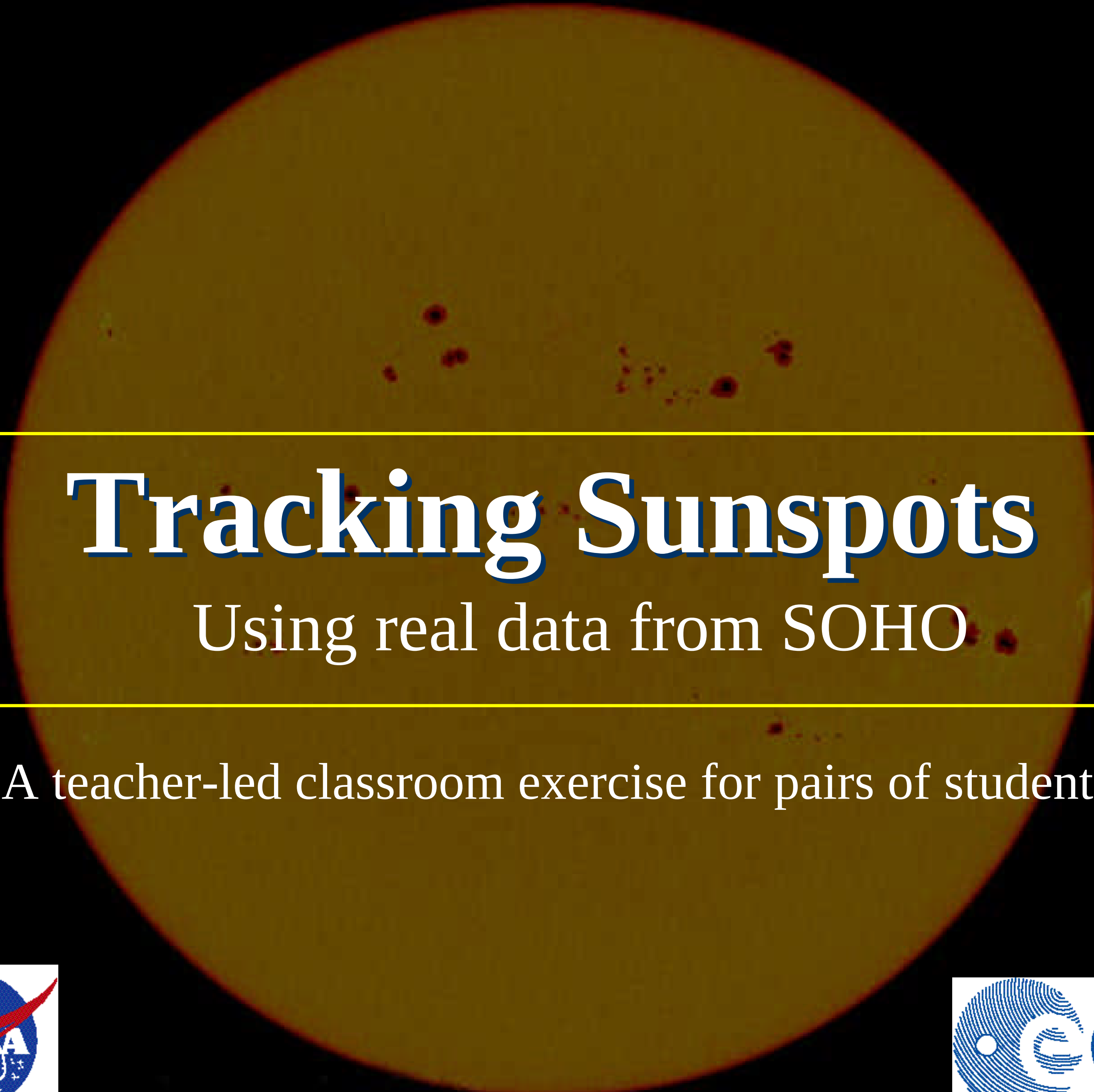


Tracking Sunspots

Using real data from SOHO

A teacher-led classroom exercise for pairs of students

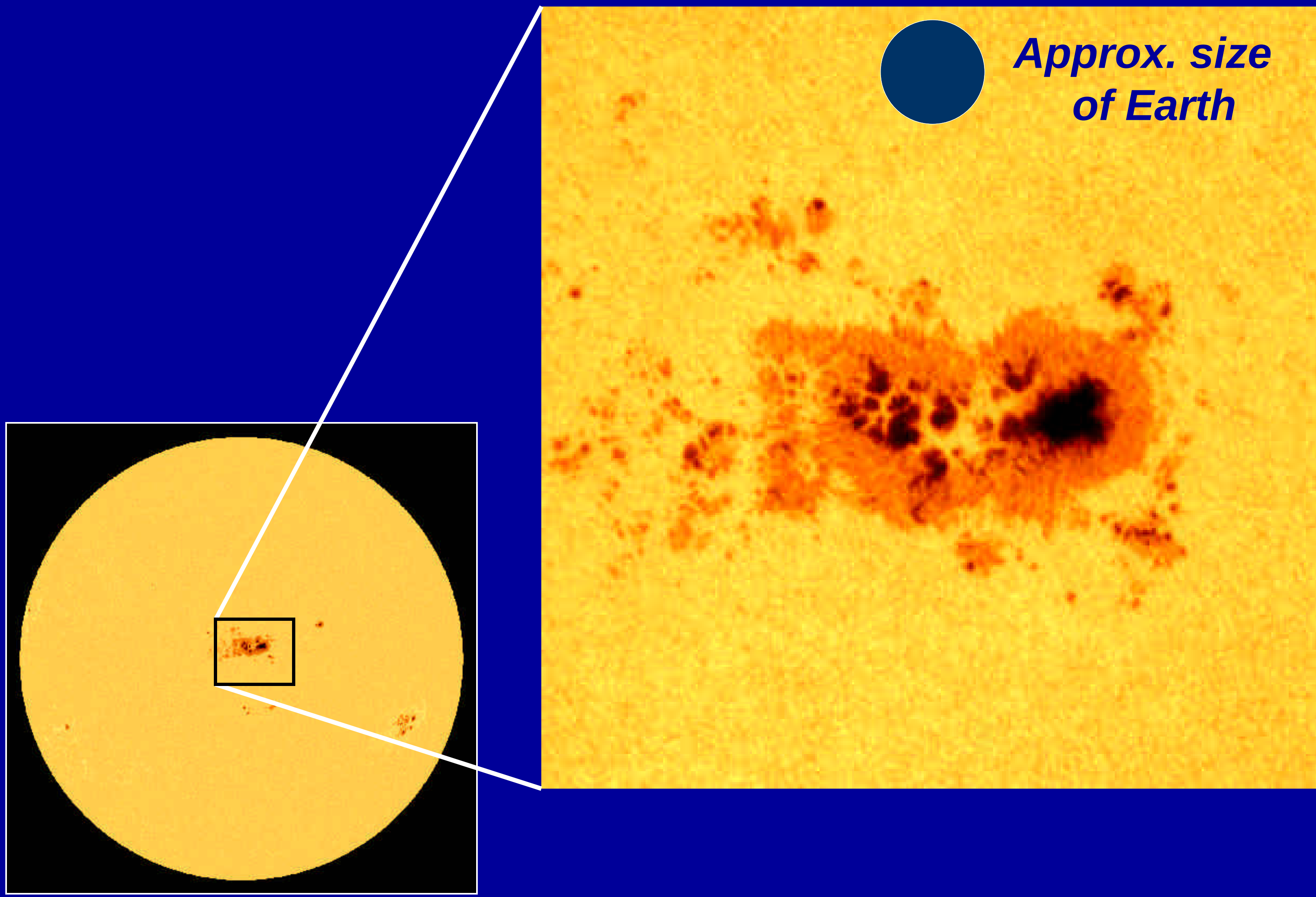
You are about ready to start observing and tracking sunspots across the Sun using real images. You can then use this information to determine the rate of the Sun’s rotation.

