

Total Eclipse of the Sun

Total Eclipse of the Sun

Dr Steve Barrett

8 Feb 2007

2 Introduction

Total Eclipse of the Sun

- The Sun Core
- Surface
- Atmosphere

Eclipses Why?

When?

Total Eclipse of 29 Mar 2006

3 Vital Statistics

Total Eclipse of the Sun

- Size ~ 100 x Earth
- Mass ~ 1,000,000 x Earth
- Composition ~ 75% hydrogen
- 25% helium
- 0.1% other stuff
- Power ~ 400,000,000,000,000,000,000,000,000,000,000 watts

4 Power Source

Total Eclipse of the Sun

1871 Hermann von Helmholtz

Burning coal, one ton per hour per square foot of the Sun's surface, would exhaust the fuel in a few million years

1919 Sir Arthur Eddington

Conversion of hydrogen to helium could provide enough energy to power the Sun for billions of years

5 Fusion

Total Eclipse of the Sun

hydrogen → helium + energy

6 Fusion

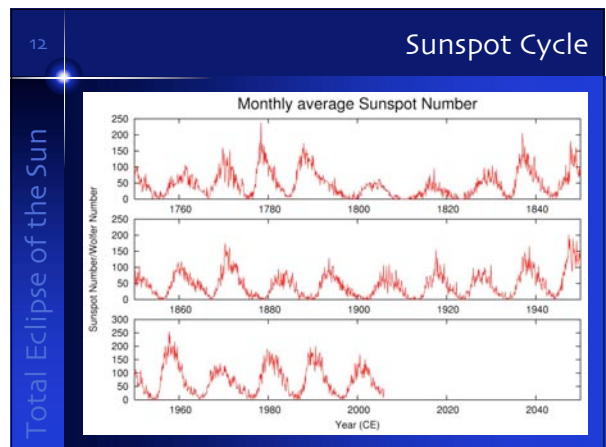
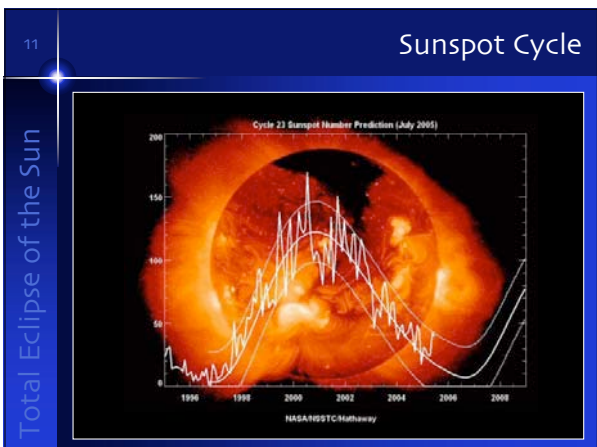
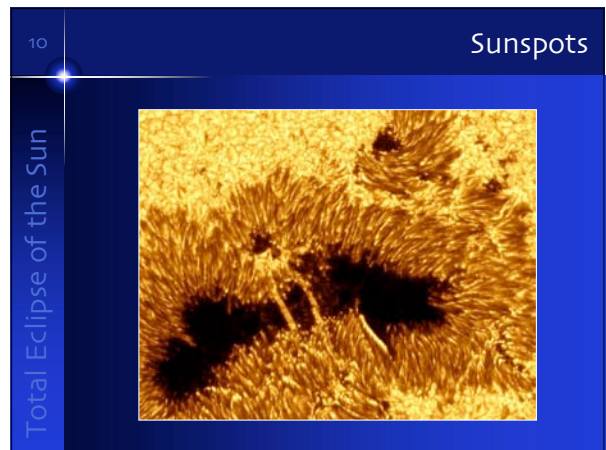
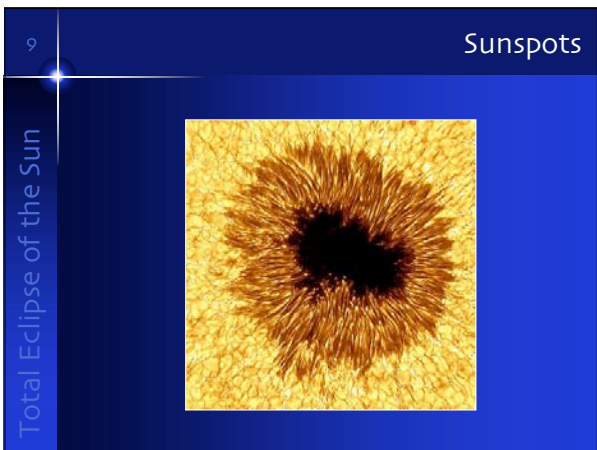
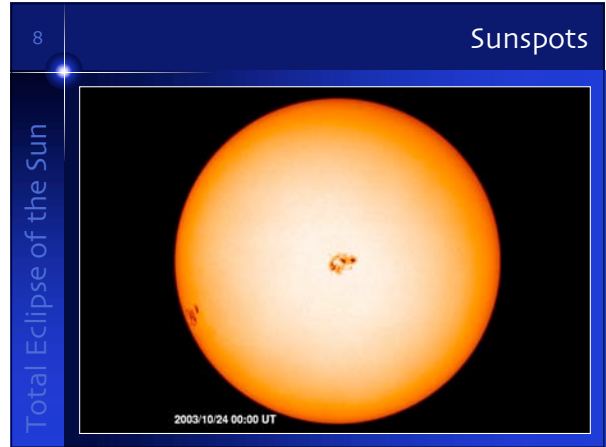
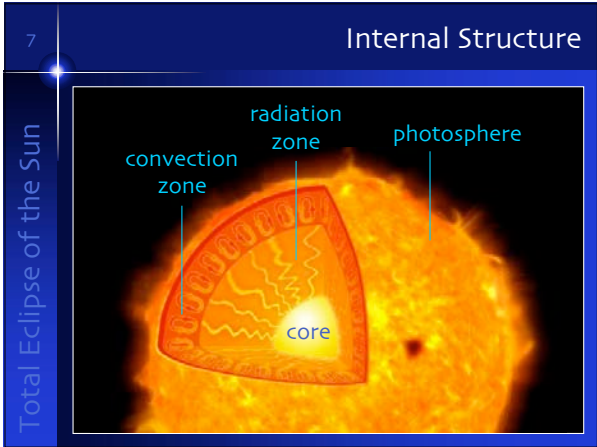
Total Eclipse of the Sun

