your Junk Mail for the email, or see the Registration Desk if you require further assistance.

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