Some sunspot facts:

- Sunspots are dark, cooler areas on the Sun’s surface that indicate areas of strong magnetic activity
- They appear dark only because they are not as hot or bright as the area surrounding them (4,000 degrees C. vs. 6,000 degrees C.)
- Sunspots extend down into the Sun as well as above where loops of magnetic field lines carry charged particles
- They can last from just hours to several months

How BIG are they? **Next page…**

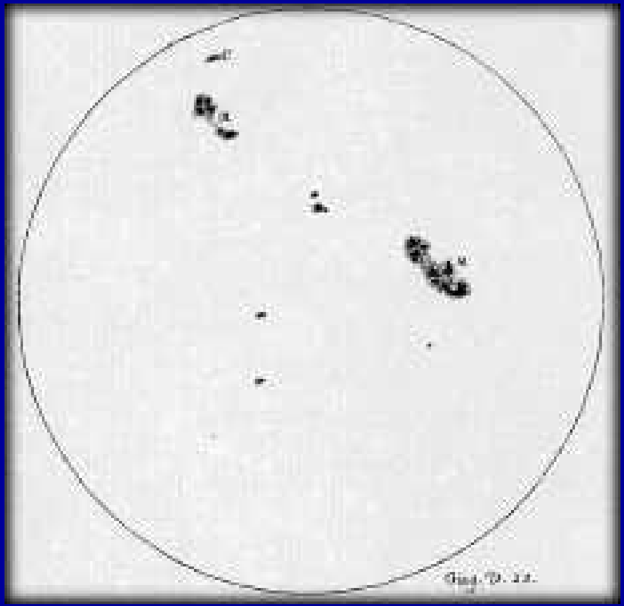
Sunspots, which usually appear in groups, can grow to many times the size of Earth



How and when did scientists discover that there were spots on the Sun?

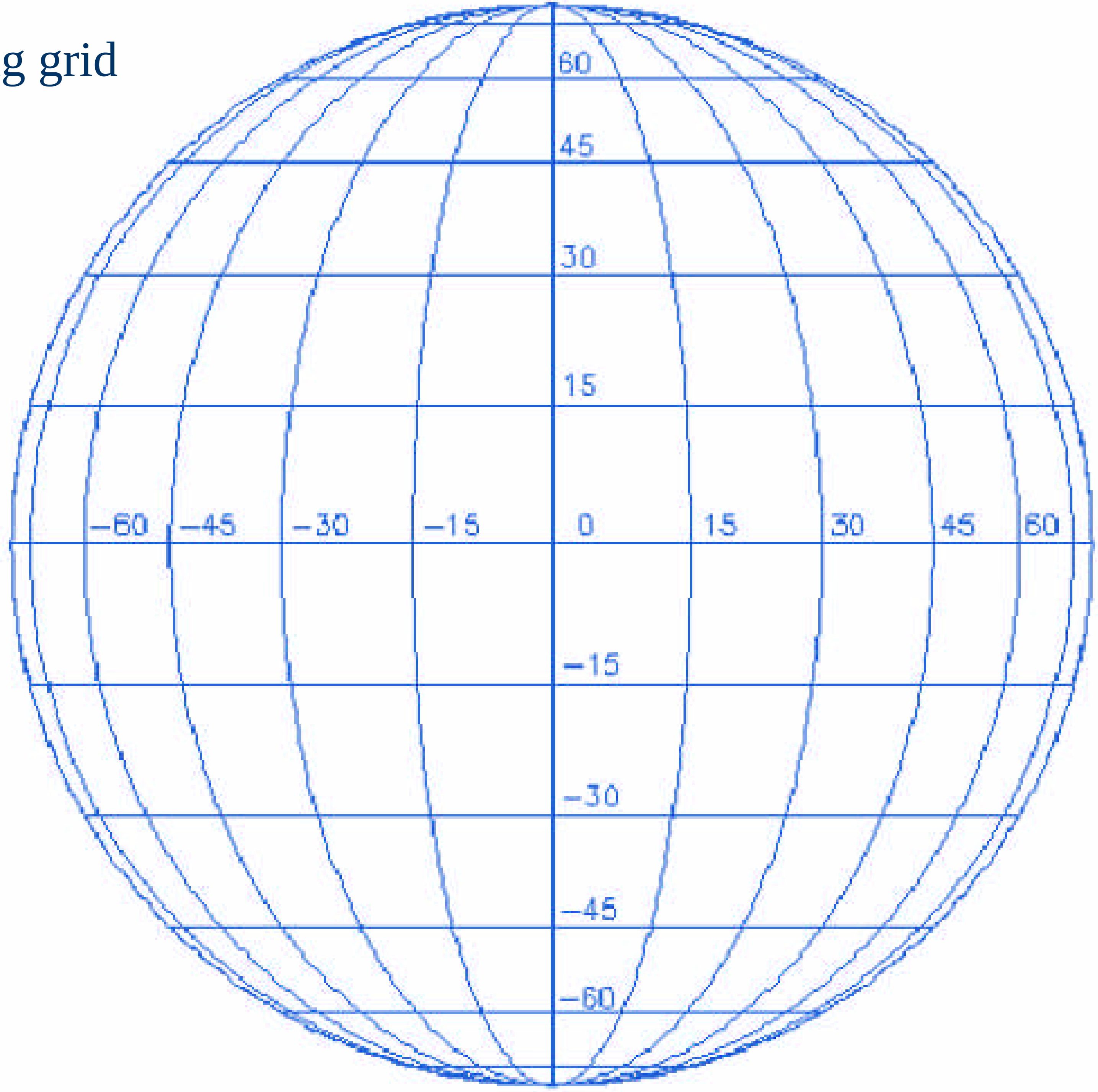
The first telescope was made in Europe in 1608. Galileo, who first performed scientific observations in the early 1613, concluded that the Sun did indeed have spots. If, as others suggested, these spots are planets passing in front of the Sun, they'd be the same in the center as near the edges. He noted changes in size and shape. Other scientists came to similar conclusions.

Galileo and one of his original sunspot drawings



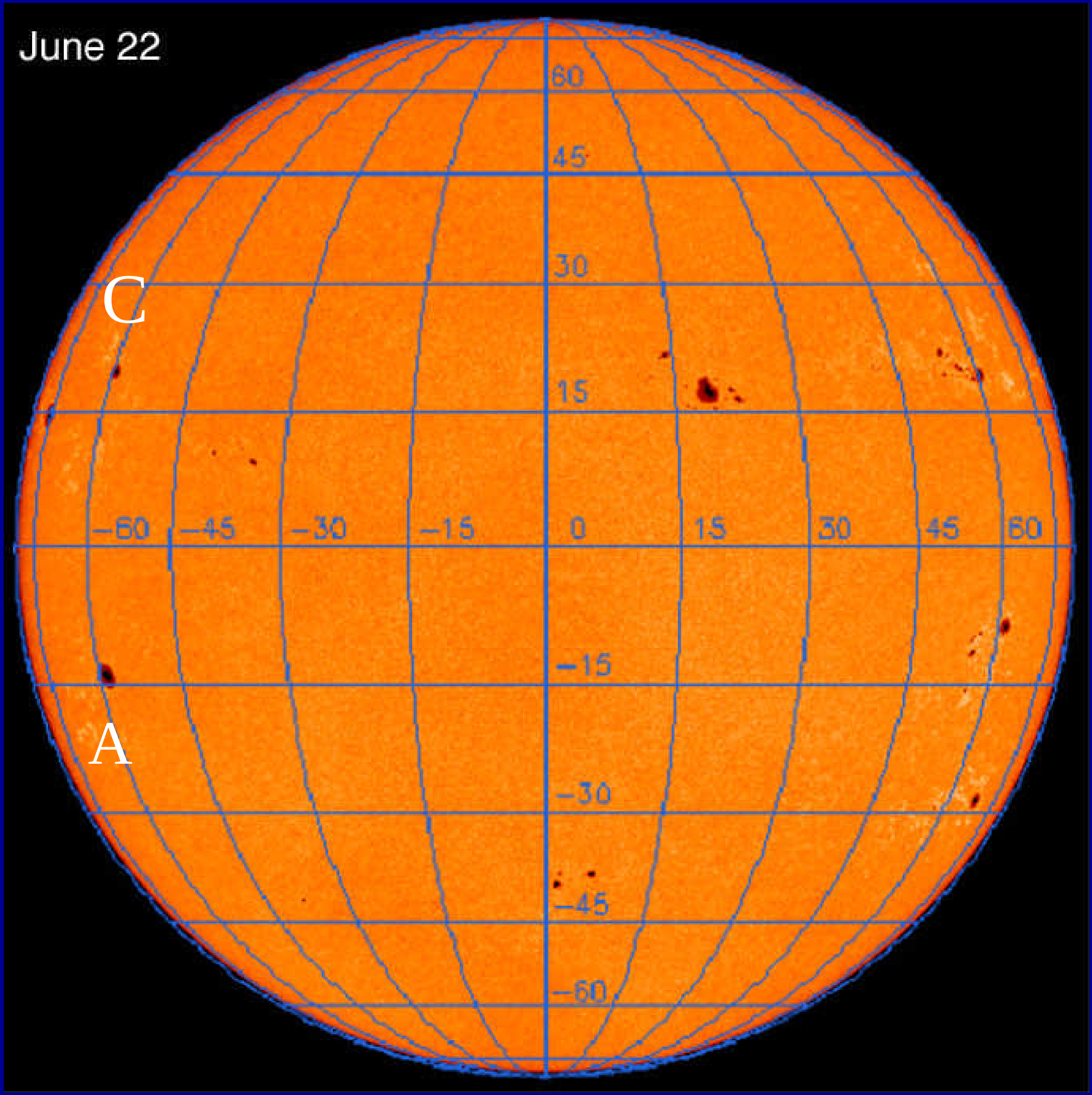
To begin, first print out the mapping grid on the following page -- each two-person team will need one