600 Mt of H → 596 Mt of He

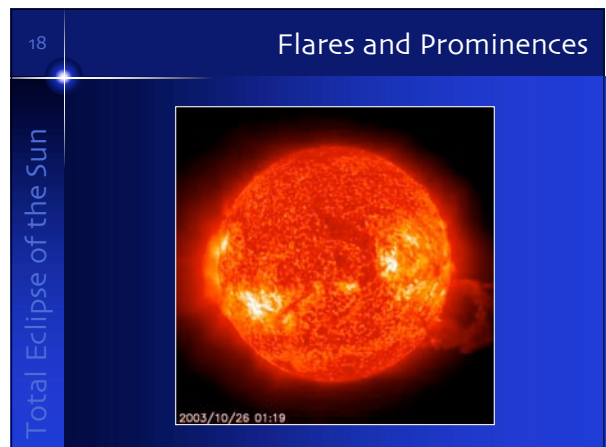
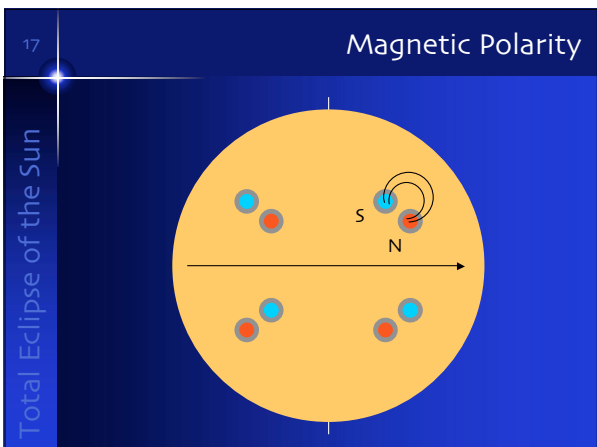
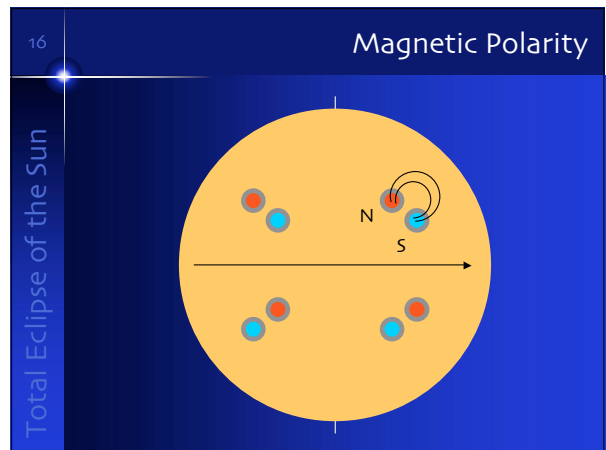
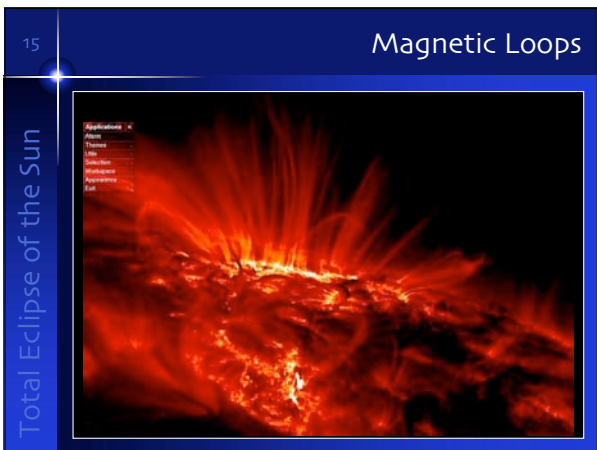
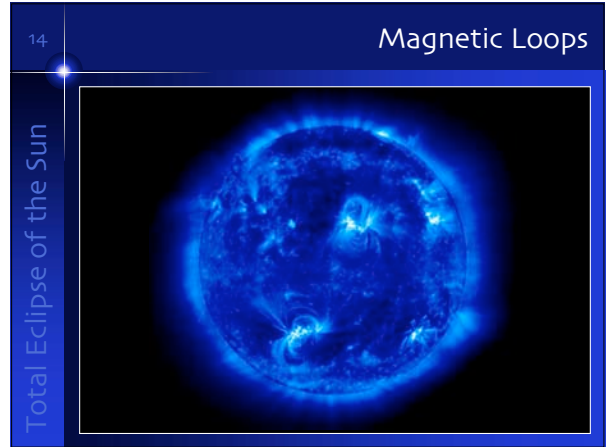
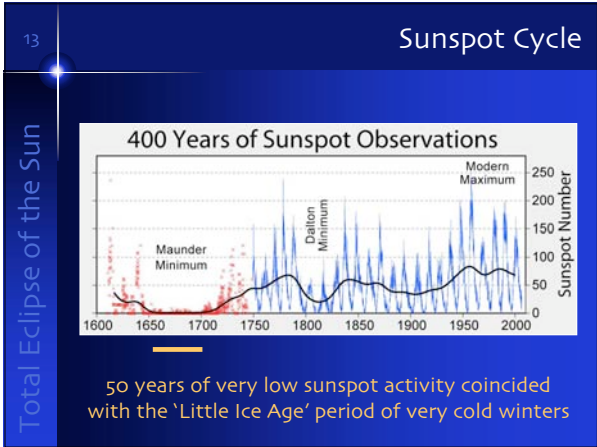
Sun loses 4 million tons every second

Mass loss → energy thanks to $E = mc^2$

Total Eclipse of the Sun



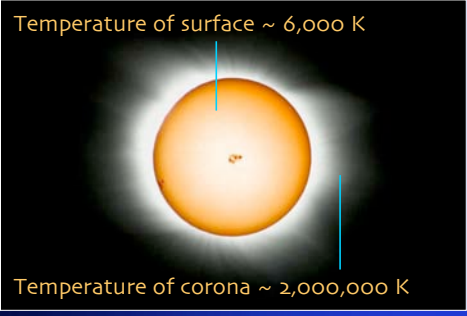
Total Eclipse of the Sun



Total Eclipse of the Sun

19 Corona

Total Eclipse of the Sun



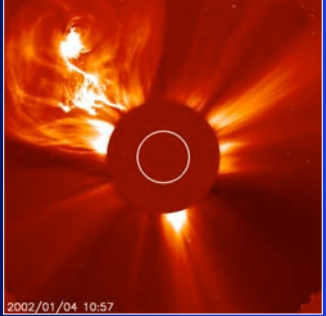
Temperature of surface ~ 6,000 K

Temperature of corona ~ 2,000,000 K

The diagram shows a bright orange-yellow sphere representing the Sun's surface, with a smaller, fainter white sphere representing the corona. Two blue lines point from the text labels to the respective parts of the Sun.