Mapping grid

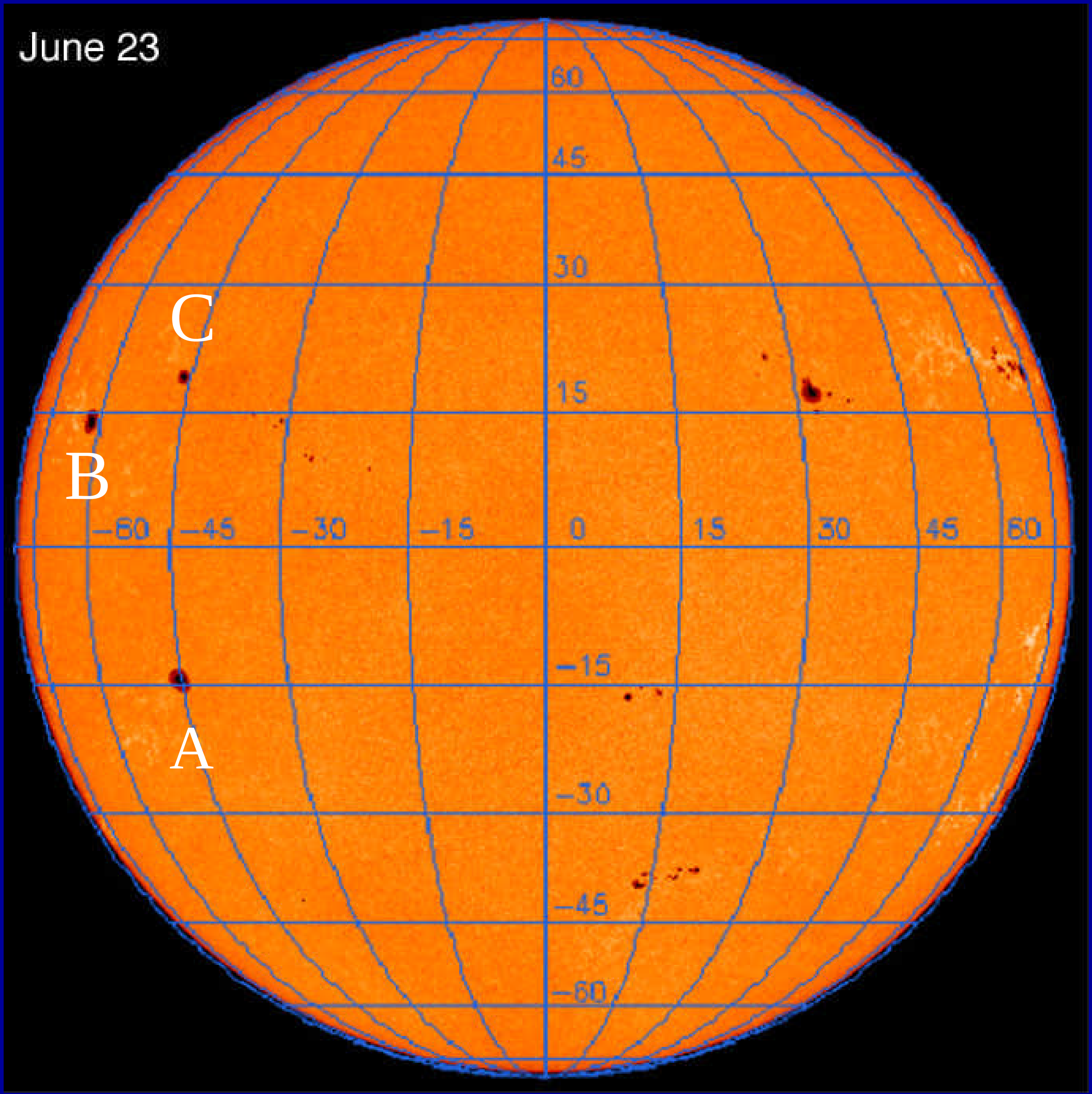


How to proceed

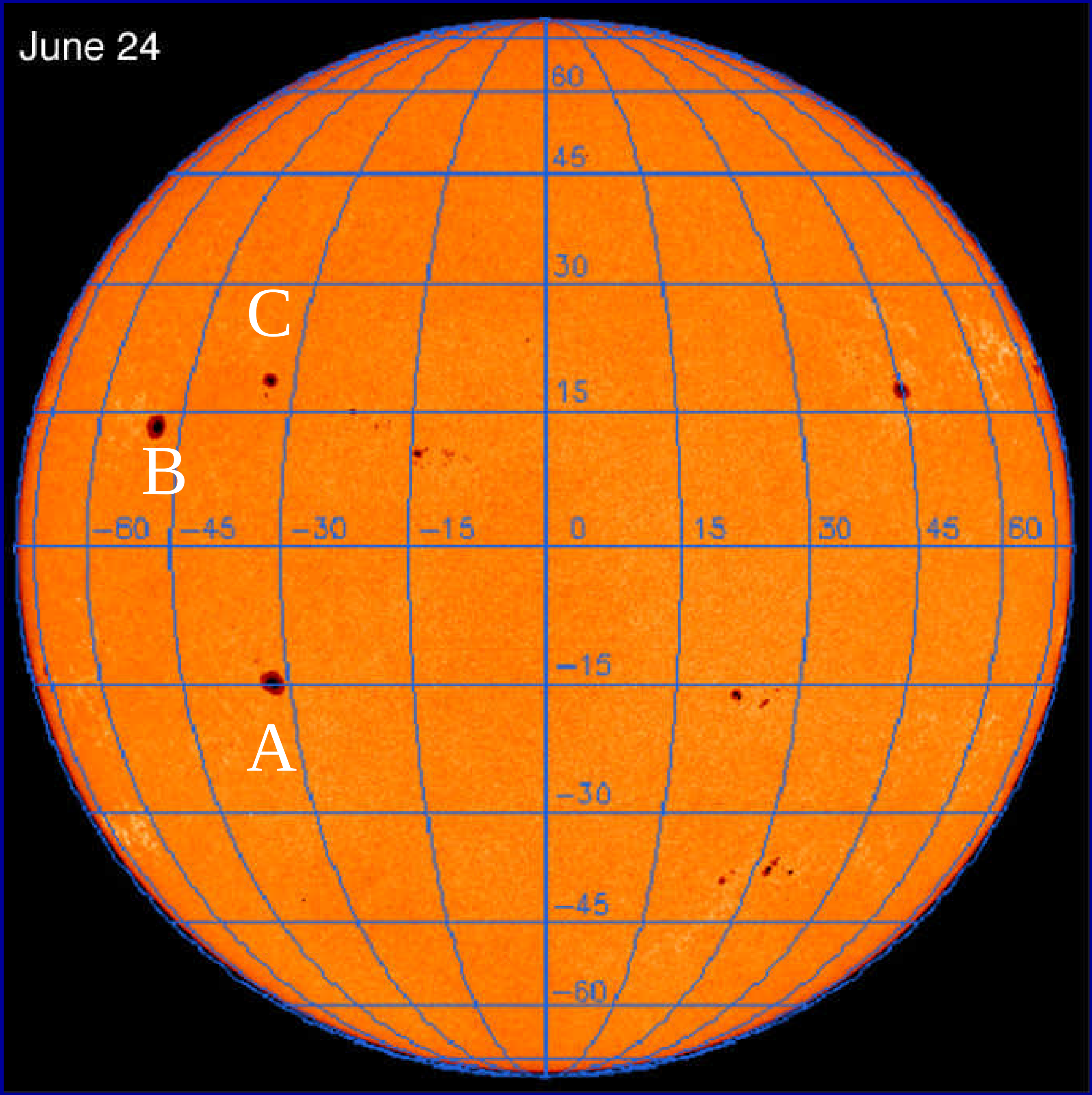
- Divide the class into teams of two students, then have the teams assigned to track one of three marked sunspot groups: (A), (B), or (C)
- Show the sunspot images from June 22 to July 3
- For each day, one team member notes on their printed grid where the group Groups A, B, C are, and note the date and any changes in shape or size. The other writes down its position in terms of longitude (for example, spot A appears at -60 longitude on June 23).
- We are pretending that for each day we are stepping outside at about the same time each day, projecting the sunspots onto paper, and tracing where they appear. Thus, we are observing and recording sunspots.


June 22
60
45
30
15
0
−15
−30
−45
−60
−60
−45
−30
−15
0
15
30
45
60
C
A

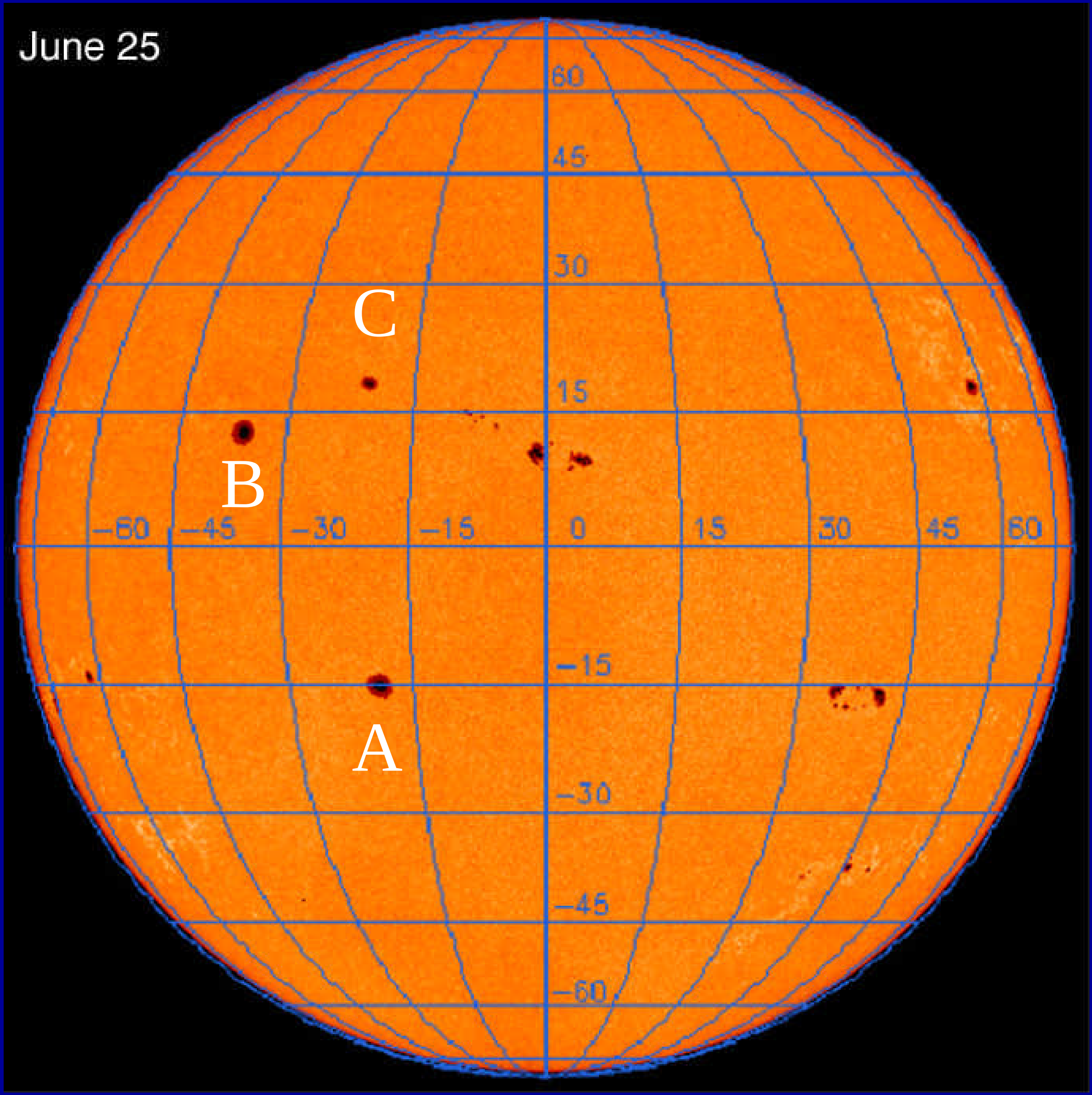
June 23



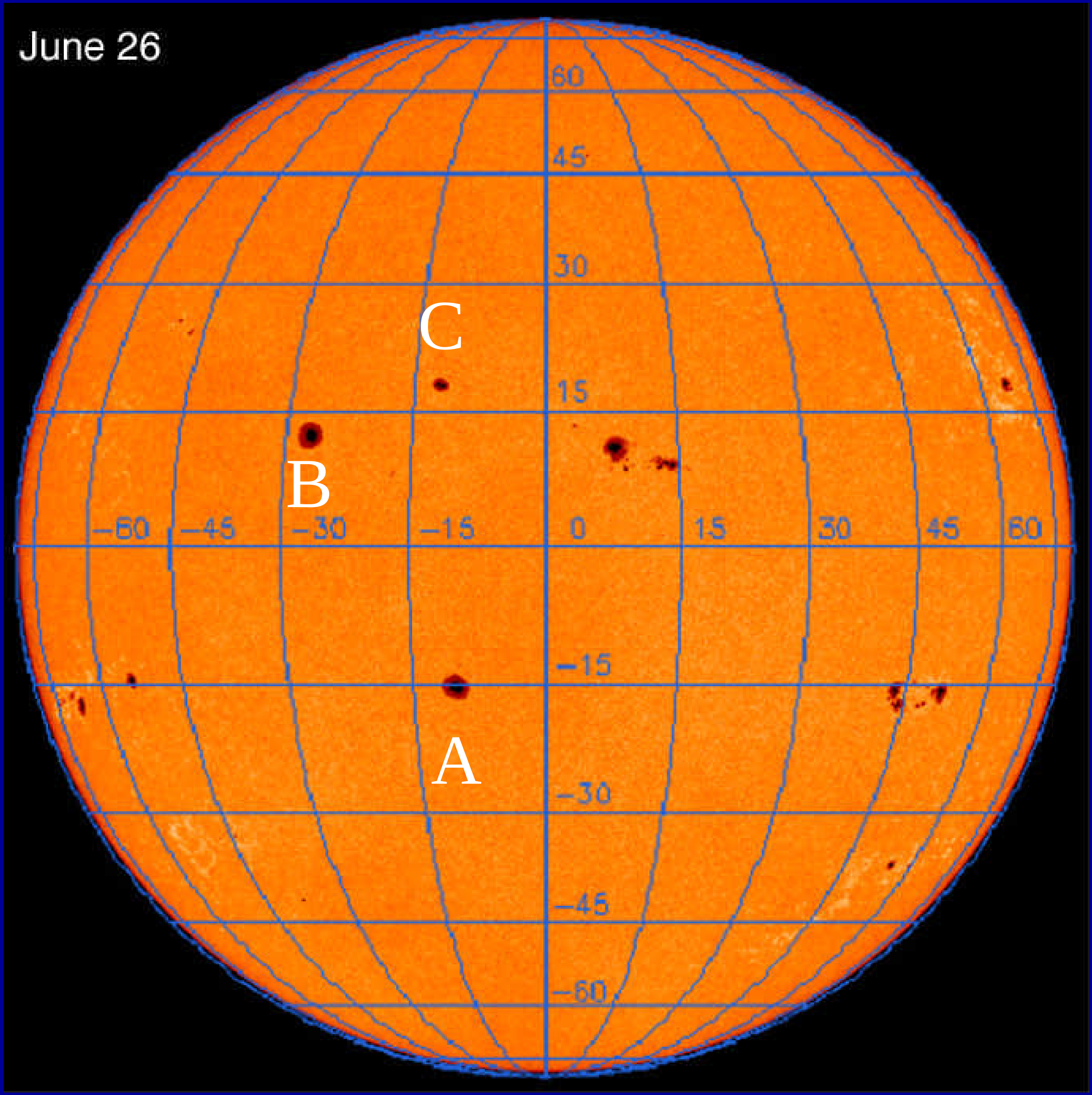
June 24



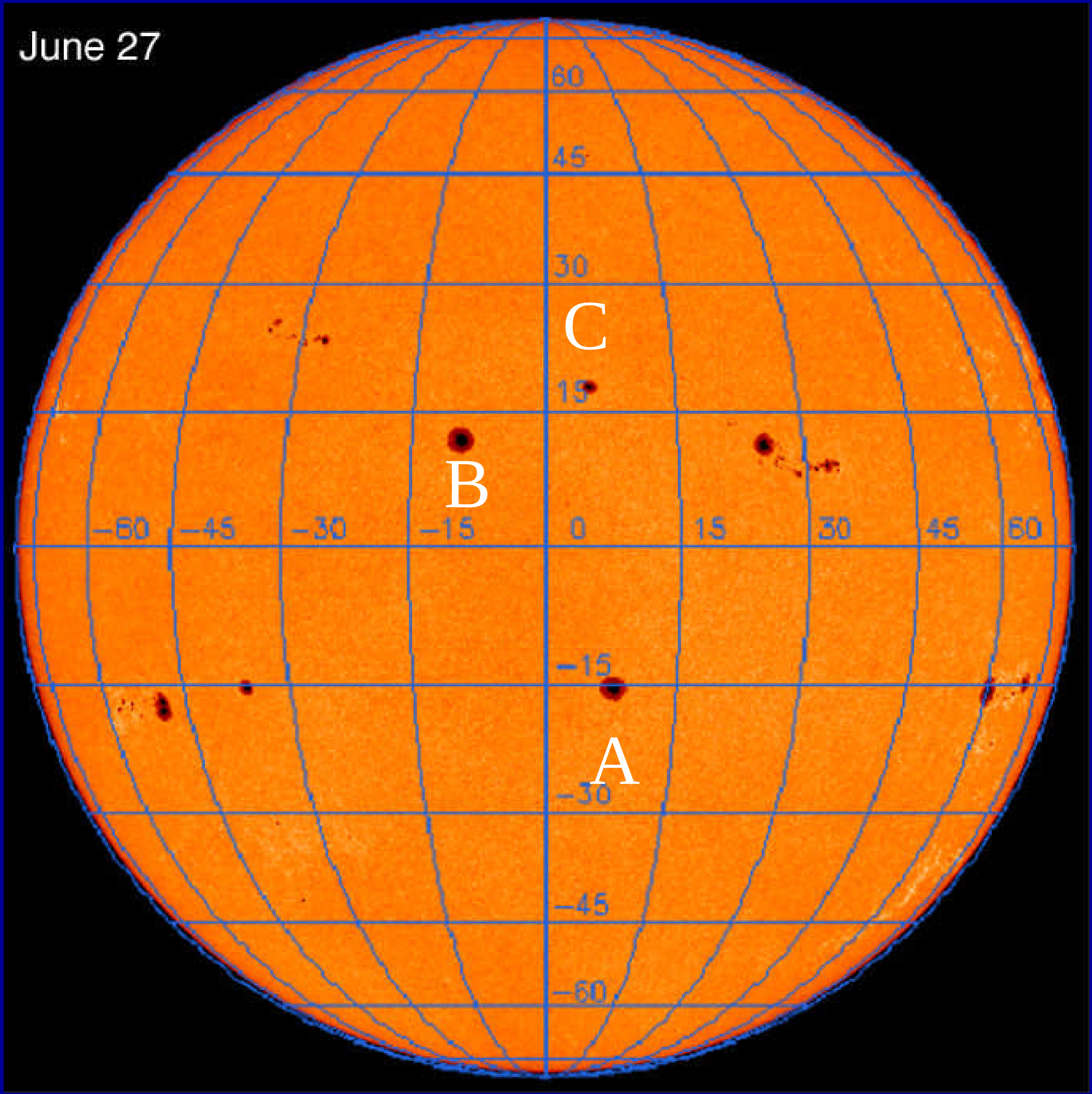
June 25



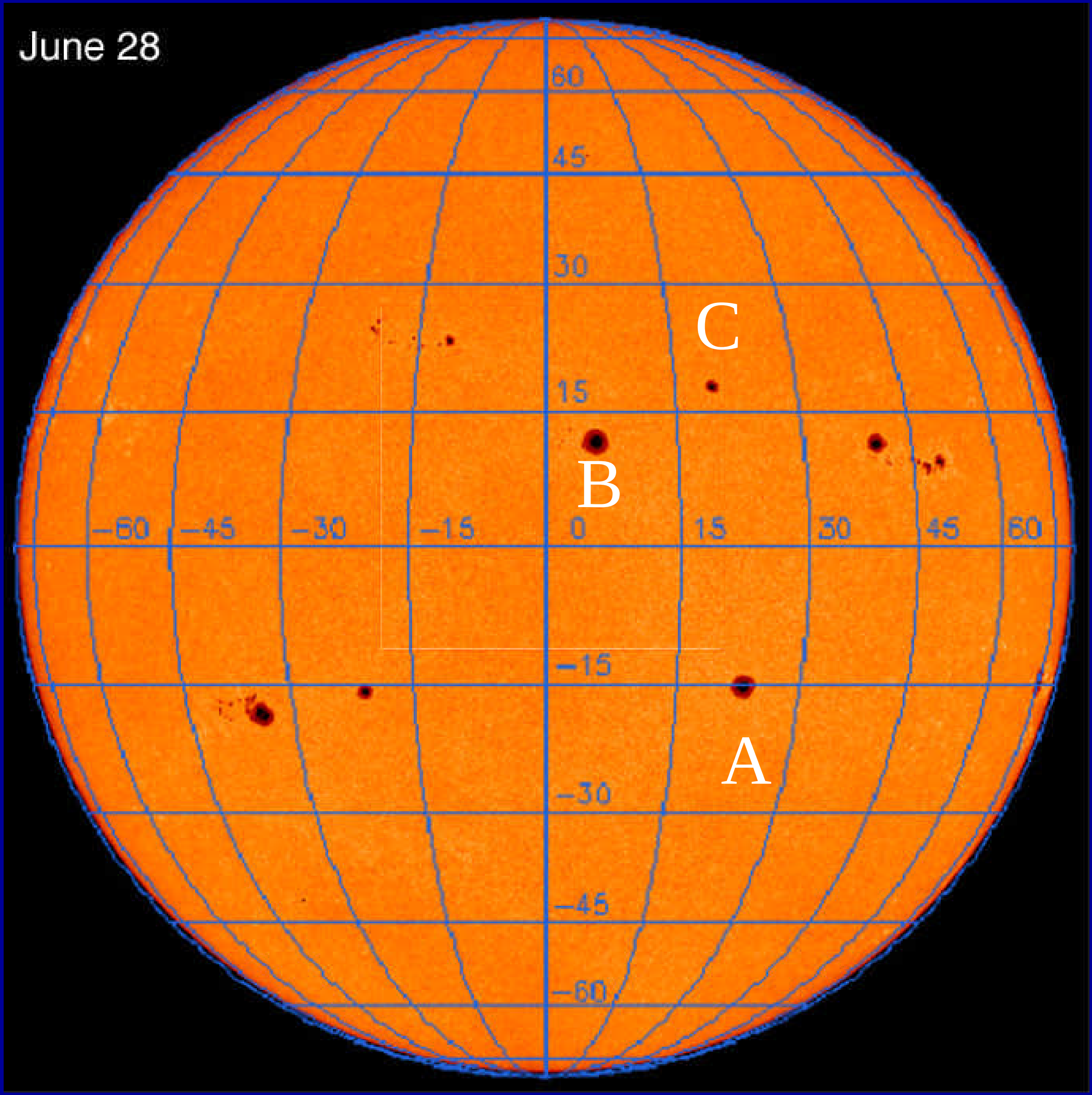
June 26



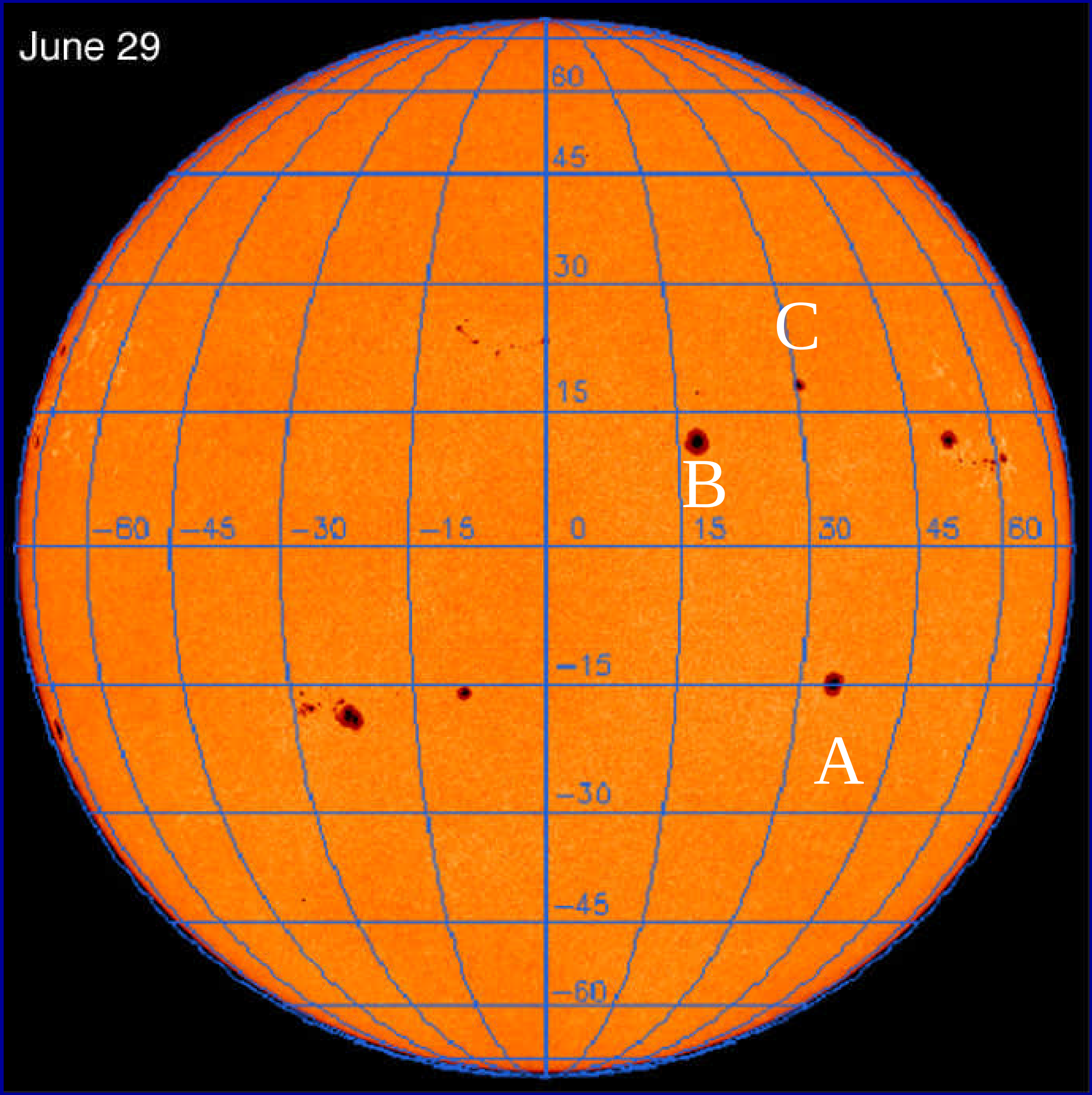
June 27



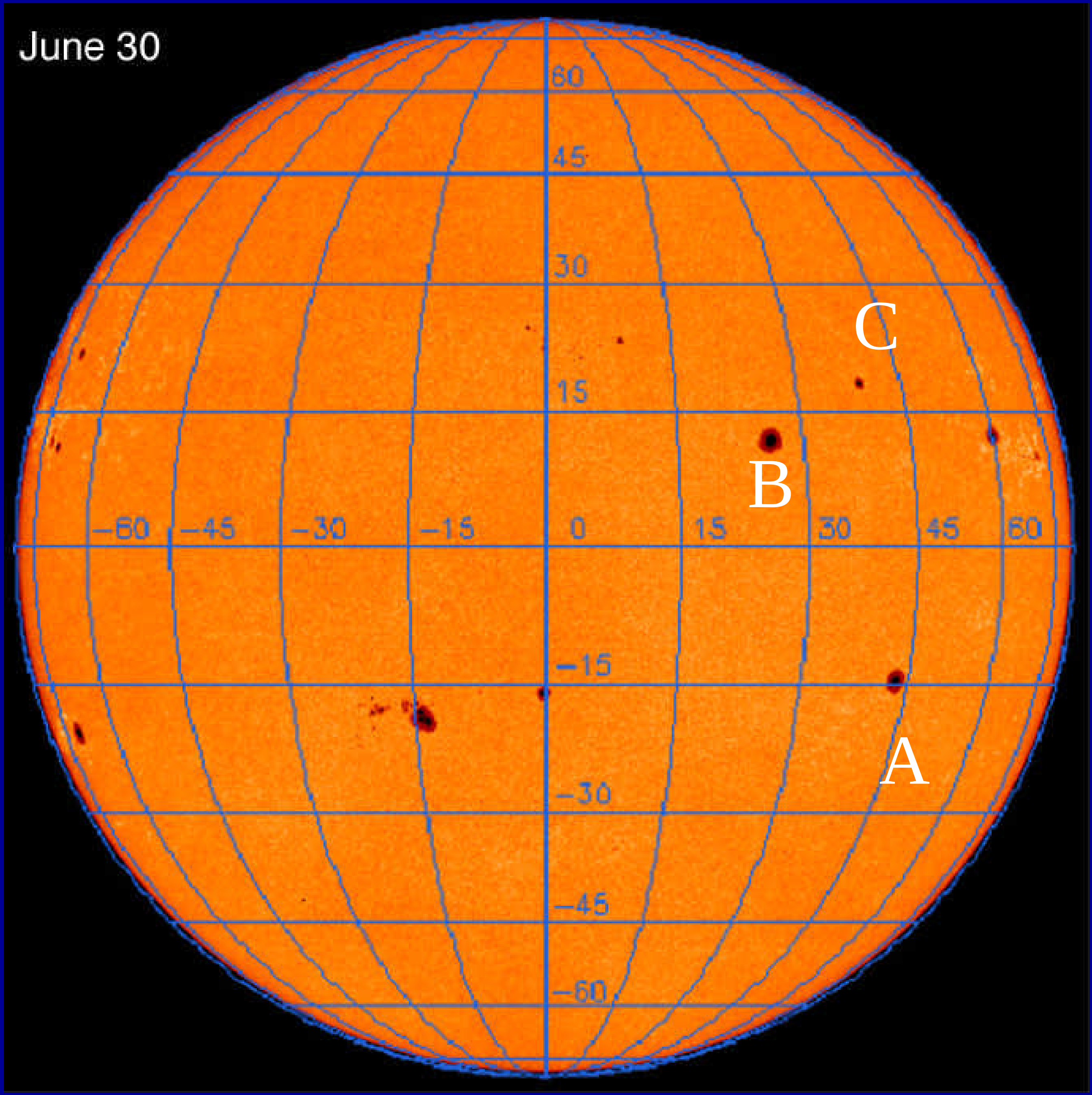
June 28



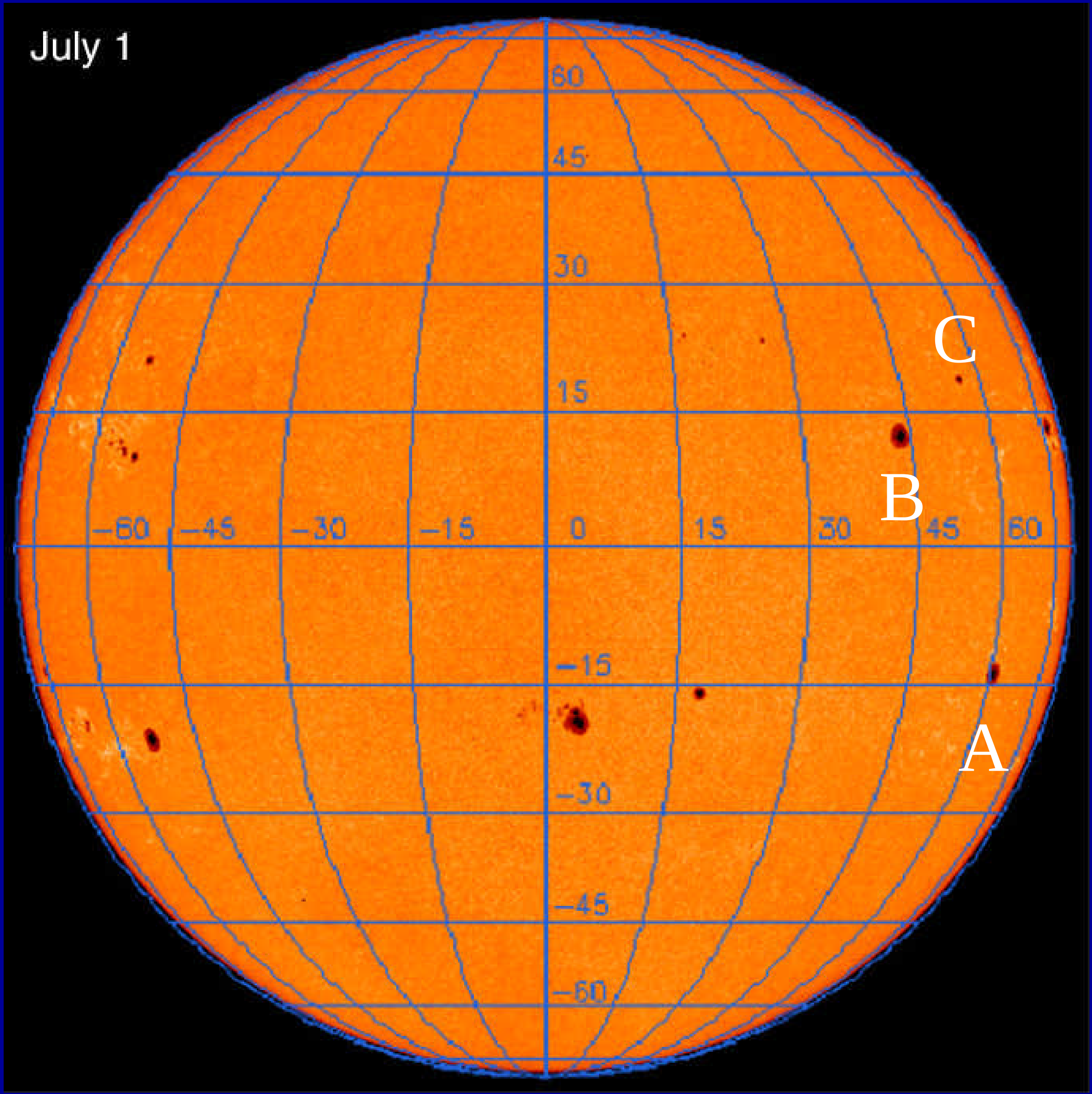
June 29



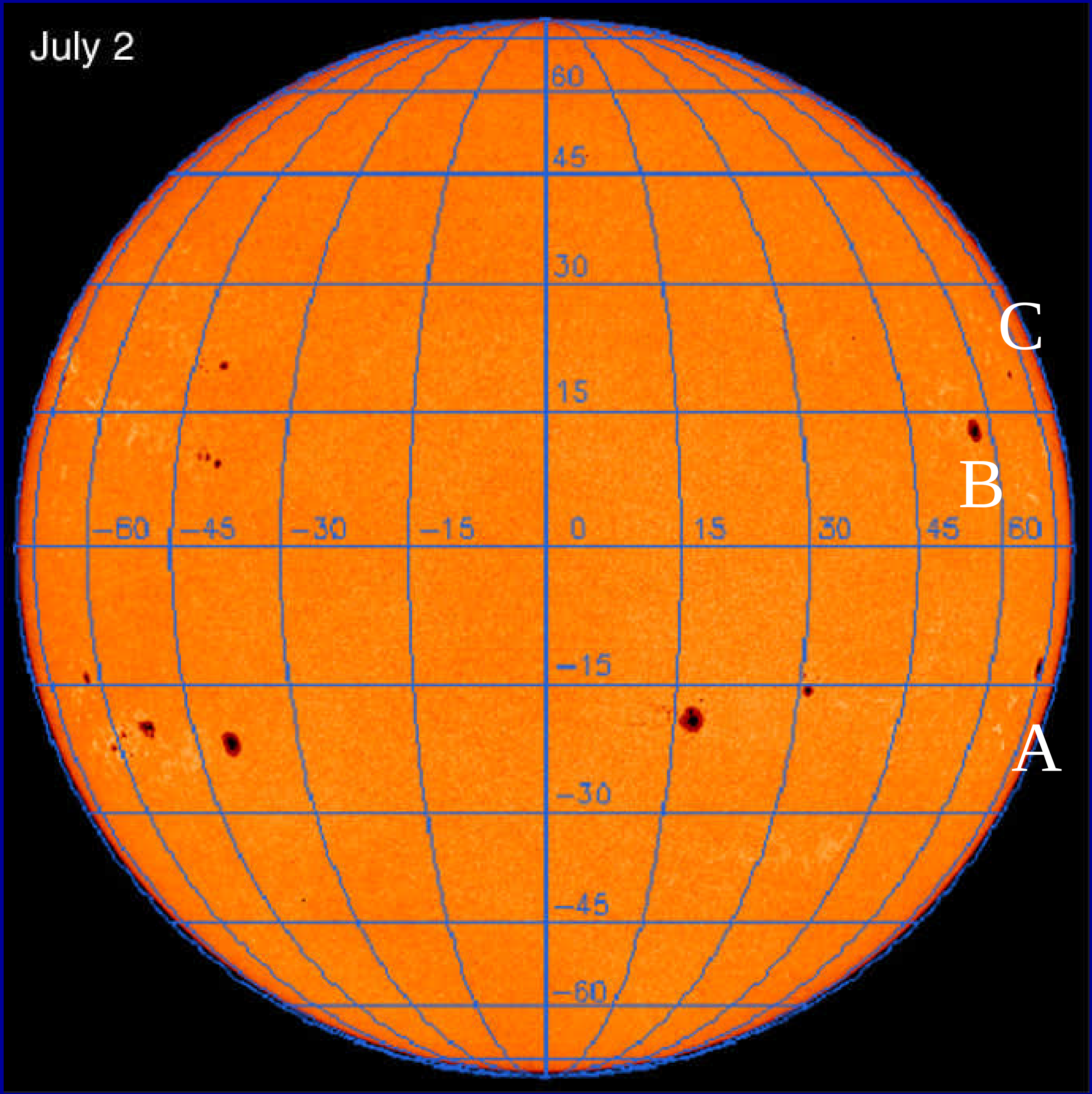
June 30



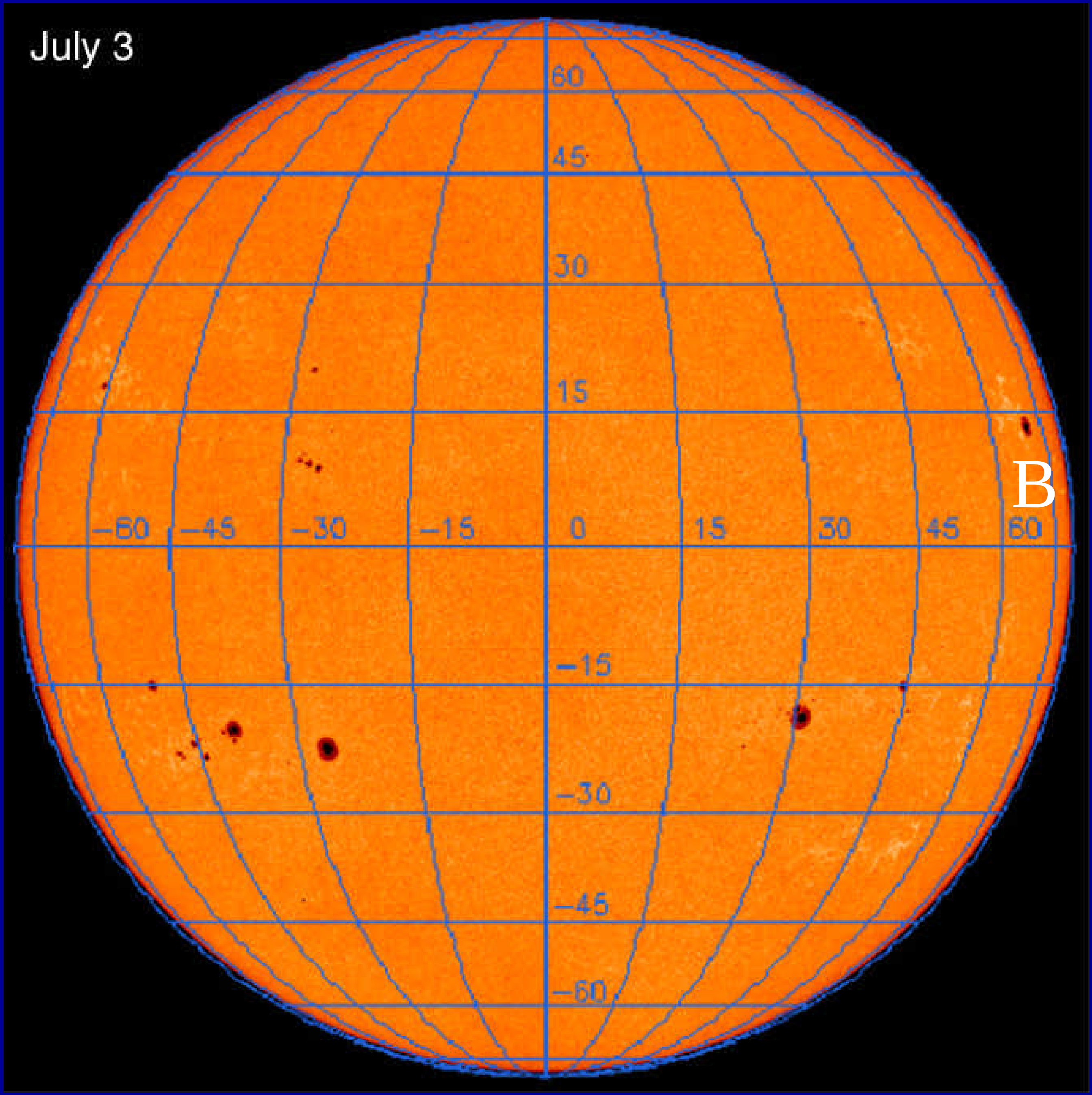