20 Corona

Total Eclipse of the Sun

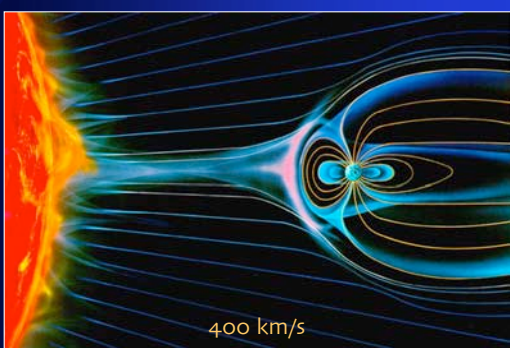


2002/01/04 10:57

The photograph shows the Sun's corona as a bright, white, fibrous structure surrounding the dark disk of the Moon. The corona is illuminated from the side, creating a dramatic, glowing effect.

21 Solar Wind

Total Eclipse of the Sun




400 km/s

The diagram illustrates the solar wind as a stream of particles flowing from the Sun's surface. The magnetic field lines are shown as curved lines that are compressed on the side facing the Sun and stretched out on the opposite side.

22 Aurora Borealis


Total Eclipse of the Sun



The left photograph shows a vibrant green and purple aurora borealis over a dark landscape. The right photograph shows a bright green aurora borealis over a dark landscape.

23 Aurora Borealis

Total Eclipse of the Sun



The photograph shows a bright green aurora borealis over a dark landscape. The aurora is a large, glowing green shape that fills much of the sky.

24 Eclipses

Total Eclipse of the Sun

Eclipse
The passage of one object into the shadow cast by another.
Thus an *Eclipse of the Sun* should be called an *Eclipse of the Earth*.

Occultation
The passage of one object in front of another, hiding the latter from view.

Total Eclipse of the Sun

25 Eclipses

Total Eclipse of the Sun

Total Eclipse (long)
 Total Eclipse (short)
 Annular Eclipse

26 Transit of Venus 2004

Total Eclipse of the Sun

27 Transit of Venus 2004

Total Eclipse of the Sun

28 Eclipse Geometry

Total Eclipse of the Sun

An eclipse cannot occur at every New Moon because the Moon's orbit is **tilted** by $\sim 5^\circ$.

29 Eclipse Geometry

Total Eclipse of the Sun

The Moon crosses the plane of the Earth's orbit (the Ecliptic) at a **node**.

30 Eclipse Timing

Total Eclipse of the Sun

Synodic Month	
New Moon to New Moon	29.53 days
Draconic Month	
Node to Node	27.21 days
Anomalistic Month	
Perigee to Perigee	27.55 days

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31 The Saros Cycle

Total Eclipse of the Sun

223 Synodic months = 6585.32 days
 242 Draconic months = 6585.36 days
 239 Anomalistic months = 6585.54 days

Over this time, the **saros** cycle, the Moon's orbital periods are back in 'synch'.

Two eclipses separated by one saros cycle have similar geometries.