July 1



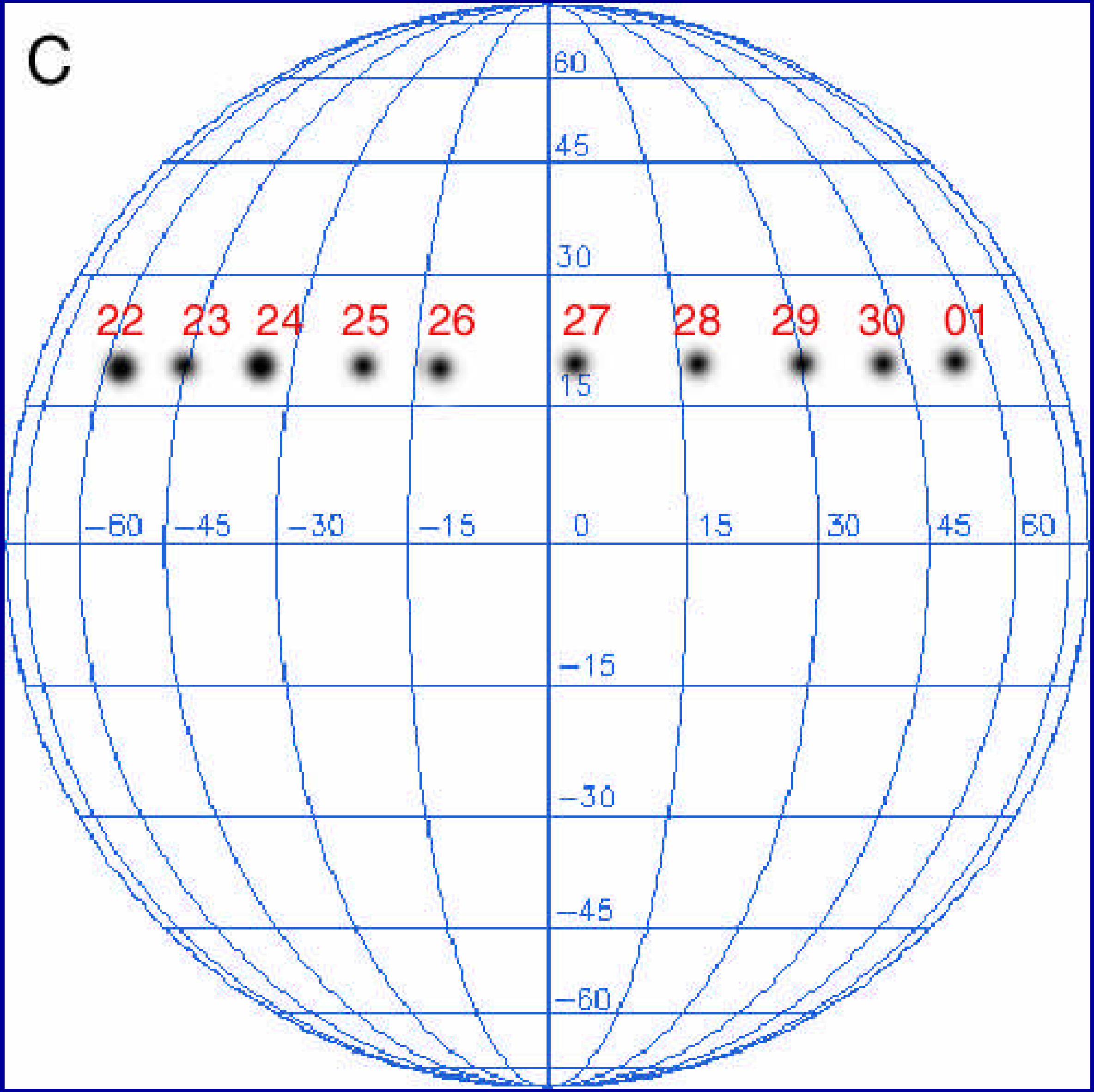
July 2



July 3



Sample mapping worksheet



Sample data recorded

(numbers are approximate)

Spot Group	A	B	C
	Longitude		
June 22	-60	--	-60
June 23	-45	-58	-45
June 24	-30	-30	-33
June 25	-18	-23	-20
June 26	-12	-12	-13
June 27	8	-7	4
June 28	23	5	17
June 29	33	17	30
June 30	43	23	38
July 01	55	42	53
July 02	65	56	--
July 03	--	70	--

Analysis

- Team members should review their data to make sure that the numbers match the drawings.