32 Saros 139

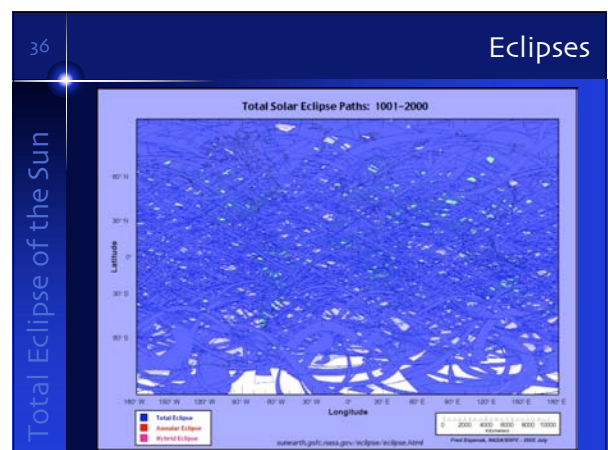
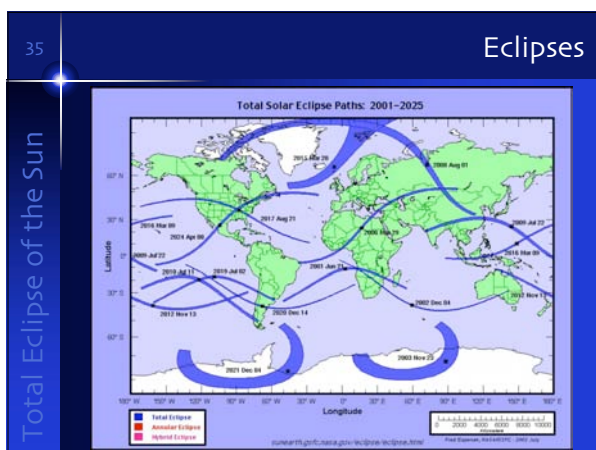
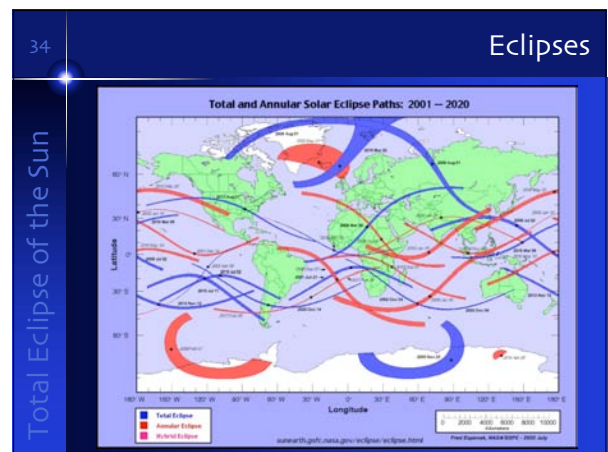
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Date	ØM/ØS	Length	Seen from
1988 Mar 18	1.046	3 ^m 46 ^s	Asia
2006 Mar 29	1.052	4 ^m 07 ^s	Africa
2024 Apr 08	1.057	4 ^m 28 ^s	Americas
2042 Apr 20	1.061	4 ^m 51 ^s	Asia
2060 Apr 30	1.066	5 ^m 15 ^s	Africa
2078 May 11	1.070	5 ^m 40 ^s	Americas
2096 May 22	1.074	6 ^m 06 ^s	Asia

33 Eclipses Coming Soon

Total Eclipse of the Sun

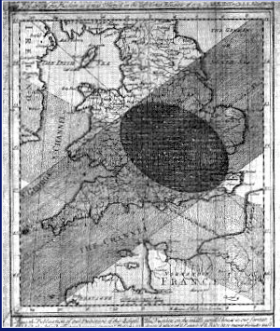
Date	Saros	Length	Seen from
2006 Mar 29	139	4 ^m 07 ^s	Africa, Turkey
2008 Aug 01	126	2 ^m 27 ^s	Greenland, Siberia
2009 Jul 22	136	6 ^m 39 ^s	India, China
2010 Jul 11	146	5 ^m 20 ^s	S Pacific, S America
2012 Nov 13	133	4 ^m 02 ^s	Australia, S Pacific
2013 Nov 03	143	1 ^m 40 ^s	Africa



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37 Eclipses

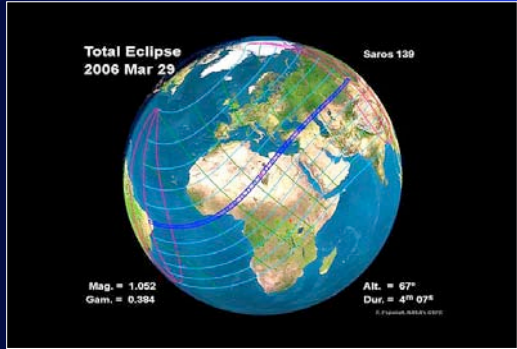
Total Eclipse of the Sun



A historical map showing the path of a total solar eclipse in 1859. The path is a dark, shaded area that starts in the Pacific Ocean, crosses North America, and ends in the Atlantic Ocean. The map is detailed with geographical features and text.