- Next, determine about how many degrees of longitude their group moved each day.
- To get the average daily movement, determine the the total degrees of change noted from one day to the next. Next, add these up,and divide by the number of days these represent.
- Do the A, B, and C teams agree? Did all sunspot groups move at about the same rate? What was the average?
- Did some spots seems to change in size or shape?

What can we conclude?

- The sunspots seem to be moving at about 12 degrees per day. Now we are ready to answer the BIG question: How long does it seem to take the Sun to make a full rotation of 360 degrees?
- But remember, because the Earth is moving around the Sun in the same direction at about 1 degree per day (almost 365 days to circle the Sun in a year), we need to add one degree per day to the apparent movement to allow for this (Earth's movement makes it seem like the Sun is rotating less than it really is).

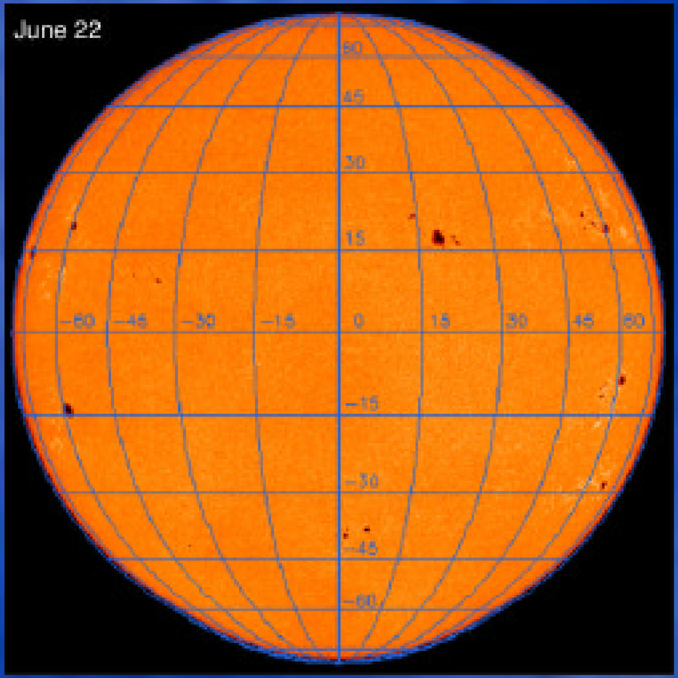
How long does it take to rotate?

- Congratulations! Your basic calculations are correct: the Sun does rotate every 27 days at its middle, about where the spots we observed appeared.

Note: The Sun, being a gaseous body - not a solid object - does not rotate at the same speed all over its surface: thus, it rotates about every 35 days near its poles.

Watch the frames be put into motion!

Click on image to start movie



Remember that you can see daily images of sunspots on the SOHO web site at soho.nascom.nasa.gov

For more sunspot information, go to http://cse.ssl.berkeley.edu/segwayed/lessons/sunspots/index.html