38 Total Eclipse of 29 Mar 2006

Total Eclipse of the Sun



Total Eclipse
2006 Mar 29

Saros 129

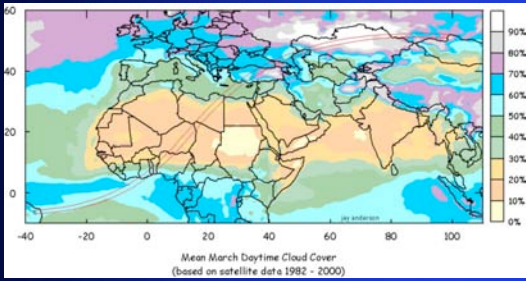
Mag. = 1.052
Gam. = 0.394

Alt. = 67°
Dur. = 4^m 07^s

A map of the Earth showing the path of the total solar eclipse on March 29, 2006. The path is a purple line that starts in the Pacific Ocean, crosses North America, and ends in the Atlantic Ocean. The map includes latitude and longitude lines.

39 Total Eclipse of 29 Mar 2006

Total Eclipse of the Sun

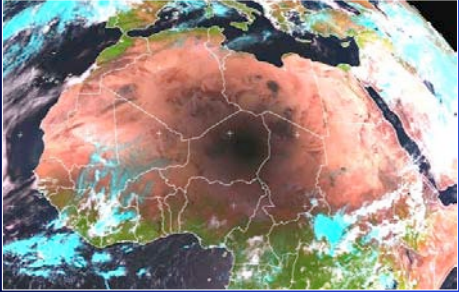


Mean March Daytime Cloud Cover
(based on satellite data 1982 - 2000)

A map of the Earth showing the mean March daytime cloud cover. The map is color-coded by cloud cover percentage, with a legend on the right ranging from 0% (dark blue) to 90% (dark red). The map includes latitude and longitude lines.

40 Total Eclipse of 29 Mar 2006

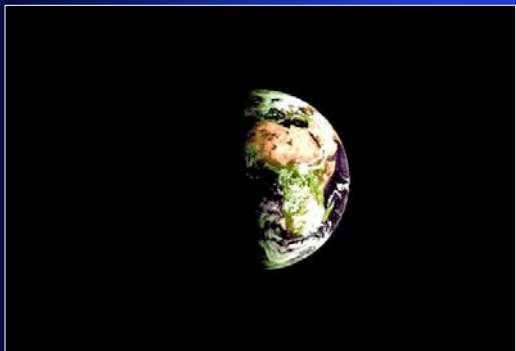
Total Eclipse of the Sun



A satellite image of the Earth during the total solar eclipse on March 29, 2006. The image shows the Earth's surface with a large, dark, reddish-brown area in the center, representing the eclipse path. The image includes latitude and longitude lines.

41 Total Eclipse of 29 Mar 2006


Total Eclipse of the Sun



A photograph of the Earth from space, showing the curvature of the planet and the atmosphere. The image is taken from a low angle, showing the horizon and the dark sky.

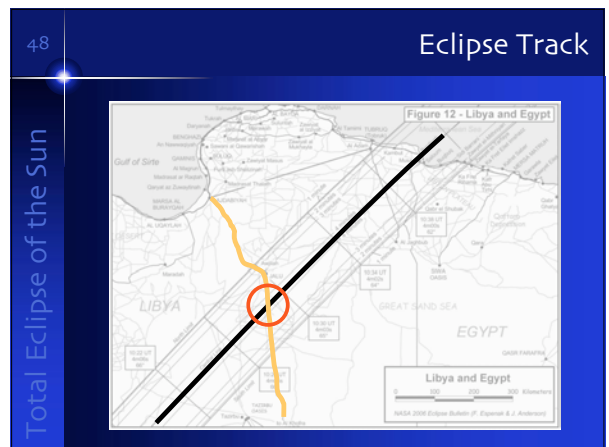
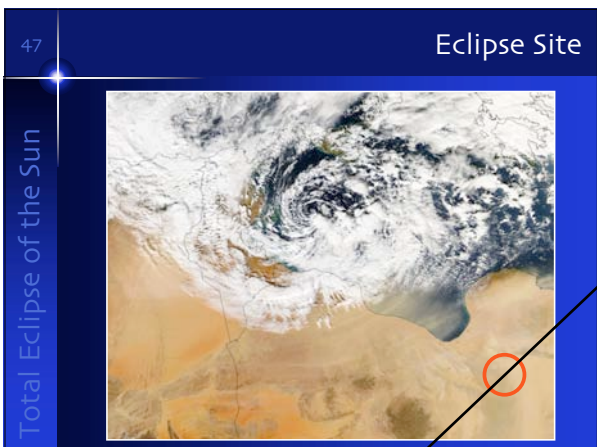
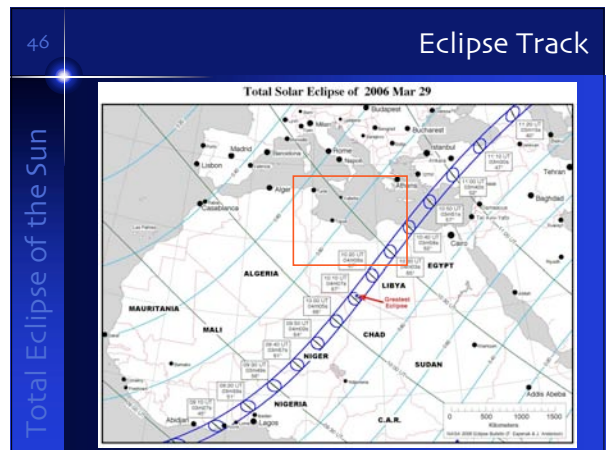
42 Eclipse Cruise

Total Eclipse of the Sun

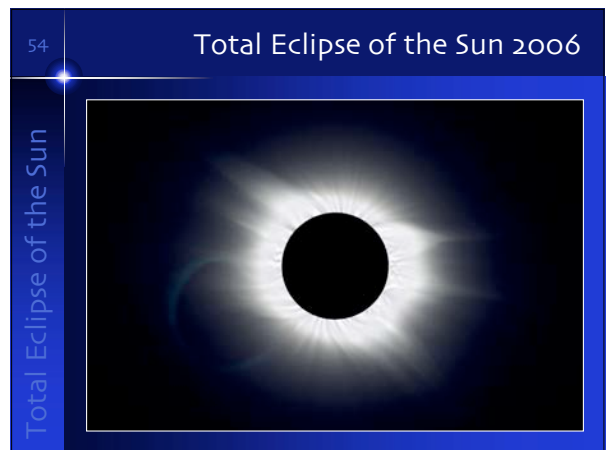
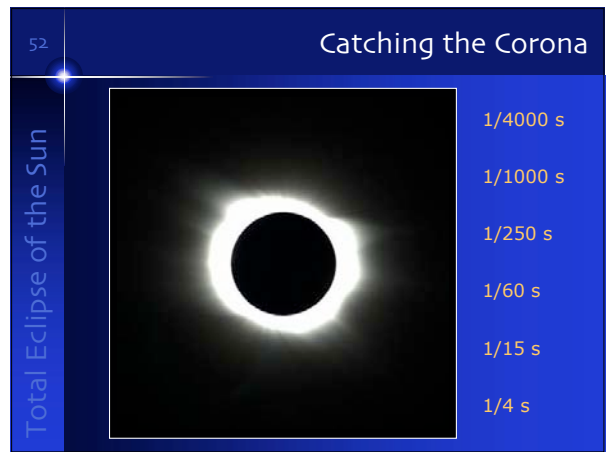
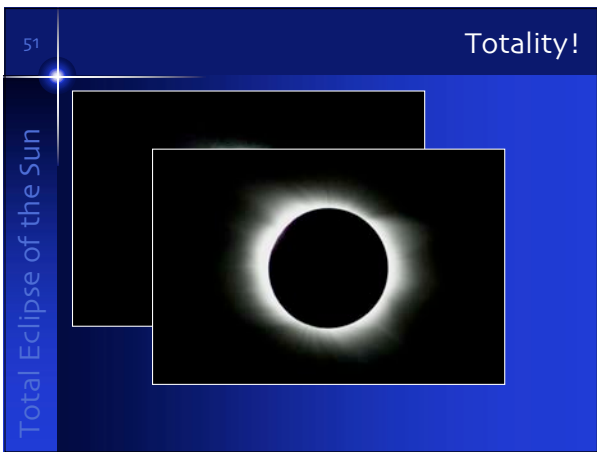


A photograph of a large white cruise ship sailing on the water. The ship is viewed from a distance, and the background shows a rocky coastline with mountains.

Total Eclipse of the Sun



Total Eclipse of the Sun



Total Eclipse of the Sun

55 Viewing Totality

Total Eclipse of the Sun




56 Viewing Totality

Total Eclipse of the Sun




57 Shadow Bands

Total Eclipse of the Sun



58 Green Flash

Total Eclipse of the Sun



59 An African Experience

Total Eclipse of the Sun



<http://www.liv.ac.uk/~sdb/Talks>



Dr Steve Barrett 8 Feb 2007